

GENERAL INFORMATION

Commonly Used Abbreviations

*** PLEASE READ THIS FIRST ***

NOTE: This article is intended for general information purposes only. This information may not apply to all makes and models. Not all abbreviations are covered as manufacturers add new ones every day.

"A"

A

Amperes

ABS

Anti-Lock Brakes

ABRS

Air Bag Restraint System

AC

Alternating Current

A/C

Air Conditioning

ACCS

A/C Cycling Switch

ACCUM

Accumulator

ACCY

Accessory

ACT

Air Charge Temperature Sensor

ADJ

Adjust or Adjustable

ADV

Advance

AFS

Airflow Sensor

AI

Air Injection

AIR or A.I.R.

Air Injection Reactor

AIS

Air Injection System

Alt.

Alternator or Altitude

Amp./amp/amps

Ampere

ASCS

Air Suction Control Solenoid

ASD

Auto Shutdown

ASDM

Air Bag System Diagnostic Module

ASV

Air Suction Valve

A/T

Automatic Transmission/Transaxle

ATC

Automatic Temperature Control

ATDC

After Top Dead Center

ATF

Automatic Transmission Fluid

ATS

Air Temperature Sensor

Aux.

Auxiliary

Avg.

Average

AXOD

Automatic Transaxle Overdrive (Ford Models Only)

"B"

BAC

By-Pass Air Control

BAP

Barometric Absolute Pressure Sensor

BARO

Barometric

Batt.

Battery

Bbl.

Barrel (Example: 4-Bbl.)

BCM

Body Control Module

BHP

Brake Horsepower

BMAP

Barometric and Manifold Absolute Pressure Sensor

BOO

Brake On-Off Switch

B/P

Backpressure

BPS

Barometric Pressure Sensor

BPT

Backpressure Transducer

BTDC

Before Top Dead Center

BTSI

Brake Transmission Shift Interlock

BTU

British Thermal Unit

BVSV

Bimetallic Vacuum Switching Valve

"C"**° C**

Celsius (Degrees)

Calif.

California

CANP

Canister Purge

CARB

California Air Resources Board

CAT

Catalytic Converter

CB

Circuit Breaker

CBD

Closed Bowl Distributor

cc

cubic centimeter

CCC

Close Coupled Catalyst

CCC

Computer Command Control

CCD

Computer Controlled Dwell

CCOT

Cycling Clutch Orifice Tube

CCW

Counterclockwise

CDI

Capacitor Discharge Ignition

CEC

Computerized Engine Control

CID

Cubic Inch Displacement

cm

Centimeter

CMP

Camshaft Position Sensor

CO

Carbon Monoxide

CO₂

Carbon Dioxide

Cont.

Continued

CONV

Convertible

CP

Canister Purge

CKP

Crankshaft Position Sensor

CTS

Coolant Temperature Sensor

Cu. In.

Cubic Inch

CVC

Constant Vacuum Control

CV

Check Valve or Constant Velocity

CW

Clockwise

CYL or Cyl.

Cylinder

C³ I

Computer Controlled Coil Ignition

C⁴

Computer Controlled Catalytic Converter

"D"

"D"

Drive

DC

Direct Current Or Discharge

DDD

Dual Diaphragm Distributor

Def.

Defrost

Defog.

Defogger

DERM

Diagnostic Energy Reserve Module

DFI

Digital Fuel Injection

Diag.

Diagnostic

DTC

Diagnostic Trouble Code

DIC

Driver Information Center

DIS

Distributorless Ignition System

DIST

Distribution

DLC

Data Link Connector

DOC

Diesel Oxidation Catalyst

DOHC

Double Overhead Cam

DOT

Department of Transportation

DPF

Diesel Particulate Filter

DRB-II

Diagnostic Readout Box

DVOM

Digital Volt-Ohmmeter

"E"

EACV

Electric Air Control Valve

EATX

Electronic Automatic Transaxle

EBCM

Electronic Brake Control Module

EBL

Electronic Back Light

ECM

Engine Control Module

ECT

Engine Coolant Temperature Sensor

EDIS

Electronic Distributorless Ignition System

EEC

Electronic Engine Control

EECS

Evaporative Emission Control System

EEPROM

Electronically Erasable PROM

EFE

Early Fuel Evaporation

EGO

Exhaust Gas Oxygen Sensor

EGR

Exhaust Gas Recirculation

EOT

Engine Oil Temperature

ESA

Electronic Spark Advance

ESC

Electronic Spark Control

EST

Electronic Spark Timing

EVAP

Fuel Evaporative System

EVIC

Electronic Vehicle Information Center

EVP

EGR Valve Position Sensor

EWMA

Exponentially Weighted Moving Average (MODE 6)

Exc.

Except

"F"**° F**

Fahrenheit (Degrees)

F/B

Fuse Block

Fed.

Federal

FI

Fuel Injection

FICU

Fuel Injection Control Unit

FIPL

Fuel Injector Pump Lever

FLI

Fuel Level Indicator

FPR-VSV

Fuel Pressure Regulator Vacuum Switching Valve

Ft. Lbs.

Foot Pounds

FWD

Front Wheel Drive

"G"

g

grams

Gals.

gallons

GND or GRND

Ground

"H"

HAC

High Altitude Compensation

HC

Hydrocarbons

H/D

Heavy Duty

HO2S

Heated Exhaust Gas Oxygen Sensor

Hg

Mercury

Hgt.

Height

HLDT

Headlight

HO

High Output

HO2S

Heated Oxygen Sensor

HP

High Performance

HSC

High Swirl Combustion

HSO

High Specific Output

HTR

Heater

Hz

Hertz (Cycles Per Second)

"I"

IAC

Idle Air Control

IACV

Idle Air Control Valve

IAT

Intake Air Temperature

IC

Integrated Circuit

ID

Identification

I.D.

Inside Diameter

IFS

Independant Front Suspension

IFS

Inertia Fuel Shutoff (Ford)

Ign.

Ignition

IMRC

Intake Manifold Runner Control

In.

Inches

INCH Lbs.

Inch Pounds

in. Hg

Inches of Mercury

Inj.

Injector

IP

Instrument Panel

IRS

Independant Rear Suspension

ISC

Idle Speed Control

IVD

Interactive Vehicle Dynamics (Ford)

IVSV

Idle Vacuum Switching Valve

"J"**J/B**

Junction Block

"K"**KAPWR**

Keep Alive Power

k/ohms

kilo-ohms (1000 ohms)

kg

Kilograms (weight)

kg/cm²

Kilograms Per Square Centimeter

KM/H

Kilometers Per Hour

KOEO

Key On, Engine Off

KOER

Key On, Engine Running

KS

Knock Sensor

kW

Kilowatt

kV

Kilovolt

"L"

L

Liter

lbs. (Lbs. when used in table)

Pounds

LCD

Liquid Crystal Display

L/D

Light Duty

LDP

Leak Detection Pump (Part of EVAP system.)

LED

Light Emitting Diode

LH

Left Hand

"M"

mA

Milliamps

MA or MAF

Mass Airflow

MAFS

Mass Airflow Sensor

MAP

Manifold Absolute Pressure

MAT

Manifold Air Temperature

Mem.

Memory

MEM-CAL

Memory Calibration Chip

mfd.

Microfarads

MFI

Multiport Fuel Injection

MICU

Multiplex Integrated Control Unit (Acura/Honda)

MIL

Malfunction Indicator Light

MPI

Multi-Point (Fuel) Injection

mm

Millimeters

MPH

Miles Per Hour

mV

Millivolts

"N"

NA

Not Available

NAC

NOx Adsorber Catalyst

NCA

No Color Available (Wiring Diagrams)

NGS

New Generation Star

N.m

Newton Meter

No.

Number

Nos.

Numbers

NOx

Oxides of Nitrogen

"O"

O₂

Oxygen

OBD

On-Board Diagnostics

OC

Oxidation Catalyst

OD

Overdrive

O.D.

Outside Diameter

OHC

Overhead Camshaft

OSS

Output Speed Sensor

O/S

Oversize

oz.

Ounce

ozs.

Ounces

"P"

"P"

Park

P/C

Printed Circuit

PCM

Powertrain Control Module

PCS

Purge Control Solenoid

PC-SOL

Purge Control Solenoid

PCV

Positive Crankcase Ventilation

PFI

Port Fuel Injection

PGM-FI

Programmed Fuel Injection

PID

Parameter Identification

PIP

Profile Ignition Pick-up

PNP

Park Neutral Position Switch

P/N

Park/Neutral

PRNDL

Park Reverse Neutral Drive Low

PROM

Programmable Read-Only Memory

psi

Pounds Per Square Inch

P/S

Power Steering

PSPS

Power Steering Pressure Switch

PTC

Positive Temperature Coefficient

PTO

Power Take-Off

Pts.

Pints

Pwr.

Power

"Q"

Qts.

Quarts

"R"

RABS

Rear Anti-Lock Brake System

RECIRC

Recirculation

RH

Right Hand

RPM

Revolutions Per Minute

RWAL

Rear Wheel Anti-Lock Brake

RWD

Rear Wheel Drive

"S"

SAS

Steering Angle Sensor

SBC

Single Bed Converter

SBEC

Single Board Engine Controller

SDARS

Satellite Digital Audio Radio Service

SES

Service Engine Soon

SFI

Sequential (Port) Fuel Injection

SIL

Shift Indicator Light

SIR

Supplemental Inflatable Restraint

SOHC

Single Overhead Cam

SOL or Sol.

Solenoid

SPFI

Sequential Port Fuel Injection

SPK

Spark Control

SPOUT

Spark Output

SRI

Service Reminder Indicator

SRS

Supplemental Restraint System (Air Bag)

STAR

Self-Test Automatic Readout

STO

Self-Test Output

SUB-O₂

Sub Oxygen Sensor

Sw.

Switch

Sys.

System

"T"

TAB

Thermactor Air By-Pass

TAC

Throttle Actuator Module

TAD

Thermactor Air Diverter

TBC

Body Control Module (General Motors)

TBI

Throttle Body Injection

TCC

Torque Converter Clutch

TDC

Top Dead Center

Temp.

Temperature

TFI

Thick Film Ignition

THERMAC

Thermostatic Air Cleaner

TPM

Tire Pressure Monitor

TPMS

Tire Pressure Monitor System

TPS

Throttle Position Sensor/Switch

TS

Temperature Sensor

TV

Therموالve

TWC

Three-Way Catalyst

"V"

V

Valve

Vac.

Vacuum

VAF

Vane Airflow

VAPS

Variable Assist Power Steering

VCC

Viscous Converter Clutch

VCRM

Variable Control Relay Module

VIN

Vehicle Identification Number

VM

Vacuum Modulator

Volt.

Voltage

VOM

Volt-Ohmmeter (Analog)

VRV

Vacuum Regulator Valve

VSS

Vehicle Speed Sensor

VSV

Vacuum Switching Valve

"W"**W/**

With

W/O

Without

WAC

Wide Open Throttle A/C Switch

WOT

Wide Open Throttle

EMISSION CONTROL ABBREVIATIONS

Gasoline & Diesel

"A"

A/C

Air Conditioning

A/C-ISUS

A/C Idle Speed-Up Solenoid

A/F

Air/Fuel

AAI

Air Assist Injector

ACL

Air Cleaner (Thermostatic Air Cleaner)

ACL-BMS

ACL Bimetallic Sensor

ACL-CKV

ACL Check Valve

ACL-DV

ACL Delay Valve

ACL-PVS

ACL Ported Vacuum Switch

ACL-RDV

ACL Reverse Delay Valve

ACL-RDVS

ACL Reverse Delay Valve (Single)

ACL-TCV

ACL Thermal Control Valve

ACL-TS

ACL Temperature Sensor

ACL-TSOV

ACL Temperature Sensor Override Valve

ACL-TVS

ACL Thermal Vacuum Switch

ACL-TVV

ACL Thermal Vacuum Valve

ACL-VCDV

ACL Vacuum Control Delay Valve

ACL-VCV

ACL Vacuum Control Valve

ACL-VM

ACL Vacuum Motor

ACL-WP

ACL Wax Pellet Type Motor

ADS

Anti-Dieseling Solenoid

AFR

Air/Fuel Ratio Sensor

AFS

Air/Fuel Ratio Sensor

AIH

Air Intake Heaters

AIH-TS

AIH Temperature Sensor

AIR

Air Injection System

AIS

Air Injection System

AIS-ACV

AIS Air Control Valve

AIS-AMV

AIS Air Management Valve

AIS-ASV

AIS Air Switching Valve

AIS-BPV

AIS By-Pass Valve

AIS-CC

AIS Computer Controlled

AIS-CKV

AIS Check Valve

AIS-CSV

AIS Control Solenoid Valve

AIS-CV

AIS Combination Valve

AIS-DV

AIS Diverter Valve

AIS-IMCV

AIS Intake Manifold Change-Over Valve

AIS-MCV

AIS Manifold Change-Over Valve

AIS-PAF

AIS Pulse Air Feeder

AIS-PM

AIS Pump Motor

AIS-PV

AIS Pneumatic Valve

AIS-RV

AIS Relief Valve

AIS-SAV

AIS Secondary Air Valve

AIS-SOL

AIS Solenoid

AIS-SV

AIS Solenoid Valve

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIS-VT

AIS Vacuum Tank

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIV

Air Injection Valve

AIV-SOL

Air Injection Valve Solenoid

ALVW

Adjusted Loaded Vehicle Weight

AMV

Air Management Valve

AP

Air Pump Injection System

AP-ACV

AP Air Control Valve

AP-AMV

AP Air Management Valve

AP-ASRV

AP Air Switching Relief Valve

AP-ASS

AP Air Switching Solenoid

AP-ASV

AP Air Switching Valve

AP-BPV

AP By-Pass Valve

AP-CKV

AP Check Valve

AP-CS

AP Control Solenoid

AP-DCTO

AP Dual Coolant Temperature Override

AP-DLY

AP Delay Valve

AP-DV

AP Diverter Valve

AP-EADV

AP Electric Air Control Diverter Valve

AP-EAMR

AP Electric Air Management Relay

AP-EAMS

AP Electric Air Management Solenoid

AP-EAP

AP Electric Air Pump

AP-EC

AP Electromagnetic Clutch

AP-ERLY

AP Electric Air Pump Relay

AP-RDV

AP Reed Valve

AP-RV

AP Relief Valve

AP-SOL

AP Solenoid

AP-SOV

AP Shut-Off Valve

AP-SV

AP Solenoid Valve

AP-SWV

AP Switchover Valve

AP-TV

AP Transmitting Valve

AP-VCS

AP Vacuum Control Solenoid

AP-VCSV

AP Vacuum Controlled Air Shut-Off Valve

AP-VCV

AP Vacuum Control Valve

AP-VSV

AP Vacuum Switching Valve

A/T

Automatic Transmission

ATCV

Air Temperature Control Valve

"B"**BP/EGR**

Backpressure EGR System

BP/EGR-BPS

BP/EGR Backpressure Sensor

BP/EGR-BPT

BP/EGR Backpressure Transducer

BP/EGR-BPV

BP/EGR Backpressure Valve

BP/EGR-BS

BP/EGR Bleed Solenoid

BP/EGR-BVSV

BP/EGR Bimetallic Vacuum Switching Valve

BP/EGR-C

BP/EGR Controller

BP/EGR-CLR

BP/EGR Cooler

BP/EGR-CS

BP/EGR Control Solenoid

BP/EGR-CTO

BP/EGR Coolant Temperature Override

BP/EGR-CV

BP/EGR Control Valve

BP/EGR-DCTO

BP/EGR Dual Coolant Temperature Override

BP/EGR-DS

BP/EGR Diagnostic Solenoid

BP/EGR-DSOL

BP/EGR Duty Solenoid

BP/EGR-DTVSW

BP/EGR Distributor Thermal Vacuum Switch

BP/EGR-DV

BP/EGR Delay Valve

BP/EGR-EET

BP/EGR Electric Transducer

BP/EGR-EPV

BP/EGR External Pressure Valve

BP/EGR-FDV

BP/EGR Forward Delay Valve

BP/EGR-LC

BP/EGR Load Control Valve

BP/EGR-PS

BP/EGR Position Sensor

BP/EGR-PT

BP/EGR Pressure Transducer

BP/EGR-PVS

BP/EGR Ported Vacuum Switch

BP/EGR-RES

BP/EGR Reservoir

BP/EGR-RST

BP/EGR Restrictor

BP/EGR-SOL

BP/EGR Solenoid

BP/EGR-TCTVS

BP/EGR Torque Converter Thermal Vacuum Switch

BP/EGR-TCV

BP/EGR Thermal Control Valve

BP/EGR-TCVLV

BP/EGR Temperature Control Valve

BP/EGR-TS

BP/EGR Temperature Sensor

BP/EGR-TVS

BP/EGR Thermal Vacuum Switch

BP/EGR-TVV

BP/EGR Thermal Vacuum Valve

BP/EGR-VCV

BP/EGR Vacuum Control Valve

BP/EGR-VM

BP/EGR Vacuum Modulator

BP/EGR-VRV

BP/EGR Vacuum Regulator Valve

BP/EGR-VS

BP/EGR Vacuum Switch

BP/EGR-VSOL

BP/EGR Vent Solenoid

BP/EGR-VSV

BP/EGR Vacuum Switching Valve

"C"

C-4

Computer Controlled Catalytic Converter

CAC

Charge Air Cooler

CAS

Clean Air System

CB

Crankcase Breather

CB-VC

Crankcase Breather-Vapor Canister

CBPS

Coasting By-Pass System

CBVC

Crankcase Breather Vapor Canister

CCIEV

Coolant Controlled Idle Enrichment Valve

CCS

Controlled Combustion System

CCV

Closed Crankcase Ventilation

CD-REGVLV

Crankcase Depression Regulator Valve

CDRV

Crankcase Depression Relief Valve

CEAB

Cold Engine Air Bleed

CEAB-TVS

CEAB Thermal Vacuum Switch

CEAB-TVV

CEAB Thermal Vacuum Valve

CEC

Computerized Engine Controls

CESS

Cold Engine Sensor Switch

CETS

Cold Engine Temperature Switch

CFI

Continuous Fuel Injection

CMH

Cold Mixture Heater

CNG

Compressed Natural Gas

CO

Carbon Monoxide

CO₂

Carbon Dioxide

CPI

Central Port Injection

CRV

Coasting Richer Valve

CSI

Central Sequential Injection

CTAVS

Cold Temperature Activated Vacuum System

CTOX

Continuous Trap Oxidizer

"D"**DCLV**

Deceleration Valve

DCS

Deceleration Control System

DDI

Direct Diesel Injection

DFI

Direct Diesel Injection

DI

Direct Injection

DKV

Deceleration Kick Valve

DMCV

Deceleration Mixture Control Valve

DMS

Dual Manifold System

DOC

Diesel Oxidation Catalyst

DOHC

Dual Overhead Cam

DPF

Diesel Particulate Filter

DPFE

Differential Pressure Feedback EGR Valve

DPFEGR

Differential Pressure Feedback EGR Valve

DTM

Deceleration Throttle Modulator

"E"

EAIR

Electric Air Injection System

EAIR-DV

EAIR Diverter Valve

ECM

Electronic Control Module

ECU

Electronic Control Unit

EDC

Electronic Diesel Control

EDS

Electronic Diesel System

EEC

Electronic Engine Control

EFE

Early Fuel Evaporation

EFE-CKV

EFE Check Valve

EFE-CV

EFE Control Valve

EFE-DTVS

EFE Delay Thermal Vacuum Switch

EFE-HTR

EFE Heater

EFE-HCV

EFE Heat Control Valve

EFE-OTS

EFE Oil Temperature Switch

EFE-PTC

EFE Positive Temperature Coefficient (Intake Heater Grid)

EFE-PVS

EFE Ported Vacuum Switch

EFE-SOL

EFE Solenoid

EFE-TVS

EFE Thermal Vacuum Switch

EFE-TVV

EFE Thermal Vacuum Valve

EFE-VSV

EFE Vacuum Switching Valve

EFI

Electronic Fuel Injection

EFI-MA

EFI Mass Airflow Sensor

EFI-MAF

EFI Mass Airflow Sensor

EGR

Exhaust Gas Recirculation System

EGR-BCS

EGR Boost Check Solenoid

EGR-BPBV

EGR By-Pass Backpressure Valve

EGR-BPT

EGR Backpressure Transducer

EGR-BPV

EGR By-Pass Valve

EGR-BS

EGR Bleed Solenoid

EGR-BSSV

EGR Boost Sensor Solenoid Valve

EGR-BVSV

EGR Bimetallic Vacuum Switching Valve

EGR-C

EGR Controller

EGR-CC

EGR Coolant Controlled

EGR-CLR

EGR Cooler

EGR-VSOL

EGR Vacuum Solenoid

EGR-CKV

EGR Check Valve

EGR-CS

EGR Control Solenoid

EGR-CSOL

EGR Cut-Off Solenoid

EGR-CSV

EGR Control Solenoid

EGR-CTO

EGR Coolant Temperature Override

EGR-CTS

EGR Charge Temperature Sensor

EGR-CTSW

EGR Charge Temperature Switch

EGR-CTTS

EGR Coolant Temperature Thermostwitch

EGR-CV

EGR Control Valve

EGR-CVCV

EGR Constant Vacuum Control Valve

EGR-CVS

EGR Control Vent Solenoid

EGR-DC

EGR Digital Control

EGR-DCTO

EGR Dual Coolant Temperature Override

EGR-DPFE

Differential Pressure Feedback EGR Sensor

EGR-DPFS

EGR Differential Pressure Feedback Sensor

EGR-DS

EGR Diagnostic Solenoid

EGR-DSOL

EGR Duty Solenoid

EGR-DTVS

EGR Delay Thermal Vacuum Switch

EGR-DTVSW

EGR Distributor Thermal Vacuum Switch

EGR-DV

EGR Delay Valve

EGR-EPRS

EGR Exhaust Pressure Regulator Solenoid

EGR-EPRV

EGR Exhaust Pressure Regulator Valve

EGR-EPV

EGR External Pressure Valve

EGR/EVAP-CSV

EGR/EVAP Control Solenoid Valve

EGR-EVR

EGR Vacuum Regulator

EGR-EVRV

EGR Electronic Vacuum Regulator Valve

EGR-FDV

EGR Forward Delay Valve

EGR-FJS

EGR Floor Jet System

EGR-FPS

EGR Feedback Pressure Sensor

EGR-LCV

EGR Load Control Valve

EGR-MAP

EGR Manifold Absolute Pressure Sensor

EGR-PFE

EGR-PFE Sensor

EGR-PS

EGR Position Sensor

EGR-PSW

EGR Pulse Switch

EGR-PVS

EGR Ported Vacuum Switch

EGR-REG

EGR Regulator

EGR-RES

EGR Reservoir

EGR-RST

EGR Restrictor

EGR-SC

EGR Signal Converter

EGR-SEC

EGR, Secondary

EGR-SEN

EGR Sensor

EGR-SOL

EGR Solenoid

EGR-SU

EGR Switchover Valve

EGR-SUB

Sub-EGR Valve

EGR-SVV

EGR Solenoid Vacuum Valve

EGR-T

EGR Temperature Sensor

EGR-TC

EGR Transmission Controlled

EGR-TCTVS

EGR Torque Converter Thermal Vacuum Switch

EGR-TCV

EGR Thermal Control Valve

EGR-TCVLV

EGR Temperature Control Valve

EGR-TRANS

EGR Transducer

EGR-TS

EGR Temperature Sensor

EGR-TSW

EGR Temperature Switch

EGR-TVD

EGR Throttle Valve Diaphragm

EGR-TVS

EGR Thermal Vacuum Switch

EGR-TVSOL

EGR Throttle Valve Solenoid

EGR-TVV

EGR Thermal Vacuum Valve

EGR-VA

EGR Vacuum Amplifier

EGR-VCV

EGR Vacuum Control Valve

EGR-VM

EGR Vacuum Modulator

EGR-VR

EGR Vacuum Regulator

EGR-VRS

EGR Vacuum Regulator Solenoid

EGR-VRSV

EGR Vacuum Regulator Solenoid Valve

EGR-VRV

EGR Vacuum Regulator Valve

EGR-VS

EGR Vacuum Switch

EGR-VSDV

EGR Vacuum Switch Dump Valve

EGR-VSEN

EGR Vacuum Sensor

EGR-VSOL

EGR Vent Solenoid

EGR-VSS

EGR Vacuum Switching Solenoid

EGR-VST

EGR Vacuum Surge Tank

EGR-VSV

EGR Vacuum Switching Valve

EGR-VVCS

EGR Venturi Vacuum Control System

EGRB

EGR Boost Sensor

EGRC

EGR Control Solenoid

EGRC-BPT

EGR Control Backpressure Transducer

EGRC-SV

EGR Control Solenoid Valve

EHOC

Electronically Heated Oxidation Catalyst

EHTWC

Electronically Heated Three-Way Catalyst

EI

Electronic Ignition System

EIS

Electronic Ignition System

ELB

Electronic Lean Burn

EPR

Exhaust Pressure Regulator

EPR-SOL

EPR Solenoid

ESA

Electronic Spark Advance

EVAP

Fuel Evaporative System

EVAP-AAC

EVAP Auxiliary Air Control

EVAP-BPSV

EVAP By-Pass Solenoid Valve

EVAP-BVSV

EVAP Bimetallic Vacuum Switching Valve

EVAP-CAV

EVAP Canister Air Valve

EVAP-CCV

EVAP Control Canister Close Valve

EVAP-CCVSV

EVAP Control Canister Vent Shut Valve

EVAP-CCVVS

EVAP Closed Canister Valve Vacuum Switching Valve

EVAP-CDCV

EVAP Canister Drain Cut Valve

EVAP-CKV

EVAP Check Valve

EVAP-CPCS

EVAP Canister Purge Control Solenoid

EVAP-CPCSV

EVAP Canister Purge Control Solenoid Valve

EVAP-CPCV

EVAP Canister Purge Control Valve

EVAP-CPRV

EVAP Canister Purge Regulator Valve

EVAP-CPSV

EVAP Canister Vent Shut Valve

EVAP-CPT

EVAP Canister Purge Timer

EVAP-CPTVS

EVAP Canister Purge Thermal Vacuum Switch

EVAP-CPV

EVAP Canister Vent Valve

EVAP-CPVCSV

EVAP Canister Purge Volume Control

EVAP-CPVCV

EVAP Canister Purge Volume Control Valve

EVAP-CPVDV

EVAP Canister Purge Vacuum Delay Valve

EVAP-CPVR

EVAP Canister Purge Valve Resonator

EVAP-CS

EVAP Control Solenoid

EVAP-CSPS

EVAP Control System Pressure Sensor

EVAP-CST

EVAP Canister Surge Tank

EVAP-CT

EVAP Catch Tank

EVAP-CVCS

EVAP Canister Vent Control Solenoid

EVAP-CVCV

EVAP Canister Vent Control Valve

EVAP-CVS

EVAP Canister Vent Solenoid

EVAP-CVSV

EVAP Carburetor Vent Switching Valve

EVAP-CVV

EVAP Canister Vent Valve

EVAP-DCTO

EVAP Dual Coolant Temperature Override

EVAP-DF

EVAP Drain Filter

EVAP-DPS

EVAP Differential Pressure Sensor

EVAP-DV

EVAP-Drain Valve

EVAP-EV

EVAP Emission Valve

EVAP-FBVV

EVAP Fuel Bowl Vent Valve

EVAP-FBVS

EVAP Fuel Bowl Vent Solenoid

EVAP-FCV

EVAP Fuel Cut Valve

EVAP-FLS

EVAP Fuel Level Sensor

EVAP-FOLV

EVAP Fuel Overflow Limiter Valve

EVAP-FS

EVAP Flow Switch

EVAP-FSV

EVAP Flow Switchover Valve<

EVAP-FTEV

EVAP Fuel Tank EVAP Valve

EVAP-FTPCSV

EVAP Fuel Tank Pressure Control Solenoid Valve

EVAP-FTPS

EVAP Fuel Tank Pressure Sensor

EVAP-FTS

EVAP Fuel Temperature Sensor

EVAP-FVCV

EVAP Fuel Vapor Control Valve

EVAP-FVS

EVAP Fuel Vapor Separator

EVAP-FVTS

EVAP Fuel Vapor Temperature Sensor

EVAP-FVV

EVAP Fuel Vent Valve

EVAP-FVVV

EVAP Fuel Vapor Vent Valve

EVAP-IVS

EVAP Inner Vent Solenoid

EVAP-LDP

EVAP Leak Detection Pump

EVAP-LDPAF

EVAP Leak Detection Pump Air Filter

EVAP-LDPF

EVAP Leak Detection Pump Filter

EVAP-LDPVV

EVAP Leak Detection Pump Vent Valve

EVAP-LSEP

EVAP Liquid Separator

EVAP-NVLD

EVAP Natural Vacuum Leak Detection

EVAP-ORVR

Evaporative On-Board Refueling Vapor Recovery System

EVAP-ORVRCV

Evaporative On-Board Refueling Vapor Recovery Check Valve

EVAP-ORVRFTVRV

EVAP-ORVR Fuel Tank Vapor Recirculation

EVAP-OVCV

EVAP Outer Vent Control Valve

EVAP-OWV

EVAP One-Way Valve

EVAP-PCDV

EVAP Purge Control Diaphragm Valve

EVAP-PCSV

EVAP Purge Cut-Off Solenoid Valve

EVAP-PFS

EVAP Purge Flow Sensor

EVAP-PFSVVS

EVAP Purge Flow Switching Valve Vacuum Switching Valve

EVAP-PRRV

EVAP Pressure Relief Rollover Valve

EVAP-PSVVS

EVAP Pressure Switching Valve Vacuum Switching Valve

EVAP-PSOL

EVAP Purge Solenoid

EVAP-PSSV

EVAP Pressure Switching Solenoid

EVAP-PSVVSV

EVAP Pressure Switching Valve Vacuum Switching Valve

EVAP-PV

EVAP Purge (Frequency) Valve

EVAP-PVS

EVAP Ported Vacuum Switch

EVAP-RV

EVAP Rollover Valve

EVAP-RV/FTPS

EVAP Rollover Valve/Fuel Tank

EVAP-RVSV

EVAP Rollover Vapor Separator Valve

EVAP-SNR

EVAP Canister Sensor

EVAP-SOL

EVAP Solenoid

EVAP-SOV

EVAP Shutoff Valve

EVAP-SSV

EVAP Shut-Off Solenoid Valve

EVAP-SV

EVAP Solenoid Valve

EVAP-TC

EVAP Trap Canister

EVAP-TS

EVAP Temperature Switch

EVAP-TPBPV

EVAP Tank Pressure By-Pass Valve

EVAP-TPCS

EVAP Tank Pressure Control Solenoid

EVAP-TPCV

EVAP Tank Pressure Control Valve

EVAP-TRWV

EVAP Tree-Way Valve

EVAP-TV

EVAP Thermal Valve

EVAP-TVS

EVAP Thermal Vacuum Switch

EVAP-TVV

EVAP Thermal Vacuum Valve

EVAP-TWV

EVAP Two-Way Valve

EVAP-VC

EVAP Vapor Canister

EVAP-VCAT

EVAP Vapor Canister Air Tank

EVAP-VCF

EVAP Vapor Canister Filter

EVAP-VCSV

EVAP Vapor Canister Shut-off Valve

EVAP-VCTV

EVAP Vacuum Control Valve

EVAP-VCV

EVAP Vacuum Canister Valve

EVAP-VCVS

EVAP Vapor Canister Vent Solenoid

EVAP-VM

EVAP Vacuum Motor

EVAP-VPS

EVAP Vapor Pressure Sensor

EVAP-VPSVSV

EVAP Vapor Pressure Sensor Vacuum Switching Valve

EVAP-VS

EVAP Vacuum Sensor

EVAP-VSOL

EVAP Ventilation Solenoid

EVAP-VSOL/LDP

EVAP Ventilation Solenoid/Leak Detection Pump

EVAP-VST

EVAP Vacuum Surge Tank

EVAP-VSV

EVAP Vacuum Switching Valve

EVAP-VV

EVAP Ventilation Valve

EVRS

EGR Vacuum Regulator Solenoid

"F"

FBC

Feedback Carburetor

FCOV

Fuel Change Over Valve

FF

Flex Fuel

FF-CKV

Fuel Fill Check Valve

FF-FCV

Fuel Tank Fuel Cut-Off Valve

FF-FLVV

Fuel Tank Fill Limit Vent Valve

FGOV

Fuel Gravity/Overflow Valve

FGVV

Fuel Gravity Vent Valve

FI

Fuel Injected

FICD

Fast Idle Control Device

FISR

Fast Idle Solenoid Relay

FLV

Fill Limit Valve

FLVV

Fill Limiting Vent Valve

FP-CKV

Fill Pipe Check Valve

FP-RV

Fill Pipe Rollover Valve

FR

Fill Pipe Restrictor

FT-FLVV

Fuel Tank Fill Limit Vent Valve

FT-GVV

Fuel Tank Grade Vent Valve

FT-OPRV

Fuel Tank Over Pressure Vent Valve

FT-PCV

Fuel Tank Pressure Control Valve

FT-VCV

Fuel Tank Vapor Control Valve

FT-VRV

Fuel Tank Vapor Recirculation Valve

FTCV

Fuel Tank Check Valve

FTDPS

Fuel Tank Differential Pressure Sensor

FTEV

Fuel Tank EVAP Valve

FTPS

Fuel Tank Pressure Sensor

FTT

Fuel Tank Temperature Sensor

FTTS

Fuel Tank Temperature Sensor

FTV/LSV

Fuel Tank Vapor/Liquid Separation Valve

FTVCV

Fuel Tank Vapor Control Valve

FTVPRV

Fuel Tank Ventilation Pressure Retention Valve

FVPS

Fuel Vapor Pressure Sensor

FTVV

Fuel Tank Vent Valve

FVV

Fuel Vapor Valve

"G"

GVWR

Gross Vehicle Weight Rating

"H"

HAC

High Altitude Compensator

HAFS

Heated Air Fuel Ratio Sensor

HAI

Hot Air Intake

HAS

High Altitude System

HC

Hydrocarbons

HCAC-VSV

Hydrocarbon Absorber Catalyst Vacuum Switching Valve

HDC

Heavy Duty Cooling

HDC-CTO

HDC Coolant Temperature Override

HFM-SFI

Hot Film Engine Management SFI

HIC

Hot Idle Compensator

HIM

Heated Intake Manifold

HO

High Output

HO2S

Heated Oxygen Sensor

HP

High Performance

HP

Horsepower

HPCA

Housing Pressure Cold Advance

HSC

High Swirl Combustion

"I"

IAC

Idle Air Control Valve

IACV-SW

IACV Switch

ICOM

Idle Compensator

IDI

Indirect Diesel Injection

IES

Idle Enrichment System

IMCO

Improved Combustion System

"K"**KS**

Knock Sensor

"L"**LH-SFI**

Hot Wire Sequential Multiport Fuel Injection

LVFD

Liquid/Vapor Fuel Discriminator

LVW

Loaded Vehicle Weight

"M"**MD-TICS**

Timing & Injection rate Control System

MDP

Manifold Differential Pressure sensor

ME-SFI

Motor Electronics Sequential Fuel Injection

MFI

Multiport Fuel Injection

MFI-MAF

MFI Mass Airflow Sensor

MFLS

Main Fuel Level Sensor

MI

Mechanical Fuel Injection

MIL

Malfunction Indicator Light

M/T

Manual Transmission

"N"

NAC

Nitrogen Oxides (NO_x) Adsorbing Catalyst

NLV

Non-Linear Valve

NOS

NO_x Sensor

NO_x

NO_x Emission Control

NO_xC

Nitrogen Oxide Catalyst

NO_xS

Nitrogen Oxide Sensor

NO_xTWC

NOx adsorptive TWC

NSC

Nitrogen Oxides (NOx) Storage Catalyst

"O"

OBD

On-Board Diagnostic System

PBD (F)/(P)

Full/Partial On-Board Diagnostic

OC

Oxidation Catalytic Converter

OHC

Overhead Cam

ORVR

On-Board Refueling Vapor Recovery

ORVR-COV

ORVR Cut-Off Valve

ORVR-CV

ORVR Control Valve

ORVR-FMV

ORVR Flow Management Valve

ORVR-FTVCV

ORVR Fuel Tank Vapor Control Valve

ORVR-FTVRV

ORVR Fuel Tank Vapor Recirculation Valve

ORVR-LV

ORVR Leveling Valve

ORVR-OCKV

ORVR Overfill Check Valve

ORVR-RCV

ORVR Refueling Control Valve

ORVR-VCV

ORVR Vapor Cut Valve

ORVR-VRV

ORVR Vapor Recirculating Valve

ORVR-VSV

ORVR Vent Shut Valve

ORVR-VV

ORVR Vent Valve

OVCV

Outer Vent Control Valve

O2S

Oxygen Sensor

"P"

PAIR

Pulsed Secondary Air Injection

PAIR-ABV

PAIR Anti-Backfire Valve

PAIR-ACOV

PAIR Air Cut-Off Valve

PAIR-ACS

PAIR Air Control Solenoid

PAIR-ACV

PAIR Air Control Valve

PAIR-AIV

PAIR Air Injection Valve

PAIR-ASCS

PAIR Air Suction Control Solenoid

PAIR-ASOV

PAIR Air Shutoff Valve

PAIR-ASS

PAIR Air Switching Solenoid

PAIR-ASV

PAIR Air Switching Valve

PAIR-ASVL

PAIR Air Suction Valve

PAIR-AVCS

PAIR Air Valve Control Solenoid

PAIR-CSV

PAIR Control Solenoid Valve

PAIR-CKV

PAIR Check Valve

PAIR-DV

PAIR Diverter Valve

PAIR-PAF

PAIR Pulse Air Feeder

PAIR-PAV

PAIR Pulse Air Valve

PAIR-RES

PAIR Resonator

PAIR-RV

PAIR Reed Valve

PAIR-SCSV

PAIR Swirl Control Solenoid Valve

PAIR-SCV

PAIR Swirl Control Valve

PAIR-SOL

PAIR Solenoid

PAIR-VSV

PAIR Vacuum Switching Valve

PCM

Powertrain Control Module

PCV

Positive Crankcase Ventilation

PCV-DOV

PCV Dual Orifice Valve

PCV-HCB

PCV Heated Crankcase Breather

PCV-HE

PCV Heating Element

PCV-PRV

PCV Pressure Regulator Valve

PCV-SOL

PCV Solenoid

PEVR

Power Enrichment Vacuum Regulator

PPM

Parts Per Million

PTOX

Periodic Trap Oxidizer

PURCV

Purge Crankcase Ventilation

PVCS

Ported Valve Control System

PVCS-A

PVCS Actuator

PVCS-CS

PVCS Control Solenoid

PVLCs

Power Valve Control System

"R"

ROV

Rollover Valve

"S"

SAI-SV

Secondary Air Injection Shutoff Valve

SAIR-CV

Secondary Air Injection Control Valve

SC

Supercharged or Super Charger

SC MFI

Supercharged Multiport Fuel Injection

SCR

Selective Catalytic Reduction

SCSV

Swirl Control Solenoid Valve

SCV

Swirl Control Valve

SCV-A

SCV Actuator

SFI

Sequential Multiport Fuel Injection

SFI-MAF

SFI Mass Airflow Sensor

SFLS

Sub-Fuel Level Sensor

SOHC

Single Overhead Cam

SPK

Spark Controls

SPK-AVM

SPK Advance Vacuum Modulator

SPK-BVSV

SPK Bimetal Vacuum Switching Valve

SPK-CC

SPK Computer Controlled

SPK-CKV

SPK Check Valve

SPK-CSSA

SPK Cold Start Spark Advance System

SPK-CSSH

SPK Cold Start Spark Hold System

SPK-CTO

SPK Coolant Temperature Override

SPK-DAVS

SPK Distributor Vacuum Advance Solenoid

SPK-DCKV

SPK Distributor Check Valve

SPK-DCTO

SPK Dual Coolant Temperature Override

SPK-DDD

SPK Dual Diaphragm Distributor

SPK-DMV

SPK Distributor Modulator Valve

SPK-DPD

SPK Dual Point Distributor

SPK-DPVS

SPK Distributor Ported Vacuum Switch

SPK-DRCV

SPK Distributor Retard Control Valve

SPK-DRS

SPK Distributor Retard Solenoid

SPK-DSVMV

SPK Distributor Spark Vacuum Modulator Valve

SPK-DTVS

SPK Distributor Thermal Vacuum Switch

SPK-DTVV

SPK Distributor Thermal Vacuum Valve

SPK-DV

SPK Delay Valve

SPK-DVA

SPK Distributor Vacuum Advance

SPK-DVAS

SPK Distributor Vacuum Advance Solenoid

SPK-DVCS

SPK Distributor Vacuum Control Solenoid

SPK-DVCSW

SPK Distributor Vacuum Controlled Switch

SPK-DVCV

SPK Distributor Vacuum Control Valve

SPK-DVDV

SPK Distributor Vacuum Delay Valve

SPK-DVRS

SPK Distributor Vacuum Retard Switch

SPK-DVRV

SPK Distributor Vacuum Regulating Valve

SPK-DVVV

SPK Distributor Vacuum Vent Valve

SPK-EA VS

SPK Electronically Actuated Vacuum Switch

SPK-EDM

SPK Electronic Distributor Modulator

SPK-EI

SPK Electronic Ignition

SPK-ESA

SPK Electronic Spark Advance

SPK-ESC

SPK Electronic Spark Control (Retard)

SPK-ESS

SPK Electronic Spark Selection

SPK-EST

SPK Electronic Spark Timing

SPK-FDV

SPK Forward Delay Valve

SPK-HPCA

SPK Housing Pressure Cold Advance

SPK-ITCS

SPK Ignition Timing Control System

SPK-ITVS

SPK Ignition Timing Vacuum Switch

SPK-NLVR

SPK Non-Linear Vacuum Regulator

SPK-OSAC

SPK Orifice Spark Advance Control

SPK-PVA

SPK Ported Vacuum Advance

SPK-PVS

SPK Ported Vacuum Switch

SPK-RDO

SPK Retard Delay Orifice

SPK-RDV

SPK Reverse Delay Valve

SPK-RDVD

SPK Reverse Delay Valve (Dual)

SPK-RDVLV

SPK Retard Delay Valve

SPK-RDVS

SPK Reverse Delay Valve (Single)

SPK-RETS

SPK Retard Switch

SPK-SC

SPK Speed Controlled

SPK-SOL

SPK Solenoid

SPK-SRRV

SPK Spark Relay Regulator Valve

SPK-TAVIA

SPK Temperature Activated Vacuum Ignition Advance

SPK-TCS

SPK Transmission Controlled Spark

SPK-TCSYS

SPK Timing Control System

SPK-TIDC

SPK Thermostatic Ignition Distributor Control

SPK-TV

SPK Thermal Valve

SPK-TVS

SPK Thermal Vacuum Switch

SPK-VACTO

SPK Vacuum Advance Coolant Temperature Override

SPK-VAS

SPK Vacuum Advance Solenoid

SPK-VAV

SPK Vacuum Advance Valve

SPK-VR

SPK Vacuum Retard

SPK-VRSW

SPK Vacuum Retard Switch

SPK-VSV

SPK Vacuum Switching Valve

SPK-VTCS

SPK Vacuum Timing Control System

SPL

Smoke Puff Limiter

SRI

Service Reminder Indicator

SSCA

Stepped Speed Control Actuator

SSCS

Stepped Speed Control Solenoid

STS

Service Throttle Soon Light

STVS

Secondary Throttle Valve System

SUB-HO2S

Sub-Heated Oxygen Sensor (after CAT)

SUB-O2S

Sub-Oxygen Sensor

SUB-TWC

Sub Three-Way Catalytic Converter

"T"

TAA

Turbo Air-To-Air

TAA

Throttle Actuator Assembly

TAB

Thermactor Air By-Pass

TAD

Thermactor Air Diverter

TAC

Thermostatic Air Cleaner

TBI

Throttle Body Injection

TBPCS

Throttle By-Pass Control System

TC

Turbo Charger

TCC

Torque Converter Clutch

TCCL

Torque Converter Control

TCD

Throttle Closing Dashpot

TC-DV

TC Delay Valve

TC-TVC

TC Thermal Vacuum Switch

TC-VS

TC Vacuum Switch

TD

Thermactor Diverter

TFT

Tank Fuel Temperature Sensor

THOS2

Third Heated Oxygen Sensor

TICV

Thermal Ignition Control Valve

TIV

Thermal Idle Valve

TK

Throttle Kicker

TLUC

Transmission Lock-Up Converter

TLUC-TVS

TLUC Thermal Vacuum Switch

TLUC-VS

TLUC Vacuum Switch

TM

Throttle Modulator

TOS

Throttle Opener System

TP

Throttle Positioner

TPI

Tuned Port Fuel Injection

TPV

Throttle Poppet Valve

TR

Thermal Reactor

TRC

Throttle Return Control

TRCS

Throttle Return Control Solenoid

TRCTL

Throttle Return Control Throttle Lever Actuator

TRSCV

Throttle Return Solenoid Control Valve

TRTVV

Temperature Regulator Thermal Vacuum Valve

TRVV

Transmission Vacuum Valve

TSOL

Throttle Solenoid

TVISD

Throttle Vacuum Idle Speed Diaphragm

TVM

Transmission Vacuum Modulator

TWC

Three-Way Catalytic Converter

TWC+OC

Three-Way + Oxidation Catalytic Converter

"V"**VA**

Vacuum Advance Unit

VAC-AMP

Vacuum Amplifier

VA-CTO

VA Coolant Temperature Override

VCV

Vacuum Cut Valve

VCV-BV

VCV By-Pass Valve

VLFR

Vent Line Flow Restrictor/Anti-Trickle Fill Valve

"W"

WU

Warm-Up Catalyst

WU-OC

Warm-Up Oxidation Converter

WU-TWC

Warm-Up Three-Way Catalytic Converter

General Information

Air/Wind Noise

DIAGNOSTIC INFORMATION AND PROCEDURES

AIR/WIND NOISE

Special Tools

- **CH-39570** Chassis Ear
- **GE-41416** Ultrasonic Leak Detector

For equivalent regional tools, refer to **Special Tools**.

WARNING: Refer to **Assistant Driving Warning** .

To analyze a reported windnoise condition, test drive the vehicle to determine the origin of the noise.

Choose a regular route with smooth and straight streets that run in all 4 directions: North, South, East, and West. The area should have little traffic or little noise in order to eliminate interference with the test.

NOTE: **Often there is one primary leak source and one or more secondary leaks that contribute to the noise condition. Repairing only one of the contributing leak sources may not completely repair the total condition but only reduce the condition.**

Drive the vehicle at the speed in which the noise was noticed, or until the noise is heard. Maintain safe and legal speeds.

Many of the waterleak diagnosis tests are also used for the windnoise diagnosis.

Most windnoise is caused either by leaking seals or by misaligned body surfaces. You can diagnose the following types of windnoise with the aid of **CH-39570** ear or **GE-41416** detector.

- Wind whistle
- Wind roar
- Wind rush

When moving at highway speeds, air pressure inside the vehicle becomes greater than the air pressure outside. When a leak occurs, the escaping air causes a hiss or a whistle.

Wind roar occurs when air passes over or through an opening between the 2 body surfaces. To correct the condition, adjust the alignment to the body surfaces.

Wind rush occurs when air presses over the vehicle's body, and is related to the aerodynamics of the vehicle. Wind whistle and wind roar are repairable. Rule out wind whistle and wind roar before concluding that the wind noise is due to wind rush.

Use the following inspections in order to aid in diagnosing wind whistle or wind roar:

1. Note the details for wind noise:
 - The perceived location
 - The location where the noise is loudest
 - When the noise occurs
 - The vehicle speed
 - The interior fan speed
 - The position of the windows
 - What the noise sounds like
2. Inspect the vehicle for the possible cause of the windnoise.
3. Test drive the vehicle and determine if the windnoise is external or internal.
4. Perform a visual inspection of the following components:
 - Loose fasteners
 - Torn weatherstrips
 - Broken weld joints
 - Sealer and/or adhesive skips

TRACING POWDER OR CHALK TEST

Clean the weatherstrips and the contact surfaces with cleaning solvent.

1. Apply powder or chalk in an unbroken line to the contact surface of the weatherstrip surrounding the perimeter of the suspected areas.
2. Close the panel completely without slamming the panel. Closing the panel completely presses the weatherstrip firmly against the mating surface.
3. Inspect the applied line on the weatherstrip. The applied line is marred where contact is good. A corresponding imprint is on the mating surfaces.
4. Gaps or irregularities in the powder or the chalk line on the mating surfaces indicate the areas with a poor seal.

AIR PRESSURE TEST

1. Mask off both the pressure relief valves.
2. Close all the windows.
3. Turn the vehicles ventilation fan to the on position, with the selector on high speed and in the defrost mode.
4. Unlock and close the doors.

5. Listen for escaping air along the door and the window seals with a stethoscope or a length of heater hose.

SOAP SUDS OR BUBBLE TEST

1. Mask off the pressure relief valves.
2. Close all the windows and the doors.
3. Turn the vehicles ventilation fan to the on position, with the selector on high speed and in the defrost mode.
4. Unlock and close the doors.
5. Apply the soap solution to the potential leak areas.
6. Look for bubbles revealing escaping air.

REPAIR INSTRUCTIONS

EXTERIOR WINDNOISE

WARNING: Refer to Assistant Driving Warning .

Exterior windnoise is louder when the vehicle is driven with one or more windows down. Exterior windnoise occurs when air passes over the body panels, the seams, or the openings. Use the following items during the test drive in order to aid in the detection of leaks:

- Mechanic's stethoscope or heater hose
 - Masking tape-51 mm (2 in) width
 - Strip caulk
 - A water soluble marking pencil
1. While driving, determine the location of the exterior windnoise by lowering one window at a time. If the location corresponds with the condition in step 2, pull over and make a temporary repair with 51 mm (2 in) wide masking tape.
 2. Tape over the gaps and the moldings one at a time. Test between each taping. Taping over the gaps and moldings will correct the condition.
 3. Temporarily repair the condition with masking tape. Adjust the tape when needed.
 4. Continue testing in order to determine if the noise has been eliminated or other leak areas exist.
 5. When all the reported leak conditions are located, make permanent repairs using the proper alignment techniques and the sealing materials.

INTERIOR WINDNOISE

WARNING: Refer to Assistant Driving Warning .

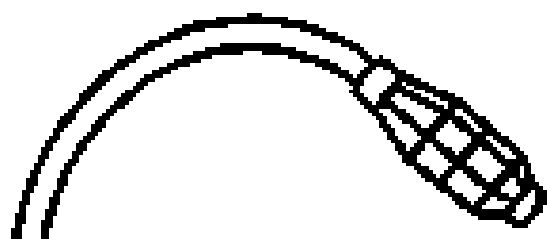
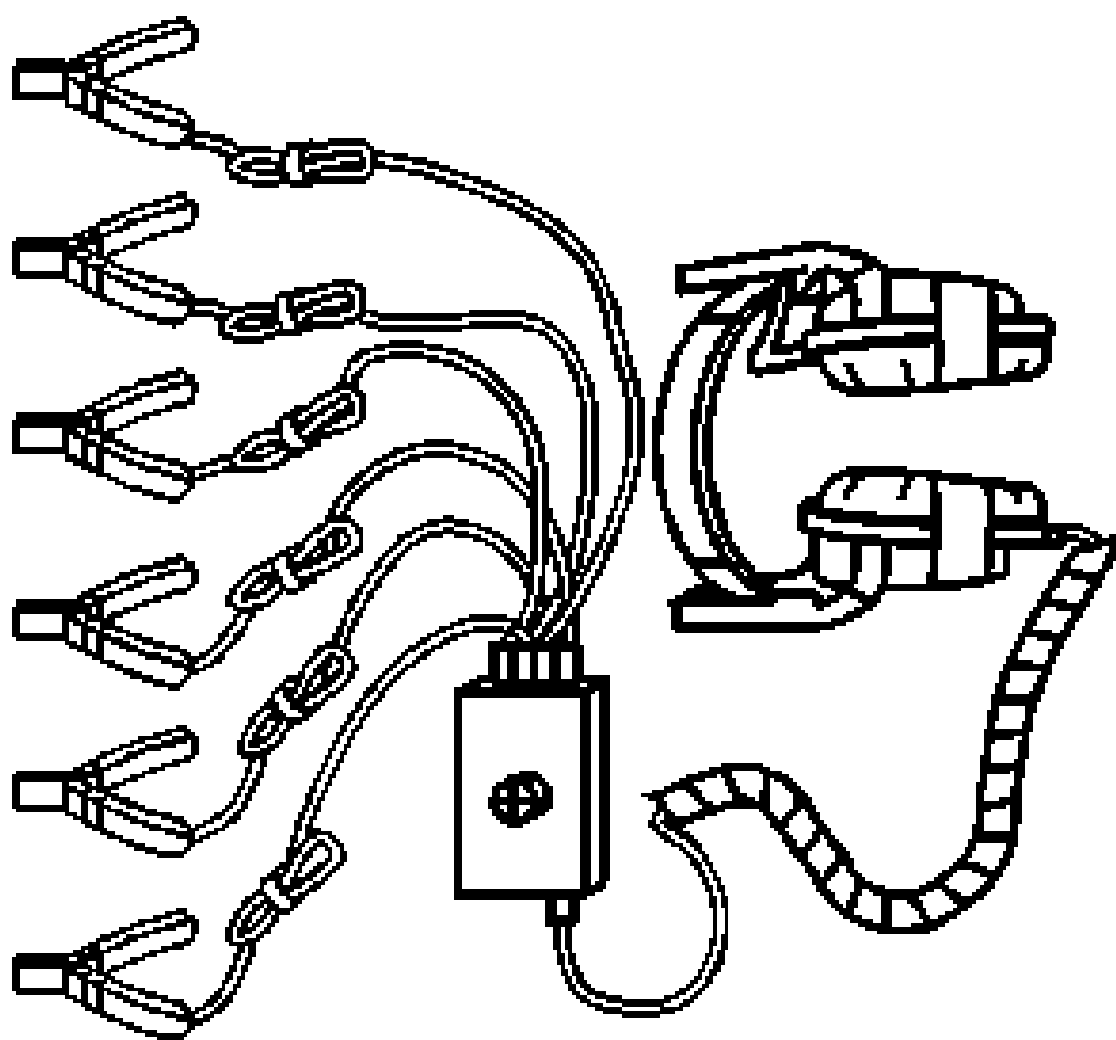
Interior windnoise is not heard when the window is lowered. Interior windnoise is caused by the air leaving the inside of the vehicle through a seal or a seam.

1. Tape over the relief valves to cause added air pressure within the vehicle.
2. Test drive the vehicle and listen for windnoise or a whistle.
3. Pull the vehicle over and make the temporary repairs using masking tape. If you cannot determine the source of the windnoise, perform one or more of the following diagnostic tests:
 - Air Pressure Test
 - Soap Suds or Bubble Test
 - Tracing Powder or Chalk Test

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	CH-39570 J 39570 Chassis Ear



GE-41416 J 41416 Ultrasonic Leak Detector

Brakes

Antilock Brake System

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Pipe Fitting	18 N.m	13 lb ft
Electronic Brake Control Module Bolt	3 N.m	26 lb in
Electronic Brake and Traction Control Module Bolt	20 N.m	15 lb ft
Electronic Brake and Traction Control Module Bracket Bolt	10 N.m	89 lb in
Electronic Brake and Traction Control Module Nut	20 N.m	15 lb ft
Wheel Speed Sensor Bolt	9 N.m	80 lb in
Vehicle Yaw Sensor Nut	9 N.m	80 lb in

SCHEMATIC WIRING DIAGRAMS

ANTILOCK BRAKE SYSTEM WIRING SCHEMATICS

Module Power, Ground, Brake Apply Signal and Subsystem References

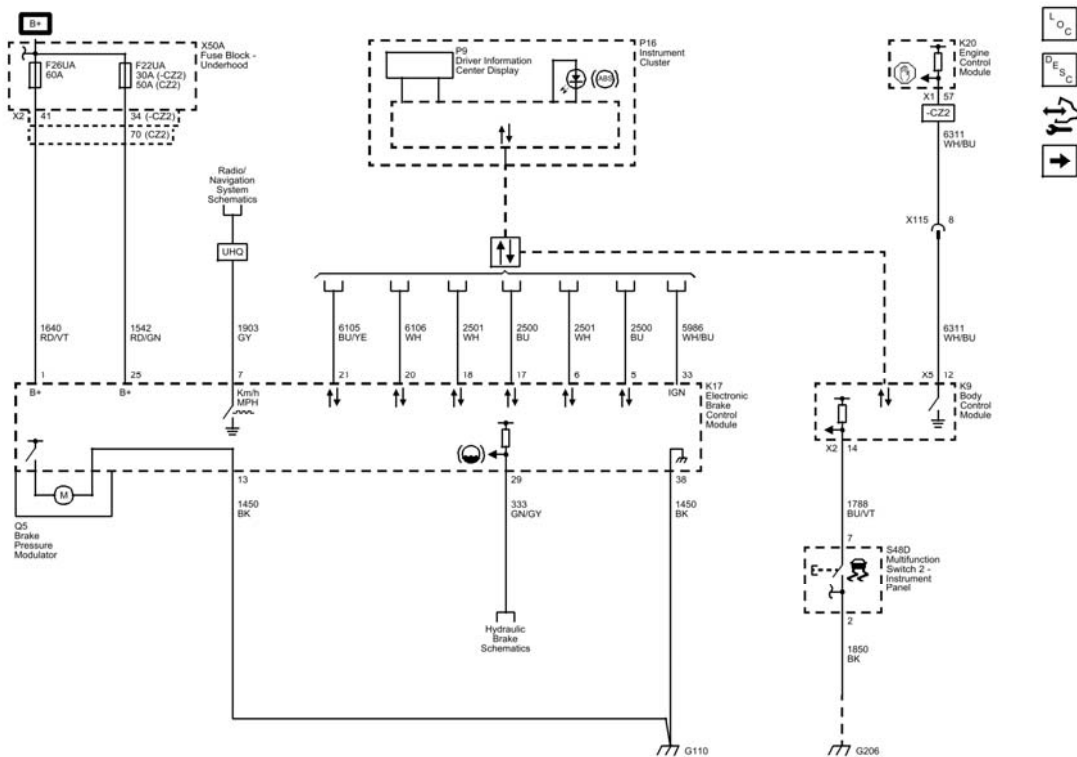


Fig. 1: Module Power, Ground, Brake Apply Signal and Subsystem References
Courtesy of GENERAL MOTORS COMPANY

Wheel Speed Sensors

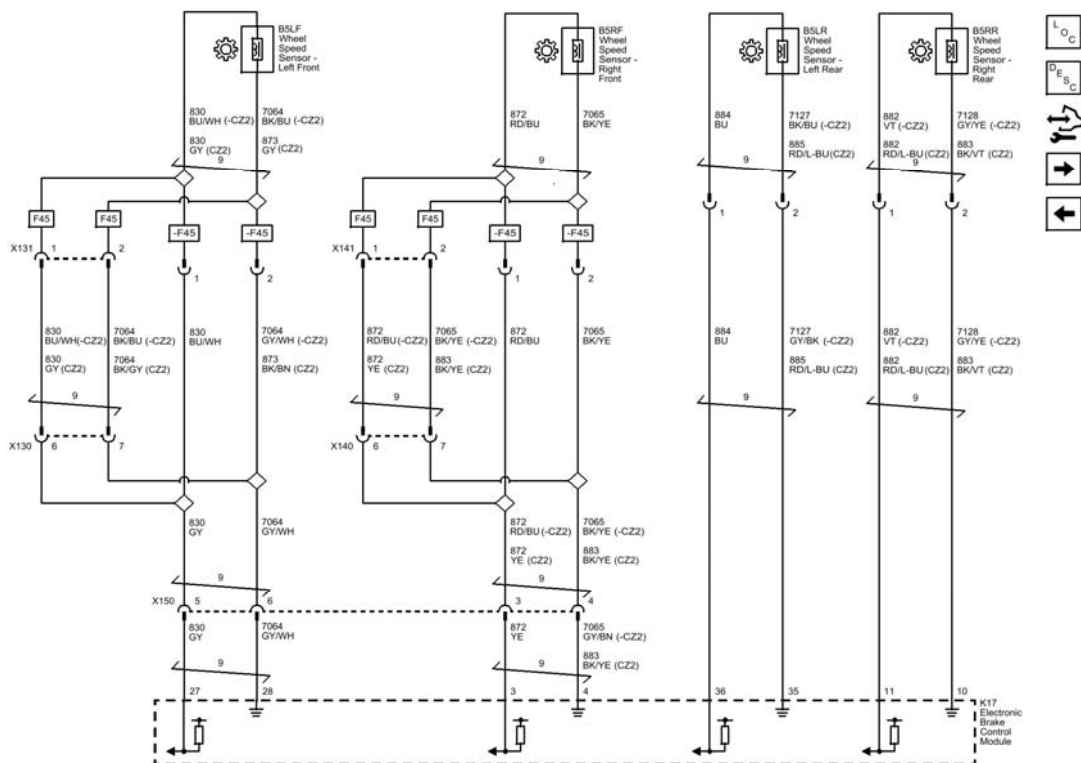


Fig. 2: Wheel Speed Sensors
 Courtesy of GENERAL MOTORS COMPANY

Yaw, Lateral Acceleration and Steering Angle Sensors

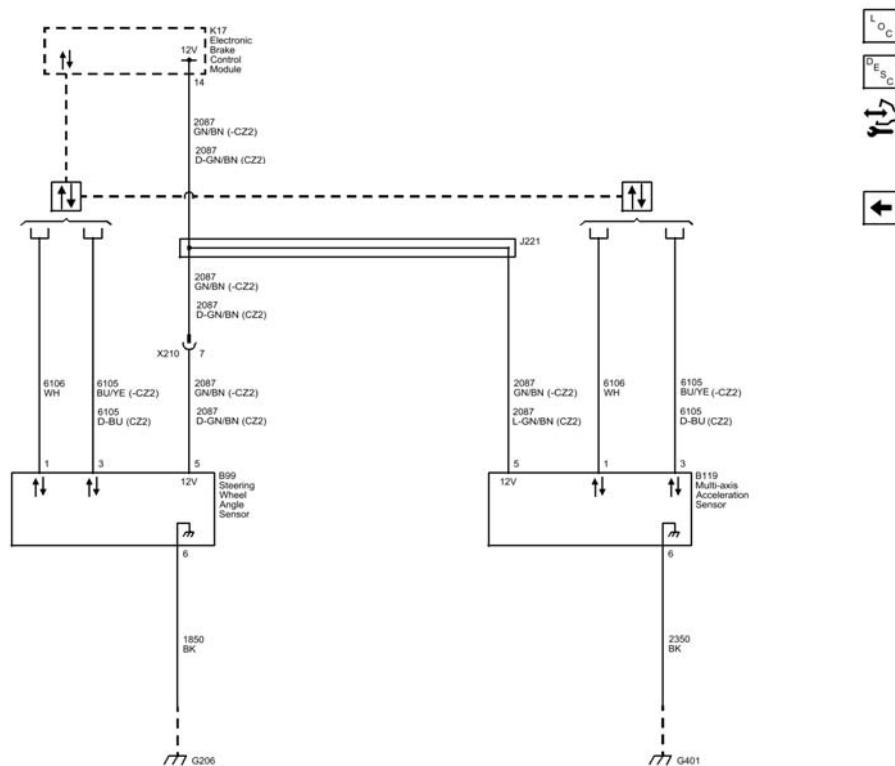


Fig. 3: Yaw, Lateral Acceleration and Steering Angle Sensors
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B2745</u>	DTC B2745 02 Traction Control Switch Circuit Short to Ground
<u>DTC C0035, C0040, C0045, or C0050</u>	DTC C0035 06 Left Front Wheel Speed Sensor Circuit Low Voltage/Open DTC C0035 0F Left Front Wheel Speed Sensor Circuit Signal Erratic DTC C0035 18 Left Front Wheel Speed Sensor Circuit Low Signal Amplitude DTC C0035 5A Left Front Wheel Speed Sensor Circuit Not Plausible DTC C0040 06 Right Front Wheel Speed Sensor Circuit Low Voltage/Open DTC C0040 0F Right Front Wheel Speed Sensor Circuit Signal Erratic DTC C0040 18 Right Front Wheel Speed Sensor Circuit Low Signal Amplitude DTC C0040 5A Right Front Wheel Speed Sensor Circuit Not Plausible DTC C0045 06 Left Rear Wheel Speed Sensor Circuit Low Voltage/Open DTC C0045 0F Left Rear Wheel Speed Sensor Circuit Signal Erratic DTC C0045 18 Left Rear Wheel Speed Sensor Circuit Low Signal Amplitude DTC C0045 5A Left Rear Wheel Speed Sensor Circuit Not Plausible

	DTC C0050 06 Right Rear Wheel Speed Sensor Circuit Low Voltage/Open DTC C0050 0F Right Rear Wheel Speed Sensor Circuit Signal Erratic DTC C0050 18 Right Rear Wheel Speed Sensor Circuit Low Signal Amplitude DTC C0050 5A Right Rear Wheel Speed Sensor Circuit Not Plausible
<u>DTC C0110</u>	DTC C0110 06 Pump Motor Circuit Low Voltage/Open DTC C0110 61 Pump Motor Circuit Stuck
<u>DTC C0131</u>	DTC C0131 00 Traction Control System Pressure Circuit Malfunction DTC C0131 4B Traction Control System Pressure Circuit Calibration Not Learned DTC C0131 5A Traction Control System Pressure Circuit Not Plausible
<u>DTC C0161</u>	DTC C0161 5A Antilock Braking System Brake Switch Circuit Not Plausible DTC C0161 71 Antilock Braking System Brake Switch Circuit Invalid Data
<u>DTC C0186, C0187, C0196, or C0287 (Without KSG)</u>	DTC C0186 Lateral Acceleration Sensor Signal (Inflatable Restraint Sensing and Diagnostic Module) DTC C0187 Multi-Axis Acceleration Sensor Circuit (Electronic Brake Control Module) DTC C0196 Yaw Rate Signal (Inflatable Restraint Sensing and Diagnostic Module and/or Electronic Brake Control Module) DTC C0287 Longitudinal Acceleration Sensor Signal (Inflatable Restraint Sensing and Diagnostic Module and/or Electronic Brake Control Module)
<u>DTC C0187, C018B, C0196, C019B, C0287, or C0297 (With KSG)</u>	DTC C0187 5A Lateral Acceleration Sensor Signal Not Plausible DTC C018B 5A Lateral Acceleration Sensor Signal Not Plausible DTC C0196 00 Yaw Rate Circuit DTC C0196 5A Yaw Rate Signal Not Plausible DTC C0196 71 Yaw Rate Circuit Invalid Serial Data Received DTC C019B 5A Yaw Rate Signal Not Plausible DTC C0287 00 Longitudinal Acceleration Sensor Circuit DTC C0287 4B Longitudinal Acceleration Sensor Circuit Calibration Not Learned DTC C0287 5A Longitudinal Acceleration Sensor Signal Not Plausible DTC C0287 71 Longitudinal Acceleration Sensor Signal Invalid Serial Data Received DTC C0297 4A Lost Communication With Yaw Rate Sensor Checksum Error
<u>DTC C018C</u>	DTC C018C 3A Multi-Axis Acceleration Sensor Module - Incorrect Component Installed
<u>DTC C0242</u>	DTC C0242 Engine Control Module Indicated Traction Control
<u>DTC C0245</u>	DTC C0245 00 Wheel Speed Sensor Frequency Malfunction
<u>DTC C0252</u>	DTC C0252 00 Vehicle Stability Control Module Sensors Correlation Malfunction
<u>DTC C0274, C0275, or C0280</u>	DTC C0274 54 Isolation Valve High Temperature DTC C0275 54 Dump Valve High Temperature DTC C0280 54 Stability System Active Too Long
<u>DTC C0460 or C0710</u>	DTC C0460 71 Steering Position Sensor Invalid Data DTC C0710 00 Steering Position Signal Malfunction DTC C0710 42 Steering Position Signal Calibration Not Programmed DTC C0710 71 Steering Position Signal Invalid Data

	DTC C0710 5A Steering Position Signal Not Plausible
<u>DTC C0552</u>	DTC C0552 00 Improper Shutdown
<u>DTC C0558</u>	DTC C0558 4B Calibration Data Calibration Not Learned
<u>DTC C0569</u>	DTC C0569 00 System Configuration Malfunction
<u>DTC C1207-C1210, C1221-C1228, or C1232-C1235</u>	DTC C1207 00 Left Front Wheel Speed Sensor Circuit High Input DTC C1208 00 Right Front Wheel Speed Sensor Circuit High Input DTC C1209 00 Left Rear Wheel Speed Sensor Circuit High Input DTC C1210 00 Right Rear Wheel Speed Sensor Circuit High Input DTC C1221 00 Left Front Wheel Speed Sensor Circuit Malfunction DTC C1222 00 Right Front Wheel Speed Sensor Circuit Malfunction DTC C1223 00 Left Rear Wheel Speed Sensor Circuit Malfunction DTC C1224 00 Right Rear Wheel Speed Sensor Circuit Malfunction
<u>DTC P0856</u>	DTC P0856 Traction Control Torque Request Circuit
<u>DTC P15F8</u>	DTC P15F8 Automatic Braking Engine Torque Request Signal Message Counter Incorrect

DTC B2745: TRACTION CONTROL SWITCH CIRCUIT SHORT TO GROUND

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2745 02

Traction Control Switch Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	U0422 71, B2745 02	1	1	-
Ground	-	1	-	-
1. Traction control switch is inoperative				

Circuit/System Description

The body control module monitors the traction control switch signal. When the traction control switch is pressed once, the body control module will request the electronic brake control module via serial data to disable the traction control. The electronic brake control module will request the instrument cluster via serial data to turn the Traction Control Off indicator ON to notify the driver of the deactivation.

When the traction control switch is pressed and held for five seconds, the body control module will request the electronic brake control module to disable the traction control and the stability control. The electronic brake control module will request the instrument cluster via serial data to turn the Traction Control Off and Stability Control Off indicator ON to notify the driver of the deactivation.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

- The body control module detects a short to ground on the signal circuit.
- The electronic brake control module detects an invalid signal from the body control module.

Action Taken When the DTC Sets

The body control module ignores the traction control switch signal input.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Body Control Module Traction Control Switch parameter changes between Active and Inactive when pressing and releasing the traction control switch.
 - **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Ignition ON.
4. Verify the scan tool Body Control Module Traction Control Switch parameter is Inactive.
 - **If not inactive**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 14 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 7 and the ground circuit terminal 2
6. Verify the scan tool Traction Control Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 Body Control Module.

- **If Active**

7. Test or replace the S48D Multifunction Switch 2 - Instrument Panel.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel.
2. Test for infinite resistance between the signal circuit terminal 7 and the ground circuit terminal 2 with the switch in the open position.

- **If less than infinite resistance**

Replace the S48D Multifunction Switch 2 - Instrument Panel.

- **If infinite resistance**

3. Test for less than 2 ohms between the signal circuit terminal 7 and the ground circuit terminal 2 with the switch in the pressed or closed position.

- **If 2 ohms or greater**

Replace the S48D Multifunction Switch 2 - Instrument Panel.

- **If less than 2 ohms**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for Body Control Module replacement, programming and setup

DTC C0035, C0040, C0045, OR C0050: WHEEL SPEED SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0035 06

Left Front Wheel Speed Sensor Circuit Low Voltage/Open

DTC C0035 0F

Left Front Wheel Speed Sensor Circuit Signal Erratic

DTC C0035 18

Left Front Wheel Speed Sensor Circuit Low Signal Amplitude

DTC C0035 5A

Left Front Wheel Speed Sensor Circuit Not Plausible

DTC C0040 06

Right Front Wheel Speed Sensor Circuit Low Voltage/Open

DTC C0040 0F

Right Front Wheel Speed Sensor Circuit Signal Erratic

DTC C0040 18

Right Front Wheel Speed Sensor Circuit Low Signal Amplitude

DTC C0040 5A

Right Front Wheel Speed Sensor Circuit Not Plausible

DTC C0045 06

Left Rear Wheel Speed Sensor Circuit Low Voltage/Open

DTC C0045 0F

Left Rear Wheel Speed Sensor Circuit Signal Erratic

DTC C0045 18

Left Rear Wheel Speed Sensor Circuit Low Signal Amplitude

DTC C0045 5A

Left Rear Wheel Speed Sensor Circuit Not Plausible

DTC C0050 06

Right Rear Wheel Speed Sensor Circuit Low Voltage/Open

DTC C0050 0F

Right Rear Wheel Speed Sensor Circuit Signal Erratic

DTC C0050 18

Right Rear Wheel Speed Sensor Circuit Low Signal Amplitude

DTC C0050 5A

Right Rear Wheel Speed Sensor Circuit Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Wheel Speed Sensor Ignition	C0035 06	C0035 06	-	C0035 0F, C0035 18, C0035 5A
Left Front Wheel Speed Sensor Signal	C0035 06	C0035 06	C0035 06	C0035 0F, C0035 18, C0035 5A
Right Front Wheel Speed Sensor Ignition	C0040 06	C0040 06	-	C0040 0F, C0040 18, C0040 5A
Right Front Wheel Speed Sensor Signal	C0040 06	C0040 06	C0040 06	C0040 0F, C0040 18, C0040 5A
Left Rear Wheel Speed Sensor Ignition	C0045 06	C0045 06	-	C0045 0F, C0045 18, C0045 5A
Left Rear Wheel Speed Sensor Signal	C0045 06	C0045 06	C0045 06	C0045 0F, C0045 18, C0045 5A
Right Rear Wheel Speed Sensor Ignition	C0050 06	C0050 06	-	C0050 0F, C0050 18, C0050 5A
Right Rear Wheel Speed Sensor Signal	C0050 06	C0050 06	C0050 06	C0050 0F, C0050 18, C0050 5A

Component	Condition	DTC Symptom Bytes
Wheel Speed Sensor	<ul style="list-style-type: none">Physical damageDebris on the wheel speed sensor or the encoder ringLoose or worn wheel bearingLoose or improperly mounted sensorAir gap between the wheel speed sensor and the encoder ring too largeWater intrusion in the wiring harness	0F, 18 or 5A

Circuit/System Description

The wheel speeds are detected by active wheel speed sensors and encoder rings. The encoder rings consist of permanent magnets located in the hub. As the wheel spins the magnetic encoder ring rotates and passes by the wheel speed sensor head; which generates a sign wave in the wheel speed sensor. Each wheel speed sensor receives ignition voltage from the electronic brake control module and provides an alternating current square wave signal to the electronic brake control module. As the wheel spins, the electronic brake control module uses the frequency of the signals to calculate the wheel speeds.

Conditions for Running the DTC

C0035 06, C0040 06, C0045 06, and C0050 06

Ignition ON

C0035 0F, C0040 0F, C0045 0F, and C0050 0F

- Ignition ON
- Vehicle speed is greater than 12.9 km/h (8 MPH).

C0035 18, C0040 18, C0045 18, and C0050 18

- Ignition ON
- Vehicle speed is greater than 6 km/h (3.7 MPH).

C0035 5A, C0040 5A, C0045 5A, and C0050 5A

- Ignition ON
- Vehicle speed is greater than 1.5 km/h (0.9 MPH).

Conditions for Setting the DTC

C0035 06, C0040 06, C0045 06, or C0050 06

- A short to ground or open/high resistance is detected on the wheel speed sensor ignition circuit.
- A short to voltage, short to ground, or open/high resistance is detected on the wheel speed sensor signal circuit.

C0035 0F, C0040 0F, C0045 0F, or C0050 0F

An erratic wheel speed sensor signal is detected.

C0035 18, C0040 18, C0045 18, or C0050 18

A missing wheel speed sensor signal is detected.

C0035 5A, C0040 5A, C0045 5A, or C0050 5A

The difference between fastest and slowest wheel speed is greater than 50%.

Action Taken When the DTC Sets

- The ABS indicator turns ON.
- The traction/stability Control indicator turns ON.
- The electronic brake control module disables the ABS, the traction control, and the electronic stability control for the duration of the ignition cycle.

Conditions for Clearing the DTC

- The DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

- Do not use a magnet to clean the encoder ring.
- Inspect the wheel hub bearing encoder ring for rust or corrosion.
- If two or more wheel speed sensors are inoperative, diagnose each wheel speed sensor individually.
- If any of the symptom codes 0F, 18 or 5A are set, refer to the Diagnostic Fault Information table for possible mechanical faults or conditions.
- If the customer comments that the ABS indicator is ON only during moist environmental conditions (rain, snow, vehicle wash, etc.), inspect the wheel speed sensor wiring for signs of water intrusion.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Test drive the vehicle in a straight line at a speed greater than 40 km/h (25 MPH).
2. Verify all scan tool Wheel Speed Sensor parameters are within 4 km/h (2.5 MPH) of each other.
 - **If any parameter is not within 4 km/h (2.5 MPH) of each other**

Refer to Circuit/System Testing.

- **If each parameter is within 4 km/h (2.5 MPH) of each other**
3. All OK.

Circuit/System Testing

NOTE: If any of the symptom codes 0F, 18 or 5A are set, refer to the Diagnostic Fault Information table for possible mechanical faults or conditions.

1. Ignition OFF, disconnect the harness connector at the appropriate B5 Wheel Speed Sensor, ignition ON.
2. Test for greater than 11 V between the ignition circuit terminal 1 and ground.
 - **If 11 V or less**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If greater than 11 V**
3. Install a 3 A fused jumper wire at the ignition circuit terminal 1, ignition ON.
4. Verify the scan tool Wheel Speed Sensor parameter changes while rapidly tapping the fused jumper wire to the signal circuit terminal 2.
 - **If the parameter does not change**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for infinite resistance between the signal circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 5. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
- **If the parameter changes**
- 5. Replace the B5 Wheel Speed Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Wheel Speed Sensor Replacement (Without F45), Front Wheel Speed Sensor Replacement (With F45)**
- **Rear Wheel Speed Sensor Replacement**
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup

DTC C0110: PUMP MOTOR CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0110 06

Pump Motor Circuit Low Voltage/Open

DTC C0110 61

Pump Motor Circuit Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	C0110 06	C0110 06	-	C0110 61
Ground Terminal 13	-	C0110 06	-	C0110 61
Ground Terminal 38	-	U0121	-	-

Component	Condition	DTCs
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Pump Motor	<ul style="list-style-type: none"> • Wear • Damage • Lock 	C0110 61
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Circuit/System Description

The pump motor is an integral part of the brake pressure modulator, while the pump motor relay is integral to the electronic brake control module. The pump motor relay is not engaged during normal system operation. When the ABS, the traction control or the stability control operation is required, the electronic brake control module activates the pump motor relay and turns the pump motor ON.

Conditions for Running the DTC

Engine running.

Conditions for Setting the DTC

C0110 06

- An open/high resistance is detected on the pump motor ground circuit.
- A short to ground or an open/high resistance is detected on the pump motor B+ circuit.

C0110 61

A faulty pump motor is detected.

Action Taken When the DTC Sets

- The ABS indicator turns ON.
- The red Brake Warning indicator turns ON.
- The traction/stability control indicator turns ON.
- The electronic brake control module disables the ABS, the traction control, and the electronic stability control for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K17 Electronic Brake Control Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminals listed below and ground:
 - Terminal 13
 - Terminal 38
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open high/resistance in the circuit.
 - If less than 2 ohms, repair open high/resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K17 Electronic Brake Control Module.
 - **If the test lamp illuminates**
5. Replace the K17 Electronic Brake Control Module with Brake Pressure Modulator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement**
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup

DTC C0131: TRACTION CONTROL SYSTEM PRESSURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0131 00

Traction Control System Pressure Circuit Malfunction

DTC C0131 4B

Traction Control System Pressure Circuit Calibration Not Learned

DTC C0131 5A

Traction Control System Pressure Circuit Not Plausible

Circuit/System Description

The electronic brake control module monitors the brake pressure sensor which is integral to the brake pressure modulator. The body control module monitors the brake pedal position sensor signal when the brake pedal is applied and sends a serial data message to the electronic brake control module indicating the brake pedal position. The electronic brake control module compares the brake pressure to the brake pedal position and uses this information for vehicle stability control.

Conditions for Running the DTC

- The engine is running.
- The brake pedal has been applied and released.

Conditions for Setting the DTC

C0131 00

The electronic brake control module detects the brake pressure is out of the specified range.

C0131 4B

The electronic brake control module detect the brake pressure sensor is not calibrated.

C0131 5A

- The brake pressure is not plausible with the brake pedal position sensor signal.
- The brake pressure is not plausible with the vehicle acceleration or deceleration.
- The electronic brake control module detects an invalid or erratic brake pressure.

Action Taken When the DTC Sets

- A message and/or indicator may be displayed.
- The traction/stability control indicator turns ON if equipped with electronic stability control.
- The electronic brake control module disables the ABS, the traction and the electronic stability control for the duration of the ignition cycle.

Conditions for Clearing the DTC

- The DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

This DTC may set if the electronic brake control module is loosely attached to the hydraulic unit. The fasteners should be checked for proper torque.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C0131 is not set.
 - **If the DTC is set**
 1. Ignition ON.
 2. Perform the **Brake Pressure Modulator Valve Pressure Sensor Calibration**.
 3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
 - If the DTC sets, replace the K17 Electronic Brake Control Module with Brake Pressure Modulator.
 - If the DTC does not set.
 4. All OK.
 - **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement**
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup

DTC C0161: ANTILOCK BRAKING SYSTEM BRAKE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0161 5A

Antilock Braking System Brake Switch Circuit Not Plausible

DTC C0161 71

Antilock Braking System Brake Switch Circuit Invalid Data

Circuit/System Description

When the brake pedal is applied, the body control module sends a serial data message to the electronic brake control module in reference to the brake pedal positions. The electronic brake control module compares the correlation between the brake pedal position and the amount of brake pressure it senses from the brake pressure sensor, which is internal to the brake pressure modulator. It uses this information to control the vehicle during an electronic stability control event.

Conditions for Running the DTC

- Ignition ON.
- DTC C0131 is not present.

Conditions for Setting the DTC

- The electronic brake control module detects the brake pedal is not applied and the brake pressure is greater than 1500 kPa (218 psi) for 2 s.
- The electronic brake control module detects the vehicle speed is greater than 16 km/h (10 MPH), the brake pedal is applied for 122 s, and the brake pressure is less than 620 kPa (90 psi).

Action Taken When the DTC Sets

- A message and/or indicator may be displayed.
- The electronic brake control module disables the ABS, the traction control and the electronic stability control for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

- Diagnose all other stop lamp DTCs or symptoms prior to performing this diagnostic procedure.
- DTC C0161 may set if the brake pedal is applied while accelerating, such as two footed driving.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C0277 or C0890 is not set.
 - **If either DTC is set**

Refer to **DTC C0277 or C0890** .

- **If the DTC is not set**
 3. Verify the B22 Brake Pedal Position Sensor or the brake pedal are not binding causing residual brake pressure to be detected.
 - **If a condition is found**
- Repair or replace the appropriate component.
- **If a condition is not found**
 4. Verify the scan tool Electronic Brake Control Module Brake Pedal Position Sensor parameter changes between Inactive and Active while applying and releasing the brake pedal.
 - **If the parameter does not change**

Refer to **Symptoms - Lighting** .

- **If the parameter changes**
5. All OK, refer to Diagnostic Aids.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

DTC C0186, C0187, C0196, OR C0287 (WITHOUT KSG): LATERAL ACCELERATION SENSOR/MULTI-AXIS ACCELERATION SENSOR/YAW RATE SIGNAL/LONGITUDINAL ACCELERATION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0186

Lateral Acceleration Sensor Signal (Inflatable Restraint Sensing and Diagnostic Module)

DTC C0187

Multi-Axis Acceleration Sensor Circuit (Electronic Brake Control Module)

DTC C0196

Yaw Rate Signal (Inflatable Restraint Sensing and Diagnostic Module and/or Electronic Brake Control Module)

DTC C0287

Longitudinal Acceleration Sensor Signal (Inflatable Restraint Sensing and Diagnostic Module and/or Electronic Brake Control Module)

For symptom byte information refer to **Symptom Byte List** .

Circuit/System Description

The yaw rate, lateral acceleration and longitudinal acceleration sensors are combined into one multi-axis acceleration sensor, internal to the inflatable restraint sensing and diagnostic module. The multi-axis acceleration sensor communicates with the electronic brake control module via serial data. The electronic brake control module activates the stability control function depending on the multi-axis acceleration sensor input. The inflatable restraint sensing and diagnostic module uses the multi-axis acceleration sensor to determine if the vehicle is in a roll over or near collision incident.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

C0186 00 or C0187 5A

- The lateral acceleration signal offset is out of the specified range.
- An internal fault in multi-axis acceleration sensor will set this DTC.
- Improperly mounted or loose inflatable restraint sensing and diagnostic module may set this DTC.
- The lateral acceleration signal is not plausible with the yaw rate, the steering wheel angle signal and the vehicle speed.

C0196 5A

- The yaw rate signal is out of the specified range.
- An internal fault in multi-axis acceleration sensor may set DTC C0196 5A.
- Improperly mounted or loose inflatable restraint sensing and diagnostic module may set this DTC.
- The yaw rate signal is not plausible with the lateral acceleration signal, the steering wheel angle sensor signal and the vehicle speed.

C0196 00

The yaw rate signal is out of the specified range.

C0287 00

The longitudinal acceleration signal is out of the specified range.

C0287 5A

- An Internal fault in multi-axis acceleration sensor will set this DTC.
- The longitudinal acceleration signal is not plausible with the vehicle acceleration.

Action Taken When the DTC Sets

- The Air Bag Indicator turns ON.
- The traction/stability control indicator turns ON.
- The electric brake control module disables the stability control and the Hill Start Assist for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC C0186, C0196, or C0287 is not set in the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If any of the DTCs are set**

Perform the Vehicle Yaw Sensor Learn.
 - **If none of the DTCs are set**
2. Verify DTC C0187, C0196, or C0287 is not set in the K17 Electronic Brake Control Module.
 - **If any of the DTCs are set**
 1. Replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 2. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
 - If the DTC sets, replace the K17 Electronic Brake Control Module.
 - If the DTC does not set
 3. All OK.
 - **If none of the DTCs are set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Electronic Brake Control Module or Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC C0187, C018B, C0196, C019B, C0287, OR C0297 (WITH KSG): LATERAL ACCELERATION SENSOR/YAW RATE SIGNAL/LONGITUDINAL ACCELERATION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0187 5A

Lateral Acceleration Sensor Signal Not Plausible

DTC C018B 5A

Lateral Acceleration Sensor Signal Not Plausible

DTC C0196 00

Yaw Rate Circuit

DTC C0196 5A

Yaw Rate Signal Not Plausible

DTC C0196 71

Yaw Rate Circuit Invalid Serial Data Received

DTC C019B 5A

Yaw Rate Signal Not Plausible

DTC C0287 00

Longitudinal Acceleration Sensor Circuit

DTC C0287 4B

Longitudinal Acceleration Sensor Circuit Calibration Not Learned

DTC C0287 5A

Longitudinal Acceleration Sensor Signal Not Plausible

DTC C0287 71

Longitudinal Acceleration Sensor Signal Invalid Serial Data Received

DTC C0297 4A

Lost Communication With Yaw Rate Sensor Checksum Error

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V Reference	U0125, U0126	U0125, U0126	-	-
Ground	-	U0125	-	-

Circuit/System Description

The yaw rate, lateral acceleration and longitudinal acceleration sensors are combined into one multi-axis acceleration sensor, external to the electronic brake control module. The electronic brake control module supplies a 12 V reference voltage to the multi-axis acceleration sensor. The multi-axis acceleration sensor communicates with the electronic brake control module via serial data. The electronic brake control module activates the stability control function depending on multi-axis acceleration sensor input.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

C0187 5A

- The lateral acceleration sensor offset is out of specified range.
- An Internal fault in multi-axis acceleration sensor will set this DTC.
- Improperly mounted or loose multi-axis acceleration sensor may set this DTC.
- The lateral acceleration sensor signal is not plausible with the yaw rate sensor signal, steering angle sensor signal and vehicle speed.

C018B 5A

The lateral acceleration sensor signal is out of specified range.

C0196 5A and C0196 71

- The yaw rate sensor offset is out of specified range.
- An Internal fault in multi-axis acceleration sensor will set C0196 5A.
- Improperly mounted or loose multi-axis acceleration sensor may set this DTC.
- The yaw rate sensor signal is not plausible with the lateral acceleration sensor signal, steering angle sensor signal and vehicle speed.

C0196 00 or C019B 5A

The yaw rate sensor signal is out of specified range.

C0287 00

The longitudinal acceleration sensor is out of specified range.

C0287 71

The electronic brake control module received an invalid longitudinal acceleration sensor signal.

C0287 4B

The longitudinal acceleration sensor calibration has not been learned.

C0287 5A

- An Internal fault in multi-axis acceleration sensor will set this DTC.
- Improperly mounted or loose multi-axis acceleration sensor may set this DTC.
- The longitudinal acceleration sensor signal is not plausible with the vehicle acceleration.

C0297 4A

Invalid serial data received from multi-axis acceleration sensor.

Action Taken When the DTC Sets

- The traction/stability control indicator turns ON.
- The electric brake control module disables the stability control and hill start assist for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

A condition may result in a stored history DTC U0121 in the Multi-Axis Acceleration Sensor Module this is considered a normal condition. Do not attempt to repair or replace any parts.

Reference Information

Schematic Reference

Antilock Brake System Schematics

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition ON
2. Verify that DTC C0287 4B is not set.
 - **If the DTC is set**

Perform the **Vehicle Yaw Sensor Learn**.

- **If the DTC is not set**
3. Verify the B119 Multi-axis Acceleration Sensor is installed correctly.
 - **If loose or incorrect installation**

Correct the installation of the component.

- **If installed correctly**
4. Ignition OFF, scan tool disconnected, and all vehicle systems OFF, disconnect the harness connector at the B119 Multi-axis Acceleration Sensor. It may take up to 2 minutes for all vehicle systems to power

down.

5. Test for less than 10 ohms between the ground circuit terminal 6 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
6. Ignition ON.
7. Verify a test lamp illuminates between the 12 V reference circuit terminal 5 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the B99 Steering Wheel Angle Sensor and the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the 12 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 12 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the test lamp illuminates**
8. Replace the B119 Multi-axis Acceleration Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Vehicle Yaw Sensor Replacement**
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup

DTC C018C: MULTI-AXIS ACCELERATION SENSOR MODULE - INCORRECT COMPONENT INSTALLED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C018C 3A

Multi-Axis Acceleration Sensor Module - Incorrect Component Installed

Circuit/System Description

The distance sensing cruise control module detects that the incorrect multi-axis acceleration sensor is installed. No external circuit diagnosis is involved.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

The distance sensing cruise control module detects that the incorrect multi-axis acceleration sensor is installed.

Action Taken When the DTC Sets

- The traction/stability control indicator turns ON.
- The electric brake control module disables the stability control and hill start assist for the duration of the ignition cycle.
- The drivers information center displays the CRUISE TEMPORARILY UNAVAILABLE message.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Antilock Brake System Schematics

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Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition ON
2. Verify that DTC C018C 3A is not set.
 - **If the DTC is set**
 1. Install the correct part number multi-axis acceleration sensor. Clear DTCs and retest.
 - If the DTC returns, replace the K14 Distance Sensing Cruise Control Module.
 - If the DTC does not return
 2. All OK.
 - **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Vehicle Yaw Sensor Replacement**
- **Control Module References** for distance sensing cruise control module replacement, programming and setup.

DTC C0242: ENGINE CONTROL MODULE INDICATED TRACTION CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0242

Engine Control Module Indicated Traction Control

For symptom byte information refer to **Symptom Byte List** .

Circuit/System Description

The electronic brake control module and the engine control module simultaneously control the traction control.

The electronic brake control module sends a serial data message to the engine control module requesting torque reduction. When certain engine control module DTCs are set, the engine control module will not be able to perform the torque reduction for traction control. A serial data message is sent to the electronic brake control module indicating that traction control is not allowed.

Conditions for Running the DTC

Engine running

Conditions for Setting the DTC

The engine control module detects a fault that prevents it from performing a traction control function and sends a serial data message to the electronic brake control module indicating that torque reduction is not allowed.

Action Taken When the DTC Sets

The electronic brake control module sends a serial data message to illuminate the appropriate warning/indicator message.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The electronic brake control module clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- Inspect for proper transmission operation.
- Inspect the exhaust system for a possible restriction.
- Inspect for lack of engine power, hesitation, stumble or rough idle.
- Some intermittent communication concerns may be caused by fretting corrosion on the serial data circuit terminals. Inspect all connectors at the control module that set the communication DTC, the control module that the communication DTC was set against, and any inline harness connectors between the two control modules. Do not replace a control module based only on fretting corrosion.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no other DTCs are set except for C0242.
 - **If any other DTCs are set**

Refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no other DTCs are set**
3. Replace the K20 Engine Control Module.
 4. Verify that DTC C0242 does not set while operating the vehicle within the Conditions for Running the DTC.
 - **If DTC sets**

Replace the K17 Electronic Brake Control Module.

- **If DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for electronic brake control module or engine control module replacement, programming and setup

DTC C0245: WHEEL SPEED SENSOR FREQUENCY MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0245 00

Wheel Speed Sensor Frequency Malfunction

Circuit/System Description

The wheel speeds are detected by active wheel speed sensors. Each wheel speed sensor receives ignition voltage from the electronic brake control module and provides an alternating current square wave signal to the electronic brake control module. As the wheel spins, the electronic brake control module uses the frequency of the square wave signal to calculate the wheel speed.

Conditions for Running the DTC

- Brake is not applied.
- Vehicle is not cornering.
- Vehicle speed is greater than 14 km/h (9 MPH).
- DTC C0035, C0040, C0045, or C0050 is not present.

Conditions for Setting the DTC

Wheel speed differences between one wheel and the others is greater than 20 percent.

Action Taken When the DTC Sets

- A message may be displayed.
- The ABS indicator turns ON.
- The red Brake warning indicator turns ON.
- The traction/stability control indicator turns ON.
- The electronic brake control module disables the ABS, the traction control, the electronic stability control and the hill start assist for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that all tires have the proper air pressure.

- **If not the proper air pressure**

Adjust all tire air pressures to the stated cold air pressure as identified on the tire placard or specification.

- **If the proper air pressure**

2. Verify that all tires are of uniform size and matching brand.

- **If not of uniform size or matching brand**

1. Replace the mis-sized or non-matching brand tire.

2. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

- If the DTC is set, replace the K17 Electronic Brake Control Module.

- If the DTC does not set.

3. All OK.

- **If all tires are of uniform size and matching brand**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for electronic brake control module replacement, programming and setup

DTC C0252: VEHICLE STABILITY CONTROL MODULE SENSORS CORRELATION MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0252 00

Vehicle Stability Control Module Sensors Correlation Malfunction

Circuit/System Description

The Yaw Rate, Lateral Acceleration and Longitudinal Acceleration Sensors are combined into one Multi-axis Acceleration Sensor. The Electronic Brake Control Module controls the stability control by monitoring the inputs of the Yaw Rate Sensor, the Lateral Acceleration Sensor, and the Steering Wheel Angle Sensor. The readings are compared to an internal calibrated value so it knows if the vehicle is having an instability condition to activate the stability control.

Conditions for Running the DTC

The vehicle is operated at a speed greater than 13 km/h (8 MPH).

Conditions for Setting the DTC

When the vehicle is driven in a straight line the Multi-axis Acceleration Sensor, the Steering Wheel Angle Sensor, and the vehicle speed correlation is not recognized after a distance of 2.5 km (1.5 mi).

Action Taken When the DTC Sets

- The Traction/stability Control indicator turns ON.
- The Electronic Brake Control Module disables the traction control, the stability control and the Hill Start Assist for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

The following conditions can cause this concern:

- An improperly mounted or loose Multi-axis Acceleration Sensor
- The car should not pull in either direction causing the Steering Wheel to be off center while driving in a straight line on a level surface.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C0187, C018B, C0196, C019B, C0287, C0297, or C0710 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If none of the DTCs are set**
3. Perform the **Vehicle Yaw Sensor Learn**, and **Steering Angle Sensor Centering** procedures.
4. Ignition ON.
5. Verify DTC C0252 does not set while operating vehicle within the conditions for running the DTC.
 - **If the DTC is set**
6. Replace the B119 Multi-axis Acceleration Sensor.
7. Ignition ON.

8. Verify DTC C0252 does not set while operating the vehicle within the Conditions for Running the DTC.
 - **If the DTC is set**
 1. Replace the B99 Steering Wheel Angle Sensor.
 2. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
 - If the DTC sets, replace the K17 Electronic Brake Control Module.
 - If the DTC does not set
 3. All OK.
 - **If the DTC is not set**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Steering Angle Sensor Replacement**
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup

DTC C0274, C0275, OR C0280: ISOLATION VALVE/DUMP VALVE/STABILITY SYSTEM ACTIVE TOO LONG

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0274 54

Isolation Valve High Temperature

DTC C0275 54

Dump Valve High Temperature

DTC C0280 54

Stability System Active Too Long

Circuit/System Description

The solenoid valves are integral parts of the brake pressure modulator. The brake pressure modulator contains an isolation solenoid valve and a dump solenoid valve for each wheel. A traction/stability control supply

solenoid valve and a isolation solenoid valve for each brake circuit. The solenoid valves are not engaged during normal system operation. When the ABS, the traction control or the stability control operation is required the electronic brake control module turns the required solenoid ON.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

The calculated solenoid valve temperature is greater than the threshold.

Action Taken When the DTC Sets

C0274 54 or C0275 54

- The ABS indicator turns ON.
- The traction/stability control indicator turns ON.
- The electronic brake control module disables the ABS, the traction control, the stability control and the hill start assist for the duration of the ignition cycle.

C0280 54

- The traction/stability control indicator turns ON.
- The electronic brake control module disables the stability control for the duration of the ignition cycle.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Diagnostic Aids

DTCs may set due to extended operation of the ABS, the traction control or the stability control.

Reference Information

Schematic Reference

Antilock Brake System Schematics

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Since most occurrences of this DTC are caused by excessive ABS or traction control usage, review with the customer the conditions under which the DTC set.

1. Ignition ON.
2. Verify that DTC C0186, C0187, C0196, C0287, or C0710 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Ignition OFF, allow the hydraulic brake pressure modulator to cool down to ambient temperature.
 4. Ignition ON.
 5. Verify that DTC C0274 54, C0275 54, or C0280 54 are not set while driving the vehicle within normal braking conditions.
 - **If any of the DTCs are set**

Replace the K17 Electronic Brake Control Module with Brake Pressure Modulator.

- **If none of the DTCs are set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement**
- **Control Module References** for electronic brake control module replacement, programming and setup

DTC C0460 OR C0710: STEERING POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0460 71

Steering Position Sensor Invalid Data

DTC C0710 00

Steering Position Signal Malfunction

DTC C0710 42

Steering Position Signal Calibration Not Programmed

DTC C0710 71

Steering Position Signal Invalid Data

DTC C0710 5A

Steering Position Signal Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V Reference	U0125, U0126	U0125, U0126	-	-
CAN Bus High Serial Data	U0073, U0074, U0125, U0126	U0073, U0074, U0125, U0126	U0073, U0074, U0125, U0126	C0710 71, C0710 5A
CAN Bus Low Serial Data	U0073, U0074, U0125, U0126	U0073, U0074, U0125, U0126	U0073, U0074, U0125, U0126	C0710 71, C0710 5A
Ground	-	U0126	-	-

Circuit/System Description

The steering wheel angle sensor receives a 12 V reference voltage from the electronic brake control module. The electronic brake control module receives serial data inputs from the steering wheel angle sensor identifying the position and direction of the steering wheel rotation. The module utilizes this signal to calculate the driver intended driving direction.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

C0460 71

The control module received an invalid steering angle sensor signal.

C0710 00

The steering angle sensor signal is invalid.

C0710 42

The steering angle sensor is not calibrated.

C0710 5A

- No steering angle sensor signal
- The steering angle sensor signal is not plausible with the yaw rate sensor signal.
- The steering angle sensor offset is out of specified range.

Action Taken When the DTC Sets

- The traction/stability control indicator turns ON.
- The electronic brake control module disables the traction control, the stability control and the hill start assist for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

- Improperly mounted or loose steering wheel angle sensor.
- The car should not pull in either direction causing the steering wheel to be off center while driving in a straight line on a level surface.
- Confirm that all tires are of the proper size and that all are matching brands. Check and adjust all tires to the stated cold air pressure as identified on the tire placard. If a miss sized or non-matching brand tire is present, inform the customer that in order for the vehicle stability enhanced system to function normally, tires need to be a uniform size and rolling diameter.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Steering Column Position parameter corresponds to the actual steering position as the steering wheel is turned through its entire range of motion.
 - **If the parameter does not correspond with the steering wheel position or the reading is erratic**

Refer to Circuit/System Testing.

- **If the parameter reading corresponds with the steering wheel position**

3. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify that DTC U0073, U0074, U0125 or U0126 is not set.
 - **If DTC U0073, U0074, U0125 or U0126 is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If DTC U0073, U0074, U0125 or U0126 is not set**

3. Verify that DTC C0710 42 or C0710 5A is not set.

- **If DTC C0710 42 or C0710 5A is set**

Refer to **Steering Angle Sensor Centering.**

- **If DTC C0710 42 or C0710 5A is not set**

4. Verify the B99 Steering Wheel Angle Sensor is installed correctly.

- **If loose or incorrect installation**

Correct the installation or replace the component.

- **If correct installation**

5. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B99 Steering Wheel Angle Sensor. It may take up to 2 minutes for all vehicle systems to power down.

6. Test for less than 5 ohms between the ground circuit terminal 6 and ground.

- **If 5 ohms or greater**

1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 5 ohms**

7. Ignition ON.

8. Verify a test lamp illuminates between the 12 V reference circuit terminal 5 and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.

2. Test for infinite resistance between 12 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

3. Test for less than 2 ohms in the 12 V reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K17 Electronic Brake Control Module.

- **If the test lamp illuminates**

9. Replace the B99 Steering Wheel Angle Sensor.

10. Ignition ON.

11. Verify that DTC C0710 is not set.

- **If DTC C0710 is set**

Replace the K17 Electronic Brake Control Module.

- **If DTC C0710 is not set**

12. Verify that DTC C0460 71 is not set.

- **If DTC C0460 71 is set**

Replace the K19 Suspension Control Module.

- **If DTC C0460 71 is not set**

13. All OK.

Repair Instructions

- Perform the **Diagnostic Repair Verification** after completing the repair.
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup

DTC C0552: IMPROPER SHUTDOWN

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C0552 00

Improper Shutdown

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Terminal 1	C0110 06	C0110 06	-	C0552 00
B+ Terminal 25	U0121 00	U0121 00	-	C0552 00
Ground Terminal 13	-	C0110 04	-	-
Ground Terminal 38	-	U0121 00	-	-

Circuit/System Description

The electronic brake control module monitors the number of Ignition On and Ignition Off cycles. When it detects that a Ignition Off cycle was incomplete or non-existent this fault will set. This means the fault reports a problem that occurred at the end of the previous ignition cycle. If this occurs during an electronic brake control module service operation, any calibrations or offsets learned during that service operation may not be properly stored in memory.

Conditions for Running the DTC

- Ignition ON.

- The ignition voltage is greater than 10 V.
- The electronic brake control module is initializing.

Conditions for Setting the DTC

- A ignition Off cycle was interrupted before completion.
- This DTC can set if battery voltage drops below 8 V with ignition ON.
- The power was removed from the electronic brake control module with the ignition in the ON position while the vehicle is moving and the brake was applied.

Action Taken When the DTC Sets

- A message and/or a warning indicator may be displayed.
- The electronic brake control module disables the ABS, the traction control and the electronic stability control for the duration of the ignition cycle.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The electronic brake control module clears the history DTC when a current DTC is not detected in 40 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K17 Electronic Brake Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminals listed below and ground:
 - Terminal 13
 - Terminal 38
 - **If 10 ohms or greater**
 1. Ignition OFF
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminals listed below and ground.
 - Terminal 1
 - Terminal 25
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K17 Electronic Brake Control Module.
 - **If the test lamp illuminates**
5. Replace the K17 Electronic Brake Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for electronic brake control module replacement, programming and setup

DTC C0558: CALIBRATION DATA CALIBRATION NOT LEARNED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0558 4B

Calibration Data Calibration Not Learned

Circuit/System Description

The electronic brake control module receives serial data messages from other modules. The electronic brake control module must be configured with the Vehicle Identification Number (VIN), configuration data and vehicle options. If not properly configured after installation, the electronic brake control module may set a DTC.

The internal fault detection is handled inside the control module. No external circuits are involved.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The electronic brake control module is not programmed.

Action Taken When the DTC Sets

- The traction/stability control indicator turns ON.
- The electronic brake control module disables the traction control, the stability control and the hill start assist for the duration of the ignition cycle.

Conditions for Clearing the DTC

A current DTC clears when the diagnostic runs and passes.

Diagnostic Aids

A newly replaced electronic brake control module can set one or more DTC on its initial ignition ON cycle.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C0558 4B is not set.
 - **If DTC C0558 4B is set**
 1. Program the K17 Electronic Brake Control Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K17 Electronic Brake Control Module.
 - If the DTC does not set
 - 3. All OK.
 - **If DTC C0558 4B is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Electronic Brake Control Module replacement, programming and setup

DTC C0569: SYSTEM CONFIGURATION MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0569 00

System Configuration Malfunction

Circuit/System Description

The electronic brake control module receives serial data messages from other modules. The electronic brake control module must be configured with the Vehicle Identification Number (VIN), configuration data and vehicle options. If not properly configured after installation, the electronic brake control module may set a DTC.

The internal fault detection is handled inside the control module. No external circuits are involved.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

The electronic brake control module is not programmed.

Action Taken When the DTC Sets

- The traction/stability control indicator turns ON.
- The electronic brake control module disables the traction control, the stability control and the hill start assist for the duration of the ignition cycle.

Conditions for Clearing the DTC

- The DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

A newly replaced electronic brake control module can set one or more DTCs on its initial ignition ON cycle.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C0569 00 is not set.
 - **If DTC C0569 00 is set**
 1. Program the K17 Electronic Brake Control Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K17 Electronic Brake Control Module.
 - If the DTC does not set.
 - 3. All OK.
 - **If DTC C0569 00 is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Electronic Brake Control Module replacement, programming and setup

DTC C1207-C1210, C1221-C1228, OR C1232-C1235: WHEEL SPEED SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C1207 00

Left Front Wheel Speed Sensor Circuit High Input

DTC C1208 00

Right Front Wheel Speed Sensor Circuit High Input

DTC C1209 00

Left Rear Wheel Speed Sensor Circuit High Input

DTC C1210 00

Right Rear Wheel Speed Sensor Circuit High Input

DTC C1221 00

Left Front Wheel Speed Sensor Circuit Malfunction

DTC C1222 00

Right Front Wheel Speed Sensor Circuit Malfunction

DTC C1223 00

Left Rear Wheel Speed Sensor Circuit Malfunction

DTC C1224 00

Right Rear Wheel Speed Sensor Circuit Malfunction

Circuit/System Description

Each Wheel Speed Sensor receives ignition voltage through the signal high circuit from the Electronic Brake Control Module. Wheel speeds are detected by Active Wheel Speed Sensors and Encoder Rings. The Magnetic Encoder Rings consists of multiple North and South Pole pairs surrounding the outer circumference. When the Encoder Ring rotates and passes by the Wheel Speed Sensor; it generates a sign wave in the Wheel Speed Sensor. The sensor converts the signal to a digital square wave; the square wave values switch between 7mA (Low) and 14mA (High) DC current. As the wheel spins, the module uses the frequency of the square wave signal to calculate the wheel speeds.

Conditions for Running the DTC

Vehicle speed is greater than 12.9 km/h (8 MPH).

Conditions for Setting the DTC

A supervised periodic message indicates the wheel speed serial data has not been received.

Action Taken When the DTC Sets

- The Traction/stability Control indicator turns ON.
- The Electric Brake Control Module disables the traction control, the stability control and the Hill Start Assist for the duration of the ignition cycle.

Conditions for Clearing the DTC

- The DTC clears when the diagnostic runs and passes.
- The history DTC will clear after 40 consecutive fault-free drive cycles have occurred.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC C0035, C0040, C0045, or C0050 is not set.
 - **If any of the DTCs are set**

Refer to **DTC C0035, C0040, C0045, or C0050.**

- **If none of the DTCs are set**
- 2. Replace the K17 Electronic Brake Control Module.
- 3. Verify DTC C1207, C1208, C1209, C1210, C1221, C1222, C1223, or C1224 does not set while operating the vehicle within the Conditions for Running the DTC.

- **If any of the DTCs are set**

Replace the module that set the DTC.

- **If none of the DTCs are set**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Electronic Brake Control Module or module replacement, programming and setup

DTC P0856: WHEEL SPEED SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0856

Traction Control Torque Request Circuit

Circuit/System Description

When traction control is active, the electronic brake control module sends a serial data message to the engine control module requesting torque reduction. When certain electronic brake control module DTCs are set, the engine control module will not be able to perform the torque reduction for traction control. A serial data message is sent to the electronic brake control module indicating that traction control is not allowed.

Conditions for Running the DTC

Engine running.

Conditions for Setting the DTC

The engine control module detects a fault that prevents it from performing a traction control function and sends

a serial data message to the electronic brake control module indicating that torque reduction is not allowed.

Action Taken When the DTC Sets

- The traction/stability control indicator turns ON.
- The electronic brake control module disables the traction control and stability control for the duration of the ignition cycle.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The electronic brake control module will turn OFF the indicator in the next ignition cycle.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify that no other DTCs are set except for P0856.
 - **If any other DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If only DTC P0856 is set**

2. Replace the K20 Engine Control Module.
3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
 - **If DTC sets**

Replace the K17 Electronic Brake Control Module.

- **If DTC does not set**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for electronic brake control module and engine control module replacement, programming and setup

DTC P15F8: AUTOMATIC BRAKING ENGINE TORQUE REQUEST SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P15F8

Automatic Braking Engine Torque Request Signal Message Counter Incorrect

Circuit/System Description

The electronic brake control module and the engine control module simultaneously control the vehicle performance. During a automatic brake event the electronic brake control module sends a serial data message to the engine control module requesting torque reduction. If the engine control module receives corrupt data from the electronic brake control module, DTC P15F8 will set in the engine control module. The engine control module then sends a serial data message to the electronic brake control module that torque reduction is not allowed.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 8 V.

Conditions for Setting the DTC

The engine control module detects a corrupted data message from the electronic brake control module.

Action Taken When the DTC Sets

- The ABS remains functional.
- DTC P15F8 is a Type B DTC.
- The traction Off indicator turns ON.
- The traction/stability control indicator turns ON.
- The Service Stabilitrak message may be displayed on the driver information center.

Conditions for Clearing the DTC

DTC P15F8 is a Type B DTC.

Diagnostic Aids

Inspect the serial data circuits and connections at the engine control module and the electronic brake control module. They should be free from sources of electromagnetic interference and the connections should be clean and tight.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify that no other DTCs are set except for DTC P15F8.

- **If any other DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If only DTC P15F8 is set**

2. Replace the K17 Electronic Brake Control Module.
3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
 - **If DTC sets**

Replace the K20 Engine Control Module.

- **If DTC does not set**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for electronic brake control module and engine control module replacement, programming and setup

SYMPTOMS - ANTILOCK BRAKE SYSTEM

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to **ABS Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the ABS. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components, for obvious damage or conditions, which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **ABS Indicator Malfunction**
- **Traction Control/Stability Control Indicator Malfunction**

ABS INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The instrument cluster turns the ABS indicator ON for 5 s after the ignition is turned ON, or when the electronic brake control module detects a fault it sends a serial data message to the instrument cluster commanding the indicator ON.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no DTCs are set.
 - **If any DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs are set**
3. Verify the Instrument Cluster ABS indicator turns ON and OFF when commanding the All Indicators ON and OFF with a scan tool.
 - **If ABS indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster.

- **If the ABS indicator turns ON and OFF**
4. Verify the ABS indicator turns OFF 5 s after the ignition is turned ON.
 - **If the ABS indicator does not turn OFF**

Replace the K17 Electronic Brake Control Module.

- **If the ABS indicator turns OFF**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for electronic brake control module or instrument cluster replacement, programming and setup

TRACTION CONTROL/STABILITY CONTROL INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	U0422 71, B2745 02	1	1	-

Ground	-	1	-	-
1. Traction control switch is inoperative				

Circuit/System Description

The instrument cluster illuminates the traction/stability control indicator, traction control off indicator and stability control off indicator for five seconds after the ignition is turned ON. When the electronic brake control module detects a fault it sends a serial data message to the instrument cluster commanding the traction/stability control indicator ON.

The body control module monitors the signal circuit from the traction control switch. When the traction control switch is pressed once, the body control module sends a serial data message to the electronic brake control module to disable the traction control system. The electronic brake control module will request the instrument cluster via serial data to turn the traction control off indicator ON to notify the driver of the deactivation.

When the traction control switch is pressed and held for five seconds, the body control module will request the electronic brake control module to disable the electronic stability control. The electronic brake control module will request the instrument cluster to turn the traction control off and the stability control off indicator ON to notify the driver of the deactivation.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the Instrument Cluster indicators listed below turn ON and OFF when commanding the All Indicators ON and OFF with a scan tool.

- Traction/stability control indicator
- Traction control off indicator
- Stability control off indicator
- **If any indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster.

- **If all indicators turn ON and OFF**

3. Verify the scan tool Body Control Module Traction Control Switch parameter changes between Active and Inactive when pressing and releasing the traction control switch.

- **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**

4. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before Circuit/System Testing.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.

- **If 5 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 5 ohms**

3. Ignition ON.
4. Verify the scan tool Body Control Module Traction Control Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 14 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**

5. Install a 3 A fused jumper wire between the signal circuit terminal 7 and the ground circuit terminal 2.
6. Verify the scan tool Traction Control Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
7. Test or replace the S48D Multifunction Switch 2 - Instrument Panel.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel.
2. Test for infinite resistance between the signal circuit terminal 7 and the ground circuit terminal 2 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S48D Multifunction Switch 2 - Instrument Panel.
 - **If infinite resistance**
3. Test for less than 2 ohms between the signal circuit terminal 7 and the ground circuit terminal 2 with the switch in the closed position.
 - **If 2 ohms or greater**

Replace the S48D Multifunction Switch 2 - Instrument Panel.
 - **If less than 2 ohms**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for Body Control Module, Electronic Brake Control Module or Instrument Cluster replacement, programming and setup

REPAIR INSTRUCTIONS

ANTILOCK BRAKE SYSTEM AUTOMATED BLEED

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

NOTE: Before performing the ABS Automated Bleed Procedure, first perform a pressure bleed of the base brake system. Refer to Hydraulic Brake System Bleeding (Manual) , Hydraulic Brake System Bleeding (Pressure) . The automated bleed procedure is recommended when one of the following conditions exist:

- Base brake system bleeding does not achieve the desired pedal height or feel
- Extreme loss of brake fluid has occurred
- Air ingestion is suspected in the secondary circuits of the brake modulator assembly

The ABS Automated Bleed Procedure uses a scan tool to cycle the system solenoid valves and run the pump in order to purge any air from the secondary circuits. These circuits are normally closed off, and are only opened during system initialization at vehicle start up and during ABS operation. The automated bleed procedure opens these secondary circuits and allows any air trapped in these circuits to flow out toward the brake corners.

Performing the Automated Bleed Procedure

CAUTION: The Auto Bleed Procedure may be terminated at any time during the process by pressing the EXIT button. No further Scan Tool prompts pertaining to the Auto Bleed procedure will be given. After exiting the bleed procedure, relieve bleed pressure and disconnect bleed equipment per manufacturers instructions. Failure to properly relieve pressure may result in spilled brake fluid causing damage to components and painted surfaces.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove all four tire and wheel assemblies. Refer to Tire and Wheel Removal and Installation .
3. Inspect the brake system for leaks and visual damage. Repair or replace components as needed.
4. Lower the vehicle.
5. Inspect the battery state of charge. Refer to Battery Inspection/Test .
6. Install a scan tool.
7. Turn the ignition ON, with the engine OFF.
8. With the scan tool, establish communications with the ABS system. Select Control Functions. Select Automated Bleed from the Control Functions menu.
9. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

10. Following the directions given on the scan tool, pressure bleed the base brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** , **Hydraulic Brake System Bleeding (Pressure)** .
11. Follow the scan tool directions until the desired brake pedal height is achieved.
12. If the bleed procedure is aborted, a malfunction exists. Perform the following steps before resuming the bleed procedure:
 - If a DTC is detected, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** , and diagnose the appropriate DTC.
 - If the brake pedal feels spongy, perform the conventional brake bleed procedure again. Refer to **Hydraulic Brake System Bleeding (Manual)** , **Hydraulic Brake System Bleeding (Pressure)** .
13. When the desired pedal height is achieved, press the brake pedal to inspect for firmness.
14. Lower the vehicle.
15. Remove the scan tool.
16. Install the tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
17. Inspect the brake fluid level. Refer to **Master Cylinder Reservoir Filling** .
18. Road test the vehicle while inspecting that the pedal remains high and firm.

STEERING ANGLE SENSOR REPLACEMENT

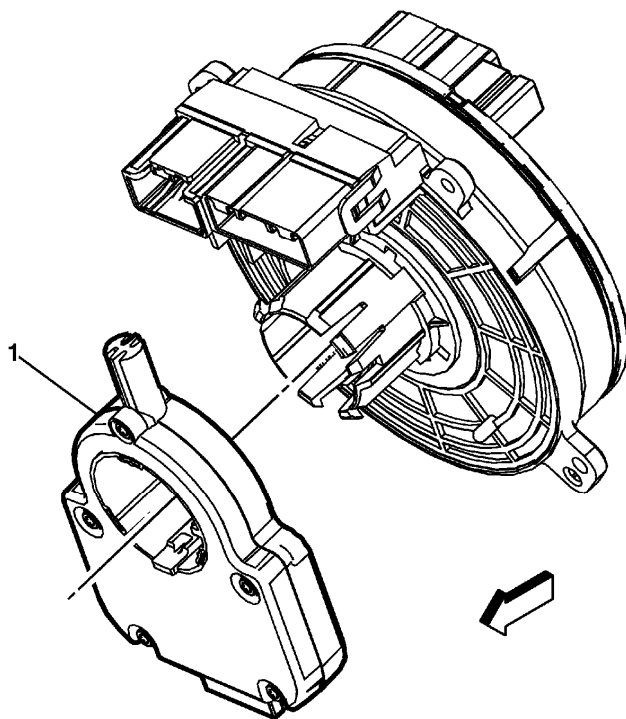


Fig. 4: Steering Angle Sensor
 Courtesy of GENERAL MOTORS COMPANY

Steering Angle Sensor Replacement

Callout	Component Name
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Preliminary Procedure

Remove the steering wheel airbag coil. Refer to **Steering Wheel Airbag Coil Replacement** .

	Steering Angle Sensor
1	Procedure <ol style="list-style-type: none">1. Press in the clip on the steering wheel airbag coil in order to remove the steering angle sensor.2. After the installation is complete, center the steering angle sensor. Refer to <u>Steering Angle Sensor Centering</u>.

STEERING ANGLE SENSOR CENTERING

WARNING: An inaccurate or not centered steering angle sensor could limit the operation of the electric power steering (EPS) and result in personal injury.

For vehicles WITHOUT electronic stability control program and INTERNAL Steering Angle Sensor

Refer to the Steering Angle Centering procedure in **Power Steering Control Module Calibration (NJ1)** .

For vehicles WITH electronic stability control program and EXTERNAL Steering Angle Sensor

The external, column mounted, steering angle sensor does not require a centering often. Centering of the external steering angle sensor might be required after certain service procedures are performed. Some of these procedures are as follows:

- Wheel alignment
- Steering gear replacement
- Steering column replacement
- Steering angle sensor replacement
- Collision or other physical damage
- Electronic brake control module (EBCM) replacement

The external steering angle sensor centering procedure can be completed with a scan tool using the following steps:

1. Using the steering wheel, align the front wheels forward.
2. Apply the parking brake, or set the transmission in the Park.
3. Install the scan tool to the data link connector.
4. Ignition ON, engine OFF
5. Select Steering Wheel Angle Sensor Reset in the Steering Wheel Angle Sensor Module Configuration/Reset Functions list.
6. Follow the scan tool directions to complete the reset procedure.

7. Select Steering Wheel Angle Sensor Learn in the Steering Wheel Angle Sensor Module Configuration/Reset Functions list.
8. Follow the scan tool directions to complete the learn procedure.
9. Select Steering Wheel Angle Sensor Learn in the Electronic Brake Control Module Configuration/Reset Functions list.
10. Follow the scan tool directions to complete the learn procedure.
11. If the vehicle is equipped with electronic power steering, perform the Software Endstop Learning procedure. Refer to **Power Steering Control Module Calibration (NJ1)** .
12. Clear any DTCs that may be set.

ELECTRONIC BRAKE CONTROL MODULE REPLACEMENT

Removal Procedure

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

1. Remove the electronic brake and traction control module with brake pressure modulator valve assembly. Refer to **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement**.

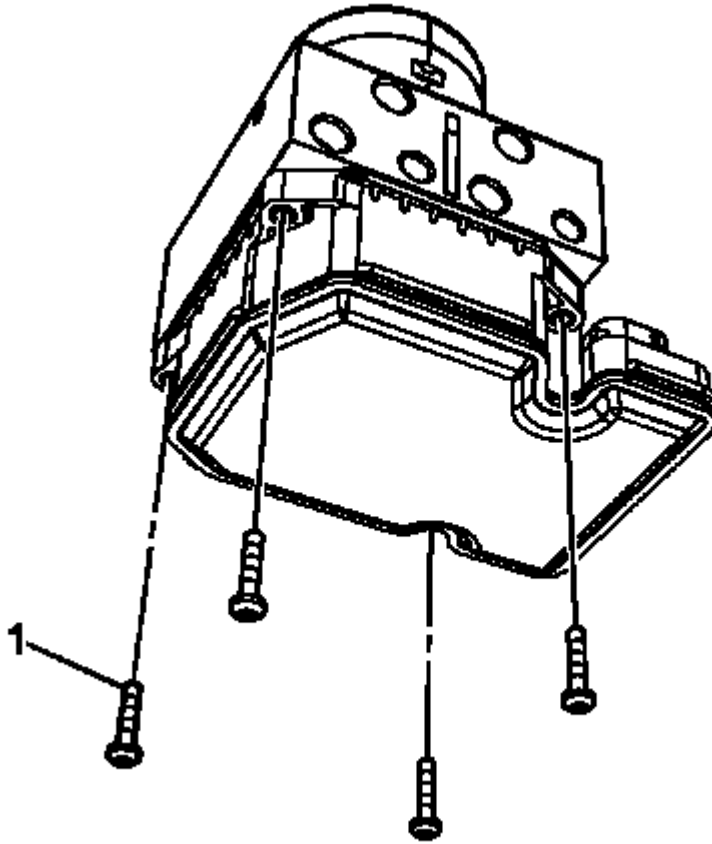


Fig. 5: Electronic Brake Control Module (EBCM) And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the electronic brake control module (EBCM) bolts (1),

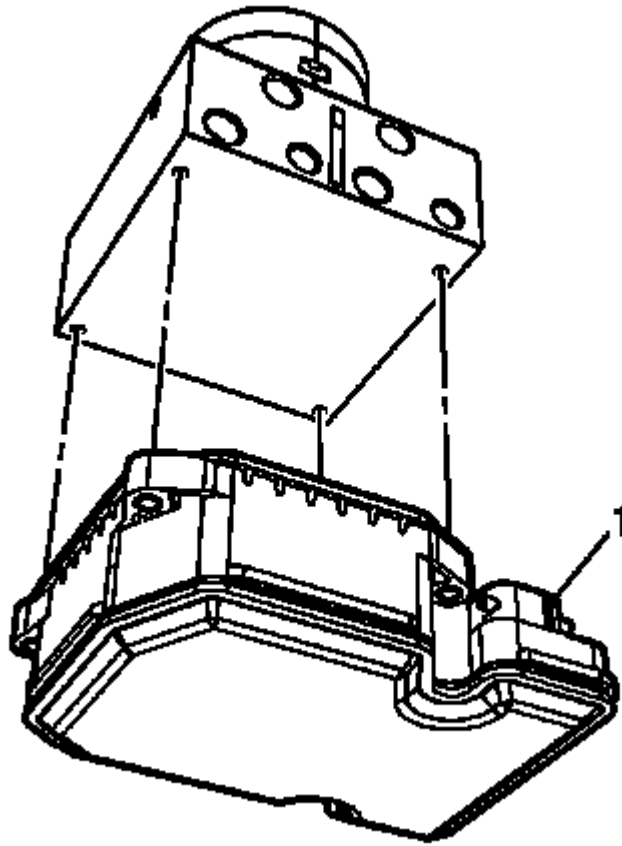


Fig. 6: EBCM And Brake Pressure Modulator Valve (BPMV)
Courtesy of GENERAL MOTORS COMPANY

3. Carefully separate the EBCM (1) from the brake pressure modulator valve (BPMV).

NOTE: **Do not pry the components apart.**

4. Clean the sealing surfaces of the EBCM and the brake pressure modulator valve with denatured alcohol and allow to dry.

Installation Procedure

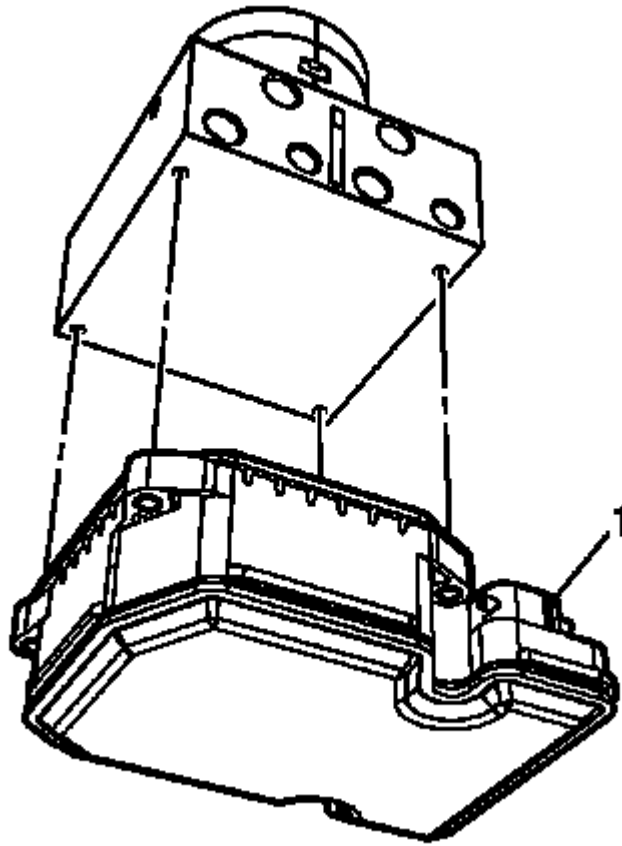


Fig. 7: EBCM And Brake Pressure Modulator Valve (BPMV)
Courtesy of GENERAL MOTORS COMPANY

1. Install the EBCM (1) to the BPMV.

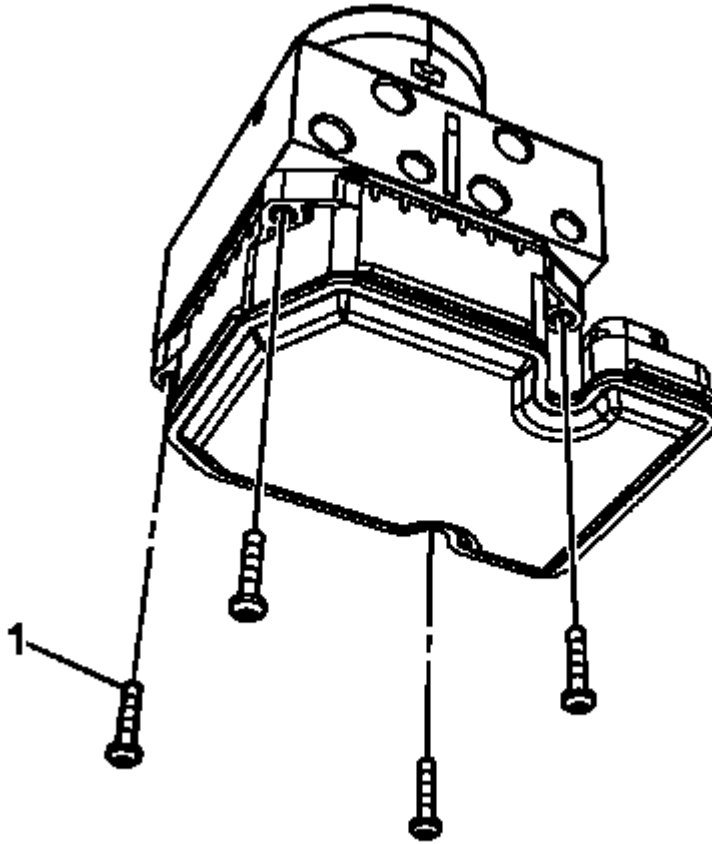


Fig. 8: Electronic Brake Control Module (EBCM) And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the EBCM bolts (1) and tighten to 3 N.m (26 lb in),
3. Install the electronic brake and traction control module with brake pressure modulator valve assembly. Refer to **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement**.
4. Program the EBCM. Refer to Control Module References .

ELECTRONIC BRAKE AND TRACTION CONTROL MODULE WITH BRAKE PRESSURE MODULATOR VALVE REPLACEMENT

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

CAUTION: To prevent equipment damage, never connect or disconnect the wiring harness connection from the EBCM with the ignition switch in the ON position.

1. Remove the battery tray. Refer to Battery Tray Replacement .
2. Disconnect the brake fluid level sensor electrical connector.
3. Without draining the coolant and without disconnecting the hoses, remove and position aside the radiator surge tank. Refer to Radiator Surge Tank Replacement (LUK) , Radiator Surge Tank Replacement (LTG) .
4. Thoroughly clean the electronic brake control module (EBCM) to brake pressure modulator valve (BPMV) area of any accumulated dirt and debris.
5. Disconnect the EBCM electrical connector.

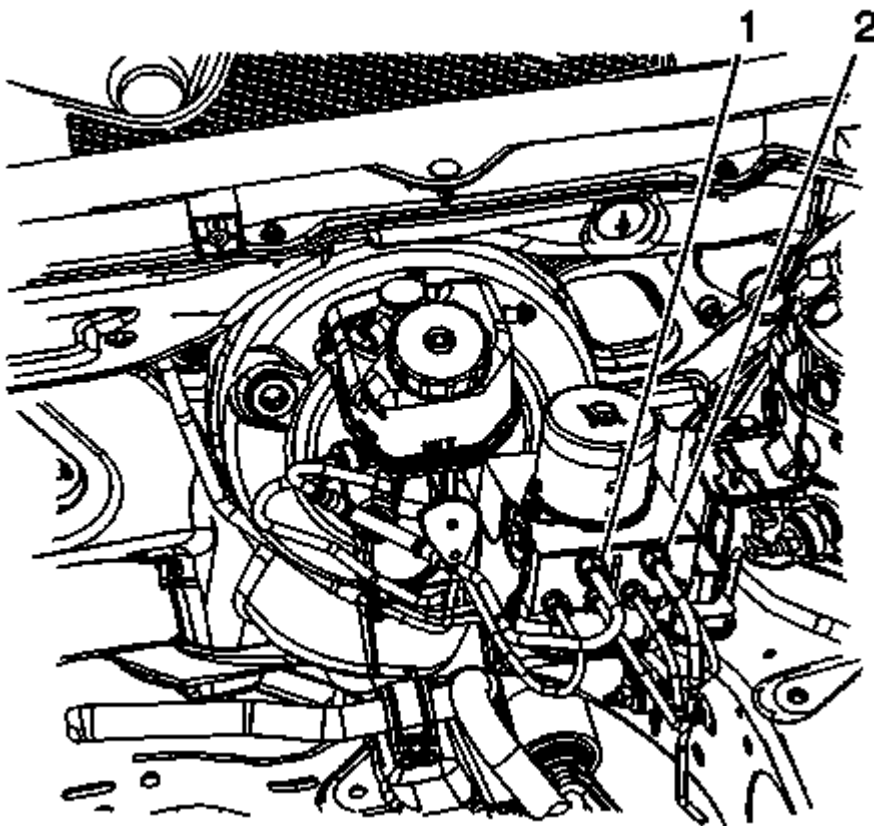


Fig. 9: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the master cylinder primary brake pipe fitting (1).

7. Cap the brake pipe fitting and plug the BPMV inlet port to prevent brake fluid loss and contamination.
8. Disconnect the master cylinder secondary brake pipe fitting (2).
9. Cap the brake pipe fitting and plug the BPMV inlet port to prevent brake fluid loss and contamination.

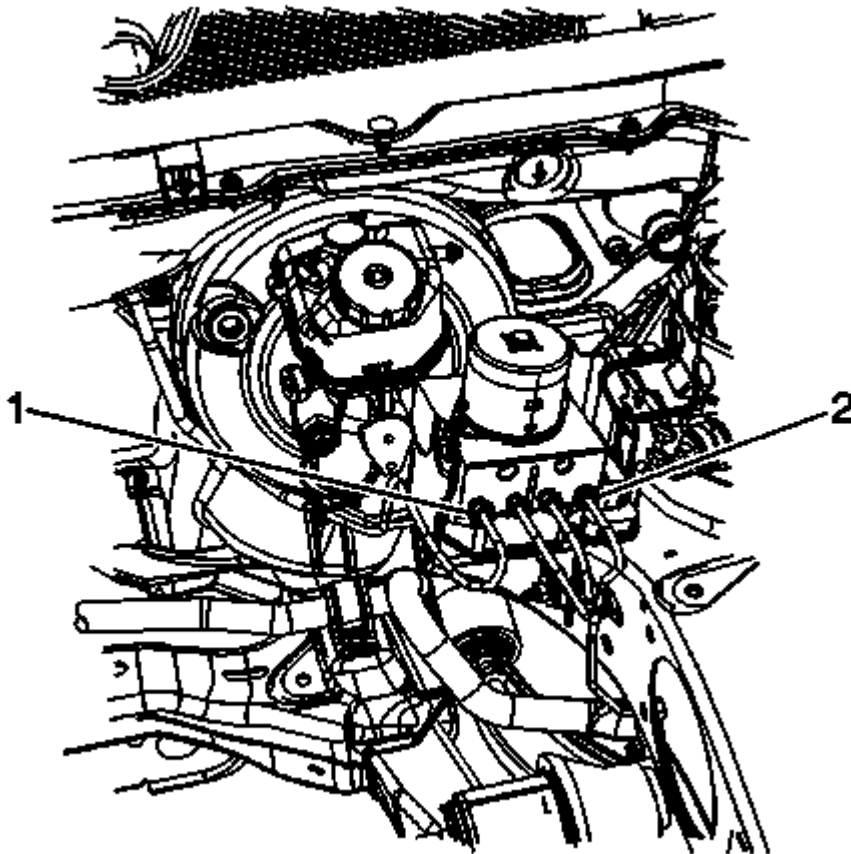


Fig. 10: Right Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the right front brake pipe fitting (1).
11. Cap the brake pipe fitting and plug the BPMV outlet port to prevent brake fluid loss and contamination.
12. Disconnect the left front brake pipe fitting (2).
13. Cap the brake pipe fitting and plug the BPMV outlet port to prevent brake fluid loss and contamination.

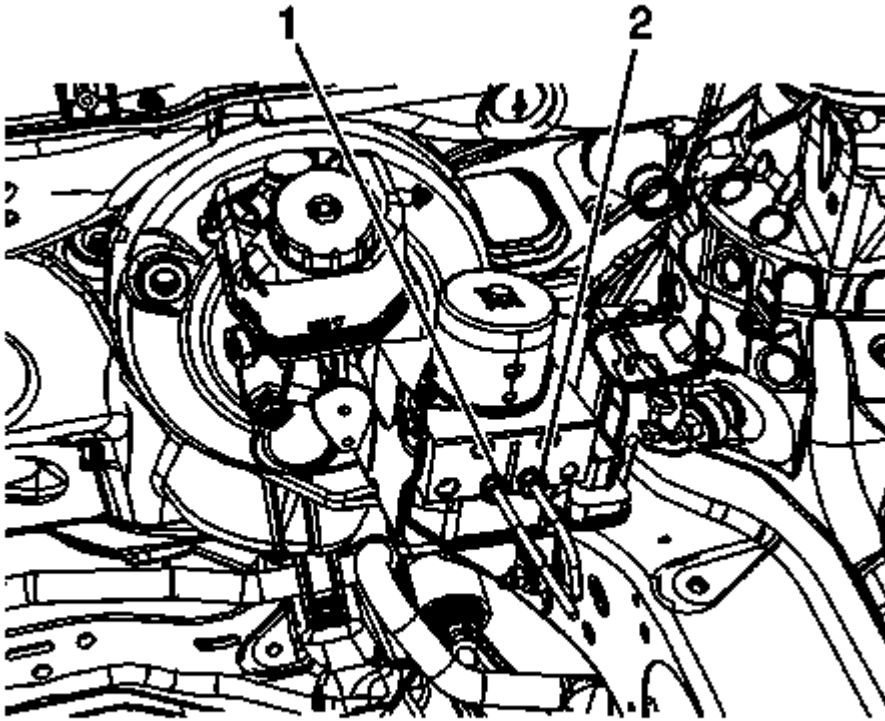


Fig. 11: Left Rear Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the left rear brake pipe fitting (1).
15. Cap the brake pipe fitting and plug the BPMV outlet port to prevent brake fluid loss and contamination.
16. Disconnect the right rear brake pipe fitting (2).
17. Cap the brake pipe fitting and plug the BPMV outlet port to prevent brake fluid loss and contamination.

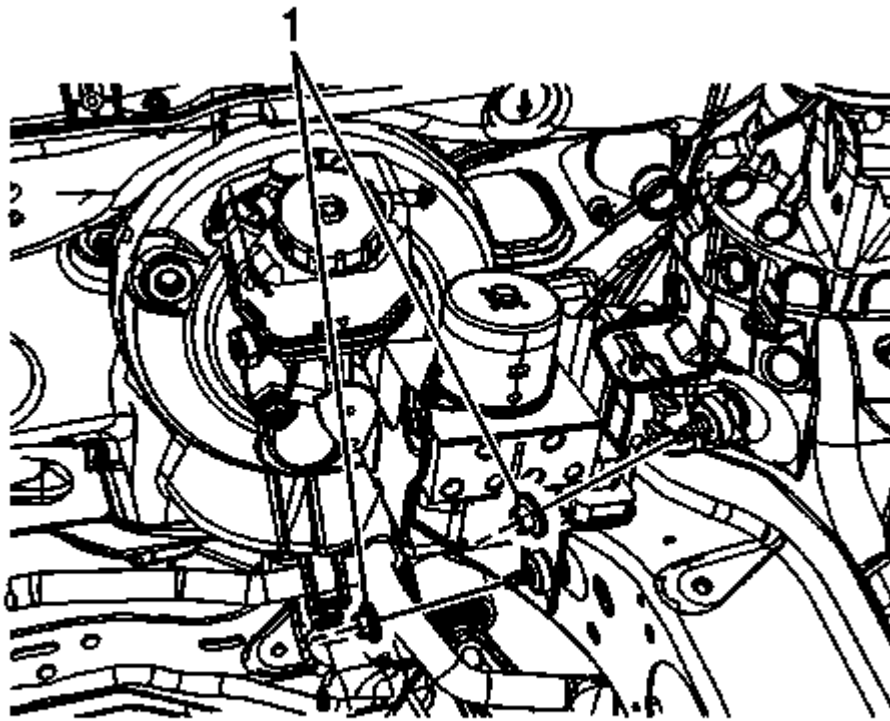


Fig. 12: Brake Pressure Modulator Valve Assembly Nuts
Courtesy of GENERAL MOTORS COMPANY

18. Remove the electronic brake and traction control module with brake pressure modulator valve assembly nuts (1).

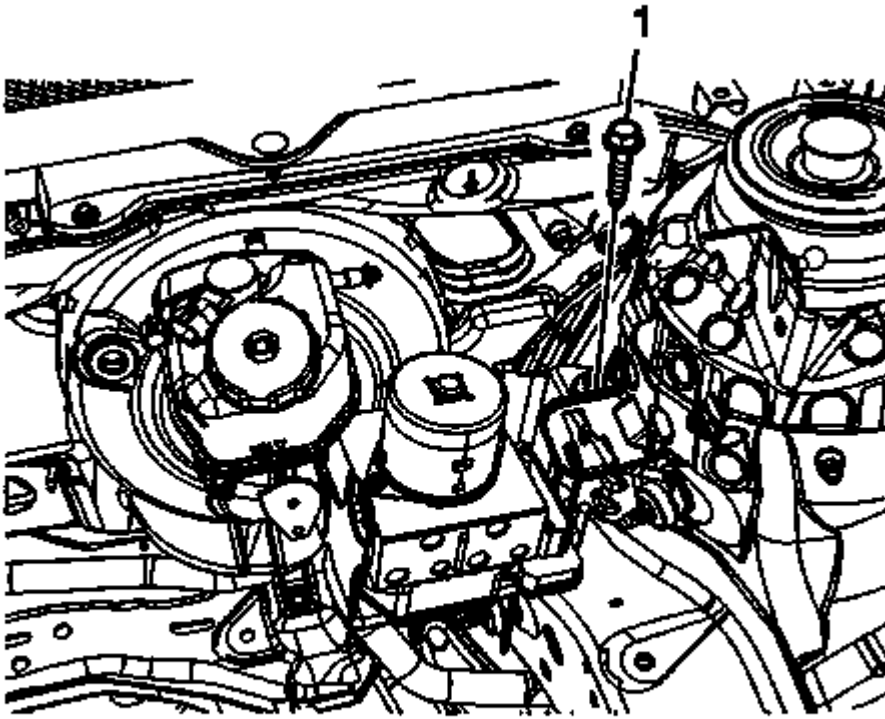


Fig. 13: Brake Pressure Modulator Valve Assembly Bolt
Courtesy of GENERAL MOTORS COMPANY

19. Remove the electronic brake and traction control module with brake pressure modulator valve assembly bolt (1).
20. Remove the electronic brake and traction control module with brake pressure modulator valve assembly.

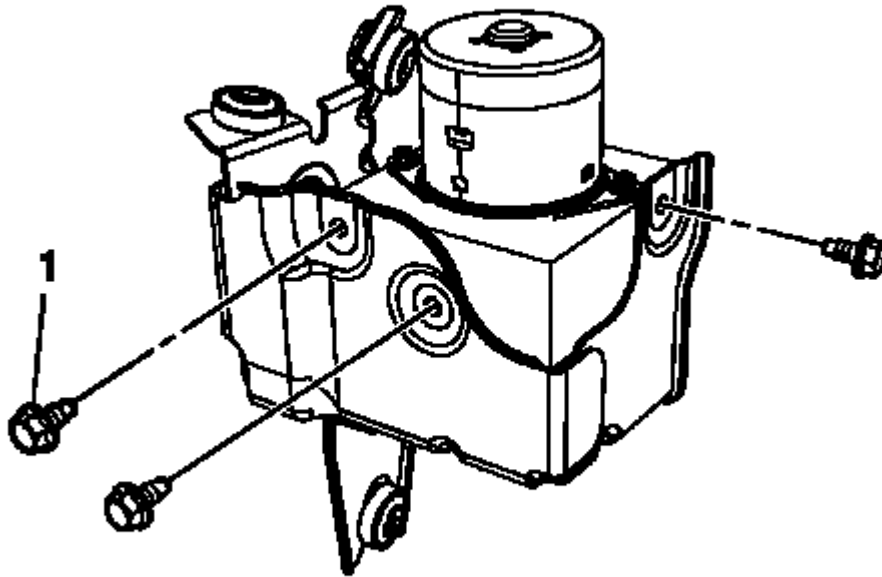


Fig. 14: Electronic Brake And Traction Control Module, Assembly Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Remove the electronic brake and traction control module with brake pressure modulator valve assembly bracket bolts (1).
22. Remove the EBCM. Refer to **Electronic Brake Control Module Replacement**.

Installation Procedure

1. Install the EBCM. Refer to **Electronic Brake Control Module Replacement**.

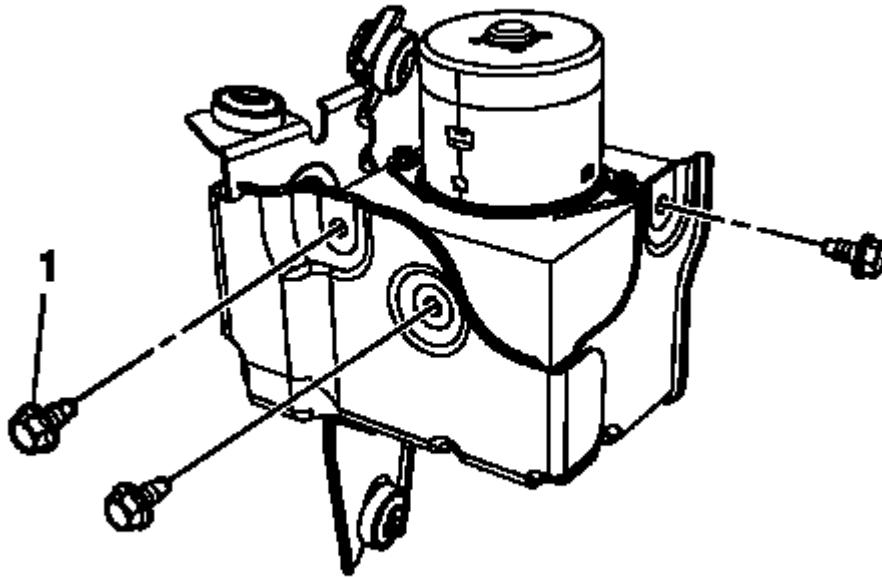


Fig. 15: Electronic Brake And Traction Control Module, Assembly Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the electronic brake and traction control module with brake pressure modulator valve assembly bracket bolts (1) and tighten to 10 N.m (89 lb in).

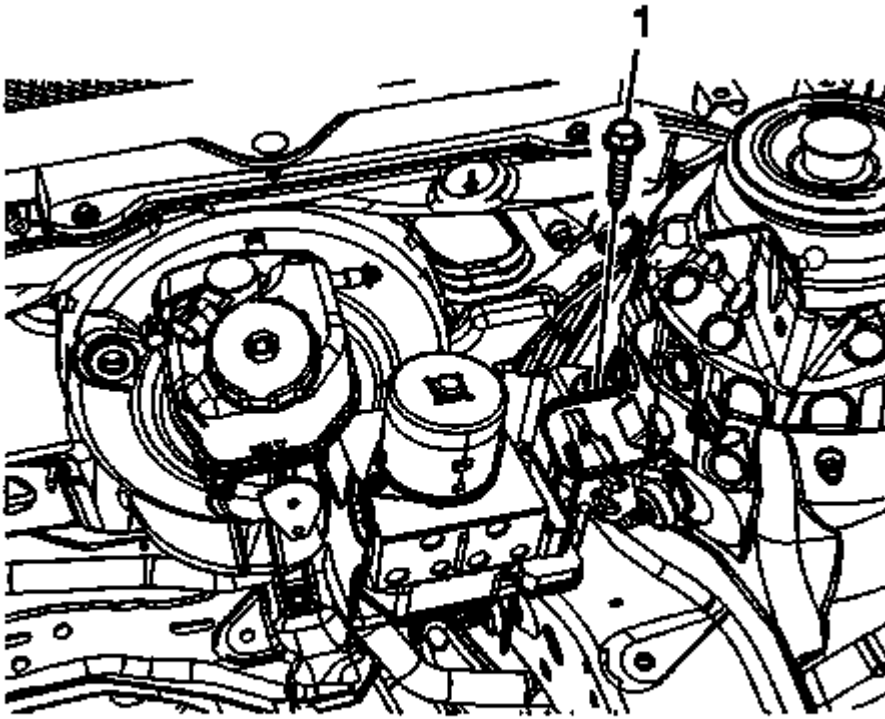


Fig. 16: Brake Pressure Modulator Valve Assembly Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the electronic brake and traction control module with brake pressure modulator valve assembly.
4. Install the electronic brake and traction control module with brake pressure modulator valve assembly bolt (1) and tighten to 20 N.m (15 lb ft).

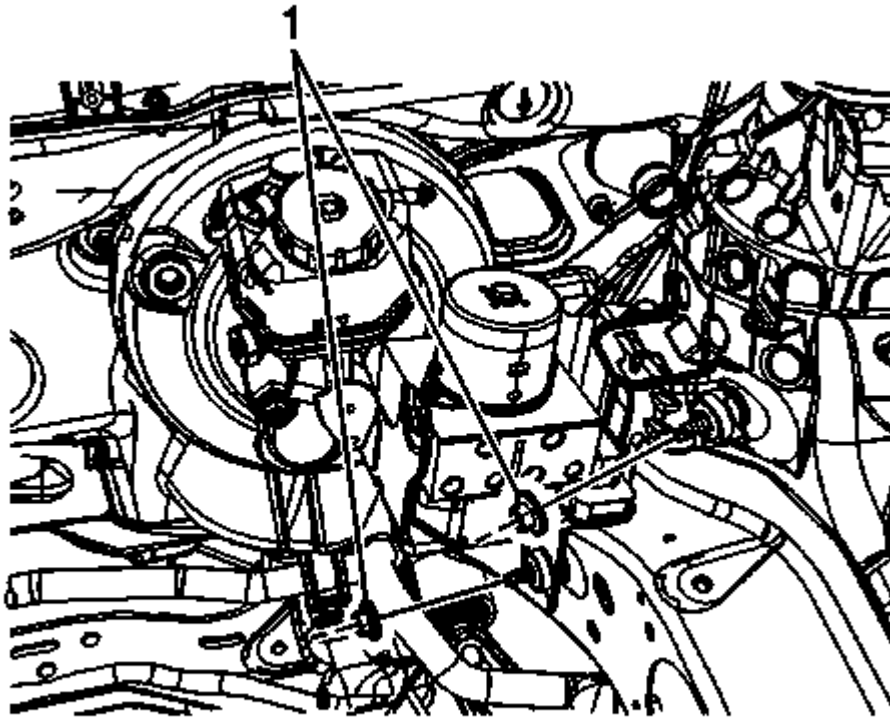


Fig. 17: Brake Pressure Modulator Valve Assembly Nuts
Courtesy of GENERAL MOTORS COMPANY

5. Install the electronic brake and traction control module with brake pressure modulator valve assembly nuts (1) and tighten to 20 N.m (15 lb ft).

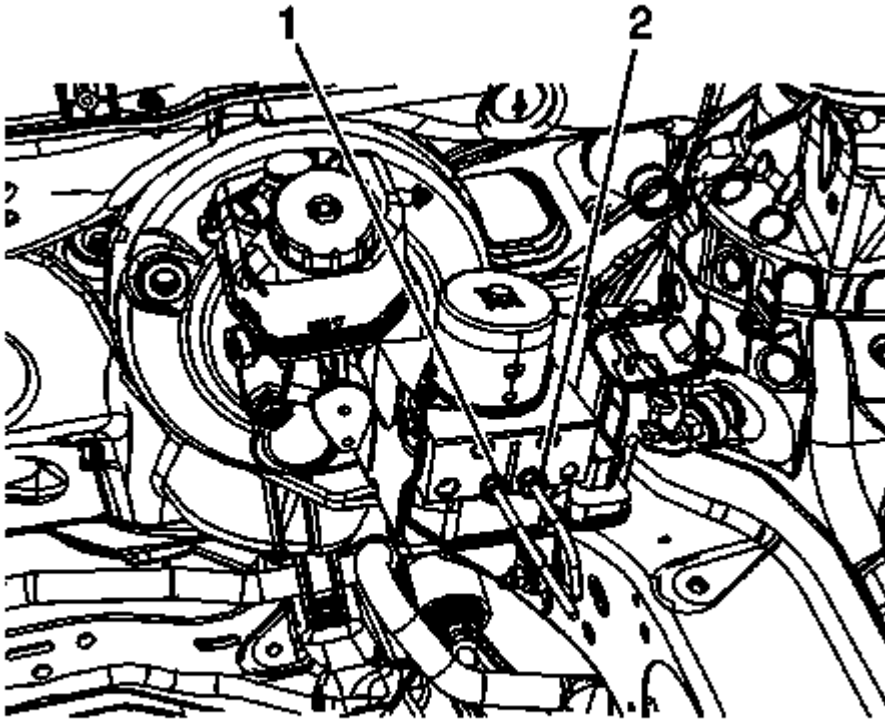


Fig. 18: Left Rear Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Install the left rear brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).
7. Install the right rear brake pipe fitting (2) and tighten to 18 N.m (13 lb ft).

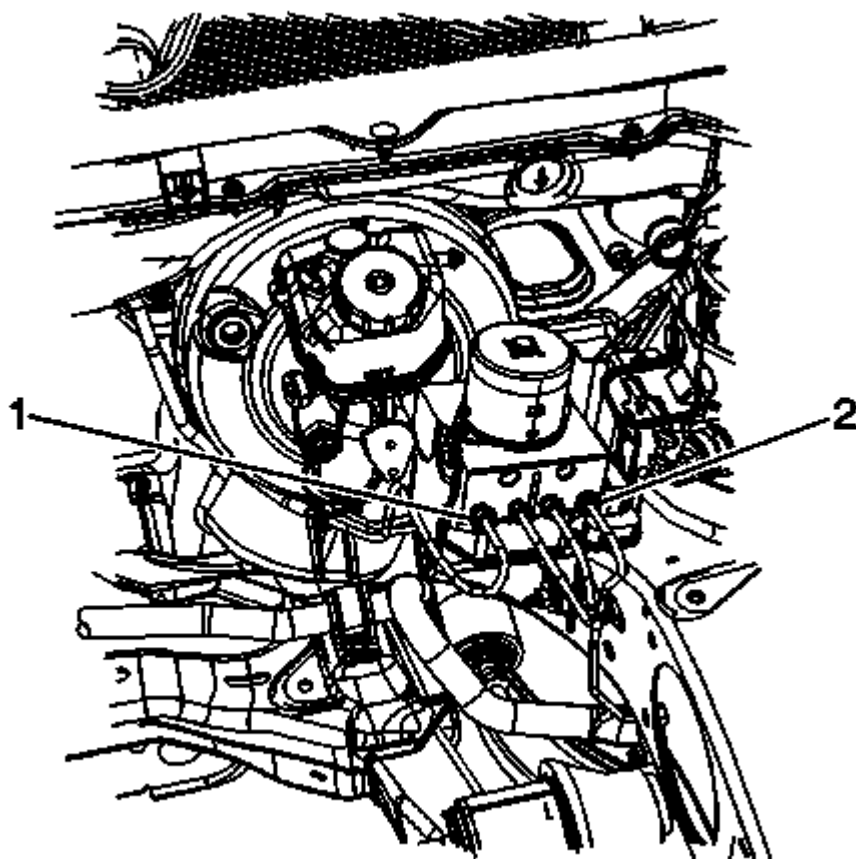


Fig. 19: Right Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

8. Install the right front brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).
9. Install the left front brake pipe fitting (2) and tighten to 18 N.m (13 lb ft).

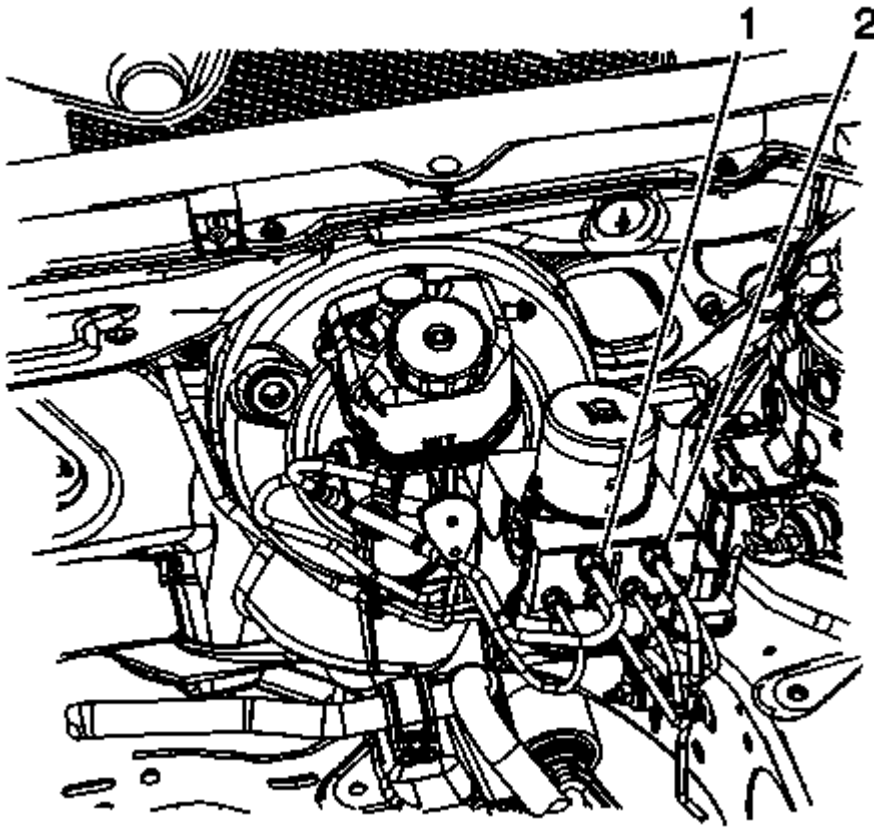


Fig. 20: Master Cylinder Primary Brake Pipe Fitting
 Courtesy of GENERAL MOTORS COMPANY

10. Install the master cylinder primary brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).
11. Install the master cylinder secondary brake pipe fitting (2) and tighten to 18 N.m (13 lb ft).
12. Connect the EBCM electrical connector.
13. Install the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LUK)** , **Radiator Surge Tank Replacement (LTG)** .
14. Connect the brake fluid level sensor electrical connector.
15. Install the battery tray. Refer to **Battery Tray Replacement** .
16. Program the EBCM. Refer to **Control Module References** .
17. Bleed the antilock brake system. Refer to **Antilock Brake System Automated Bleed**.
18. Perform the **Diagnostic System Check - Vehicle** .
19. Calibrate the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Calibration** .
20. Center the steering angle sensor. Refer to **Steering Angle Sensor Centering**.

BRAKE PRESSURE MODULATOR VALVE ADAPTIVE PRESSURE CALIBRATION

The adaptive pressure control learn is not required the learn will automatically perform a maintenance run every

200-300 ignition cycles at vehicle speeds between (40-50 mph). If a customer is concerned about an intermittent humming or buzzing noise perform this adaptive pressure control learn to determine if this is what the customer heard.

The adaptive pressure control learn can be completed with a scan tool using the following steps:

1. Place the vehicle on a flat level surface.
2. Maintain the system voltage by connecting a battery charger.
3. Apply the parking brake, or set the transmission in the Park.
4. Release the brake pedal.
5. Install the scan tool to the data link connector.
6. Engine running
7. Turn Off or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
8. Select Adaptive Pressure Control Learn in the Electronic Brake Control Module Configuration/Reset Functions list.
9. Follow the scan tool directions to complete the calibration learn procedure.
10. Clear any DTCs that may be set.

BRAKE PRESSURE MODULATOR VALVE PRESSURE SENSOR CALIBRATION

The brake pressure sensor does not require calibration often. Calibration of the brake pressure sensor might be required after certain service procedures are performed. Some of these procedures are as follows:

- Electronic brake control module (EBCM) replacement.
- Brake pressure modulator valve assembly replacement

The Brake Pressure Sensor Calibration procedure can be completed with a scan tool using the following steps:

1. Apply the parking brake, or set the transmission in the P position.
2. Release the brake pedal.
3. Install the scan tool to the data link connector.
4. Ignition ON, engine OFF
5. Select Brake Pressure Sensor Calibration in the EBCM Configuration/Reset Functions list.
6. Follow the scan tool directions to complete the calibration procedure.
7. Clear any DTCs that may be set.

FRONT WHEEL SPEED SENSOR REPLACEMENT (WITHOUT F45)

Removal Procedure

WARNING: Refer to Brake Dust Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
3. Clean the wheel speed sensor mounting area on the steering knuckle of any accumulated dirt and debris.

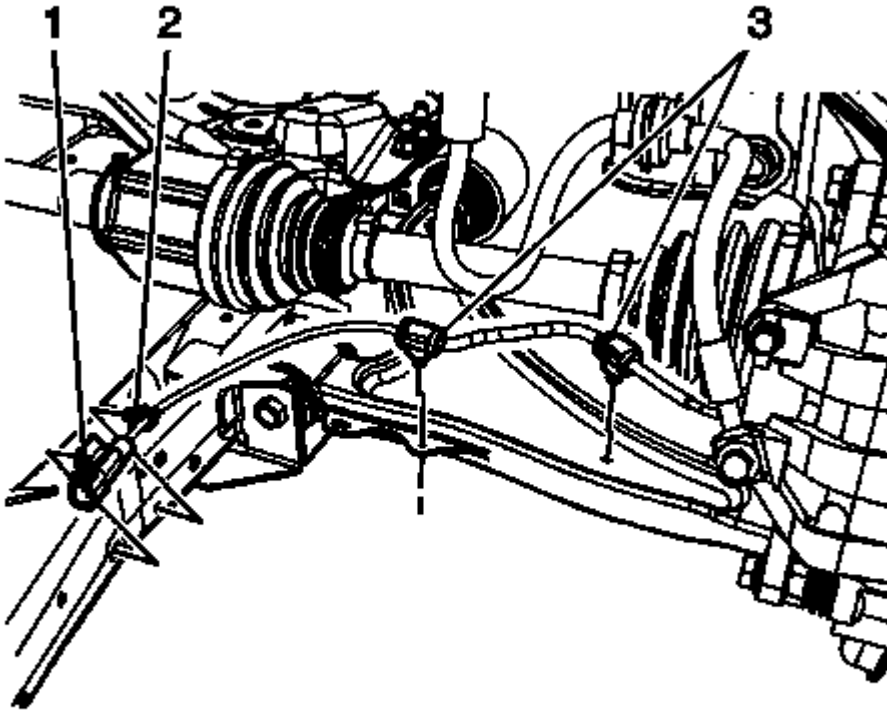


Fig. 21: Wheel Speed Sensor Electrical Connector & Harness Clips
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the wheel speed sensor electrical connector (1) and release the connector from the frame.
5. Release the harness clip (2) from the frame.
6. Release the harness clips (3) from the lower control arm.

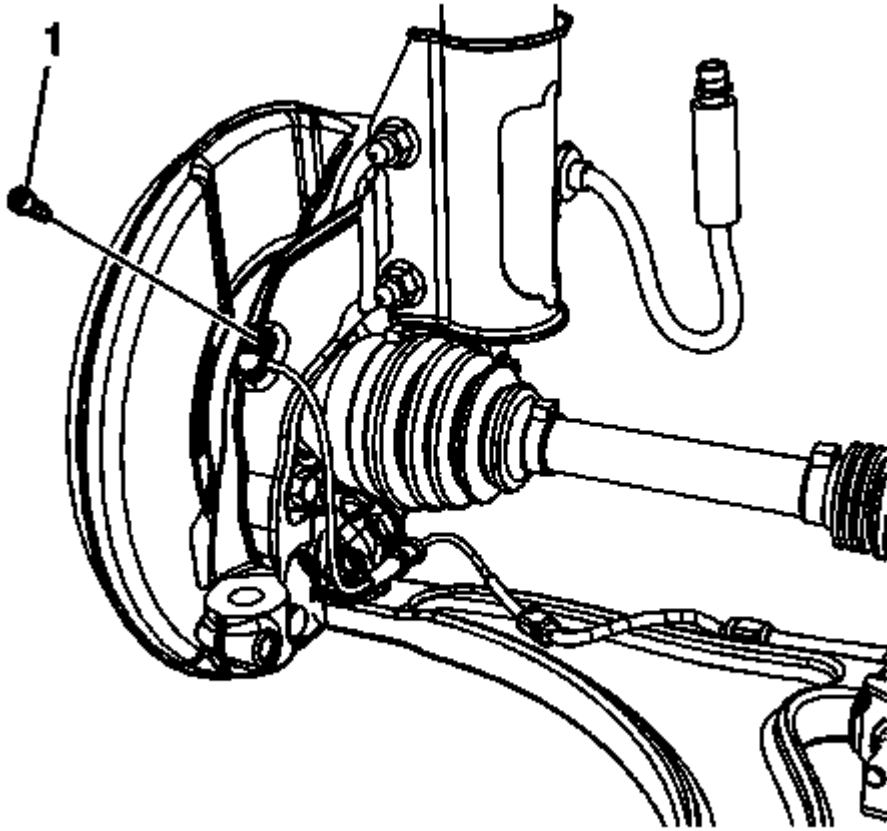


Fig. 22: Wheel Speed Sensor Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove any accumulated dirt and debris from the surrounding the wheel speed sensor.
8. Remove the wheel speed sensor bolt (1).

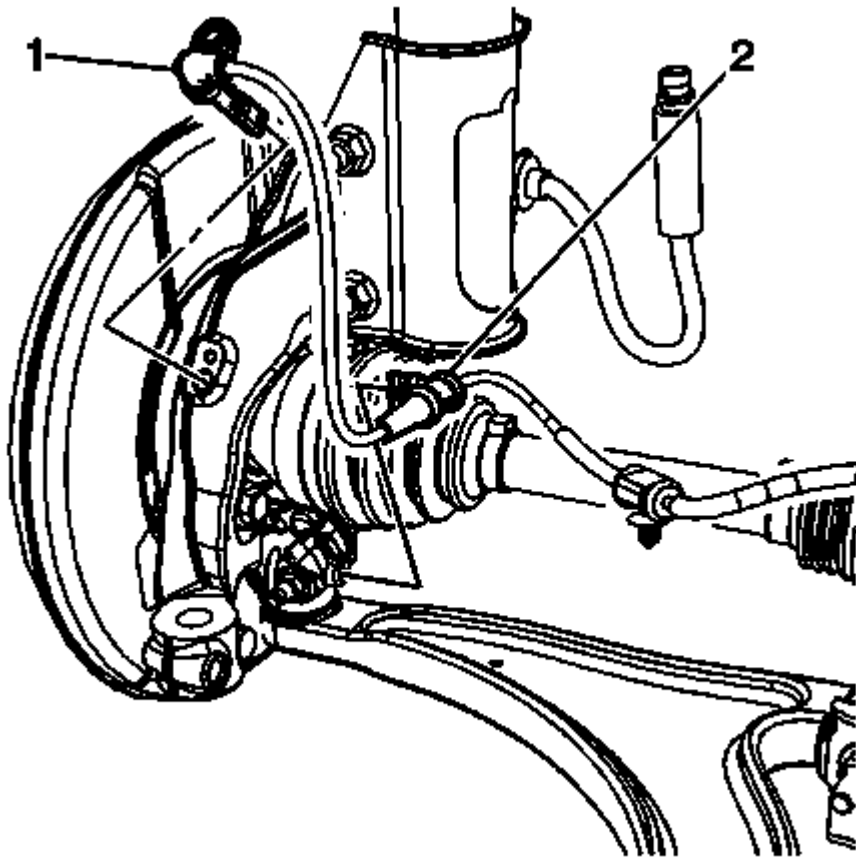


Fig. 23: Wheel Speed Sensor And Harness Clip
Courtesy of GENERAL MOTORS COMPANY

9. Remove the wheel speed sensor (1) from the steering knuckle.
10. Release the harness clip (2) from the steering knuckle and remove the wheel speed sensor.

Installation Procedure

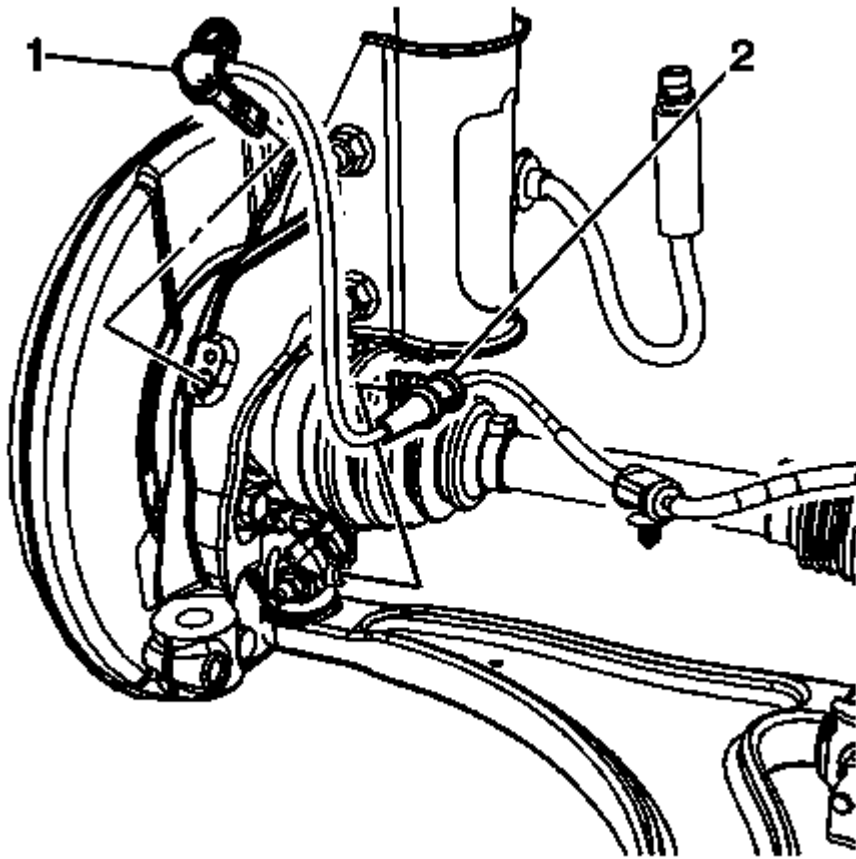


Fig. 24: Wheel Speed Sensor And Harness Clip
Courtesy of GENERAL MOTORS COMPANY

1. Install the wheel speed sensor (1) to the steering knuckle.
2. Install the harness clip (2) to the steering knuckle.

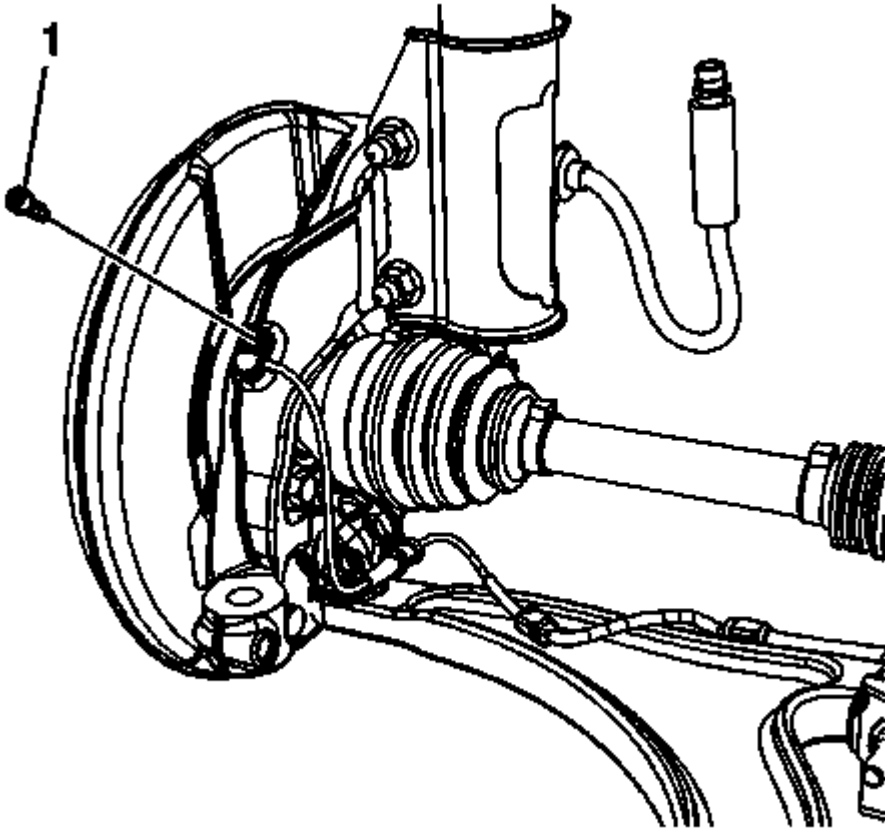


Fig. 25: Wheel Speed Sensor Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the wheel speed sensor bolt (1) and tighten to 9 N.m (80 lb in).

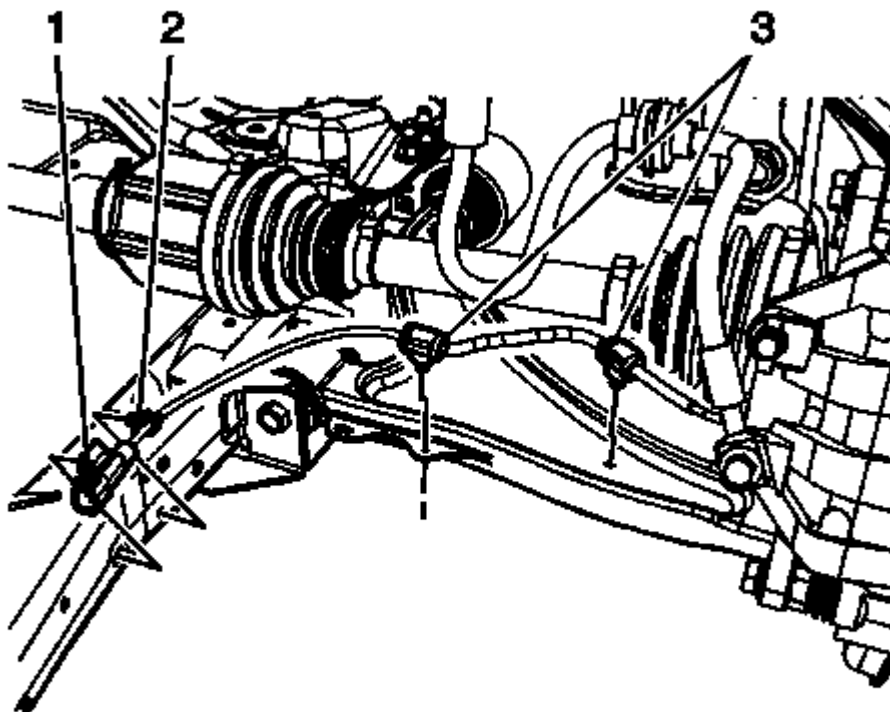


Fig. 26: Wheel Speed Sensor Electrical Connector & Harness Clips
Courtesy of GENERAL MOTORS COMPANY

4. Connect the wheel speed sensor electrical connector (1) and secure the connector to the frame.
5. Install the harness clip (2) to the frame.
6. Install the harness clips (3) to the lower control arm.
7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Perform the **Diagnostic System Check - Vehicle** .

FRONT WHEEL SPEED SENSOR REPLACEMENT (WITH F45)

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

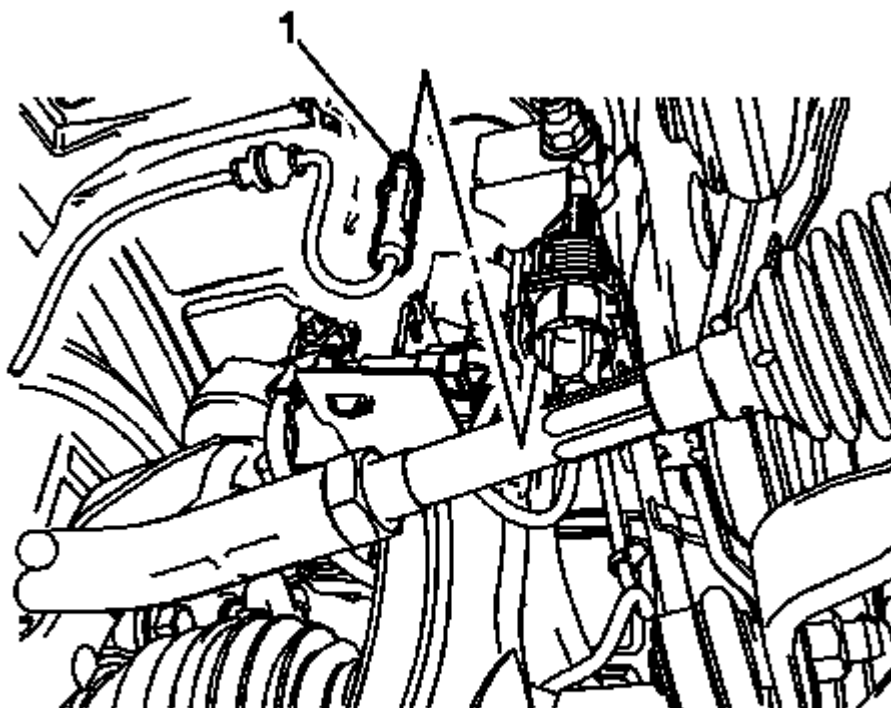


Fig. 27: Wheel Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Unlock and disconnect the wheel speed sensor electrical connector (1). Refer to **Electronic Suspension Position Sensor Front Jumper Harness Disconnection** .

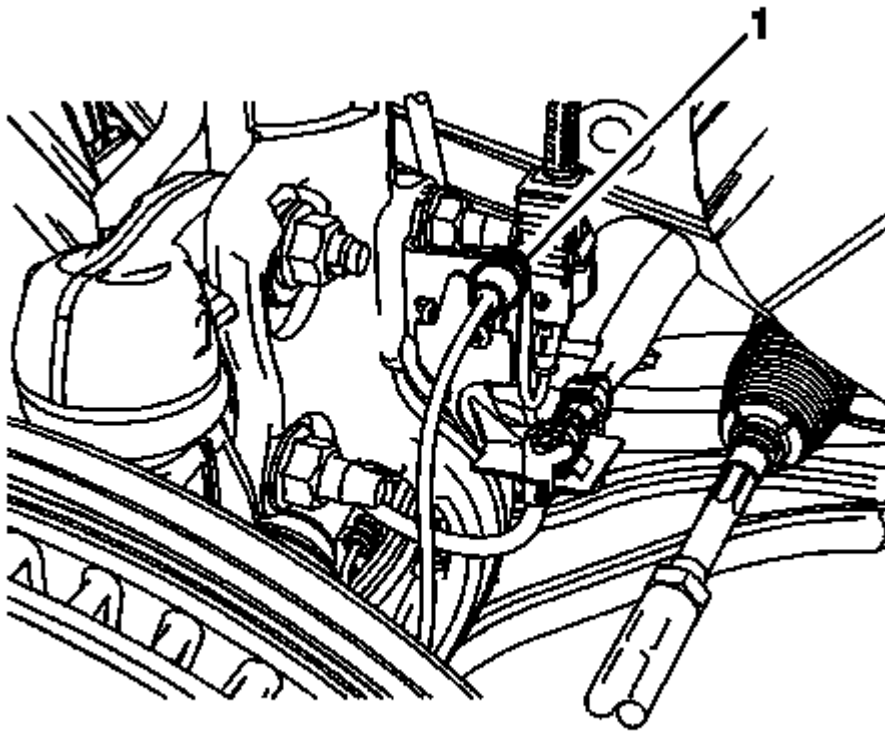


Fig. 28: Wheel Speed Sensor Harness Grommet
Courtesy of GENERAL MOTORS COMPANY

4. Release the wheel speed sensor harness grommet (1) from the strut bracket.
5. Clean the wheel speed sensor mounting area on the steering knuckle of any accumulated dirt and debris.

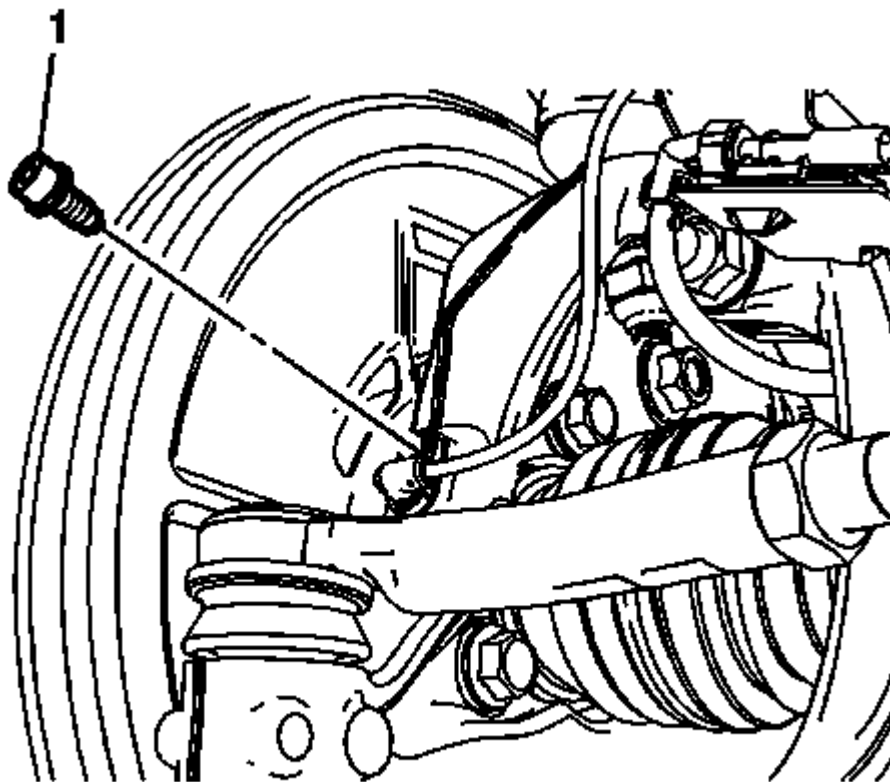


Fig. 29: Wheel Speed Sensor Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the wheel speed sensor bolt (1).

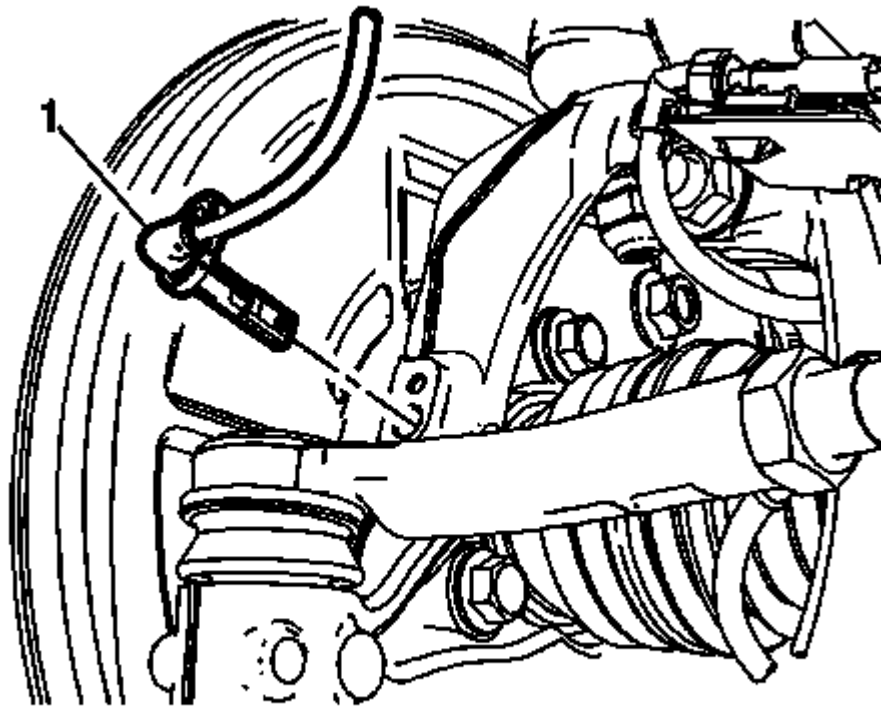


Fig. 30: Wheel Speed Sensor

Courtesy of GENERAL MOTORS COMPANY

7. Remove the wheel speed sensor (1) from the steering knuckle.

Installation Procedure

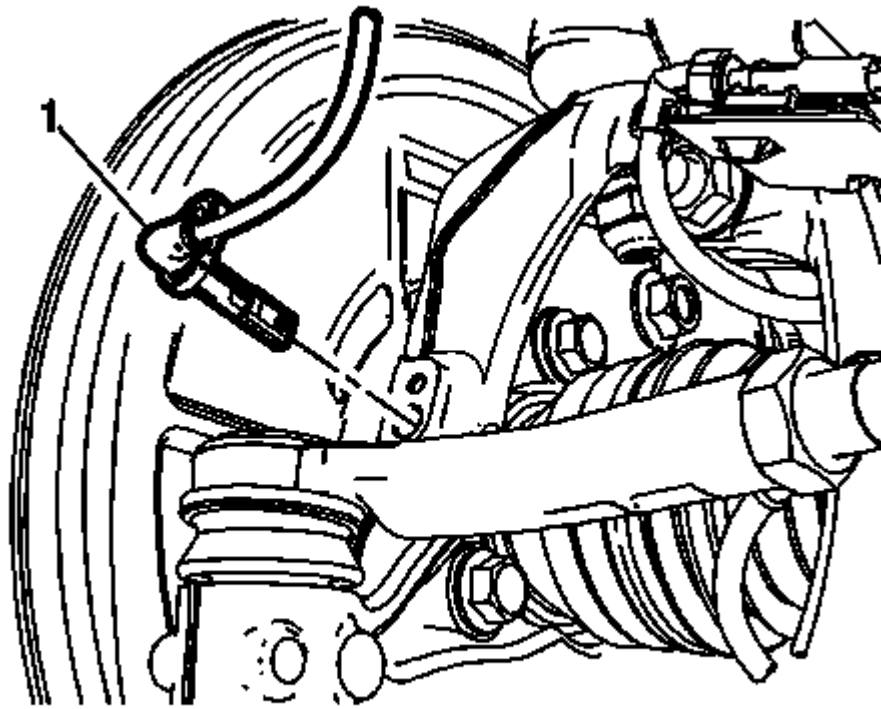


Fig. 31: Wheel Speed Sensor

Courtesy of GENERAL MOTORS COMPANY

1. Install the wheel speed sensor (1) to the steering knuckle.

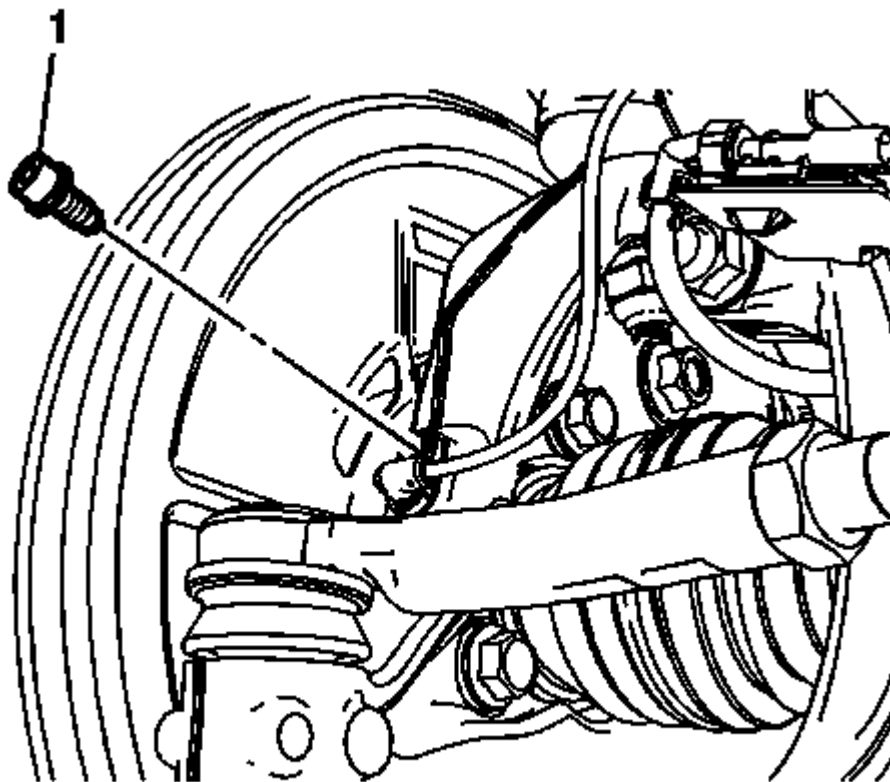


Fig. 32: Wheel Speed Sensor Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the wheel speed sensor bolt (1) and tighten to 9 N.m (80 lb in).

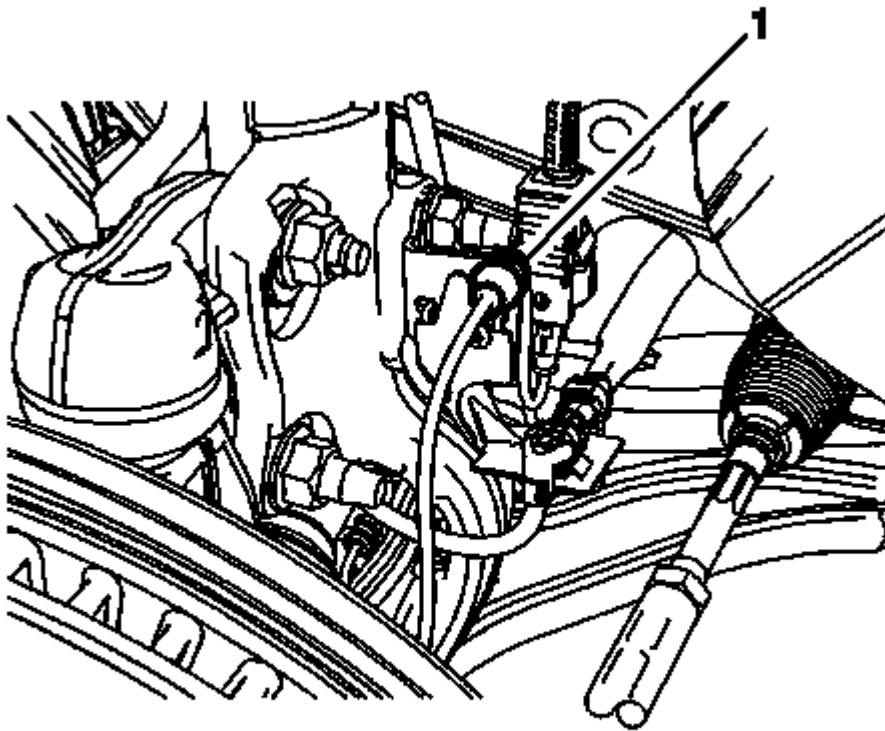


Fig. 33: Wheel Speed Sensor Harness Grommet
Courtesy of GENERAL MOTORS COMPANY

3. Install the wheel speed sensor harness grommet (1) to the strut bracket.

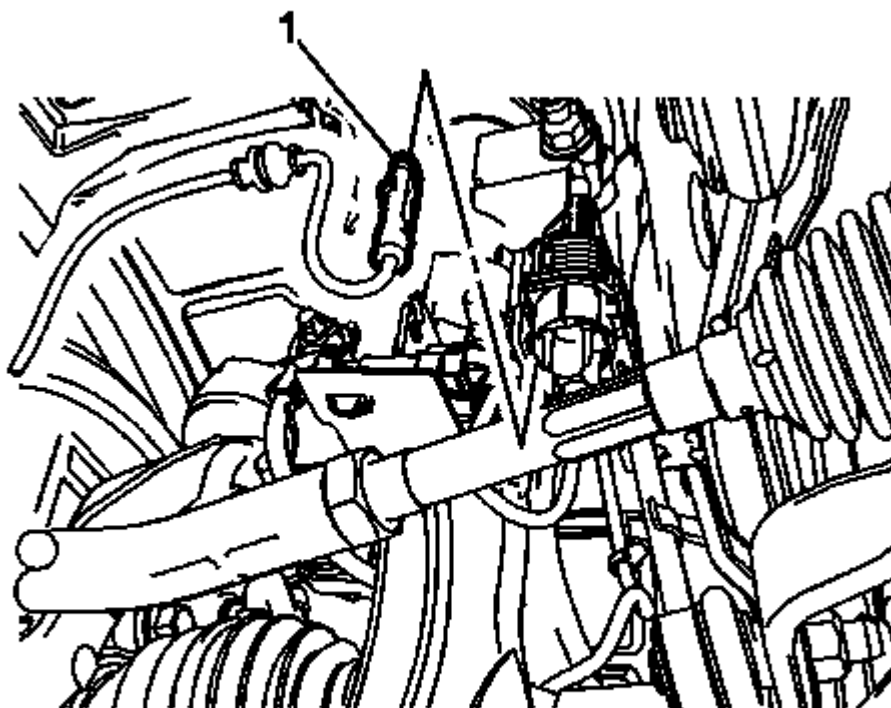


Fig. 34: Wheel Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Lock and connect the wheel speed sensor electrical connector (1). Refer to **Electronic Suspension Position Sensor Front Jumper Harness Disconnection** .
5. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
6. Perform the **Diagnostic System Check - Vehicle** .

REAR WHEEL SPEED SENSOR REPLACEMENT

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .
4. Clean the wheel speed sensor mounting area on the suspension knuckle of any accumulated dirt and debris.

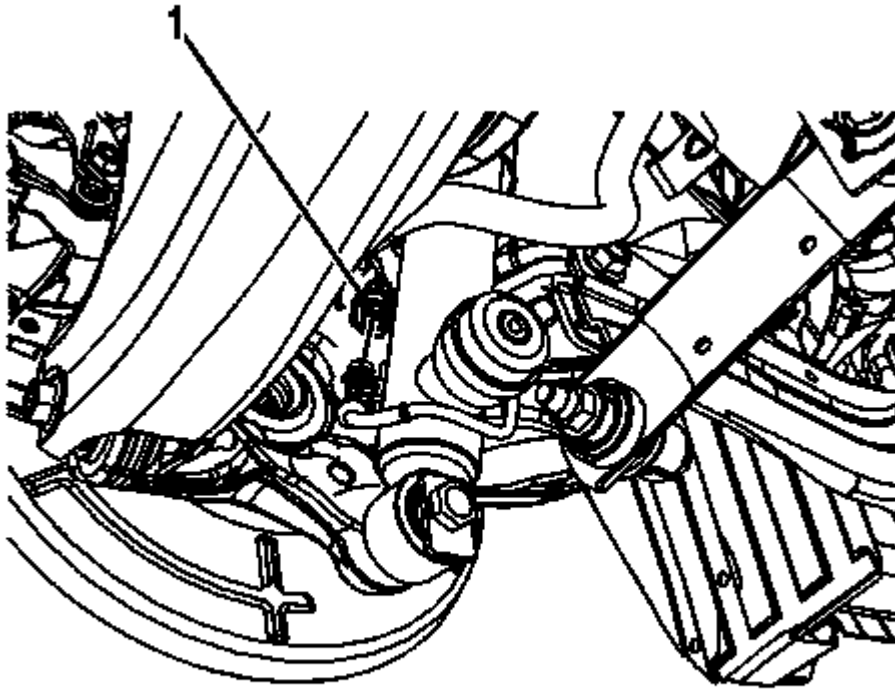


Fig. 35: Shock Absorber Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the shock absorber electrical connector (1), if equipped.

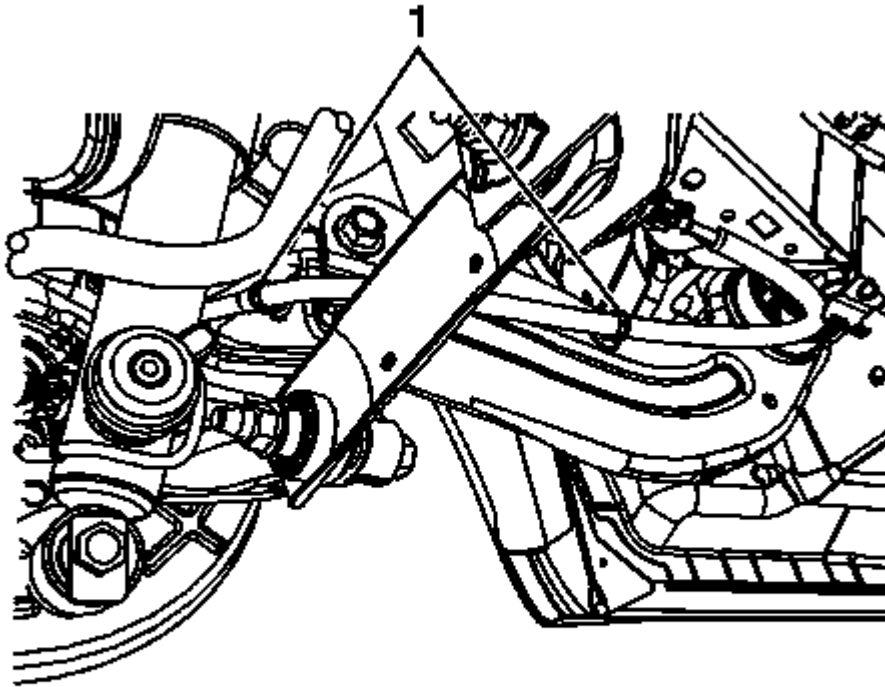


Fig. 36: Wheel Speed Sensor Harness Clips And Rear Suspension Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Release the wheel speed sensor harness clips (1) from the rear suspension bracket.
7. Disconnect the wheel speed sensor harness electrical connector.

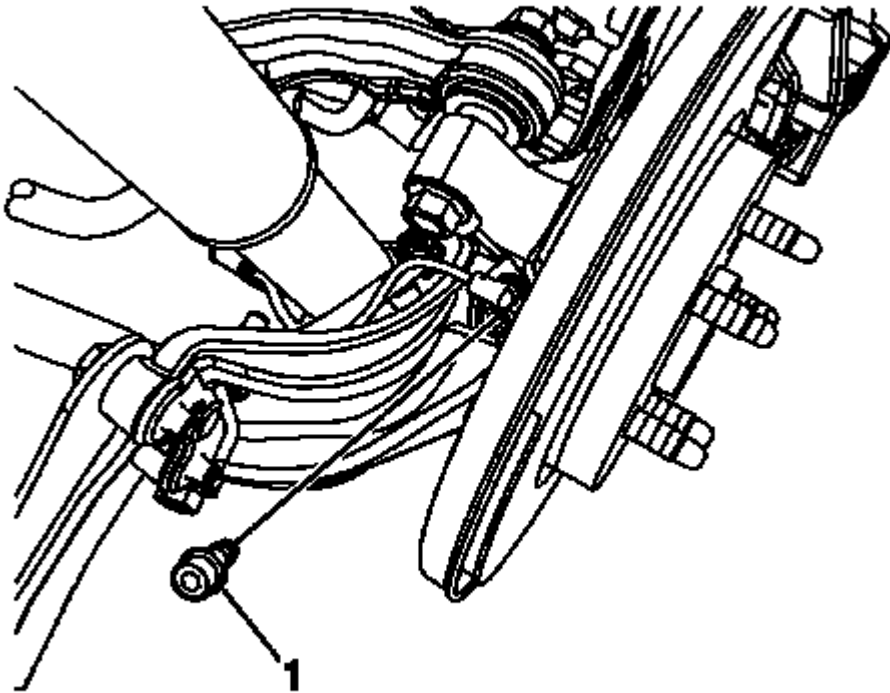


Fig. 37: Wheel Speed Sensor Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the wheel speed sensor bolt (1).
9. Remove the wheel speed sensor from the rear suspension knuckle.

Installation Procedure

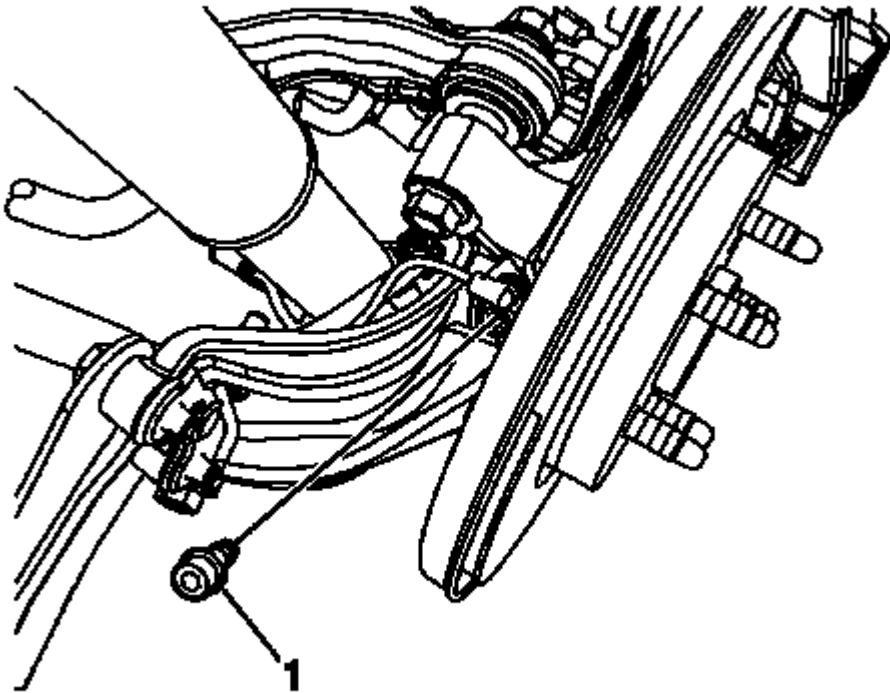


Fig. 38: Wheel Speed Sensor Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the wheel speed sensor to the rear suspension knuckle.

CAUTION: Refer to Fastener Caution .

2. Install the wheel speed sensor bolt (1) and tighten to 9 N.m (80 lb 0n).

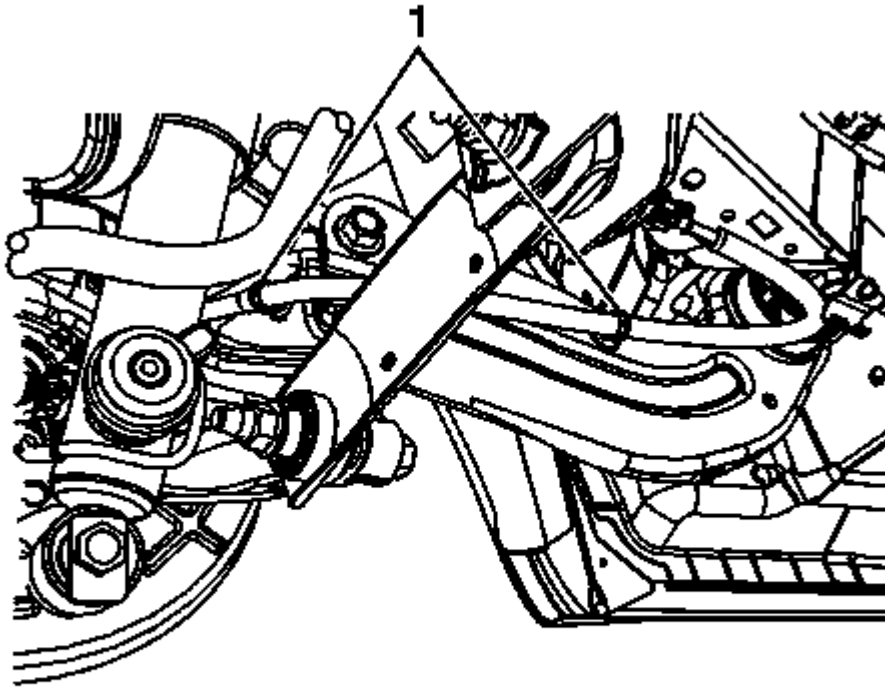


Fig. 39: Wheel Speed Sensor Harness Clips And Rear Suspension Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Install the wheel speed sensor harness clips (1) to the rear suspension bracket.
4. Connect the wheel speed sensor harness electrical connector.

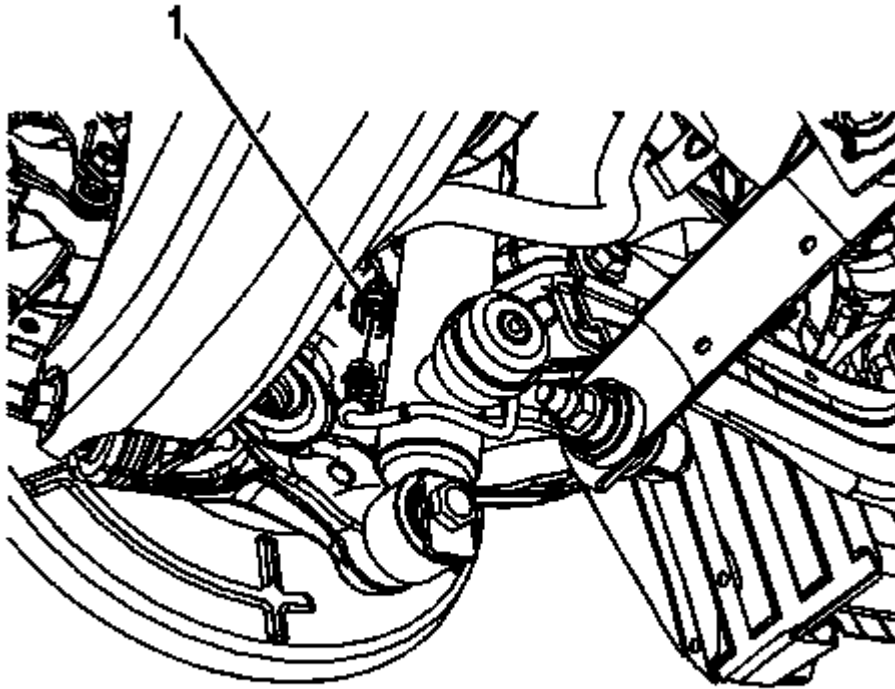


Fig. 40: Shock Absorber Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect the shock absorber electrical connector (1), if equipped.
6. Install the rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .
7. Install the rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Perform the **Diagnostic System Check - Vehicle** .

VEHICLE YAW SENSOR LEARN

The yaw sensor does not require calibration often. Calibration of the yaw rate sensor might be required after certain service procedures are performed. Some of these procedures are as follows:

- Electronic brake control module (EBCM) replacement. Refer to **Electronic Parking Brake Control Module Replacement**
- Yaw rate sensor replacement. Refer to **Vehicle Yaw Sensor Replacement**

The Yaw Rate Sensor Learn procedure can be completed with a scan tool using the following steps:

1. Place vehicle on a level surface

2. Apply the parking brake, or set the transmission in the P position.
3. Install the scan tool to the data link connector.
4. Ignition ON, engine OFF
5. Select Yaw Rate Sensor Reset in the Multi-axis Acceleration Sensor Module Configuration/Reset Functions list.
6. Follow the scan tool directions to complete the calibration procedure.
7. Select Yaw Rate Sensor Learn in the Multi-axis Acceleration Sensor Module Configuration/Reset Functions list.
8. Follow the scan tool directions to complete the calibration procedure.
9. Select Yaw Rate Sensor Learn in the EBCM Configuration/Reset Functions list.
10. Follow the scan tool directions to complete the calibration procedure.
11. Clear any DTCs that may be set.

VEHICLE YAW SENSOR REPLACEMENT

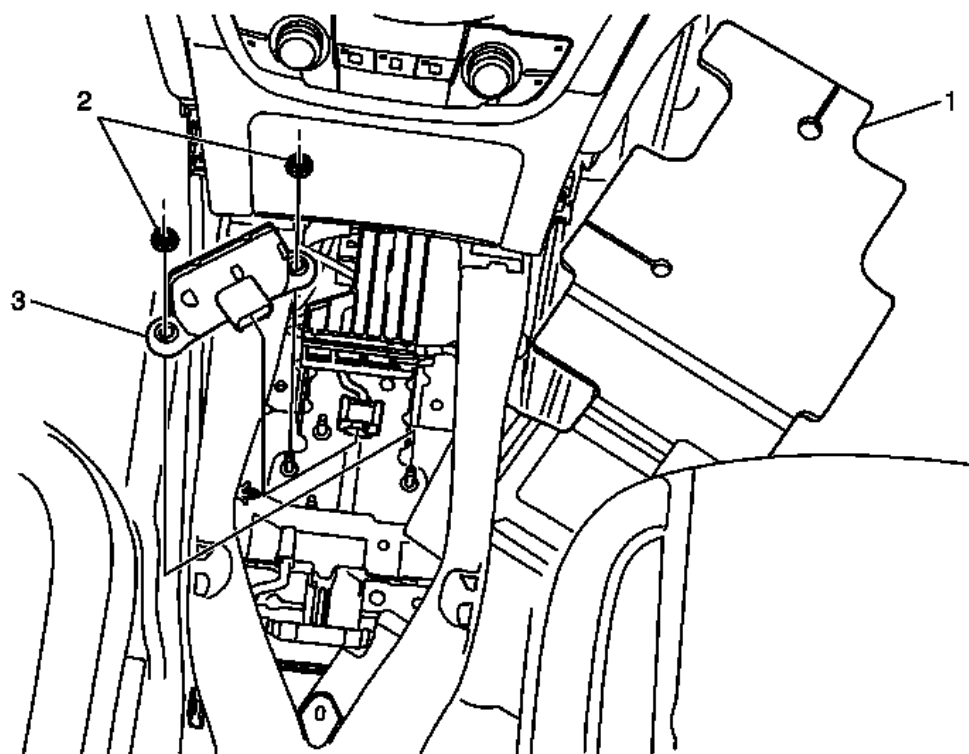


Fig. 41: Vehicle Yaw Sensor & Nuts
 Courtesy of GENERAL MOTORS COMPANY

Vehicle Yaw Sensor Replacement

Callout	Component Name
Preliminary Procedures	
Remove the front floor console. Refer to <u>Front Floor Console Replacement</u> .	
1	Front Floor Tunnel Insulation

2	<p>Vehicle Yaw Sensor Nut (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 9 N.m (80 lb in)</p>
3	<p>Vehicle Yaw Sensor</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Perform a diagnostic system check. Refer to <u>Diagnostic System Check - Vehicle</u> . 2. Perform a steering angle sensor calibration. Refer to <u>Vehicle Yaw Sensor Learn</u>.

DESCRIPTION AND OPERATION

ABS DESCRIPTION AND OPERATION

This vehicle is equipped with a TRW EBC460 brake system. The electronic brake control module and the brake pressure modulator are serviced separately. The brake pressure modulator uses a four circuit configuration to control hydraulic pressure to each wheel independently.

Depending on options, the following vehicle performance enhancement systems are provided.

- ABS
- Traction control
- Stability control
- Dynamic rear proportioning
- Hill hold start assist
- Cornering brake control
- Hydraulic Brake Assist
- Optimized Hydraulic Braking System
- Intelligent brake assist
- Trailer stability assist

The following components listed below are involved in the operation of the brake system:

- Electronic brake control module - The electronic brake control module controls the system functions and detects failures. It supplies voltage to the solenoid valves and pump motor.
- Brake pressure modulator - The brake pressure modulator contains the following components:
 - Brake pressure sensor
 - Hydraulic pump with pump motor

- Four isolation valves
- Four dump valves
- Two traction/stability control supply valves
- Two traction/stability control isolation valves
- High pressure accumulator
- Low pressure accumulator
- Body control module monitors the brake pedal position sensor signal when the brake pedal is applied and sends a high speed serial data message to the electronic brake control module indicating the brake pedal position.
- Brake pressure sensor is used to sense the action of the driver application of the brake pedal. The sensor provides an analog voltage signal that will increase as the brake pedal is applied. The electronic brake control module monitors the brake pressure sensor which is integral to the brake pressure modulator.
- Instrument cluster - The instrument cluster displays the vehicle speed based on the information from the engine control module. The engine control module sends the vehicle speed information via a high speed serial data to the body control module. The body control module then sends the vehicle speed information via a low speed serial data to the instrument cluster in order to display the vehicle speed, either in kilometers or miles, based on the vehicle requirements.
- Multi-axis acceleration sensor in vehicles equipped (without KSG) - The yaw rate, lateral acceleration and longitudinal acceleration sensors are combined into one multi-axis acceleration sensor, internal to the inflatable restraint sensing and diagnostic module. The electronic brake control module receives serial data message inputs from the yaw rate, lateral acceleration and longitudinal acceleration sensor and activates stability control and hill hold start assist function depending on multi-axis acceleration sensor input.
- Multi-axis acceleration sensor in vehicles equipped (with KSG) - The yaw rate, lateral acceleration and longitudinal acceleration sensors are combined into one multi-axis acceleration sensor, external to the electronic brake control module. The electronic brake control module receives serial data message inputs from the yaw rate, lateral acceleration and longitudinal acceleration sensor and activates stability control depending on multi-axis acceleration sensor input.
- Multifunction switch - The traction control switch is a multifunction momentary switch. The body control module monitors the signal circuit from the traction control switch and sends a high speed serial data message to the electronic brake control module indicating the switch position. The traction control and stability control are manually disabled or enabled by pressing the traction control switch.
- Steering wheel angle sensor - The electronic brake control module receives serial data message inputs from the steering angle sensor. The steering wheel angle sensor signal is used to calculate the intended driving direction.
- Transmission control module - The electronic brake control module receives high speed serial data message inputs from the transmission control module indicating the gear position of the transmission for hill start assist or hill hold functions.
- Active wheel speed sensors - The electronic brake control module supplies a ignition voltage to each wheel speed sensor. As the wheel spins, the wheel speed sensor produces an alternating current square wave signal. The electronic brake control module uses the frequency of the square wave signal to calculate the wheel speed. The electronic brake control module uses the frequency of the square wave signal to calculate the wheel speed. The electronic brake control module sends the wheel speed information via high speed serial data to the engine control module.

Power-Up-Self Test

The electronic brake control module is able to detect many malfunctions whenever the ignition is ON. However, certain failures cannot be detected unless active diagnostic tests are performed on the components. Shorted solenoid coil or motor windings, for example, cannot be detected until the components are commanded ON by the electronic brake control module. Therefore, a power-up self-test is performed to verify correct operation of system components. The electronic brake control module performs the first phase of the power-up self-test when the ignition is first turned ON. This phase consists of internal self-testing of the electronic brake control module along with electrical checks of system sensors and circuits.

Initialization Sequence

The initialization sequence cycles each solenoid valve and the pump motor, as well as the necessary relays, for approximately forty milliseconds to check component operation. One of the checks performed is the adaptive pressure calibration that occurs when the engine is running and the brake pedal is not applied. The adaptive pressure calibration will cycle each of the six isolation valves to verify valve operation. The initialization sequence may be heard and felt while it is taking place, and is considered part of normal system operation. The active test is initiated by the electronic brake control module at the start of the ignition cycle and the speed of the fastest wheel exceeds 16 km/h (10 MPH). If a fault condition is detected the electronic brake control module sets a DTC.

ABS

When wheel slip is detected during a brake application, an ABS event occurs. During ABS braking, hydraulic pressure in the individual wheel circuits is controlled to prevent any wheel from slipping. A separate hydraulic line and specific solenoid valves are provided for each wheel. The ABS can decrease, hold, or increase hydraulic pressure to each wheel. The ABS does not, however, increase hydraulic pressure above the amount which is transmitted by the master cylinder during braking.

During ABS braking, a series of rapid pulsations is felt in the brake pedal. These pulsations are caused by the rapid changes in position of the individual solenoid valves as the electronic brake control module responds to wheel speed sensor inputs and attempts to prevent wheel slip. These pedal pulsations are present only during ABS braking and stop when normal braking is resumed or when the vehicle comes to a stop. A ticking or popping noise may also be heard as the solenoid valves cycle rapidly. During ABS braking on dry pavement, intermittent chirping noises may be heard as the tires approach slipping. These noises and pedal pulsations are considered normal during ABS operation.

Vehicles equipped with ABS may be stopped by applying normal force to the brake pedal. Brake pedal operation during normal braking is no different than that of previous non-ABS systems. Maintaining a constant force on the brake pedal provides the shortest stopping distance while maintaining vehicle stability. The typical ABS activation sequence is as follows.

Pressure Hold

The electronic brake control module closes the isolation valve and keeps the dump valve closed in order to isolate the slipping wheel when wheel slip occurs. This holds the pressure steady on the brake so that the hydraulic pressure does not increase or decrease.

Pressure Decrease

If a pressure hold does not correct the wheel slip condition, a pressure decrease occurs. The electronic brake control module decreases the pressure to individual wheels during deceleration when wheel slip occurs. The isolation valve is closed and the dump valve is opened. The excess fluid is stored in the accumulator until the pump can return the fluid to the master cylinder or fluid reservoir.

Pressure Increase

After the wheel slip is corrected, a pressure increase occurs. The electronic brake control module increases the pressure to individual wheels during deceleration in order to reduce the speed of the wheel. The isolation valve is opened and the dump valve is closed. The increased pressure is delivered from the master cylinder.

Traction Control

When drive wheel slip is noted, the electronic brake control module will enter traction control mode.

First, the electronic brake control module requests the engine control module to reduce the amount of torque to the drive wheels via a serial data message. The engine control module reduces torque to the drive wheels and reports the amount of delivered torque.

If the engine torque reduction does not reduce drive wheel slip, the electronic brake control module will actively apply the brakes on the slipping drive wheel. During traction control braking, hydraulic pressure in each drive wheel circuit is controlled to prevent the drive wheels from slipping. The electronic brake control module commands the pump motor and appropriate solenoid valves ON and OFF to apply brake pressure to the slipping wheel.

Stability Control

Stability control provides added stability during aggressive maneuvers. Yaw rate is the rate of rotation about the vehicle's vertical axis. The stability control is activated when the electronic brake control module determines that the desired yaw rate does not match the actual yaw rate as measured by the yaw rate sensor.

The desired yaw rate is calculated by the electronic brake control module using the following inputs:

- Steering wheel position
- Vehicle speed
- Lateral acceleration

The difference between the desired yaw rate and the actual yaw rate is the yaw rate error, which is a measurement of oversteer or understeer. When a yaw rate error is detected, the electronic brake control module attempts to correct the vehicle's yaw motion by applying brake pressure to one or more of the wheels. The amount of applied brake pressure varies, depending on the correction required. The engine torque may be reduced also, if it is necessary to slow the vehicle while maintaining stability.

Stability control activations generally occur in turns during aggressive driving. When braking during stability control activation, the brake pedal may pulsate.

Dynamic Rear Proportioning

The dynamic rear proportioning is a control system that replaces the mechanical proportioning valve. Under certain driving conditions the electronic brake control module will reduce the rear wheel brake pressure by commanding the appropriate solenoid valves ON and OFF.

Hill Hold Start Assist

The hill hold start assist allows the driver to launch the vehicle without a roll back while moving the foot from the brake pedal to the accelerator pedal. The electronic brake control module calculates the brake pressure, which is needed to hold the vehicle on an incline and locks that pressure for a certain time by commanding the appropriate solenoid valves ON and OFF when the brake pedal is released. Hill hold start assist is activated when the electronic brake control module determines that the driver wishes to move the vehicle up-hill, either backwards or forwards.

The following inputs are used for hill hold start assist feature:

- Accelerator pedal position
- Brake switch
- Brake pressure
- Clutch switch, if equipped
- Engine torque
- Longitudinal acceleration
- Reverse gear information
- Vehicle speed

Cornering Brake Control

Cornering brake control is a slip control function that is intended to improve the vehicle's lateral/yaw stability during combined braking and cornering situations.

The electronic brake control module will reduce the brake pressure to the inside wheels by commanding the appropriate solenoid valves ON and OFF.

Hydraulic Brake Assist

The hydraulic brake assist function is designed to support the driver in emergency braking situations.

The electronic brake control module receives inputs from the brake pressure sensor. When the electronic brake control module senses an emergency braking situation, the electronic brake control module will actively increase the brake pressure to a specific maximum.

Intelligent Brake Assist

The intelligent brake assist function is designed to provide limited braking to help prevent front and rear low speed collisions.

The electronic brake control module receives inputs from the brake pedal position sensor, wheel speed sensors, short range radar and ultrasonic sensors to detect a collision. When the electronic brake control module senses a possible collision, it will actively increase the hydraulic brake pressure to apply the brakes.

Optimized Hydraulic Braking System

With some engines the electronic brake control module monitors the vacuum in the brake booster with a vacuum sensor and controls a brake booster vacuum pump depending on vacuum sensor input. It also has a hydraulic brake boost feature which supplements the brake system to maintain consistent brake performance under conditions of low brake booster vacuum. Low brake booster vacuum conditions can include initial start up after the vehicle has been parked for several hours, very frequent brake stops, or high altitude driving. The hydraulic brake boost system activates only during a brake apply under low vacuum conditions. In this case the electronic brake control module will actively increase and control the hydraulic brake pressure by turning the pump motor ON and the appropriate solenoid valves ON and OFF. When hydraulic brake boost is active, a series of rapid pulsations is felt in the brake pedal.

Trailer Stability Assist

The trailer stability assist will detect any vehicle yaw instability, caused by an attached trailer. When instability is detected, the electronic brake control module attempts to correct the vehicle's yaw motion by applying brake pressure to one or more of the wheels. The engine torque may be reduced also, if it is necessary to slow down the vehicle.

Driver Information Indicators

ABS Indicator

The instrument cluster turns the ABS indicator ON when the following occurs:

- The instrument cluster performs the bulb check.
- The electronic brake control module detects a malfunction which disables the ABS and sends a serial data message to the instrument cluster requesting illumination.

Brake Warning Indicator

The instrument cluster turns the brake warning indicator ON when the following occurs:

- The instrument cluster performs the bulb check.
- The electronic brake control module detects a faulty pump motor, solenoid valves, an internal hardware failure or a too high or too low battery voltage and sends a serial data message to the instrument cluster requesting illumination.
- The body control module detects that the parking brake is engaged. The instrument cluster receives a serial data message from the body control module requesting illumination.

Traction Control Off Indicator

The instrument cluster turns the traction control off indicator ON when the following occurs:

- The instrument cluster performs the bulb check.
- The driver manually disables the traction control by pressing the traction control switch. The electronic brake control module sends a serial data message to the instrument cluster requesting illumination.

Stability Control Off Indicator

The instrument cluster turns the stability control off indicator ON when the following occurs:

- The instrument cluster performs the bulb check.
- The driver manually disables the stability control by pressing and holding the traction control switch for five seconds. The electronic brake control module sends a serial data message to the instrument cluster requesting illumination.

Traction/Stability Control Indicator

The instrument cluster turns the traction/stability control indicator ON when the following occurs:

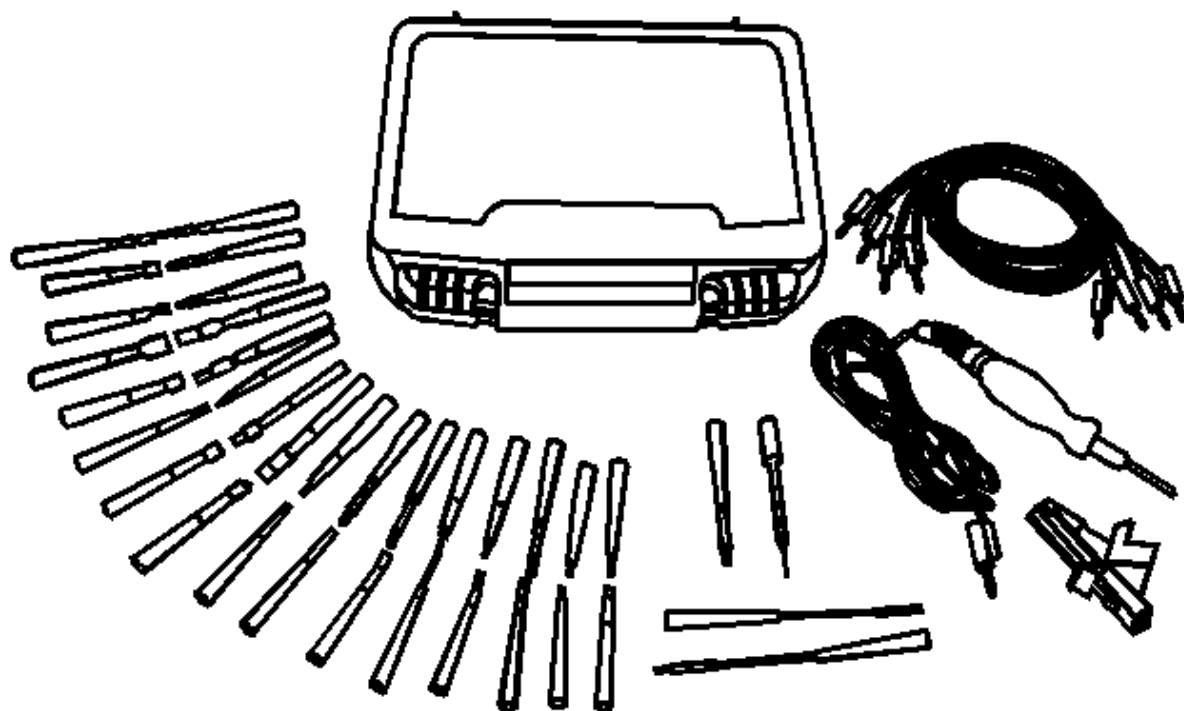
- The instrument cluster performs the bulb check.
- The ABS system is in traction control or stability control mode.
- The electronic brake control module detects a traction/stability control disabling malfunction and sends a serial data message to the instrument cluster requesting illumination.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	EL 35616-F J 35616 GM-

Approved
Terminal
Test Kit



Transmission

Automatic Transmission - 6T40 (MH8 MHH) - Component Locator

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Case and Associated Parts

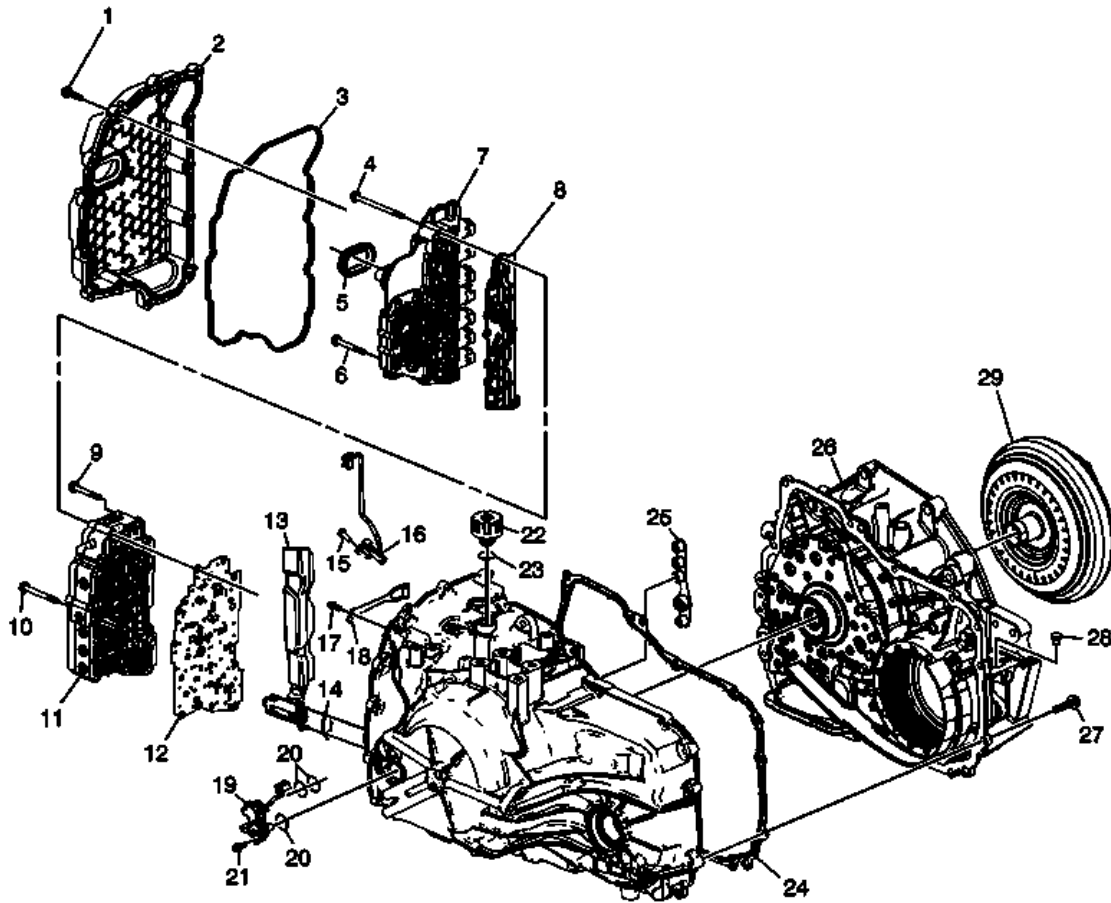


Fig. 1: Disassembled View Of Case & Associated Parts

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Control Valve Body Cover Bolt
2	Control Valve Body Cover Assembly
3	Control Valve Body Cover Gasket
4	Control Valve Body Bolt

5	Control Valve Body Cover Hole Seal
6	Control Solenoid Valve Heat Sink Bolt
7	Control Solenoid (w/Body and TCM) Valve Assembly
8	Control Valve Body Filter Plate Assembly
9	Control Valve Body Bolt
10	Control Valve Body Bolt
11	Control Valve Body Assembly
12	Control Valve Body Spacer Plate Assembly
13	A/Trans Fluid Level Control Valve
14	A/Trans Fluid Level Control Valve Gasket
15	A/Trans Output Speed Sensor Bolt
16	A/Trans Output Speed Sensor Assembly
17	Manual Shaft Detent Spring Bolt
18	Manual Shaft Detent Lever Spring Assembly
19	A/Trans Input Speed Sensor Assembly
20	A/Trans Input Speed Sensor Assembly O-Ring Seal
21	A/Trans Input Speed Sensor Bolt
22	Fill Cap
23	Fill Cap Seal
24	Torque Converter Housing Gasket
25	A/Trans Fluid Pump Seal Assembly
26	Torque Converter with Fluid Pump Housing Assembly
27	Torque Converter and Differential Housing Bolt
28	A/Trans Fluid Fill Tube Plug Assembly
29	Torque Converter Assembly

Transmission Case Assembly - 6T30 - Gen 1

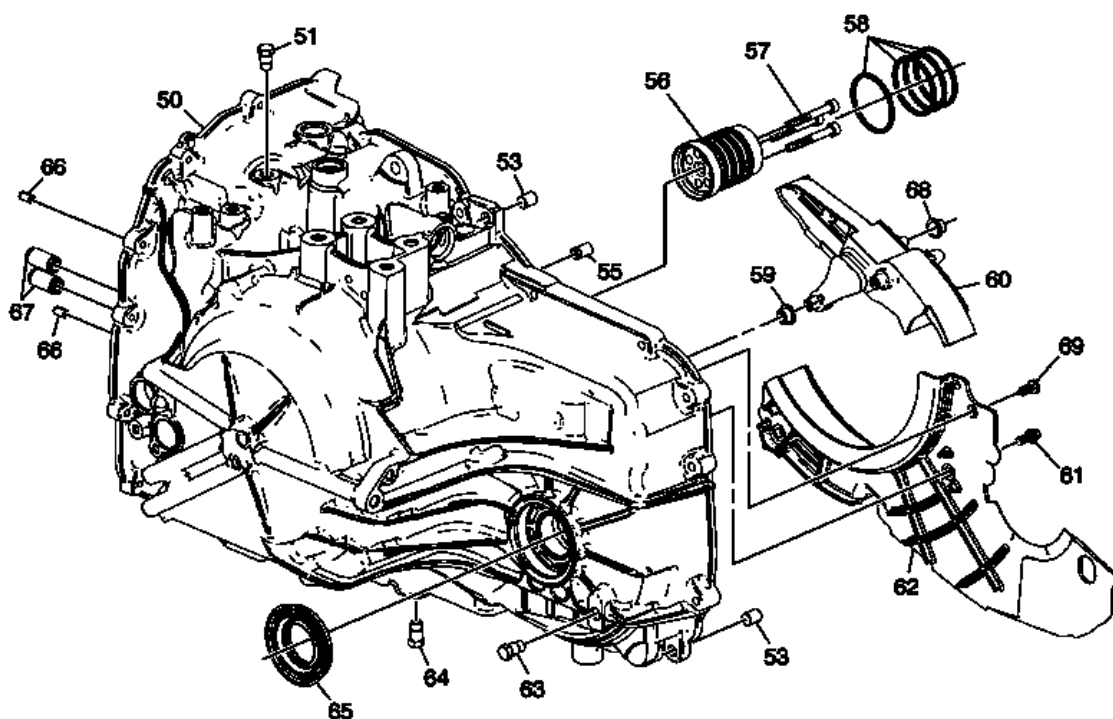


Fig. 2: Transmission Case Assembly -- 6T30 -- Gen 1
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
50	A/Trans Case Assembly
51	A/Trans Fluid Pressure Test Hole Plug
53	Transmission Case Cover Locator Pin
55	A/Trans Fluid Check Ball
56	Input Shaft Support
57	Input Shaft Support Bolt
58	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
59	Drive Link Lube Fluid Seal
60	Drive Link Lube Scoop
61	Front Differential Carrier Baffle Bolt
62	Front Differential Carrier Baffle
63	Oil Level Plug
64	Drain Plug
65	Drive Shaft Oil Seal Assembly
66	Control Valve Body Locator Pin
67	1-2-3-4 and Low Reverse Clutch Fluid Passage Seal
68	Drive Link Lube Fluid Seal
69	Baffle Retainer

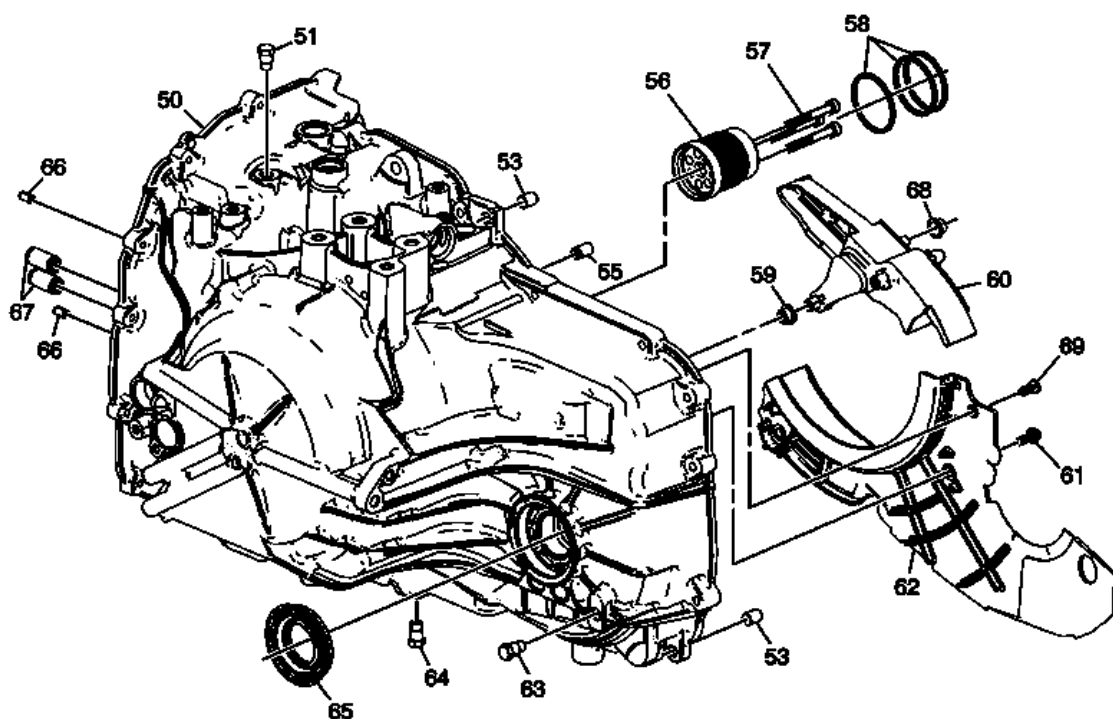


Fig. 3: Transmission Case Assembly -- 6T30 -- Gen 2
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
50	A/Trans Case Assembly
51	A/Trans Fluid Pressure Test Hole Plug
53	Transmission Case Cover Locator Pin
55	A/Trans Fluid Check Ball
56	Input Shaft Support
57	Input Shaft Support Bolt
58	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
59	Drive Link Lube Fluid Seal
60	Drive Link Lube Scoop
61	Front Differential Carrier Baffle Bolt
62	Front Differential Carrier Baffle
63	Oil Level Plug
64	Drain Plug
65	Drive Shaft Oil Seal Assembly
66	Control Valve Body Locator Pin
67	1-2-3-4 and Low Reverse Clutch Fluid Passage Seal
68	Drive Link Lube Fluid Seal
69	Baffle Retainer

Transmission Case Assembly - 6T40/6T45/6T50 - Gen 1

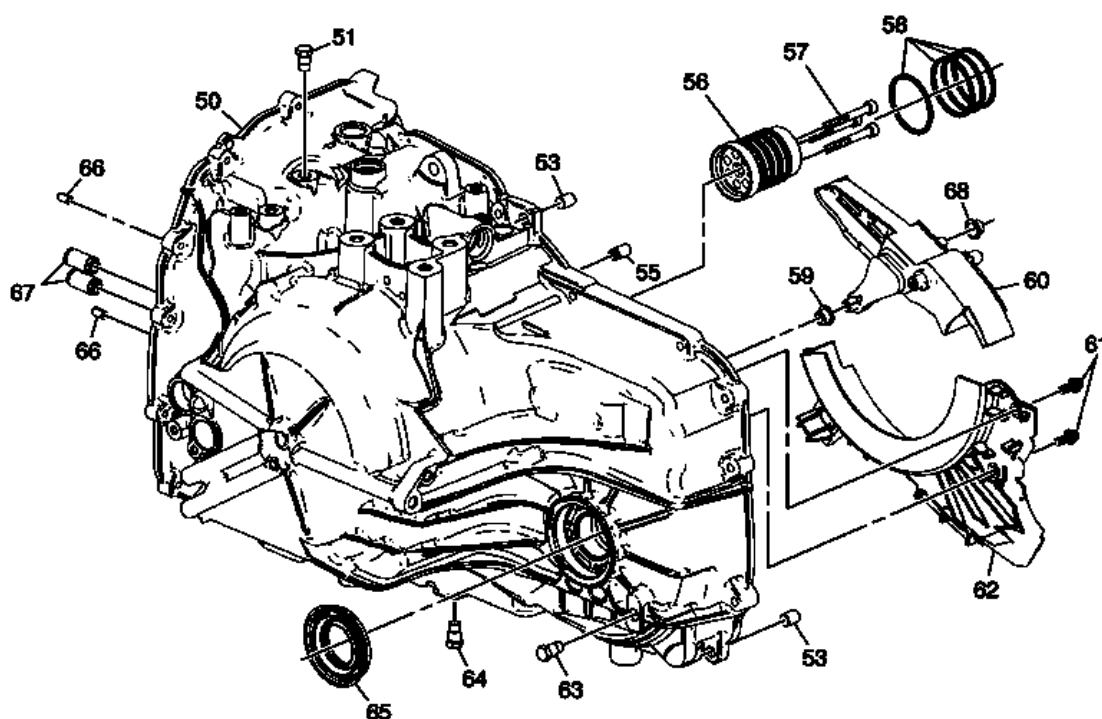


Fig. 4: View Of Transmission Case Assembly
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
50	A/Trans Case Assembly
51	A/Trans Fluid Pressure Test Hole Plug
53	Transmission Case Cover Locator Pin
55	A/Trans Fluid Check Ball
56	Input Shaft Support
57	Input Shaft Support Bolt
58	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
59	Drive Link Lube Fluid Seal
60	Drive Link Lube Scoop
61	Front Differential Carrier Baffle Bolt
62	Front Differential Carrier Baffle
63	Oil Level Plug
64	Drain Plug
65	Drive Shaft Oil Seal Assembly
66	Control Valve Body Locator Pin
67	1-2-3-4 and Low Reverse Clutch Fluid Passage Seal
68	Drive Link Lube Fluid Seal

Transmission Case Assembly - 6T40/6T45/6T50 - Gen 2

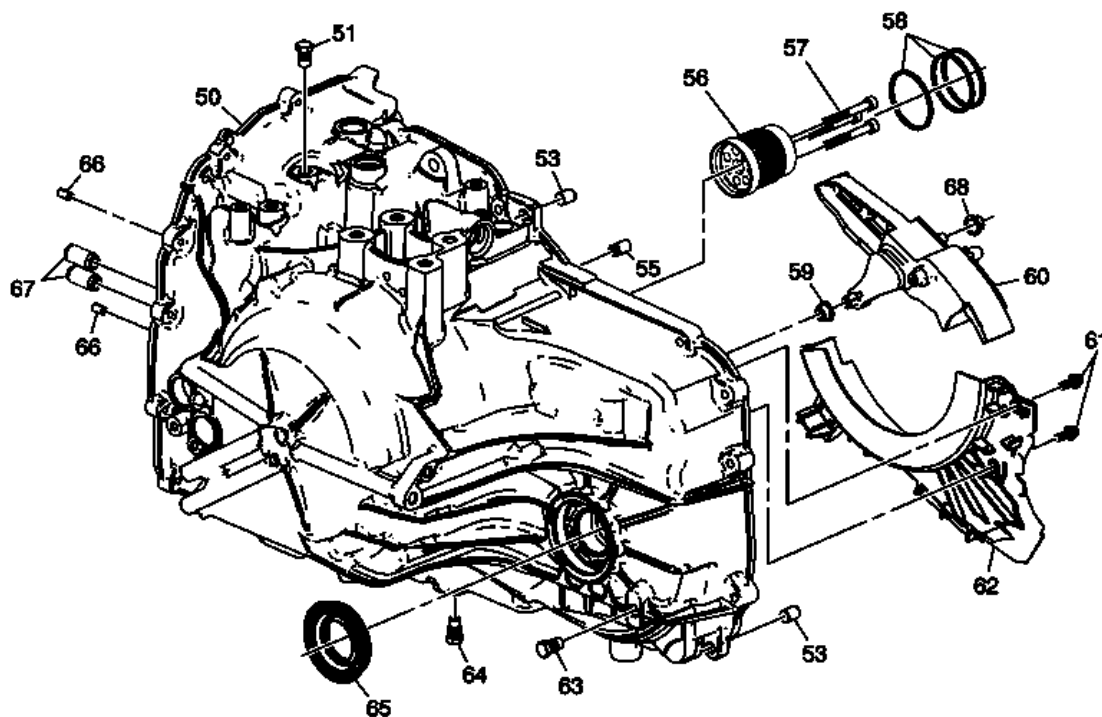


Fig. 5: Transmission Case Assembly Components -- 6T40/6T45/6T50 -- Gen 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
50	A/Trans Case Assembly
51	A/Trans Fluid Pressure Test Hole Plug
53	Transmission Case Cover Locator Pin
55	A/Trans Fluid Check Ball
56	Input Shaft Support
57	Input Shaft Support Bolt
58	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring (Qty: 3)
59	Drive Link Lube Fluid Seal
60	Drive Link Lube Scoop
61	Front Differential Carrier Baffle Bolt
62	Front Differential Carrier Baffle
63	Oil Level Plug
64	Drain Plug
65	Drive Shaft Oil Seal Assembly
66	Control Valve Body Locator Pin
67	1-2-3-4 and Low Reverse Clutch Fluid Passage Seal
68	Drive Link Lube Fluid Seal

Torque Converter and Fluid Pump Housing Assembly- 6T30

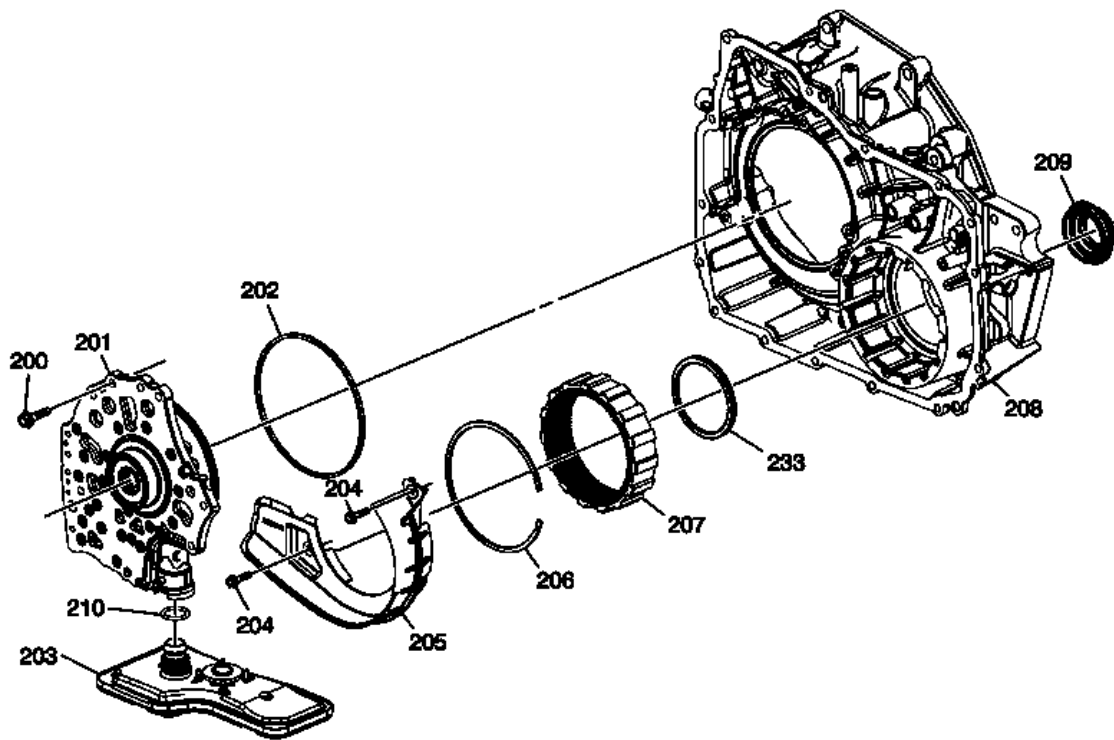


Fig. 6: Torque Converter and Fluid Pump Housing Assembly -- 6T30
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
200	A/Trans Fluid Pump Bolt
201	A/Trans Fluid Pump Assembly
202	Torque Converter and Differential Housing Seal
203	A/Trans Fluid Filter Assembly
204	Front Differential Carrier Baffle Bolt
205	Front Differential Carrier Baffle
206	Front Differential Ring Gear Retainer
207	Front Differential Ring Gear
208	Torque Converter and Differential Housing
209	Front Wheel Drive Shaft Oil Seal Assembly
210	A/Trans Fluid Filter Seal
233	Front Differential Carrier Bearing Assembly

Torque Converter and Fluid Pump Housing Assembly- 6T40/6T45/6T50

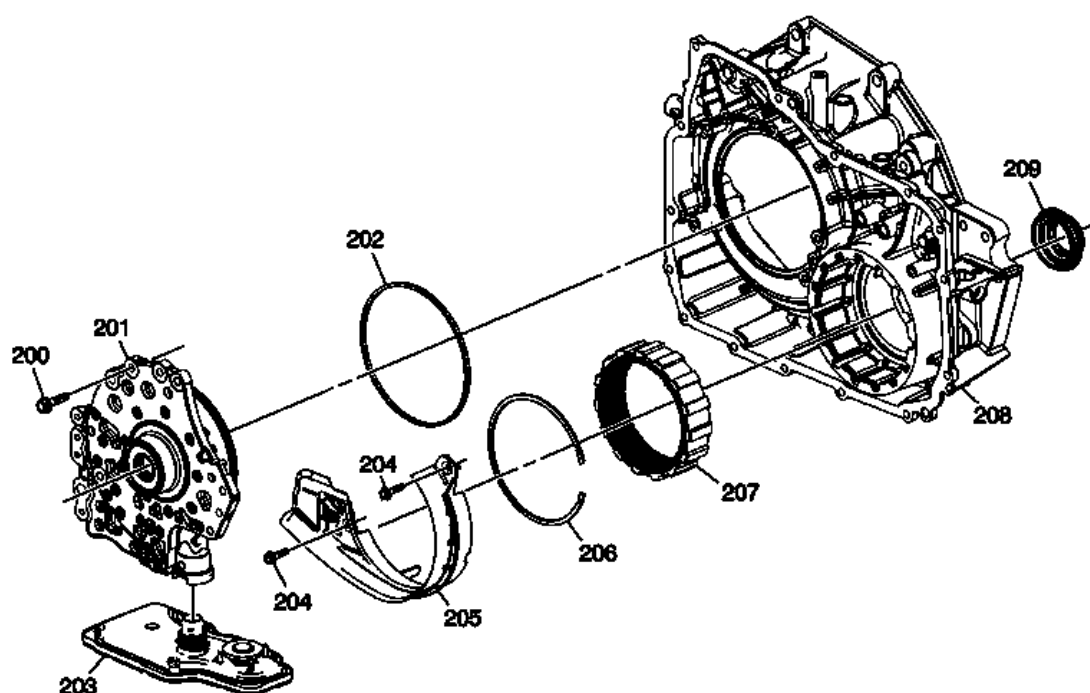


Fig. 7: Torque Converter and Fluid Pump Housing Assembly Components -- 6T40/6T45/6T50 -- Gen 2
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
200	A/Trans Fluid Pump Bolt
201	A/Trans Fluid Pump Assembly
202	Torque Converter and Differential Housing Seal
203	A/Trans Fluid Filter Assembly
204	Front Differential Carrier Baffle Bolt
205	Front Differential Carrier Baffle
206	Front Differential Ring Gear Retainer
207	Front Differential Ring Gear
208	Torque Converter and Differential Housing
209	Front Wheel Drive Shaft Oil Seal Assembly

Drive Link Assembly

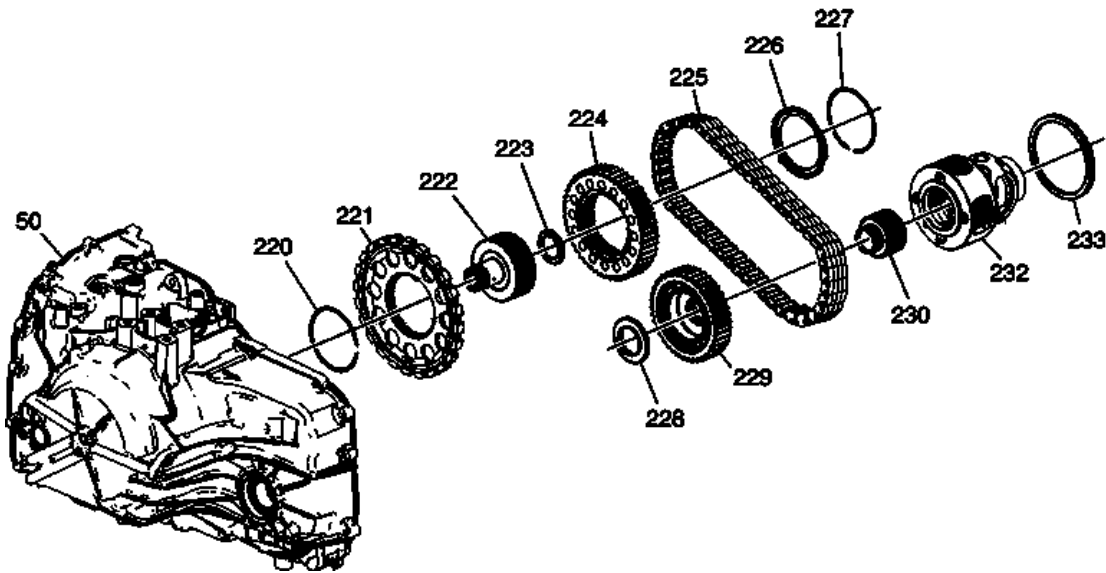


Fig. 8: Disassembled View Of Drive Link Assembly
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
50	A/Trans Case
220	Park Gear Retainer Ring
221	Park Gear
222	Output Carrier Transfer Drive Gear Hub
223	Drive Sprocket Bearing Assembly
224	Drive Sprocket
225	Drive Link Assembly
226	Drive Sprocket Thrust Washer
227	Drive Sprocket Retainer Ring
228	Driven Sprocket Bearing Assembly
229	Driven Sprocket
230	Final Drive Sun Gear
232	Differential Carrier Assembly
233	Front Differential Carrier Bearing Assembly

Oil Pump Assembly- 6T30

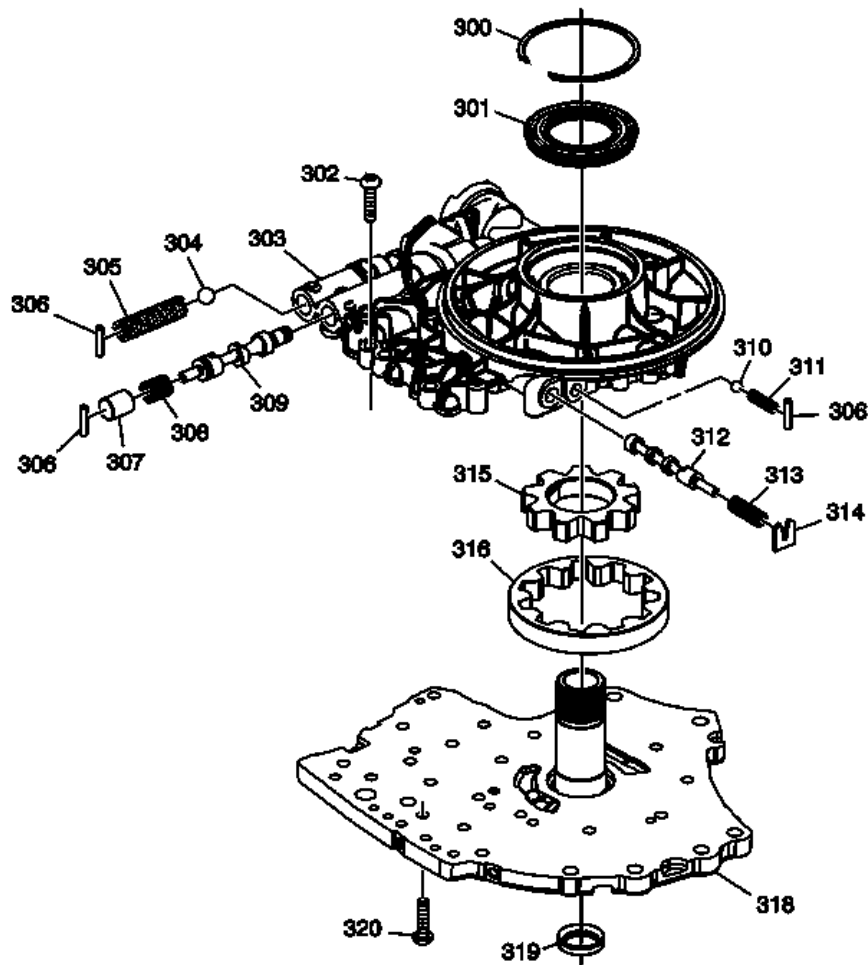


Fig. 9: Oil Pump Assembly -- 6T30
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
300	Torque Converter Fluid Seal Retainer
301	Torque Converter Fluid Seal Assembly
302	A/Trans Fluid Pump Cover Bolt
303	A/Trans Fluid Pump Body
304	Pump Blowoff Ball Valve
305	Pump Blowoff Valve Spring
306	Pressure Regulator Valve Bore Plug Retainer
307	Pressure Regulator Valve Bore Plug
308	Pressure Regulator Valve Spring
309	Pressure Regulator Valve
310	Torque Converter Clutch Blowoff Ball Valve
311	Torque Converter Clutch Blowoff Ball Valve Spring
312	Torque Converter Clutch Control Valve

313	Torque Converter Clutch Control Valve Spring
314	Torque Converter Clutch Control Valve Spring Retainer
315	A/Trans Fluid Pump Drive Gear
316	A/Trans Fluid Pump Driven Gear
318	A/Trans Fluid Pump Cover Assembly
319	Torque Converter Fluid Seal Assembly
320	A/Trans Fluid Pump Cover Bolt

Oil Pump Assembly- 6T40/6T45/6T50- Gen 1

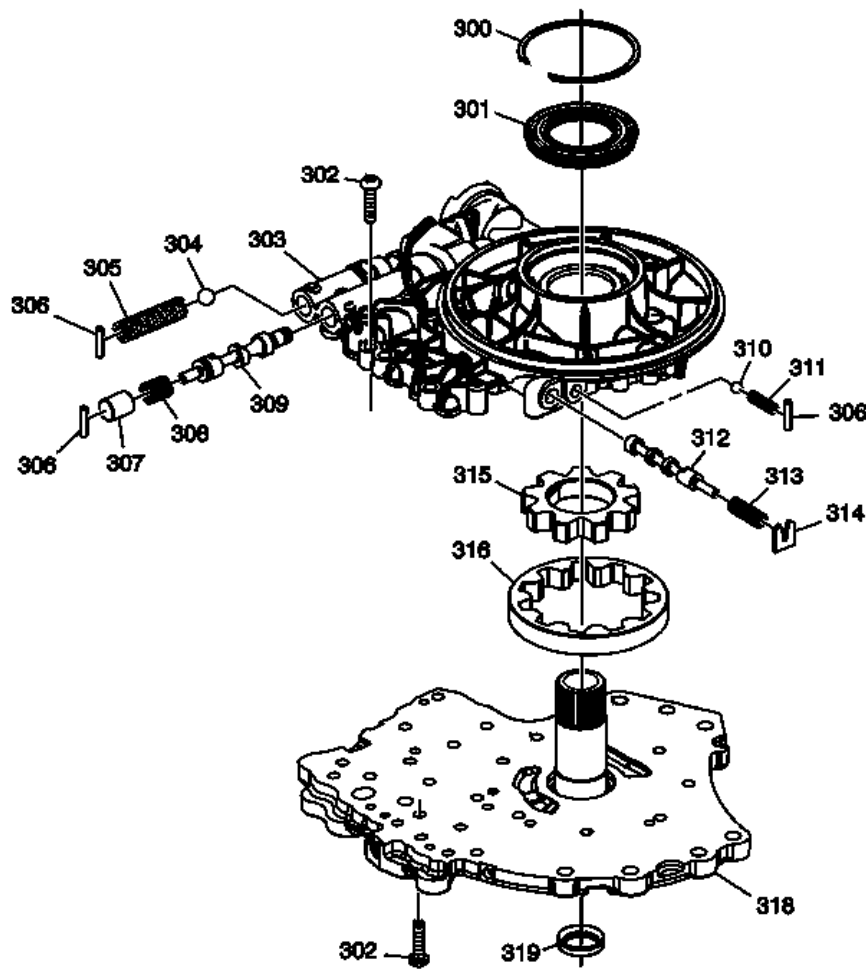


Fig. 10: Disassembled View Of Oil Pump Assembly
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
300	Torque Converter Fluid Seal Retainer
301	Torque Converter Fluid Seal Assembly
302	A/Trans Fluid Pump Cover Bolt

303	A/Trans Fluid Pump Body
304	Pump Blowoff Ball Valve
305	Pump Blowoff Valve Spring
306	Pressure Regulator Valve Bore Plug Retainer
307	Pressure Regulator Valve Bore Plug
308	Pressure Regulator Valve Spring
309	Pressure Regulator Valve
310	Torque Converter Clutch Blowoff Ball Valve
311	Torque Converter Clutch Blowoff Ball Valve Spring
312	Torque Converter Clutch Control Valve
313	Torque Converter Clutch Control Valve Spring
314	Torque Converter Clutch Control Valve Spring Retainer
315	A/Trans Fluid Pump Drive Gear
316	A/Trans Fluid Pump Driven Gear
318	A/Trans Fluid Pump Cover Assembly
319	Torque Converter Fluid Seal Assembly

Oil Pump Assembly- 6T40/6T45/6T50- Gen 2

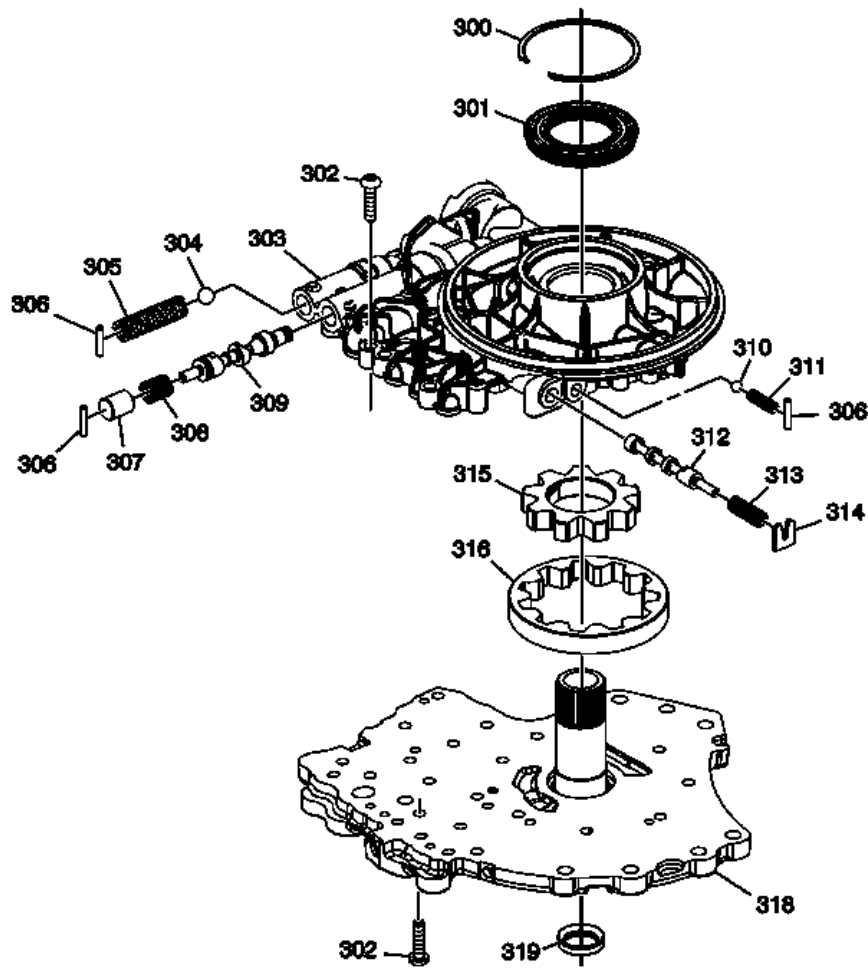


Fig. 11: Oil Pump Assembly Components -- 6T40/6T45/6T50 -- Gen 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
300	Torque Converter Fluid Seal Retainer
301	Torque Converter Fluid Seal Assembly
302	A/Trans Fluid Pump Cover Bolt
303	A/Trans Fluid Pump Body
304	Pump Blowoff Ball Valve
305	Pump Blowoff Valve Spring
306	Pressure Regulator Valve Bore Plug Retainer
307	Pressure Regulator Valve Bore Plug
308	Pressure Regulator Valve Spring
309	Pressure Regulator Valve
310	Torque Converter Clutch Blowoff Ball Valve
311	Torque Converter Clutch Blowoff Ball Valve Spring
312	Torque Converter Clutch Control Valve

313	Torque Converter Clutch Control Valve Spring
314	Torque Converter Clutch Control Valve Spring Retainer
315	A/Trans Fluid Pump Drive Gear
316	A/Trans Fluid Pump Driven Gear
318	A/Trans Fluid Pump Cover Assembly
319	Torque Converter Fluid Seal Assembly

Auxiliary Fluid Pump and Hybrid Components - Hybrid Models

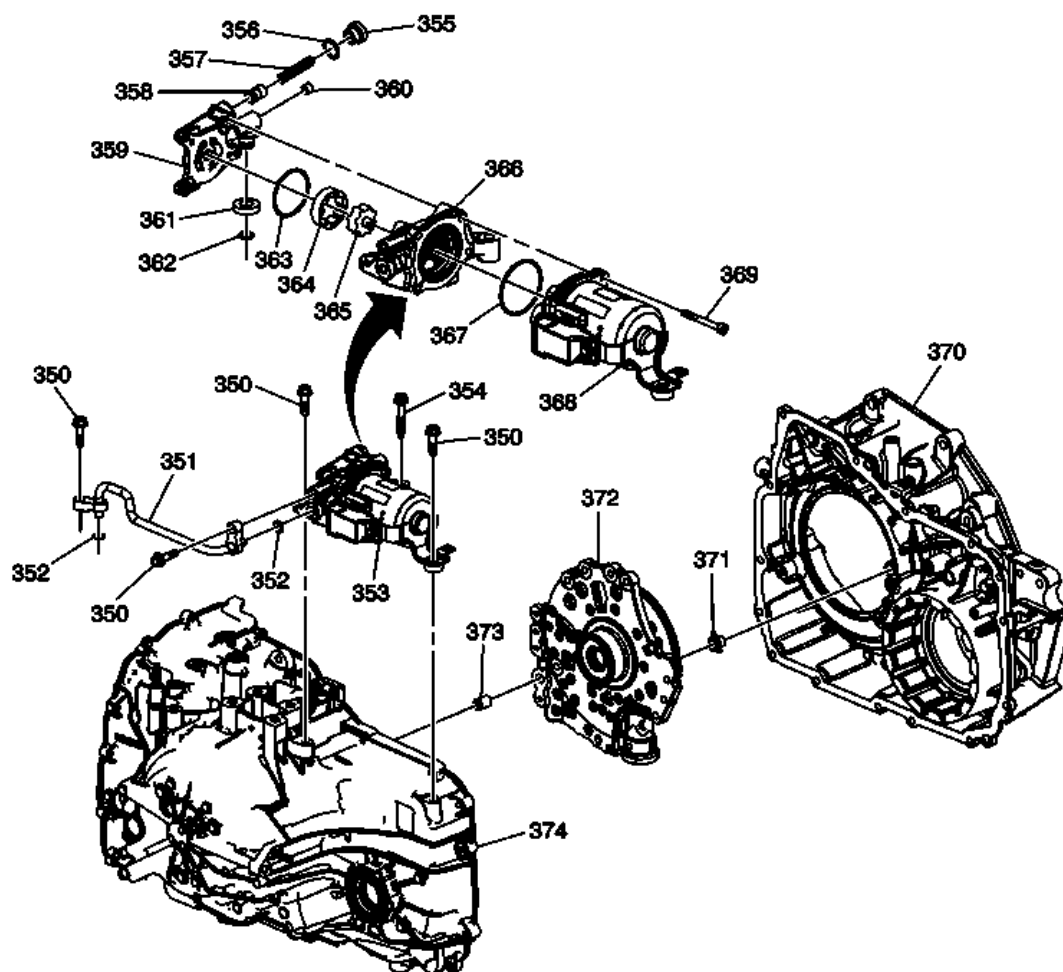


Fig. 12: Auxiliary Fluid Pump and Hybrid Components -- Hybrid Models
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
350	A/Trans Auxiliary Fluid Pump Outlet Bolt (Qty: 4)
351	A/Trans Auxiliary Fluid Pump Outlet Pipe Assembly
352	A/Trans Auxiliary Fluid Pump Outlet Pipe Seal Assembly
353	A/Trans Auxiliary Fluid Pump Assembly

354	A/Trans Auxiliary Fluid Pump Bolt
355	Pressure Regulator Valve Spring Retainer
356	Pressure Regulator Valve Spring Spacer
357	Pressure Regulator Valve Spring
358	Pressure Regulator Valve
359	A/Trans Auxiliary Fluid Pump Cover
360	A/Trans Auxiliary Fluid Pump Cover Hole Plug
361	A/Trans Auxiliary Fluid Pump Gasket
362	A/Trans Auxiliary Fluid Pump Seal
363	A/Trans Auxiliary Fluid Pump Cover Seal
364	A/Trans Auxiliary Fluid Pump Outer Rotor
365	A/Trans Auxiliary Fluid Pump Inner Rotor
366	A/Trans Auxiliary Fluid Pump Body
367	A/Trans Auxiliary Fluid Pump Motor Cover Seal - O-ring
368	A/Trans Auxiliary Fluid Pump Motor Assembly
369	A/Trans Auxiliary Fluid Pump (Pump to Motor) Bolt (Qty: 4)
370	Torque Converter and Differential Housing
371	A/Trans Auxiliary Fluid Inlet Pump Seal
372	A/Trans Fluid Pump Assembly
373	A/Trans Fluid Trough Check Ball
374	A/Trans Case

Control Valve Body Assembly (1 of 2 - Gen 1)

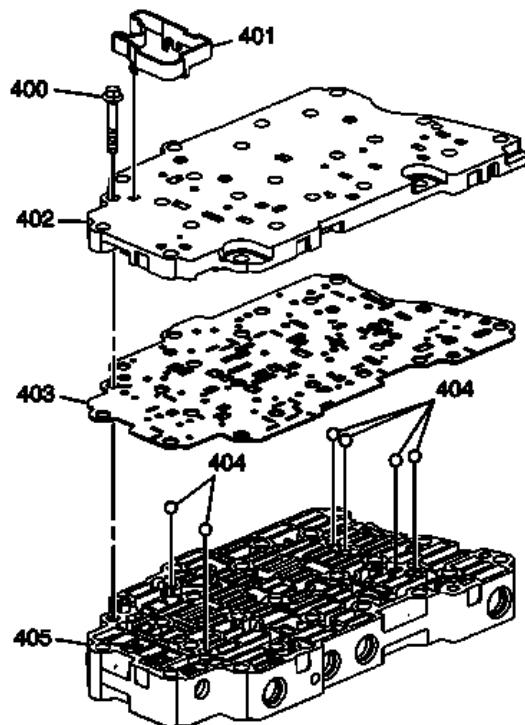


Fig. 13: View Of Control Valve Body Assembly (1 Of 2)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
400	Control Valve Body Bolt
401	Control Solenoid Valve Support
402	Valve Channel Plate
403	Channel Plate to Valve Body Spacer Plate Assembly
404	Control Valve Body Ball Check Valve
405	Control Valve Body Assembly

Control Valve Body Assembly (2 of 2 - Gen 1)

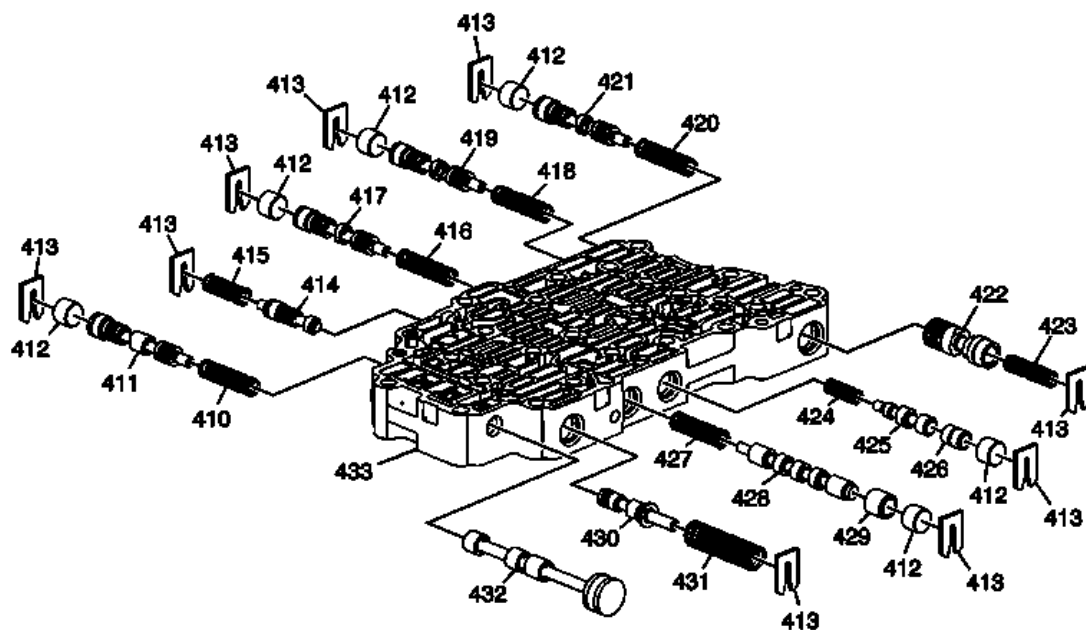


Fig. 14: View Of Control Valve Body Assembly (2 Of 2)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
410	Reverse and 4-5-6 Clutch Regulator Valve Spring
411	Reverse and 4-5-6 Clutch Regulator Valve
412	Clutch Valve Bore Plug
413	Valve Spring Retainer
414	1-2-3-4 Clutch Boost Valve
415	1-2-3-4 Clutch Boost Valve Spring
416	1-2-3-4 Clutch Regulator Valve Spring

417	1-2-3-4 Clutch Regulator Valve
418	2-6 Clutch Regulator Valve Spring
419	2-6 Clutch Regulator Valve
420	3-5-Reverse Clutch Regulator Valve Spring
421	3-5-Reverse Clutch Regulator Valve
422	Clutch Piston Dam Feed Regulator Valve
423	Clutch Piston Dam Feed Regulator Valve Spring
424	Torque Converter Clutch Regulator Apply Valve Spring
425	Torque Converter Clutch Regulator Apply Valve
426	Torque Converter Clutch Regulator Apply Shuttle Valve
427	Clutch Select Valve Spring
428	Clutch Select Valve
429	Default Override Shuttle Valve
430	Actuator Feed Limit Valve
431	Actuator Feed Limit Valve Spring
432	Manual Valve
433	Control Valve Body Assembly

Control Valve Body Assembly (1 of 2 - Gen 2)

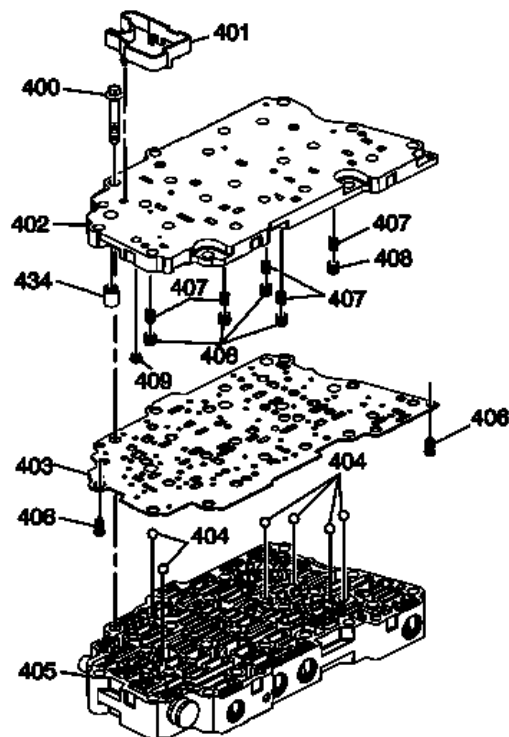


Fig. 15: Control Valve Body Assembly -- Gen 2 (1 Of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
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400	Control Valve Body Bolt
401	Control Solenoid Valve Support
402	Valve Channel Plate
403	Channel Plate to Valve Body Spacer Plate Assembly
404	Control Valve Body Ball Check Valve (Qty:6)
405	Control Valve Body Assembly
406	Control Valve Body Spacer Plate Retainer (Qty: 2)
407	Actuator Feed Accumulator Spring (Qty: 5)
408	Actuator Feed Accumulator Piston (Qty: 5)
409	Variable Hi and 2-3-4 Clutch Housing Valve Ball
434	Control Valve Channel Plate Ball Spring Assembly

Control Valve Body Assembly (2 of 2 - Gen 2)

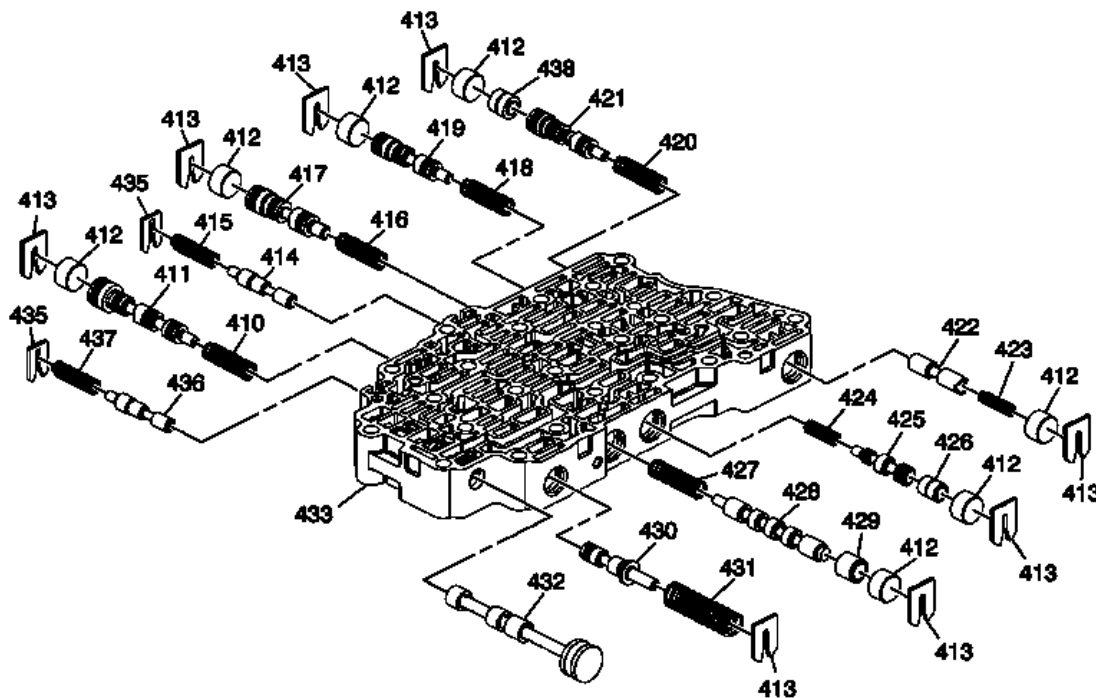


Fig. 16: Control Valve Body Assembly -- Gen 2 (2 Of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
410	Low-Reverse and 4-5-6 Clutch Regulator Valve Spring
411	Low-Reverse and 4-5-6 Clutch Regulator Valve
412	Clutch Valve Bore Plug
413	Valve Spring Retainer
414	1-2-3-4 Clutch Boost Valve
415	1-2-3-4 Clutch Boost Valve Spring

416	1-2-3-4 Clutch Regulator Valve Spring
417	1-2-3-4 Clutch Regulator Valve
418	2-6 Clutch Regulator Valve Spring
419	2-6 Clutch Regulator Valve
420	3-5-Reverse Clutch Regulator Valve Spring
421	3-5-Reverse Clutch Regulator Valve
422	Default Override Valve
423	Default Override Valve Spring
424	Torque Converter Clutch Regulator Apply Valve Spring
425	Torque Converter Clutch Regulator Apply Valve
426	Torque Converter Clutch Regulator Apply Shuttle Valve
427	Clutch Select Valve Spring
428	Clutch Select Valve
429	Clutch Select (Shuttle) Valve
430	Actuator Feed Limit Valve
431	Actuator Feed Limit Valve Spring
432	Manual Valve
433	Control Valve Body Assembly
435	Control Valve Body Bore Plug Retainer
436	Low-Reverse and 4-5-6 Clutch Boost Valve
437	Low-Reverse and 4-5-6 Clutch Boost Valve Spring
438	3-5 Reverse Clutch Regulator (Shuttle) Valve

3-5 Reverse Clutch Assembly - Gen 1

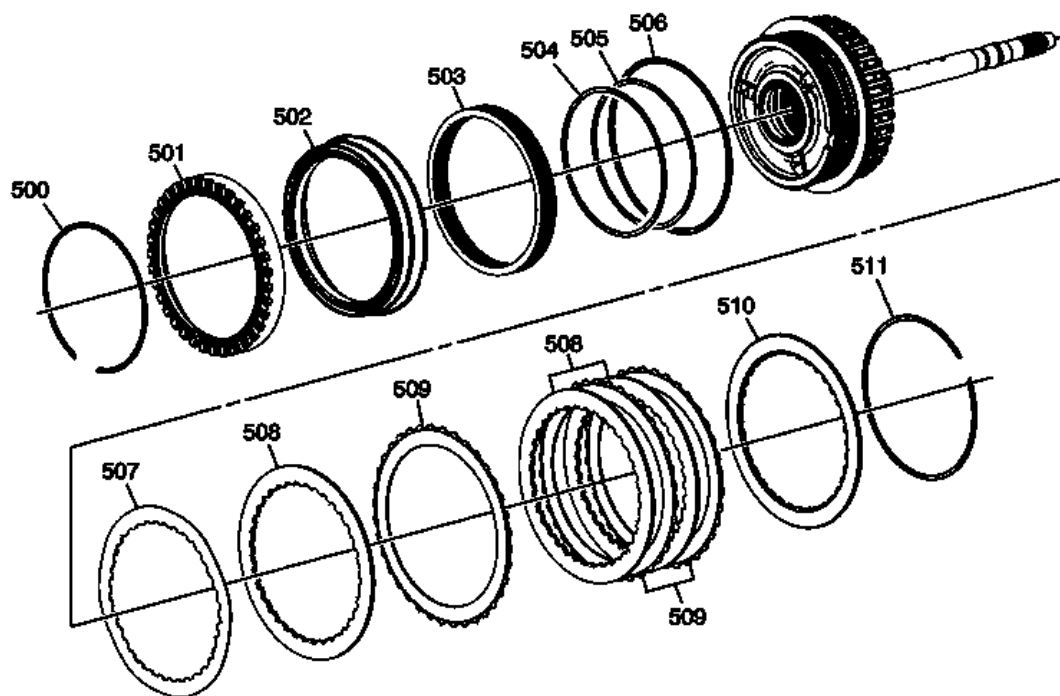


Fig. 17: View Of 3-5 Reverse Clutch Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
500	A/Trans Input Shaft Speed Sensor Reluctor Wheel Retainer Ring
501	A/Trans Input Shaft Speed Sensor Reluctor Wheel
502	3-5-Reverse Clutch Piston
503	3-5-Reverse Clutch Piston Return Spring Assembly
504	3-5-Reverse Clutch Piston Inner Seal
505	3-5-Reverse Clutch Piston Inner Seal
506	3-5-Reverse Clutch Piston Dam Seal
507	3-5-Reverse Clutch Apply Plate
508	3-5-Reverse Clutch Plate
509	3-5-Reverse Clutch (w/Friction Material) Plate Assembly
510	3-5-Reverse Clutch Backing Plate
511	3-5-Reverse Clutch Backing Plate Retainer Ring

3-5 Reverse Clutch Assembly - Gen 2

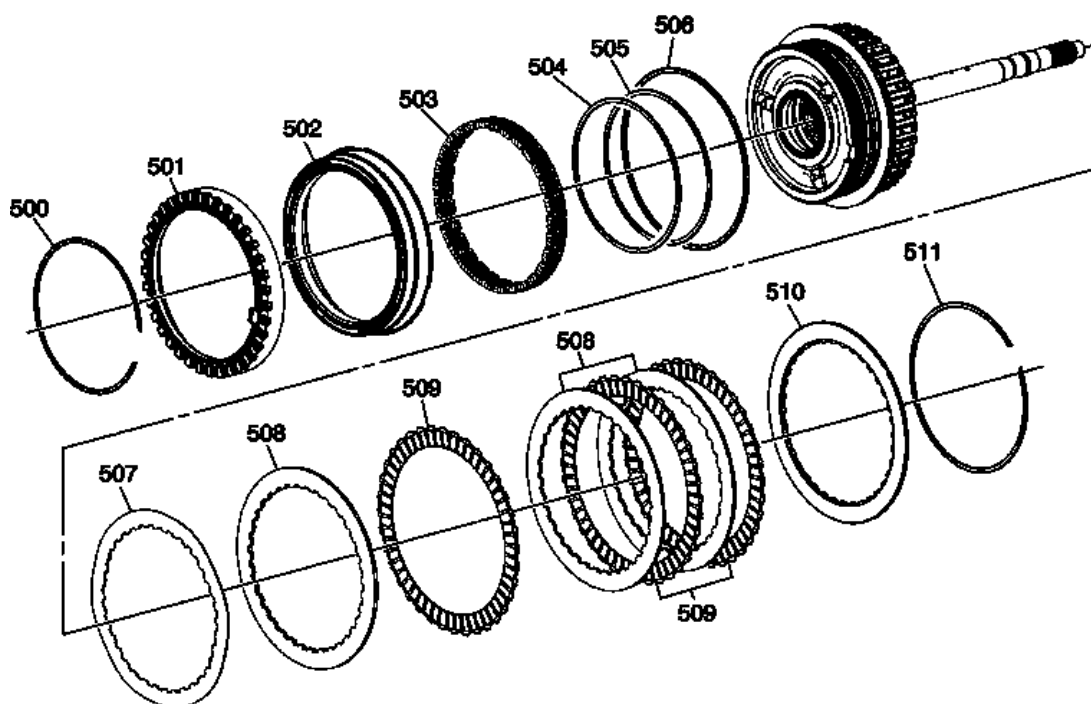


Fig. 18: 3-5 Reverse Clutch Assembly Components - Gen 2
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
500	A/Trans Input Shaft Speed Sensor Reluctor Wheel Retainer Ring
501	A/Trans Input Shaft Speed Sensor Reluctor Wheel
502	3-5-Reverse Clutch Piston
503	3-5-Reverse Clutch Piston Return Spring Assembly
504	3-5-Reverse Clutch Piston Inner Seal
505	3-5-Reverse Clutch Piston Inner Seal
506	3-5-Reverse Clutch Piston Dam Seal
507	3-5-Reverse Clutch Apply Plate
508	3-5-Reverse Clutch Plate
509	3-5-Reverse Clutch (w/Friction Material) Plate Assembly
510	3-5-Reverse Clutch Backing Plate
511	3-5-Reverse Clutch Backing Plate Retainer Ring

4-5-6 Clutch Assembly - Gen 1

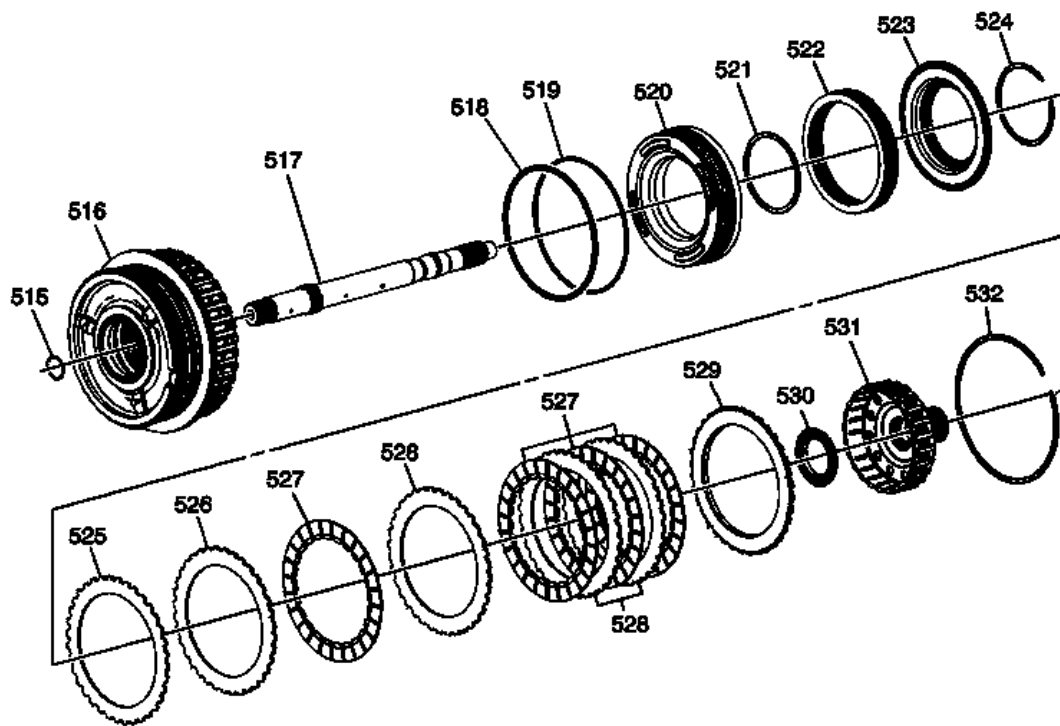


Fig. 19: View Of 4-5-6 Clutch Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
515	Turbine Shaft Retainer Ring
516	3-5-Reverse and 4-5-6 Clutch Housing Assembly
517	Turbine Shaft
518	4-5-6 Clutch Piston Outer Seal
519	4-5-6 Clutch Piston Outer Seal
520	4-5-6 Clutch Piston
521	4-5-6 Clutch Piston Inner Seal
522	4-5-6 Clutch Piston Return Spring Assembly
523	4-5-6 Clutch Piston Fluid Dam Assembly
524	4-5-6 Clutch Piston Fluid Dam Retainer Ring
525	4-5-6 Clutch (Waved) Plate
526	4-5-6 Clutch Apply Plate
527	4-5-6 Clutch (w/Friction Material) Plate Assembly
528	4-5-6 Clutch Plate
529	4-5-6 Clutch Backing Plate
530	Reaction Carrier Hub Thrust Bearing Assembly
531	Reaction Carrier Hub Assembly
532	4-5-6 Clutch Backing Plate Retainer Ring

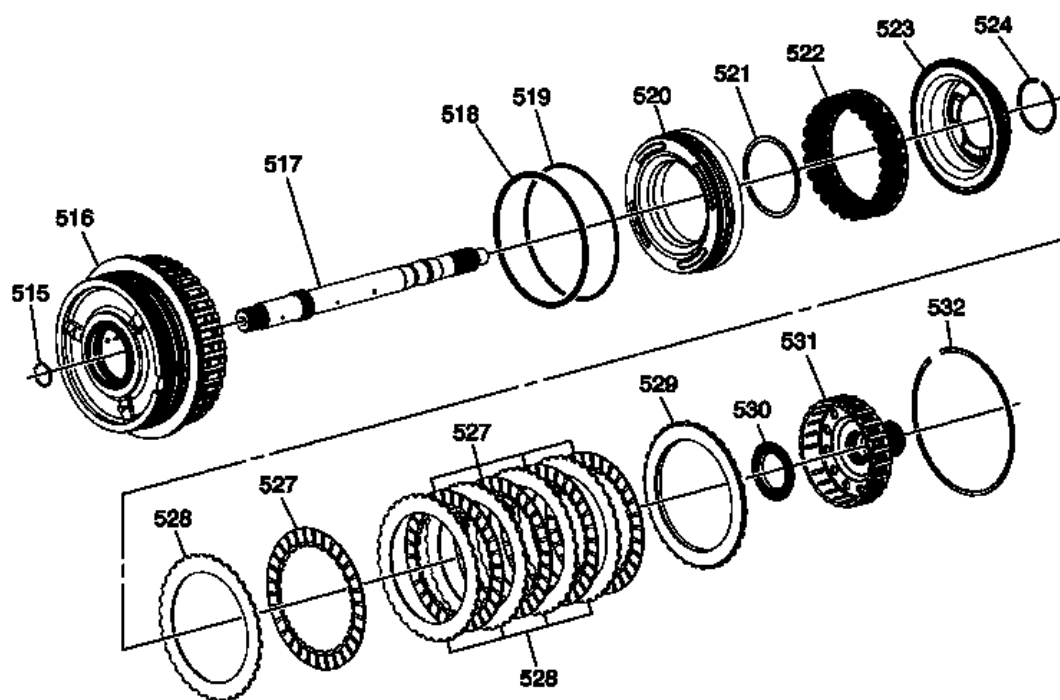


Fig. 20: 4-5-6 Clutch Assembly Components -- Gen 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
515	Turbine Shaft Retainer Ring
516	3-5-Reverse and 4-5-6 Clutch Housing Assembly
517	Turbine Shaft
518	4-5-6 Clutch Piston Outer Seal
519	4-5-6 Clutch Piston Outer Seal
520	4-5-6 Clutch Piston
521	4-5-6 Clutch Piston Inner Seal
522	4-5-6 Clutch Piston Return Spring Assembly
523	4-5-6 Clutch Piston Fluid Dam Assembly
524	4-5-6 Clutch Piston Fluid Dam Retainer Ring
527	4-5-6 Clutch (w/Friction Material) Plate Assembly Gen 1 (Qty: 4), Gen 2 (Qty: 5)
528	4-5-6 Clutch Plate - Gen 1 (Qty: 3), Gen 2 (Qty: 5)
529	4-5-6 Clutch Backing Plate
530	Reaction Carrier Hub Thrust Bearing Assembly
531	Reaction Carrier Hub Assembly
532	4-5-6 Clutch Backing Plate Retainer Ring

2-6, Low and Reverse and 1-2-3-4 Clutch Plate Assemblies - Gen 1

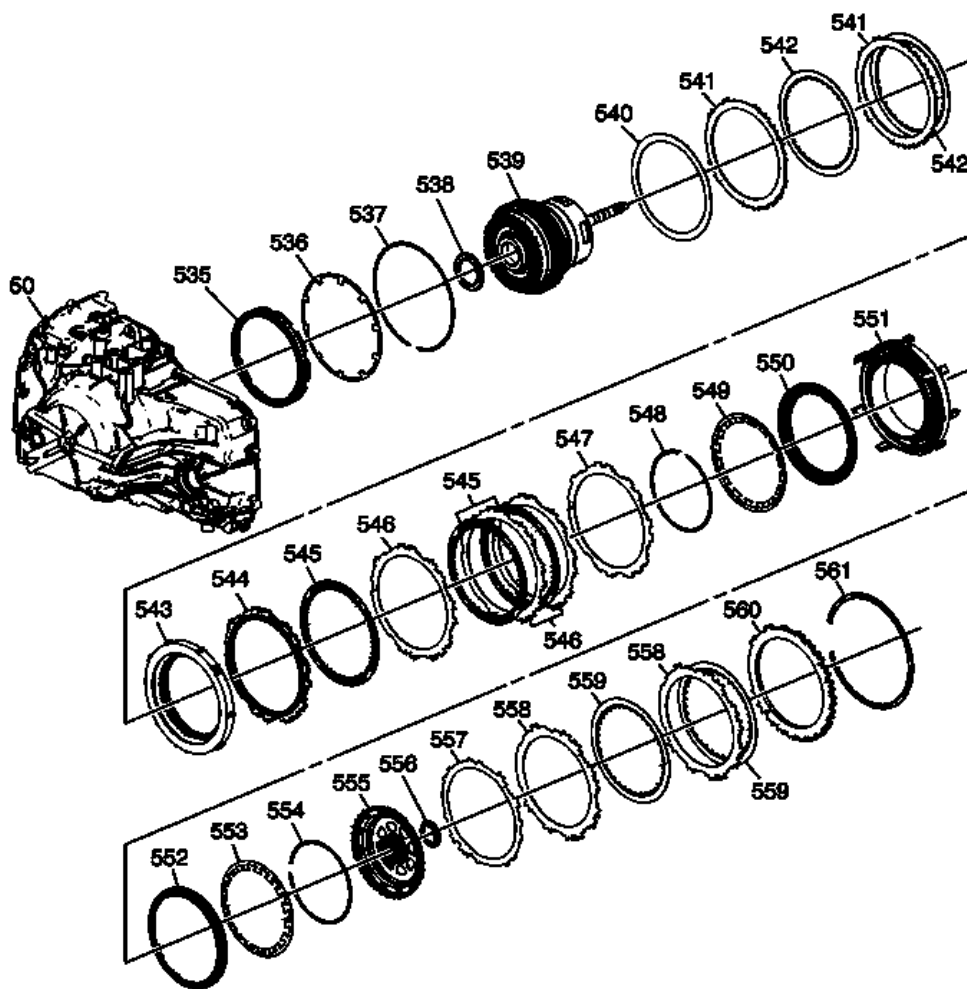


Fig. 21: Disassembled View Of 2-6, Low 7 Reverse & 1-2-3-4 Clutch Plate Assemblies
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
50	A/Trans Case
535	2-6 Clutch Piston Assembly
536	2-6 Clutch Spring
537	2-6 Clutch Spring Retainer Ring
538	3-5-Reverse and 4-5-6 Clutch Housing Thrust Bearing
539	3-5-Reverse and 4-5-6 Clutch Housing Assembly
540	2-6 Clutch Apply (Waved) Plate
541	2-6 Clutch Plate
542	2-6 Clutch (w/Friction Material) Plate Assembly
543	Low and Reverse Clutch Assembly
544	Low and Reverse Clutch Backing Plate
545	Low and Reverse Clutch (w/Friction Material) Plate Assembly
546	Low and Reverse Clutch Plate

547	Low and Reverse Clutch Apply (Waved) Plate
548	Low and Reverse Clutch Spring Retainer
549	Low and Reverse Clutch Spring
550	Low and Reverse Clutch Piston
551	Low and Reverse and 1-2-3-4 Clutch Housing
552	1-2-3-4 Clutch Piston
553	1-2-3-4 Clutch Spring
554	1-2-3-4 Clutch Piston Retainer
555	Output Sun Gear Assembly
556	Output Sun Thrust Bearing Assembly
557	1-2-3-4 Clutch (Waved) Plate
558	1-2-3-4 Clutch Plate
559	1-2-3-4 Clutch (w/Friction Material) Plate Assembly
560	1-2-3-4 Clutch Backing Plate
561	1-2-3-4 Clutch Backing Plate Retainer Ring

2-6, Low and Reverse and 1-2-3-4 Clutch Plate Assemblies - Gen 2

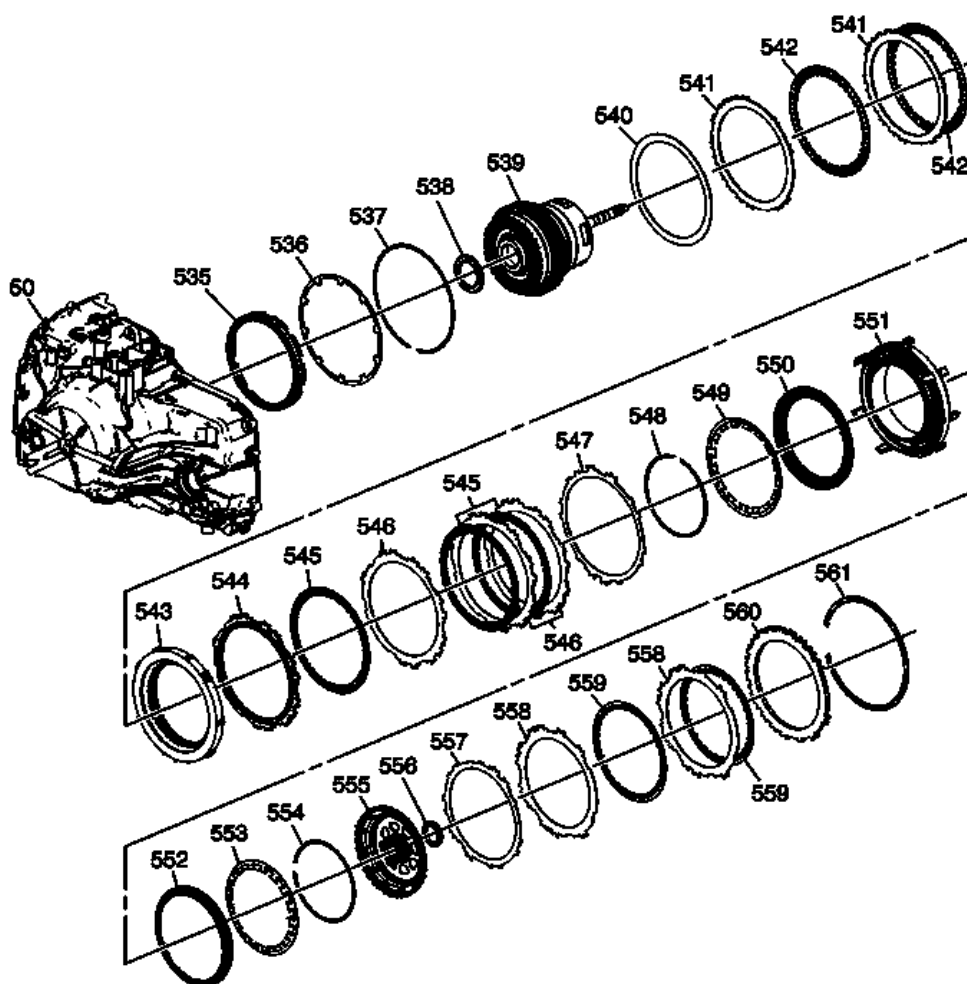


Fig. 22: 2-6, Low, Reverse And 1-2-3-4 Clutch Plate Assemblies - Gen 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
50	A/Trans Case
535	2-6 Clutch Piston Assembly
536	2-6 Clutch Spring
537	2-6 Clutch Spring Retainer Ring
538	3-5-Reverse and 4-5-6 Clutch Housing Thrust Bearing
539	3-5-Reverse and 4-5-6 Clutch Housing Assembly
540	2-6 Clutch Apply (Waved) Plate
541	2-6 Clutch Plate (Qty: 2)
542	2-6 Clutch (w/Friction Material) Plate Assembly (Qty: 2) - Model Dependent
543	Low and Reverse Clutch Assembly
544	Low and Reverse Clutch Backing Plate
545	Low and Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 3)
546	Low and Reverse Clutch Plate (Qty: 3)

547	Low and Reverse Clutch Apply (Waved) Plate
548	Low and Reverse Clutch Spring Retainer
549	Low and Reverse Clutch Spring
550	Low and Reverse Clutch Piston
551	Low and Reverse and 1-2-3-4 Clutch Housing
552	1-2-3-4 Clutch Piston
553	1-2-3-4 Clutch Spring
554	1-2-3-4 Clutch Piston Retainer
555	Output Sun Gear Assembly
556	Output Sun Thrust Bearing Assembly
557	1-2-3-4 Clutch (Waved) Plate
558	1-2-3-4 Clutch Plate (Qty: 2)
559	1-2-3-4 Clutch (w/Friction Material) Plate Assembly (Qty: 2)
560	1-2-3-4 Clutch Backing Plate
561	1-2-3-4 Clutch Backing Plate Retainer Ring

Input, Output and Reaction Gearsets- 6T30/6T40

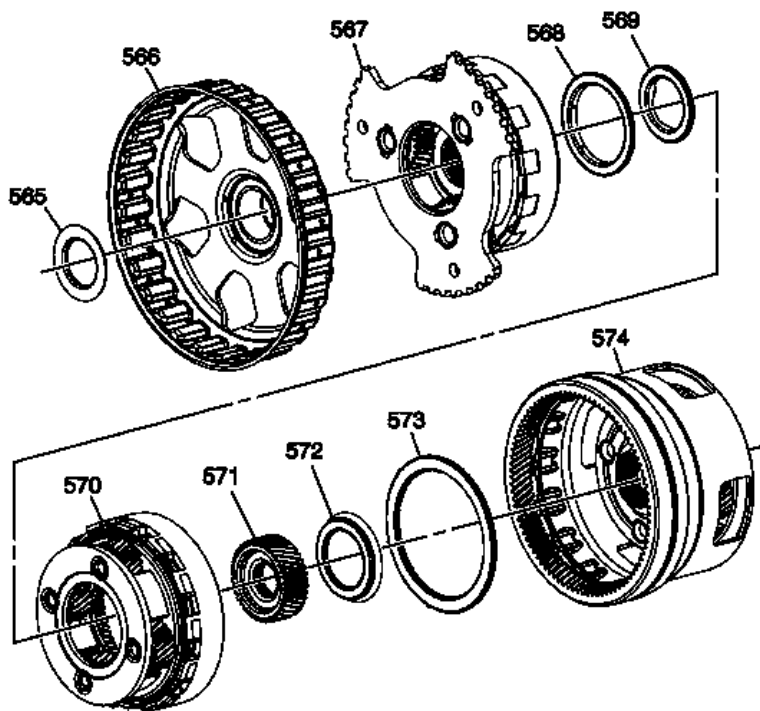


Fig. 23: Input, Output and Reaction Gearsets -- 6T30/6T40

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
565	Reaction Sun Gear Thrust Bearing Assembly
566	Reaction Sun Gear Assembly

567	Reaction Carrier Assembly
568	Input Carrier Thrust Bearing Assembly
569	Input Sun Gear Thrust Bearing Assembly
570	Input Carrier Assembly
571	Input Sun Gear
572	Input Sun Gear Thrust Bearing Assembly
573	Output Carrier Thrust Bearing Assembly
574	Output Carrier Assembly

Input, Output and Reaction Gearsets- 6T45/6T50

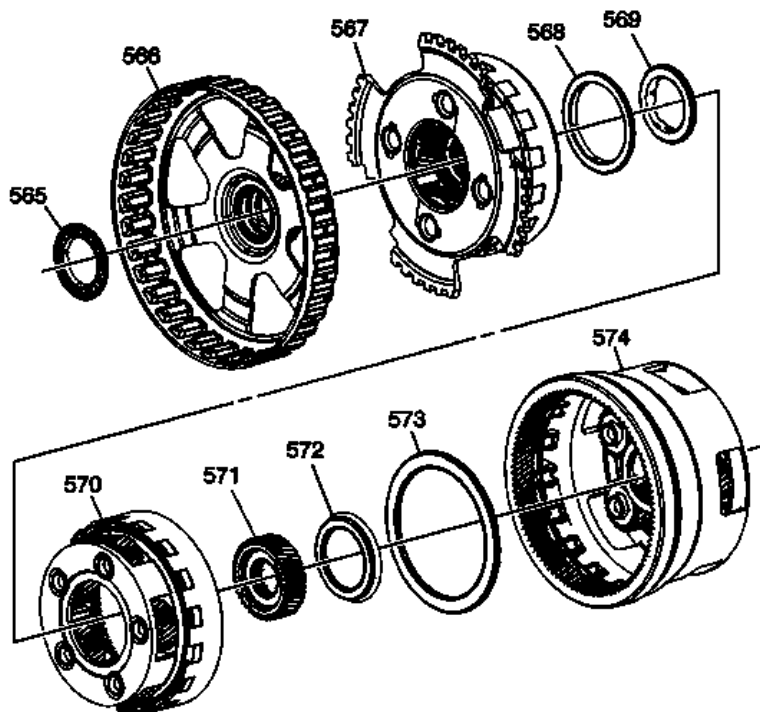


Fig. 24: View Of Input, Output & Reaction Gearsets
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
565	Reaction Sun Gear Thrust Bearing Assembly
566	Reaction Sun Gear Assembly
567	Reaction Carrier Assembly
568	Input Carrier Thrust Bearing Assembly
569	Input Sun Gear Thrust Bearing Assembly
570	Input Carrier Assembly
571	Input Sun Gear
572	Input Sun Gear Thrust Bearing Assembly
573	Output Carrier Thrust Bearing Assembly

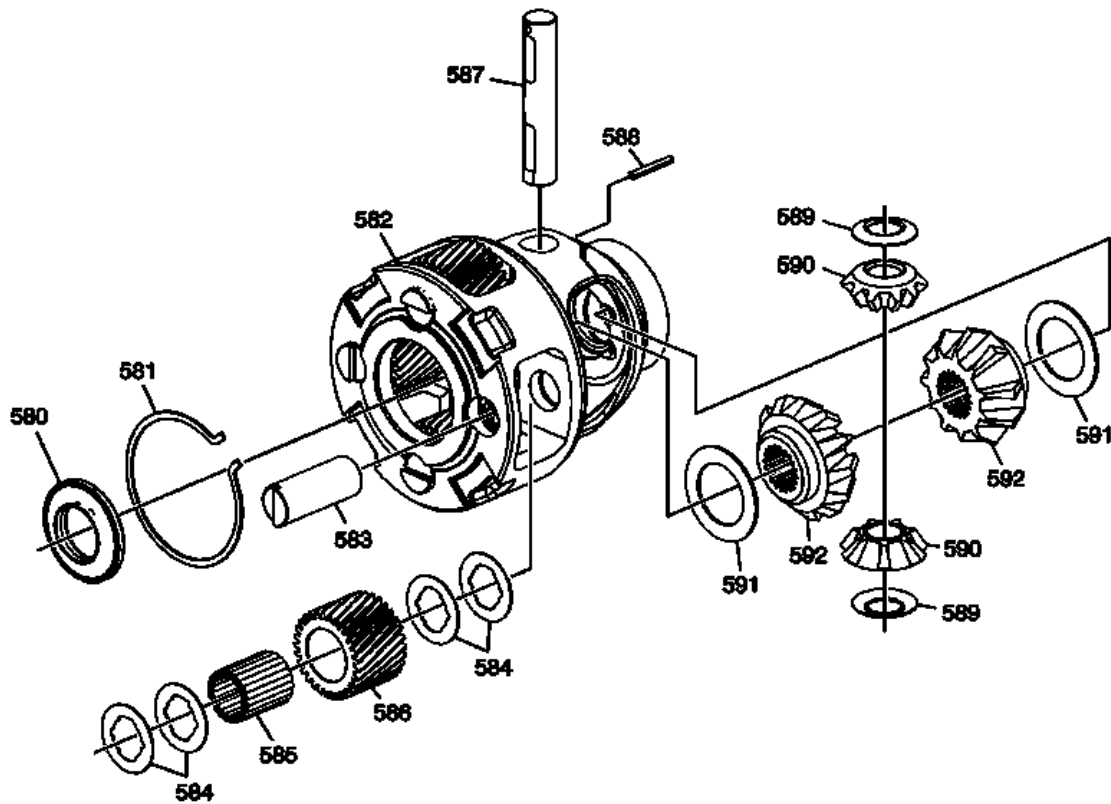
Front Differential Carrier Assembly (2 Pinion)

Fig. 25: Disassembled View Of Front Differential Carrier Assembly
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
580	Differential Sun Gear to Differential Housing Bearing Assembly
581	Final Drive Retainer
582	Differential Carrier Assembly
583	Final Drive Pinion Pin
584	Final Drive Inner and Outer Washer
585	Final Drive Roller
586	Pinion Final Drive Gear
587	Front Differential Pinion Gear Shaft
588	Front Differential Pinion Gear Shaft Pin

707	Front Differential Side Gear Thrust Washer
708	Front Differential Carrier Cover
709	Front Differential Carrier Cover Bolts
710	Front Differential Pinion Gear Shaft Washer
711	Front Differential Drive Pinion Gear
712	Front Differential Carrier Pinion Gear Bearing Rollers
713	Front Differential Pinion Gear Shaft Pin
714	Front Differential Pinion Gear Shaft Retainer
715	Front Differential Bearing

Park System Components

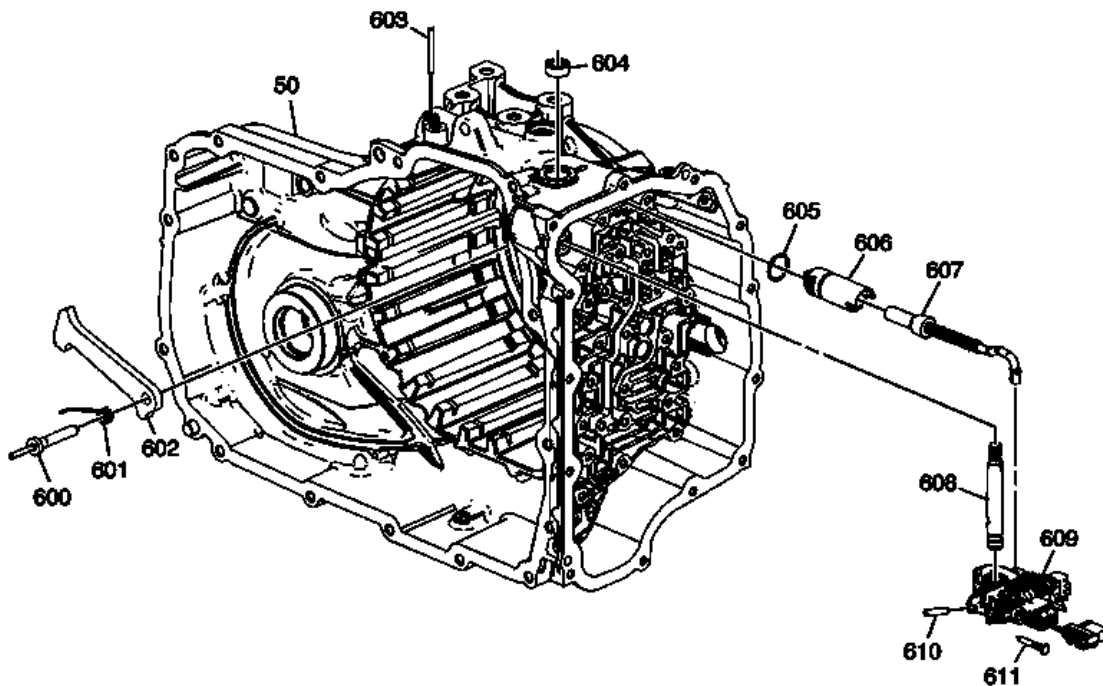


Fig. 27: View Of Park System Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
50	A/Trans Case
600	Park Pawl Shaft
601	Park Pawl Spring
602	Park Pawl
603	Park Pawl Actuator Guide Pin
604	Manual Shift Shaft Seal
605	Park Pawl Actuator Guide Seal
606	Park Pawl Actuator Guide

607	Park Pawl Actuator Assembly
608	Manual Shift Detent Lever Shaft
609	Manual Shift Detent (w/Shaft Position Switch) Lever Assembly
610	Manual Shift Detent Lever Pin
611	Manual Shift Shaft Pin

COMPONENT LOCATION

Internal Component Location

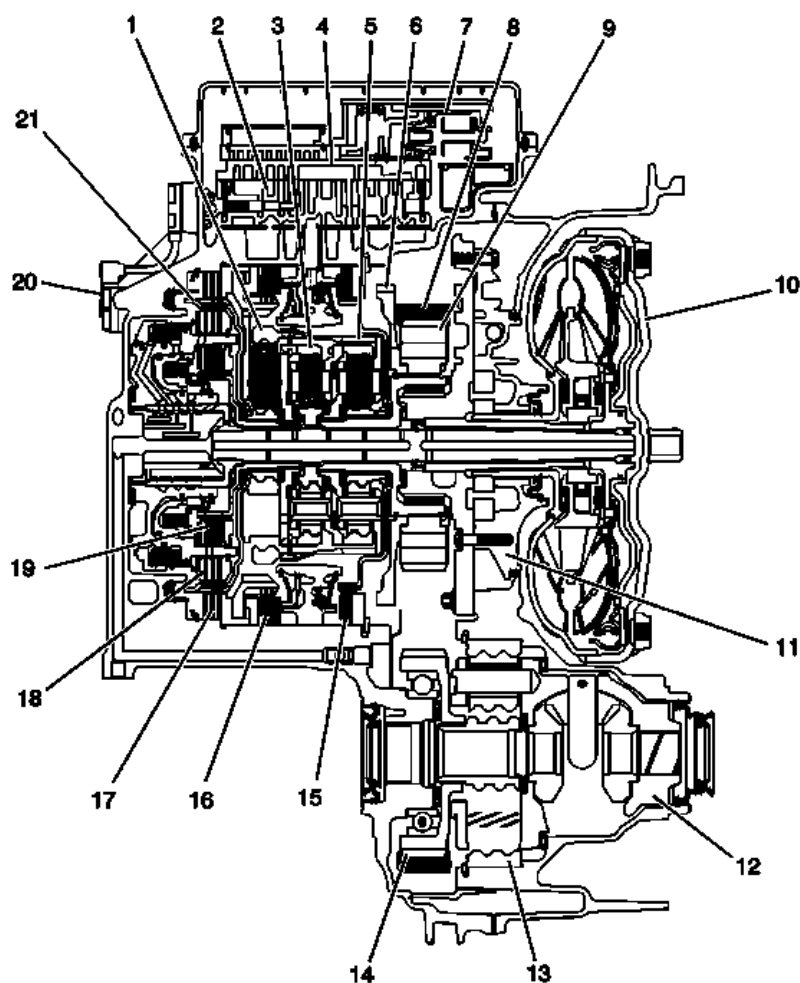


Fig. 28: Identifying Component Location
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Reaction Carrier Assembly
2	Control Valve Body Assembly
3	Input Carrier Assembly
4	Valve Channel Plate

5	Output Carrier Assembly
6	Park Gear
7	Control Solenoid (w/Body and TCM) Valve Assembly
8	Drive Link Assembly
9	Drive Sprocket
10	Torque Converter Assembly
11	A/Trans Fluid Pump Assembly
12	Differential Carrier Assembly
13	Front Differential Ring Gear
14	Driven Sprocket
15	1-2-3-4 Clutch Assembly
16	Low and Reverse Clutch Assembly
17	2-6 Clutch Assembly
18	3-5 Reverse Clutch Assembly
19	4-5-6 Clutch Assembly
20	A/Trans Input Speed Sensor Assembly
21	Reaction Sun Gear Assembly

BUSHING, BEARING, AND WASHER LOCATIONS (GEN 2/HYBRID)

Internal Bushings, Bearings, and Washers

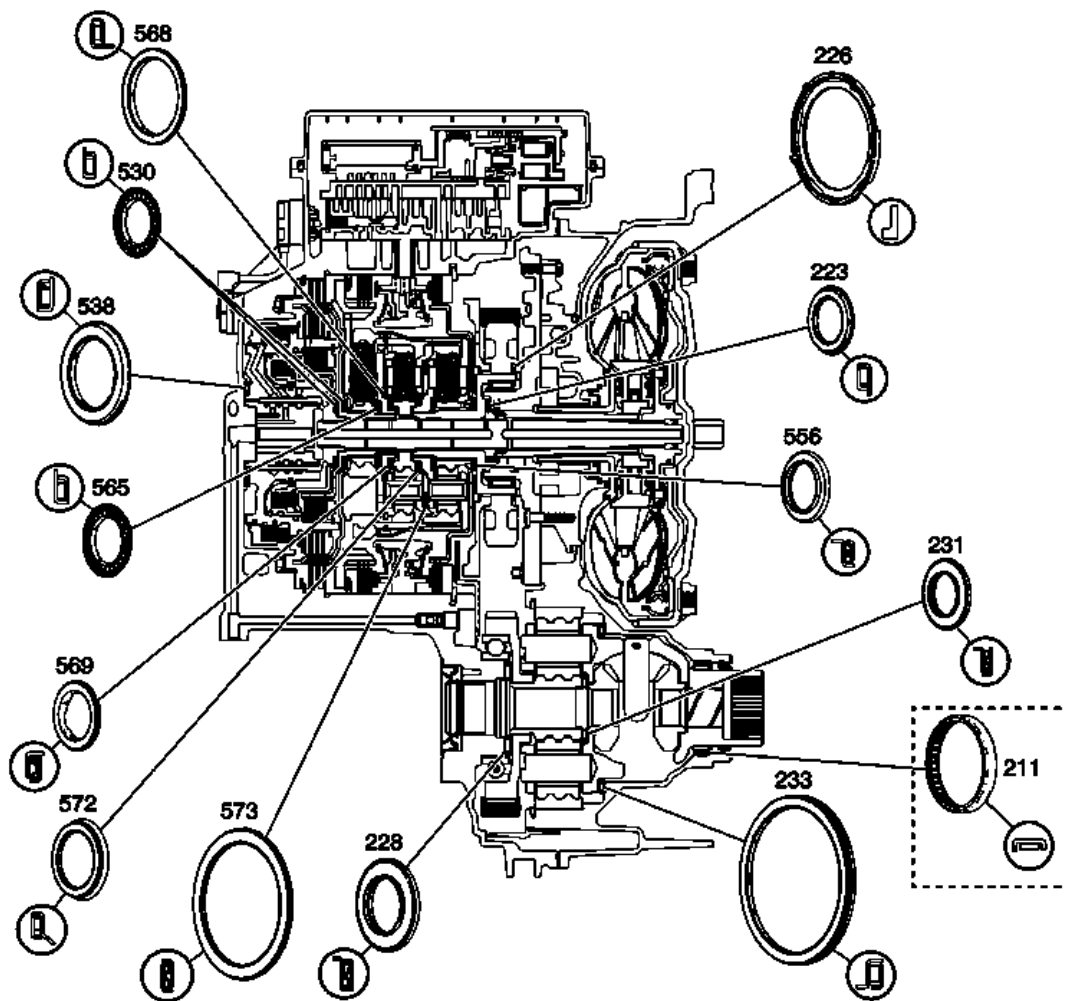


Fig. 29: Bushing, Bearing, and Washer Locations (Gen 2/Hybrid)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
211	Front Differential Carrier Bearing Assembly - AWD Models
223	Drive Spocket Bearing Assembly
226	Drive Spocket Thrust Washer
228	Drive Spocket Bearing Assembly
231	Differential Sun Gear to Differential Housing Bearing Assembly
233	Front Differential Carrier Bearing Assembly
530	Reaction Carrier Hub Thrust Bearing Assembly
538	3-5-Reverse and 4-5-6 Clutch Housing Thrust Bearing
556	Output Sun Thrust Bearing Assembly
565	Reaction Sun Gear Thrust Bearing Assembly
568	Input Carrier Thrust Bearing Assembly
569	Input Sun Gear Thrust Bearing Assembly
572	Input Sun Gear Thrust Bearing Assembly

SEAL LOCATIONS (GEN 2/HYBRID)

Seal Locations (1 of 2)

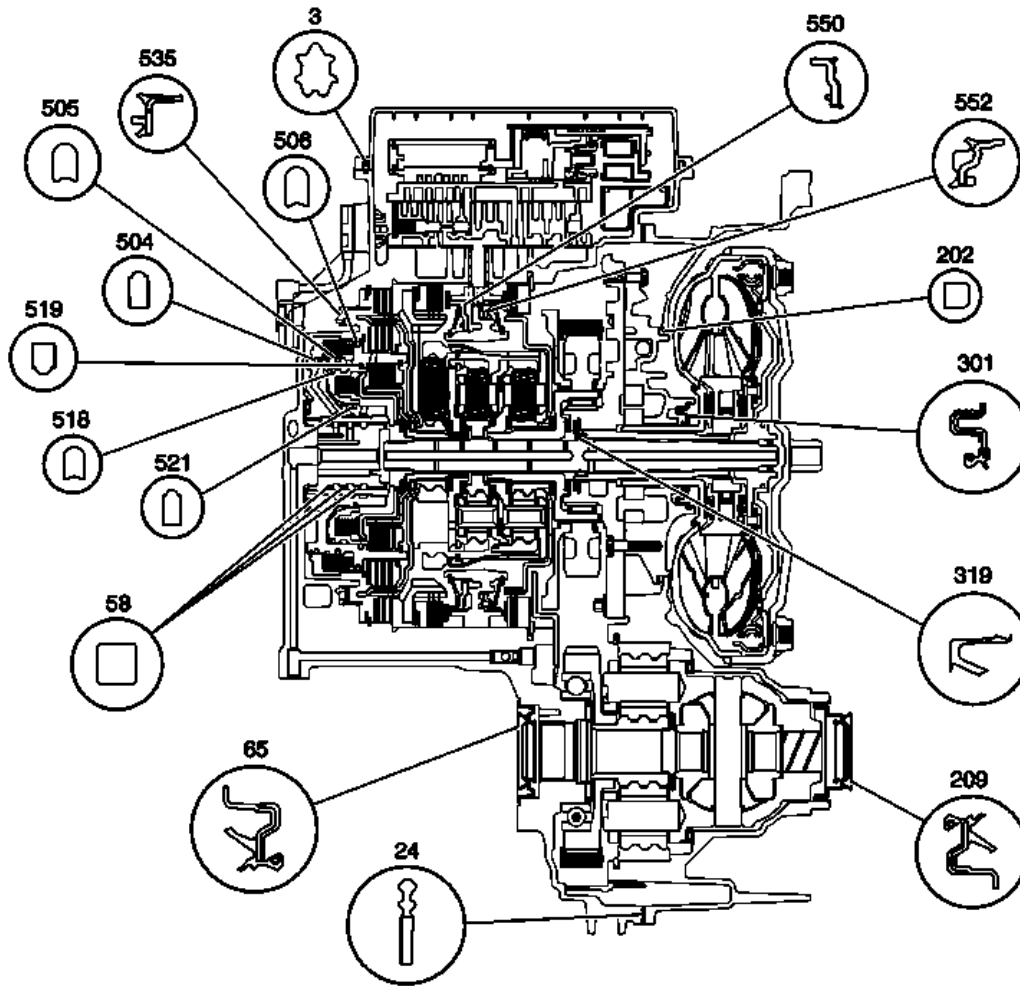


Fig. 30: Seal Locations (Gen 2/Hybrid)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
3	Control Valve Body Cover Gasket
24	Torque Converter Housing Gasket
58	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring (Qty: 3)
65	Drive Shaft Oil Seal Assembly
202	Torque Converter and Differential Housing Seal
209	Front Wheel Drive Shaft Oil Seal Assembly
301	Torque Converter Fluid Seal Assembly
319	Torque Converter Fluid Seal Assembly

504	3-5-Reverse Clutch Piston Inner Seal
505	3-5-Reverse Clutch Piston Inner Seal
506	3-5-Reverse Clutch Piston Dam Seal
518	4-5-6 Clutch Piston Outer Seal
519	4-5-6 Clutch Piston Outer Seal
521	4-5-6 Clutch Piston Inner Seal
535	2-6 Clutch Piston Assembly
550	Low and Reverse Clutch Piston
552	1-2-3-4 Clutch Piston

Seal Locations (2 of 2)

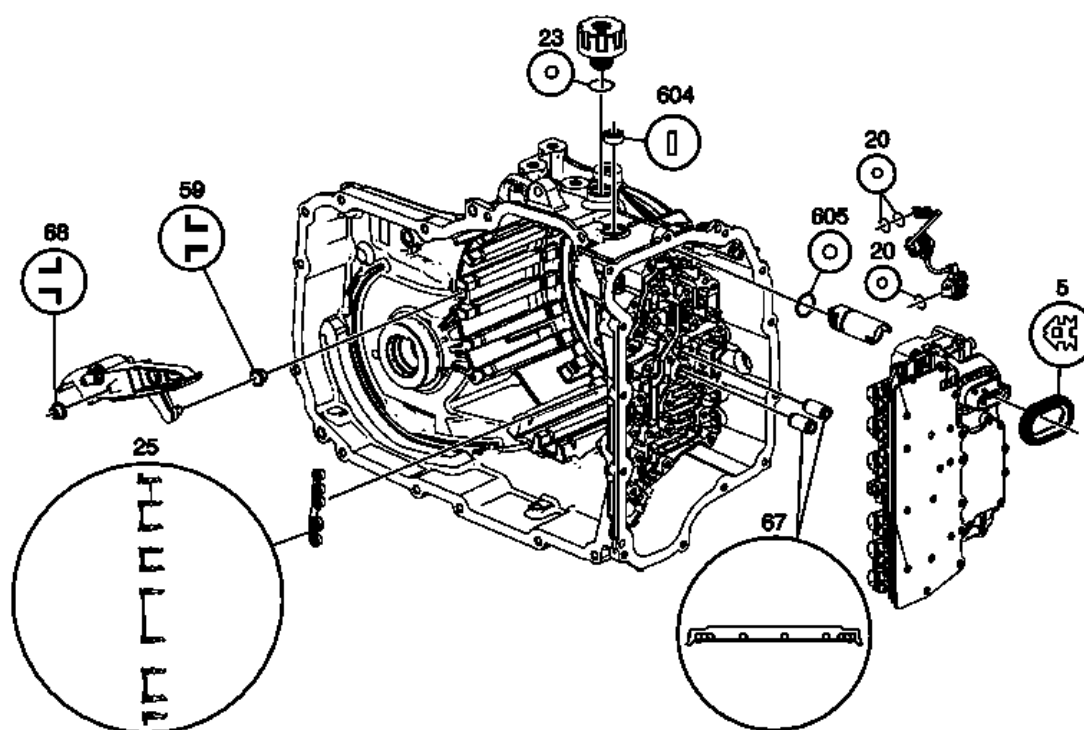


Fig. 31: Seal Locations (Gen 2/Hybrid)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5	Control Valve Body Cover Hole Seal
20	A/Trans Input Speed Sensor Assembly O-Ring Seal
23	Fill Cap Seal
25	A/Trans Fluid Pump Seal Assembly
59	Drive Link Lube Fluid Seal
67	1-2-3-4 and Low Reverse Clutch Fluid Passage
68	Drive Link Lube Fluid Seal
604	Manual Shift Shaft Seal

Auxiliary Fluid Pump and Hybrid Seals - Hybrid Models

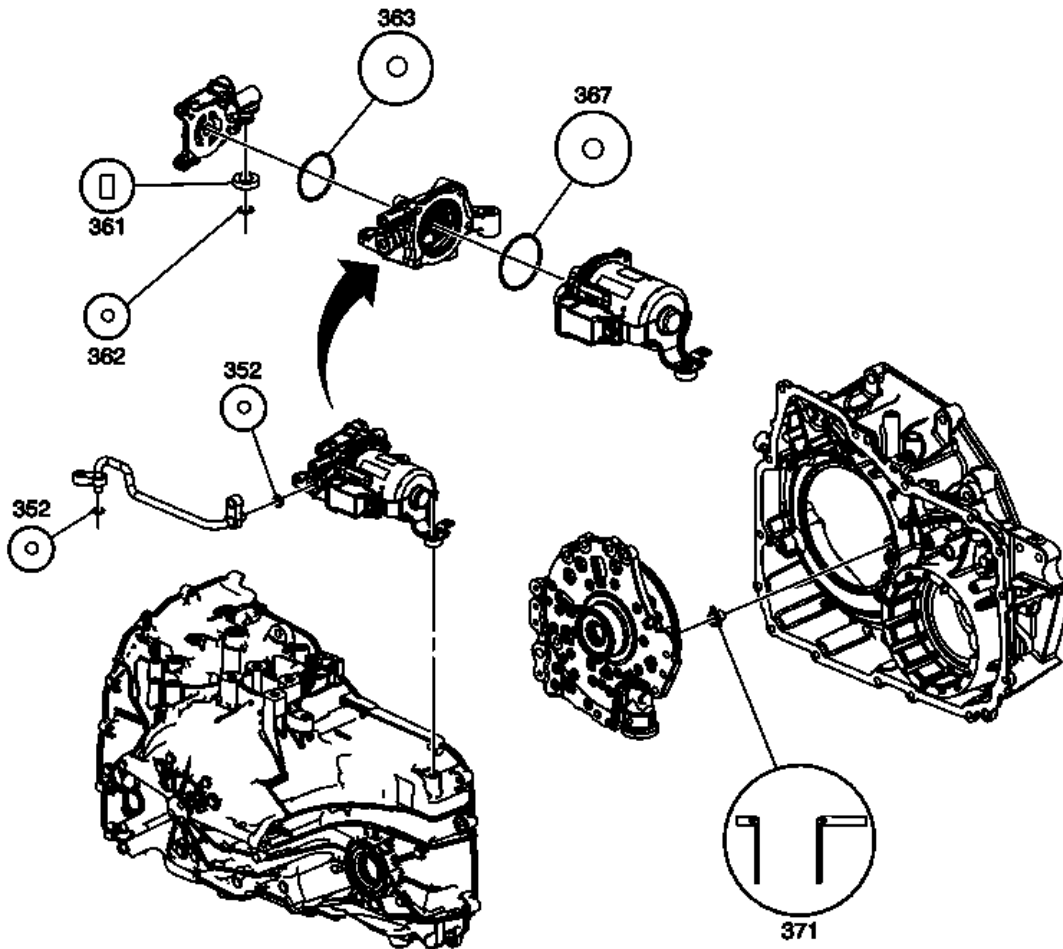


Fig. 32: Auxiliary Fluid Pump and Hybrid Seals -- Hybrid Models
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
352	A/Trans Auxiliary Fluid Pump Outlet Pipe Seal Assembly
361	A/Trans Auxiliary Fluid Pump Gasket
362	A/Trans Auxiliary Fluid Pump Seal
363	A/Trans Auxiliary Fluid Pump Cover Seal
367	A/Trans Auxiliary Fluid Pump Motor Cover Seal - O-ring
371	A/Trans Auxiliary Fluid Inlet Pump Seal

BALL CHECK VALVE LOCATIONS (GEN 2/HYBRID)

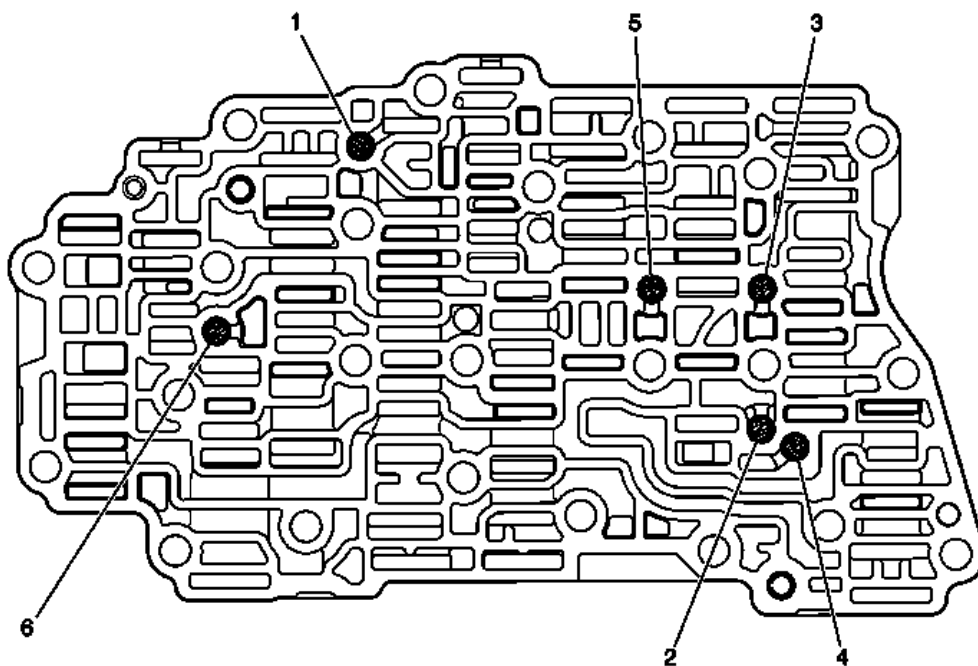


Fig. 33: Ball Check Valve Locations (Gen 2/Hybrid)
 Courtesy of GENERAL MOTORS COMPANY

Ball Check Valve Locations (Gen 2/Hybrid)

I.D.	Input Oil	Input Oil	Output Oil
1	Latch	456 CL	Latch
2	35 Rev CL FD	Drive 1-6	35 Rev CL FD/Drive 1-6
3	35 Rev CL FD/Drive 1-6	-	35 Rev CL FD/Drive 1-6
4	Act FD LM	-	35 Rev CL
5	Drive	-	Drive
6	Line	Auxiliary Line	Line

Transmission

Automatic Transmission - 6T40 (MH8 MHH) - Description and Operation

DESCRIPTION AND OPERATION

DEFINITIONS AND ABBREVIATIONS

Throttle Positions

Engine Braking

A condition where the engine is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Full Throttle Downshift

A quick apply of the accelerator pedal to its full travel, forcing a downshift.

Heavy Throttle

Approximately 3/4 of accelerator pedal travel, 75 percent throttle position.

Light Throttle

Approximately 1/4 of accelerator pedal travel, 25 percent throttle position.

Medium Throttle

Approximately 1/2 of accelerator pedal travel, 50 percent throttle position.

Minimum Throttle

The least amount of throttle opening required for an upshift.

Wide Open Throttle (WOT)

Full travel of the accelerator pedal, 100 percent throttle position.

Zero Throttle Coastdown

A full release of the accelerator pedal while the vehicle is in motion and in drive range.

Shift Condition Definitions

Bump

A sudden and forceful apply of a clutch or a band.

Chuggle

A bucking or jerking. This condition may be most noticeable when the converter clutch is engaged. It is similar to the feel of towing a trailer.

Delayed

A condition where a shift is expected but does not occur for a period of time. This could be described as a clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle apply of the accelerator, or during manual downshifting to a lower range. This term is also defined as LATE or EXTENDED.

Double Bump - Double Feel

Two sudden and forceful applies of a clutch or a band.

Early

A condition where the shift occurs before the car has reached proper speed. This condition tends to labor the engine after the upshift.

End Bump

A firmer feel at the end of a shift than at the start of the shift. This is also defined as END FEEL or SLIP BUMP.

Firm

A noticeably quick apply of a clutch or band that is considered normal with a medium to heavy throttle. This apply should not be confused with HARSH or ROUGH.

Flare

A quick increase in engine RPM along with a momentary loss of torque. This most generally occurs during a shift. This condition is also defined as SLIPPING.

Harsh - Rough

A more noticeable apply of a clutch or band than FIRM. This condition is considered undesirable at any throttle position.

Hunting

A repeating quick series of upshifts and downshifts that causes a noticeable change in engine RPM, such as a 4-3-4 shift pattern. This condition is also defined as BUSYNESS.

Initial Feel

A distinctly firmer feel at the start of a shift than at the finish of the shift.

Late

A shift that occurs when the engine RPM is higher than normal for a given amount of throttle.

Shudder

A repeating jerking condition similar to CHUGGLE but more severe and rapid. This condition may be most noticeable during certain ranges of vehicle speed.

Slipping

A noticeable increase in engine RPM without a vehicle speed increase. A slip usually occurs during or after initial clutch or band apply.

Soft

A slow, almost unnoticeable clutch or band apply with very little shift feel.

Surge

A repeating engine related condition of acceleration and deceleration that is less intense than CHUGGLE.

Tie-Up

A condition where two opposing clutch and/or bands are attempting to apply at the same time causing the engine to labor with a noticeable loss of engine RPM.

Noise Conditions**Drive Link Noise**

A whine or growl that increases or fades with vehicle speed, and is most noticeable under a light throttle acceleration. It may also be noticeable in PARK or NEUTRAL operating ranges with the vehicle stationary.

Final Drive Noise

A hum related to vehicle speed which is most noticeable under a light throttle acceleration.

Planetary Gear Noise

A whine related to vehicle speed, which is most noticeable in FIRST gear, SECOND gear, FOURTH gear or REVERSE. The condition may become less noticeable, or go away, after an upshift.

Pump Noise

A high pitched whine that increases in intensity with engine RPM. This condition may also be noticeable in all operating ranges with the vehicle stationary or moving.

Torque Converter Noise

A whine usually noticed when a vehicle is stopped, and the transmission is in DRIVE or REVERSE. The noise will increase with engine RPM.

Driver Shift Control

Driver shift control (DSC) allows the driver to change gears similar to a manual transmission. Refer to the vehicle owner's manual for specific DSC operating instructions.

Transmission Abbreviations

A/C

Air Conditioning

AC

Alternating Current

AT

Automatic Transmission

CC

Climate Control

DC

Direct Current

DIC

Driver Information Center

DLC

Diagnostic Link Connector

DMM

Digital Multimeter

DSC

Driver Shift Control

DTC

Diagnostic Trouble Code

EBTCM

Electronic Brake/Traction Control Module

ECCC

Electronically-Controlled Capacity Clutch

ECT

Engine Coolant Temperature

EMI

Electromagnetic Interference

IAT

Intake Air Temperature

IGN

Ignition

IMS

Internal Mode Switch

ISS

Input Speed Sensor

MAP

Manifold Absolute Pressure

MIL

Malfunction Indicator Lamp

NC

Normally Closed

NO

Normally Open

OBD

On Board Diagnostic

OSS

Output Speed Sensor

PC

Pressure Control

PCM

Powertrain Control Module

PCS

Pressure Control Solenoid

PS

Pressure Switch

PWM

Pulse Width Modulation

RPM

Revolutions Per Minute

SS

Shift Solenoid

STL

Service Transmission Lamp

TAP

Transmission Adaptive Pressure

TCC

Torque Converter Clutch

TFP

Transmission Fluid Pressure

TFT

Transmission Fluid Temperature

TP

Throttle Position

VSS

Vehicle Speed Sensor

WOT

Wide Open Throttle

TRANSMISSION IDENTIFICATION INFORMATION

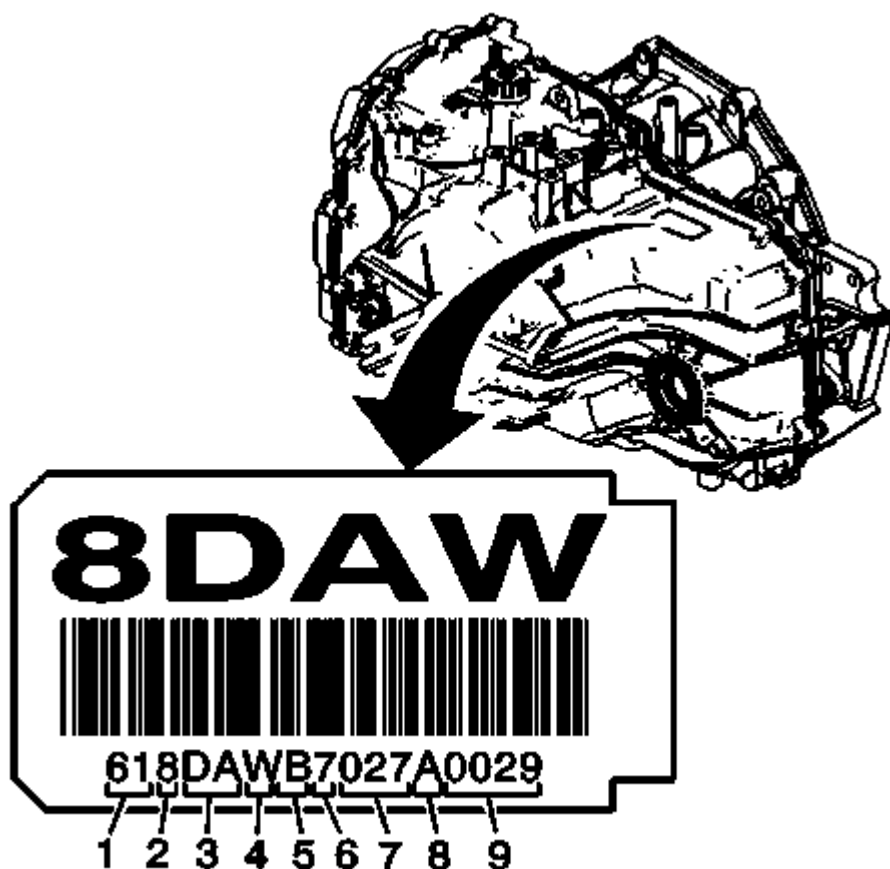


Fig. 1: Identifying Transmission Identification Information Plate
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Code for Automatic Transmission
2	Model Year
3	Model for Transmission
4	Transmission Family
5	Source Code for Plant
6	Calender Year
7	Julian Date
8	Shift/Line (A/B)
9	Numeric sequence starting at 0001 @ 12:01 AM each day

Source Code for Plant

- 4 - Ramos Arizpe, Mexico
- H - N.mpsilanti, Michigan
- J - Windsor, Ontario

- K - St. Catharines, Ontario
- S - Strasbourg, France
- W - Warren, Michigan
- Y - Toledo, Ohio
- R - Boryeong, Korea
- M - N.man Tai, Shan Dong, China
- P - San Luis Potosi, Mexico

TRANSMISSION GENERAL DESCRIPTION

The Hydra-matic 6T40/45/50 is a fully automatic, 6-speed, front-wheel drive, electronic-controlled transmission. It consists primarily of a 4-element torque converter, a compound planetary gear set, friction and mechanical clutch assemblies, and a hydraulic pressurization and control system. There are 2 variants of the transmission, based on torque capacity. Architecture is common between the variants, and component differences are primarily related to size.

The 4-element torque converter contains a pump, a turbine, a pressure plate splined to the turbine, and a stator assembly. The torque converter acts as a fluid coupling to smoothly transmit power from the engine to the transmission. It also hydraulically provides additional torque multiplication when required. The pressure plate, when applied, provides a mechanical direct drive coupling of the engine to the transmission.

The planetary gear sets provide the 6 forward gear ratios and reverse. Changing gear ratios is fully automatic and is accomplished through the use of a transmission control module (TCM) located inside the transmission. The TCM receives and monitors various electronic sensor inputs and uses this information to shift the transmission at the optimum time.

The TCM commands shift solenoids and variable bleed pressure control solenoids to control shift timing and feel. The TCM also controls the apply and release of the torque converter clutch which allows the engine to deliver the maximum fuel efficiency without sacrificing vehicle performance. All the solenoids, including the TCM, are packaged into a self-contained control solenoid valve assembly.

The hydraulic system primarily consists of a gear-type pump, a control valve body assembly and case. The pump maintains the working pressures needed to stroke the clutch pistons that apply or release the friction components. These friction components, when applied or released, support the automatic shifting qualities of the transmission.

The friction components used in this transmission consist of 5 multiple disc clutches. The multiple disc clutches combine with one way clutch to deliver 7 different gear ratios, 6 forward and one reverse, through the gear sets. The gear sets then transfer torque through the transfer drive gear, transfer driven gear and differential assembly.

The transmission may be operated in any of the following gear ranges:

PARK (P)

This position locks the front wheels and prevents the vehicle from rolling either forward or backward. PARK is the best position to use when starting the vehicle. Because the transmission utilizes a shift lock

control system, it is necessary to fully depress the brake pedal before shifting out of PARK. For safety reasons, use the parking brake in addition to the PARK position.

REVERSE (R)

This position allows the vehicle to be operated in a rearward direction.

NEUTRAL (N)

This position allows the engine to be started and operated while driving the vehicle. If necessary, you may select this position in order to restart the engine with the vehicle moving. This position should also be used when towing the vehicle.

DRIVE (D)

Drive range should be used for all normal driving conditions for maximum efficiency and fuel economy. Drive range allows the transmission to operate in each of the 6 forward gear ratios. Downshifts to a lower gear, or higher gear ratio, are available for safe passing by depressing the accelerator or by manually selecting a lower gear in the manual mode range.

Driver Shift Control (DSC) or Electronic Range Selection (ERS)

This position (M-Manual / L-Low) allows the driver to utilize the DSC/ERS system. When the shift selector lever is moved to this position, the driver may select upshifts or downshifts by using the paddle switches located on the steering wheel/shifter. An upshift is requested by pushing either + button. Refer to the vehicle owner's manual for more specific DSC/ERS information.

TRANSMISSION COMPONENT AND SYSTEM DESCRIPTION

The mechanical components of the 6T40/45/50 are as follows:

- A torque converter with an electronically controlled capacity clutch (ECCC)
- Gear-type fluid pump assembly
- 1-2-3-4 and low and reverse clutch housing assembly
- 4-5-6 and 3-5 reverse clutch housing assembly
- 2-6 clutch assembly
- Low and reverse clutch (one way clutch) assembly
- Control valve body assembly
- Drive sprocket, driven sprocket and link assembly
- Front differential carrier assembly
- Input Carrier Assembly
- Reaction Carrier Assembly
- Output Carrier Assembly

The electrical components of the 6T40/45/50 are as follows:

- Output speed sensor assembly
- Input speed sensor assembly
- Manual shift shaft with internal mode switch
- Control solenoid valve assembly, which contains the following components:
 - Transmission control module (TCM)
 - 5 variable bleed line pressure control (PC) solenoids
 - Transmission fluid pressure (TFP) switch assembly
 - Torque converter clutch (TCC) pressure control solenoid
 - shift solenoid
 - Transmission fluid temperature sensor

For more information, refer to **Electronic Component Description**.

TRANSMISSION ADAPTIVE FUNCTIONS

The 6T30/40/45/50 transmission utilizes a line pressure control system during upshifts to compensate for the normal wear of transmission components. As the apply components within the transmission wear or change over time, shift time (the time required to apply a clutch) increase or decreases. In order to compensate for these changes, the transmission control module (TCM) adjusts the pressure commands to the various PC solenoids, to maintain the originally calibrated shift timing. The automatic adjusting process is referred to as "adaptive learning" and it is used to ensure consistent shift feel plus increase transmission durability. The TCM monitors the A/T input speed sensor (ISS) and the A/T output speed sensor (OSS) during commanded shifts to determine if a shift is occurring too fast (harsh) or too slow (soft) and adjusts the corresponding pressure control (PC) solenoid signal to maintain the set shift feel.

The purpose of the adapt function is to automatically compensate the shift quality for the various vehicle shift control systems. The adapt function is a continuous process that will help to maintain optimal shift quality throughout the life of the vehicle.

TRANSMISSION INDICATORS AND MESSAGES

The following transmission-related indicators and messages may be displayed on the Instrument Panel Cluster (IPC). For a complete listing and description of all vehicle indicators and messages, refer to **Indicator/Warning Message Description and Operation** .

"TRANSMISSION HOT IDLE ENGINE"

This message is displayed when the TCM detects a transmission fluid temperature (TFT) equal to or greater than 132°C (270°F) for 5 seconds.

"SERVICE TRANSMISSION"

This message displays when there is a problem with the transmission.

ELECTRONIC COMPONENT DESCRIPTION

Control Solenoid Valve Assembly

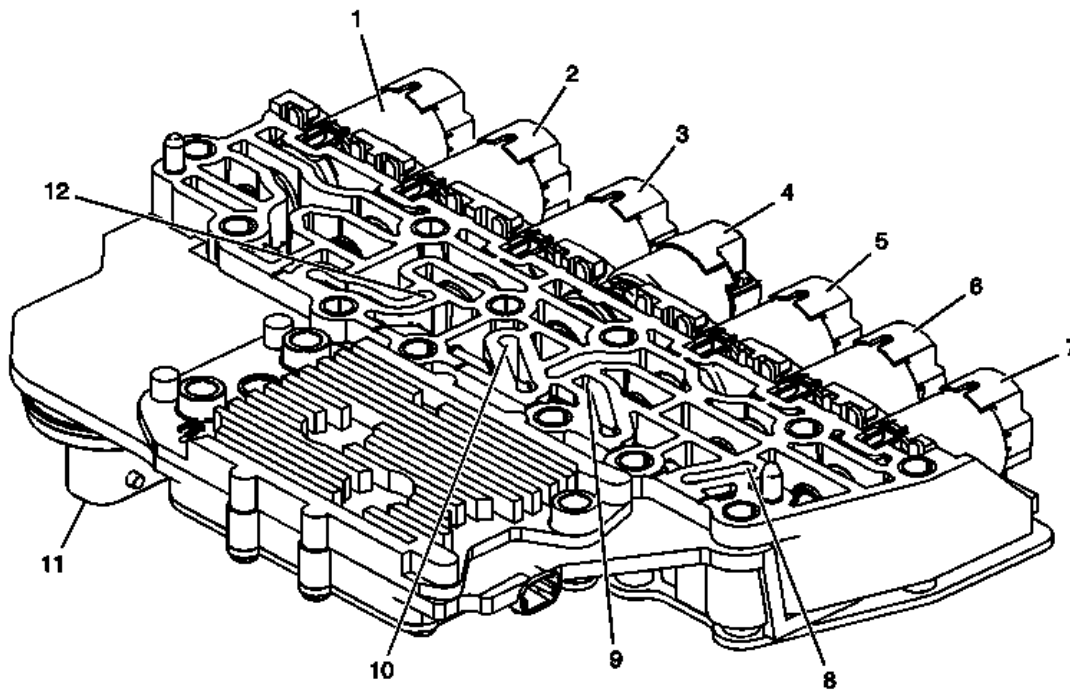


Fig. 2: View Of Control Solenoid (W/Body & TCM) Valve Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Pressure Control Solenoid 3 (R-1/4-5-6)
2	(GEN 1) Pressure Control Solenoid 2 (3-5-R)
2	(GEN 2) Pressure Control Solenoid 5 (1-2-3-4)
3	Torque Converter Clutch (TCC) Pressure Control Solenoid
4	Shift Solenoid 1 (On/Off)
5	(GEN 1) Pressure Control Solenoid 5 (1-2-3-4)
5	(GEN 2) Pressure Control Solenoid 2 (3-5-R)
6	Pressure Control Solenoid 4 (2-6)
7	Line Pressure Control Solenoid
8	(GEN 1) Transmission Fluid Pressure (TFP) Switch 1 (3-5-R)
9	(GEN 1) Transmission Fluid Pressure (TFP) Switch 3 (2-6)
10	(GEN 1) Transmission Fluid Pressure (TFP) Switch 4 (1-2-3-4)
11	Pass Through Connector
12	(GEN 1) Transmission Fluid Pressure (TFP) Switch 5 (4-5-6/R-1)

Manual Shift Detent Lever with Shaft Position Switch Assembly

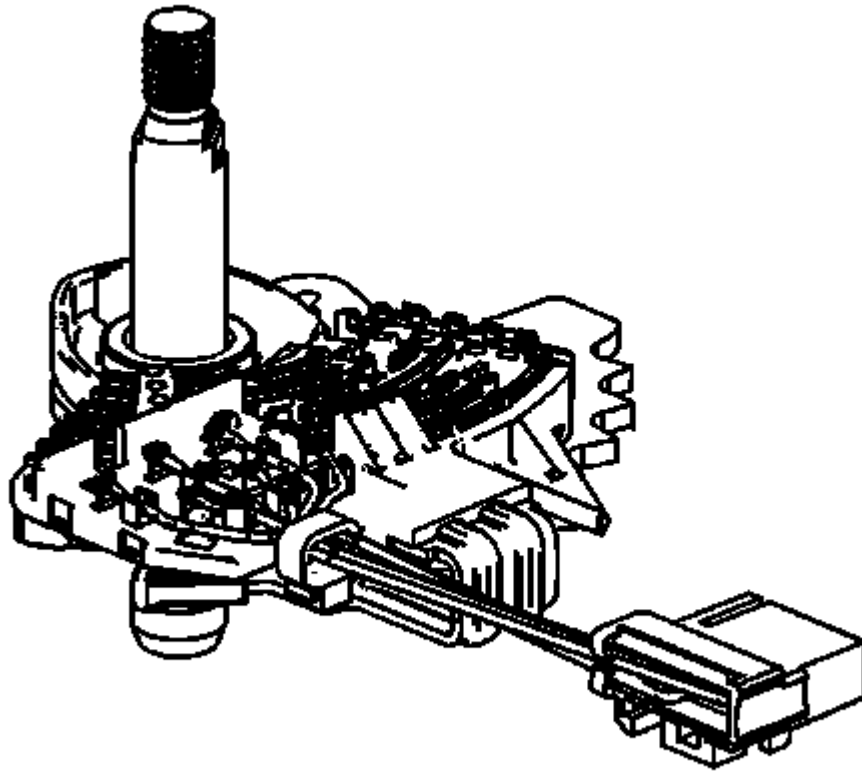


Fig. 3: View Of Manual Shift Detent Lever W/ Shaft Position Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

The transmission shaft position switch assembly is a sliding contact switch attached to the manual shaft detent lever assembly inside the transmission case. The five inputs to the TCM from the transmission manual shift shaft switch assembly indicate the transmission gear selector lever position. This information is used for engine controls as well as determining the transmission shift patterns. The state of each input is available for display on the scan tool. The five input parameters represented are Signal A, Signal B, Signal C, Signal P (Parity) and Signal N (P/N Start).

Input Speed Sensor (ISS)

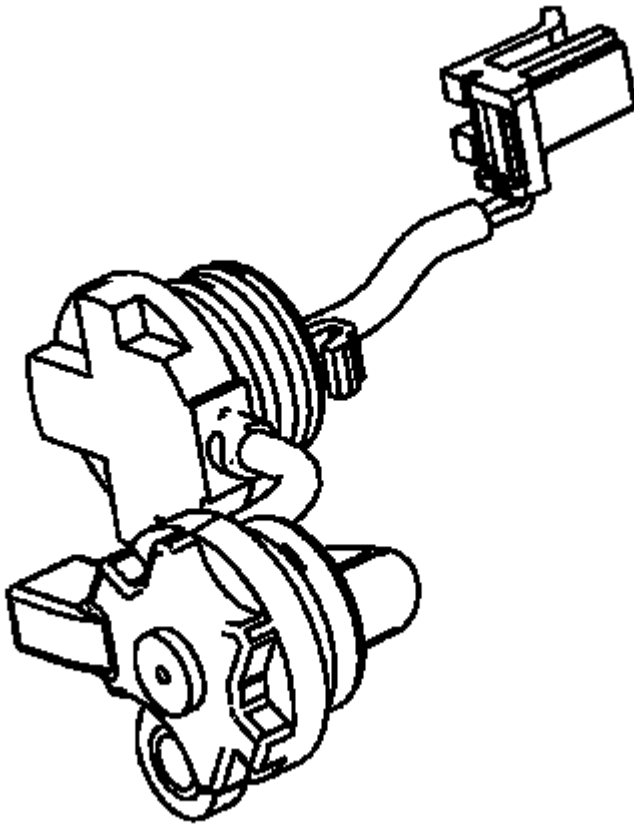


Fig. 4: View Of Input Speed Sensor (ISS)

Courtesy of GENERAL MOTORS COMPANY

The input speed sensor (ISS) is a hall-effect type sensor. The ISS mounts to the transmission case assembly and connects to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the 3-5-R clutch piston housing machined teeth surface. The sensor receives 8.3-9.3 volts on the ISS/OSS Supply Voltage circuit from the TCM. As the 3-5-R/4-5-6 clutch piston housing rotates, the sensor produces a signal frequency based on the machined surface of the 3-5-R/4-5-6 clutch piston housing. This signal is transmitted through the ISS signal circuit to the control solenoid (w/body and TCM) valve assembly. The TCM uses the ISS signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

Output Speed Sensor (OSS)

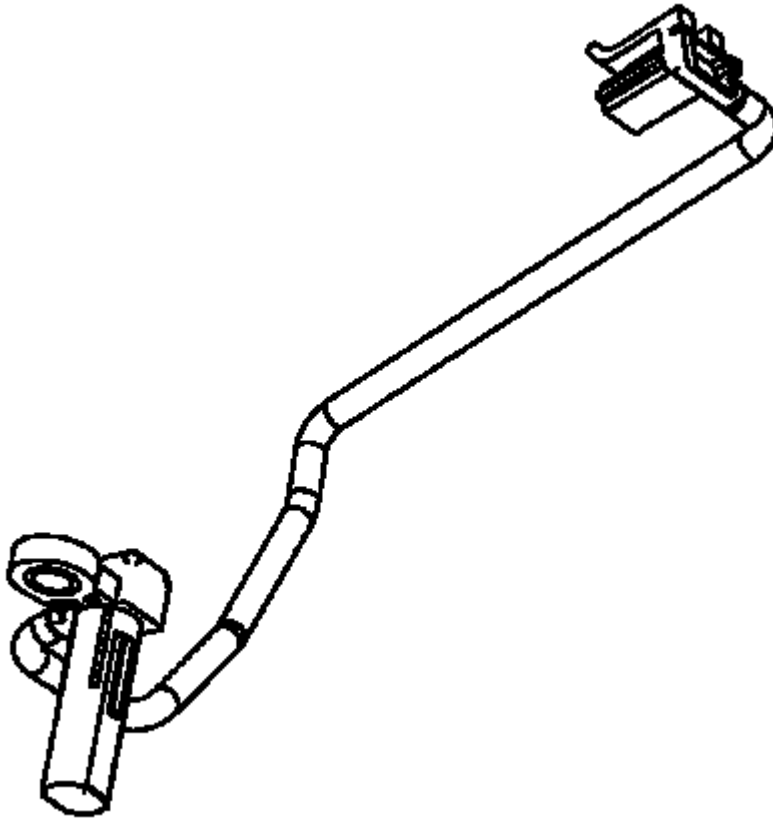


Fig. 5: View Of Output Speed Sensor (OSS)
Courtesy of GENERAL MOTORS COMPANY

The output speed sensor (OSS) is a hall-effect type sensor. The OSS mounts to the transmission case below the control valve body assembly and connects to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the Park gear machined teeth surface. The sensor receives 8.3-9.3 volts on the ISS/OSS supply voltage circuit from the TCM. As the front differential transfer drive gear assembly rotates, the sensor produces a signal frequency based on the machined surface of the Park gear. This signal is transmitted through the OSS signal circuit to the TCM. The TCM uses the OSS signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

Transmission Fluid Pump- Auxiliary

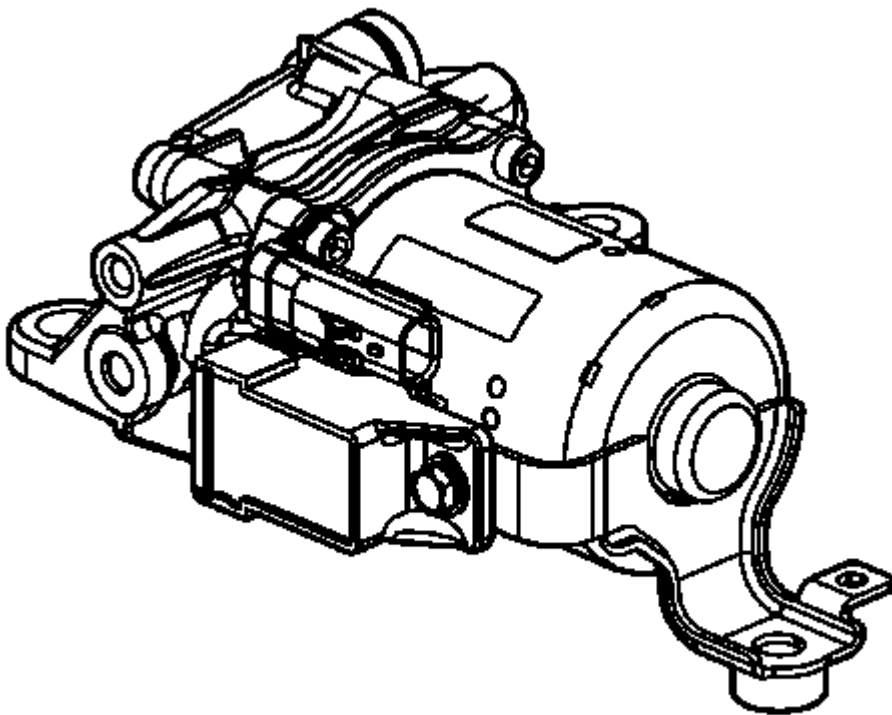


Fig. 6: Transmission Fluid Pump - Auxiliary
Courtesy of GENERAL MOTORS COMPANY

The transmission fluid pump- auxiliary is a hydraulic pump driven by an electric motor. The transmission fluid pump- auxiliary attaches to the transmission case assembly. The transmission fluid pump relay- auxiliary receives voltage through the battery positive voltage circuit. The hybrid powertrain control module controls the auxiliary pump by providing the ground path on the transmission pump relay- auxiliary coil control circuit. When the control circuit is grounded, battery positive voltage is directed to the transmission fluid pump- auxiliary. Under certain conditions, the hybrid vehicle's engine will shut off and the transmission fluid pump- auxiliary will start running to keep the transmission hydraulic circuits pressurized and ready for the engine restart. This engine off condition is a fuel economy feature.

NON-SHIFTING CLUTCH FUNCTION VERIFICATION DESCRIPTION

The 6T30/40/45/50 transmission uses a pressure control system to apply and release clutches during shifts. The transmission control module (TCM) controls pressure commands to the pressure control solenoids.

As normal wear of the transmission clutches occur, the TCM performs a clutch function verification. The TCM momentarily commands a clutch on at a low pressure. The clutch function verification is conducted on smooth roads when the transmission is not shifting and engine torque is consistent and positive.

When a clutch function verification is occurring, a slight bump or drag may be detected momentarily. The

clutch function verification will occur a few times over several minutes and will not repeat again for a thousand or more miles. This is a normal condition and no repair attempts should be performed.

The clutch function verification will be performed sooner for a particular clutch if the TCM detects it is producing frequent poor shift control.

AUTOMATIC TRANSMISSION HYDRAULIC DIAGRAMS

Park - Engine Running (Gen 2/Hybrid)

When the gear selector lever is in the Park (P) position, fluid is drawn into the pump through the transmission fluid filter assembly. Line pressure is then directed to the following valves:

Fluid Pressure Directed in Preparation for a Shift

Manual Valve

Mechanically controlled by the gear selector lever, the manual valve is in the Park (P) position and prevents line pressure from the pressure regulator valve from entering the reverse and drive fluid circuits.

Actuator Feed Limit Valve

Line pressure is regulated through the valve into the actuator feed limit circuit. Actuator feed limit fluid passes through orifice #10 to a differential area to move the valve against actuator feed limit valve spring pressure. Actuator feed limit fluid is routed to the pressure control solenoids, the shift solenoid, and to the #4 ball check valve.

TCC Regulated Apply Valve

Shift solenoid fluid is routed to the TCC regulated apply valve and moves the valve against TCC regulated apply valve spring force.

Default Override Valve

Shift solenoid fluid is routed to the default override valve and moves the valve against default override valve spring force.

Low and Reverse Clutch Applies

R1/456 Pressure Control (PC) Solenoid

The R1/456 PC solenoid is energized (ON) allowing actuator feed limit fluid to enter the PCS R1/456 clutch fluid circuit. PCS R1/456 clutch fluid is then routed through orifice #11 to the R1/4-5-6 clutch regulator valve, and through orifice #34 to the R1/4-5-6 clutch boost valve.

R1/4-5-6 Clutch Regulator Valve

PCS R1/456 clutch fluid at the R1/4-5-6 clutch regulator valve, opposes R1/4-5-6 clutch regulator spring force

and orificed R1/456 clutch feedback fluid pressure to regulate line pressure into the R1/456 clutch feed circuit. R1/456 clutch feed fluid is routed to the R1/4-5-6 clutch boost valve and to the clutch select valve.

R1/4-5-6 Clutch Boost Valve

PCS R1/456 clutch fluid pressure acts on a differential area, moving the R1/4-5-6 clutch boost valve against R1/4-5-6 clutch boost valve spring force, to regulate R1/456 clutch feed fluid into the R1/456 clutch feedback circuit. As PCS R1/456 clutch fluid pressure is increased to a given value, the R1/4-5-6 clutch boost valve opens the R1/456 clutch feedback circuit to exhaust backfill. This results in the R1/4-5-6 clutch regulator valve moving to the full feed position, sending full R1/456 clutch feed pressure (full line pressure) to the low and reverse clutch.

Shift Solenoid

The shift solenoid is energized (ON) allowing actuator feed limit fluid to enter the shift solenoid circuit. Shift solenoid fluid is routed to the clutch select valve through orifice #13, to the TCC regulated apply valve through orifice #14, and through orifice #44 to the default override valve.

Clutch Select Valve

Shift solenoid fluid is routed to the clutch select valve and moves the valve against clutch select valve spring force. This allows R1/456 clutch feed fluid to pass through the valve and enter the R1 circuit. R1 fluid is then routed through orifice #42 to the low and reverse clutch assembly in preparation for a shift into low or reverse gear.

Low and Reverse Clutch

R1/456 fluid enters the transmission case assembly and moves the low and reverse clutch piston against spring force to apply the low and reverse clutch plates. In Park range, the low and reverse clutch has no effect. However, when Reverse or a forward range is selected, only one apply device has to be energized, which helps create a smooth starting motion.

Accumulator

PCS R1/456 clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS R1/456 clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

Park - Engine Running - Gen 2/Hybrid

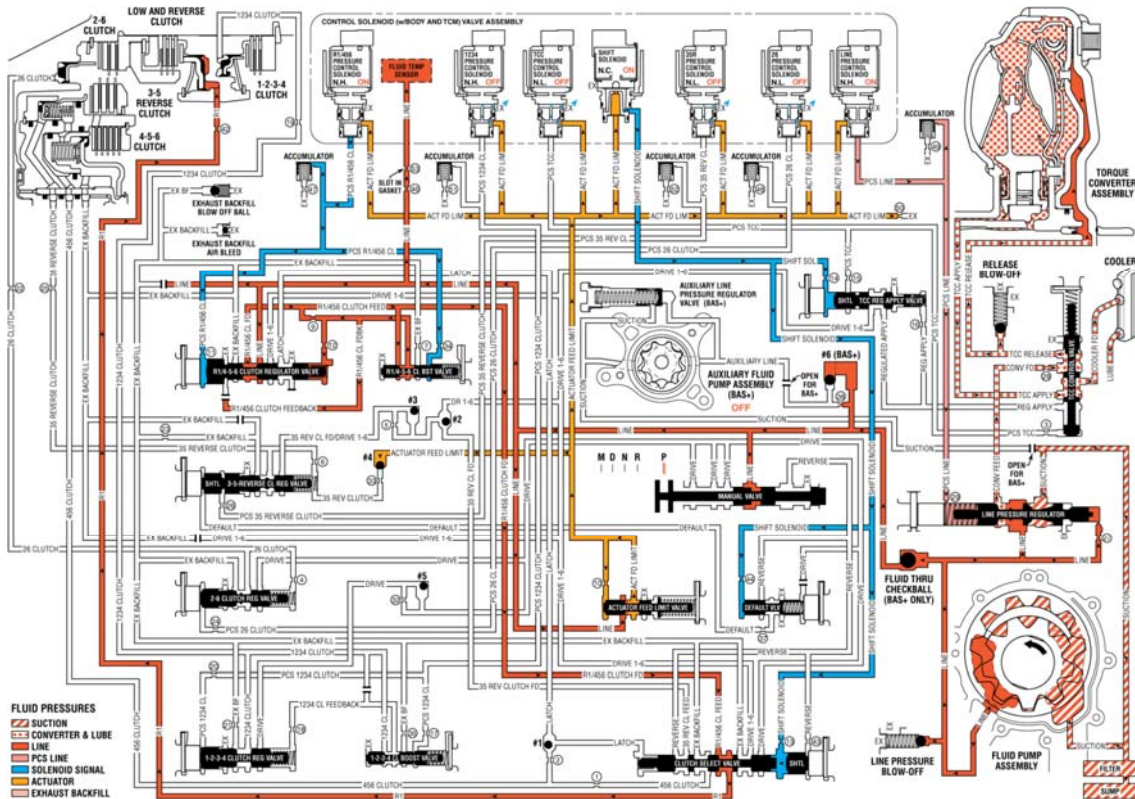


Fig. 7: Park -- Engine Running -- Gen 2/Hybrid Fluid Flow Diagram
Courtesy of GENERAL MOTORS COMPANY

Reverse (Gen 2/Hybrid)

When the gear selector lever is moved to the Reverse (R) position (from the Park position) the normally-low 35R pressure control solenoid is commanded ON and the following changes occur in the transmission's hydraulic and electrical systems:

3-5-Reverse Clutch Applies

Manual Valve

With the manual valve in the reverse position, line pressure is directed into the reverse fluid circuit. Reverse fluid is then routed to the clutch select valve and to the default override valve.

Clutch Select Valve

Reverse fluid is routed to a differential area of the clutch select shuttle valve and assists shift solenoid fluid, present at the valve from Park position, in holding the clutch select valve against clutch select valve spring force. Reverse fluid passes through the clutch select valve into the 35 reverse clutch feed circuit and is routed to the #2 ball check valve. R1/456 clutch feed fluid, present at the valve from Park position, continues to pass through the valve into the R1 circuit in order to keep the low and reverse clutch applied.

#2 Ball Check Valve

3-5 reverse fluid seats the #2 ball check valve against the drive 1-6 fluid passage, and enters the 35 reverse/drive 1-6 circuit. 35 reverse/drive 1-6 fluid is routed to the #3 ball check valve.

#3 Ball Check Valve

35 reverse/drive 1-6 fluid unseats the #3 ball check valve and is routed to the 3-5-reverse clutch regulator valve.

35R Pressure Control (PC) Solenoid

The 35R PC solenoid is energized (ON), allowing actuator feed limit fluid to enter the PCS 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is then routed through orifice #26 to the 3-5-reverse clutch regulator valve.

3-5-Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid, at the 3-5-reverse clutch regulator valve, opposes 3-5-reverse clutch regulator valve spring force and orificed 35 reverse clutch feedback fluid pressure to regulate 35 reverse clutch feed/drive 1-6 pressure into the 35 reverse clutch circuit. 35 reverse clutch fluid is then routed through orifice #25 to the 3-5-reverse clutch, and through orifice #33 to the #4 ball check valve.

3-5-Reverse Clutch

35 reverse clutch fluid enters the 3-5-reverse and 4-5-6 clutch housing assembly to move the 3-5-reverse clutch piston against spring force to apply the 3-5-reverse clutch plates.

#4 Ball Check Valve

35 reverse clutch feed fluid unseats the #4 ball check valve, allowing excess pressure to pass into the actuator feed limit circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

Accumulator

PCS 35 reverse clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS 35 reverse clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

Fluid Pressure Directed in Preparation for a Possible Default Action

Reverse fluid is directed to the default override valve in preparation for Reverse (R) range operation in the event of a transmission default action. If a transmission electrical component malfunction occurs, all solenoids will default to their normal state. The shift solenoid will default to its normally-closed state (OFF), and shift solenoid fluid will exhaust, allowing default override valve spring force to move the default override valve to the released position. With the default override valve in the released position, reverse fluid pressure passes through the valve into the default circuit and is routed to the 3-5-reverse clutch regulator shuttle valve. Default fluid pressure replaces exhausting PCS 35 reverse clutch fluid pressure to keep the 3-5-reverse clutch regulator valve in the applied position, and allow continued Reverse (R) range operation. Refer to Drive Range- Fourth Gear Default for a complete description of the default actions that occur during an electrical component malfunction.

Reverse - Gen 2/Hybrid

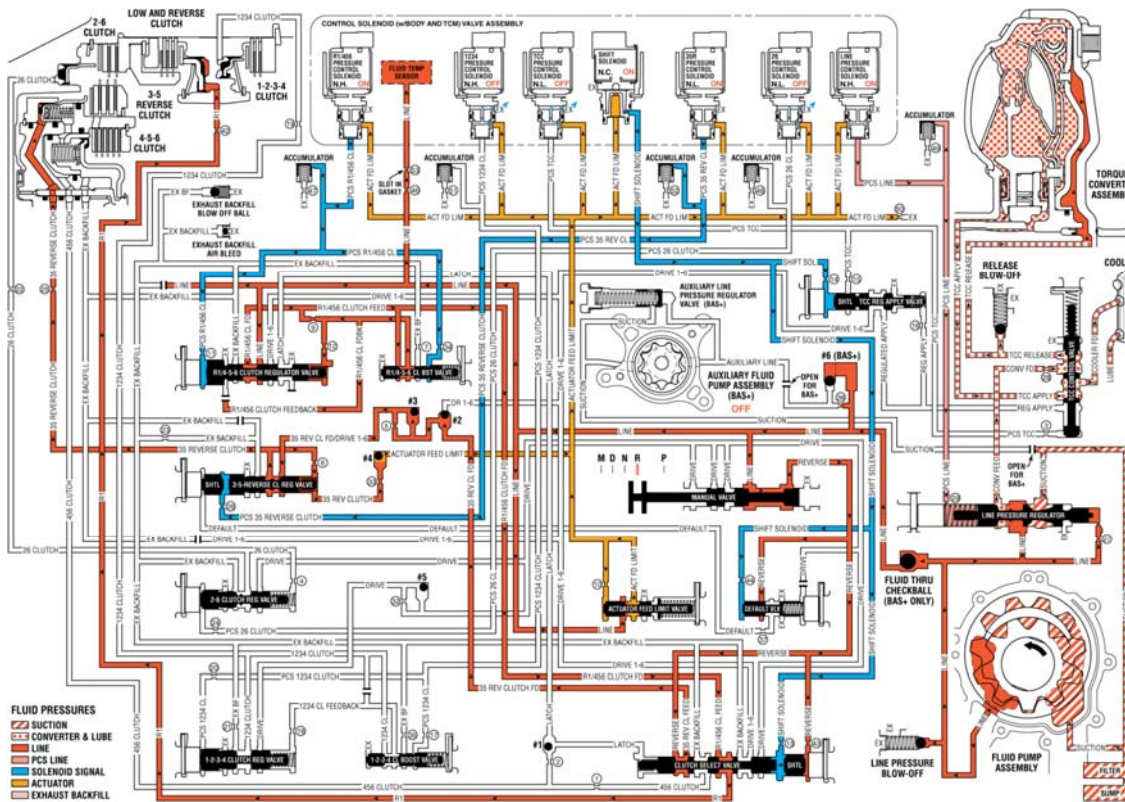


Fig. 8: Reverse -- Gen 2/Hybrid Fluid Flow Diagram
Courtesy of GENERAL MOTORS COMPANY

Neutral - Engine Running (Gen 2/Hybrid)

When the gear selector is moved to the Neutral (N) position, the hydraulic and electrical system operation is identical to Park (P) range. However, if Neutral is selected after the vehicle was operating in Reverse (R), the normally-low 35R pressure control solenoid is commanded OFF and the following changes would occur in the hydraulic system.

3-5 Reverse Clutch Releases

Manual Valve

The manual valve is moved to the Neutral position and blocks line pressure from entering the reverse fluid circuit. Reverse fluid, from the 3-5-reverse clutch regulator valve, the clutch select valve, and the default override valve is opened to an exhaust passage at the manual valve.

35R Pressure Control Solenoid

The 35R PC solenoid is commanded OFF allowing PCS 35 reverse clutch fluid from the 3-5-reverse clutch regulator valve to exhaust.

3-5-Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid exhausts, allowing 3-5-reverse clutch regulator valve spring force to move the 3-5-reverse clutch regulator valve to the released position. This allows exhausting 35 reverse clutch fluid pressure to pass into the exhaust backfill circuit in order to assist the 3-5-reverse line clutch piston spring to quickly release the 3-5-reverse clutch.

3-5-Reverse Clutch

3-5-reverse clutch spring force, assisted by exhaust backfill pressure, moves the 3-5-reverse clutch piston to release the 3-5-reverse clutch plates and force 35 reverse clutch fluid to exhaust from the 3-5-reverse and 4-5-6 clutch housing assembly. The exhausting 35 reverse clutch fluid pressure is routed to the 3-5-reverse clutch regulator valve where it enters the exhaust backfill circuit.

Clutch Select Valve

When reverse fluid exhausts from the clutch select shuttle valve, shift solenoid fluid continues to hold the clutch select valve against clutch select valve spring force allowing 35 reverse clutch feed fluid to exhaust into the reverse circuit.

Neutral - Engine Running - Gen 2/Hybrid

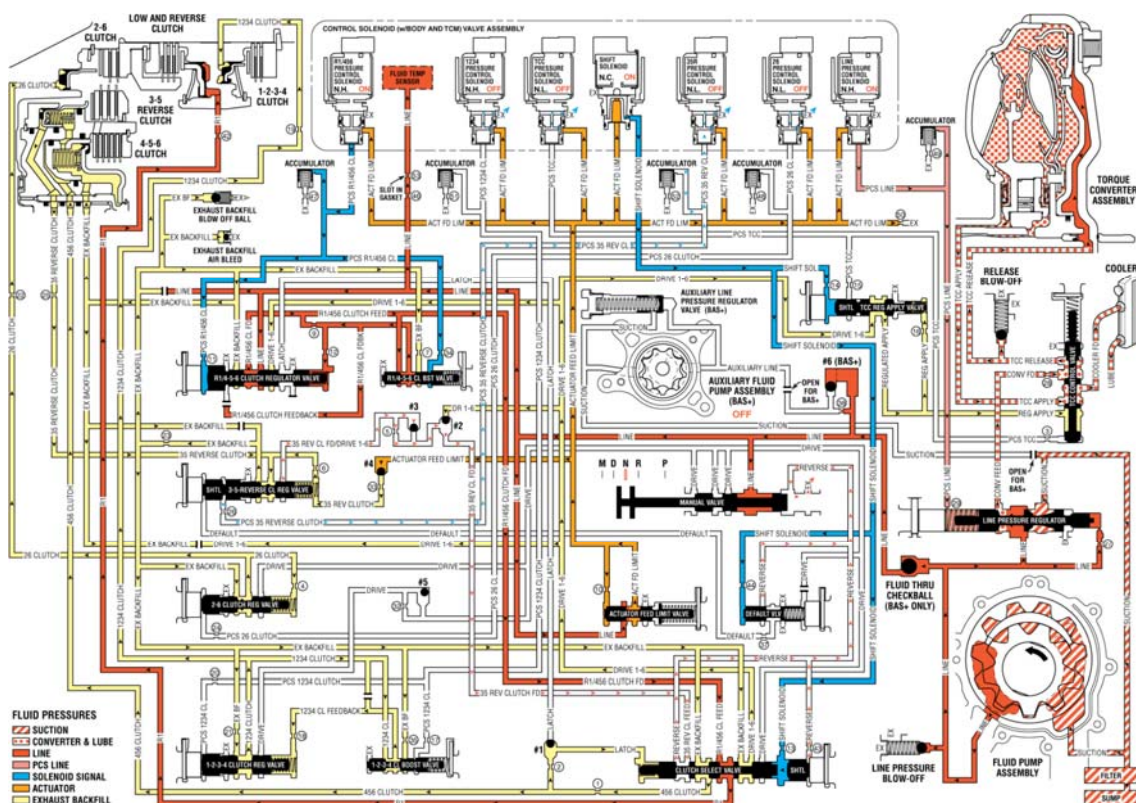


Fig. 9: Neutral -- Engine Running Fluid Flow Diagram
Courtesy of GENERAL MOTORS COMPANY

Drive Range, First Gear Engine Braking (Gen 2/Hybrid)

Note: Some models of the 6T30/40/45/50 automatic transmission are equipped with an electric auxiliary fluid

pump for use in hybrid vehicles (BAS+). Hybrid vehicles do not require internal combustion engine (ICE) operation at all times. After a successful engine start, the hybrid powertrain control module (HPCM) may turn OFF the engine (Auto Stop) when not required for the current vehicle conditions. The engine will remain OFF while in Auto Stop mode, until such time that vehicle conditions require the engine to run. During Auto Stop mode the main fluid pump is no longer driven by the engine, and the auxiliary fluid pump is commanded ON to provide hydraulic fluid pressure to operate the transmission. This functional description of Drive Range- First Gear (Engine Braking), and its accompanying hydraulic circuit, is written for a non-hybrid transmission. For a hybrid (BAS+) transmission, the description and illustration are the same, with the exception that, when the engine is OFF, the main fluid pump is not operating and the auxiliary fluid pump is ON.

When the gear selector lever is moved to the Drive (D) range from the Neutral (N) position, the transmission will provide engine braking. In this operating range, the normally-high 1234 pressure control solenoid is commanded ON and, in the engine braking mode, the following changes occur within the hydraulic circuits.

1-2-3-4 Clutch Applies

Manual Valve

The manual valve is moved to the Drive (D) position and allows line fluid pressure to enter the drive fluid circuit. Drive fluid is then routed to the clutch select valve, the #5 ball check valve, and to the 2-6 clutch regulator valve.

#5 Ball Check Valve

Drive fluid unseats the #5 ball check valve and is routed to the 1-2-3-4 clutch regulator valve.

1234 Pressure Control (PC) Solenoid

The 1234 PC solenoid is commanded ON allowing actuator feed limit fluid to enter the PCS 1234 clutch fluid circuit. PCS 1234 clutch fluid is then routed through orifice #20 to the 1-2-3-4 clutch regulator valve, and through orifice #17 to the 1-2-3-4 clutch boost valve.

1-2-3-4 Clutch Regulator Valve

PCS 1234 clutch fluid, at the 1-2-3-4 clutch regulator valve, opposes 1-2-3-4 clutch regulator valve spring force and 1234 clutch feedback fluid pressure to regulate drive fluid pressure into the 1234 clutch fluid circuit. The 1234 clutch fluid is then routed to the 1-2-3-4 clutch boost valve and through orifice #19 to the 1-2-3-4 clutch.

1-2-3-4 Clutch Boost Valve

PCS 1234 clutch fluid pressure acts on a differential area, moving the 1-2-3-4 clutch boost valve against 1-2-3-4 clutch boost valve spring force, to regulate 1234 clutch fluid into the 1234 clutch feedback circuit. As PCS 1234 clutch fluid pressure is increased to a given value, the 1-2-3-4 clutch boost valve opens the 1234 clutch feedback circuit to exhaust backfill. This results in the 1-2-3-4 clutch regulator valve moving to the full feed position, sending full 1234 clutch feed pressure (full line pressure) to the 1-2-3-4 clutch.

1-2-3-4 Clutch

Fig. 10: Drive Range, First Gear Engine Braking Fluid Flow Diagram
Courtesy of GENERAL MOTORS COMPANY

Drive Range, First Gear (Gen 2/Hybrid)

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, throttle position sensor and other vehicle sensors to determine the precise moment to de-energize or "turn OFF" the shift solenoid, and to command OFF the normally-high R1/456 pressure control solenoid.

Low & Reverse Clutch Releases

Shift Solenoid

The shift solenoid is commanded OFF allowing shift solenoid fluid pressure to exhaust from the clutch select valve, the default override valve, and the TCC regulator apply valve.

Clutch Select Valve

Shift solenoid fluid is exhausted from the clutch select valve and clutch select valve spring force moves the valve to the released position. This allows R1 fluid pressure to pass through the valve into the exhaust backfill circuit. Drive fluid from the manual valve passes through the clutch select valve and enters the drive 1-6 fluid circuit. Drive 1-6 fluid is routed to the R1/4-5-6 clutch regulator valve, the 3-5-reverse clutch regulator valve, and the TCC regulator apply valve.

Low and Reverse Clutch

Low and reverse clutch spring force moves the low and reverse clutch piston to release the low and reverse clutch plates and force R1 fluid to exhaust from the case assembly. The exhausting R1 fluid is routed to the clutch select valve where it enters the exhaust backfill circuit.

Fluid Pressure Directed in Preparation for a Shift

R1/456 Pressure Control (PC) Solenoid

The R1/456 PC solenoid is commanded OFF allowing PCS R1/456 clutch fluid to exhaust from the R1/4-5-6 clutch regulator valve and the R1/4-5-6 clutch boost valve.

R1/4-5-6 Clutch Regulator Valve

R1/4-5-6 clutch regulator valve spring force moves the valve to the released position, allowing R1/456 clutch feed fluid to enter the exhaust backfill circuit, and drive 1-6 fluid to enter the latch fluid circuit. Latch fluid is routed to the #1 ball check valve.

#1 Ball Check Valve

Latch fluid pressure seats the #1 ball check valve against the 456 clutch fluid circuit. Latch fluid is then directed to the clutch select valve. Latch fluid combines with clutch select valve spring force and holds the valve in this position during all six forward gear ranges.

#2 Ball Check Valve

Drive 1-6 fluid pressure seats the #2 ball check valve against the 35 reverse clutch feed fluid passage, and is directed into the 35 reverse clutch feed/drive 1-6 circuit. 35 reverse clutch feed/drive 1-6 fluid is routed to the #3 ball check valve.

#3 Ball Check Valve

35 reverse clutch feed/drive 1-6 fluid pressure unseats the #3 ball check valve and is directed to the 3-5-reverse clutch regulator valve.

Fluid Pressure Directed in Preparation for Torque Converter Clutch (TCC) Apply

TCC Regulator Apply Valve

Drive 1-6 fluid is routed to the TCC regulator apply valve in preparation for TCC apply.

Drive Range, First Gear - Gen 2/Hybrid

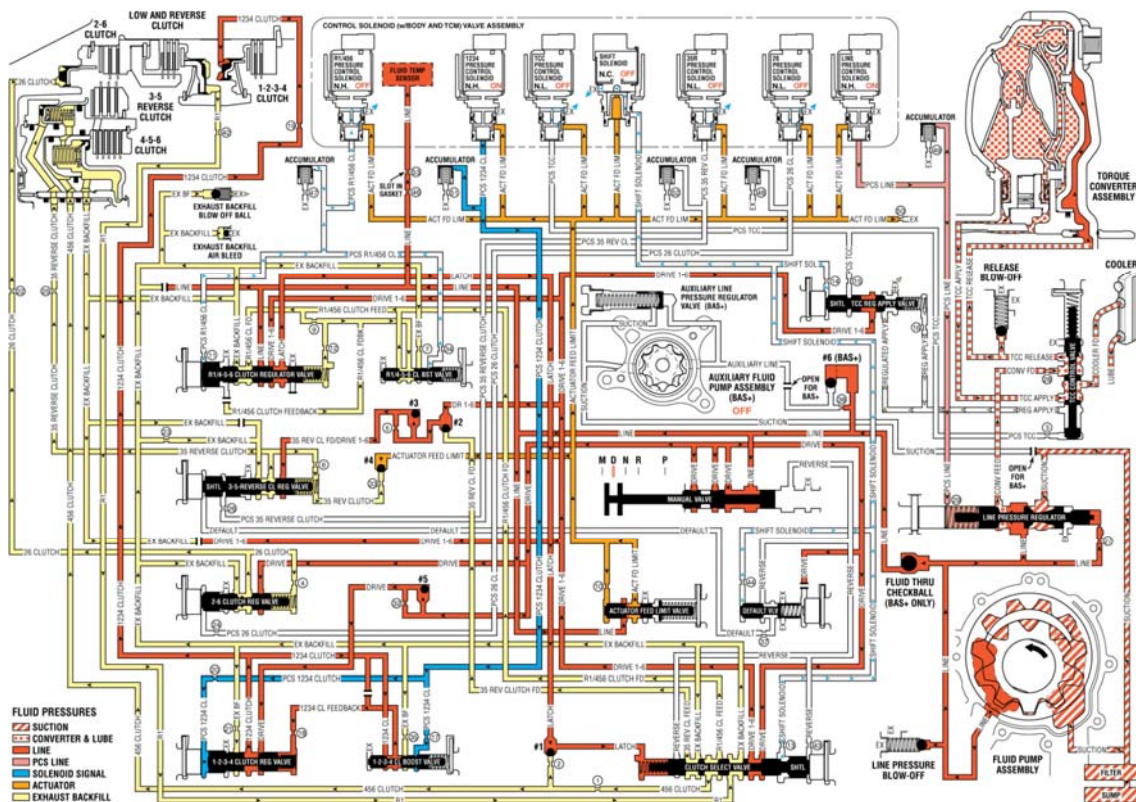


Fig. 11: Drive Range, First Gear -- Gen 2/Hybrid Fluid Flow Diagram
 Courtesy of GENERAL MOTORS COMPANY

Drive Range, Second Gear (Gen 2/Hybrid)

As vehicle speed increases and operating conditions become appropriate, the transmission control module (TCM) processes input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-low 26 pressure control solenoid and shift the transmission into Second gear. The manual valve remains in the Drive

(D) position and line pressure continues to feed the drive fluid circuit.

2-6 Clutch Applies

26 Pressure Control (PC) Solenoid

The 26 PC solenoid is commanded ON, allowing actuator feed limit fluid to enter the PCS 26 clutch fluid circuit. PCS 26 clutch fluid is then routed through orifice #24 to the 2-6 clutch regulator valve.

2-6 Clutch Regulator Valve

PCS 26 clutch fluid, at the 2-6 clutch regulator valve, opposes 2-6 clutch regulator valve spring force and orificed 26 clutch fluid pressure to regulate drive fluid pressure into the 26 clutch circuit. 26 clutch fluid is then routed through orifice #22 to the 2-6 clutch assembly in the transmission case, and through orifice #4 to the spring end of the 2-6 clutch regulator valve.

2-6 Clutch

The 26 clutch fluid from the 2-6 clutch regulator valve is routed through the transmission case to the 2-6 clutch piston assembly. The 26 clutch fluid pressure moves the piston against 2-6 clutch spring force to apply the 2-6 clutch plates.

Accumulator

PCS 26 clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS 26 clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

Drive Range, Second Gear - Gen 2/Hybrid

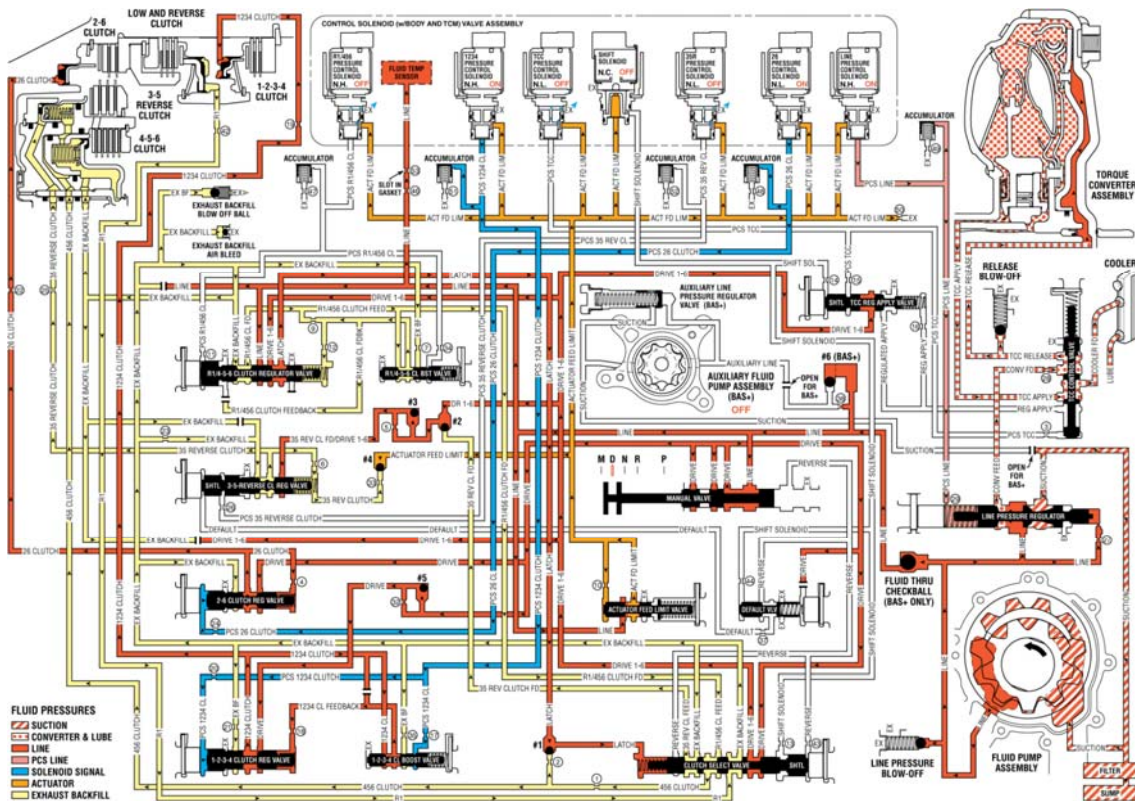


Fig. 12: Drive Range, Second Gear -- Gen 2/Hybrid Fluid Flow Diagram
Courtesy of GENERAL MOTORS COMPANY

Drive Range, Third Gear (Gen 2/Hybrid)

As vehicle speed increases and operating conditions become appropriate, the transmission control module (TCM) processes input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command OFF the normally-low 26 pressure control solenoid. At the same time the 35R pressure control solenoid is also commanded ON to regulate 3-5 clutch apply, and the transmission shifts into Third gear. The manual valve remains in the Drive (D) position and line pressure continues to feed the drive fluid circuit.

3-5-Reverse Clutch Applies

35R Pressure Control (PC) Solenoid

The 35R PC solenoid is commanded ON, allowing actuator feed limit fluid to enter the PCS 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #26 to the 3-5-reverse clutch regulator valve.

3-5-Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid, at the 3-5-reverse clutch regulator valve, opposes 3-5-reverse clutch regulator valve spring force and 35 reverse clutch feedback fluid pressure to regulate 35 reverse clutch feed/drive 1-6 pressure into the 35 reverse clutch circuit. The 35 reverse clutch fluid is then routed through orifice #25 to the 3-5-reverse clutch assembly, through orifice #6 to the spring end of the 3-5-reverse clutch regulator valve and through orifice #33 to the #4 ball check valve.

3-5-Reverse Clutch

35 reverse clutch fluid enters the 3-5-reverse and 4-5-6 clutch housing assembly to move the 3-5-reverse clutch piston against spring force and exhaust backfill fluid pressure to apply the 3-5-reverse clutch plates.

#4 Ball Check Valve

35 reverse clutch feed fluid unseats the #4 ball check valve, allowing excess pressure to pass into the actuator feed limit circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

Accumulator

PCS 35 reverse clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS 35 reverse clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

2-6 Clutch Releases

26 Pressure Control (PC) Solenoid

The 26 PC solenoid is commanded OFF, allowing PCS 26 clutch fluid to exhaust from the 2-6 clutch regulator valve.

2-6 Clutch Regulator Valve

2-6 clutch regulator valve spring force moves the valve to the released position, allowing 26 clutch fluid from the 2-6 clutch to pass through the valve and enter the exhaust backfill fluid circuit.

2-6 Clutch

2-6 clutch spring force moves the 2-6 clutch piston to release the 2-6 clutch plates and force 26 clutch fluid to exhaust from the transmission case assembly. The exhausting 26 clutch fluid pressure is routed to the 2-6 clutch regulator valve where it enters the exhaust backfill fluid circuit.

Drive Range, Third Gear - Gen 2/Hybrid

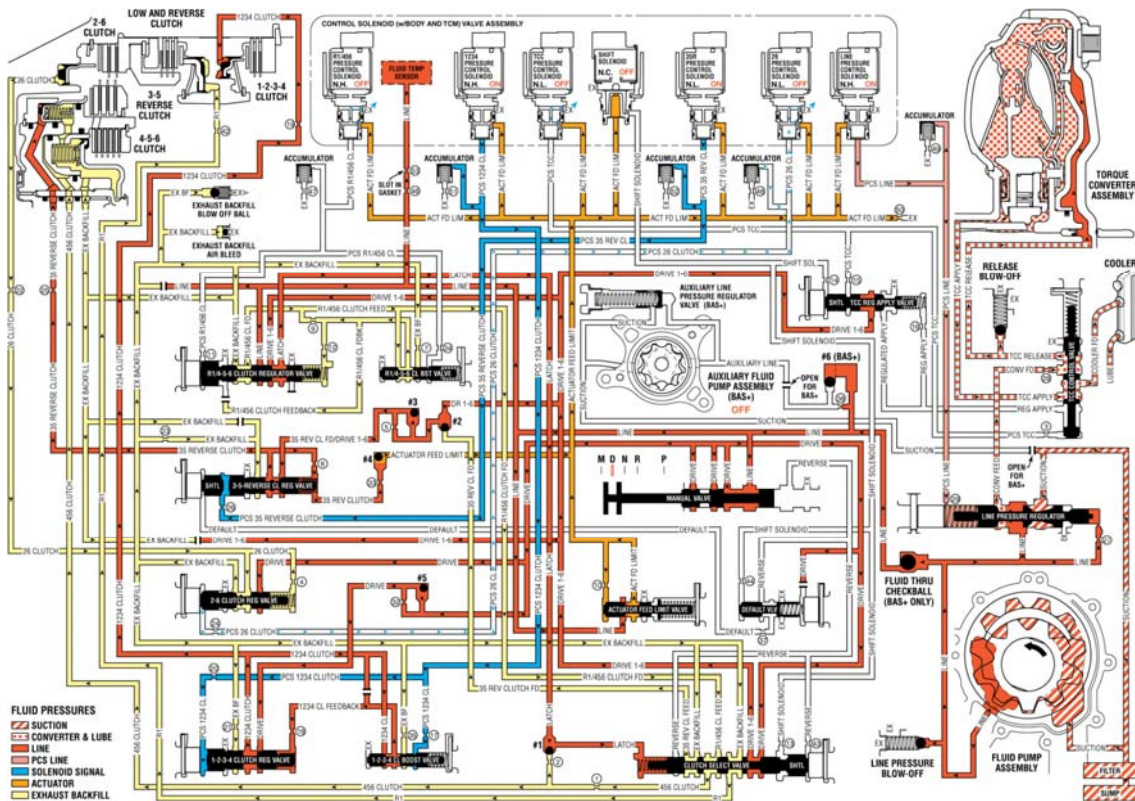


Fig. 13: Drive Range, Third Gear -- Gen 2/Hybrid Fluid Flow Diagram
Courtesy of GENERAL MOTORS COMPANY

Drive Range - Fourth Gear (Gen 2/Hybrid)

As vehicle speed increases, the transmission control module (TCM) processes input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command OFF the normally-low 35R pressure control solenoid. At the same time, the normally-high R1/456 pressure control solenoid is commanded ON to regulate 4-5-6 clutch apply and the transmission shifts into Fourth gear.

4-5-6 Clutch Applies

R1/456 Pressure Control (PC) Solenoid

The R1/456 PC solenoid is commanded ON allowing actuator feed limit fluid to enter the PCS R1/456 clutch fluid circuit. PCS R1/456 clutch fluid is routed through orifice #11 to the R1/4-5-6 clutch regulator valve, and through orifice #34 to the R1/4-5-6 clutch boost valve.

R1/4-5-6 Clutch Regulator Valve

PCS R1/456 clutch fluid, at the R1/4-5-6 clutch regulator valve, opposes R1/4-5-6 clutch regulator valve spring force and orificed R1/456 clutch feed fluid pressure to regulate line pressure into the R1/456 clutch feed circuit. R1/456 clutch feed fluid is then routed to the clutch select valve, the R1/4-5-6 clutch boost valve, and through orifices #9 and #12 to the spring end of the R1/4-5-6 clutch regulator valve. When the R1/4-5-6 clutch regulator valve is in this position, latch fluid exhausts through the valve allowing 456 clutch fluid to shuttle the #1 ball

check valve.

R1/4-5-6 Clutch Boost Valve

PCS R1/456 clutch fluid pressure acts on a differential area, moving the R1/4-5-6 clutch boost valve against R1/4-5-6 clutch boost valve spring force, to regulate R1/456 feed clutch fluid into the R1/456 clutch feedback circuit. As PCS R1/456 clutch fluid pressure is increased to a given value, the R1/4-5-6 clutch boost valve opens the R1/456 clutch feedback circuit to exhaust backfill. This results in the R1/4-5-6 clutch regulator valve moving to the full feed position, sending full R1/456 clutch feed pressure (full line pressure) to the 4-5-6 clutch.

#1 Ball Check Valve

Orificed 456 clutch fluid pressure seats the #1 ball check valve against the exhausting latch fluid passage. 456 clutch fluid is then directed into the latch circuit to replace the exhausting latch pressure and is routed to the clutch select valve. Latch fluid combines with clutch select valve spring force and holds the valve in this position during all six forward gear ranges.

Clutch Select Valve

R1/456 clutch feed fluid passes through the clutch select valve and enters the 456 clutch circuit. 456 clutch fluid is routed to the 4-5-6 clutch assembly, and through orifice #2 to the #1 ball check valve.

4-5-6 Clutch

456 clutch fluid enters the 3-5-reverse and 4-5-6 clutch housing assembly, and moves the 4-5-6 clutch piston against spring force and exhaust backfill pressure to apply the 4-5-6 clutch plates.

Accumulator

PCS R1/456 clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS R1/456 clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

3-5-Reverse Clutch Releases

35R Pressure Control (PC) Solenoid

The 35R PC solenoid is commanded OFF allowing PCS 35 reverse clutch fluid from the 3-5-reverse clutch regulator valve to exhaust.

3-5-Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid exhausts, allowing 3-5-reverse clutch regulator valve spring force to move the 3-5-reverse clutch regulator valve to the released position. This allows exhausting 35 reverse clutch fluid pressure to pass into the exhaust backfill circuit in order to assist the 3-5-reverse clutch piston spring to quickly release the 3-5-reverse clutch.

3-5-Reverse Clutch

3-5-reverse clutch spring force, assisted by exhaust backfill pressure, moves the 3-5-reverse clutch piston to release the 3-5-reverse clutch plates and force 35 reverse clutch fluid to exhaust from the 3-5-reverse and 4-5-6 clutch housing assembly. The exhausting 35 reverse clutch fluid pressure is routed to the 3-5-reverse clutch regulator valve where it enters the exhaust backfill feed circuit.

Torque Converter Clutch (TCC) Applies

Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid

The TCC PC solenoid is commanded ON, allowing actuator feed limit fluid to enter the PCS TCC fluid circuit. PCS TCC fluid is routed through orifice #15 to the TCC regulator apply valve and through orifice #3 to the TCC control valve.

TCC Regulator Apply Valve

PCS TCC fluid, at the TCC regulator apply valve, opposes TCC regulator apply valve spring force and orificed regulated apply fluid pressure to regulate drive 1-6 fluid into the regulated apply circuit. Regulated apply fluid is routed to the TCC control valve and through orifice #16 to the spring end of the TCC regulator apply valve.

TCC Control Valve

PCS TCC fluid moves the TCC control valve against TCC control valve spring force, allowing regulated apply fluid to pass through the valve into the TCC apply fluid circuit and apply the torque converter clutch. Converter feed fluid passes through orifice #28 to the TCC control valve, replacing TCC apply fluid, to supply the cooler feed circuit. TCC release fluid passes through the TCC control valve and is exhausted.

Drive Range, Fourth Gear - Gen 2/Hybrid

moving to the full feed position, sending full 1234 clutch feed pressure (full line pressure) to the 1-2-3-4 clutch.

1-2-3-4 Clutch Regulator Valve

PCS 1234 clutch fluid moves the 1-2-3-4 clutch regulator valve, against 1-2-3-4 clutch regulator valve spring force, to the applied position. This allows drive fluid pressure to pass through the valve into the 1234 clutch fluid circuit. The 1234 clutch fluid is then routed to the 1-2-3-4 clutch boost valve and through orifice #19 to the 1-2-3-4 clutch.

1-2-3-4 Clutch

1234 clutch fluid enters the transmission case assembly and moves the 1-2-3-4 clutch piston against spring force to apply the 1-2-3-4 clutch plates.

Accumulator

PCS 1234 clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS 1234 clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

4-5-6 Clutch Applies or Remains Applied

R1/456 Pressure Control (PC) Solenoid

The R1/456 PC solenoid defaults to its normally-high state (ON), allowing actuator feed limit fluid to enter the PCS R1/456 clutch fluid circuit. PCS R1/456 clutch fluid is routed through orifice #11 to the R1/4-5-6 clutch regulator valve, and through orifice #34 to the R1/4-5-6 clutch boost valve. If the transmission is operating in First, Second or Third gear when an electrical malfunction occurs, the 4-5-6 clutch will apply. If the transmission is operating in Fourth, Fifth or Sixth gear when the electrical malfunction occurs, the 4-5-6 clutch remains applied.

R1/4-5-6 Clutch Boost Valve

PCS R1/456 clutch fluid pressure acts on a differential area, moving the R1/4-5-6 clutch boost valve against R1/4-5-6 clutch boost valve spring force, to block R1/456 clutch feed fluid from entering the R1/456 clutch feedback circuit, and opening the R1/456 clutch feedback circuit to exhaust backfill. This results in the R1/4-5-6 clutch regulator valve moving to the full feed position, sending full R1/456 clutch feed pressure (full line pressure) to the 4-5-6 clutch.

R1/4-5-6 Clutch Regulator Valve

PCS R1/456 clutch fluid moves the R1/4-5-6 clutch regulator valve, against R1/4-5-6 clutch regulator valve spring force, to the applied position. This allows line fluid pressure to pass through the valve into the R1/456 clutch feed circuit. R1/456 clutch feed fluid is then routed to the clutch select valve, the R1/4-5-6 clutch boost valve, and through orifices #9 and #12 to the spring end of the R1/4-5-6 clutch regulator valve. When the R1/4-5-6 clutch regulator valve is in this position, latch fluid exhausts through the valve allowing 456 clutch fluid to shuttle the #1 ball check valve.

#1 Ball Check Valve

Orificed 456 clutch fluid pressure seats the #1 ball check valve against the exhausting latch fluid passage. 456 clutch fluid is then directed into the latch circuit to replace the exhausting latch pressure and is routed to the clutch select valve. Latch fluid combines with clutch select valve spring force and holds the valve in this position during all six forward gear ranges.

Clutch Select Valve

R1/456 clutch feed fluid passes through the clutch select valve and enters the 456 clutch circuit. 456 clutch fluid is routed to the 4-5-6 clutch assembly, and through orifice #2 to the #1 ball check valve.

4-5-6 Clutch

456 clutch fluid enters the 3-5-reverse and 4-5-6 clutch housing assembly, and moves the 4-5-6 clutch piston against spring force and exhaust backfill pressure to apply the 4-5-6 clutch plates.

Accumulator

PCS R1/456 clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS R1/456 clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

3-5-Reverse Clutch Releases

35R Pressure Control (PC) Solenoid

If the transmission is in Third or Fifth gear when an electrical condition commands a protection mode, the 35R PC solenoid defaults to its normally-low state (OFF), allowing PCS 35R clutch fluid pressure to exhaust and the 3-5-reverse clutch to release. See Drive Range- Fourth Gear for a complete description of 3-5-reverse clutch release.

2-6 Clutch Releases

26 Pressure Control (PC) Solenoid

If the transmission is in Second or Sixth gear when an electrical condition commands a protection mode, the 26 PC solenoid defaults to its normally-low state (OFF), allowing PCS 26 clutch fluid pressure to exhaust and the 2-6 clutch to release. See Drive Range- Third Gear for a complete description of 2-6 clutch release.

Torque Converter Clutch (TCC) Releases

Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid

If the TCC is applied when an electrical condition commands a protection mode, the TCC PC solenoid defaults to its normally-low state (OFF), allowing PCS TCC fluid to exhaust and the TCC to release. See Drive Range- Sixth Gear for a complete description of TCC release.

Drive Range, Fourth Gear Default - Gen 2/Hybrid

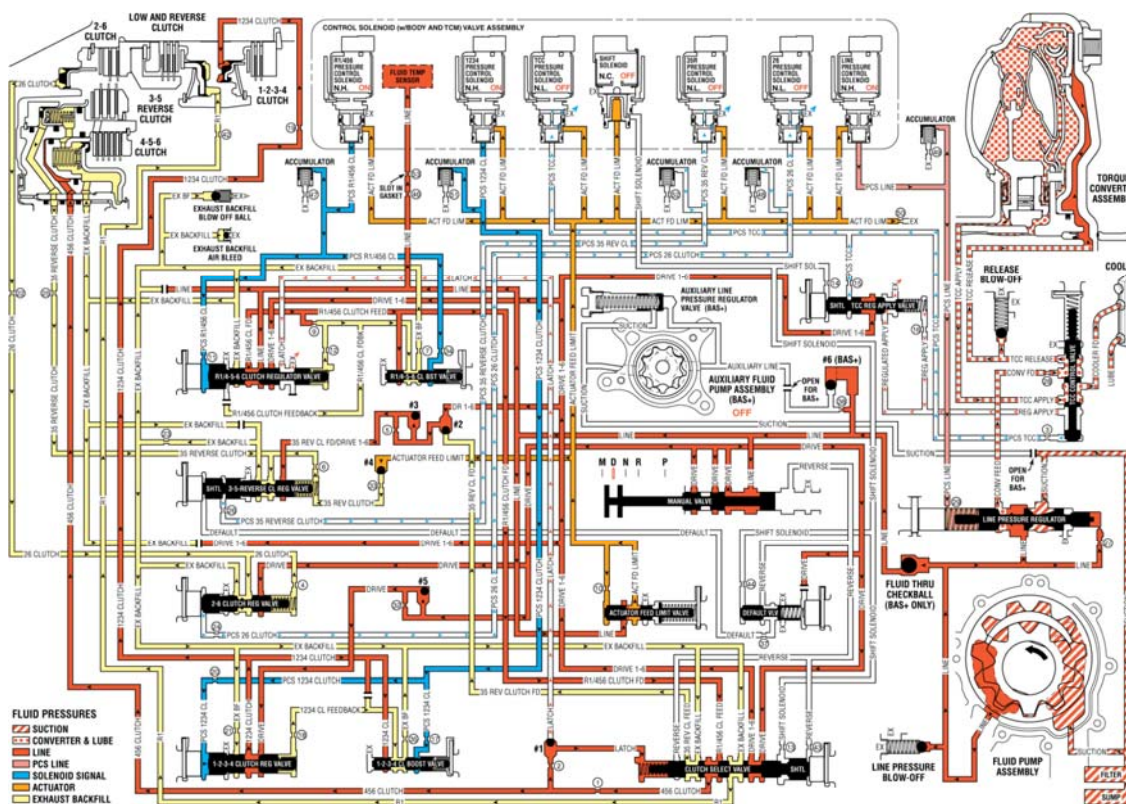


Fig. 15: Drive Range, Fourth Gear Default -- Gen 2/Hybrid Fluid Flow Diagram
 Courtesy of GENERAL MOTORS COMPANY

Drive Range, Fifth Gear (Gen 2/Hybrid)

As vehicle speed increases, the transmission control module (TCM) processes input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-low 35R pressure control solenoid. At the same time, the normally-high 1234 pressure control solenoid is commanded OFF and the transmission shifts into Fifth gear.

3-5-Reverse Clutch Applies

35R Pressure Control (PC) Solenoid

The 35R PC solenoid is commanded ON, allowing actuator feed limit fluid to enter the PCS 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #26 to the 3-5-reverse clutch regulator valve.

3-5-Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid, at the 3-5-reverse clutch regulator valve, opposes 3-5-reverse clutch regulator valve spring force and 35 reverse clutch feedback fluid pressure to regulate 35 reverse clutch feed/drive 1-6 pressure into the 35 reverse clutch circuit. The 35 reverse clutch fluid is then routed through orifice #25 to the 3-5-reverse clutch assembly, through orifice #6 to the spring end of the 3-5-reverse clutch regulator valve and through orifice #33 to the #4 ball check valve.

3-5-Reverse Clutch

35 reverse clutch fluid enters the 3-5-reverse and 4-5-6 clutch housing assembly to move the 3-5-reverse clutch piston against spring force and exhaust backfill fluid pressure to apply the 3-5-reverse clutch plates.

#4 Ball Check Valve

35 reverse clutch feed fluid unseats the #4 ball check valve, allowing excess pressure to pass into the actuator feed limit circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

Accumulator

PCS 35 reverse clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS 35 reverse clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

1-2-3-4 Clutch Releases

1234 Pressure Control (PC) Solenoid

The 1234 PC solenoid is commanded OFF, allowing PCS 1234 clutch fluid to exhaust from the 1-2-3-4 clutch regulator valve and the 1-2-3-4 clutch boost valve.

1-2-3-4 Clutch Regulator Valve

1-2-3-4 clutch regulator valve spring force moves the valve to the released position, allowing 1234 clutch fluid pressure from the 1-2-3-4 clutch to pass through the valve and enter the exhaust backfill circuit. The exhausting 1234 clutch fluid pressure is routed through orifice #21 in order to help control the release of the 1-2-3-4 clutch.

1-2-3-4 Clutch Boost Valve

1-2-3-4 clutch boost valve spring force moves the 1-2-3-4 clutch boost valve to the released position, allowing 1234 clutch feedback fluid pressure to exhaust from the 1-2-3-4 clutch regulator valve into the 1234 clutch circuit.

1-2-3-4 Clutch

1-2-3-4 clutch spring force moves the 1-2-3-4 clutch piston to release the 1-2-3-4 clutch plates and force 1234 clutch fluid to exhaust from the transmission case assembly. The exhausting 1234 clutch fluid is routed to the 1-2-3-4 clutch regulator valve where it enters the exhaust backfill circuit.

Drive Range, Fifth Gear - Gen 2/Hybrid

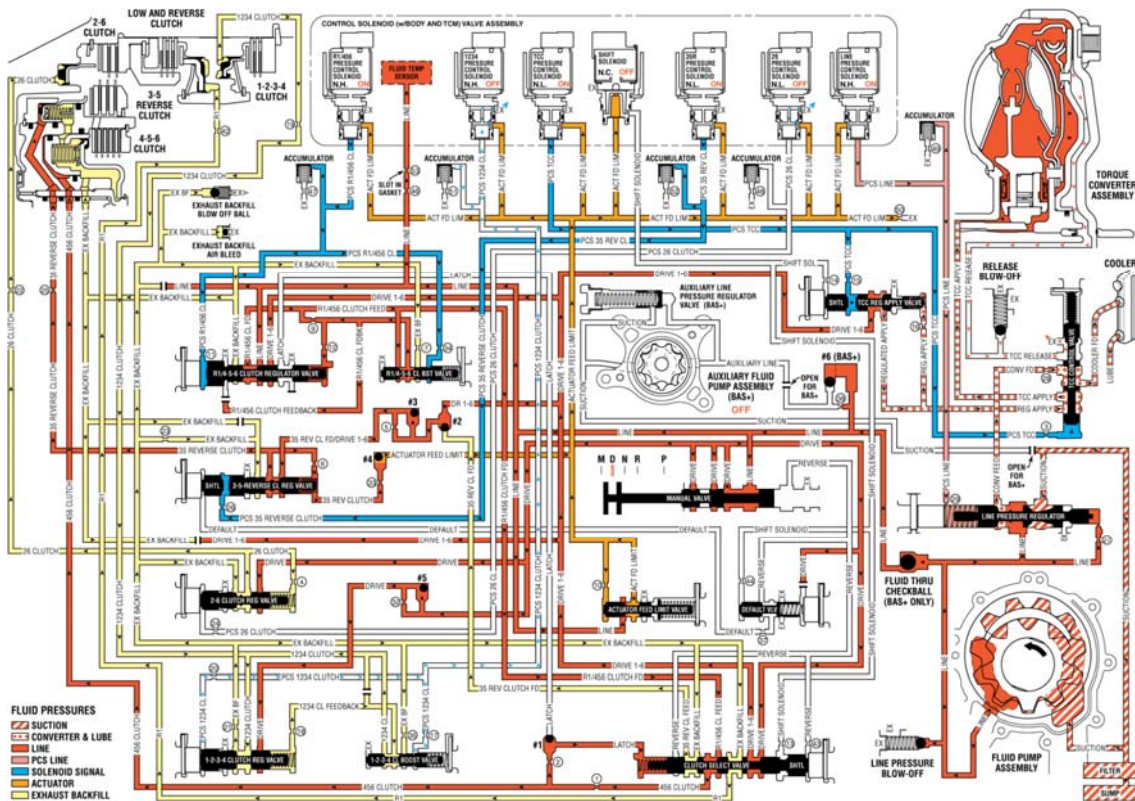


Fig. 16: Drive Range, Fifth Gear -- Gen 2/Hybrid Fluid Flow Diagram
 Courtesy of GENERAL MOTORS COMPANY

Drive Range, Sixth Gear (Gen 2/Hybrid)

As vehicle speed increases, the transmission control module (TCM) processes input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-low 26 pressure control solenoid. At the same time, the normally-low 35R pressure control solenoid is commanded OFF and the transmission shifts into Sixth gear.

2-6 Clutch Applies

26 Pressure Control (PC) Solenoid

The 26 PC solenoid is commanded ON, allowing actuator feed limit fluid to enter the PCS 26 clutch fluid circuit. PCS 26 clutch fluid is then routed through orifice #24 to the 2-6 clutch regulator valve.

2-6 Clutch Regulator Valve

PCS 26 clutch fluid, at the 2-6 clutch regulator valve, opposes 2-6 clutch regulator valve spring force and orificed 26 clutch fluid pressure to regulate drive fluid pressure into the 26 clutch circuit. 26 clutch fluid is then routed through orifice #22 to the 2-6 clutch assembly in the transmission case, and through orifice #4 to the spring end of the 2-6 clutch regulator valve.

2-6 Clutch

The 26 clutch fluid from the 2-6 clutch regulator valve is routed through the transmission case to the 2-6 clutch piston assembly. The 26 clutch fluid pressure moves the piston against 2-6 clutch spring force to apply the 2-6 clutch plates.

Accumulator

PCS 26 clutch fluid is also routed to an accumulator valve. The accumulator valve is used to dampen any pressure irregularities occurring in the PCS 26 clutch fluid circuit. This helps to control clutch apply fluid pressure and clutch apply feel.

3-5 Reverse Clutch Releases

35R Pressure Control (PC) Solenoid

The 35R PC solenoid is commanded OFF allowing PCS 35 reverse clutch fluid from the 3-5-reverse clutch regulator valve to exhaust.

3-5-Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid exhausts, allowing 3-5-reverse clutch regulator valve spring force to move the 3-5-reverse clutch regulator valve to the released position. This allows exhausting 35 reverse clutch fluid pressure to pass into the exhaust backfill circuit in order to assist the 3-5-reverse clutch piston spring to quickly release the 3-5-reverse clutch.

3-5-Reverse Clutch

3-5-reverse clutch spring force, assisted by exhaust backfill pressure, moves the 3-5-reverse clutch piston to release the 3-5-reverse clutch plates and force 35 reverse clutch fluid to exhaust from the 3-5-reverse and 4-5-6 clutch housing assembly. The exhausting 35 reverse clutch fluid pressure is routed to the 3-5-reverse clutch regulator valve where it enters the exhaust backfill circuit.

Drive Range, Sixth Gear - Gen 2/Hybrid

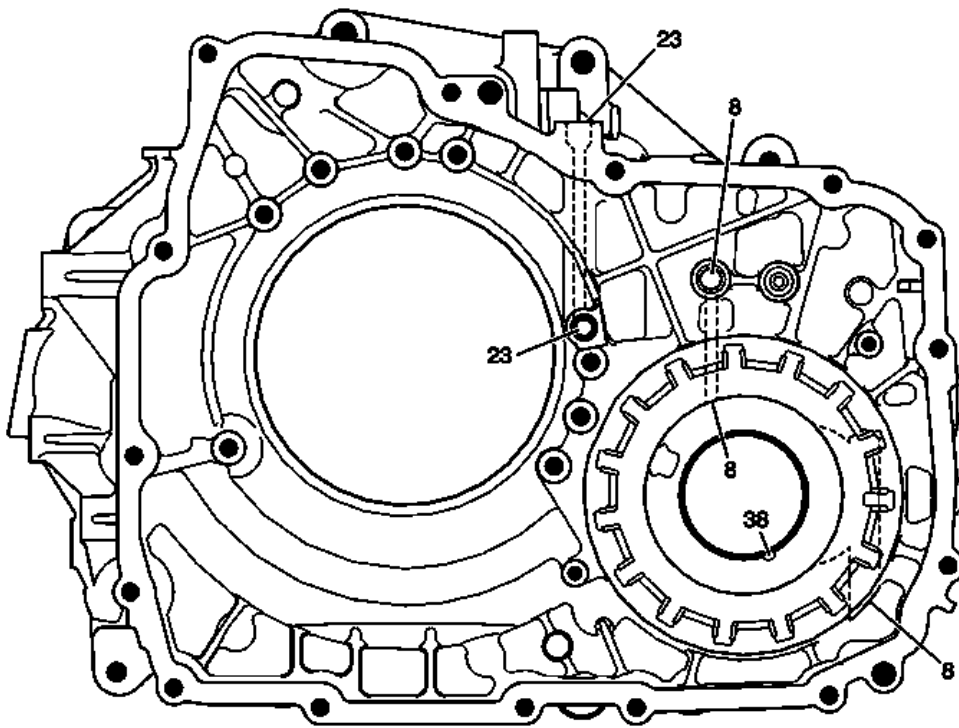


Fig. 18: Torque Converter and Differential Housing -- Case Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
8	Lube
23	Auxiliary Suction (BAS+ Only)
38	Seal Drainback

Fluid Pump Body - Fluid Pump Cover Side

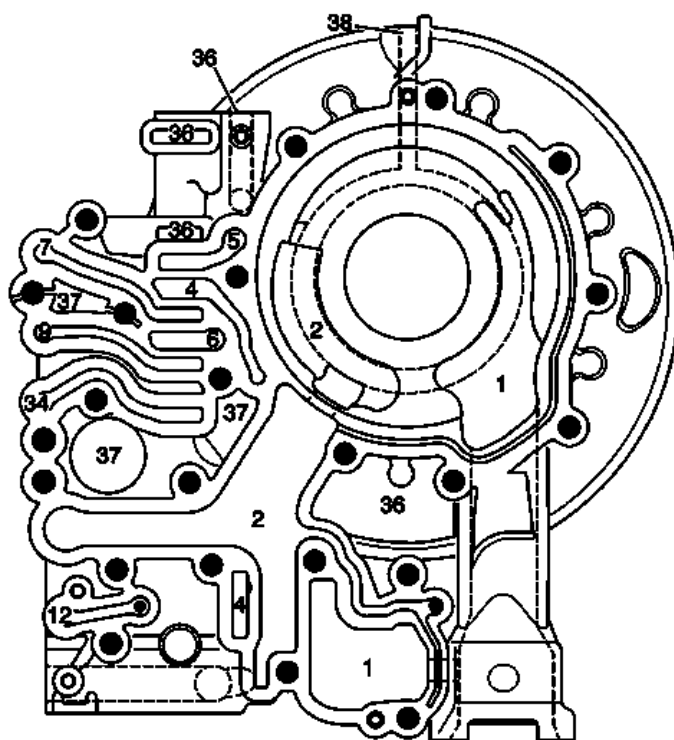


Fig. 19: Fluid Pump Body -- Fluid Pump Cover Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Suction
2	Line
4	Converter Feed
5	TCC Release
6	TCC Apply
7	Cooler Feed
9	Regulated Apply
12	PCS Line
34	PCS TCC
36	Exhaust
37	Void
38	Seal Drainback

Fluid Pump Cover - Fluid Pump Body Side

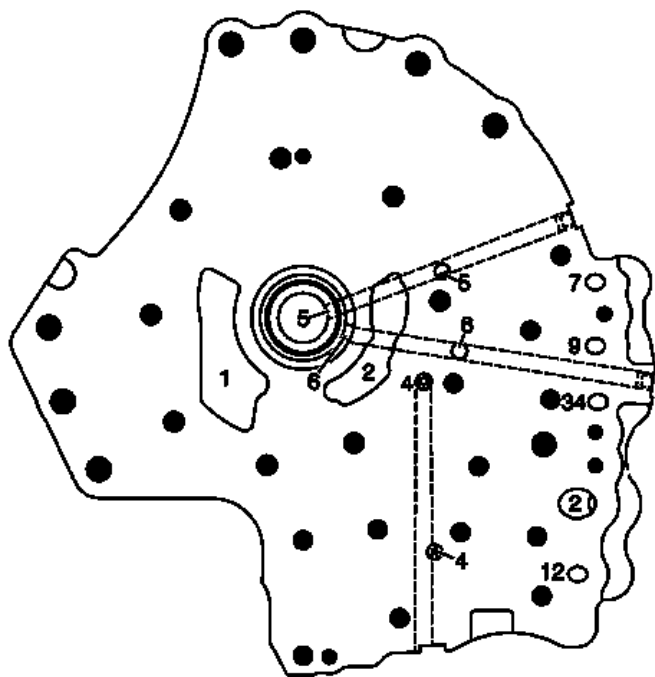


Fig. 20: Fluid Pump Cover -- Fluid Pump Body Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Suction
2	Line
4	Converter Feed
5	TCC Release
6	TCC Apply
7	Cooler Feed
9	Regulated Apply
12	PCS Line
34	PCS TCC

Case - Torque Converter and Differential Housing Side

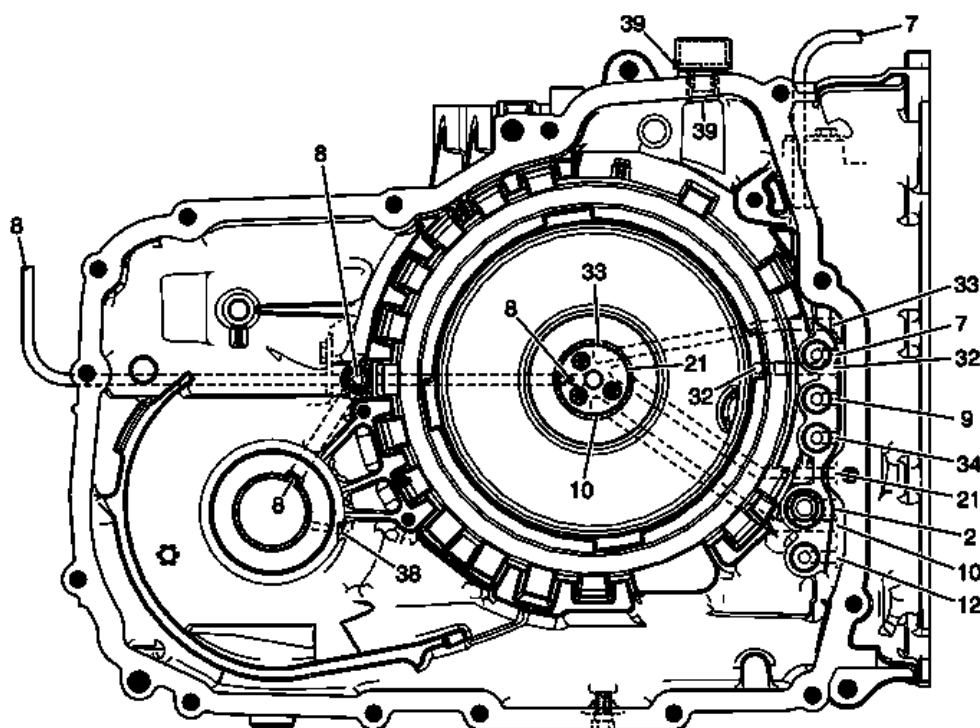


Fig. 21: Case -- Torque Converter and Differential Housing Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
7	Cooler Feed
8	Lube
9	Regulated Apply
10	Exhaust Backfill
12	PCS Line
21	35 Reverse Clutch
32	26 Clutch
33	456 Clutch
34	PCS TCC
38	Seal Drainback
39	Vent

Case - Control Valve Body Side

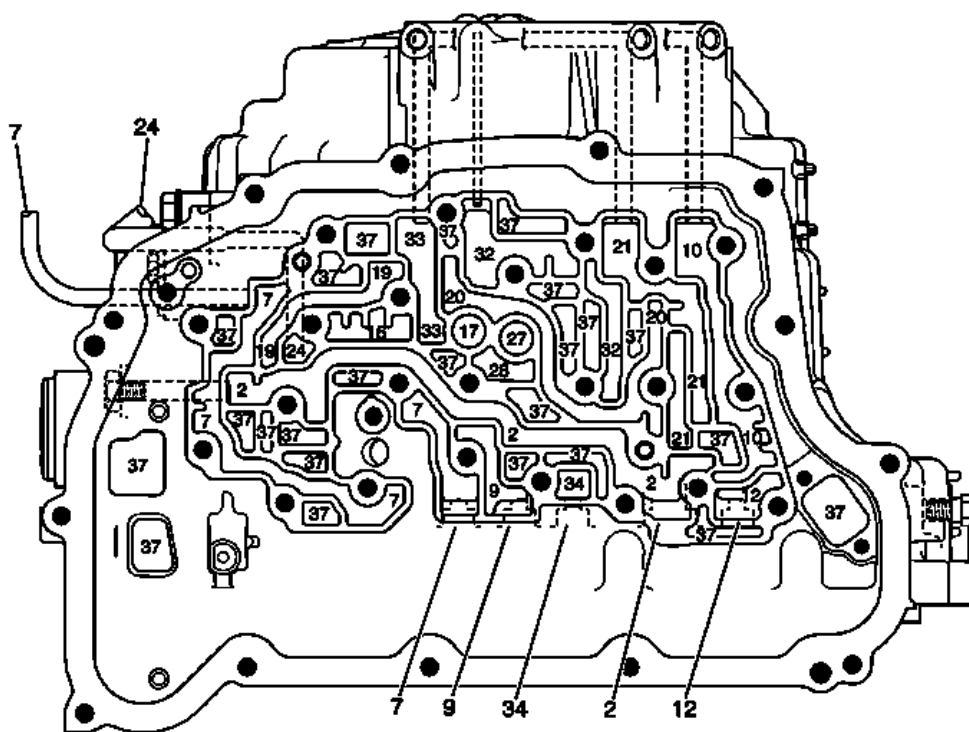


Fig. 22: Case -- Control Valve Body Side Components Name
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
7	Cooler Feed
9	Regulated Apply
10	Exhaust Backfill
12	PCS Line
16	R1/456 Clutch Feedback
17	R1
19	Reverse
20	35 Reverse Clutch Feed
21	35 Reverse Clutch
24	Auxiliary Line (BAS+ Only)
27	1234 Clutch
28	1234 Clutch Feedback
32	26 Clutch
33	456 Clutch
34	PCS TCC
37	Void

Control Valve Body Spacer Plate Assembly - Case Side

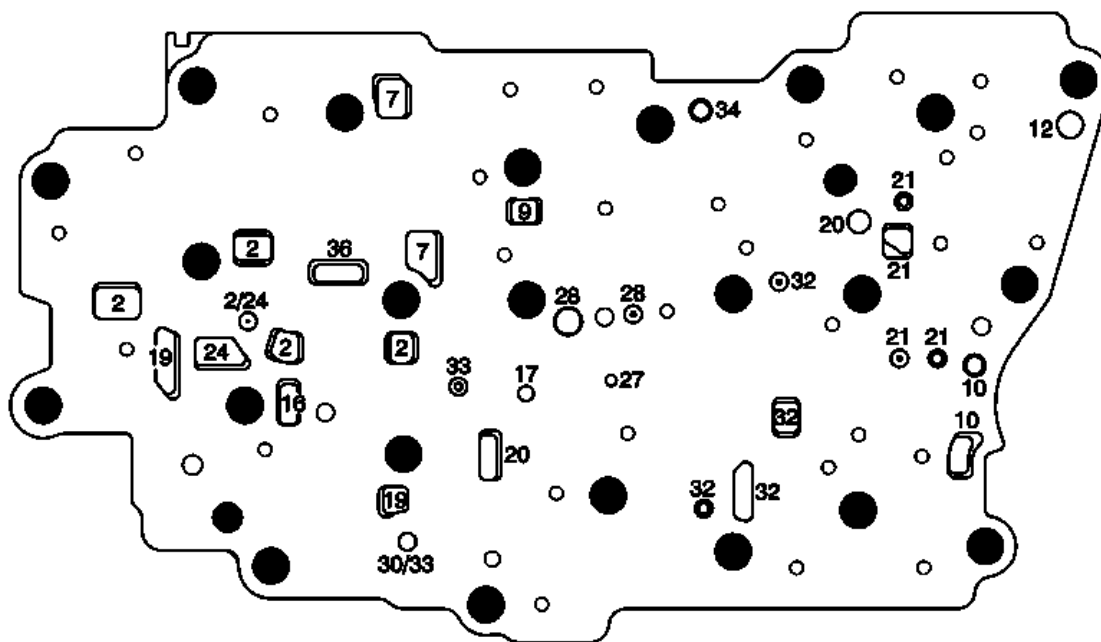


Fig. 23: Control Valve Body Spacer Plate Assembly -- Case Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
7	Cooler Feed
9	Regulated Apply
10	Exhaust Backfill
12	PCS Line
16	R1/456 Clutch Feedback
17	R1
19	Reverse
20	35 Reverse Clutch Feed
21	35 Reverse Clutch
24	Auxiliary Line (BAS+ Only)
27	1234 Clutch
28	1234 Clutch Feedback
30	Latch
32	26 Clutch
33	456 Clutch
34	PCS TCC
36	Exhaust

Control Valve Body - Case Side

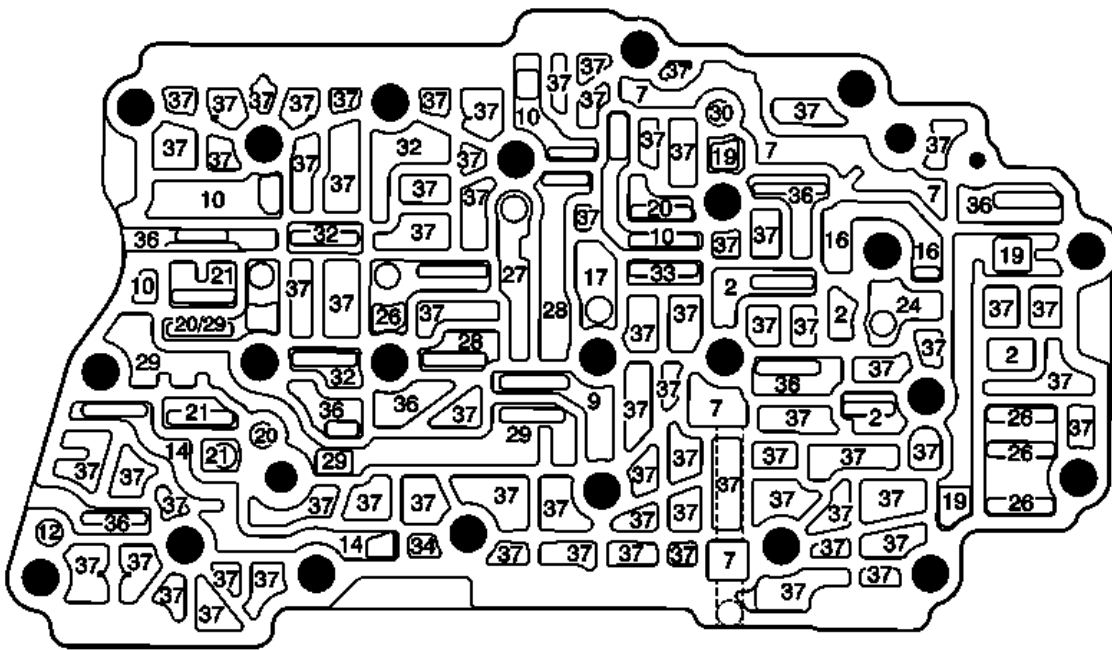


Fig. 24: Control Valve Body -- Case Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
7	Cooler Feed
9	Regulated Apply
10	Exhaust Backfill
12	PCS Line
14	Shift Solenoid
16	R1/456 Clutch Feedback
17	R1
19	Reverse
20	35 Reverse Clutch Feed
21	35 Reverse Clutch
24	Auxiliary Line (BAS+ Only)
26	Drive
27	1234 Clutch
28	1234 Clutch Feedback
29	Drive 1-6
30	Latch
32	26 Clutch
33	456 Clutch

34	PCS TCC
36	Exhaust
37	Void

Control Valve Body - Channel Plate Side

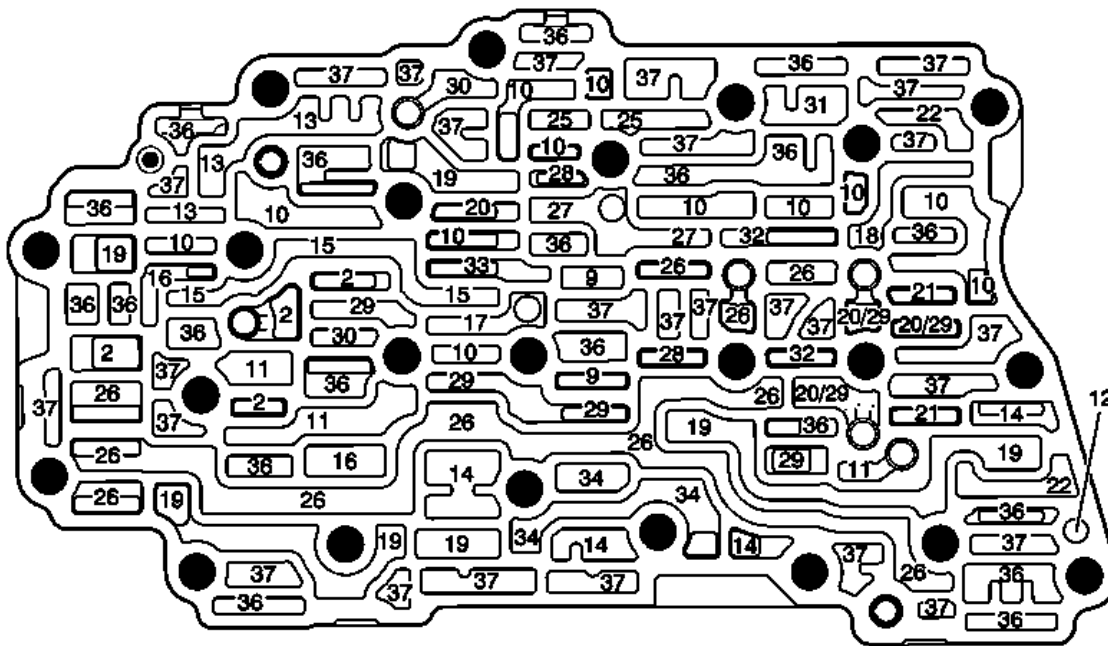


Fig. 25: Control Valve Body -- Channel Plate Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
9	Regulated Apply
10	Exhaust Backfill
11	Actuator Feed Limit
12	PCS Line
13	PCS R1/456 Clutch
14	Shift Solenoid
15	R1/456 Clutch Feed
16	R1/456 Clutch Feedback
17	R1
18	PCS 35 Reverse Clutch
19	Reverse
20	35 Reverse Clutch Feed
21	35 Reverse Clutch

22	Default
25	PCS 1234 Clutch
26	Drive
27	1234 Clutch
28	1234 Clutch Feedback
29	Drive 1-6
30	Latch
31	PCS 26 Clutch
32	26 Clutch
33	456 Clutch
34	PCS TCC
36	Exhaust
37	Void

Channel Plate to Valve Body Spacer Plate Assembly - Channel Plate Side

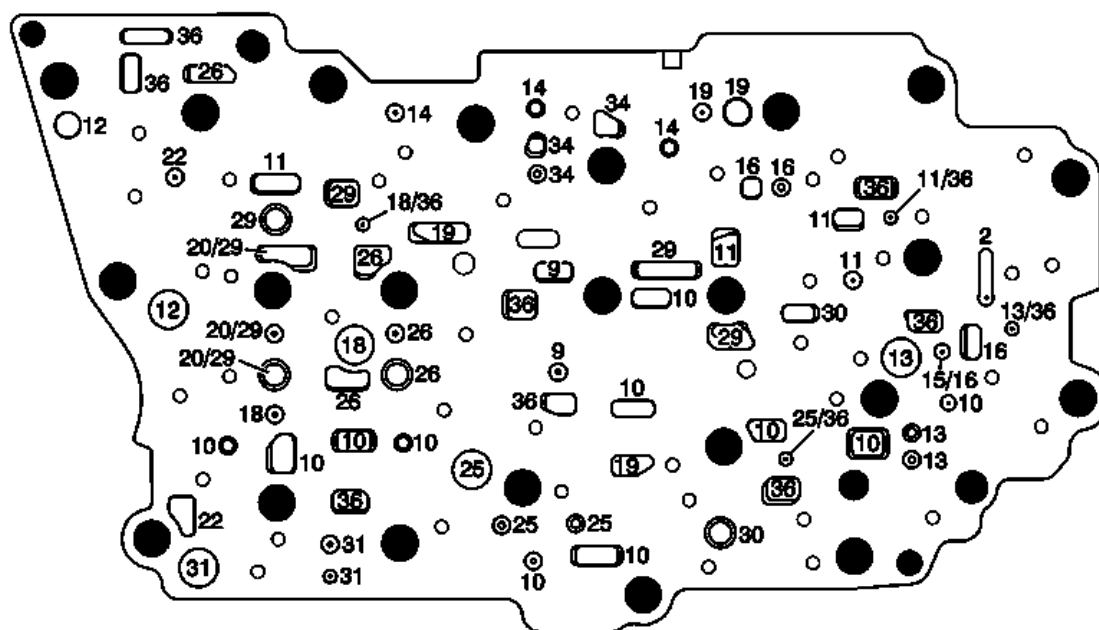


Fig. 26: Channel Plate to Valve Body Spacer Plate Assembly -- Channel Plate Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
9	Regulated Apply
10	Exhaust Backfill
11	Actuator Feed Limit

12	PCS Line
13	PCS R1/456 Clutch
14	Shift Solenoid
15	R1/456 Clutch Feed
16	R1/456 Clutch Feedback
18	PCS 35 Reverse Clutch
19	Reverse
20	35 Reverse Clutch Feed
22	Default
25	PCS 1234 Clutch
26	Drive
29	Drive 1-6
30	Latch
31	PCS 26 Clutch
34	PCS TCC
36	Exhaust

Channel Plate - Control Valve Body Side

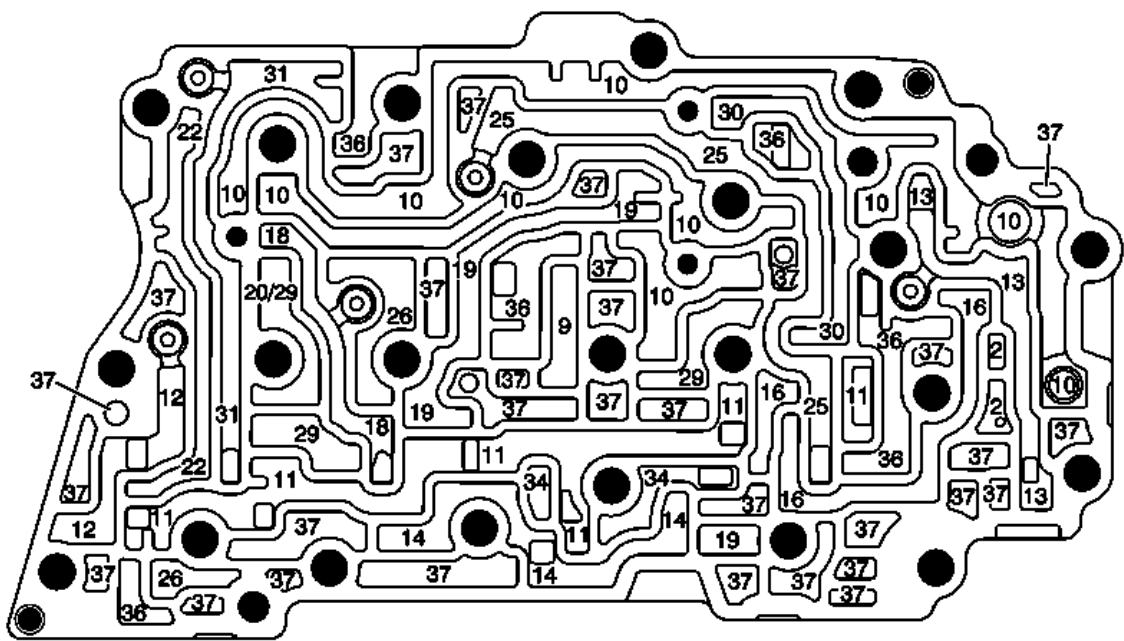


Fig. 27: Channel Plate -- Control Valve Body Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line

9	Regulated Apply
10	Exhaust Backfill
11	Actuator Feed Limit
12	PCS Line
13	PCS R1/456 Clutch
14	Shift Solenoid
16	R1/456 Clutch Feedback
18	PCS 35 Reverse Clutch
19	Reverse
20	35 Reverse Clutch Feed
22	Default
25	PCS 1234 Clutch
26	Drive
29	Drive 1-6
30	Latch
31	PCS 26 Clutch
34	PCS TCC
36	Exhaust
37	Void

Channel Plate - Control Solenoid (w/Body and TCM) Valve Assembly Side

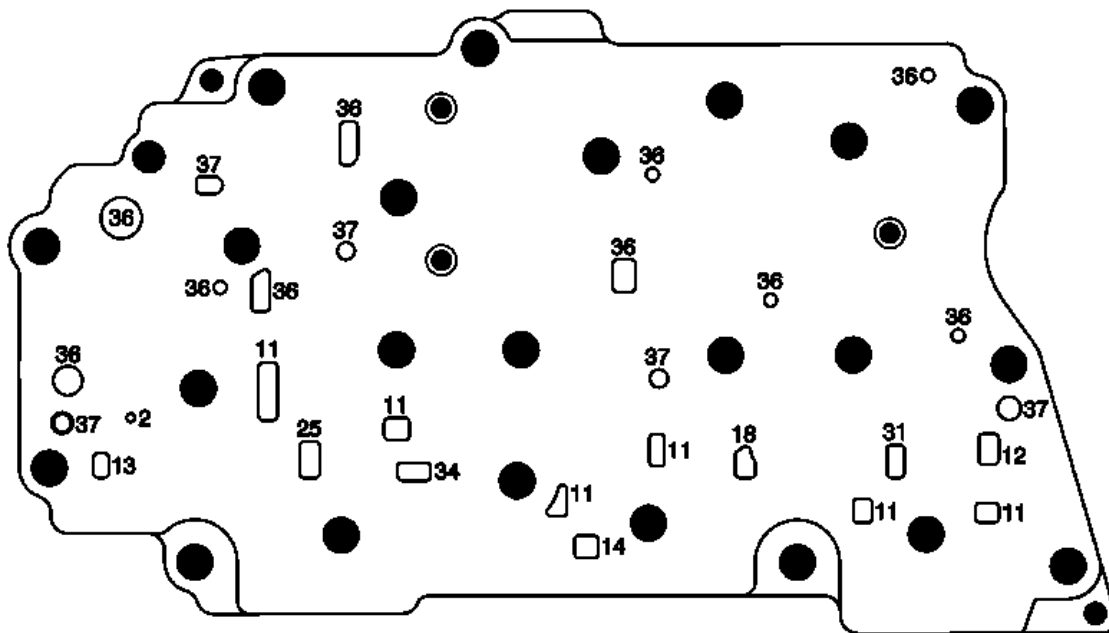


Fig. 28: Channel Plate -- Control Solenoid (w/Body and TCM) Valve Assembly Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
11	Actuator Feed Limit
12	PCS Line
13	PCS R1/456 Clutch
14	Shift Solenoid
18	PCS 35 Reverse Clutch
25	PCS 1234 Clutch
31	PCS 26 Clutch
34	PCS TCC
36	Exhaust
37	Void

Control Solenoid (w/Body and TCM) Valve Assembly - Channel Plate Side

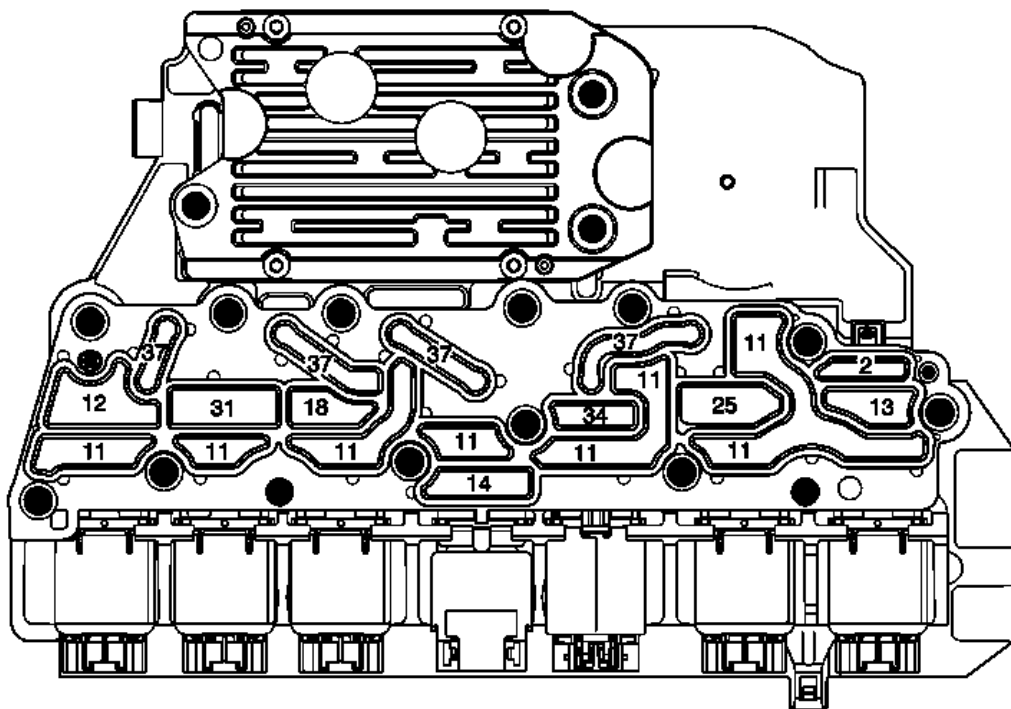


Fig. 29: Control Solenoid (w/Body and TCM) Valve Assembly -- Channel Plate Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
11	Actuator Feed Limit
12	PCS Line
13	PCS R1/456 Clutch

14	Shift Solenoid
18	PCS 35 Reverse Clutch
25	PCS 1234 Clutch
31	PCS 26 Clutch
34	PCS TCC
37	Void

Transmission

Automatic Transmission - 6T40 (MH8 MHH) - Diagnostic Information and Procedures

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0601, P0603, P0604, OR P062F

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: DTCs P0601, P0603, P0604 or P062F could set in other control modules. Verify the DTCs are set in the transmission control module (TCM).

DTC P0601

Control Module Read Only Memory Performance

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P062F

Control Module Long Term Memory Performance

Circuit/System Description

This is an internal fault detection of the transmission control module (TCM), which is part of the control solenoid valve assembly. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P0601 or P0604

Runs continuously when TCM is powered up.

P0603

One time at TCM power up.

P062F

One time at TCM power down.

Conditions for Setting the DTC

P0601

TCM has detected a read only memory (ROM) checksum error 5 times.

P0603

TCM has detected a non-volatile memory checksum error at TCM powerup.

P0604

TCM has detected a random access memory (RAM) test error 5 times.

P062F

TCM has detected a non-volatile memory error during power-down.

Action Taken When the DTC Sets

- P0601, P0603, P0604, and P062F are Type A DTCs.
- TCM commands maximum line pressure.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM inhibits TCC engagement.
- TCM freezes transmission adaptive functions.
- TCM commands the high side driver OFF.
- TCM defaults the transmission to 4th gear and reverse.
- Torque management is enabled.
- TCM inhibits neutral idle.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

P0601, P0603, P0604, and P062F are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
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Description and Operation

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- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

CAUTION: Before programming a control module, the following must be observed, or control module damage may occur:

- The TIS terminal, MDI, and/or scan tool must have the latest software.
- The vehicle battery must be fully charged. The battery voltage should be between 12-14 volts.
- The TIS terminal, MDI, and/or scan tool connections must be secure.
- A battery charger must NOT be connected to the battery when programming a control module.

1. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.

2. Ignition ON.
3. Verify that DTC P0601, P0603, P0604, or P062F is not set.
 - **If any of the DTCs are set**

Replace the Q8 Control Solenoid Valve Assembly.

- **If none of the DTCs are set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 5. Verify the DTC does not set.
 - **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the DTC does not set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0634

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0634

Control Module Overtemperature

Circuit/System Description

The transmission control module (TCM) temperature sensor is located inside of the control solenoid valve assembly which has no serviceable components. The TCM monitors the TCM temperature sensor for over temperature protection.

Conditions for Running the DTC

- DTC P0634 is not set.
- TCM temperature is between 0-240°C (32-464°F) for 0.25 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when above conditions are met.

Conditions for Setting the DTC

Condition 1

TCM has detected an internal temperature condition of 144°C (291°F) or greater for 5 s.

Condition 2

Ignition voltage is 18 V or greater and the TCM temperature is 50°C (122°F) or greater for 2 s.

Action Taken When the DTC Sets

- P0634 is a Type A DTC.
- TCM limits the transmission to 4th gear and reverse.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM enables torque management.
- TCM shuts down.
- TCM commands maximum line pressure.

Conditions for Clearing the DTC

P0634 is a Type A DTC.

Diagnostic Aids

During a road test, the TCM temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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- **Transmission General Description**

Electrical Information Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Engine Coolant Temperature parameter was less than 125°C (257°F) when DTC set by reviewing the scan tool Freeze Frame/Failure Records.
 - **If 125°C (257°F) or greater**

Refer to **Engine Overheating** .

- **If less than 125°C (257°F)**
3. Verify the scan tool TCM Temperature parameter is less than 146°C (295°F).
 - **If 146°C (295°F) or greater**

Replace the Q8 Control Solenoid Valve assembly.

- **If less than 146°C (295°F)**
4. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
 - **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level and condition is correct**

5. Clear the TCM DTCs with a scan tool.
6. Operate the vehicle until normal engine temperature is reached.
7. Verify the scan tool Transmission Fluid Temperature parameter is less than 140°C (284°F).
 - **If 140°C (284°F) or greater**
 1. Ignition OFF.
 2. Verify the conditions listed below do not exist:
 - Obstructions to the airflow to the radiator or transmission
 - Radiator damage
 - Transmission cooler damage
 - Transmission cooler pipe kinked or damaged
 - If a condition exists, repair or replace as necessary.
 - If none of the conditions exist, refer to **Transmission Fluid Cooler Flushing and Flow Test (6T40)**.
 - **If less than 140°C (284°F)**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
 - **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If the DTC does not set**
10. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Fluid Cooler Inlet Hose Replacement (MHH)**
- **Fluid Cooler Outlet Hose Replacement (MHH)**
- **Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MHH, MHK)**, **Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MDK)**
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0658 OR P0659

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0658

Actuator High Control Circuit Group 1 Low Voltage

DTC P0659

Actuator High Control Circuit Group 1 High Voltage

Circuit/System Description

The transmission control module (TCM) high side driver 1 is located inside the control solenoid valve assembly which has no serviceable components. The high side driver 1 provides power to the pressure control solenoid valves and shift solenoid valves.

Conditions for Running the DTC

P0658

- DTC P0658 is not set.
- High side driver 1 is enabled.
- Runs continuously when above conditions are met.

P0659

- DTC P0659 is not set.
- Runs one time when ignition transitions from OFF to ON.

Conditions for Setting the DTC

P0658

TCM detects an internal open or short to ground in the high side driver 1 circuit for 1 s.

P0659

TCM detects an internal short to voltage on the high side driver 1 circuit for 1 s.

Action Taken When the DTC Sets

P0658

- P0658 is a Type A DTC.
- TCM turns the high side driver OFF.
- TCM commands all solenoids OFF.
- TCM commands the TCC OFF.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits neutral idle.
- TCM inhibits the Tap Up/Tap Down function.
- TCM inhibits manual shifting of forward gears.
- TCM defaults the transmission to 4th gear and reverse.
- TCM enables torque management.

P0659

P0659 is a Type C DTC.

Conditions for Clearing the DTC

- P0658 is a Type A DTC.
- P0659 is a Type C DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool High Side Driver 1 parameter displays ON.
 - **If ON is not displayed**

Refer to Circuit/System Testing.

- **If ON is displayed**
3. Engine Running and the gear selector lever in the Park position.
 4. Verify the scan tool parameters listed below do not display Malfunction:
 - High Side Driver 1 Circuit Low Voltage Test Status
 - High Side Driver 1 Circuit Open Test Status
 - High Side Driver 1 Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: You must perform the **Circuit/System Verification** first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.
 - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-48616-10** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - High Side Driver 1 Circuit Low Voltage Test Status
 - High Side Driver 1 Circuit Open Test Status
 - High Side Driver 1 Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0667, P0668, OR P0669

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0667

Control Module Temperature Sensor Performance

DTC P0668

Control Module Temperature Sensor Circuit Low Voltage

DTC P0669

Control Module Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission control module (TCM) temperature sensor is located inside of the control solenoid valve assembly which has no serviceable components. The TCM temperature sensor provides the temperature of the TCM. This temperature reading is used in various shifting and diagnostic routines in the TCM software. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P0667

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0658, P0667, P0668, P0669, P06AD, P06AE, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.
- Engine torque signal is valid.
- Ignition voltage is 9-32 V.
- Engine speed is 400-7,500 RPM for 5 s.
- Throttle position signal is valid.
- Runs continuously when above conditions are met.

P0668

- DTC P0668 is not set.
- Ignition voltage is 9-32 V.
- Engine speed is 400-7,500 RPM for 5 s.

- Runs continuously when above conditions are met.

P0669

- DTC P0669, P0716, P0717, P0722, or P0723 is not set.
- Ignition voltage is 9-32 V.
- Engine speed is 400-7,500 RPM for 5 s.
- Runs continuously when above conditions are met.

Conditions for Setting the DTC

P0667

- TCM detects a 20-50°C (36-90°F) or greater difference between the transmission fluid temperature and TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- TCM detects a 8-10°C (14-18°F) or greater difference between the TCM power up temperature and TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min within a 6 min period.

P0668

TCM internal temperature is 254°C (489°F) or greater for 1 min.

P0669

TCM internal temperature is -254°C (-425°F) or less for 1 min.

Action Taken When the DTC Sets

- P0667, P0668, and P0669 are Type B DTCs.
- TCM defaults the TCM substrate temperature to a calculated temperature based on the TCM power up temperature.

Conditions for Clearing the DTC

P0667, P0668, and P0669 are Type B DTCs.

Diagnostic Aids

The TCM temperature sensor is located inside of the control solenoid valve assembly and its output should resemble that of the transmission fluid temperature sensor output. During a road test, the TCM temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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Electrical Information Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool TCM Temperature parameter is between -254 and +254°C (-425 and +489°F).
 - **If not between -254 and +254°C (-425 and +489°F)**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If between -254 and +254°C (-425 and +489°F)**
3. Verify the scan tool TCM Temperature parameter increases greater than 2°C (3.6°F) after operating the vehicle at 64 km/h (40 mph) for 10 min.
 - **If the temperature does not increase greater than 2°C (3.6°F)**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the temperature increases greater than 2°C (3.6°F)**
- 4. Verify the scan tool Transmission Fluid Temperature and TCM Temperature parameters are within 20°C (36°F) of each other.

- **If the temperatures are not within 20°C (36°F)**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the temperatures are within 20°C (36°F)**
- 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
- 6. Verify the DTC does not set.
 - **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the DTC does not set**
- 7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P06AC, P06AD, OR P06AE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06AC

Control Module Power Up Temperature Sensor Performance

DTC P06AD

Control Module Power Up Temperature Sensor Circuit Low Voltage

DTC P06AE

Control Module Power Up Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission control module (TCM) power up temperature sensor is located inside of the Control Solenoid Valve Assembly which has no serviceable components. The TCM power up temperature sensor provides the temperature of the TCM when the TCM power is on. This temperature reading is used in various shifting and diagnostic routines in the TCM software. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P06AC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0658, P0668, P0669, P06AC, P06AD, P06AE, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.
- Throttle position signal is valid.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Engine torque signal is valid.
- DTC runs continuously when the above conditions are met.

P06AD

- DTC P06AD, P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when the above conditions are met.

P06AE

- DTC P06AE is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P06AC

- TCM detects a 20-50°C (36-90°F), or greater difference between the transmission fluid temperature and TCM power up temperature, which depends on the average of transmission fluid temperature, TCM

substrate temperature, and TCM power up temperature.

- TCM detects an 8-10°C (14-18°F), or greater difference between the TCM substrate temperature and TCM power up temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min within a 6 min period.

P06AD

TCM power up temperature is -254°C (-425°F) or less for 1 min.

P06AE

TCM power up temperature is 254°C (489°F) or greater for 1 min.

Action Taken When the DTC Sets

- P06AC, P06AD, and P06AE are Type B DTCs.
- TCM defaults the TCM power up temperature to a calculated temperature based on the TCM substrate temperature.

Conditions for Clearing the DTC

P06AC, P06AD, and P06AE are Type B DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, clear the DTCs with a scan tool.
2. Operate the vehicle at 64 km/h (40 mph) for 10 min.
3. Verify DTC P06AC, P06AD, or P06AE is not set.

- **If any of the DTCs are set**

Replace the Q8 Control Solenoid Valve Assembly.

- **If none of the DTCs are set**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.

- **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the DTC does not set**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0711-P0713

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0711

Transmission Fluid Temperature Sensor Performance

DTC P0712

Transmission Fluid Temperature Sensor Circuit Low Voltage

DTC P0713

Transmission Fluid Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission fluid temperature sensor is located inside of the transmission control solenoid valve assembly which has no serviceable components. The transmission fluid temperature sensor provides transmission fluid temperature to the transmission control module (TCM). This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P0711

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0658, P0668, P0669, P06AD, P06AE, P0711, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Accelerator position signal is valid.
- Engine torque signal is valid.
- Brake torque is not active.
- DTC runs continuously when above conditions are met.

P0712

- DTC P0712, P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when above conditions are met.

P0713

- DTC P0713, P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when above conditions are met.

Conditions for Setting the DTC

P0711

- TCM detects a 20-50°C (36-90°F) or greater difference between the transmission fluid temperature and the TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- TCM detects a 20-50°C (36-90°F) or greater difference between the transmission fluid temperature and the TCM power up temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min within a 6 min period.

P0712

Transmission fluid temperature is 254°C (489°F) or greater for 1 min.

P0713

Transmission fluid temperature is -254°C (-425°F) or less for 1 min.

Action Taken When the DTC Sets

- P0711, P0712, and P0713 are Type B DTCs.
- TCM defaults to a calculated transmission fluid temperature based on the TCM temperature.

Conditions for Clearing the DTC

P0711, P0712, and P0713 are Type B DTCs.

Diagnostics Aids

The TCM temperature sensor is located inside of the control solenoid valve assembly and its output should resemble that of the transmission fluid temperature sensor's output. During a road test, the transmission fluid temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling at the normal operating temperature.
2. Verify the scan tool Transmission Fluid Temperature parameter is between -254 and +254°C (-425 and +489°F).
 - **If not between -254 and +254°C (-425 and +489°F)**

Replace the Q8 Control Solenoid Valve Assembly.

- **If between -254 and +254°C (-425 and +489°F)**
3. Verify the scan tool Transmission Fluid Temperature parameter increases greater than 2°C (3.6°F) after operating the vehicle at 64 km/h (40 mph) for 10 min.
 - **If the temperature does not increase greater than 2°C (3.6°F)**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the temperature increases greater than 2°C (3.6°F)**

4. Verify the scan tool Transmission Fluid Temperature and the TCM Temperature parameters are within 20°C (36°F).

- **If the temperatures are not within 20°C (36°F)**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the temperatures are within 20°C (36°F)**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

6. Verify the DTC does not set.

- **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the DTC does not set**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0716, P0717, P07BF, OR P07C0

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0716

Input Speed Sensor Performance

DTC P0717

Input Speed Sensor Circuit No Signal

DTC P07BF

Input Speed Sensor Circuit Low Voltage

DTC P07C0

Input Speed Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V	P0716, P0717, P07BF	P0716, P0717, P07BF	-	P0716
Signal	P0716, P0717	P0716, P0717, P07BF	P0716, P0717, P07C0	P0716

Typical Scan Tool Data

Transmission ISS

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, normal operating temperature, transmission in PARK Parameter Normal Range: 500-5,800 RPM			
12 V	0 RPM	0 RPM	-
Signal	0 RPM	0 RPM	0 RPM

ISS/OSS Supply Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Key ON, Engine OFF or Engine running, normal operating temperature Parameter Normal Range: OK			
Signal	OK	OK	OK
12 V	Out of Range	OK	OK

Circuit/System Description

The input shaft speed (ISS) sensor is a hall-effect type sensor. The ISS sensor mounts to the inside of the automatic transmission case assembly and connects to the control solenoid valve assembly through a 2-wire harness and connector. The sensor faces a reluctor wheel, which is attached to the 4-5-6 clutch and 3-5-R clutch housing assembly. The sensor receives battery voltage on the ISS sensor supply voltage circuit from the transmission control module (TCM). As the 4-5-6 clutch and 3-5-R clutch housing rotates, the sensor produces a signal frequency based on the teeth of the reluctor wheel. This signal is transmitted through the ISS sensor signal circuit to the TCM. The TCM uses the ISS sensor signal to calculate input shaft speed to determine commanded line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

Conditions for Running the DTC

P0716

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0716, P0717, P0752, P0973, or P0974 is not set.
- Vehicle speed is 10 km/h (6 mph) or greater.

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Engine torque signal is valid.
- Throttle position signal is valid.
- DTC runs continuously when above conditions are met.

P0717

- DTC P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Vehicle speed is 16 km/h (10 mph) or greater.
- Engine torque is 50 N.m (37 lb ft) or greater.
- DTC runs continuously when above conditions are met.

P07BF or P07C0

- Ignition voltage is 9-32 V.
- DTC runs continuously when above condition is met.

Conditions for Setting the DTC

P0716

TCM detects the transmission input shaft speed signal dropped greater than 1,350 RPM for 1 s.

P0717 - Condition 1

TCM detects the transmission input shaft speed signal is less than 33 RPM for 5 s.

P0717 - Condition 2

The TCM detects that P0722 set and the Transmission input speed is less than 1,000 RPM for 5 s.

P07BF

Transmission ISS sensor analog signal voltage is 0.25 V or less for 4 s.

P07C0

Transmission ISS sensor analog signal voltage is 4.75 volts or greater for 4 s.

Action Taken When the DTC Sets

- P0716, P0717, P07BF, and P07C0 are Type A DTCs.

- TCM freezes transmission adaptive functions.
- TCM forces TCC OFF.
- TCM inhibits Tap-Up/Tap-Down functions.
- TCM inhibits manual up, manual down shifts with the shift selector.
- TCM commands maximum line pressure.
- TCM enables torque management.
- TCM limits the transmission to reverse and 4th gear.
- TCM commands the high side driver off - P0716 only.

Conditions for Clearing the DTC

P0716, P0717, P07BF, and P07C0 are Type A DTCs.

Diagnostic Aids

- Inspect the ISS sensor harness and connector for metallic debris and the reluctor wheel for damage or misalignment.
- If the scan tool ISS/OSS Supply Voltage indicates out of range, the fault could also be caused by the transmission output shaft speed sensor.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ISS/OSS Supply Voltage parameter displays OK.
 - **If OK is not displayed**

Refer to Circuit/System Testing.

- **If OK is displayed**
3. Engine idling, transmission in Park.
 4. Verify the scan tool Transmission ISS parameter changes without spikes or dropouts, while varying the engine speed.
 - **If the Transmission ISS does not change with engine speed or has spikes or dropouts**

Refer to Circuit/System Testing.

- **If the Transmission ISS changes with engine speed and there are no spikes or dropouts**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
3. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
4. Test for 11-13 V between the ISS 12 V circuit terminal B on the Q8 Control Solenoid Valve Assembly X3 connector and ground.

- **If not between 11-13 V**

Replace the Q8 Control Solenoid Valve Assembly.

- **If between 11-13 V**

5. Verify the scan tool Transmission ISS parameter is between 495-505 RPM when performing the input shaft speed test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Input Shaft Speed/Output Shaft Speed Input Test**.

- **If not between 495-505 RPM**

Replace the Q8 Control Solenoid Valve Assembly.

- **If between 495-505 RPM**

6. Verify there is no damage to the reluctor, which is attached to the 4-5-6 clutch and 3-5-R clutch housing assembly, or misalignment between the B14C Transmission Input Shaft Speed Sensor and reluctor.

- **If the reluctor is damaged or misaligned**

Repair or replace as necessary.

- **If the reluctor is not damaged or misaligned**

7. Replace the B14C Transmission Input Shaft Speed Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Input and Output Speed Sensor Installation**
- **Input and Output Speed Sensor Removal**
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0722, P0723, P077C, OR P077D

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0722

Output Speed Sensor Circuit No Signal

DTC P0723

Output Speed Sensor Circuit Intermittent

DTC P077C

Output Speed Sensor Circuit Low Voltage

DTC P077D

Output Speed Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0722, P0723, P077C	P0722, P0723, P077C	P0722, P0723, P077D	P0723
12 V	P0722, P0723, P077C	P0722, P0723, P077C	-	P0723

Typical Scan Tool Data

Transmission OSS

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Drive vehicle, normal operating temperature Parameter Normal Range: 0-7,000 RPM			
12 V	0 RPM	0 RPM	0-7000 RPM
Signal	0 RPM	0 RPM	0 RPM

ISS/OSS Supply Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Key ON, Engine OFF or Engine running, normal operating temperature Parameter Normal Range: OK			
Output Speed Sensor Signal	OK	OK	OK
Output Speed Sensor Supply Voltage	Out of Range	OK	Out of Range

Circuit/System Description

The output shaft speed (OSS) sensor is a hall-effect type sensor. The OSS sensor mounts to the automatic transmission case assembly and connects to the control solenoid valve assembly through a 2-wire harness and connector. The sensor faces the park gear teeth. The sensor receives battery voltage on the OSS sensor supply voltage circuit from the transmission control module (TCM). As the output shaft rotates, the sensor produces a signal frequency based on the park gear teeth. This signal is transmitted through the OSS sensor signal circuit to the TCM. The TCM uses the OSS sensor signal to calculate output shaft speed to determine commanded line pressure, transmission shift patterns, vehicle speed and gear ratio.

Conditions for Running the DTC

P0722

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0716, P0717, P0722, or P0723 is not set.
- Ignition voltage is 9-32 V.
- Engine speed is 400-7,500 RPM for 5 s.
- Engine torque signal is valid.
- Throttle position signal is valid.
- Transmission input speed is between 1,000-8,191 RPM.
- Calculated throttle position is 8% or greater.
- Engine torque is 30 N.m (22 lb ft) or greater.
- Transmission fluid temperature is -40°C (-40°F) or greater.
- DTC runs continuously when the above conditions are met.

P0723

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0723, P0973, P0974, P0976, or P0977 is not set.
- Ignition voltage is 9-32 V.
- Greater than 5 s since last transmission upshift or downshift.
- Engine speed is 400-7,500 RPM for 5 s.
- DTC runs continuously when the above conditions are met.

P077C

- DTC P077D is not set.
- Ignition voltage is 9-32 V.
- DTC runs continuously when the above conditions are met.

P077D

- DTC P077C is not set.
- Ignition voltage is 9-32 V.

- DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0722

Transmission output speed is 35 RPM or less for 5 s.

P0723

- Transmission output speed is 105 RPM or greater.
- TCM detects the transmission output shaft speed dropped greater than 1,000 RPM for 3 s.

P077C

Transmission OSS sensor analog signal voltage is 0.25 V or less for 4 s.

P077D

Transmission OSS sensor analog signal voltage is 4.75 V or greater for 4 s.

Action Taken When the DTC Sets

P0722

- P0722 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM Enables torque management.
- TCM limits the transmission to reverse and 2nd gear.
- TCM inhibits neutral idle.
- TCM inhibits auto grade braking.
- TCM inhibits Tap-Up/Tap-Down functions.
- TCM inhibits manual up, manual down shifts with the shift selector.
- TCM commands 2nd gear when in a forward range and the output speed is less than 700 RPM, or neutral if the output speed is 700 RPM or greater.

P0723, P077C or P077D

- P0723, P077C, and P077D are Type A DTCs.
- TCM freezes transmission adaptive functions.
- TCM forces TCC OFF.
- TCM commands the high side driver OFF.

- TCM commands maximum line pressure.
- TCM enables torque management.
- TCM limits the transmission to reverse and 4th gear.
- TCM inhibits neutral idle.
- TCM inhibits Tap-Up/Tap-Down functions.
- TCM inhibits manual up, manual down shifts with the shift selector.
- TCM inhibits auto grade braking.

Conditions for Clearing the DIC/DTC

P0722, P0723, P077C, and P077D are Type A DTCs.

Diagnostic Aids

- Inspect the OSS sensor, harness, and connector for metallic debris.
- Proper torque of the OSS sensor mounting bolt is critical to proper OSS sensor operation.
- If the scan tool ISS/OSS Supply Voltage indicates out of range, the fault could also be caused by the transmission input shaft speed sensor.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ISS/OSS Supply Voltage parameter displays OK.

- **If OK is not displayed**

Refer to Circuit/System Testing.

- **If OK is displayed**

3. Verify the scan tool Transmission OSS parameter changes with vehicle speed or does not drop out, while operating the vehicle at 16-32 km/h (10-20 mph).

- **If the Transmission OSS does not vary with vehicle speed or drops out**

Refer to Circuit/System Testing.

- **If the Transmission OSS varies with vehicle speed and does not drop out**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector.

3. Ignition ON.
4. Test for 11-13 V between the OSS sensor voltage circuit terminal B at the Q8 Control Solenoid Valve Assembly X4 connector and ground.

- **If not between 11-13 V**

Replace the Q8 Control Solenoid Valve Assembly.

- **If between 11-13 V**

5. Verify the scan tool Transmission OSS parameter is between 745-825 RPM when performing the output shaft speed test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Input Shaft Speed/Output Shaft Speed Input Test**.

- **If not between 745-825 RPM**

Replace the Q8 Control Solenoid Valve Assembly.

- **If between 745-825 RPM**

6. Verify there is no damage to the park gear, or misalignment between the B14A Transmission Output Shaft Speed Sensor and the park gear.

- **If the park gear is damaged or misaligned**

Repair or replace as necessary.

- **If the park gear is not damaged or misaligned**

7. Replace the B14A Transmission Output Shaft Speed Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Input and Output Speed Sensor Installation**
- **Input and Output Speed Sensor Removal**
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0741 OR P0742

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.

DTC P0741

Torque Converter Clutch (TCC) System Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0742

Torque Converter Clutch (TCC) System Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

The torque converter clutch (TCC) pressure control solenoid valve is part of the control solenoid valve assembly which has no serviceable components. The TCC pressure control solenoid valve is normally low and regulates transmission fluid pressure to the TCC regulator valve in the lower valve body and the TCC control valve in the fluid pump assembly. When vehicle operating conditions are appropriate to apply the torque converter clutch, the transmission control module (TCM) will increase TCC pressure control solenoid valve current flow, thereby increasing pressure to move the TCC control valve into the apply position. When the TCC is fully applied, the engine is coupled directly to the transmission. TCC release is accomplished by the TCM decreasing current flow to the TCC pressure control solenoid valves, which decreases the apply pressure and allows the TCC control valve to move to the release position. The TCM calculates torque converter slip speed based on the speed signal from the input shaft speed sensor and engine RPM provided by the engine control module (ECM).

Conditions for Running the DTC

P0741

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, P0741, P0742, P2763, or P2764 is not set.
- Engine speed is 400-7,500 RPM or greater for 5 s.
- Ignition voltage is 9-32 V.
- Transmission fluid temperature is between -6.7 to +130°C (+20 to +266°F).
- Throttle position is 8% or greater.
- Engine torque is 50 N.m (36 lb ft) or greater.
- Engine torque signal is valid.
- Throttle position signal is valid.
- TCM detects the transmission gear ratios listed below for the commanded gear when TCC is commanded ON:
 - 2nd gear ratio is between 2.75-3.17.
 - 3rd gear ratio is between 1.78-2.04.
 - 4th gear ratio is between 1.35-1.55.

- 5th gear ratio is between 0.93-1.07.
- 6th gear ratio is between 0.70-0.80.
- DTC runs continuously when the above conditions are met.

P0742

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, P0741, P0742, P2763, or P2764 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Transmission fluid temperature is between 15-130°C (59-266°F).
- Calculated throttle position was 10% or greater and has not dropped below 2%.
- Engine torque signal is valid.
- Throttle position signal is valid.
- Engine torque is 60 N.m (44 lb ft) or greater.
- Vehicle speed greater than 1 km/h (0.6 mph).
- TCC is commanded OFF.
- Engine torque signal is valid.
- Throttle position signal is valid.
- DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0741

- TCC pressure command is 500 kPa (73 PSI) or greater for 2 s.
- TCM detects TCC slip is 130 RPM or greater for 5 s.
- The above conditions must occur 2 times.

P0742

TCM detects the TCC slip is between -50 and +13 RPM for 1 s when TCC is commanded OFF. This condition must occur 8 times.

Action Taken When the DTC Sets

P0741

- P0741 is a Type B DTC.
- TCM inhibits 6th gear.
- TCM initiates Hot Mode shift pattern.

- TCM commands the TCC OFF.

P0742

- P0742 is a Type A DTC.
- TCM initiates Hot Mode shift pattern.
- TCM freezes transmission adaptive functions.
- TCM commands the TCC ON.
- TCM inhibits neutral idle.

Conditions for Clearing the DIC/DTC

- P0741 is a Type B DTC.
- P0742 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616 Solenoid Assembly Test Kit & Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON, engine OFF.
2. Verify DTC P0716, P0717, P07BF, or P07C0 was not set by reviewing the scan tool TCM Failure Records.

- **If any of the DTCs were set**

Refer to **DTC P0716, P0717, P07BF, or P07C0.**

- **If none of the DTCs were set**

3. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
4. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check.**

- **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level and condition is correct**

5. Ignition ON, clear the TCM DTCs with a scan tool.
6. Verify DTC P0741 or P0742 does not set while performing a road test. Refer to **Road Test.**

- **If DTC P0741 or P0742 sets**

Refer to Circuit/System Testing.

- **If DTC P0741 or P0742 does not set**

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check (Non Hybrid)**, **Line Pressure Check (Hybrid)**, and **Solenoid Valve Pressure (Gen 1)** , **Solenoid Valve Pressure (Gen 2)** .

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low**.

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0741 Upper Valve Body

Release exhaust port/orifice plugged or blocked.

P0741 or P0742 - Upper Valve Body

Torque converter clutch regulator valve stuck/sticking - debris, binding, damaged valve, or scored bore.

P0741 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P0741 or P0742 - Fluid Pump Assembly

Torque converter clutch control valve stuck/sticking - debris, binding, damaged valve, or scored bore.

P0741 - Torque Converter

- Torque converter clutch delamination or material worn off.
- Converter bolts too long damaging the clutch apply surface.
- Damaged seal.

P0741 - Support

Damaged seal.

P0741 or P0742 - A/Trans Case Cover (403)

- Pressure release blow-off not seating/sealing.
- Damaged spring.

P0741 - Turbine Shaft O-ring Seal

Cut or damaged.

P0741 or P0742 - Q8 Control Solenoid Valve Assembly

- Torque converter clutch pressure control solenoid stuck OFF or leaking.
- Torque converter clutch pressure control solenoid stuck ON.
- Control signal fluid supply leak due to valve body filter plate assembly cracked, or damaged gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs.
- **Control Valve Body Assembly Removal**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming and setup.

DTC P0751 OR P0752

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: **The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.**

DTC P0751

Shift Solenoid Valve 1 Performance - Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0752

Shift Solenoid Valve 1 Performance - Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Shift solenoid valve 1 is part of the control solenoid valve assembly, which has no serviceable components. The solenoid operates by the transmission control module (TCM) turning the low side driver ON or OFF. When the shift solenoid valve 1 is commanded OFF, the plunger forces the metering ball against the actuator feed limit seat, blocking the flow and any existing pressure is exhausted through the exhaust port. When the shift solenoid valve 1 is commanded ON, the internal plunger moves, allowing the metering valve to move away from the actuator feed limit seat and against the exhaust seat, creating signal fluid pressure. The signal fluid pressure acts against the clutch select valve 2 to overcome the valve spring force, moving the valve to the apply position. Fluid pressure from the R1/4-5-6 regulator valve flows through clutch select valve 2 and is directed to either the low and reverse clutch or the 4-5-6 clutch, depending on the position of clutch select valve 2.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Transmission fluid temperature is -6.6°C (-20°F) or greater.
- Engine speed is 400-7,500 RPM for 5 s.
- Output shaft speed is 100 RPM or greater or the throttle is 0.5% or greater.
- Ignition voltage is 9-32 V.
- Shift is complete.
- Engine torque signal is valid.
- Throttle position signal is valid.
- High-Side driver is enabled.
- DTC runs continuously when above conditions are met.

Conditions for Setting the DTC

P0751

- Commanded gear is 1st.
- TCM detects gear ratio 1.37-1.52.
- Gearbox slip is 400 RPM or greater for 2 s.
- Conditions listed above have to occur 8 times.

P0752

- Commanded gear is 3rd.
- Transmission has achieved 1st or 2nd.
- Gear slip is 400 RPM or greater for 1.5 s.
- TCM commands 4th gear if above conditions exist and detects a gear ratio of 4.35-4.81 for 1.5 s.
- Conditions listed above have to occur 5 times.

Action Taken When the DTC Sets

P0751

- P0751 is a type B DTC.
- TCM inhibits 1st gear.
- TCM inhibits Neutral idle.

P0752

- P0752 is a type A DTC.
- TCM limits the transmission to 2nd range and reverse.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM disables neutral idle.
- TCM freezes adapts.
- TCM commands maximum line pressure.
- TCM commands 2nd gear if transmission is in a forward range and the output speed is less than 1,350 RPM, or neutral if the output speed is 1,350 RPM or greater.

Conditions for Clearing the DTC

- P0751 is a type B DTC.
- P0752 is a type A DTC.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This allows you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Drive Range, First Gear Engine Braking (Gen 2/Hybrid)**
- **Electronic Component Description**

- **Transmission Component and System Description**
- **Transmission General Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If other DTCs are set, diagnose those DTCs first.**

1. Ignition ON, engine OFF.
2. Verify no other TCM DTCs are set using a scan tool.
 - **If another DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no other DTCs are set**
3. Engine idling at the normal operating temperature, transmission in Park, with parking brake applied and drive wheels chocked.
 4. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
 - **If the transmission fluid level and condition is not correct**
- Repair as necessary.
- **If the transmission fluid level and condition is correct**
5. Ignition ON, clear the TCM DTCs with a scan tool.
 6. From a stop, accelerate to 72 km/h (45 mph) with the throttle position greater than 15%. Perform this test 8 times.
 7. Verify DTC P0751 or P0752 did not set.
 - **If DTC P0751 or P0752 sets**

Refer to Circuit/System Testing.

- **If DTC P0751 or P0752 does not set**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 9. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

10. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check (Non Hybrid)**, **Line Pressure Check (Hybrid)**, and **Solenoid Valve Pressure (Gen 1)** , **Solenoid Valve Pressure (Gen 2)** .

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low.**

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test.**

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0751 - Control Valve Body

- Clutch select valve bore plug undersized. Plug should be a valve fit in the bore.
- Check ball #1 missing, damaged/malformed.
- Seat for check ball #1 damaged or leaking.

P0751 or P0752 - Control Valve Body

- Clutch select valve stuck from debris, sediment, binding, or a scored bore.
- Low and reverse and 4-5-6 clutch regulator valve stuck or sticking from debris, sediment, binding, or a scored bore.

P0751 or P0752 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P0752 Output Carrier Assembly

Output carrier pinion pins too high or too low.

P0751 or P0752 - Q8 Control Solenoid Valve Assembly

- Not pressurizing due to shift solenoid valve 1 being stuck OFF or leaking.
- Pressure not exhausting due to shift solenoid valve 1 being stuck ON.
- Control signal fluid supply leak due to valve body filter plate assembly cracked, blocked, or damaged gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0776 OR P0777

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the **Circuit/System Verification and Circuit/System Testing** to identify the cause.

DTC P0776

Pressure Control Solenoid Valve 2 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0777

Pressure Control Solenoid Valve 2 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Pressure control solenoid valve 2 is part of the control solenoid valve assembly, which has no serviceable

components. Pressure control solenoid valve 2 regulates transmission fluid pressure to the 3-5-R regulator valve, which controls pressure to the 3-5-R clutch. The transmission control module (TCM) calculates gear ratio based on the speed signals from the input shaft speed sensor and the output shaft speed sensor. The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

P0776

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Transmission fluid temperature is -6.7°C (20°F) or greater.
- Transmission output speed is 100 RPM or greater, or the throttle position is 0.5% or greater.
- Throttle position signal is valid.
- High side driver is enabled.
- Commanded range is reverse, 3rd gear or 5th gear.
- DTC runs continuously when the above conditions are met.

P0777

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Transmission fluid temperature is -6.7°C (20°F) or greater.
- Transmission output shaft speed is 100 RPM or greater, or the throttle position is 0.5% or greater.
- Throttle position signal is valid.
- High side driver is enabled.
- Throttle position is 10% or greater and the engine torque is 45 N.m (33 lb ft) or greater.
- DTC runs continuously during shift when the 3-5-R clutch is commanded OFF, until commanded range is attained.

Conditions for Setting the DTC

P0776 - Condition 1

- Commanded gear is 3rd.
- Gearbox slip of 400 RPM or greater is detected for 2.5 s.
- TCM commands 4th gear if the above conditions exist and detects a gear ratio of 1.37-1.52 for 3 s.

- Conditions listed above have to occur 2 times.

P0776 - Condition 2

- Commanded gear is 5th.
- Gearbox slip of 400 RPM or greater is detected for 3 s.
- TCM commands 6th gear if the above conditions exist and detects 6th gear ratio for 3.5 s.
- Conditions listed above have to occur 3 times.

P0777

- The TCM detects an incorrect off-going clutch gear ratio, or tie-up, when the 3-5-R clutch is commanded OFF for 1 s.
- The transmission input shaft speed is 400 RPM or less from the anticipated input shaft speed.
- The conditions listed above must occur 3 times.

Action Taken When the DTC Sets

P0776

- P0776 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits TAP Up/TAP Down function.
- TCM inhibits manual shifting of forward gears.
- TCM inhibits powertrain braking.
- TCM inhibits auto grade braking.
- TCM inhibits neutral idle.
- TCM commands 2nd gear if the transmission is in a forward gear and the output speed is less than 700 RPM.
- TCM commands neutral if the output speed is 700 RPM or greater.

P0777

- P0777 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM limits the transmission to reverse and 3rd gear.
- TCM freezes transmission adaptive functions.
- TCM inhibits TAP Up/TAP Down function.
- TCM inhibits manual shifting of forward gears.
- TCM inhibits neutral idle.
- TCM inhibits powertrain braking.

- TCM inhibits auto grade braking.

Conditions for Clearing the DTC

P0776 and P0777 are Type A DTCs.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This will allow you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Drive Range, Third Gear (Gen 2/Hybrid)**
- **Drive Range - Fourth Gear (Gen 2/Hybrid)**
- **Drive Range, Fifth Gear (Gen 2/Hybrid)**
- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to **Parking Brake and Drive Wheels Warning** .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Ignition ON.
2. Verify DTC P0716, P0717, P0722, P0723, P077C, P077D, P07BF, or P07C0 was not set by reviewing the scan tool Freeze Frame/Failure Records data.

- **If any of the DTCs were set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs were set**

3. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
4. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.

- **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level and condition is correct**

5. Ignition ON, clear the TCM DTCs with a scan tool.
6. Verify DTC P0776 or P0777 does not set while performing a road test. Refer to **Road Test**.

- **If DTC P0776 or P0777 sets**

Refer to Circuit/System Testing.

- **If DTC P0776 or P0777 does not set**

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Engine idling at the normal operating temperature.
 2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check (Non Hybrid)**, **Line Pressure Check (Hybrid)**, and **Solenoid Valve Pressure (Gen 1)** , **Solenoid Valve Pressure (Gen 2)** .
- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low.**

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test.**
 - **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

DTC P0776 or P0777 - Control Valve Body Assembly

- Actuator feed limit circuit supply fluid to solenoids restricted or not available - debris or sediment blockage.
- 3-5-R Regulator Valve stuck/sticking - debris, binding, damaged valve, or scored bore.
- Control valve body ball check valve not seating correctly - debris.

DTC P0776 - 3-5-R and 4-5-6 Clutch Housing Assembly

3-5-R clutch backing plate retaining ring not seated, causing clutch pack over-travel.

DTC P0776 or P0777 - Torque Converter (w/Fluid Pump) Housing Assembly

Fluid pump housing/gear damaged/scored.

DTC P0776 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

DTC P0776 or P0777 - Q8 Control Solenoid Valve Assembly

- Clutch Pressure Control Solenoid 2 stuck ON/OFF.
- O-ring seals leaking.
- Valve body filter plate assembly cracked, blocked, or damaged gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0796 OR P0797

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the **Circuit/System Verification and Circuit/System Testing** to identify the cause.

DTC P0796

Pressure Control Solenoid Valve 3 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0797

Pressure Control Solenoid Valve 3 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Pressure control solenoid valve 3 is part of the control solenoid valve assembly, which has no serviceable components. Pressure control solenoid valve 3 regulates transmission fluid pressure to the R1/4-5-6 regulator valve which controls pressure to the reverse and low clutch and the 4-5-6 clutch. The transmission control module (TCM) calculates gear ratio based on the speed signals from the automatic transmission input shaft speed sensor and the output shaft speed sensor. The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

P0796

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Transmission output speed is 100 RPM or greater or the throttle position is 0.5% or greater.
- Ignition voltage is 9-32 V.
- Transmission fluid temperature is -6.7°C (20°F) or greater.
- High side driver is enabled.
- Throttle position signal is valid.

P0797

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Transmission output speed is 100 RPM or greater or the throttle position is 0.5% or greater.
- Throttle position signal is valid.
- Ignition voltage is 9-32 V.
- Transmission fluid temperature is -6.7°C (20°F) or greater.
- High side driver is enabled.
- The throttle position is 10% or greater and the engine torque is 45 N.m (33 lb ft) or greater if attained gear is 1st free wheel.
- DTC runs continuously during shift when the 4-5-6 clutch is commanded OFF, until commanded range is attained.

Conditions for Setting the DTC

P0796

The TCM detects an incorrect gear ratio when the 4-5-6 clutch is commanded ON. This condition must occur 3 times.

P0797

The TCM detects an incorrect gear ratio change when the 4-5-6 clutch is commanded OFF during a shift. This must occur 3 times.

Action Taken When the DTC Sets

- P0796 and P0797 are Type A DTCs.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits TAP Up/TAP Down functions.
- TCM inhibits manual up, manual down shifts with the shift selector.
- TCM inhibits powertrain braking.
- TCM inhibits neutral idle.
- TCM inhibits auto grade braking.
- TCM limits the transmission to reverse and 3rd gear - DTC P0796 only.
- TCM limits the transmission to reverse and 4th gear - DTC P0797 only.

Conditions for Clearing the DIC/DTC

P0796 and P0797 are Type A DTCs.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This allows you to monitor, display, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Drive Range - Fourth Gear (Gen 2/Hybrid)**
- **Drive Range, Fifth Gear (Gen 2/Hybrid)**
- **Drive Range, Sixth Gear (Gen 2/Hybrid)**
- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Ignition ON.
2. Verify DTC P0716, P0717, P0722, P0723, P077C, P077D, P07BF, or P07C0 was not set by reviewing the scan tool Freeze Frame/Failure Records data.

- **If any of the DTCs were set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs were set**

3. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
4. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.

- **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level and condition is correct**

5. Ignition ON, clear the TCM DTCs with a scan tool.
6. Verify DTC P0796 or P0797 does not set while performing a road test. Refer to **Road Test**.

- **If DTC P0796 or P0797 sets**

Refer to Circuit/System Testing.

- **If DTC P0796 or P0797 does not set**

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check (Non Hybrid)**, **Line Pressure Check (Hybrid)**, and **Solenoid Valve Pressure (Gen 1)** , **Solenoid Valve Pressure (Gen 2)** .

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low.**

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test.**

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0796 or P0797 - Control Valve Body Assembly

4-5-6 Regulator Valve stuck/sticking - debris, binding, damaged valve, or scored bore.

P0796 - Transmission Cooling/Lubrication

- Restriction/leak in OAC, oil to air, cooler/radiator.
- Restricted/leaking/kinked/damaged transmission oil cooler lines.
- Restriction/leak in transmission fluid pump assembly.

P0796 - Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged.

P0796 - Input Shaft Support

Input shaft tower seals damaged or leaking.

P0796 - 4-5-6 Clutch Housing Assembly

4-5-6 Clutch Piston Assembly damaged/leaking.

P0796 - Torque Converter (w/Fluid Pump) Housing Assembly

- Fluid pump housing vanes/rotor/slide damaged/scored.
- Fluid pump or torque converter overstressed due to high temperature.

P0796 - 4-5-6 Reaction Carrier Hub Assembly

4-5-6 Reaction Carrier Hub/Shaft - broken hub weld.

P0796 - 3-5-R and 4-5-6 Clutch Housing Assembly

4-5-6 Clutch Backing Plate Retaining Ring not seated/oriented, causing clutch pack/piston overtravel.

P0796 Output Carrier Assembly

Output carrier pinion pins too high or too low.

P0796 or P0797 - Q8 Control Solenoid Valve Assembly

- Clutch Pressure Control Solenoid 3 stuck ON/OFF.
- O-ring seals leaking.
- Valve body filter plate assembly cracked, blocked, or damaged gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0815, P0816, OR P0826

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0815

Upshift Switch Circuit

DTC P0816

Downshift Switch Circuit

DTC P0826

Up and Down Shift Switch Circuit

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0826	P0826	P0826	-

Typical Scan Tool Data

Driver Shift Request

Circuit	Short to Ground	Open	Short to Voltage
Signal	Invalid	None	Invalid/None
Ground	-	None	-

Circuit/System Description

When the shift lever is moved left of the D position, the transmission will enter sport mode. With the shift lever in this position, the transmission will enter manual mode if the gear shift lever is pressed forward or rearward. This allows the operator to select an upshift by pressing the gear shift lever forward, and downshift by pressing the gear shift lever rearward. The body control module (BCM) supplies an ignition circuit and a signal circuit to the shift controller. The shift controller has Hall-effect switches connected to a resistor array. When the lever is left of the D position, a voltage drop occurs across the resistor network. When the gear shift lever is pressed forward or rearward, a corresponding voltage drop occurs across the resistor network. This voltage drop is monitored by the BCM. The BCM will send the request to the transmission control module to perform the upshift or downshift. The TCM will not allow a downshift if the engine would be compromised by overspeeding.

Conditions for Running the DTC

P0815 or P0816

- DTC P0815, P0816, P0826, P1761, P182E, P1876, P1877, or P1915 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Time since the last gear range change is 1 s or greater.
- DTC runs continuously when the above conditions are met.

P0826

- DTC P0826 or P1761 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0815 - Condition 1

Transmission control module (TCM) detects an upshift request for 1 s with the shift lever in Park or Neutral.

P0815 - Condition 2

TCM detects an upshift request for 10 min with the shift lever in a forward range.

P0816 - Condition 1

TCM detects a downshift request for 1 s with the shift lever in Park or Neutral.

P0816 - Condition 2

TCM detects a downshift request for 10 min with the shift lever in a forward range.

P0826

TCM detects an invalid voltage on the Tap Up/Down signal circuit for 1 min.

Action Taken When the DTC Sets

- P0815, P0816, and P0826 are Type C DTCs.
- TCM inhibits Tap Up/Down function.

Conditions for Clearing the DTC

P0815, P0816, and P0826 are Type C DTCs.

Diagnostic Aids

A high resistance in the signal circuit may not set a DTC. Symptoms could include an inoperative manual mode Tap Up/Down, or a Tap Down shift when the Tap/Up button is pressed.

If battery positive voltage is not present at the shift selector lever, it will not cause a DTC to set, but will result in an inoperative manual mode Tap Up/Down.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

NOTE: The engine may have to be started to move the shift lever out of the Park position. Once out of the Park position, the engine can be turned OFF.

1. Verify DTC P182E or P1915 was not set by reviewing the scan tool Freeze Frame/Failure Records.
 - **If DTC P182E or P1915 was set**

Refer to **DTC P182E or P1915**.

- **If DTC P182E or P1915 was not set**
2. Ignition ON, engine OFF.
3. Verify the scan tool Driver Shift Control Mode parameter displays Inactive with the shift lever in the Park, Reverse, Neutral and Drive positions, and Active when the shift lever is left of the Drive position.
 - **If the parameter does not display the correct values**

Refer to Circuit/System Testing.

- **If the parameter displays the correct value**
4. Shift lever left of the D position.
5. Verify the scan tool Driver Shift Request parameter changes from None to Upshift when the shift lever is

pressed forward, and from None to Downshift when the gear shift lever is pressed rearward.

- **If the parameter does not display the correct values**

Refer to Circuit/System Testing.

- **If the parameter displays the correct value**

6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, disconnect the harness connector from the S3 Transmission Shift Lever.
2. Test for less than 10 ohms between the vehicle harness connector ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**

Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**

3. Ignition ON.
4. Test for 11-13 V at the vehicle harness connector between signal circuit terminal 3 and ground.
 - **If not between 11-13 V**

1. Ignition OFF, disconnect the connector at the BCM.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance.
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the BCM.

- **If between 11-13 V**

5. Ignition OFF, connect the harness connector at the S3 Transmission Shift Lever, ignition ON.

6. Test for voltage between the S3 Transmission Shift Lever connector signal circuit terminal 3 and ground, by back probing the connector, for the conditions listed below.
 - 2.0-4.6 V - Shift lever left of D, pressed forward
 - 5.1-7.3 V - Shift lever left of D, pressed rearward
 - 8.0-10.6 V - Shift lever left of D
 - 11-13 V - Shift lever in D
 - **If voltage values are not correct**

Replace the S3 Transmission Shift Lever.

- **If voltage values are correct**

7. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic repair.

- **Transmission Control Replacement** - for Transmission Shift Lever replacement
- **Control Module References** - for Body Control Module replacement, programming and setup

DTC P0850-P0852

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0850

Park/Neutral Position Switch Circuit

DTC P0851

Park/Neutral Position Switch Circuit Low Voltage

DTC P0852

Park/Neutral Position Switch Circuit High Voltage

Diagnostic Fault Information

	Short to	Open/High	Short to	Signal
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Circuit	Ground	Resistance	Voltage	Performance
Signal	P0850, P0851	P0850, P0852	P0850, P0852	-

Typical Scan Tool Data

Park/Neutral Position Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in park at normal operating temperature Parameter Normal Range: Park/Neutral			
Signal	Park/Neutral	In-Gear	In-Gear

Circuit/System Description

The transmission manual shift shaft switch assembly, also known as the transmission internal mode switch is a sliding contact switch attached to the manual shift shaft inside the transmission case. The park/neutral position switch is integrated into the transmission internal mode switch and connects to the transmission control module (TCM) lead-frame through a short wire harness. The park/neutral signal circuit uses the TCM as a pass-through connector only. The TCM provides the low reference circuit to the park/neutral position switch.

The Park/Neutral Signal is sent from the park/neutral switch directly to the Engine Control Module (ECM) and is used for engine start enable.

Conditions for Running the DTC

- Ignition voltage is between 8-18 V.
- Engine speed is 1000 RPM or greater.
- Runs continuously when above conditions are met.

Conditions for Setting the DTC

P0850 and P0851

- ECM detects the Park/Neutral switch signal equals 0 V (Park/Neutral) when the transmission internal mode switch reports a Drive range.
- Throttle position is 10 % or greater.
- Engine torque is 75 (55 lb ft) or greater.
- Vehicle speed is 10 km/h (6 mph) or greater.
- Above conditions must be met for 0.2 s.

P0852

ECM detects the Park/Neutral switch signal equals 12 V (In-Gear) when the IMS reports a Park/Neutral range for 0.2 s.

Action Taken When the DTC Sets

- DTCs P0850, P0851, and P0852 are Type C DTCs.
- ECM uses the transmission internal mode switch position, which is determined by the transmission control module and broadcast over GMLAN, for engine start-up.

Conditions for Clearing the DTC

DTCs P0850, P0851, and P0852 are Type C DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Electronic Component Description**
- **Transmission Component and System Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P182E or P1915 is not set.

- **If any of the DTCs are set**

Refer to **DTC P182E or P1915**.

- **If none of the DTCs are set**

3. Verify the range selector lever cable is adjusted properly. Refer to **Range Selector Lever Cable Adjustment**.

- **If the cable adjustment is not OK**

Adjust, repair or replace as necessary.

- **If the cable adjustment is OK**

4. Ignition ON.
5. Verify the scan tool TCM Internal Mode Switch parameter matches the gear shift lever position while slowly moving the gear shift lever from Park through all gear ranges.

- **If any gear shift lever position does not match**

Refer to **DTC P182E or P1915**.

- **If all gear positions match**

6. Verify the scan tool Park/Neutral Position Switch parameter displays Park/Neutral when in Park or Neutral and In-Gear when in Reverse or Drive.

- **If Park/Neutral or In Gear is not displayed**

Refer to Circuit/System Testing.

- **If Park/Neutral and In Gear is displayed**

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF, disconnect the X1 Q8 Control Solenoid Valve Assembly harness connector at the automatic transmission.
2. Install the **DT-48616-10** adapter harness to the vehicle harness connector.

NOTE: **All testing in steps 3 through 5 will be performed at the DT-48616-10 adapter harness connector.**

3. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
4. Ignition ON.
5. Test for 11-13 V between signal circuit terminal 3 and ground.
 - **If not between 11-13 V**
 1. Ignition OFF, remove the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If between 11-13 V**
6. Ignition OFF, disconnect the **DT-48616-10** adapter harness from the vehicle wire harness.
7. Remove the transmission control valve body cover.
8. Connect the vehicle harness connector to the Q8 Control Solenoid Valve Assembly.
9. Disconnect the B15 Transmission Internal Mode Switch X2 electrical connector from the Q8 Control Solenoid Valve Assembly.
10. Ignition ON.
11. Verify the scan tool ECM Park/Neutral Position Switch parameter displays In Gear.
 - **If In Gear is not displayed**
 1. Ignition OFF, disconnect the X1 harness connector at the Q8 Control Solenoid Valve Assembly.
 2. Install the **DT-48616-10** adapter harness to the Q8 Control Solenoid Valve Assembly X1 connector.
 3. Test for infinite resistance between the **DT-48616-10** adapter harness connector terminals 2 and 3.
 - If less than infinite resistance, replace the Q8 Control Solenoid Valve Assembly.
 - If infinite resistance, replace the K20 Engine Control Module.

- **If In Gear is displayed**
- 12. Connect a 3A fused jumper between the Q8 Control Solenoid Valve Assembly X2 connector signal circuit terminal A and ground. Ignition ON.
- 13. Verify the scan tool ECM Park/Neutral Position Switch parameter displays Park/Neutral.
 - **If Park/Neutral is not displayed**
 1. Ignition OFF, disconnect the X1 harness connector at the Q8 Control Solenoid Valve Assembly.
 2. Install the **DT-48616-10** adapter harness to the Q8 Control Solenoid Valve Assembly X1 connector.
 3. Test for less than 2 ohms between adapter harness connector terminal 3 and the Q8 Control Solenoid Valve Assembly connector signal circuit terminal A.
 - If 2 ohms or greater, replace the Q8 Control Solenoid Valve Assembly.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Park/Neutral is displayed**
- 14. Replace the B15 Transmission Internal Mode Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs.
- **Range Selector Lever Cable Adjustment**
- **Control Valve Body Cover Replacement**
- **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**
- **Control Valve Body Cover Replacement**
- **Control Module References** - for Engine Control Module or Control Solenoid Valve Assembly replacement, programming and setup

DTC P0961-P0963

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0961

Line Pressure Control Solenoid Valve Performance

DTC P0962

Line Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P0963

Line Pressure Control Solenoid Valve Control Circuit High Voltage

Circuit/System Description

The line pressure control solenoid valve is part of the control solenoid valve assembly which has no serviceable components. The normally high line pressure control solenoid valve regulates and directs oil pressure to the pressure regulator valve. Increasing line pressure control solenoid valve pressure increases transmission line pressure. The transmission control module (TCM) varies the current to the line pressure control solenoid valve by controlling the amount of time the low side driver is ON and OFF. Decreasing the ON time, decreases the current to the line pressure control solenoid, which increases line pressure control solenoid oil pressure by closing OFF the solenoid exhaust port. Increasing the current to the line pressure control solenoid decreases line pressure control oil pressure by opening the solenoid exhaust port. Line pressure control solenoid power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Runs continuously when above conditions are met.

Conditions for Setting the DTC

P0961

TCM detects an internal electrical malfunction of the line pressure control solenoid valve circuit where the measured line pressure control solenoid valve current does not equal the commanded line pressure control solenoid valve current for 5 s.

P0962

TCM detects a short to ground on the line pressure control solenoid valve control circuit for 2 s.

P0963

TCM detects an open circuit or short to voltage on the line pressure control solenoid valve control circuit for 5 s.

Action Taken When the DTC Sets

P0961 or P0963

- P0961 and P0963 are Type B DTCs.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.

P0962

- P0962 is a Type A DTC.
- TCM limits the transmission to 4th gear and reverse.
- TCM inhibits the torque converter clutch (TCC).
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM inhibits neutral idle.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM enables torque management.

Conditions for Clearing the DTC

- P0961 and P0963 are Type B DTCs.
- P0962 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Engine idling, transmission in Park, with service brake applied. Move the S3 Transmission Shift Lever into each gear position for 2-3 s and back into the Park position.
2. Verify the scan tool parameters listed below do not display Malfunction:
 - Line Pressure Control Solenoid Valve Performance Test Status
 - Line Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
 - Line Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records.
4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.
 - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid valve listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Line Pressure Control Solenoid Valve Performance Test Status
 - Line Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
 - Line Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0965-P0967

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0965

Pressure Control Solenoid Valve 2 Performance

DTC P0966

Pressure Control Solenoid Valve 2 Control Circuit Low Voltage

DTC P0967

Pressure Control Solenoid Valve 2 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid valve 2 is part of the control solenoid valve assembly which has no serviceable components. The normally low pressure control solenoid valve 2 regulates and directs fluid pressure to the 3-5 reverse clutch regulator valve. Increasing pressure control solenoid valve 2 pressure increases pressure to the 3-5 reverse clutch. The transmission control module (TCM) varies the current to the pressure control solenoid valve 2 by controlling the amount of time the low side driver is ON and OFF. Increasing the current to the pressure control solenoid valve 2 increases pressure control solenoid valve 2 fluid pressure by closing OFF the solenoid valve exhaust port. Decreasing the current to the pressure control solenoid valve 2 decreases clutch pressure control solenoid valve 2 fluid pressure by opening the solenoid valve exhaust port. Power to pressure control solenoid valve 2 is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Runs continuously when above conditions are met.

Conditions for Setting the DTC

P0965

TCM detects an internal electrical performance malfunction of the pressure control solenoid valve 2 control circuit where the measured pressure control solenoid valve 2 current does not equal the commanded pressure control solenoid valve 2 current for 5 s.

P0966

TCM detects a short to ground on the pressure control solenoid valve 2 control circuit for 1 s.

P0967

TCM detects an open or short to voltage on the pressure control solenoid valve 2 control circuit for 1 s.

Action Taken When the DTC Sets

P0965

- P0965 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 3-5 Reverse clutch.

P0966 or P0967

- P0966 and P0967 are Type A DTCs.
- TCM limits the transmission to 4th gear and reverse.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM forces the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM enables torque management.

Conditions for Clearing the DTC

- P0965 is a Type C DTC.
- P0966 and P0967 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**

- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature, then operate the vehicle with the transmission in Park for 5 s.
2. Operate the vehicle in drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 2 Performance Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- If the DTC does not set
6. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to Control Solenoid Valve and Transmission Control Module Assembly Inspection.
 - **If contaminated**

Repair as necessary.
 - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid valve listed in the Control Solenoid Valve and Transmission Control Module Assembly Inspection.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 2 Performance Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Perform the Transmission Adaptive Values Learn following all transmission repairs
- Control Module References for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0969-P0971

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0969

Pressure Control Solenoid Valve 3 Performance

DTC P0970

Pressure Control Solenoid Valve 3 Control Circuit Low Voltage

DTC P0971

Pressure Control Solenoid Valve 3 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid valve 3 is part of the control solenoid valve assembly which has no serviceable components. The normally high pressure control solenoid valve 3 regulates and directs fluid pressure to the R1/4-5-6 regulator valve. Increasing pressure control solenoid valve 3 pressure increases pressure to the low and reverse clutch or 4-5-6 clutch, depending on the position of the clutch select valve. The transmission control module (TCM) varies current to pressure control Solenoid valve 3 by controlling the time the low side driver is ON and OFF. Decreasing the current to pressure control solenoid valve 3 increases fluid pressure by closing off the solenoid valve exhaust port. Increasing the current to the pressure control solenoid valve 3 decreases fluid pressure by opening the exhaust port. Power is supplied to the pressure control solenoid valve 3 by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- Runs continuously when above conditions are met.

Conditions for Setting the DTC

P0969

TCM detects an internal electrical performance malfunction of the pressure control solenoid valve 3 control

circuit where the measured pressure control solenoid valve 3 currents does not equal the commanded clutch pressure control solenoid valve 3 current for 5 s.

P0970

TCM detects a short to ground on the pressure control solenoid valve 3 control circuit for 1 s.

P0971

TCM detects an open or short to voltage on the pressure control solenoid valve 3 control circuit for 1 s.

Action Taken When the DTC Sets

P0969

- P0969 is a Type C DTC.
- TCM freezes transmission adaptive functions on the low and reverse clutch and the 4-5-6 clutch.

P0970 or P0971

- P0970 and P0971 are Type A DTCs.
- TCM limits the transmission to 4th gear and reverse.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM enables torque management.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM inhibits auto grade braking.
- TCM forces the high side driver OFF - P0970 only.
- TCM forces the torque converter clutch (TCC) OFF - P0970 only.

Conditions for Clearing the DTC

- P0969 is a Type C DTC.
- P0970 and P0971 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**

- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature, then operate the vehicle with the transmission in Park for 5 s.
2. Operate the vehicle in drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 3 Performance Test Status
 - Pressure Control Solenoid Valve 3 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 3 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within

the conditions that you observed from the Freeze Frame/Failure Records data.

5. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.

- **If contaminated**

Repair as necessary.

- **If not contaminated**

3. Verify the resistance is within the specified range for each solenoid valve listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.

- **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 2 Performance Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P0973 OR P0974

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0973

Shift Solenoid Valve 1 Control Circuit Low Voltage

DTC P0974

Shift Solenoid Valve 1 Control Circuit High Voltage

Circuit/System Description

The shift solenoid valve 1 is part of the control solenoid valve assembly which has no serviceable components. Shift solenoid valve 1 is a normally closed ON/OFF solenoid and is controlled by the transmission control module (TCM) through a low side driver. When the shift solenoid valve 1 is energized (ON), fluid pressure is directed to the clutch select valve. Power to shift solenoid valve 1 is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7500 RPM for 5 s.
- Ignition voltage is 9-32 V.

Conditions for Setting the DTC

P0973

TCM detects a short to ground on the shift solenoid valve 1 control circuit for 2 s.

P0974

TCM detects an open or short to voltage on the shift solenoid valve 1 control circuit for 2 s.

Action Taken When the DTC Sets

P0973

- DTC P0973 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM limits the transmission to neutral or 2nd gear and reverse.
- TCM inhibits neutral idle.
- TCM inhibits auto grade braking.
- TCM inhibits the Tap Up/Tap Down function.
- TCM inhibits manual shifting of forward gears.

P0974

- DTC P0974 is a Type B DTC.
- TCM inhibits 1st gear.
- TCM inhibits neutral idle.

Conditions for Clearing the DIC/DTC

- DTC P0973 is a Type A DTC.
- DTC P0974 is a Type B DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

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- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in 2nd gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature.
2. Place the gear selector in Reverse for 5 s and then idle vehicle for 5 s.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Shift Solenoid Valve 1 Control Circuit Low Voltage Test Status
 - Shift Solenoid Valve 1 Control Circuit Open Test Status
 - Shift Solenoid Valve 1 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.
 - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid valve listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Shift Solenoid Valve 1 Control Circuit Low Voltage Test
 - Shift Solenoid Valve 1 Control Circuit Open Test
 - Shift Solenoid Valve 1 Control Circuit High Voltage Test
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P1761

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1761

Up and Down Shift Switch Signal Message Counter Incorrect

Circuit/System Description

When the shift lever is moved left of the D position, the transmission will enter sport mode. With the shift lever in this position, the transmission will enter manual mode if the gear shift lever is pressed forward or rearward. This allows the operator to select an upshift by pressing the gear shift lever forward, and downshift by pressing the gear shift lever rearward. The body control module (BCM) supplies battery voltage, ground, and a signal circuit to the shift controller. The shift controller has Hall-effect switches connected to a resistor array. When the lever is left of the D position, a voltage drop occurs across the resistor network. When the gear shift lever is pressed forward or rearward, a corresponding voltage drop occurs across the resistor network. This voltage drop is monitored by the BCM. The BCM will send the request to the transmission control module (TCM) to perform the upshift or downshift. The TCM is constantly monitoring the serial data sent from the BCM for the correct number and sequence of counts for Tap Up and Tap Down function.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Runs continuously when above condition is met.

Conditions for Setting the DTC

TCM detects the internal rolling count value does not match the expected BCM count, 3 times within 10 s.

Action Taken When the DTC Sets

- P1761 is a Type C DTC.
- TCM inhibits the Tap Up Tap Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

P1761 is a Type C DTC.

Reference Information

Schematic Reference

- **Automatic Transmission Controls Schematics**
- **Body Control System Schematics**

- **Data Communication Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **DTC P1761 is an informational DTC.**
- **Diagnose all other Body Control Module DTCs prior to DTC P1761.**

1. Verify there are no other K9 Body Control Module or communication DTCs set.
 - **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If a DTC is not set**
2. Complete the diagnosis by looking for a GMLAN circuit fault. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** .
 - **If a GMLAN circuit fault is found**

Repair as necessary.

- **If a GMLAN circuit fault is not found**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Body Control Module and Control Solenoid Valve Assembly replacement, programming and setup

DTC P1762

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1762

Transmission Mode Switch Signal Message Counter Incorrect

Circuit/System Description

When the sport switch is depressed and released, sport mode becomes active. Sport mode changes the transmission shift pattern, as well as the suspension and steering characteristics. Pressing and releasing the sport switch again returns the vehicle to standard mode. The body control module (BCM) supplies a signal circuit to the sport switch. When the sport switch is pressed, the signal circuit is pulled lowed and sport is activated. The BCM continually sends the sport mode status message to the TCM. The BCM internal counter increments each time the sport mode status is sent and the BCM sends the rolling count with the sport mode status. The TCM counter increments each time the sport mode status is received. The DTC will set if the rolling count value of the TCM does not match the rolling count sent from the BCM.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Runs continuously when above condition is met.

Conditions for Setting the DTC

TCM detects the internal rolling count value does not match the expected BCM count value, 3 times within 10 s.

Action Taken When the DTC Sets

- P1762 is a Type C DTC.
- TCM inhibits the Tap Up Tap Down function.
- TCM inhibits manual shifting of forward gears.
- TCM cancels sport mode.

Conditions for Clearing the DTC

P1762 is a Type C DTC.

Reference Information

Schematic Reference

- **Automatic Transmission Controls Schematics**
- **Body Control System Schematics**
- **Data Communication Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- DTC P1762 is an informational DTC.
- Diagnose all other Body Control Module DTCs prior to DTC P1762.

1. Verify there are no other K9 Body Control Module or communication DTCs set.

- If a DTC is set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- If a DTC is not set

2. Complete the diagnosis by looking for a GMLAN circuit fault. Refer to Scan Tool Does Not Communicate with High Speed GMLAN Device .

- If a GMLAN circuit fault is found

Repair as necessary.

- If a GMLAN circuit fault is not found

3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Perform the Transmission Adaptive Values Learn following all transmission repairs
- Control Module References - for Body Control Module and Control Solenoid Valve Assembly replacement, programming and setup

DTC P182E OR P1915**Diagnostic Instructions**

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors**DTC P182E**

Internal Mode Switch Indicates Invalid Range

DTC P1915

Internal Mode Switch Does Not Indicate Park/Neutral During Start

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal A	P182E	P1915	P1915	P182E, P1915
Signal B	P1915	P182E	P182E	P182E, P1915
Signal C	P1915	P182E	P182E	P182E, P1915
Signal P	P182E	P1915	P1915	P182E, P1915
Low Reference	-	P182E	P182E	P182E, P1915

Typical Scan Tool Data

Internal Mode Switch A/B/C/P

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, range selector in Park			
Parameter Normal Range Low High High Low			
Signal A	Low	High	High
Signal B	Low	High	High
Signal C	Low	High	High
Signal P	Low	High	High
High = 12 volts			
Low = 0 volts			

Circuit/System Description

The manual shift detent lever with shaft position switch assembly, also known as the transmission internal mode switch assembly, is a sliding contact switch attached to the manual shift detent lever shaft inside the transmission. The 4 inputs to the transmission control module (TCM) from the switch indicate the position selected by the transmission manual shaft. The input voltage at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool TCM Internal Mode Switch A/B/C/P parameter. The Internal Mode Switch A/B/C/P parameter represents transmission range Signal A, Signal B, Signal C, and Signal P.

The park/neutral position switch is integrated into the transmission internal mode switch. The circuit uses the TCM as a pass-through connector only.

The park/neutral signal is sent from the park/neutral switch directly to the engine control module (ECM) and is used for engine start enable.

Conditions for Running the DTC

P182E

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.

- Ignition voltage is 9-32 V.
- Engine torque signal is valid.
- DTC runs continuously when the above conditions are met.

P1915

- DTC P0722, P0723, or P1915 is not set.
- Transmission output shaft speed is 90 RPM or less.
- Ignition voltage is 6-32 V.
- DTC runs when conditions above are met during engine start sequence.

Conditions for Setting the DTC

P182E

Internal mode switch does not indicate a valid Park, Reverse, Neutral, or Drive Range position for 7 s.

P1915

Internal mode switch does not indicate Park or Neutral during the following sequence:

- Engine speed is less than 50 RPM for greater than 0.10 s.
- Engine speed is 50-480 RPM for greater than 0.07 s.
- Engine speed is greater than 500 RPM and the transmission input speed is greater than 100 RPM for greater than 1.25 s.

Action Taken When the DTC Sets

- P182E and P1915 are Type A DTCs.
- TCM commands maximum line pressure.
- TCM turns OFF all solenoids.
- TCM freezes transmission adaptive functions.
- TCM limits the transmission to reverse and 4th gear.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM inhibits the Tap Up/Tap Down function.
- TCM inhibits neutral idle.
- TCM inhibits auto grade braking.
- TCM inhibits manual shifting of forward gears.
- TCM turns the high side driver OFF.
- TCM enables torque management.

Conditions for Clearing the DTC

P182E and P1915 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
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- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Verify the range selector lever cable is adjusted properly. Refer to **Range Selector Lever Cable Adjustment** .
 - If cable adjustment is not OK

Repair as necessary.

- **If cable adjustment is OK**

2. Ignition ON.
3. Verify the scan tool TCM Internal Mode Switch A/B/C/P parameter matches the **Transmission Internal Mode Switch Logic** table for each transmission shift lever position.
 - **If the parameter does not match**

Refer to Circuit/System Testing.

- **If the parameter matches**

4. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays Park/Neutral with the gear shift lever in Park or Neutral and In Gear in Reverse or Drive.
 - **If Park/Neutral or In Gear is not displayed**

Refer to Circuit/System Testing.

- **If Park/Neutral and In Gear is displayed**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

NOTE: **You must perform Circuit/System Verification first.**

1. Ignition OFF, remove the control valve body cover.
2. Connect the vehicle harness connector to the Q8 Control Solenoid Valve Assembly.
3. Disconnect the B15 Transmission Internal Mode Switch connector at the Q8 Control Solenoid Valve Assembly.
4. Ignition ON.
5. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays In Gear.
 - **If In Gear is not displayed**
 1. Ignition OFF, disconnect the vehicle harness X1 connector at the Q8 Control Solenoid Valve Assembly.
 2. Install the **DT-48616-10** adapter harness to the X1 connector at the Q8 Control Solenoid Valve Assembly.

3. Test for infinite resistance between the **DT-48616-10** adapter harness connector terminals 2 and 3.
 - If less than infinite resistance, replace the Q8 Control Solenoid Valve Assembly.
 - If infinite resistance.
4. Disconnect the harness connector at the K20 Engine Control Module.
5. Test for infinite resistance between the signal circuit and ground at the vehicle harness K20 Engine Control Module connector.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If In Gear is displayed**
6. Verify the scan tool transmission control module Internal Mode Switch A/B/C/P parameter displays High High High.
 - **If High High High High is not displayed**

Replace the Q8 Control Solenoid Valve Assembly.

○ **If High High High High is displayed**
7. Install a 3 A fused jumper wire between the low reference circuit terminal F and each signal circuit listed below one at a time at the Q8 Control Solenoid Valve Assembly.
 - Signal A - terminal B
 - Signal B - terminal C
 - Signal C - terminal D
 - Signal P - terminal E
8. Verify the scan tool transmission control module A/B/C/P parameter displays 1 Low and 3 High when a signal circuit is grounded.
 - **If 1 Low and 3 High is not displayed**

Replace the Q8 Control Solenoid Valve Assembly.

○ **If 1 Low and 3 High is displayed**
9. Connect a 3-amp fused jumper wire between terminal A and terminal F.
10. Verify the ECM Park/Neutral Position Switch parameter displays Park/Neutral.
 - **If Park/Neutral is not displayed**
 1. Ignition OFF, remove the jumper wire and disconnect the X1 connector at the Q8 Control Solenoid Valve Assembly.
 2. Install the **DT-48616-10** adapter harness to the X1 connector at the Q8 Control Solenoid Valve Assembly.
 3. Test for less than 2 ohms between the adapter harness terminal 2 and the X2 connector terminal F at the Q8 Control Solenoid Valve Assembly.
 - If greater than 2 ohms, replace the Q8 Control Solenoid Valve Assembly.
 - If less than 2 ohms .
 4. Disconnect the connector at the K20 Engine Control Module.

5. Test for less than 2 ohms in the vehicle harness park/neutral signal circuit, end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Park/Neutral is displayed**

11. Replace the B15 Transmission Internal Mode Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs.
- **Control Valve Body Cover Replacement**
- **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**
- **Range Selector Lever Cable Adjustment**
- **Control Module References** - for Control Solenoid Valve Assembly or Engine Control Module replacement, programming and setup

DTC P1876

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1876

Up and Down Shift Enable Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0826, P1876	-	P0826	-

Typical Scan Tool Data

Driver Shift Request

Circuit	Short to Ground	Open	Short to Voltage
Signal	Invalid	None	Invalid/None
Ground	-	None	-

Circuit/System Description

When the shift lever is moved left of the D position, the transmission will enter sport mode. With the shift lever in this position, the transmission will enter manual mode if the gear shift lever is pressed forward or rearward. This allows the operator to select an upshift by pressing the gear shift lever forward, and downshift by pressing the gear shift lever rearward. The body control module (BCM) supplies a signal circuit to the shift controller. The shift controller has Hall-effect switches connected to a resistor array. When the lever is left of the D position, a voltage drop occurs across the resistor network. When the gear shift lever is pressed forward or rearward, a corresponding voltage drop occurs across the resistor network. This voltage drop is monitored by the BCM. The BCM will send the request to the transmission control module (TCM) to perform the upshift or downshift. The TCM will not allow shifting to the next higher gear if the vehicle speed or engine RPM is too low. The transmission will not allow shifting to the next lower gear if the vehicle speed or engine RPM is too high.

Conditions for Running the DTC

- DTC P0815, P0816, P0826, P1761, P1825, P1876, P1877, P1915, or U0100 is not set.
- Engine speed is greater than 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when above conditions are met.

Conditions for Setting the DTC

Transmission control module (TCM) detects a TAP Enable Switch request for 3 s when the shift lever is in Park, Reverse, or Neutral, a total of 5 times.

Action Taken When the DTC Sets

- P1876 is a Type C DTC.
- TCM inhibits Tap-Up/Tap-Down functions.
- TCM inhibits manual up, manual down shifts with the shift selector.

Conditions for Clearing the DIC/DTC

P1876 is a Type C DTC.

Diagnostic Aids

A high resistance in the signal circuit may not set a DTC. Symptoms could include an inoperative manual mode Tap Up/Down, or a Tap Down shift when the Tap/Up button is pressed.

If battery positive voltage is not present at the shift selector lever, it will not cause a DTC to set, but will result in an inoperative manual mode Tap Up/Down.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to **Parking Brake and Drive Wheels Warning** .

NOTE: **The engine may have to be started to move the shift lever out of the Park position. Once out of the Park position, the engine can be turned OFF.**

1. Verify DTC P182E or P1915 was not set by reviewing the scan tool Freeze Frame/Failure Records.
 - **If DTC P182E or P1915 was set**

Refer to **DTC P182E or P1915**.

- **If DTC P182E or P1915 was not set**
2. Ignition ON.
 3. Verify the gear shift lever position matches the scan tool TCM Internal Mode Switch parameter while

slowly moving the S3 Transmission Shift Lever from Park through all ranges.

- **If the parameter does not display the correct values**

Refer to **Range Selector Lever Cable Adjustment** .

- **If the parameter displays the correct values**

4. Verify the Driver Shift Control Mode parameter displays Inactive with the S3 Transmission Shift Lever in the P (Park), R (Reverse), N (Neutral), and D (Drive) positions.

- **If Inactive is not displayed**

Refer to Circuit/System Testing.

- **If Inactive is displayed**

5. Shift lever left of the D position.
6. Verify the scan tool Driver Shift Request parameter changes from Inactive to Upshift when the shift lever is pressed forward, and from Inactive to Downshift when the gear shift lever is pressed rearward.

- **If the parameter does not display the correct values**

Refer to Circuit/System Testing.

- **If the parameter displays the correct values**

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

NOTE: **You must perform Circuit/System Verification first.**

1. Ignition OFF, disconnect the harness connector from the S3 Transmission Shift Lever.
2. Test for less than 10 ohms between the vehicle harness connector terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**

3. Ignition ON.
4. Test for 11-13 V at the vehicle harness connector between signal circuit terminal 3 and ground.
 - **If not between 11-13 V**
 1. Ignition OFF, disconnect the connector at the BCM.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the BCM.
 - **If between 11-13 V**
5. Ignition OFF, connect the harness connector at the S3 Transmission Shift Lever, ignition ON.
6. Test for voltage between the S3 Transmission Shift Lever connector signal circuit terminal 3 and ground, by back probing the connector, for the conditions listed below.
 - 2.0-4.6 V - Shift lever left of D, pressed forward
 - 5.1-7.3 V - Shift lever left of D, pressed rearward
 - 8.0-10.6 V - Shift lever left of D
 - 11-13 V - Shift lever in D
 - **If voltage values are not correct**

Replace the S3 Transmission Shift Lever.
 - **If voltage values are correct**
7. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Transmission Control Replacement** - for Transmission Shift Lever replacement
- **Control Module References** - for Body Control Module replacement, programming and setup

DTC P2714 OR P2715

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.

DTC P2714

Pressure Control Solenoid Valve 4 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P2715

Pressure Control Solenoid Valve 4 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Pressure control solenoid valve 4 is part of the control solenoid valve assembly which has no serviceable components. Pressure control solenoid valve 4 regulates transmission fluid pressure to the 2-6 regulator valve which controls pressure to the 2-6 clutch. The transmission control module (TCM) calculates gear ratio based on the speed signals from the input shaft speed sensor and the output shaft speed sensor. The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

P2714

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- High side driver is enabled.
- Throttle position signal is valid.
- Ignition voltage is 9-32 V.
- Transmission fluid temperature is -6.6°C (20°F) or greater.
- Engine speed is 400-7,500 RPM for 5 s.
- Pressure control solenoid 4 is commanded ON, applying the 2-6 clutch.
- Output speed is 100 RPM or greater, or the throttle position is greater than 0.5%.
- Runs continuously when above conditions are met.

P2715

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 9-32 V.
- Transmission output shaft speed is 100 RPM or greater, or throttle position is 0.5% or greater.
- Pressure control solenoid 4 is commanded OFF, releasing the 2-6 clutch.

- Transmission fluid temperature is -6.6°C (20°F) or greater.
- Engine speed is 400-7,500 RPM for 5 s.
- Engine torque is 45 N.m (33 lb ft) or greater.
- The attained range is not 1st gear.
- High side driver is enabled.
- Runs continuously when above conditions are met.

Conditions for Setting the DTC

P2714

TCM detects an incorrect on-coming clutch gear ratio, or shift flare. This condition must occur 3 times.

P2715

TCM detects an incorrect off-going clutch gear ratio, or shift tie-up. This condition must occur 3 times.

Action Taken When the DTC Sets

P2714

- P2714 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits the Tap Up/Tap Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to reverse and 3rd gear.
- TCM inhibits powertrain braking.
- TCM inhibits neutral idle.
- TCM inhibits auto grade braking.

P2715

- P2715 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits the Tap Up/Tap Down function.
- TCM inhibits manual shifting of forward gears.
- TCM inhibits powertrain braking.
- TCM inhibits auto grade braking.
- TCM inhibits neutral idle.
- TCM commands 2nd gear if the output speed is less than 700 RPM.

- TCM commands neutral if the output speed is 700 RPM or greater.

Conditions for Clearing the DTC

P2714 and P2715 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Drive Range, Second Gear (Gen 2/Hybrid)**
- **Drive Range, Sixth Gear (Gen 2/Hybrid)**
- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Ignition ON.
2. Verify DTC P0716, P0717, P0722, P0723, P077C, P077D, P07BF, or P07C0 was not set by reviewing the scan tool Freeze Frame/Failure Records data.

- **If any of the DTCs were set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs were set**

3. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
4. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.

- **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level and condition is correct**

5. Ignition ON, clear the TCM DTCs with a scan tool.
6. Verify DTC P2714 or P2715 does not set while performing a road test. Refer to **Road Test**.

- **If DTC P2714 or P2715 sets**

Refer to Circuit/System Testing.

- **If DTC P2714 or P2715 does not set**

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check (Non Hybrid)**, **Line Pressure Check (Hybrid)**, and **Solenoid Valve Pressure (Gen 1)** , **Solenoid Valve Pressure (Gen 2)** .

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low.**

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoid valves when performing the solenoid valve test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test.**

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the conditions listed below do not exist. Repair or replace as necessary.

P2714 Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P2714 or P2715 Control Valve Body Assembly

2-6 clutch regulator valve stuck/sticking, debris, binding, damaged valve, or scored bore.

P2714 Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged.

P2714 Torque Converter (w/fluid pump) Housing Assembly

Fluid pump housing/gear damaged/scored.

P2714 Trans case and 1-2-3-4 clutch backing plate retainer ring

1-2-3-4 clutch backing plate retaining ring not seated/oriented correctly at trans case groove.

P2714 or P2715 Transmission case, 2-6 clutch piston, spring retaining ring, reaction sun gear

- 2-6 clutch return spring retaining ring not seated in groove
- 2-6 clutch piston assembly - seal damaged or leaking
- 2-6 clutch plates worn or damaged
- 2-6 clutch plates will not slide over the reaction sun gear shell freely

P2714 or P2715 Q8 Control Solenoid Valve Assembly

- Pressure Control Solenoid Valve 4 Stuck ON/OFF.

- Control signal fluid supply leak - valve body filter plate assembly cracked or damaged gasket seal.
- O-ring seals leaking.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P2719-P2721

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2719

Pressure Control Solenoid Valve 4 Performance

DTC P2720

Pressure Control Solenoid Valve 4 Control Circuit Low Voltage

DTC P2721

Pressure Control Solenoid Valve 4 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid valve 4 is part of the control solenoid valve assembly which has no serviceable components. The normally low pressure control solenoid valve 4 regulates and directs oil pressure to the 2-6 clutch regulator valve. Increasing pressure control solenoid valve 4 pressure increases pressure to the 2-6 clutch. The transmission control module (TCM) varies current to the pressure control solenoid valve 4 by controlling the amount of time the low side driver is ON and OFF. Increasing the ON time increases current to the pressure control solenoid valve 4. Increasing current to pressure control solenoid valve 4 increases oil pressure by closing off the solenoid valve exhaust port. Decreasing the current to the pressure control solenoid valve 4 decreases oil pressure by opening the exhaust port. Pressure control solenoid valve 4 power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when above conditions are met.

Conditions for Setting the DTC

P2719

TCM detects an internal electrical performance malfunction on the clutch pressure solenoid valve 4 control circuit where the measured clutch pressure control solenoid valve 4 current does not equal the commanded clutch pressure control solenoid valve 4 current for 5 s.

P2720

TCM detects a short to ground on the clutch pressure control solenoid valve 4 control circuit for 1 s.

P2721

TCM detects an open or short to voltage on the clutch pressure control solenoid valve 4 control circuit for 1 s.

Action Taken When the DTC Sets

P2719

- P2719 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 2-6 clutch.

P2720

- P2720 is a Type A DTC.
- TCM limits the transmission to 2nd gear and reverse.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits neutral idle.
- TCM inhibits auto grade braking.
- TCM inhibits Tap Up/Tap Down function.
- TCM inhibits manual up, manual down shifts with the shift selector.
- TCM commands 2nd gear if the transmission is in a forward gear and the output speed is less than 700 RPM, or neutral if the output speed is 700 RPM or greater.

P2721

- P2721 is a Type A DTC.

- TCM limits the transmission to 3rd gear and reverse.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits neutral idle.
- TCM inhibits Tap Up/Tap Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

- P2719 is a Type C DTC.
- P2720 and P2721 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature.
2. Operate the vehicle in drive range. Allow the transmission to shift through all forward gear ranges.
3. Ignition ON.
4. Verify the scan tool parameters listed below do not display Malfunction:

- Pressure Control Solenoid Valve 4 Performance Test Status
- Pressure Control Solenoid Valve 4 Control Circuit Low Voltage Test Status
- Pressure Control Solenoid Valve 4 Control Circuit High Voltage Test Status

- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.

- **If contaminated**

Repair as necessary.

- **If not contaminated**

3. Verify the resistance is within the specified range for each solenoid valve listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.

- **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
 5. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
 6. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 2 Performance Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P2723 OR P2724

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the **Circuit/System Verification and Circuit/System Testing** to identify the cause.

DTC P2723

Pressure Control Solenoid Valve 5 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P2724

Pressure Control Solenoid Valve 5 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Pressure control solenoid valve 5 is part of the control solenoid valve assembly, which has no serviceable components. The pressure control solenoid valve 5 regulates transmission fluid pressure to the 1-2-3-4 regulator valve which controls pressure to the 1-2-3-4 clutch. The transmission control module (TCM) calculates gear ratio based on the speed signals from the input shaft speed sensor and the output shaft speed sensor. The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 9-32 V.
- Throttle position signal is valid.
- Engine speed is 400-7,500 RPM for 5 s.
- High side driver is enabled.
- Transmission fluid temperature is -6.6°C (20°F) or greater.
- Transmission output speed is 100 RPM or greater or the throttle position is 0.5% or greater.
- DTC runs continuously when above conditions are met.

Conditions for Setting the DTC

P2723

TCM detects an incorrect on-coming clutch gear ratio, or shift flare when the 1-2-3-4 clutch is commanded ON. This condition must occur 3 times.

P2724

TCM detects an incorrect off-going clutch gear ratio, or shift tie-up when the 1-2-3-4 clutch is commanded OFF. This condition must occur 3 times.

Action Taken When the DTC Sets

- P2723 and P2724 are Type A DTCs.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Tap Down.
- TCM inhibits Manual Up/Manual Down with the gear selector.
- Torque management is enabled.

- TCM inhibits powertrain braking.
- TCM inhibits neutral idle.
- TCM inhibits auto grade braking.
- TCM limits the transmission to reverse and 5th range - P2723 only.
- TCM limits the transmission to reverse and 3rd range - P2724 only.

Conditions for Clearing the DIC/DTC

P2723 and P2724 are Type A DTCs.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This will allow you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Drive Range, First Gear (Gen 2/Hybrid)**
- **Drive Range, Second Gear (Gen 2/Hybrid)**
- **Drive Range, Third Gear (Gen 2/Hybrid)**
- **Drive Range - Fourth Gear (Gen 2/Hybrid)**
- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to **Parking Brake and Drive Wheels Warning** .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
 - **If the transmission fluid level and condition is not correct**

Repair as necessary.
 - **If the transmission fluid level and condition is correct**
3. Ignition ON, clear the TCM DTCs with a scan tool.
4. Verify DTC P2723 or P2724 does not set while performing a road test. Refer to **Road Test**.
 - **If DTC P2723 or P2724 sets**

Refer to Circuit/System Testing.
 - **If DTC P2723 or P2724 does not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Engine idling at the normal operating temperature.

2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check (Non Hybrid)**, **Line Pressure Check (Hybrid)**, and **Solenoid Valve Pressure (Gen 1)** , **Solenoid Valve Pressure (Gen 2)** .

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low**.

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoid valves when performing the solenoid valve test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P2723 or P2724 - Control Valve Body Assembly

1-2-3-4 clutch regulator valve stuck/sticking - debris, binding, damaged valve, or scored bore.

P2723 - Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged.

P2723 - Torque Converter (w/Fluid Pump) Housing Assembly

- Fluid pump housing/gear damaged/scored.
- Fluid pump or torque converter overstressed due to high temperatures.

P2723 - Trans Case and 1-2-3-4 Clutch Backing Plate Retaining Ring

1-2-3-4 clutch backing plate retaining ring not seated/oriented, causing clutch pack/piston over travel.

P2723 - Output Sun Gear Assembly

Housing/hub weld cracked/leaking.

P2723 - Lo and Reverse and 1-2-3-4 Clutch Housing Assembly

1-2-3-4 clutch piston cracked/damaged/leaking.

P2723 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P2723 or P2724 - Q8 Control Solenoid Valve Assembly

- Q27E Pressure Control Solenoid Valve 5 Stuck ON/OFF.
- O-ring seals leaking.
- Valve body filter plate assembly cracked, blocked, or damage gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

DTC P2728-P2730

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2728

Pressure Control Solenoid Valve 5 Performance

DTC P2729

Pressure Control Solenoid Valve 5 Control Circuit Low Voltage

DTC P2730

Pressure Control Solenoid Valve 5 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid valve 5 is part of the control solenoid valve assembly which has no serviceable components. The normally high pressure control solenoid valve 5 regulates and directs oil pressure to the 1-2-3-4 clutch regulator valve. Increasing pressure control solenoid valve 5 pressure increases pressure to the 1-2-3-4 clutch. The transmission control module (TCM) varies the current to the pressure control solenoid valve 5 by controlling the amount of time the low side driver is ON and OFF. Increasing the current to pressure control solenoid valve 5 decreases pressure control solenoid valve 5 oil pressure by opening the solenoid valve exhaust

port. Decreasing the current to pressure control solenoid valve 5 increases pressure control solenoid valve 5 oil pressure by closing OFF the solenoid valve exhaust port. Pressure control solenoid valve 5 power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when above conditions are met.

Conditions for Setting the DTC

P2728

TCM detects an internal electrical performance malfunction of the pressure control solenoid valve 5 control circuit where the measured clutch pressure control solenoid valve 5 current does not equal the commanded clutch pressure control solenoid valve 5 current for 5 s.

P2729

TCM detects a short to ground on the clutch pressure control solenoid valve 5 control circuit for 1 s.

P2730

TCM detects an open or short to voltage on the clutch pressure control solenoid valve 5 control circuit for 1 s.

Action Taken When the DTC Sets

P2728

- P2728 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 1-2-3-4 clutch.

P2729

- P2729 is a Type A DTC.
- TCM commands the high side driver OFF.
- TCM forces the torque converter clutch OFF.
- TCM limits the transmission to 4th gear and reverse.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Tap Down.
- TCM inhibits manual up, manual down with the shift selector.

- TCM inhibits neutral idle.
- TCM inhibits powertrain braking.

P2730

- P2730 is a Type A DTC.
- TCM limits the transmission to reverse and 4th gear.
- TCM inhibits powertrain braking.
- TCM inhibits neutral idle.
- TCM inhibits Tap Up/Tap Down function.
- TCM inhibits manual shifting of forward gears.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.

Conditions for Clearing the DTC

- P2728 is a Type C DTC.
- P2729 and P2730 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature.
2. Operate the vehicle in drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 5 Performance Test Status
 - Pressure Control Solenoid Valve 5 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 5 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.

- **If contaminated**

Repair as necessary.

- **If not contaminated**

3. Verify the resistance is within the specified range for each solenoid valve listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.

- **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
 5. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
 6. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 5 Performance Test Status
 - Pressure Control Solenoid Valve 5 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 5 Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming and setup

DTC P2762, P2763, OR P2764

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2762

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Performance

DTC P2763

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit High Voltage

DTC P2764

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit Low Voltage

Circuit/System Description

The torque converter clutch (TCC) pressure control solenoid valve is part of the control solenoid valve assembly which has no serviceable components. The normally low TCC pressure control solenoid valve regulates oil pressure to the TCC regulator valve and TCC control valve. Increasing TCC pressure control solenoid valve oil pressure increases oil pressure to the torque converter to apply the clutch. The transmission control module (TCM) varies the current to the TCC pressure control solenoid valve by controlling the amount of time the low side driver is ON and OFF. Increasing current to the TCC pressure control solenoid valve increases oil pressure by closing OFF the solenoid valve exhaust port. Decreasing current to the TCC pressure control solenoid valve decreases oil pressure by opening up the solenoid valve exhaust port. TCC pressure control solenoid valve power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

P2762

- P2762 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- DTC runs continuously when above conditions are met.

P2763 or P2764

- P0658 or P0659 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 9-32 V.
- High side driver is enabled.
- DTC runs continuously when above conditions are met.

Conditions for Setting the DTC

P2762

TCM detects an internal electrical performance malfunction on the TCC pressure control solenoid valve control

circuit where the measured TCC pressure control solenoid valve current does not equal the commanded TCC pressure control solenoid valve current for 5 s.

P2763

TCM detects an open/high resistance or short to voltage on the TCC pressure control solenoid valve control circuit for 5 s.

P2764

TCM detects a short to ground on the TCC pressure control solenoid valve control circuit for 5 s.

Action Taken When the DTC Sets

P2762

P2762 is a Type C DTC.

P2763

- P2763 is a Type B DTC.
- TCM inhibits 6th gear.
- TCM forces TCC OFF.
- TCM changes to a Hot Mode shift pattern.

P2764

- P2764 is a Type A DTC.
- TCM inhibits TCC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM defaults the transmission to 4th gear and reverse.
- TCM inhibits neutral idle.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM forces the high side driver OFF.
- TCM enables torque management.
- TCM inhibits auto grade braking.
- TCM inhibits powertrain braking.

Conditions for Clearing the DIC/DTC

- P2762 is a Type C DTC.
- P2763 is a Type B DTC.

- P2764 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- COMPONENT CONNECTOR END VIEWS - INDEX
- INLINE HARNESS CONNECTOR END VIEWS - INDEX

Description and Operation

- Electronic Component Description
- Transmission Component and System Description
- Transmission General Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-48616-10 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in 2nd gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature.
2. Operate the vehicle in drive range and ensure TCC is commanded ON for 1 min.
3. Verify the scan tool parameters listed below do not display Malfunction:

- TCC Pressure Control Solenoid Valve Performance Test Status
- TCC Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
- TCC Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.

- **If not contaminated**

3. Verify the resistance is within the specified range for each solenoid valve listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-48616-10** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - TCC Pressure Control Solenoid Valve Performance Test Status
 - TCC Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status

- TCC Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Transmission Adaptive Values Learn** following all transmission repairs
- **Control Module References** - for Control Solenoid Valve Assembly replacement, programming and setup

SYMPTOMS - AUTOMATIC TRANSMISSION

NOTE: Use the symptom tables only if the following conditions are met:

- Refer to **Diagnostic Starting Point - Vehicle** .
- There are no DTCs set.
- The control modules can communicate via the serial data link.
- Review the system operation in order to familiarize yourself with the system functions. Refer to **Transmission General Description** , and **Transmission Component and System Description** .

Visual/Physical Inspection

Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Fluid Diagnosis
 - **Transmission Fluid Level and Condition Check**
 - **Fluid Pressure High or Low**
 - **Automatic Transmission Fluid Leaks**

- **Fluid Leak Diagnosis (Non Hybrid), Fluid Leak Diagnosis (Hybrid)**
- Noise and Vibration Diagnosis
 - **Whine/Growl Noise**
 - **Noise and Vibration Analysis**
 - **Torque Converter Diagnosis**
 - **Non-Shifting Clutch Function Verification Description** for bump
- Range Performance Diagnosis
 - **No Park**
 - **No Drive in All Ranges**
 - **No Reverse Gear**
- Shift Quality Feel Diagnosis
 - **Harsh Garage Shift**
 - **Harsh or Late First, Second, Third, and Fourth Shift**
 - **Harsh First and Reverse Shift**
 - **Harsh or Late Second and Sixth Shift**
 - **Harsh or Late Third, Fifth, and Reverse Shift**
 - **Harsh Fourth, Fifth, and Sixth Shift**
 - **Non-Shifting Clutch Function Verification Description** for bump
- Shift Pattern
 - **No First and Reverse Gears**
 - **No First, Second, Third, and Fourth Gear**
 - **No Second and Sixth Gear**
 - **No Fourth, Fifth, and Sixth Gear**
 - **No Third, Fifth, and Reverse Gear**
- Torque Converter Diagnosis
 - **Torque Converter Diagnosis**
 - **No Torque Converter Clutch Apply**
 - **No Torque Converter Clutch Release**
- Symptom Not Found or No Symptom Detected
 - **Transmission Fluid Level and Condition Check**
 - **Road Test**
 - **Line Pressure Check (Non Hybrid), Line Pressure Check (Hybrid)**
 - **Non-Shifting Clutch Function Verification Description** for bump

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY INSPECTION

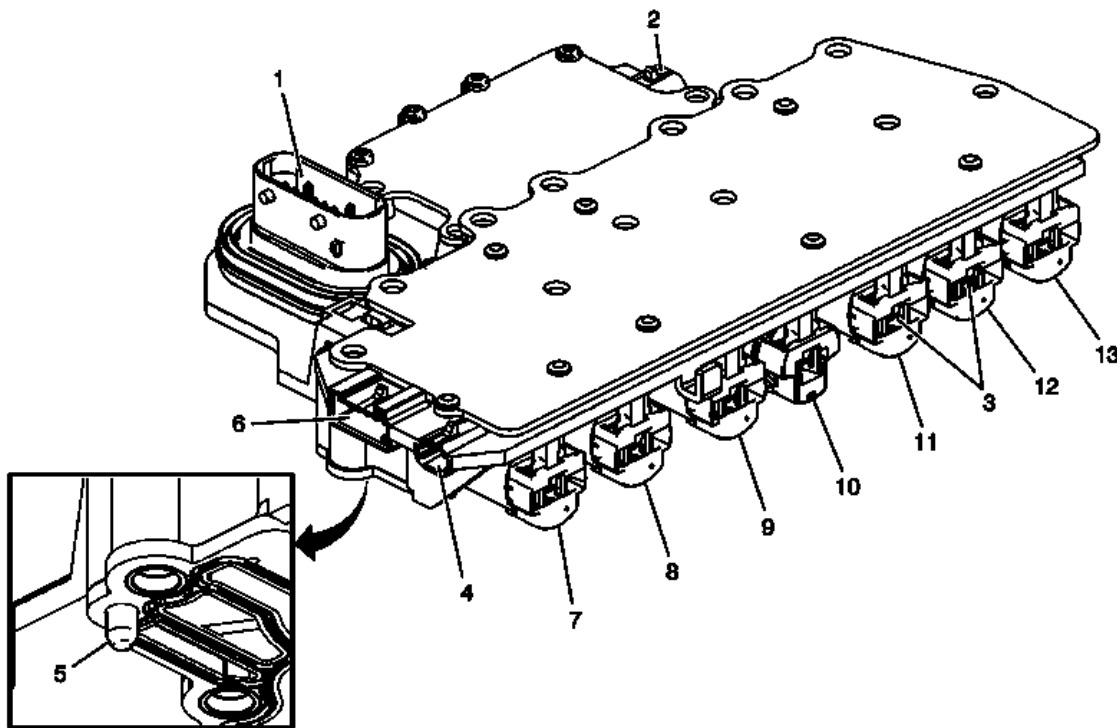


Fig. 1: View Of Control Solenoid Valve & Transmission Control Module Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Verify the conditions listed below do not exist. Carefully inspect the control solenoid valve assembly connectors and pins (1, 2, 4, 6) for the condition. Repair or replace as necessary.
 - Damage
 - Bent pins
 - Debris
 - Broken retaining tab
 - Contamination
2. Verify there is no metallic debris inside the connectors near the terminal pins. Clean as necessary.
3. Verify the control solenoid valve assembly solenoid leads (3) do not have contamination or metallic debris. Clean as necessary.
4. Verify the resistance between the leads of each solenoid valve is within the range in the table below, with the solenoid valves at room temperature. If the resistance of any solenoid valve is not within range, replace the Control Valve Body Assembly.
5. Inspect the 2 control solenoid valve assembly filter plate retaining tabs (5) for cracks and ensure proper tension when filter plate is attached.

NOTE: **The connector on the TCC pressure control solenoid valve (8) will be either clear/transparent or yellow. The clear/transparent connector will have a color contrast when compared to the connectors on pressure control solenoid valve 2 (11) and pressure control solenoid valve 4 (12).**

Solenoid Resistance

Solenoid Name	Illustration Number	Expected Resistance ohms
Pressure Control Solenoid Valve 3	7	4.55-5.75
Pressure Control Solenoid Valve 5	8	4.55-5.75
TCC Pressure Control Solenoid Valve	9	3.42-4.18 Clear/transparent Connector 4.55-5.75 Yellow Connector
Shift Solenoid Valve 1	10	16.2-19.8
Pressure Control Solenoid Valve 2	11	4.55-5.75
Pressure Control Solenoid Valve 4	12	4.55-5.75
Line Pressure Control Solenoid Valve	13	4.55-5.75

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY INPUT SHAFT SPEED/OUTPUT SHAFT SPEED INPUT TEST

Special Tools

- **EL 35616** GM-Approved Terminal Test Kit
- **EL 38522** Variable Signal Generator

For equivalent regional tools, refer to **Special Tools** .

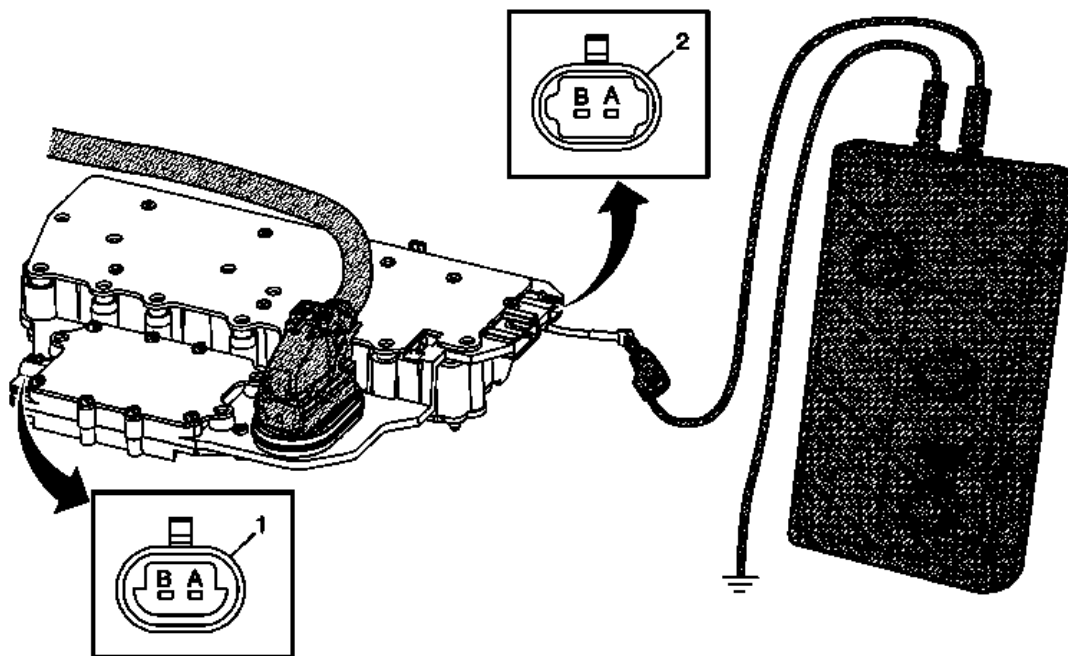


Fig. 2: View Of Special Tool & Control Solenoid Valve and Transmission Control Module Assembly
Courtesy of GENERAL MOTORS COMPANY

The purpose of this test is to provide a simulated input/output speed sensor (ISS/OSS) signal to the control solenoid valve assembly ISS/OSS input circuits.

Transmission Input Speed Sensor

1. Ignition OFF, disconnect the ISS wiring harness connector X3 (1) from the control solenoid valve assembly.
2. Ignition ON, test for 11-14 volts at terminal B.
 - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Ignition OFF, using the **EL 35616** terminal test kit , connect the **EL 38522** variable signal generator red lead to the ISS signal circuit terminal A on the TCM.
4. Connect the black lead from the **EL 38522** variable signal generator to ground.
5. Set the **EL 38522** variable signal generator to 5 volts, the frequency to 300 Hz, and the percent duty cycle to 50 or the normal position.
6. Ignition ON, verify with a scan tool the Transmission ISS parameter is between 495-505 RPM.
 - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .

Transmission Output Speed Sensor

1. Ignition OFF, disconnect the OSS wiring harness connector X4 (2) from the control solenoid valve

assembly.

2. Ignition ON, test for 11-14 volts at terminal B.
 - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Ignition OFF, using the **EL 35616** terminal test kit , connect the **EL 38522** variable signal generator red lead to the OSS signal circuit terminal A on the TCM.
4. Connect the black lead from the **EL 38522** variable signal generator to ground.
5. Set the **EL 38522** variable signal generator to 5 volts, the frequency to 300 Hz, and the percent duty cycle to 50 or the normal position.
6. Ignition ON, verify with a scan tool the Transmission OSS parameter is between 745-825 RPM.
 - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY SOLENOID PERFORMANCE TEST

Special Tools

DT-48616 Solenoid Assembly Test Kit & Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

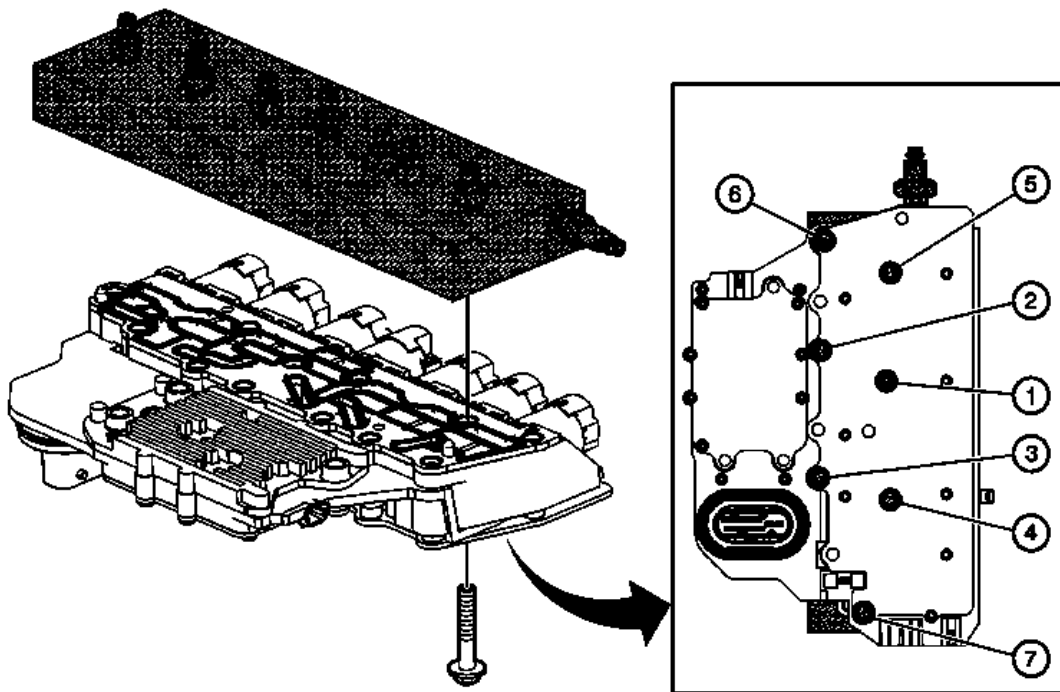


Fig. 3: Identifying Control Solenoid (W/Body & TCM) Valve Assembly Test Points
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Air inlet may be installed at either end of the DT-48616-1 test plate.**

The purpose of this procedure is to test the functionality of the control solenoid valve assembly solenoids for a gross stuck open or stuck closed condition. The **DT-48616-1** test plate is bolted to the control solenoid valve assembly on the valve body mounting surface. Pressurized air is passed into the aluminum test block, through the control solenoid valve assembly solenoid passage and back to a pressure gauge on the test block. The pressure gauge indicates open if air pressure is passed through the solenoid, or closed if the solenoid is unable to pass air through. A scan tool is used to command the solenoids ON and OFF. While watching the pressure gauge, one can determine the valve functionality.

NOTE: **The scan tool output control will not work on Gen 1 transmissions, thus the Q8 Control Solenoid Valve Assembly performance test cannot be performed on these models. Gen 2 and later transmissions do not contain transmission fluid pressure switches. As a result, Gen 2 and later transmissions cannot have a valid Transmission Fluid Pressure Switch DTC. Steps 1 and 2 in the test procedure will determine if you are working with a Gen 1 or Gen 2 and later transmission.**

1. Ignition ON, use a scan tool to check for Specific DTC P0842.
2. Verify that DTC P0842 shows Invalid or a blank screen.
 - **If scan tool does not show Invalid or a blank form**
 1. Do not attempt to complete the performance test as it will not work on a Gen 1 Q8 Control Solenoid Valve Assembly.
 2. Verify the vehicle model year, engine, and options to make certain the correct diagnostic is selected.
 - **If scan tool shows Invalid or a blank form**
3. Remove the Q8 Control Solenoid Valve Assembly and filter plate from the transmission. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .

CAUTION: Refer to **Fastener Caution** .

NOTE: **Drain the TCM of excess transmission fluid before attaching to test block and use caution when attaching air to test block air inlet.**

4. Bolt the **DT-48616-1** test plate to the filter plate, and Q8 Control Solenoid Valve Assembly. Use the bolts and washers supplied with the tool to attach the test block. Tighten the bolts to 5 N.m (44 lb in) using a center out alternating torque sequence.
5. Install the pressure gauge to the affected solenoid air port. Reference the Control Solenoid Valve Assembly Solenoid Performance Test Plate to Component Identification for test plate port identification.

NOTE: **If air pressure greater than 345 kpa (50 psi) is applied, an accurate test of the shift solenoid cannot be performed.**

6. Regulate the shop air pressure to 310-345 kpa (45-50 psi) and connect the line to the **DT-48616-1** test plate air inlet port.
7. Connect the **DT-48616-10** harness to the vehicle harness and the Q8 Control Solenoid Valve Assembly.

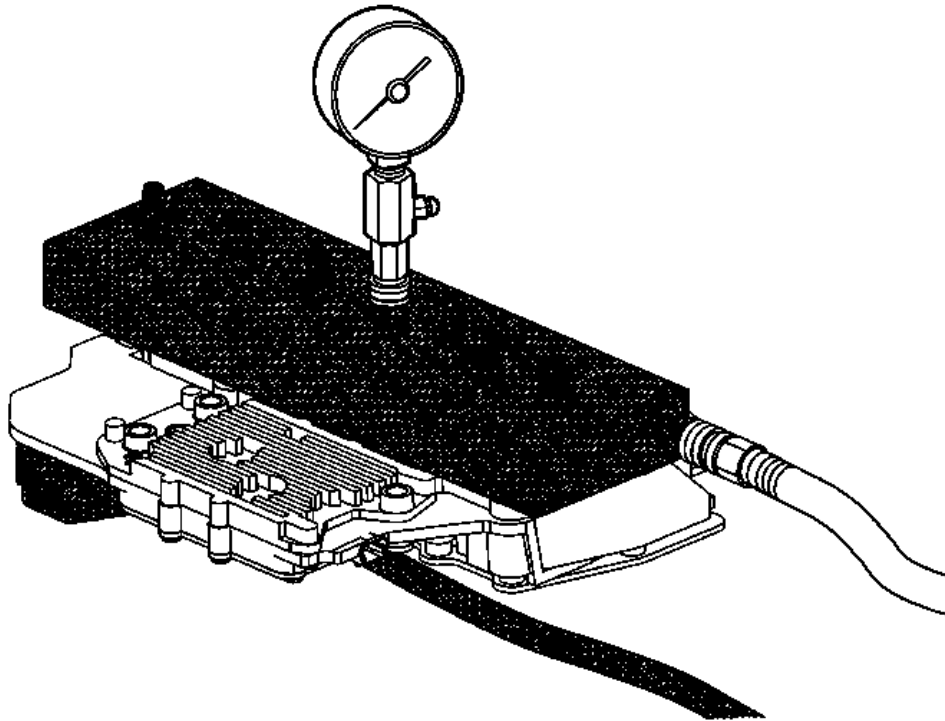


Fig. 4: Valve Pressure Test
Courtesy of GENERAL MOTORS COMPANY

NOTE: The TCM limits the time the solenoids are commanded on to prevent overheating of the solenoids. Once the time limit is reached, the TCM prevents the test from being continued for 5 min. The ignition must remain ON during the 5 min countdown period.

8. Ignition ON.

NOTE:

- Release the air pressure in the gauge between pressurization tests.
- If the solenoid valve is stuck, no pressure change will occur.

9. Verify the pressure gauge changes when commanding the appropriate solenoid ON and OFF with a scan tool. Repeat test as necessary.
 - If the pressure gauge does not change

Replace the Q8 Control Solenoid Valve Assembly.

- If the pressure gauge changes

10. Solenoids are not grossly stuck.

Control Solenoid Valve Assembly Solenoid Performance Test Plate to Component Identification

Component	Port On Test Plate	Commanded State	
		ON	OFF
Pressure Control Solenoid Valve 2, 35R	GEN 2 - C	Full pressure to gauge	No pressure to gauge
Pressure Control Solenoid Valve 3, R1/456	G	Full pressure to gauge	No pressure to gauge
Pressure Control Solenoid Valve 4, 2-6	B	Full pressure to gauge	No pressure to gauge
Pressure Control Solenoid Valve 5, 1234	GEN 2 - F	Full pressure to gauge	No pressure to gauge
Shift Solenoid Valve	D	Full pressure to gauge	Below full pressure to gauge
Line Pressure Control Solenoid Valve	A	Command to highest setting, full pressure to gauge	Command to lowest setting, below full pressure to gauge
TCC Pressure Control Solenoid Valve	E	Full pressure to gauge	No pressure to gauge
NOTE: With the key on engine off, the TCM will normally cycle some of the transmission solenoids On and Off to facilitate keeping the ports and solenoids clean and free of debris. This dither function is a normal activity and will cause the valves to cycle open and closed quickly when the TCM is powered up. This can cause the psi gauge to flicker high and low as the valves open and close. This may cause some air to exit the ports where the psi gauge is not connected as those solenoids cycle on and off.			

TRANSMISSION ADAPTIVE VALUES LEARN

Transmission Adaptive Values Learn is a procedure for 6 speed automatic transmissions in which a series of tests are run to allow the transmission control module (TCM) to learn individual clutch characteristics. Once the clutch data is learned, Transmission Adaptive Values Learn translates it into the adaptive data cells, which the TCM uses for clutch control during shifts. The scan tool provides initiation of the Transmission Adaptive Values Learn procedure. This procedure is to be used following transmission repair.

The Transmission Adaptive Values Learn procedure must be performed when one of the following repairs have been made to the vehicle. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, as well as transmission DTCs being set:

- Transmission internal service/overhaul
- Valve body repair or replacement
- Control solenoid valve assembly replacement
- TCM software/calibration update
- Any service in response to a shift quality concern

NOTE: Ensure the following conditions are met before performing the Transmission Adaptive Values Learn procedure:

- Drive wheels are blocked
- Parking brake is applied
- Service brake is applied
- Zero percent throttle and no external engine RPM control
- Transmission fluid temperature is between values listed below, if you attempt to run the test above or below these temperatures, the test will not start:
 - MY 2011 and prior 70-95°C (158-203°F)
 - MY 2012 Gen 1 70-95°C (158-203°F)
 - MY 2012 Gen 2 64-95°C (147-203°F)
 - MY 2013 Gen 1 70-95°C (158-203°F)
 - MY 2013 Gen 2 64-76°C (147-169°F)
 - MY 2014 and later 64-76°C (147-169°F)
- Transmission gear selector has been cycled from Park to Reverse 3 times in order to purge air from the reverse clutches.
- Transmission Adaptive Values Learn will abort if the transmission fluid temperature increases to the values listed below:
 - MY 2011 and prior 110°C (230°F)
 - MY 2012 Gen 1 110°C (230°F)
 - MY 2012 Gen 2 100°C (212°F)
 - MY 2013 Gen 1 110°C (230°F)
 - MY 2013 Gen 2 86°C (187°F)
 - MY 2014 and later 86°C (187°F)

NOTE: If at any time during the procedure, required conditions are not met, Transmission Adaptive Values Learn Adapts may abort and the process may need to be started again from the beginning. If this occurs, the transmission will be left in a neutral state until the controller is shut down, key OFF and remove the scan tool and wait for more than 30 seconds prior to re-try procedure. If the procedure repeatedly fails, a limit that engineering set is being exceeded and there is possibly a transmission hardware issue.

1. Use the scan tool to navigate to Transmission Adaptive Values Learn by selecting the following:
 1. Module Diagnostics
 2. Transmission Control Module
 3. Configurations/Reset Functions
 4. Transmission Adaptive Values Learn

NOTE: If at any time during the procedure, required conditions are not met, Transmission Adaptive Values Learn may abort and the process may need to be started again from the beginning.

2. Use the scan tool to perform the Transmission Adaptive Values Learn procedure. As the procedure is being performed, the scan tool data display will provide operator instructions. Follow the scan tool instructions, as required.
3. Once the procedure is complete, shut OFF the engine and power down the TCM. You will lose communication to the scan tool.

NOTE: When the Transmission Adaptive Values Learn procedure is completed, the transmission will remain in a neutral state until the controller shuts down. If after 1-2 minutes of sitting, with the key OFF and scan tool removed, the vehicle remains in a neutral state, disconnect the battery and wait 5-10 minutes and then hook the battery back up. Reverse and drive should return.

4. Restart the engine. This will complete the Transmission Adaptive Values Learn procedure.

Troubleshooting

If the Transmission Adaptive Values Learn will not run and the above stated conditions have been met, ensure the following:

NOTE: The generation of transmission can be determined by using a scan tool to check for Specific DTC P0842. If DTC does not show Invalid, the transmission is Gen 1. If DTC shows Invalid, transmission is Gen 2.

- Determine if transmission is Gen 1 or Gen 2.
- Verify vehicle model year.
- Verify transmission fluid temperature is between the temperatures listed above for the vehicle model year and generation of transmission.
- Brakes and brake switch are functioning properly
- No active DTCs
- Closed throttle and engine RPM increases above 1,500 RPM while at entrance of the test
- Park/Neutral position switch is properly adjusted and functioning
- Line pressure control is able to provide 1,000 kPa and is within specifications
- Vehicle is not moving or vibrating excessively
- Clutches are properly assembled

MANUAL MODE OR TAP UP/DOWN DIAGNOSIS

1. If any DTCs are set, diagnose those DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.

2. If the Manual Mode or Tap Up/Down does not function, refer to the Circuit/System Verification for **DTC P0815, P0816, or P0826**.

TRANSMISSION FLUID LEVEL AND CONDITION CHECK

This procedure checks both the transmission fluid level, as well as the condition of the fluid itself.

CAUTION: Use Dexron VI transmission fluid only. Failure to use the proper fluid may result in transmission internal damage.

NOTE: Ensure the transmission has enough fluid in it to safely start the vehicle without damaging the transmission. With the vehicle off and the transmission fluid temperature at approximately 20-25°C (68-77°F) there must be at least enough fluid to drain out of the fluid level hole. This will ensure that there is enough fluid in the sump to fill the components once the vehicle is started.

Non Dipstick Level Checking Procedure

1. Start the engine.
2. Depress the brake pedal and move the shift lever through each gear range, pausing for about 3 seconds in each range. Then move the shift lever back to PARK (P).
3. Allow the engine to idle 500-800 rpm for at least 3 minutes to allow any fluid foaming to dissipate and the fluid level to stabilize. Release the brake pedal.

NOTE: If the TFT reading is not at the required temperature, allow the vehicle to cool, or operate the vehicle until the appropriate TFT is reached. If the fluid temperature is below the specified range, perform the following procedure to raise the fluid temperature to the specification.

Drive the vehicle in second gear until the fluid temperature is at the specified temperature.

4. Keep the engine running and observe the transmission fluid temperature (TFT) using the Driver Information Center or a scan tool.

CAUTION: The transmission fluid level must be checked when the transmission fluid temperature (TFT) is at 85-95°C (185-203°F). If the TFT is not at this temperature, operate the vehicle or allow the fluid to cool as required. Setting the fluid level with a TFT outside this temperature will result in either an under or over-filled transmission. TFT 95°C under-filled, TFT 85°C over-filled. An under-filled transmission will cause premature component wear or damage. An over-filled transmission will cause fluid to discharge out the vent tube, fluid foaming, or pump cavitation.

5. Raise the vehicle on a hoist. The vehicle must be level, with the engine running and the shift lever in the PARK range.

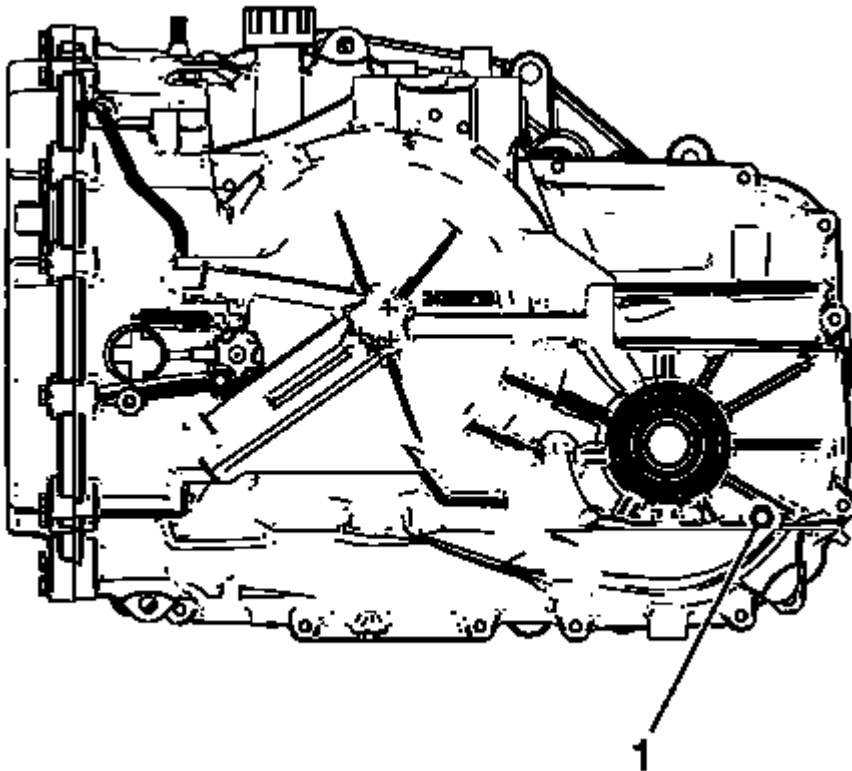


Fig. 5: View of Oil Level Plug

Courtesy of GENERAL MOTORS COMPANY

6. While the vehicle is idling, remove the oil level set plug. Allow any fluid to drain.

Oil Level Plug (1)

- If the fluid is flowing as a steady stream, wait until the fluid begins to drip.
 - If no fluid comes out, add fluid until fluid drips out.
7. Inspect the fluid color. The fluid should be red or dark brown.
 - If the fluid color is very dark or black and has a burnt odor, inspect the fluid for excessive metal particles or other debris. A small amount of "friction" material is a "normal" condition. If large pieces and/or metal particles are noted in the fluid, flush the oil cooler and cooler lines and overhaul the transmission. If there are no signs of transmission internal damage noted, replace the fluid, repair the oil cooler, and flush the cooler lines.
 - Fluid that is cloudy or milky or appears to be contaminated with water indicates engine coolant or water contamination. Refer to **Engine Coolant/Water in Transmission**.

8. Inspect for external leaks. Refer to **Fluid Leak Diagnosis (Non Hybrid)**, **Fluid Leak Diagnosis (Hybrid)**.
9. If the fluid was changed, reset the transmission oil life monitor if applicable.

Dipstick Level Checking Procedure (If equipped)

1. Park the vehicle on a level surface, apply the parking brake and place the shift lever in PARK (P). Start the engine.
2. Depress the brake pedal and move the shift lever through each gear range, pausing for about 3 seconds in each range. Then move the shift lever back to PARK (P).
3. Allow the engine to idle 500-800 rpm for at least 3 minutes to allow any fluid foaming to dissipate and the fluid level to stabilize. Release the brake pedal.
4. Keep the engine running and observe the transmission fluid temperature (TFT) using the Driver Information Center or a scan tool.

CAUTION: The transmission fluid level must be checked when the transmission fluid temperature (TFT) is at 85-95°C (185-203°F). If the TFT is not at this temperature, operate the vehicle or allow the fluid to cool as required. Setting the fluid level with a TFT outside this temperature will result in either an under or over-filled transmission. TFT 95°C under-filled, TFT 85°C over-filled. An under-filled transmission will cause premature component wear or damage. An over-filled transmission will cause fluid to discharge out the vent tube, fluid foaming, or pump cavitation.

NOTE:

- If the TFT reading is not at the required temperature, allow the vehicle to cool, or operate the vehicle until the appropriate TFT is reached. If the fluid temperature is below the specified range, perform the following procedure to raise the fluid temperature to the specification.
- Check the transmission fluid level when the TFT is at between 85-95°C (185-203°F). The fluid level rises as fluid temperature increases, so it is important to ensure the transmission fluid temperature is at the specified temperature.

Drive the vehicle in second gear until the fluid temperature is at the specified temperature.

5. The vehicle must be level, with the engine running and the shift lever in the PARK range.
6. Remove the dipstick and wipe it with a clean rag or paper towel.
7. Inspect the fluid color. The fluid should be red or dark brown.
 - If the fluid color is very dark or black and has a burnt odor, inspect the fluid for excessive metal particles or other debris. A small amount of "friction" material is a "normal" condition. If large pieces and/or metal particles are noted in the fluid, flush the oil cooler and cooler lines and

overhaul the transmission. If there are no signs of transmission internal damage noted, replace the fluid, repair the oil cooler, and flush the cooler lines.

- Fluid that is cloudy or milky or appears to be contaminated with water indicates engine coolant or water contamination. Refer to **Engine Coolant/Water in Transmission**.

8. Install the dipstick. Wait three seconds and then remove it again.

NOTE: Always check the fluid level at least twice. Consistent readings are important to maintaining proper fluid level. If inconsistent readings are noted, inspect the transmission vent cap to ensure it is clean and unclogged.

NOTE: It is not necessary to get the fluid level all the way up to the MAX mark. Anywhere within the crosshatch band is acceptable.

9. Check both sides of the dipstick and read the lower level.

10. Install and remove the dipstick again to verify the reading.

NOTE: Do not add more than one half pint (0.25L) at a time without rechecking the level. Once the oil is on the dipstick bullet, it will not take much more fluid to raise the fluid level into the crosshatch band. Do not overfill. Also, if the fluid level is low, inspect the transmission for leaks. Refer to **Fluid Leak Diagnosis (Non Hybrid)**, **Fluid Leak Diagnosis (Hybrid)**.

11. If the fluid level is not within the crosshatch band, and the transmission temperature is at 90°C (194°F), add or drain fluid as necessary to bring the level into the crosshatch band. If the fluid level is low, add only enough fluid to bring the level into the crosshatch band.

12. If the fluid level is in the acceptable range, install the dipstick.

13. If the fluid was changed, reset the transmission oil life monitor if applicable.

Fluid Condition Inspection

- Inspect the fluid color. The fluid should be red in color. The fluid may also turn brown from normal use, and does not always indicate contamination.

NOTE: Fluid that is very dark or black and has a burnt odor usually indicates contamination or overheating.

- If the fluid color is very dark or black and has a burnt odor, inspect the fluid for excessive metal particles or other debris which may indicate transmission damage. Refer to **Road Test** to verify transmission operation. Change the transmission fluid if no other conditions are found.
- Fluid that is cloudy or milky or appears to be contaminated with water indicates engine coolant or water contamination. Refer to **Engine Coolant/Water in Transmission**.

LINE PRESSURE CHECK (NON HYBRID)

Special Tools

GE-21867-A Oil Pressure Gauge Kit

For equivalent regional tools, refer to Special Tools .

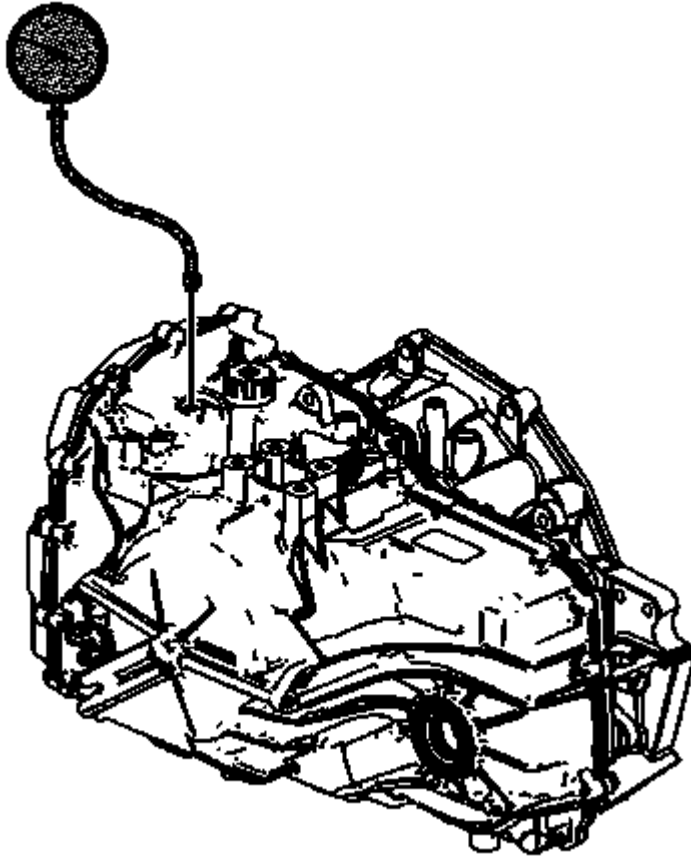


Fig. 6: Illustrating Line Pressure Checking
Courtesy of GENERAL MOTORS COMPANY

WARNING: Keep the brakes applied at all times in order to prevent unexpected vehicle motion. Personal injury may result if the vehicle moves unexpectedly.

1. Install a scan tool.
2. Start the engine.
3. Inspect the transmission for the proper fluid level. Refer to Transmission Fluid Level and Condition Check.
4. Use the scan tool to inspect for any active or stored diagnostic trouble codes.
5. Inspect the manual linkage at the transmission for proper function.
6. Turn the engine OFF.

7. Remove the line pressure test hole plug.
8. Install the **GE-21867-A** pressure gauge.
9. Access the Scan Tool Transmission Output Controls for the Line PC Solenoid.
10. Start the engine.

NOTE:

- In order to achieve accurate line pressure readings, the following procedure must be performed at least 3 times in order to gather uniform pressure readings.
 - The scan tool is only able to control the line PC solenoid in PARK and NEUTRAL with engine speeds below 1500 RPM. This protects the clutches from extreme high or low line pressures.
11. Use the scan tool to increase and decrease the Line PC Solenoid in increments of approximately 100 KPa (15 psi). The scan tool commands the increment values automatically.
 12. Allow the pressure to stabilize between increments.
 13. Compare the pressure readings on the scan tool to those indicated on the **GE-21867-A** pressure gauge. Refer to **Solenoid Valve Pressure (Gen 1)** , **Solenoid Valve Pressure (Gen 2)** .
 14. If the pressure readings vary greatly, refer to **Fluid Pressure High or Low**.
 15. Turn the engine OFF.
 16. Remove the **GE-21867-A** pressure gauge.

CAUTION: Refer to Fastener Caution .

17. Install the line pressure test hole plug. Tighten the pressure test hole plug to 12 N.m (106 lb in).

LINE PRESSURE CHECK (HYBRID)

Special Tools

GE-21867-A Oil Pressure Gauge Kit

For equivalent regional tools, refer to **Special Tools** .

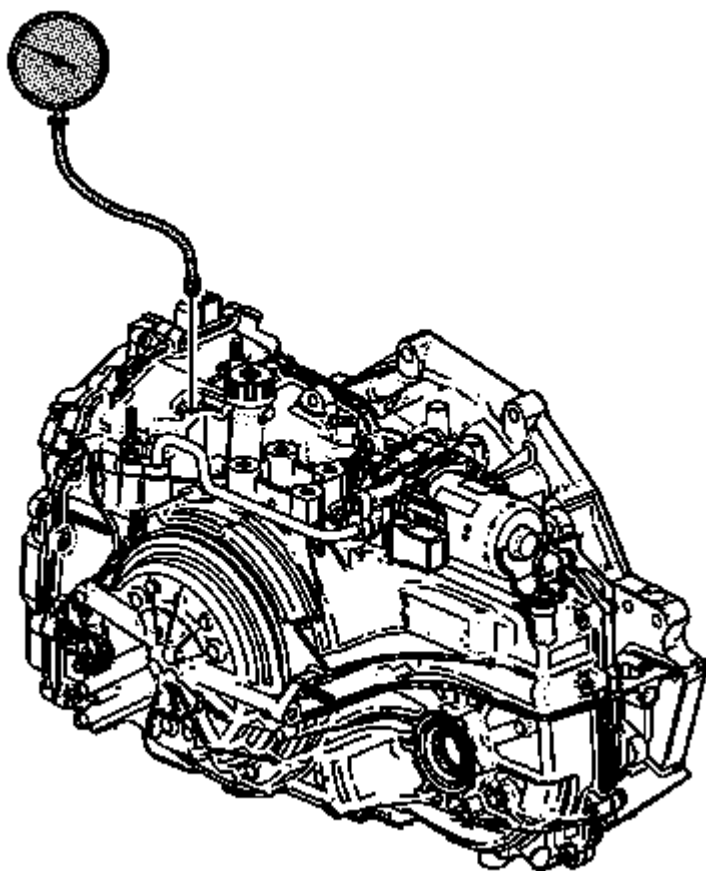


Fig. 7: Checking Line Pressure

Courtesy of GENERAL MOTORS COMPANY

1. Install the GM MDI communication tool.
2. Start the engine.
3. Inspect the transmission for the proper fluid level. Refer to **Transmission Fluid Level and Condition Check**.
4. Use the communication tool to inspect for any active or stored diagnostic trouble codes. If there are any DTC's refer to the DTC table.
5. Inspect the manual linkage at the transmission for proper function.
6. Turn the engine OFF.

CAUTION: When the transmission is at operating temperatures, take necessary precautions when removing the auxiliary pump pressure test hole plug, to avoid being burned by the catalytic converter.

7. Remove ECM and set aside but do not disconnect electrical harness connectors.
8. Remove the auxiliary pump pressure test hole plug.
9. Install the **GE-21867-A** pressure gauge.

10. Access the Hybrid Powertrain Control Module for the Auxiliary Transmission Fluid Pump Relay.
11. Turn Key On, Engine Off Position.

NOTE: **The Auxiliary Transmission Fluid Pump does not contain circuitry to vary its speed. Only on and off states are available.**

12. Use the communication tool to turn On the Auxiliary Transmission Fluid Pump Relay.
13. Allow the pressure to stabilize.
14. Your pressure reading on the **GE-21867-A** pressure gauge should be at 35-40 psi.
15. If the pressure readings vary greatly, refer to auxiliary **Fluid Pressure High or Low**.
16. Use the communication tool to turn Off the Auxiliary Transmission Fluid Pump Relay.
17. Repeat steps 12-16 two to three times to gather accuracy readings.
18. Turn the key Off.
19. Disconnect **GE-21867-A** pressure gauge.
20. Disconnect the GM MDI communication tool.

CAUTION: Refer to Fastener Caution .

21. Install the auxiliary pump pressure test hole plug. Tighten the pressure test hole plug to 11 N.m (97 lb in).
22. Reattach the ECM.

ROAD TEST

NOTE: **The Road Test Procedure should be performed only as part of the Symptom Diagnosis.**

Perform the road test in conjunction with the symptom diagnosis. Refer to **Symptoms - Automatic Transmission**.

The following test provides a method of evaluating the condition of the automatic transmission. The test is structured so that most driving conditions would be achieved. The test is divided into the following parts:

- Electrical Function Check
- Upshift Control and Torque Converter Clutch (TCC) Apply
- Part Throttle Step-In Downshifts
- Manual Downshifts
- Coasting Downshifts
- Manual Gear Range Selection
 - REVERSE
 - Driver Shift Control

NOTE: **Complete the test in the sequence given. Incomplete testing cannot guarantee an accurate evaluation.**

Before the road test, ensure the following:

- The engine is performing properly.
- Transmission fluid level is correct. Refer to **Transmission Fluid Level and Condition Check**.
- Tire pressure is correct.

During the road test:

- Perform the test only when traffic conditions permit.
- Operate the vehicle in a controlled, safe manner.
- Observe all traffic regulations.
- View the scan tool data while conducting this test.

Take along qualified help in order to operate the vehicle safely.

- Observe any unusual sounds or smells.
- Ensure the transmission fluid temperature is at least 90°C (194°F).

After the road test, check the following:

- Inspect for proper transmission fluid level. Refer to **Transmission Fluid Level and Condition Check**.
- Inspect for any diagnostic trouble codes (DTCs) that may have set during the testing. Refer to the applicable DTC.
- Monitor the scan tool data for any abnormal readings or data.
- Inspect for fluid leaks. Refer to **Fluid Leak Diagnosis (Non Hybrid)**, **Fluid Leak Diagnosis (Hybrid)**.

Electrical Function Check

Perform this procedure first in order to ensure the electronic transmission components are functioning properly. If these components are not checked, a simple electrical condition could be misdiagnosed.

1. Connect the scan tool.
2. Ensure the gear selector is in PARK and set the parking brake.
3. Start the engine.
4. Verify that the following scan tool data can be obtained and is functioning properly.

Refer to **Control Module References** for typical data values. Data that is questionable may indicate a concern.

- Engine Speed
- Transmission ISS

- Transmission OSS
- Vehicle Speed
- IMS
- Commanded Gear
- Gear Ratio
- Line PC Sol. Pressure Cmd.
- Brake Switch
- ECT, Engine Data List
- Trans. Fluid Temp.
- TCM Temperature
- Calc. Throttle Position
- Ignition Voltage
- TFP Switch 1
- TFP Switch 3
- TFP Switch 4
- TFP Switch 5
- PC Sol. 2 Pressure Cmd.
- PC Sol. 3 Pressure Cmd.
- PC Sol. 4 Pressure Cmd.
- PC Sol. 5 Pressure Cmd.
- Shift Solenoid 1
- Shift Solenoid 2
- TCC PC Sol. Duty Cycle
- TCC Slip Speed

5. Check the garage shifts.

1. Apply the brake pedal and ensure the parking brake is set.
2. Move the gear selector through the following ranges:
 1. PARK to REVERSE
 2. REVERSE to NEUTRAL
 3. NEUTRAL to DRIVE
 4. DRIVE to REVERSE
 5. REVERSE to DRIVE
3. Pause 2 to 3 seconds in each gear position.
4. Verify the gear engagements are immediate (less than 2 seconds to complete if transmission fluid temperature is above 20°C (68°C) and not harsh. Note that these shifts may be almost imperceptible in some applications. Using the scan tool to monitor Transmission ISS achieving 0 rpm can be used to check delay in these cases.

NOTE: Harsh engagement may be caused by any of the following conditions:

- High engine idle speed-Compare engine idle speed to desired idle speed.
- Incorrect line pressure-Investigate Line PC Sol. Pressure Cmd. kPa (psi), also perform Line Pressure Check (Non Hybrid), Line Pressure Check (Hybrid).
- A default condition caused by certain DTCs that result in maximum line pressure to prevent clutch slippage.
- Incomplete adapting or incorrect adapting-Repeat maneuver multiple times to see if shift quality improves. If it does not, refer to the service procedures for Harsh Garage Shift.

NOTE: Delayed engagement may be caused by any of the following conditions:

- Low idle speed-Compare engine idle speed to desired idle speed.
- Low fluid level
- Incorrect line pressure-Investigate Line PC Sol. Pressure Cmd. kPa (psi), also perform Line Pressure Check (Non Hybrid), Line Pressure Check (Hybrid).
- Cold transmission fluid temperature (TFT)-Use the scan tool to determine TFT.
- Selector linkage-Inspect and adjust as necessary.
- Incomplete adapting or incorrect adapting-Repeat maneuver multiple times to see if delay improves. If it does not, refer to the service procedures for Harsh First and Reverse Shift.

6. Monitor transmission range on the scan tool, transmission data list.

1. Apply the brake pedal and ensure the parking brake is set.
2. Move the gear selector through all ranges.
3. Pause 2 to 3 seconds in each range.
4. Return gear selector to PARK.
5. Verify that all selector positions match the scan tool display.

7. Check throttle position input.

1. Apply the brake pedal and ensure the parking brake is set.
2. Ensure the gear selector is in PARK.
3. Monitor the scan tool Calc. Throttle Position while increasing and decreasing engine speed with the throttle pedal. The scan tool Calc. Throttle Position percentage should increase and decrease with engine speed.

If any of the above checks do not perform properly, record the result for reference after completion of the road test.

Upshift Control and Torque Converter Clutch (TCC) Apply

The TCM calculates the upshift points based primarily on 2 inputs: throttle position and vehicle speed. When the TCM determines that conditions are met for a shift to occur, the TCM commands the shift by varying current to the appropriate PC solenoids to control oncoming and offgoing clutch pressures.

Perform the following steps:

1. Monitor the following scan tool parameters:

- Calc. Throttle Position
- Vehicle Speed
- Engine Speed
- Transmission ISS
- Transmission OSS
- Commanded Gear
- TCC PC Sol. Pressure Cmd.
- TCC Slip Speed
- TFP Switch 1
- TFP Switch 3
- TFP Switch 4
- TFP Switch 5
- PC Sol. 2 Pressure Cmd.
- PC Sol. 3 Pressure Cmd.
- PC Sol. 4 Pressure Cmd.
- PC Sol. 5 Pressure Cmd.
- Shift Solenoid 1 and 2

2. Place the gear selector in the DRIVE position.

3. Accelerate the vehicle using a steady throttle position between 15 and 20 percent. Hold the throttle steady.

4. As the transmission upshifts, there should be a noticeable shift feel or engine speed change within 1 to 2 seconds of the commanded gear change. The PC solenoid pressure command should change to "YES" for the oncoming clutch and the PC solenoid pressure command should change to "NO" for the offgoing clutch.

5. Note any harsh, soft or delayed shifts or slipping. Note any noise or vibration.

6. The TCC feel may not be noticeable. In many applications the TCC will apply after the 1-2 shift and TCC events will not be easily detected using engine speed.

NOTE: This transmission is equipped with an electronically controlled capacity clutch (ECCC), which allows operation of the clutch without fully locking to the torque converter cover. The clutch maintains a small amount of slippage, approximately 20 RPM, in 2nd, 3rd, 4th, 5th, and 6th gears, depending on the vehicle application. ECCC was developed to reduce the

possibility of noise, vibration or chuggle caused by TCC apply. Full lockup is available at highway speeds on some applications.

7. Monitor TCC PC solenoid pressure command while driving and check TCC slip speed when the pressure command indicates that the TCC is commanded to apply:

When the TCC applies, slip speed should be controlled to below 100 RPM when the transmission is not shifting and the throttle is held steady. If the TCC slip exceeds this value for more than 6 seconds after the TCC PC Sol. Pressure Command indicates that the TCC is commanded on:

- Check for DTCs.
- Refer to **Torque Converter Diagnosis**.

Part Throttle Step-In Downshifts

1. Place the gear selector in the DRIVE position.
2. Accelerate the vehicle at light throttle (5-15 percent) until 3rd gear is just achieved.
3. Quickly increase throttle angle until commanded gear indicates that a downshift to 2nd gear is commanded.
4. Verify that the transmission downshifts within 2 seconds of the throttle movement.
5. Repeat steps 2 to 4 at higher speed to achieve 4th gear and then step in to command a 4th gear to 3rd gear downshift.
6. Repeat steps 2 to 4 at higher speed to achieve 5th gear and then step in to command a 5th to 4th gear downshift.
7. Repeat steps 2 to 4 at higher speed to achieve 6th gear and then step in to command a 6th gear to 5th gear downshift.
8. Note any harsh, soft or delayed shifts or slipping. Note any noise or vibration.

Manual Downshifts

Manual downshift testing is not required since all vehicles equipped are also equipped with some form of Driver Shift Control(DSC). The TCM will automatically override DSC downshifts to protect the transmission from damage.

Coasting Downshifts

1. Place the gear selector in the DRIVE position.
2. Accelerate the vehicle to 6th gear with the TCC applied.
3. Release the throttle and apply the brakes
4. Verify that the downshifts occur as commanded by monitoring gear ratio, which should change after commanded gear changes.

Manual Gear Range Selection

This application does not utilize manual forward gear ranges.

Reverse

Perform the following test using a 10-15 percent throttle position.

1. With the vehicle stopped, move the gear selector to REVERSE.
2. Slowly accelerate the vehicle.
3. Verify that there is no noticeable slip, noise or vibration.

Driver Shift Control (DSC)

Refer to the owner's manual for specific instructions on the type of DSC available in this application. Utilize the DSC to ensure that the transmission responds appropriately to driver's commands. The TCM will upshift automatically when maximum engine speed is achieved and will protect from any downshift which may cause excessive engine RPMs.

TORQUE CONVERTER DIAGNOSIS

Torque Converter Stator

The torque converter stator roller clutch can have 2 different malfunctions.

- The stator assembly freewheels in both directions.
- The stator assembly remains locked up in both directions.

Poor Acceleration at Low Speed - Stator Roller Clutch Freewheels at All Times

If the stator is freewheeling at all times, the vehicle tends to have poor acceleration from a standstill and at speeds below 48-55 km/h (30-34 mph). At speeds above 48-55 km/h (30-34 mph), the vehicle may act normally.

For poor acceleration at low speeds, you should first determine that the exhaust system is not blocked, and the transmission is in First gear when starting out. If the engine freely accelerates to high RPM in NEUTRAL, you can assume that the engine and the exhaust system are normal. Check for poor performance in DRIVE and REVERSE to help determine if the stator is freewheeling at all times.

Poor Acceleration at High Speed - Stator Roller Clutch is Locked Up at All Times

If the stator is locked up at all times, performance is normal when accelerating from a standstill. Engine RPM and vehicle speed are limited or restricted at speeds above 48-55 km/h (30-34 mph). Visual examination of the converter may reveal a blue color from overheating.

Torque Converter Bearing Noise

NOTE: **Do not confuse this noise with pump whine noise, which is usually noticeable in all gear ranges. Pump whine will vary with line pressure.**

Torque converter whine is noticed when the vehicle is stopped and the transmission is in DRIVE or REVERSE.

This noise will increase as you increase the engine RPM. The noise will stop when the vehicle is moving or when you apply the torque converter clutch, because there is no slip speed across the bearings.

Perform a stall test to verify that the noise is actually coming from the torque converter:

1. Place your foot on the brake.
2. Put the gear selector in DRIVE.

CAUTION: You may damage the transmission if you depress the accelerator for more than 6 seconds.

3. Depress the accelerator to approximately 1,200 RPM for no more than six seconds.

A torque converter noise will increase under this load.

Torque Converter Clutch

The torque converter clutch (TCC) is applied by fluid pressure, which is controlled by a TCC pressure control (PC) solenoid. This solenoid is part of the control solenoid valve assembly, which is located inside the automatic transmission assembly. The solenoid is controlled through a combination of computer controlled switches and sensors. Electronically controlled capacity clutch (ECCC) is controlled slip across the TCC.

Torque Converter Clutch Shudder

The key to diagnosing torque converter clutch (TCC) shudder is to note when it happens and under what conditions. TCC shudder should only occur during the apply, release, or ECCC conditions of the converter clutch. Shudder should never occur after the TCC is fully locked (approximately 0 RPM slip).

If Shudder Occurs During TCC Apply, Release, and ECCC

If the shudder occurs while the TCC is applying, the problem can be within the transmission or the torque converter. Something is causing one of the following conditions to occur:

- The clutch is not engaging completely.
- The clutch is not releasing completely.
- The clutch is releasing and applying rapidly and continuously.

One of the following conditions may be causing the TCC Shudder to occur:

- Leaking turbine shaft/TCC seals
- A restricted release orifice
- A distorted clutch or converter cover due to long flexplate to converter bolts
- Defective friction material on the TCC plate

If Shudder Occurs After TCC has Locked

Engine problems may go unnoticed under light throttle and load, but they become noticeable after the TCC has locked when going up a hill or accelerating.

Refer to **Symptoms - Engine Controls (LUK)** , **Symptoms - Engine Controls (LEA)** in order to avoid misdiagnosis of TCC shudder and the unnecessary disassembly of a transmission or the unnecessary replacement of a torque converter.

Torque Converter Vibration Test

The **Noise and Vibration Analysis** procedure should be performed prior to performing this test.

Indexing Torque Converter

To determine and correct a torque converter vibration, the following procedure may have to be performed several times to achieve the best possible torque converter to flexplate balance.

1. Remove the torque converter bolts.
2. Rotate the torque converter one bolt position from the original marked position.

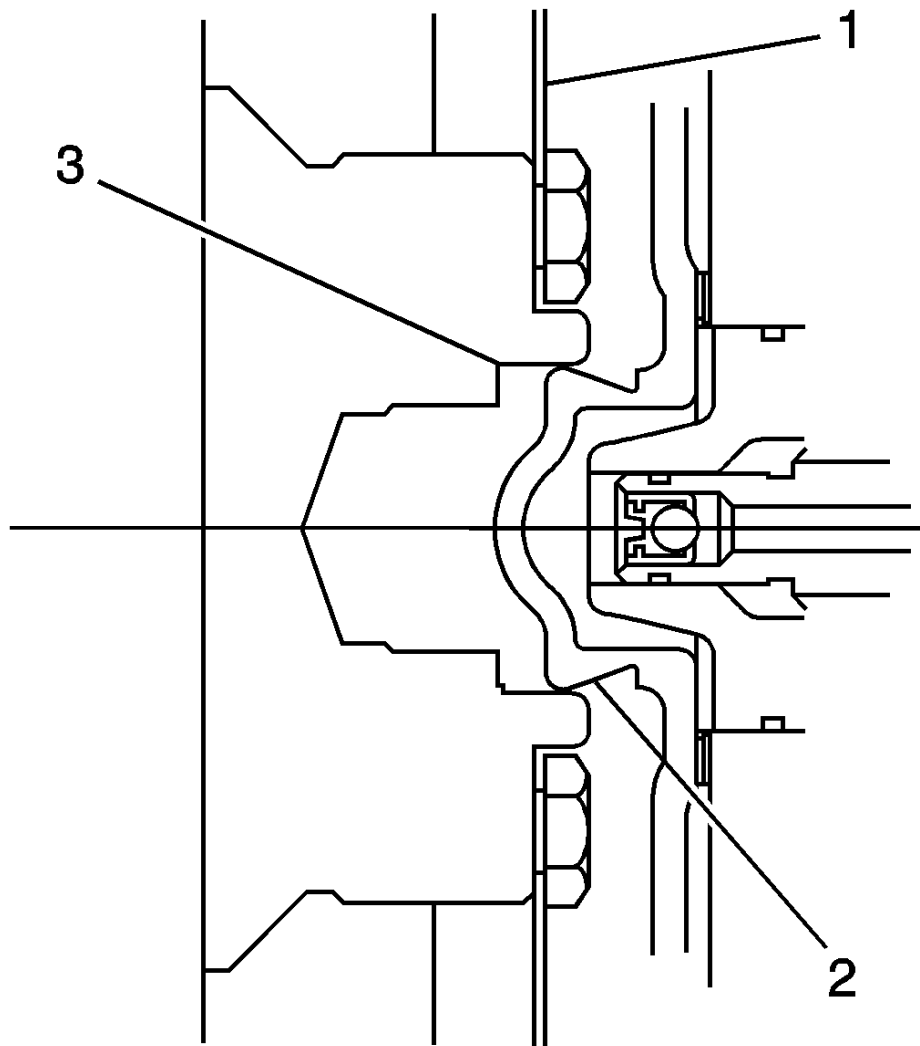


Fig. 8: View Of Torque Converter Hub In Engine Crankshaft
Courtesy of GENERAL MOTORS COMPANY

CAUTION: When installing the torque converter to the flexplate, make sure to use specified bolts. **DO NOT** use longer bolts. Using longer bolts will result in deformation of the torque converter cover and cause internal damage.

CAUTION: Refer to Fastener Caution .

3. Align the torque converter pilot (2) in the engine crankshaft (3). Install the torque converter to flexplate bolts, and tighten according to Fastener Tightening Specifications (On Vehicle) , Fastener Tightening Specifications (Off Vehicle) .
4. Lower the vehicle.
5. With the engine at idle speed and the transmission in PARK or NEUTRAL, observe the vibration.

Repeat this procedure until the best possible balance is obtained.

6. Install the torque converter access cover and bolts (if equipped) and tighten according to **Fastener Tightening Specifications (On Vehicle)** , **Fastener Tightening Specifications (Off Vehicle)** .

Torque Converter Replacement Guide

Condition	Action
<ul style="list-style-type: none"> • Transmission Fluid Oxidized/Discolored • Clutch Fiber Material 	Do not replace the torque converter. Refer to <u>Transmission Fluid Level and Condition Check</u> .
Transmission Fluid Contaminated with Metal Particles	Do not replace the torque converter for clutch system or gearset component damage. Fine metallic debris or clutch plate material that is suspended in the fluid will not cause damage to the internal torque converter components nor any internal transmission components.
Harsh Gear Shifts	Do not replace the torque converter. Refer to <u>Symptoms - Automatic Transmission</u> .
Noise-Whine	<ul style="list-style-type: none"> • Refer to <u>Symptoms - Automatic Transmission</u>. • Do not replace the torque converter if noise is present in Neutral/Park. Refer to <u>Symptoms - Engine Mechanical</u> .
Vibration-Out of Balance	Refer to Torque Converter Vibration Test in this procedure.
No Drive/Slips in Drive	Do not replace the torque converter until completing all engine and transmission diagnostics.
Idle Surge/Rough Idle	Do not replace the torque converter. Refer to <u>Symptoms - Engine Controls (LUK)</u> , <u>Symptoms - Engine Controls (LEA)</u>
TCC Apply/Release Shudder	Do not replace the torque converter. Refer to Torque Converter Clutch Shudder in this procedure.
TCC Chuggle	Do not replace the torque converter. Refer to <u>Symptoms - Engine Controls (LUK)</u> , <u>Symptoms - Engine Controls (LEA)</u> .
DTC P0741-TCC Stuck OFF/High Slip-Intermittent Only	Do not replace the torque converter. Refer to <u>DTC P0741 or P0742</u> diagnostic table.
DTC P0741-TCC Stuck OFF/High Slip	Do not replace the torque converter. Refer to <u>DTC P0741 or P0742</u> diagnostic table.
DTC P0742-TCC Stuck ON	Do not replace the torque converter. Refer to <u>DTC P0741 or P0742</u> diagnostic table.
Transmission Fluid Contaminated with Sludge/Metal Particles as a result of:	

<ul style="list-style-type: none"> • Engine Coolant/Oil • Pump damage • Drive sprocket support damage • Turbine/stator shaft damage • Internal converter damage with no damage found in the transmission 	Replace the torque converter.
Poor Acceleration above 48 km/h (30 mph) - Good Launch	<p>Do not replace the torque converter until completing all engine and transmission diagnostics.</p> <ul style="list-style-type: none"> • Refer to Torque Converter Stator in this procedure. • Refer to <u>Symptoms - Engine Controls (LUK)</u> , <u>Symptoms - Engine Controls (LEA)</u> .
Poor Launch - Good Acceleration above 48 km/h (30 mph)	<p>Do not replace the torque converter until completing all engine and transmission diagnostics.</p> <ul style="list-style-type: none"> • Refer to Torque Converter Stator in this procedure. • Refer to <u>Symptoms - Engine Controls (LUK)</u> , <u>Symptoms - Engine Controls (LEA)</u> .
Stripped Converter Bolt Holes	<ul style="list-style-type: none"> • Replace the torque converter. • Inspect flexplate and refer to <u>Lower Engine Noise, Regardless of Engine Speed</u> .
Torque Converter Pilot Damaged	Replace the torque converter.
Torque Converter Hub surface is damaged - scored, raised/transferred metal.	Replace the torque converter.
External Leaks in the weld areas - hub, lug or closure weld.	Replace the torque converter.
Broken/Cracked Flexplate	Replace the torque converter.
Torque Converter Discolored/Overheated	Replace the torque converter.

CLUTCH PLATE DIAGNOSIS

Composition Plates

Dry the plates and inspect the plates for the following conditions:

- Pitting
- Flaking

- Delamination-splitting or separation of bonded clutch material
- Wear
- Glazing
- Cracking
- Charring
- Chips or metal particles embedded in the lining

Replace a composition plate which shows any of these conditions.

Steel Plates

Wipe the plates dry and check the plates for heat discoloration. If the surfaces are smooth, even if color smear is indicated, you can reuse the plate. If the plate is discolored with heat spots or if the surface is scuffed, replace the plate.

Causes of Burned Clutch Plates

The following conditions can result in a burned clutch plate:

- Incorrect usage of clutch or apply plates
- Engine coolant or water in the transmission fluid
- A cracked clutch piston
- Damaged or missing seals
- Low line pressure
- Valve body conditions
 - The valve body face is not flat.
 - Porosity in between channels.
 - The valve train retainers are improperly installed.
 - The checkballs are misplaced.
 - Malfunctioning valves.
- The Teflon® seal rings are worn or damaged.

ENGINE COOLANT/WATER IN TRANSMISSION

CAUTION: The antifreeze or water will deteriorate the seals, gaskets and the glue that bonds the clutch material to the pressure plate. Both conditions may cause damage to the transmission.

If antifreeze or water has entered the transmission, perform the following:

1. Disassemble the transmission.
2. Replace all of the rubber type seals. The coolant will attack the seal material which will cause leakage.

3. Replace the composition-faced clutch plate assemblies. The facing material may separate from the steel center portion.
4. Replace all of the nylon parts - washers.
5. Replace the torque converter.
6. Thoroughly clean and rebuild the transmission, using new gaskets and oil filter.
7. Flush the cooler lines after the transmission cooler has been properly repaired or replaced.
8. Inspect the rubber hose portion of the oil cooler lines for damage, if applicable. Refer to **Transmission Fluid Cooler Flushing and Flow Test (6T40)** .

FLUID LEAK DIAGNOSIS (NON HYBRID)

General Method

1. Verify that the leak is transmission fluid.

CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

2. Thoroughly clean the suspected leak area using a rag.

NOTE: Do not idle vehicle, this will not actuate transmission systems, and do not drive the vehicle on the freeway as this will splatter oil inhibiting leak diagnosis.

3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut OFF the engine.
6. Look for fluid spots on the paper.
7. Make the necessary repairs.

Powder Method

CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

1. Thoroughly clean the suspected leak area using a rag.
2. Apply an aerosol type leak tracing powder to the suspected leak area.

NOTE: Do not idle vehicle, this will not actuate transmission systems, and do not drive the vehicle on the freeway as this will splatter oil inhibiting leak diagnosis.

3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Shut OFF the engine.
5. Inspect the suspected leak area.
6. Trace the leak path through the powder in order to find the source of the leak.
7. Make the necessary repairs.

Dye and Black Light Method

A fluid dye and black light kit is available from various tool manufacturers.

1. Follow the manufacturer's instructions in order to determine the amount of dye to use.
2. Operate the vehicle for 24 km (15 mi) or until normal operating temperatures are reached.
3. Detect the leak with the black light.
4. Make the necessary repairs.

Find the Cause of the Leak

Pinpoint the leak and trace the leak back to the source. You must determine the cause of the leak in order to repair the leak properly. For example, if you replace a gasket, but the sealing flange is bent, the new gasket will not repair the leak. You must also repair the bent flange. Before you attempt to repair a leak, check for the following conditions, and make repairs as necessary:

Gaskets

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Improperly tightened fasteners
- Dirty or damaged threads
- Warped flanges or sealing surface
- Scratches, burrs, or other damage to the sealing surface
- Damaged or worn gasket
- Cracking or porosity of the component
- Improper sealant used, where applicable
- Incorrect gasket

Seals

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Damaged seal bore
- Damaged or worn seal

- Improper installation
- Cracks in component
- Manual shaft or output shaft surface is scratched, nicked, or damaged
- Loose or worn bearing causing excess seal wear

Possible Points of Fluid Leaks

Transmission Valve Body Cover

- Incorrectly tightened bolts
- Improperly installed or damaged gasket/seal
- Damaged mounting face
- Incorrect gasket seal

Case Leak

- Damaged input speed sensor seal
- Damaged manual shaft seal
- Loose or damaged oil cooler lines/seals
- Worn or damaged axle shaft oil seal
- Loose line pressure pipe plug or fluid level pipe plug
- Porous casting
- Warped torque converter housing
- Damaged converter housing to case seal

Leak at the Torque Converter End

- Converter leak in the weld area
- Converter seal lip cut. Check the converter hub for damage
- Converter seal bushing moved forward and damaged
- Converter seal garter spring missing from the seal
- Porous casting of the torque converter housing

Leak at the Vent

- Overfilled system
- Water or coolant in the fluid; The fluid will appear milky
- Transmission case porous
- Incorrect fluid level indicator causing an overfilled system
- Plugged vent

Leak Inspection Points

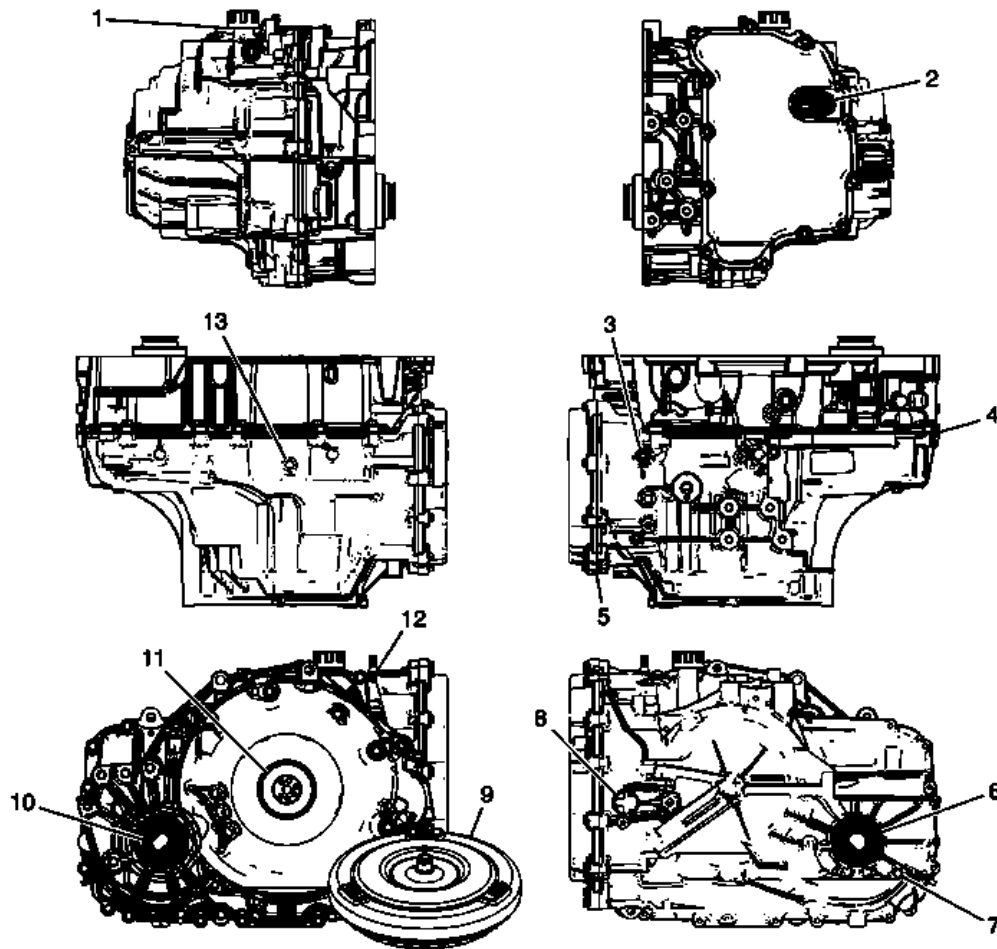


Fig. 9: Identifying Leak Inspection Points
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fill Cap Seal
2	Control Valve Body Cover Hole Seal
3	Line Pressure Tap Plug
4	Converter Housing to Case Joint
5	Control Valve Body Cover Gasket
6	Drive Shaft Oil Seal Assembly
7	Oil Level Plug
8	A/Trans Input Speed Sensor Assembly O-Ring Seal
9	Torque Converter Assembly
10	Front Wheel Drive Shaft Oil Seal Assembly
11	Torque Converter Fluid Seal Assembly
12	Manual Shift Shaft Seal
13	Drain Plug

FLUID LEAK DIAGNOSIS (HYBRID)

General Method

1. Verify that the leak is transmission fluid.

CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

2. Thoroughly clean the suspected leak area using a rag.

NOTE: Do not idle vehicle, this will not actuate transmission systems, and do not drive the vehicle on the freeway as this will splatter oil inhibiting leak diagnosis.

3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut OFF the engine.
6. Look for fluid spots on the paper.
7. Make the necessary repairs.

Powder Method

CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

1. Thoroughly clean the suspected leak area using a rag.
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3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Shut OFF the engine.
5. Inspect the suspected leak area.
6. Trace the leak path through the powder in order to find the source of the leak.
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Dye and Black Light Method

A fluid dye and black light kit is available from various tool manufacturers.

1. Follow the manufacturer's instructions in order to determine the amount of dye to use.
2. Operate the vehicle for 24 km (15 mi) or until normal operating temperatures are reached.
3. Detect the leak with the black light.
4. Make the necessary repairs.

Find the Cause of the Leak

Pinpoint the leak and trace the leak back to the source. You must determine the cause of the leak in order to repair the leak properly. For example, if you replace a gasket, but the sealing flange is bent, the new gasket will not repair the leak. You must also repair the bent flange. Before you attempt to repair a leak, check for the following conditions, and make repairs as necessary:

Gaskets

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Improperly tightened fasteners
- Dirty or damaged threads
- Warped flanges or sealing surface
- Scratches, burrs, or other damage to the sealing surface
- Damaged or worn gasket
- Cracking or porosity of the component
- Improper sealant used, where applicable
- Incorrect gasket

Seals

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Damaged seal bore
- Damaged or worn seal
- Improper installation
- Cracks in component
- Manual shaft or output shaft surface is scratched, nicked, or damaged
- Loose or worn bearing causing excess seal wear

Possible Points of Fluid Leaks

Transmission Valve Body Cover

- Incorrectly tightened bolts

- Improperly installed or damaged gasket/seal
- Damaged mounting face
- Incorrect gasket seal

Case Leak

- Damaged input speed sensor seal
- Damaged manual shaft seal
- Loose or damaged oil cooler lines/seals
- Worn or damaged axle shaft oil seal
- Loose line pressure pipe plug or fluid level pipe plug
- Porous casting
- Warped torque converter housing
- Damaged converter housing to case seal

Leak at the Torque Converter End

- Converter leak in the weld area
- Converter seal lip cut. Check the converter hub for damage
- Converter seal bushing moved forward and damaged
- Converter seal garter spring missing from the seal
- Porous casting of the torque converter housing

Leak at the Vent

- Overfilled system
- Water or coolant in the fluid; The fluid will appear milky
- Transmission case porous
- Incorrect fluid level indicator causing an overfilled system
- Plugged vent

Leak Inspection Points - Hybrid

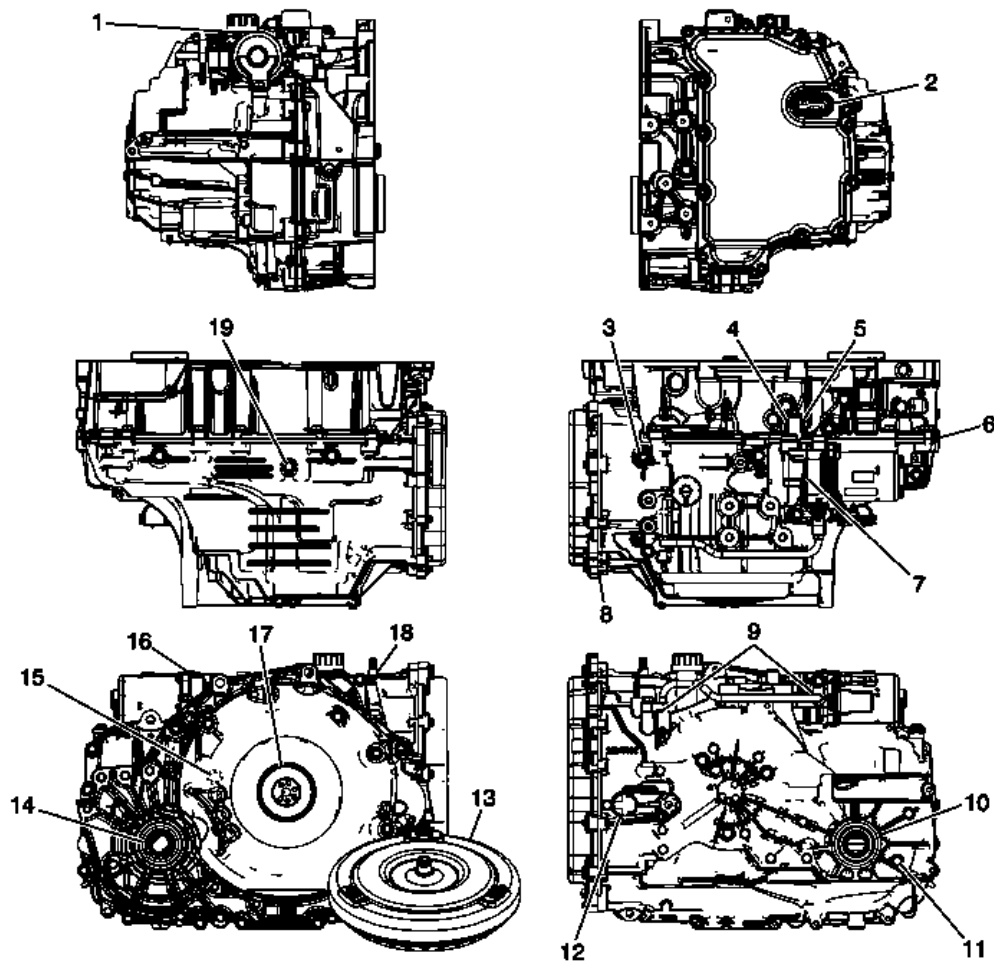


Fig. 10: Leak Inspection Points -- Hybrid
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fill Cap Seal
2	Control Valve Body Cover Hole Seal
3	Line Pressure Tap Plug
4	A/Trans Auxiliary Fluid Pump Gasket
5	A/Trans Auxiliary Fluid Pump Seal
6	Converter Housing to Case Joint
7	A/Trans Auxiliary Fluid Pump Cover Seal
8	Control Valve Body Cover Gasket
9	A/Trans Auxiliary Fluid Pump Outlet Pipe Seal Assembly
10	Drive Shaft Oil Seal Assembly
11	Oil Level Plug
12	A/Trans Input Speed Sensor Assembly O-Ring Seal
13	Torque Converter Assembly

14	Front Wheel Drive Shaft Oil Seal Assembly
15	A/Trans Auxiliary Fluid Inlet Pump Seal
16	A/Trans Auxiliary Fluid Pump Motor Cover Seal - O-Ring
17	Torque Converter Fluid Seal Assembly
18	Manual Shift Shaft Seal
19	Drain Plug

CASE POROSITY REPAIR

Some external leaks are caused by case porosity in non-pressurized areas.

1. Thoroughly clean the area to be repaired with a cleaning solvent. Air dry the area.

WARNING: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Using instructions from the manufacturer, mix a sufficient amount of an epoxy to make the repair.
3. Apply the epoxy. A clean, dry soldering acid brush can be used to clean the area and also to apply the epoxy cement. Make certain that the area to be repaired is fully covered.
4. Allow the epoxy cement to cure for three hours before assembling the components.
5. Repeat the fluid leak diagnosis procedures.

BUSHING AND MATING SHAFT INSPECTION

NOTE: Proper bushing and corresponding mating shaft inspection should be performed before replacing the bushing, shaft, and in some cases, the component which houses the bushing. Thoroughly clean and dry the bushing and shaft surfaces before inspecting for damage.

Any of the following bushing conditions require replacement of the bushing and/or housing:

- Discoloration due to heat distress
- Misalignment or displacement of bushing as a result of spinning in housing
- Medium to heavy scoring that can be easily detected with fingernail. Light scoring is a normal condition.
- Debris embedded into the bushing lining material
- Obvious damage, including excessive and uneven wear
- Excessive polishing. Minor polishing of the bushing is an indication of normal wear and does not require replacement.

Any of the following conditions require replacement of the bushing's mating shaft:

- Discoloration due to heat distress

- Rough surface finish that can be easily detected with finger
- Obvious shaft abnormalities, including warping or uneven surfaces
- Obvious damage or cracking

NOISE AND VIBRATION ANALYSIS

A noise or vibration that is noticeable when the vehicle is in motion MAY NOT be the result of the transmission.

If noise or vibration is noticeable in PARK and NEUTRAL with the engine at idle, but is less noticeable as RPM increases, the vibration may be a result of poor engine performance.

- Vibration may also be caused by a small amount of water inside the converter.
- Inspect the engine and transmission mounts for damage and loose bolts.
- Inspect the transmission case mounting holes for the following conditions:
 - Missing bolts, nuts, and studs
 - Stripped threads
 - Cracks
- Inspect the flywheel for the following conditions:
 - Missing or loose bolts
 - Cracks
 - Imbalance
- Inspect the torque converter for the following conditions:
 - Missing or loose bolts or lugs
 - Missing or loose balance weights
 - Imbalance caused by heat distortion or fluid contamination
- If the noise or vibration is noticeable in PARK and NEUTRAL with the engine at idle, but is more noticeable as RPM increases, the vibration may be an engine imbalance or a transmission imbalance. Refer to **Torque Converter Diagnosis**.

WHINE/GROWL NOISE

Whine/Growl Noise

Checks	Causes
Differential Assembly (232)	<ul style="list-style-type: none"> • Inspect for worn wheel bearings or axles. • Inspect for worn or damaged Side Gear Thrust Washer) or Pinion Gear Thrust Washer • Inspect for loose or worn Side Gear Axle Splines • Inspect for damaged or worn Side Gear • Inspect for worn or damaged Final Drive Inner and Outer Washers (584)

	<ul style="list-style-type: none"> • Inspect for loose, damaged or worn Front Differential Carrier Thrust Bearings, (228, 231, 233) • Inspect for broken, worn or disengaged Final Drive Pinion Pin Retainer (581) • Inspect for damaged or worn Pinion Gears
Drive Link Assembly (225)	<ul style="list-style-type: none"> • Inspect for worn, loose or damaged links • Inspect for broken, worn or loose Drive Link Lube Scoop (60)
Drive Sprocket Assembly (224)	<ul style="list-style-type: none"> • Inspect for improper Drive Sprocket (224) tooth surface finish • Inspect for broken or damaged Drive Sprocket (224) teeth • Inspect for worn or damaged Drive Sprocket Thrust Bearings (223, 556) • Inspect for worn or damaged Output Carrier Transfer Drive Gear Hub Assembly splines (222) • Inspect for loose, worn or damaged Output Carrier Transfer Drive Gear Hub Assembly bushing
Driven Sprocket Assembly (229)	<ul style="list-style-type: none"> • Inspect for worn, binding or damaged Driven Sprocket Bearing Assembly (228) • Inspect for worn or damaged Driven Sprocket Ball Bearing Assembly • Inspect for improper Driven Sprocket (229) tooth surface finish • Inspect for broken or damaged Driven Sprocket (229) teeth
Input Carrier Assembly (570)	<ul style="list-style-type: none"> • Inspect for pitted/spalled Pinion Gear teeth • Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings • Inspect for loose or broken Hub and Ring Gear • Inspect for loose or broken Output Internal Gear Retainer • Inspect for loose or worn Sun Gear Thrust Bearings (569, 572)
Output Carrier Assembly (574)	<ul style="list-style-type: none"> • Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings • Inspect for loose Hub and Ring Gear
Output Sun Gear Assembly (555)	<ul style="list-style-type: none"> • Inspect for worn or damaged Output Sun Gear Thrust Bearing (556)

	<ul style="list-style-type: none"> • Inspect for loose, worn or damaged Output Sun Gear bushing • Inspect for worn or damaged Output Sun Gear teeth
Reaction Carrier Assembly (567)	<ul style="list-style-type: none"> • Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings • Inspect for loose hub and Ring Gear • Inspect for worn or damaged Reaction Carrier Thrust Bearings (565)
Reaction Sun Gear Assembly (566)	Inspect for loose, worn or damaged Reaction Sun Gear Assembly bushing
Fluid Pump Assembly (201)	<ol style="list-style-type: none"> 1. Inspect for proper fluid level 2. Inspect for leaking Pump Fluid Outlet Seal Assembly (24) or Filter Seal
3-5-Reverse Clutch Assembly	<ul style="list-style-type: none"> • Inspect for inadequate Clutch Plate Clearance • Inspect for stripped or sheared Clutch Plate Splines (508-510) • Inspect for loose or worn Backing Plate Retainer (511) • Inspect for loose Speed Sensor Reluctor Wheel (501) or Retainer (500)
4-5-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for inadequate Clutch Plate Clearance • Inspect for stripped or sheared Clutch Plate Splines (425-428) • Inspect for loose or worn Clutch Dam Retainer (524) • Inspect for loose or worn 3-5-Reverse/4-5-6 Clutch Housing Bushing
1-2-3-4 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for inadequate Clutch Plate Clearance • Inspect for stripped or sheared Clutch Plate Splines (557-559) • Inspect for loose or worn Clutch Spring Retainer (561)
Low and Reverse Clutch Assembly (OWC) (543)	<ul style="list-style-type: none"> • Inspect for stripped or sheared Low and Reverse Clutch Assembly (543) splines • Inspect for non-rotating Low and Reverse Clutch Assembly (543)
Low and Reverse Clutch	<ul style="list-style-type: none"> • Inspect for inadequate Clutch Plate Clearance • Inspect for stripped or sheared Clutch Plate Splines (545-547) • Inspect for loose or worn Clutch Spring Retainer (548)
	<ul style="list-style-type: none"> • Inspect for inadequate Clutch Plate Clearance

2-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for stripped or sheared Clutch Plate Splines (540-542) • Inspect for loose or worn Clutch Spring Retainer (537)
Case Assembly (50)	<ul style="list-style-type: none"> • Inspect for loose or broken Transmission Mount Bolts • Inspect for loose Torque Converter and Differential Housing Bolts (26) • Inspect for loose, worn or damaged differential bushing • Inspect for loose or broken Input Shaft Support Bolts (57) • Inspect for loose or broken Front Differential Carrier Baffle Bolts (61) • Inspect for stripped or sheared splines • Inspect for loose, worn or damaged bushing
Torque Converter Housing Assembly (208)	<ul style="list-style-type: none"> • Inspect for loose or broken Front Differential Ring Gear Retainer (206) • Inspect for loose, worn or damaged differential bushing • Inspect for loose or broken Pinion Gear Shaft Retainer Pin • Inspect for loose or broken Front Differential Carrier Baffle Bolts (204) • Inspect for loose or broken Fluid Pump Bolts (200) • Inspect for loose Torque Converter and Differential Housing Bolts (26) • Inspect for loose, worn or damaged bushing
Control Valve Body Cover Assembly (2)	Inspect for loose, missing or broken Valve Body Cover Bolts (1)
Torque Converter (28)	<ul style="list-style-type: none"> • Inspect for improper alignment of Torque Converter to the Crankshaft • Inspect for ballooning of the Torque Converter
Differential Carrier Assembly (232)	<ul style="list-style-type: none"> • Inspect for worn or damaged Differential Carrier (582) • Inspect for worn or damaged Pinion Pins (583) • Inspect for broken, worn or damaged Differential Sun Gear Bearing (231) or Driven Sprocket Bearing (228) • Inspect for worn or damaged Differential Side Gear teeth, Final Drive Pinion Gear (586) teeth or Final Drive Sun Gear (230) teeth • Inspect for worn or damaged Differential Side Gear Thrust Washers or Final Drive Inner and Outer Washers (584) • Inspect for worn or damaged Final Drive Rollers (585) • Inspect for broken or damaged Differential Pinion Gear Shaft Retainer

AUTOMATIC TRANSMISSION FLUID LEAKS

Automatic Transmission Fluid Leaks

Checks	Causes
Torque Converter (28)	Inspect for damage
Case Assembly (50)	<ul style="list-style-type: none">• Inspect for cracked or broken Case (50)• Inspect for porosity or damage on the sealing surfaces• Inspect for loose Oil Cooler Line Bolts or damaged Oil Cooler Line Seals• Inspect for damaged Manual Shift Shaft Seal (604)• Inspect for damaged or worn Axle Seal (65) or Axle Seal Slinger on the axle shafts• Inspect for plugged Vent Cap (52)• Inspect for loose Pressure Test Plug (51), Drain Plug (64) and Fluid Level Plug (63)• Inspect for damaged Park Pawl Actuator Guide Seal (605)• Inspect for damaged or worn Input Speed Sensor Seals (19)
Torque Converter Housing Assembly (208)	<ul style="list-style-type: none">• Inspect for damaged Torque Converter Housing Assembly (208)• Inspect for porosity or damage on the sealing surfaces• Inspect for damaged Torque Converter Housing Seal (23)• Inspect for damaged or worn Torque Converter Fluid Seal (301)• Inspect for loose Torque Converter and Differential Housing Bolts (26)• Inspect for damaged or worn Axle Seal (209) or Axle Seal Slings on the axle shafts• Inspect for loose, missing or damaged Fluid Fill Tube Plug Assembly (27)• Inspect for damaged Torque Converter and Differential Housing Seal (202)
Valve Body Cover Assembly (2)	<ul style="list-style-type: none">• Inspect for damaged or warped Valve Body Cover Assembly (2)• Inspect for damaged or improperly installed Valve Body Cover Gasket (3)• Inspect for loose Valve Body Cover Bolts (1)• Inspect for damaged or improperly installed Wire Connector Hole Seal (5)

SHIFT INDICATOR INDICATES WRONG GEAR SELECTION

Shift Indicator Indicates Wrong Gear Selection

Checks	Causes
Shift Cable	<ul style="list-style-type: none">• Inspect for damage.• Verify proper attachment to shifter.• Verify cable is locked into shifter bracket.• Verify cable is properly attached to the transmission.• Verify that the cable is locked into the transmission bracket.• Verify proper cable adjustment. Refer to <u>Range Selector Lever Cable Adjustment</u> .
Manual Shaft	<ul style="list-style-type: none">• Verify shift lever is properly attached to the manual shaft.• Verify manual shaft is not twisted or damaged.
Manual Shift Detent Lever with Shaft Position Switch Assembly, IMS	Verify proper operation. Refer to <u>Transmission Internal Mode Switch Logic</u> .

NO PARK

No Park

Checks	Causes
Differential Carrier Assembly (232)	<ul style="list-style-type: none">• Inspect for damaged or broken Front Differential Assembly (232).• Inspect for damaged or broken Front Differential Side Gear or Pinion Gear.• Inspect for damaged or broken Front Differential Pinion Gear Shaft.• Inspect for damaged or broken Front Differential Pinion Gear Shaft Pin.• Inspect for worn, stripped or sheared Front Differential Side Gear splines.• Inspect for damaged or broken Final Drive Sun, Pinion or Ring Gear.• Inspect for worn, stripped or sheared Final Drive Sun Gear splines.
Output Carrier Transfer Drive Gear Hub Assembly (222)	<ul style="list-style-type: none">• Inspect for broken Drive Gear Hub (222).• Inspect for worn, stripped or sheared Drive Gear hub (222) splines.• Inspect for disengaged or broken Park Gear Retainer Ring (220).• Inspect for damaged or broken park Gear (221).• Inspect for disengaged or broken Drive Sprocket Retainer Ring (227).

Drive Link Assembly (225)	<ul style="list-style-type: none"> • Inspect for broken, worn or damaged Drive Link Assembly (225). • Inspect for broken, worn or damaged Drive Sprocket (224). • Inspect for broken, worn or damaged Driven Sprocket Assembly (229). • Inspect for worn, stripped or sheared Driven Sprocket splines. • Inspect for broken Drive Gear Hub (222).
Case Assembly (50)	<ul style="list-style-type: none"> • Inspect for broken or damaged Case. • Inspect for broken or bent Park Pawl Shaft (600). • Inspect for broken or missing Park Pawl Actuator Guide Pin (603) or Manual Shaft Pin (611). • Inspect for broken or missing Manual Shaft Detent Lever Pin (610). • Inspect for broken or missing Manual Shift Shaft Pin (611). • Inspect for damaged or broken Manual Shift Detent Lever Shaft (608). • Inspect for loose, damaged or broken Detent Lever Spring Assembly (17). • Inspect for broken, loose or misaligned Park Pawl Actuator Guide (606). • Inspect for binding, bent or broken Park Pawl (602) or Actuator Assembly (607).

HARSH GARAGE SHIFT

Harsh Garage Shift

Checks	Causes
Input Carrier Assembly (570)	Inspect for worn or stripped Output Internal Gear Splines.
Low-Reverse and 1-2-3-4 Clutch Housing (551)	<ul style="list-style-type: none"> • Inspect for damaged or fatigued 1-2-3-4 Clutch Wave Plate (557) and Low and Reverse Clutch Wave Plate (547). Refer to <u>Clutch Plate Diagnosis</u>. • Inspect for stripped or sheared splines on 1-2-3-4 Clutch Plate (546). Refer to <u>Clutch Plate Diagnosis</u>. • Inspect for improperly positioned or plugged Low Reverse Piston (550) air bleed. • Inspect for correct fluid level.
Low and Reverse Clutch Assembly (OWC) (543)	Inspect for stripped or sheared internal and external splines on Low and Reverse Clutch Assembly (543).

NO DRIVE IN ALL RANGES

No Drive in All Ranges

Checks	Causes
Case Assembly (50)	<ul style="list-style-type: none">• Inspect for cracked or broken Case (50).• Inspect for stripped or sheared splines.• Inspect for binding Manual Shift Detent Lever Assembly (609).• Inspect for missing Manual Shift Shaft Pin (611).• Inspect for missing Manual Shaft Lever Pin (610).• Inspect for interference or binding Park Pawl Actuator Assembly (607).• Inspect for broken or disengaged 1-2-3-4 Clutch Backing Plate Retainer Ring (561).• Inspect for loose or damaged case bushing.• Inspect A/Trans Fluid Pump Seal Assembly (25) for damage.
Torque Converter (28)	<ul style="list-style-type: none">• Inspect for stripped or sheared splines on Turbine Shaft.• Inspect for missing Torque Converter to Flywheel bolts.• Inspect for damaged or disengaged Torque Converter Hub to Oil Pump Drive Gear.
Torque Converter Housing (208)	<ul style="list-style-type: none">• Inspect for stripped or sheared Differential Ring Gear splines.• Inspect for broken or disengaged Differential Ring Gear Retainer (206).• Inspect for loose, missing or broken Torque Converter and Differential Housing bolts (26).• Inspect for loose, missing or broken Fluid Pump bolts (200).
35R/456 Housing Assembly (516)	<ul style="list-style-type: none">• Inspect for damaged or broken Input Shaft Thrust Bearing Assembly (538).• Inspect for stripped or sheared splines on the Input Shaft to the 3-5 Reverse/4-5-6 Clutch Housing (516).
Oil Pump Assembly (201)	<ul style="list-style-type: none">• Inspect for fluid leaks / improper fluid level.• Inspect for leaking Fluid Outlet Seal Assembly (24).• Inspect for loose or missing Oil Pump Bolts (200).• Inspect for damaged, restricted or improperly installed Oil Filter Assembly (203).• Inspect for damaged or leaking Oil Filter Neck Seal.• Inspect for broken or seized Fluid Pump Drive Gear (315) and Fluid Pump Driven Gear (316).
Low & Reverse Clutch Assembly (543)	Inspect for stripped or sheared splines to the Reaction Carrier (567).
	<ul style="list-style-type: none">• Inspect for stripped or sheared castle splines to ring gear.

Input Carrier Assembly (570)	<ul style="list-style-type: none"> • Inspect for improperly installed carrier pinion gear pins. • Inspect for damaged or broken Pinion Gears. • Inspect for stripped or sheared splines on the Input Sun Gear (571). • Inspect for damaged or broken Output Internal Gear. • Inspect for broken or disengaged Output Internal Gear Retainer Ring. • Inspect for damaged or broken Input Carrier Thrust Bearing Assembly (568) and Output Carrier Thrust Bearing Assembly (573). • Inspect for damaged or broken Input Carrier Thrust Bearings (569, 572).
Reaction Carrier Assembly (567)	<ul style="list-style-type: none"> • Inspect for stripped or sheared Reaction Carrier Assembly (567) splines. • Inspect for damaged or broken Input Carrier Thrust Bearings (568). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for damaged or broken Reaction Internal Gear teeth. • Inspect for disengaged or broken Reaction Internal Gear retainer ring.
Reaction Sun Gear Assembly (566)	<ul style="list-style-type: none"> • Inspect for damaged or broken weld at Sun Gear. • Inspect for loose or worn Reaction Sun Gear Assembly bushing.
Output Carrier Assembly (574)	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines to reaction internal ring gear. • Inspect for damaged or broken Input Sun Gear Thrust Bearings (572). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for damaged or broken Input Carrier Thrust Bearings (573). • Inspect for broken or damaged Output Internal Gear.
Output Sun Gear Assembly (555)	<ul style="list-style-type: none"> • Inspect for stripped or sheared Output Sun Gear Assembly (555) splines. • Inspect for broken Output Sun Gear Assembly (555) hub or weld.
Low-Reverse and 1-2-3-4 Clutch Housing (551)	Inspect for disengaged or broken 1-2-3-4 Clutch Piston Spring Retainer (554).
Drive Link Assembly (225)	<ul style="list-style-type: none"> • Inspect for broken, worn or damaged Drive Link Assembly (225). • Inspect for broken, worn or damaged Drive Sprocket (224).

	<ul style="list-style-type: none"> • Inspect for broken, worn or damaged Driven Sprocket Assembly (229). • Inspect for broken Drive Gear Hub (222).
Differential Carrier Assembly (232)	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines on Differential Side Gear. • Inspect for stripped or sheared splines Final Drive Sun Gear (230). • Inspect for stripped or sheared splines Differential Carrier to PTU (AWD only). • Inspect for stripped broken or disengaged Final Drive Retainer (581). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for damaged or broken Final Drive Rollers (585). • Inspect for broken, worn or damaged Final Drive Inner and Outer Thrust Washers (584).
Control Solenoid (w/Body and TCM) Valve Assembly	<ul style="list-style-type: none"> • Check that the Manual Valve (432) is engaged with Manual Shift Detent Lever Assembly (609). • Inspect the Control Solenoid (w/Body and TCM) Valve Assembly (7) and verify that it is functioning properly.

NO FIRST AND REVERSE GEARS

No First and Reverse Gears

Checks	Causes
Low and Reverse Clutch Assembly (543)	<ul style="list-style-type: none"> • Inspect for stripped or sheared internal or external splines on Low and Reverse Clutch Assembly (543) • Inspect for broken or disengaged retainer ring
Low and Reverse Clutch	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines on Low and Reverse Clutch Plates (545-547) • Inspect for damaged, deformed or improper surface finish on the Low and Reverse Clutch Plates (545-547) • Inspect for stripped or sheared splines on Low and Reverse Clutch Backing Plate (544) • Inspect for worn, damaged or debonding Low and Reverse Clutch Piston Seals (550) • Inspect for broken or fatigued Low and Reverse Clutch Piston Return Spring (549)
Low-Reverse and 1-2-3-4 Clutch Housing (551)	<ul style="list-style-type: none"> • Inspect for disengaged or broken Low and Reverse Clutch Piston Spring Retainer (548) • Inspect for broken or deformed Low and Reverse Clutch Piston (550)

- Inspect for damaged or improper surface finish in the piston bore

NO FIRST, SECOND, THIRD, AND FOURTH GEAR

No First, Second, Third, and Fourth Gear

Checks	Causes
Control Solenoid (w/Body and TCM) Valve Assembly	Check 1234 PC Solenoid 5 for proper operation. Refer to <u>Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test.</u>
Control Valve Body Assembly	Inspect 1-2-3-4 Clutch Regulator Valve (417) and 1-2-3-4 Clutch Boost Valve (414) for debris and stickyness.
1-2-3-4 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for damaged, stripped or sheared splines on 1-2-3-4 Clutch Plates (557-559), Backing Plate (560). • Inspect for damaged or broken 1-2-3-4 Clutch Piston (552) and Piston Seals damaged, worn or delaminating. • Inspect for broken or fatigued 1-2-3-4 Clutch Piston Return Spring (553). • Inspect for broken or disengaged 1-2-3-4 Clutch Piston Return Spring Retainer (554). • Inspect for broken or fatigued 1-2-3-4 Clutch Waved Plate (557). • Inspect for disengaged or broken 1-2-3-4 Clutch Backing Plate Retainer (561). • Inspect for broken, porous or improper surface finish or plugged oil passages of the Low-Reverse/1-2-3-4 Clutch Housing (551). • Inspect for worn or damaged Low-Reverse/ 1-2-3-4 Clutch Housing (551) splines.
Output Sun Gear Assembly (555)	Inspect for stripped or sheared splines on the Output Sun Gear shell.
Reaction Carrier Assembly (567)	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines on the Input Ring Gear • Inspect for disengaged or broken Input Ring Gear Retainer.
Output Carrier Assembly (574)	<ul style="list-style-type: none"> • Low/Reverse Clutch Assembly (OWC) (543) splines stripped or sheared. • Inspect for disengaged or broken Reaction Ring Gear Retainer.
Case Assembly (50)	<ol style="list-style-type: none"> 1. Inspect for leaking or damaged 1-2-3-4 and Low-Reverse Clutch Fluid Passage Seals (67). 2. Inspect for worn or damaged case splines or retainer ring grooves.
Input Sun Gear (571)	Inspect for damaged gear teeth and damaged splines.
Turbine Shaft (517)	Inspect for damaged splines to the Input Shaft Sun Gear.

NO SECOND AND SIXTH GEAR

No Second and Sixth Gear

Checks	Causes
2-6 Clutch Assembly	<ul style="list-style-type: none">• Inspect for damaged or worn 2-6 Clutch Plates (540-542).• Inspect for damaged, worn, broken, improper surface finish or sheared splines on the Low-Reverse Clutch Assembly (543).• Inspect for damaged or broken 2-6 Clutch Piston (535) and piston seals damaged, worn or delaminating.• Inspect for broken or binding 2-6 clutch Piston Return Spring (536).
Reaction Carrier Assembly (567)	<ul style="list-style-type: none">• Inspect for stripped or sheared splines on the Input Ring Gear.• Inspect for disengaged or broken Input Ring Gear Retainer.
Reaction Sun Gear Assembly (566)	<ul style="list-style-type: none">• Inspect for damaged or broken Reaction Sun Gear Assembly hub.• Inspect for damaged or broken sun gear weld.• Inspect for loose or worn Reaction Sun Gear Assembly bushing.
Case Assembly (50)	<ul style="list-style-type: none">• Inspect for stripped or sheared splines.• Inspect for broken or disengaged 2-6 Clutch Piston Return Spring Retainer (537).• Inspect for damaged, worn, or improper surface finish in the piston bore.
Output Carrier Assembly (574)	Inspect for reaction ring gear damage or missing ring gear snap ring.
Control Valve Body Assembly	Inspect 2-6 Clutch Regulator Valve (419) for debris and stickiness.
Control Solenoid (w/Body and TCM) Valve Assembly	Check 2-6 PC Solenoid 4 for proper operation. Refer to <u>Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test</u> .

HARSH OR LATE FIRST, SECOND, THIRD, AND FOURTH SHIFT

Harsh or Late First, Second, Third, and Fourth Shift

Checks	Causes
Low-Reverse and 1-2-3-4 Clutch Housing (551)	<ul style="list-style-type: none">• Inspect for damaged or broken 1-2-3-4 Clutch Piston (552) and piston seals damaged, worn or leaking.• Inspect for fatigued or binding 1-2-3-4 Clutch Piston Return Spring (553).• Inspect for improper surface finish on 1-2-3-4 Clutch Plates (557-559). Refer to <u>Clutch Plate Diagnosis</u>.• Inspect for broken or fatigued 1-2-3-4 Clutch Waved Plate (557).

	<ul style="list-style-type: none"> • Inspect for plugged or restricted Low-Reverse and 1-2-3-4 Clutch Piston Housing (551) air bleed.
Case Assembly (50)	<ul style="list-style-type: none"> • Inspect for leaking or loose fitting Fluid Check Valve (55). • Inspect for leaking or damaged 1-2-3-4 and Low-Reverse Clutch Fluid Passage Seals (67).

HARSH FIRST AND REVERSE SHIFT

Harsh First and Reverse Shift

Checks	Causes
Low-Reverse and 1-2-3-4 Clutch Housing (551)	Inspect for plugged or restricted Low-Reverse/1-2-3-4 Clutch Piston Housing (551) air bleed
Low and Reverse Clutch	<ul style="list-style-type: none"> • Inspect for improper surface finish on Low and Reverse Clutch Plates (545-547) • Inspect for broken or fatigued Low and Reverse Clutch Apply Plate (547) • Inspect for damaged or broken Low and Reverse Clutch Piston (550) and piston seals damaged, worn or leaking • Inspect for fatigued or binding Low and Reverse Clutch Piston Return Spring (549)

NO THIRD, FIFTH, AND REVERSE GEAR

No Third, Fifth, and Reverse Gear

Checks	Causes
3-5 Reverse Clutch Assembly	<ul style="list-style-type: none"> • Inspect for damaged, stripped or sheared splines on 3-5 Reverse Clutch Plates (507-509), Backing Plate (510) • Inspect for sheared or stripped splines on 3-5 Rev/4-5-6 Housing (516) to Turbine Shaft (517) • Inspect for damage, improper surface finish, porosity, deformed or unbalanced 3-5 Rev/4-5-6 Housing (516) • Inspect for damaged, worn, loose or seized hub bushing in the 3-5 Rev/4-5-6 Housing • Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5 Rev/4-5-6 Housing (516) • Inspect for failure of the Input Shaft Thrust Bearing (538) • Inspect for disengaged or broken 3-5 Reverse Clutch Backing Plate (511) • Inspect for damaged, worn or leaking 3-5 Reverse Clutch Piston Seals (504-506) • Inspect for damaged or broken 3-5 Rev/4-5-6 Clutch Housing (516)

	<ul style="list-style-type: none"> • Inspect for warped, damaged, improper surface finish or debonding 3-5 Reverse Clutch Piston (502) • Inspect for broken or fatigued 3-5 Reverse Clutch Spring (503) • Inspect for disengaged or broken Speed Sensor Reluctor Retainer (500) • Inspect for worn, broken or damaged Speed Sensor Reluctor Wheel (501)
Reaction Sun Gear Assembly (566)	Inspect for stripped or sheared splines
Reaction Carrier (567)	<ul style="list-style-type: none"> • Inspect for broken or disengaged Input Internal Gear Retainer • Inspect for stripped or sheared splines on the Input Internal Gear
Output Carrier (574)	Inspect for stripped or sheared splines for the Reaction Internal Ring Gear
4-5-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for plugged or missing 4-5-6 Piston Dam Oil Feed hole • Inspect for leaking 4-5-6 Piston Dam

HARSH OR LATE SECOND AND SIXTH SHIFT

Harsh or Late Second and Sixth Shift

Checks	Causes
2-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for worn or improper surface finish on the 2-6 Clutch Plates (540-542) • Inspect for fatigued 2-6 Clutch Piston Apply Plate (540) • Inspect for plugged, restricted or incorrect orientation of the 2-6 Clutch Piston (535) air bleed
Case Assembly (50)	<ul style="list-style-type: none"> • Inspect for damaged or broken 2-6 Clutch Piston (535) and piston seals damaged, worn or delaminating • Inspect for fatigued 2-6 Clutch Piston Return Spring (536)

NO FOURTH, FIFTH, AND SIXTH GEAR

No Fourth, Fifth, and Sixth Gear

Checks	Causes
4-5-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for damaged, stripped or sheared splines on 4-5-6 Clutch Plates (526-528), Backing Plate (529) • Inspect for broken or fatigued 4-5-6 Clutch Waved Plate (525) • Inspect for damaged or broken 4-5-6 Clutch Piston (520) and Piston Seals (518, 519, 521)

	<ul style="list-style-type: none"> • Inspect for broken or fatigued 4-5-6 Piston Return Spring (522) • Inspect for broken or disengaged 4-5-6 Backing Plate Retainer (532) • Inspect for damaged or broken 4-5-6 Clutch Dam Piston (523) and piston seals damaged, worn or delaminating • Inspect for broken or disengaged 4-5-6 Clutch Dam Retainer (524) • Inspect for stripped or sheared splines on the Reaction Carrier Hub (531) • Inspect for stripped or sheared splines on 3-5 Rev/4-5-6 Housing to Turbine Shaft (516) • Inspect for loose, worn or damaged 3-5 Rev/4-5-6 Housing Bushing • Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5 Rev/4-5-6 Housing (516)
Transmission Case Assembly	Inspect the input shaft support (56) for missing or damaged fluid ring seals (58).
Control Valve Body Assembly	Inspect the reverse and 4-5-6 regulator valve (411) and ball check valve (404) for debris and stickyness.
Control Solenoid (w/Body and TCM) Valve Assembly	Check the pressure control solenoid 3 (R1/456) for proper operation. Refer to <u>Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test.</u>

HARSH OR LATE THIRD, FIFTH, AND REVERSE SHIFT

Harsh or Late Third, Fifth, and Reverse Shift

Checks	Causes
3-5 Reverse Clutch Assembly	<ul style="list-style-type: none"> • Inspect for damaged splines or improper surface finish on 3-5 Reverse Clutch Plates (507-509), Backing Plate (510) • Inspect for damaged, worn or leaking 3-5 Reverse Clutch Piston Seals (504-506) • Inspect for warped 3-5 Rev/4-5-6 Clutch Housing (516) • Inspect for broken or fatigued 3-5 Reverse Clutch Waved Plate (507)

HARSH FOURTH, FIFTH, AND SIXTH SHIFT

Harsh Fourth, Fifth, and Sixth Shift

Checks	Causes
	<ul style="list-style-type: none"> • Inspect for leaking or damaged 4-5-6 Clutch Piston (520) and Piston Seals (518, 519, 521)

4-5-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for plugged or restricted 4-5-6 Piston Dam air bleed • Inspect for leaking or damaged 4-5-6 Clutch Dam (523) • Inspect for plugged or restricted Dam oil feed hole in the 4-5-6 Piston (520) • Inspect for fatigued 4-5-6 Clutch Piston Spring (522) • Inspect for leaking 4-5-6 Clutch Dam Seals (523) • Inspect for improper surface finish on 4-5-6 Clutch Plates (525-528) • Inspect for fatigued 4-5-6 Clutch Waved Plate (525) • Inspect for porous, improper surface finish, seal groove damage or plugged or restricted oil passages of the 3-5 Rev/4-5-6 Housing (516)
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NO TORQUE CONVERTER CLUTCH APPLY

No Torque Converter Clutch Apply

Checks	Causes
Torque Converter Assembly (28)	<ul style="list-style-type: none"> • Inspect for damaged Torque Converter Clutch Seal (inside converter assembly). • Diagnose Torque Converter Assembly for possible internal damage. Refer to <u>Torque Converter Diagnosis</u>.
Valve Body Assembly (433)	Inspect for worn, damaged or sticking TCC Regulator Apply (425) and TCC Regulator Apply Shuttle (426) Valves. Refer to <u>Control Solenoid Valve and Transmission Control Module Assembly Inspection</u> .
Oil Pump Assembly (201)	Inspect for worn or damaged Torque Converter Fluid Seal Assembly (301).
Torque Converter Housing Assembly (29)	Inspect for leaking or damaged Torque Converter Fluid Seal Assembly (301), Torque Converter Fluid Seal Assembly (319) and A/Trans Fluid Pump Assembly (201).

NO TORQUE CONVERTER CLUTCH RELEASE

No Torque Converter Clutch Release

Checks	Causes
Torque Converter Assembly (28)	Diagnose Torque Converter Assembly for possible internal damage. Refer to <u>Torque Converter Diagnosis</u> .
Valve Body Assembly (433)	Inspect for worn, damaged or sticking TCC Regulator Apply (425) and TCC Regulator Apply Shuttle (426) Valves.

HARSH TORQUE CONVERTER CLUTCH APPLY, OR INOPERATIVE OR NO ELECTRONICALLY CONTROLLED CAPACITY CLUTCH CONTROL

Harsh Torque Converter Clutch Apply, or Inoperative or No Electronically Controlled Capacity Clutch Control

Checks	Causes
Torque Converter Assembly (28)	<ul style="list-style-type: none"> Inspect for leaking or damaged Torque Converter Clutch Hub Seal. Diagnose Torque Converter Assembly for possible internal damage. Refer to <u>Torque Converter Diagnosis</u>.
Valve Body Assembly (433)	Inspect for worn, damaged or sticking TCC Regulator Apply (425) and TCC Regulator Apply Shuttle (426) Valves.

NO REVERSE GEAR

No Reverse Gear

Checks	Causes
Control Solenoid (w/Body and TCM) Valve Assembly	Check the 35R PC Solenoid 2 for proper operation. Refer to <u>Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test</u> .
Control Valve Body Assembly	<ul style="list-style-type: none"> Inspect the 3-5-Reverse Clutch Regulator Valve (421) and Control Valve Body Ball Check Valve (404) for debris and stickyness. Inspect the Clutch Select Valve (428) and the Actuator Feed Limit Valve (430) for debris and stickyness.
Transmission Case Assembly	Inspect the Input Shaft Support (56) for missing or damaged Fluid Seal Rings (58).
3-5 Reverse Clutch Assembly	<ul style="list-style-type: none"> Inspect for damaged, stripped or sheared splines on 3-5 Reverse Clutch Plates (507-509), Backing Plate (510). Inspect for stripped or sheared splines on 3-5 Rev/4-5-6 Housing to Turbine Shaft (516). Inspect for damage, improper surface finish, porosity, deformed or unbalanced 3-5 Rev/4-5-6 Housing (516). Inspect for damaged, worn, loose or seized hub bushing in the 3-5 Rev/4-5-6 Housing. Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5 Rev/4-5-6 Housing (516). Inspect for failure of the Input Shaft Thrust Bearing (538). Inspect for disengaged or broken 3-5 Reverse Clutch Backing Plate Retainer (511). Inspect for damaged, worn or leaking 3-5 Reverse Clutch Piston Seals (504-506). Inspect for damaged or broken 3-5 Rev/4-5-6 Clutch Housing (516). Inspect for warped, damaged, improper surface finish or debonding 3-5 Reverse Clutch Piston (502).

- Inspect for broken or fatigued 3-5 Reverse Clutch Spring (503).
- Inspect for disengaged or broken Speed Sensor Reluctor Retainer (500).
- Inspect for broken Speed Sensor Reluctor Wheel (501).

FLUID PRESSURE HIGH OR LOW

Fluid Pressure High or Low

Checks	Causes
Fluid Pump Assembly (201)	<ul style="list-style-type: none"> • Inspect for loose fluid pump bolts (204). • Inspect for leaking or damaged fluid pump outlet seals (24) and oil filter seal. • Inspect for improperly installed, restricted or damaged oil filter (203). • Inspect for sticking line pressure blow off valve (304). • Inspect for worn, sticking or damaged pressure regulator valve (309) or pressure regulator valve spring (308). • Inspect for damaged or restricted oil ports in the oil pump body (303). • Inspect for missing, leaking, or damaged auxiliary fluid inlet pump seal (371) - Hybrid Models.
Torque Converter Housing (208)	<ul style="list-style-type: none"> • Inspect for missing or restricted differential lube oil circuit orifice. • Inspect for missing front differential carrier baffle (205).
Control Solenoid Valve Assembly (w/Body and TCM) (7)	<ul style="list-style-type: none"> • Inspect for leaking or damaged filter plate assembly seals (8). • Verify VBS operation is not stuck high or low.
Case Assembly (50)	<ul style="list-style-type: none"> • Inspect for proper fluid level. • Inspect for missing lube oil circuit orifice or front differential carrier baffle (62). • Inspect for leaking or damaged valve body spacer plate assembly (12). • Inspect for damaged or leaking fluid check valve (55). • Inspect for leaking, damaged or broken fluid level control valve (13).
Torque Converter Assembly (28)	<ul style="list-style-type: none"> • Inspect for damaged torque converter clutch seal (inside converter assembly). • Inspect for damaged or disengaged torque converter hub to oil pump drive gear.

AUXILIARY FLUID PUMP PRESSURE HIGH OR LOW (HYBRID)

Auxiliary Fluid Pump Pressure High or Low (Hybrid)

Checks	Causes
Auxiliary Fluid Inlet Pump Seal (371)	Inspect for seal damage.
Pressure Regulator Valve (358)	<ul style="list-style-type: none">• Inspect for worn, sticking, or damaged pressure regulator valve (358).• Inspect for worn, sticking, or damaged pressure regulator valve spring (357).
A/Trans Fluid Trough Check Ball (373)	Check for debris, or damaged fluid trough check ball (373).
A/Trans Auxiliary Fluid Pump Outlet Pipe Seal Assembly (351)	<ul style="list-style-type: none">• Inspect for damaged auxiliary fluid pump outlet pipe (351).• Inspect for damaged auxiliary fluid pump outlet pipe seals (352).
Control Valve Body Ball Check Valve (404)	<ul style="list-style-type: none">• Check for damaged control valve body ball check valve (404).• Check the valve body spacer plate (403) for damage or debris.

Transmission

Automatic Transmission - 6T40 (MH8 MHH) - Repair Instructions - Off Vehicle

REPAIR INSTRUCTIONS - OFF VEHICLE

LIFT PLATE AND HOLDING FIXTURE INSTALLATION

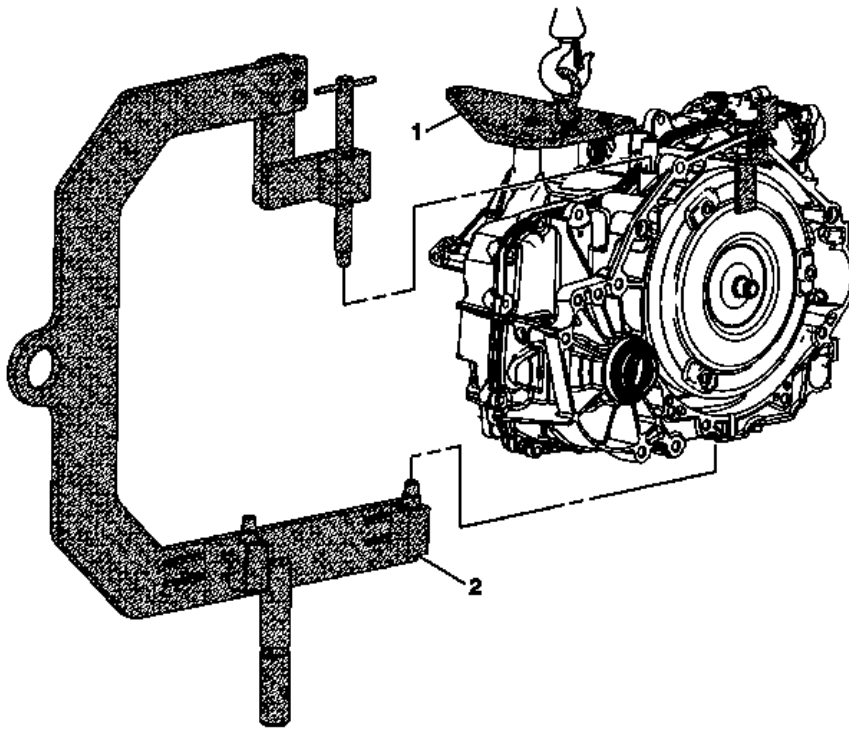


Fig. 1: Identifying Lift Plate & Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

Lift Plate and Holding Fixture Installation

Callout	Component Name
1	<p>DT-47811-A Transmission Lift Plate</p> <p>WARNING: Handle with care, the transmission assembly weighs over 83 Kg (183 lbs). Bodily injury could occur if not handled properly.</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Tighten bolts and nut.</p>

	<p>Tighten 12 N.m (106 lb in)</p> <p>Special Tools DT-47811-A Transmission Lift Plate For equivalent regional tools, refer to Special Tools .</p>
2	<p>DT-46625 Transmission Holding Fixture</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Raise the transmission with an overhead hoist. 2. Adjust mounting block on fixture to match bosses on case, then tighten bolts. <p>Tighten 13 N.m (10 lb ft)</p> <p>Special Tools DT-46625-10 Holding Fixture Adapter For equivalent regional tools, refer to Special Tools .</p>

TORQUE CONVERTER REMOVAL

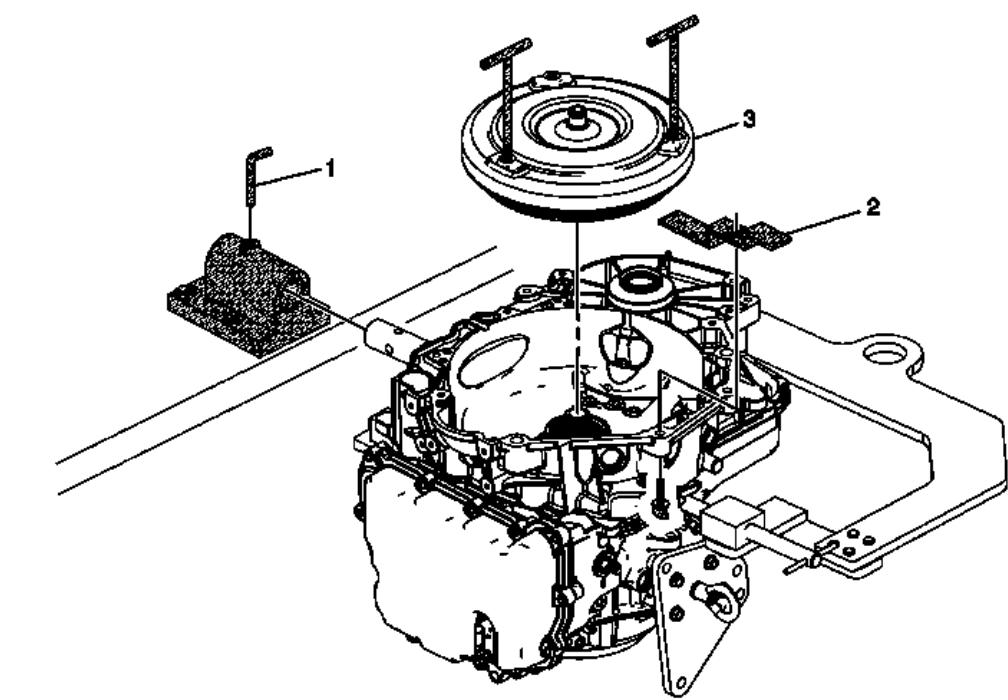


Fig. 2: View Of Torque Converter
 Courtesy of GENERAL MOTORS COMPANY

Torque Converter Removal

Callout	Component Name
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1	<p>Lock Pin</p> <p>WARNING: Lock pin must be secured into the bench fixture to hold the transmission and prevent bodily injury.</p> <p>NOTE: Ensure the DT 3289-20 holding fixture is mounted to a bench that is properly supported and will support the weight of the transmission assembly without tipping. DT-39890 holding fixture adapter and an engine stand can be used as an alternative method for supporting the transmission assembly during repairs.</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT 3289-20 Holding Fixture • DT-39890 Transmission Holding Fixture Adapter <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	<p>DT 21366 Torque Converter Holding Strap</p>
3	<p>Torque Converter Assembly</p> <p>CAUTION: Only install the lift assist handles until it stops. Do not tighten. Over tightening the lift assist handles can cause damage to the torque converter.</p> <p>NOTE: Failure to raise the torque converter straight up could damage the torque converter clutch lip seal inside the torque converter clutch assembly.</p> <p>Special Tool DT 46409 Torque Converter Lifting Handles</p> <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>

AUXILIARY FLUID PUMP REMOVAL (HYBRID)

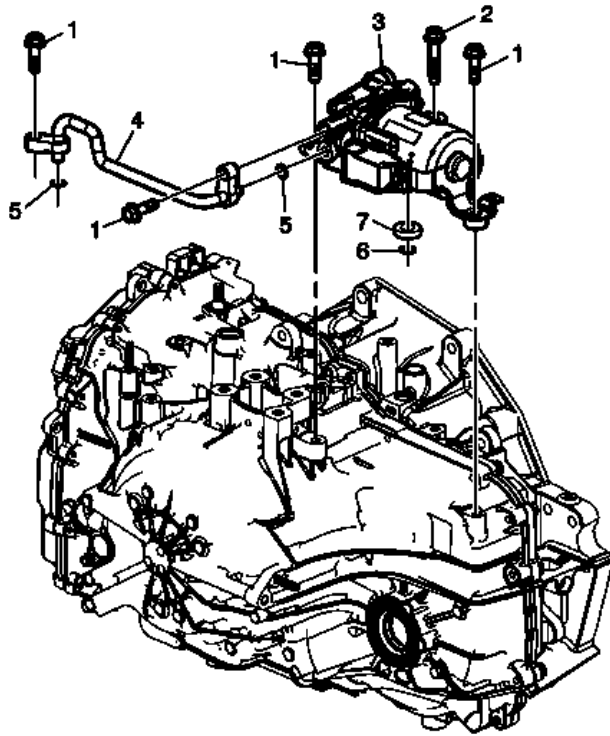


Fig. 3: Auxiliary Fluid Pump Components (Hybrid)
Courtesy of GENERAL MOTORS COMPANY

Auxiliary Fluid Pump Removal (Hybrid)

Callout	Component Name
1	A/Trans Auxiliary Fluid Pump Outlet Bolt (Qty: 4)
2	A/Trans Auxiliary Fluid Pump Bolt
3	A/Trans Auxiliary Fluid Pump Assembly
4	A/Trans Auxiliary Fluid Pump Outlet Pipe
5	A/Trans Auxiliary Fluid Pump Outlet Pipe Seal (Qty: 2)
6	A/Trans Auxiliary Fluid Pump Seal
7	A/Trans Auxiliary Fluid Pump Gasket

CONTROL VALVE BODY ASSEMBLY REMOVAL

Control Valve Body Cover Removal

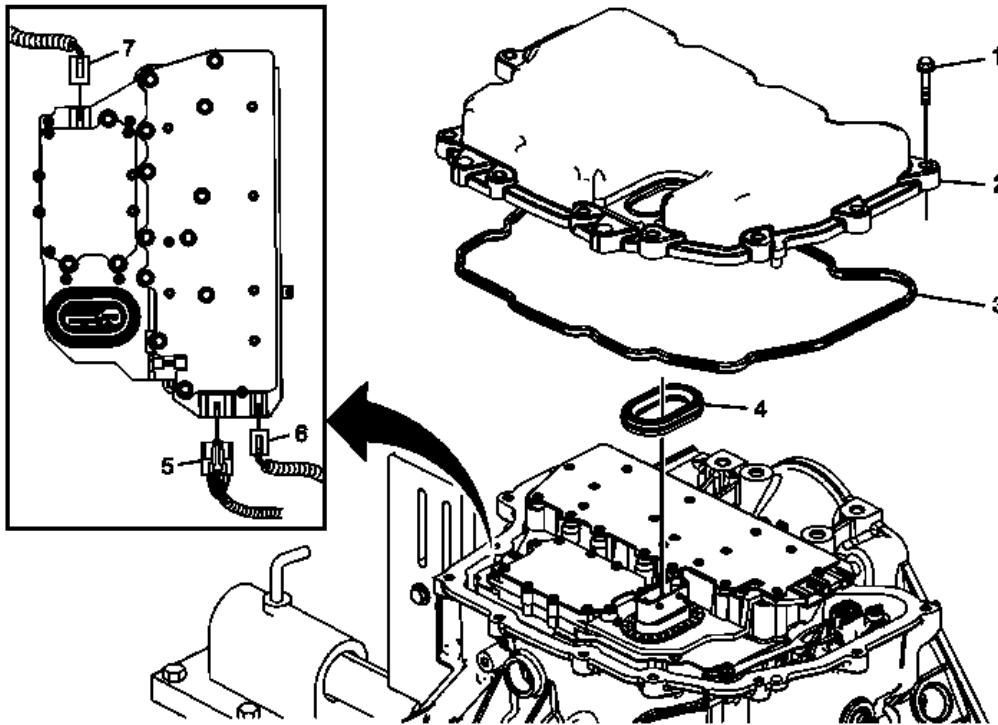


Fig. 4: View Of Control Valve Body Cover
 Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Cover Removal

Callout	Component Name
1	Control Valve Body Cover Bolts M6 x 30 (Qty: 13)
2	Control Valve Body Cover
3	Control Valve Body Gasket
	NOTE: Discard the seal. It is not reusable.
4	Control Valve Body Cover Wiring Connector Hole Seal
	CAUTION: Support the control solenoid valve assembly around the connector when removing the seal. Excessive pulling force can damage the internal electrical connections.
	NOTE: Discard the seal. It is not reusable.
5	Shift Position Switch Connector
6	Output Speed Sensor Connector
7	Input Speed Sensor Connector

Control Solenoid (With Body and TCM) Valve Assembly Removal

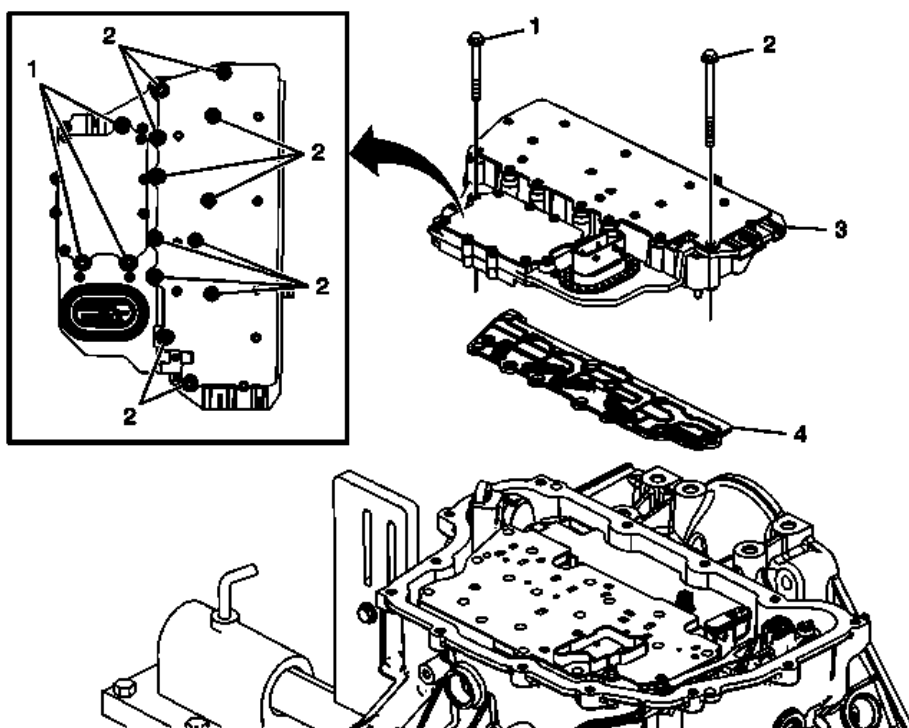


Fig. 5: View Of Control Solenoid (w/Body & TCM) Valve Assembly
 Courtesy of GENERAL MOTORS COMPANY

Control Solenoid (With Body and TCM) Valve Assembly Removal

Callout	Component Name
1	Control Valve Body M5 x 40.5 (Qty: 3)
2	Control Valve Body Bolt M6 x 30 (Qty: 12)
3	Control Solenoid (with Body and TCM) Valve Assembly
4	<p>Control Solenoid Valve Assembly Filter Plate</p> <p>CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.</p> <p>NOTE: Discard the filter plate. It is not reusable.</p>

Control Valve Body Assembly Removal

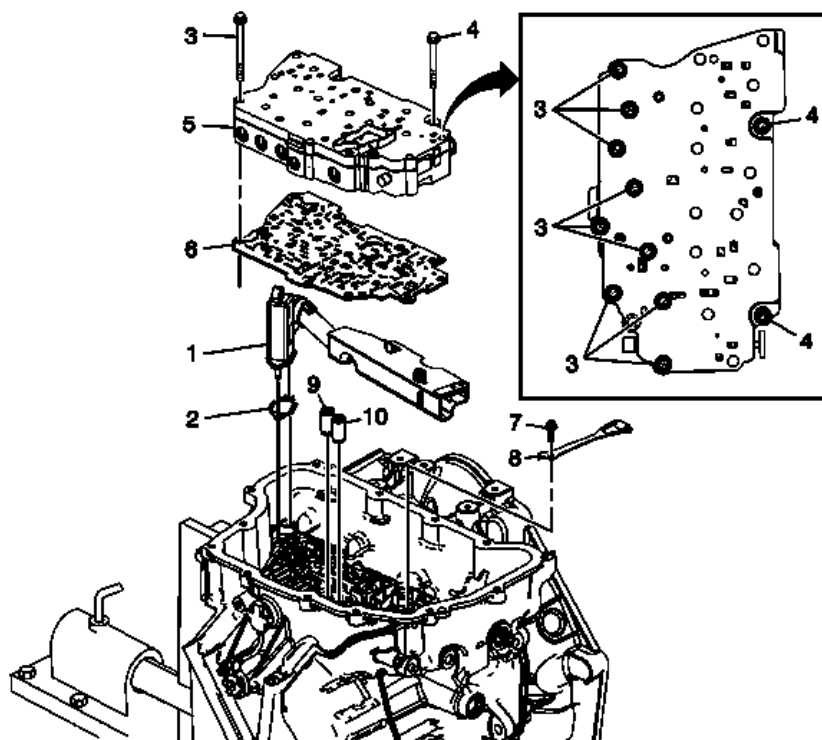


Fig. 6: View Of Control Valve Body Assembly
 Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Assembly Removal

Callout	Component Name
1	Fluid Level Control Valve
2	Fluid Level Control Valve Gasket
3	Control Valve Body Bolt M6 x 60 (Qty: 9)
4	Control Valve Body Bolt M6 x 53 (Qty: 2)
5	Control Valve Body Assembly
6	Control Valve Body Spacer Plate Assembly
7	Manual Shaft Detent Spring Bolt M6 x 16 (Qty: 1)
8	Manual Shaft Detent Lever Spring Assembly
9	1-2-3-4 Clutch Fluid Passage Seal NOTE: Discard the seal. It is not reusable.
10	Low/Reverse Clutch Fluid Passage Seal NOTE: Discard the seal. It is not reusable.

INPUT AND OUTPUT SPEED SENSOR REMOVAL

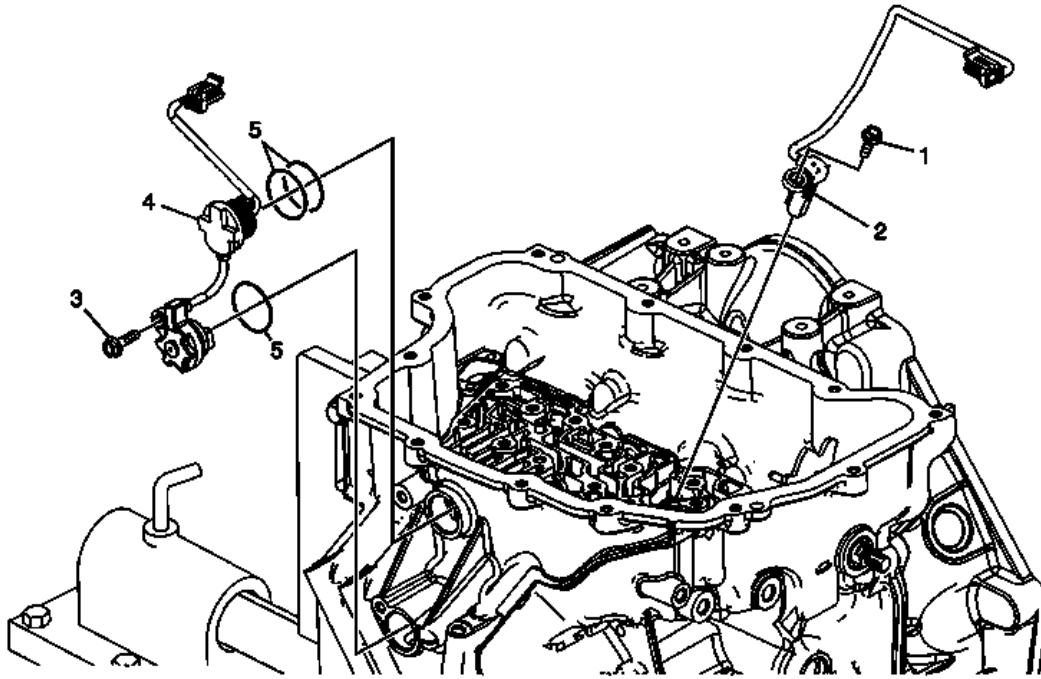


Fig. 7: View Of Input & Output Speed Sensor
 Courtesy of GENERAL MOTORS COMPANY

Input and Output Speed Sensor Removal

Callout	Component Name
1	A/Trans Output Speed Sensor Bolt M6 x 18 (Qty: 1)
2	A/Trans Output Speed Sensor Assembly
3	Input Speed Sensor Bolt M6 x 23 (Qty: 1)
4	Input Speed Sensor Assembly NOTE: Compress the locking tabs on the plug to release it from the case and to avoid damaging the retainers.
5	Input Speed Sensor Assembly Seals (Qty: 3) NOTE: Discard the seals. They are not reusable.

TORQUE CONVERTER HOUSING WITH FLUID PUMP ASSEMBLY REMOVAL (HYBRID)

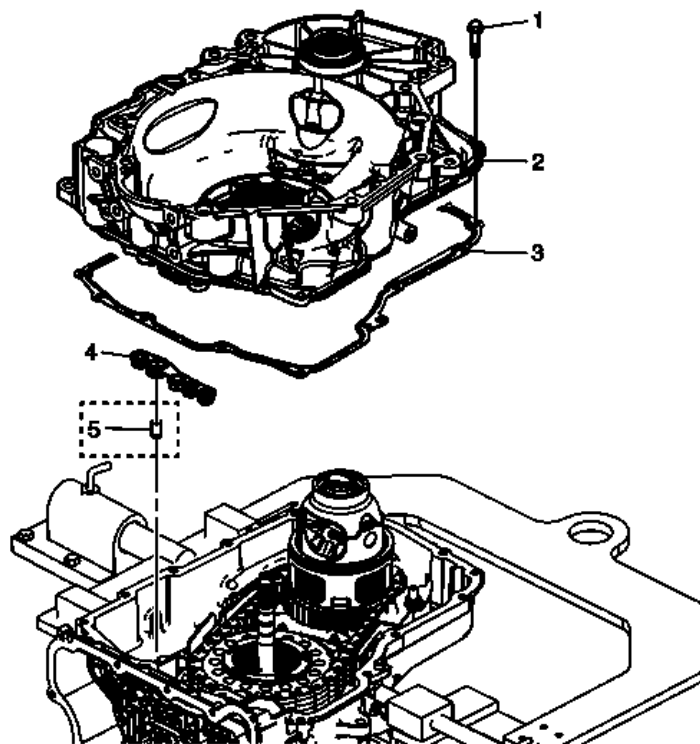


Fig. 8: Torque Converter Housing with Fluid Pump Assembly
 Courtesy of GENERAL MOTORS COMPANY

Torque Converter Housing with Fluid Pump Assembly Removal (Hybrid)

Callout	Component Name
1	Torque Converter and Differential Housing Bolts M8 x 30 (Qty: 15)
2	Torque Converter with Fluid Pump Housing Assembly
3	Torque Converter Housing Gasket NOTE: Discard the seal. It is not reusable.
4	Fluid Pump Seal Assembly NOTE: Discard the seal. It is not reusable.
5	A/Trans Fluid Trough Check Ball - Hybrid Models

DIFFERENTIAL CARRIER REMOVAL (6T40/45/50)

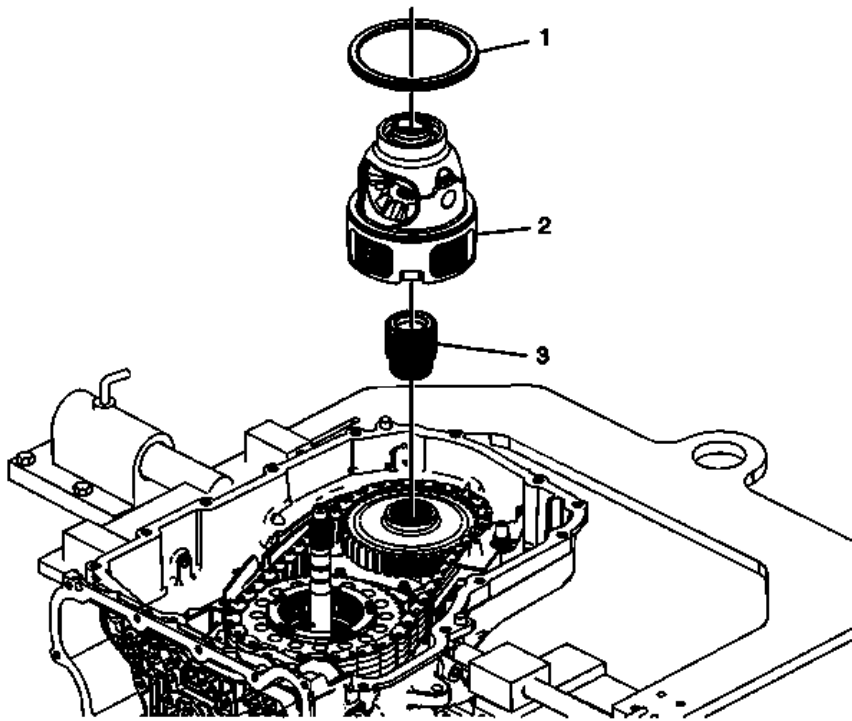


Fig. 9: View Of Front Differential Carrier Assembly
 Courtesy of GENERAL MOTORS COMPANY

Differential Carrier Removal (6T40/45/50)

Callout	Component Name
1	Front Differential Carrier Bearing Assembly
2	Differential Carrier Assembly
3	Final Drive Sun Gear

DRIVE AND DRIVEN SPROCKET, DRIVE LINK, AND PARK PAWL REMOVAL (6T40/45/50)

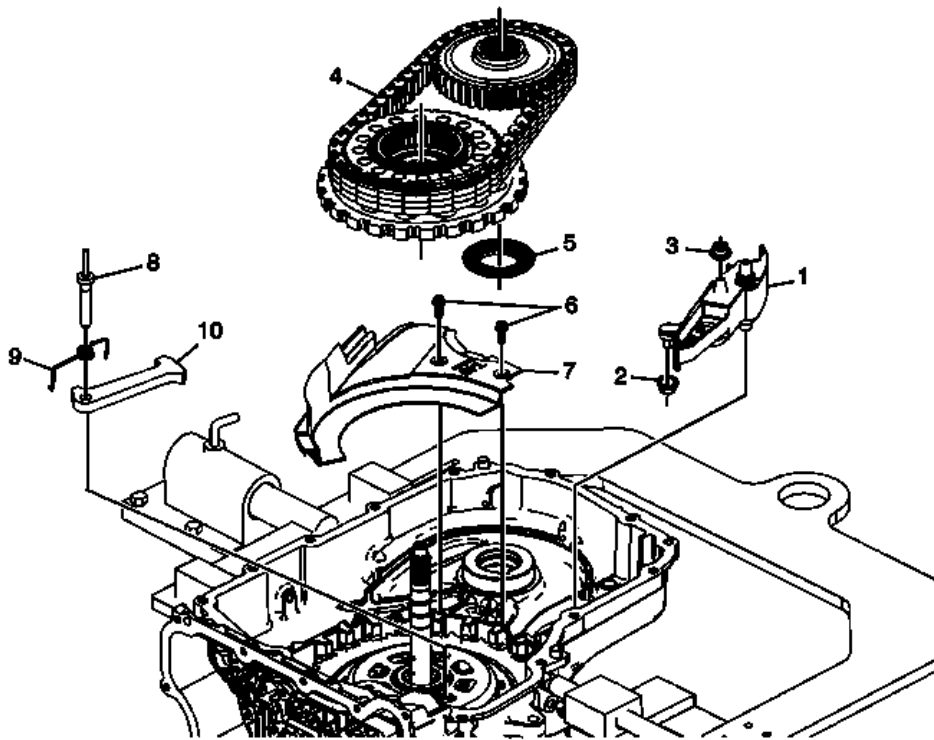


Fig. 10: View Of Drive and Driven Sprocket, Drive Link & Park Pawl
 Courtesy of GENERAL MOTORS COMPANY

Drive and Driven Sprocket, Drive Link, and Park Pawl Removal (6T40/45/50)

Callout	Component Name
1	Drive Link Lube Scoop
2	Drive Link Lube Scoop Seals
3	Drive Link Lube Fluid Seal
4	<p>Driven Sprocket Assembly, Drive Sprocket and Park Gear Assembly and Drive Link</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. The drive link, drive and driven sprocket assemblies must be removed at the same time. 2. The driven sprocket ball bearing inner race has a slight interference fit with the case. Pull straight up to ease removal.
5	<p>Driven Sprocket Bearing Assembly</p> <p>NOTE: The driven sprocket bearing may be stuck to the driven sprocket.</p>
6	Front Differential Carrier Baffle Bolts M6 x 16 (Qty: 2)
7	Front Differential Carrier Baffle
8	Park Pawl Shaft
9	Park Pawl Spring

INTERNAL COMPONENTS REMOVAL

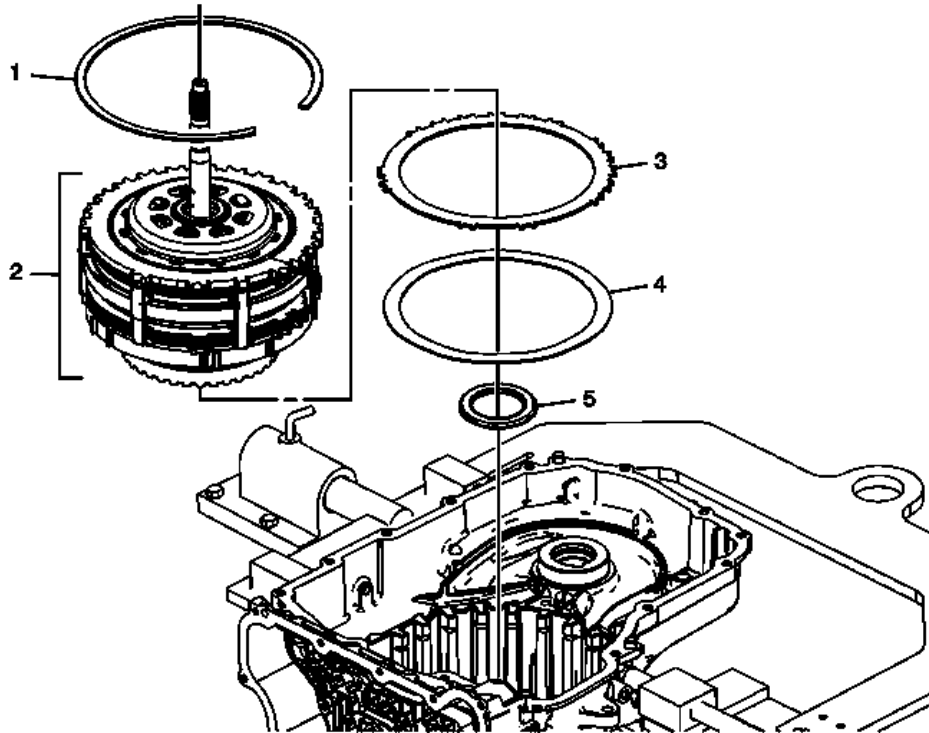


Fig. 11: View Of Transmission Internal Components
 Courtesy of GENERAL MOTORS COMPANY

Internal Components Removal

Callout	Component Name
1	<p>1-2-3-4 Clutch Backing Plate Retainer Ring</p> <p>WARNING: The retainer is under tension. Use care when removing or installing the retainer. Personal injury could result.</p> <p>CAUTION: Use caution during removal or installation of the retainer ring to avoid damage to the case machined surface in the park pawl area. Burrs or raised edges on the case machined surface can cause the park pawl to bind and prohibit it from engaging the park gear.</p> <p>NOTE: Remove one end of the retainer using DT-28585 snap ring remover or equivalent and work the retainer out of the case groove.</p>

	Special Tool DT-28585 Snap Ring Remover or equivalent For equivalent regional tools, refer to Special Tools .
2	3-5 Reverse and 4-5-6 Clutch Housing Assembly, Gearset, Low-Reverse Clutch Assembly and Low-Reverse and 1-2-3-4 Clutch Housing NOTE: This unit is heavy - weighs 40 lbs. (18 Kg).
3	2-6 Clutch Plate (Qty: 1)
4	2-6 Clutch Apply Plate (Waved)
5	35R and 456 Clutch Housing Thrust Bearing Assembly

2-6 CLUTCH PISTON REMOVAL

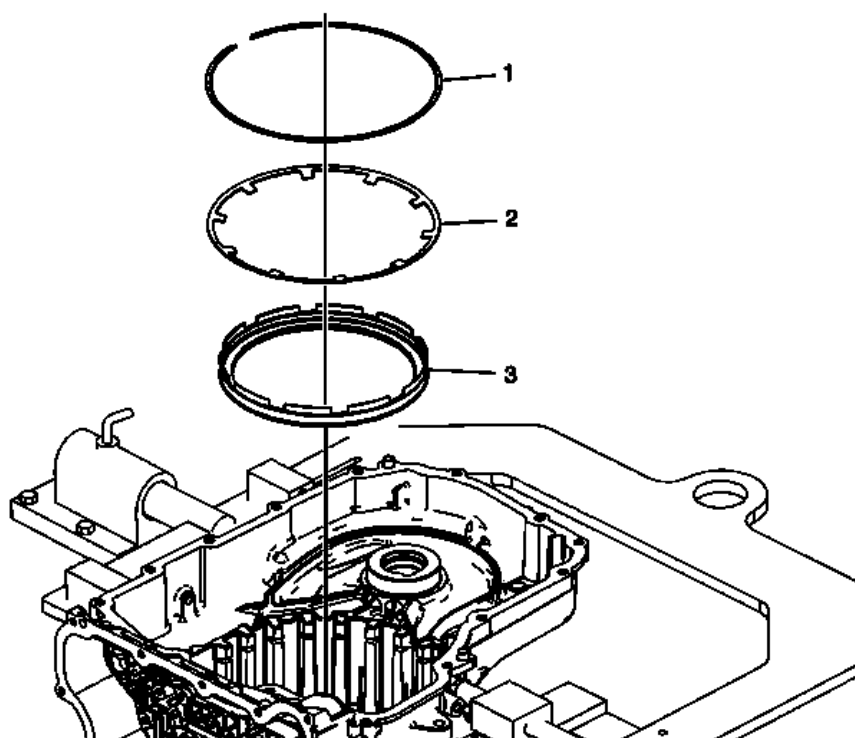


Fig. 12: View Of 2-6 Clutch Piston & Attached Components
Courtesy of GENERAL MOTORS COMPANY

2-6 Clutch Piston Removal

Callout	Component Name
1	2-6 Clutch Spring Retainer Special Tool DT-28585 Snap Ring Remover or equivalent For equivalent regional tools, refer to Special Tools .
2	2-6 Clutch Spring
	2-6 Clutch Piston Assembly

3

NOTE:

- Use pliers to remove the piston.
- Inspect the piston seals for damage and/or wear. The piston is reusable.

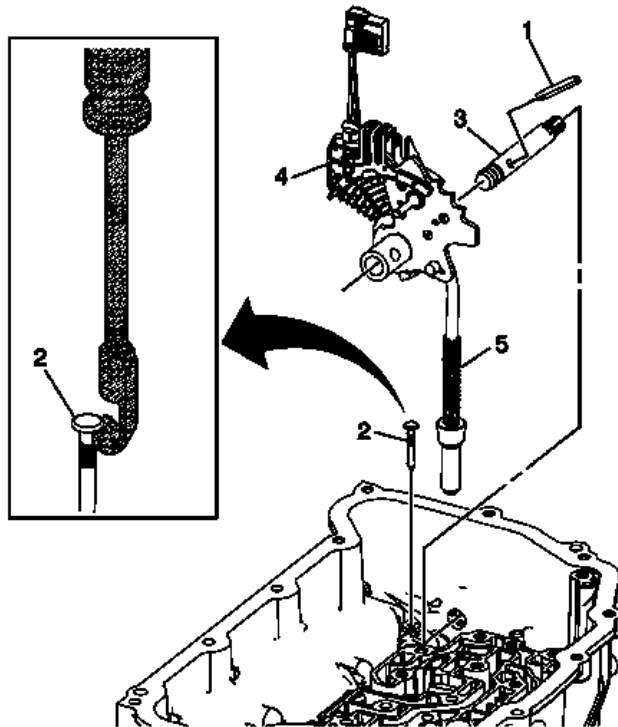
MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY AND PARK PAWL ACTUATOR REMOVAL**Manual Shaft Detent (w/Shift Position Switch) Lever Assembly Removal**

Fig. 13: Identifying Manual Shaft Detent Lever Assembly
Courtesy of GENERAL MOTORS COMPANY

Manual Shaft Detent (w/Shift Position Switch) Lever Assembly Removal

Callout	Component Name
1	Manual Shaft Detent Lever Hub Pin NOTE: Use side cutter to remove the pin (1) and discard.
	Manual Shift Shaft Pin NOTE: Discard the pin. It is not reusable.
	Special Tools

2	<ul style="list-style-type: none"> • DT-23129 Universal Seal Remover • GE-6125-1B Slide Hammer <p>For equivalent regional tools, refer to Special Tools .</p>
3	Manual Shaft
4	Manual Shaft Detent (w/Shift Position Switch) Lever Assembly
5	Park Pawl Actuator Assembly

Park Pawl Actuator Guide Removal

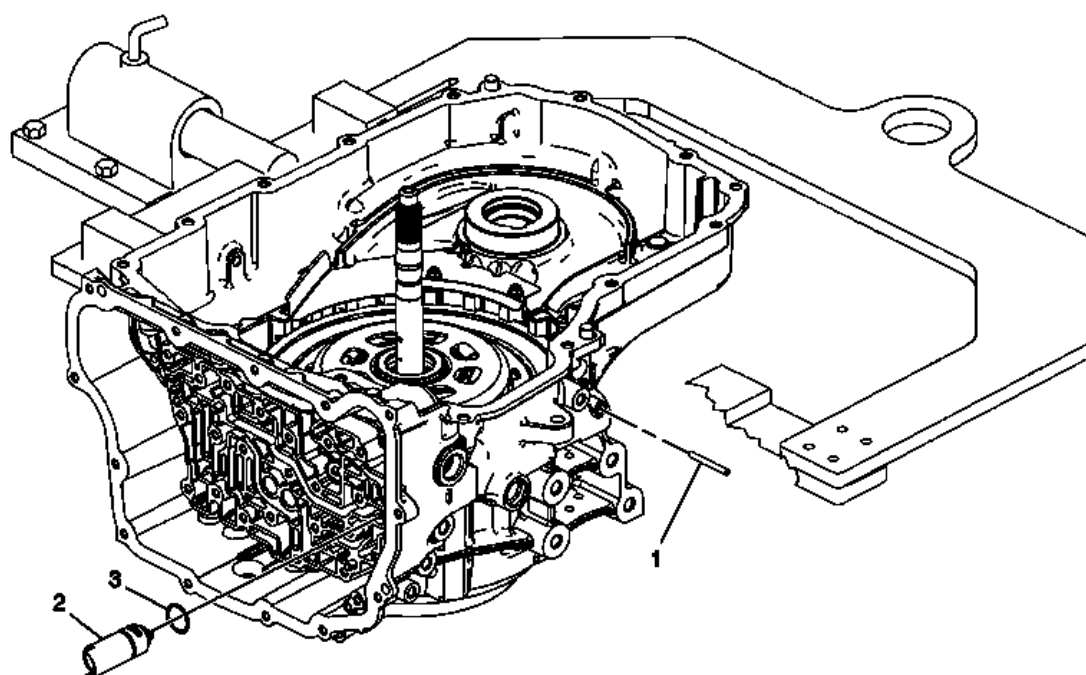


Fig. 14: Identifying Park Pawl Actuator Guide Components
 Courtesy of GENERAL MOTORS COMPANY

Park Pawl Actuator Guide Removal

Callout	Component Name
1	Park Pawl Actuator Guide Pin NOTE: Use side cutter to remove the pin (1) and discard.
2	Park Pawl Actuator Guide Assembly
3	Park Pawl Actuator Guide Assembly Seal NOTE:

Discard the seal. It is not reusable.

MANUAL SHIFT SHAFT SEAL REMOVAL

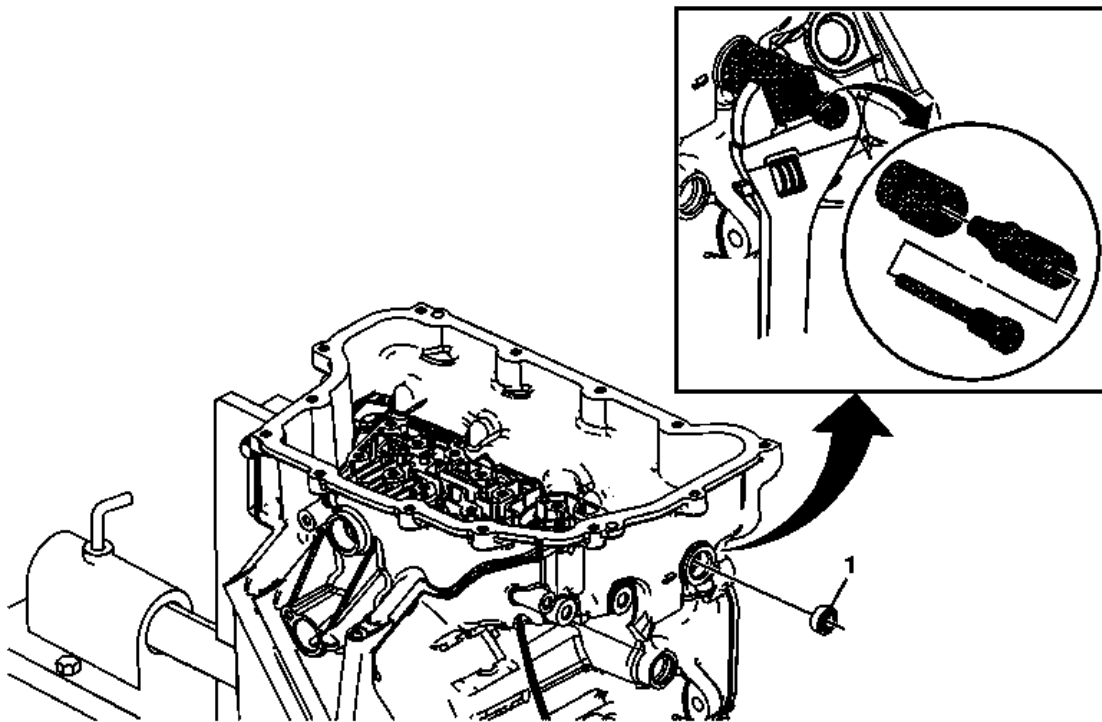


Fig. 15: identifying Manual Shift Shaft Seal
Courtesy of GENERAL MOTORS COMPANY

Manual Shift Shaft Seal Removal

Callout	Component Name
1	<p>Manual Shift Shaft Seal</p> <p>NOTE: Use the DT-45201 seal remover to remove the seal to prevent damage to the case surface.</p> <p>Special Tools DT-45201 Seal Remover For equivalent regional tools, refer to Special Tools .</p>

INPUT SHAFT SUPPORT REPLACEMENT (GEN 2)

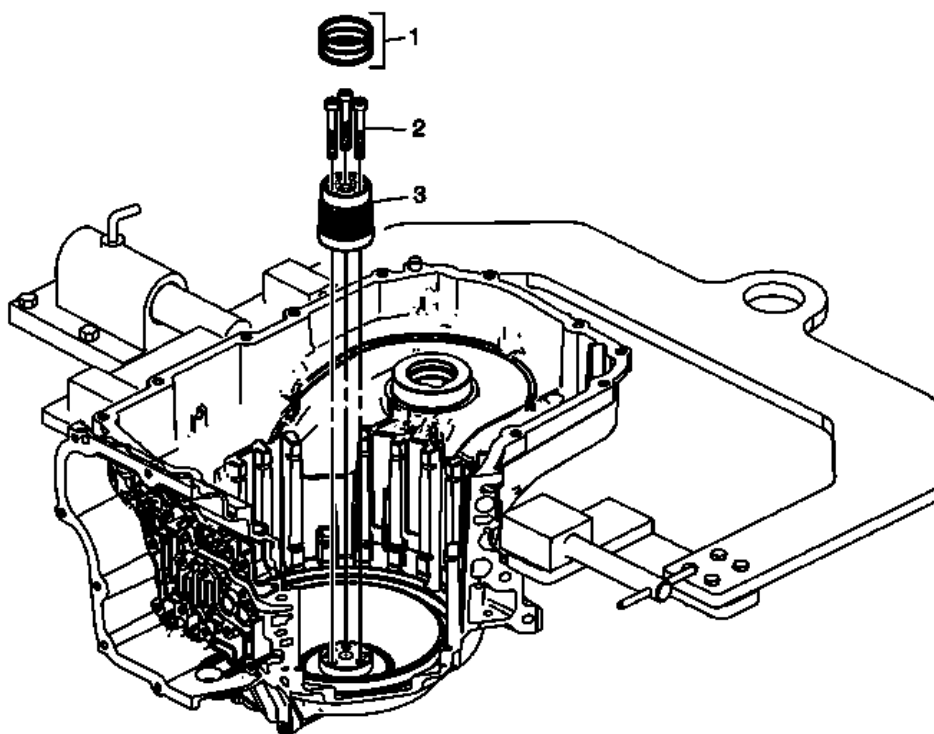


Fig. 16: Input Shaft Support Components (Gen 2)
 Courtesy of GENERAL MOTORS COMPANY

Input Shaft Support Replacement (Gen 2)

Callout	Component Name
1	3-5 Reverse and 4-5-6 Clutch Fluid Seals (Qty: 3) NOTE: <ul style="list-style-type: none"> • Discard the fluid seals. They are not reusable. • Refer to <u>3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring Replacement (Gen 2)</u>.
2	Input Shaft Support Bolts M6 x 50 (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)
3	Input Shaft Support NOTE: Inspect the support for wear, damage or porosity.

3-5-REVERSE AND 4-5-6 CLUTCH FLUID SEAL RING REPLACEMENT (GEN 2)

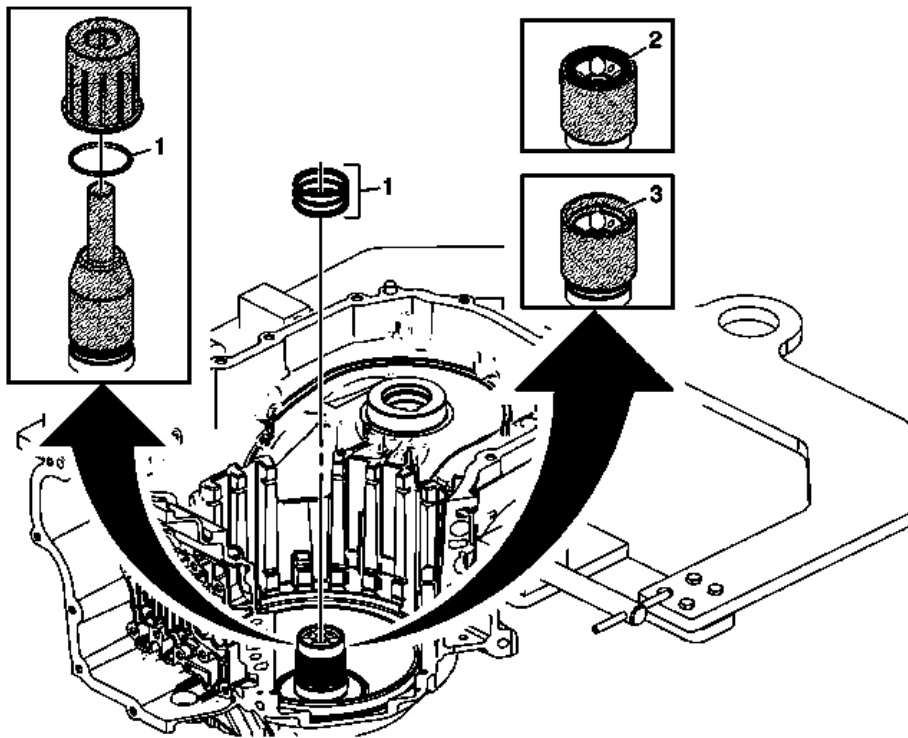


Fig. 17: 3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring (Gen 2)
 Courtesy of GENERAL MOTORS COMPANY

3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring Replacement (Gen 2)

Callout	Component Name
Special Tools DT-46620 Seal Installer For equivalent regional tools, refer to Special Tools .	
1	3-5 Reverse and 4-5-6 Clutch Fluid Seals (Qty: 3) Procedure <ol style="list-style-type: none"> 1. Place DT-46620-3 which is part of DT-46620 seal installer over the case hub and adjust it so that only the bottom seal ring is exposed. 2. Place a NEW fluid seal ring onto DT-46620-3 which is part of DT-46620 seal installer. 3. Use DT-46620-2 which is part of DT-46620 seal installer to push the fluid seal ring down over DT-46620-3 which is part of DT-46620 seal installer into the hub ring groove. 4. Repeat the above steps to install all 3 seal rings, adjusting DT-46620-3 which is part of DT-46620 seal installer to the appropriate ring groove.
	Small Chamfer Up CAUTION: Do not force the seal installer down over the seals as this will roll and damage the

	<p>seals. The large chamfer is designed to fit over the over stretched seal. Use a hand to help shrink the seal if the seal installer is difficult to install over the seal rings.</p>
2	<p>Procedure</p> <p>Install DT-46620-1 which is part of DT-46620 seal installer with the large chamfer end down over the fluid seal rings and leave DT-46620-1 which is part of DT-46620 seal installer on the seals for at least 60 seconds.</p>
3	<p>Large Chamfer Up</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Install DT-46620-1 which is part of DT-46620 seal installer with the small chamfer end facing down for at least 60 seconds. This will properly size the bottom seal ring. 2. Leaving DT-46620-1 which is part of DT-46620 seal installer on the fluid seal rings for an extended period of time could cause a fluid leak on the initial clutch piston circuit until the seal rings warm up and expand to the proper dimension.

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - CASE SIDE

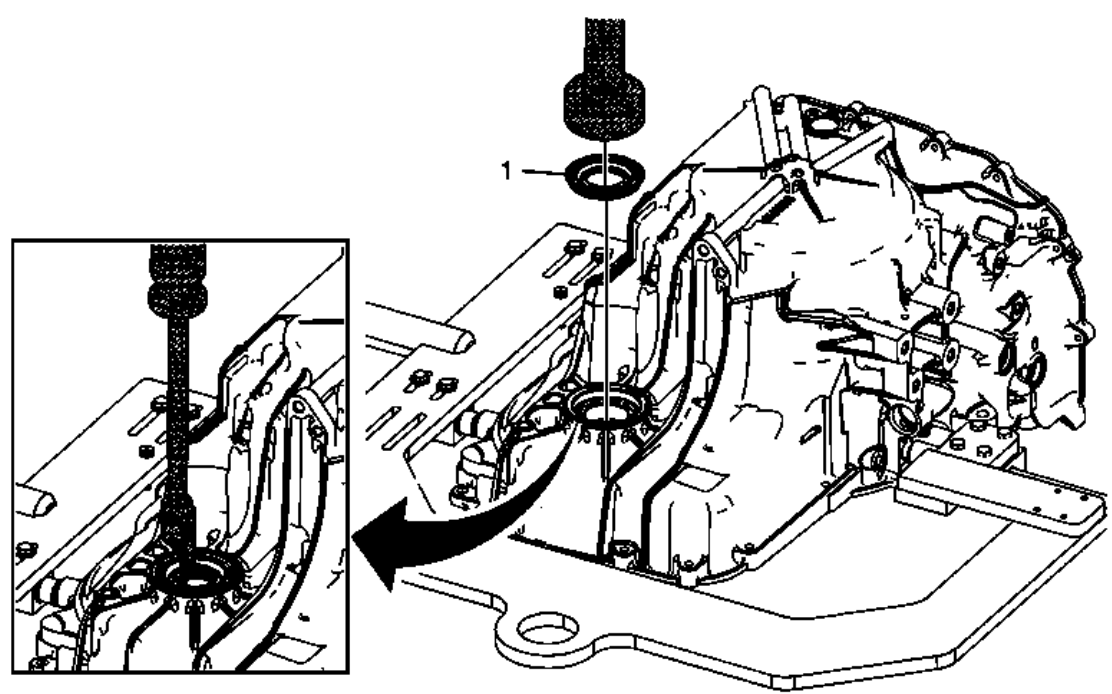


Fig. 18: View Of Case Side Front Wheel Drive Shaft Seal
 Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Case Side

Callout	Component Name

Front Wheel Drive Shaft Oil Seal

Special Tools

1

- **DT-23129** Universal Seal Remover
- **DT-47790** Seal Installer
- **GE-6125-1B** Slide Hammer
- **GE-8092** Driver Handle

For equivalent regional tools, refer to **Special Tools** .

TRANSMISSION CASE CLEANING AND INSPECTION

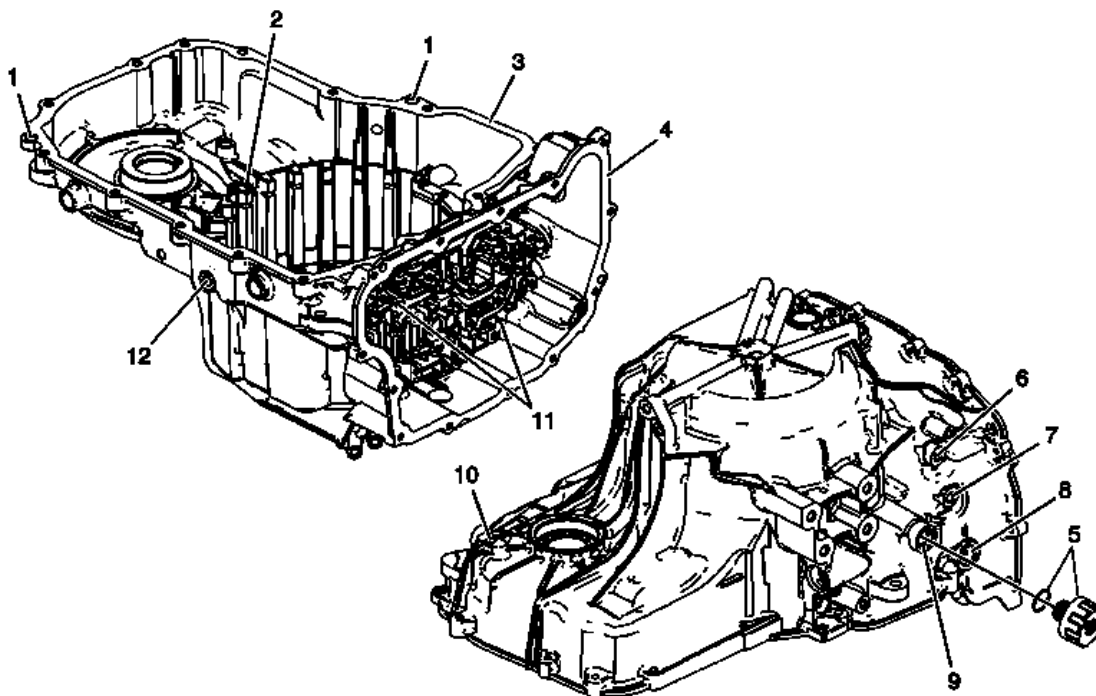


Fig. 19: Cleaning & Inspecting Transmission Case
Courtesy of GENERAL MOTORS COMPANY

Transmission Case Cleaning and Inspection

Callout	Component Name
CAUTION: Do not use abrasive pads or bristle devices to clean the sealing surfaces. Abrasive pads produce a fine grit that can effect transmission function. Abrasive pads can also remove enough metal to create oil leaks.	
CAUTION:	

After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.

CAUTION:

Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.

Preliminary Procedures

1. Thoroughly clean the transmission case assembly, including case threads, with clean solvent.
2. Clean gasket sealing surfaces. Remove all residual gasket material.
3. Inspect all threaded holes. If necessary, repair any thread damage.

1	Torque Converter Housing Locating Pin Procedure Inspect the torque converter housing locating pins. NOTE: The locating pins installed height is 7.4 mm (0.29 in).
2	Fluid Trough Check Ball NOTE: The check ball installed depth is 11 mm (0.43 in).
3	Converter Housing Sealing Surface
4	Control Valve Body Cover Sealing Surface
5	Fill Cap Seal
6	Transmission Fluid Cooler Pipe Sealing Surface
7	Fluid Pressure Test Plug CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)
8	Manual Shift Shaft Seal Surface
9	Fluid Fill Cap Sealing Surface
10	Fluid Level Plug Tighten 12 N.m (106 lb in)
11	Valve Body Locating Pin Procedure Inspect the valve body locating pins. NOTE:

	The locating pins installed height is 5.8 mm (0.22 in).
12	Drain Plug Tighten 12 N.m (106 lb in)

MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY AND PARK PAWL ACTUATOR INSTALLATION

Park Pawl Actuator Guide Installation

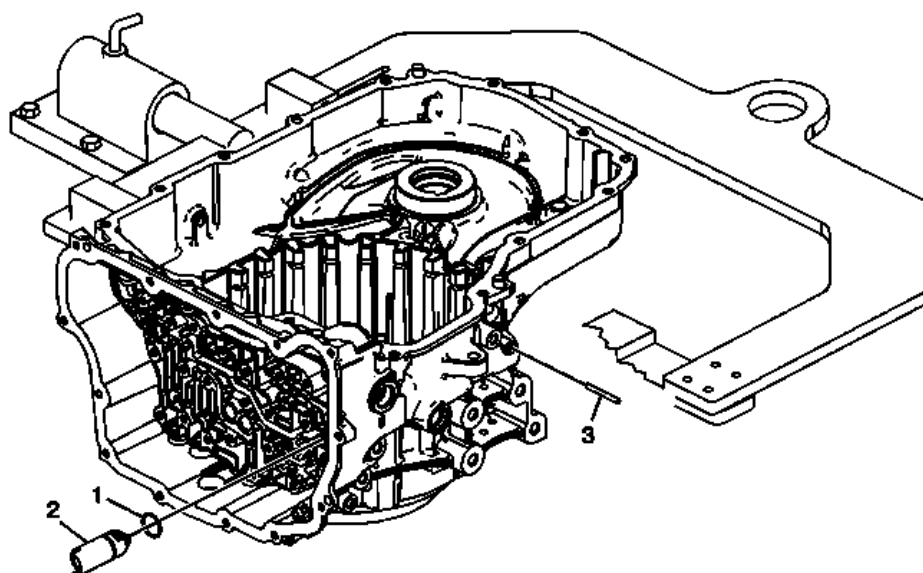


Fig. 20: View Of Park Pawl Actuator Guide & Seal
Courtesy of GENERAL MOTORS COMPANY

Park Pawl Actuator Guide Installation

Callout	Component Name
1	Park Pawl Actuator Guide Assembly Seal
2	Park Pawl Actuator Guide Assembly
3	<p>Park Pawl Actuator Guide Pin</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Install the park pawl actuator guide pin to correct height.</p>

Tighten
7.2 mm (0.28 in)

Park Pawl Actuator Installation

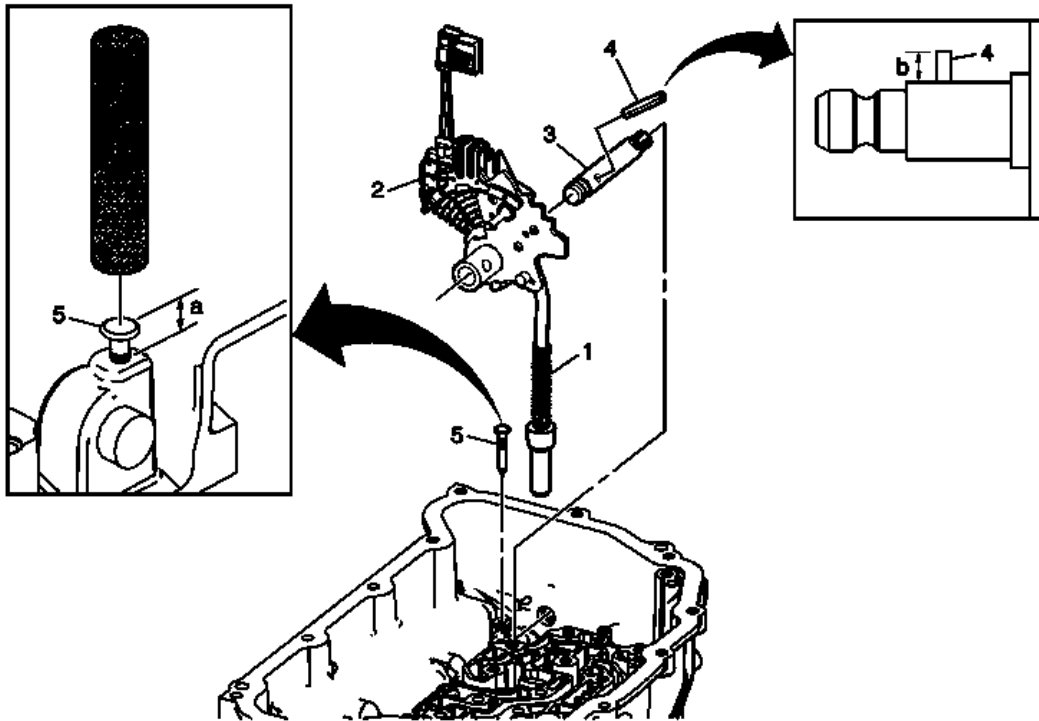


Fig. 21: Identifying Manual Shift Detent Lever with Shaft Position Switch Assembly & Park Pawl Actuator

Courtesy of GENERAL MOTORS COMPANY

Park Pawl Actuator Installation

Callout	Component Name
1	Park Pawl Actuator Assembly
2	Manual Shift Detent (w/Shaft Position Switch) Lever Assembly
3	Manual Shaft NOTE: Lubricate the shaft with ATF to prevent damage to the manual shift shaft seal during installation.
	Manual Shaft Detent Lever Hub Pin CAUTION: Refer to <u>Fastener Caution</u> . Procedure

4	<p>Install the manual shaft detent lever hub pin to correct height.</p> <p>NOTE: Use a NEW pin to ensure proper engagement with the shaft.</p> <p>Specification 7.9 mm (0.38 in) (b)</p> <p>Special Tools DT-48550 Detent Lever Pin Remover For equivalent regional tools, refer to <u>Special Tools</u> .</p>
5	<p>Manual Shift Shaft Pin</p> <p>CAUTION: Use the manual shaft pin installer to install the pin at the correct height in order to properly secure the manual shaft. If you install the pin too deep, the case bore may crack.</p> <p>Procedure Inspect pin installed height is within specifications.</p> <p>NOTE: Use a NEW pin to ensure proper engagement with the case.</p> <p>Specification 7.2-8.2 mm (0.28-0.32 in) (a)</p> <p>Special Tools DT-41229 Manual Shaft Pin Installer For equivalent regional tools, refer to <u>Special Tools</u> .</p>

MANUAL SHIFT SHAFT SEAL INSTALLATION

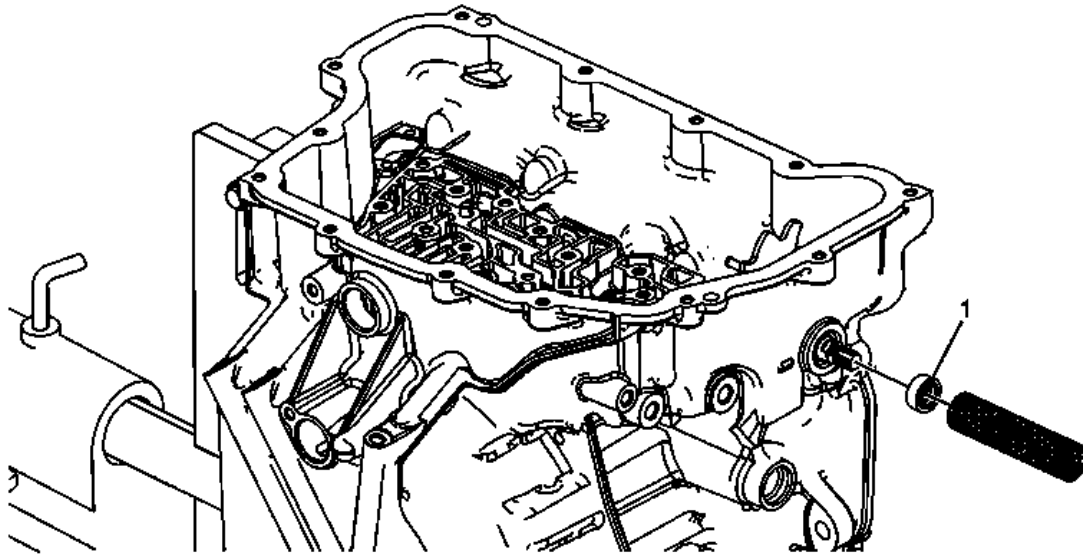


Fig. 22: Identifying Manual Shift Shaft Seal
 Courtesy of GENERAL MOTORS COMPANY

Manual Shift Shaft Seal Installation

Callout	Component Name
1	Manual Shift Shaft Seal Special Tool DT-49101 Seal Installer For equivalent regional tools, refer to <u>Special Tools</u> .

2-6 CLUTCH PISTON INSTALLATION (6T40/45/50)

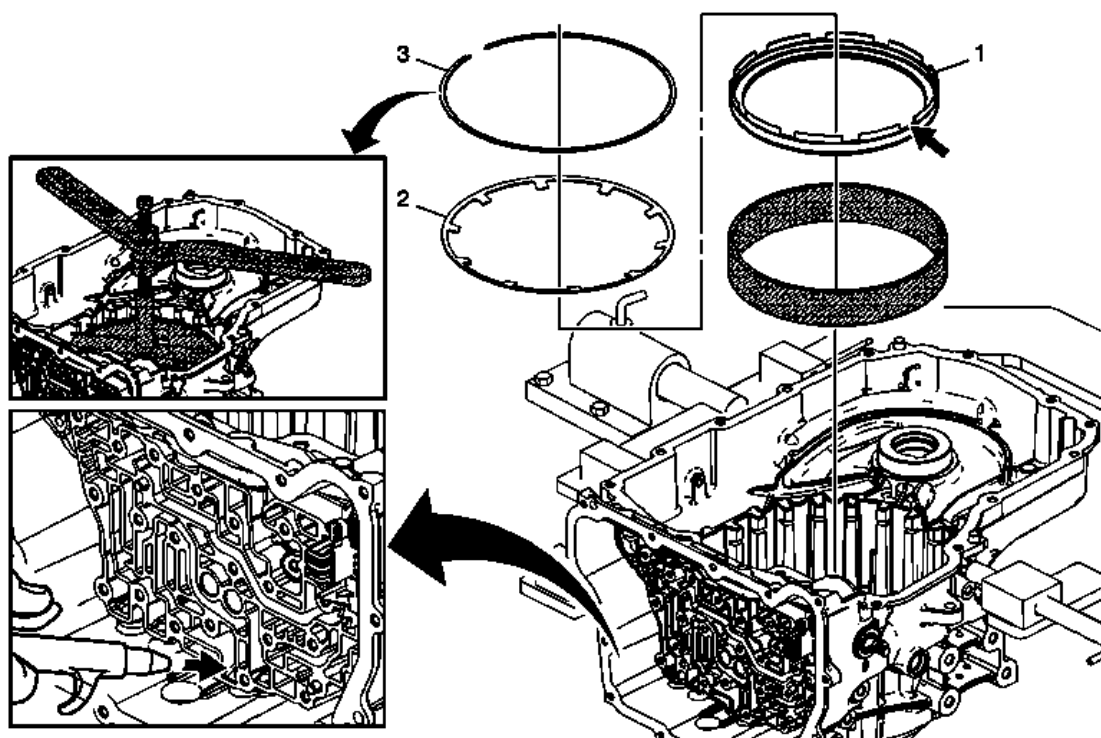


Fig. 23: View Of 2-6 Clutch Piston Assembly
 Courtesy of GENERAL MOTORS COMPANY

2-6 Clutch Piston Installation (6T40/45/50)

Callout	Component Name
1	<p>2-6 Clutch Piston Assembly</p> <p>NOTE:</p> <ul style="list-style-type: none"> • Position the 2-6 piston air bleed and large slot toward the top of the case. • DT-47796 seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of the DT-47796 seal protector to ease installation of the piston. <p>Special Tool DT-47796 Seal Protector For equivalent regional tools, refer to Special Tools .</p>
2	2-6 Clutch Spring
	<p>2-6 Clutch Spring Retainer</p> <p>CAUTION: Regulate the air pressure to 276 kPa (40 psi) maximum. High pressure could cause the piston to over travel and damage the piston seals.</p> <p>NOTE:</p>

- Place the retainer on the 2-6 clutch spring and align the retainer opening with the largest gap in the case splines toward the bottom of the case. The retainer opening should be supported by a spline tooth of the case.
- Apply shop air to the clutch fluid feed hole in the case to verify proper piston operation.

3 Special Tools

- DT-47797 Spring Installer
- DT-48056 Spring Compressor Bridge

For equivalent regional tools, refer to **Special Tools** .

LOW AND REVERSE AND 1-2-3-4 CLUTCH HOUSING, LOW AND REVERSE CLUTCH ASSEMBLY, OUTPUT SUN GEAR, AND 2-6 CLUTCH PLATE DISASSEMBLE (GEN 2)

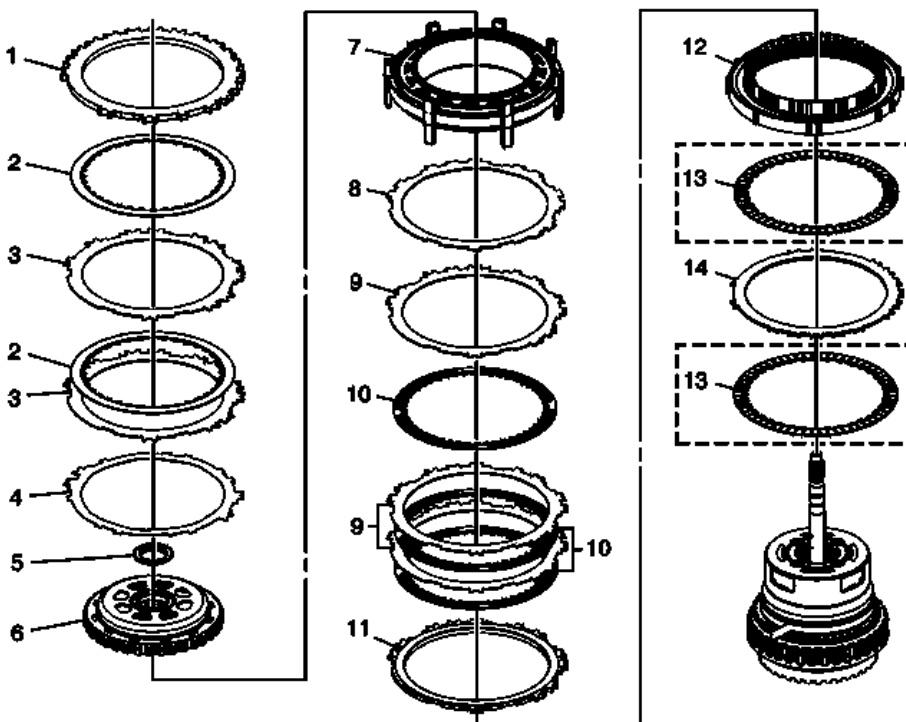


Fig. 24: 1-2-3-4 Clutch Housing And Clutch Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Low and Reverse and 1-2-3-4 Clutch Housing, Low and Reverse Clutch Assembly, Output Sun Gear, and 2-6 Clutch Plate Disassemble (Gen 2)

Callout	Component Name
1	1-2-3-4 Clutch Backing Plate
2	1-2-3-4 Clutch Plate Assembly (Qty: 2)

3	1-2-3-4 Clutch Plate (Qty: 2)
4	1-2-3-4 Clutch Waved Plate
5	Output Sun Gear Thrust Bearing Assembly NOTE: The sun gear thrust bearing may be stuck to the driven sprocket hub.
6	Output Sun Gear Assembly
7	Low-Reverse and 1-2-3-4 Clutch Housing Assembly
8	Low and Reverse Clutch Apply Plate
9	Low and Reverse Clutch Plate (Qty: 3)
10	Low and Reverse Clutch Plate Assembly (Qty: 3)
11	Low and Reverse Clutch Backing Plate
12	Low and Reverse Clutch Assembly (OWC)
13	2-6 Clutch Plate Assembly (Qty: 2) - Model Dependent NOTE: The number of grooves in the clutch plate friction material varies depending on model.
14	2-6 Clutch Plate (Qty: 1)

INPUT, REACTION, AND OUTPUT CARRIER DISASSEMBLE

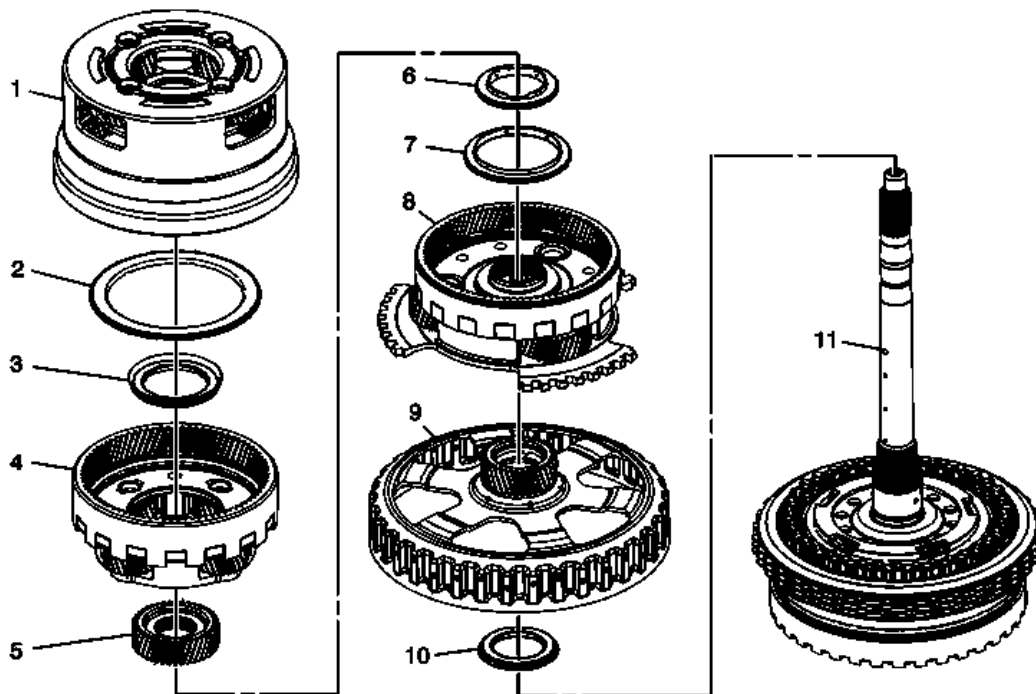


Fig. 25: Disassembled View Of Input, Reaction & Output Carrier
Courtesy of GENERAL MOTORS COMPANY

Input, Reaction, and Output Carrier Disassemble

Callout	Component Name
1	Output Carrier Assembly NOTE: <ul style="list-style-type: none">• The 6T30 and 6T40 have 4 pinions.• The 6T45 and 6T50 have 5 pinions.
2	Output Carrier Thrust Bearing Assembly
3	Input Sun Gear Thrust Bearing Assembly
4	Input Carrier Assembly NOTE: <ul style="list-style-type: none">• The 6T30 and 6T40 have 4 pinions.• The 6T45 and 6T50 have 5 pinions.
5	Input Sun Gear
6	Input Sun Gear Thrust Bearing Assembly
7	Input Carrier Thrust Bearing Assembly
8	Reaction Carrier Assembly NOTE: Starting in 2012, all 6T30/40/45/50 models have 3 pinion reaction carriers. The 3 pinion reaction carriers are back serviceable for all models. Original Configuration: <ul style="list-style-type: none">• The 6T30 and 6T40 had 3 pinions.• The 6T45 and 6T50 had 4 pinions.
9	Reaction Carrier Sun Gear Assembly
10	Reaction Carrier Sun Gear Thrust Bearing NOTE: The sun gear thrust bearing may be stuck to the sun gear.
11	3-5 Reverse and 4-5-6 Clutch Housing Assembly

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING DISASSEMBLE (6T40/45/50 - GEN 2)

Turbine Shaft, Reluctor Wheel and Piston Removal

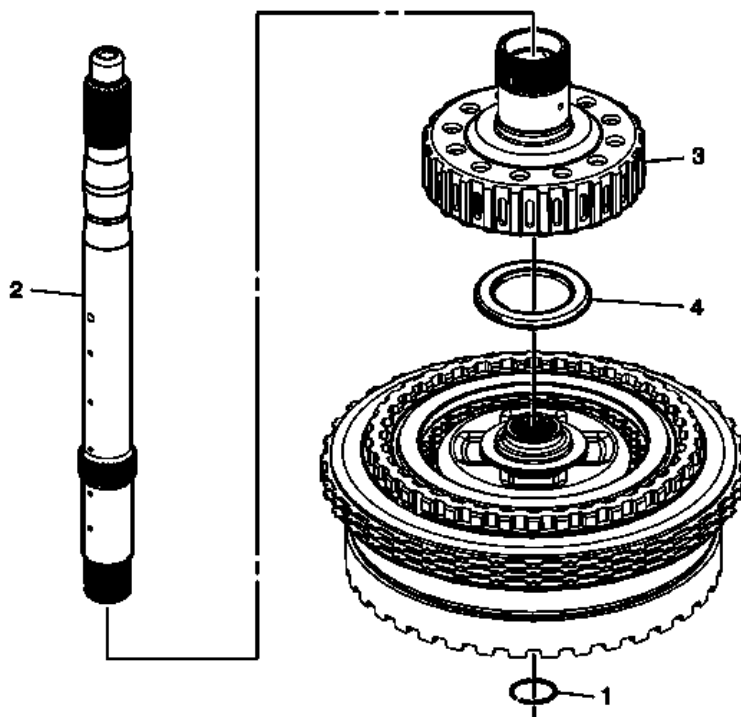


Fig. 26: Turbine Shaft, Reluctor Wheel And Piston
 Courtesy of GENERAL MOTORS COMPANY

Turbine Shaft, Reluctor Wheel and Piston Removal

Callout	Component Name
1	Turbine Shaft Retainer Ring NOTE: Discard the retainer ring. It is not re-usable. Special Tools GE 5586-A Snap Ring Pliers or equivalent For equivalent regional tools, refer to Special Tools .
2	Turbine Shaft
3	Reaction Carrier Hub Assembly
4	Reaction Carrier Hub Thrust Bearing Assembly

4-5-6 Clutch Plate Removal

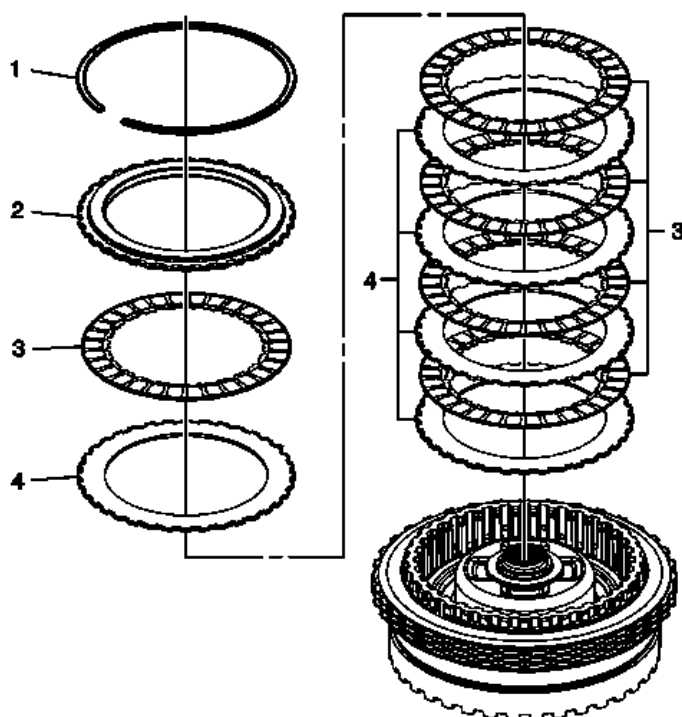


Fig. 27: 4-5-6 Clutch Plate Components
 Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Plate Removal

Callout	Component Name
1	4-5-6 Clutch Backing Plate Retaining Ring
2	4-5-6 Clutch Backing Plate
3	4-5-6 Clutch Plate Assembly (Qty: 5)
4	4-5-6 Clutch Plate (Gen 2 - Qty: 5)

4-5-6 Clutch Piston Removal

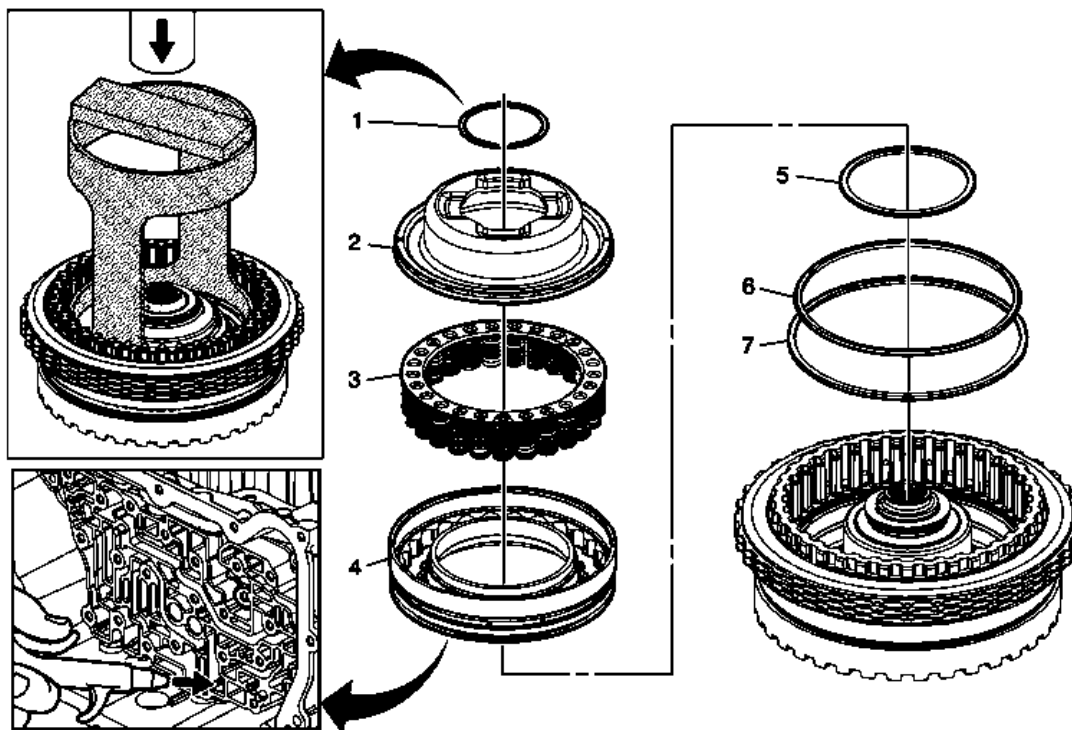


Fig. 28: 4-5-6 Clutch Piston Components
 Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Piston Removal

Callout	Component Name
1	<p>4-5-6 Clutch Dam Retaining Ring</p> <p>NOTE: The 4-5-6 clutch dam retaining ring is not reusable.</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-47951-2 Spring Compressor • GE 5586-A Snap Ring Pliers or equivalent <p>For equivalent regional tools, refer to Special Tools .</p>
2	<p>4-5-6 Clutch Piston Fluid Dam Assembly</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Place the 3-5 reverse and 4-5-6 clutch housing onto the support hub in the case. 2. Apply shop air to the 4-5-6 clutch feed hole using a rubber tipped air gun to dislodge the dam piston and the 4-5-6 clutch piston from the clutch housing.
3	4-5-6 Clutch Piston Return Spring Assembly

	4-5-6 Clutch Piston
4	NOTE: Apply shop air to the 4-5-6 clutch feed hole using a rubber tipped air gun to dislodge the clutch piston.
5	4-5-6 Clutch Piston Inner Seal
6	4-5-6 Clutch Piston Outer Seal (Dark Blue) (Stepped)
7	4-5-6 Clutch Piston Outer Seal (Large) (Rounded)

Reluctor Wheel and Piston Removal

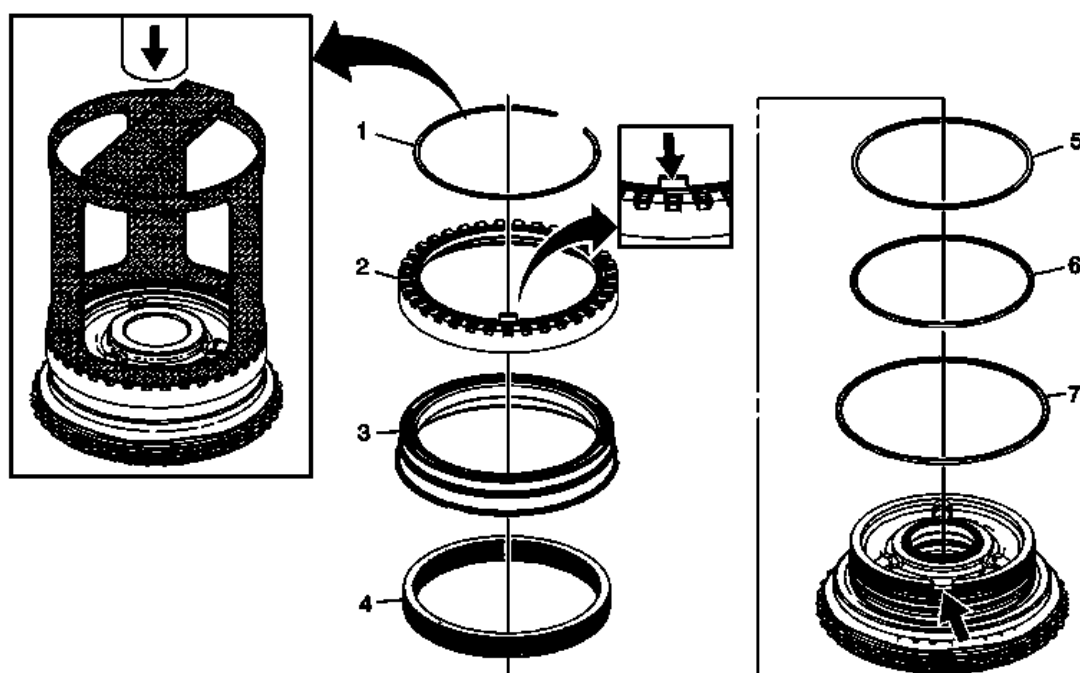


Fig. 29: Disassembled View Of Reluctor Wheel & Piston
Courtesy of GENERAL MOTORS COMPANY

Reluctor Wheel and Piston Removal

Callout	Component Name
1	Input Shaft Speed Sensor Reluctor Ring Retainer Ring CAUTION: Compress the reluctor wheel just enough to clear the retainer. Over compressing the reluctor wheel will break the alignment tab and the clutch housing. Special Tool DT-47694 Piston Spring Compressor

	For equivalent regional tools, refer to Special Tools .
2	Input Shaft Speed Sensor Reluctor Wheel
3	3-5 Reverse Clutch Piston
4	3-5 Reverse Clutch Piston Return Spring Assembly
5	3-5 Reverse Clutch Piston Inner (Reluctor) Seal (Orange)
6	3-5 Reverse Clutch Piston Inner Seal
7	3-5 Reverse Clutch Piston Dam Seal (Black)

3-5 Reverse Clutch Plate Removal

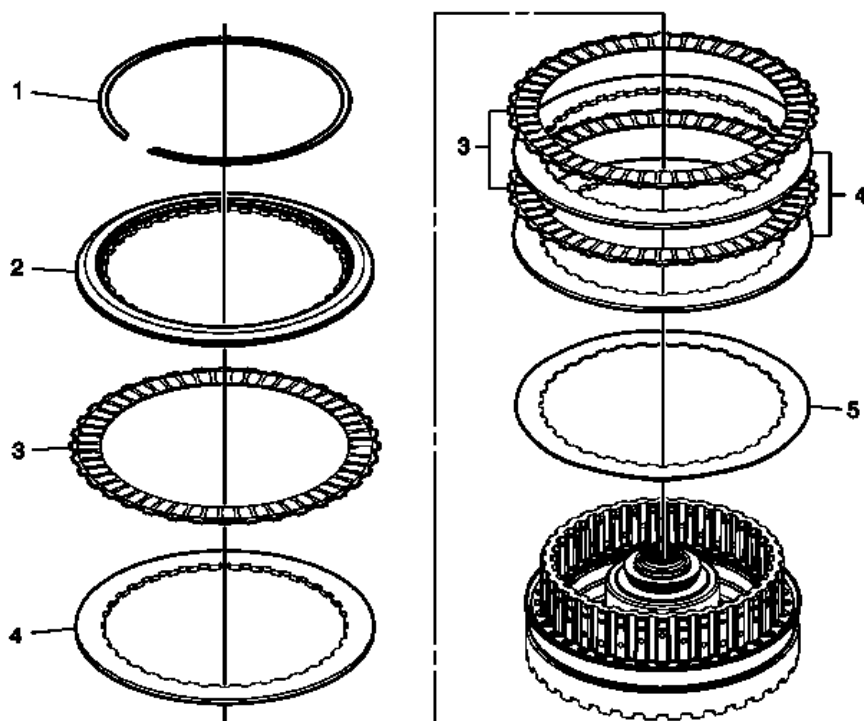


Fig. 30: 3-5 Reverse Clutch Plate Components
 Courtesy of GENERAL MOTORS COMPANY

3-5 Reverse Clutch Plate Removal

Callout	Component Name
1	3-5 Reverse Clutch Backing Plate Ring Retainer Ring NOTE: Gently push down on the backing plate to get enough clearance between the backing plate and retainer.
2	3-5 Reverse Clutch Backing Plate
3	3-5 Reverse Clutch Plate Assembly (Qty: 3)
4	3-5 Reverse Clutch Plate (Qty: 3)
5	3-5 Reverse Clutch Apply Plate (Waved)

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING ASSEMBLE (6T40/45/50 - GEN 2)

4-5-6 Clutch Piston Installation

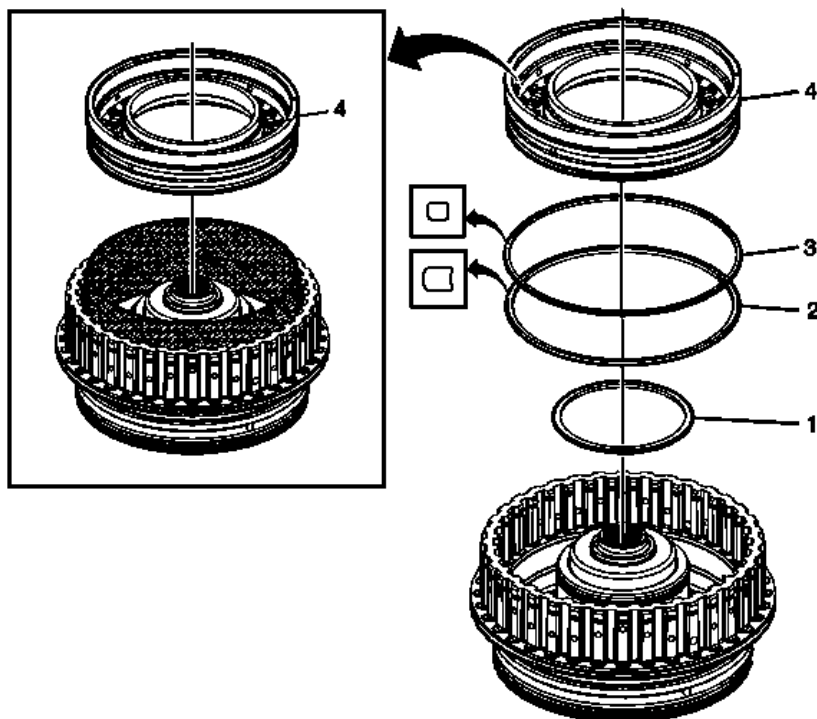


Fig. 31: 4-5-6 Clutch Piston Components
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Piston Installation

Callout	Component Name
1	4-5-6 Clutch Piston Inner Seal
2	4-5-6 Clutch Piston Outer Seal (Large) (Rounded)
3	4-5-6 Clutch Piston Outer Seal (Dark Blue) (Stepped)
4	<p>4-5-6 Clutch Piston</p> <p>NOTE:</p> <ul style="list-style-type: none"> DT-47805 seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT-47805 seal protector to ease the installation of the piston. DT-47951-2 spring compressor can be used as a pusher if necessary. <p>Special Tools</p> <ul style="list-style-type: none"> DT-47805 Seal Protector DT-47951-2 Spring Compressor

For equivalent regional tools, refer to **Special Tools** .

4-5-6 Clutch Fluid Dam Installation

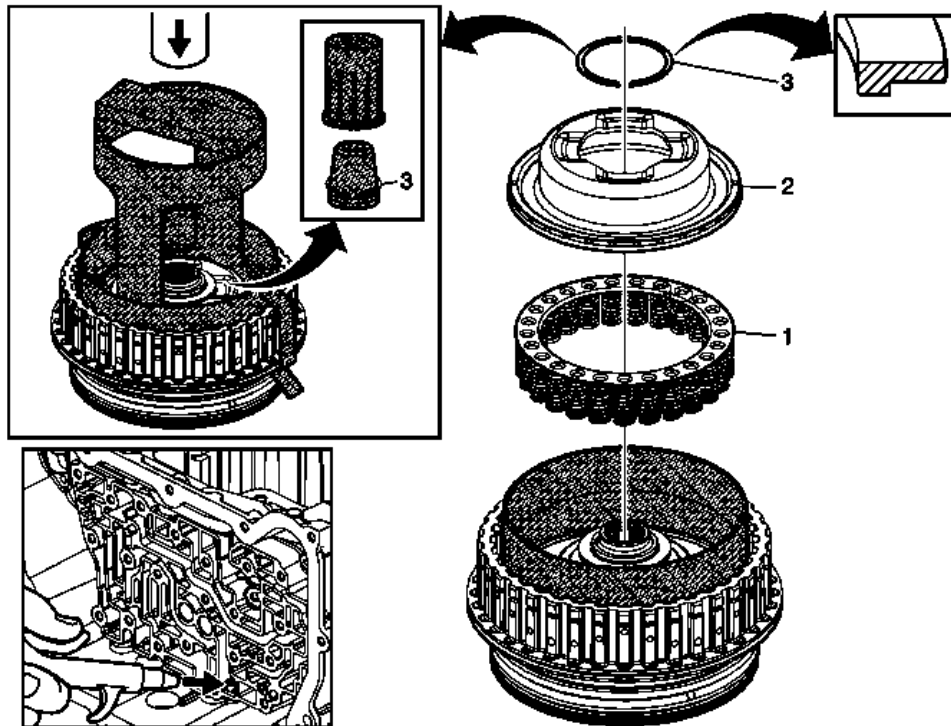


Fig. 32: 4-5-6 Clutch Fluid Dam
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Fluid Dam Installation

Callout	Component Name
1	4-5-6 Clutch Piston Return Spring Assembly
2	<p>4-5-6 Clutch Piston Fluid Dam Assembly</p> <p>NOTE: The seal protector prevents the dam seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of the seal protector to ease the installation of the dam.</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-47951-1 Seal Protector for 6T40/45 applications • DT-50117 Seal Protector for 6T50 applications <p>For equivalent regional tools, refer to Special Tools .</p>
	4-5-6 Clutch Dam Retaining Ring

CAUTION:

Regulate the air pressure to 276 kPa (40 psi) maximum. High pressure could cause the piston to over travel and damage the piston seals.

Procedure

3

1. Leave the seal protector on the clutch housing while installing the retaining ring. Install the dam retainer clips **DT 50117-1** seal protector to hold the seal protector in place.
2. Use **DT 46620-2** retaining clips and **DT 50573** ring guide to install a NEW 4-5-6 clutch dam retaining ring. Assemble the ring "L" leg facing down, DT 50573 and DT 46620 and insert as an assembly onto the clutch hub to install the ring.
3. Place the housing assembly onto the input shaft support inside the case. Apply shop air to the clutch fluid feed hole in the case to verify proper piston operation.

Special Tools

- **DT-47951-2** Spring Compressor
- **DT 46620** Seal Installer
- **DT 50117-1** Seal Protector
- **DT 50117-2** Seal Protector Retaining Clips
- **DT 50573** Retaining Ring Installer

For equivalent regional tools, refer to **Special Tools** .

3-5 Reverse Clutch Plates Installation

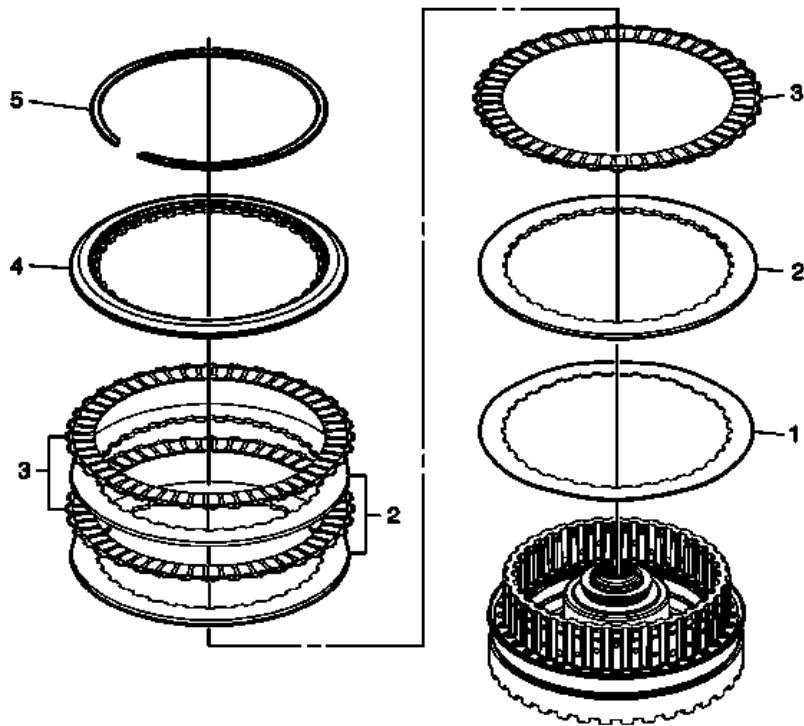


Fig. 33: 3-5 Reverse Clutch Plates
 Courtesy of GENERAL MOTORS COMPANY

3-5 Reverse Clutch Plates Installation

Callout	Component Name
1	3-5 Reverse Clutch Apply Plate (Waved)
2	3-5 Reverse Clutch Plate (Qty: 3)
3	3-5 Reverse Clutch Plate Assembly (Qty: 3)
4	3-5 Reverse Clutch Backing Plate
5	3-5 Reverse Clutch Backing Plate Ring Retainer Ring

Reluctor Wheel and Piston Installation

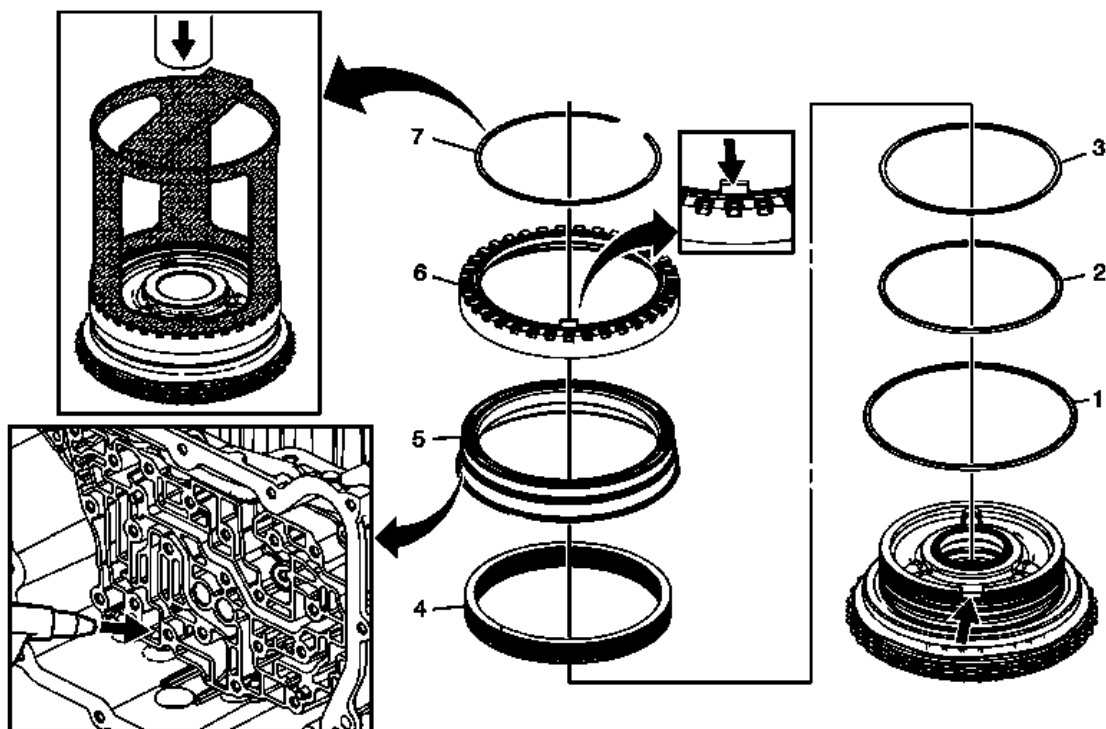


Fig. 34: Exploded View Of Reluctor Wheel & Piston
 Courtesy of GENERAL MOTORS COMPANY

Reluctor Wheel and Piston Installation

Callout	Component Name
1	3-5 Reverse Clutch Piston Dam Seal (Black)
2	3-5 Reverse Clutch Piston Inner Seal
3	3-5 Reverse Clutch Piston Inner (Reluctor) Seal (Orange)
4	3-5 Reverse Clutch Piston Return Spring Assembly
5	3-5 Reverse Clutch Piston
6	Input Shaft Speed Sensor Reluctor Wheel
7	<p>Input Shaft Speed Sensor Reluctor Ring Retainer Ring</p> <p>CAUTION: Compress the reluctor wheel just enough to clear the retainer. Over compressing the reluctor wheel will break the alignment tab and the clutch housing.</p> <p>CAUTION: Regulate the air pressure to 276 kPa (40 psi) maximum. High pressure could cause the piston to over travel and damage the piston seals.</p> <p>Procedure Place the housing assembly onto the input shaft support inside the case. Apply shop air to the clutch fluid feed hole in the case to verify proper piston operation.</p>

Special Tools

DT-47694 Piston Spring Compressor

For equivalent regional tools, refer to **Special Tools** .

4-5-6 Clutch Plates Installation

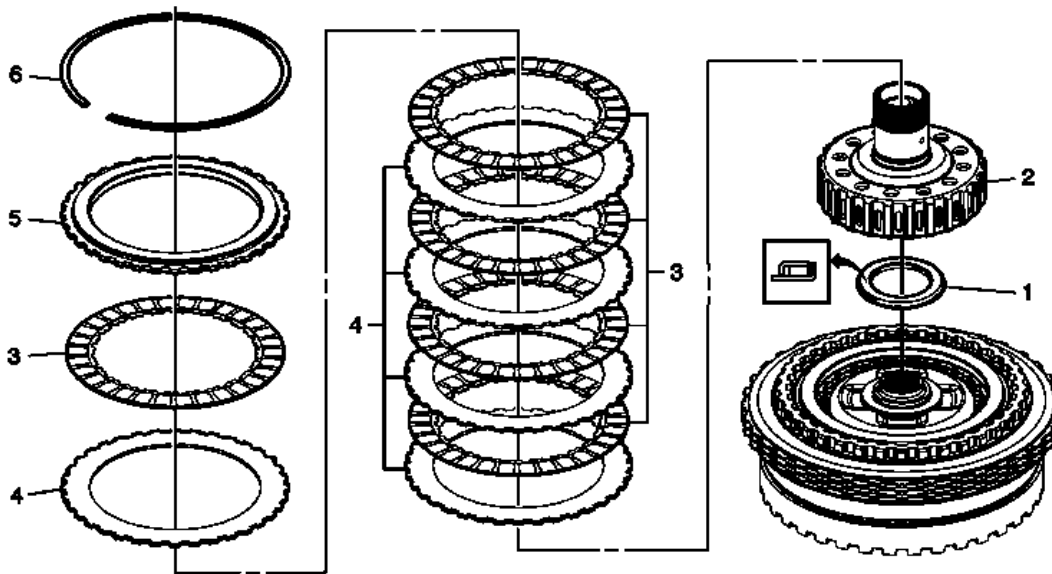


Fig. 35: 4-5-6 Clutch Plates

Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Plates Installation

Callout	Component Name
1	Reaction Carrier Hub Thrust Bearing Assembly
2	Reaction Carrier Hub Assembly
3	4-5-6 Clutch Plate Assembly (Qty: 5)
4	4-5-6 Clutch Plate (Qty: 5)
5	4-5-6 Clutch Backing Plate
6	4-5-6 Clutch Backing Plate Retaining Ring

Turbine Shaft Installation

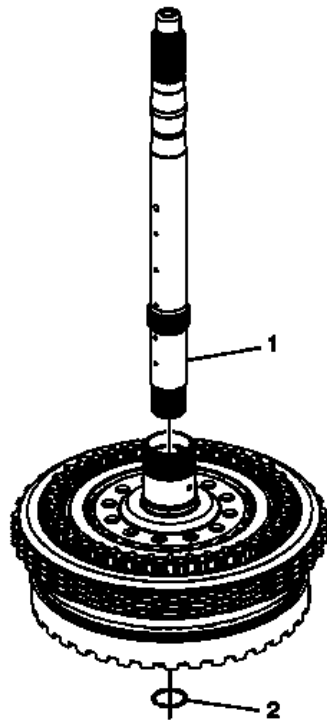


Fig. 36: View Of Turbine Shaft
 Courtesy of GENERAL MOTORS COMPANY

Turbine Shaft Installation

Callout	Component Name
1	Turbine Shaft
2	Turbine Shaft Retainer Ring NOTE: Do not re-use the turbine shaft retainer ring. Special Tools GE 5586-A Snap Ring Pliers or equivalent For equivalent regional tools, refer to <u>Special Tools</u> .

INPUT, REACTION, AND OUTPUT CARRIER ASSEMBLE (GEN 2)

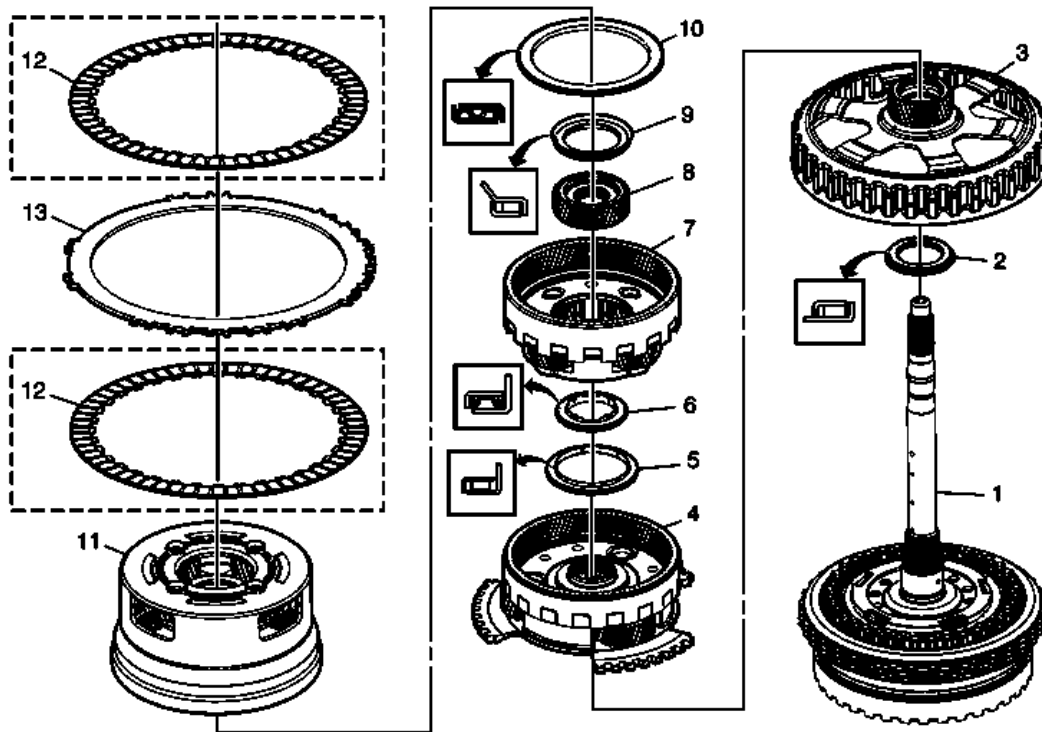


Fig. 37: Input, Reaction, and Output Carrier Components (Gen 2)
 Courtesy of GENERAL MOTORS COMPANY

Input, Reaction, and Output Carrier Assemble (Gen 2)

Callout	Component Name
1	3-5 Reverse and 4-5-6 Clutch Housing Assembly
2	Reaction Carrier Sun Gear Thrust Bearing
3	Reaction Carrier Sun Gear Assembly
4	Reaction Carrier Assembly NOTE: Starting in 2012, all 6T30/40/45/50 models have 3 pinion reaction carriers. The 3 pinion reaction carriers are back serviceable for all models. Original Configuration: <ul style="list-style-type: none"> • The 6T30 and 6T40 had 3 pinions. • The 6T45 and 6T50 had 4 pinions.
5	Input Carrier Thrust Bearing Assembly
6	Input Sun Gear Thrust Bearing Assembly
7	Input Carrier Assembly NOTE: <ul style="list-style-type: none"> • The 6T30 and 6T40 have 4 pinions.

	<ul style="list-style-type: none"> • The 6T45 and 6T50 have 5 pinions.
8	Input Sun Gear
9	Input Sun Gear Thrust Bearing Assembly
10	Output Carrier Thrust Bearing Assembly
11	Output Carrier Assembly NOTE: <ul style="list-style-type: none"> • The 6T30 and 6T40 have 4 pinions. • The 6T45 and 6T50 have 5 pinions.
12	2-6 Clutch Plate Assembly (Qty: 2) - Model Dependent NOTE: <ul style="list-style-type: none"> • Begin with the clutch plate assembly and alternate with the clutch plate. • The number of grooves in the clutch plate friction material varies depending on model.
13	2-6 Clutch Plate (Qty: 1) NOTE: Only install one 2-6 Clutch Plate at this time. The remaining clutch plate is installed into the case.

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING, AND INPUT, REACTION, AND OUTPUT CARRIER INSTALLATION

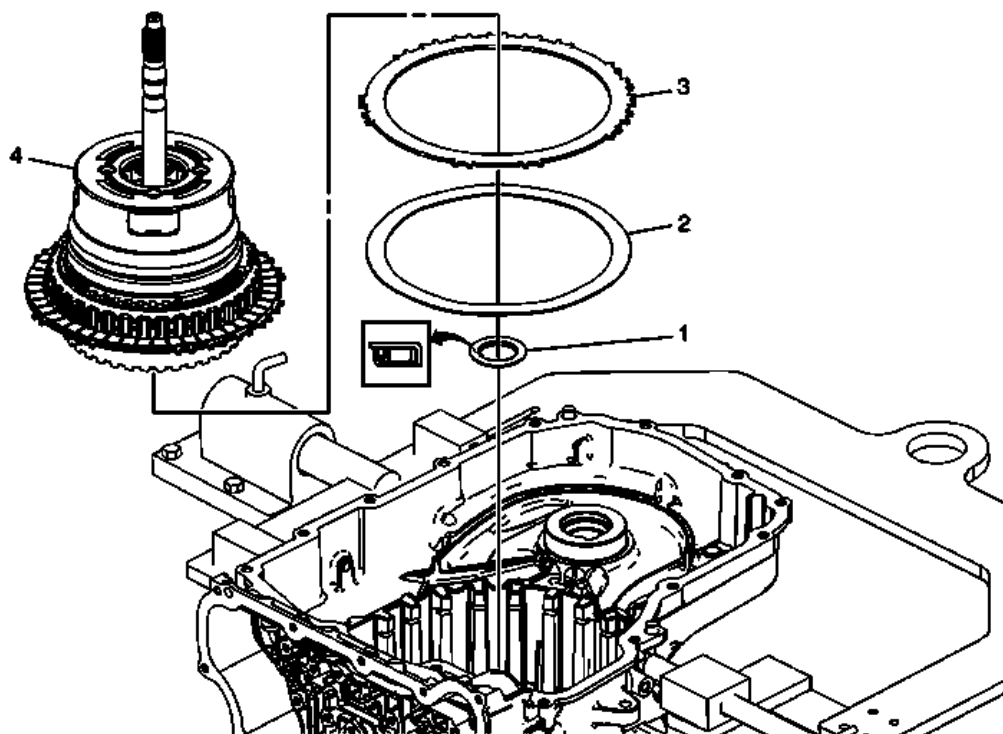


Fig. 38: View Of 3-5-Reverse, 4-5-6 Clutch Housing, Input, Reaction & Output Carrier Components
 Courtesy of GENERAL MOTORS COMPANY

3-5-Reverse and 4-5-6 Clutch Housing, and Input, Reaction, and Output Carrier Installation

Callout	Component Name
1	3-5 Reverse and 4-5-6 Clutch Housing Thrust Bearing
2	2-6 Clutch Apply Plate (Waved)
3	2-6 Clutch Plate (Qty: 1) NOTE: <ul style="list-style-type: none"> • Only install one 2-6 Clutch Plate. The remaining clutch plate is installed with the gearset assembly. • Align the large flat areas with the valve body end of the case and the 2 tabs on the clutch plate that are close to each other with the slots at the bottom right corner of the case.
4	3-5 Reverse and 4-5-6 Clutch Housing Assembly and Gearset NOTE: Align the large flat areas of the 2-6 Clutch Plate with the valve body end of the case and the 2 tabs on the clutch plate that are close to each other with the slots at the bottom right corner of the case.

LOW AND REVERSE CLUTCH ASSEMBLY AND LOW AND REVERSE CLUTCH PLATE INSTALLATION

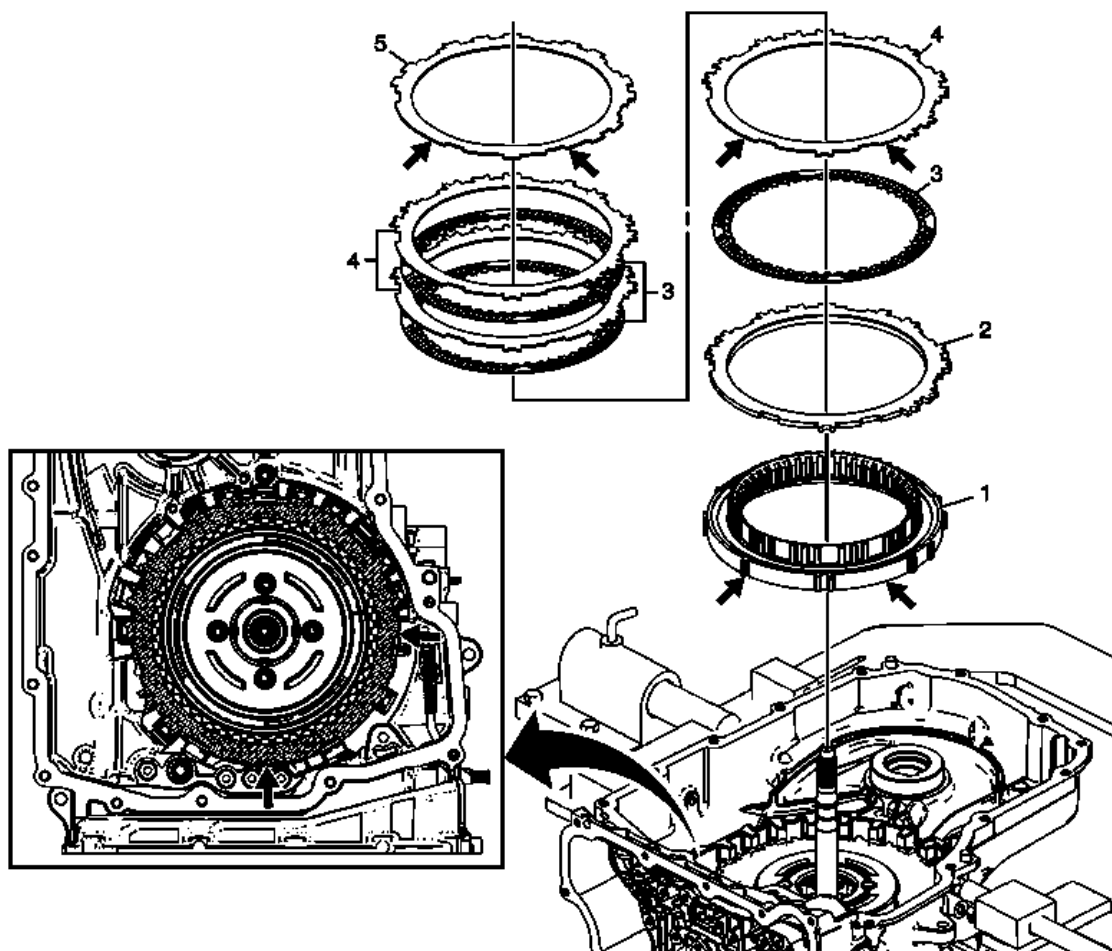


Fig. 39: View Of Low and Reverse Clutch Assembly
 Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Assembly and Low and Reverse Clutch Plate Installation

Callout	Component Name
1	Low and Reverse Clutch Assembly (OWC) NOTE: <ul style="list-style-type: none"> • The Low and Reverse Clutch Assembly should rotate freely in one direction and lock in the opposite direction. • With the valve body face at the 6 o'clock position, align the large flat areas of the low and reverse clutch assembly between the 2 o'clock and 5 o'clock position.
2	Low and Reverse Clutch Backing Plate
3	Low and Reverse Clutch Plate Assembly (Qty: 3)
4	Low and Reverse Clutch Plate (Qty: 3) NOTE: With the valve body face at the 6 o'clock position, align the large flat areas of the low

	and reverse clutch plate between the 2 o'clock and 5 o'clock position.
5	<p>Low and Reverse Clutch Apply (Waved) Plate</p> <p>NOTE:</p> <ul style="list-style-type: none"> • With the valve body face at the 6 o'clock position, align the large flat areas of the low and reverse clutch apply plate between the 2 o'clock and 5 o'clock position. • Ensure the correct waved plate is being installed. The 1-2-3-4 clutch and low and reverse clutch waved plates are visually similar, however the low and reverse clutch waved plate is thicker.

LOW AND REVERSE AND 1-2-3-4 CLUTCH HOUSING DISASSEMBLE

Low and Reverse Clutch Piston Removal

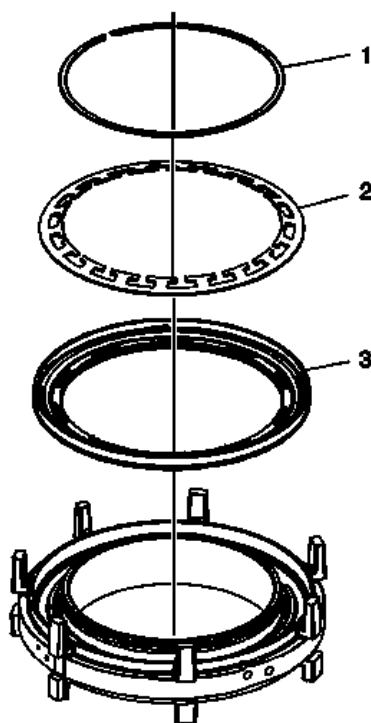


Fig. 40: View Of Low & Reverse Clutch Piston
 Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Piston Removal

Callout	Component Name
1	<p>Low and Reverse Clutch Spring Retainer</p> <p>Special Tool GE-8059 Snap Ring Pliers - Parallel Jaw For equivalent regional tools, refer to Special Tools .</p>
2	Low and Reverse Clutch Spring
3	Low and Reverse Clutch Piston

1-2-3-4 Clutch Piston Removal

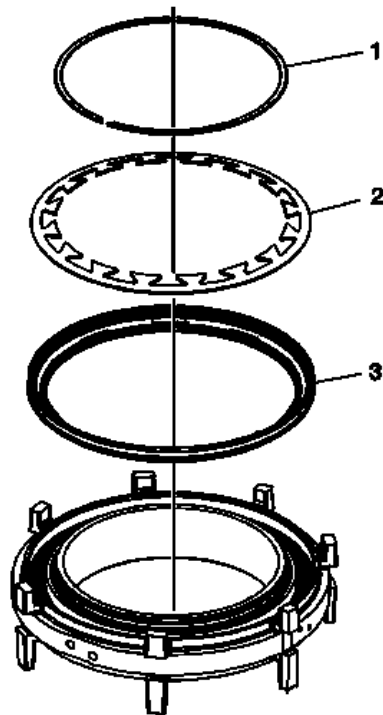


Fig. 41: View Of 1-2-3-4 Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

1-2-3-4 Clutch Piston Removal

Callout	Component Name
1	1-2-3-4 Clutch Spring Retainer Special Tool GE-8059 Snap Ring Pliers - Parallel Jaw For equivalent regional tools, refer to Special Tools .
2	1-2-3-4 Clutch Spring
3	1-2-3-4 Clutch Piston

LOW AND REVERSE AND 1-2-3-4 CLUTCH HOUSING CLEANING AND INSPECTION

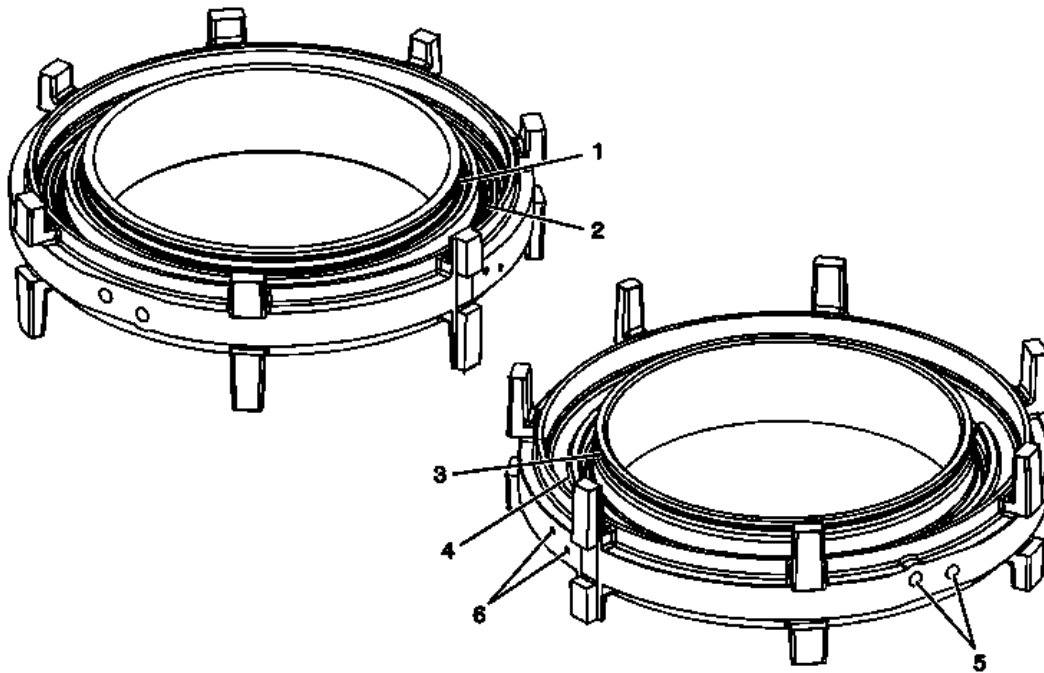


Fig. 42: Identifying Low and Reverse & 1-2-3-4 Clutch Housing
 Courtesy of GENERAL MOTORS COMPANY

Low and Reverse and 1-2-3-4 Clutch Housing Cleaning and Inspection

Callout	Component Name
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	
CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.	
Preliminary Procedures <ol style="list-style-type: none"> 1. Thoroughly clean the housing with clean solvent. 2. Inspect the piston bores and retainer ring grooves for wear, damage or porosity. 	
1	1-2-3-4 Clutch Spring Retainer Groove
2	1-2-3-4 Clutch Piston Bore
3	Low and Reverse Clutch Spring Retainer Groove
4	Low and Reverse Clutch Piston Bore
5	Clutch Oil Passages
6	Air Bleed Passages

LOW AND REVERSE AND 1-2-3-4 CLUTCH HOUSING ASSEMBLE

1-2-3-4 Clutch Piston Installation

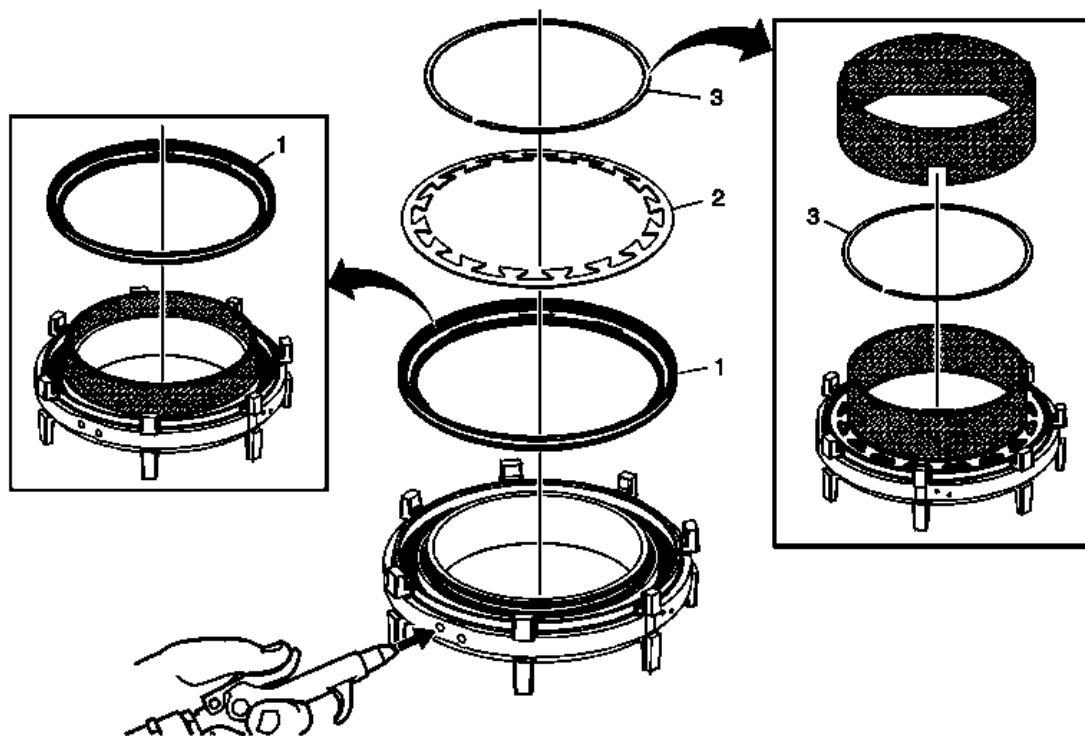


Fig. 43: View Of 1-2-3-4 Clutch Piston
 Courtesy of GENERAL MOTORS COMPANY

1-2-3-4 Clutch Piston Installation

Callout	Component Name
1	1-2-3-4 Clutch Piston NOTE: DT-47798 protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the ID of DT-47798 protector to ease the installation of the piston. Special Tools DT-47798 Seal Protector
2	1-2-3-4 Clutch Spring
3	1-2-3-4 Clutch Spring Retainer CAUTION: Regulate the air pressure to 276 kPa (40 psi) maximum. High pressure could cause the piston to over travel and damage the piston seals. Procedure 1. Place the retainer onto DT-47799-1 which is part of DT-47799 compressor.

Compressing the spring using DT-47799-2 which is part of **DT-47799** compressor , will install the retainer into the retainer groove.

2. Apply shop air to the clutch fluid feed hole in the clutch housing to verify proper piston operation.

Special Tools

DT-47799 Clutch Piston Spring Compressor

Low and Reverse Clutch Piston Installation

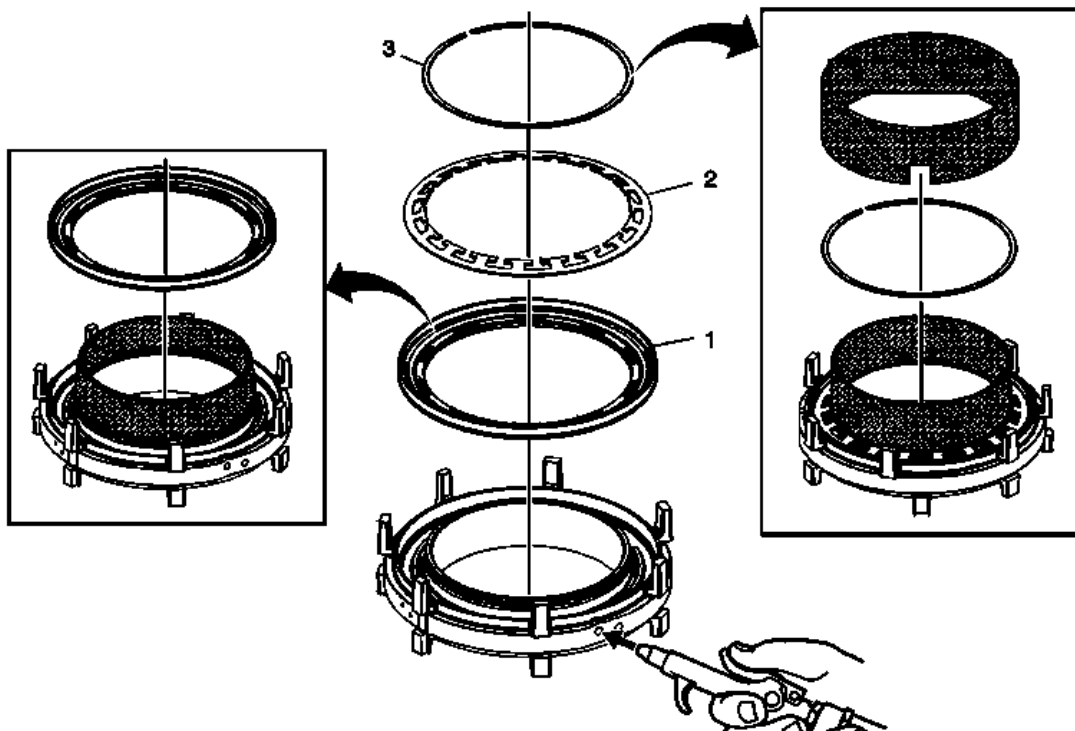


Fig. 44: View Of Low & Reverse Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Piston Installation

Callout	Component Name
1	<p>Low and Reverse Clutch Piston</p> <p>NOTE: DT-47807 protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the ID of DT-47807 protector to ease the installation of the piston.</p> <p>Special Tools DT-47807 Clutch Piston Seal Protector</p>

2	Low and Reverse Clutch Spring
3	<p>Low and Reverse Clutch Spring Retainer</p> <p>CAUTION: Regulate the air pressure to 276 kPa (40 psi) maximum. High pressure could cause the piston to over travel and damage the piston seals.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Place the retainer onto DT-47794-1 which is part of DT-47794 compressor. Compressing the spring using DT-47794-2 which is part of DT-47794 compressor , will install the retainer into the retainer groove. 2. Apply shop air to the clutch fluid feed hole in the clutch housing to verify proper piston operation. <p>Special Tools DT-47794 Spring Compressor</p>

LOW AND REVERSE AND 1-2-3-4 CLUTCH HOUSING, AND 1-2-3-4 CLUTCH PLATE INSTALLATION (6T40/45/50)

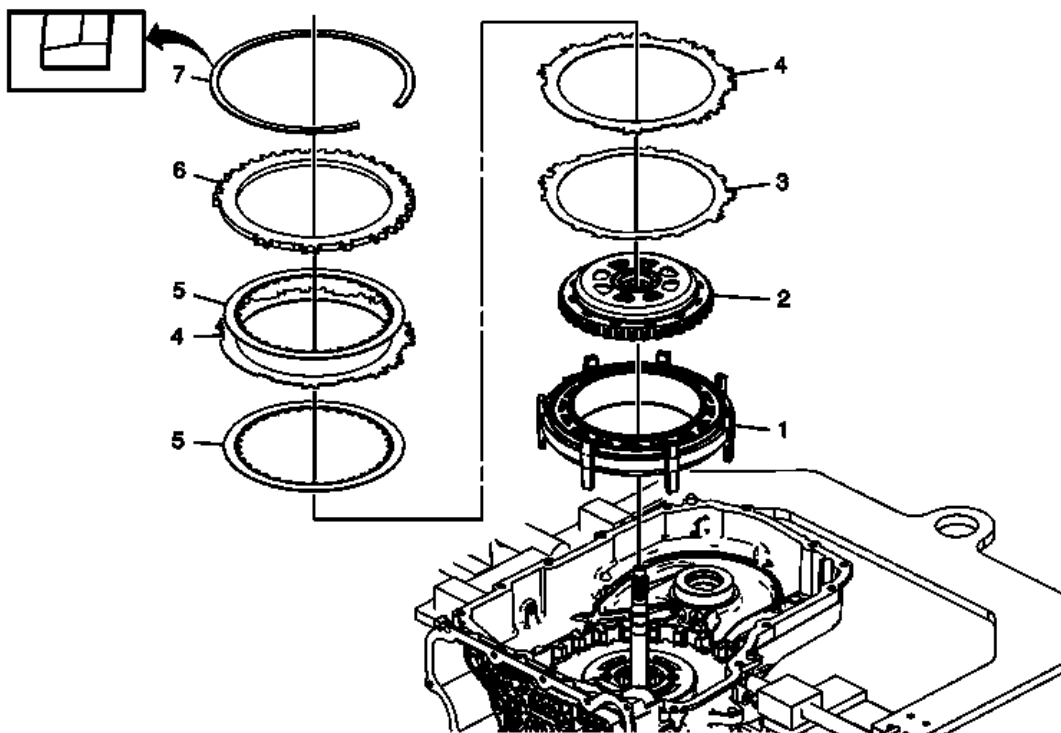


Fig. 45: View Of Low and Reverse & 1-2-3-4 Clutch Housing & Attached Components
Courtesy of GENERAL MOTORS COMPANY

Low and Reverse and 1-2-3-4 Clutch Housing, and 1-2-3-4 Clutch Plate Installation (6T40/45/50)

Callout	Component Name
1	<p>Low and Reverse and 1-2-3-4 Clutch Housing</p> <p>NOTE: The longer legs face the bottom of the case and the oil passages face the valve body end of the case.</p>
2	Output Sun Gear Assembly
3	<p>1-2-3-4 Clutch Waved Plate</p> <p>NOTE:</p> <ul style="list-style-type: none"> Align the single pair of tabs with the bottom valve body end of the case. Ensure the correct waved plate is being installed. The 1-2-3-4 clutch and low and reverse clutch waved plates are visually similar, however the low and reverse clutch waved plate is thicker.
4	1-2-3-4 Clutch Plate (Qty: 2)
5	1-2-3-4 Clutch Plate Assembly (Qty: 2)
6	<p>1-2-3-4 Clutch Backing Plate</p> <p>NOTE: Align the single skinny tab with the case spline facing the top of the case.</p>
7	<p>1-2-3-4 Clutch Backing Plate Retainer Ring</p> <p>WARNING: The retainer is under tension. Use care when removing or installing the retainer. Personal injury could result.</p> <p>CAUTION: Use caution during removal or installation of the retainer ring to avoid damage to the case machined surface in the park pawl area. Burrs or raised edges on the case machined surface can cause the park pawl to bind and prohibit it from engaging the park gear.</p> <p>NOTE:</p> <ul style="list-style-type: none"> Install the retainer with the taper facing away from the backing plate. Align the retainer opening with the largest gap in the case splines toward the bottom of the case. Install one end of the retainer into the retainer ring groove. Use DT-28585 snap ring remover and work the retainer into the case groove. Use a screwdriver to hold the retainer away from the case while pushing down on the retainer with DT-28585 snap ring remover. <p>Special Tool DT-28585 Snap Ring Remover or equivalent For equivalent regional tools, refer to <u>Special Tools</u> .</p>

DRIVE SPROCKET, DRIVEN SPROCKET, AND DRIVE LINK CLEANING AND INSPECTION

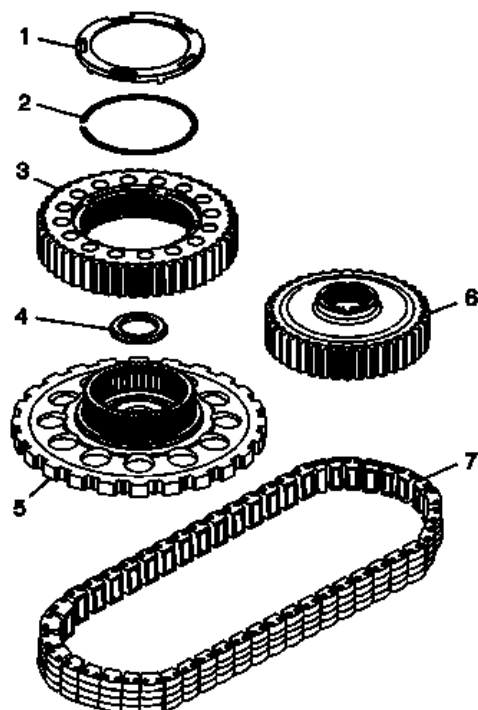


Fig. 46: View Of Drive Sprocket, Driven Sprocket & Drive Link
Courtesy of GENERAL MOTORS COMPANY

Drive Sprocket, Driven Sprocket, and Drive Link Cleaning and Inspection

Callout	Component Name
1	Drive Sprocket Thrust Washer
2	Drive Sprocket Retainer Ring
3	Drive Sprocket
4	Drive Sprocket Bearing Assembly
5	Park Gear
6	Driven Sprocket
7	Drive Link Assembly

DRIVE AND DRIVEN SPROCKET, DRIVE LINK, AND PARK PAWL INSTALLATION (6T40/45/50)

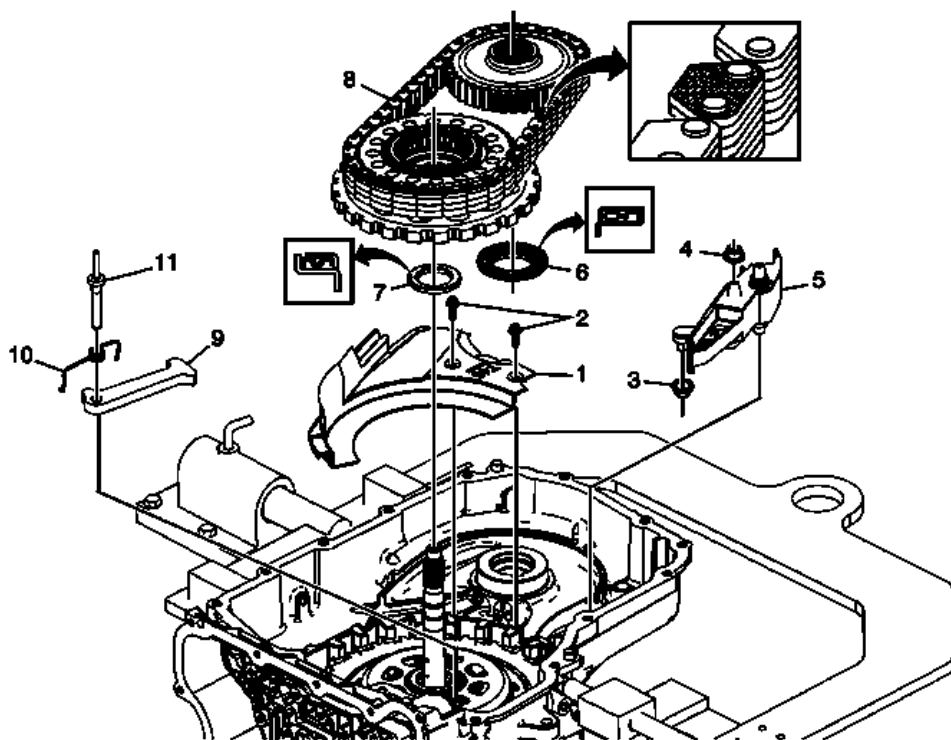


Fig. 47: View Of Drive Sprocket, Driven Sprocket & Park Pawl
 Courtesy of GENERAL MOTORS COMPANY

Drive and Driven Sprocket, Drive Link, and Park Pawl Installation (6T40/45/50)

Callout	Component Name
1	Front Differential Carrier Baffle
2	Front Differential Carrier Baffle Bolt M6 x 16 (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)
3	Drive Link Lube Scoop Seal
4	Drive Link Lube Fluid Seal
5	Drive Link Lube Scoop
6	Driven Sprocket Bearing Assembly
7	Drive Sprocket Bearing Assembly
8	Driven Sprocket Assembly, Drive Sprocket Assembly and Drive Link NOTE: <ul style="list-style-type: none"> • Install the drive link with the colored links and/or part number facing up. • The drive link, drive, and driven sprocket assemblies must be installed at the

	<p>same time.</p> <ul style="list-style-type: none"> • The ball bearing should spin freely and smoothly. • The driven sprocket ball bearing inner race has a slight interference fit with the case. Tap gently with the palm of a hand or a soft tip hammer to install.
9	Park Pawl
10	Park Pawl Spring
11	<p>Park Pawl Shaft</p> <p>NOTE: Check to ensure that the park pawl operates freely and is not binding.</p>

FRONT DIFFERENTIAL CARRIER CLEANING AND INSPECTION

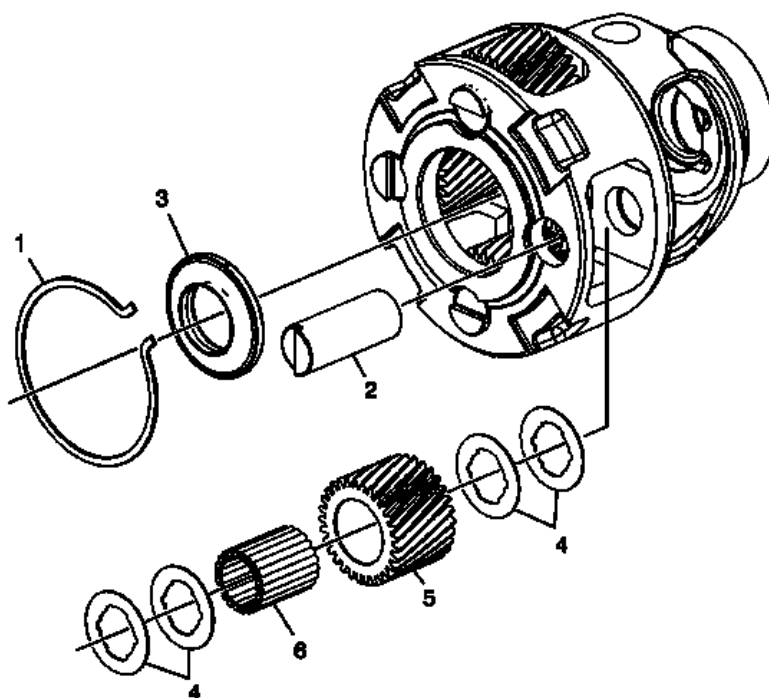


Fig. 48: View Of Front Differential Carrier
Courtesy of GENERAL MOTORS COMPANY

Front Differential Carrier Cleaning and Inspection

Callout	Component Name
<p>CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.</p> <p>CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage</p>	

the component.

CAUTION:

Keep thrust washers with the gear it was matched to. The thrust washers are selective sizes and it is difficult to identify the proper washer thickness. Improper assembly can cause premature failure of the differential assembly.

Preliminary Procedures

- Clean and inspect the differential assembly, pinion gears and thrust washers for scoring, wear or damage.
- The differential assembly is only serviced as an assembly.

1	Front Differential Pinion Gear Shaft Retainer
2	Front Differential Pinion Gear Pin
3	Sun Gear to Differential Housing Bearing Assembly
4	Front Differential Pinion Gear Washer
5	Front Differential Pinion Gear
6	Front Differential Planetary Pinion Gear Bearing Roller

FRONT DIFFERENTIAL CARRIER INSTALLATION (6T40/45/50)

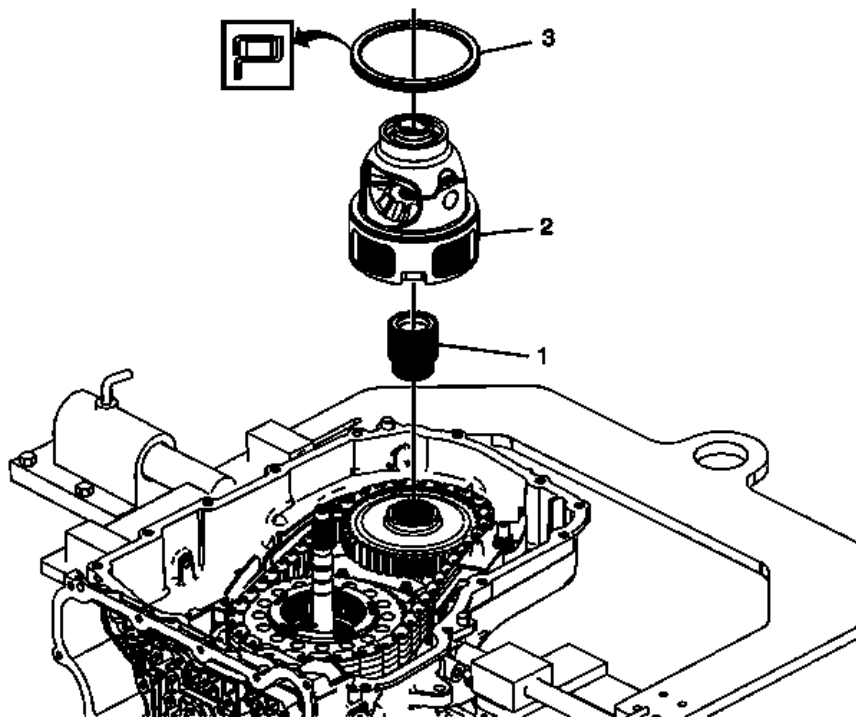


Fig. 49: View Of Front Differential Carrier Components
Courtesy of GENERAL MOTORS COMPANY

Front Differential Carrier Installation (6T40/45/50)

Callout	Component Name
1	Final Drive Sun Gear
2	Differential Carrier Assembly
3	Front Differential Carrier Bearing Assembly

TRANSMISSION FLUID PUMP, FRONT DIFFERENTIAL CARRIER BAFFLE, AND FRONT DIFFERENTIAL RING GEAR REMOVAL (6T40/6T45/6T50 HYBRID)

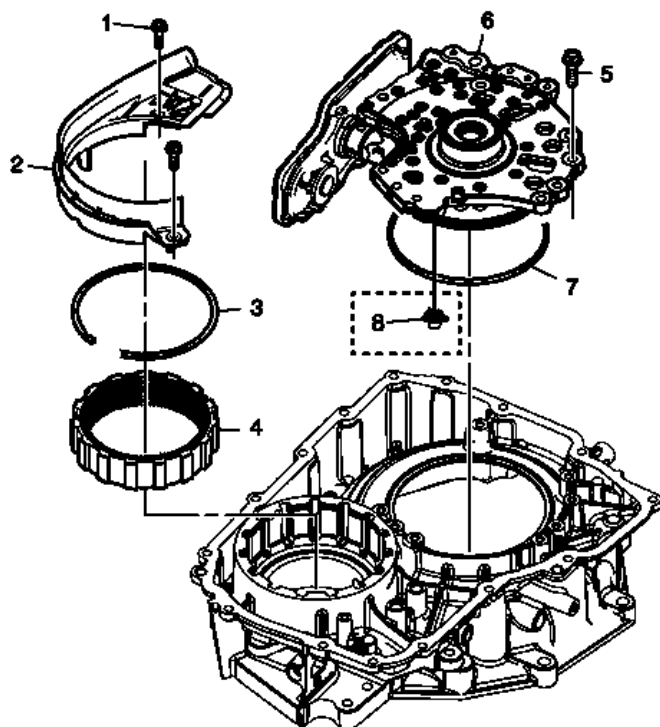


Fig. 50: Transmission Fluid Pump, Front Differential Carrier Baffle, and Front Differential Ring Gear
 Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Pump, Front Differential Carrier Baffle, and Front Differential Ring Gear Removal (6T40/6T45/6T50 Hybrid)

Callout	Component Name
1	Front Differential Carrier Baffle Bolts M6 x 25 (Qty: 2)
2	Front Differential Carrier Baffle
3	Front Differential Ring Gear Retainer NOTE: Note the direction of the taper to ensure proper installation.
4	Front Differential Ring Gear
5	Fluid Pump Bolts M8 x 33 (Qty: 8)
6	Fluid Pump Assembly
7	Torque Converter and Differential Housing Seal

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - TORQUE CONVERTER HOUSING SIDE

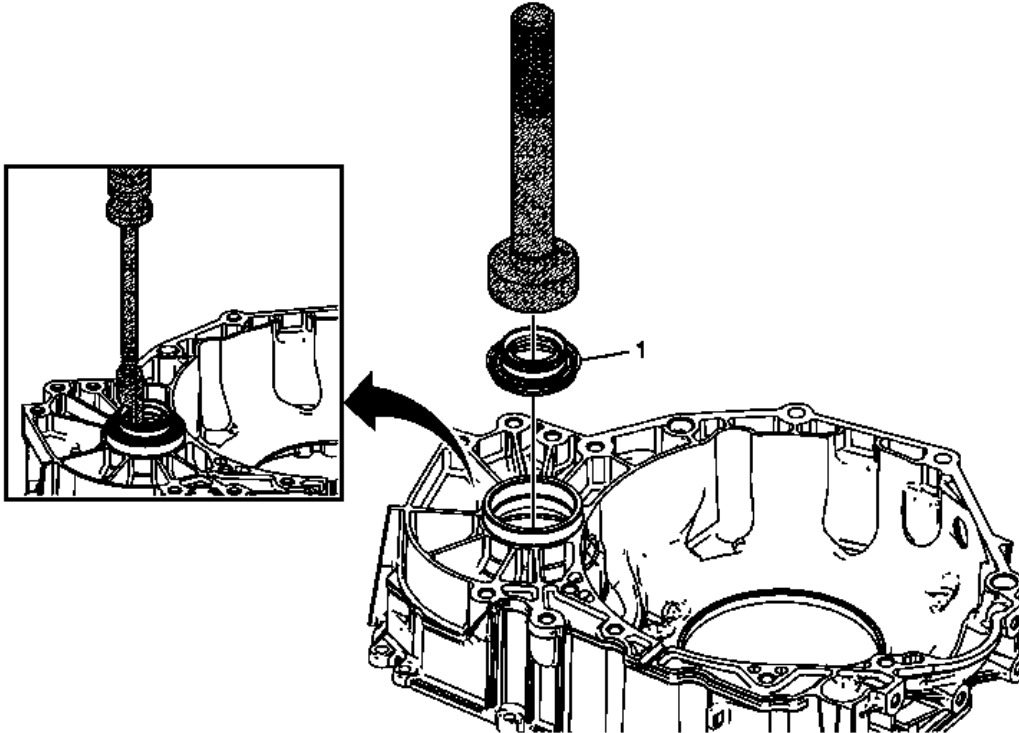


Fig. 51: View Of Front Wheel Drive Shaft Seal - Torque Converter Housing Side
 Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Torque Converter Housing Side

Callout	Component Name
1	<p>Front Wheel Drive Shaft Oil Seal Assembly</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-23129 Universal Seal Remover • DT-47790 Seal Installer • GE-6125-1B Slide Hammer • GE-8092 Driver Handle <p>For equivalent regional tools, refer to Special Tools .</p>

TORQUE CONVERTER HOUSING CLEANING AND INSPECTION

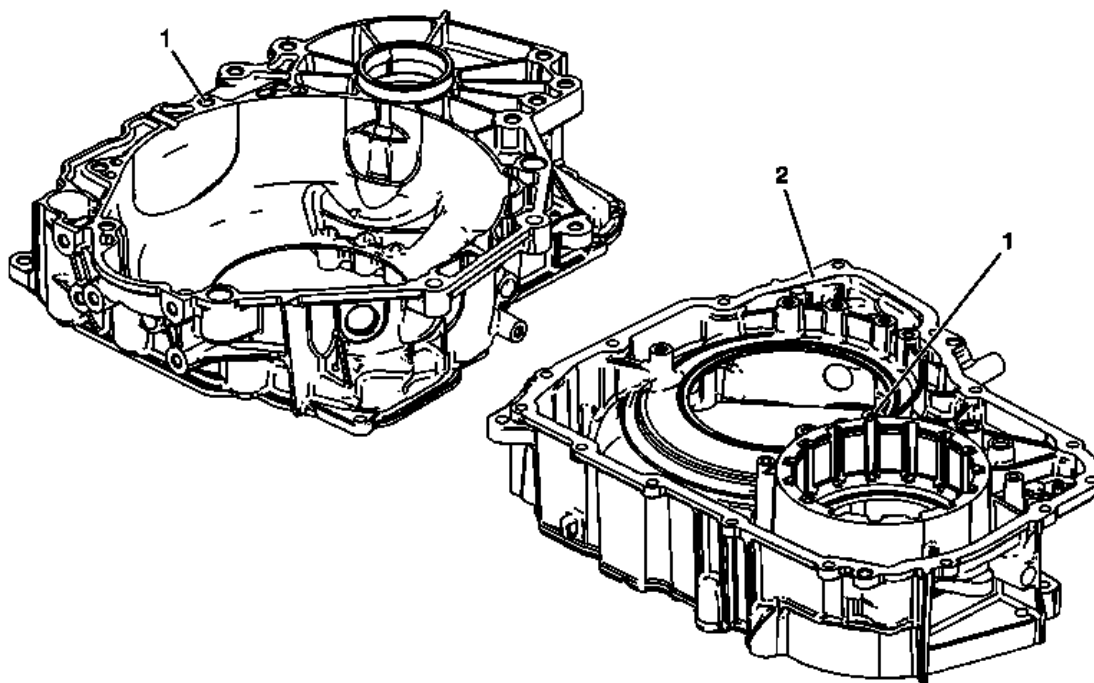


Fig. 52: Identifying Torque Converter Housing Inspection Areas
 Courtesy of GENERAL MOTORS COMPANY

Torque Converter Housing Cleaning and Inspection

Callout	Component Name
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	
CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.	
CAUTION: Do not use abrasive pads or bristle devices to clean the sealing surfaces. Abrasive pads produce a fine grit that can effect transmission function. Abrasive pads can also remove enough metal to create oil leaks.	
Preliminary Procedure Thoroughly clean the torque converter housing, including case threads with clean solvent.	
1	Threaded Hole
2	Gasket Sealing Surface

TRANSMISSION FLUID PUMP DISASSEMBLE (6T40/45/50)

Fluid Filter Assembly and Torque Converter Fluid Seal Disassemble

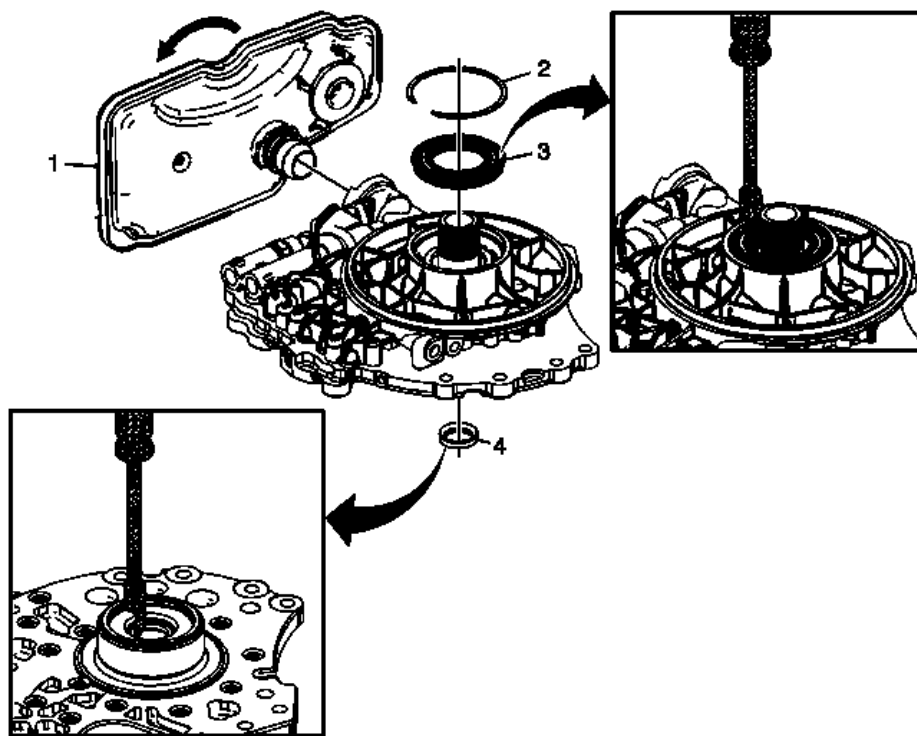


Fig. 53: View Of Fluid Filter Assembly & Torque Converter Fluid Seal
 Courtesy of GENERAL MOTORS COMPANY

Fluid Filter Assembly and Torque Converter Fluid Seal Disassemble

Callout	Component Name
1	Fluid Filter Assembly NOTE: Rotate filter 90 degrees to disengage locking tangs.
2	Torque Converter Fluid Seal Retainer
3	Torque Converter Fluid Seal Special Tools <ul style="list-style-type: none"> • DT-23129 Universal Seal Remover • GE-6125-1B Slide Hammer For equivalent regional tools, refer to Special Tools .
4	Torque Converter Fluid Seal Assembly Special Tools <ul style="list-style-type: none"> • DT-23129 Universal Seal Remover • GE-6125-1B Slide Hammer

For equivalent regional tools, refer to **Special Tools** .

Fluid Pump Disassemble

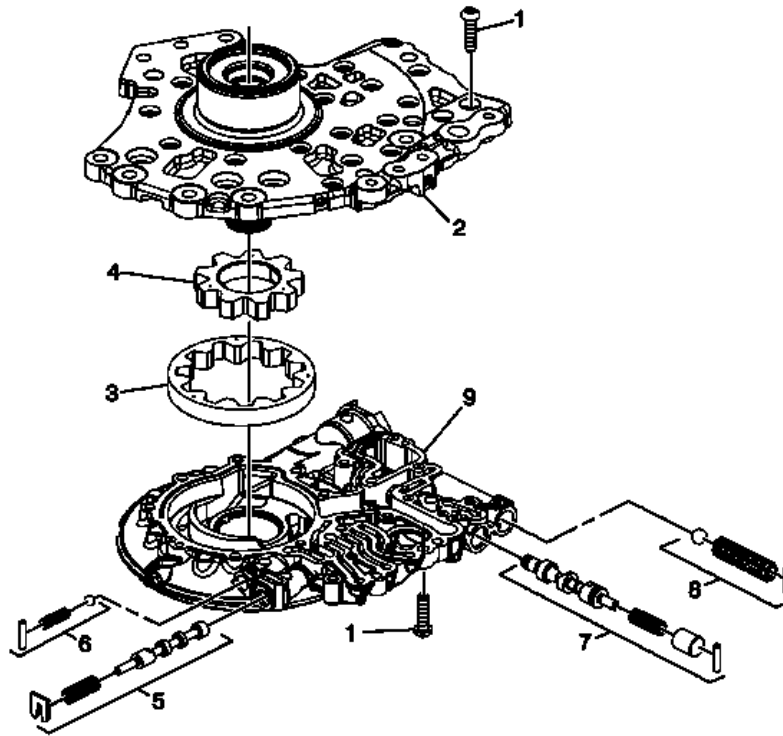


Fig. 54: Transmission Fluid Pump & Components
Courtesy of GENERAL MOTORS COMPANY

Fluid Pump Disassemble

Callout	Component Name
<p>WARNING: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result.</p> <p>CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.</p> <p>CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.</p> <p>Preliminary Procedure Clean and inspect all valve components and the pump body for wear and/or damage.</p>	
	Fluid Pump Cover Bolts M6 x 25 (Qty: 23)

1	NOTE: There are 3 bolts on the pump cover side and 20 bolts on the pump body side.
2	Fluid Pump Cover
3	Fluid Pump Driven Gear
4	Fluid Pump Drive Gear
5	TCC Control Valve Train
6	TCC Blow Off Ball Valve Train
7	Pressure Regulator Valve Train
8	Fluid Pump Blow Off Ball Valve Train
9	A/Trans Fluid Pump Body

FLUID PUMP SELECTIVE MEASUREMENT

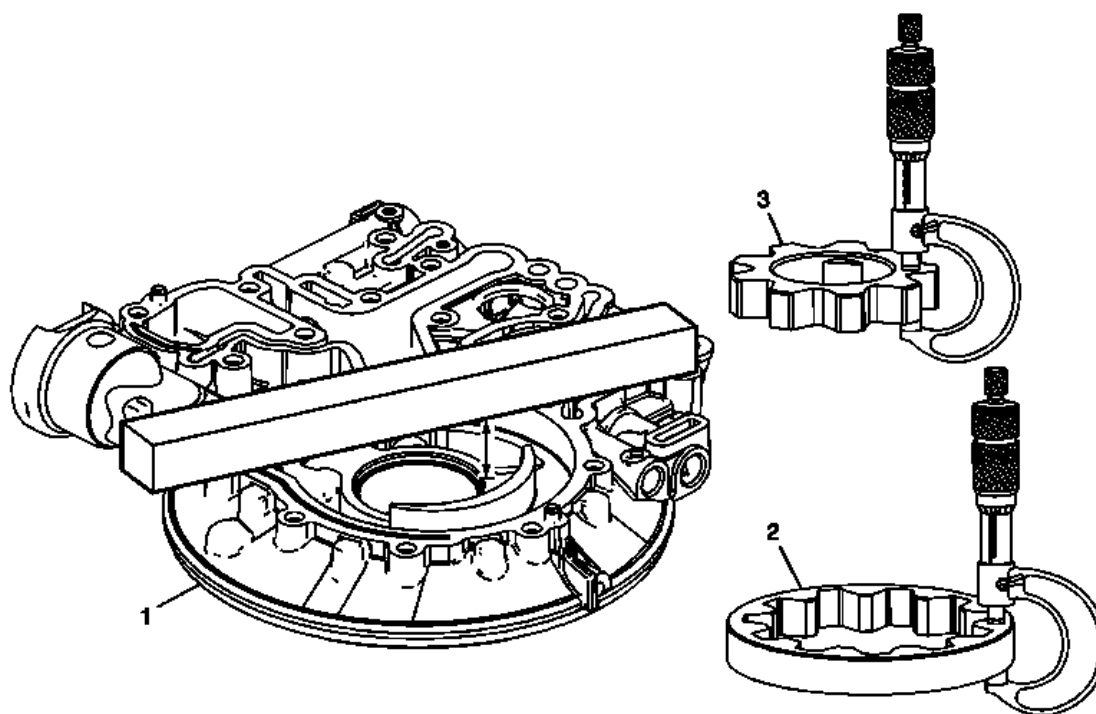


Fig. 55: Measuring Fluid Pump Components
 Courtesy of GENERAL MOTORS COMPANY

Fluid Pump Selective Measurement

Callout	Component Name
1	A/Trans Fluid Pump Body NOTE: Measure the distance from the bottom of the gauge bar to the bottom of the pump rotor cavity. Refer to <u>Fluid Pump Selective Specifications</u> .

	Special Tool GE 34673 Flat Gauge Bar or equivalent
2	A/Trans Fluid Pump Driven Gear NOTE: Refer to Fluid Pump Selective Specifications to select the correct gear.
3	A/Trans Fluid Pump Drive Gear NOTE: Refer to Fluid Pump Selective Specifications to select the correct gear.

TRANSMISSION FLUID PUMP ASSEMBLY (6T40/45/50)

Fluid Pump w/Valve Trains Assemble

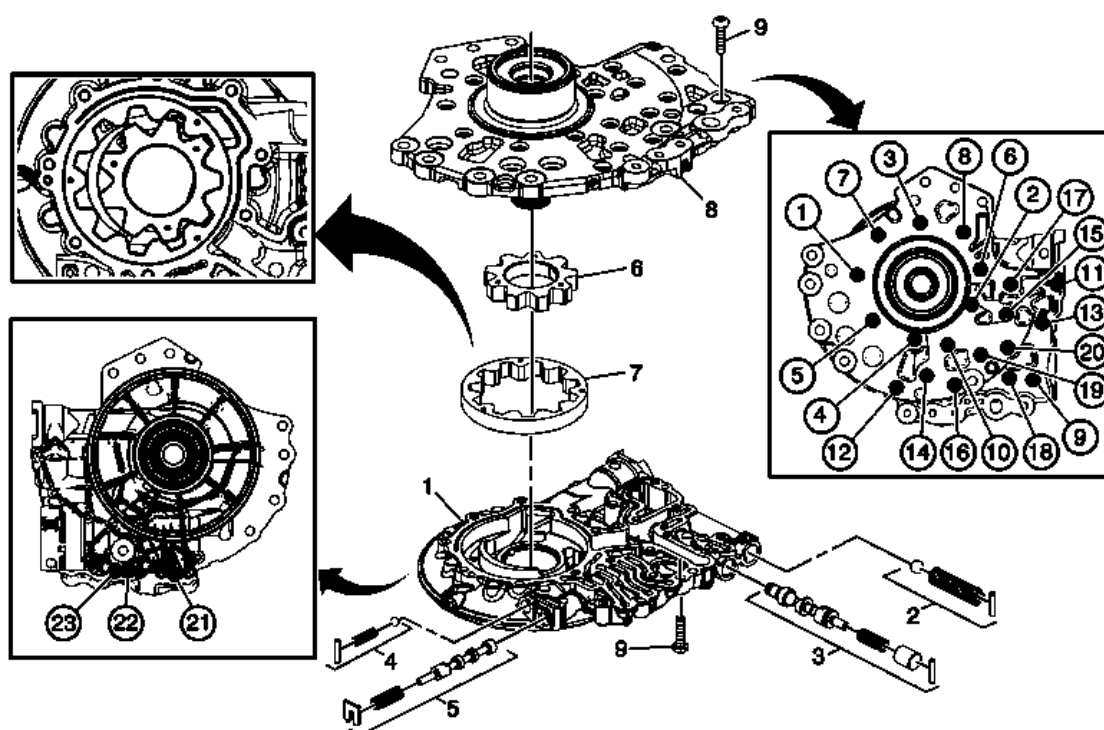


Fig. 56: Fluid Pump W/Valve Trains Assembly
Courtesy of GENERAL MOTORS COMPANY

Fluid Pump w/Valve Trains Assemble

Callout	Component Name
1	A/Trans Fluid Pump Body
2	Fluid Pump Blow Off Ball Valve Train
3	Pressure Regulator Valve Train
4	TCC Blow Off Ball Valve Train

5	TCC Control Valve Train
6	Fluid Pump Drive Gear NOTE: <ul style="list-style-type: none"> • Align ID feature dots with the driven gear as shown above. • The chamfer on the drive gear teeth faces the pump body.
7	Fluid Pump Driven Gear NOTE: <ul style="list-style-type: none"> • Align ID feature dots with the drive gear as shown above, some models. • The chamfer on the driven gear O.D. faces the pump body.
8	Fluid Pump Cover
9	Fluid Pump Cover Bolts M6 x 25 (Qty: 23) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)

Torque Converter Fluid Seal and Fluid Filter Assembly Assemble

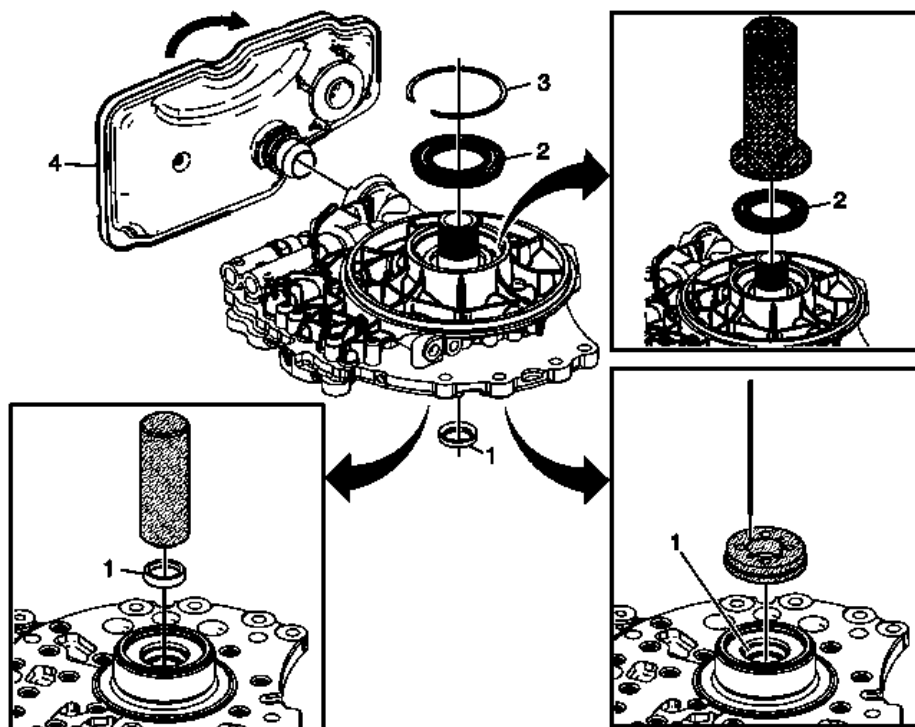


Fig. 57: View Of Torque Converter Fluid Seal & Fluid Filter Assembly

Courtesy of GENERAL MOTORS COMPANY

Torque Converter Fluid Seal and Fluid Filter Assembly Assemble

Callout	Component Name
1	<p>Torque Converter Fluid Seal Assembly</p> <p>NOTE: The fluid seal assembly must be staked in place using DT-49131 seal staking tool to ensure proper seal retention.</p> <p>Special Tool</p> <ul style="list-style-type: none">• DT-47792 Seal Installer• DT-49131 Seal Staking Tool <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	<p>Torque Converter Fluid Seal</p> <p>Special Tool DT-47791-A Seal Installer</p> <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>
3	Torque Converter Fluid Seal Retainer
4	<p>Fluid Filter Assembly</p> <p>NOTE: Rotate filter 90 degrees to engage locking tangs.</p>

TRANSMISSION FLUID PUMP, FRONT DIFFERENTIAL CARRIER BAFFLE, AND FRONT DIFFERENTIAL RING GEAR INSTALLATION (6T40/6T45/6T50 HYBRID)

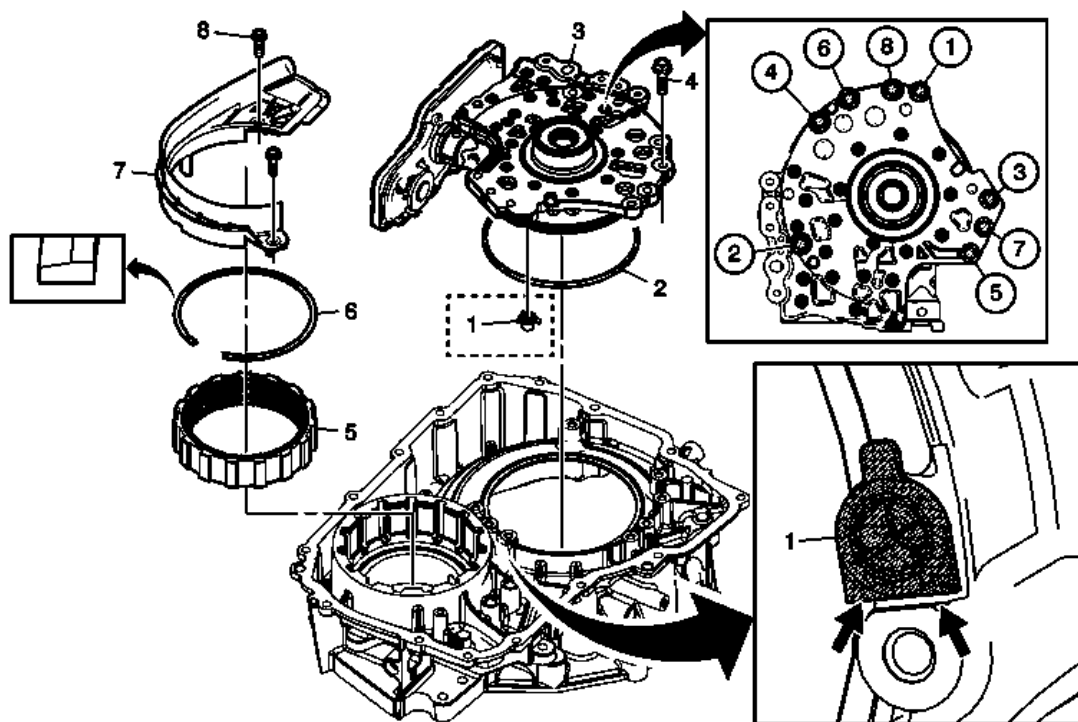


Fig. 58: Transmission Fluid Pump, Front Differential Carrier Baffle, and Front Differential Ring Gear
Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Pump, Front Differential Carrier Baffle, and Front Differential Ring Gear Installation (6T40/6T45/6T50 Hybrid)

Callout	Component Name
1	A/Trans Auxiliary Fluid Inlet Pump Seal - Hybrid Models NOTE: Ensure seal is installed with the correct orientation.
2	Torque Converter and Differential Housing Seal
3	Fluid Pump Assembly
4	Fluid Pump Bolts M8 x 33 (Qty: 8) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in) then rotate the bolt an additional 45 degrees Special Tool EN-45059 Angle Meter or equivalent For equivalent regional tools, refer to <u>Special Tools</u> .
5	Front Differential Ring Gear
	Front Differential Ring Gear Retainer

6	NOTE: Install the retainer with the taper facing away from the ring gear.
7	Front Differential Carrier Baffle
8	Front Differential Carrier Baffle Bolts M6 x 25 (Qty: 2) Tighten 12 N.m (106.21 lb in)

TORQUE CONVERTER HOUSING WITH FLUID PUMP ASSEMBLY INSTALLATION (6T40/6T45/6T50 HYBRID)

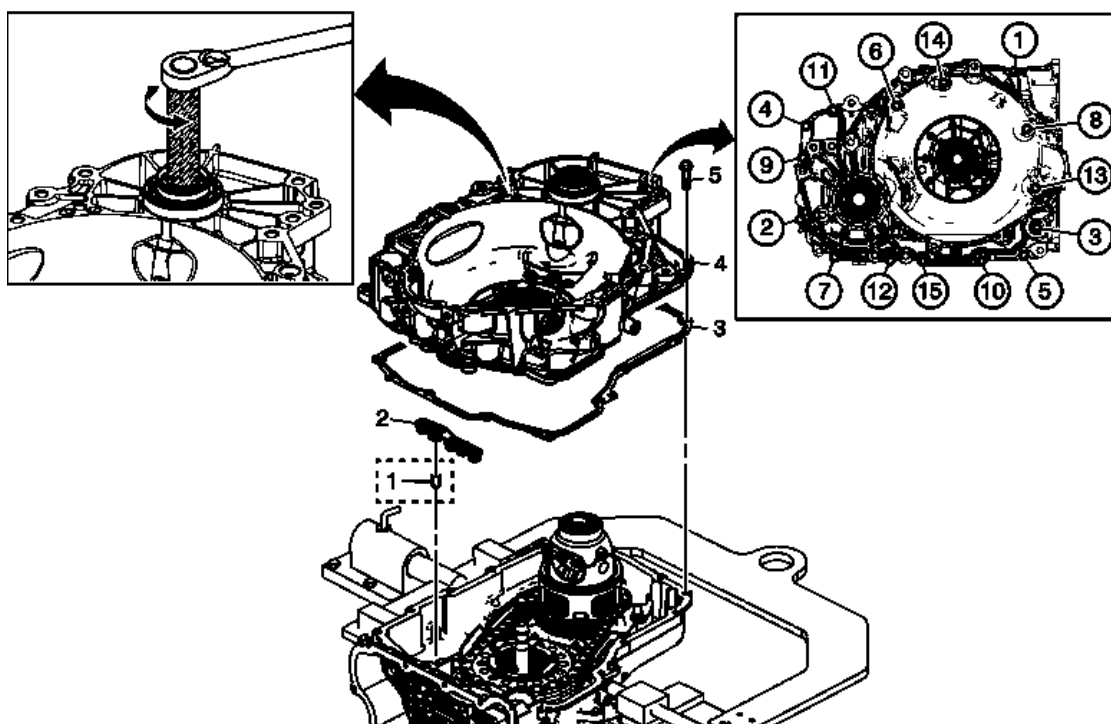


Fig. 59: Torque Converter Housing with Fluid Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

Torque Converter Housing with Fluid Pump Assembly Installation (6T40/6T45/6T50 Hybrid)

Callout	Component Name
1	A/Trans Fluid Trough Check Ball - Hybrid Models
2	Fluid Pump Seal Assembly
3	Torque Converter Housing Gasket
	Torque Converter (w/Fluid Pump) Housing Assembly
	NOTE: Rotate the differential slightly in each direction using the rotating tool to align the Differential Pinion Gears with the Differential Ring Gear in the Torque Converter Housing.

4	<ul style="list-style-type: none"> • DT-47793 Differential Rotating Tool for 6T40/45 applications • DT-49938 Differential Rotating Tool for 6T50 applications <p>Special Tools</p> <ul style="list-style-type: none"> • DT-47793 Differential Rotating Tool • DT-49938 Differential Rotating Tool <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>
5	<p>Torque Converter and Differential Housing Bolts M8 x 30 (Qty: 15)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Tighten the bolts in sequence shown.</p> <p>Tighten 10 N.m (89 lb in) then rotate the bolt an additional 50 degrees</p> <p>Special Tool EN-45059 Angle Meter or equivalent</p> <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>

INPUT AND OUTPUT SPEED SENSOR INSTALLATION

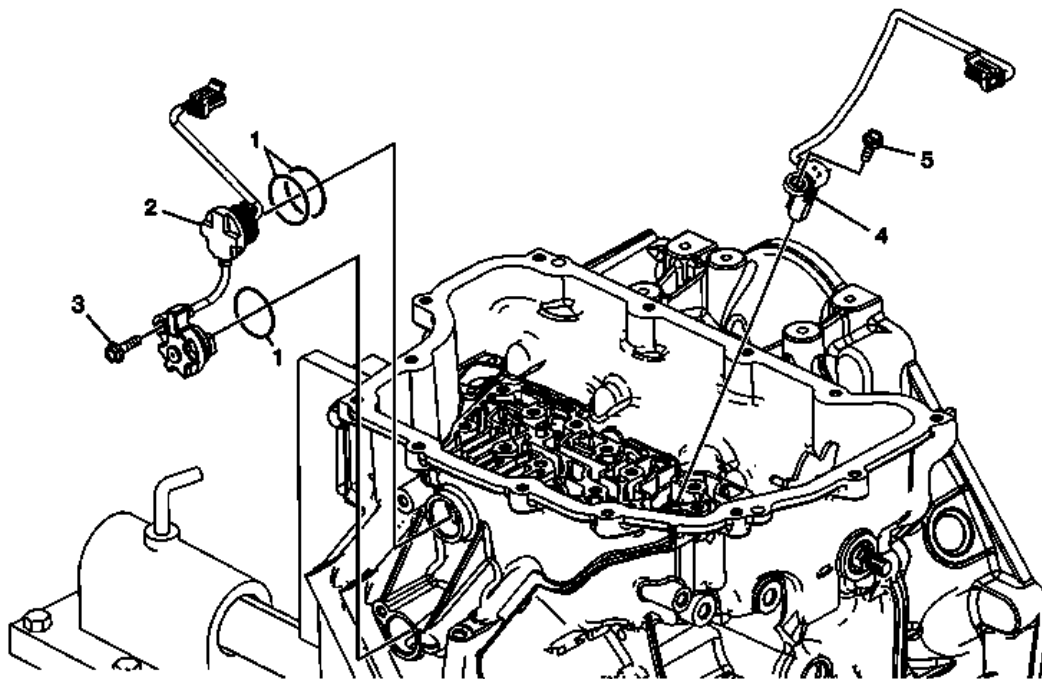


Fig. 60: Identifying Input & Output Speed Sensor
 Courtesy of GENERAL MOTORS COMPANY

Input and Output Speed Sensor Installation

Callout	Component Name
1	Input Speed Sensor Assembly Seals
2	Input Speed Sensor Assembly
3	Input Speed Sensor Bolt M6 x 23 (Qty: 1) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
4	A/Trans Output Speed Sensor Assembly
5	A/Trans Output Speed Sensor Bolt M6 x 18 (Qty: 1) Tighten 9 N.m (80 lb in)

CONTROL VALVE BODY ASSEMBLY DISASSEMBLE (GEN 2)

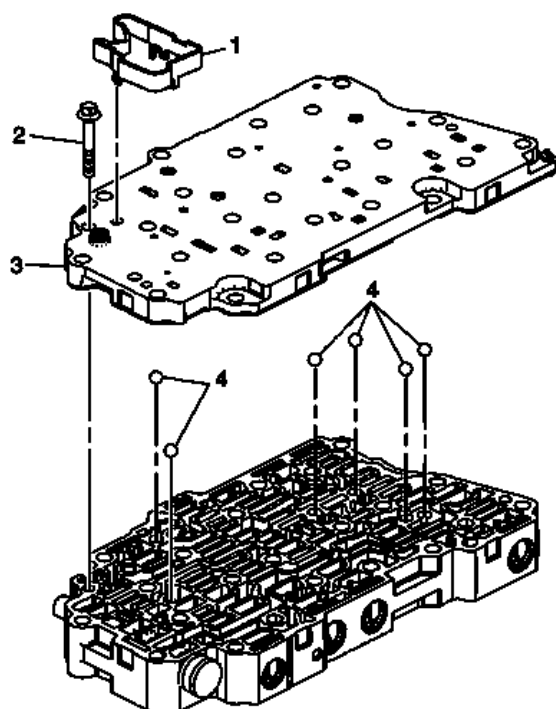


Fig. 61: Control Valve Body (Gen 2)

Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Assembly Disassemble (Gen 2)

Callout	Component Name
1	Control Solenoid Valve Support
2	Control Valve Body Bolt M5 x 40.5 (Qty: 1)
3	Valve Channel Plate NOTE: Inspect the channel plate bolt pass through holes for damage or brinelling. Any damage will cause incorrect pressure switch operation. Replace as necessary.
4	Valve Body Ball Check Valves (Qty: 6)

CONTROL VALVE BODY CLEANING AND INSPECTION (GEN 2)

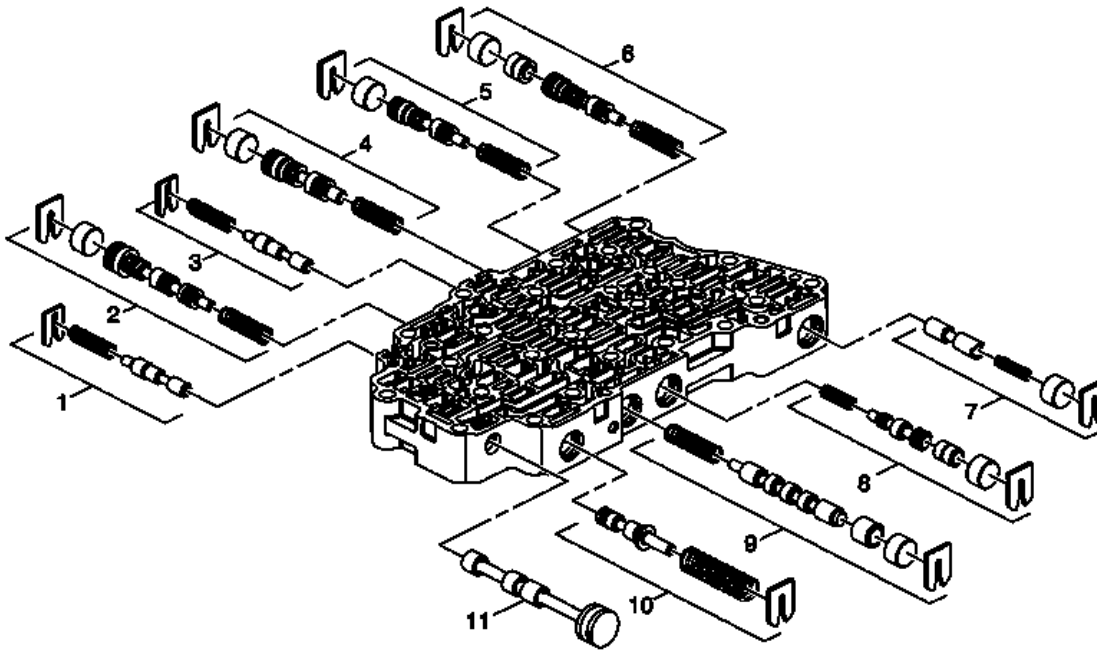


Fig. 62: Control Valve Body Cleaning and Inspection (Gen 2)
 Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Cleaning and Inspection (Gen 2)

Callout	Component Name
WARNING: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result.	
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	
CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.	
Preliminary Procedure Clean and inspect all valve components and the valve body. The control valve body assembly is only replaceable as an assembly.	
1	Low-Reverse and 4-5-6 Clutch Boost Valve Train
2	Low-Reverse and 4-5-6 Clutch Regulator Valve Train
3	1-2-3-4 Clutch Boost Valve Train
4	1-2-3-4 Clutch Regulator Valve Train
5	2-6 Clutch Regulator Valve Train
6	3-5 Reverse Clutch Regulator Valve Train

7	Default Override Valve Train
8	TCC Regulator Apply Valve Train
9	Clutch Select Valve Train
10	Actuator Feed Limit Valve Train
11	Manual Valve

CONTROL VALVE CHANNEL PLATE CLEANING AND INSPECTION (6T40/45/50 - GEN 2)

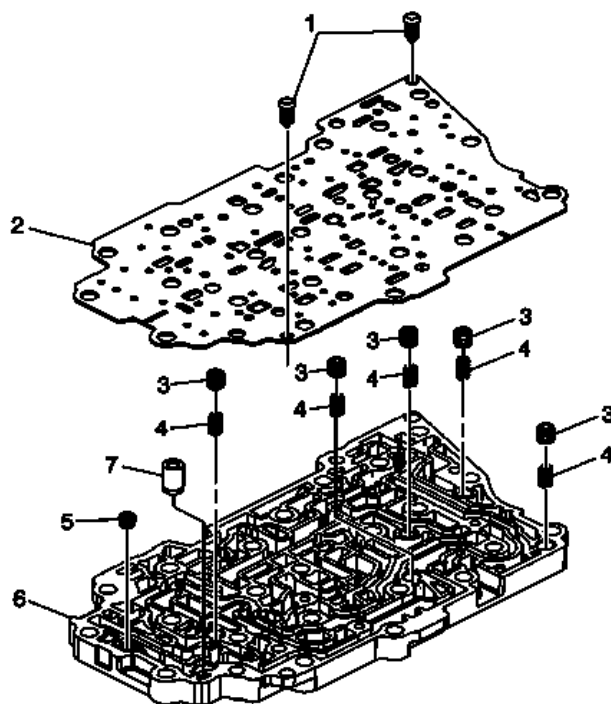


Fig. 63: Control Valve Channel Plate Cleaning and Inspection
Courtesy of GENERAL MOTORS COMPANY

Control Valve Channel Plate Cleaning and Inspection (6T40/45/50 - Gen 2)

Callout	Component Name
1	Control Valve Body Spacer Plate Retainer
2	Channel Plate to Valve Body Spacer Plate Assembly
3	Actuator Feed Accumulator Piston (Qty: 5)
4	Actuator Feed Accumulator Spring (Qty: 5)
5	Variable Hi and 2-3-4 Clutch Housing Valve Ball
6	Valve Channel Plate NOTE: Inspect the channel plate bolt pass through holes for damage or brinelling. Any damage will cause incorrect pressure switch operation. Replace as necessary.
7	Control Valve Channel Plate Ball Spring Assembly

CONTROL VALVE BODY ASSEMBLY ASSEMBLE (GEN 2)

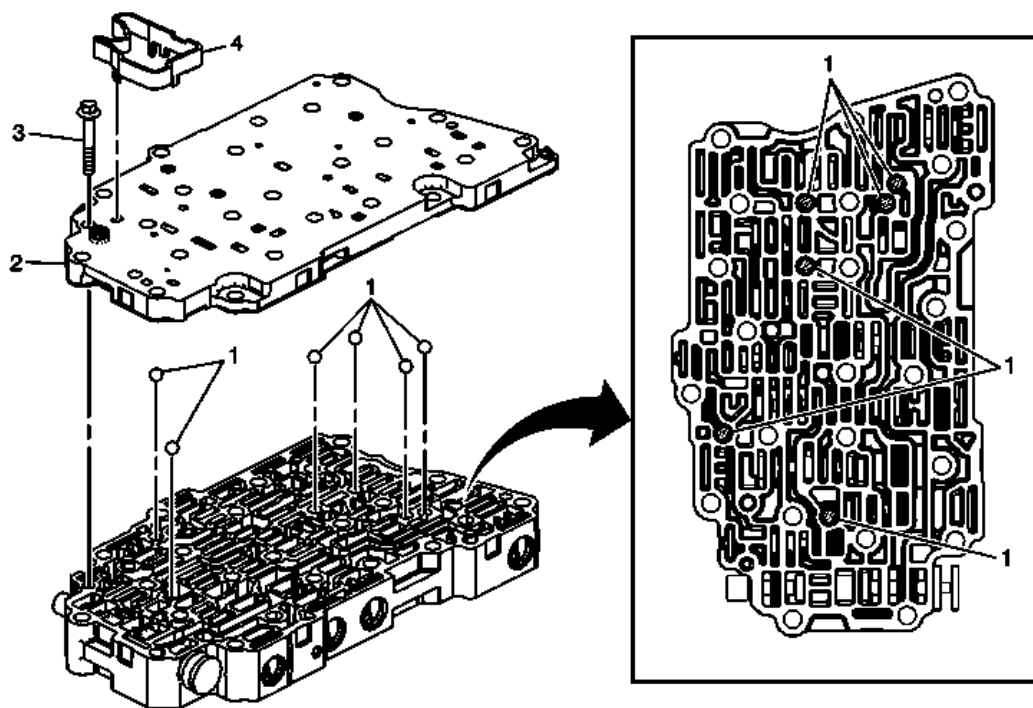


Fig. 64: Control Valve Body And Components
 Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Assembly Assemble (Gen 2)

Callout	Component Name
1	Valve Body Ball Check Valve (Qty: 6)
2	Valve Channel Plate
3	Control Valve Body Bolt M5 x 40.5 (Qty: 1) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7 N.m (62 lb in)
4	Control Solenoid Valve Support

CONTROL VALVE BODY ASSEMBLY INSTALLATION

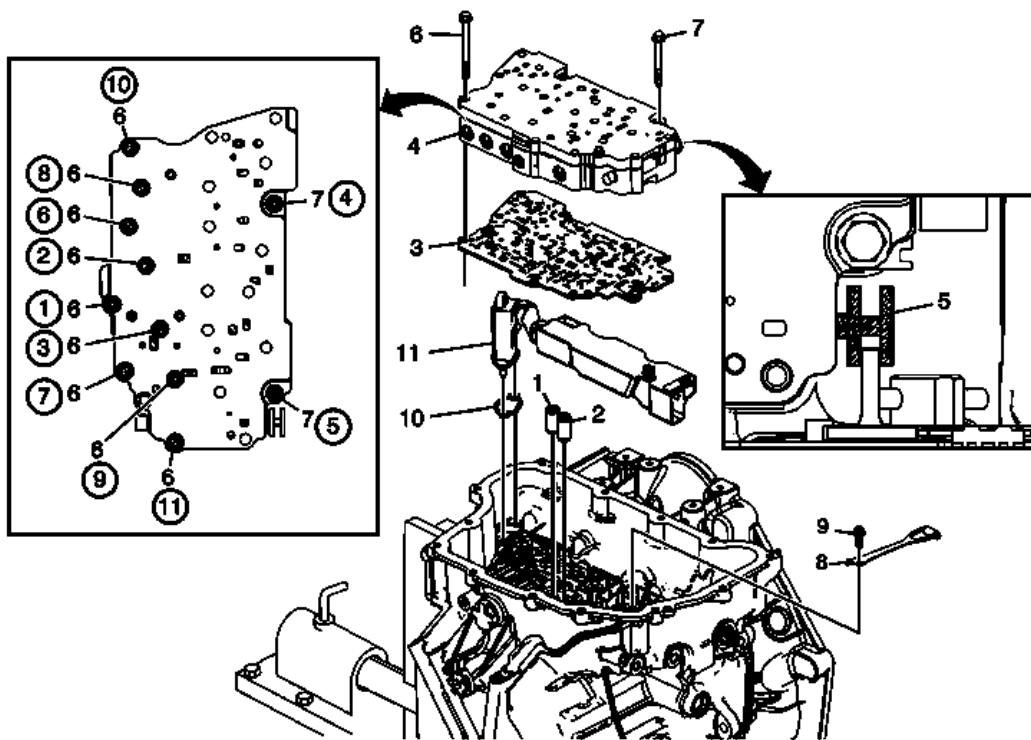


Fig. 65: View Of Control Valve Body Assembly Attachments
 Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Assembly Installation

Callout	Component Name
1	Low and Reverse Clutch Fluid Passage Seal
2	1-2-3-4 Clutch Fluid Passage Seal
3	Control Valve Body Spacer Plate Assembly
4	Control Valve Body Assembly NOTE: Align the manual valve to the rod on the manual shaft.
5	Control Valve Body Bolt M6 x 60 (Qty: 9) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 11 N.m (97 lb in)
6	Control Valve Body Bolt M6 x 53 (Qty: 2) Tighten 11 N.m (97 lb in)
7	Manual Shaft Detent Lever Spring Assembly
	Manual Shaft Detent Spring Bolt M6 x 16 (Qty: 1)

8	Tighten 12 N.m (106 lb in)
9	Fluid Level Control Valve Gasket
10	Fluid Level Control Valve

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY INSTALLATION

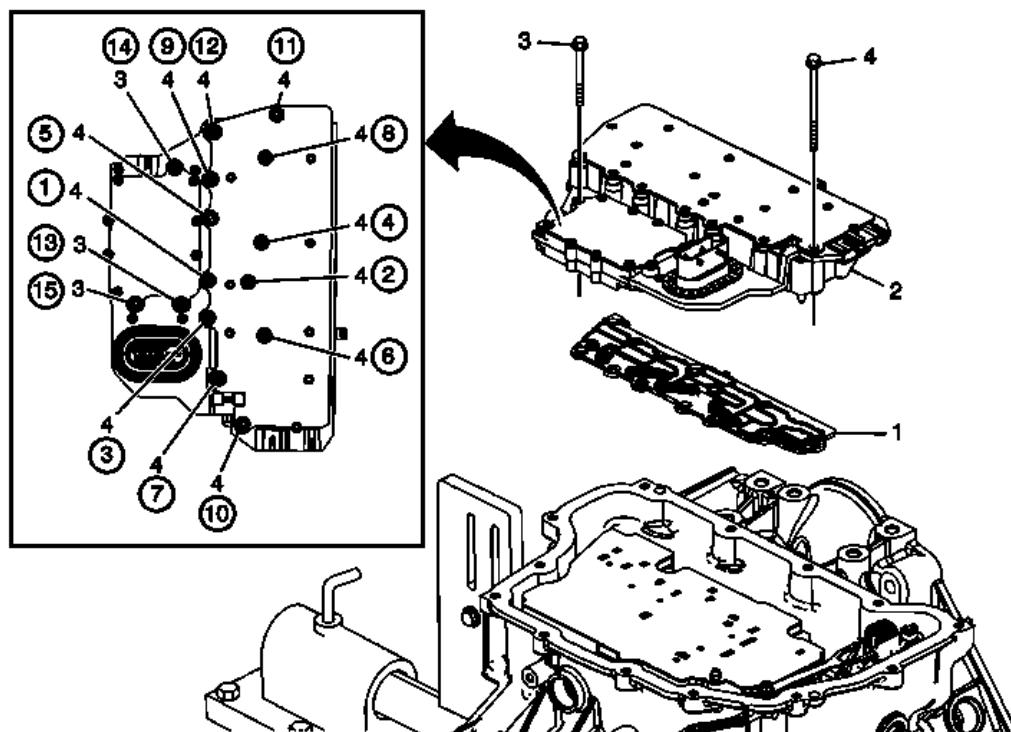


Fig. 66: Identifying Control Solenoid Valve & TCM Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Control Solenoid Valve and Transmission Control Module Assembly Installation

Callout	Component Name
1	Control Solenoid Valve Assembly Filter Plate CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination. NOTE: Install a NEW filter plate to prevent fluid leaks past the fluid seals.
2	Control Solenoid (w/Body and TCM) Valve Assembly
	Control Valve Body Bolt M5 x 40.5 (Qty: 3)

3	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7 N.m (62 lb in)
4	Control Valve Body Bolt M6 x 97 (Qty: 12) Tighten 10 N.m (89 lb in)

CONTROL VALVE BODY COVER INSTALLATION

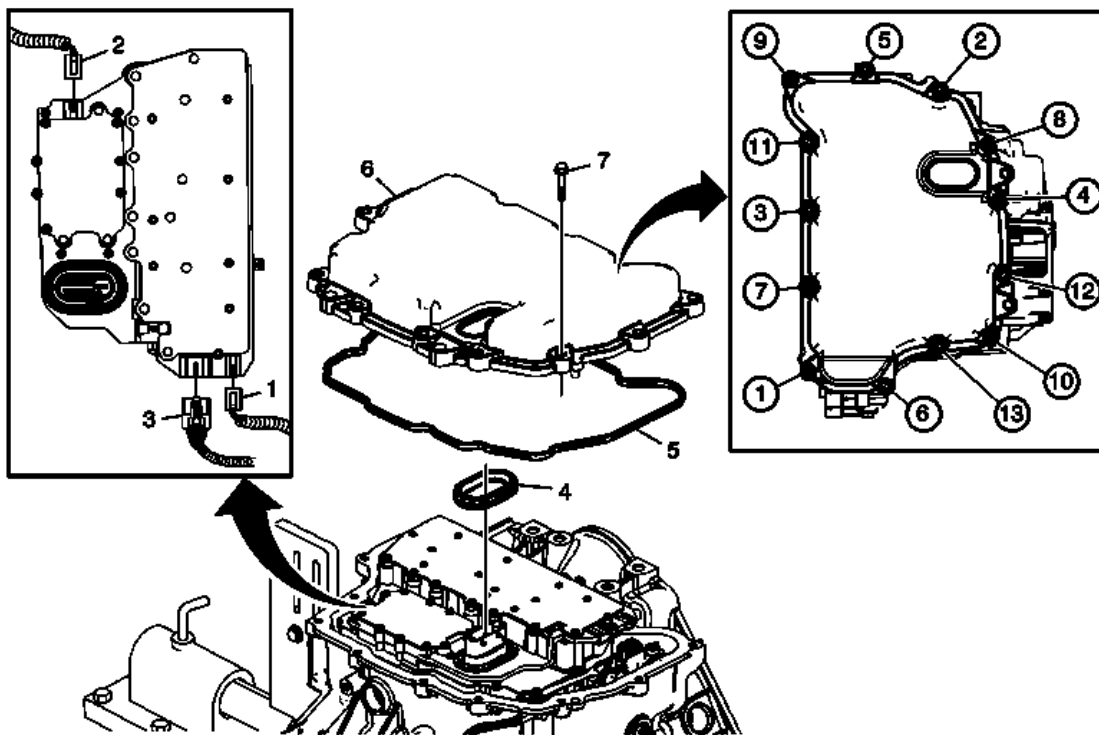


Fig. 67: Identifying Control Valve Body Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Cover Installation

Callout	Component Name
1	Input Speed Sensor Connector
2	Output Speed Sensor Connector
3	Shift Position Switch Connector
4	Control Valve Body Cover Wiring Connector Hole Seal NOTE: Do not re-use the valve body cover wiring connector hole seal.
	Control Valve Body Cover Gasket

5	NOTE: Do not re-use the valve body cover gasket.
6	Control Valve Body Cover
7	Control Valve Body Cover Bolts M6 x 30 (Qty: 13) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)

AUXILIARY FLUID PUMP CLEANING AND INSPECTION (HYBRID)

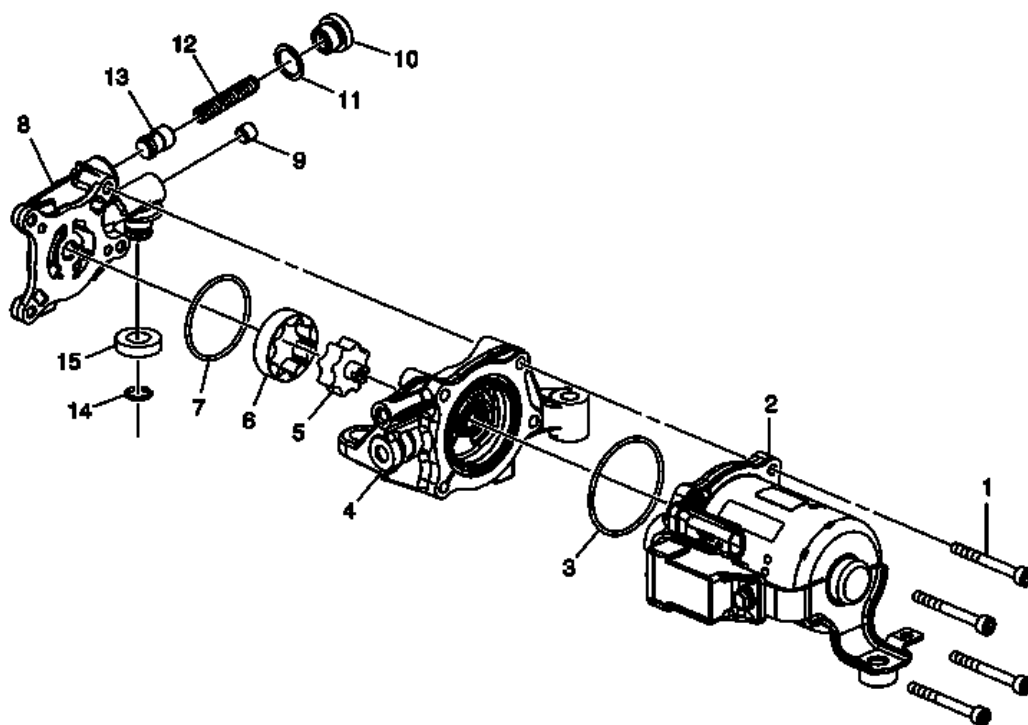


Fig. 68: Auxiliary Fluid Pump Cleaning and Inspection (Hybrid)
Courtesy of GENERAL MOTORS COMPANY

Auxiliary Fluid Pump Cleaning and Inspection (Hybrid)

Callout	Component Name
Preliminary Procedure Clean and inspect only the auxiliary fluid pump components shown above. The only serviceable components are listed as serviceable below.	
	A/Trans Auxiliary Fluid Pump (Pump to Motor) Bolt (Qty: 4)

1	CAUTION: Refer to <u>Fastener Caution</u> .
	Tighten 10-12 N.m (88-106 lb in)
2	A/Trans Auxiliary Fluid Pump Motor
3	A/Trans Auxiliary Fluid Pump Motor Cover Seal (O-ring) - serviceable
4	A/Trans Auxiliary Fluid Pump Body
5	A/Trans Auxiliary Fluid Pump Inner Rotor
6	A/Trans Auxiliary Fluid Pump Outer Rotor
7	A/Trans Auxiliary Fluid Pump Cover Seal - serviceable
8	A/Trans Auxiliary Fluid Pump Cover
9	A/Trans Auxiliary Fluid Pump Cover Hole Plug
10	Pressure Regulator Valve Spring Retainer
11	Pressure Regulator Valve Spring Spacer - serviceable
12	Pressure Regulator Valve Spring
13	Pressure Regulator Valve
14	A/Trans Auxiliary Fluid Pump Seal - serviceable
15	A/Trans Auxiliary Fluid Pump Gasket - serviceable

AUXILIARY FLUID PUMP INSTALLATION (HYBRID)

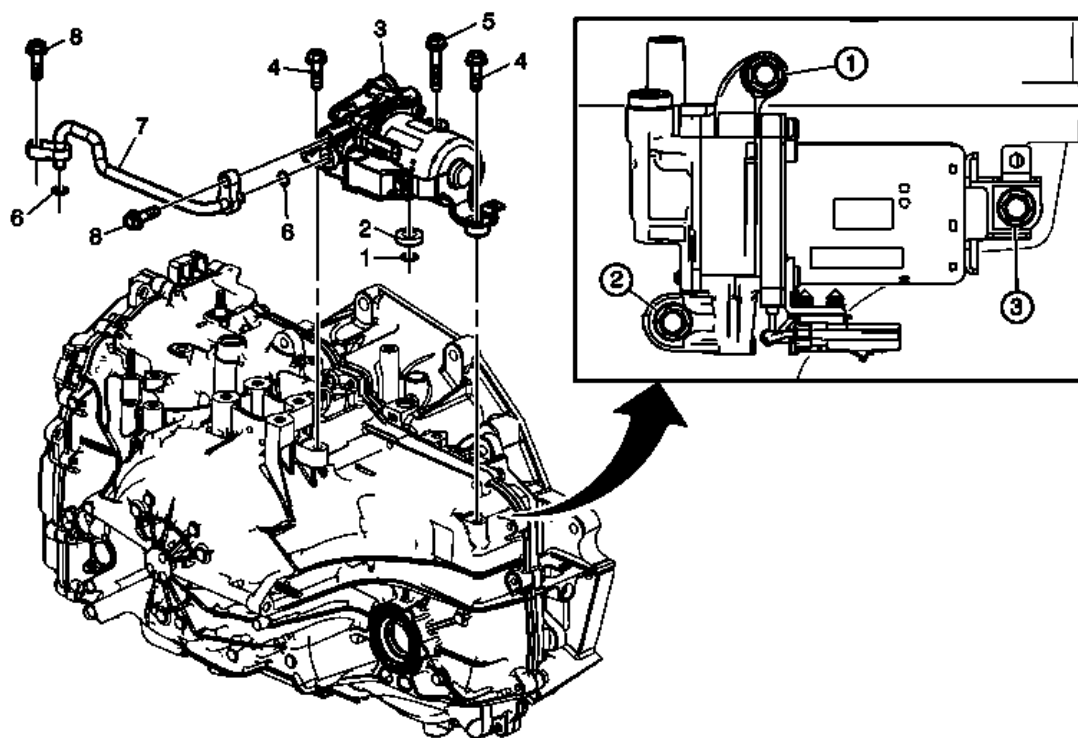


Fig. 69: Auxiliary Fluid Pump & Components

Courtesy of GENERAL MOTORS COMPANY

Auxiliary Fluid Pump Installation (Hybrid)

Callout	Component Name
1	A/Trans Auxiliary Fluid Pump Seal
2	A/Trans Auxiliary Fluid Pump Gasket
3	A/Trans Auxiliary Fluid Pump Assembly
4	<p>A/Trans Auxiliary Fluid Pump Outlet Bolt (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Tighten in sequence shown. Tighten 22 N.m (16 lb ft)</p>
5	<p>A/Trans Auxiliary Fluid Pump Bolt</p> <p>Procedure Tighten in sequence shown. Tighten 22 N.m (16 lb ft)</p>
6	Trans Auxiliary Fluid Pump Outlet Pipe Seal (Qty: 2)
7	<p>A/Trans Auxiliary Fluid Pump Outlet Pipe</p> <p>Procedure</p> <ol style="list-style-type: none">1. Fasten pipe to auxiliary pump and tighten bolt just enough to hold in place.2. Align pipe to case and tighten bolt just enough to hold in place.
8	<p>A/Trans Auxiliary Fluid Pump Outlet Bolt (Qty: 2)</p> <p>Tighten 22 N.m (16 lb ft)</p>

TORQUE CONVERTER FLUID SEAL REPLACEMENT

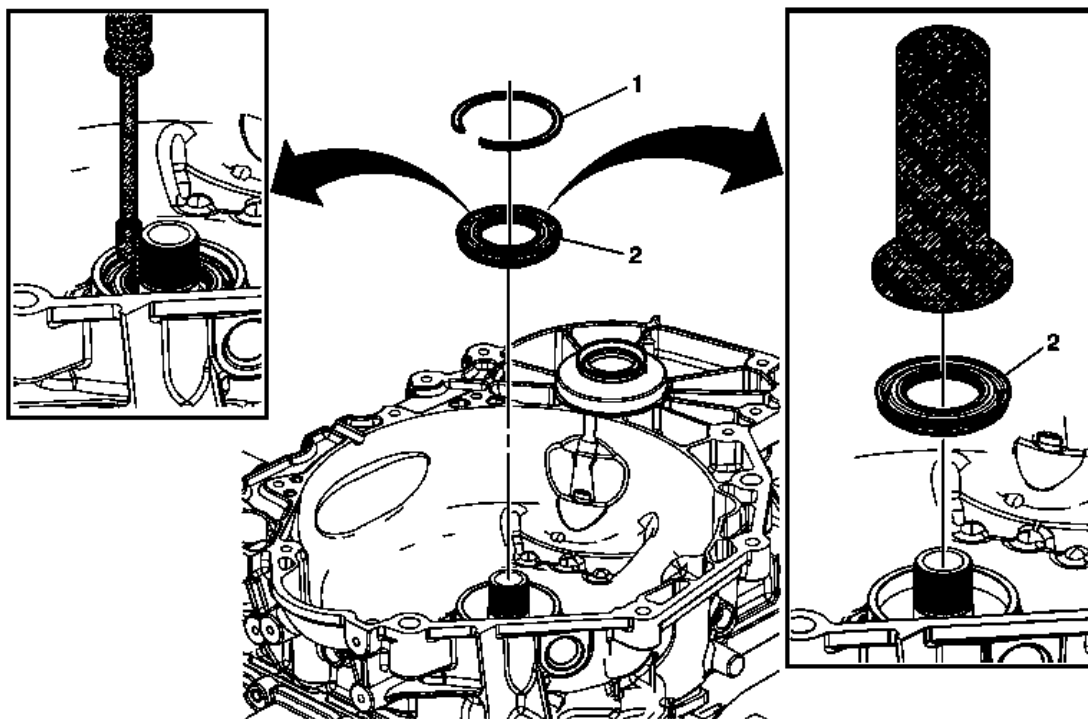


Fig. 70: View Of Torque Converter Fluid Seal & Retainer
 Courtesy of GENERAL MOTORS COMPANY

Torque Converter Fluid Seal Replacement

Callout	Component Name
1	Torque Converter Fluid Seal Retainer
2	Torque Converter Fluid Seal
	Special Tools <ul style="list-style-type: none"> • DT-47791-B Seal Installer • DT-6125-B Slide Hammer • EN-23129 Universal Seal Remover
	For equivalent regional tools, refer to Special Tools .

TORQUE CONVERTER INSTALLATION

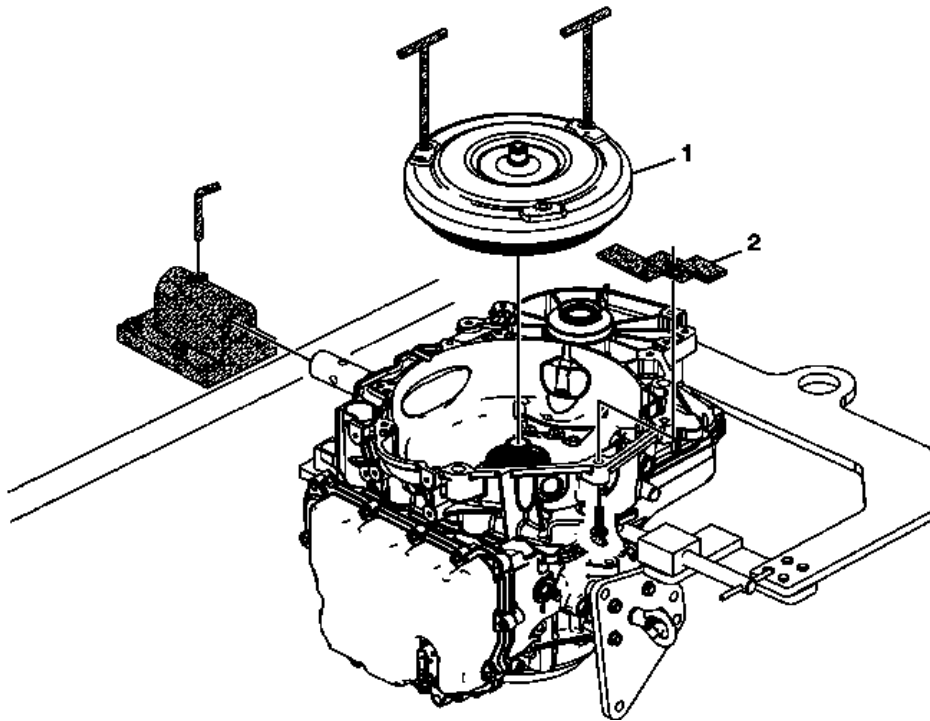


Fig. 71: View Of Torque Converter
 Courtesy of GENERAL MOTORS COMPANY

Torque Converter Installation

Callout	Component Name
1	<p>Torque Converter Assembly</p> <p>NOTE: Failure to lower the torque converter straight down could damage the torque converter clutch lip seal inside the torque converter clutch assembly.</p> <p>Special Tool DT-46409 Torque Converter Lifting Handles For equivalent regional tools, refer to Special Tools .</p>
2	<p>DT-21366 Converter Holding Strap</p> <p>WARNING: The torque converter must be held to the torque converter housing by a retaining device such as shipping brackets. Without the retaining device, the torque converter may slide forward, disengaging the oil pump, or may fall completely out of the transmission causing personal injury and/or property damage.</p>

LIFT PLATE AND HOLDING FIXTURE REMOVAL

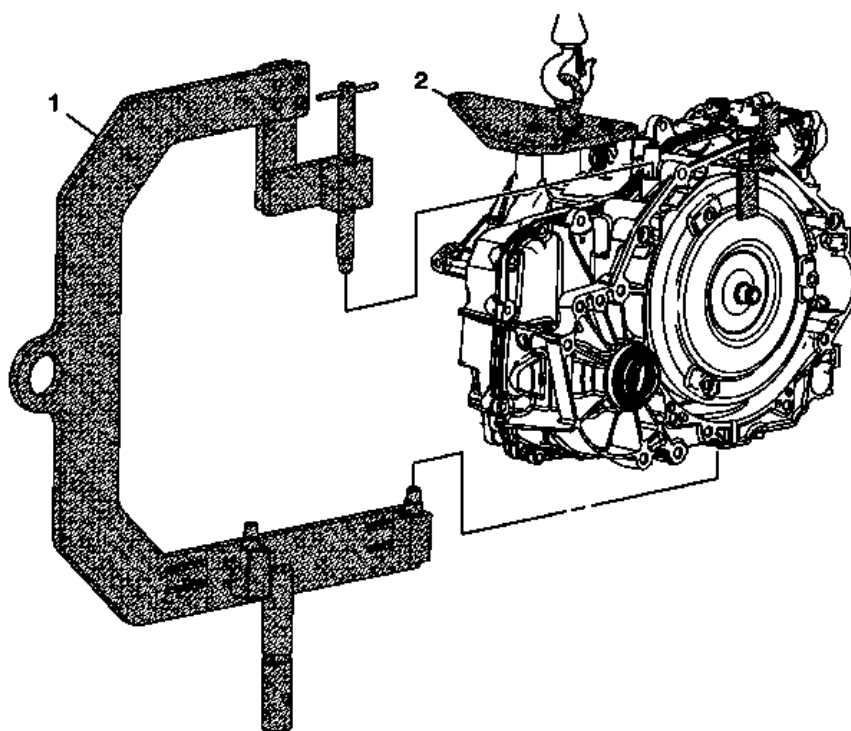


Fig. 72: Identifying Lift Plate & Holding Fixture
 Courtesy of GENERAL MOTORS COMPANY

Lift Plate and Holding Fixture Removal

Callout	Component Name
1	DT-46625 Transmission Holding Fixture For equivalent regional tools, refer to Special Tools . NOTE: Raise the transmission in order to remove the holding fixture.
2	DT-47811-S1 Transmission Lift Plate For equivalent regional tools, refer to Special Tools . NOTE: Lower the transmission assembly onto the transmission jack in order to remove the lift plate.

Transmission

Automatic Transmission - 6T40 (MH8 MHH) - Repair Instructions - On Vehicle

REPAIR INSTRUCTIONS - ON VEHICLE

MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY REPLACEMENT

Special Tools

- **DT-41229** Manual Shaft Pin Installer
- **DT-48550** Detent Lever Pin Remover

For equivalent regional tools, refer to Special Tools .

Removal Procedure

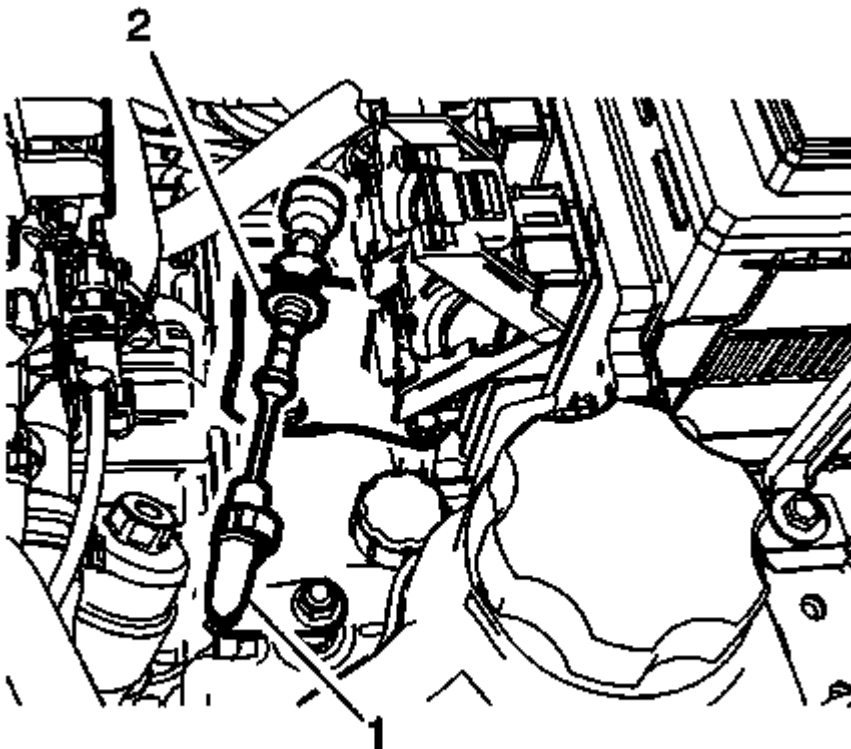


Fig. 1: Automatic Transmission Range Selector Lever Cable Terminal And Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin.
2. Remove the control valve body cover. Refer to Control Valve Body Cover Replacement.
3. Remove the control valve body. Refer to Control Valve Body Replacement.

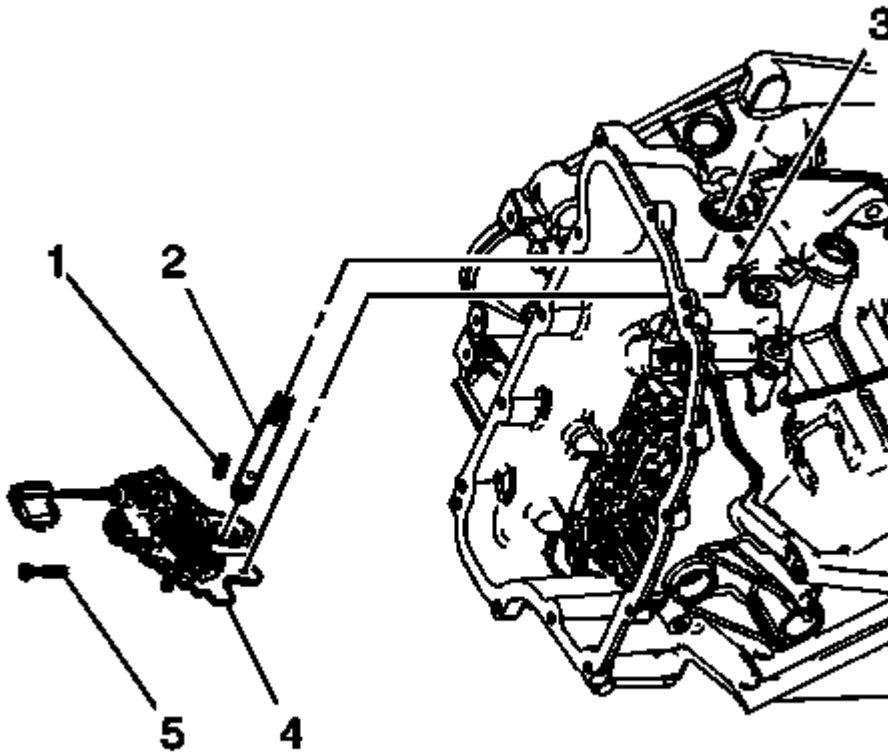


Fig. 2: View Of Manual Shift Detent Lever & Shaft Position Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Remove the manual shaft detent lever hub pin (1) using **DT-48550** remover.
5. Remove the manual shift shaft pin (5) using diagonal pliers or equivalent tool. Discard the pin.
6. Remove the manual shaft (2).

NOTE:

- **Disconnect the actuator rod (3) from the detent lever assembly. Do not remove the actuator rod from the transmission case.**
- **Do not pull the park actuator rod end out beyond the machined oil passage surface in the case. A no park condition will exist if the park pawl actuator assembly is pulled out of the transmission too far and the actuator rod disengages from the park pawl. The transmission assembly will require disassembly to reinstall the actuator rod over the park pawl.**

7. Remove the manual shaft detent (w/shift position switch) lever assembly (4).

Installation Procedure

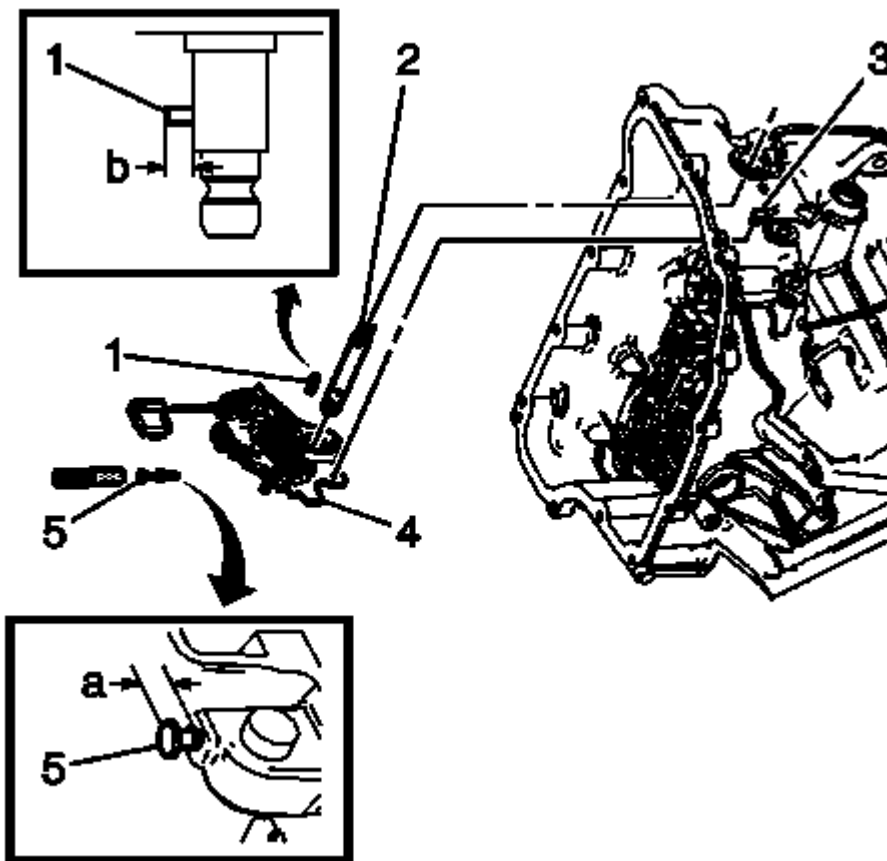


Fig. 3: Identifying Manual Shaft Detent (W/Shift Position Switch) Lever Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: Connect the actuator rod (3) to the detent lever assembly.

1. Install the manual shaft detent (w/shift position switch) lever assembly (4).

NOTE: Lubricate the shaft with automatic transmission fluid to prevent damage to the manual shift shaft seal during installation.

2. Install the manual shaft (2).
3. Install the manual shaft detent lever hub pin (1) using **DT-41229** Installer.

Specification

Install the Manual Shaft Detent Lever Hub Pin to height of (b) 7.9 mm (0.38 in).

CAUTION: Use the manual shaft pin installer to install the pin at the correct height in order to properly secure the manual shaft. If you install the pin too deep, the case bore may crack.

4. Install the NEW manual shift shaft pin (5) using **DT-41229** Installer. Use a NEW pin to ensure proper engagement with the case.

Specification

Inspect pin installed height is within (a) 7.2-8.2 mm (0.28-0.32 in).

5. Install the control valve body. Refer to **Control Valve Body Replacement.**
6. Install the control valve body cover. Refer to **Control Valve Body Cover Replacement.**

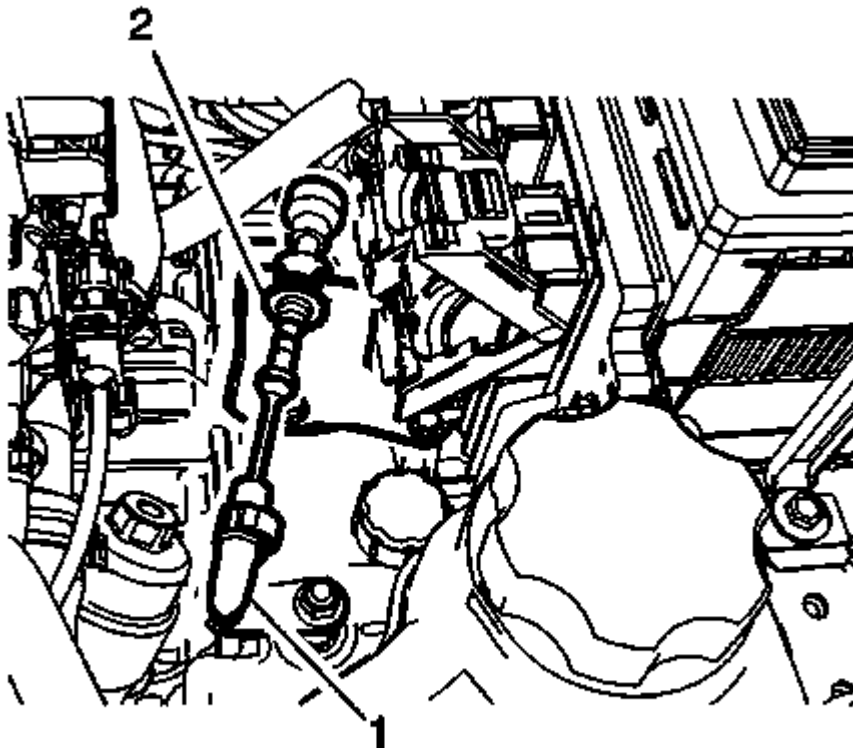


Fig. 4: Automatic Transmission Range Selector Lever Cable Terminal And Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

7. Connect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin.

TRANSMISSION CONTROL LEVER KNOB REPLACEMENT

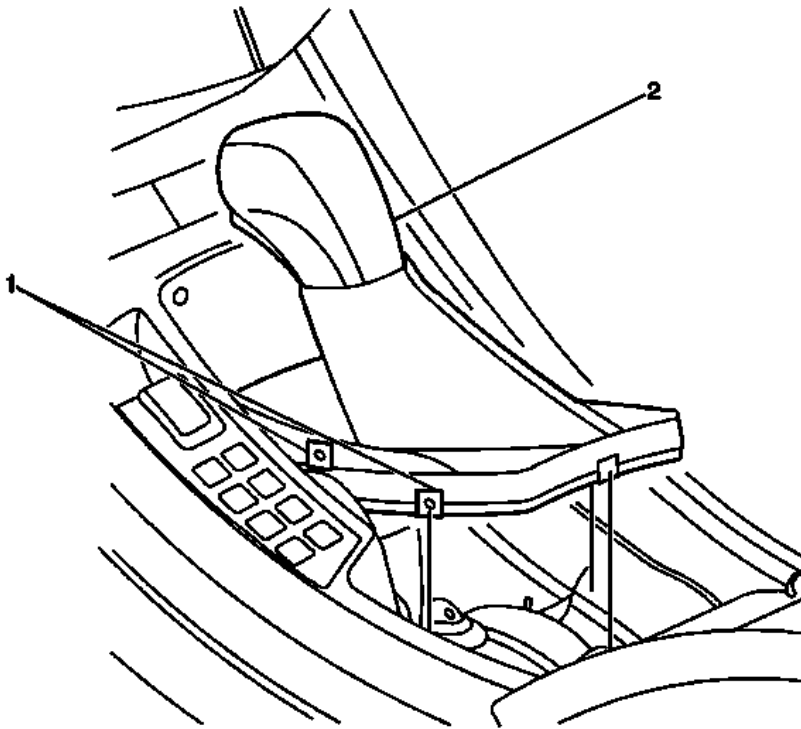


Fig. 5: Transmission Control Lever Knob, Boot & Retainers
Courtesy of GENERAL MOTORS COMPANY

Transmission Control Lever Knob Replacement

Callout	Component Name
1	Transmission Control Lever Knob Retainer (Qty: 12) Procedure Use a flat-bladed plastic trim tool in order to release the retainer clips securing the control lever boot.
2	Transmission Control Lever Knob NOTE: <ul style="list-style-type: none"> • The control lever boot and knob are replaced as an assembly. • To remove the knob, pull upward and twist.

TRANSMISSION CONTROL LEVER BOOT REPLACEMENT

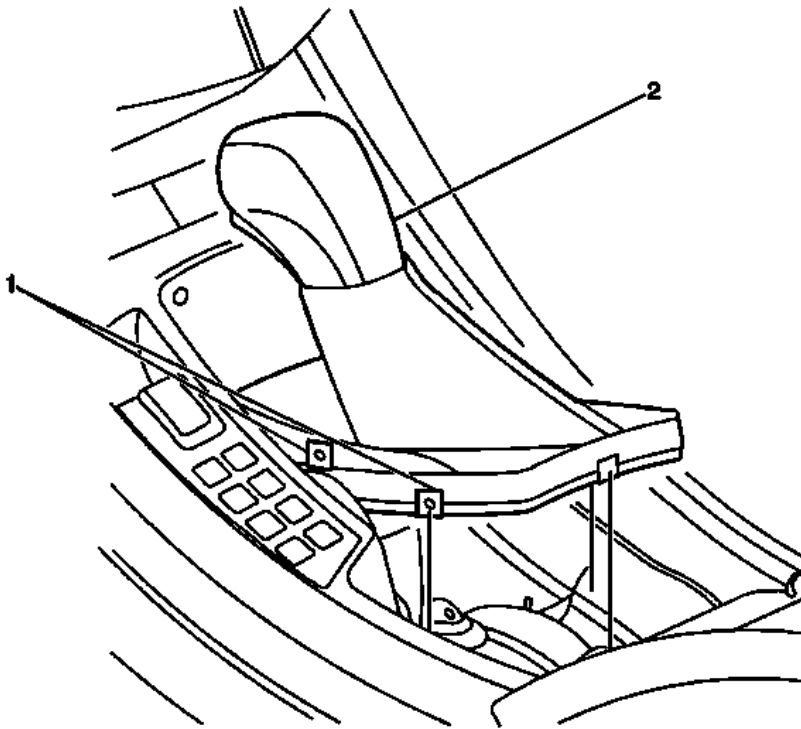


Fig. 6: Transmission Control Lever Knob, Boot & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Transmission Control Lever Boot Replacement

Callout	Component Name
1	Transmission Control Lever Knob Retainer (Qty: 12) Procedure Use a flat-bladed plastic trim tool in order to release the retainer clips securing the control lever boot.
2	Transmission Control Lever Knob NOTE: <ul style="list-style-type: none"> • The control lever boot and knob are replaced as an assembly. • To remove the knob, pull upward and twist.

TRANSMISSION CONTROL REPLACEMENT

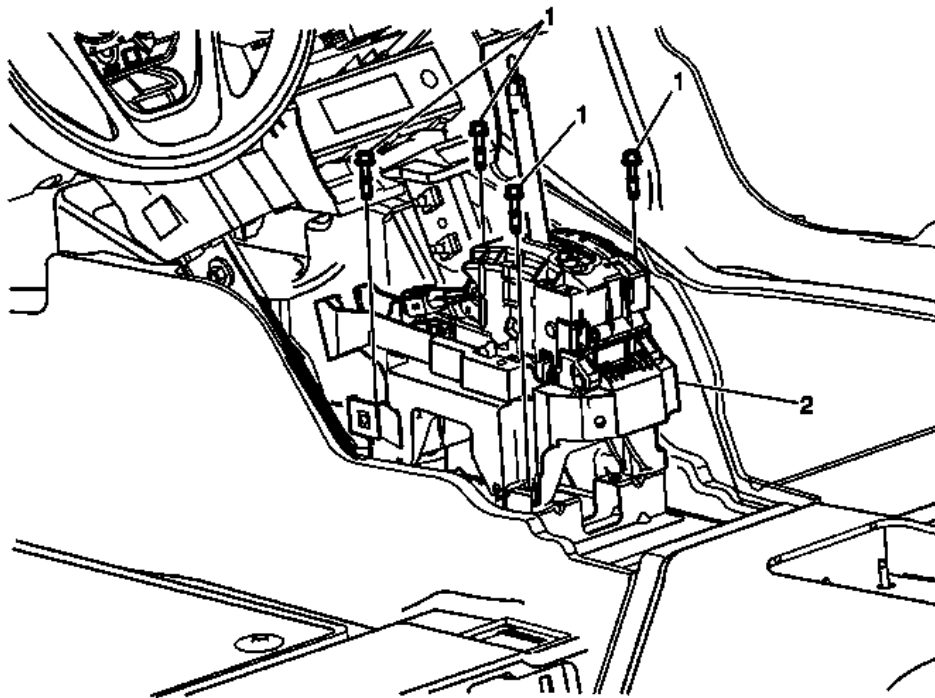


Fig. 7: Transmission Control Module & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Transmission Control Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the control lever boot. Refer to <u>Transmission Control Lever Boot Replacement.</u> 2. Remove floor console. Refer to <u>Front Floor Console Replacement .</u>	
1	Transmission Control Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution .</u> Procedure 1. Remove the clips on the wiring harness and disconnect the shift control electrical connector 2. Disconnect the shift control cable. Tighten 9 N.m (80 lb in)
2	Transmission Control

RANGE SELECTOR LEVER CABLE REPLACEMENT

Removal Procedure

1. Set the park brake and chock the wheels.
2. Remove the battery tray. Refer to **Battery Tray Replacement** .

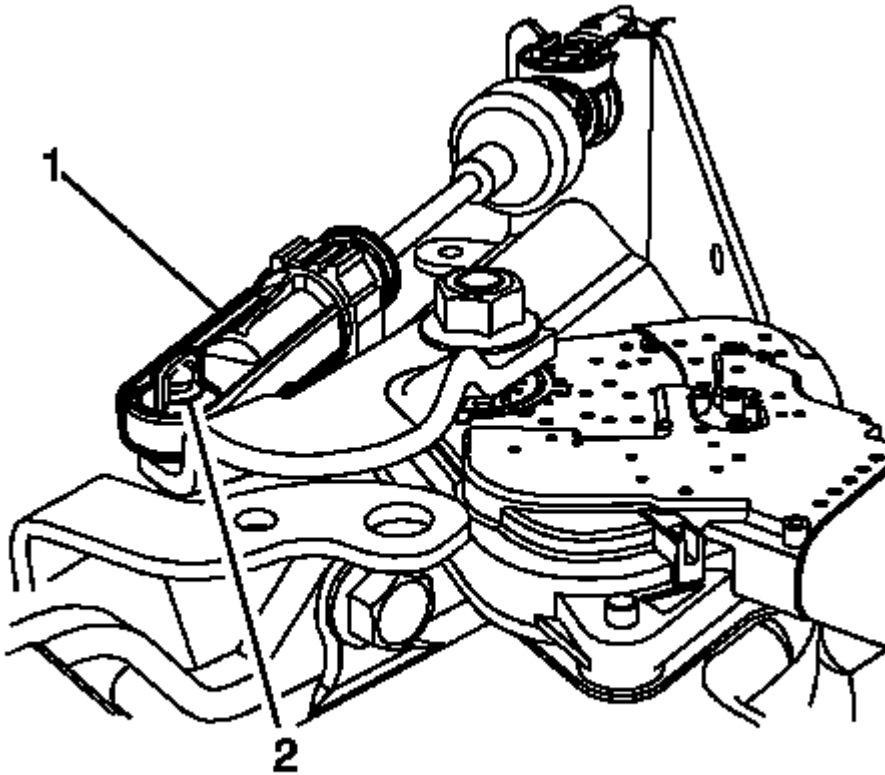


Fig. 8: Transmission Range Selector Lever Cable Terminal And Lever Pin
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin (2).

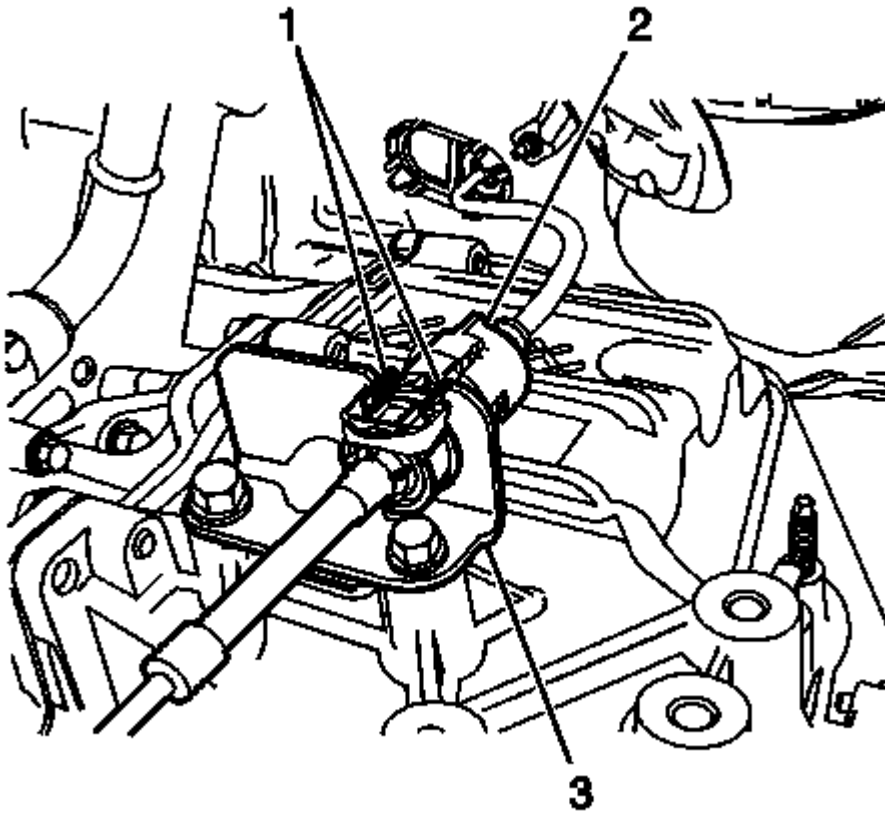


Fig. 9: Transmission Range Selector Lever Cable & Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Press the locking tabs inward (1) in order to release the transmission range selector lever cable (2) from the cable bracket (3).
5. Remove the console. Refer to **Front Floor Console Replacement** .

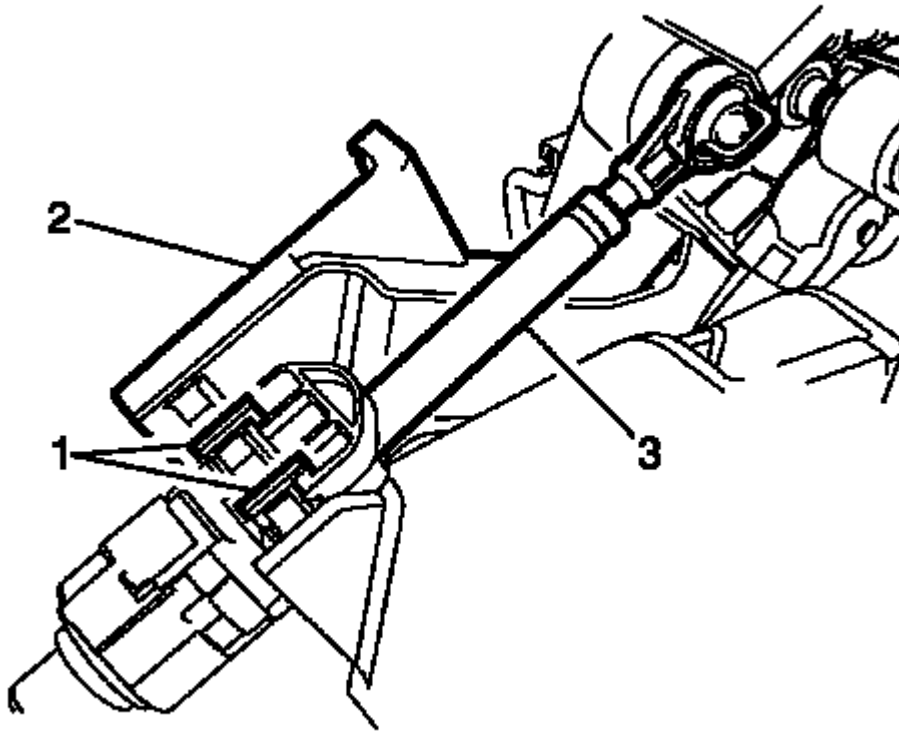


Fig. 10: Transmission Range Selector Lever Cable, Locking Tabs And Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Press the locking tabs inward (1) in order to release the transmission range selector lever cable (3) from the cable bracket (2).
7. Release the retainer and then remove the cable end terminal from shifter pin.

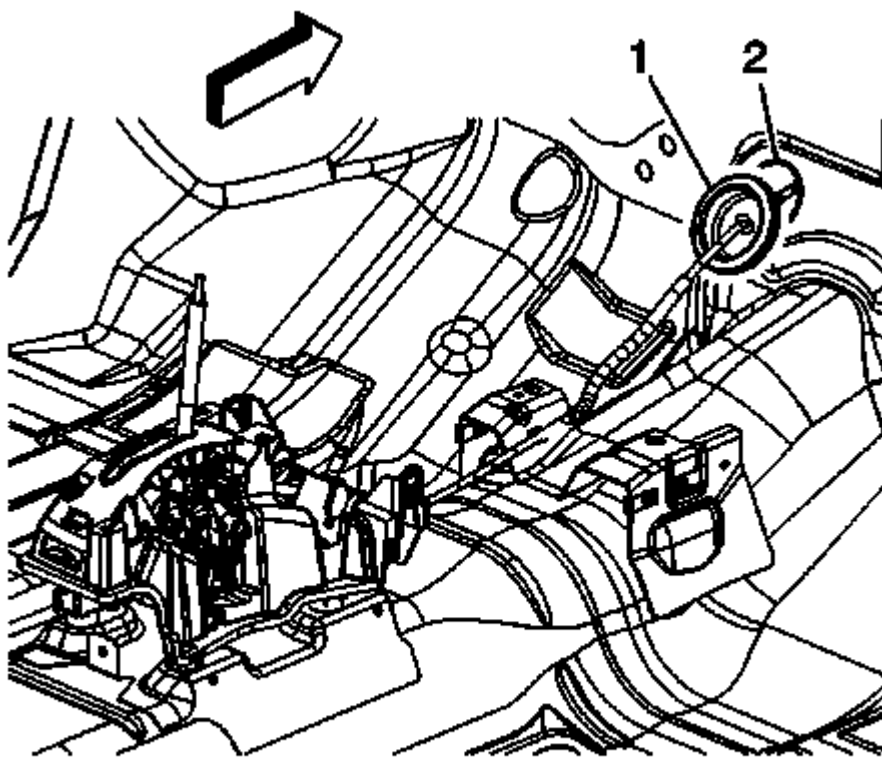


Fig. 11: Identifying Cowl Panel & Selector Lever Cable Grommet
Courtesy of GENERAL MOTORS COMPANY

8. Remove the transmission range selector lever cable grommet (1) from the cowl panel.
9. Remove the transmission range selector lever cable from the vehicle.

Installation Procedure

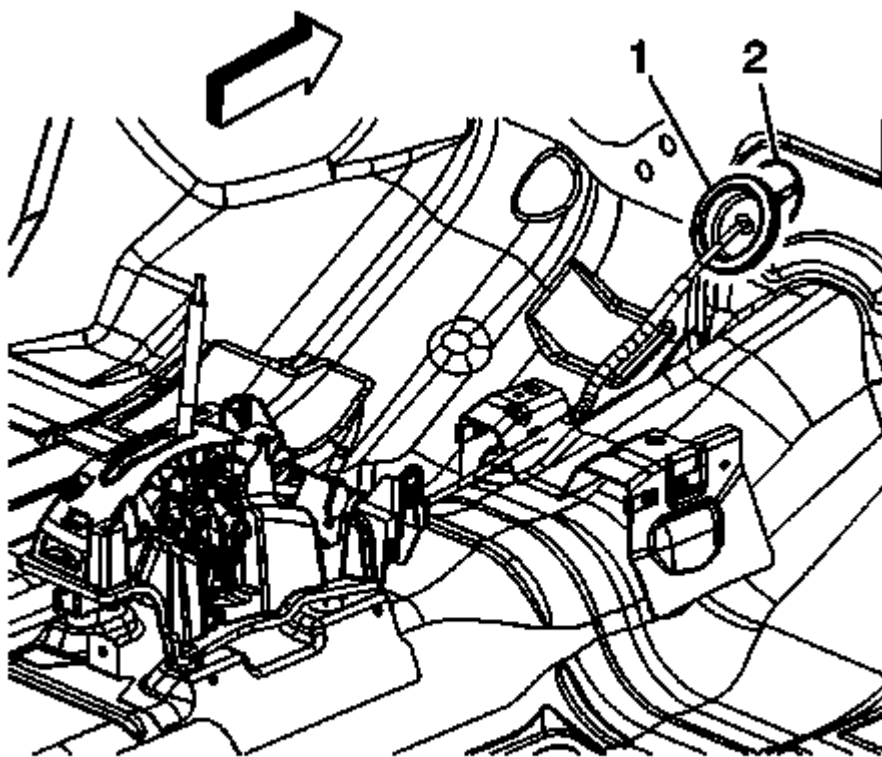


Fig. 12: Identifying Cowl Panel & Selector Lever Cable Grommet
Courtesy of GENERAL MOTORS COMPANY

1. Install the transmission range selector lever cable to the vehicle.
2. Install the transmission range selector lever cable grommet (1) to the cowl panel (2).

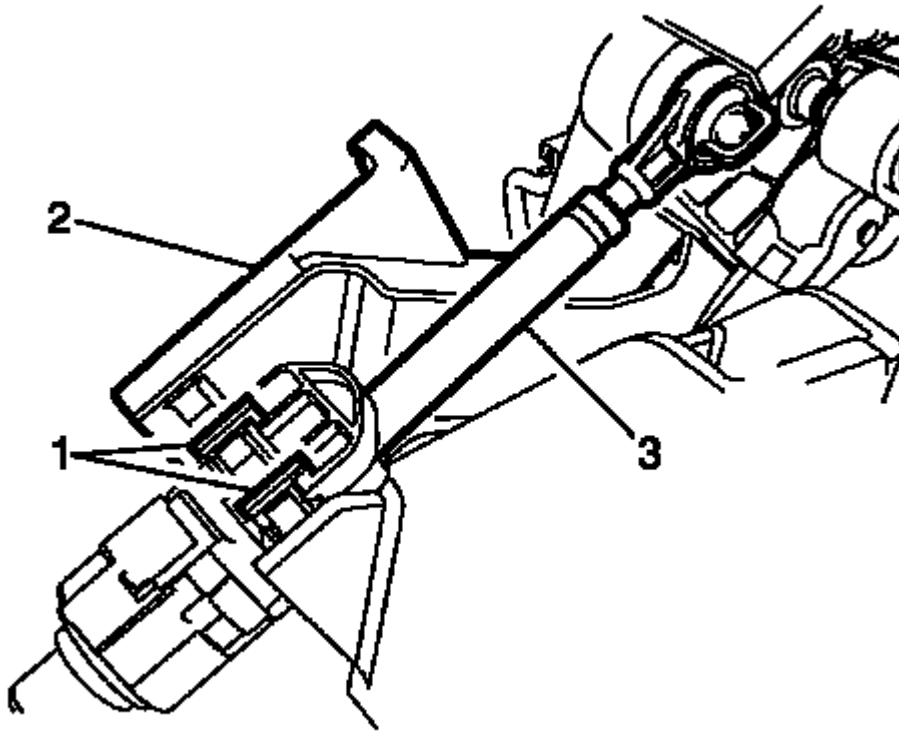


Fig. 13: Transmission Range Selector Lever Cable, Locking Tabs And Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Connect the transmission range selector cable terminal to the shift lever pin.
4. Remove the cable tie and secure the retainer.
5. Install the cable (3) to transmission shifter base (2).
6. Install the console. Refer to **Front Floor Console Replacement** .

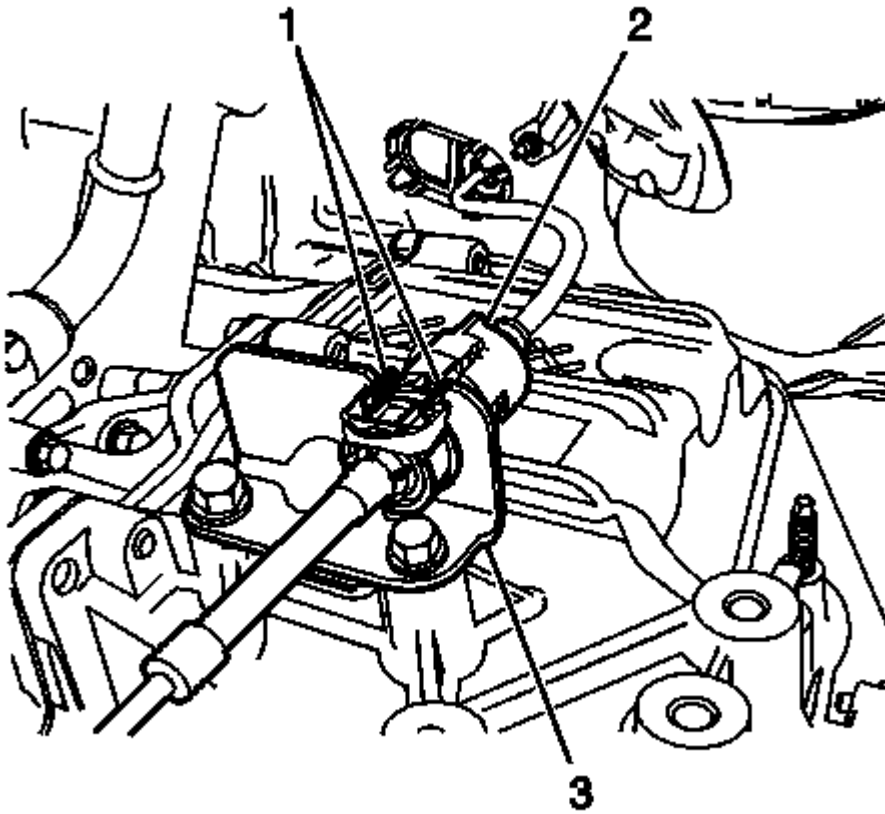


Fig. 14: Transmission Range Selector Lever Cable & Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Install the transmission range selector lever cable (2) to the cable bracket (3).

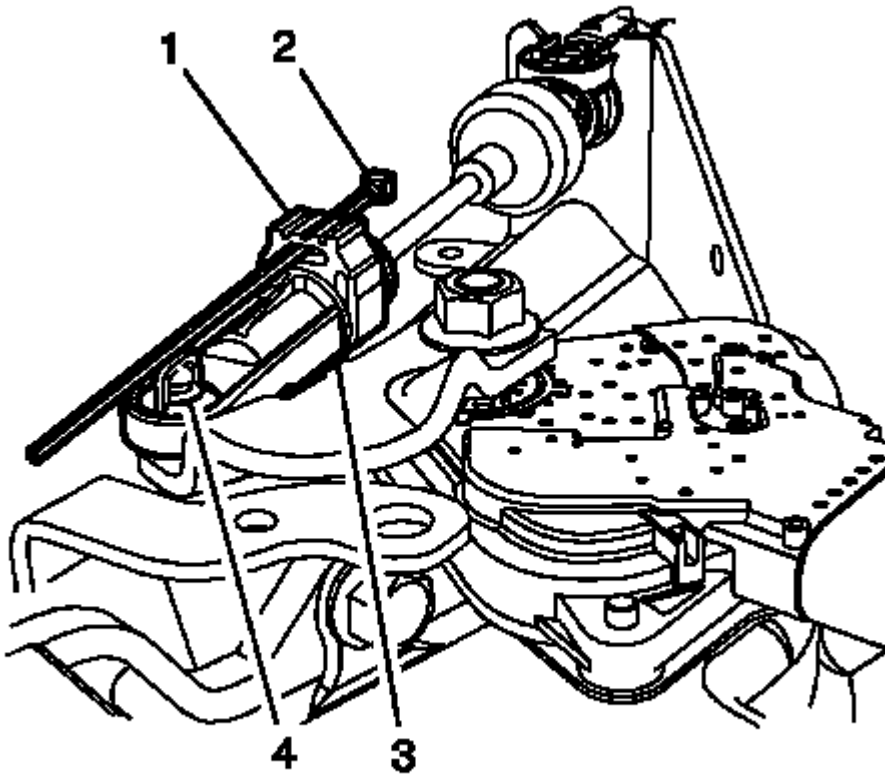


Fig. 15: Range Selector Lever Cable Terminal And Transmission Manual Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

8. Connect the transmission range selector lever cable terminal (4) to the transmission manual shift lever pin.
9. Ensure that the shift lever and the shifter are in the Park position. Secure the shift cable adjustable lock into place. Remove the lock retainer (2). Ensure that the adjustable lock (1) is properly seated.
10. Install the battery tray. Refer to **Battery Tray Replacement** .

RANGE SELECTOR LEVER CABLE ADJUSTMENT

The shift cable on this vehicle does not require an adjustment.

TRANSMISSION FLUID DRAIN AND FILL

Removal Procedure

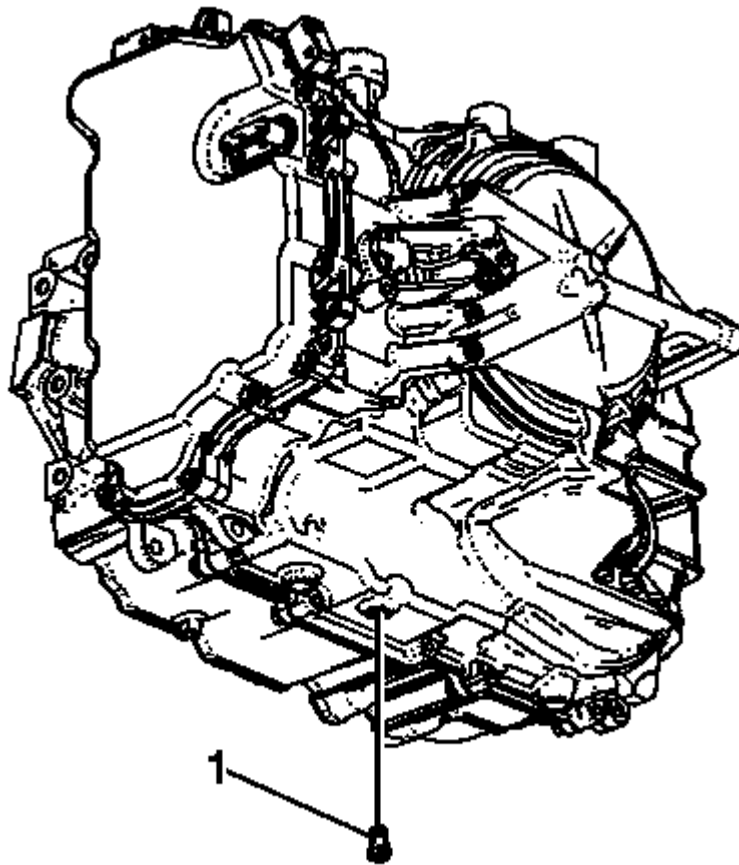


Fig. 16: Identifying Fluid Level Hole Plug
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the fluid drain plug (1).
3. Drain transmission fluid into a suitable container.

CAUTION: Refer to Fastener Caution .

4. Install the fluid drain plug (1) and tighten to 12 N.m (106 lb in).

Installation Procedure

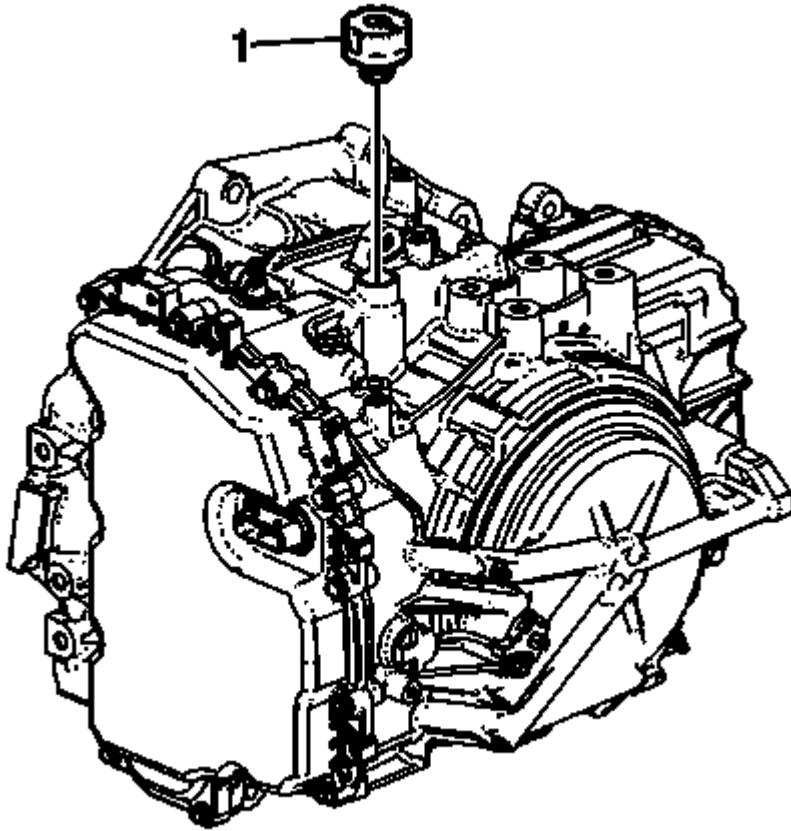


Fig. 17: Identifying Fluid Fill Cap

Courtesy of GENERAL MOTORS COMPANY

1. Lower the vehicle.
2. Remove the fluid fill cap (1).
3. Fill the transmission to the proper level with the correct fluid. Refer to **Transmission Fluid Level and Condition Check** , and **Fluid Capacity Specifications (6T40/45/50)** .
4. Install the fluid fill cap (1).

AUXILIARY FLUID PUMP REPLACEMENT (HYBRID)

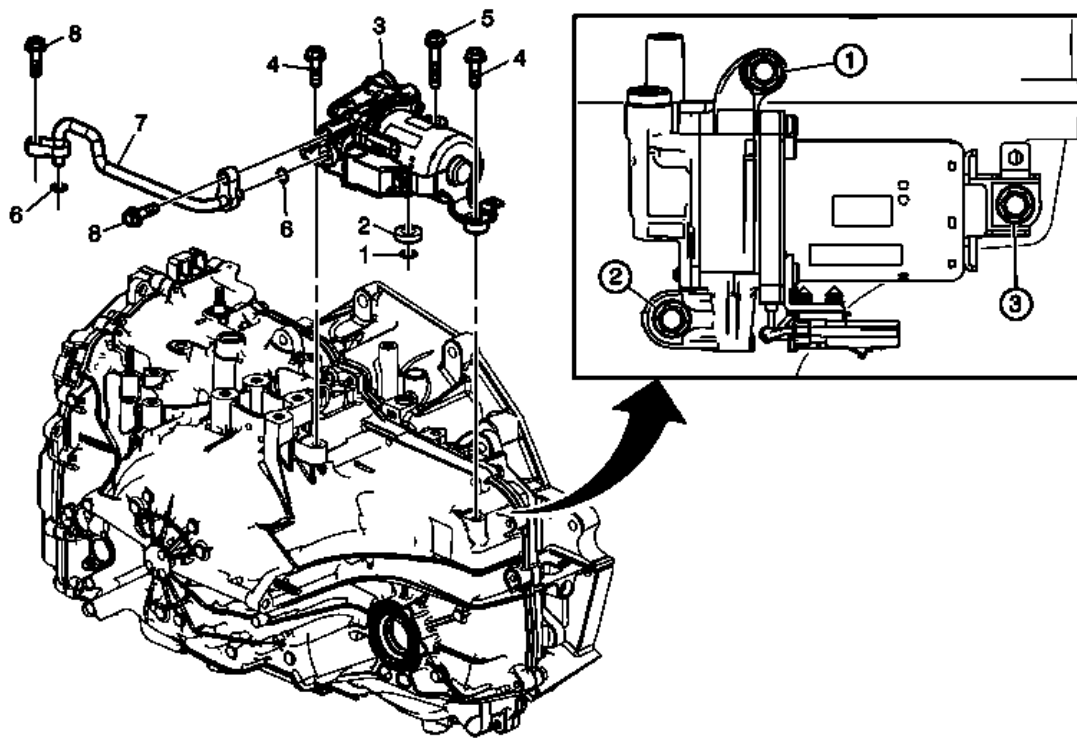


Fig. 18: Auxiliary Fluid Pump & Components
Courtesy of GENERAL MOTORS COMPANY

Auxiliary Fluid Pump Replacement (Hybrid)

Callout	Component Name
Preliminary Procedures	
1. Reposition the ECU and bracket. 2. Set the park brake and chock the wheels. 3. Disconnect the range selector cable from the range selector lever. Refer to <u>Range Selector Lever Cable Replacement</u> .	
1	A/Trans Auxiliary Fluid Pump Seal
2	A/Trans Auxiliary Fluid Pump Gasket
3	A/Trans Auxiliary Fluid Pump Assembly
4	A/Trans Auxiliary Fluid Pump Outlet Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
5	A/Trans Auxiliary Fluid Pump Bolt Tighten 22 N.m (16 lb ft)

6	Trans Auxiliary Fluid Pump Outlet Pipe Seal (Qty: 2)
7	A/Trans Auxiliary Fluid Pump Outlet Pipe Procedure 1. Fasten pipe to auxiliary pump and tighten bolt just enough to hold in place. 2. Align pipe to case and tighten bolt just enough to hold in place.
8	A/Trans Auxiliary Fluid Pump Outlet Bolt (Qty: 2) NOTE: Check the fluid. Tighten 22 N.m (16 lb ft)

AUXILIARY FLUID PUMP OUTLET PIPE REPLACEMENT (HYBRID)

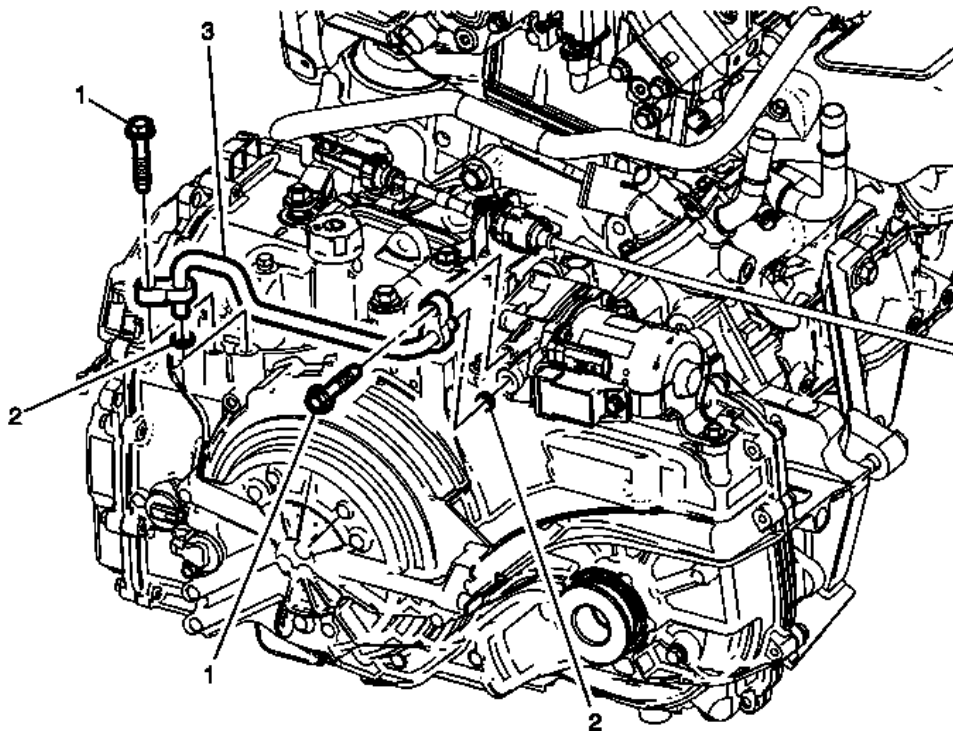


Fig. 19: Auxiliary Fluid Pump Outlet Pipe, Seals & Bolts
Courtesy of GENERAL MOTORS COMPANY

Auxiliary Fluid Pump Outlet Pipe Replacement (Hybrid)

Callout	Component Name
Preliminary Procedure	

Remove the battery tray. Refer to **Battery Tray Replacement** .

1	<p>A/Trans Auxiliary Fluid Pump Outlet Bolt (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 22 (16 lb ft)</p>
2	Trans Auxiliary Fluid Pump Outlet Pipe Seal (Qty: 2)
3	<p>A/Trans Auxiliary Fluid Pump Outlet Pipe</p> <p>Procedure</p> <ol style="list-style-type: none">1. Fasten pipe to auxiliary pump and tighten bolt just enough to hold in place.2. Align pipe to case and tighten bolt just enough to hold in place.3. Check the transmission fluid level. Refer to <u>Transmission Fluid Level and Condition Check</u> .

AUTOMATIC TRANSMISSION FLUID PRESSURE TEST HOLE PLUG REPLACEMENT

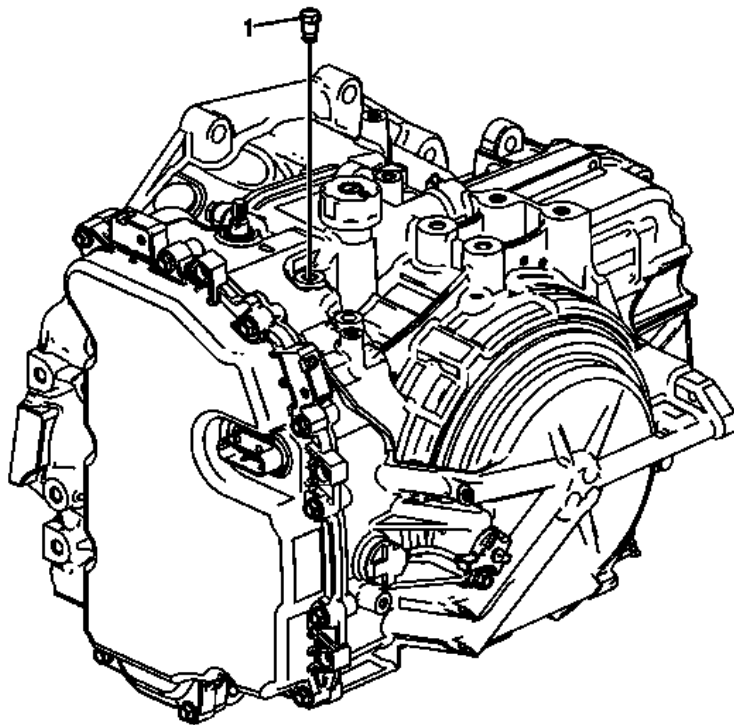


Fig. 20: Identifying Pressure Test Plug
Courtesy of GENERAL MOTORS COMPANY

Automatic Transmission Fluid Pressure Test Hole Plug Replacement

Callout	Component Name
1	Fluid Pressure Test Plug CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - LEFT SIDE

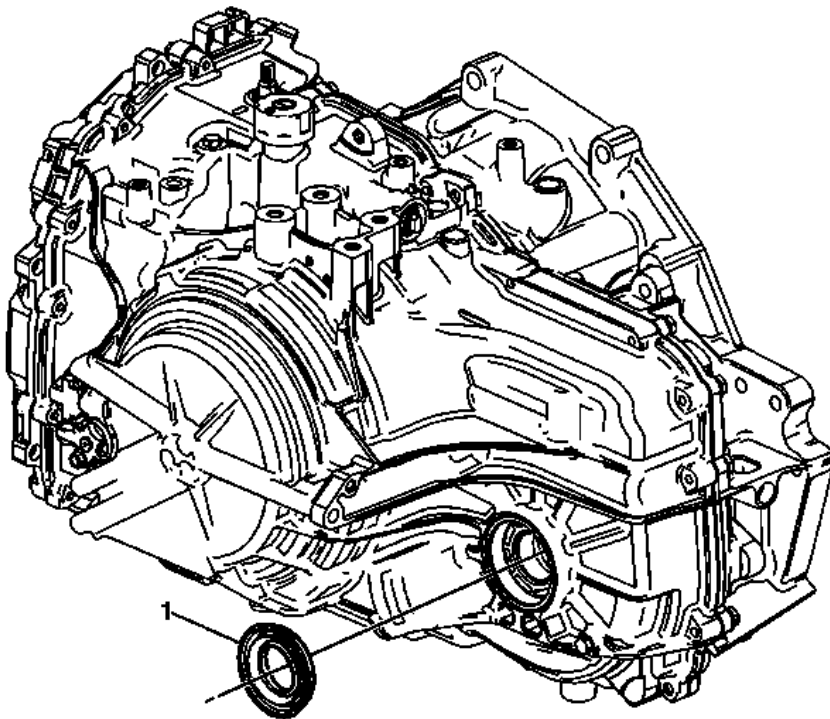


Fig. 21: Identifying Left Front Wheel Drive Shaft Seal
Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Left Side

Callout	Component Name
Preliminary Procedures	
1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
2. Remove the left wheel drive shaft. Refer to <u>Front Wheel Drive Shaft Replacement - Left Side</u> .	
	Left Front Wheel Drive Shaft Oil Seal

NOTE:

- For seal removal use GE-6125-B hammer with DT-23129 remover.
- For seal installation use GE-8092 handle with DT-47790 installer.

Special Tools

1

- **DT-23129** Universal Seal Remover
- **DT-47790** Seal Installer
- **GE-6125-B** Slide Hammer
- **GE-8092** Driver Handle

For equivalent regional tools, refer to **Special Tools** .

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - RIGHT SIDE

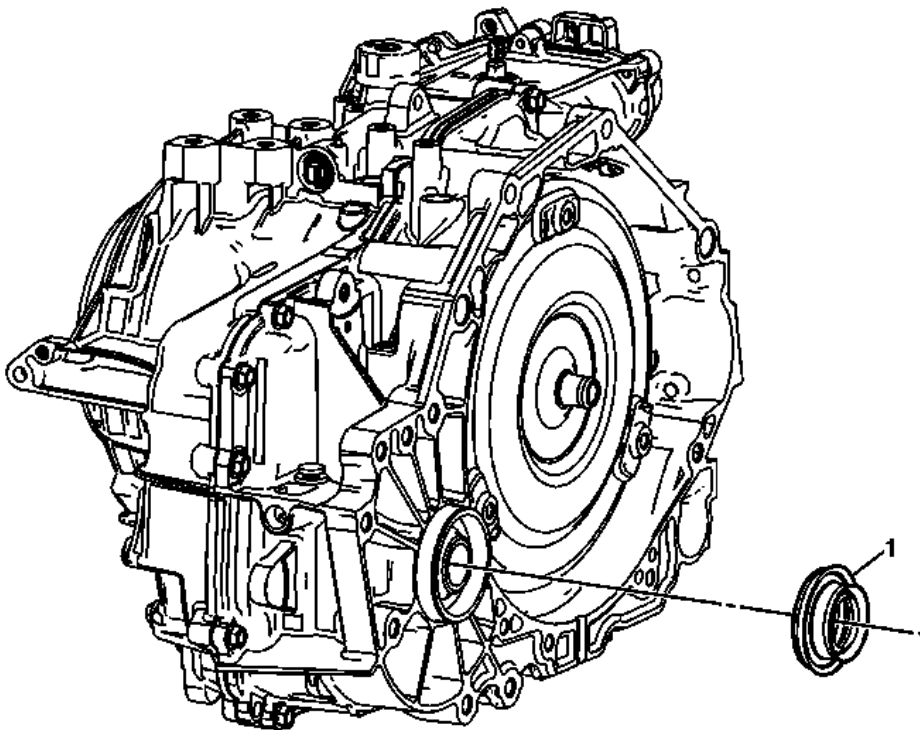


Fig. 22: Identifying Right Front Wheel Drive Shaft Seal
Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Right Side

Callout	Component Name
Preliminary Procedures	
1.	Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .

2. Remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)** , **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)**

Right Front Wheel Drive Shaft Oil Seal

NOTE:

- For seal removal use GE-6125-B hammer with DT-23129 remover.
- For seal installation use GE-8092 handle with DT-47790 installer.

Special Tools

1

- **DT-23129** Universal Seal Remover
- **DT-47790** Seal Installer
- **GE-6125-B** Slide Hammer
- **GE-8092** Driver Handle

For equivalent regional tools, refer to **Special Tools** .

MANUAL SHIFT SHAFT AND SEAL REPLACEMENT

Special Tools

- **DT-45201** Cooler Line Seal Remover
- **DT-46626** Seal Installer

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the manual shaft and position switch assembly. Refer to **Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Removal** .

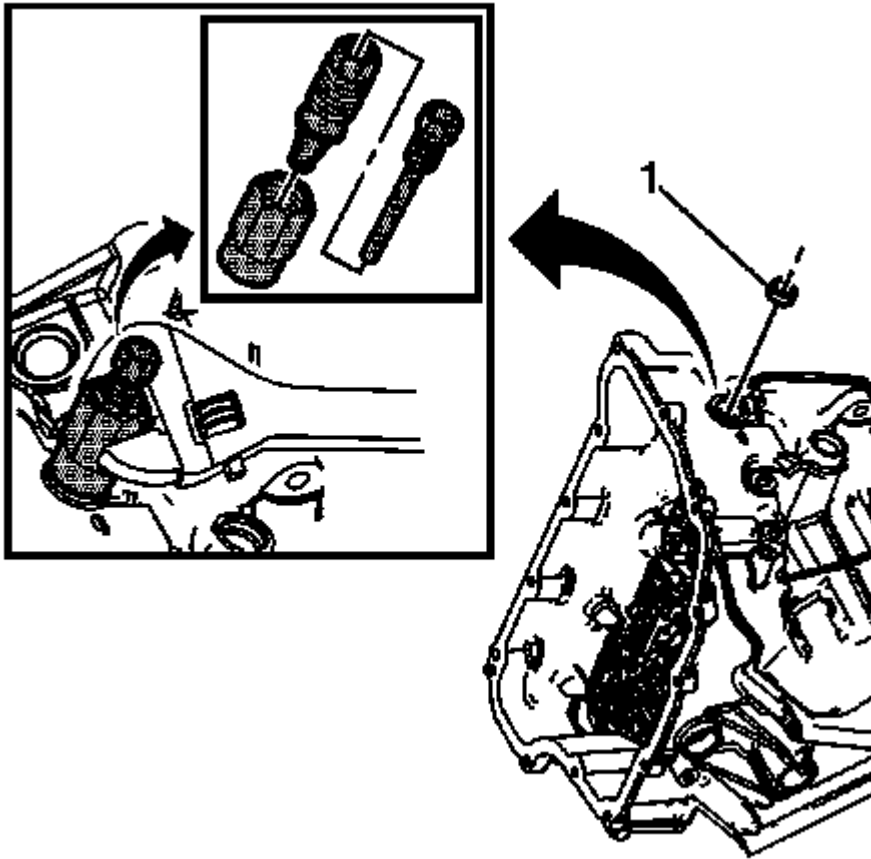


Fig. 23: Cooler Line Seal Remover
Courtesy of GENERAL MOTORS COMPANY

2. Remove the manual shaft seal (1) using **DT-45201** remover.

Installation Procedure

1. Install the manual shaft and position switch assembly. Refer to **Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Removal** .

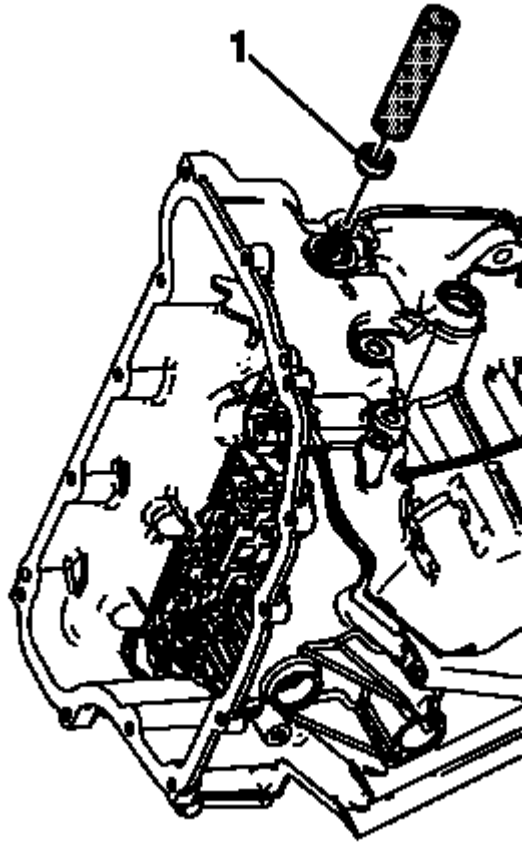


Fig. 24: Seal Installation Tool

Courtesy of GENERAL MOTORS COMPANY

2. Install the manual shaft seal (1) using **DT-46626** installer.

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the transmission control valve body cover. Refer to **Control Valve Body Cover Replacement**.

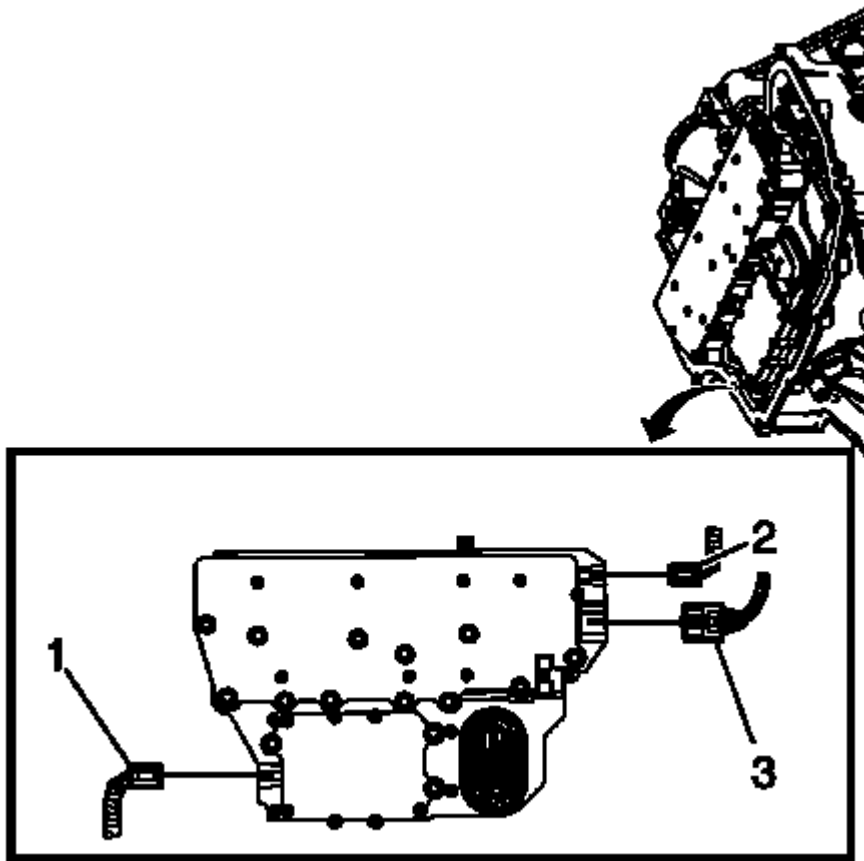


Fig. 25: Input Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the input speed sensor electrical connector (1).
3. Disconnect the output speed sensor electrical connector (2).
4. Disconnect the shift position switch electrical connector (3).

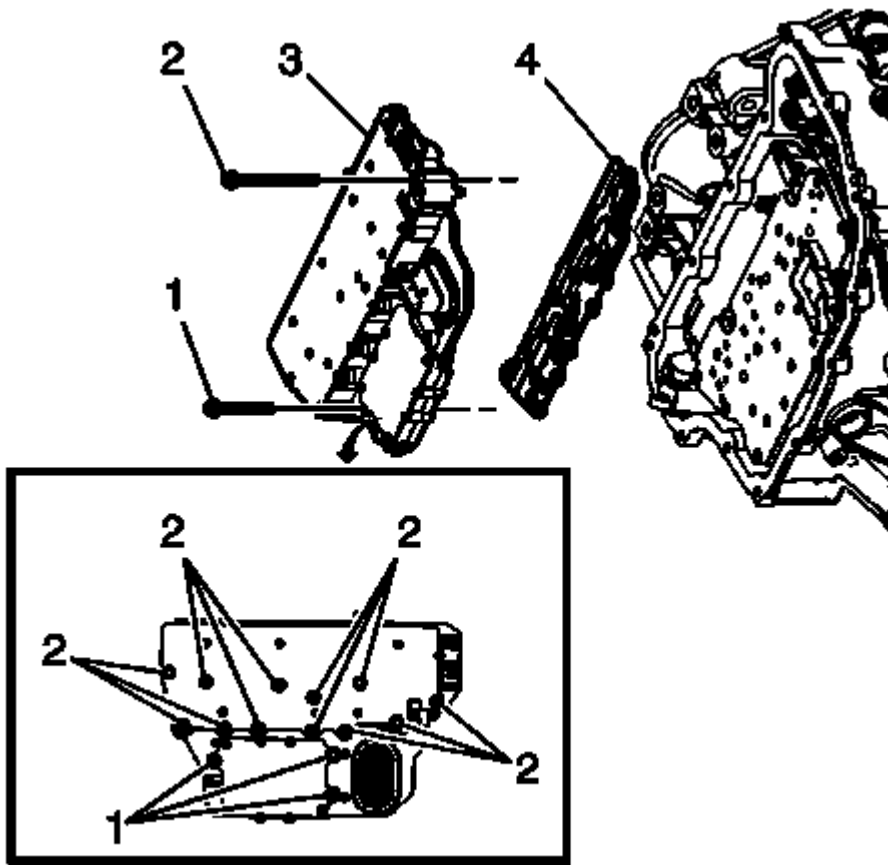


Fig. 26: Locating Control Valve Body & Bolts
 Courtesy of GENERAL MOTORS COMPANY

5. Remove the 3 control solenoid valve assembly bolts (1) M5 x 40.5.
6. Remove the 12 control solenoid valve assembly bolts (2) M6 x 97.
7. Remove the control solenoid valve assembly with transmission control module (3).

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

8. Remove the control solenoid valve assembly filter plate (4). Discard the filter plate. It is not reusable.
9. Inspect the pressure switch seals for damage or contamination. Replace the control solenoid valve assembly as necessary.
10. Inspect the channel plate bolt pass through holes for damage or burnelling. Any damage could cause leaking. Replace as necessary.

Installation Procedure

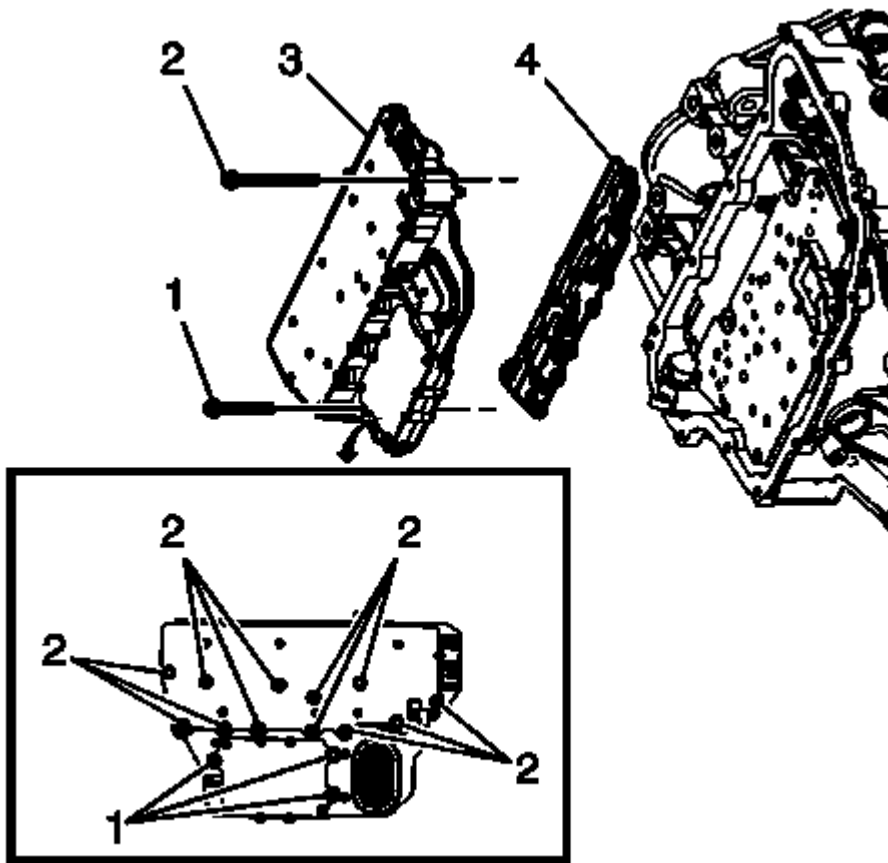


Fig. 27: Locating Control Valve Body & Bolts
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

1. Install a NEW control solenoid valve assembly filter plate (4) to prevent fluid leaks past the fluid seals.
2. Install the control solenoid valve assembly with transmission control module (3).
3. Hand start the control valve body bolts (1, 2).

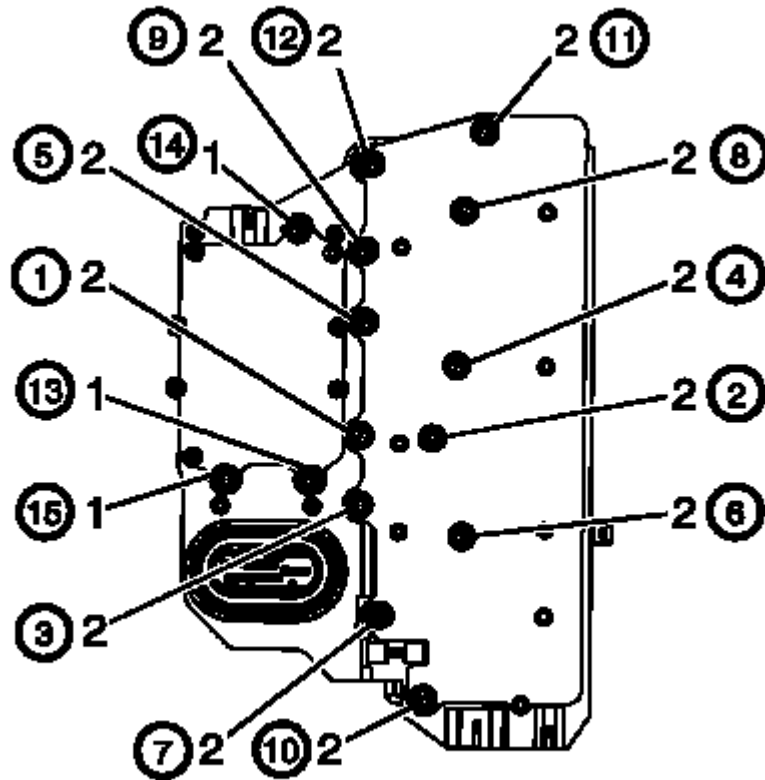


Fig. 28: Control Valve Body Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Secure the 12 control solenoid valve assembly bolts (2) M6 x 97 and tighten in sequence to 10 N.m (89 lb in).
5. Secure the 3 control solenoid valve assembly bolts (1) M5 x 40.5 and tighten in sequence to 7 N.m (62 lb in).

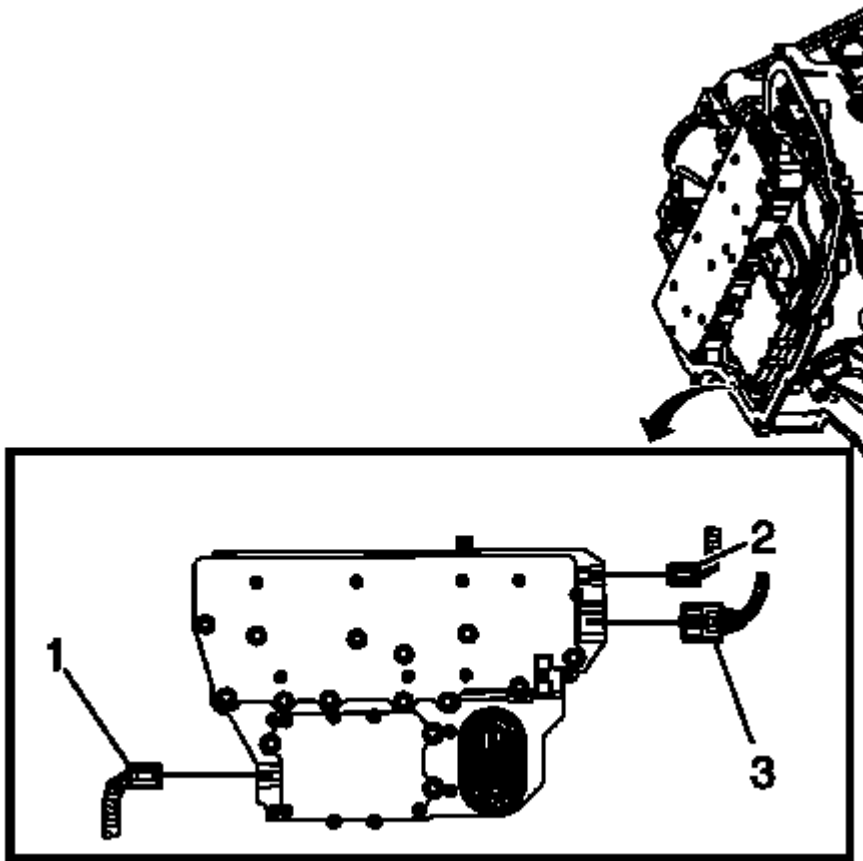


Fig. 29: Input Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Connect the input speed sensor electrical connector (1).
7. Connect the output speed sensor electrical connector (2).
8. Connect the shift position switch electrical connector (3).
9. Install the transmission control valve body cover. Refer to **Control Valve Body Cover Replacement**.
10. If a NEW TCM has been installed into the vehicle, the NEW module needs to be reprogrammed. Refer to **Service Programming System (SPS)** .

NOTE:

The Transmission Adaptive Values Learn procedure must be performed when one of the following repairs have been made to the vehicle. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, as well as transmission DTCs being set:

- Transmission internal service/overhaul
- Valve body repair or replacement
- Control solenoid valve assembly replacement
- TCM software/calibration update

- Any service in response to a shift quality concern

11. Perform the Transmission Adaptive Values Learn procedure. Refer to Transmission Adaptive Values Learn .

CONTROL VALVE BODY COVER REPLACEMENT

Removal Procedure

1. Remove the battery tray. Refer to Battery Tray Replacement .

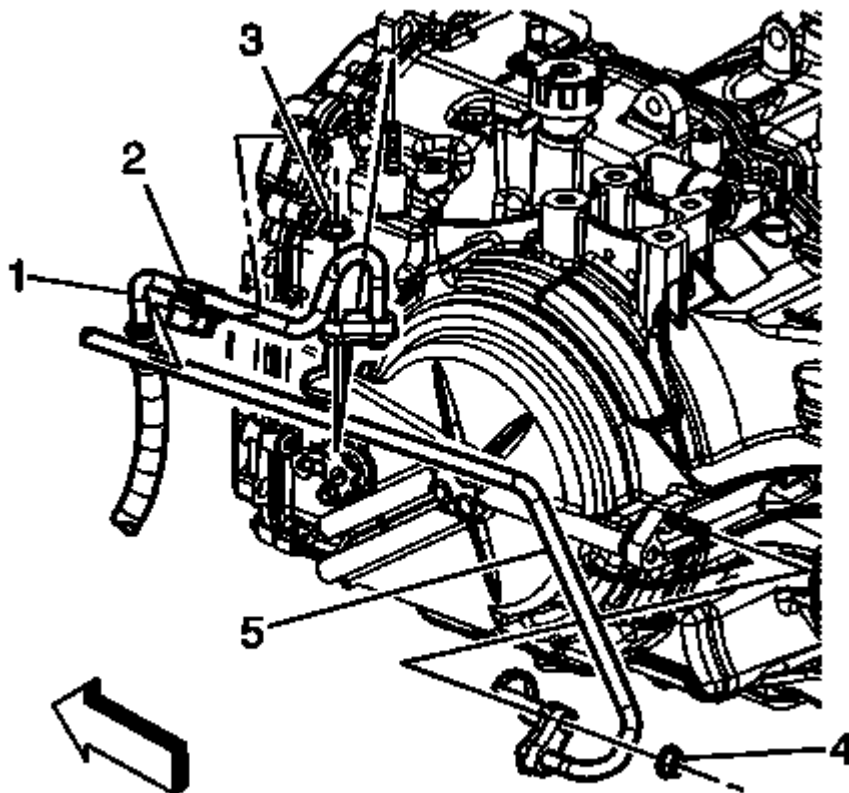


Fig. 30: Cooler Inlet And Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil cooler inlet (1) and outlet (2) hoses from the retainer (2) on the control valve body cover.
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove the front transmission mount. Refer to Transmission Front Mount Replacement.
5. Drain the transmission. Refer to Transmission Fluid Drain and Fill.

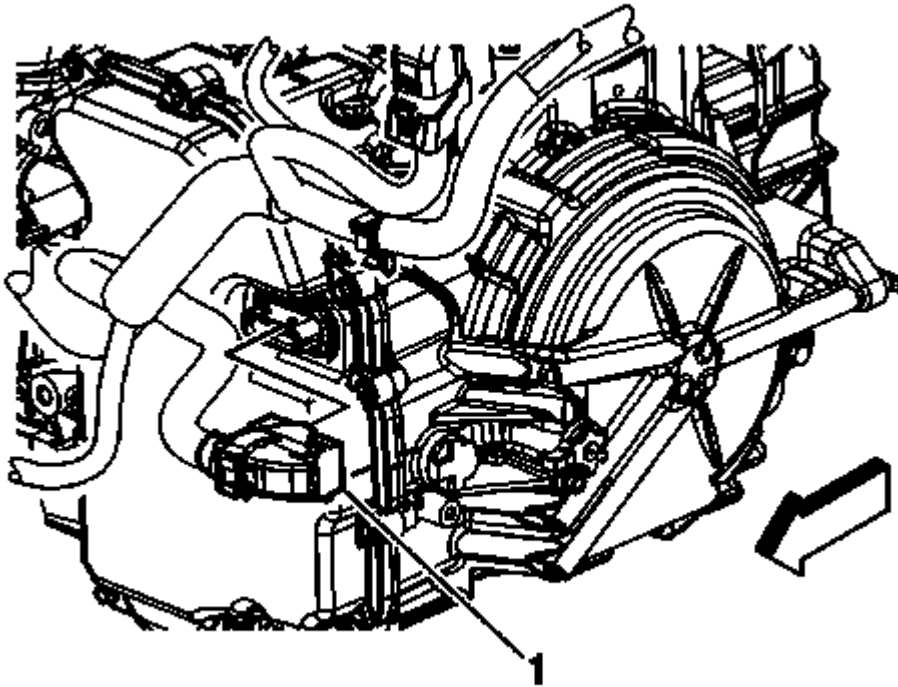


Fig. 31: Control Valve Body Transmission Control Module (TCM) Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the control valve body transmission control module (TCM) electrical connector (1), then the wiring harness from the cover.

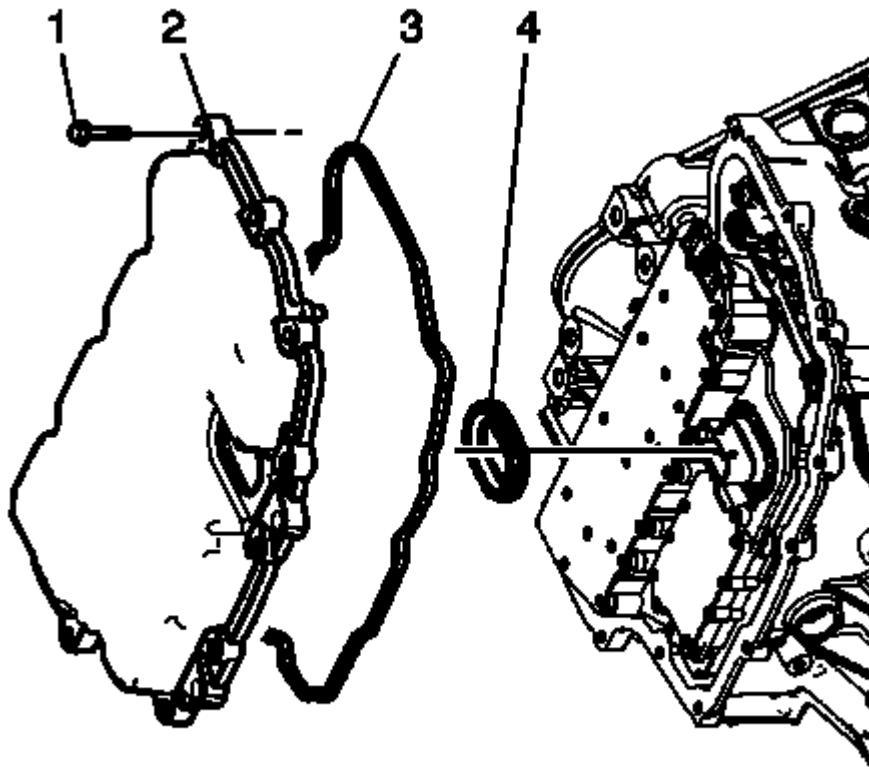


Fig. 32: View Of Control Valve Body
Courtesy of GENERAL MOTORS COMPANY

7. Remove the control valve body cover bolts (1).
8. Support the transmission with a transmission jack.
9. Using the transmission jack raise the transmission to gain clearance for removal of the control valve body cover.
10. Remove the control valve body cover.
11. Remove the control valve body cover gasket.

CAUTION: Support the control solenoid valve assembly around the connector when removing the seal. Excessive pulling force can damage the internal electrical connections.

12. Remove the control valve body cover wiring connector hole seal.
13. Remove all traces of the old gasket material. Clean the transmission case and control valve body cover gasket surfaces.

Installation Procedure

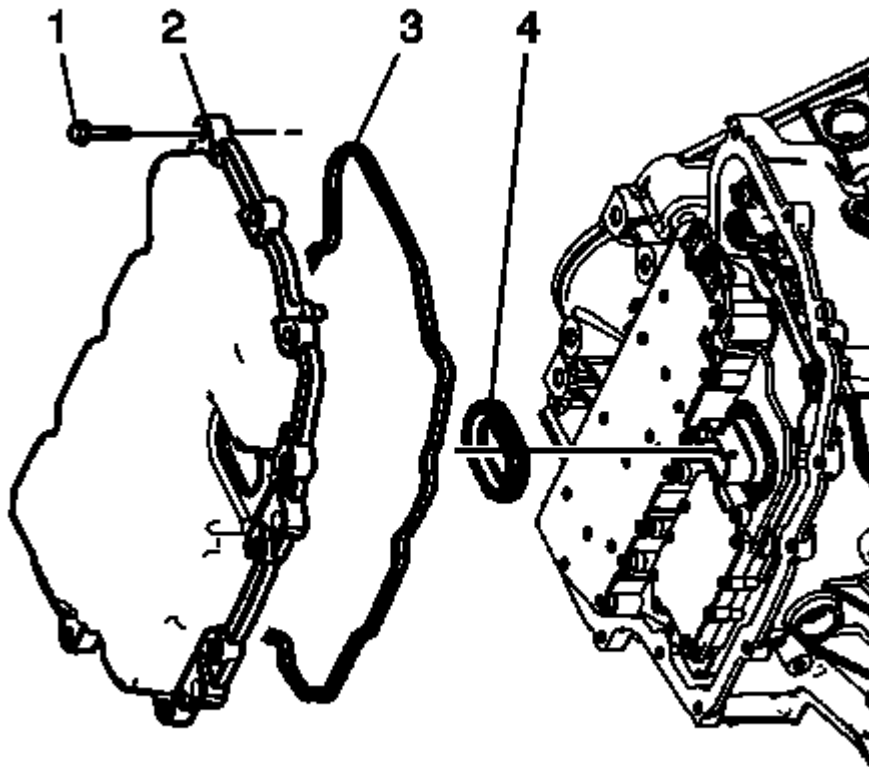


Fig. 33: View Of Control Valve Body
Courtesy of GENERAL MOTORS COMPANY

1. Install the control valve body cover wiring connector hole seal (4).
2. Install the control valve body cover gasket (3) to the control valve body cover.
3. Install the control valve body cover (2).
4. Lower the transmission and remove the transmission jack.
5. Hand start the control valve body cover bolts (1).

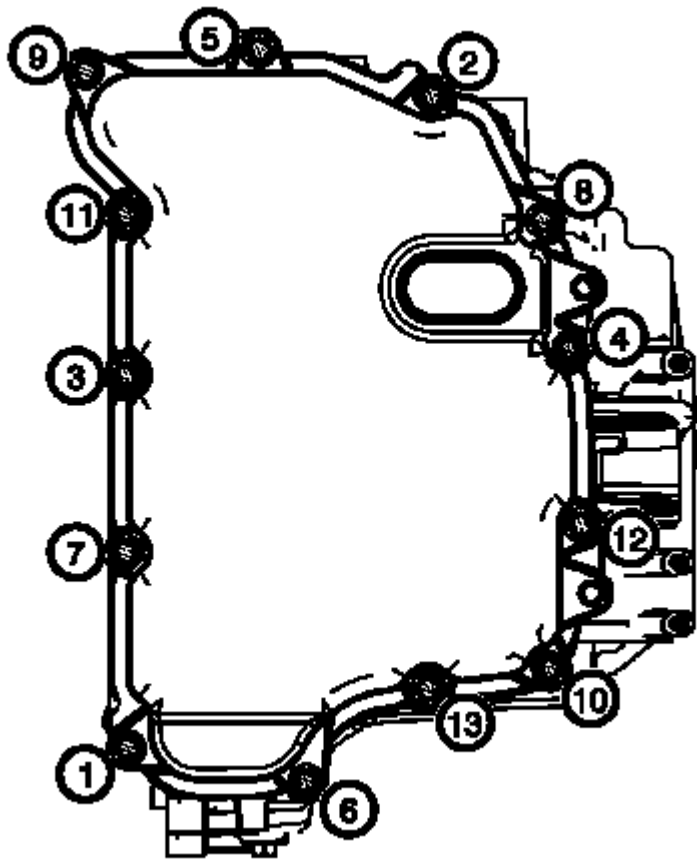


Fig. 34: Valve Body Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Install all control valve body cover bolts and studs by hand then torque all bolts and studs in sequence.

6. Install the control valve body cover bolts. Tighten the bolts in sequence to 12 N.m (106 lb in).

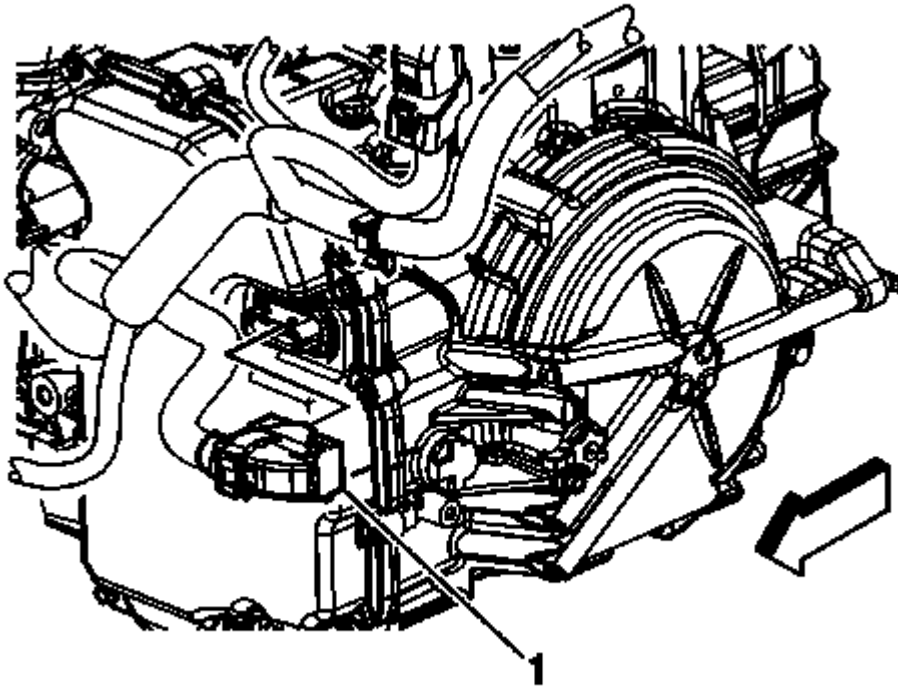


Fig. 35: Control Valve Body Transmission Control Module (TCM) Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Connect the control valve body TCM electrical connector (1), then clip the wiring harness to the cover.
8. Install the front transmission mount. Refer to **Transmission Front Mount Replacement**.
9. Lower the vehicle.

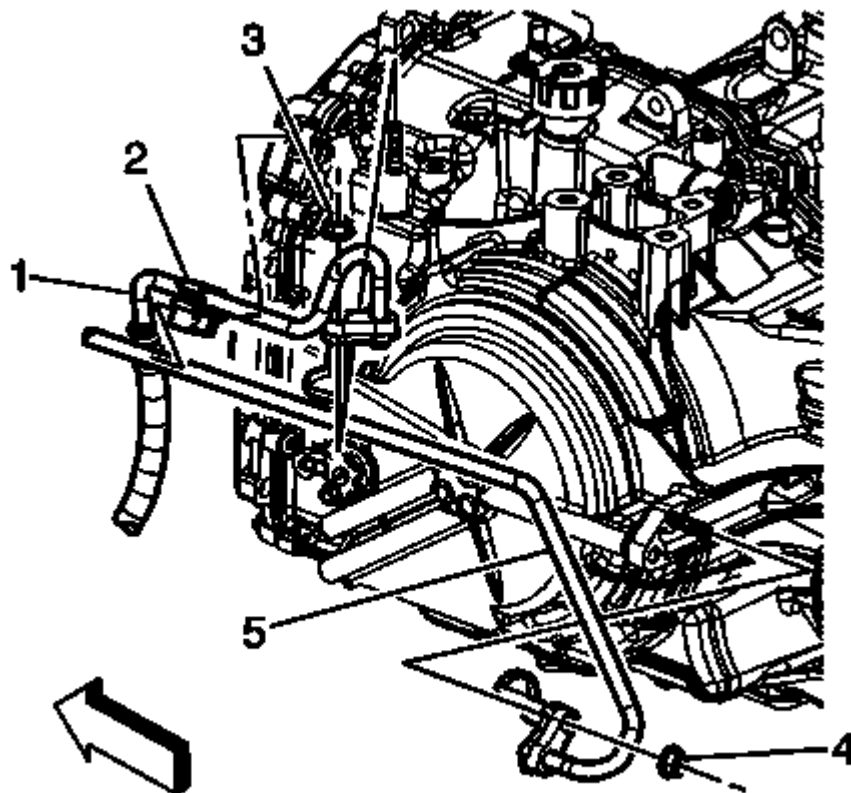


Fig. 36: Cooler Inlet And Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

10. Install the oil cooler inlet (1) and outlet (5) hoses to the retainer (2) on the control valve body cover.
11. Fill the transmission. Refer to **Transmission Fluid Drain and Fill**.
12. Install the battery tray. Refer to **Battery Tray Replacement**.
13. Check for leaks.

CONTROL VALVE BODY REPLACEMENT

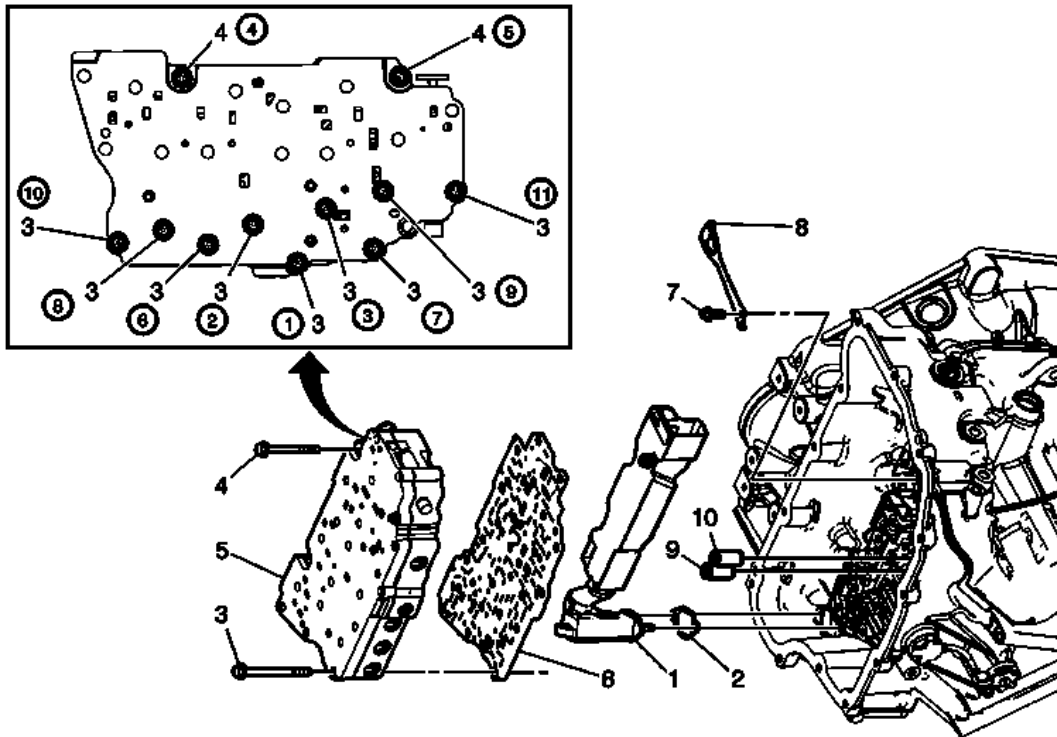


Fig. 37: View Of Control Valve Body
 Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Replacement

Callout	Component Name
Preliminary Procedure Remove the control solenoid valve and transmission control module assembly. Refer to <u>Control Solenoid Valve and Transmission Control Module Assembly Replacement</u> .	
1	Fluid Level Control Valve
2	Fluid Level Control Valve Gasket
3	Control Valve Body Bolt M6 x 60 (Qty: 9) CAUTION: Refer to <u>Fastener Caution</u> . NOTE: Tighten in specified sequence. Tighten 11 N.m (97 lb in)
	Control Valve Body Bolt M6 x 53 (Qty: 2) NOTE:

4	Tighten in specified sequence. Tighten 11 N.m (97 lb in)
5	Control Valve Body Assembly
6	Control Valve Body Spacer Plate Assembly
7	Manual Shaft Detent Spring Bolt M6 x 16 NOTE: Tighten in specified sequence. Tighten 12 N.m (106 lb in)
8	Manual Shaft Detent Lever Spring Assembly
9	1-2-3-4 Clutch Fluid Passage Seal NOTE: Discard the seal. It is not reusable.
10	Low/Reverse Clutch Fluid Passage Seal NOTE: Discard the seal. It is not reusable.

OUTPUT SPEED SENSOR REPLACEMENT

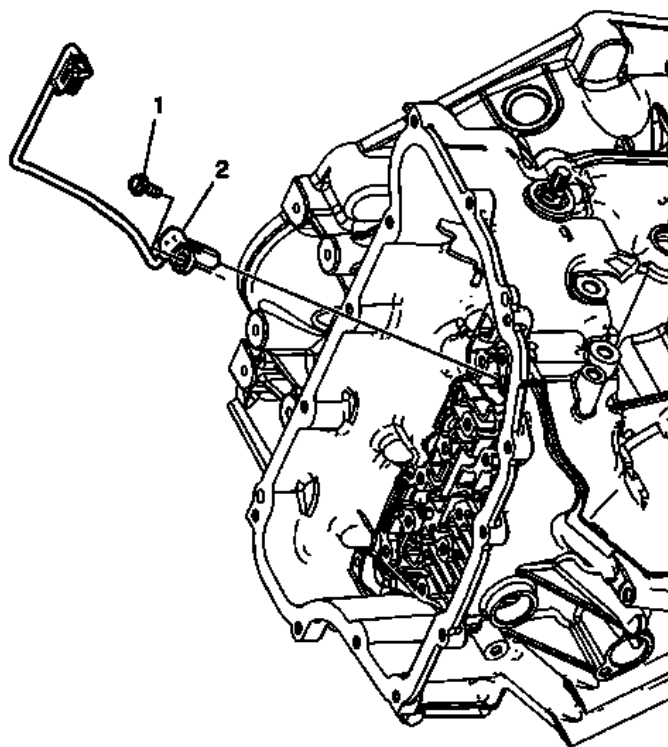


Fig. 38: Output Speed Sensor
 Courtesy of GENERAL MOTORS COMPANY

Output Speed Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the control solenoid valve and transmission control module assembly. Refer to <u>Control Solenoid Valve and Transmission Control Module Assembly Replacement</u> .	
1	Output Speed Sensor Bolt M6 x 18 CAUTION: Refer to <u>Fastener Caution</u> . NOTE: Tighten in specified sequence. Tighten 9 N.m (80 lb in)
2	Output Speed Sensor Procedure Perform the service fast learn adapt procedure.

INPUT SPEED SENSOR REPLACEMENT

Removal Procedure

1. Remove the control solenoid valve and transmission control module assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement**.

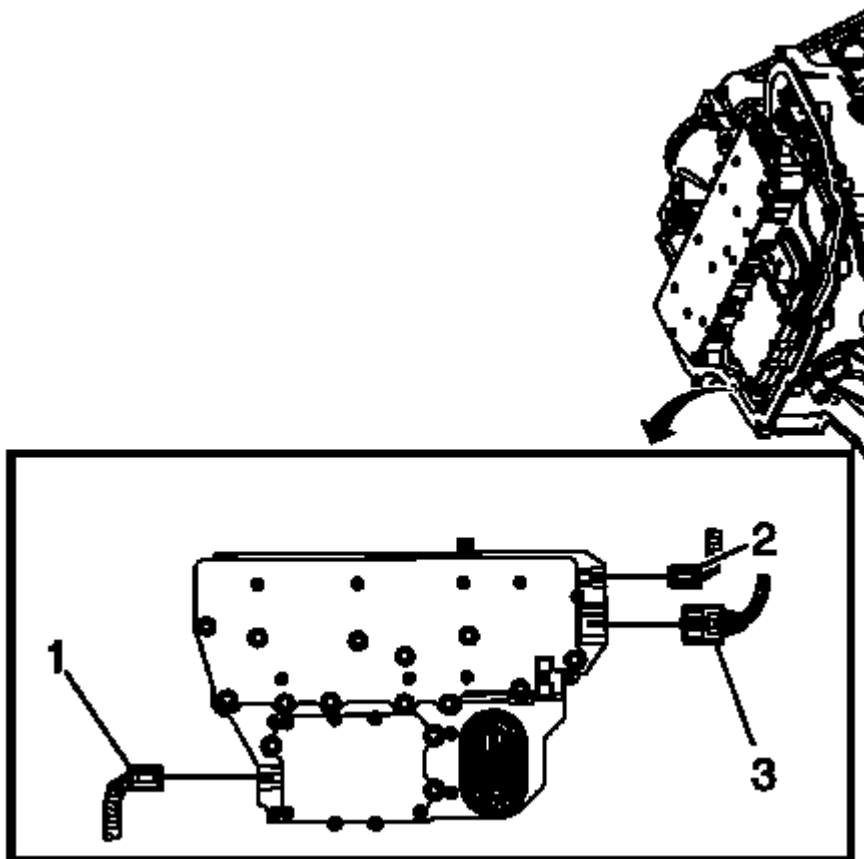


Fig. 39: Input Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the input speed sensor electrical connector (1).

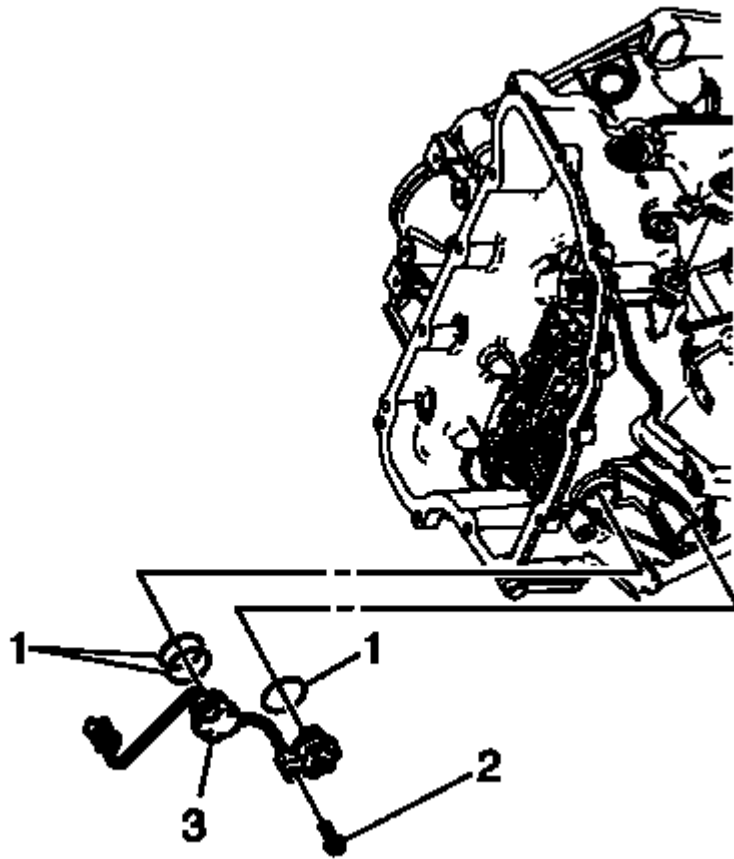


Fig. 40: Input Speed Sensor Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the input speed sensor bolt (2) M6 x 23.
4. Remove the input speed sensor (3).
5. Remove the 3 input speed sensor seals (1).

Installation Procedure

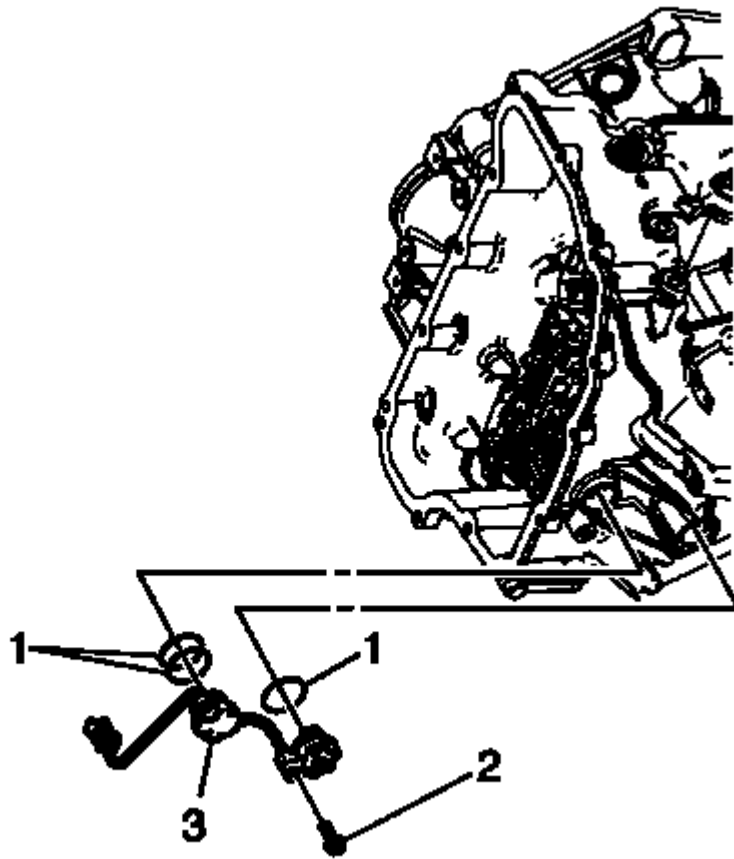


Fig. 41: Input Speed Sensor Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the 3 input speed sensor seals (1).
2. Install the input speed sensor (3).

CAUTION: Refer to Fastener Caution .

3. Install the input speed sensor bolt (2) M6 x 23 and tighten to 9 (80 lb in).

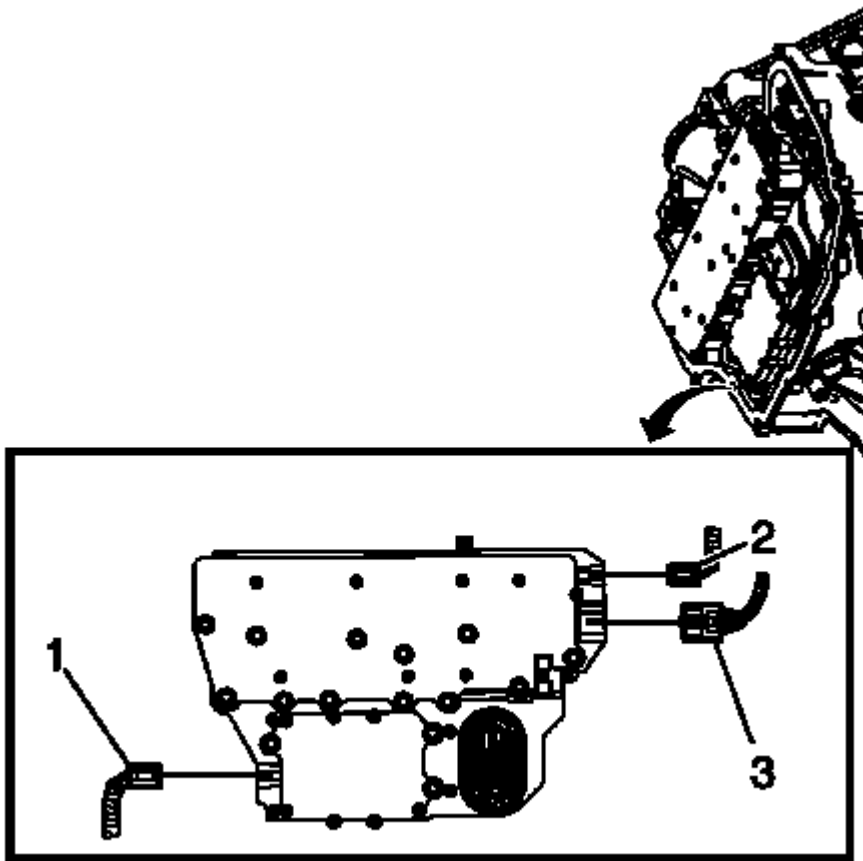


Fig. 42: Input Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Connect the input speed sensor electrical connector (1).
5. Install the control solenoid valve and transmission control module assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement**.
6. Perform the service fast learn adapt procedure.

TRANSMISSION BRACE REPLACEMENT

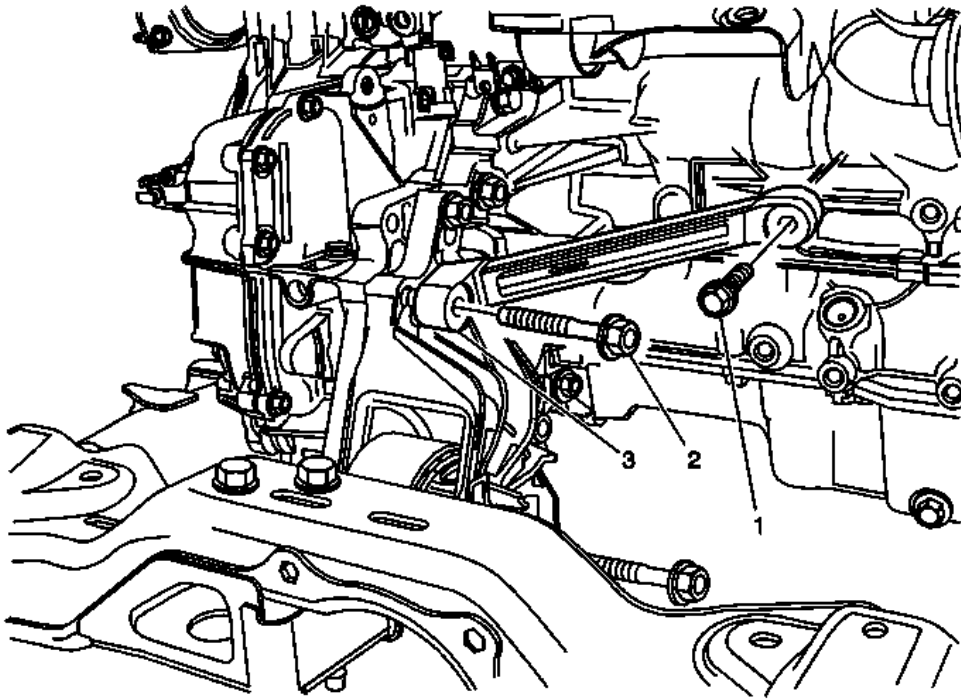


Fig. 43: Transmission Brace & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Transmission Brace Replacement

Callout	Component Name
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Support the transaxle with a transaxle jack.	
1	Rear Transaxle Brace Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 50 N.m (37 lb ft)
2	Rear Transaxle Brace Bolt Tighten 100 N.m (74 lb ft)
3	Rear Transaxle Brace

TRANSMISSION MOUNT REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the battery box. Refer to **Battery Tray Replacement** .
2. Prior to removing the mount, mark mount to transmission, mount to body interfaces and fasteners to mount interfaces using spray paint or a marker for correct positioning during installation.
3. Install the engine support fixture. Refer to , for the 2.0L engine or **Engine Support Fixture** for the 2.2L or 2.4L engine .
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

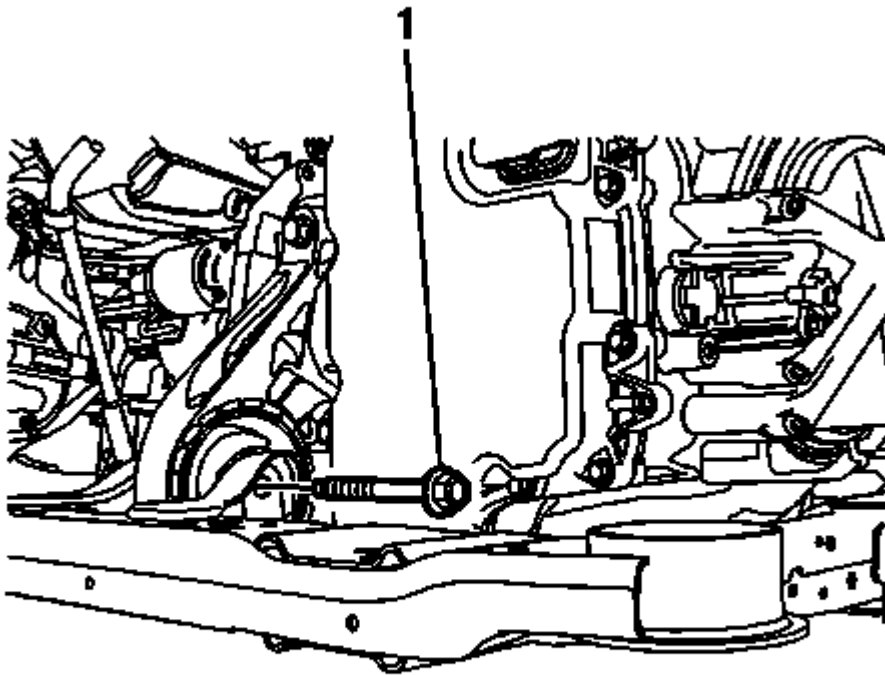


Fig. 44: Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the front transmission mount through bolt (1).

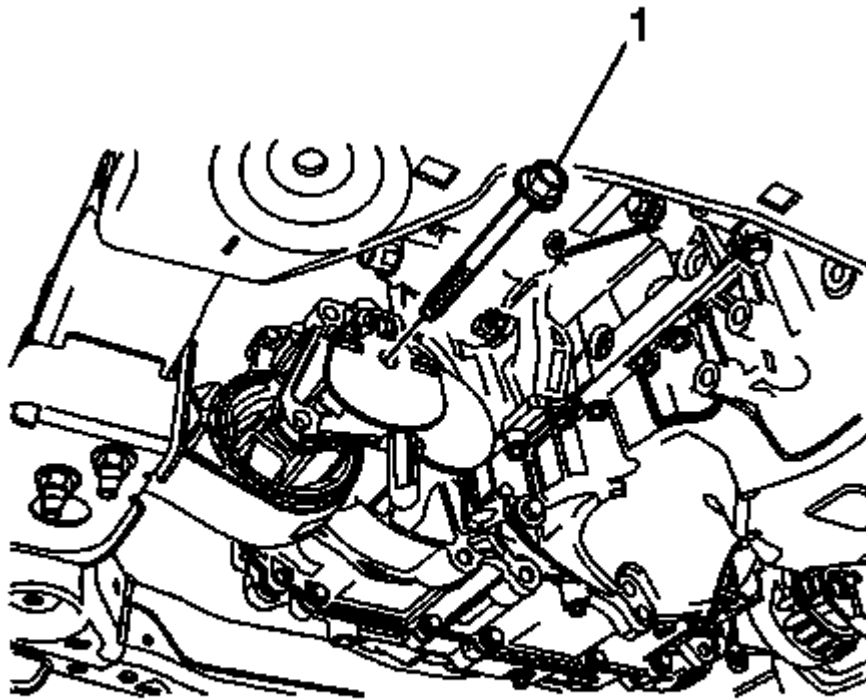


Fig. 45: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the rear transmission mount through bolt (1).
7. Lower the vehicle.

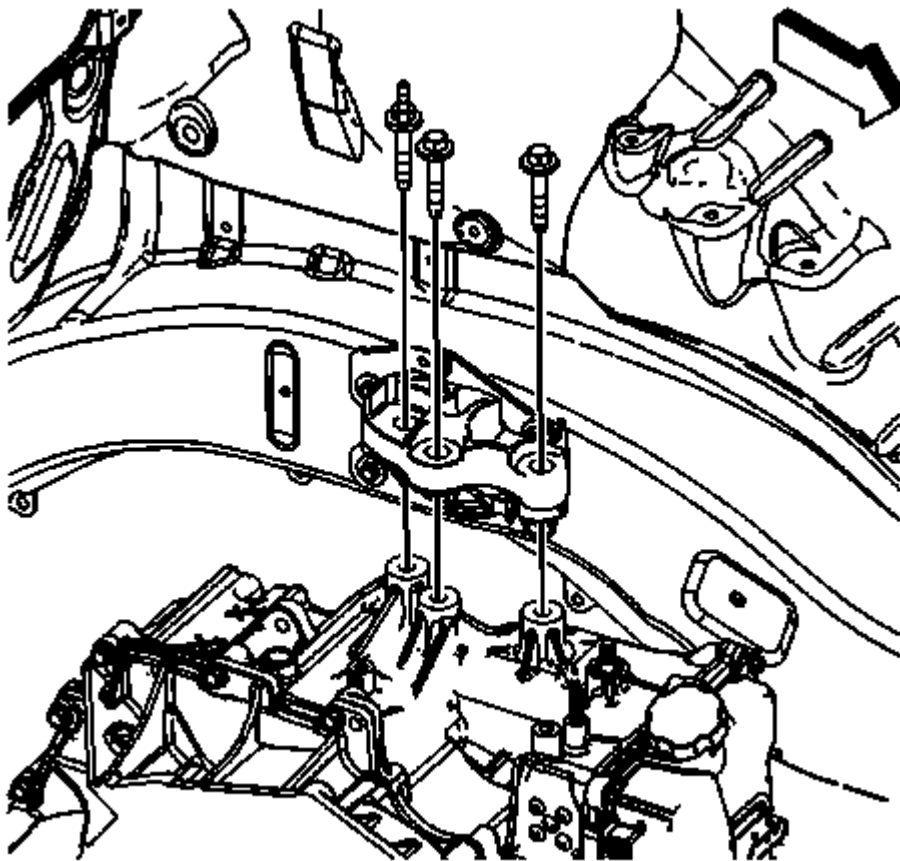


Fig. 46: Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the transmission mount to transmission bolts.

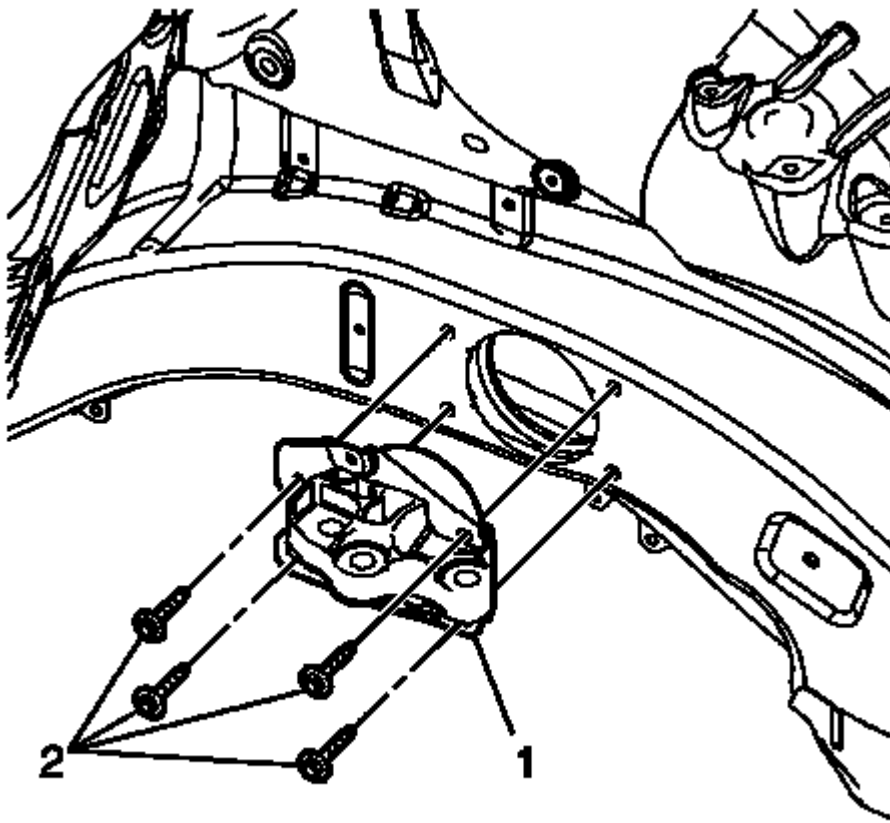


Fig. 47: Transmission Mount To Frame Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Using the engine support, lower the transmission enough to provide clearance for the left transmission mount.
10. Remove the transmission mount to frame rail bolts (2).
11. Remove the left transmission mount (1).

Installation Procedure

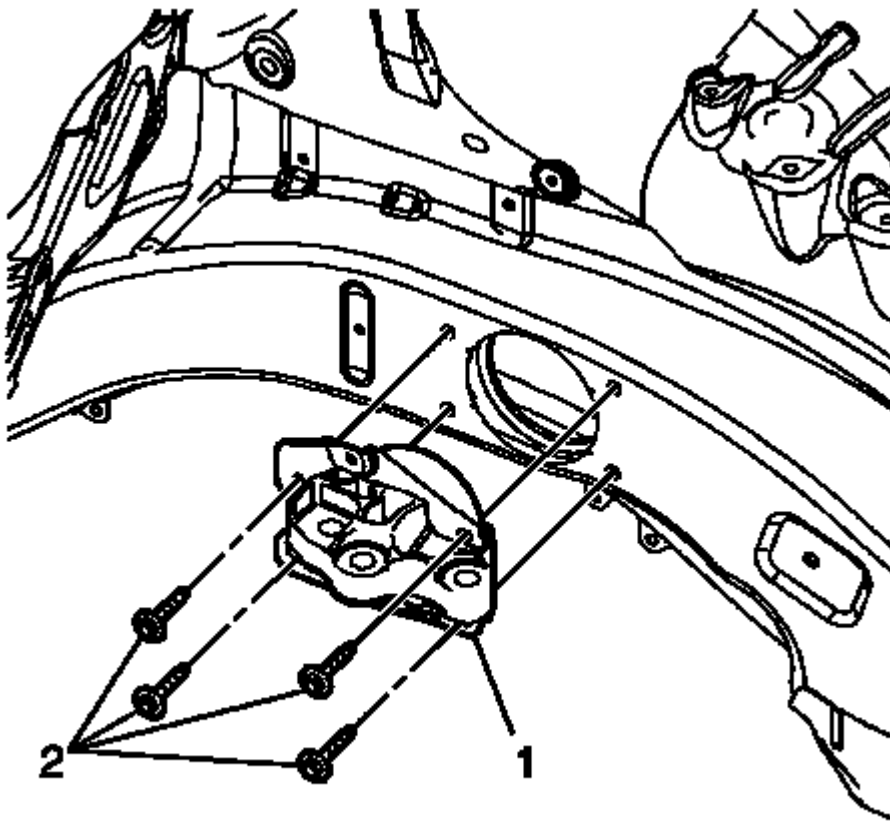


Fig. 48: Transmission Mount To Frame Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Using the outline made by the spray paint or marker, install the left transmission mount (1).

CAUTION: Refer to Fastener Caution .

2. Install the transmission mount to frame rail bolts (2) and tighten to 22 (16 lb ft).
3. Using the engine support, raise the transmission until the transmission contacts the left transmission mount.

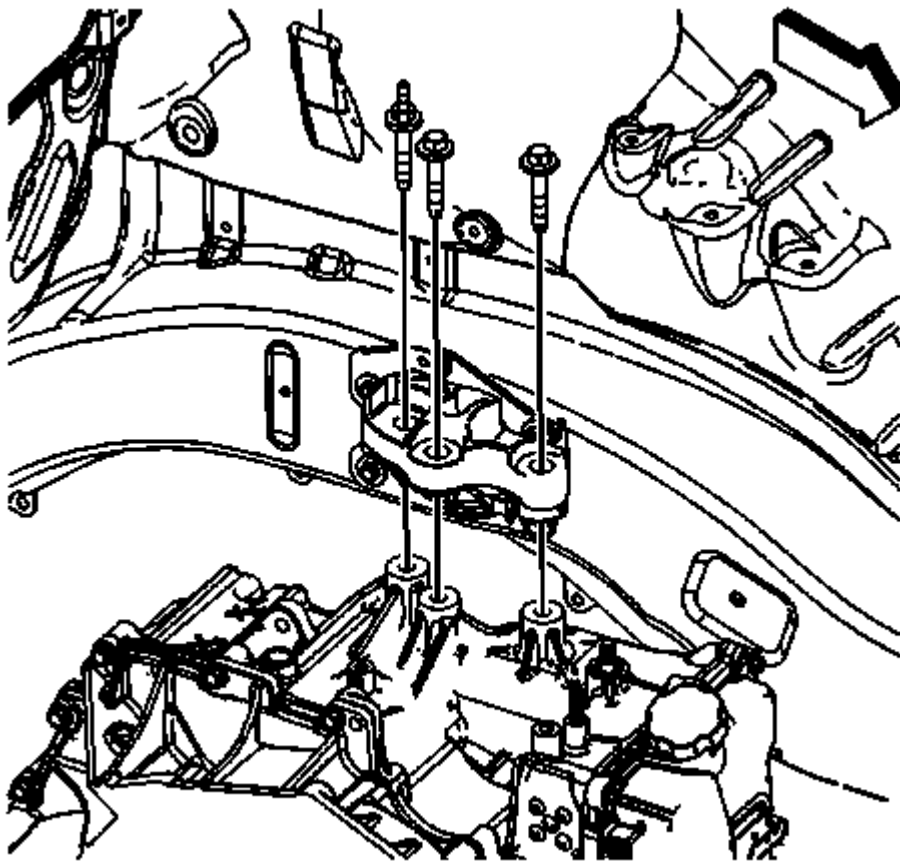


Fig. 49: Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the transmission mount to transmission bolts and tighten to 50 (37 lb ft) plus 90-105 degrees.
5. Install the wheel and tire assembly. Refer to **Tire and Wheel Removal and Installation** .
6. Raise the vehicle.

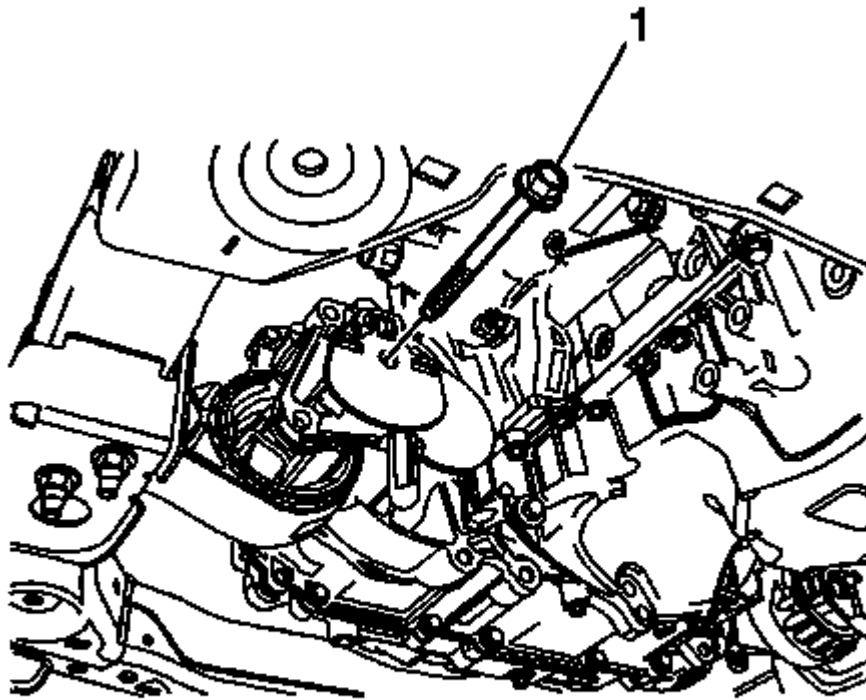


Fig. 50: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install the rear transmission mount through bolt (1) and tighten to 105 (77 lb ft).

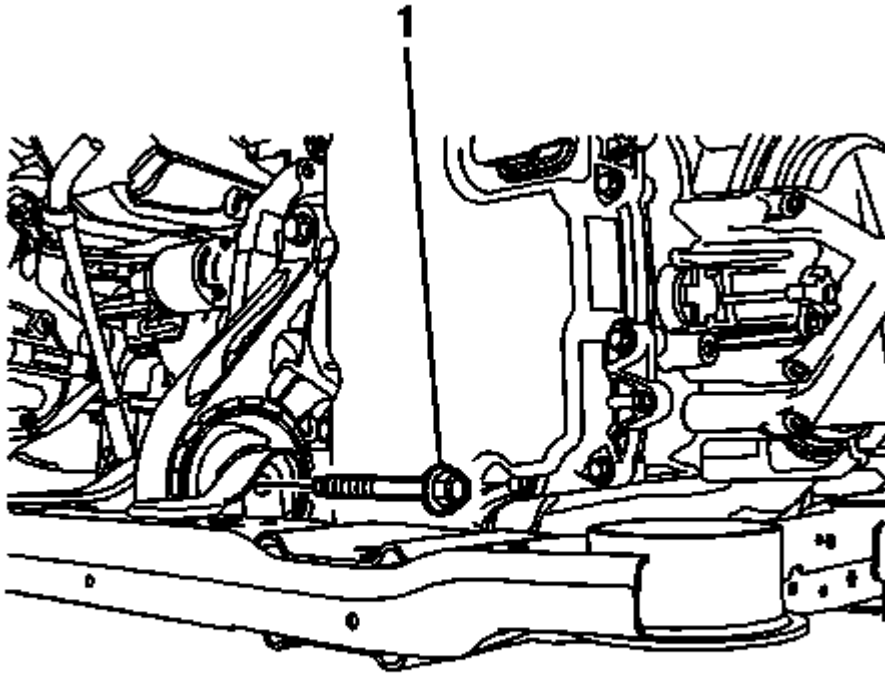


Fig. 51: Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install the front transmission mount through bolt (1) and tighten to 100 (74 lb ft).
9. Perform the Powertrain Mount Balancing - Lower. Refer to the appropriate engine section.
10. Lower the vehicle.
11. Remove the engine support fixture.
12. Install the battery box. Refer to **Battery Tray Replacement** .

TRANSMISSION FRONT MOUNT REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

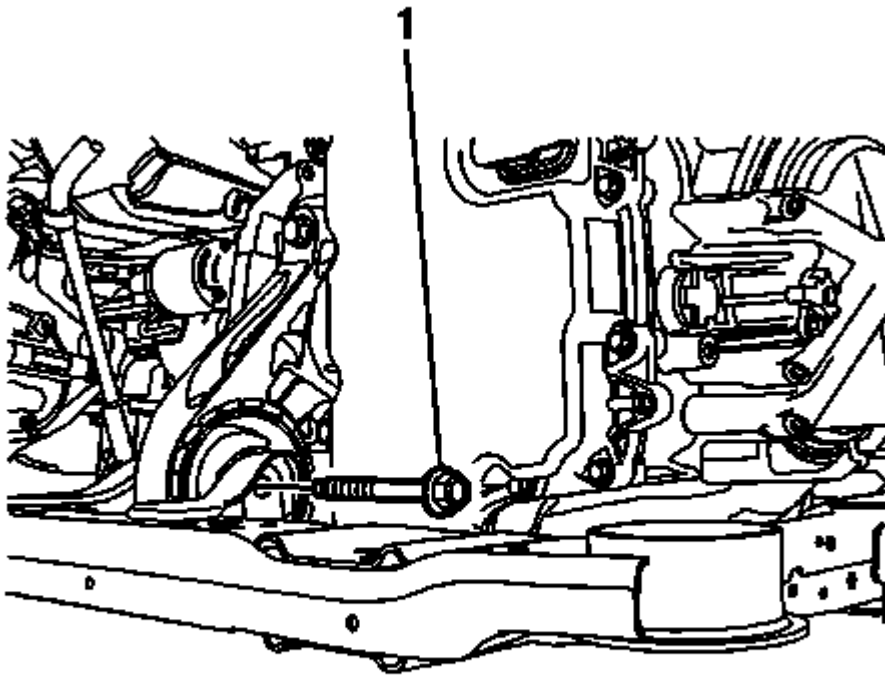


Fig. 52: Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the front transaxle mount through bolt (1).

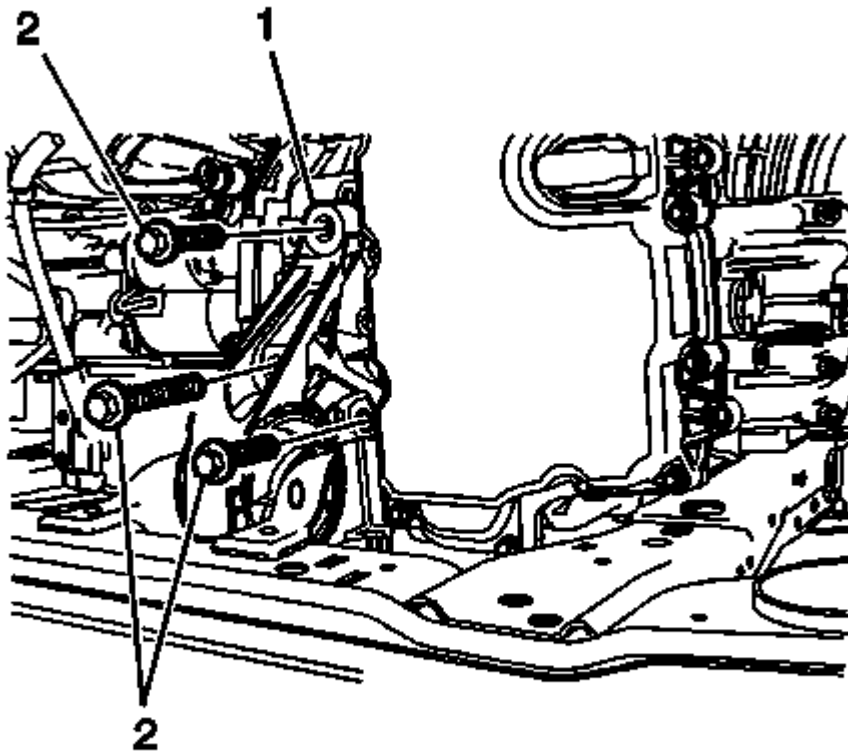


Fig. 53: Transaxle Mount & Attachment Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the three transaxle mount-to-transaxle attachment bolts (2).
4. Remove the transaxle mount (1) from the vehicle.

Installation Procedure

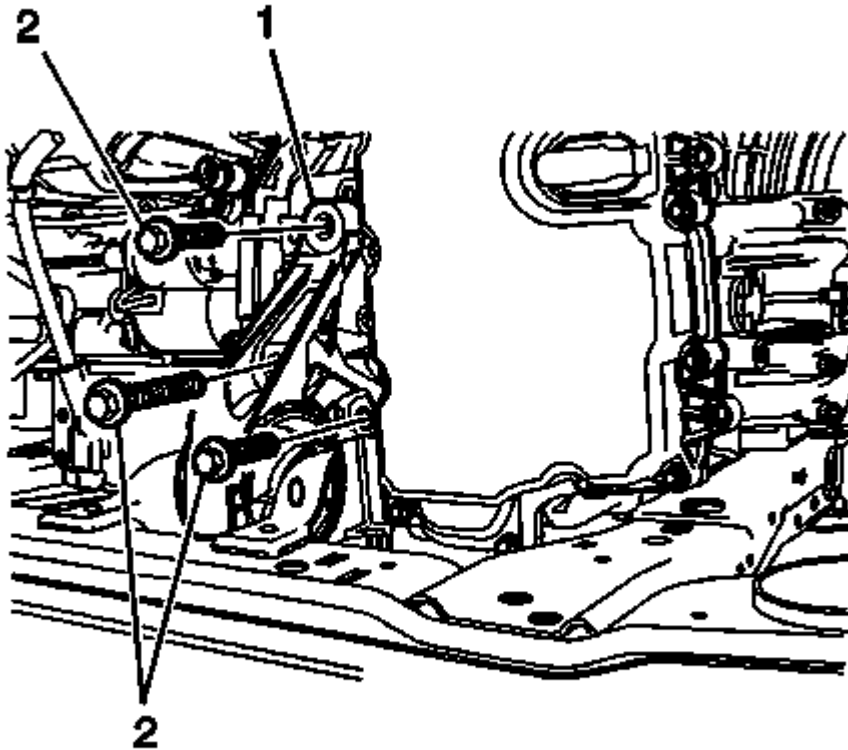


Fig. 54: Transaxle Mount & Attachment Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the transaxle mount (1).

CAUTION: Refer to Fastener Caution .

2. Install the transaxle mount bolts (2) and tighten to 62 N.m (46 lb ft).

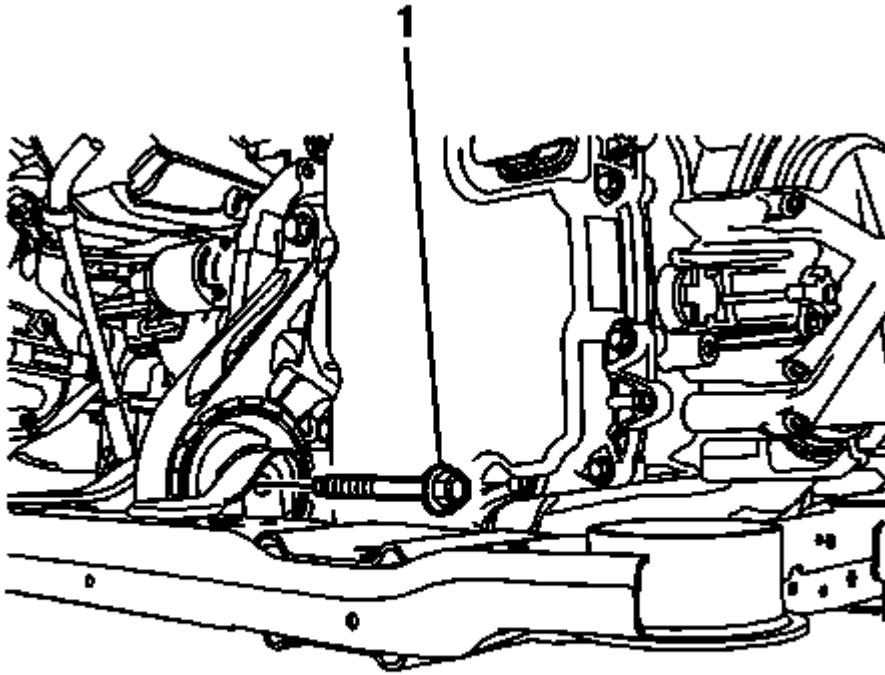


Fig. 55: Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the transaxle mount through bolt (1) and tighten to 100 N.m (74 lb ft).
4. Perform the Powertrain Mount Balancing - Lower procedure. Refer to the appropriate engine section.
5. Lower the vehicle.

TRANSMISSION REAR MOUNT BRACKET REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the left tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Using a suitable jack stand, support the rear of the powertrain.

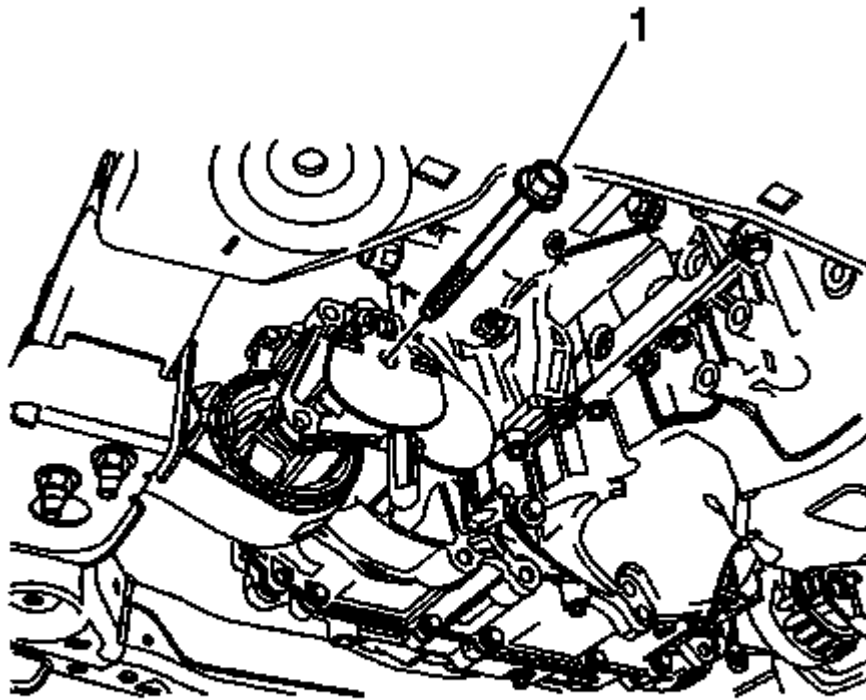


Fig. 56: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the transmission mount to bracket through bolt (1).

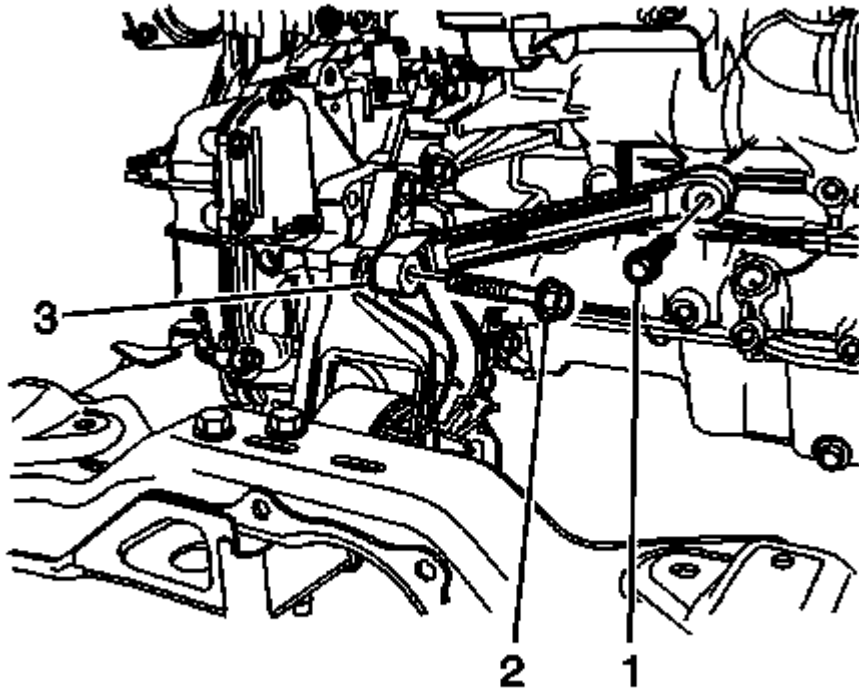


Fig. 57: Transaxle Brace & Bolt

Courtesy of GENERAL MOTORS COMPANY

5. Remove the transaxle brace bolt (1), then loosen bolt (2) until it no longer engages the transaxle.
6. Remove the transaxle brace (3) with bolt (2) still retained in the brace.
7. Vehicles equipped with LF1 engine, remove the four transmission mount bracket fasteners.

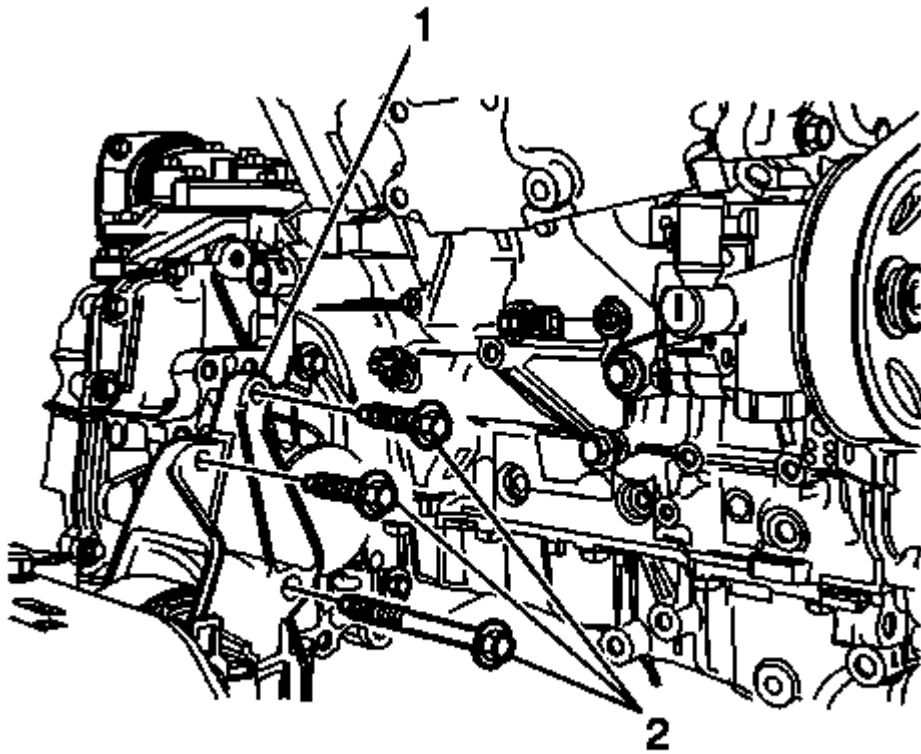


Fig. 58: Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Vehicles not equipped with LF1 engine, remove the three transmission mount to transmission bolts (2).

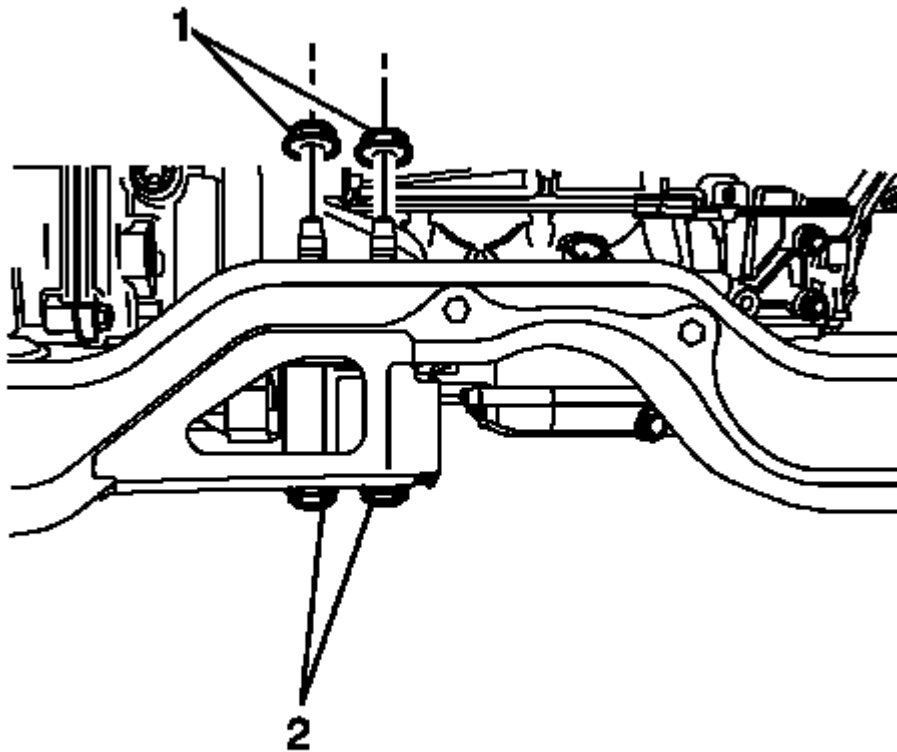


Fig. 59: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Remove the rear mount to frame fasteners (1, 2), then remove the mount and bracket from the vehicle.

Installation Procedure

CAUTION: Refer to Fastener Caution .

1. Vehicles equipped with LF1 engine, install the four transmission mount bracket to transmission fasteners and tighten to 100 (74 lb ft)

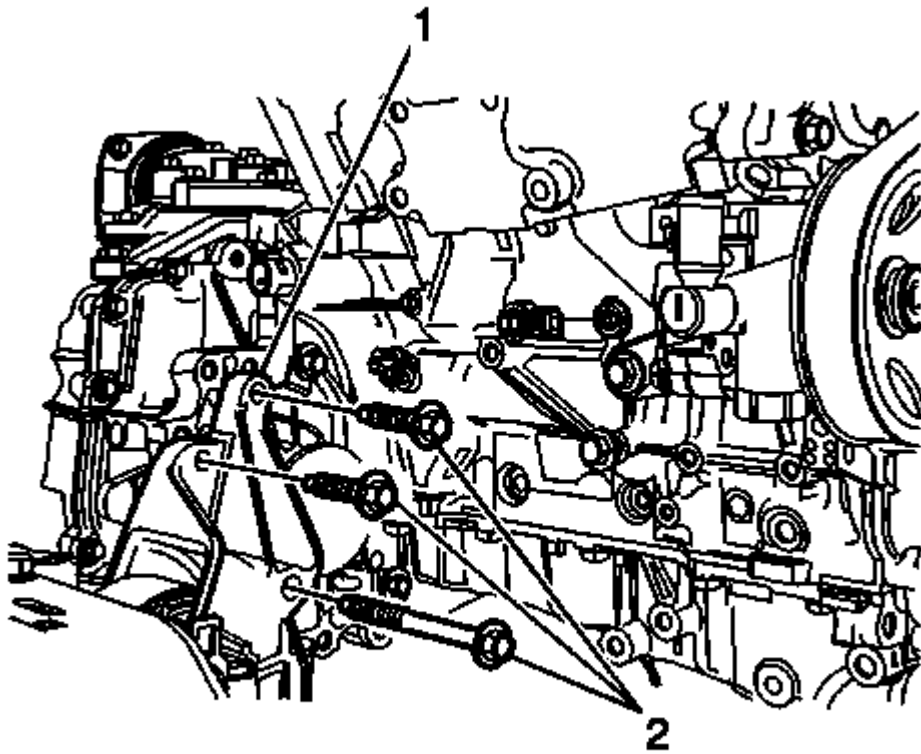


Fig. 60: Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Vehicles not equipped with LF1 engine, install the three transmission mount bracket to transmission bolts (2) and tighten to 100 (74 lb ft).

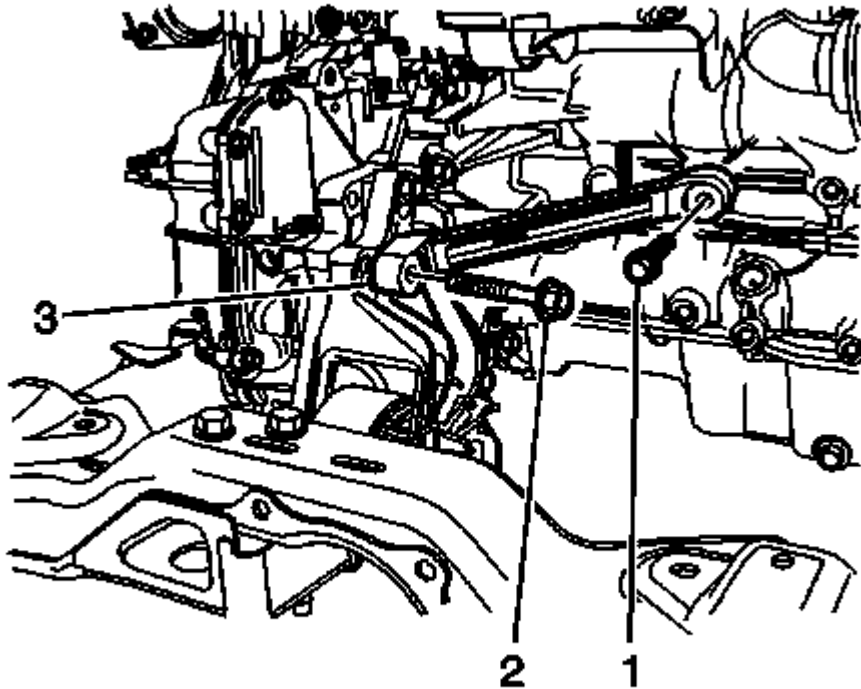


Fig. 61: Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the transaxle brace (3) with bolt (2) seated in the brace.
4. Install the transaxle brace bolt (1) and tighten to 50 (37 lb ft).
5. Tighten brace bolt (2) to 100 (74 lb ft).

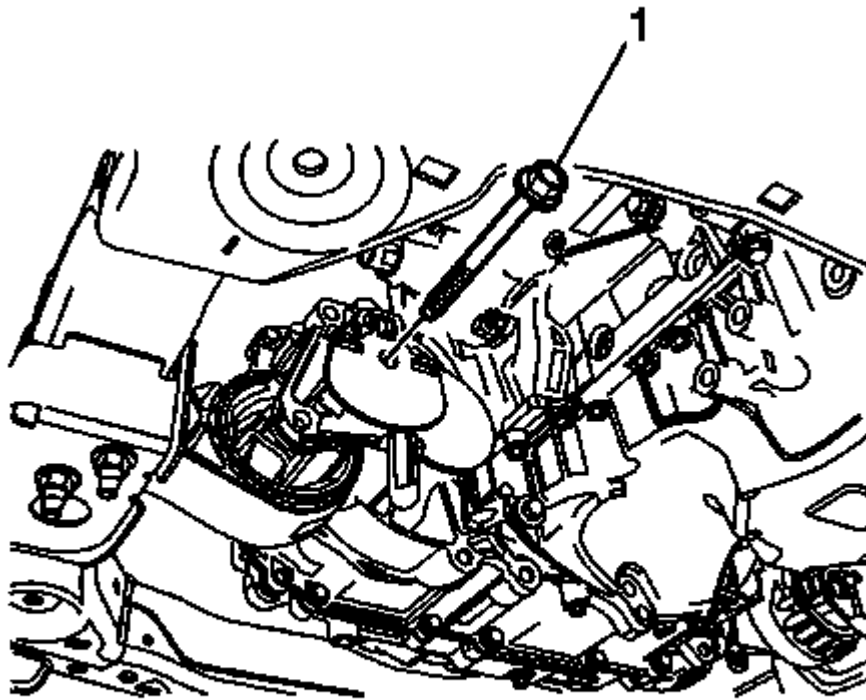


Fig. 62: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install the transmission mount to bracket through bolt (1) and tighten to 105 (77 lb ft).

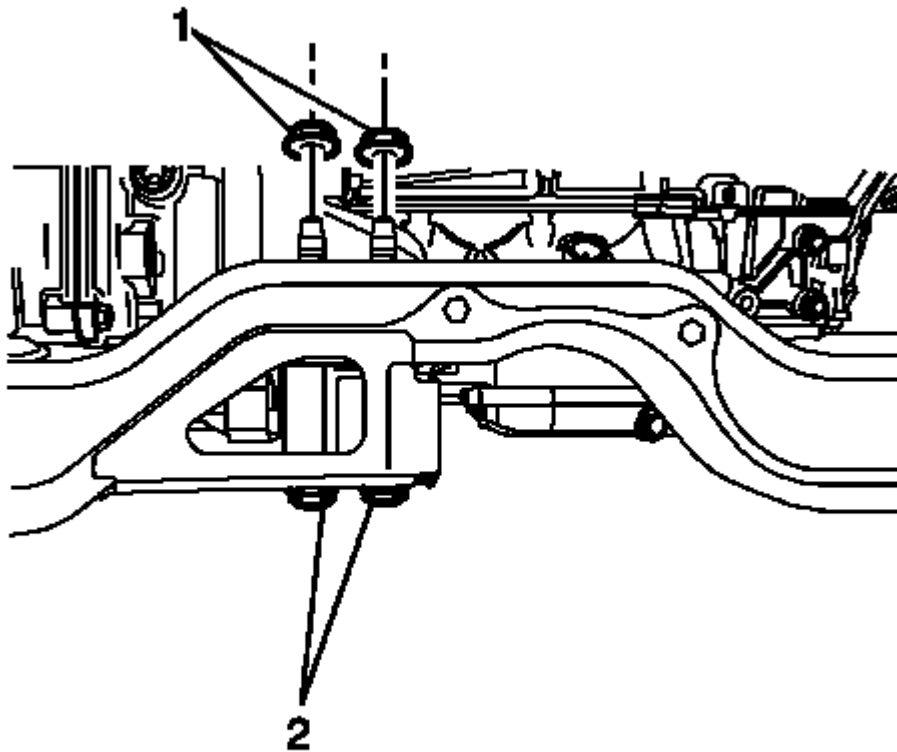


Fig. 63: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use NEW bolts only.

7. Install the rear mount to frame fasteners (1, 2) and tighten to 100 (74 lb ft) plus 120-130 degrees.
8. Remove the jack stand.
9. Install the left tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
10. Lower the vehicle.

TRANSMISSION REAR MOUNT REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Prior to removing the mount, mark the mount fasteners to mount and mount to sub frame interfaces using spray paint or a marker for correct positioning during installation.
3. Using a suitable jack stand, support the rear of the powertrain.

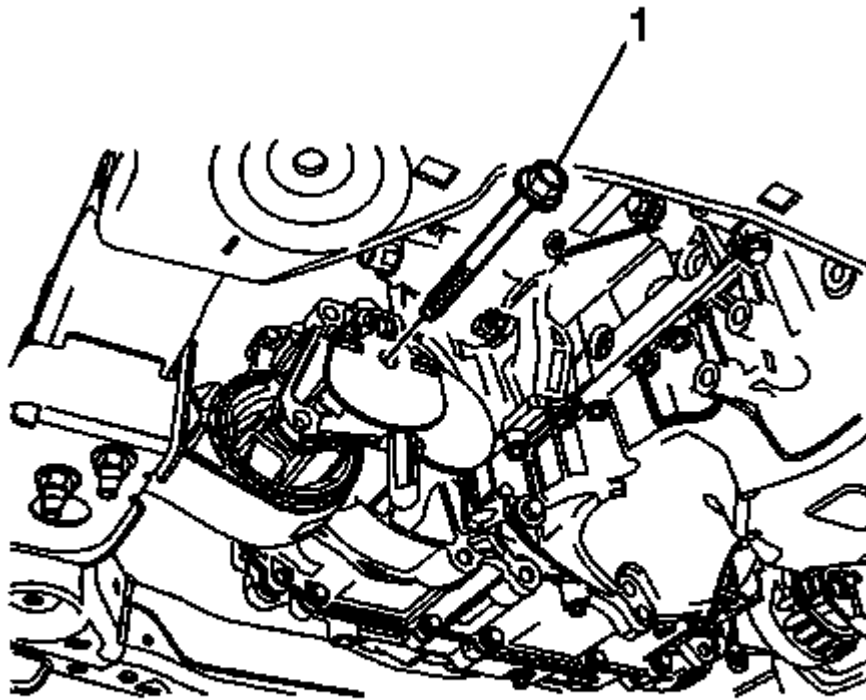


Fig. 64: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the transmission mount to bracket through bolt (1).

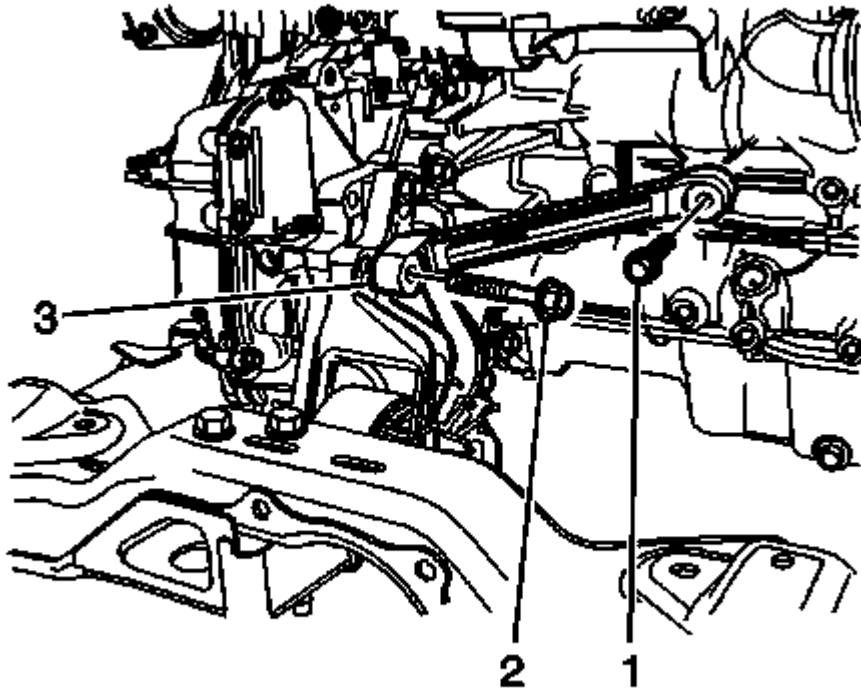


Fig. 65: Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the transaxle brace bolt (1), then loosen bolt (2) until it no longer engages the transaxle.
6. Remove the transaxle brace (3) with bolt (2) still retained in the brace.

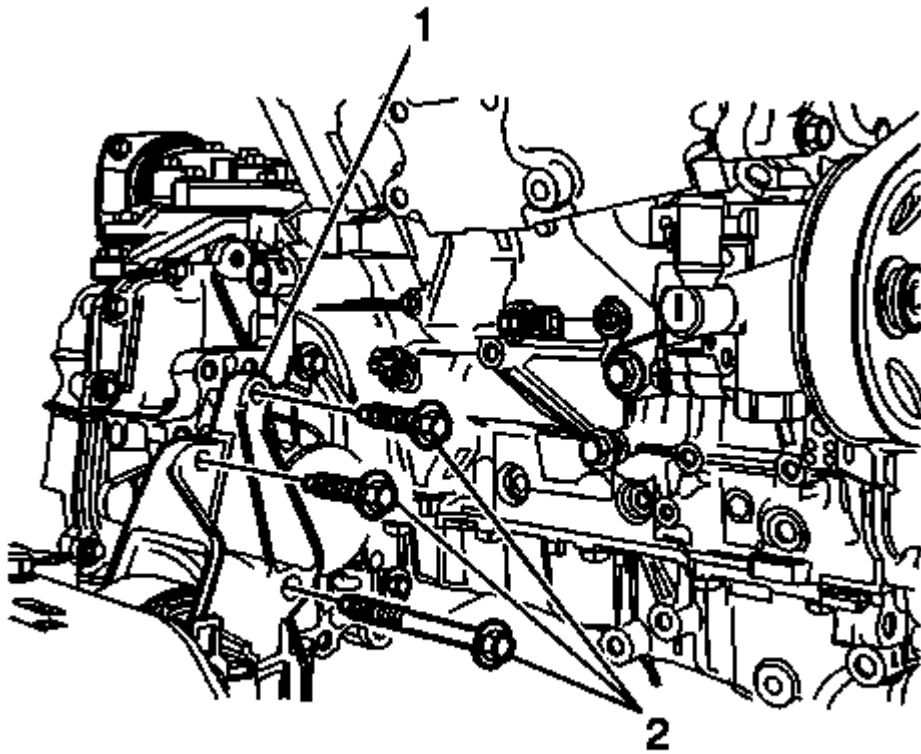


Fig. 66: Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the transmission mount to transmission bolts (2).

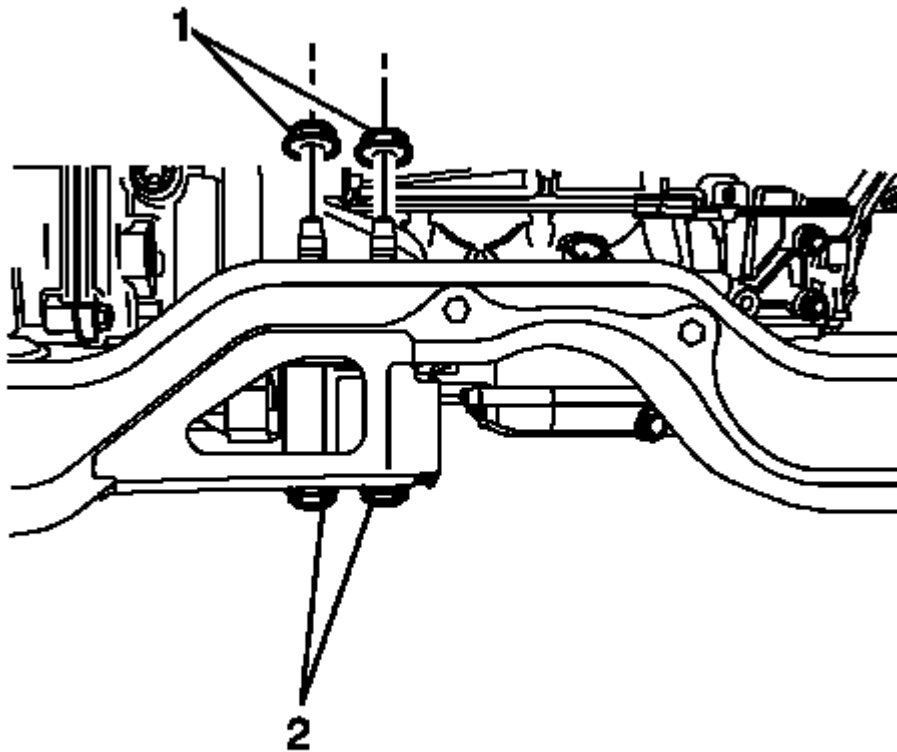


Fig. 67: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the rear mount to frame fasteners (1, 2), then remove the mount from the vehicle.

Installation Procedure

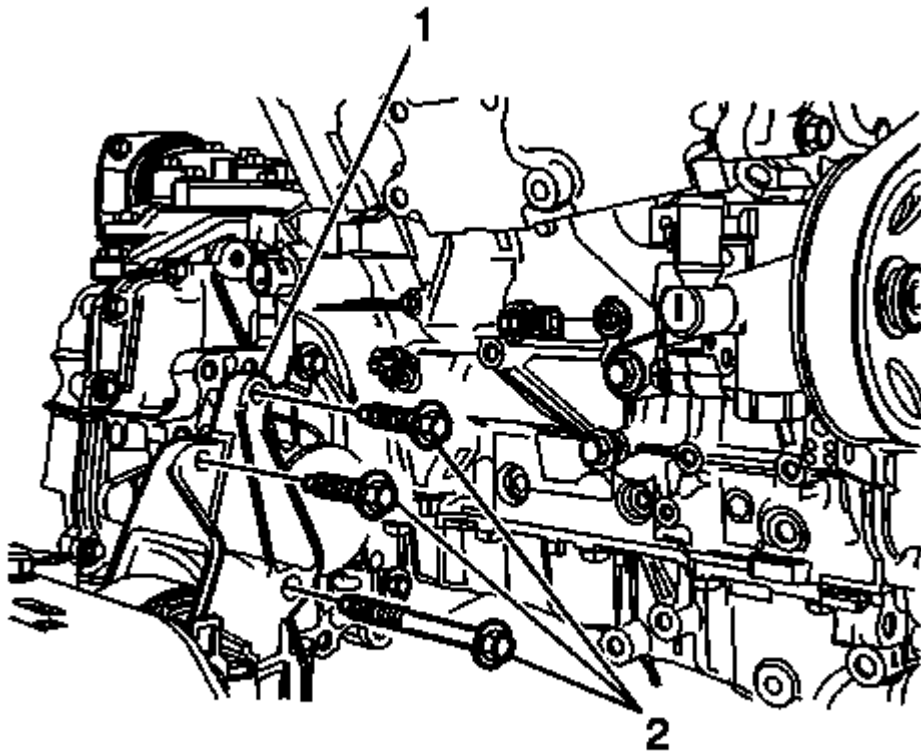


Fig. 68: Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Using the outline made by the spray paint or marker, install the transmission mount to transmission bolts (2) and tighten to 100 (74 lb ft).

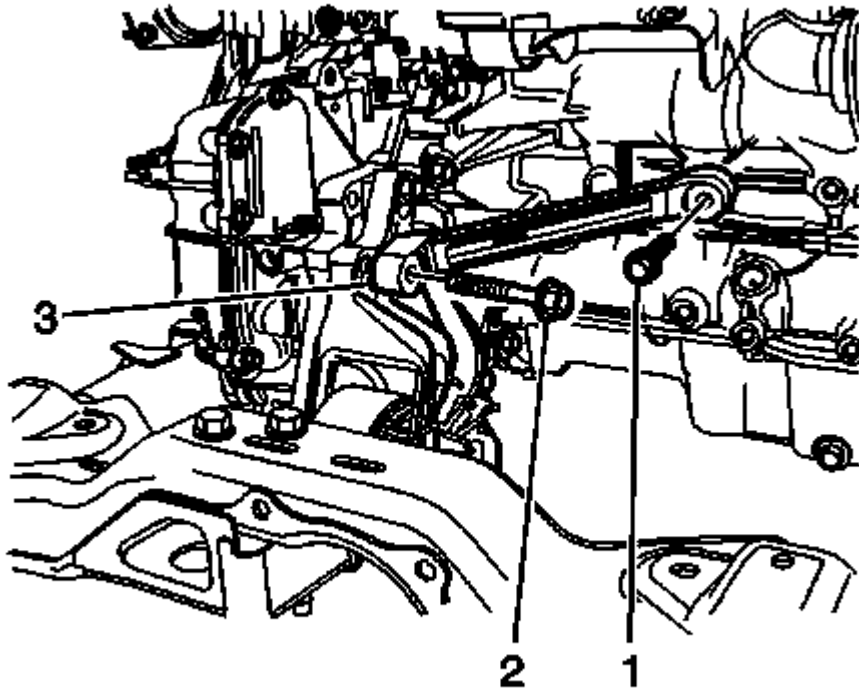


Fig. 69: Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the transaxle brace (3) with bolt (2) seated in the brace.
3. Install the transaxle brace bolt (1) and tighten to 50 (37 lb ft).
4. Tighten the brace bolt (2) to 100 (74 lb ft).

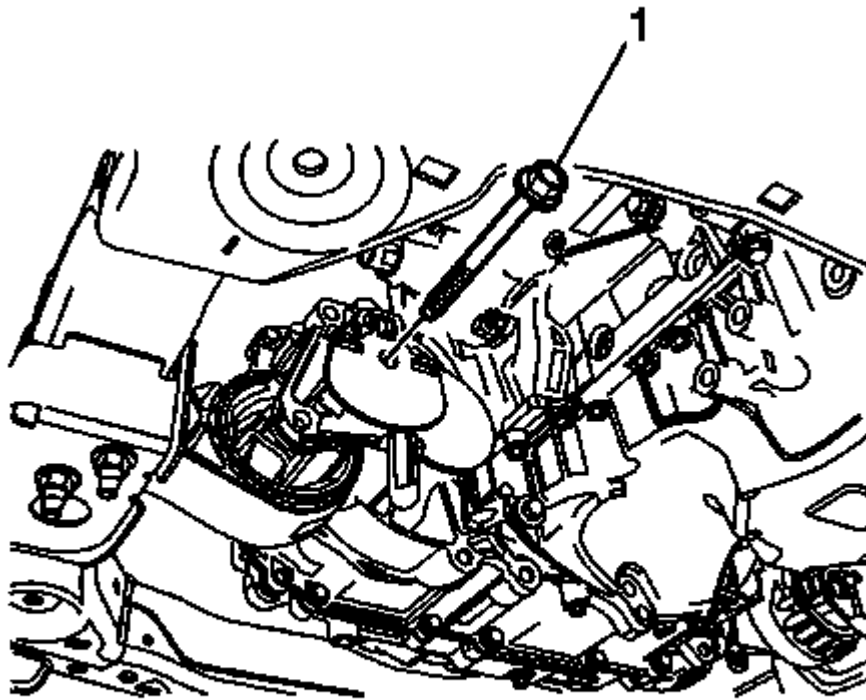


Fig. 70: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission mount to bracket through bolt (1) and tighten to 100 (74 lb ft).

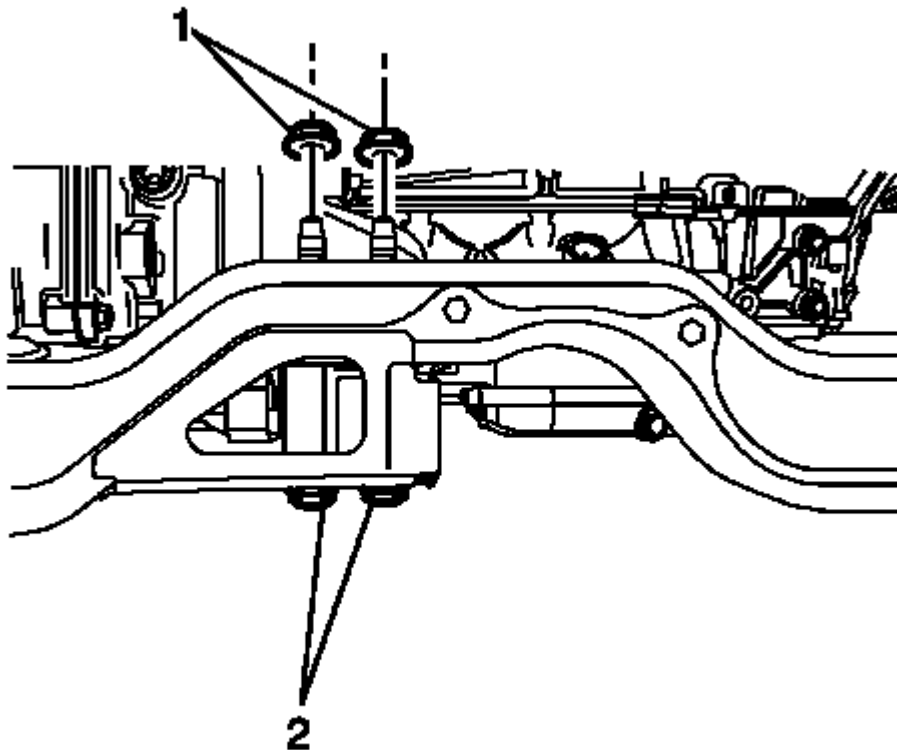


Fig. 71: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use NEW bolts only.

6. Install the rear mount to frame fasteners (1, 2) and tighten to 100 (74 lb ft) plus 120-130 degrees.
7. Perform the Powertrain Mount Balancing - Lower procedure. Refer to 2.0L **POWERTRAIN MOUNT BALANCING - LOWER** or 2.4L **POWERTRAIN MOUNT BALANCING - LOWER**.
8. Remove the jack stand.
9. Lower the vehicle.

TRANSMISSION REPLACEMENT

Removal Procedure

1. Remove the battery tray. Refer to **Battery Tray Replacement**.
2. Remove the transmission range select lever cable and bracket from the transmission.
3. Drain the transmission fluid. Refer to **Transmission Fluid Drain and Fill**.

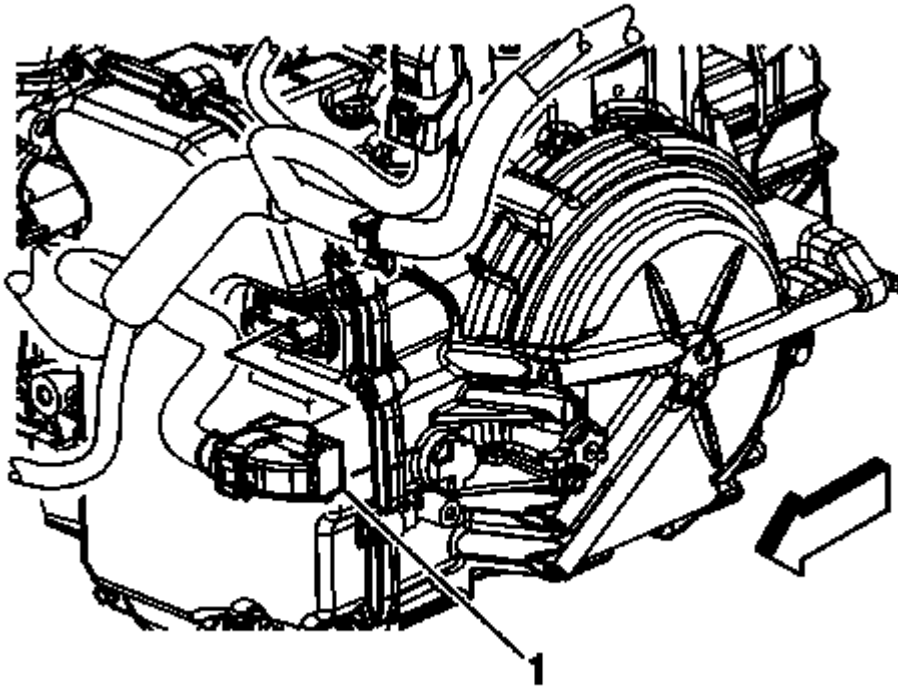


Fig. 72: Control Valve Body Transmission Control Module (TCM) Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the control valve body transmission control module (TCM) electrical connector (1) then unclip the connector from the transmission.

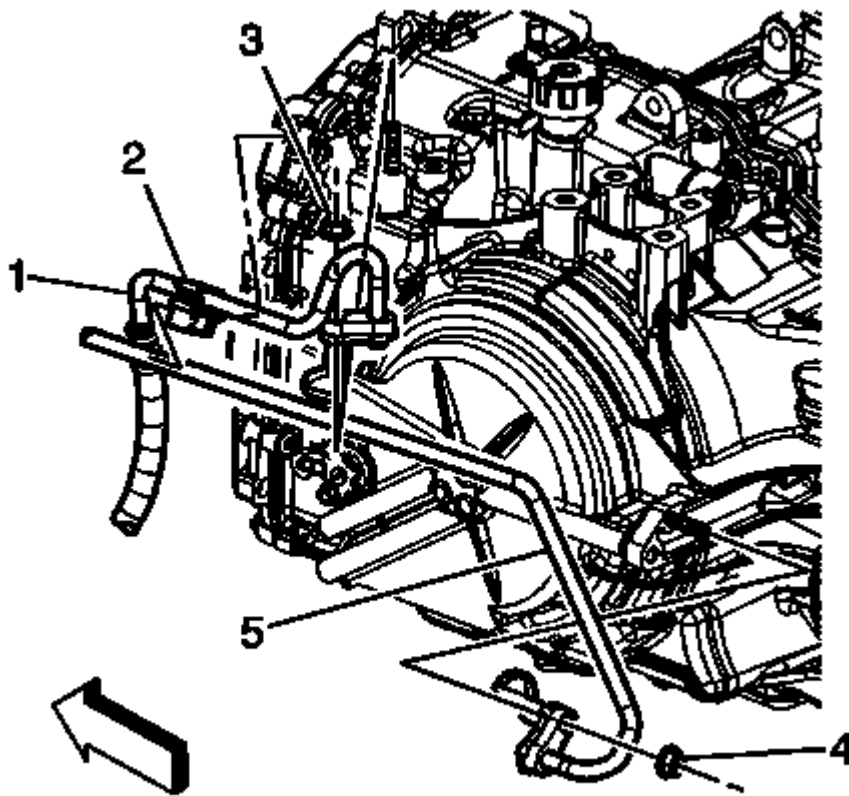


Fig. 73: Cooler Inlet And Outlet Hoses

Courtesy of GENERAL MOTORS COMPANY

5. Remove the transmission fluid cooler inlet (1) and outlet (5) hoses from the retainer (2) on the control valve body cover.
6. Remove the transmission fluid cooler inlet hose nut (3) from the transmission.
7. Remove the transmission fluid cooler inlet hose (1) from the transmission.
8. Remove the transmission fluid cooler outlet hose nut (4) from the transmission.
9. Remove the transmission fluid cooler outlet hose (5) from the transmission.
10. Plug and/or cap the hose and transmission to prevent contamination.

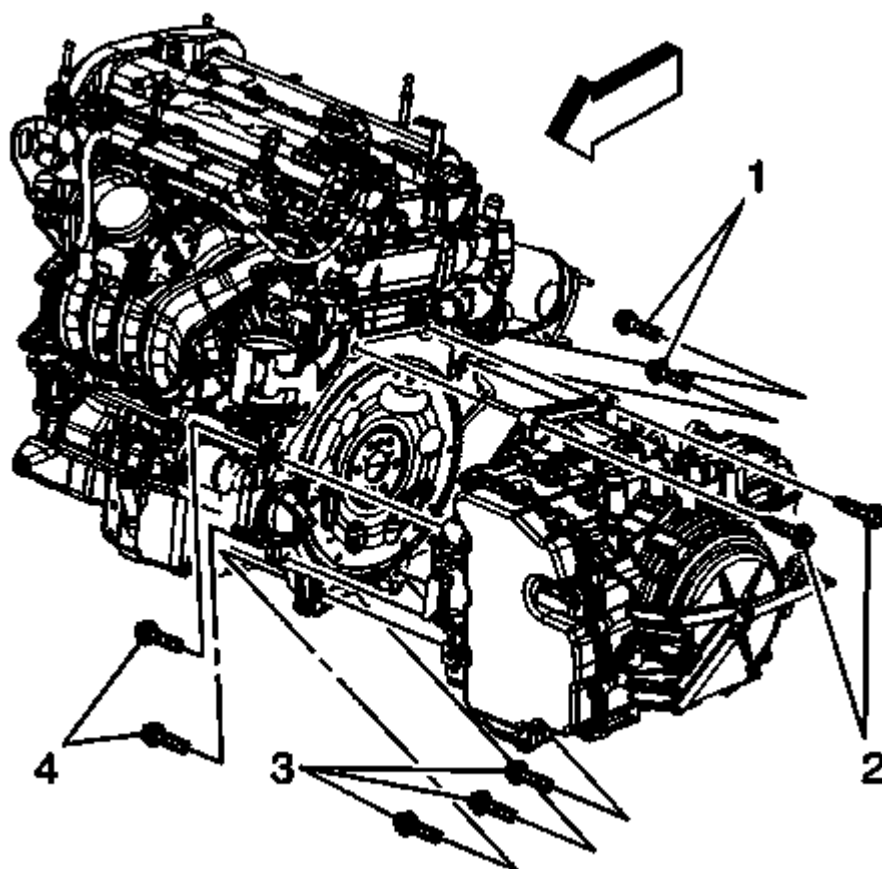


Fig. 74: Transmission To Engine Bolts
 Courtesy of GENERAL MOTORS COMPANY

11. Remove the upper transmission to engine bolts (2).
12. Remove the frame. Refer to **Drivetrain and Front Suspension Frame Replacement** .
13. Disconnect the left wheel drive shaft from the transmission. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
14. Remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)** , **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)** .
15. Remove the rear transmission mount from the transmission. Refer to **Transmission Rear Mount Replacement**.
16. Remove the front transmission mount from the transmission. Refer to **Transmission Front Mount Replacement**.

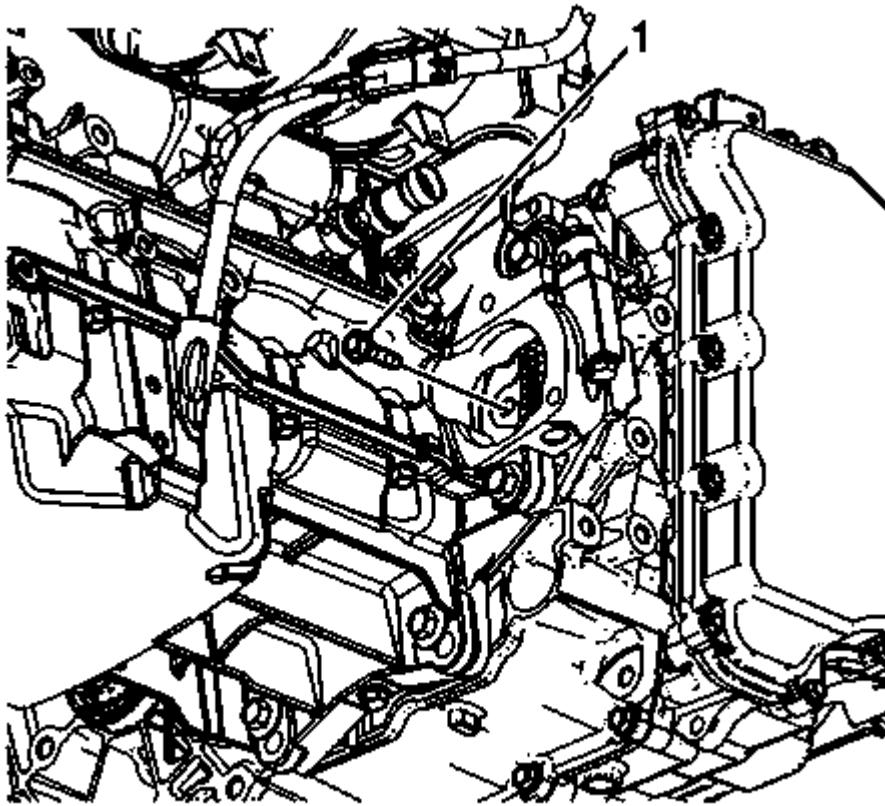


Fig. 75: Torque Converter To Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Remove the starter. Refer to **Starter Replacement (LUK)** , **Starter Replacement (LTG)** .
18. Mark the relationship of the flywheel to the torque converter for reassembly.
19. Remove the torque converter to flywheel bolts (1).
20. Use a transmission jack in order to support the transmission.
21. Lower the vehicle.
22. Remove the three left transmission mount bolts from the transmission. Refer to **Transmission Mount Replacement - Left Side**.
23. Lower the transmission side with the support fixture to allow clearance for removal.
24. Unclip the engine wiring harness from the transmission.
25. Raise the vehicle.
26. Use a transmission jack in order to support the transmission.

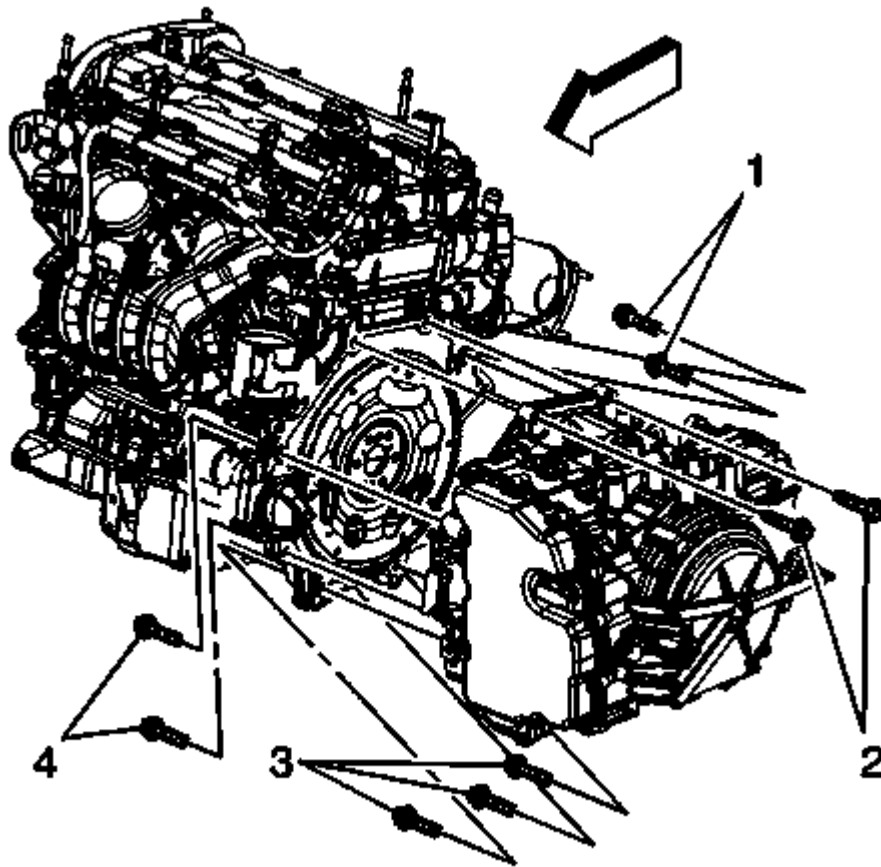


Fig. 76: Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

27. Remove the remaining transmission fasteners (1, 3, 4).

NOTE: Insure the torque converter remains securely in place on the transmission input shaft while separating and removing the transmission.

28. Separate the transmission from the engine.
29. Lower the transmission with the transmission jack far enough to remove the transmission.
30. Flush and flow test the transmission oil cooler and lines. Refer to **TRANSMISSION FLUID COOLER FLUSHING AND FLOW TEST (6T40)** .

Installation Procedure

1. Raise the transmission with the transmission jack and position the transmission to the engine.

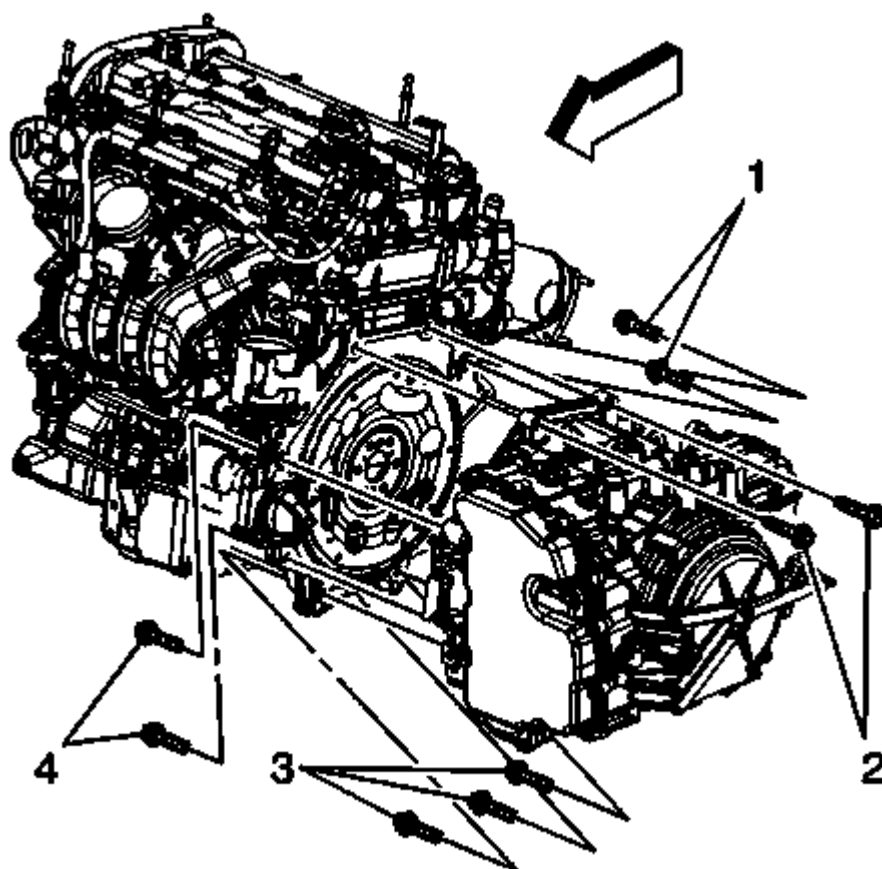


Fig. 77: Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the transmission bolts (1, 3, 4) and tighten to 75 (55 lb ft).
3. Remove the transmission jack.

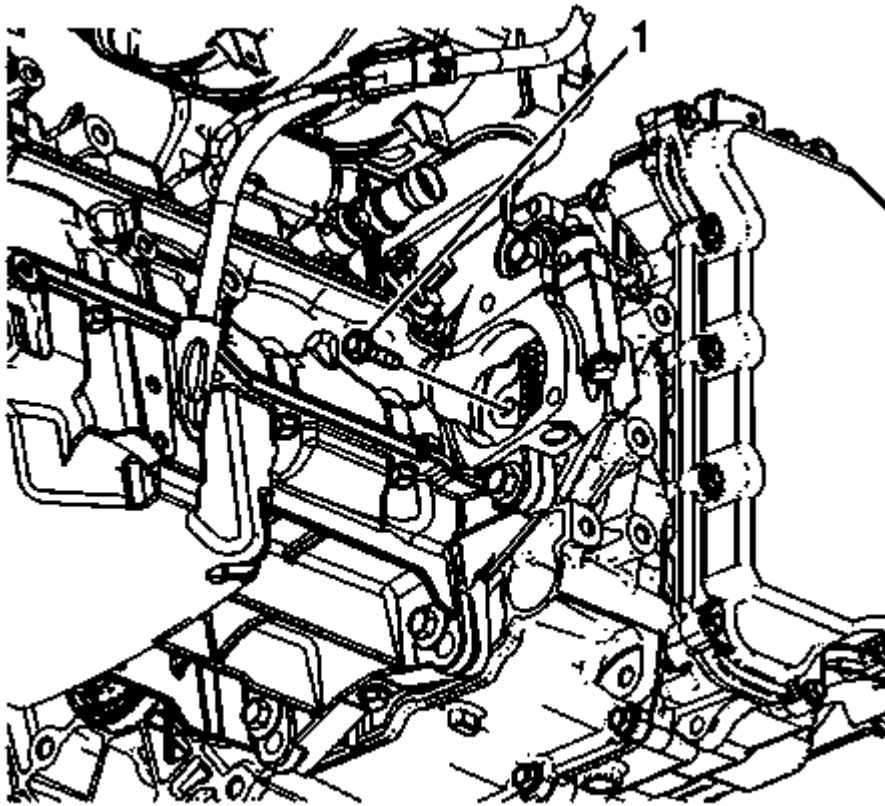


Fig. 78: Torque Converter To Flywheel Bolts
 Courtesy of GENERAL MOTORS COMPANY

NOTE: If reusing the torque converter bolts, clean the threads and apply threadlocker to the threads prior to installation. Refer to Adhesives, Fluids, Lubricants, and Sealers for the recommended threadlock material.

4. Install the torque converter to flywheel bolts (1) and tighten to 62 (46 lb ft).
5. Install the starter. Refer to Starter Replacement (LUK) , Starter Replacement (LTG) .
6. Install the front transmission mount to the transmission. Refer to Transmission Front Mount Replacement.
7. Install the rear transmission mount to the transmission. Refer to Transmission Rear Mount Replacement.
8. Install the left transmission mount to the transmission. Refer to Transmission Mount Replacement - Left Side.
9. Install the intermediate drive shaft. Refer to Front Wheel Drive Intermediate Shaft Replacement (with MR6) , Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK) .
10. Install the left wheel drive shaft to the transmission. Refer to Front Wheel Drive Shaft Replacement - Left Side .
11. Install the frame. Refer to Drivetrain and Front Suspension Frame Replacement .

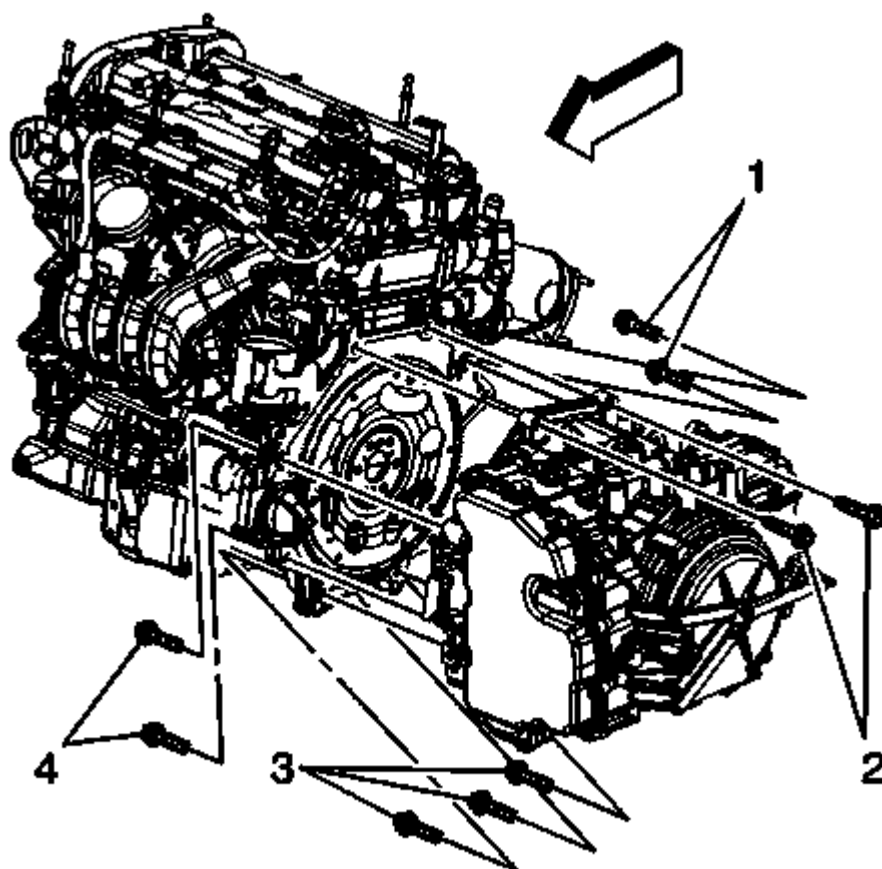


Fig. 79: Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Install the upper transmission to engine bolt (2) and tighten to 75 (55 lb ft).
13. Remove the engine support fixture.

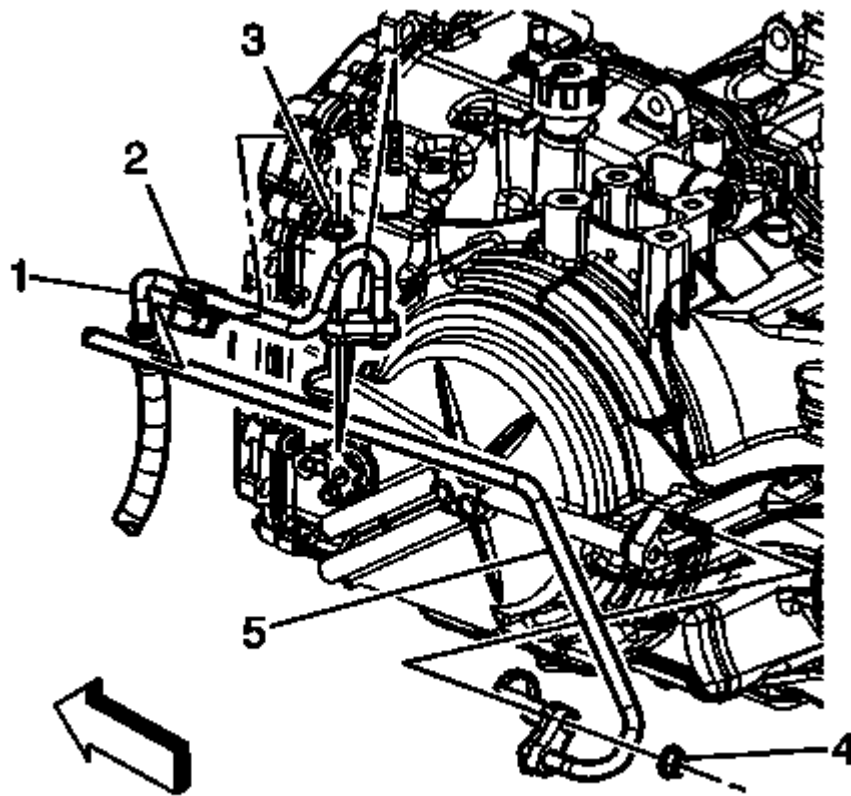


Fig. 80: Cooler Inlet And Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

14. Install the transmission fluid cooler outlet hose (5) to the transmission.
15. Install the transmission fluid cooler pipe retainer nut (4) and tighten to 22 (16 lb ft).
16. Install the transmission fluid cooler inlet hose (1) to the transmission.
17. Install the transmission fluid cooler pipe retainer nut (3) and tighten to 22 (16 lb ft).

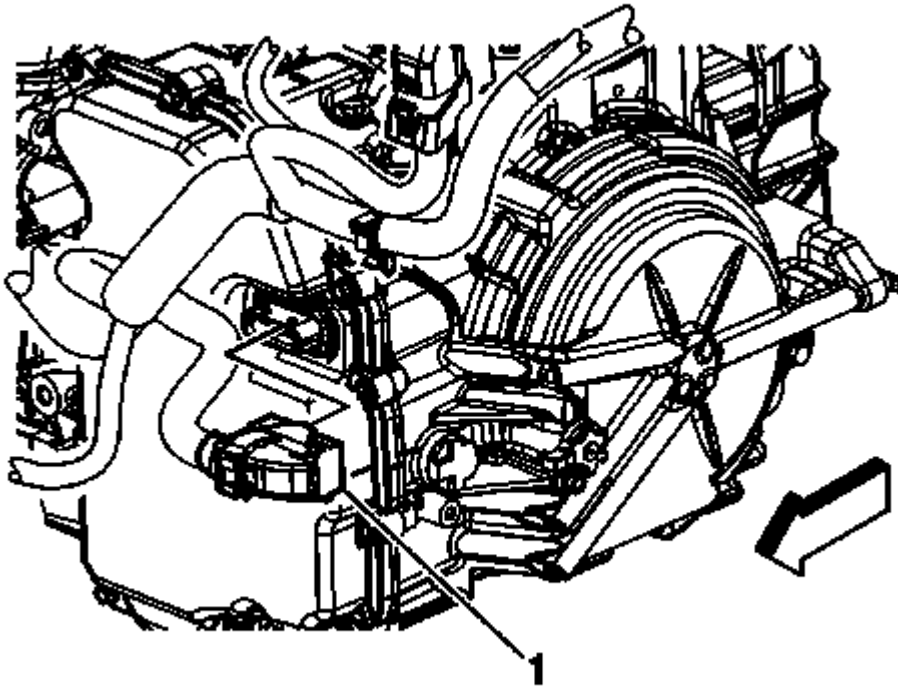


Fig. 81: Control Valve Body Transmission Control Module (TCM) Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

18. Connect the control valve body TCM electrical connector (1).

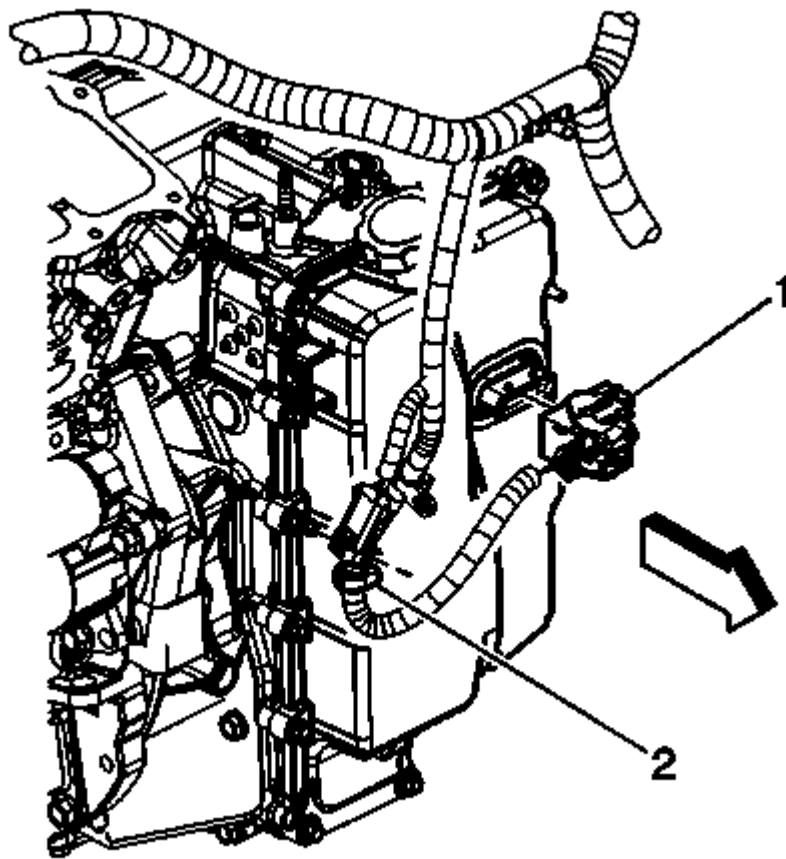


Fig. 82: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

19. Connect the control valve body TCM electrical connector (1).
20. Install the transmission range select lever cable and bracket on the transmission.
21. Install the battery tray. Refer to **Battery Tray Replacement** .
22. Adjust the automatic transmission range selector lever cable. Refer to **Range Selector Lever Cable Adjustment**.
23. Fill the transmission with fluid. Refer to **Transmission Fluid Drain and Fill**.
24. If a NEW TCM has been installed into the vehicle, the NEW module needs to be reprogrammed. Refer to **Service Programming System (SPS)** .

NOTE: The Transmission Adaptive Values Learn procedure must be performed when one of the following repairs have been made to the vehicle. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, as well as transmission DTCs being set:

- Transmission internal service/overhaul
- Valve body repair or replacement
- Control solenoid valve assembly replacement

- **TCM software/calibration update**
- **Any service in response to a shift quality concern**

25. Perform the Transmission Adaptive Values Learn procedure. Refer to **Transmission Adaptive Values Learn** .
26. Road test the vehicle.

Transmission

Automatic Transmission - 6T40 (MH8 MHH) - Schematic Wiring Diagrams

SCHEMATIC WIRING DIAGRAMS

AUTOMATIC TRANSMISSION CONTROLS WIRING SCHEMATICS

Module Power, Ground, Serial Data, and MIL

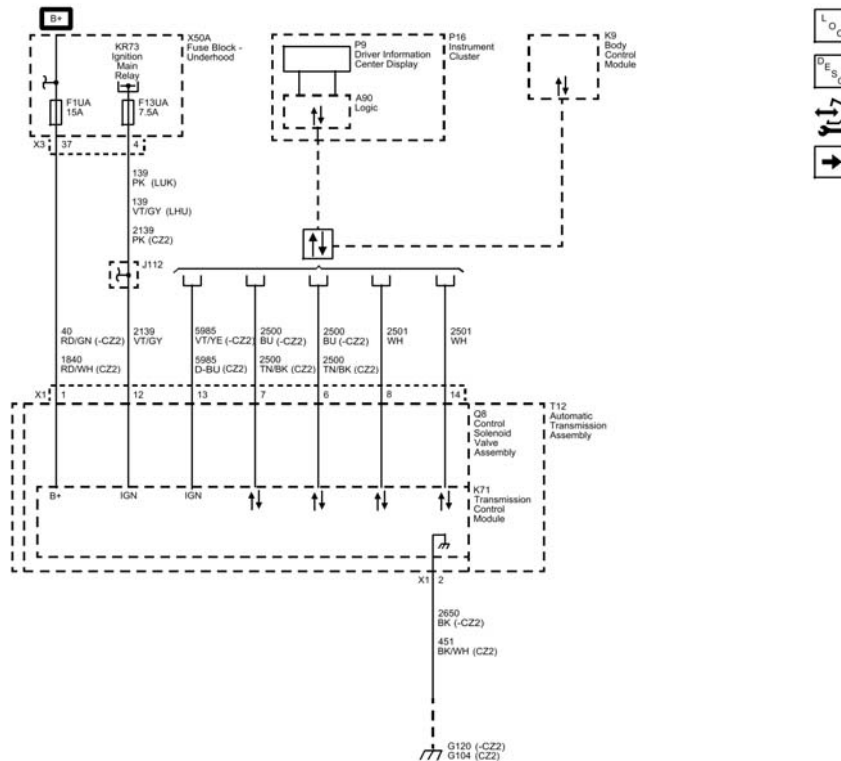


Fig. 1: Module Power, Ground, Serial Data, and MIL
Courtesy of GENERAL MOTORS COMPANY

Speed and Temperature Sensors, Valve Position, Pressure and Shift Controls

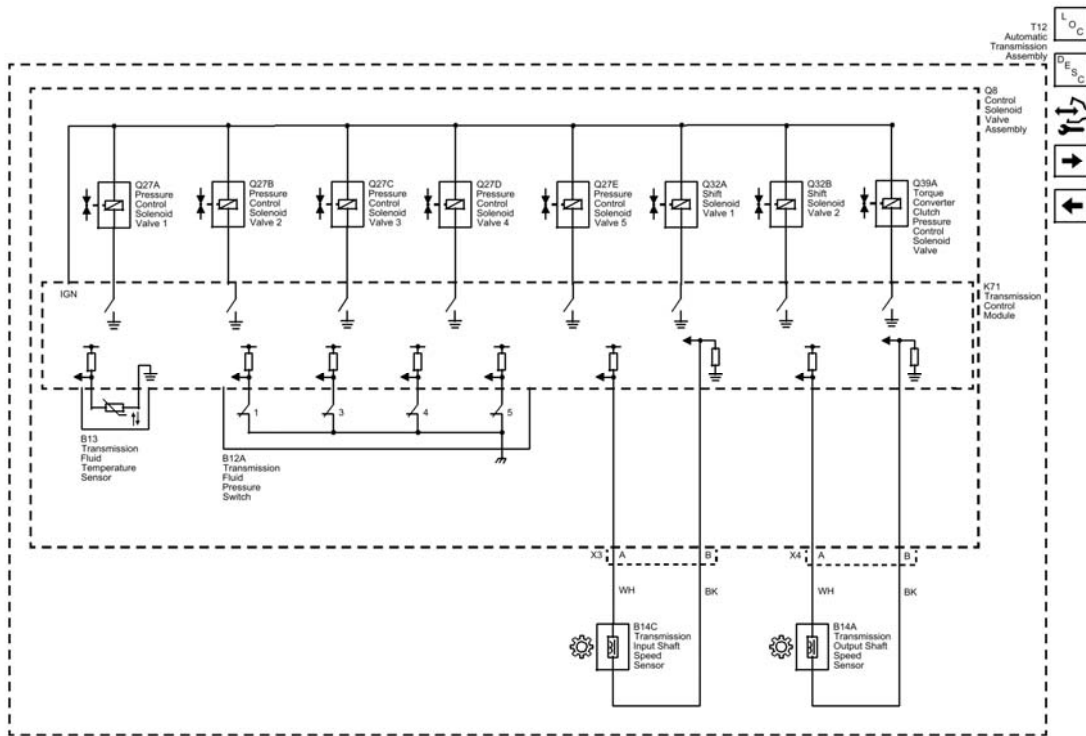


Fig. 2: Speed and Temperature Sensors, Valve Position, Pressure and Shift Controls
Courtesy of GENERAL MOTORS COMPANY

Brake Apply, Internal Mode and Manual Shift Switch (-CZ2)

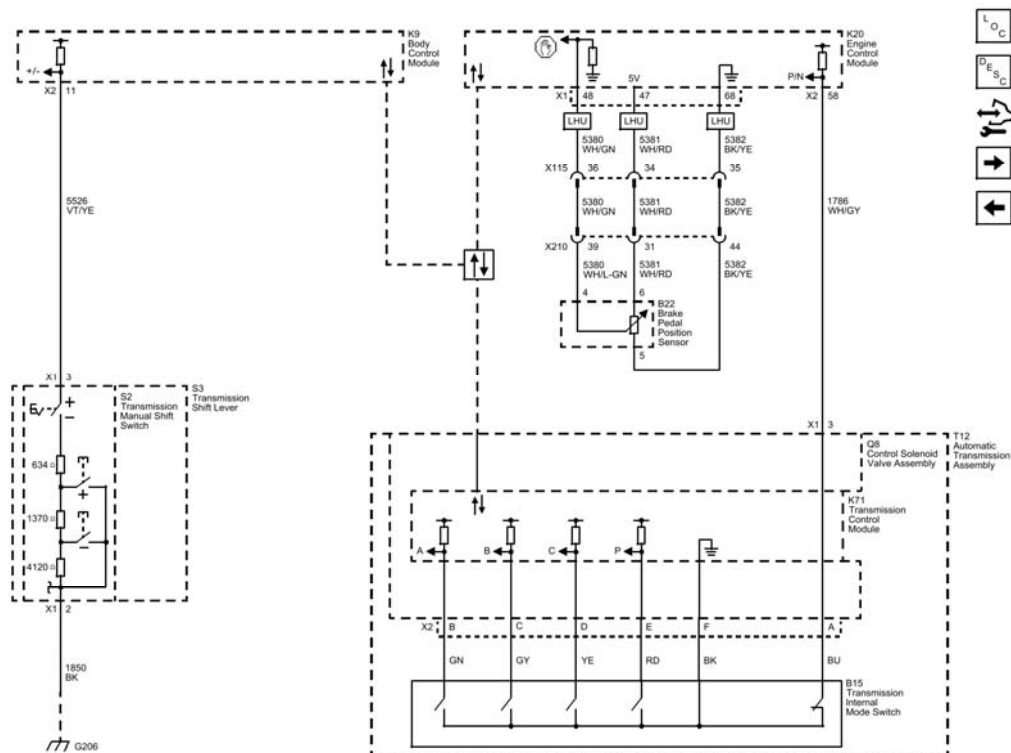


Fig. 3: Brake Apply, Internal Mode and Manual Shift Switch (-CZ2)
Courtesy of GENERAL MOTORS COMPANY

Shift Lever Position Indicator (-CZ2)

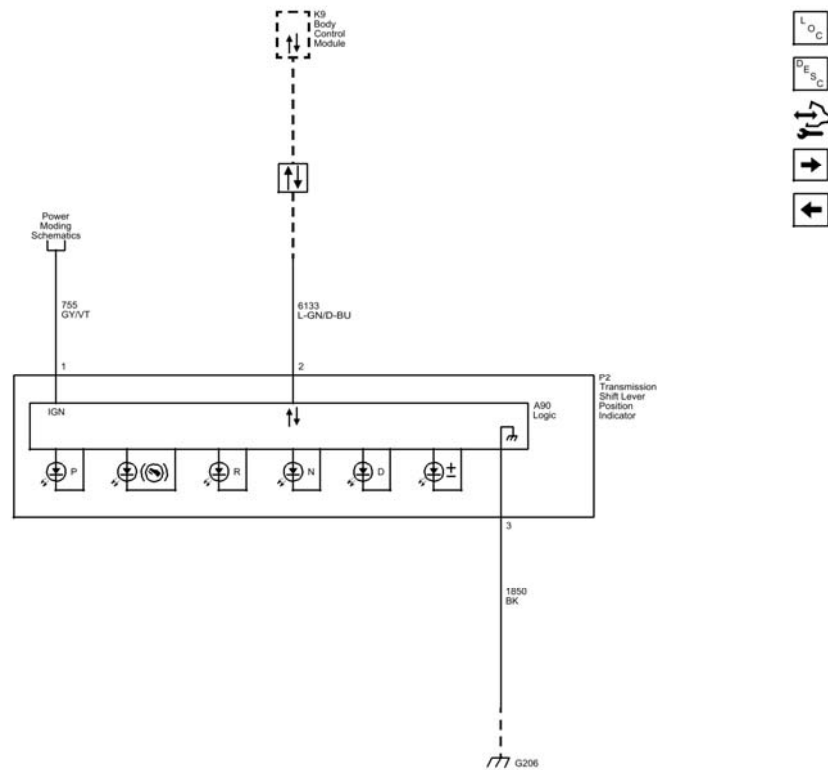


Fig. 4: Shift Lever Position Indicator (-CZ2)
Courtesy of GENERAL MOTORS COMPANY

Internal Mode and Tap Up/Tap Down Switches (MHH or MHK/CZ2)

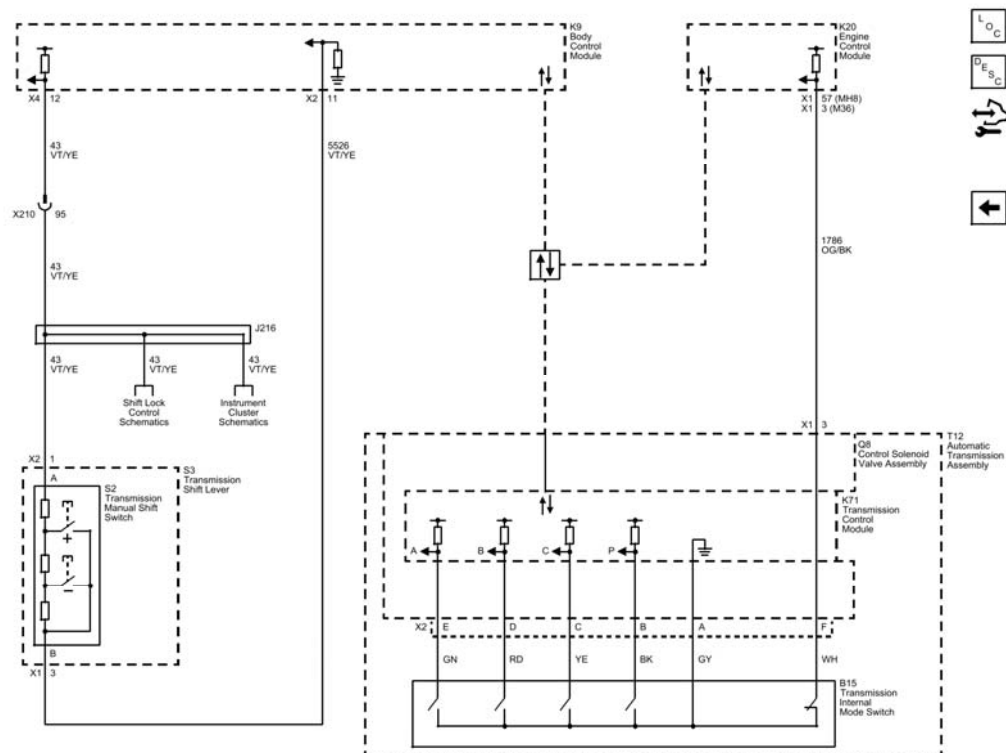


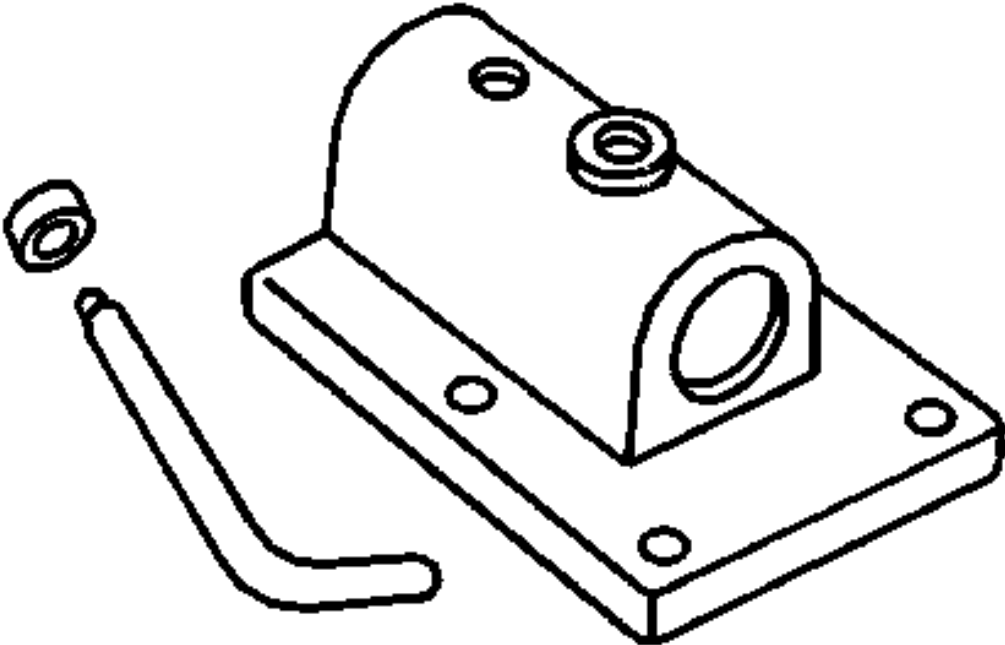
Fig. 5: Internal Mode and Tap Up/Tap Down Switches (MHH or MHK/CZ2)
Courtesy of GENERAL MOTORS COMPANY

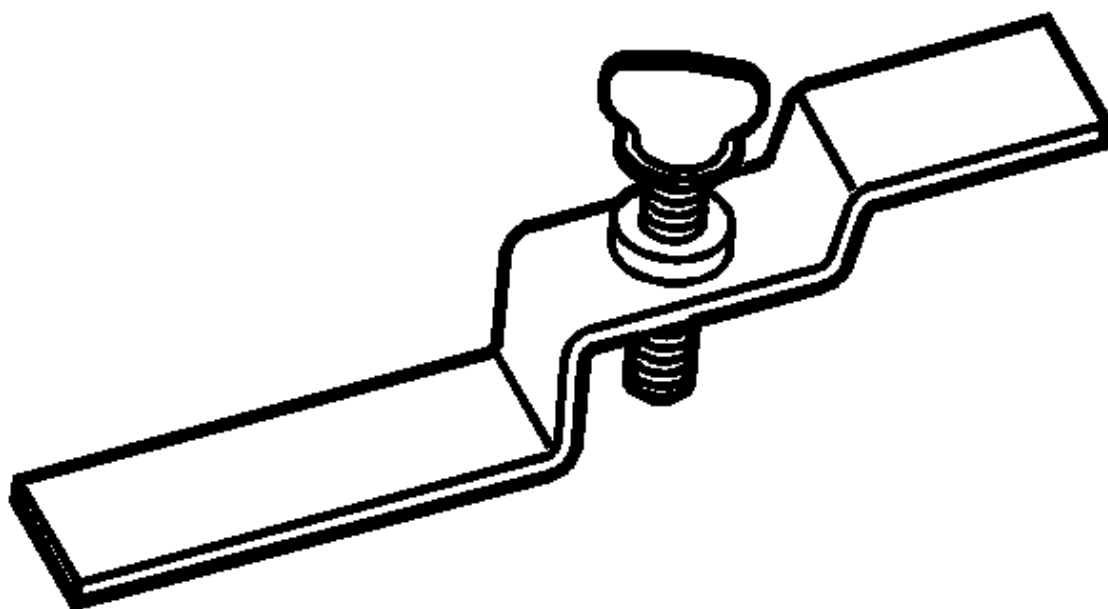
Transmission

Automatic Transmission - 6T40 (MH8 MHH) - Special Tools and Equipment

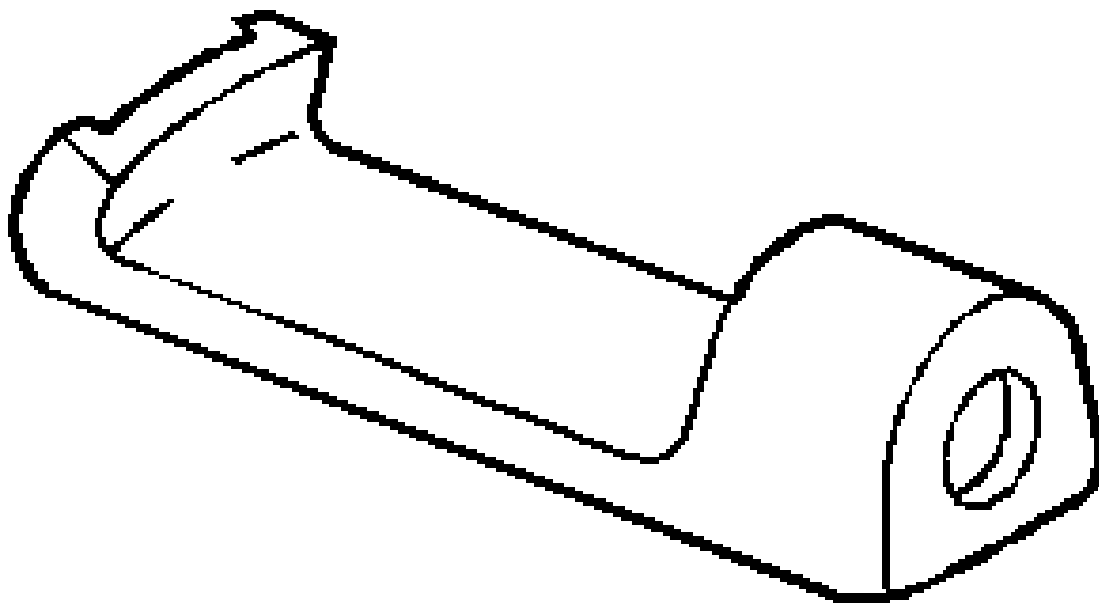
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

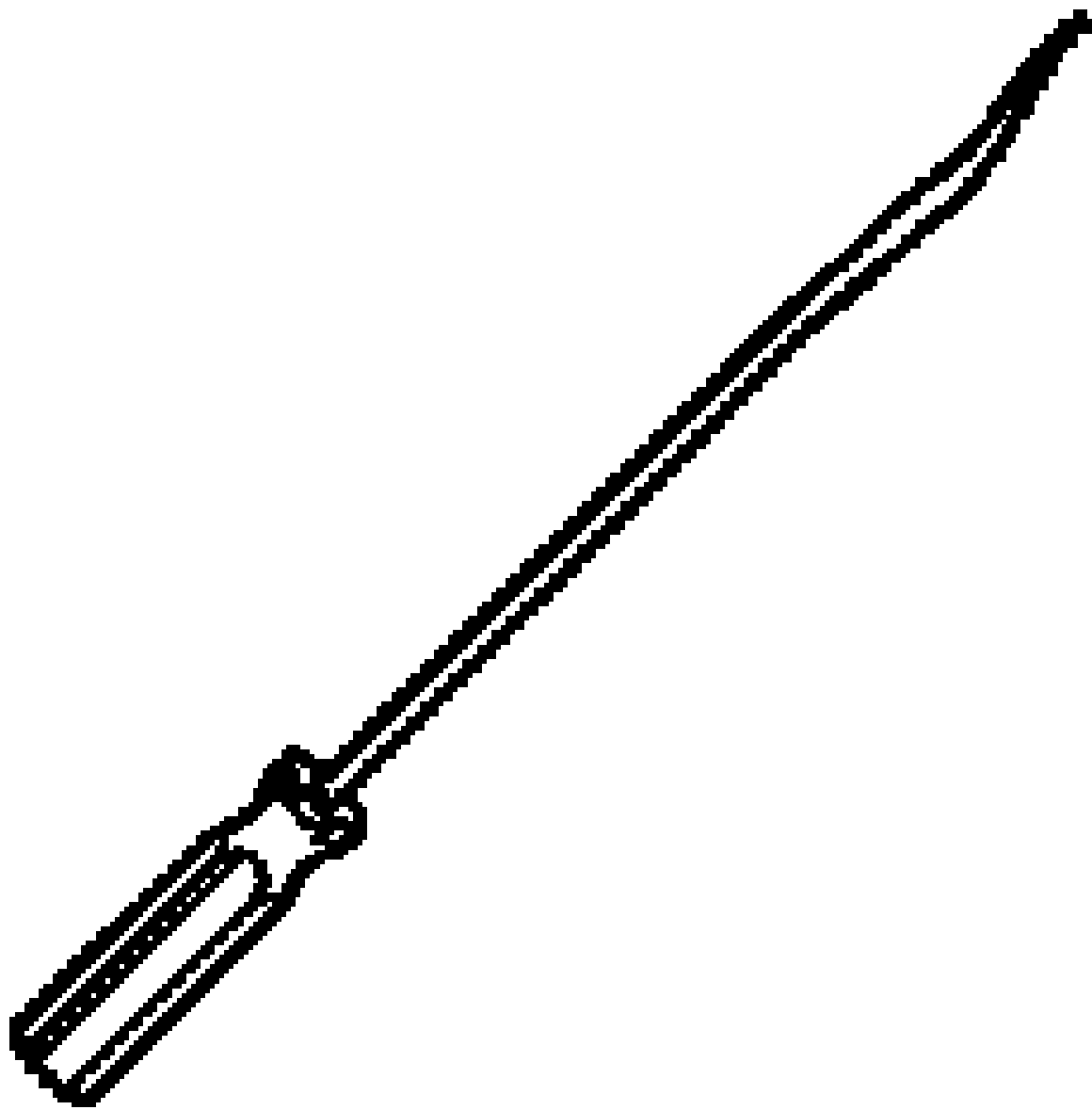
Illustration	Tool Number/Descrip
	<p>DT-3289-20 J-3289-20 KM-113-2-A Holding Fixtur</p>



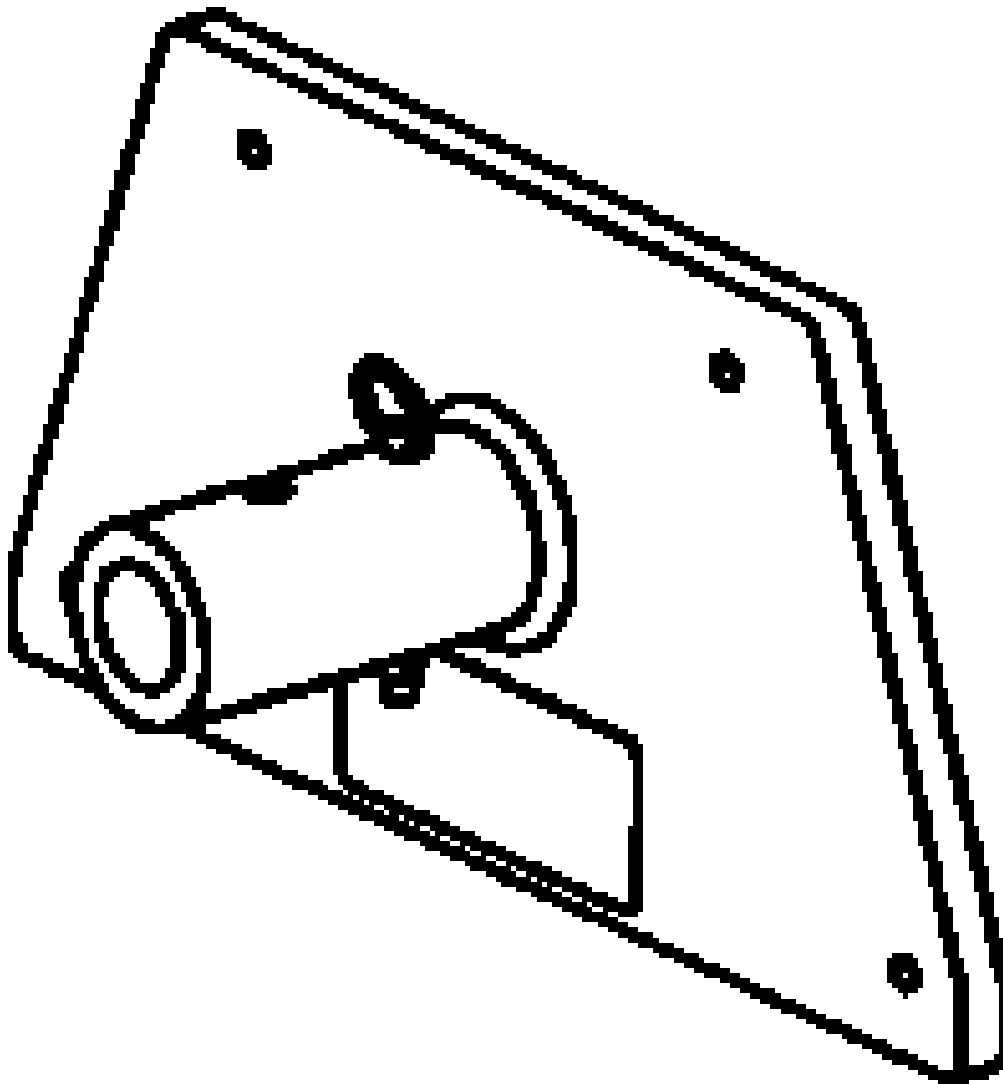
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J-21366
Converter Holdi
Strap



DT-23129
J-23129
KM-586
Universal Seal
Remover

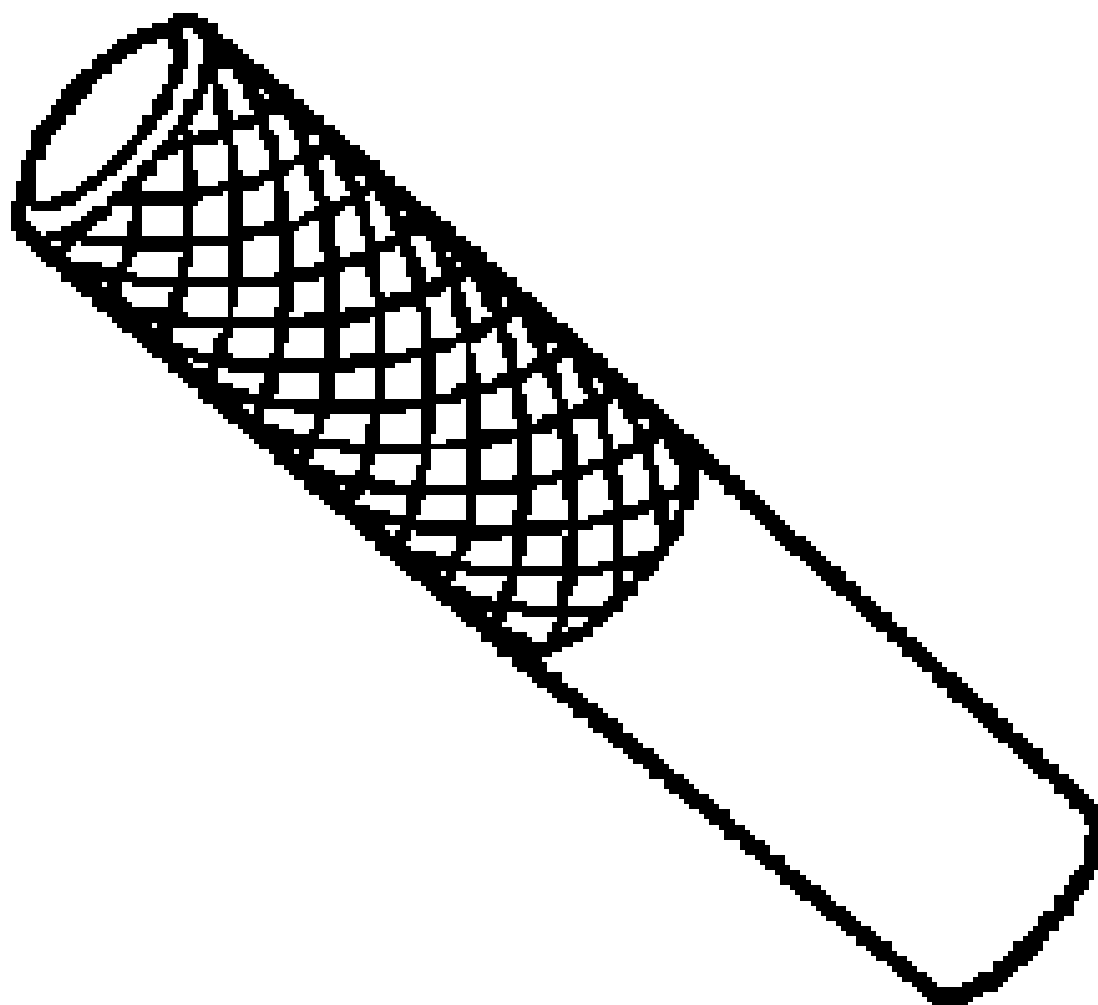


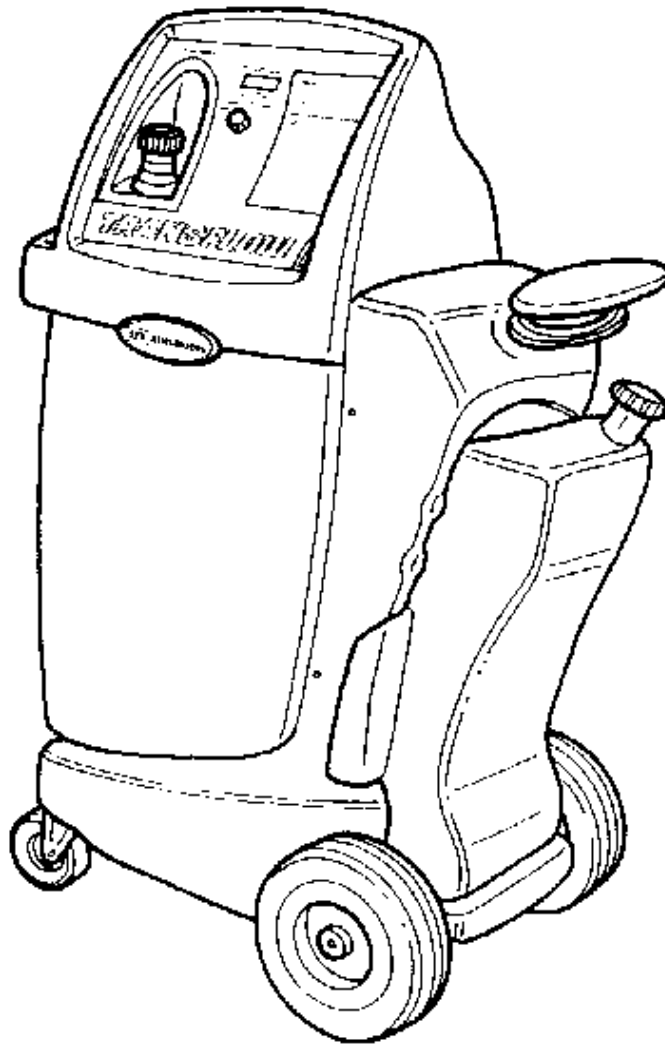
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J-28585
KM-J-28585
Snap Ring Remo



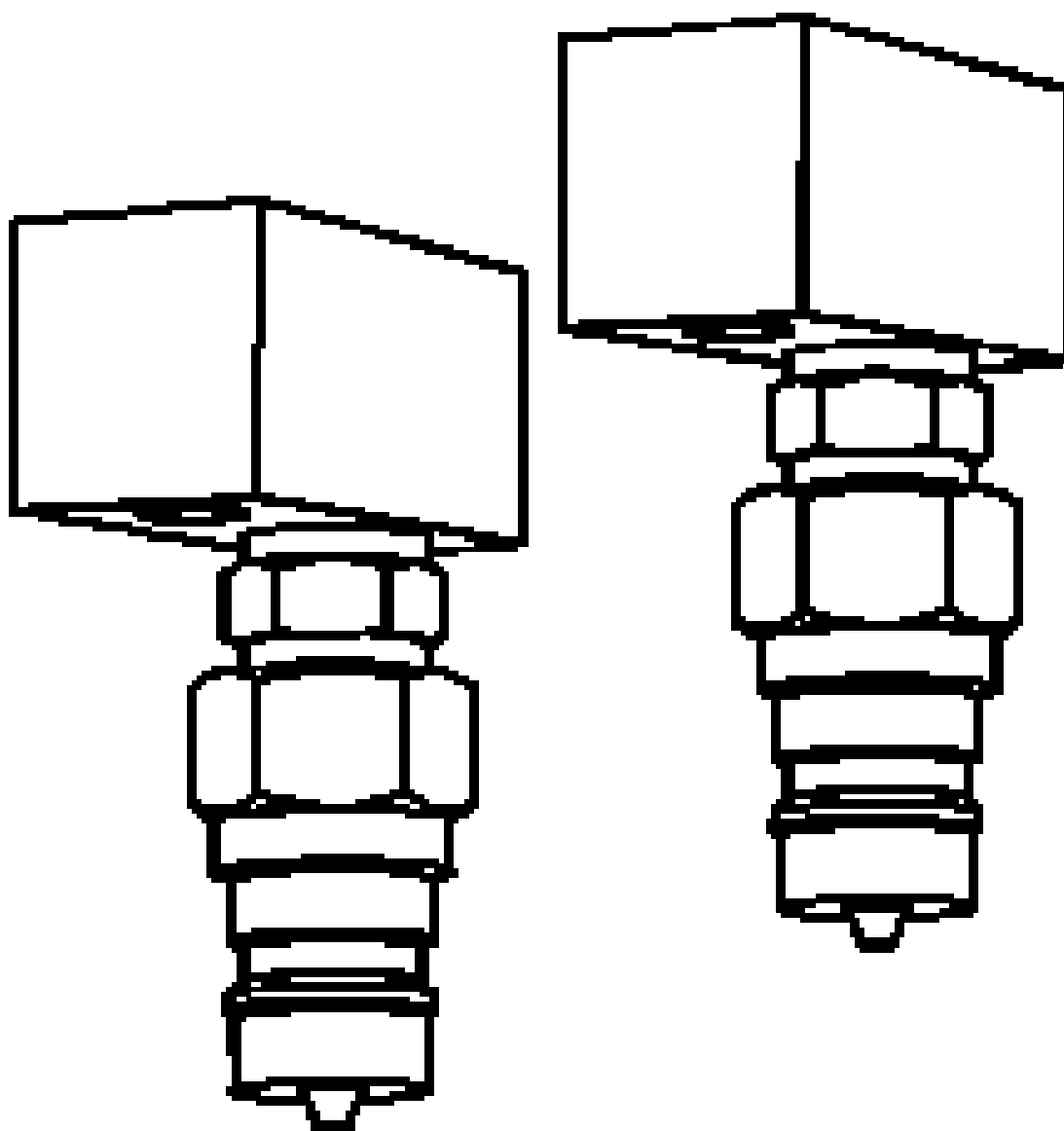
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J-39890
Transmission
Holding Fixtur
Adapter

DT-41229
J-41229
Manual Shaft P
Installer

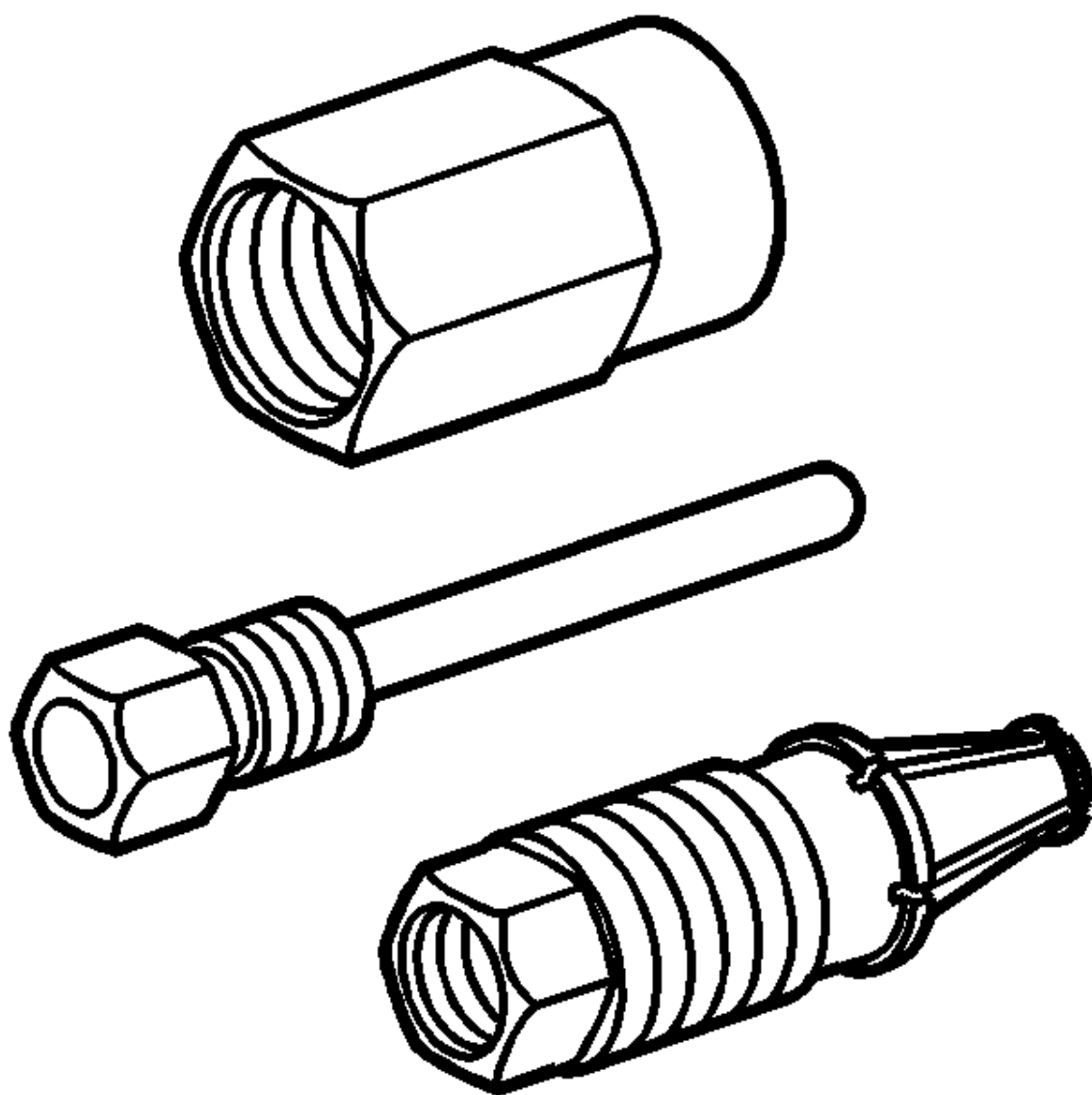




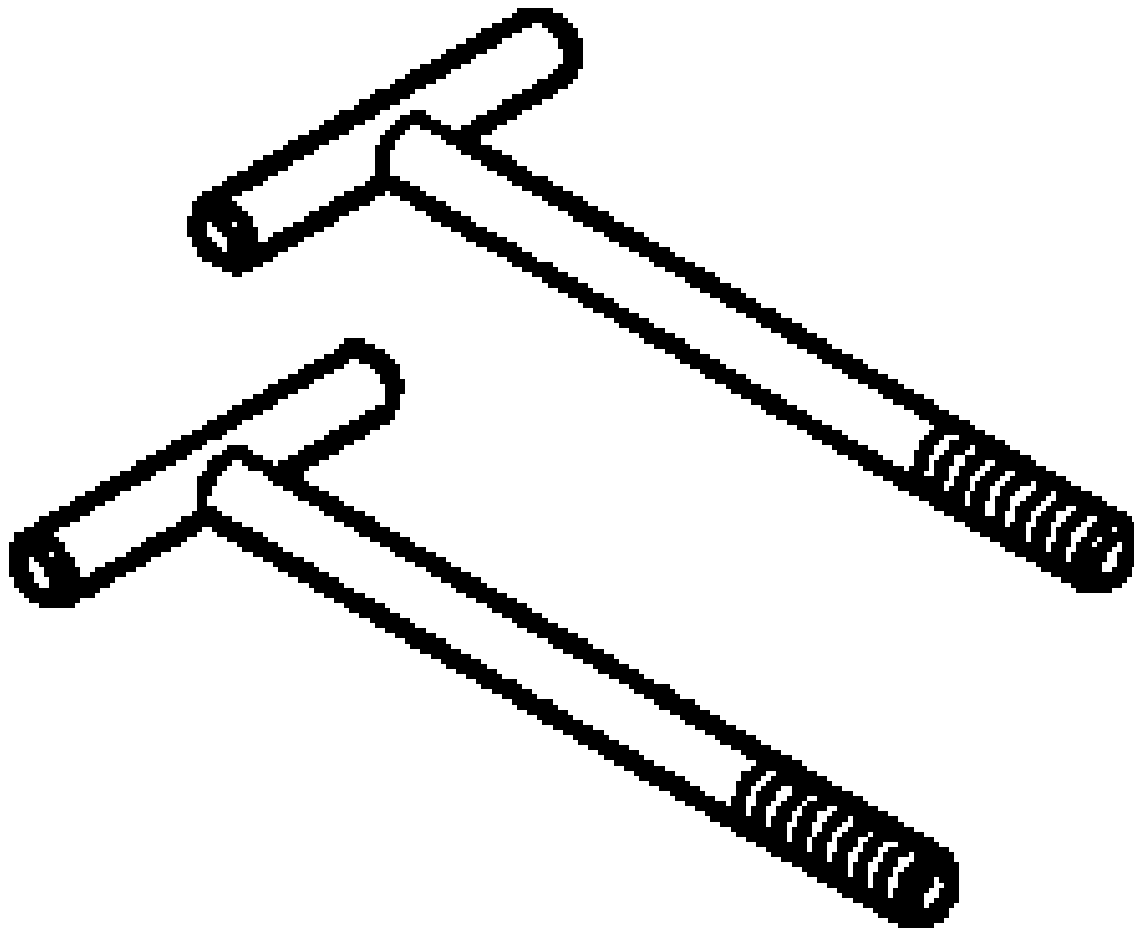
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J-45096
Transmission C
Cooling Syster
Flush and Flow T
Tool



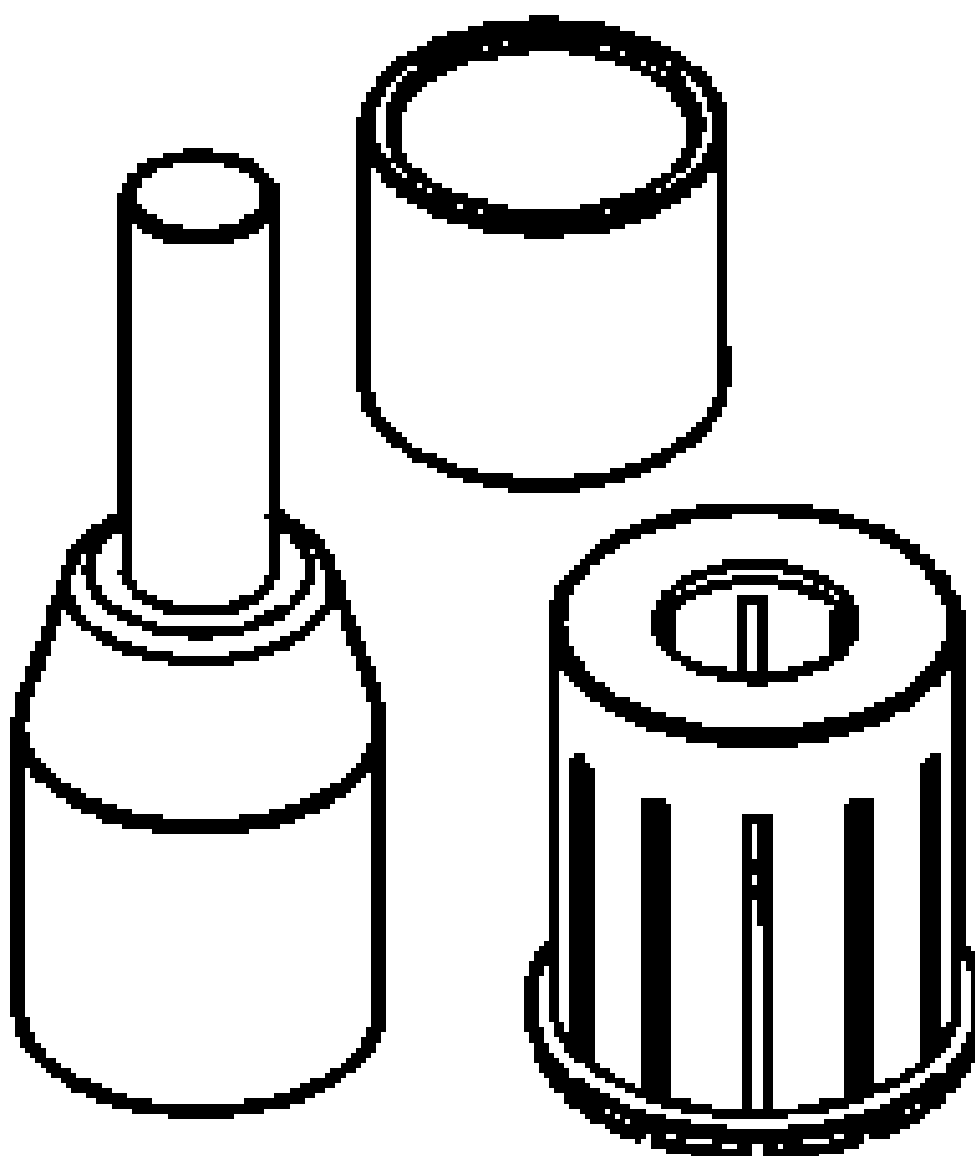
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Cooling Flush
Adapter



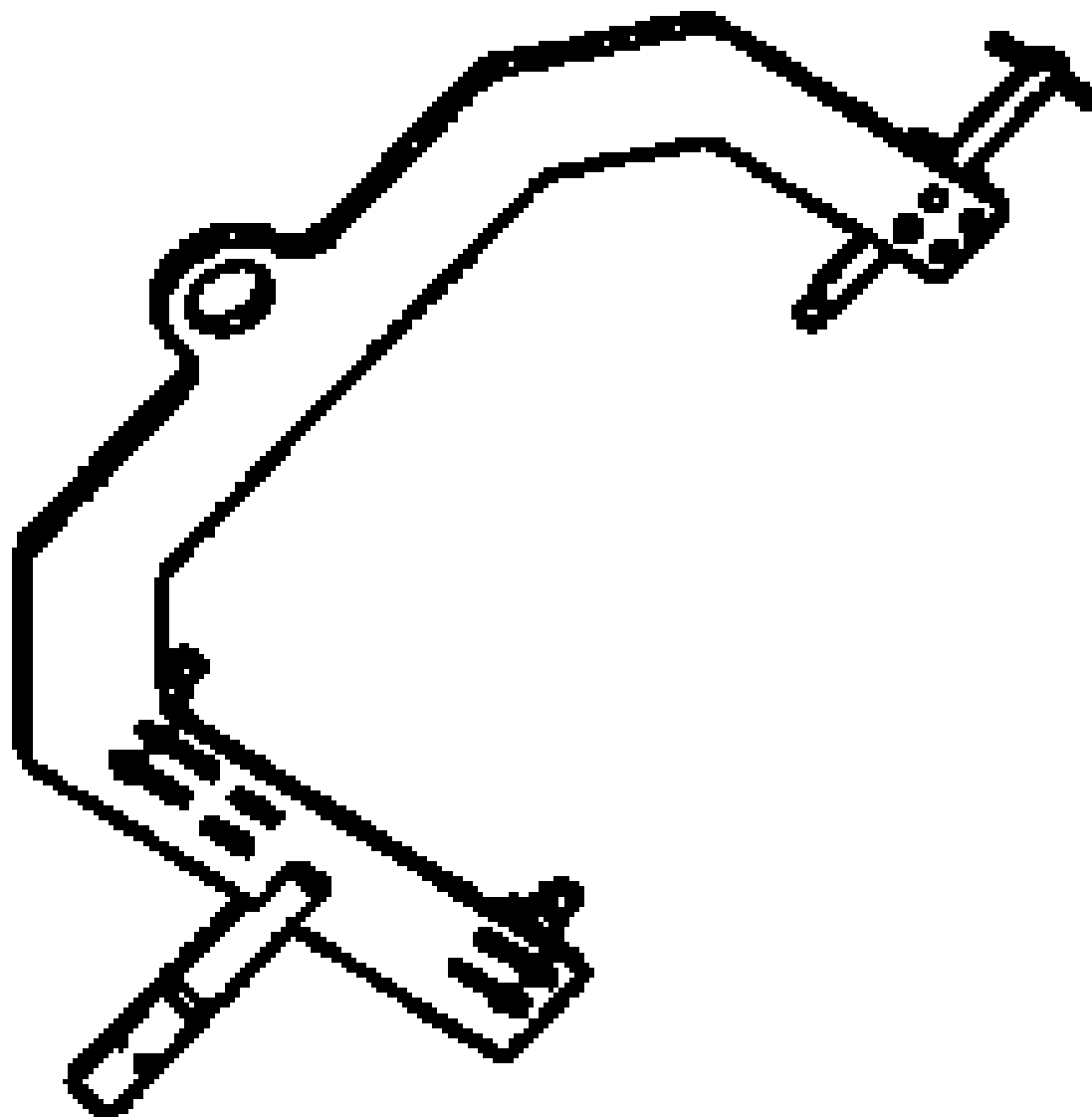
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J-45201
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Remover



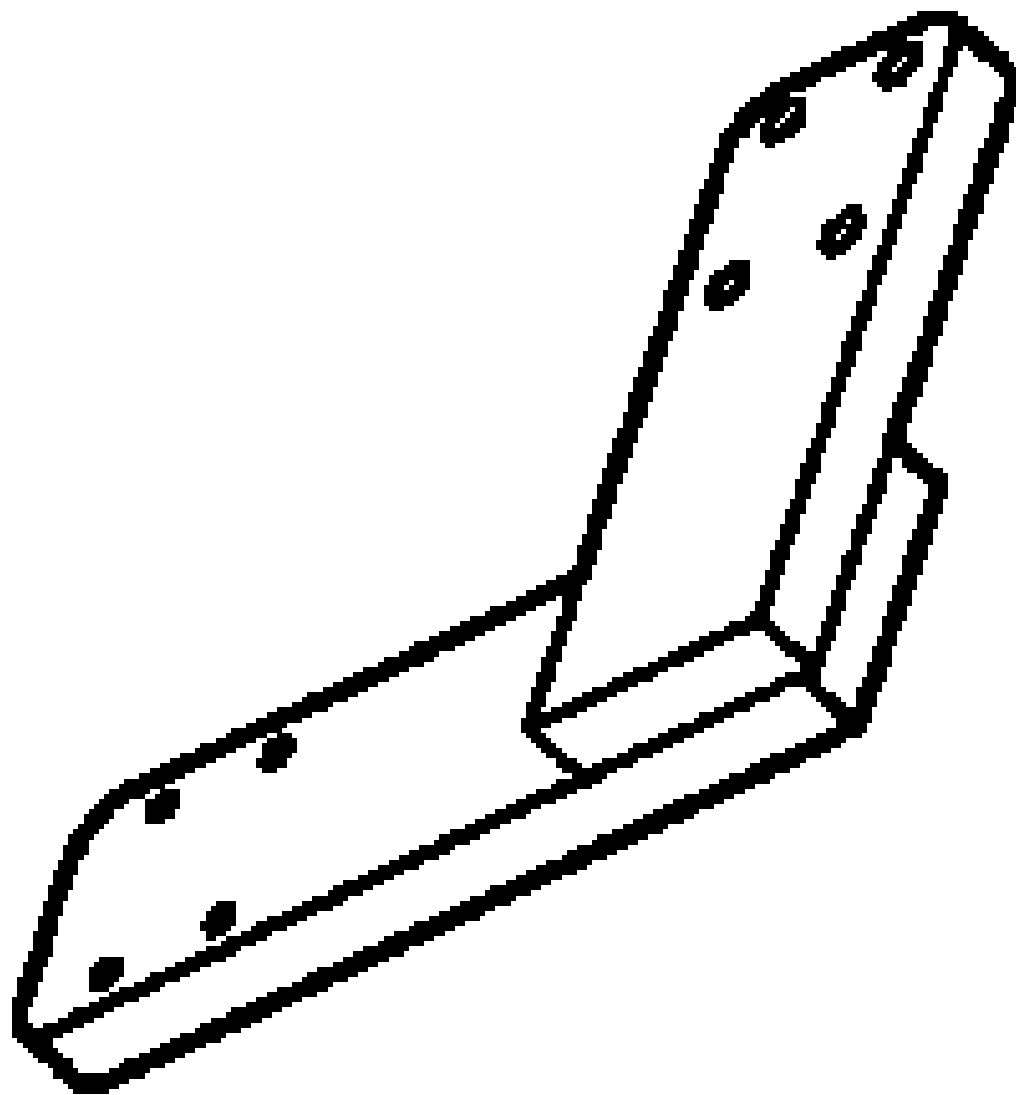
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KM-922
Torque Convert
Lifting Handle



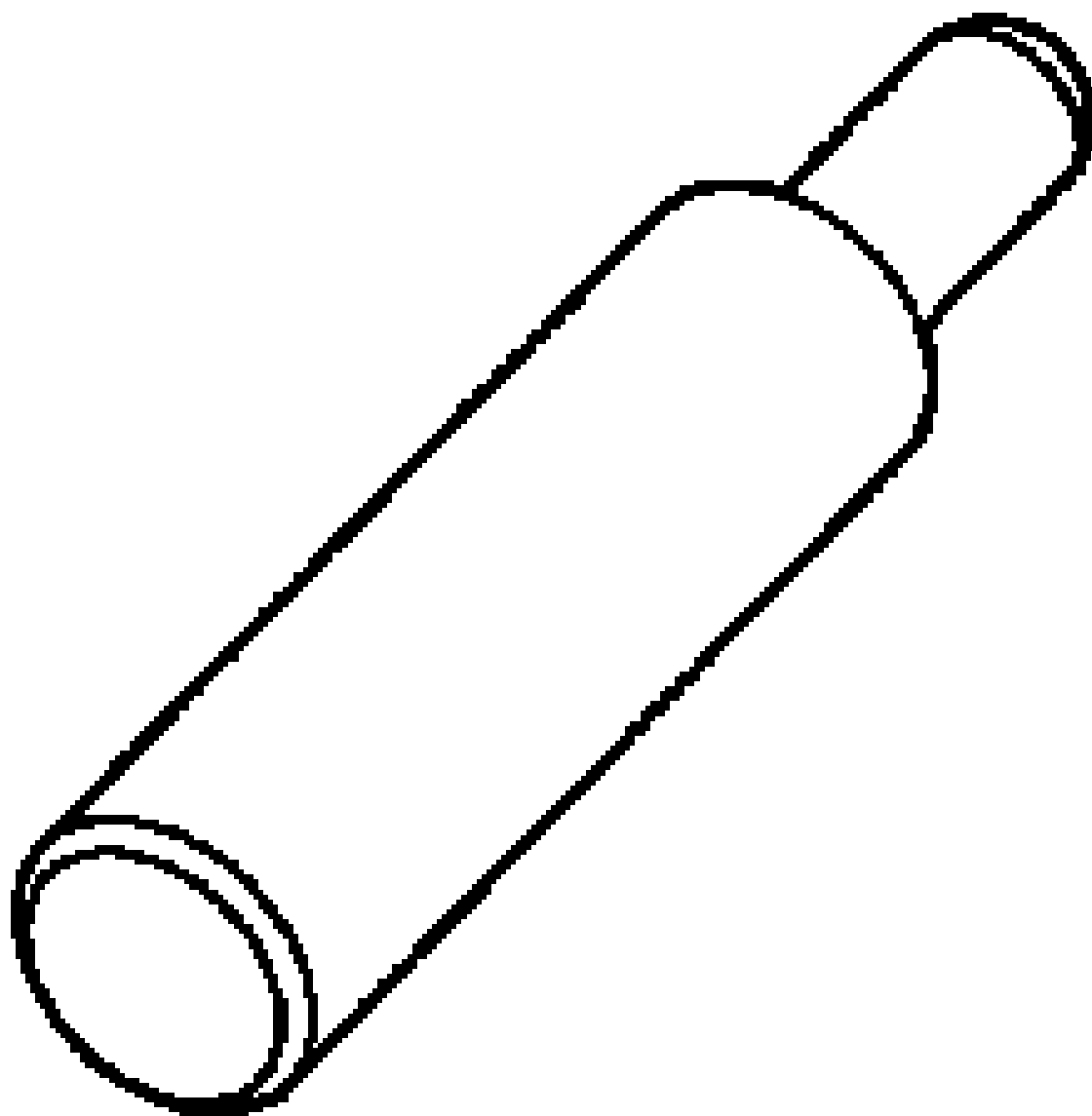
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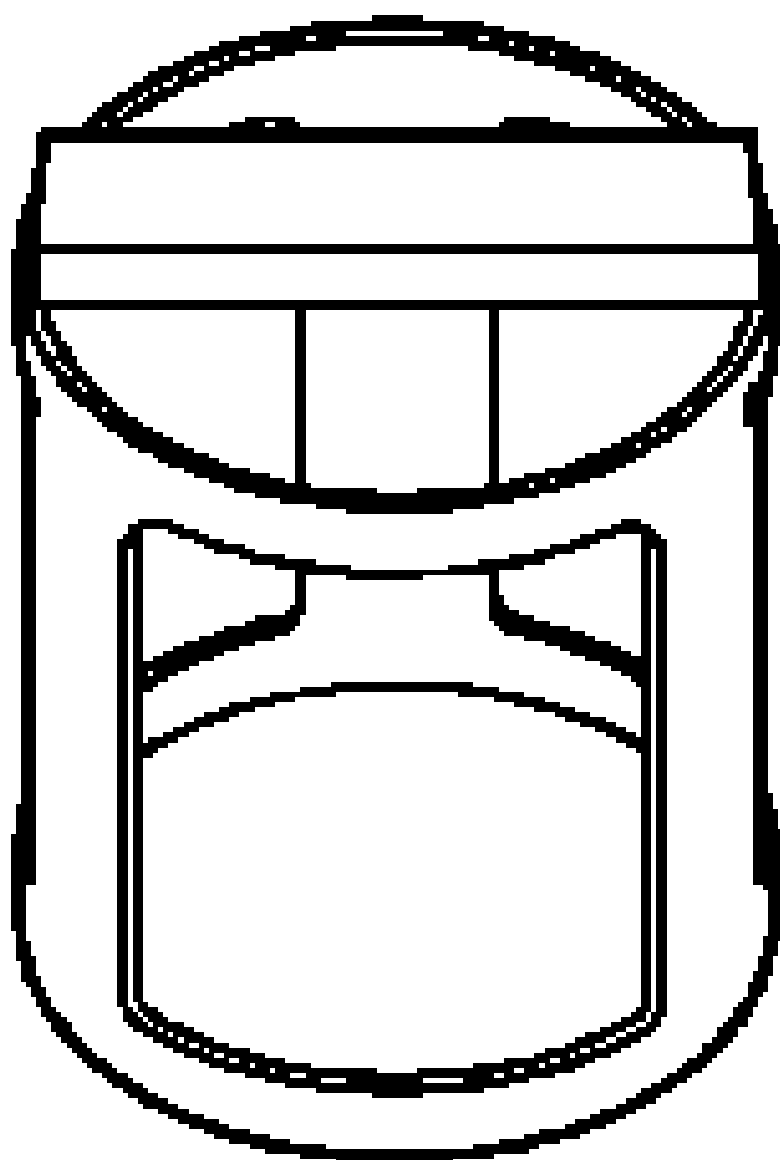
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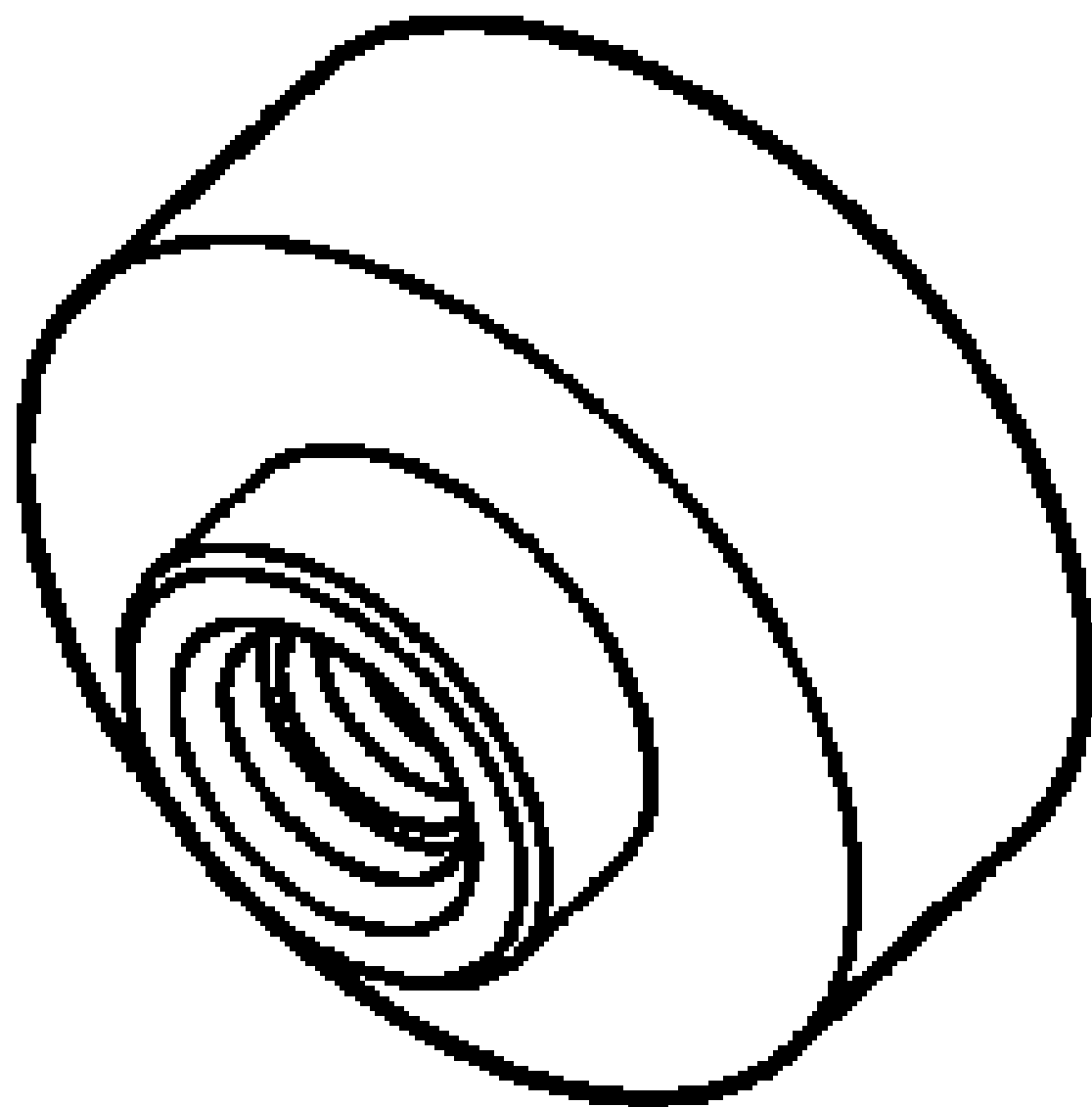
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Adapter



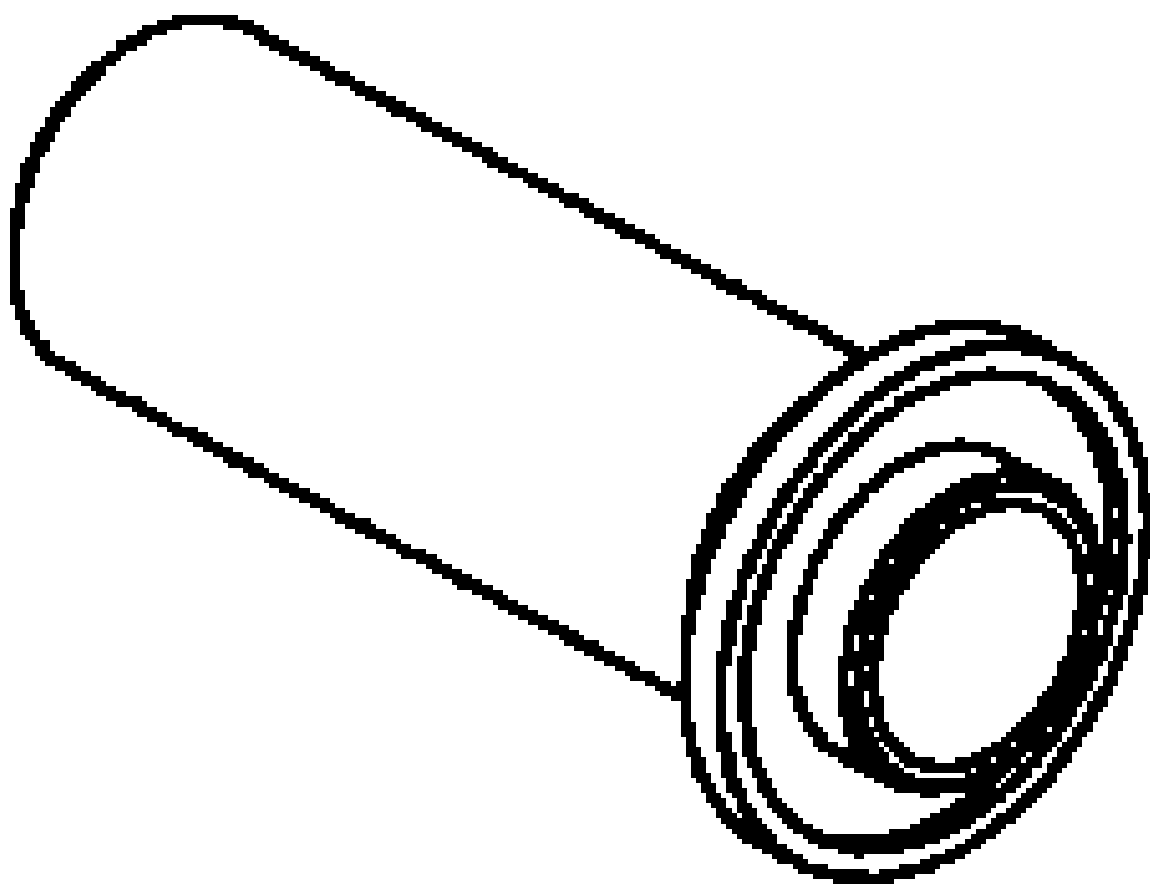
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Seal Installer



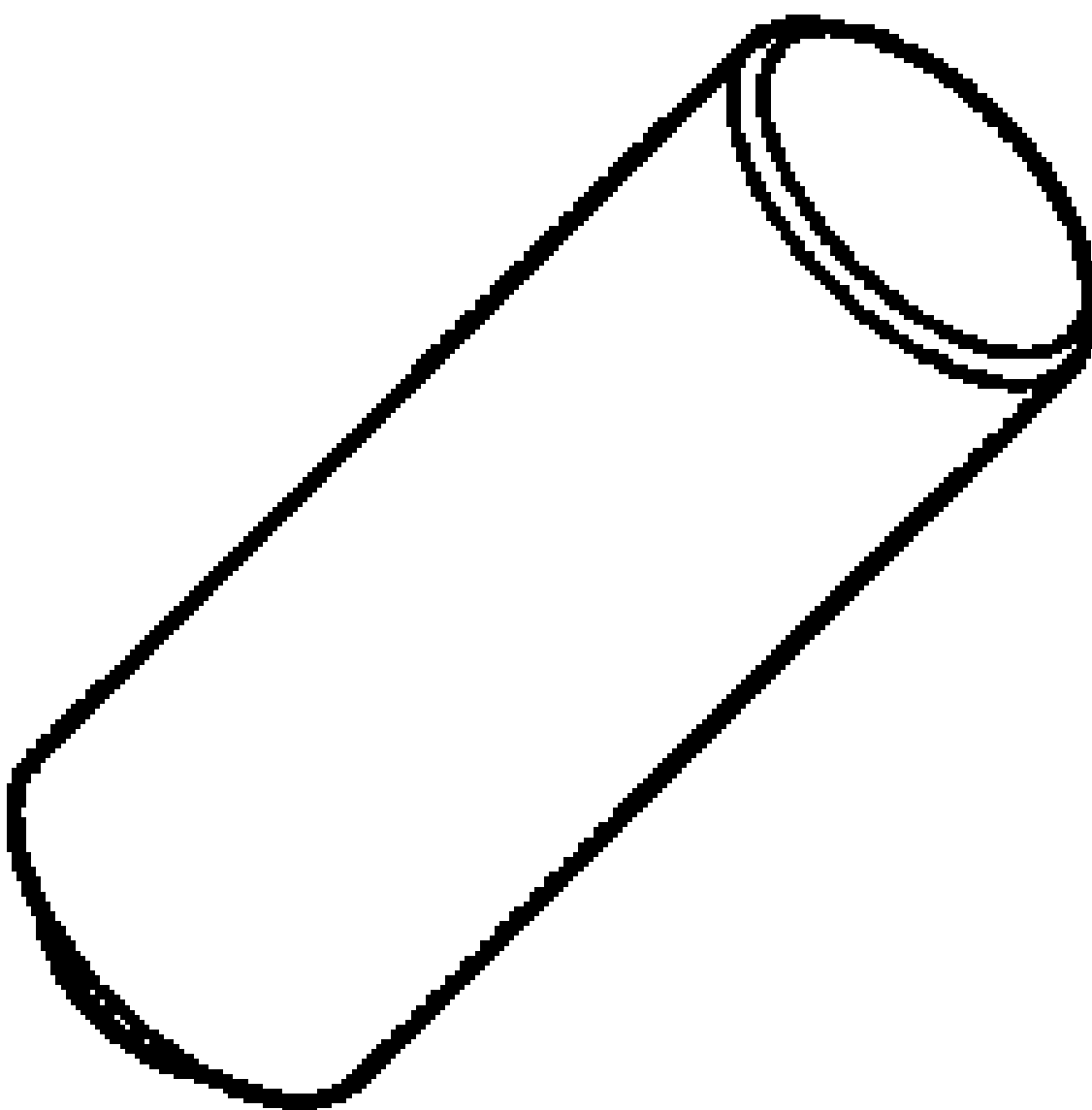
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Spring Compress



DT-47790
Seal Installer

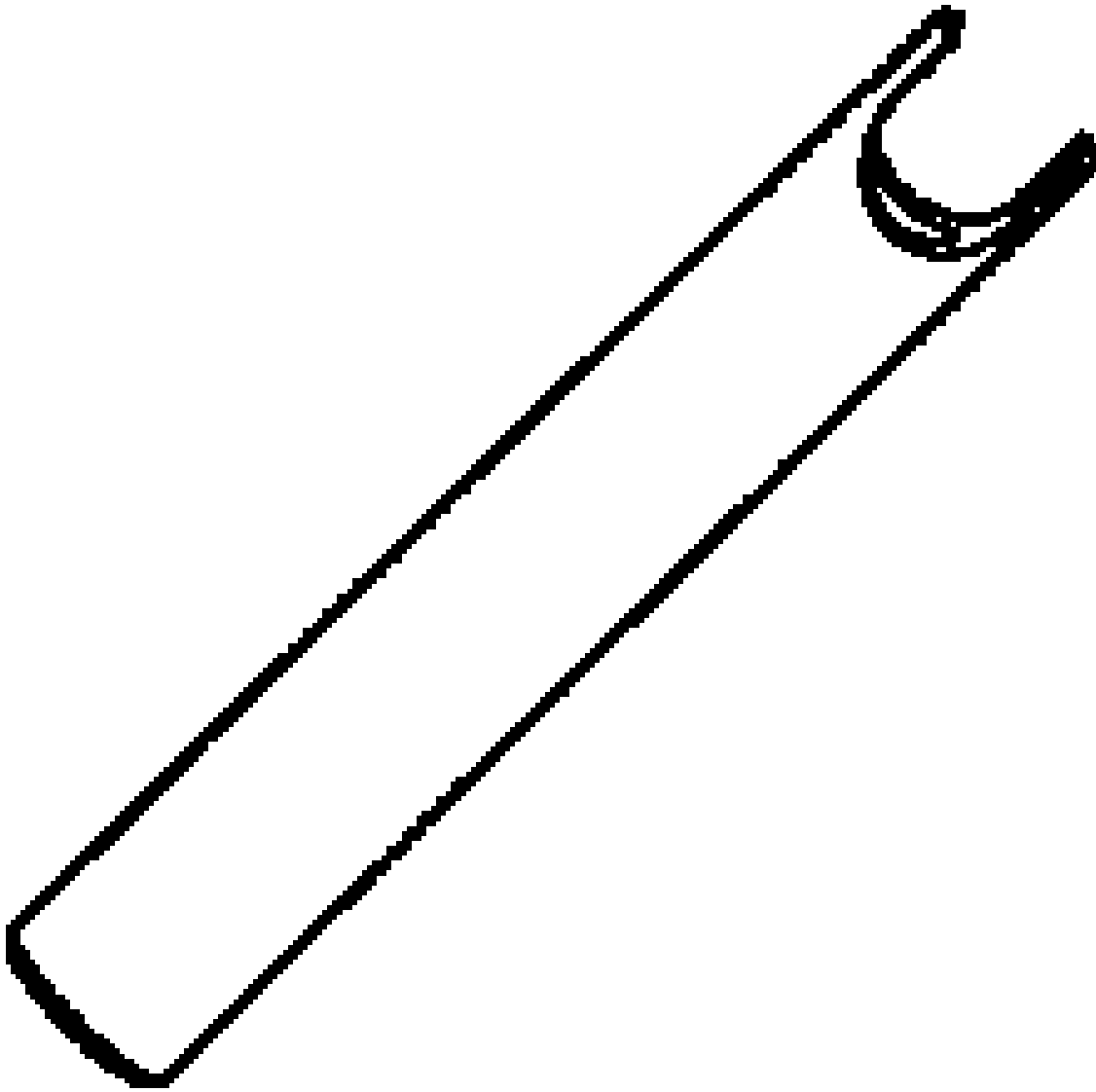


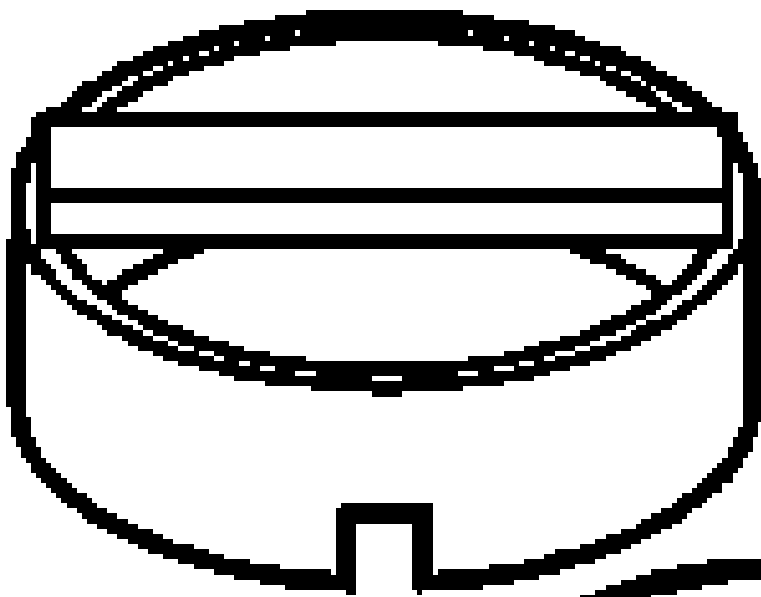
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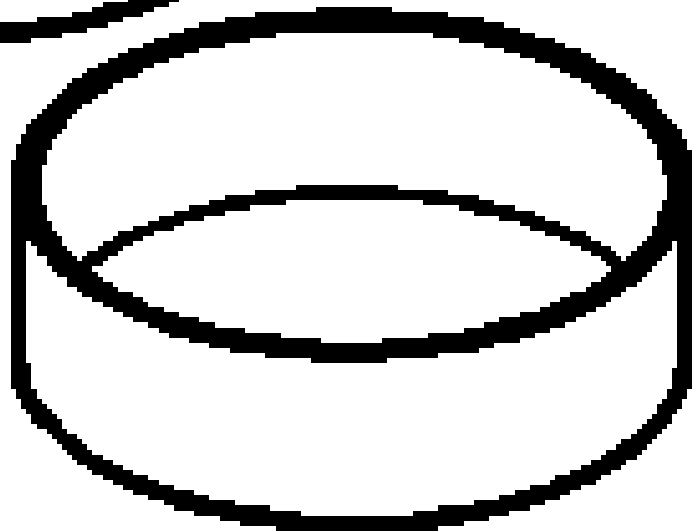
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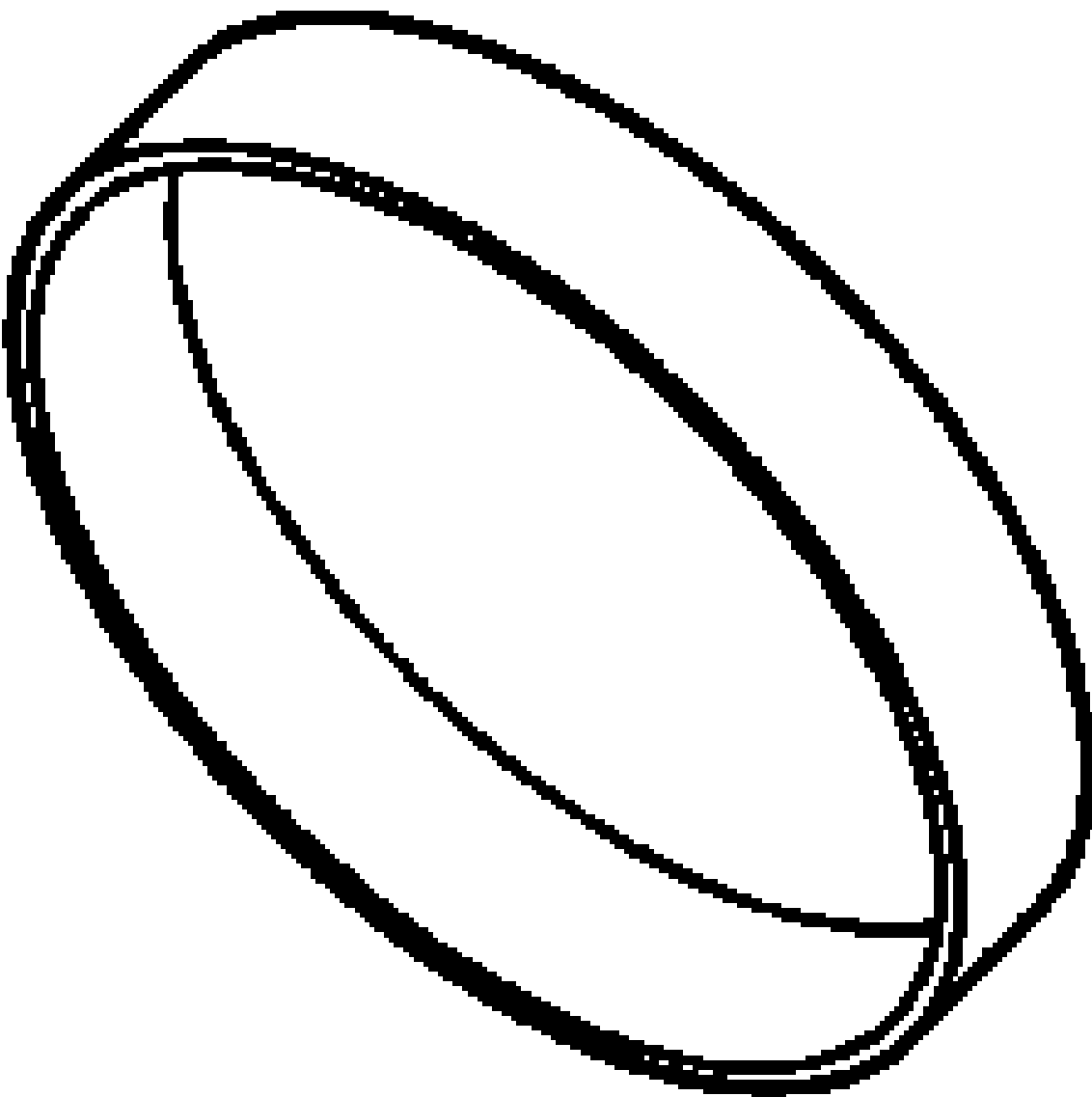
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Tool



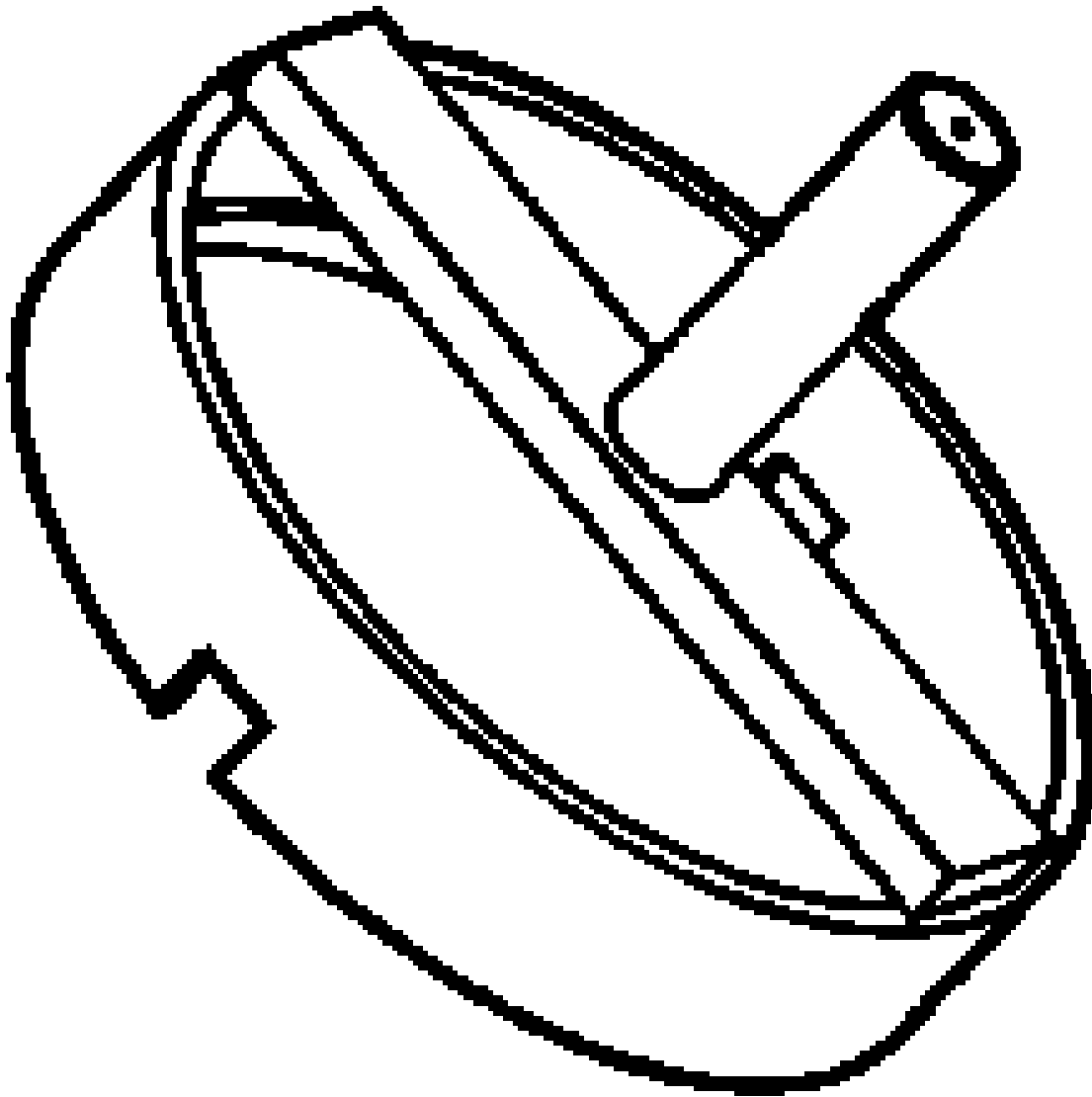


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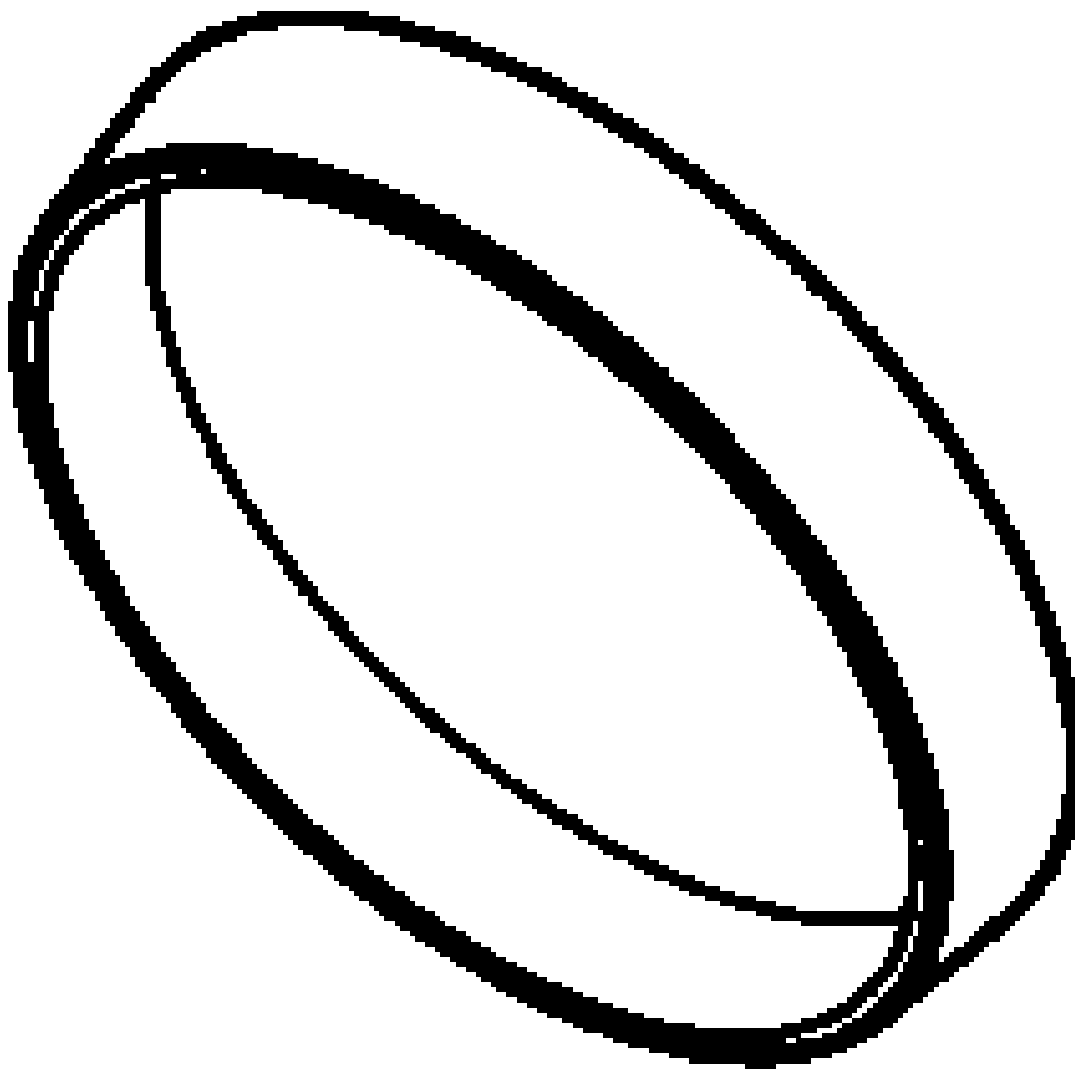




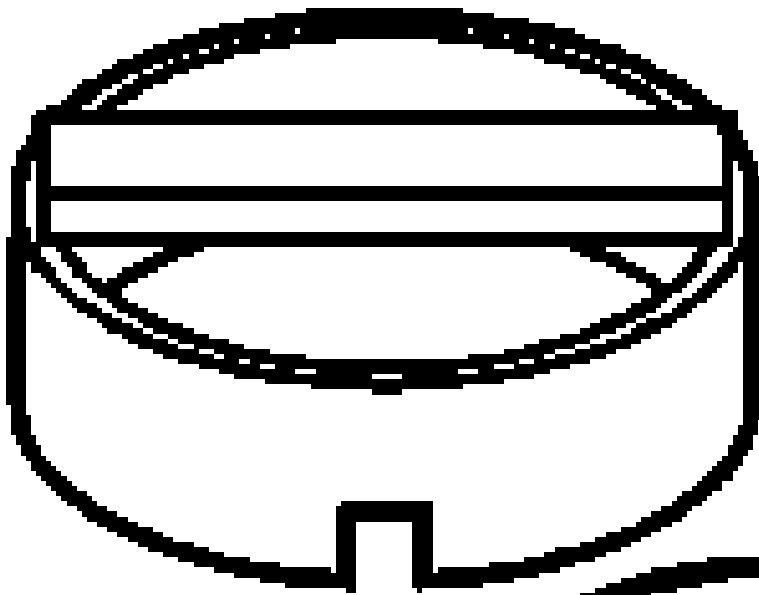
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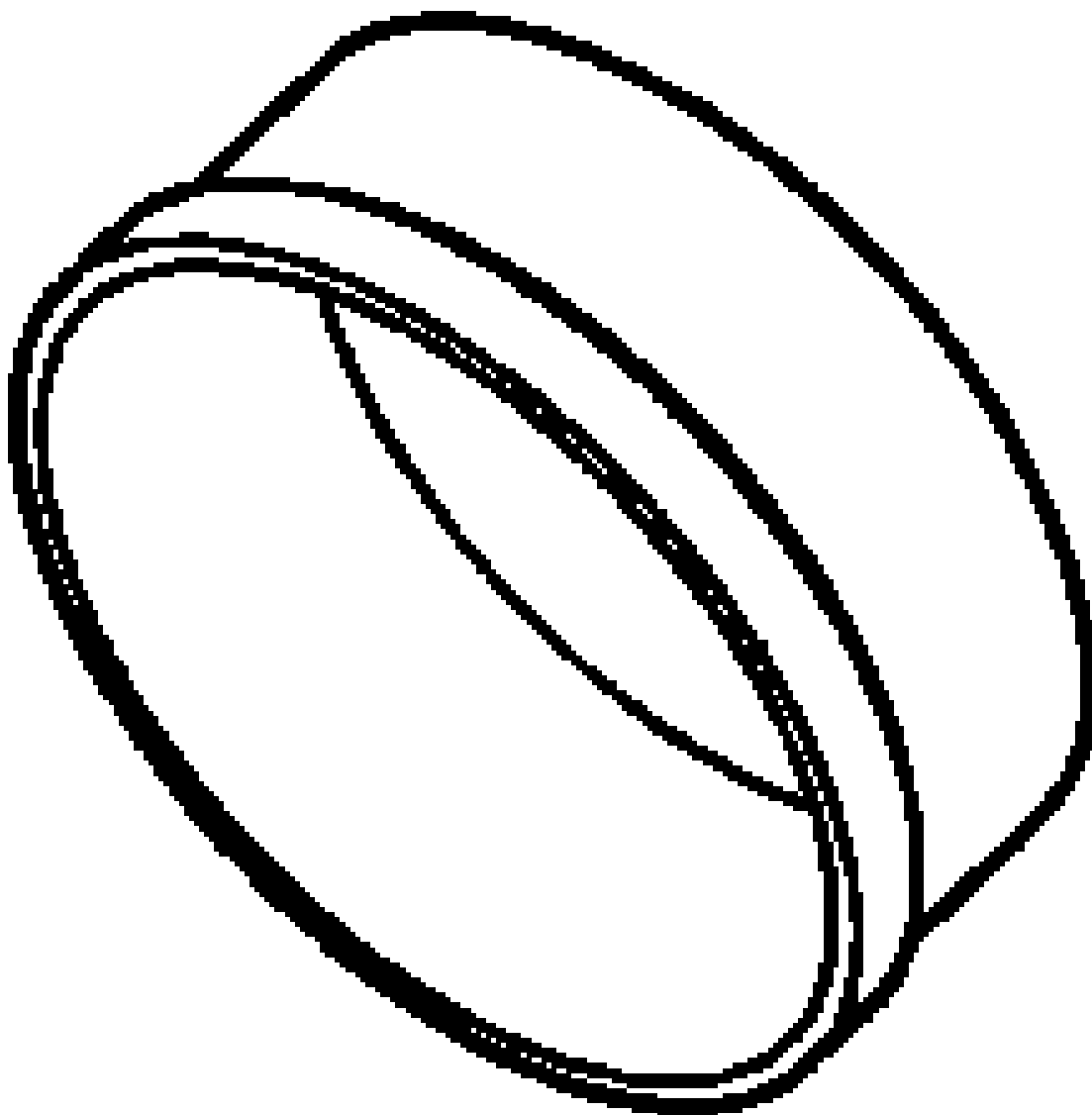
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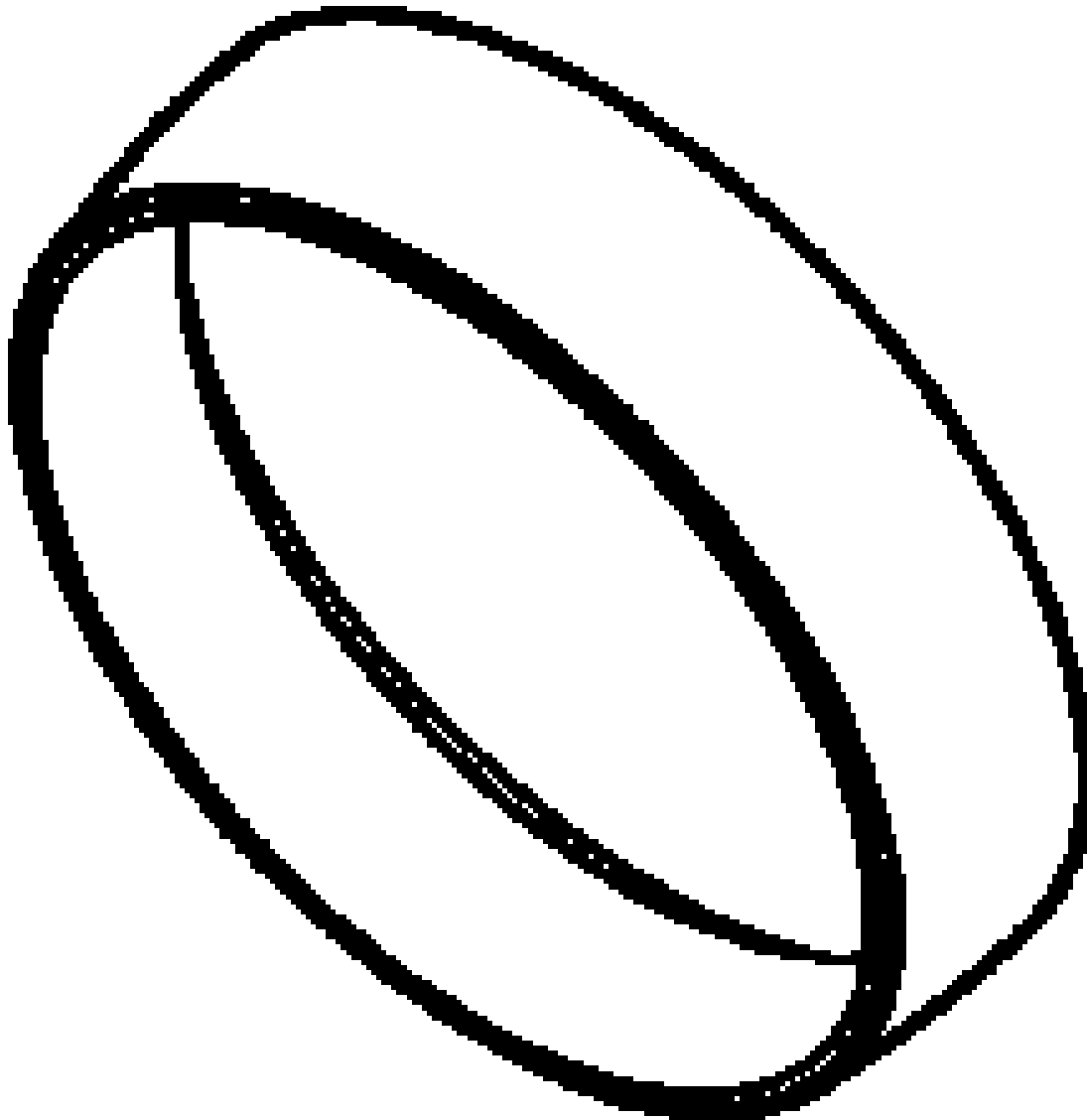
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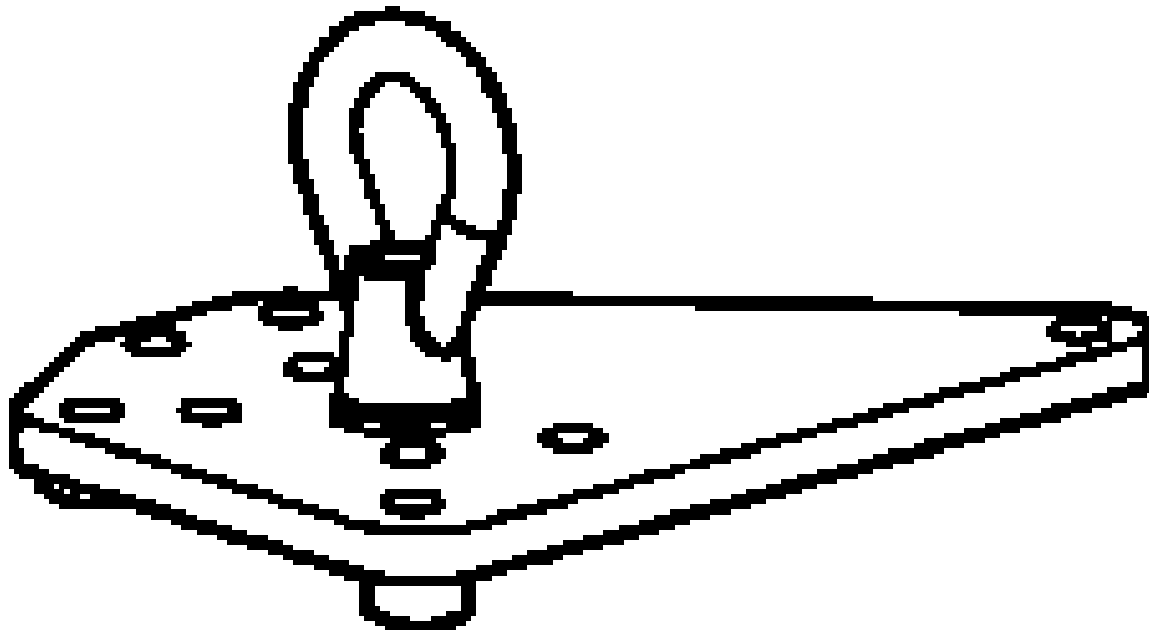
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Clutch Piston Sp
Compressor



DT-47805
Seal Protector

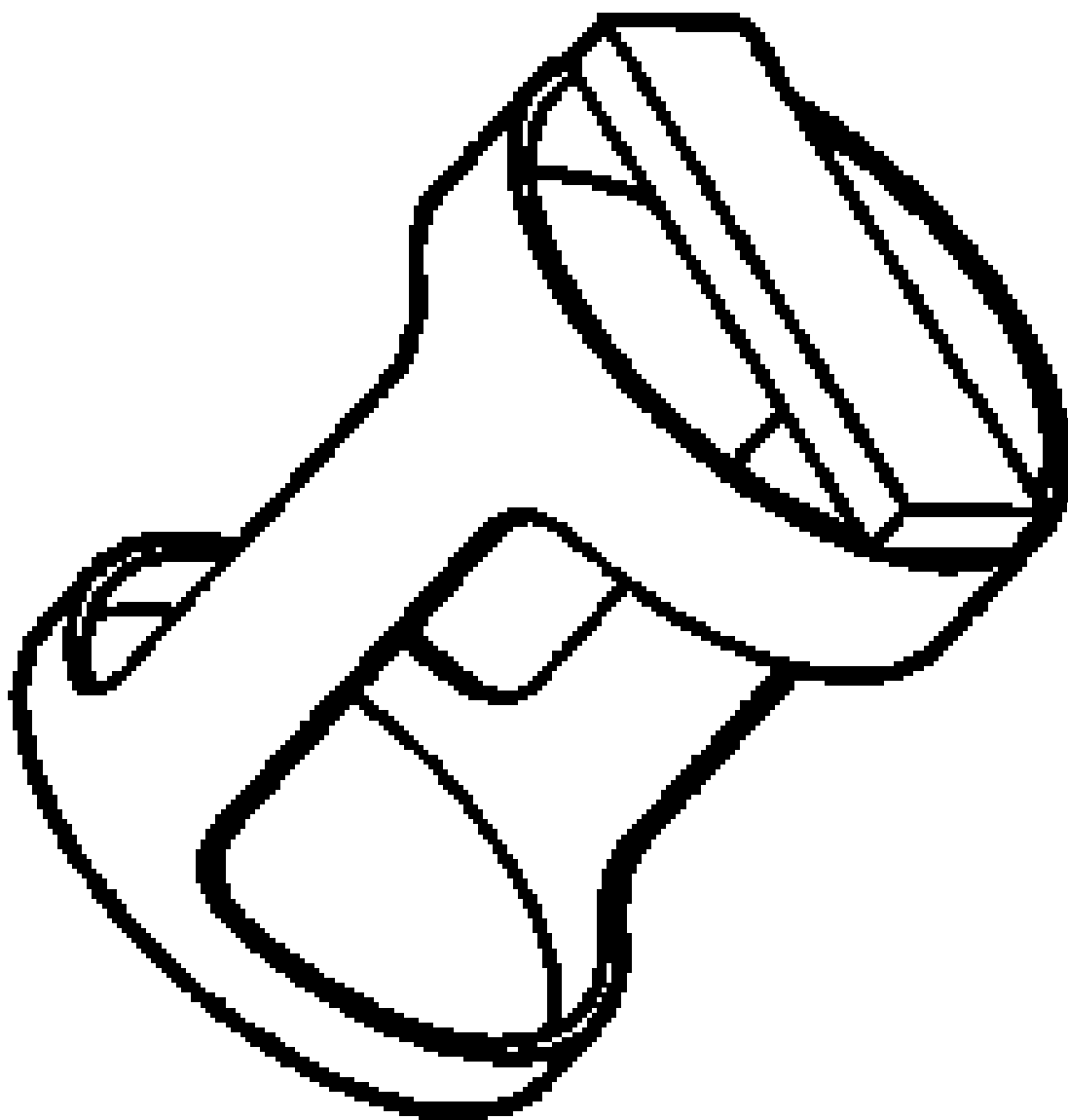


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Clutch Piston Set
Installer

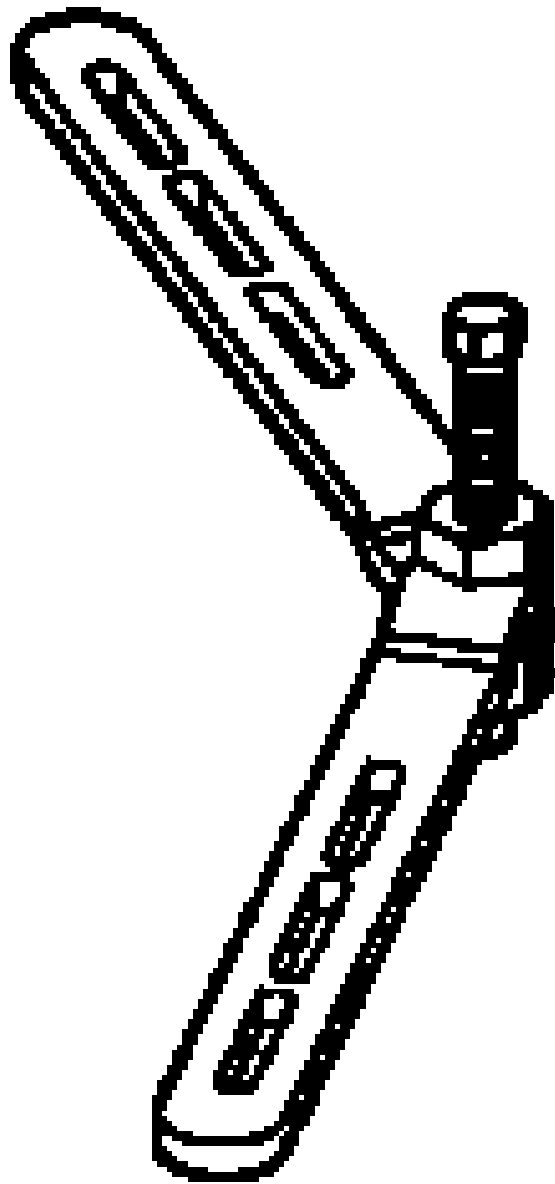


DT-47811-A
Lift Plate

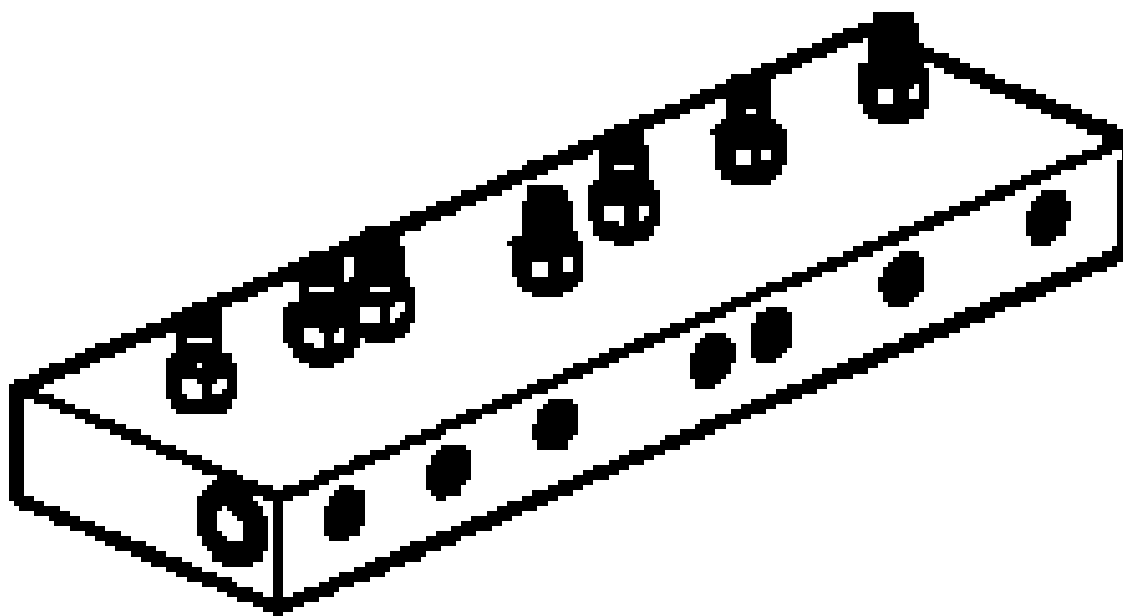
DT-47951-1
Seal Protector



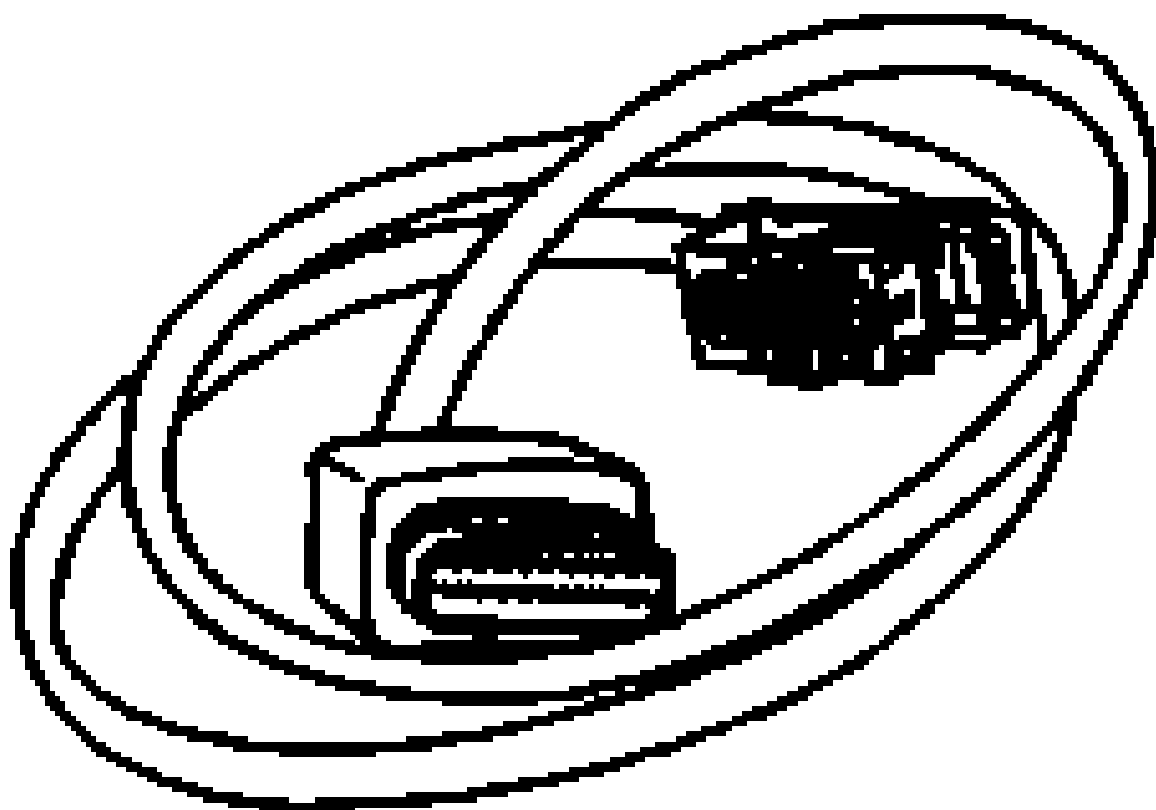
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Spring Compressor



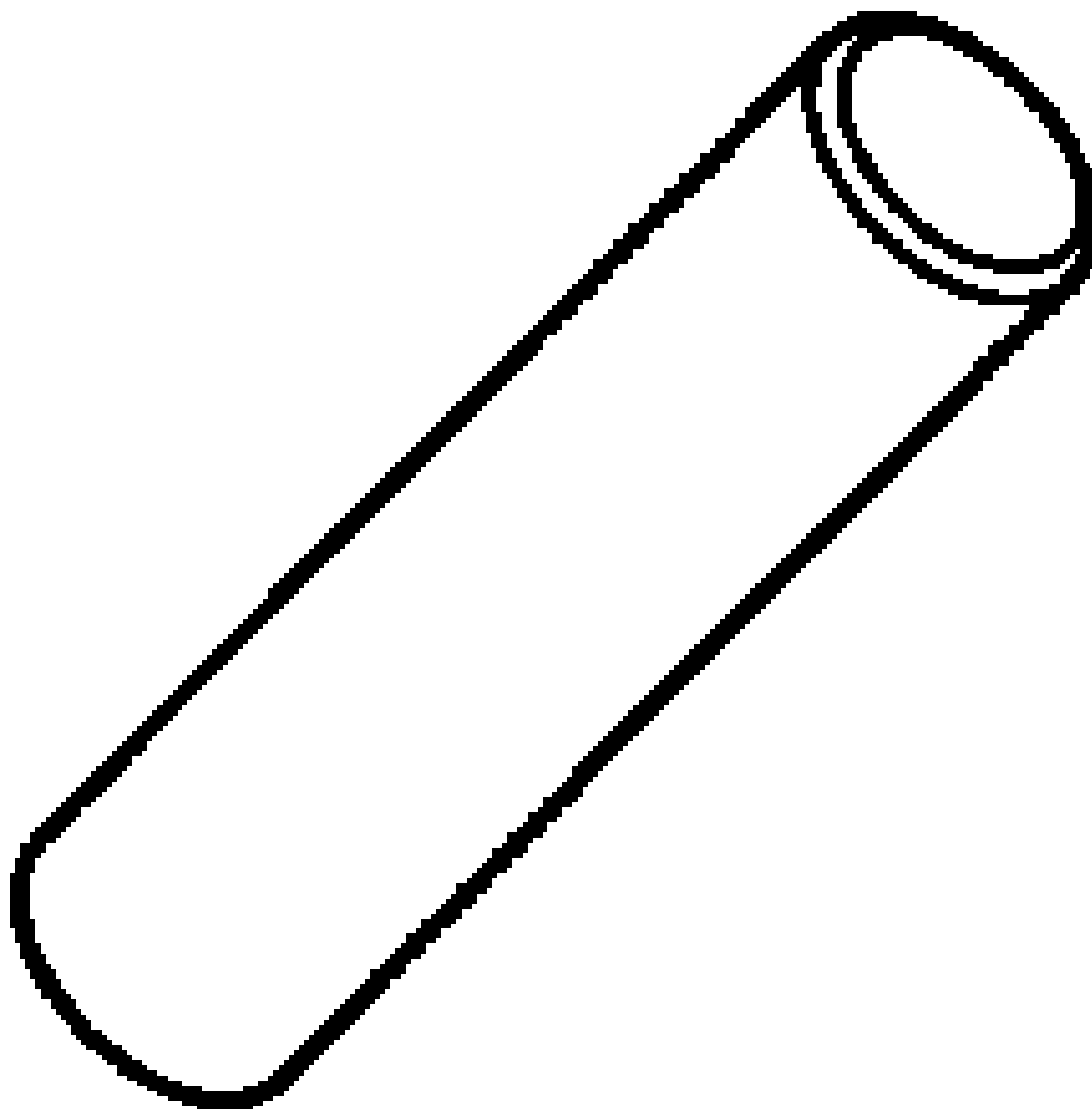
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Bridge



DT-48616
Control Solenoid
Test Plate

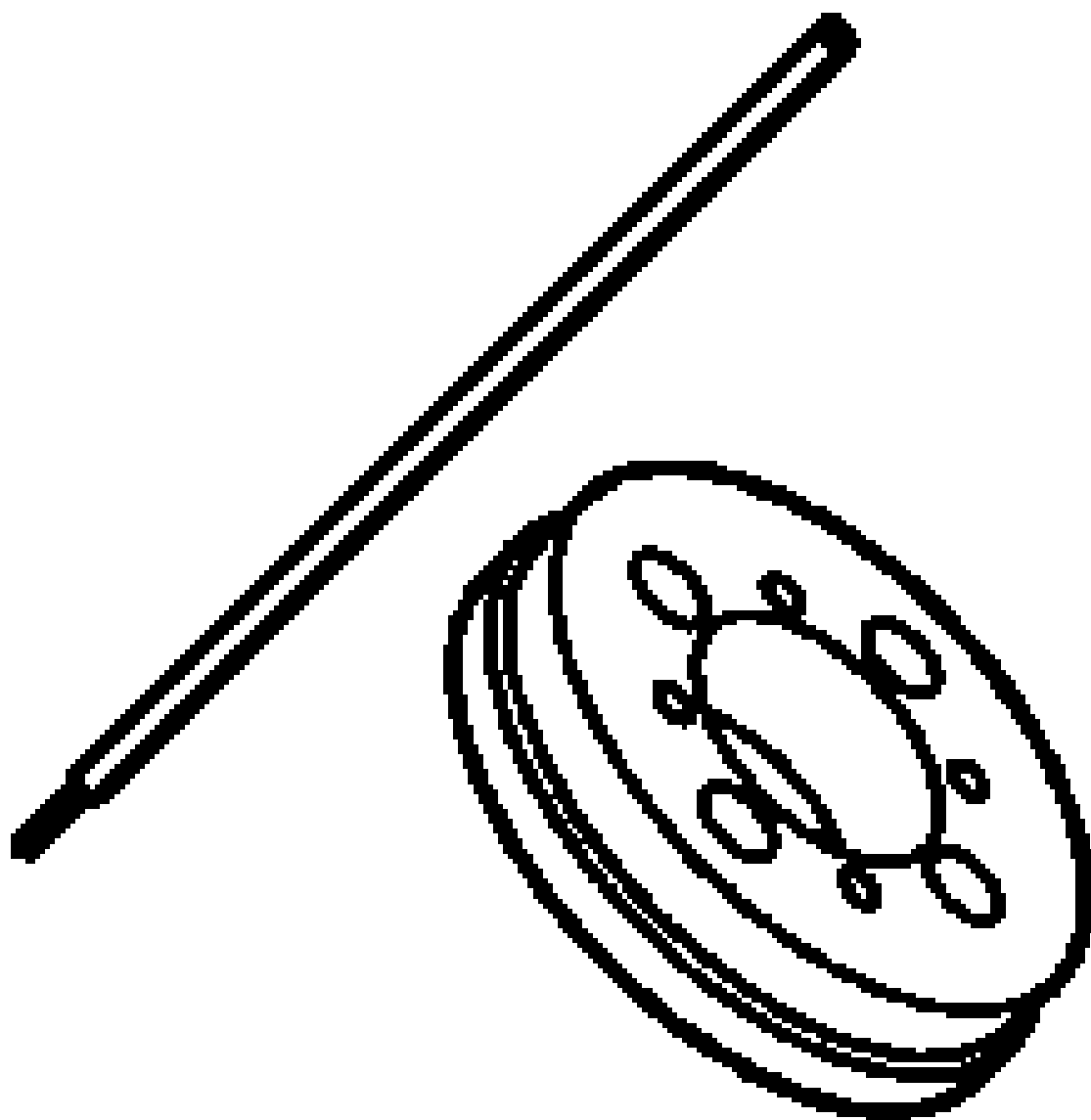


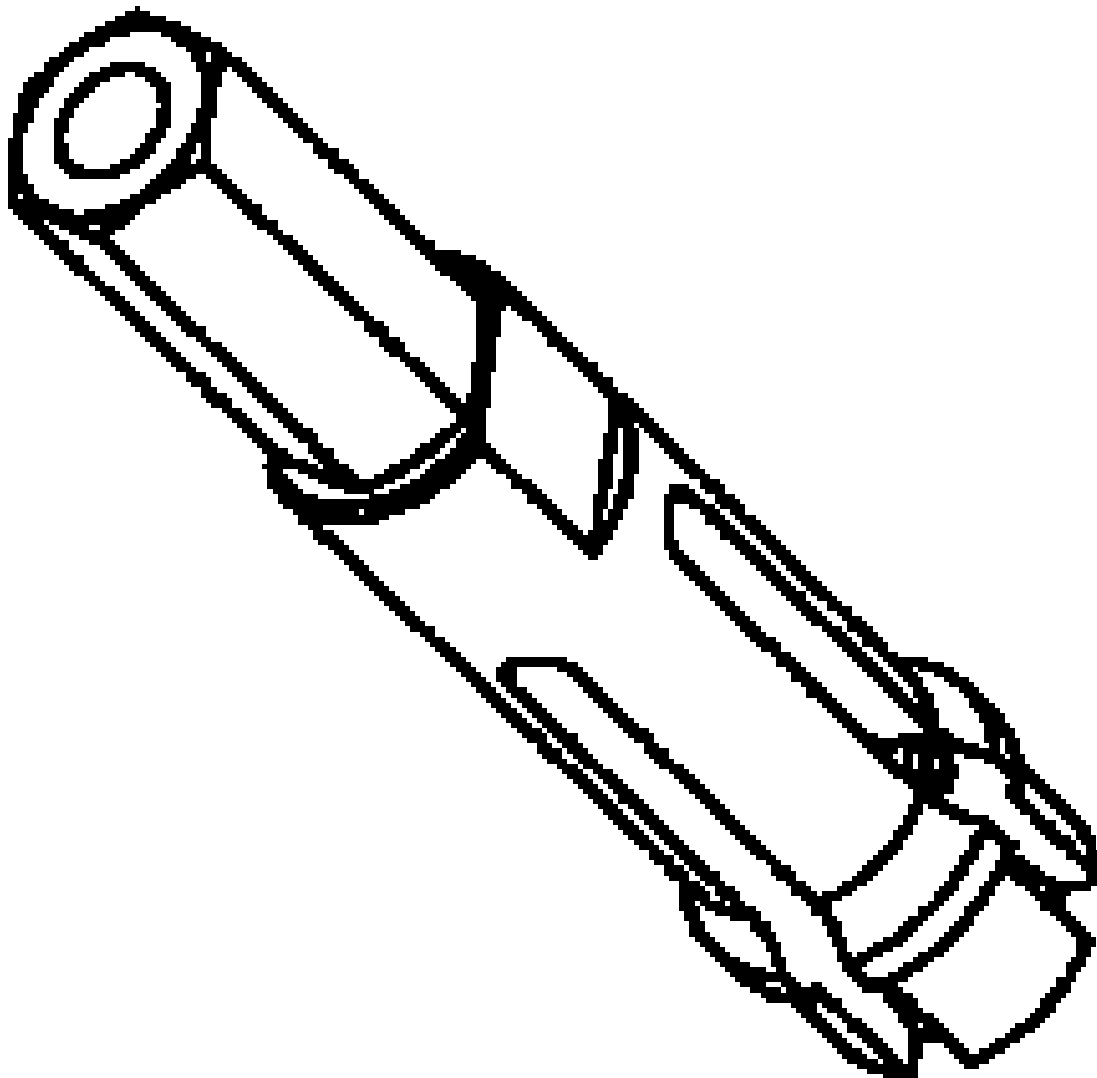
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DT-49101
Seal Installer

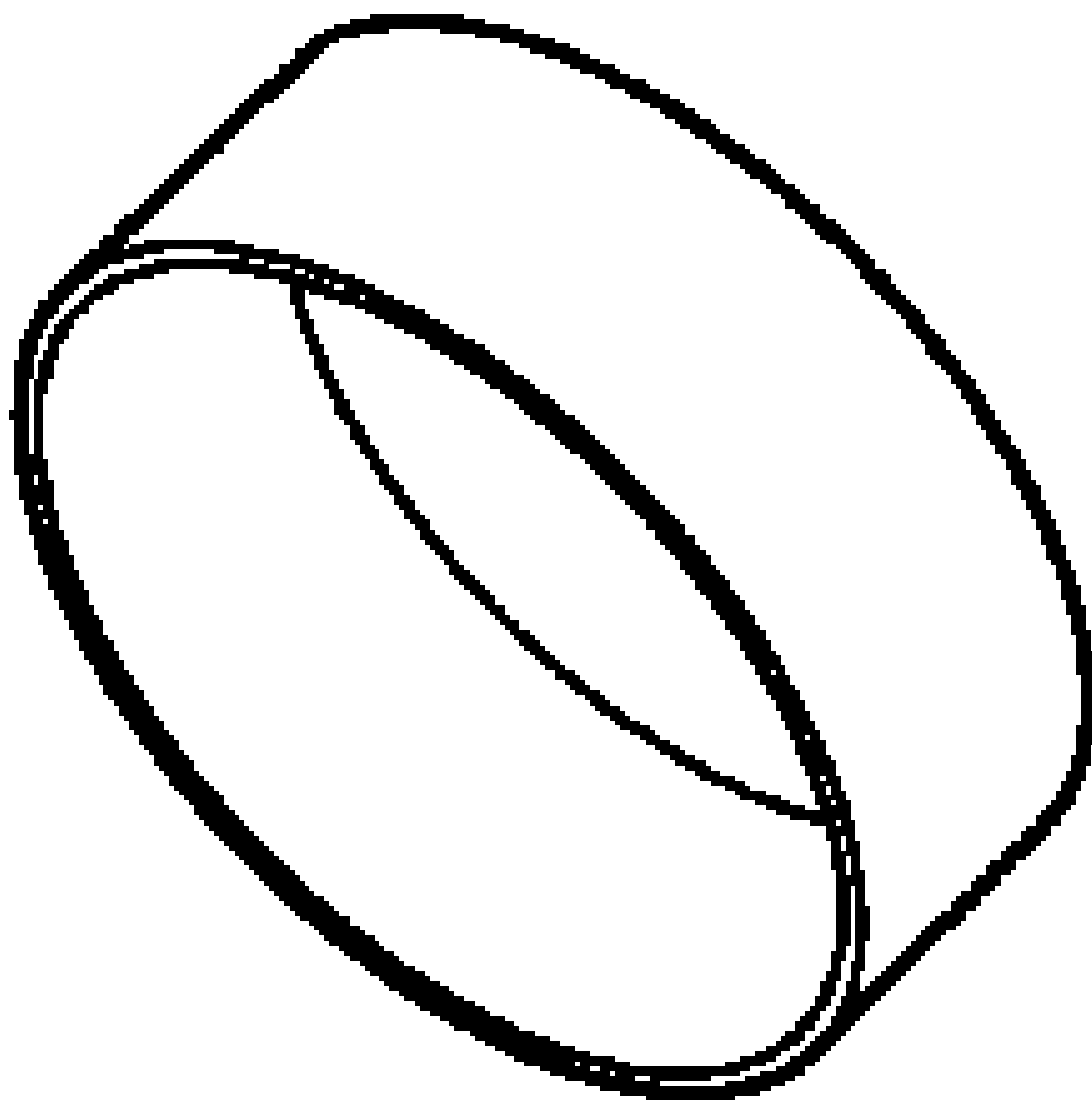
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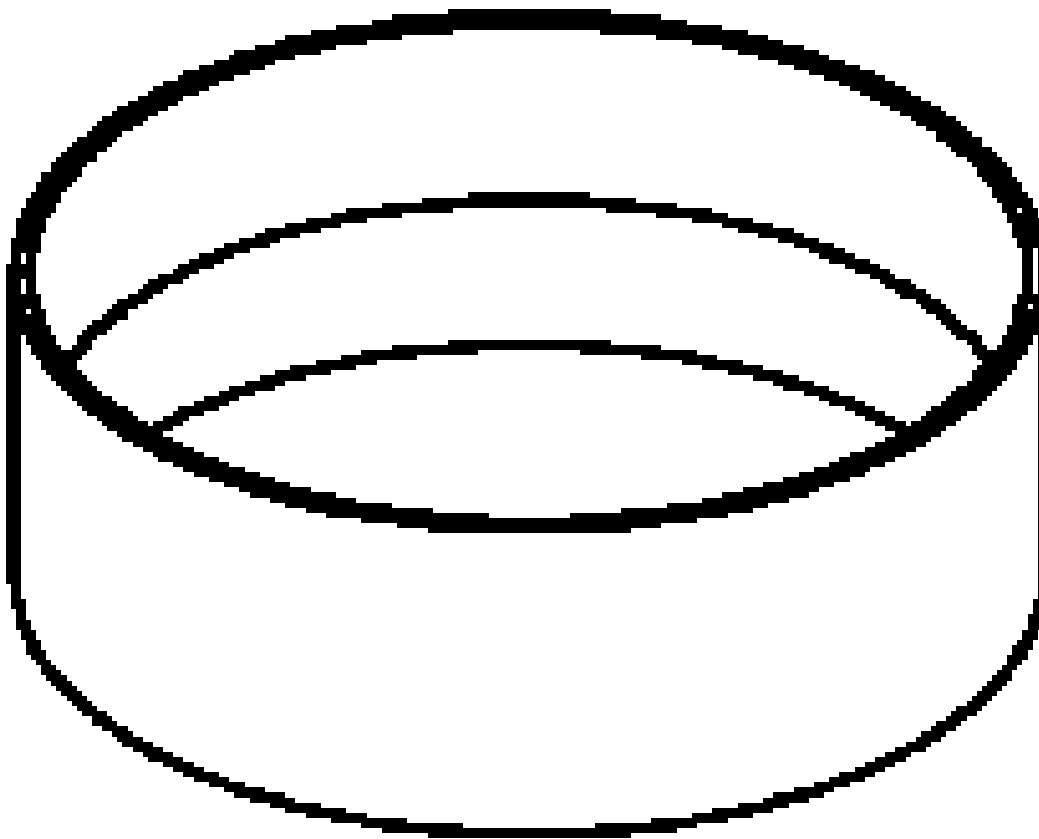




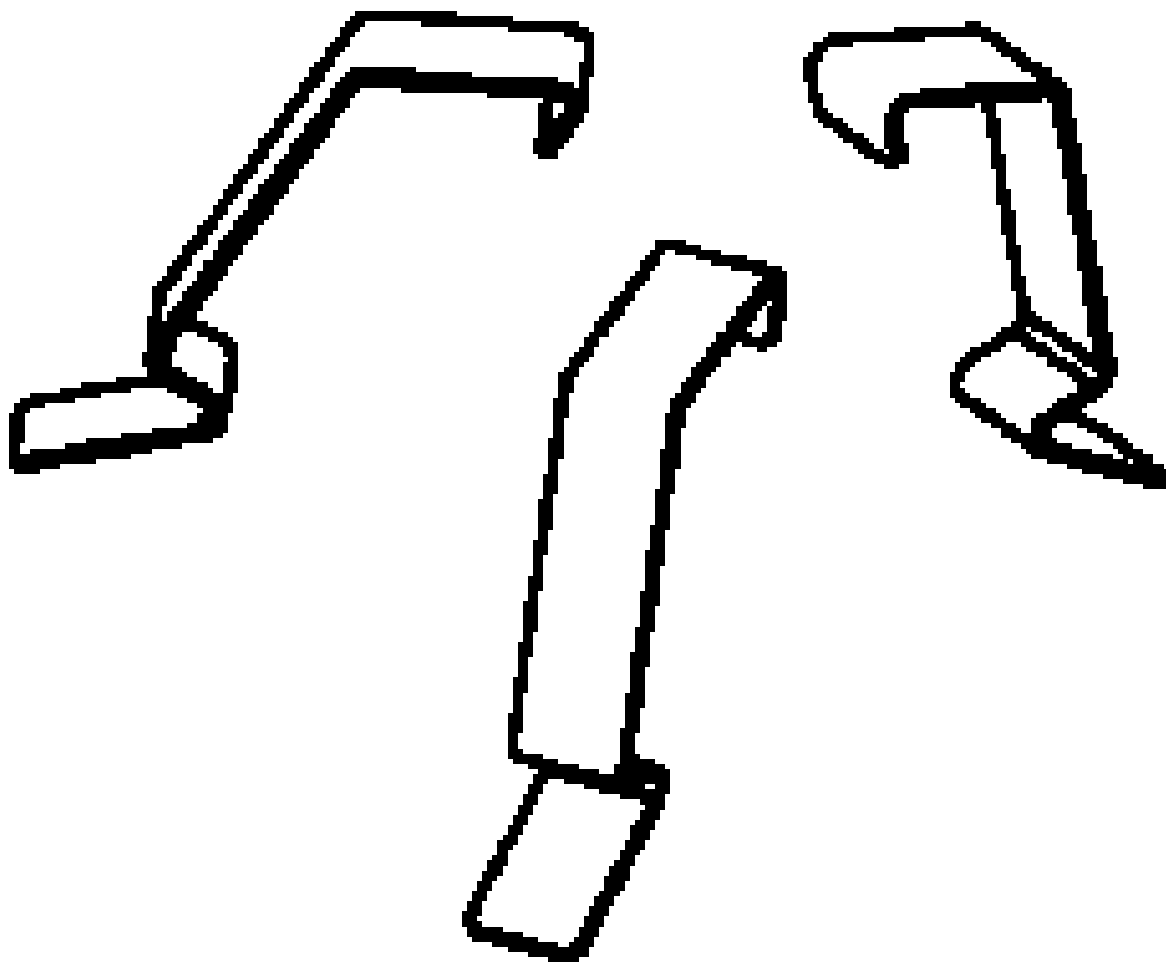
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Differential Rotat
Tool

DT-50117
Seal Installer

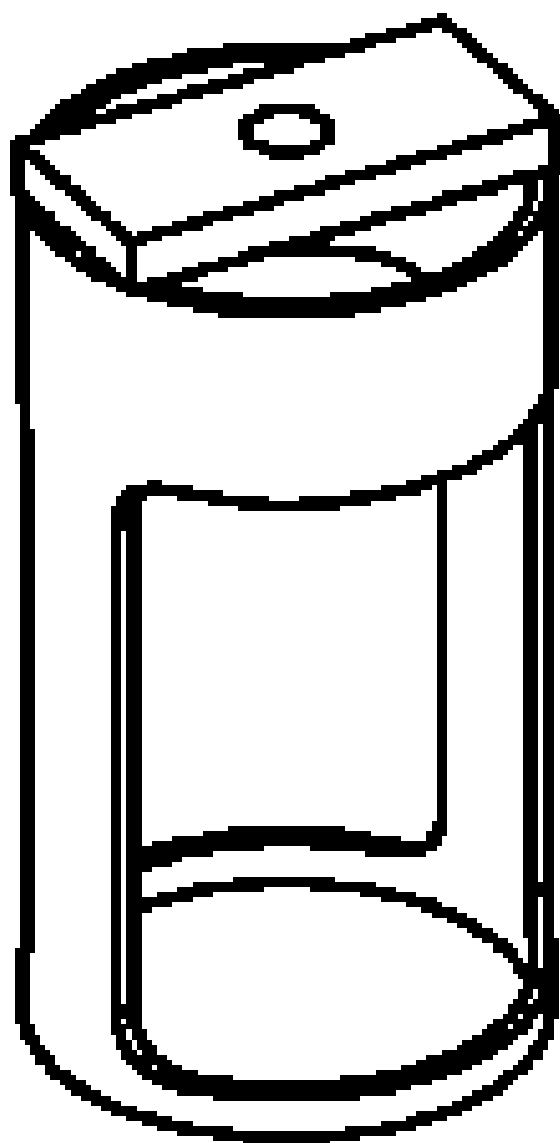




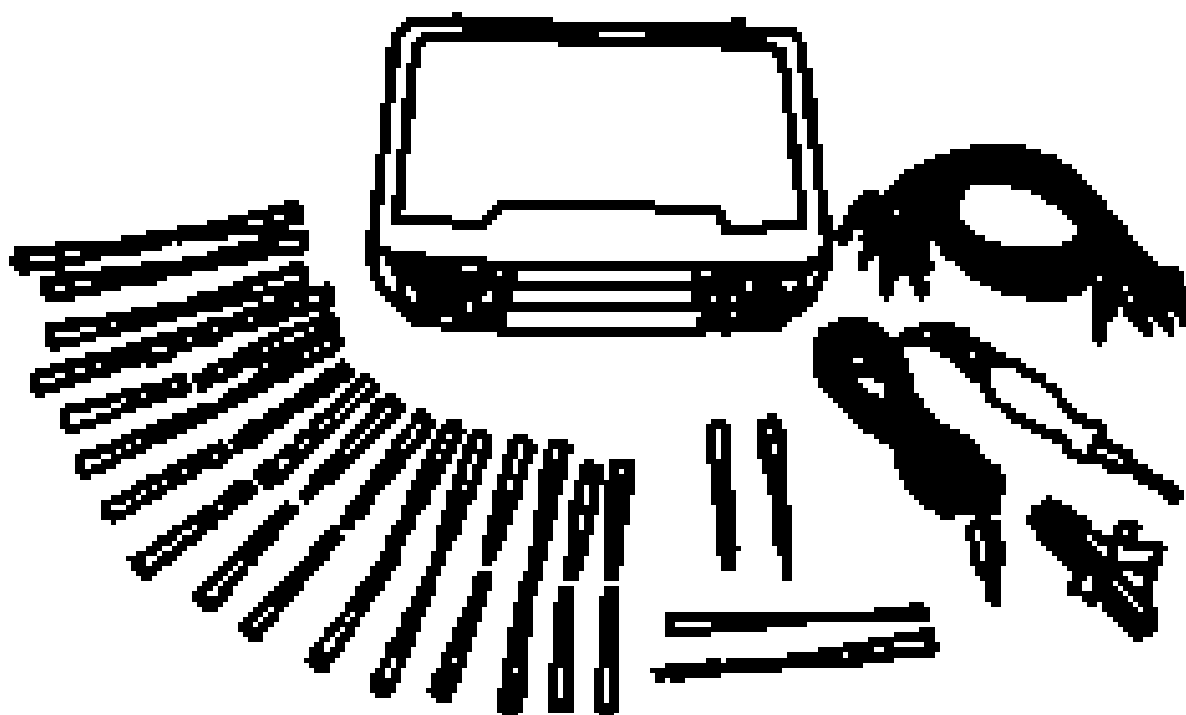
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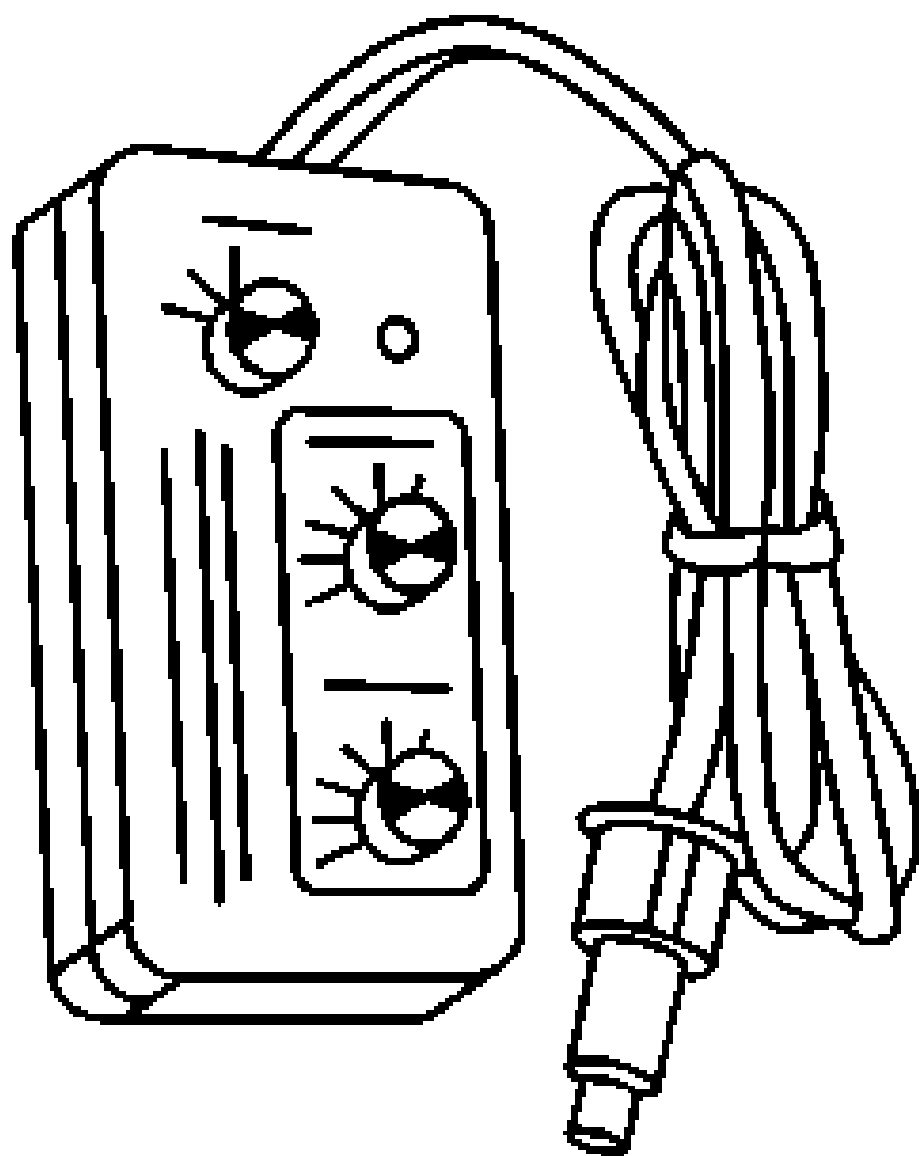
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Seal Protector
Retaining Clip



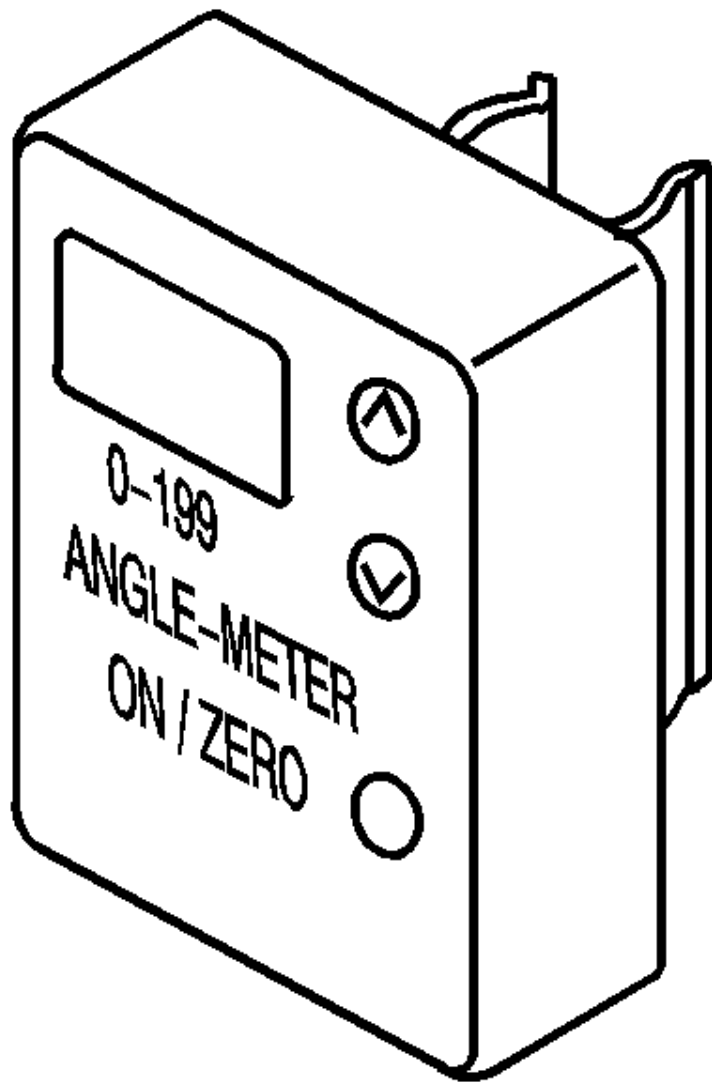
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Installer



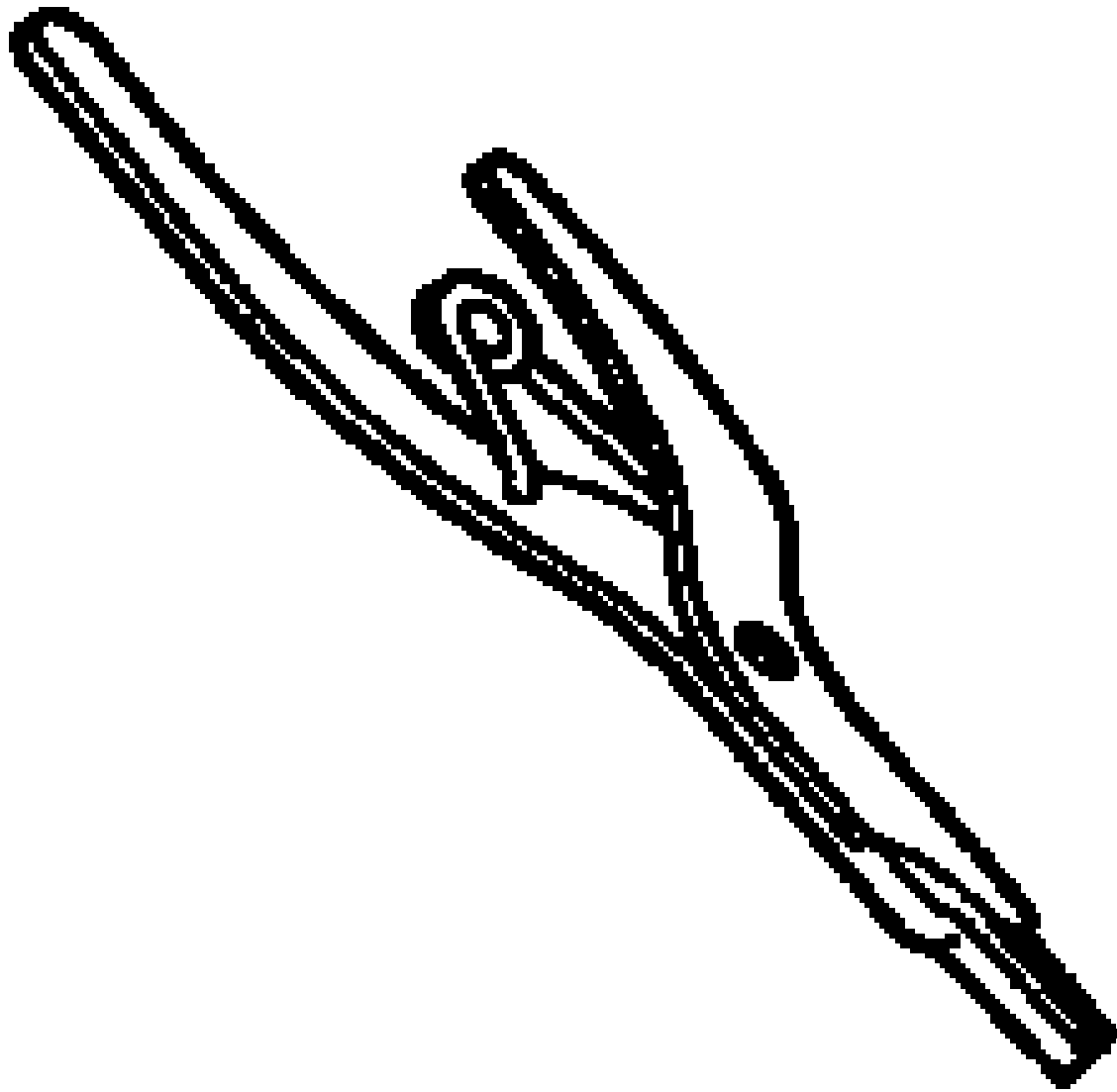
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J-35616
GM-Approved
Terminal Test Kit



EL-38522
J-38522
Variable Signal
Generator



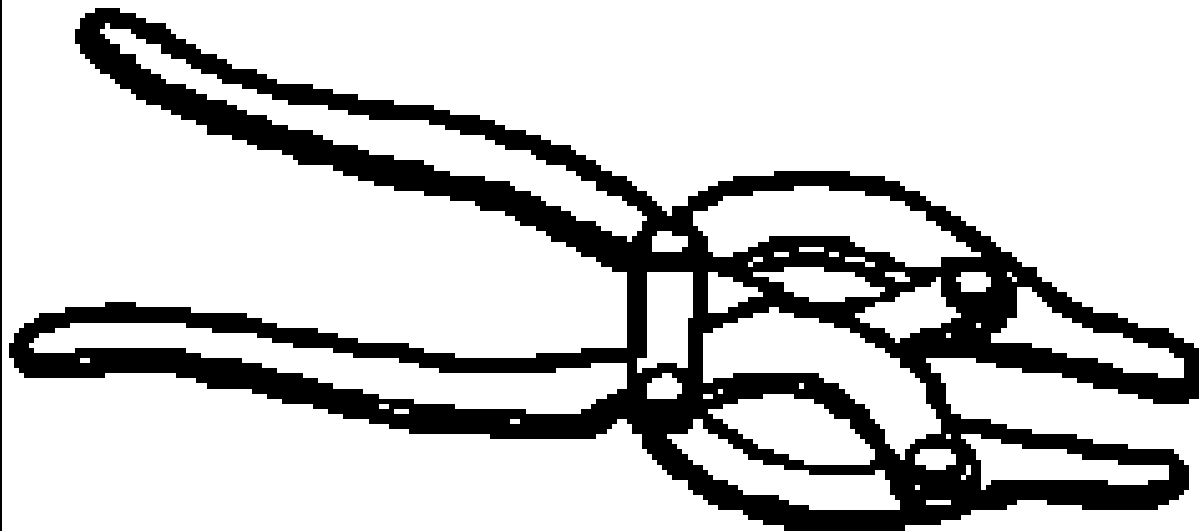
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J-45059
KM-470-B
Angle Meter



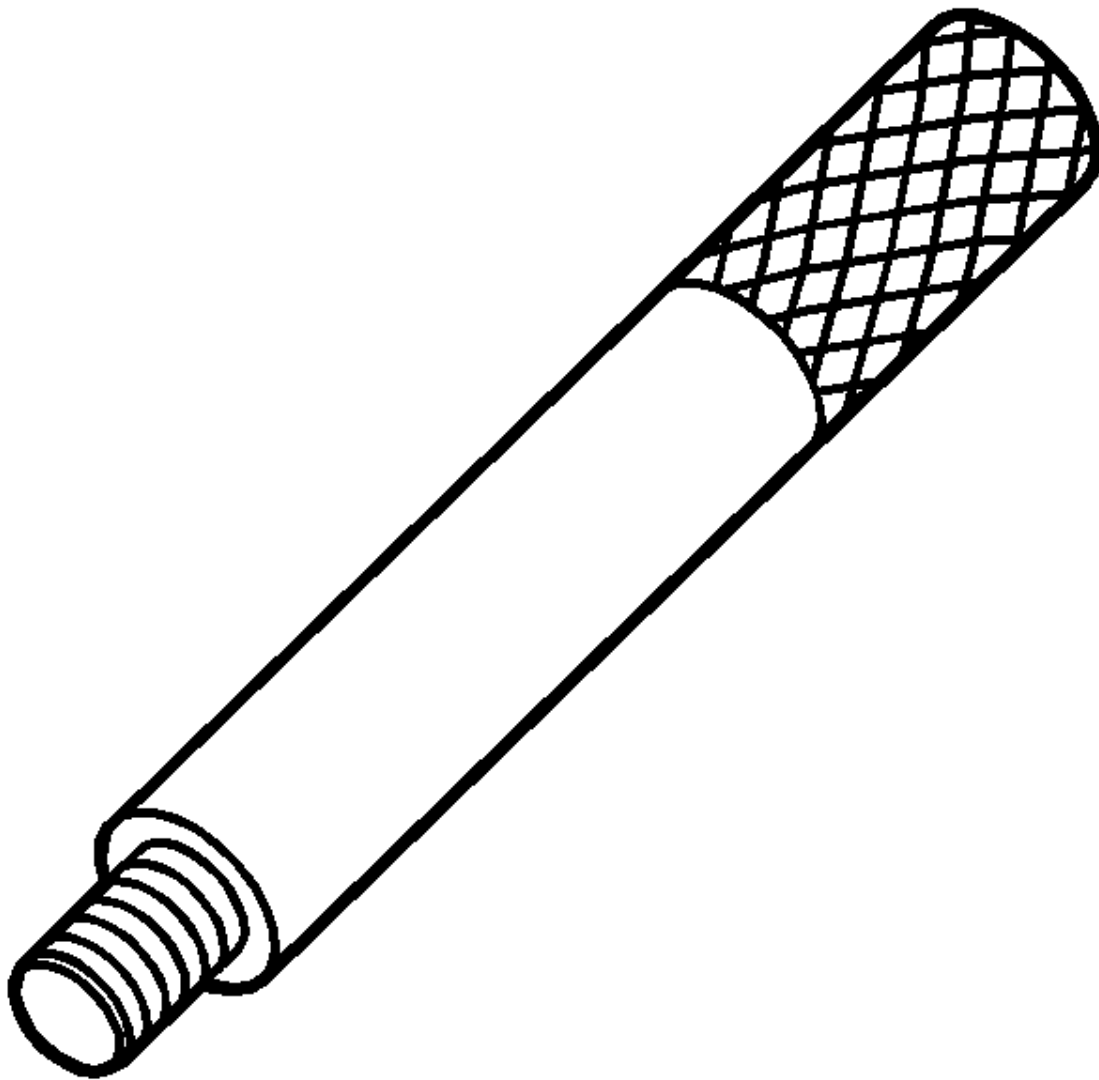
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J-5586-A
Snap Ring Pliers



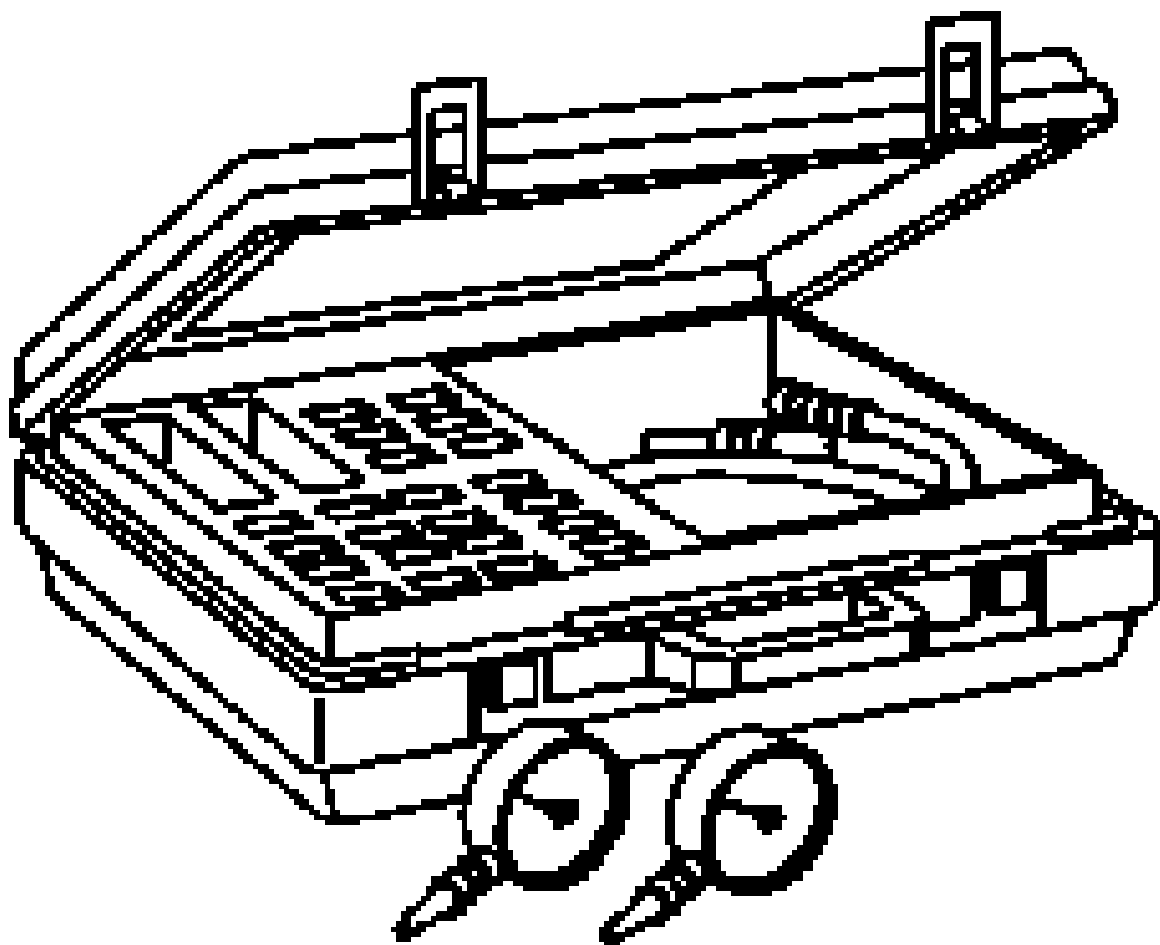
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J-6125-1B
KM-J-7004
Slide Hammer



GE-8059
J-8059
KM-396
Snap Ring Plier
Parallel Jaw



GE-8092
J-8092
KM-J-8092
Driver Handle



GE-21867-A
J-21867-A
Oil Pressure Gauge
Kit



GE-34673
J-34673
Flat Gauge Ba

Transmission

Automatic Transmission - 6T40 (MH8 MHH) - Specifications

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS (OFF VEHICLE)

Fastener Tightening Specifications (Off Vehicle)

Application	Ref No.*	Quantity	Size	Specification	
				Metric	English
A/Trans Auxiliary Fluid Pump Outlet Bolt (Hybrid Models)	350	4	-	22 N.m	16 lb ft
A/Trans Auxiliary Fluid Pump Bolt (Hybrid Models)	355	1	-	22 N.m	16 lb ft
A/Trans Auxiliary Fluid Pump (Pump to Motor) Bolt (Hybrid Models)	370	4	-	10-12 N.m	89-106 lb in
A/Trans Fluid Pump Bolt to Converter Housing					
• First Pass	200	7 - 6T30, 8 - 6T40/45/50	M8x33	10 N.m	89 lb in
• Final Pass	200		M8x33	45°	
A/Trans Fluid Pump Cover Bolt	302	3 - 6T30, 23 - 6T40/45/50	M6x25	12 N.m	106 lb in
A/Trans Fluid Pump Cover Bolt	320	20 - 6T30,	M6x21.5	12 N.m	106 lb in
Control Solenoid Valve Assembly (w/TCM and Body) to Case Bolt	4	12	M6x97	10 N.m	89 lb in
Control Solenoid Valve Assembly (w/TCM and Body) to Case Bolt	6	3	M5x40.5	7 N.m	62 lb in
Control Valve Body Assembly (Complete) Bolt	400	1	M5x40.5	7 N.m	62 lb in
Control Valve Body to Case Bolt	9	2	M6x53	11 N.m	97 lb in
Control Valve Body to Case Bolt	10	9	M6x60	11 N.m	97 lb in
Control Valve Body Cover Bolt	1	13	M6x30	12 N.m	106 lb in
Drain Plug	64	1	1/8"-27 NPTF	12 N.m	106 lb in
Fluid Level Hole Plug	63	1	1/8"-27 NPTF	12 N.m	106 lb in
Fluid Pressure Test Hole Plug	51	1	1/8"-27 NPTF	12 N.m	106 lb in

Front Differential Carrier Baffle Bolt - Converter Housing	204	2	M6x25	12 N.m	106 lb in
Front Differential Carrier Baffle Bolt - Case	61	2	M6x18.5 - 6T30, M6x16 - 6T40/45/50	12 N.m	106 lb in
Input Shaft Support Bolt	57	3	M6x50	12 N.m	106 lb in
Input Speed Sensor Bolt	21	1	M6x23	9 N.m	80 lb in
Manual Shift Detent Spring	17	1	M6x16	12 N.m	106 lb in
Output Speed Sensor Bolt	15	1	M6x18	9 N.m	80 lb in
Torque Converter and Differential Housing Bolt					
• First Pass	27	14 - 6T30, 15 - 6T40/45/50	M8x30	10 N.m	89 lb in
• Final Pass	27		M8x30	50°	
*Reference number refers to the component callout number in Disassembled Views					

FASTENER TIGHTENING SPECIFICATIONS (ON VEHICLE)

Fastener Tightening Specifications (On Vehicle)

Application	Specification	
	Metric	English
A/Trans Control Bolt	9	80 lb in
A/Trans Flex Plate Bolt	60	45 lb ft
Rear Trans Brace Bolt - Inboard	50	37 lb ft
Rear Trans Brace Bolt - Outboard	100	74 lb ft
Torque Converter to Flywheel Bolt	60	45 lb ft
Transmission Bolt (1, 2, 3) - 6T40	75	55 lb ft
Transmission Bolt (4, 5) - 6T40	50	37 lb ft
Transmission Bolt (1, 2, 3, 4) - 6T45	75	55 lb ft
Transmission Bolt (5) - 6T45	50	37 lb ft
Transmission Fluid Cooler Outlet Pipe Nut	22	17 lb ft
Transmission Fluid Cooler Pipe Inlet Nut	22	17 lb ft
Transmission Front Mount Through Bolt	100	74 lb ft
Transmission Front Mount to Transmission Bolts	62	46 lb ft
Transmission Mount Bolt - Left Side to Frame Rail	22	16 lb ft
Transmission Mount Bolt - Left Side to Transmission	50 + 60-75°	37 lb ft + 60-75°
Transmission Mount Nut - Left Side to Body	22	16 lb ft
Transmission Rear Mount Through Bolt	105	747 lb ft
Transmission Rear Mount to Cradle	100 + 120-130°	74 lb ft + 120-130°
Transmission Rear Mount to Transmission	100	74 lb ft
Transmission Range Selector Cable Bracket Bolt	18	14 lb ft
Transmission Range Selector Lever Nut	20	15 lb ft

TRANSMISSION GENERAL SPECIFICATIONS (6T40/6T45/6T50)

Transmission General Specifications (6T40/6T45/6T50)

Name	6T40/6T45/6T50
RPO Codes	MH8, MH7, MHK, MHH, MHC, MHJ, MNH, MHB
Production Location	Korea/China/Mexico/Toledo
Transmission Drive	Front Wheel Drive
Reverse Gear Ratio	2.94
1st Gear Ratio	4.584
2nd Gear Ratio	2.964
3rd Gear Ratio	1.912
4th Gear Ratio	1.446
5th Gear Ratio	1.000
6th Gear Ratio	0.746
Effective Final Drive Gear Ratio	2.64/2.89/3.23/3.53/3.87
Torque Converter Size- Diameter of Torque Converter Turbine	236 mm
Pressure Taps Line	Pressure
Transmission Fluid Type	DEXRON VI®
Transmission Fluid Capacity	8.0 L/8.5 Quarts
Transmission Type: 6	Six Forward Gears
Transmission Type: T	Transverse Mount
Transmission Type: 40/45/50	Product Series
Position Quadrant	P, R, N, D, * *(Refer to the applicable owner's manual)
Case Material	Die Cast Aluminum
Transmission Net Weight	81/86 kg (178/190 lbs)
Maximum Trailer Towing Capacity	N/A
Maximum Gross Vehicle Weight (GVW)	6T40 - 2000 kg (4,409 lbs) 6T45 - 2200 kg (4,850 lbs) 6T50 - 2500 kg (5,511 lbs)

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Automatic Transmission Fluid	DEXRON®VI	88861037	19264717
Torque Converter Bolts	Threadlock	12345382	10953489

FLUID CAPACITY SPECIFICATIONS (6T40/45/50)

Fluid Capacity Specifications (6T40/45/50)

	Specification
--	---------------

Application	Metric	English
Valve Body Cover Removal - Approximate Capacity	5.0-7.0 liters	5.3-7.4 quarts
Fluid Change - Drain Plug - Approximate Capacity	4.0-6.0 liters	4.2- 6.3 quarts
Overhaul - Approximate Capacity	8.0-8.5 liters	8.5-9.0 quarts

FLUID PUMP SELECTIVE SPECIFICATIONS

Fluid Pump Selective Specifications

Fluid Pump Body Pocket Depth		Fluid Pump Gear Thickness	
Metric	English	Metric	English
12.617-12.625 mm	0.4967-0.4970 in	12.580-12.588 mm	0.4952-0.4955 in
12.626-12.636 mm	0.4970-0.4974 in	12.589-12.599 mm	0.4956-0.4960 in
12.637-12.645 mm	0.4975-0.4978 in	12.600-12.608 mm	0.4960-0.4963 in

RANGE REFERENCE

Range Reference

Range	Park	Reverse	Neutral	Drive						
				1st Braking	1st	2nd	3rd	4th	5th	6th
1-2-3-4 Clutch	-	-	-	Applied	Applied	Applied	Applied	Applied	-	-
3-5 Reverse Clutch	-	Applied	-	-	-	-	Applied	-	Applied	-
4-5-6 Clutch	-	-	-	-	-	-	-	Applied	Applied	Applied
2-6 Clutch	-	-	-	-	-	Applied	-	-	-	Applied
Low and Reverse Clutch	Applied*	Applied	Applied*	Applied	-	-	-	-	-	-
Low Clutch Assembly (OWL)	-	-	-	Holding	Holding	-	-	-	-	-

* = Applied with NO load

SHIFT SOLENOID VALVE STATE AND GEAR RATIO

Shift Solenoid Valve State and Gear Ratio

Gear	Shift SOL 1	1-2-3-4 CL PC SOL 5 N.L.	2-6 CL PC SOL 4 N.L.	3-5 REV CL PC SOL 2 N.H.	LOW REV 4-5-6 CL PC SOL 3 N.H.	Gear Ratio 6T30	Gear Ratio 6T40/45/50

Park	ON	OFF	OFF	OFF	ON	-	-
Reverse	ON	OFF	OFF	ON	ON	2.87	2.940
Neutral	ON	OFF	OFF	OFF	ON	-	-
1st Braking	ON	ON	OFF	OFF	ON	4.449	4.584
1st	OFF	ON	OFF	OFF	OFF	4.449	4.584
2nd	OFF	ON	ON	OFF	OFF	2.908	2.964
3rd	OFF	ON	OFF	ON	OFF	1.893	1.912
4th	OFF	ON	OFF	OFF	ON	1.446	1.446
5th	OFF	OFF	OFF	ON	ON	1.000	1.000
6th	OFF	OFF	ON	OFF	ON	0.742	0.746
For shift solenoid 1, "ON" = Solenoid Energized (Pressurized) "OFF" = Solenoid De-energized (No Pressure).							
For pressure control solenoids, "ON" = Pressurized, "OFF" = No Pressure							

TRANSMISSION INTERNAL MODE SWITCH LOGIC

Transmission Internal Mode Switch Logic

Gear Selector Position	Signal A	Signal B	Signal C	Signal P
Park	LOW	HI	HI	LOW
Park/Reverse	LOW	LOW	HI	LOW
Reverse	LOW	LOW	HI	HI
Reverse/Neutral	HI	LOW	HI	HI
Neutral	HI	LOW	HI	LOW
Neutral/Drive 6	HI	LOW	LOW	LOW
Drive 6	HI	LOW	LOW	HI
Drive 6/Drive 4	LOW	LOW	LOW	HI
Drive 4/M	LOW	LOW	LOW	LOW
Drive 4/Drive 3	LOW	HI	LOW	LOW
Drive 3	LOW	HI	LOW	HI
Drive 3/Drive 2	HI	HI	LOW	HI
Drive 2	HI	HI	LOW	LOW
Open	HI	HI	HI	HI
Invalid	HI	HI	HI	LOW
Invalid	LOW	HI	HI	HI
HI = Ignition voltage				
LOW = 0 volts				

SOLENOID VALVE PRESSURE (GEN 1)

Line PC Solenoid Valve Pressure

Requested Pressure (kPa)	Actual Pressure	
	Metric	English

None	345-550 kPa	50-80 psi
200	690-900 kPa	100-130 psi
400	1100-1310 kPa	160-190 psi
600	1520-1725 kPa	220-250 psi
800	1860-2275 kPa	270-330 psi
1000	1860-2275 kPa	270-330 psi
1200	1860-2275 kPa	270-330 psi
1400	1860-2275 kPa	270-330 psi
1600	1860-2275 kPa	270-330 psi
1800	1860-2275 kPa	270-330 psi
2000	1860-2275 kPa	270-330 psi

SOLENOID VALVE PRESSURE (GEN 2)

Line PC Solenoid Valve Pressure

Requested Pressure (kPa)	Actual Pressure	
	Metric	English
None	172-379 kPa	25-55 psi
200	662-869 kPa	96-126 psi
400	1145-1351 kPa	166-196 psi
600	1634-1841 kPa	237-267 psi
800	2117-2324 kPa	307-337 psi
1000	2117-2324 kPa	307-337 psi
1200	2117-2324 kPa	307-337 psi
1400	2117-2324 kPa	307-337 psi
1600	2117-2324 kPa	307-337 psi
1800	2117-2324 kPa	307-337 psi

TRANSMISSION PARTS KIT SPECIFICATIONS

A/Trans Seal Kit (Gen 1& 2) 24251028

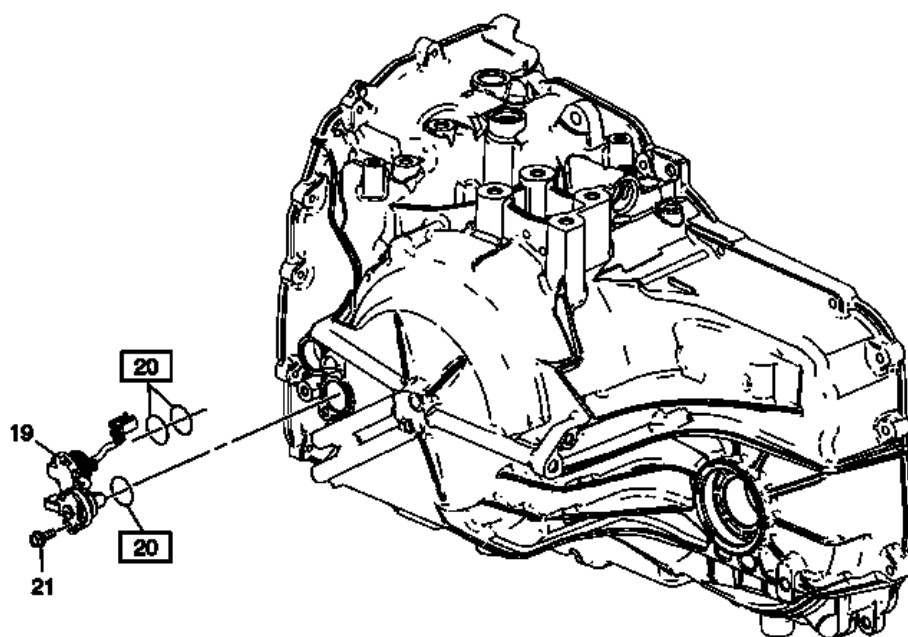


Fig. 1: Automatic Trans Seal Kit (Gen 1 And 2) 24251028

Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

A/Trans Seal Kit (Gen 1& 2) 24251028

Callout	Quantity	Component Name
20	3	A/Trans Input Speed Sensor Assembly O-Ring Seal

Front Wheel Seal Kit (Gen 1& 2) 19258415

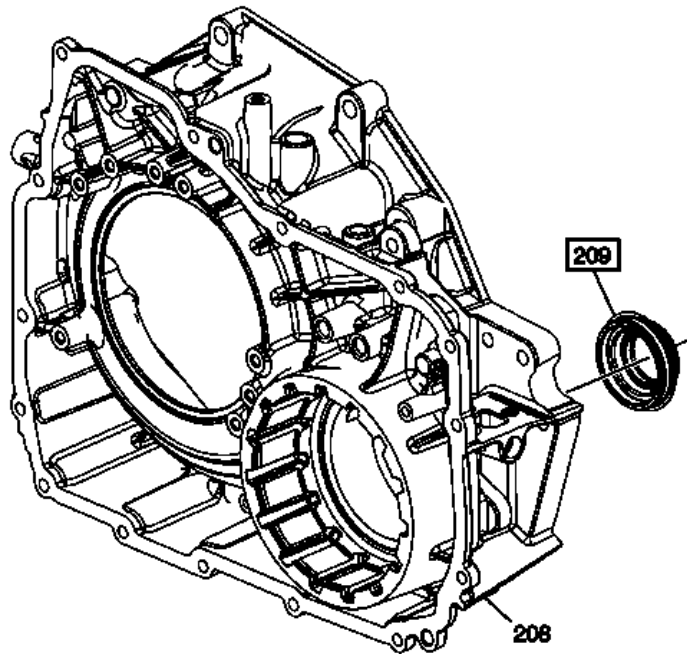


Fig. 2: Front Wheel Seal Kit (Gen 1 And 2) 19258415
Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

Front Wheel Seal Kit (Gen 1& 2) 19258415

Callout	Quantity	Component Name
209	1	Front Wheel Drive Shaft Oil Seal Assembly

Front Wheel Seal Kit (Gen 1& 2) 19258416

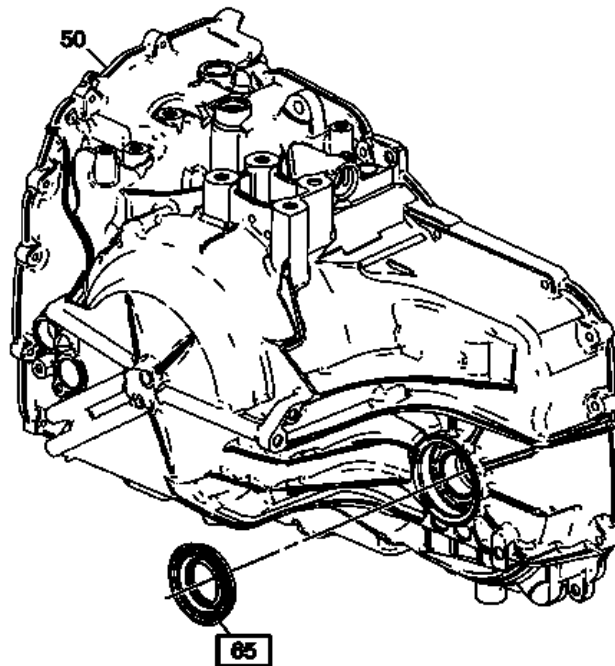


Fig. 3: Front Wheel Seal Kit (Gen 1 And 2) 19258416
Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

Front Wheel Seal Kit (Gen 1& 2) 19258416

Callout	Quantity	Component Name
65	1	Drive Shaft Oil Seal Assembly

A/Trans Seal Kit (Gen 1) 24251353 (1 of 2)

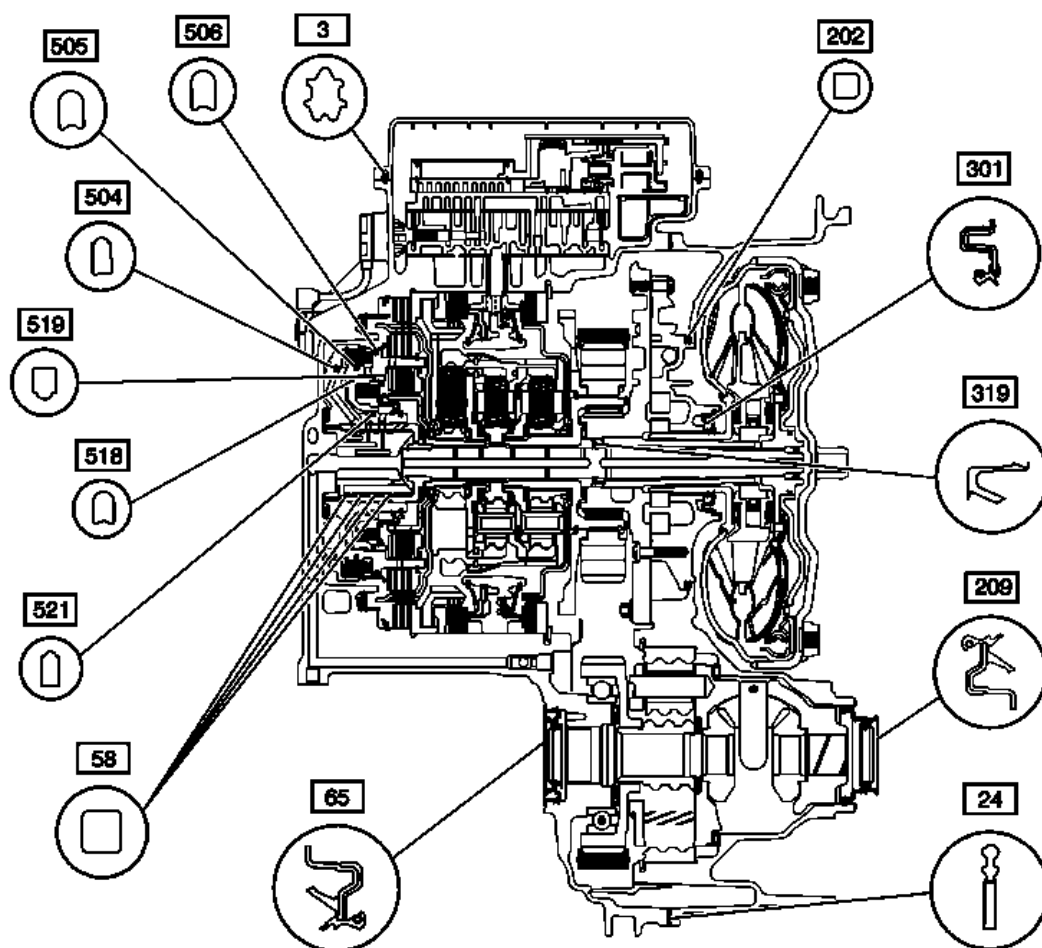


Fig. 4: Automatic Trans Seal Kit (Gen 1) 24251353 (1 Of 2)
 Courtesy of GENERAL MOTORS COMPANY

A/Trans Seal Kit (Gen 1) 24251353 (1 of 2)

Callout	Quantity	Component Name
3	1	Control Valve Body Cover Gasket
24	1	Torque Converter Housing Gasket
58	4	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
65	1	Drive Shaft Oil Seal Assembly
202	1	Torque Converter and Differential Housing Seal
209	1	Front Wheel Drive Shaft Oil Seal Assembly
301	1	Torque Converter Fluid Seal Assembly
319	1	Torque Converter Fluid Seal Assembly
504	1	3-5-Reverse Clutch Piston Inner Seal
505	1	3-5-Reverse Clutch Piston Inner Seal
506	1	3-5-Reverse Clutch Piston Dam Seal
518	1	4-5-6 Clutch Piston Outer Seal

519	1	4-5-6 Clutch Piston Outer Seal
521	1	4-5-6 Clutch Piston Inner Seal

A/Trans Seal Kit (Gen 1) 24251353 (2 of 2)

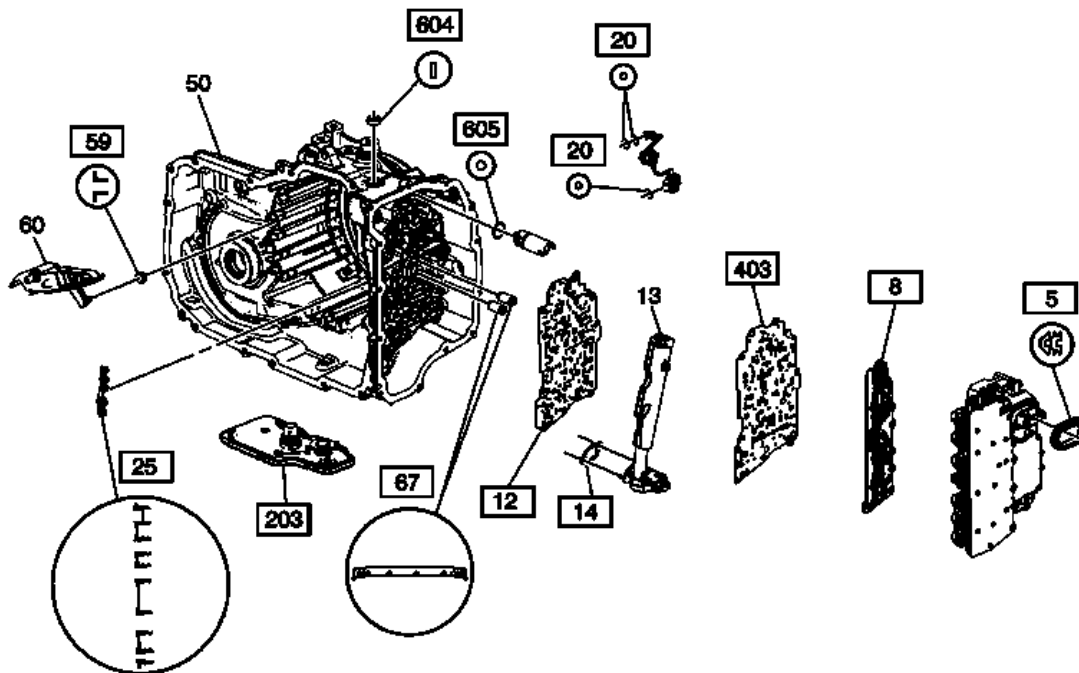


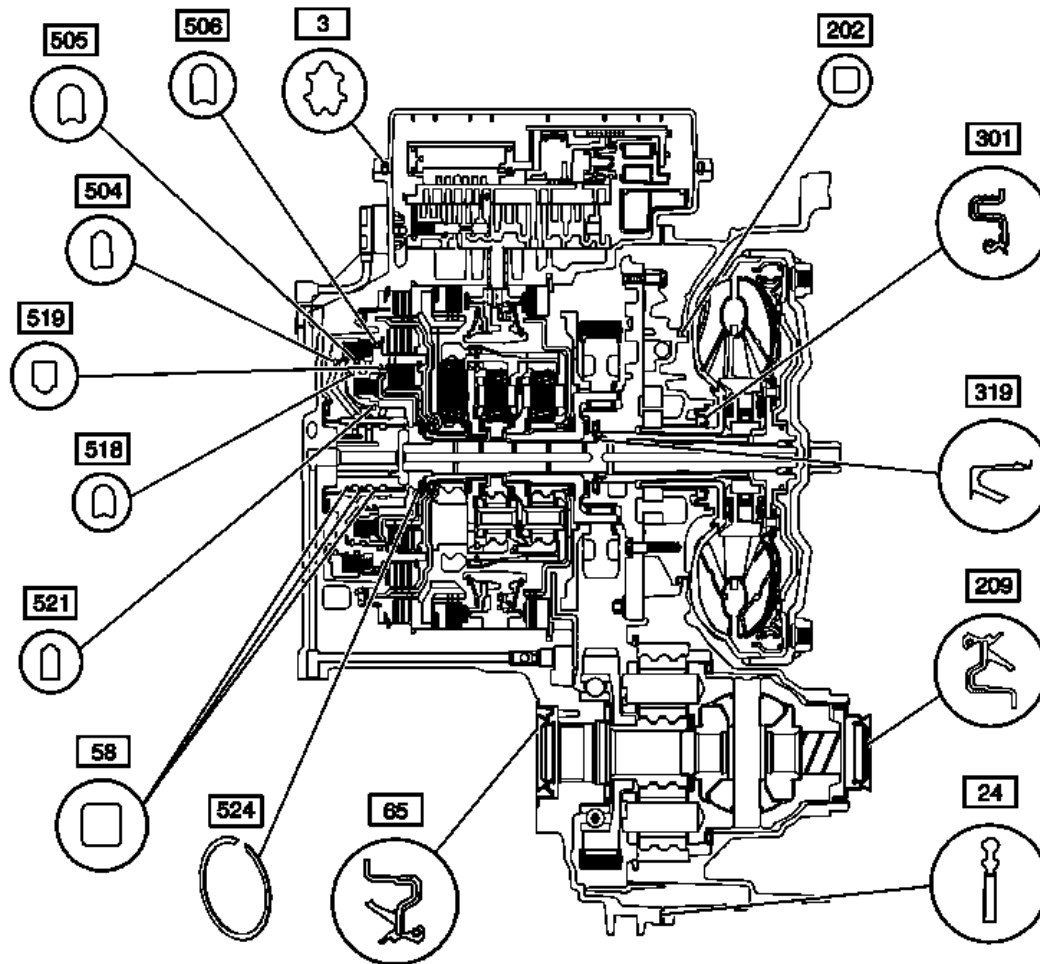
Fig. 5: Automatic Trans Seal Kit (Gen 1) 24251353 (2 Of 2)
Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

A/Trans Seal Kit (Gen 1) 24251353 (2 of 2)

Callout	Quantity	Component Name
5	1	Control Valve Body Cover Hole Seal
8	1	Control Valve Body Filter Plate Assembly
12	1	Control Valve Body Spacer Plate Assembly
14	1	A/Trans Fluid Level Control Valve Gasket
20	3	A/Trans Input Speed Sensor Assembly O-Ring Seal
25	1	A/Trans Fluid Pump Seal Assembly
59	1	Drive Link Lube Fluid Seal
67	1	1-2-3-4 and Low Reverse Clutch Fluid Passage Seal
203	1	A/Trans Fluid Filter Assembly
403	1	Channel Plate to Valve Body Spacer Plate Assembly
604	1	Manual Shift Shaft Seal

A/Trans Seal Kit (Gen 2) 24260603 (1 of 2)

**Fig. 6: Automatic Trans Seal Kit (Gen 2) 24260603 (1 Of 2)**

Courtesy of GENERAL MOTORS COMPANY

A/Trans Seal Kit (Gen 2) 24260603 (1 of 2)

Callout	Quantity	Component Name
3	1	Control Valve Body Cover Gasket
24	1	Torque Converter Housing Gasket
58	3	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
65	1	Drive Shaft Oil Seal Assembly
202	1	Torque Converter and Differential Housing Seal
209	1	Front Wheel Drive Shaft Oil Seal Assembly
301	1	Torque Converter Fluid Seal Assembly
319	1	Torque Converter Fluid Seal Assembly
504	1	3-5-Reverse Clutch Piston Inner Seal

505	1	3-5-Reverse Clutch Piston Inner Seal
506	1	3-5-Reverse Clutch Piston Dam Seal
518	1	4-5-6 Clutch Piston Outer Seal
519	1	4-5-6 Clutch Piston Outer Seal
521	1	4-5-6 Clutch Piston Inner Seal
524	1	4-5-6 Clutch Piston Fluid Dam Retainer Ring

A/Trans Seal Kit (Gen 2) 24260603 (2 of 2)

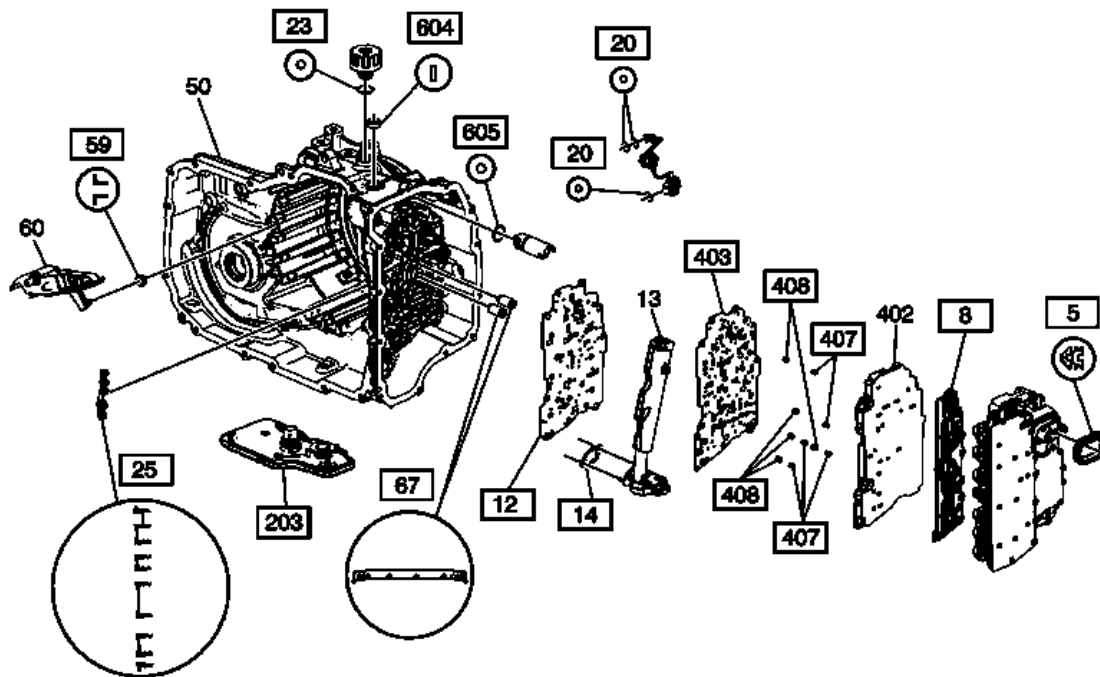


Fig. 7: Automatic Trans Seal Kit (Gen 2) 24260603 (2 Of 2)

Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

A/Trans Seal Kit (Gen 2) 24260603 (2 of 2)

Callout	Quantity	Component Name
5	1	Control Valve Body Cover Hole Seal
8	1	Control Valve Body Filter Plate Assembly
12	1	Control Valve Body Spacer Plate Assembly
14	1	A/Trans Fluid Level Control Valve Gasket
20	3	A/Trans Input Speed Sensor Assembly O-Ring Seal
23	1	Fill Cap Seal
25	1	A/Trans Fluid Pump Seal Assembly

59	1	Drive Link Lube Fluid Seal
67	1	1-2-3-4 and Low Reverse Clutch Fluid Passage Seal
203	1	A/Trans Fluid Filter Assembly
403	1	Channel Plate to Valve Body Spacer Plate Assembly
407	5	Actuator Feed Accumulator Spring
408	5	Actuator Feed Accumulator Piston
604	1	Manual Shift Shaft Seal
605	1	Park Pawl Actuator Guide Seal

Transmission Kit (Gen 1) 24260701

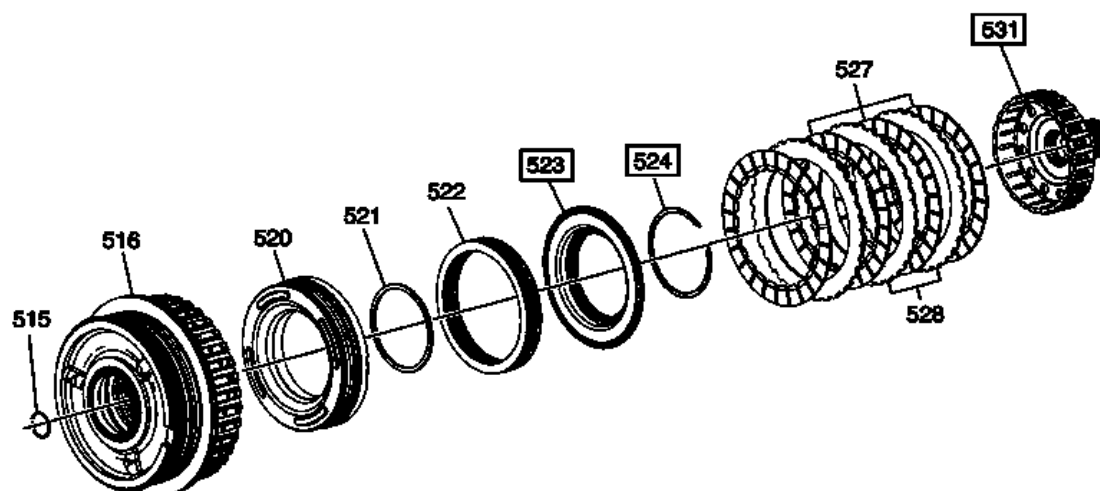


Fig. 8: Transmission Kit (Gen 1) 24260701

Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

Transmission Kit (Gen 1) 24260701

Callout	Quantity	Component Name
523	1	4-5-6 Clutch Piston Fluid Dam Assembly
524	1	4-5-6 Clutch Piston Fluid Dam Retainer Ring
531	1	Reaction Carrier Hub Assembly

Control Valve Body Kit (Gen 1) 24248473

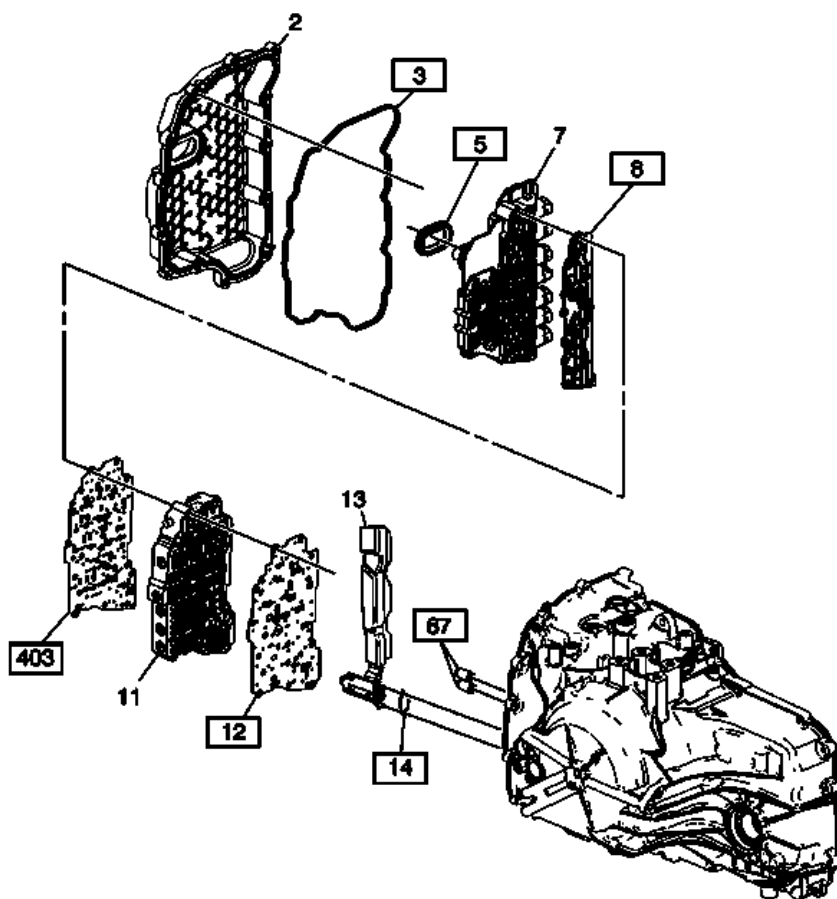


Fig. 9: Control Valve Body Kit (Gen 1) 24248473

Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.

Control Valve Body Kit (Gen 1) 24248473

Callout	Quantity	Component Name
3	1	Control Valve Body Cover Gasket
5	1	Control Valve Body Cover Hole Seal
8	1	Control Valve Body Filter Plate Assembly
12	1	Control Valve Body Spacer Plate Assembly
14	1	A/Trans Fluid Level Control Valve Gasket
67	2	1-2-3-4 and Low Reverse Clutch Fluid Passage Seal
403	1	Channel Plate to Valve Body Spacer Plate Assembly

Control Valve Body Kit (Gen 2) 24260702

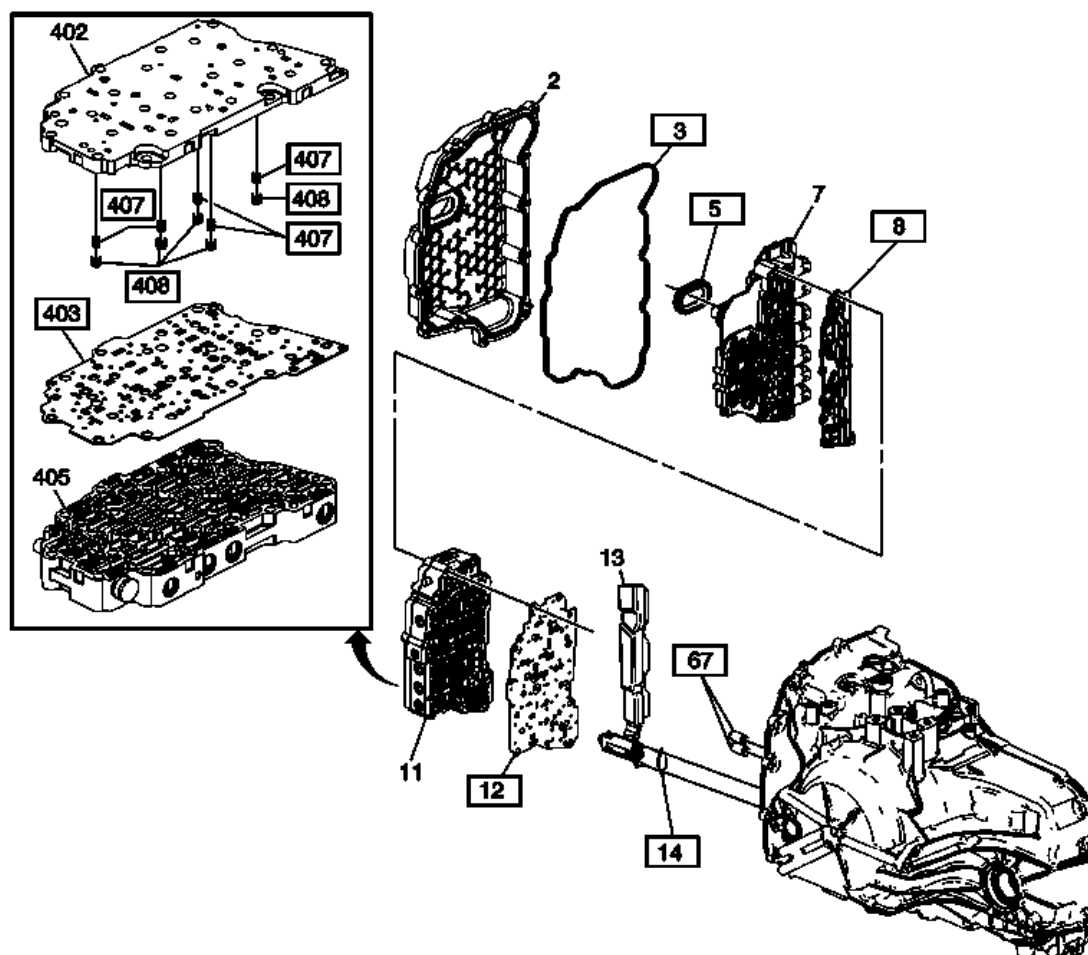


Fig. 10: Control Valve Body Kit (Gen 2) 24260702
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
 Callouts without boxes are shown for relationship purposes only.

Control Valve Body Kit (Gen 2) 24260702

Callout	Quantity	Component Name
3	1	Control Valve Body Cover Gasket
5	1	Control Valve Body Cover Hole Seal
8	1	Control Valve Body Filter Plate Assembly
12	1	Control Valve Body Spacer Plate Assembly
14	1	A/Trans Fluid Level Control Valve Gasket
67	2	1-2-3-4 and Low Reverse Clutch Fluid Passage Seal
403	1	Channel Plate to Valve Body Spacer Plate Assembly
407	5	Actuator Feed Accumulator Spring
408	5	Actuator Feed Accumulator Piston

Clutch Plate Package (Gen 1) 24249460

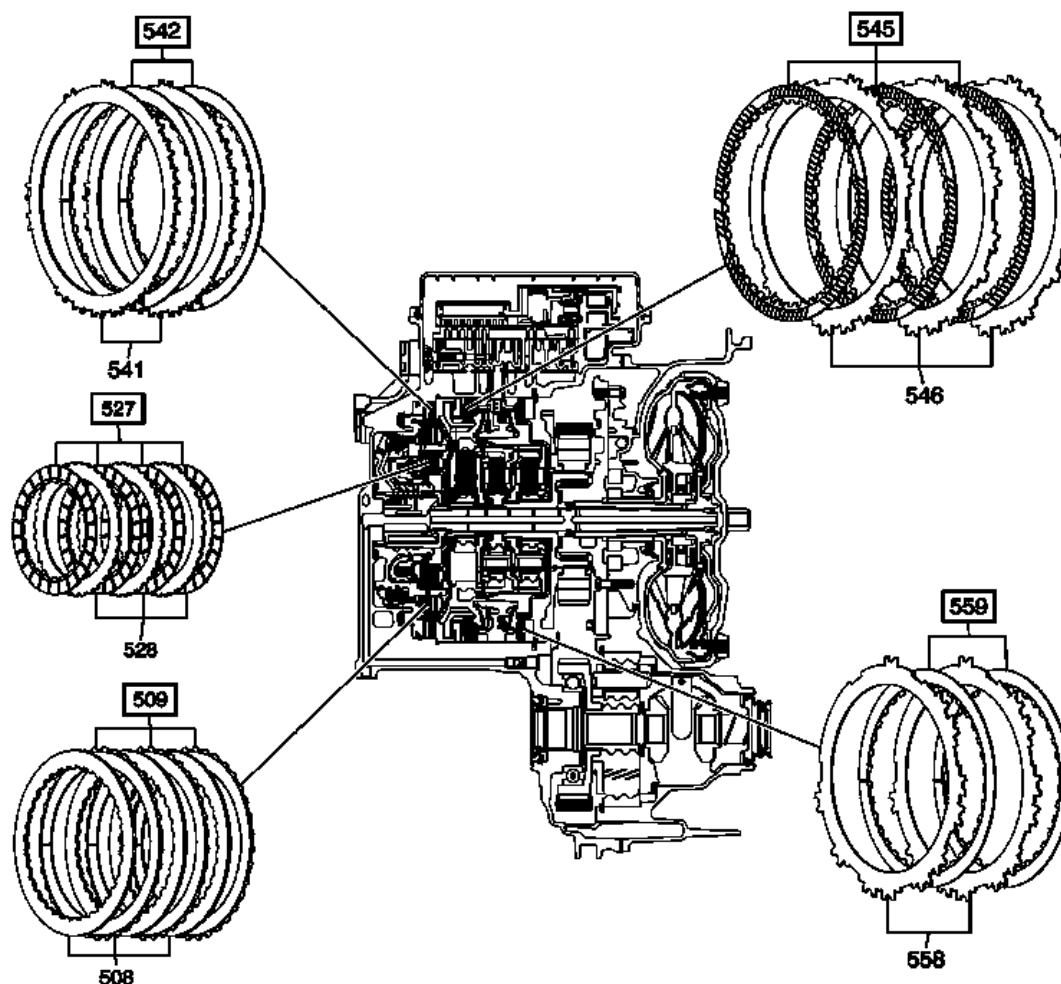


Fig. 11: Clutch Plate Package (Gen 1) 24249460
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
 Callouts without boxes are shown for relationship purposes only.

Clutch Plate Package (Gen 1) 24249460

Callout	Quantity	Component Name
509	3	3-5 Reverse Clutch (w/Friction Material) Plate Assembly
527	4	4-5-6 Clutch (w/Friction Material) Plate Assembly
542	2	2-6 Clutch (w/Friction Material) Plate Assembly
545	3	Low and Reverse Clutch (w/Friction Material) Plate Assembly
559	2	1-2-3-4 Clutch (w/Friction Material) Plate Assembly

Clutch Plate Package (Gen 2) 24260695

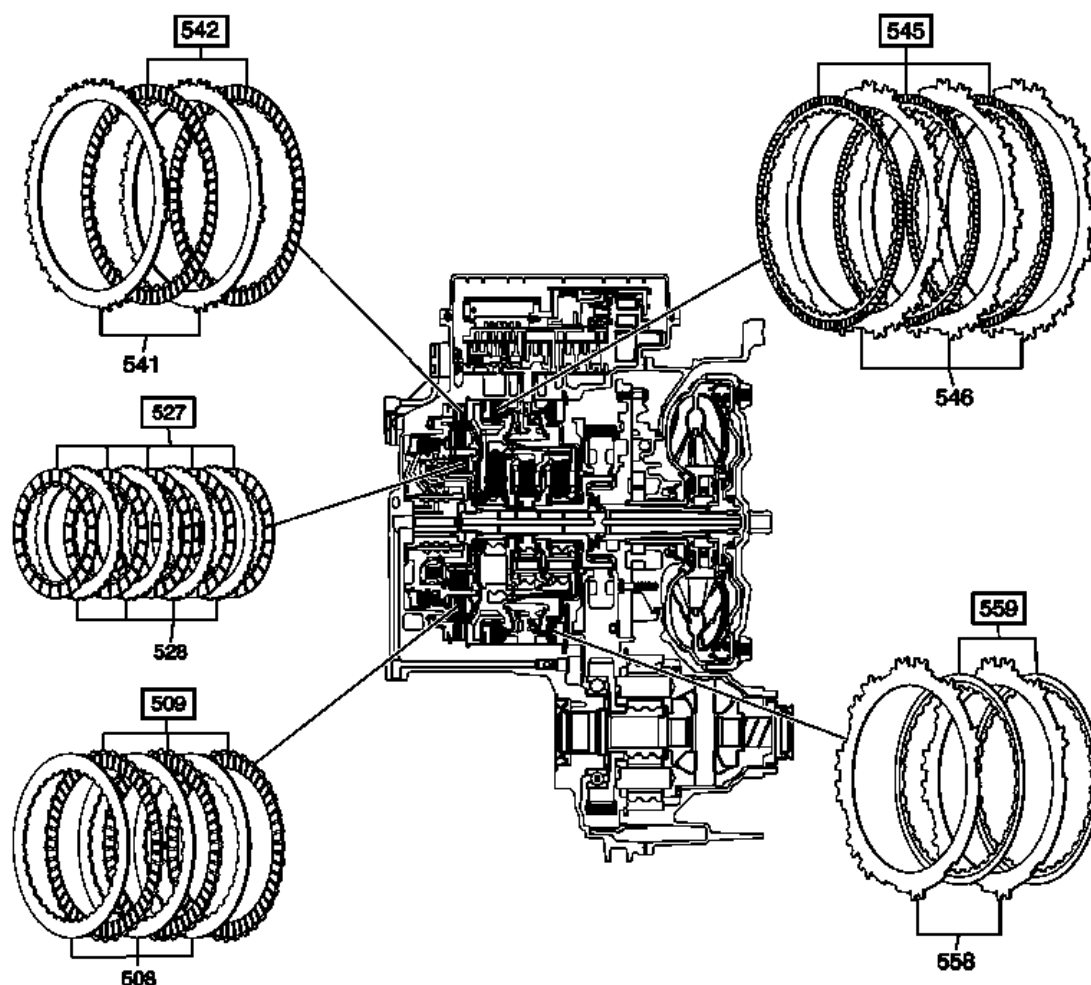


Fig. 12: Clutch Plate Package (Gen 2) 24260695

Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.

Clutch Plate Package (Gen 2) 24260695

Callout	Quantity	Component Name
509	3	3-5 Reverse Clutch (w/Friction Material) Plate Assembly
527	5	4-5-6 Clutch (w/Friction Material) Plate Assembly
542	2	2-6 Clutch (w/Friction Material) Plate Assembly
545	3	Low and Reverse Clutch (w/Friction Material) Plate Assembly
559	2	1-2-3-4 Clutch (w/Friction Material) Plate Assembly

4-5-6 Plate Assembly (Gen 2) 24260700

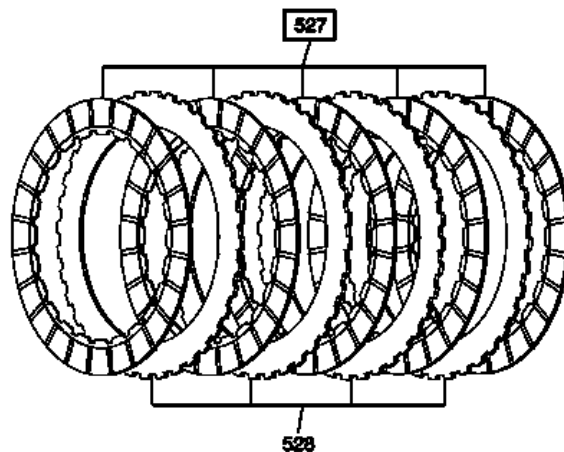


Fig. 13: 4-5-6 Plate Assembly (Gen 2) 24260700

Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

4-5-6 Plate Assembly (Gen 2) 24260700

Callout	Quantity	Component Name
527	5	4-5-6 Clutch (w/Friction Material) Plate Assembly

Low and Reverse Plate Assembly (Gen 2) 24260696

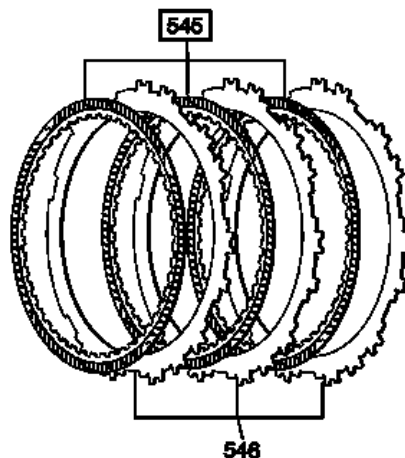


Fig. 14: Low And Reverse Plate Assembly (Gen 2) 24260696

Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

Low and Reverse Plate Assembly (Gen 2) 24260696

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Callout	Quantity	Component Name
545	3	Low and Reverse Clutch (w/Friction Material) Plate Assembly

3-5 Reverse Plate Assembly (Gen 2) 24260697

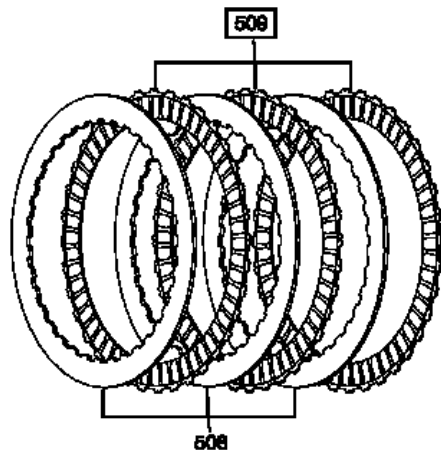


Fig. 15: 3-5 Reverse Plate Assembly (Gen 2) 24260697
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
 Callouts without boxes are shown for relationship purposes only.

3-5 Reverse Plate Assembly (Gen 2) 24260697

Callout	Quantity	Component Name
509	3	3-5 Reverse Clutch (w/Friction Material) Plate Assembly

2-6 Plate Assembly (Gen 2) 24260698

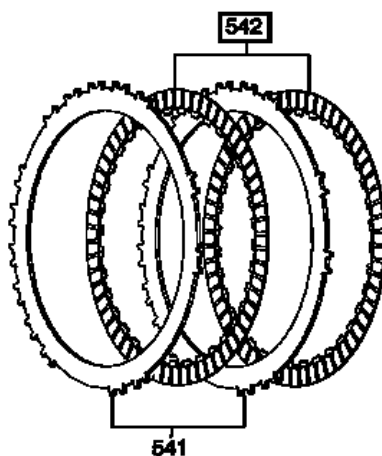


Fig. 16: 2-6 Plate Assembly (Gen 2) 24260698
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

2-6 Plate Assembly (Gen 2) 24260698

Callout	Quantity	Component Name
542	2	2-6 Clutch (w/Friction Material) Plate Assembly

1-2-3-4 Plate Assembly (Gen 2) 24260699

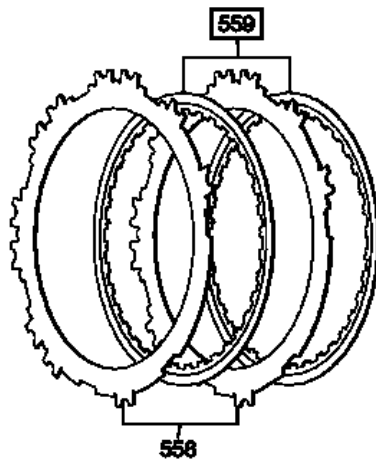


Fig. 17: 1-2-3-4 Plate Assembly (Gen 2) 24260699
Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
Callouts without boxes are shown for relationship purposes only.

1-2-3-4 Plate Assembly (Gen 2) 24260699

Callout	Quantity	Component Name
559	2	1-2-3-4 Clutch (w/Friction Material) Plate Assembly

A/Trans Seal Kit (Gen 2) 24260704

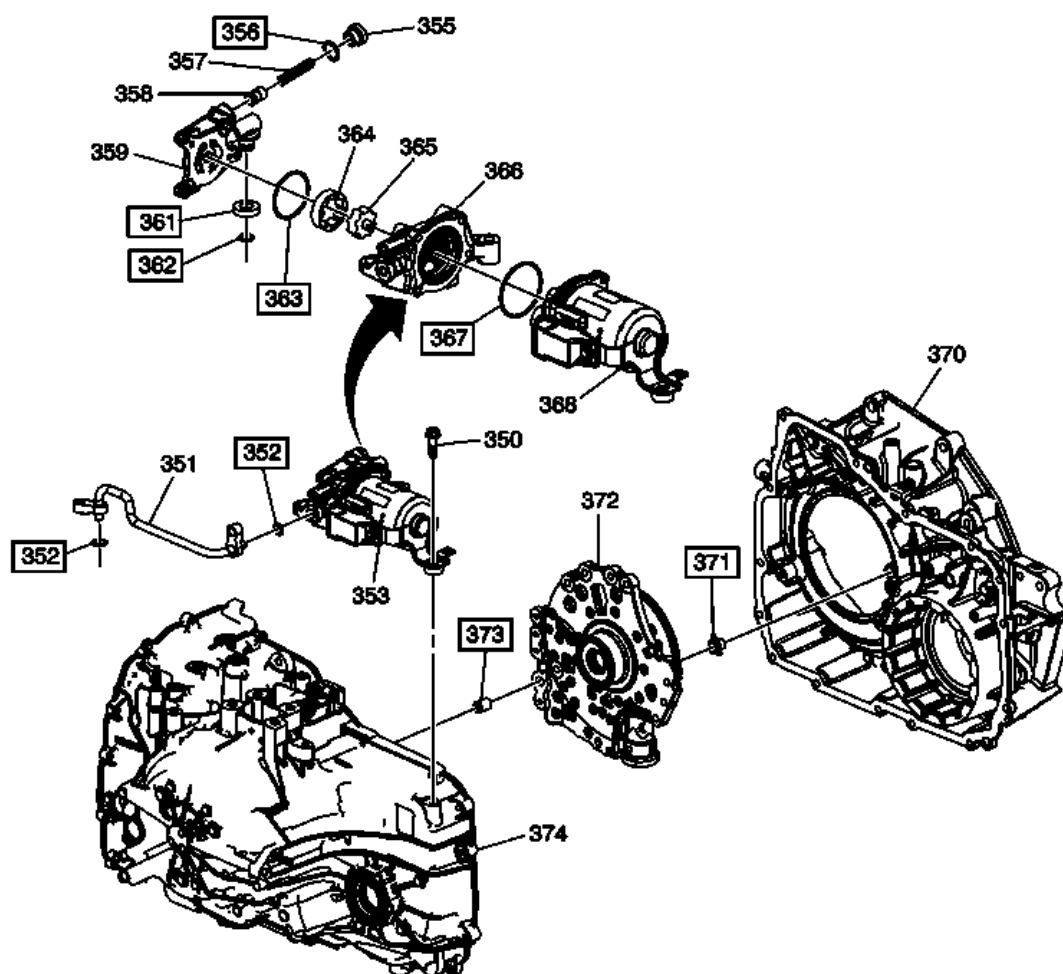


Fig. 18: Automatic Trans Seal Kit (Gen 2) 24260704
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
 Callouts without boxes are shown for relationship purposes only.

A/Trans Seal Kit (Gen 2) 24260704

Callout	Quantity	Component Name
352	2	A/Trans Auxiliary Fluid Pump Outlet Pipe Seal Assembly
356	1	Pressure Regulator Valve Spring Spacer
361	1	A/Trans Auxiliary Fluid Pump Gasket
362	1	A/Trans Auxiliary Fluid Pump Seal
363	1	A/Trans Auxiliary Fluid Pump Cover Seal
367	1	A/Trans Auxiliary Fluid Pump Motor Cover Seal- O-Ring
371	1	A/Trans Auxiliary Fluid Inlet Pump Seal
373	1	A/Trans Fluid Trough Check Ball

A/Trans Auxiliary Seal Kit (Gen 2) 24260705

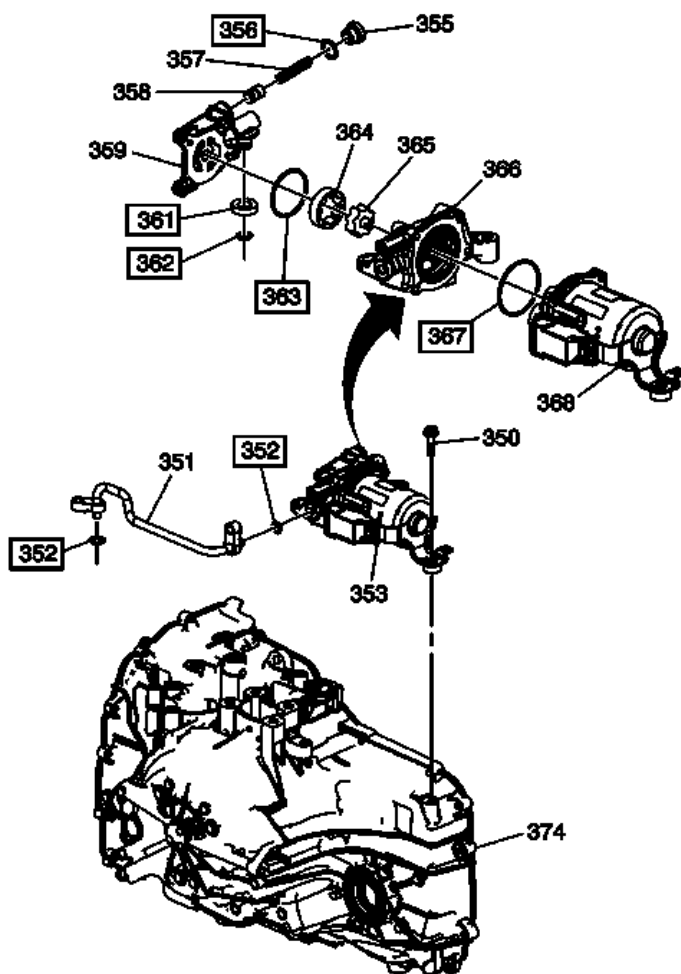


Fig. 19: Automatic Trans Auxiliary Seal Kit (Gen 2) 24260705
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts with boxes around them indicate part is included in the service kit.
 Callouts without boxes are shown for relationship purposes only.

A/Trans Auxiliary Seal Kit (Gen 2) 24260705

Callout	Quantity	Component Name
352	2	A/Trans Auxiliary Fluid Pump Outlet Pipe Seal Assembly
356	1	Pressure Regulator Valve Spring Spacer
361	1	A/Trans Auxiliary Fluid Pump Gasket
362	1	A/Trans Auxiliary Fluid Pump Seal
363	1	A/Trans Auxiliary Fluid Pump Cover Seal
367	1	A/Trans Auxiliary Fluid Pump Motor Cover Seal- O-Ring

Transmission

Automatic Transmission - 6T70 (M7U M7W) - Component Locator

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Case and Associated Parts

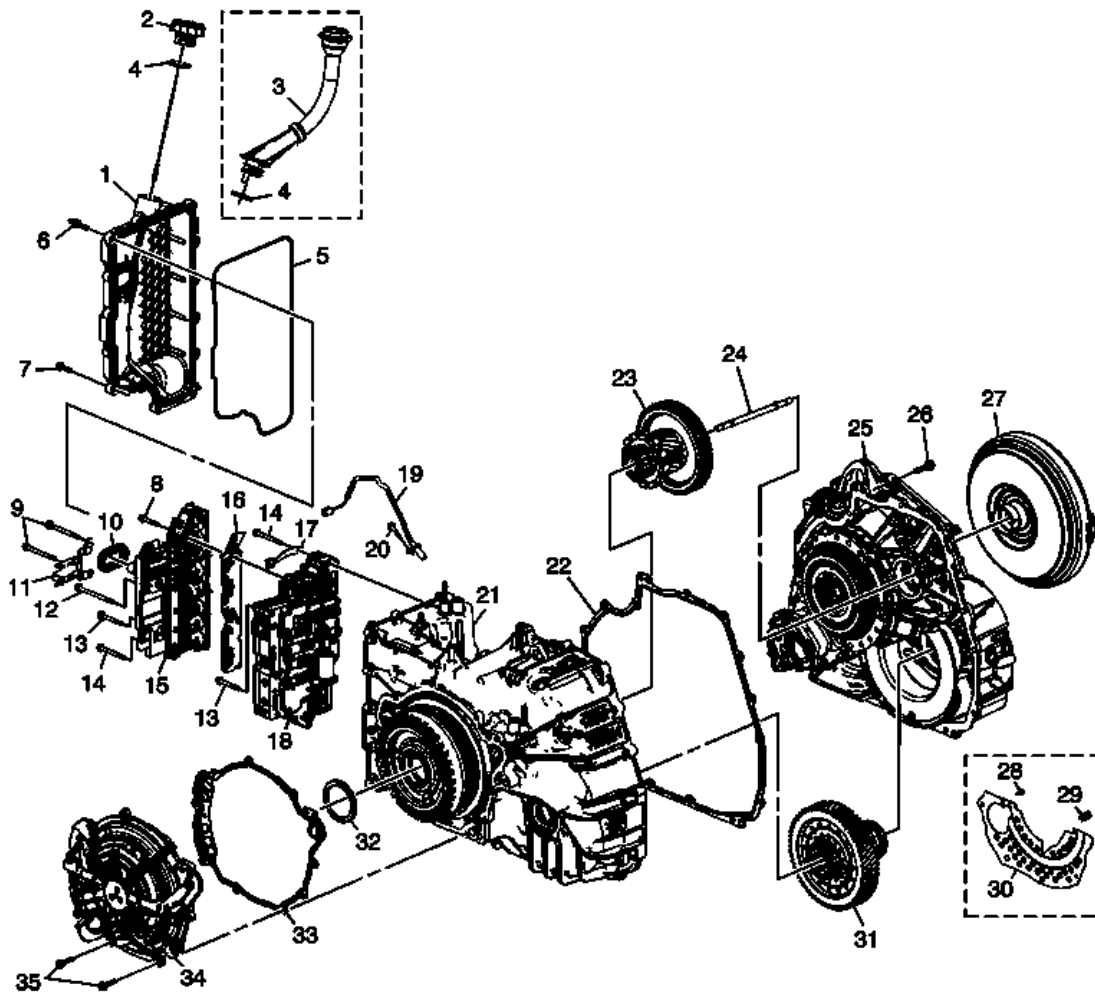


Fig. 1: Case & Associated Parts

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Control Valve Body Cover Assembly
2	Transmission Fluid Level Indicator Assembly
3	Fluid Level Indicator Tube - Model Dependent
4	Fluid Level Indicator Tube Seal - Model Dependent

5	Control Valve Body Cover Assembly Gasket
6	Control Valve Body Cover Stud
7	Control Valve Body Cover Bolt
8	Control Valve Body Bolt
9	Control Valve Body Bolt
10	Control Valve Body Cover Wiring Connector Hole Seal
11	Control Solenoid Valve Spring
12	Control Valve Body Bolt
13	Control Valve Body Bolt
14	Control Valve Body Bolt
15	Control Solenoid (w/Body and TCM) Valve Assembly
16	Control Solenoid (w/Body and TCM) Filter Plate Assembly
17	Manual Shaft Detent Assembly
18	Control Valve Body Assembly
19	A/Trans Output Speed Sensor Assembly
20	A/Trans Output Speed Sensor Bolt
21	A/Trans Case Assembly
22	Torque Converter Housing Outer Seal
23	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly
24	Front Differential Drive Pinion Gear Lube Tube
25	Torque Converter and Support and A/Trans Fluid Pump Housing Assembly
26	Torque Converter and Differential Housing Bolt
27	Torque Converter Assembly
28	Dust Cover Push Pin - Model Dependent
29	Dust Cover Bolt - Model Dependent
30	Dust Cover - Model Dependent
31	Front Differential Carrier Assembly
32	Input Shaft Thrust Bearing Assembly
33	A/Trans Case Cover Gasket
34	A/Trans Case Cover Assembly
35	A/Trans Case Cover Assembly Bolt

Transmission Case Assembly

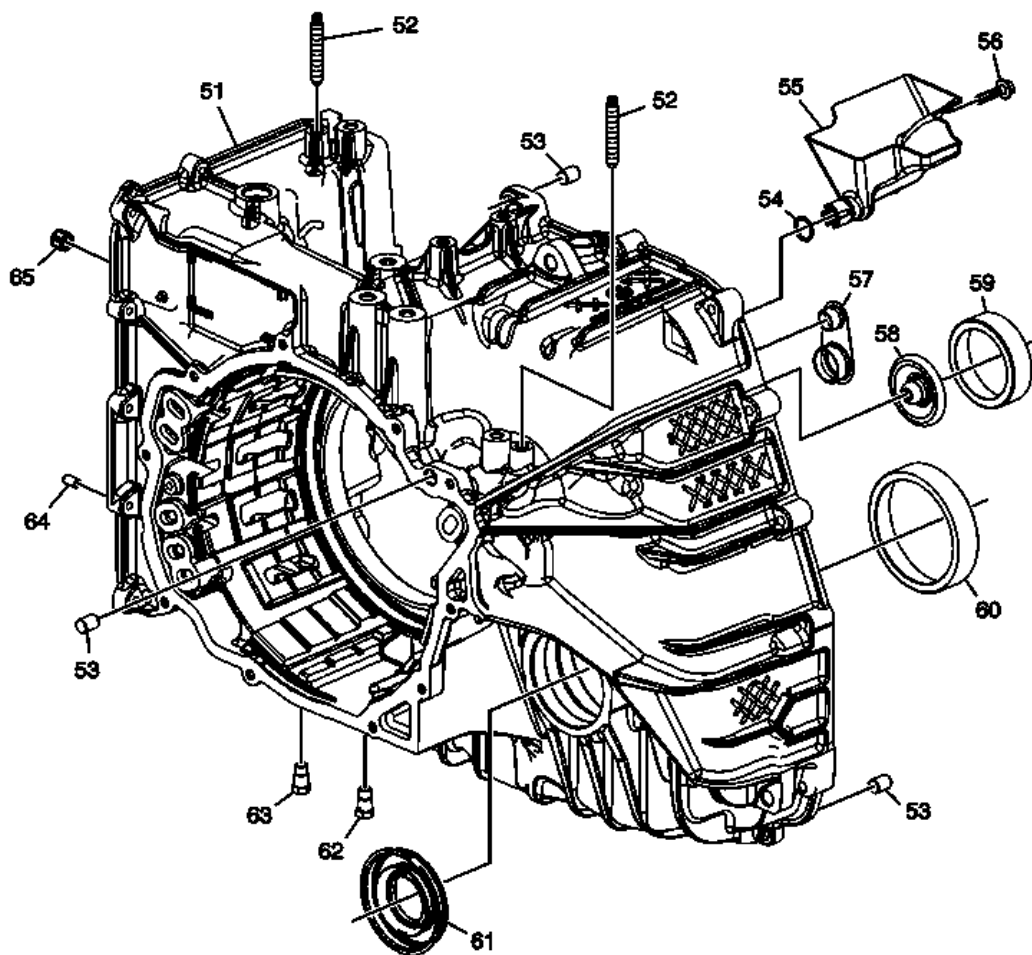


Fig. 2: Transmission Case Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
51	A/Trans Case Assembly
52	Transmission Fluid Cooler Pipe Stud
53	Transmission Case Cover Locator Pin
54	A/Trans Fluid Trough O-Ring Seal
55	A/Trans Fluid Trough Assembly
56	A/Trans Fluid Trough Bolt
57	A/Trans Pump Fluid Outlet Seal Assembly
58	Front Differential Drive Pinion Gear Lube Dam
59	Front Differential Drive Pinion Gear Bearing Cup
60	Front Differential Carrier Bearing Cup
61	Front Wheel Drive Shaft Oil Seal Assembly
62	A/Trans Fluid Press Test Hole Plug
63	A/Trans Fluid Level Hole Plug

64	Control Valve Body Locator Pin
65	1-2-3-4 Clutch Fluid Passage Seal

Torque Converter, Support and Fluid Pump Housing Assembly

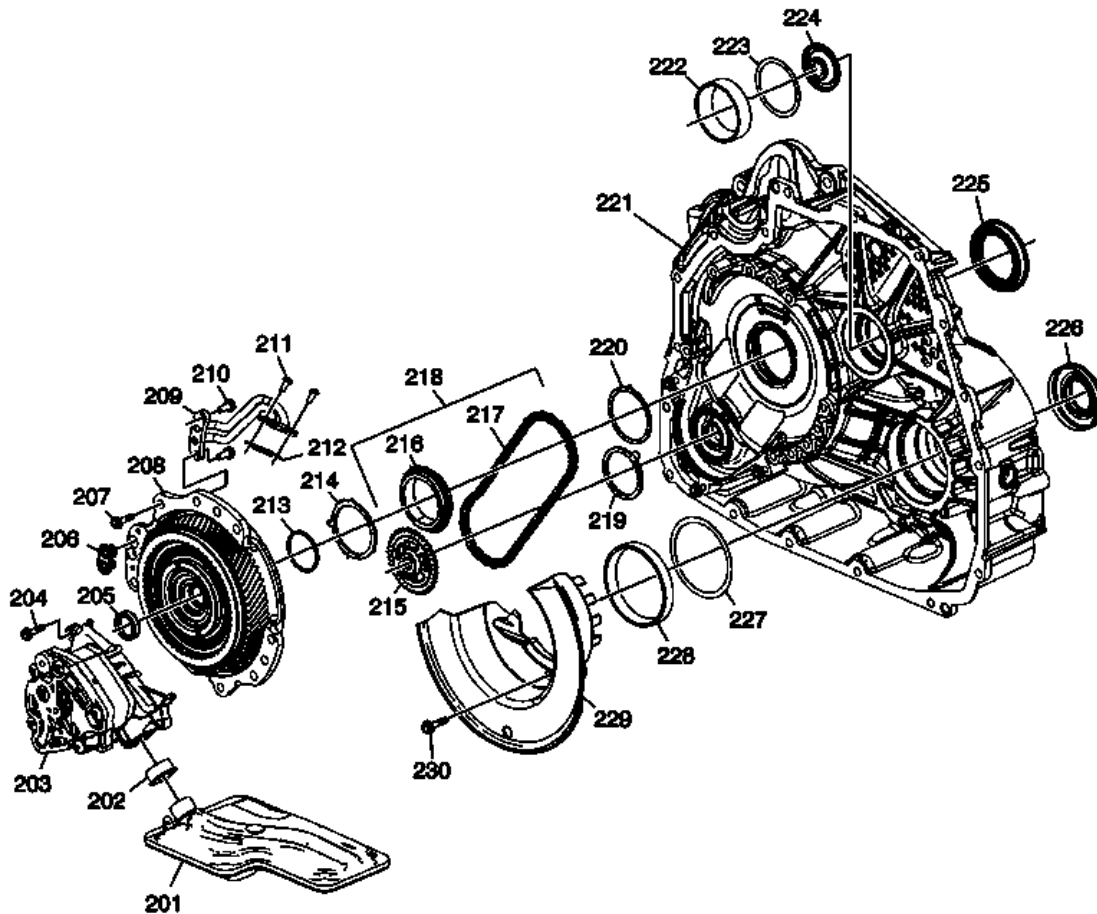


Fig. 3: Torque Converter, Support & Fluid Pump Housing Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
201	A/Trans Fluid Filter Assembly
202	Filter Neck Seal
203	A/Trans Fluid Pump Assembly
204	A/Trans Fluid Pump Bolt
205	Front Differential Transfer Drive Gear Support Seal Assembly
206	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly
207	Front Differential Transfer Drive Gear Support Bolt
208	Front Differential Transfer Drive Gear Support Assembly

209	Front Differential Transfer Drive Gear Fluid Passage Tube Assembly
210	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt
211	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt
212	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
213	Front Differential Transfer Drive Gear Support Seal
214	Drive Sprocket Thrust Washer
215	Oil Pump Drive Link Driven Sprocket
216	Oil Pump Drive Link Drive Sprocket
217	Drive Link
218	Drive Link Assembly
219	Drive Sprocket Thrust Washer
220	Drive Sprocket Thrust Washer
221	Torque Converter and Differential Housing Assembly
222	Front Differential Drive Pinion Gear Bearing Cup
223	Front Differential Drive Pinion Gear Bearing Thrust Washer
224	Front Differential Drive Pinion Gear Lube Dam
225	Torque Converter Fluid Seal Assembly
226	Front Wheel Drive Shaft Oil Seal Assembly
227	Front Differential Bearing Thrust Washer
228	Front Differential Carrier Bearing Cup
229	Front Differential Carrier Baffle
230	Front Differential Carrier Baffle Bolt

Control Valve Body Assembly

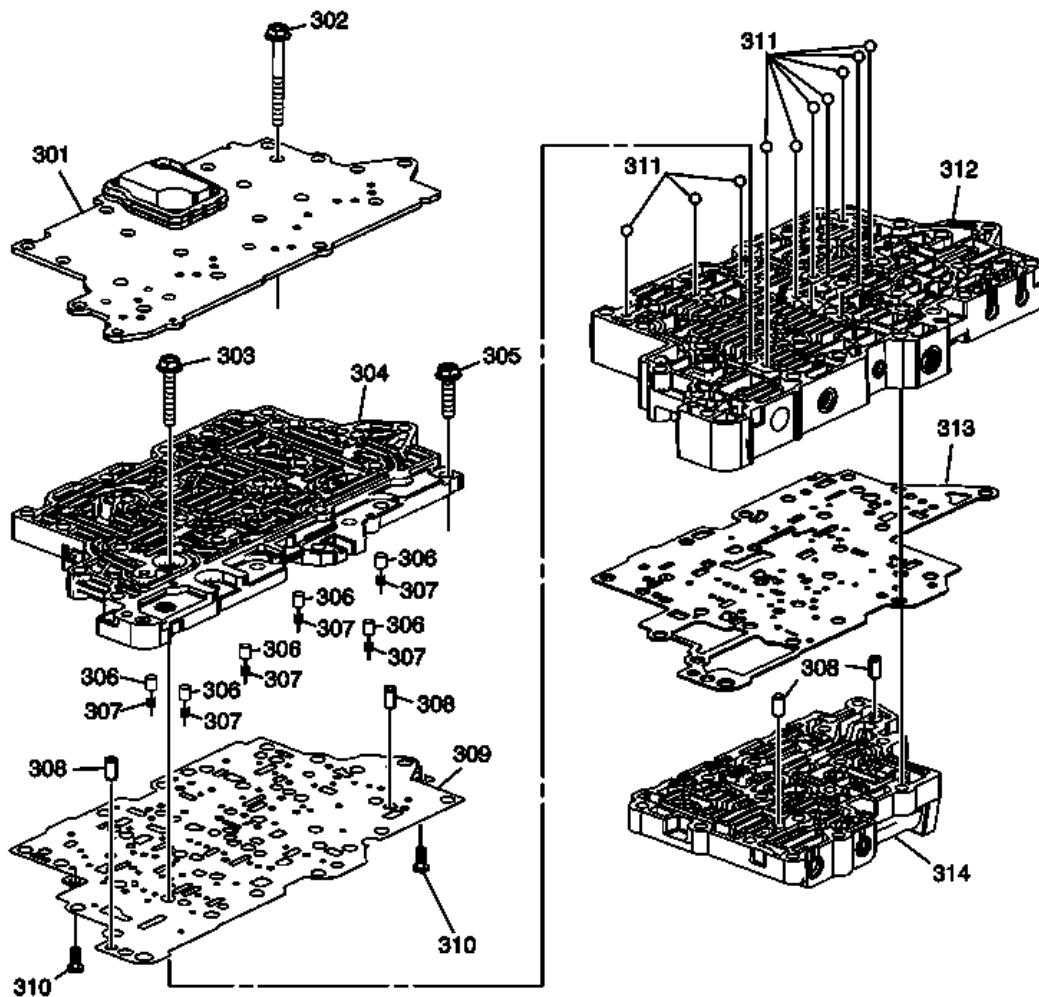


Fig. 4: Control Valve Body Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
301	Control Valve Channel Upper Plate Assembly
302	Control Valve Body Bolt
303	Control Valve Body Bolt
304	Control Valve Channel Plate
305	Control Valve Body Bolt
306	Actuator Feed Accumulator Piston
307	Actuator Feed Accumulator Spring
308	Control Valve Body Locator Pin
309	Control Valve Upper Body Spacer Plate Assembly
310	Control Valve Body Spacer Plate Retainer
311	Control Valve Body Ball Check Valve
312	Control Valve Upper Body Assembly
313	Control Valve Lower Body Spacer Plate Assembly

Upper Valve Body Assembly

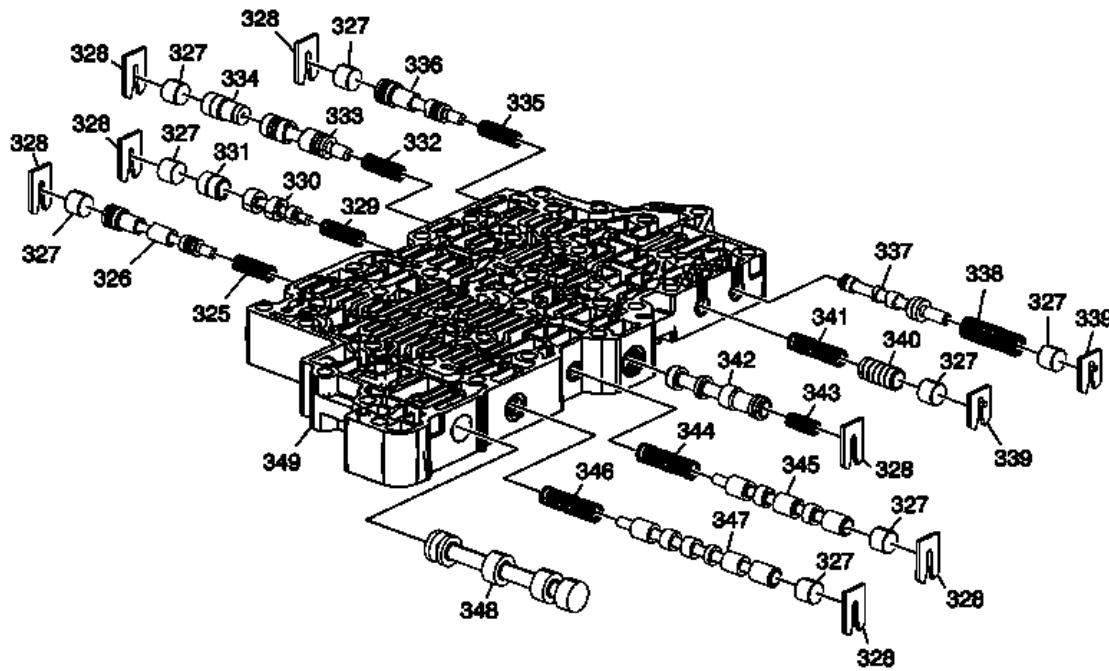


Fig. 5: Upper Valve Body Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
325	Low and Reverse and 4-5-6 Clutch Regulator Valve Spring
326	Low and Reverse and 4-5-6 Clutch Regulator Valve
327	Pressure Regulator Valve Bore Plug
328	Torque Converter Clutch Valve Spring Retainer
329	Torque Converter Clutch Regulator Apply Valve Spring
330	Torque Converter Clutch Regulator Apply Valve
331	Torque Converter Clutch Regulator Apply Shuttle Valve
332	2-6 Clutch Regulator Valve Spring
333	2-6 Clutch Regulator Valve
334	2-6 Clutch Regulator Valve Gain Valve
335	3-5-Reverse Clutch Regulator Valve Spring
336	3-5-Reverse Clutch Regulator Valve
337	Pressure Regulator Valve
338	Pressure Regulator Valve Spring
339	Pressure Regulator Valve Bore Plug Retainer
340	Isolator Valve

341	Isolator Valve Spring
342	Torque Converter Clutch Control Valve
343	Torque Converter Clutch Control Valve Spring
344	Clutch Select Solenoid Valve #3 Spring
345	Clutch Select Solenoid #3 Valve
346	Clutch Select Solenoid Valve #2 Spring
347	Clutch Select Solenoid #2 Valve
348	Manual Valve
349	Control Valve Upper Body

Lower Valve Body Assembly

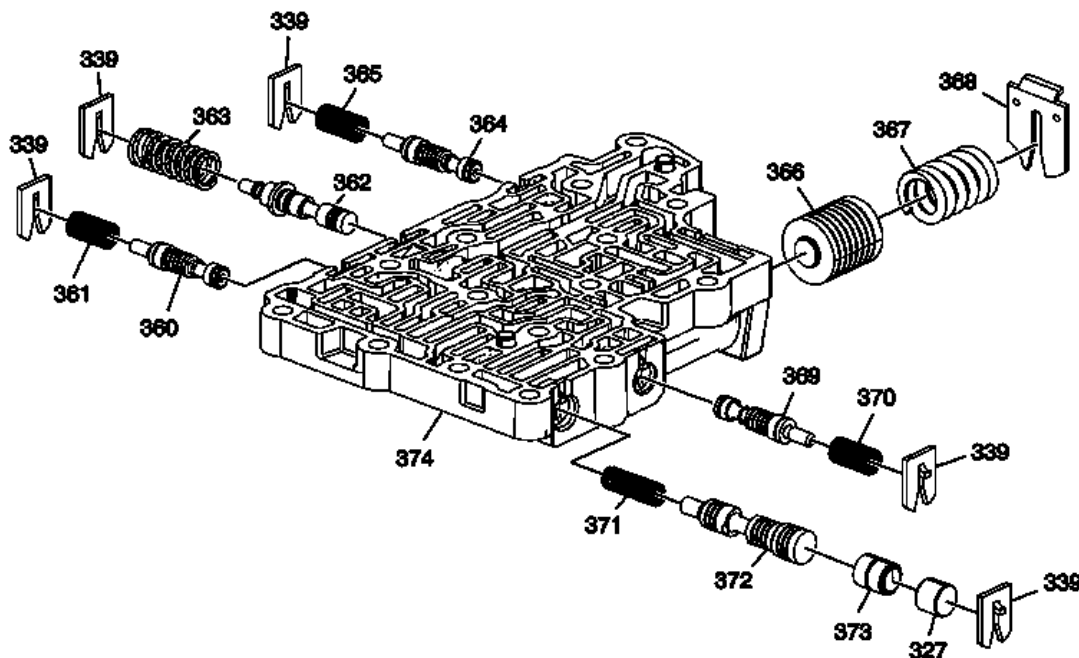


Fig. 6: Lower Valve Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
327	1-2-3-4 Clutch Regulator Valve Bore Plug
339	Actuator Feed Limit Valve Spring Retainer
360	4-5-6 Clutch Boost Valve
361	4-5-6 Clutch Boost Valve Spring
362	Actuator Feed Limit Valve
363	Actuator Feed Limit Valve Spring
364	3-5-Reverse Clutch Boost Valve
365	3-5-Reverse Clutch Boost Valve Spring

366	4-5-6 Clutch Accumulator Piston
367	4-5-6 Clutch Accumulator Piston Spring
368	4-5-6 Clutch Accumulator Piston Retainer
369	1-2-3-4 Clutch Boost Valve
370	1-2-3-4 Clutch Boost Valve Spring
371	1-2-3-4 Clutch Regulator Valve Spring
372	1-2-3-4 Clutch Regulator Valve
373	Default Override 1-2-3-4 Clutch Valve
374	Control Valve Lower Body

A/Trans Case Cover, 2-6 and Low Reverse Pistons

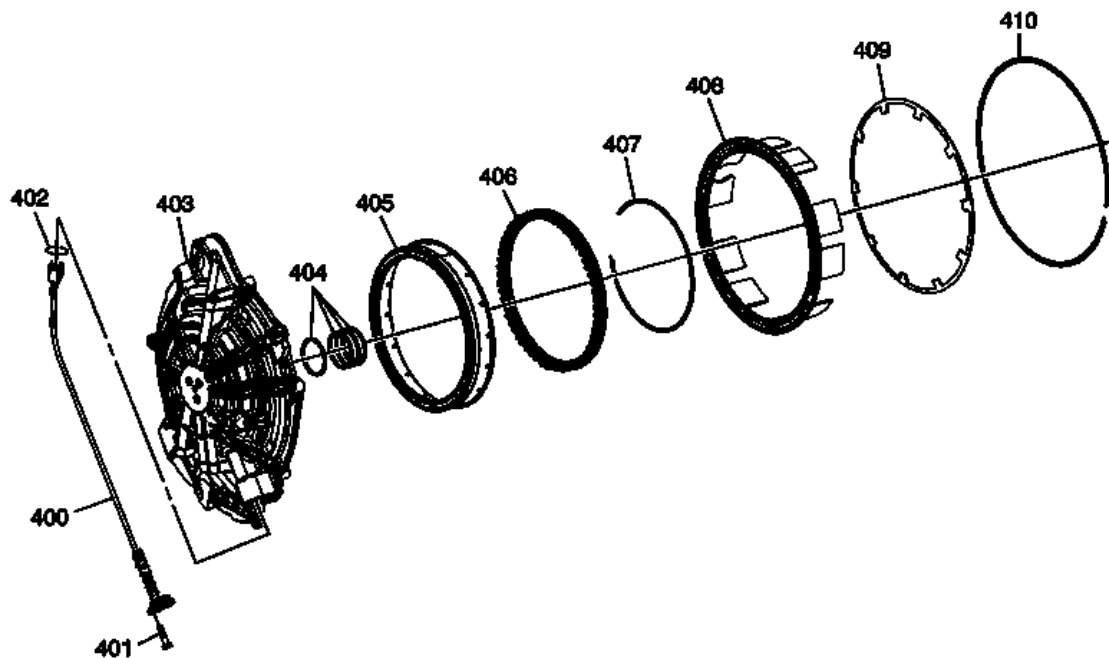


Fig. 7: A/T Case Cover, 2-6 & Low Reverse Pistons & Retainer Rings
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
400	A/Trans Input Speed Sensor Assembly
401	A/Trans Input Speed Sensor Bolt
402	ISS O-Ring Seal
403	A/Trans Case Cover Assembly
404	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
405	2-6 Clutch Piston
406	2-6 Clutch Spring Assembly
407	2-6 Clutch Spring Retainer Ring

408	Low and Reverse Clutch Piston Assembly
409	Low and Reverse Clutch Spring
410	Low and Reverse Clutch Spring Retainer Ring

3-5 Reverse Clutch Assembly

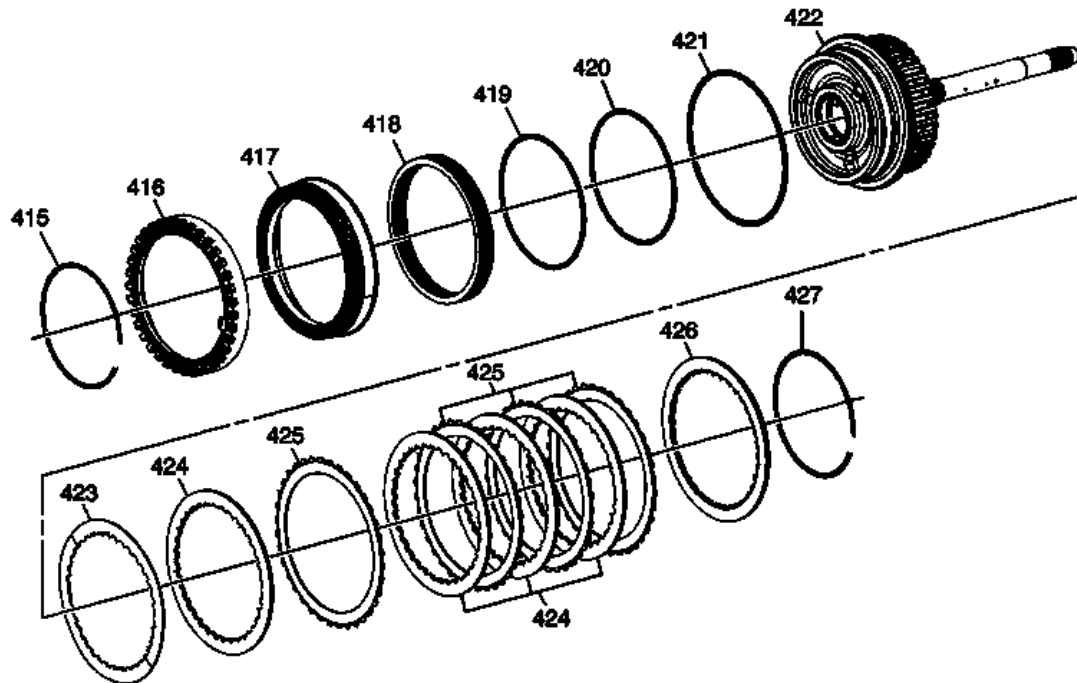


Fig. 8: Identifying 3-5 Reverse Clutch Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
415	A/Trans Input Shaft Speed Sensor Reluctor Ring Retainer Ring
416	A/Trans Input Shaft Speed Sensor Reluctor Wheel
417	3-5-Reverse Clutch Piston
418	3-5-Reverse Clutch Spring
419	3-5-Reverse Clutch Piston Inner Seal
420	3-5-Reverse Clutch Piston Inner Seal
421	3-5-Reverse Clutch Piston Dam Seal
422	3-5-Reverse and 4-5-6 Clutch Housing Assembly
423	3-5-Reverse Clutch (Waved) Plate
424	3-5-Reverse Clutch Plate
425	3-5-Reverse Clutch (w/Friction Material) Plate Assembly
426	3-5-Reverse Clutch Backing Plate
427	3-5-Reverse Clutch Backing Plate Retainer Ring

4-5-6 Clutch Assembly

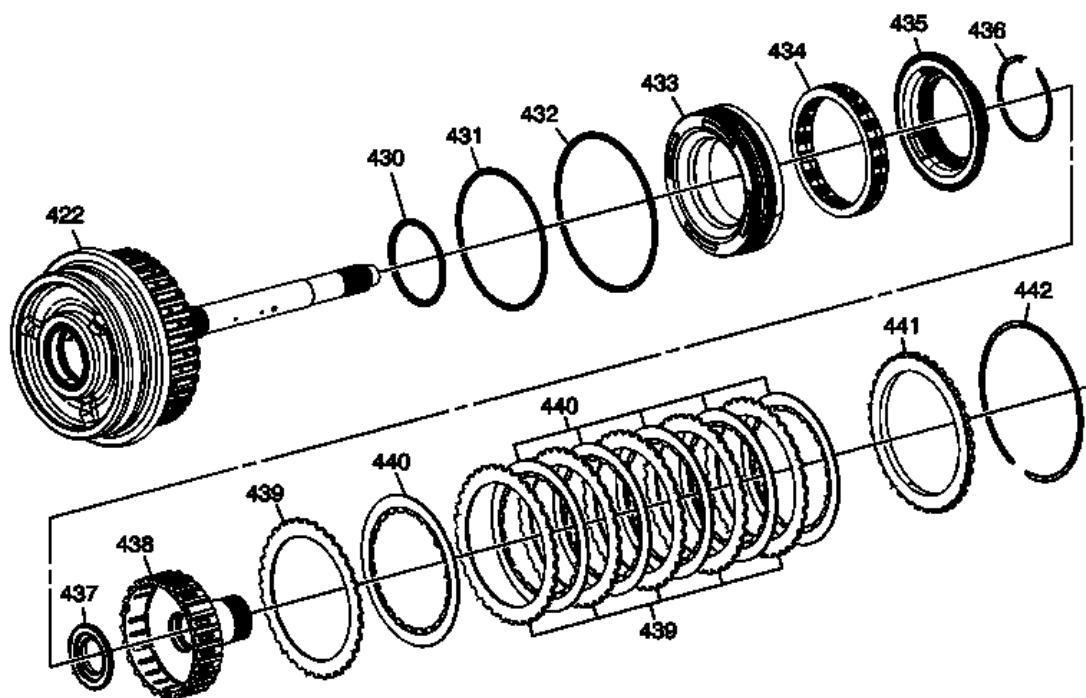


Fig. 9: 4-5-6 Clutch Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
422	3-5-Reverse and 4-5-6 Clutch Housing Assembly
430	4-5-6 Clutch Piston Inner Seal
431	4-5-6 Clutch Piston Outer Seal
432	4-5-6 Clutch Piston Outer Seal
433	4-5-6 Clutch Piston
434	4-5-6 Clutch Spring
435	4-5-6 Clutch Piston Fluid Dam
436	4-5-6 Clutch Dam Retainer Ring
437	4-5-6 Clutch Hub Thrust Bearing Assembly
438	Reaction Carrier Hub Assembly
439	4-5-6 Clutch Plate
440	4-5-6 Clutch (w/Friction Material) Plate Assembly
441	4-5-6 Clutch Backing Plate
442	4-5-6 Clutch Backing Plate Retainer Ring

2-6, Low and Reverse and 1-2-3-4 Clutch Plate Assemblies

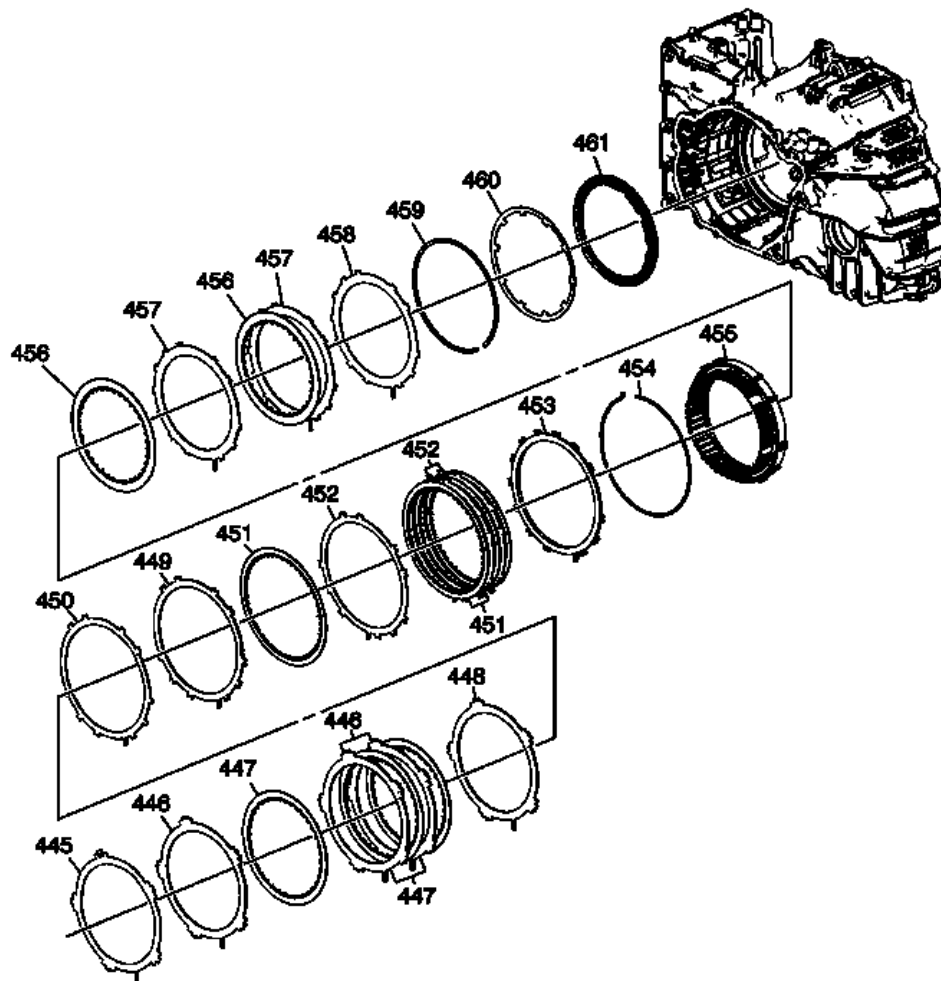


Fig. 10: 2-6, Low & Reverse & 1-2-3-4 Clutch Plate Assemblies
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
445	2-6 Clutch Cushion Spring
446	2-6 Clutch Plate
447	2-6 Clutch (w/Friction Material) Plate Assembly
448	2-6 Clutch Backing Plate
449	Low and Reverse Clutch Apply Plate
450	Low and Reverse Clutch Cushion (Waved) Spring
451	Low and Reverse Clutch (w/Friction Material) Plate Assembly
452	Low and Reverse Clutch Plate
453	Low and Reverse Clutch Backing Plate
454	Low and Reverse Clutch Retainer Ring
455	Low and Reverse Clutch Assembly (OWC)
456	1-2-3-4 Clutch (w/Friction Material) Plate Assembly
457	1-2-3-4 Clutch Plate

458	1-2-3-4 Clutch (Waved) Plate
459	1-2-3-4 Clutch Spring Retainer Ring
460	1-2-3-4 Clutch Spring
461	1-2-3-4 Clutch Piston
449	Low and Reverse Clutch Apply Plate

Input, Output and Reaction Gearsets

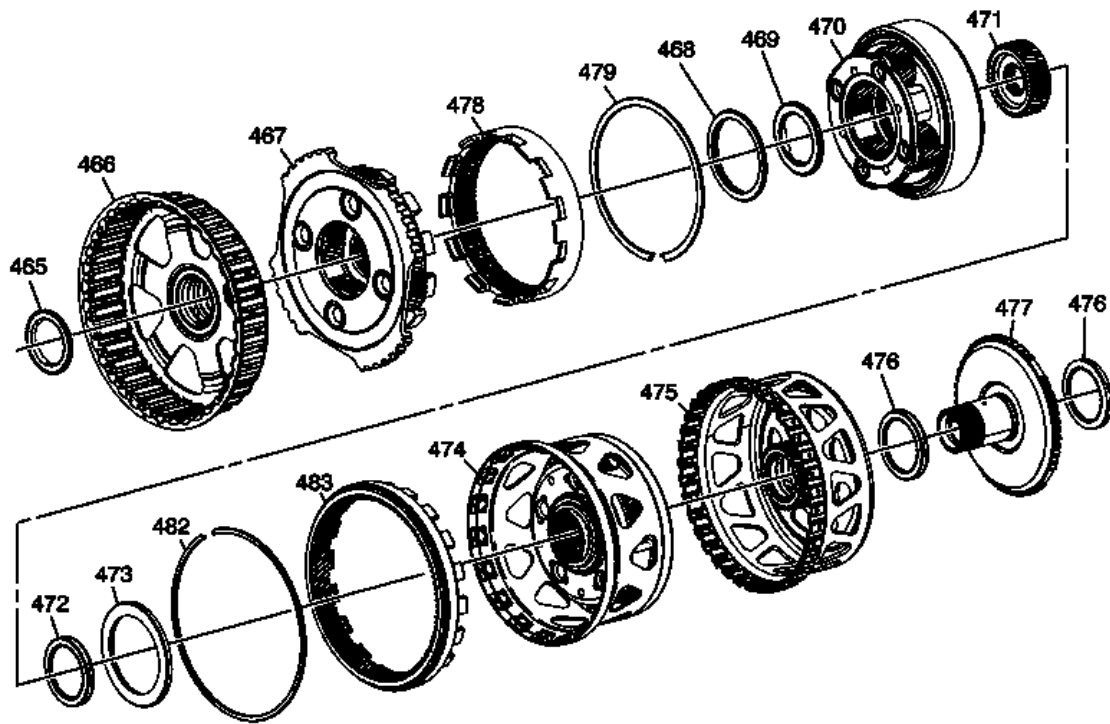


Fig. 11: Input, Output & Reaction Gearsets
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
465	2-6 Clutch Hub Thrust Bearing
466	Reaction Sun Gear Assembly
467	Reaction Carrier Assembly
468	Input Carrier Thrust Bearing Assembly
469	Input Sun Gear Thrust Bearing Assembly
470	Input Carrier Assembly
471	Input Sun Gear
472	Output Carrier Thrust Bearing Assembly
473	Output Carrier Thrust Bearing Assembly
474	Output Carrier Assembly
475	Output Sun Gear Assembly
476	Front Differential Transfer Drive Gear Input Hub Bearing Assembly

477	Output Carrier Transfer Drive Gear Hub Assembly
478	Input Internal Gear
479	Input Internal Gear Retaining Ring
482	Reaction Internal Gear Retaining Ring
483	Reaction Carrier Internal Gear

Front Differential Transfer Drive Gear Assembly

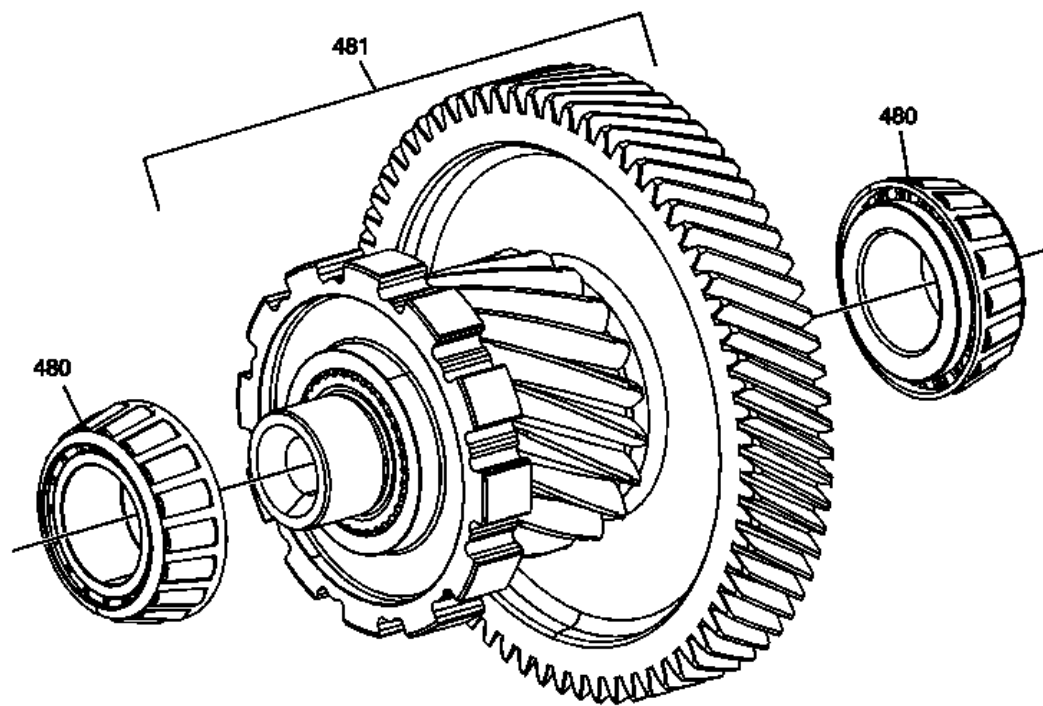


Fig. 12: Front Differential Transfer Drive Gear Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
480	Front Differential Drive Pinion Gear Bearing Assembly
481	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly

Front Differential Carrier Assembly

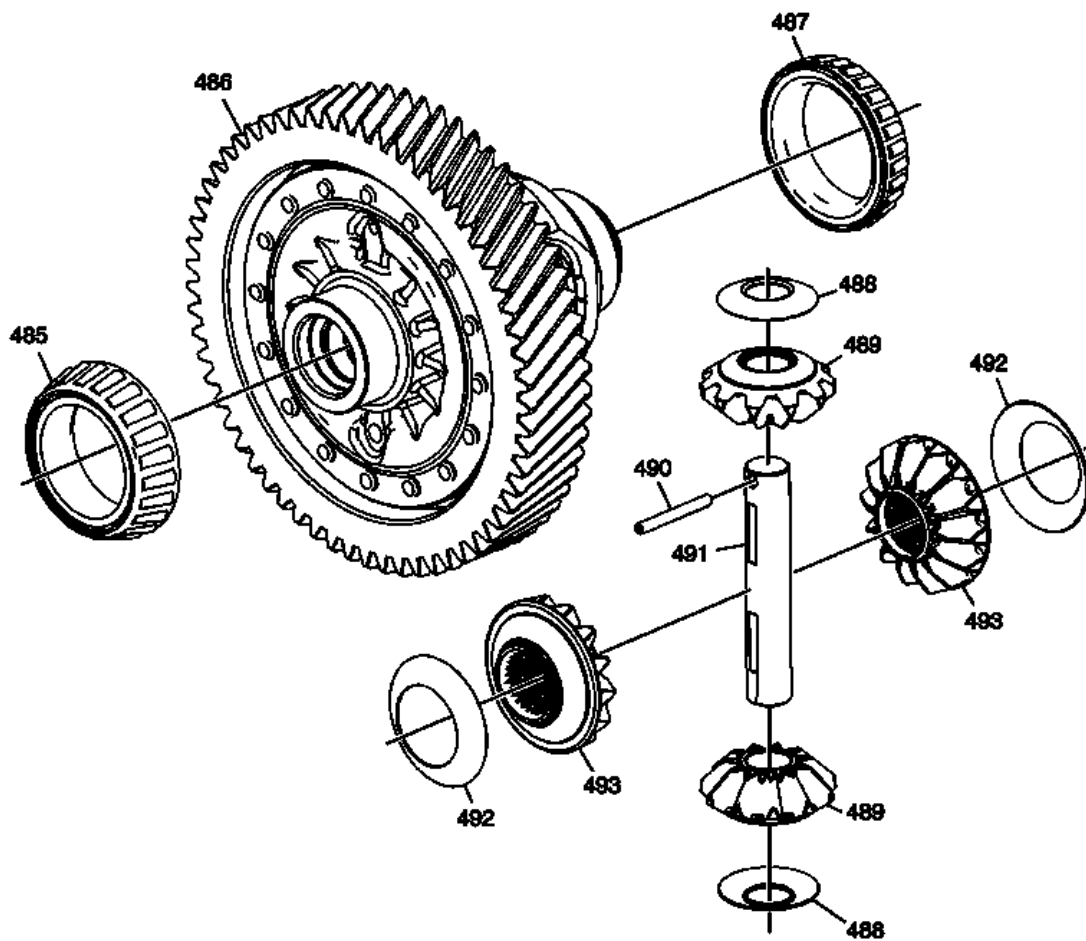


Fig. 13: Front Differential Carrier Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
485	Front Differential Carrier Bearing Assembly
486	Front Differential Carrier Assembly
487	Front Differential Carrier Bearing Assembly
488	Front Differential Carrier Thrust Washer
489	Front Differential Pinion Gear
490	Front Differential Pinion Gear Shaft Retainer
491	Front Differential Pinion Gear Shaft
492	Front Differential Side Gear Thrust Washer
493	Front Differential Side Gear

Park System Components

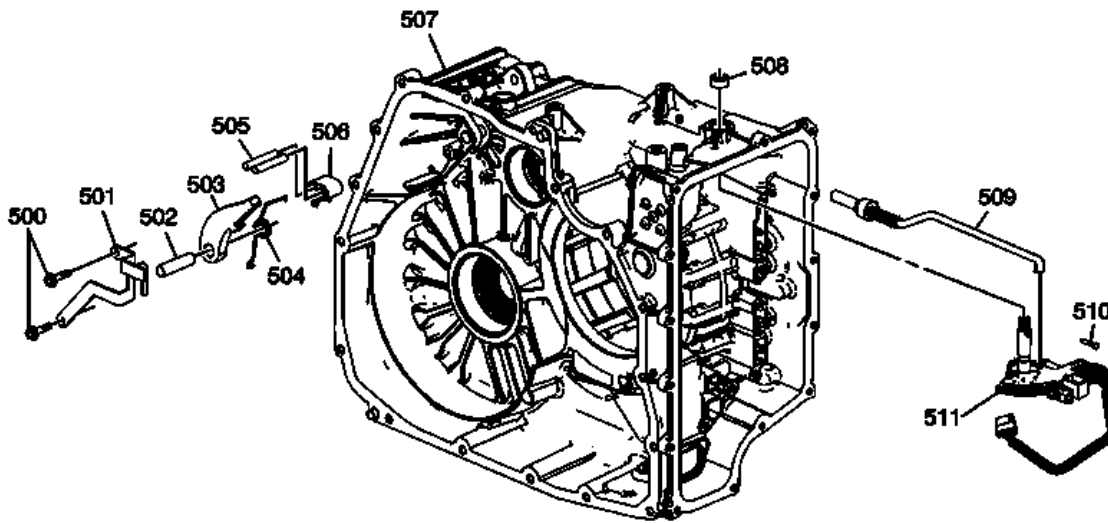


Fig. 14: Park System Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
500	Park Pawl Actuator Bracket Bolt
501	Park Pawl Actuator Bracket
502	Park Pawl Shaft
503	Park Pawl
504	Park Pawl Spring
505	Park Pawl Actuator Guide Pin
506	Park Pawl Actuator Guide
507	A/Trans Case Assembly
508	Manual Shift Shaft Seal
509	Park Pawl Actuator Assembly
510	Manual Shift Shaft Pin
511	Manual Shift Detent (w/Shaft Position Switch) Lever Assembly

COMPONENT LOCATION

Component Locations

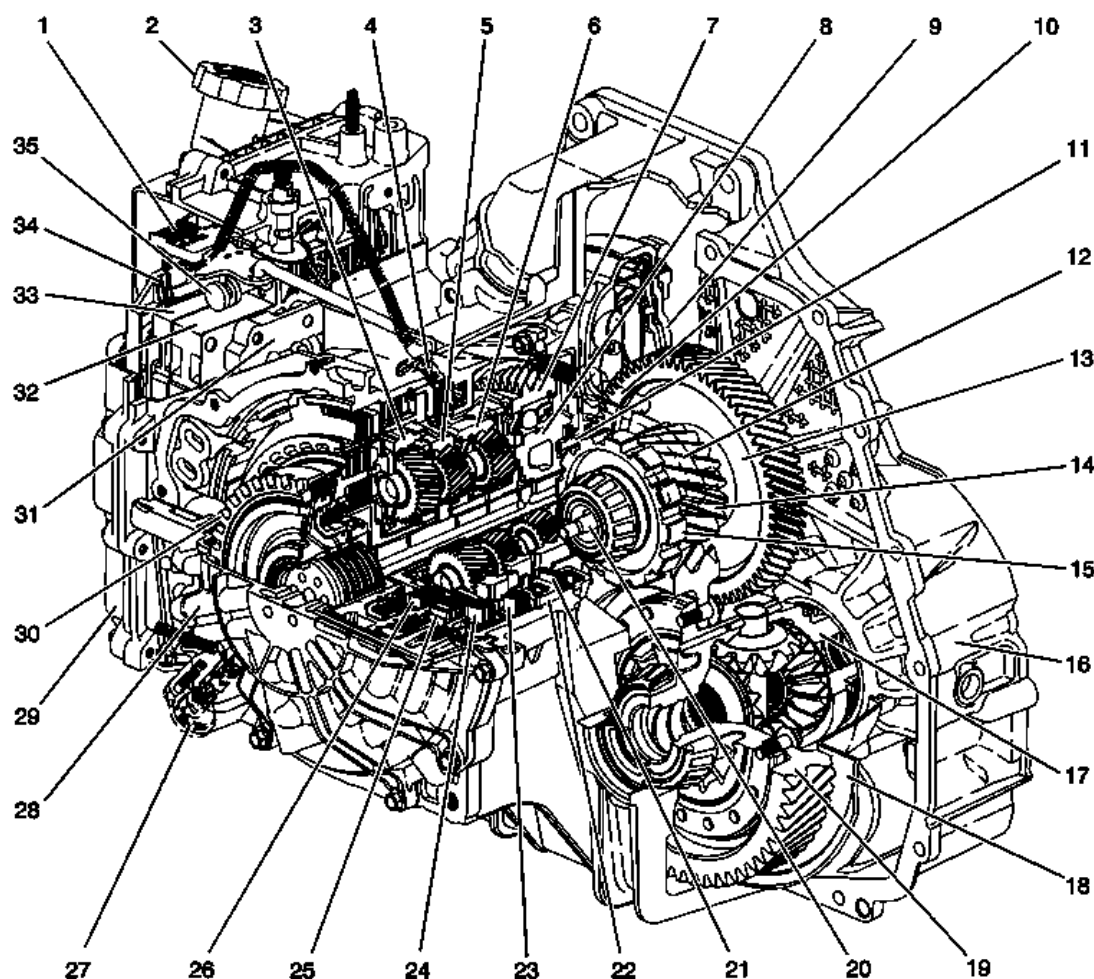


Fig. 15: A/T Component Locations
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Manual Shift Detent Lever Assembly (w/Shaft Position Switch)
2	Trans Fluid Level Indicator
3	Reaction Carrier Assembly
4	Output Speed Sensor
5	Input Carrier Assembly
6	Output Carrier Assembly
7	Front Differential Transfer Drive Gear
8	Front Differential Transfer Drive Gear Support Assembly
9	Torque Converter Assembly
10	Park Pawl Actuator Assembly
11	Fluid Pump Drive Link Assembly
12	Park Pawl
13	Front Differential Transfer Driven Gear

14	Front Differential Drive Pinion Gear
15	Park Gear
16	Torque Converter and Support and Fluid Pump Housing Assembly
17	Front Differential Carrier Assembly
18	Front Differential Carrier Baffle
19	Front Differential Ring Gear
20	Front Differential Drive Pinion Gear Lube Tube
21	1-2-3-4 Clutch Assembly
22	Low and Reverse Clutch Assembly (OWC)
23	Low and Reverse Clutch
24	2-6 Clutch Assembly
25	3-5-Reverse Clutch Assembly
26	4-5-6 Clutch Assembly
27	Input Speed Sensor
28	Case Cover Assembly
29	Control Valve Body Cover
30	Input Shaft Speed Sensor Reluctor Wheel
31	Control Valve Lower Body Assembly
32	Control Valve Upper Body Assembly
33	Control Valve Channel Plate Assembly
34	Control Solenoid Valve Assembly (w/Body and TCM)
35	Manual Valve

BUSHING, BEARING, AND WASHER LOCATIONS

Bushing and Bearing Locations

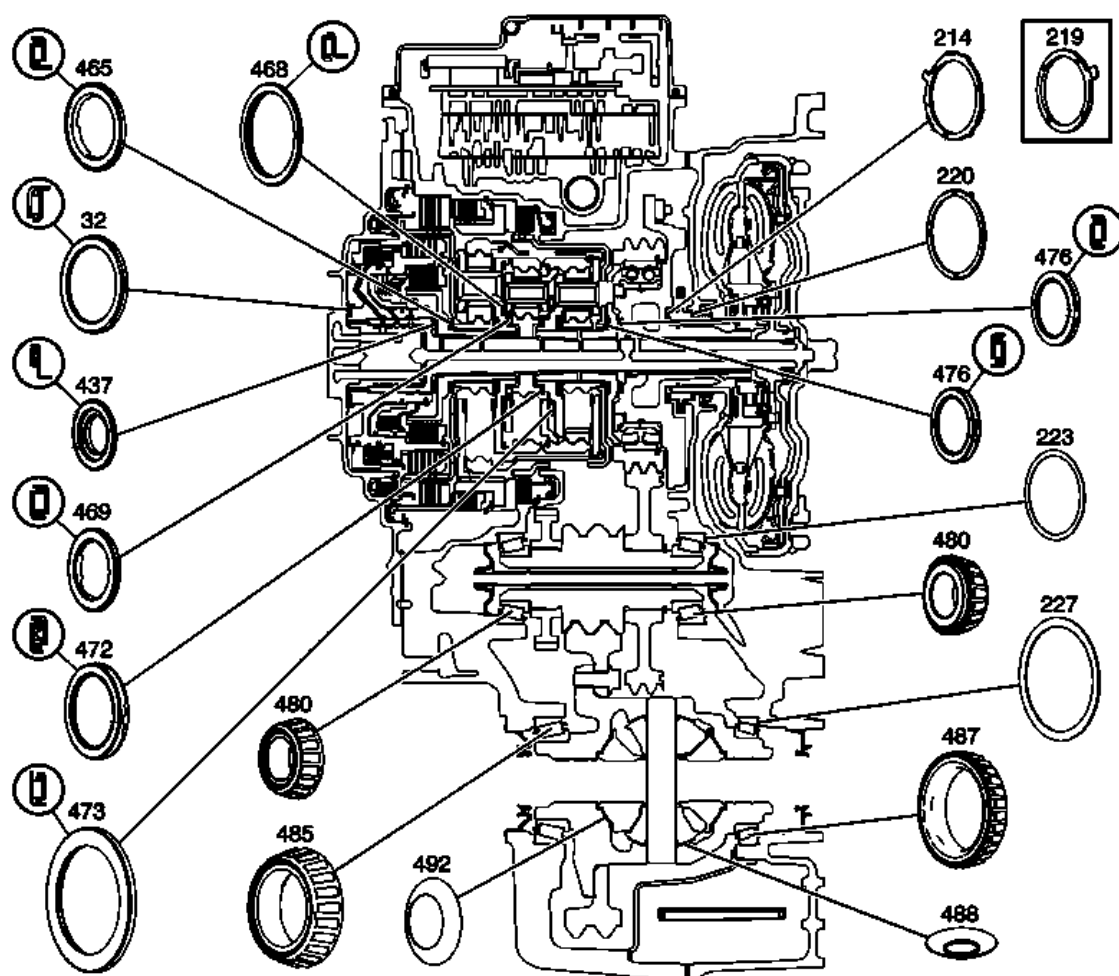


Fig. 16: Bushing & Bearing Locations
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
32	Input Shaft Thrust Bearing Assembly
214	Drive Sprocket Thrust Washer
219	Drive Sprocket Thrust Washer
220	Drive Sprocket Thrust Washer
223	Front Differential Drive Pinion Gear Bearing Thrust Washer
227	Front Differential Bearing Thrust Washer
437	4-5-6 Clutch Hub Thrust Bearing Assembly
465	2-6 Clutch Hub Thrust Bearing
468	Input Carrier Thrust Bearing Assembly
469	Input Sun Gear Thrust Bearing Assembly
472	Output Carrier Thrust Bearing Assembly
473	Output Carrier Thrust Bearing Assembly
476	Front Differential Transfer Drive Gear Input Hub Bearing Assembly

480	Front Differential Drive Pinion Gear Bearing Assembly
485	Front Differential Carrier Bearing Assembly
487	Front Differential Carrier Bearing Assembly
488	Front Differential Carrier Thrust Washer
492	Front Differential Side Gear Thrust Washer

SEAL LOCATIONS

Seal Locations #1

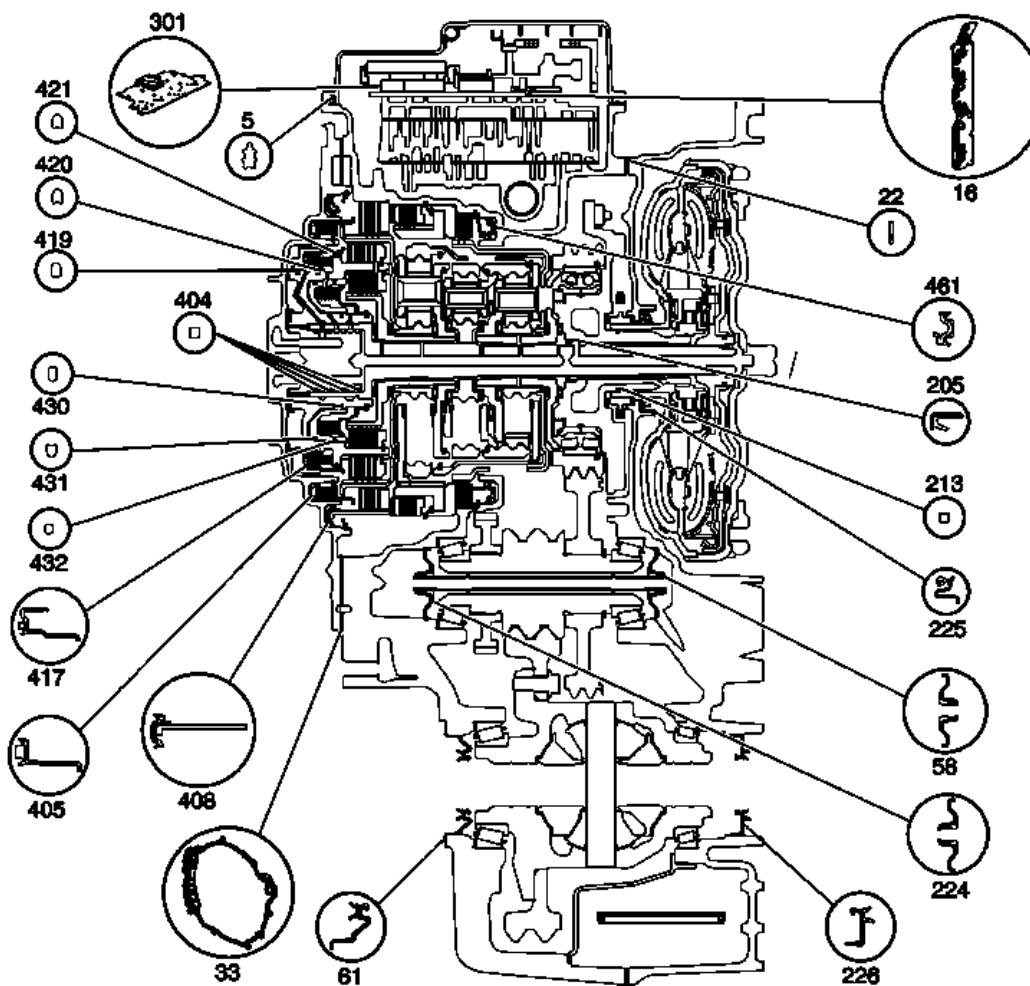


Fig. 17: Seal Locations (1 of 2)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5	Control Valve Body Cover Assembly Gasket
16	Control Solenoid (w/Body and TCM) Filter Plate Assembly
22	Torque Converter Housing Outer Seal
33	A/Trans Case Cover Gasket

58	Front Differential Drive Pinion Gear Lube Dam
61	Front Wheel Drive Shaft Oil Seal Assembly
205	Front Differential Transfer Drive Gear Support Seal Assembly
213	Front Differential Transfer Drive Gear Support Seal
224	Front Differential Drive Pinion Gear Lube Dam
225	Torque Converter Fluid Seal Assembly
226	Front Wheel Drive Shaft Oil Seal Assembly
301	Control Valve Channel Upper Plate Assembly
404	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
405	2-6 Clutch Piston
408	Low and Reverse Clutch Piston Assembly
417	3-5-Reverse Clutch Piston
419	3-5-Reverse Clutch Piston Inner Seal
420	3-5-Reverse Clutch Piston Inner Seal
421	3-5-Reverse Clutch Piston Dam Seal
430	4-5-6 Clutch Piston Inner Seal
431	4-5-6 Clutch Piston Outer Seal
432	4-5-6 Clutch Piston Outer Seal
461	1-2-3-4 Clutch Piston

Seal Locations #2

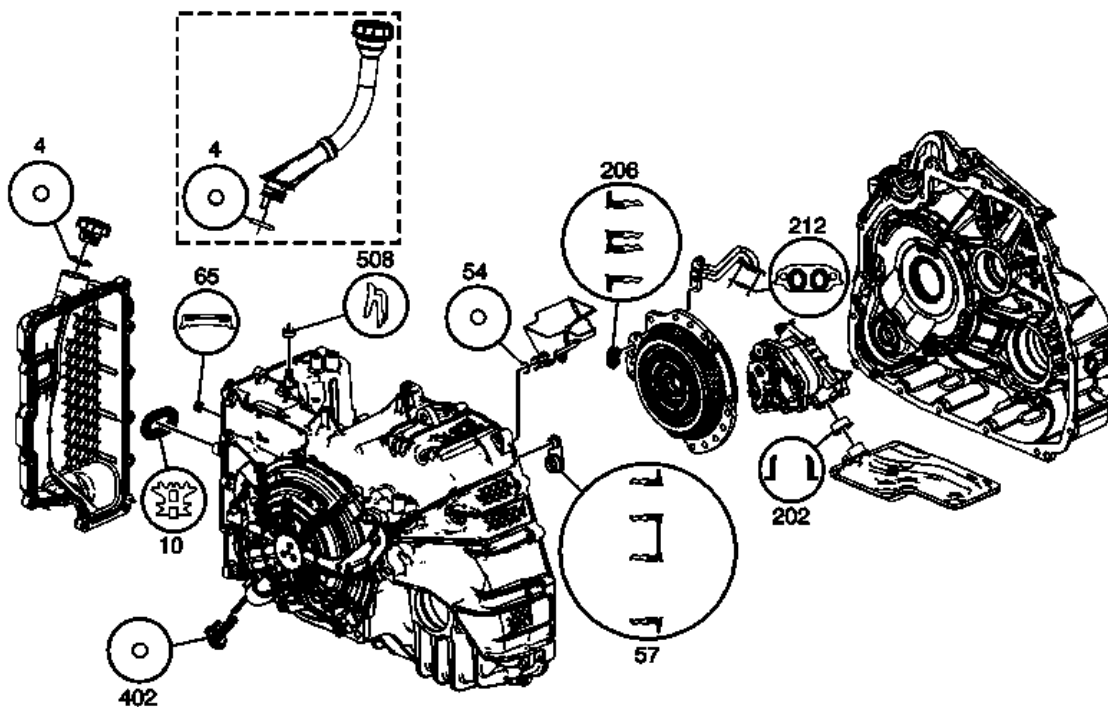


Fig. 18: Seal Locations (2 Of 2)

Courtesy of GENERAL MOTORS COMPANY

BALL CHECK VALVE LOCATIONS

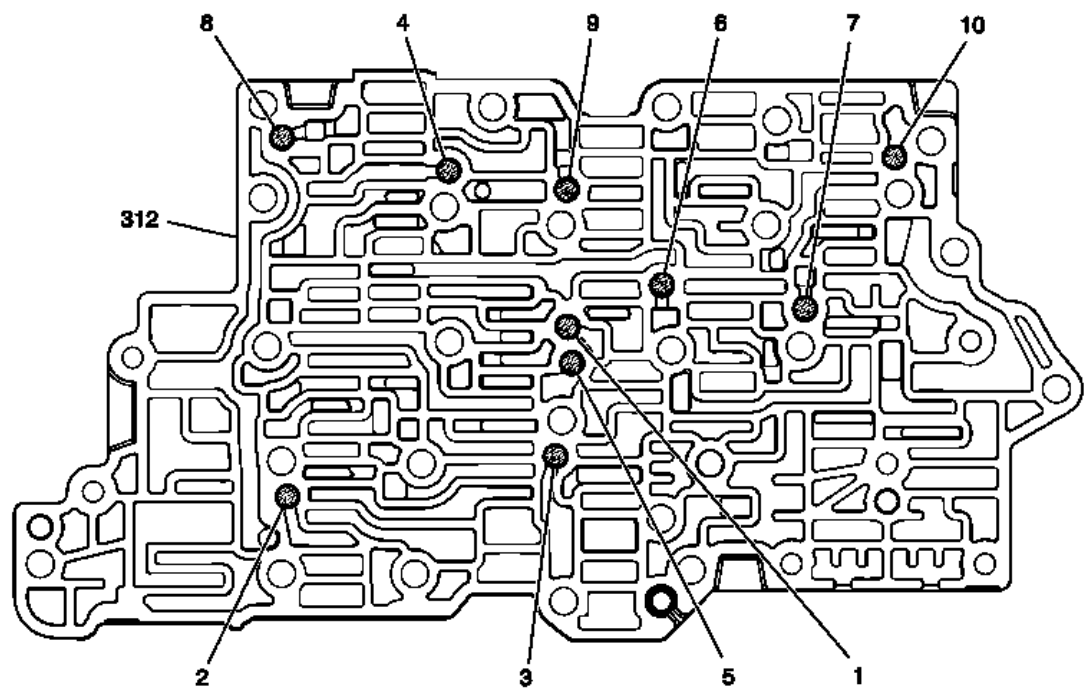


Fig. 19: Ball Check Valve Locations
Courtesy of GENERAL MOTORS COMPANY

Ball Check Valve Locations

I.D.	Input Oil	Input Oil	Output Oil
1	Drive 1-6	DRV B	26/1234 CL Feed
2	Solenoid 1	Reverse	CSV2 Enable
3	Solenoid 2	456	CSV3 Enable
4	Latch Feed	456	CSV2 Latch
5	Drive 1-6	35 Rev FD	35 Rev Supply
6	2-6/1234	-	1234 Clutch Feed
7	35R Supply	-	35R Clutch Feed
8	Low/Rev Supply	-	Low/Rev Clutch Feed
9	456 Clutch Supply	-	456 Clutch Feed
10	Compensator Feed	-	Exhaust Backfeed

Transmission

Automatic Transmission - 6T70 (M7U M7W) - Description and Operation

DESCRIPTION AND OPERATION

DEFINITIONS AND ABBREVIATIONS

Throttle Positions

Engine Braking

A condition where the engine is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Full Throttle Downshift

A quick apply of the accelerator pedal to its full travel, forcing a downshift.

Heavy Throttle

Approximately 3/4 of accelerator pedal travel, 75 percent throttle position.

Light Throttle

Approximately 1/4 of accelerator pedal travel, 25 percent throttle position.

Medium Throttle

Approximately 1/2 of accelerator pedal travel, 50 percent throttle position.

Minimum Throttle

The least amount of throttle opening required for an upshift.

Wide Open Throttle (WOT)

Full travel of the accelerator pedal, 100 percent throttle position.

Zero Throttle Coastdown

A full release of the accelerator pedal while the vehicle is in motion and in drive range.

Shift Condition Definitions

Bump

A sudden and forceful apply of a clutch or a band.

Chuggle

A bucking or jerking. This condition may be most noticeable when the converter clutch is engaged. It is similar to the feel of towing a trailer.

Delayed

A condition where a shift is expected but does not occur for a period of time. This could be described as a clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle apply of the accelerator, or during manual downshifting to a lower range. This term is also defined as LATE or EXTENDED.

Double Bump - Double Feel

Two sudden and forceful applies of a clutch or a band.

Early

A condition where the shift occurs before the car has reached proper speed. This condition tends to labor the engine after the upshift.

End Bump

A firmer feel at the end of a shift than at the start of the shift. This is also defined as END FEEL or SLIP BUMP.

Firm

A noticeably quick apply of a clutch or band that is considered normal with a medium to heavy throttle. This apply should not be confused with HARSH or ROUGH.

Flare

A quick increase in engine RPM along with a momentary loss of torque. This most generally occurs during a shift. This condition is also defined as SLIPPING.

Harsh - Rough

A more noticeable apply of a clutch or band than FIRM. This condition is considered undesirable at any throttle position.

Hunting

A repeating quick series of upshifts and downshifts that causes a noticeable change in engine RPM, such as a 4-3-4 shift pattern. This condition is also defined as BUSYNESS.

Initial Feel

A distinctly firmer feel at the start of a shift than at the finish of the shift.

Late

A shift that occurs when the engine RPM is higher than normal for a given amount of throttle.

Shudder

A repeating jerking condition similar to CHUGGLE but more severe and rapid. This condition may be most noticeable during certain ranges of vehicle speed.

Slipping

A noticeable increase in engine RPM without a vehicle speed increase. A slip usually occurs during or after initial clutch or band apply.

Soft

A slow, almost unnoticeable clutch or band apply with very little shift feel.

Surge

A repeating engine related condition of acceleration and deceleration that is less intense than CHUGGLE.

Tie-Up

A condition where two opposing clutch and/or bands are attempting to apply at the same time causing the engine to labor with a noticeable loss of engine RPM.

Noise Conditions**Drive Link Noise**

A whine or growl that increases or fades with vehicle speed, and is most noticeable under a light throttle acceleration. It may also be noticeable in PARK or NEUTRAL operating ranges with the vehicle stationary.

Final Drive Noise

A hum related to vehicle speed which is most noticeable under a light throttle acceleration.

Planetary Gear Noise

A whine related to vehicle speed, which is most noticeable in FIRST gear, SECOND gear, FOURTH gear or REVERSE. The condition may become less noticeable, or go away, after an upshift.

Pump Noise

A high pitched whine that increases in intensity with engine RPM. This condition may also be noticeable in all operating ranges with the vehicle stationary or moving.

Torque Converter Noise

A whine usually noticed when a vehicle is stopped, and the transmission is in DRIVE or REVERSE. The noise will increase with engine RPM.

Driver Shift Control

Driver shift control (DSC) allows the driver to change gears similar to a manual transmission. Refer to the vehicle owner's manual for specific DSC operating instructions.

Transmission Abbreviations

A/C

Air Conditioning

AC

Alternating Current

AT

Automatic Transmission

CCDIC

Climate Control Driver Information Center

DC

Direct Current

DIC

Driver Information Center

DLC

Diagnostic Link Connector

DMM

Digital Multimeter

DSC

Driver Shift Control

DTC

Diagnostic Trouble Code

EBTCM

Electronic Brake/Traction Control Module

ECCC

Electronically-Controlled Capacity Clutch

ECT

Engine Coolant Temperature

EMI

Electromagnetic Interference

IAT

Intake Air Temperature

IGN

Ignition

IMS

Internal Mode Switch

ISS

Input Speed Sensor

MAP

Manifold Absolute Pressure

MIL

Malfunction Indicator Lamp

NC

Normally Closed

NO

Normally Open

OBD

On Board Diagnostic

OSS

Output Speed Sensor

PC

Pressure Control

PCM

Powertrain Control Module

PCS

Pressure Control Solenoid

PS

Pressure Switch

PWM

Pulse Width Modulation

RPM

Revolutions Per Minute

SS

Shift Solenoid

STL

Service Transmission Lamp

TAP

Transmission Adaptive Pressure

TCC

Torque Converter Clutch

TFP

Transmission Fluid Pressure

TFT

Transmission Fluid Temperature

TP

Throttle Position

VSS

Vehicle Speed Sensor

WOT

Wide Open Throttle

TRANSMISSION IDENTIFICATION INFORMATION

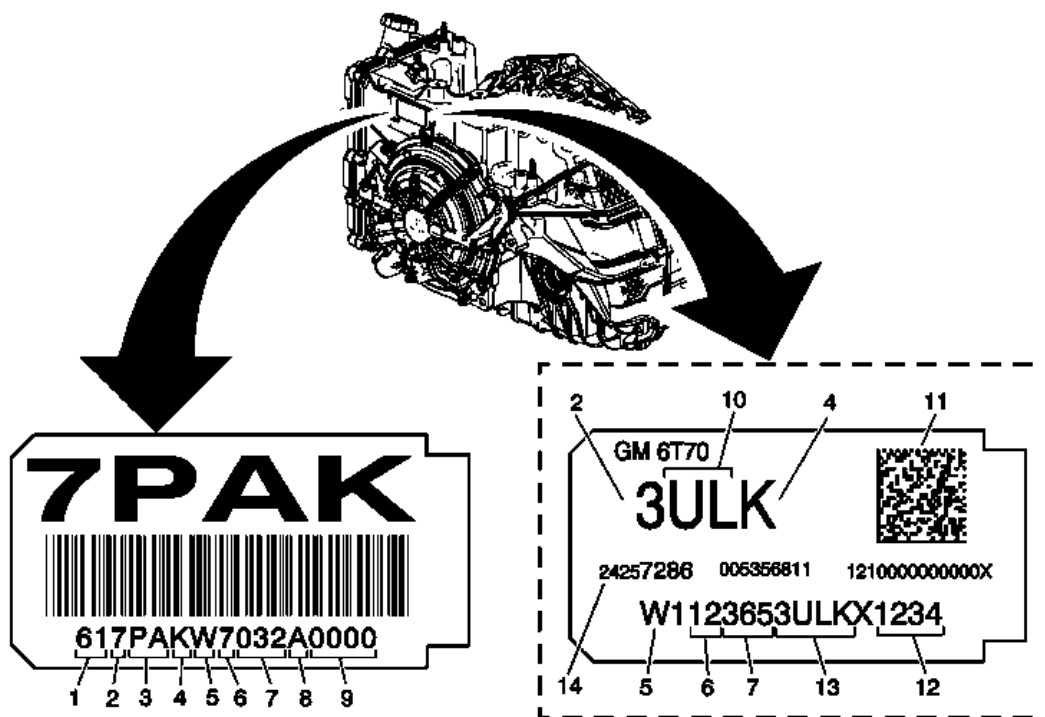


Fig. 1: Transmission Identification Label
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Code for Automatic Transmission
2	Model Year
3	Model for Transmission
4	Transmission Family
5	Source Code for Plant
6	Calendar Year
7	Julian Date
8	Shift/Line (A/B)
9	Numeric sequence starting at 0001 @ 12:01 AM each day
10	Model Code
11	Machine Readable Matrix
12	Sequential Serial Number
13	Broadcast Code
14	Transmission Assembly Number

Source Code for Plant

- 4 - Ramos Arizpe, Mexico
- J - Windsor, Ontario
- S - Strasbourg, France

- W - Warren, Michigan
- Y - Toledo, Ohio
- R - Boryeong, Korea
- M - N.man Tai, Shan Dong, China
- P - San Luis Potosi, Mexico
- S - Silao, Mexico

TRANSMISSION GENERAL DESCRIPTION

The Hydra-matic 6T70/75 is a fully automatic, 6-speed, front-wheel drive, electronic-controlled transmission. It consists primarily of a 4-element torque converter, a compound planetary gear set, friction and mechanical clutch assemblies, and a hydraulic pressurization and control system. There are 2 variants of the transmission, based on torque capacity. Architecture is common between the variants, and component differences are primarily related to size.

The 4-element torque converter contains a pump, a turbine, a pressure plate splined to the turbine, and a stator assembly. The torque converter acts as a fluid coupling to smoothly transmit power from the engine to the transmission. It also hydraulically provides additional torque multiplication when required. The pressure plate, when applied, provides a mechanical direct drive coupling of the engine to the transmission.

The planetary gear sets provide the 6 forward gear ratios and reverse. Changing gear ratios is fully automatic and is accomplished through the use of a transmission control module (TCM) located inside the transmission. The TCM receives and monitors various electronic sensor inputs and uses this information to shift the transmission at the optimum time.

The TCM commands shift solenoids and variable bleed pressure control solenoids to control shift timing and feel. The TCM also controls the apply and release of the torque converter clutch which allows the engine to deliver the maximum fuel efficiency without sacrificing vehicle performance. All the solenoids, including the TCM, are packaged into a self-contained control solenoid valve assembly.

The hydraulic system primarily consists of a vane-type pump, 2 control valve body assemblies, transfer drive gear support assembly and case. The pump maintains the working pressures needed to stroke the clutch pistons that apply or release the friction components. These friction components, when applied or released, support the automatic shifting qualities of the transmission.

The friction components used in this transmission consist of 5 multiple disc clutches. The multiple disc clutches combine with one way clutch to deliver 7 different gear ratios, 6 forward and one reverse, through the gear sets. The gear sets then transfer torque through the transfer drive gear, transfer driven gear and differential assembly.

The transmission may be operated in any of the following gear ranges:

PARK (P)

This position locks the front wheels and prevents the vehicle from rolling either forward or backward. PARK is the best position to use when starting the vehicle. Because the transmission utilizes a shift lock control system, it is necessary to fully depress the brake pedal before shifting out of PARK. For safety

reasons, use the parking brake in addition to the PARK position.

REVERSE (R)

This position allows the vehicle to be operated in a rearward direction.

NEUTRAL (N)

This position allows the engine to be started and operated while driving the vehicle. If necessary, you may select this position in order to restart the engine with the vehicle moving. This position should also be used when towing the vehicle.

DRIVE (D)

Drive range should be used for all normal driving conditions for maximum efficiency and fuel economy. Drive range allows the transmission to operate in each of the 6 forward gear ratios. Downshifts to a lower gear, or higher gear ratio, are available for safe passing by depressing the accelerator or by manually selecting a lower gear in the manual mode range.

Driver Shift Control (DSC) or Electronic Range Selection (ERS)

This position (M-Manual / L-Low) allows the driver to utilize the DSC/ERS system. When the shift selector lever is moved to this position, the driver may select upshifts or downshifts by using the paddle switches located on the steering wheel/shifter. An upshift is requested by pushing either + button. Refer to the vehicle owner's manual for more specific DSC/ERS information.

TRANSMISSION COMPONENT AND SYSTEM DESCRIPTION

The mechanical components of the 6T70/75 are as follows:

- A torque converter with an electronically controlled capacity clutch (ECCC)
- Off axis chain driven vane-type fluid pump assembly
- Input sun gear and carrier assembly
- 4-5-6 and 3-5 reverse clutch assembly with turbine shaft
- Low and reverse clutch (one way clutch) assembly
- Control valve body assembly
- Front differential transfer drive gear support assembly
- Front differential transfer drive gear assembly
- Front differential carrier assembly
- Case cover assembly

The electrical components of the 6T70/75 are as follows:

- Output speed sensor assembly
- Input speed sensor assembly

- Manual shift shaft with internal mode switch
- Control solenoid valve assembly, which contains the following components:
 - Transmission control module (TCM)
 - 5 variable bleed line pressure control (PC) solenoids
 - Torque converter clutch (TCC) pressure control solenoid
 - 2 shift solenoids
 - Transmission fluid temperature sensor

For more information, refer to **Electronic Component Description**.

TOW/HAUL MODE DESCRIPTION AND OPERATION

Tow/haul mode is a function within the vehicle's software/calibration that optimizes transmission gear selection for operation during towing or with heavy loads. This optimization includes improving acceleration performance during launches, reducing shift busyness, assisting brake performance and speed control during engine braking situations, and improving vehicle speed control while requiring less throttle pedal activity.

In general, tow/haul mode maintains lower gears longer and increases shift pressures. It is designed to be most effective when the vehicle and trailer combined weight is at least 75% of the vehicle's Gross Combined Weight Rating (GCWR). Operation of tow/haul in a lightly loaded or non-loaded vehicle will not cause damage. However, there is no benefit to the selection of tow/haul when the vehicle is unloaded, and use of tow/haul mode during unloaded driving conditions will decrease fuel economy and may generate shift feel concerns.

TRANSMISSION ADAPTIVE FUNCTIONS

The 6T70/75 transmission utilizes a line pressure control system during upshifts to compensate for the normal wear of transmission components. As the apply components within the transmission wear or change over time, shift time (the time required to apply a clutch) increase or decreases. In order to compensate for these changes, the transmission control module (TCM) adjusts the pressure commands to the various PC solenoids, to maintain the originally calibrated shift timing. The automatic adjusting process is referred to as "adaptive learning" and it is used to ensure consistent shift feel plus increase transmission durability. The TCM monitors the A/T input speed sensor (ISS) and the A/T output speed sensor (OSS) during commanded shifts to determine if a shift is occurring too fast (harsh) or too slow (soft) and adjusts the corresponding pressure control (PC) solenoid signal to maintain the set shift feel.

The purpose of the adapt function is to automatically compensate the shift quality for the various vehicle shift control systems. The adapt function is a continuous process that will help to maintain optimal shift quality throughout the life of the vehicle.

TRANSMISSION INDICATORS AND MESSAGES

The following transmission-related indicators and messages may be displayed on the Instrument Panel Cluster (IPC). For a complete listing and description of all vehicle indicators and messages, refer to **Indicator/Warning Message Description and Operation** .

"TRANSMISSION HOT IDLE ENGINE"

This message is displayed when the TCM detects a transmission fluid temperature (TFT) equal to or greater than 132°C (270°F) for 5 seconds.

"SERVICE TRANSMISSION"

This message displays when there is a problem with the transmission.

ELECTRONIC COMPONENT DESCRIPTION

Control Solenoid (W/Body and TCM) Valve Assembly

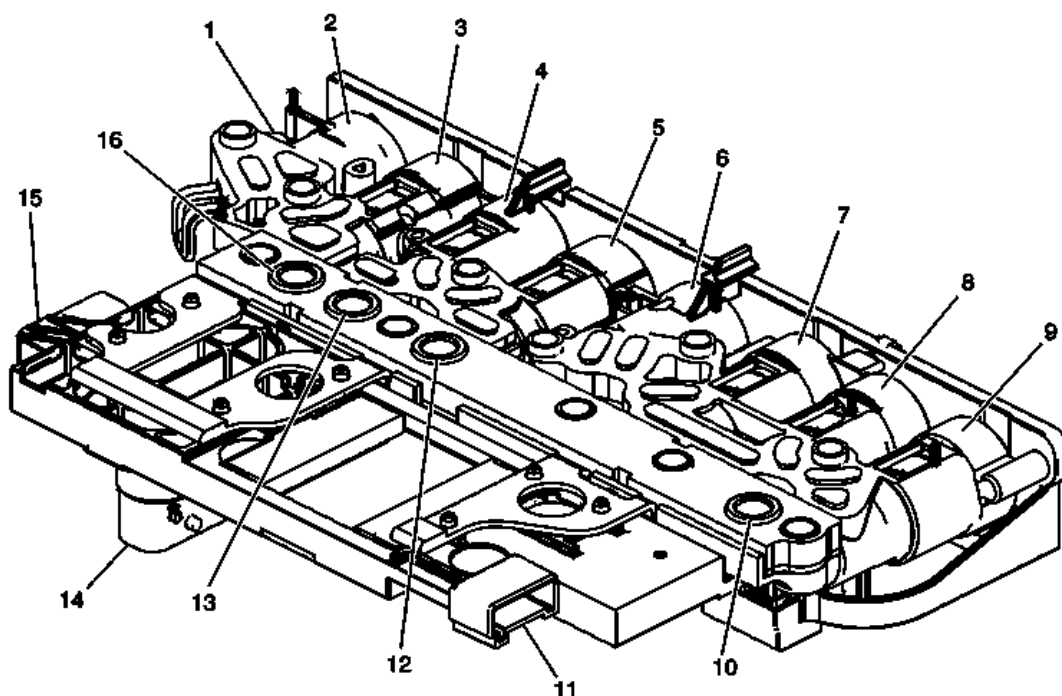


Fig. 2: Identifying Control Solenoid (W/Body & TCM) Valve Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Control Solenoid Valve Assembly X3 (ISS)
2	Shift Solenoid 1
3	Pressure Control Solenoid 3 (R1/456)
4	Pressure Control Solenoid 5 (1234)
5	Torque Converter Clutch (TCC) Pressure Control Solenoid
6	Shift Solenoid 2
7	Pressure Control Solenoid 2 (35R)
8	Pressure Control Solenoid 4 (26)
9	Line Pressure Control Solenoid
10	Transmission Fluid Pressure (TFP) Switch 5 (35R)

11	Control Solenoid Valve Assembly X2 (IMS)
12	Transmission Fluid Pressure (TFP) Switch 3 (26)
13	Transmission Fluid Pressure (TFP) Switch 4 (456/R1)
14	Control Solenoid Valve Assembly X1
15	Control Solenoid Valve Assembly X4 (OSS)
16	Transmission Fluid Pressure (TFP) Switch 5 (35R)

The control solenoid (w/body and TCM) valve assembly contains the following components:

- Transmission control module (TCM)
- Clutch pressure control solenoids (Clutch PC Sol)
- Shift solenoids (SS)
- Line pressure control solenoid (Line PC Sol)
- Torque converter clutch pressure control solenoid (TCC PC Sol)
- Transmission fluid temperature sensor (TFT Sensor)
- TCM temperature sensor
- Power-up temperature sensor
- Transmission fluid pressure switches (TFP Sw)

These components are not serviced separately. The control solenoid (w/body and TCM) valve assembly utilizes a lead-frame system to connect these components electrically to the TCM. No wires are used for these components. The control solenoid (w/body and TCM) valve assembly bolts directly to the lower and upper valve body assemblies inside the transmission. The control solenoid (w/body and TCM) valve assembly connects to the engine harness 20-way connector.

Manual Shift Detent Lever with Shaft Position Switch Assembly (IMS)

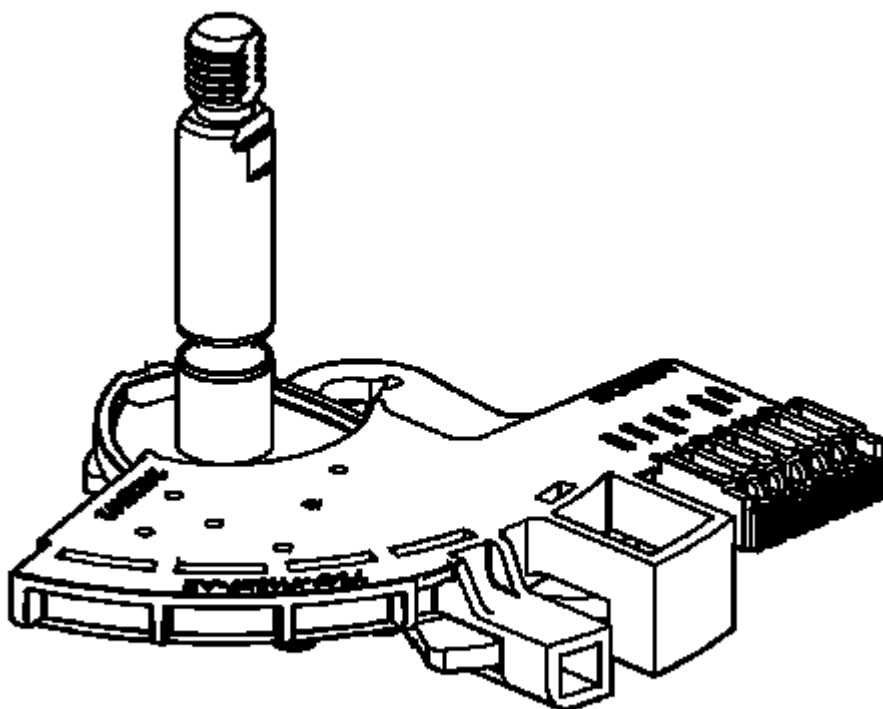


Fig. 3: Identifying Manual Shift Detent Lever with Shaft Position Switch
Courtesy of GENERAL MOTORS COMPANY

The transmission shaft position switch assembly is a sliding contact switch attached to the manual shaft detent lever assembly inside the transmission case. The five inputs to the TCM from the transmission manual shift shaft switch assembly indicate the transmission gear selector lever position. This information is used for engine controls as well as determining the transmission shift patterns. The state of each input is available for display on the scan tool. The five input parameters represented are Signal A, Signal B, Signal C, Signal P (Parity) and Signal N (P/N Start). The transmission shaft position switch assembly is connected to the Control Solenoid (W/Body and TCM) Valve Assembly via the Control Solenoid Valve Assembly X2 (IMS) connector.

Input Speed Sensor (ISS)

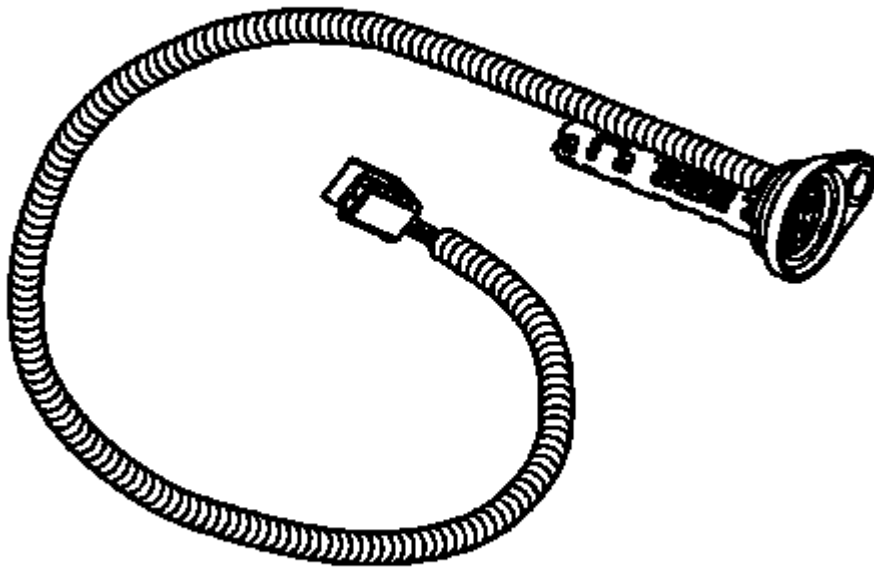


Fig. 4: Identifying Input Speed Sensor (ISS)
Courtesy of GENERAL MOTORS COMPANY

The input speed sensor (ISS) is a hall-effect type sensor. The ISS mounts to the transmission case cover assembly and connects to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the 3-5-R clutch piston housing machined teeth surface. The sensor receives 8.3-9.3 volts on the ISS/OSS Supply Voltage circuit from the TCM. As the 3-5-R/4-5-6 clutch piston housing rotates, the sensor produces a signal frequency based on the machined surface of the 3-5-R/4-5-6 clutch piston housing. This signal is transmitted through the ISS signal circuit to the control solenoid (w/body and TCM) valve assembly. The TCM uses the ISS signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio. The input speed sensor (ISS) is connected to the Control Solenoid (W/Body and TCM) Valve Assembly via the Control Solenoid Valve Assembly X3 (ISS) connector.

Output Speed Sensor (OSS)

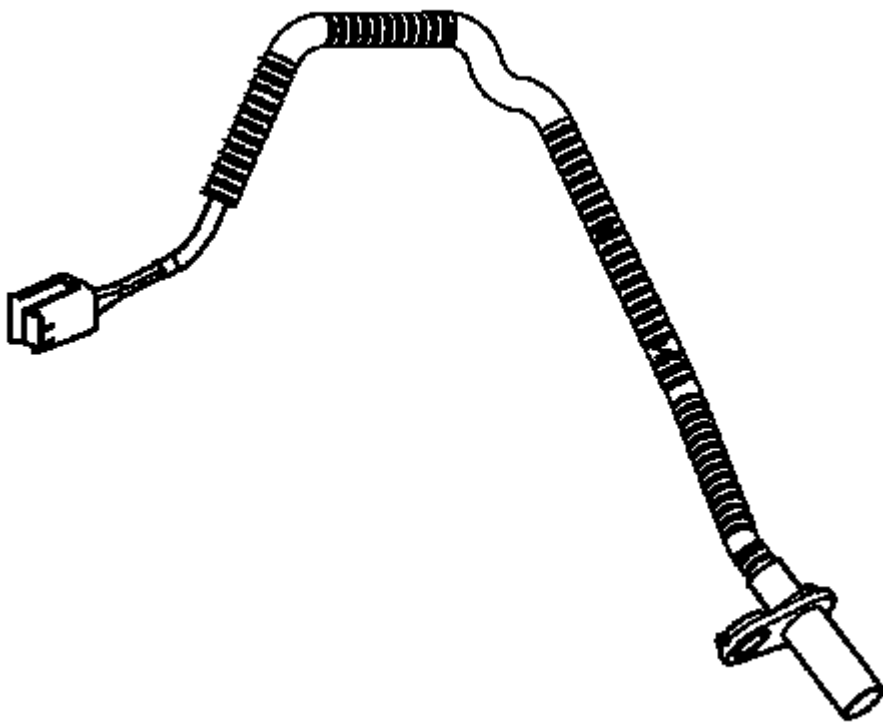


Fig. 5: Identifying Output Speed Sensor (OSS)
Courtesy of GENERAL MOTORS COMPANY

The output speed sensor (OSS) is a hall-effect type sensor. The OSS mounts to the transmission case below the control valve body assembly and connects to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the Park gear machined teeth surface. The sensor receives 8.3-9.3 volts on the ISS/OSS supply voltage circuit from the TCM. As the front differential transfer drive gear assembly rotates, the sensor produces a signal frequency based on the machined surface of the Park gear. This signal is transmitted through the OSS signal circuit to the TCM. The TCM uses the OSS signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio. The output speed sensor (OSS) is connected to the Control Solenoid (W/Body and TCM) Valve Assembly via the Control Solenoid Valve Assembly X4 (OSS) connector.

AUTOMATIC TRANSMISSION INLINE 20-WAY CONNECTOR DESCRIPTION

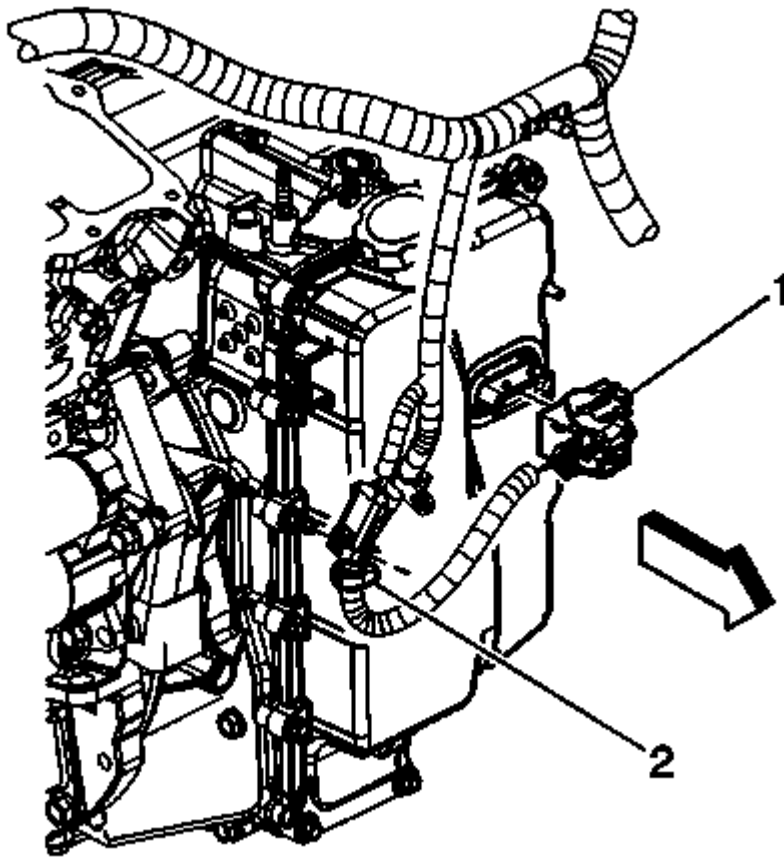


Fig. 6: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

The transmission electrical connector is an important part of the transmission operating system. Any interference with the electrical connection can cause the transmission to set diagnostic trouble codes or affect proper operation. The following items can affect the electrical connection:

- Bent pins in the connector from rough handling during connection and disconnection
- Wires backing away from the pins or coming uncrimped, in the external wiring harness
- Dirt contamination entering the connector when disconnected
- Transmission fluid leaking into the connector, wicking up into the external wiring harness and degrading the wire insulation
- Moisture intrusion in the connector
- Low pin retention in the external connector from excessive connection and disconnection of the wiring connector assembly
- Pin corrosion from contamination
- Damaged connector assembly

Remember the following points:

- Limit twisting or wiggling the connector during removal. Bent pins can occur.
- Do not pry the connector off with a screwdriver or other tool.
- Whenever the transmission external wiring connector is disconnected from the internal harness and the engine is operating, DTCs will set. Clear these DTCs after reconnecting the external connector.

NON-SHIFTING CLUTCH FUNCTION VERIFICATION DESCRIPTION

The 6T70/75 transmission uses a pressure control system to apply and release clutches during shifts. The transmission control module (TCM) controls pressure commands to the pressure control solenoids.

As normal wear of the transmission clutches occur, the TCM performs a clutch function verification. The TCM momentarily commands a clutch on at a low pressure. The clutch function verification is conducted on smooth roads when the transmission is not shifting and engine torque is consistent and positive.

When a clutch function verification is occurring, a slight bump or drag may be detected momentarily. The clutch function verification will occur a few times over several minutes and will not repeat again for a thousand or more miles. This is a normal condition and no repair attempts should be performed.

The clutch function verification will be performed sooner for a particular clutch if the TCM detects it is producing frequent poor shift control.

CRUISE GRADE BRAKING DESCRIPTION

Purpose

- Cruise grade braking assists when driving on a downhill grade.
- It maintains vehicle speed by automatically implementing a shift schedule that uses the engine and the transmission to slow the vehicle.

Activation

- This feature is internal to the vehicle's software/calibration and requires no customer action to activate.
- Cruise grade braking is not available in Range Selection Mode.

Function

- Automatic downshifting to assist in speed control will activate when vehicle speed has increased from the set point by a certain amount. Multiple downshift may be commanded depending on the amount of deviation of vehicle speed to the set speed. As vehicle speed slows and approaches the original set speed, upshifts will be commanded to return to a normal operating condition.
- At some speeds and on some downhill grades, the transmission may not be able to command a gear low enough to slow the vehicle to the set point without overspeeding the engine.
- In this case the transmission will command all available downshifts, but if further engine braking is desired, the driver must press the brake pedal to slow the vehicle enough so additional downshift(s) can be commanded.
- Pressing the brake pedal has the normal effect of cancelling cruise control operation and in this case a

transition to Normal - Powertrain Braking is completed.

- As always, if cruise control operation was cancelled through usage of the brake pedal, it must be reinitiated by tapping either the Set or Resume Cruise switches.

AUTOMATIC TRANSMISSION HYDRAULIC DIAGRAMS

Park - Engine Running

When the gear selector lever is in the Park (P) position, fluid is drawn into the pump through the transmission fluid filter assembly. Line pressure is then directed to the following valves:

Fluid Pressure Directed in Preparation for a Shift

Manual Valve

Mechanically controlled by the gear selector lever, the manual valve is in the Park (P) position and prevents line pressure from the pressure regulator valve from entering the reverse and drive circuits.

R1/456 Pressure Control (PC) Solenoid 3

The R1/456 pressure control solenoid (PCS) is energized (HIGH) allowing actuator feed limit fluid to enter the PCS R1/456 CL fluid circuit. PCS R1/456 CL fluid is then routed through orifice #22 to the 4-5-6 clutch boost valve and through orifice #21 to the R1/ 456 clutch regulator valve.

R1/456 Clutch Regulator Valve

PCS R1/456 CL fluid at the R1/4-5-6 clutch regulator valve moves the valve against R1/4-5-6 clutch regulator spring force and R1/FDBK fluid. This allows line pressure to pass through the valve and enter the R1/456CL FD circuit. R1/456CL FD is then routed to clutch select valve 2.

Shift Solenoid 1

Shift solenoid 1 is energized (ON) allowing actuator feed limit fluid to enter the solenoid 1 circuit. Solenoid 1 fluid is routed to the #2 ball check valve and through orifice #10 to the torque converter clutch (TCC) regulator valve and shuttle valve (SHTL).

TCC Regulator Valve and Shuttle Valve

Solenoid 1 fluid is routed to the TCC regulator valve and shuttle valve and moves the valve against TCC regulator valve spring force.

#2 Ball Check Valve

Solenoid 1 fluid seats the #2 ball check valve against the reverse fluid passage and fluid is forced through orifice #15 into the CSV2 enable fluid circuit.

Clutch Select Valve 2

CSV2 enable fluid is routed to the clutch select valve 2 and moves the valve against clutch select valve 2 spring force. This allows R1/456 CL FD fluid to pass through the valve and enter the R1 supply circuit. R1 Supply fluid is then routed into the R1 fluid circuit and, through orifice #18. R1 fluid is then routed to the low & reverse clutch assembly in preparation for a shift into low or reverse gear.

Shift Solenoid 2

Shift solenoid 2 is energized (ON) allowing actuator feed limit fluid to enter the solenoid 2 fluid circuit and is then routed to the #3 ball check valve and through orifice #13 to the clutch select valve #3.

3-5 Reverse Clutch Regulator Valve

Actuator feed limit fluid is routed through the valve and into the PS2 fluid passage. PS2 fluid is then sent to the normally closed #2 pressure switch and opens the switch.

#3 Ball Check Valve

Solenoid 2 fluid seats the #3 ball check valve against 456 CL fluid passage and fluid is forced through orifice #13 into the CSV3 enable fluid circuit. CSV3 enable fluid is then routed to the clutch select valve 3.

Clutch Select Valve #3

CSV3 enable fluid moves the clutch select valve 3 against clutch select valve 3 spring force.

Compensator Blow Off

Line pressure is routed through orifice #17 to the compensator feed circuit. Compensator feed fluid enters the compensator blow off circuit and fills the 4-5-6 dam piston area.

Park- Engine Running

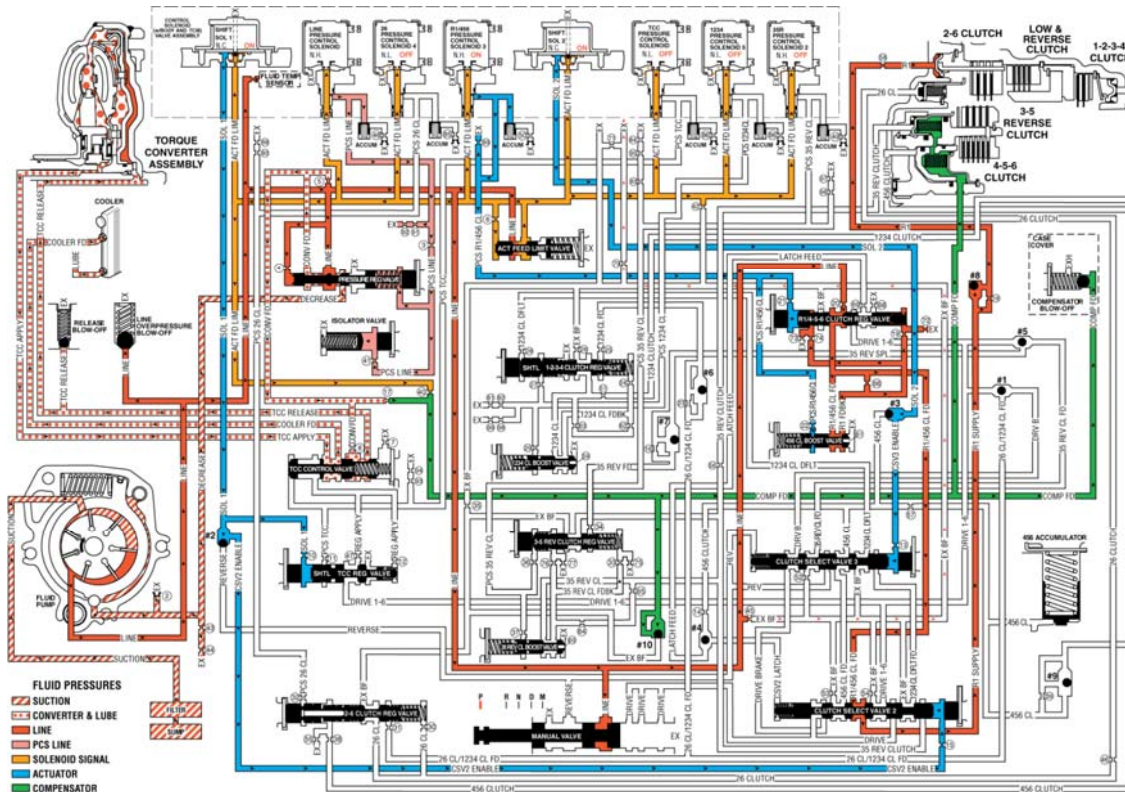


Fig. 7: Fluid Flow Diagram - Park - Engine Running
 Courtesy of GENERAL MOTORS COMPANY

Reverse

When the gear selector lever is moved to the Reverse (R) position (from the Park position) the normally high 35R pressure control solenoid 2 is commanded ON and the following changes occur in the transmission's hydraulic and electrical systems:

Fluid Pressure Directed in Preparation for a Shift

Manual Valve

With the manual valve in the reverse position, line pressure is directed into the reverse fluid circuit to the #2 ball check valve and clutch select valve 3.

#2 Ball Check Valve

Reverse fluid seats the #2 ball check valve against the solenoid 1 fluid passage and fluid is forced through orifice #15 into the CSV2 enable circuit.

Clutch Select Valve 2

CSV2 enable fluid, present at the valve from Park position, continues to hold the clutch select valve 2 against clutch select valve 2 spring force.

Low & Reverse Clutch Applies

Clutch Select Valve 3

Reverse fluid from the manual valve is routed to clutch select valve 3 to combine with clutch select valve 3 spring force to keep the valve in the off position. This allows reverse fluid to pass through the valve and enter the 3-5 clutch reverse feed circuit. The 3-5 clutch reverse feed fluid from the clutch select valve 3 is also routed to #5 ball check valve.

Low & Reverse Clutch

R1 supply fluid passes through orifice #18 and unseats check ball #8. R1 supply fluid enters the low & reverse clutch piston circuit and moves the piston against the spring force to apply the low & reverse clutch plates.

#5 Ball Check Valve

The 3-5 clutch reverse feed fluid seats #5 ball check valve against the drive 1-6 circuit allowing 3-5 clutch reverse feed fluid to enter the 3-5 reverse supply circuit. The 3-5 reverse supply fluid is then routed to #7 ball check valve and through orifice #16 where it enters the 3-5 reverse feed circuit. The 3-5 reverse feed passes through orifice #34 and then is routed to the 3-5 reverse clutch regulator valve.

3-5 Reverse Clutch Applies

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is energized (HIGH) allowing actuator feed limit fluid to enter the PCS 3-5 reverse clutch circuit. PCS 3-5 reverse clutch fluid is then routed through orifice #36 to the 3-5 reverse clutch regulator valve and through orifice #37 to the 3-5 reverse boost valve.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3-5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. The 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch and the 3-5 reverse boost valve. PS2 fluid from pressure switch 2 exhausts through the valve allowing the switch to close.

3-5 Reverse Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 clutch reverse feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch

The 3-5 reverse clutch fluid enters the 3-5R/456 clutch housing to move the piston against spring force and compensator feed fluid to apply the 3-5 reverse clutch plates.

Reverse

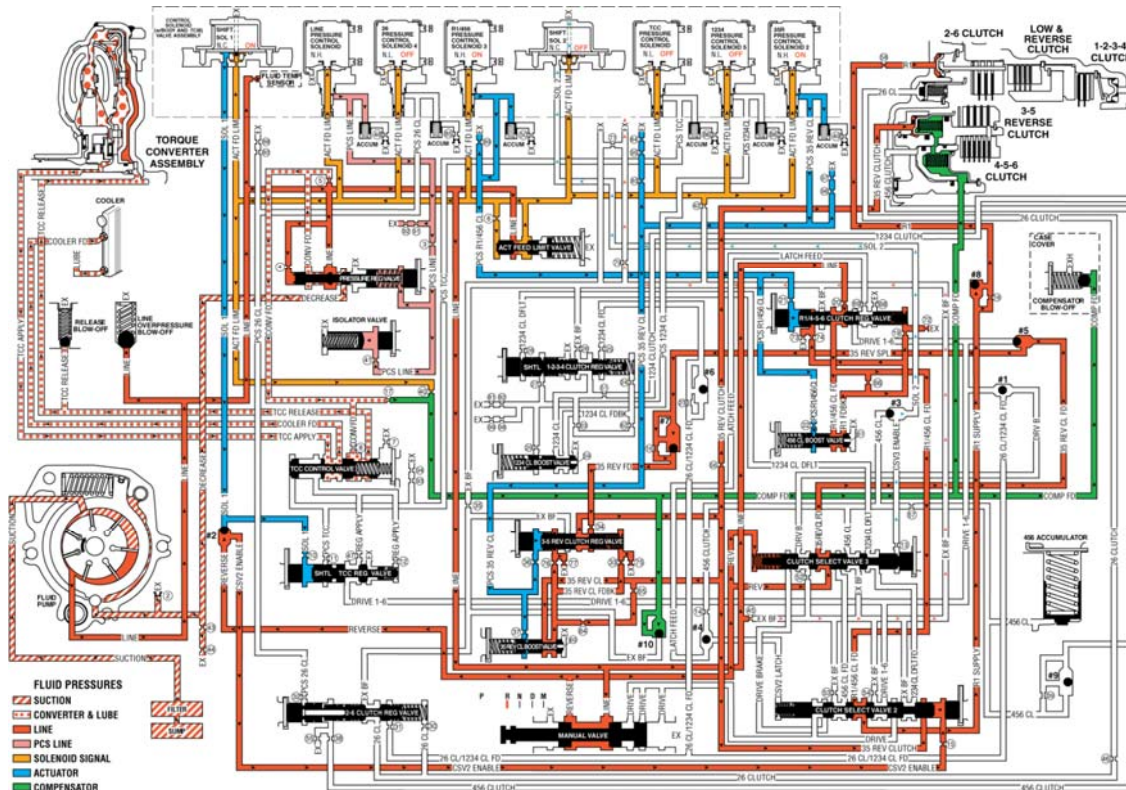


Fig. 8: Fluid Flow Diagram - Reverse
Courtesy of GENERAL MOTORS COMPANY

Neutral - Engine Running

When the gear selector is moved to the Neutral (N) position, the hydraulic and electrical system operation is identical to Park (P) range. However, if Neutral is selected after the vehicle was operating in Reverse (R), the normally high 35R pressure control solenoid 2 is commanded OFF and the following changes would occur in the hydraulic system:

3-5 Reverse Clutch Releases

Manual Valve

The manual valve is moved to the Neutral position and blocks line pressure from entering the reverse and drive fluid circuits. The reverse fluid from the #2 ball check valve and clutch select valve 3 is opened to an exhaust passage at the manual valve.

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded OFF allowing PCS 3-5 reverse clutch fluid from the 3-5

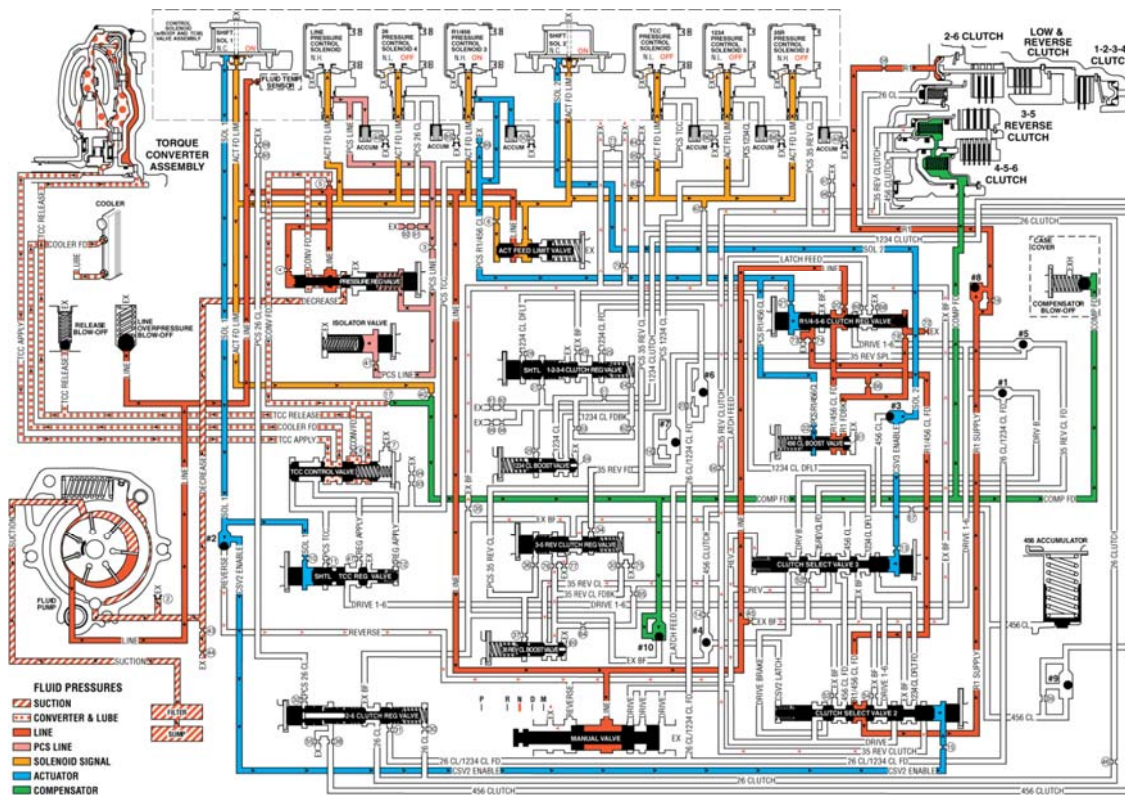


Fig. 9: Fluid Flow Diagram - Neutral - Engine Running
Courtesy of GENERAL MOTORS COMPANY

Drive Range, First Gear Engine Braking

When the gear selector lever is moved to the Drive (D) range from the Neutral (N) position, the transmission will provide engine braking. In this operating range, the normally-low 1234 pressure control solenoid 5 is commanded ON and in the engine braking mode the following changes occur within the hydraulic circuits:

Fluid Pressure is Directed to the 1-2-3-4 Clutch and the Low & Reverse Clutch to Provide Engine Braking

Manual Valve

The manual valve is moved to the Drive (D) position and allows line fluid pressure to enter the drive fluid circuit. Drive fluid is then routed to the clutch select valve 2.

Clutch Select Valve 2

Drive fluid at the clutch select valve 2 passes through the valve and enters the drive brake circuit. Drive brake fluid is then routed to the clutch select valve 3.

Clutch Select Valve 3

Drive brake fluid at the clutch select valve 3 passes through the valve and enters the Drive B fluid circuit. Drive B fluid is then routed to #1 ball check valve.

#1 Ball Check Valve

Drive B fluid seats the #1 ball check valve against drive 1-6 fluid to force drive B fluid into the 26/1234 feed passage. The 26/ 1234 feed fluid is routed through orifice #31 and, to the 2-6 clutch regulator valve. The 26/1234 feed fluid passes through the 2-6 clutch regulator valve and enters the pressure switch 3 (PS3) fluid circuit. PS3 fluid is then routed to the normally closed pressure switch 3 and opens the switch.

#6 Ball Check Valve

26/1234 feed fluid unseats the #6 ball check valve allowing 26/1234 feed fluid to enter the 1234 clutch feed circuit. The 1234 clutch feed fluid is routed through orifice #25 and then to the 1-2-3-4 clutch regulator valve.

1-2-3-4 Clutch Applies

1234 Pressure Control Solenoid 5

The 1234 pressure control solenoid 5 is commanded ON allowing actuator feed limit to enter the PCS 1234 clutch fluid circuit. PCS 1234 clutch fluid is then routed through orifice #27 to the 1-2-3-4 clutch regulator valve. PCS1234 clutch fluid is also routed through orifice #29 and then to the 1-2-3-4 clutch boost valve.

1-2-3-4 Clutch Regulator Valve

PCS1234 clutch fluid moves the 1-2-3-4 clutch regulator valve against 1-2-3-4 clutch regulator valve spring force to allow 1234 clutch feed fluid to pass through the valve and enter the 1234 clutch fluid circuit. The 1234 clutch fluid is then routed to the 1234 clutch boost valve and the 1-2-3-4 clutch.

1-2-3-4 Clutch Boost Valve

PCS1234 clutch fluid pressure acts on a differential area moving the 1234 clutch boost valve against the 1234 clutch boost valve spring. The 1234 clutch fluid passes through the valve and enters the 1234 clutch feedback circuit. As PCS 1234 clutch fluid pressure is increased to a given value, the 1234 clutch boost valve opens the 1234 clutch feedback circuit to exhaust. This results in the 1234 clutch regulator valve moving to the full feed position sending full 26 CL/1234 CL feed pressure (full line pressure) to the clutch.

1-2-3-4 Clutch

The 1234 clutch fluid enters the 1234 clutch to move the piston against spring force to apply the 1-2-3-4 clutch plates.

Drive Range, First Gear Engine Braking

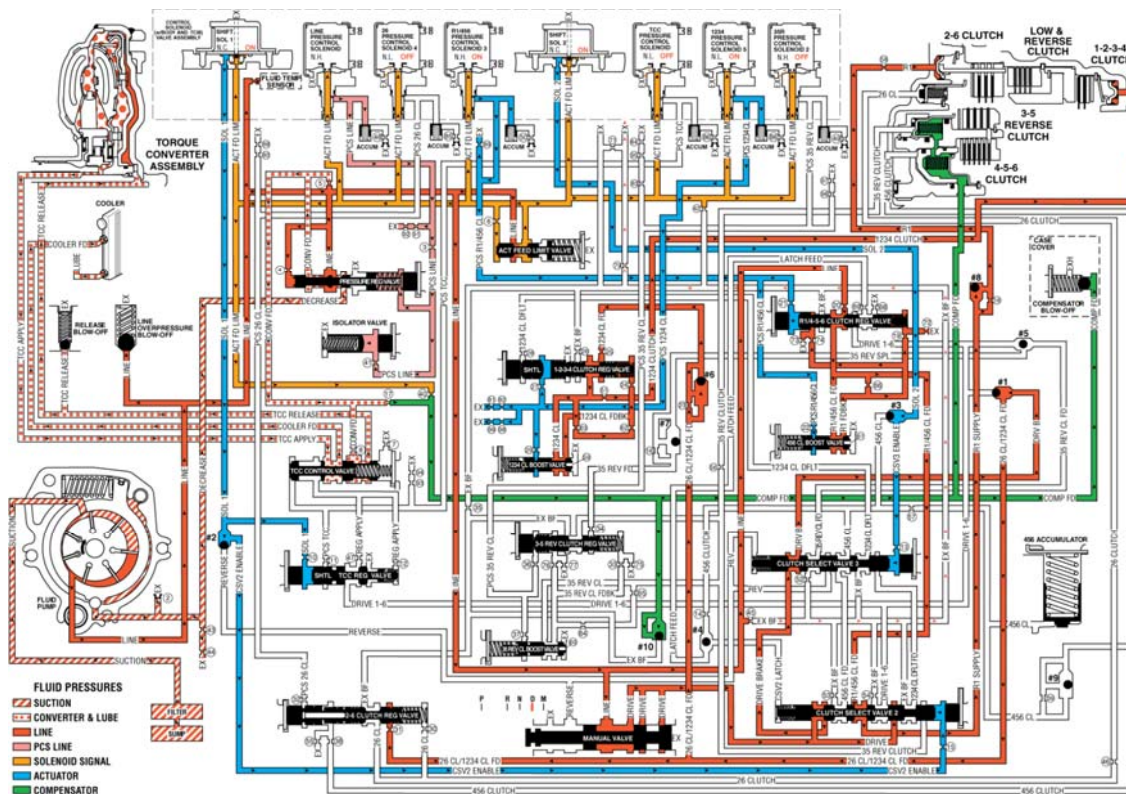


Fig. 10: Fluid Flow Diagram - Drive Range, First Gear Engine Braking
Courtesy of GENERAL MOTORS COMPANY

Drive Range, First Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, throttle position sensor and other vehicle sensors to

determine the precise moment to deenergize or "turn off" shift solenoid 1 and command OFF the normally-high R1/456 pressure control solenoid 3.

Low & Reverse Clutch Releases

Shift Solenoid 1

When shift solenoid 1 is "turned OFF", CSV2 enable fluid from the clutch select valve 2 passes by the #2 ball check valve and enters the solenoid 1 fluid circuit. Solenoid 1 fluid from the #2 ball check valve and TCC regulator valve is then routed to the solenoid where it exhausts.

Clutch Select Valve 2

Clutch select valve 2 (CSV2) enable fluid is exhausted from the clutch select valve 2 and clutch select valve 2 spring force moves the valve to the released position. With clutch select valve 2 in the released position, drive fluid from the manual valve passes through the valve and enters the drive 1-6 fluid circuit. Drive 1-6 fluid then feeds the R1/456 and 35 reverse clutch regulator valves and the TCC regulator valve.

R1/456 Pressure Control Solenoid 3

The R1/456 pressure control solenoid 3 is commanded OFF allowing PCS R1/456 fluid from the R1/456 clutch regulator valve and 456 clutch boost valve to exhaust.

R1/456 Clutch Regulator Valve

R1/456 clutch regulator valve spring force moves the valve to exhaust the R1/456 clutch feed circuit and allow drive 1-6 fluid to enter the PS4 fluid circuit. PS4 fluid is then routed to the normally-closed pressure switch 4 and opens the switch. PS4 fluid is also routed to the #4 ball check valve and flows into the CSV2 latch fluid circuit.

#4 Ball Check Valve

PS4 fluid pressure seats the #4 ball check valve against the 456 clutch fluid circuit. PS4 fluid is then directed into the CSV2 latch fluid circuit and routed to the clutch select valve 2. CSV2 latch fluid combines with clutch select valve 2 spring force and holds the valve in this position during all 6 forward gear ranges.

#5 Ball Check Valve

Drive 1-6 fluid pressure seats the #5 ball check valve against the 35 reverse clutch feed fluid passage. Drive 1-6 fluid is then directed into the 35R supply fluid circuit which is routed to the #7 ball check valve and orifice #16.

#7 Ball Check Valve

The 35R supply fluid seats the #7 ball check valve against the 35R feed fluid passage to force 35R supply fluid through orifice #16 before entering the 35R feed circuit. The 35R feed fluid is then routed to the 3-5 reverse clutch regulator valve.

Low and Reverse Clutch

Low and reverse clutch spring force moves the low and reverse clutch piston which forces R1 fluid out. R1 fluid is routed to the clutch select valve 2 where it enters the exhaust backfill circuit. The low and reverse clutch is in the released position.

Drive Range, First Gear

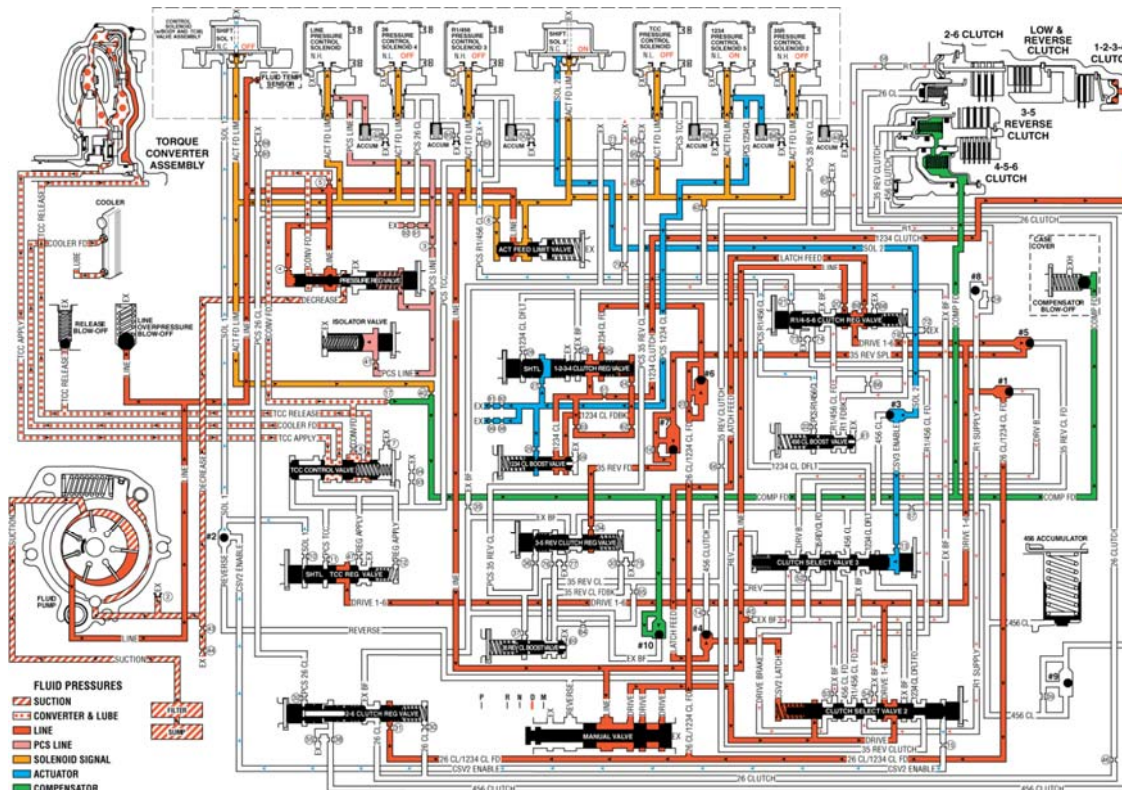


Fig. 11: Fluid Flow Diagram - Drive Range, First Gear
Courtesy of GENERAL MOTORS COMPANY

Drive Range, Second Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-low pressure control solenoid 4.

Second Clutch Applies

26 Pressure Control Solenoid 4

The 26 pressure control solenoid 4 is commanded ON, allowing actuator feed limit fluid to enter the pressure control solenoid (PCS) 26 clutch fluid circuit. PCS 26 clutch fluid is then routed through orifice #32 to the 2-6 clutch regulator valve.

2-6 Clutch Regulator Valve

PCS 26 clutch fluid moves the 2-6 clutch regulator valve assembly against the 2-6 clutch regulator valve spring

force to allow 26 clutch/1234 clutch feed fluid to pass through the valve. The 26 clutch/1234 clutch feed fluid is routed into the 26 clutch fluid circuit where it passes through orifice #46 and then to the spring end of the 2-6 clutch regulator valve, and to the 2-6 clutch within the case cover.

2-6 Clutch

The 26 clutch fluid from the 2-6 clutch regulator valve is routed through the case cover and to the 2-6 clutch piston assembly. The 26 clutch fluid pressure moves the piston against 2-6 clutch spring force to apply the 2-6 clutch plates.

Drive Range, Second Gear

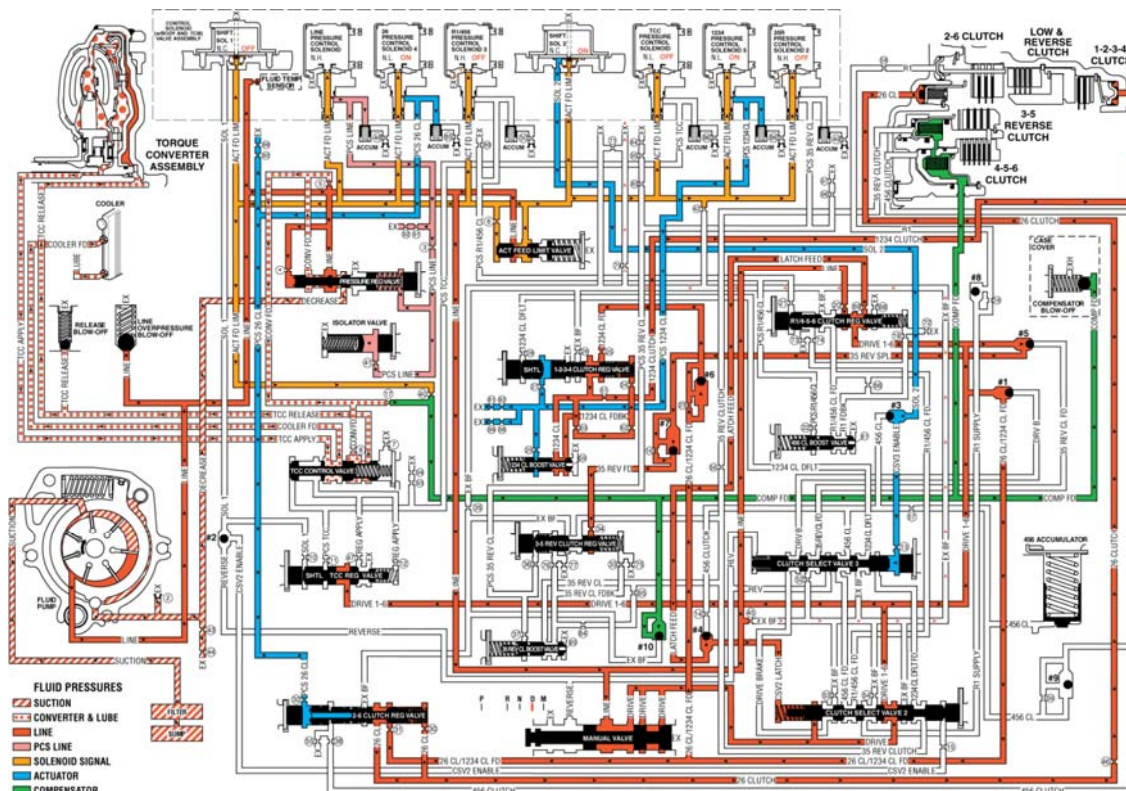


Fig. 12: Fluid Flow Diagram - Drive Range, First Gear
Courtesy of GENERAL MOTORS COMPANY

Drive Range, Third Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command OFF the normally-low 26 pressure control solenoid 4. At the same time the 35R pressure control solenoid 2 is also commanded ON to regulate 3-5 clutch apply.

3-5 Reverse Clutch Applies

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded ON allowing actuator feed fluid to enter the pressure control solenoid (PCS) 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #36 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #37 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 35 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 35 reverse clutch fluid passes through the valve and enters the 35 reverse clutch feedback circuit. As PCS 35 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 35 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 35 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 35 reverse clutch feedback fluid. This allows 35 reverse feed to pass through the valve and enter the 35 reverse clutch circuit. The 35 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS2 fluid from the pressure switch 2 exhausts through the valve allowing the switch to close.

3-5 Reverse Clutch

The 35 reverse clutch fluid enters the 3-5 reverse/4-5-6 clutch housing to move the piston against spring force to apply the 3-5 reverse clutch plates.

2-6 Clutch Releases

26 Pressure Control Solenoid 4

The 26 pressure control solenoid 4 is commanded OFF allowing PCS 26 clutch fluid from the 2-6 clutch regulator valve to exhaust. The 26 clutch/1234 clutch feed fluid at the 2-6 clutch regulator valve passes through the valve and enters the PS3 fluid circuit. PS3 fluid is then routed to pressure switch 3 and opens the normally-closed switch.

2-6 Clutch Regulator Valve

The 2-6 clutch regulator valve spring force moves the valve to allow 26 clutch fluid from the 2-6 clutch to pass through the valve and enter the exhaust backfill fluid circuit.

2-6 Clutch

The 2-6 clutch spring force moves the 2-6 clutch piston to release the 2-6 clutch plates and forces 26 clutch fluid to exhaust. The 26 clutch fluid is routed through the 2-6 clutch regulator valve where it enters the exhaust backfill fluid circuit and is exhausted.

Drive Range, Third Gear

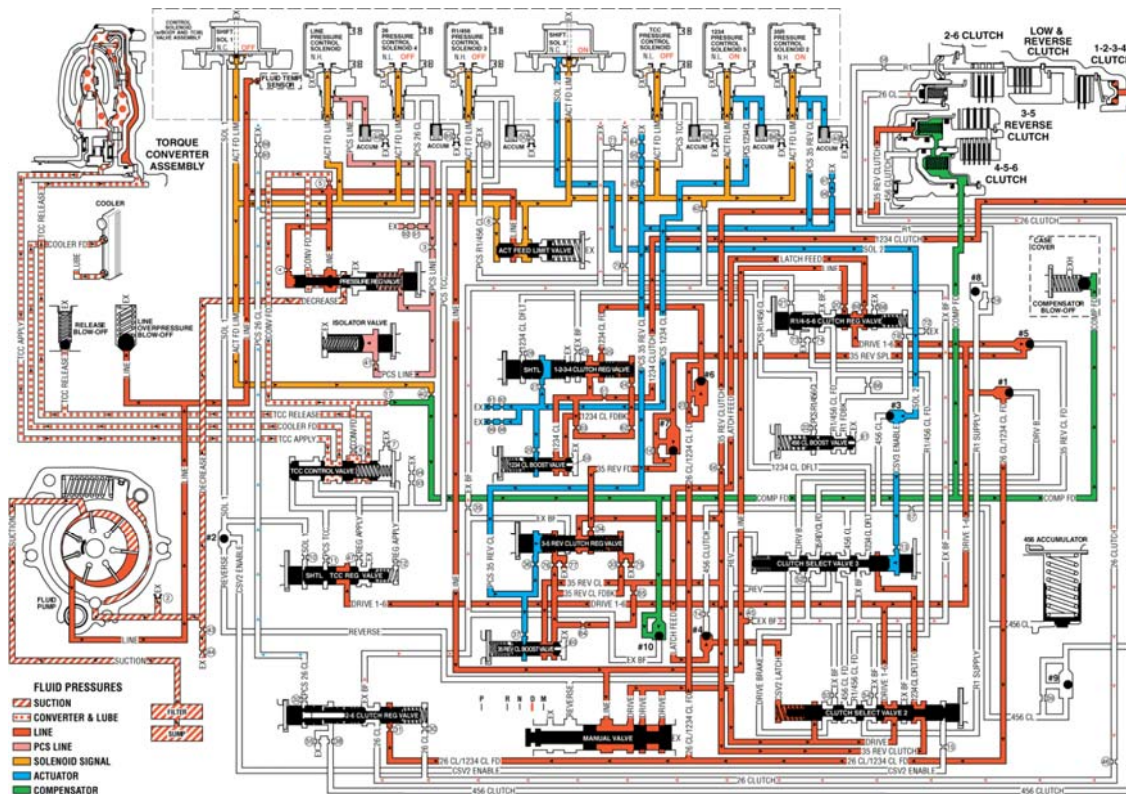


Fig. 13: Fluid Flow Diagram - Drive Range, Third Gear
 Courtesy of GENERAL MOTORS COMPANY

Drive Range, Third Gear Default

If the transmission is in 1st, 2nd or 3rd gear during a transmission electrical component failure, the transmission will default to 3rd gear. All solenoids will default to their normal state. If the torque converter clutch was applied, it will release. This default action will enable the vehicle to be safely driven to a service center.

1-2-3-4 Clutch Stays Applied

Shift Solenoid 2

Shift solenoid 2 defaults to it's normally-closed state (OFF), and SOL 2 fluid exhausts through the solenoid.

Clutch Select Valve 3

Solenoid 2 fluid pressure no longer holds the clutch select valve 3 open. When the valve moves back to the closed position, it opens the 1234 clutch default fluid circuit, and 1234 default fluid is routed to the 1-2-3-4 clutch regulator valve.

1-2-3-4 Clutch Regulator Valve

With the absence of PCS 1234 clutch fluid, due to the default state of the 1234 pressure control solenoid 5, the 1-2-3-4 regulator valve would close from spring force. However, the 1234 clutch default fluid enters behind the 1-2-3-4 regulator shuttle valve and keeps the valve in the open position.

1-2-3-4 Clutch

With the 1-2-3-4 clutch regulator valve still held in the open position, the 1-2-3-4 clutch will stay applied.

3-5 Reverse Clutch Applied or Applies

35R Pressure Control Solenoid 2

The normal state for the 35R pressure control solenoid 2 is ON, therefore PSC 35 reverse clutch fluid will still be routed to the 3-5 reverse clutch regulator valve and the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3-5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS2 fluid from the pressure switch 2 exhausts through the valve, allowing the switch to close.

3-5 Reverse Clutch Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch

The 3-5 reverse clutch fluid enters the 3-5 reverse/456 clutch housing to move the piston against spring force to apply the 3-5 reverse clutch plates.

Drive Range, Third Gear Default

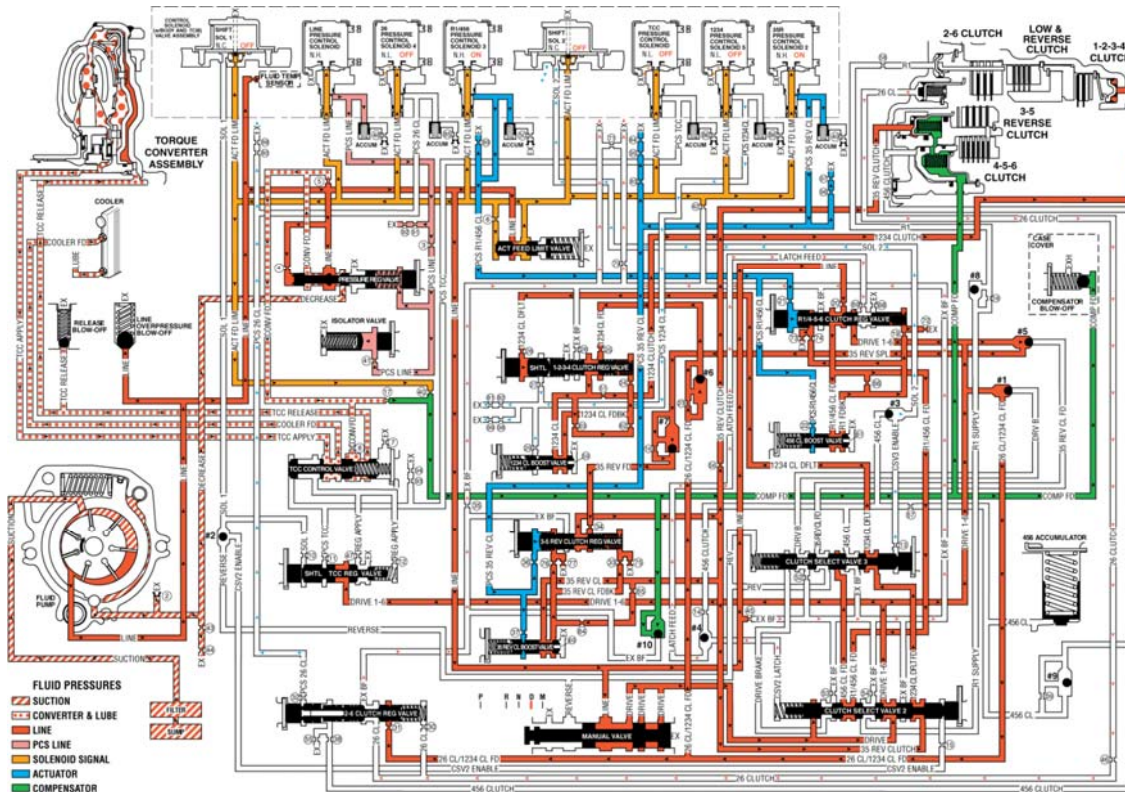


Fig. 14: Fluid Flow Diagram - Drive Range, Third Gear Default
 Courtesy of GENERAL MOTORS COMPANY

Drive Range - Fourth Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command OFF the normally-high 35R pressure control solenoid 2. At the same time the normally-low R1/456 pressure control solenoid 3 is commanded ON to regulate 4-5-6 clutch apply.

4-5-6 Clutch Applies

R1/456 Pressure Control Solenoid 3

The R1/456 pressure control solenoid 3 (PCS) is commanded ON allowing actuator feed fluid to enter the PCS R1/456 clutch fluid circuit. PCS R1/456 clutch fluid is routed through orifice #21 to the R1/456 clutch regulator valve and, through orifice #22 to the R1/456 clutch boost valve.

R1/456 Clutch Regulator Valve

PCS R1/456 clutch fluid moves the R1/456 clutch regulator valve against R1/456 clutch regulator valve spring force to allow line fluid to pass through the valve and enter the R1/456 clutch feed circuit. R1/456 clutch feed is then routed to the 4-5-6 clutch boost valve and clutch select valve 2.

4-5-6 Clutch Boost Valve

PCS R1/456 clutch fluid pressure acts on a differential area moving the R1/456 clutch boost valve against the R1/456 clutch boost valve spring. R1/456 clutch fluid passes through the valve and enters the R1/456 clutch feedback circuit. As PCS R1/456 clutch fluid pressure is increased to a given value, the R1/456 clutch boost valve opens the R1/456 clutch feedback circuit to exhaust. This results in the R1/456 clutch regulator valve moving to the full feed position, sending full line pressure to the clutch.

Clutch Select Valve 2

R1/456 clutch feed fluid passes through the clutch select valve 2 and enters the 456 clutch feed circuit. The 456 clutch feed fluid is routed to the clutch select valve 3 where it passes through the valve and enters the 456 clutch fluid circuit. The 456 clutch fluid is routed to the 4-5-6 clutch, the 4-5-6 accumulator, #9 ball check valve and to the #4 ball check valve. The 456 clutch fluid seats the #9 ball check valve and routes fluid through orifice #39. The 456 clutch fluid passes through orifice #14, seats #4 ball check valve against the PS4 fluid circuit and routes fluid to the CSV2 latch circuit.

4-5-6 Clutch

The 456 clutch fluid enters the 4-5-6 clutch housing to move the piston against spring force, combined with force from the compensator to apply the 4-5-6 clutch plates.

3-5 Reverse Clutch Releases

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded OFF, allowing PCS 35 reverse clutch fluid from the 3-5 reverse clutch boost valve and the 3-5 reverse clutch regulator valve to exhaust through the solenoid.

3-5 Reverse Clutch Boost Valve

The 3-5 reverse boost valve spring force moves the valve to allow 35 reverse clutch feedback fluid from the 3-5 reverse clutch regulator valve to enter the 35 reverse clutch fluid circuit and exhaust.

#9 Ball Check Valve

The 456 clutch fluid pressure seats #9 ball check valve to force fluid through orifice #39 and applies the 456 clutch.

3-5 Reverse Clutch Regulator Valve

The 3-5 reverse clutch regulator valve spring force moves the valve to allow 35 reverse clutch fluid from the 3-5 reverse clutch to pass through the valve and enter the exhaust backfill fluid circuit. The 35 reverse clutch fluid then enters the exhaust backfill fluid circuit and is routed through orifice #30 to the exhaust backfill pressure relief valve where excess pressure is exhausted.

3-5 Reverse Clutch

The 3-5 reverse clutch spring force combined with force from the compensator move the 3-5 reverse clutch piston to release the 3-5 clutch plates and forces 35 reverse clutch fluid to exhaust from 3-5 reverse/456 clutch

housing. The 35 reverse clutch fluid is then routed to the 3-5 reverse clutch regulator valve and exhausted.

#4 Ball Check Valve

The 456 clutch fluid pressure passes through orifice #14 to seat #4 ball check valve against PS4 fluid passage. The 456 clutch fluid is then directed into the CSV2 latch circuit.

456 Accumulator

The 456 clutch fluid enters the 456 accumulator to move the piston against spring force to cushion the 456 clutch piston apply.

Drive Range, Fourth Gear

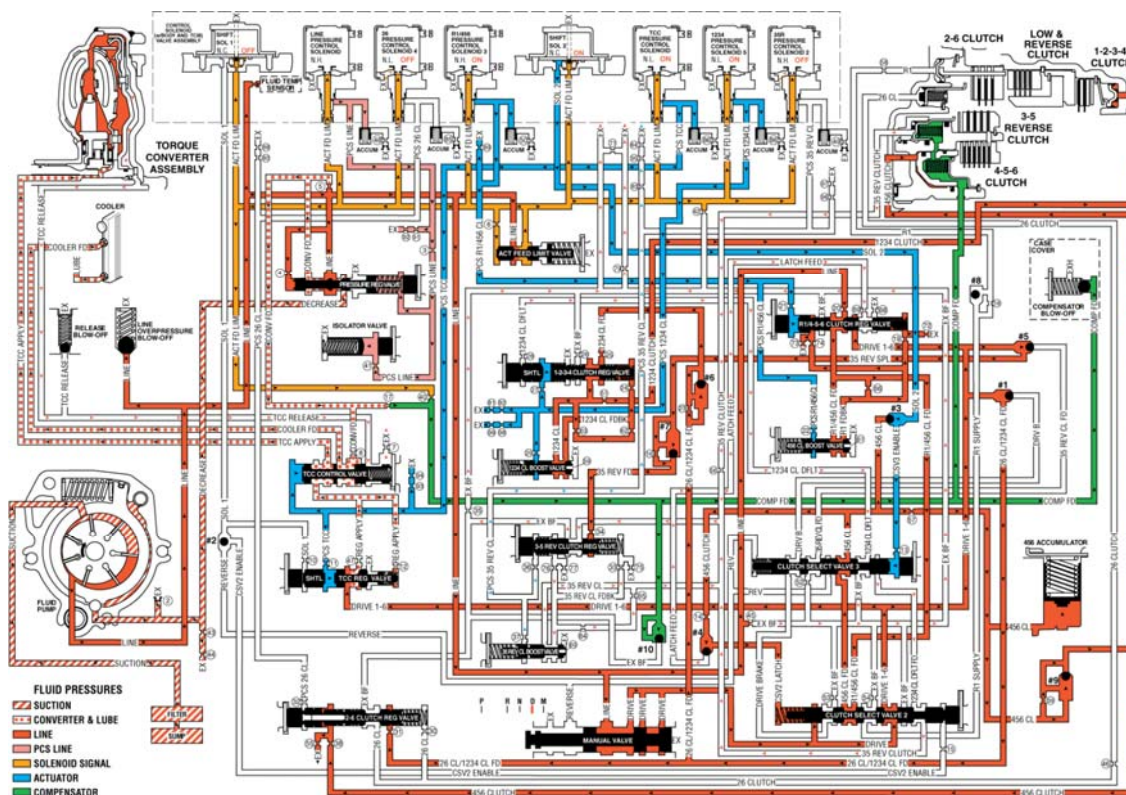


Fig. 15: Fluid Flow Diagram - Drive Range, Fourth Gear
Courtesy of GENERAL MOTORS COMPANY

Drive Range, Fifth Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-high 35R pressure control solenoid 2. At the same time the normally-low 1234 pressure control solenoid 5 is commanded OFF.

3-5 Reverse Clutch Applies

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded ON, allowing actuator feed fluid to enter the PCS 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #36 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #37 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 35 reverse clutch fluid pressure acts on a differential area moving the PCS 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 35 reverse clutch fluid passes through the valve and enters the 35 reverse clutch feedback circuit. As PCS 35 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 35 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 35 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 35 reverse clutch feedback fluid. This allows 35 reverse feed to pass through the valve and enter the 35 reverse clutch circuit. The 35 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS2 fluid from the pressure switch 2 exhausts through the valve allowing the switch to close.

Clutch Select Valve 2

The 35 reverse clutch fluid passes through the clutch select valve 2 and enters the 1234 clutch default feed fluid circuit. The 1234 clutch default feed fluid is then routed to the clutch select valve 3.

3-5 Reverse Clutch

The 35 reverse clutch fluid enters the 3-5 reverse/456 clutch housing to move the piston against spring force combined with force from the compensator to apply the 3-5 reverse clutch plates.

1-2-3-4 Clutch Releases

1234 Pressure Control Solenoid 5

The 1234 pressure control solenoid 5 is commanded OFF, allowing PCS 1234 clutch fluid from the 1-2-3-4 clutch regulator valve and 1-2-3-4 clutch boost valve to exhaust.

1-2-3-4 Clutch Regulator Valve

The 1-2-3-4 clutch regulator valve spring force moves the valve to allow 1234 clutch feed fluid from the 1-2-3-4 clutch to pass through the valve and enter the exhaust backfill fluid circuit. The 1234 clutch fluid enters the exhaust backfill fluid circuit and is routed through orifice #26 where excess pressure is exhausted. Also, 1234 clutch regulator valve spring force moves the valve to allow 1234 clutch feed fluid to pass through the valve and enter the PS1 fluid circuit. PS1 fluid is then routed to pressure switch 1 and opens the normally-

closed switch.

1-2-3-4 Clutch Boost Valve

The 1-2-3-4 clutch boost valve spring force moves the valve to allow 1234 clutch feedback fluid from the 1-2-3-4 clutch regulator valve to enter the 1234 clutch circuit and exhaust.

1-2-3-4 Clutch

The 1-2-3-4 clutch spring force moves the 1-2-3-4 clutch piston to release the clutch plates and force 1234 clutch fluid from the 1-2-3-4 clutch. The 1234 clutch fluid is routed through the 1-2-3-4 clutch regulator valve where it enters the exhaust backfill fluid circuit.

Drive Range, Fifth Gear

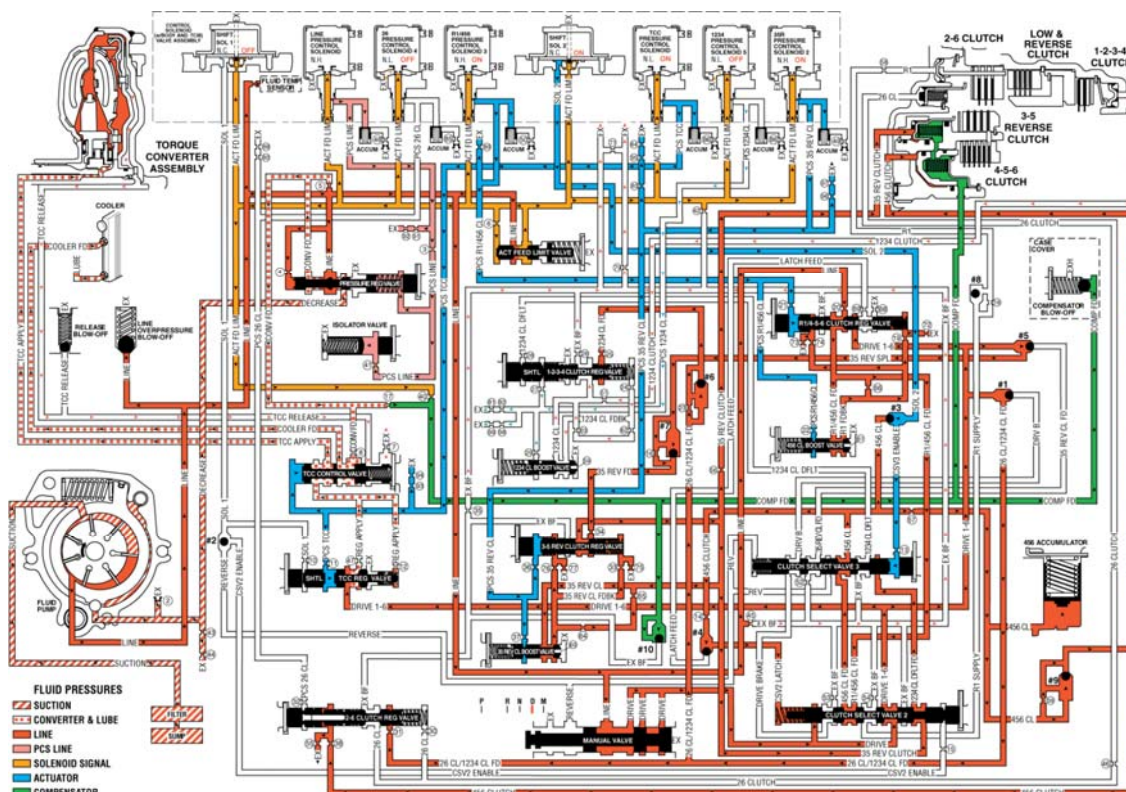


Fig. 16: Fluid Flow Diagram - Drive Range, Fifth Gear
Courtesy of GENERAL MOTORS COMPANY

Drive Range, Fifth Gear Default

If the transmission is in 4th, 5th or 6th gear during a transmission electrical component failure, the transmission will default to 5th gear. All solenoids will default to their normal state. If the torque converter clutch was applied, it will release. The transmission will stay in 5th gear default range until the ignition has been turned off or transmission shifted to reverse. When the vehicle is restarted, and shifted back into drive, the transmission will then operate in the 3rd gear default range. This default action will enable the vehicle to be safely driven to a service center.

3-5 Reverse Clutch Applies

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 defaults to ON, allowing actuator feed fluid to enter the pressure control solenoid (PCS) 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #36 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #37 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the PCS 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3-5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. The 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS2 fluid from the pressure switch 2 exhausts through the valve, allowing the switch to close.

3-5 Reverse Clutch

The 3-5 reverse clutch fluid enters the 3-5 reverse/456 clutch housing to move the piston against spring force to apply the 3-5 reverse clutch plates.

Clutch Select Valve 3

Once the clutch select valve 3 is moved to the ON position in 4th gear, it will remain in this position throughout the 5th gear default range, until the ignition has been turned OFF. When the ignition is OFF, fluid will exhaust from the valve, thus when the vehicle is restarted, the transmission will then be in the 3rd gear default range.

1-2-3-4 Clutch Releases or 2-6 Clutch Releases

1234 Pressure Control Solenoid 5

If the transmission was in 4th gear when an electrical condition commands a protection mode, the 1234 pressure control solenoid 5 defaults to the OFF position, allowing PCS 1234 clutch fluid from the 1-2-3-4 clutch, the 1-2-3-4 clutch regulator valve and 1-2-3-4 clutch boost valve to exhaust.

2-6 26 Pressure Control Solenoid 4

If the transmission was in 6th gear when an electrical condition commands a protection mode, the 26 pressure

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the

automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-low 26 pressure control solenoid 4 (PCS). At the same time the normally-high 35R pressure control solenoid 2 is commanded OFF.

2-6 Clutch Applies

26 Pressure Control Solenoid 4

The 26 pressure control solenoid 4 is commanded ON, allowing actuator feed fluid to enter the PCS 26 clutch fluid circuit. PCS 26 fluid is routed through orifice #32 and then to the 2-6 clutch regulator valve.

2-6 Clutch Regulator Valve

PCS 26 clutch fluid moves the 2-6 clutch regulator valve assembly against the 2-6 clutch regulator valve spring force to allow 26 clutch/1234 clutch feed fluid to pass through the valve. The 26 clutch/1234 clutch feed fluid is routed into the 26 clutch fluid circuit where it passes through orifice #46 and then to the spring end of the 2-6 clutch regulator valve, and to the 2-6 clutch.

2-6 Clutch

The 26 clutch fluid from the 2-6 clutch regulator valve is routed to the 2-6 clutch piston assembly. The 26 clutch fluid pressure moves the piston against 2-6 clutch spring force to apply the 2-6 clutch plates.

3-5 Clutch Releases

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded OFF, allowing PCS 35 reverse clutch fluid from the 3-5 reverse clutch boost valve and the 3-5 reverse clutch regulator valve to exhaust through the solenoid.

3-5 Reverse Clutch Boost Valve

The 3-5 reverse boost valve spring force moves the valve to allow 35 reverse clutch feedback fluid from the 3-5 reverse clutch regulator valve to enter the 35 reverse clutch circuit and exhaust.

3-5 Reverse Clutch Regulator Valve

The 3-5 reverse clutch regulator valve spring force moves the valve to allow actuator feed limit fluid to pass through the valve and enter the PS2 fluid circuit which opens PS2. The 35 reverse clutch fluid then enters the exhaust backfill fluid circuit and is routed through orifice #30 to the exhaust backfill pressure relief valve where excess pressure is exhausted.

3-5 Reverse Clutch

The 3-5 reverse clutch spring force moves the 3-5 reverse clutch piston to release the 3-5 clutch plates and forces 35 reverse clutch fluid to exhaust from 3-5 reverse/456 clutch housing. The 35 reverse clutch fluid is then routed to the 3-5 reverse clutch regulator valve where it exhaust excess pressure.

Drive Range, Sixth Gear

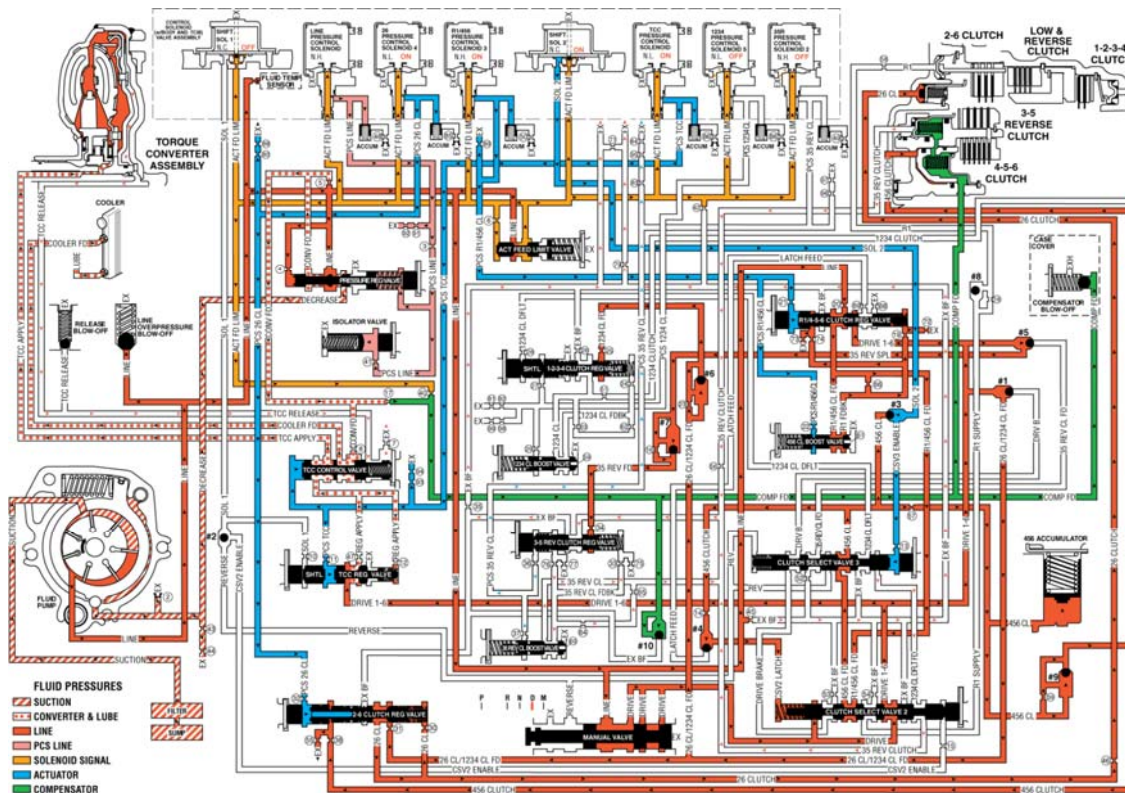


Fig. 18: Fluid Flow Diagram - Drive Range, Sixth Gear
Courtesy of GENERAL MOTORS COMPANY

FLUID PASSAGES (6T70/75)

Control Solenoid (w/Body and TCM) Valve Assembly

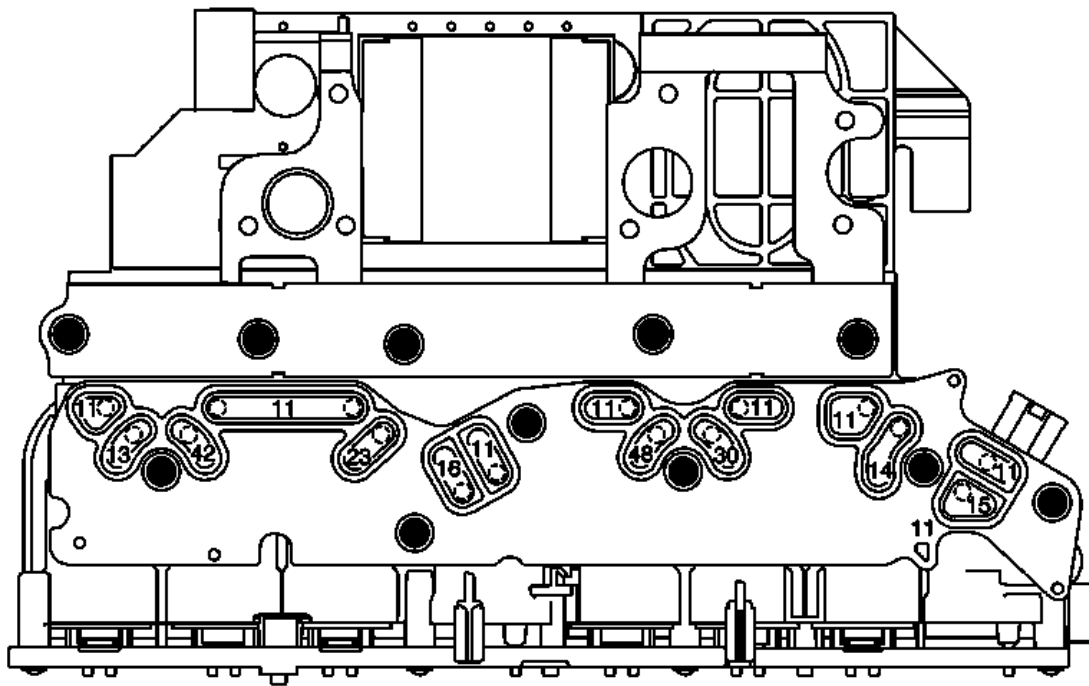


Fig. 19: Control Solenoid Valve Assembly Components (w/Body and TCM)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
23	PCS 35 Reverse Clutch
30	PCS 1234 Clutch
42	PCS 26 Clutch
48	PCS TCC

Control Valve Channel Upper Plate Assembly

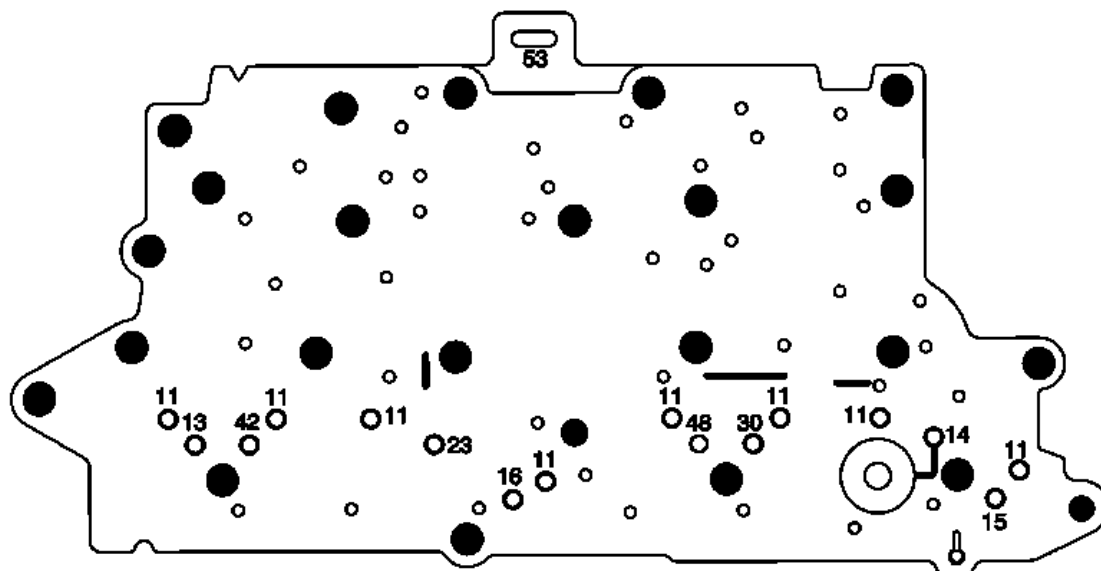


Fig. 20: Control Valve Channel Upper Plate Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
23	PCS 35 Reverse Clutch
30	PCS 1234 Clutch
42	PCS 26 Clutch
48	PCS TCC
53	Void

Control Valve Channel Plate- Upper Plate Side

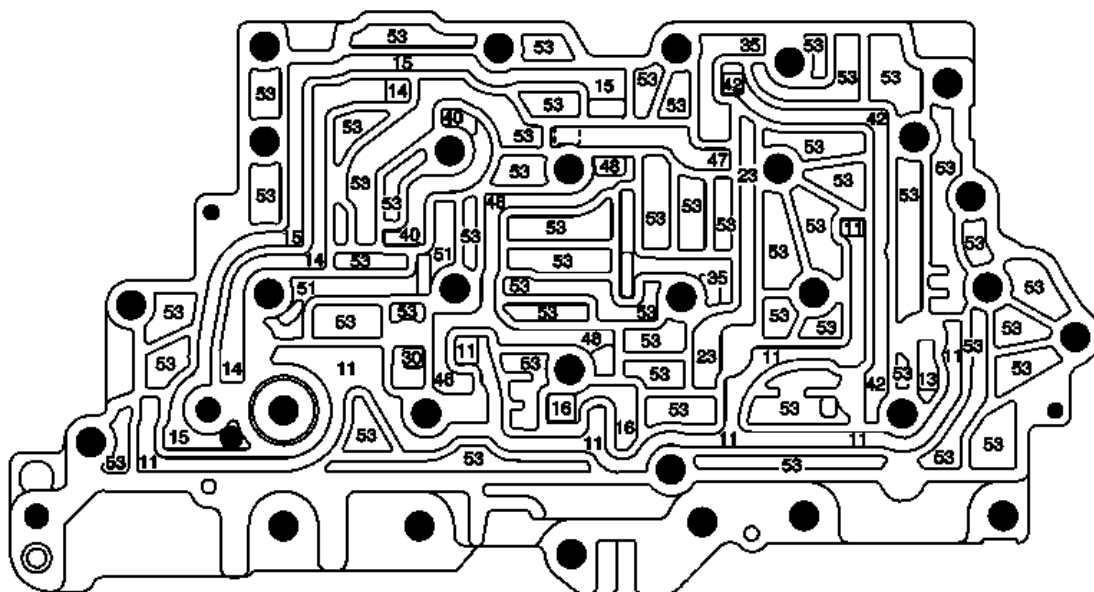


Fig. 21: Control Valve Channel Plate-- Upper Plate Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
23	PCS 35 Reverse Clutch
30	PCS 1234 Clutch
35	Exhaust
40	Latch Feed
42	PCS 26 Clutch
47	456 Clutch
48	PCS TCC
51	Exhaust
53	Void

Control Valve Channel Plate- Upper Body Spacer Plate Side

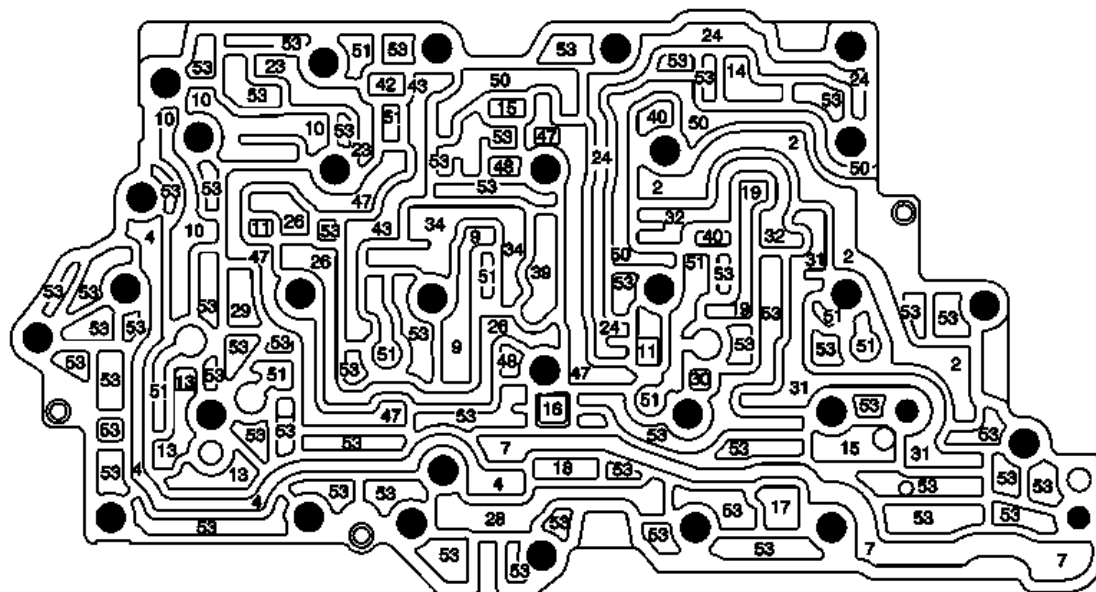


Fig. 22: Control Valve Channel Plate-- Upper Body Spacer Plate Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
4	Converter Feed
7	Cooler Feed
9	Regulated Apply
10	Compensator Feed
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
17	CSV2 Enable
18	CSV3 Enable
19	R1/456 Clutch Feed
23	PCS 35 Reverse Clutch
24	Reverse
26	35 Reverse Supply
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch

31	Drive
32	Drive Brake
34	26 Clutch/1234 Clutch Feed
39	Drive 1-6
40	Latch Feed
42	PCS 26 Clutch
43	26 Clutch
47	456 Clutch
48	PCS TCC
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Upper Body Spacer Plate Assembly

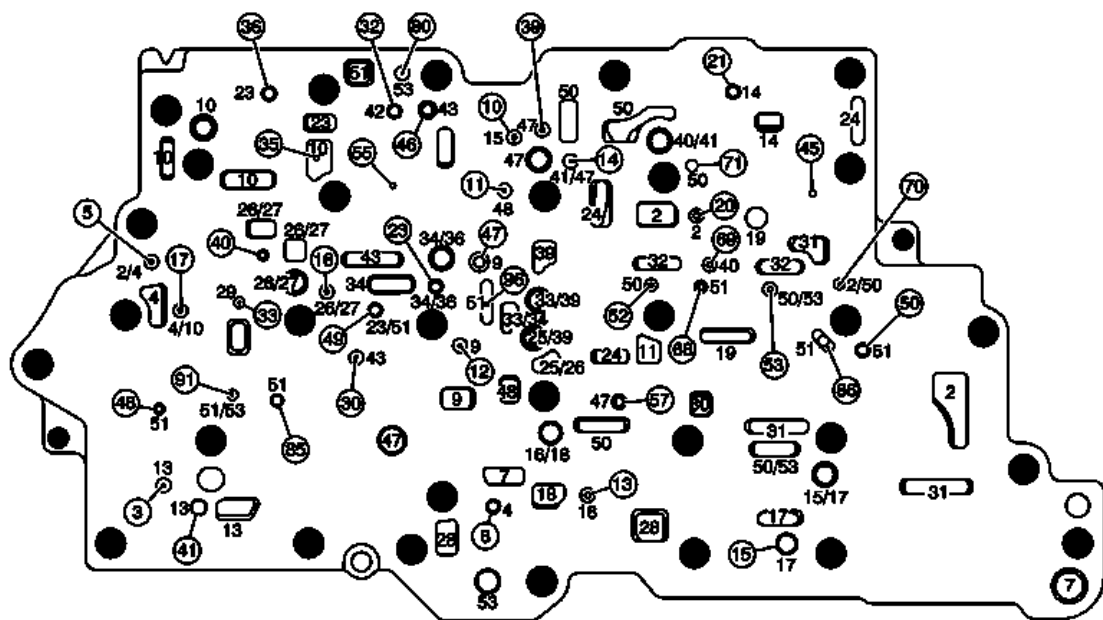


Fig. 23: Control Valve Upper Body Spacer Plate Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
4	Converter Feed
5	TCC Release
7	Cooler Feed

8	Lube
9	Regulated Apply
10	Compensator Feed
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
17	CSV2 Enable
18	CSV3 Enable
19	R1/456 Clutch Feed
20	R1 Feedback
21	R1 Supply
23	PCS 35 Reverse Clutch
24	Reverse
25	35 Reverse Clutch Feed
26	35 Reverse Supply
27	35 Reverse Feed
28	35 Reverse Clutch
29	C35 Reverse Feedback
30	PCS 1234 Clutch
31	Drive
32	Drive Brake
33	Drive B
34	26 Clutch/1234 Clutch Feed
36	1234 Clutch Feed
39	Drive 1-6
40	Latch Feed
41	CSV2 Latch
42	PCS 26 Clutch
43	26 Clutch Feedback
45	1234 Clutch Default
46	456 Clutch Feed
47	456 Clutch
48	PCS TCC
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Upper Body Assembly- Upper Body Spacer Plate Side

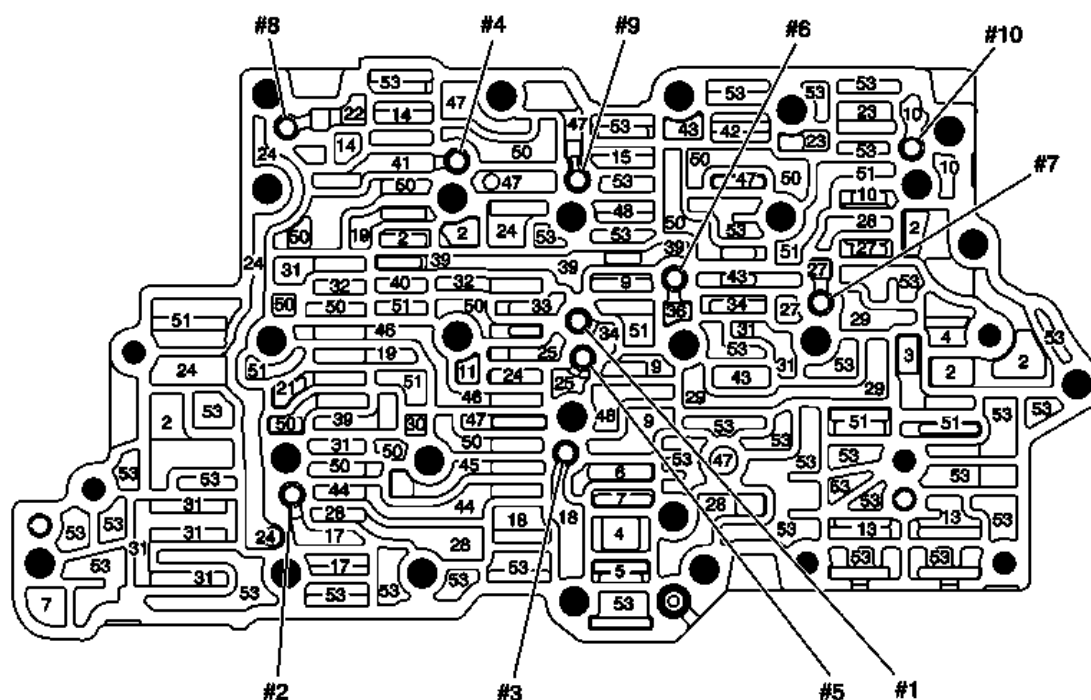


Fig. 24: Control Valve Upper Body Assembly-- Upper Body Spacer Plate Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
4	Converter Feed
5	TCC Release
6	TCC Apply
7	Cooler Feed
9	Regulated Apply
10	Compensator Feed
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
17	CSV2 Enable
18	CSV3 Enable
19	R1/456 Clutch Feed
21	R1 Supply
22	R1
23	PCS 35 Reverse Clutch
24	Reverse

25	35 Reverse Clutch Feed
27	35 Reverse Feed
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch
31	Drive
32	Drive Brake
33	Drive B
34	26 Clutch/1234 Clutch Feed
36	1234 Clutch Feed
39	Drive 1-6
40	Latch Feed
41	CSV2 Latch
42	PCS 26 Clutch
43	26 Clutch
44	1234 Clutch Default Feed
45	1234 Clutch Default
46	456 Clutch Feed
47	456 Clutch
48	PCS TCC
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Upper Body Assembly- Lower Body Spacer Plate Side

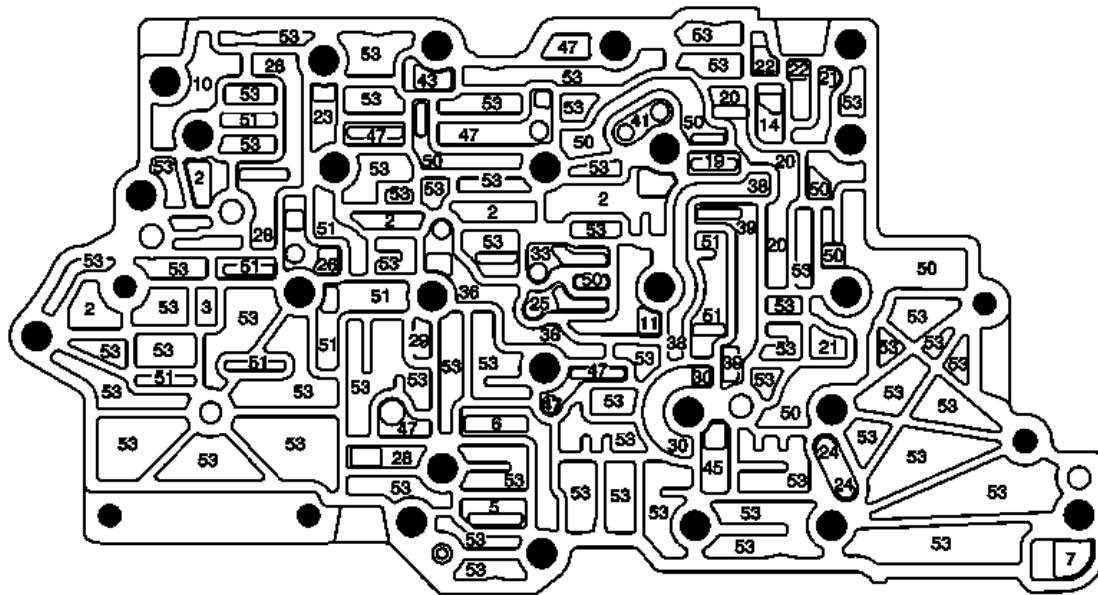


Fig. 25: Control Valve Upper Body Assembly-- Lower Body Spacer Plate Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
5	TCC Release
6	TCC Apply
7	Cooler Feed
10	Compensator Feed
11	Actuator Feed Limit
14	PCS R1/456 Clutch
19	R1/456 Clutch Feed
20	R1/456 Feedback
21	R1 Supply
22	R1
23	PCS 35 Reverse Clutch
24	Reverse
25	35 Reverse Clutch Feed
26	35 Reverse Supply
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch

33	Drive B
36	1234 Clutch Feed
38	1234 Clutch Feedback
39	Drive 1-6
41	CSV2 Latch
43	26 Clutch
45	1234 Clutch Default
47	456 Clutch
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Lower Body Spacer Plate Assembly

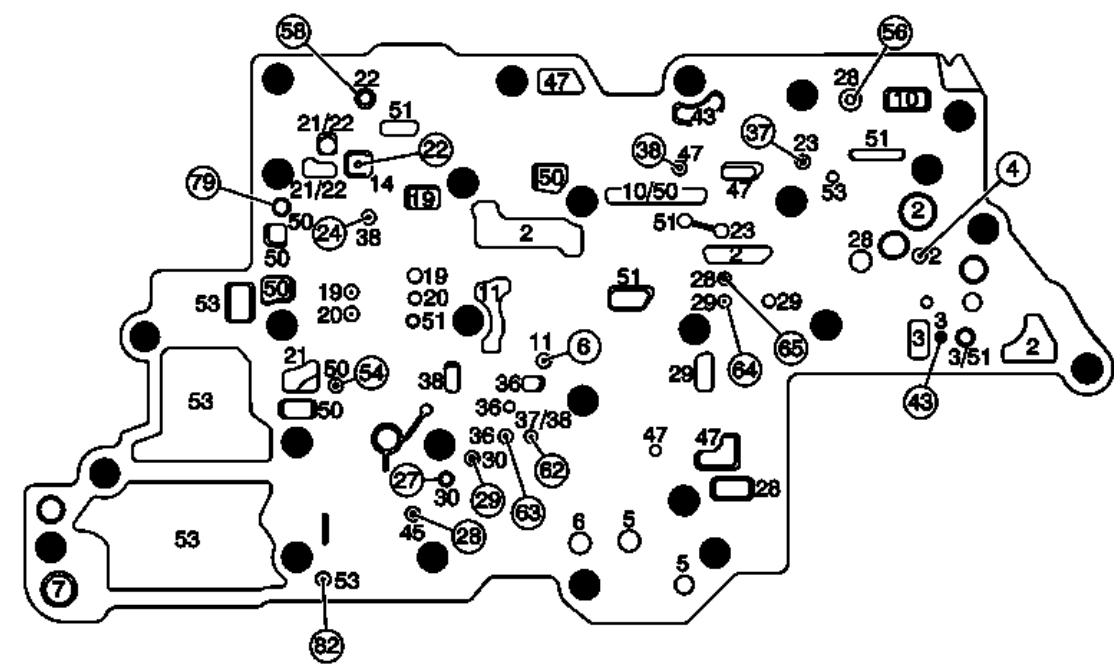


Fig. 26: Control Valve Lower Body Spacer Plate Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
5	TCC Release
6	TCC Apply
10	Compensator Feed
11	Actuator Feed Limit

14	PCS R1/456 Clutch
19	R1/456 Clutch Feed
20	R1 Feedback
21	R1 Supply
22	R1
23	PCS 35 Reverse Clutch
27	35 Reverse Feed
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch
36	1234 Clutch Feed
37	1234 Clutch
38	1234 Clutch Feedback
43	26 Clutch Feedback
45	1234 Clutch Default
47	456 Clutch
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Lower Body

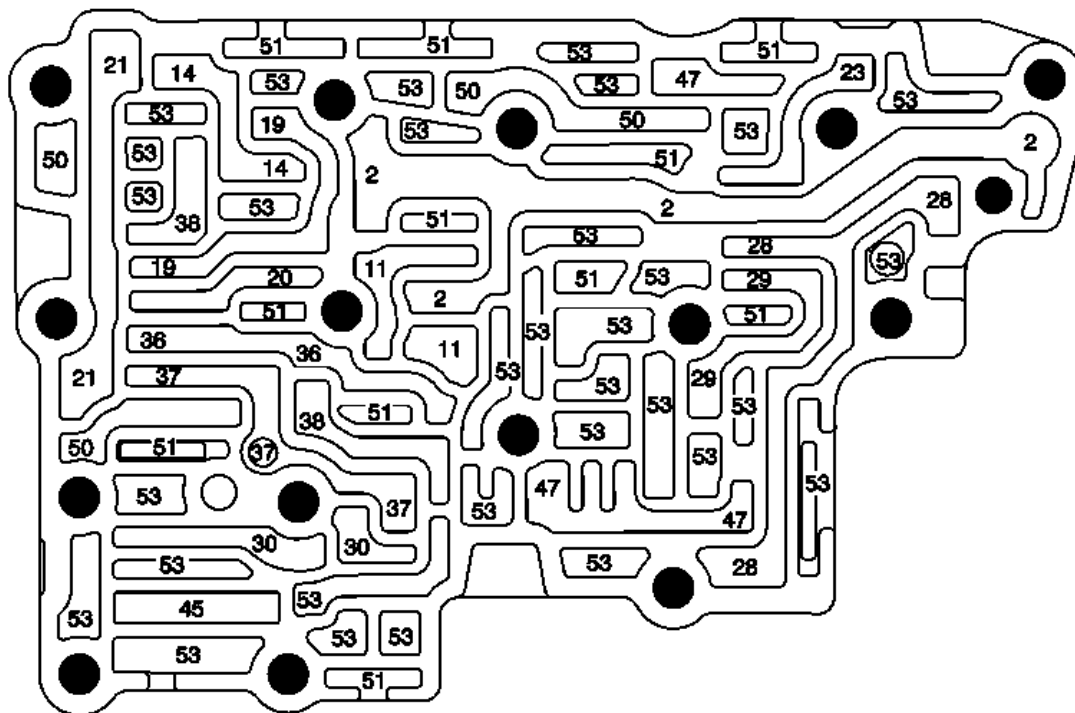


Fig. 27: Control Valve Lower Body Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
11	Actuator Feed Limit
14	PCS R1/456 Clutch
19	R1/456 Clutch Feed
20	R1 Feedback
21	R1 Supply
23	PCS 35 Reverse Clutch
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch
36	1234 Clutch Feed
37	1234 Clutch
38	1234 Clutch Feedback
45	1234 Clutch Default
47	456 Clutch
50	Exhaust Backfill
51	Exhaust
53	Void

A/Trans Case Assembly- Control Valve Body Side

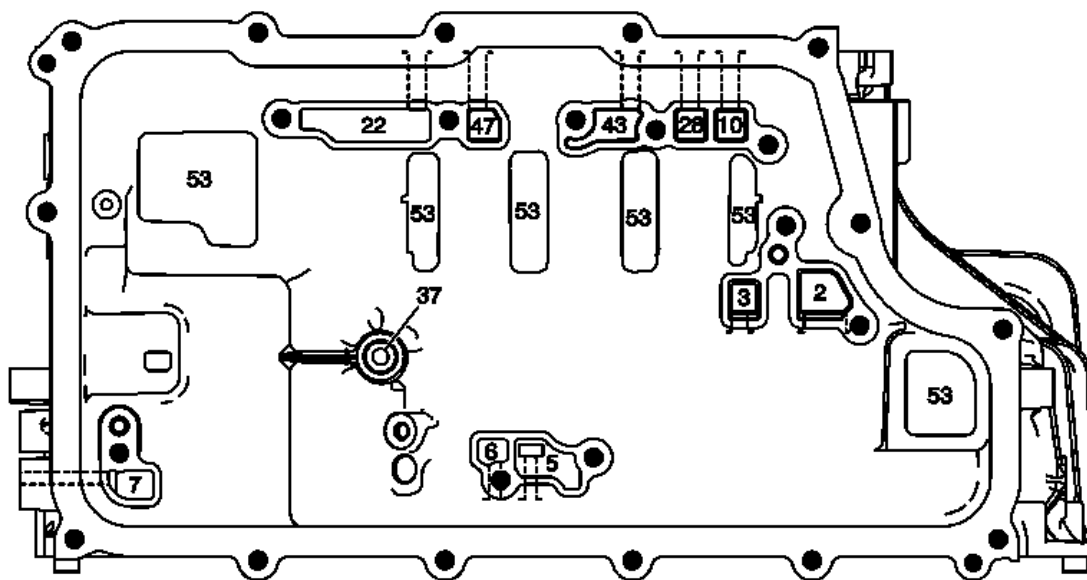


Fig. 28: A/Trans Case Assembly-- Control Valve Body Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
5	TCC Release
6	TCC Apply
7	Cooler Feed
10	Compensator Feed
22	R1
28	35 Reverse Clutch
37	1234 Clutch
43	26 Clutch
47	456 Clutch
53	Void

A/Trans Case Assembly- Torque Converter and Differential Housing Side

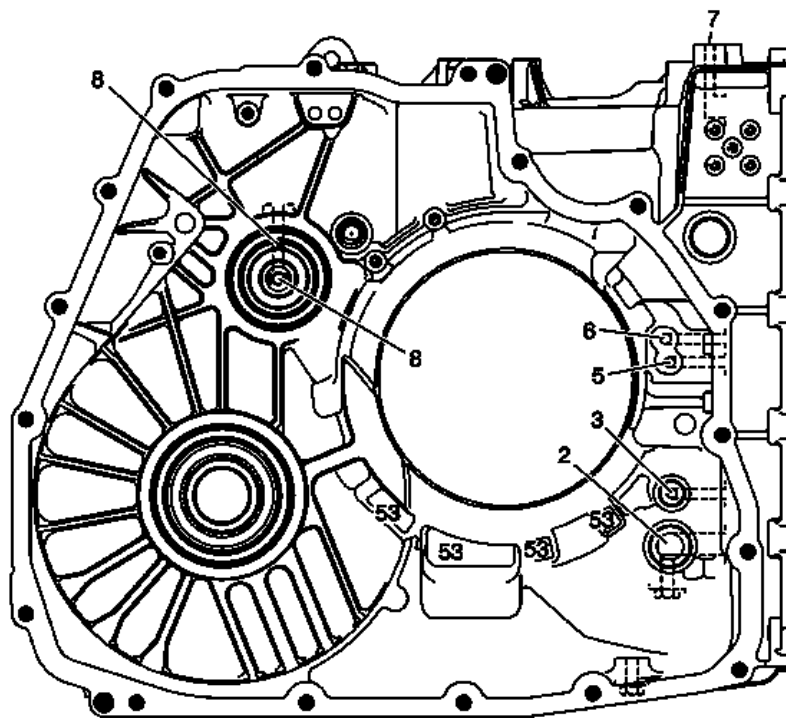


Fig. 29: A/Trans Case Assembly-- Torque Converter and Differential Housing Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
5	TCC Release
6	TCC Apply

7	Cooler Feed
8	Lube
53	Void

A/Trans Case Assembly Case Cover Side

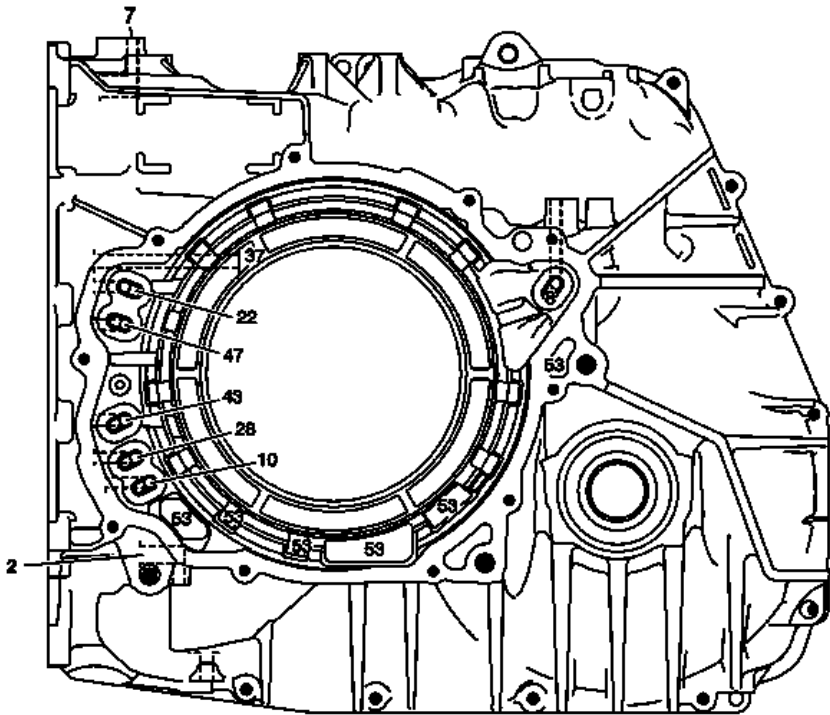


Fig. 30: A/Trans Case Assembly Case Cover Side Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line (to valve body)
7	Cooler Feed
8	Lube
10	Compensator Feed
22	R1
28	35 Reverse Clutch
37	1234 Clutch
43	26 Clutch
47	456 Clutch
53	Void

A/Trans Case Cover Assembly

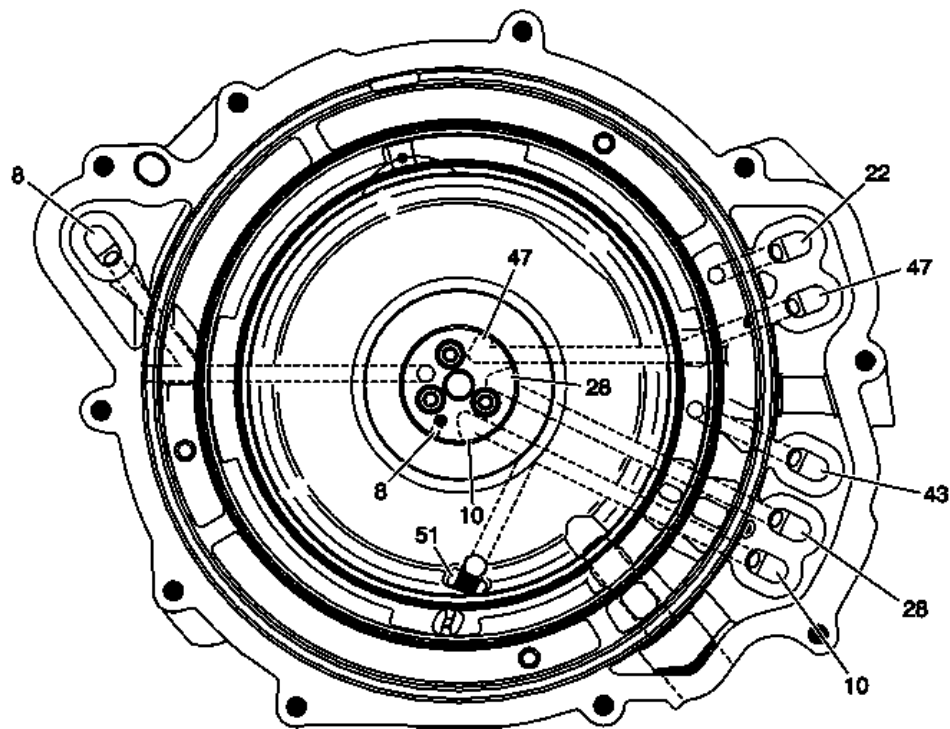


Fig. 31: A/Trans Case Cover Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
8	Lube
10	Compensator Feed
22	R1
28	35 Reverse Clutch
43	26 Clutch
47	456 Clutch
51	Compensator Feed Exhaust

Front Differential Transfer Drive Gear Support- Case Side

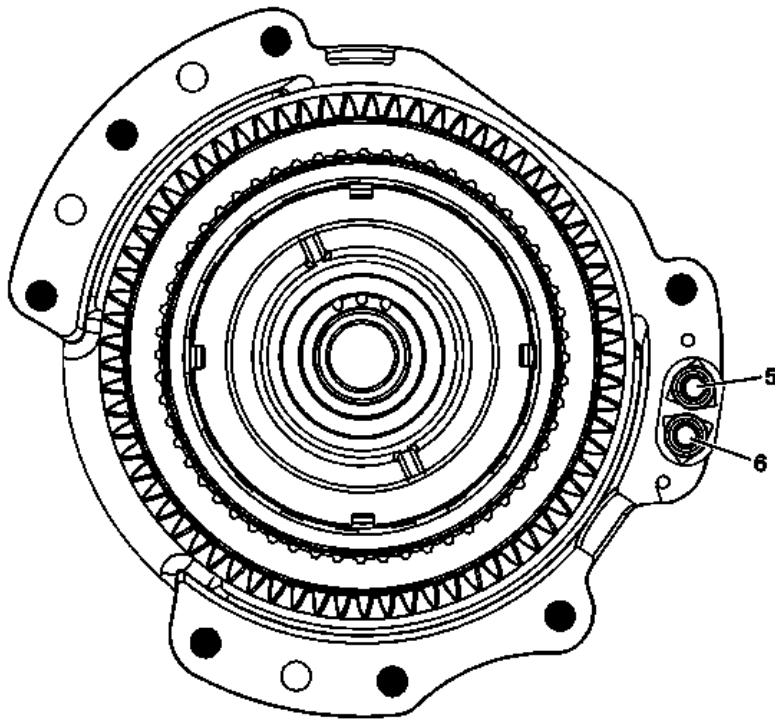


Fig. 32: Identifying Front Differential Transfer Drive Gear Support Fluid Passages - Case Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5	TCC Release
6	TCC Apply

Front Differential Transfer Drive Gear Support- Torque Converter and Differential Housing Side

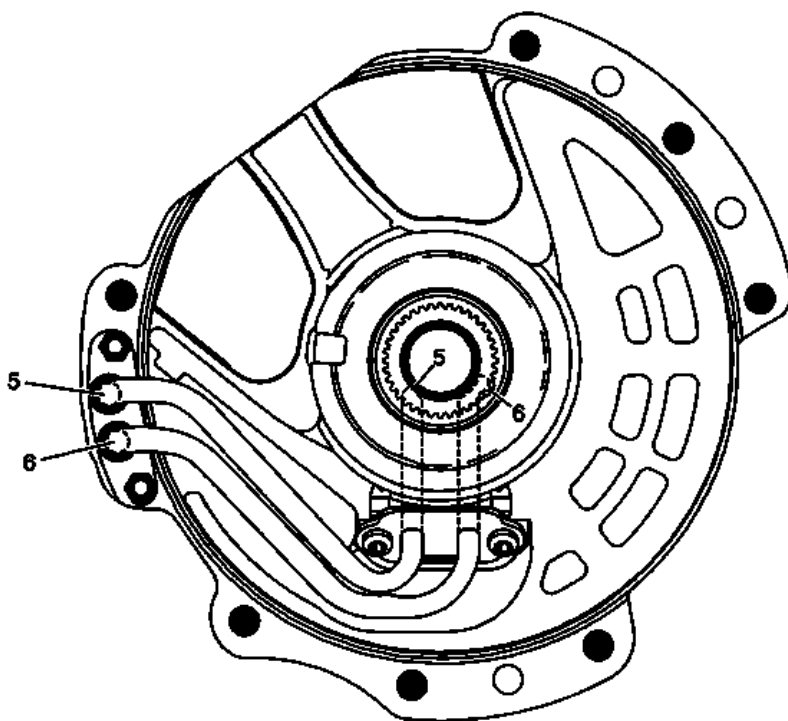


Fig. 33: Identifying Front Differential Transfer Drive Gear Support Fluid Passages - Torque Converter & Differential Housing Side

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5	TCC Release
6	TCC Apply

FLUID PASSAGES (6T80)

Control Solenoid (w/Body and TCM) Valve Assembly

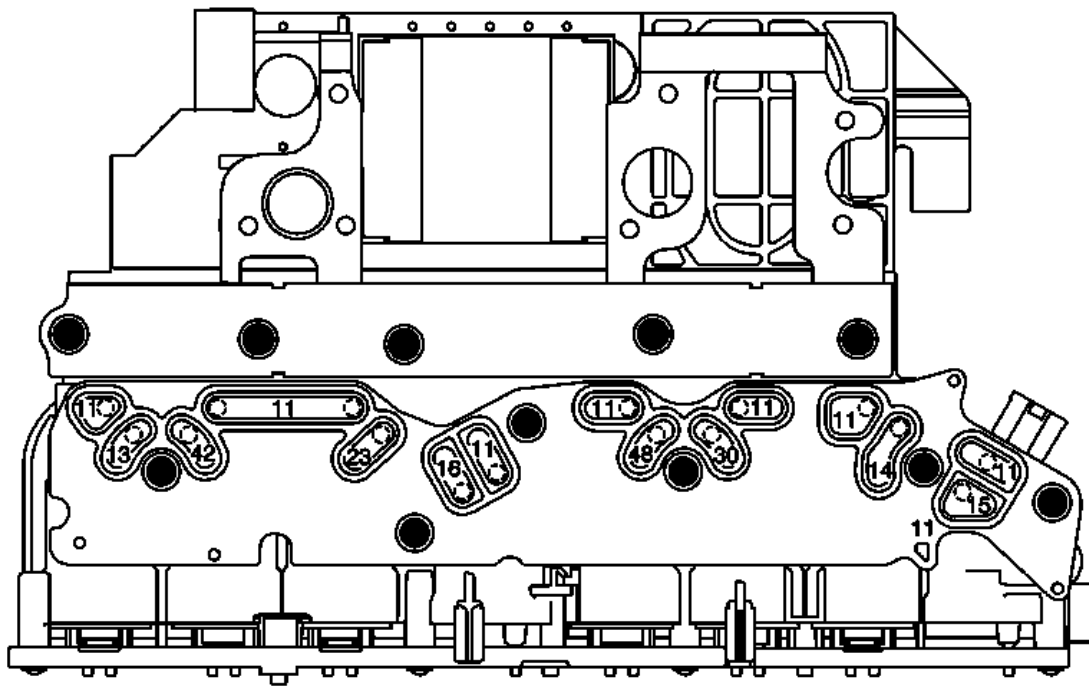


Fig. 34: Control Solenoid Valve Assembly Components (w/Body and TCM)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
23	PCS 35 Reverse Clutch
30	PCS 1234 Clutch
42	PCS 26 Clutch
48	PCS TCC

Control Valve Channel Upper Plate Assembly

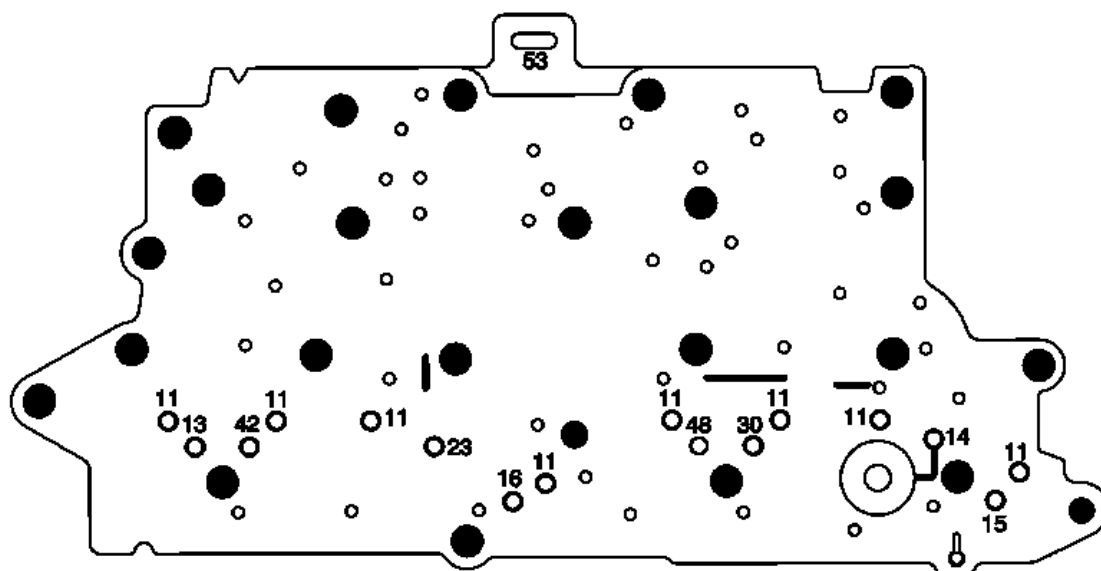


Fig. 35: Control Valve Channel Upper Plate Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
23	PCS 35 Reverse Clutch
30	PCS 1234 Clutch
42	PCS 26 Clutch
48	PCS TCC
53	Void

Control Valve Channel Plate- Upper Plate Side

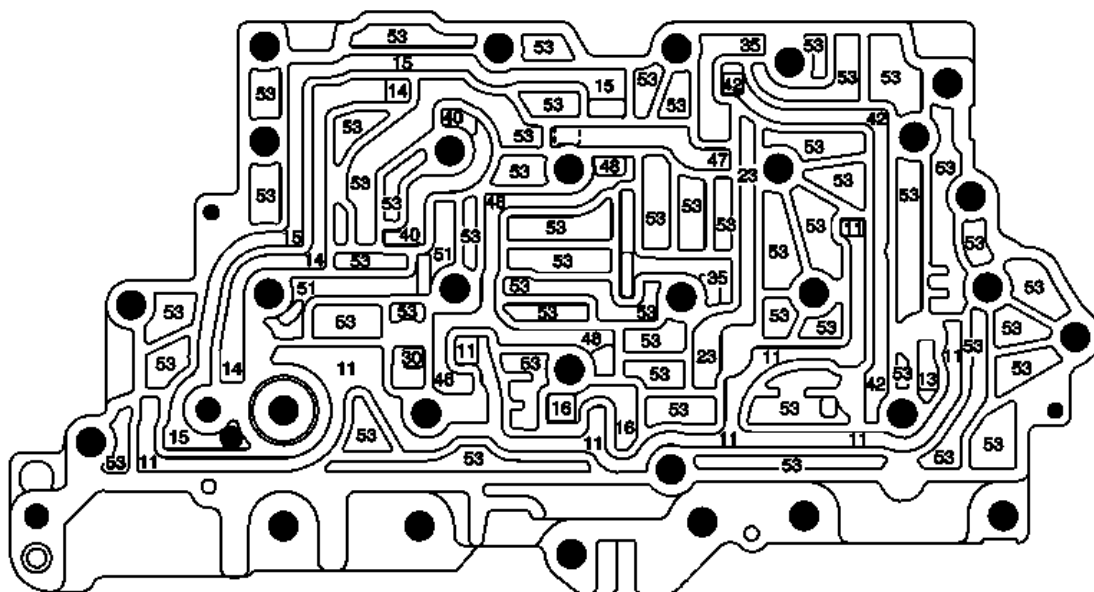


Fig. 36: Control Valve Channel Plate-- Upper Plate Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
23	PCS 35 Reverse Clutch
30	PCS 1234 Clutch
35	Exhaust
40	Latch Feed
42	PCS 26 Clutch
47	456 Clutch
48	PCS TCC
51	Exhaust
53	Void

Control Valve Channel Plate - Upper Body Spacer Plate Side

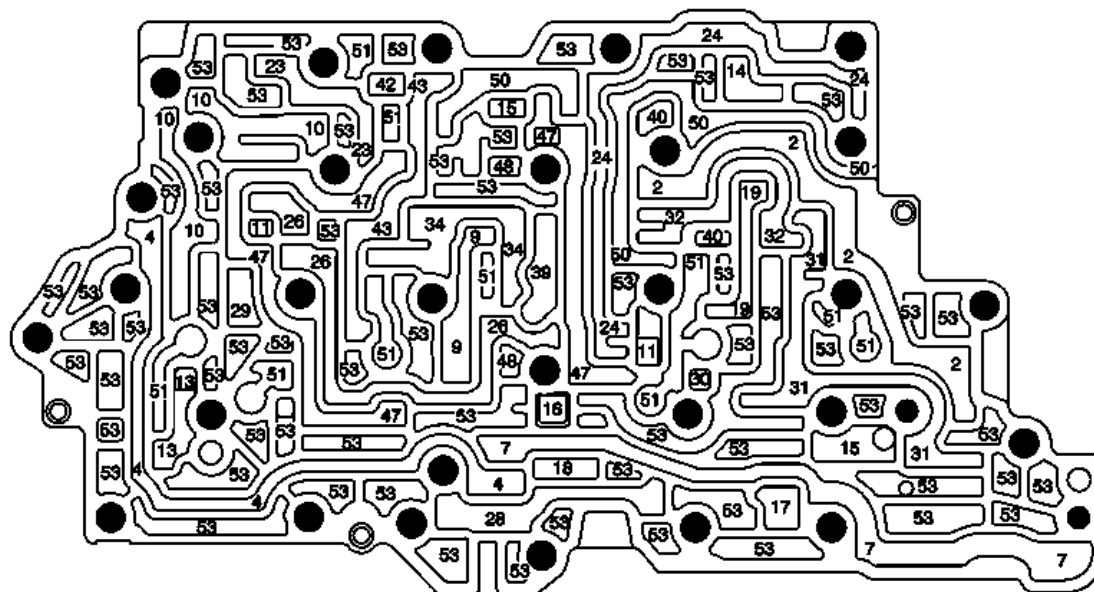


Fig. 37: Control Valve Channel Plate - Upper Body Spacer Plate Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
4	Converter Feed
7	Cooler Feed
9	Regulated Apply
10	Compensator Feed
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
17	CSV2 Enable
18	CSV3 Enable
19	R1/456 Clutch Feed
23	PCS 35 Reverse Clutch
24	Reverse
26	35 Reverse Supply
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch

31	Drive
32	Drive Brake
34	26 Clutch/1234 Clutch Feed
39	Drive 1-6
40	Latch Feed
42	PCS 26 Clutch
43	26 Clutch
47	456 Clutch Feed
48	456 Clutch
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Upper Body Spacer Plate Assembly

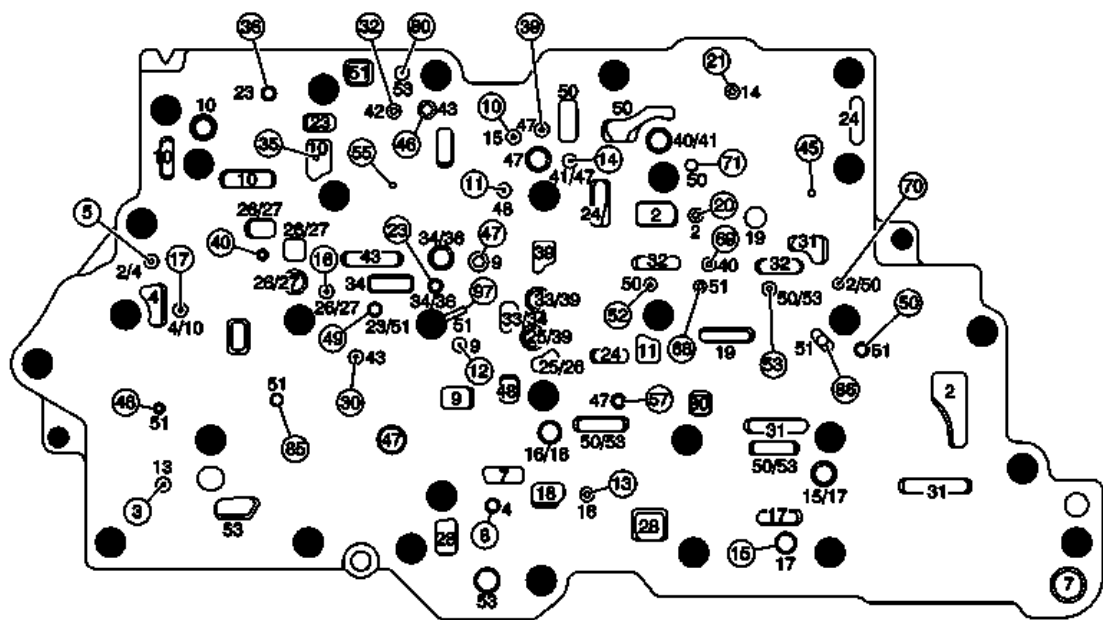


Fig. 38: Control Valve Upper Body Spacer Plate Assembly
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
4	Converter Feed
5	TCC Release
7	Cooler Feed

8	Lube
9	Regulated Apply
10	Compensator Feed
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
16	Solenoid 2
17	CSV2 Enable
18	CSV3 Enable
19	R1/456 Clutch Feed
20	R1/456 Clutch Feedback
21	R1 Supply
22	R1
23	PCS 35 Reverse Clutch
24	Reverse
25	35 Reverse Clutch Feed
26	35 Reverse Supply
27	35 Reverse Feed
28	35 Reverse Clutch
29	C35 Reverse Feedback
30	PCS 1234 Clutch
31	Drive
32	Drive Brake
33	Drive B
34	26 Clutch/1234 Clutch Feed
36	1234 Clutch Feed
39	Drive 1-6
40	Latch Feed
41	CSV2 Latch
42	PCS 26 Clutch
43	26 Clutch
45	1234 Clutch Default Feed
46	1234 Clutch Default
47	456 Clutch Feed
48	456 Clutch
50	Exhaust Backfill
51	Exhaust

Control Valve Upper Body Assembly - Upper Body Spacer Plate Side

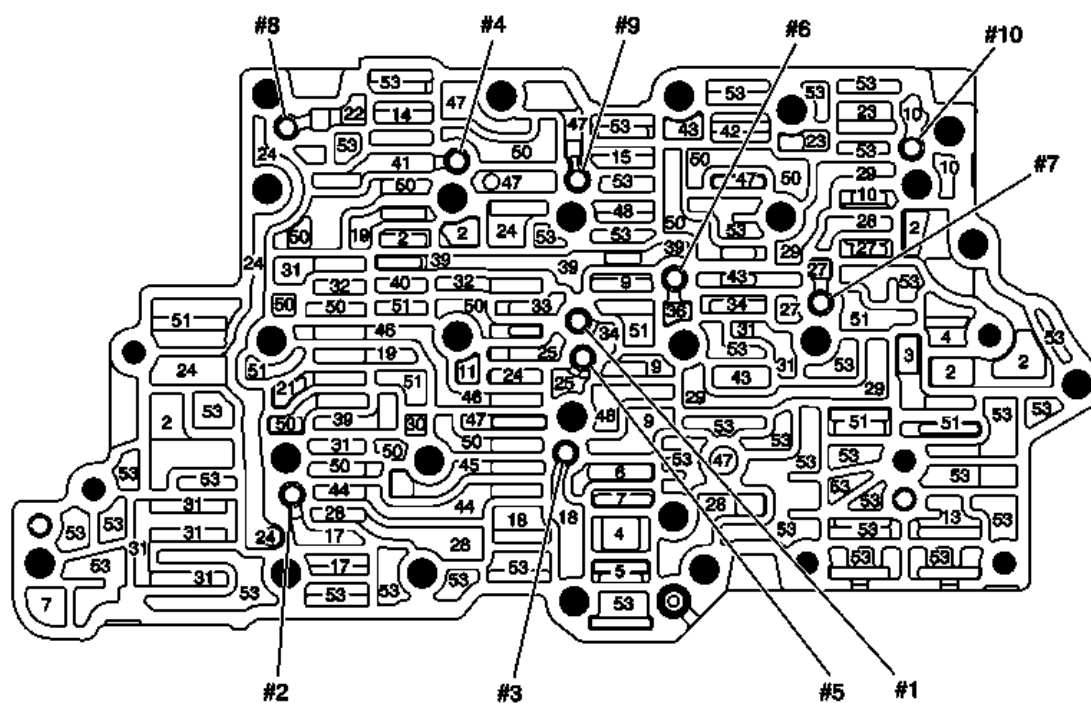


Fig. 39: Control Valve Upper Body Assembly - Upper Body Spacer Plate Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
4	Converter Feed
5	TCC Release
6	TCC Apply
7	Cooler Feed
9	Regulated Apply
10	Compensator Feed
11	Actuator Feed Limit
13	PCS Line
14	PCS R1/456 Clutch
15	Solenoid 1
17	CSV2 Enable
18	CSV3 Enable
19	R1/456 Clutch Feed
20	R1/456 Feedback
21	R1 Supply
22	R1
23	PCS 35 Reverse Clutch

24	Reverse
25	35 Reverse Clutch Feed
27	35 Reverse Feed
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch
31	Drive
32	Drive Brake
33	Drive B
34	26 Clutch/1234 Clutch Feed
36	1234 Clutch Feed
39	Drive 1-6
40	Latch Feed
41	CSV2 Latch
42	PCS 26 Clutch
43	26 Clutch
44	26 Clutch Feedback
45	1234 Clutch Default Feed
46	1234 Clutch Default
47	456 Clutch Feed
48	456 Clutch
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Upper Body Assembly - Lower Body Spacer Plate Side

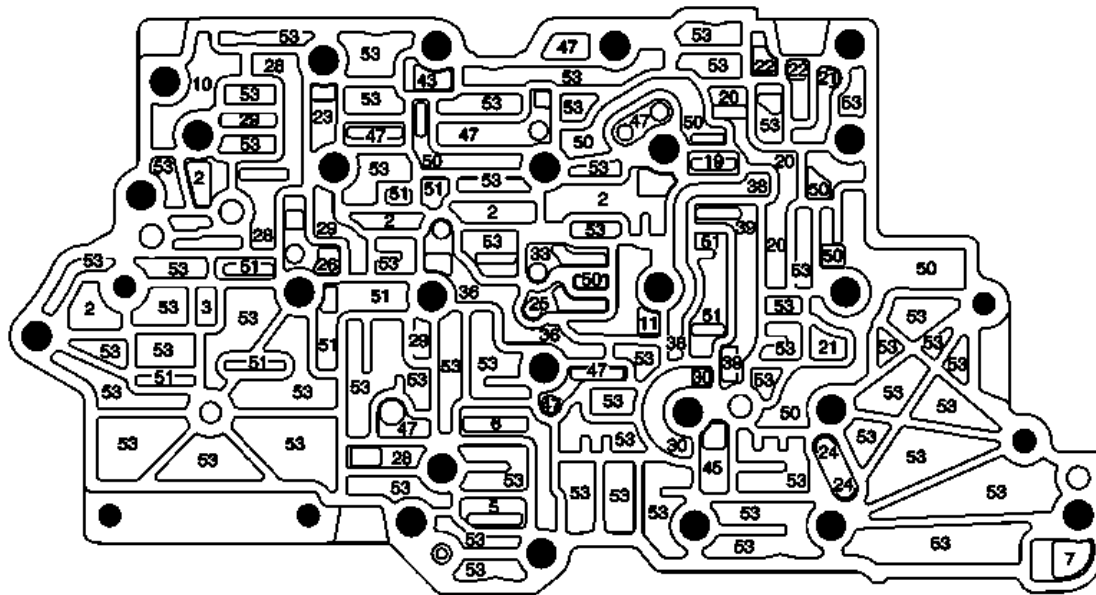


Fig. 40: Control Valve Upper Body Assembly - Lower Body Spacer Plate Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
5	TCC Release
6	TCC Apply
7	Cooler Feed
10	Compensator Feed
11	Actuator Feed Limit
14	PCS R1/456 Clutch
19	R1/456 Clutch Feed
20	R1/456 Feedback
21	R1 Supply
22	R1
23	PCS 35 Reverse Clutch
24	Reverse
25	35 Reverse Clutch Feed
26	35 Reverse Supply
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch

33	Drive B
36	1234 Clutch Feed
38	1234 Clutch Feedback
39	Drive 1-6
41	CSV2 Latch
43	26 Clutch
45	1234 Clutch Default Feed
47	456 Clutch Feed
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Lower Body Spacer Plate Assembly

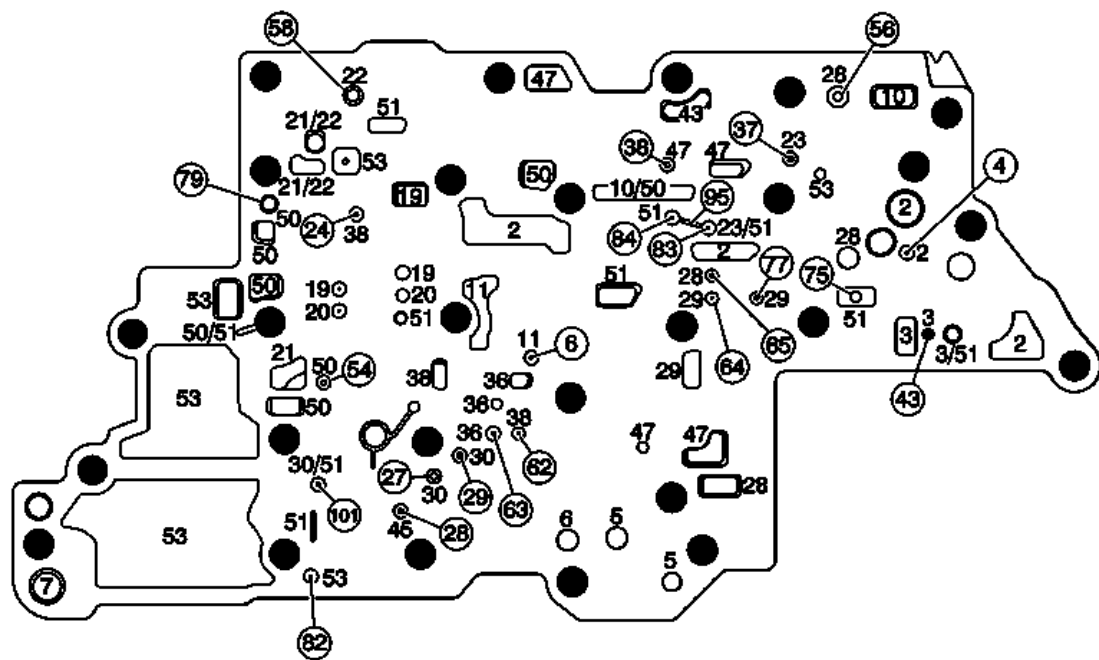


Fig. 41: Control Valve Lower Body Spacer Plate Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
5	TCC Release
6	TCC Apply
10	Compensator Feed
11	Actuator Feed Limit

14	PCS R1/456 Clutch
18	CSV3 Enable
19	R1/456 Clutch Feed
20	R1/456 Clutch Feedback
21	R1 Supply
22	R1
23	PCS 35 Reverse Clutch
24	Reverse
25	35 Reverse Clutch Feed
26	35 Reverse Supply
27	35 Reverse Feed
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch
33	Drive B
36	1234 Clutch Feed
37	1234 Clutch
38	1234 Clutch Feedback
43	26 Clutch
44	26 Clutch Feedback
45	1234 Clutch Default Feed
47	456 Clutch Feed
50	Exhaust Backfill
51	Exhaust
53	Void

Control Valve Lower Body

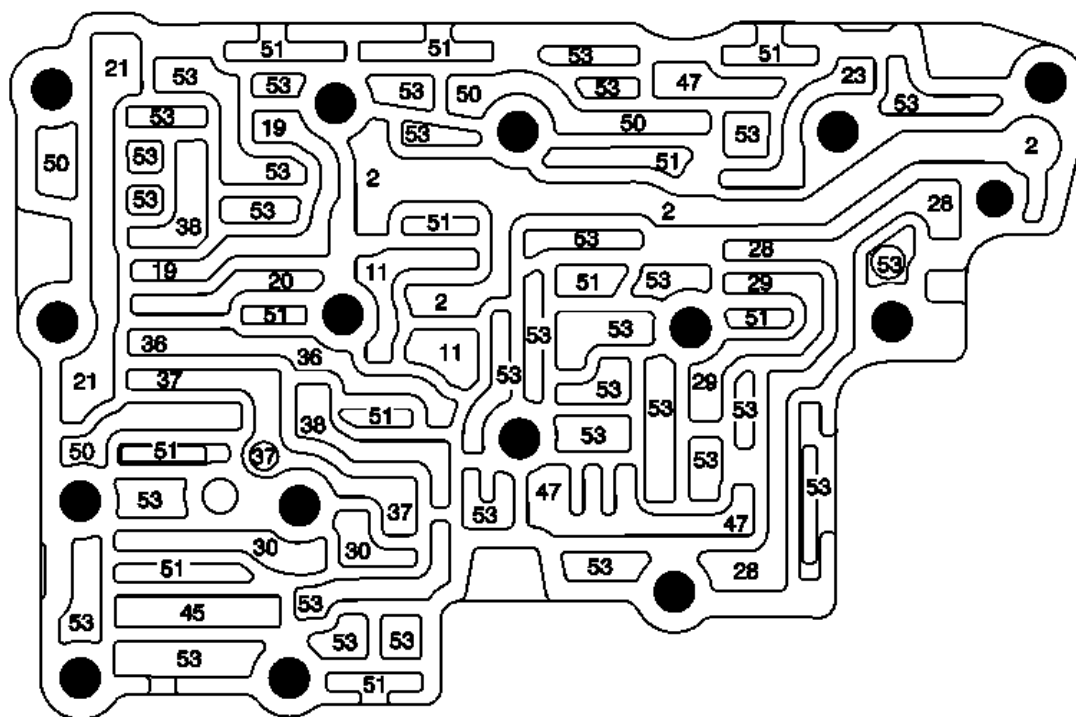


Fig. 42: Control Valve Lower Body
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
11	Actuator Feed Limit
19	R1/456 Clutch Feed
20	R1/456 Clutch Feedback
21	R1 Supply
23	PCS 35 Reverse Clutch
28	35 Reverse Clutch
29	35 Reverse Clutch Feedback
30	PCS 1234 Clutch
36	1234 Clutch Feed
37	1234 Clutch
38	1234 Clutch Feedback
45	1234 Clutch Default Feed
47	456 Clutch Feed
50	Exhaust Backfill
51	Exhaust
53	Void

A/Trans Case Assembly- Control Valve Body Side

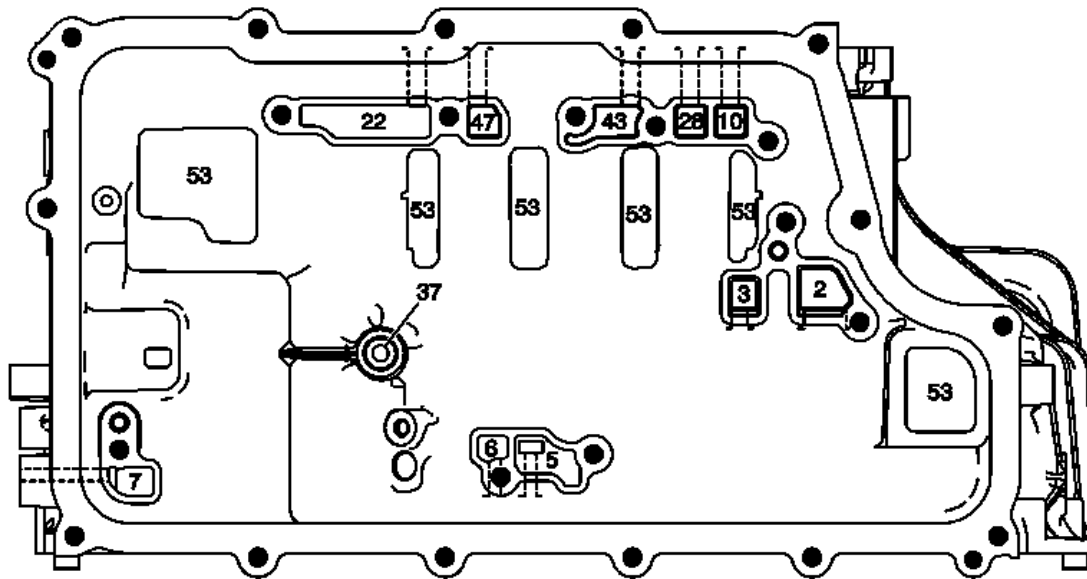


Fig. 43: A/Trans Case Assembly-- Control Valve Body Side
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
5	TCC Release
6	TCC Apply
7	Cooler Feed
10	Compensator Feed
22	R1
28	35 Reverse Clutch
37	1234 Clutch
43	26 Clutch
47	456 Clutch
53	Void

A/Trans Case Assembly- Torque Converter and Differential Housing Side

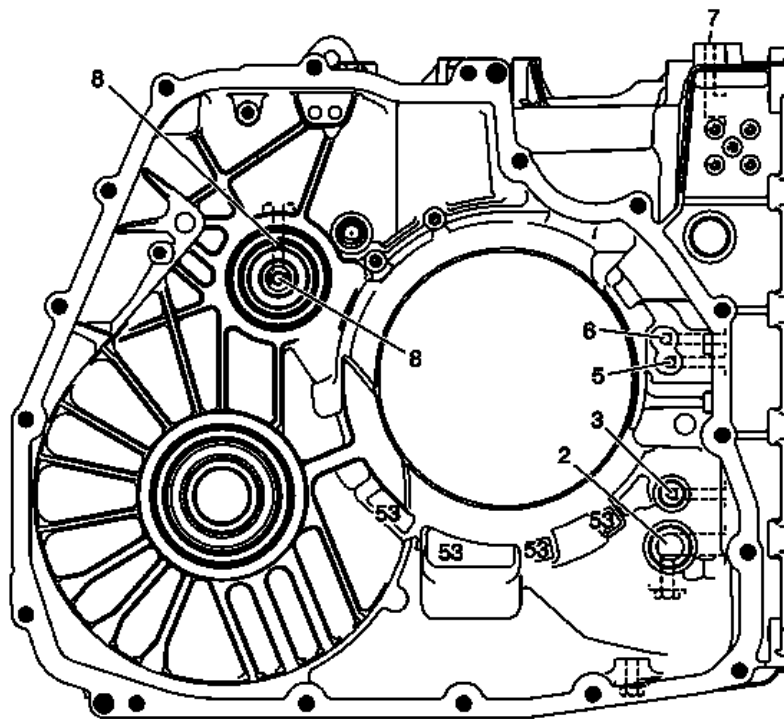


Fig. 44: A/Trans Case Assembly-- Torque Converter and Differential Housing Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line
3	Decrease
5	TCC Release
6	TCC Apply
7	Cooler Feed
8	Lube
53	Void

A/Trans Case Assembly Case Cover Side

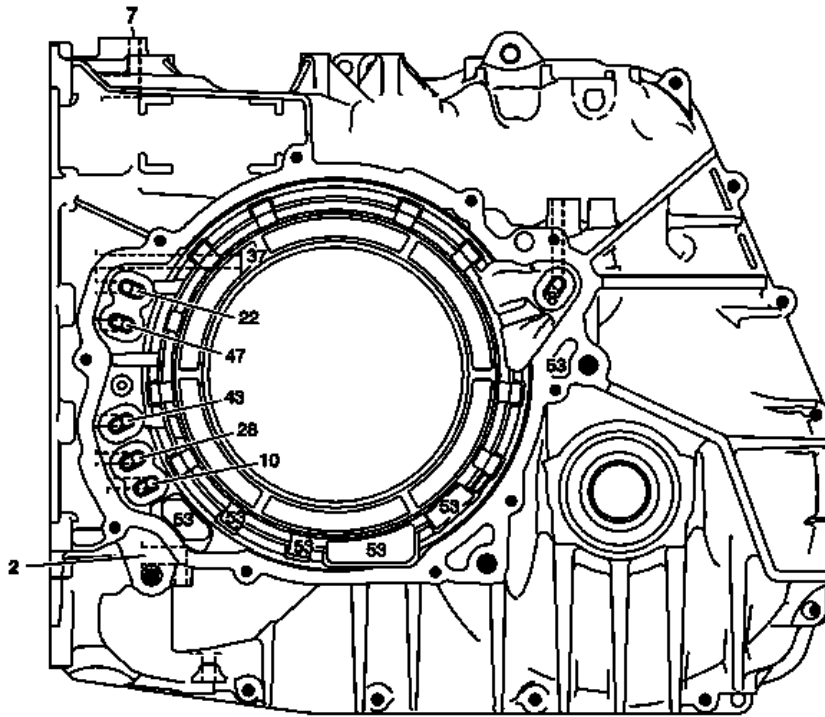


Fig. 45: A/Trans Case Assembly Case Cover Side Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2	Line (to valve body)
7	Cooler Feed
8	Lube
10	Compensator Feed
22	R1
28	35 Reverse Clutch
37	1234 Clutch
43	26 Clutch
47	456 Clutch
53	Void

A/Trans Case Cover Assembly

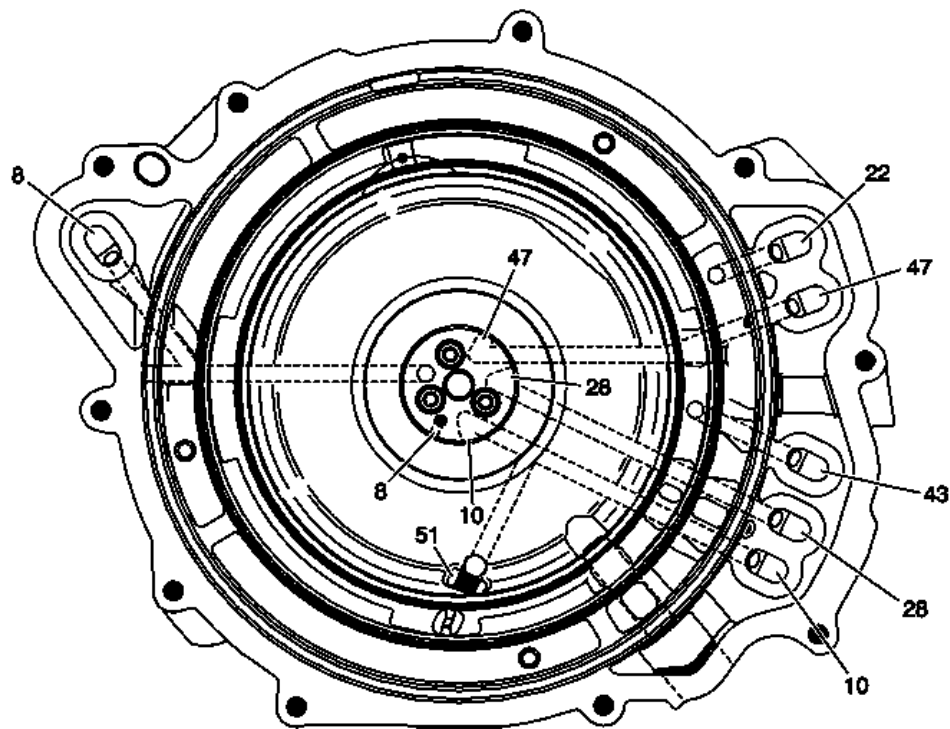


Fig. 46: A/Trans Case Cover Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
8	Lube
10	Compensator Feed
22	R1
28	35 Reverse Clutch
43	26 Clutch
47	456 Clutch
51	Compensator Feed Exhaust

Front Differential Transfer Drive Gear Support- Case Side

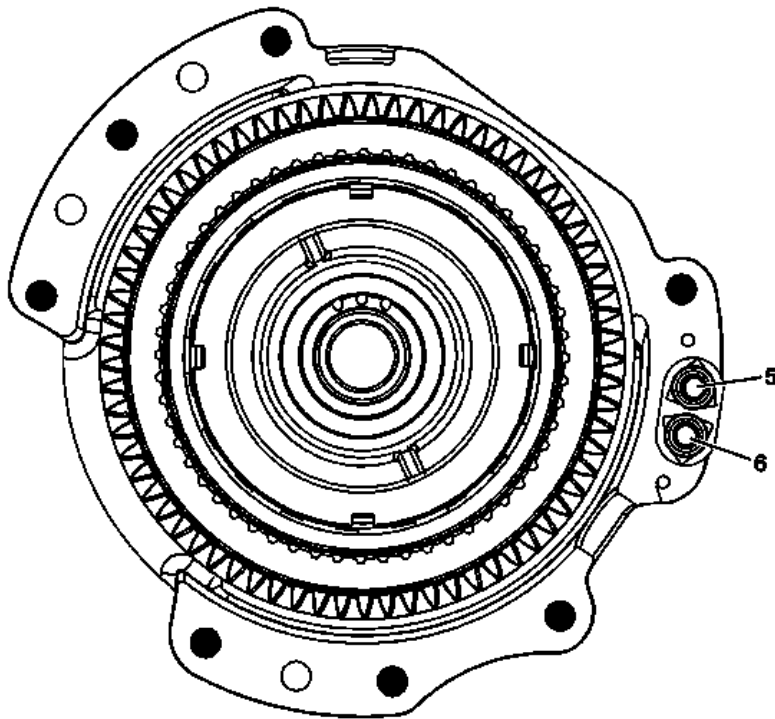


Fig. 47: Identifying Front Differential Transfer Drive Gear Support Fluid Passages - Case Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5	TCC Release
6	TCC Apply

Front Differential Transfer Drive Gear Support- Torque Converter and Differential Housing Side

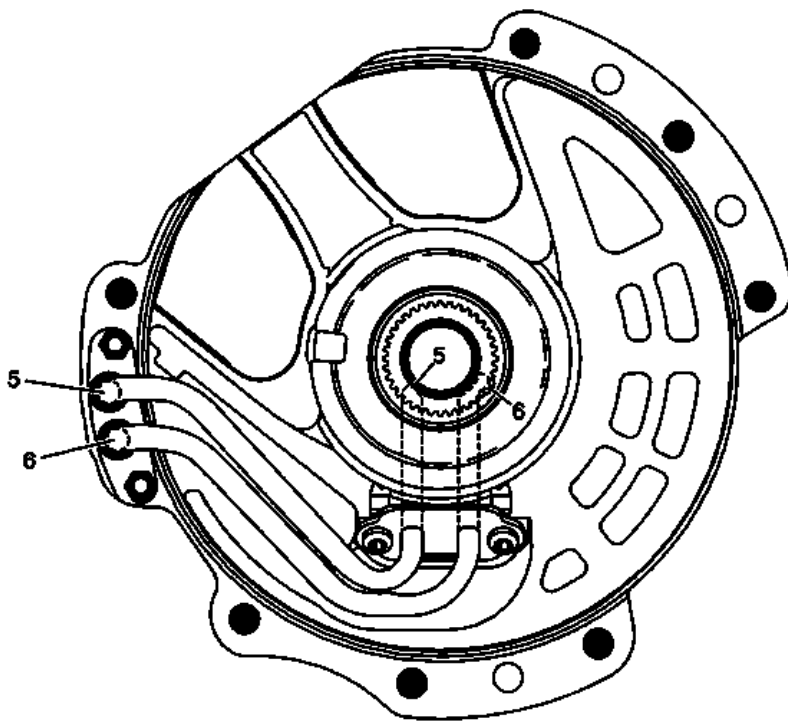


Fig. 48: Identifying Front Differential Transfer Drive Gear Support Fluid Passages - Torque Converter & Differential Housing Side

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5	TCC Release
6	TCC Apply

Transmission

Automatic Transmission - 6T70 (M7U M7W) - Diagnostic Information and Procedures

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0601-P0604 OR P062F

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: DTCs P0601, P0602, P0603, P0604 or P062F could set in other control modules. Verify the DTCs are set in the transmission control module (TCM).

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P062F

Control Module Long Term Memory Performance

Circuit/System Description

This is an internal fault detection of the control solenoid valve assembly. This fault is handled inside the control solenoid valve assembly and no external circuits are involved.

Conditions for Running the DTC

Ignition voltage is between 8.6 volts and 18.0 volts.

Conditions for Setting the DTC

P0601

Read only memory (ROM) test has failed 5 or greater times.

P0602

TCM has not been programmed and is unable to detect the start program.

P0603

TCM has detected a memory checksum error.

P0604

TCM has detected a random access memory (RAM) test error 5 or greater times.

P062F

TCM has detected a non-volatile memory error during power-down.

Action Taken When the DTC Sets

P0601, P0602, P0603, P0604, or P062F

- DTCs P0601, P0603, P0604, and P062F are Type A DTCs.
- TCM limits the transmission to Reverse and 5th gear operation.
- TCM commands maximum line pressure.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM freezes transmission adaptive functions.
- TCM commands the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

P0602

- DTC P0602 is a Type C DTC.
- TCM limits the transmission to Reverse and 5th gear operation.
- TCM commands maximum line pressure.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM freezes transmission adaptive functions.

- TCM commands the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

P0601, P0603, P0604, or P062F

DTCs P0601, P0603, P0604, and P062F are Type A DTCs.

P0602

DTC P0602 is a Type C DTC.

Reference Information

Description and Operation

Electronic Component Description for control solenoid valve assembly

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

CAUTION: Before programming a control module, the following must be observed, or control module damage may occur:

- The TIS terminal, MDI, and/or scan tool must have the latest software.
- The vehicle battery must be fully charged. The battery voltage should be between 12-14 volts.
- The TIS terminal, MDI, and/or scan tool connections must be secure.
- A battery charger must NOT be connected to the battery when programming a control module.

1. Ignition OFF for 1 minute.
2. Ignition ON.
3. Verify with a scan tool, that DTC P0602 is not set.

- If DTC P0602 is set
 - Program the K71 transmission control module. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Programming and Setup (6T70)** . If the DTC resets, replace the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
 - If DTC P0602 is not set
4. Verify with a scan tool that DTC P0601, P0603, P0604, or P062F is not set.
- If DTC P0601, P0603, P0604, or P062F is set
- Replace the Q8 control solenoid valve assembly.
- If DTC P0601, P0603, P0604 or P062F is not set
5. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, refer to **Testing for Intermittent Conditions and Poor Connections** .

Repair Instructions

NOTE: **Perform the Reset Transmission Adapts any time a transmission related component is serviced.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control solenoid valve assembly replacement, setup, and programming

DTC P0634

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0634

Control Module Overtemperature

Circuit/System Description

The transmission control module (TCM) temperature sensor is located inside of the control solenoid valve assembly which has no serviceable components. The TCM monitors the TCM temperature sensor for over temperature protection.

Conditions for Running the DTC

- Ignition voltage is 8.6-32 V.
- TCM temperature is between 0-170°C (32-338°F) for 0.25 s.

Conditions for Setting the DTC

Condition 1

TCM detects an internal temperature condition of 146°C (295°F) or greater for 5 s.

Condition 2

Ignition voltage is 18 V or greater and the TCM detects an internal temperature of 50°C (122°F) or greater for 2 s.

Action Taken When the DTC Sets

- DTC P0634 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.
- TCM inhibits Tap Up/Down function.
- TCM inhibits Neutral Idle.
- TCM inhibits auto grade braking.
- TCM requests reduced engine torque based on input speed.

Conditions for Clearing the DTC

DTC P0634 is a Type A DTC.

Diagnostic Aids

During a road test, the TCM temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Engine Coolant Temperature parameter was less than 125° C (257° F) when DTC set by reviewing the scan tool Freeze Frame/Failure Records.
 - **If 125° C (257° F) or greater**

Refer to **Engine Overheating** .

- **If less than 125° C (257° F)**
3. Verify transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
 - **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level and condition is correct**
4. Clear the DTCs from the TCM with a scan tool.
5. Operate the vehicle until normal engine temperature is reached.
6. Verify the scan tool Transmission Fluid Temperature parameter is less than 140° C (284° F).
 - **If 140° C (284° F) or greater**
 1. Ignition OFF.
 2. Verify the conditions listed below do not exist:
 - Obstructions to the airflow to the radiator or transmission

- Radiator damage
 - Transmission cooler damage
 - Transmission cooler pipe kinked or damaged
 - If conditions exist, repair or replace as necessary.
 - If conditions do not exist, refer to **Transmission Fluid Cooler Flushing and Flow Test (6T70)**.
 - **If less than 140° C (284° F)**
7. Verify the DTC does not set.
- **If DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If DTC does not set**
8. Operate the vehicle within the conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Record data.
9. Verify the DTC does not set.
- **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the DTC does not set**
10. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Transmission Fluid Cooler Inlet Pipe Replacement (M7U)**
- **Transmission Fluid Cooler Outlet Pipe Replacement (M7U)**
- **Transmission Fluid Cooler Pipe Connector Replacement - Radiator**
- **Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MHH, MHK) , Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MDK)**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup

DTC P0658 OR P0659

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0658

Actuator High Control Circuit Group 1 Low Voltage

DTC P0659

Actuator High Control Circuit Group 1 High Voltage

Circuit/System Description

The transmission control module (TCM) high side driver 1 is located inside of the control solenoid valve assembly, which has no serviceable components. The high side driver 1 provides power to the pressure control solenoids and shift solenoids.

Conditions for Running the DTC

P0658

- DTC P0658 is not set.
- High side driver 1 is enabled.

P0659

- DTC P0659 is not set.
- Ignition transitions from OFF to ON

Conditions for Setting the DTC

P0658

TCM detects an internal open or short to ground in the high side driver 1 circuit for 1 s.

P0659

TCM detects an internal short to voltage on the high side driver 1 for 1 s.

Action Taken When the DTC Sets

P0658

- DTC P0658 is a Type A DTC.
- TCM turns the high side driver OFF.
- TCM turns OFF all solenoids.
- TCM commands maximum line pressure.

- TCM freezes transmission adaptive functions.
- TCM commands the torque converter clutch (TCC) OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 5th gear operation.
- TCM requests a reduced torque value based on input speed.

P0659

DTC P0659 is a Type C DTC.

Conditions for Clearing the DTC

- DTC P0658 is a Type A DTC.
- DTC P0659 is a Type C DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool High Side Driver 1 parameter displays ON.
 - **If ON is not displayed**

Refer to Circuit/System Testing.

- **If ON is displayed**
3. Engine Running, and transmission in Park.
 4. Verify the scan tool parameters listed below do not display Malfunction:
 - High Side Driver 1 Circuit Low Voltage Test Status
 - High Side Driver 1 Circuit Open Test Status
 - High Side Driver 1 Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.

2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**
 - **If contaminated**

Repair as necessary
 - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT 47825-20** adapter harness between the vehicle wire harness electrical connector and the Q8 Control Solenoid Valve Assembly electrical connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - High Side Driver 1 Circuit Low Voltage Test Status
 - High Side Driver 1 Circuit Open Test Status
 - High Side Driver 1 Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0667, P0668, OR P0669

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0667

Control Module Temperature Sensor Performance

DTC P0668

Control Module Temperature Sensor Circuit Low Voltage

DTC P0669

Control Module Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission control module (TCM) temperature sensor is located inside of the control solenoid valve assembly, which has no serviceable components. The TCM temperature sensor provides the temperature of the TCM. This temperature reading is used in various shifting and diagnostic routines in the TCM software. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P0667

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0658, P0668, P0669, P06AD, P06AE, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.
- Brake torque is not active.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.
- Engine torque signal is valid.
- Accelerator pedal position signal is valid.

P0668

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.

P0669

- DTC P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM .
- Ignition voltage is between 8.6-32 V.

Conditions for Setting the DTC

P0667

- TCM detects a 20-50°C (36-90°F) or greater difference between the transmission fluid temperature and TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- TCM detects an 8-10°C (14-18°F) or greater difference between the TCM power up temperature and TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min within a 6 min period.

P0668

TCM temperature is -249°C (-416°F) or less for 1 min.

P0669

TCM temperature is 249°C (480°F) or greater for 1 min.

Action Taken When the DTC Sets

- DTCs P0667, P0668, and P0669 are Type B DTCs.
- TCM defaults the TCM substrate temperature to a calculated temperature based on the TCM power up temperature.

Conditions for Clearing the DTC

DTCs P0667, P0668, and P0669 are Type B DTCs.

Diagnostic Aids

The TCM temperature sensor is located inside of the control solenoid valve assembly and its output should resemble that of the transmission fluid temperature sensor output. During a road test, the TCM temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool TCM Temperature parameter is between -249 and +249°C (-416 and +480°F).
 - **If not between -249 and +249°C (-416 and +480°F)**
3. Verify the scan tool TCM Temperature parameter increases greater than 2°C (3.5°F) after operating the vehicle at 64 km/h (40 mph) for 10 min.
 - **If the temperature does not increase greater than 2°C (3.5°F)**

Replace the Q8 Control Solenoid Valve Assembly.

- **If between -249 and +249°C (-416 and +480°F)**

Replace the Q8 Control Solenoid Valve Assembly

- **If the temperature increases greater than 2°C (3.5°F)**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly

- **If the DTC does not set**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P06AC-P06AE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06AC

Control Module Power Up Temperature Sensor Performance

DTC P06AD

Control Module Power Up Temperature Sensor Circuit Low Voltage

DTC P06AE

Control Module Power Up Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission control module (TCM) power up temperature sensor is located inside of the control solenoid valve assembly, which has no serviceable components. The TCM power up temperature sensor provides the temperature of the TCM when the TCM power is ON. This temperature reading is used in various shifting and diagnostic routines and also to protect the control solenoid valve assembly and TCM. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P06AC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0658,

P0668, P0669, P06AD, P06AE, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.
- Brake torque is not active.
- Engine torque signal is valid.
- Accelerator pedal position signal is valid.

P06AD

- DTC P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.

P06AE

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.

Conditions for Setting the DTC

P06AC

- TCM detects a 20-50° C (36-90°F) or greater difference between the transmission fluid temperature and TCM power up temperature, which depends on the average of transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- TCM detects an 8-10° C (14-18°F) or greater difference between the TCM substrate temperature and TCM power up temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min. within a 6 min. period.

P06AD

TCM power up temperature is -59°C (-74°F) or less for 1 min.

P06AE

TCM power up temperature is 164°C (327°F) or greater for 1 min.

Action Taken When the DTC Sets

- DTC P06AC, P06AD, P06AE are Type B DTCs.
- TCM defaults the TCM power up temperature to a calculated temperature based on the TCM substrate temperature.

Conditions for Clearing the DTC

DTC P06AC, P06AD, P06AE are Type B DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description** for control solenoid valve assembly

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, clear the DTCs with a scan tool.
2. Operate the vehicle at 64 km/h (40 mph) for 10 min.
3. Verify DTC P06AC, P06AD, or P06AE is not set.

- **If any of the DTCs are set**

Replace the Q8 Control Solenoid Valve Assembly.

- **If none of the DTCs are set.**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the DTC does not set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0711-P0713

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0711

Transmission Fluid Temperature Sensor Performance

DTC P0712

Transmission Fluid Temperature Sensor Circuit Low Voltage

DTC P0713

Transmission Fluid Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission fluid temperature sensor is located inside of the transmission control module (TCM) assembly which has no serviceable components. The transmission fluid temperature sensor provides transmission fluid temperature to the TCM. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P0711

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0658, P0668, P0669, P06AD, P06AE, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.
- Brake torque is not active.
- Engine torque signal is valid.
- Throttle position signal is valid.

P0712 and P0713

- DTC P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.

Conditions for Setting the DTC

P0711

- TCM detects a 20-50° C (36-90° F) or greater difference between the transmission fluid temperature and the TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- TCM detects a 20-50° C (36-90° F) or greater difference between the transmission fluid temperature and the TCM power up temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min within a 6 min period.

P0712

Transmission fluid temperature is -74°C (-101°F) or lower for 1 min.

P0713

Transmission fluid temperature is 174°C (345°F) or greater for 1 min.

Action Taken When the DTC Sets

- DTCs P0711, P0712, and P0713 are Type B DTCs.
- TCM defaults to a calculated transmission fluid temperature based on the TCM Temperature.

Conditions for Clearing the DTC

DTCs P0711, P0712, and P0713 are Type B DTCs.

Diagnostic Aids

The TCM temperature sensor is located inside of the control solenoid valve assembly and its output should resemble that of the transmission fluid temperature sensor's output. During a road test, the transmission fluid temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling at the normal operating temperature.
2. Verify the scan tool Transmission Fluid Temperature parameter is between -74 and +174° C (-101 and

+345° F).

- **If not between -74 and +174° C (-101 and +345° F)**

Replace the Q8 Control Solenoid Valve Assembly.

- **If between -74 and +174° C (-101 and +345° F)**

3. Verify the scan tool Transmission Fluid Temperature parameter increases greater than 2° C (3.5° F) after operating the vehicle at 64 km/h (40 mph) for 10 min.

- **If the temperature does not increase greater than 2° C (3.6° F)**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the temperature increases greater than 2° C (3.6° F)**

4. Verify the scan tool Transmission Fluid Temperature and the TCM Temperature parameters are within 20° C (36° F).

- **If the temperatures are not within 20° C (36° F)**

1. Ignition OFF, remove the control valve body cover. Refer to **Control Valve Body Cover Replacement**.
2. Verify the heat sink on the control valve channel upper plate and the control solenoid valve spring are in place and undamaged.
 - If the heat sink on the control valve channel upper plate or the control solenoid valve spring are damaged, replace as necessary
 - If the heat sink on the control valve channel upper plate and the control solenoid valve spring are in place and undamaged, replace the Q8 Control Solenoid Valve Assembly

- **If the temperatures are within 20° C (36° F)**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

6. Verify the DTC does not set.

- **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the DTC does not set**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Lower Body and Upper Body Replacement** for control valve channel upper plate assembly and control solenoid valve spring replacement.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and

setup.

DTC P0716 OR P0717

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0716

Input Speed Sensor Performance

DTC P0717

Input Speed Sensor Circuit No Signal

Diagnostic Fault Information

Circuit	Short to Ground	Open	Short to Voltage	Signal Performance
8.6 V Reference	P0716, P0717	P0716, P0717	-	P0716
Signal	P0716, P0717	P0716, P0717	P0716, P0717	P0716

Typical Scan Tool Data

Transmission ISS

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, normal operating temperature, transmission in PARK Parameter Normal Range: 450-7000 RPM			
8.6 V Reference	0 RPM	0 RPM	-
Signal	0 RPM	0 RPM	0 RPM

ISS/OSS Supply Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, normal operating temperature Parameter Normal Range: OK			
8.6 V Reference	Out of Range	OK	Out of Range
Signal	OK	OK	OK

Circuit/System Description

The input shaft speed (ISS) sensor is a hall-effect type sensor. The ISS sensor mounts to the inside of the automatic transmission case assembly and connects to the control solenoid valve assembly through a 2-wire harness and connector. The sensor faces the reluctor wheel which is attached to the 4-5-6 clutch and 3-5-R clutch housing. The sensor receives 8.3-9.3 volts on the ISS supply voltage circuit from the transmission control module (TCM). As the 4-5-6 clutch and 3-5-R clutch housing rotates, the sensor produces a signal frequency based on the teeth of the reluctor wheel. This signal is transmitted through the ISS sensor signal circuit to the TCM. The TCM uses the ISS sensor signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed, and gear ratio.

Conditions for Running the DTC

P0716

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0717, P0752, P0973, or P0974 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.
- Engine torque signal is valid.
- Throttle position signal is valid.
- Vehicle speed is 10 km/h (6 mph) or greater.

P0717

- DTC P0101, P0102, P0103, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.
- Vehicle speed is 16 km/h (10 mph) or greater.
- Engine torque is 50 N.m (37 lb ft) or greater.
- Engine torque signal is valid.

Conditions for Setting the DTC

P0716

TCM detects the transmission input shaft speed signal dropped greater than 1350 RPM for 1 s.

P0717 - Condition 1

TCM detects the transmission input shaft speed signal is less than 33 RPM for 5 s.

P0717 - Condition 2

The TCM detects that P0722 set and the Transmission input speed is less than 1000 RPM for 5 s.

Action Taken When the DTC Sets

- DTCs P0716 and P0717 are Type A DTCs.
- TCM freezes transmission adaptive functions.
- TCM commands the high side driver OFF.
- TCM commands TCC OFF.
- TCM commands maximum line pressure.
- TCM disables neutral idle.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- Torque management is enabled.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.

Conditions for Clearing the DTC

DTCs P0716 and P0717 are Type A DTCs.

Diagnostic Aids

If the scan tool ISS/OSS supply voltage parameter is out of range, the fault could also be caused by the transmission output shaft speed sensor.

Damage or misalignment of the 4-5-6 clutch and 3-5-R clutch housing reluctor machined teeth surface may cause a speed sensor malfunction.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ISS/OSS Supply Voltage parameter displays OK.
 - **IF OK is not displayed**

Refer to Circuit/System Testing.
 - **If OK is displayed**
3. Engine idling, transmission in Park, parking brake applied, and drive wheels chocked.
4. Verify the scan tool Transmission ISS parameter changes or does not drop out while varying the engine speed.
 - **If the Transmission ISS does not vary with engine speed or drops out**

Refer to Circuit/System Testing.
 - **If the Transmission ISS varies with engine speed and does not drop out**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the control valve body cover.
2. Connect the vehicle wire harness electrical connector to the Q8 Control Solenoid Valve Assembly

electrical connector.

3. Disconnect the B14C Transmission Input Shaft Speed Sensor wiring harness connector from the Q8 Control Solenoid Valve Assembly.
4. Ignition ON.
5. Test for 8.3-9.3 V between the ISS sensor supply voltage circuit terminal A at the Q8 Control Solenoid Valve Assembly, and ground at the transmission case.
 - **If not between 8.3-9.3 V**
 1. Ignition OFF, disconnect the B14A Transmission Output Shaft Speed Sensor wiring harness connector from the Q8 Control Solenoid Valve Assembly. Ignition ON.
 2. Test for 8.3-9.3 V between the OSS sensor supply voltage circuit terminal A X3 at the Q8 Control Solenoid Valve Assembly, and ground at the transmission case.
 - If not between 8.3-9.3 V, replace the Q8 Control Solenoid Valve Assembly.
 - If between 8.3-9.3 V, replace the B14A Transmission Output Shaft Speed Sensor.
 - **If between 8.3-9.3 V**
6. Verify the scan tool Transmission ISS parameter is between 495-505 RPM when performing the input shaft speed test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Input Shaft Speed/Output Shaft Speed Input Test**.
 - **If not between 495-505 RPM**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If between 495-505 RPM**
7. Verify there is no damage to the reluctor, which is attached to the 4-5-6 clutch and 3-5-R clutch housing assembly, or misalignment between the B14C Transmission Input Shaft Speed Sensor and reluctor.
 - **If the reluctor is damaged or misaligned**

Repair or replace as necessary.
 - **If the reluctor is not damaged or misaligned**
8. Replace the B14C Transmission Input Shaft Speed Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Input Speed Sensor Replacement**
- **Output Speed Sensor Replacement**
- **Control Valve Body Cover Replacement**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P071D

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P071D

Transmission Sport Mode Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Trans Mode Switch B Signal	P071D	-	-	-

Circuit/System Description

The Body Control Module (BCM) supplies a signal circuit to the sport mode switch. When the sport mode switch is momentarily pressed, the signal circuit is connected to ground. The BCM detects the change in voltage and initiates sport mode and sends a GMLAN message to the transmission control module (TCM) indicating the status of sport mode. The status of the sport mode switch is also sent as a GMLAN message. When sport mode is active, the TCM holds a pending transmission upshift during high speed cornering maneuvers.

Conditions for Running the DTC

- DTC P1762 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.
- DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

TCM detects that the sport mode switch has been continuously activated for 10 min.

Action Taken When the DTC Sets

- P071D is a type C DTC.
- TCM inhibits Tap Up/Down function.

Conditions for Clearing the DTC

P071D is a Type C DTC.

Diagnostic Aids

- Diagnose all communication and body DTCs first.
- The multifunction switch being diagnosed is labeled GS.

Reference Information

Schematic Reference

- **Automatic Transmission Controls Schematics**
- **Body Control System Schematics**
- **Electronic Suspension Control Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Body Control System Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Transmission Sport Mode parameter changes between Active and Inactive each time the sport mode switch is depressed and released.
 - **If Inactive or Active is not displayed**

Refer to Circuit/System Testing.

- **If Inactive and Active are displayed**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Ignition OFF, disconnect the harness connector at the S48A Multifunction Switch - Instrument Panel.
2. Test for less than 10 ohms between the vehicle harness connector ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit, end to end.
 - If 2 ohms or greater, repair the open/high resistance in the ground circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for greater than 11 V between the vehicle harness connector signal circuit terminal 4 and ground.
 - **If less than 11 V**
 1. Ignition OFF, remove the X3 harness connector at the BCM.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the signal circuit, end to end.
 - If 2 ohms or greater, repair the open/high resistance in the signal circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 11 V**
5. Ignition OFF, install a 3 amp fused jumper wire between vehicle harness connector signal circuit terminal 4 and ground, ignition ON.
6. Verify the scan tool Transmission Sport Mode parameter changes between Inactive and Active each time the jumper wire is connected to ground and then removed.

- **If Active or Inactive is not displayed**

Replace the K9 Body Control Module.

- **If Active and Inactive are displayed**

7. Replace the S48A Multifunction Switch - Instrument Panel.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Accessory Switch Replacement**
- **Control Module References** for Body Control Module replacement, programming and setup.

DTC P0722 OR P0723

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0722

Output Speed Sensor Circuit No Signal

DTC P0723

Output Speed Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
8.6 V Referene	P0722, P0723	P0722, P0723	-	P0723
Signal	P0722, P0723	P0722, P0723	P0722, P0723	P0723

Typical Scan Tool Data

Transmission OSS

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, normal operating temperature Parameter Normal Range: 0-7,000 RPM			

8.6 V Reference	0 RPM	0 RPM	0-7000 RPM
Signal	0 RPM	0 RPM	0 RPM

ISS/OSS Supply Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Key ON, Engine OFF or Engine running, normal operating temperature Parameter Normal Range: OK			
8.6 V	Out of Range	OK	Out of Range
Signal	OK	OK	OK

Circuit/System Description

The automatic transmission output shaft speed (OSS) sensor is a hall-effect type sensor. The sensor faces the front differential transfer drive gear. The sensor receives 8.3-9.3 volts on the OSS sensor supply voltage circuit from the transmission control module (TCM). As the output shaft rotates, the sensor produces a signal frequency based on the machined surface of the output shaft. This signal is transmitted through the OSS sensor signal circuit to the TCM. The TCM uses the OSS sensor signal to calculate output shaft speed to determine commanded line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

Conditions for Running the DTC

P0722

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0716, P0717, or P0723 is not set.
- Selected range is not PARK or NEUTRAL.
- Transmission input speed is 1,000 RPM or greater.
- Engine speed is 3,200 RPM or greater.
- Throttle position is 5 % or greater.
- Throttle position signal is valid.
- Engine torque is 35 N.m (26 lb ft) or greater.
- Engine torque signal is valid.
- Transmission fluid temperature is -40°C (-40°F) or greater.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.

P0723

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0973, P0974, P0976, or P0977 is not set.
- Greater than 5 s since last transmission upshift or downshift.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.

Conditions for Setting the DTC

P0722

Transmission output speed is 35 RPM or less for 4.0 s.

P0723

- Transmission output speed is 105 RPM or greater for 0.2 s.
- TCM detects the transmission output shaft speed dropped greater than 650 RPM for 1.5 s.

Action Taken When the DTC Sets

- DTCs P0722 and P0723 are Type A DTCs.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.

Conditions for Clearing the DTC

DTCs P0722 and P0723 are Type A DTCs.

Diagnostic Aids

- Damage or misalignment of the front differential transfer drive gear teeth surface or metallic debris on the face of the sensor may cause a speed sensor malfunction.
- Proper torque of the OSS mounting bolt is critical to proper OSS operation.
- If the scan tool ISS/OSS Supply Voltage indicates out of range, the fault could also be caused by the transmission input shaft speed sensor.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**

- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ISS/OSS Supply Voltage parameter displays OK.
 - **If OK is not displayed**
 Refer to Circuit/System Testing.
 - **If OK is displayed**
3. Verify the scan tool Transmission OSS parameter changes with vehicle speed or does not drop out while operating the vehicle at 16-32 km/h (10-20 mph).
 - **If the Transmission OSS does not vary with vehicle speed or drops out**
 Refer to Circuit/System Testing.
 - **If the Transmission OSS varies with vehicle speed and does not drop out**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set
 - **If the DTC sets**
 Refer to Circuit/System Testing.
 - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: You must perform the **Circuit/System Verification** first.

1. Ignition OFF, remove the control valve body cover.
2. Connect the vehicle wire harness electrical connector to the Q8 Control Solenoid Valve Assembly electrical connector.
3. Disconnect the B14A Transmission Output Shaft Speed Sensor wiring harness connector from the Q8 Control Solenoid Valve Assembly.
4. Ignition ON.
5. Test for 8.3-9.3 V between the OSS sensor supply voltage circuit terminal A at the Q8 Control Solenoid Valve Assembly, and ground at the transmission case.
 - **If not between 8.3-9.3 V**
 1. Ignition OFF, disconnect the B14C Transmission Input Shaft Speed Sensor wiring harness connector from the Q8 Control Solenoid Valve Assembly. Ignition ON.
 2. Test for 8.3-9.3 V between the OSS sensor supply voltage circuit terminal A X4 electrical connector at the Q8 Control Solenoid Valve Assembly, and ground at the transmission case.
 - If not between 8.3-9.3 V, replace the Q8 Control Solenoid Valve Assembly.
 - If between 8.3-9.3 V, replace the B14C Transmission Input Shaft Speed Sensor.
 - **If between 8.3-9.3 V**
6. Verify the scan tool Transmission OSS parameter is between 256-266 RPM when performing the output shaft speed test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Input Shaft Speed/Output Shaft Speed Input Test**.
 - **If not between 256-266 RPM**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If between 256-266 RPM**
7. Verify there is no damage to the front differential transfer drive gear teeth surface or misalignment with the B14A Transmission Output Shaft Speed Sensor.
 - **If the front differential transfer drive gear is damaged or is misaligned**

Repair or replace as necessary.
 - **If the front differential transfer drive gear is not damaged or misaligned.**
8. Replace the B14A Transmission Output Shaft Speed Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Body Cover Replacement** .

- **Output Speed Sensor Replacement**
- **Input Speed Sensor Replacement**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup

DTC P0741 OR P0742

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the **Circuit/System Verification and Circuit/System Testing** to identify the cause.

DTC P0741

Torque Converter Clutch (TCC) System Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0742

Torque Converter Clutch (TCC) System Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

The torque converter clutch (TCC) pressure control solenoid is part of the control solenoid valve assembly which has no serviceable components. The TCC pressure control solenoid is a normally low pressure control solenoid. The TCC pressure control solenoid regulates transmission fluid to the TCC regulator valve in the lower valve body and the TCC control valve in the pump cover. When vehicle operating conditions are appropriate to apply the converter clutch, the transmission control module (TCM) will increase current flow to the TCC pressure control solenoid, thereby increasing pressure directed to the TCC control valve. The increase in fluid pressure moves the TCC control valve to the apply position, and moves the TCC regulator apply valve to the regulating position. The TCC regulator valve regulates TCC apply fluid pressure proportional to TCC solenoid pressure. When the TCC is fully applied, the engine is coupled directly to the transmission. TCC release is accomplished by the TCM decreasing current flow to the TCC PC solenoid. This results in decreasing the apply pressure which allows the TCC control valve to move to the release position. The TCM calculates torque converter slip speed based on the speed signal from the input shaft speed sensor and the engine speed provided by the engine control module.

Conditions for Running the DTC

P0741

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, P0742, P2763, or P2764 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.
- Transmission fluid temperature is between -6.7 to +130°C (20-266°F).
- Throttle position is 8.5 % or greater.
- Engine torque is 50 N.m (36 lb ft) or greater.
- Engine torque signal is valid.
- Throttle position signal is valid.
- TCM detects the transmission gear ratios listed below for the commanded gear when TCC is commanded ON:
 - 2nd gear ratio is between 2.67-3.07.
 - 3rd gear ratio is between 1.71-1.97.
 - 4th gear ratio is between 1.32-1.51.
 - 5th gear is between 0.93-1.07.
 - 6th gear is between 0.69-0.79.

P0742

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, P0741, P2763, or P2764 is not set.
- Commanded range is 2nd gear or higher.
- Ignition voltage is 8.5 V or greater.
- Transmission fluid temperature is between 18-130°C (64-266°F).
- Throttle position is 5 % or greater.
- Engine torque is 80 N.m (59 lb ft) or greater.
- Engine speed is 400-7,500 RPM for 5 s.
- Vehicle speed is 1 km/h (0.6 mph) or greater.
- Engine speed is 500 RPM or greater
- Engine torque signal is valid.
- Throttle position signal is valid.
- TCC is commanded OFF.

Conditions for Setting the DTC

P0741

- TCC Pressure command is 800 kPa (116 psi) or greater for 2 s.
- TCM detects TCC slip of 50 RPM or greater for 5 s.

- The above conditions must occur 3 times.

P0742

TCM detects the TCC slip between -50 and +13 RPM for 2.5 s when the TCC is commanded OFF. This condition must occur 6 times.

Action Taken When the DTC Sets

P0741

- DTC P0741 is a Type B DTC.
- TCM inhibits 6th gear.
- TCM commands TCC OFF.
- TCM forces hot mode shift pattern.

P0742

- DTC P0742 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM forces hot mode shift pattern.
- TCM commands the TCC ON.

Conditions for Clearing the DTC

P0741

DTC P0741 is a Type B DTC.

P0742

DTC P0742 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

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- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling, transmission in the Park, parking brake applied, and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.

- **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level and condition is correct**

3. Ignition ON, clear the TCM DTCs with a scan tool.
4. Verify DTC P0741 or P0742 does not set while performing a road test. Refer to **Road Test**.

- **If DTC P0741 or P0742 sets**

Refer to Circuit/System Testing.

- **If DTC P0741 or P0742 did not set**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure**.

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low**.

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0741 - Upper Valve Body

Release exhaust port/orifice plugged or blocked.

P0741 or P0742 - Upper Valve Body

Torque converter clutch regulator valve stuck/sticking - debris, binding, damaged valve, or scored bore.

P0741 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P0741 - Torque Converter

- Torque converter clutch delamination or material worn off.
- Converter bolts too long damaging the clutch apply surface.
- Damaged seal.

P0741 - Support

Damaged seal.

P0741 or P0742 - Transmission Case Cover

- Pressure release blow-off not seating/sealing.
- Damaged spring.

P0741 - Turbine Shaft

O-ring seal cut or damaged

P0741 or P0742 Q8 Control Solenoid Valve Assembly

- Torque converter clutch pressure control solenoid stuck OFF or leaking.
- Torque converter clutch pressure control solenoid stuck ON.
- Control signal fluid supply leak due to valve body filter plate assembly cracked, or damaged gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Torque Converter Removal**
- **Torque Converter and Differential Housing, Front Differential Transfer Drive Gear, and Front Differential Carrier Removal** , and **Torque Converter and Differential Housing Installation**
- **Torque Converter Installation**
- **Control Valve Lower Body and Upper Body Replacement**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0751 OR P0752

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.

DTC P0751

Shift Solenoid Valve 1 Performance - Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0752

Shift Solenoid Valve 1 Performance - Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Shift solenoid valve 1 is part of the control solenoid valve assembly, which has no serviceable components. The solenoid operates by the transmission control module (TCM) turning the low side driver ON or OFF. When the shift solenoid valve 1 is commanded OFF, the plunger forces the metering ball against the actuator feed limit seat, blocking the flow and any existing pressure is exhausted through the exhaust port. When the shift solenoid valve 1 is commanded ON, the internal plunger moves, allowing the metering valve to move away from the actuator feed limit seat and against the exhaust seat, creating signal fluid pressure. The signal fluid pressure acts against the clutch select valve 2 to overcome the valve spring force, moving the valve to the apply position. Fluid pressure from the R1/4-5-6 regulator valve flows through clutch select valve 2 and is directed to either the low and reverse clutch or the 4-5-6 clutch, depending on the position of clutch select valve 2.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is greater than 8.5 V.
- Engine speed is 400-7,500 RPM for 5 s.
- Throttle position signal is valid.
- Engine torque signal is valid.
- High side driver is enabled.
- Output shaft speed is 36 RPM or greater, or the throttle position is 0.5 % or greater.
- Transmission fluid temperature is -6.6°C (20°F) or greater.

Conditions for Setting the DTC

P0751

- Commanded gear is 1st.
- TCM detects gear ratio 1.34-1.48.
- Gear slip is 400 RPM or greater for 2 s.
- Above conditions have to occur 8 times.

P0752

- Commanded gear is 3rd
- Transmission has achieved 1st or 2nd.
- Gear slip is 400 RPM or greater for 3 s.

- TCM commands 4th gear if above conditions exist and detects a gear ratio of 4.26-4.71 for 3 s.
- The conditions listed above have to occur 5 times.

Action Taken When the DTC Sets

P0751

- DTC P0751 is a Type B DTC.
- TCM inhibits 1st gear.
- TCM inhibits neutral idle.

P0752

- DTC P0752 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM commands second gear if output speed is less than 1,350 RPM, or neutral if output speed is 1,350 RPM or greater.
- TCM inhibits neutral idle.

Conditions for Clearing the DTC

- DTC P0751 is a Type B DTC.
- DTC P0752 is a Type A DTC.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This allows you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**
- **Drive Range, First Gear**
- **Drive Range, Third Gear**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling at the normal operating temperature, gear selector in the Park position, parking brake applied, and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
 - **If the transmission fluid level and condition is not correct**

Repair as necessary
 - **If the transmission fluid level and condition is correct**
3. From a stop, accelerate to 72 km/h (45 mph) with the scan tool Calculated Throttle Position greater than 15 %. Perform this test 8 times.
4. Verify DTC P0751 or P0752 did not set.
 - **If DTC P0751 or P0752 set**

Refer to Circuit/System Testing.
 - **If DTC P0751 or P0752 did not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within

the conditions that you observed from the Freeze Frame/Failure Records data.

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low** .

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0751 - Upper Control Valve Body

- Clutch select valve 2 bore plug undersized causing a leak - plug should be a valve fit in the bore.
- Check ball #2 - missing, damaged or malformed, or damage to the seat causing leakage.

P0751 or P0752 - Upper Control Valve Body

Clutch select valve 2 stuck from debris, sediment, binding, or a scored bore.

P0751 or P0752 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P0751 - Lower Control Valve Body

- Shift solenoid 1 - not pressurizing, stuck OFF or leaking.

- Shift solenoid 1 - not exhausting, stuck ON.

P0751 or P0752 - Q8 Control Solenoid Valve Assembly

- Shift solenoid valve 1 stuck OFF or leaking.
- Shift solenoid valve 1 stuck ON.
- Valve body filter plate assembly cracked, blocked, or damaged gasket seal.
- Pressure control solenoid valve 3 stuck ON, stuck OFF, or leaking. Low and Reverse, and 4-5-6 regulator valve stuck or sticking from debris, sediment, binding or scored bore.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0756

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

NOTE: **The DTC listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.**

DTC P0756

Shift Solenoid Valve 2 Performance - Stuck Off - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Shift solenoid valve 2 is part of the control solenoid valve assembly, which has no serviceable components. Shift solenoid valve 2 is a normally closed solenoid valve and controls fluid to the clutch select valve 3. The transmission control module (TCM) operates the solenoid by turning the low side driver ON or OFF. When the shift solenoid valve 2 is commanded OFF, the plunger forces the metering ball against the actuator feed limit seat, blocking the flow and any existing pressure is exhausted through the exhaust port. When shift solenoid valve 2 is commanded ON, the internal plunger moves and allows the metering ball to move away from the feed seat and against the exhaust seat, creating signal fluid pressure. The signal fluid acts against the clutch select valve 3 to overcome the valve spring force, moving it to the apply position. Shift solenoid valve 2 is commanded OFF in Reverse, and commanded ON in Park, Neutral, Drive 1 Engine Braking, and Drive 1-6 gear

ranges.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- High side driver is enabled.
- Ignition voltage is greater than 8.5 V.
- Throttle position signal is valid.
- Transmission fluid temperature is -6.6°C (20°F) or greater.
- Output shaft speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater

Conditions for Setting the DTC

- Commanded Gear is 1st locked.
- Gearbox Slip is 400 RPM or greater for 3 s.
- If above conditions exist, the TCM commands second gear. If the gear ratio is between 2.72-3.01 for 1 s, the counter will increment. DTC will set after 3 occurrences.

Action Taken When the DTC Sets

- DTC P0756 is a Type A DTC.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM commands second gear if output speed is less than 1,350 RPM, or neutral if output speed is 1,350 RPM or greater.

Conditions for Clearing the DTC

DTC P0756 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**

- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**
- **Drive Range, First Gear Engine Braking**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If other DTCs are set, diagnose those DTCs first.**

1. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
 - **If the transmission fluid level and condition is not correct**

Repair as necessary.
 - **If the transmission fluid level and condition is correct**
3. Ignition ON, clear the TCM DTCs with a scan tool.
4. Engine running, brakes applied, transmission gear shift selector in Reverse. Shift to Drive and accelerate to 56 km/h (35 mph) with the scan tool Calculated Throttle Position greater than 15 %. Perform this test 5 consecutive times.
5. Verify DTC P0756 did not set.
 - **If DTC P0756 sets**

Refer to Circuit/System Testing.

- **If DTC P0756 did not set**

6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

1. Engine idling at the normal operating temperature.

2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low**.

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.

4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

Upper Control Valve Body

- Clutch select valve 3 stuck from debris, sediment, binding or scored bore
- Clutch select valve 3 bore plug undersized causing a leak - plug should be a valve fit in the bore.
- Check ball #3 - missing, damaged or malformed, or damage to the seat causing leakage.
- Check ball #1 - missing, damaged or malformed, or damage to the seat causing leakage.

Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

Mechanical Diode

Broken or not capable of holding torque.

Pump Assembly

Fluid pump vanes or fluid pump rotor broken

Pump Seal

Seal is torn or cut, causing a small leak that is overcome with enough speed and pump capacity.

Q8 Control Solenoid Valve Assembly

- Shift solenoid 2 not pressurizing - stuck OFF or leaking.
- Valve body filter plate assembly cracked, blocked, or damaged gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Upper Body Assembly Cleaning and Inspection**
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0776 OR P0777

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the **Circuit/System Verification and Circuit/System Testing** to identify the cause.

DTC P0776

Pressure Control Solenoid Valve 2 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0777

Pressure Control Solenoid Valve 2 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Clutch pressure control solenoid valve 2 is part of the control solenoid valve assembly, which has no serviceable components. Pressure control solenoid valve 2 regulates transmission fluid pressure to the 3-5-Reverse clutch regulator valve which controls pressure to the 3-5-Reverse clutch. The transmission control module (TCM) calculates gear ratio based on the speed signals from the input shaft speed (ISS) sensor and the output shaft speed (OSS) sensor. The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is greater than 8.5 V.
- Engine speed is 400-7,500 RPM for 5 s.
- Transmission fluid temperature is -6.7°C (20°F) or greater.
- Transmission output speed is 36 RPM or greater, or the accelerator pedal position is 0.5 % or greater.
- Throttle position signal is valid.
- High side driver is enabled.
- Engine torque is 20 N.m (15 lb ft) or greater - DTC P0777 only.

Conditions for Setting the DTC

P0776

TCM has detected an incorrect gear ratio or neutral condition when the 3-5-Reverse clutch is commanded ON. This condition must occur 3 times.

P0777

TCM has detected an incorrect gear ratio change when the 3-5-Reverse clutch is commanded OFF during a shift or when 3rd gear ratio is detected in 1st gear. This condition must occur 3 times.

Action Taken When the DTC Sets

P0776

- DTC P0776 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM freezes transmission adaptive functions.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse, 2nd, and 4th gear operation.
- TCM inhibits auto grade braking.
- TCM inhibits neutral idle.

P0777

- DTC P0777 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM freezes transmission adaptive functions.
- TCM limits the transmission to 3rd gear and Reverse operation.
- TCM inhibits auto grade braking.
- TCM inhibits neutral idle.

Conditions for Clearing the DTC

DTCs P0776 and P0777 are Type A DTCs.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This will allow you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Reverse**
- **Drive Range, Third Gear**
- **Drive Range, Fifth Gear**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to **Parking Brake and Drive Wheels Warning** .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling, transmission in Park, parking brake applied, and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.

- If the transmission fluid level and condition is not correct

Repair as necessary.

- If the transmission fluid level and condition is correct

3. Ignition ON, clear the TCM DTCs with a scan tool.
4. Verify DTC P0776 or P0777 does not set while performing a road test. Refer to **Road Test**.

- If DTC P0776 or P0777 sets

Refer to Circuit/System Testing.

- If DTC P0776 or P0777 does not set

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.

- If the DTC sets

Refer to Circuit/System Testing.

- If the DTC does not set

7. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Engine idling at the normal operating temperature
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low** .

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

DTC P0776 or P0777 - Upper Control Valve Body Assembly

3-5-R regulator valve stuck/sticking - debris, binding, damaged valve, or scored bore.

DTC P0776 or P0777 - Lower Control Valve Body Assembly

- Actuator feed limit circuit supply fluid to solenoid restricted from debris, a stuck limit valve or sediment blockage.
- 3-5-R clutch boost valve - binding or scored bore - can cause harsh shifts.

DTC P0776 or P0777 - Q8 Control Solenoid Valve Assembly

- Clutch pressure control solenoid 2 stuck ON or stuck OFF.
- Control solenoid valve filter plate assembly, blocked or damaged gasket seal.

DTC P0776 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

DTC P0776 or P0777 - Transmission Fluid Pump

- Fluid pump housing vanes/rotor/slide damaged/scored.
- Transmission pump fluid outlet seal assembly damaged/leaking.

DTC P0776 - Transmission Cooling/Lubrication

- Oil filter or filter seal loose, plugged, or damaged.

- Restriction/leak in oil to air cooler/radiator.
- Restricted/leaking/kinked/damaged transmission oil cooler lines.
- Restriction/leak in transmission fluid pump assembly.

DTC P0776 - Torque Converter Assembly

Torque converter overstressed due to high temperature, fluid boiled out.

DTC P0776 - 4-5-6 and 3-5-R Clutch Housing Assembly

- 3-5-R clutch backing plate retaining ring not seated or wave plate broken.
- 3-5-R piston seal torn, cut, or rolled.
- 4-5-6 and 3-5-R clutch housing assembly inner/outer seal damaged or dam pressure too high.

DTC P0776 or P0777 - Automatic Transmission Case Cover

Blow off regulator ball stuck.

DTC P0776 or P0777

3-5-R and 4-5-6 clutch fluid seal rings damaged, worn, or leaking.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0796 OR P0797

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.

DTC P0796

Pressure Control Solenoid Valve 3 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0797

Pressure Control Solenoid Valve 3 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Clutch pressure control solenoid 3 is part of the control solenoid valve assembly, which has no serviceable components. Pressure Control solenoid 3 regulates transmission fluid pressure to the R1/4-5-6 clutch regulator valve which controls pressure to the low and reverse clutch and the 4-5-6 clutch. The transmission control module (TCM) calculates gear ratio based on the speed signals from the input speed shaft (ISS) sensor and the output shaft speed (OSS) sensor. The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is greater than 8.5 V.
- Engine speed is 400-7,500 RPM for 5 s.
- Output speed is 36 RPM or greater, or the accelerator pedal position is 0.5 % or greater.
- Throttle position signal is valid.
- High side driver is enabled.
- Transmission fluid temperature is -6.7°C (20°F) or greater.
- Engine torque is 20 N.m (15 lb ft) or greater when 1st gear is commanded-DTC P0797 only.

Conditions for Setting the DTC

P0796

The TCM has detected an incorrect gear ratio or neutral condition when the low and reverse clutch or the 4-5-6 clutch is commanded ON. This condition must occur 3 times.

P0797

The TCM has detected an incorrect gear ratio change when the low and reverse clutch or the 4-5-6 clutch is commanded OFF during a shift or when 4th gear ratio is detected in 1st gear. This condition must occur 3 times.

Action Taken When the DTC Sets

P0796

- DTC P0796 is a Type A DTC.
- TCM commands maximum line pressure.

- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse, 1st, and 3rd gear operation.
- TCM inhibits auto grade braking.
- TCM inhibits neutral idle.

P0797

- DTC P0797 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 4th gear operation.
- TCM inhibits neutral idle.
- TCM requests a reduced engine torque based on input speed.
- TCM inhibits auto grade braking.

Conditions for Clearing the DTC

DTCs P0796 and P0797 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**
- **Reverse**
- **Drive Range, First Gear Engine Braking**
- **Drive Range - Fourth Gear**

- **Drive Range, Fifth Gear**
- **Drive Range, Sixth Gear**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to **Parking Brake and Drive Wheels Warning** .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling, transmission in Park, parking brake applied, and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
 - **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level is condition is correct**
3. Ignition ON, clear the TCM DTCs with a scan tool.
 4. Verify DTC P0796 or P0797 does not set while performing a road test. Refer to **Road Test**.
 - **If DTC P0796 or P0797 sets**

Refer to Circuit/System Testing.

- **If DTC P0796 or P0797 does not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure**.

- **If the pressures are not within range**

Refer to **Fluid Pressure High or Low**.

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.

- **If the pressure does not change**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0796 or P0797 - Control Valve Upper Body Assembly

4-5-6 regulator valve stuck/sticking from debris, binding, damaged valve, or scored bore.

P0796 - Channel Plate and Spacer Plate

Channel Plate and spacer plate oil channels or orifices blocked by debris.

P0796 - Lower Control Valve Body Assembly

- Actuator feed limit circuit supply fluid to solenoid restricted or not available from debris, stuck limit valve, or sediment blockage.
- 4-5-6 clutch boost valve binding or a scored bore which can also cause harsh shifts.
- 4-5-6 clutch accumulator piston leaking, cracked, or broken.

P0796 or P0797 - Input Shaft Support

Input shaft support 3-5-R and 4-5-6 clutch fluid seal rings damaged, worn, or leaking.

P0796 or P0797 - Q8 Control Solenoid Valve Assembly

- Clutch pressure control solenoid valve 3 stuck ON or stuck OFF.
- Control solenoid filter plate assembly cracked, blocked, or damaged gasket seal.

P0796 - 4-5-6 Clutch Housing Assembly

- 4-5-6 clutch piston assembly damaged or leaking.
- 4-5-6 clutch inner/outer seal damaged.
- Dam pressure too high

P0796 - Automatic Transmission Case Cover

Blow off regulator ball stuck.

P0796 - Transmission Cooling/Lubrication

- Restriction/leak in oil to air cooler/radiator.
- Restricted/leaking/kinked/damaged transmission oil cooler lines.
- Restriction/leak in transmission fluid pump assembly.

P0796 - Torque Converter Assembly

Fluid pump or torque converter overstressed due to high temperature of fluid boiled out.

P0796 - 4-5-6 Reaction Carrier Hub Assembly

4-5-6 reaction carrier hub/shaft - broken hub weld.

P0796 - Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged

P0796 - Automatic Transmission Fluid Pump

Pump fluid outlet seal assembly damaged/leaking.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.

- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0815, P0816, OR P0826

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0815

Upshift Switch Circuit

DTC P0816

Downshift Switch Circuit

DTC P0826

Up and Down Shift Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Tap Up/Tap Down Shift Signal	P0826	P0826	P0826	-

Typical Scan Tool Data

Driver Shift Request

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Tap Up/Tap Down Switch Signal	Invalid	None	Invalid/None

Circuit/System Description

When the shift lever is moved left of the D position, the transmission will enter sport mode. With the shift lever in this position, the transmission will enter manual mode if the gear shift lever is pressed forward or rearward. This allows the operator to select an upshift by pressing the gear shift lever forward, and downshift by pressing the gear shift lever rearward. The Body Control Module (BCM) supplies an ignition circuit and a signal circuit to the shift controller. The shift controller has Hall-effect switches connected to a resistor array. When the lever is left of the D position, a voltage drop occurs across the resistor network. When the gear shift lever is pressed forward or rearward, a corresponding voltage drop occurs across the resistor network. This voltage drop is

monitored by the BCM. The BCM will send the request to the transmission control module to perform the upshift or downshift.

Conditions for Running the DTC

P0815 or P0816

- DTC P0826, P1761, P182E, P1876, P1877, or P1915 is not set.
- Time since the range change is 1 s or greater.
- Engine speed is 400 RPM or greater for 5 s.
- Ignition voltage is 8.6 volts or greater.

P0826

- Engine speed is 400 RPM or greater for 5 seconds.
- Ignition voltage is 8.6 volts or greater.
- DTC P1761 is not set.

Conditions for Setting the DTC

P0815 - Condition 1

TCM detects an upshift request for 1 second in Park or Neutral.

P0815 - Condition 2

TCM detects an upshift request for 10 minutes in any forward range.

P0816 - Condition 1

TCM detects a downshift request for 1 second in Park or Neutral.

P0816 - Condition 2

TCM detects a downshift request for 10 minutes in any forward range.

P0826

TCM detects an invalid voltage on the Tap up/Tap down signal circuit for 1 minute.

Action Taken When the DTC Sets

- DTCs P0815, P0816, and P0826 are Type C DTCs.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

DTCs P0815, P0816, and P0826 are Type C DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Ignition ON, engine OFF.
2. Verify with a scan tool no internal mode switch (IMS) DTCs set.
 - **If IMS DTCs were set**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- **If IMS DTCs are not set**

3. Verify with a scan tool the Driver Shift Control Mode parameter displays Inactive with the shift lever in the Park, Reverse, Neutral, and Drive positions, and Active when the gear shift lever is moved left of the D position, then pressed forward or rearward.

- **If the parameter does not display the correct values**

Refer to Circuit/System Testing below.

- **If the parameter displays the correct value**

4. Shift lever left of the D position, verify the scan tool Driver Shift Request parameter changes from Inactive to Upshift when the shift lever is pressed forward, and from Inactive to Downshift when the shift lever is pressed rearward.

- **If the parameter does not display the correct values**

Refer to Circuit/System Testing below.

- **If the parameter displays the correct value**

5. Operate the vehicle within the conditions for running the DTC to verify the DTC does not set. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, disconnect the harness connector from the S3 Transmission Shift Lever.
2. Test for less than 10 ohms between the shift lever harness connector terminal 2 and ground.

- **If 10 ohms or greater**

Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**

3. Ignition ON.

4. Verify a test lamp illuminates between the S3 Transmission Shift Lever harness connector ignition circuit terminal 1 and ground circuit terminal 2.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the ignition circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
5. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
6. Test for infinite resistance between the S3 Transmission Shift Lever harness connector signal circuit terminal 3 and ground.
 - **If less than infinite resistance**

Repair the short to ground in the circuit.
 - **If infinite resistance**
7. Test for less than 2 ohms in the signal circuit end to end.
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.
 - **If less than 2 ohms**
8. Connect the K9 Body Control Module harness connector, ignition ON.
9. Verify the scan tool Driver Shift Control parameter displays inactive.
 - **If Driver Shift Control Mode Parameter does not display Inactive**

Replace the K9 Body Control Module.
 - **If Driver Shift Control Parameter displays Inactive**
10. Test for 11-13 volts at the S3 Transmission Shift Lever harness connector between signal circuit terminal 3 and ground.
 - **If not between 11-13 volts**

Replace the K9 Body Control Module.
 - **If between 11-13 volts**
11. Ignition OFF, connect the S3 Transmission Shift Lever harness connector, Ignition ON.
12. Test for 11-13 volts by back probing the transmission shift lever connector between terminal 3 and ground with the shift lever in Park, Reverse, Neutral, and Drive.
 - **If not between 11-13 volts**

Replace the S3 Transmission Shift Lever.
 - **If between 11-13 volts**
13. Shift Lever left of D position

14. Test for 8.0-10.6 volts between S3 Transmission Shift Lever connector terminal 3 and ground.

- **If not between 8.0-10.6 volts**

Replace the S3 Transmission Shift Lever.

- **If between 8.0-10.6 volts**

15. Test for 5.1-7.3 volts between S3 Transmission Shift Lever connector terminal 3 and ground with the shift lever pressed rearward.

- **If not between 5.1-7.3 volts**

Replace the S3 Transmission Shift Lever.

- **If between 5.1-7.3 volts**

16. Test for 2.0-4.6 volts between S3 Transmission Shift Lever connector terminal 3 and ground with the shift lever pressed forward.

- **If not between 2.0-4.6 volts**

Replace the S3 Transmission Shift Lever.

- **If between 2.0-4.6 volts**

17. Replace the K9 Body Control Module.

Repair Instructions

NOTE:

- Perform the Reset Transmission Adapts following all transmission related repairs.
- Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for BCM or control solenoid valve assembly replacement, setup and programming
- Transmission Control Replacement

DTC P0851

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0851

Park/Neutral Position Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0851	-	-	-
Ground	-	-	-	-

Typical Scan Tool Data

Park/Neutral Position Switch

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature Parameter Normal Range: 12 Volts = In-Gear, 0 Volts = Park/Neutral			
Signal	Park/Neutral	In-Gear	In-Gear
Ground	-	In-Gear	-

Circuit/System Description

The transmission manual shift shaft switch assembly, also known as the transmission internal mode switch, is a sliding contact switch attached to the manual shift shaft inside the transmission case. The park/neutral position switch is integrated into the transmission internal mode switch and connects to the transmission control module (TCM) lead-frame through a short wire harness. The circuit uses the TCM as a pass-through connector only. The park/neutral signal is sent from the park/neutral switch directly to the engine control module (ECM) and is used for engine start enable.

Conditions for Running the DTC

- DTC P182E is not set.
- Ignition voltage is 8-32 V.
- Engine speed is running. Vehicle speed is 10 km/h (6 mph) or greater.
- Throttle position is 8 % or greater.

Conditions for Setting the DTC

ECM detects the park/neutral switch signal equals 0 V for 4 s.

Action Taken When the DTC Sets

- DTC P0851 is a Type C DTC.
- ECM uses the indicated transmission range from the TCM to prevent engine start-up with the transmission in reverse or a forward range.

Conditions for Clearing the DTC

DTC P0851 is a Type C DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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Electrical Information Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P182E or P1915 is not set.

- **If any of the DTCs are set**

Refer to **DTC P182E or P1915**.

- **If none of the DTCs are set**

3. Verify the gear shift lever position matches the scan tool TCM Internal Mode Switch parameter while slowly moving the gear shift lever from Park through all ranges.

- **If the gear shift lever position does not match the Internal Mode Switch parameter**

Adjust or replace the range selector lever cable as necessary.

- **If the gear shift lever position matches the Internal Mode Switch parameter**

4. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays Park/Neutral when in Park or Neutral and In-Gear when in Reverse or Drive.

- **If the Park/Neutral Position Switch parameter is not as specified**

Refer to Circuit/System Testing.

- **If the Park/Neutral Position Switch parameter is as specified**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, disconnect the X1 harness connector at the Q8 Control Solenoid Valve Assembly harness connector at the automatic transmission.
2. Install the **DT-47825-20** Adapter Harness to the vehicle harness connector.

NOTE: **All testing in steps 3 through 5 will be performed at the DT-47825-20 Adapter Harness connector.**

3. Test for less than 5 ohms between the ground circuit terminal 18 and ground.

- **If 5 ohms or greater**

1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
4. Ignition ON.
5. Test for 11-13 V between signal circuit terminal 20 and ground.
 - **If not between 11-13 V**
 1. Ignition OFF, remove the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between signal circuit terminal 20 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance.
 1. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If between 11-13 V**
6. Ignition OFF, transmission in Park, disconnect the **DT-47825-20** Adapter Harness from the vehicle wire harness.
7. Connect the **DT-47825-20** Adapter Harness to the Q8 Control Solenoid Valve Assembly X1 connector.

NOTE: The ignition will need to be ON momentarily to shift from Park.

8. Test for less than 10 ohms between the Park/Neutral signal circuit terminal 20 and ground circuit terminal 18 with the transmission in Park and Neutral.
 - **If 10 ohms or greater**
 1. Disconnect the **DT-47825-20** Adapter Harness and remove the transmission control valve body cover.
 2. Install the **DT-47825-20** Adapter Harness to the Q8 Control Solenoid Valve Assembly X1 connector.
 3. Disconnect the B15 Transmission Internal Mode Switch electrical connector from the Q8 Control Solenoid Valve Assembly.
 4. Test for less than 10 ohms between Park/Neutral signal circuit terminal 20 and terminal A at the Q8 Control Solenoid Valve Assembly X2 connector.
 - If 10 ohms or greater, replace the Q8 Control Solenoid Valve Assembly.
 - If less than 10 ohms, replace the B15 Transmission Internal Mode Switch.
 - **If less than 10 ohms**
9. Test for infinite resistance between the Park/Neutral signal circuit terminal 20 and ground circuit terminal 18 with the transmission in Reverse and Drive.
 - **If less than infinite resistance**
 1. Disconnect the **DT-47825-20** Adapter Harness and remove the transmission control valve body cover.

2. Install the **DT-47825-20** Adapter Harness to the Q8 Control Solenoid Valve Assembly X1 connector.
3. Disconnect the B15 Transmission Internal Mode Switch electrical connector from the Q8 Control Solenoid Valve Assembly.
4. Test for infinite resistance between the Park/Neutral signal circuit terminal 20 and ground circuit terminal 18.
 - If less than infinite resistance, replace the Q8 Control Solenoid Valve Assembly.
 - If infinite resistance, replace the B15 Transmission Internal Mode Switch.
 - **If infinite resistance**
10. Replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**
- **Range Selector Lever Cable Adjustment**
- **Control Valve Body Cover Replacement**
- **Control Module References** for ECM or control solenoid valve assembly replacement, programming, or setup.

DTC P0961-P0963

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0961

Line Pressure Control Solenoid Valve Performance

DTC P0962

Line Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P0963

Line Pressure Control Solenoid Valve Control Circuit High Voltage

Circuit/System Description

The line pressure control solenoid is part of the control solenoid valve assembly which has no serviceable components. The normally high line pressure control solenoid regulates and directs the line pressure control solenoid oil pressure to the pressure regulator valve. Increasing line pressure control solenoid pressure increases transmission line pressure. The transmission control module (TCM) varies the current to the line pressure control solenoid by controlling the amount of time the low side driver is ON and OFF. Decreasing the ON time, decreases the current to the line pressure control solenoid, which increases line pressure control solenoid oil pressure by closing OFF the solenoid exhaust port. Increasing the current to the line pressure control solenoid decreases line pressure control oil pressure by opening the solenoid exhaust port. Line pressure control solenoid power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0961

TCM detects an internal electrical malfunction of the line pressure control solenoid where the measured line pressure control solenoid current does not equal the commanded line pressure control solenoid current for 5 s.

P0962

TCM detects a short to ground on the line pressure control solenoid control circuit for 2 s.

P0963

TCM detects an open or a short to voltage on the line pressure control solenoid control circuit for 5 s.

Action Taken When the DTC Sets

P0961 or P0963

- DTCs P0961 and P0963 are Type B DTCs.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.

P0962

- DTC P0962 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.
- TCM inhibits the torque converter clutch (TCC).

- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM enables torque management.

Conditions for Clearing the DTC

- DTCs P0961 and P0963 are Type B DTCs.
- DTC P0962 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Refer to **Parking Brake and Drive Wheels Warning** .

1. Engine running, transmission in Park. Move the gear shift lever into each gear position and back into Park position.
2. Verify the scan tool parameters listed below do not display Malfunction:
 - Line Pressure Control Solenoid Valve Performance Test Status
 - Line Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
 - Line Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
5. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.

- **If not contaminated**

3. Verify the resistance of each solenoid is within the specified range for listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Line Pressure Control Solenoid Valve Performance Test Status
 - Line Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
 - Line Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0965-P0967

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0965

Pressure Control Solenoid Valve 2 Performance

DTC P0966

Pressure Control Solenoid Valve 2 Control Circuit Low Voltage

DTC P0967

Pressure Control Solenoid Valve 2 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid 2 is part of the control solenoid valve assembly which has no serviceable components. The normally high pressure control solenoid 2 regulates and directs oil pressure to the 3-5 reverse clutch regulator valve. Increasing pressure to the 3-5 reverse clutch regulator valve increases pressure to the 3-5 reverse clutch. The transmission control module (TCM) varies the current to the pressure control solenoid 2 by controlling the amount of time the low side driver is ON and OFF. Decreasing the current to the pressure control solenoid 2 increases pressure control solenoid 2 oil pressure by closing OFF the solenoid exhaust port. Increasing the current to the pressure control solenoid 2 decreases pressure control solenoid 2 oil pressure by opening the solenoid exhaust port. Power to pressure control solenoid 2 is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0965

TCM detects an internal electrical performance malfunction of the pressure control solenoid 2 control circuit where the measured pressure control solenoid 2 current does not equal the commanded pressure control solenoid 2 current for 5 s.

P0966

TCM detects a short to ground on the pressure control solenoid 2 control circuit for 1 s.

P0967

TCM detects an open or short to voltage on the pressure control solenoid 2 control circuit for 1 s.

Action Taken When the DTC Sets

P0965

- DTC P0965 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 3-5-Reverse clutch.

P0966

- DTC P0966 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM enables torque management.

P0967

- DTC P0967 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd gear operation.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

- DTC P0965 is a Type C DTC.
- DTCs P0966 and P0967 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature, then operate the vehicle in Park for 5 s.
2. Operate the vehicle in Drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 2 Performance Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: You must perform the **Circuit/System Verification** first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.

- **If not contaminated**

3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 2 Performance Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0969-P0971

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0969

Pressure Control Solenoid Valve 3 Performance

DTC P0970

Pressure Control Solenoid Valve 3 Control Circuit Low Voltage

DTC P0971

Pressure Control Solenoid Valve 3 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid 3 is part of the control solenoid valve assembly which has no serviceable components. The normally high pressure control solenoid 3 regulates and directs oil pressure to the R1/4-5-6 regulator valve. Increasing pressure control solenoid 3 pressure increases pressure to the low and reverse clutch or 4-5-6 clutch, depending on the position of the clutch select valve 2. The transmission control module (TCM) varies current to pressure control Solenoid 3 by controlling the time the low side driver is ON and OFF. Decreasing the current to pressure control solenoid 3 increases oil pressure by closing off the solenoid exhaust port. Increasing the current to the pressure control solenoid 3 decreases oil pressure by opening the exhaust port. Power is supplied to the pressure control solenoid 3 by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0969

TCM detects an internal electrical performance malfunction of the clutch pressure control solenoid 3 control circuit where the measured clutch pressure control solenoid 3 currents does not equal the commanded clutch pressure control solenoid 3 current for 5 s.

P0970

TCM detects a short to ground on the clutch pressure control solenoid 3 control circuit for 1 s.

P0971

TCM detects an open or short to voltage on the clutch pressure control solenoid 3 control circuit for 1 s.

Action Taken When the DTC Sets

P0969

- DTC P0969 is a Type C DTC.
- TCM freezes transmission adaptive functions to the low and reverse clutch and 4-5-6 clutch.

P0970 or P0971

- DTCs P0970 and P0971 are Type A DTCs.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.
- TCM inhibits the torque converter clutch (TCC).
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM enables torque management.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

- DTC P0969 is a Type C DTC.
- DTCs P0970 and P0971 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature, then operate the vehicle with transmission in Park for 5 s.
2. Operate the vehicle in Drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 3 Performance Test Status
 - Pressure Control Solenoid Valve 3 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 3 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: You must perform the **Circuit/System Verification** first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.

- **If not contaminated**

3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 3 Performance Test Status
 - Pressure Control Solenoid Valve 3 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 3 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0973 OR P0974

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0973

Shift Solenoid Valve 1 Control Circuit Low Voltage

DTC P0974

Shift Solenoid Valve 1 Control Circuit High Voltage

Circuit/System Description

Shift solenoid 1 is part of the control solenoid valve assembly, which has no serviceable components. Shift Solenoid 1 is a normally closed (NC) ON/OFF solenoid and is controlled by the transmission control module (TCM) through a low side driver. When the shift solenoid 1 is energized (ON), shift solenoid 1 fluid pressure is directed to the clutch select valve 2, which allows the valve to overcome the spring pressure and move to the applied position. Power to the shift solenoid 1 is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0973

TCM detects a short to ground on the shift solenoid 1 control circuit for 2 s.

P0974

TCM detects an open or a short to power on the shift solenoid 1 control circuit for 2 s.

Action Taken When the DTC Sets

P0973

- DTC P0973 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd gear operation.
- TCM commands maximum line pressure.

- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM inhibits auto grade braking

P0974

- DTC P0974 is a Type B DTC.
- TCM inhibits 1st gear.

Conditions for Clearing the DTC

- DTC P0973 is a Type A DTC.
- DTC P0974 is a Type B DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

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- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature, then operate the vehicle in Park for 5 s.
2. Place the gear selector in Reverse for 5 s and then idle the engine with the gear selector in Park for 5 s.
3. Verify the scan tool parameters listed below do not display Malfunction.
 - Shift Solenoid Valve 1 Control Circuit Low Voltage Test Status
 - Shift Solenoid Valve 1 Control Circuit Open Test Status
 - Shift Solenoid Valve 1 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.
 - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.
 - **If not contaminated**

3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.

- **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Shift Solenoid Valve 1 Control Circuit Low Voltage Test Status
 - Shift Solenoid Valve 1 Control Circuit Open Test Status
 - Shift Solenoid Valve 1 Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0976 OR P0977

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0976

Shift Solenoid Valve 2 Control Circuit Low Voltage

DTC P0977

Shift Solenoid Valve 2 Control Circuit High Voltage

Circuit/System Description

Shift solenoid 2 is part of the control solenoid valve assembly, which has no serviceable components. Shift solenoid 2 is a normally closed ON/OFF solenoid and is controlled by the transmission control module (TCM) through a low side driver. When the shift solenoid 2 is energized, fluid pressure is directed to the clutch select valve 3, which allows the valve to overcome the spring pressure and move to the applied position. Power to the shift solenoid 2 is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0976

TCM detects a short to ground on the shift solenoid 2 control circuit for 2 s.

P0977

TCM detects an open or short to power on the shift solenoid 2 control circuit for 2 s.

Action Taken When the DTC Sets

P0976

- DTC P0976 is a Type C DTC.
- TCM freezes transmission adaptive functions.

P0977

- DTC P0977 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd gear operation.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function
- TCM inhibits manual shifting of forward gears

Conditions for Clearing the DTC

- DTC P0976 is a Type C DTC.

- DTC P0977 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- COMPONENT CONNECTOR END VIEWS - INDEX
- INLINE HARNESS CONNECTOR END VIEWS - INDEX

Description and Operation

- Transmission General Description
- Transmission Component and System Description
- Electronic Component Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in 3rd gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature.
2. Place the gear selector in Reverse for 5 s and then idle the engine with the gear selector in Park for 5 s.
3. Verify the scan tool parameters listed below do not display Malfunction:

- Shift Solenoid Valve 2 Control Circuit Low Voltage Test Status
- Shift Solenoid Valve 2 Control Circuit Open Test Status
- Shift Solenoid Valve 2 Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection.**
 - **If contaminated**

Repair as necessary.

- **If not contaminated**

3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection.**
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Shift Solenoid Valve 2 Control Circuit Low Voltage Test Status
 - Shift Solenoid Valve 2 Control Circuit Open Test Status

- Shift Solenoid Valve 2 Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P1761

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1761

Up and Down Shift Switch Signal Message Counter Incorrect

Circuit/System Description

When the shift lever is placed left of the D position, the driver shift request (DSR), also known as the tap shift function, is activated. The DSR allows the vehicle operator to shift gears by pushing the shift lever forward for an upshift or pulling the shift lever rearward for a downshift. The BCM supplies battery voltage, ground and a signal circuit to the shift controller. The shift controller has Hall-effect switches connected to a resistor array. When the lever is left of the position, then pushed forward for an upshift, or pulled rearward for a downshift, a corresponding voltage drop occurs across the resistor network. This voltage drop is monitored by the BCM. The BCM will send the request to the transmission control module to perform the upshift or downshift. The TCM is constantly monitoring the serial data sent from the BCM for the correct number and sequence of counts for Tap Up and Tap Down function.

Conditions for Running the DTC

- Tap Up and Tap Down message health is received from the BCM.
- Engine speed is 400 RPM or greater for 5 seconds.

Conditions for Setting the DTC

TCM detects an error in the rolling count value that does not match with the BCM count, 3 times within 10 seconds.

Action Taken When the DTC Sets

- DTC P1761 is a Type C DTC.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

DTC P1761 is a Type C DTC.

Reference Information

Schematic Reference

- **Automatic Transmission Controls Schematics**
- **Data Communication Schematics**
- **Body Control System Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

Electronic Component Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. DTC P1761 is an informational DTC. Diagnose all other body control module DTCs prior to DTC P1761.
 - If other body control module DTCs are set

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- If no other body control module DTCs are set
2. Diagnosis is accomplished by looking for an intermittent CAN circuit fault. Refer to **Scan Tool Does Not Communicate with Chassis High Speed GMLAN Device** .
 3. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, refer to **Testing for Intermittent Conditions and Poor Connections** .

Repair Instructions

- Perform the **Reset Transmission Adapts** following all transmission related repairs.
- Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P1762

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1762

Transmission Mode Switch Signal Message Counter Incorrect

Circuit/System Description

A signal circuit is provided by the body control module (BCM) to the Tow/Haul switch. When tow/haul mode is pressed, the tow/haul switch input signal to the BCM is momentarily toggled to zero volts. The BCM is constantly sending the transmission control module (TCM) serial data messages with information regarding the status of the Tow/Haul switch. This signals the transmission control module (TCM) to change the shift points, the application of TCC, and transmission line pressure. The TCM sets this DTC when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

Conditions for Running the DTC

- The TCM rolling counter diagnostic is enabled.

- The Tow/Haul message health is received from the BCM.
- The ignition voltage is 8.6 volts or greater.
- The engine speed is 400 RPM or greater for 5 seconds.

Conditions for Setting the DTC

The TCM detects an error in the rolling count value that does not match with the BCM count, 3 times within 10 seconds.

Action Taken When the DTC Sets

DTC P1762 is a type C DTC.

Conditions for Clearing the DTC

DTC P1762 is a type C DTC.

Diagnostic Aids

If the electrical circuit tests are OK and the shift pattern is not occurring, there may be a mechanical/hydraulic condition that prevents operation. Refer to **Symptoms - Automatic Transmission**.

Reference Information

Schematic Reference

- **Automatic Transmission Controls Schematics**
- **Data Communication Schematics**
- **Body Control System Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Electrical Information Reference

- **Circuit Testing**
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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Description and Operation

Electronic Component Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. DTC P1762 is an informational DTC. Diagnose all other body control module DTCs prior to DTC P1762. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If there are no other body control DTCs, diagnosis is accomplished by looking for an intermittent CAN circuit fault. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** .
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

- Perform the **Reset Transmission Adapts** following all transmission related repairs.
- Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P182E OR P1915

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P182E

Internal Mode Switch Indicates Invalid Range

DTC P1915

Internal Mode Switch Does Not Indicate Park/Neutral During Start

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal A	P182E	P1915	P1915	P182E, P1915

Signal B	P1915	P182E	P182E	P182E, P1915
Signal C	P1915	P182E	P182E	P182E, P1915
Signal P	P182E	P1915	P1915	P182E, P1915
Ground	-	P182E	P182E	P182E, P1915

Typical Scan Tool Data

Internal Mode Switch A/B/C/P

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, range selector in Park			
Parameter Normal Range: Low High High Low			
Signal A	Low	High	High
Signal B	Low	High	High
Signal C	Low	High	High
Signal P	Low	High	High

Circuit/System Description

The manual shift detent lever with shaft position switch assembly, or internal mode switch assembly, is a sliding contact switch attached to the manual shift detent lever within the transmission. The 4 inputs to the transmission control module (TCM), from the switch, indicate the position selected by the transmission manual shaft. The input voltage at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as the internal mode switch A/B/C/P parameter. The internal mode switch input parameters represented are transmission range Signal A, Signal B, Signal C, and Signal P.

The park/neutral position switch is integrated into the transmission internal mode switch. The circuit uses the TCM as a pass-through connector only.

The park/neutral signal is sent from the park/neutral switch directly to the engine control module (ECM) and is used for engine start enable.

Conditions for Running the DTC

P182E

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.
- Engine torque signal is valid.

P1915

- DTC P0722, P0723, or P1915 is not set.
- Transmission output shaft speed is 90 RPM or less.
- Ignition voltage was 5 V or greater, and has not dropped below 2 V.

Conditions for Setting the DTC

P182E

Internal mode switch does not indicate a valid Park, Reverse, Neutral or Drive Range gear position for 7 s.

P1915

Internal mode switch does not indicate Park or Neutral during the following sequence:

- Engine speed is 50 RPM or less for 0.25 s or greater.
- Engine speed is 50-480 RPM for 0.07 s or greater.
- Engine speed is 525 RPM or greater and the transmission input speed is 200 RPM or greater for 1.25 s.

Action Taken When the DTC Sets

- DTCs P182E and P1915 are Type A DTCs.
- TCM commands maximum line pressure.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM turns all the solenoids OFF.
- TCM freezes transmission adaptive functions.
- TCM limits the transmission to Reverse and 5th gear operation.
- Torque management is enabled.
- TCM turns the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

DTCs P182E and P1915 are Type A DTCs.

Diagnostic Aids

Under certain driving conditions, DTC P182E could set due to an intermittent low voltage fault on the park/neutral signal circuit, before conditions for setting DTC P0851 are met. Reference Information

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
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- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Verify the range selector lever cable is adjusted correctly. Refer to **Range Selector Lever Cable Adjustment** .
 - **If cable adjustment is not correct**

Repair as necessary.
 - **If cable adjustment is correct**
2. Ignition ON.
3. Verify the scan tool transmission control module Internal Mode Switch A/B/C/P parameter matches the

Transmission Internal Mode Switch Logic table for each gear shift lever position.

- **If the parameter does not match**

Refer to Circuit/System Testing.

- **If the parameter matches**

4. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays Park/Neutral with the gear shift lever in Park or Neutral and In Gear when in Reverser or Drive.

- **If Park/Neutral or In Gear is not displayed**

Refer to Circuit/System Testing.

- **If Park/Neutral and In Gear is displayed**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

NOTE:

- **You must perform Circuit/System Verification first.**

1. Ignition OFF, remove the control valve body cover.
2. Connect the vehicle harness connector to the Q8 Control Solenoid Valve Assembly.
3. Disconnect the B15 Transmission Internal Mode Switch connector at the Q8 Control Solenoid Valve Assembly.
4. Ignition ON.
5. Verify the scan tool transmission control module Internal Mode Switch A/B/C/P parameter displays High High High High.

- **If High High High High is not displayed**

Replace the Q8 control solenoid valve assembly.

- **If High High High High is displayed**

6. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays In Gear.

- **If In Gear is not displayed**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the neutral start signal circuit and ground at the vehicle harness

K20 Engine Control Module connector.

- If less than infinite resistance, repair the short to ground on the circuit
- If infinite resistance, replace the K20 Engine Control Module
- **If In Gear is displayed**

7. Install a 3 A fused jumper wire between the low reference circuit terminal A and each signal circuit listed below one at a time at the Q8 Control Solenoid Valve Assembly.
 - Signal A - terminal E
 - Signal B - terminal D
 - Signal C - terminal C
 - Signal P - terminal B
8. Verify the scan tool TCM A/B/C/P displays 1 Low and 3 High when a signal circuit is grounded.
 - **If 1 Low and 3 High is not displayed**

Replace the Q8 control solenoid valve assembly.

- **If 1 Low and 3 High is displayed**

9. Connect a 3 A fused jumper wire between park/neutral switch signal circuit terminal F and low reference circuit terminal A at the Q8 Control Solenoid Valve Assembly.
10. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays Park/Neutral.
 - **If Park/Neutral is not displayed**
 1. Ignition OFF, disconnect the connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the signal circuit end to end
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K20 Engine Control Module
 - **If Park/Neutral is displayed**
11. Replace the B15 Transmission Internal Mode Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Body Cover Replacement**
- **Control Solenoid Valve and Transmission Control Module Assembly Replacement**
- **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**
- **Range Selector Lever Cable Adjustment**
- **Control Module References** for ECM or control solenoid valve assembly replacement, programming, and setup.

DTC P1876

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1876

Up and Down Shift Enable Switch Circuit Low Voltage

Circuit/System Description

When the shift lever is moved left of the D position, the transmission will enter sport mode. With the shift lever in this position, the transmission will enter manual mode if the gear shift lever is pressed forward or rearward. This allows the operator to select an upshift by pressing the gear shift lever forward, and downshift by pressing the gear shift lever rearward. The Body Control Module (BCM) supplies a signal circuit to the shift controller. The shift controller has Hall-effect switches connected to a resistor array. When the lever is left of the D position, a voltage drop occurs across the resistor network. When the gear shift lever is pressed forward or rearward, a corresponding voltage drop occurs across the resistor network. This voltage drop is monitored by the BCM. The BCM will send the request to the transmission control module to perform the upshift or downshift.

Conditions for Running the DTC

- DTC P0815, P0816, or P0826, P1825, P1915 or U0100 is not set.
- Engine speed is 400 RPM or greater for 5 seconds.
- Ignition voltage is 8.6 V or greater.

Conditions for Setting the DTC

The Tap Up/Tap Down switch signal is Active when the IMS does not indicate L (M) for 2 seconds or greater 3 times during the same ignition cycle.

Action Taken When the DTC Sets

- DTC P1876 is a Type C DTC.
- TCM disables Tap shift functions.

Conditions for Clearing the DIC/DTC

DTC P1876 is a Type C DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Transmission General Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Ignition ON.
2. Verify with a scan tool there are no transmission internal mode switch (IMS) DTCs set.
 - **If IMS DTCs were set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If no IMS DTCs were set**
3. Verify the gear shift lever position matches the scan tool TCM Internal Mode Switch parameter while slowly moving the gear shift lever from Park through all ranges.
 - **If the displayed values are not correct**

Refer to **Range Selector Lever Cable Adjustment** .

- **If the displayed values are correct**

4. Verify the scan tool Driver Shift Control Mode parameter displays Inactive with the transmission shift lever in Park, Reverse, Neutral, and Drive, and Active with the shift lever left of the D or manual mode position.

- **If the Driver Shift Mode parameter does not display the correct values**

Refer to Circuit/System Testing below.

- **If the Driver Shift Mode parameter displays the correct values**

5. Shift lever left of the D position.
6. Verify the scan tool Up and Down Shift Switch parameter changes from None to Upshift when the tap up button is pressed, and from None to Downshift when the tap down button is pressed.

- **If parameter values are not correct**

Refer to Circuit/System Testing below.

- **If parameter values are correct**

7. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

NOTE: **You must perform Circuit/System Verification first.**

1. Ignition OFF, disconnect the harness connector from the S3 Transmission Shift Lever. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the S3 Transmission Shift Lever harness connector terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test the ground circuit for less than 2 ohms end to end.
 - If greater than 2 ohms, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Driver Shift Control parameter displays inactive.
 - **If Driver Shift Control Parameter does not display Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.

2. Test for infinite resistance between the transmission shift lever vehicle harness connector signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Driver Shift Control Parameter displays Inactive**
5. Verify a test lamp illuminates between the S3 Transmission Shift Lever harness connector ignition circuit terminal 1 and ground circuit terminal 2.
 - **If the test lamp does not illuminate**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the ignition circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
6. Test for 11 V or greater at the S3 Transmission Shift Lever harness connector between signal circuit terminal 3 and ground.
 - **If less than 11 V**
 1. Ignition OFF, disconnect the connector at the K9 Body Control Module.
 2. Test for less than 2 ohms in the signal circuit wire end to end.
 - If 2 ohms or greater, repair the open/high resistance in the signal circuit wire.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If 11 V or greater**
7. Ignition OFF, connect the S3 Transmission Shift Lever harness connector, ignition ON.
8. Test for 11 V or greater between the S3 Transmission Shift Lever connector terminal 3 and ground in the park, reverse, neutral, and drive gear select lever positions by back probing the connector.
 - **If less than 11 V**

Replace the S3 Transmission Shift Lever.

 - **If 11 V or greater**
9. Shift selector lever left of the D position.
10. Test for 8.0-10.6 V between the S3 Transmission Shift Lever connector terminal 3 and ground.
 - **If not between 8.0-10.6 V**
 1. Ignition OFF.
 2. Test the signal circuit for less than 2 ohms end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S3 Transmission Shift Lever.
 - **If between 8.0-10.6 V**
11. Test for 5.1-7.3 V between the S3 Transmission Shift Lever connector terminal 3 and ground with the shift lever pressed forward.

- **If not between 5.1-7.3 V**
- 1. Ignition OFF.
- 2. Test the signal circuit for less than 2 ohms end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S3 Transmission Shift Lever.
 - **If between 5.1-7.3 V**
- 12. Test for 2.0-4.6 V between the S3 Transmission Shift Lever connector terminal 3 and ground with the shift lever pressed rearward.
 - **If not between 2.0-4.6 V**
 - 1. Ignition OFF.
 - 2. Test the signal circuit for less than 2 ohms end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S3 Transmission Shift Lever.
 - **If between 2.0-4.6 V**
- 13. Replace the K9 Body Control Module.

Repair Instructions

NOTE:

- Perform the Reset Transmission Adapts following all transmission related repairs.
- Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Transmission Control Replacement for AT TAP shift switch replacement
- Control Module References for Body Control Module (BCM) or control solenoid valve assembly replacement, setup, and programming

DTC P2714 OR P2715

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

NOTE:

The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.

DTC P2714

Pressure Control Solenoid Valve 4 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P2715

Pressure Control Solenoid Valve 4 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Pressure control solenoid 4 is part of the control solenoid valve assembly which has no serviceable components. Pressure control solenoid 4 regulates transmission fluid pressure to the 2-6 clutch regulator valve which controls pressure to the 2-6 clutch. The transmission control module (TCM) calculates gear ratio based on the speed signals from the input shaft speed (ISS) sensor and the output shaft speed (OSS) sensor. The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

P2714

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is between 8.6-32 V.
- Output speed is 36 RPM or greater, or accelerator pedal position is 0.5 % or greater.
- Throttle position signal is valid.
- Engine speed is 400-7,500 RPM for 5 s.
- Transmission fluid temperature is -6.7°C (20°F) or greater.
- High side driver is enabled.

P2715

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.6-32.0 V.
- High side driver is enabled.
- Transmission fluid temperature is -6.7°C (20°F) or greater.
- Engine speed is 400-7,500 RPM for 5 s.
- Transmission output shaft speed is 36 RPM or greater, or the accelerator pedal position is 0.5 % or greater.
- Commanded and attained range is not 1st gear.

Conditions for Setting the DTC

P2714

TCM has detected an incorrect gear ratio or neutral condition when the 2-6 clutch is commanded ON. This condition must occur 3 times.

P2715

TCM has detected an incorrect gear ratio change when the 2-6 clutch is commanded OFF during a shift or, when 2nd gear ratio is detected in 1st gear. This condition must occur 3 times.

Action Taken When the DTC Sets

- DTCs P2714 and P2715 are Type A DTCs.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM freezes transmission adaptive functions.
- TCM limits the transmission to Reverse and 3rd gear operation - P2714 only.
- TCM inhibits auto grade braking.
- TCM inhibits neutral idle.
- TCM limits the transmission to Reverse and 2nd gear operation - P2715 only.

Conditions for Clearing the DTC

DTCs P2714 and P2715 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**
- **Drive Range, First Gear**
- **Drive Range, Sixth Gear**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to **Parking Brake and Drive Wheels Warning** .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling with transmission in Park, with parking brake applied and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.

- **If the transmission fluid level and condition is not correct**

Repair as necessary.

- **If the transmission fluid level and condition is correct**

3. Ignition ON, clear the TCM DTCs with a scan tool.
4. Verify DTC P2714 or P2715 does not set while performing a road test. Refer to **Road Test**.
 - **If DTC P2714 or P2715 sets**

Refer to Circuit/System Testing.

- **If DTC P2714 or P2715 does not set**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- If DTC does not set

7. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Verify the transmission line pressures are within the specified range. Refer to Line Pressure Check, and Solenoid Valve Pressure.

- If the pressures are not within range

Refer to Fluid Pressure High or Low.

- If the pressures are within range

2. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
3. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test.

- If the pressure does not change

Replace the Q8 Control Solenoid Valve Assembly.

- If the pressure changes

4. Verify the conditions listed below do not exist. Repair or replace as necessary.

P2714 or P2715 Control Valve Upper Body Assembly

2-6 clutch regulator valve stuck/sticking - debris, binding, damaged valve, or scored bore.

P2714

Actuator feed limit circuit supply fluid to solenoid restricted or not available - debris or sediment blockage.

P2714 or P2715 Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P2714 or P2715 Control Solenoid Valve Assembly

- Clutch pressure control solenoid 4 stuck ON or stuck OFF.
- Control signal fluid supply leak - valve body filter plate assembly cracked or damaged gasket seal.
- Clutch pressure control solenoid 2 stuck OFF.

P2714 or P2715 Automatic Transmission Case Cover

- 2-6 clutch return spring retaining ring not seated in groove.

- 2-6 clutch piston assembly seal damaged or leaking.
- 2-6 clutch plates worn or damaged.

P2714 1-2-3-4 Clutch Plate Assembly

- 1-2-3-4 clutch backing plate retaining ring not seated/oriented correctly.
- 1-2-3-4 clutch piston seals damaged or leaking.
- 1-2-3-4 clutch piston cracked or damaged.

P2714 Automatic Transmission Fluid Pump Assembly

- Fluid pump housing/vanes/rotor/slide damaged/scored.
- A/Trans pump fluid outlet seal assembly damaged/leaking.

P2714 Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Lower Body and Upper Body Replacement**
- **Low and Reverse Clutch and 1-2-3-4 Clutch Plate Removal**
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P2719-P2721

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2719

Pressure Control Solenoid Valve 4 Performance

DTC P2720

Pressure Control Solenoid Valve 4 Control Circuit Low Voltage

DTC P2721

Pressure Control Solenoid Valve 4 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid 4 is part of the control solenoid valve assembly which has no serviceable components. The normally low pressure control solenoid 4 regulates and directs oil pressure to the 2-6 clutch regulator valve. Increasing pressure control solenoid 4 pressure increases pressure to the 2-6 clutch. The transmission control module (TCM) varies current to the pressure control solenoid 4 by controlling the amount of time the low side driver is ON and OFF. Increasing the ON time increases current to the clutch pressure control solenoid 4. Increasing current to pressure control solenoid 4 increases oil pressure by closing off the solenoid exhaust port. Decreasing the current to the pressure control solenoid 4 decreases oil pressure by opening the exhaust port. Pressure control solenoid 4 power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P2719

TCM detects an internal electrical performance malfunction on the clutch pressure control 4 control circuit where the measured pressure control solenoid 4 current does not equal the commanded clutch pressure control solenoid 4 current for 5 s.

P2720

TCM detects a short to ground on the clutch pressure control solenoid 4 control circuit for 1 s.

P2721

TCM detects an open or short to voltage on the clutch pressure control solenoid 4 control circuit for 1 s.

Action Taken When the DTC Sets

P2719

- DTC P2719 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 2-6 clutch.

P2720

- DTC P2720 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM commands 2nd gear if the transmission is in a forward gear and the output speed is less than 1350 RPM, or neutral if the output speed is 1,350 RPM or greater.

P2721

- DTC P2721 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 3rd gear operation.

Conditions for Clearing the DTC

- DTC P2719 is a Type C DTC.
- DTCs P2720 and P2721 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature, then operate the vehicle in Park for 5 s.
2. Operate the vehicle in Drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 4 Performance Test Status
 - Pressure Control Solenoid Valve 4 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 4 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.
 - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly
 - **If the resistance is within range.**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 4 Performance Test Status
 - Pressure Control Solenoid Valve 4 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 4 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P2723 OR P2724

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.

DTC P2723

Pressure Control Solenoid Valve 5 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P2724

Pressure Control Solenoid Valve 5 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Pressure control solenoid 5 is part of the control solenoid valve assembly which has no serviceable components. Pressure control solenoid 5 regulates the transmission fluid pressure to the 1-2-3-4 clutch regulator valve, which controls pressure to the 1-2-3-4 clutch. The transmission control module (TCM) calculates gear ratio based on the speed signals from the input shaft speed (ISS) sensor and the output shaft speed (OSS) sensor. The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is between 8.6-32 V.
- High side driver is enabled.
- Output speed is 36 RPM or greater, or the accelerator pedal position is 0.5 % or greater.
- Throttle position signal is valid.
- Engine speed is 400-7,500 RPM for 5 s.
- Transmission fluid temperature is -6.7°C (20°F) or greater.

Conditions for Setting the DTC

P2723

TCM has detected an incorrect gear ratio or neutral condition when the 1-2-3-4 clutch is commanded ON. This condition must occur 3 times.

P2724

TCM has detected an incorrect gear ratio change when the 1-2-3-4 clutch is commanded OFF during a shift. This condition must occur 3 times.

Action Taken When the DTC Sets

P2723

- DTC P2723 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- Torque management is enabled.
- TCM inhibits auto grade braking.
- TCM limits the transmission to Reverse and fifth gear operation.

P2724

- DTC P2724 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM inhibits auto grade braking.
- TCM limits the transmission to Reverse, first, or third gear operation.

Conditions for Clearing the DTC

DTCs P2723 and P2724 are Type A DTCs.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This will allow you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**
- **Drive Range, First Gear Engine Braking**
- **Drive Range, Second Gear**
- **Drive Range, Third Gear**
- **Drive Range - Fourth Gear**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to **Parking Brake and Drive Wheels Warning** .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
 - If the transmission fluid level and condition is not correct

Repair as necessary.
 - If the transmission fluid level and condition is correct
3. Ignition ON, clear the TCM DTCs with a scan tool.
4. Verify DTC P2723 or P2724 does not set while performing a road test. Refer to **Road Test**.
 - If DTC P2723 or P2724 sets

Refer to Circuit/System Testing.

- **If DTC P2723 or P2724 does not set**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame//Failure Records data.
6. Verify the does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .
 - **If the pressures are not within range**

Refer to **Fluid Pressure High or Low**.

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.
 - **If the pressure change does not occur**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the pressure changes**

5. Verify the conditions listed below do not exist. Repair or replace as necessary.

DTC P2723 Control Valve Upper Body Assembly

Manual shift detent (w/shaft position switch) lever assembly not engaged with manual shaft.

DTC P2723 Control Valve Upper Body Assembly

Clutch select valve 3 stuck OFF from debris, binding, damaged valve, or scored bore.

DTC P2723 or P2724 Lower Control Valve Body Assembly

- Actuator feed limit circuit supply fluid to solenoid restricted or not available from debris or sediment blockage.

- 1-2-3-4 clutch boost valve binding or scored bore which can also cause harsh shifts.
- 1-2-3-4 clutch regulator valve stuck/sticking from debris, binding, damaged valve, or scored bore.

DTC P2723 or P2724 Control Solenoid Valve Assembly

- Clutch pressure control solenoid 5 stuck ON or stuck OFF.
- Clutch pressure control solenoid 2 stuck OFF.
- Control solenoid filter plate assembly blocked, or damaged gasket seal.

DTC P2723 Channel Plate and Spacer Plate

Channel plate and spacer plate oil channels or orifices blocked by debris.

DTC P2723 1-2-3-4 Clutch Assembly

- 1-2-3-4 clutch piston cracked/damaged/leaking.
- 1-2-3-4 clutch backing plate retaining ring not seated/oriented, causing clutch pack/piston over travel.

DTC P2723 Low and Reverse Clutch Assembly

- Low and reverse clutch assembly will not hold torque.
- Low and reverse clutch assembly friction plate support face cracked/damaged.

DTC P2723 Automatic Transmission Case

Transmission case 1-2-3-4 clutch fluid passage seal damaged/leaking.

DTC P2723 Automatic Transmission Fluid Pump

- Fluid pump housing vanes/rotor/slide damaged/scored.
- Fluid pump outlet seal assembly damaged/leaking.

DTC P2723 Torque Converter Assembly

Fluid pump or torque converter overstressed due to high temperatures.

DTC P2723 Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged.

DTC P2723 Reaction Sun Gear Assembly

- Reaction sun gear broke away from shell.
- Input sun gear missing or broken.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Lower Body and Upper Body Replacement**
- **Low and Reverse Clutch and 1-2-3-4 Clutch Plate Removal**
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P2728-P2730

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2728

Pressure Control Solenoid Valve 5 Performance

DTC P2729

Pressure Control Solenoid Valve 5 Control Circuit Low Voltage

DTC P2730

Pressure Control Solenoid Valve 5 Control Circuit High Voltage

Circuit/System Description

Pressure solenoid 5 is part of the control solenoid valve assembly which has no serviceable components. The normally low pressure control solenoid 5 regulates and directs oil pressure to the 1-2-3-4 clutch regulator valve. Increasing pressure control solenoid 5 pressure increases pressure to the 1-2-3-4 clutch. The transmission control module (TCM) varies the current to the pressure control solenoid 5 by controlling the amount of time the low side driver is ON and OFF. Decreasing the current to pressure control solenoid 5 decreases pressure control solenoid 5 oil pressure by opening the solenoid exhaust port. Increasing the current to pressure control solenoid 5 increases pressure control solenoid 5 oil pressure by closing OFF the solenoid exhaust port. Pressure control solenoid 5 power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.

- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P2728

TCM detects an internal electrical performance malfunction of the pressure control solenoid 5 control circuit where the measured pressure control solenoid 5 current does not equal the commanded pressure control solenoid 5 current for 5 s.

P2729

TCM detects a short to ground on the pressure control solenoid 5 control circuit for 1 s.

P2730

TCM detects an open or short to voltage on the pressure control solenoid 5 control circuit for 1 s.

Action Taken When the DTC Sets

P2728

- DTC P2728 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 1-2-3-4 clutch.

P2729

- DTC P2729 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse, 1st and 3rd gear operation.

P2730

- DTC P2730 is a Type A DTC.
- TCM inhibits the TCC.
- TCM forces the high side driver OFF.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- Torque management in enabled.

- TCM limits the transmission to Reverse and 3rd or 5th gear operation.

Conditions for Clearing the DTC

- DTC P2728 is a Type C DTC.
- DTCs P2729 and P2730 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature.
2. Operate the vehicle in Drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 5 Performance Test Status
 - Pressure Control Solenoid Valve 5 Control Circuit Low Voltage Test Status
 - Pressure Control Solenoid Valve 5 Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.

- **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.

5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - Pressure Control Solenoid Valve 5 Performance Test Status
 - Pressure Control Solenoid Valve 5 Control Circuit High Voltage Test Status
 - Pressure Control Solenoid Valve 5 Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P2762, P2763, OR P2764

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2762

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Performance

DTC P2763

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit High Voltage

DTC P2764

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit Low Voltage

Circuit/System Description

The torque converter clutch (TCC) pressure control solenoid is part of the control solenoid valve assembly

which has no serviceable components. The normally low TCC pressure control solenoid regulates oil pressure to the TCC regulator valve and TCC control valve. Increasing TCC pressure control solenoid oil pressure increases oil pressure to the torque converter to apply the clutch. The transmission control module (TCM) varies the current to the TCC pressure control solenoid by controlling the amount of time the low side driver is ON and OFF. Increasing current to the TCC pressure control solenoid increases oil pressure by closing OFF the solenoid exhaust port. Decreasing current to the TCC pressure control solenoid decreases oil pressure by opening up the solenoid exhaust port. TCC pressure control solenoid power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

P2762

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

P2763 and P2764

- DTC P0658 or P0659 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.
- High side driver is enabled.

Conditions for Setting the DTC

P2762

TCM detects an internal electrical performance malfunction of the TCC pressure control solenoid control circuit where the measured TCC pressure control solenoid current does not equal the commanded TCC pressure control solenoid for 5 s.

P2763

TCM detects an open/high resistance or short to voltage on the TCC pressure control solenoid control circuit for 5 s.

P2764

TCM detects a short to ground on the TCC pressure control solenoid control circuit for 5 s.

Action Taken When the DTC Sets

P2762

DTC P2762 is a Type C DTC.

P2763

- DTC P2763 is a Type B DTC.
- TCM inhibits 6th gear.
- TCM forces TCC OFF.
- TCM commands the hot mode shift pattern.

P2764

- DTC P2764 is a Type A DTC.
- TCM inhibits TCC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 5th gear operation.
- Torque management is enabled.
- TCM commands the high side driver OFF.

Conditions for Clearing the DTC

- DTC P2762 is a Type C DTC.
- DTC P2763 is a Type B DTC.
- DTC P2764 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3°C (5°F) rise in TCM temperature.
2. Operate the vehicle in Drive range and ensure TCC is commanded ON for 1 min.
3. Verify the scan tool parameters listed below do not display Malfunction:
 - TCC Pressure Control Solenoid Valve Control Circuit Status
 - TCC Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
 - TCC Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If contaminated**

Repair as necessary.
 - **If not contaminated.**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
 - **If the resistance is not within range**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
 - TCC Pressure Control Solenoid Valve Control Circuit Status
 - TCC Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
 - TCC Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Replace the Q8 Control Solenoid Valve Assembly.
 - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

SYMPTOMS - AUTOMATIC TRANSMISSION

NOTE: **Use the symptom tables only if the following conditions are met:**

- Refer to **Diagnostic Starting Point - Vehicle** .

- There are no DTCs set.
- The control modules can communicate via the serial data link.
- Review the system operation in order to familiarize yourself with the system functions. Refer to Transmission General Description , and Transmission Component and System Description .

Visual/Physical Inspection

Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Fluid Diagnosis
 - Transmission Fluid Level and Condition Check
 - Fluid Pressure High or Low
 - Automatic Transmission Fluid Leaks
 - Fluid Leak Diagnosis
- Noise and Vibration Diagnosis
 - Whine/Growl Noise
 - Noise and Vibration Analysis
 - Torque Converter Diagnosis
- Range Performance Diagnosis
 - No Park
 - No Drive in All Ranges
 - No Reverse Gear
- Shift Quality Feel Diagnosis
 - Harsh Garage Shift
 - Harsh or Late First, Second, Third, and Fourth Shift
 - Harsh First and Reverse Shift
 - Harsh or Late Second and Sixth Shift
 - Harsh or Late Third, Fifth, and Reverse Shift
 - Harsh Fourth, Fifth, and Sixth Shift
- Shift Pattern

- No First and Reverse Gears
- No First, Second, Third, and Fourth Gear
- No Second and Sixth Gear
- No Fourth, Fifth, and Sixth Gear
- No Third, Fifth, and Reverse Gear
- Torque Converter Diagnosis
 - Torque Converter Diagnosis
 - No Torque Converter Clutch Apply
 - No Torque Converter Clutch Release
- Symptom Not Found or No Symptom Detected
 - Transmission Fluid Level and Condition Check
 - Road Test
 - Line Pressure Check

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY INSPECTION

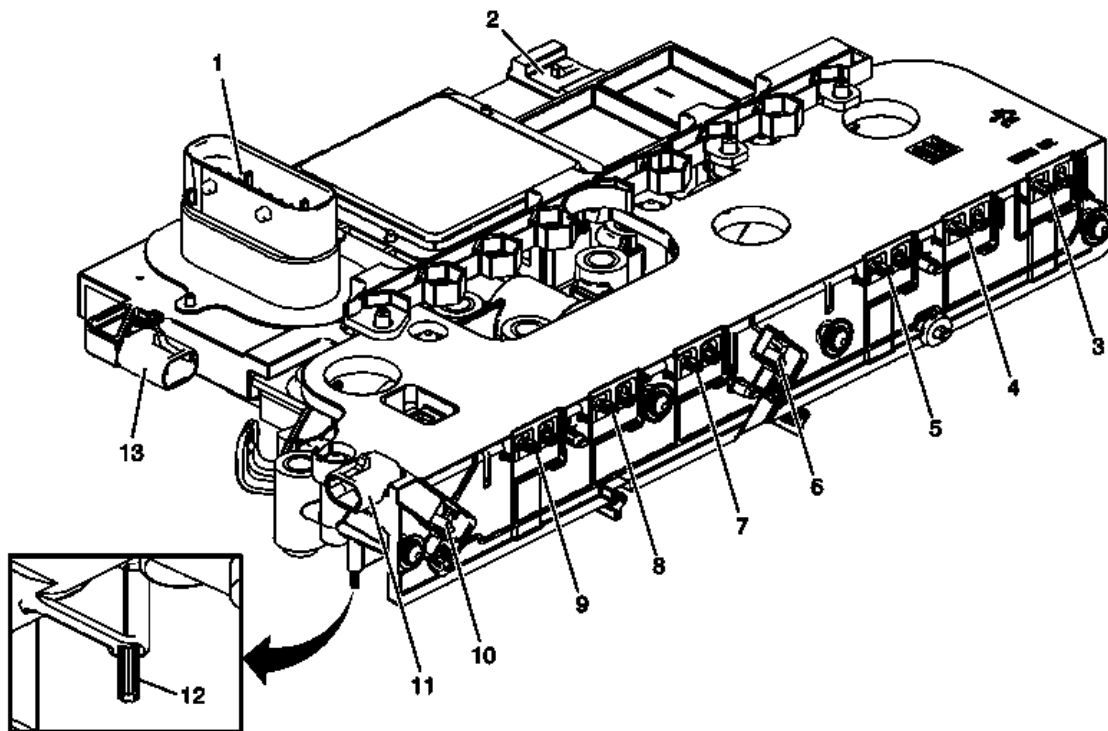


Fig. 1: Control Solenoid Valve and Transmission Control Module Assembly
 Courtesy of GENERAL MOTORS COMPANY

1. Inspect the control solenoid valve assembly connectors and pins (1, 2, 11, 13) for the following conditions:
 - Damage

- Bent pins
 - Debris
 - Broken retaining tab
 - Contamination
2. Ensure no metallic debris is inside the connectors near the terminal pins.
 3. Inspect the control solenoid valve assembly solenoid leads (3) for contamination or metallic debris.
 4. Inspect the 4 control solenoid valve assembly filter plate retaining tabs (12) for cracks and ensure proper tension when filter plate is attached.

Solenoid Identification & Resistance Values

Solenoid Name	Illustration Number of Solenoid Lead	Expected Resistance (Ohms)
Line Pressure Control Solenoid	3	4.5-5.2 ohms
Pressure Control Solenoid 2 (PCS2)	5	4.5-5.2 ohms
Pressure Control Solenoid 3 (PCS3)	9	4.5-5.2 ohms
Pressure Control Solenoid 4 (PCS4)	4	4.5-5.2 ohms
Pressure Control Solenoid 5 (PCS5)	8	4.5-5.2 ohms
Shift Solenoid 1 (SS1)	10	22-25 ohms
Shift Solenoid 2 (SS2)	6	22-25 ohms
Torque Converter Clutch (TCC) Pressure Control Solenoid	7	4.5-5.2 ohms

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY INPUT SHAFT SPEED/OUTPUT SHAFT SPEED INPUT TEST

Special Tools

- **EL 35616** GM-Approved Terminal Test Kit
- **EL 38522** Variable Signal Generator

For equivalent regional tools, refer to **Special Tools** .

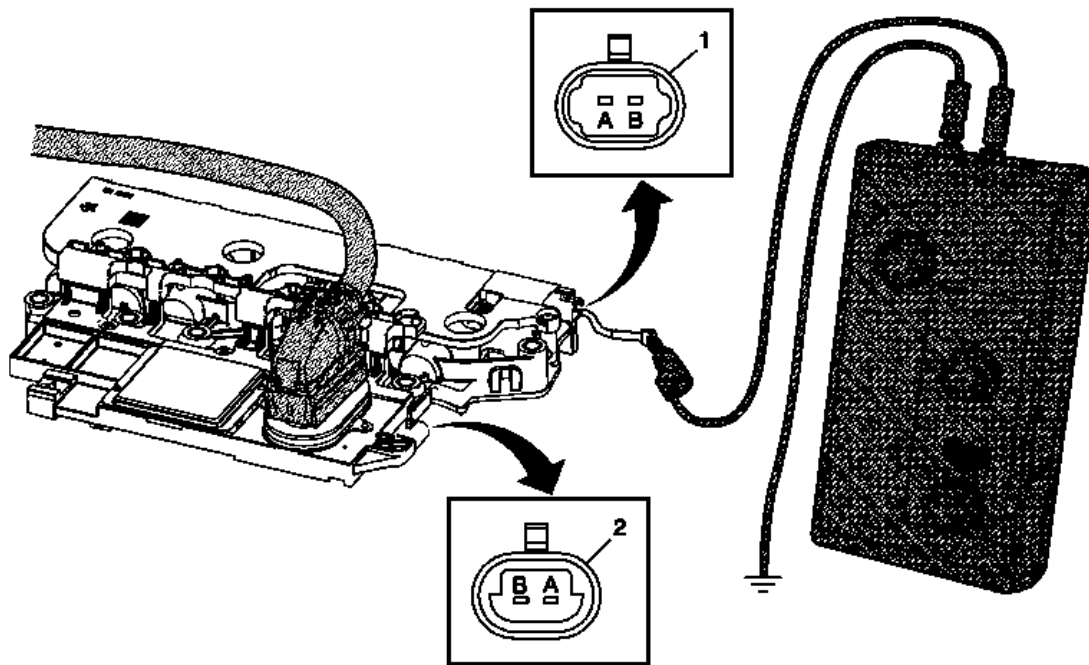


Fig. 2: GM-Approved Terminal Test Kit And Variable Signal Generator
 Courtesy of GENERAL MOTORS COMPANY

The purpose of this test is to provide a simulated input/output speed sensor (ISS/OSS) signal to the control solenoid valve assembly ISS/OSS input circuits.

Transmission Input Speed Sensor

1. Ignition OFF, disconnect the ISS wiring harness connector X3 (1) from the control solenoid valve assembly.
2. Ignition ON, test for 8.3-9.3 volts at terminal A.
 - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Ignition OFF, using the **EL 35616** terminal test kit , connect the **EL38522** variable signal generator red lead to the ISS signal circuit terminal B on the TCM.
4. Connect the black lead from the **EL 38522** variable signal generator to ground.
5. Set the **EL 38522** variable signal generator to 5 volts, the frequency to 300 Hz, and the percent duty cycle to 50 or the normal position.
6. Ignition ON, verify with a scan tool the Transmission ISS parameter is between 495-505 RPM.
 - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .

Transmission Output Speed Sensor

1. Ignition OFF, disconnect the OSS wiring harness connector X4 (2) from the control solenoid valve assembly.
2. Ignition ON, test for 8.3-9.3 volts at terminal A.
 - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Ignition OFF, using the **EL 35616** terminal test kit , connect the **EL 38522** variable signal generator red lead to the OSS signal circuit terminal B on the TCM.
4. Connect the black lead from the **EL 38522** variable signal generator to ground.
5. Set the **EL 38522** variable signal generator to 5 volts, the frequency to 300 Hz, and the percent duty cycle to 50 or the normal position.
6. Ignition ON, verify with a scan tool the Transmission OSS parameter is between 256-266 RPM.
 - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY SOLENOID PERFORMANCE TEST

Special Tools

- **DT-47825-100** Solenoid Test Plate
- **DT-47825-20** Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

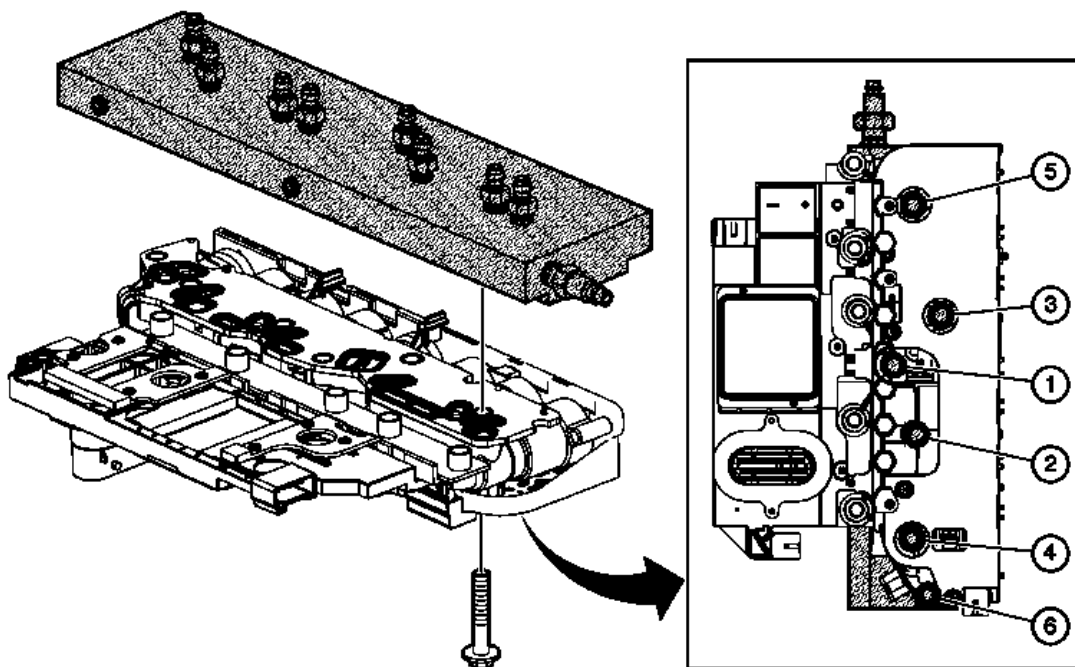


Fig. 3: Control Solenoid Valve Assembly Solenoids
Courtesy of GENERAL MOTORS COMPANY

The purpose of this procedure is to test the functionality of the control solenoid valve assembly solenoids for a gross stuck open or stuck closed condition. The **DT-47825-100** test plate is bolted to the control solenoid valve assembly on the valve body mounting surface. Pressurized air is passed into the aluminum test plate, through the control solenoid valve assembly solenoid passage and back to a pressure gauge on the test plate. The pressure gauge indicates open if air pressure is passed through the solenoid, or closed if the solenoid is unable to pass air through. A scan tool is used to command the solenoids ON and OFF. While watching the pressure gauge, one can determine the valve functionality. The recommended shop air pressure for this test is 90-100 psi.

1. Remove the control solenoid valve assembly from the transmission.
2. Bolt the **DT-47825-100** test plate to the control solenoid valve assembly on the valve body mounting surface. Use the bolts and washers supplied with the tool to attach the test plate. Tighten the bolts to 5 N.m (44 lb in) using a center out alternating torque sequence.
3. Install the pressure gauge to the affected solenoid air port. Reference component to air port table.
4. Connect the shop air pressure line to the **DT-47825-100** test plate test plate air psi inlet port.
5. Connect the **DT-47825-20** harness to the vehicle and control solenoid valve assembly.

CAUTION: Do not energize the solenoids for more than two minutes or the solenoids could be damaged.

6. Ignition ON, with a scan tool command the solenoid in question ON and OFF. Watch the air pressure gauge and look for the change in pressure as you command the valve ON and OFF. The valve should allow air pressure to flow through the valve port to the gauge with a result of pressure reading on the gauge. If the valve is stuck closed, no pressure change will occur. Command the solenoid valve ON and OFF several times to determine the state of the solenoid valve in question. Release the air pressure in the gauge between pressurization tests.

Control Solenoid Valve Assembly Solenoid Performance Test Plate to Component Identification

Component	Port On Test Plate	Commanded State	
		ON	OFF
PC Solenoid 2, 35R	C	Full pressure to gauge	No pressure to gauge
PC Solenoid 3, R1/456	G	Full pressure to gauge	No pressure to gauge
PC Solenoid 4, 2-6	B	Full pressure to gauge	No pressure to gauge
PC Solenoid 5, 1234	F	Full pressure to gauge	No pressure to gauge
Shift Solenoid 1	H	Full pressure to gauge	No pressure to gauge
Shift Solenoid 2	D	Full pressure to gauge	No pressure to gauge
Line Pressure Control Solenoid	A	Command to highest setting, full pressure to gauge	Command to lowest setting, below 620.5 kPa (90 psi) to gauge
TCC PC Solenoid	E	Full pressure to gauge	No pressure to gauge

NOTE: With the key ON, engine OFF (KOEO), the transmission control module (TCM)

will normally cycle some of the transmission solenoids On and Off to facilitate keeping the ports and solenoids clean and free of debris. This dither function is a normal activity and will cause the valves to cycle open and closed quickly when the TCM is powered up. This can cause the psi gauge to flicker high and low as the valves open and close. This may cause some air to exit the ports where the psi gauge is not connected as those solenoids cycle on and off.

Drain the TCM of excess transmission fluid before attaching to test plate and use caution when attaching air to test plate air inlet.

RESET TRANSMISSION ADAPTS

The Reset Transmission Adapts is a procedure for automatic transmissions in which the shift pressure learn values of each individual clutch is reset to zero or a base calibrated value, in the transmission control module (TCM).

Once the transmission adapts are set to zero or a calibrated value, the vehicle is then road test under various drive cycle events for the TCM to relearn shift pressure values for the best possible shift feel in all gear ranges.

The Reset Transmission Adapts procedure must be performed when one of the following repairs have been made to the transmission. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, DTCs being set, or customer dissatisfaction.

- Transmission internal service, repair or overhaul
 - Valve body repair or replacement
 - Control solenoid valve assembly replacement
 - Any service/repair in response to a shift quality concern
1. Install any components or connectors that have been removed or replaced during diagnosis.
 2. Perform any adjustments, programming or setup procedures that are required when a component or module is removed or replaced.
 3. Clear the DTCs.
 4. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes.

NOTE: Do not cycle or turn the ignition switch OFF until directed to do so below.

5. Ignition ON, engine running, with a scan tool Reset Transmission Adapts.
6. Perform the **Road Test**.
7. Ignition OFF for 2 minutes.

TRANSMISSION FLUID LEVEL AND CONDITION CHECK

This procedure checks both the transmission fluid level, as well as the condition of the fluid itself.

CAUTION: Use Dexron VI transmission fluid only. Failure to use the proper fluid may result in transmission internal damage.

NOTE: Ensure the transmission has enough fluid in it to safely start the vehicle without damaging the transmission. With the vehicle off there must be at least enough fluid to wet the end of the dipstick bullet. This will ensure that there is enough fluid in the sump to fill the components once the vehicle is started.

Level Checking Procedure

1. Park the vehicle on a level surface, apply the parking brake and place the shift lever in PARK (P).
2. Start the engine.
3. Depress the brake pedal and move the shift lever through each gear range, pausing for about 3 seconds in each range. Then move the shift lever back to PARK (P).
4. Allow the engine to idle 500-800 rpm for at least 1 minute. Release the brake pedal.
5. Keep the engine running and observe the transmission fluid temperature (TFT) using the Driver Information Center or a scan tool.

NOTE: If the fluid temperature is below the specified range, perform the following procedure to raise the fluid temperature to the specified range.

6. If the TFT reading is not within the required temperature ranges, allow the vehicle to cool, or operate the vehicle until the appropriate TFT is reached.

Drive the vehicle in second gear until the fluid temperature is within the specified range.

NOTE: Check the transmission fluid level when the TFT is between 180°F and 200°F (82°C and 93°C). The fluid level rises as fluid temperature increases, so it is important to ensure the transmission fluid temperature is within range.

7. Remove the dipstick and wipe it with a clean rag or paper towel.
8. Inspect the fluid color. The fluid should be red or dark brown.
 - If the fluid color is very dark or black and has a burnt odor, inspect the fluid for excessive metal particles or other debris. A small amount of "friction" material is a "normal" condition. If large pieces and/or metal particles are noted in the fluid, flush the oil cooler and cooler lines and overhaul the transmission. If there are no signs of transmission internal damage noted, replace the fluid, repair the oil cooler, and flush the cooler lines.
 - Fluid that is cloudy or milky or appears to be contaminated with water indicates engine coolant or water contamination. Refer to Engine Coolant/Water in Transmission.
9. Install the dipstick and tighten. Wait three seconds and then remove it again.

NOTE: Always check the fluid level at least twice. Consistent readings are important to maintaining proper fluid level. If inconsistent readings are

noted, inspect the transmission vent assembly to ensure it is clean and unclogged.

NOTE: It is not necessary to get the fluid level all the way up to the MAX mark. Anywhere within the crosshatch band is acceptable.

10. Check both sides of the dipstick and read the lower level.
11. Install and remove the dipstick again to verify the reading.
12. If the fluid level is not within the crosshatch band, and the transmission temperature is between 180°F and 200°F (82°C and 93°C), add or drain fluid as necessary to bring the level into the crosshatch band. If the fluid level is low, add only enough fluid to bring the level into the crosshatch band.

NOTE: Do not add more than one pint (0.5L) at a time without rechecking the level. Once the oil is on the dipstick bullet, it will not take much more fluid to raise the fluid level into the crosshatch band. Do not overfill. Also, if the fluid level is low, inspect the transmission for leaks. Refer to Fluid Leak Diagnosis.

13. If the fluid level is in the acceptable range, install the dipstick.
14. If the fluid was changed, reset the transmission oil life monitor if applicable.

Fluid Condition Inspection

- Inspect the fluid color. The fluid should be red in color. The fluid may also turn brown from normal use, and does not always indicate contamination.

NOTE: Fluid that is very dark or black and has a burnt odor usually indicates contamination or overheating.

- If the fluid color is very dark or black and has a burnt odor, inspect the fluid for excessive metal particles or other debris which may indicate transmission damage. Refer to Road Test to verify transmission operation. Change the transmission fluid if no other conditions are found.
- Fluid that is cloudy or milky or appears to be contaminated with water indicates engine coolant or water contamination. Refer to Engine Coolant/Water in Transmission.

LINE PRESSURE CHECK

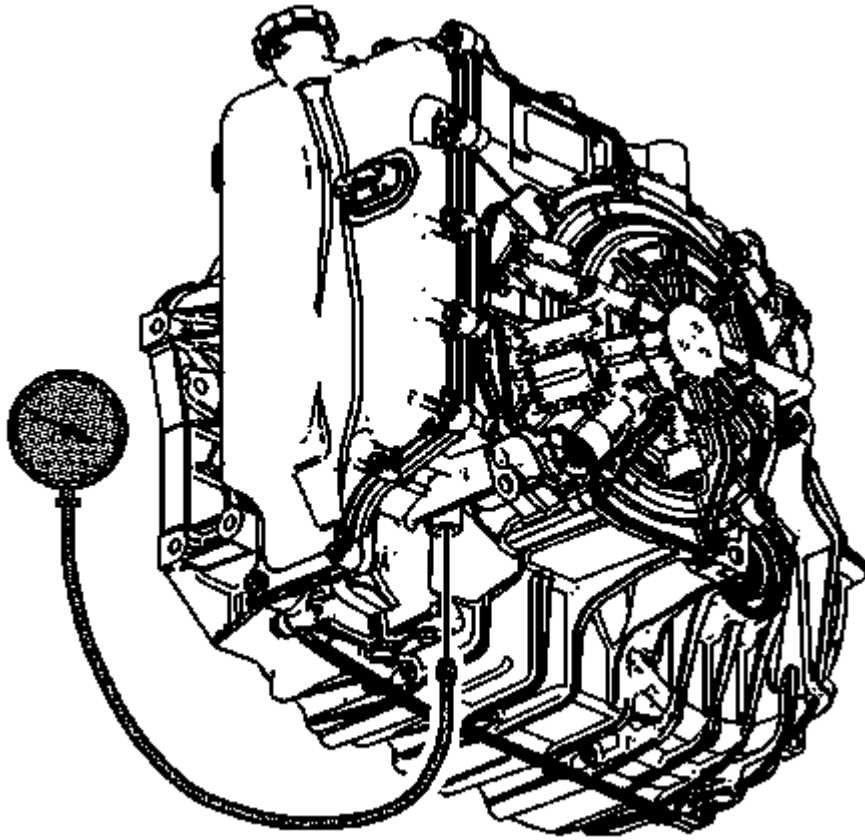


Fig. 4: Pressure Gauge And Test Port
Courtesy of GENERAL MOTORS COMPANY

Special Tools

DT 21867-A Pressure Gauge

For equivalent regional tools, refer to **Special Tools** .

WARNING: Keep the brakes applied at all times in order to prevent unexpected vehicle motion. Personal injury may result if the vehicle moves unexpectedly.

1. Install a scan tool.
2. Start the engine.
3. Inspect the transmission for the proper fluid level. Refer to **Transmission Fluid Level and Condition Check**.
4. Use the scan tool to inspect for any active or stored diagnostic trouble codes.
5. Inspect the manual linkage at the transmission for proper function.
6. Turn the engine OFF.

7. Remove the line pressure test hole plug.
8. Install the **DT 21867-A** pressure gauge.
9. Access the Scan Tool Transmission Output Controls for the Line PC Solenoid.
10. Start the engine.

NOTE: In order to achieve accurate line pressure readings, the following procedure must be performed at least 3 times in order to gather uniform pressure readings.

The scan tool is only able to control the line PC solenoid in PARK and NEUTRAL with engine speeds below 1500 RPM. This protects the clutches from extreme high or low line pressures.

11. Use the scan tool to increase and decrease the Line PC Solenoid in increments of approximately 200 KPa (29 psi). The scan tool commands the increment values automatically.
12. Allow the pressure to stabilize between increments.
13. Compare the pressure readings on the **DT 21867-A** pressure gauge to the actual pressure values in the solenoid valve pressure chart. Refer to **Solenoid Valve Pressure** .
14. If the pressure readings vary greatly, refer to **Fluid Pressure High or Low**.
15. Turn the engine OFF.
16. Remove the **DT 21867-A** pressure gauge.

CAUTION: Refer to **Fastener Caution** .

17. Install the line pressure test hole plug and tighten to 12 N.m (106 lb in).

ROAD TEST

The following test provides a method of evaluating the condition of the automatic transmission. The test is structured so that most driving conditions would be achieved. The test is divided into the following parts:

- Electrical Function Check
- Upshift Control and Torque Converter Clutch (TCC) Apply
- Part Throttle Step-In Downshifts
- Manual Downshifts
- Coasting Downshifts
- Manual Gear Range Selection
 - REVERSE
 - Driver Shift Control

NOTE: Complete the test in the sequence given. Incomplete testing cannot guarantee

an accurate evaluation.

Before the road test, ensure the following:

- The engine is performing properly.
- Transmission fluid level is correct. Refer to **Transmission Fluid Level and Condition Check**.
- Tire pressure is correct.

During the road test:

- Perform the test only when traffic conditions permit.
- Operate the vehicle in a controlled, safe manner.
- Observe all traffic regulations.
- View the scan tool data while conducting this test.

Take along qualified help in order to operate the vehicle safely.

- Observe any unusual sounds or smells.

After the road test, check the following:

- Inspect for proper transmission fluid level. Refer to **Transmission Fluid Level and Condition Check**.
- Inspect for any diagnostic trouble codes (DTCs) that may have set during the testing. Refer to the applicable DTC.
- Monitor the scan tool data for any abnormal readings or data.
- Inspect for fluid leaks. Refer to **Fluid Leak Diagnosis**.

Electrical Function Check

Perform this procedure first in order to ensure the electronic transmission components are functioning properly. If these components are not checked, a simple electrical condition could be misdiagnosed.

1. Connect the scan tool.
2. Ensure the gear selector is in PARK and set the parking brake.
3. Start the engine.
4. Verify that the following scan tool data can be obtained and is functioning properly.

Refer to **Control Module References** for typical data values. Data that is questionable may indicate a concern.

- Engine Speed
- Transmission ISS
- Transmission OSS

- Vehicle Speed
- IMS
- Commanded Gear
- Gear Ratio
- Line PC Sol. Pressure Cmd.
- Brake Switch
- ECT, Engine Data List
- Trans. Fluid Temp.
- TCM Temperature
- Calc. Throttle Position
- Ignition Voltage
- TFP Switch 1
- TFP Switch 3
- TFP Switch 4
- TFP Switch 5
- PC Sol. 2 Pressure Cmd.
- PC Sol. 3 Pressure Cmd.
- PC Sol. 4 Pressure Cmd.
- PC Sol. 5 Pressure Cmd.
- Shift Solenoid 1
- Shift Solenoid 2
- TCC PC Sol. Duty Cycle
- TCC Slip Speed

5. Check the garage shifts.

1. Apply the brake pedal and ensure the parking brake is set.
2. Move the gear selector through the following ranges:
 1. PARK to REVERSE
 2. REVERSE to NEUTRAL
 3. NEUTRAL to DRIVE
 4. DRIVE to REVERSE
 5. REVERSE to DRIVE
3. Pause 2 to 3 seconds in each gear position.
4. Verify the gear engagements are immediate (less than 2 seconds to complete if trans fluid temperature is above 20°C) and not harsh. Note that these shifts may be almost imperceptible in some applications. Using the scan tool to monitor Transmission ISS achieving 0 RPM can be used to check delay in these cases.

NOTE: Harsh engagement may be caused by any of the following conditions:

- **High engine idle speed-Compare engine idle speed to desired idle speed.**
- **Incorrect line pressure-Investigate Line PC Sol. Pressure Cmd. kPa (psi), also perform Line Pressure Check.**
- **A default condition caused by certain DTCs that result in maximum line pressure to prevent clutch slippage.**
- **Incomplete adapting or incorrect adapting-Repeat maneuver multiple times to see if shift quality improves. If it does not, refer to the service procedures for Harsh Garage Shift, and for Harsh First and Reverse Shift.**

NOTE: Delayed engagement may be caused by any of the following conditions:

- **Low idle speed-Compare engine idle speed to desired idle speed.**
- **Low fluid level**
- **Incorrect line pressure-Investigate Line PC Sol. Pressure Cmd. kPa (psi), also perform Line Pressure Check.**
- **Cold transmission fluid temperature (TFT)-Use the scan tool to determine TFT.**
- **Selector linkage-Inspect and adjust as necessary.**
- **Incomplete adapting or incorrect adapting-Repeat maneuver multiple times to see if delay improves. If it does not, refer to the service procedures for Harsh First and Reverse Shift.**

6. Monitor transmission range on the scan tool, transmission data list.

1. Apply the brake pedal and ensure the parking brake is set.
2. Move the gear selector through all ranges.
3. Pause 2 to 3 seconds in each range.
4. Return gear selector to PARK.
5. Verify that all selector positions match the scan tool display.

7. Check throttle position input.

1. Apply the brake pedal and ensure the parking brake is set.
2. Ensure the gear selector is in PARK.
3. Monitor the scan tool Calc. Throttle Position while increasing and decreasing engine speed with the throttle pedal. The scan tool Calc. Throttle Position percentage should increase and decrease with engine speed.

If any of the above checks do not perform properly, record the result for reference after completion of the road test.

Upshift Control and Torque Converter Clutch (TCC) Apply

The TCM calculates the upshift points based primarily on 2 inputs: throttle position and vehicle speed. When the TCM determines that conditions are met for a shift to occur, the TCM commands the shift by varying current to the appropriate PC solenoids to control oncoming and offgoing clutch pressures.

Perform the following steps:

1. Monitor the following scan tool parameters:

- Calc. Throttle Position
- Vehicle Speed
- Engine Speed
- Transmission ISS
- Transmission OSS
- Commanded Gear
- TCC PC Sol. Pressure Cmd.
- TCC Slip Speed
- TFP Switch 1
- TFP Switch 3
- TFP Switch 4
- TFP Switch 5
- PC Sol. 2 Pressure Cmd.
- PC Sol. 3 Pressure Cmd.
- PC Sol. 4 Pressure Cmd.
- PC Sol. 5 Pressure Cmd.
- Shift Solenoid 1 and 2

2. Place the gear selector in the DRIVE position.

3. Accelerate the vehicle using a steady throttle position between 15 and 20 percent. Hold the throttle steady.

4. As the transmission upshifts, there should be a noticeable shift feel or engine speed change within 1 to 2 seconds of the commanded gear change. The PC solenoid pressure command should change to "YES" for the oncoming clutch and the PC solenoid pressure command should change to "NO" for the offgoing clutch.

5. Note any harsh, soft or delayed shifts or slipping. Note any noise or vibration.

6. The TCC feel may not be noticeable. In many applications the TCC will apply after the 1-2 shift and TCC events will not be easily detected using engine speed.

NOTE: This transmission is equipped with an electronically controlled capacity clutch (ECCC), which allows operation of the clutch without fully locking to the torque converter cover. The clutch maintains a small amount of slippage, approximately 20 RPM, in 2nd, 3rd, 4th, 5th, and 6th gears, depending on the vehicle application. ECCC was developed to reduce the possibility of noise, vibration or chugle caused by TCC apply. Full lockup

is available at highway speeds on some applications.

7. Monitor TCC PC solenoid pressure command while driving and check TCC slip speed when the pressure command indicates that the TCC is commanded to apply:

When the TCC applies, slip speed should be controlled to below 100 RPM when the transmission is not shifting and the throttle is held steady. If the TCC slip exceeds this value for more than 6 seconds after the TCC PC Sol. Pressure Command indicates that the TCC is commanded ON:

- Check for DTCs.
- Refer to **Torque Converter Diagnosis**.

Part Throttle Step-In Downshifts

1. Place the gear selector in the DRIVE position.
2. Accelerate the vehicle at light throttle (5-15 percent) until 3rd gear is just achieved.
3. Quickly increase throttle angle until commanded gear indicates that a downshift to 2nd gear is commanded.
4. Verify that the transmission downshifts within 2 seconds of the throttle movement.
5. Repeat steps 2 to 4 at higher speed to achieve 4th gear and then step in to command a 4th gear to 3rd gear downshift.
6. Repeat steps 2 to 4 at higher speed to achieve 5th gear and then step in to command a 5th gear to 4th gear downshift.
7. Repeat steps 2 to 4 at higher speed to achieve 6th gear and then step in to command a 6th gear to 5th gear downshift.
8. Note any harsh, soft or delayed shifts or slipping. Note any noise or vibration.

Manual Downshifts

Manual downshift testing is not required since all vehicles equipped are also equipped with some form of Driver Shift Control (DSC). The TCM will automatically override DSC downshifts to protect the transmission from damage.

Coasting Downshifts

1. Place the gear selector in the DRIVE position.
2. Accelerate the vehicle to 6th gear with the TCC applied.
3. Release the throttle and apply the brakes
4. Verify that the downshifts occur as commanded by monitoring gear ratio, which should change after commanded gear changes.

Manual Gear Range Selection

This application does not utilize manual forward gear ranges.

Reverse

Perform the following test using a 10-15 percent throttle position.

1. With the vehicle stopped, move the gear selector to REVERSE.
2. Slowly accelerate the vehicle.
3. Verify that there is no noticeable slip, noise or vibration.

Driver Shift Control (DSC)

Refer to the owner's manual for specific instructions on the type of DSC available in this application. Utilize the DSC to ensure that the transmission responds appropriately to driver's commands. The TCM will upshift automatically when maximum engine speed is achieved and will protect from any downshift which may cause excessive engine RPM.

TORQUE CONVERTER DIAGNOSIS

Torque Converter Stator

The torque converter stator roller clutch can have 2 different malfunctions.

- The stator assembly freewheels in both directions.
- The stator assembly remains locked up in both directions.

Poor Acceleration at Low Speed - Stator Roller Clutch Freewheels at All Times

If the stator is freewheeling at all times, the vehicle tends to have poor acceleration from a standstill and at speeds below 48-55 km/h (30-34 mph). At speeds above 48-55 km/h (30-34 mph), the vehicle may act normally.

For poor acceleration at low speeds, you should first determine that the exhaust system is not blocked, and the transmission is in First gear when starting out. If the engine freely accelerates to high RPM in NEUTRAL, you can assume that the engine and the exhaust system are normal. Check for poor performance in DRIVE and REVERSE to help determine if the stator is freewheeling at all times.

Poor Acceleration at High Speed - Stator Roller Clutch is Locked Up at All Times

If the stator is locked up at all times, performance is normal when accelerating from a standstill. Engine RPM and vehicle speed are limited or restricted at speeds above 48-55 km/h (30-34 mph). Visual examination of the converter may reveal a blue color from overheating.

Torque Converter Bearing Noise

NOTE: Do not confuse this noise with pump whine noise, which is usually noticeable in all gear ranges. Pump whine will vary with line pressure.

Torque converter whine is noticed when the vehicle is stopped and the transmission is in DRIVE or REVERSE.

This noise will increase as you increase the engine RPM. The noise will stop when the vehicle is moving or when you apply the torque converter clutch, because there is no slip speed across the bearings.

Perform a stall test to verify that the noise is actually coming from the torque converter:

1. Place your foot on the brake.
2. Put the gear selector in DRIVE.

CAUTION: You may damage the transmission if you depress the accelerator for more than 6 seconds.

3. Depress the accelerator to approximately 1,200 RPM for no more than six seconds.

A torque converter noise will increase under this load.

Torque Converter Clutch

The torque converter clutch (TCC) is applied by fluid pressure, which is controlled by a TCC pressure control (PC) solenoid. This solenoid is part of the control solenoid valve assembly, which is located inside the automatic transmission assembly. The solenoid is controlled through a combination of computer controlled switches and sensors. Electronically controlled capacity clutch (ECCC) is controlled slip across the TCC.

Torque Converter Clutch Shudder

The key to diagnosing torque converter clutch (TCC) shudder is to note when it happens and under what conditions. TCC shudder should only occur during the apply, release, or ECCC conditions of the converter clutch. Shudder should never occur after the TCC is fully locked (approximately 0 RPM slip).

If Shudder Occurs During TCC Apply, Release, and ECCC

If the shudder occurs while the TCC is applying, the problem can be within the transmission or the torque converter. Something is causing one of the following conditions to occur:

- The clutch is not engaging completely.
- The clutch is not releasing completely.
- The clutch is releasing and applying rapidly and continuously.

One of the following conditions may be causing the TCC Shudder to occur:

- Leaking turbine shaft/TCC seals
- A restricted release orifice
- A distorted clutch or converter cover due to long flexplate to converter bolts
- Defective friction material on the TCC plate

If Shudder Occurs After TCC has Locked

Engine problems may go unnoticed under light throttle and load, but they become noticeable after the TCC has locked when going up a hill or accelerating.

Refer to 2.0L **SYMPTOMS - ENGINE CONTROLS** or 2.4L **SYMPTOMS - ENGINE CONTROLS (LUK)** or **SYMPTOMS - ENGINE CONTROLS (LEA)** in order to avoid misdiagnosis of TCC shudder and the unnecessary disassembly of a transmission or the unnecessary replacement of a torque converter.

Torque Converter Vibration Test

NOTE: **The Noise and Vibration Analysis procedure should be performed prior to performing this test.**

Indexing Torque Converter

To determine and correct a torque converter vibration, the following procedure may have to be performed several times to achieve the best possible torque converter to flexplate balance.

1. Remove the torque converter bolts.
2. Rotate the torque converter one bolt position from the original marked position.

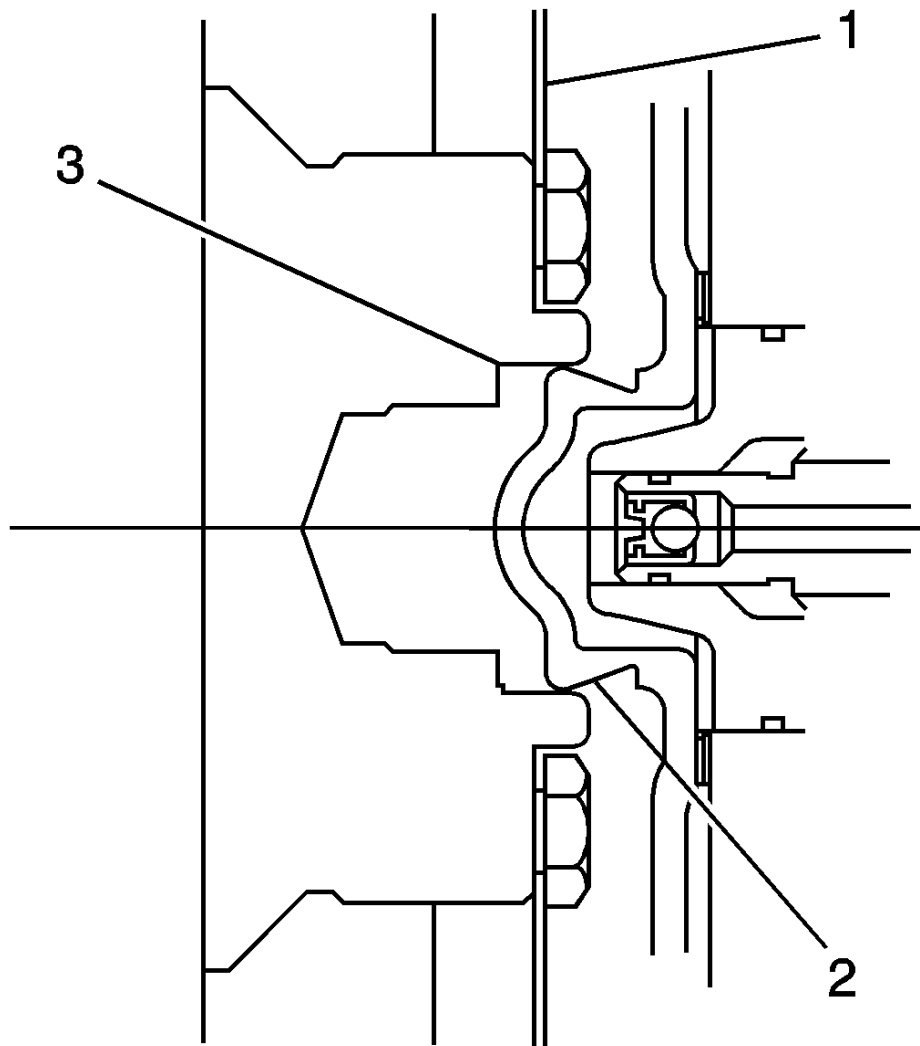


Fig. 5: View Of Torque Converter Hub In Engine Crankshaft
Courtesy of GENERAL MOTORS COMPANY

CAUTION: When installing the torque converter to the flexplate, make sure to use specified bolts. **DO NOT** use longer bolts. Using longer bolts will result in deformation of the torque converter cover and cause internal damage.

CAUTION: Refer to Fastener Caution .

3. Align the torque converter pilot (2) in the engine crankshaft (3). Install the torque converter to flexplate bolts, and tighten according to Fastener Tightening Specifications (Off Vehicle) , Fastener Tightening Specifications (On Vehicle) .
4. Lower the vehicle.
5. With the engine at idle speed and the transmission in PARK or NEUTRAL, observe the vibration.

Repeat this procedure until the best possible balance is obtained.

6. Install the torque converter access cover and bolts (if equipped) and tighten according to **Fastener Tightening Specifications (Off Vehicle)** , **Fastener Tightening Specifications (On Vehicle)** .

Torque Converter Replacement Guide

Condition	Action
<ul style="list-style-type: none"> • Transmission Fluid Oxidized/Discolored • Clutch Fiber Material 	Do not replace the torque converter. Refer to <u>Transmission Fluid Level and Condition Check</u> .
Transmission Fluid Contaminated with Metal Particles	NOTE: Do not replace the torque converter for clutch system or gearset component damage. Fine metallic debris or clutch plate material that is suspended in the fluid will not cause damage to the internal torque converter components nor any internal transmission components.
Harsh Gear Shifts	Do not replace the torque converter. Refer to <u>Symptoms - Automatic Transmission</u> .
Noise-Whine	<ul style="list-style-type: none"> • Refer to <u>Symptoms - Automatic Transmission</u>. • Do not replace the torque converter if noise is present in Neutral/Park. Refer to 2.0L <u>SYMPTOMS - ENGINE CONTROLS</u> or 2.4L <u>SYMPTOMS - ENGINE CONTROLS (LUK)</u> or <u>SYMPTOMS - ENGINE CONTROLS (LEA)</u> .
Vibration-Out of Balance	Refer to Torque Converter Vibration Test in this procedure.
No Drive/Slips in Drive	Do not replace the torque converter until completing all engine and transmission diagnostics.
Idle Surge/Rough Idle	Do not replace the torque converter. Refer to 2.0L <u>SYMPTOMS - ENGINE CONTROLS</u> or 2.4L <u>SYMPTOMS - ENGINE CONTROLS (LUK)</u> or <u>SYMPTOMS - ENGINE CONTROLS (LEA)</u>
TCC Apply/Release Shudder	Do not replace the torque converter. Refer to Torque Converter Clutch Shudder in this procedure.
TCC Chuggle	Do not replace the torque converter. Refer to 2.0L <u>SYMPTOMS - ENGINE CONTROLS</u> or 2.4L <u>SYMPTOMS - ENGINE CONTROLS (LUK)</u> or <u>SYMPTOMS - ENGINE CONTROLS (LEA)</u> .
DTC P0741-TCC Stuck OFF/High Slip-Intermittent Only	Do not replace the torque converter. Refer to <u>DTC P0741 or P0742</u> diagnostic table.

DTC P0741-TCC Stuck OFF/High Slip	Do not replace the torque converter. Refer to <u>DTC P0741 or P0742</u> diagnostic table.
DTC P0742-TCC Stuck ON	Do not replace the torque converter. Refer to <u>DTC P0741 or P0742</u> diagnostic table.
Transmission Fluid Contaminated with Sludge/Metal Particles as a result of: <ul style="list-style-type: none"> • Engine Coolant/Oil • Pump damage • Drive sprocket support damage • Turbine/stator shaft damage • Internal converter damage with no damage found in the transmission 	Replace the torque converter.
Poor Acceleration above 48 km/h (30 mph) - Good Launch	Do not replace the torque converter until completing all engine and transmission diagnostics. <ul style="list-style-type: none"> • Refer to Torque Converter Stator in this procedure. • Refer to 2.0L <u>SYMPTOMS - ENGINE CONTROLS</u> or 2.4L<u>SYMPTOMS - ENGINE CONTROLS (LUK)</u> or <u>SYMPTOMS - ENGINE CONTROLS (LEA)</u> .
Poor Launch - Good Acceleration above 48 km/h (30 mph)	Do not replace the torque converter until completing all engine and transmission diagnostics. <ul style="list-style-type: none"> • Refer to Torque Converter Stator in this procedure. • Refer to 2.0L <u>SYMPTOMS - ENGINE CONTROLS</u> or 2.4L<u>SYMPTOMS - ENGINE CONTROLS (LUK)</u> or <u>SYMPTOMS - ENGINE CONTROLS (LEA)</u> .
Stripped Converter Bolt Holes	<ul style="list-style-type: none"> • Replace the torque converter. • Inspect flexplate and refer to 2.0L <u>LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED</u> or 2.4L <u>LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED</u> .
Torque Converter Pilot Damaged	Replace the torque converter.
Torque Converter Hub surface is damaged - scored, raised/transferred metal.	Replace the torque converter.
External Leaks in the weld areas - hub, lug or closure weld.	Replace the torque converter.

Broken/Cracked Flexplate	Replace the torque converter.
Torque Converter Discolored/Overheated	Replace the torque converter.

CLUTCH PLATE DIAGNOSIS

Composition Plates

Dry the plates and inspect the plates for the following conditions:

- Pitting
- Flaking
- Delamination-splitting or separation of bonded clutch material
- Wear
- Glazing
- Cracking
- Charring
- Chips or metal particles embedded in the lining

Replace a composition plate which shows any of these conditions.

Steel Plates

Wipe the plates dry and check the plates for heat discoloration. If the surfaces are smooth, even if color smear is indicated, you can reuse the plate. If the plate is discolored with heat spots or if the surface is scuffed, replace the plate.

Causes of Burned Clutch Plates

The following conditions can result in a burned clutch plate:

- Incorrect usage of clutch or apply plates
- Engine coolant or water in the transmission fluid
- A cracked clutch piston
- Damaged or missing seals
- Low line pressure
- Valve body conditions
 - The valve body face is not flat.
 - Porosity in between channels.
 - The valve train retainers are improperly installed.
 - The checkballs are misplaced.
- The Teflon® seal rings are worn or damaged.

ENGINE COOLANT/WATER IN TRANSMISSION

CAUTION: The antifreeze or water will deteriorate the seals, gaskets and the glue that bonds the clutch material to the pressure plate. Both conditions may cause damage to the transmission.

If antifreeze or water has entered the transmission, perform the following:

1. Disassemble the transmission.
2. Replace all of the rubber type seals. The coolant will attack the seal material which will cause leakage.
3. Replace the composition-faced clutch plate assemblies. The facing material may separate from the steel center portion.
4. Replace all of the nylon parts - washers.
5. Replace the torque converter.
6. Thoroughly clean and rebuild the transmission, using new gaskets and oil filter.
7. Flush the cooler lines after the transmission cooler has been properly repaired or replaced.
8. Inspect the rubber hose portion of the oil cooler lines for damage, if applicable. Refer to **Transmission Fluid Cooler Flushing and Flow Test (6T70)** .

FLUID LEAK DIAGNOSIS

General Method

1. Verify that the leak is transmission fluid.

CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

2. Thoroughly clean the suspected leak area using a rag.

NOTE: Do not idle vehicle, this will not actuate transmission systems, and do not drive the vehicle on the freeway as this will splatter oil inhibiting leak diagnosis.

3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut OFF the engine.
6. Look for fluid spots on the paper.
7. Make the necessary repairs.

Powder Method

CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

1. Thoroughly clean the suspected leak area using a rag.
2. Apply an aerosol type leak tracing powder to the suspected leak area.

NOTE: **Do not idle vehicle, this will not actuate transmission systems, and do not drive the vehicle on the freeway as this will splatter oil inhibiting leak diagnosis.**

3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Shut OFF the engine.
5. Inspect the suspected leak area.
6. Trace the leak path through the powder in order to find the source of the leak.
7. Make the necessary repairs.

Dye and Black Light Method

A fluid dye and black light kit is available from various tool manufacturers.

1. Follow the manufacturer's instructions in order to determine the amount of dye to use.
2. Operate the vehicle for 24 km (15 mi) or until normal operating temperatures are reached.
3. Detect the leak with the black light.
4. Make the necessary repairs.

Find the Cause of the Leak

Pinpoint the leak and trace the leak back to the source. You must determine the cause of the leak in order to repair the leak properly. For example, if you replace a gasket, but the sealing flange is bent, the new gasket will not repair the leak. You must also repair the bent flange. Before you attempt to repair a leak, check for the following conditions, and make repairs as necessary:

Gaskets

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Improperly tightened fasteners
- Dirty or damaged threads
- Warped flanges or sealing surface
- Scratches, burrs, or other damage to the sealing surface
- Damaged or worn gasket
- Cracking or porosity of the component
- Improper sealant used, where applicable
- Incorrect gasket

Seals

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Damaged seal bore
- Damaged or worn seal
- Improper installation
- Cracks in component
- Manual shaft or output shaft surface is scratched, nicked, or damaged
- Loose or worn bearing causing excess seal wear

Possible Points of Fluid Leaks

Transmission Case Cover and/or Valve Body Cover

- Incorrectly tightened bolts
- Improperly installed or damaged gasket/seal
- Damaged mounting face
- Incorrect gasket seal

Case Leak

- Damaged input speed sensor seal
- Damaged manual shaft seal
- Loose or damaged oil cooler lines/seals
- Worn or damaged axle shaft oil seal
- Loose line pressure pipe plug or fluid level pipe plug
- Porous casting
- Warped torque converter housing
- Damaged converter housing to case seal

Leak at the Torque Converter End

- Converter leak in the weld area
- Converter seal lip cut. Check the converter hub for damage
- Converter seal bushing moved forward and damaged
- Converter seal garter spring missing from the seal
- Porous casting of the torque converter housing

Leak at the Vent

- Overfilled system

- Water or coolant in the fluid; The fluid will appear milky
- Transmission case porous
- Incorrect fluid level indicator causing an overfilled system
- Plugged vent

Leak Inspection Points

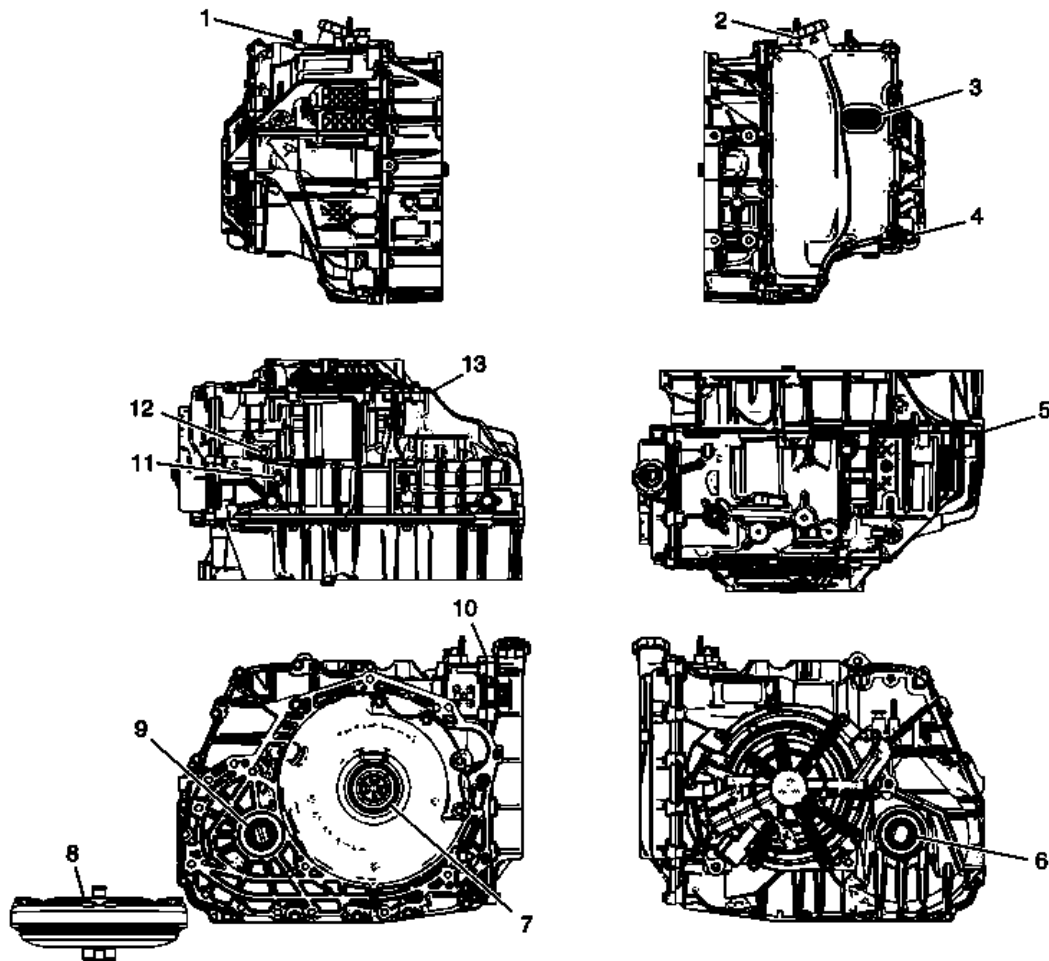


Fig. 6: Identifying Leak Inspection Points
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Manual Shift Shaft Seal
2	Automatic Transmission Vent
3	Control Valve Body Cover Wiring Connector Hole Seal
4	Input Speed Sensor Seal
5	Converter Housing to Case Joint
6	Front Wheel Drive Shaft Oil Seal Assembly - Case

7	Torque Converter Fluid Seal Assembly
8	Torque Converter Assembly
9	Front Wheel Drive Shaft Oil Seal Assembly - Torque Converter Housing
10	Control Valve Body Cover Assembly Gasket
11	Fluid Level Hole Plug
12	Fluid Pressure Hole Plug
13	Case Cover Gasket

CASE POROSITY REPAIR

Some external leaks are caused by case porosity in non-pressurized areas.

1. Thoroughly clean the area to be repaired with a cleaning solvent. Air dry the area.

WARNING: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Using instructions from the manufacturer, mix a sufficient amount of an epoxy to make the repair.
3. Apply the epoxy. A clean, dry soldering acid brush can be used to clean the area and also to apply the epoxy cement. Make certain that the area to be repaired is fully covered.
4. Allow the epoxy cement to cure for three hours before assembling the components.
5. Repeat the fluid leak diagnosis procedures.

BUSHING AND MATING SHAFT INSPECTION

NOTE: Proper bushing and corresponding mating shaft inspection should be performed before replacing the bushing, shaft, and in some cases, the component which houses the bushing. Thoroughly clean and dry the bushing and shaft surfaces before inspecting for damage.

Any of the following bushing conditions require replacement of the bushing and/or housing:

- Discoloration due to heat distress
- Misalignment or displacement of bushing as a result of spinning in housing
- Medium to heavy scoring that can be easily detected with fingernail. Light scoring is a normal condition.
- Debris embedded into the bushing lining material
- Obvious damage, including excessive and uneven wear
- Excessive polishing. Minor polishing of the bushing is an indication of normal wear and does not require replacement.

Any of the following conditions require replacement of the bushing's mating shaft:

- Discoloration due to heat distress
- Rough surface finish that can be easily detected with finger
- Obvious shaft abnormalities, including warping or uneven surfaces
- Obvious damage or cracking

NOISE AND VIBRATION ANALYSIS

A noise or vibration that is noticeable when the vehicle is in motion MAY NOT be the result of the transmission.

If noise or vibration is noticeable in PARK and NEUTRAL with the engine at idle, but is less noticeable as RPM increases, the vibration may be a result of poor engine performance.

- Vibration may also be caused by a small amount of water inside the converter.
- Inspect the engine and transmission mounts for damage and loose bolts.
- Inspect the transmission case mounting holes for the following conditions:
 - Missing bolts, nuts, and studs
 - Stripped threads
 - Cracks
- Inspect the flywheel for the following conditions:
 - Missing or loose bolts
 - Cracks
 - Imbalance
- Inspect the torque converter for the following conditions:
 - Missing or loose bolts or lugs
 - Missing or loose balance weights
 - Imbalance caused by heat distortion or fluid contamination
- If the noise or vibration is noticeable in PARK and NEUTRAL with the engine at idle, but is more noticeable as RPM increases, the vibration may be an engine imbalance or a transmission imbalance. Refer to **Torque Converter Diagnosis**.

WHINE/GROWL NOISE

Whine/Growl Noise

Checks	Causes
Front Differential Drive Pinion Gear Assembly (23)	<ul style="list-style-type: none"> • Inspect for worn wheel bearings or axles. • Inspect for proper Taper Roller Bearing Pre-load • Inspect for loose or worn transfer Driven Gear
Differential Assembly (486)	<ul style="list-style-type: none"> • Inspect for worn wheel bearings or axles. • Inspect for proper Taper Roller Bearing Pre-load

	<ul style="list-style-type: none"> • Inspect for worn or damaged Side Gear Thrust Washer (492) or Pinion Gear Thrust Washer (488) • Inspect for loose or worn Side Gear Axle Splines
Input Carrier Assembly (470)	<ul style="list-style-type: none"> • Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings • Inspect for loose Hub and Ring Gear
Output Carrier Assembly (474)	<ul style="list-style-type: none"> • Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings • Inspect for loose Hub and Ring Gear
Reaction Carrier Assembly (467)	<ul style="list-style-type: none"> • Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings • Inspect for loose hub and Ring Gear
Fluid Pump Assembly (203)	<ul style="list-style-type: none"> • Inspect for proper fluid level • Inspect for loose or worn Drive Link Assembly (218) • Inspect for worn Driven Sprocket Thrust Washer (214) or Drive Sprocket Thrust Washers (219, 220) • Inspect for leaking Transfer Drive Gear Support Seal (213), Pump Fluid Outlet Seal Assembly (57) or Filter Seal (202) • Inspect for worn or damaged Fluid Pump Shaft Splines
3-5-Reverse Clutch Assembly	<ul style="list-style-type: none"> • Inspect for inadequate Clutch Plate Clearance • Inspect for loose or worn Clutch Plate Splines (423-425) • Inspect for loose or worn Clutch Spring Retainer (427) • Inspect for loose Speed Sensor Reluctor Wheel (416) or Retainer (415)
4-5-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for inadequate Clutch Plate Clearance • Inspect for loose or worn Clutch Plate Splines (449, 440) • Inspect for loose or worn Clutch Spring Retainer (442) • Inspect for loose or worn 3-5-Reverse/4-5-6 Clutch Housing Bushing
1-2-3-4 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for inadequate Clutch Plate Clearance • Inspect for loose or worn Clutch Plate Splines (456-458) • Inspect for loose or worn Clutch Spring Retainer (459)
Low and Reverse Clutch Assembly	<ul style="list-style-type: none"> • Inspect for loose or worn Splines (455)

(OWC) (455)	<ul style="list-style-type: none"> Inspect for loose or worn Retainer (454)
Low and Reverse Clutch	<ul style="list-style-type: none"> Inspect for inadequate Clutch Plate Clearance Inspect for loose or worn Clutch Plate Splines (449-452) Inspect for loose or worn Clutch Spring Retainer (410)
2-6 Clutch Assembly	<ul style="list-style-type: none"> Inspect for inadequate Clutch Plate Clearance Inspect for loose or worn Clutch Plate Splines (445-447) Inspect for loose or worn Clutch Spring Retainer (407)
Case Assembly (51)	<ul style="list-style-type: none"> Inspect for loose or broken Transmission Mount Bolts Inspect for loose Torque Converter and Differential Housing Bolts (26) Inspect for loose or broken Fluid Trough Bolts (56)

AUTOMATIC TRANSMISSION FLUID LEAKS

Automatic Transmission Fluid Leaks

Checks	Causes
Torque Converter (27)	Inspect for damage.
Case Assembly (21)	<ul style="list-style-type: none"> Inspect for porosity or damage on the sealing surfaces Inspect for loose Oil Cooler Line Bolts or damaged Oil Cooler Line Seals Inspect for damaged Manual Shift Shaft Seal (58) Inspect for damaged or worn Axle Seal (61) or Axle Seal Slinger on the axle shafts Inspect for loose Pressure Test Plug (62) and Fluid Level Plug (63)
Torque Converter Housing Assembly (221)	<ul style="list-style-type: none"> Inspect for damaged Torque Converter Housing Assembly (25) Inspect for porosity or damage on the sealing surfaces Inspect for damaged Torque Converter Housing Seal (22) Inspect for damaged or worn Torque Converter Fluid Seal (225) Inspect for loose Torque Converter and Differential Housing Bolts (26) Inspect for damaged or worn Axle Seal (226) or Axle Seal Slingers on the axle shafts
Case Cover assembly (34)	<ul style="list-style-type: none"> Inspect for porosity or damage on the sealing surface Inspect for damaged Case Cover Gasket (33) Inspect for loose Case Cover Assembly Bolts (35) Inspect for loose Input Speed Sensor (ISS) Bolt (401)

	<ul style="list-style-type: none"> • Inspect for damaged Input Speed Sensor (ISS) Seal (402) • Inspect for loose, damaged or leaking Case Cover Assembly bore plugs
Valve Body Cover Assembly (1)	<ul style="list-style-type: none"> • Inspect for damaged or warped Valve Body Cover Assembly (1) • Inspect for damaged Valve Body Cover Gasket (5) • Inspect for loose Valve Body Cover Bolts (7) and Valve Body Cover Studs (6) • Inspect for damaged or improperly installed Wire Connector Hole Seal (10) • Inspect for damaged or worn Fluid Level Indicator Seal • Inspect for plugged vent holes in the Fluid Level Indicator (2)

SHIFT INDICATOR INDICATES WRONG GEAR SELECTION

Shift Indicator Indicates Wrong Gear Selection

Checks	Causes
Shift Cable	<ul style="list-style-type: none"> • Inspect for damage. • Verify proper attachment to shifter. • Verify cable is locked into shifter bracket. • Verify cable is properly attached to the transmission. • Verify that the cable is locked into the transmission bracket.
Manual Shaft	<ul style="list-style-type: none"> • Verify shift lever is properly attached to the manual shaft. • Verify manual shaft is not twisted or damaged.
Manual Shift Detent Lever with Shaft Position Switch Assembly, IMS	Verify proper operation. Refer to <u>Transmission Internal Mode Switch Logic</u> .

NO PARK

No Park

Checks	Causes
Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly (481)	<ul style="list-style-type: none"> • Inspect for broken or stripped Park Gear splines • Inspect for broken or worn Park Gear
Front Differential Carrier Assembly (486)	Inspect for damaged, broken or loose Front Differential Ring Gear
Output Carrier Transfer Drive Gear Hub Assembly (477)	<ul style="list-style-type: none"> • Inspect for worn, stripped or broken splines • Inspect for disengaged hub to Transfer Drive Gear
Reaction Carrier Assembly (467)	<ul style="list-style-type: none"> • Inspect for worn, stripped or broken splines

	<ul style="list-style-type: none"> Inspect for disengaged to the Output Sun Gear (475)
Case Assembly (507)	<ul style="list-style-type: none"> Inspect for broken or damaged Case Inspect for loose or stripped Park Pawl Actuator Bracket Bolts (500) Inspect for broken or bent Park Pawl Actuator Bracket (501) Inspect for broken or missing Park Pawl Actuator Guide Pin (505) or Manual Shaft Pin (510) Inspect for broken, loose or misaligned Park Pawl Guide (506) Inspect for binding or broken Park Pawl (503) or Actuator Assembly (509)
Manual Shift Detent Lever Assembly (511)	Inspect for broken or disengaged Manual Valve Link Pin

HARSH GARAGE SHIFT

Harsh Garage Shift

Checks	Causes
Input Carrier Assembly (470)	Inspect for worn or stripped ring gear splines
Case Assembly (51)	<ul style="list-style-type: none"> Check the engine for diagnostic codes. If the engine controller signals the transmission that engine torque is inaccurate, the transmission will command high line pressure. Check line pressure at idle is below 800 kPa. Inspect for stuck valves in the lower valve body, particularly the boost valves. Inspect for damaged or fatigued 1-2-3-4 clutch wave plate (458) and low and reverse clutch wave plate (450). Inspect for stripped or worn splines on 1-2-3-4 clutch plate (456). Inspect for improperly positioned or plugged low reverse piston (408) air bleed. Inspect for correct fluid level.
Low and Reverse Clutch Assembly (OWC) (455)	Inspect for stripped or sheared internal and external splines on the low and reverse clutch assembly (455).

NO DRIVE IN ALL RANGES

No Drive in All Ranges

Checks	Causes
For an explanation of which clutches are applied during the transmission gear ranges, refer to <u>Range Reference</u> .	
Case Assembly (51)	<ul style="list-style-type: none"> Inspect for cracked or broken Case (51)

	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines • Inspect for binding Manual Shift Detent Lever Assembly (511) • Inspect for missing Manual Shift Shaft Pin (510) • Inspect for interference or binding Park Pawl Actuator Assembly (509) • Inspect for disengaged or broken 1-2-3-4 Clutch Piston Spring Retainer (459) • Inspect for loose or damaged case bushing. • Inspect for missing Lube Orifice Plug
Torque Converter (29)	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines on Turbine Shaft • Inspect for missing Torque Converter to Flywheel bolts.
Torque Converter Housing (221)	<ul style="list-style-type: none"> • Inspect for loose, missing or broken Torque Converter and Differential Housing bolts (26). • Inspect for loose, missing or broken Fluid Pump bolts (204).
35R/456 Housing Assembly (422)	<ul style="list-style-type: none"> • Inspect for damaged or broken Input Shaft Thrust Bearing Assembly (32) • Inspect for stripped, sheared or loose splines on the Input Shaft to the 3-5 Reverse/4-5-6 Clutch Housing (422)
Oil Pump Assembly (203)	<ul style="list-style-type: none"> • Inspect for fluid leaks / improper fluid level • Inspect for disengaged, worn, binding or failed Drive Sprocket (216), Driven Sprocket (215) or Drive Link (217) • Inspect for leaking Fluid Outlet Seal Assembly (57) • Inspect for damaged or worn Drive (219, 220) and Driven Sprocket Thrust Washers (214) • Inspect for loose or missing Oil Pump Bolts (204) • Inspect for stripped or sheared splines on the Oil Pump Shaft or Driven Sprocket (215) • Inspect for damaged, clogged or improperly installed Oil Filter Assembly (201) • Inspect for damaged or leaking Oil Filter Neck Seal (202)
Low & Reverse Clutch Assembly (455)	Inspect for stripped or sheared splines to the Reaction Carrier (467)
Input Carrier Assembly (470)	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines to ring gear • Inspect for improperly installed carrier pinion gear pins • Inspect for damaged or broken Pinion Gears. • Inspect for stripped or sheared splines on the Input Sun Gear (471). • Inspect for damaged or broken Output Internal Gear.

	<ul style="list-style-type: none"> • Inspect for broken or disengaged Output Internal Gear Retainer Ring. • Inspect for damaged or broken Input Carrier Thrust Bearing Assembly (468) and Output Carrier Thrust Bearing Assembly (473). • Inspect for damaged or broken Input Carrier Thrust Bearings (469, 472).
Reaction Carrier Assembly (467)	<ul style="list-style-type: none"> • Inspect for stripped or sheared Reaction Carrier Assembly (467) splines. • Inspect for damaged or broken Input Carrier Thrust Bearings (468). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for damaged or broken Reaction Internal Gear teeth. • Inspect for disengaged or broken Reaction Internal Gear retainer ring.
Reaction Sun Gear Assembly (466)	<ul style="list-style-type: none"> • Inspect for damaged or broken weld at Sun Gear. • Inspect for loose or worn Reaction Sun Gear Assembly bushing.
Output Carrier Assembly (474)	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines to reaction internal ring gear. • Inspect for damaged or broken Input Sun Gear Thrust Bearings (472). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for damaged or broken Input Carrier Thrust Bearings (473). • Inspect for broken or damaged Output Internal Gear.
Output Sun Gear Assembly (475)	<ul style="list-style-type: none"> • Inspect for stripped or sheared Output Sun Gear Assembly (475) splines. • Inspect for broken Output Sun Gear Assembly (4755) hub or weld.
Low and Reverse Clutch Assembly (455)	Inspect for disengaged or broken Low and Reverse Clutch Assembly (455).
Differential Carrier Assembly (486)	<ul style="list-style-type: none"> • Inspect for stripped or sheared splines on Differential Side Gear. • Inspect for stripped or sheared splines Differential Carrier to PTU (AWD only). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for broken, worn or damaged Final Drive Inner and Outer Thrust Washers (492).
	<ul style="list-style-type: none"> • Check that the Manual Valve (348) is engaged with Manual Shift Detent Lever Assembly (511).

Control Solenoid (w/Body and TCM) Valve Assembly	<ul style="list-style-type: none"> Inspect the Control Solenoid (w/Body and TCM) Valve Assembly (15) and verify that it is functioning properly. Refer to <u>Control Solenoid Valve and Transmission Control Module Assembly Inspection</u>.
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NO FIRST AND REVERSE GEARS

No First and Reverse Gears

Checks	Causes
Low and Reverse Clutch Assembly (455)	<ul style="list-style-type: none"> Inspect for disengaged or broken low and reverse clutch retainer (454). Inspect for stripped or sheared splines on low and reverse clutch (455).
Low and Reverse Clutch	<ul style="list-style-type: none"> Inspect for stripped or sheared splines on low and reverse clutch plates (449-453). Inspect for damaged, deformed or improper surface finish on the low and reverse clutch plates (449-453).
Case Cover Assembly (403)	<ul style="list-style-type: none"> Inspect for disengaged or broken low and reverse clutch piston spring retainer (410). Inspect for worn, damaged or debonding low and reverse clutch piston seals (408). Inspect for broken or deformed low and reverse clutch piston (408). Inspect for improperly position or too large bleed hole in low and reverse piston (408). Inspect for porosity or improper finish on the case cover. Inspect for broken or fatigued low and reverse clutch piston return spring (409).

NO FIRST, SECOND, THIRD, AND FOURTH GEAR

No First, Second, Third, and Fourth Gear

Checks	Causes
1-2-3-4 Clutch Assembly	<ul style="list-style-type: none"> Inspect for damaged or worn 1-2-3-4 clutch plates (456-458). Inspect for damaged or broken 1-2-3-4 clutch piston (461) and piston seals damaged, worn or delaminating. Inspect for broken or binding 1-2-3-4 clutch piston return spring (460). Inspect for broken or disengaged 1-2-3-4 clutch piston return spring retainer (459). Inspect for broken or fatigued 1-2-3-4 clutch wave plate (458).

Output Sun Gear Assembly (457)	Inspect for stripped or sheared splines on the output sun gear shell.
Reaction Carrier Assembly (467)	<ul style="list-style-type: none"> Inspect for stripped or sheared splines on the input ring gear. Inspect for disengaged or broken input ring gear retainer.
Output Carrier Assembly (474)	<ul style="list-style-type: none"> Low/reverse clutch assembly (OWC) (455) splines sheared or broken. Inspect for disengaged or broken reaction ring gear retainer.
Case Assembly (51)	Inspect for worn or damaged case splines or retainer ring grooves.

NO SECOND AND SIXTH GEAR

No Second and Sixth Gear

Checks	Causes
2-6 Clutch Assembly	<ul style="list-style-type: none"> Inspect for damaged or worn 2-6 clutch plates (445-447). Inspect for damaged, worn, broken, improper surface finish or sheared splines on the 2-6 clutch backing plate (448).
Reaction Carrier Assembly (467)	<ul style="list-style-type: none"> Inspect for stripped or sheared splines on the input ring gear. Inspect for disengaged or broken input ring gear retainer.
Case Cover Assembly (403)	<ul style="list-style-type: none"> Inspect for damaged or broken 2-6 clutch piston (405) and piston seals damaged, worn or delaminating. Inspect for broken or binding 2-6 clutch piston return spring (406). Inspect for broken or disengaged 2-6 clutch piston return spring retainer (407). Inspect for damaged, worn or improper surface finish in the piston bore (403).
Case Assembly (51)	Inspect for stripped or sheared splines (51).

HARSH OR LATE FIRST, SECOND, THIRD, AND FOURTH SHIFT

Harsh or Late First, Second, Third, and Fourth Shift

Checks	Causes
1-2-3-4 Clutch Assembly	<ul style="list-style-type: none"> Inspect for damaged or broken 1-2-3-4 clutch piston (461) and piston seals damaged, worn or leaking. Inspect for fatigued or binding 1-2-3-4 clutch piston return spring (460). Inspect for improper surface finish on 1-2-3-4 clutch plates (456-458). Inspect for broken or fatigued 1-2-3-4 clutch waved plate (458).
Case	Inspect for leaking or damaged 1-2-3-4 clutch fluid passage seal (65).

HARSH FIRST AND REVERSE SHIFT

Harsh First and Reverse Shift

Checks	Causes
Case Cover Assembly (403)	Inspect for plugged or improperly positioned low and reverse piston (408) air bleed.
Low and Reverse Clutch	<ul style="list-style-type: none">• Inspect for improper surface finish on low and reverse clutch plates (449-453).• Inspect for damaged or worn low and reverse clutch plates (452).• Inspect for damaged low and reverse clutch backing plate (453).• Inspect for worn splines on backing plate (453).• Inspect for damaged low and reverse clutch piston assembly (408), spring (409), and spring retaining ring (410).• Inspect for fatigued or binding low and reverse clutch piston return spring (409).• Inspect for broken low and reverse clutch wave plate (449).
Lower Valve Body	Inspect for stuck 4-5-6 clutch boost valve.

NO THIRD, FIFTH, AND REVERSE GEAR

No Third, Fifth, and Reverse Gear

Checks	Causes
3-5-Reverse Clutch Assembly	<ul style="list-style-type: none">• Inspect for damaged, worn or stripped splines on 3-5-reverse clutch plates (423-426), backing plate (426).• Inspect for sheared or stripped splines on 3-5-rev/4-5-6 housing to turbine shaft (422).• Inspect for damage, improper surface finish, porosity, deformed or unbalanced 3-5-rev/4-5-6 housing (422).• Inspect for damaged, worn, loose or seized hub bushing in the 3-5-rev/4-5-6 housing.• Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5-rev/4-5-6 housing (422).• Inspect for failure of the Input shaft thrust bearing (32).• Inspect for disengaged or broken 3-5-reverse clutch backing plate retainer (427).• Inspect for disengaged or broken 3-5-reverse backing plate (426).• Inspect for damaged, worn or leaking 3-5-reverse clutch piston seals (419-421).• Inspect for damaged or broken 3-5-rev/4-5-6 clutch housing

	(422). <ul style="list-style-type: none"> • Inspect for warped, damaged, improper surface finish or debonding 3-5-reverse clutch piston (417). • Inspect for broken or fatigued 3-5-reverse clutch spring (418). • Inspect for disengaged or broken speed sensor reluctor retainer (415). • Inspect for broken speed sensor reluctor wheel (416). • Inspect for seized input shaft thrust bearing (32).
Reaction Carrier (467)	<ul style="list-style-type: none"> • Inspect for broken or disengaged input internal gear retainer. • Inspect for stripped or sheared splines on the input internal gear.
Output Carrier (474)	Inspect for stripped or sheared splines for the reaction internal ring gear.
4-5-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for plugged or missing 4-5-6 piston dam oil feed hole. • Inspect for leaking 4-5-6 piston dam.

HARSH OR LATE SECOND AND SIXTH SHIFT

Harsh or Late Second and Sixth Shift

Checks	Causes
2-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for worn or improper surface finish on the 2-6 Clutch Plates (446, 447) and Backing Plate (448) • Inspect for fatigued 2-6 Clutch Piston Cushion Spring (445)
Case Cover Assembly (403)	<ul style="list-style-type: none"> • Inspect for damaged or broken 2-6 Clutch Piston (405) and piston seals damaged, worn or delaminating • Inspect for fatigued 2-6 Clutch Piston Return Spring (406)

NO FOURTH, FIFTH, AND SIXTH GEAR

No Fourth, Fifth, and Sixth Gear

Checks	Causes
4-5-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for damaged or broken 4-5-6 clutch piston (433) and piston seals (430-432). • Inspect for broken or disengaged 4-5-6 backing plate retainer (442). • Inspect for damaged or broken 4-5-6 clutch dam piston (435) and piston seals damaged, worn or delaminating. • Inspect for broken or disengaged 4-5-6 clutch dam retainer (436). • Inspect for sheared or stripped splines on the reaction carrier

	<p>hub (438).</p> <ul style="list-style-type: none"> • Inspect for sheared or stripped splines on 3-5-rev/4-5-6 housing to turbine shaft (422). • Inspect for loose, worn or damaged 3-5-rev/4-5-6 housing bushing. • Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5-rev/4-5-6 housing (422). • Inspect for failure of the input shaft thrust bearing (32). • Inspect for damaged, stripped or sheared splines on 4-5-6 clutch plates (439-441). • Inspect for broken or fatigued 4-5-6 clutch piston return spring (434).
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HARSH OR LATE THIRD, FIFTH, AND REVERSE SHIFT

Harsh or Late Third, Fifth, and Reverse Shift

Checks	Causes
3-5-Reverse Clutch Assembly	<ul style="list-style-type: none"> • Inspect for improper surface finish on 3-5-Reverse Clutch Plates (423-426), Backing Plate (426) • Inspect for plugged or restricted oil passages and air bleed of the 3-5-Rev/4-5-6 Housing (422) • Inspect for damaged, worn or leaking 3-5-Reverse Clutch Piston Seals (419-421) • Inspect for warped 3-5-Rev/4-5-6 Clutch Housing (422) • Inspect for fatigued 3-5-Reverse Clutch Waved Plate (423)

HARSH FOURTH, FIFTH, AND SIXTH SHIFT

Harsh Fourth, Fifth, and Sixth Shift

Checks	Causes
4-5-6 Clutch Assembly	<ul style="list-style-type: none"> • Inspect for leaking 4-5-6 clutch piston (433) and piston seals (430-432). • Inspect for plugged or restricted 4-5-6 piston dam air bleed. • Inspect for fatigued 4-5-6 clutch piston spring (434). • Inspect for leaking 4-5-6 clutch dam seals (435). • Inspect for improper surface finish on 4-5-6 clutch plates (439-441). • Inspect for porous, improper surface finish, seal groove damage or plugged or restricted oil passages of the 3-5-rev/4-5-6 housing (422). • Inspect for leaking or damaged 4-5-6 piston dam (435).

NO TORQUE CONVERTER CLUTCH APPLY

No Torque Converter Clutch Apply

Checks	Causes
Torque Converter Assembly (27)	<ul style="list-style-type: none">Inspect for damaged Torque Converter Clutch Seal (inside converter assembly).Diagnose Torque Converter Assembly for possible internal damage. Refer to <u>Torque Converter Diagnosis</u>.
Upper Valve Body Assembly (349)	Inspect for worn, damaged or sticking TCC Regulator Apply (330) and TCC Regulator Apply Shuttle (331) Valves.
Transfer Drive Gear Support Assembly (208)	Inspect for worn or damaged Transfer Drive Gear Support Seal (213).
Torque Converter Housing Assembly (221)	Inspect for leaking or damaged Torque Converter Fluid Seal Assembly (225).

NO TORQUE CONVERTER CLUTCH RELEASE

No Torque Converter Clutch Release

Checks	Causes
Torque Converter Assembly (27)	Diagnose Torque Converter Assembly for possible internal damage. Refer to <u>Torque Converter Diagnosis</u> .
Upper Valve Body Assembly (349)	Inspect for worn, damaged or sticking TCC Regulator Apply (330) and TCC Regulator Apply Shuttle (331) Valves.

HARSH TORQUE CONVERTER CLUTCH APPLY, OR INOPERATIVE OR NO ELECTRONICALLY CONTROLLED CAPACITY CLUTCH CONTROL

Harsh Torque Converter Clutch Apply, or Inoperative or No Electronically Controlled Capacity Clutch Control

Checks	Causes
Torque Converter Assembly (27)	<ul style="list-style-type: none">Inspect for leaking or damaged Torque Converter Clutch Hub Seal.Diagnose Torque Converter Assembly for possible internal damage. Refer to <u>Torque Converter Diagnosis</u>.
Drive Gear Support Assembly (208)	Inspect for leaking Drive Gear Support Seal (213).

NO REVERSE GEAR

No Reverse Gear

Checks	Causes
3-5-Reverse Clutch Assembly	<ul style="list-style-type: none">Inspect for damaged, worn or stripped splines on 3-5-Reverse Clutch Plates (423-426), Backing Plate (426)Inspect for sheared or stripped splines on 3-5-Rev/4-5-6

	<p>Housing to Turbine Shaft (422)</p> <ul style="list-style-type: none"> • Inspect for damage, improper surface finish, porosity, deformed or unbalanced 3-5-Rev/4-5-6 Housing (422) • Inspect for damaged, worn, loose or seized hub bushing in the 3-5-Rev/4-5-6 Housing • Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5-Rev/4-5-6 Housing (422) • Inspect for failure of the Input Shaft Thrust Bearing (32) • Inspect for disengaged or broken 3-5-Reverse Clutch Backing Plate Retainer (427) • Inspect for damaged, worn or leaking 3-5-Reverse Clutch Piston Seals (419-421) • Inspect for damaged or broken 3-5-Rev/4-5-6 Clutch Housing (422) • Inspect for warped, damaged, improper surface finish or debonding 3-5-Reverse Clutch Piston (417) • Inspect for broken or fatigued 3-5-Reverse Clutch Spring (418) • Inspect for disengaged or broken Speed Sensor Reluctor Retainer (415) • Inspect for broken Speed Sensor Reluctor Wheel (416) • Inspect for seized Input Shaft Thrust Bearing (32)
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FLUID PRESSURE HIGH OR LOW

Fluid Pressure High or Low

Checks	Causes
Fluid Pump Assembly (203)	<ul style="list-style-type: none"> • Inspect for loose fluid pump bolts (204). • Inspect for leaking or damaged fluid pump outlet seals (57) and oil filter seal (202). • Inspect for improperly installed or damaged oil filter (201). • Inspect for sticking line pressure blow off valve.
Front Differential Drive Gear Support Assembly (208)	<ul style="list-style-type: none"> • Inspect for leaking or damaged drive gear support torque converter seal assembly (206) or fluid passage tube gasket (212). • Inspect for leaking or damaged drive gear support fluid passage tube assembly (209).
Upper Valve Body Assembly (312)	<ul style="list-style-type: none"> • Inspect for leaking or damaged upper valve body assembly (309) gasket. • Inspect for worn, sticking or damaged pressure regulator valve (337) or pressure regulator valve spring (338).

Lower Valve Body Assembly (313)	Inspect for leaking or damaged lower valve body assembly (313) gasket.
Control Valve (w/Body and TCM) Valve Assembly (15)	<ul style="list-style-type: none"> • Inspect for leaking or damaged filter plate assembly seals (16). • Verify VBS operation in not stuck high or low.
Filter Assembly	Inspect for damaged, restricted, or mis-installed fluid filter assembly.
Case Assembly (51)	Inspect for missing lube oil circuit orifice or baffle (229).

Transmission

Automatic Transmission - 6T70 (M7U M7W) - Repair Instructions - Off Vehicle

REPAIR INSTRUCTIONS - OFF VEHICLE

LIFT PLATE AND HOLDING FIXTURE INSTALLATION

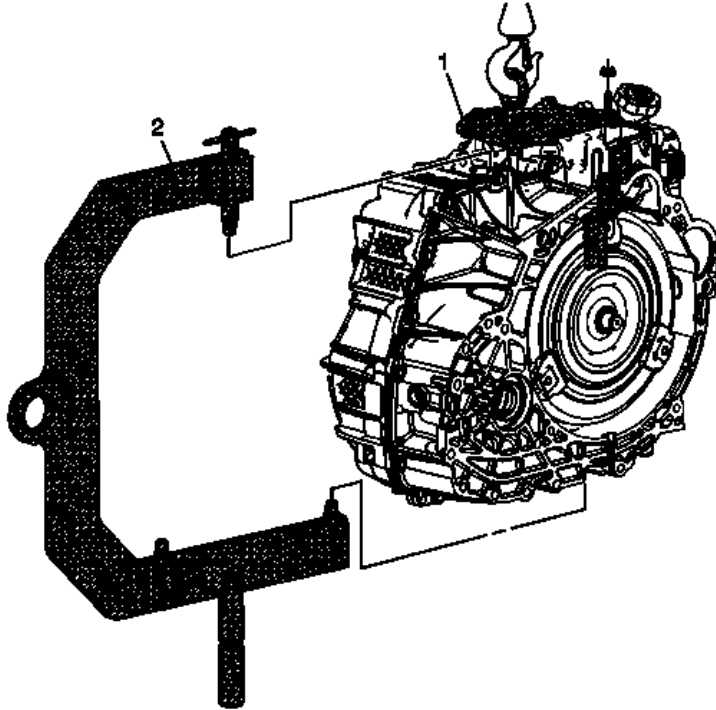


Fig. 1: Identifying Lift Plate & Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

Lift Plate and Holding Fixture Installation

Callout	Component Name
1	<p>DT-47811-A Transmission Lift Plate</p> <p>WARNING: Handle with care, the transmission assembly weighs over 90.7 kg (200 lbs). Bodily injury could occur if not handled properly.</p> <p>NOTE: After Installation of lift plate, raise the transmission with an overhead hoist.</p> <p>Tighten 12 N.m (9 lb ft)</p>

	Special Tools DT-47811-A Transmission Lift Plate For equivalent regional tools, refer to Special Tools .
2	DT-46625 Transmission Holding Fixture CAUTION: Refer to Fastener Caution . NOTE: Adjust mounting block on fixture to match bosses on case, then tighten bolts to: Tighten 13 N.m (10 lb ft) Special Tools DT-46625 Transmission Holding Fixture For equivalent regional tools, refer to Special Tools .

TORQUE CONVERTER REMOVAL

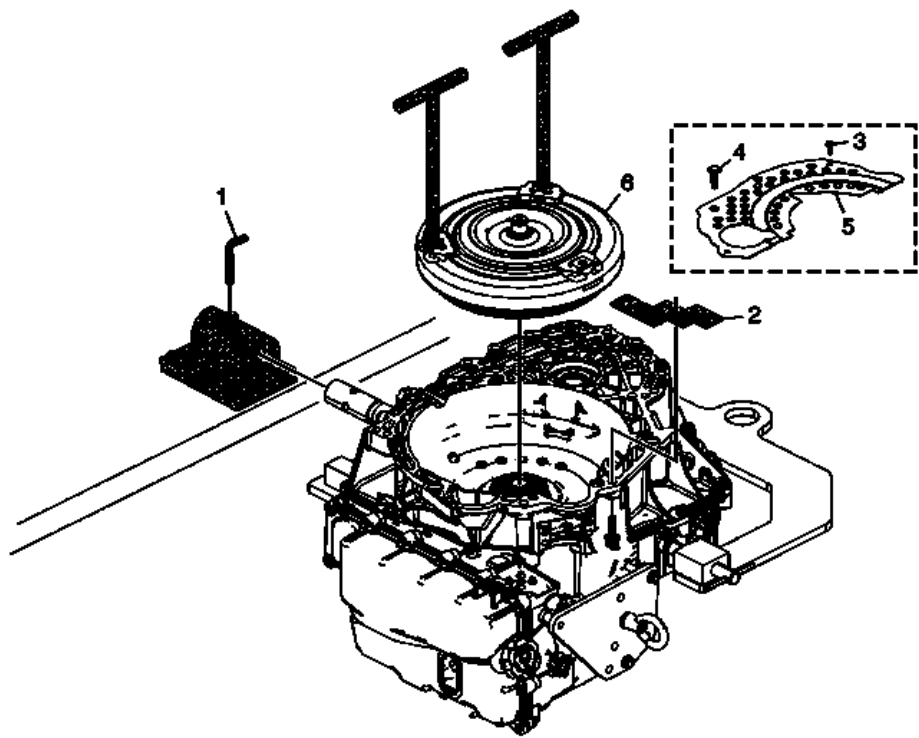


Fig. 2: View Of Torque Converter
Courtesy of GENERAL MOTORS COMPANY

Torque Converter Removal

Callout	Component Name

1	<p>Lock Pin</p> <p>WARNING: Lock pin must be secured into the bench fixture to hold the transmission and prevent bodily injury.</p> <p>NOTE: Ensure the DT 3289-20 holding fixture is mounted to a bench that is properly supported and will support the weight of the transmission assembly without tipping. DT-39890 holding fixture adapter adapter and an engine stand can be used as an alternative method for supporting the transmission assembly during repairs.</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT 3289-20 Holding Fixture • DT-39890 Transmission Holding Fixture Adapter <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	<p>DT 21366 Converter Holding Strap</p> <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>
3	Dust Cover Bolts M10 x 25, model dependent (Qty: 2)
4	Dust Cover Push Pin, model dependent
5	Dust Cover, model dependent
6	<p>Torque Converter Assembly</p> <p>CAUTION: Only install the lift assist handles until it stops. Do not tighten. Over tightening the lift assist handles can cause damage to the torque converter.</p> <p>NOTE: Failure to raise the torque converter straight up could damage the torque converter clutch lip seal inside the torque converter clutch assembly.</p> <p>Special Tools DT 46409 Torque Converter Lifting Handles</p> <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>

CONTROL VALVE BODY ASSEMBLY REMOVAL

Control Valve Body Cover Removal

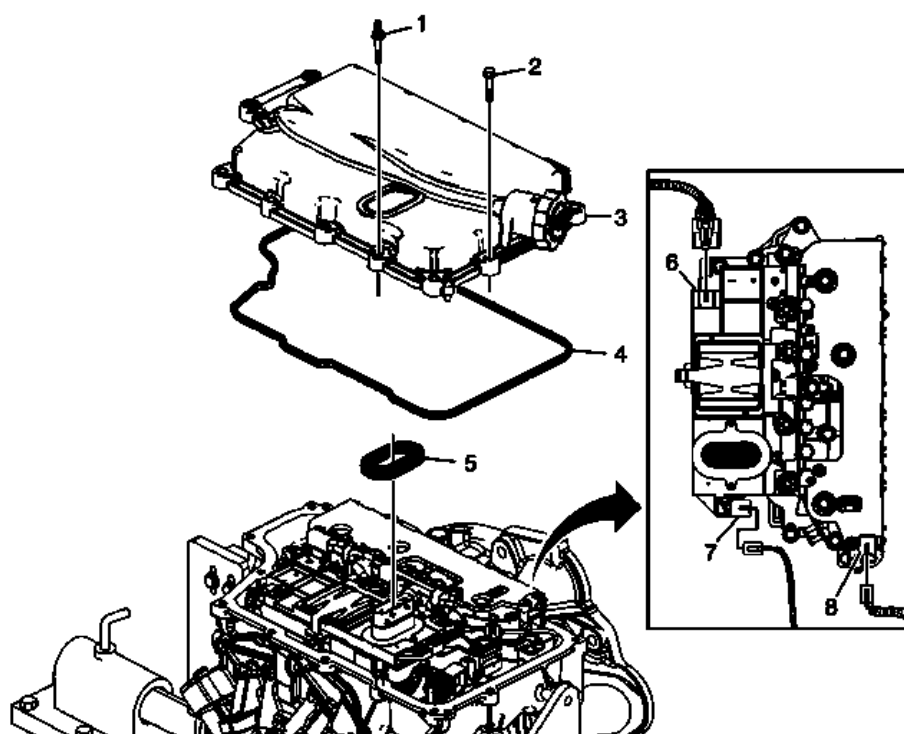


Fig. 3: Control Valve Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Cover Removal

Callout	Component Name
1	Control Valve Body Cover Stud M6 x 30 (Qty: 3)
2	Control Valve Body Cover Bolt M6 x 30 (Qty: 11)
3	Control Valve Body Cover
4	Control Valve Body Cover Gasket NOTE: Do not re-use the valve body cover gasket.
5	Control Valve Body Cover Wiring Connector Hole Seal CAUTION: Support the control solenoid valve assembly around the connector when removing the seal. Excessive pulling force can damage the internal electrical connections.
6	Shift Position Switch Connector
7	Output Speed Sensor Connector
8	Input Speed Sensor Connector

Control Solenoid (w/Body and TCM) Valve Assembly Removal

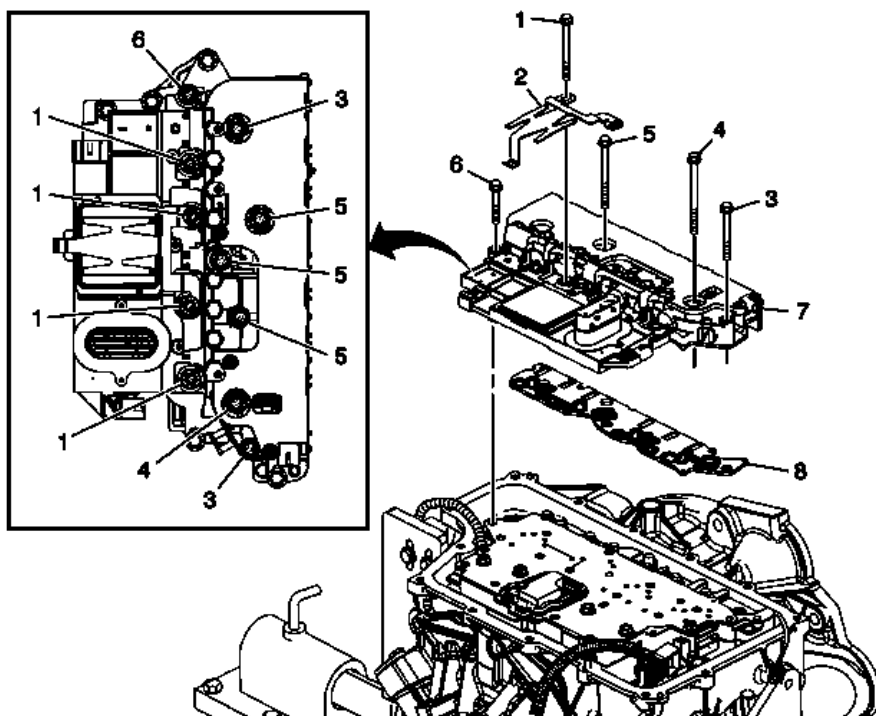


Fig. 4: Control Solenoid (w/Body and TCM) Valve Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Control Solenoid (w/Body and TCM) Valve Assembly Removal

Callout	Component Name
1	Control Valve Body Bolt M6 x 80 (Qty: 4)
2	Control Solenoid Valve Spring
3	Control Valve Body Bolt M6 x 65 (Qty: 2)
4	Control Valve Body Bolt M6 x 42 (Qty: 1)
5	Control Valve Body Bolt M6 x 95 (Qty: 3)
6	Control Valve Body Bolt M6 x 55 (Qty: 1)
7	Control Solenoid (w/Body and TCM) Valve Assembly
8	<p>Control Solenoid Valve Assembly Filter Plate</p> <p>CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.</p> <p>NOTE: Discard the filter plate, it is not reusable.</p>

Control Valve Body Assembly and Output Speed Sensor Removal

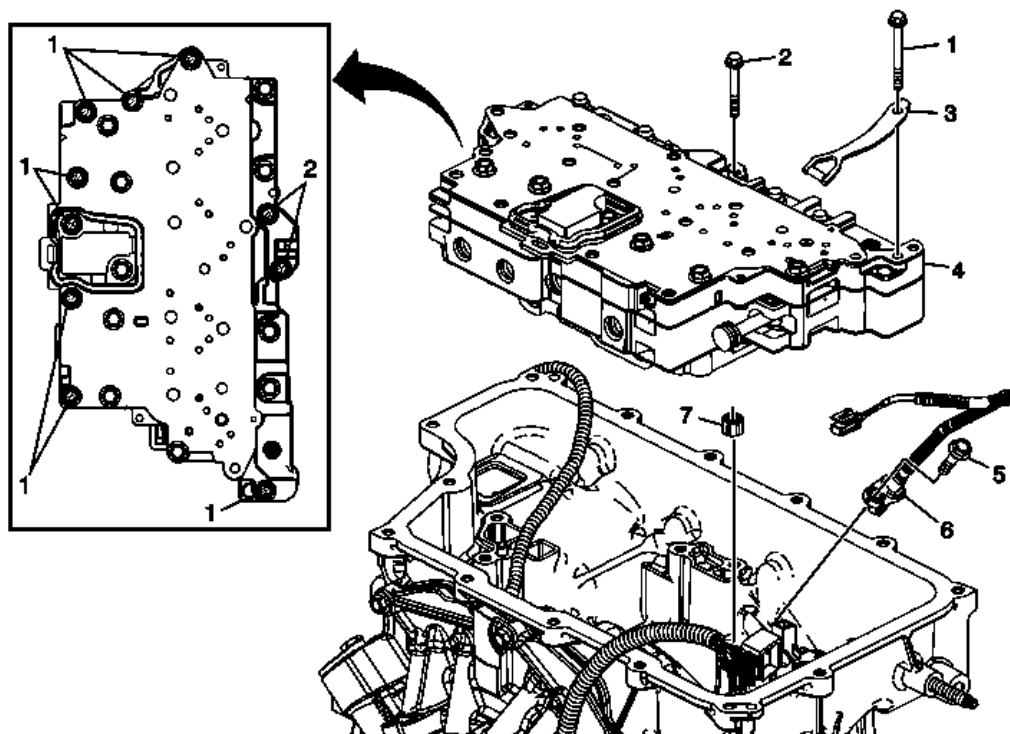


Fig. 5: Control Valve Body Assembly and Output Speed Sensor Components
 Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Assembly and Output Speed Sensor Removal

Callout	Component Name
1	Control Valve Body Bolt M6 x 65 (Qty: 8)
2	Control Valve Body Bolt M6 x 55 (Qty: 2)
3	Manual Shaft Detent Assembly
4	Control Valve Body Assembly
5	A/Trans Output Speed Sensor Bolt M6 x 25
6	A/Trans Output Speed Sensor
7	1-2-3-4 Clutch Fluid Passage Seal NOTE: The seal is not reusable.

CASE COVER AND 3-5-REVERSE AND 4-5-6 CLUTCH HOUSING REMOVAL

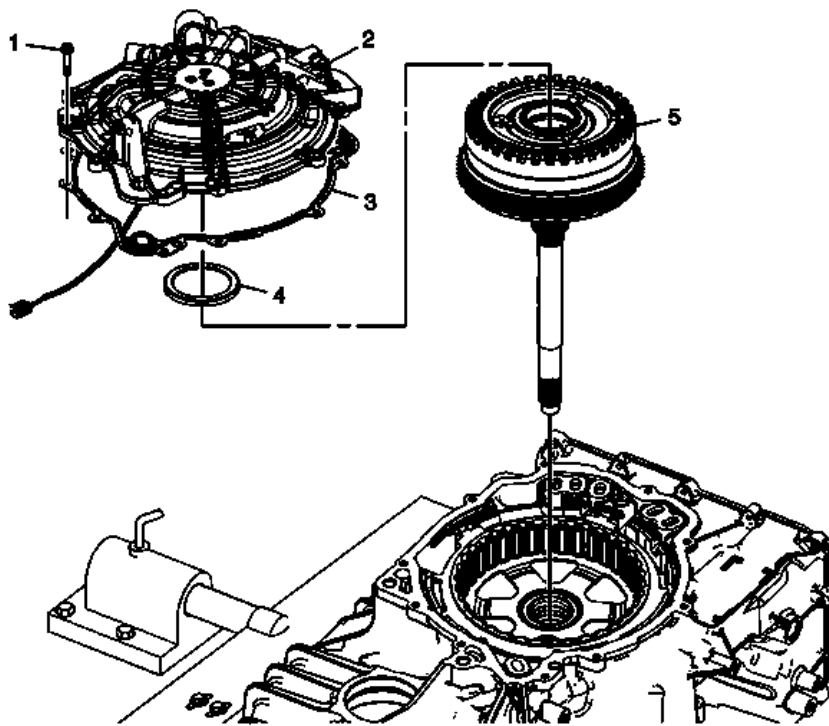


Fig. 6: Identifying Case Cover, 3-5-Reverse & 4-5-6 Clutch Housing
 Courtesy of GENERAL MOTORS COMPANY

Case Cover and 3-5-Reverse and 4-5-6 Clutch Housing Removal

Callout	Component Name
1	A/Trans Case Cover Assembly Bolt M6 x 30 (Qty: 10)
2	A/Trans Case Cover Assembly CAUTION: Use care when pulling the input speed sensor wire harness through the case to avoid damaging the harness.
3	A/Trans Case Cover Gasket NOTE: The gasket is not reusable.
4	Input Shaft Thrust Bearing Assembly NOTE: The bearing may be stuck to the case cover.
5	3-5 Rev/4-5-6 Clutch Housing Assembly

REACTION CARRIER HUB AND 2-6 CLUTCH PLATE REMOVAL

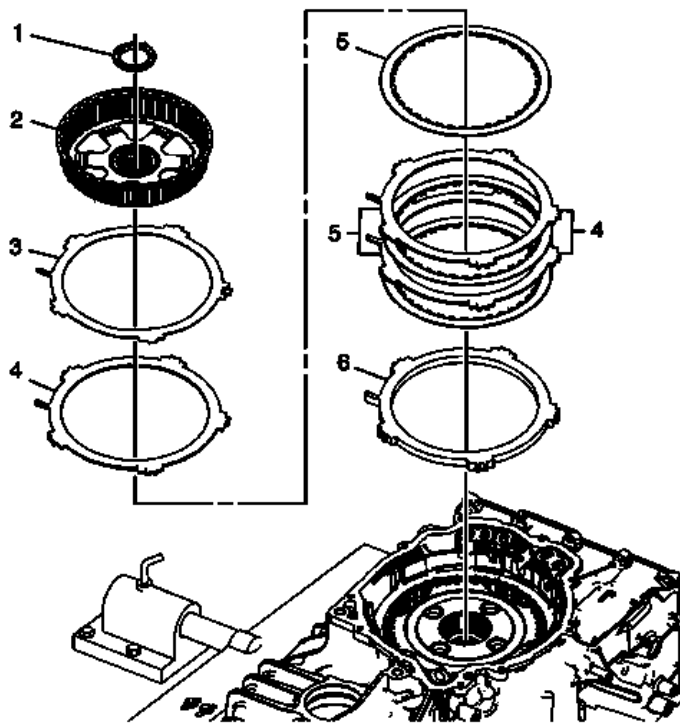


Fig. 7: Identifying Reaction Carrier Hub & 2-6 Clutch Plate
 Courtesy of GENERAL MOTORS COMPANY

Reaction Carrier Hub and 2-6 Clutch Plate Removal

Callout	Component Name
1	2-6 Clutch Hub Thrust Bearing Assembly NOTE: The 2-6 clutch hub thrust bearing assembly may be stuck to the reaction carrier hub assembly.
2	Reaction Sun Gear Assembly
3	2-6 Clutch Cushion Spring
4	2-6 Clutch Plate (Qty: 3)
5	2-6 Clutch (w/Friction Material) Plate Assembly (Qty: 3)
6	2-6 Clutch Backing Plate

INPUT, REACTION, AND OUTPUT CARRIER REMOVAL

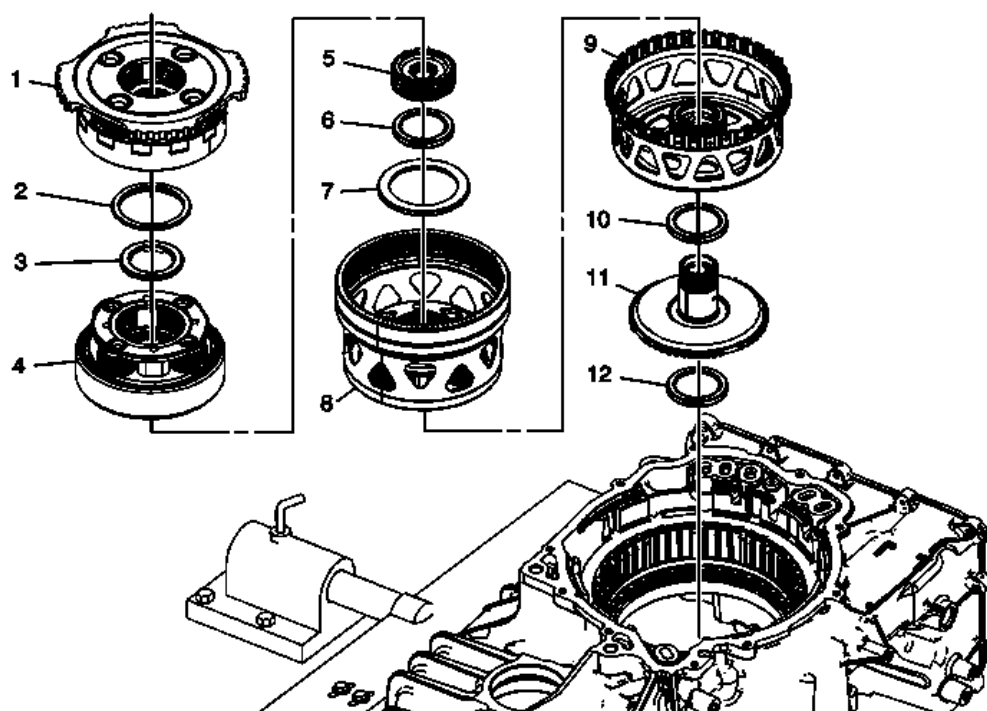


Fig. 8: View Of Input, Reaction & Output Carriers
 Courtesy of GENERAL MOTORS COMPANY

Input, Reaction, and Output Carrier Removal

Callout	Component Name
1	Reaction (w/Input Internal Gear) Carrier Assembly
2	Input Carrier Thrust Bearing Assembly
3	Input Sun Gear Thrust Bearing Assembly
4	Input (w/Output Internal Gear) Carrier Assembly
5	Input Sun Gear
6	Output Carrier Thrust Bearing Assembly
7	Output Carrier Thrust Bearing Assembly
8	Output Carrier Assembly
9	Output Sun Gear Assembly
10	Front Differential Transfer Drive Gear Input Hub Bearing Assembly
11	Output Carrier Transfer Drive Gear Hub Assembly
12	Output Carrier Transfer Drive Gear Hub Bearing Assembly
	NOTE: The bearing may be stuck to the support assembly.

LOW AND REVERSE CLUTCH PLATE REMOVAL

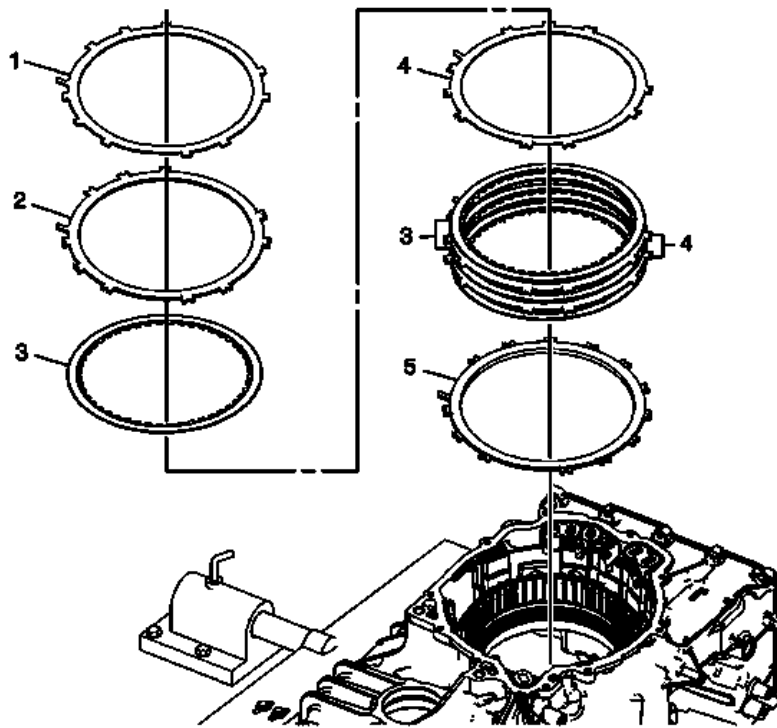


Fig. 9: Identifying Low & Reverse Clutch Plate
 Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Plate Removal

Callout	Component Name
1	Low and Reverse Clutch Cushion (Waved) Spring
2	Low and Reverse Clutch Apply Plate
3	Low and Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 4)
4	Low and Reverse Clutch Plate (Qty: 3)
5	Low and Reverse Clutch Backing Plate

LOW AND REVERSE CLUTCH AND 1-2-3-4 CLUTCH PLATE REMOVAL

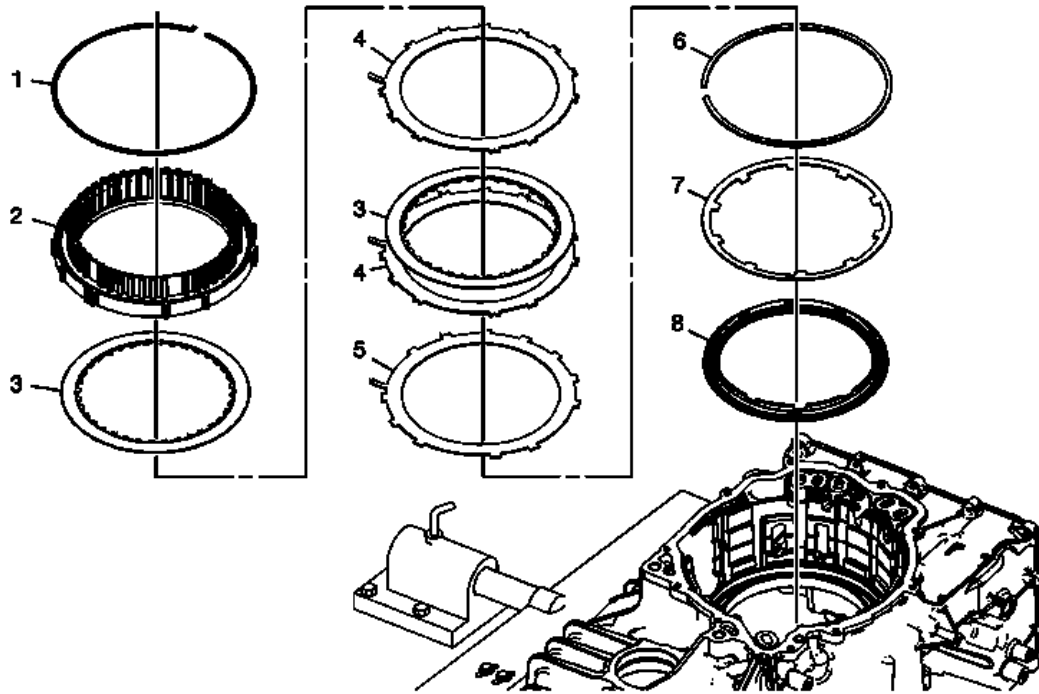


Fig. 10: Identifying Low, Reverse Clutch & 1-2-3-4 Clutch Plates
 Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch and 1-2-3-4 Clutch Plate Removal

Callout	Component Name
1	Low and Reverse Clutch Retainer Ring
2	Low and Reverse Clutch Assembly
3	1-2-3-4 Clutch (w/Friction Material) Plate Assembly (Qty: 2)
4	1-2-3-4 Clutch Plate (Qty: 2)
5	1-2-3-4 Clutch (Waved) Plate
6	1-2-3-4 Clutch Spring Retainer Ring
7	1-2-3-4 Clutch Spring
8	1-2-3-4 Clutch Piston
	NOTE: <ul style="list-style-type: none"> • Use pliers to remove the piston. • Inspect the piston seals for damage and/or wear. The piston is reusable.

TORQUE CONVERTER AND DIFFERENTIAL HOUSING, FRONT DIFFERENTIAL TRANSFER DRIVE GEAR, AND FRONT DIFFERENTIAL CARRIER REMOVAL

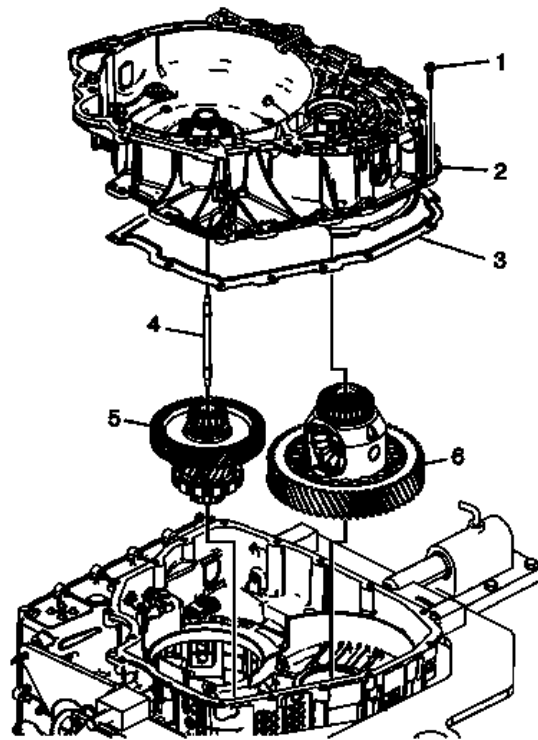


Fig. 11: Identifying Torque Converter, Differential Housing, Front Differential Transfer Drive Gear & Front Differential Carrier

Courtesy of GENERAL MOTORS COMPANY

Torque Converter and Differential Housing, Front Differential Transfer Drive Gear, and Front Differential Carrier Removal

Callout	Component Name
1	Torque Converter and Differential Housing Bolt M8 x 35 (Qty: 17)
2	Torque Converter, Support and A/Trans Fluid Pump Housing Assembly
3	Torque Converter Housing Outer Seal NOTE: The seal is not reusable.
4	Front Differential Drive Pinion Gear Lube Tube
5	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly
6	Front Differential Carrier Assembly

FLUID TROUGH REMOVAL

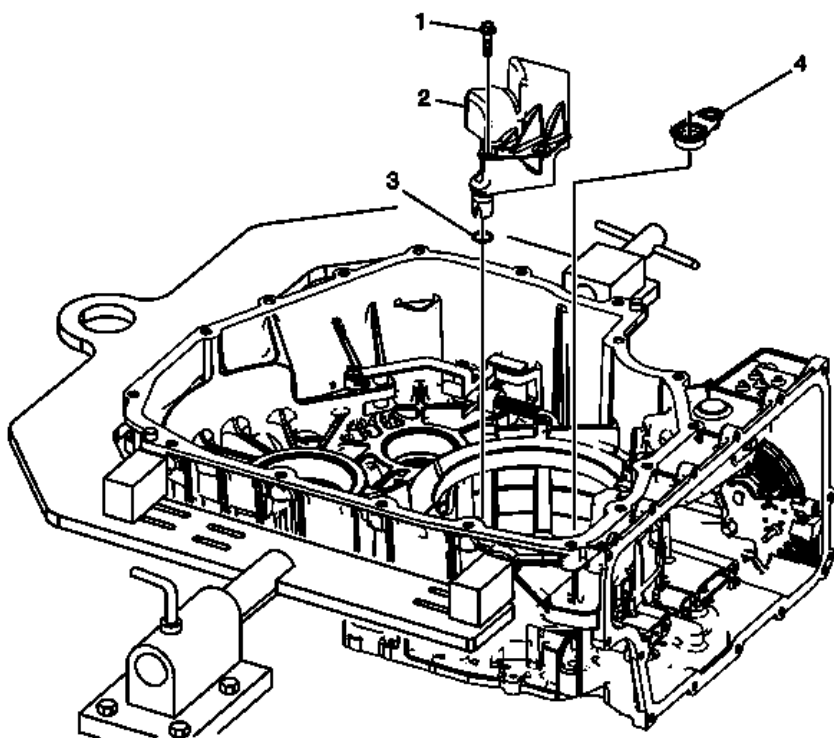


Fig. 12: Identifying Fluid Trough
 Courtesy of GENERAL MOTORS COMPANY

Fluid Trough Removal

Callout	Component Name
1	A/Trans Fluid Trough Bolt M6 x 25 (Qty: 1)
2	A/Trans Fluid Trough
3	A/Trans Fluid Trough (O-Ring) Seal
4	A/Trans Fluid Pump Outlet Seal Assembly NOTE: The seal assembly is not reusable.

MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY AND PARK PAWL ACTUATOR REMOVAL

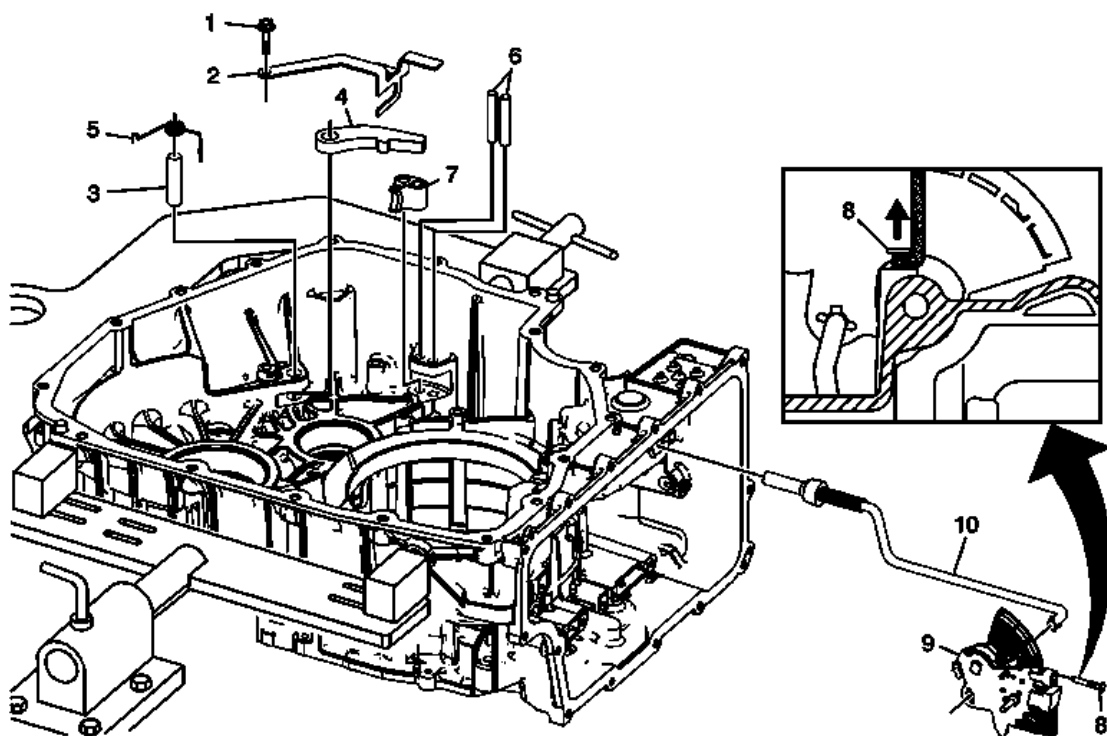


Fig. 13: Identifying Manual Shift Detent Lever With Shaft Position Switch Assembly & Park Pawl Actuator

Courtesy of GENERAL MOTORS COMPANY

Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Removal

Callout	Component Name
1	Park Pawl Actuator Bracket Bolt M6 x 25 (Qty: 2)
2	Park Pawl Actuator Bracket
3	Park Pawl Shaft
4	Park Pawl
5	Park Pawl Spring
6	Park Pawl Actuator Guide Pin
7	Park Pawl Actuator Guide
8	Manual Shift Detent Lever Pin NOTE: <ul style="list-style-type: none">• Use a small nail puller or other suitable tool.• Discard the pin. The pin is not reusable. Special Tools <ul style="list-style-type: none">• DT 23129 Universal Seal Remover• GE 6125-1B Slide Hammer with Adapter

	For equivalent regional tools, refer to Special Tools .
9	Manual Shaft Detent (w/Shift Position Switch) Lever Assembly NOTE: Rotate the assembly counterclockwise so the actuator rod will fit through the case opening.
10	Park Pawl Actuator Assembly

MANUAL SHIFT SHAFT SEAL REPLACEMENT

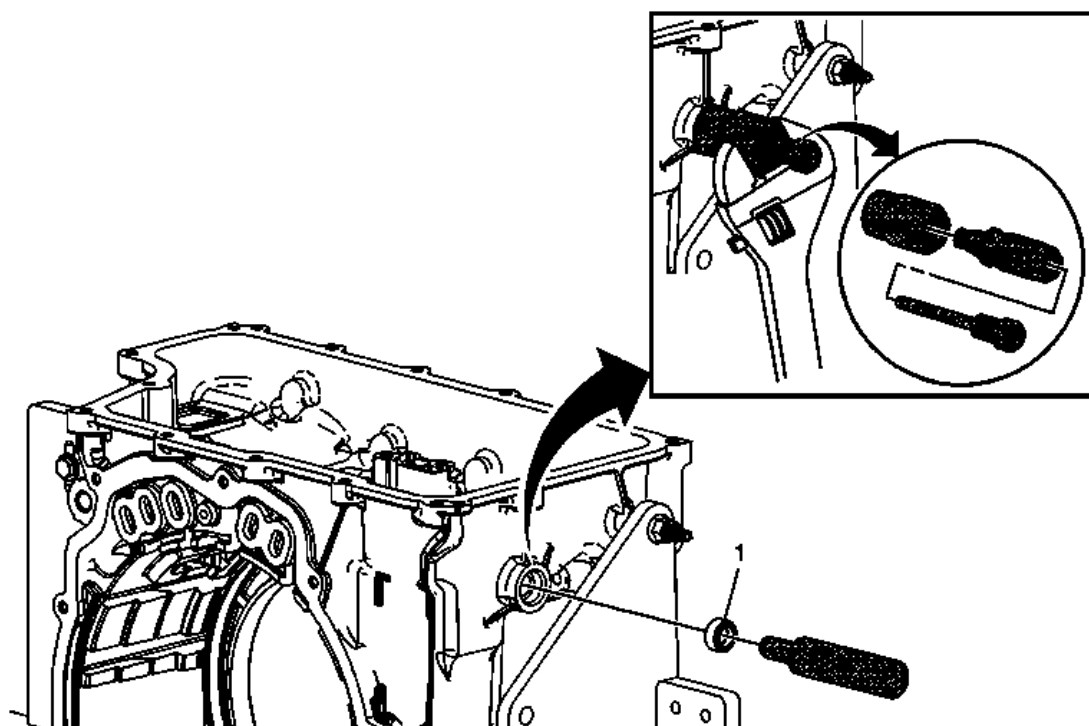


Fig. 14: Identifying Manual Shift Shaft Seal
Courtesy of GENERAL MOTORS COMPANY

Manual Shift Shaft Seal Replacement

Callout	Component Name
1	Manual Shift Shaft Seal Special Tools <ul style="list-style-type: none"> • DT 45201 Cooler Line Seal Remover • DT 46626 Seal Installer For equivalent regional tools, refer to Special Tools .

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - CASE SIDE

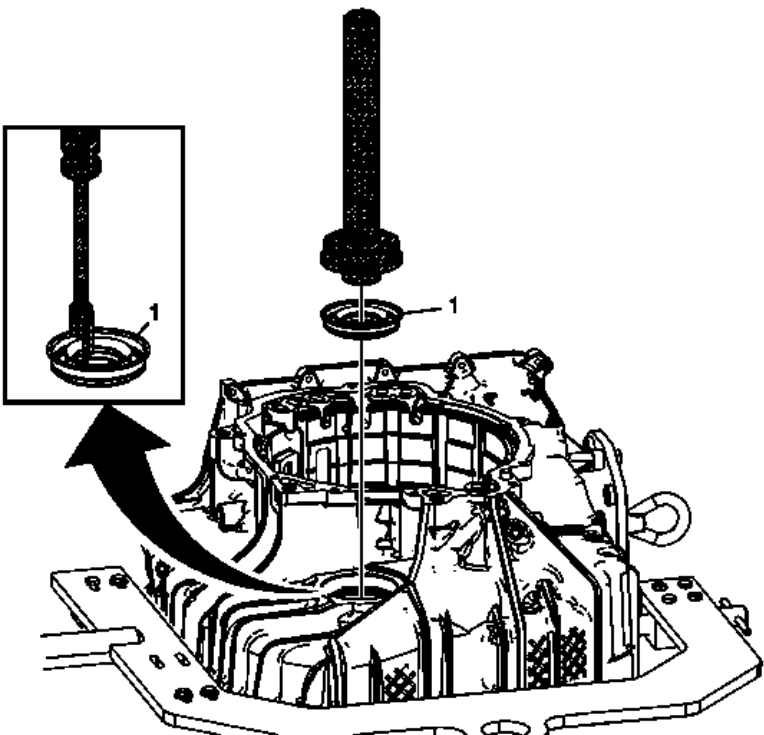


Fig. 15: Front Wheel Drive Shaft Seal - Case Side
Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Case Side

Callout	Component Name
1	<p>Front Wheel Drive Shaft Oil Seal Assemble</p> <p>NOTE: Use the flat side of J 46629-A seal installer to seat the seal to the case surface.</p> <p>Special Tools</p> <ul style="list-style-type: none">• DT 23129 Universal Seal Remover• DT 46629-A Seal Installer• GE 6125-1B Slide Hammer• GE 8092 Driver Handle <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>

FRONT DIFFERENTIAL CARRIER BEARING CUP REPLACEMENT - CASE SIDE

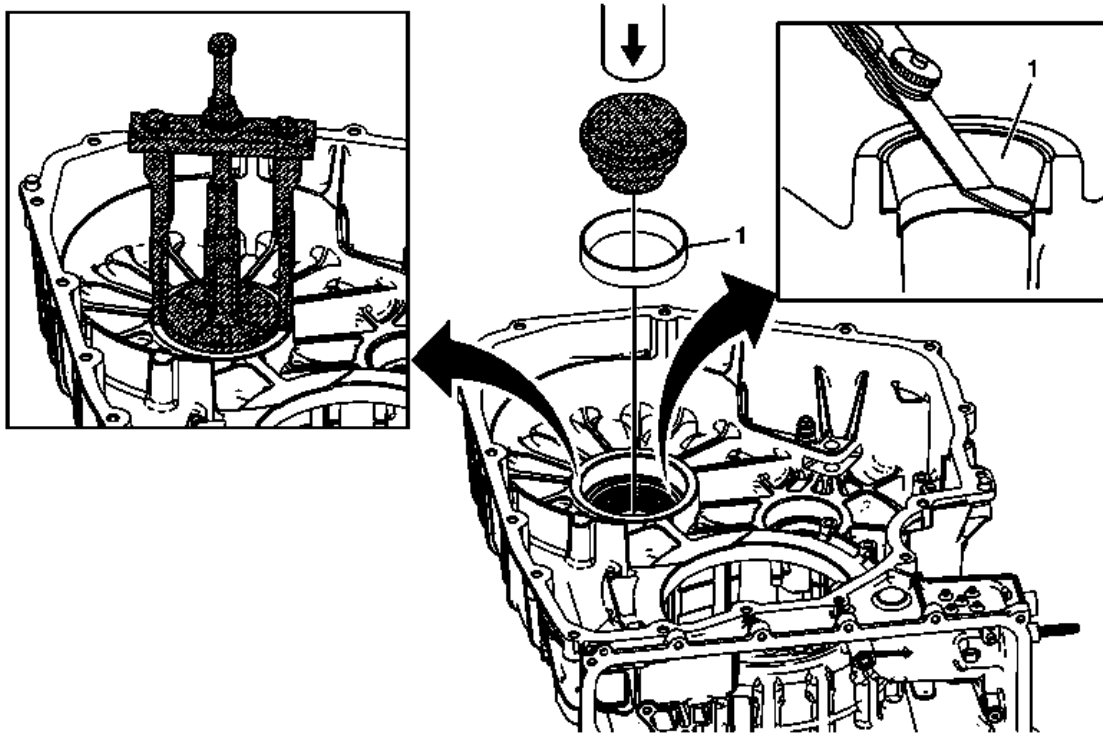


Fig. 16: Front Differential Carrier Bearing Cup - Case Side
 Courtesy of GENERAL MOTORS COMPANY

Front Differential Carrier Bearing Cup Replacement - Case Side

Callout	Component Name
	<p>Front Differential Bearing Cup</p> <p>CAUTION: Support the back side of the case before installing the bearing cup. Apply a light coating of transmission fluid to the bore before pressing the cup into position. Install the bearing cup until it stops moving. Applying excessive pressure to the bearing cup once it is seated could cause damage to the case casting.</p> <p>CAUTION: An unseated or improperly installed bearing cup will result in premature bearing failure. Visually inspect the bearing cup to insure there is "no gap" between the case, thrust washer, and the bearing cup. Use of a feeler gauge may assist in identifying a bearing cup that is not fully seated.</p> <p>CAUTION: Failure to apply the lubricant will cause damage to the bolt and nut threads.</p> <p>CAUTION: There are first and second design front differential bearing cups. First design bearing cups are manufactured by Timken. Second design bearing cups are manufactured by NSK. Second design bearing cups require DT-45087-A cup installer. If installing second</p>

design bearing cups, second design front differential carrier bearings must be used. All four parts must be kept as a set to prevent damage to the transmission.

NOTE:

- Tighten DT-47927-2 which is part of DT-47927 cup remover until it fits snugly on the bearing cup.
- Adjust DT 45124 removal bridge so it sits on the torque converter housing surface just beyond the bearing cup opening.
- Apply the extreme pressure lubricant DT 23444-A extreme press lubricant to the puller bolt threads to prevent damage to the bolt threads during bearing cup removal.
- Hold the puller bridge bolt and turn the nut to remove the bearing cup.

1

Special Tools

- **DT 23444-A** Extreme Press Lubricant - 1/4 Ounce Tube
- **DT-45087** Bearing Cup Installer
- **DT-45087-A** Bearing Cup Installer
- **DT 45124** Removal Bridge
- **DT-47927** Bearing Cup Remover

For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL DRIVE PINION GEAR BEARING CUP AND LUBRICANT DAM REPLACEMENT

Removal

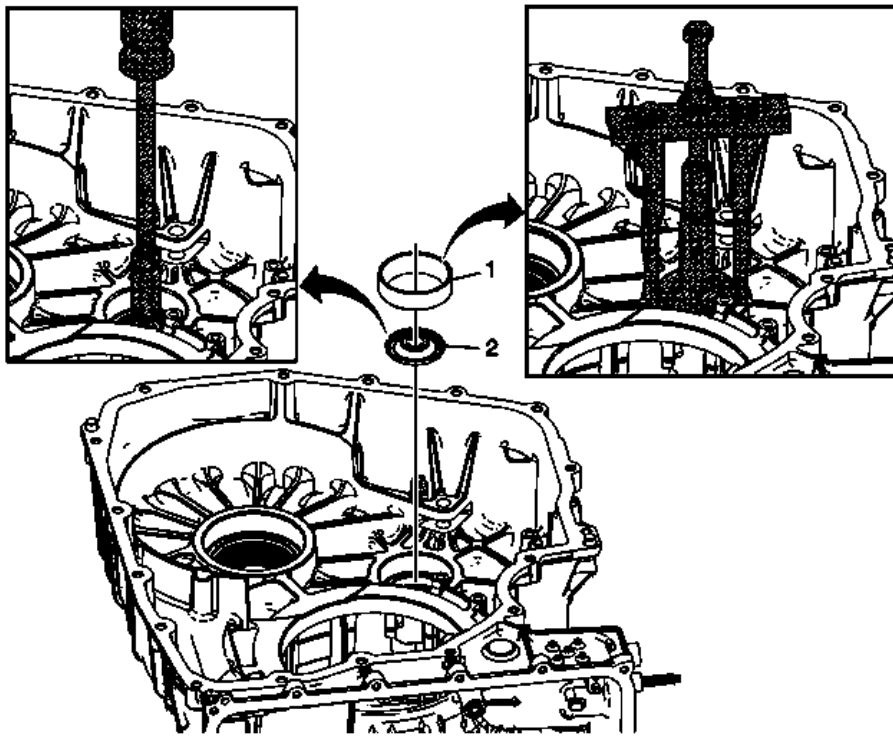


Fig. 17: Identifying Front Differential Drive Pinion Gear Bearing Cup & Lube Dam
 Courtesy of GENERAL MOTORS COMPANY

Removal

Callout	Component Name
1	<p>Front Differential Drive Pinion Gear Bearing Cup</p> <p>CAUTION: Failure to apply the lubricant will cause damage to the bolt and nut threads.</p> <p>NOTE:</p> <ul style="list-style-type: none"> • Tighten DT-45094 cup remover until it fits snugly on the bearing cup. • Adjust DT 45124 removal bridge so it sits on the case surface just beyond the bearing cup opening. • Apply the extreme pressure lubricant DT 23444-A extreme press lubricant to the puller bolt threads to prevent damage to the bolt threads during bearing cup removal. • Hold the puller bridge nut and turn the bolt to remove the bearing cup. <p>Special Tools</p> <ul style="list-style-type: none"> • DT 23444-A Extreme Press Lubricant - 1/4 Ounce Tube • DT-45094 Bearing Cup Remover • DT 45124 Removal Bridge

	For equivalent regional tools, refer to Special Tools .
2	<p>Front Differential Drive Pinion Gear Lube Dam</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-48055 Lube Dam Removal • GE 6125-1B Slide Hammer with Adapter <p>For equivalent regional tools, refer to Special Tools .</p>

Installation

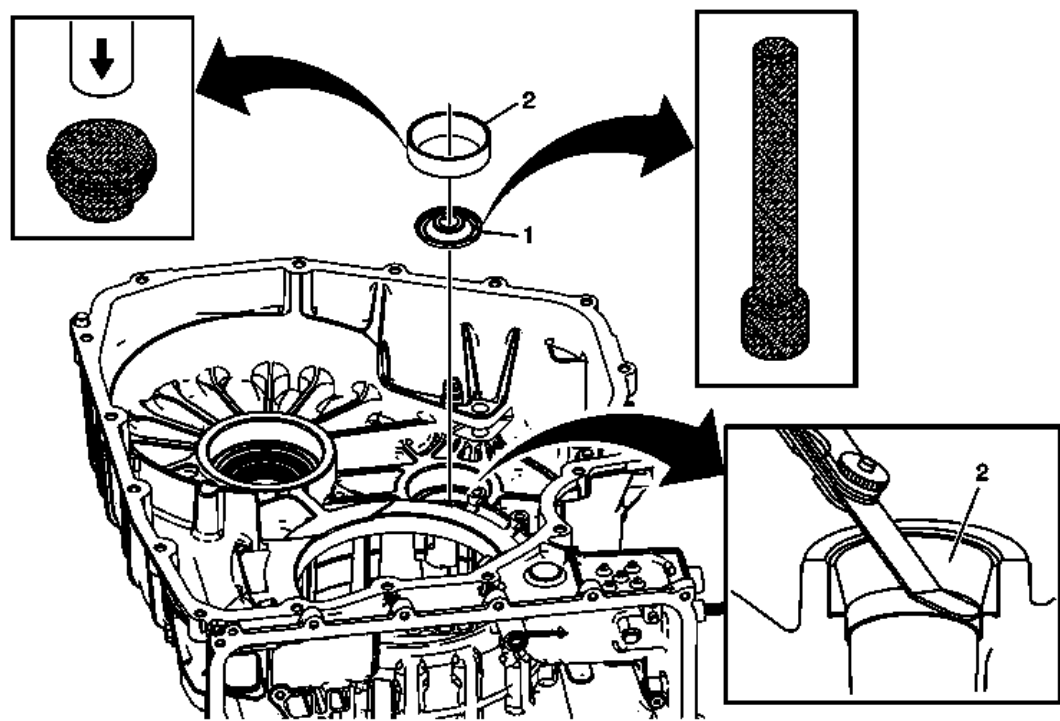


Fig. 18: View Of Front Differential Drive Pinion Gear Bearing Cup & Lube Dam
 Courtesy of GENERAL MOTORS COMPANY

Installation

Callout	Component Name
1	<p>Front Differential Drive Pinion Gear Lube Dam</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-46630 Lube Dam Installer • GE 8092 Driver Handle

	For equivalent regional tools, refer to <u>Special Tools</u> .
2	<p>Front Differential Drive Pinion Gear Bearing Cup</p> <p>CAUTION: Support the back side of the case before installing the bearing cup. Apply a light coating of transmission fluid to the bore before pressing the cup into position. Install the bearing cup until it stops moving. Applying excessive pressure to the bearing cup once it is seated could cause damage to the case casting.</p> <p>CAUTION: An unseated or improperly installed bearing cup will result in premature bearing failure. Visually inspect the bearing cup to insure there is "no gap" between the case, thrust washer, and the bearing cup. Use of a feeler gauge may assist in identifying a bearing cup that is not fully seated.</p> <p>Special Tools DT-45087 Bearing Cup Installer For equivalent regional tools, refer to <u>Special Tools</u> .</p>

TRANSMISSION CASE CLEANING AND INSPECTION

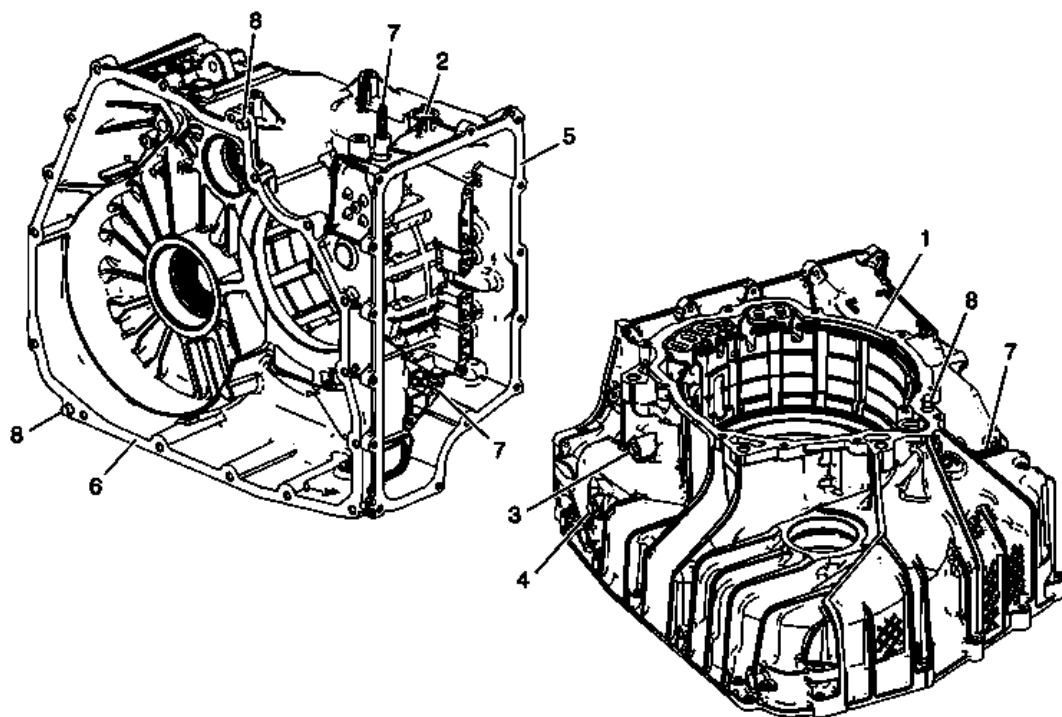


Fig. 19: Identifying Transmission Case Components
Courtesy of GENERAL MOTORS COMPANY

Transmission Case Cleaning and Inspection

Callout	Component Name
<p>CAUTION: Do not use abrasive pads or bristle devices to clean the sealing surfaces. Abrasive pads produce a fine grit that can effect transmission function. Abrasive pads can also remove enough metal to create oil leaks.</p> <p>CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.</p> <p>CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none"> 1. Thoroughly clean the transmission case assembly, including case threads, with clean solvent. 2. Clean gasket sealing surfaces. Remove all residual gasket material. 3. Inspect all threaded holes. If necessary, repair any thread damage. 	
1	Case Cover Sealing Surface
2	Manual Shift Shaft Seal Surface NOTE: Refer to <u>Manual Shift Shaft Seal Replacement</u>.
3	Fluid Pressure Test Plug
4	Fluid Drain Plug
5	Control Valve Body Cover Sealing Surface
6	Torque Converter Housing Sealing Surface
7	Transmission Fluid Cooler Pipe Stud M8 x 30.5 (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)
8	Transmission Case Cover Locator Pin Procedure Inspect the locating pins to be fully seated in case.

MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY AND PARK PAWL ACTUATOR INSTALLATION

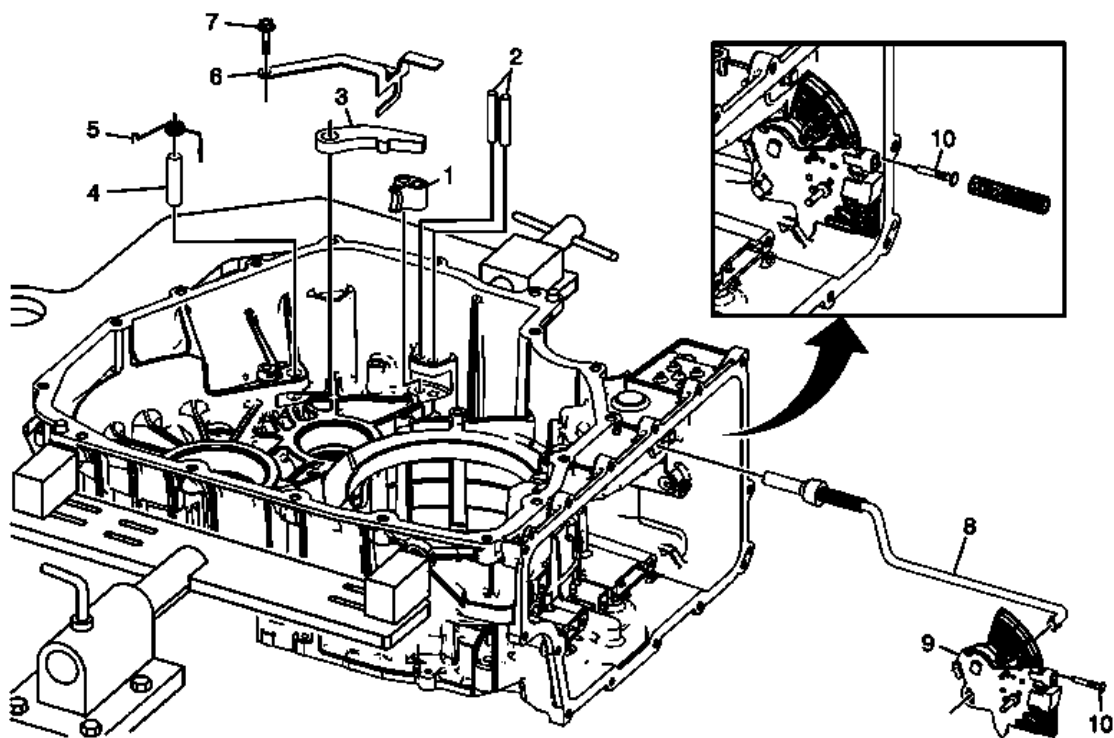


Fig. 20: Identifying Manual Shift Detent Lever With Shaft Position Switch Assembly & Park Pawl Actuator

Courtesy of GENERAL MOTORS COMPANY

Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Installation

Callout	Component Name
1	Park Pawl Actuator Guide
2	Park Pawl Actuator Guide Pin
3	Park Pawl
4	Park Pawl Shaft
5	Park Pawl Spring
6	Park Pawl Actuator Bracket
7	Park Pawl Actuator Bracket Bolt M6 x 25 (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in).
8	Park Pawl Actuator Assembly NOTE: Install the park pawl actuator assembly onto the detent lever assembly.

9	<p>Manual Shaft Detent (w/Shift Position Switch) Lever Assembly</p> <p>NOTE:</p> <ul style="list-style-type: none"> • Rotate the assembly clockwise so the actuator rod will fit through the case opening. • Lubricate shaft with ATF to prevent damage to the manual shift shaft seal.
10	<p>Manual Shift Shaft Pin</p> <p>CAUTION: Use J 41229 to install the manual shaft pin at the correct height in order to properly secure the manual shaft. If you install the pin too deep, the case bore may crack.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Use a NEW pin to ensure proper engagement to the case. 2. Inspect pin installed height is within 6.5-7.5 mm (0.25-0.30 in). <p>Special Tools DT 41229 Manual Shaft Pin Installer For equivalent regional tools, refer to Special Tools .</p>

FLUID TROUGH INSTALLATION

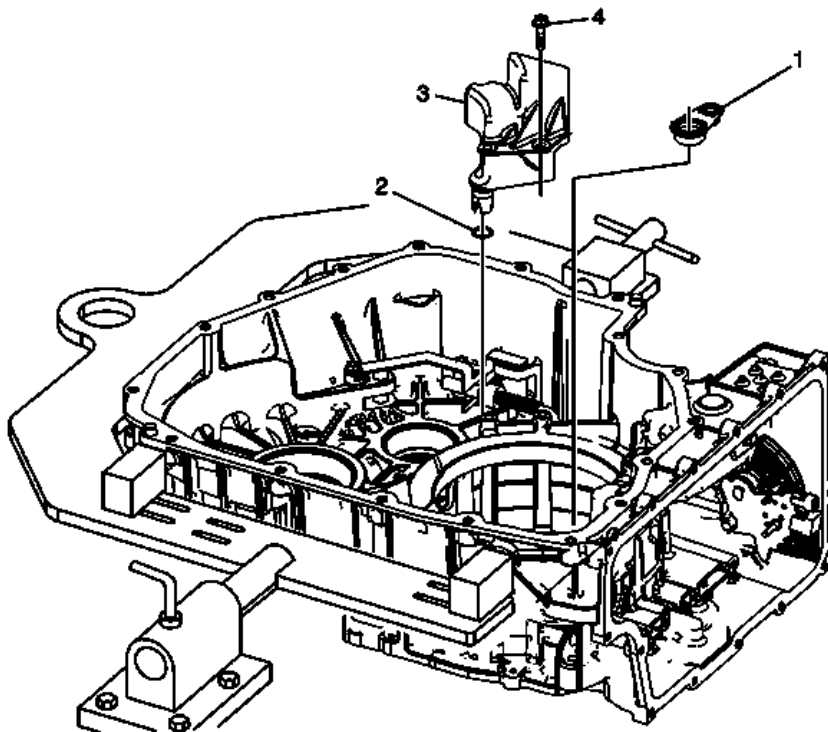


Fig. 21: Fluid Trough

Courtesy of GENERAL MOTORS COMPANY

Fluid Trough Installation

Callout	Component Name
1	A/Trans Fluid Pump Outlet Seal Assembly
2	A/Trans Fluid Trough (O-ring) Seal
3	A/Trans Fluid Trough
4	A/Trans Fluid Trough Bolt M6 x 25 (Qty: 1) CAUTION: Refer to Fastener Caution . Tighten 12 N.m (106 lb in).

TORQUE CONVERTER AND DIFFERENTIAL HOUSING ASSEMBLY DISASSEMBLE

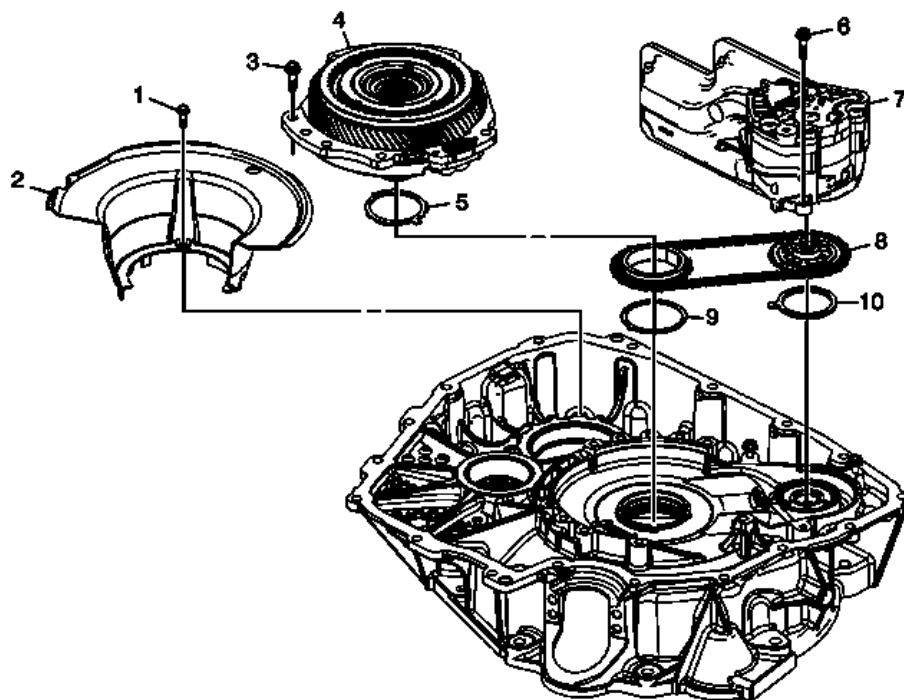


Fig. 22: Identifying Torque Converter & Differential Housing Assembly Components

Courtesy of GENERAL MOTORS COMPANY

Torque Converter and Differential Housing Assembly Disassemble

Callout	Component Name
1	Front Differential Carrier Baffle Bolt M6 x 25
2	Front Differential Carrier Baffle

3	Front Differential Transfer Drive Gear Support Bolt M8 x 25 (Qty: 9)
4	Front Differential Transfer Drive Gear Support Assembly
5	Drive Sprocket Thrust Washer
6	A/Trans Fluid Pump Bolt M6 x 25 (Qty: 3)
7	A/Trans Fluid Pump Assembly
8	Drive Link Assembly NOTE: Link and sprockets will be removed as an assembly.
9	Drive Sprocket Thrust Washer NOTE: Drive sprocket thrust washer may be stuck to the torque converter housing.
10	Driven Sprocket Thrust Washer

FRONT DIFFERENTIAL CARRIER BEARING CUP AND WASHER REPLACEMENT - TORQUE CONVERTER HOUSING SIDE

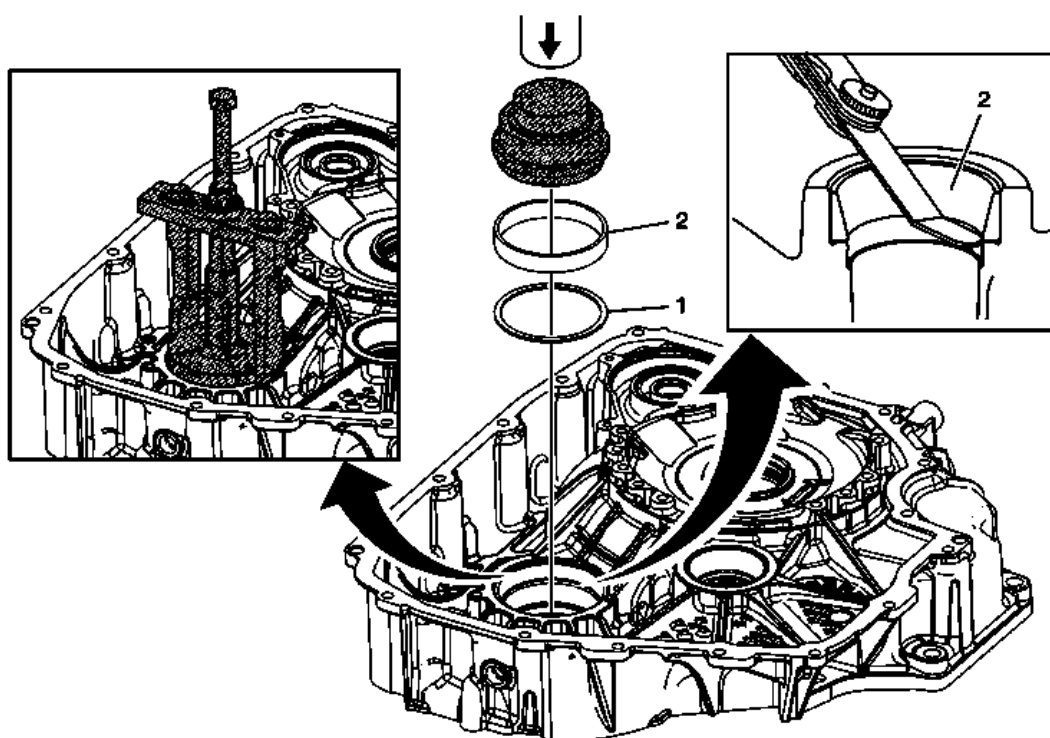


Fig. 23: Front Differential Carrier Bearing Cup & Washer - Torque Converter Housing Side
 Courtesy of GENERAL MOTORS COMPANY

Front Differential Carrier Bearing Cup and Washer Replacement - Torque Converter Housing Side

Callout	Component Name
Preliminary Procedures	

- Do not install the bearing cup until after the selective washer measurement has been performed.
- Install the correct differential bearing washer as determined by the thrust washer measurement procedure. Refer to **Front Differential Drive Pinion Gear Bearing Thrust Washer and Front Differential Bearing Washer Measurement.**

1 Front Differential Bearing Thrust Washer

Front Differential Carrier Bearing Cup

CAUTION:

Support the back side of the torque converter housing before installing the bearing cup. Apply a light coating of transmission fluid to the bore before pressing the cup into position. Install the bearing cup until it stops moving. Applying excessive pressure to the bearing cup once it is seated could cause damage to the torque converter housing casting.

CAUTION:

An unseated or improperly installed bearing cup will result in premature bearing failure. Visually inspect the bearing cup to insure there is "no gap" between the converter housing, thrust washer, and the bearing cup. Use of a feeler gauge may assist in identifying a bearing cup that is not fully seated.

CAUTION:

Failure to apply the lubricant will cause damage to the bolt and nut threads.

CAUTION:

There are first and second design front differential bearing cups. First design bearing cups are manufactured by Timken. Second design bearing cups are manufactured by NSK. Second design bearing cups require DT-45087-A cup installer. If installing second design bearing cups, second design front differential carrier bearings must be used. All four parts must be kept as a set to prevent damage to the transmission.

2

Procedure

1. Tighten DT 47927-1 which is part of **DT-47927** bearing cup remover until it fits snugly on the bearing cup.
2. Adjust **DT 45124** remover bridge so it sits on the torque converter housing surface just beyond the bearing cup opening.
3. Apply the extreme pressure lubricant supplied with **DT 23444-A** extreme press lubricant to the puller bolt threads to prevent damage to the bolt threads during bearing cup removal.
4. Hold the puller bridge bolt and turn the nut to remove the bearing cup.

Special Tools

- **DT 23444-A** Extreme Press Lubricant - 1/4 Ounce Tube
- **DT-45087** Bearing Cup Installer

- DT-45087-A Bearing Cup Installer
- DT 45124 Remover Bridge
- DT-47927 Bearing Cup Remover

For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL DRIVE PINION BEARING CUP, WASHER, AND LUBRICANT DAM REPLACEMENT - TORQUE CONVERTER HOUSING SIDE

Bearing Cup, Washer and Lubricant Dam Removal

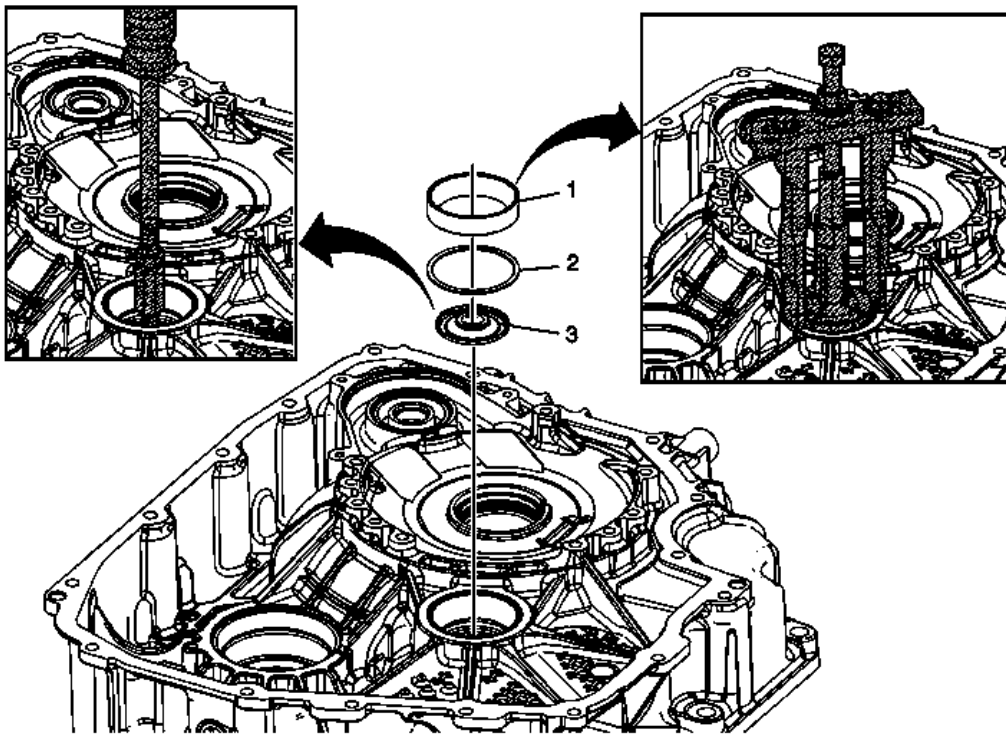


Fig. 24: Front Differential Drive Pinion Bearing Cup, Washer & Lubricant Dam - Torque Converter Housing Side

Courtesy of GENERAL MOTORS COMPANY

Bearing Cup, Washer and Lubricant Dam Removal

Callout	Component Name
Preliminary Procedure	
Do not install the bearing cup until after the selective washer measurement has been performed.	
	Front Differential Drive Pinion Gear Bearing Cup
	CAUTION: Failure to apply the lubricant will cause damage to the bolt and nut threads.

	<p>Procedure</p> <ol style="list-style-type: none"> 1. Tighten DT-45094 bearing cup remover until it fits snugly on the bearing cup. 2. Adjust DT 45124 removal bridge so it sits on the torque converter housing surface just beyond the bearing cup opening. 3. Apply the extreme pressure lubricant DT 23444-A extreme press lubricant to the puller bolt threads to prevent damage to the bolt threads during bearing cup removal. 4. Hold the puller bridge bolt and turn the nut to removal the bearing cup.
1	<p>Special Tools</p> <ul style="list-style-type: none"> • DT 23444-A Extreme Press Lubricant - 1/4 Ounce Tube • DT-45087 Transfer Shaft and Differential Bearing Cup Installer • DT-45094 Bearing Cup Remover • DT 45124 Removal Bridge • DT-47927 Bearing Cup Remover <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	Front Differential Drive Pinion Gear Bearing Thrust Washer
3	<p>Front Differential Drive Pinion Gear Lube Dam</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-48055 Lube Dam Remover • GE 6125-1B Slide Hammer with Adapter or equivalent <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>

Bearing Cup, Washer and Lubricant Dam Installation

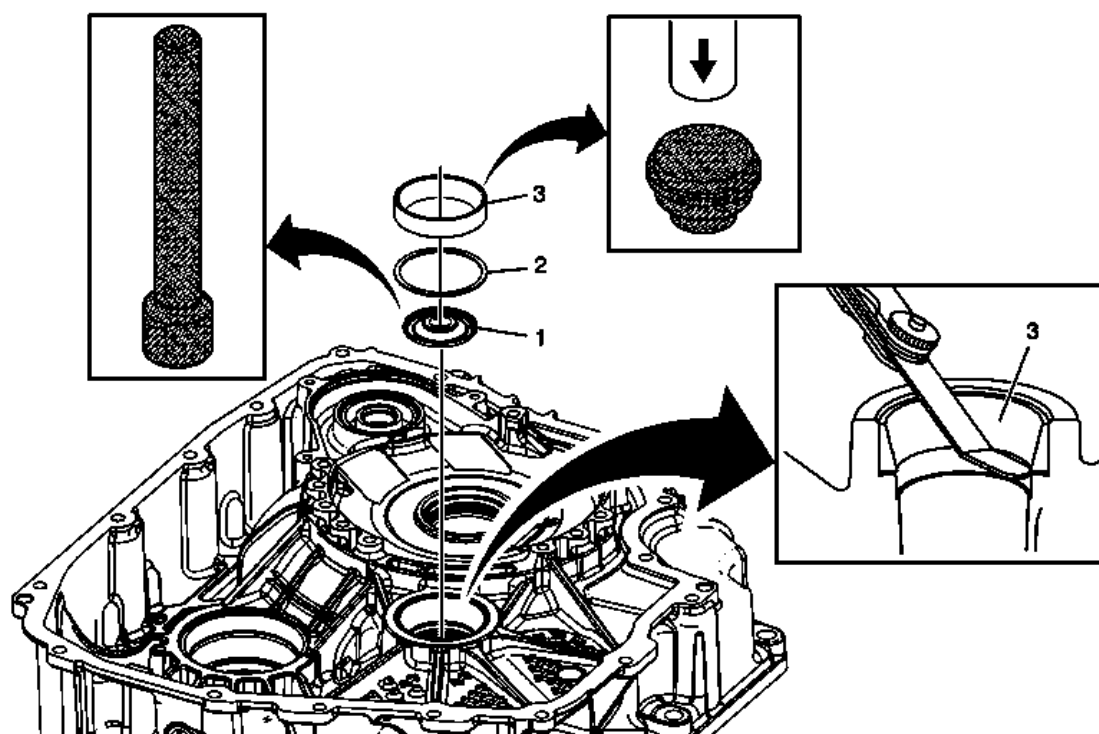


Fig. 25: Identifying Front Differential Drive Pinion Bearing Cup, Washer & Lube Dam
 Courtesy of GENERAL MOTORS COMPANY

Bearing Cup, Washer and Lubricant Dam Installation

Callout	Component Name
Preliminary Procedure Do not install the bearing cup until after the selective washer measurement has been performed.	
1	Front Differential Drive Pinion Gear Lube Dam Special Tools <ul style="list-style-type: none"> • DT-46630 Lube Dam Installer • GE 8092 Driver Handle For equivalent regional tools, refer to Special Tools .
2	Front Differential Drive Pinion Gear Bearing Thrust Washer NOTE: Install the correct drive pinion gear bearing thrust washer as determined by the thrust washer measurement procedure. Refer to Front Differential Drive Pinion Gear Bearing Thrust Washer and Front Differential Bearing Washer Measurement .
	Front Differential Drive Pinion Gear Bearing Cup CAUTION:

3

Support the back side of the torque converter housing before installing the bearing cup. Apply a light coating of transmission fluid to the bore before pressing the cup into position. Install the bearing cup until it stops moving. Applying excessive pressure to the bearing cup once it is seated could cause damage to the torque converter housing casting.

CAUTION:

An unseated or improperly installed bearing cup will result in premature bearing failure. Visually inspect the bearing cup to insure there is "no gap" between the converter housing, thrust washer, and the bearing cup. Use of a feeler gauge may assist in identifying a bearing cup that is not fully seated.

Special Tools

DT-45087 Bearing Cup Installer

For equivalent regional tools, refer to **Special Tools** .

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - TORQUE CONVERTER HOUSING SIDE

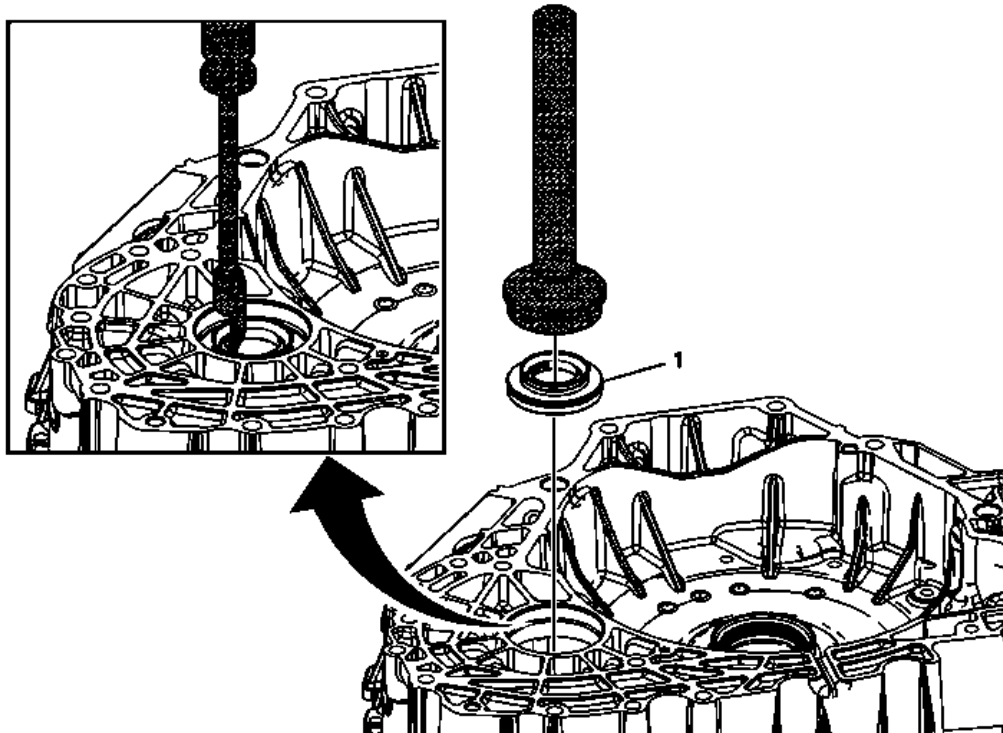


Fig. 26: Front Wheel Drive Shaft Seal - Torque Converter Housing Side
 Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Torque Converter Housing Side

Callout	Component Name
	Torque Converter - Front Wheel Drive Shaft Oil Seal Assembly

NOTE:

Use the open side of DT 46629-A seal installer to avoid seal lip damage and to install the seal to the proper depth.

Special Tools

1

- DT 23129 Universal Seal Remover
- DT 46629-A Seal Installer
- GE 6125-1B Slide Hammer with Adapter
- GE 8092 Driver Handle

For equivalent regional tools, refer to **Special Tools** .

TORQUE CONVERTER HOUSING CLEANING AND INSPECTION

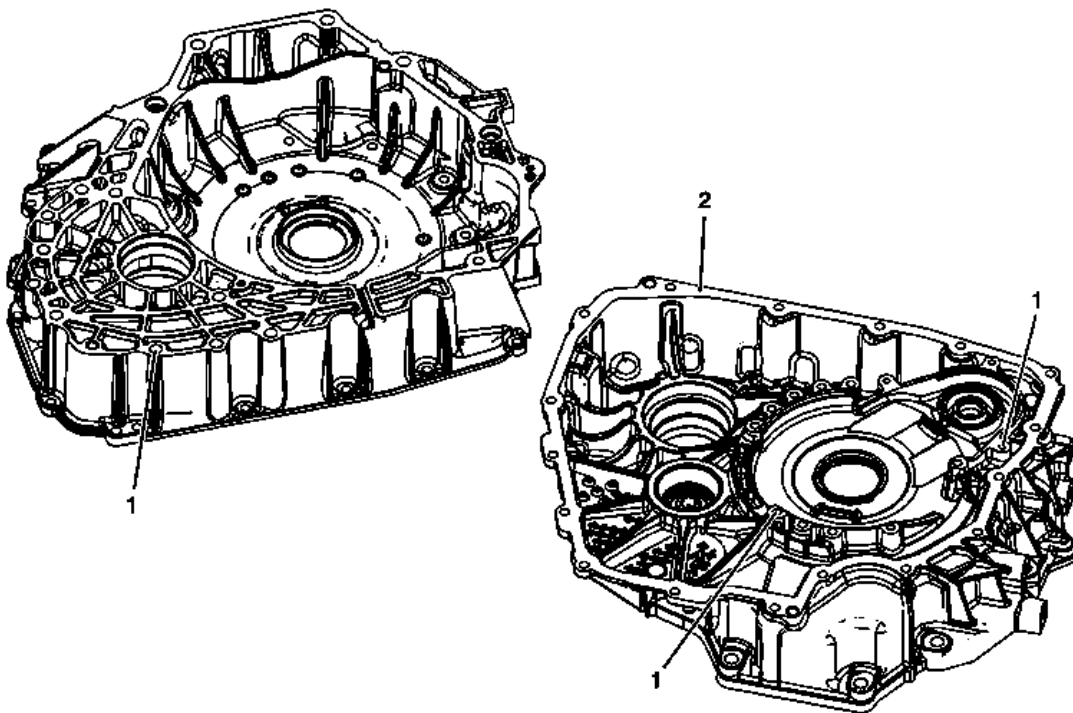


Fig. 27: Identifying Torque Converter Housing
Courtesy of GENERAL MOTORS COMPANY

Torque Converter Housing Cleaning and Inspection

Callout	Component Name
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	

CAUTION:

Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.

CAUTION:

Do not use abrasive pads or bristle devices to clean the sealing surfaces. Abrasive pads produce a fine grit that can effect transmission function. Abrasive pads can also remove enough metal to create oil leaks.

Preliminary Procedure Thoroughly clean the torque converter and differential housing, including threads, with clean solvent.

1	Threaded Holes
2	Gasket Sealing Surfaces

TORQUE CONVERTER FLUID SEAL REPLACEMENT

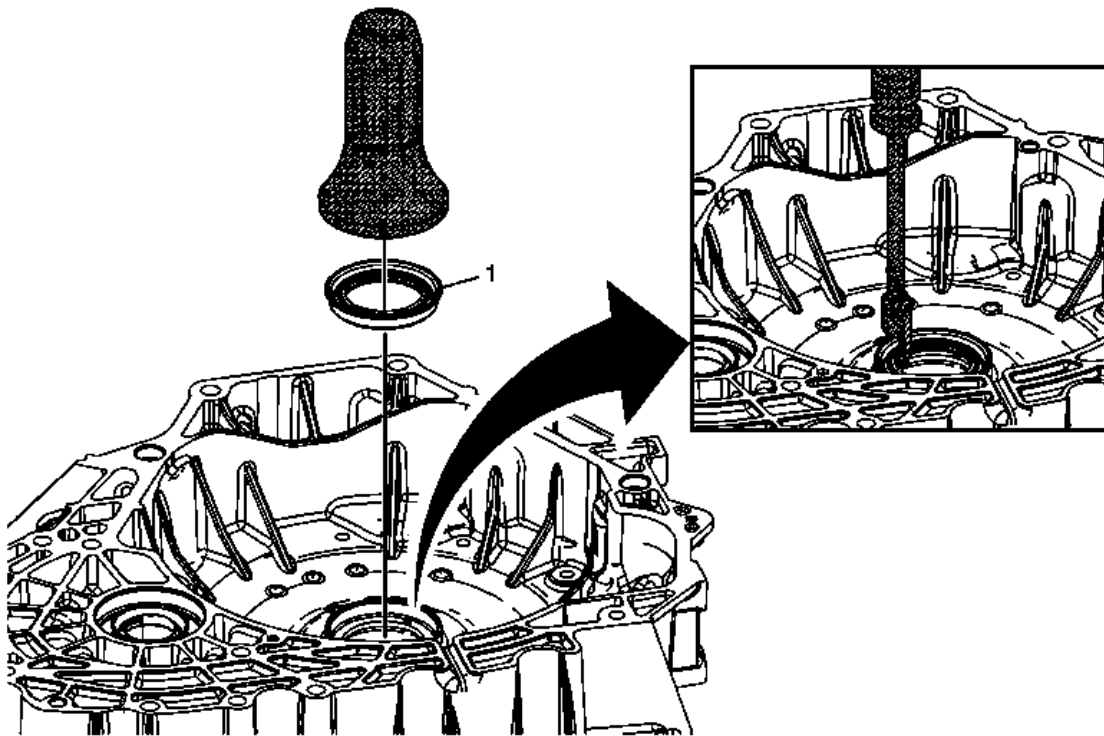


Fig. 28: Identifying Torque Converter Fluid Seal
Courtesy of GENERAL MOTORS COMPANY

Torque Converter Fluid Seal Replacement

Callout	Component Name
	Torque Converter Fluid Seal
	CAUTION: Support the back side of the torque converter housing while installing the seal. Install

the seal until it stops moving. Applying excessive pressure to the seal once it is seated could cause damage to the torque converter housing casting.

Special Tools

1

- **DT 23129** Universal Seal Remover
- **DT 49861** Seal Installer
- **GE 6125-1B** Slide Hammer with Adapter or equivalent

For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL TRANSFER DRIVE GEAR SUPPORT ASSEMBLY DISASSEMBLE

Seal Removal

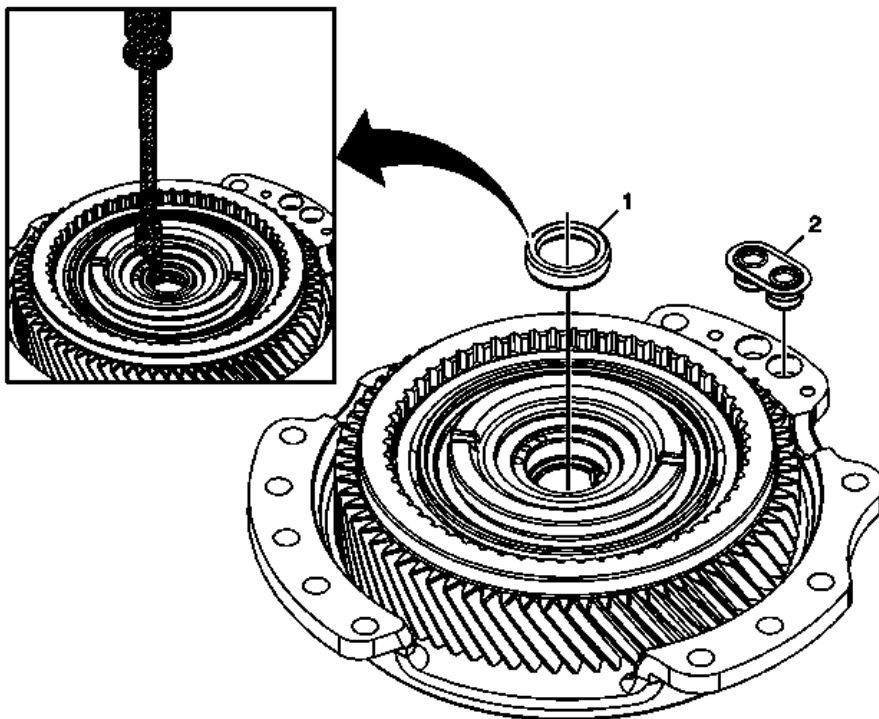


Fig. 29: Identifying Front Differential Transfer Drive Gear Support Seal
Courtesy of GENERAL MOTORS COMPANY

Seal Removal

Callout	Component Name
CAUTION: Do not remove the transfer drive gear bearing retaining nut. The drive gear and bearing are not serviceable. Removing the retaining nut will damage the support.	

Preliminary Procedure

- Inspect the support assembly for damage or wear to the splines, bushings, machined surfaces and threaded holes.
- Inspect the transfer drive gear for damage or wear.
- Inspect the transfer drive gear bearing assembly for proper operation.
- The bearing should roll smoothly and quietly.

1	Front Differential Transfer Drive Gear Support Seal
	Special Tools <ul style="list-style-type: none">• DT 23129 Universal Seal Remover• GE 6125-1B Slide Hammer with Adapter or equivalent
	For equivalent regional tools, refer to Special Tools .
2	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly

Fluid Passage Tube Removal

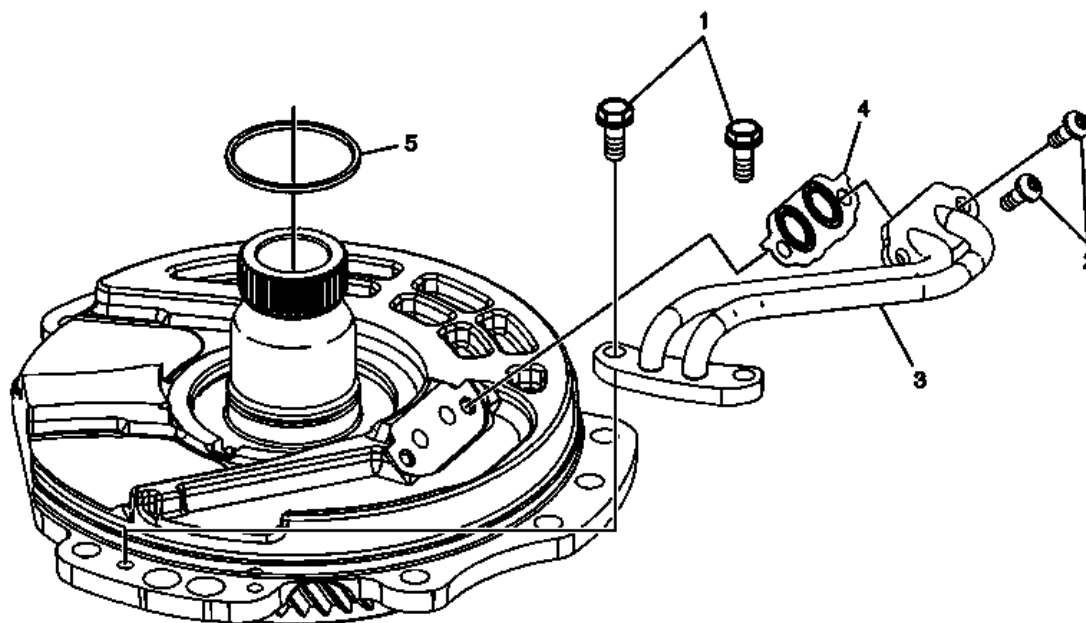


Fig. 30: Identifying Fluid Passage Tube Assembly
Courtesy of GENERAL MOTORS COMPANY

Fluid Passage Tube Removal

Callout	Component Name
---------	----------------

CAUTION:

Do not remove the transfer drive gear bearing retaining nut. The drive gear and bearing are not serviceable. Removing the retaining nut will damage the support.

Preliminary Procedures

- Inspect the support assembly for damage or wear to the splines, bushings, machined surfaces and threaded holes.
- Inspect the transfer drive gear for damage or wear.
- Inspect the transfer drive gear bearing assembly for proper operation.
- The bearing should roll smoothly and quietly.

1	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt M6 x 15 (Qty: 2)
2	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt M5 x 12 (Qty: 2)
3	Fluid Passage Tube Assembly NOTE: Inspect the tubes for damage, wear or cracked welds.
4	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
5	Front Differential Transfer Drive Gear Support Seal

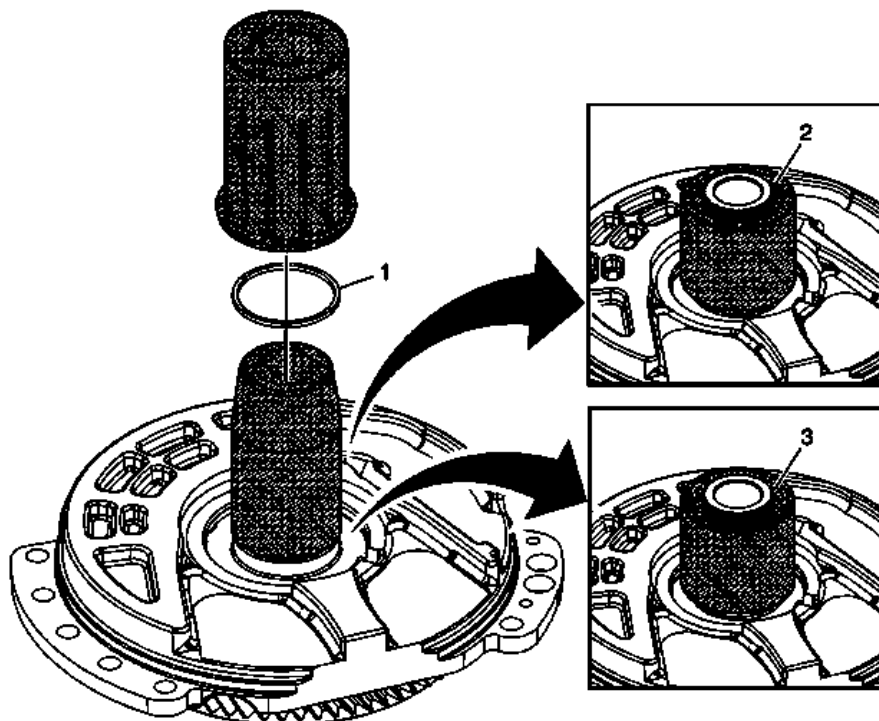
FRONT DIFFERENTIAL TRANSFER DRIVE GEAR SUPPORT ASSEMBLY ASSEMBLE**Drive Support Seal Installation**

Fig. 31: Identifying Front Differential Transfer Drive Gear Support Seal
 Courtesy of GENERAL MOTORS COMPANY

Drive Support Seal Installation

Callout	Component Name
1	<p>Front Differential Transfer Drive Gear Support Seal</p> <p>NOTE: A NEW seal must be installed.</p> <p>Special Tools DT-46624 Support Seal Installer For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	<p>Small Chamfer Faces Up</p> <p>CAUTION: To avoid damaging the seal, first place DT 46624-1 with the small chamfer end facing up and leave in place for at least 60 seconds.</p>
3	<p>Large Chamfer Faces Up</p> <p>NOTE: Turn DT 46624-1 which is part of DT-46624 seal installer , over with the large chamfer end facing up for 60 seconds to ensure that the seal has been properly sized.</p>

Fluid Passage Tube Installation

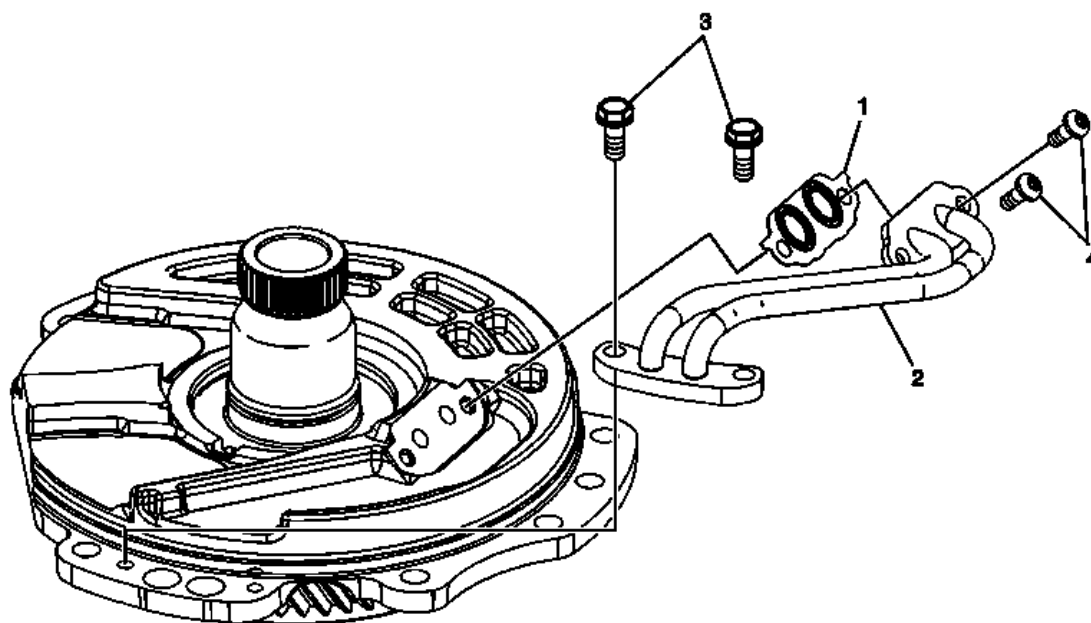


Fig. 32: Identifying Front Differential Transfer Drive Gear Support Fluid Passage Tube
 Courtesy of GENERAL MOTORS COMPANY

Fluid Passage Tube Installation

Callout	Component Name
1	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
2	Fluid Passage Tube Assembly
3	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt M6 x 15 (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (106 lb in)
4	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt M5 x 12 (Qty: 2) Tighten 7 N.m (62 lb in)

Seal Installation

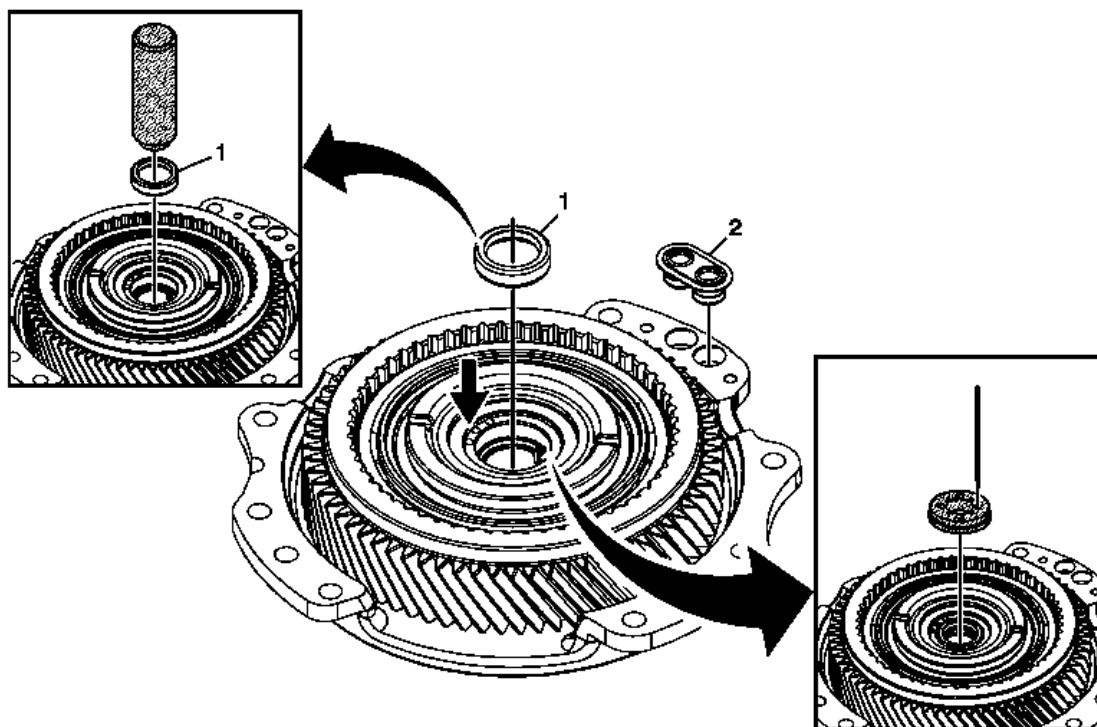


Fig. 33: View Of Front Differential Transfer Drive Gear Support Seal

Courtesy of GENERAL MOTORS COMPANY

Seal Installation

Callout	Component Name
1	<p>Front Differential Transfer Drive Gear Support Seal</p> <p>CAUTION:</p> <ul style="list-style-type: none"> • Ensure staking does not line up with lubrication holes or the holes may be damaged. • Stop driving the seal once it bottoms out to avoid seal damage. <p>NOTE:</p> <p>The fluid seal assembly must be staked in place using DT-49131 seal staking tool to ensure proper seal retention.</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-46627-A Seal Installer • DT-49131 Seal Staking Tool <p>For equivalent regional tools, refer to Special Tools .</p>
2	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly

TRANSMISSION FLUID PUMP CLEANING AND INSPECTION

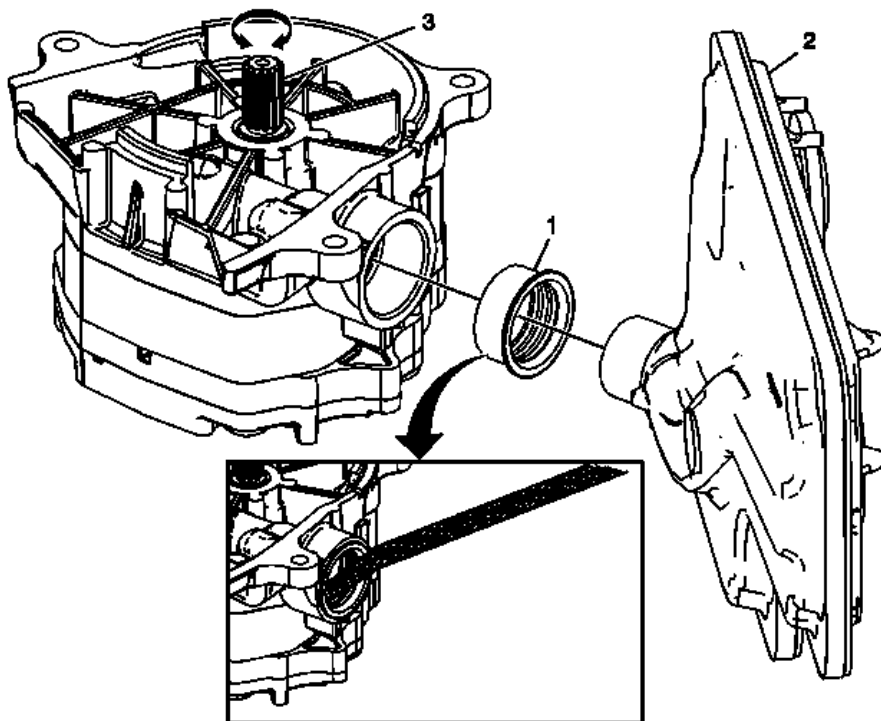


Fig. 34: Identifying Fluid Pump Components
 Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Pump Cleaning and Inspection

Callout	Component Name
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	
CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.	
Preliminary Procedure The fluid pump assembly is not serviceable.	
1	Filter Neck Seal NOTE: Install a NEW filter neck seal. Special Tools 28585 Snap ring Remover or equivalent For equivalent regional tools, refer to Special Tools .

2	A/Trans Fluid Filter Assembly NOTE: Install a NEW fluid filter assembly.
3	Fluid Pump Drive Shaft NOTE: <ul style="list-style-type: none"> • Inspect the fluid pump drive shaft splines for damage or wear. • Rotate the fluid pump drive shaft for free operation.

FRONT DIFFERENTIAL DRIVE PINION GEAR BEARING THRUST WASHER AND FRONT DIFFERENTIAL BEARING WASHER MEASUREMENT

Differential Thrust Washer Gauge Installation

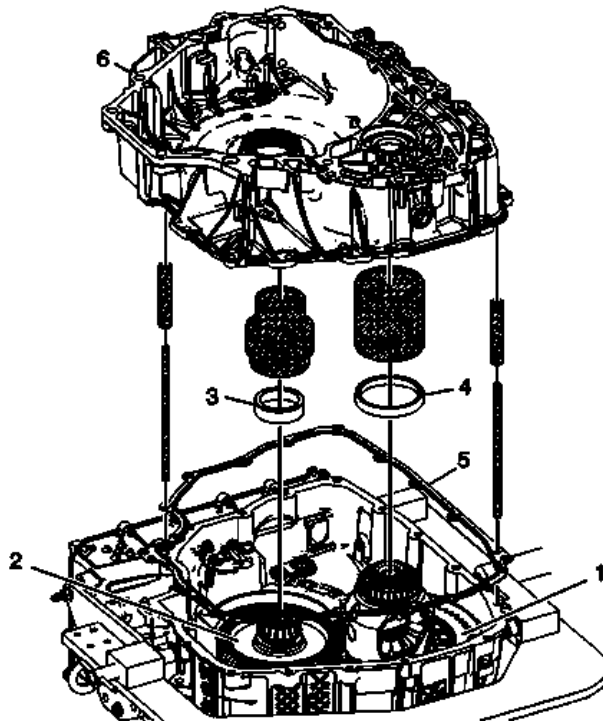


Fig. 35: Identifying Differential Thrust Washer Gage
Courtesy of GENERAL MOTORS COMPANY

Differential Thrust Washer Gauge Installation

Callout	Component Name
1	Front Differential Carrier Assembly NOTE: Install the differential assembly and the pinion gear assembly together to avoid interference with the gears during installation.

2	<p>Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly</p> <p>NOTE: Install the differential assembly and the pinion gear assembly together to avoid interference with the gears during installation.</p>
3	<p>Front Differential Drive Pinion Gear Bearing Cup</p> <p>NOTE: After placing the bearing cup on the gear, place DT 47800-2 which is part of DT-47800 selection gauge kit , onto the bearing cup.</p> <p>Special Tools DT-47800 Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to <u>Special Tools</u> .</p>
4	<p>Front Differential Carrier Bearing Cup</p> <p>NOTE: After placing the bearing cup on the gear, place DT 47800-1 which is part of DT-47800 selection gauge kit , onto the bearing cup.</p> <p>Special Tools DT-47800 Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to <u>Special Tools</u> .</p>
5	Torque Converter Housing Outer Seal
6	<p>Torque Converter and Support and A/Trans Fluid Pump Housing Assembly</p> <p>NOTE:</p> <ul style="list-style-type: none"> • Install 2 DT 47800-6 which is part of DT-47800 selection gauge kit , into a case threaded hole at approximately 180 degrees apart. • Some alignment of DT 47800-1 and 2 which is part of DT-47800 selection gauge kit , may be required while lowering the TC housing onto the case. • Install DT 47800-3 which is part of DT-47800 selection gauge kit , spacer over DT 47800-6. <p>Special Tools DT-47800 Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to <u>Special Tools</u> .</p>

Torque Sequence

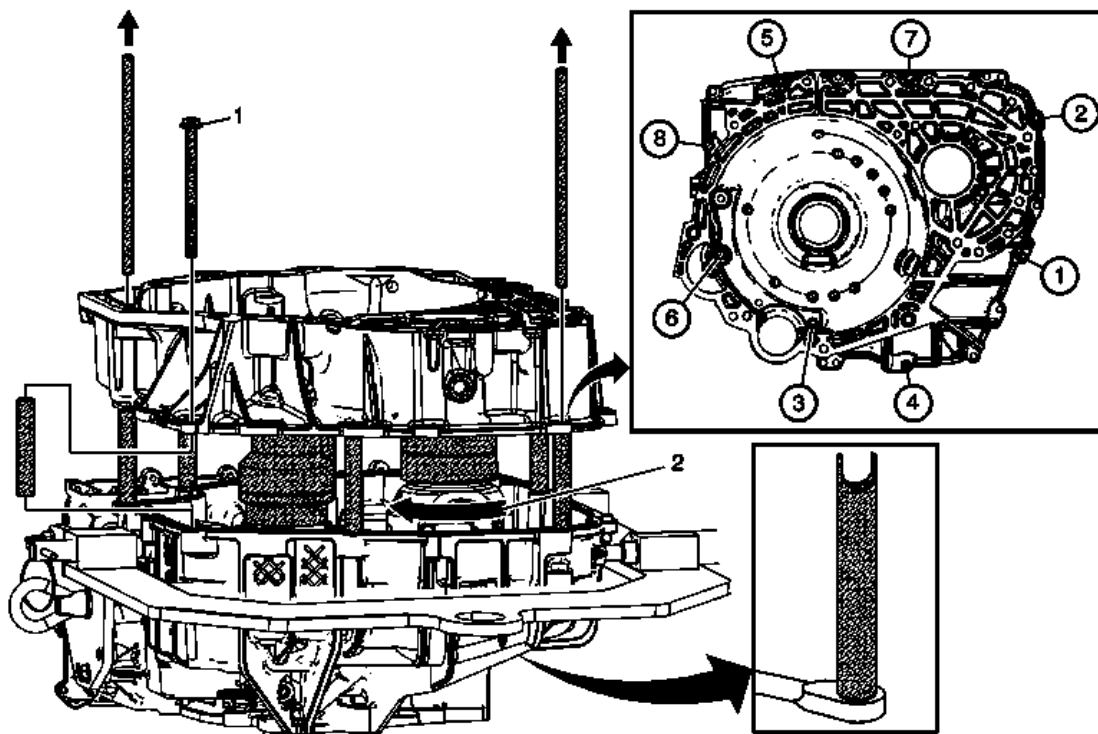


Fig. 36: Identifying Front Differential Carrier Assembly Torque Sequence
 Courtesy of GENERAL MOTORS COMPANY

Torque Sequence

Callout	Component Name
1	<p>Spacer Bolt M8 x 127 (Qty: 8)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Install the remaining spacers evenly at every other bolt hole. 2. Remove the DT 47800-6 which is part of DT-47800 selection gauge kit , guide pins and install spacer bolts in all bolt holes at spacer locations. 3. Tighten the bolts in sequence. <p>Tighten</p> <p>30 N.m (22 lb ft)</p> <p>Special Tools DT-47800 Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to <u>Special Tools</u> .</p>

Front Differential Carrier Assembly

CAUTION:

If the bearings are not properly seated into the bearing cups, the washer selection will be inaccurate and the bearing pre-load will be set too low. Low bearing pre-load will cause premature failure of the front differential drive pinion gear.

Procedure

- 2 Rotate the differential assembly 10 revolutions to allow the bearings to seat into the cups.

NOTE:

Differential rotating tool DT-47793 differential rotating tool can be used to rotate the differential from the case side.

Special Tools

DT-47793 Differential Rotating Tool

For equivalent regional tools, refer to **Special Tools** .

Differential Thrust Washer Selection

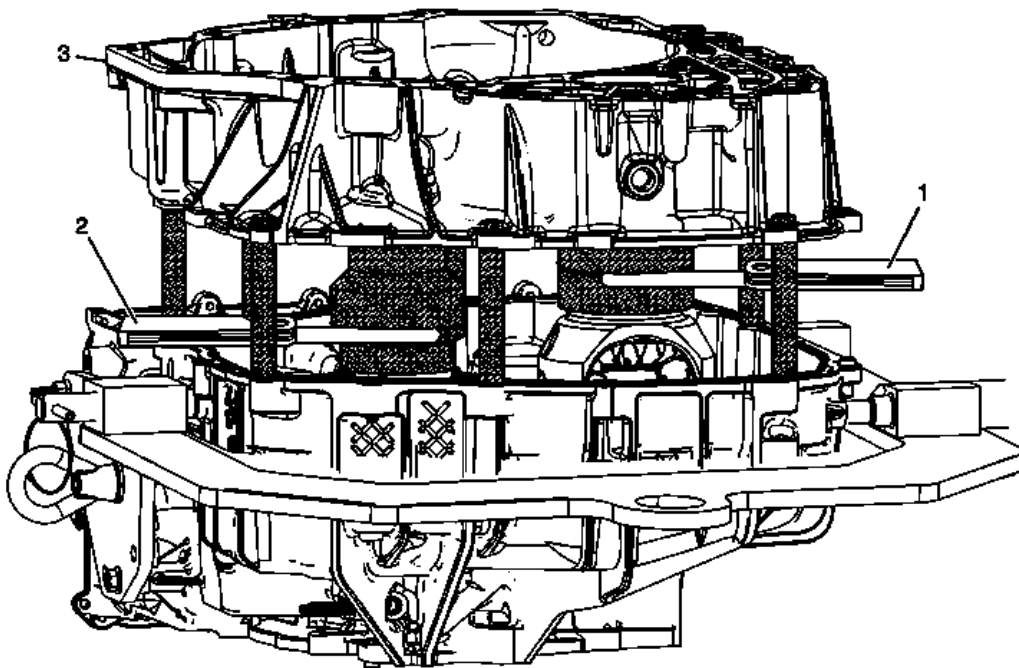


Fig. 37: Identifying Differential Thrust Washer Selection
Courtesy of GENERAL MOTORS COMPANY

Differential Thrust Washer Selection

Callout	Component Name
CAUTION: Improper thrust washer selection can cause insufficient taper bearing pre-load which will cause premature failure of the front differential drive pinion gear.	
1	<p>Front Differential Bearing Washer</p> <p>Procedure Place DT 47800-7 in the gap in DT 47800-2 which are both part of DT-47800 selection gauge kit , to determine the proper thrust washer. Choose the correct thrust washer. Refer to <u>Taper Bearing Preload Selective Specifications</u> .</p> <p>NOTE:</p> <ul style="list-style-type: none"> • Continue trying different sizes of DT 47800-7 which is part of DT-47800 selection gauge kit , until the gauge will no longer fit into the gap. The correct thrust washer size is equal to the largest blade gauge that fits into the gap. • Match the size of the correct DT 47800-7 blade which is part of DT-47800 selection gauge kit , to the color code in the thrust washer specification chart. The washer color coding is on the outside diameter of the washer. • The gap in DT 47800-2 which are both part of DT-47800 selection gauge kit may not be even. Hold the top of the gauge and rotate the bottom of the gauge to even out the gap. Take two gap measurements 180 degrees apart. Average the two measurements and select the thrust washer that is closest to the average. • The washer color coding is on the outside diameter of the washer. <p>Special Tools DT-47800 Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	<p>Front Differential Drive Pinion Gear Bearing Thrust Washer</p> <p>Procedure Place DT 47800-7 in the gap in DT 47800-1 which are both part of DT-47800 selection gauge kit , to determine the proper thrust washer. Choose the correct thrust washer. Refer to <u>Taper Bearing Preload Selective Specifications</u> .</p> <p>NOTE:</p> <ul style="list-style-type: none"> • Continue trying different sizes of DT 47800-7 which is part of DT-47800 selection gauge kit , until the gauge will no longer fit into the gap. The correct thrust washer size is equal to the largest gauge that fits into the gauge. • Match the size of the correct DT 47800-7 blade which is part of DT-47800 selection gauge kit to the color code in the thrust washer selection chart. • The gap in DT 47800-1 which is part of DT-47800 selection gauge kit may not be even. Hold the top of the gauge and rotate the bottom of the gauge to even out the gap. Take two gap measurements 180 degrees apart. Average the two measurements and select the thrust washer that is closest to the average. • The washer color coding is on the outside diameter of the washer.

	<p>Special Tools DT-47800 Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to <u>Special Tools</u> .</p>
3	<p>Torque Converter and Support and A/Trans Fluid Pump Housing Assembly</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove DT 47800-3 which are both part of DT-47800 selection gauge kit , bolts and spacers. 2. Remove the torque converter housing. 3. Remove DT 47800-1 and DT 47800-2 which are both part of DT-47800 selection gauge kit. 4. Remove the torque converter housing seal. 5. Remove the pinion gear and differential bearing cups. 6. Install the bearing cups and thrust washers into the torque converter housing per the replacement procedures. Refer to <u>Front Differential Carrier Bearing Cup and Washer Replacement - Torque Converter Housing Side</u>, and <u>Front Differential Drive Pinion Bearing Cup, Washer, and Lubricant Dam Replacement - Torque Converter Housing Side</u>. <p>NOTE: DT 47800-1 and DT 47800-2 which are both part of DT-47800 selection gauge kit , may stick in the torque converter housing. Be careful not to drop the gauges.</p> <p>Special Tools DT-47800 Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to <u>Special Tools</u> .</p>

TORQUE CONVERTER AND DIFFERENTIAL HOUSING ASSEMBLY ASSEMBLE

Pump Assembly Installation

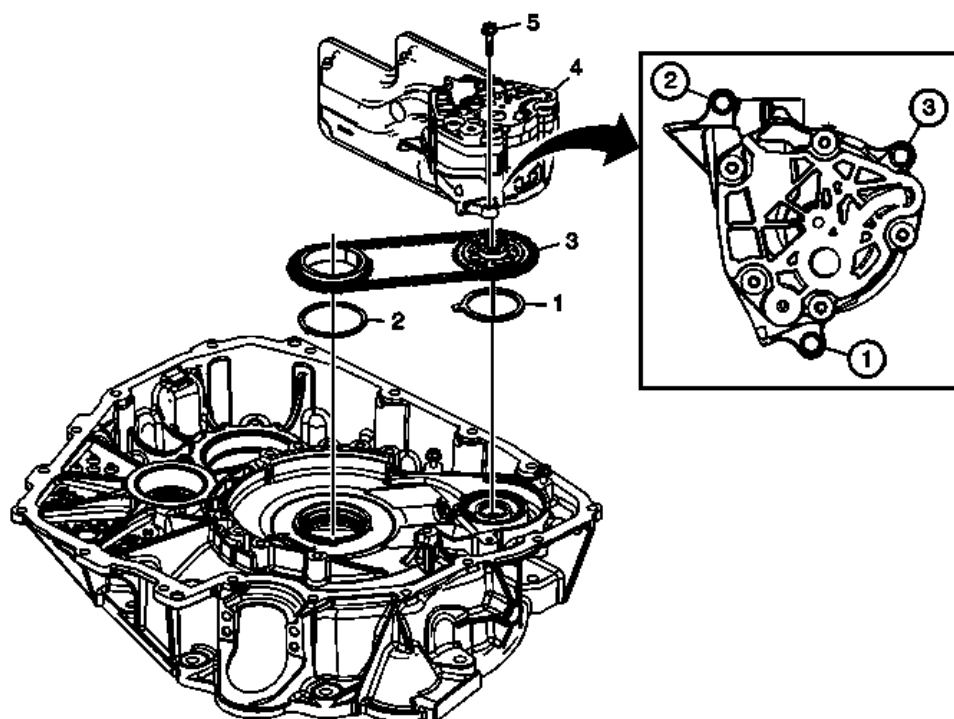


Fig. 38: View Of Pump Assembly
 Courtesy of GENERAL MOTORS COMPANY

Pump Assembly Installation

Callout	Component Name
1	Driven Sprocket Thrust Washer
2	Drive Sprocket Thrust Washer
3	Install Drive Link Assembly NOTE: Install as an assembly.
4	A/Trans Fluid Pump Assembly NOTE: Rotating the drive sprocket and link assembly while installing the oil pump will aid in aligning the driven sprocket and oil pump drive shaft splines.
5	A/Trans Fluid Pump Bolt M6 x 25 (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure: Tighten in sequence shown. Tighten

12 N.m (106 lb in).

Transfer Drive Gear Assembly Installation

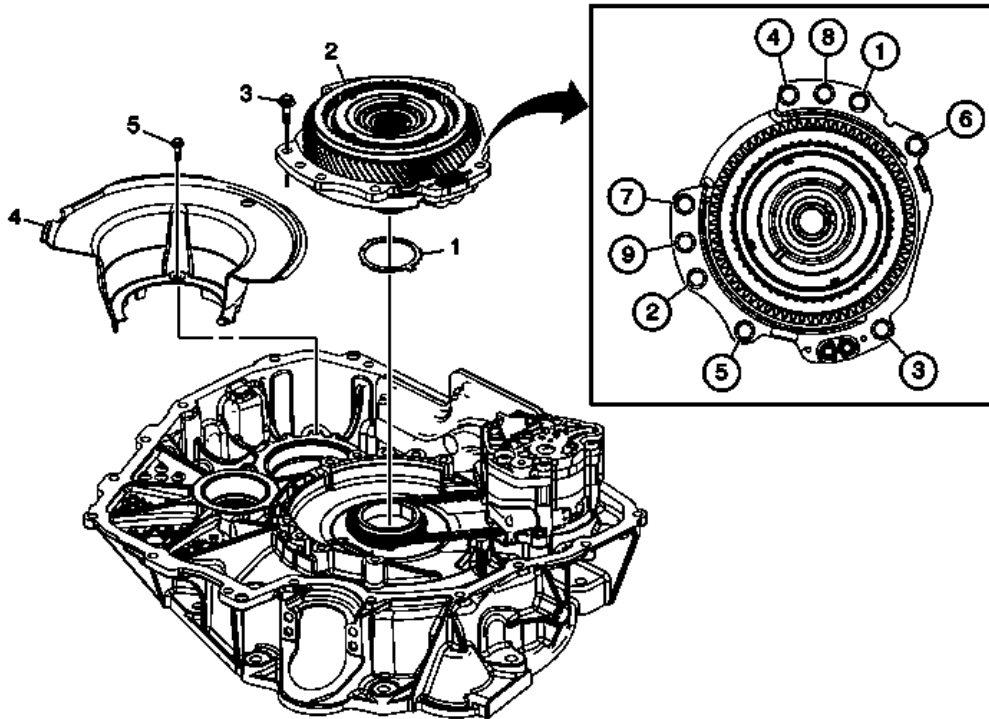


Fig. 39: View of Transfer Drive Gear Assembly
Courtesy of GENERAL MOTORS COMPANY

Transfer Drive Gear Assembly Installation

Callout	Component Name
1	Drive Sprocket Thrust Washer
2	Front Differential Transfer Drive Gear Support Assembly
3	Front Differential Transfer Drive Gear Support Bolt M8 x 25 (Qty: 9)
	CAUTION: Refer to Fastener Caution .
	Procedure Tighten in sequence shown. Tighten 10 N.m (89 lb in) plus 50 degrees \pm 4 degrees. Special Tools: EN 45059 Angle Meter For equivalent regional tools, refer to Special Tools .
4	Front Differential Carrier Baffle

5

Front Differential Carrier Baffle Bolt M6 x 25

Tighten

12 N.m (106 lb in).

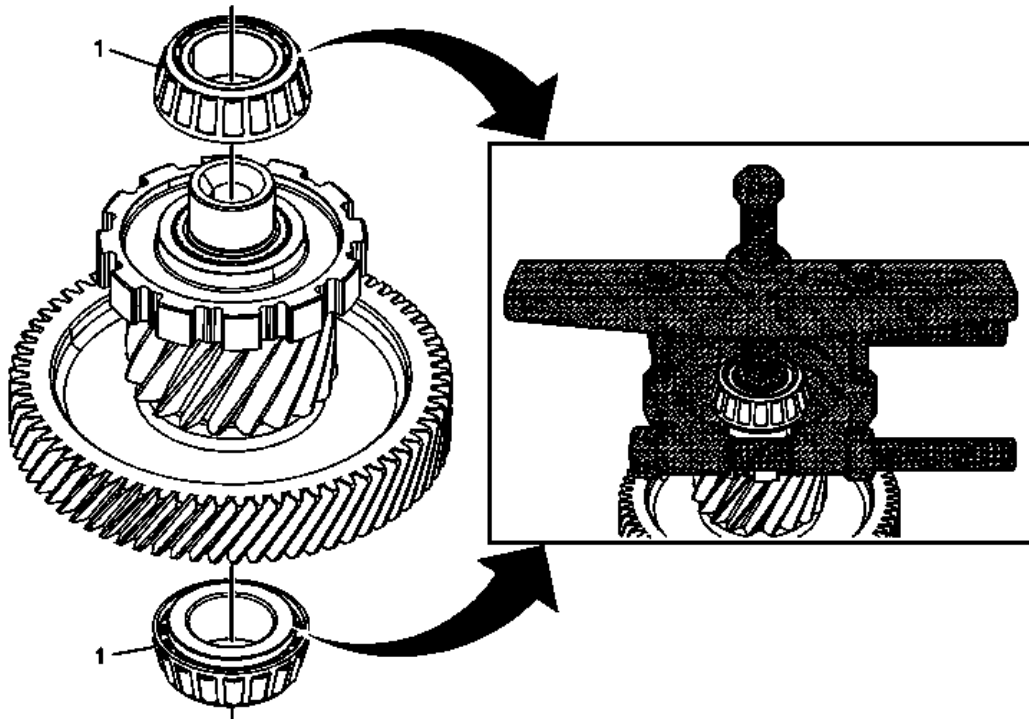
FRONT DIFFERENTIAL DRIVE PINION GEAR BEARING REPLACEMENT**Removal**

Fig. 40: View Of Front Differential Drive Pinion Gear Bearing
Courtesy of GENERAL MOTORS COMPANY

Removal

Callout	Component Name
1	<p>Front Differential Drive Pinion Gear Bearing</p> <p>NOTE:</p> <ul style="list-style-type: none">• When removing the front differential drive pinion gear bearing use DT 41816-2 step plate.• Use DT 8433-1 puller bar or equivalent with bolts 2-3/8 x 3 x 24. <p>Special Tools</p> <ul style="list-style-type: none">• DT 8433-1 Puller Bar or equivalent• DT 22912-B Split Plate Bearing Remover or equivalent• DT 41816-2 Step Plate

For equivalent regional tools, refer to Special Tools .

Installation

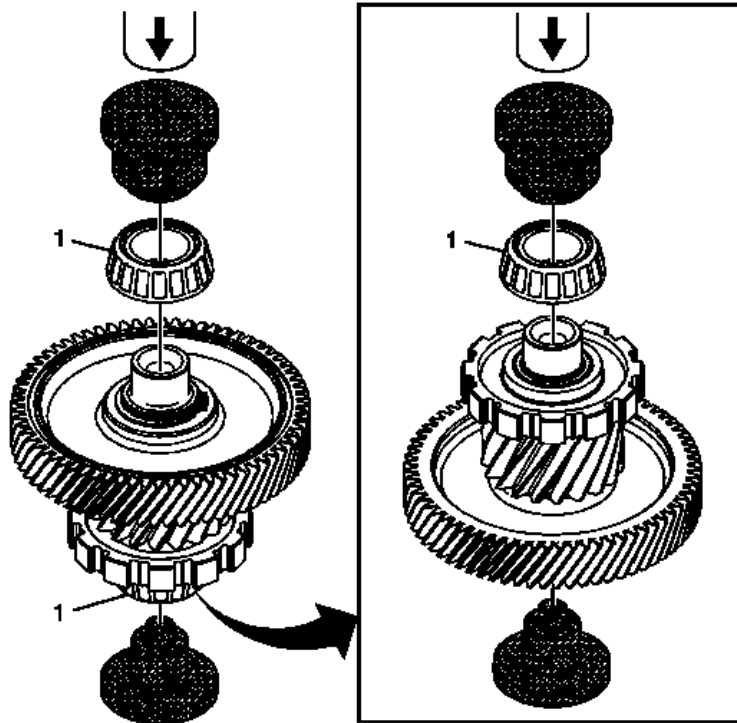


Fig. 41: Identifying Front Differential Drive Pinion Gear Bearing
Courtesy of GENERAL MOTORS COMPANY

Installation

Callout	Component Name
1	<p>Front Differential Drive Pinion Gear Bearing</p> <p>CAUTION: Pressing against the bearing assembly can damage the bearing and cause premature bearing failure.</p> <p>Special Tools DT-47928 Bearing Installer For equivalent regional tools, refer to <u>Special Tools</u> .</p>

FRONT DIFFERENTIAL CARRIER BEARING REPLACEMENT

Removal

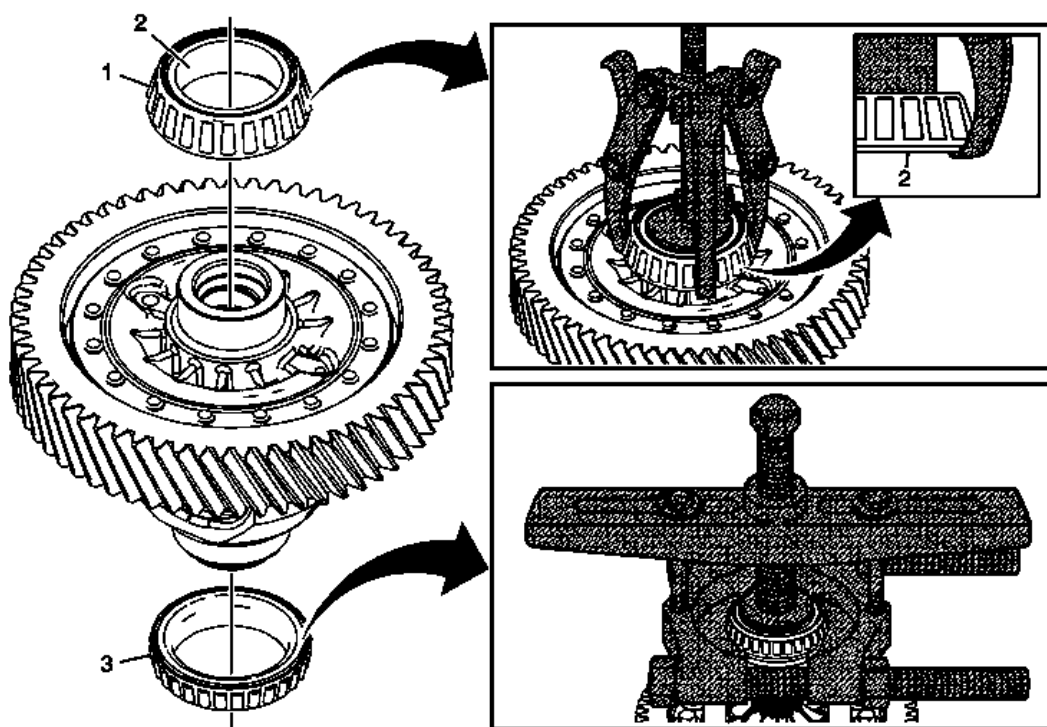


Fig. 42: Identifying Front Differential Carrier Bearing
 Courtesy of GENERAL MOTORS COMPANY

Removal

Callout	Component Name
1	<p>Front Differential Carrier Bearing Assembly</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-41816 Three Legged Puller • DT 41816-2 Step Plate <p>For equivalent regional tools, refer to Special Tools .</p>
2	<p>Inner Race</p> <p>NOTE: Ensure all 3 legs of the puller make contact with the inner race of the bearing.</p>
	<p>Front Differential Carrier Bearing Assembly</p> <p>NOTE:</p> <ul style="list-style-type: none"> • AWD differential may need longer bolts, 2-3/8 x 5 x 24 thread bolts. • When removing the front differential carrier bearing assembly use DT 41816-2 step plate.

3

Special Tools

- DT 8433-1 Puller Bar or equivalent
- DT 22912-B Split Plate Bearing Remover or equivalent
- DT 41816-2 Step Plate

For equivalent regional tools, refer to **Special Tools** .

Installation

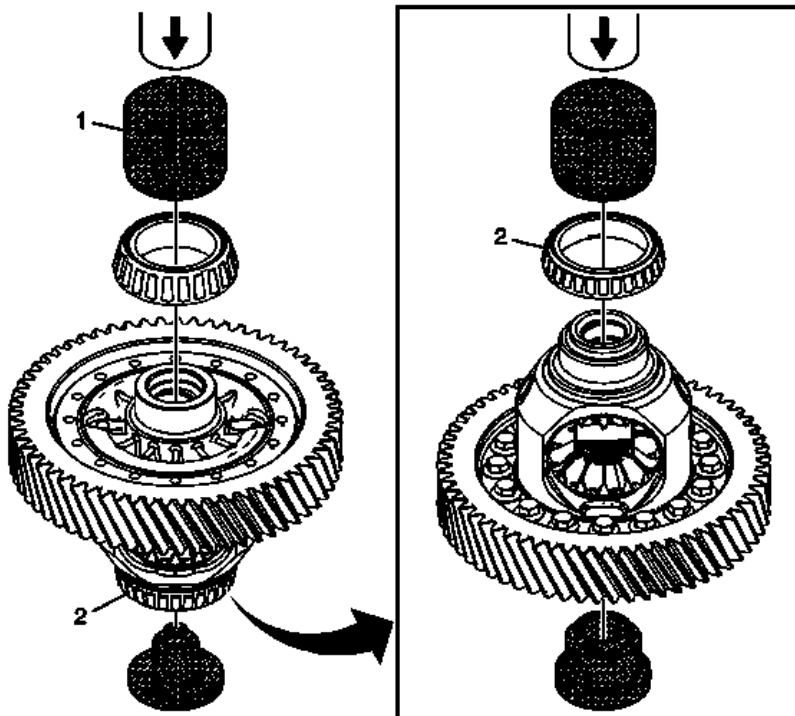


Fig. 43: View Of Front Differential Carrier Bearing
Courtesy of GENERAL MOTORS COMPANY

Installation

Callout	Component Name
1	<p>Front Differential Carrier Bearing Assembly</p> <p>CAUTION: Pressing against the bearing assembly can damage the bearing and cause premature bearing failure.</p> <p>CAUTION: There are first and second design front differential carrier bearings. First design bearings have twenty eight rollers and are manufactured by Timken. Second design</p>

	<p>bearings have 30 rollers and are manufactured by NSK. If installing second design bearings, second design front differential carrier bearing cups must be used. All four parts must be kept as a set to prevent damage to the transmission.</p> <p>Special Tools DT-47928 Bearing Installer For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	<p>Front Differential Carrier Bearing Assembly</p> <p>CAUTION: Pressing against the bearing assembly can damage the bearing and cause premature bearing failure.</p> <p>CAUTION: There are first and second design front differential carrier bearings. First design bearings have twenty eight rollers and are manufactured by Timken. Second design bearings have 30 rollers and are manufactured by NSK. If installing second design bearings, second design front differential carrier bearing cups must be used. All four parts must be kept as a set to prevent damage to the transmission.</p> <p>Special Tools DT-47928 Bearing Installer For equivalent regional tools, refer to <u>Special Tools</u> .</p>

FRONT DIFFERENTIAL CARRIER CLEANING AND INSPECTION

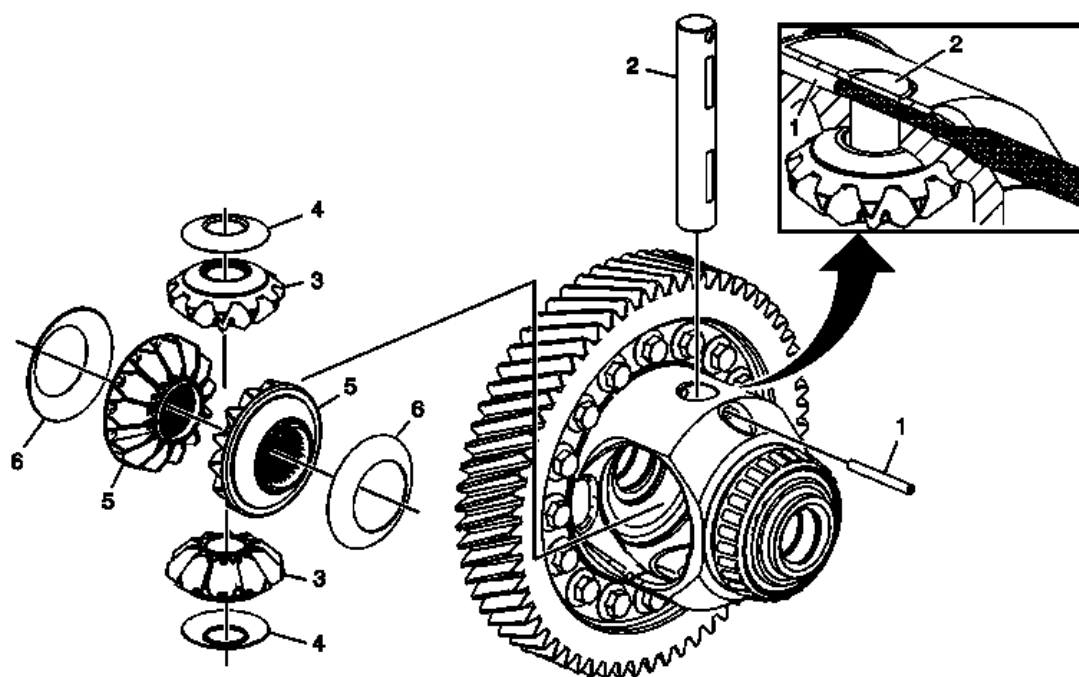


Fig. 44: Identifying Front Differential Carrier Components
 Courtesy of GENERAL MOTORS COMPANY

Front Differential Carrier Cleaning and Inspection

Callout	Component Name
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	
CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.	
CAUTION: Keep the thrust washers with gear it was matched to. The thrust washers are selective sizes and it is difficult to identify the proper washer thickness. Improper assembly can cause premature failure of the differential assembly.	
Preliminary Procedure Clean and inspect the differential assembly, pinion gears and thrust washers for scoring, wear or damage. The differential assembly is only serviced as an assembly.	
1	Front Differential Pinion Gear Shaft Retainer NOTE: Discard and use a new retainer.

	Special Tools 3/16 in (5 mm) 7 in Punch or equivalent For equivalent regional tools, refer to Special Tools .
2	Front Differential Pinion Gear Shaft
3	Front Differential Pinion Gears
4	Front Differential Carrier Thrust Washers
5	Front Differential Pinion Side Gears
6	Front Differential Side Gear Thrust Washer

FRONT DIFFERENTIAL DRIVE PINION GEAR AND CARRIER INSTALLATION

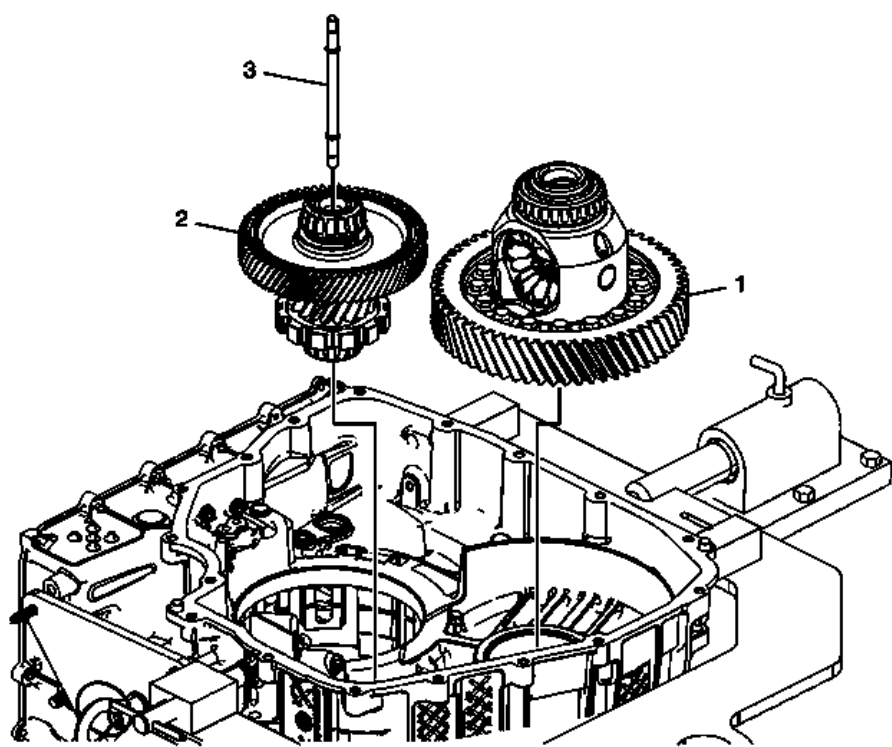


Fig. 45: Identifying Front Differential Carrier Assembly
Courtesy of GENERAL MOTORS COMPANY

Front Differential Drive Pinion Gear and Carrier Installation

Callout	Component Name
1	Front Differential Carrier Assembly NOTE: Install the differential assembly and the pinion gear assembly together to avoid interference with the gears during installasion.
2	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly
3	Front Differential Drive Pinion Gear Lube Tube

TORQUE CONVERTER AND DIFFERENTIAL HOUSING INSTALLATION

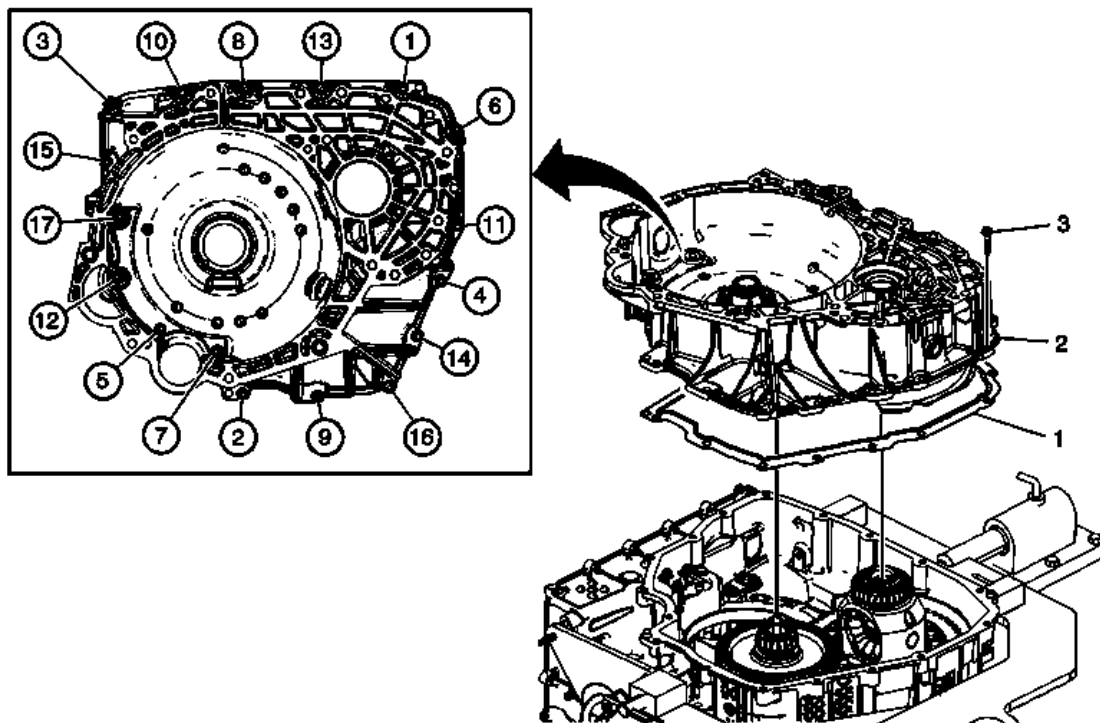


Fig. 46: Identifying Torque Converter & Differential Housing
 Courtesy of GENERAL MOTORS COMPANY

Torque Converter and Differential Housing Installation

Callout	Component Name
1	Torque Converter Housing Outer Seal
2	Torque Converter and Support and A/Trans Fluid Pump Housing Assembly
3	<p>Torque Converter and Differential Housing Bolts M8 x 35 (Qty: 17)</p> <p>CAUTION: Some bolt torques specifications are different. Over tightening the bolts at the 12, 15 and 17 positions in the sequence could cause damage to the case threads.</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure: Tighten in sequence shown. Tighten</p> <ul style="list-style-type: none"> • Bolts 1-11, 13-14 and 16 to 36Y (27 lb ft) • Bolts 12, 15 and 17 to 30 N.m (22 lb ft)

FRONT DIFFERENTIAL CARRIER PRELIMINARY ROTATIONAL TORQUE MEASUREMENT

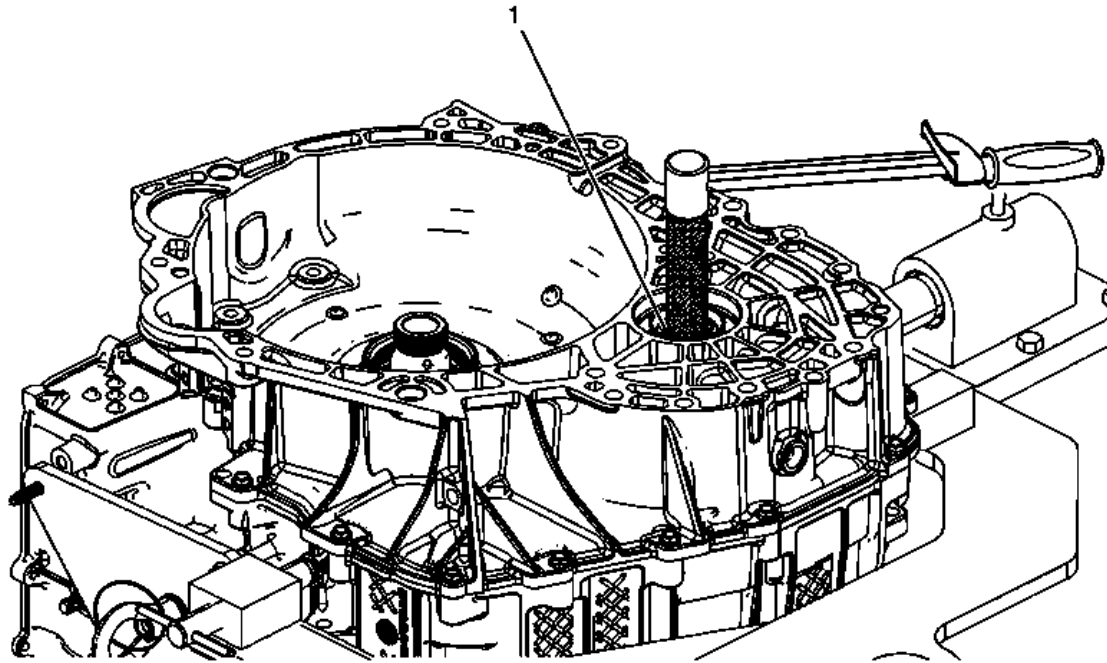


Fig. 47: Differential Rotating Tool

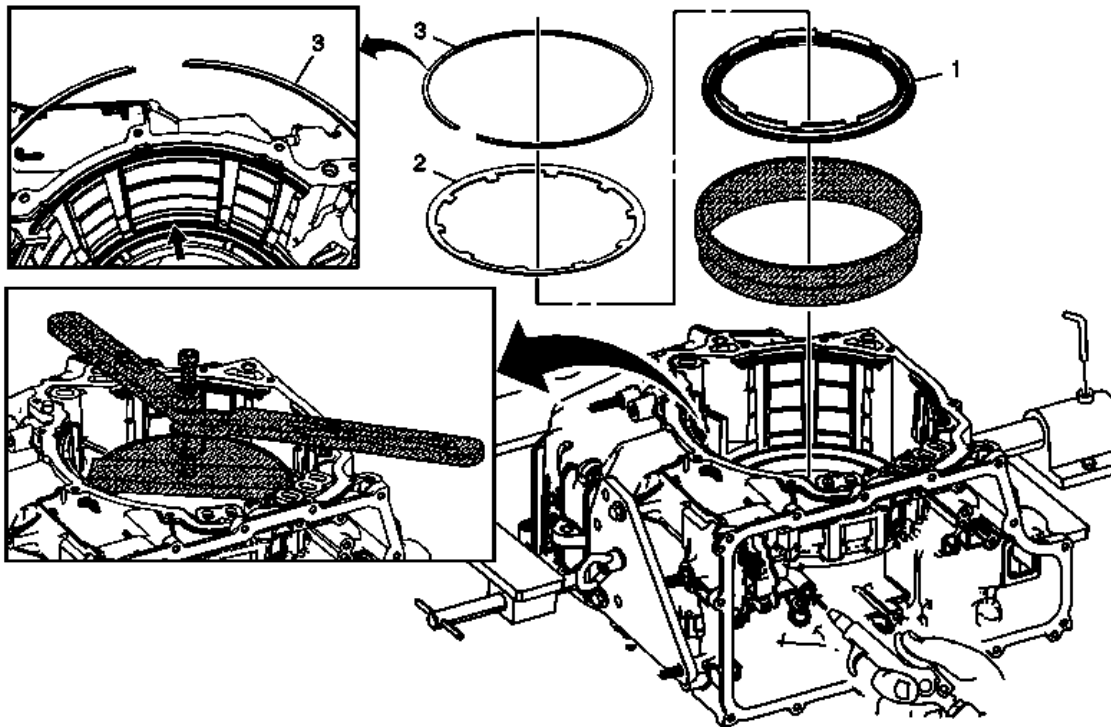
Courtesy of GENERAL MOTORS COMPANY

Front Differential Carrier Preliminary Rotational Torque Measurement

Callout	Component Name
1	<p>Front Differential Carrier Assembly</p> <p>CAUTION: Low bearing pre-load will cause premature failure of the front differential drive pinion gear.</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>NOTE:</p> <ul style="list-style-type: none">• If the turning torque is not within specifications, the transfer gear assembly and differential bearing thrust washer is incorrect and must be corrected. Refer to <u>Front Differential Drive Pinion Gear Bearing Thrust Washer and Front Differential Bearing Washer Measurement</u>.• Use a dial or beam torque wrench with DT-47793 differential rotating tool to measure turning torque.

Tighten

4-12 N.m (35-106 lb in)

Special Tools**DT-47793** Differential Rotating ToolFor equivalent regional tools, refer to **Special Tools** .**1-2-3-4 CLUTCH PLATE AND LOW AND REVERSE CLUTCH INSTALLATION****Piston and Spring Installation****Fig. 48: Identifying 1-2-3-4 Clutch Components**

Courtesy of GENERAL MOTORS COMPANY

Piston and Spring Installation

Callout	Component Name
1	<p>1-2-3-4 Clutch Piston</p> <p>NOTE: DT-46623 seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT-46623 seal protector to ease the installation of the piston.</p> <p>Special Tools DT-46623 Piston Seal Protector For equivalent regional tools, refer to Special Tools .</p>

2	1-2-3-4 Clutch Spring
3	<p>1-2-3-4 Clutch Spring Retainer Ring</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure:</p> <ol style="list-style-type: none"> 1. The retainer opening should be supported by a spline tooth of the case. 2. Install DT-46632 spring compressor and DT-48056 spring compressor bridge and retain to the case using 2 case cover assembly bolts. 3. Turn the DT-48056 spring compressor bridge compressor bolt to compress the 1-2-3-4 Clutch Spring until the retaining ring groove is exposed. 4. Push retainer ring into the groove. 5. Remove DT-48056 spring compressor bridge and DT-46632 spring compressor. 6. Air check the piston operation by applying air to the 1-2-3-4 clutch feed passage in the case. 7. Excessive air leaks indicate damage to the clutch piston seal. <p>Tighten 12 N.m (9 lb ft).</p> <p>Special Tools</p> <ul style="list-style-type: none"> • DT-48056 Spring Compressor Bridge • DT-46632 Piston Spring Compressor <p>For equivalent regional tools, refer to <u>Special Tools</u> .</p>

1-2-3-4 Clutch Plates and Low Reverse Clutch Installation

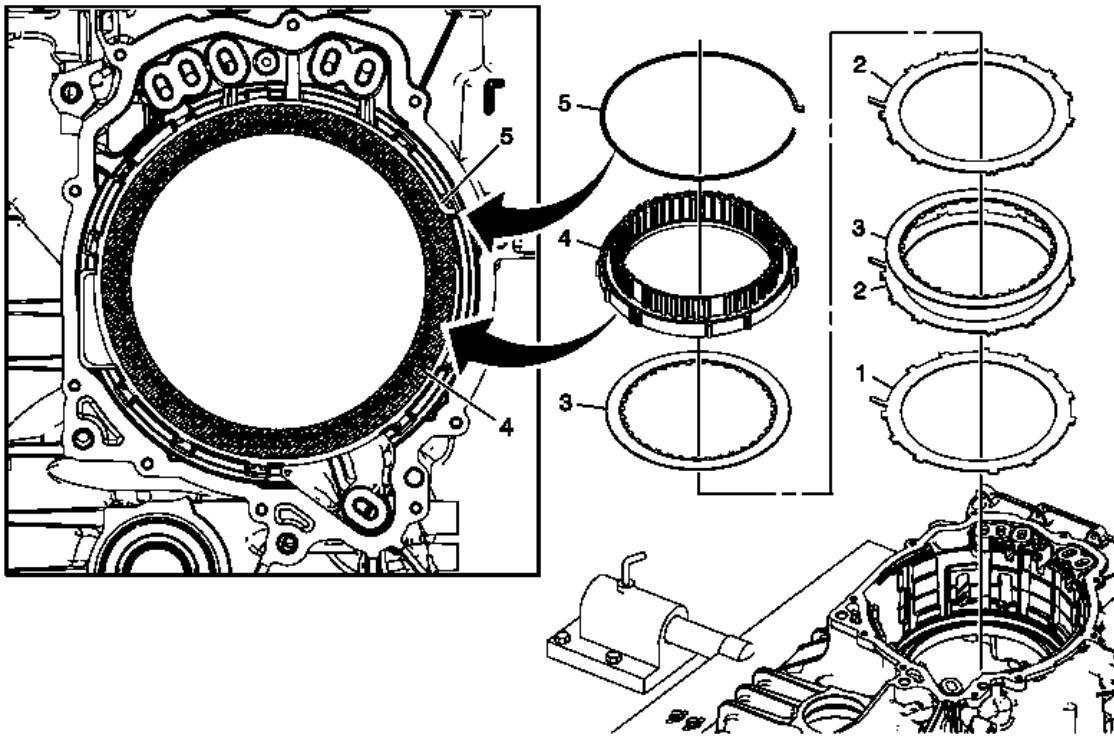


Fig. 49: Identifying 1-2-3-4 Clutch Plates & Low Reverse Clutch Installation Order
 Courtesy of GENERAL MOTORS COMPANY

1-2-3-4 Clutch Plates and Low Reverse Clutch Installation

Callout	Component Name
1	1-2-3-4 Clutch (Waved) Plate NOTE: The tab on the clutch plate faces the bottom of the case.
2	1-2-3-4 Clutch Plate (Qty: 2) NOTE: The tab on the clutch plate faces the bottom of the case.
3	1-2-3-4 Clutch (w/Friction Material) Plate Assembly (Qty: 2)
4	Low and Reverse Clutch Assembly
5	Low and Reverse Clutch Retaining Ring NOTE: The tab needs to go in groove at about 2 o'clock and snap ring opening needs to face 3 o'clock.

Low and Reverse Clutch Plate Installation

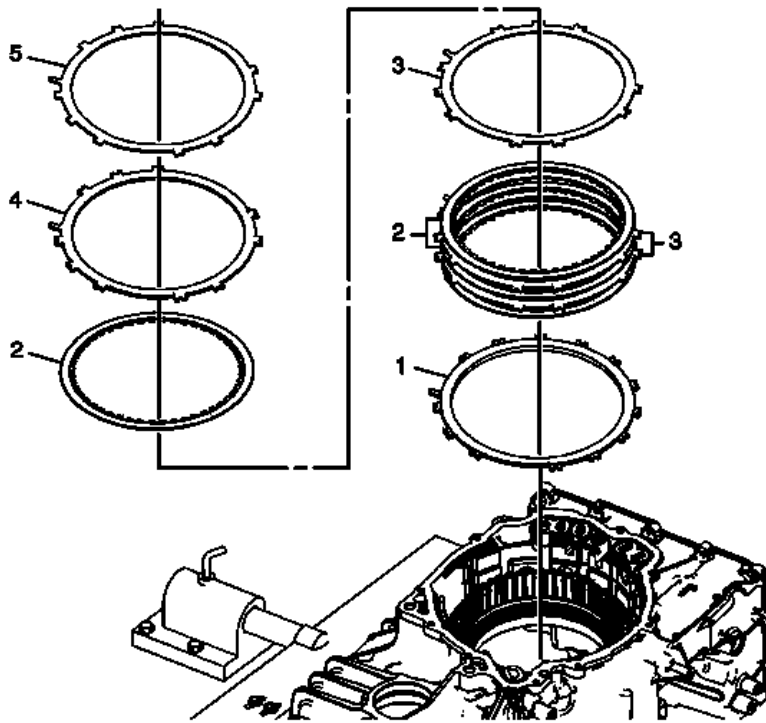


Fig. 50: Identifying Low & Reverse Clutch Plate
 Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Plate Installation

Callout	Component Name
1	Low and Reverse Clutch Backing Plate NOTE: The tab on the clutch plate faces the bottom of the case.
2	Low and Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 4)
3	Low and Reverse Clutch Plate (Qty: 3) NOTE: The tab on the clutch plate faces the bottom of the case.
4	Low and Reverse Clutch Apply Plate NOTE: The tab on the clutch plate faces the bottom of the case.
5	Low and Reverse Clutch Cushion (Waved) Spring NOTE: The tab on the clutch plate faces the bottom of the case.

REACTION CARRIER CLEANING AND INSPECTION

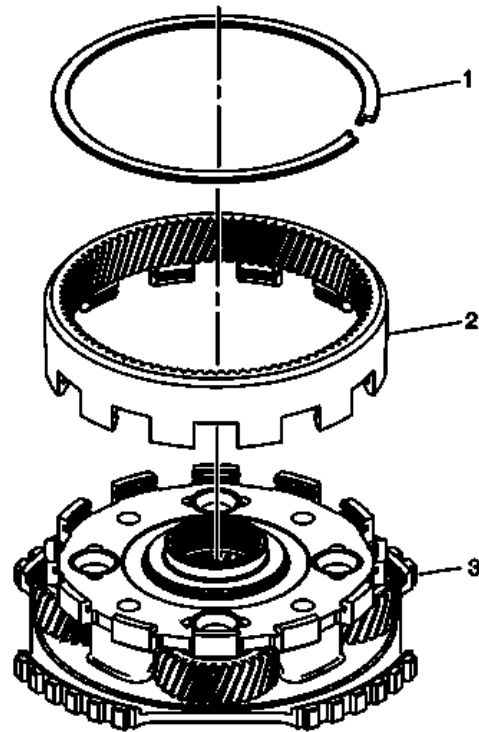


Fig. 51: View Of Reaction Carrier Assembly & Components
 Courtesy of GENERAL MOTORS COMPANY

Reaction Carrier Cleaning and Inspection

Callout	Component Name
Preliminary Procedures	
Clean and Inspect the carrier as an assembly. If wear or damage is found disassemble to replace the affected component.	
1	Input Internal Gear Retaining Ring
2	Input Internal Gear
3	Reaction Carrier Assembly

OUTPUT CARRIER CLEANING AND INSPECTION

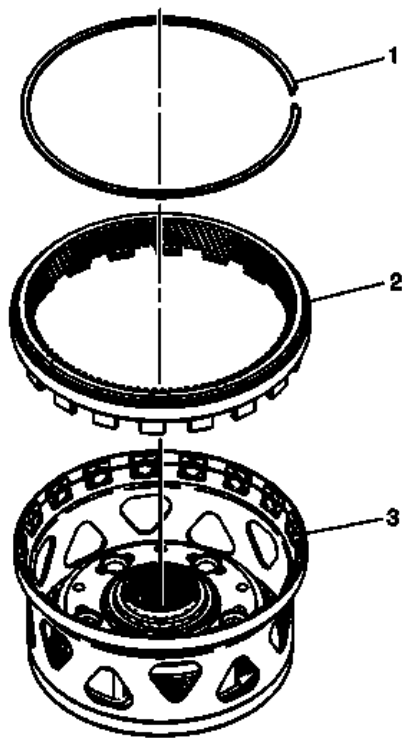


Fig. 52: View Of Output Carrier Components
 Courtesy of GENERAL MOTORS COMPANY

Output Carrier Cleaning and Inspection

Callout	Component Name
Preliminary Procedures	
Clean and Inspect the carrier as an assembly. If wear or damage is found disassemble to replace the affected component.	
1	Reaction Internal Gear Retaining Ring
2	Reaction Carrier Internal Gear
3	Output Carrier Assembly

INPUT, REACTION, AND OUTPUT CARRIER INSTALLATION

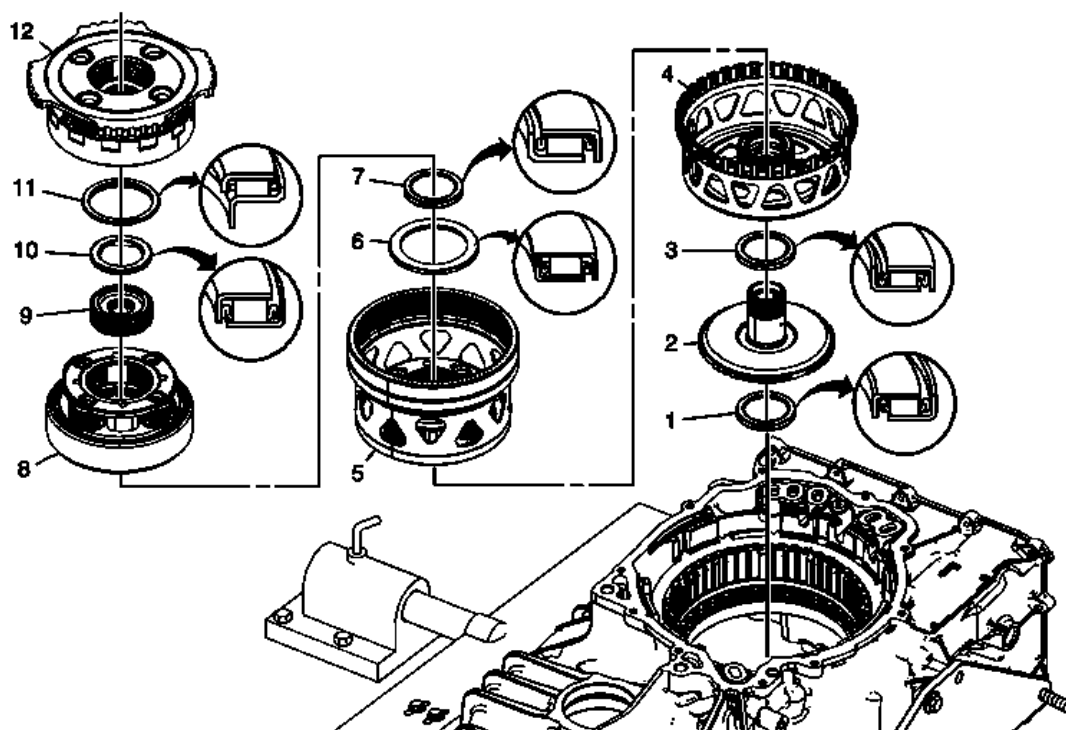


Fig. 53: Identifying Input, Reaction & Output Carrier
 Courtesy of GENERAL MOTORS COMPANY

Input, Reaction, and Output Carrier Installation

Callout	Component Name
Preliminary Procedure	
Note location of the orientation lip on bearings. All thrust bearings can only be assembled one way.	
1	Input Shaft Thrust Bearing Assembly
2	Output Carrier Transfer Drive Gear Hub Assembly
3	Front Differential Transfer Drive Gear Input Hub Bearing Assembly
4	Output Sun Gear Assembly
5	Output Carrier Assembly
6	Output Carrier Thrust Bearing Assembly
7	Output Carrier Thrust Bearing Assembly
8	Input (w/Output Internal Gear) Carrier Assembly
9	Input Sun Gear
10	Input Sun Gear Thrust Bearing Assembly
11	Input Carrier Thrust Bearing Assembly
12	Reaction (w/Input Internal Gear) Carrier Assembly

2-6 CLUTCH PLATE INSTALLATION

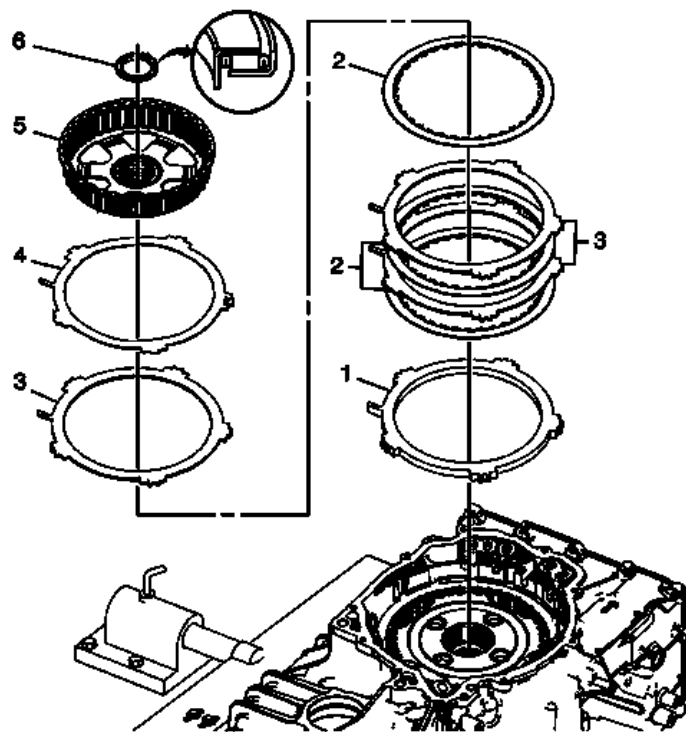


Fig. 54: 2-6 Clutch Plate
Courtesy of GENERAL MOTORS COMPANY

2-6 Clutch Plate Installation

Callout	Component Name
1	2-6 Clutch Backing Plate NOTE: The tab on the clutch plate faces the bottom of the case.
2	2-6 Clutch (w/Friction Material) Plate Assembly (Qty: 3)
3	2-6 Clutch Plate (Qty: 3) NOTE: The tab on the clutch plate faces the bottom of the case.
4	2-6 Clutch Cushion Spring
5	Reaction Sun Gear Assembly
6	2-6 Clutch Hub Thrust Bearing Assembly NOTE: Note location of the orientation lip on bearing. All thrust bearings can only be assembled one way.

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING DISASSEMBLE

Reluctor Wheel and Piston Removal

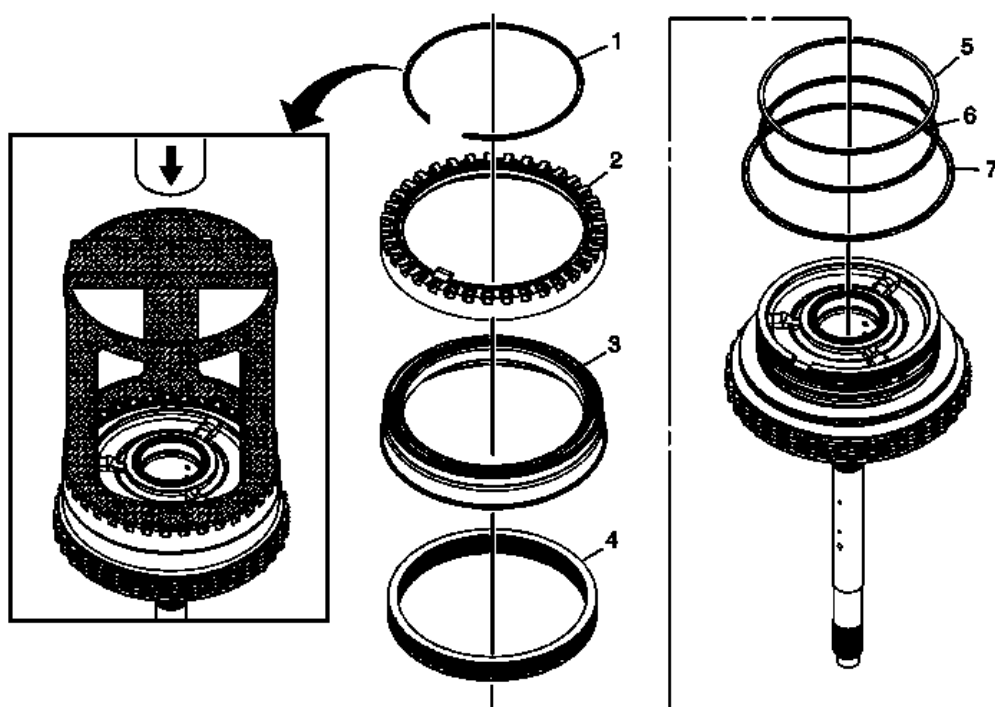


Fig. 55: View Of Input Shaft Speed Sensor Reluctor Wheel Piston & 3-5 Reverse Clutch Piston
 Courtesy of GENERAL MOTORS COMPANY

Reluctor Wheel and Piston Removal

Callout	Component Name
1	A/Trans Input Shaft Speed Sensor Reluctor Ring Retaining Ring CAUTION: Compress the reluctor wheel just enough to clear the retainer. Over compressing the reluctor wheel will break the alignment tab and the clutch housing. Special Tools DT-47694 Piston Spring Compressor For equivalent regional tools, refer to Special Tools .
2	A/Trans Input Shaft Speed Sensor Reluctor Wheel
3	3-5 Reverse Clutch Piston NOTE: Inspect piston seals for damage and/or wear. Piston is reusable.
4	3-5 Reverse Clutch Spring Assembly
5	3-5 Reverse Clutch Piston Inner Seal (Orange)
6	3-5 Reverse Clutch Piston Inner Seal (Black)
7	3-5 Reverse Clutch Piston Dam Seal

Clutch Plate Removal

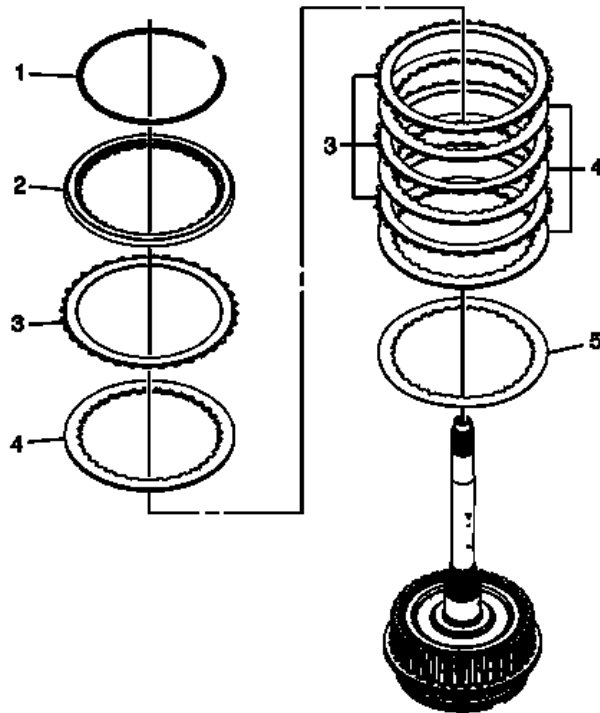


Fig. 56: Clutch Plate

Courtesy of GENERAL MOTORS COMPANY

Clutch Plate Removal

Callout	Component Name
1	3-5 Reverse Clutch Backing Plate Retaining Ring
2	3-5 Reverse Clutch Backing Plate
3	3-5 Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 4)
4	3-5 Reverse Clutch Plate (Qty: 4)
5	3-5 Reverse Clutch (Waved) Plate

4-5-6 Clutch Hub Removal

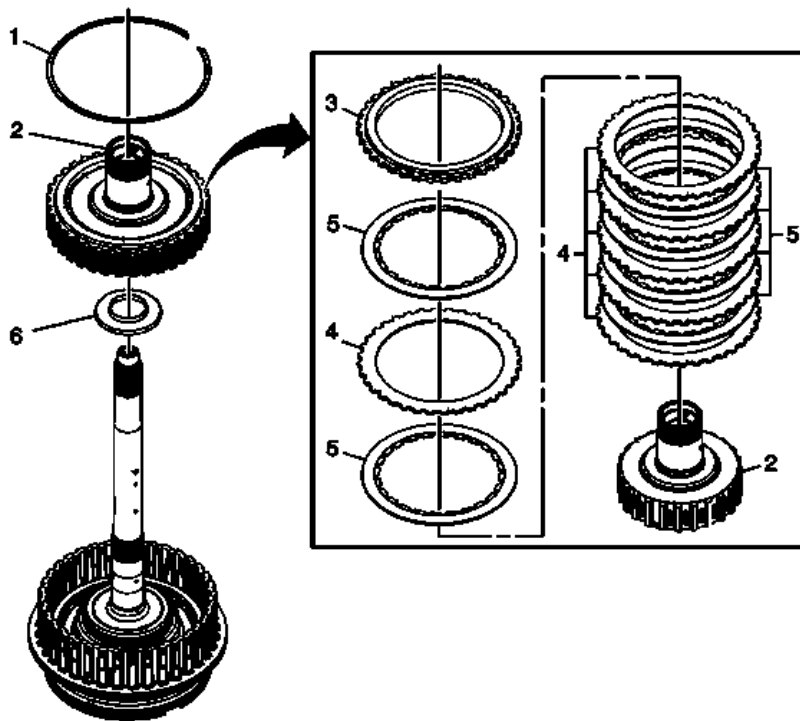


Fig. 57: 4-5-6 Clutch Hub
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Hub Removal

Callout	Component Name
1	4-5-6 Backing Plate Retaining Ring NOTE: Gently push down on the backing plate to get enough clearance between the backing plate and retainer.
2	Reaction Carrier Hub Assembly NOTE: The clutch plates will come out of the housing with the hub assembly.
3	4-5-6 Clutch Backing Plate
4	4-5-6 Clutch Plate (Qty: 6)
5	4-5-6 Clutch (w/Friction Material) Plate Assembly (Qty: 6)
6	4-5-6 Clutch Hub Thrust Bearing Assembly NOTE: The bearing may stick to the reaction carrier hub.

4-5-6 Clutch Piston Removal

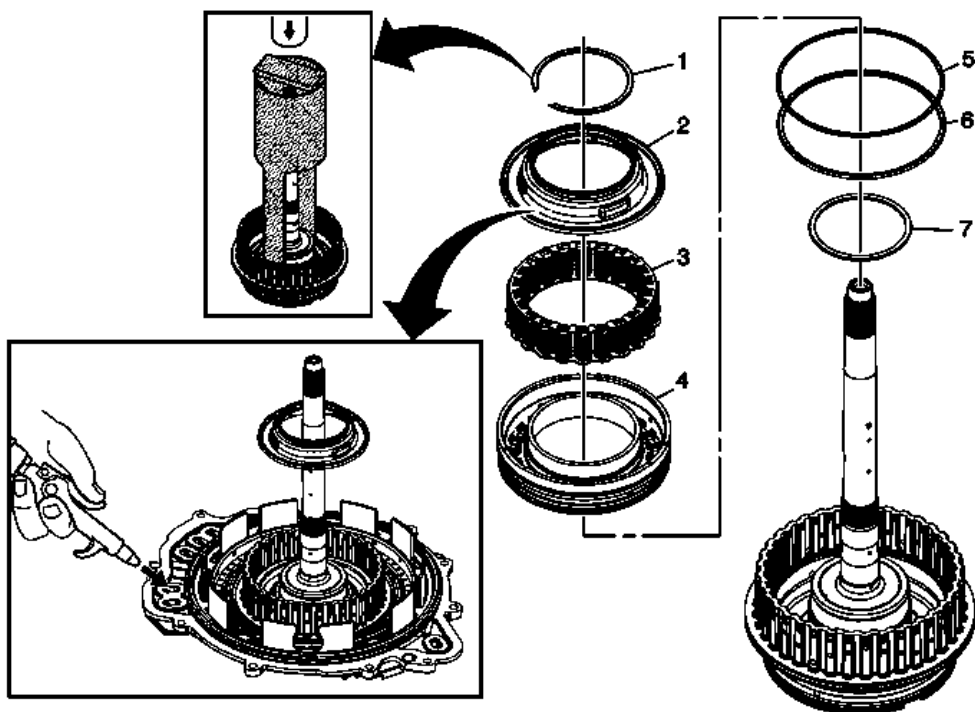


Fig. 58: 4--5--6 Clutch Spring Assembly
 Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Piston Removal

Callout	Component Name
1	4-5-6 Clutch Dam Retaining Ring Special Tools <ul style="list-style-type: none"> • DT-47693 Dam Protector • GE 8059 Snap Ring Pliers-Parallel Jaw or equivalent For equivalent regional tools, refer to Special Tools .
2	4-5-6 Clutch Piston Fluid Dam Procedure: <ol style="list-style-type: none"> 1. Place the 3-5-R and 4-5-6 clutch housing onto the case cover assembly. 2. Apply shop air to the 4-5-6 clutch feed hole using a rubber tipped air gun to dislodge the dam piston and the 4-5-6 clutch piston from the clutch housing.
3	4-5-6 Clutch Spring Assembly
4	4-5-6 Clutch Piston
5	4-5-6 Clutch Piston Outer Seal (Stepped)
6	4-5-6 Clutch Piston Outer Seal (Rounded)

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING ASSEMBLE

4-5-6 Clutch Piston Installation

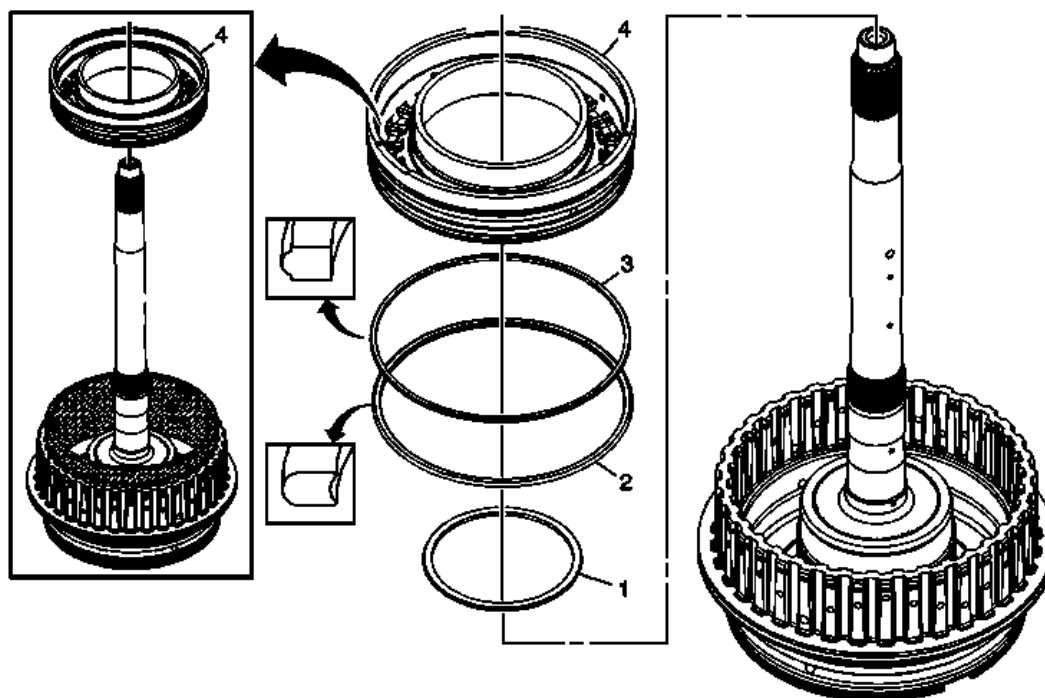


Fig. 59: Identifying 4-5-6 Clutch Piston

Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Piston Installation

Callout	Component Name
1	4-5-6 Clutch Piston Inner Seal
2	4-5-6 Clutch Piston Outer Seal (Rounded)
3	4-5-6 Clutch Piston Outer Seal (Stepped) (Orange)
4	<p>4-5-6 Clutch Piston</p> <p>NOTE: DT-47859 outer seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT-47859 outer seal protector to ease the installation of the piston.</p> <p>Special Tools DT-47859 Piston Outer Seal Protector For equivalent regional tools, refer to Special Tools .</p>

4-5-6 Clutch Dam Installation

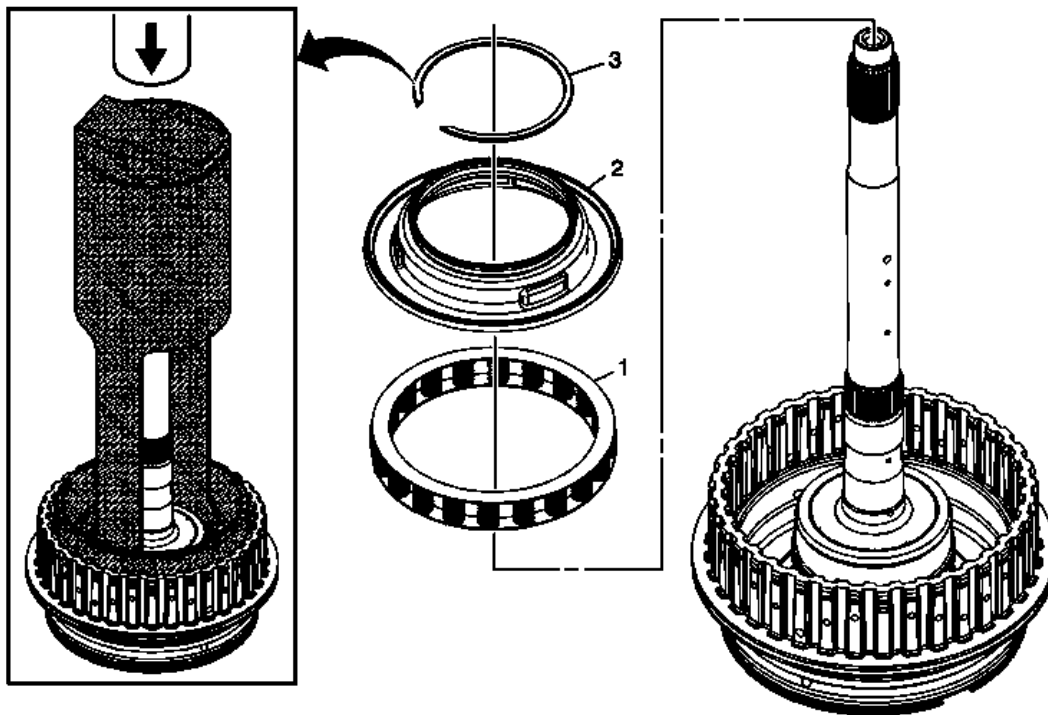


Fig. 60: View Of 4-5-6 Clutch Dam
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Dam Installation

Callout	Component Name
1	4-5-6 Clutch Spring
2	<p>4-5-6 Clutch Piston Fluid Dam</p> <p>NOTE: DT 47693-1 which is part of DT-47693 dam protector prevents the dam seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT 47693-1 which is part of DT-47693 dam protector to ease the installation of the dam.</p> <p>Special Tools DT-47693 Dam Protector For equivalent regional tools, refer to Special Tools .</p>
3	<p>4-5-6 Clutch Dam Retaining Ring</p> <p>Special Tools</p> <ul style="list-style-type: none"> DT 47693-2 Clutch Spring Compressor which is part of DT-47693 Dam Protector GE 8059 Snap Ring Pliers-Parallel Jaw or equivalent

For equivalent regional tools, refer to **Special Tools** .

4-5-6 Clutch Plates Installation

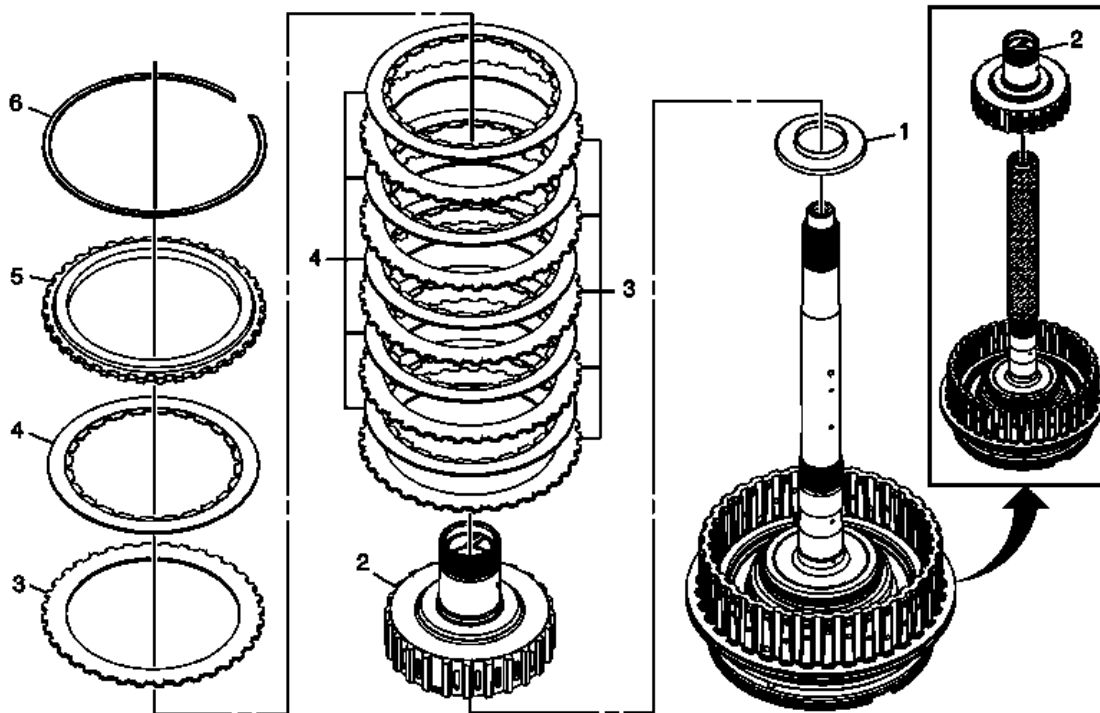


Fig. 61: Locating 4-5-6 Clutch Plates
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Plates Installation

Callout	Component Name
1	4-5-6 Clutch Hub Thrust Bearing NOTE: Note location of the orientation lip on bearing. All thrust bearings can only be assembled one way.
2	Reaction Carrier Hub Assembly CAUTION: Failure to use DT 48551 could cause damage to the hub assembly bushings which could cause premature transmission failure. Special Tools DT-48551 Reaction Hub Bushing Protector For equivalent regional tools, refer to Special Tools .

3	4-5-6 Clutch Plate (Qty: 6)
4	4-5-6 Clutch (w/Friction Material) Plate Assembly (Qty: 6)
5	4-5-6 Clutch Backing Plate
6	4-5-6 Clutch Backing Plate Retaining Ring
	NOTE: Gently push down on the backing plate to get enough clearance between the backing plate and retainer.

3-5 Reverse Clutch Plates Installation

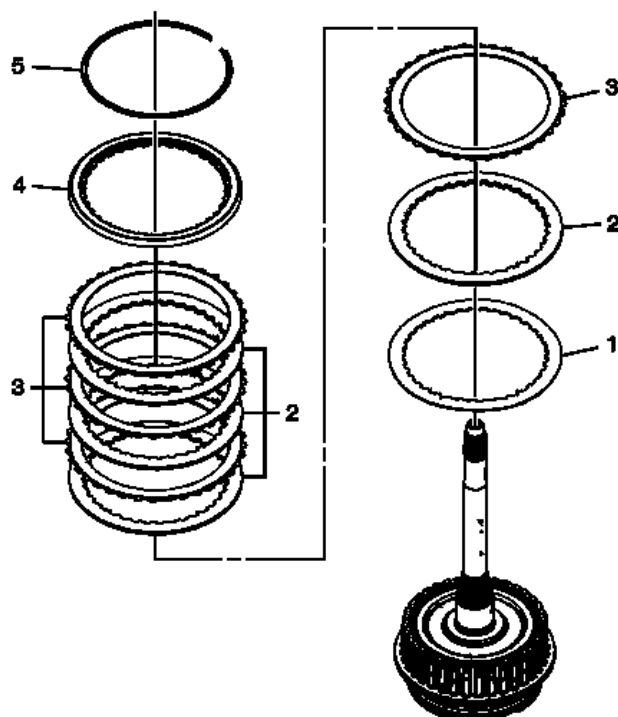


Fig. 62: Identifying 3-5 Reverse Clutch Plates
Courtesy of GENERAL MOTORS COMPANY

3-5 Reverse Clutch Plates Installation

Callout	Component Name
1	3-5 Reverse Clutch (Waved) Plate
2	3-5 Reverse Clutch Plate (Qty: 4)
3	3-5 Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 4)
4	3-5 Reverse Clutch Backing Plate
5	3-5 Reverse Clutch Backing Plate Retaining Ring

Piston and Reluctor Wheel Installation

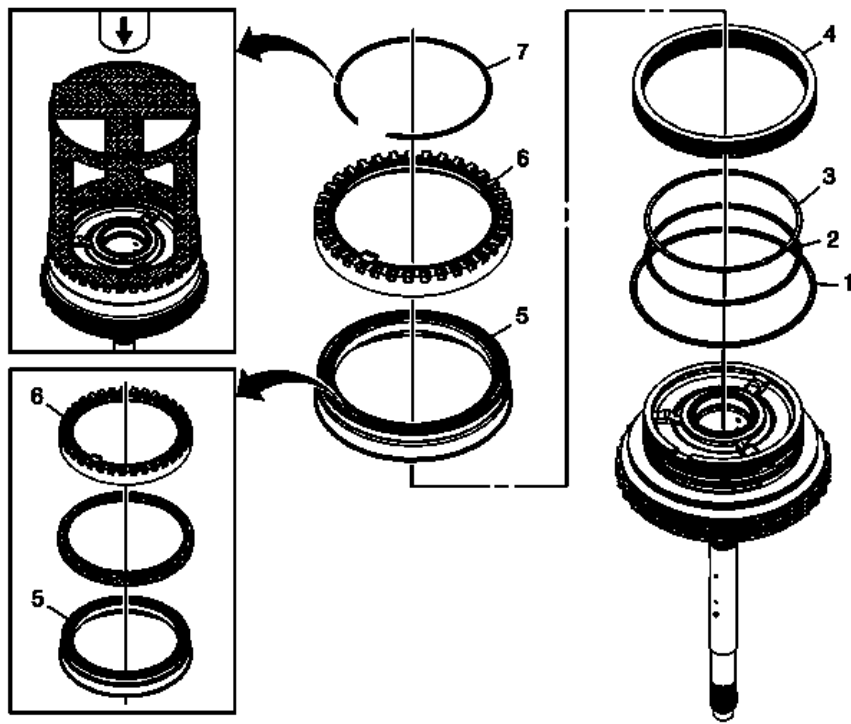


Fig. 63: View Of Piston & Reluctor Wheel
 Courtesy of GENERAL MOTORS COMPANY

Piston and Reluctor Wheel Installation

Callout	Component Name
1	3-5 Reverse Clutch Piston Dam Seal
2	3-5 Reverse Clutch Piston Inner Seal (Black) NOTE: Apply a thin coat of ATF to the seal to ease the installation of the piston.
3	3-5 Reverse Clutch Piston Inner Seal (Orange) NOTE: Apply a thin coat of ATF to the seal to ease the installation of the piston.
4	3-5 Reverse Clutch Spring Assembly
5	3-5 Reverse Clutch Piston NOTE: <ul style="list-style-type: none"> DT-46622 seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT-46622 seal protector to ease the installation of the piston. Install DT-46622 seal protector onto the speed sensor reluctor wheel. Push the 3-5 Reverse Clutch piston into the reluctor wheel until it stops against J-46622 seal protector. Remove DT-46622 seal protector by separating it at the opening.

	Special Tools DT-46622 Piston Seal Protector For equivalent regional tools, refer to Special Tools .
6	A/Trans Input Shaft Speed Sensor Reluctor Wheel
7	A/Trans Input Shaft Speed Sensor Reluctor Wheel Retaining Ring CAUTION: Compress the reluctor wheel just enough to clear the retainer ring groove. Over compressing the reluctor wheel will break the alignment tab and the clutch housing. Special Tools DT-47694 Piston Spring Compressor For equivalent regional tools, refer to Special Tools .

3-5-R and 4-5-6 Clutch Piston Air Check

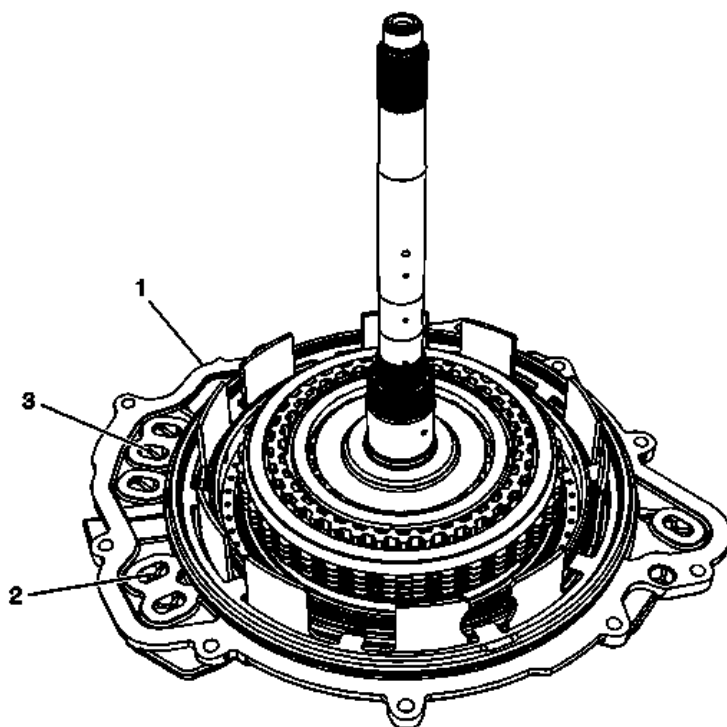


Fig. 64: View of 35R and 4-5-6 Clutch Piston Air Check
Courtesy of GENERAL MOTORS COMPANY

3-5-R and 4-5-6 Clutch Piston Air Check

Callout	Component Name
1	Case Cover Assembly

	<p>NOTE: The fluid seal rings should be in place and not damaged.</p>
2	<p>4-5-6 Clutch Feed Fluid Passage</p> <p>CAUTION: Regulate the air pressure to 40 psi maximum. High pressure could cause the piston to over travel and damage the piston seals.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Apply shop air to the 4-5-6 clutch feed passage. 2. Observe the 4-5-6 piston movement. <p>NOTE: Minimal piston movement and excessive air leaking could indicate damage to the 4-5-6 piston seals or improper assembly.</p>
3	<p>3-5 Rev Clutch Feed Fluid Passage</p> <p>CAUTION: Regulate the air pressure to 40 psi maximum. High pressure could cause the piston to over travel and damage the piston seals.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Apply shop air to the 3-5-Rev clutch feed passage. 2. Observe the 3-5-Rev piston movement. <p>NOTE: Minimal piston movement and excessive air leaking could indicate damage to the 3-5-Rev piston seals or improper assembly.</p>

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING INSTALLATION

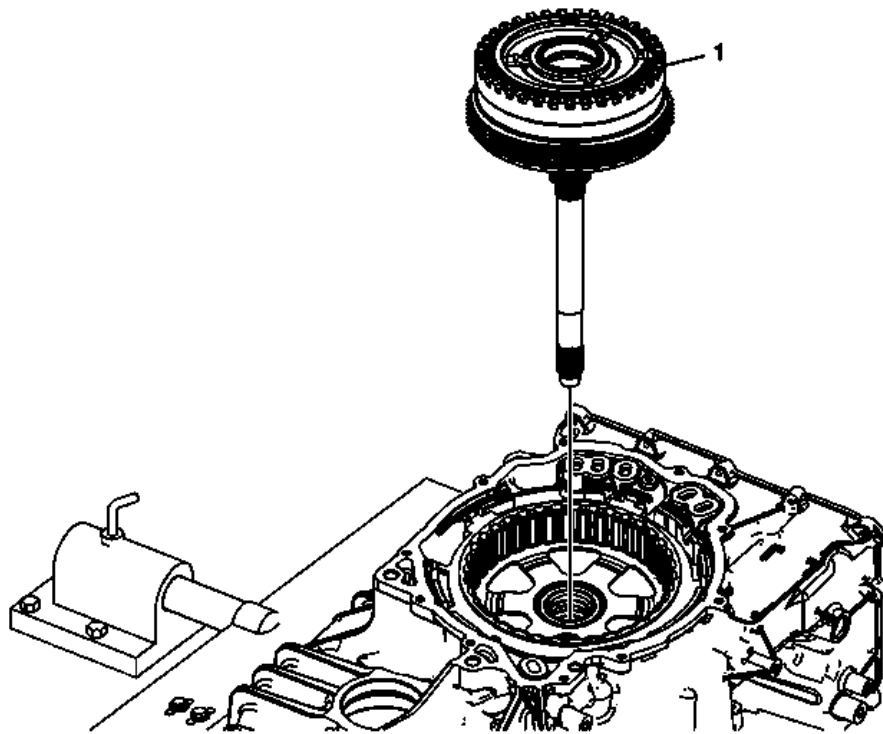


Fig. 65: Identifying 3-5 Reverse & 4-5-6 Clutch Housing
 Courtesy of GENERAL MOTORS COMPANY

3-5-Reverse and 4-5-6 Clutch Housing Installation

Callout	Component Name
1	3-5 Reverse and 4-5-6 Clutch Assembly NOTE: Rotate the assembly back and forth to align the 3-5 reverse clutch plates with the reaction sun gear housing.

CASE COVER ASSEMBLY DISASSEMBLE

ISS Removal

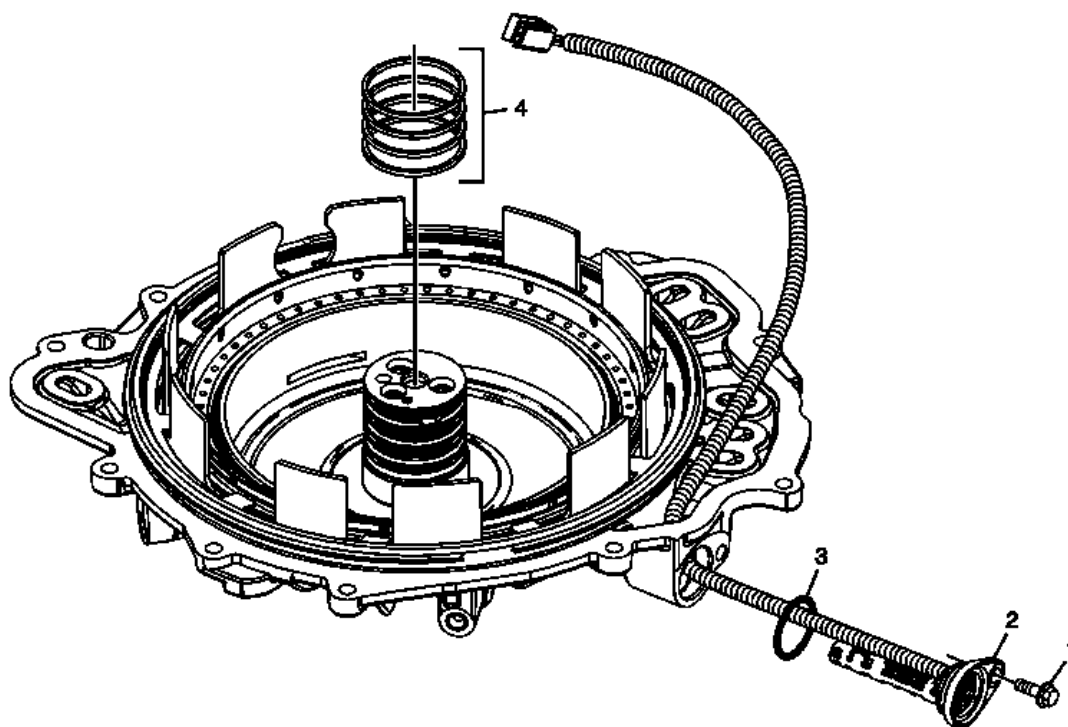


Fig. 66: View Of 3-5 Reverse & 4-5-6 Clutch Fluid Seal Ring
 Courtesy of GENERAL MOTORS COMPANY

ISS Removal

Callout	Component Name
1	A/Trans Input Speed Sensor Bolt M6 x 25
2	A/Trans Input Speed Sensor
3	A/Trans Input Speed Sensor Seal NOTE: Discard the seal.
4	3-5 Reverse and 4-5-6 Clutch Fluid Seal Ring NOTE: Discard the seals.

Low and Reverse Clutch Piston Removal

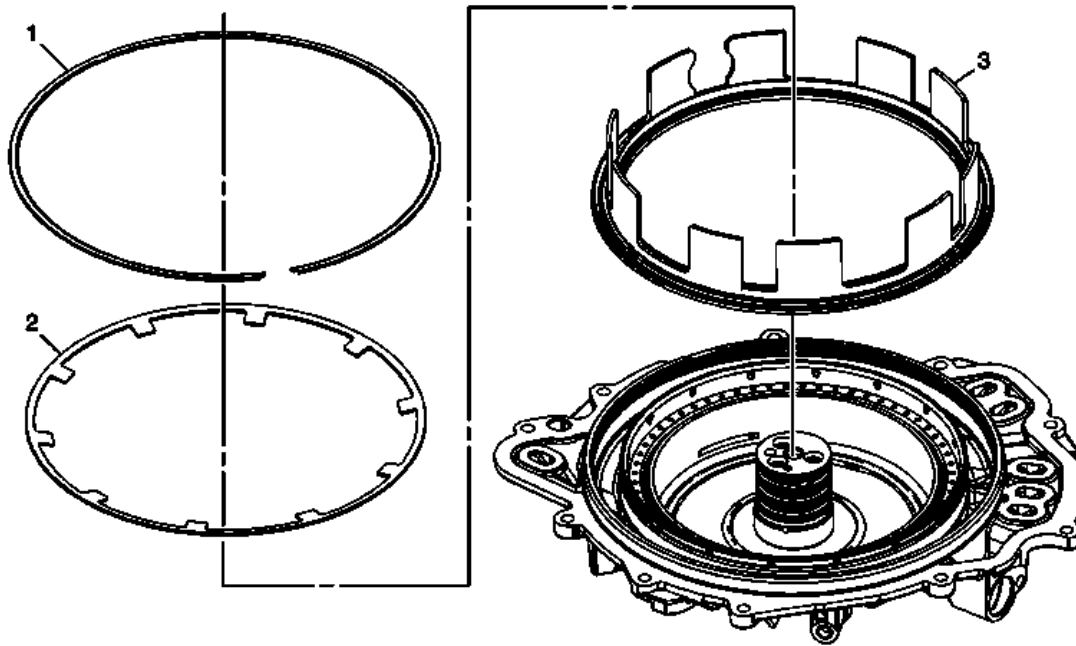


Fig. 67: Identifying Low & Reverse Clutch Piston
 Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Piston Removal

Callout	Component Name
1	Low and Reverse Clutch Spring Retaining Ring
2	Low and Reverse Clutch Spring
3	Low and Reverse Clutch Piston Assembly NOTE: Inspect piston seals for damage and/or wear. Piston is reusable.

2-6 Clutch Piston Removal

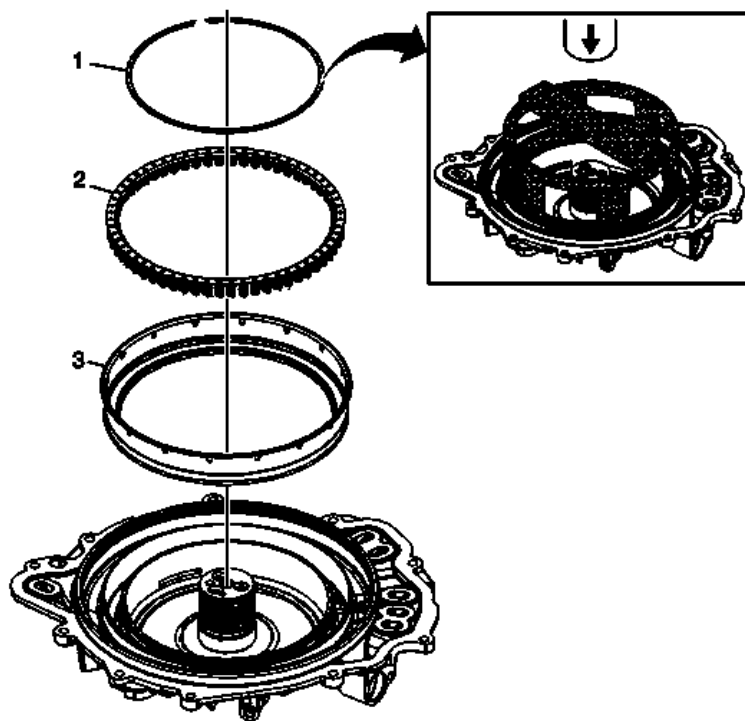


Fig. 68: View Of 2-6 Clutch Piston
 Courtesy of GENERAL MOTORS COMPANY

2-6 Clutch Piston Removal

Callout	Component Name
1	2-6 Clutch Spring Retaining Ring Special Tools DT-46632 Spring Compressor For equivalent regional tools, refer to Special Tools .
2	2-6 Clutch Spring Assembly
3	2-6 Clutch Piston NOTE: Inspect piston seals for damage and/or wear. Piston is reusable.

Clean and Inspect

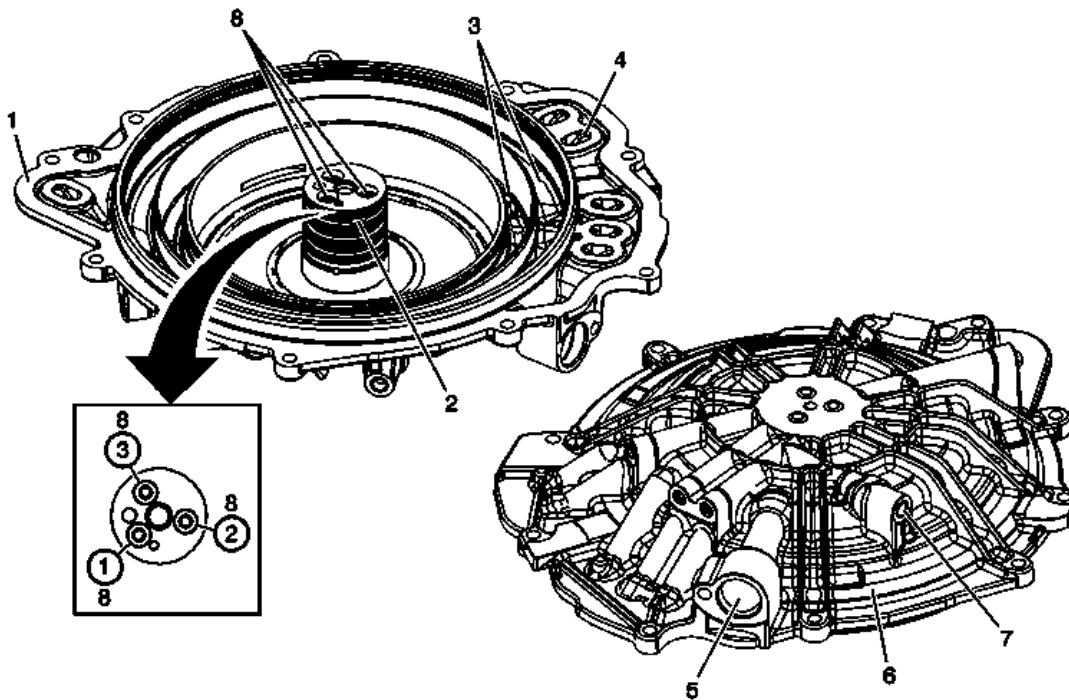


Fig. 69: Identifying Case Cover Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Clean and Inspect

Callout	Component Name
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	
CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.	
Preliminary Procedures <ol style="list-style-type: none"> 1. Thoroughly clean the case cover assembly, including threads, with clean solvent. 2. Clean gasket sealing surfaces. Remove all residual gasket material. 3. Inspect all threaded holes. If necessary, repair any thread damage. 	
1	Gasket Sealing Surface
2	Fluid Passages
3	Piston Bores
4	Cover to Case Passages
5	A/Trans Input Speed Sensor Assembly Bore
6	Cover Casting

7	Passage Cup Plugs Input Shaft Support Bolts
8	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Tightened bolts in sequence. Tighten 12 N.m (106 lb in).</p>

CASE COVER ASSEMBLY ASSEMBLE

Fluid Seal Ring Installation

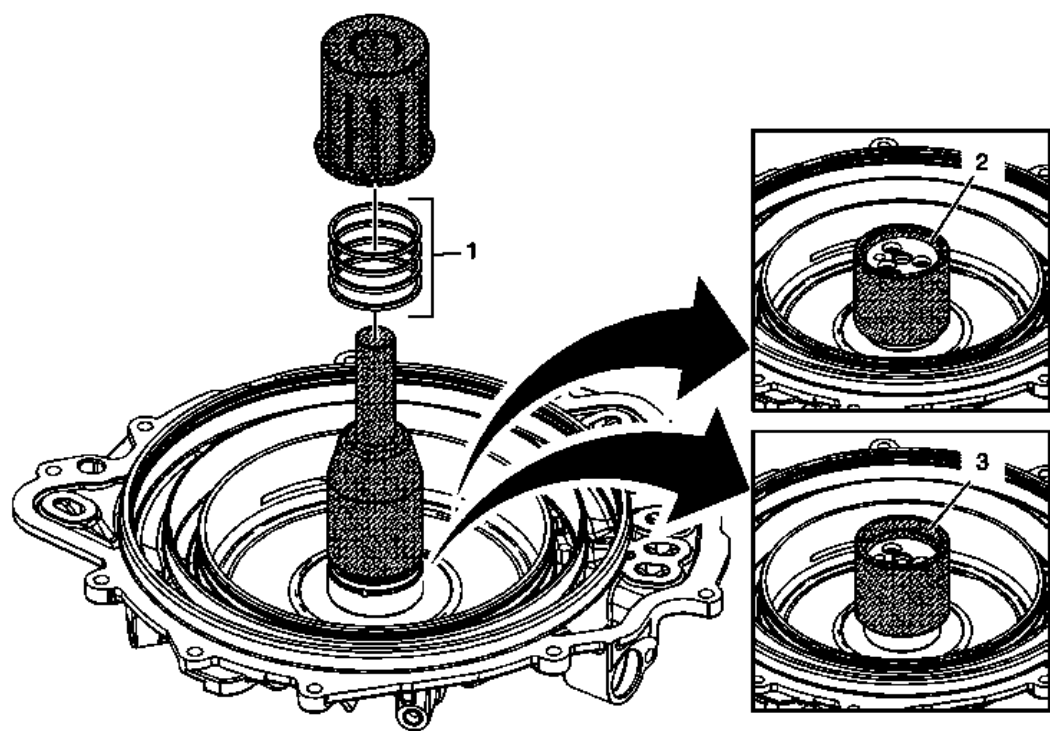


Fig. 70: Identifying Fluid Seal Ring
Courtesy of GENERAL MOTORS COMPANY

Fluid Seal Ring Installation

Callout	Component Name
	3-5 Reverse and 4-5-6 Clutch Fluid Seal Ring Procedure

1	<ol style="list-style-type: none"> 1. Place DT 46620-3 which is part of DT-46620 seal installer over the case cover hub and adjust it so that only the bottom seal ring is exposed. 2. Place a NEW fluid seal ring onto DT 46620-3 which is part of DT-46620 seal installer. 3. Use DT 46620-2 which is part of DT-46620 seal installer to push the fluid seal ring down over DT 46620-3 which is part of DT-46620 seal installer into the hub ring groove. 4. Repeat the above steps to install all 4 seal rings, adjusting DT 46620-3 which is part of DT-46620 seal installer to the appropriate ring groove. <p>Special Tools DT-46620 Seal Installer For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	<p>Small Chamfer Up</p> <p>CAUTION: Do not force the seal installer down over the seals as this will roll and damage the seals. The large chamfer is designed to fit over the over stretched seal. Use a hand to help shrink the seal if the seal installer is difficult to install over the seal rings.</p> <p>Procedure Install DT 46620-1 which is part of DT-46620 seal installer with the large chamfer end down over the fluid seal rings and leave DT 46620-1 which is part of DT-46620 seal installer on the seals for at least 60 seconds.</p>
3	<p>Large Chamfer Up</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Install DT 46620-1 which is part of DT-46620 seal installer with the small chamfer end facing down for at least 60 seconds. This will properly size the bottom seal ring. 2. Leaving DT 46620-1 which is part of DT-46620 seal installer on the fluid seal rings for an extended period of time could cause a fluid leak on the initial clutch piston circuit until the seal rings warm up and expand to the proper dimension.

2-6 Clutch Piston Installation

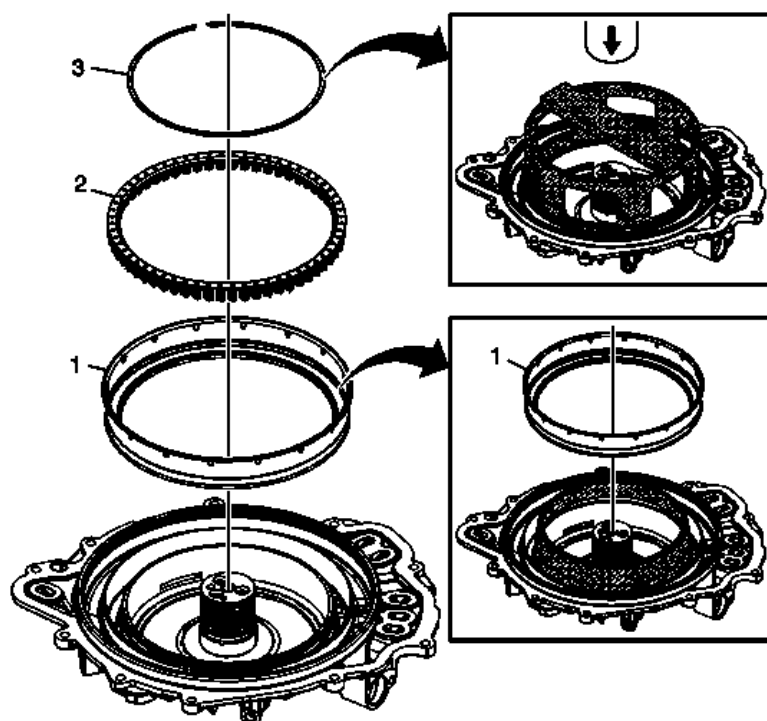


Fig. 71: View Of 2-6 Clutch Piston

Courtesy of GENERAL MOTORS COMPANY

2-6 Clutch Piston Installation

Callout	Component Name
1	<p>2-6 Clutch Piston</p> <p>Procedure DT-46621 seal protector prevents the piston seal lip from damage over the retaining ring groove during installation. Apply a thin coat of ATF to the O.D. of DT-46621 seal protector to ease the installation of the piston.</p> <p>Special Tools DT-46621 Seal Protector For equivalent regional tools, refer to Special Tools .</p>
2	<p>2-6 Clutch Spring Assembly</p>
3	<p>2-6 Clutch Spring Assembly</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Install the retaining ring with the opening positioned to the top of the case cover. 2. Place the retainer ring inside DT-46632 spring compressor prior to placing DT-46632 spring compressor onto the spring. <p>Special Tools DT-46632 Spring Compressor For equivalent regional tools, refer to Special Tools .</p>

Low and Reverse Clutch Piston Installation

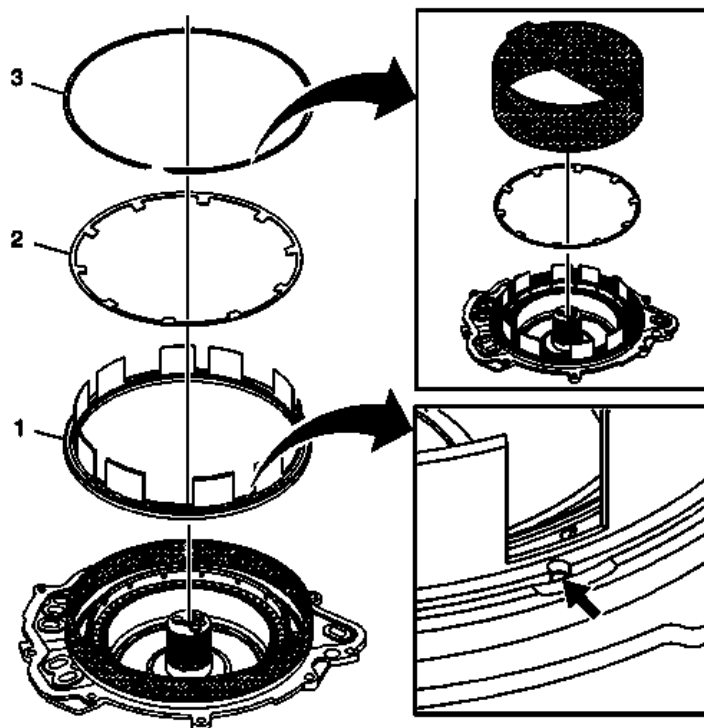


Fig. 72: Identifying Low & Reverse Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Piston Installation

Callout	Component Name
	Low and Reverse Clutch Piston Assembly
1	<p>Procedure</p> <ol style="list-style-type: none"> 1. Install the L/R piston with the air bleed positioned at the alignment feature on the cover, using DT-46628-1 seal protector. This will orient the piston fingers with the openings in the case. 2. DT-46628-1 seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT-46628-1 seal protector to ease the installation of the piston. <p>Special Tools DT-46628-1 Piston Seal Protector For equivalent regional tools, refer to Special Tools .</p>
2	Low and Reverse Clutch Spring
	Low and Reverse Clutch Spring Retaining Ring
	NOTE:

3

Do not align the retainer opening with other retaining ring openings.

Special Tools

DT-46628-2 Spring Compressor

For equivalent regional tools, refer to Special Tools .

2-6 and Low-Reverse Piston Function Inspection

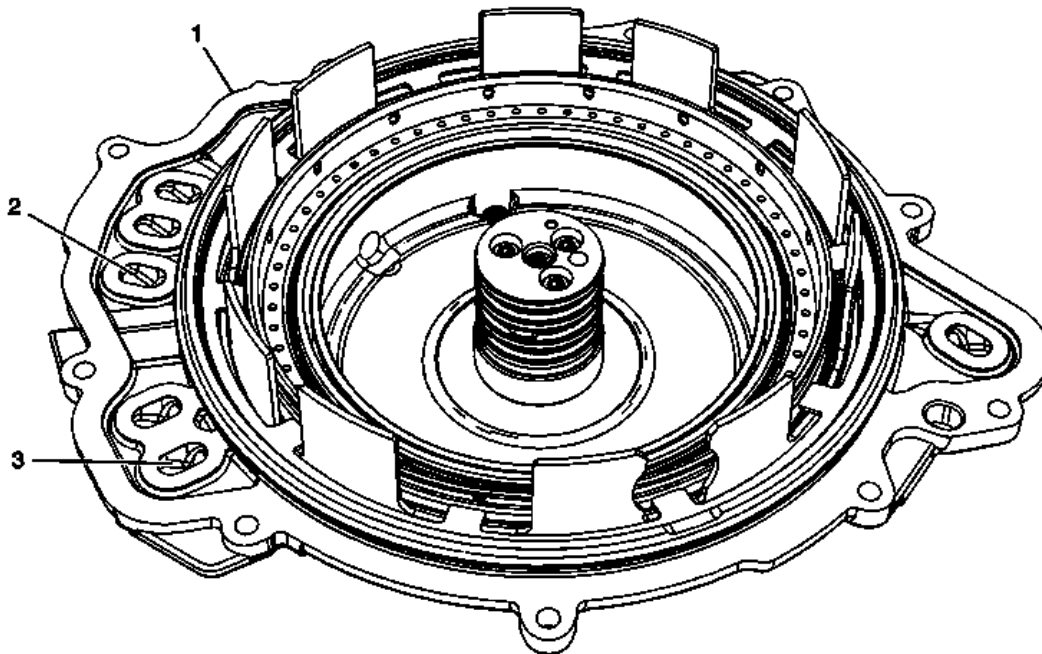


Fig. 73: 2-6 and Low-Reverse Piston Function Inspection
Courtesy of GENERAL MOTORS COMPANY

2-6 and Low-Reverse Piston Function Inspection

Callout	Component Name
1	Case Cover Assembly NOTE: The fluid seal rings should be in place and not damaged.
2	2-6 Clutch Feed Passage CAUTION: Regulate the air pressure to 40 psi maximum. High pressure could cause the piston to over travel and damage the piston seals.

	<p>Procedure Apply shop air to the 2-6 clutch feed. Observe the 2-6 piston movement.</p> <p>NOTE: Minimal piston movement and excessive air leaking could indicate damage to the 2-6 piston seals or improper assembly.</p>
3	<p>Low and Reverse Clutch Feed Passage</p> <p>CAUTION: Regulate the air pressure to 40 psi maximum. High pressure could cause the piston to over travel and damage the piston seals.</p> <p>Procedure Apply shop air to the Low and Reverse clutch feed. Observe the Low and Reverse piston movement.</p> <p>NOTE: Minimal piston movement and excessive air leaking could indicate damage to the Low and Reverse piston seals or improper assembly.</p>

Input Speed Sensor Installation

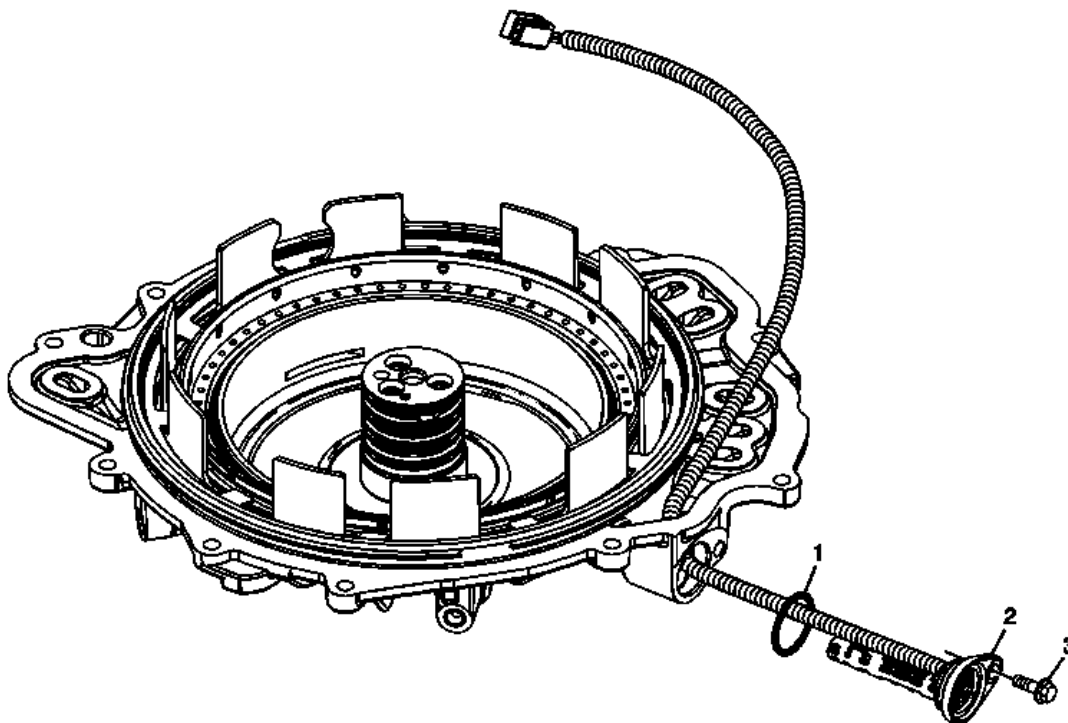


Fig. 74: View Of Input Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

Input Speed Sensor Installation

Callout	Component Name
1	Input Speed Sensor Seal
2	A/Trans Input Speed Sensor Assembly
3	<p>A/Trans Input Speed Sensor Bolt M6 x 25</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Apply threadlocker or equivalent to the input speed sensor bolt. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .</p> <p>NOTE: The seal is coated with a dry lubricant. If the coating is missing, lubricate the seal with automatic transmission fluid prior to installation.</p> <p>Tighten 9 N.m (7 lb ft)</p>

CASE COVER ASSEMBLY INSTALLATION

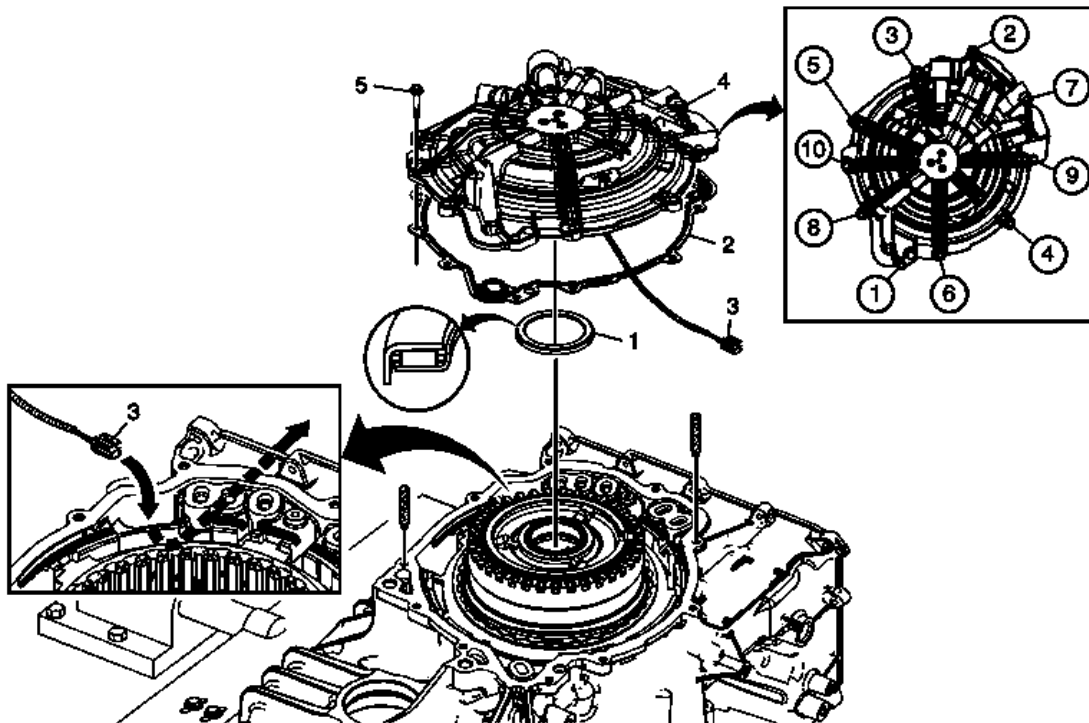


Fig. 75: Identifying Case Cover Assembly Components

Courtesy of GENERAL MOTORS COMPANY

Case Cover Assembly Installation

Callout	Component Name
1	Input Shaft Thrust Bearing NOTE: Note location of the orientation lip on bearing. All thrust bearings can only be assembled one way.
2	A/Trans Case Cover Gasket
3	Input Speed Sensor Wire Harness NOTE: Route the input speed sensor wire harness through the case passage.
4	A/Trans Case Cover Assembly Procedure <ol style="list-style-type: none">1. Use guide pins to install the case cover assembly to prevent damage to the input shaft thrust bearing.2. Pull the input speed sensor wire harness through the case passage while lowering the cover assembly onto the case. Special Tools 39068 Guide Pins For equivalent regional tools, refer to Special Tools .
5	A/Trans Case Cover Assembly Bolt M6 x 30 (Qty: 10) CAUTION: Refer to Fastener Caution . Procedure Tighten in sequence shown. Tighten 12 N.m (106 lb in)

FRONT DIFFERENTIAL CARRIER FINAL ROTATIONAL TORQUE MEASUREMENT

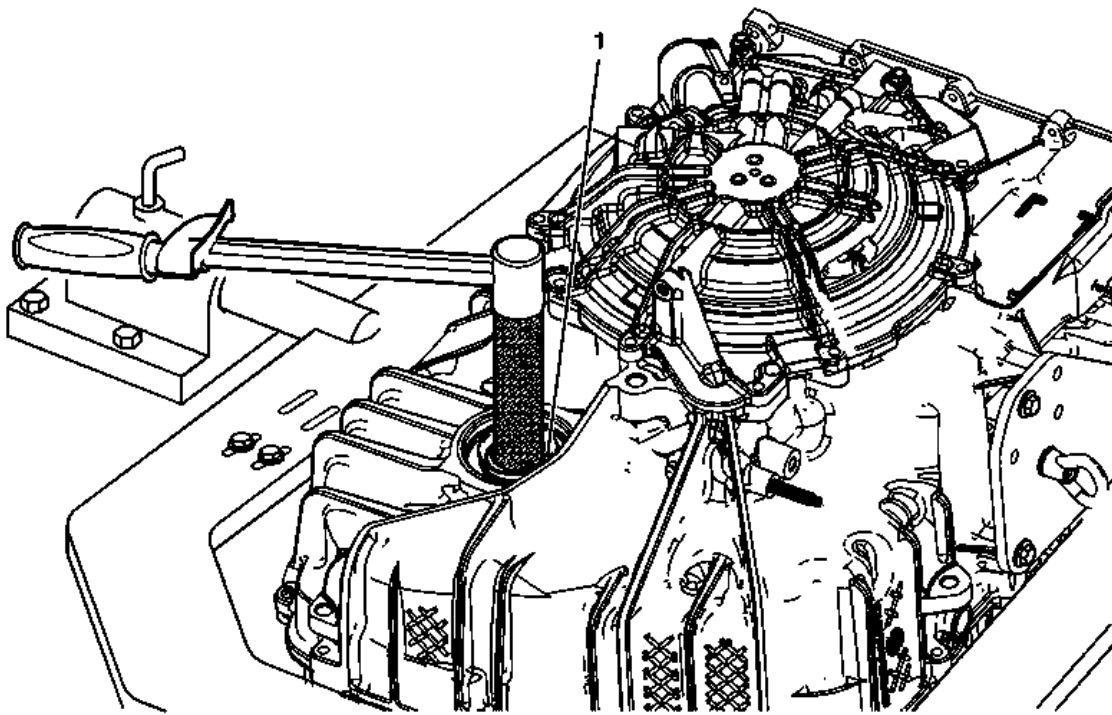


Fig. 76: Differential Rotating Tool
 Courtesy of GENERAL MOTORS COMPANY

Front Differential Carrier Final Rotational Torque Measurement

Callout	Component Name
1	<p>Front Differential Carrier Assembly</p> <p>CAUTION: Low bearing pre-load will cause premature failure of the front differential drive pinion gear.</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>NOTE:</p> <ul style="list-style-type: none"> • If the turning torque is not within specifications, the transfer gear assembly and differential bearing thrust washer is incorrect and must be corrected. Refer to <u>Front Differential Drive Pinion Gear Bearing Thrust Washer and Front Differential Bearing Washer Measurement</u>. • Use a dial or beam torque wrench with DT-47793 differential rotating tool to measure turning torque. <p>Tighten 14-22 (10-16 lb ft) Special Tools</p>

CONTROL VALVE BODY ASSEMBLY DISASSEMBLE

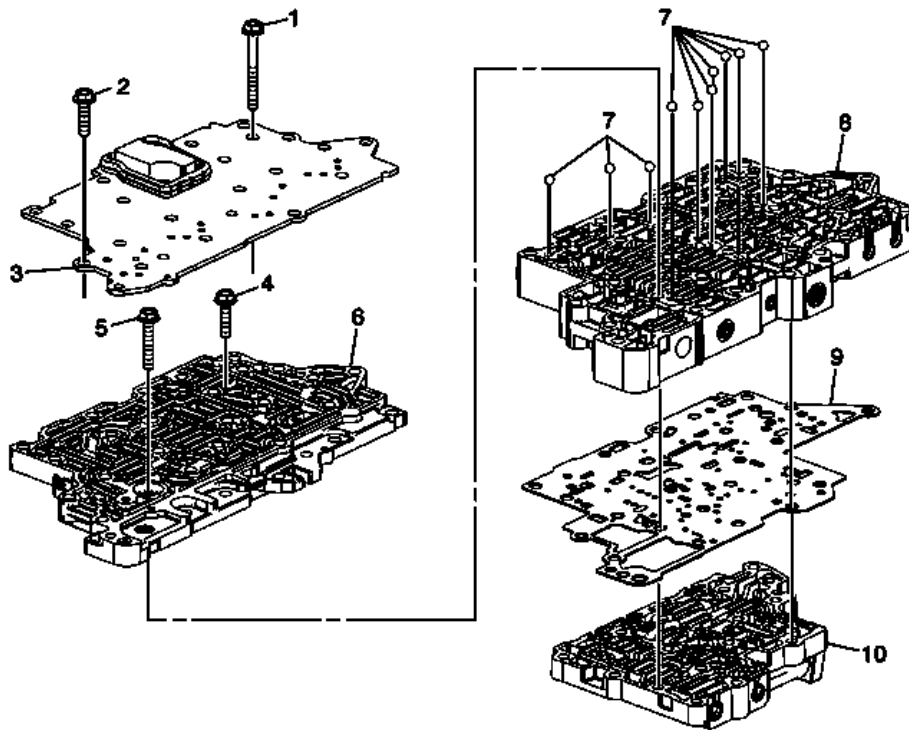


Fig. 77: Control Valve Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Assembly Disassemble

Callout	Component Name
1	Control Valve Body Bolt M6 x 65 (Qty: 5)
2	Control Valve Body Bolt M6 x 35 (Qty: 3)
3	Control Valve Channel Upper Plate Assembly NOTE: <ul style="list-style-type: none"> Inspect the upper channel plate bolt pass through holes for damage or brinelling. Any damage near the PCS feed hole will cause incorrect pressure switch operation. Replace as necessary. The TCU pin gasket is not serviceable. If the gasket is damaged, the control valve channel upper plate assembly must be replaced.
4	Control Valve Body Bolt M6 x 55 (Qty: 2)
5	Control Valve Body Bolt M6 x 55 (Qty: 1)
6	Control Valve Channel Plate Assembly
7	Control Valve Body Ball Check Valve (Qty: 10)

8	Control Valve Upper Body Assembly
9	Control Valve Lower Body Spacer Plate Assembly NOTE: Discard the spacer plate assembly.
10	Control Valve Lower Body Assembly

CONTROL VALVE LOWER BODY ASSEMBLY CLEANING AND INSPECTION

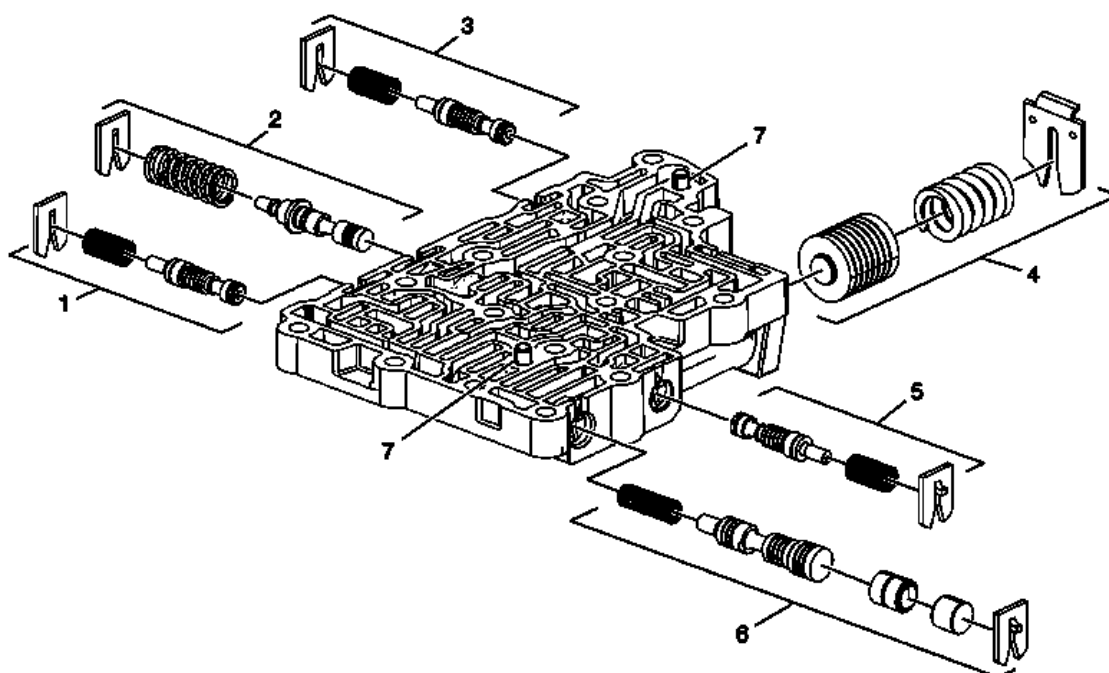


Fig. 78: Control Valve Lower Body Assembly Cleaning and Inspection
Courtesy of GENERAL MOTORS COMPANY

Control Valve Lower Body Assembly Cleaning and Inspection

Callout	Component Name
WARNING: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result.	
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	
CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.	

Preliminary Procedure Clean and inspect all valve components and the valve body. The control valve lower body is replaceable only as an assembly.

1	3-5 Reverse Clutch Boost Valve Train
2	Accumulator Feed Limit Valve Train
3	4-5-6 Clutch Boost Valve Train
4	4-5-6 Clutch Accumulator Piston Assembly
5	1-2-3-4 Clutch Boost Valve Train
6	1-2-3-4 Clutch Regulator Valve Train
7	Control Valve Body Locating Pins (Qty: 2)
NOTE: Inspect Valve Body locating pins for proper installed height of 4.25 mm (0.17 in).	

CONTROL VALVE UPPER BODY ASSEMBLY CLEANING AND INSPECTION

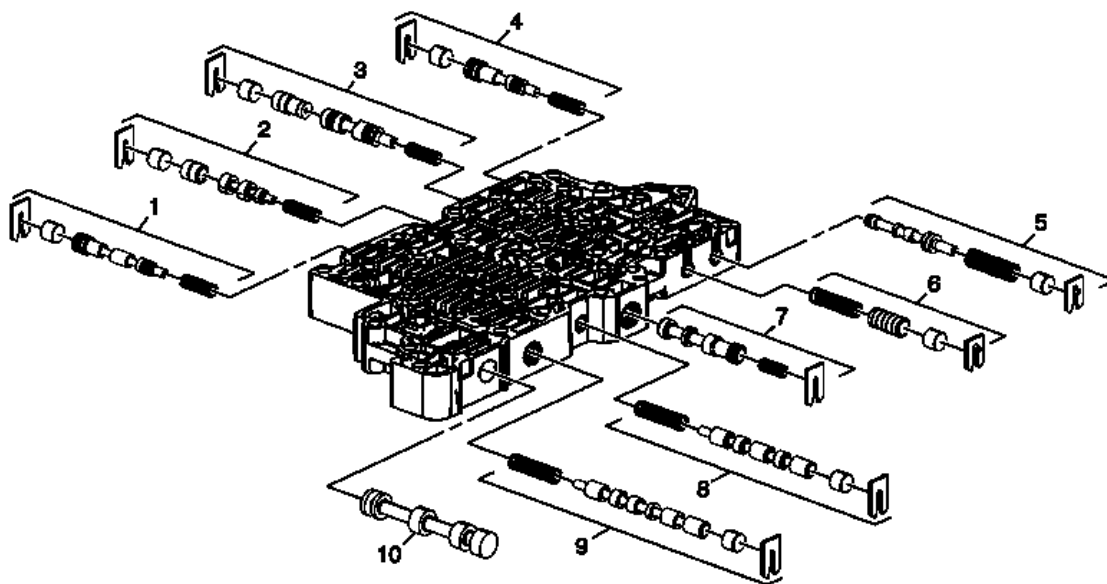


Fig. 79: Control Valve Upper Body Assembly Cleaning and Inspection Components
 Courtesy of GENERAL MOTORS COMPANY

Control Valve Upper Body Assembly Cleaning and Inspection

Callout	Component Name
WARNING: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result.	

CAUTION:

After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.

CAUTION:

Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.

Preliminary Procedure Clean and inspect all valve components and the valve body. The control valve upper body is replaceable only as an assembly.

1	1st Reverse and 4-5-6 Clutch Regulator Valve Train
2	TCC Regulator Apply Valve Train
3	2-6 Clutch Regulator Valve Train
4	3-5 Reverse Clutch Regulator Valve Train
5	Pressure Regulator Valve Train
6	Isolator Valve Train
7	TCC Control Valve Train
8	Clutch Select Solenoid #3 Valve Train
9	Clutch Select Solenoid #2 Valve Train
10	Manual Valve

CONTROL VALVE CHANNEL PLATE CLEANING AND INSPECTION

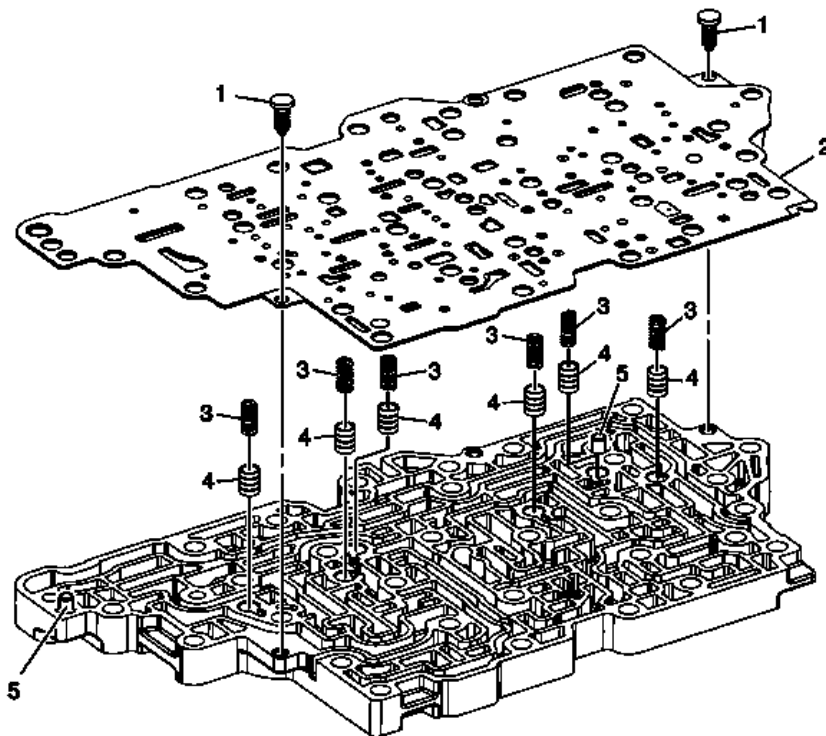


Fig. 80: Control Valve Channel Plate Cleaning and Inspection

Courtesy of GENERAL MOTORS COMPANY

Control Valve Channel Plate Cleaning and Inspection

Callout	Component Name
CAUTION: After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.	
CAUTION: Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.	
1	Control Valve Body Spacer Plate Retainer (Qty: 2)
2	Control Valve Upper Body Spacer Plate Assembly
3	Actuator Feed Accumulator Spring (Qty: 3)
4	Actuator Feed Accumulator Piston (Qty: 3)
5	Control Valve Body Locating Pin (Qty: 2)
	NOTE: Inspect locating pins for proper installed height of 4.25 mm (0.17 in).

CONTROL VALVE BODY ASSEMBLY ASSEMBLE

Lower and Upper Body Assemble

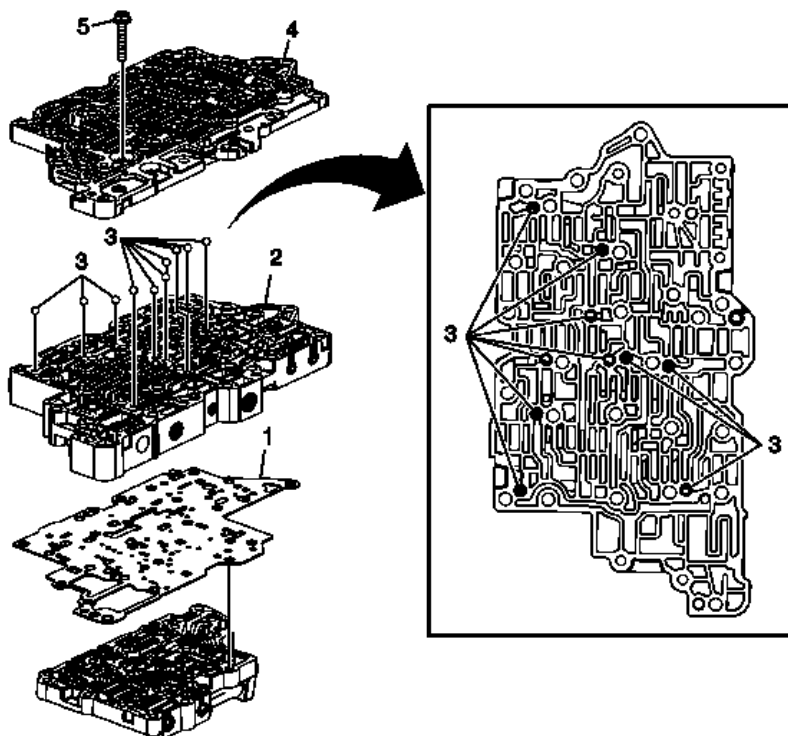


Fig. 81: Control Valve Body Assembly Components

Courtesy of GENERAL MOTORS COMPANY

Lower and Upper Body Assemble

Callout	Component Name
1	Control Valve Lower Body Spacer Plate Assembly CAUTION: Do not use the old spacer plate. Install a NEW spacer plate. Reusing an old spacer plate may cause internal transmission leaks and transmission damage. NOTE: Inspect the upper channel plate bolt through holes for damage or brinelling. Any damage around the PCS switch feed holes could cause leakage around the PCS switch seals. Replace as necessary.
2	Control Valve Upper Body Assembly
3	Control Valve Body Ball Check Valve (Qty: 10) CAUTION: Do not use any type of grease or other material to hold the check ball valves in place during assembly. Grease will cause the valves to not operate properly, resulting in damage to the transmission.
4	Control Valve Channel Plate Assembly
5	Control Valve Body Bolt 6 x 55 (Qty: 1) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 N.m (9 lb ft)

Channel Plate and Upper Channel Plate Assemble

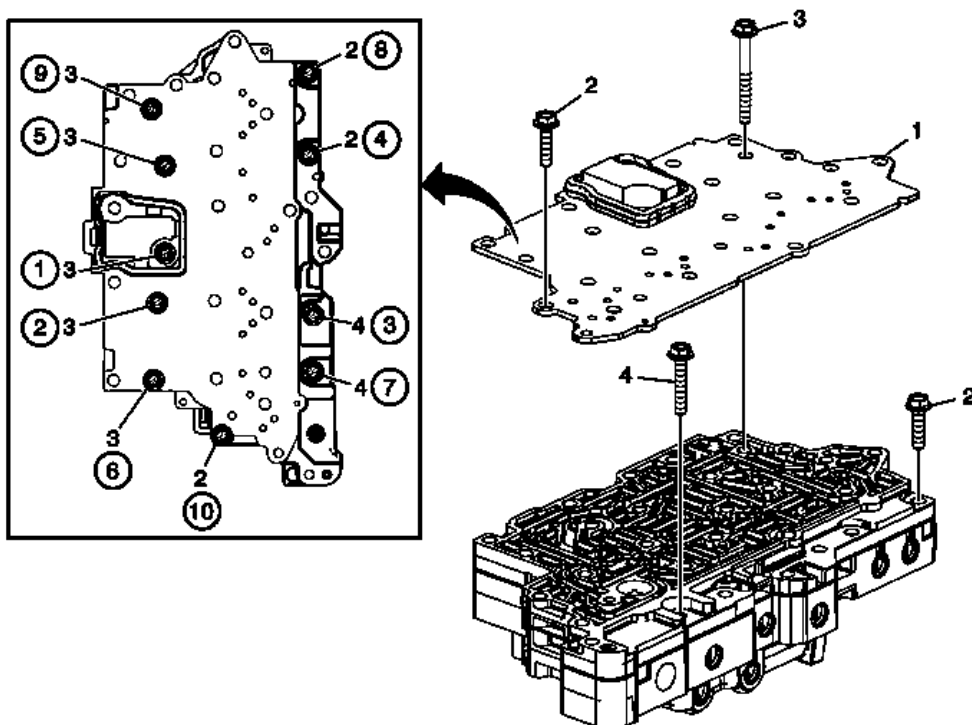


Fig. 82: Channel Plate and Upper Channel Plate Components
 Courtesy of GENERAL MOTORS COMPANY

Channel Plate and Upper Channel Plate Assemble

Callout	Component Name
1	<p>Control Valve Channel Upper Plate Assembly</p> <p>NOTE:</p> <ul style="list-style-type: none"> Inspect the upper channel plate bolt pass through holes for damage or burnelling. Any damage near the PCS feed holes could cause leaking around the PCS switch seal. Replace as necessary. The TCU pin gasket is not serviceable. If the gasket is damaged, the control valve channel upper plate assembly must be replaced.
2	<p>Control Valve Body Bolt M6 x 35 (Qty: 3)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Hand tighten for alignment, then tighten in sequence, after all bolts are installed. Tighten 12 N.m (9 lb ft)</p>
	<p>Control Valve Body Bolt M6 x 65 (Qty: 5)</p> <p>Procedure</p>

3	Tighten in sequence. Tighten 12 N.m (9 lb ft)
4	Control Valve Body Bolt M6 x 55 (Qty: 2) Procedure Tighten in sequence. Tighten 12 N.m (9 lb ft)

CONTROL VALVE BODY ASSEMBLY INSTALLATION

Output Speed Sensor and Valve Body Installation

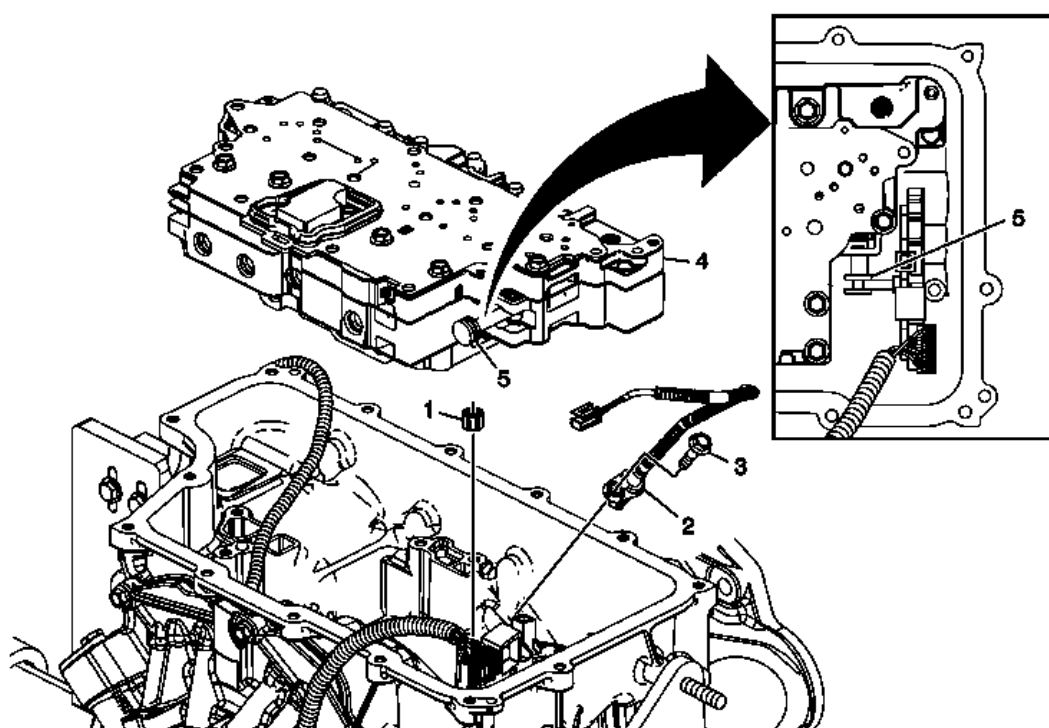


Fig. 83: Output Speed Sensor And Control Valve Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Output Speed Sensor and Valve Body Installation

Callout	Component Name
1	1-2-3-4 Clutch Fluid Passage Seal
2	A/Trans Output Speed Sensor Assembly
3	A/Trans Output Speed Sensor Assembly Bolt M6 x 25 CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 12 N.m (9 lb ft)
4	Control Valve Body Assembly
5	Manual Valve NOTE: <ul style="list-style-type: none"> Align the manual valve to the detent lever assembly. Removing the manual shaft assembly pin will aid in aligning the manual valve to the detent lever. Install the manual shaft pin after the valve body assembly is installed using DT 41229 pin installer , if it was not installed previously. Refer to <u>Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Removal</u>. Special Tools DT 41229 Manual Shaft Pin Installer For equivalent regional tools, refer to Special Tools .

Control Valve Body Bolts Installation

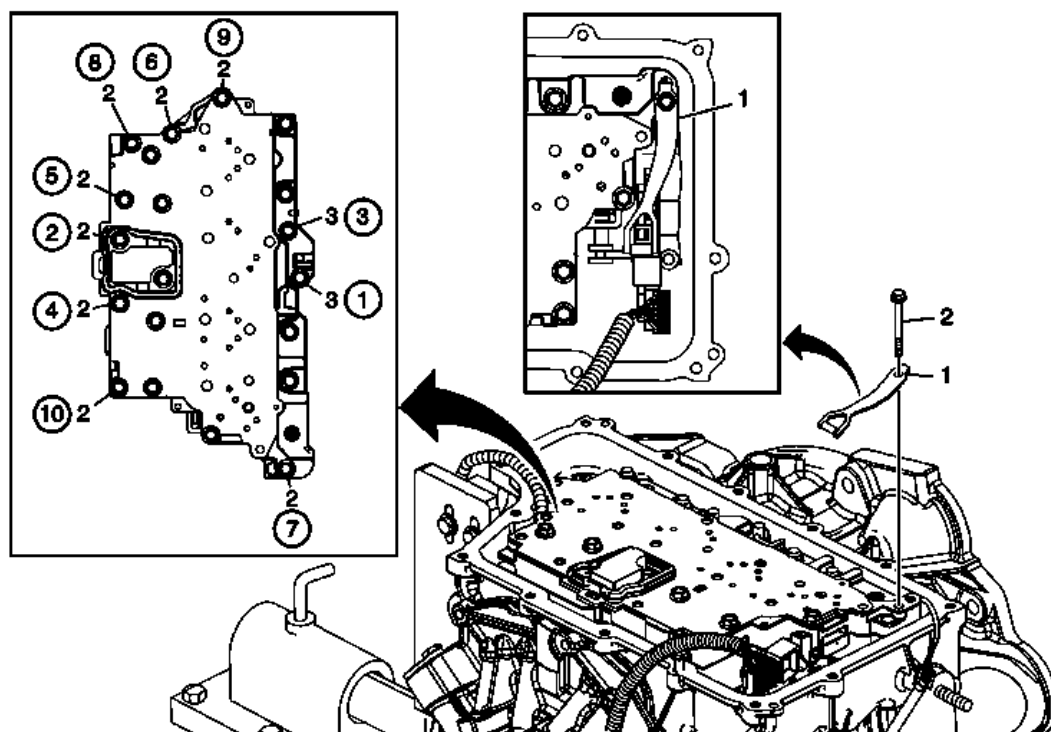


Fig. 84: Control Valve Body Bolts
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Bolts Installation

Callout	Component Name
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1	Manual Shaft Detent Assembly NOTE: Ensure proper alignment of the detent assembly to the detent lever assembly with position switch while tightening the bolt. The detent assembly can move and hit the valve body assembly that could cause improper engagement with the detent lever assembly.
2	Control Valve Body Bolt M6 x 65 (Qty: 8) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Tighten in sequence. Tighten 12 N.m (9 lb ft).
3	Control Valve Body Bolt M6 x 55 (Qty: 2) Procedure Tighten in sequence. Tighten 12 N.m (9 lb ft).

Filter Plate Installation

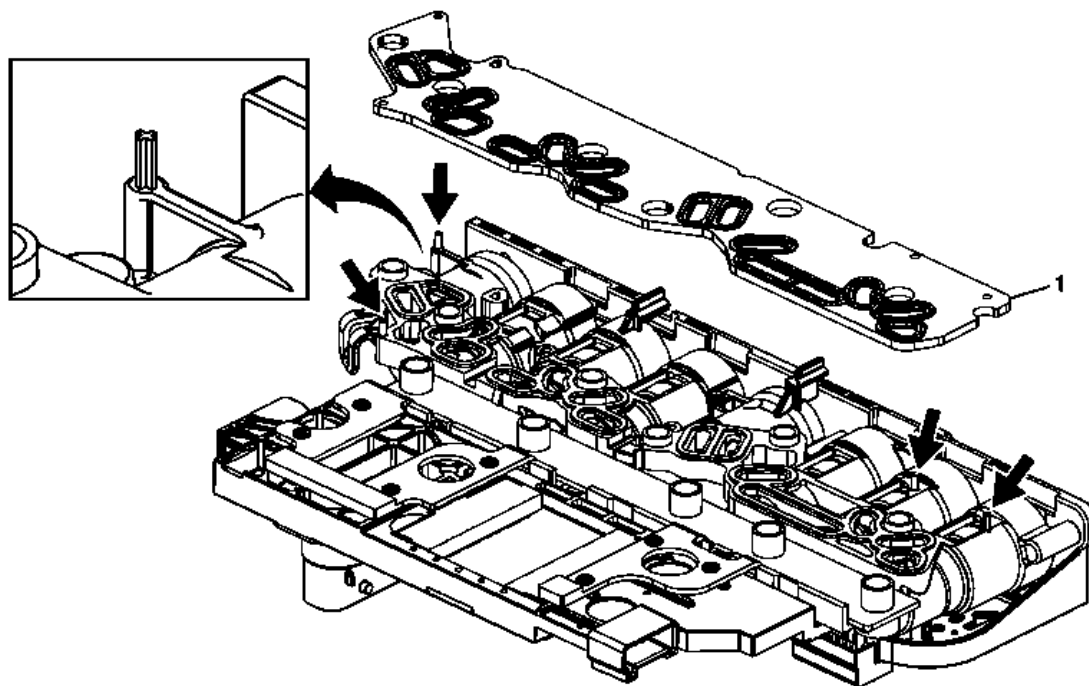


Fig. 85: Filter Plate Installation

Courtesy of GENERAL MOTORS COMPANY

Filter Plate Installation

Callout	Component Name
1	Control Solenoid Valve Assembly Filter Plate CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination. NOTE: Install a NEW filter plate to prevent fluid leaks past the oil seals.

Control Solenoid (w/Body and TCM) Valve Assembly Installation

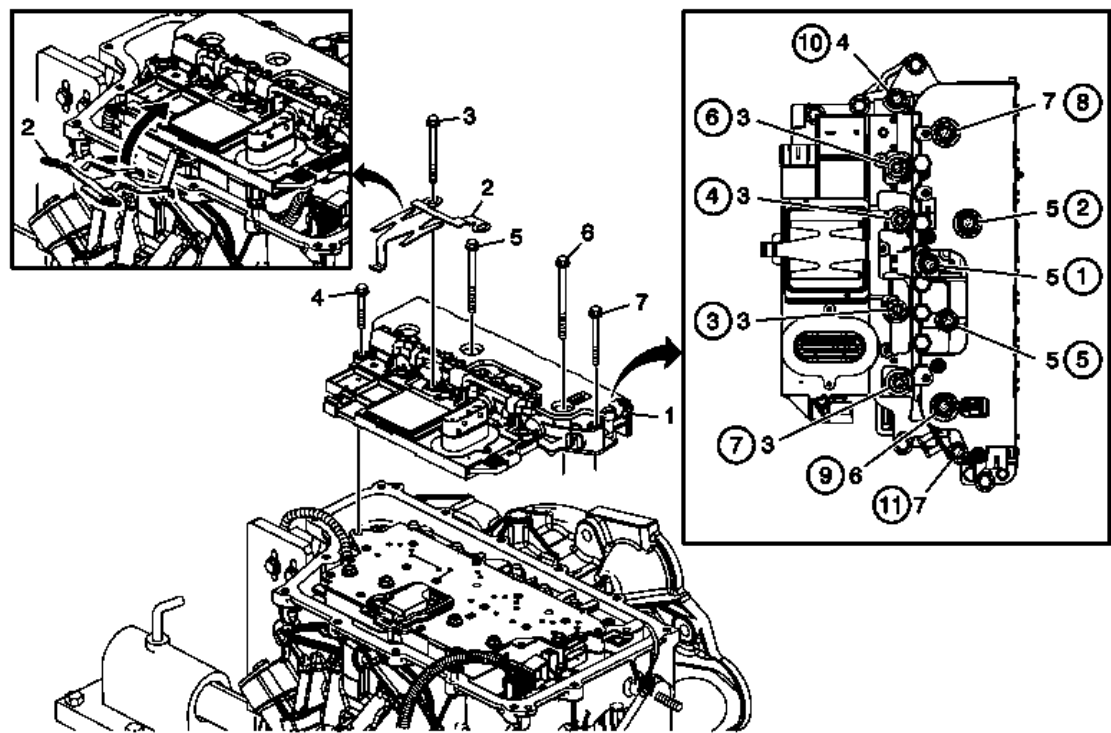


Fig. 86: Control Solenoid (w/Body and TCM) Valve Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Control Solenoid (w/Body and TCM) Valve Assembly Installation

Callout	Component Name
	CAUTION: Refer to <u>Fastener Caution</u> .
	Preliminary Procedure Install all bolts before tightening, then tighten in sequence to 12 N.m (9 lb ft).

1	<p>Control Solenoid (w/Body and TCM) Valve Assembly</p> <p>CAUTION: Do not drop the control solenoid with body and transmission control module (TCM) valve assembly. Internal damage can occur if the control solenoid with body and TCM valve assembly is dropped. DO NOT reuse the control solenoid with body and TCM valve assembly if it is dropped.</p>
2	<p>Control Solenoid Valve Spring</p> <p>NOTE:</p> <ul style="list-style-type: none"> • If the control solenoid spring is missing or improperly installed, the TCM may overheat causing the TCM to shut down. The transmission will default to 3rd or 5th gear. • Insert tab of spring into slot on spacer plate, then rotate into position.
3	Control Valve Body Bolt M6 x 80 (Qty: 4)
4	Control Valve Body Bolt M6 x 55 (Qty: 1)
5	Control Valve Body Bolt M6 x 95 (Qty: 3)
6	Control Valve Body Bolt M6 x 42 (Qty: 1)
7	Control Valve Body Bolt M6 x 65 (Qty: 2)

Wire Routing and Connector Locations

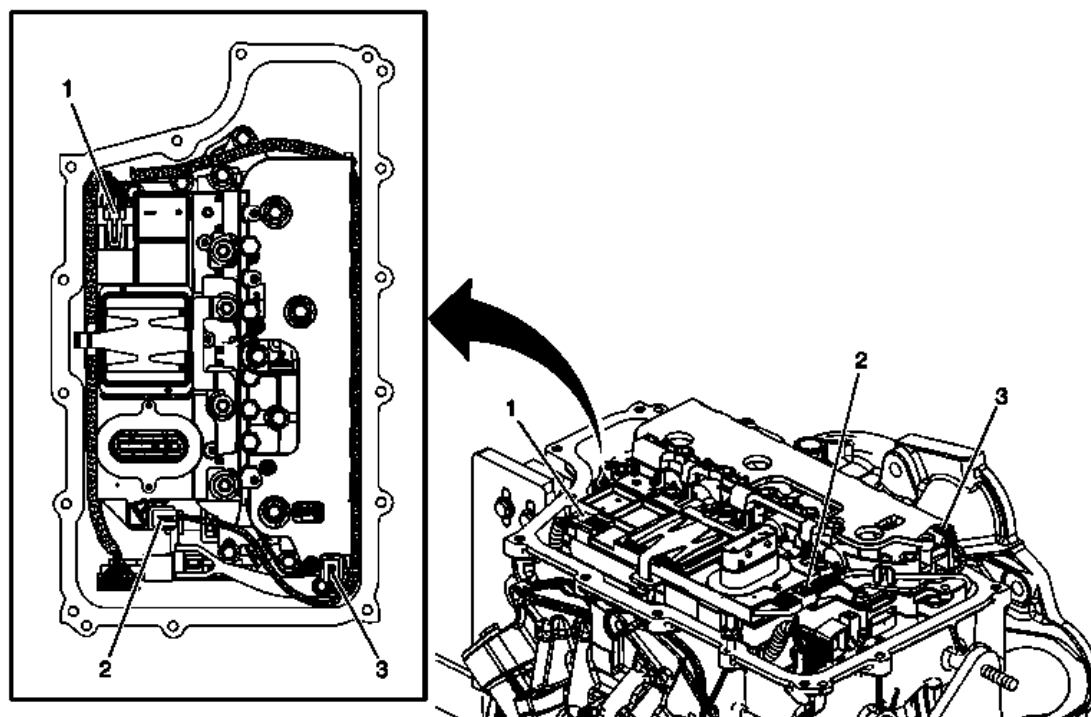


Fig. 87: Identifying Wire Routing & Connector Locations
Courtesy of GENERAL MOTORS COMPANY

Wire Routing and Connector Locations

Callout	Component Name
Preliminary Procedure Route all wires as shown.	
1	Shift Position Switch Connector
2	Output Speed Sensor Connector
3	Input Speed Sensor Connector

Control Valve Body Cover Installation

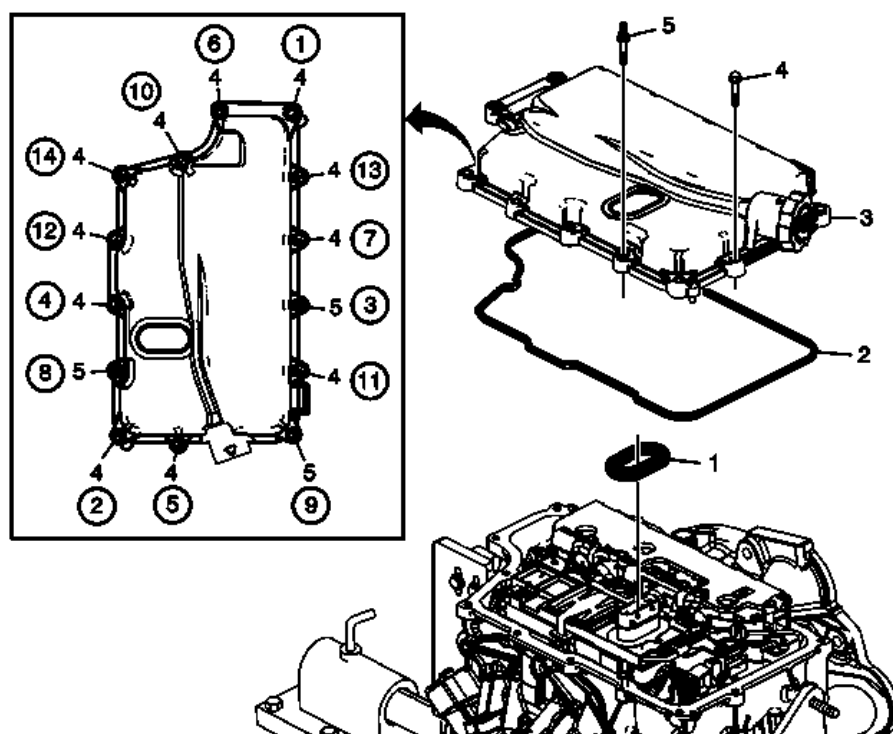


Fig. 88: Control Valve Body Cover Assembly Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Cover Installation

Callout	Component Name
1	Control Valve Body Cover Wiring Connector Hole Seal NOTE: Holes in the seal must face down.
2	Control Valve Body Cover Assembly Gasket
3	Control Valve Body Cover Assembly
	Control Valve Body Cover Bolt M6 x 30 (Qty: 11) CAUTION:

	Refer to <u>Fastener Caution</u> .
4	Procedure Tighten in sequence. Tighten 12 N.m (9 lb ft).
5	Control Valve Body Cover Stud M6 x 30 (Qty: 3) Procedure Tighten in sequence. Tighten 12 N.m (9 lb ft).

TORQUE CONVERTER INSTALLATION

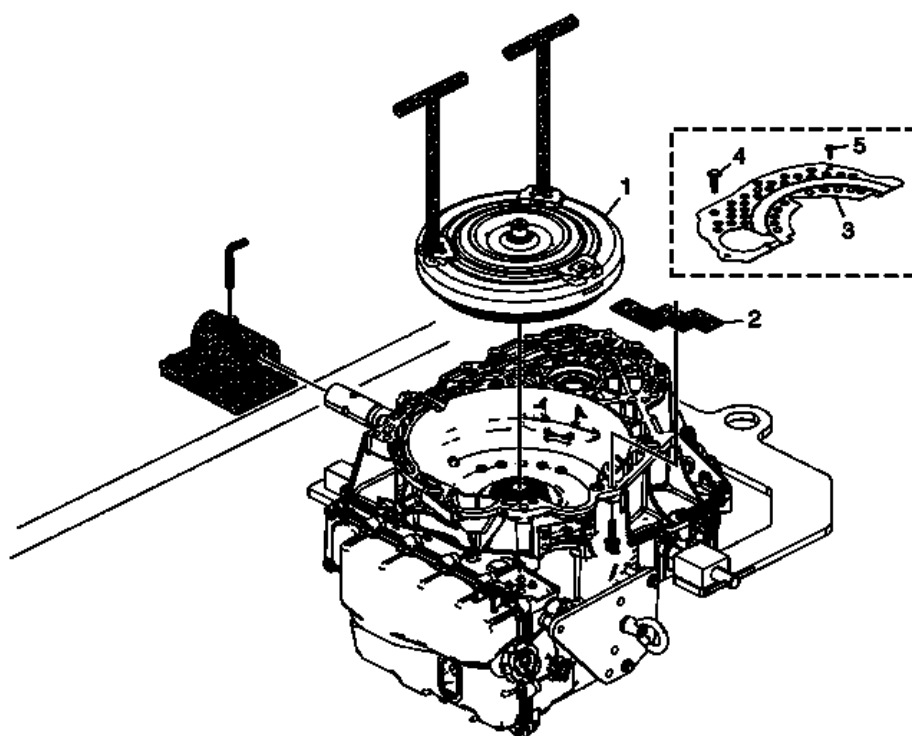


Fig. 89: View Of Torque Converter
Courtesy of GENERAL MOTORS COMPANY

Torque Converter Installation

Callout	Component Name
1	Torque Converter Assembly CAUTION: Lower the torque converter straight down. Failure to lower the torque converter straight down could damage the torque converter clutch lip seal inside the torque converter clutch assembly.

	Special Tools DT 46409 Torque Converter Lifting Handles For equivalent regional tools, refer to <u>Special Tools</u> .
2	DT 21366 Converter Holding Strap WARNING: The torque converter must be held to the torque converter housing by a retaining device such as shipping brackets. Without the retaining device, the torque converter may slide forward, disengaging the oil pump, or may fall completely out of the transmission causing personal injury and/or property damage.
3	Dust Cover - Model Dependant
4	Dust Cover Push Pin - Model Dependant (Qty: 2)
5	Dust Cover Bolt - Model Dependant CAUTION: Refer to <u>Fastener Caution</u> . Tighten 75 N.m (37 lb ft)

LIFT PLATE AND HOLDING FIXTURE REMOVAL

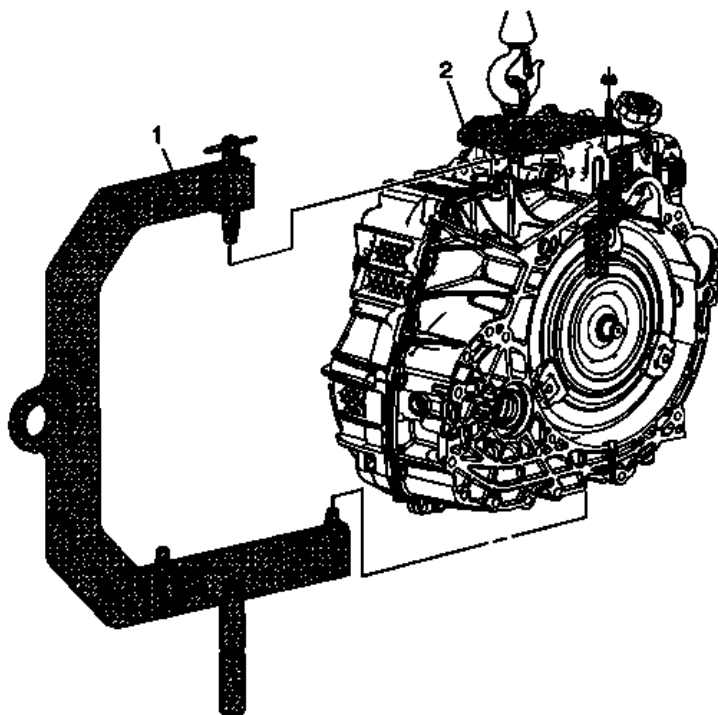


Fig. 90: Identifying Lift Plate & Holding Fixture

Courtesy of GENERAL MOTORS COMPANY

Lift Plate and Holding Fixture Removal

Callout	Component Name
1	DT 46625 Transmission Holding Fixture NOTE: Raise the transmission in order to remove the holding fixture. For equivalent regional tools, refer to <u>Special Tools</u> .
2	DT-47811-A Lift Plate NOTE: Lower the transmission assembly onto the transmission jack in order to remove the lift plate. For equivalent regional tools, refer to <u>Special Tools</u> .

Transmission

Automatic Transmission - 6T70 (M7U M7W) - Repair Instructions - On Vehicle

REPAIR INSTRUCTIONS - ON VEHICLE

MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY REPLACEMENT

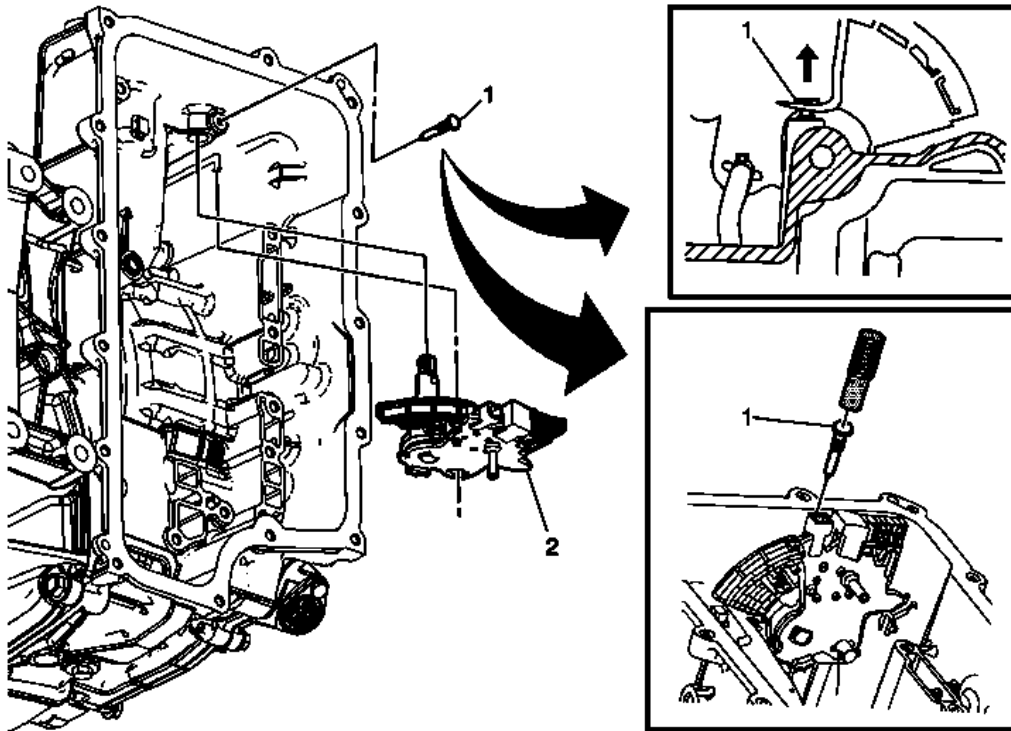


Fig. 1: Identifying Manual Shift Detent Lever & Shaft Position Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Remove the transmission range selector lever. Refer to <u>Automatic Transmission Range Selector Lever Replacement</u>.2. Remove the lower control valve body. Refer to <u>Control Valve Lower Body and Upper Body Replacement</u>.	
	Manual Shaft Detent Lever Pin
	CAUTION: Use J 41229 to install the manual shaft pin at the correct height in order to properly secure the manual shaft. If you install the pin too deep, the case bore may crack.

1	<p>Procedure</p> <ol style="list-style-type: none"> 1. Use a small nail puller to remove the pin. Discard the pin. It is not reusable. 2. Use J-41229 installer to install the pin. <p>Inspect that the pin installed height is within 6.5-7.5 mm (0.25-0.30 in).</p> <p>Special Tools J-41229 Manual Shaft Pin Installer For equivalent regional tools, refer to <u>Special Tools</u> .</p>
2	<p>Manual Shaft Detent Lever Assembly (w/Shift Position Switch)</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Removal: Partly lower the manual shaft detent lever assembly (w/shift position switch) in order to rotate the detent lever and disconnect the park actuator rod. Then fully remove the manual shaft detent lever assembly from the transmission case. 2. Installation: Partly install the manual shaft detent lever assembly (w/shift position switch). Rotate the detent lever and connect the park actuator rod. Then fully install the manual shaft detent lever assembly in the transmission case. 3. Lubricate the manual shaft with automatic transmission fluid (ATF) to prevent damage to the manual shift shaft seal. <p>NOTE: Do not pull the park actuator rod end out beyond the machined oil passage surface in the case. A no park condition will exist if the park pawl actuator assembly is pulled out of the transmission too far and the actuator rod disengages from the park pawl. The transmission assembly will require disassembly to re-install the actuator rod over the park pawl.</p>

TRANSMISSION CONTROL LEVER KNOB REPLACEMENT

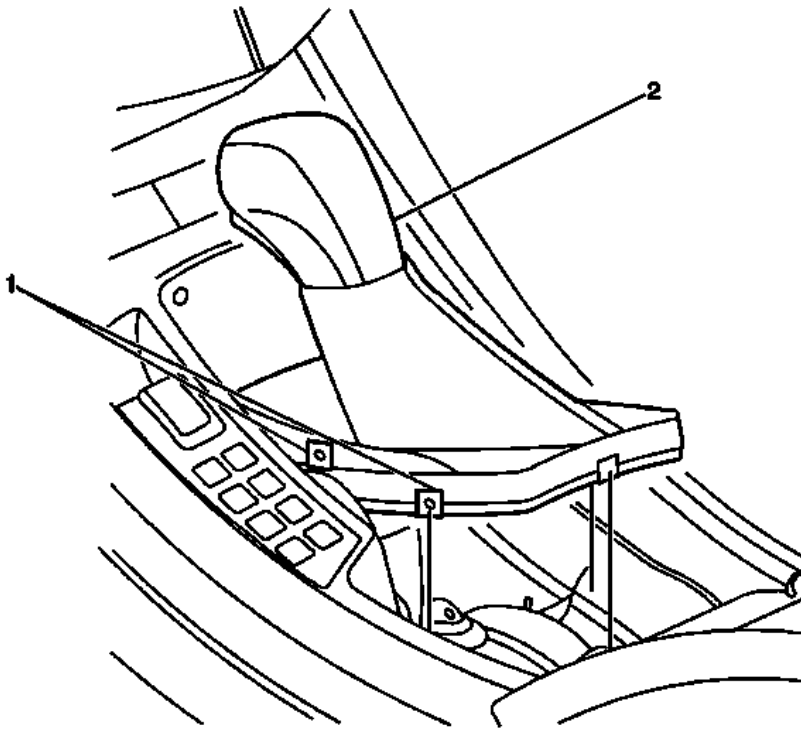


Fig. 2: Transmission Control Lever Knob, Boot & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Transmission Control Lever Knob Replacement

Callout	Component Name
1	Transmission Control Lever Knob Retainer (Qty: 12) Procedure Use a flat-bladed plastic trim tool in order to release the retainer clips securing the control lever boot.
2	Transmission Control Lever Knob NOTE: <ul style="list-style-type: none"> • The control lever boot and knob are replaced as an assembly. • To remove the knob, pull upward and twist.

TRANSMISSION CONTROL LEVER BOOT REPLACEMENT

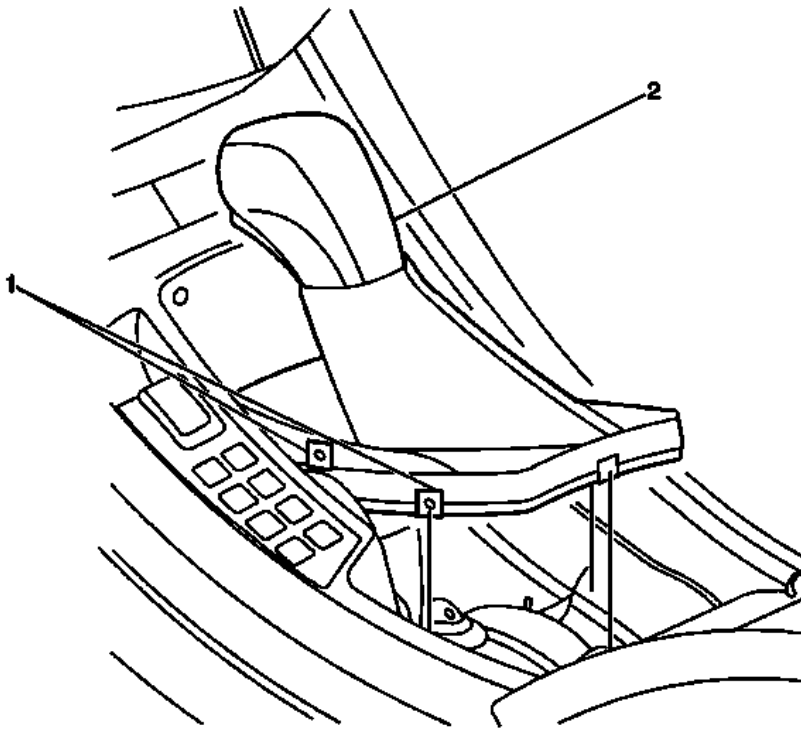


Fig. 3: Transmission Control Lever Knob, Boot & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Transmission Control Lever Boot Replacement

Callout	Component Name
1	Transmission Control Lever Knob Retainer (Qty: 12) Procedure Use a flat-bladed plastic trim tool in order to release the retainer clips securing the control lever boot.
2	Transmission Control Lever Knob NOTE: <ul style="list-style-type: none"> • The control lever boot and knob are replaced as an assembly. • To remove the knob, pull upward and twist.

TRANSMISSION CONTROL REPLACEMENT

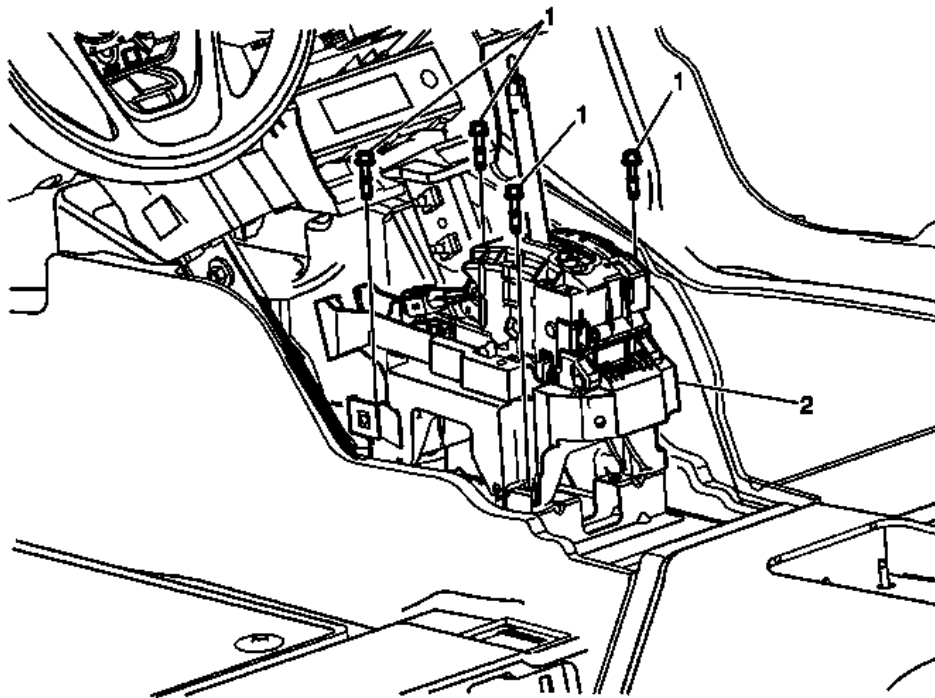


Fig. 4: Transmission Control Module & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Transmission Control Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the control lever boot. Refer to <u>Transmission Control Lever Boot Replacement</u> . 2. Remove floor console. Refer to <u>Front Floor Console Replacement</u> .	
1	Transmission Control Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Remove the clips on the wiring harness and disconnect the shift control electrical connector 2. Disconnect the shift control cable. Tighten 9 N.m (80 lb in)
2	Transmission Control

AUTOMATIC TRANSMISSION RANGE SELECTOR LEVER REPLACEMENT

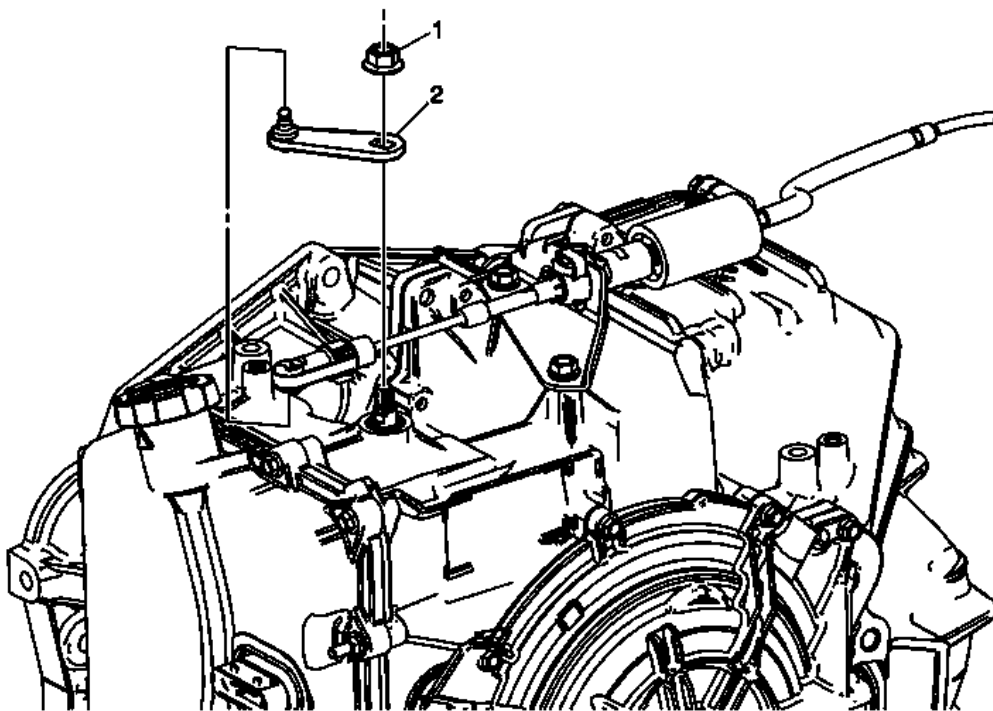


Fig. 5: Identifying A/T Range Selector Lever Components
Courtesy of GENERAL MOTORS COMPANY

Automatic Transmission Range Selector Lever Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Set the park brake and chock the wheels.2. Disconnect the range selector cable from the range selector lever.	
1	<p>Transmission Range Selector Lever Nut</p> <p>WARNING: Hold the transmission range selector lever while removing or installing the lever retaining nut. Failure to hold the lever can cause damage to the transmission internal park system components which could allow the vehicle to roll when placed in the park position.</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 20 (15 lb ft)</p>

RANGE SELECTOR LEVER CABLE REPLACEMENT

Removal Procedure

1. Set the park brake and chock the wheels.
2. Remove the battery tray. Refer to **Battery Tray Replacement** .

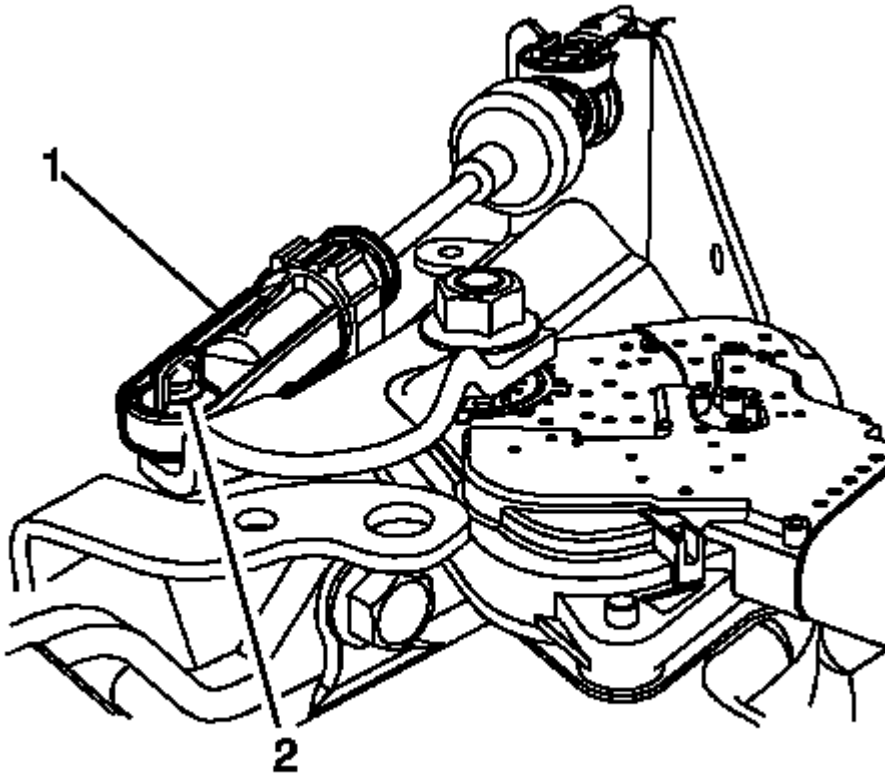


Fig. 6: Transmission Range Selector Lever Cable Terminal And Lever Pin
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin (2).

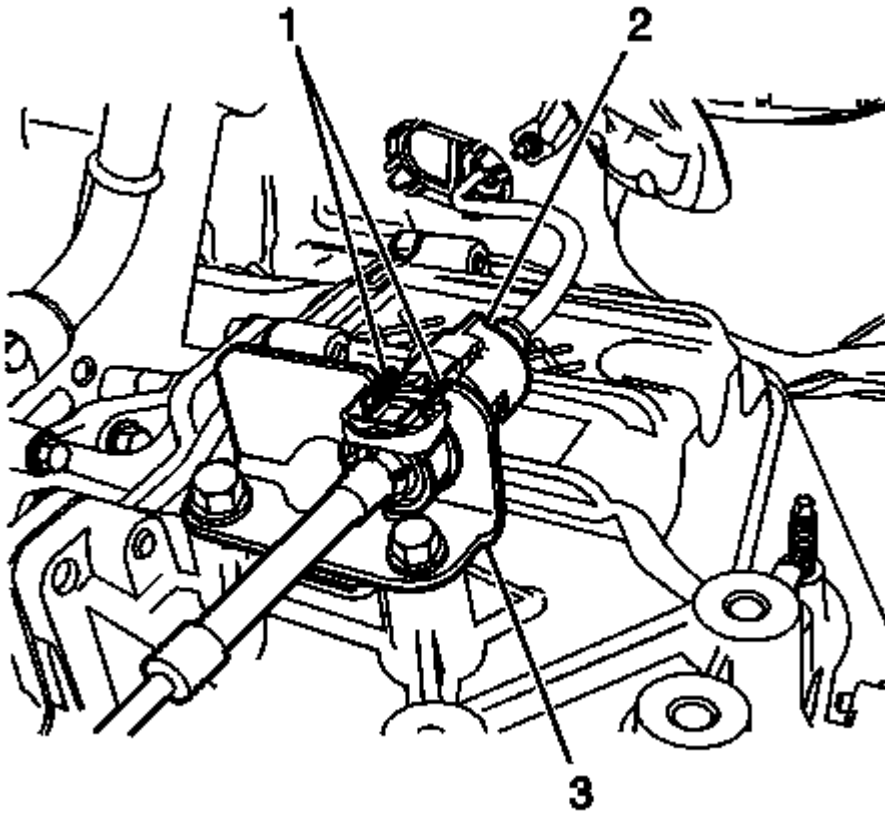


Fig. 7: Transmission Range Selector Lever Cable & Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Press the locking tabs inward (1) in order to release the transmission range selector lever cable (2) from the cable bracket (3).
5. Remove the console. Refer to **Front Floor Console Replacement** .

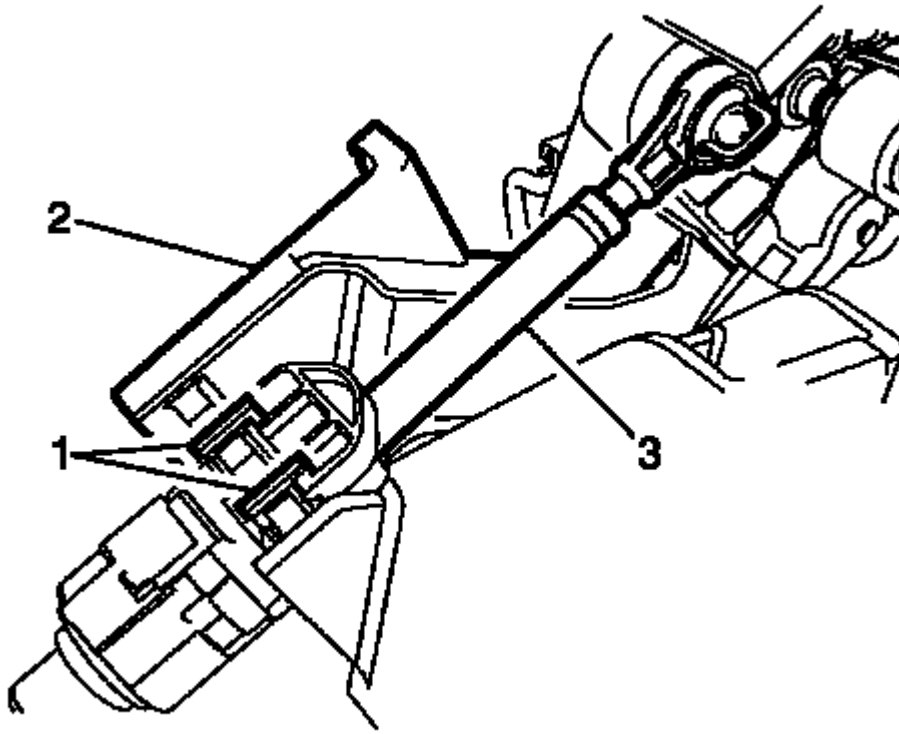


Fig. 8: Transmission Range Selector Lever Cable, Locking Tabs And Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Press the locking tabs inward (1) in order to release the transmission range selector lever cable (3) from the cable bracket (2).
7. Release the retainer and then remove the cable end terminal from shifter pin.

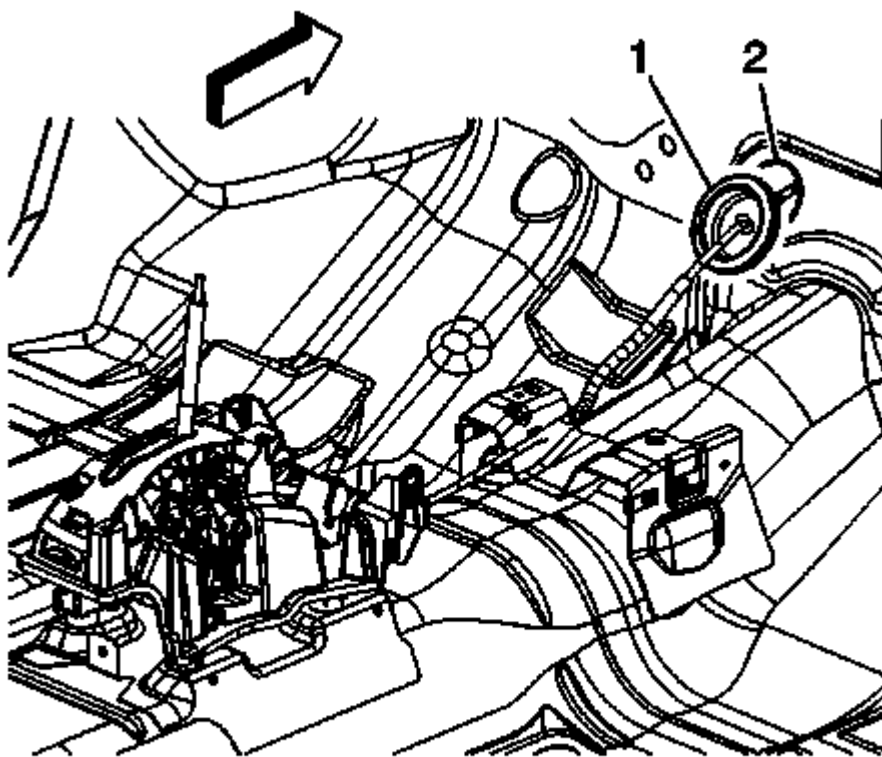


Fig. 9: Identifying Cowl Panel & Selector Lever Cable Grommet
Courtesy of GENERAL MOTORS COMPANY

8. Remove the transmission range selector lever cable grommet (1) from the cowl panel.
9. Remove the transmission range selector lever cable from the vehicle.

Installation Procedure

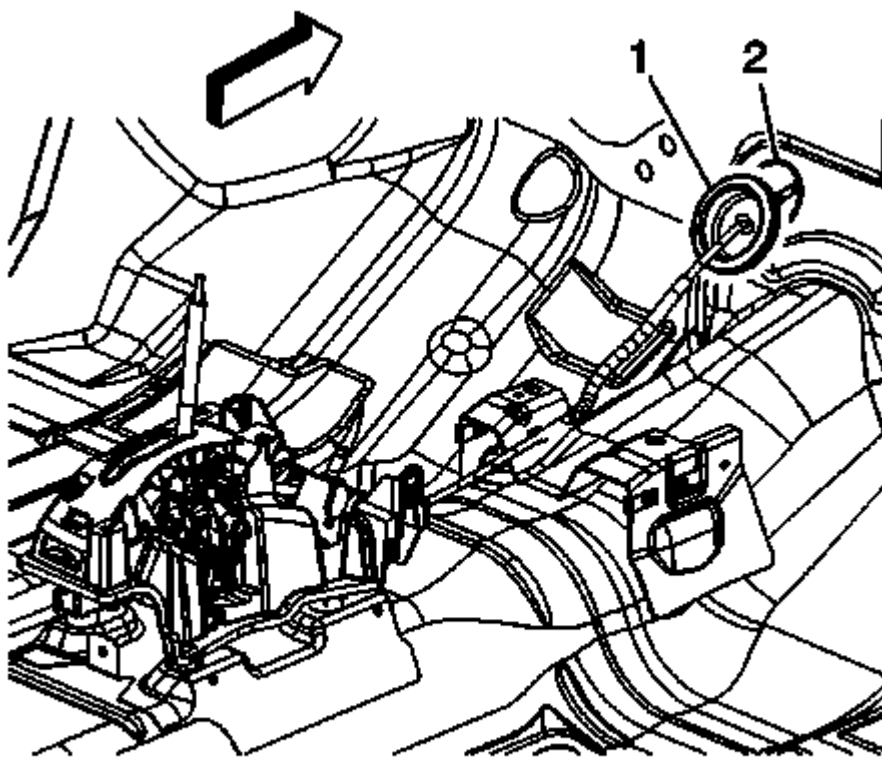


Fig. 10: Identifying Cowl Panel & Selector Lever Cable Grommet
Courtesy of GENERAL MOTORS COMPANY

1. Install the transmission range selector lever cable to the vehicle.
2. Install the transmission range selector lever cable grommet (1) to the cowl panel (2).

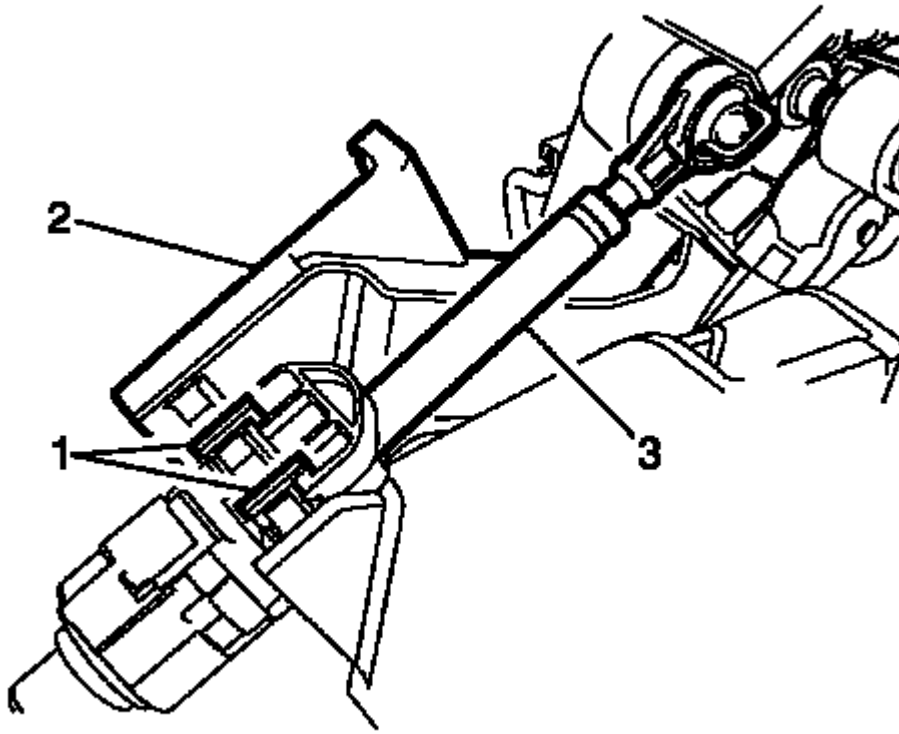


Fig. 11: Transmission Range Selector Lever Cable, Locking Tabs And Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Connect the transmission range selector cable terminal to the shift lever pin.
4. Remove the cable tie and secure the retainer.
5. Install the cable (3) to transmission shifter base (2).
6. Install the console. Refer to **Front Floor Console Replacement** .

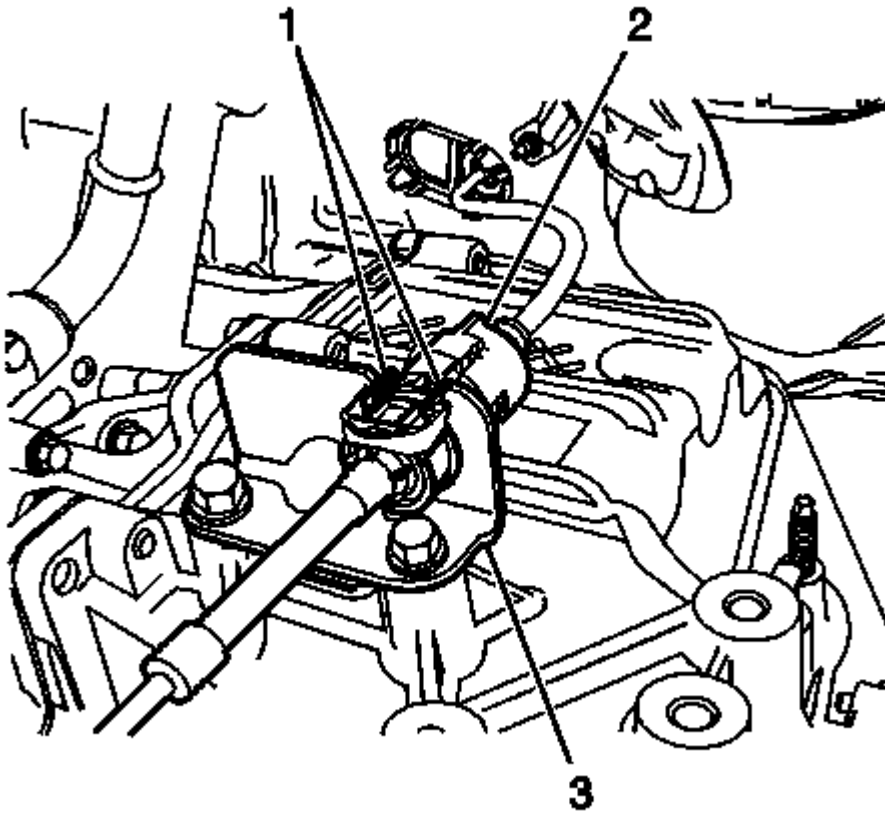


Fig. 12: Transmission Range Selector Lever Cable & Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Install the transmission range selector lever cable (2) to the cable bracket (3).

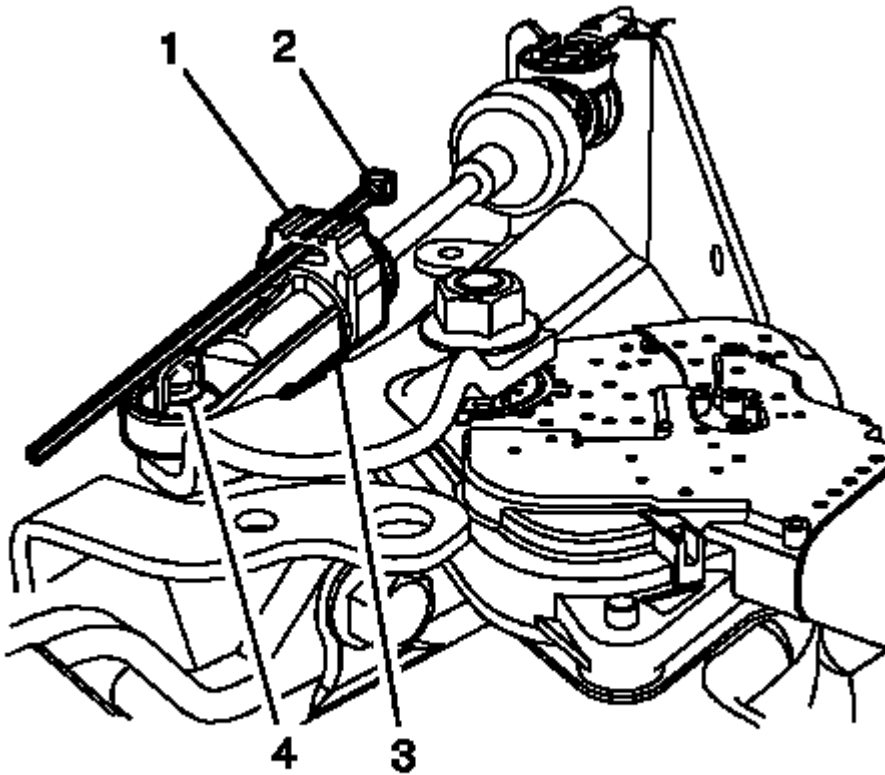


Fig. 13: Range Selector Lever Cable Terminal And Transmission Manual Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

8. Connect the transmission range selector lever cable terminal (4) to the transmission manual shift lever pin.
9. Ensure that the shift lever and the shifter are in the Park position. Secure the shift cable adjustable lock into place. Remove the lock retainer (2). Ensure that the adjustable lock (1) is properly seated.
10. Install the battery tray. Refer to **Battery Tray Replacement** .

RANGE SELECTOR LEVER CABLE ADJUSTMENT

The shift cable on this vehicle does not require an adjustment.

TRANSMISSION FLUID DRAIN AND FILL

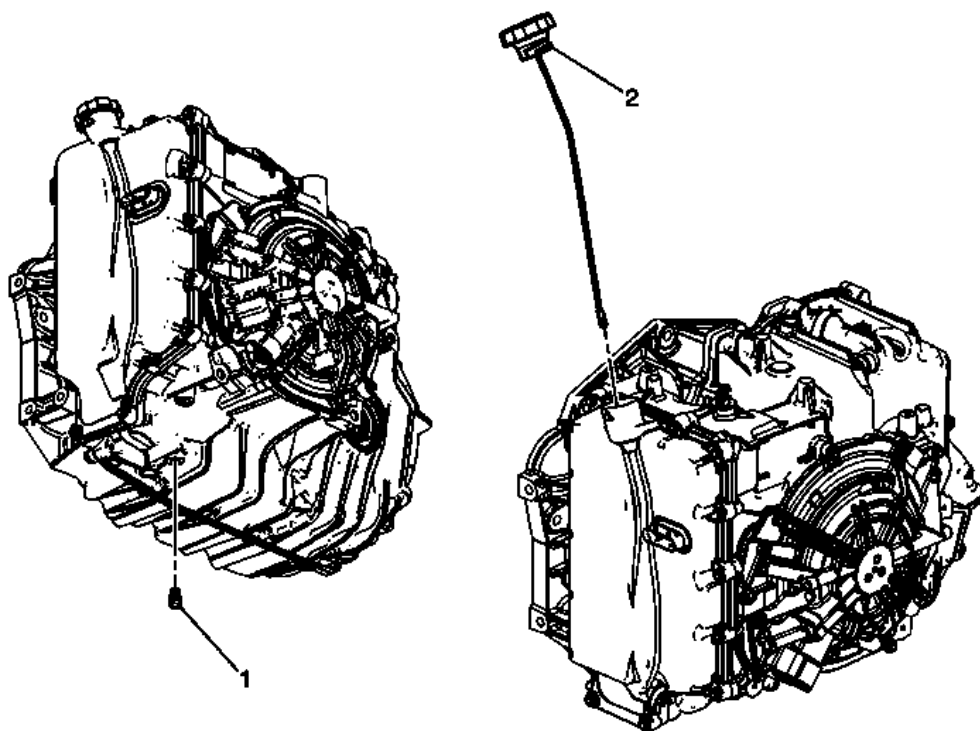


Fig. 14: Identifying Fluid Level Indicator & Drain Plug
 Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Drain and Fill

Callout	Component Name
Preliminary Procedures	
1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the front compartment insulator, if equipped.	
1	Fluid Drain Plug CAUTION: Refer to <u>Fastener Caution</u> . Procedure Place a drain pan capable of containing more than 5 quarts of fluid under the transmission before removing the plug to drain the fluid. Tighten 12 (106 lb in)
2	Fluid Level Indicator Procedure Fill the transmission with fluid. Refer to <u>Transmission Fluid Level and Condition Check</u> .

NOTE:

Transmission will require approximately 5 quarts of fluid.

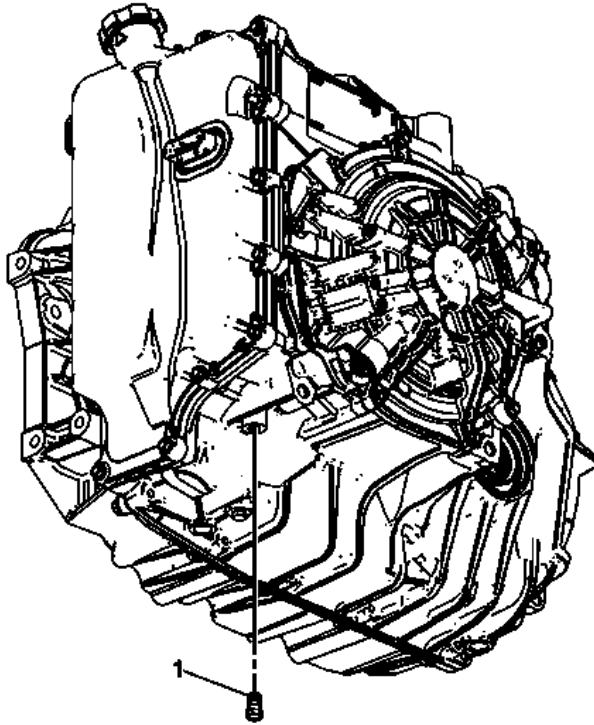
AUTOMATIC TRANSMISSION FLUID PRESSURE TEST HOLE PLUG REPLACEMENT

Fig. 15: Identifying Automatic Transmission Fluid Pressure Test Hole Plug
Courtesy of GENERAL MOTORS COMPANY

Automatic Transmission Fluid Pressure Test Hole Plug Replacement

Callout	Component Name
Preliminary Procedures	
1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
2. Remove the front compartment insulator, if equipped.	
1	Fluid Pressure Test Plug CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 (106 lb in)

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - LEFT SIDE

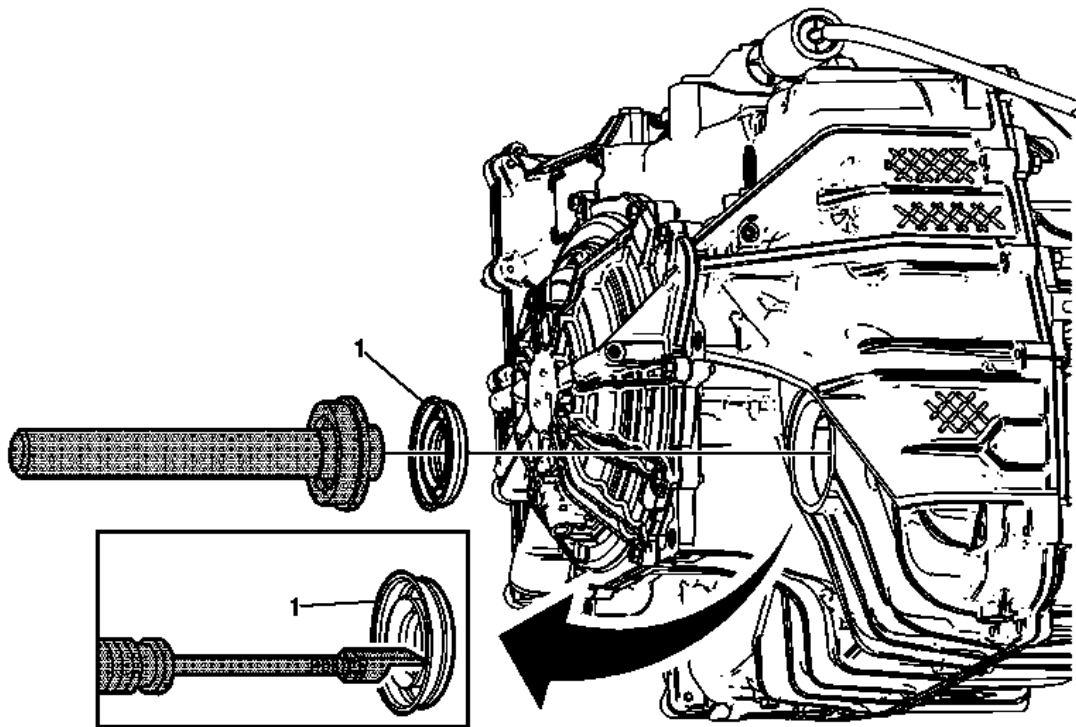


Fig. 16: View Of Front Wheel Drive Shaft Oil Seal - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Left Side

Callout	Component Name
Preliminary Procedures	
1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the left wheel drive shaft. Refer to <u>Front Wheel Drive Shaft Replacement - Left Side</u> .	
	Left Front Wheel Drive Shaft Oil Seal NOTE: <ul style="list-style-type: none"> • For seal removal use J-6125-1B hammer with J-23129 remover. • For seal installation use J-8092 handle with J-46629-A installer.
1	Special Tools <ul style="list-style-type: none"> • J-6125-1B Slide Hammer • J-8092 Driver Handle • J-23129 Universal Seal Remover • J-46629-A Axle Seal Installer
For equivalent regional tools, refer to <u>Special Tools</u> .	

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - RIGHT SIDE

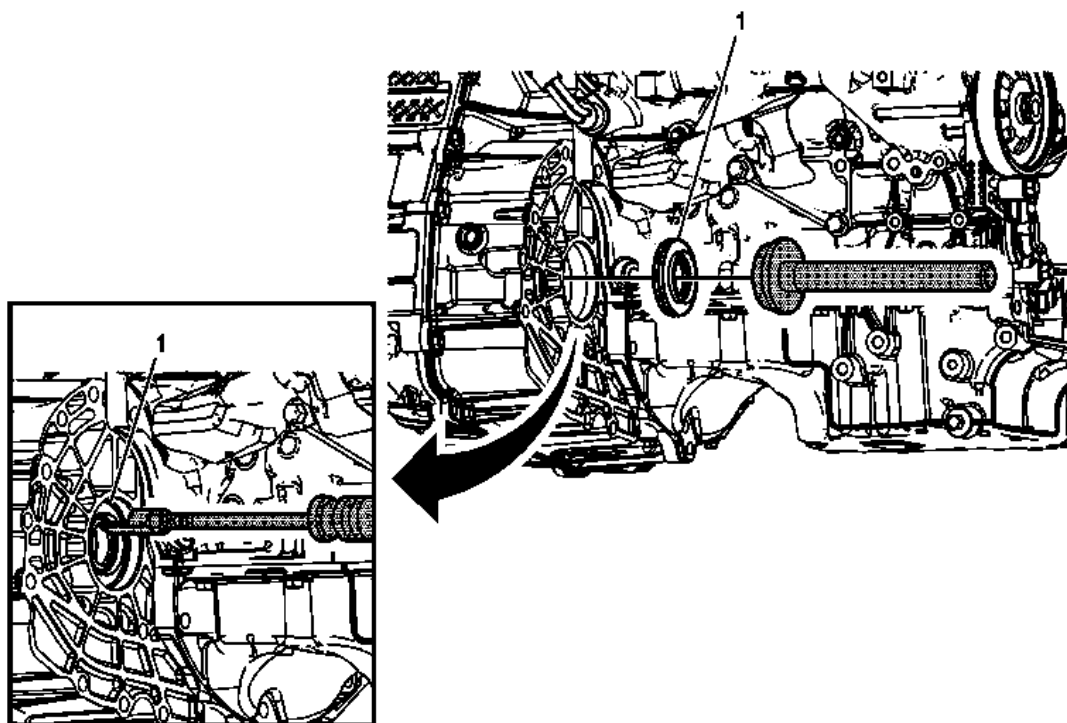


Fig. 17: Identifying Front Wheel Drive Shaft Oil Seal - Right Side
Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Right Side

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .2. Remove the intermediate drive shaft. Refer to <u>Front Wheel Drive Intermediate Shaft Replacement (with MR6)</u> , <u>Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)</u> .	
1	<p>Right Front Wheel Drive Shaft Oil Seal</p> <p>NOTE:</p> <ul style="list-style-type: none">• For seal removal use J-6125-1B hammer with J-23129 remover.• For seal installation use J-8092 handle with J-46629-A installer. <p>Special Tools</p> <ul style="list-style-type: none">• J-6125-1B Slide Hammer• J-8092 Driver Handle• J-23129 Universal Seal Remover

- **J-46629-A** Axle Seal Installer

For equivalent regional tools, refer to **Special Tools** .

MANUAL SHIFT SHAFT AND SEAL REPLACEMENT

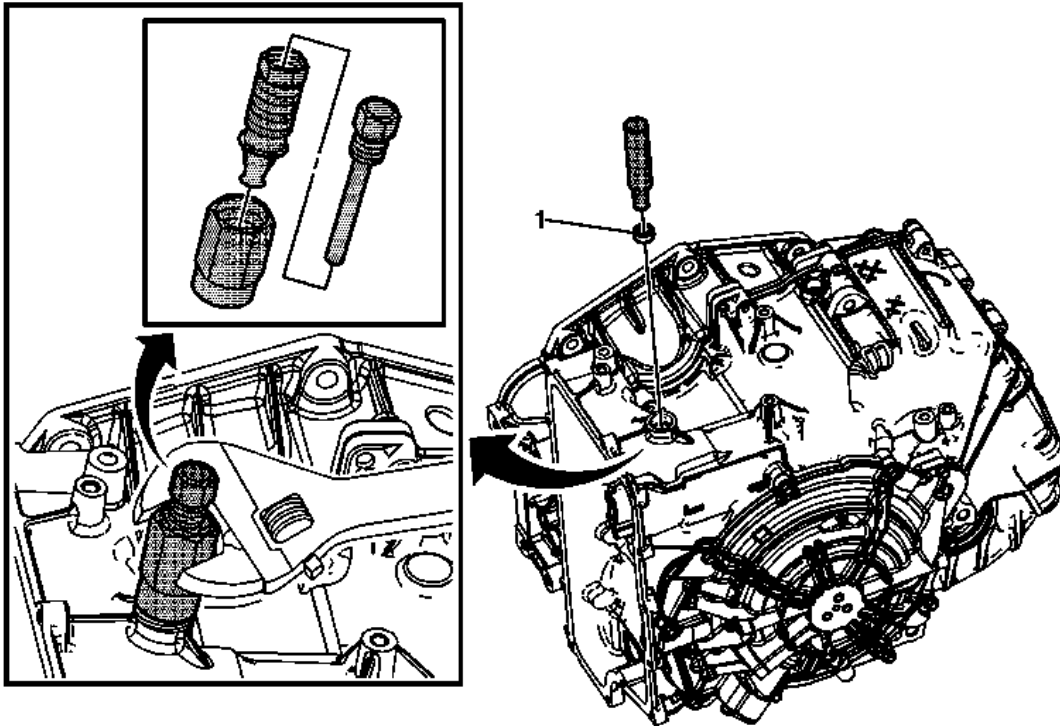


Fig. 18: Identifying Manual Shift Shaft & Seal
Courtesy of GENERAL MOTORS COMPANY

Manual Shift Shaft and Seal Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the battery tray. Refer to Battery Tray Replacement . 2. Remove the manual shaft and position switch assembly. Refer to Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement. 	
	Manual Shift Shaft Seal NOTE: <ul style="list-style-type: none"> • For seal removal use J-45201 remover. • For seal installation use J-46626 installer. • Lubricate the manual shaft with automatic transmission fluid (ATF) to prevent damage to the manual shift shaft seal.

Special Tools

1

- **J-45201** Cooler Line Seal Remover
- **J-46626** Seal Installer

For equivalent regional tools, refer to **Special Tools** .

CONTROL VALVE BODY COVER REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

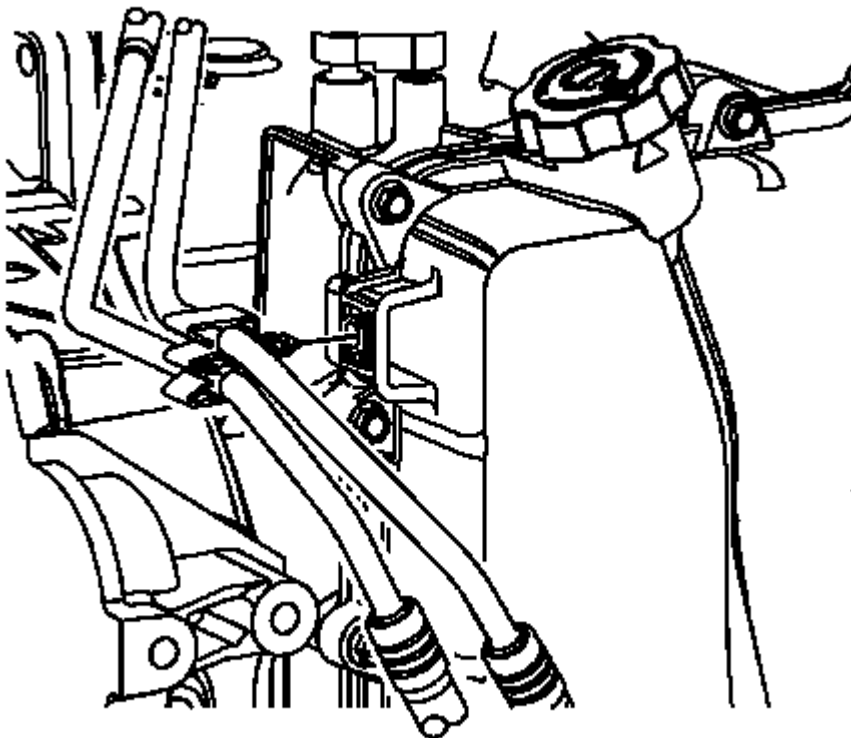


Fig. 19: Identifying Oil Cooler Inlet And Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil cooler inlet hose. Refer to **Fluid Cooler Inlet Hose Replacement (MHH)** .
3. Remove the oil cooler outlet hose. Refer to **Fluid Cooler Outlet Hose Replacement (MHH)** .

4. Disconnect and reposition the battery positive and negative cable from in front of the valve body cover. Refer to **Battery Negative Cable Replacement** , and **Battery Positive Cable Replacement** .
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
6. Drain the transmission. Refer to **Transmission Fluid Drain and Fill**.

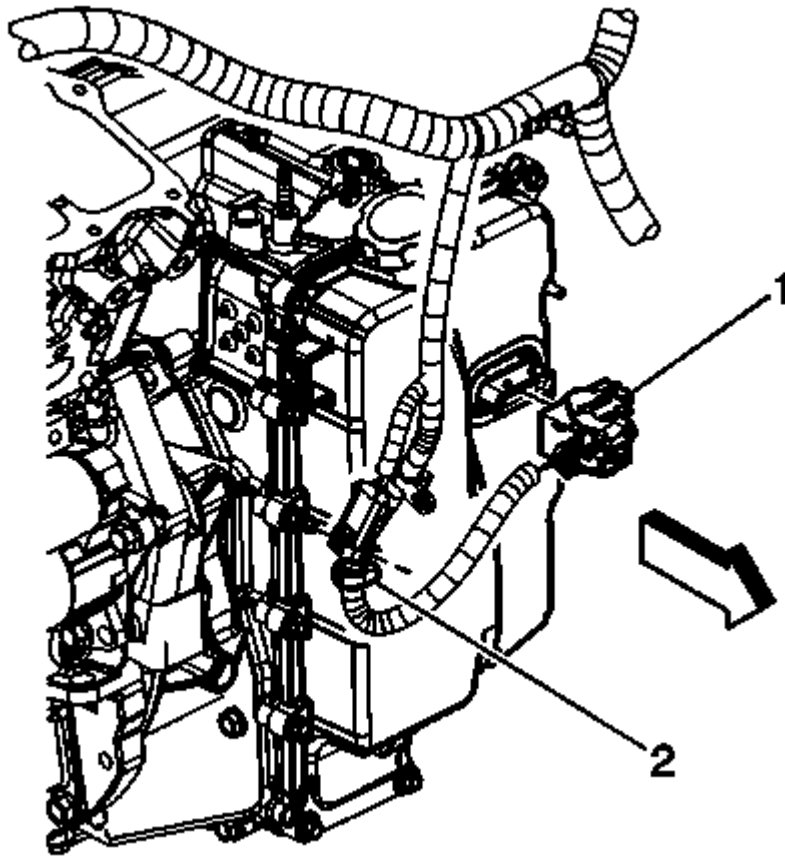


Fig. 20: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Remove the wire harness retainer (2) from the control valve body cover stud, if equipped .
8. Disconnect the control valve body transmission control module (TCM) electrical connector (1).

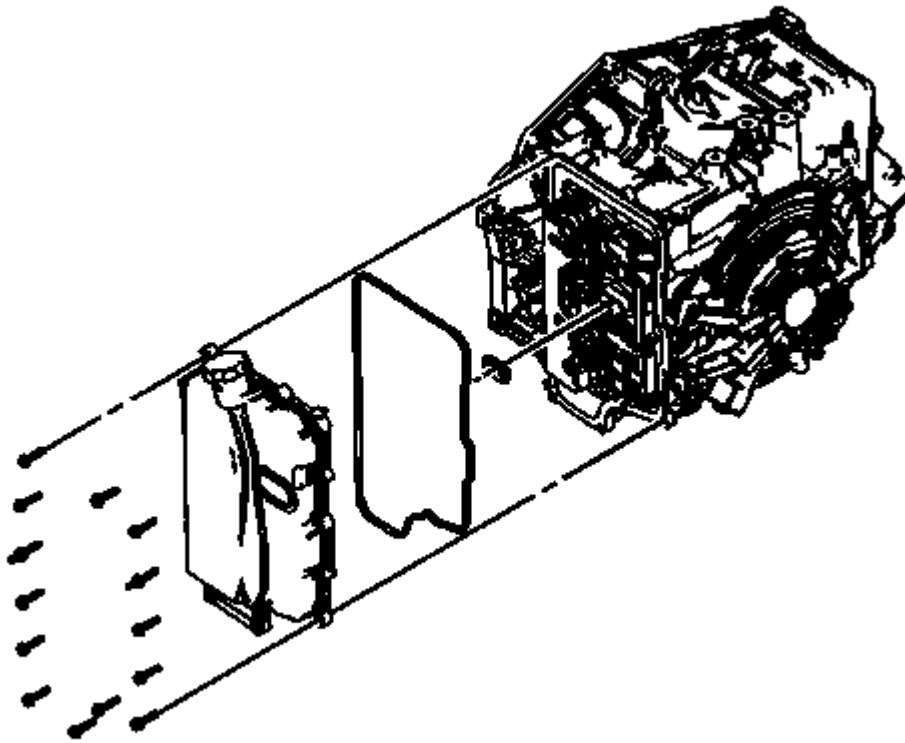


Fig. 21: Identifying Control Valve Body Cover Studs & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the 2 control valve body cover studs M6 x 30.
10. Remove the 12 control valve body cover bolts M6 x 30.
11. Remove the front transmission mount. Refer to **Transmission Front Mount Replacement**.
12. Remove the control valve body cover.
13. Remove the control valve body cover gasket.

CAUTION: Support the control solenoid valve assembly around the connector when removing the seal. Excessive pulling force can damage the internal electrical connections.

14. Remove the control valve body cover wiring connector hole seal.
15. Remove all traces of the old gasket material. Clean the transmission case and control valve body cover gasket surfaces.

Installation Procedure

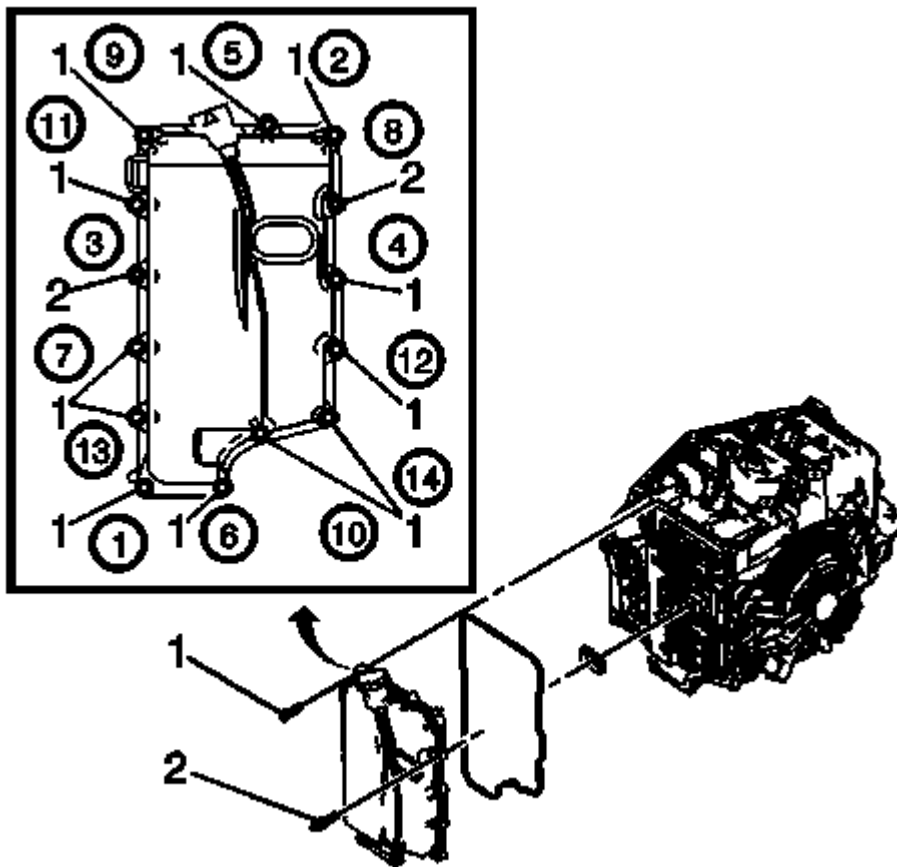


Fig. 22: Identifying Control Valve Body Cover Bolts Torque Sequence
 Courtesy of GENERAL MOTORS COMPANY

NOTE: The holes in the control valve body cover wiring connector hole seal must face toward the control solenoid valve assembly. If the holes face toward the valve body cover, there is a potential for a leak around the seal.

1. Install the control valve body cover wiring connector hole seal.
2. Install the control valve body cover gasket to the control valve body cover.
3. Install the control valve body cover.

CAUTION: Refer to Fastener Caution .

NOTE: Install all control valve body cover bolts and studs by hand then torque all bolts and studs in sequence.

4. Install the 12 control valve body cover bolts (1) M6 x 30 and tighten in sequence to 12 (106 lb in).
5. Install the 2 control valve body cover studs (2) M6 x 30 and tighten in sequence to 12 (106 lb in).

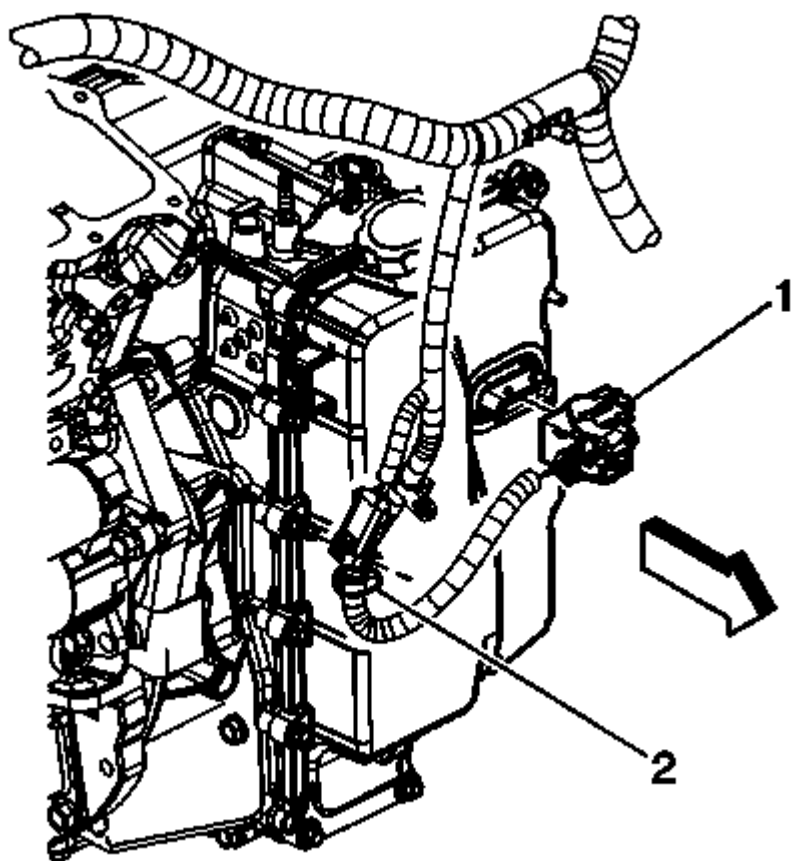


Fig. 23: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Connect the control valve body TCM electrical connector (1).
7. Install the wire harness retainer (2) to the control valve body cover stud. Tighten the nut to 12 (106 lb in).
8. Install the front transmission mount. Refer to **Transmission Front Mount Replacement**.

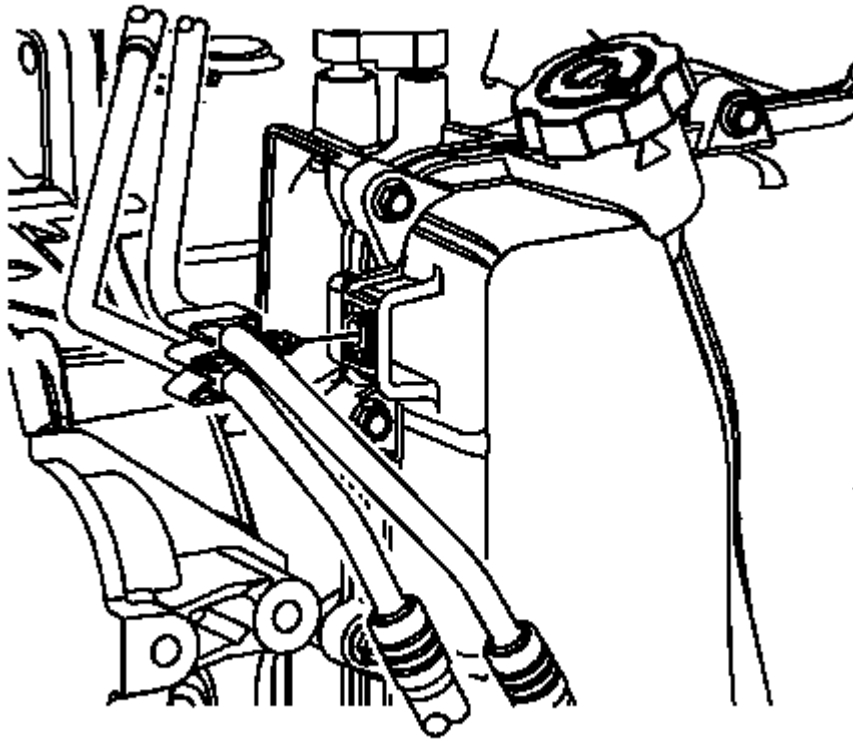


Fig. 24: Identifying Oil Cooler Inlet And Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

9. Install the oil cooler inlet hose. Refer to **Fluid Cooler Inlet Hose Replacement (MHH)** .
10. Install the oil cooler outlet hose. Refer to **Fluid Cooler Outlet Hose Replacement (MHH)** .
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
12. Connect and reposition the battery positive and negative cable to the front of the valve body cover. Refer to **Battery Negative Cable Replacement** , and **Battery Positive Cable Replacement** .
13. Fill the transmission. Refer to **Transmission Fluid Drain and Fill**.
14. Check for leaks.

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the control valve body cover. Refer to **Control Valve Body Cover Replacement**.

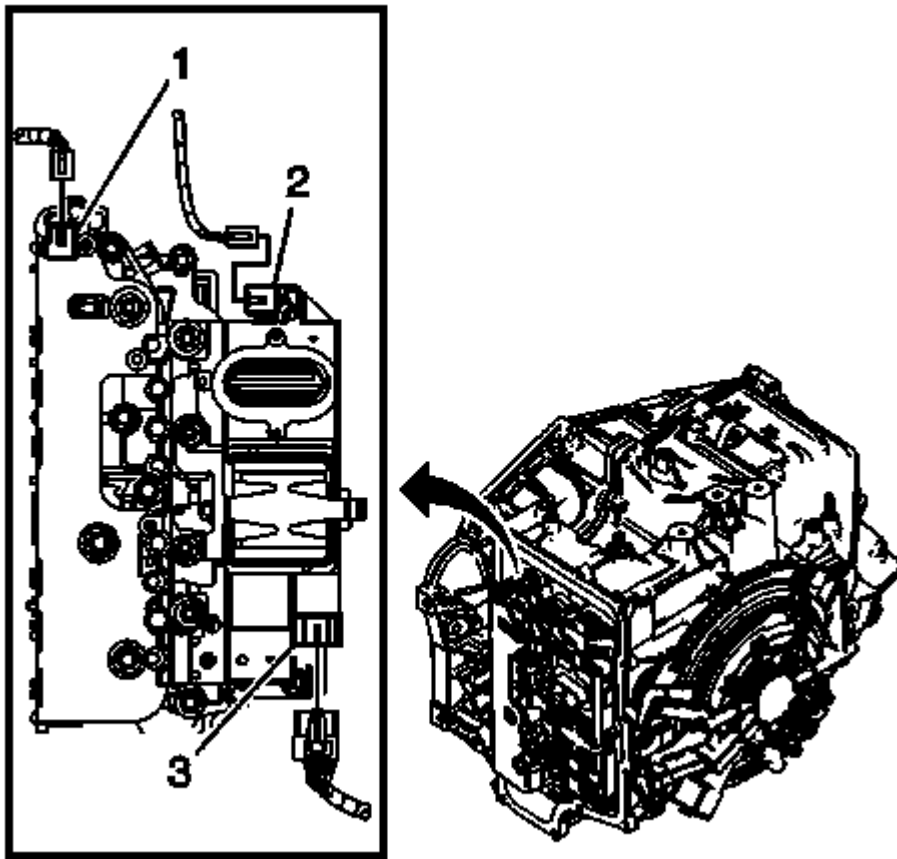


Fig. 25: Identifying Input Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the input speed sensor electrical connector (1).
3. Disconnect the output speed sensor electrical connector (2).
4. Disconnect the shift position switch electrical connector (3).

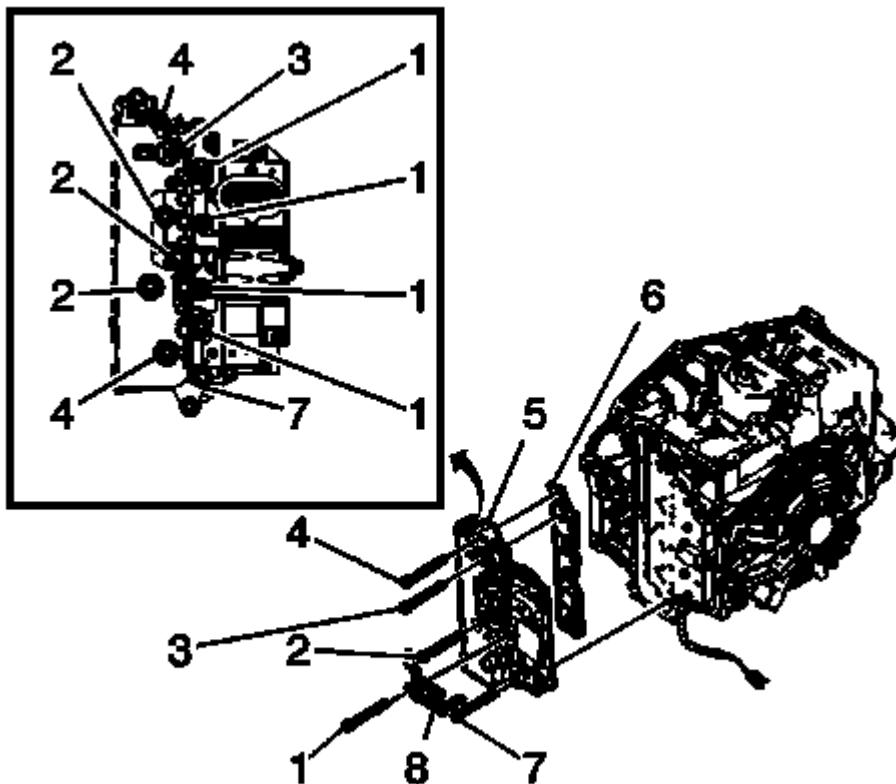


Fig. 26: Identifying Control Valve Body Bolts
 Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 control valve body bolts (1) M6 x 80.
6. Position the control solenoid valve spring (8) to the side. Spring will be released with the removal of the control valve body assembly.
7. Remove the 2 control valve body bolts (4) M6 x 65.
8. Remove the control valve body bolt (3) M6 x 42.
9. Remove the 3 control valve body bolts (2) M6 x 95.
10. Remove the control valve body bolt (7) M6 x 55.
11. Remove the control solenoid valve body and transmission control module (TCM) assembly (5).

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

12. Remove the control solenoid valve assembly filter plate (6).
 - Discard the filler plate. It is not reusable.

- Inspect the pressure switch manifold seals for damage or contamination. Replace the control solenoid valve assembly as necessary.
- Inspect the upper channel plate bolt holes for damage, peening or burnelling. Any damage around the bolt holes near the pressure control switch (PCS) feed holes could cause leakage around the PCS seals. Replace the upper channel plate as necessary.

Installation Procedure

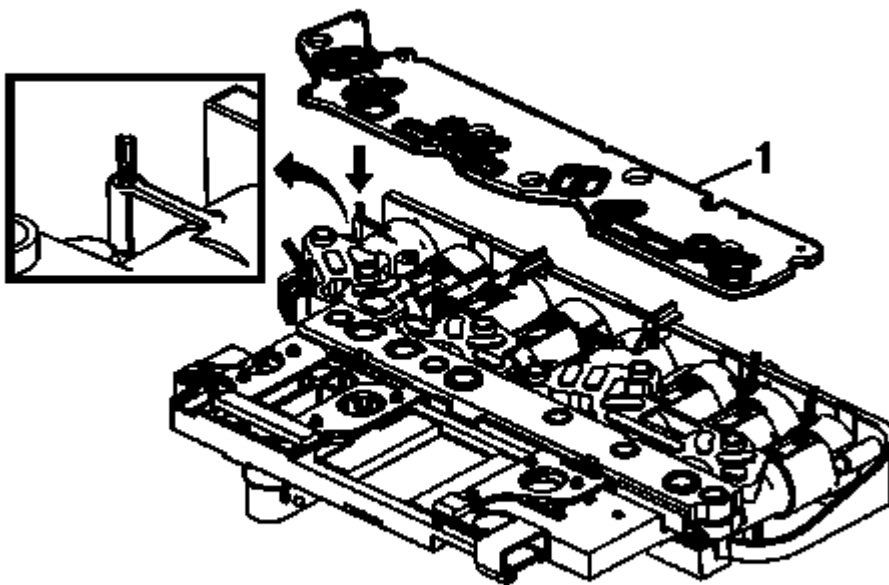


Fig. 27: Identifying Control Solenoid Valve Assembly Filter Plate
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

1. Install a NEW control solenoid valve assembly filter plate (1).

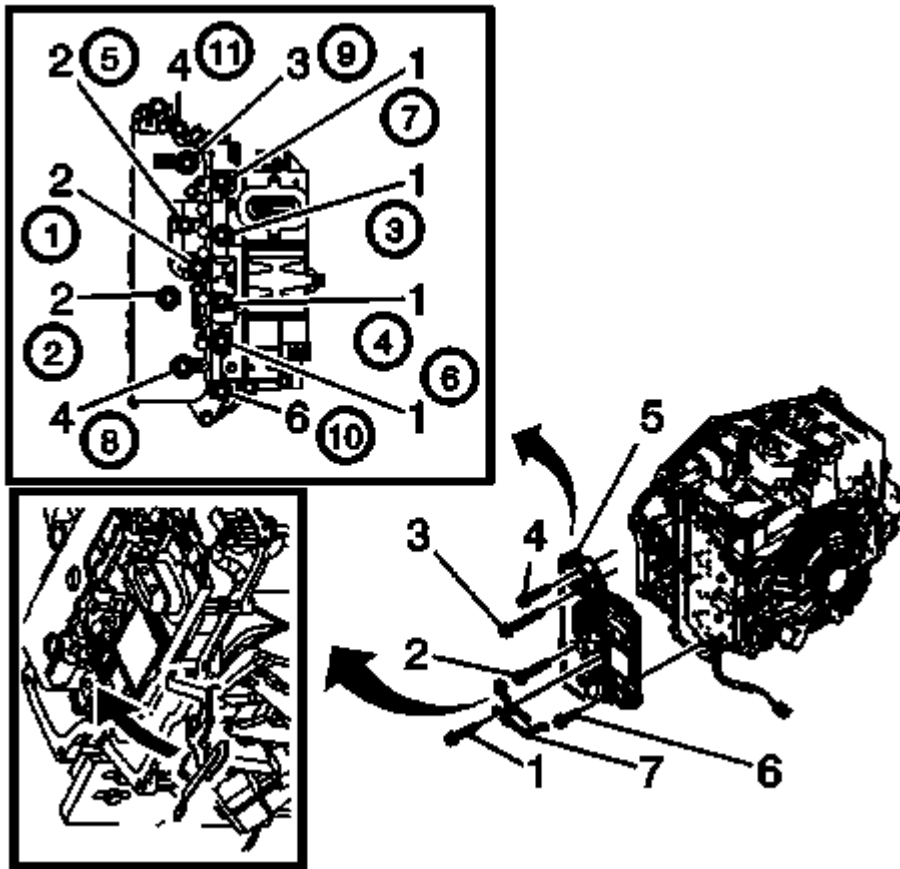


Fig. 28: Identifying Control Valve Body Bolts Torque Sequence
 Courtesy of GENERAL MOTORS COMPANY

2. Install the control solenoid valve body and TCM assembly (5).
3. Rotate the control solenoid valve spring (7) into position.

CAUTION: Refer to Fastener Caution .

NOTE: Install all bolts before tightening, then tighten in specified sequence.

4. Install the 4 control valve body bolts (1) M6 x 80.
5. Install the control valve body bolt (6) M6 x 55.
6. Install the 3 control valve body bolts (2) M6 x 95.
7. Install the control valve body bolt (3) M6 x 42.
8. Install the 2 control valve body bolts (4) M6 x 65.
9. Tighten all valve body bolts in specified sequence to 12 (106 lb in).

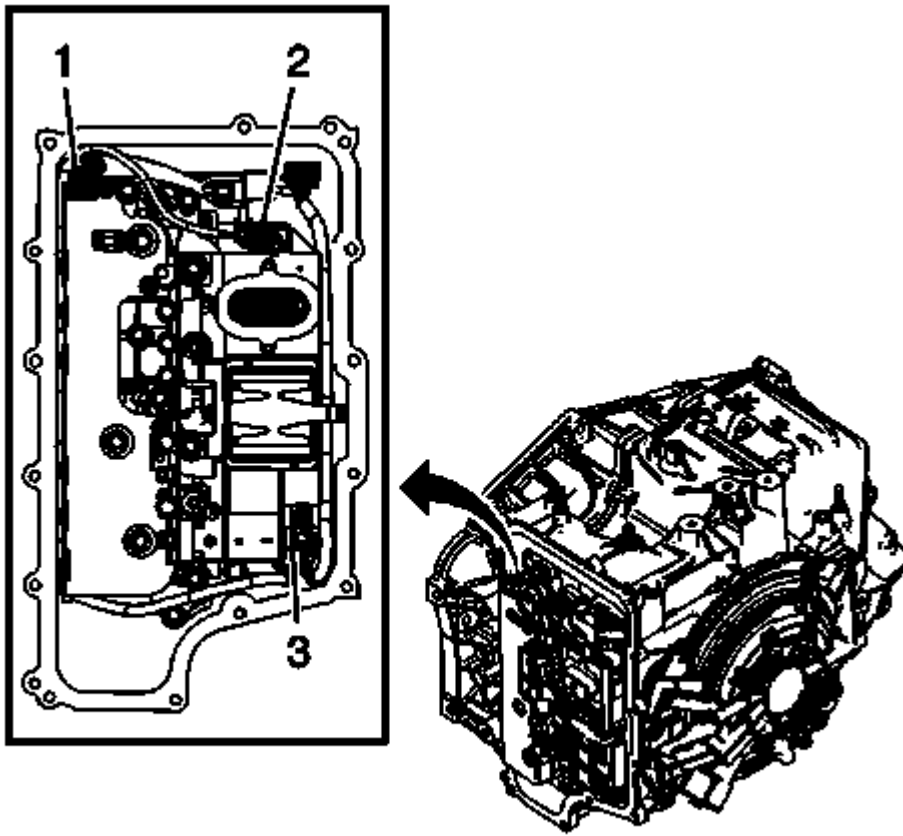


Fig. 29: Identifying Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

10. Connect the input speed sensor electrical connector (1).
11. Connect the output speed sensor electrical connector (2).
12. Connect the shift position switch electrical connector (3).
13. Install the control valve body cover. Refer to **Control Valve Body Cover Replacement**.
14. Program the module. Refer to **Control Module References** .

CONTROL VALVE LOWER BODY AND UPPER BODY REPLACEMENT

Removal Procedure

1. Remove the control valve body cover. Refer to **Control Valve Body Cover Replacement**.

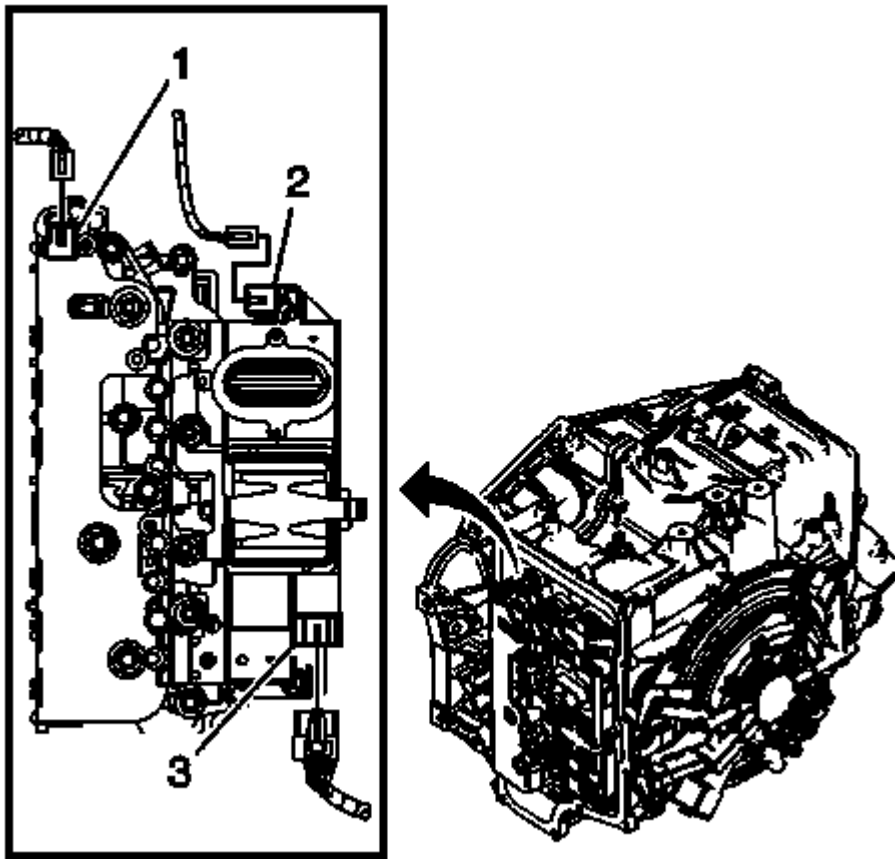


Fig. 30: Identifying Input Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the input speed sensor electrical connector (1).
3. Disconnect the output speed sensor electrical connector (2).
4. Disconnect the shift position switch electrical connector (3).

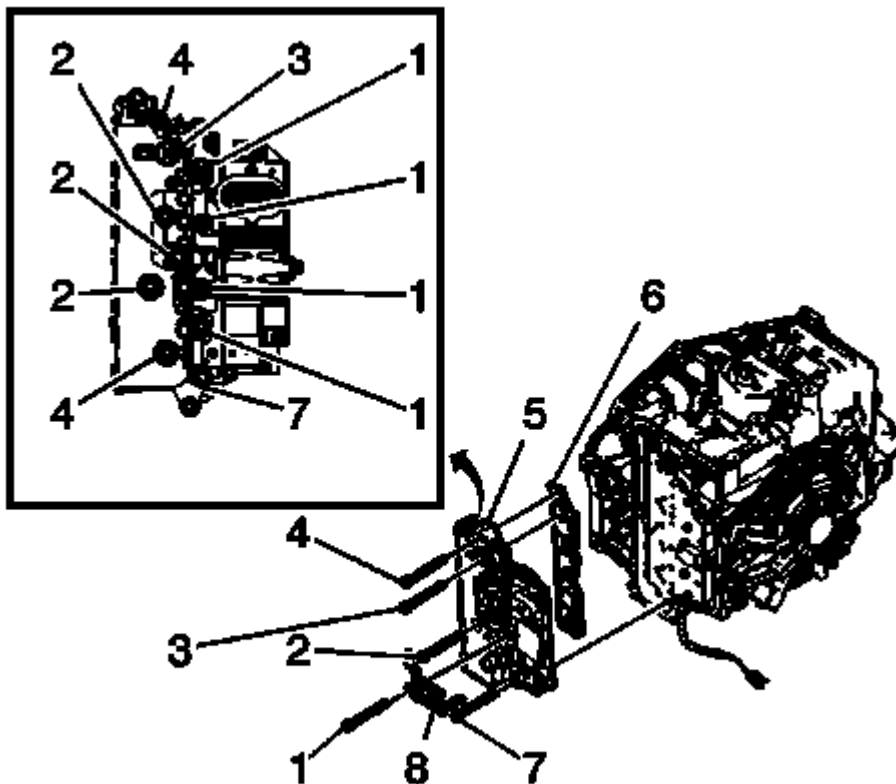


Fig. 31: Identifying Control Valve Body Bolts
 Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 control valve body bolts (1) M6 x 80.
6. Position the control solenoid valve spring (8) to the side. Spring will be released with removal of lower control valve body.
7. Remove the 2 control valve body bolts (4) M6 x 65.
8. Remove the control valve body bolt (3) M6 x 42.
9. Remove the 3 control valve body bolts (2) M6 x 95.
10. Remove the control valve body bolt (7) M6 x 55.
11. Remove the control solenoid valve body and transmission control module (TCM) assembly (5).

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

12. Remove the control solenoid valve body assembly filter plate (6).
 - Discard the filler plate. It is not reusable.

- Inspect the pressure switch manifold seals for damage or contamination. Replace the control solenoid valve assembly as necessary.
- Inspect the upper channel plate bolt holes for damage, peening or burnelling. Any damage around the bolt holes near the PCS switch feed holes could cause leakage around the PCS switch seals. Replace the upper channel plate as necessary.

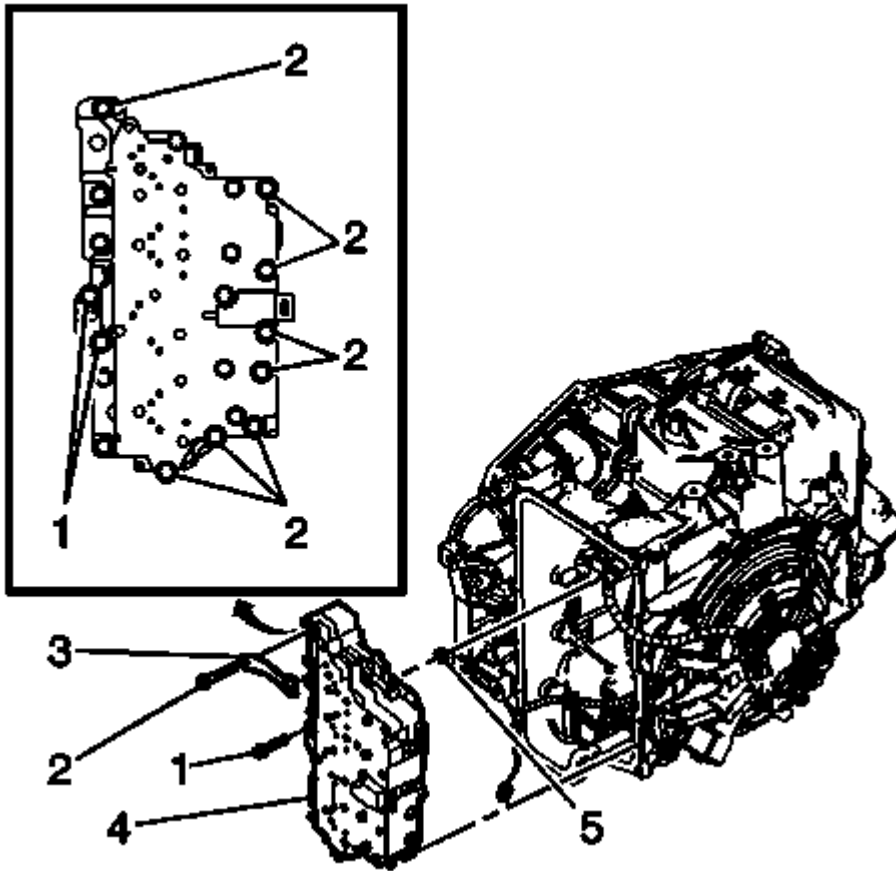


Fig. 32: Identifying Control Valve Body Bolts
 Courtesy of GENERAL MOTORS COMPANY

13. Remove the 8 control valve body bolts (2) M6 x 65.
14. Remove the 2 control valve body bolts (1) M6 x 55.
15. Remove the manual shaft detent assembly (3).
16. Remove the control valve body assembly (4).
17. The control solenoid valve spring can now be fully removed from the lower control valve body assembly.

NOTE: The clutch fluid passage seal is not reusable.

18. Remove the 1-2-3-4 clutch fluid passage seal (5).

Installation Procedure

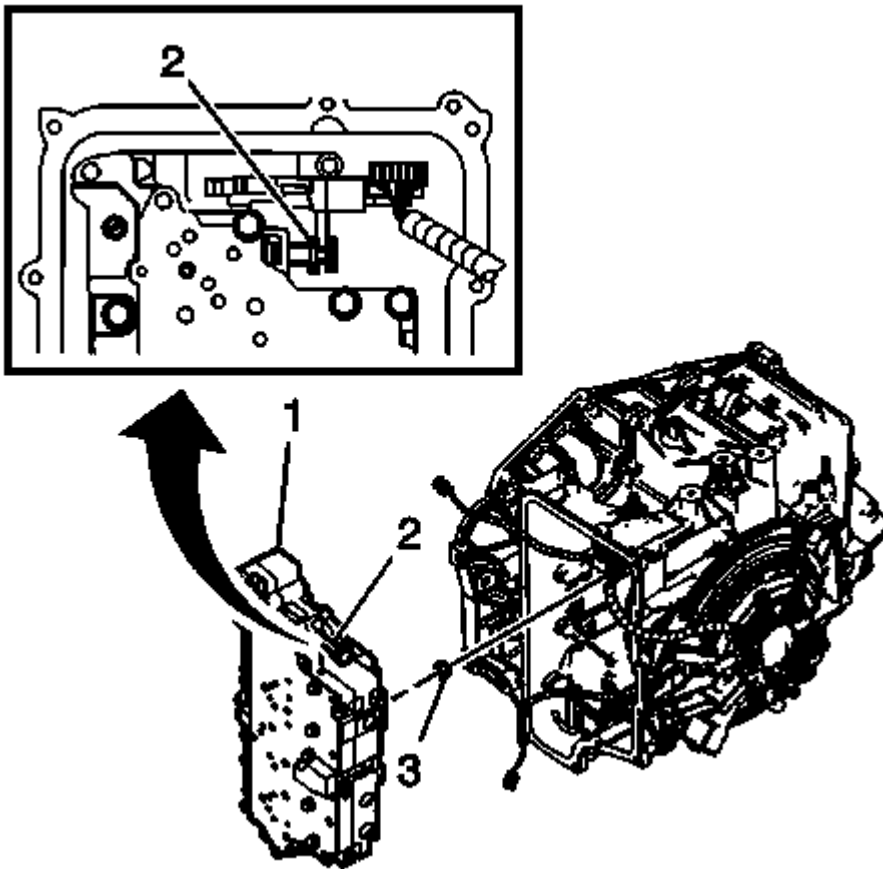


Fig. 33: Identifying Control Valve Body Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The clutch fluid passage seal is not reusable.

1. Install a NEW 1-2-3-4 clutch fluid passage seal (3).

NOTE:

- Ensure the control solenoid valve spring is attached to the lower control valve body assembly.
- Align the manual valve (2) to the detent lever assembly while installing the lower control valve body assembly.

2. Install the control valve body assembly (1).

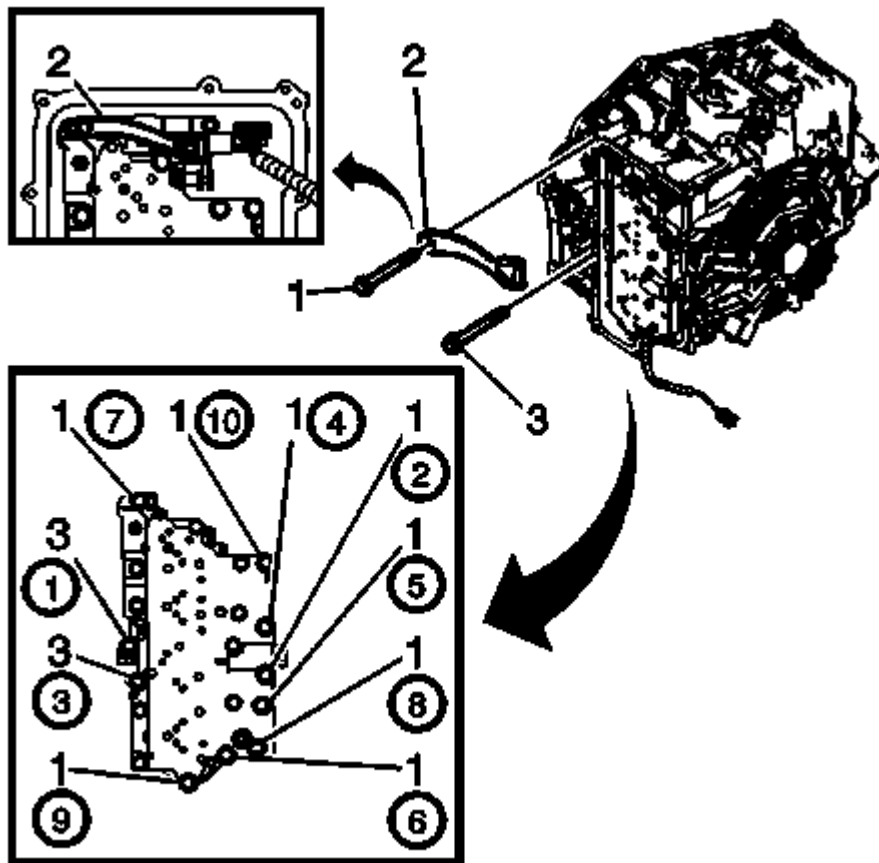


Fig. 34: Identifying Control Valve Body Bolts Torque Sequence
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure proper alignment of the detent assembly to the detent lever assembly with position switch while tightening the bolt. The detent assembly can move and hit the valve body assembly that could cause improper engagement with the detent lever assembly.

3. Install the manual shaft detent assembly (2).

CAUTION: Refer to Fastener Caution .

NOTE: Install all bolts before tightening, then tighten in specified sequence.

4. Install the 8 control valve body bolts (1) M6 x 65 and tighten to 12 (106 lb in).
5. Install the 2 control valve body bolts (3) M6 x 55 and tighten to 12 (106 lb in).

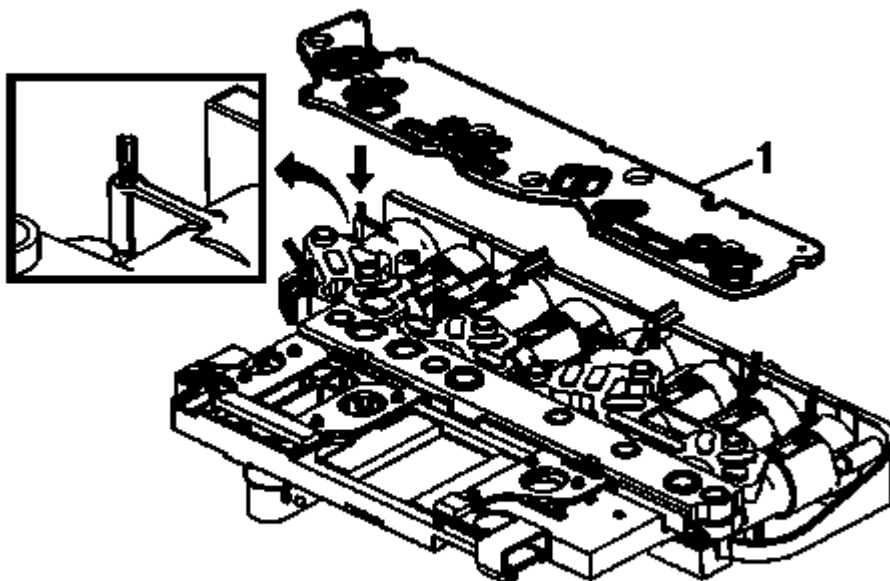


Fig. 35: Identifying Control Solenoid Valve Assembly Filter Plate
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

6. Install a NEW control solenoid valve assembly filter plate (1).

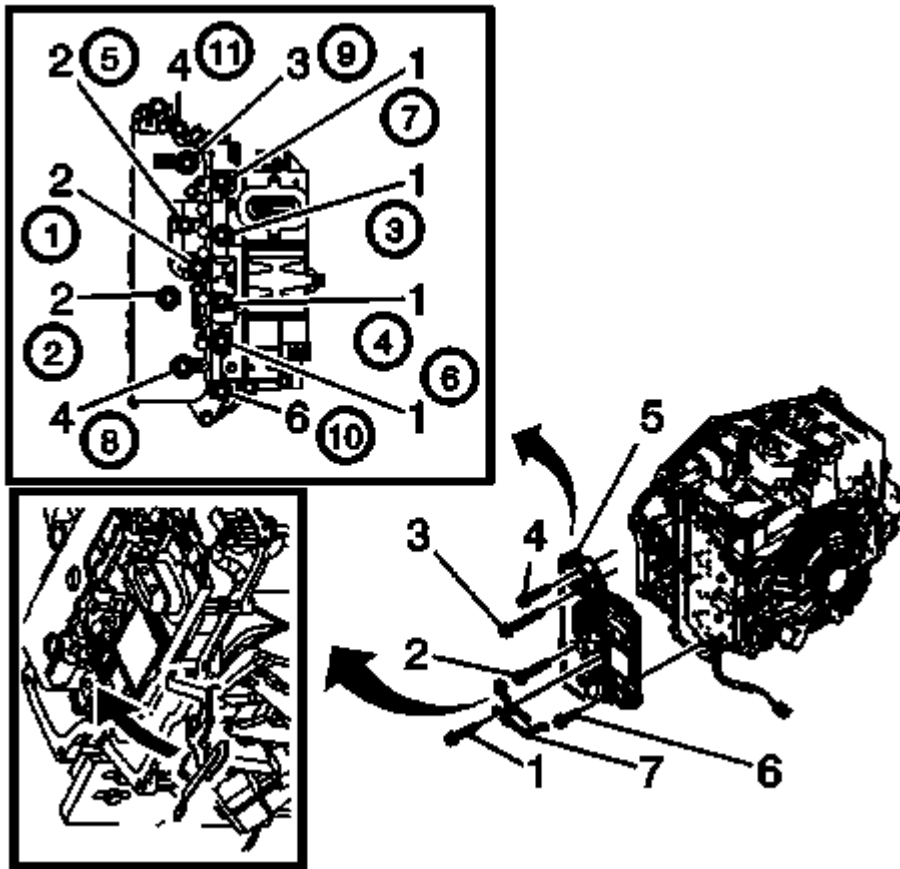


Fig. 36: Identifying Control Valve Body Bolts Torque Sequence
 Courtesy of GENERAL MOTORS COMPANY

7. Install the control solenoid valve body and TCM assembly (5).
8. Rotate the control solenoid valve spring (7) into position.

NOTE: Install all bolts before tightening, then tighten in specified sequence.

9. Install the 4 control valve body bolts (1) M6 x 80.
10. Install the control valve body bolt (6) M6 x 55.
11. Install the 3 control valve body bolts (2) M6 x 95.
12. Install the control valve body bolt (3) M6 x 42.
13. Install the 2 control valve body bolts (4) M6 x 65.
14. Tighten all valve body bolts in specified sequence to 12 (106 lb in).

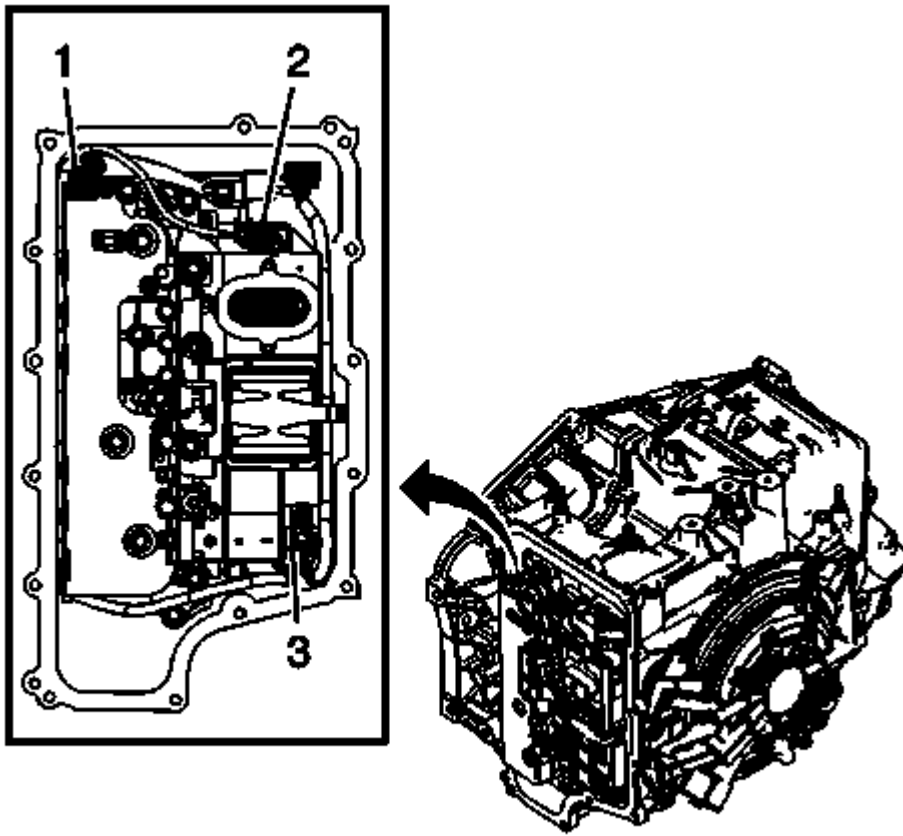


Fig. 37: Identifying Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

15. Connect the input speed sensor electrical connector (1).
16. Connect the output speed sensor electrical connector (2).
17. Connect the shift position switch electrical connector (3).
18. Install the control valve body cover. Refer to **Control Valve Body Cover Replacement**.
19. For transmission control module programming and setup. Refer to **Control Module References** .

NOTE: **After an internal transmission repair or internal part replacement the service fast learn adapt procedure should be performed.**

20. Perform the service fast learn adapt procedure.

OUTPUT SPEED SENSOR REPLACEMENT

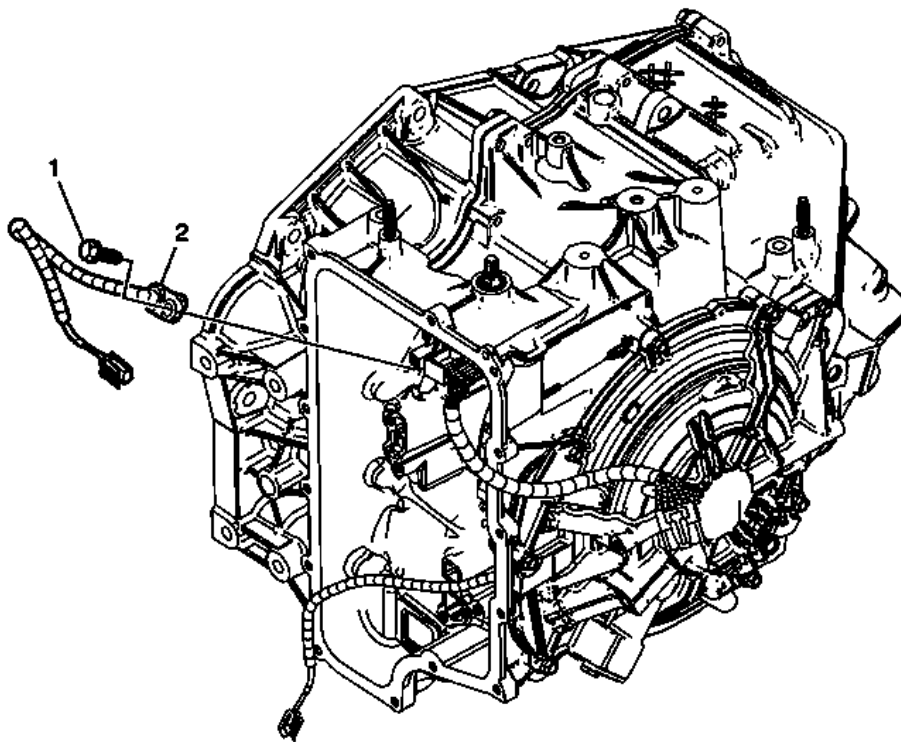


Fig. 38: View Of Output Speed Sensor
 Courtesy of GENERAL MOTORS COMPANY

Output Speed Sensor Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the control valve lower body and upper body. Refer to <u>Control Valve Lower Body and Upper Body Replacement</u>. 	
1	Output Speed Sensor Bolt M6 x 25 CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 (106 lb in)
2	Output Speed Sensor Procedure Perform the service fast learn adapt procedure. NOTE: After an internal transmission repair or internal part replacement the service fast learn adapt procedure should be performed.

INPUT SPEED SENSOR REPLACEMENT

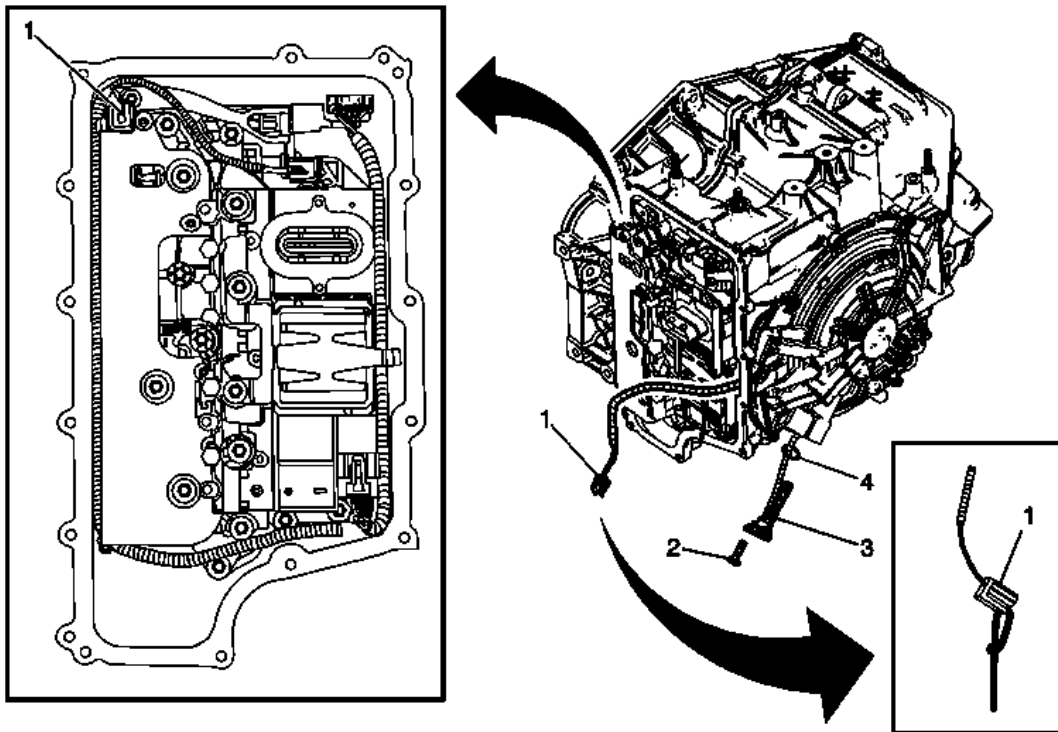


Fig. 39: View Of Input Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

Input Speed Sensor Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Drain the transmission, refill when repair is completed. Refer to <u>Transmission Fluid Drain and Fill</u>. 3. Remove the left engine splash shield. 4. Remove the left transmission mount and bracket. Refer to <u>Transmission Mount Replacement - Left Side</u>. 5. Remove the control valve body cover. Refer to <u>Control Valve Body Cover Replacement</u>. 6. Perform the service fast learn adapt procedure. 	
1	<p>Input Speed Sensor (ISS) Wire Harness</p> <p>Procedure Attach the DT-47734 tether to the ISS electrical connector locking tab before removal of old ISS to assist in installation of the new ISS.</p> <p>Special Tools DT-47734 Speed Sensor Harness Tether For equivalent regional tools, refer to <u>Special Tools</u> .</p>

2	<p>Input Speed Sensor Bolt M6 x 25</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Apply threadlocker to the input speed sensor bolt. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> for the recommended threadlock material. Tighten 9 (80 lb in)</p>
3	<p>Input Speed Sensor</p> <p>NOTE: After an internal transmission repair or internal part replacement the service fast learn adapt procedure should be performed.</p>
4	Input Speed Sensor Seal

TRANSMISSION MOUNT REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the battery box. Refer to Battery Tray Replacement .
2. Install the engine support fixture. Refer to Engine Support Fixture .
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

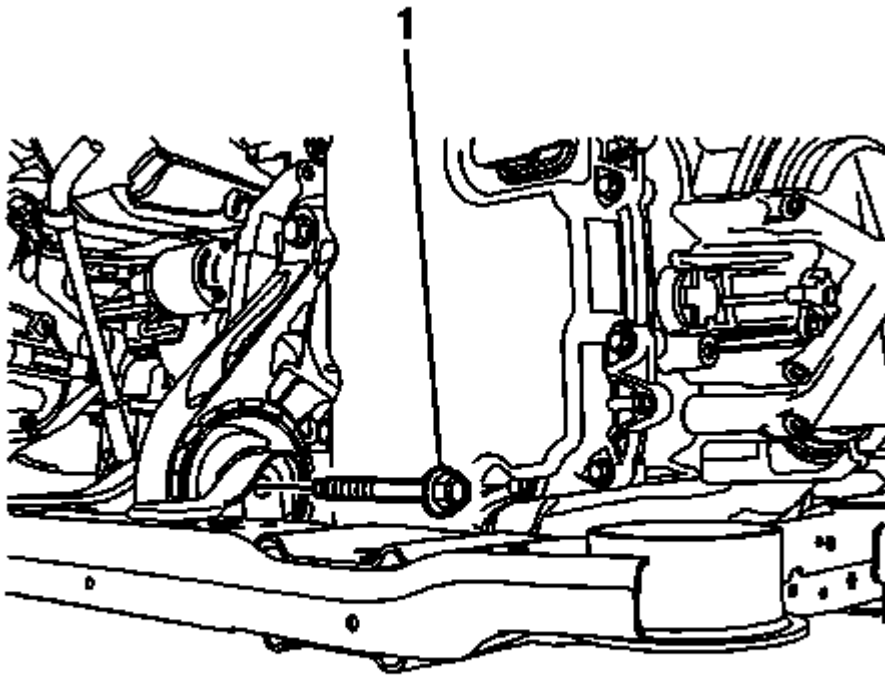


Fig. 40: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front transmission mount through fastener (1).

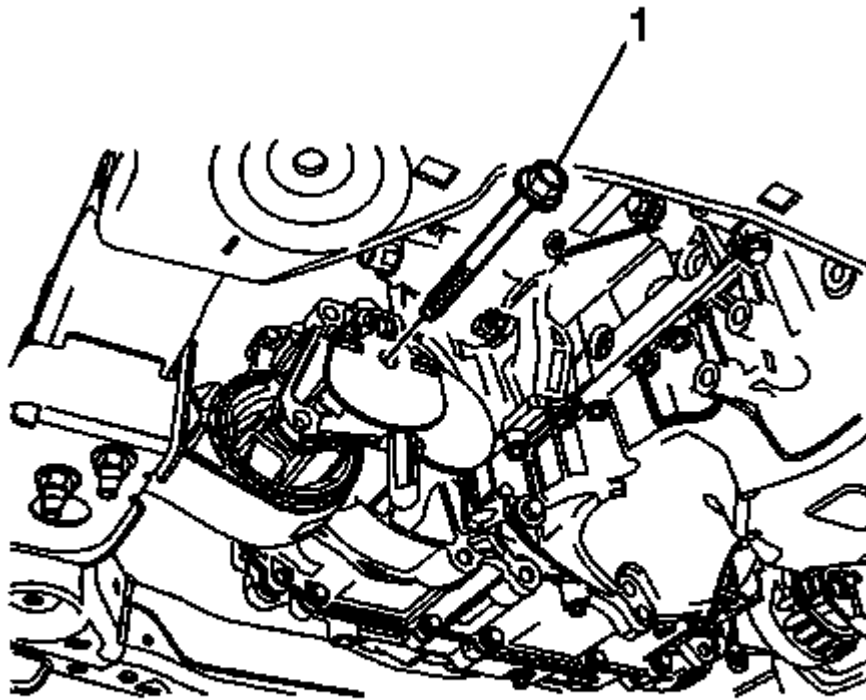


Fig. 41: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the rear transmission mount through fastener (1).

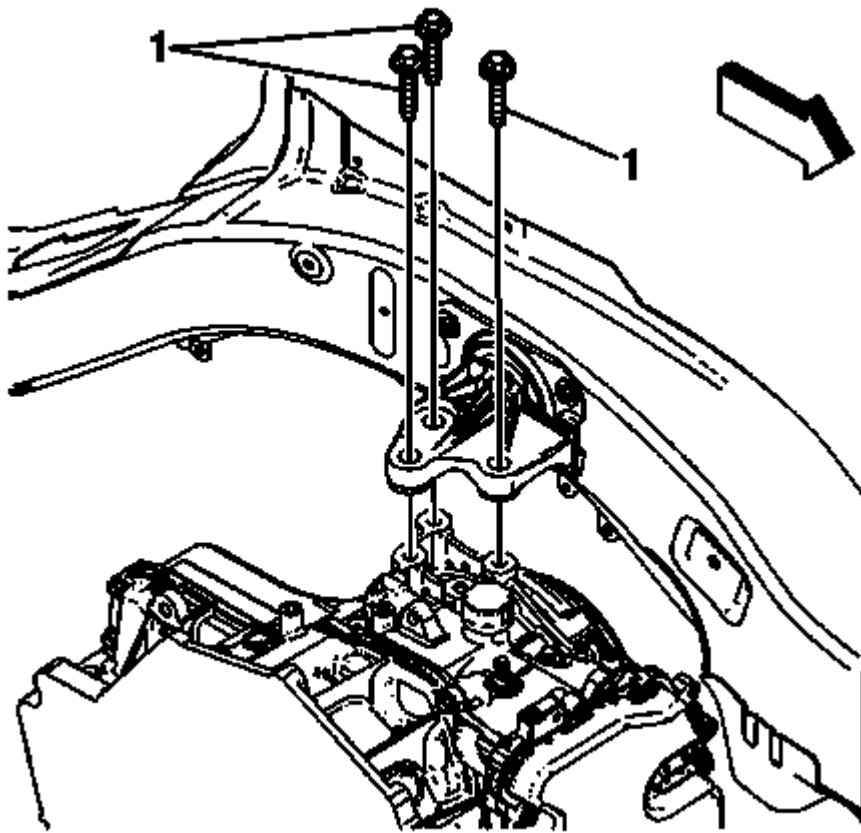


Fig. 42: Left Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transmission mount to transmission fasteners (1). Discard the bolts.

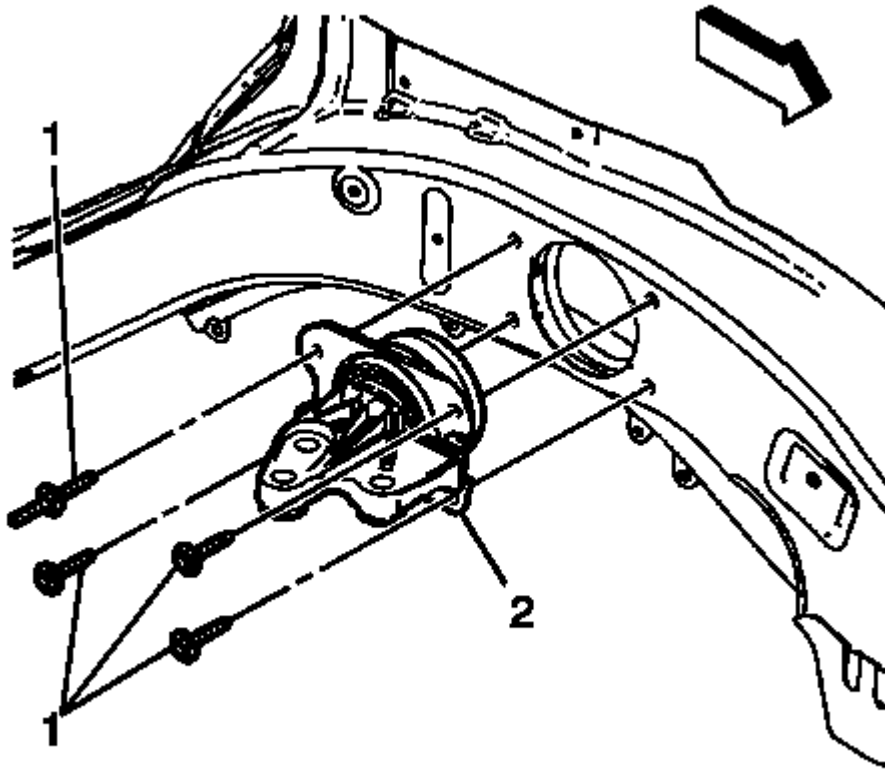


Fig. 43: Left Transmission Mount
Courtesy of GENERAL MOTORS COMPANY

7. Using the engine support, lower the transmission enough to provide clearance for the left transmission mount.
8. If applicable, disengage the wiring harness from the frame rail fastener stud.

NOTE: **Some vehicles may be equipped without a stud fastener.**

9. Remove the transmission mount to frame rail fasteners (1).
10. Remove the left transmission mount (2).

Installation Procedure

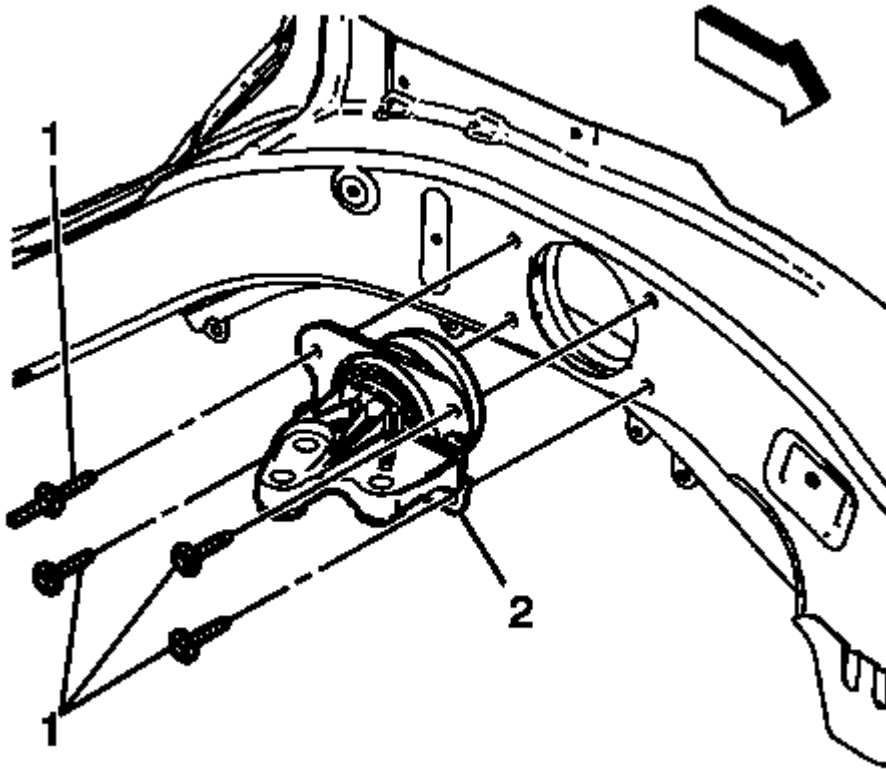


Fig. 44: Left Transmission Mount

Courtesy of GENERAL MOTORS COMPANY

1. Install the left transmission mount (2).

CAUTION: Refer to Fastener Caution .

2. Install the transmission mount to frame rail fasteners (1) and tighten to 22 (16 lb ft).
3. If applicable, connect the wiring harness to the frame rail fastener stud.
4. Using the engine support, raise the transmission until the transmission contacts the left transmission mount.

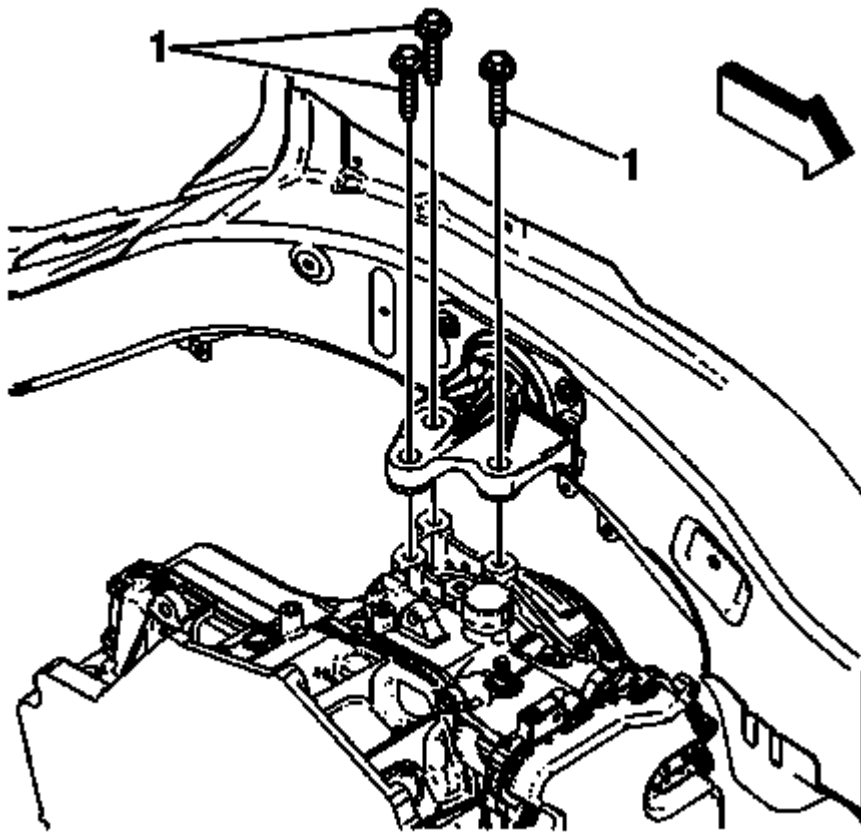


Fig. 45: Left Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT** reuse the old bolts. Always use **NEW** bolts when reinstalling the mount.

5. Install the **NEW** transmission mount to transmission fasteners (1) and tighten to 50 (37 lb ft) plus 90-105 degrees.
6. Raise the vehicle.

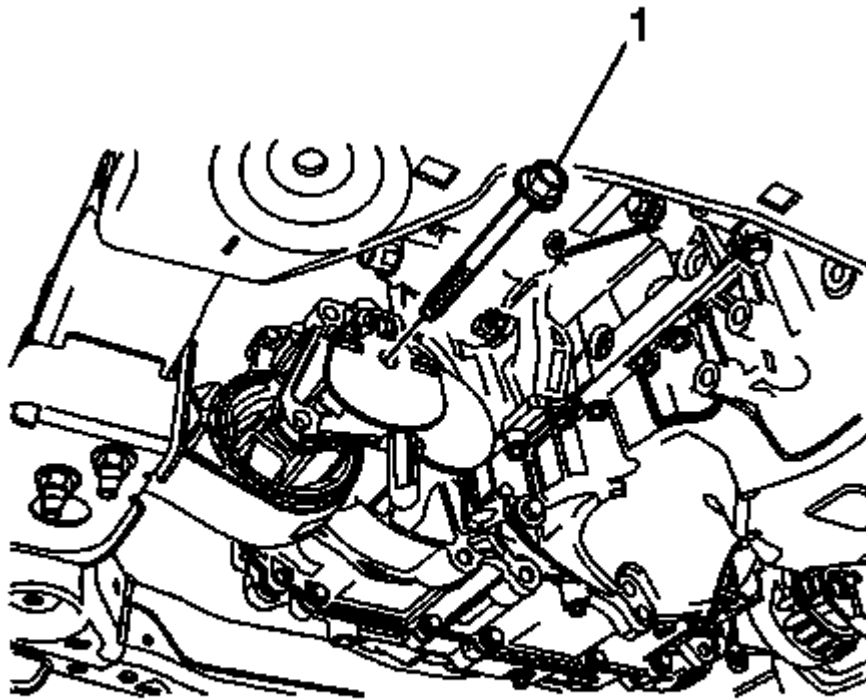


Fig. 46: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install the rear transmission mount through fastener (1) and tighten to 105 (77 lb ft).

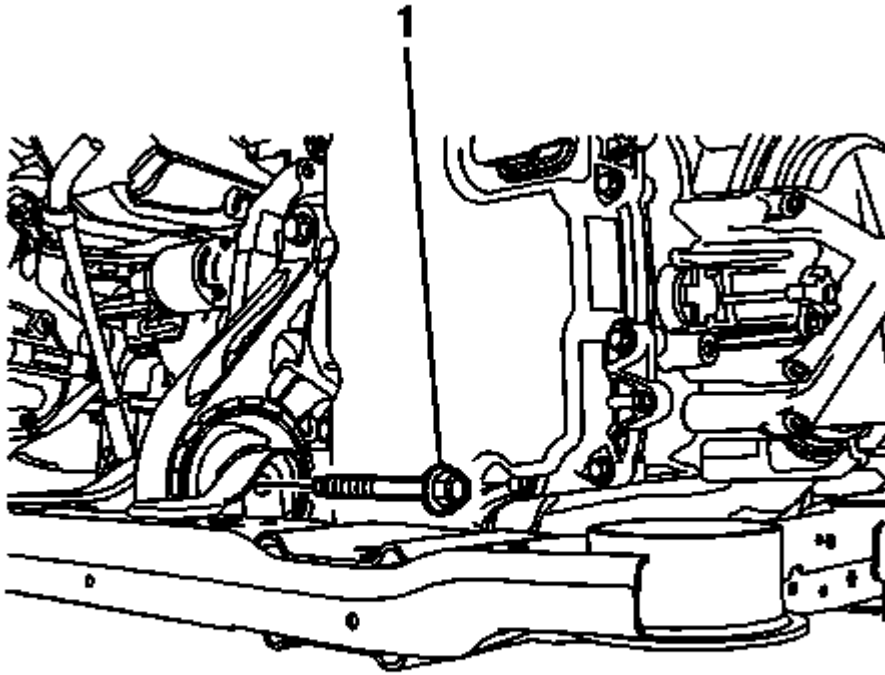


Fig. 47: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install the front transmission mount through fastener (1) and tighten to 100 (74 lb ft).
9. Lower the vehicle.
10. Remove the engine support fixture.
11. Install the battery box. Refer to **Battery Tray Replacement** .

TRANSMISSION FRONT MOUNT REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Support the transmission with a suitable jack.

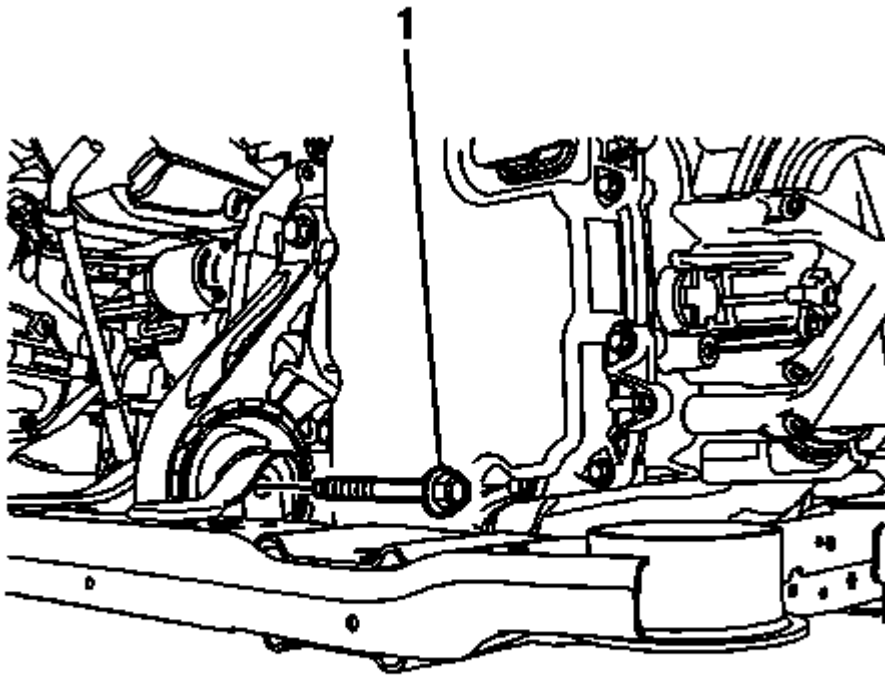


Fig. 48: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the front transaxle mount through bolt (1).

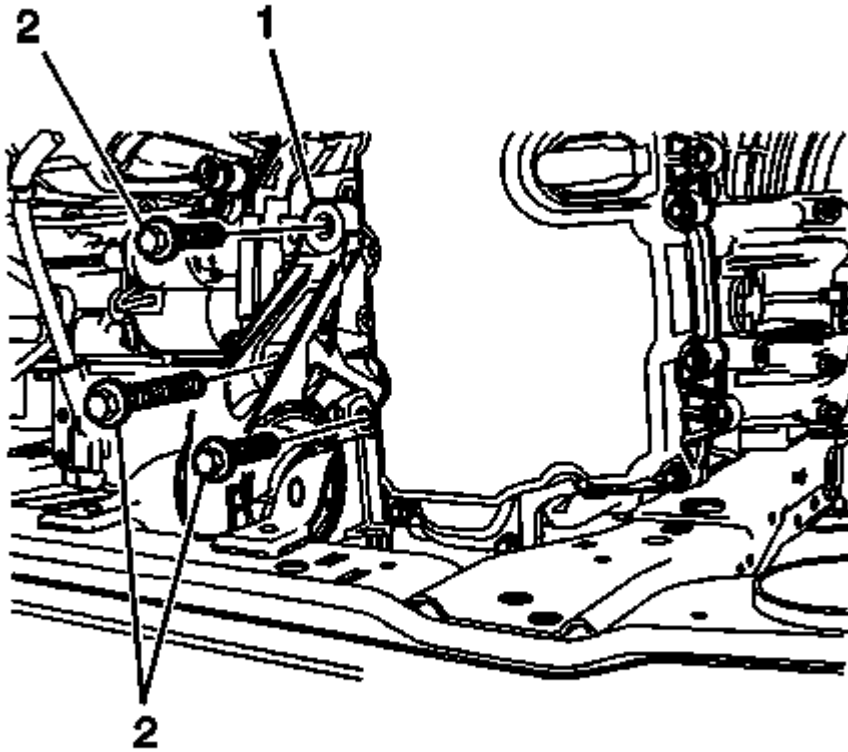


Fig. 49: Transaxle Mount & Attachment Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the three transaxle mount-to-transaxle attachment bolts (2).
5. Remove the transaxle mount (1) from the vehicle.

Installation Procedure

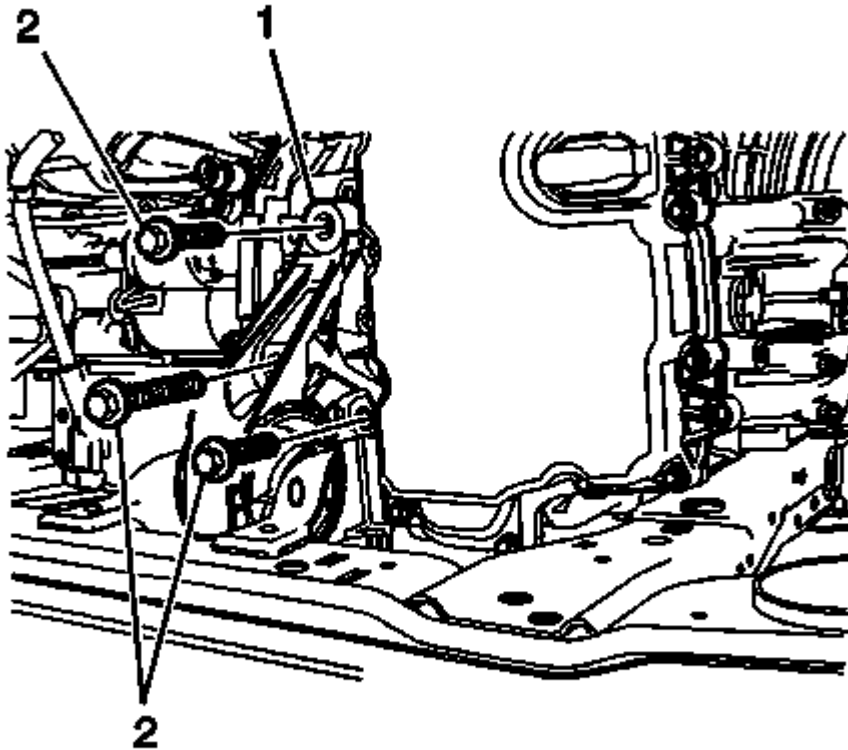


Fig. 50: Transaxle Mount & Attachment Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the transaxle mount (1).

CAUTION: Refer to Fastener Caution .

2. Install the NEW transaxle mount bolts (2) and tighten to 62 (46 lb ft).

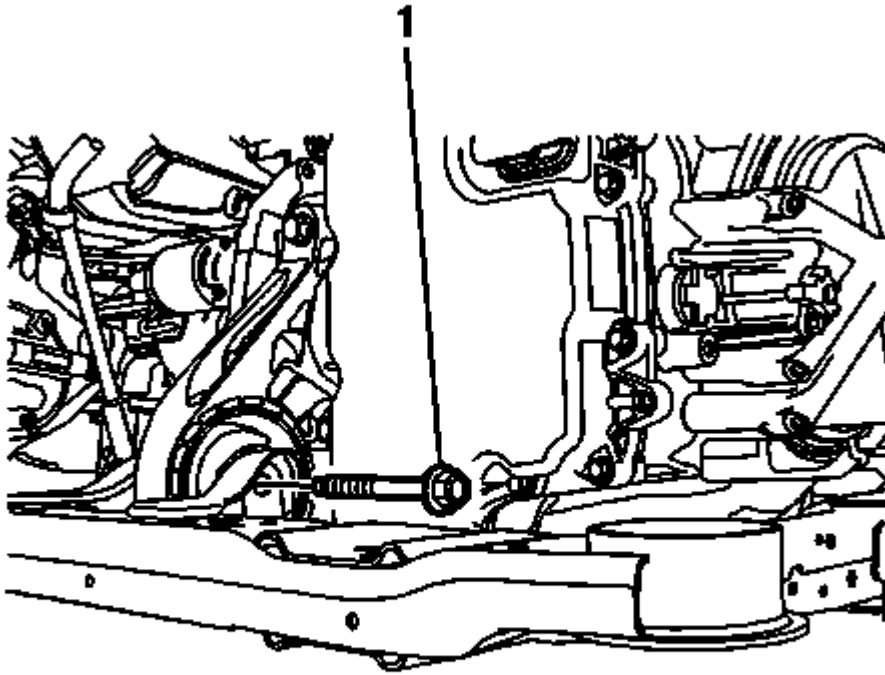


Fig. 51: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the transaxle mount through bolt (1) and tighten to 105 (77 lb ft).
4. Remove the jack from the transmission.
5. Lower the vehicle.

TRANSMISSION REAR MOUNT REPLACEMENT (AWD)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the propeller shaft from the vehicle. Refer to **Propeller Shaft Replacement** .
3. Use a suitable jack to support the transaxle.

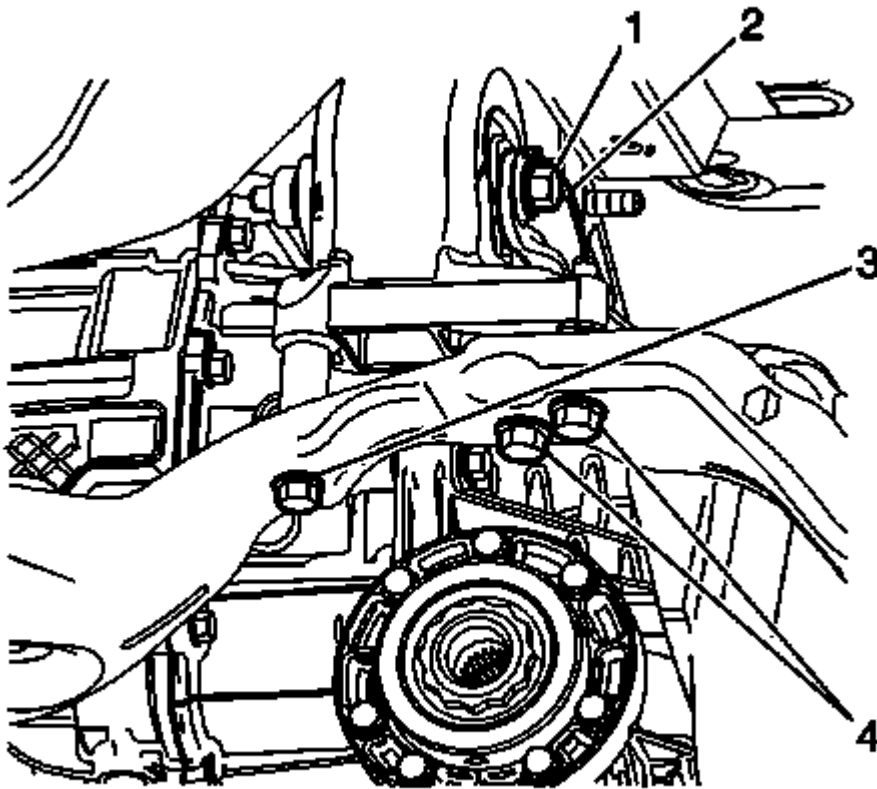


Fig. 52: Transaxle Mount Components
Courtesy of GENERAL MOTORS COMPANY

4. With a jack, slightly take the weight off mount, and remove the transaxle mount to frame fasteners (3, 4).
5. Remove the transaxle mount through bolt (1).
6. Remove the transaxle mount from the vehicle (2).

Installation Procedure

1. Position the transaxle bracket to the transaxle.

CAUTION: Refer to Fastener Caution .

2. Install the transfer case bracket bolts and tighten to 100 (74 lb ft).

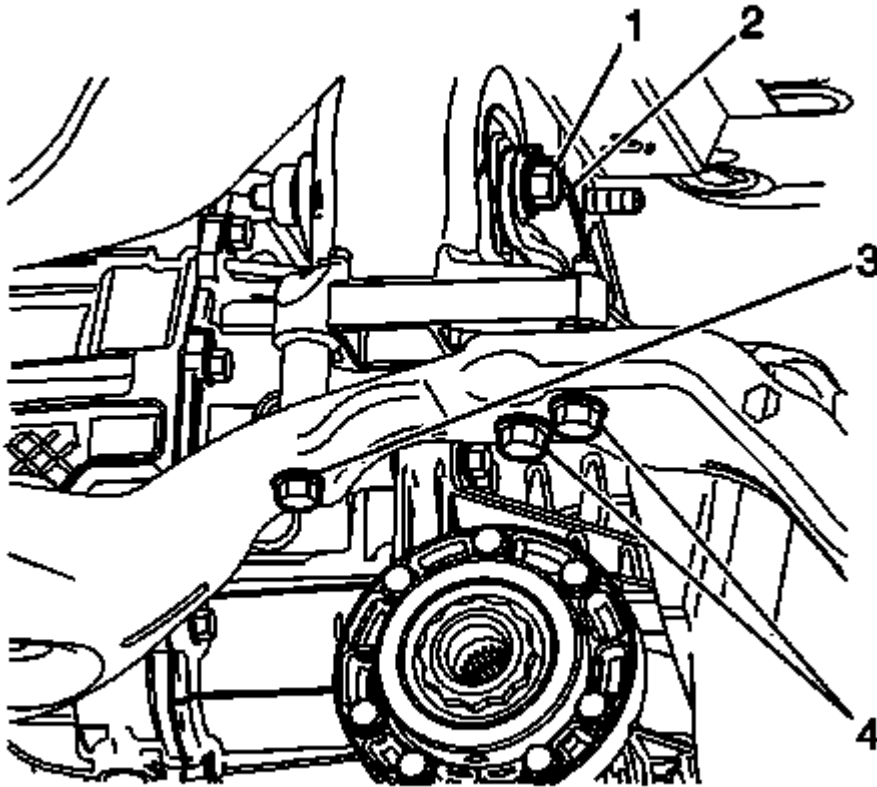


Fig. 53: Transaxle Mount Components
Courtesy of GENERAL MOTORS COMPANY

3. Install the transaxle mount (2) to the frame.
4. Install the longer transaxle mount to frame bolt (3, 4) and tighten to 62 (46 lb ft).
5. Install the shorter transaxle mount to frame bolts and tighten to 100 (74 lb ft).
6. Install the through bolt (1) and tighten to 100 (74 lb ft).
7. Remove the support from the transaxle.
8. Install the propeller shaft. Refer to **Propeller Shaft Replacement**
9. Lower the vehicle.

TRANSMISSION REAR MOUNT REPLACEMENT (FWD)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the left tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Using a suitable jack stand, support the rear of the powertrain.

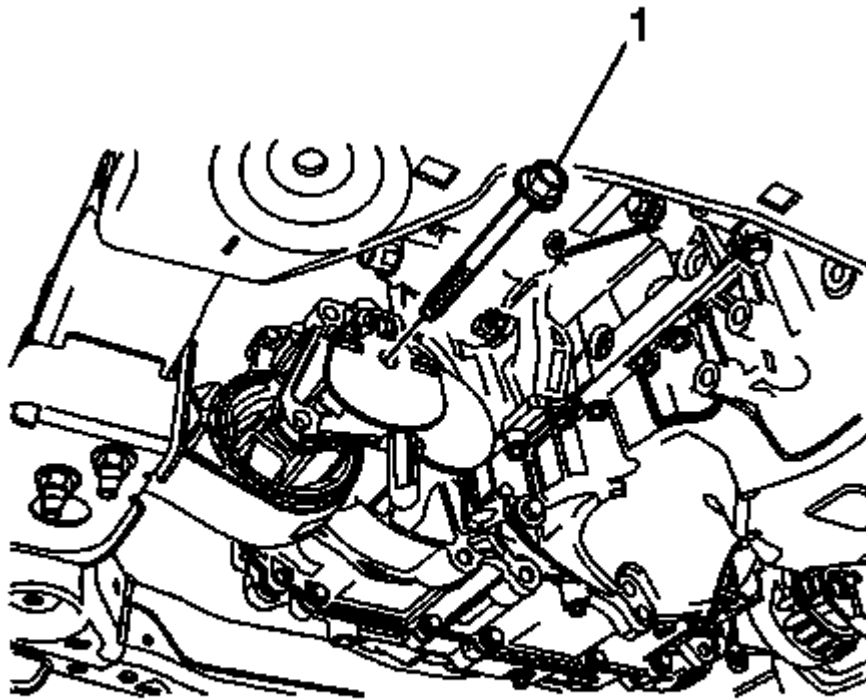


Fig. 54: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the transmission mount to bracket through bolt (1).

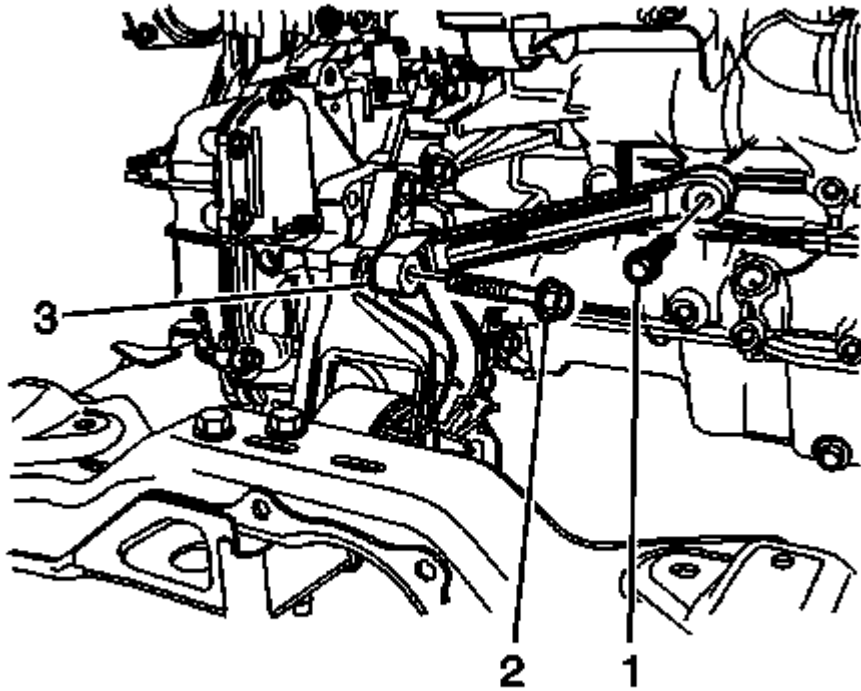


Fig. 55: Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the transaxle brace bolt (1), then loosen bolt (2) until it no longer engages the transaxle.
6. Remove the transaxle brace (3) with bolt (2) still retained in the brace.

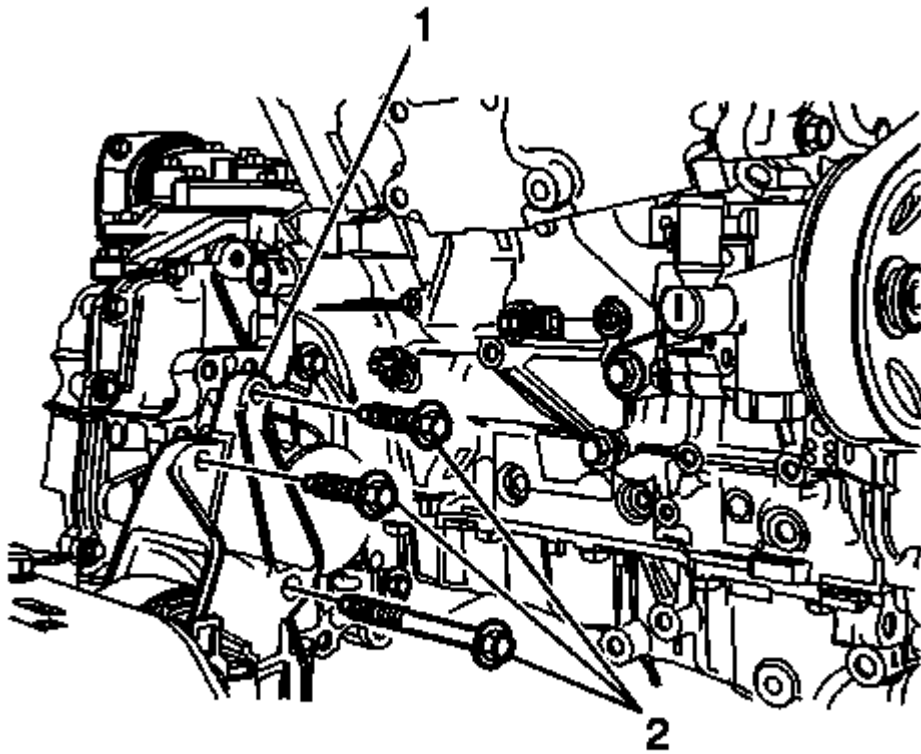


Fig. 56: Transmission Mount To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the transmission mount bracket (1) to transmission bolts (2).

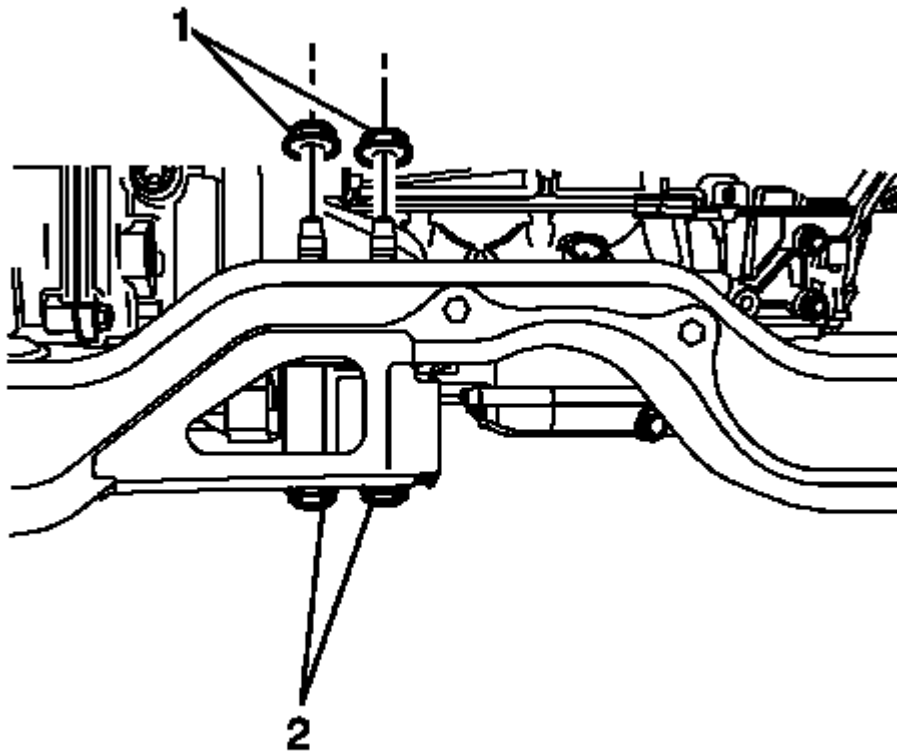


Fig. 57: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the rear mount to frame fasteners (1, 2), then remove the mount and bracket from the vehicle.

Installation Procedure

CAUTION: Refer to Fastener Caution .

1. Install the transmission mount to transmission bolts and tighten to 100 (74 lb ft).

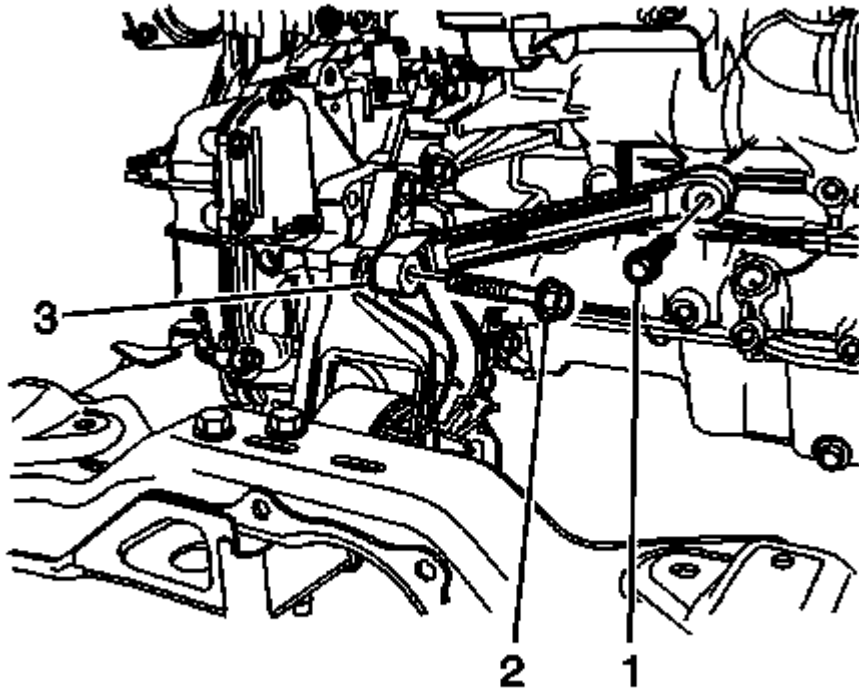


Fig. 58: Transaxle Brace & Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Install the transaxle brace (3) with bolt (2) seated in the brace.
3. Install the transaxle brace bolt (1) and tighten to 50 (37 lb ft).
4. Tighten the brace bolt (2) to 100 (74 lb ft).

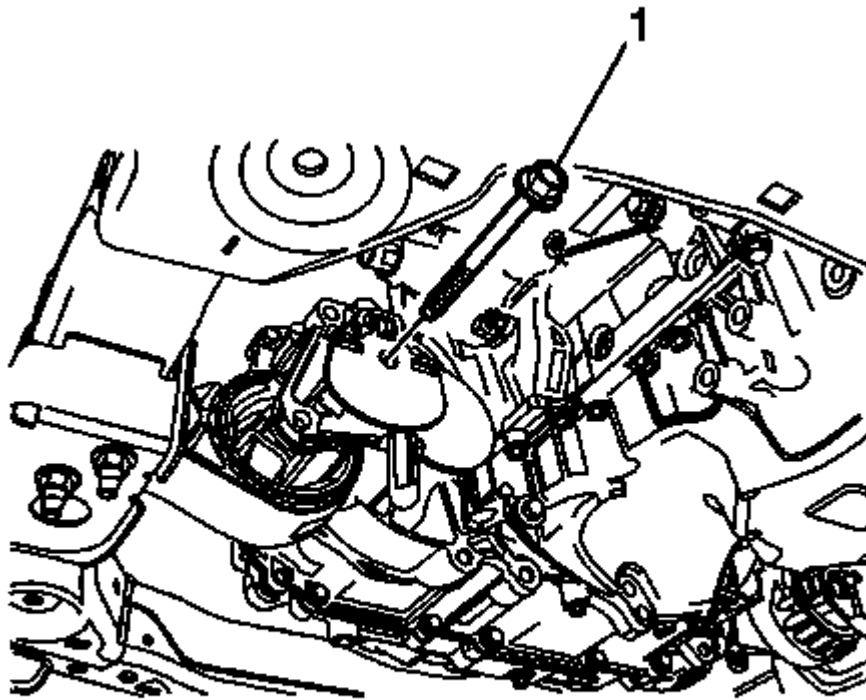


Fig. 59: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission mount to bracket through bolt (1) and tighten to 105 (77 lb ft).

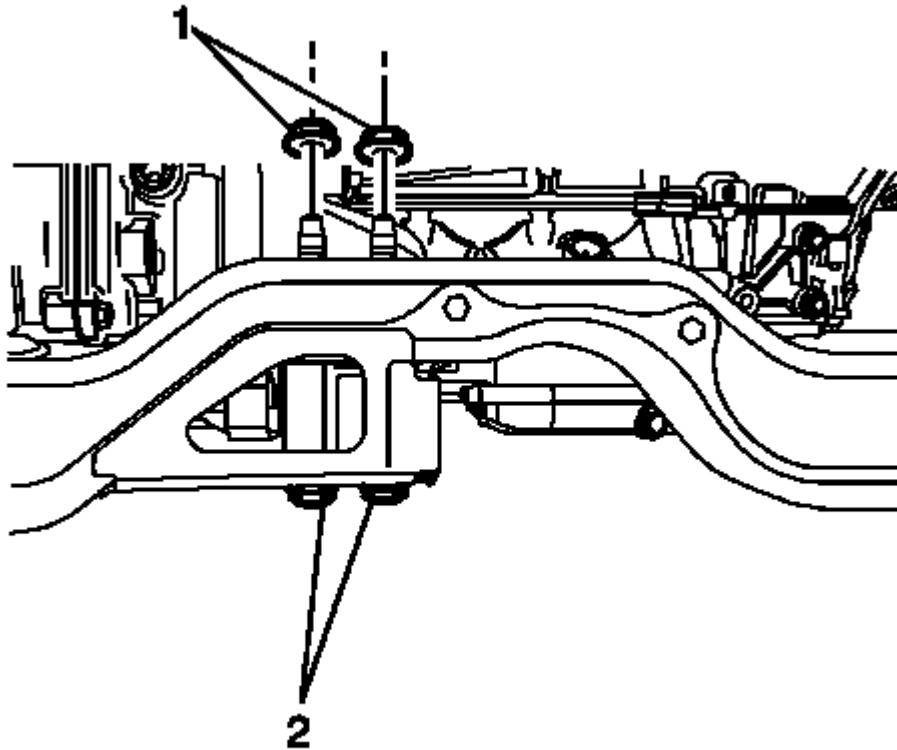


Fig. 60: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Install the rear mount to frame fasteners (1, 2) and tighten to 100 (74 lb ft) plus 120-130 degrees.
7. Remove the jack stand.
8. Install the left tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
9. Lower the vehicle.

TRANSMISSION REAR MOUNT BRACKET REPLACEMENT (AWD)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the left tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Using a suitable jack stand, support the rear of the powertrain.

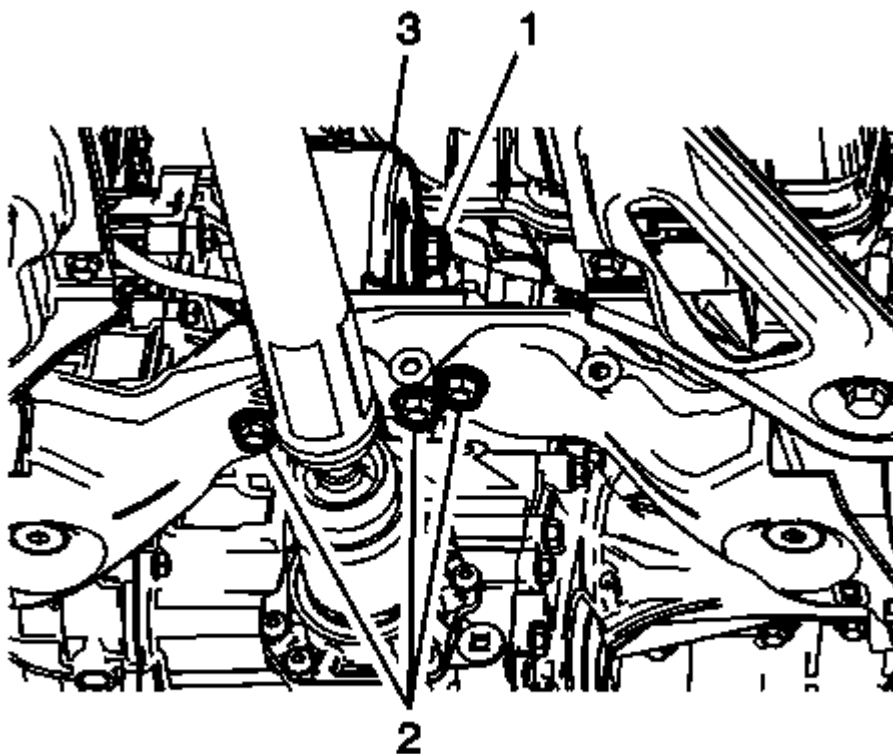


Fig. 61: NO CONTENT

Courtesy of GENERAL MOTORS COMPANY

4. Remove the transmission mount to bracket through bolt (1).

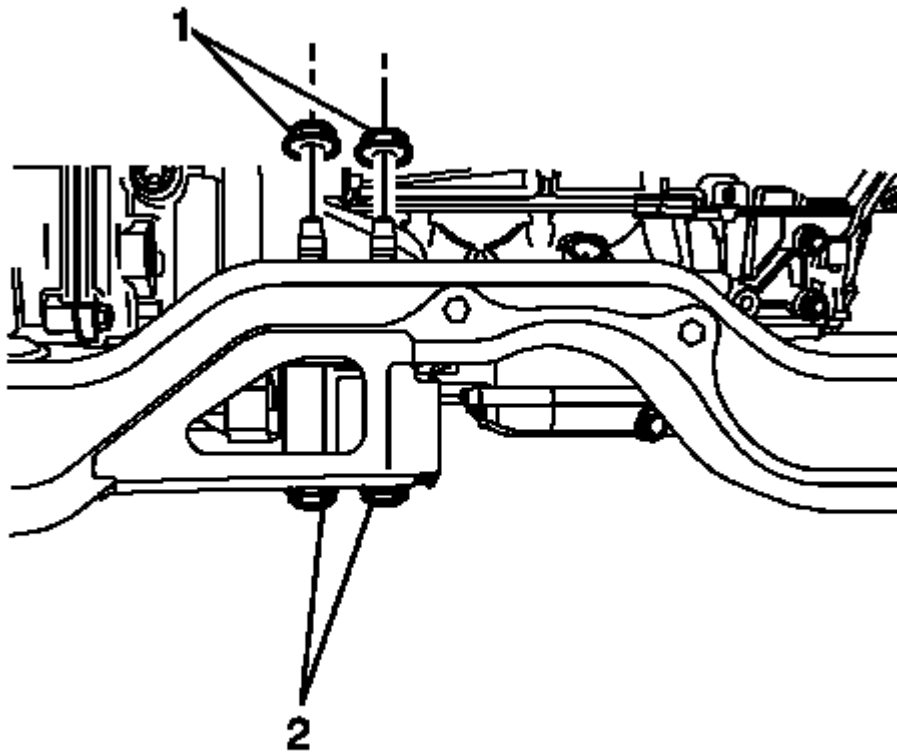


Fig. 62: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the rear mount to frame fasteners (2), then remove the mount (3) from the vehicle.

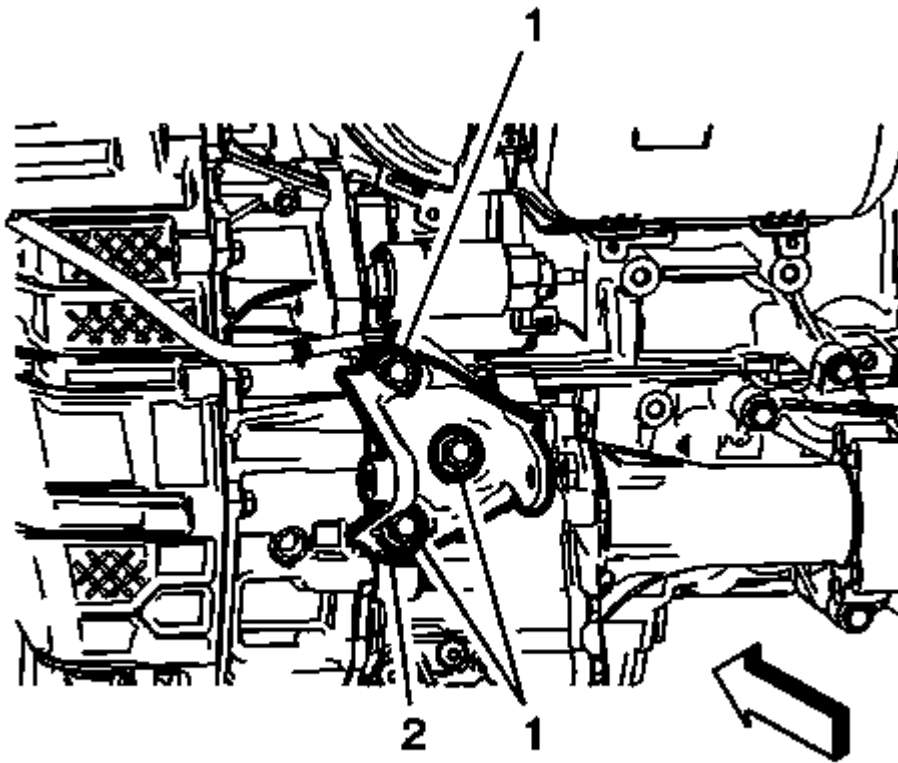


Fig. 63: NO CONTENT

Courtesy of GENERAL MOTORS COMPANY

6. Remove the three transmission mount to transmission bolts (1).
7. Remove the transmission mount bracket (2) from the vehicle.

Installation Procedure

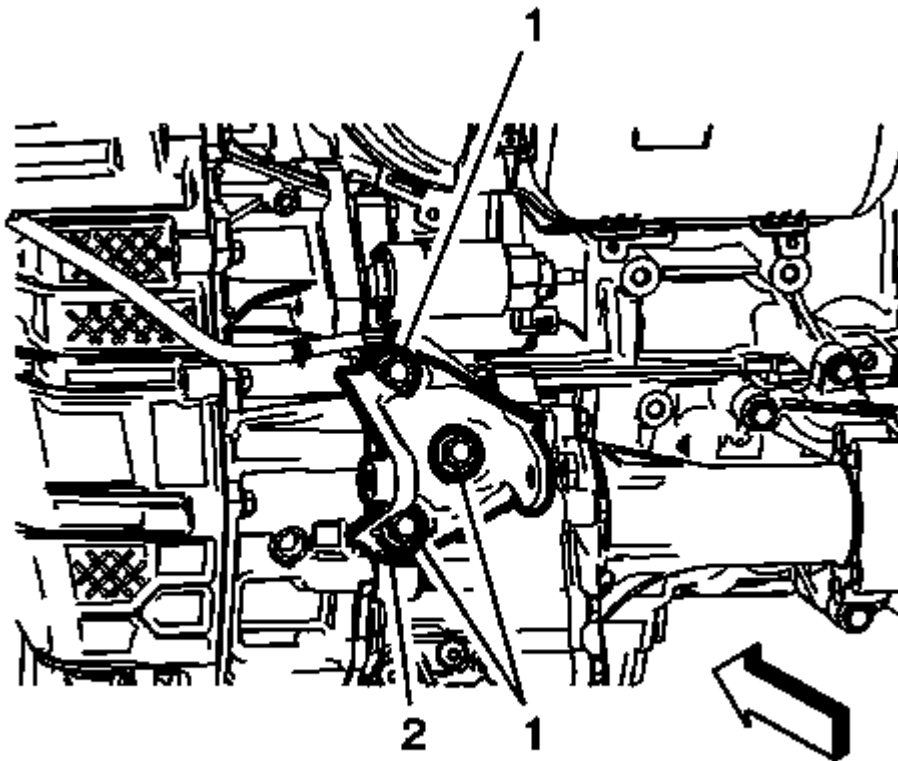


Fig. 64: NO CONTENT

Courtesy of GENERAL MOTORS COMPANY

1. Position the transmission mount bracket (2) to the transmission.

CAUTION: Refer to Fastener Caution .

2. Install the three transmission mount bracket to transmission fasteners (1) and tighten to 100 (74 lb ft)

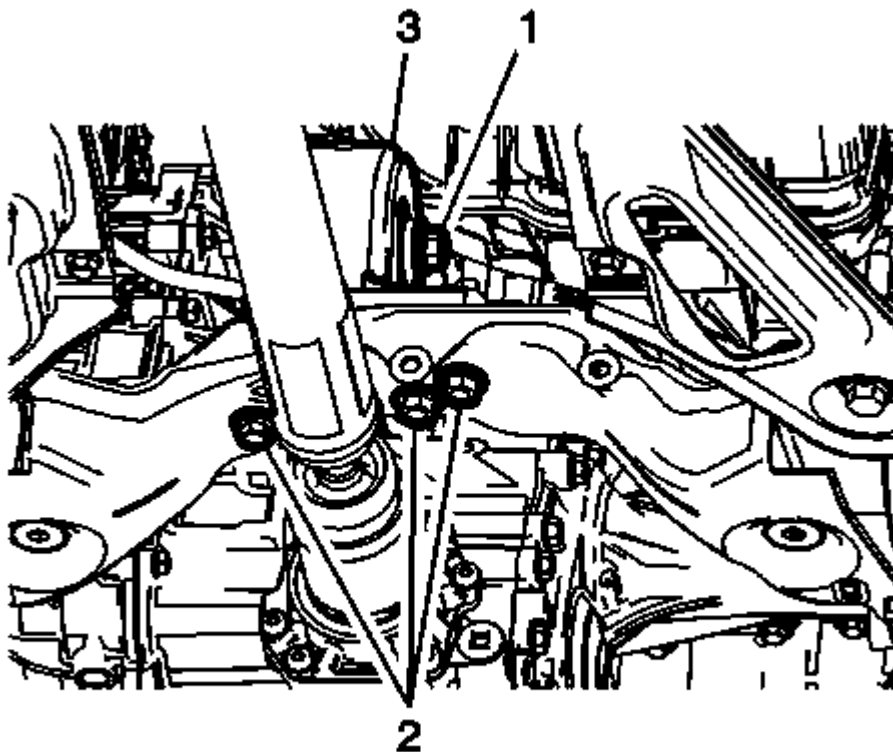


Fig. 65: NO CONTENT

Courtesy of GENERAL MOTORS COMPANY

3. Position the transmission mount (3) in the vehicle.
4. Install the rear mount to frame fasteners (2) and tighten to 110 (81 lb ft) plus 120-130 degrees.
5. Install the transmission mount to bracket through bolt (1) and tighten to 105 (77 lb ft).
6. Remove the jack stand.
7. Install the left tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.

TRANSMISSION REAR MOUNT BRACKET REPLACEMENT (FWD)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the left tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Using a suitable jack stand, support the rear of the powertrain.

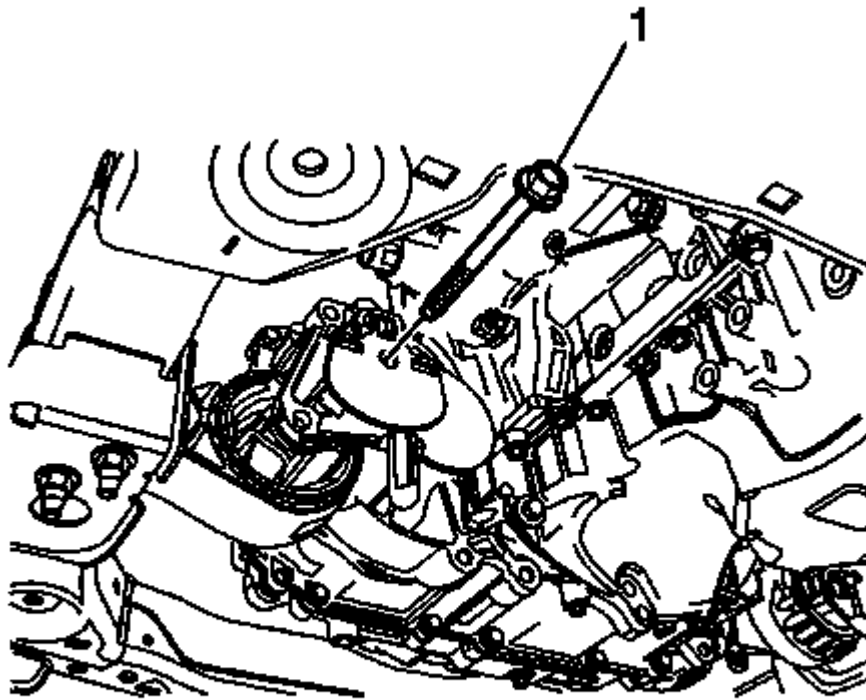


Fig. 66: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the transmission mount to bracket through bolt (1).

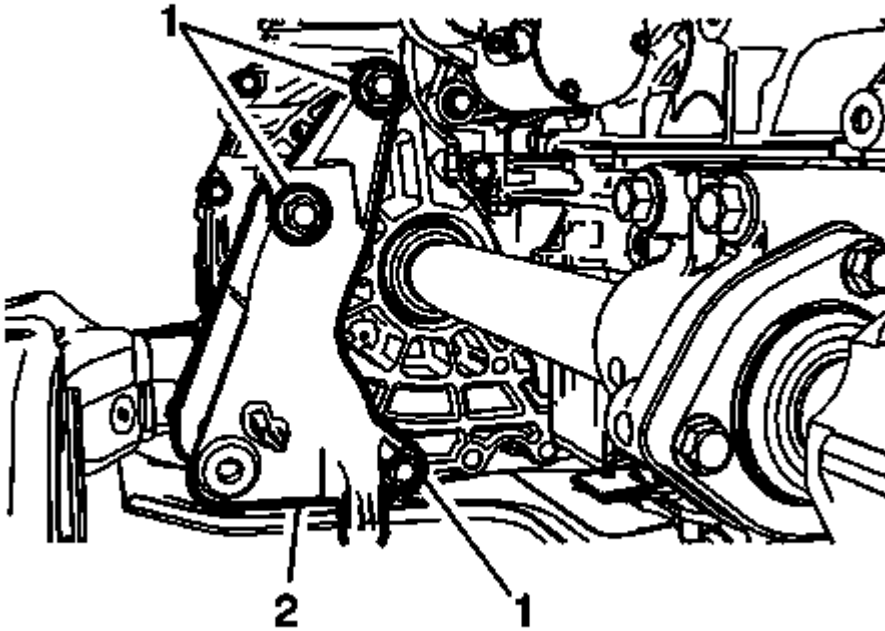


Fig. 67: NO CONTENT

Courtesy of GENERAL MOTORS COMPANY

5. Remove the three transmission mount to transmission bolts (1).

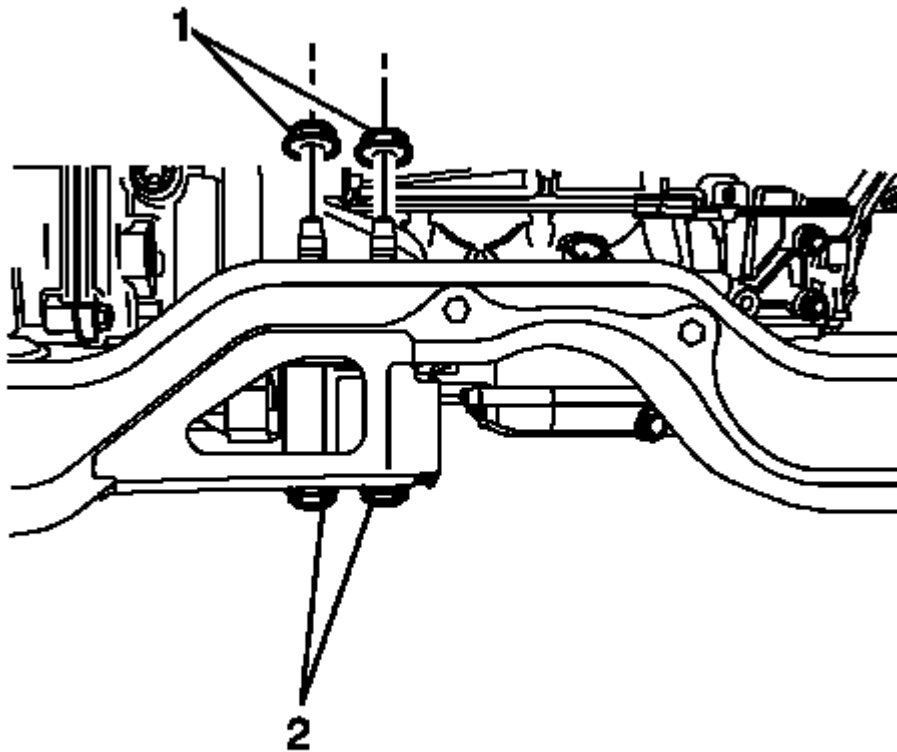


Fig. 68: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the rear mount to frame fasteners (1, 2), then remove the mount and bracket from the vehicle.

Installation Procedure

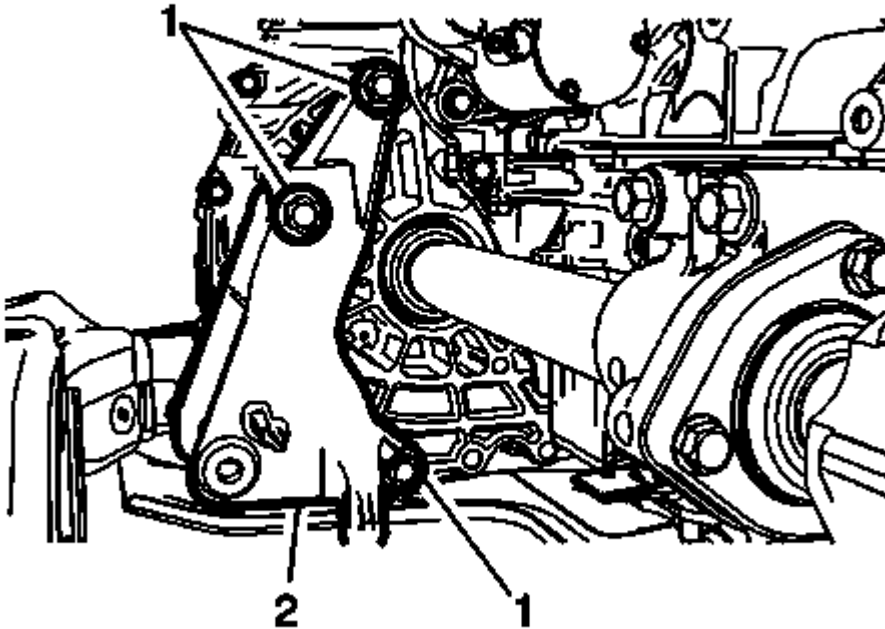


Fig. 69: NO CONTENT

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the three transmission mount bracket to transmission fasteners and tighten to 100 (74 lb ft)

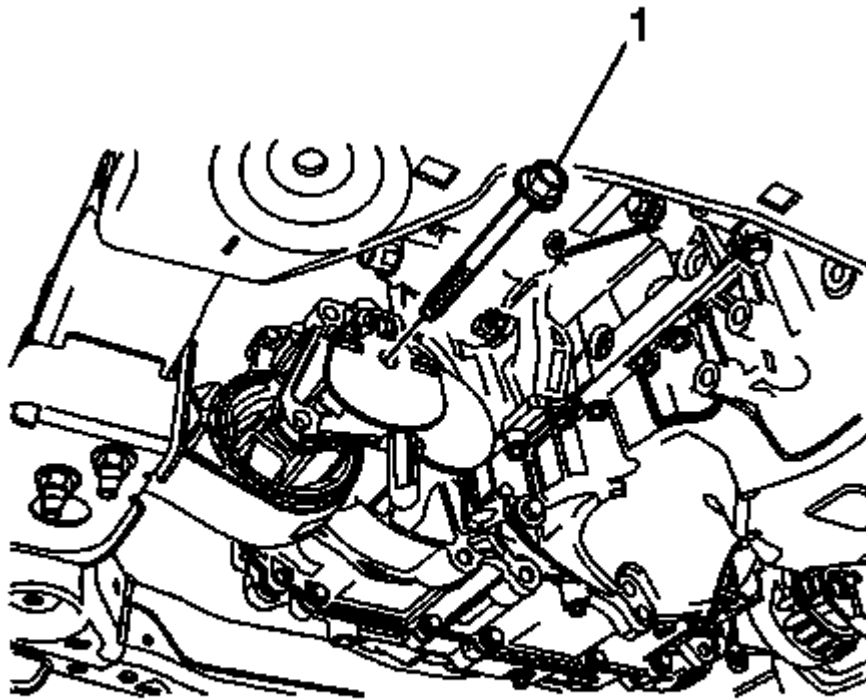


Fig. 70: Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the transmission mount to bracket through bolt (1) and tighten to 105 (77 lb ft).

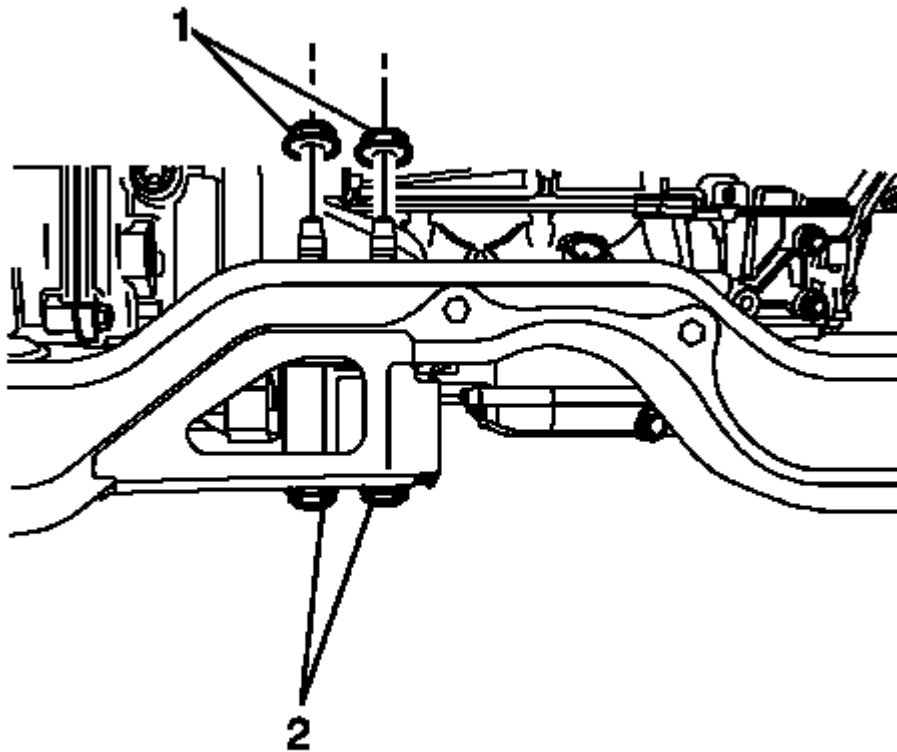


Fig. 71: Rear Mount To Frame Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Install the rear mount to frame fasteners (1, 2) and tighten to 110 (81 lb ft) plus 120-130 degrees.
4. Remove the jack stand.
5. Install the left tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
6. Lower the vehicle.

TRANSMISSION REPLACEMENT (AWD)

Removal Procedure

1. Remove the battery tray. Refer to **Battery Tray Replacement** .
2. Remove the transmission range select lever cable and bracket.
3. Drain the transmission fluid. Refer to **Transmission Fluid Drain and Fill**.

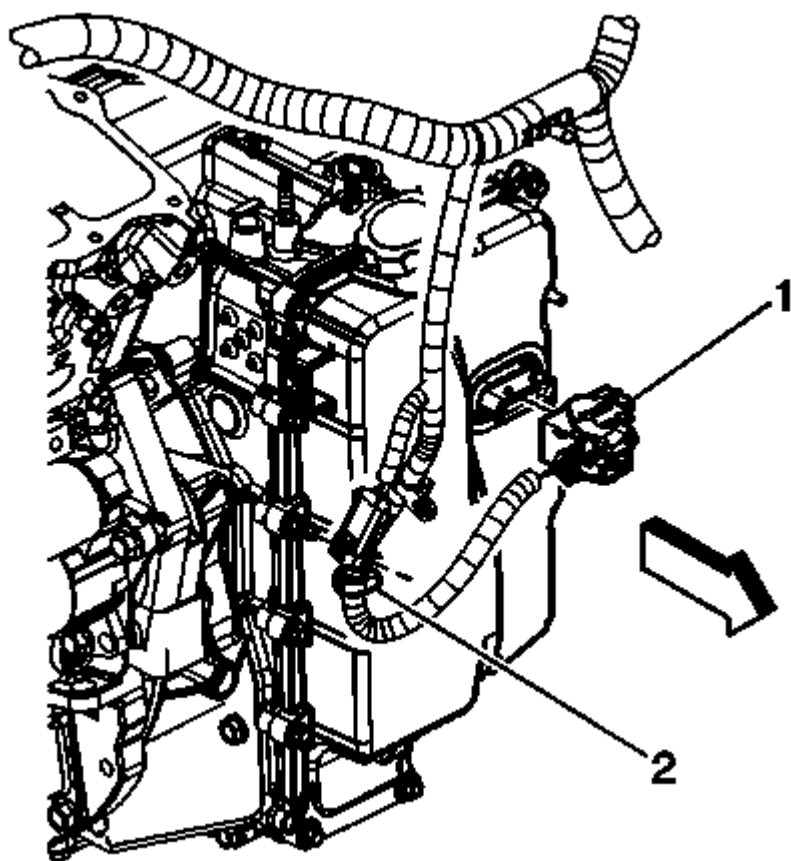


Fig. 72: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove the wire harness retainer (2) from the control valve body cover stud.
5. Disconnect the control valve body transmission control module (TCM) electrical connector (1).

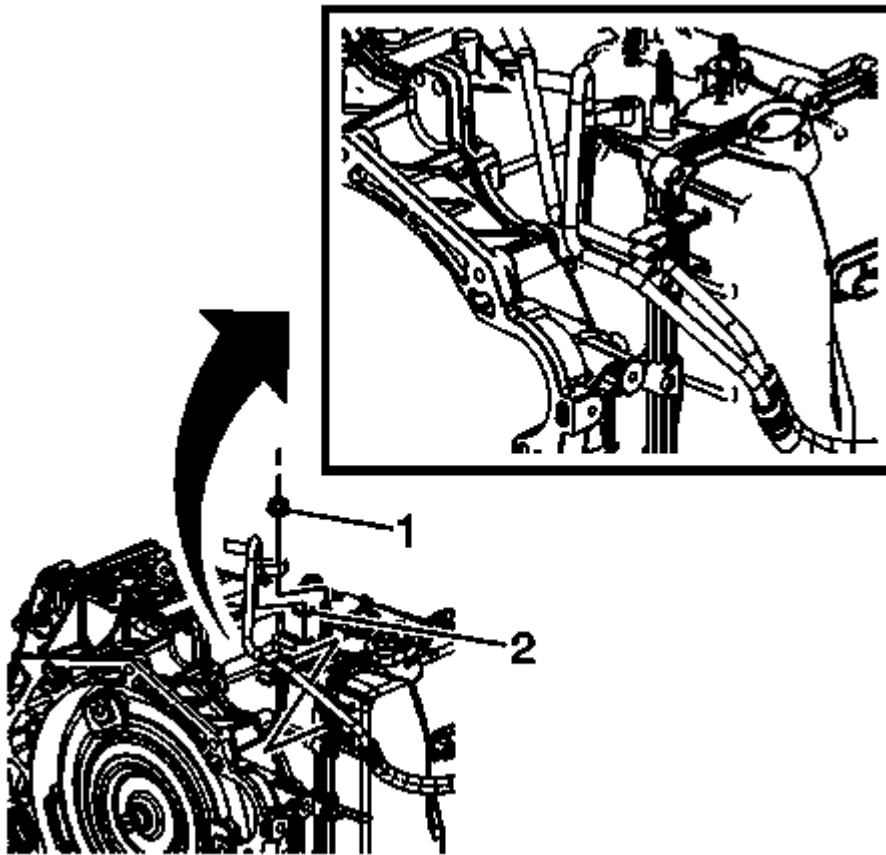


Fig. 73: Identifying Transmission Fluid Cooler Inlet Hose Components
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transmission fluid cooler pipe retainer nut (1).
7. Remove the transmission fluid cooler inlet hose and seal (2) from the transmission.
8. Plug and/or cap the hose and transmission to prevent contamination.

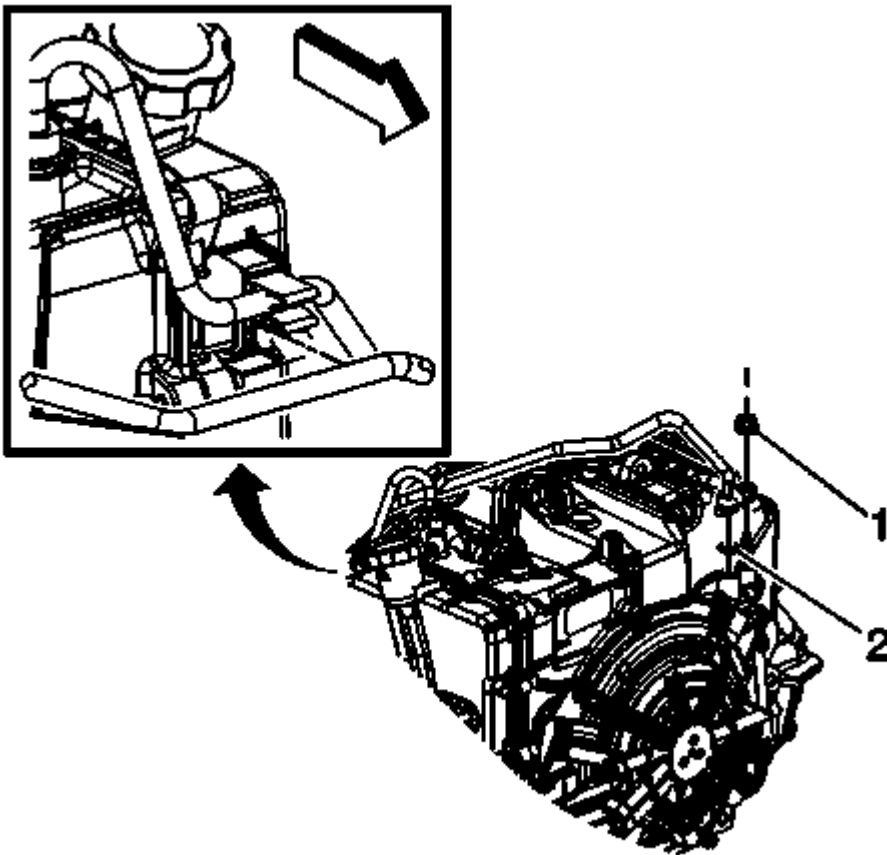


Fig. 74: Identifying Transmission Fluid Cooler Pipe Components
Courtesy of GENERAL MOTORS COMPANY

9. Remove the transmission fluid cooler pipe retainer nut (1).
10. Remove the transmission fluid cooler outlet hose and seal (2) from the transmission.
11. Plug and/or cap the hose and transmission to prevent contamination.
12. Disconnect both pipes from the retainer.
13. Install the engine support fixture. Refer to **Engine Support Fixture** .
14. Remove the rear transmission mount from the transmission. Refer to **Transmission Rear Mount Replacement (AWD)**, **Transmission Rear Mount Replacement (FWD)**.
15. Remove the front transmission mount from the transmission. Refer to **Transmission Front Mount Replacement**.
16. Remove the left transmission mount from the transmission. Refer to **Transmission Mount Replacement - Left Side**.

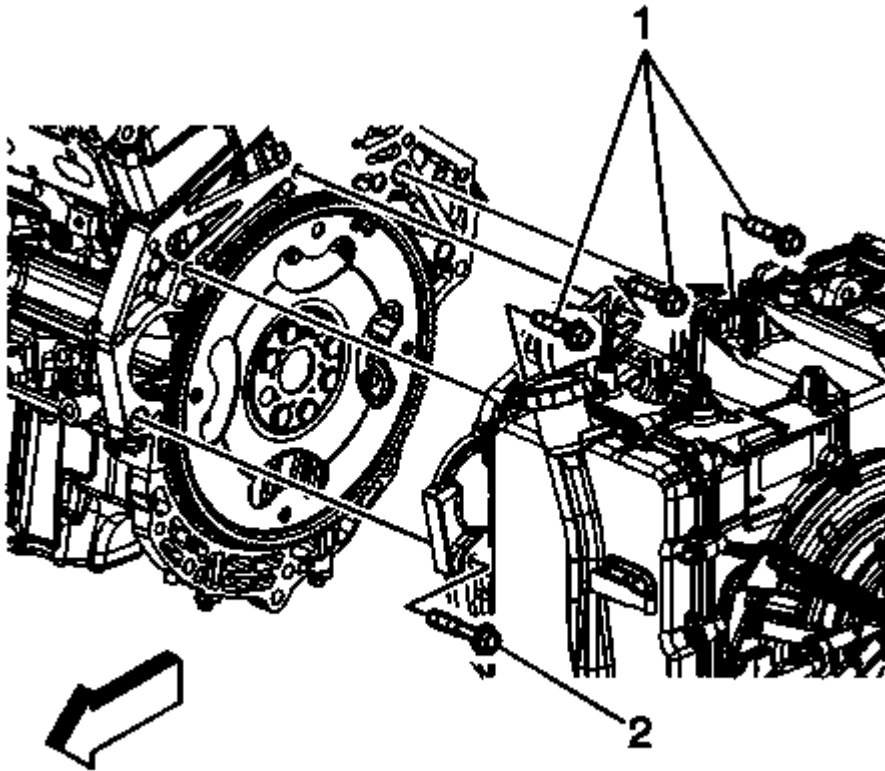


Fig. 75: Identifying Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Remove the upper transmission to engine bolts (1, 2).
18. Remove the frame. Refer to **Drivetrain and Front Suspension Frame Replacement** .
19. Disconnect the left wheel drive shaft from the transmission. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
20. Disconnect the right wheel drive shaft from the transmission. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .
21. Remove the transfer case. Refer to **Transfer Case Replacement** .

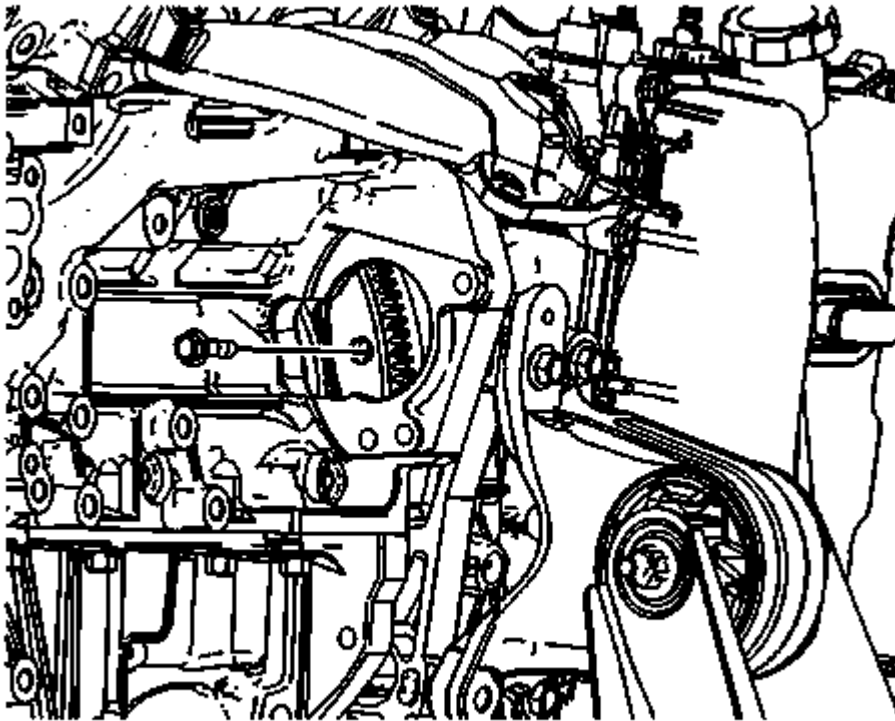


Fig. 76: Identifying Starter

Courtesy of GENERAL MOTORS COMPANY

22. Remove the starter. Refer to **Starter Replacement (LUK)** , **Starter Replacement (LTG)** .
23. Mark the relationship of the flywheel to the torque converter for reassembly.
24. Remove the torque converter to flywheel bolts.
25. Use a transmission jack in order to support the transmission.

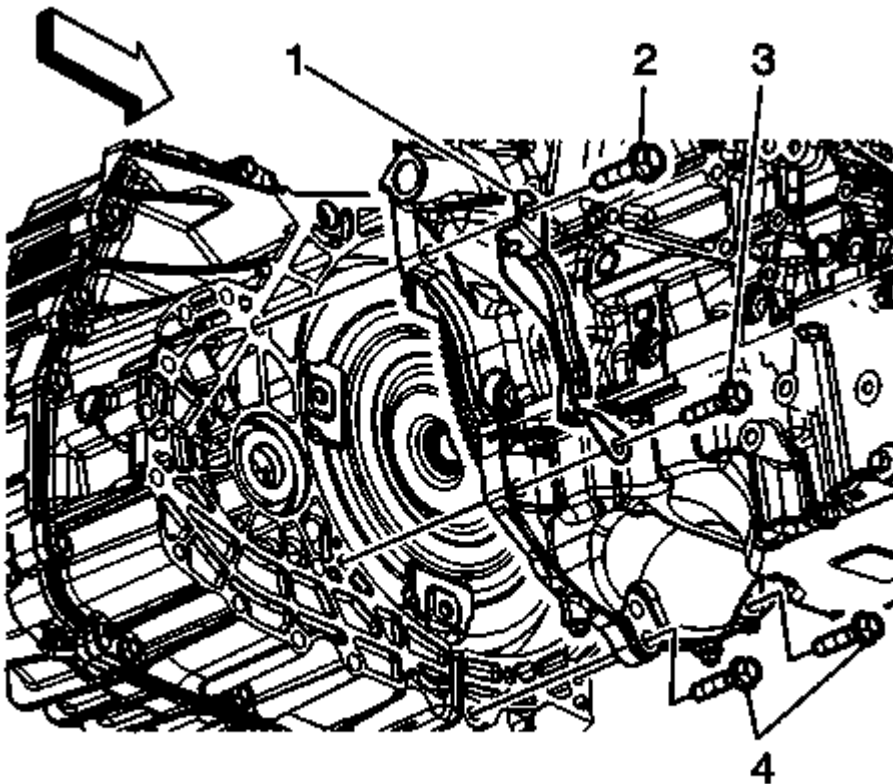


Fig. 77: Identifying Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

26. Remove the flywheel inspection cover bolts (2, 3).
27. Remove the flywheel inspection cover (1).
28. Remove the remaining transmission bolts (4).

NOTE: **Ensure the torque converter remains securely in place on the transmission input shaft while separating and removing the transmission.**

29. Separate the transmission from the engine.
30. Lower the transmission with the transmission jack far enough to remove the transmission.
31. Flush and flow test the transmission oil cooler and lines. Refer to **Transmission Fluid Cooler Flushing and Flow Test (6T40)** , **Transmission Fluid Cooler Flushing and Flow Test (6T70)** .

Installation Procedure

1. Raise the transmission with the transmission jack and position the transmission to the engine.

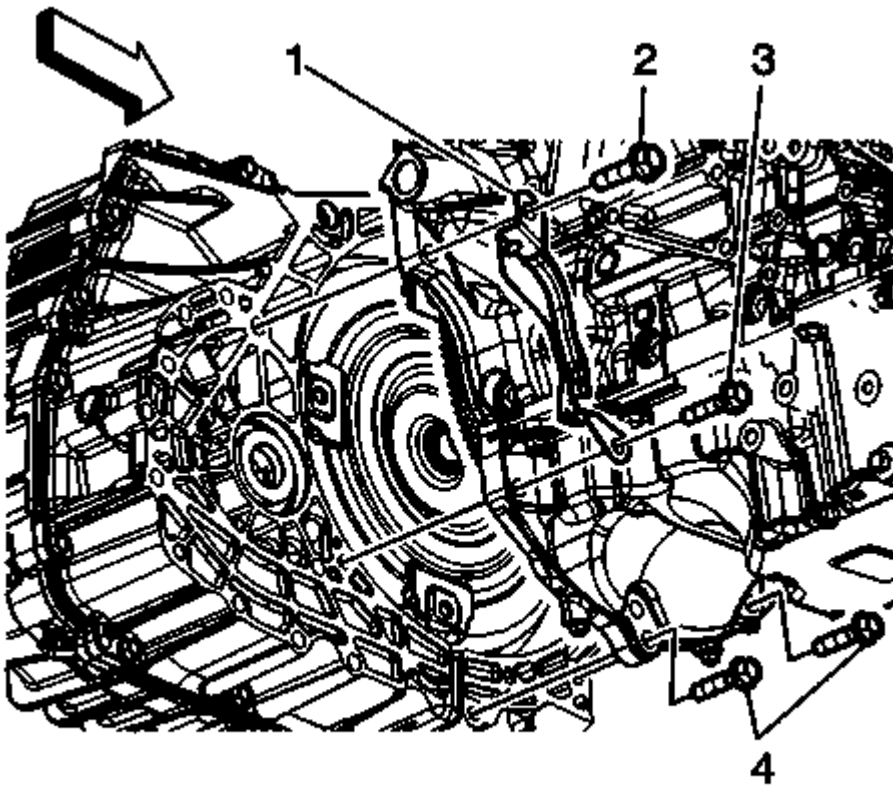


Fig. 78: Identifying Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the transmission bolts (4) and tighten to 75 (55 lb ft).
3. Install the flywheel inspection cover (1).
4. Install the flywheel inspection cover bolts (2, 3) and tighten to 75 (55 lb ft).
5. Remove the transmission jack.

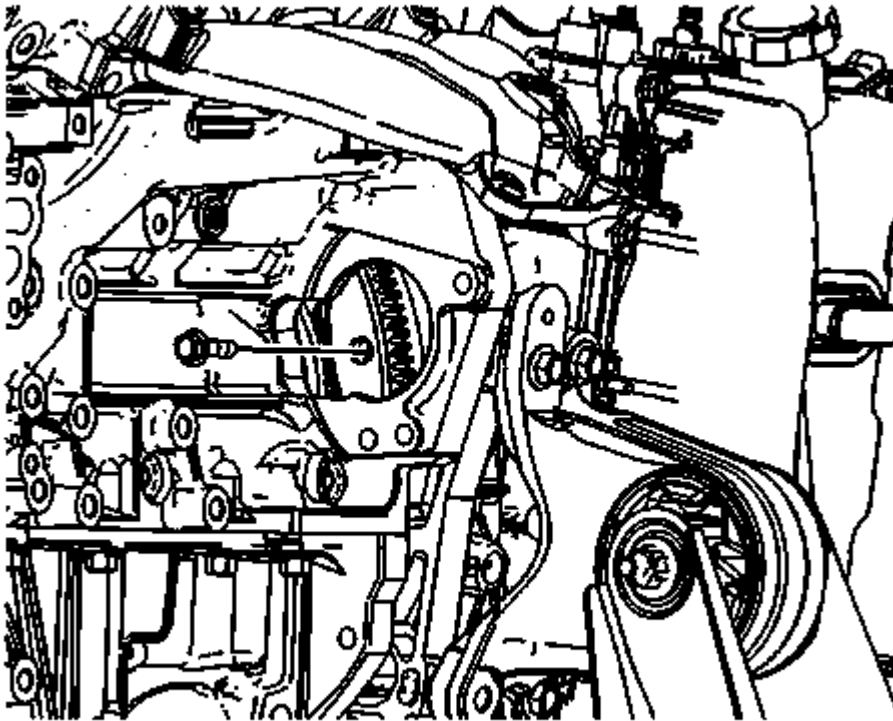


Fig. 79: Identifying Starter

Courtesy of GENERAL MOTORS COMPANY

NOTE: If reusing the torque converter bolts, clean the threads and apply threadlocker to the threads prior to installation. Refer to Adhesives, Fluids, Lubricants, and Sealers for the recommended threadlock material.

6. Install the torque converter to flywheel bolts and tighten to 62 (46 lb ft).
7. Install the starter. Refer to Starter Replacement (LUK) , Starter Replacement (LTG) .
8. Install the front transmission mount to the transmission. Refer to Transmission Front Mount Replacement.
9. Install the rear transmission mount to the transmission. Refer to Transmission Rear Mount Replacement (AWD), Transmission Rear Mount Replacement (FWD).
10. Install the left transmission mount to the transmission. Refer to Transmission Mount Replacement - Left Side.
11. Install the transmission brace. Refer to .
12. Install the transfer case. Refer to Transfer Case Replacement .
13. Install the left wheel drive shafts to the transmission. Refer to Front Wheel Drive Shaft Replacement - Left Side .

14. Install the right wheel drive shaft from the transmission. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .
15. Install the frame. Refer to **Drivetrain and Front Suspension Frame Replacement** .

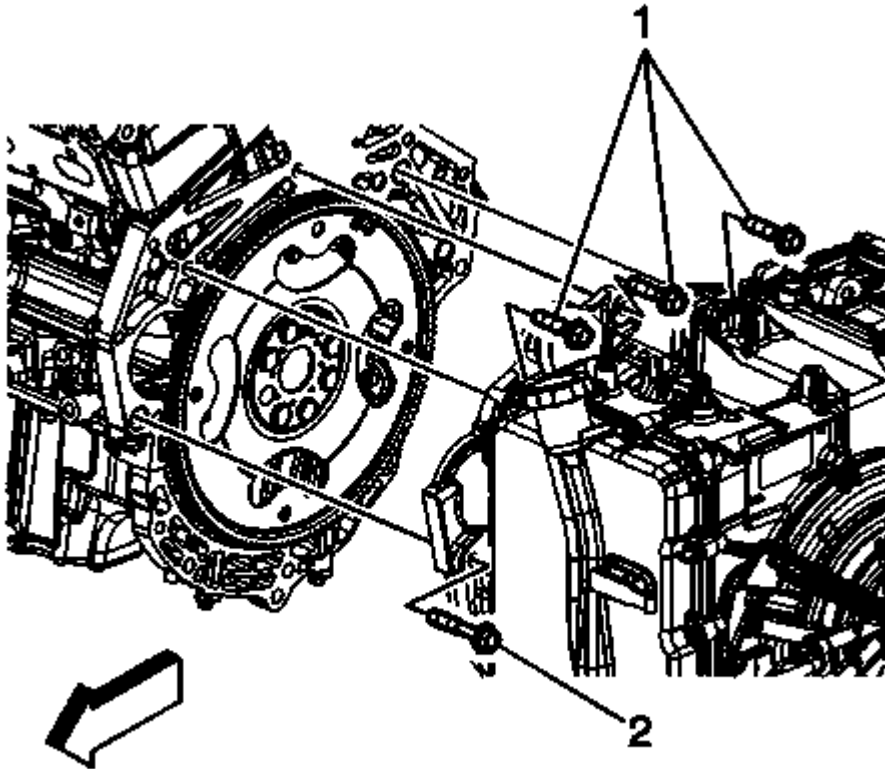


Fig. 80: Identifying Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Install the upper transmission to engine bolt (1, 2) and tighten to 75 (55 lb ft).
17. Remove the engine support fixture.

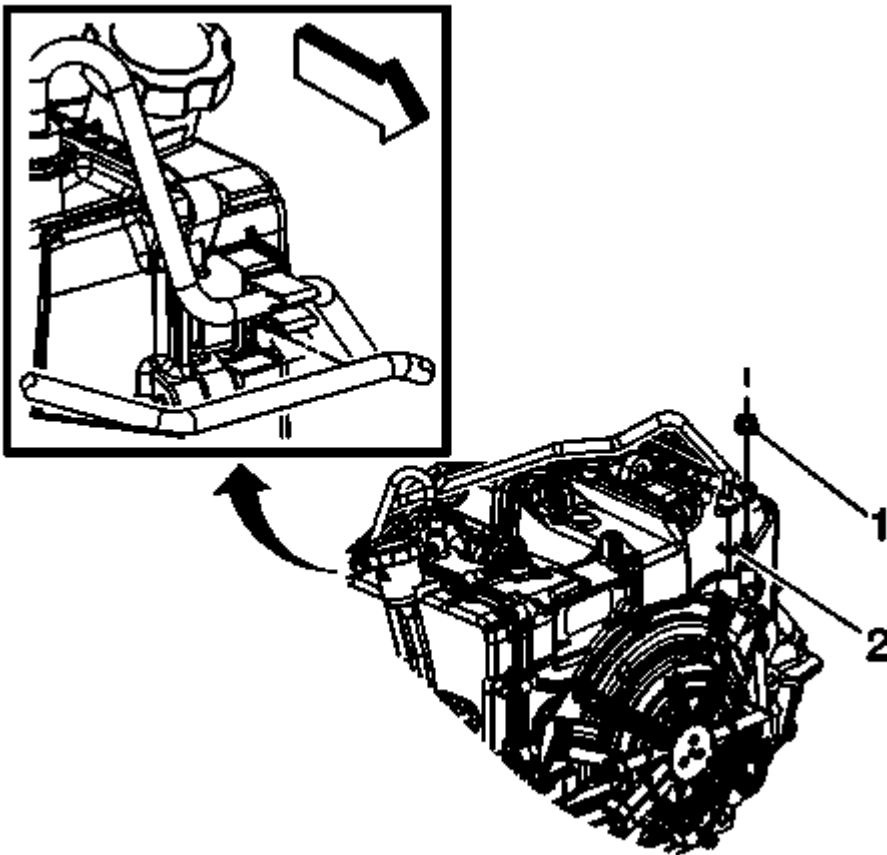


Fig. 81: Identifying Transmission Fluid Cooler Pipe Components
Courtesy of GENERAL MOTORS COMPANY

18. Install the transmission fluid cooler outlet hose and seal (2) to the transmission.
19. Install the transmission fluid cooler pipe retainer nut (1) and tighten to 22 (16 lb ft).

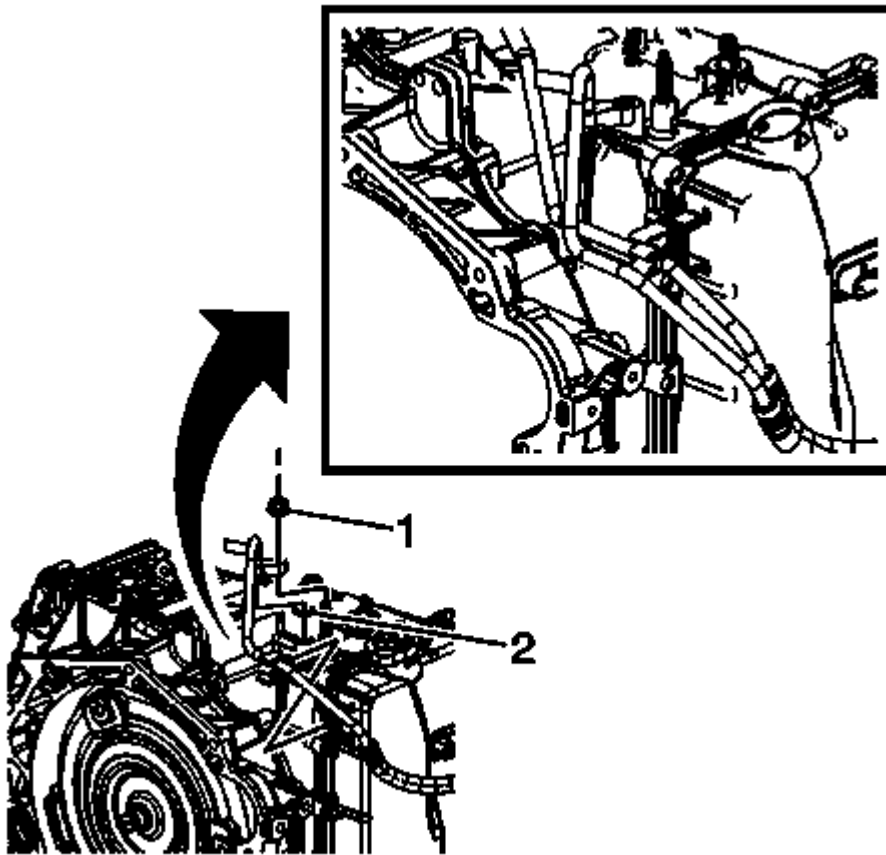


Fig. 82: Identifying Transmission Fluid Cooler Inlet Hose Components
Courtesy of GENERAL MOTORS COMPANY

20. Install the transmission fluid cooler inlet hose and seal (2) to the transmission.
21. Install the transmission fluid cooler pipe retainer nut (1) and tighten to 22 (16 lb ft).

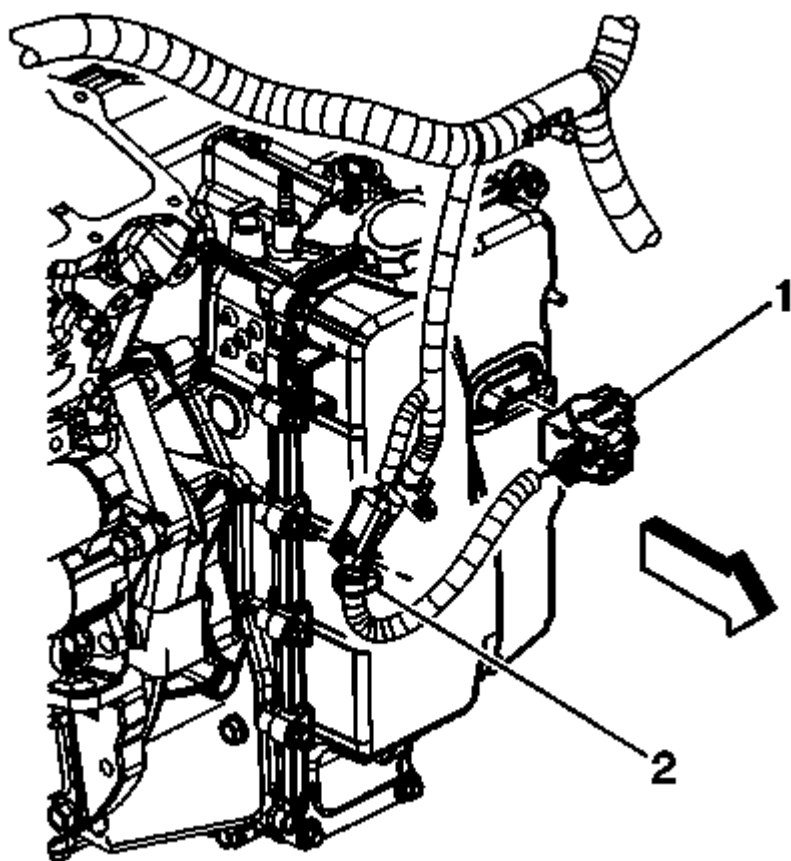


Fig. 83: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

22. Connect the control valve body TCM electrical connector (1).
23. Install the wire harness retainer (2) to the control valve body cover stud and tighten the nut to 12 (106 lb in).
24. Install the transmission range select lever cable and bracket.
25. Install the battery tray. Refer to **Battery Tray Replacement** .
26. Adjust the automatic transmission range selector lever cable. Refer to **Range Selector Lever Cable Adjustment**.
27. Fill the transmission with fluid. Refer to **Transmission Fluid Drain and Fill**.
28. If a NEW TCM has been installed into the vehicle, the NEW module needs to be reprogrammed. Refer to **Service Programming System (SPS)** .

NOTE: The Reset Transmission Adapts procedure must be performed when one of the following repairs have been made to the vehicle. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, as well as transmission DTCs being set:

- Transmission internal service/overhaul

- Valve body repair or replacement
- Control solenoid valve assembly replacement
- TCM software/calibration update
- Any service in response to a shift quality concern

29. Perform the Reset Transmission Adapts. Refer to Reset Transmission Adapts .
30. Road test the vehicle.

TRANSMISSION REPLACEMENT (FWD)

Removal Procedure

1. Remove the battery tray. Refer to Battery Tray Replacement .
2. Remove the transmission range select lever cable and bracket.
3. Drain the transmission fluid. Refer to Transmission Fluid Drain and Fill.

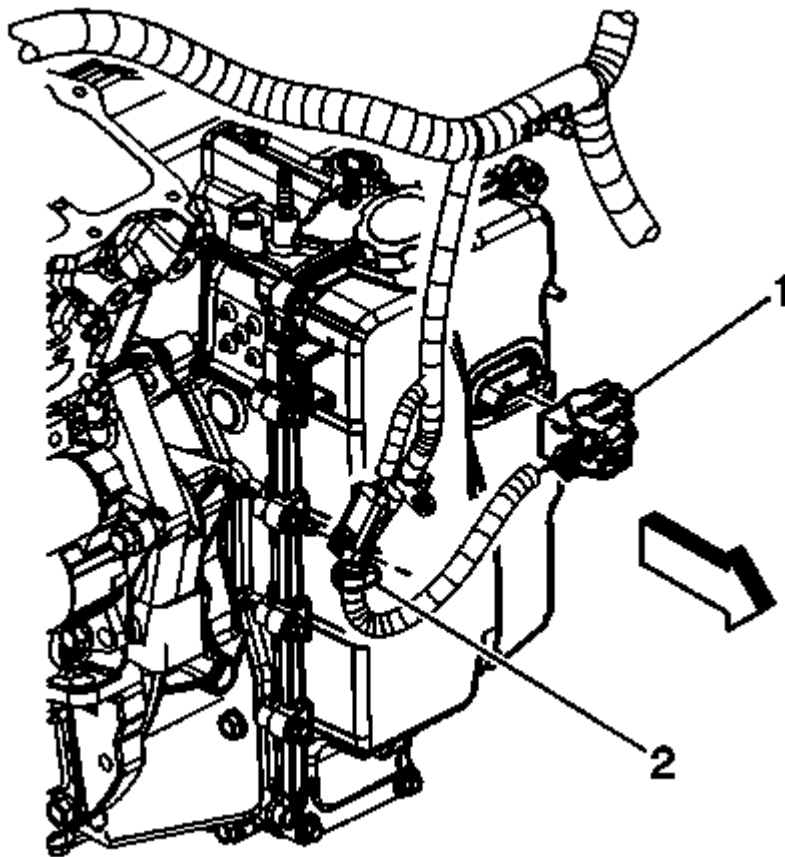


Fig. 84: Identifying Wire Harness Retainer & TCM Electrical Connector
 Courtesy of GENERAL MOTORS COMPANY

4. Remove the wire harness retainer (2) from the control valve body cover stud.

5. Disconnect the control valve body transmission control module (TCM) electrical connector (1).

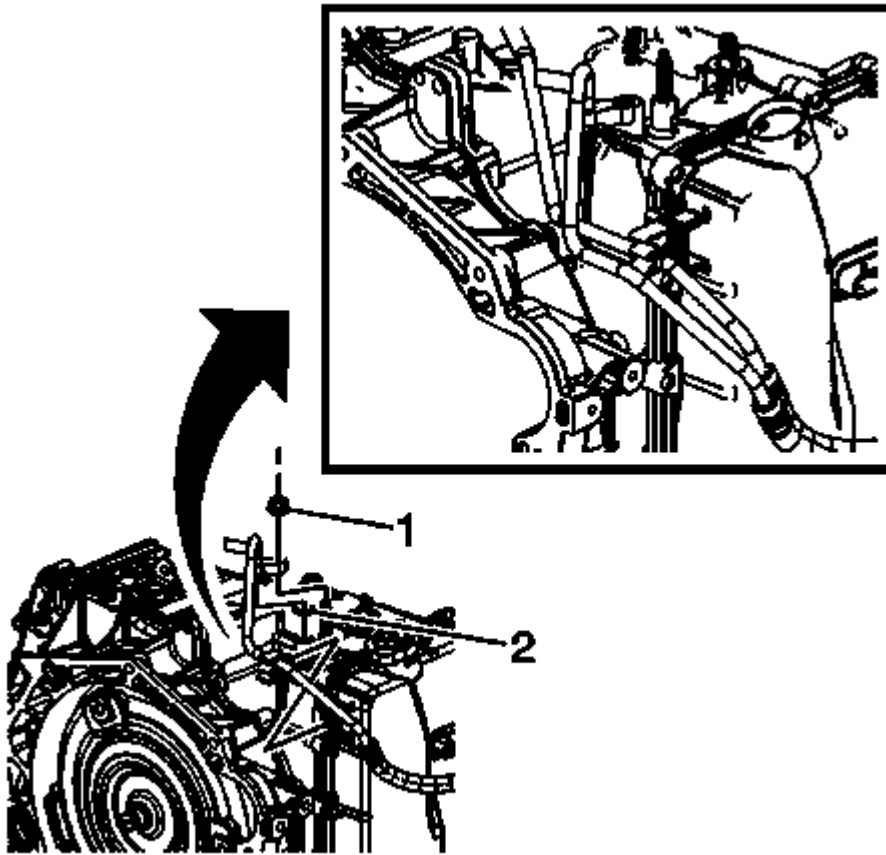


Fig. 85: Identifying Transmission Fluid Cooler Inlet Hose Components
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transmission fluid cooler pipe retainer nut (1).
7. Remove the transmission fluid cooler inlet hose and seal (2) from the transmission.
8. Plug and/or cap the hose and transmission to prevent contamination.

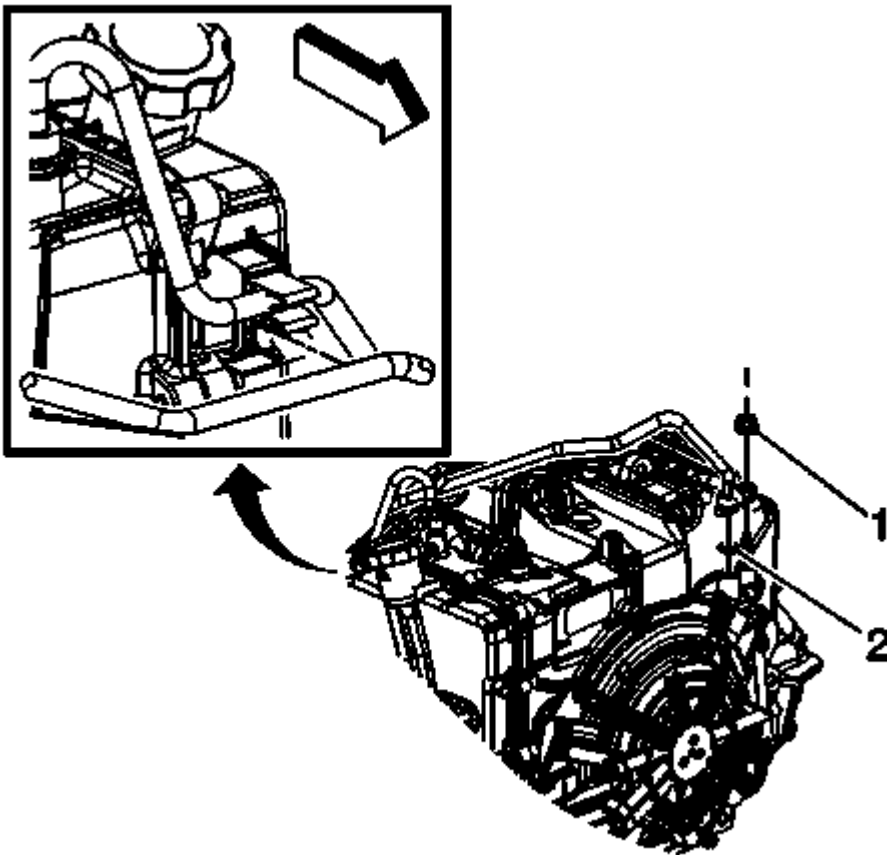


Fig. 86: Identifying Transmission Fluid Cooler Pipe Components
 Courtesy of GENERAL MOTORS COMPANY

9. Remove the transmission fluid cooler pipe retainer nut (1).
10. Remove the transmission fluid cooler outlet hose and seal (2) from the transmission.
11. Plug and/or cap the hose and transmission to prevent contamination.
12. Disconnect both pipes from the retainer.
13. Install the engine support fixture. Refer to **Engine Support Fixture** .
14. Remove the rear transmission mount from the transmission. Refer to **Transmission Rear Mount Replacement (AWD)**, **Transmission Rear Mount Replacement (FWD)**.
15. Remove the front transmission mount from the transmission. Refer to **Transmission Front Mount Replacement**.
16. Remove the left transmission mount from the transmission. Refer to **Transmission Mount Replacement - Left Side**.

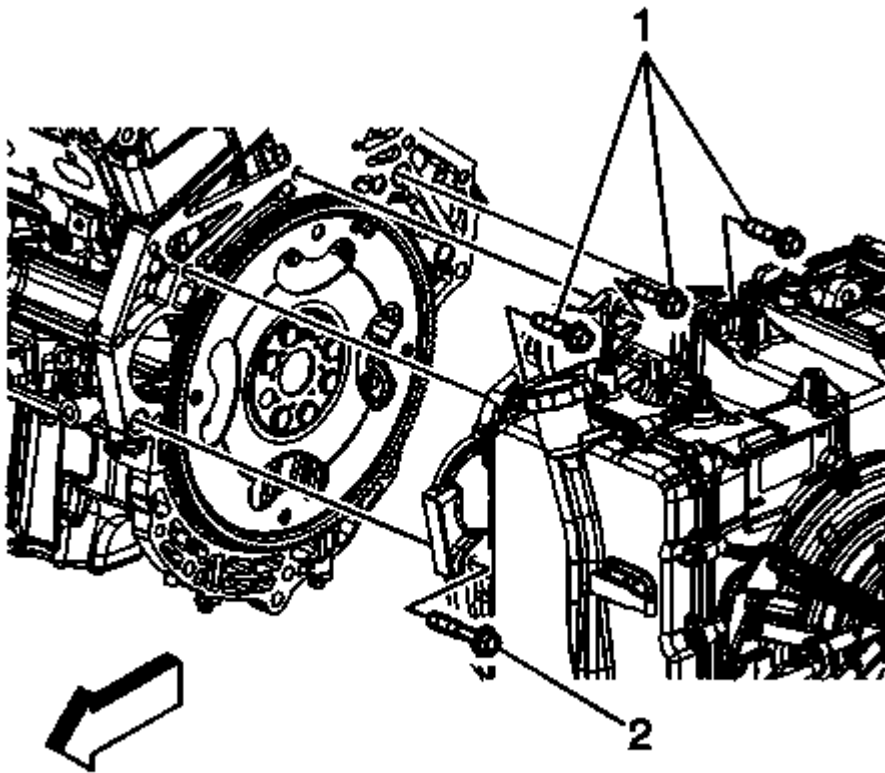


Fig. 87: Identifying Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Remove the upper transmission to engine bolts (1, 2).
18. Remove the frame. Refer to **Drivetrain and Front Suspension Frame Replacement** .
19. Disconnect the left wheel drive shafts from the transmission. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
20. Remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)** , **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)** .

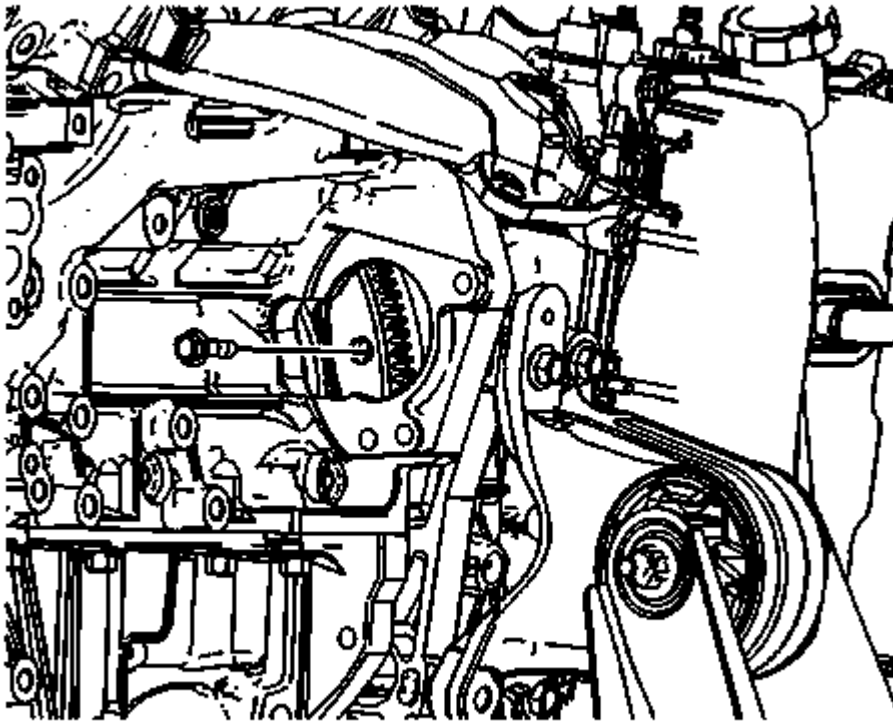


Fig. 88: Identifying Starter

Courtesy of GENERAL MOTORS COMPANY

21. Remove the starter. Refer to **Starter Replacement (LUK)** , **Starter Replacement (LTG)** .
22. Mark the relationship of the flywheel to the torque converter for reassembly.
23. Remove the torque converter to flywheel bolts.
24. Use a transmission jack in order to support the transmission.

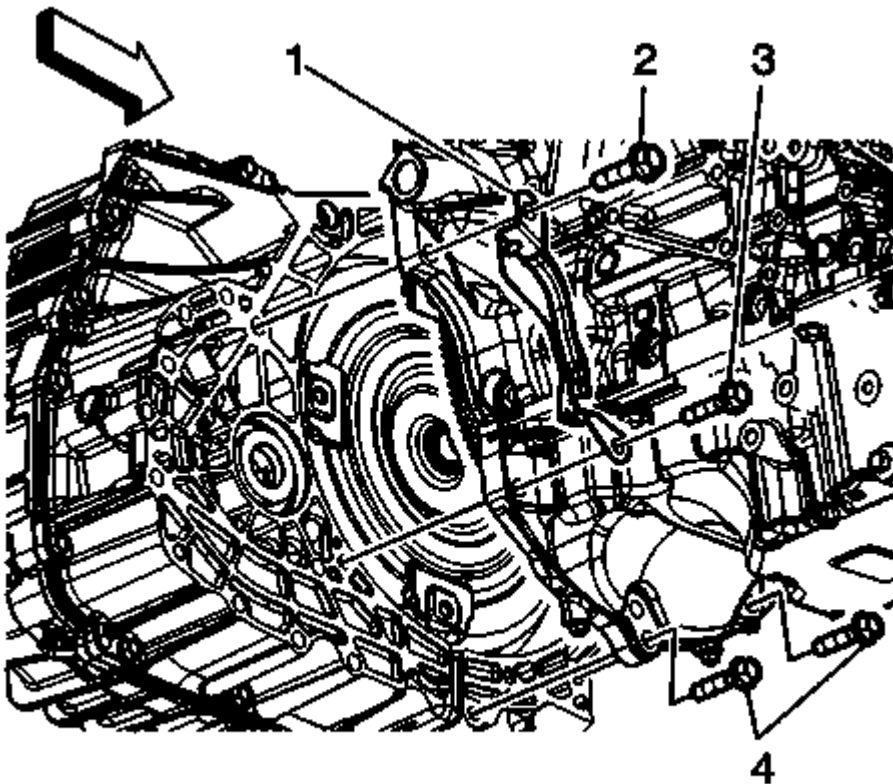


Fig. 89: Identifying Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

25. Remove the flywheel inspection cover bolts (2, 3).
26. Remove the flywheel inspection cover (1).
27. Remove the remaining transmission bolts (4).

NOTE: **Ensure the torque converter remains securely in place on the transmission input shaft while separating and removing the transmission.**

28. Separate the transmission from the engine.
29. Lower the transmission with the transmission jack far enough to remove the transmission.
30. Flush and flow test the transmission oil cooler and lines. Refer to **Transmission Fluid Cooler Flushing and Flow Test (6T40)** , **Transmission Fluid Cooler Flushing and Flow Test (6T70)** .

Installation Procedure

1. Raise the transmission with the transmission jack and position the transmission to the engine.

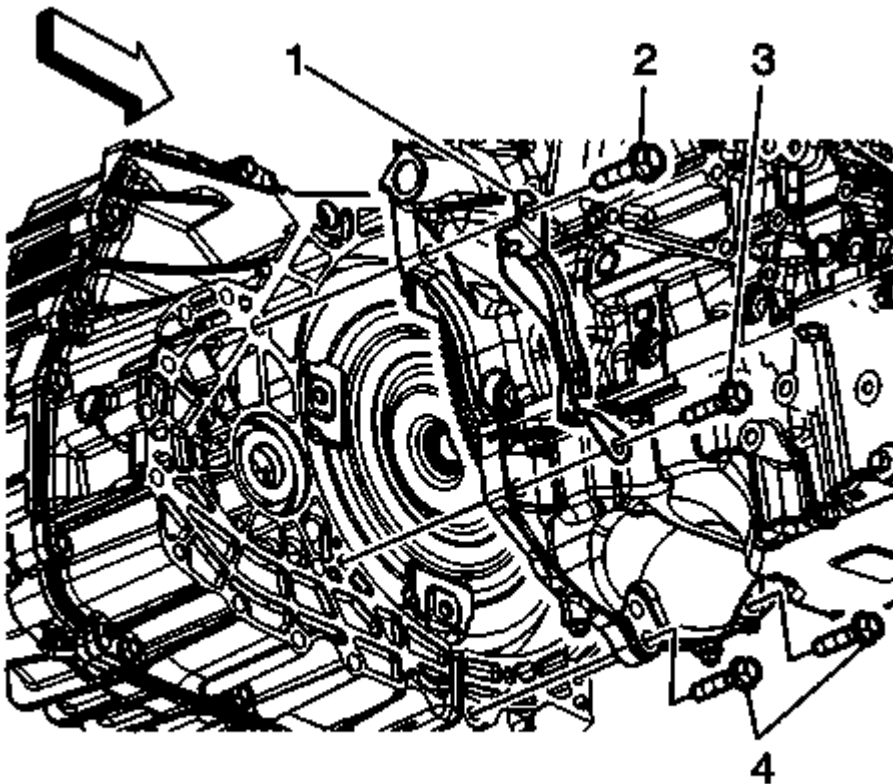


Fig. 90: Identifying Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the transmission bolts (4) and tighten to 75 (55 lb ft).
3. Install the flywheel inspection cover (1).
4. Install the flywheel inspection cover bolts (2, 3) and tighten to 75 (55 lb ft).
5. Remove the transmission jack.

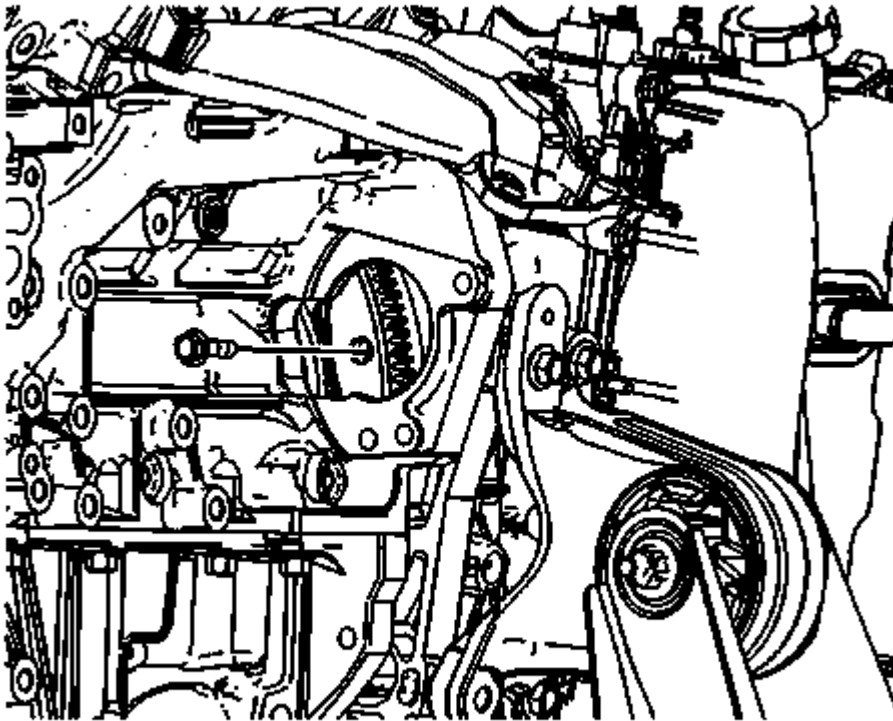


Fig. 91: Identifying Starter

Courtesy of GENERAL MOTORS COMPANY

NOTE: If reusing the torque converter bolts, clean the threads and apply threadlocker to the threads prior to installation. Refer to Adhesives, Fluids, Lubricants, and Sealers for the recommended threadlock material.

6. Install the torque converter to flywheel bolts and tighten to 62 (46 lb ft).
7. Install the starter. Refer to Starter Replacement (LUK) , Starter Replacement (LTG) .
8. Install the front transmission mount to the transmission. Refer to Transmission Front Mount Replacement.
9. Install the rear transmission mount to the transmission. Refer to Transmission Rear Mount Replacement (AWD), Transmission Rear Mount Replacement (FWD).
10. Install the left transmission mount to the transmission. Refer to Transmission Mount Replacement - Left Side.
11. Install the transmission brace. Refer to .
12. Install the intermediate drive shaft. Refer to Front Wheel Drive Intermediate Shaft Replacement (with MR6) , Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK) .
13. Install the left wheel drive shafts to the transmission. Refer to Front Wheel Drive Shaft Replacement - Left Side .

14. Install the frame. Refer to **Drivetrain and Front Suspension Frame Replacement** .

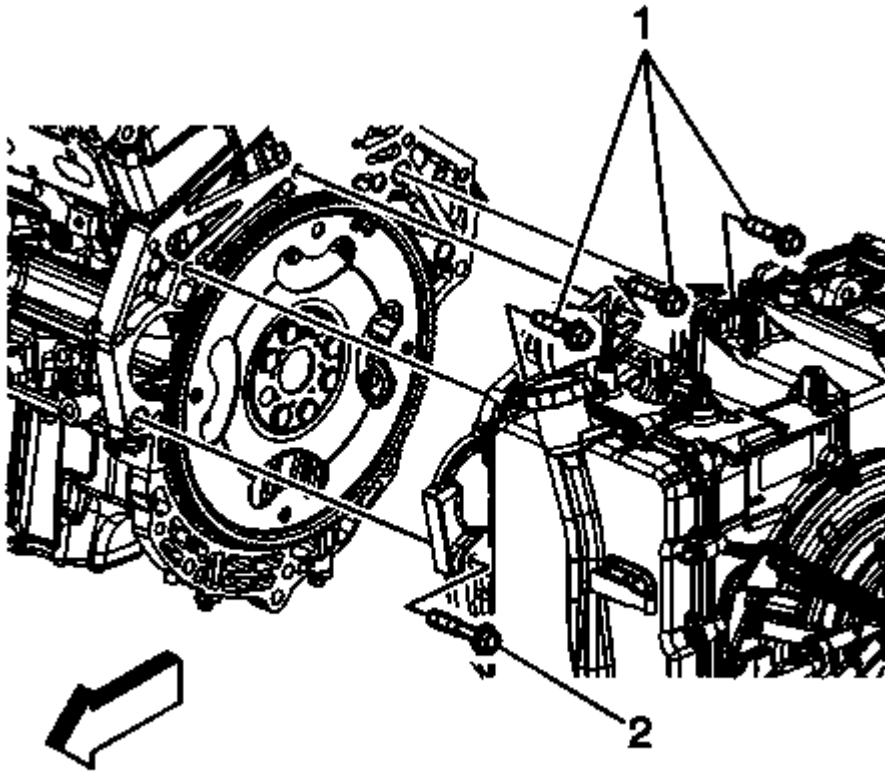


Fig. 92: Identifying Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Install the upper transmission to engine bolt (1, 2) and tighten to 75 (55 lb ft).
16. Remove the engine support fixture.

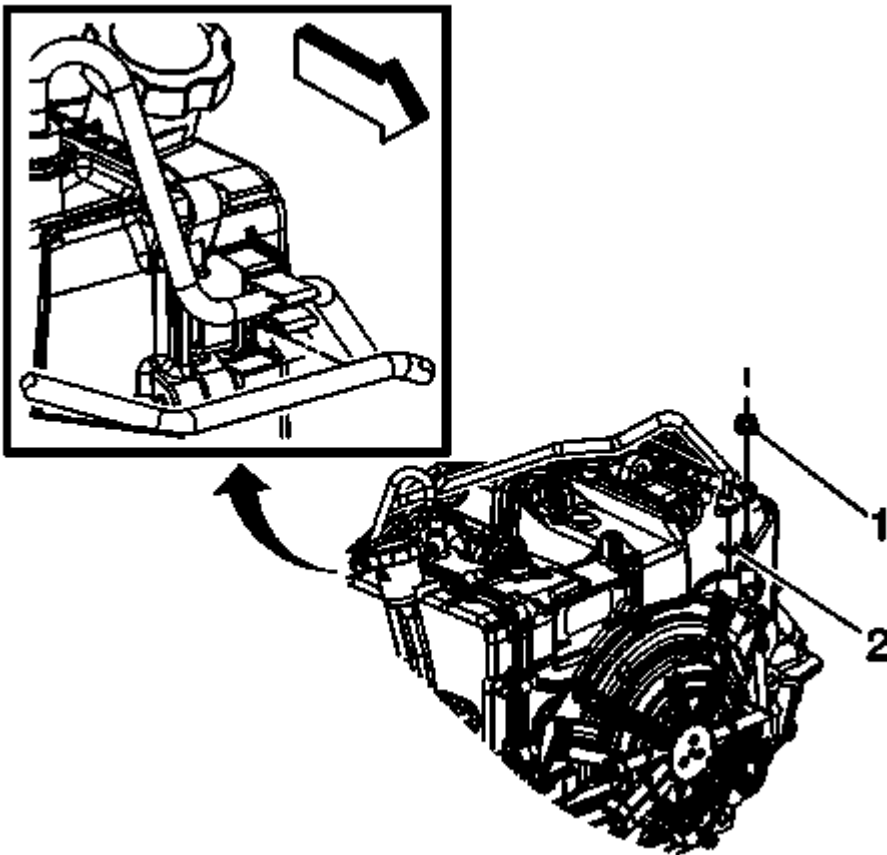


Fig. 93: Identifying Transmission Fluid Cooler Pipe Components
Courtesy of GENERAL MOTORS COMPANY

17. Install the transmission fluid cooler outlet hose and seal (2) to the transmission.
18. Install the transmission fluid cooler pipe retainer nut (1) and tighten to 22 (16 lb ft).

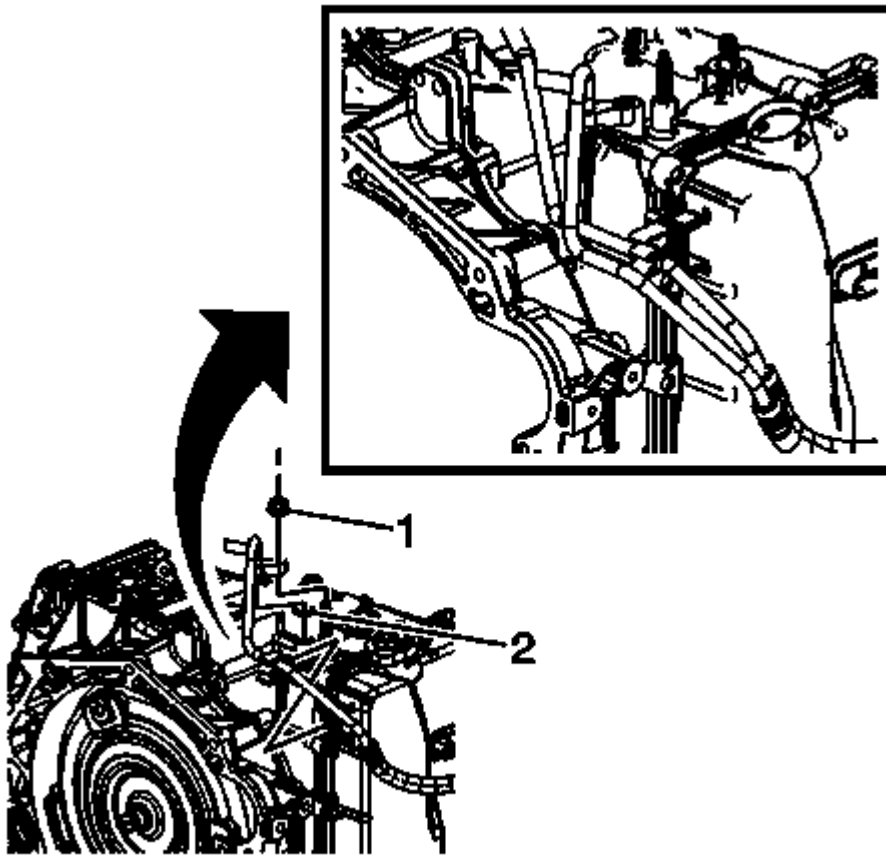


Fig. 94: Identifying Transmission Fluid Cooler Inlet Hose Components
Courtesy of GENERAL MOTORS COMPANY

19. Install the transmission fluid cooler inlet hose and seal (2) to the transmission.
20. Install the transmission fluid cooler pipe retainer nut (1) and tighten to 22 (16 lb ft).

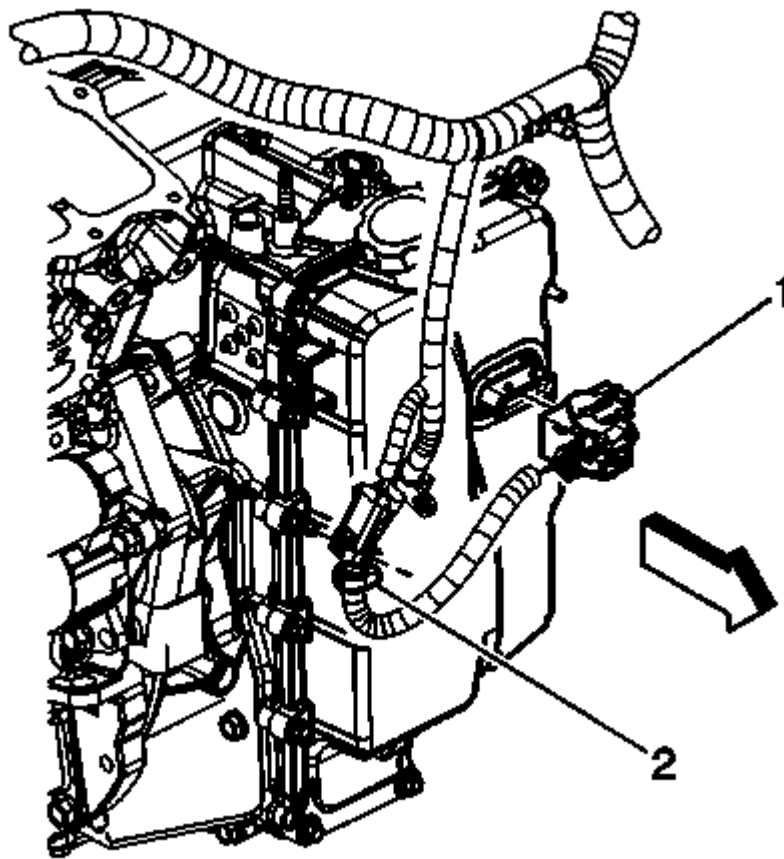


Fig. 95: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

21. Connect the control valve body TCM electrical connector (1).
22. Install the wire harness retainer (2) to the control valve body cover stud and tighten the nut to 12 (106 lb in).
23. Install the transmission range select lever cable and bracket.
24. Install the battery tray. Refer to **Battery Tray Replacement** .
25. Adjust the automatic transmission range selector lever cable. Refer to **Range Selector Lever Cable Adjustment**.
26. Fill the transmission with fluid. Refer to **Transmission Fluid Drain and Fill**.
27. If a NEW TCM has been installed into the vehicle, the NEW module needs to be reprogrammed. Refer to **Service Programming System (SPS)** .

NOTE: The Reset Transmission Adapts procedure must be performed when one of the following repairs have been made to the vehicle. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, as well as transmission DTCs being set:

- Transmission internal service/overhaul

- Valve body repair or replacement
- Control solenoid valve assembly replacement
- TCM software/calibration update
- Any service in response to a shift quality concern

28. Perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .
29. Road test the vehicle.

Transmission

Automatic Transmission - 6T70 (M7U M7W) - Schematic Wiring Diagrams

SCHEMATIC AND ROUTING DIAGRAMS

AUTOMATIC TRANSMISSION CONTROLS SCHEMATICS

Module Power, Ground, Serial Data, MIL, Brake Apply, and Tap Up/Tap Down (-CZ2)

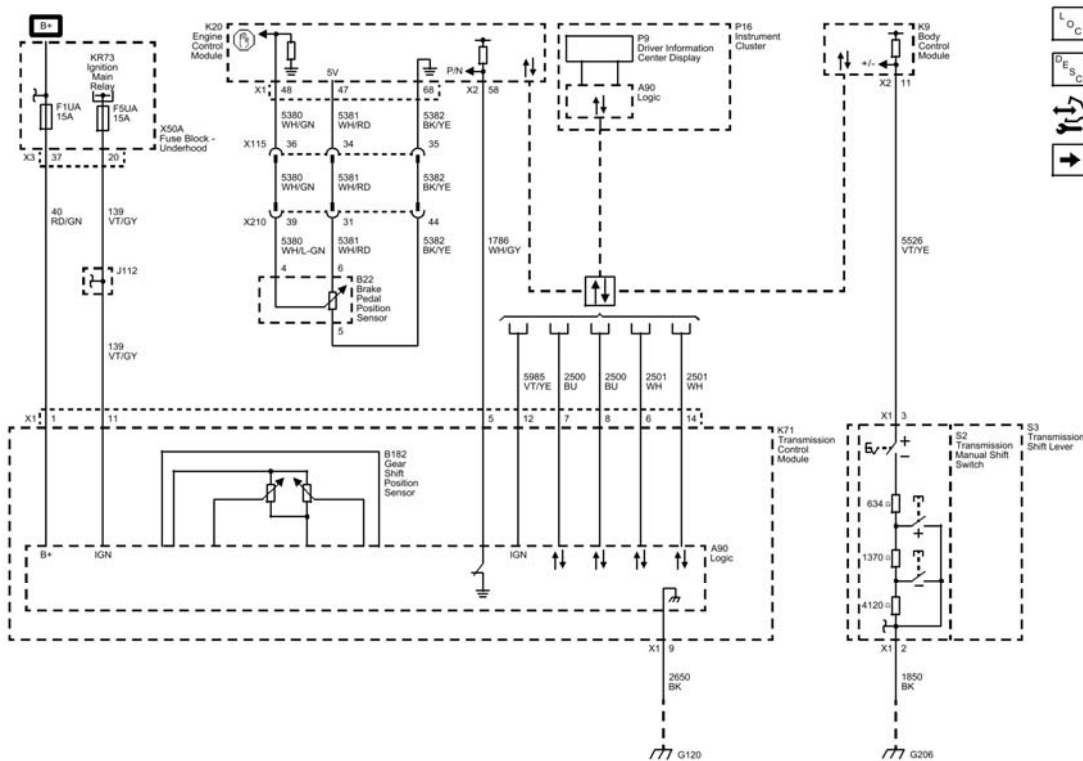


Fig. 1: Module Power, Ground, Serial Data, MIL, Brake Apply, and Tap Up/Tap Down (-CZ2)
Courtesy of GENERAL MOTORS COMPANY

Speed and Temperature Sensors, Pressure and Shift Controls (-CZ2)

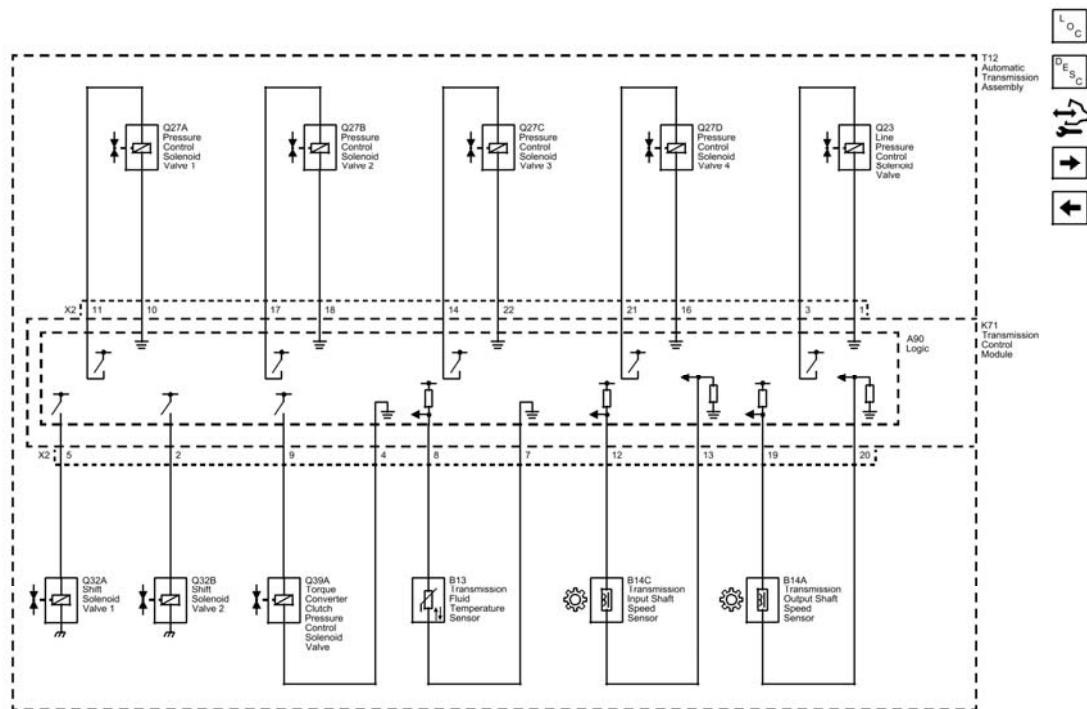


Fig. 2: Speed and Temperature Sensors, Pressure and Shift Controls (-CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Shift Lever Position Indicator (-CZ2)

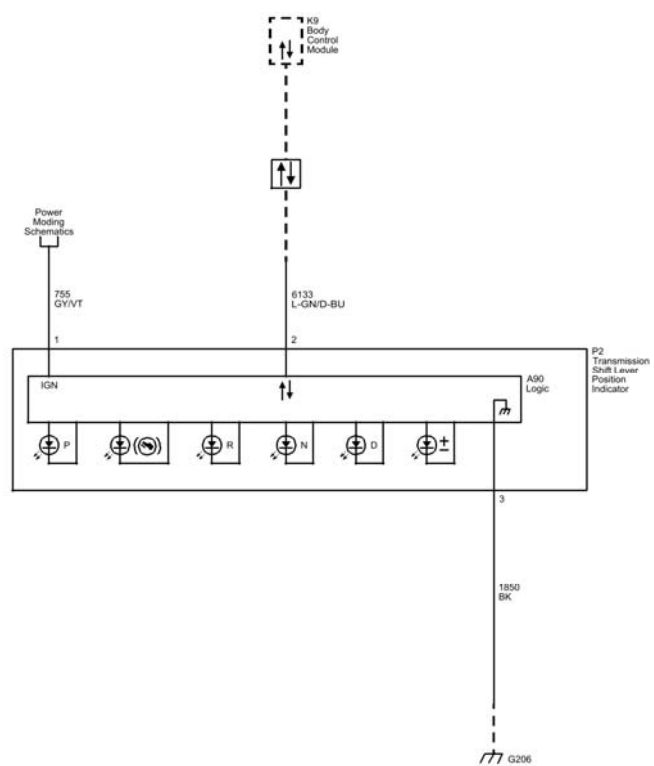


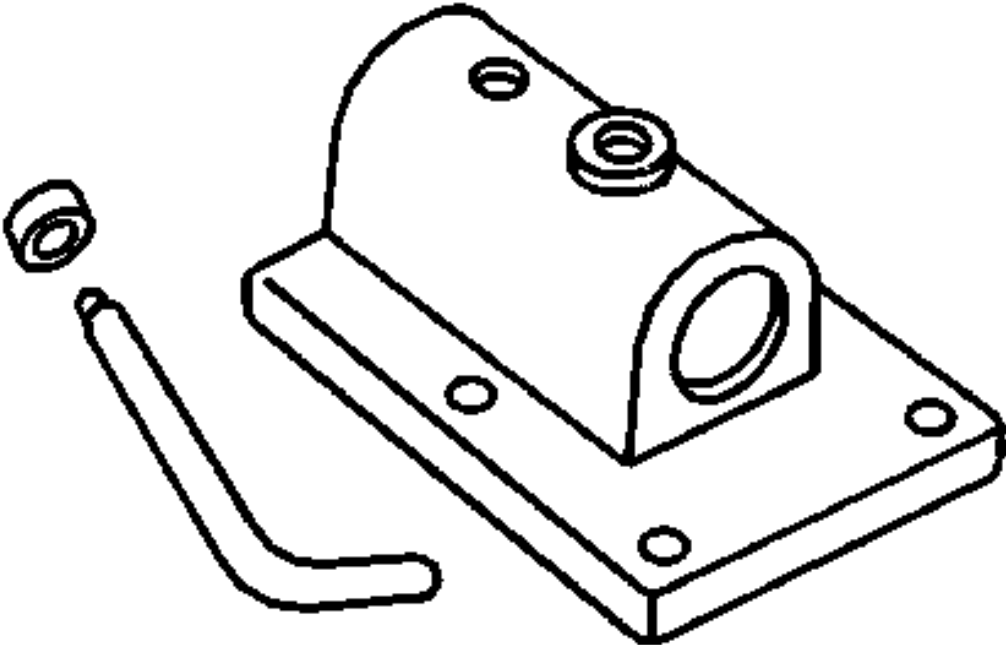
Fig. 3: Shift Lever Position Indicator (-CZ2)
Courtesy of GENERAL MOTORS COMPANY

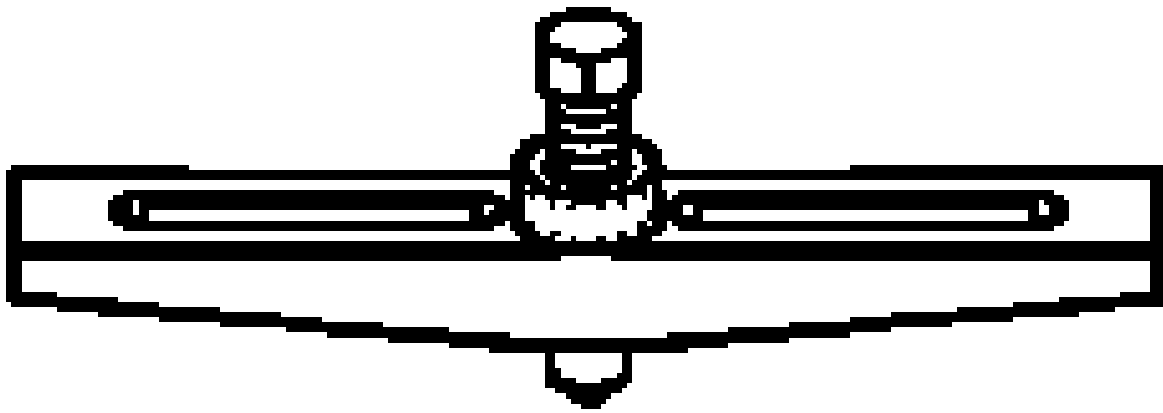
Transmission

Automatic Transmission - 6T70 (M7U M7W) - Special Tools and Equipment

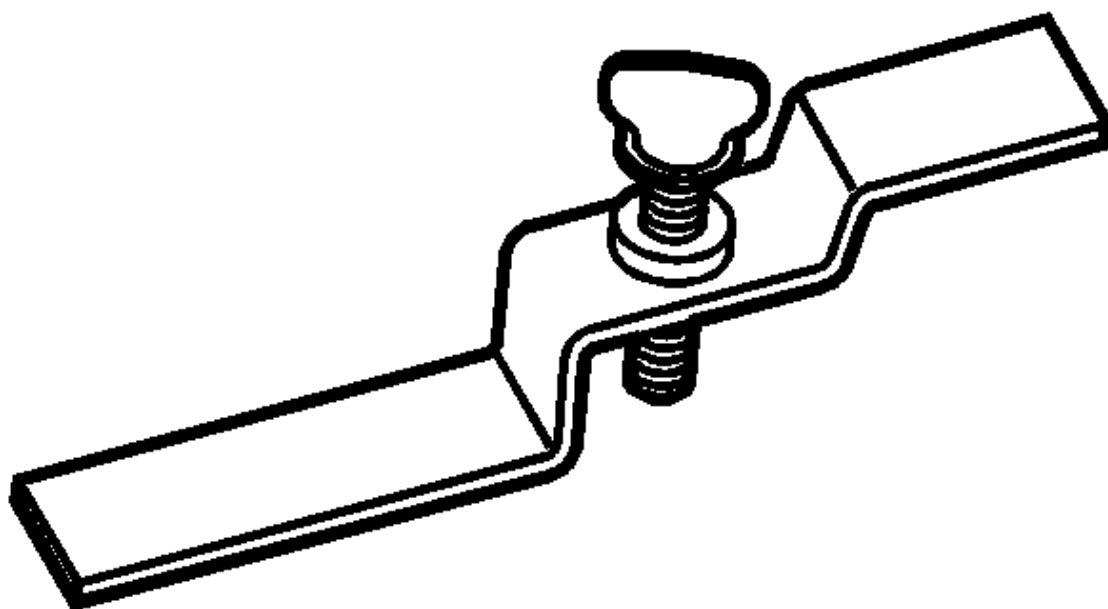
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

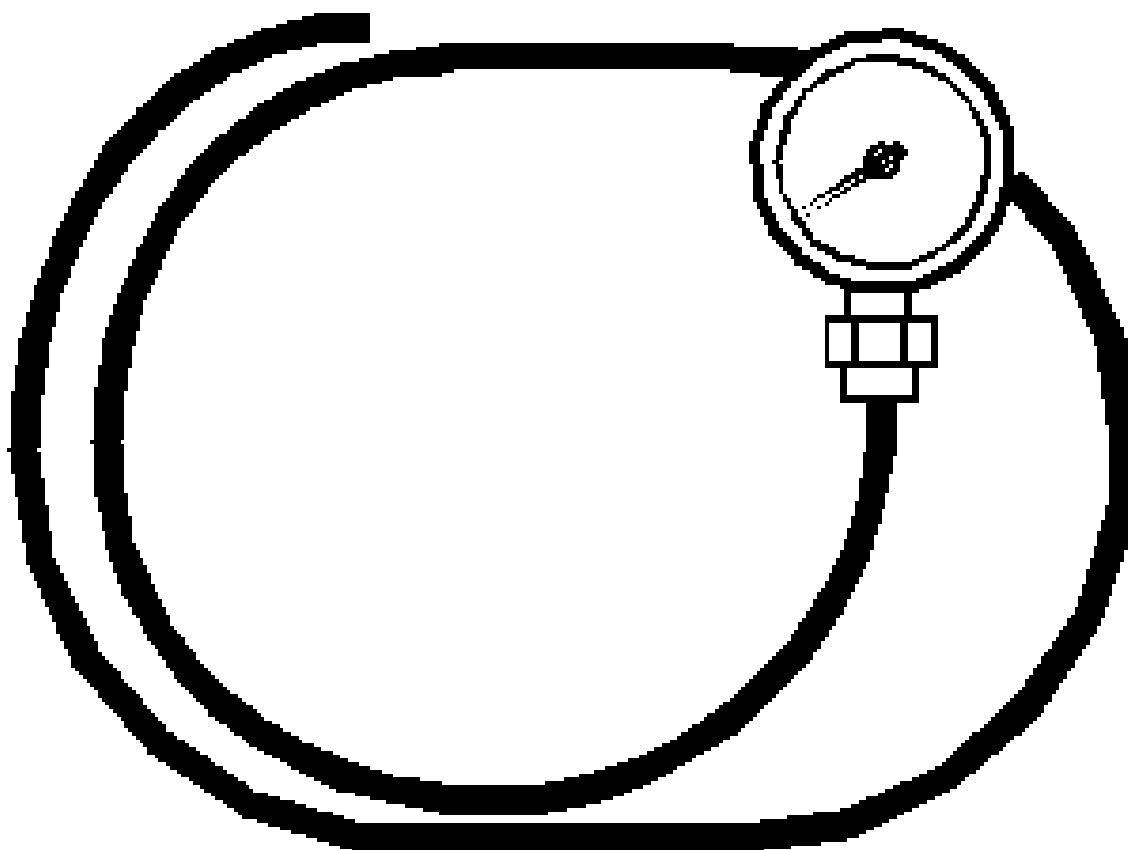
Illustration	Tool Number/Descrip
	DT 3289-20 J 3289-20 KM-113-2-A Holding Fixtur



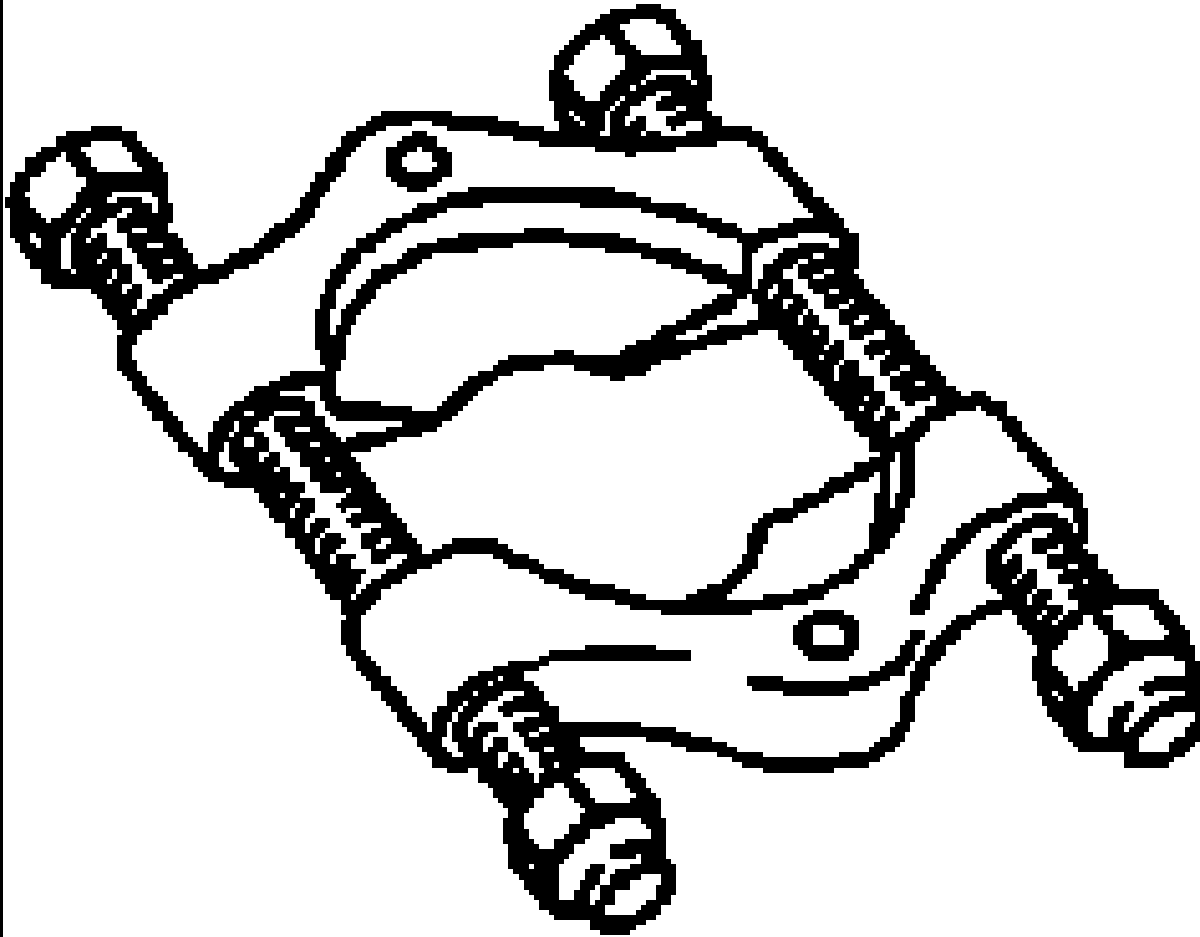
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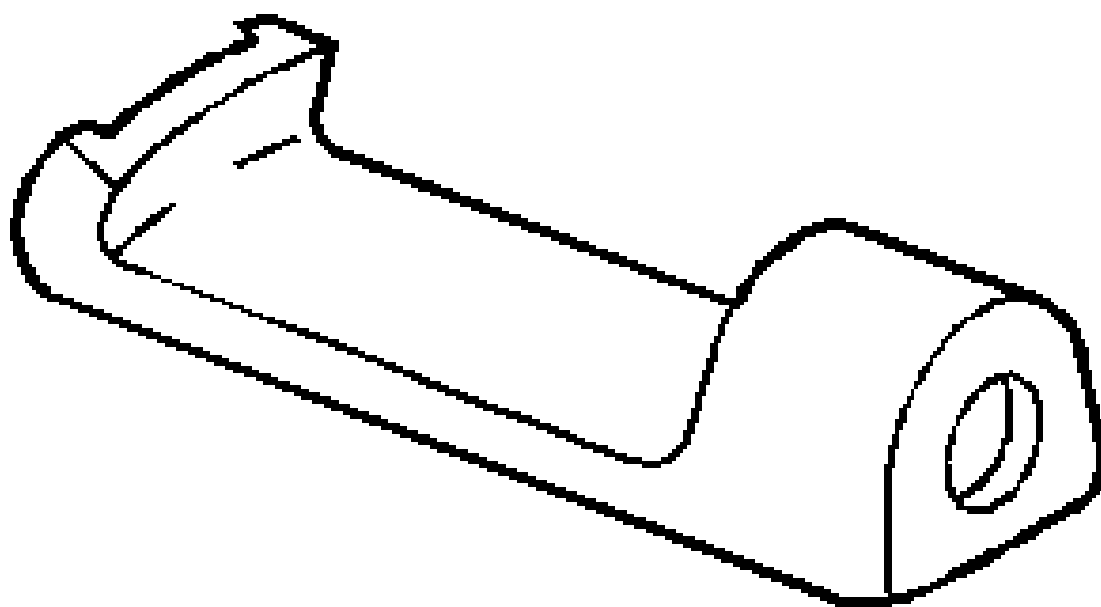
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J 21366
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Strap



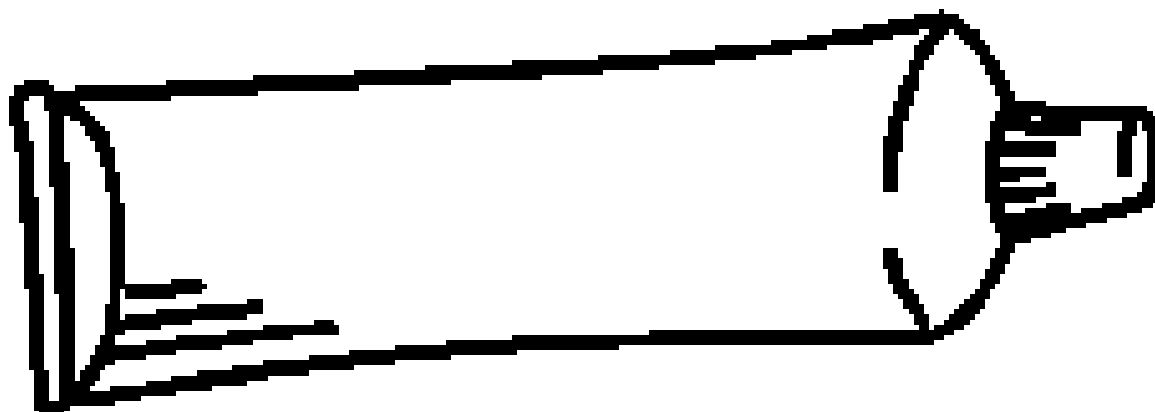
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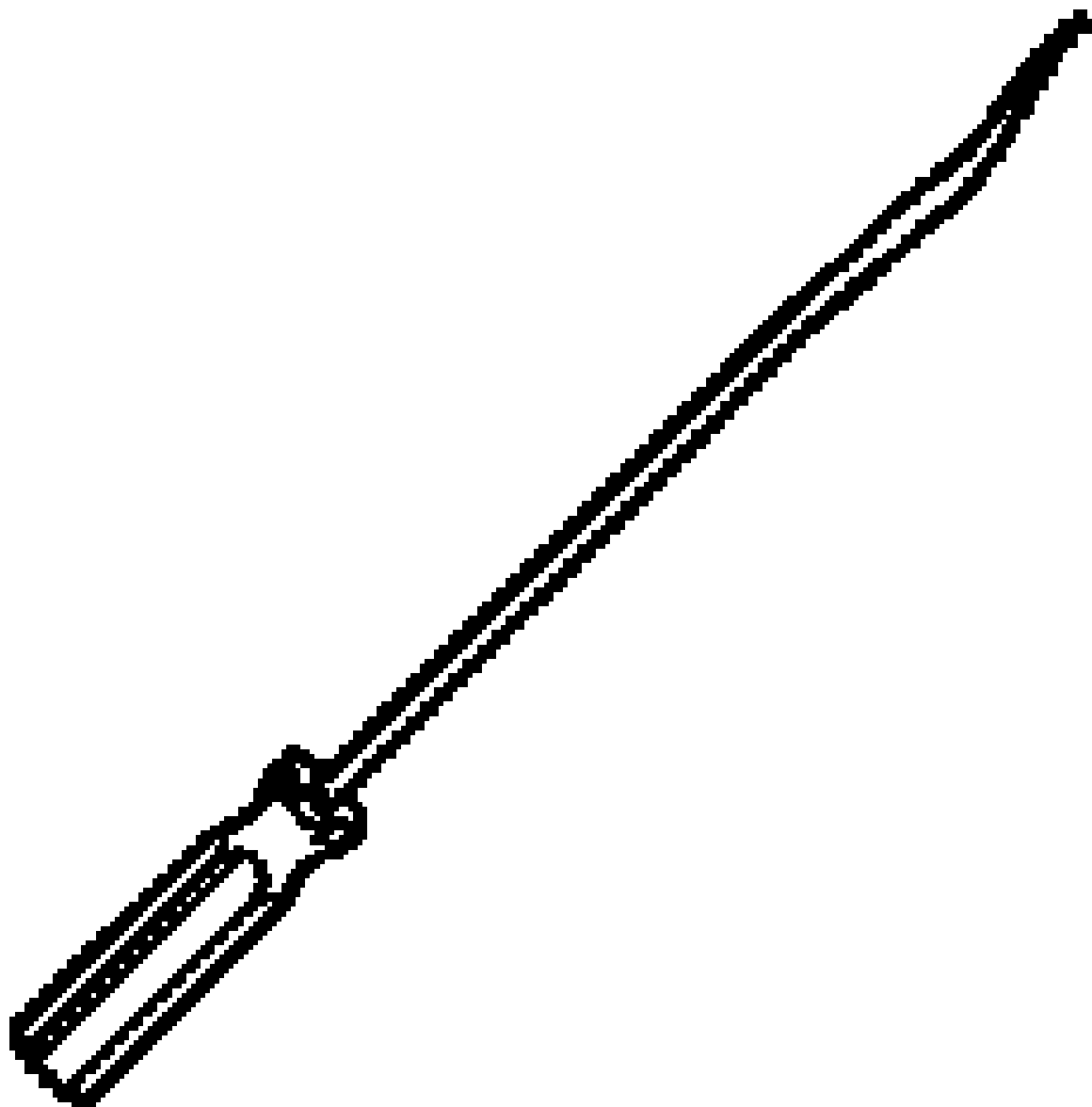
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Remover



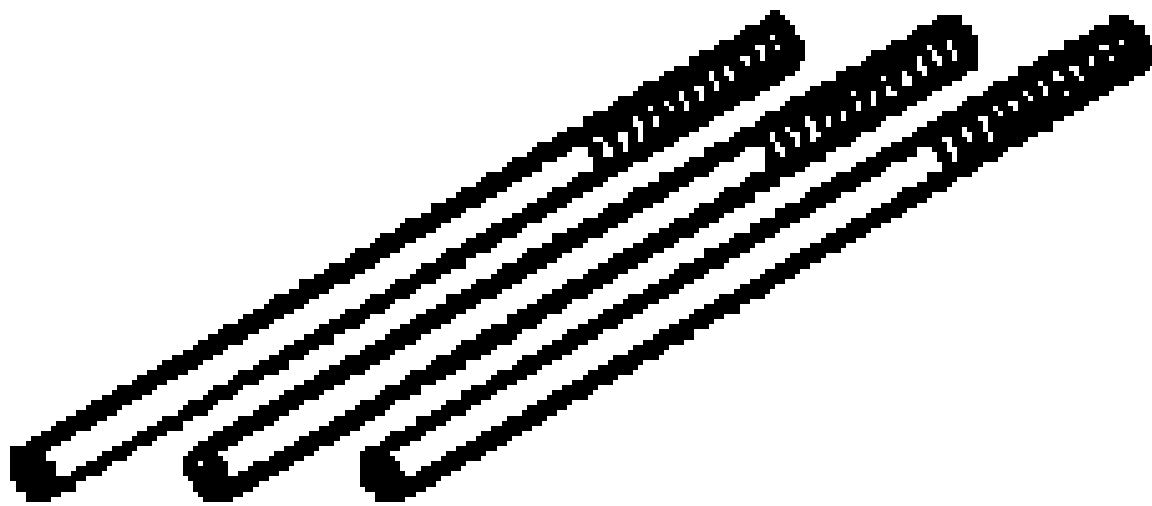
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KM-586
Universal Seal
Remover



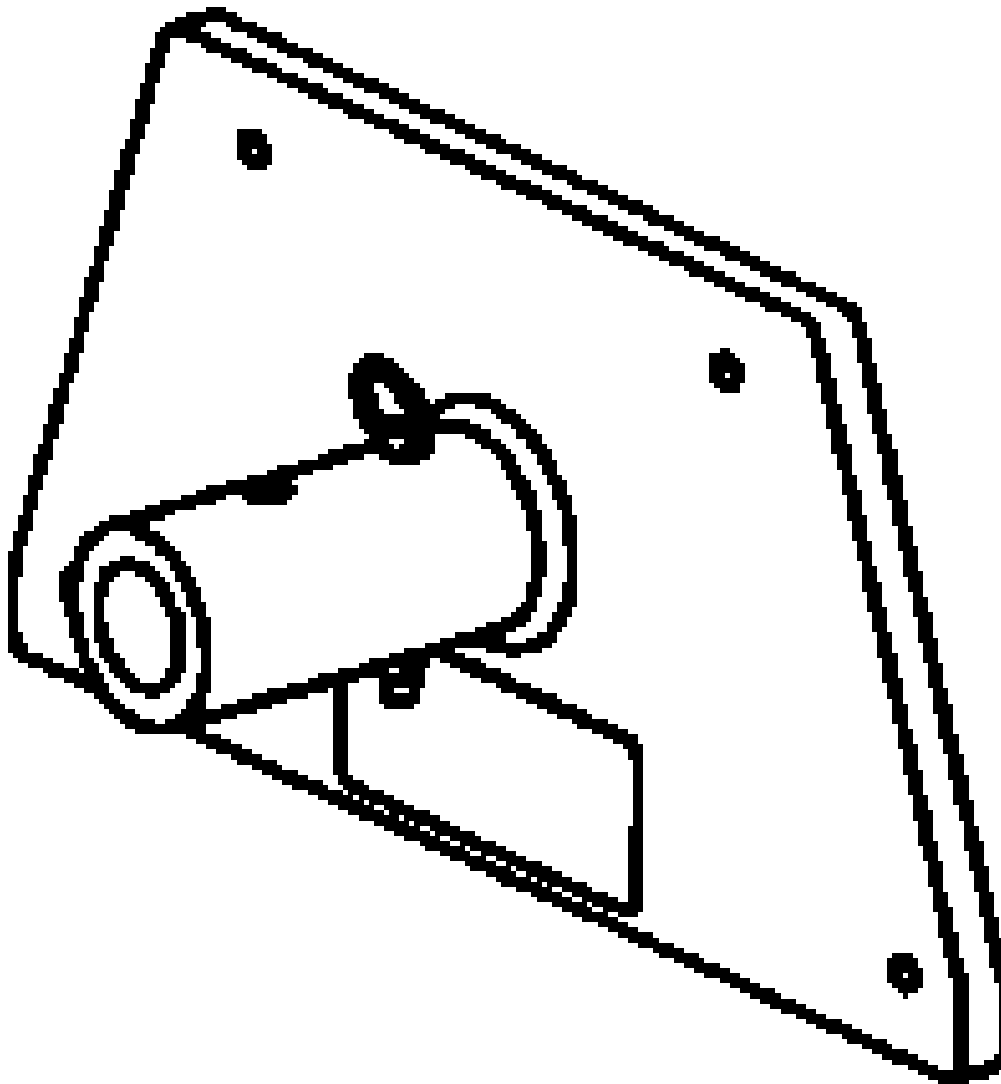
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Lubricant-1/4 Ou
Tube



DT 28585
J 28585
Snap Ring Remo

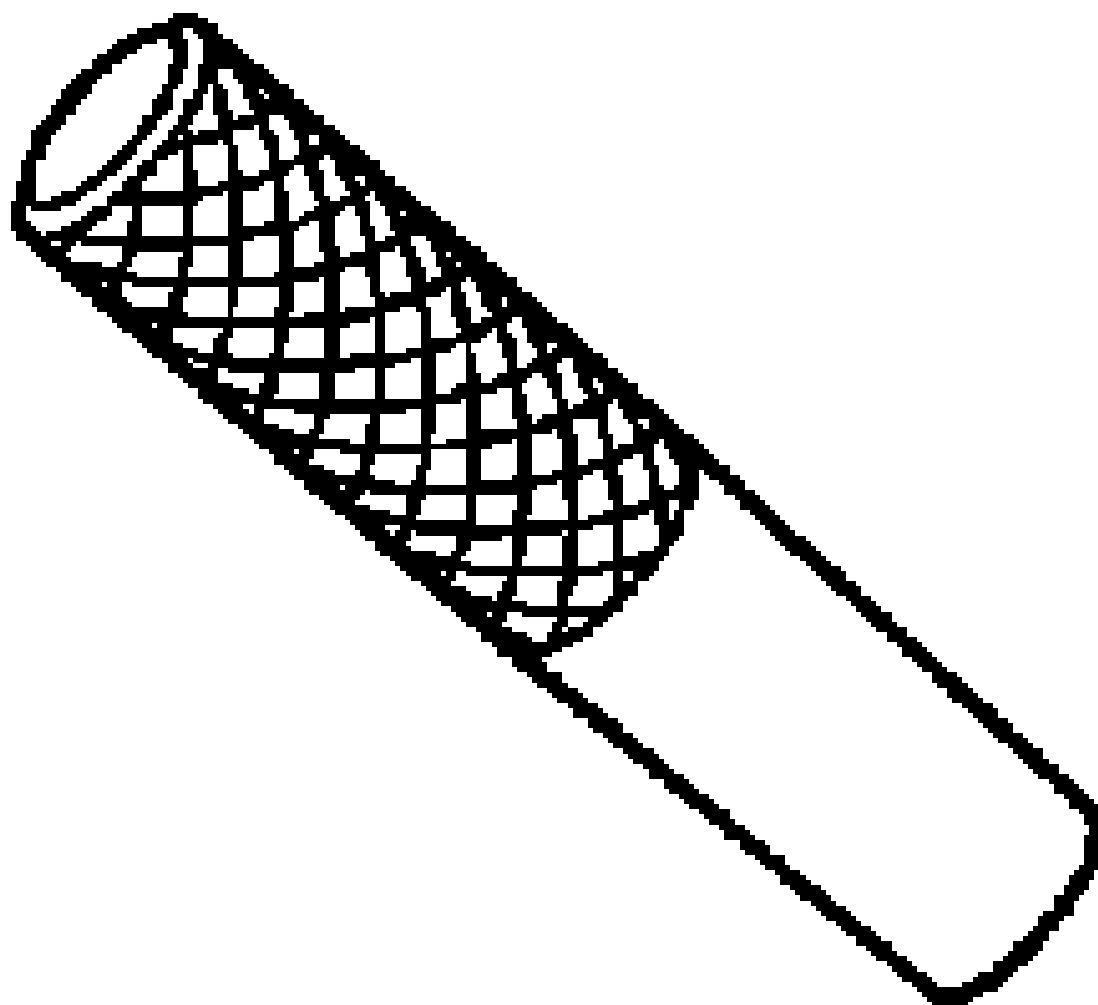


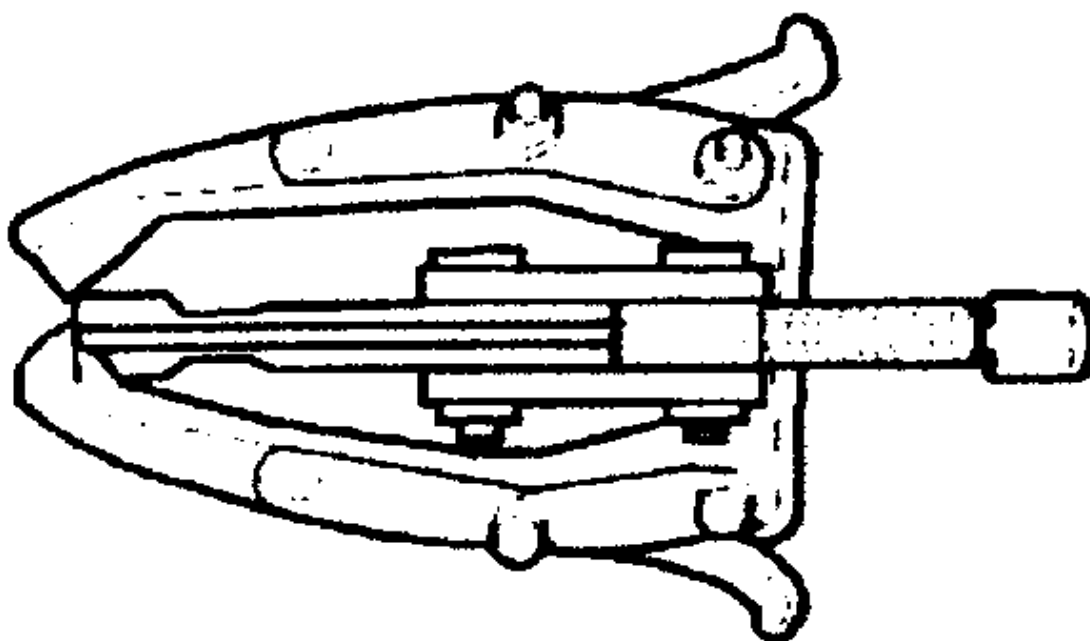
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Pins (3)



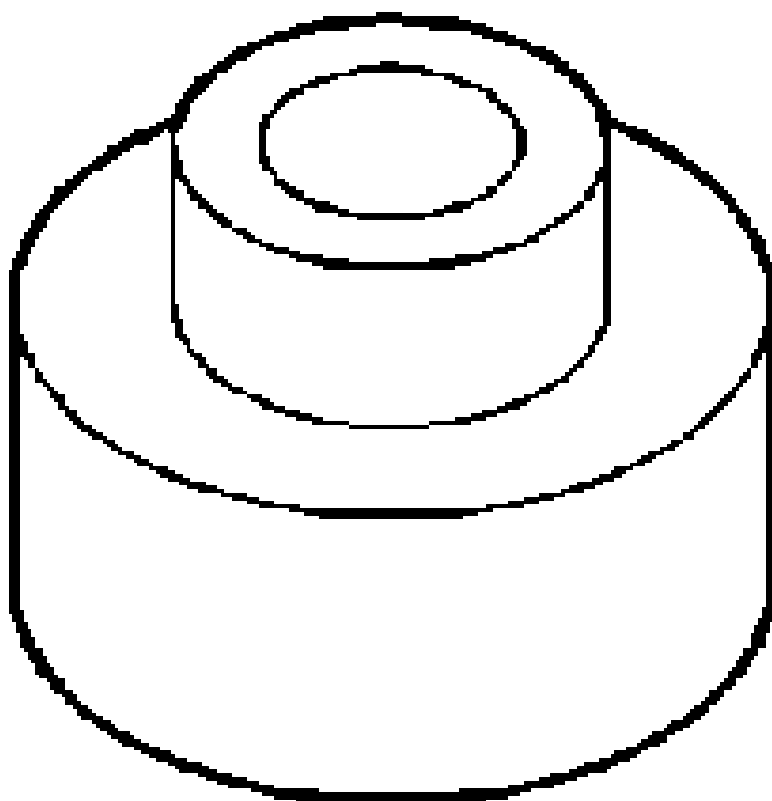
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J 39890
Holding Fixtur
Adapter

DT 41229
J 41229
Manual Shaft P
Installer

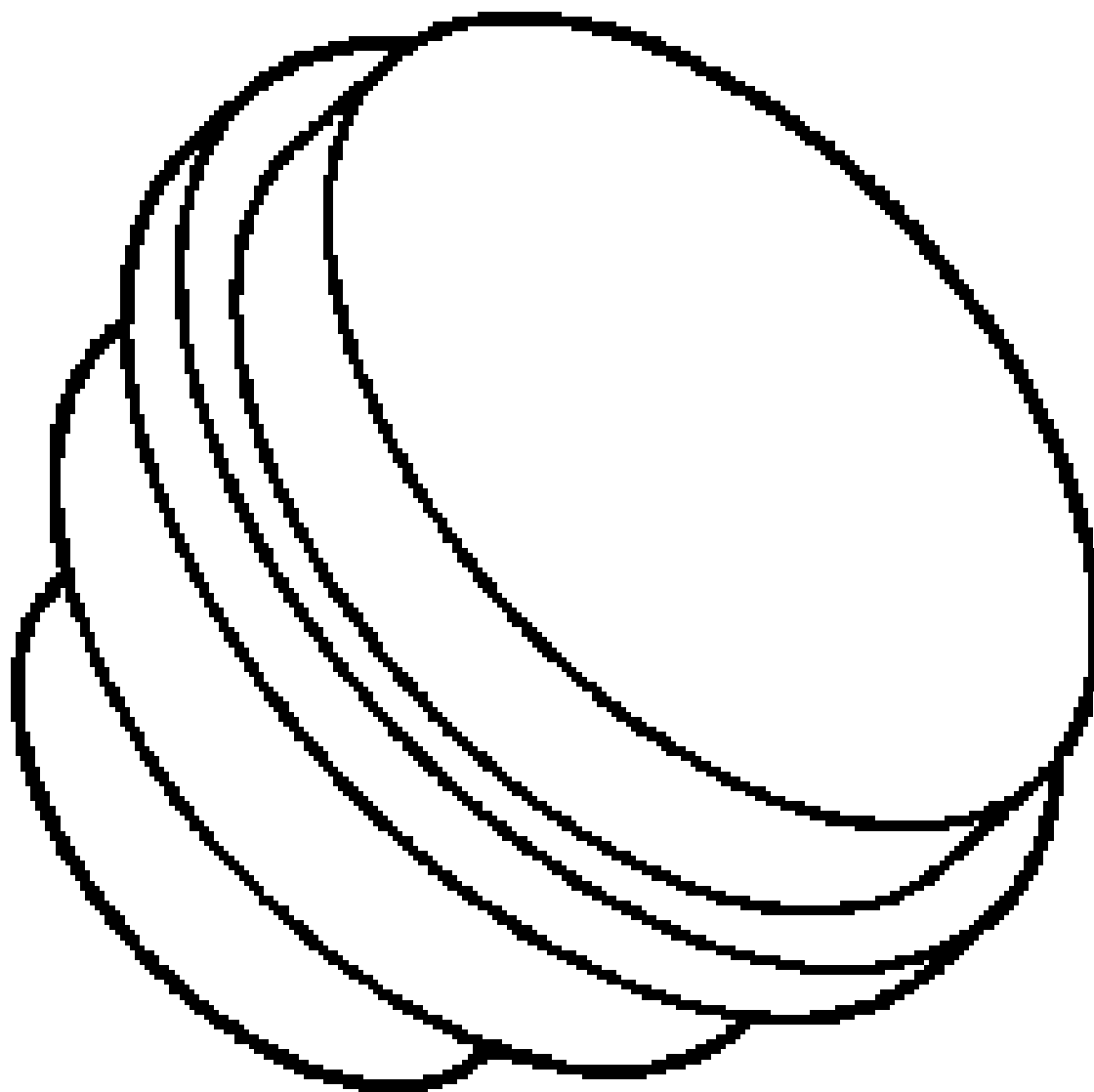




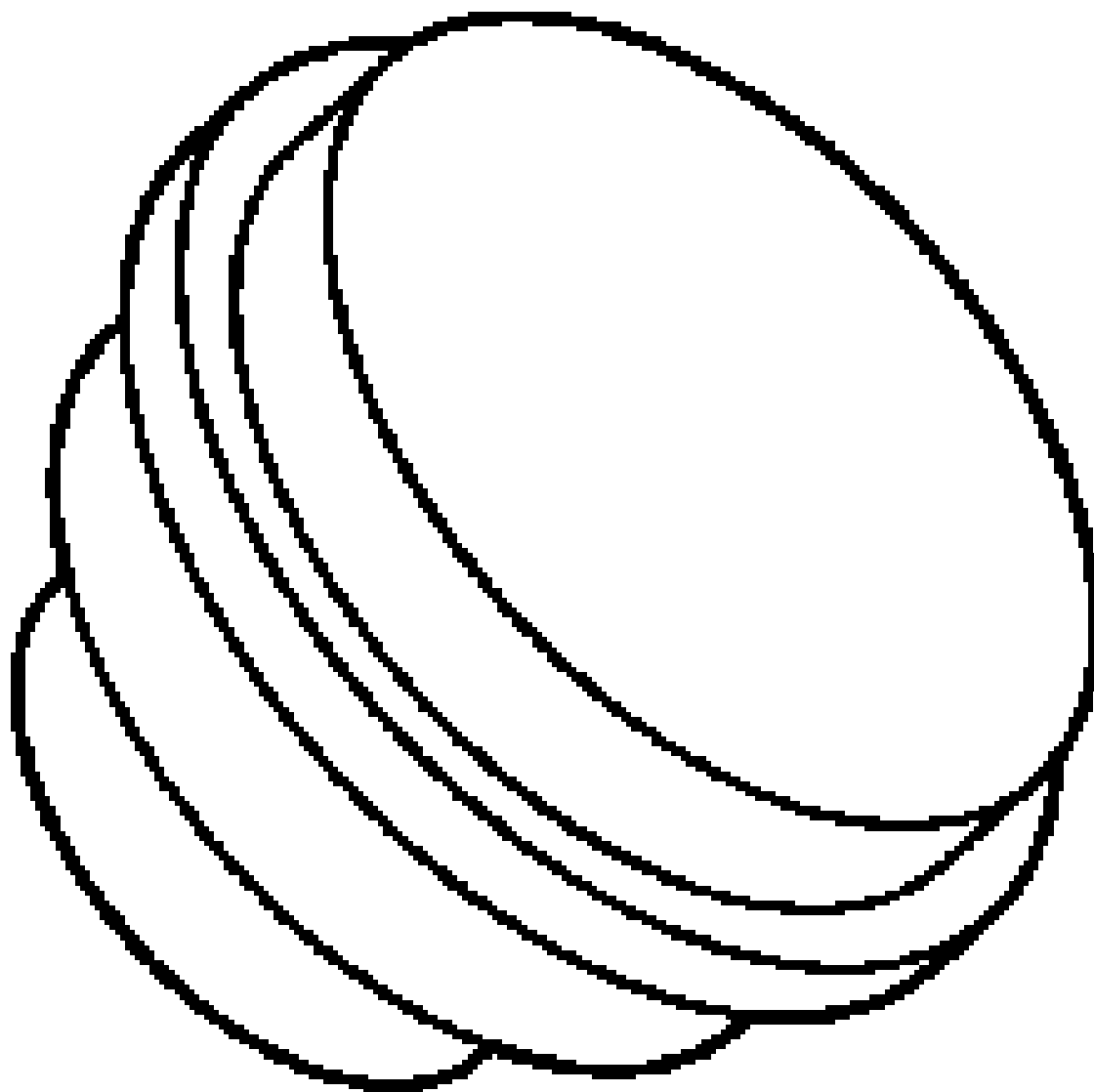
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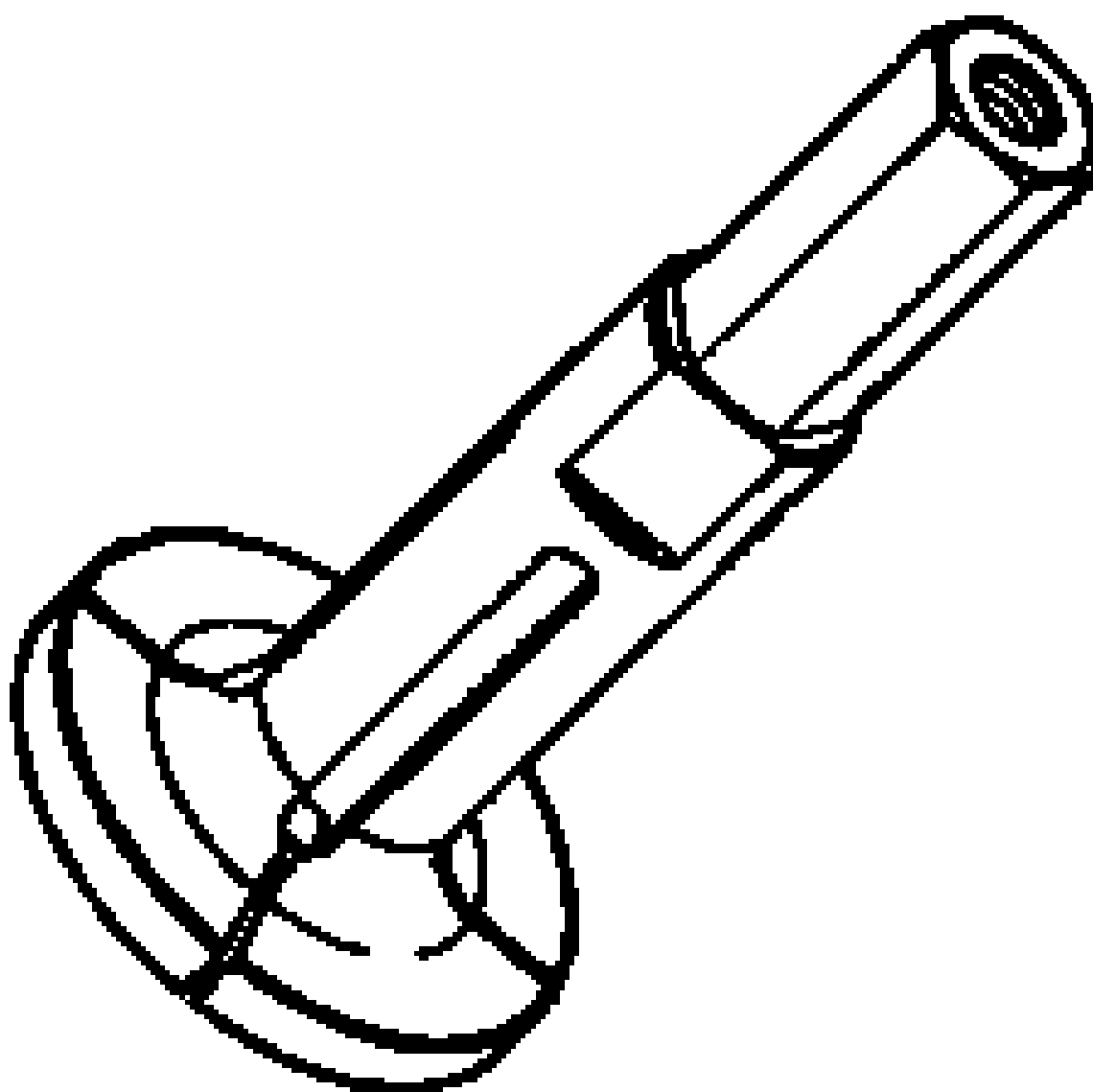
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J 41816-2
Crankshaft End
Protector



DT 45087
J 45087
Bearing Cup Instt



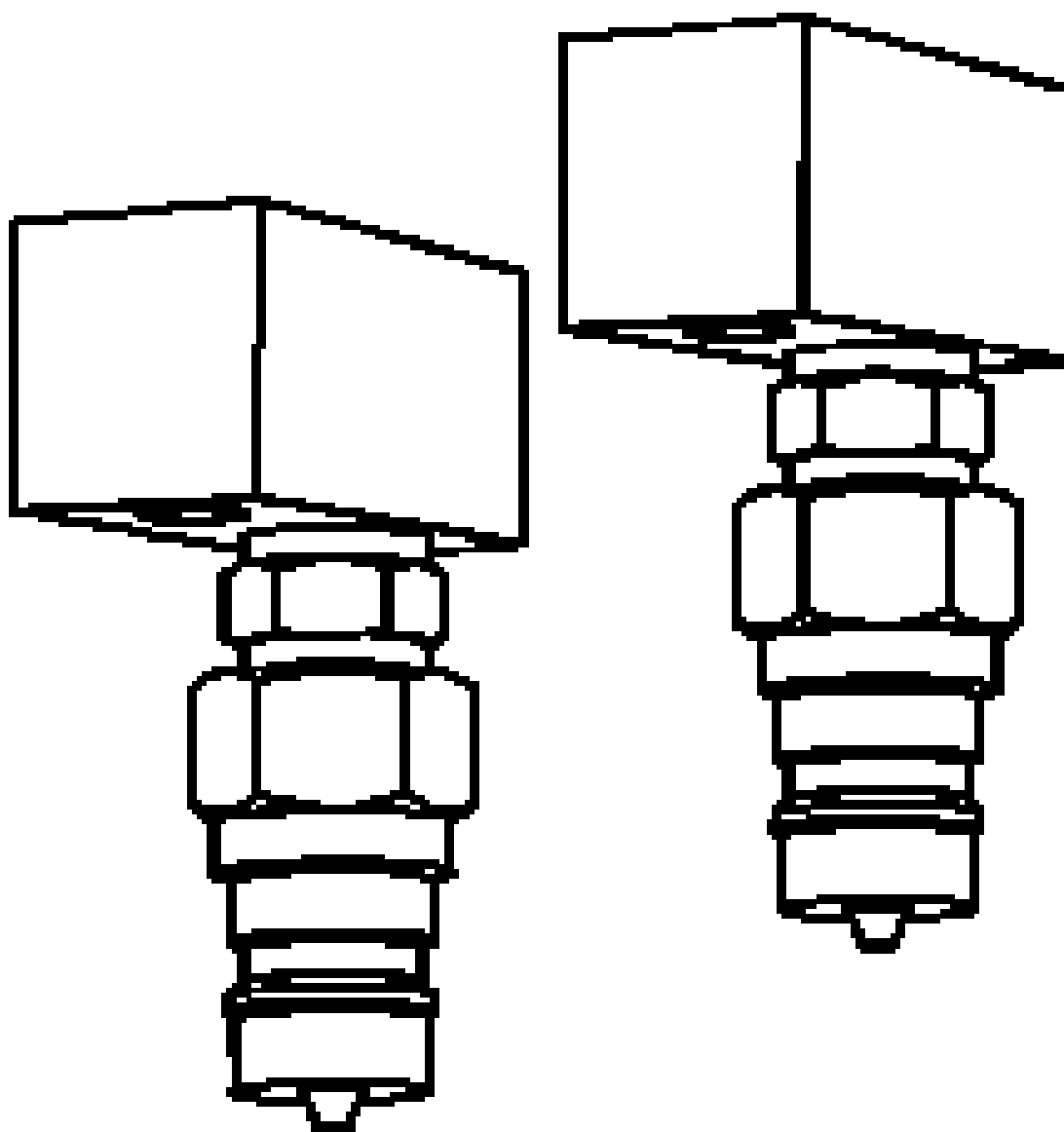
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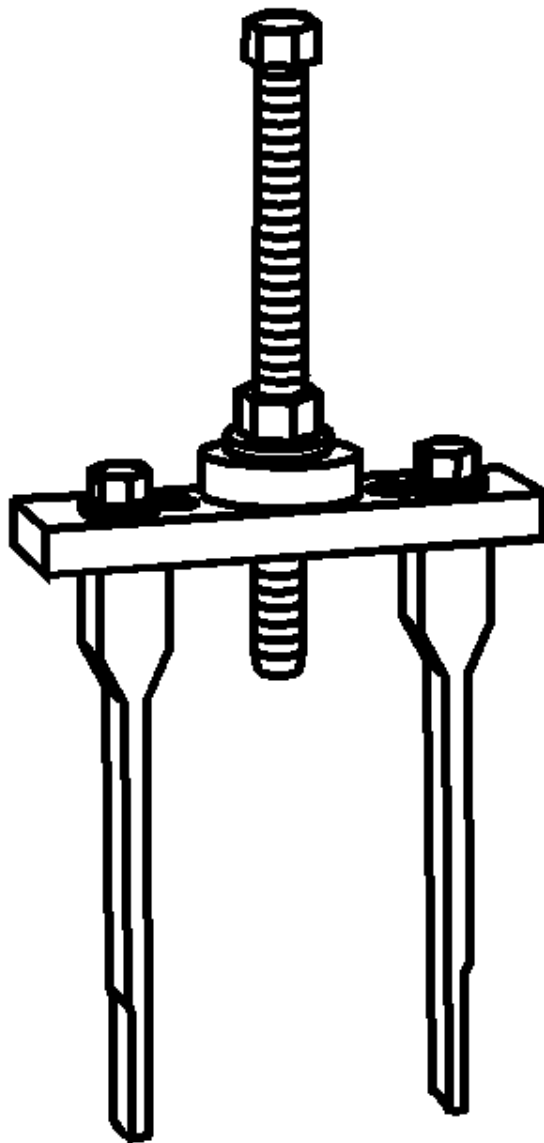
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J 45094
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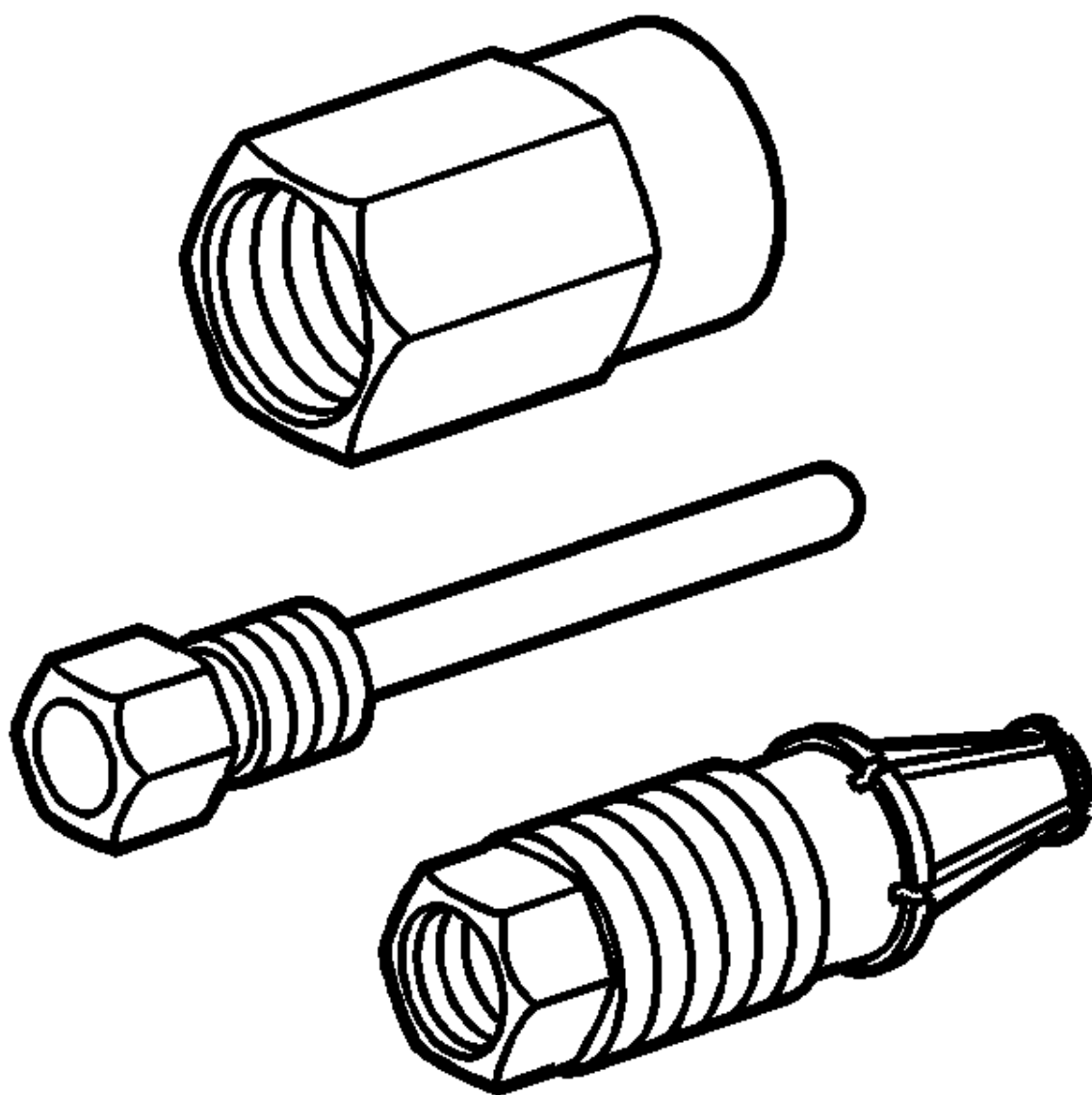
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J 45096
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Cooling Syster
Flush and Flow T
Tool



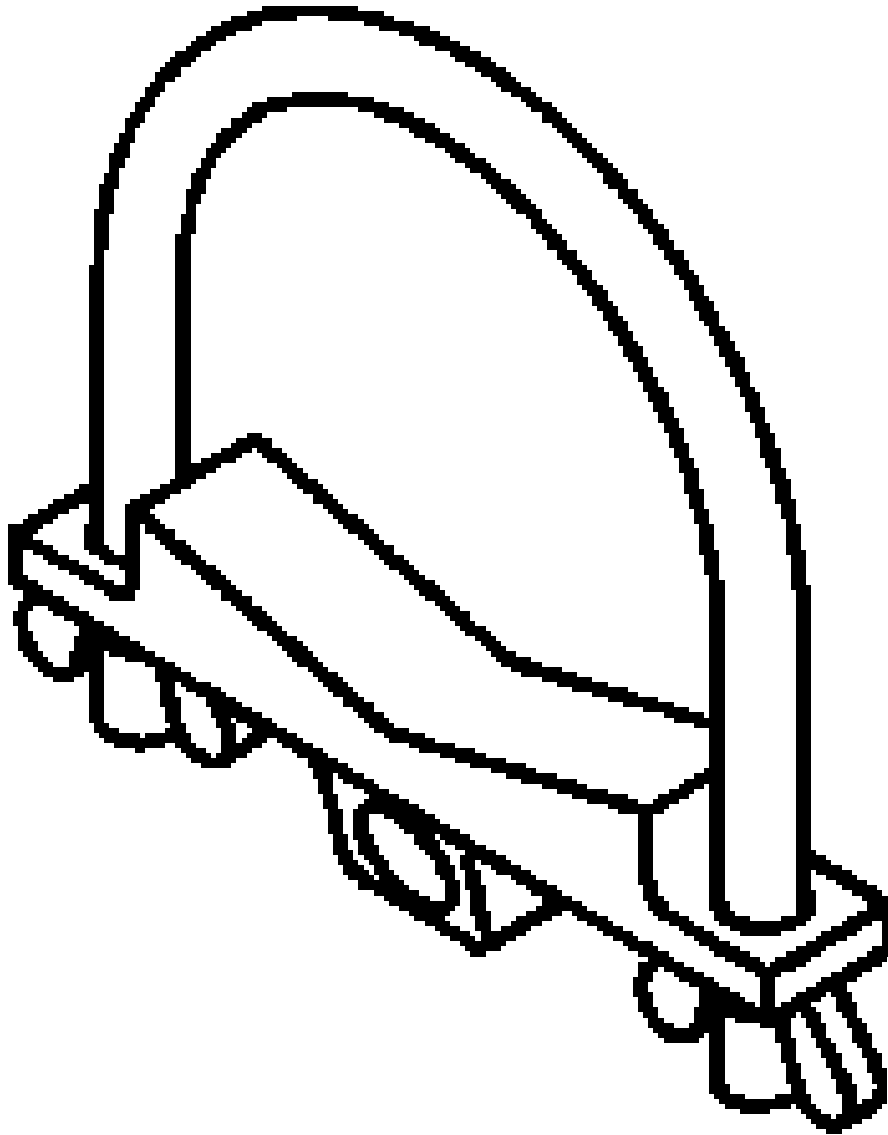
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Flush Adapter



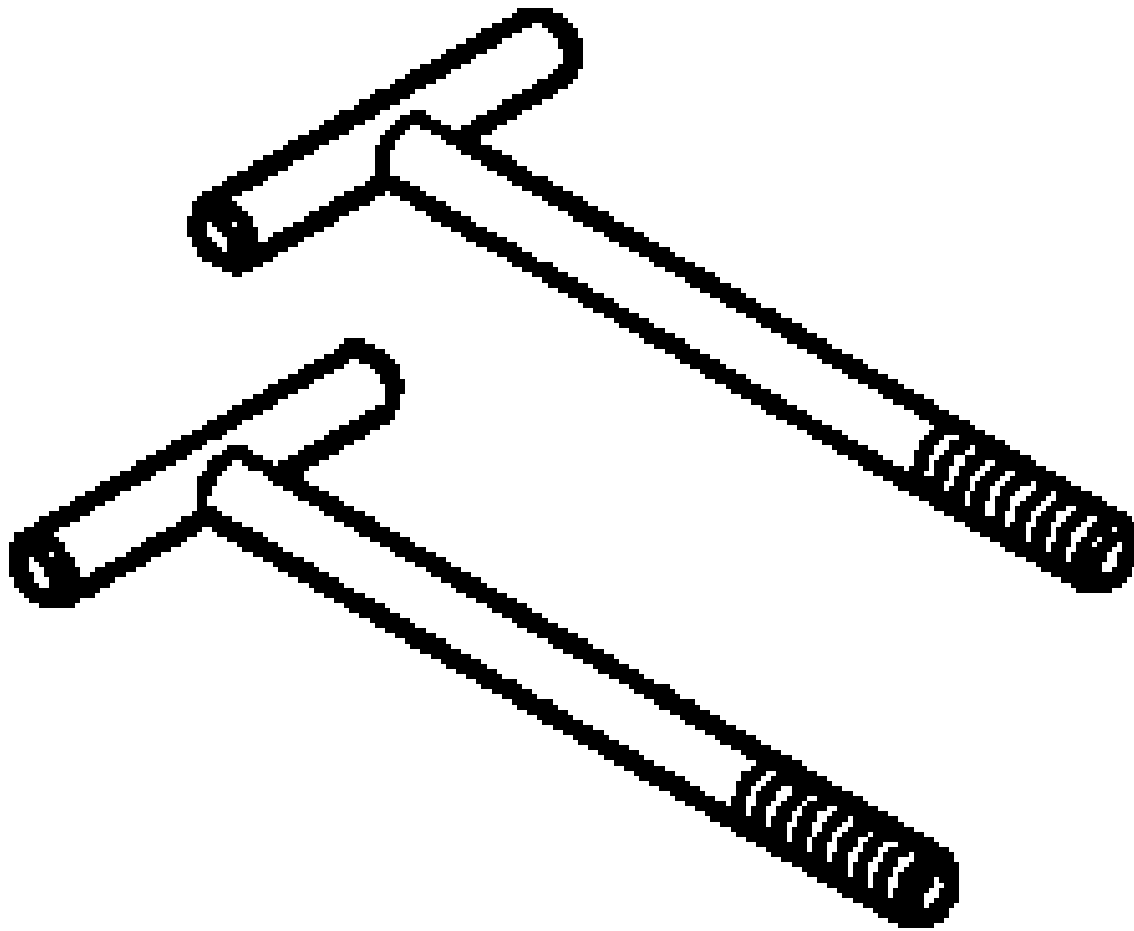
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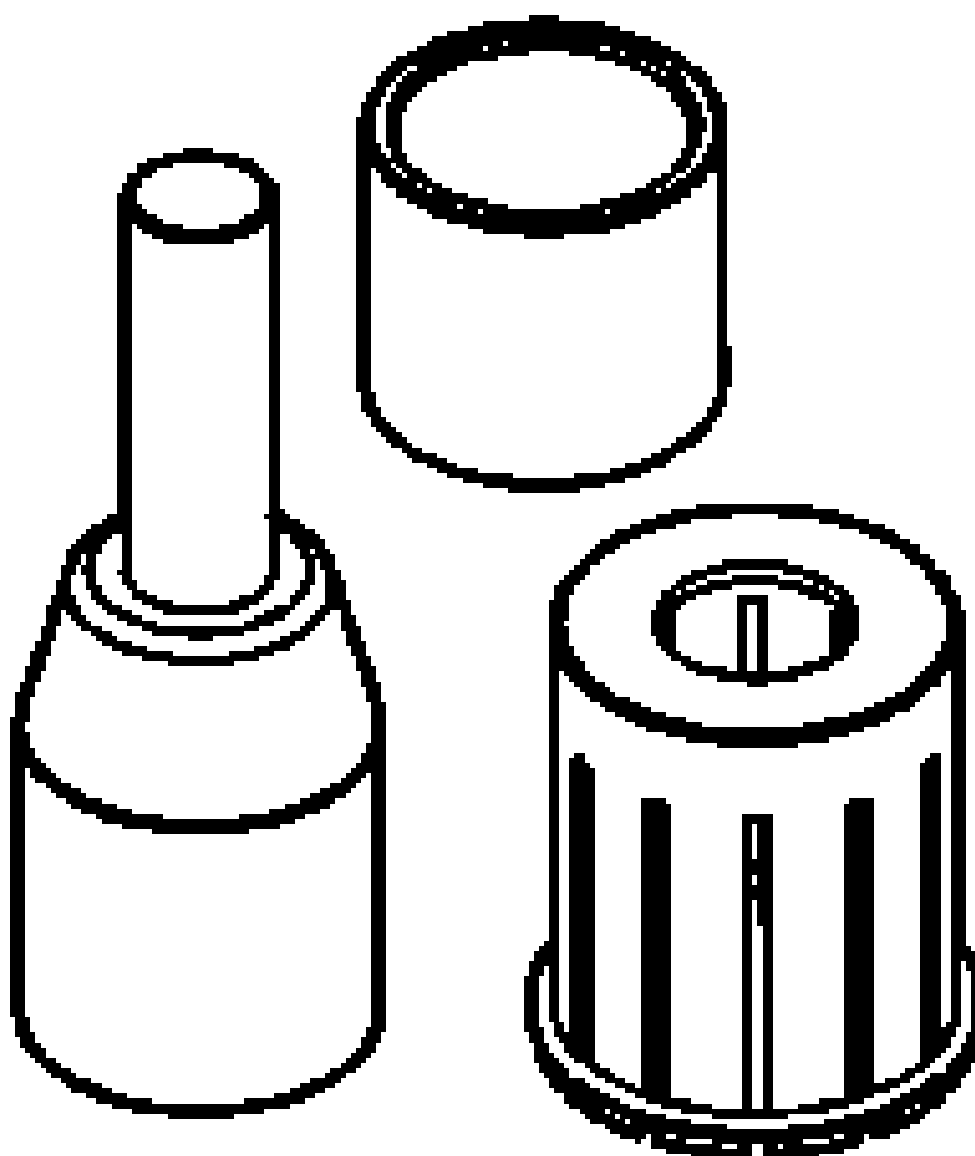
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DT 48203
J 45201
Cooler Line Se.
Remover



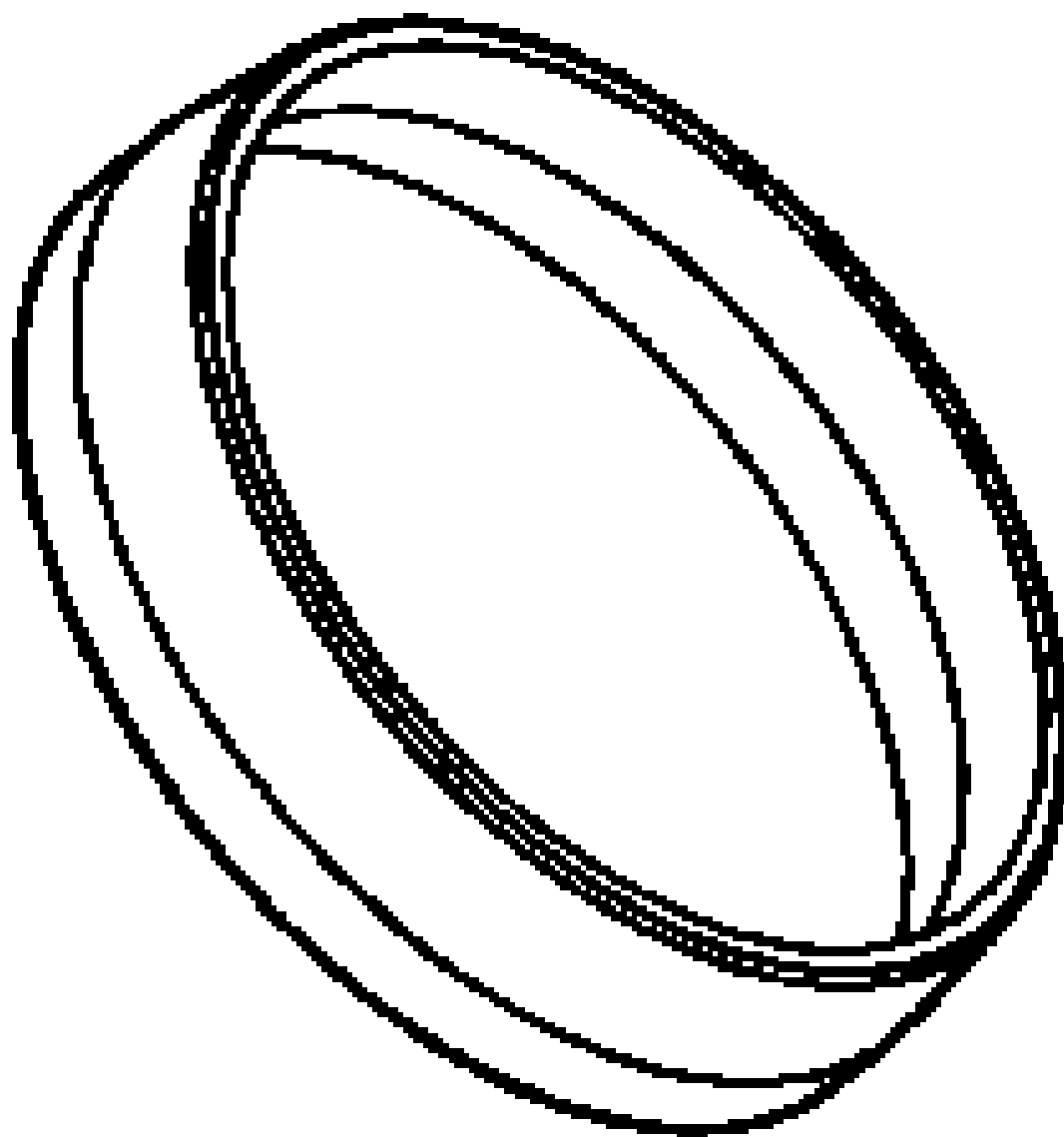
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Shaft Removal Tool



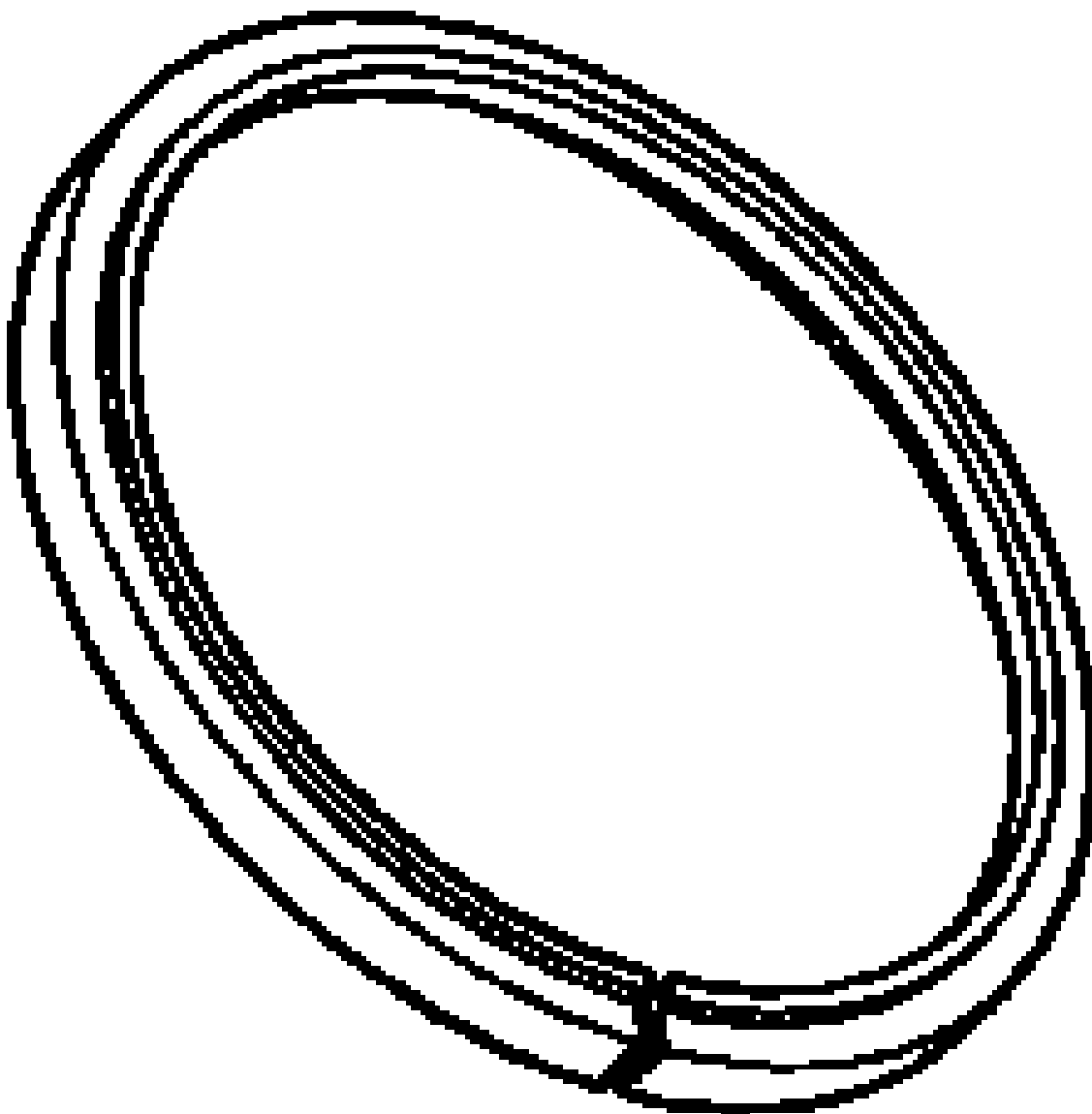
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KM-922
Torque Convert
Lifting Handle



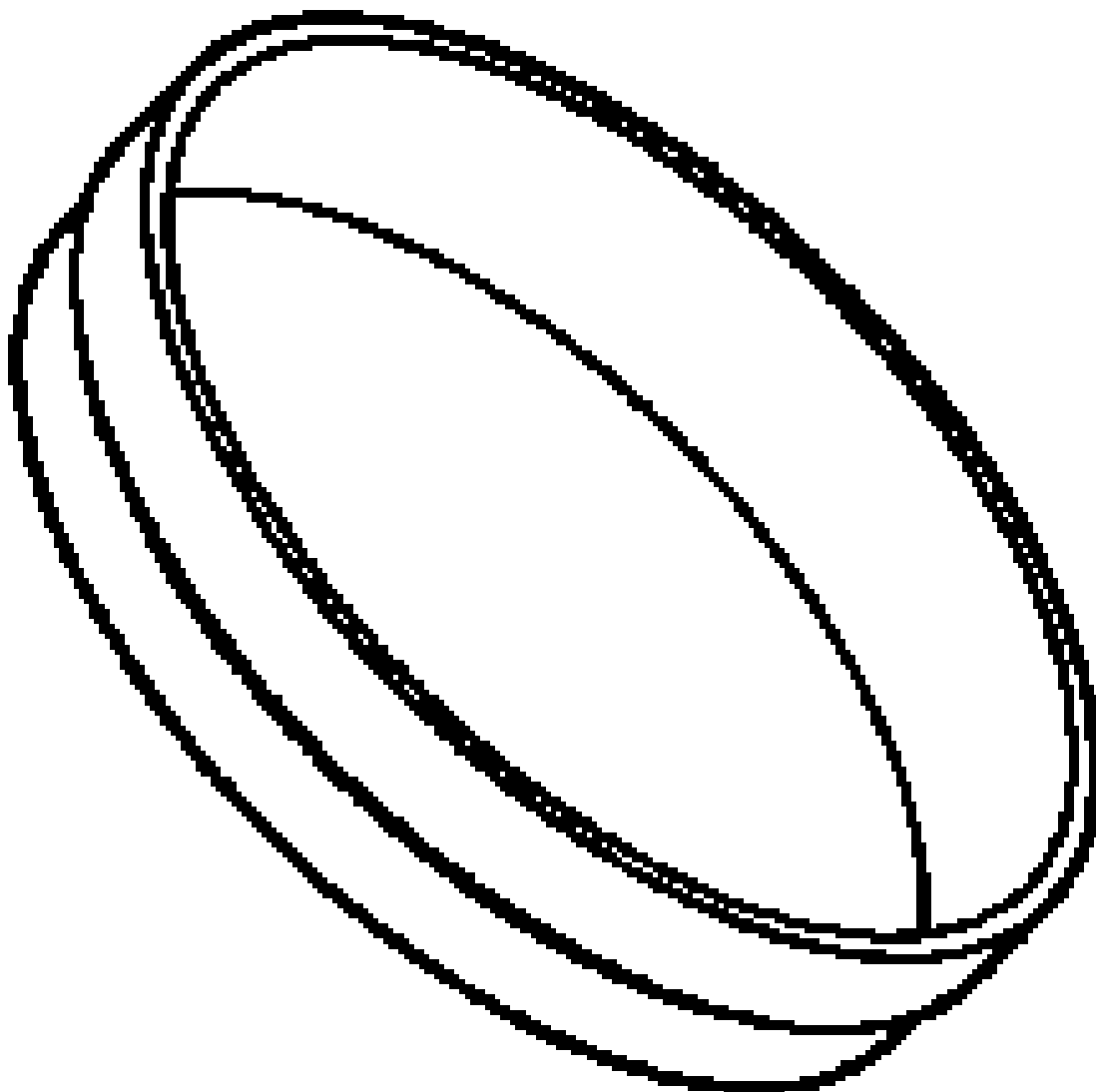
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J 46620
Seal Installer



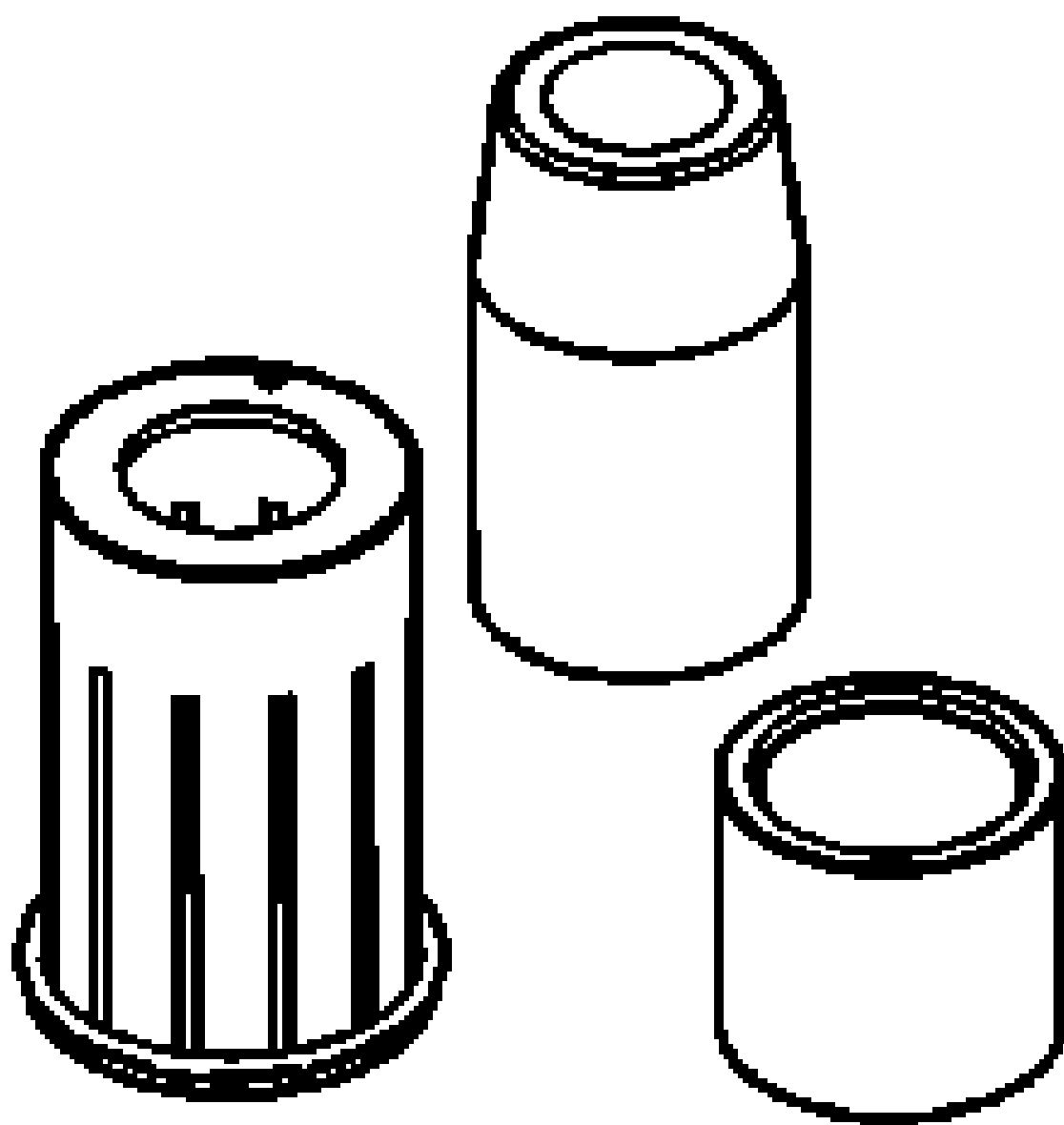
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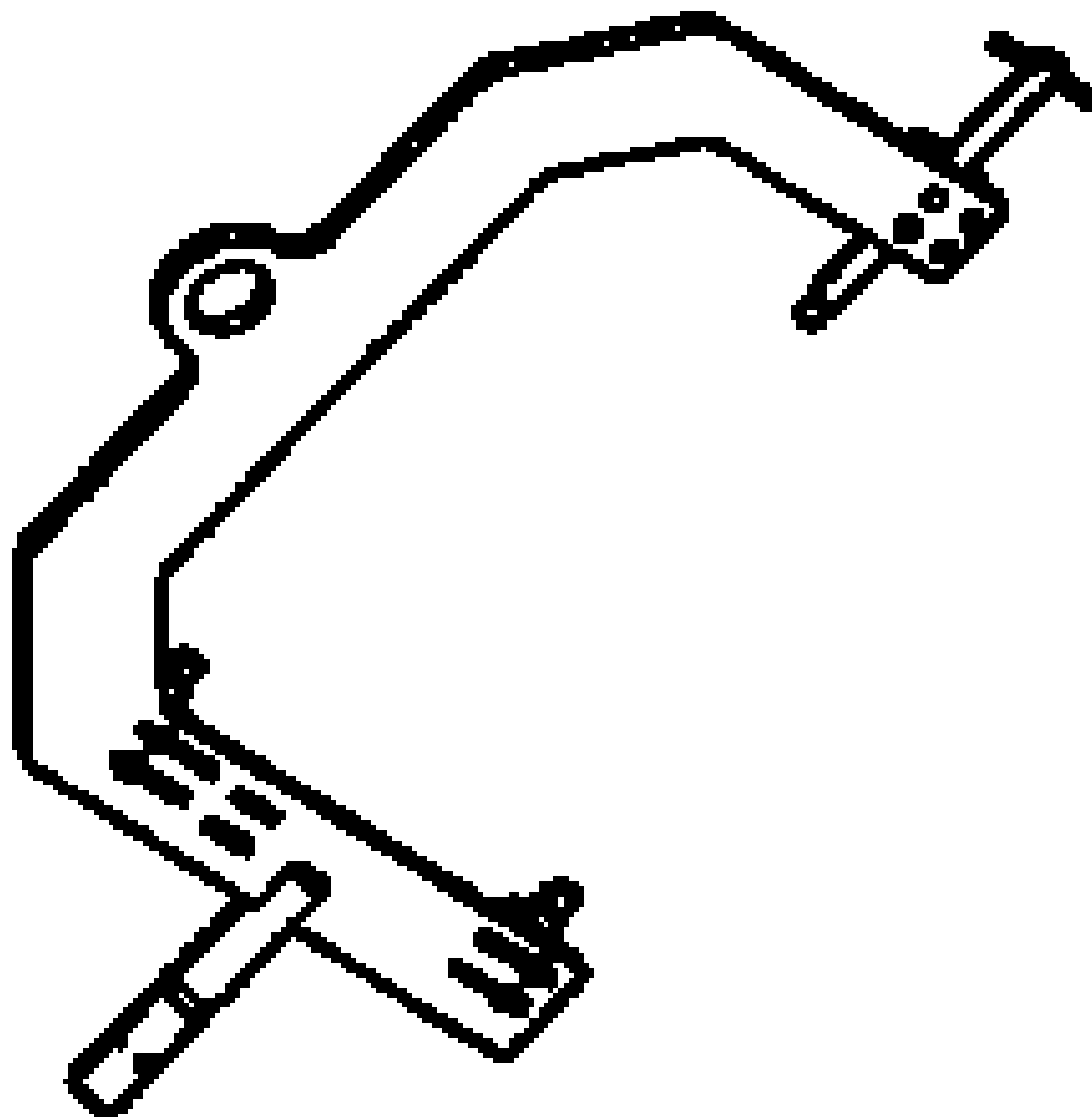
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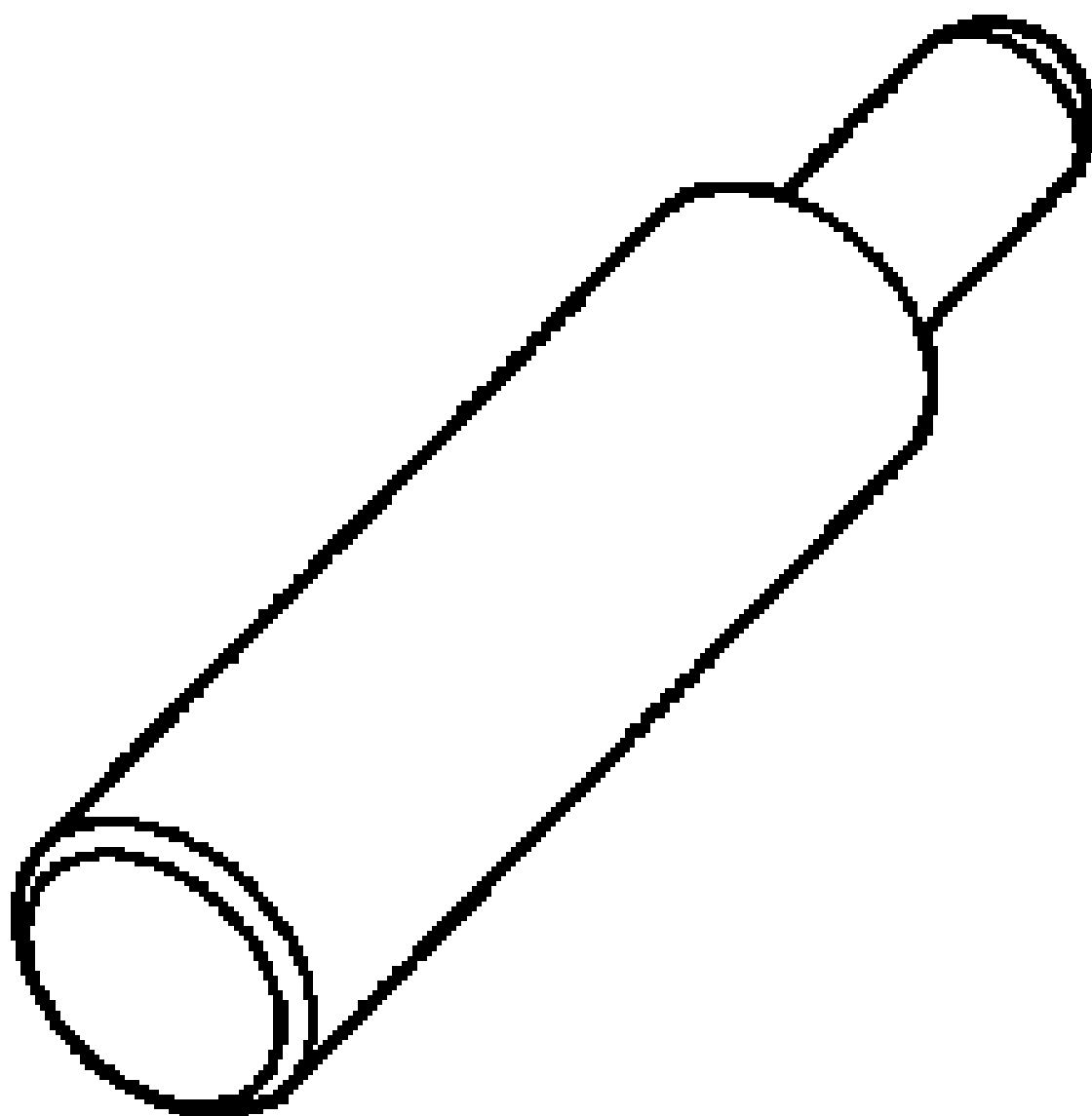
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Piston Seal Prote



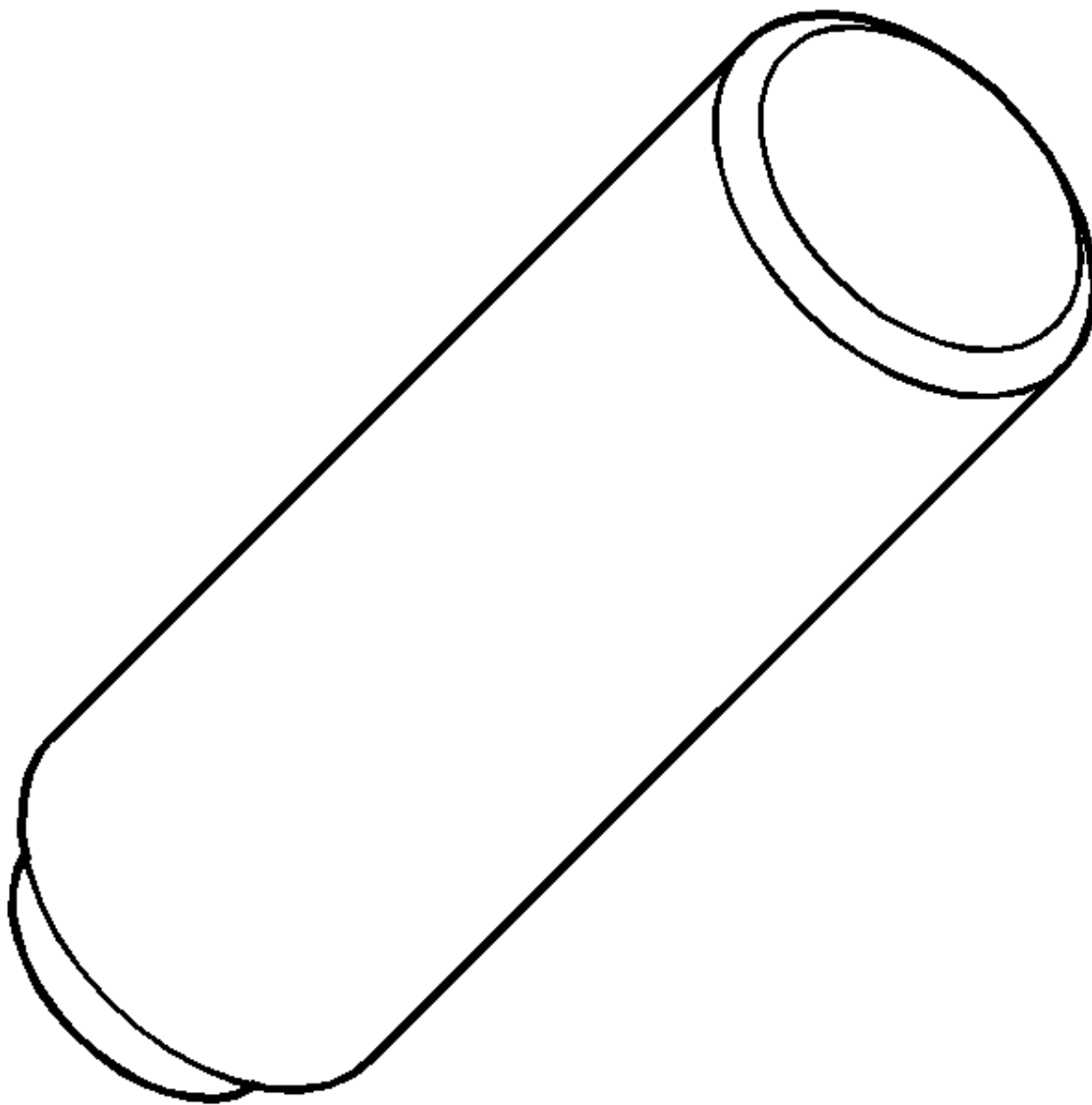
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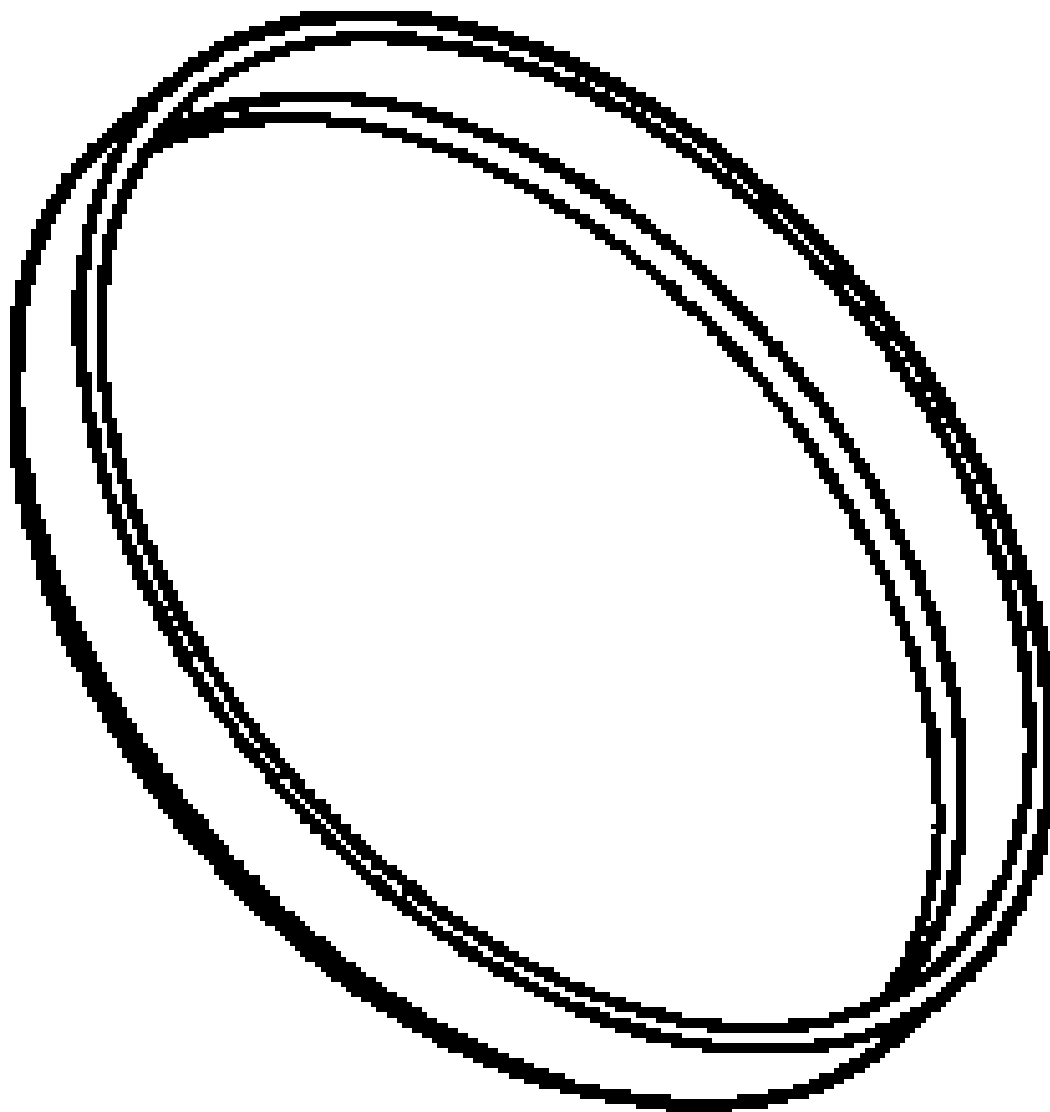
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Holding Fixtur



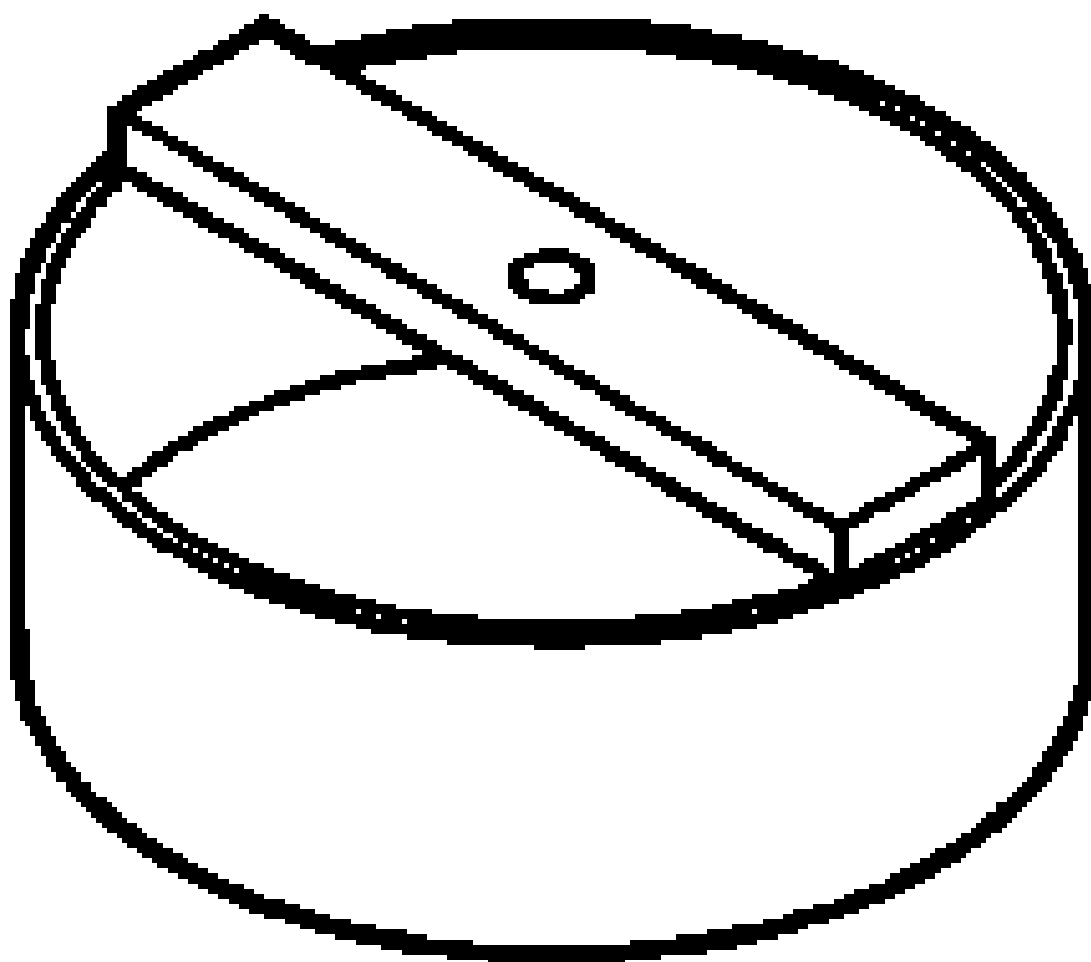
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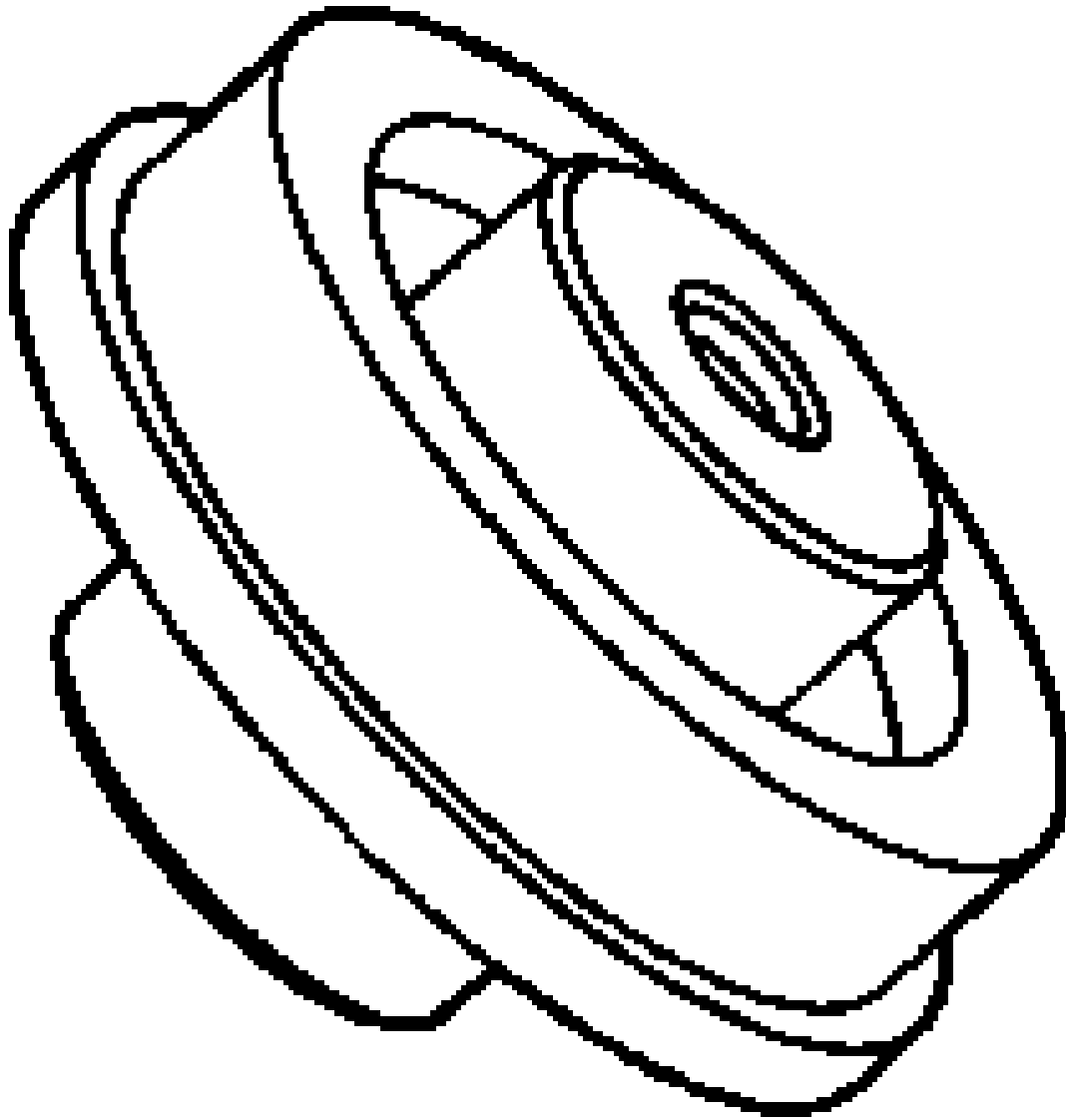
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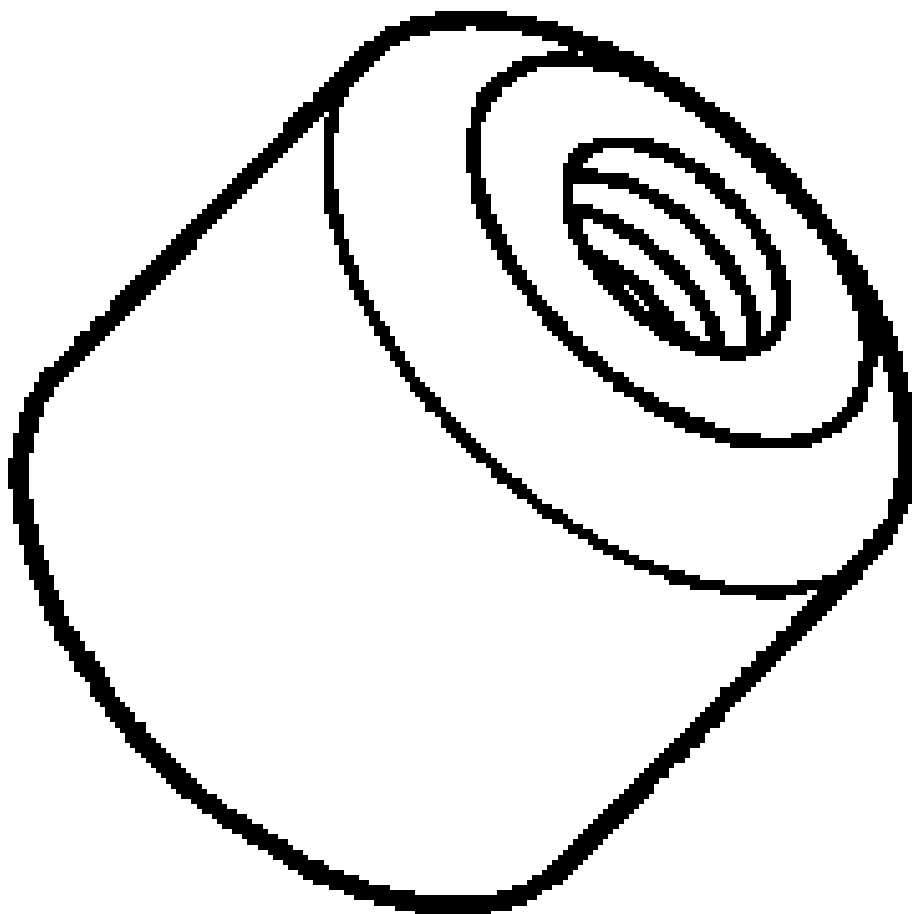
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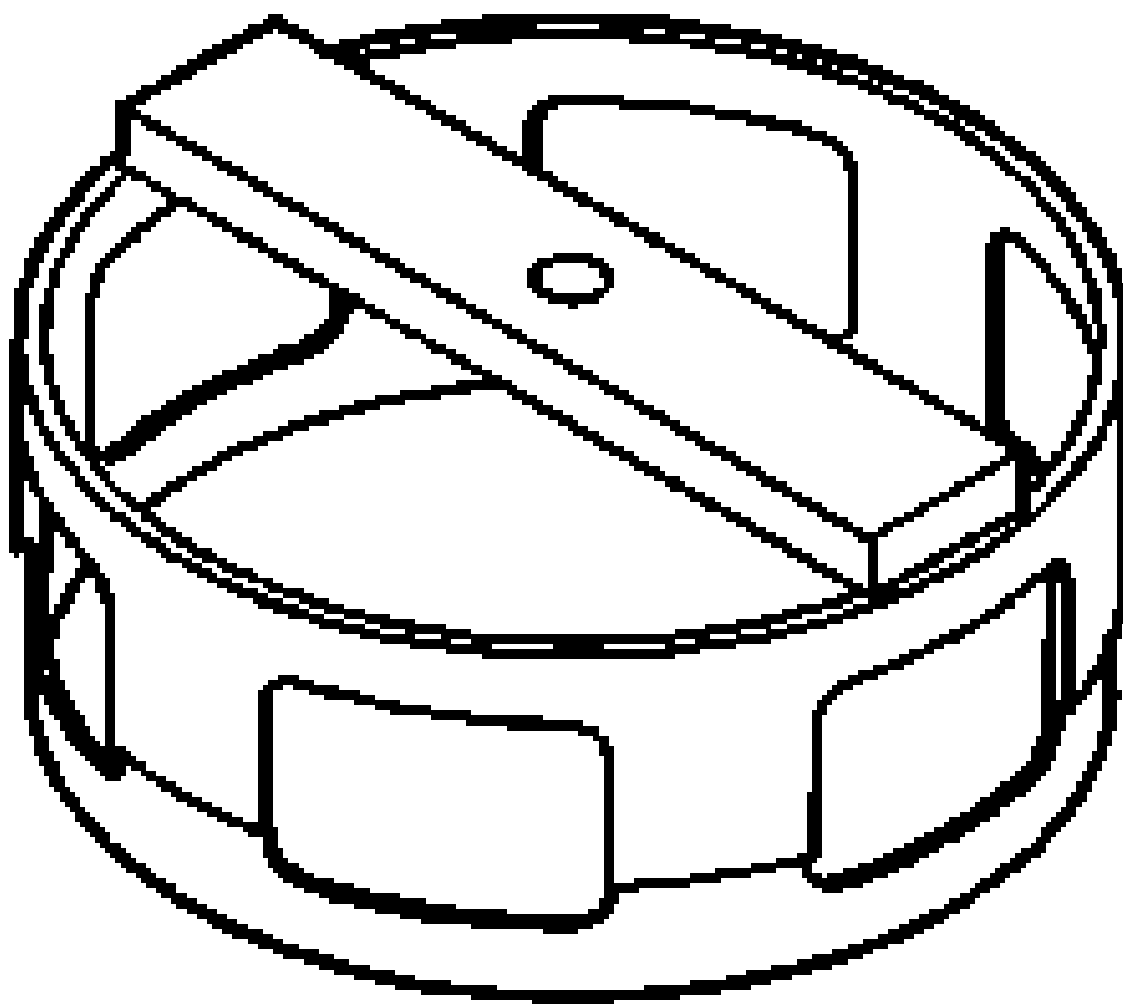
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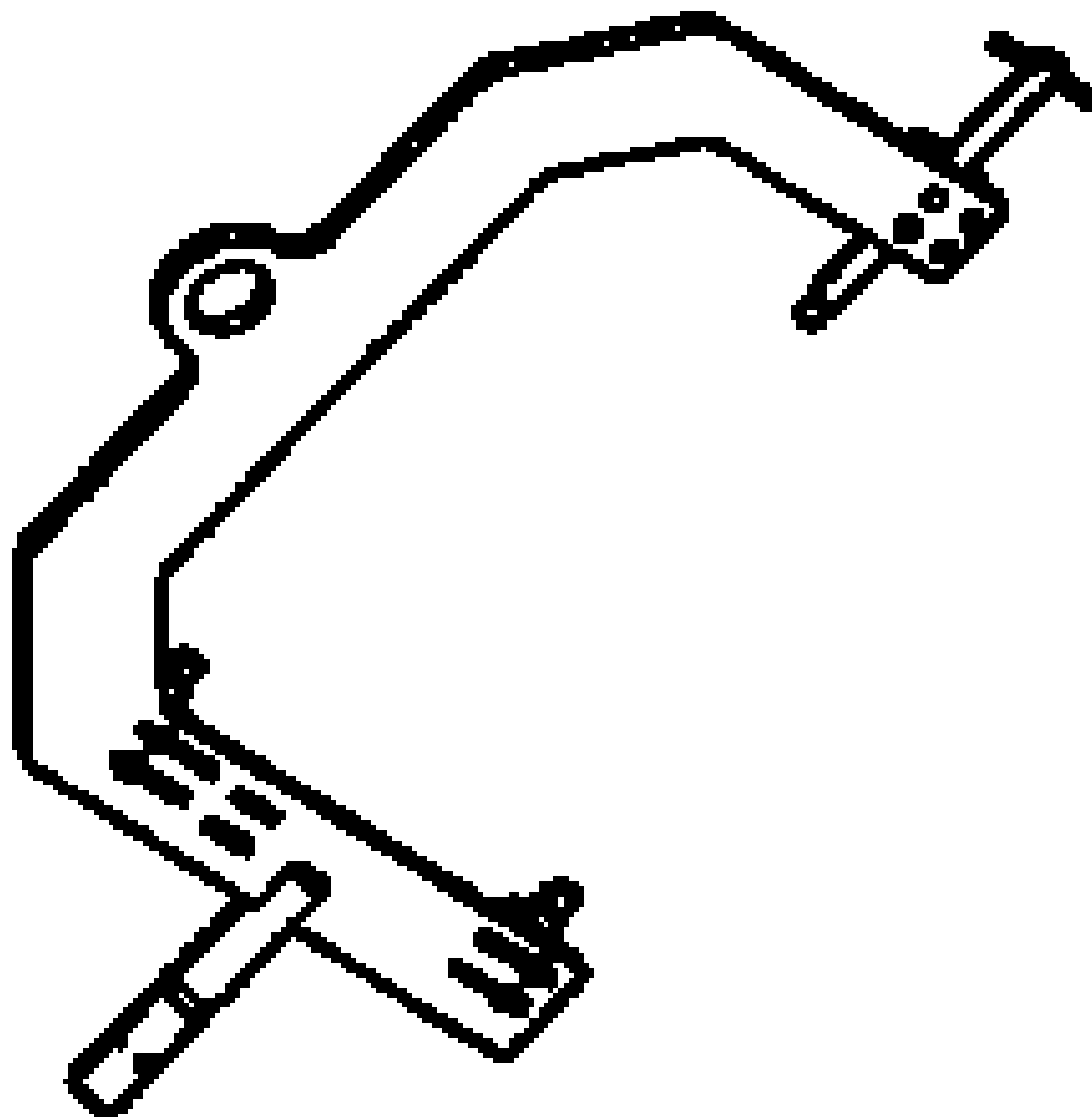
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Lube Dam Instal

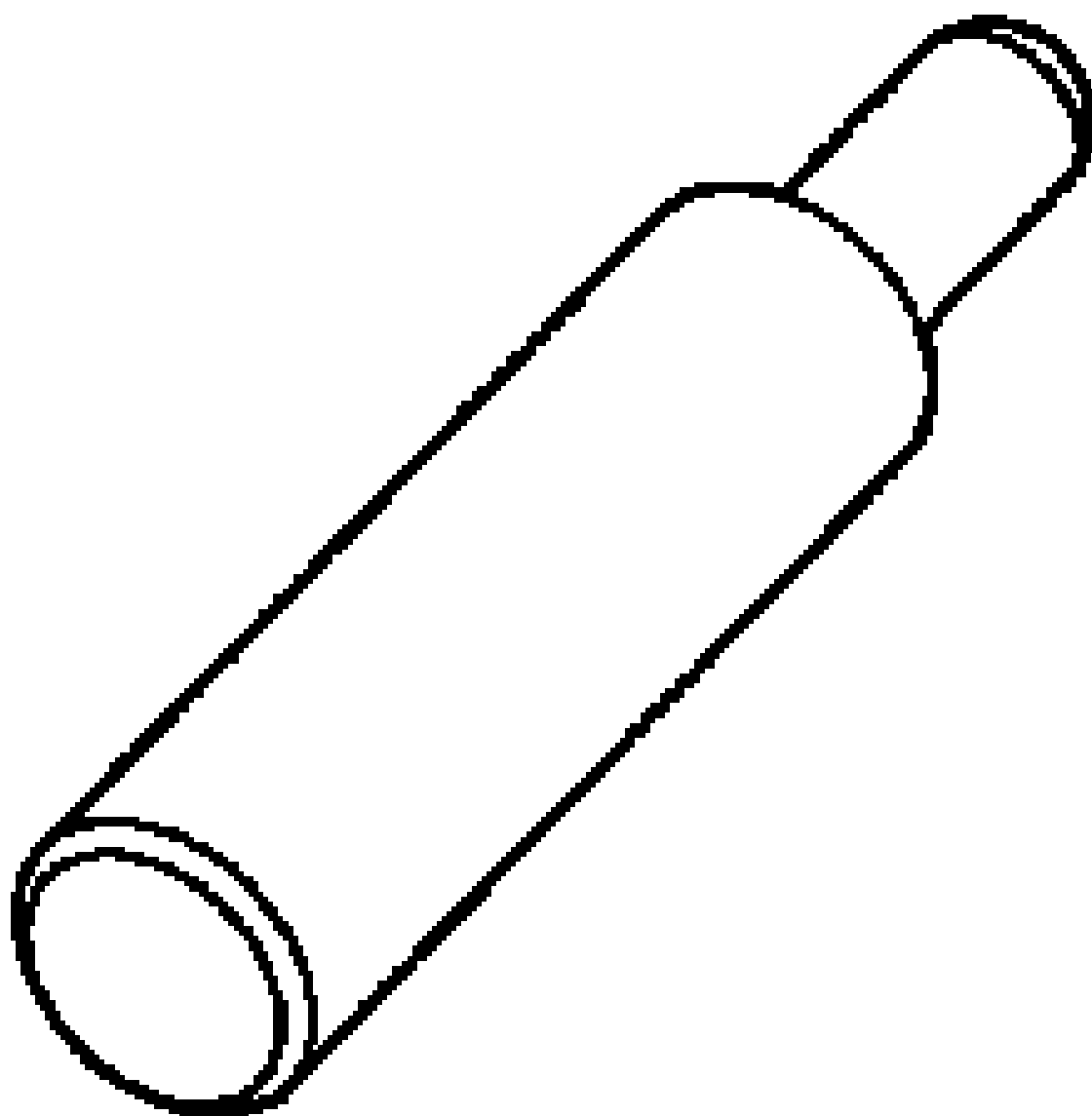


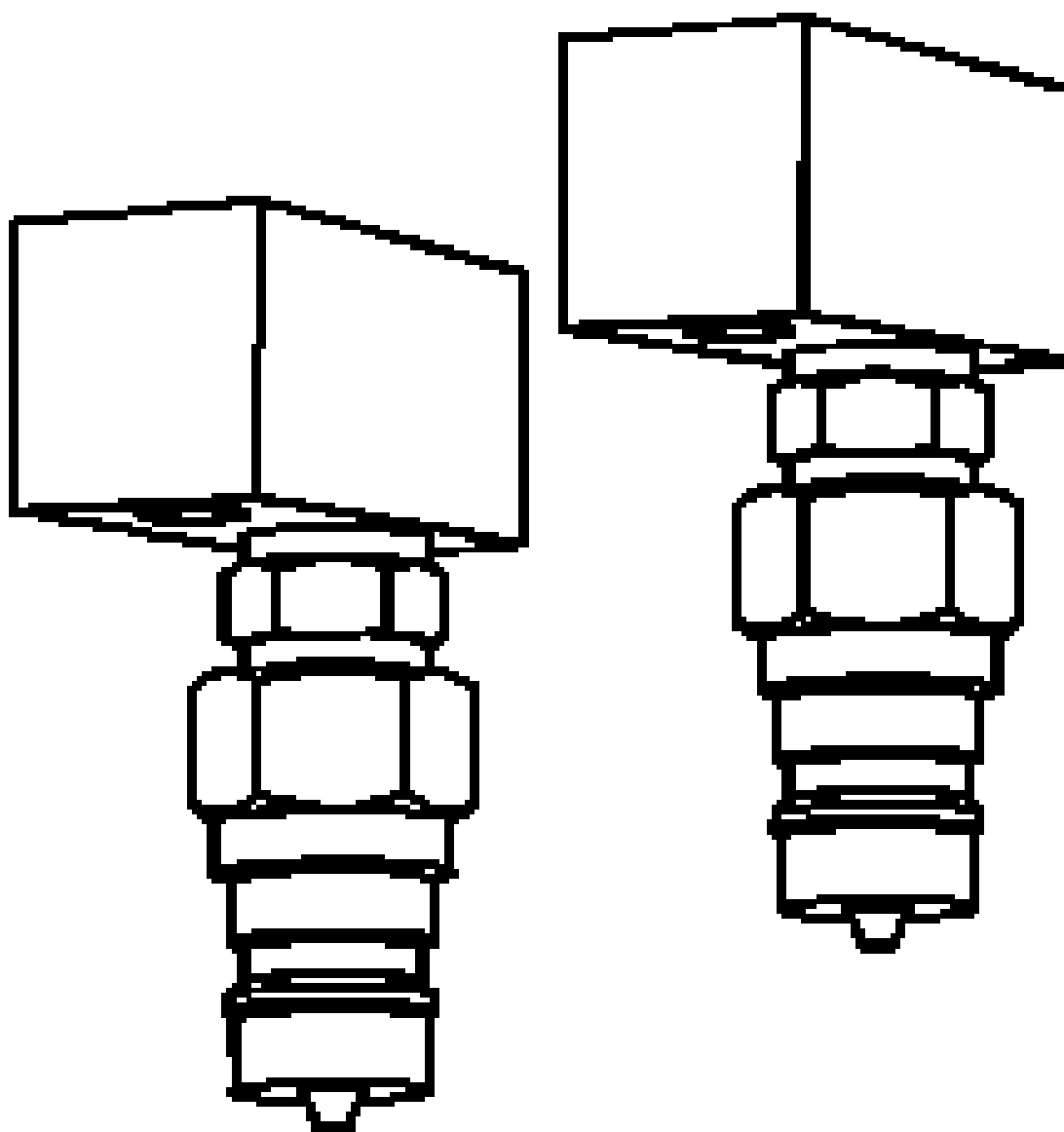
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J 46632
Spring Compressor



DT 47693
Dam Protector

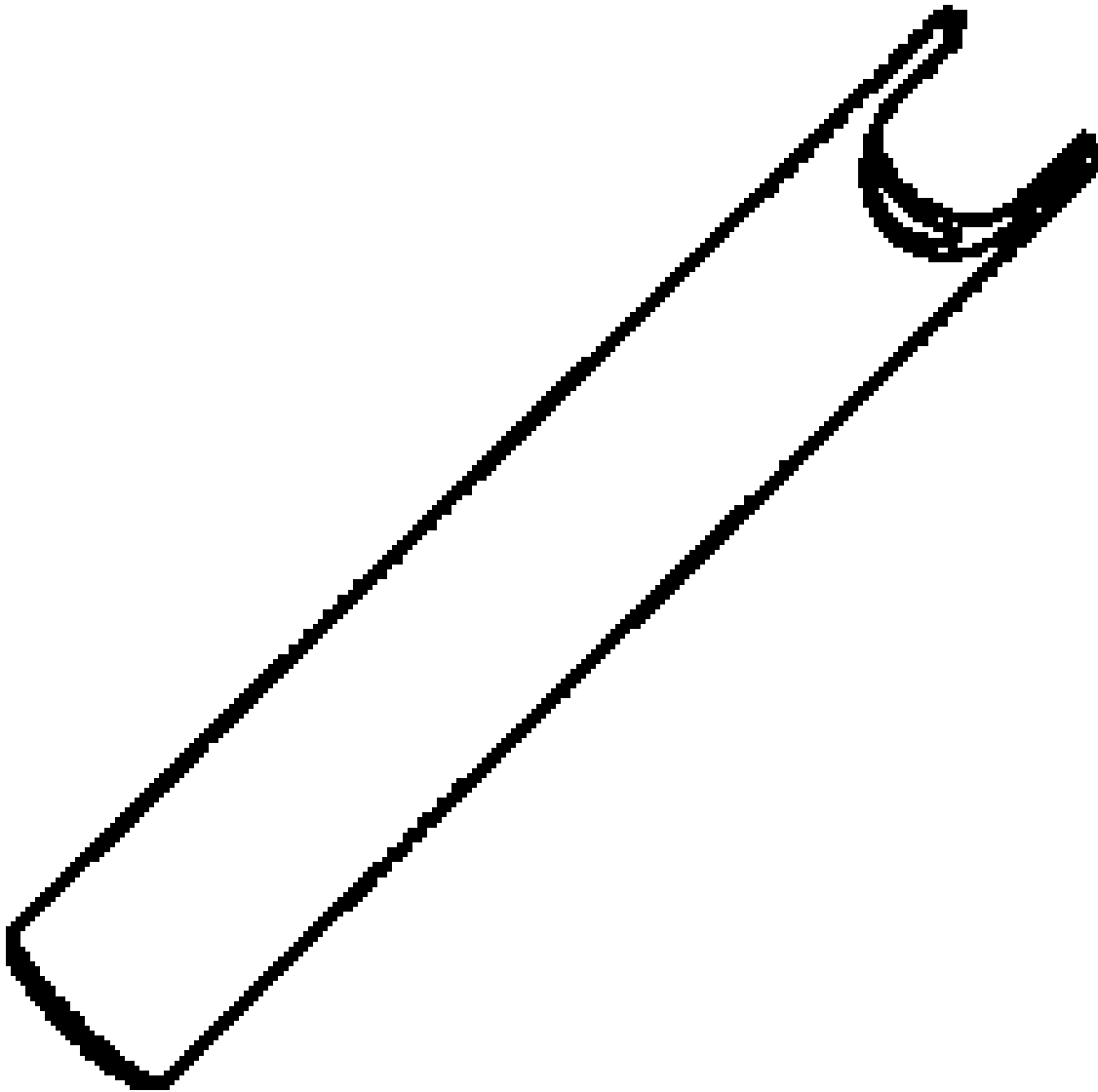
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Piston Spring
Compressor

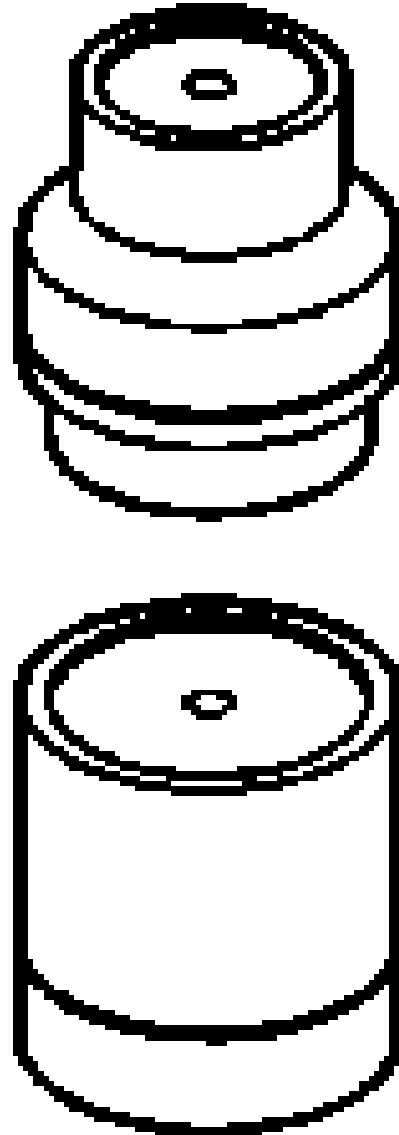
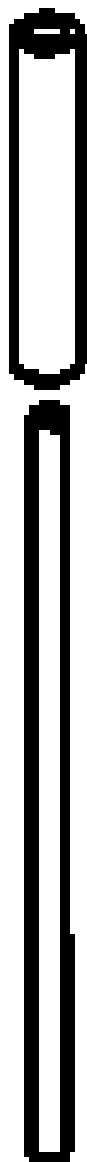
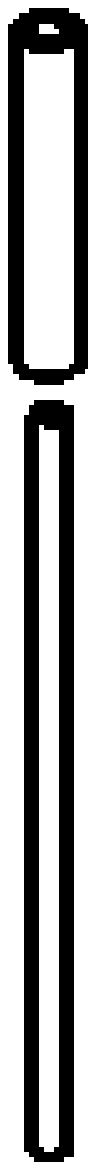




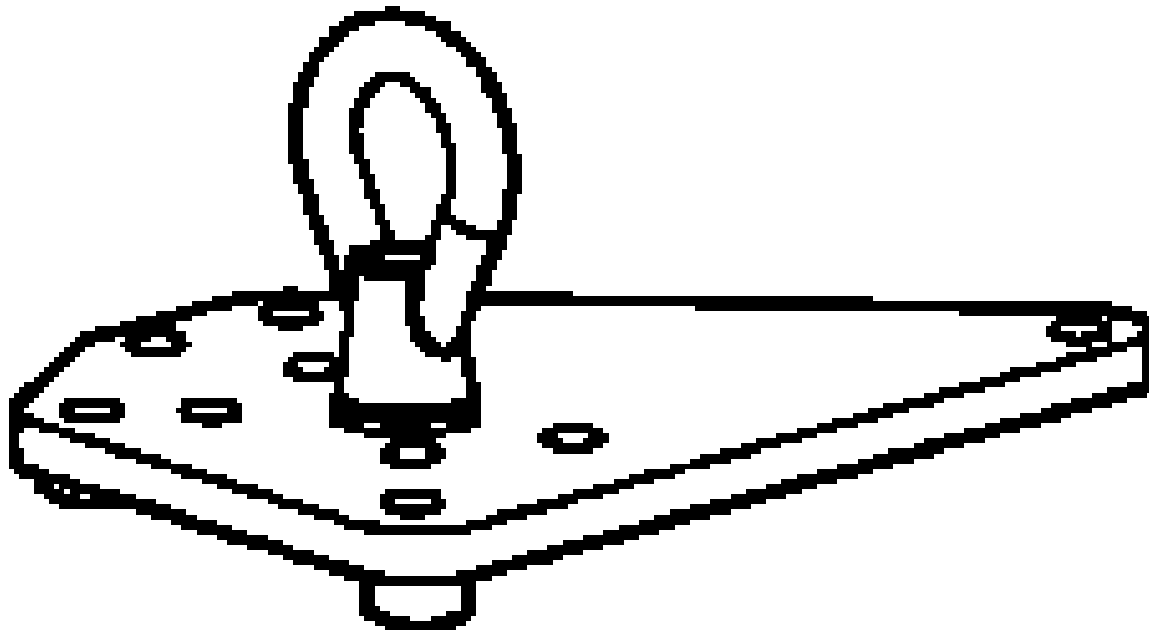
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Speed Sensor
Harness Teth

DT 47793
Differential Rotat
Tool

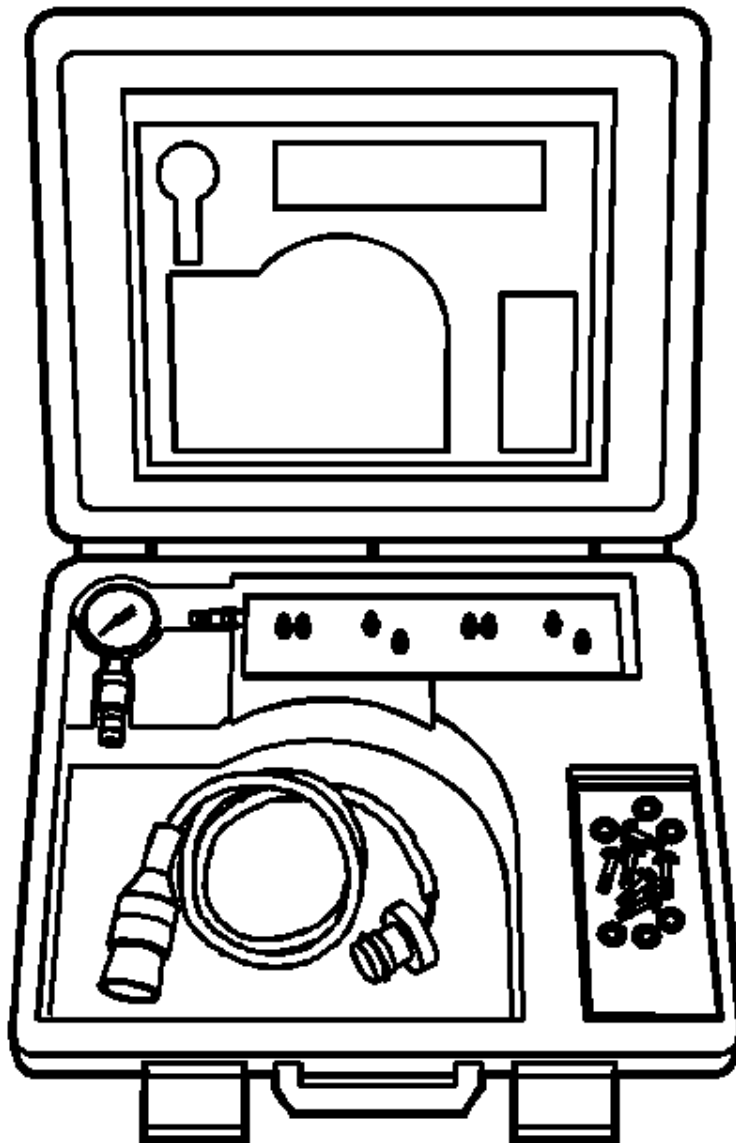




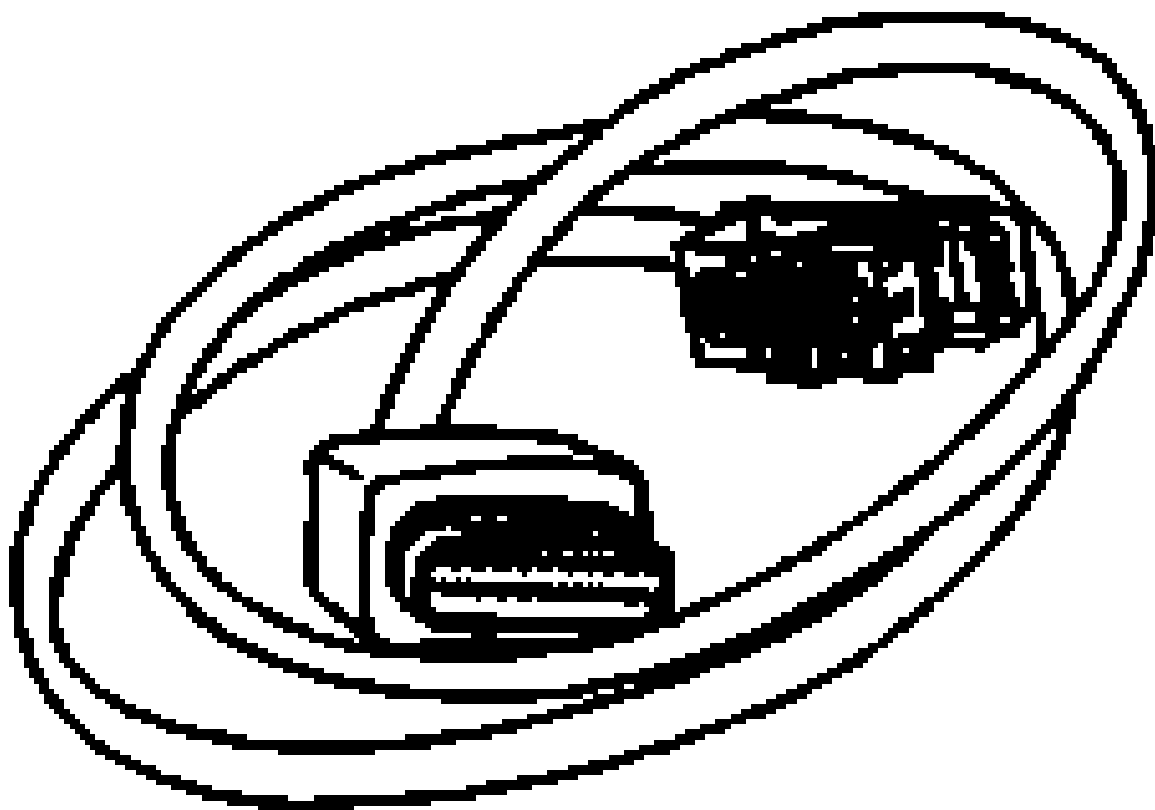
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Shim Selection
Gauge



DT 47811-A
Lift Plate

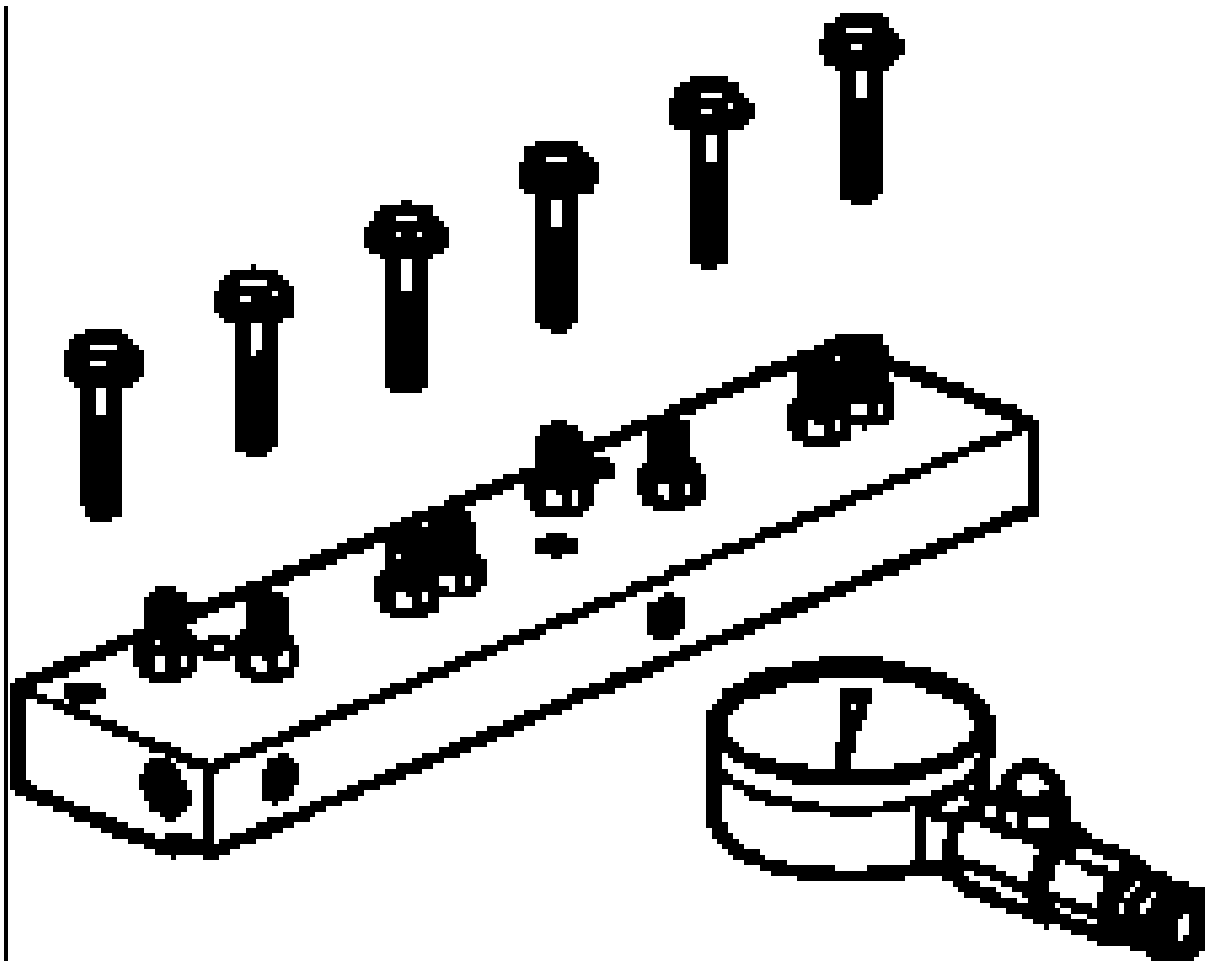


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Control Solenoid
Test Plate



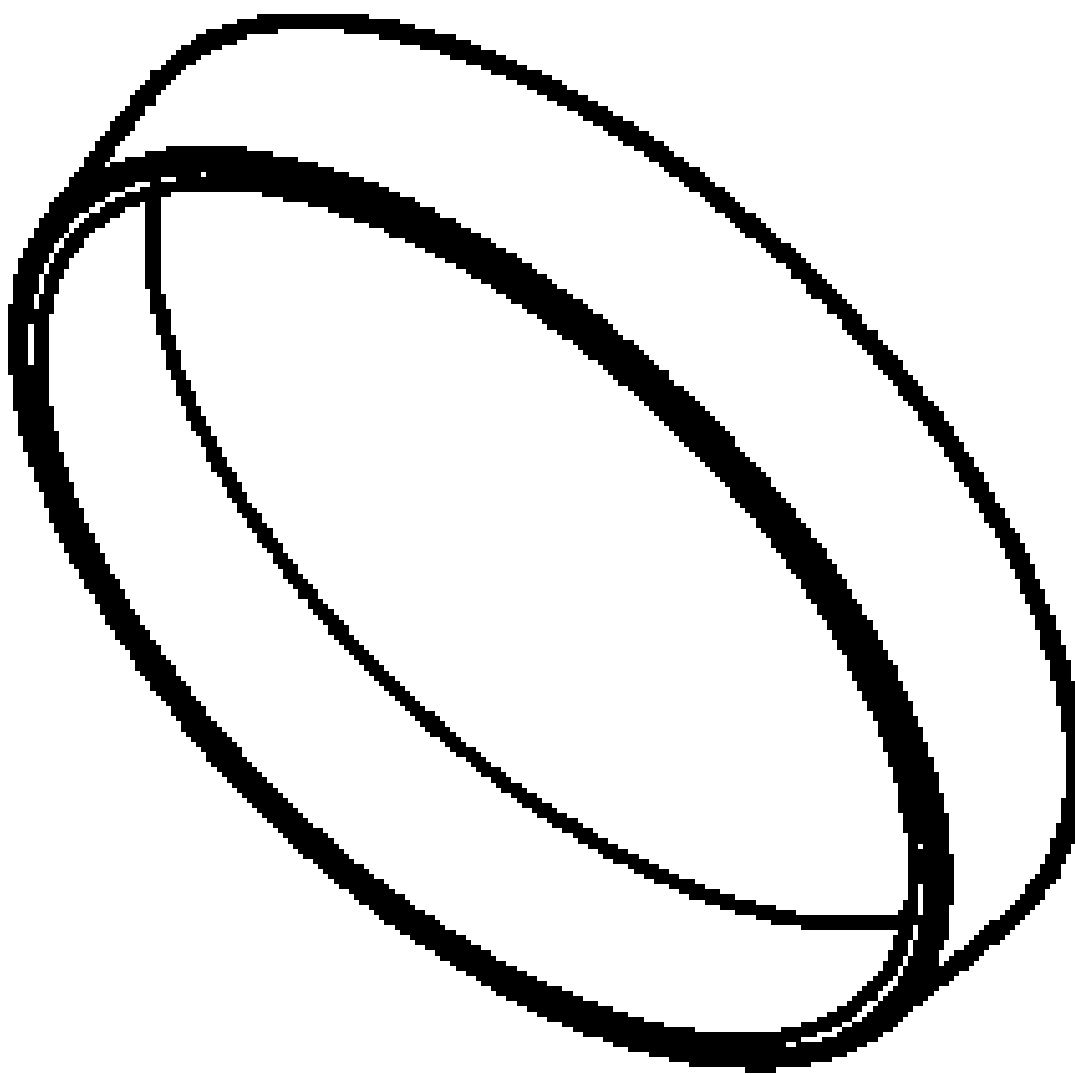
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DT 47825-10C
Solenoid Test Pl

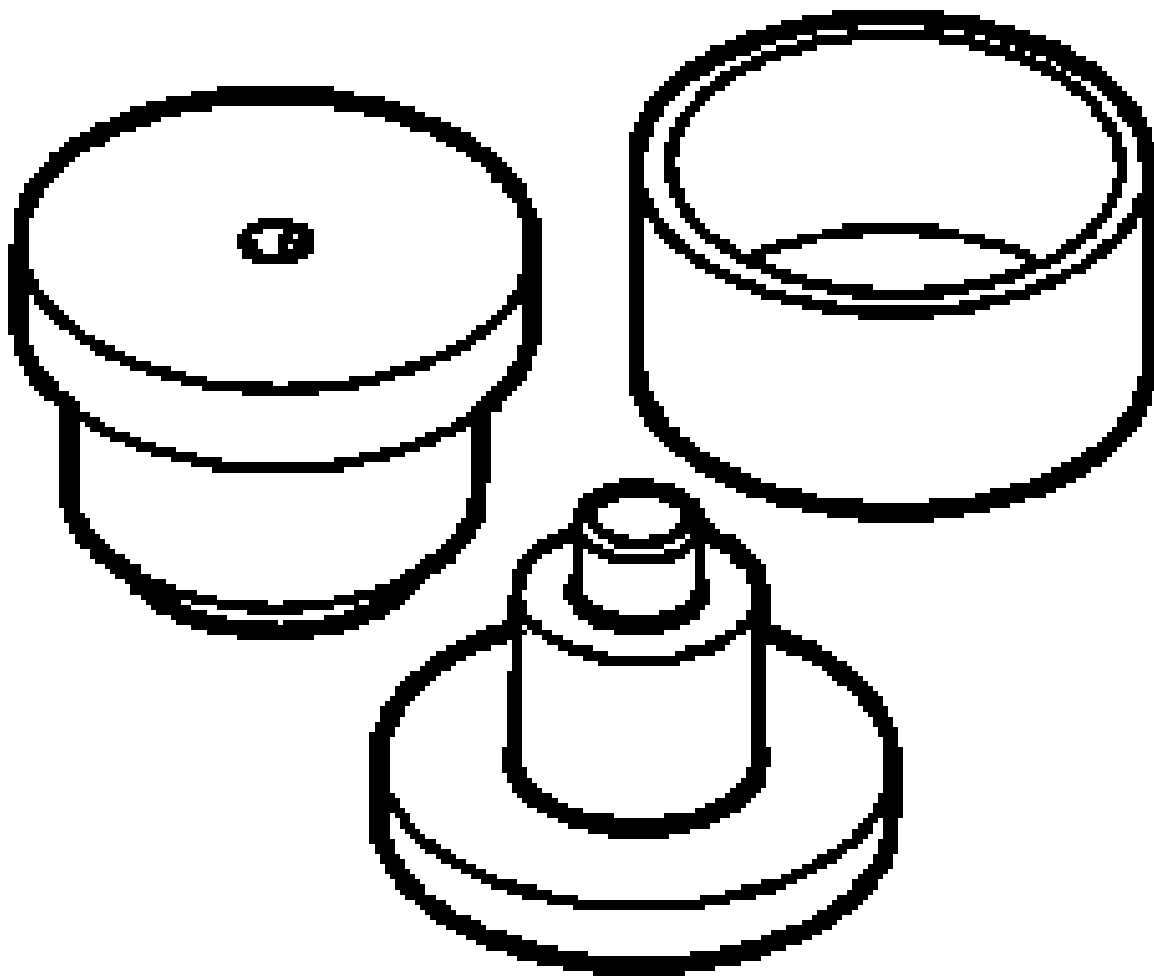


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Protector

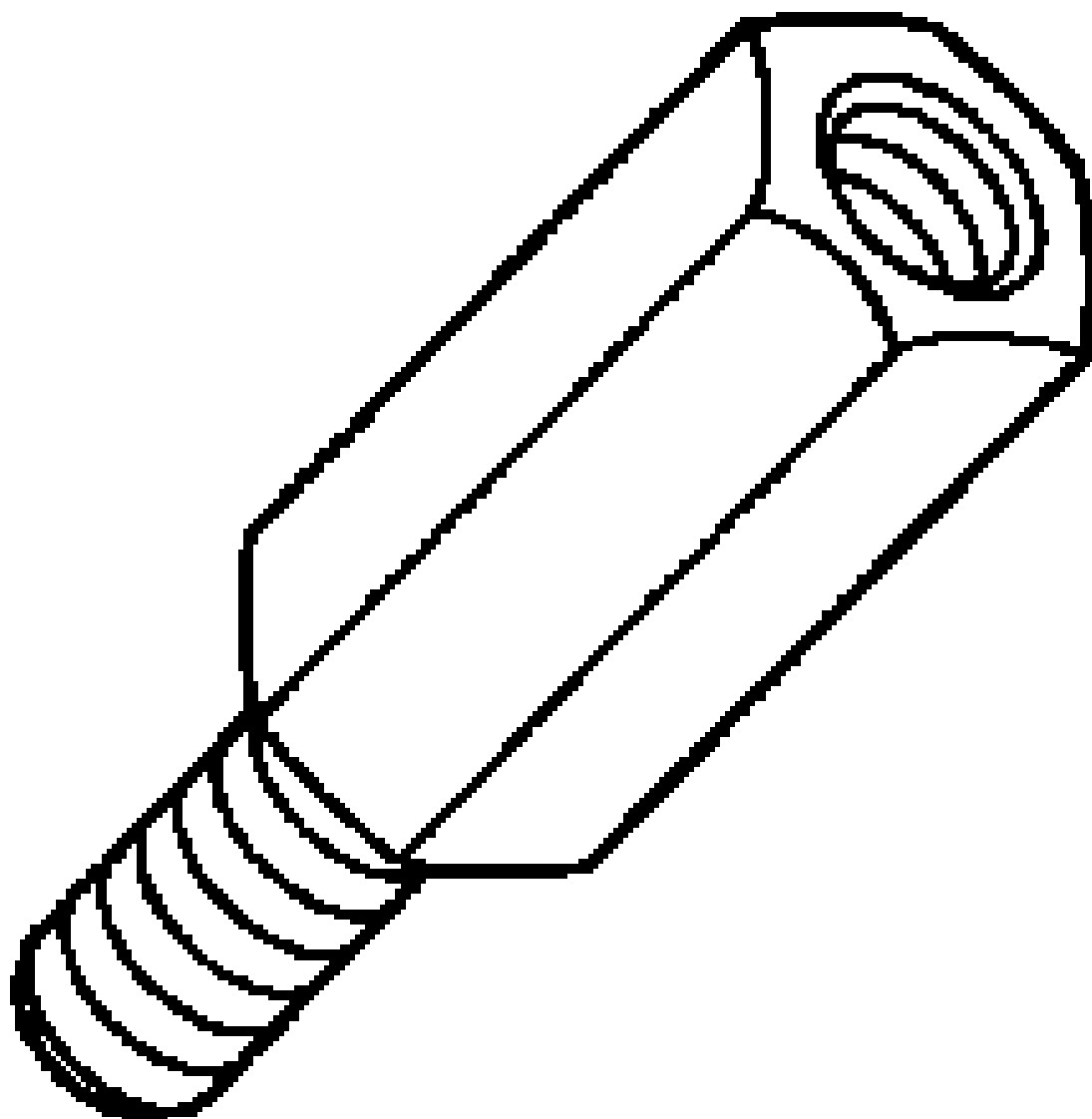




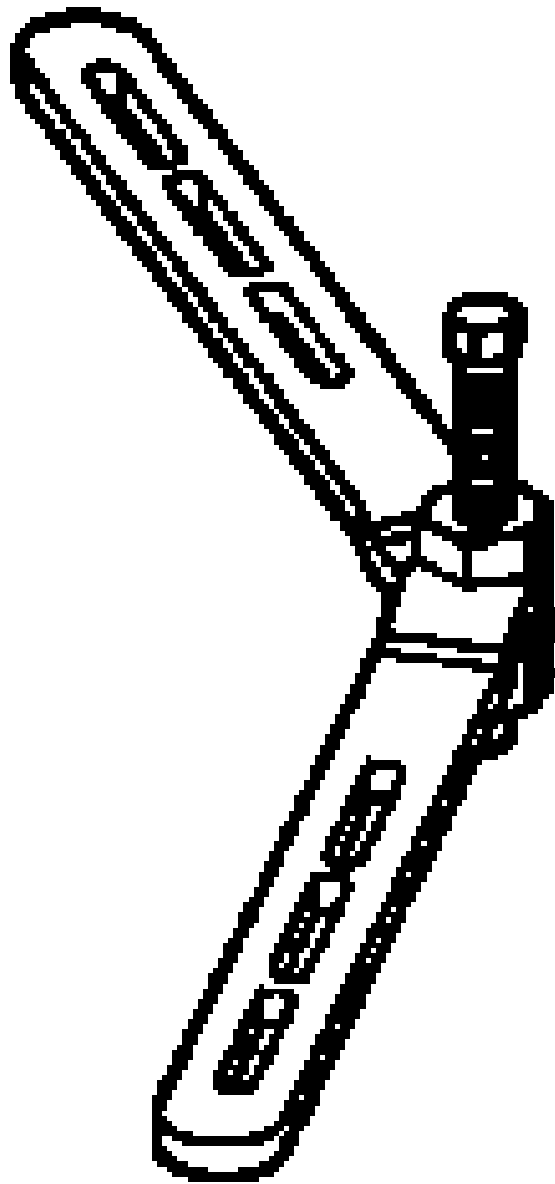
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Bearing Cup
Remover



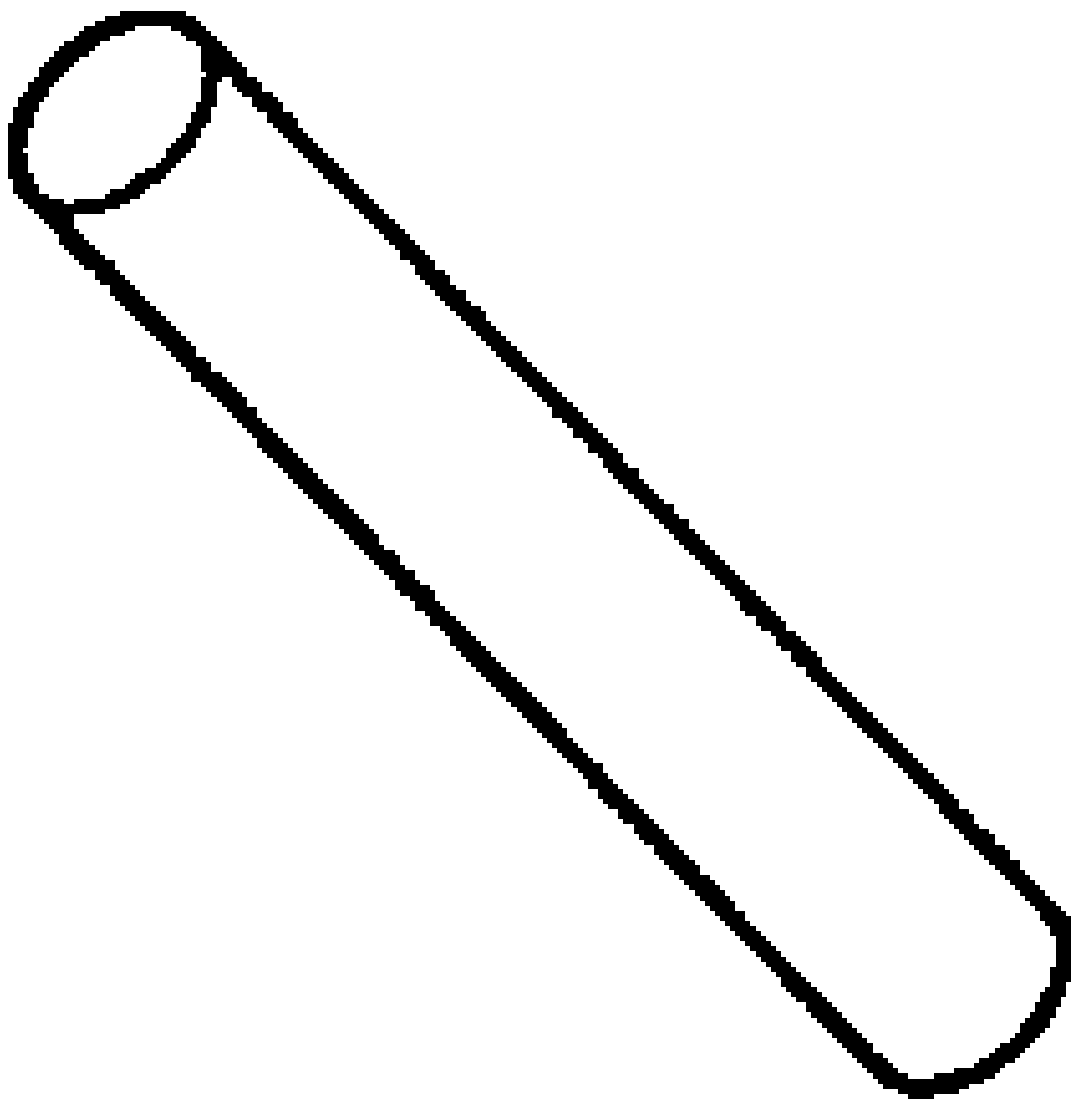
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Bearing Install



DT 48055
Lube Dam Remo

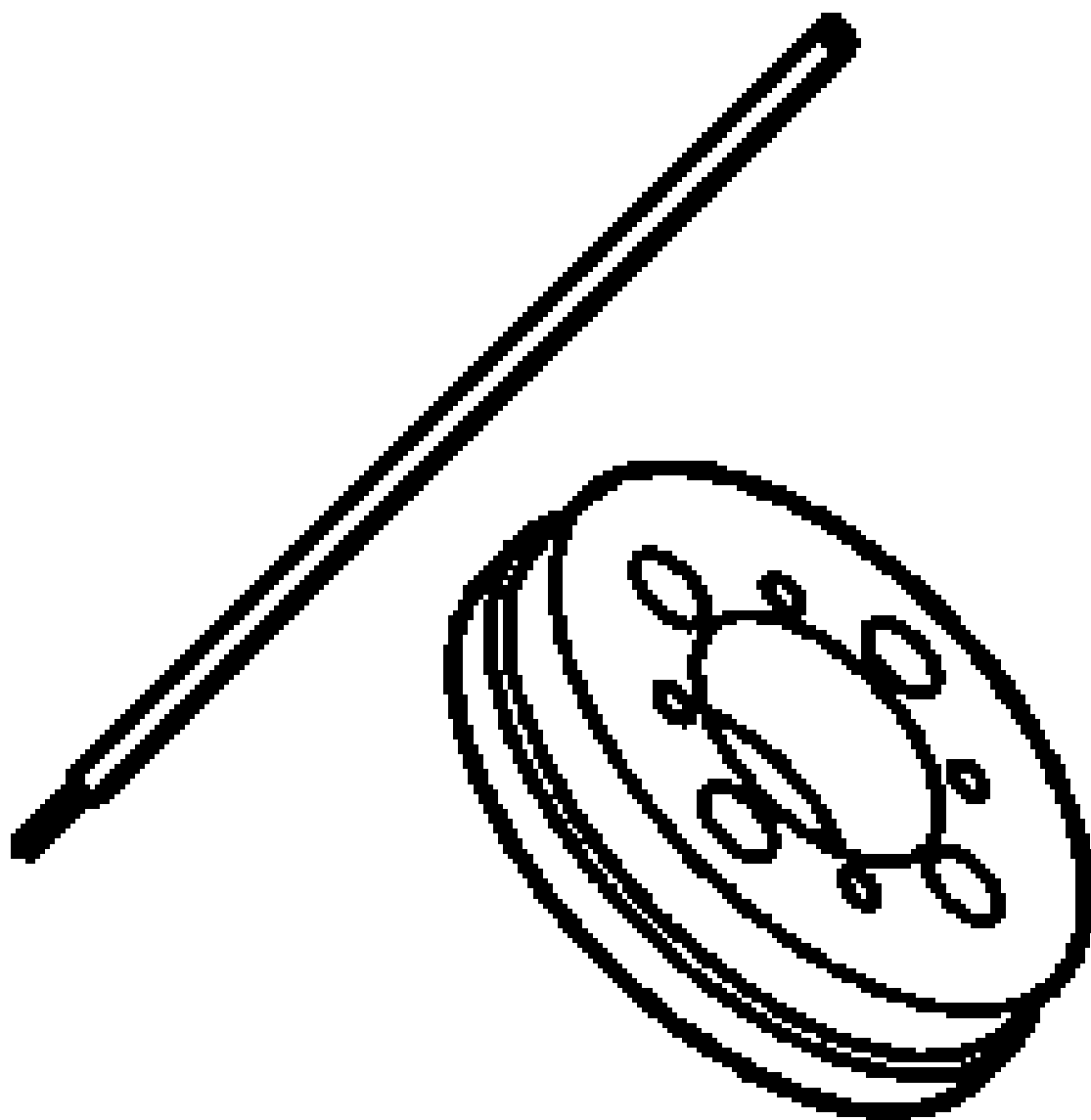


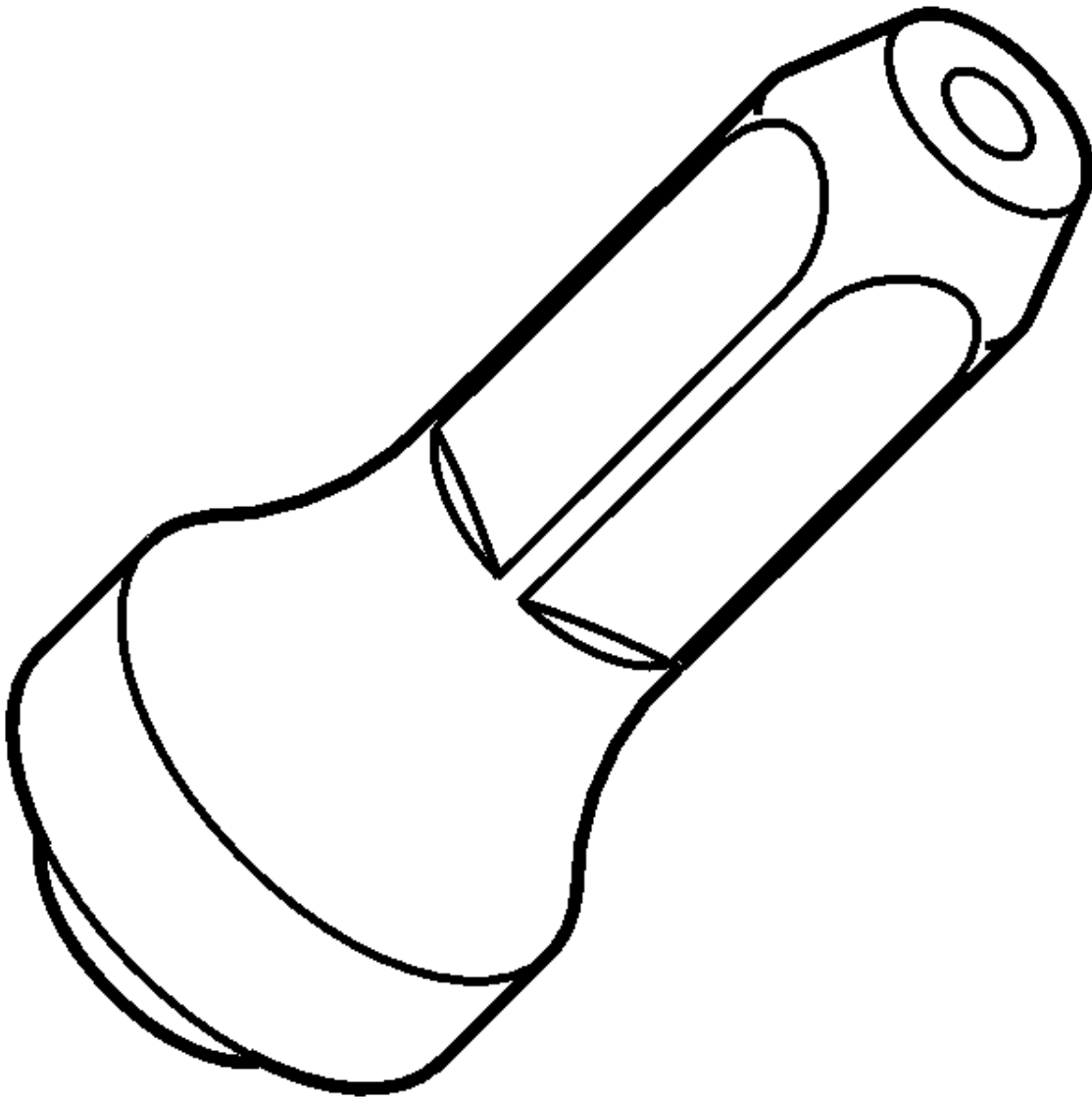
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Spring Compressor
Bridge



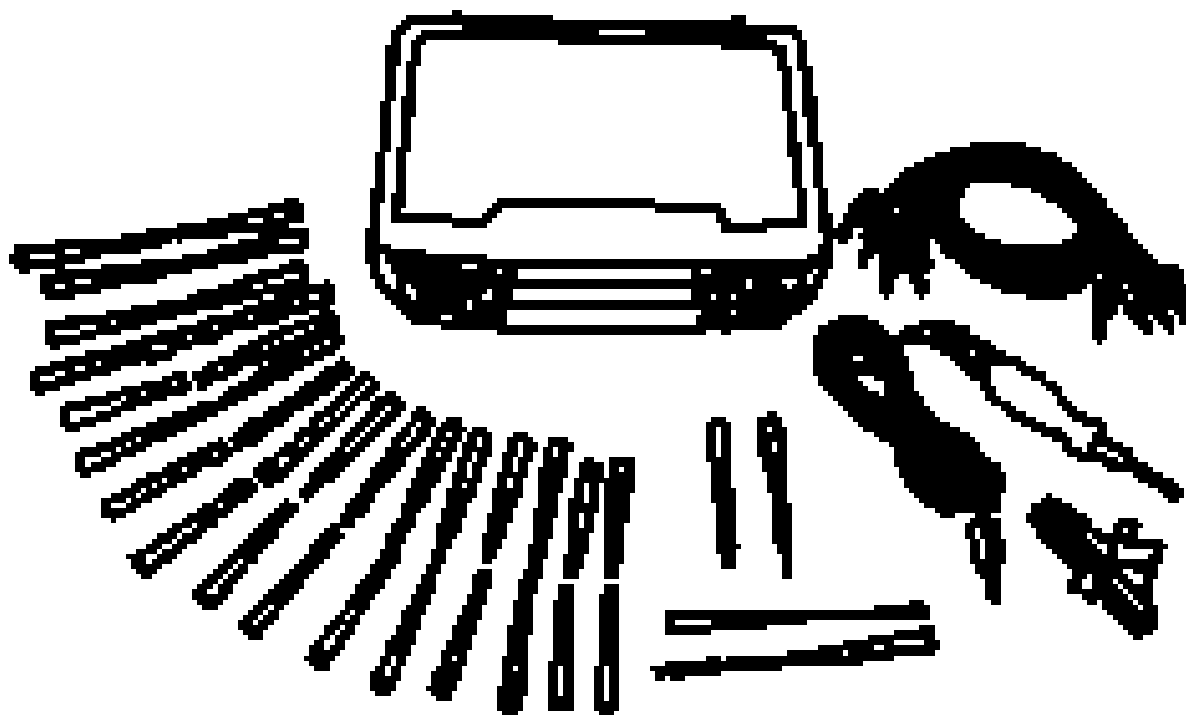
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Reaction Hub
Bushing Protect

DT 49131
Seal Staking To

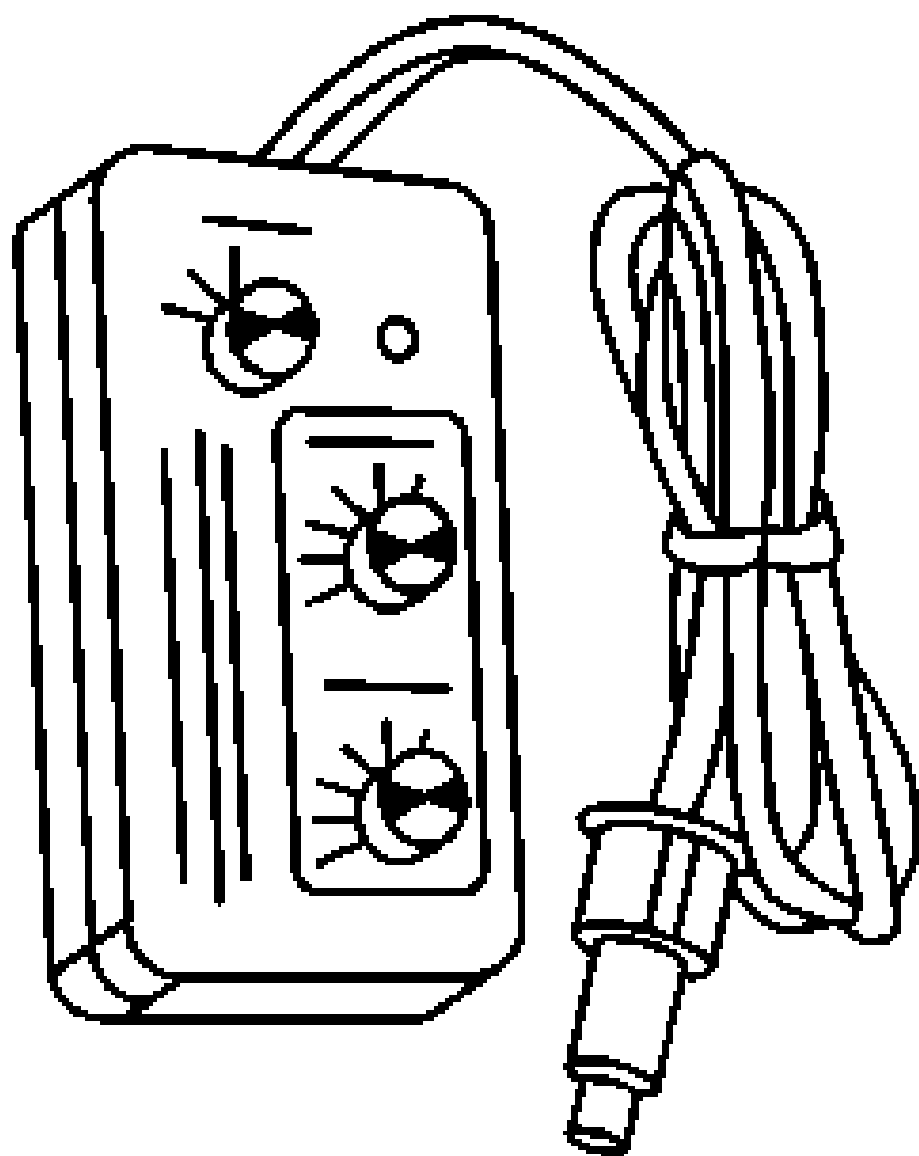




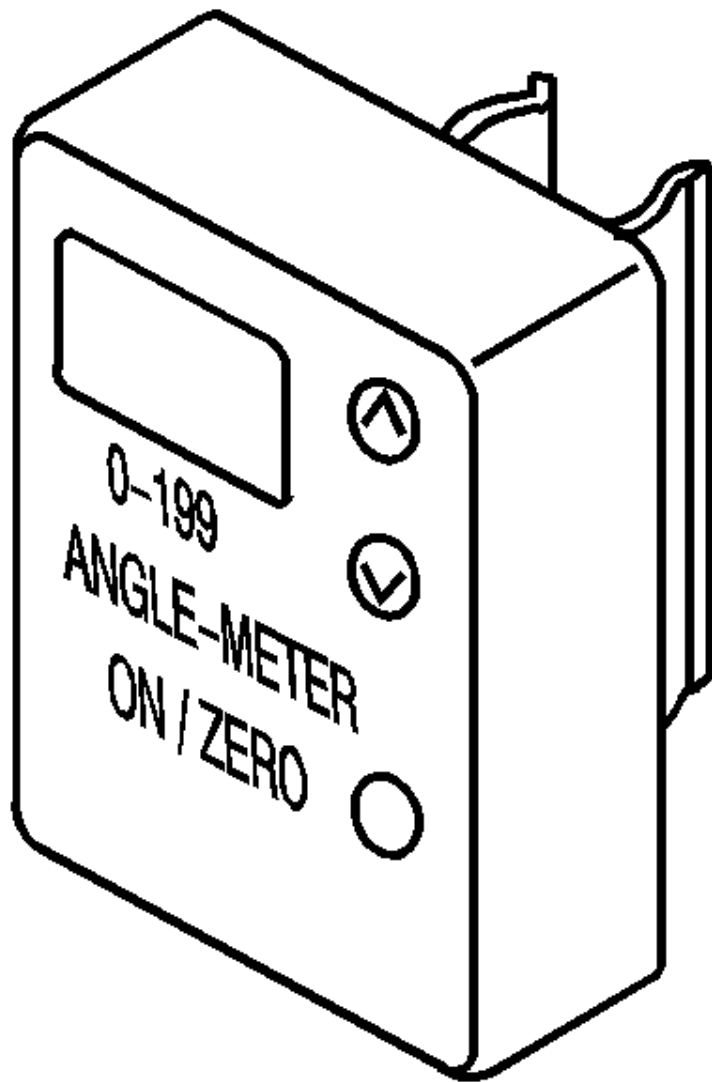
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Seal Installer



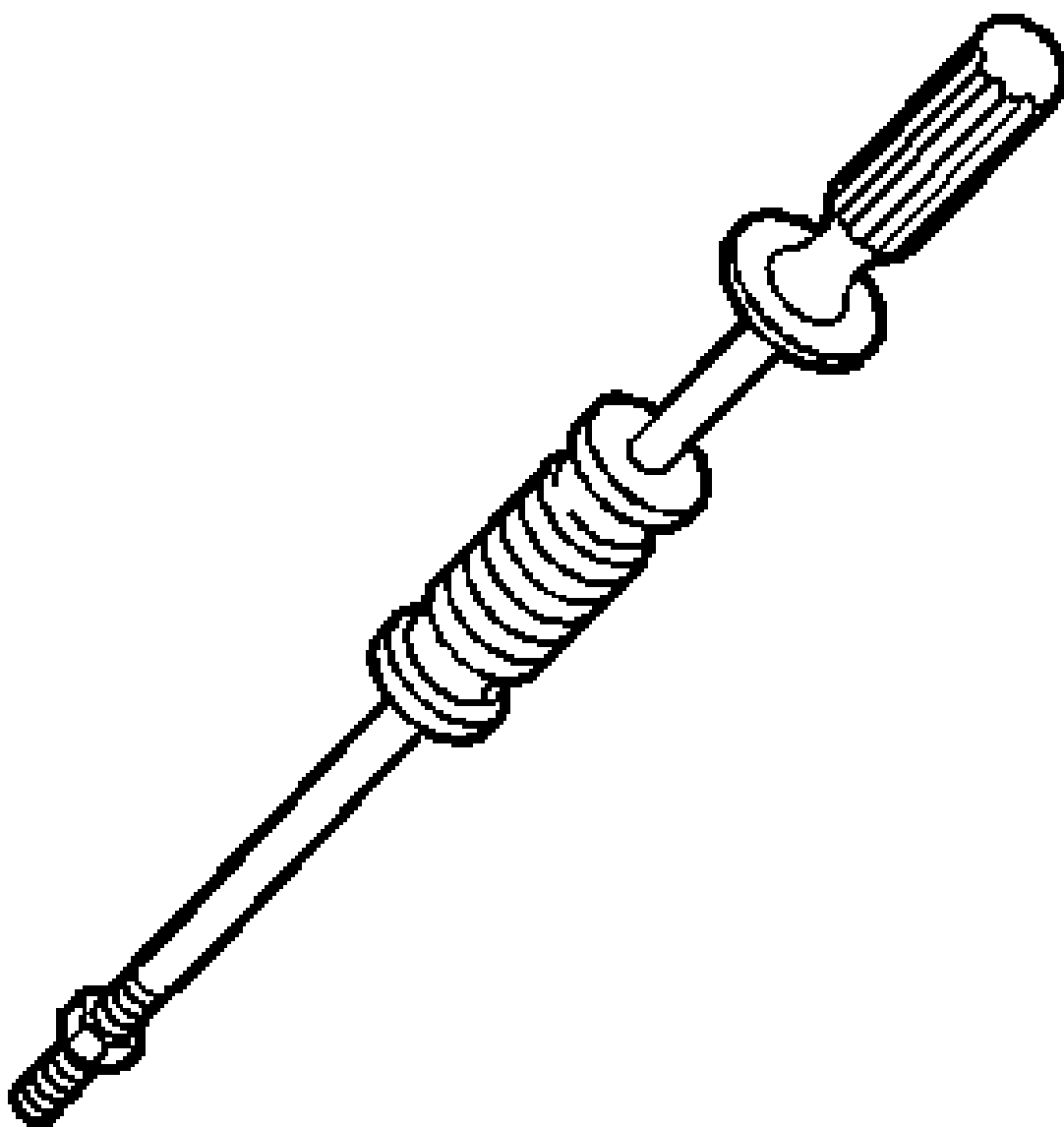
EL 35616
J 35616
GM-Approved
Terminal Test K



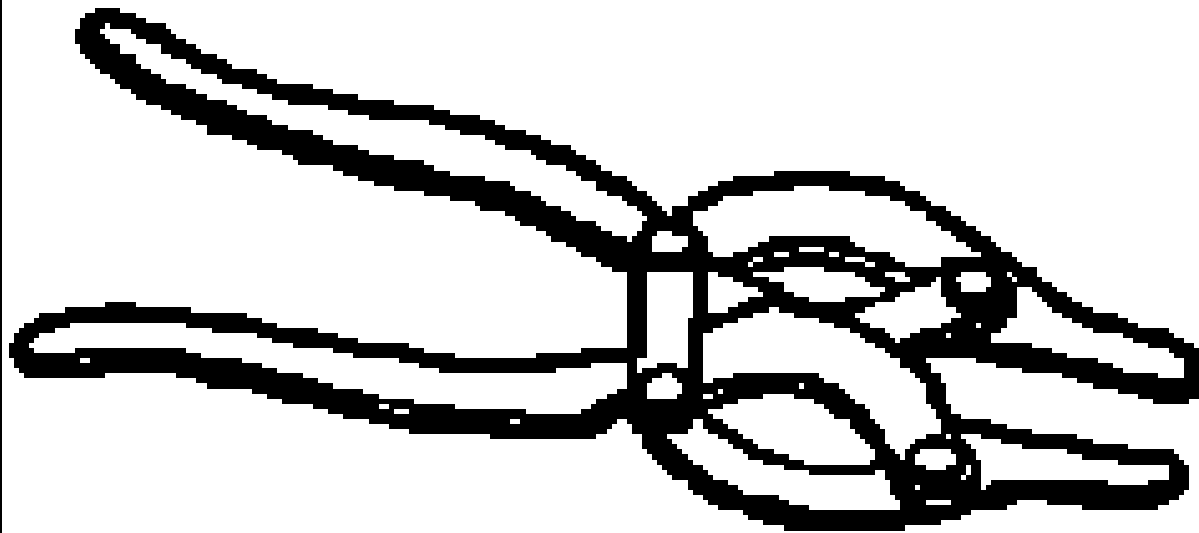
EL 38522
J 38522
Variable Signal
Generator



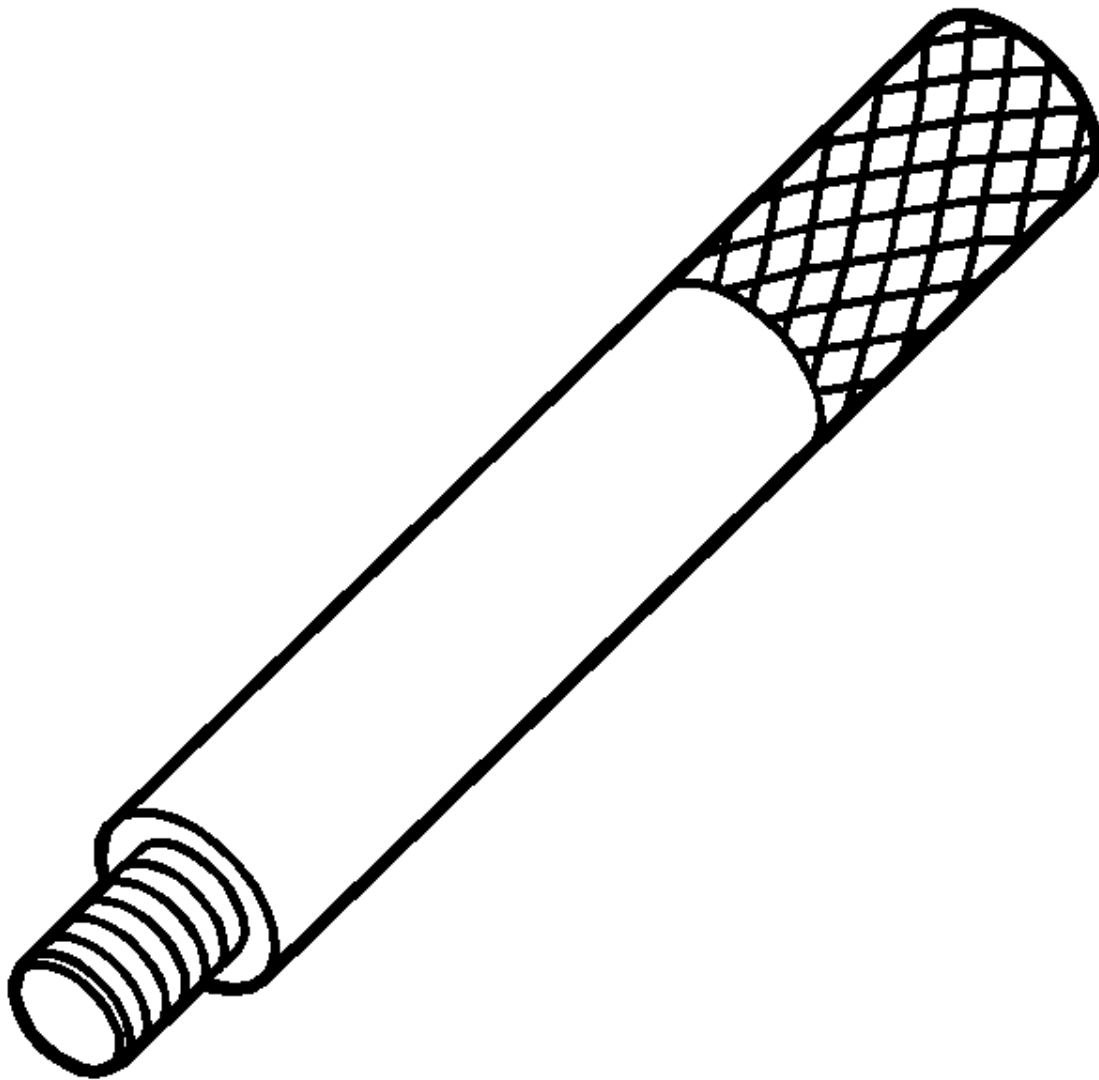
EN 45059
J 45059
Angle Meter



GE 6125-1B
J 6125-1B
J 6125-B
KM-J-7004
Slide Hammer w
Adapter



GE 8059
J 8059
KM-396
Snap Ring Pliers
Parallel Jaw



GE 8092
J 8092
KM-J-8092
Driver Handle

Transmission

Automatic Transmission - 6T70 (M7U M7W) - Specifications

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS (ON VEHICLE)

Fastener Tightening Specifications (On Vehicle)

Application	Specification	
	Metric	English
Control Valve Assembly (with TCM and Body) to Case Bolt - M6x1.0x42	12	106 lb in
Control Valve Assembly (with TCM and Body) to Case Bolt - M6x1.0x55	12	106 lb in
Control Valve Assembly (with TCM and Body) to Case Bolt - M6x1.0x65	12	106 lb in
Control Valve Assembly (with TCM and Body) to Case Bolt - M6x1.0x80	12	106 lb in
Control Valve Body Assembly Bolt - M6x1.0x35	12	106 lb in
Control Valve Body Assembly Bolt - M6x1.0x55	12	106 lb in
Control Valve Body Assembly Bolt - M6x1.0x65	12	106 lb in
Control Valve Body Cover Bolt - M6x1.0x30	12	106 lb in
Control Valve Body Cover Bolt - M6x1.0x95	12	106 lb in
Control Valve Body to Case Bolt - M6x1.0x55	12	106 lb in
Fluid Cooler Fitting at Radiator	38	28 lb ft
Fluid Cooler Pipe Nut	22	16 lb ft
Fluid Level Hole Plug	12	106 lb in
Fluid Pressure Test Hole Plug	12	106 lb in
Flywheel Cover Bolt	10	89 lb in
Input Speed Sensor Bolt	9	80 lb in
Manual Shift Position Switch Screw	3.5	31 lb in
Output Speed Sensor Bolt	12	106 lb in
Torque Converter to Flywheel Bolt	62	46 lb ft
Transaxle Front Brace Bolts	50	37 lb ft
Transaxle Rear Brace Bolts	100	74 lb ft
Transaxle Range Switch Bolt	20	15 lb ft
Transaxle Range Switch Lever Nut	35	26 lb ft
Transaxle Shift Control Nut	8	71 lb in
Transaxle to Engine Bolt	75	55 lb ft
Transmission Cooler Pipe Stud - External Torx	12	106 lb in
Transmission Front Mount Through Bolt	100	74 lb ft
Transmission Front Mount To Transmission Bolts	62	46 lb ft

Transmission Mount Bolt - Left Side to Body	22	16 lb ft
Transmission Mount Bolt - Left Side to Transmission	50 + 60-75 Degrees	37 lb ft + 60-75 Degrees
Transmission Rear Mount Through Bolt	105	77 lb ft
Transmission Rear Mount to Cradle Short Bolts - AWD	100	74 lb ft
Transmission Rear Mount to Cradle Long Bolt - AWD	62	46 lb ft
Transmission Rear Mount to Cradle Bolts - FWD	100 +120-130 Degrees	74 lb ft +120-130 Degrees
Transmission Rear Mount to Transmission Through Bolt	100	74 lb ft

FASTENER TIGHTENING SPECIFICATIONS (OFF VEHICLE)

Fastener Tightening Specifications (Off Vehicle)

Application	*Ref No.	Quantity	Size	Specification	
				Metric	English
A/Trans Case Cover Bolt	18	10	M6x1.0x30	12 N.m	106 lb in
A/Trans Fluid Pump Bolt	1	3	M6x1.0x25	12 N.m	106 lb in
A/Trans Fluid Trough Bolt	11	1	M6x1.0x25	12 N.m	106 lb in
Control Valve Body Assembly (Complete) Bolt	19, 21	3	M6x1.0x55	12 N.m	106 lb in
Control Valve Body Assembly (Complete) Bolt	20	3	M6x1.0x35	12 N.m	106 lb in
Control Valve Body Assembly (Complete) Bolt	22	5	M6x1.0x65	12 N.m	106 lb in
Control Valve Body to Case	23	2	M6x1.0x55	12 N.m	106 lb in
Control Valve Body to Case Bolt	24	8	M6x1.0x65	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	25	1	M6x1.0x42	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	26	1	M6x1.0x55	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	27	2	M6x1.0x65	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	28	4	M6x1.0x80	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	29	3	M6x1.0x95	12 N.m	106 lb in
Control Valve Body Cover					

Bolt	30	12	M6x1.0x30	12 N.m	106 lb in
Control Valve Body Cover Stud	31	2	M6x1.0x30	12 N.m	106 lb in
Fluid Pressure Test Hole Plug	12	1	1/8"-27 NPTF	12 N.m	106 lb in
Fluid Level Hole Plug	13	1	1/8"-27 NPTF	12 N.m	106 lb in
Front Differential Carrier Baffle Bolt	6	1	M6x1.0x25	12 N.m	106 lb in
Front Differential Transfer Drive Gear Support Bolt					
• First Pass	5	9	M8x1.25x25	10 N.m	89 lb in
• Final Pass	5	9	M8x1.25x25	50 degrees	
Input Shaft Support Bolt (Torx)	N/A	3	M6x1.0x50	12 N.m	106 lb in
Input Speed Sensor Bolt	17	1	M6x1.0x25	9 N.m	80 lb in
Output Speed Sensor Bolt	14	1	M6x1.0x25	12 N.m	106 lb in
Park Pawl Actuator Bracket Bolt	10	2	M6x1.0x25	12 N.m	106 lb in
Support Fluid Passage Tube (Torx) Bolt	2	2	M5x0.8x12	7 N.m	62 lb in
Support Fluid Passage Tube Bolt	3	2	M6x1.0x15	12 N.m	106 lb in
Torque Converter and Differential Housing Bolt	8	14	M8x1.25x35	36 N.m	27 lb ft
Torque Converter and Differential Housing Bolt	9	3	M8x1.25x35	30 N.m	22 lb ft
Transmission Cooler Pipe (External Torx) Stud	15	2	M8x1.25x30.5	12 N.m	106 lb in
*Reference number refers to the component callout number in Disassembled Views					

TRANSMISSION GENERAL SPECIFICATIONS

Transmission General Specifications

Name	6T70/6T75/6T80
RPO Codes	6T70-MH2, M7W (2WD), MH4, M7U (4WD) 6T75-MY9, M7V (2WD), MH6, M7X (4WD), 6T80-MHM (2WD)
Production Location	Warren Michigan (USA), Ramos, Mexico
Transaxle Drive	Front Wheel Drive, All Wheel Drive
Reverse Gear Ratio	2.88
1st Gear Ratio	4.484
2nd Gear Ratio	2.872
3rd Gear Ratio	1.842
4th Gear Ratio	1.414

5th Gear Ratio	1.000
6th Gear Ratio	0.742
Effective Final Drive Gear Ratio	2.77/3.16/3.39
Torque Converter Size- Diameter of Torque Converter Turbine	246 mm
Pressure Taps	Line Pressure
Transaxle Fluid Type	DEXRON VI®
Transaxle Fluid Capacity	9.0 L/9.5 qts Quarts
Transaxle Type: 6	Six Forward Gears
Transaxle Type: T	Transverse Mount
Transaxle Type: 70/75/80	Product Series
Position Quadrant	P, R, N, D, * *(Refer to the applicable owner's manual)
Case Material	Die Cast Aluminum
Transaxle Net Weight	104 kg
Maximum Trailer Towing Capacity	N/A
Maximum Gross Vehicle Weight (GVW)	4,000 lbs

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Automatic Transmission Fluid	DEXRON®VI	88861037	19264717
Input Speed Sensor	Threadlock	12345382	10953489
Torque Converter Bolts	Threadlock	12345382	10953489

FLUID CAPACITY SPECIFICATIONS

Fluid Capacity Specifications

Application	Specification	
	Metric	English
Valve Body Cover Removal - Approximate Capacity	5.0-7.0 liters	5.3-7.4 quarts
Fluid Change - Drain Plug - Approximate Capacity	4.0-6.0 liters	4.2- 6.3 quarts
Overhaul - Approximate Capacity	7.0-9.0 liters	7.4-9.5 quarts

TAPER BEARING PRELOAD SELECTIVE SPECIFICATIONS

Front Differential Drive Pinion Gear and Differential Thrust Washer Selection Chart

Thrust Washer O.D. Color Code	Washer Thickness	
	Metric	English
Brown	0.494 mm	0.020 in
Purple	0.545 mm	0.022 in

Black	0.596 mm	0.024 in
Pink	0.647 mm	0.026 in
Dark Blue	0.698 mm	0.028 in
Light Green	0.749 mm	0.030 in
Plain	0.800 mm	0.032 in
White	0.851 mm	0.034 in
Light Blue	0.902 mm	0.036 in
Orange	0.953 mm	0.038 in
White/Black	1.004 mm	0.040 in
White/Orange	1.055 mm	0.042 in
White/Light Green	1.106 mm	0.044 in

RANGE REFERENCE

Range Reference

Range	Park	Reverse	Neutral	Drive						
				1st Braking	1st	2nd	3rd	4th	5th	6th
1-2-3-4 Clutch	-	-	-	Applied	Applied	Applied	Applied	Applied	-	-
3-5 Reverse Clutch	-	Applied	-	-	-	-	Applied	-	Applied	-
4-5-6 Clutch	-	-	-	-	-	-	-	Applied	Applied	Applied
2-6 Clutch	-	-	-	-	-	Applied	-	-	-	Applied
Low and Reverse Clutch	Applied*	Applied	Applied*	Applied	-	-	-	-	-	-
Low Clutch Assembly (OWC)	-	-	-	Holding	Holding	-	-	-	-	-

* = Applied with NO load

SHIFT SOLENOID VALVE STATE AND GEAR RATIO

Shift Solenoid Valve State and Gear Ratio

Gear	Shift SOL 1	Shift SOL 2	1-2-3-4 CL PC SOL 5 N.L.	2-6 CL PC SOL 4 N.L.	3-5 REV CL PC SOL 2 N.H.	LOW REV 4-5-6 CL PC SOL 3 N.H.	Gear Ratio
Park	ON	ON	OFF	OFF	OFF	ON	-
Reverse	ON	OFF	OFF	OFF	ON	ON	2.88

Neutral	ON	ON	OFF	OFF	OFF	ON	-
1st Braking	ON	ON	ON	OFF	OFF	ON	4.484
1st	OFF	ON	ON	OFF	OFF	OFF	4.484
2nd	OFF	ON	ON	ON	OFF	OFF	2.872
3rd	OFF	ON	ON	OFF	ON	OFF	1.842
4th	OFF	ON	ON	OFF	OFF	ON	1.414
5th	OFF	ON	OFF	OFF	ON	ON	1.000
6th	OFF	ON	OFF	ON	OFF	ON	0.742

Effective Final Drive Ratio - 6T70/75/80 - 2.77/3.16/3.39

For shift solenoids 1 and 2, "ON" = Solenoid Energized (Pressurized) "OFF" = Solenoid De-energized (No Pressure).

For pressure control solenoids, "ON" = Pressurized, "OFF" = No Pressure

SHIFT SPEED

Shift Speed

Shift @ TP	km/h	mph	OSS (RPM)
1-2 @ 12.5	18	11.2	400
2-3 @ 12.5	34	21.1	755
3-4 @ 12.5	46	28.6	1021
4-5 @ 12.5	60	37.3	1332
5-6 @ 12.5	74	46.0	1643
6-5 @ 12.5	69	42.9	1532
5-4 @ 12.5	69	42.9	1532
4-3 @ 12.5	43	26.7	955
3-2 @ 12.5	16	9.9	355
2-1 @ 12.5	16	9.9	355
1-2 @ 25	36	22.4	799
2-3 @ 25	59	36.7	1310
3-4 @ 25	78	48.5	1732
4-5 @ 25	94	58.4	2087
5-6 @ 25	150	93.2	3331
6-5 @ 25	69	42.9	1532
5-4 @ 25	52	32.3	1155
4-3 @ 25	43	26.7	955
3-2 @ 25	16	9.9	355
2-1 @ 25	16	9.9	355

NOTE: Shift speed points are affected by many different vehicle and transmission operating conditions. The table above represents shift speed points calibrated at specific throttle angles during normal operating conditions and a temperature range between 0-130°C (32-266°F). These shift speed points are

also based on an effective final drive ratio of 2.77, and assume a production-intent tire size. The table below illustrates a number of different variables that influence these shift speed points. Based on a given operating condition, these variables may override the normal shift speed points. To assist in monitoring the different variables, the respective scan tool data parameter is also listed.

Shift Speed Variables

Scan Tool Parameter	Shift Speed Variables
Calc. Throttle Position	Calc. Throttle Position (TP) is one of the most important inputs in the transmission shift pattern logic. A very low TP angle will impact the shift pattern by causing upshifts. A very high TP angle will impact the shift pattern by causing downshifts.
Commanded Gear	Based on numerous inputs, the transmission control module (TCM) selects the optimum gear. Once the TCM commands a gear, the pressure control solenoids are activated to hydraulically control engagement of the proper clutch.
Cruise	When cruise control is activated, the shift pattern is altered to reduce excessive shifting.
ECT	Shift speed points may be offset to enhance engine coolant temperature (ECT) warm-up. Also, operating the vehicle at higher engine speeds will reduce the time to warm the ECT and the TFT.
Engine Speed	To protect against an over speed condition, engine speed is monitored. If the engine speed becomes too high, an upshift will occur.
Engine Torque	Engine torque is used to predict vehicle operating conditions, in order to determine the optimum gear and provide for a smoother ride.
IMS	The internal mode switch (IMS) indicates the position of the transmission manual valve. The operator controls this valve by moving the gear range selector. Therefore, the possible gears may be limited by this valve position.
TCC PC Sol. Duty Cycle	The torque converter clutch (TCC) pressure control (PC) solenoid duty cycle indicates when the TCC has been engaged.
TCC Slip Speed	The TCC Slip Speed indicates the difference between engine speed and transmission input speed. The TCC is locked when slip speed is at or near zero, and may be controlling slip when at lower slip speeds.
TFP Switch 1, 3, 4 or 5	The transmission fluid pressure (TFP) switch is used to indicate if fluid pressure to a specific clutch has been applied or released.
Trans. Fluid Temp.	A lower TFT will extend shift speeds, a higher TFT, or hot mode condition, will invoke shorter shift speeds in order to establish a shift pattern required to cool the TFT.
Transmission Hot Mode	If the TFT becomes too hot, a hot mode shift pattern is used. The hot mode shift pattern will invoke lower shift speed points to establish a shift pattern necessary to cool the TFT.
Transmission OSS	The transmission output speed sensor (OSS) is one of the most important inputs into the transmission shift pattern logic. A very low transmission output speed will impact the shift pattern by causing

downshifts. A very high transmission output speed will impact the shift pattern by causing upshifts.

TRANSMISSION INTERNAL MODE SWITCH LOGIC

Transmission Internal Mode Switch Logic

Gear Selector Position	Signal A	Signal B	Signal C	Signal P
Park	LOW	HI	HI	LOW
Park/Reverse	LOW	LOW	HI	LOW
Reverse	LOW	LOW	HI	HI
Reverse/Neutral	HI	LOW	HI	HI
Neutral	HI	LOW	HI	LOW
Neutral/Drive 6	HI	LOW	LOW	LOW
Drive 6	HI	LOW	LOW	HI
Drive 6/Drive 4	LOW	LOW	LOW	HI
Drive 4	LOW	LOW	LOW	LOW
Drive 4/Drive 3	LOW	HI	LOW	LOW
Drive 3	LOW	HI	LOW	HI
Drive 3/Drive 2	HI	HI	LOW	HI
Drive 2	HI	HI	LOW	LOW
Open	HI	HI	HI	HI
Invalid	HI	HI	HI	LOW
Invalid	LOW	HI	HI	HI

HI = Ignition voltage
LOW = 0 volts

SOLENOID VALVE PRESSURE

Line PC Solenoid Valve Pressure

Requested Pressure (kPa)	Actual Pressure	
	Metric	English
0	345-900 kPa	50-130 psi
200	690-900 kPa	100-130 psi
400	1100-1310 kPa	160-190 psi
600	1520-1725 kPa	220-250 psi
800	1860-2070 kPa	270-300 psi
1000	1860-2070 kPa	270-300 psi

GENERAL INFORMATION

Trouble Shooting - Basic Procedures

* PLEASE READ THIS FIRST *

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to **SUBJECT**, **DIAGNOSTIC**, or **TESTING** articles available in the section(s) you are accessing.

ACCESSORIES & ELECTRICAL

CHARGING SYSTEM TROUBLE SHOOTING

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to **SUBJECT**, **DIAGNOSTIC**, or **TESTING** articles available in the section(s) you are accessing.

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to **SUBJECT**, **DIAGNOSTIC**, or **TESTING** articles available in the section(s) you are accessing.

BASIC CHARGING SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Vehicle Will Not Start	
Dead battery	Check battery cells, alternator belt tension and alternator output
Loose or corroded battery connections	Check all charging system connections
Ignition circuit or switch malfunction	Check and replace as necessary
Alternator Light Stays On With Engine Running	
Loose or worn alternator drive belt	Check alternator drive tension and condition, See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Loose alternator wiring connections	Check all charging system connections

Short in alternator light wiring	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Defective alternator stator or diodes	See Bench Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Alternator Light Stays Off With Ignition Switch ON	
Blown fuse	See WIRING DIAGRAMS
Defective alternator	See Testing in ALTERNATOR article
Defective indicator light bulb or socket	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Alternator Light Stays OFF With Ignition Switch ON	
Short in alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective rectifier bridge	See Bench Tests in ALTERNATOR article
Lights or Fuses Burn Out Frequently	
Defective alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Defective battery	Check and replace as necessary
Ammeter Gauge Shows Discharge	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Defective wiring	Check all wires and wire connections
Defective alternator or regulator	See Bench Tests and On- Vehicle Tests in ALTERNATOR article
Defective ammeter, or improper ammeter wiring connection	See Testing in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Noisy Alternator	
Loose drive pulley	Tighten drive pulley attaching nut

Loose mounting bolts	Tighten all alternator mounting bolts
Worn or dirty bearings	See Bearing Replacement ALTERNATOR article
Defective diodes or stator	See Bench Test in ALTERNATOR article
Battery Does Stay Charged	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in appropriate TUNE-UP article in the TUNE-UP section
Loose or corroded battery connections	Check all charging system connections
Loose alternator connections	Check all charging system connections
Defective alternator or battery	See On-Vehicle Tests and Bench Tests in ALTERNATOR article
Add-on electrical accessories exceeding alternator capacity	Install larger alternator
Battery Overcharged-Uses Too Much Water	
Defective battery	Check alternator output and repair as necessary
Defective alternator	See On-Vehicle Test and Bench Tests in ALTERNATOR article
Excessive alternator voltage	Check alternator output and repair as necessary

IGNITION SYSTEM TROUBLE SHOOTING

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Ignition Secondary Trouble shooting Chart

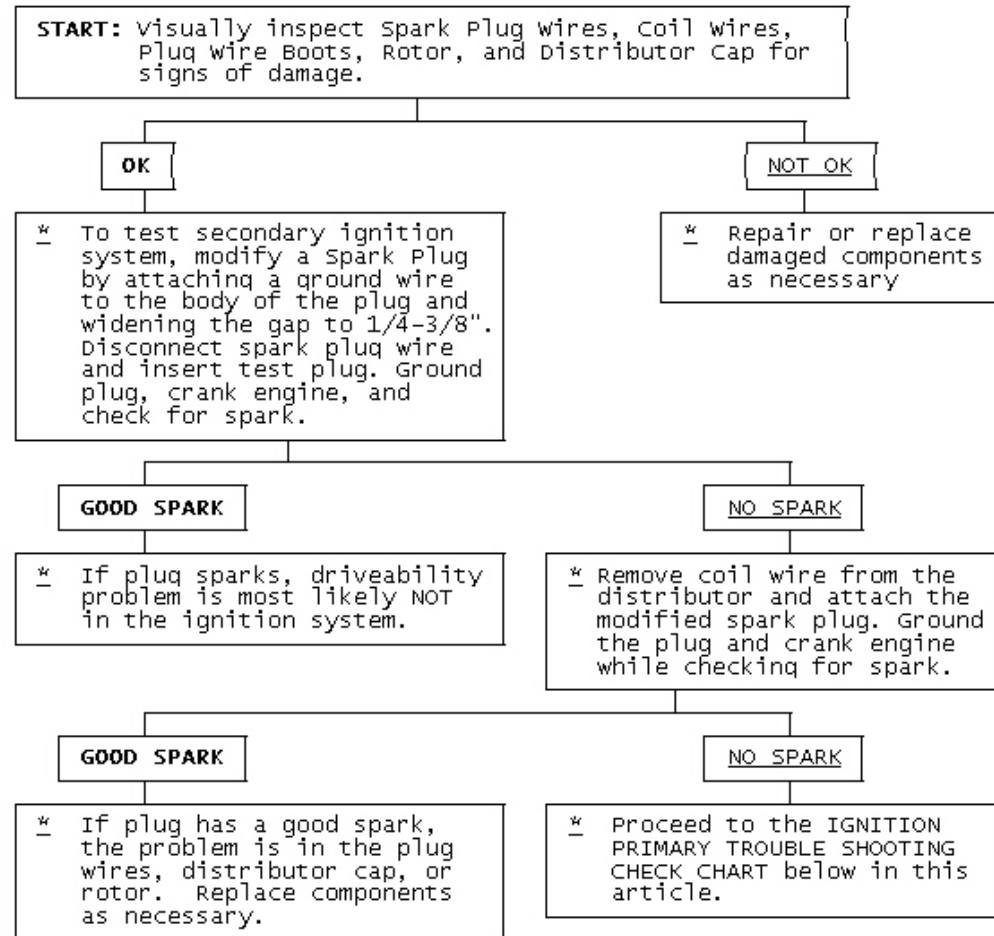


Fig. 1: Ignition Secondary Trouble Shooting Chart

Ignition Primary Trouble Shooting Chart

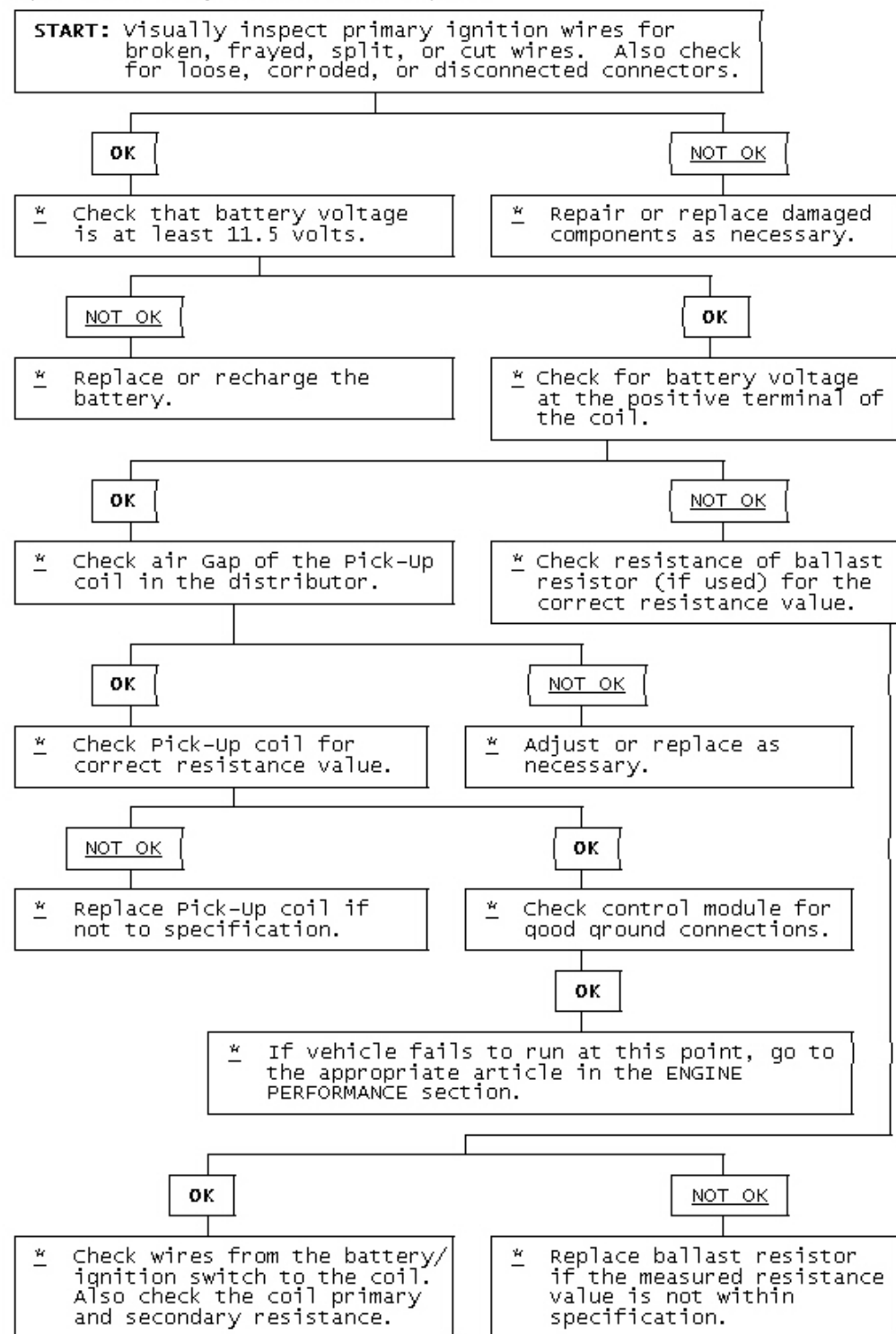


Fig. 2: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

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BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole	See STARTER article shoes
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	
Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check

	for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearing	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as

	necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch	Replace ignition switch contacts sticking
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	solenoid
Low Current Draw	
Worn brushes or weak brush springs	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

AIR CONDITIONING & HEAT

AIR CONDITIONING TROUBLE SHOOTING

WARNING: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to **SUBJECT**, **DIAGNOSTIC**, or **TESTING** articles available in the section(s) you are accessing.

BASIC AIR CONDITIONING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Compressor Not Working	Compressor clutch circuit open.
.....	Compressor clutch coil inoperative.
.....	Poor clutch ground connection.
.....	Fan belts loose.
.....	Thermostatic switch inoperative.
.....	Thermostatic switch not adjusted.
.....	Ambient temperature switch open.
.....	Superheat fuse blown.
Excessive Noise or Vibration	Missing or loose mounting bolts.
.....	Bad idler pulley bearings.
.....	Fan belts not tightened correctly.
.....	Compressor clutch contacting body.
.....	Excessive system pressure.
.....	Compressor oil level low.
.....	Damaged clutch bearings.
.....	Damaged reed valves.
.....	Damaged compressor.
Insufficient or No Cooling; Compressor Working	Expansion valve inoperative.
.....	Heater control valve stuck open.
.....	Low system pressure.
.....	Blocked condenser fins.
.....	Blocked evaporator fins.
.....	Vacuum system leak.
.....	Vacuum motors inoperative.
.....	Control cables improperly adjusted.
.....	Restricted air inlet.
.....	Mode doors binding.
.....	Blower motor inoperative.

.....	Temperature above system capacity.
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HEATER SYSTEM TROUBLE SHOOTING

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BASIC HEATER SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Insufficient, Erratic, or No Heat	Low Coolant Level
.....	Incorrect thermostat.
.....	Restricted coolant flow through core.
.....	Heater hoses plugged.
.....	Misadjusted control cable.
.....	Sticking heater control valve.
.....	Vacuum hose leaking.
.....	Vacuum hose blocked.
.....	Vacuum motors inoperative.
.....	Blocked air inlet.
.....	Inoperative heater blower motor.
.....	Oil residue on heater core fins.
.....	Dirt on heater core fins.
Too Much Heat	Improperly adjusted cables.
.....	Sticking heater control valve.
.....	No vacuum to heater control valve.
.....	Temperature door stuck open.
Air Flow Changes During Acceleration	Vacuum system leak.
.....	Bad check valve or reservoir.
Air From Defroster At All Times	Vacuum system leak.
.....	Improperly adjusted control cables.
.....	Inoperative vacuum motor.
Blower Does Not Operate Correctly	Blown fuse.
.....	Blower motor windings open.
.....	Resistors burned out.
.....	Motor ground connection loose.
.....	Wiring harness connections loose.
.....	Blower motor switch inoperative.
.....	Blower relay inoperative.

.....	Fan binding or foreign object in housing.
.....	Fan blades broken or bent.

BRAKES

BRAKE SYSTEM TROUBLE SHOOTING

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BRAKE SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Brakes Pull Left or Right	
Incorrect tire pressure	Inflate tires to proper pressure
Front end out of alignment	See WHEEL ALIGNMENT
Mismatched tires	Check tires sizes
Restricted brake lines or hoses	Check hose routing
Loose or malfunctioning caliper	See DISC BRAKES or BRAKE SYSTEM
Bent shoe or oily linings	See DRUM BRAKES or BRAKE SYSTEM
Malfunctioning rear brakes	See DRUM, DISC BRAKES or BRAKE SYSTEM
Loose suspension parts	See SUSPENSION
Noises Without Brakes Applied	
Front linings worn out	Replace linings
Dust or oil on drums or rotors	See DRUM, DISC BRAKES or BRAKE SYSTEM
Noises With Brakes Applied	
Insulator on outboard shoe damaged	See DISC BRAKES or BRAKE SYSTEM
Incorrect pads or linings	Replace pads or linings
Brake Rough, Chatters or Pulsates	
Excessive lateral runout	Check rotor runout
Parallelism not to specifications	Reface or replace rotor
Wheel bearings not adjusted	See SUSPENSION
Rear drums out-of-round	Reface or replace drums
Disc pad reversed, steel against rotor	Remove and reinstall pad
Excessive Pedal Effort	
Malfunctioning power unit	See POWER BRAKES or

	BRAKE SYSTEM
Partial system failure	Check fluid and pipes
Worn disc pad or lining	Replace pad or lining
Caliper piston stuck or sluggish	See DISC BRAKES or BRAKE SYSTEM
Master cylinder piston stuck	See MASTER CYLINDERS or BRAKE SYSTEM
Brake fade due to incorrect pads for linings	Replace pads or linings
Linings or pads glazed	Replace pads or linings
Worn drums	Reface or replace drums
Excessive Pedal Travel	
Partial brake system failure	Check fluid and pipes
Insufficient fluid in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Air trapped in system	See BRAKE BLEEDING or BRAKE SYSTEM
Rear brakes not adjusted	See Adjustments in DRUM BRAKES or BRAKE SYSTEM
Bent shoe or lining	See DRUM BRAKES or BRAKE SYSTEM
Plugged master cylinder cap	See MASTER CYLINDERS or BRAKE SYSTEM
Improper brake fluid	Replace brake fluid
Pedal Travel Decreasing	
Compensating port plugged	See MASTER CYLINDERS or BRAKE SYSTEM
Swollen cup in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Master cylinder piston not returning	See MASTER CYLINDERS or BRAKE SYSTEM
Weak shoe retracting springs	See DRUM BRAKES BRAKE SYSTEM
Wheel cylinder piston sticking	See DRUM BRAKES or BRAKE SYSTEM
Dragging Brakes	
Master cylinder pistons not returning	See MASTER CYLINDERS BRAKE SYSTEM
Restricted brake lines or hoses	Check line routing
Incorrect parking brake adjustment	See DRUM BRAKES BRAKE SYSTEM
Parking Brake cables frozen	See DRUM BRAKES BRAKE SYSTEM

Incorrect installation of inboard disc pad	Remove and replace correctly
Power booster output rod too long	See POWER BRAKE UNITS BRAKE SYSTEM
Brake pedal not returning freely	See DISC, DRUM BRAKES BRAKE SYSTEM
Brakes Grab or Uneven Braking Action	
Malfunction of combination valve	See CONTROL VALVE or BRAKE SYSTEM
Malfunction of power brake unit	See POWER BRAKE UNITS or BRAKE SYSTEM
Binding brake pedal	See DISC, DRUM BRAKES or BRAKE SYSTEM
Pulsation or Roughness	
Uneven pad wear caused by caliper	See DISC BRAKES or BRAKE SYSTEM
Uneven rotor wear	See DISC BRAKES or BRAKE SYSTEM
Drums out-of-round	Reface or replace drums

ENGINE MECHANICAL

COOLING SYSTEM TROUBLE SHOOTING

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COOLING SYSTEM TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Overheating	
Coolant Leak	Fill/Pressure Test System
A/C Condenser Fins Clogged	Remove/Clean Condenser
Radiator Fins Clogged	Remove/Clean Radiator
Thermostat Stuck Closed	Replace Thermostat
Clogged Cooling System Passages	Clean/Flush Cooling System
Water Pump Malfunction	Replace Water Pump
Fan Clutch Malfunction	Replace Fan Clutch
Retarded Ignition Timing	Reset Ignition Timing
Cooling Fan Malfunction	Test Cooling Fan/Circuit
Cooling Fan Motor Malfunction	Test Fan Motor
Cooling Fan Relay Malfunction	Test Fan Relay

Faulty Radiator Cap	Replace Radiator Cap
Broken/Slipping Fan Belt	Replace Fan Belt
Restricted Exhaust	Repair Exhaust System
Corrosion	
Impurities In Coolant	Clean/Flush System
Coolant Leakage	
Damaged hose	Replace Hose
Leaky Water Pump	Replace Water Pump
Damaged Radiator Seam	Replace/Repair Radiator
Leaky Thermostat Cover	Replace Thermostat Cover
Cylinder Head Problem	Check Head/Head Gasket
Leaky Freeze Plugs	Replace Freeze Plugs
Recovery System Inoperative	
Loose and/or Defective Radiator Cap	Replace Radiator Cap
Overflow Tube Clogged and/or Leaking	Repair Tube
Recovery Bottle Vent Restricted	Clean Vent
No Heater Core Flow	
Collapsed Heater Hose	Replace Heater Hose
Plugged Heater Core	Clean/Replace Heater Core
Faulty Heater Valve	Replace Heater Valve

GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING

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BASIC GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Lopes At Idle	
Intake manifold-to-head leaks	Replace manifold gasket, See ENGINES
Blown head gasket	Replace head gasket, See ENGINES
Worn timing gears, chain or sprocket	Replace gears, chain or sprocket
Worn camshaft lobes	Replace camshaft, See ENGINES
Overheated engine	Check cooling system, See COOLING
Blocked crankcase vent valve	Remove restriction

Leaking EGR valve	Repair leak and/or replace valve
Faulty fuel pump	Replace fuel pump
Engine Has Low Power	
Leaking fuel pump	Repair leak and/or replace fuel pump
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Sticking valves or weak valve springs	Check valve train components, See ENGINES
Incorrect valve timing	Reset valve timing, See ENGINES
Worn camshaft lobes	Replace camshaft, See ENGINES
Blown head gasket	Replace head gasket. See ENGINES.
Clutch slipping	Adjust pedal and/or replace components, See ENGINES
Engine overheating	Check cooling system, See COOLING
Auto. Trans. pressure regulator valve faulty	Replace pressure regulator valve
Auto. Trans. fluid level too low	Add fluid as necessary
Improper vacuum diverter valve operation	Replace vacuum diverter valve
Vacuum leaks	Inspect vacuum system and repair as required
Leaking piston rings	Replace piston rings, See ENGINES
Faulty High Speed Operation	
Low fuel pump volume	Replace fuel pump
Leaking valves or worn	Replace valves and/or springs, See ENGINES
Incorrect valve timing	Reset valve timing, See ENGINES
Intake manifold restricted	Remove restriction
Worn distributor shaft	Replace distributor
Faulty Acceleration	
Improper fuel pump stroke	Remove pump and reset pump stroke
Incorrect ignition timing	Reset ignition timing, See TUNE-UP
Leaking valves	Replace valves, See ENGINES

Worn fuel pump diaphragm or piston	Replace diaphragm or piston
Intake Backfire	
Improper ignition timing	Reset ignition timing, See TUNE-UP
Faulty accelerator pump discharge	Replace accelerator pump
Improper choke operation	Check choke and adjust as required
Defective EGR valve	Replace EGR valve
Fuel mixture too lean	Reset air/fuel mixture, See TUNE-UP
Choke valve initial clearance too large	Reset choke valve initial clearance
Exhaust Backfire	
Vacuum leak	Inspect and repair vacuum system
Faulty vacuum diverter valve	Replace vacuum diverter valve
Faulty choke operation	Check choke and adjust as required
Exhaust system leak	repair exhaust system leak
Engine Detonation	
Ignition timing too far advanced	Reset ignition timing, See TUNE-UP
Faulty ignition system	Check ignition timing, See TUNE-UP
Spark plugs loose or faulty	Retighten or replace plugs
Fuel delivery system clogged	Inspect lines, pump and filter for clog
EGR valve inoperative	Replace EGR valve
PCV system inoperative	Inspect and/or replace hoses or valve
Vacuum leaks	Check vacuum system and repair leaks
Excessive combustion chamber deposits	Remove built-up deposits
Leaking, sticking or broken valves	Inspect and/or replace valves
External Oil Leakage	
Fuel pump improperly seated or worn gasket	Remove pump, replace gasket and seat properly
Oil pan gasket broken or pan bent	Straighten pan and replace gasket
Timing chain cover gasket broken	Replace timing chain cover gasket
Rear main oil seal worn	Replace rear main oil seal

Oil pan drain plug not seated properly	Remove and reinstall drain plug
Camshaft bearing drain hole blocked	Remove restriction
Oil pressure sending switch leaking	Remove and reinstall sending switch
Excessive Oil Consumption	
Worn valve stems or guides	Replace stems or guides, See ENGINES
Valve "O" ring seals damaged	Replace "O" ring seals, See ENGINES
Plugged oil drain back holes	Remove restrictions
Improper PCV valve operation	Replace PCV valve
Engine oil level too high	Remove excess oil
Engine oil too thin	Replace thicker oil
Valve stem oil deflectors damaged	Replace oil deflectors
Incorrect piston rings	Replace piston rings, See ENGINES
Piston ring gaps not staggered	Reinstall piston rings, See ENGINES
Insufficient piston ring tension	Replace rings, See ENGINES
Piston ring grooves or oil return	slots clogged Replace piston rings, See ENGINES
Piston rings sticking in grooves	Replace piston rings, See ENGINES
Piston ring grooves excessively worn	Replace piston and rings, See ENGINES
Compression rings installed upside down	Replace compression rings correctly, See ENGINES
Worn or scored cylinder walls	Rebore cylinders or replace block
Mismatched oil ring expander and rail	Replace oil ring expander and rail, See ENGINES
Intake gasket dowels too long	Replace intake gasket dowels
Excessive main or connecting rod bearing clearance	Replace main or connecting rod bearings, See ENGINES
No Oil Pressure	
Low oil level	Add oil to proper level
Oil pressure sender or gauge broken	Replace sender or gauge
Oil pump malfunction	Remove and overhaul oil pump, See ENGINES
Oil pressure relief valve sticking	Remove and reinstall valve
Oil pump passages blocked	Overhaul oil pump, See ENGINES

Oil pickup screen or tube blocked	Remove restriction
Loose oil inlet tube	Tighten oil inlet tube
Loose camshaft bearings	Replace camshaft bearings, See ENGINES
Internal leakage at oil passages	Replace block or cylinder head
Low Oil Pressure	
Low engine oil level	Add oil to proper level
Engine oil too thin	Remove and replace with thicker oil
Excessive oil pump clearance	Reduce oil pump clearance, See ENGINES
Oil pickup tube or screen blocked	Remove restrictions
Main, rod or cam bearing clearance excessive	Replace bearing to reduce clearance, See ENGINES
High Oil Pressure	
Improper grade of oil	Replace with proper oil
Oil pressure relief valve stuck closed	Eliminate binding
Oil pressure sender or gauge faulty	Replace sender or gauge
Noisy Main Bearings	
Inadequate oil supply	Check oil delivery to main bearings
Excessive main bearing clearance	Replace main bearings, See ENGINES
Excessive crankshaft end play	Replace crankshaft, See ENGINES
Loose flywheel or torque converter	Tighten attaching bolts
Loose or damaged vibration damper	Tighten or replace vibration damper
Crankshaft journals out-of-round	Re-grind crankshaft journals
Excessive belt tension	Loosen belt tension
Noisy Connecting Rods	
Excessive bearing clearance or missing bearing	Replace bearing, See ENGINES
Crankshaft rod journal out-of-round	Re-grind crankshaft journal
Misaligned connecting rod or cap	Remove rod or cap and realign
Incorrectly tightened rod bolts	Remove and re-tighten rod bolts
Noisy Pistons and Rings	
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Bore tapered or out-of-round	Rebore block

Piston ring broken	Replace piston rings, See ENGINES
Piston pin loose or seized	Replace piston pin, See ENGINES
Connecting rods misaligned	Realign connecting rods
Ring side clearance too loose or tight	Replace with larger or smaller rings
Carbon build-up on piston	Remove carbon
Noisy Valve Train	
Worn or bent push rods	Replace push rods, See ENGINES
Worn rocker arms or bridged pivots	Replace push rods, See ENGINES
Dirt or chips in valve lifters	Remove lifters and remove dirt/chips
Excessive valve lifter leak-down	Replace valve lifters, See ENGINES
Valve lifter face worn	Replace valve lifters, See ENGINES
Broken or cocked valve springs	Replace or reposition springs
Too much valve stem-to-guide clearance	Replace valve guides, See ENGINES
Valve bent	Replace valve, See ENGINES
Loose rocker arms	Retighten rocker arms, See ENGINES
Excessive valve seat run-out	Reface valve seats, See ENGINES
Missing valve lock	Install new valve lock
Excessively worn camshaft lobes	Replace camshaft, See ENGINES
Plugged valve lifter oil holes	Eliminate restriction or replace lifter
Faulty valve lifter check ball	Replace lifter check ball, See ENGINES
Rocker arm nut installed upside down	Remove and reinstall correctly
Valve lifter incorrect for engine	Remove and replace valve lifters
Faulty push rod seat or lifter plunger	Replace plunger or push rod
Noisy Valves	
Improper valve lash	Re-adjust valve lash, See ENGINES
Worn or dirty valve lifters	Clean and/or replace lifters
Worn valve guides	Replace valve guides, See ENGINES

Excessive valve seat or face run-out	Reface seats or valve face
Worn camshaft lobes	Replace camshaft, See ENGINES
Loose rocker arm studs	Re-tighten rocker arm studs, See ENGINES
Bent push rods	Replace push rods, See ENGINES
Broken valve springs	Replace valve springs, See ENGINES
Burned, Sticking or Broken Valves	
Weak valve springs or warped valves	Replace valves and/or springs, See ENGINES
Improper lifter clearance	Re-adjust clearance or replace lifters
Worn guides or improper guide clearance	Replace valve guides, See ENGINES
Out-of-round valve seats or improper seat width	Re-grind valve seats
Gum deposits on valve stems, seats or guide	Remove deposits
Improper spark timing	Re-adjust spark timing
Broken Pistons/Rings	
Undersize pistons	Replace with larger pistons, See ENGINES
Wrong piston rings	Replace with correct rings, See ENGINES
Out-of-round cylinder bore	Re-bore cylinder bore
Improper connecting rod alignment	Remove and realign connecting rods
Excessively worn ring grooves	Replace pistons, See ENGINES
Improperly assembled piston pins	Re-assemble pin-to-piston, See ENGINES
Insufficient ring gap clearance	Install new rings, See ENGINES
Engine overheating	Check cooling system
Incorrect ignition timing	Re-adjust ignition timing, See TUNE-UP
Excessive Exhaust Noise	
Leaks at manifold to head, or to pipe	Replace manifold or pipe gasket
Exhaust manifold cracked or broken	Replace exhaust manifold, See ENGINES

ENGINE PERFORMANCE

CARBURETOR TROUBLE SHOOTING:

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BASIC COLD START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Choke not closing	Check choke operation, see FUEL SYSTEMS
Choke linkage bent	Check linkage, see FUEL SYSTEM
Engine Starts, Then Dies	
Choke vacuum kick setting too wide	Check setting and adjust see, FUEL SYSTEMS
Fast idle RPM too low	Reset RPM to specification, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Vacuum leak	Inspect vacuum system for leaks
Low fuel pump outlet	Repair or replace pump, see FUEL SYSTEMS
Low carburetor fuel level	Check float setting see FUEL SYSTEM
Engine Quits Under Load	
Choke vacuum kick setting incorrect	Reset vacuum kick setting, see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEM
Incorrect hot fast idle speed RPM	Reset fast idle RPM, see TUNE-UP
Engine Starts, Runs Up, Then Idles, Slowly With Black Smoke	
Choke vacuum kick set too narrow	Reset vacuum kick, see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Hot fast idle RPM too low	Reset fast idle RPM, see TUNE-UP

BASIC HOT START SYMPTOMS TROUBLE SHOOTING CHART

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CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Engine flooded	Allow fuel to evaporate

BASIC COLD ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Stalls in Gear	
Choke vacuum kick setting incorrect	Reset choke vacuum kick, see FUEL SYSTEMS
Fast idle RPM incorrect	Reset fast idle RPM, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam see FUEL SYSTEMS
Acceleration Sag or Stall	
Defective choke control switch	Replace choke control switch
Choke vacuum kick setting incorrect	Reset choke vacuum kick see, FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, FUEL SYSTEMS
Accelerator pump defective	Repair or replace pump see FUEL SYSTEMS
Secondary throttles not closed	Inspect lockout adjustment, see FUEL SYSTEMS
Sag or Stall After Warmup	
Defective choke control switch	Replace choke control switch, see FUEL SYSTEMS
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, see FUEL SYSTEMS
Backfiring & Black Smoke	
Plugged heat crossover system	Remove restriction

BASIC WARM ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Hesitation With Small Amount of Gas Pedal Movement	
Vacuum leak	Inspect vacuum lines
Accelerator pump weak or inoperable	Replace pump, see FUEL SYSTEMS
Float level setting too low	Reset float level, see, FUEL SYSTEMS
Metering rods sticking or binding	Inspect and/or replace rods, see FUEL SYSTEMS

Carburetor idle or transfer system plugged	Inspect system and remove restriction
Frozen or binding heated air inlet	Inspect heated air door for binding
Hesitation With Heavy Gas Pedal Movement	
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Metering rod carrier sticking or binding	Remove restriction
Large vacuum leak	Inspect vacuum system and repair leak
Float level setting too low	Reset float level, see FUEL SYSTEMS
Defective fuel pump, lines or filter	Inspect pump, lines and filter
Air door setting incorrect	Adjust air door setting, see FUEL

DIESEL ENGINE TROUBLE SHOOTING

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NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

BASIC DIESEL ENGINE TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Crank	
Bad battery connections or dead batteries	Check connections and/or replace batteries
Bad starter connections or bad starter	Check connections and/or replace starter
Engine Cranks Slowly, Won't Start	
Bad battery connections or dead batteries	Check connections and/or replace batteries
Engine oil too heavy	Replace engine oil
Engine Cranks Normally, But Will Not Start	
Glow plugs not functioning	Check glow plug system, see FUEL SYSTEMS
Glow plug control not functioning	Check controller, see FUEL SYSTEMS

Fuel not injected into cylinders	Check fuel injectors, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Fuel filter blocked	Replace fuel filter
Fuel tank filter blocked	Replace fuel tank filter
Fuel pump not operating	Check pump operation and/or replace pump
Fuel return system blocked	Inspect system and remove restriction
No voltage to fuel solenoid	Check solenoid and connections
Incorrect or contaminated fuel	Replace fuel
Incorrect injection pump timing	Re-adjust pump timing, see FUEL SYSTEMS
Low compression	Check valves, pistons, rings, see ENGINES
Injection pump malfunction	Inspect and/or replace injection pump
Engine Starts, Won't Idle	
Incorrect slow idle adjustment	Reset idle adjustment, see TUNE-UP
Fast idle solenoid malfunctioning	Check solenoid and connections
Fuel return system blocked	Check system and remove restrictions
Glow plugs go off too soon	See glow plug diagnosis in FUEL SYSTEMS
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Incorrect or contaminated fuel	Replace fuel
Low compression	Check valves, piston, rings, see ENGINES
Injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Fuel solenoid closes in RUN position	Check solenoid and connections
Engines Starts/Idles Rough W/out Smoke or Noise	
Incorrect slow idle adjustment	Reset slow idle, see TUNE-UP
Injection line fuel leaks	Check lines and connections
Fuel return system blocked	Check lines and connections
Air in fuel system	Bleed air from system
Incorrect or contaminated fuel	Replace fuel

Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engines Starts and Idles Rough W/out Smoke or Noise, But Clears After Warm-Up	
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Engine not fully broken in	Put more miles on engine
Air in system	Bleed air from system
Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engine Idles Correctly, Misfires Above Idle	
Blocked fuel filter	Replace fuel filter
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Incorrect or contaminated fuel	Replace fuel
Engine Won't Return To Idle	
Fast idle adjustment incorrect	Reset fast idle, see TUNE-UP
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
External linkage binding	Check linkage and remove binding
Fuel Leaks On Ground	
Loose or broken fuel line	Check lines and connections
Internal injection pump seal leak	Replace injection pump, see FUEL SYSTEMS
Cylinder Knocking Noise	
Injector nozzles sticking open	Test injectors, see FUEL SYSTEMS
Very low nozzle opening pressure	Test injectors and/or replace
Loss of Engine Power	
Restricted air intake	Remove restriction
EGR valve malfunction	Replace EGR valve
Blocked or damaged exhaust system	Remove restriction and/or replace components
Blocked fuel tank filter	Replace filter
Restricted fuel filter	Remove restriction and/or replace filter
Block vent in gas cap	Remove restriction and/or replace cap
Tank-to-injection pump fuel supply blocked	Check fuel lines and connections
Blocked fuel return system	Remove restriction
Incorrect or contaminated fuel	Replace fuel
Blocked injector nozzles	Check nozzle for blockage, see

	FUEL SYSTEMS
Low compression	Check valves, rings, pistons, see ENGINES
Loud Engine Noise With Black Smoke	
Basic timing incorrect	Reset timing, see FUEL SYSTEMS
EGR valve malfunction	Replace EGR valve
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Incorrect injector pump housing pressure	Check pressure, see FUEL SYSTEMS
Engine Overheating	
Cooling system leaks	Check cooling system and repair leaks
Belt slipping or damaged	Check tension and/or replace belt
Thermostat stuck closed	Remove and replace thermostat, see ENGINE COOLING
Head gasket leaking	Replace head gasket
Oil Light on at Idle	
Low oil pump pressure	Check oil pump operation, see ENGINES
Oil cooler or line restricted	Remove restriction and/or replace cooler
Engine Won't Shut Off	
Injector pump fuel solenoid does not return fuel valve to OFF position	Remove and check solenoid and replace if needed

VACUUM PUMP DIAGNOSIS

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

FUEL INJECTION TROUBLE SHOOTING

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble

Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC FUEL INJECTION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start (Crankes Normally)	
Cold start valve inoperative	Test valve and circuit
Poor connection;vacuum or wiring	Check vacuum and electrical connections
Contaminated fuel	Test fuel for water or alcohol
Defective fuel pump relay or circuit	Test relay and wiring
Battery too low	Charge and test battery
Low fuel pressure	Test pressure regulator and fuel pump, check for restricted lines and filters
No distributor reference pulses	Repair ignition system as necessary
Open coolant temperature sensor circuit	Test sensor and wiring
Shorted W.O.T. switch in T.P.S.	Disconnect W.O.T. switch, engine should start
Defective ECM	Replace ECM
Fuel tank residual pressure valve leaks	Test for fuel pressure drop after shut down
Hard Starting	
Disconnected hot air tube to air cleaner	Reconnect tube and test control valve
Defective Idle Air Control (IAC) valve	Test valve operation and circuit
Shorted, open or misadjusted T.P.S.	Test and adjust or replace T.P.S.
EGR valve open	Test EGR valve and control circuit
Poor Oxygen sensor signal	Test for shorted or circuit
Incorrect mixture from PCV system	Test PCV for flow, check sealing of oil filter cap
Poor High Speed Operation	
Low fuel pump volume	Faulty pump or restricted fuel lines or filters
Poor MAP sensor signal	Test MAP sensor, vacuum hose and wiring
Poor Oxygen sensor signal	Test for shorted or open sensor or circuit

Open coolant temperature sensor circuit	Test sensor and wiring
Faulty ignition operation	Check wires for cracks or poor connections, test secondary voltage with oscilloscope
Contaminated fuel	Test fuel for water or alcohol
Intermittent ECM ground	Test ECM ground connection for resistance
Restricted air cleaner	Replace air cleaner
Restricted exhaust system	Test for exhaust manifold back pressure
Poor MAF sensor signal	Check leakage between sensor and manifold
Poor VSS signal	If tester for ALCL hook-up is available check that VSS reading matches speedometer
Ping or Knock on Acceleration	
Poor Knock sensor signal	Test for shorted or open sensor or circuit
Poor Baro sensor signal	Test for shorted or open sensor or circuit
Improper ignition timing	See VEHICLE EMISSION CONTROL LABEL (where applicable)
Check for engine overheating problems	Low coolant, loose belts or electric cooling fan inoperative

NOTE: For additional electronic fuel injection trouble shooting information, see the appropriate article in the **ENGINE PERFORMANCE** section (not all vehicles have Computer Engine Control articles). Information is provided there for diagnosing fuel system problems on vehicles with electronic fuel injection.

IGNITION SYSTEM TROUBLE SHOOTING

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Ignition Secondary Trouble shooting Chart

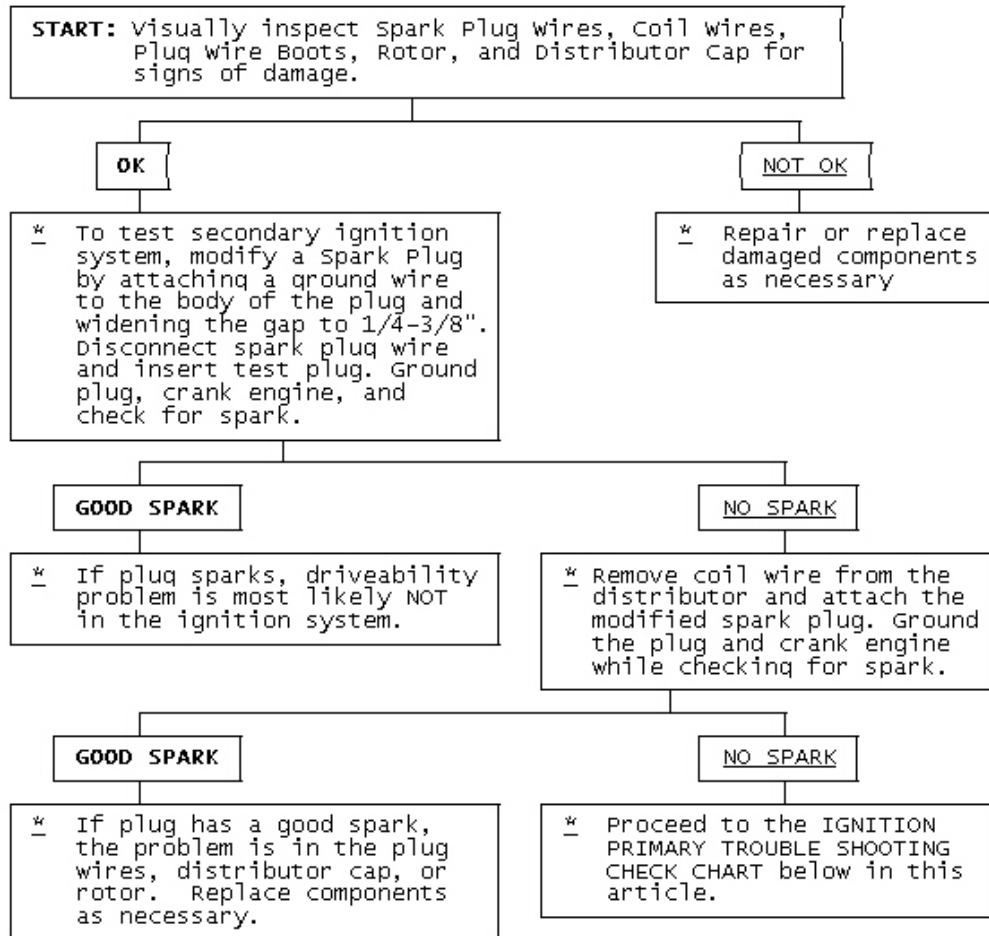


Fig. 3: Ignition Secondary Trouble Shooting Chart

Ignition Primary Trouble Shooting Chart

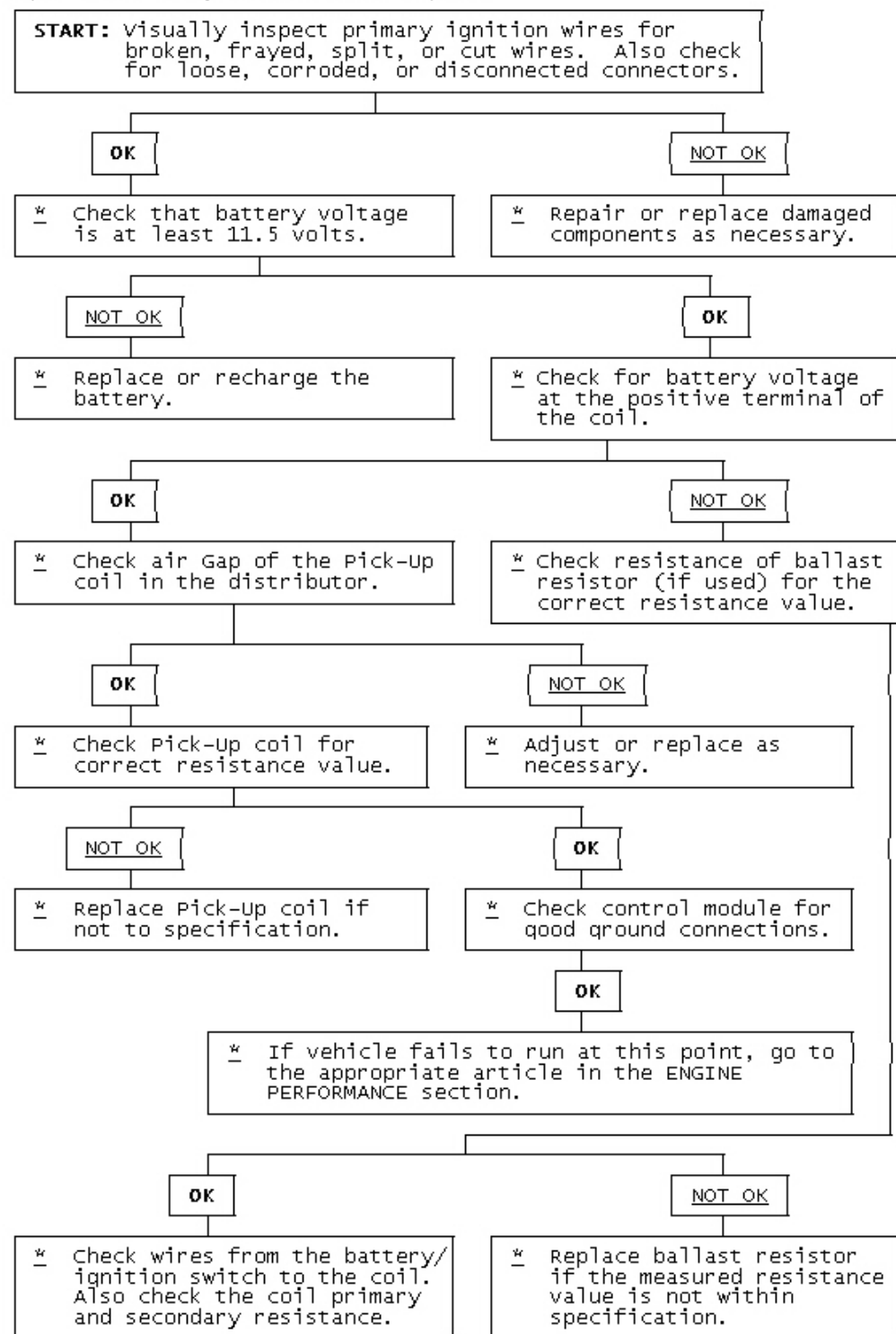


Fig. 4: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to **SUBJECT**, **DIAGNOSTIC**, or **TESTING** articles available in the section(s) you are accessing.

BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole shoes	See STARTER article
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	

Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearings	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER

	article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	Replace solenoid
Low Current Draw	
Worn brushes or weak	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that

	correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

TUNE-UP TROUBLE SHOOTING - GAS ENGINE VEHICLES

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BASIC SPARK PLUG TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Normal Spark Plug Condition	
Light Tan or Gray deposits	No Action
Electrode not burned or fouled	No Action
Gap tolerance not changed	No Action
Cold Fouling or Carbon Deposits	
Overrich air/fuel mixture	Adjust air/fuel mixture, see ENGINE PERFORMANCE section
Faulty choke	Replace choke assembly, see ENGINE PERFORMANCE section
Clogged air filter	Clean and/or replace air filter
Incorrect idle speed or dirty carburetor	Reset idle speed and/ or clean carburetor
Faulty ignition wires	Replace ignition wiring
Prolonged operation at idle	Shut engine off during long idle
Sticking valves or worn valve guide seals	Check valve train
Wet Fouling or Oil Deposits	
Worn rings and pistons	Install new rings and pistons
Excessive cylinder wear	Rebore or replace block
Excessive valve guide clearance	Worn or loose bearing
Gap Bridged	
Deposits in combustion chamber becoming fused to electrode	Clean combustion chamber of deposits
Blistered Electrode	
Engine overheating	Check cooling system

Wrong type of fuel	Replace with correct fuel
Loose spark plugs	Retighten spark plugs
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Pre-Ignition or Melted Electrodes	
Incorrect type of fuel	Replace with correct fuel
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Burned valves	Replace valves
Engine Overheating	Check cooling system
Wrong type of spark plug, too hot	Replace with correct spark plug, see ENGINE PERFORMANCE
Chipped Insulators	
Severe detonation	Check for over-advanced timing or combustion
Improper gapping procedure	Re-gap spark plugs
Rust Colored Deposits	
Additives in unleaded fuel	Try different fuel brand
Water In Combustion Chamber	
Blown head gasket or cracked head	Repair or replace head or head gasket

NOTE: Before diagnosing an electronic ignition system, ensure that all wiring is connected properly between distributor, wiring connector and spark plugs. Ignition problem will show up either as: Engine Will Not Start or Engine Runs Rough.

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Open circuit between distributor and bulkhead connector	Repair circuit
Open circuit between bulkhead connector and ignition switch	Repair circuit
Open circuit between ignition switch and starter solenoid	Repair circuit
Engine Runs Rough	
Fuel lines leaking or clogged	Tighten fitting, remove restriction
Initial timing incorrect	Reset ignition timing see ENGINE PERFORMANCE
Centrifugal advance malfunction	Repair distributor advance
Defective spark plugs or wiring	Replace plugs or plug wiring
Component Failure	
Spark arc-over on cap, rotor or coil	Replace cap, rotor or or coil

Defective pick-up coil	Replace pick-up coil
Defective ignition coil	Replace ignition coil
Defective vacuum unit	Replace vacuum unit
Defective control module	Replace control module

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS - USING OSCILLOSCOPE PATTERNS

CONDITION & POSSIBLE CAUSE	CORRECTION
Firing Voltage Lines are the Same, but Abnormally High	
Retarded ignition timing	Reset ignition timing, see ENGINE PERFORMANCE section
Fuel mixture too lean	Readjust carburetor, see ENGINE PERFORMANCE
High resistance in coil wire	Replace coil wire
Corrosion in coil tower terminal	Clean and/or replace coil
Corrosion in distributor coil terminal	Clean and/or replace distributor cap
Firing Voltage Lines are the Same but Abnormally Low	
Fuel mixture too rich	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in coil wire causing arcing	Replace coil wire
Cracked coil tower causing arcing	Replace coil
Low coil output	Replace coil
Low engine compression	Determine cause and repair
One or More, But Not All Firing Voltage Lines are Higher Than Others	
Carburetor idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
EGR valve stuck open	Clean and/or replace valve
High resistance in spark plug wires	Replace spark plug wires
Cracked or broken spark plug insulator	Replace spark plugs
Intake vacuum leak	Repair leak
Defective spark plugs	Replace spark plugs
Corroded spark plug terminals	Replace spark plugs
One or More, But Not All Firing Voltage Lines Are Lower Than Others	
Curb idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in plug wires	Replace plug wires causing arcing
Cracked coil tower causing arcing	Replace coil
Low compression	Determine cause and repair
Defective spark plugs	Replace spark plugs

Corroded spark plugs	Replace spark plugs
Cylinders Not Firing	
Cracked distributor cap terminals	Replace distributor cap
Shorted spark plug wire	Determine cause and repair
Mechanical problem in engine	Determine cause and repair
Defective spark plugs	Replace spark plugs
Spark plugs fouled	Replace spark plugs

BASIC DRIVEABILITY PROBLEMS TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Hard Starting	
Binding carburetor linkage	Eliminate binding
Binding choke linkage	Eliminate binding
Binding choke piston	Eliminate binding
Restricted choke vacuum	Check vacuum lines for blockage
Worn or dirty needle valve and seat	Clean carburetor, see ENGINE PERFORMANCE
Float sticking	Readjust or replace float see the ENGINE PERFORMANCE section
Incorrect choke adjustment	Reset choke adjustment see ENGINE PERFORMANCE
Defective coil	Replace coil
Improper spark plug gap	Regap spark plugs
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Detonation	
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective spark plugs	Replace spark plugs
Fuel lines clogged	Clean fuel lines
EGR system malfunction	Check and repair EGR system
PCV system malfunction	Repair PCV system
Vacuum leaks	Check and repair vacuum system
Loose fan belts	Tighten or replace fan belts, see ENGINE PERFORMANCE
Restricted airflow	Remove restriction
Vacuum advance malfunction	Check distributor operation
Dieseling	
Binding carburetor linkage	Eliminate binding

Binding throttle linkage	Eliminate blinding
Binding choke linkage or fast idle cam	Eliminate binding
Defective idle solenoid	Replace idle solenoid see ENGINE PERFORMANCE
Improper base idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Incorrect idle mixture setting	Reset idle mixture, see ENGINE PERFORMANCE
Faulty Acceleration	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Engine cold and choke too lean	Adjust choke and allow engine to warm-up
Defective spark plugs	Replace spark plugs
Defective coil	Replace coil
Faulty Low Speed Operation	
Clogged idle transfer slots	Clean idle transfer slots, see FUEL
Restricted idle air bleeds and passages	Disassemble and clean carburetor, see FUEL
Clogged air cleaner	Replace air filter
Defective spark plugs	Replace spark plugs
Defective ignition wires	Replace ignition wire see ENGINE PERFORMANCE
Defective distributor cap	Replace distributor cap
Faulty High Speed Operation	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective distributor centrifugal advance	Replace advance mechanism
Defective distributor vacuum advance	Replace advance unit
Incorrect spark plugs or plug gap	Check gap and/or replace spark plugs
Faulty choke operation	Check choke and repair as required
Clogged vacuum passages	Remove restrictions
Improper size or clogged main jet	Check jet size and clean, see FUEL
Restricted air cleaner	Check filter and replace as necessary
Defective distributor cap, rotor or coil	Replace cap, rotor or coil
Misfire at All Speeds	

Defective spark plugs	Replace spark plugs
Defective spark plug wires	Replace spark plug wires
Defective distributor cap, rotor, or coil	Replace cap, rotor, or coil
Cracked or broken vacuum hoses	Replace vacuum hoses
Vacuum leaks	Repair vacuum leaks
Fuel lines clogged	Remove restriction
Hesitation	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair Vacuum leaks
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate binding
Binding choke linkage or fast idle cam	Eliminate binding
Improper float setting	Readjust float setting, see FUEL
Cracked or broken ignition wires	Replace ignition wires
Rough Idle, Missing or Stalling	
Incorrect curb idle or fast idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect basic timing	Reset ignition timing see ENGINE PERFORMANCE
Improper idle mixture adjustment	Reset idle mixture, see ENGINE PERFORMANCE
Improper feedback system operation	Check feedback system see ENGINE PERFORMANCE
Incorrect spark plug gap	Reset spark plug gap, see ENGINE PERFORMANCE
Moisture in ignition components	Dry components
Loose or broken ignition wires	Replace ignition wires
Damaged distributor cap or or rotor	Replace distributor cap or rotor
Faulty ignition coil	Replace ignition coil
Fuel filter clogged or worn	Replace fuel filter
Damaged idle mixture screw	Replace idle mixture screw, see FUEL
Improper fast idle cam adjustment	Reset fast idle cam adjustment, see TUNE- see ENGINE PERFORMANCE
Improper EGR valve operation	Replace EGR valve
Faulty PCV valve air flow	Replace PCV valve
Choke binding or improper choke setting	Reset choke or eliminate binding
Vacuum leak	Repair vacuum leak
Improper float bowl fuel level	Reset float adjustment, see

	FUEL
Clogged air bleed or idle passages	Clean carburetor passages, see FUEL
Clogged or worn air cleaner filter	Replace air filter
Faulty choke vacuum diaphragm	Replace diaphragm, see ENGINE PERFORMANCE
Exhaust manifold heat valve inoperative	Replace heat valve
Improper distributor spark advance	Check distributor operation
Leaking valves or valve components	Check and repair valvetrain
Improper carburetor mounting	Remove and remount carburetor
Excessive play in distributor shaft	Replace distributor
Loose or corroded wiring connections	Repair or replace as required
Engine Surges	
Improper PCV valve airflow	Replace PCV valve
Vacuum leaks	Repair vacuum leaks
Clogged air bleeds	Remove restriction
EGR valve malfunction	Replace EGR valve
Restricted air cleaner filter	Replace air filter
Cracked or broken vacuum hoses	Replace vacuum hoses
Cracked or broken ignition wires	Replace ignition wires
Vacuum advance malfunction	Check unit and replace as necessary
Defective or fouled spark plugs	Replace spark plugs
Ping or Spark Knock	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Distributor centrifugal or vacuum advance malfunction	Check operation and replace as necessary
Carburetor setting too lean	Readjust mixture setting, see ENGINE PERFORMANCE
Vacuum leak	Eliminate vacuum leak
EGR valve malfunction	Replace EGR valve
Poor Gasoline Mileage	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair vacuum leaks
Defective ignition wires	Replace wires
Incorrect choke setting	Readjust setting, see ENGINE PERFORMANCE
Defective vacuum advance	Replace vacuum advance
Defective spark plugs	Replace spark plugs
Binding carburetor power piston	Eliminate binding

Dirt in carburetor jets	Clean and/or replace jets
Incorrect float adjustment	Readjust float setting, see FUEL
Defective power valve	Replace power valve, see ENGINE PERFORMANCE
Incorrect idle speed	Readjust idle speed
Engine Stalls	
Improper float level	Readjust float level
Leaking needle valve and seat	Replace needle valve and seat
Vacuum leaks	Eliminate vacuum leaks

VACUUM PUMP - DIESEL TROUBLE SHOOTING

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NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

VACUUM PUMP (DIESEL) TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

MANUAL TRANSMISSION

MANUAL TRANSMISSION TROUBLE SHOOTING

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MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	Low gear oil level, Loose bell housing bolts, Worn bearings or gears
Clunk On Deceleration (FWD Only)	Loose engine mounts, Worn inboard CV joints, Worn differential pinion shaft, Side gear hub counterbore in case worn oversize
Gear Clash When Shifting Forward Gears	Clutch Out Of Adjustment, Shift linkage damaged or out of adjustment, Gears or synchronizers damaged, Low gear oil level
Transmission Noisy When Moving (RWD Only) Quiet In Neutral With Clutch Engaged	Worn rear outputshaft bearing
Gear Rattle	Worn bearings, Wrong gear oil, Low gear oil, Worn gears
Steady Ticking At Idle (Increases With RPM)	Broken tooth on gear
Gear Clash When Shifting Forward Gears	Worn or broken synchronizers
Loud Whine In Reverse	Normal condition ⁽¹⁾
Noise When Stepping On Clutch	Bad release bearing, Worn pilot bearing
Ticking Or Screeching As Clutch Is Engaged	Faulty release bearing, Uneven pressure plate fingers
Click Or Snap When Clutch Is Engaged	Worn clutch fork, Worn or broken front bearing retainer
Transmission Shifts Hard	Clutch not releasing, Shift mechanism binding, Clutch installed backwards
Will Not Shift Into One Gear, Shifts Into All Others	Bent shift fork, Worn detent balls
Locked Into Gear, Cannot Shift	Clutch adjustment, Worn detent balls
Transmission Jumps Out Of Gear	Pilot bearing worn, Bent shift fork, Worn gear teeth or face, Excessive gear train end play, Worn synchronizers, Missing detent ball spring, Shift mechanism worn or out of adjustment, Engine or transmission mount bolts loose or out of adjustment, Transmission not aligned
Shift Lever Rattle	Worn shift lever or detents, Worn shift forks, Worn synchronizers sleeve
Shift Lever Hops Under Acceleration	Worn engine or transmission mounts
(1) Most units use spur cut gears in reverse and are noisy	

POWERTRAIN

CLUTCH TROUBLE SHOOTING

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Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC CLUTCH TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Chattering or Grabbing	
Incorrect clutch adjustment	Adjust clutch
Oil, grease or glaze on facings	Disassemble and clean or replace
Loose "U" joint flange	See DRIVE AXLES article
Worn input shaft spline	Replace input shaft
Binding pressure plate	Replace pressure plate
Binding release lever	See CLUTCH article
Binding clutch disc hub	Replace clutch disc
Unequal pressure plate contact	Replace worn/misaligned components
Loose/bent clutch disc	Replace clutch disc
Incorrect transmission alignment	Realign transmission
Worn pressure plate, disc or flywheel	Replace damaged components
Broken or weak pressure springs	Replace pressure plate
Sticking clutch pedal	Lubricate clutch pedal & linkage
Incorrect clutch disc facing	Replace clutch disc
Engine loose in chassis	Tighten all mounting bolts
Failure to Release	
Oil or grease on clutch facings	Clean or replace clutch disc
Incorrect release lever or pedal adjustment	See CLUTCH article
Worn or broken clutch facings	Replace clutch disc
Bent clutch disc or pressure plate	Replace damaged components
Clutch disc hub binding on input shaft	Clean or replace clutch disc and/or input shaft
Binding pilot bearing	Replace pilot bearing
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Binding clutch cable	See CLUTCH article
Defective clutch master	Replace master cylinder
Defective clutch slave	Replace slave cylinder
Air in hydraulic system	Bleed hydraulic system
Rattling	
Weak or broken release lever spring	Replace spring and check alignment
Damaged pressure plate	Replace pressure plate

Broken clutch return spring	Replace return spring
Worn splines on clutch disc or input shaft	Replace clutch disc and/or input shaft
Worn clutch release bearing	Replace release bearing
Dry or worn pilot bearing	Lubricate or replace pilot bearing
Unequal release lever contact	Align or replace release lever
Incorrect pedal free play	Adjust free play
Warped or damaged clutch disc	Replace damaged components
Slipping	
Pressure springs worn or	Release pressure plate
Oily, greasy or worn facings	Clean or replace clutch disc
Incorrect clutch alignment	Realign clutch assembly
Warped clutch disc or pressure plate	Replace damaged components
Binding release levers or clutch pedal	Lubricate and/or replace release components
Squeaking	
Worn or damaged release	Replace release bearing
Dry or worn pilot or release bearing	Lubricate or replace assembly
Pilot bearing turning in crankshaft	Replace pilot bearing and/or crankshaft
Worn input shaft bearing	Replace bearing and seal
Incorrect transmission alignment	Realign transmission
Dry release fork between pivot	Lubricate release fork and pivot
Heavy and/or Stiff Pedal	
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Dry or binding clutch pedal hub	Lubricate and align components
Floor mat interference with pedal	Lay mat flat in proper area
Dry or binding ball/fork pivots	Lubricate and align components
Faulty clutch cable	Replace clutch cable
Noisy Clutch Pedal	
Faulty interlock switch	Replace interlock switch
Self-adjuster ratchet noise	Lubricate or replace self-adjuster
Speed control interlock switch	Lubricate or replace interlock switch
Clutch Pedal Sticks Down	
Binding clutch cable	See CLUTCH article
Springs weak in pressure plate	Replace pressure plate
Binding in clutch linkage	Lubricate and free linkage
Noisy	
Dry release bearing	Lubricate or replace release bearing

Dry or worn pilot bearing	Lubricate or replace bearing
Worn input shaft bearing	Replace bearing
Transmission Click	
Weak springs in pressure	Replace pressure plate plate
Release fork loose on ball stud	Replace release fork and/or ball stud
Oil on clutch disc damper	Replace clutch disc
Broken spring in slave cylinder	Replace slave cylinder

DRIVE AXLE - NOISE DIAGNOSIS

Unrelated Noises

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. Ensure cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any of its parts.

Non-Drive Axle Noises

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and wheel trim rings.

In certain conditions, the pitch of the exhaust gases may e gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings also can cause a whistling or whining noise. Ensure none of these components are causing the noise before disassembling the drive axle.

Gear Noise

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear ke sure that tires, exhaust, and vehicle trim have been checked as possible causes.

Chuckle

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The

frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused by clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough to cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

Knock

This is very similar to a chuckle, though it may be louder, and occur on acceleration or deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

Clunk

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1. Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.
2. On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in Drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in Drive condition.
3. Measure the length of the chalk mark, which is the total axle backlash. If backlash is one inch or less, drive axle is not the source of clunk noise.

Bearing Whine

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at drive shaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of drive shaft speed.

Chatter On Turns

This is a condition where the entire front or rear of vehicle vibrates when vehicle is moving. The vibration is plainly felt as well as heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates this chatter.

Axle Shaft Noise

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (Drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect parts, replace wheel seals and install a new set of bearings. Re-evaluate vehicle for noise before removing any internal components.

Vibration

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and can occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can be divided into 3 main groups:

- Vibrations of various unbalanced rotating parts of the vehicle.
- Resonance vibrations of the body and frame structures caused by rotating of unbalanced parts.
- Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

DRIVE AXLE - RWD TROUBLE SHOOTING

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DRIVE AXLE (RWD) TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Knocking or Clunking	
Differential Side Gear Clearance	Check Clearance
Worn Pinion Shaft	Replace Pinion Shaft
Axle Shaft End Play	Check End Play
Missing Gear Teeth	Check Differential/Replace Gear
Wrong Axle Backlash	Check Backlash
Misaligned Driveline	Realign Driveline
Clinking During Engagement	
Side Gear Clearance	Check Clearance
Ring and Pinion Backlash	Check Backlash
Worn/Loose Pinion Shaft	Replace Shaft/Bearing

Bad "U" Joint	Replace "U" Joint
Sticking Slip Yoke	Lube Slip Yoke
Broken Rear Axle Mount	Replace Mount
Loose Drive Shaft Flange	Check Flange
Click/Chatter On Turns	
Differential Side Gear Clearance	Check Clearance
Wrong Turn On Plates ⁽¹⁾	Replace Clutch Plates
Wrong Differential Lubricant ⁽¹⁾	Change Lubricant
Knock Or Click	
Flat Spot on Rear Wheel Bearing	Replace Wheel Bearing
Low Vibration At All Speeds	
Faulty Wheel Bearing	Replace Wheel Bearing
Faulty "U" Joint	Replace "U" Joint
Faulty Drive Shaft	Balance Drive Shaft
Faulty Companion Flange	Replace Flange
Faulty Slip Yoke Flange	Replace Flange
⁽¹⁾ Limited slip differential only.	

FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING

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BASIC FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Grease Leaks	CV boot torn or cracked
Clicking Noise on Cornering	Damaged outer CV
Clunk Noise on Acceleration	Damaged inner CV
Vibration or Shudder on Acceleration	Sticking, damaged or worn CV Misalignment or spring height

STEERING & SUSPENSION

MANUAL STEERING GEAR TROUBLE SHOOTING

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DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC MANUAL STEERING GEAR TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise in Rack and Pinion	
Rack and pinion mounting bracket loose	Tighten all mounting bolts
Lack of/or incorrect lubricant	Correct as necessary
Steering gear mounting bolts loose	Tighten all mounting bolts
Excessive Play	
Front wheel bearing improperly adjusted	See FRONT SUSPENSION article
Loose or worn steering linkage	See STEERING LINKAGE article
Loose or worn steering gear shift	See MANUAL STEERING GEAR article
Steering arm loose on gear shaft	See MANUAL STEERING GEAR article
Steering gear housing bolts loose	Tighten all mounting bolts
Steering gear adjustment too loose	See MANUAL STEERING GEAR article
Steering arms loose on knuckles	Tighten and check steering linkage
Rack and pinion mounting loose	Tighten all mounting bolts
Rack and pinion out of adjustment	See adjustment in STEERING article
Tie rod end loose	Tighten and check steering linkage
Excessive Pitman shaft-to-ball nut lash	Repair as necessary
Poor Returnability	
Lack of lubricant in ball joint or linkage	Lubricate and service systems
Binding in linkage or ball joints	See STEERING LINKAGE and SUSPENSION article
Improper front end alignment	See WHEEL ALIGNMENT article
Improper tire pressure	Inflate to proper pressure
Tie rod binding	Inflate to proper pressure
Shaft seal rubbing shaft	See STEERING COLUMN article
Excessive Vertical Motion	
Improper tire pressure	Inflate to proper pressure
Tires, wheels or rotors out of balance	Balance tires then check wheels and rotors
Worn or faulty shock absorbers	Check and replace if necessary

Loose tie rod ends or steering	Tighten or replace if necessary
Loose or worn wheel bearings	See SUSPENSION article
Steering Pulls to One Side	
Improper tire pressure	Inflate to proper pressure
Front tires are different sizes	Rotate or replace if necessary
Wheel bearings not adjusted properly	See FRONT SUSPENSION article
Bent or broken suspension components	See FRONT SUSPENSION article
Improper wheel alignment	See WHEEL ALIGNMENT article
Brakes dragging	See BRAKES article
Instability	
Low or uneven tire pressure	Inflate to proper pressure
Loose or worn wheel bearings	See FRONT SUSPENSION article
Loose or worn idler arm bushing	See FRONT SUSPENSION article
Loose or worn strut bushings	See FRONT SUSPENSION article
Incorrect front wheel alignment	See WHEEL ALIGNMENT article
Steering gear not centered	See MANUAL STEERING GEARS article
Springs or shock	Check and replace if necessary
Improper cross shaft	See MANUAL STEERING GEARS article

POWER STEERING TROUBLE SHOOTING

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BASIC POWER STEERING TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise	
Pressure hoses touching engine parts	Adjust to proper clearance
Loose Pitman shaft	Adjust or replace if necessary
Tie rods ends or Pitman arm loose	Tighten and check system
Rack and pinion mounts loose	Tighten all mounting bolts

Free play in worm gear	See POWER STEERING GEAR article
Loose sector shaft or thrust bearing adjustment	See POWER STEERING GEAR
Free play in pot coupling	See STEERING COLUMN article
Worn shaft serrations	See STEERING COLUMN article
Growl in Steering Pump	
Excessive pressure in hoses	Restricted hoses, see POWER STEERING GEAR article
Scored pressure plates	See POWER STEERING GEAR article
Scored thrust plates or rotor	See POWER STEERING GEAR article
Extreme wear of cam ring	See POWER STEERING GEAR article
Rattle in Steering Pump	
Vanes not installed	See POWER STEERING PUMP article
Vanes sticking in rotor	See POWER STEERING PUMP article
Swish noise in Pump	
Defective flow control valve	See POWER STEERING PUMP article
Groan in Steering Pump	
Air in fluid	See POWER STEERING PUMP article
Poor pressure hose connection	Tighten and check, replace if necessary
Squawk When Turning	
Damper "O" ring on valve spool cut	See POWER STEERING PUMP article
Moan or Whine in Pump	
Pump shaft bearing scored	Replace bearing and fluid
Air in fluid or fluid level low	See POWER STEERING PUMP article
Hose or column grounded	Check and replace if necessary
Cover "O" ring missing or damaged	See POWER STEERING PUMP article
Valve cover baffle missing or damaged	See POWER STEERING PUMP article
Interference of components in pump	See POWER STEERING

	PUMP article
Loose or poor bracket alignment	Correct or replace if necessary
Hissing When Parking	
Internal leakage in steering gear	Check valved assembly first
Chirp in Steering Pump	
Loose or worn power steering belt	Adjust or replace if necessary
Buzzing When Not Steering	
Noisy pump	See POWER STEERING PUMP article
Free play in steering shaft bearing	See STEERING COLUMN article
Bearing loose on shaft serrations	See STEERING COLUMN article
Clicking Noise in Pump	
Pump slippers too long	See POWER STEERING PUMP article
Broken slipper springs	See POWER STEERING PUMP article
Excessive wear or nicked rotors	See POWER STEERING PUMP article
Damaged cam contour	See POWER STEERING PUMP article
Poor Return of Wheel	
Wheel rubbing against turn signal	See STEERING COLUMN SWITCHES article
Flange rubbing steering gear adjuster	See STEERING COLUMN article
Tight or frozen steering shaft bearing	See STEERING COLUMN article
Steering gear out of adjustment	See POWER STEERING GEAR article
Sticking or plugged spool valve	See POWER STEERING PUMP article
Improper front end alignment	See WHEEL ALIGNMENT article
Wheel bearings worn or loose	See FRONT SUSPENSION article
Ties rods or ball joints binding	Check and replace if necessary
Intermediate shaft joints binding	See STEERING COLUMN article
Kinked pressure hoses	Correct or replace if necessary
Loose housing head spanner nut	See POWER STEERING GEAR article

Damaged valve lever	See POWER STEERING GEAR article
Sector shaft adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Worm thrust bearing adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Reaction ring sticking in cylinder	See POWER STEERING GEAR article
Reaction ring sticking in housing head	See POWER STEERING GEAR article
Steering pump internal leakage	See POWER STEERING PUMP article
Steering gear-to-column misalignment	See STEERING COLUMN article
Lack of lubrication in linkage	Service front suspension
Lack of lubrication in ball joints	Service front suspension
Increased Effort When Turning Wheel Fast Foaming, Milky Power Steering Fluid, Low Fluid Level or Low Pressure	
High internal pump leakage	See POWER STEERING PUMP article
Power steering pump belt slipping	Adjust or replace if necessary
Low fluid level	Check and fill to proper level
Engine idle speed too low	Adjust to correct setting
Air in pump fluid system	See POWER STEERING PUMP article
Pump output low	See POWER STEERING PUMP article
Steering gear malfunctioning	See POWER STEERING GEAR article
Wheel Surges or Jerks	
Low fluid level	Check and fill to proper level
Loose fan belt	Adjust or replace if necessary
Insufficient pump pressure	See POWER STEERING PUMP article
Sticky flow control valve	See POWER STEERING PUMP article
Linkage hitting oil pan at full turn	Replace bent components
Kick Back or Free Play	
Air in pump fluid system	See POWER STEERING PUMP article
Worn poppet valve in steering gear	See POWER STEERING PUMP article

Excessive over center lash	See POWER STEERING GEAR article
Thrust bearing out of adjustment	See POWER STEERING GEAR article
Free play in pot coupling	See POWER STEERING PUMP article
Steering gear coupling loose on shaft	See POWER STEERING PUMP article
Steering disc mounting bolts loose	Tighten or replace if necessary
Coupling loose on worm shaft	Tighten or replace if necessary
Improper sector shaft adjustment	See POWER STEERING GEAR article
Excessive worm piston side play	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Universal joint loose	Tighten or replace if necessary
Defective rotary valve	See POWER STEERING GEAR article
No Power When Parking	
Sticking flow control valve	See POWER STEERING PUMP article
Insufficient pump pressure output	See POWER STEERING PUMP article
Excessive internal pump leakage	See POWER STEERING PUMP article
Excessive internal gear leakage	See POWER STEERING PUMP article
Flange rubs against gear adjust plug	See STEERING COLUMN article
Loose pump belt	Adjust or replace if necessary
Low fluid level	Check and add proper amount of fluid
Engine idle too low	Adjust to correct setting
Steering gear-to-column misaligned	See STEERING COLUMN article
No Power, Left Turn	
Left turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Left turn reaction seal damaged/missing	See POWER STEERING GEAR article

Cylinder head "O" ring damaged	See POWER STEERING PUMP article
No Power, Right Turns	
Column pot coupling bottomed	See STEERING COLUMN article
Right turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Right turn reaction seal damaged	See POWER STEERING GEAR article
Internal leakage through piston end plug	See POWER STEERING GEAR article
Internal leakage through side plugs	See POWER STEERING GEAR article
Lack of Effort in Turning	
Left and/or right reaction seal sticking in cylinder head	Replace, see POWER STEERING GEAR article
Wanders to One Side	
Front end alignment incorrect	See WHEEL ALIGNMENT article
Unbalanced steering gear valve	See POWER STEERING GEAR article
Low Pressure Due to Steering Pump	
Flow control valve stuck or inoperative	See POWER STEERING PUMP article
Pressure plate not flat against cam ring	See POWER STEERING PUMP article
Extreme wear of cam ring	Replace and check adjustments
Scored plate, thrust plate or rotor	See POWER STEERING PUMP article
Vanes not installed properly	See POWER STEERING PUMP article
Vanes sticking in rotor slots	See POWER STEERING PUMP article
Cracked/broken thrust or pressure plate	See POWER STEERING PUMP article

STEERING COLUMN TROUBLE SHOOTING

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BASIC STEERING COLUMN TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Noise in Steering	
Coupling pulled apart	See STEERING COLUMNS article
Column not correctly aligned	See STEERING COLUMNS article
Broken lower joint	Replace joint
Horn contact ring not	See STEERING COLUMN article
Bearing not lubricated	See STEERING COLUMN article
Shaft snap ring not properly seated	Reseat or replace snap ring
Plastic spherical joint not lubricated	See STEERING COLUMN article
Shroud or housing loose	Tighten holding screws
Lock plate retaining ring not seated	See STEERING COLUMN article
Loose sight shield	Tighten holding screws
High Steering Shaft Effort	
Column assembly misaligned	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Tight steering universal joint	See STEERING COLUMN article
High Shift Effort	
Column is out of alignment	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Seals or bearings not lubricated	See STEERING COLUMNS article
Mounting bracket screws too long	Replace with new shorter screws
Burrs on shift tube	Remove burrs or replace tube
Lower bowl bearing assembled wrong	See STEERING COLUMN article
Shift tube bent or broken	Replace as necessary
Improper adjustment of shift levers	See STEERING COLUMN article
Improper Trans. Shifting	
Sheared shift tube joint	Replace as necessary
Sheared lower shaft lever	Replace as necessary
Improper shift lever adjustment	See STEERING COLUMN

	article
Improper gate plate adjustment	See STEERING COLUMN article
Excess Play in Column	
Instrument panel bracket bolts loose	Tighten bolts and check bracket
Broken weld nut on jacket	See STEERING COLUMN article
Instrument bracket capsule sheared	See STEERING COLUMN article
Column bracket/jacket bolts loose	Tighten bolts and check bracket
Steering Locks in Gear	
Release lever mechanism	See STEERING COLUMN article

SUSPENSION TROUBLE SHOOTING

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BASIC SUSPENSION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Front End Noise	
Loose or worn wheel	See Wheel Bearing Adjustment in SUSPENSION
Worn shocks or shock mountings	Replace struts or strut mountings
Worn struts or strut mountings	Replace struts or strut mountings
Loose or worn lower control arm	See SUSPENSION
Loose steering gear-to-frame bolts	See STEERING
Worn control arm bushings	See SUSPENSION
Ball joints not lubricated	Lubricate ball joints & see Ball Joint Checking in SUSPENSION
Front Wheel Shake, Shimmy, or Vibration	
Tires or wheels out of balance	Check tire balance
Incorrect wheel alignment	See WHEEL ALIGNMENT
Drive shaft unbalanced	Check drive shaft balance
Loose or worn wheel bearings	See WHEEL ALIGNMENT

Loose or worn tie rod ends	See SUSPENSION
Worn upper ball joints	See Ball Joint Checking in SUSPENSION
Worn shock absorbers	Replace shock absorbers
Worn strut bushings	Replace strut bushings
Car Pulls to One Side	
Mismatched or uneven tires	Check tire condition
Broken or sagging springs	See SUSPENSION
Loose or worn strut bushings	See SUSPENSION
Improper wheel alignment	See WHEEL ALIGNMENT
Improper rear axle alignment	Check rear axle alignment
Power steering gear unbalanced	See STEERING
Front brakes dragging	See BRAKES
Abnormal Tire Wear	
Unbalanced tires	Check tire balance & rotation
Sagging or broken springs	See SUSPENSION
Incorrect front end alignment	See WHEEL ALIGNMENT
Faulty shock absorbers	Replace chock absorbers
Scuffed Tires	
Toe-In incorrect	See WHEEL ALIGNMENT
Suspension arm bent or twisted	See appropriate SUSPENSION article
Springs Bottom or Sag	
Bent or broken springs	See SUSPENSION
Leaking or worn shock absorbers	Replace shock absorbers
Frame misalignment	Check frame for damage
Spring Noises	
Loose "U" Bolts	See SUSPENSION
Loose or worn bushings	See SUSPENSION
Worn or missing interliners	See SUSPENSION
Shock Absorber Noise	
Loose shock mountings	Check & tighten mountings
Worn bushings	Replace bushings
Air in system	Bleed air from system
Undercoating on shocks	Remove undercoating
Car Leans or Sways on Corners	
Loose stabilizer bar	See SUSPENSION
Faulty shocks or mountings	Replace shocks or mountings
Broken or sagging springs	See SUSPENSION
Shock Absorbers Leaking	
Worn seals or reservoir tube crimped	See SUSPENSION

Broken Springs	
Loose "U" bolts	See SUSPENSION
Inoperative shock absorbers	Replace shock absorbers

WHEEL ALIGNMENT TROUBLE SHOOTING

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BASIC WHEEL ALIGNMENT TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Premature Tire Wear	
Improper tire inflation	Check tire pressure
Front alignment out of tolerance	See ALIGNMENT SPECS in WHEEL ALIGNMENT section
Suspension components worn	See SUSPENSION section
Steering system components worn	See STEERING section
Improper standing height	See WHEEL ALIGNMENT
Uneven or sagging springs	See SUSPENSION section
Bent wheel	See WHEEL ALIGNMENT
Improper torsion bar adjustment	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARING ADJ. in SUSPENSION section
Worn or defective shock	Replace shock absorbers
Tires out of balance	Check tire balance
Pulls to One Side	
Improper tire inflation	Check tire pressure
Brake dragging	See BRAKE section
Mismatched tires	See WHEEL ALIGNMENT
Broken or sagging spring	See SUSPENSION section
Broken torsion bar	See SUSPENSION section
Power steering valve not centered	See STEERING section
Front alignment out of tolerance	See WHEEL ALIGNMENT section
Defective wheel bearing	See WHEEL BEARINGS in SUSPENSION section
Uneven sway bar links	See SUSPENSION section
Frame bent	Check for frame damage
Steering system bushing worn	See STEERING section

Hard Steering

Idler arm bushing too tight	See STEERING LINKAGE in STEERING section
Ball joint tight or seized	See SUSPENSION section
Steering linkage too tight	See STEERING LINKAGE in STEERING section
Power steering fluid low	Add proper amount of fluid
Power steering drive belt loose	See STEERING section
Power steering pump defective	See STEERING section
Steering gear out of adjustment	See STEERING section
Incorrect wheel alignment	See WHEEL ALIGNMENT
Damaged steering gear	See STEERING section
Damaged suspension	See SUSPENSION section
Bent steering knuckle or supports	See SUSPENSION section

Vehicle "Wanders"

Strut rod or control arm bushing worn	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARINGS in SUSPENSION section
Improper tire inflation	Check tire pressure
Stabilizer bar missing or defective	See SUSPENSION section
Wheel alignment out of tolerance	See Adjustment in WHEEL ALIGNMENT section
Broken spring	See SUSPENSION section
Defective shock absorber	Replace shock absorbers
Worn steering & suspension components	See SUSPENSION section

Front End Shimmy

Tire out of balance/round	Check tire balance
Excessive wheel runout	See WHEEL ALIGNMENT
Insufficient or improper caster	See WHEEL ALIGNMENT section
Worn suspension or steering components	See SUSPENSION section
Defective shock absorbers	Replace shock absorber
Wheel bearings worn or loose	See WHEEL BEARING ADJ. in SUSPENSION section
Power steering reaction Bracket loose	See STEERING section
Steering gear box (rack) mounting loose	See STEERING section
Steering gear adjustment loose	See STEERING section
Worn spherical joints	See SUSPENSION section

Toe-In Not Adjustable

Lower control arm bent	See SUSPENSION section
Frame bent	Check frame for damage

Camber Not Adjustable

Control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Hub & bearing not seated properly	See SUSPENSION section

ACCESSORIES & EQUIPMENT

Bolted Exterior Body Panels and Closures

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Bumper Energy Absorber	115	85 lb ft
Front End Upper Tie Bar	22	16 lb ft
Front Fender	9	80 lb in
Front Side Door Check Link - Body Side	22	16 lb ft
Front Side Door Check Link - Door Side	9	80 lb in
Front Side Door - Door Side	25	18 lb ft
Front Side Door Hinge	22	16 lb ft
Front Side Door- Hinge	25	18 lb ft
Headlamp Mount Panel Outer Bracket	9	80 lb in
Hood	9	80 lb in
Hood Front Bumper Bracket	22	16 lb ft
Hood Hinge	9	80 lb in
Hood Hinge Bracket	22	16 lb ft
Horn	17	12 lb ft
Rear Bumper Impact Bar	40	29 lb ft
Rear Compartment Lid	22	16 lb ft
Rear Compartment Lid Hinge	22	16 lb ft
Rear Side Door Check Link - Body Side	22	16 lb ft
Rear Side Door Check Link - Door Side	9	80 lb in
Rear Side Door - Door Side	25	18 lb ft
Rear Side Door Hinge	22	16 lb ft
Rear Side Door - Hinge	25	18 lb ft

SCHEMATIC WIRING DIAGRAMS

HOOD LATCH WIRING SCHEMATICS

Hood Ajar Switch (except CZ2)

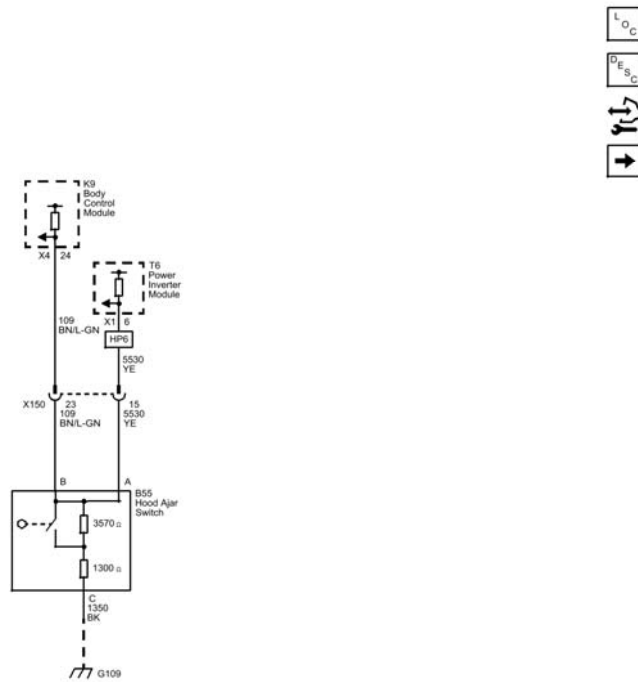


Fig. 1: Hood Ajar Switch (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

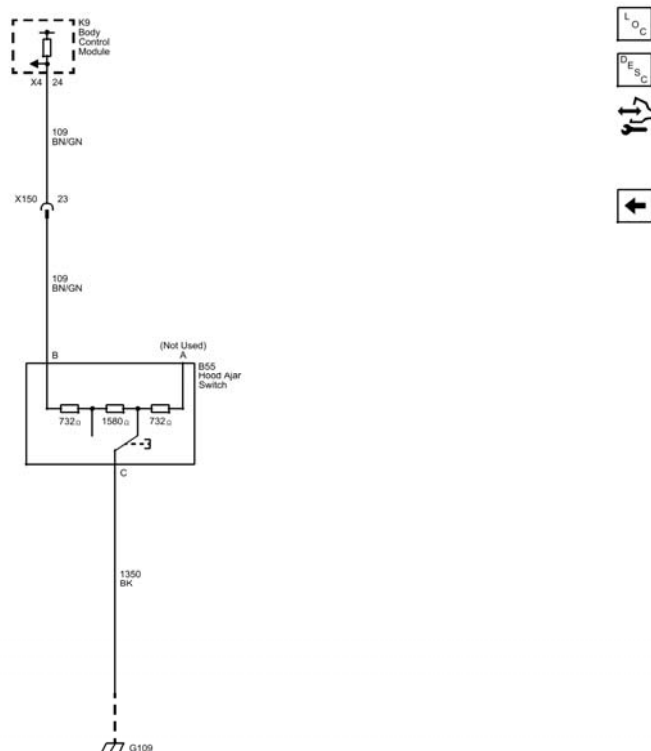


Fig. 2: Hood Ajar Switch (CZ2)

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B3006</u>	DTC B3006 01 Hood Ajar Circuit Short to Battery DTC B3006 02 Hood Ajar Circuit Short to Ground DTC B3006 04 Hood Ajar Circuit Open
<u>DTC P257D-P257F</u>	DTC P257D Engine Hood Switch Performance DTC P257E Engine Hood Switch Circuit Low Voltage DTC P257F Engine Hood Switch Circuit High Voltage

DTC B3006: HOOD AJAR CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3006 01

Hood Ajar Circuit Short to Battery

DTC B3006 02

Hood Ajar Circuit Short to Ground

DTC B3006 04

Hood Ajar Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal B	B3006 02	B3006 04	B3006 01	-
Signal - Terminal A*	P257E	P257F	P257F	P257D
Ground	-	B3006 04, P257F*	-	-
*with LUK				

Circuit/System Description

The Body Control Module applies B+ to the hood ajar signal circuit and monitors the voltage to determine the position of the hood. When the hood is closed, the switch is open and voltage remains high. When the hood is open, the switch is closed and the voltage is pulled low.

Conditions for Running the DTC

The Body Control Module continuously monitors for this DTC

Conditions for Setting the DTC

B3006 01

The Body Control Module detects that the hood ajar switch signal circuit is shorted to battery.

B3006 02

The Body Control Module detects that the hood ajar switch signal circuit is shorted to ground.

B3006 04

The Body Control Module detects that the hood ajar switch signal circuit is open.

Action Taken When the DTC Sets

- The hood ajar switch input will be ignored as a content theft deterrent trigger.
- Remote vehicle start will be disabled.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction free ignition cycles.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM) , Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Body Control Module Hood Ajar Switch parameter is Open with the hood open and Closed with the hood closed
 - **If the parameter does not change**

Refer to Circuit/System Testing.
 - **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B55 Hood Ajar Switch. It may take up to two minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal C and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for greater than 11.5 V between the signal circuit terminal B and ground.
 - **If 11.5 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If Infinite resistance.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 11.5 V**
5. Ignition OFF, disconnect the X4 and X7 harness connector at the K9 Body Control Module, ignition ON.
6. Test for less than 1 V between the signal circuit terminal B and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

 - **If less than 1 V**
7. Test or replace the B55 Hood Ajar Switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B55 Hood Ajar Switch.
2. Test for 2738-3350 ohms between the signal terminal A and the signal terminal B with the hood latch in the CLOSED position.
 - **If not between 2738-3350 ohms**

Replace the B55 Hood Ajar Switch.

- **If between 2738-3350 ohms**
- 3. Test for 658-806 ohms between the signal terminal A and the ground terminal C with the hood latch in the CLOSED position.
 - **If not between 658-806 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 658-806 ohms**
- 4. Test for 2080-2545 ohms between the signal terminal B and the ground terminal C with the hood latch in the CLOSED position.
 - **If not between 2080-2545 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 2080-2545 ohms**
- 5. Test for 2738-3350 ohms between the signal terminal A and the signal terminal B with the hood latch in the OPEN position.
 - **If not between 2738-3350 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 2738-3350 ohms**
- 6. Test for 2080-2545 ohms between the signal terminal A and the ground terminal C with the hood latch in the OPEN position.
 - **If not between 2080-2545 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 2080-2545 ohms**
- 7. Test for 658-806 ohms between the signal terminal B and the ground terminal C with the hood latch in the OPEN position.
 - **If not between 658-806 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 658-806 ohms**
- 8. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Hood Primary Latch Replacement**
- **Control Module References** for Body Control Module replacement, programming, and setup

DTC P257D-P257F: ENGINE HOOD SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P257D

Engine Hood Switch Performance

DTC P257E

Engine Hood Switch Circuit Low Voltage

DTC P257F

Engine Hood Switch Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal B	B3006 02	B3006 04	B3006 01	-
Signal - Terminal A	P257E	P257F	P257F	P257D
Ground	-	B3006 04, P257F	-	-

Circuit/System Description

The Starter/Generator Control Module applies B+ to the hood ajar signal 2 circuit and monitors the voltage to determine the position of the hood. The hood ajar switch contains a multiplexed resistor. This resistor will vary the voltage seen by the Starter/Generator Control Module by pulling down the applied voltage based on the position of the switch.

Conditions for Running the DTC

Propulsion system is active.

Conditions for Setting the DTC

P257D

The hood ajar switch signal 2 voltage as measured by the Starter/Generator Control Module is not within a valid voltage range.

P257E

The hybrid powertrain control module 2 detects a short to ground in the hood ajar signal input to the Starter/Generator Control Module.

P257F

The hybrid powertrain control module 2 detects a short to voltage or an open/high resistance in the hood ajar signal input to the Starter/Generator Control Module.

Action Taken When the DTC Sets

The engine will start and run whenever the vehicle ignition is on or the vehicle speed is less than 5 kph (3 mph).

Conditions for Clearing the DTC

DTCs P257D, P257E, and P257F are Type B DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hood Ajar Indicator Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Hybrid Powertrain Control Module Hood Position parameter is Open when the hood

is open and Closed when the hood is closed.

- **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B55 Hood Ajar Switch. It may take up to two minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal C and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify DTC P257F is set as current
 - **If DTC P257F is not set as current**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K59 Starter/Generator Control Module.
 - **If DTC P257F is set as current**
5. Install a 5 A fused jumper wire between the signal circuit terminal A and ground. Ignition ON
6. Verify DTC P257E is set as current.
 - **If DTC P257E is not set as current**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If DTC P257E is set as current**
7. Test or replace the B55 Hood Ajar Switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B55 Hood Ajar Switch.
2. Test for 2738-3350 ohms between the signal terminal A and the signal terminal B with the hood latch in the CLOSED position.
 - **If not between 2738-3350 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 2738-3350 ohms**
3. Test for 658-806 ohms between the signal terminal A and the ground terminal C with the hood latch in the CLOSED position.
 - **If not between 658-806 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 658-806 ohms**
4. Test for 2080-2545 ohms between the signal terminal B and the ground terminal C with the hood latch in the CLOSED position.
 - **If not between 2080-2545 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 2080-2545 ohms**
5. Test for 2738-3350 ohms between the signal terminal A and the signal terminal B with the hood latch in the OPEN position.
 - **If not between 2738-3350 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 2738-3350 ohms**
6. Test for 2080-2545 ohms between the signal terminal A and the ground terminal C with the hood latch in the OPEN position.
 - **If not between 2080-2545 ohms**

Replace the B55 Hood Ajar Switch.
 - **If between 2080-2545 ohms**
7. Test for 658-806 ohms between the signal terminal B and the ground terminal C with the hood latch in the OPEN position.
 - **If not between 658-806 ohms**

Replace the B55 Hood Ajar Switch.

- If between 658-806 ohms
8. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Hood Primary Latch Replacement**
- **Control Module References** for Starter/Generator Control Module or Body Control Module replacement, programming, and setup

SYMPTOMS - BOLTED EXTERIOR BODY PANELS AND CLOSURES

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Hood Ajar Indicator Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to **Hood Ajar Indicator/Message Malfunction** in order to diagnose the symptom.

HOOD AJAR INDICATOR/MESSAGE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3006 01

Hood Ajar Circuit Short to Battery

DTC B3006 02

Hood Ajar Circuit Short to Ground

DTC B3006 04

Hood Ajar Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal B	B3006 02	B3006 04	B3006 01	-
Signal - Terminal A*	P257E	P257F	P257F	P257D
Ground	-	B3006 04, P257F*	-	-
*with LUK				

Circuit/System Description

The Body Control Module applies B+ to the hood ajar signal circuit and monitors the voltage to determine the position of the hood. When the hood is closed, the switch is open and voltage remains high. When the hood is open, the switch is closed and the voltage is pulled low.

Conditions for Running the DTC

The Body Control Module continuously monitors for this DTC

Conditions for Setting the DTC

B3006 01

The Body Control Module detects that the hood ajar switch signal circuit is shorted to battery.

B3006 02

The Body Control Module detects that the hood ajar switch signal circuit is shorted to ground.

B3006 04

The Body Control Module detects that the hood ajar switch signal circuit is open.

Action Taken When the DTC Sets

- The hood ajar switch input will be ignored as a content theft deterrent trigger.
- Remote vehicle start will be disabled.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction free ignition cycles.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM) , Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Body Control Module Hood Ajar Switch parameter is Open with the hood open and Closed with the hood closed
 - **If the parameter does not change**

Refer to Circuit/System Testing.
 - **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B55 Hood Ajar Switch. It may take up to two minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal C and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for greater than 11.5 V between the signal circuit terminal B and ground.
 - **If 11.5 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If Infinite resistance.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 11.5 V**
5. Ignition OFF, disconnect the X4 and X7 harness connector at the K9 Body Control Module, ignition ON.
6. Test for less than 1 V between the signal circuit terminal B and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

 - **If less than 1 V**
7. Test or replace the B55 Hood Ajar Switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B55 Hood Ajar Switch.
2. Test for 2738-3350 ohms between the signal terminal A and the signal terminal B with the hood latch in the CLOSED position.
 - **If not between 2738-3350 ohms**

Replace the B55 Hood Ajar Switch.

- **If between 2738-3350 ohms**

3. Test for 658-806 ohms between the signal terminal A and the ground terminal C with the hood latch in the CLOSED position.

- **If not between 658-806 ohms**

Replace the B55 Hood Ajar Switch.

- **If between 658-806 ohms**

4. Test for 2080-2545 ohms between the signal terminal B and the ground terminal C with the hood latch in the CLOSED position.

- **If not between 2080-2545 ohms**

Replace the B55 Hood Ajar Switch.

- **If between 2080-2545 ohms**

5. Test for 2738-3350 ohms between the signal terminal A and the signal terminal B with the hood latch in the OPEN position.

- **If not between 2738-3350 ohms**

Replace the B55 Hood Ajar Switch.

- **If between 2738-3350 ohms**

6. Test for 2080-2545 ohms between the signal terminal A and the ground terminal C with the hood latch in the OPEN position.

- **If not between 2080-2545 ohms**

Replace the B55 Hood Ajar Switch.

- **If between 2080-2545 ohms**

7. Test for 658-806 ohms between the signal terminal B and the ground terminal C with the hood latch in the OPEN position.

- **If not between 658-806 ohms**

Replace the B55 Hood Ajar Switch.

- **If between 658-806 ohms**

8. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Hood Primary Latch Replacement**
- **Control Module References** for Body Control Module replacement, programming, and setup

REPAIR INSTRUCTIONS

FRONT END UPPER TIE BAR REPLACEMENT

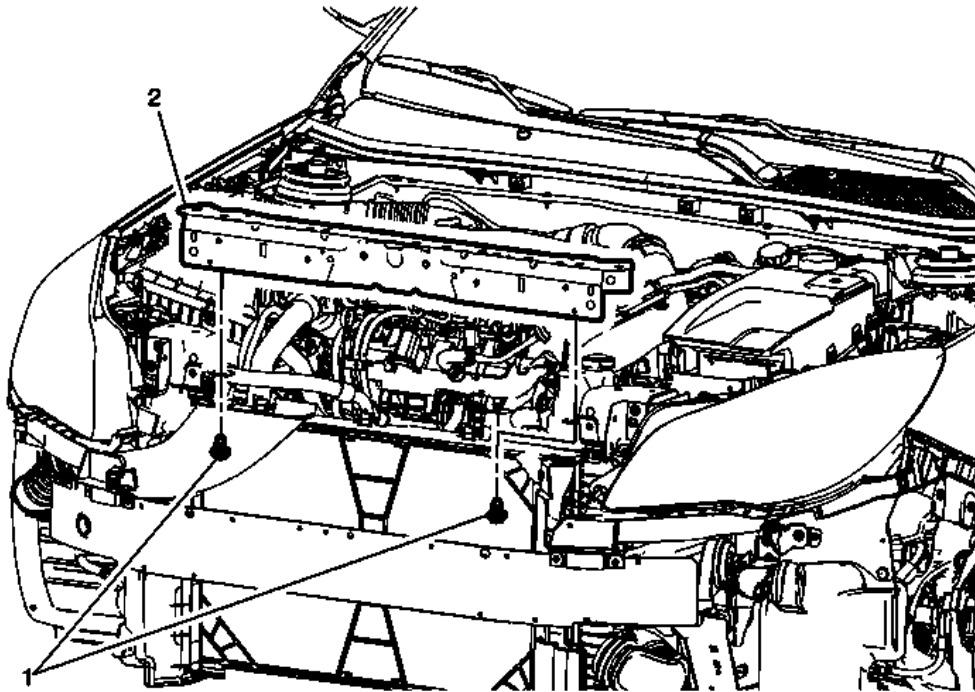


Fig. 3: Front End Upper Tie Bar
Courtesy of GENERAL MOTORS COMPANY

Front End Upper Tie Bar Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u>	
2. Remove the front bumper fascia upper support. Refer to <u>Front Bumper Fascia Center Support Replacement - Upper</u> .	
3. Remove the front bumper fascia lower support. Refer to <u>Front Bumper Fascia Center Support Replacement - Lower</u>	
4. Remove the hood primary latch. Refer to <u>Hood Primary Latch Replacement</u> .	
5. Remove the hood front bumper bracket. Refer to <u>Hood Front Bumper Bracket Replacement</u>	
6. Remove the forward radar range bracket. Refer to <u>Forward Range Radar Bracket Replacement</u>	
7. Reposition the hood latch cable from the front end upper tie bar.	
	Front End Upper Tie Bar Bolt (Qty: 2)
	CAUTION:

1	Refer to Fastener Caution . Tighten 20 (15 lb ft)
2	Front End Upper Tie Bar Procedure Transfer parts as necessary. Disconnect and unclip the wiring harness from the tie bar if needed.

DASH PANEL BRACE REPLACEMENT

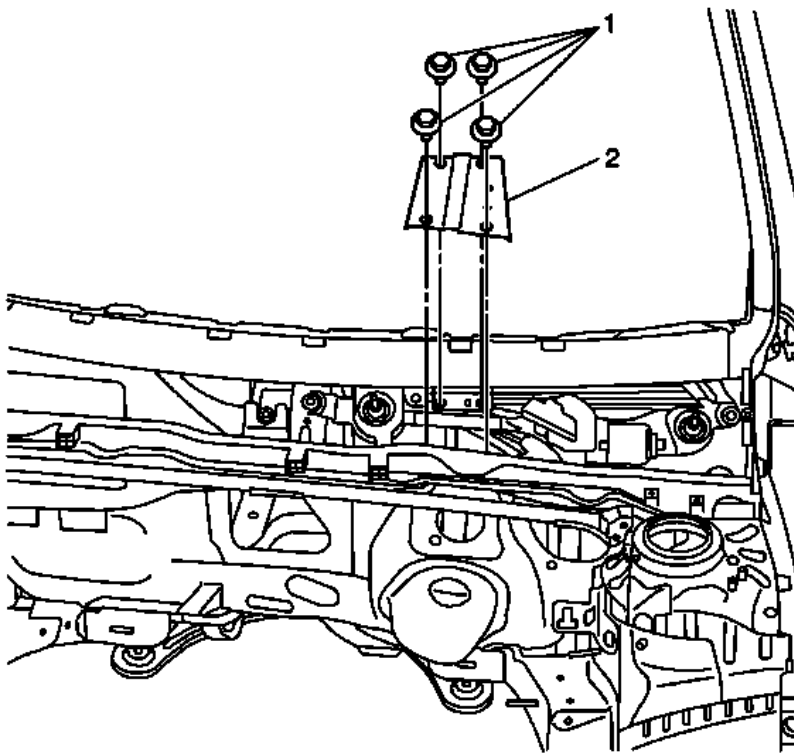


Fig. 4: Dash Panel Brace And Fasteners
Courtesy of GENERAL MOTORS COMPANY

Dash Panel Brace Replacement

Callout	Component Name
Preliminary Procedure Remove the air inlet panel. Refer to Air Inlet Grille Panel Replacement .	
1	Dash Panel Brace Fastener (Qty: 4) CAUTION: Refer to Fastener Caution .

	Tighten 22 N.m (16 lb ft)
2	Dash Panel Brace

HOOD ADJUST SIDE BUMPER REPLACEMENT

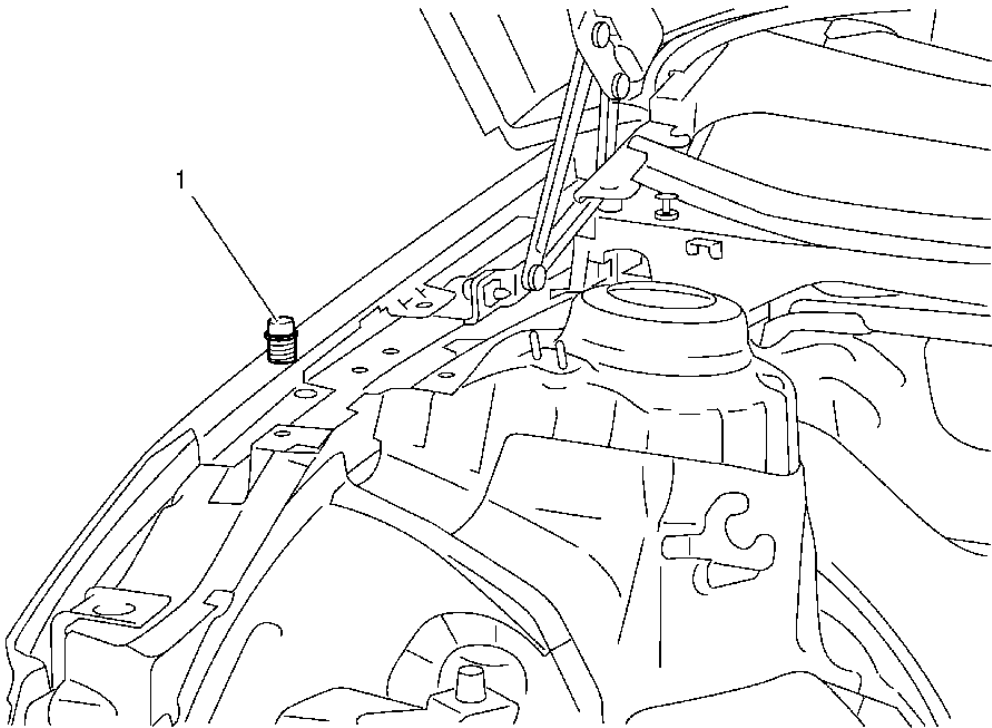


Fig. 5: Hood Adjust Side Bumper
 Courtesy of GENERAL MOTORS COMPANY

Hood Adjust Side Bumper Replacement

Callout	Component Name
1	Hood Adjust Side Bumper

HOOD PRIMARY LATCH RELEASE CABLE REPLACEMENT

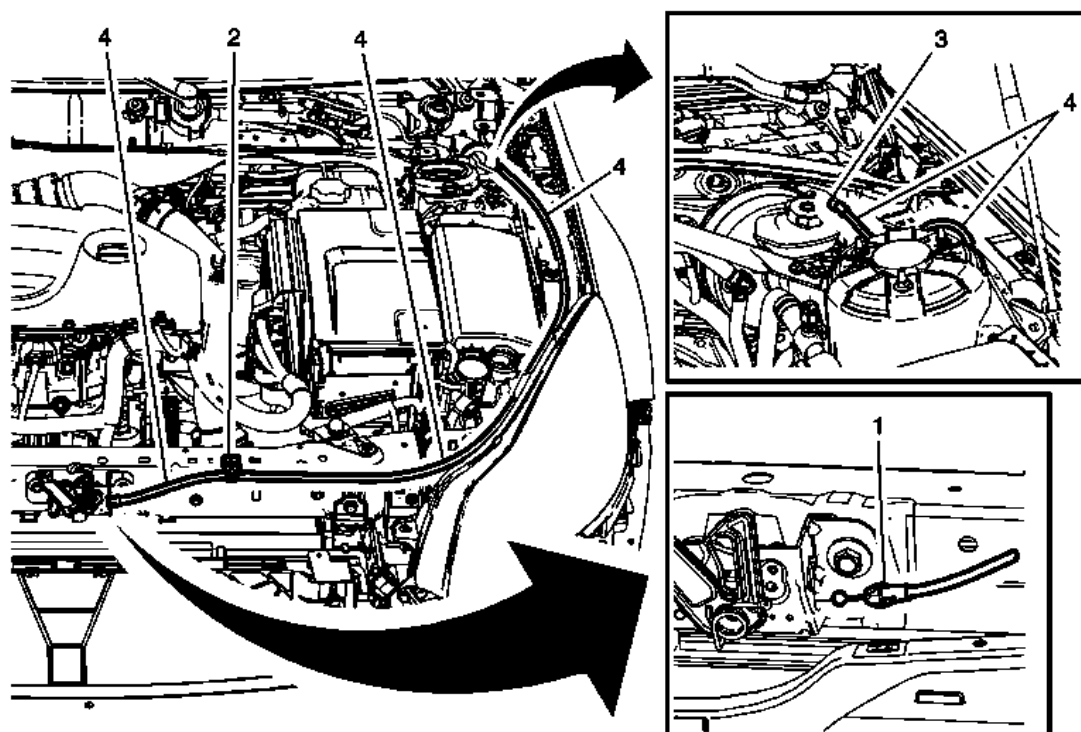


Fig. 6: Hood Primary Latch Release Cable & Components
 Courtesy of GENERAL MOTORS COMPANY

Hood Primary Latch Release Cable Replacement

Callout	Component Name
Preliminary Procedure Remove the plenum upper panel hole plug.	
1	Hood Primary Latch Cable Procedure Disconnect the hood primary latch release cable from the primary hood latch.
2	Hood Primary Latch Release Cable Retainer Procedure Disconnect the hood primary latch release cable from the hood primary latch release cable retainer.
3	Hood Primary Latch Release Cable Grommet
4	Hood Primary Latch Release Cable Procedure Disconnect the hood primary latch release cable handle from the hood latch cable bracket. Refer to <u>Hood Primary Latch Release Cable Handle Replacement</u> .

FRONT SIDE DOOR ADJUSTMENT

Up/Down or In/Out Adjustment

NOTE: The door side upper and lower hinge bolts must remain tight enough to

retain door adjusted position.

1. Loosen the bolts on the door side upper and lower hinges. Do not remove the bolts.
2. Adjust the door up or down by repositioning the door as needed.
3. Adjust the door in or out by repositioning the door as needed.

CAUTION: Refer to Fastener Caution .

4. Tighten the door side upper and lower hinge bolts to 25 (18 lb ft).

Fore/Aft Adjustment

1. Remove the front wheelhouse rear liner in order to gain access to the body side hinge bolts. Refer to **Front Wheelhouse Rear Liner Replacement** .
2. Adjust the door fore and aft by repositioning the door as needed.
3. Tighten the body side upper and lower hinge bolts to 32 (24 lb ft).
4. Install the front fender insulator.

FRONT SIDE DOOR REPLACEMENT

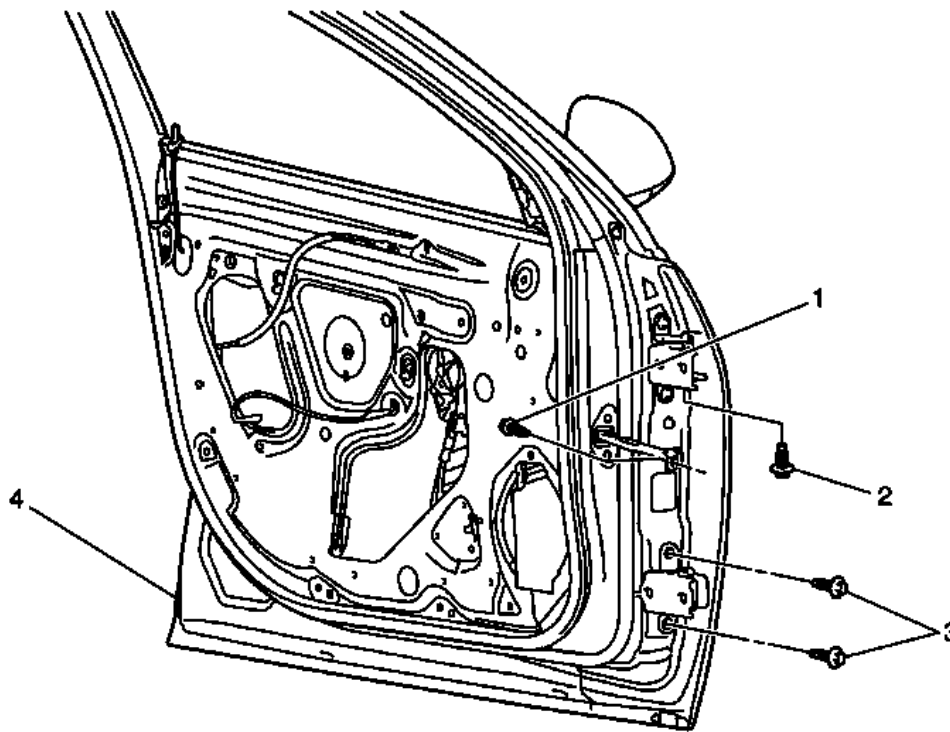


Fig. 7: Front Side Door & Mounting Components
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Replacement

Callout	Component Name
1	<p>Front Side Door Check Link Fastener</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none">1. Disconnect the door electrical connector.2. Support the door before removing the hinge fastener. <p>Tighten 22 N.m (16 lb ft)</p>
2	<p>Front Side Door Upper Hinge Fastener to Hinge</p> <p>Tighten 25 N.m (18 lb ft)</p>
3	<p>Front Side Door Hinge Fastener to Door (Qty: 2)</p> <p>Tighten 25 N.m (18 lb ft)</p>
4	<p>Front Side Door Assembly</p> <p>Procedure</p> <ol style="list-style-type: none">1. With the aid of an assistant, remove the door.2. When replacing the door it is necessary to transfer all of the internal components.3. Inspect door for proper alignment. Refer to <u>Front Side Door Adjustment</u>.

REAR SIDE DOOR ADJUSTMENT

Removal Procedure

Up/Down or In/Out Adjustment

1. Open the rear door.

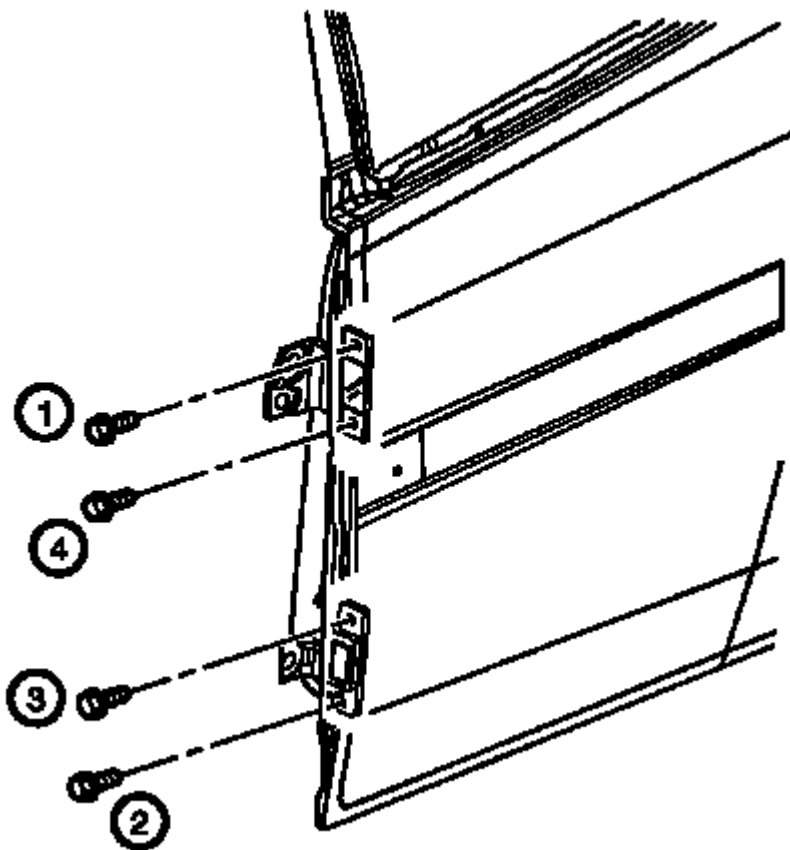


Fig. 8: Door Side Upper and Lower Hinges
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Paint Damage Caution .

NOTE: The door side upper and lower hinge bolts must remain tight enough to retain door adjusted position.

2. Apply masking tape to the fender and the door edges.

Loosen the door side hinge bolts in the specified sequence (1, 2, 3, 4).

Do not remove the bolts from the door.

3. Adjust the door up or down by repositioning the door as needed.
4. Adjust the door in or out by repositioning the door as needed.

Installation Procedure

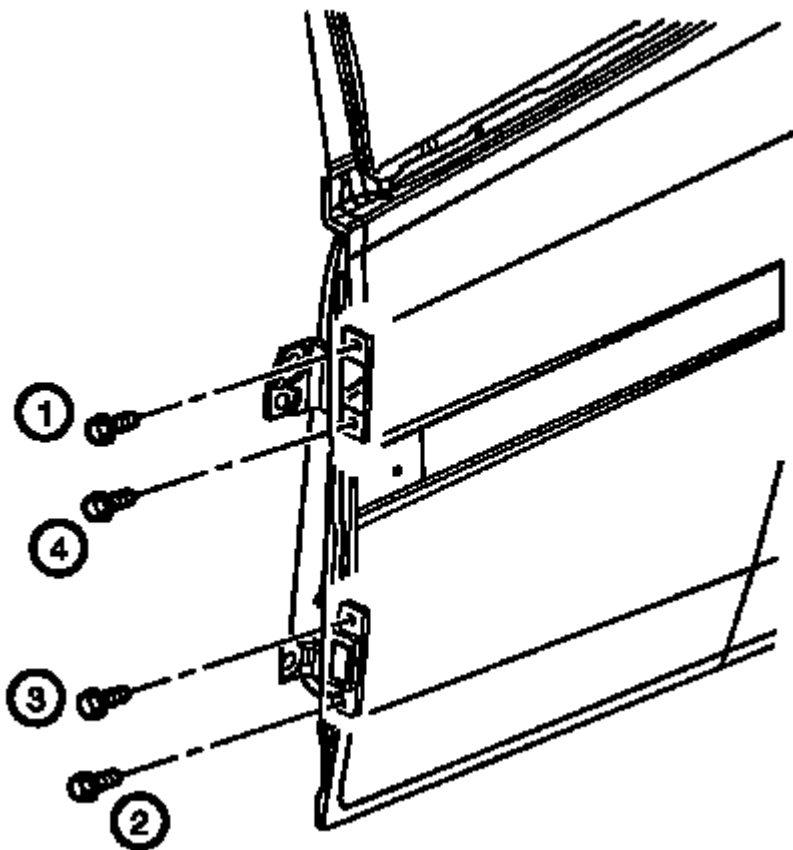


Fig. 9: Door Side Upper and Lower Hinges
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the door side hinge bolts in the specified sequence (1, 2, 3, 4).

Tighten

Tighten the bolts to 25 N.m (18 lb ft).

2. Inspect the door for proper operation and alignment.
3. Remove the masking tape.

Removal Procedure

Fore/Aft Adjustment

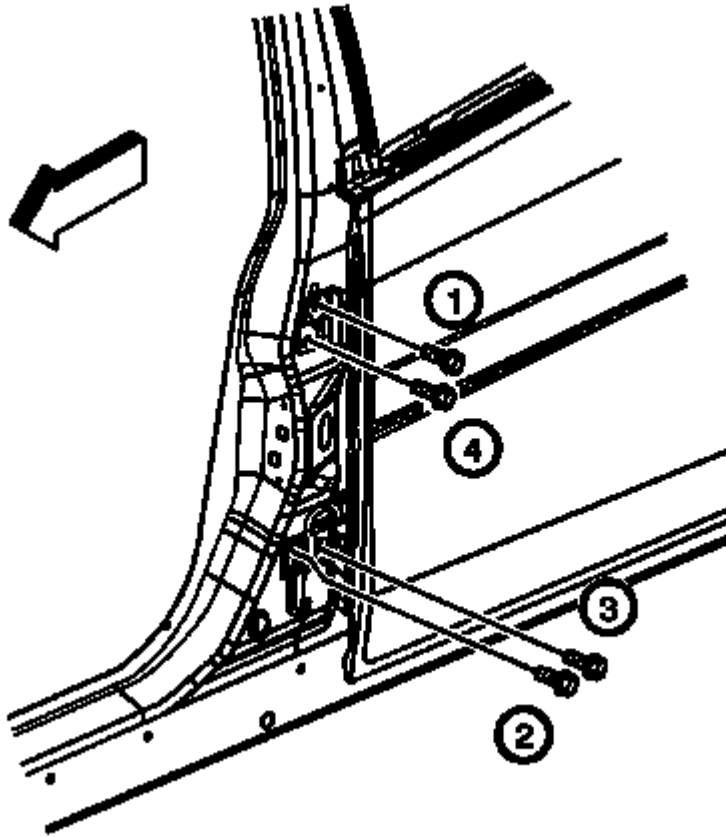


Fig. 10: Hinge Pillar Side Bolts (Rear Door)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Paint Damage Caution .

NOTE: The door side upper and lower hinge bolts must remain tight enough to retain door adjusted position.

1. Apply masking tape to the fender and door edges.

Loosen the body side hinge bolts in the specified sequence (1, 2, 3, 4).

Do not remove the bolts from the door.

2. Adjust the door fore and aft by repositioning the door as needed.

Installation Procedure

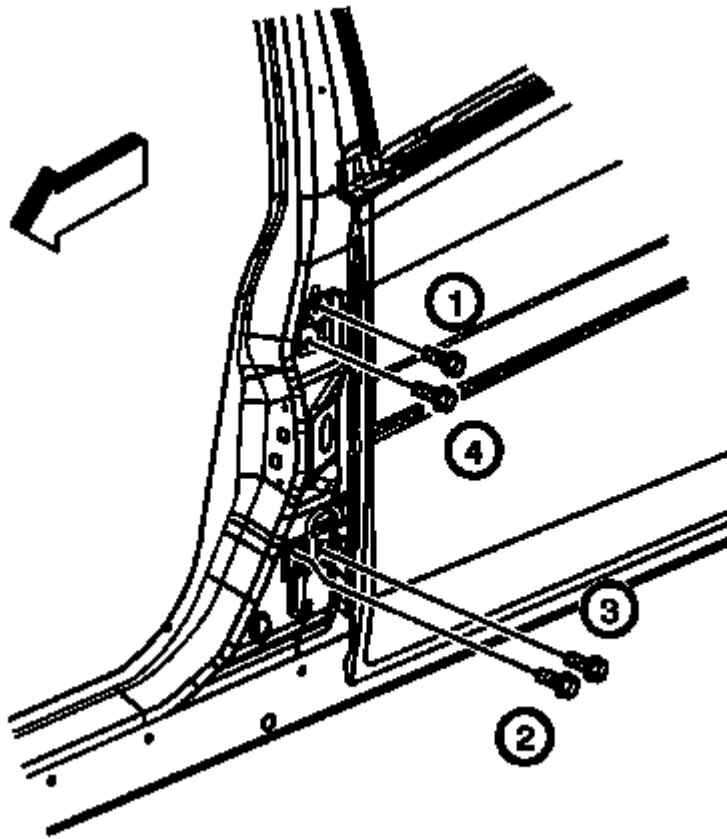


Fig. 11: Hinge Pillar Side Bolts (Rear Door)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the body side hinges bolts in the specified sequence (1, 2, 3, 4).

Tighten

Tighten the bolts to 32 N.m (24 lb ft).

2. Inspect the door for proper operation and alignment.
3. Remove the masking tape.

REAR SIDE DOOR REPLACEMENT

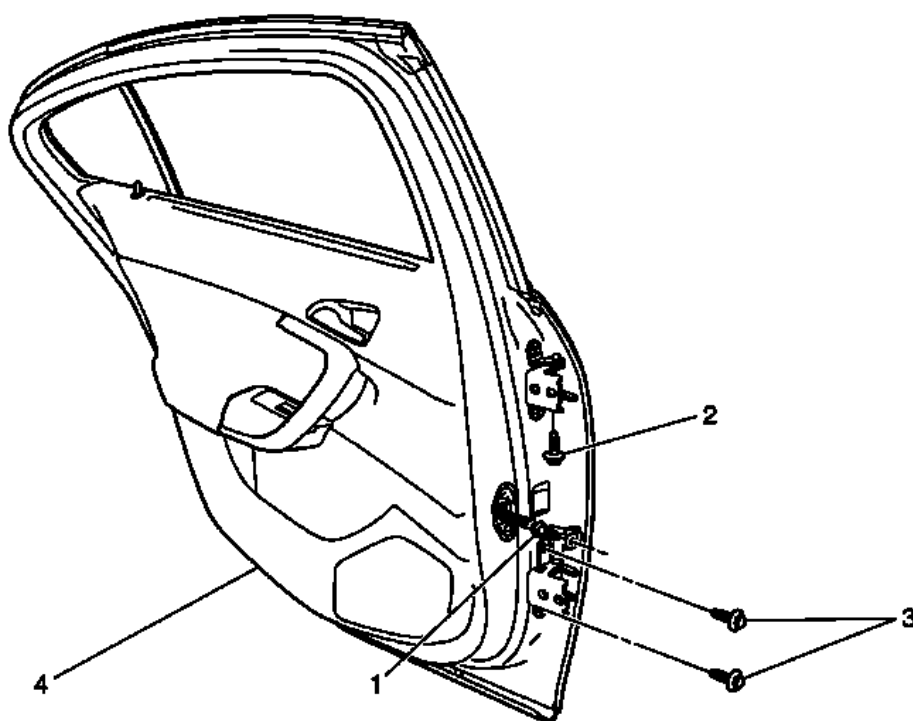


Fig. 12: Rear Side Door & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Replacement

Callout	Component Name
1	<p>Rear Side Door Check Link Fastener</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the door electrical connector. 2. Support the door before removing the hinge fastener. <p>Tighten 22 N.m (16.2 lb ft)</p>
2	<p>Rear Side Door Hinge Fastener to Hinge</p> <p>Tighten 25 N.m (18.4 lb ft)</p>
3	<p>Rear Side Door Hinge Fastener to Door (Qty: 2)</p> <p>Tighten 25 N.m (18.4 lb ft)</p>

Rear Side Door

Procedure

4

1. With the aid of an assistant, remove the door.
2. When replacing the door it is necessary to transfer all of the internal components.
3. Inspect the door for proper operation and alignment. Refer to **Rear Side Door Adjustment**.

FRONT FENDER REPLACEMENT

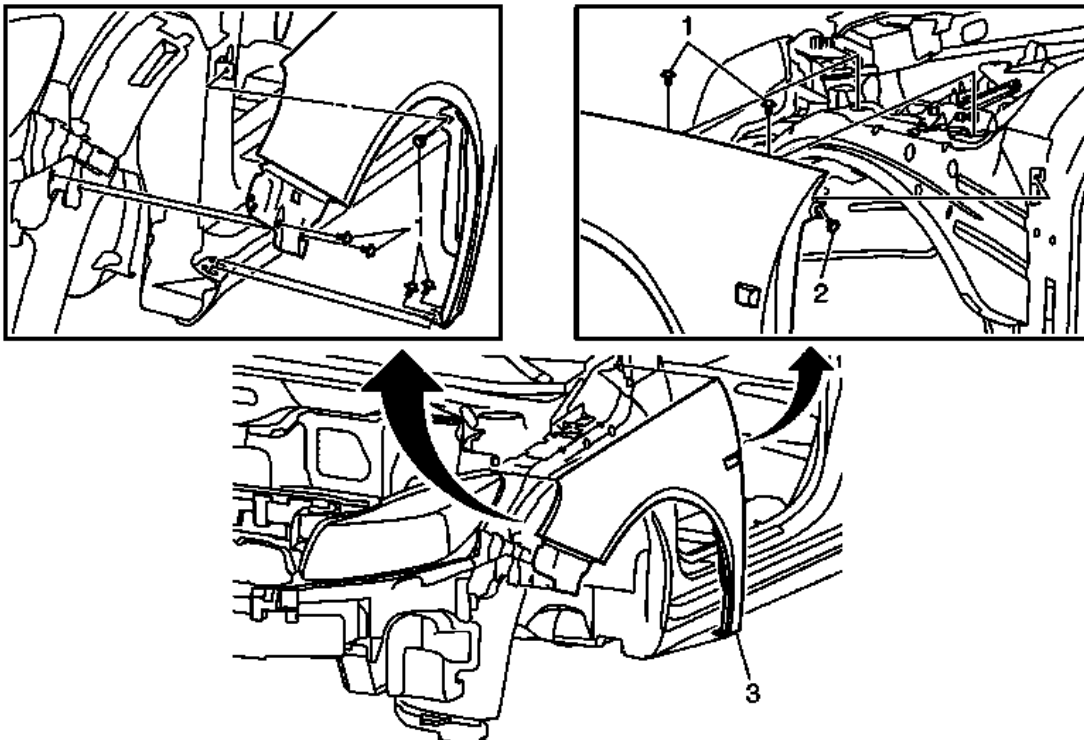


Fig. 13: Front Fender & Mounting Components
Courtesy of GENERAL MOTORS COMPANY

Front Fender Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
2. Remove the headlamp. Refer to <u>Headlamp Replacement</u> .	
3. Remove the front wheelhouse front liner. Refer to <u>Front Wheelhouse Front Liner Replacement</u> .	
4. Remove the front wheelhouse rear liner. Refer to <u>Front Wheelhouse Rear Liner Replacement</u> .	
5. Remove the body hinge pillar lower insulator.	

1	<p>Front Fender Fastener (Qty: 7)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Use a grease pencil to mark the alignment of the fender before removing the fastener. Tighten 9 N.m (80 lb in)</p>
2	<p>Front Fender Fastener</p> <p>Procedure Open the door to access the fastener. Tighten 9 N.m (80 lb in)</p>
3	<p>Front Fender</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Pull gently to remove the fender. 2. Transfer parts as needed. 3. Align the fender after installing as needed.

FRONT SIDE DOOR WIRING HARNESS REPLACEMENT

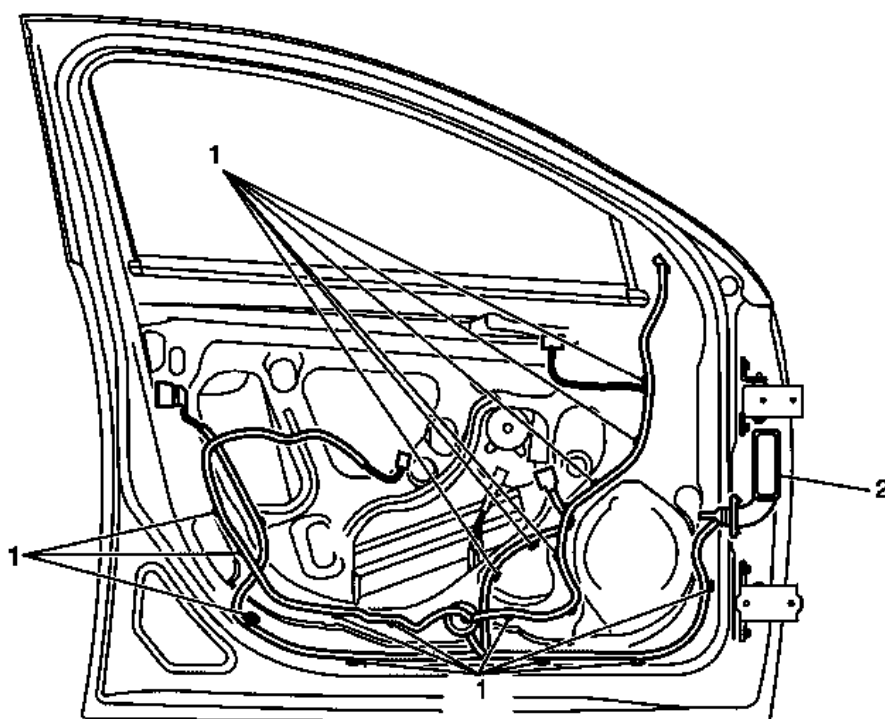


Fig. 14: Front Side Door Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Wiring Harness Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the front side door water deflector. Refer to <u>Front Side Door Water Deflector Replacement</u> .	
2. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
1	Front Side Door Wiring Harness Retainer
2	Front Side Door Wiring Harness Procedure Disconnect the electrical connector.

REAR SIDE DOOR WIRING HARNESS REPLACEMENT

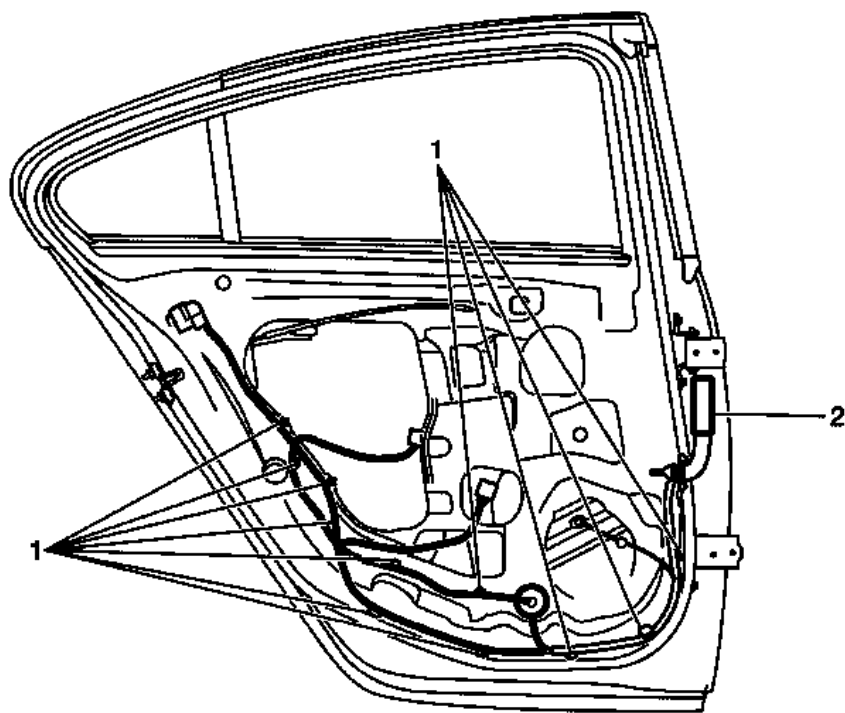


Fig. 15: Rear Side Door Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Wiring Harness Replacement

Callout	Component Name
Preliminary Procedures	

1. Remove the rear side door water deflector. Refer to **Rear Side Door Water Deflector Replacement** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

1	Rear Side Door Wiring Harness Retainer
2	Rear Side Door Wiring Harness Procedure Disconnect the electrical connector.

HOOD PRIMARY LATCH RELEASE CABLE HANDLE REPLACEMENT

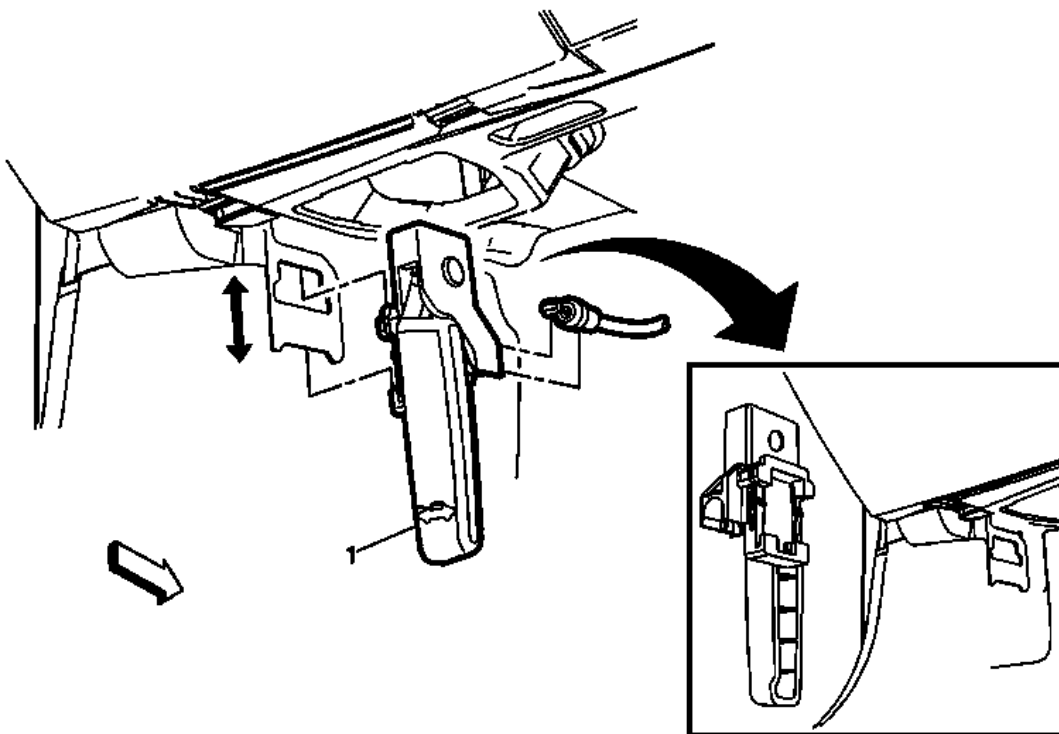


Fig. 16: Hood Primary Latch Release Cable Handle
Courtesy of GENERAL MOTORS COMPANY

Hood Primary Latch Release Cable Handle Replacement

Callout	Component Name
1	Hood Primary Latch Release Cable Handle Procedure <ol style="list-style-type: none"> 1. Press the hood primary latch release cable handle downward and pull outward to release the retainers from the instrument panel bracket. 2. Disconnect the hood primary latch release cable from the hood primary latch release cable handle.

FRONT SIDE DOOR UPPER HINGE AND LOWER HINGE REPLACEMENT

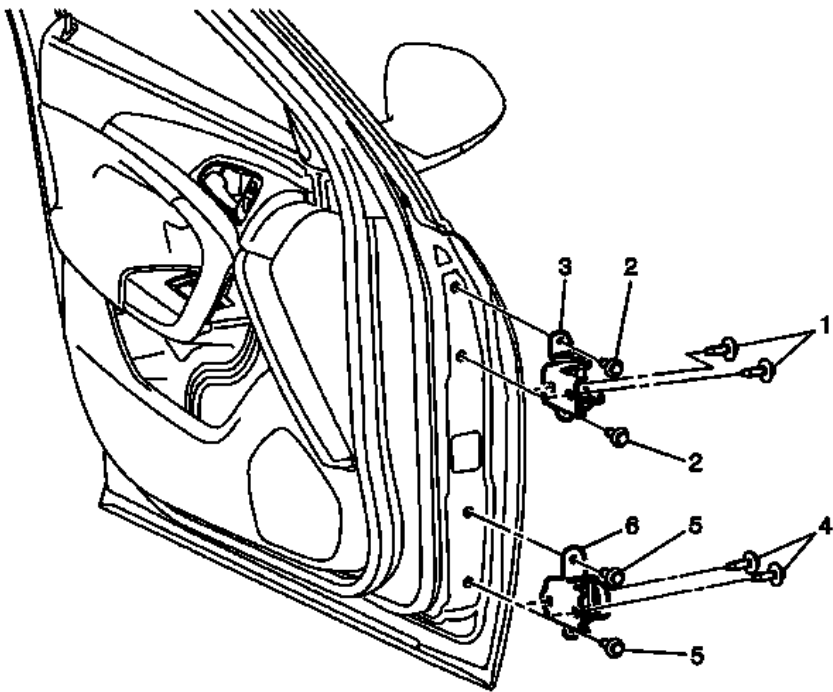


Fig. 17: Front Side Door Upper Hinge And Lower Hinge
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Upper Hinge and Lower Hinge Replacement

Callout	Component Name
1	<div>Front Side Door Upper Hinge to Body Bolts (Qty: 2)</div> <div>CAUTION: Refer to <u>Fastener Caution</u> .</div> <div>Procedure 1. Support the door before removing the hinge fastener. 2. Disconnect the door electrical connector.</div> <div>Tighten 32 N.m (24 lb ft)</div>
2	<div>Front Side Door Upper Hinge to Door Bolts (Qty: 2)</div> <div>Tighten 25 N.m (18 lb ft)</div>
3	Front Side Door Upper Hinge
	Front Side Door Lower Hinge to Body Bolts (Qty: 2)

4	Tighten 32 N.m (24 lb ft)
5	Front Side Door Lower Hinge to Door Bolts (Qty: 2) Tighten 25 N.m (18 lb ft)
6	Front Side Door Lower Hinge Procedure Inspect the door for proper operation and alignment. Refer to <u>Front Side Door Adjustment.</u>

HOOD HINGE BRACKET REPLACEMENT

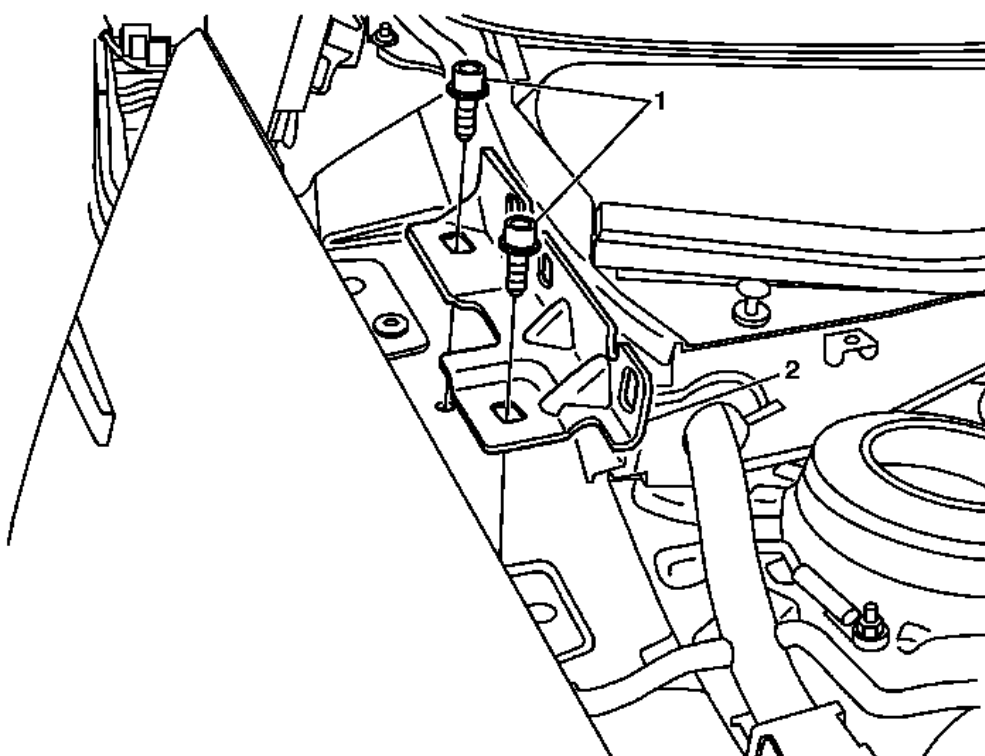


Fig. 18: Hood Hinge Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

Hood Hinge Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the hood hinge. Refer to <u>Hood Hinge Replacement.</u>	
	Hood Hinge Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution .</u>

1	Procedure <ol style="list-style-type: none"> 1. Mark the location of the hood hinge bracket to the body with a grease pencil to aid in alignment. 2. Adjust the hood hinge bracket after replacing, if needed.
	Tighten 22 N.m (16 lb ft)
2	Hood Hinge Bracket

HOOD HINGE REPLACEMENT

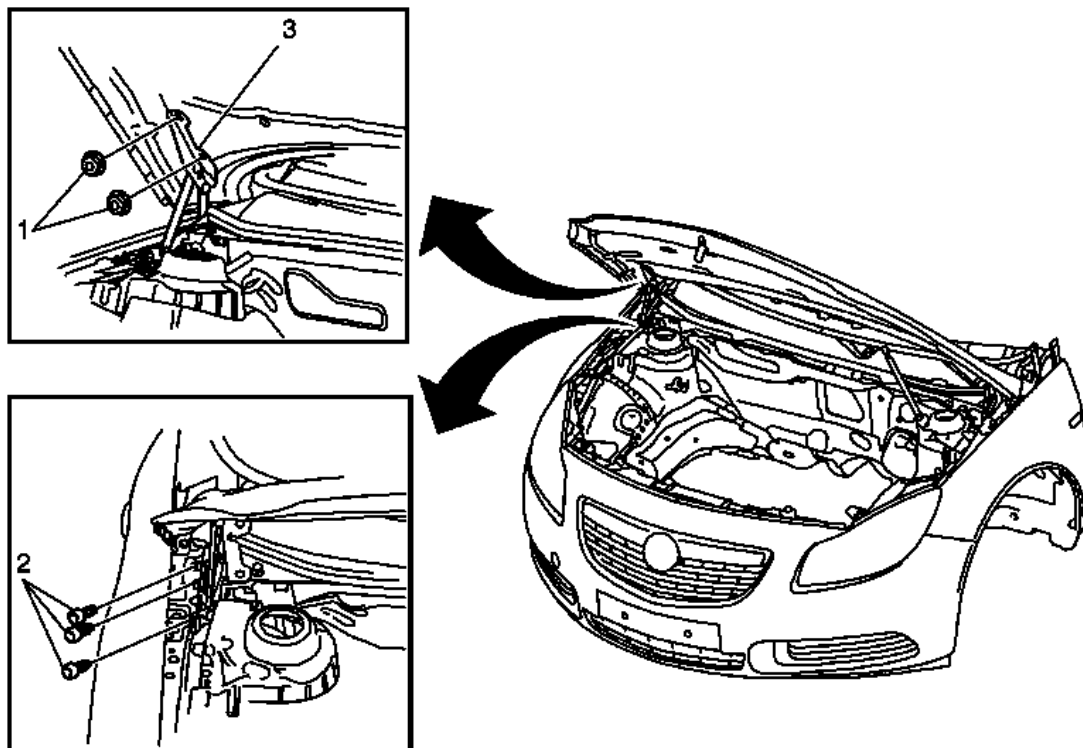


Fig. 19: Hood Hinge And Fasteners
Courtesy of GENERAL MOTORS COMPANY

Hood Hinge Replacement

Callout	Component Name
	Hood Hinge Fastener (Qty: 2) WARNING: When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Mark the location of the hood hinge to the hood with a grease pencil to aid in alignment.</p> <p>Tighten 22 N.m (16 lb ft)</p>
2	<p>Hood Hinge Fastener (Qty: 3)</p> <p>Procedure Adjust the hood hinge after replacing, if needed. Refer to <u>Hood Adjustment</u>.</p> <p>Tighten 22 N.m (16 lb ft)</p>
3	Hood Hinge

REAR COMPARTMENT LID HINGE REPLACEMENT

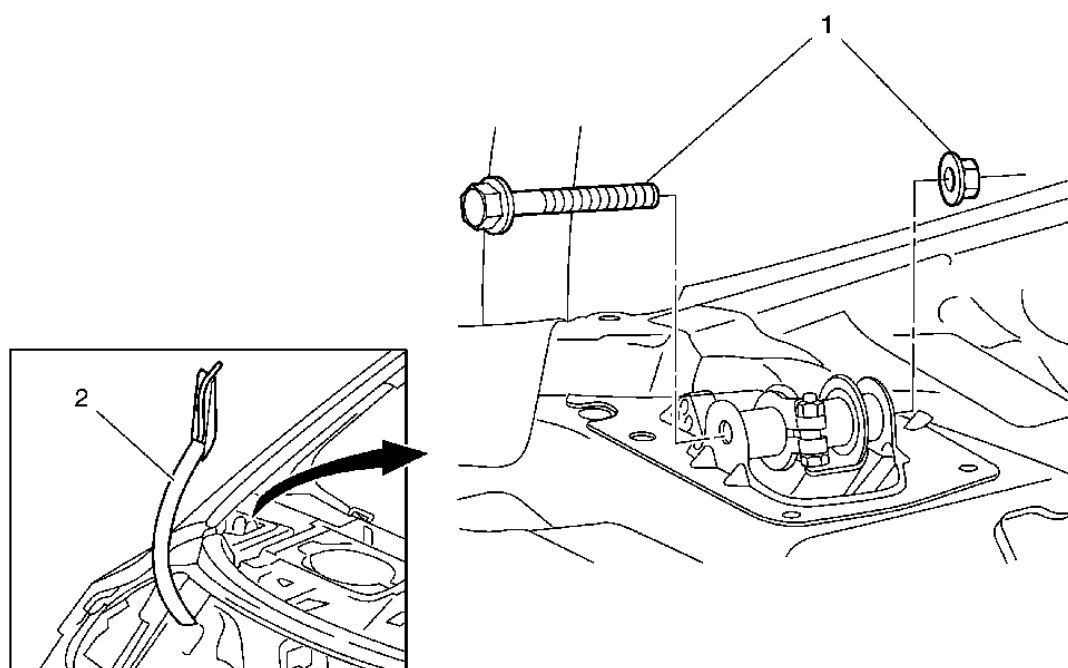


Fig. 20: Rear Compartment Lid Hinge & Fastener
Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Hinge Replacement

Callout	Component Name
Preliminary Procedures	
1.	Remove the rear compartment lid. Refer to <u>Rear Compartment Lid Replacement</u> .

2. Remove the rear window panel trim. Refer to **Rear Window Panel Trim Replacement (with HP6)** , **Rear Window Panel Trim Replacement (without HP6)** .
3. Remove the rear compartment lid hinge spring. Refer to **Rear Compartment Lid Hinge Spring Replacement** .

1	Rear Compartment Lid Hinge Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
2	Rear Compartment Lid Hinge

REAR SIDE DOOR UPPER HINGE AND LOWER HINGE REPLACEMENT

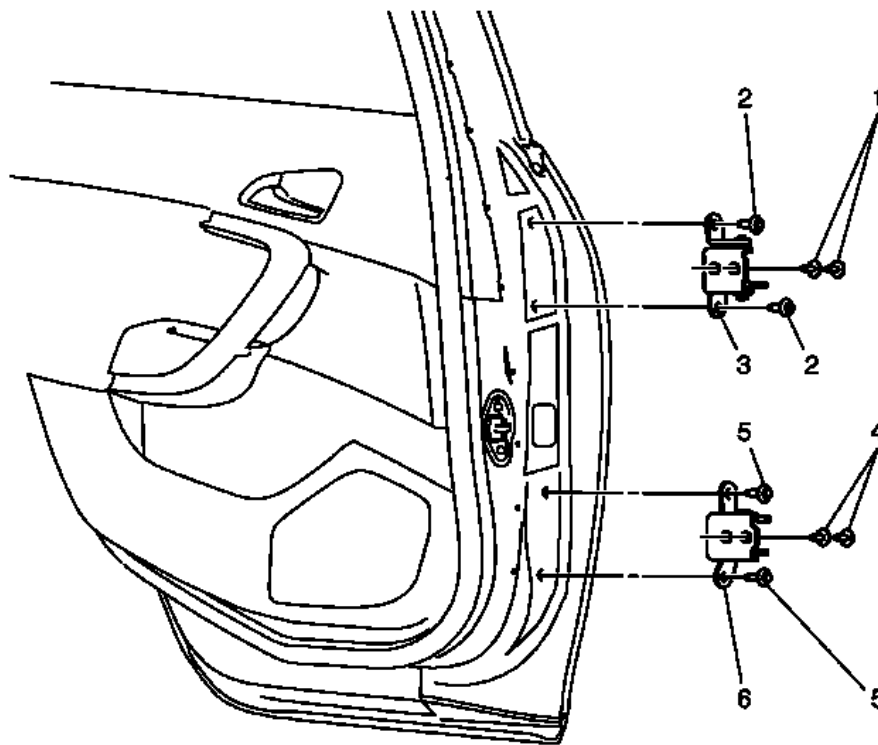


Fig. 21: Rear Side Door Upper Hinge And Lower Hinge
Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Upper Hinge and Lower Hinge Replacement

Callout	Component Name
	Rear Side Door Upper Hinge to Body (Upper) (Qty: 2)
	CAUTION:

1	<p>Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Support the door before removing the hinge fastener. 2. Disconnect the door electrical connector. <p>Tighten: 32 N.m (24 lb ft).</p>
2	<p>Rear Side Door Upper Hinge to Door Bolts (Upper) (Qty: 2)</p> <p>Tighten 25 N.m (18 lb ft).</p>
3	<p>Rear Side Door Upper Hinge</p> <p>Procedure Check the door for proper alignment, adjust as necessary.</p>
4	<p>Rear Side Door Lower Hinge to Body Bolts (Lower) (Qty: 2)</p> <p>Tighten 25 N.m (18 lb ft).</p>
5	<p>Rear Side Door Lower Hinge to Door Body (Lower) (Qty: 2)</p> <p>Tighten 32 N.m (24 lb ft).</p>
6	<p>Rear Side Door Lower Hinge</p> <p>Procedure Inspect the door for proper operation and alignment. Refer to <u>Rear Side Door Adjustment</u>.</p>

HOOD ADJUSTMENT

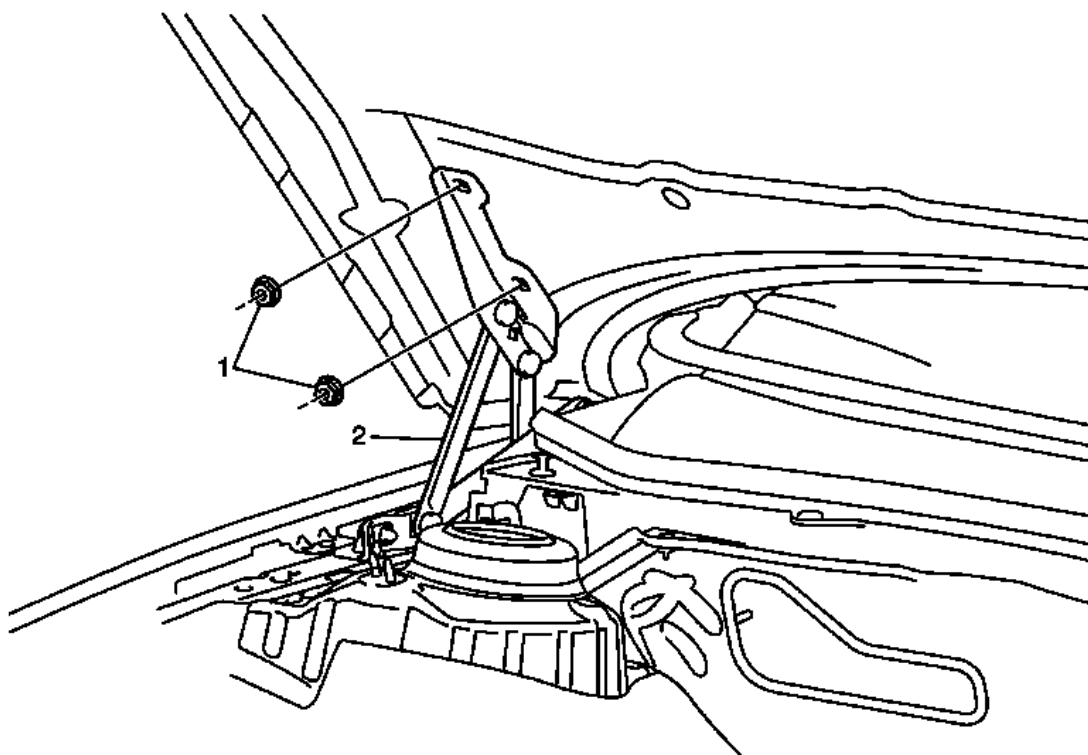


Fig. 22: Hood Hinge & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Hood Adjustment

Callout	Component Name
1	<p>Hood Hinge Fastener (Qty: 2)</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Loosen the fasteners that secure the hood. 2. Adjust the hood in order to obtain an even gap on both sides between the hood and the fenders and so that the hood is flush with both fenders on the front edge.
2	<p>Hood Hinge</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Tighten the fasteners in order to secure the hood to the hood hinges.</p> <p>Tighten 22 N.m (16 lb ft)</p>

HOOD REPLACEMENT

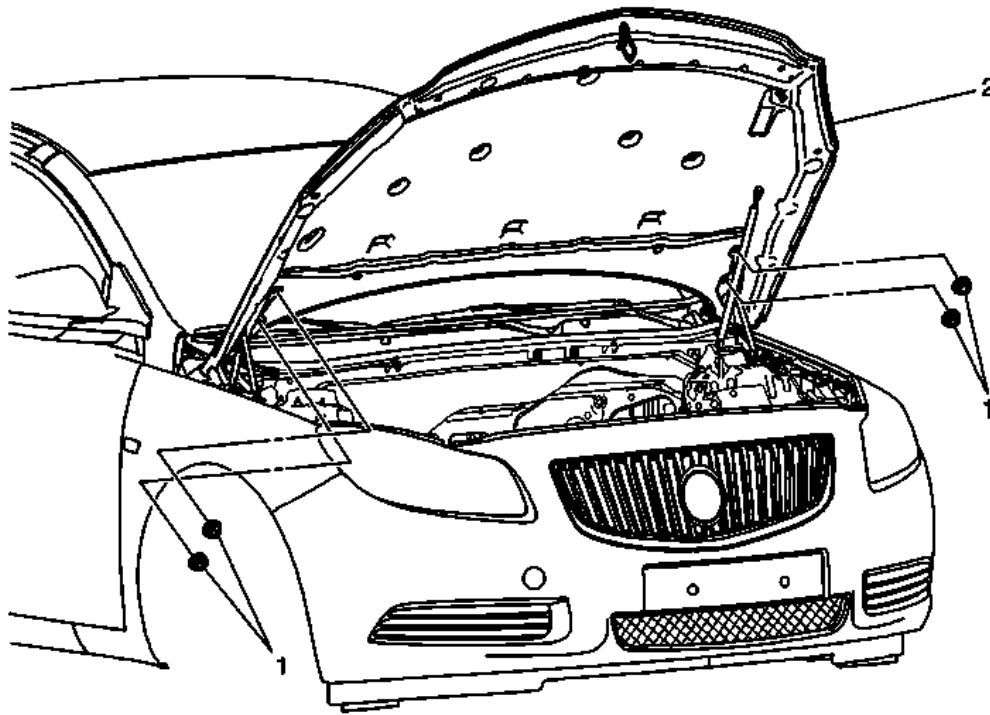


Fig. 23: Hood And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Hood Replacement

Callout	Component Name
WARNING: When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.	
Preliminary Procedure Disconnect the hood strut. Refer to <u>Hood Strut Replacement</u>	
1	Hood Hinge Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
2	Hood Procedure <ol style="list-style-type: none"> 1. Transfer any parts as needed. 2. Adjust the hood as needed. Refer to <u>Hood Adjustment</u>.

HOOD FRONT BUMPER BRACKET REPLACEMENT

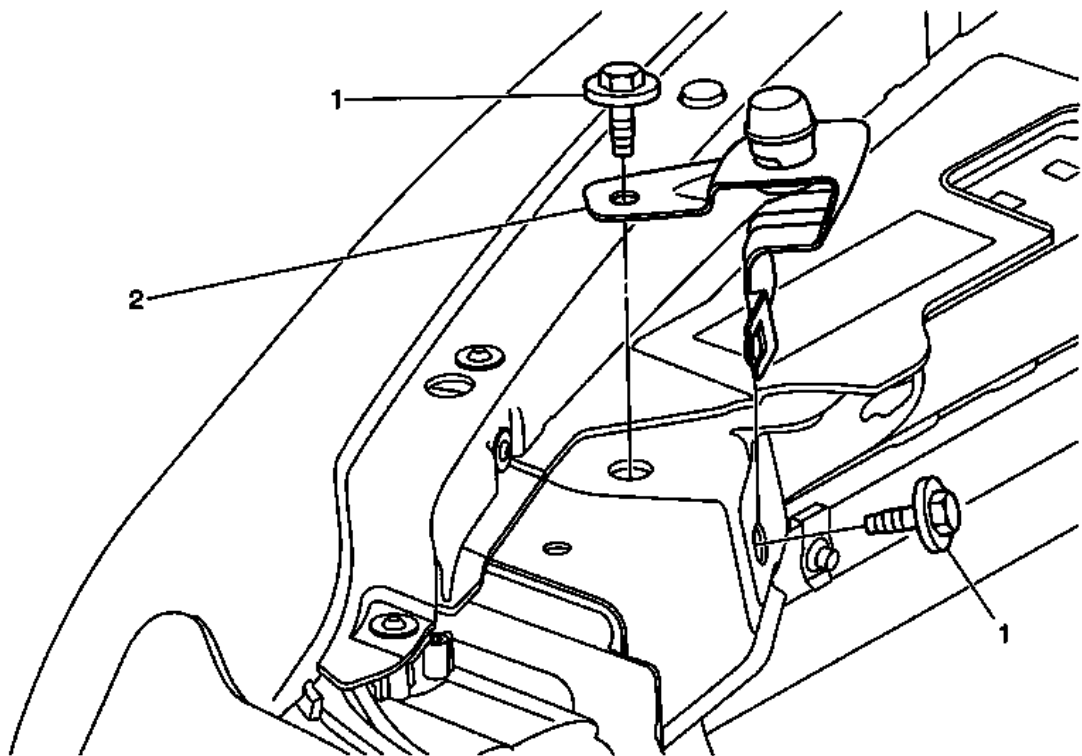


Fig. 24: Hood Front Bumper Bracket & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Hood Front Bumper Bracket Replacement

Callout	Component Name
1	Hood Front Bumper Bracket Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
2	Hood Front Bumper Bracket

HOOD INSULATOR REPLACEMENT

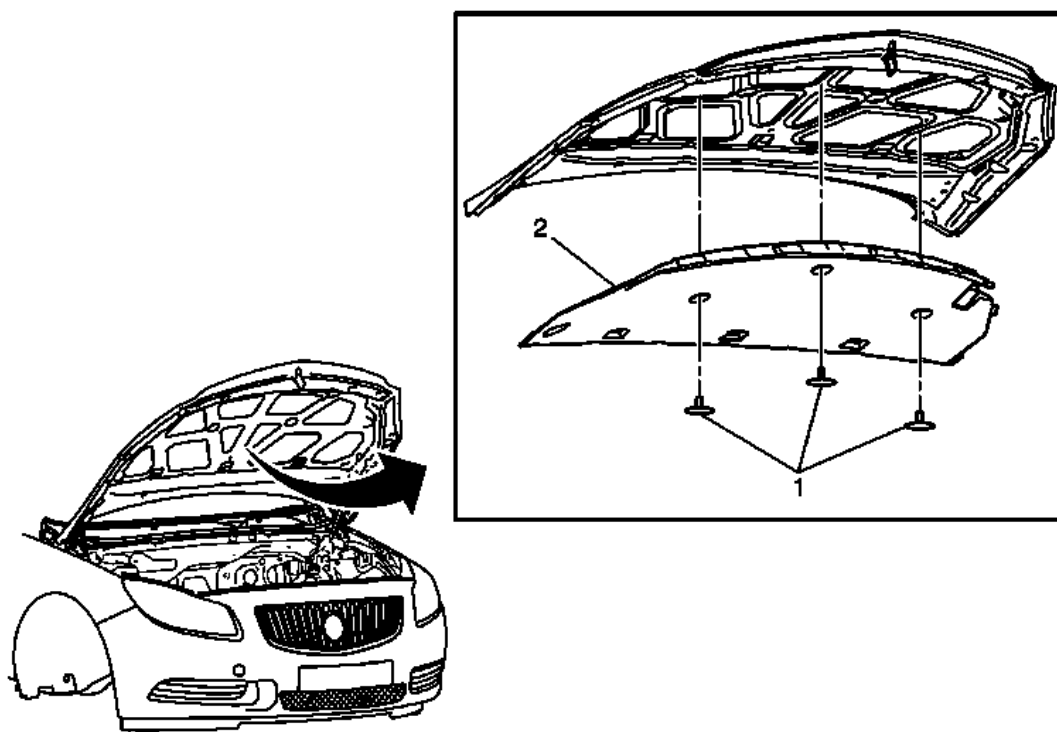


Fig. 25: Hood Insulator & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Hood Insulator Replacement

Callout	Component Name
1	Hood Insulator Plastic Retainer (Qty: 3)
2	Hood Insulator

HOOD PRIMARY LATCH REPLACEMENT

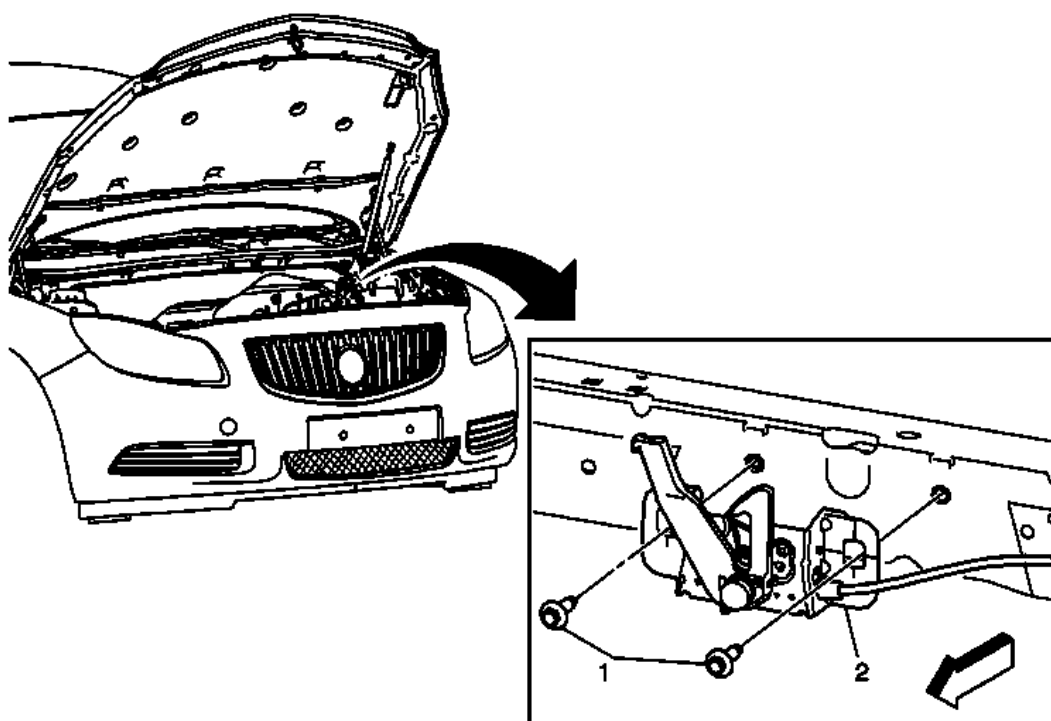


Fig. 26: Hood Primary Latch & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Hood Primary Latch Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia center support - upper. Refer to Front Bumper Fascia Center Support Replacement - Upper .	
1	Hood Primary Latch Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft)
2	Hood Primary Latch Procedure Release the hood cable.

REAR COMPARTMENT LID ADJUSTMENT

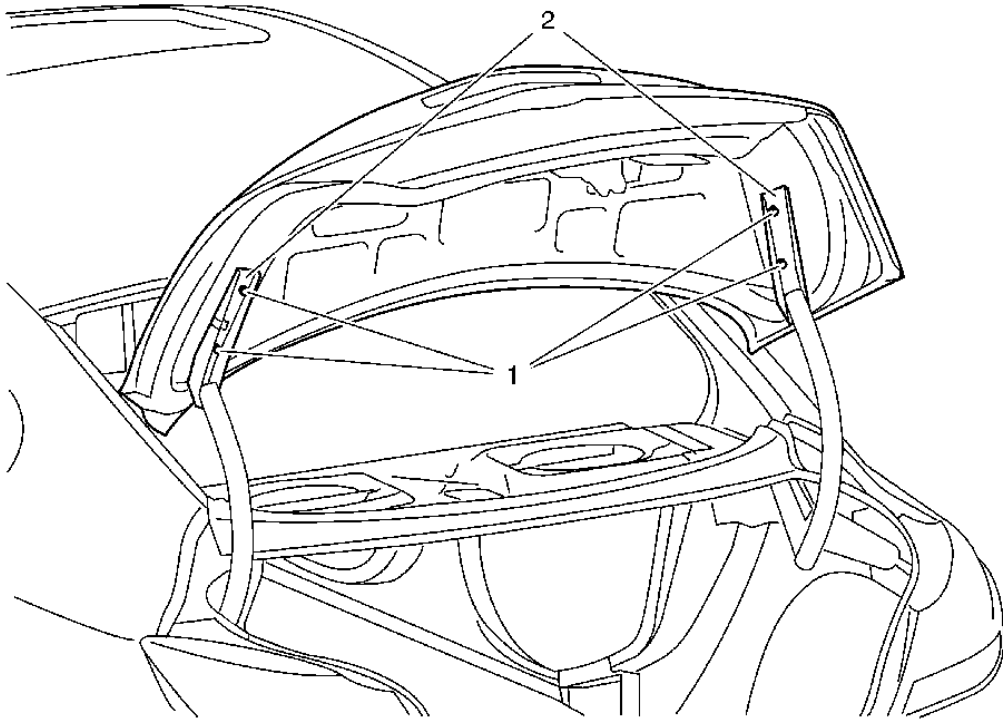


Fig. 27: Rear Compartment Lid & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Adjustment

Callout	Component Name
Preliminary Procedure Remove the rear compartment lid inner panel trim. Refer to <u>Rear Compartment Lid Inner Panel Trim Replacement</u> .	
1	Rear Compartment Lid Fastener (Qty: 4) Procedure <ol style="list-style-type: none"> 1. Loosen the fasteners securing the rear compartment lid to the rear compartment lid hinges. 2. Align the rear compartment lid in order to achieve an equal gap around the entire perimeter of the rear compartment lid.
2	Rear Compartment Lid Hinge CAUTION: Refer to <u>Fastener Caution</u> . Procedure <ol style="list-style-type: none"> 1. Tighten the fasteners in order to secure the rear compartment lid to the rear compartment lid hinges.

2. Adjusting the rear compartment overslam rear bumper fascia may be necessary.

Tighten

22 N.m (16 lb ft)

REAR COMPARTMENT LID REPLACEMENT

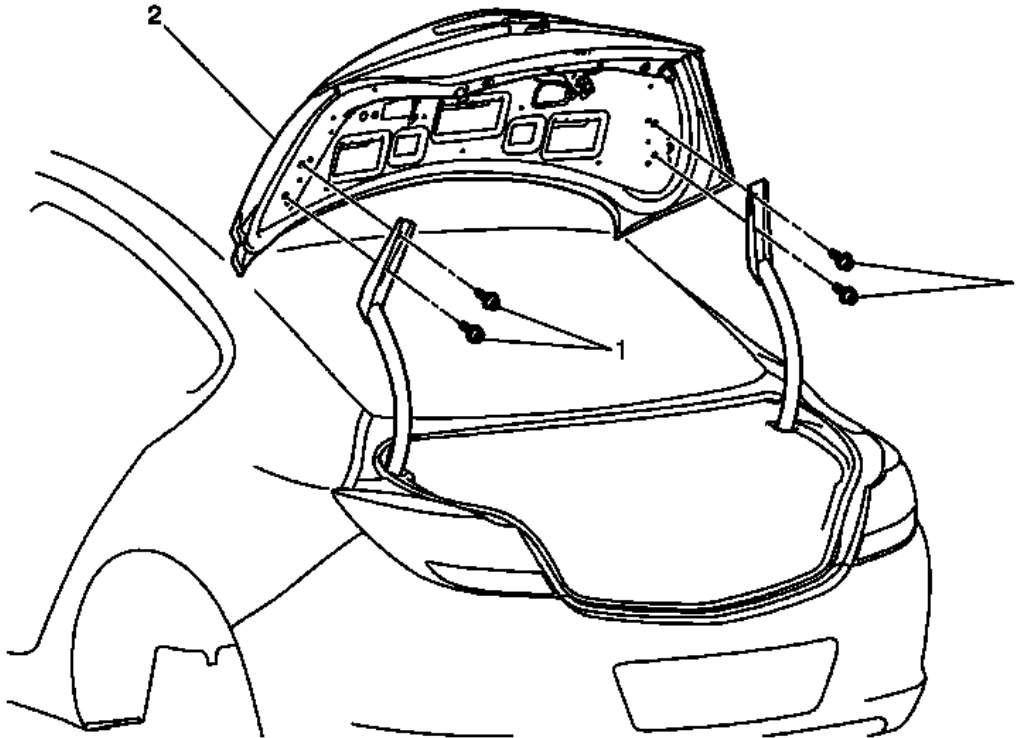


Fig. 28: Rear Compartment Lid And Fasteners

Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment lid inner panel trim. Refer to <u>Rear Compartment Lid Inner Panel Trim Replacement</u> .	
1	Rear Compartment Lid Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)

Rear Compartment Lid

Procedure

- 2
 1. Disconnect the electrical connector.
 2. Release retainer electrical wiring harness.
 3. Adjust rear compartment lid. Refer to **Rear Compartment Lid Adjustment**.
 4. Transfer all components on the new rear compartment lid as necessary.

FRONT SIDE DOOR CHECK LINK REPLACEMENT

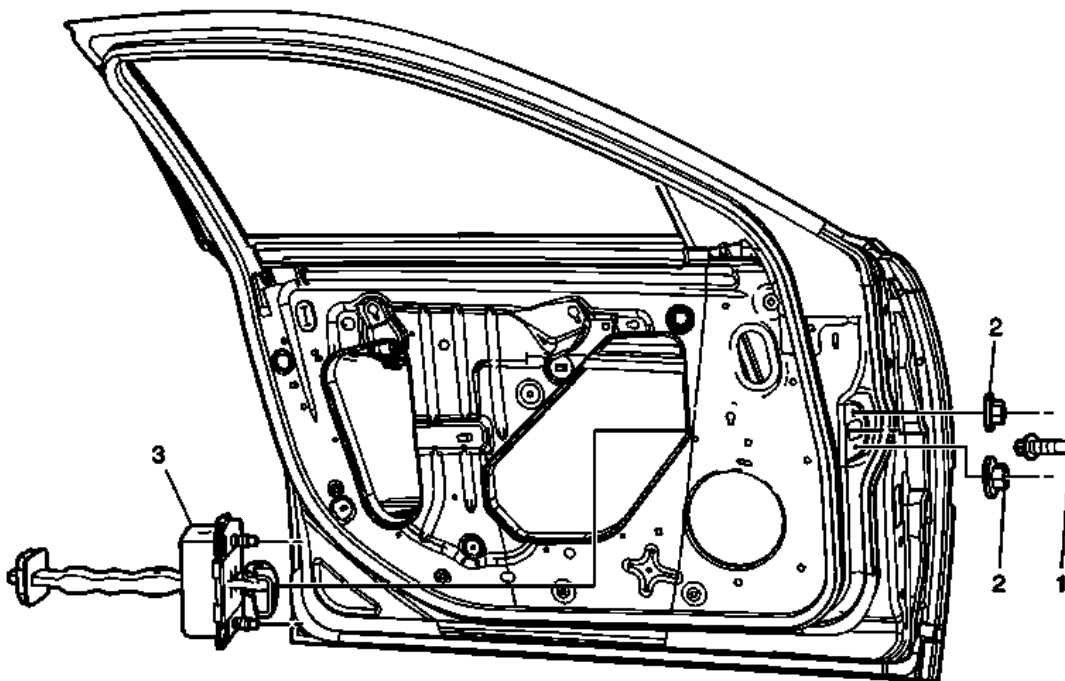


Fig. 29: Front Side Door Check Link Replacement

Courtesy of GENERAL MOTORS COMPANY

Front Side Door Check Link Replacement

Callout	Component Name
Preliminary Procedure Remove the front side door trim panel. Refer to <u>Front Side Door Trim Panel Replacement</u> .	
1	Front Side Door Check Link to Body Screw CAUTION: Refer to <u>Fastener Caution</u> .

	TIP: Place the door in the full open position. Tighten 22 N.m (16 lb ft)
2	Front Side Door Check Link to Door Nuts (Qty: 2) Procedure Remove the water deflector. Tighten 10 N.m (89 lb in)
3	Front Side Door Check Link

REAR SIDE DOOR CHECK LINK REPLACEMENT

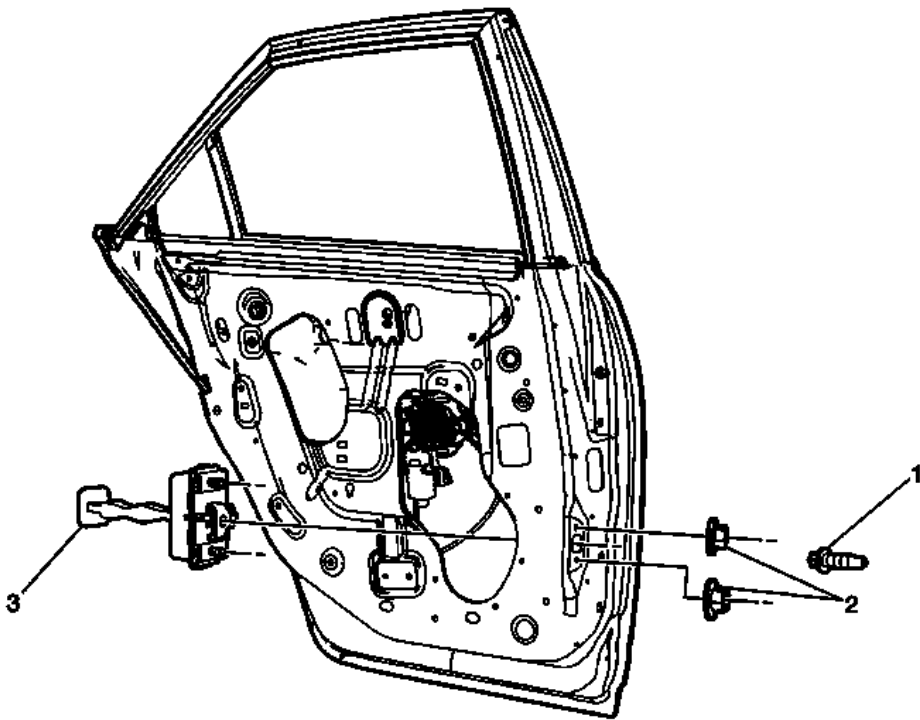


Fig. 30: Rear Side Door Check Link
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Check Link Replacement

Callout	Component Name
Preliminary Procedure Remove the rear side door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u> .	
1	Rear Side Door Check Link to Body Screw CAUTION: Refer to <u>Fastener Caution</u> .

	TIP: Place the door in the full open position. Tighten 22 N.m (16 lb ft)
2	Rear Side Door Check Link to Door Nuts (Qty: 2) Procedure Remove the water deflector. Tighten 10 N.m (89 lb in)
3	Rear Side Door Check Link

FUEL TANK FILLER DOOR REPLACEMENT

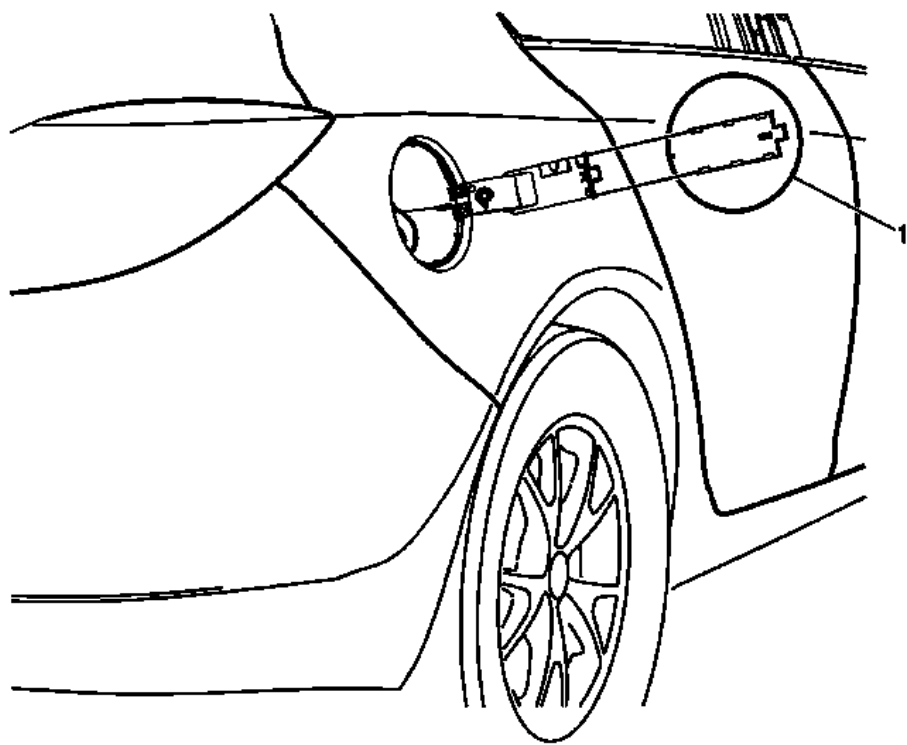


Fig. 31: Fuel Tank Filler Door
 Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Filler Door Replacement

Callout	Component Name
1	Fuel Tank Filler Door Procedure Position the fuel tank filler door to the full open position. Using light outward sliding pressure on the filler door, release the retainer on the fuel tank filler door from the hinge.

FUEL TANK FILLER PIPE HOUSING REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .

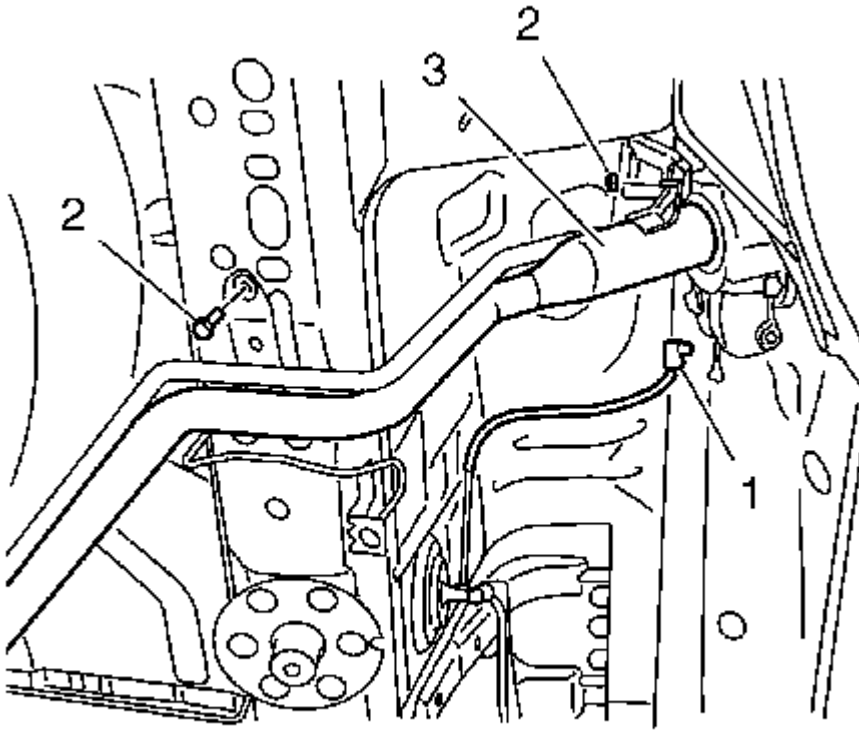


Fig. 32: Fuel Tank Filler Pipe, Housing & Door Lock Actuator Wiring Harness Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel tank filler door lock actuator wiring harness electrical connector (1).
5. Remove fuel tank filler pipe fastener (2).
6. Remove the fuel tank filler pipe from fuel tank filler pipe housing (3).

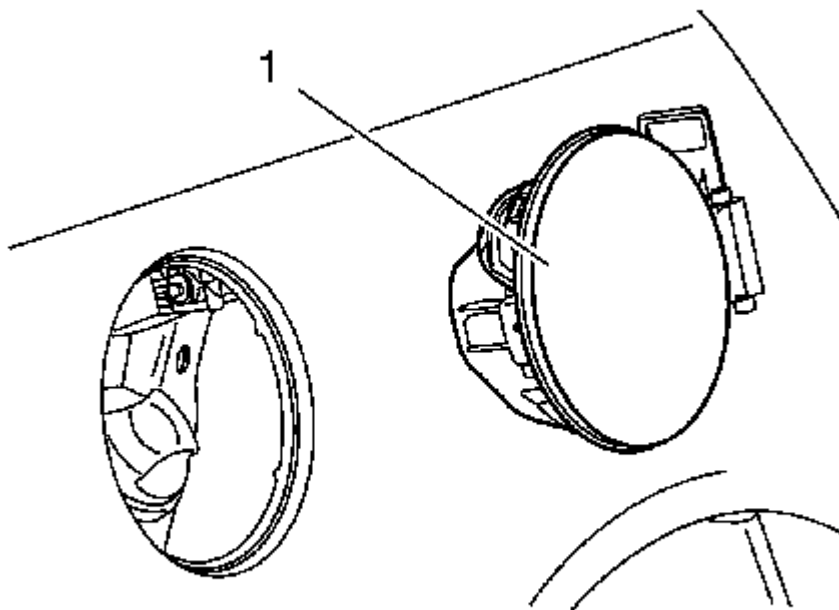


Fig. 33: Fuel Tank Filler Pipe Housing
Courtesy of GENERAL MOTORS COMPANY

7. Remove the fuel tank filler pipe housing (1) from the body side outer panel by depressing in on the far retainer tab on the backside of the fuel tank filler pipe housing.

Installation Procedure

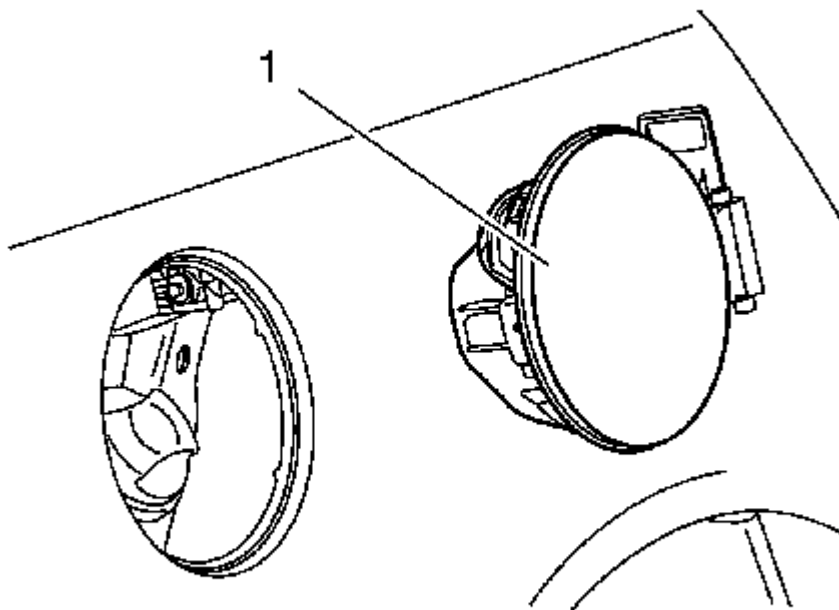


Fig. 34: Fuel Tank Filler Pipe Housing
Courtesy of GENERAL MOTORS COMPANY

1. Insert the fuel tank filler pipe housing (1) to the body side outer panel.

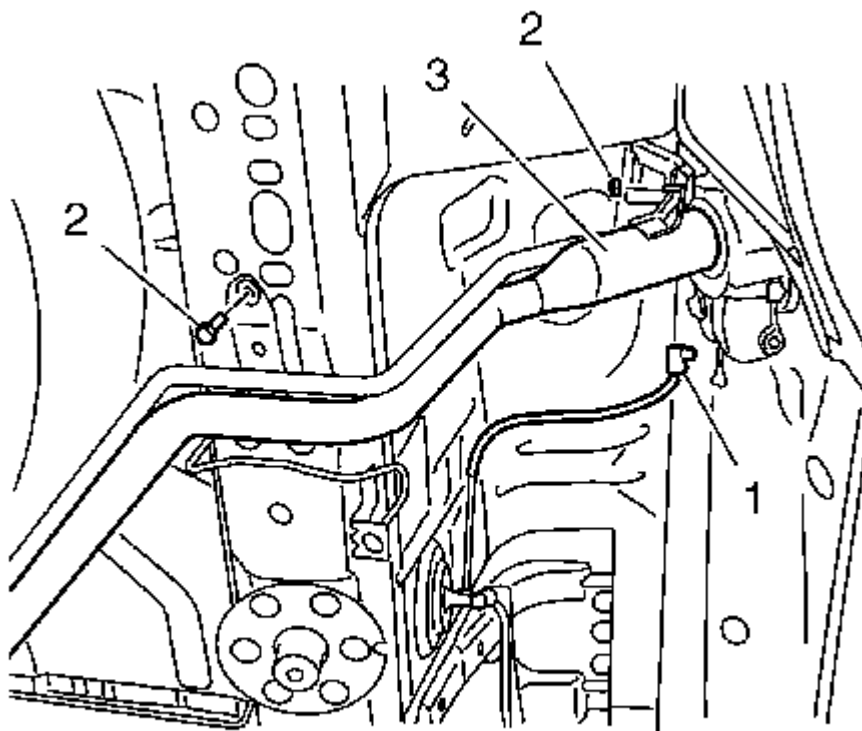


Fig. 35: Fuel Tank Filler Pipe, Housing & Door Lock Actuator Wiring Harness Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

2. Install the fuel tank filler pipe (3) at the fuel tank filler pipe housing.
3. Install the fuel tank filler pipe fastener (2).
4. Connect the fuel tank filler door lock actuator wiring harness electrical connector (1).
5. Install the rear wheelhouse panel liner.
6. Install the right rear wheel.

HOOD STRUT REPLACEMENT

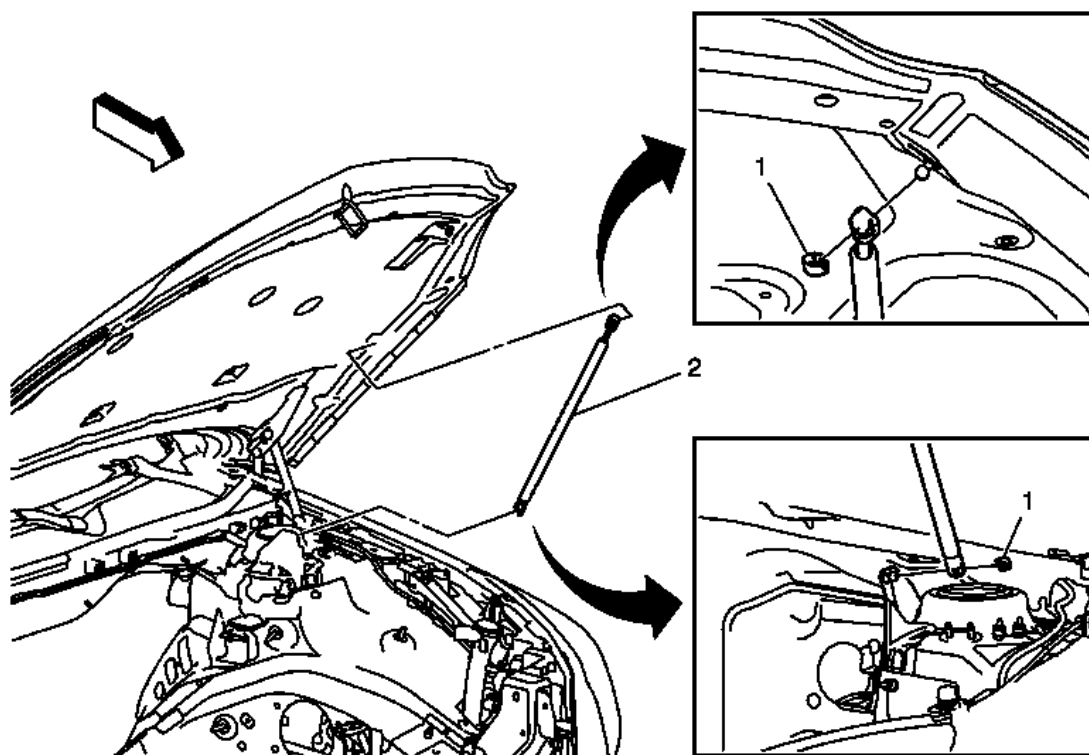


Fig. 36: Hood Strut Rod & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Hood Strut Replacement

Callout	Component Name
1	<p>Hood Strut Retainer (Qty: 2)</p> <p>WARNING: When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.</p> <p>CAUTION: Apply pressure only at the end of the liftgate/hood assist rod that you are removing or attaching. Do NOT apply pressure to the middle of the rod because damage or bending will result.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Release the locking retainer on the strut. 2. Ensure the clip is fully seated when the rod is reinstalled. If the retainer cannot be fully seated a new rod should be installed.
2	Hood Strut Rod

REAR COMPARTMENT LID STRUT REPLACEMENT

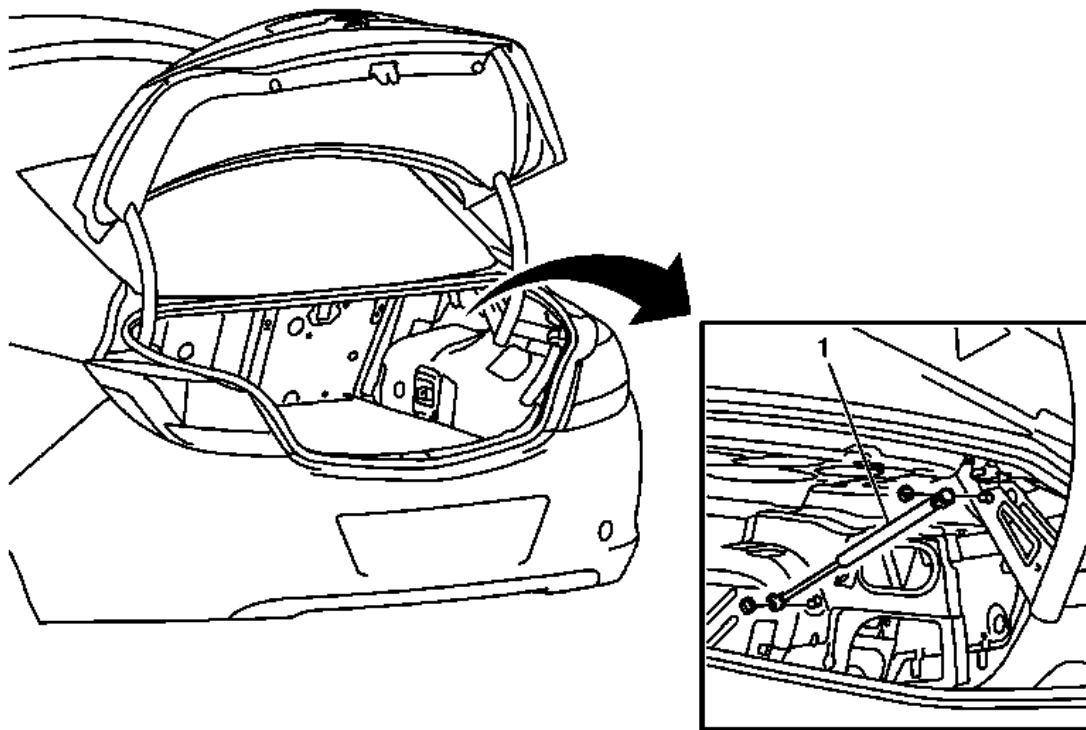


Fig. 37: Rear Compartment Lid Strut
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Strut Replacement

Callout	Component Name
WARNING: When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.	
CAUTION: Apply pressure only at the end of the liftgate/hood assist rod that you are removing or attaching. Do NOT apply pressure to the middle of the rod because damage or bending will result.	
Preliminary Procedure Remove the rear compartment side trim panel. Refer to <u>Rear Compartment Side Trim Panel Replacement (without HP6)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Rear Compartment Lid Strut Procedure <ol style="list-style-type: none"> 1. Release the locking tabs on the strut. 2. Ensure the clip is fully seated when the rod is reinstalled. If the clip cannot be fully seated a new rod should be installed.

FRONT OR REAR SIDE DOOR LOWER WEATHERSTRIP REPLACEMENT

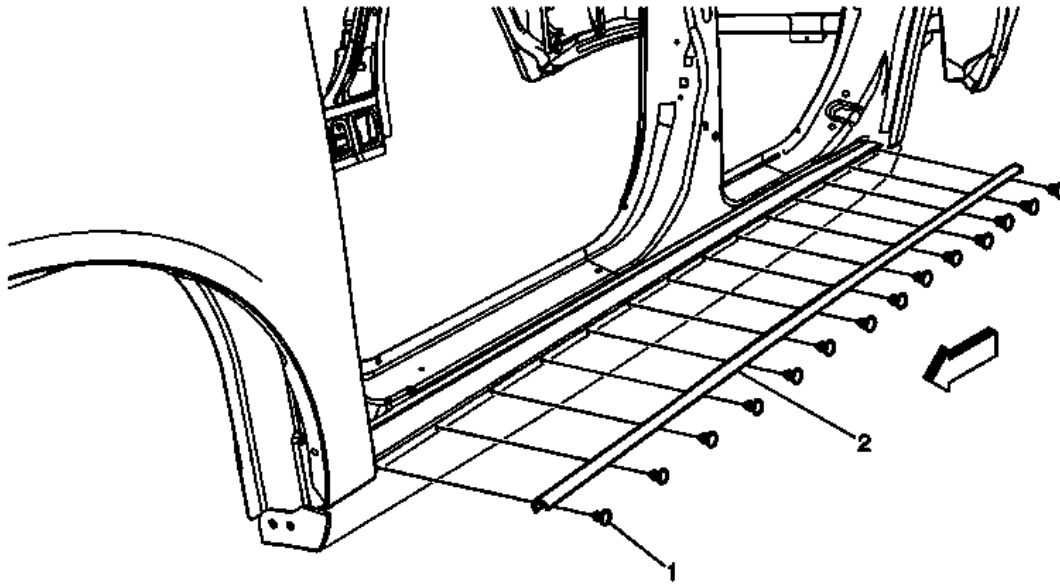


Fig. 38: Identifying Front or Rear Side Door Lower Weatherstrip Components
 Courtesy of GENERAL MOTORS COMPANY

Front or Rear Side Door Lower Weatherstrip Replacement

Callout	Component Name
1	Front and Rear Door Lower Weatherstrip Retainer (Qty: 17) Procedures 1. Open both side doors on the side the weatherstrip is being serviced. 2. Use a suitable tool in the removal of the retainers.
2	Front and Rear Door Lower Weatherstrip

FRONT SIDE DOOR WEATHERSTRIP REPLACEMENT

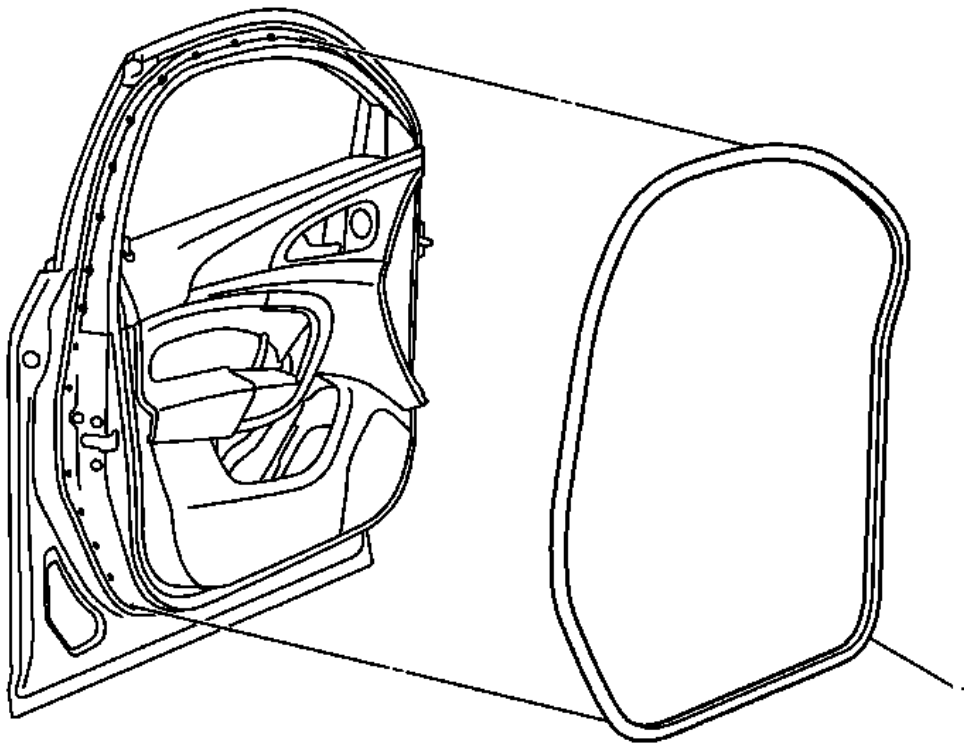


Fig. 39: Identifying Front Side Door Weatherstrip
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Weatherstrip Replacement

Callout	Component Name
1	Front Side Door Weatherstrip Procedure Use a suitable tool in the removal of the front side door weatherstrip retainers.

FRONT SIDE DOOR AUXILIARY WEATHERSTRIP REPLACEMENT

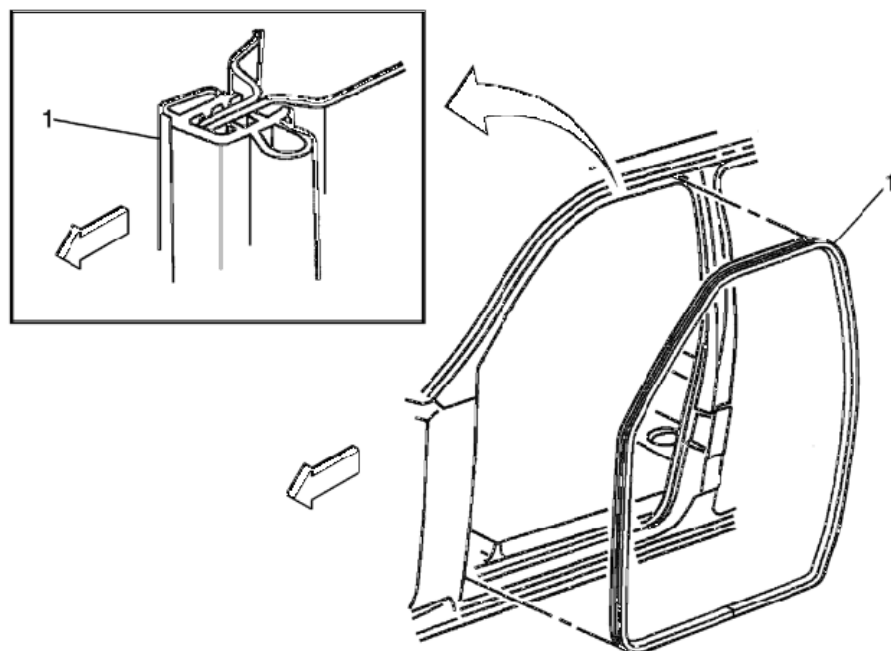


Fig. 40: Identifying Front Side Door Auxiliary Weatherstrip - Body Side
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Auxiliary Weatherstrip Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the lower center pillar trim. Refer to <u>Center Pillar Lower Trim Panel Replacement</u> . 2. Remove the front and rear side door trim plate. Refer to <u>Front and Rear Side Door Sill Trim Plate Replacement</u> .	
1	Front Side Door Weatherstrip Procedures <ol style="list-style-type: none"> 1. Starting in the center bottom of the weatherstrip, pull the weatherstrip upward and away from the pinch-weld flange. 2. Start in the center bottom of the pinch-weld flange. 3. Ensure that the weatherstrip and retainers are fully seated on the flange before installing the front carpet retainer. 4. Inspect the door for proper operation.

REAR COMPARTMENT LID WEATHERSTRIP REPLACEMENT

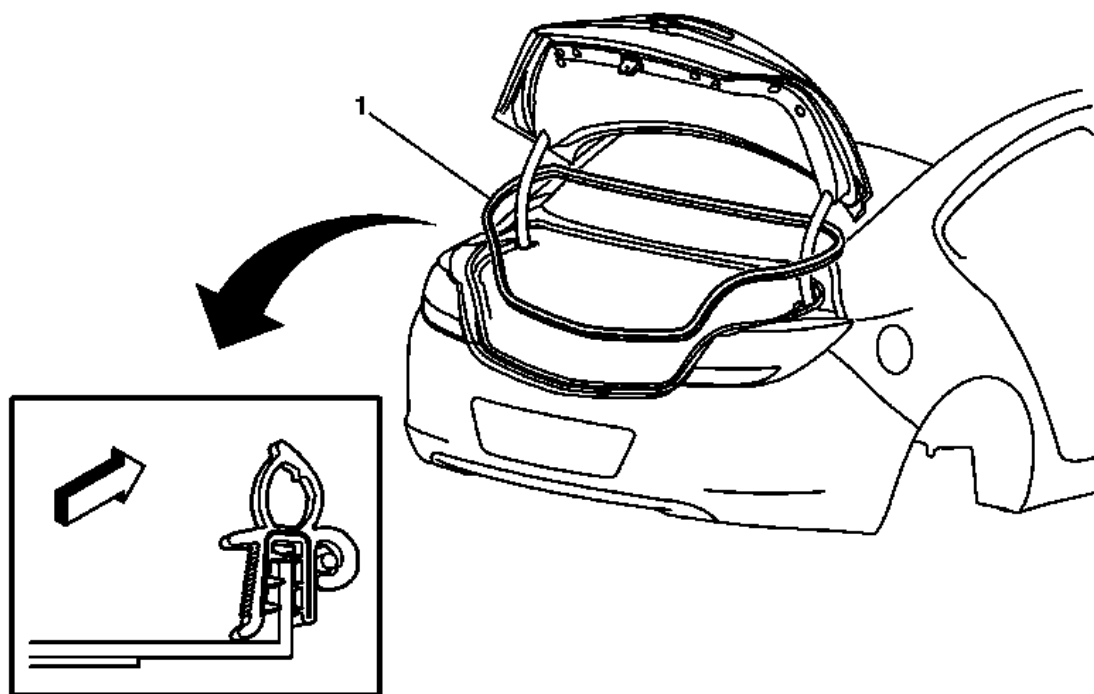


Fig. 41: Rear Compartment Lid Weatherstrip
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Weatherstrip Replacement

Callout	Component Name
1	Rear Compartment Lid Weatherstrip Procedure Clean the area where the seal will be mounted. Use a suitable solvent with a mixture of 50 percent isopropyl alcohol and 50 percent water by volume, or high-flash naphtha.

REAR SIDE DOOR AUXILIARY WEATHERSTRIP REPLACEMENT

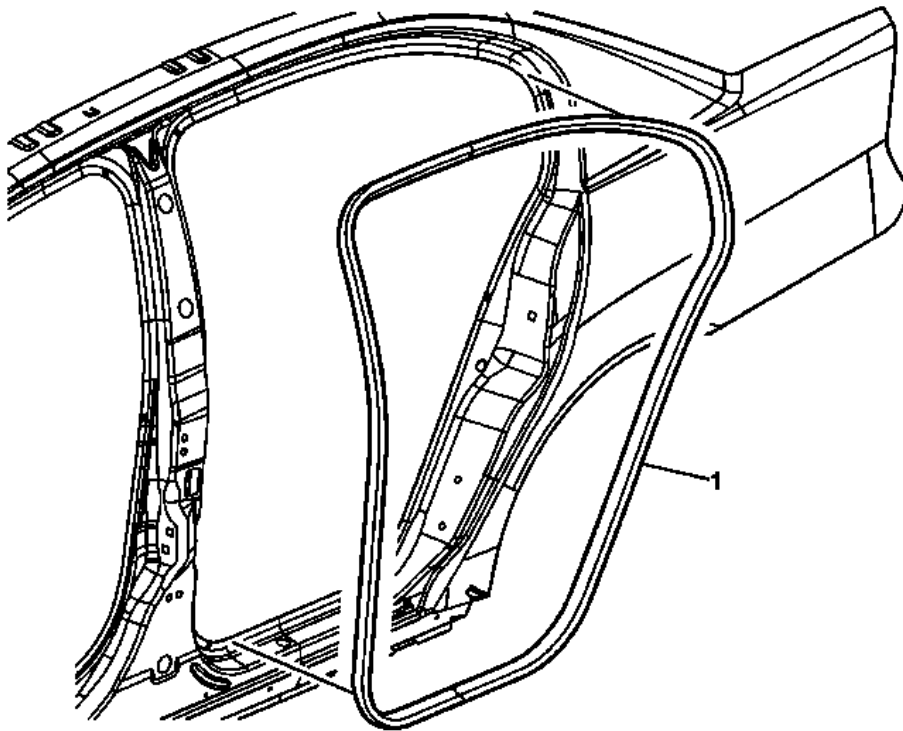


Fig. 42: View Of Rear Door Opening Weatherstrip
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Auxiliary Weatherstrip Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the lower center pillar trim. Refer to <u>Center Pillar Lower Trim Panel Replacement</u> . 2. Remove the body lock pillar lower trim panel. Refer to <u>Body Lock Pillar Upper Trim Panel Replacement (Sedan)</u> . 3. Remove the front and rear side door sill plate. Refer to <u>Front and Rear Side Door Sill Trim Plate Replacement</u> . 	
1	Rear Side Door Auxiliary Weatherstrip Procedures <ol style="list-style-type: none"> 1. Starting in the center bottom of the weatherstrip, pull the weatherstrip upward and away from the pinch-weld flange. 2. Start in the center bottom of the pinch-weld flange. 3. Ensure that the weatherstrip and retainers are fully seated on the flange before installing the rear carpet retainer. 4. Inspect the door for proper operation.

REAR SIDE DOOR WEATHERSTRIP REPLACEMENT

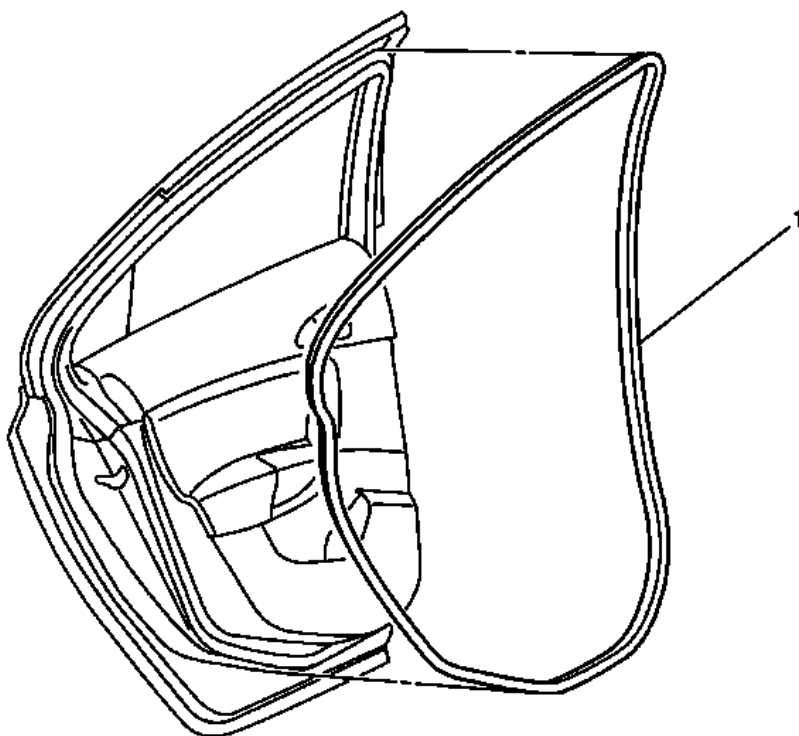


Fig. 43: Rear Side Door Weatherstrip
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Weatherstrip Replacement

Callout	Component Name
1	Rear Side Door Weatherstrip Procedure Use a suitable tool in the removal of the rear side door weatherstrip retainers.

DESCRIPTION AND OPERATION

HOOD AJAR INDICATOR DESCRIPTION AND OPERATION

Hood Ajar Indicator System Components

- Body Control Module (BCM)
- Starter/Generator Control Module (with RPO HP6)
- Driver information center
- Hood ajar switch, part of the hood latch assembly

Hood Ajar Operation - Body Control Module

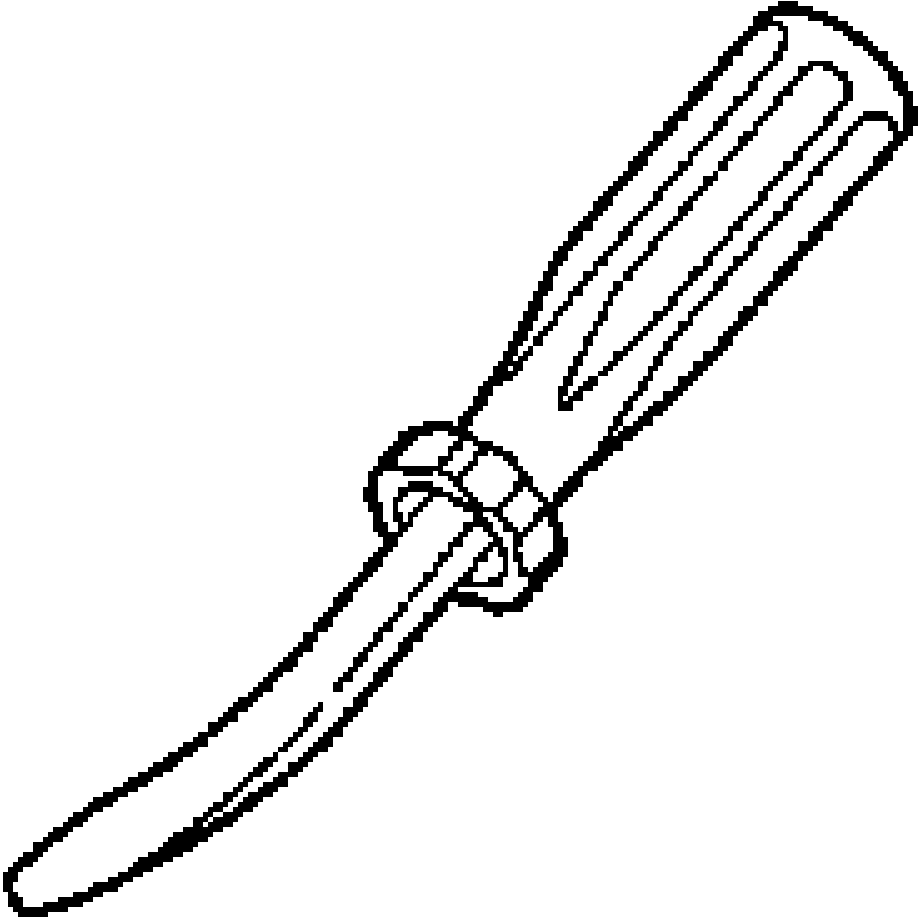
The BCM applies B+ to the hood ajar signal circuit and monitors the voltage to determine the position of the hood. The hood ajar switch contains a multiplexed resistor. This resistor will vary the voltage seen by the BCM by pulling down the applied voltage based on the position of the switch.

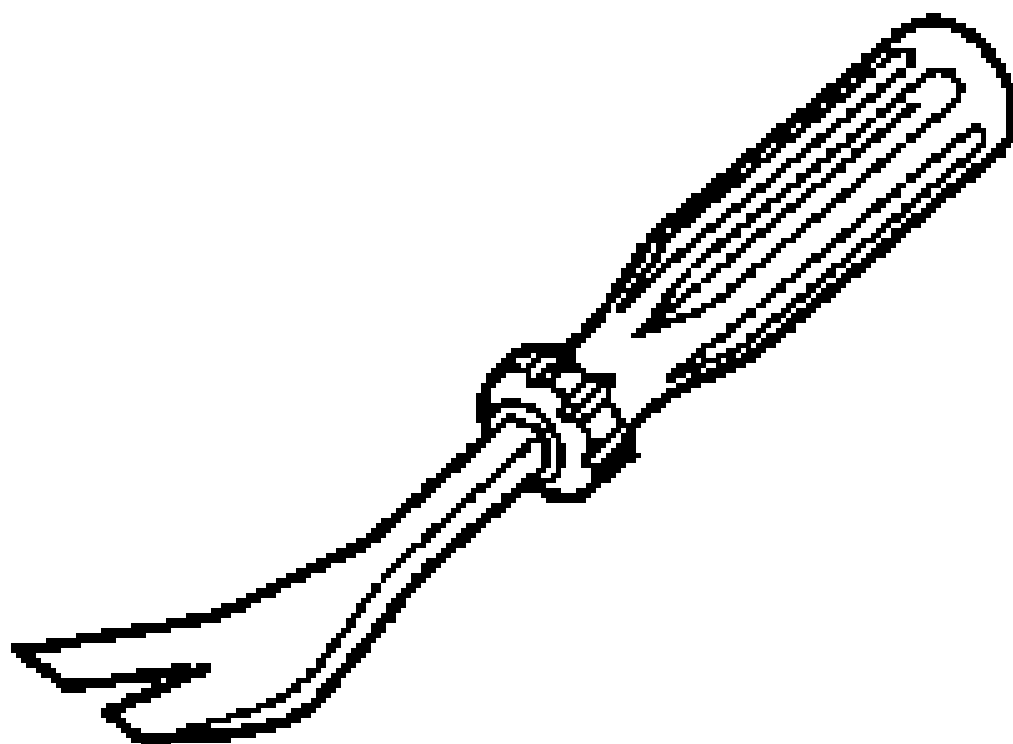
Hood Ajar Operation - Starter/Generator Control Module (with RPO HP6)

The starter/generator control module applies B+ to the hood ajar signal circuit and monitors the voltage to determine the position of the hood. The hood ajar switch contains a multiplexed resistor. This resistor will vary the voltage seen by the starter/generator control module by pulling down the applied voltage based on the position of the switch.

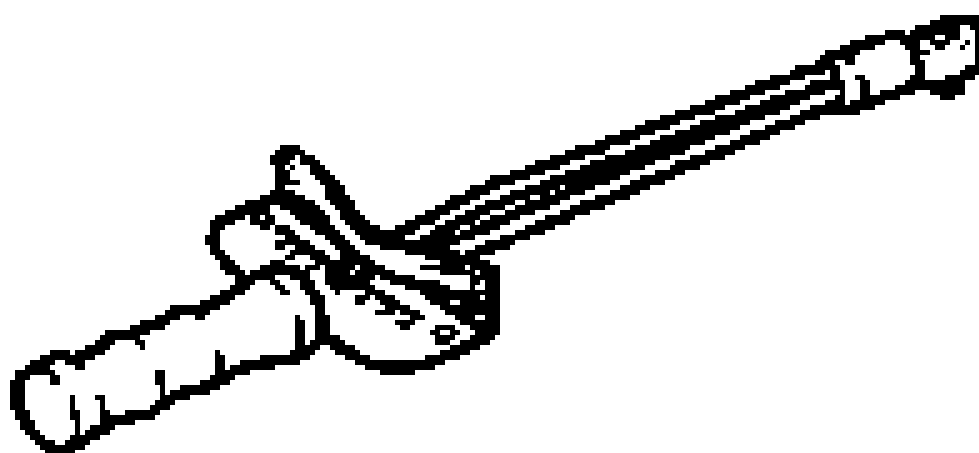
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	BO-347 KM-347 Installer



BO-569-A
KM-569-A
Plug Lifter



DT-6459-B
Torque
Wrench



GE-604-D
MKM-604-
D
TORX Bit
and Socket
Set

ACCESSORIES & EQUIPMENT

Bumpers and Fascias

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Bumper Energy Absorber Fasteners	115 N.m	85 lb ft
Front Bumper Fascia Air Deflector Center Screws	2.2 N.m	19 lb in
Front Bumper Fascia Air Deflector Outer Screws	2.2 N.m	19 lb in
Front Bumper Fascia Center Support Bracket Bolts	7 N.m	61 lb in
Front Bumper Fascia Screws	3 N.m	27 lb in
Front Bumper Fascia Side Bracket Screw	2.5 N.m	22 lb in
Front Bumper Impact Bar Bracket Bolts	22 N.m	16 lb ft
Front End Upper Tie Bar Fasteners	22 N.m	16 lb ft
Front Fascia Bolts	3 N.m	27 lb in
Front Fascia Support Screws	2 N.m	18 lb in
Front Fascia to Fender Bolts	3 N.m	27 lb in
Lower Front Fascia Impact Bar Rear Bolts	25 N.m	18 lb ft
Rear Impact Bar Nuts	42 N.m	31 lb ft
Rear Wheelhouse Liner Screws	2.5 N.m	22 lb in

REPAIR INSTRUCTIONS

FRONT BUMPER FASCIA ENERGY UPPER ABSORBER REPLACEMENT

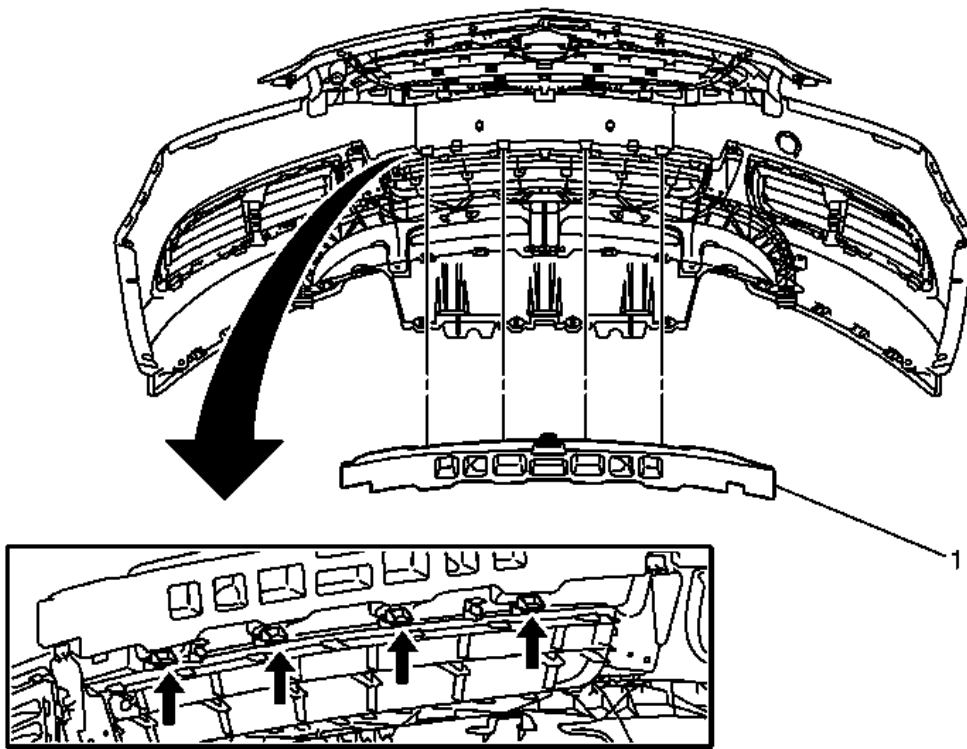


Fig. 1: Front Bumper Fascia Energy Upper Absorber
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Energy Upper Absorber Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Front Bumper Fascia Energy Absorber
Procedure	
Release the 4 retainers.	

FRONT BUMPER ENERGY ABSORBER REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

WARNING: Refer to **Glass and Sheet Metal Handling Warning** .

1. Disable the SIR System. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

3. Remove all related panels and components.

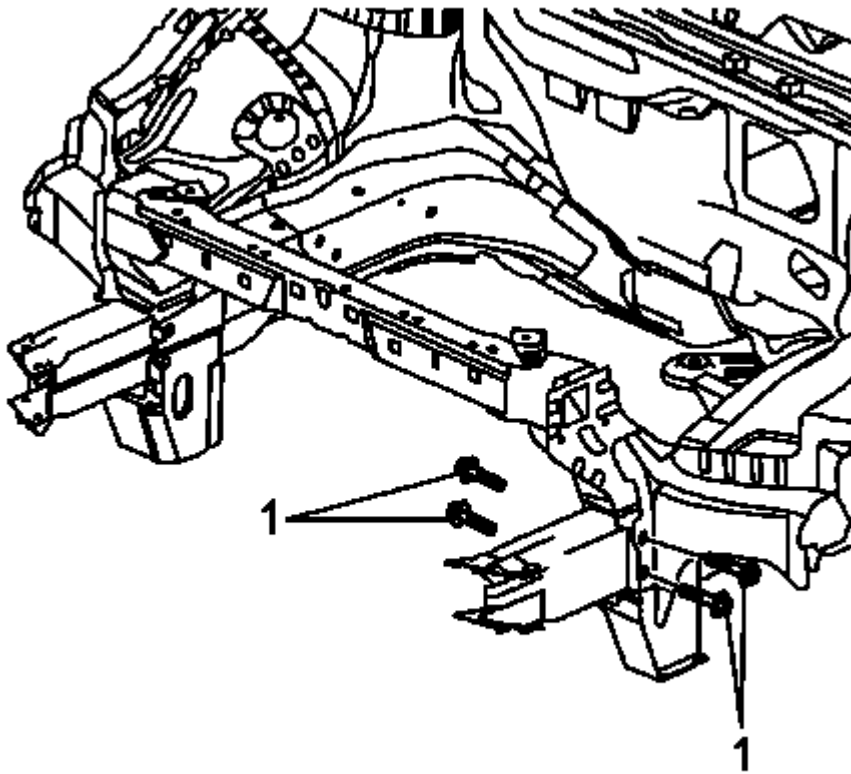


Fig. 2: Front Bumper Energy Absorber Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the 4 front bumper energy absorber fastener (1).
5. Locate and mark all factory welds.

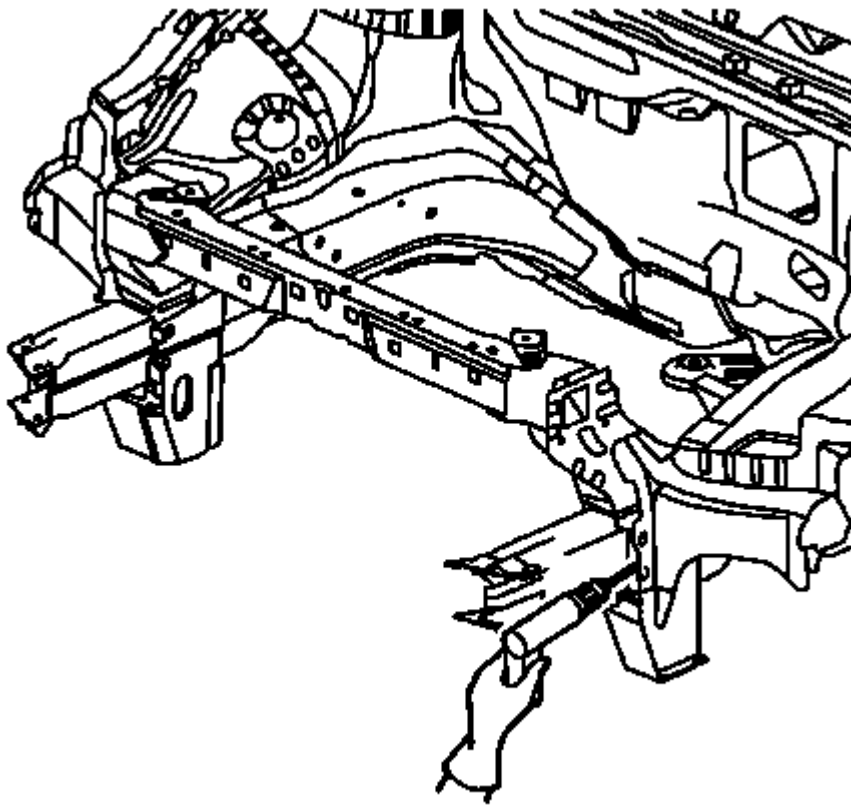


Fig. 3: Identifying Factory Welds
Courtesy of GENERAL MOTORS COMPANY

6. Drill all factory welds.
7. Remove the front bumper energy absorber.

Installation Procedure

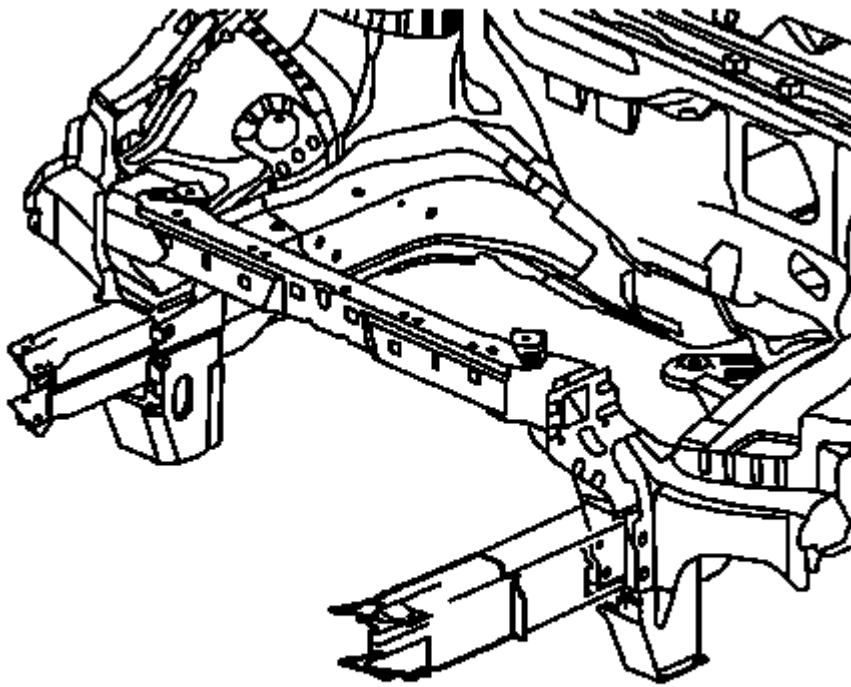


Fig. 4: Front Bumper Energy Absorber
Courtesy of GENERAL MOTORS COMPANY

1. Position the front bumper energy absorber on the vehicle.

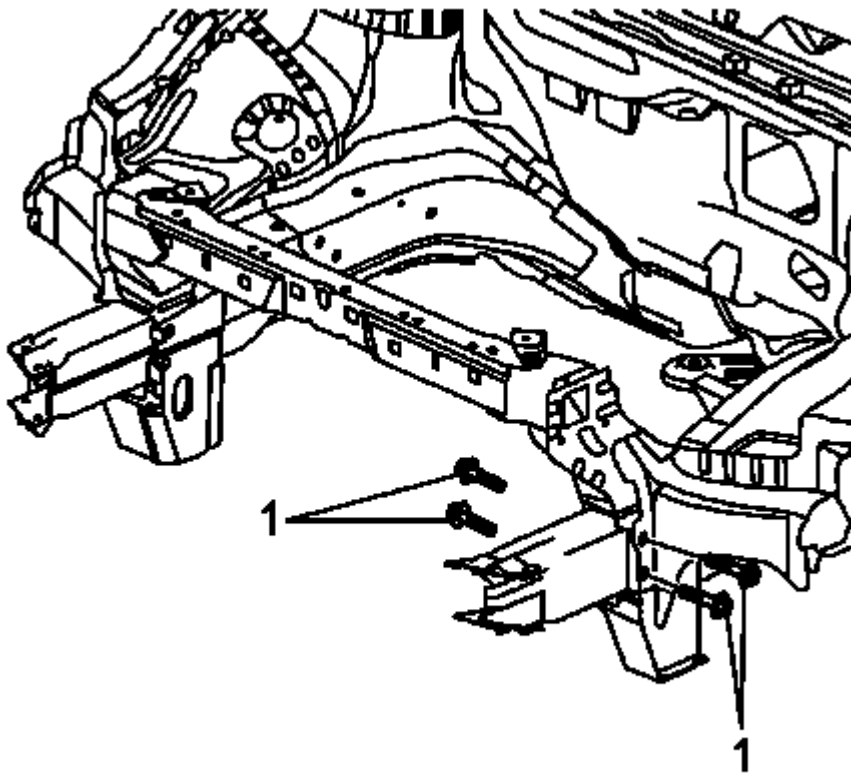


Fig. 5: Front Bumper Energy Absorber Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Use only the original front bumper energy absorber fastener. Replace fastener if damaged.

2. Install the 4 front bumper energy absorber fasteners (1) and tighten to the front compartment front inner side rail 115 N.m (85 lb ft).

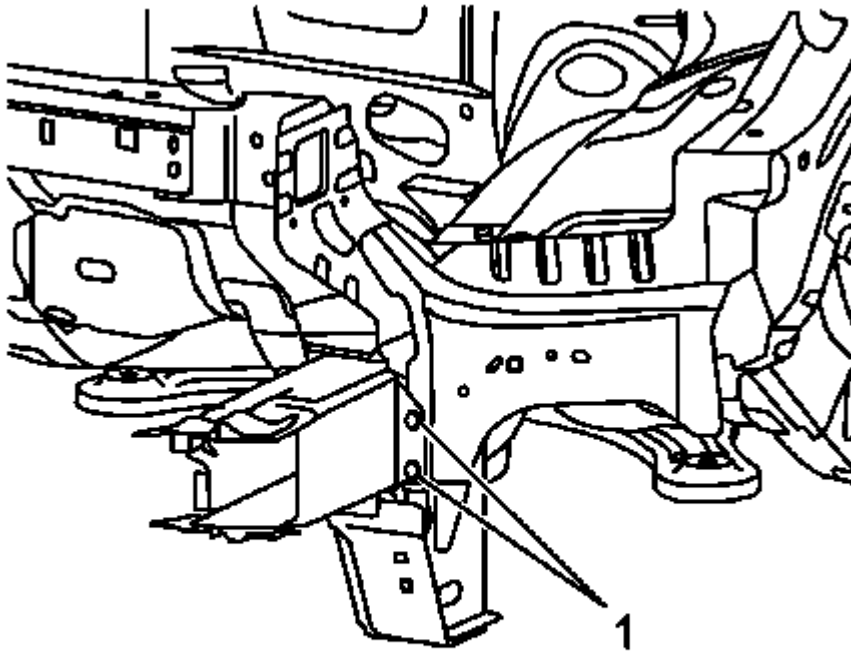


Fig. 6: Identifying Drill Holes

Courtesy of GENERAL MOTORS COMPANY

3. Drill two holes (1) 6 mm (0.24 in) along the edges of the front bumper energy absorber.

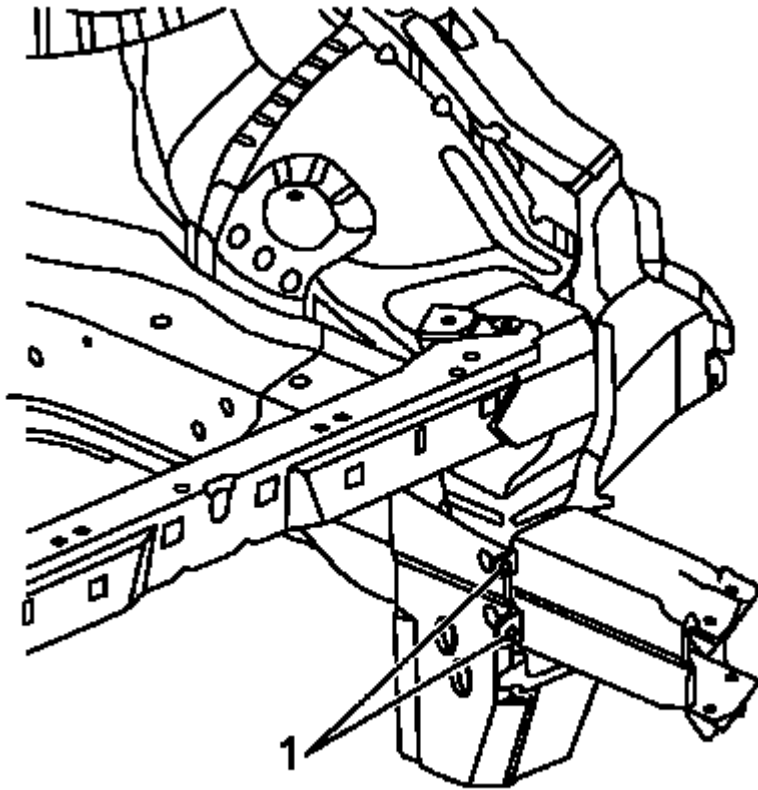


Fig. 7: Two Drill Holes

Courtesy of GENERAL MOTORS COMPANY

4. Drill two holes (1) 6 mm (0.24 in) along the edges of the front bumper energy absorber.

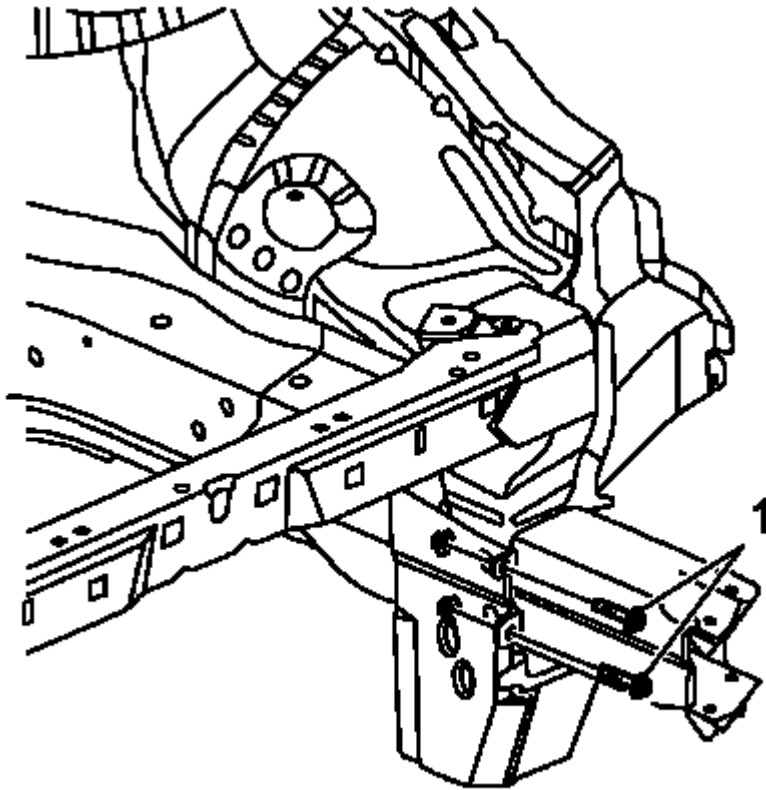


Fig. 8: Front End Upper Tie Bar Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use only the original front end upper tie bar fastener (M6 bolt and nut).
Replace the fastener if damaged.

5. Install the 2 front end upper tie bar fasteners (1) and tighten to the front compartment front inner side rail 22 N.m (16 lb ft).

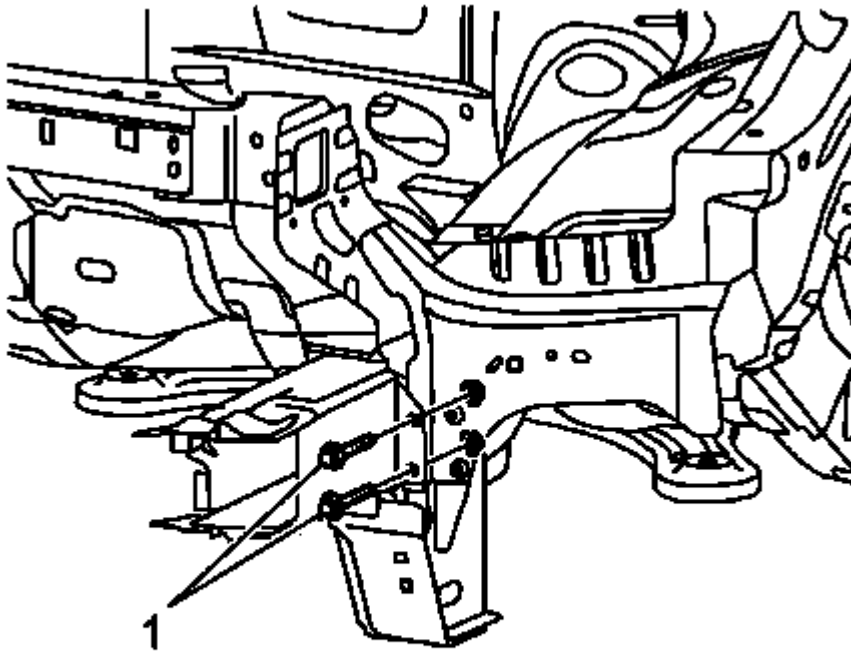


Fig. 9: Upper Front End Tie Bar Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use only the original front end upper tie bar fastener (M6 bolt and nut).
Replace the fastener if damaged.

6. Install the 2 front end upper tie bar fasteners (1) and tighten to the front compartment front inner side rail 22 N.m (16 lb ft).
7. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems .
8. Install all related panels and components.
9. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
10. Enable the SIR system. Refer to SIR Disabling and Enabling .

FRONT BUMPER IMPACT BAR REPLACEMENT

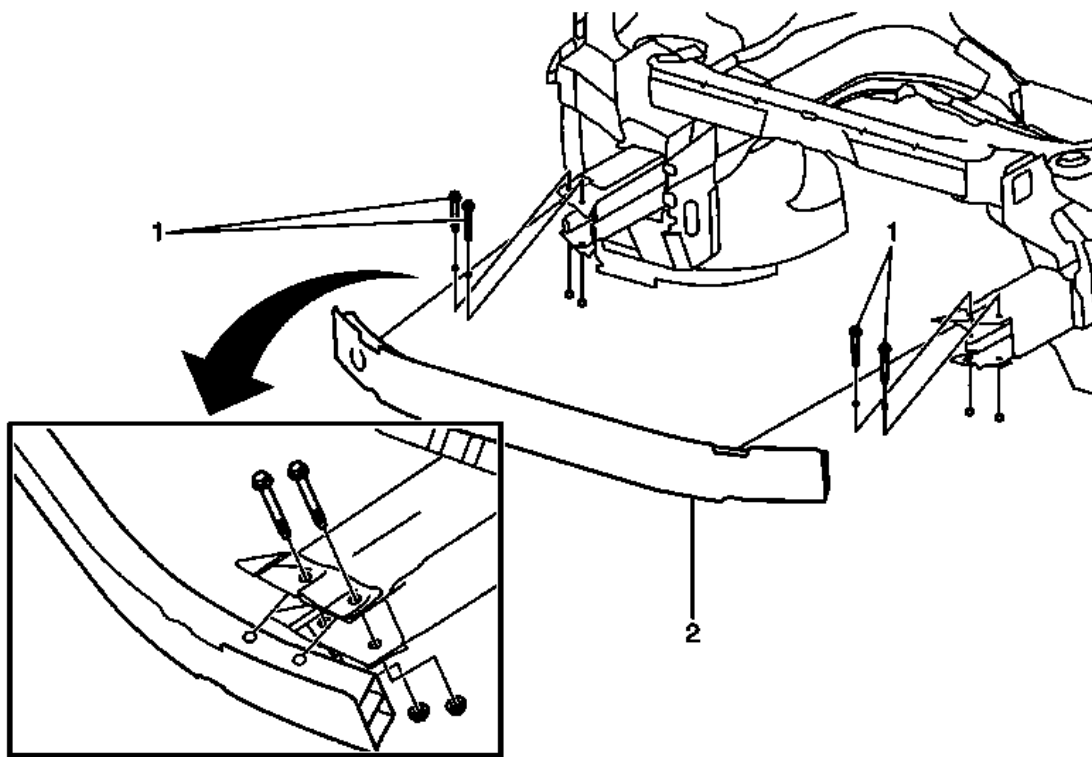


Fig. 10: Front Bumper Impact Bar And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Impact Bar Replacement

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement. 2. Remove the front bumper fascia support. Refer to Front Bumper Fascia Support Replacement (Left Side), Front Bumper Fascia Support Replacement (Right Side) 3. Remove the air cleaner inlet duct. Refer to Air Cleaner Inlet Duct Replacement 	
1	Front Bumper Impact Bar Fastener (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft)
2	Front Bumper Impact Bar

FRONT BUMPER FASCIA REPLACEMENT

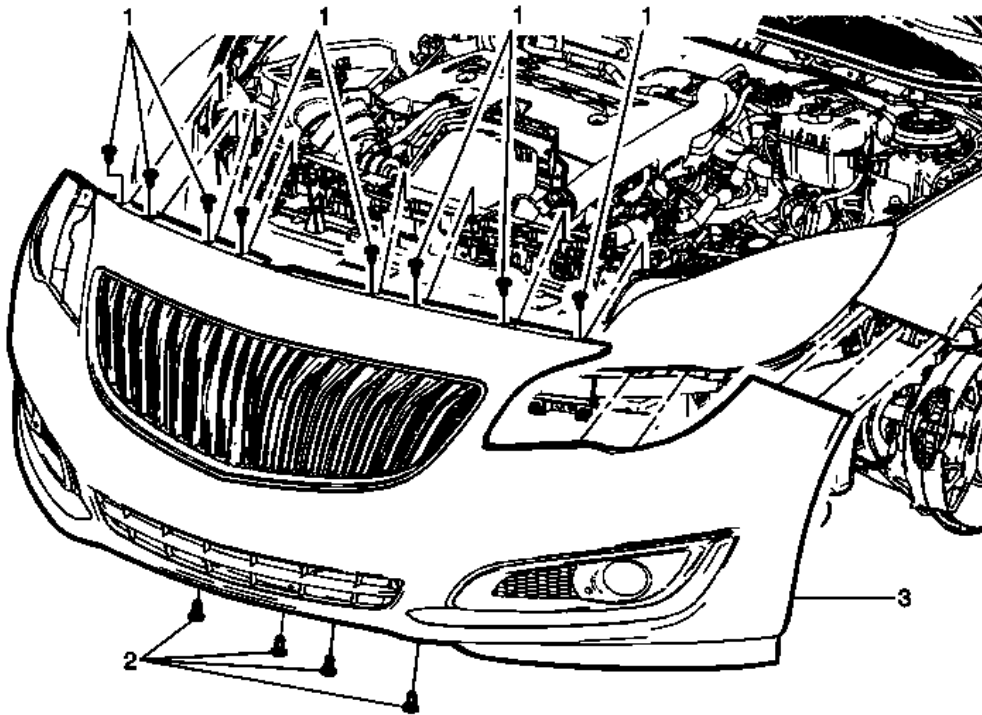


Fig. 11: Front Bumper Fascia
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Replacement

Callout	Component Name
Preliminary Procedure Remove the front wheelhouse liner screws to fascia. Refer to <u>Front Wheelhouse Front Liner Replacement</u> .	
1	Front Bumper Fascia Upper Bolts (Qty: 8) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 3 (27 lb in)
2	Front Bumper Fascia Plastic Retainer (Qty: 4)
3	Front Bumper Fascia Procedure 1. Carefully push a small nylon wedge between the front bumper fascia and the front bumper fascia guide. Insert a small flat-bladed tool into the front bumper fascia slot and depress the snaps one at a time and pull on the fascia at the same time to gradually remove the fascia from the front fascia guide.

2. Disconnect any electrical connectors.
3. Transfer components as necessary.

FRONT BUMPER FASCIA CENTER SUPPORT REPLACEMENT - UPPER

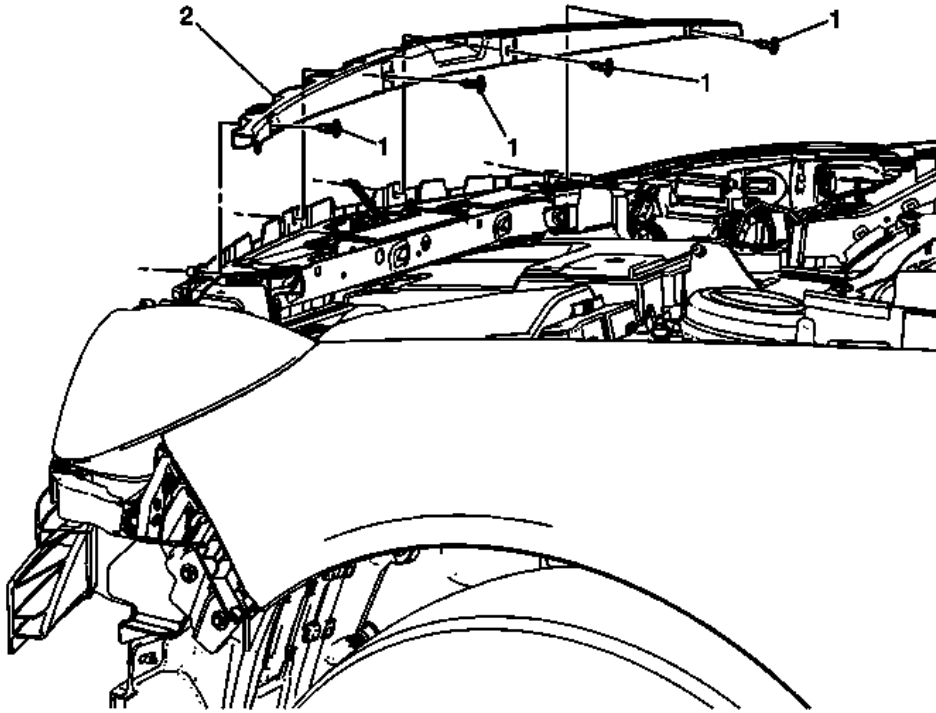


Fig. 12: Front Bumper Fascia Center Upper Support
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Center Support Replacement - Upper

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Front Bumper Fascia Center Support - Upper Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
2	Front Bumper Fascia Center Support - Upper

FRONT BUMPER FASCIA CENTER SUPPORT REPLACEMENT - LOWER

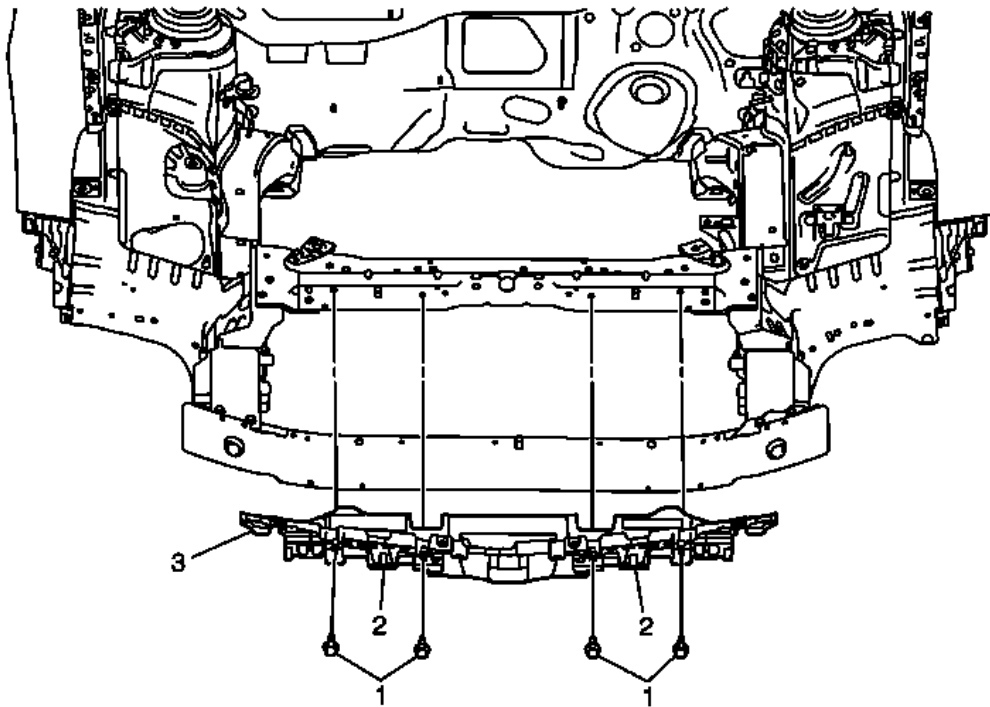


Fig. 13: Front Bumper Fascia Center Support - Lower
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Center Support Replacement - Lower

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Front Bumper Fascia Center Support - Lower Fastener (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Front Bumper Fascia Center Support - Lower Retainer (Qty: 2)
3	Front Bumper Fascia Center Support - Lower

FRONT BUMPER FASCIA SUPPORT REPLACEMENT (LEFT SIDE)

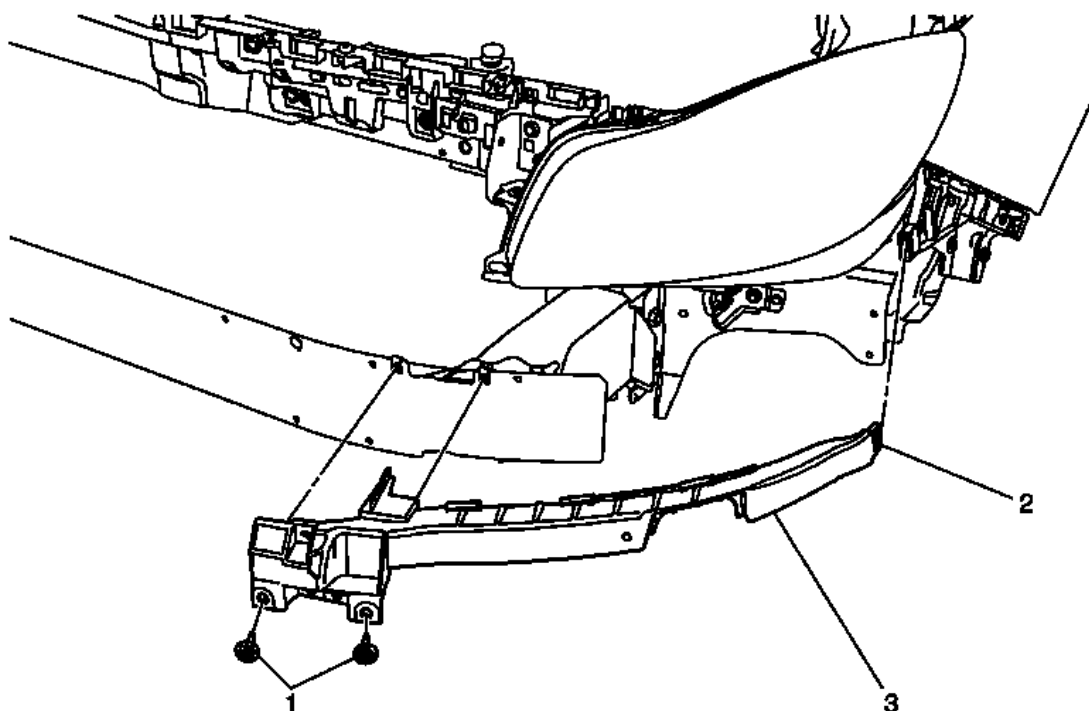


Fig. 14: Front Bumper Fascia Support (Left Side)
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Support Replacement (Left Side)

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u>	
1	Front Bumper Fascia Support Fastener (Qty: 2)
2	Front Bumper Fascia Support Retainer
Procedure	
Using a small flat-bladed tool, release the one outer locking retainer from the front bumper fascia outer bracket support.	
3	Front Bumper Fascia Support

FRONT BUMPER FASCIA SUPPORT REPLACEMENT (RIGHT SIDE)

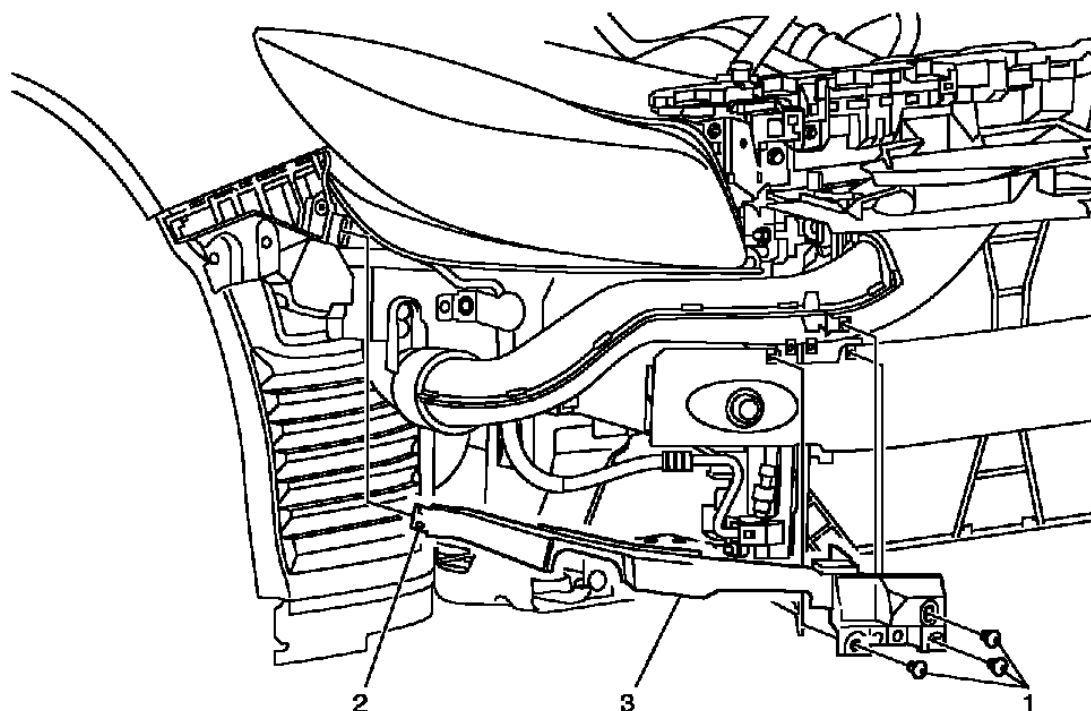


Fig. 15: Front Bumper Fascia Support (Right Side)
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Support Replacement (Right Side)

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Front Bumper Fascia Bracket Support Fastener (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 2 N.m (18 lb in)
2	Front Bumper Fascia Bracket Support Retainer
3	Front Bumper Fascia Bracket Support Procedure Using a small flat-bladed tool, release the one outer locking retainer from the front bumper fascia outer bracket support.

FRONT BUMPER VALANCE PANEL REPLACEMENT

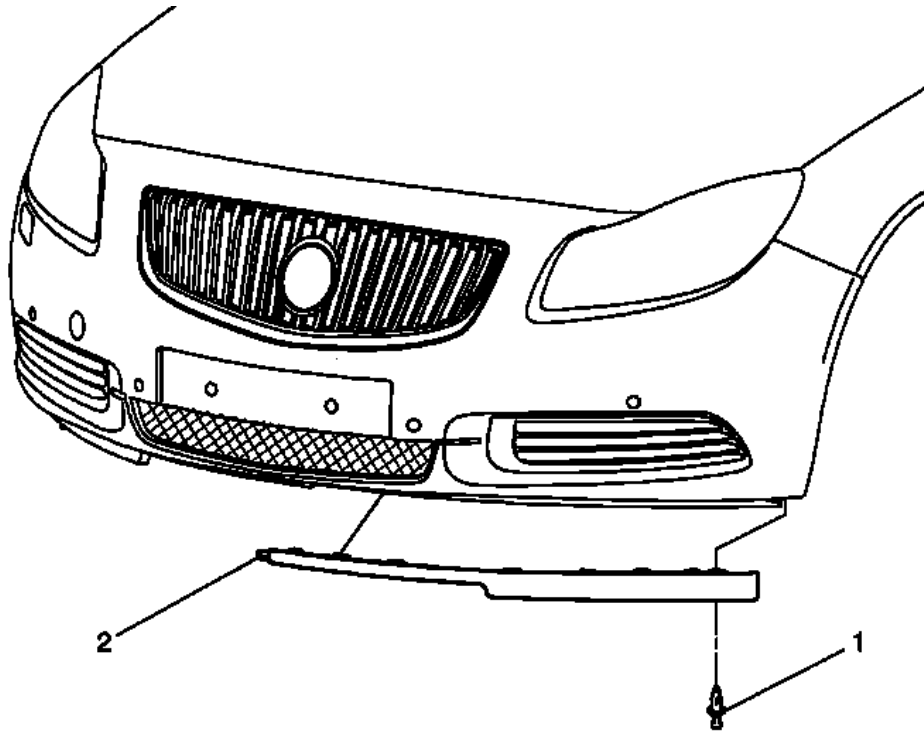


Fig. 16: Front Bumper Valance Panel & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Valance Panel Replacement

Callout	Component Name
Preliminary Procedure Lift and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Front Bumper Valance Panel Retainer (Qty: 2) Procedure <ol style="list-style-type: none"> 1. Release the five flat locking retainers from the front bumper fascia. 2. Push the front bumper valance panel outward from the front bumper fascia in order to remove. NOTE: Using a small flat-bladed tool, pull and release the outer front bumper fascia locking retainer from the front bumper valance panel.
2	Front Bumper Valance Panel

REAR BUMPER FASCIA REPLACEMENT

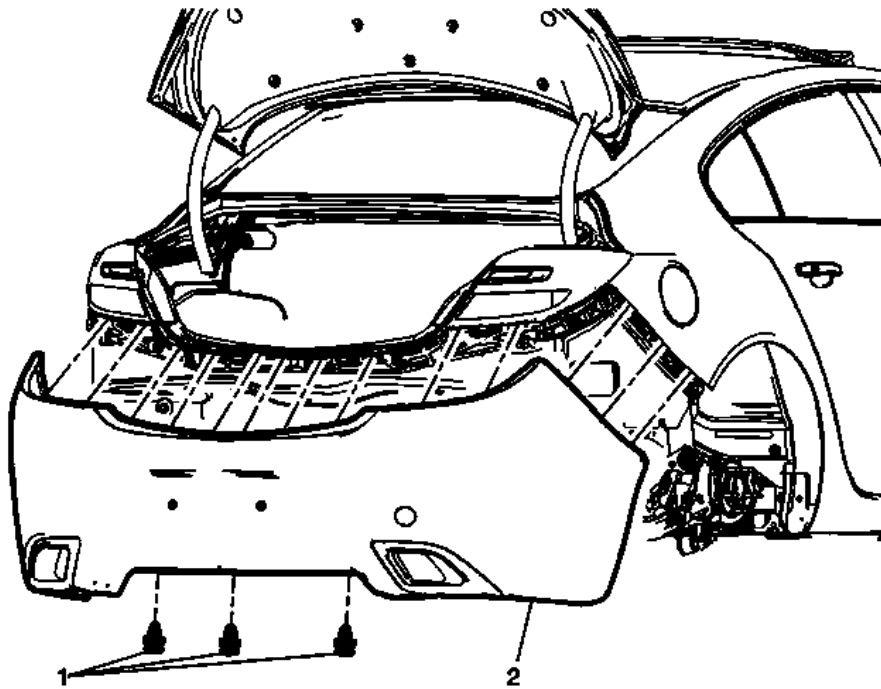


Fig. 17: Rear Bumper Fascia
 Courtesy of GENERAL MOTORS COMPANY

Rear Bumper Fascia Replacement

Callout	Component Name
Preliminary Procedure Remove the six wheel house panel screws to fascia. Refer to <u>Front Wheelhouse Rear Liner Replacement</u>	
1	Rear Bumper Fascia Retainer (Qty: 3)
2	Rear Bumper Fascia Procedure <ol style="list-style-type: none"> Carefully push a small nylon wedge between the fascia and the rear fascia retainers. Insert a small flat-bladed tool into the fascia slot and depress the snaps one at a time and pull on the fascia at the same time to gradually remove the fascia from the rear fascia retainers. Disconnect any electrical connectors as needed. Transfer any parts as needed.

REAR BUMPER FASCIA GUIDE REPLACEMENT (LEFT SIDE)

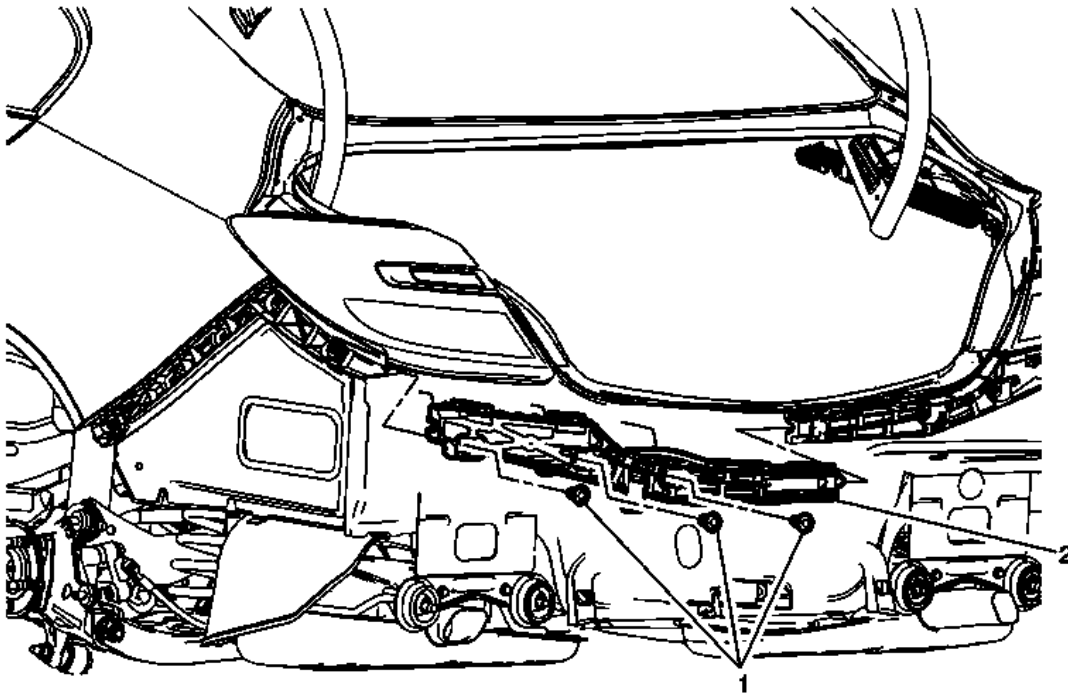


Fig. 18: Rear Bumper Fascia Guide (Left Side)
 Courtesy of GENERAL MOTORS COMPANY

Rear Bumper Fascia Guide Replacement (Left Side)

Callout	Component Name
WARNING: Eye protection must be worn when drilling rivets to reduce the chance of personal injury.	
Preliminary Procedure Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
1	Rear Bumper Fascia Guide Rivet (Qty: 3)
2	Rear Bumper Fascia Guide

REAR BUMPER FASCIA GUIDE REPLACEMENT (RIGHT SIDE)

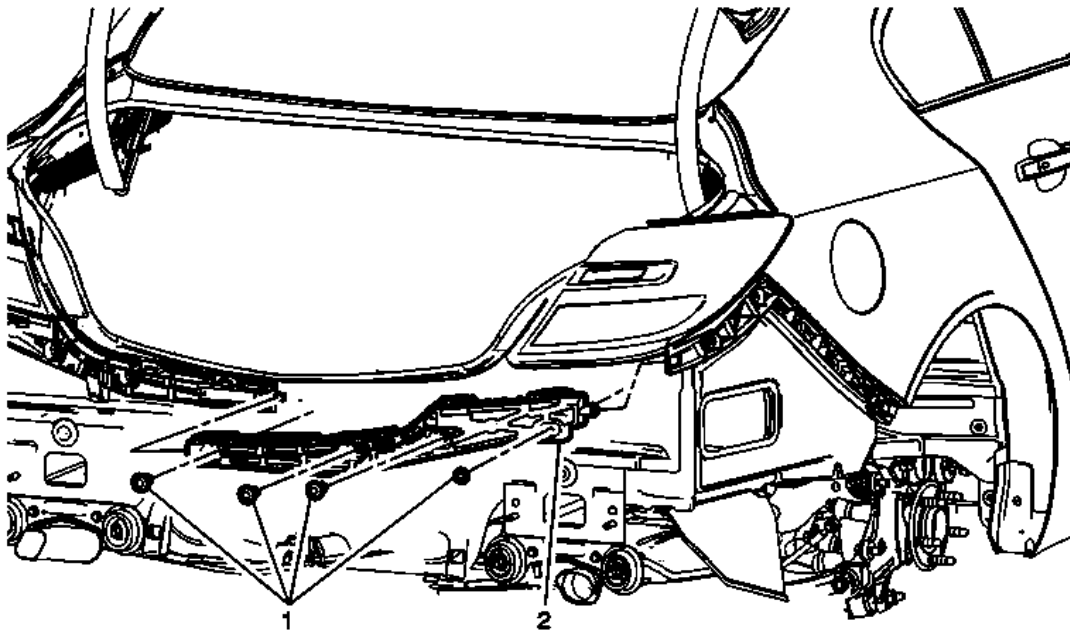


Fig. 19: Rear Bumper Fascia Guide (Right Side)
 Courtesy of GENERAL MOTORS COMPANY

Rear Bumper Fascia Guide Replacement (Right Side)

Callout	Component Name
WARNING: Eye protection must be worn when drilling rivets to reduce the chance of personal injury.	
Preliminary Procedure Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
1	Rear Bumper Fascia Guide Rivet (Qty: 4)
2	Rear Bumper Fascia Guide

REAR BUMPER FASCIA OUTER GUIDE REPLACEMENT

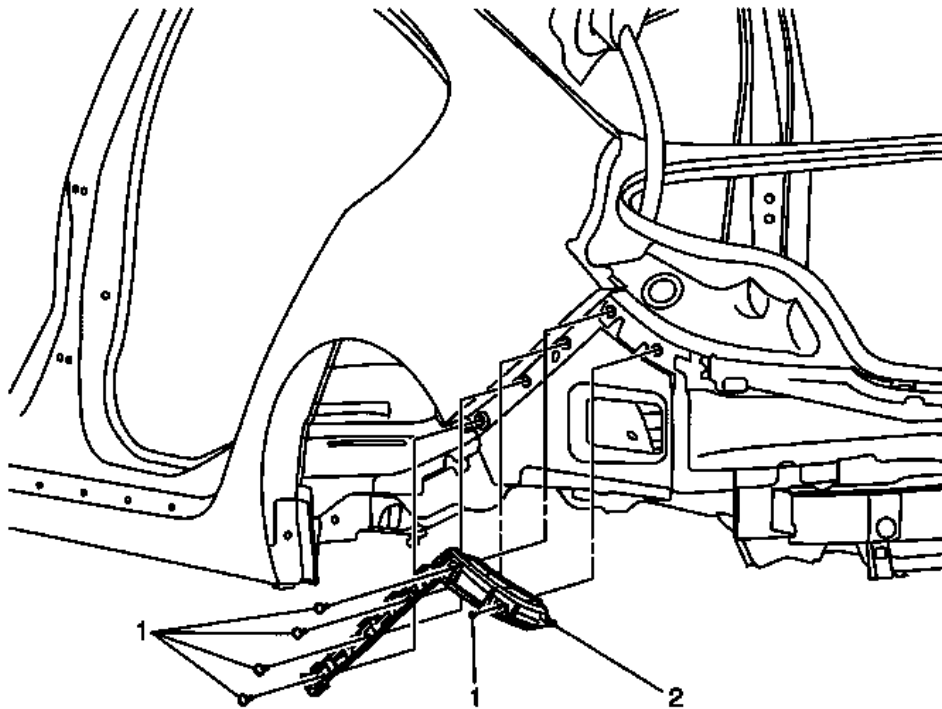


Fig. 20: Rear Bumper Fascia Outer Guide And Rivets
 Courtesy of GENERAL MOTORS COMPANY

Rear Bumper Fascia Outer Guide Replacement

Callout	Component Name
WARNING: Eye protection must be worn when drilling rivets to reduce the chance of personal injury.	
Preliminary Procedure Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
1	Rear Bumper Fascia Outer Guide Rivet (Qty: 5)
2	Rear Bumper Fascia Outer Guide

FRONT BUMPER FASCIA INNER GUIDE REPLACEMENT

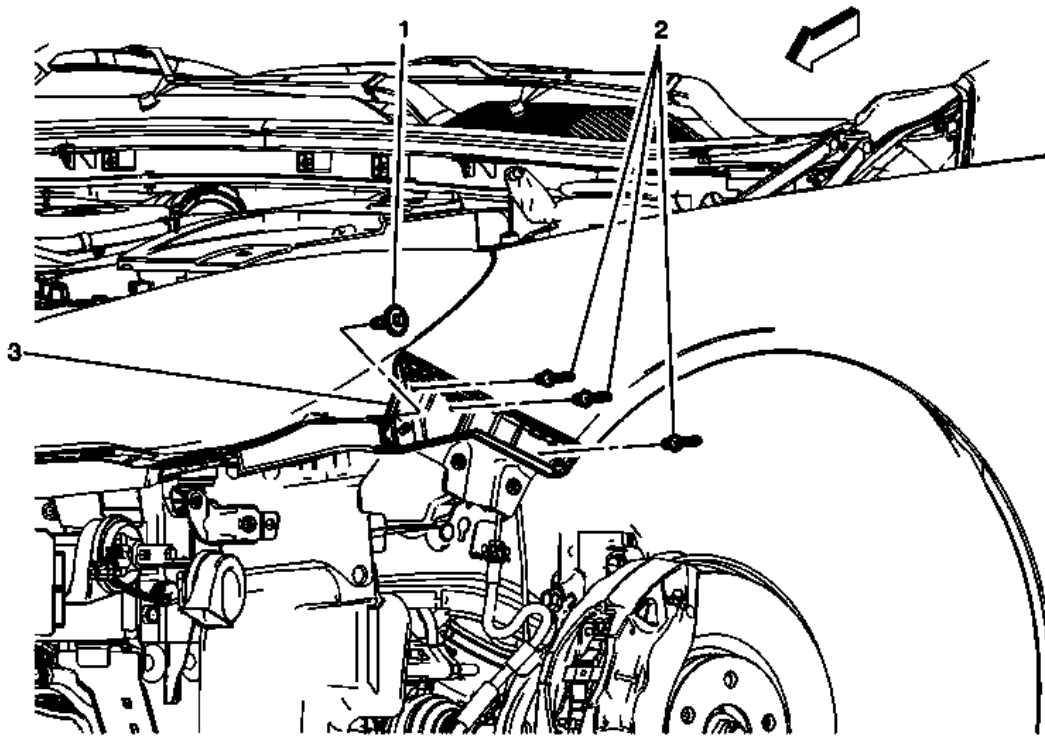


Fig. 21: Front Bumper Fascia Inner Guide
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Inner Guide Replacement

Callout	Component Name
WARNING: Eye protection must be worn when drilling rivets to reduce the chance of personal injury.	
Preliminary Procedure Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Front Headlamp Bolt Tighten 2.5 (22 lb in)
2	Front Bumper Fascia Guide Rivet (Qty: 3)
3	Front Bumper Fascia Guide

REAR BUMPER LOWER FASCIA REPLACEMENT

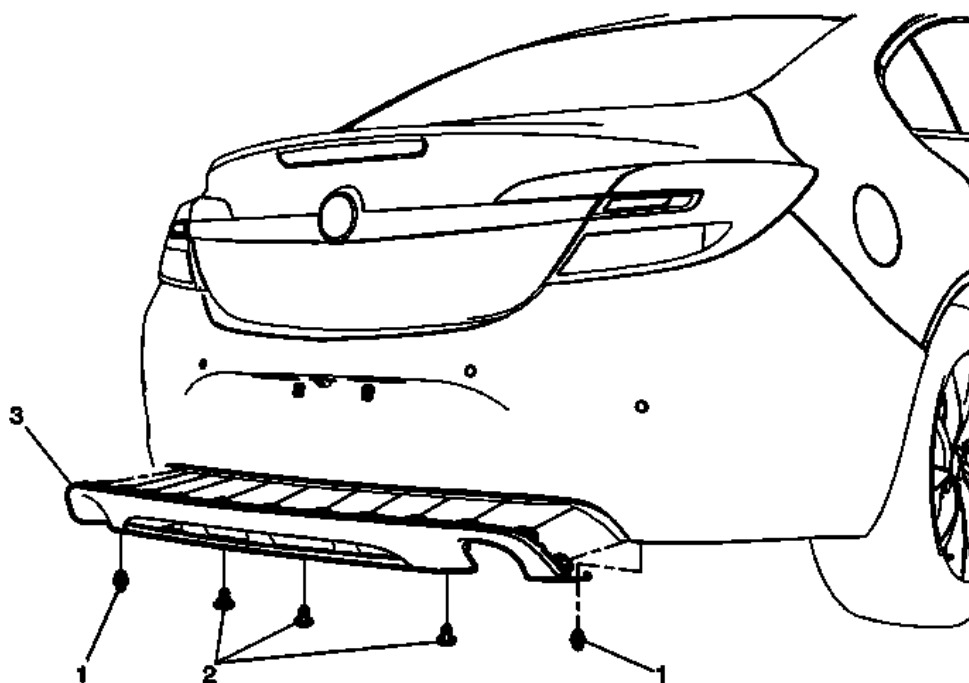


Fig. 22: Rear Bumper Lower Fascia
 Courtesy of GENERAL MOTORS COMPANY

Rear Bumper Lower Fascia Replacement

Callout	Component Name
1	Rear Bumper Lower Fascia Plastic Rivet (Qty: 2)
2	Rear Bumper Lower Fascia Retainer (Qty: 3)
3	Rear Bumper Lower Fascia Procedure Use a small flat-bladed tool to release the rear bumper lower fascia locking retainers from the rear bumper fascia.

REAR BUMPER FASCIA LOWER BRACKET REPLACEMENT

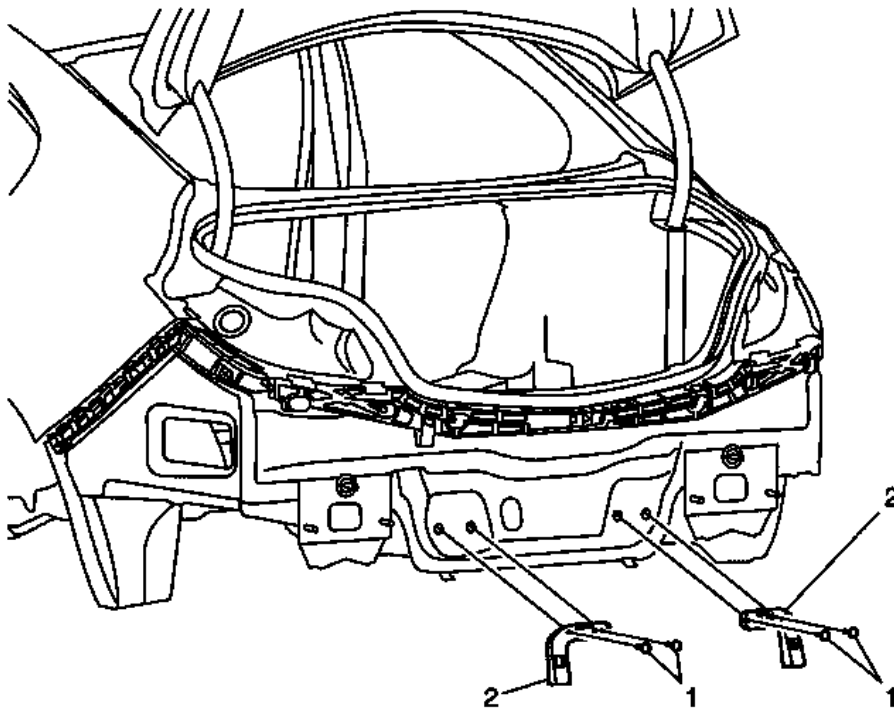


Fig. 23: Rear Bumper Fascia Lower Brackets & Rivets
 Courtesy of GENERAL MOTORS COMPANY

Rear Bumper Fascia Lower Bracket Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
2. Remove the rear bumper impact bar. Refer to <u>Rear Bumper Impact Bar Replacement</u> .	
1	Rear Bumper Fascia Lower Bracket Rivet (Qty: 4)
2	Rear Bumper Fascia Lower Bracket

REAR BUMPER IMPACT BAR REPLACEMENT

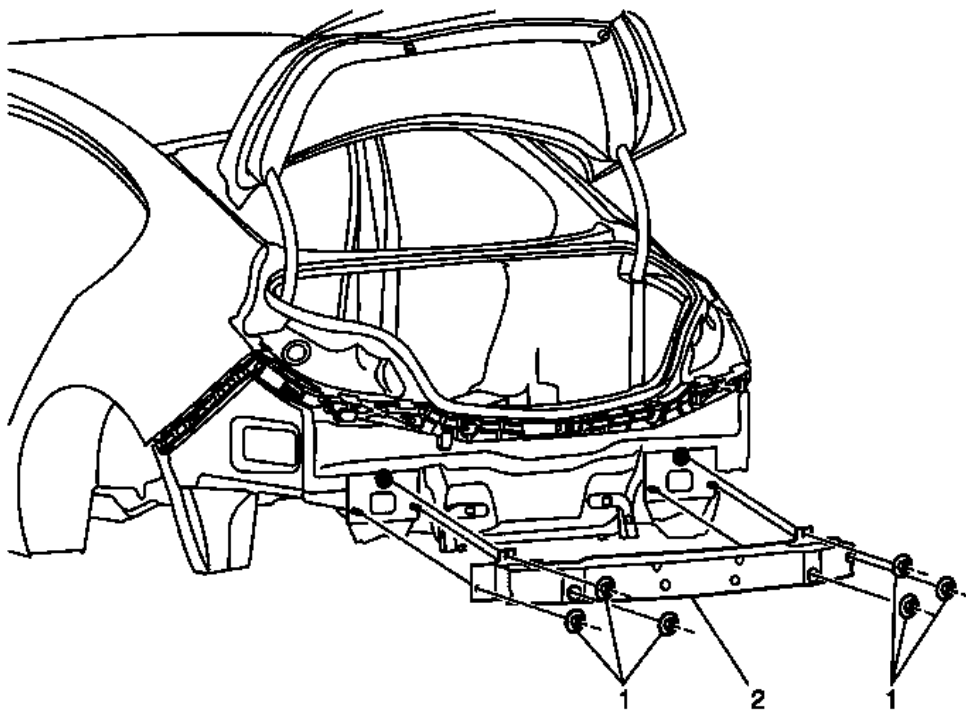


Fig. 24: Rear Bumper Impact Bar And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Rear Bumper Impact Bar Replacement

Callout	Component Name
Preliminary Procedure Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
1	Rear Bumper Impact Bar Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 40 (30 lb ft)
2	Rear Bumper Impact Bar

CABIN AIR FILTER

REMOVAL & INSTALLATION

NOTE: Manufacturer's terminology for this filter is passenger compartment air filter.

CABIN AIR FILTER

Removal & Installation

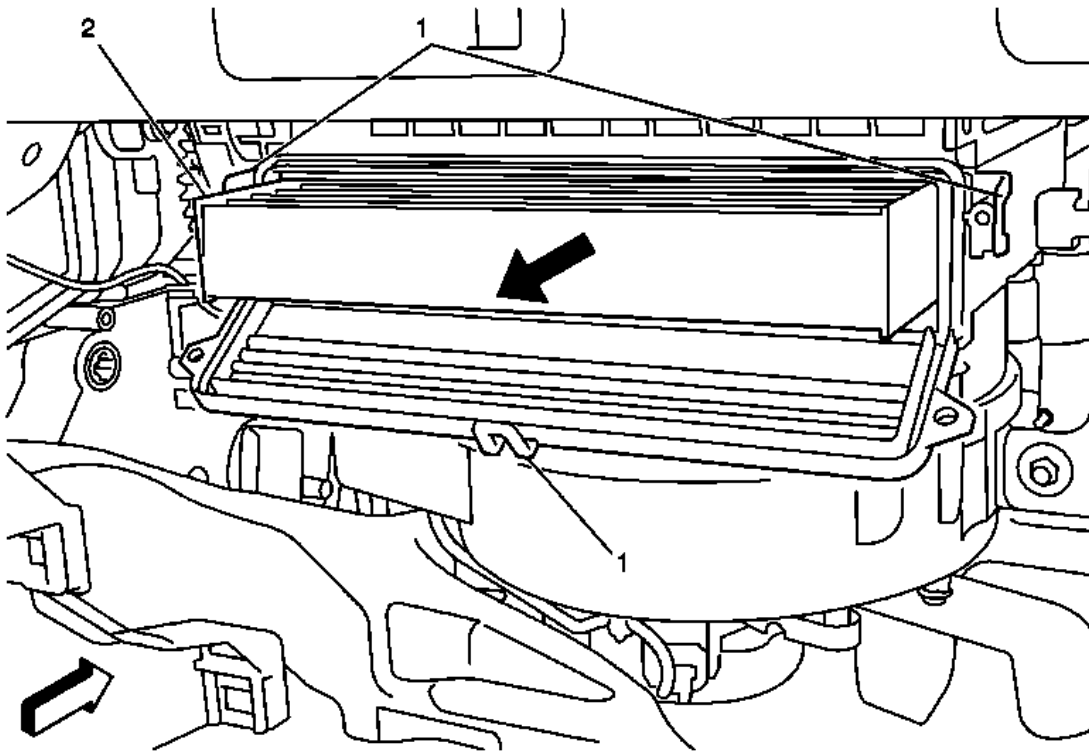


Fig. 1: Passenger Compartment Air Filter
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove instrument panel outer trim cover. <u>INSTRUMENT PANEL OUTER TRIM COVER REPLACEMENT - RIGHT SIDE</u> Remove instrument panel compartment. Refer to <u>INSTRUMENT PANEL COMPARTMENT REPLACEMENT</u>	
1	Passenger Compartment Air Filter Service Lid Retainer (Qty:3) Procedure : Release the retainer and open the service lid.
2	Passenger Compartment Air Filter

ACCESSORIES & EQUIPMENT

Cellular, Entertainment, and Navigation

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Radio Antenna Coil Fastener	8 N.m	70 lb in
Radio Antenna Module Fastener	9 N.m	80 lb in
Video Display Fastener	9.5 N.m	84 lb in

SCHEMATIC WIRING DIAGRAMS

RADIO/NAVIGATION SYSTEM WIRING SCHEMATICS

Power, Ground, Serial Data and Antennas

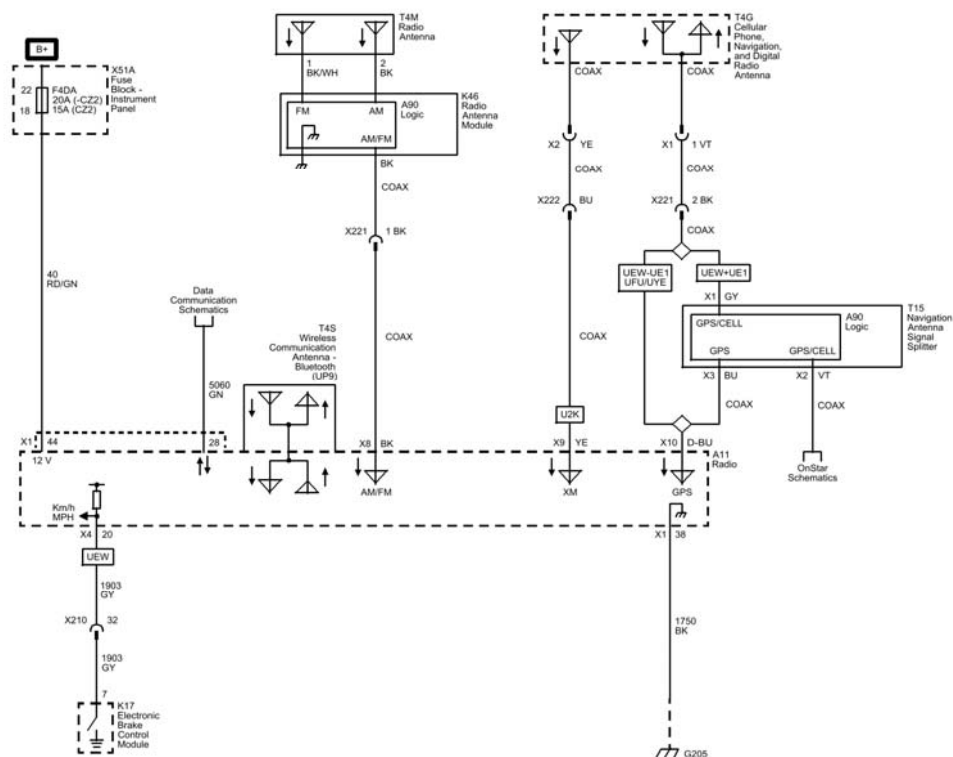


Fig. 1: Power, Ground, Serial Data and Antennas

Courtesy of GENERAL MOTORS COMPANY

Power, Ground, Antennas, and Serial Data CZ2

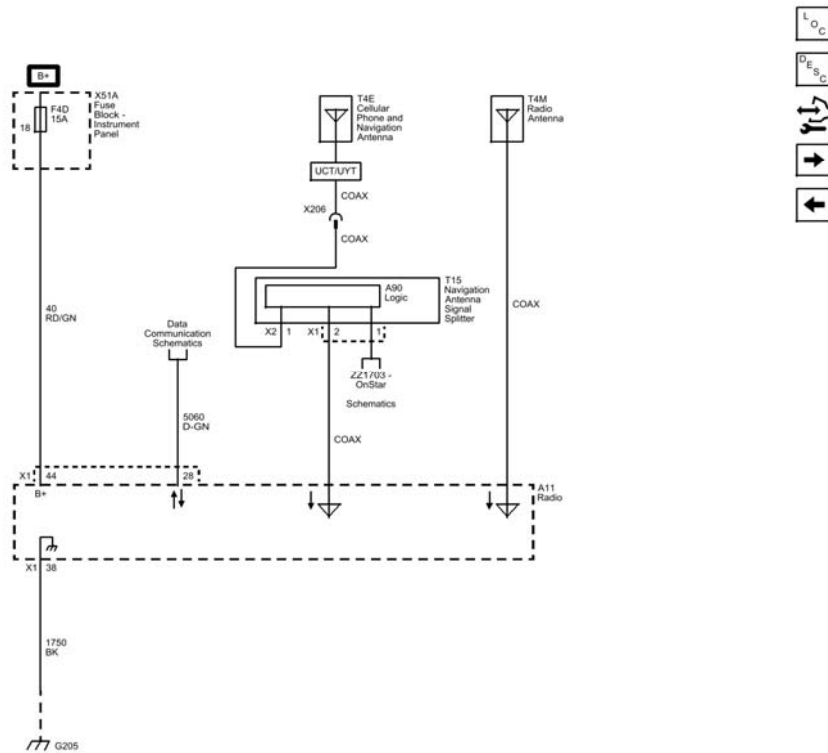


Fig. 2: Power, Ground, Antennas, and Serial Data CZ2

Courtesy of GENERAL MOTORS COMPANY

Amplifier Inputs (UQA) (Except CZ2)

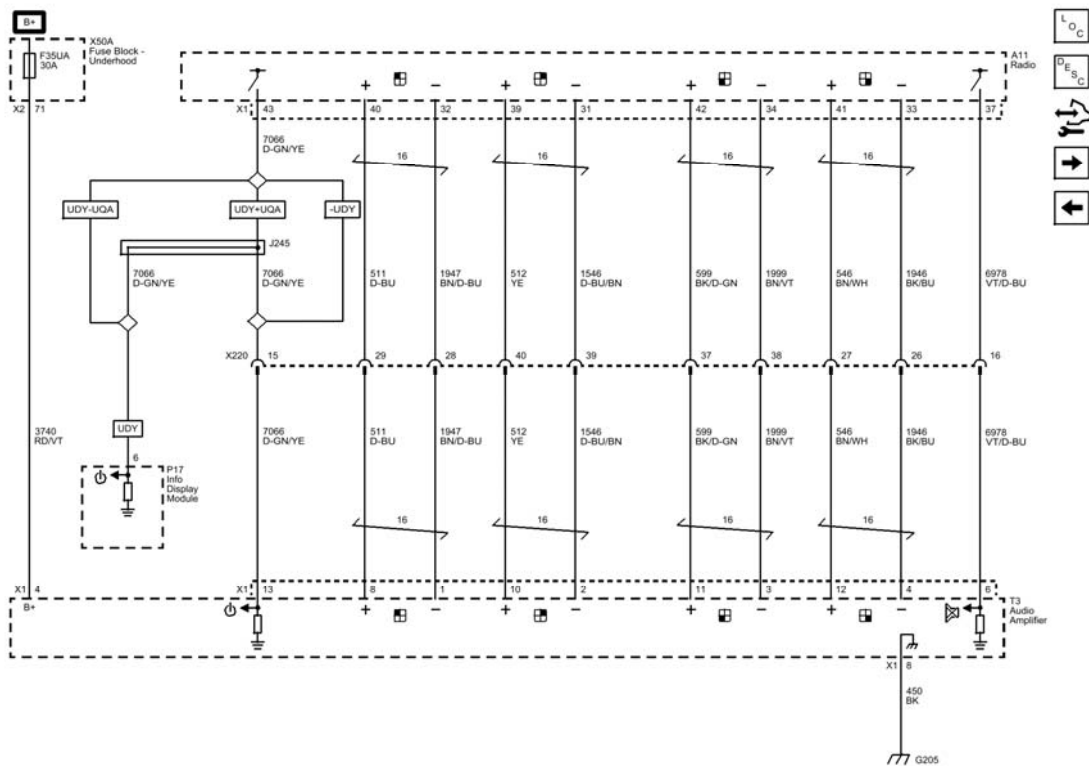


Fig. 3: Amplifier Inputs (UQA) (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Amplifier Inputs (UQS) (1 of 2) (CZ2)

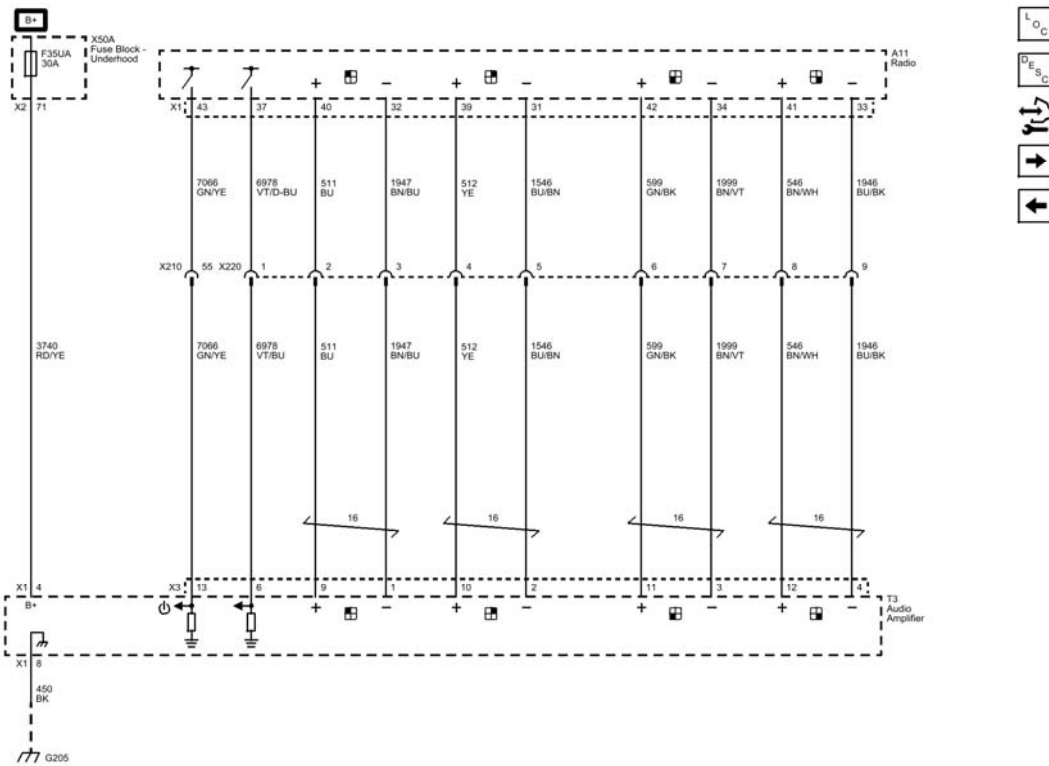


Fig. 4: Amplifier Inputs (UQS) (1 of 2) (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Amplifier Inputs (UQS) (2 of 2) (CZ2)

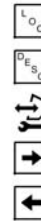
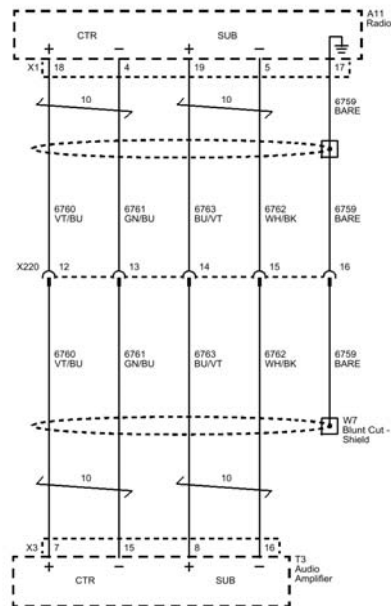


Fig. 5: Amplifier Inputs (UQS) (2 of 2) (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Speakers (U65) (Except CZ2)

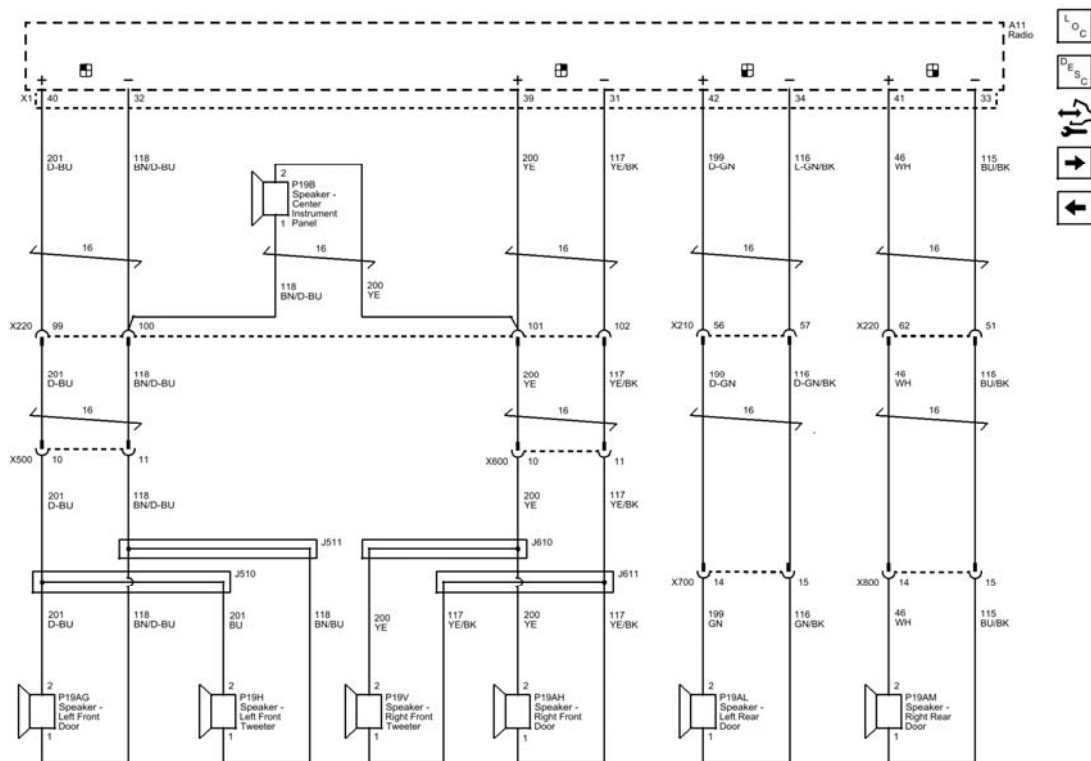


Fig. 6: Speakers (U65) (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Speakers (U65) (CZ2)

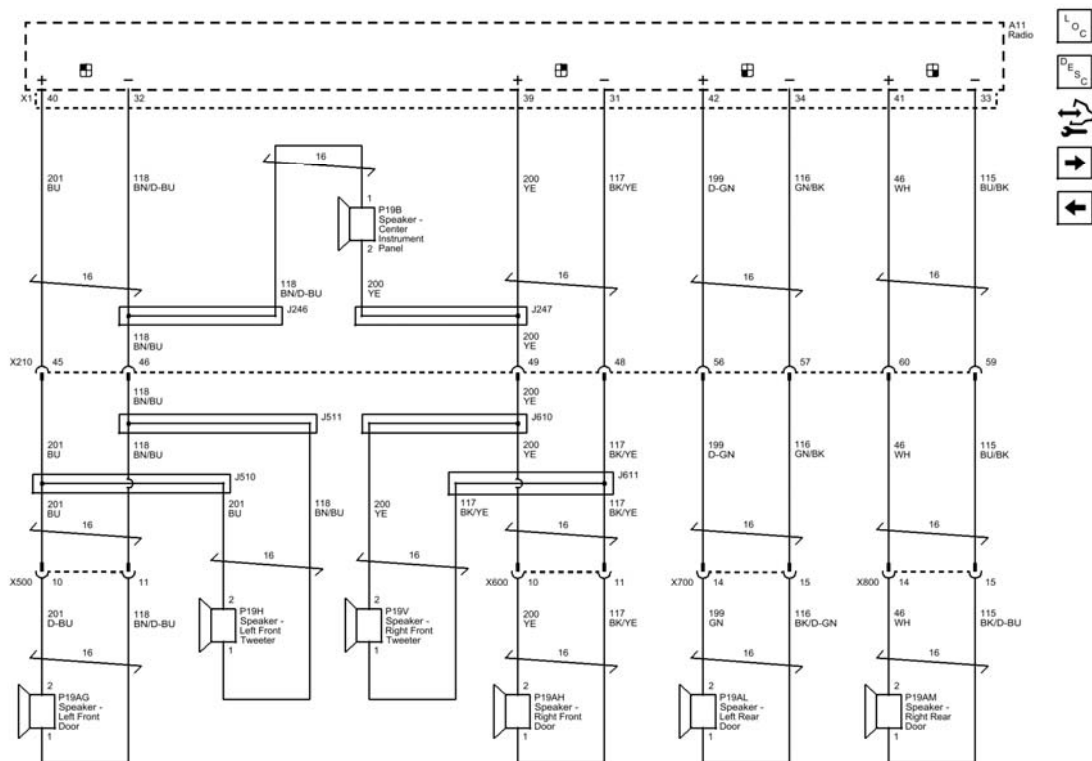


Fig. 7: Speakers (U65) (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Speakers (UQA) (Except CZ2)

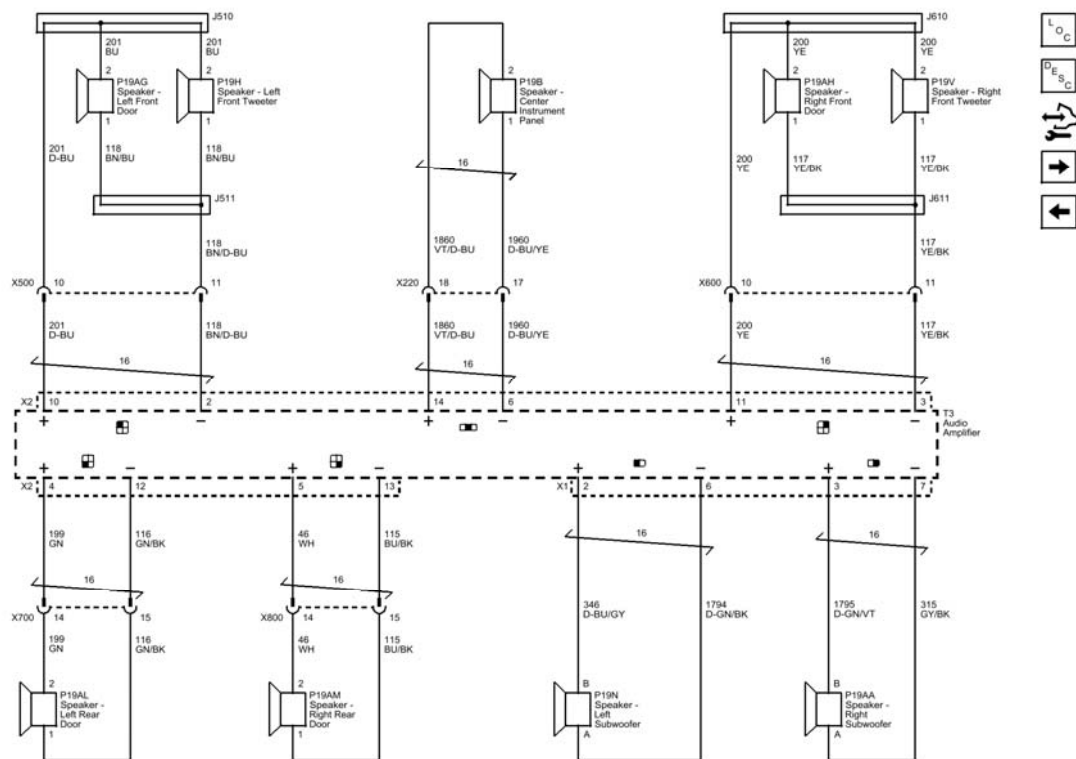


Fig. 8: Speakers (UQA) (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Speakers (UQS) (CZ2)

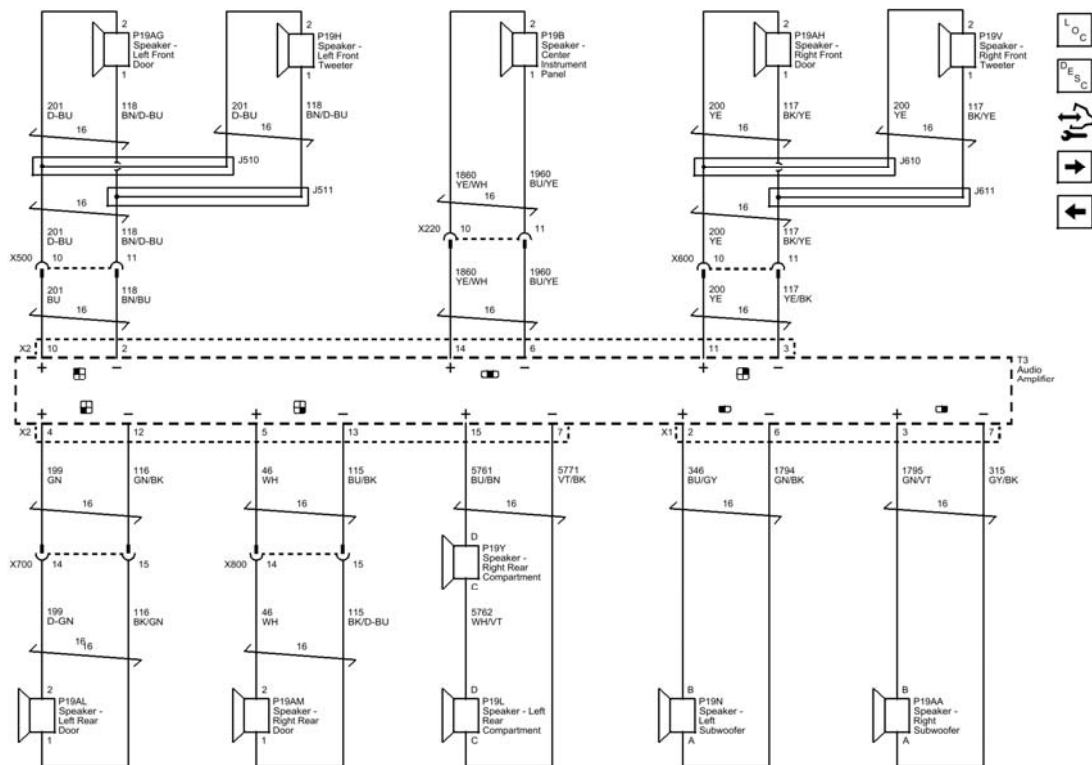


Fig. 9: Speakers (UQS) (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Auxiliary Inputs (KTA) (Except CZ2)

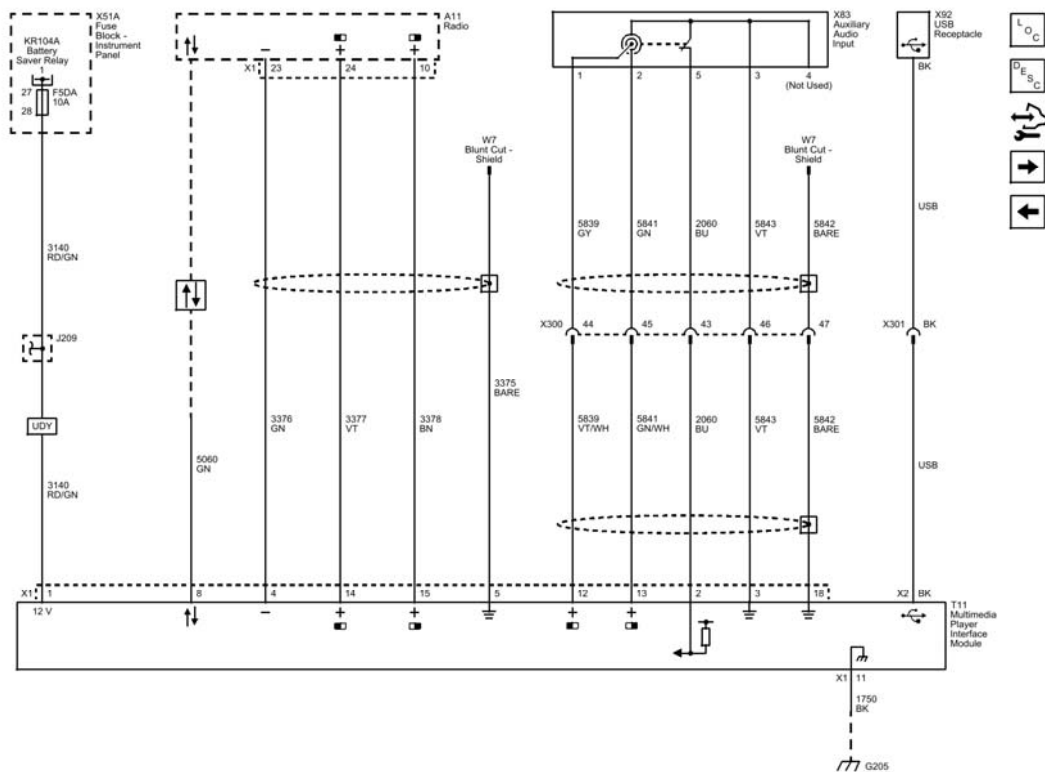


Fig. 10: Auxiliary Inputs (KTA) (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Auxiliary Inputs (without KTA) (Except CZ2)

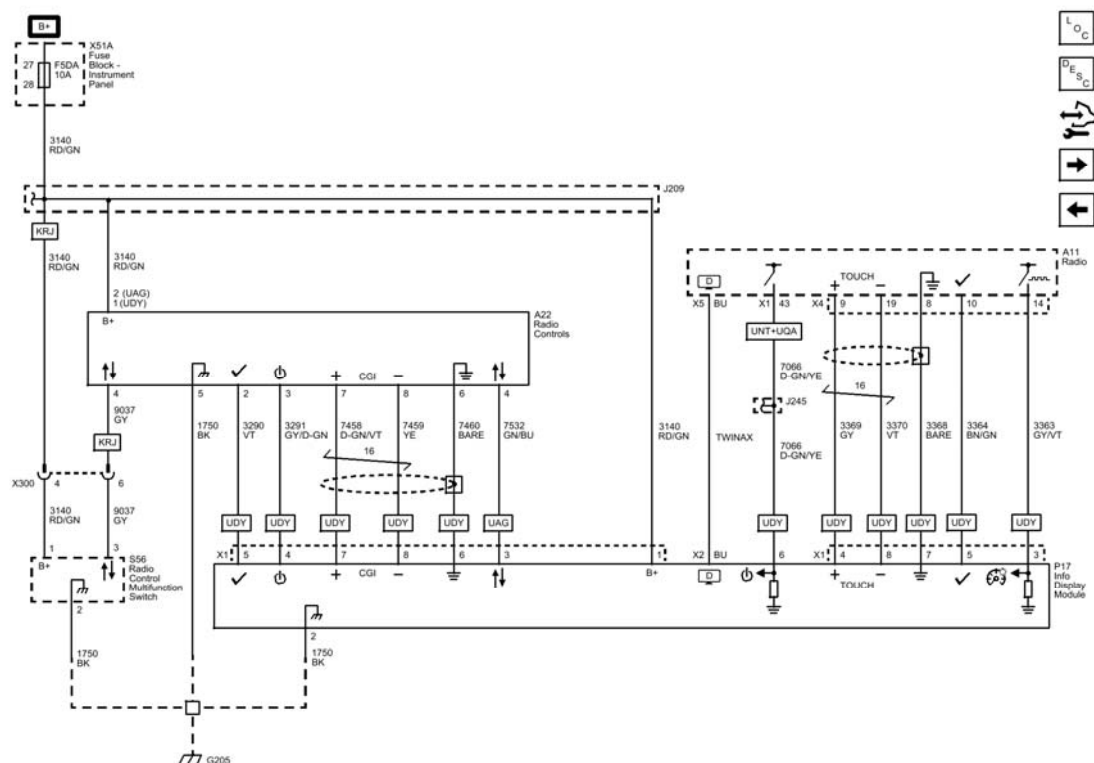
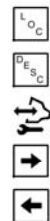


Fig. 12: Controls and Display (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Navigation System (UYT) (CZ2)



Auxiliary Audio Input (CZ2)

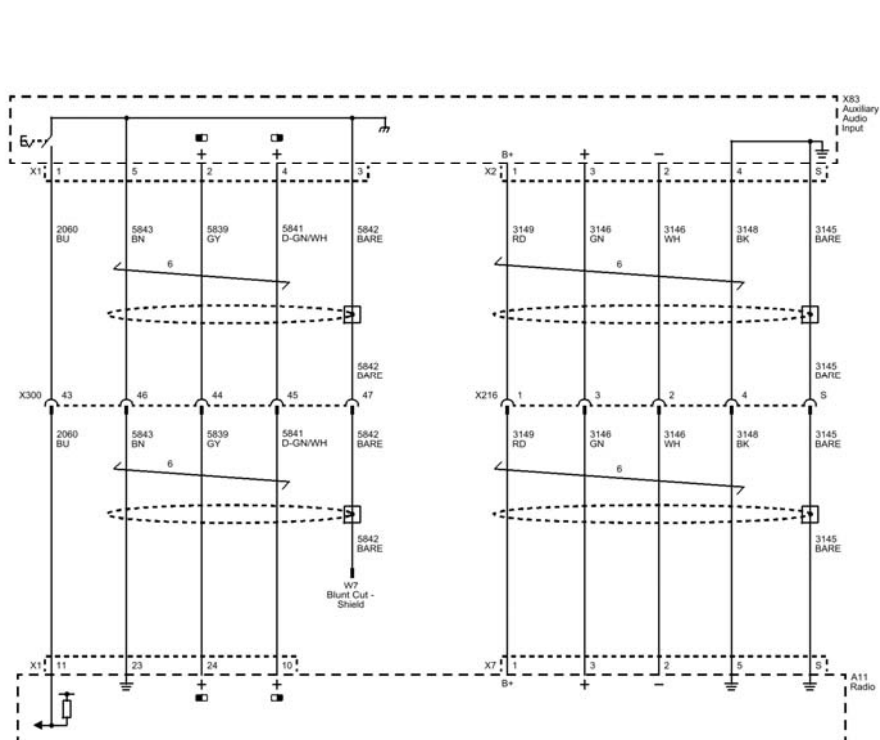


Fig. 14: Auxiliary Audio Input (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Radio Controls (CZ2)

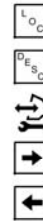
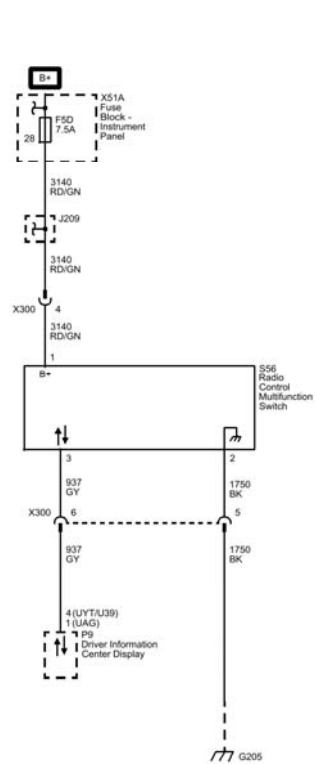


Fig. 15: Radio Controls (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Info Display (without UAG) (CZ2)

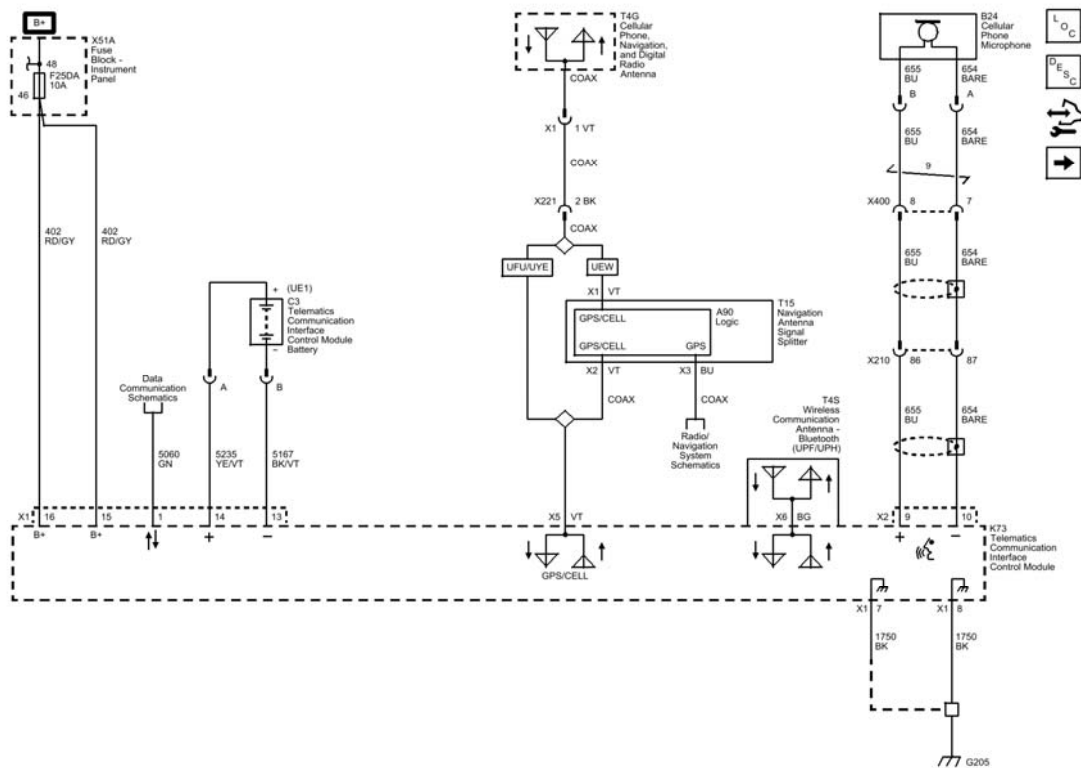


Fig. 17: Power, Ground, Serial Data, Antennas, and Microphone (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Controls and Outputs (Except CZ2)

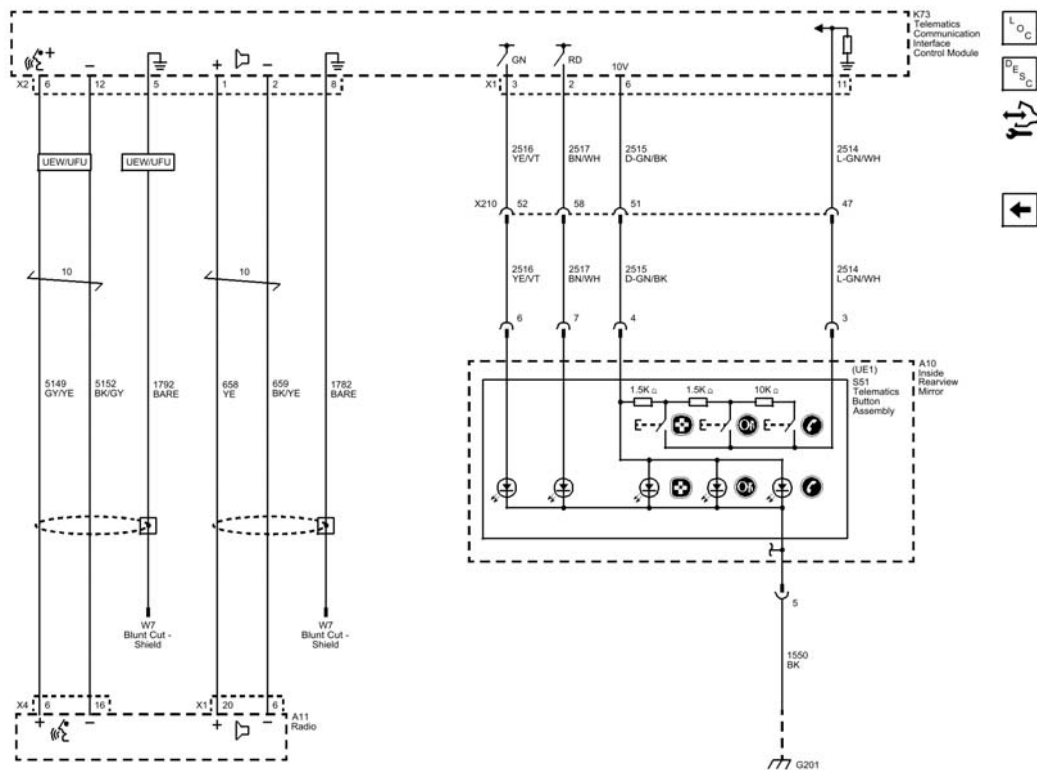


Fig. 18: Controls and Outputs (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Redundant Controls KRJ/CZ2

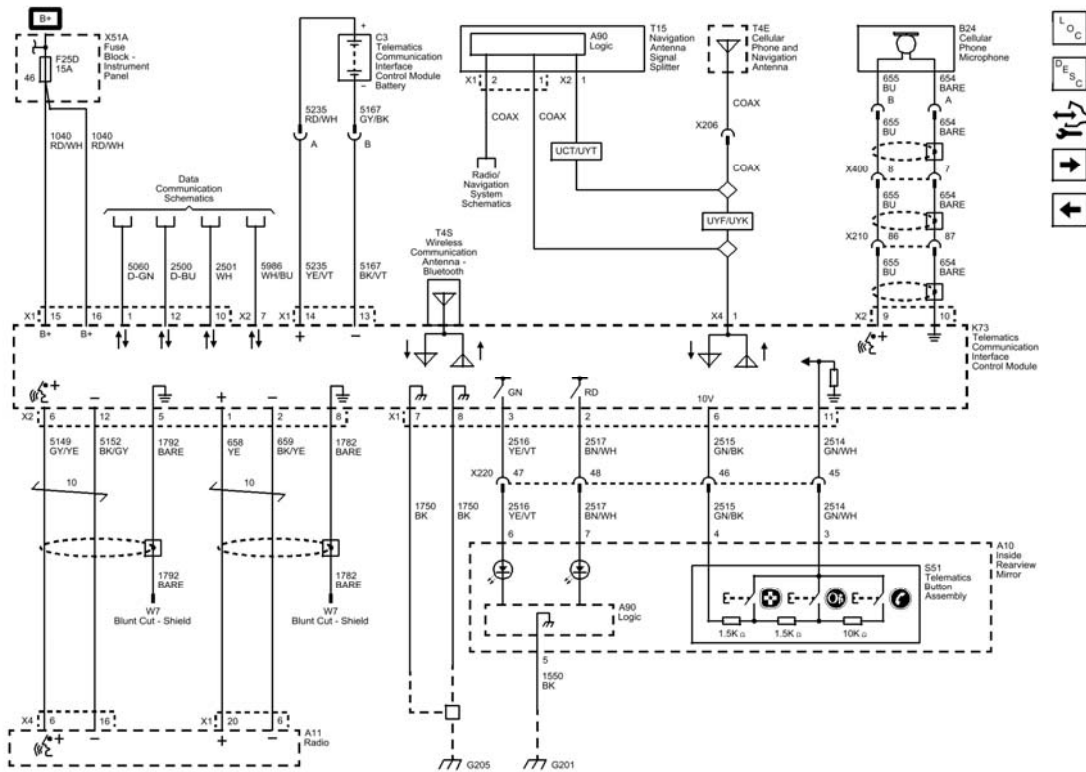


Fig. 19: Redundant Controls KRJ/CZ2
 Courtesy of GENERAL MOTORS COMPANY

CELLULAR TELEPHONE WIRING SCHEMATICS

Cellular Telephone Controls CZ2

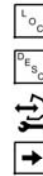
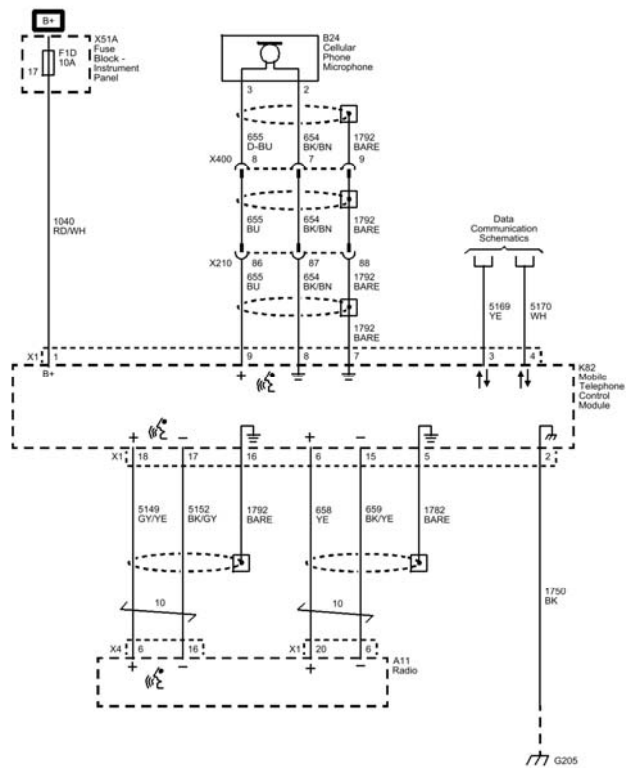


Fig. 20: Cellular Telephone Controls CZ2
 Courtesy of GENERAL MOTORS COMPANY

Cellular Telephone Microphone CZ2

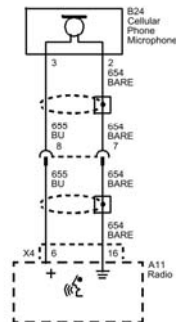


Fig. 21: Cellular Telephone Microphone CZ2
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B0997</u>	DTC B0997 3A Auxiliary Electronic Control Unit Performance Incorrect Component Installed DTC B0997 39 Auxiliary Electronic Control Unit Performance Internal Electronic Failure
<u>DTC B1024 (Human Machine Interface Control Module)</u>	DTC B1024 53 Circuit Board Temperature Sensor Below Minimum Threshold DTC B1024 54 Circuit Board Temperature Sensor Above Maximum Threshold
<u>DTC B1024 (Audio Amplifier)</u>	DTC B1024 11 Circuit Board Temperature Sensor Above Maximum Threshold
<u>DTC B1025-B1135 (UQA)</u>	DTC B1025 Audio Output 1 Circuit DTC B1035 Audio Output 2 Circuit DTC B1045 Audio Output 3 Circuit DTC B1055 Audio Output 4 Circuit

	DTC B1065 Audio Output 5 Circuit DTC B1075 Audio Output 6 Circuit DTC B1085 Audio Output 7 Circuit
<u>DTC B1025-B1135 (U65)</u>	DTC B1025 Left Front Audio Output Circuit DTC B1035 Right Front Audio Output Circuit DTC B1045 Left Rear Audio Output Circuit DTC B1055 Right Rear Audio Output Circuit
<u>DTC B124F</u>	DTC B124F Universal Serial Bus (USB) Programming
<u>DTC B124B</u>	DTC B124B 0B USB 1 Circuit
<u>DTC B124C</u>	DTC B124C 0B USB 2 Circuit
<u>DTC B125A</u>	DTC B125A 02 Antenna Signal Circuit Short to Ground DTC B125A 04 Antenna Signal Circuit Open Circuit
<u>DTC B125C</u>	DTC B125C 01 Satellite Antenna Circuit Short to Battery DTC B125C 02 Satellite Antenna Circuit Short to Ground DTC B125C 04 Satellite Antenna Circuit Open
<u>DTC B1271</u>	DTC B1271 00 Theft Protection Active
<u>DTC B127E</u>	DTC B127E 00 Front Video Display Output Signal
<u>DTC B12A7</u>	DTC B12A7 39 Optical Media Drive Internal Electronic Failure DTC B12A7 45 Optical Media Drive Build Variant not Programmed
<u>DTC B12A8</u>	DTC B12A8 00 Optical Media Drive Theft Locked
<u>DTC B1446 or B1447</u>	DTC B1446 Replace Backup Power Source Below Minimum Threshold DTC B1447 Backup Power Source Open Circuit
<u>DTC B2455</u>	DTC B2455 02 Cellular Phone Microphone Circuit Short to Ground DTC B2455 04 Cellular Phone Microphone Circuit Open/High Resistance
<u>DTC B2462</u>	DTC B2462 Global Positioning System Signal
<u>DTC B2470</u>	DTC B2470 02 Cellular Phone Antenna Circuit Malfunction Short to Ground DTC B2470 04 Cellular Phone Antenna Circuit Malfunction Open Circuit
<u>DTC B2476 or B2482</u>	DTC B2476 04 Cellular Phone Select Service Switch Open DTC B2476 59 Cellular Phone Select Service Switch Protection Time-out DTC B2482 00 Cellular Phone Select Service Switch Range/Performance
<u>DTC B2485</u>	DTC B2485 02 Wireless Communication (BT) Antenna Circuit Short to Ground DTC B2485 04 Wireless Communication (BT) Antenna Circuit Open

DTC B0997: AUXILIARY ELECTRONIC CONTROL UNIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B0997 3A

Auxiliary Electronic Control Unit Performance Incorrect Component Installed

DTC B0997 39

Auxiliary Electronic Control Unit Performance Internal Electronic Failure

Circuit/System Description

The Info Display Module monitors itself for internal failures and reports its condition to the Human Machine Interface Control Module when requested. The info display also reports electronic identification information when requested.

Conditions for Running DTC

- Ignition is ON or in the ACC position
- The system voltage is 9-16 V
- DTC B101E is not set as current in the Human Machine Interface Control Module
- The test is run once during Human Machine Interface Control Module wake up

Conditions for Setting the DTC

B0997 3A

The Info Display Module has reported identification information that differs from the information calibrated in the Human Machine Interface Control Module.

B0997 39

The Info Display Module reports an internal malfunction.

Action Taken When DTC Sets

The Human Machine Interface Control Module will set the DTC and the Info Display Module will have limited or no functionality.

Conditions for Clearing the DTC

The Human Machine Interface Control Module detects a compatible Info Display Module with no internal malfunctions reported.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, Infotainment system ON.
2. Verify DTC B101E is not set
 - **If DTC B101E is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If DTC B101E is not set**
3. Verify DTC B0997 is not set
 - **If DTC B0997 is set**

Replace the P17 Info Display Module.

- **If DTC B0997 is not set**
4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Radio Control Assembly Replacement

DTC B1024 (HUMAN MACHINE INTERFACE CONTROL MODULE): CIRCUIT BOARD TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1024 53

Circuit Board Temperature Sensor Below Minimum Threshold

DTC B1024 54

Circuit Board Temperature Sensor Above Maximum Threshold

Circuit/System Description

The human machine interface control module monitors the internal circuitry for excessive temperature. When a temperature outside of the range is detected, the module sets the DTC and limits its operation to avoid damage.

Conditions for Running the DTC

- Ignition is ON or in the ACC position
- The system voltage is 9-16 V
- The test is run once per second when the infotainment system is operating

Conditions for Setting the DTC

B1024 53

The module senses an internal temperature less than -40°C (-40°F).

B1024 54

The module senses an internal temperature greater than 69°C (156°F).

Action Taken When the DTC Sets

- The human machine interface control module sets the DTC.
- A message is displayed indicating that the system performance is being impacted by the excessive temperature condition.
- The module stops communicating on the MOST Bus network, but does not interrupt communication on the network.
- The infotainment system and the Info Display Module will have limited or no functionality.
- Components or other subsystems that interface with the infotainment system may have limited or no

functionality.

Conditions for Clearing the DTC

- The internal temperature is between -40°C (-40°F) and 69°C (156°F).
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

Under certain conditions it may be normal for this DTC to set to prevent permanent damage to the module.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Allow the vehicle cabin to cool if the temperature inside the vehicle is excessive before proceeding with this diagnostic procedure.**

1. Verify the DTC sets outside of the Conditions for Running and Setting. Since most occurrences of this DTC are caused by extreme vehicle cabin temperatures due to ambient conditions, review with the customer the conditions under which the DTC set.
 - **If the DTC sets within the Conditions for Running and Setting.**

The system is operating as designed, All OK.

- **If the DTC sets outside the Conditions for Running and Setting.**

2. Using the scan tool, clear the DTC.
3. Verify the DTC does not set while operating the infotainment system under the conditions the customer experienced the concern.
 - **If the DTC sets**

Replace the K74 Human Machine Interface Control Module

- **If the DTC does not set**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for human machine interface control module replacement, programming, and setup.

DTC B1024 (AUDIO AMPLIFIER): CIRCUIT BOARD TEMPERATURE SENSOR ABOVE MAXIMUM THRESHOLD

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1024 11

Circuit Board Temperature Sensor Above Maximum Threshold

Circuit/System Description

The audio amplifier monitors the internal circuitry for excessive temperature. When the amplifier senses an internal circuitry temperature greater than 95°C (203°F), the amplifier will set DTC B1024 11 and shut down until the internal circuitry cools below 90°C (194°F). No external circuit diagnosis is involved.

Conditions for Running the DTC

- Radio ON.
- Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

The audio amplifier detects an over-heat condition greater than 95°C (203°F) of the internal amplifier circuitry.

Action Taken When the DTC Sets

The audio amplifier will shut down and all speakers will be inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

Extended use or extremely high volume especially in warm weather conditions may cause this DTC to set. Under these conditions it may be normal for this DTC to set to prevent permanent damage to the audio amplifier circuitry.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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Radio/Audio System Description and Operation

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Allow the vehicle cabin to cool if the temperature inside the vehicle is excessive before proceeding with this diagnostic procedure.**

1. Verify the DTC sets outside of the Conditions for Running and Setting. Since most occurrences of this DTC are caused by extreme vehicle cabin temperatures due to ambient conditions, review with the customer the conditions under which the DTC set.

- **If the DTC sets within the Conditions for Running and Setting.**

The system is operating as designed, All OK.

- **If the DTC sets outside the Conditions for Running and Setting.**

2. Using the scan tool, clear the DTC.
3. Verify the DTC does not set while operating the infotainment system under the conditions the customer experienced the concern.

- **If the DTC sets**

Replace the T3 Audio Amplifier

- **If the DTC does not set**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for audio amplifier replacement, setup, and programming

DTC B1025-B1135 (UQA): AUDIO OUTPUT 1-7 CIRCUITS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC B1025

Audio Output 1 Circuit

DTC B1035

Audio Output 2 Circuit

DTC B1045

Audio Output 3 Circuit

DTC B1055

Audio Output 4 Circuit

DTC B1065

Audio Output 5 Circuit

DTC B1075

Audio Output 6 Circuit

DTC B1085

Audio Output 7 Circuit

For symptom byte information refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Audio Output 1 Signal Circuits (Left Front Door and tweeter)	B1025 02	B1025 04	B1025 01	-
Audio Output 2 Signal Circuits (Right Front Door and tweeter)	B1035 02	B1035 04	B1035 01	-
Audio Output 3 Signal Circuits (Left Rear Subwoofer)	B1045 02	B1045 04	B1045 01	-
Audio Output 4 Signal Circuits (Right Rear Subwoofer)	B1055 02	B1055 04	B1055 01	-
Audio Output 5 Signal Circuits (Left Rear Door)	B1065 02	B1065 04	B1065 01	-
Audio Output 6 Signal Circuits (Right Rear Door)	B1075 02	B1075 04	B1075 01	-
Audio Output 7 Signal Circuits (Center I/P)	B1085 02	B1085 04	B1085 01	-

Circuit/System Description

The Media Oriented Systems Transport (MOST) is a high-speed multimedia network technology. The serial MOST bus uses a ring topology and synchronous data communication to transmit audio, video, data and control information between any devices attached.

The audio amplifier is a participant on the MOST network. The audio amplifier receives audio inputs and control information from the MOST bus.

Each of the audio output channel circuits (+) and (-), at the audio amplifier have a DC bias voltage that is approximately one half of the battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound.

Diagnostic Aids

- Improper speaker mounting or loose trim may cause an audible buzz or distortion. Inspect the appropriate speaker and the surrounding interior trim for proper and secure mounting.

The EL-50334-6 Audio System Diagnostic CD contains audio tracks that can be used to duplicate and isolate such concerns. Tracks 11 and 12 contain audio sweep tones for testing for speaker and grill rattles.

If the speaker or surrounding interior trim is found to be loose or improperly secured, correctly secure the item.

- The test tones on the CD may be copied to a USB drive or other device to use during testing.
- Some audio output circuits are connected to more than one speaker, dependant on vehicle equipment. It may be necessary to disconnect one or more speakers during testing of some circuits.

Conditions for Running the DTC

NOTE: DTC B1325 must not be set as current for the amplifier to run any of the following tests.

DTC B1025 01, B1035 01, B1045 01, B1055 01, B1065 01, B1075 01, B1085 01

The test is run initially upon amplifier wake-up, and periodically every one second after amplifier operation begins.

DTC B1025 02, B1035 02, B1045 02, B1055 02, B1065 02, B1075 02, B1085 02

The test is run initially upon amplifier wake-up, and periodically every one second after amplifier operation begins.

DTC B1025 04, B1035 04, B1045 04, B1055 04, B1065 04, B1075 04, B1085 04

The test is run once during amplifier wake-up.

Conditions for Setting the DTC

DTC B1025 01, B1035 01, B1045 01, B1055 01, B1065 01, B1075 01, B1085 01

A short to voltage is detected on the specified (+) or (-) signal circuit

DTC B1025 02, B1035 02, B1045 02, B1055 02, B1065 02, B1075 02, B1085 02

A short to ground is detected on the specified (+) or (-) signal circuit

DTC B1025 04, B1035 04, B1045 04, B1055 04, B1065 04, B1075 04, B1085 04

An open is detected on the specified (+) or (-) signal circuit

Action Taken When the DTC Sets

The amplifier mutes the output channel and no sound is present from the speaker(s) that have a current circuit fault.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-50 USB Cable and Adapter Kit

Circuit/System Verification

1. Ignition ON, infotainment system ON, mute OFF.
2. Verify clear audio is heard from each speaker, adjusting fade and balance controls to test each speaker individually.

- **If audio is inoperative from one or more speakers, or the audio emitted is not clear**

Refer to Circuit/System Testing.

- **If clear audio is heard from all speakers**

3. All OK.

Circuit/System Testing

NOTE: Some circuits supply audio signals to more than one speaker. It may be necessary to disconnect all speakers on the affected audio circuit when performing circuit tests.

1. Ignition OFF, disconnect the harness connector at the appropriate P19 Speaker. Ignition ON, infotainment system ON, mute OFF.
2. Test for 5-7 V between each audio signal circuit terminal 1 and terminal 2 and ground.
 - **If less than 5 V**
 1. Ignition OFF, disconnect the X1 and X2 harness connectors at the T3 Audio Amplifier.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the T3 Audio Amplifier.
 - **If greater than 7 V**
 1. Ignition OFF, disconnect the X1 and X2 harness connectors at the T3 Audio Amplifier. Ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the T3 Audio Amplifier.
 - **If 5-7 V**
3. Test or replace the P19 Speaker.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Speaker Replacement Reference**
- **Control Module References** for audio amplifier replacement, programming, and setup.

DTC B1025-B1135 (U65): AUDIO OUTPUT CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1025

Left Front Audio Output Circuit

DTC B1035

Right Front Audio Output Circuit

DTC B1045

Left Rear Audio Output Circuit

DTC B1055

Right Rear Audio Output Circuit

For symptom byte information refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Speaker Output Signal	B1025 02, 1	B1025 04, 1	B1025 01, 1, 2	-
Right Front Speaker Output Signal	B1035 02, 1	B1035 04, 1	B1035 01, 1, 2	-
Left Rear Speaker Output Signal	B1045 02, 1	B1045 04, 1	B1045 01, 1, 2	-
Right Rear Speaker Output Signal	B1055 02, 1	B1055 04, 1	B1055 01, 1, 2	-
1. No or reduced audio from speaker(s) on the affected audio circuit. 2. Noticeable audio distortion may be present.				

Circuit/System Description

Each of the audio output channel circuits (+) and (-), at the radio have a DC bias voltage that is approximately

one half of battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5 V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound. The frequency (Hz) of the AC voltage signal is directly related to the frequency of the input (audio source playing) to the audio system. Both the DC bias voltage and the AC voltage signals are needed for the audio system to properly produce sound.

Conditions for Running the DTC

- Ignition is ON or in the ACC position
- The system voltage is 9-16 V
- The test is run once during radio wake up

Conditions for Setting the DTC

B1025 01, B1035 01, B1045 01, B1055 01

The radio detects a short to voltage on the specified audio (+) or (-) circuit.

B1025 02, B1035 02, B1045 02, B1055 02

The radio detects a short to ground on the specified audio (+) or (-) circuit.

B1025 04, B1035 04, B1045 04, B1055 04

The radio detects an open on the specified audio (+) or (-) circuit.

Action Taken When the DTC Sets

The radio continues to send the output signal to the speaker signal circuit with the current fault.

Conditions for Clearing the DTC

- A current DTC clears when the conditions for setting the DTC are no longer present and the ignition has been cycled from OFF to ON.
- A history DTC clears after 50 malfunction-free ignition cycles.

Diagnostic Aids

- Improper speaker mounting or loose trim may cause an audible buzz or distortion. Inspect the appropriate speaker and the surrounding interior trim for proper and secure mounting.
- The EL-50334-6 Audio System Diagnostic CD contains audio tracks that can be used to duplicate and isolate such concerns. Tracks 11 and 12 contain audio sweep tones for testing for speaker and grill rattles.
- The test tones on the CD may be copied to a USB drive or other device to use during testing.
- If the speaker or surrounding interior trim is found to be loose or improperly secured, correctly secure the item.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, A11 Radio ON, mute OFF.
2. Verify clear audio is heard from each speaker, adjusting fade and balance controls to test each speaker individually.
 - **If audio is inoperative from one or more speakers, or the audio emitted is not clear.**

Refer to Circuit/System Testing.
 - **If clear audio is heard from all speakers.**
3. All OK.

Circuit/System Testing

NOTE: **Some circuits supply audio signals to more than one speaker. It may be necessary to disconnect all speakers on the affected audio circuit when performing circuit tests.**

1. Ignition OFF, disconnect the harness connector at the appropriate P19 Speaker. Ignition ON, A11 Radio ON, mute OFF.

2. Test for 5-7 V between each audio signal circuit terminal 1 and terminal 2 and ground.
 - **If less than 5 V**
 1. Ignition OFF, disconnect the X1 harness connector at the A11 Radio.
 2. Test for infinite resistance between the signal circuits and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the A11 Radio.
 - **If greater than 7 V**
 1. Ignition OFF, disconnect the X1 harness connector at the A11 Radio. Ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the A11 Radio.
 - **If between 5-7 V**
3. Test or replace the P19 Speaker.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Speaker Replacement Reference**
- **Control Module References** for radio replacement, programming, and setup.

DTC B124F: UNIVERSAL SERIAL BUS (USB) PROGRAMMING

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B124F

Universal Serial Bus (USB) Programming

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Certain devices in the entertainment system must be programmed with specific software and other information

to operate correctly. This DTC is the result of an unsuccessful USB programming event of the device. The symptom byte information is for engineering reference only. No external circuit diagnosis is involved

Conditions for Running the DTC

Once upon each USB Programming Event.

Conditions for Setting the DTC

The programming event was incomplete, or completed with errors.

Action Taken When the DTC Sets

The entertainment system has limited or no functionality.

Conditions for Clearing the DTC

The programming event completes successfully.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B124F is not set.
 - **If DTC B124F is set**
 1. Program the device that set the DTC.
 2. Verify the DTC does not set.
 - If DTC is set, replace the device that set the DTC.
 - If the DTC is not set
 - 3. All OK.
3. All OK
 - **If DTC B124F is not set**

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming, and setup.

DTC B124B: USB 1 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B124B 0B

USB 1 Circuit

For symptom byte information refer to **Symptom Byte List** .

Circuit/System Description

The infotainment system has a USB port and SD card reader slot located in the center console. The USB port and the card reader slot interface with a hub device, internal to the auxiliary jack, USB, and memory card receptacle assembly. The auxiliary jack, USB, and memory card receptacle assembly receives fused battery voltage and ground from the harness to power the internal hub device as well as providing additional amperage to power USB devices.

The internal hub device interfaces directly with the human machine interface control module via a standard USB cable. A Mini type USB connector is used to connect the cable at the USB port and at the human machine interface control module and at the auxiliary jack, USB, and memory card receptacle. Standard USB male to female connections are typically used for connecting USB cables together where an in-line connection is required. An in-line cable connection is typically found between the console and I/P harness.

USB Port

The USB port allows connectivity to the infotainment system from portable media players or a USB storage device (memory stick/ flash drive). When a device is connected to the USB port, the system detects the device and switches to USB as the audio source. Once connected, the device can be controlled from the radio controls.

Not all portable media player devices or file types are compatible. Refer to the owner's manual for information on USB devices, control, and operation.

SD Card Reader

The infotainment uses the SD card reader as a mass storage device, similar to a USB storage device.

Refer to the owners manual for information on media types supported via the SD card reader.

Conditions for Running the DTC

- Ignition is ON or in the ACC position
- The system voltage is 9-16 V
- The infotainment system is ON
- The test is run once per second when the infotainment system is operating

Conditions for Setting the DTC

B124B 0B

The human machine interface control module detects an excessive current condition on the USB 5 V circuit.

B124B 04

The human machine interface control module does not detect the vehicle hub device.

B124B 11

The human machine interface control module detects an additional hub device attached to the vehicle USB port.

Action Taken When the DTC Sets

The USB port and SD card reader are inoperative while the DTC is current.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

- This DTC may be set due to the connection of an incompatible or faulty USB device.
- The human machine interface control module has two available USB connections. The human machine interface control module calibrations determine what is expected to be connected to each of these connection: either a USB port or a USB/SD Card reader HUB. USB 1 and USB 2 refers to the connector at the module that the port or hub is connected to.

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Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-20 Multi-Media Interface Tester (MIT)

Circuit/System Verification

1. Verify DTC B124B is not set. Since occurrences of this DTC can be caused by an incompatible or faulty USB device, review with the customer the conditions under which their concern occurred.

- **If DTC B124B is set.**

Refer to Circuit/System Testing.

- **If DTC B124B is not set.**

2. Ignition ON, infotainment system ON.
3. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
4. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.
 - **If audio is not heard from the test tool**
 1. Insert an SD card with compatible media into the SD card slot.
 2. Verify the media on the SD card can be accessed while operating the system to connect to the SD card.
 - If the SD card reader cannot be accessed, refer to Circuit/System Testing.
 - If the SD card reader can be accessed, replace the X83 Auxiliary Audio Input.
 - **If audio is heard from the test tool**
5. Insert an SD card with compatible media into the SD card slot.
6. Verify the media on the SD card can be accessed while operating the system to connect to the SD card.
 - **If the SD card reader media cannot be accessed**

Refer to Circuit/System Testing

- **If the SD card reader media can be accessed**

7. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the X83 Auxiliary Audio Input.

2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Verify that a test lamp illuminates between the B+ circuit terminal 6 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - **If the test lamp illuminates**
4. Verify the USB cable is properly connected at all components and in-line connections, and there is no damage to the cable or connections.
 - **If connection problems or cable damage is noted.**

Perform the appropriate repair or replacement to correct any issues.

- **If no connection problems or cable damage is noted.**
5. Replace the X83 Auxiliary Audio Input. Connect all harness connectors.
 6. Ignition ON, infotainment system ON.
 7. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
 8. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.
 - **If audio is not heard from the test tool**
 1. Replace the K74 Human Machine Interface Control Module.
 2. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
 3. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.
 - If audio is not heard from the test tool, replace the USB cable connected to the X83 Auxiliary Audio Input. Verify audio is heard from the test tool. If audio is not heard from the test tool, replace the USB cable connected to the K74 Human Machine Interface Control Module.
 - If audio is heard from the test tool.
 4. All OK.
 - **If audio is heard from the test tool**
 9. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Audio Disc Player, USB, Auxiliary In, and Memory Card Receptacle Replacement**
- **Control Module References** for human machine interface control module replacement, programming, and setup.

DTC B124C: USB 2 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B124C 0B

USB 2 Circuit

For symptom byte information refer to **Symptom Byte List** .

Circuit/System Description

The infotainment system has a USB port and SD card reader slot located in the center console. The USB port and the card reader slot interface with a hub device, internal to the auxiliary jack, USB, and memory card receptacle assembly. The auxiliary jack, USB, and memory card receptacle assembly receives fused battery voltage and ground from the harness to power the internal hub device as well as providing additional amperage to power USB devices.

The internal hub device interfaces directly with the human machine interface control module via a standard USB cable. A mini type USB connector is used to connect the cable at the USB port and at the human machine interface control module and at the auxiliary jack, USB, and memory card receptacle. Standard USB male to female connections are typically used for connecting USB cables together where an in-line connection is required. An in-line cable connection is typically found between the console and I/P harness.

USB Port

The USB port allows connectivity to the infotainment system from portable media players or a USB storage device (memory stick/ flash drive). When a device is connected to the USB port, the system detects the device and switches to USB as the audio source. Once connected, the device can be controlled from the radio controls.

Not all portable media player devices or file types are compatible. Refer to the owner's manual for information on USB devices, control, and operation.

SD Card Reader

The infotainment uses the SD card reader as a mass storage device, similar to a USB storage device.

Refer to the owners manual for information on media types supported via the SD card reader.

Conditions for Running the DTC

- Ignition is ON or in the ACC position
- The system voltage is 9-16 V
- The infotainment system is ON
- The test is run once per second when the infotainment system is operating

Conditions for Setting the DTC

B124C 0B

The human machine interface control module detects an excessive current condition on the USB 5 V circuit.

B124C 04

The human machine interface control module does not detect the vehicle hub device.

B124C 11

The human machine interface control module detects an additional hub device attached to the vehicle USB port.

Action Taken When the DTC Sets

The USB port and SD card reader are inoperative while the DTC is current.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

- This DTC may be set due to the connection of an incompatible or faulty USB device.
- The human machine interface control module has two available USB connections. The human machine interface control module calibrations determine what is expected to be connected to each of these connection: either a USB port or a USB/SD Card reader HUB. USB 1 and USB 2 refers to the connector at the module that the port or hub is connected to.

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-20 Multi-Media Interface Tester (MIT)

Circuit/System Verification

1. Verify DTC B124C is not set. Since occurrences of this DTC can be caused by an incompatible or faulty USB device, review with the customer the conditions under which their concern occurred.
 - **If DTC B124C is set.**

Refer to Circuit/System testing.
 - **If DTC B124C is not set.**
2. Ignition ON, infotainment system ON.
3. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
4. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.
 - **If audio is not heard from the test tool**
 1. Insert an SD card with compatible media into the SD card slot.
 2. Verify the media on the SD card can be accessed while operating the system to connect to the SD card.
 - If the SD card reader cannot be accessed, refer to Circuit/System testing.

- If the SD card reader can be accessed, replace the X83 Auxiliary Audio Input.
- **If audio is heard from the test tool**
- 5. Insert an SD card with compatible media into the SD card slot.
- 6. Verify the media on the SD card can be accessed while operating the system to connect to the SD card.
 - **If the SD card reader media cannot be accessed**

Refer to Circuit/System testing

- **If the SD card reader media can be accessed**
- 7. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the X83 Auxiliary Audio Input.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Verify that a test lamp illuminates between the B+ circuit terminal 6 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - **If the test lamp illuminates**
4. Verify the USB cable is properly connected at all components and in-line connections, and there is no damage to the cable or connections.
 - **If connection problems or cable damage is noted.**

Perform the appropriate repair or replacement to correct any issues.

- **If no connection problems or cable damage is noted.**
- 5. Replace the X83 Auxiliary Audio Input. Connect all harness connectors.
- 6. Ignition ON, infotainment system ON.
- 7. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
- 8. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.
 - **If audio is not heard from the test tool**

1. Replace the K74 Human Machine Interface Control Module.
 2. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
 3. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.
 - If audio is not heard from the test tool, replace the USB cable connected to the X83 Auxiliary Audio Input. Verify audio is heard from the test tool. If audio is not heard from the test tool, replace the USB cable connected to the K74 Human Machine Interface Control Module.
 - If audio is heard from the test tool.
 4. All OK
 - **If audio is heard from the test tool**
9. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Audio Disc Player, USB, Auxiliary In, and Memory Card Receptacle Replacement**
- **Control Module References** for human machine interface control module replacement, programming, and setup.

DTC B125A: ANTENNA SIGNAL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B125A 02

Antenna Signal Circuit Short to Ground

DTC B125A 04

Antenna Signal Circuit Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Radio Antenna Coax	B125A 02	B125A 04	1	-

Antenna Module Ground	-	1	-	-
1. May exhibit possible AM/FM interference.				

Circuit/System Description

The active antenna system uses an integral antenna applied as an applique to the rear glass. The antenna module receives both AM and FM signals from the rear glass antenna. The radio antenna module is enabled when the radio is turned on. The radio provides battery voltage to the antenna module using the center conductor of the antenna coaxial cable. When a 12 V signal is seen by the module on the center conductor of the antenna coax, both AM and FM signals are amplified.

Conditions for Running the DTC

- Ignition ON.
- Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B125A 02

The radio detects a short to ground in the antenna signal circuit center conductor.

B125A 04

The radio detects an open in the antenna signal circuit center conductor.

Action Taken When the DTC Sets

Radio reception may be poor or not available.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 50 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

Poor AM and FM radio reception may be due to multiple influences, some of which may not be vehicle related. Areas which have high RF traffic or block the signal path may cause a degradation in radio reception. Radio reception may also be influenced by items within the vehicle, but not part of the radio system. Such examples are aftermarket electrical accessories or other items which may generate noise in the vehicle electrical system. Aftermarket window tinting, especially when there is a metallic in the film, may reduce radio reception.

AM reception is highly dependent on the antenna module receiving battery voltage from the radio and being properly grounded. The antenna module has a built in antenna amplifier that boosts both AM and FM reception. When the antenna module does not receive power, AM stations may not be received and FM reception will be limited. If the module is not properly grounded, excessive interference in the signal may occur, or reception

may be limited.

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Inspect the antenna located in the rear window. Verify all branches of the antennas are intact, with no scratches or other damage.
 - **If damage is found**

Repair or replace as necessary
 - **If no damage is found**
2. Ignition ON, A11 Radio ON.
3. Verify station reception is normal when tuned to several known good AM and FM stations.
 - **If AM or FM reception is poor.**

Refer to Circuit/System Testing
 - **If reception is normal**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the radio antenna coax cable from the A11 Radio and from the K46 Radio Antenna Module.
2. Verify the antenna coax cable passes the coax cable component test. Refer to Component Testing.
 - **If the coax cable does not pass the test**

Replace the antenna coax cable
 - **If the coax cable passes the test**
3. Connect the antenna coax cable to the A11 Radio. Ignition ON, A11 Radio ON.
4. Verify a test lamp illuminates between the antenna coax cable center terminal and ground at the K46 Radio Antenna Module connector.
 - **If the test lamp does not illuminate**

Replace the A11 Radio.
 - **If the test lamp illuminates**
5. Test or replace the K46 Radio Antenna Module.

Component Testing

CAUTION: Refer to Test Probe Caution .

NOTE: Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.

To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.

Coax Cable Test

1. Ignition OFF, disconnect the coax cable at both components.
2. Test for less than 5 ohms between coax cable center terminal end to end.
 - **If 5 ohms or greater**

Replace the coax cable
 - **If less than 5 ohms**
3. Test for less than 5 ohms between the coax cable outer shield end to end.
 - **If 5 ohms or greater**

Replace the coax cable

- **If less than 5 ohms**

4. Test for infinite resistance between the coax cable center terminal and the coax cable outer shield.

- **If less than infinite resistance**

Replace the coax cable

- **If infinite resistance**

5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for radio replacement, programming, and setup.

DTC B125C: SATELLITE ANTENNA CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B125C 01

Satellite Antenna Circuit Short to Battery

DTC B125C 02

Satellite Antenna Circuit Short to Ground

DTC B125C 04

Satellite Antenna Circuit Open

Circuit/System Description

The digital radio receiver, located inside the radio, receives digital radio information from the digital radio antenna located on the outside of the vehicle. The digital radio receiver is connected to the digital radio antenna via a shielded coax cable. The digital radio antenna contains an amplifier which is powered by the radio through the coax cable.

Conditions for Running the DTC

This DTC is run every 300 milliseconds.

Conditions for Setting the DTC

The radio detects a circuit fault in the digital radio antenna.

Action Taken When the DTC Sets

The radio displays No XM Signal or Check Antenna.

Conditions for Clearing the DTC

- A current DTC clears when the condition for setting the DTC is no longer present.
- A history DTC clears after 100 malfunction-free ignition cycles.

Diagnostic Aids

The digital radio antenna requires a clear line of sight to the sky to operate properly. Reception may be limited, intermittent, or unavailable inside structures.

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Connector End View Reference

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Special Tools

EL-48028 Digital Radio Test Antenna

For equivalent regional tools, refer to **Special Tools, Special Tools (MIT Tool Instructions)**.

Circuit/System Verification

1. With the vehicle outside in an area with an unobstructed view of the southern sky, tune to XM.
2. Verify DTC B125C is not set as current and the No XM Signal message is not displayed on the radio.
 - **If DTC B125C is set as current or the No XM Signal message is displayed.**

Refer to Circuit/System Testing.

- **If DTC B125C is not set as current and the No XM Signal message is not displayed.**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the digital radio antenna coax cable from the A11 Radio. Connect the **EL-48028** Digital Radio Test Antenna to the radio and place on the roof of the vehicle.
2. Ignition ON, radio tuned to XM channel 1.
3. Verify DTC B125C is not set as current and XM reception is improved.
 - **If DTC B125C is set as current or XM reception is not improved**

Replace the A11 Radio.

- **If DTC B125C is not set as current and XM reception is improved**
4. Ignition OFF, disconnect the digital radio antenna coax cable from the T4G Cellular Phone, Navigation, and Digital Radio Antenna.
 5. Verify the digital radio antenna coax cable passes the coax cable component test. Refer to Component Testing.
 - **If the coax cable does not pass the test**

Replace the antenna coax cable

- **If the coax cable passes the test**
6. Test or replace the T4G Cellular Phone, Navigation, and Digital Radio Antenna.

Component Testing

CAUTION: Refer to **Test Probe Caution** .

NOTE: Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.

To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.

Coax Cable Test

1. Ignition OFF, disconnect the coax cable at both components.
2. Test for less than 5 ohms between coax cable center terminal end to end.
 - **If 5 ohms or greater**

Replace the coax cable

- **If less than 5 ohms**

3. Test for less than 5 ohms between the coax cable outer shield end to end.
 - **If 5 ohms or greater**

Replace the coax cable

- **If less than 5 ohms**

4. Test for infinite resistance between the coax cable center terminal and the coax cable outer shield.
 - **If less than infinite resistance**

Replace the coax cable

- **If infinite resistance**

5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Radio Antenna Base Replacement**
- **Control Module References** for radio replacement, programming, and setup.

DTC B1271: THEFT PROTECTION ACTIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1271 00

Theft Protection Active

Circuit/System Description

When the radio is initially installed in the vehicle, the radio receives VIN information via serial data. The radio stores a portion of the VIN and compares this sequence to the VIN information received each time the radio powers on. The VIN in the radio is a single one-time learn.

The radio theft deterrent system is intended to disable or limit radio functionality if incorrect vehicle information is received by the radio. The radio disables functionality if the VIN information received by the radio does not match the VIN information that has been learned by the radio. This DTC is generated by the module when the Theft Protection is activated.

Conditions for Running the DTC

This DTC test runs when the radio changes from OFF to ON.

Conditions for Setting the DTC

The radio has learned a correct VIN sequence and the VIN information received via serial data does NOT match the learned VIN sequence.

Action Taken When the DTC Sets

- The radio may be disabled or have limited functionality.
- The radio display will indicate that theft protection is active.

Conditions for Clearing the DTC

The radio receives the correct VIN information via serial data.

Diagnostic Aids

A possible cause of incorrect VIN info could be the radio was originally installed in another vehicle.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, A11 Radio ON.
2. Verify DTC B1271 is not set.
 - **If DTC B1271 is set**

Replace the A11 Radio.

- **If DTC B1271 is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Radio replacement, programming, and setup

DTC B127E: FRONT VIDEO DISPLAY OUTPUT SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B127E 00

Front Video Display Output Signal

Circuit/System Description

The infotainment system Info Display Module is supplied battery voltage and ground . The Human Machine Interface Control Module communicates with the info display via a dedicated cable for the LVDS data circuits.

All video information to the display, as well as backlighting dimming level, and screen touch signals, are communicated over the LVDS data circuits.

If the Human Machine Interface Control Module detects the display is not responding to the output on the LVDS circuits, the Human Machine Interface Control Module sets the DTC.

Conditions for Running the DTC

- Ignition is ON or in the ACC position
- The system voltage is 9-16 V
- The infotainment system is ON
- The test is continuously when the infotainment system is operating

Conditions for Setting the DTC

The Human Machine Interface Control Module detects the display is not responding to the output on the LVDS circuits.

Action Taken When the DTC Sets

- The Human Machine Interface Control Module sets this DTC
- No images are shown on the Info Display Module

Conditions for Clearing the DTC

- The Human Machine Interface Control Module detects a properly synced digital video signal.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF.
2. Verify the LVDS interface cable is properly connected at the P17 Info Display Module X2 and the K74 Human Machine Interface Control Module X5 connections and there is no damage to the cable or connections.
3. Ignition ON, infotainment system ON.
4. Verify the P17 Info Display Module does not display an image.
 - **If the P17 Info Display Module displays an image.**

All OK.

- **If the P17 Info Display Module does not display an image.**
5. Ignition OFF.
 6. Replace the video interface cable.
 7. Ignition ON, infotainment system ON.
 8. Verify the P17 Info Display Module displays an image.
 - **If the P17 Info Display Module does not display an image**
 1. Replace the P17 Info Display Module. Connect all harness connectors.
 2. Ignition ON, infotainment system ON.
 3. Verify the P17 Info Display Module displays an image.
 - If the P17 Info Display Module still does not display an image, replace the K74 Human Machine Interface Control Module.
 - If the P17 Info Display Module displays an image.
 4. All OK.
 - **If the P17 Info Display Module displays an image.**
 9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Radio Control Assembly Replacement**
- **Control Module References** for Human Machine Interface Control Module replacement, programming, and setup.

DTC B12A7: OPTICAL MEDIA DRIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B12A7 39

Optical Media Drive Internal Electronic Failure

DTC B12A7 45

Optical Media Drive Build Variant not Programmed

Circuit/System Description

The Media Disc Player monitors itself for internal failures and reports its condition to the radio via serial data when in use.

Conditions for Running the DTC

This test runs once per second while the Media Disc Player is being accessed.

Conditions for Setting the DTC

B12A7 39

The Media Disc Player reports an internal failure via serial data.

B12A7 45

The Media Disc Player reports a variant mismatch via serial data.

Action Taken When the DTC Sets

The Media Disc Player may be disabled or have limited functionality.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

B12A7 39

1. Ignition ON.
2. Verify DTC B12A7 39 is not set.
 - **If DTC B12A7 39 is set**

Replace the A33 Media Disc Player.

- **If DTC B12A7 39 is not set**
3. All OK.

B12A7 45

1. Ignition ON.
2. Verify DTC B12A7 45 is not set.
 - **If DTC B12A7 45 is set**
 1. Program the A33 Media Disc Player.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the A33 Media Disc Player.

- If the DTC does not set
- 3. All OK.
- If DTC B12A7 45 is not set
- 3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for media disc player replacement, programming, and setup.

DTC B12A8: OPTICAL MEDIA DRIVE THEFT LOCKED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B12A8 00

Optical Media Drive Theft Locked

Circuit/System Description

When the Media Disc Player is initially installed in the vehicle, it receives VIN information via serial data. The Media Disc Player stores a portion of the VIN and compares this sequence to the VIN information received each time the Media Disc Player powers on. The VIN in the Media Disc Player is a single one-time learn.

The Media Disc Player theft deterrent system is intended to disable or limit Media Disc Player functionality if incorrect vehicle information is received by the Media Disc Player. The Media Disc Player disables functionality if the VIN information received by the Media Disc Player does not match the VIN information that has been learned by the Media Disc Player. This DTC is generated by the module when the Theft Protection is activated.

Conditions for Running the DTC

This test runs once per second while the Media Disc Player is being accessed.

Conditions for Setting the DTC

The Media Disc Player has learned a correct VIN sequence and the VIN information received via serial data does NOT match the learned VIN sequence.

Action Taken When the DTC Sets

The Media Disc Player may be disabled or have limited functionality.

Conditions for Clearing the DTC

The Media Disc Player receives the correct VIN information via serial data.

Diagnostic Aids

A possible cause of incorrect VIN information could be the Media Disc Player was originally installed in another vehicle.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B12A8 is not set.
 - **If DTC B12A8 is set**

Replace the A33 Media Disc Player.

- **If DTC B12A8 is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for media disc player replacement, programming, and setup.

DTC B1446 OR B1447: BACKUP POWER SOURCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1446

Replace Backup Power Source Below Minimum Threshold

DTC B1447

Backup Power Source Open Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Backup Battery B+	B1447 03	B1447 04	-	-
Backup Battery Low Reference	B1447 03	B1447 04	-	-

Circuit/System Description

The backup power source provides voltage to the telematics communication interface control module , to be able to successfully place a call in the event of a main battery disconnect during a collision event.

Conditions for Running the DTC

B1446 03

- Ignition is ON.
- System voltage is between 9.5 and 15.5 V.
- DTC B1447 is not set.

B1447 04

- Ignition is ON.
- System voltage is between 9.5 and 15.5 V.
- The above conditions are present for greater than 10 s.

Conditions for Setting the DTC

B1446 03

The telematics communication interface control module detects that the backup power source voltage has dropped below the minimum threshold value.

B1447 04

The telematics communication interface control module detects no voltage from the backup power source.

Action Taken When the DTC Sets

B1446 03

The OnStar® status LED turns red.

B1447 04

- The OnStar® status LED turns red.
- The telematics communication interface control module will be unable to place a call in the event of a main battery disconnect during a collision event.

Conditions for Clearing the DTC

- A current DTC B1446 will clear when the telematics communication interface control module detects the voltage of the backup power source is above the minimum threshold value.
- A current DTC B1447 will clear when the telematics communication interface control module detects voltage from the backup power source.
- A history DTC clears after 50 malfunction-free ignition cycles.

Diagnostic Aids

- Shorting the backup power source positive voltage circuit to the backup power source ground circuit or chassis ground will activate the internal circuit protection of the backup power source, rendering the backup power source inoperative.
- DTC B1447 may set if the K73 Telematics Communication Interface Control Module has been incorrectly disconnected or serviced. When disconnecting the K73 Telematics Communication Interface Control Module, disconnect the harness connector X1 at the K73 Telematics Communication Interface Control Module prior to disconnecting any other harness connectors. This will ensure the backup power

source is preserved when voltage is removed from the K73 Telematics Communication Interface Control Module .

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Testing for Intermittent Conditions and Poor Connections**
- **Circuit Testing**
- **Wiring Repairs**
- **Connector Repairs**

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for greater than 9.5 V between the B+ circuit terminal 14 and the low reference circuit terminal 13.
 - **If 9.5 V or less**

Test or replace the C3 Telematics Communication Interface Control Module Battery.

- **If greater than 9.5 V**
3. Replace the K73 Telematics Communication Interface Control Module .

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Communication Interface Module Battery Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming and setup.

DTC B2455: CELLULAR PHONE MICROPHONE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC B2455 02

Cellular Phone Microphone Circuit Short to Ground

DTC B2455 04

Cellular Phone Microphone Circuit Open/High Resistance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Microphone Signal	B2455 02	B2455 04	B2455 04	-
Microphone Low Signal	B2455 02	B2455 04	B2455 04	-

Circuit/System Description

The telematics communication interface control module provides the cellular phone microphone with a supplied voltage on the cellular phone microphone high signal circuit. When the microphone is in use, voice data from the user is sent back to the telematics communication interface control module on the microphone low signal circuit.

Conditions for Running the DTC

- The ignition must be in the RUN or ACC position.
- The system voltage is at least 9.5 V and no more than 15.5 V.
- All the above conditions are present for greater than 10 s.

Conditions for Setting the DTC

B2455 02

The telematics communication interface control module detects an short to ground in the cellular phone microphone high signal circuit for 10 s or greater.

B2455 04

The following conditions will set this DTC:

- The telematics communication interface control module detects an open/high resistance in the cellular phone microphone high signal circuit for 10 s or greater.
- The telematics communication interface control module detects an open/high resistance in the microphone low signal circuit for 10 s or greater.

Action Taken When the DTC Sets

- The OnStar® status LED turns red.
- The telematics communication interface control module will not receive a signal from the cellular phone microphone.
- Calls can be placed but the caller cannot be heard.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B24 Cellular Phone Microphone, ignition ON.

2. Test for 8.0-10.5 V between the signal circuit terminal B and ground.
 - **If less than 8.0 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the vehicle K73 Telematics Communication Interface Control Module.
 - **If greater than 10.5 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.
 - **If between 8.0-10.5 V**
3. Test for less than 1 V between the signal circuit terminal A and ground.
 - **If greater than 1 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, repair the K73 Telematics Communication Interface Control Module.
 - **If less than 1 V**
4. Test for greater than 8 V between the signal circuit terminal B and the signal circuit terminal A.
 - **If less than 8 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the low signal circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the vehicle K73 Telematics Communication Interface Control Module.
 - **If greater than 8 V**
5. Test or replace the B24 Cellular Phone Microphone.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mobile Telephone Microphone Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming and setup.

DTC B2462: GLOBAL POSITIONING SYSTEM SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2462

Global Positioning System Signal

For symptom byte information refer to **Symptom Byte List** .

Circuit/System Description

The navigation antenna is connected to the telematics communication interface control module and the human machine interface control module through the navigation signal splitter. The navigation signal splitter distributes the navigation signal to both the telematics communication interface control module and the human machine interface control module. The telematics communication interface control module supplies 5 V through the coax cable to power the internal antenna amplifier through the signal splitter. The human machine interface control module supplies 5 V through the center conductor of the coax cable to power the splitter.

Conditions for Running the DTC

- Radio On.
- System voltage is greater than 9 V and less than 16 V.
- The human machine interface control module tests the GPS antenna every 10 seconds.

Conditions for Setting the DTC

B2462 01

The human machine interface control module detects a short to B+ on the GPS antenna signal circuit.

B2462 02

The human machine interface control module detects a short to ground on the GPS antenna signal circuit.

B2462 04

The human machine interface control module detects an open/high resistance on the GPS antenna signal circuit.

Action Taken When the DTC Sets

- The human machine interface control module uses the last reported position and the vehicle speed signal to calculate the vehicle position.
- Route guidance may be inaccurate.
- Turn by turn navigation may be inaccurate or inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

- This DTC can only be retrieved from the human machine interface control module. The telematics communication interface control module does not set this DTC.
- The human machine interface control module only monitors the connection between the navigation signal splitter and the human machine interface control module. The human machine interface control module cannot detect faults between the signal splitter and the navigation antenna. Faults between the signal splitter and the navigation antenna will result in a loss of GPS signal without setting DTC B2462.
- The navigation antenna requires a clear line of sight to the sky to operate properly. The GPS may have limited, intermittent, or no reception near tall buildings or inside structures.

Reference Information

Schematic Reference

- **OnStar/Telematics Schematics**
- **Radio/Navigation System Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **OnStar Description and Operation**
- **Radio/Audio System Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-49903 OnStar Antenna Diagnostic Tool Kit

Circuit/System Testing

1. Ignition OFF, disconnect the navigation antenna coax cable connector at the K74 Human Machine Interface Control Module. Connect the **EL-49903** GM OnStar antenna diagnostic tool kit to the K74 Human Machine Interface Control Module, place the test antenna on the roof of the vehicle.
2. Ignition ON, infotainment system ON, navigation selected.
3. Verify DTC B2462 is not set.
 - **If DTC B2462 is set**

Replace the K74 Human Machine Interface Control Module.
 - **If DTC B2462 is not set**
4. Ignition OFF, disconnect the human interface control module navigation coax cable at the T15 Navigation Antenna Signal Splitter.
5. Verify the human interface control module navigation coax cable passes the coax cable component test. Refer to Component Testing.
 - **If the coax cable does not pass the test**

Replace the coax cable
 - **If the coax cable passes the test**
6. Test or replace the T15 Navigation Antenna Signal Splitter.

Component Testing

CAUTION: Refer to **Test Probe Caution** .

NOTE: Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.

To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.

Coax Cable Test

1. Ignition OFF, disconnect the coax cable at both components.
2. Test for less than 5 ohms between coax cable center terminal end to end.
 - **If 5 ohms or greater**

Replace the coax cable

- **If less than 5 ohms**

3. Test for less than 5 ohms between the coax cable outer shield end to end.
 - **If 5 ohms or greater**

Replace the coax cable

- **If less than 5 ohms**

4. Test for infinite resistance between the coax cable center terminal and the coax cable outer shield.
 - **If less than infinite resistance**

Replace the coax cable

- **If infinite resistance**

5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Navigation Signal Splitter Replacement**
- **Control Module References** for human machine interface control module replacement, programming, and setup.

DTC B2470: CELLULAR PHONE ANTENNA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2470 02

Cellular Phone Antenna Circuit Malfunction Short to Ground

DTC B2470 04

Cellular Phone Antenna Circuit Malfunction Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cellular Antenna Signal	B2470 02	B2470 04	-	-

Circuit/System Description

The cellular phone and navigation antenna is connected to the telematics communication interface control module. This module supplies 5 V to the cellular phone and navigation antenna to power the internal amplifier. When the vehicle is equipped with the optional navigation radio, a navigation antenna signal splitter is installed to distribute the GPS signal to both the telematics communication interface control module and the navigation radio. The navigation radio supplies 5 V through the GPS antenna coaxial cable to the navigation antenna signal splitter to power the internal navigation radio signal amplifier.

Conditions for Running the DTC

- Ignition in the RUN or ACC position.
- System voltage is between 9.5 volts and 15.5 volts.
- The above conditions are present for greater than 1 s.

Conditions for Setting the DTC

- The telematics communication interface control module does not detect the presence of a cellular antenna.
- The above conditions are present for greater than 1 s.

Action Taken When the DTC Sets

- The vehicle is unable to connect to the OnStar® Call Center.
- The OnStar® status LED turns red.

Conditions for Clearing the DTC

- The telematics communication interface control module detects the presence of a cellular antenna.
- A history DTC clears after 50 malfunction-free ignition cycles.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-49903 GM OnStar Antenna Diagnostic Tool Kit

Circuit/System Testing

NOTE:

- **The vehicle may be equipped with sectioned coax. Test each section and replace only the faulty section, not the entire length of coax.**
- **The following verification requires the vehicle to be outside with an unobstructed view of the southern sky. Allow 5 minutes after turning the ignition ON for the GPS satellites to acquire vehicle signal.**

Without Navigation Radio

1. Ignition OFF and all vehicle systems OFF, disconnect the GPS and cellular coax cable connector at the K73 Telematics Communication Interface Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Using the EL-49903-3 kit (EL-49903-5 adapter and EL-49903-4 coax cable), connect the **EL-49903** GM OnStar antenna diagnostic tool kit to the K73 Telematics Communication Interface Control Module. Place the test antenna on the roof of the vehicle, ignition ON.
3. Verify the DTC does not set while operating the vehicle within the conditions for running the DTC.
 - **If the DTC sets**

Replace the K73 Telematics Communications Interface Control Module.

- **If the DTC does not set**

4. Ignition OFF.
5. Disconnect the **EL-49903** GM OnStar antenna diagnostic tool kit from the K73 Telematics Communication Interface Control Module
6. Test the coax cable. Refer to Component Testing.
 - **If the coax cable does not pass the test**

Replace the coax cable.

- **If the coax cable passes the test**

7. Test or replace the T4G Cellular Phone, Navigation, and Digital Radio Antenna.

With Navigation Radio

1. Ignition OFF and all vehicle systems OFF, disconnect the GPS and cellular coax cable connector at the K73 Telematics Communication Interface Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Using the EL-49903-3 kit (EL-49903-5 adapter and EL-49903-4 coax cable), connect the **EL-49903** GM OnStar antenna diagnostic tool kit to the K73 Telematics Communication Interface Control Module. Place the test antenna on the roof of the vehicle, ignition ON.
3. Verify the DTC does not set while operating the vehicle within the conditions for running the DTC.
 - **If the DTC sets**

Replace the K73 Telematics Communication Interface Control Module.

- **If the DTC does not set**

4. Ignition OFF.
5. Disconnect the **EL-49903** GM OnStar antenna diagnostic tool kit from the K73 Telematics Communication Interface Control Module
6. Connect the coax cable to the K73 Telematics Communications Interface Control Module and disconnect the coax cable from the T15 Navigation Antenna Signal Splitter, ignition ON.
7. Test for 4.5-5.5 V between the coax cable center conductor and the outer shield.
 - **If less than 4.5 V**
 1. Ignition OFF.
 2. Test the coax cable. Refer to Component Testing.
 - If the coax cable does not pass the test, replace the coax cable.
 - If the coax cable passes the test, test or replace the K73 Telematics Communications Interface Control Module.
 - **If greater than 5.5 V**
 1. Ignition OFF.

2. Test the coax cable. Refer to Component Testing.
 - If the coax cable does not pass the test, replace the coax cable.
 - If the coax cable passes the test, test or replace the K73 Telematics Communications Interface Control Module.
 - **If between 4.5-5.5 V**
8. Ignition OFF, connect the coax cable to the T15 Navigation Antenna Signal Splitter and disconnect the coax cable from the T4G Cellular Phone, Navigation, and Digital Radio Antenna, ignition ON.
9. Test for 4.5-5.5 V between the coax cable center conductor and the outer shield.
 - **If less than 4.5 V**
 1. Ignition OFF.
 2. Test the coax cable. Refer to Component Testing.
 - If the coax cable does not pass the test, replace the coax cable.
 - If the coax cable passes the test, test or replace the T15 Navigation Antenna Signal Splitter.
 - **If greater than 5.5 V**
 1. Ignition OFF.
 2. Test the coax cable. Refer to Component Testing.
 - If the coax cable does not pass the test, replace the coax cable.
 - If the coax cable passes the test, test or replace the T15 Navigation Antenna Signal Splitter.
 - **If between 4.5-5.5 V**
 - 10. Test or replace the T4G Cellular Phone, Navigation, and Digital Radio Antenna.

Component Testing

CAUTION: Refer to Test Probe Caution

NOTE:

- **Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.**
- **To prevent false readings when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.**

Coax Cable Test

1. Ignition OFF, disconnect the coax cable at both components.
2. Test for less than 5 ohms between the coax cable center terminal end to end.
 - **If 5 ohms or greater**

Replace the coax cable.
 - **If less than 5 ohms**

3. Test for greater than 5 ohms between the coax cable outer shield end to end.

- **If 5 ohms or greater**

Replace the coax cable.

- **If less than 5 ohms**

4. Test for infinite resistance between the coax cable center terminal and the coax cable outer shield.

- **If less than infinite resistance**

Replace the coax cable.

- **If infinite resistance**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Navigation Signal Splitter Replacement**
- **Radio Antenna Base Replacement**
- **Control Module References** for Telematics Communication Interface Control Module replacement, programming and setup.

DTC B2476 OR B2482: CELLULAR PHONE SELECT SERVICE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2476 04

Cellular Phone Select Service Switch Open

DTC B2476 59

Cellular Phone Select Service Switch Protection Time-out

DTC B2482 00

Cellular Phone Select Service Switch Range/Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
10 V Reference	B2476 04	B2476 04	B2476 04	-
Signal Terminal 3	1	B2476 04	B2476 59	B2476 59, B2482 00
Ground	-	B2476 04	-	-
1. OnStar® Buttons Inoperative				

Circuit/System Description

The OnStar® button assembly consists of 3 buttons: Call/Answer, OnStar® Call Center, and OnStar® Emergency. The telematics communication interface control module supplies the OnStar® button assembly with 10 V via the 10 V reference circuit. Each of the buttons, when pressed, completes the circuit across a resistor allowing a specific voltage to be returned to the telematics communication interface control module over the keypad signal circuit. Depending upon the voltage range returned, the telematics communication interface control module is able to identify which button has been pressed.

Conditions for Running the DTC

- Ignition ON.
- Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B2476 04

The telematics communication interface control module detects a short to voltage or an open/high resistance on the keypad 10 V reference circuit.

B2482 and B2476 59

The telematics communication interface control module detects a valid signal on the keypad signal circuit for longer than 15 s. If one of the OnStar® buttons is held or stuck for 15 s or greater, the telematics communication interface control module will set this DTC.

Action Taken When the DTC Sets

- The OnStar® status LED turns red.
- No calls can be placed.
- The telematics communication interface control module will ignore all inputs from the OnStar® button assembly.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Contact the OnStar® Call Center first before pressing the emergency button in order to notify them of the test.**

1. Ignition ON.
2. Verify that each button of the S51 Telematics Button Assembly operates normally by pressing each button individually.
 - **If none of the buttons operate normally**

Refer to Circuit/System testing
 - **If some, but not all, of the buttons operate normally**

Test or replace the A10 Inside Rearview Mirror
 - **If all of the buttons operate normally**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A10 Inside Rearview Mirror. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 8.0-10.5 V between the 10 V reference circuit terminal 4 and ground.
 - **If less than 8.0 V**
 1. Ignition OFF, disconnect the harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the 10 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 10 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K73 Telematics Communication Interface Control Module.
 - **If greater than 10.5 V**
 1. Ignition OFF, disconnect the harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
 2. Test for less than 1 V between the 10 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.
 - **If between 8.0-10.5 V**
5. Ignition OFF.
6. Test for 500-900 ohms between the signal circuit terminal 3 and ground.
 - **If less than 500 ohms**
 1. Disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K73 Telematics Communication Interface Control Module.

- **If greater than 900 ohms**
- 1. Disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
- 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
- 3. Ignition OFF.
- 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K73 Telematics Communication Interface Control Module.
- **If between 500-900 ohms**
- 7. Test or replace the A10 Inside Rearview Mirror.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

- **Inside Rearview Mirror Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming, and setup.

DTC B2485: WIRELESS COMMUNICATION (BT) ANTENNA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC B2485 02

Wireless Communication (BT) Antenna Circuit Short to Ground

DTC B2485 04

Wireless Communication (BT) Antenna Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B2485 02	B2485 04	-	-

Circuit/System Description

Bluetooth ® wireless technology is a short-range communications technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. The operating range of the signal is approximately 30 feet.

The Bluetooth ® antenna is a small fixed antenna connected directly to the telematics communication interface control module and is used to send and receive signals from a Bluetooth ® enabled cellular phone.

Conditions for Running the DTC

- The ignition is in OFF, ACCESSORY or RUN position.
- The system voltage is between 9-16 V.
- The telematics communication interface control module tests the antenna once every second.

Conditions for Setting the DTC

B2485 02

- The signal voltage is less than 1 V.
- The above conditions must be met for 500 ms.

B2485 04

- The signal voltage is greater than 2 V.
- The above conditions must be met for 500 ms.

Actions Taken When the DTC Sets

- The OnStar ® status LED turns red.
- Bluetooth ® functionality is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

- Verify the mobile device is properly configured for the feature being used. Refer to the device manufacturers information.
- Verify the function/feature that is being used is supported by the mobile device.
- The device must be paired to the telematics communication interface control module to use the available Bluetooth ® feature(s). The pairing process must only be performed once for each device, unless that device's information is deleted.
- The system can store pairing information for multiple devices, but can only be actively connected to one

at any given time.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Special Tools

EL-50334-20 Multi-Media Interface Tester (Multi-Media Interface Tool)

Circuit/System Testing

1. Verify that the T4S Wireless Communication Antenna - Bluetooth ® is properly connected to the K73 Telematics Communication Interface Control Module and is not damaged.
 - **If the antenna is disconnected**

Connect the T4S Wireless Communication Antenna - Bluetooth ® to the module.
 - **If the antenna is damaged**

Test or replace the T4S Wireless Communication Antenna - Bluetooth ® .
 - **If the antenna is connected and not damaged**

NOTE: **The Multi-Media Interface Tool tool can be used to test either cellular phone or streaming audio functions. Refer to the tool instructions, and perform the appropriate test(s) related to the customers concern in the following steps.**

2. Ignition ON, infotainment system ON.
3. Verify the infotainment system successfully pairs with the Multi-Media Interface Tool.
 - **If the infotainment system does not successfully pair with the Multi-Media Interface Tool.**
 1. Test or replace the T4S Wireless Communication Antenna - Bluetooth ®.
 2. Clear the DTC, ignition OFF.
 3. Ignition ON.
 4. Verify the DTC is not set.
 - If the DTC is set, replace the K73 Telematics Communication Interface Control Module.
 - If the DTC is not set
 5. All OK.
 - **If the infotainment system successfully pairs with the Multi-Media Interface Tool.**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for telematics communication interface control module replacement, programming and setup.

SYMPTOMS - CELLULAR COMMUNICATION

NOTE: **The following steps must be completed before using the symptom table.**

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **OnStar Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Radio/Audio System. Refer to **Checking Aftermarket Accessories** .
- Inspect for easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Bluetooth Malfunction (OnStar), Bluetooth Malfunction**
- **No Global Positioning System (GPS) Reception**
- **OnStar Microphone Malfunction**
- **OnStar Audio Malfunction**
- **OnStar Button LED Malfunction**
- **OnStar Call Center Remote Function Requests Malfunction**
- **OnStar Button Malfunction**
- **OnStar Voice Recognition Malfunction**
- **OnStar Steering Wheel Control Functions Malfunction**

SYMPTOMS - ENTERTAINMENT

IMPORTANT: The following steps must be completed before using the symptom table.

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Radio/Audio System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Radio/Audio System. Refer to **Checking Aftermarket Accessories**.
- Inspect for easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Application Malfunction**
- **Auxiliary Audio Input Malfunction**
- **Bluetooth Malfunction (OnStar), Bluetooth Malfunction**

- **Digital Radio Poor or No Reception**
- **No Global Positioning System (GPS) Reception**
- **Radio Poor Reception**
- **Speaker Malfunction (U65), Speaker Malfunction (UQA)**
- **Voice Recognition Malfunction**

APPLICATION MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

Circuit/System Description

The term application refers to any piece of software that works on a system (hardware) that is being operated by its own software. Applications are typically small software programs which use the hardware to perform a specific task, as opposed to operating the entire system.

Diagnostic Aids

- For an application to be used, it must be installed on both the vehicle infotainment system and a compatible mobile device.
- The application must work correctly on the device to work with the vehicle infotainment system.
- The user may be required to log-in to the application on the mobile device before using the application from the vehicle controls.
- Applications use the mobile device and connection to a service provider to operate. Connection quality issues, or service provider data transmission issues can give the appearance of a vehicle malfunction.
- The device must be connected to the system. This may be done wirelessly via Bluetooth®, or via the vehicle USB port.

When a mobile device is connected via Bluetooth®, some or all of the device controls may be unavailable from the radio controls. This varies dependant upon the device being used. Refer to the vehicle owners manual, supplements, and the device manufacturers information for information on devices, control, and operation.

Refer to the device manufacturers information for the preferred connection method.

- The device must be unlocked, and any additional applications should be closed.
- If the device has any sound enhancement features such as noise reduction or echo control, these features should be turned off.
- A low battery condition in the mobile device may not allow the device to connect to the system, or can create communication issues with the device. Verify the device battery state of charge and re-charge or

replace as needed.

- If a 'Please See Device' or similar type error message is displayed, this may indicate the device has lost its connection to the vehicle, or the device has lost its external data connection.
- If a cable is used for connection, attempt to connect the device using a different cable; cables can deteriorate over time or become damaged.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the application is installed on the mobile device and is up to date.
 - **If the application is not installed or is not up to date.**

Install or update the application on the device.

- **If the application is installed on the mobile device and is up to date**
2. Verify the application operates correctly on the mobile device.
 - **If the application is not operating correctly on the mobile device.**

Refer to the application web site.

- **If the application is operating correctly on the mobile device.**

3. Verify the K74 Human Machine Interface Control Module calibrations are current.

- **If the calibrations are not current**

Reprogram the K74 Human Machine Interface Control Module and re-evaluate the concern.

- **If no update calibrations are available**

4. Verify the application is installed on the K74 Human Machine Interface Control Module and is up to date.

- **If the application is not installed or is not up to date.**

Install or update the application and re-evaluate the concern.

- **If the application is installed and is up to date**

5. Ignition ON, infotainment system ON.

6. Verify the mobile device can connect to the infotainment system. Refer to the owners manual for information on the preferred connection method for the device.

- **If the mobile device cannot connect to the vehicle infotainment system.**

- If unable to connect via Bluetooth, refer to **Bluetooth Malfunction (OnStar)**, **Bluetooth Malfunction**.

- If unable to connect via USB, refer to **Auxiliary Audio Input Malfunction**.

- **If the mobile device connects to the vehicle infotainment system.**

7. Launch the application.

8. Verify the applications operates properly with the vehicle infotainment system.

- **If the application does not function properly**

Refer to diagnostic aids.

- **If the application functions properly**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

AUXILIARY AUDIO INPUT MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B124B, 1, 6	1, 5	-	-
Auxiliary Audio Common Signal	-	8	-	-
Auxiliary Detection Signal	7	8	-	-
Left Auxiliary Audio Signal	2	2	2, 4	-
Right Auxiliary Audio Signal	3	3	3, 4	-
USB Cable	B124B	B124B	B124B	-
Ground	-	1	-	-
1. SD Card reader and USB port Inoperative 2. No left side audio from device connected to AUX jack 3. No right side audio from device connected to AUX jack 4. Noticeable distortion may be present in affected audio channel 5. Fault may affect one or more components, dependant on fault location 6. Fault affects multiple components, dependant on vehicle equipment 7. Radio does not detect auxiliary device connection, AUX not available as input selection 8. AUX always available as an input selection, with or without auxiliary device connected				

Circuit/System Description

Auxiliary Audio Input Jack

The 3.5 mm (1/8 in.) auxiliary audio input jack is located in the console. When a portable audio playback device is connected to the auxiliary jack, an internal switch opens the detection signal circuit and the radio will switch to AUX as the audio source. The radio detects the device and AUX becomes available as an audio source. Audio signals from the device are sent to the radio from the auxiliary input jack via the left, right, and common audio signal circuits.

The infotainment system has a USB port and SD card reader slot located in the center console. The USB port and the card reader slot interface with a hub device, internal to the auxiliary jack, USB, and memory card receptacle assembly. The auxiliary jack, USB, and memory card receptacle assembly receives fused battery voltage and ground from the harness to power the internal hub device as well as providing additional amperage to power USB devices.

The internal hub device interfaces directly with the human machine interface control module via a standard USB cable. A Mini type USB connector is used to connect the cable at the USB port and at the human machine interface control module and at the auxiliary jack, USB, and memory card receptacle. Standard USB male to female connections are typically used for connecting USB cables together where an in-line connection is required. An in-line cable connection is typically found between the console and I/P harness.

USB Port

The USB port allows connectivity to the infotainment system from portable media players or a USB storage device (memory stick/ flash drive). When a device is connected to the USB port, the system detects the device and switches to USB as the audio source. Once connected, the device can be controlled from the radio controls.

Not all portable media player devices or file types are compatible. Refer to the owner's manual for information on USB devices, control, and operation.

SD Card Reader

The infotainment uses the SD card reader as a mass storage device, similar to a USB storage device.

Refer to the owners manual for information on media types supported via the SD card reader.

Diagnostic Aids

3.5 mm (1/8 in.) Input Jack

- If the system detects the device, but the audio is not heard or is not clear, attempt to connect the device using a different cable; cables can deteriorate over time or become damaged.
- Playback of an audio device that is connected to the 3.5 mm jack can only be controlled using the controls on the device.
- The volume control on the device may need to be adjusted to ensure sufficient playback volume through the infotainment system.

USB Port and SD Card Reader

- A low battery condition in a portable media player may not allow the device to connect to the system, or can create communication issues with the device. Verify the device battery state of charge and re-charge or replace as needed.
- Connect the device directly to the USB port if possible. Only use a cable if it is required to connect the device. The use of extension cables can cause communication issues.
- If a cable is required for connection, attempt to connect the device using a different cable; cables can deteriorate over time or become damaged.
- Attempt audio playback from multiple USB devices when diagnosing USB concerns. Device compatibility can vary based on vehicle equipment. If the infotainment system is capable of operating any USB type device, the cause of the concern is not with the vehicle system. The inoperative device(s) may be incompatible or contain no recognized media types.
- If a 'Device Not Supported' or similar type error message is displayed, this indicates the system has connected to the device but cannot communicate with it properly. This does not indicate an issue with the vehicle system. The device may be incompatible, may require a 'reset', or may require an update to its software/firmware.
- If a 'No Supported Data Found' or similar type error message is displayed, this indicates the system has connected to the device and is communicating, but cannot find any compatible files/data. This does not indicate an issue with the vehicle system. Verify the device contains compatible media/file types.
- Poor connections or damaged USB cables can cause intermittent or no operation of USB devices. Inspect connectors, terminals, and cables for damage and replace components as necessary. Ensure all USB inline connections and connections at components are fully seated and connector position retainers/locks are secure.

Reference Information

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-20 Multi-Media Interface Tester (MIT)

Circuit/System Verification

Auxiliary Audio Input Jack

1. Verify no DTCs are present.
 - **If any DTCs are present**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs are present**
2. Ignition ON, infotainment system ON.
3. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input 3.5 mm (1/8 in.) input jack and select the AUX test mode.
4. Verify that AUX becomes an available media selection to the infotainment system.
 - **If AUX does not become an available media selection**

Refer to Circuit/System Testing - Auxiliary Audio Input Jack.

- **If AUX becomes an available media selection**

5. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.

- **If audio is not heard from the test tool.**

Refer to Circuit/System Testing - Auxiliary Audio Input Jack.

- **If audio is heard from the test tool.**

6. All OK

USB Port and SD Card Reader

1. Ignition ON, infotainment system ON.
2. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
3. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.

- **If audio is not heard from the test tool**

1. Insert an SD card with compatible media into the SD card slot.
2. Verify the media on the SD card can be accessed while operating the system to connect to the SD card.
 - If the SD card reader cannot be accessed, refer to Circuit/System Testing - USB Port and SD Card Reader.
 - If the SD card reader can be accessed, replace the X83 Auxiliary Audio Input.

- **If audio is heard from the test tool**

4. Insert an SD card with compatible media into the SD card slot.
5. Verify the media on the SD card can be accessed while operating the system to connect to the SD card.
 - **If the SD card reader media cannot be accessed**

Refer to Circuit/System Testing - USB Port and SD Card Reader

- **If the SD card reader media can be accessed**

6. All OK.

Circuit/System Testing

Auxiliary Audio Input Jack

1. Ignition OFF, disconnect the X1 harness connector at the X83 Auxiliary Audio Input. Ignition ON, infotainment system ON.
2. Test for 2.5-3.5 V between the signal circuit terminal 5 and ground.
 - **If less than 2.5 V**
 1. Ignition OFF, disconnect the X1 harness connector at the A11 Radio.

2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the A11 Radio.
 - **If greater than 3.5 V**
1. Ignition OFF, disconnect the X1 harness connector at the A11 Radio, ignition ON.
2. Test for less than 1 V between the detection circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the A11 Radio.
 - **If between 2.5-3.5 V**
3. Test for less than 1 V between the signal circuits listed below and ground:
 - Left auxiliary audio signal circuit terminal 1
 - Right auxiliary audio signal circuit terminal 2
 - Auxiliary audio common signal circuit terminal 3
 - **If 1 V or greater**
1. Ignition OFF, disconnect the X1 harness connector at the A11 Radio. Ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the A11 Radio.
 - **If less than 1 V**
4. Ignition OFF, disconnect the X1 harness connector at the A11 Radio.
5. Test for infinite resistance between the signal circuits listed below and ground:
 - Auxiliary audio common signal circuit terminal 8
 - Left auxiliary audio signal circuit terminal 9
 - Right auxiliary audio signal circuit terminal 10
 - **If less than infinite resistance**

Repair the short to ground on the circuit.

 - **If infinite resistance**
6. Test for less than 5 ohms between the signal circuit terminals listed below:
 - A11 Radio signal circuit terminal 9 X1 and the X83 Auxiliary Audio Input signal circuit terminal 1 X1
 - A11 Radio signal circuit terminal 10 X1 and the X83 Auxiliary Audio Input signal circuit terminal 2 X1
 - A11 Radio signal circuit terminal 8 X1 and the X83 Auxiliary Audio Input signal circuit terminal 3 X1

- **If 5 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 5 ohms**

7. Replace the X83 Auxiliary Audio Input. Connect all harness connectors.
8. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input 3.5 mm (1/8 in.) input jack and select the AUX test mode.
9. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.

- **If audio is not heard from the test tool**

Replace the A11 Radio.

- **If audio is heard from the test tool**

10. All OK.

USB Port and SD Card Reader

1. Ignition OFF, disconnect the X1 harness connector at the X83 Auxiliary Audio Input.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Verify that a test lamp illuminates between the B+ circuit terminal 6 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - **If the test lamp illuminates**
4. Verify the USB cable is properly connected at all components and in-line connections, and there is no damage to the cable or connections.
 - **If connection problems or cable damage is noted.**

Perform the appropriate repair or replacement to correct any issues.

- **If no connection problems or cable damage is noted.**

5. Replace the X83 Auxiliary Audio Input. Connect all harness connectors.

6. Ignition ON, infotainment system ON.
7. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
8. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.
 - **If audio is not heard from the test tool**
 1. Replace the K74 Human Machine Interface Control Module.
 2. Connect the EL-50334-20 Multi-Media Interface Tester (MIT) to the X83 Auxiliary Audio Input USB port and select the USB test mode.
 3. Verify the audio from the EL-50334-20 Multi-Media Interface Tester (MIT) is heard through the infotainment system while operating the system to play audio from the test tool.
 - If audio is not heard from the test tool, replace the USB cable connected to the X83 Auxiliary Audio Input. Verify audio is heard from the test tool. If audio is not heard from the test tool, replace the USB cable connected to the K74 Human Machine Interface Control Module.
 - If audio is heard from the test tool.
 4. All OK.
 - **If audio is heard from the test tool**
9. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Audio Disc Player, USB, Auxiliary In, and Memory Card Receptacle Replacement**
- **Control Module References** for radio or human machine interface control module replacement, programming, and setup.

BLUETOOTH MALFUNCTION (ONSTAR)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

Circuit/System Description

The Bluetooth ® antenna is internal to, or is a small fixed antenna connected directly to, the telematics communication interface control module and is used to send and receive signals from a Bluetooth ® enabled cellular phone. The antenna utilizes no cabling and is not external to the vehicle.

In order to use hands-free calling, the cellular phone must be paired to the vehicle. Up to five devices can be paired to the vehicle at one time, but only one can be connected at any given time. To pair a phone, the customer must know how to operate the Bluetooth ® functionality of their phone. The pairing process must

only be done one time for each phone, unless that phone's information is deleted. For safety reasons, the pairing process is disabled while the vehicle is moving.

Diagnostic Aids

- The purpose of this diagnostic is to verify the ability of the telematics communication interface control module to pair to a Bluetooth ® device.
- Before performing this test, verify compatibility of the cellular phone(s) the customer is attempting to use with the vehicle. Based on the cellular phone's service provider and the manufacturer's implementation of Bluetooth ®, not all phones support all available Bluetooth ® functionality. A vehicle and feature compatibility list will be provided via the GM Bluetooth ® website:
<http://www.onstar.com/web/Bluetooth/>
- If the vehicle passes the following tests and a compatible device is being used, the concern may be due to a device malfunction or an incomplete/improper pairing attempt.
- A Bluetooth ® test tool or equivalent can also be used to verify the ability of the customers cellular phone (s) to pair with another device.

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-20 Multi-Media Interface Tester (Multi-Media Interface Tool)

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B2485 is not set.
 - **If DTC B2485 is set**

Refer to **DTC B2485**

- **If DTC B2485 is not set**

NOTE: **The Multi-Media Interface Tool can be used to test either cellular phone or streaming audio functions. Refer to the tool instructions, and perform the appropriate test(s) related to the customers concern in the following steps.**

3. Ignition ON, infotainment system ON.
4. Verify the infotainment system successfully pairs with the Multi-Media Interface Tool.
 - **If the infotainment system does not successfully pair with the Multi-Media Interface Tool.**
 1. Verify the vehicle is equipped with an external Bluetooth® Antenna.
 - If not equipped with an external Bluetooth® Antenna, replace the K73 Telematics Communication Interface Control Module
 - If equipped with an external Bluetooth® Antenna
 2. Replace the Bluetooth® Antenna.
 3. Verify the infotainment system successfully pairs with the Multi-Media Interface Tool.
 - If the infotainment system does not successfully pair with the Multi-Media Interface Tool, replace the K73 Telematics Communication Interface Control Module.
 - If the infotainment system successfully pairs with the Multi-Media Interface Tool.
 4. All OK.
 - **If the infotainment system successfully pairs with the Multi-Media Interface Tool.**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

Control Module References for telematics communication interface control module replacement, programming, and setup.

BLUETOOTH MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

Circuit/System Description

Bluetooth ® wireless technology is a short-range communications technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. The operating range of the signal is approximately 30 feet.

The available features and functions are determined by the type of device and the software within the devices being used. For a feature or function to operate, it must be supported in both devices.

The Bluetooth ® hardware is internal to the Human Machine Interface Control Module. The Human Machine Interface Control Module supports streaming of data (music, voice, information) from cellular phones and other mobile devices that support those features. The Human Machine Interface Control Module is also capable of interfacing with cellular phones for hands-free features.

Refer to the vehicle owners manual, supplements, and the device manufacturers information for information on devices, control, operation. and pairing instructions.

Diagnostic Aids

- Verify the mobile device is properly configured for the feature being used. Refer to the device manufacturers information.
- Verify the function/feature that is being used is supported by the mobile device.
- The device must be paired to the system to use the available Bluetooth ® feature(s). The pairing process must only be performed once for each device, unless that device's information is deleted.
- The system can store pairing information for multiple devices, but can only be actively connected to one at any given time.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-20 Multi-Media Interface Tester (MIT)

Circuit/System Verification

1. Verify no DTCs are present.

- **If any DTCs are present**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs are present**

2. Verify the K74 Human Machine Interface Control Module calibrations are current.

- **If the K74 Human Machine Interface Control Module calibrations are not current**

Reprogram the K74 Human Machine Interface Control Module and re-evaluate the concern.

- **If no update calibrations are available**

NOTE: **The MIT tool can be used to test either cellular phone or streaming audio functions. Refer to the tool instructions, and perform the appropriate test (s) related to the customers concern in the following steps.**

3. Ignition ON, infotainment system ON.

4. Verify the infotainment system successfully pairs with the MIT tool.

- **If the infotainment system does not successfully pair with the MIT tool.**

Replace the K74 Human Machine Interface Control Module.

- **If the infotainment system successfully pairs with the MIT tool.**

5. Verify the infotainment system successfully completes the desired feature test using the MIT tool.

- **If the feature test is not successful**

Replace the K74 Human Machine Interface Control Module.

- **If the feature test is successful**

6. All OK. Refer to Diagnostic Aids.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Human Machine Interface Control Module replacement, programming, and setup

DIGITAL RADIO POOR OR NO RECEPTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B125C 01

Satellite Antenna Circuit Short to Battery

DTC B125C 02

Satellite Antenna Circuit Short to Ground

DTC B125C 04

Satellite Antenna Circuit Open

Circuit/System Description

The digital radio receiver, located inside the radio, receives digital radio information from the digital radio antenna located on the outside of the vehicle. The digital radio receiver is connected to the digital radio antenna via a shielded coax cable. The digital radio antenna contains an amplifier which is powered by the radio through the coax cable.

Conditions for Running the DTC

This DTC is run every 300 milliseconds.

Conditions for Setting the DTC

The radio detects a circuit fault in the digital radio antenna.

Action Taken When the DTC Sets

The radio displays No XM Signal or Check Antenna.

Conditions for Clearing the DTC

- A current DTC clears when the condition for setting the DTC is no longer present.
- A history DTC clears after 100 malfunction-free ignition cycles.

Diagnostic Aids

The digital radio antenna requires a clear line of sight to the sky to operate properly. Reception may be limited, intermittent, or unavailable inside structures.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Special Tools

EL-48028 Digital Radio Test Antenna

For equivalent regional tools, refer to **Special Tools, Special Tools (MIT Tool Instructions)**.

Circuit/System Verification

1. With the vehicle outside in an area with an unobstructed view of the southern sky, tune to XM.
2. Verify DTC B125C is not set as current and the No XM Signal message is not displayed on the radio.
 - **If DTC B125C is set as current or the No XM Signal message is displayed.**

Refer to Circuit/System Testing.

- **If DTC B125C is not set as current and the No XM Signal message is not displayed.**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the digital radio antenna coax cable from the A11 Radio. Connect the **EL-48028** Digital Radio Test Antenna to the radio and place on the roof of the vehicle.
2. Ignition ON, radio tuned to XM channel 1.
3. Verify DTC B125C is not set as current and XM reception is improved.
 - **If DTC B125C is set as current or XM reception is not improved**

Replace the A11 Radio.

- **If DTC B125C is not set as current and XM reception is improved**
4. Ignition OFF, disconnect the digital radio antenna coax cable from the T4G Cellular Phone, Navigation, and Digital Radio Antenna.
 5. Verify the digital radio antenna coax cable passes the coax cable component test. Refer to Component Testing.
 - **If the coax cable does not pass the test**
- Replace the antenna coax cable
- **If the coax cable passes the test**
6. Test or replace the T4G Cellular Phone, Navigation, and Digital Radio Antenna.

Component Testing

CAUTION: Refer to Test Probe Caution .

NOTE: Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.

To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.

Coax Cable Test

1. Ignition OFF, disconnect the coax cable at both components.
 2. Test for less than 5 ohms between coax cable center terminal end to end.
 - **If 5 ohms or greater**
- Replace the coax cable
- **If less than 5 ohms**
3. Test for less than 5 ohms between the coax cable outer shield end to end.

- **If 5 ohms or greater**

Replace the coax cable

- **If less than 5 ohms**

4. Test for infinite resistance between the coax cable center terminal and the coax cable outer shield.

- **If less than infinite resistance**

Replace the coax cable

- **If infinite resistance**

5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Radio Antenna Base Replacement**
- **Control Module References** for radio replacement, programming, and setup.

ONSTAR MICROPHONE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Microphone High Signal Terminal 9	B2455 02	B2455 04	B2455 04	-
Microphone Low Signal Terminal 10	B2455 02	B2455 04	B2455 04	-

Circuit/System Description

The telematics communication interface control module provides the Cellular Phone Microphone with a supplied voltage on the cellular phone microphone signal circuit. When the cellular phone microphone is in use, voice data from the user is sent back to the telematics communication interface control module on the signal circuit.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

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Description and Operation

OnStar Description and Operation

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B2455 is not set.
 - **If DTC B2455 is set**

Refer to **DTC B2455**.

- **If DTC B2455 is not set**
3. Verify that a successful OnStar voice command can be made.
 - **If your voice can not be heard clearly.**

Refer to Circuit/System Testing - Microphone Malfunction.

- **If your voice can be heard clearly**
4. All OK.

Circuit/System Testing

Microphone Malfunction

1. Ignition OFF, disconnect the harness connector at the B24 Cellular Phone Microphone, ignition ON.

2. Test for 8.0-10.5 V between the signal circuit terminal B and ground.
 - **If less than 8.0 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the vehicle K73 Telematics Communication Interface Control Module.
 - **If greater than 10.5 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.
 - **If between 8.0-10.5 V**
3. Test for less than 1 V between the signal circuit terminal A and ground.
 - **If greater than 1 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, repair the K73 Telematics Communication Interface Control Module.
 - **If less than 1 V**
4. Test for greater than 8 V between the signal circuit terminal B and the signal circuit terminal A.
 - **If less than 8 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the vehicle K73 Telematics Communication Interface Control Module.
 - **If greater than 9 V**
5. Test or replace the B24 Cellular Phone Microphone.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

- **Mobile Telephone Microphone Replacement**
- **Control Module References** for radio or telematics communication interface control module replacement, programming, and setup.

ONSTAR AUDIO MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Audio High Signal terminal 1	1	1	1	-
Audio Low Signal terminal 2	1	1	1	-
1. No (or Noisy) OnStar® Audio				

Circuit/System Description

When an OnStar® keypress is made, a serial data message is sent to the audio system to mute all radio functions and output OnStar® originated audio. After the audio system is muted, the telematics communication interface control module transmits signals to the audio system on the audio signal and audio common circuits.

Reference Information

Schematic Reference

- **OnStar/Telematics Schematics**
- **Radio/Navigation System Schematics**

Connector End View Reference

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Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, radio ON.
2. Verify that audio is heard clearly through all speaker channels when tuning radio to a known good station.
 - **If audio is not heard clearly**

Refer to **Speaker Malfunction (U65)**, **Speaker Malfunction (UQA)**

- **If audio is heard clearly**
- 3. Verify that the Connecting to OnStar® message is heard clearly through the audio system when the OnStar® blue button is pressed.
 - **If OnStar message is noisy or distorted**

Refer to Circuit/System Testing

- **If OnStar message is heard clearly**
- 4. All OK.

Circuit/System Testing

1. Ignition OFF and vehicle systems OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
2. Test for less than 4 V between each of the signal circuits listed below and ground:
 - Terminal 1
 - Terminal 2
 - **If 4 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the A11 Radio, ignition ON.
 2. Test for less than 1 V between the signal circuits and ground.
 - If greater than 1 V, repair the short to voltage in the circuit.
 - If less than 1 V, replace the A11 Radio.
 - **If less than 4 V**
3. Ignition OFF.
4. Test for infinite resistance between each of the signal circuits listed below and ground:

- Terminal 1
- Terminal 2
- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

5. Disconnect the X1 harness connector at the A11 Radio.
6. Test for less than 2 ohms in each of the signal circuits listed below end to end:
 - K73 Telematics Communication Interface Control Module Terminal 1 X2
 - K73 Telematics Communication Interface Control Module Terminal 2 X2
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 ohms**

7. Replace the K73 Telematics Communication Interface Control Module.
8. Verify that the Connecting to OnStar® message is heard clearly through the audio system when the OnStar® blue button is pressed.
 - **If audio is not heard clearly**

Replace the A11 Radio.

- **If audio is heard clearly**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

Control Module References for radio or telematics communication interface control module replacement, programming, and setup.

NO GLOBAL POSITIONING SYSTEM (GPS) RECEPTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The navigation antenna is connected to the telematics communication interface control module. The module

supplies 5 V to the antenna to power the internal amplifier through the center conductor of the antenna coax cable.

When the vehicle is equipped with the optional navigation system, a navigation signal splitter is installed to distribute the navigation signal to both the telematics communication interface control module and the human machine interface control module. The telematics communication interface control module supplies 5 V through the coax cable to power the internal antenna amplifier through the signal splitter.

Diagnostic Aids

- The scan tool telematics communication interface control module GPS signal parameter will display Active or Inactive dependent upon whether or not the module sees an increment of the seconds transmitted by GPS signals to the telematics communication interface control module. Upon entering this screen, the GPS signal title will initially display Active, regardless of the presence of time increment, for at least 2 seconds, while the algorithm in the scan tool determines the status of the clock. If increment is found, Active is continually displayed. If the clock remains static, Inactive is displayed. The scan tool looks for increment every second, regardless of current display.
- Inaccurate or aged GPS position concerns which are no longer present may have been due to the temporary loss of GPS signal reception by the vehicle. Conditions such as tunnels or parking structures will restrict the cellular phone and navigation antenna from a clear view of the satellites in the sky and may have caused this temporary data loss.
- The GPS requires a clear line of sight to the sky to operate properly. In most cases the GPS will not have reception near tall buildings or inside structures.

Reference Information

Schematic Reference

- **OnStar/Telematics Schematics**
- **Radio/Navigation System Schematics**

Connector End View Reference

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- **OnStar Description and Operation**
- **Radio/Audio System Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-49903 OnStar Antenna Diagnostic Tool Kit

Circuit/System Verification

NOTE: **The following verification requires the vehicle to be outside with an unobstructed view of the southern sky. Allow 5 minutes after turning the ignition ON for the vehicle to acquire the GPS satellites signal.**

1. Ignition ON.
2. Verify that no DTCs are set.
 - **If any DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs are set**
3. Verify that an OnStar advisor can locate the vehicle after performing a blue button press.
 - **If the advisor can not locate the vehicle and the vehicle is not equipped with a navigation system.**

Refer to Circuit System Testing- Without Navigation System.

- **If the advisor can not locate the vehicle and the vehicle is equipped with a navigation system.**

Refer to Circuit System Testing- With Navigation System.

- **If the advisor can locate the vehicle**
4. Verify that the NO GPS symbol/message is not displayed on the P17 Display Module.
 - **If the NO GPS symbol/message is displayed**

Refer to Circuit System Testing With Navigation System- Step 9.

- **If the NO GPS symbol/message is not displayed**
5. All OK.

Circuit/System Testing

without Navigation System

1. Ignition OFF, disconnect the GPS and cellular coax cable connector at the K73 Telematics

Communication Interface Control Module.

2. Using the **EL-49903** OnStar Antenna Diagnostic Tool Kit , connect the EL-49903-3 antenna to the K73 Telematics Communication Interface Control Module. Place the test antenna on the roof of the vehicle, ignition ON.
3. Verify that an OnStar advisor can locate the vehicle after performing a blue button press.
 - **If the advisor can not locate the vehicle**

Replace the K73 Telematics Communication Interface Control Module.

- **If the advisor can locate the vehicle**
4. Ignition OFF, disconnect the **EL-49903** GM OnStar antenna diagnostic tool kit from the K73 Telematics Communication Interface Control Module
 5. Disconnect the K73 Telematics Communication Interface Control Module coax at the T4G Cellular Phone, Navigation, and Digital Radio Antenna.
 6. Test the coax cable between the K73 Telematics Communication Interface Control Module and the T4G Cellular Phone, Navigation, and Digital Radio Antenna. Refer to component testing.
 - **If the coax cable does not pass the test**

Replace the coax cable.

- **If the coax cable passes the test**
7. Test or replace the T4G Cellular Phone, Navigation, and Digital Radio Antenna.

with Navigation System

NOTE: Perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the coax cable at the T15 Navigation Antenna Signal Splitter.
 2. Connect the **EL-49903** OnStar Antenna Diagnostic Tool Kit to the T15 Navigation Antenna Signal Splitter. Place the test antenna on the roof of the vehicle, ignition ON.
 3. Verify that an OnStar advisor can not locate the vehicle after performing a blue button press.
 - **If the advisor can locate the vehicle**
 1. Ignition OFF, disconnect the coax cable at the T4G Cellular Phone, Navigation, and Digital Radio Antenna.
 2. Test the coax cable between the T15 Navigation Antenna Signal Splitter and the T4G Cellular Phone, Navigation, and Digital Radio Antenna. Refer to Component Testing.
 - If the coax cable does not pass the test
- Replace the coax cable.
- If the coax cable passes the test
3. Replace the T4G Cellular Phone, Navigation, and Digital Radio Antenna.

- **If the advisor can not locate the vehicle**

4. Ignition OFF, disconnect the GPS and cellular coax cable connector at the K73 Telematics Communication Interface Control Module.
5. Connect the **EL-49903** OnStar Antenna Diagnostic Tool Kit to the K73 Telematics Communication Interface Control Module. Place the test antenna on the roof of the vehicle, ignition ON.
6. Verify that an OnStar advisor can locate the vehicle after performing a blue button press.

- **If the advisor can not locate the vehicle**

Replace the K73 Telematics Communication Interface Control Module.

- **If the advisor can locate the vehicle**

7. Ignition OFF.
8. Test the coax cable between the T15 Navigation Antenna Signal Splitter and the K73 Telematics Communication Interface Control Module. Refer to Component Testing.

- **If the coax cable does not pass the test**

Replace the coax cable.

- **If the coax cable passes the test**

9. Ignition OFF, disconnect the GPS coax cable at the K74 Human Machine Interface Control Module.
10. Connect the **EL-49903** OnStar Antenna Diagnostic Tool Kit to the K74 Human Machine Interface Control Module and place the test antenna on the roof of the vehicle.
11. Ignition ON.
12. Verify that the NO GPS symbol/message is not displayed on the P17 Display Module.

- **If the NO GPS symbol/message is displayed**

Replace the K74 Human Machine Interface Control Module

- **If the NO GPS symbol/message is not displayed**

13. Ignition OFF.
14. Test the coax cable between the T15 Navigation Antenna Signal Splitter and the K74 Human Machine Interface Control Module. Refer to Component Testing.

- **If the coax cable does not pass the test**

Replace the coax cable.

- **If the coax cable passes the test**

15. Test or replace the T15 Navigation Antenna Signal Splitter.

Component Testing

CAUTION: Refer to Test Probe Caution .

NOTE:

- Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.
- To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.
- The vehicle may be equipped with sectioned coax. Test each section and replace only the faulty section, not the entire length of coax.

Coax Cable Test

1. Ignition OFF, disconnect the coax cable at both components.
2. Test for less than 5 ohms between the coax cable center terminal end to end.
 - **If 5 ohms or greater**

Replace the coax cable.

- **If less than 5 ohms**

3. Test for greater than 5 ohms between the coax cable outer shield end to end.
 - **If 5 ohms or greater**

Replace the coax cable.

- **If less than 5 ohms**

4. Test for infinite resistance between the coax cable center terminal and the coax cable outer shield.
 - **If less than infinite resistance**

Replace the coax cable.

- **If infinite resistance**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Navigation Signal Splitter Replacement**
- **Radio Antenna Base Replacement**
- **Control Module References** for human machine interface control module or telematics communication interface control module replacement, programming, and setup.

ONSTAR BUTTON LED MALFUNCTION**Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2476 04

Cellular Phone Select Service Switch Open

DTC B2476 59

Cellular Phone Select Service Switch Protection Time-out

DTC B2482 00

Cellular Phone Select Service Switch Range/Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
10 V Reference	B2476 04	B2476 04	B2476 04	-
Control Terminal 6	1	1	2	-
Control Terminal 7	1	1	2	-
Signal Terminal 3	B2476 04	B2476 04	B2476 59	B2476 59, B2482 00
Ground	-	B2476 04	-	-
1. OnStar® LED Inoperative 2. LED Illuminated At All Times				

Circuit Description

The OnStar® status LEDs are located in the inside rearview mirror telematic button assembly. The green LED is illuminated when the system is ON and operating normally. When the green LED is green and flashing, it is an indication that a call is in progress. When the red LED is illuminated, a system malfunction is present. In the event there is a system malfunction and the OnStar® system is still able to make a call, the LED will flash red during the call. The OnStar® LEDs are controlled by the telematics communication interface control module via the keypad green LED control circuit and the keypad red LED control circuit.

Conditions for Running the DTC

- Ignition ON.
- Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B2476 04

The telematics communication interface control module detects a short to voltage or an open/high resistance on the keypad 10 V reference circuit.

B2482 and B2476 59

The telematics communication interface control module detects a valid signal on the keypad signal circuit for longer than 15 s. If one of the OnStar® buttons is held or stuck for 15 s or greater, the telematics communication interface control module will set this DTC.

Action Taken When the DTC Sets

- The OnStar® status LED turns red.
- No calls can be placed.
- The telematics communication interface control module will ignore all inputs from the OnStar® button assembly.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

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Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: If the green LED is off with the ignition ON and the LED functions correctly when commanded with the scan tool, contact the OnStar Center to confirm the vehicle has a current subscription.

1. Ignition ON.
2. Verify no DTC are set.
 - **If any DTC are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no DTC are set**
- 3. Verify that the green LED turns ON and OFF when commanding the Green Indicator ON and OFF with a scan tool.
 - **If the green LED does not turn ON and OFF**

Refer to Circuit/System Testing - Green LED Test

- **If the green LED turns ON and OFF**
- 4. Verify that the red LED turns ON and OFF when commanding the Red Indicator ON and OFF with a scan tool.
 - **If the red LED does not turn ON and OFF**

Refer to Circuit/System Testing - Red LED Test

- **If the red LED turns ON and OFF**
- 5. All OK.

Circuit/System Testing

Green LED Test

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the A10 Inside Rearview Mirror. It may take up to 2 min for all vehicle systems to power down. Doors closed, courtesy lamps OFF.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Test for less than 1 V between the control circuit terminal 6 and ground while commanding the Green Indicator OFF with a scan tool.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 6 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.
 - **If less than 1 V**
- 5. Test for greater than 8 V between the control circuit terminal 6 and ground while commanding the Green Indicator ON with a scan tool.
 - **If 8 V or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the control circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K73 Telematics Communication Interface Control Module.
 - **If greater than 8 V**
- 6. Test or replace the A10 Inside Rearview Mirror.

Red LED Test

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the A10 Inside Rearview Mirror. It may take up to 2 min for all vehicle systems to power down. Doors closed, courtesy lamps OFF.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for less than 1 V between the control circuit terminal 7 and ground while commanding the Red Indicator OFF with a scan tool.

- **If 1 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 7 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.
- **If less than 1 V**
- 5. Test for greater than 8 V between the control circuit terminal 7 and ground while commanding the Red Indicator ON with a scan tool.
 - **If 8 V or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the control circuit terminal 7 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K73 Telematics Communication Interface Control Module.
 - **If greater than 8 V**
- 6. Test or replace the A10 Inside Rearview Mirror.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Inside Rearview Mirror Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming and setup.

ONSTAR CALL CENTER REMOTE FUNCTION REQUESTS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The telematics communication interface control module has the capability of commanding the horn, initiating door lock/unlock, or operating the exterior lamps using the serial data circuits. These functions are commanded by the OnStar® Call Center per a customer request.

Diagnostic Aids

The customer concern may have been due to a lack of cellular service in a given area, or a failure in the National Cellular Network infrastructure that has since been corrected.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

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OnStar Description and Operation

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- It is necessary to inform the OnStar® Call Center advisor that this call is for vehicle diagnostic purposes.
- It is necessary to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from satellites.

1. Ignition ON.
2. Verify that the horn, lights, and the door locks on the vehicle operate properly.
 - If an applicable vehicle system does not operate properly

Refer to **Diagnostic System Check - Vehicle** .

- If all applicable vehicle systems operate properly

3. Verify that a call can be successfully placed to the OnStar Call Center by pressing the blue OnStar button.
 - **If unable to contact the OnStar® call center**

Refer to **Unable to Contact OnStar Call Center**

- **If able to contact the OnStar Call Center**
4. Verify with the OnStar advisor that all remote functions (door locks, lights, and horn) work.
 - **If the remote functions do not operate when requested**

Replace the K73 Telematics Communication Interface Control Module

- **If the remote functions operate when requested**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for telematics communication interface control module replacement, programming and setup.

ONSTAR BUTTON MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2476 04

Cellular Phone Select Service Switch Open

DTC B2476 59

Cellular Phone Select Service Switch Protection Time-out

DTC B2482 00

Cellular Phone Select Service Switch Range/Performance

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
10 V Reference	B2476 04	B2476 04	B2476 04	-
Signal Terminal 3	B2476 04	B2476 04	B2476 59	B2476 59, B2482 00
Ground	-	B2476 04	-	-

Circuit/System Description

The OnStar® button assembly consists of 3 buttons: Call/Answer, OnStar® Call Center, and OnStar® Emergency. The telematics communication interface control module supplies the OnStar® button assembly with 10 V via the 10 V reference circuit . Each of the buttons, when pressed, completes the circuit across a resistor allowing a specific voltage to be returned to the telematics communication interface control module over the keypad signal circuit. Depending upon the voltage range returned, the telematics communication interface control module is able to identify which button has been activated.

Conditions for Running the DTC

- Ignition ON.
- Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B2476 04

The telematics communication interface control module detects a short to voltage or an open/high resistance on the keypad 10 V reference circuit.

B2482 and B2476 59

The telematics communication interface control module detects a valid signal on the keypad signal circuit for longer than 15 s. If one of the OnStar® buttons is held or stuck for 15 s or greater, the telematics communication interface control module will set this DTC.

Action Taken When the DTC Sets

- The OnStar® status LED turns red.
- No calls can be placed.
- The telematics communication interface control module will ignore all inputs from the OnStar® button assembly.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

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Description and Operation

OnStar Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Contact the OnStar® Call Center first before pressing the emergency button in order to notify them of the test.**

1. Ignition ON.
2. Verify no DTCs are set.
 - **If any DTCs are set**

Diagnostic Trouble Code (DTC) List - Vehicle

- **If no DTCs are set**
3. Verify that each button of the S51 Telematics Button Assembly operates normally by pressing each button individually.
 - **If none of the buttons operate normally**

Refer to Circuit/System Testing.

- **If some, but not all, of the buttons operate normally**

Test or replace the A10 Inside Rearview Mirror.

- **If all of the buttons operate normally**

4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A10 Inside Rearview Mirror. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 8.0-10.5 V between the 10 V reference circuit terminal 4 and ground.
 - **If less than 8.0 V**
 1. Ignition OFF, disconnect the harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the 10 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 10 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K73 Telematics Communication Interface Control Module.
 - **If greater than 10.5 V**
 1. Ignition OFF, disconnect the harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
 2. Test for less than 1 V between the 10 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.
 - **If between 8.0-10.5 V**
5. Ignition OFF.
6. Test for 500-900 ohms between the signal circuit terminal 3 and ground.
 - **If less than 500 ohms**
 1. Disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for infinite resistance between the signal circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K73 Telematics Communication Interface Control Module.
- **If greater than 900 ohms**
- 1. Disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
- 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
- 3. Ignition OFF.
- 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K73 Telematics Communication Interface Control Module.
- **If between 500-900 ohms**
- 7. Test or replace the A10 Inside Rearview Mirror.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Inside Rearview Mirror Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming and setup.

ONSTAR STEERING WHEEL CONTROL FUNCTIONS MALFUNCTION

Some vehicles equipped with the OnStar® system have the capability of accessing voice mailboxes and other automated phone systems by means of the steering wheel controls, while the OnStar® Personal Calling feature is in use. If the "Talk" or "Mute" button (depending upon the vehicle) on the steering wheel controls is depressed during an OnStar® Personal Calling call, the telematics communication interface control module receives the message on the serial data bus from either the radio or body control module. This message is interpreted as a request to turn any spoken numbers into dual tone multi-frequency tones to be delivered over the airwaves to the phone system the user is communicating with. Complete instructions for operation of these features can be found in the information provided to the customer with the OnStar® system.

The steering wheel controls are a resistor network that consist of multiple momentary contact switches and a series of resistors. The switches and resistor network are arranged so that each switch has a different resistance value. When a switch is pressed, a voltage drop occurs in the resistor network, which produces a specific voltage value unique to the switch selected, to be interpreted by either the radio or BCM. In the event the OnStar® steering wheel control functions are inoperative, technicians should refer to **Steering Wheel Controls Malfunction** , to begin diagnosis of the steering wheel control concern.

RADIO POOR RECEPTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B125A 02

Antenna Signal Circuit Short to Ground

DTC B125A 04

Antenna Signal Circuit Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Radio Antenna Coax	B125A 02	B125A 04	1	-
Antenna Module Ground	-	1	-	-
1. May exhibit possible AM/FM interference.				

Circuit/System Description

The active antenna system uses an integral antenna applied as an applique to the rear glass. The antenna module receives both AM and FM signals from the rear glass antenna. The radio antenna module is enabled when the radio is turned on. The radio provides battery voltage to the antenna module using the center conductor of the antenna coaxial cable. When a 12 V signal is seen by the module on the center conductor of the antenna coax, both AM and FM signals are amplified.

Conditions for Running the DTC

- Ignition ON.
- Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B125A 02

The radio detects a short to ground in the antenna signal circuit center conductor.

B125A 04

The radio detects an open in the antenna signal circuit center conductor.

Action Taken When the DTC Sets

Radio reception may be poor or not available.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 50 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

Poor AM and FM radio reception may be due to multiple influences, some of which may not be vehicle related. Areas which have high RF traffic or block the signal path may cause a degradation in radio reception. Radio reception may also be influenced by items within the vehicle, but not part of the radio system. Such examples are aftermarket electrical accessories or other items which may generate noise in the vehicle electrical system. Aftermarket window tinting, especially when there is a metallic in the film, may reduce radio reception.

AM reception is highly dependent on the antenna module receiving battery voltage from the radio and being properly grounded. The antenna module has a built in antenna amplifier that boosts both AM and FM reception. When the antenna module does not receive power, AM stations may not be received and FM reception will be limited. If the module is not properly grounded, excessive interference in the signal may occur, or reception may be limited.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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Description and Operation

Radio/Audio System Description and Operation

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Inspect the antenna located in the rear window. Verify all branches of the antennas are intact, with no scratches or other damage.

- **If damage is found**

Repair or replace as necessary

- **If no damage is found**

2. Ignition ON, A11 Radio ON.
3. Verify station reception is normal when tuned to several known good AM and FM stations.
 - **If AM or FM reception is poor.**

Refer to Circuit/System Testing

- **If reception is normal**

4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the radio antenna coax cable from the A11 Radio and from the K46 Radio Antenna Module.
2. Verify the antenna coax cable passes the coax cable component test. Refer to Component Testing.
 - **If the coax cable does not pass the test**

Replace the antenna coax cable

- **If the coax cable passes the test**

3. Connect the antenna coax cable to the A11 Radio. Ignition ON, A11 Radio ON.
4. Verify a test lamp illuminates between the antenna coax cable center terminal and ground at the K46 Radio Antenna Module connector.
 - **If the test lamp does not illuminate**

Replace the A11 Radio.

- **If the test lamp illuminates**

5. Test or replace the K46 Radio Antenna Module.

Component Testing

CAUTION: Refer to Test Probe Caution .

NOTE: Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause

reception issues.

To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.

Coax Cable Test

1. Ignition OFF, disconnect the coax cable at both components.
2. Test for less than 5 ohms between coax cable center terminal end to end.
 - **If 5 ohms or greater**

Replace the coax cable

- **If less than 5 ohms**

3. Test for less than 5 ohms between the coax cable outer shield end to end.
 - **If 5 ohms or greater**

Replace the coax cable

- **If less than 5 ohms**

4. Test for infinite resistance between the coax cable center terminal and the coax cable outer shield.
 - **If less than infinite resistance**

Replace the coax cable

- **If infinite resistance**

5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for radio replacement, programming, and setup.

SPEAKER REPLACEMENT REFERENCE

Speaker Replacement Reference

Component	Repair Instruction
Center I/P Speaker	<u>Radio Front Speaker Replacement</u>
Front Door Speaker	<u>Radio Front Side Door Speaker Replacement</u>
Front Tweeter Speaker	<u>Radio Front Side Door Upper Speaker Replacement</u>
Rear Door Speaker	<u>Radio Rear Side Door Speaker Replacement</u>
Subwoofer Speaker	<u>Radio Rear Compartment Speaker Replacement</u>

SPEAKER MALFUNCTION (U65)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Speaker Output Signal	B1025 02, 1	B1025 04, 1	B1025 01, 1, 2	-
Right Front Speaker Output Signal	B1035 02, 1	B1035 04, 1	B1035 01, 1, 2	-
Left Rear Speaker Output Signal	B1045 02, 1	B1045 04, 1	B1045 01, 1, 2	-
Right Rear Speaker Output Signal	B1055 02, 1	B1055 04, 1	B1055 01, 1, 2	-
1. No or reduced audio from speaker(s) on the affected audio circuit. 2. Noticeable audio distortion may be present.				

Circuit/System Description

Each of the audio output channel circuits (+) and (-), at the radio have a DC bias voltage that is approximately one half of battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5 V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound. The frequency (Hz) of the AC voltage signal is directly related to the frequency of the input (audio source playing) to the audio system. Both the DC bias voltage and the AC voltage signals are needed for the audio system to properly produce sound.

Diagnostic Aids

- Improper speaker mounting or loose trim may cause an audible buzz or distortion. Inspect the appropriate speaker and the surrounding interior trim for proper and secure mounting.
- The EL-50334-6 Audio System Diagnostic CD contains audio tracks that can be used to duplicate and isolate such concerns. Tracks 11 and 12 contain audio sweep tones for testing for speaker and grill rattles.
- The test tones on the CD may be copied to a USB drive or other device to use during testing.
- If the speaker or surrounding interior trim is found to be loose or improperly secured, correctly secure the item.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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Radio/Audio System Description and Operation

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-50 USB Cable and Adapter Kit

Circuit/System Verification

1. Ignition ON, A11 Radio ON, mute OFF.
2. Verify clear audio is heard from each speaker, adjusting fade and balance controls to test each speaker individually.
 - **If audio is inoperative from one or more speakers, or the audio emitted is not clear**

Refer to Circuit/System Testing.
 - **If clear audio is heard from all speakers**
3. All OK.

Circuit/System Testing

NOTE: **Some circuits supply audio signals to more than one speaker. It may be necessary to disconnect all speakers on the affected audio circuit when performing circuit tests.**

1. Ignition OFF, disconnect the harness connector at the appropriate P19 Speaker. Ignition ON, radio ON, mute OFF.

2. Test for 5-7 V between each audio signal circuit terminal 1 and terminal 2 and ground.
 - **If less than 5 V**
 1. Ignition OFF, disconnect the X1 harness connector at the A11 Radio.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the A11 Radio.
 - **If greater than 7 V**
 1. Ignition OFF, disconnect the X1 harness connector at the A11 Radio. Ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the A11 Radio.
 - **If between 5-7 V**

NOTE: In the following tests, audio signal frequencies (Hz) will be tested. To prevent misdiagnosis, the door chime must be OFF during testing. Ensure the driver door latch is closed during testing.

3. Insert the EL-50334-6 Audio Test CD from the **EL-50334-50** USB cable and adapter kit. Play track number three (50 Hz bass test tone) from the test CD.
4. Test for 49-51 Hz between each signal circuit terminal 1 and terminal 2 and ground.
 - **If not between 49-51 Hz**

Replace the A11 Radio.
 - **If between 49-51 Hz**
5. Test or replace the P19 Speaker.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Speaker Replacement Reference**
- **Control Module References** for radio replacement, programming, and setup.

SPEAKER MALFUNCTION (UQA)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC B1025

Audio Output 1 Circuit

DTC B1035

Audio Output 2 Circuit

DTC B1045

Audio Output 3 Circuit

DTC B1055

Audio Output 4 Circuit

DTC B1065

Audio Output 5 Circuit

DTC B1075

Audio Output 6 Circuit

DTC B1085

Audio Output 7 Circuit

For symptom byte information refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Audio Output 1 Signal Circuits (Left Front Door and tweeter)	B1025 02	B1025 04	B1025 01	-
Audio Output 2 Signal Circuits (Right Front Door and tweeter)	B1035 02	B1035 04	B1035 01	-
Audio Output 3 Signal Circuits (Left Rear Subwoofer)	B1045 02	B1045 04	B1045 01	-
Audio Output 4 Signal Circuits				

(Right Rear Subwoofer)	B1055 02	B1055 04	B1055 01	-
Audio Output 5 Signal Circuits (Left Rear Door)	B1065 02	B1065 04	B1065 01	-
Audio Output 6 Signal Circuits (Right Rear Door)	B1075 02	B1075 04	B1075 01	-
Audio Output 7 Signal Circuits (Center I/P)	B1085 02	B1085 04	B1085 01	-

Circuit/System Description

The Media Oriented Systems Transport (MOST) is a high-speed multimedia network technology. The serial MOST bus uses a ring topology and synchronous data communication to transmit audio, video, data and control information between any devices attached.

The audio amplifier is a participant on the MOST network. The audio amplifier receives audio inputs and control information from the MOST bus.

Each of the audio output channel circuits (+) and (-), at the audio amplifier have a DC bias voltage that is approximately one half of the battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound.

Diagnostic Aids

- Improper speaker mounting or loose trim may cause an audible buzz or distortion. Inspect the appropriate speaker and the surrounding interior trim for proper and secure mounting.

The EL-50334-6 Audio System Diagnostic CD contains audio tracks that can be used to duplicate and isolate such concerns. Tracks 11 and 12 contain audio sweep tones for testing for speaker and grill rattles.

If the speaker or surrounding interior trim is found to be loose or improperly secured, correctly secure the item.

- The test tones on the CD may be copied to a USB drive or other device to use during testing.
- Some audio output circuits are connected to more than one speaker, dependant on vehicle equipment. It may be necessary to disconnect one or more speakers during testing of some circuits.

Conditions for Running the DTC

NOTE: DTC B1325 must not be set as current for the amplifier to run any of the following tests.

DTC B1025 01, B1035 01, B1045 01, B1055 01, B1065 01, B1075 01, B1085 01

The test is run initially upon amplifier wake-up, and periodically every one second after amplifier operation

begins.

DTC B1025 02, B1035 02, B1045 02, B1055 02, B1065 02, B1075 02, B1085 02

The test is run initially upon amplifier wake-up, and periodically every one second after amplifier operation begins.

DTC B1025 04, B1035 04, B1045 04, B1055 04, B1065 04, B1075 04, B1085 04

The test is run once during amplifier wake-up.

Conditions for Setting the DTC

DTC B1025 01, B1035 01, B1045 01, B1055 01, B1065 01, B1075 01, B1085 01

A short to voltage is detected on the specified (+) or (-) signal circuit

DTC B1025 02, B1035 02, B1045 02, B1055 02, B1065 02, B1075 02, B1085 02

A short to ground is detected on the specified (+) or (-) signal circuit

DTC B1025 04, B1035 04, B1045 04, B1055 04, B1065 04, B1075 04, B1085 04

An open is detected on the specified (+) or (-) signal circuit

Action Taken When the DTC Sets

The amplifier mutes the output channel and no sound is present from the speaker(s) that have a current circuit fault.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

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Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-50 USB Cable and Adapter Kit

Circuit/System Verification

1. Ignition ON, infotainment system ON, mute OFF.
2. Verify clear audio is heard from each speaker, adjusting fade and balance controls to test each speaker individually.
 - **If audio is inoperative from one or more speakers, or the audio emitted is not clear**

Refer to Circuit/System Testing.

 - **If clear audio is heard from all speakers**
3. All OK.

Circuit/System Testing

NOTE: **Some circuits supply audio signals to more than one speaker. It may be necessary to disconnect all speakers on the affected audio circuit when performing circuit tests.**

1. Ignition OFF, disconnect the harness connector at the appropriate P19 Speaker. Ignition ON, infotainment system ON, mute OFF.
2. Test for 5-7 V between each audio signal circuit terminal 1 and terminal 2 and ground.
 - **If less than 5 V**
 1. Ignition OFF, disconnect the X1 and X2 harness connectors at the T3 Audio Amplifier.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the T3 Audio Amplifier.
 - **If greater than 7 V**

1. Ignition OFF, disconnect the X1 and X2 harness connectors at the T3 Audio Amplifier. Ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the T3 Audio Amplifier.
 - **If 5-7 V**
3. Test or replace the P19 Speaker.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Speaker Replacement Reference**
- **Control Module References** for audio amplifier replacement, programming, and setup.

UNABLE TO CONTACT ONSTAR CALL CENTER

Diagnostic Instructions

- Perform the **DIAGNOSTIC SYSTEM CHECK - VEHICLE** prior to using this diagnostic procedure.
- Review **STRATEGY BASED DIAGNOSIS** for an overview of the diagnostic approach.
- **DIAGNOSTIC PROCEDURE INSTRUCTIONS** provides an overview of each diagnostic category.

Circuit/System Description

The navigation antenna is connected to the telematics communication interface control module directly or through the navigation signal splitter if the vehicle is equipped with a navigation radio. The navigation signal splitter distributes the navigation signal to both the telematics communication interface control module and the human machine interface control module or radio. The telematics communication interface control module supplies 5?V through the coax cable to power the internal antenna amplifier through the signal splitter. The Human Machine Interface Control Module supplies 5?V through the center conductor of the coax cable to power the splitter

Diagnostic Aids

- The telematics communication interface control module only monitors the connection between the navigation signal splitter and the telematics communication interface control module. The telematics communication interface control module cannot detect faults between the signal splitter and the other modules
- The navigation antenna requires a clear line of sight to the sky to operate properly. The GPS may have limited, intermittent, or no reception near tall buildings or inside structures

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-50334-50 USB Cable and Adapter Kit

Circuit/System Verification***

NOTE: **The following verification requires the vehicle to be outside with an unobstructed view of the southern sky. Allow 5 min after turning the ignition ON for the GPS satellites to acquire vehicle signal.**

1. Ignition ON.
2. Verify that DTC B2470 is not set.
 - **If DTC B2470 is set**

Refer to **DTC B2470**
 - **If DTC B2470 is not set**
3. Verify that a call can be successfully placed to the OnStar Call Center by pressing the blue OnStar button.
 - **If unable to connect with the OnStar Call Center.**

Refer to Circuit/System Testing (below)
 - **If able to connect with the OnStar Call Center**
4. All OK.

Circuit/System Testing

NOTE:

- **The vehicle may be equipped with sectioned coax. Test each section and replace only the faulty section, not the entire length of coax.**
- **The following verification requires the vehicle to be outside with an unobstructed view of the southern sky. Allow 5 min after turning the ignition ON for the GPS satellites to acquire vehicle signal.**

Without Navigation Radio

1. Ignition OFF and all vehicle systems OFF, disconnect the GPS and cellular coax cable connector at the K73 Telematics Communication Interface Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Using the EL-49903-3 kit (EL-49903-5 adapter and EL-49903-4 coax cable), connect the **EL-49903** GM OnStar antenna diagnostic tool kit to the K73 Telematics Communication Interface Control Module. Place the test antenna on the roof of the vehicle, ignition ON.
3. Verify the DTC does not set while operating the vehicle within the conditions for running the DTC.
 - **If the DTC sets**

Replace the K73 Telematics Communications Interface Control Module.

- **If the DTC does not set**
4. Ignition OFF.
 5. Disconnect the **EL-49903** GM OnStar antenna diagnostic tool kit from the K73 Telematics Communication Interface Control Module
 6. Test the coax cable. Refer to Component Testing (below).
 - **If the coax cable does not pass the test**
- Replace the coax cable.
- **If the coax cable passes the test**
7. Test or replace the T4G Cellular Phone, Navigation, and Digital Radio Antenna.

With Navigation Radio

1. Ignition OFF, disconnect the GPS and cellular coax cable connector at the K73 Telematics Communication Interface Control Module.
2. Using the EL-49903-3 kit (EL-49903-5 adapter and EL-49903-4 coax cable), connect the **EL-49903** GM OnStar antenna diagnostic tool kit to the K73 Telematics Communication Interface Control Module. Place the test antenna on the roof of the vehicle, ignition ON.
3. Verify the DTC does not set while operating the vehicle within the conditions for running the DTC.
 - **If the DTC sets**

Replace the K73 Telematics Communication Interface Control Module.

- **If the DTC does not set**
- 4. Ignition OFF, disconnect the EL-49903 GM OnStar antenna diagnostic tool kit. Connect the coax cable to the K73 Telematics Communication Interface Control Module and disconnect the coax cable from the T15 Navigation Antenna Signal Splitter, ignition ON.
- 5. Test for 4.5-5.5 V between the coax cable center conductor and the outer shield.
 - **If less than 4.5 V**
 1. Ignition OFF.
 2. Test the coax cable. Refer to Component Testing (below).
 - If the coax cable does not pass the test, replace the coax cable.
 - If the coax cable passes the test, test or replace the K73 Telematics Communications Interface Control Module.
 - **If greater than 5.5 V**
 1. Ignition OFF.
 2. Test the coax cable. Refer to Component Testing (below).
 - If the coax cable does not pass the test, replace the coax cable.
 - If the coax cable passes the test, test or replace the K73 Telematics Communications Interface Control Module.
- 6. Ignition OFF, connect the coax cable to the T15 Navigation Antenna Signal Splitter and disconnect the coax cable from the T4G Cellular Phone, Navigation, and Digital Radio Antenna, ignition ON.
- 7. Test for 4.5-5.5 V between the coax cable center conductor and the outer shield.
 - **If less than 4.5 V**
 1. Ignition OFF.
 2. Test the coax cable. Refer to Component Testing (below).
 - If the coax cable does not pass the test, replace the coax cable.
 - If the coax cable passes the test, test or replace the T15 Navigation Antenna Signal Splitter.
 - **If greater than 5.5 V**
 1. Ignition OFF.
 2. Test the coax cable. Refer to Component Testing (below).
 - If the coax cable does not pass the test, replace the coax cable.
 - If the coax cable passes the test, test or replace the T15 Navigation Antenna Signal Splitter.
 - **If between 4.5-5.5 V**
- 8. Test or replace the T4G Cellular Phone, Navigation, and Digital Radio Antenna.

Component Testing

CAUTION: Refer to TEST PROBE CAUTION .

NOTE: Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.

To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.

Coax Cable Test

1. Ignition OFF, disconnect the coax cable at both components.
2. Test for less than 5 ohms between the coax cable center terminal end to end.
 - **If 5 ohms or greater**

Replace the coax cable.

- **If less than 5 ohms**

3. Test for greater than 5 ohms between the coax cable outer shield end to end.
 - **If 5 ohms or greater**

Replace the coax cable.

- **If less than 5 ohms**

4. Test for infinite resistance between the coax cable center terminal and the coax cable outer shield.
 - **If less than infinite resistance**

Replace the coax cable.

- **If infinite resistance**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

- **Navigation Signal Splitter Replacement**
- **Radio Antenna Base Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming, and setup.

ONSTAR VOICE RECOGNITION MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The telematics communication interface control module is capable of interpreting voice commands received over the cellular microphone circuit. Speech recognition allows the user to speak to one computer in the vehicle, and one reached over the cellular communication network. The module attempts to understand the users command, and responds by speaking back, or by taking the appropriate action, e.g. dialing the phone.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

NOTE:

- It is necessary to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from satellites.
- The vehicle should be located in a quiet area.

1. Ignition ON, press the blue OnStar Call button.
2. Verify that your voice is heard clearly by the OnStar Call center.
 - If your voice can not be heard clearly

Refer to **OnStar Microphone Malfunction**

- If your voice can be heard clearly
3. Verify that the system responds appropriately to all voice commands by pressing the voice command

button and attempting to operate the system using multiple voice commands.

- **If the OnStar system does not respond to any voice commands**

Replace the K73 Telematics Communication Interface Control Module

- **If the OnStar system responds to some, but not all voice commands**

Refer to **OnStar Description and Operation** for tips on proper pronunciation

- **If the OnStar system responds to all voice commands**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

Control Module References for telematics communication interface control module replacement, programming, and setup.

VOICE RECOGNITION MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Voice Recognition Audio Signal	1	1	1	-
Voice Recognition Audio Low Reference	-	1	-	-
1. infotainment system voice recognition inoperative				

Circuit/System Description

When voice recognition for the infotainment system is started, voice signals from the cellular phone microphone are passed through the telematics communication interface control module to the Human Machine Interface Control Module via the voice recognition audio circuits.

Diagnostic Aids

- Refer to the Owners Manual and/or the Navigation System Owners Manual for voice recognition use and commands.

- When the system recognizes the command the system will either perform the function or ask to confirm the choice by clearly saying "yes" or "no".
- If experiencing difficulty with the system recognizing a command, confirm that the command is correct.
- Background noise such as a climate control fan positioned on high, open windows, or very loud outside noises, can cause voice commands to be misunderstood.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the OnStar ® voice recognition system is operating normally.
 - **If the OnStar ® voice recognition system is not operating normally.**

Refer to **OnStar Voice Recognition Malfunction.**

- **If the OnStar ® voice recognition system is operating normally.**
2. Ignition ON, infotainment system ON.

NOTE: **Refer to the Owners Manual and/or the Navigation System Owners Manual for voice recognition use and commands.**

3. Begin voice recognition for the infotainment system and clearly speak one of the available commands.

4. Verify the infotainment system responds correctly to the command.
 - **If the infotainment system does not respond correctly to the command.**
 1. Clearly speak a different command.
 2. Verify the infotainment system responds correctly to the command.
 - If the infotainment system does not respond correctly to any commands, refer to Circuit/System Testing.
 - If the infotainment system responds correctly to the command.
 3. Refer to the Owners Manual and/or the Navigation System Owners Manual for hints on speaking commands.
 - **If the infotainment system responds correctly to the command.**
5. All OK

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K74 Human Machine Interface Control Module.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K73 Telematics Communication Interface Control Module.
 - **If less than 10 ohms**
3. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module. Ignition ON.
4. Test for less than 1 V between the signal circuit terminal listed below and ground.
 - Voice recognition audio signal terminal 6
 - Voice recognition audio low reference terminal 12
 - **If 1 V greater**

Repair the short to voltage on the circuit.
 - **If less than 1 V**
5. Ignition OFF.
6. Test for infinite resistance between the signal circuits listed below and ground:
 - Voice recognition audio signal terminal 6
 - Voice recognition audio low reference terminal 12
 - **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

7. Test for less than 5 ohms between the terminals listed below:

- K74 Human Machine Interface Control Module signal circuit terminal 1 X1 and the K73 Telematics Communication Interface Control Module signal circuit terminal 6 X2
- K74 Human Machine Interface Control Module low reference circuit terminal 2 X1 and the K73 Telematics Communication Interface Control Module low reference circuit terminal 12 X2
- **If 5 ohms greater**

Repair the open/high resistance in the circuit.

- **If less than 5 ohms**

8. Replace the K74 Human Machine Interface Control Module. Connect all harness connectors.

NOTE: **Refer to the Owners Manual and/or the Navigation System Owners Manual for voice recognition use and commands.**

9. Begin voice recognition for the infotainment system and clearly speak one of the available commands.

10. Verify the infotainment system responds correctly to the command.

- **If the infotainment system does not respond correctly to the command**

1. Clearly speak a different command.
2. Verify the infotainment system responds correctly to the command.
 - If the infotainment system does not respond correctly to any commands, replace the K73 Telematics Communication Interface Control Module.

- **If the infotainment system responds correctly to the command**

11. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Human Machine Interface Control Module or Telematics Communication Interface Control replacement, programming and setup.

REPAIR INSTRUCTIONS

MOBILE TELEPHONE MICROPHONE REPLACEMENT

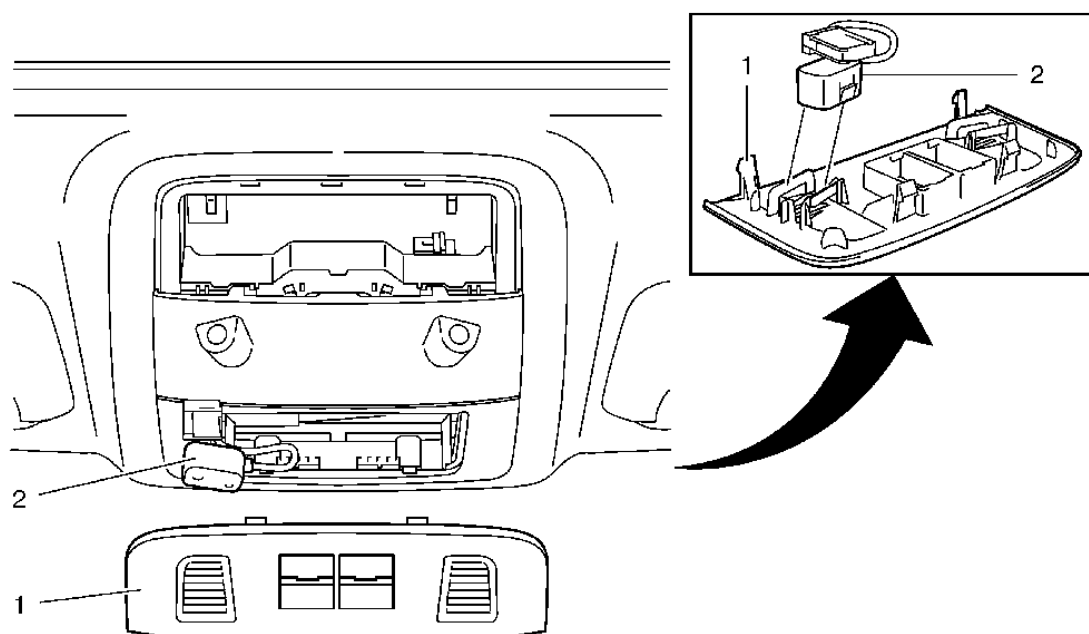


Fig. 22: Mobile Telephone Microphone & Sunroof Actuator Trim Cover
 Courtesy of GENERAL MOTORS COMPANY

Mobile Telephone Microphone Replacement

Callout	Component Name
1	Sunroof Actuator Trim Cover Procedure Remove the sunroof actuator trim cover. TIP: Use a flat bladed tool to release the trim cover.
2	Mobile Telephone Microphone Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Release the microphone out of the retainer. 3. Make a functional check.

HUMAN MACHINE INTERFACE CONTROL MODULE REPLACEMENT

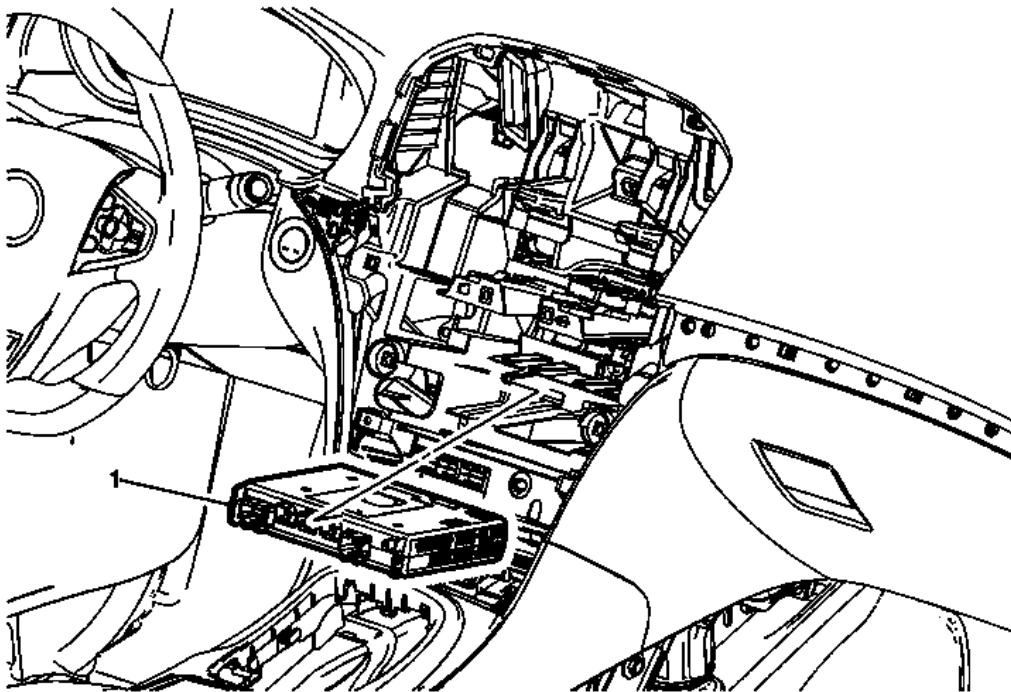


Fig. 23: Human Machine Interface Control Module
 Courtesy of GENERAL MOTORS COMPANY

Human Machine Interface Control Module Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel center trim panel. Refer to <u>Instrument Panel Lower Center Trim Panel Replacement</u> .	
1	Human Machine Interface Control Module Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connections. 2. Release tab on bracket and slide module out to remove. 3. Refer to <u>Control Module References</u> for programming and setup information.

COMMUNICATION INTERFACE MODULE REPLACEMENT

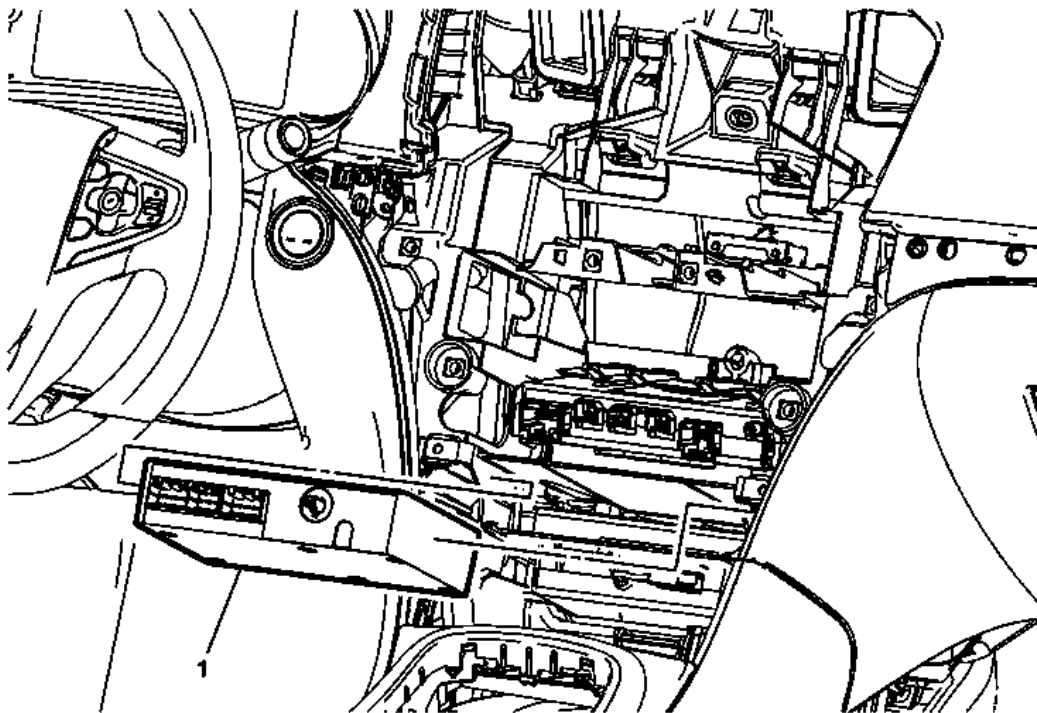


Fig. 24: Communication Interface Module
 Courtesy of GENERAL MOTORS COMPANY

Communication Interface Module Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower center trim panel. Refer to <u>Instrument Panel Lower Center Trim Panel Replacement</u> .	
1	Communication Interface Module Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connections. 2. For programming and set up information. Refer to <u>Control Module References</u> .

COMMUNICATION INTERFACE MODULE BATTERY REPLACEMENT

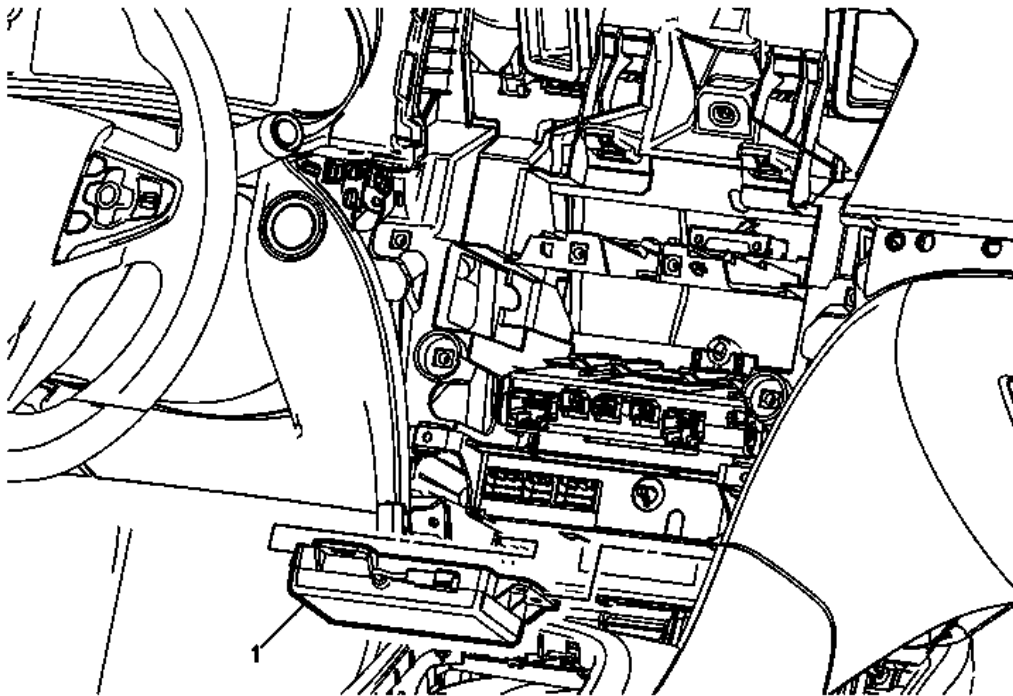


Fig. 25: Communication Interface Module Battery
 Courtesy of GENERAL MOTORS COMPANY

Communication Interface Module Battery Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower center trim panel. Refer to <u>Instrument Panel Lower Center Trim Panel Replacement</u> .	
1	Communication Interface Module Battery Procedure <ol style="list-style-type: none"> 1. Slide the communication interface module battery from the bracket tabs. 2. Disconnect the electrical connectors.

COMMUNICATION INTERFACE MODULE BRACKET REPLACEMENT

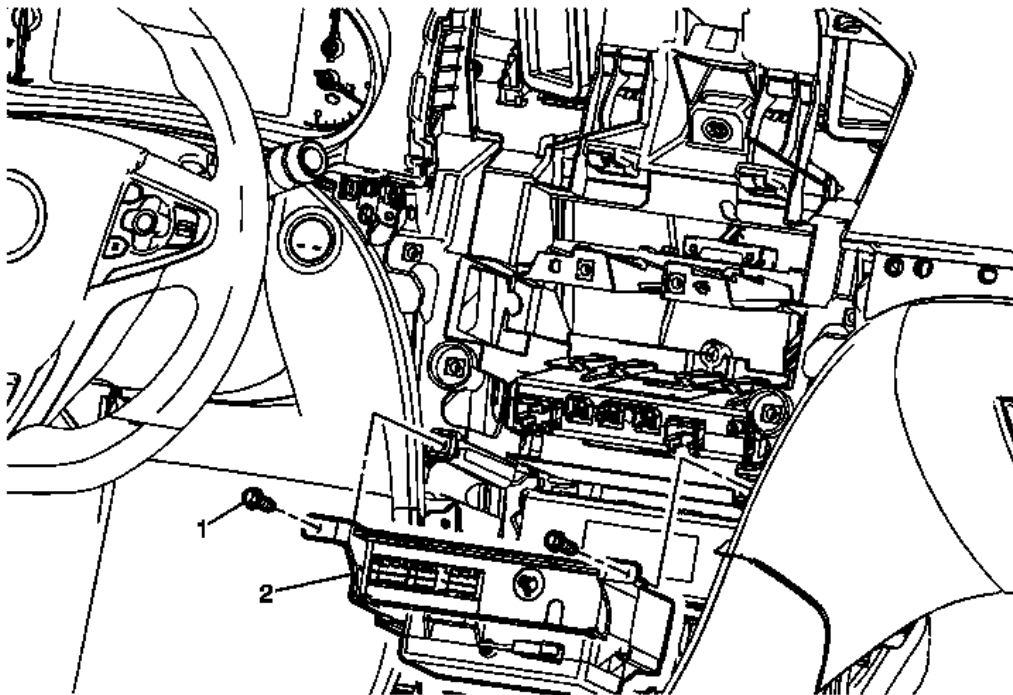


Fig. 26: Communication Interface Module Bracket
 Courtesy of GENERAL MOTORS COMPANY

Communication Interface Module Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower center trim panel. Refer to <u>Instrument Panel Lower Center Trim Panel Replacement</u> .	
1	Communication Interface Module Bracket Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m (22 lb in)
2	Communication Interface Module Bracket Procedure <ol style="list-style-type: none"> 1. Disconnect electrical connections. 2. Transfer components, as necessary.

RADIO REPLACEMENT

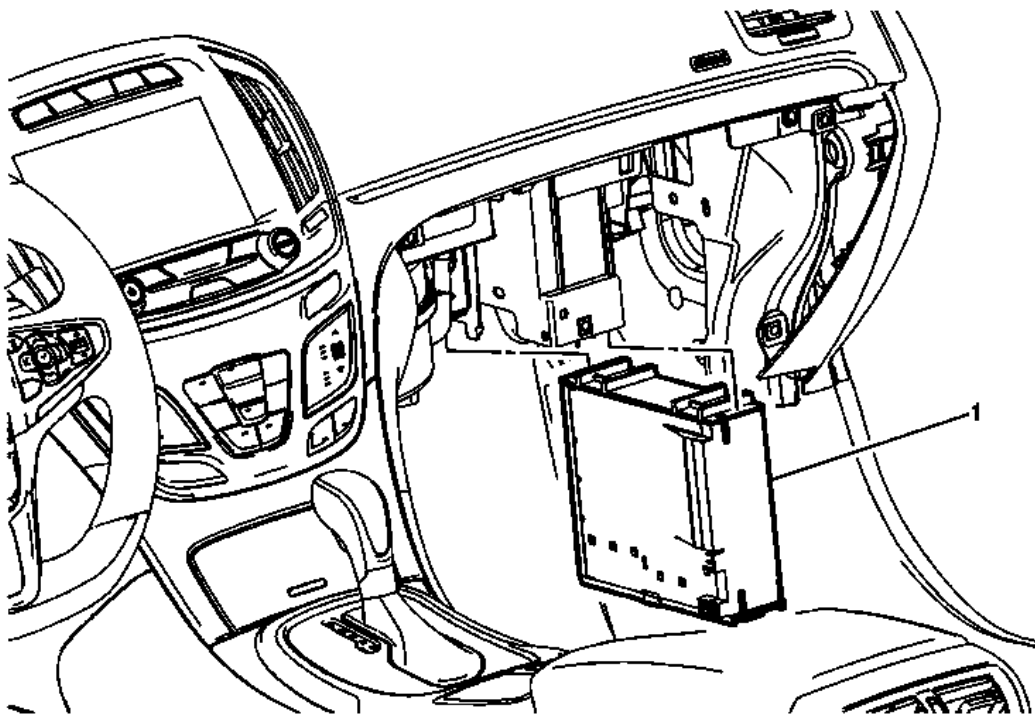


Fig. 27: Radio

Courtesy of GENERAL MOTORS COMPANY

Radio Replacement

Callout	Component Name
Preliminary Procedure	
Remove the instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> .	
1	Radio
	Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connections. 2. Slide module downward to release from bracket. 3. Refer to <u>Control Module References</u> for programming and setup information.

RADIO CONTROL ASSEMBLY REPLACEMENT

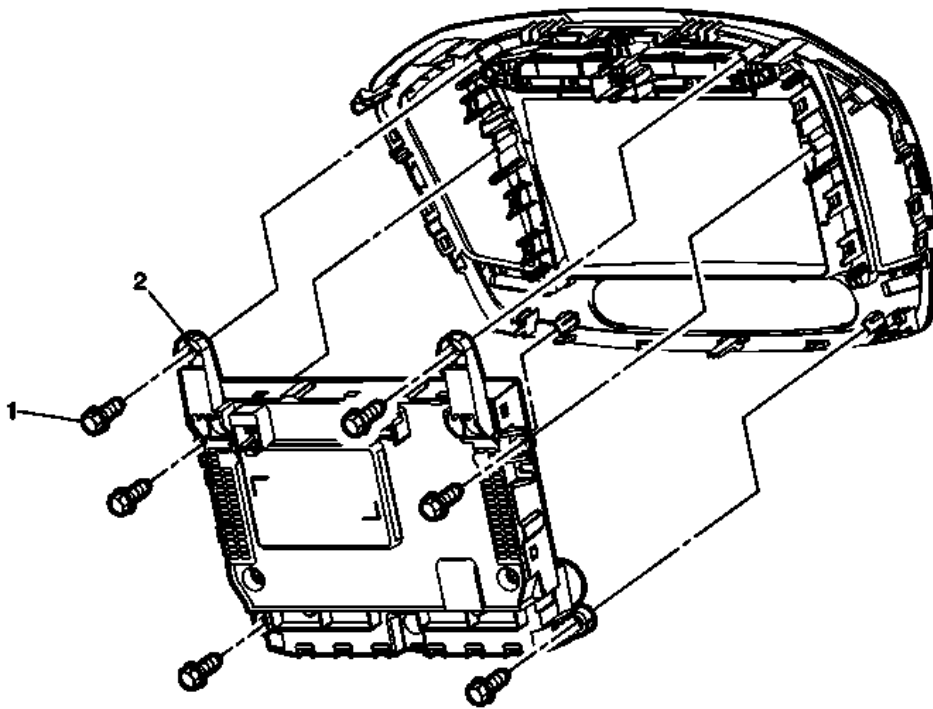


Fig. 28: Radio Control Assembly
 Courtesy of GENERAL MOTORS COMPANY

Radio Control Assembly Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel upper center trim panel. Refer to <u>Instrument Panel Upper Center Trim Panel Replacement</u> .	
1	Radio Control Assembly Fasteners (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m (22 lb in)
2	Radio Control Assembly Procedure For programming and set up, refer to <u>Control Module References</u> .

AUDIO DISC PLAYER, USB, AUXILIARY IN, AND MEMORY CARD RECEPTACLE REPLACEMENT

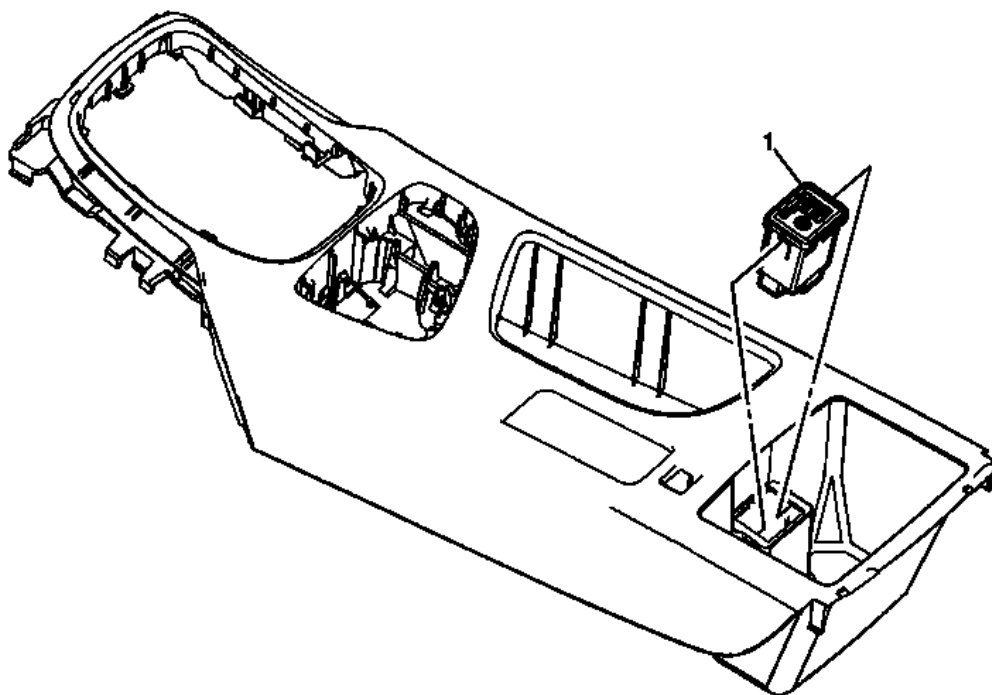


Fig. 29: Audio Disc Player, USB, Auxiliary In, and Memory Card Receptacle
 Courtesy of GENERAL MOTORS COMPANY

Audio Disc Player, USB, Auxiliary In, and Memory Card Receptacle Replacement

Callout	Component Name
Preliminary Procedure Remove the front floor upper console trim plate. Refer to <u>Front Floor Upper Console Trim Plate Replacement</u> .	
1	Audio Disc Player, USB, Auxiliary In, and Memory Card Receptacle Procedure <ol style="list-style-type: none"> 1. Depress tabs to release the receptacle. 2. Disconnect the electrical connector.

RADIO SPEAKER AMPLIFIER REPLACEMENT

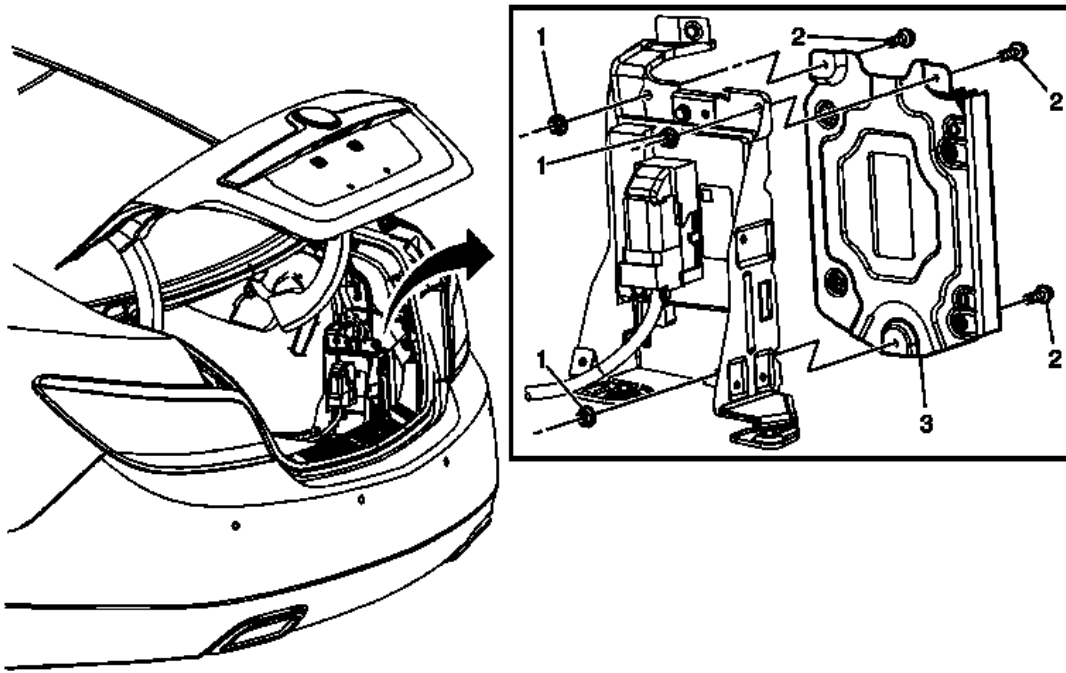


Fig. 30: Radio Speaker Amplifier & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Radio Speaker Amplifier Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment side trim panel. Refer to <u>Rear Compartment Side Trim Panel Replacement (without HP6)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Radio Speaker Amplifier Nut (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
2	Radio Speaker Amplifier Bolt (Qty: 3)
3	Radio Speaker Amplifier Assembly Procedure 1. Disconnect the electrical connectors. 2. For programming and set up information, refer to <u>Control Module References</u> .

MULTIMEDIA PLAYER INTERFACE MODULE REPLACEMENT

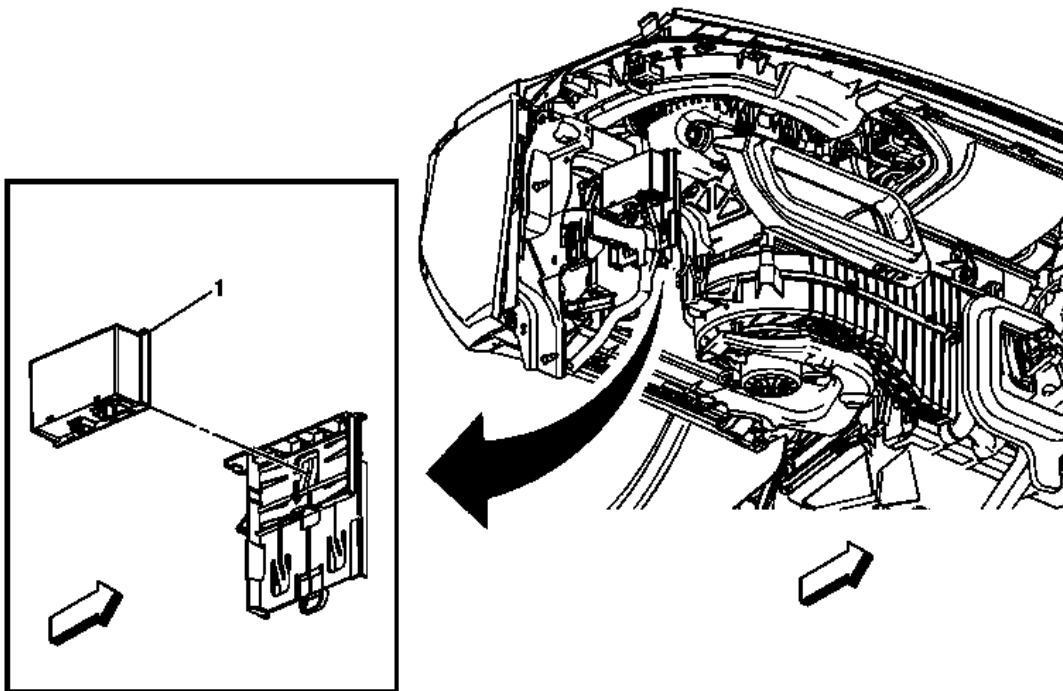


Fig. 31: Multimedia Player Interface Module
 Courtesy of GENERAL MOTORS COMPANY

Multimedia Player Interface Module Replacement

Callout	Component Name
Preliminary Procedure	
Remove the instrument panel compartment. Refer to Instrument Panel Compartment Replacement .	
1	Multi Media Player Interface Module Assembly
	Procedure
	<ol style="list-style-type: none"> 1. Disconnect the electrical connectors. 2. Unsnap to release the module from the bracket.

NAVIGATION SIGNAL SPLITTER REPLACEMENT

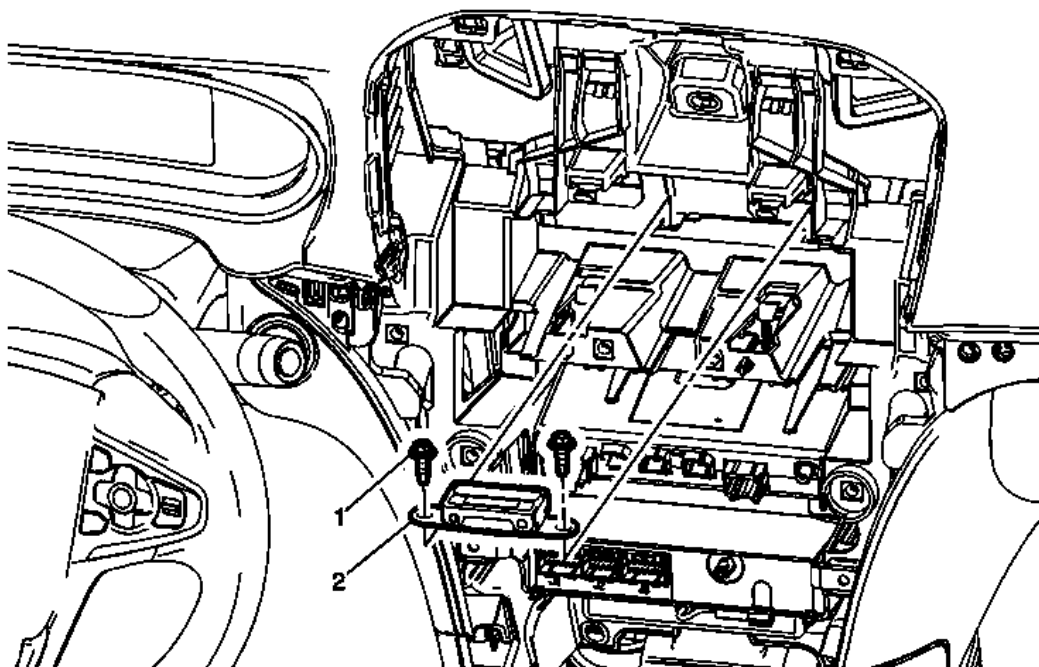


Fig. 32: Navigation Signal Splitter
 Courtesy of GENERAL MOTORS COMPANY

Navigation Signal Splitter Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel center trim panel. Refer to <u>Instrument Panel Lower Center Trim Panel Replacement</u> .	
1	Navigation Signal Splitter Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m (22 lb in)
2	Navigation Signal Splitter Procedure Disconnect the electrical connections.

RADIO ANTENNA BASE REPLACEMENT

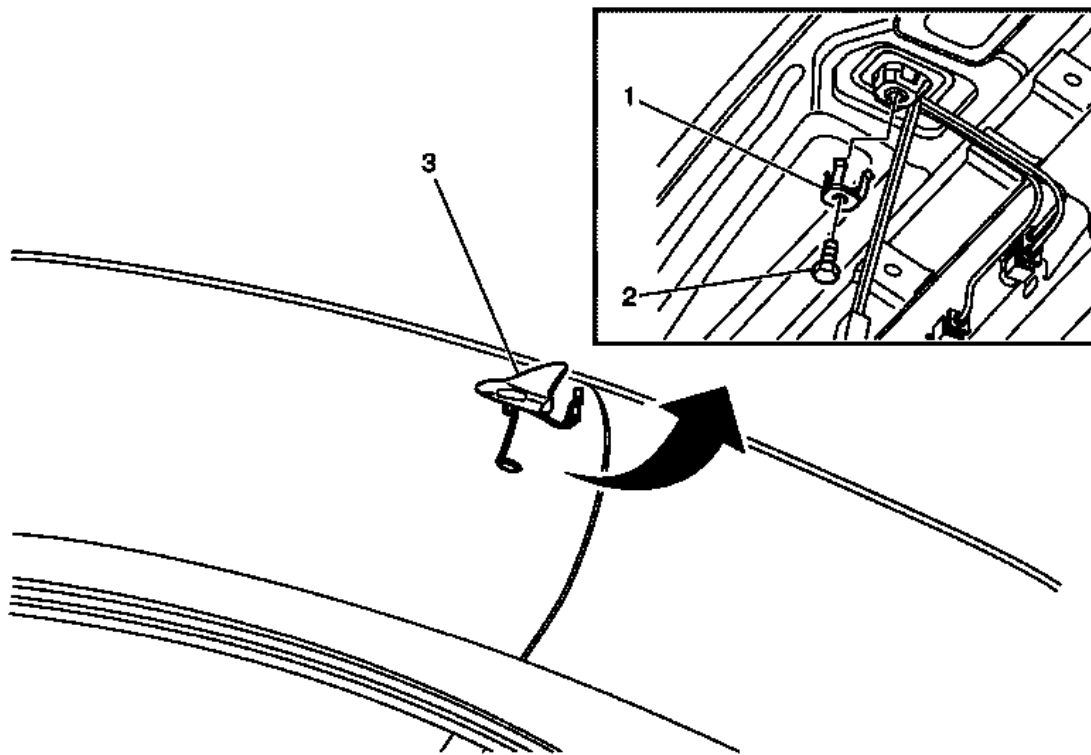


Fig. 33: Radio Antenna Base, Fastener & Retainer
 Courtesy of GENERAL MOTORS COMPANY

Radio Antenna Base Replacement

Callout	Component Name
Preliminary Procedure	
Remove the headlining trim panel. Refer to <u>Headlining Trim Panel Replacement (With Sunroof)</u> , <u>Headlining Trim Panel Replacement (Without Sunroof)</u> .	
1	Radio Antenna Base Retainer
2	Radio Antenna Base Fastener
3	Radio Antenna Base
	Procedure
	1. Disconnect the electrical connector.
	2. Use a new retainer.

RADIO ANTENNA AMPLIFIER REPLACEMENT

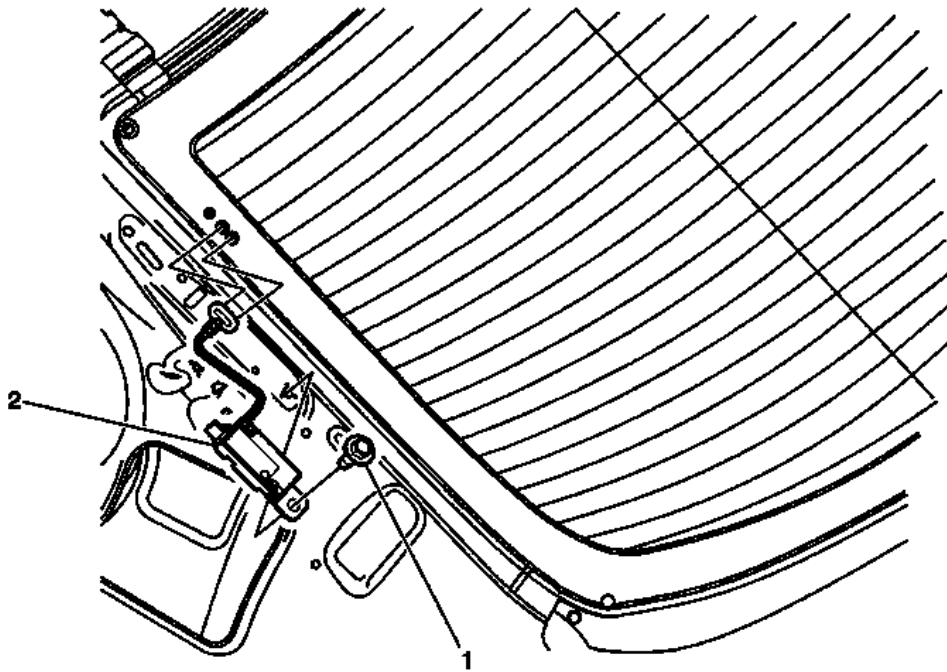


Fig. 34: Radio Antenna Amplifier & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Radio Antenna Amplifier Replacement

Callout	Component Name
Preliminary Procedure Remove the right body lock pillar upper trim panel. Refer to <u>Body Lock Pillar Upper Trim Panel Replacement (Sedan)</u> .	
1	Radio Antenna Amplifier Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 8 N.m (71 lb in)
2	Radio Antenna Amplifier Procedure Disconnect the electrical connector.

AUDIO MULTIFUNCTION CONTROL REPLACEMENT

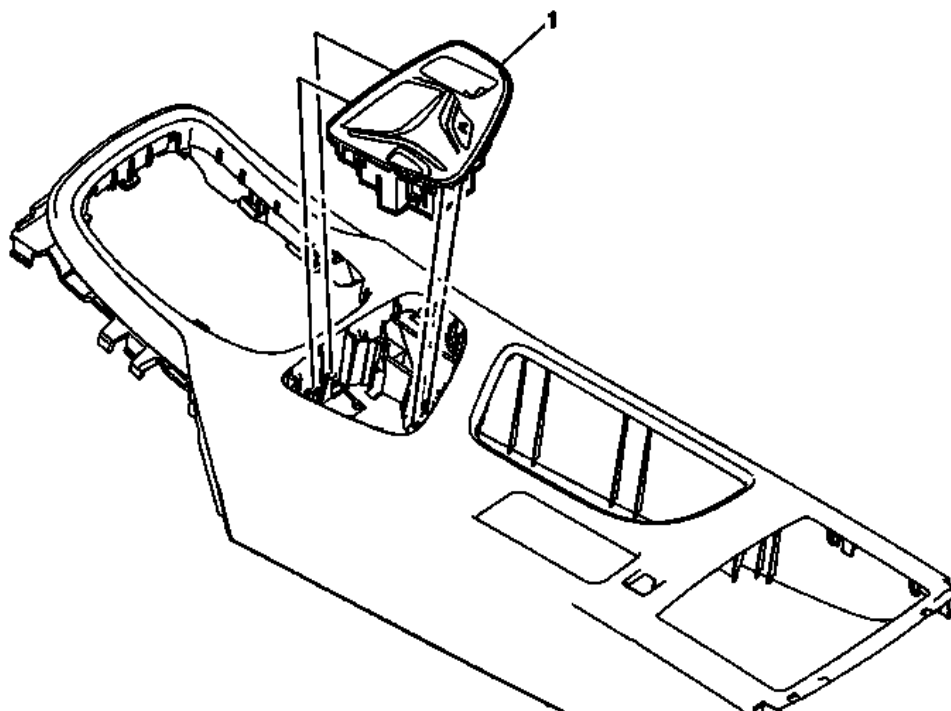


Fig. 35: Audio Multifunction Control
 Courtesy of GENERAL MOTORS COMPANY

Audio Multifunction Control Replacement

Callout	Component Name
Preliminary Procedure Remove the accessory switch mount plate. Refer to <u>Front Floor Console Accessory Switch Mount Plate Replacement</u> .	
1	Audio Multifunction Control Procedure <ol style="list-style-type: none"> 1. Use the appropriate tool to release the tabs on the control. 2. Disconnect the electrical connector.

RADIO REAR SPEAKER GRILLE REPLACEMENT

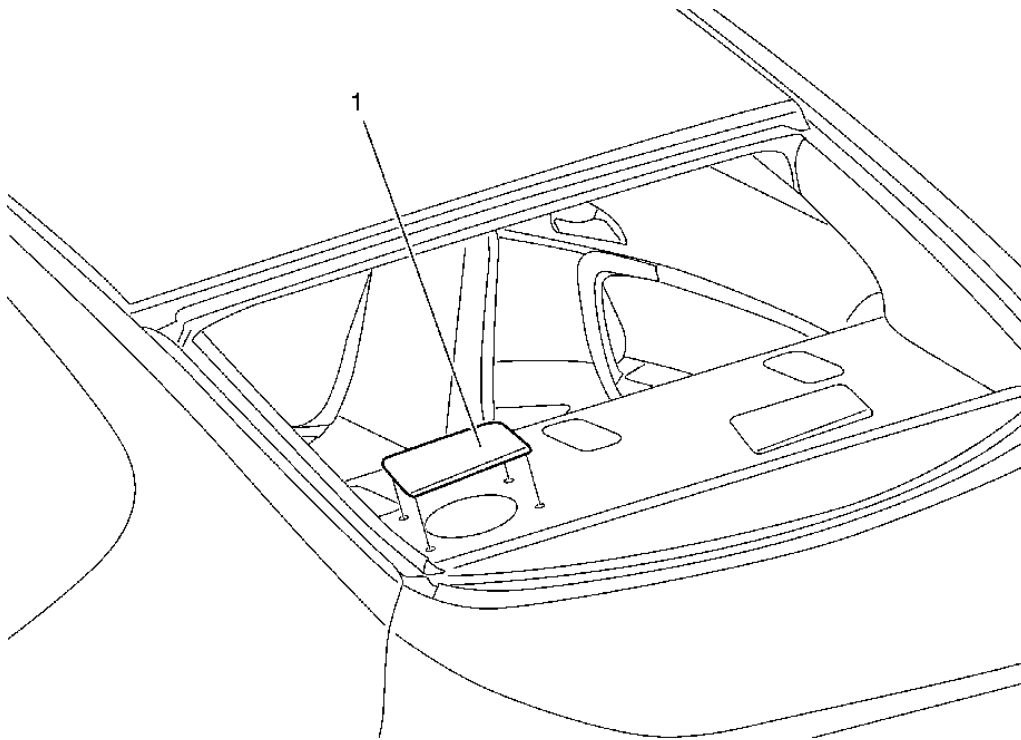


Fig. 36: Radio Rear Speaker Grille
Courtesy of GENERAL MOTORS COMPANY

Radio Rear Speaker Grille Replacement

Callout	Component Name
1	Radio Rear Speaker Grille
	Procedure Use a small flat-bladed tool to release the radio rear speaker grille.

RADIO FRONT SPEAKER REPLACEMENT

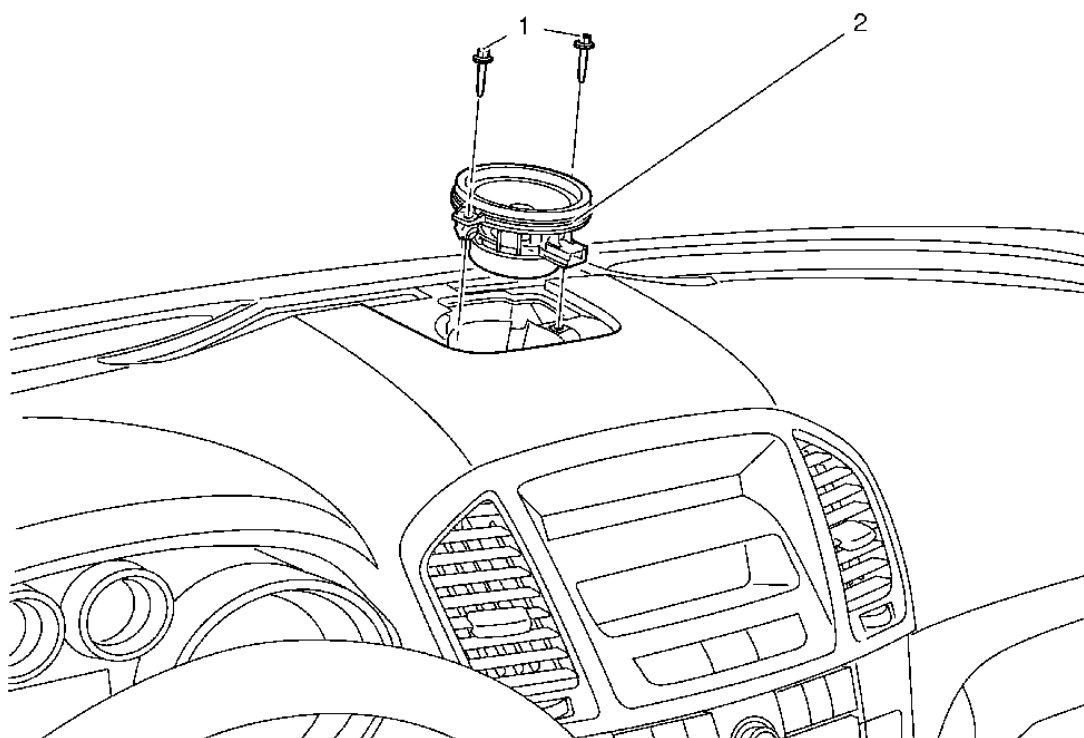


Fig. 37: Radio Front Speaker & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Radio Front Speaker Replacement

Callout	Component Name
Preliminary Procedure Remove the windshield defroster nozzle grille. Refer to <u>Windshield Defroster Nozzle Grille Replacement</u> .	
1	Radio Front Speaker Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m (22 lb in)
2	Radio Front Speaker Procedure Disconnect the electrical connector.

RADIO FRONT SIDE DOOR UPPER SPEAKER REPLACEMENT

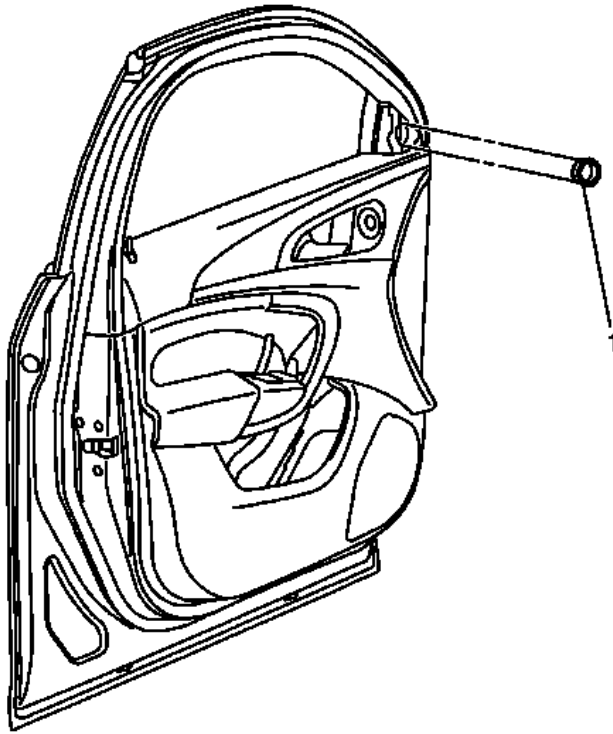


Fig. 38: Radio Front Side Door Upper Speaker
Courtesy of GENERAL MOTORS COMPANY

Radio Front Side Door Upper Speaker Replacement

Callout	Component Name
Preliminary Procedure Remove front side door outside rearview mirror filler. Refer to <u>Front Side Door Outside Rearview Mirror Filler Replacement</u> .	
1	Radio Front Side Door Upper Speaker Procedure Use a small flat-bladed tool to release the radio front side door upper speaker.

RADIO FRONT SIDE DOOR SPEAKER REPLACEMENT

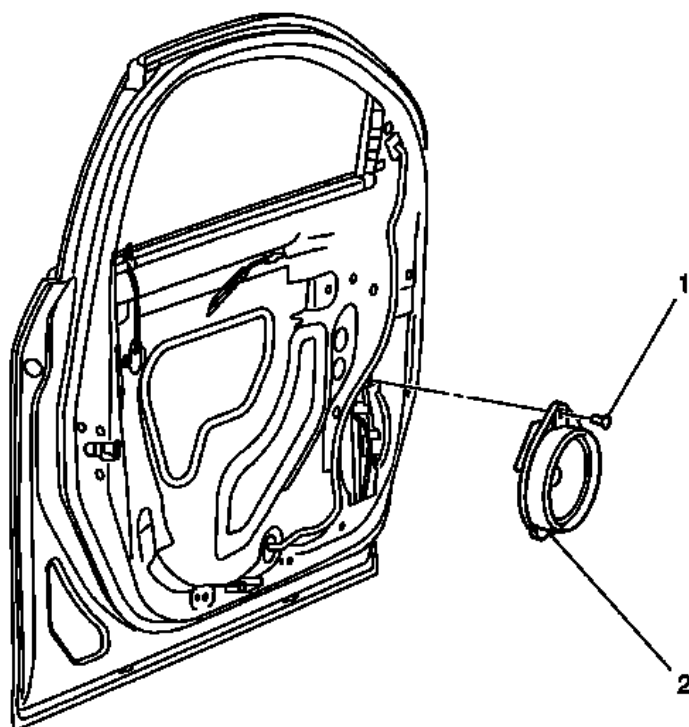


Fig. 39: Radio Front Side Door Speaker & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Radio Front Side Door Speaker Replacement

Callout	Component Name
Preliminary Procedure Remove the front side door trim panel. Refer to Front Side Door Trim Panel Replacement .	
1	Radio Front Side Door Speaker Fastener CAUTION: Refer to Fastener Caution .
2	Radio Front Side Door Speaker Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connection. 2. Release the radio front side door speaker retainer.

RADIO CONTROL SWITCH REPLACEMENT (GRAND SPORT)

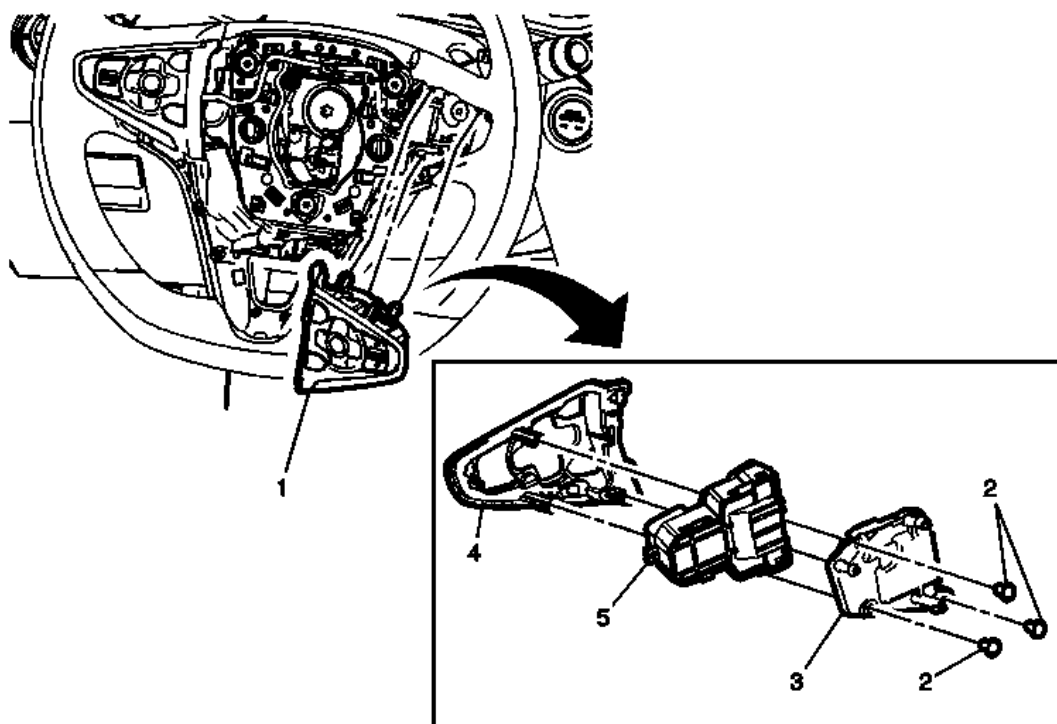


Fig. 40: Radio Control Switch (Grand Sport)
 Courtesy of GENERAL MOTORS COMPANY

Radio Control Switch Replacement (Grand Sport)

Callout	Component Name
1	Radio Control Switch Assembly Procedure 1. Use the appropriate tool to gently release the retaining tabs on the switch assembly bezel. 2. Disconnect the electrical connection. NOTE: Gently release tabs one by one, using care to avoid snapping the tab off.
2	Steering Wheel Switch Bracket Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
3	Steering Wheel Switch Bracket
4	Steering Wheel Switch Bezel
5	Radio Control Switch

RADIO CONTROL SWITCH REPLACEMENT (EXCEPT GRAND SPORT)

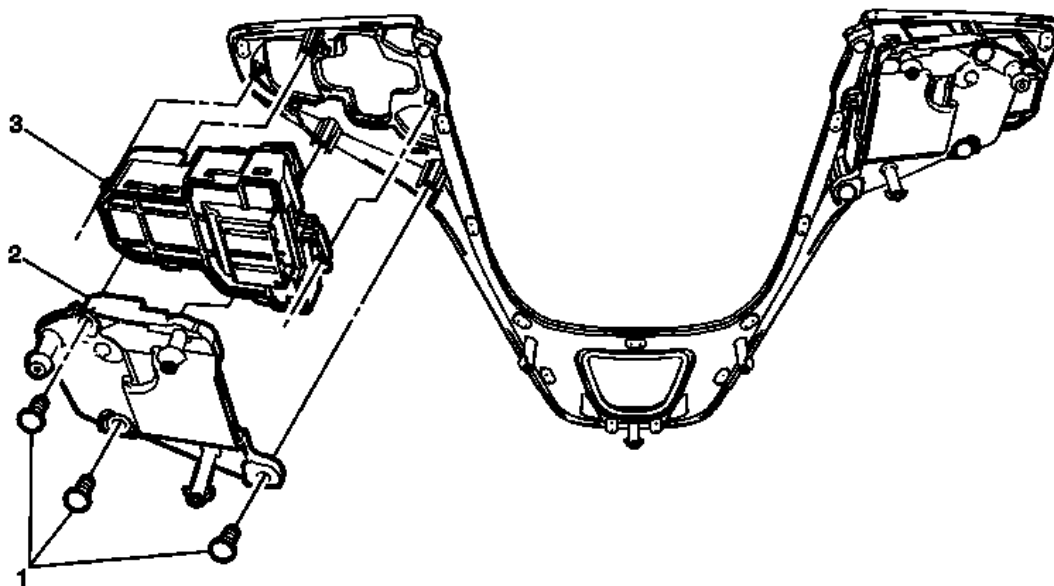


Fig. 41: Radio Control Switch (Except Grand Sport)

Courtesy of GENERAL MOTORS COMPANY

Radio Control Switch Replacement (Except Grand Sport)

Callout	Component Name
Preliminary Procedure Remove the steering wheel spoke lower cover. Refer to <u>Steering Wheel Spoke Lower Cover Replacement (Except Grand Sport)</u> .	
1	Steering Wheel Spoke Lower Cover Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
2	Steering Wheel Spoke Lower Cover Bracket
3	Radio Control Switch

RADIO REAR SIDE DOOR SPEAKER REPLACEMENT

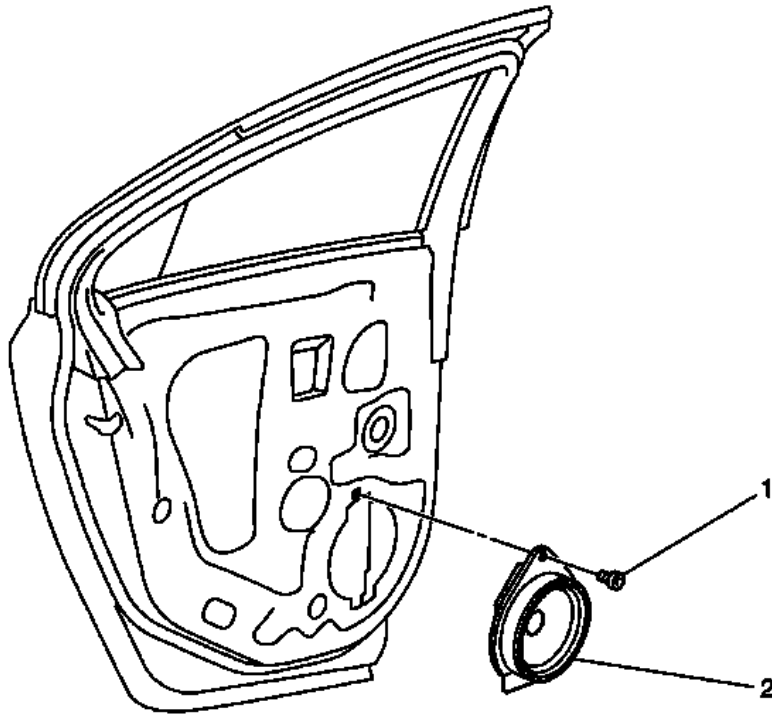


Fig. 42: Radio Rear Side Door Speaker (Hatchback, Sedan)
 Courtesy of GENERAL MOTORS COMPANY

Radio Rear Side Door Speaker Replacement

Callout	Component Name
Preliminary Procedure Remove the rear side door water deflector. Refer to <u>Rear Side Door Water Deflector Replacement</u> .	
1	Radio Rear Side Door Speaker Fastener CAUTION: Refer to <u>Fastener Caution</u> .
2	Radio Rear Side Door Speaker Procedures <ol style="list-style-type: none"> 1. Disconnect the radio rear side door speaker electrical connector. 2. Release radio rear side door speaker retainer.

RADIO REAR COMPARTMENT SPEAKER REPLACEMENT

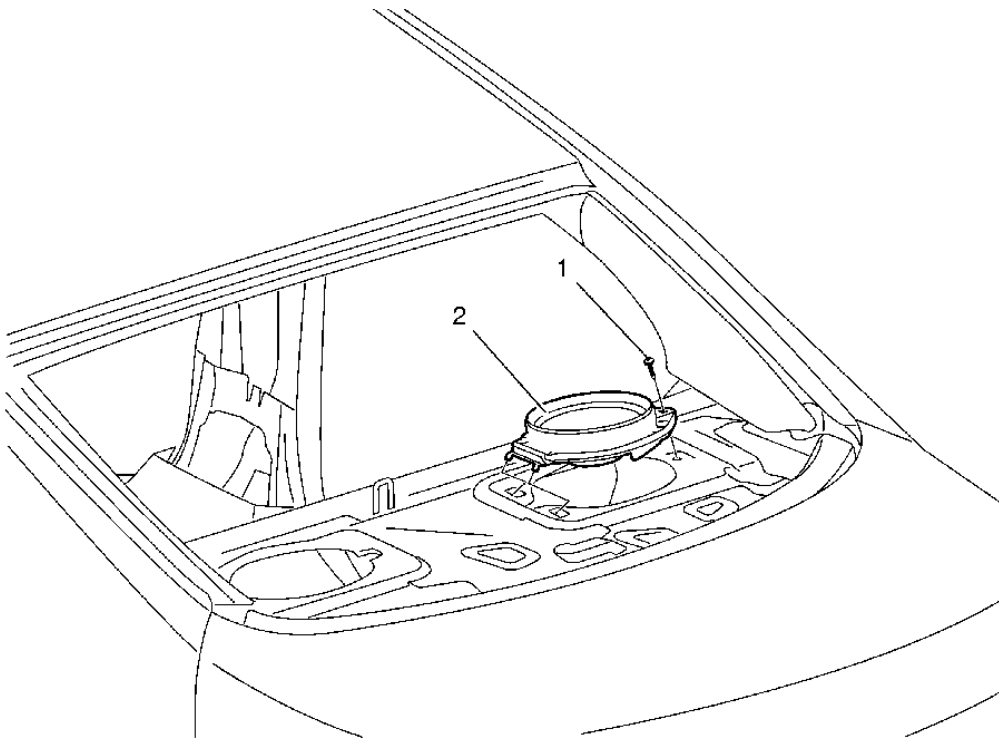


Fig. 43: Radio Rear Compartment Speaker & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Radio Rear Compartment Speaker Replacement

Callout	Component Name
Preliminary Procedure Remove the rear window panel trim. Refer to <u>Rear Window Panel Trim Replacement (with HP6)</u> , <u>Rear Window Panel Trim Replacement (without HP6)</u> .	
1	Radio Rear Compartment Speaker Fastener CAUTION: Refer to <u>Fastener Caution</u> .
2	Radio Rear Compartment Speaker Procedure Disconnect the radio rear compartment speaker electrical connector.

DESCRIPTION AND OPERATION

ONSTAR DESCRIPTION AND OPERATION

This OnStar® system consists of the following components:

- Telematics communication interface control module
- OnStar® three button assembly

- Microphone
- Cellular antenna
- Navigation antenna
- Bluetooth® antenna (If equipped)
- Back up battery (If equipped)

This system also interfaces with the factory installed vehicle audio system.

Telematics Communication Interface Control Module

The telematics communication interface control module is a cellular device that allows the user to communicate data and voice signals over the national cellular network. Power is provided by a dedicated, fused B+ circuit. Ground is provided through the vehicle wiring harness attached to the module. The ignition state is determined by the telematics communication interface control module through serial data messaging.

Dedicated circuits are used to connect the telematics communication interface control module to a microphone, the button assembly, and to command the status LED. The telematics communication interface control module communicates with the rest of the vehicle over the serial data bus.

The module houses 2 technology systems, one to process GPS data, and another for cellular information. The cellular system connects the OnStar® system to the cellular carrier's communication system by interacting with the national cellular infrastructure. The module sends and receives all cellular communications over the cellular antenna and cellular antenna coax. GPS satellites orbiting earth are constantly transmitting signals of their current location. The OnStar® system uses the GPS signals to provide location on demand.

The module also has the capability of activating the horn, initiating door lock/unlock, or activating the exterior lamps using the serial data circuits. These functions can be commanded by the OnStar® Call Center per a customer request.

OnStar® Three Button Assembly

Base Mirror

- The OnStar® button assembly may be part of the rearview mirror, or a separate, stand alone unit. The button assembly is comprised of 3 buttons and a status LED. The buttons are defined as follows:
 - The answer/end call button, which is black with a white phone icon, allows the user to answer and end calls or initiate speech recognition.
 - The blue OnStar® call center button, which displays the OnStar® logo, allows the user to connect to the OnStar® call center.
 - The emergency button, which displays a white cross with a red background, sends a high priority emergency call to the OnStar® call center when pressed.

The telematics communication interface control module supplies 10 volts to the OnStar® button assembly on the keypad supply voltage circuit. When pressed, each button completes a circuit across a resistor allowing a specific voltage to be returned to the telematics communication interface control module on the keypad signal circuit. Depending upon the voltage range returned the telematics communication interface control module is

able to identify which button has been pressed.

The OnStar® status LED is located with the button assembly. The LED is green when the system is ON and operating normally. When the status LED is green and flashing, it is an indication that a call is in progress. When the LED is red, this indicates a system malfunction is present. In the event there is a system malfunction and the OnStar® system is still able to make a call, the LED will flash red during the call.

If the mirror has the rear vision camera display in the mirror, the LED's are then interior to the mirror and controlled via data communication on the Low Speed GMLAN bus from the Telematics Communication Interface Control Module to the mirror.

If the LED does not illuminate, this may indicate that the customers OnStar® subscription is not active or has expired. Push the blue OnStar button to connect to an advisor who can then verify the account status.

Each LED is controlled by the telematics communication interface control module over dedicated LED signal circuits. Ground for the LED is provided by the wiring harness attached to the button assembly.

Prismatic Mirror (If Equipped)

- The OnStar® button assembly is apart of the rearview mirror. The button assembly is comprised of 3 capacitive touch buttons and a status LED. The buttons are defined as follows:
 - The answer/end call button, which is a white driver figure seated with voice signals near it's face, allows the user to answer and end calls or initiate speech recognition.
 - The blue OnStar® call center button, which displays the blue OnStar® logo, allows the user to connect to the OnStar® call center.
 - The emergency button, which displays red letters "SOS" as an illuminated Indicator, sends a high priority emergency call to the OnStar® call center when pressed.

The telematics communication interface control module supplies 10 volts to the OnStar® button assembly on the keypad supply voltage circuit. When pressed, each button press is processed and completes a circuit across an internal resistor allowing a specific voltage to be returned to the telematics communication interface control module on the keypad signal circuit. Depending upon the voltage range returned the telematics communication interface control module is able to identify which button has been pressed.

The OnStar® status LED is located within the mirror near the buttons. The LED is green when the system is ON and operating normally. When the status LED is green and flashing, it is an indication that a call is in progress. When the LED is red, this indicates a system malfunction is present. In the event there is a system malfunction and the OnStar® system is still able to make a call, the LED will flash red during the call.

If the LED does not illuminate, this may indicate that the customers OnStar® subscription is not active or has expired. Push the blue OnStar button to connect to an advisor who can then verify the account status.

Each LED is controlled by the telematics communication interface control module over dedicated LED signal circuits. Ground for the LED is provided by the wiring harness attached to the button assembly.

Electrochromic Mirror (If Equipped)

- The OnStar® button assembly is apart of the rearview mirror. The button assembly is comprised of 3 capacitive touch buttons and an error indicator. The buttons are defined as follows:
 - The answer/end call button, which is a white driver figure seated with voice signals near it's face, allows the user to answer and end calls or initiate speech recognition.
 - The blue OnStar® call center button, which displays the blue OnStar® logo, allows the user to connect to the OnStar® call center.
 - The emergency button, which displays red letters "SOS" as an illuminated Indicator, sends a high priority emergency call to the OnStar® call center when pressed.

The telematics communication interface control module supplies 10 volts to the OnStar® button assembly on the keypad supply voltage circuit. When pressed, each button press is processed and completes a circuit across an internal resistor allowing a specific voltage to be returned to the telematics communication interface control module on the keypad signal circuit. Depending upon the voltage range returned the telematics communication interface control module is able to identify which button has been pressed and illuminate associated indicator above each button.

The OnStar® error indicator is located within the mirror above the buttons between the OnStar® indicator and emergency "SOS" indicator. All three indicators associated with a button press are illuminated when the system is ON and operating normally. When any indicator is illuminated and flashing, it is an indication that a call is in progress. When the OnStar® error indicator is illuminated, this indicates a system malfunction is present. In the event there is a system malfunction and the OnStar® system is still able to make a call, the OnStar® error indicator will remain illuminated during the call.

If the indicators do not illuminate, this may indicate that the customers OnStar® subscription is not active or has expired. Push the blue OnStar button to connect to an advisor who can then verify the account status.

Secondary OnStar® Controls

Some vehicles may have an additional button that when pushed can engage the OnStar® system. The button may be a symbol of a face with sound waves, or may say MUTE, or be a symbol of a radio speaker with a slash through it.

By engaging the OnStar® system with this feature, the user can interact with the system by use of voice commands. A complete list of these commands is supplied in the information provided to the customer. If the information is not available for reference, at any command prompt the user can say "HELP" and the telematics communication interface control module will return an audible list of available commands.

OnStar® Microphone

The OnStar®, or cellular microphone, can be a part of the rearview mirror assembly, or on some vehicle lines, a separate, stand alone unit. In either case, the telematics communication interface control module supplies approximately 10 volts to the microphone on the cellular microphone signal circuit, and voice data from the user is sent back to the telematics communication interface control module over the same circuit. A cellular microphone low reference circuit or a drain wire provides a ground for the microphone.

Cellular and GPS Antennas

This vehicle will be equipped with one of the following types of antennas:

- A combination cellular and navigation antenna, which brings the functions of both into a single part
- A cellular, GPS, and digital radio receiver antenna, which also incorporates the functionality of the digital radio receiver satellite antenna (XM).
- A cellular, GPS, and digital radio receiver antenna, which also incorporates the AM/FM antenna.

The cellular antenna is the component that allows the OnStar® system to send and receive data over airwaves by means of cellular technology. The antenna is connected at the base to a coax cable that plugs directly into the telematics communication interface control module.

The GPS antenna is used to collect the signals of the orbiting GPS satellites. Within the antenna is housed a low noise amplifier that allows for a more broad and precise reception of this data. The antenna is connected at the base to a coax cable that plugs directly into the telematics communication interface control module. The cable also provides a path for DC current for powering the antenna.

The OnStar® Call Center also has the capability of communicating with the vehicle during an OnStar® call to retrieve the latest GPS location and transmit it to the OnStar® Call Center. A history location of the last recorded position of the vehicle is stored in the module and marked as aged, for as long as the module power is not removed. Actual GPS location may take up to 10 minutes to register in the event of a loss of power.

OnStar® RemoteLink

OnStar® RemoteLink is a mobile app to link mobile devices to a vehicle for limited diagnostics and feature controls. After downloading the app and registering the device, vehicle owners with an eligible vehicle can use their mobile devices to access real-time data from their vehicle and perform specific commands remotely.

All communication between the app and the vehicle is powered by OnStar's® advanced connected vehicle technology. An active OnStar® account as well as a valid OnStar® username and password are required to use the app. The remote commands must be enabled by logging into the user's OnStar® account prior to using the app.

Vehicle Control Features

- Lock/Unlock doors
- Start vehicle remotely
- Activate your Horn & Lights
- Contact an OnStar Advisor, Roadside Assistance or your Preferred Dealer

Available Vehicle Data:

- Real-time fuel information, including fuel range, fuel remaining, and lifetime MPG
- Lifetime mileage
- Remaining oil life
- Current tire pressure information

- OnStar® account information

Compass Heading

The telematics communication interface module has a compass feature to calculate vehicle direction which is displayed via the instrument panel cluster or designated display. The compass heading is determined by dead reckoning until the GPS 3d fix is established. The dead reckoning is accomplished by using the yaw rate sensors and wheel ticks to determine heading changes from a GPS known heading. The GPS 3d fix heading is determined by the deferential of two locations.

Bluetooth® (If Equipped)

Bluetooth® wireless technology is a short-range communications technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. Only vehicles with steering wheel controls will have Bluetooth® functionality. In order to utilize the vehicle's Bluetooth® system, a Bluetooth® equipped cellular phone is required.

The Bluetooth® antenna is a small fixed antenna connected directly to the telematics communication interface control module and is used to send and receive signals from a Bluetooth® enabled cellular phone. The antenna utilizes no cabling and is not external to the vehicle. The available features and functions are determined by the software within the device being used and the telematics communication interface control module. The operating range of the signal from the vehicle is approximately 30 feet. Note that the operating range is dependent upon the cellular phone being used and battery level of the phone.

With Bluetooth® technology customers can experience hands-free calling as their Bluetooth® capable cellular phones are wirelessly connected to the vehicle. It will allow customers to place and receive calls using the steering wheel controls and voice recognition. The vehicle audio system will allow you to listen to your call through the vehicle speakers and adjust volume through steering wheel or radio controls.

Not all Bluetooth® cellular phones are guaranteed to work with the vehicle's Bluetooth® system. Based on the cellular phone's service provider and the manufacturer's implementation of Bluetooth®, not all phones support all available Bluetooth® functionality. Bluetooth® enabled cellular phones will be tested for vehicle compatibility and a feature compatibility list will be provided via the GM Bluetooth® website:
<http://www.gm.com/vc/bluetooth/>

Bluetooth® Features Supported

The following is a list of features supported by the Bluetooth® system. Note that not all devices will support all of the listed functions.

- Automatic reconnection - highest priority phone will automatically be connected to vehicle when vehicle ignition is on
- Hands-free dialing- via digits, redial, name tags (phone number saved to a nametag via voice recognition)
- Answering a call
- Ending a call
- Mute a Call

- Rejecting a call - ignore an incoming call
- Call Waiting
- Three-way Calling - initiated from hands-free system
- Send Number During a Call - this is used when calling a menu-driven phone system
- Transfer a Call - transfer call from vehicle to cellular phone and visa versa
- Voice Pass-Thru - allow access to the voice recognition commands on the cellular phone

Pairing a Bluetooth® Cellular Phone to the Vehicle

In order to use hands-free calling, the cellular phone must be paired to the vehicle. Up to five devices can be paired to the vehicle at one time, but only one can be connected at any given time. To pair a phone, the customer must know how to operate the Bluetooth® functionality of their phone. The pairing process must only be done one time for each phone, unless that phone's information is deleted. For safety reasons, the pairing process is disabled while the vehicle is moving.

Once the Bluetooth® cellular phone has been paired with vehicle, it will automatically connect to the vehicle when the ignition is on and the device is on. When more than one paired phone is in the vehicle, the phone with the highest priority will be connected. If the cellular phone is in use while getting into the vehicle, the phone can be switched to hands-free mode with the press of a button. In addition, a call in progress can be transferred from the vehicle hands-free mode to the phone to continue the call as the customer exits the vehicle.

Complete pairing instructions are provided in the Vehicle Owners Manual.

Back-up Battery (If Equipped)

IMPORTANT: Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Disconnecting power to the OnStar® module in any way while the ignition is ON or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery. This action is per design as the back-up battery is designed to provide power to the telematics communication interface control module so an emergency notification call can be made after an event where the main battery is disabled. Once the Back-Up Battery is activated it will stay on until the power is restored back to the telematics communication interface control module. The telematics communication interface control module naturally chooses the main supply voltage as it's default supply, but if the main supply is removed or lost for any reason the OnStar® module will use the Back-Up Battery as a power supply as long as the default supply can not be detected. The back-up battery is not rechargeable and once discharged below 9.5 volts the back-up battery must be replaced.

Certain OnStar® equipped vehicles may also be equipped with a back-up battery. The back-up battery is a non-rechargeable, lithium battery intended to provide an auxiliary power source for the telematics communication interface control module in the event where power from the main vehicle battery is lost.

The back-up battery is intended to have a limited life span of approximately 4 years and is designed to maintain

an open circuit voltage between 16 V and 9 V throughout this period. This allows the battery to power the basic functions of the telematics communication interface control module for least one 200 second (5 minute) call at the end of the 4 year span, should the main vehicle battery be lost. In the case of a vehicle losing vehicle battery power, OnStar will switch over to the backup battery based on an internal algorithm. It will look for an air-bag deploy, or near-deploy, messages from the SDM. If there are no messages the OnStar module will stay wake for a few minutes longer and monitor the buttons in the mirror. If not pressed, the modules will power down and shut off completely.

The back-up battery is connected to the telematics communication interface control module through the back-up battery positive voltage circuit and back-up battery ground circuit and is protected from a short circuit by means of an internal fuse. In the event the back-up battery, battery positive voltage circuit is shorted to the back-up battery ground circuit or chassis ground, the fuse will open and render the back-up battery permanently inoperable. The status of the back-up battery and its associated wiring is monitored by the telematics communication interface control module.

Audio System Interface

When the OnStar® requires audio output, a serial data message is sent to the audio system to mute all radio functions and transmit OnStar® originated audio. The OnStar® audio is transmitted to the vehicle audio system by a dedicated signal circuit and a low reference circuit.

The audio system will mute and an audible ring will be heard though the speakers if the vehicle receives a call with the radio ON.

On some vehicles, the HVAC blower speed may be reduced when the OnStar® system is active to aid in reducing interior noise. When the system is no longer active, the blower speed will return to its previous setting.

OnStar® Sleep Cycle

The OnStar® system uses a unique sleep cycle to allow the system to receive cellular calls while the ignition is in the OFF position and retained accessory power mode has ended. This cycle enables the telematics communication interface control module to perform remote functions, such as door unlock, as commanded over the air by the OnStar® Call Center, and to continue to maintain an acceptable level of battery electrical drain.

The OnStar® system uses 4 states of readiness, depending upon the type of cellular market the vehicle is in when the ignition is put into the OFF state:

- High power
- Low power
- Sleep
- Digital standby

The high power state is in effect whenever the ignition is in the ON or RUN position, or retained accessory power is enabled, and the OnStar® system is sending or receiving calls or when the system is performing a remote function.

The low power state is in effect when the OnStar® system is idle with the ignition in the ON or RUN position,

or with retained accessory power enabled.

The sleep state is entered after the vehicle has been shut off and the retained accessory power has timed out while in an analog cellular area. At a predetermined time recorded within the telematics communication interface control module, the system re-enters the low power state to listen for a call from the OnStar® Call Center for 1 minute. After this interval, the system will again return to the sleep state for 9 minutes. If a call is sent during the 1 minute interval, the OnStar® system will receive the call and immediately go into the high power mode to perform any requested functions. If no call is received during the 1 minute interval, the system will go back into the sleep mode for another 9 minutes. This process will continue for up to 48 hours, after which the OnStar® system will turn off until the ignition is turned to the ON or RUN position.

The digital standby power state is entered after the vehicle has been shut off and the retained accessory power has timed out while in a digital cellular area. When in digital standby mode, the OnStar® module is able to perform all remote functions as commanded by an OnStar® advisor at any time, for a continuous 120 hours. After 120 hours, the OnStar® module will go into sleep mode until a wake up signal from the vehicle is seen by the telematics communication interface control module. If the OnStar module loses the digital cellular signal it will revert to analog mode and follow the standard sleep state (9 minutes OFF, 1 minute standby) based on the time of the GPS signals, this will continue until a digital cellular signal is again received.

If the OnStar® system loses battery power while the system is in a standby or sleep mode, the system will remain OFF until battery power is restored and the ignition is turned to the ON or RUN position.

Features

OnStar® Personal Calling

The hands free, OnStar® personal calling cellular phone feature is an additional feature of the OnStar® system. This feature is embedded within the telematics communication interface control module; however it must be activated by an OnStar® advisor. OnStar® personal calling operates similar to most hand held cellular phones in that the availability for its usage is based on minutes or units. The customer must have a current OnStar® subscription, as this feature cannot be utilized without it. To use OnStar® personal calling, the customer must also purchase units (minutes) as outlined in the owners guide provided with the OnStar® system. Units begin to deplete, 1 unit is equal to 1 minute, as the customer makes outbound phone calls, answers inbound phone calls, or while connected to the OnStar® virtual advisor. In addition, units may also have an expiration date, depending upon the type of units purchased.

Customers have the ability to store telephone numbers within the module, referenced by a nametag for the convenience of frequently dialed numbers. After storing a nametag, the user can dial this number by initiating the OnStar® personal calling feature, speaking the word "call," and repeating the nametag assigned.

Turn by Turn Navigation

Turn by Turn Navigation allows the driver to contact OnStar® to obtain directions for driving from a current location to a desired location. The Turn by Turn Navigation system stores your planned route and continually checks your position along that route, when you deviate from the planned route, the system will recognize this and prompt the driver with verbal prompts for how to proceed. The driver then responds verbally to direct the system to continue the current routing or to recalculate the route because of a missed turn.

Advisor Record Feature

The Advisor Record Feature allows the user to store any information given during a call with an OnStar® Advisor. Recording is activated by pressing the blue OnStar button during a call; pressing the button a second time stops the recording. The stored information can be played back by pressing the phone button on the three button assembly and using the voice command "Advisor Playback".

Deactivated OnStar® Accounts

In the event a customer has not renewed their OnStar® account after expiration or the account was never activated, OnStar® will make a discrete cellular call to the vehicle to deactivate the OnStar® system. Before taking this action, customers are notified that the OnStar® system in their vehicle will be deactivated unless they elect to renew the account. After the OnStar® account has been deactivated, customers will experience the following:

- The OnStar® status LED will not illuminate.
- The OnStar® system will NOT attempt to connect to the OnStar® Call Center in the event of a collision or if the vehicle's front air bags deploy for any other reason.
- An emergency button press will play a demo message indicating the service has been deactivated.
- An OnStar® Call Center button press will connect the customer with a dedicated sales team who can sell an OnStar® subscription and reactivate the vehicle. Depending on the type of OnStar® hardware in the vehicle, the customer may first hear a demonstration message stating there is no current OnStar® subscription for the vehicle, and directing the customer what to do to activate services.
- OnStar® personal calling will not be available, as this feature requires the customer to have a current OnStar® account. Attempts to use this feature may result in cellular connection failure messages and the inability to connect to the number dialed.

Certain vehicles that have never had an active OnStar® account, or that have been deactivated, may be unable to establish a connection with the OnStar® Call Center. When normal published diagnostic procedures do not indicate a possible cause for the no connect concern, the vehicle may have been deactivated. For deactivated vehicles, a no connect response should be considered normal operation. Further diagnosis and subsequent repair is only necessary should the customer elect to become an active OnStar® subscriber or renew the account subscription.

OnStar® Cellular, GPS, and Diagnostic Limitations

The proper operation of the OnStar® System is dependent on several elements outside the components integrated into the vehicle. These include the National Cellular Network Infrastructure, the cellular telephone carriers within the network, and the GPS.

The cellular operation of the OnStar® system may be inhibited by factors such as the users range from an analog or digital cellular tower, the state of the cellular carrier's equipment, and the location where the call is placed. Making an OnStar® key press in areas that lack sufficient cellular coverage or have a temporary equipment failure will result in either the inability of a call to complete with a data transfer or the complete inability to connect to the OnStar® Call Center. The OnStar® system may also experience connection issues if the identification numbers for the module, station identification number, electronic serial number or manufacturers electronic ID, are not recognized by the cellular carriers local signal receiving towers.

The satellites that orbit earth providing the OnStar system with GPS data have almost no failures associated with them. In the event of a no GPS concern, the failure will likely lie with the inability of the system to gain GPS signals because of its location, i.e. in a parking structure, hardware failure, or being mistaken with an OnStar® call which has reached the Call Center without vehicle data.

During diagnostic testing of the OnStar® system, the technician should ensure the vehicle is located in an area that has a clear unobstructed view of the open sky, and preferably, an area where analog or digital cellular calls have been successfully placed. These areas can be found by successfully making an OnStar® keypress in a known good OnStar® equipped vehicle and confirming success with the OnStar® Call Center advisor. Such places can be used as a permanent reference for future OnStar® testing.

Mobile Identification Number and Mobile Directory Number

The telematics communication interface control module utilizes 2 numbers for cellular device identification, call routing and connection, a mobile identification number and a mobile directory number. The mobile identification number represents the number used by the cellular carrier for call routing purposes while the mobile directory number represents the number dialed to reach the cellular device.

Operation of the OnStar® Speech Recognition Systems

OnStar® users communicate with 2 speech recognition systems. Speech recognition allows the user to speak to one computer in the vehicle, and one reached over a phone line. The computer tries to understand the users command, and responds by speaking back, or by taking the appropriate action, e.g. dialing the phone.

- Personal Calling uses a speech recognition system that resides in the vehicle. When the user presses the phone button, the system states, Ready, and listens for the user's command. The user can speak commands to control the hands-free phone.
- Virtual advisor is a remote speech recognition system that the caller can access by making a phone call. The user connects to virtual advisor by requesting it during personal calling use. The user is then transferred to the virtual advisor server and talks to it via a cellular connection.

The OnStar® speech recognition systems use speech technology that is designed to understand a wide range of American English speakers. Although there is no one right way to speak English, the system will work best when users try to modify their pronunciation should they encounter difficulty. Users who do not obtain good results are advised to try the tips and workarounds found in this section.

General Tips for Better Speech Recognition

Concern	Tip for Better Result
Noise	Noise may confuse the speech recognition system. You usually get better performance from the system in quieter conditions: <ul style="list-style-type: none">• The HVAC fan creates noise. Turn it down or OFF for better speech system performance.• Driving at high speeds creates louder engine noise and wind noise. You may get better results at lower speeds.• An open window or an open sunroof allows more noise to enter the vehicle. Close all windows for better results.

	<ul style="list-style-type: none"> Noisy rainstorms can also reduce performance. If passengers are talking while you use the speech system, it may be confused by their speech. You will get better results if all occupants of the vehicle are quiet while the system is listening for commands.
When to Speak	<p>In Personal Calling, the system is only listening after it prompts you to speak with a beep.</p> <ul style="list-style-type: none"> When the system prompts you to speak, you have about 5 seconds to respond. If the system does not hear a response, it will prompt you again, or cancel the transaction. If you begin to speak too soon, try pausing for a half second before speaking after the beep. In the Virtual Advisor, the system is always listening for commands, even while it is speaking.
How to Speak	<p>Speak forcefully, and clearly.</p> <ul style="list-style-type: none"> The noisier the environment, the louder you need to speak. If you are in the driver seat, speak facing the front of the car. If you are a passenger, speak facing the rearview mirror. Speak calmly, and naturally. The system may sometimes fail your repeated attempts to give a command. If your speech is distorted by shouting or frustration, this may cause more errors. People with high-pitched voices may have better results by speaking in a deeper, lower-pitched voice. However, do not lower the volume of the voice. Avoid speaking with a rising intonation, like asking a question. Use a flat or falling intonation, like giving an answer.
What to Say	<p>Personal Calling: One-word commands</p> <ul style="list-style-type: none"> The Personal Calling system listens for only one word at a time. There are some exceptions, 2-word phrases that are spoken and understood as a single word, e.g. "virtual advisor", "voice feedback", and "my number". You can enter phone numbers only one digit at a time, and the system repeats each digit as it hears it. Say "Help" at the Ready prompt to hear the list of Personal Calling commands. Virtual Advisor can understand sentences with more than one word. It also expects to hear a 4-digit number all at once when it asks for your PIN. Say, "What are my choices?" to hear a list of commands that the Virtual Advisor understands.
Entering a phone number	<ul style="list-style-type: none"> If you have trouble getting numbers correctly into the system, store your frequently-called number in the directory, so the system will remember them. After you have stored a number with a nametag,

	<p>then you simply say "call" and the nametag in order to call the number.</p> <ul style="list-style-type: none"> • If the system cannot understand your numbers, ask another person to help you enter your frequently-called numbers. This person can speak the numbers, then you can speak the nametag.
Storing or dialing a number	When you have finished speaking your phone number, you do not need to say "store" or "dial" to indicate that you are done. If you pause and say nothing, the system will ask you if you want to store or dial. Say "yes".
Creating nametags	<ul style="list-style-type: none"> • Short nametags that are similar may be easily confused by the system. You may get better recognition of your nametags if you make them longer, for example "George Washington" without pause, instead of "George" only. • If you want to use nametags while driving, it is best to store the nametag with some vehicle noise in the background. If you are in park while you are storing nametags, you can turn the fan on low or open windows in order to create some background noise.
Virtual Advisor 4-digit PIN	Say the 4 digits in a natural way, without pausing between digits.
Interrupting	<ul style="list-style-type: none"> • When the Virtual Advisor is speaking, you can interrupt it with another command. The first word in your command helps to get its attention. • If the Virtual Advisor has trouble understanding your commands when you interrupt, try speaking the first word loudly and clearly, then pause for an instant, then continue with the rest of the command. For example: "Get ... my weather" or "Lookup... a quote for General Motors".

RADIO/AUDIO SYSTEM DESCRIPTION AND OPERATION

The entertainment system on this vehicle may have several different configurations available to it. To determine the specific configuration of the vehicle, please see the Service Parts ID Label, and refer to **RPO Code List** .

Each item in the list below represents topics covered in detail below.

- Data Communications
- Remote Radio Receiver
- Human Machine Interface Control Module
- Media Disc Player
- Audio Amplifier (If equipped)
- Speaker Operation
- Infotainment Controls and Display
- Antenna System
- Radio Reception
- Theft Deterrent

- Bluetooth ® (if equipped)
- Applications (if equipped)
- Auxiliary Audio Input Jack
- USB Port and SD Card Reader
- Navigation System Components and Features (if equipped)
- Valet Mode
- OnStar ®
- Steering Wheel Controls (If equipped)
- Auto Volume Control

Data Communications

The infotainment system communicates with other devices on multiple serial data networks during operation.

Media Oriented Systems Transport (MOST)

At the core of the infotainment system is the Media Oriented Systems Transport (MOST) bus, a high-speed multimedia network technology. The serial MOST bus uses a ring topology and synchronous data communication to transmit audio, video, data and control information between any devices attached. The MOST bus uses a dual wire structure to communicate among these devices.

A MOST communication enable circuit is also connected to all components on the MOST bus. The MOST enable circuit is used to wake the network and trigger network diagnostics. Any component on the MOST bus may assert the enable circuit, but communications are initiated by the MOST bus master.

The MOST bus master is the device responsible for normal wake up and initialization of communication on the network. The MOST bus master receives vehicle power state information from the vehicle power mode master. The MOST bus master uses this information to control the power state of the infotainment system.

The MOST bus master is also responsible for maintaining known good network configuration. The MOST bus master will be the device that reports MOST bus errors/DTCs.

The Remote Radio Receiver, Human Machine Interface Module, Remote Optical Drive, Audio Amplifier and the Instrument Panel Cluster all communicate on the MOST bus.

Local Interconnect Network (LIN)

The Local Interconnect Network (LIN) Bus is a single wire communication system. This bus is used to exchange information between a master control module and other smart devices which provide supporting functionality.

The Remote Radio Receiver, Human Machine Interface Module, Information Display, Infotainment Controls and the Multifunction (tunnel) Controls all communicate on the LIN bus.

GMLAN

The Remote Radio Receiver, Audio Amplifier, and the Human Machine Interface Module communicate with other components and systems in the vehicle via GMLAN.

Remote Radio Receiver

The radio is the MOST BUS master. The radio also communicates with other components and systems within the vehicle via GMLAN.

The remote radio receiver is responsible for receiving all broadcast audio bands. Broadcast signals from AM, FM, and XM bands are transmitted to the radio via the vehicle antenna systems.

Radio Power

The radio receives battery power and ground from the vehicle harness.

The radio does not use a discrete ignition feed circuit for power moding. The power mode master provides the system power mode to the radio via serial data messages. The power mode master determines the system power mode by processing power mode information from ignition switch inputs. Serial data power modes supported by the radio are OFF, ACCESSORY, RUN, and CRANK REQUEST.

Radio Audio Outputs

When not equipped with an external amplifier, the radio outputs audio directly to the speakers. Each of the audio output channel circuits (+) and (-), at the radio have a DC bias voltage that is approximately one half of battery voltage. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound. The frequency (Hz) of the AC voltage signal is directly related to the frequency of the input (audio source playing) to the audio system. Both the DC bias voltage and the AC voltage signals are needed for the audio system to properly produce sound.

When equipped with an external amplifier, the radio outputs audio signals digitally over the MOST bus.

Human Machine Interface Control Module

The human machine interface module is responsible for the following: Video for the infotainment display, Bluetooth®, USB, memory card reader, and speech recognition functions.

The human machine interface module communicates with the info display module via the LIN bus for control information, touch communications and dimming level. Digital video data is sent to the display through a dedicated video cable.

Media Disc Player

The media disc player receives control information and outputs digital audio over the MOST bus.

The media disc player receives battery power and ground from the vehicle harness.

Audio Amplifier (If equipped)

Amplifier Interface

A fused battery voltage circuit provides the main amplifier power. The audio amplifier is a participant on the MOST network. The audio amplifier receives audio signals and control information from the MOST bus.

Amplifier Operation

The purpose of the amplifier is to increase the power of a voltage or current signal. The output signal of an amplifier may consist of the same frequencies as the input signal or it may consist of only a portion of the frequencies as in the case of a subwoofer or midrange speaker. The audio amplifier amplifies the signal and sends it to the appropriate speakers.

Each of the audio output channel circuits (+) and (-), at the audio amplifier outputs have a DC bias voltage that is approximately one half of the battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound. Both the DC bias voltage and the AC voltage signals are needed for the audio system to properly produce sound.

Speaker Operation

Speakers turn electrical energy into mechanical energy to move air, using a permanent magnet and an electromagnet. The electromagnet is energized when the radio or amplifier (if equipped) delivers current to the voice coil on the speaker. The voice coil will form a north and south pole that will cause the voice coil and the speaker cone to move in relation to the permanent magnet. The current delivered to the speaker is rapidly changing alternating current (A/C). This causes the speaker cone to move in two directions producing sound.

Infotainment Controls and Display

The infotainment display and controls are a separate component from the radio, combined into an assembly. The assembly contains the control knobs and buttons for all audio and HVAC functions and the information display. The assembly is supplied battery voltage and ground from the vehicle harness.

Control information, touch communications and dimming level for the display are communicated via a LIN serial data circuit to the human machine interface control module.

The human machine interface control module sends the display digital video data for on-screen display through a dedicated video cable.

The information display provides a feedback on the touch screen and certain controls. Buttons pulse when pressed to affirm that the command is being carried out,

When not actively in use, the screen reverts to minimal images. Proximity Sensing awakens the LCD screen when a hand approaches it.

The controls communicate via a LIN serial data circuit with the remote radio receiver . Messages communicated include the following:

- Wake-up/power state messages
- Diagnostic information
- Button presses/knob rotations
- Commands for the state of indicators
- Back-lighting dimming level

HVAC data for controls and status indicators is communicated between the HVAC controls and the HVAC control module with a separate LIN serial data circuit. HVAC status screen information from the HVAC control module is transmitted to the radio on the GMLAN serial data circuit. The radio communicates the desired screen information to the human machine interface module to be sent to the information display using the video data circuits.

Antenna System

Multi-Band Antenna

The multi-band antenna is located on the roof of the vehicle. This type of antenna may be used with the AM/FM radio, but is primarily for cellular and GPS signals, if the vehicle has these features. Keep this antenna clear of snow and ice build up for clear reception. If the vehicle has a sunroof, the performance of the system may be affected if the sunroof is open. Loading items onto the roof of the vehicle can interfere with the performance of the system, ensure the multi-band antenna is not obstructed.

Active Antenna

The active antenna system uses an integral antenna applied as an applique to the rear glass. The antenna amplifier receives both AM and FM signals from the rear glass antenna. The antenna is part of the rear window and looks similar to the defogger grid. One antenna receives AM signals while the other antenna receives FM signals. Any damage to the antenna requires replacing the glass.

The radio antenna amplifier is enabled when the radio is turned on. The radio provides battery voltage to the antenna amplifier using the center conductor of the antenna coaxial cable. When a 12 V signal is seen by the amplifier on the center conductor of the antenna coax, the received signals are amplified.

Radio Reception

AM/FM Radio Signal

The radio signal is sent from a broadcast station and is then received by an antenna. The strength of the signal received depends on the following:

- The power output (wattage) of the broadcasting station
- The location of the vehicle (or receiver) relative to the broadcast tower.
- Height of the broadcast antenna
- Height of the receiving antenna
- Obstacles between the tower and the receiver

- Atmospheric conditions
- What band (AM or FM) the station is broadcasting
- Type of antenna and the ground plane

Digital Radio Receiver (If equipped)

The XM satellite receiver is integrated into the radio. XM satellite radio provides digital radio reception. The XM signal is broadcast from two satellites and, where necessary, terrestrial repeaters. The high power satellites allow the antenna to receive the XM signal even when foliage and other partial obstructions block the antennas view of the satellite. Terrestrial repeaters are used in dense urban areas. These repeaters will receive the satellite signal and re-broadcast them at much higher power levels in order to ensure reception in areas with densely packed tall buildings. A service fee is required in order to receive the XM service.

Radio Data System (RDS)

The RDS feature is available only on FM stations that broadcast RDS information. This system relies upon receiving specific information from these stations and only works when the information is available. While the radio is tuned to an FM-RDS station, the station name or call letters display. RDS data is carried in what is known as a "subcarrier". A subcarrier is a frequency that the FM broadcaster is authorized to use to send data that is not audible in the main audio program.

RDS functions will only work with FM broadcast stations that are broadcasting RDS data. Not all FM Broadcast stations broadcast RDS data or offer all of the RDS services.

The information displayed is dependent upon the information broadcast by the particular station. The information may vary greatly between stations. RDS functions may not work properly when reception is weak, reception is of poor quality, or RDS is not implemented properly by the FM Broadcaster. In some cases, a radio station broadcasting incorrect information may cause the RDS features of the radio to appear to work improperly.

With RDS, the radio can do the following:

- Display text information such as: station identification, type of programming, and general information (artist and song title, station messages, call in phone numbers, etc.).
- Seek to stations broadcasting the selected type of programming
- Receive announcements concerning local and national emergencies
- Receive alert warnings of local or national emergencies. When an alert announcement comes on the current radio station, ALERT! displays. You will hear the announcement, even if the volume is low or a CD is playing. If a CD is playing, play stops during the announcement. Alert announcements cannot be turned off. ALERT! is not affected by tests of the emergency broadcast system. This feature is not supported by all RDS stations.

Theft Deterrent

The radio theft deterrent system is intended to disable or limit radio functionality if incorrect vehicle information is received by the radio. The radio disables functionality if the VIN information received by the

radio does not match the VIN information that has been learned by the radio. The radio receives this information via serial data. A possible cause of incorrect VIN info could be the radio was originally installed in another vehicle.

The radio has the following theft operating modes as part of the theft deterrent system:

- **Normal Mode:** The radio has learned a correct VIN sequence and the VIN information received via serial data matches the learned VIN sequence. In this mode the radio has full functionality.
- **No VIN Mode:** The radio has not received or learned a correct VIN sequence. In this mode the radio has limited functionality.
- **Theft Detected Mode:** The radio has learned a correct VIN sequence and the VIN information received via serial data does NOT match the learned VIN sequence. In this mode the radio may be disabled or have limited functionality. The radio display will indicate that theft protection is active.

Bluetooth ® (If equipped)

Bluetooth ® wireless technology is a short-range communications technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. The operating range of the signal is approximately 30 feet.

The available features and functions are determined by the type of device and the software within the devices being used. For a feature or function to operate, it must be supported in both devices.

The first connection between devices is established through a process called pairing. In order to pair two devices, a password (passkey) has to be exchanged between the two devices. One device will generate the password, the other device accepts the password to complete the process. Once the devices are paired, future connections between the devices will occur automatically when the devices are on and within range of each other.

The Bluetooth ® hardware is internal to the human machine interface module. The human machine interface module supports streaming of data (music, voice, information) from cellular phones and other mobile devices that support those features. The human machine interface module is also capable of interfacing with cellular phones for hands-free features.

- The device must be paired to the system to use the available Bluetooth ® feature(s). The pairing process must only be performed once for each device, unless that device's information is deleted.
- Up to five devices can be paired, but only one can be connected at any given time.
- Streaming Audio allows playing music from the mobile device wirelessly. Music stored on the mobile device can be viewed and controlled from the display.
- To stream audio from a mobile device, the device must be unlocked, and any additional applications should be closed.

Refer to the vehicle owners manual, supplements, and the device manufacturers information for pairing instructions.

Applications (If equipped)

When the system is equipped with Bluetooth ®, the system is capable of using applications, commonly referred to as apps.

The term application refers to any piece of software that works on a system (hardware) that is being operated by its own software. Applications are typically small software programs which use the hardware to perform a specific task, as opposed to operating the entire system.

- For an application to be used, it must be installed on both the vehicle infotainment system and a compatible mobile device.
- The device must be connected to the system. This may be done wirelessly via Bluetooth ®, or via the vehicle USB port. Refer to the device manufacturer's information for the proper connection method.
- When the device is connected, the vehicle infotainment system is used to remotely access and control the application on the mobile device.
- The application must work correctly on the device to work with the vehicle infotainment system.
- The user may be required to log-in to the application on the mobile device before using the application from the vehicle controls.
- Using applications will use the device's data plan.
- The device must be unlocked, and any additional applications should be closed.

Refer to the owner's manual and supplements for information on mobile devices, control, and operation.

Auxiliary Audio Input Jack (If equipped)

The infotainment system may have a 3.5mm (1/8 in.) auxiliary audio input jack. The auxiliary audio input jack interfaces directly with the radio. When a portable audio playback device is connected to the auxiliary jack, an internal switch detects the connection and the system will have AUX available as an audio source. Audio signals from the device are sent to the radio from the auxiliary jack via the left, right, and common audio signal circuits.

- When a device is connected to the 3.5mm (1/8 in.) input jack, press the AUX or CD/AUX button to select the device.
- Playback of an audio device that is connected to the 3.5mm jack can only be controlled using the controls on the device.
- The volume control on the device may need to be adjusted to ensure sufficient playback volume through the infotainment system.

USB Port and SD Card Reader

The infotainment system has a USB port and SD card reader slot located in the center console. The USB port and the card reader slot interface with a hub device, internal to the auxiliary jack, USB, and memory card receptacle assembly. The auxiliary jack, USB, and memory card receptacle assembly receives fused battery voltage and ground from the harness to power the internal hub device as well as providing additional amperage to power USB devices.

The internal hub device interfaces directly with the human machine interface module via a standard USB cable. A Mini type USB connector is used to connect the cable at the USB port and at the human machine interface

module and at the auxiliary jack, USB, and memory card receptacle. Standard USB male to female connections are typically used for connecting USB cables together where an in-line connection is required. An in-line cable connection is typically found between the console and I/P harness.

USB Port

The USB port allows connectivity to the infotainment system from portable media players or a USB storage device (memory stick/ flash drive). When a device is connected to the USB port, the system detects the device and switches to USB as the audio source. Once connected, the device can be controlled from the radio controls.

Not all portable media player devices or file types are compatible. Connection to USB HUB devices is not supported.

Refer to the owner's manual for information on USB devices, control, and operation.

SD Card Reader

The infotainment system uses the SD card reader as a mass storage device, similar to a USB storage device.

Refer to the owners manual for information on media types supported via the SD card reader.

Navigation System Components and Features (if equipped)

The human machine interface module provides navigation functionality, if equipped. The human machine interface module provides the following:

- Connection to the global positioning system (GPS) antenna, which provides the vehicle position information.
- Map data for navigation and map route guidance, stored in the human machine interface modules internal memory.
- Route guidance with verbal prompts to the operator.
- Traffic and weather information for display on the navigation system map (with active subscription, where available).

Global Positioning System (GPS) Antenna

The global positioning system (GPS) antenna is part of the multi-band antenna located on the roof of the vehicle. The GPS antenna is used to collect the signals of the orbiting GPS satellites. Within the antenna is housed a low noise amplifier that allows for a more broad and precise reception of this data. The GPS antenna amplifier is powered through the coaxial cable.

The antenna is connected to the human machine interface module through a signal splitter. The signal splitter is a component for dividing the navigation signal into two paths without any transmission loss. This allows the use of a single GPS antenna to provide a signal to both the human machine interface module and the telematics communication interface module.

Route Guidance

The map will display the route to the selected destination. Voice prompts alert the operator of upcoming events (turns) and arrivals at the destination. The navigation system will automatically recalculate if the route is not followed. The human machine interface module uses data received from the global positioning system (GPS) satellites, the vehicle speed signal, and serial data information to accurately display the current position of the vehicle.

Points of Interest

The map database provides point of interest information. Points of interest are locations that are frequently visited. Points of interest can be displayed on the map or set as a destination. The following are some of the available Points of interest:

- Gas Station
- Restaurant
- College
- Police Station

Valet Mode

Valet Mode is a customer enabled feature of the infotainment system, found in the settings menu, if equipped. The customer creates and inputs a four digit code using the infotainment controls. Confirming the code and selecting LOCK will lock the infotainment system, steering wheel controls and other vehicle features, dependant on vehicle equipment. The vehicle will remain in valet mode until the same four digit code is reentered.

In the event that the four digit code is forgotten, the scan tool can be used to clear the Valet Mode Code.

OnStar ® (If equipped)

When OnStar is activated, a serial data message is sent to the radio that activates a software program. When the software begins its process, the fade goes to the front, Bass and Treble are set to the mid range, the outputs are mono, and the audio source is OnStar. OnStar takes priority over any other audio source. All of these actions are preset values stored in the radio.

For additional OnStar information, refer to **OnStar Description and Operation**.

Steering Wheel Controls (If equipped)

Some audio functions are available using the steering wheel controls. The steering wheel controls duplicate the function of the primary controls available on the radio.

For additional information on steering wheel controls, refer to **Steering Wheel Controls Description and Operation** .

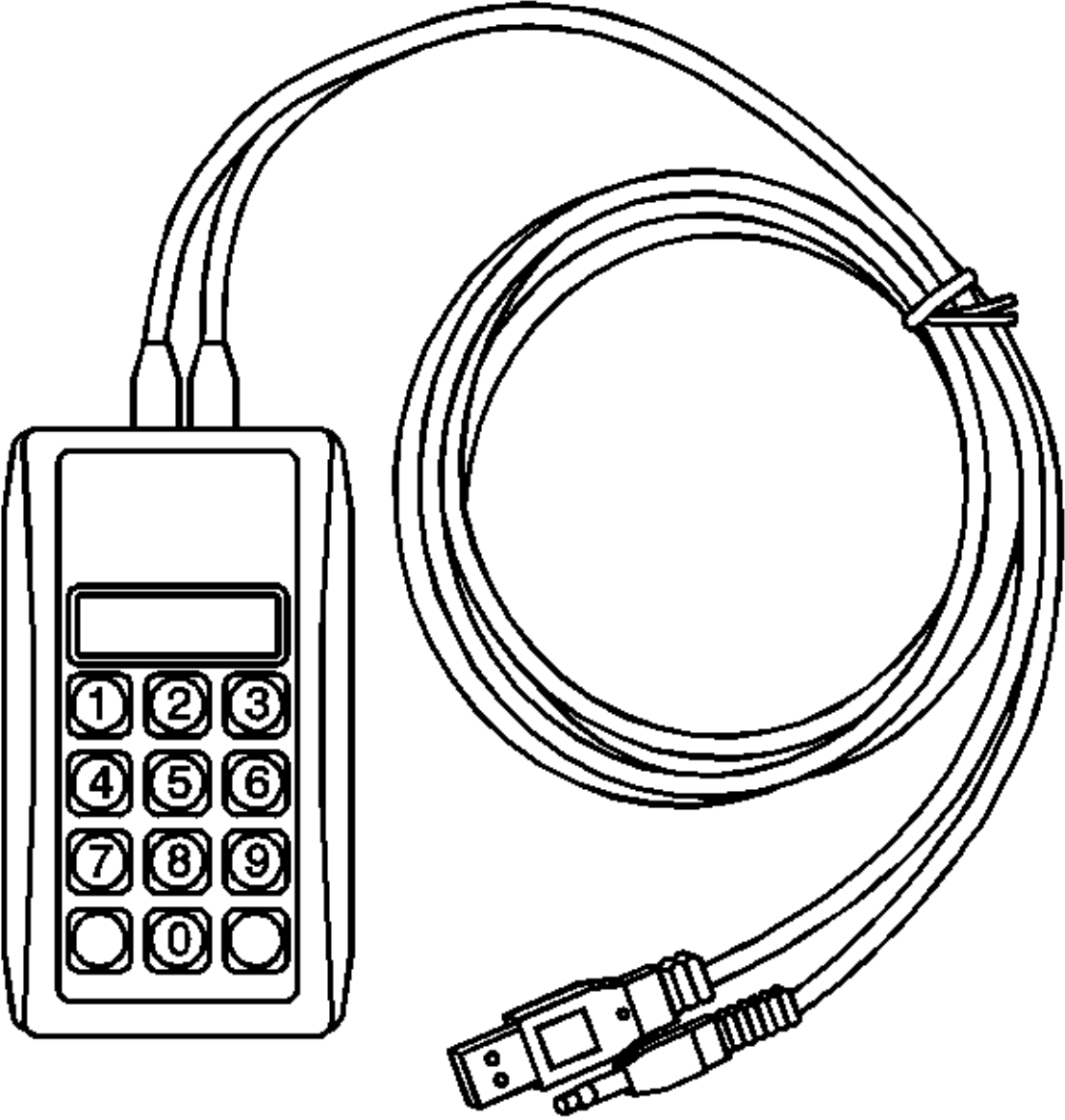
Auto Volume Control

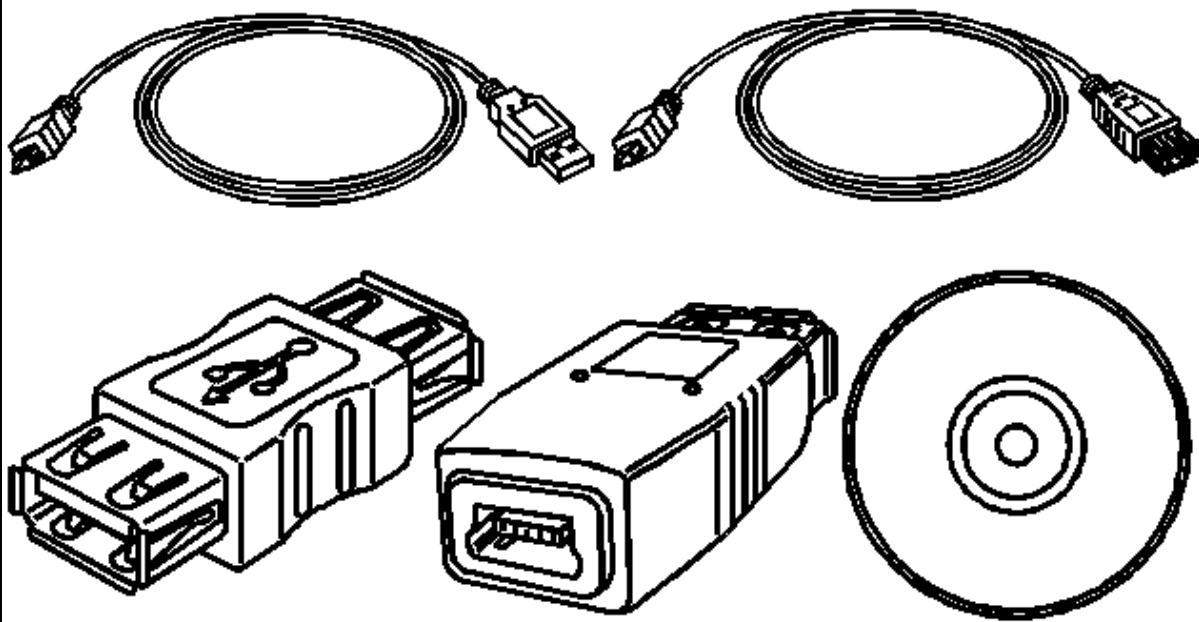
With auto volume control, the audio system will adjust automatically to make up for road and wind noise as you

drive, by increasing the volume as vehicle speed increases. To use auto volume control, set the volume at the desired level, and then select either Low, Medium, or High. To turn auto volume control off, select the Off screen button.

SPECIAL TOOLS AND EQUIPMENT

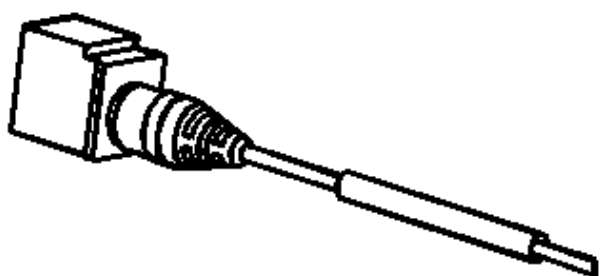
SPECIAL TOOLS

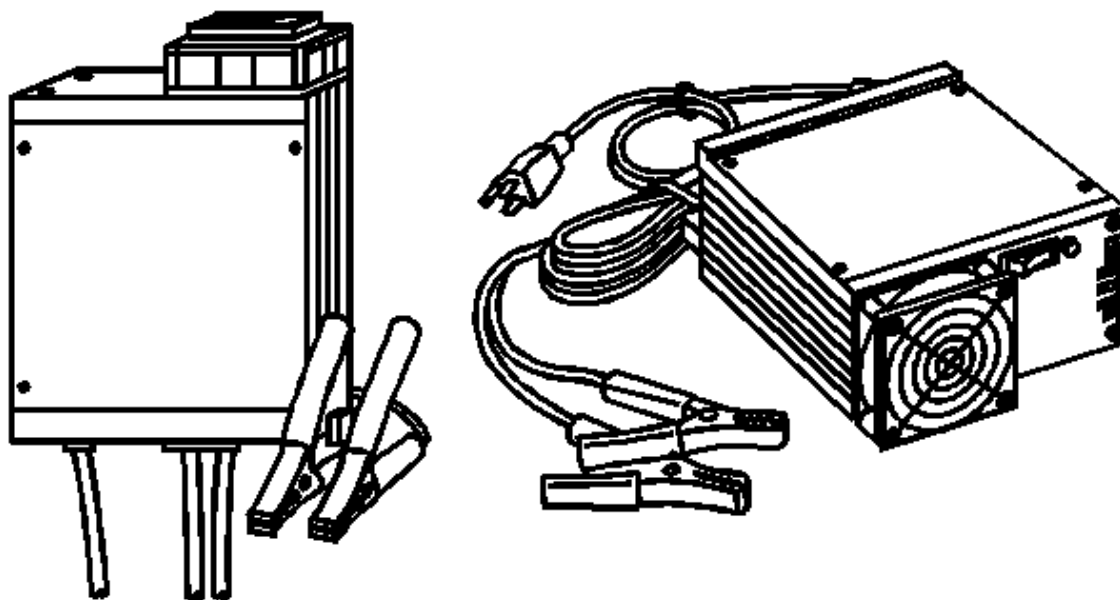
Illustration	Tool Number/Descrip
	EL-50334-20 Multi-Media Interface Tester (MIT)



EL-50334-50
USB Cable and
Adapter Kit

EL-48028
Digital Radio Te
Antenna





EL-49903
OnStar Antenn
Diagnostic Tool

SPECIAL TOOLS (MIT TOOL INSTRUCTIONS)

Bluetooth Pairing for Vehicles with Radio RPO: UF7

Either reset the pin code on the radio to 0000, or go under Device Info on the radio and see what the pin code is (to enter it later on the MIT).

1. Turn the BT discoverable ON in the radio Bluetooth settings.
2. Press Pair Device on radio (DO NOT PRESS SEARCH BLUETOOTH DEVICES ON THE RADIO).
3. Press the Pair button on the MIT.
4. When the three LED lights begin flashing on the MIT, enter the pin code (either 0000 if you reset it to that or what the radio pin code was).

5. MIT will then automatically connect with the radio and should show "MIT Connected" message.

Make test call and the audio streaming test.

Holden Radio Bluetooth Pairing Instructions

1. Using the radio controls, place the radio into "Discoverable Mode".
2. Place the MIT into Bluetooth mode by pressing TEST SELECTOR until the Bluetooth LED is illuminated.
3. With the MIT in Bluetooth mode Press and Release the #1 button (the Bluetooth LED will begin to slowly blink).
4. Now Press and release the PAIR/CALL button on the MIT (the Bluetooth LED will begin to blink a little faster).
5. On the radio Enter the PASSKEY when prompted: (press "0000" then Press "OK").
6. The MIT and radio will PAIR and CONNECT (the Bluetooth LED will be Fast Flashing).
7. Use as regular MIT at this point.

For all other Radios

Testing the Bluetooth Function

1. Verify connection of the MIT to the USB port.
2. Press and release the TEST SELECTOR button until the Bluetooth LED illuminates.
3. Disable all other Bluetooth devices present in the vehicle (ie. cell phones, laptops, etc.).

Standard Bluetooth Pairing/Bonding

1. Use the vehicle controls to place the radio into Bluetooth Pairing mode. The vehicle will prompt you with a security code.
2. Press and release the PAIR/CALL button. The Bluetooth LED will blink slowly while preparing to have a security code entered.
3. Wait for the all three LEDs to blink confirming it is ready to have the security code entered.
4. Enter the code with the MIT keypad and hit ENTER.
5. The Bluetooth LED will blink slowly while pairing/bonding and move to a quick flash once paired/bonded.

The vehicle should confirm pairing/bonding is complete.

Streaming Audio

1. Confirm pairing/bonding is complete - the Bluetooth LED will be in a quick flash mode.
2. On some radios the MIT automatically begins streaming audio via A2DP. The audio playback will confirm that the Bluetooth connection using streaming and the audio is working correctly.
3. On other radios you will need to select Bluetooth Audio from the Source menu to verify Audio

Streaming.

4. Audio playback confirms that the Bluetooth connection using Streaming Audio is working correctly.
5. Placing a test call will temporarily stop the streaming audio function, but upon disconnection of that test call,

the streaming audio from the MIT will resume.

To Place a Test Call

1. Confirm pairing/bonding is complete - the Bluetooth LED will be in a quick flash mode. If the vehicle is equipped with streaming audio, and the radio is set to play a Bluetooth audio file, the streaming audio playback will be audible.
2. Press and release PAIR/CALL button to place a test call. Streaming audio will be temporarily turned off.
3. Use the vehicle controls to answer the call.

NOTE: If the call is not answered within several rings, the MIT's audio files will not transmit, even though an active call is occurring.

4. Audio playback confirms that the Bluetooth connectivity is working correctly.

NOTE: The MIT will remain paired/bonded when the call is ended by the vehicle. To re-test the call function, place the MIT in Bluetooth mode and press and release the Pair button to reconnect. When testing is completed, delete MIT from the audio system before returning the vehicle to the customer.

5. Use the vehicle controls to end the call. If applicable, streaming audio will resume.

Testing the AUX/Line-In Function

1. Verify connection of the MIT as stated above.
2. Press and release the TEST SELECTOR button until the MIT AUX LED illuminates.
3. Use the vehicle controls to put the audio system into Audio (Line-In) mode.
4. Audio playback confirms that the audio input is working correctly.

Testing the USB Function

1. Verify connection of the MIT as stated above.
2. Press and release the TEST SELECTOR button until the MIT USB LED illuminates.
3. Use the vehicle controls to put the audio system into USB mode.

NOTE: Volume levels may vary dependent upon vehicle audio system.

4. Audio playback confirms that the USB is working correctly.

Troubleshooting Guide

If the MIT unit is still not working properly after following the below troubleshooting, the unit is malfunctioning and should be repaired or replaced.

Unit not Working

- Verify the MIT is powered on correctly as indicated by the green Power LED.
- If Power LED is not illuminated, verify USB power source is working properly.
- If USB power adapter is being used to power the MIT, check and, if necessary, replace the fuse in adapter.

Problem with Aux/Line-In Test

- Verify Aux/Line- In test cable is inserted properly into the vehicle audio input jack. Verify the MIT is in Aux/Line-In mode as indicated by the red AUX LED.
- Verify the vehicle audio system is in Auxiliary or Line-in mode. Verify the vehicle audio system volume is turned up and not in mute mode.

Problem with USB Test

- Verify MIT is in USB mode as indicated by the red USB LED. Verify the vehicle audio system is in USB mode.
- Verify the vehicle audio system volume is turned up and not in mute mode.

Problem with Bluetooth Pairing

- Delete previous devices stored in the device list of the radio and the pair the MIT
- Remove USB cable, and then reconnect to reset the MIT. Carefully follow the bonding instructions for the correct Passkey procedure.

Problem with Bluetooth Test Call Audio

- Verify the MIT is paired with the vehicle. This is indicated by the quick flashing Bluetooth LED.
- Audio system should have indicated the MIT is bonded.

Transmission

Clutch

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Clutch Fastener	28 N.m	21 lb ft
Clutch Master Cylinder Fasteners	22 N.m	16 lb ft

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number
Locking Agent	Threadlock	Refer to Electronic Parts Catalogue.
Grease	Sealant	Refer to Electronic Parts Catalogue.

GENERAL SPECIFICATIONS

General Specifications

Component	Description	Specification
Clutch Driven Plate	Type	Single plate dry disc
	Outside Diameter- AWD applications	250 mm
	Outside Diameter- FWD applications	240 mm
	Inside Diameter	155 mm
	Thickness of disc assembly with 10,000 N load	7.8± 0.2 mm
Clutch Pressure Plate	Type	Self-adjusting with pressed steel cover plate and multi-fingered bevelled diaphragm spring.

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - CLUTCH

Strategy Based Diagnostics

Review the clutch system operations in order to familiarize yourself with the system functions. Refer to **Clutch System Description and Operation**.

Visual/Physical Inspection

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the clutch master cylinder for the correct fluid level.
- Inspect the hydraulic clutch lines for dents, kinks, or other obvious damage that may affect the clutch system operations.
- Inspect the clutch system for contamination of dirt, oil, or other substances that may affect the clutch system operations.
- Inspect for aftermarket components and power take-off (PTO) set-ups.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

NOTE: Due to the variety of clutch options there may be components in the mechanical diagnostic tables that are not on a particular vehicle.

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Clutch Drag Hard Shifting**
- **Clutch Rattle**
- **Clutch Noisy**
- **Clutch Pedal Spongy Low Pedal Effort**
- **Clutch Pedal Hard to Push**
- **Clutch Vibration**

CLUTCH DRAG HARD SHIFTING

Clutch Drag Hard Shifting

Cause	Action
DEFINITION: The clutch does not disengage completely to allow smooth shift operations. It may cause gear clashing while the vehicle is not moving, at idle, and shifting out of neutral, or hard shifting in and out of gears while driving the vehicle. Review the <u>Symptoms - Clutch</u> and perform the necessary inspections.	
Pedal blocked from full travel	<ol style="list-style-type: none">1. Inspect for obstacles that prevent the pedal from going to the floor.2. Clear any obstacles from under the pedal area,

	such as floor mats, damaged floor, or interior panels.
Too much travel between pedal and clutch master cylinder	<ol style="list-style-type: none"> 1. Inspect the pedal for worn bushings. 2. Replace the pedal bushings if worn. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.
Clutch pedal mounting loose	<ol style="list-style-type: none"> 1. Inspect the clutch pedal mounting bracket for loose or missing fasteners. 2. Replace or repair the fasteners. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.
Linkage at pedal worn or damaged	<ol style="list-style-type: none"> 1. Inspect the linkage at the pedal for excessive wear. 2. Repair or replace the linkage as required. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.
Clutch master cylinder seized or binding	<ol style="list-style-type: none"> 1. Inspect the master cylinder for the piston being able to move freely and full range of travel. 2. Replace the clutch master cylinder as required. Refer to <u>Clutch Master Cylinder Replacement</u>.
Air in the clutch hydraulic system	Bleed the clutch hydraulic system. Refer to <u>Hydraulic Clutch System Bleeding</u> .
Clutch actuator cylinder seized or binding	<ol style="list-style-type: none"> 1. Inspect the clutch actuator piston for moving freely. 2. Replace the clutch actuator cylinder if the piston is binding. Refer to <u>Clutch Actuator Cylinder Replacement</u>.
Clutch master cylinder leaking internally	<ol style="list-style-type: none"> 1. Inspect for proper pedal reserve. Refer to <u>Clutch System Description and Operation</u>. <ol style="list-style-type: none"> 1. Let up halfway on pedal. 2. Apply the pedal a few times and hold down for 30 seconds. 3. Inspect to ensure there is still the proper pedal reserve, without letting pedal fully up. 2. Replace the clutch master cylinder if it will not hold pedal reserve. Refer to <u>Clutch Master Cylinder Replacement</u>.
Damaged clutch assembly components	<ol style="list-style-type: none"> 1. Remove the clutch assembly. 2. Inspect the following clutch assembly components for damage: <ul style="list-style-type: none"> • Damaged clutch disc hub splines

	<ul style="list-style-type: none"> • Bent clutch disc • Bent drive straps • Broken or warped pressure plate <p>3. Replace the clutch assembly if any of the above damage is found. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.</p>
Excessive side loading on the release bearing	<p>1. Inspect the following clutch system components:</p> <ul style="list-style-type: none"> • Worn or damaged pilot bearing • Excessive flywheel runout • Excessive engine to transmission misalignment • Clutch actuator cylinder mounting surface out of alignment <p>2. Repair or replace any faulty components.</p>
Tight or contaminated clutch disc splines	<p>1. Clean the clutch disc and input shaft splines.</p> <p>2. If the clutch disc will not clean, replace the clutch assembly. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.</p>
Grease or oil contamination on the clutch discs facing	<p>1. Repair the oil leak.</p> <p>2. Repair the grease leak.</p> <p>3. Clean the clutch disc facing and the other clutch assembly components.</p> <p>4. Replace the clutch assembly if it will not clean. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.</p>

CLUTCH RATTLE

Clutch Rattle

Cause	Action
DEFINITION: A rattle noise coming from the clutch components with the clutch disengaged or engaged. Review the <u>Symptoms - Clutch</u> and perform the necessary inspections.	
Idle rattle clutch engaged	Replace the clutch disc, due to faulty dampener springs. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u> .
Clutch is improperly installed	Remove the clutch and install it correctly. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u> .
Clutch disc dampener worn or damaged	<p>1. Inspect the clutch disc for a broken or worn dampener.</p> <p>2. Replace the clutch assembly. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.</p>

Clutch disc splines worn	<ol style="list-style-type: none"> 1. Inspect the clutch disc hub to input shaft splines for excessive clearance. 2. Replace the clutch assembly if the clutch splines are worn. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.
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CLUTCH NOISY

Clutch Noisy

Cause	Action
DEFINITION: A growl or whine noise is coming from the clutch when engaged or disengaged. Review the <u>Symptoms - Clutch</u> and perform the necessary inspections.	
Release bearing damaged or worn	Replace the release bearing. Refer to <u>Clutch Actuator Cylinder Replacement</u> .
Clutch actuator cylinder damaged or worn	Replace the clutch actuator cylinder. Refer to <u>Clutch Actuator Cylinder Replacement</u> .

CLUTCH PEDAL SPONGY LOW PEDAL EFFORT

Clutch Pedal Spongy Low Pedal Effort

Cause	Action
DEFINITION: The clutch pedal may feel spongy, or it requires very little effort to operate. Review <u>Symptoms - Clutch</u> and perform the necessary inspections.	
Air in the hydraulic system	Bleed the clutch hydraulic system. Refer to <u>Hydraulic Clutch System Bleeding</u> .
Master cylinder fluid level low	<ol style="list-style-type: none"> 1. Inspect for leakage in the clutch master cylinder, hose connections, and the clutch actuator. 2. Repair or replace any faulty components.
Clutch incorrectly installed	Remove the clutch and install it correctly. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u> .
Clutch mounting bolts loose or broken	<ol style="list-style-type: none"> 1. Remove the broken bolts. 2. Replace the broken or loose bolts and tighten. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.
Release bearing worn or damaged	Replace the release bearing. Refer to <u>Clutch Actuator Cylinder Replacement</u> .
Contaminated hydraulic fluid	<ol style="list-style-type: none"> 1. Inspect the clutch hydraulic fluid for contamination of water. If available, use a brake fluid boiling point tester. Boiling point should be above 177°C (350°F). 2. Inspect the reservoir cap for being faulty if water is present.

	<ol style="list-style-type: none"> 3. Inspect the clutch hydraulic fluid for dirt or debris. 4. Flush and bleed the clutch hydraulic system if the above conditions are found. Refer to <u>Hydraulic Clutch System Bleeding</u>. 5. If mineral oil was added, replace the clutch master cylinder and clutch actuator cylinder due to seal damage. Refer to <u>Clutch Master Cylinder Replacement</u>, and <u>Clutch Actuator Cylinder Replacement</u>.
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CLUTCH PEDAL HARD TO PUSH

Clutch Pedal Hard to Push

Cause	Action
<p>DEFINITION: The clutch pedal requires high effort to operate.</p> <p>Review the <u>Symptoms - Clutch</u> and perform the necessary inspections.</p>	
Incorrect hydraulic fluid	<ol style="list-style-type: none"> 1. Inspect for the correct fluid in the master cylinder. Refer to <u>Hydraulic Clutch System Bleeding</u>. 2. Replace the clutch master cylinder and clutch actuator cylinder. Refer to <u>Clutch Master Cylinder Replacement</u>, and <u>Clutch Actuator Cylinder Replacement</u>. 3. Flush the hydraulic system and fill with the correct fluid.
Contaminated hydraulic fluid	<ol style="list-style-type: none"> 1. Inspect the hydraulic fluid for water. 2. Inspect the hydraulic fluid for dirt or debris. 3. Flush the hydraulic system and fill with the correct fluid. Refer to <u>Hydraulic Clutch System Bleeding</u>.
Clutch pedal binding	<ol style="list-style-type: none"> 1. Inspect the pedal for binding. 2. Repair or replace the pedal. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u>.
Kinked or damaged clutch hydraulic pipe	<ol style="list-style-type: none"> 1. Inspect for a kinked or damaged hydraulic hose. 2. Repair or replace the clutch hydraulic hose. Refer to <u>Clutch Master Cylinder Replacement</u>.
Clutch disc worn too thin	Replace the clutch assembly. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u> .

CLUTCH VIBRATION

Clutch Vibration

Cause	Action
DEFINITION: Vibration from the clutch components during disengagement or engagement. Review the <u>Symptoms - Clutch</u> and perform the necessary inspections.	
Clutch incorrectly installed	Remove the clutch and install it correctly. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u> .
Transmission input splines worn or damaged	Inspect clutch disc splines and transmission input splines for wear or damage.
Clutch disc facings damaged	Replace the clutch assembly. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u> .
Clutch out of balance	Replace the clutch assembly. Refer to <u>Clutch Assembly Replacement (With DT-6263)</u> .

REPAIR INSTRUCTIONS

BRAKE, ACCELERATOR, AND CLUTCH PEDAL REPLACEMENT

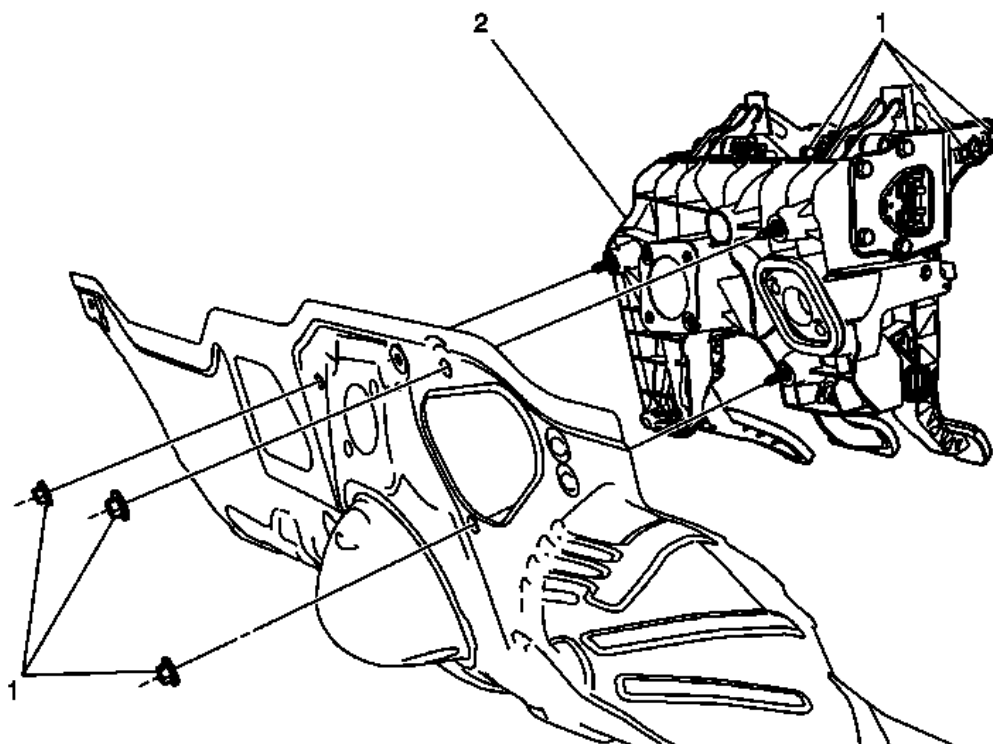


Fig. 1: Brake, Accelerator, and Clutch Pedal
Courtesy of GENERAL MOTORS COMPANY

Brake, Accelerator, and Clutch Pedal Replacement

Callout	Component Name
Preliminary Procedures	

1. Remove the front floor console. Refer to **Front Floor Console Replacement** .
2. Remove the instrument panel lower trim panel. Refer to **Instrument Panel Lower Trim Panel Replacement - Left Side** .
3. Remove the instrument panel outer trim cover. Refer to **Instrument Panel Outer Trim Cover Replacement - Left Side** .
4. Remove the windshield side garnish molding. Refer to **Windshield Side Garnish Molding Replacement** .
5. Remove the front and rear side door sill trim.
6. Remove the 2 fasteners to the power vacuum brake booster. Refer to **Power Vacuum Brake Booster Replacement** .
7. Remove the clutch master cylinder. Refer to **Clutch Master Cylinder Replacement**.
8. Remove the steering column. Refer to **Steering Column Replacement** .
9. Release the hood release handle and release the instrument panel tie bar and lift it out and secure the tie bar approximately 40 mm out, on the left side of the car. The fasteners to the pedal assembly needs to be removed before the tie bar is released. Refer to **Instrument Panel Tie Bar Replacement** .

1	<p>Brake, Accelerator, and Clutch Pedal Assembly Fastener (Qty: 7)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 22 N.m (16 lb ft)</p>
2	<p>Brake, Accelerator, and Clutch Pedal</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove the electrical connectors. 2. Release the brake pedal from the pushrod, by pulling the pedal backwards. 3. Install the NEW click fit connector on the brake pedal arm.

CLUTCH MASTER CYLINDER RESERVOIR HOSE REPLACEMENT

Removal Procedure

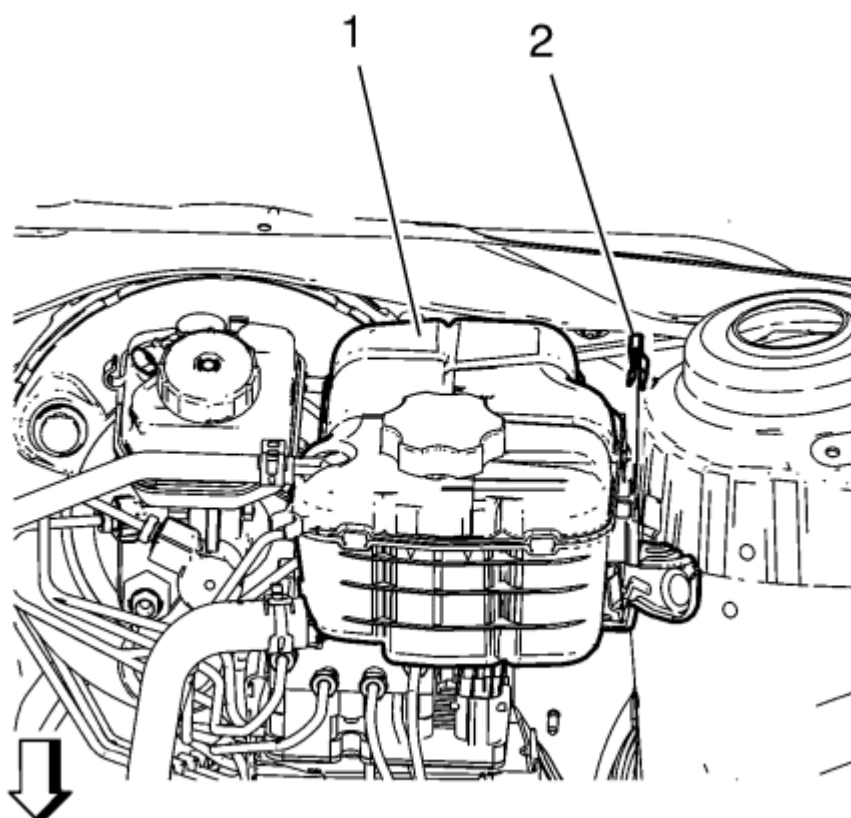


Fig. 2: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT disconnect engine coolant hoses.**

1. Remove the radiator surge tank clip (2).
2. Remove the radiator surge tank (1).

Position the radiator surge tank (1) aside.

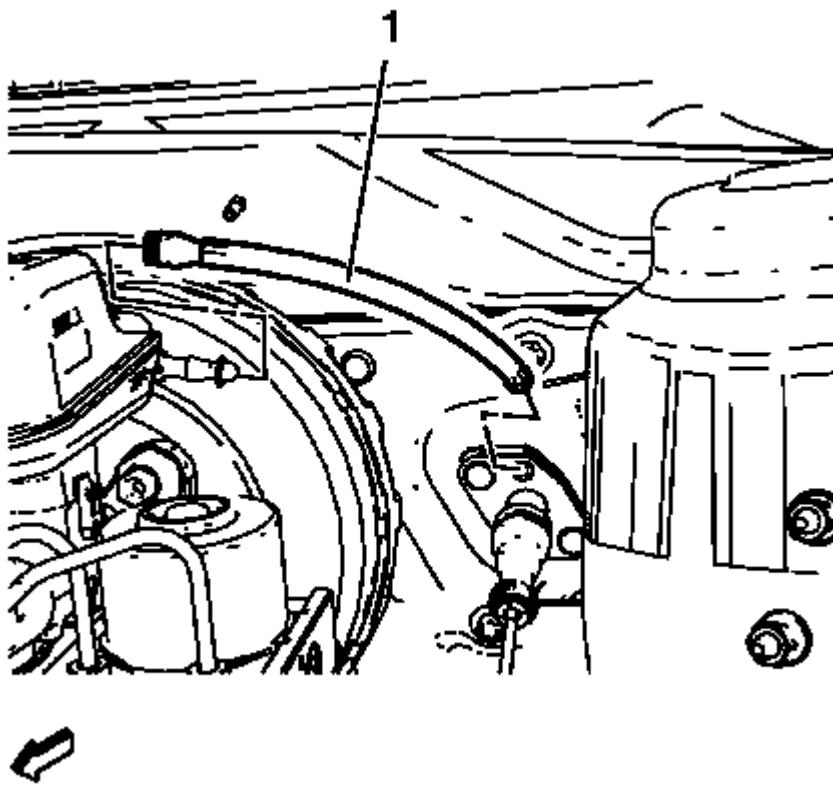


Fig. 3: Clutch Master Cylinder Reservoir Hose
Courtesy of GENERAL MOTORS COMPANY

NOTE: Before disconnecting the reservoir tank hose, remove the clutch/brake fluid from the reservoir tank.

3. Remove the clutch master cylinder reservoir hose (1) from the reservoir tank and the master cylinder.

Installation Procedure

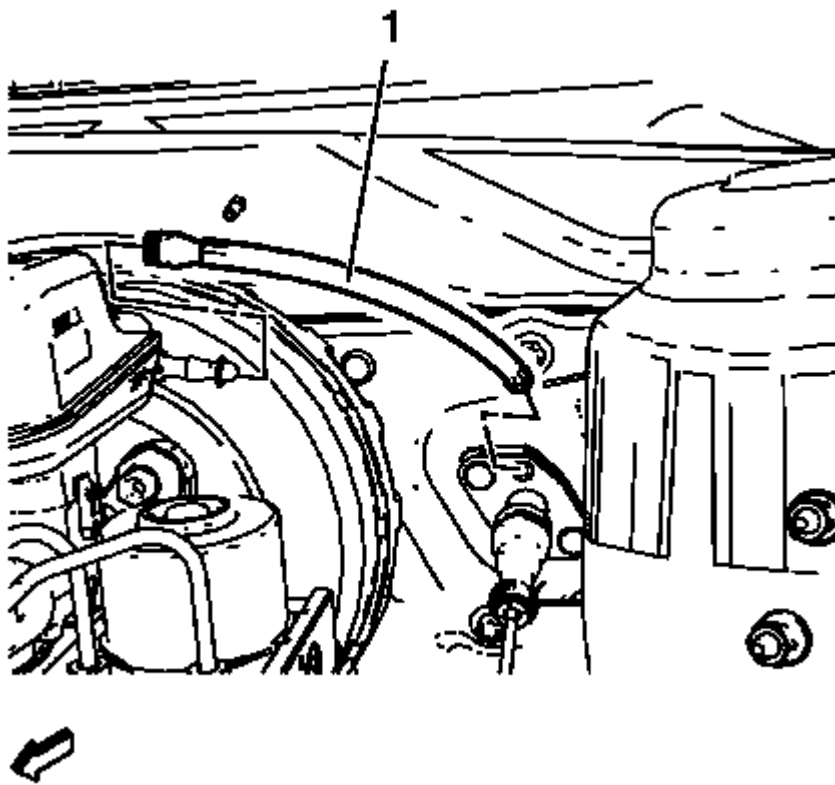


Fig. 4: Clutch Master Cylinder Reservoir Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install the clutch master cylinder reservoir hose (1) to the reservoir tank and the master cylinder.
2. Bleed the hydraulic clutch system.
3. Fill the reservoir with clutch/brake fluid up to the MAX level.

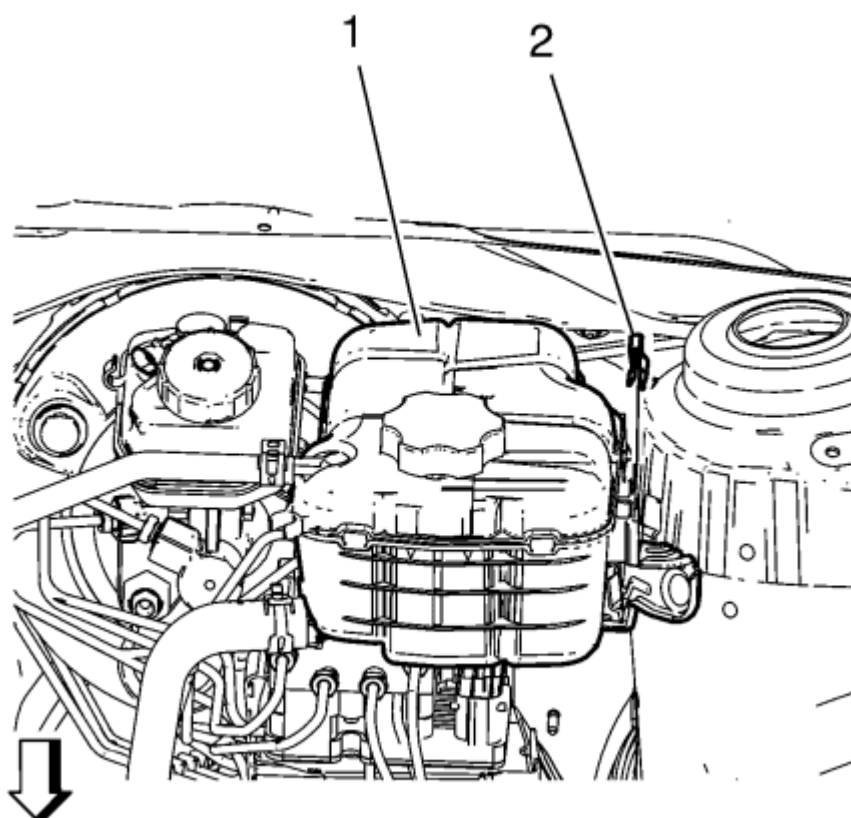


Fig. 5: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

4. Install the radiator surge tank (1).
5. Install the radiator surge tank clip (2).

CLUTCH MASTER CYLINDER REPLACEMENT

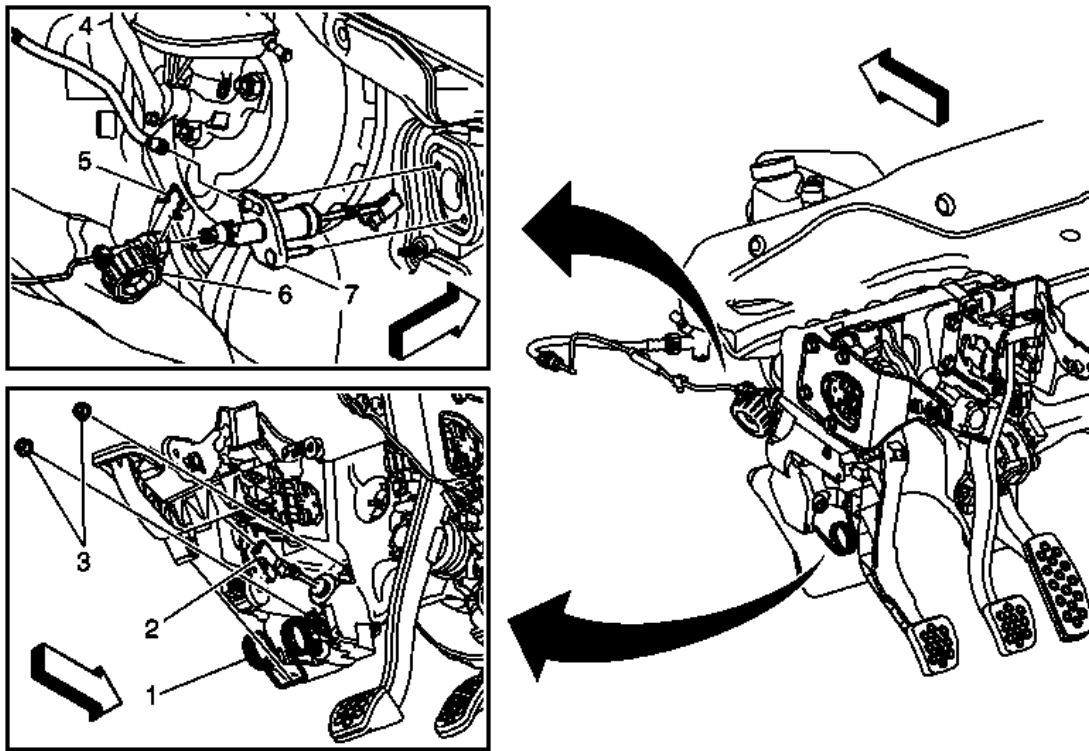


Fig. 6: Clutch Master Cylinder & Components
 Courtesy of GENERAL MOTORS COMPANY

Clutch Master Cylinder Replacement

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
CAUTION: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Caution</u> .	
Preliminary Procedures	
1. Remove the instrument panel lower trim panel insulator. Refer to <u>Instrument Panel Lower Trim Panel Insulator Replacement</u> .	
2. Remove the radiator surge tank. Refer to <u>Radiator Surge Tank Replacement (LTG)</u> .	
1	Clutch Pedal Return Spring Procedure Release the spring from the underside of the clutch pedal.
2	Clutch Pedal Master Cylinder Rod Procedure <ol style="list-style-type: none"> Depress the clutch pedal master cylinder rod retainers.

	<ol style="list-style-type: none"> Lift the clutch pedal upwards. Release the clutch pedal master cylinder rod.
3	<p>Clutch Master Cylinder Fastener (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> Release the retainers from the pedal housing. Rotate the retainers inside the clutch pedal. Remove the clutch pedal retainers. <p>Tighten 22 (16 lb ft)</p>
4	<p>Clutch Master Cylinder Inlet Pipe</p> <p>Procedure Release the clutch master cylinder inlet pipe from the master cylinder.</p>
5	<p>Clutch Master Cylinder Outlet Pipe Retainer</p> <p>Procedure Lift the retainer upwards to release the clutch master cylinder outlet pipe.</p>
6	<p>Clutch Master Cylinder Modulator Outlet Pipe</p> <p>Procedure Release the clutch master cylinder modulator outlet pipe from the master cylinder.</p>
7	<p>Clutch Master Cylinder</p> <p>Procedure Bleed the hydraulic clutch. Refer to <u>Hydraulic Clutch System Bleeding</u>.</p>

CLUTCH ACTUATOR CYLINDER FRONT PIPE REPLACEMENT

Removal Procedure

- Remove the battery tray. Refer to **Battery Tray Replacement** .

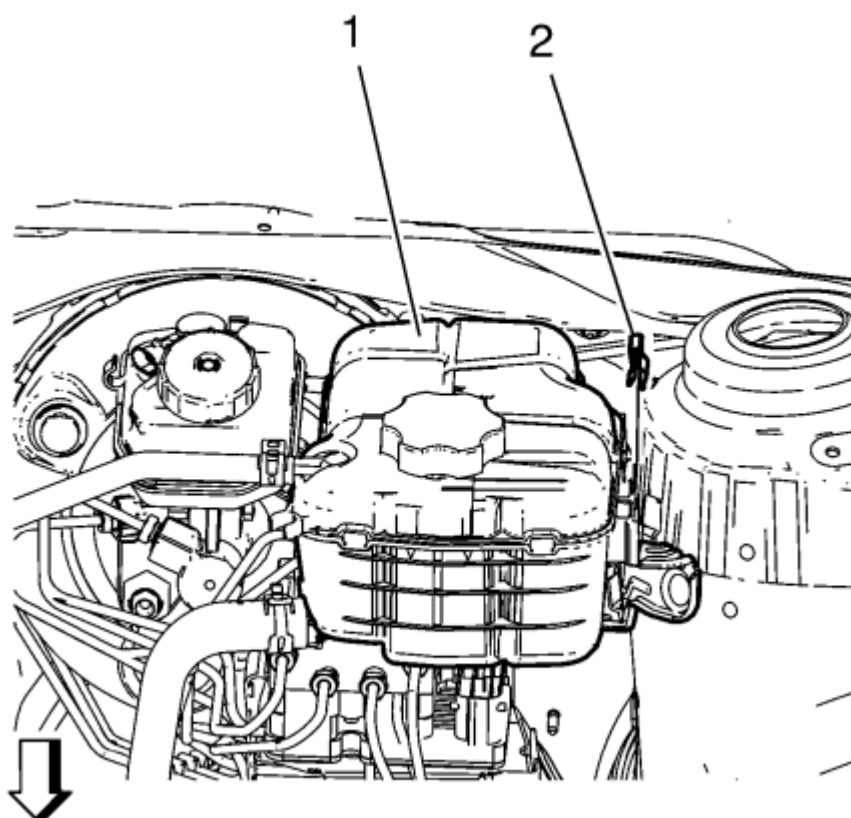


Fig. 7: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT disconnect engine coolant hoses.**

2. Remove the radiator surge tank clip (2).
3. Remove the radiator surge tank (1).

Position the radiator surge tank (1) aside.

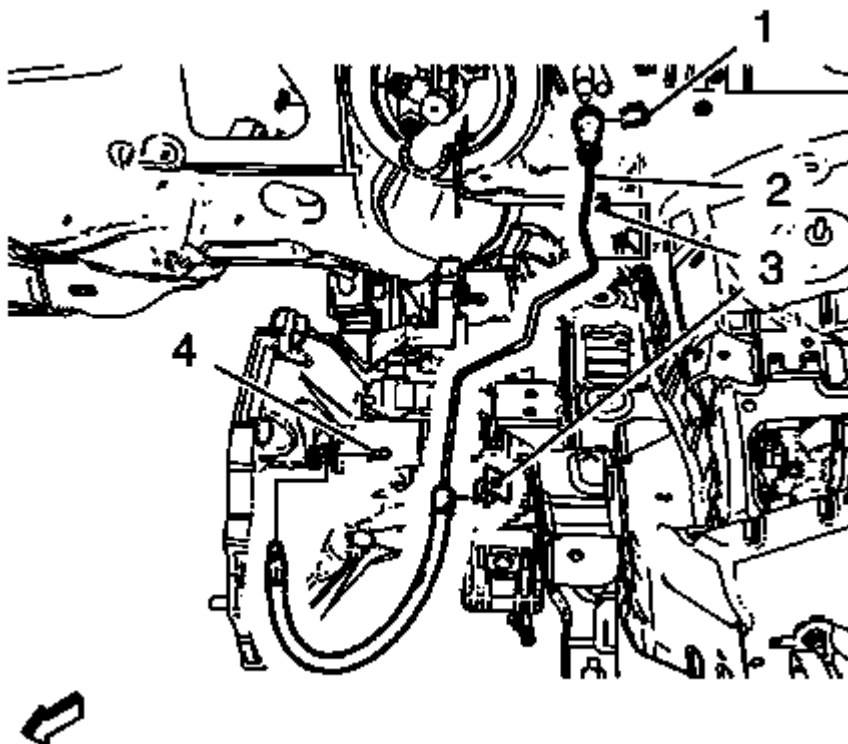


Fig. 8: Clutch Actuator Cylinder Front Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Before disconnecting the clutch actuator cylinder front pipe, remove the clutch/brake fluid from the reservoir tank.

4. Remove the clutch actuator cylinder front pipe retainer (1, 4).
5. Remove the clutch actuator cylinder front pipe from the retainer (3).
6. Remove the clutch actuator cylinder front pipe (2).

Installation Procedure

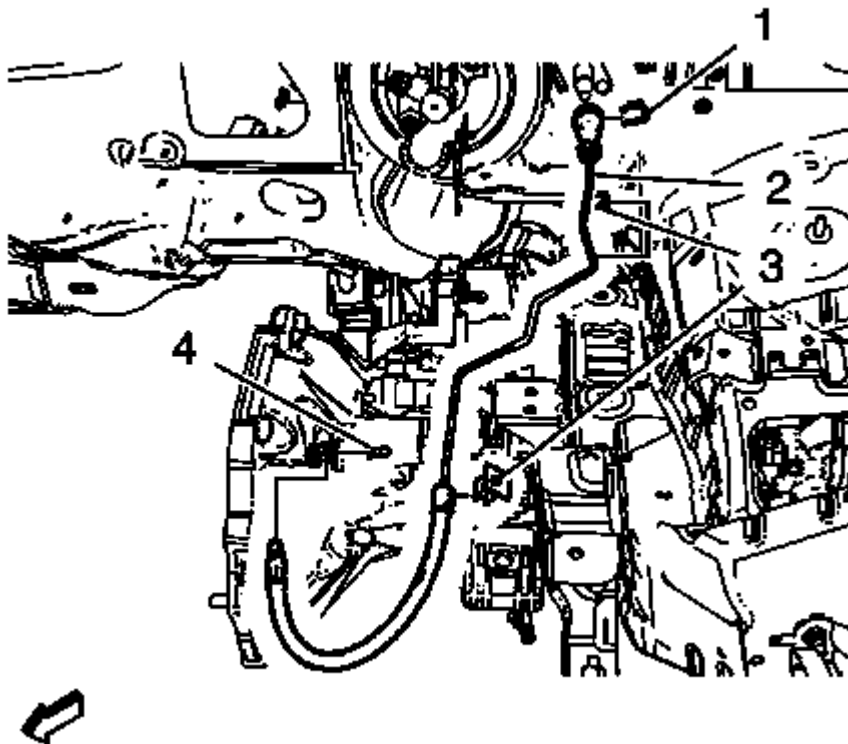


Fig. 9: Clutch Actuator Cylinder Front Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the clutch actuator cylinder front pipe (2).
2. Install the clutch actuator cylinder front pipe to the retainer (3).
3. Install the clutch actuator cylinder front pipe retainer (1, 4).
4. Bleed the hydraulic clutch system.
5. Fill the reservoir with clutch/brake fluid up to the MAX level.

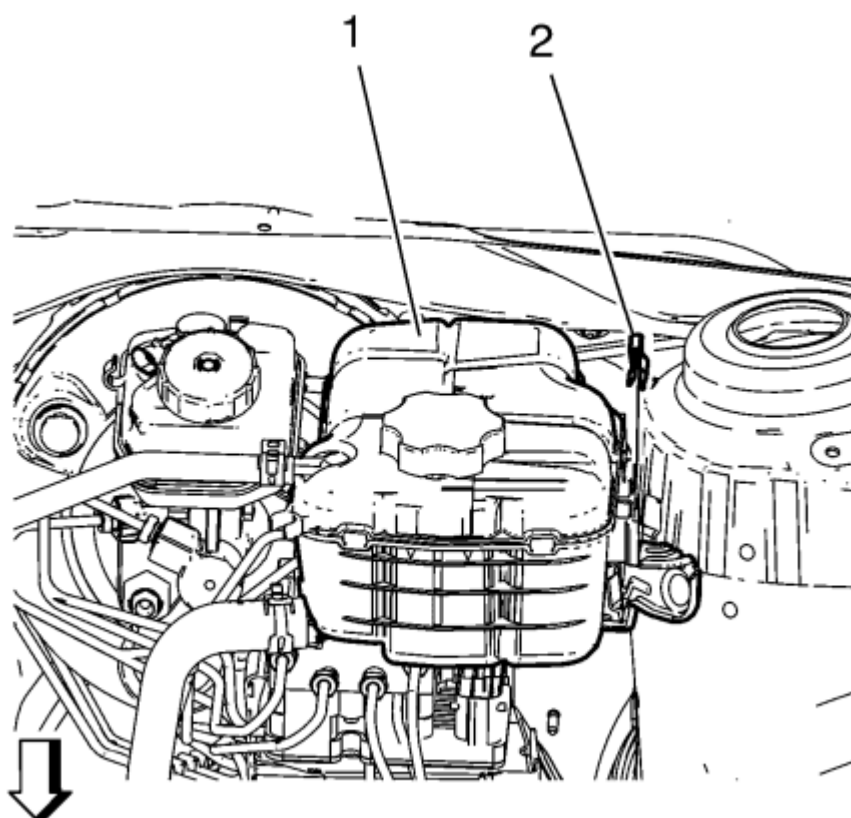


Fig. 10: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

6. Install the radiator surge tank (1).
7. Install the radiator surge tank clip (2).
8. Install the battery tray. Refer to **Battery Tray Replacement** .

CLUTCH ACTUATOR CYLINDER PIPE REPLACEMENT

Removal Procedure

1. Remove the transmission. Refer to **Transmission Replacement** .

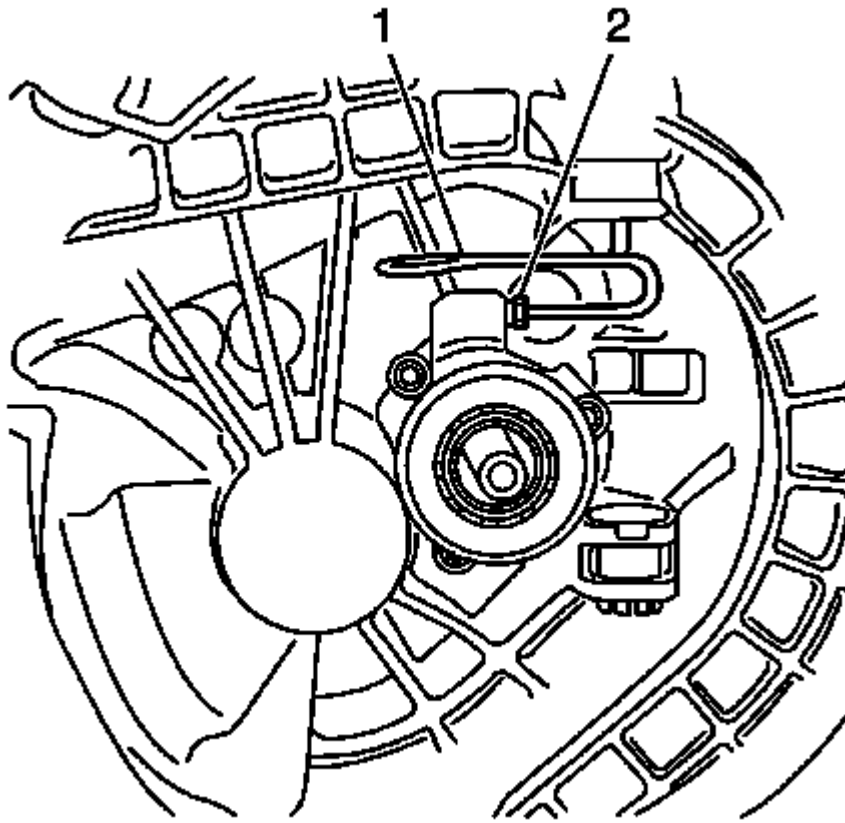


Fig. 11: Clutch Actuator Pressure Line And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Detach pressure line (1) from central release and unscrew bolt (2).

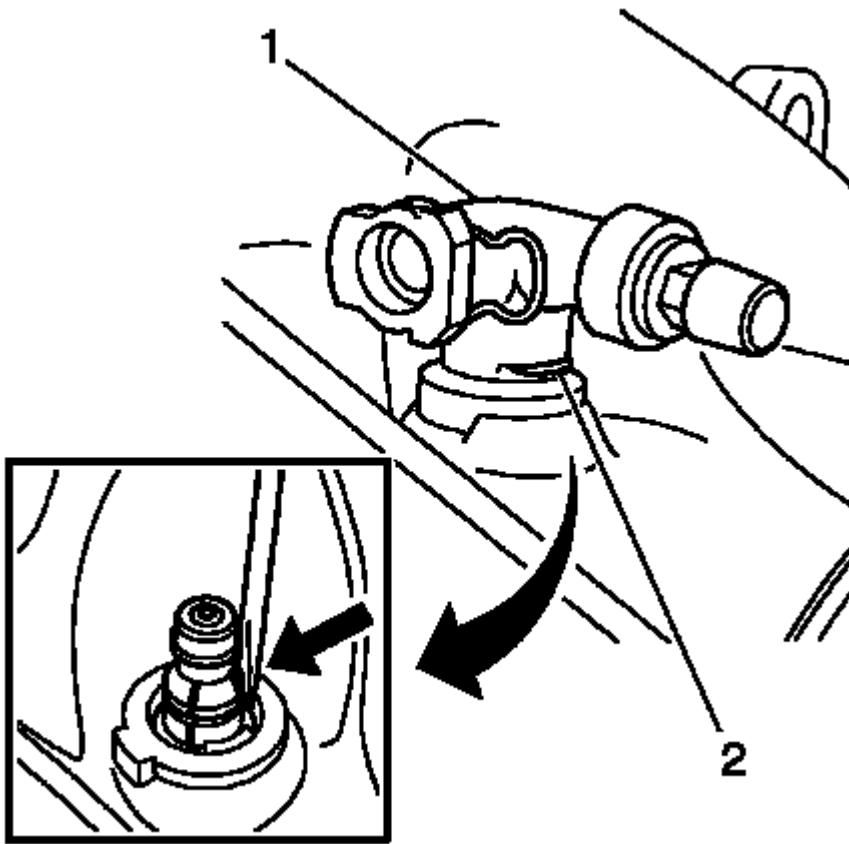


Fig. 12: Clutch Actuator Pressure Line And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

3. Remove connector for pressure line (1).
 1. Remove retaining clip (2).
 2. Remove connector.

NOTE: If necessary, bend squeeze together slightly.

3. Replace retaining clip in connector.
4. Remove pressure line.

NOTE: Carefully disengage retaining lugs.

1. Clip pressure line out of fastening sleeve using a screwdriver or equivalent.
 2. Remove pressure line.

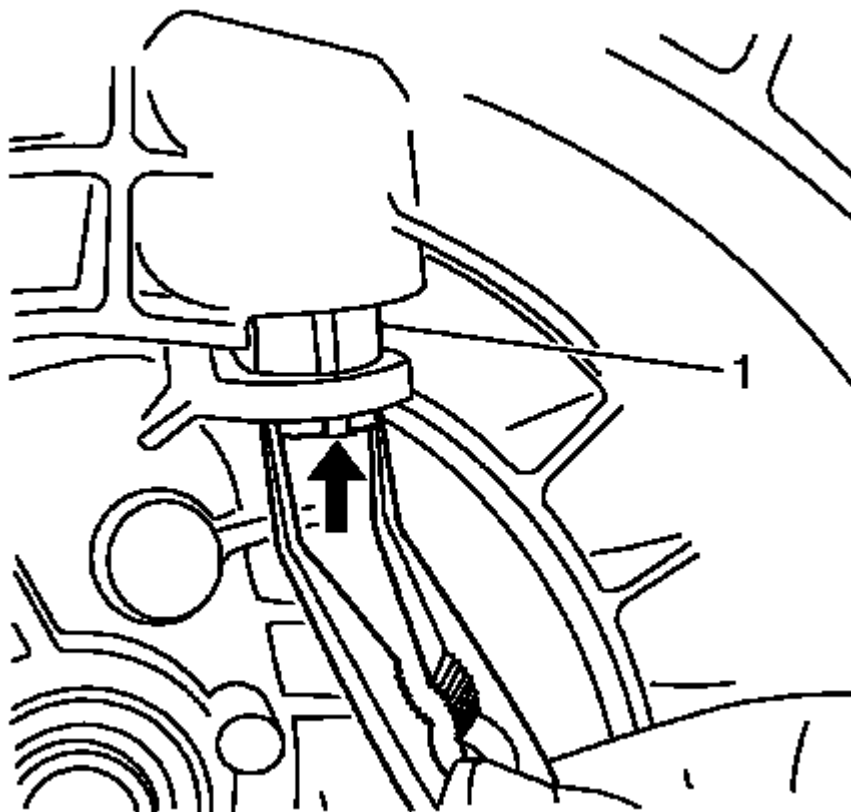


Fig. 13: Slide Fastening Sleeve Upwards
Courtesy of GENERAL MOTORS COMPANY

NOTE: Fastening sleeve must be replaced after removal.

5. Remove fastening sleeve.
 1. Disengage fastening sleeve (1) from clutch housing.
 2. Slide fastening sleeve upwards.
 3. Remove fastening sleeve.
6. Check seal ring and pressure line for damage, replace if necessary.

Installation Procedure

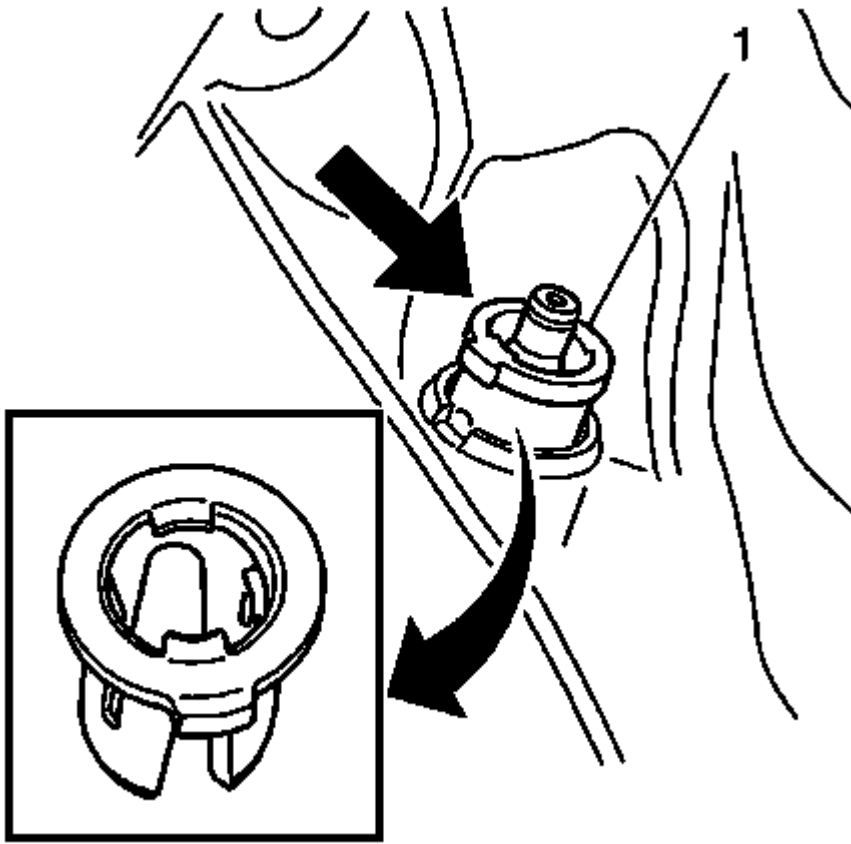


Fig. 14: Fastening Sleeve And Insertion Slot Location
Courtesy of GENERAL MOTORS COMPANY

NOTE: Insert projection on sleeve in the slot provided in the transmission.

1. Attach fastening sleeve (1). Push into transmission housing - must noticeably engage.

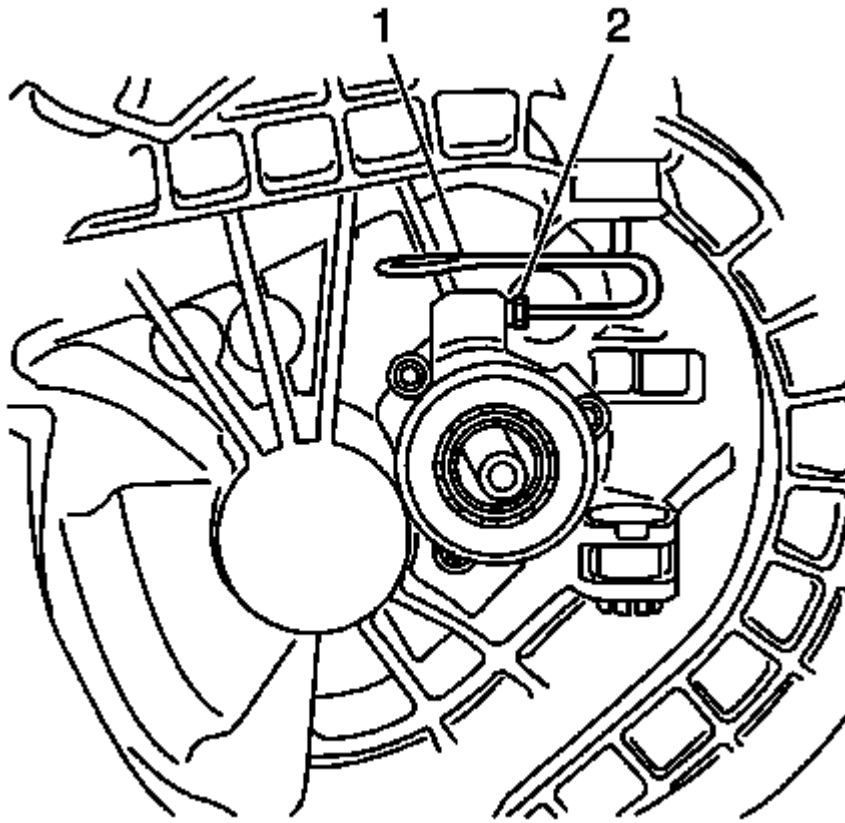


Fig. 15: Clutch Actuator Pressure Line And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install pressure line (1) and insert in fastening sleeve - must noticeably engage.
3. Attach pressure line and tighten nut (2).

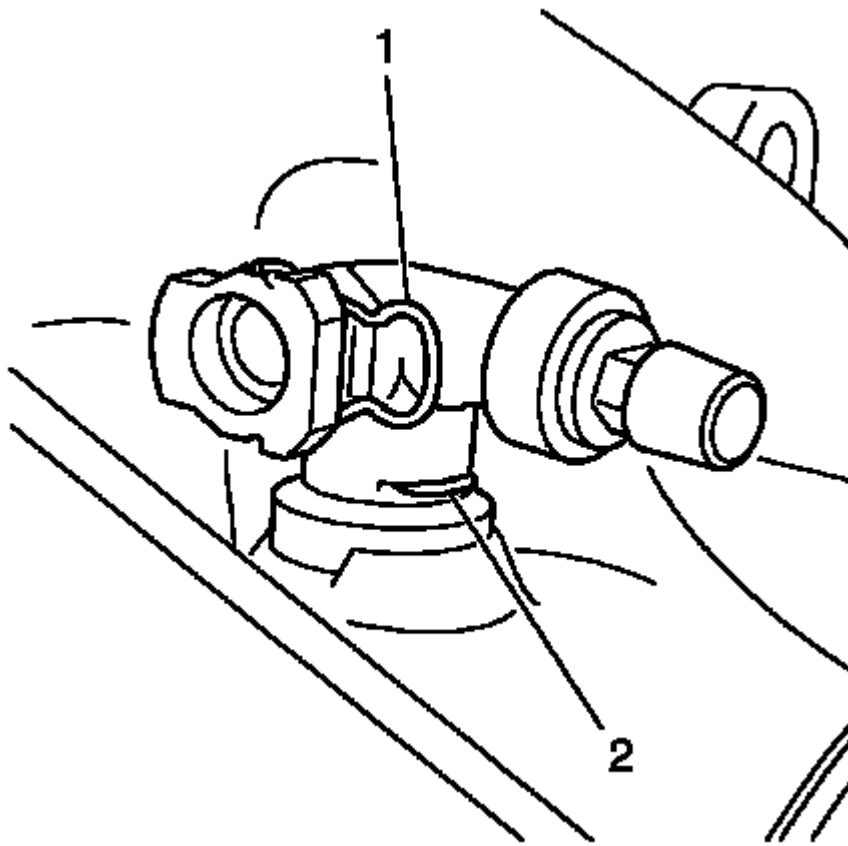


Fig. 16: Pressure Line And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

4. Attach connector for pressure line (1) and put connector on pressure line - retaining clip (2) must noticeably engage.
5. Install the transmission. Refer to **Transmission Replacement** .

HYDRAULIC CLUTCH LOW PRESSURE HOSE REPLACEMENT

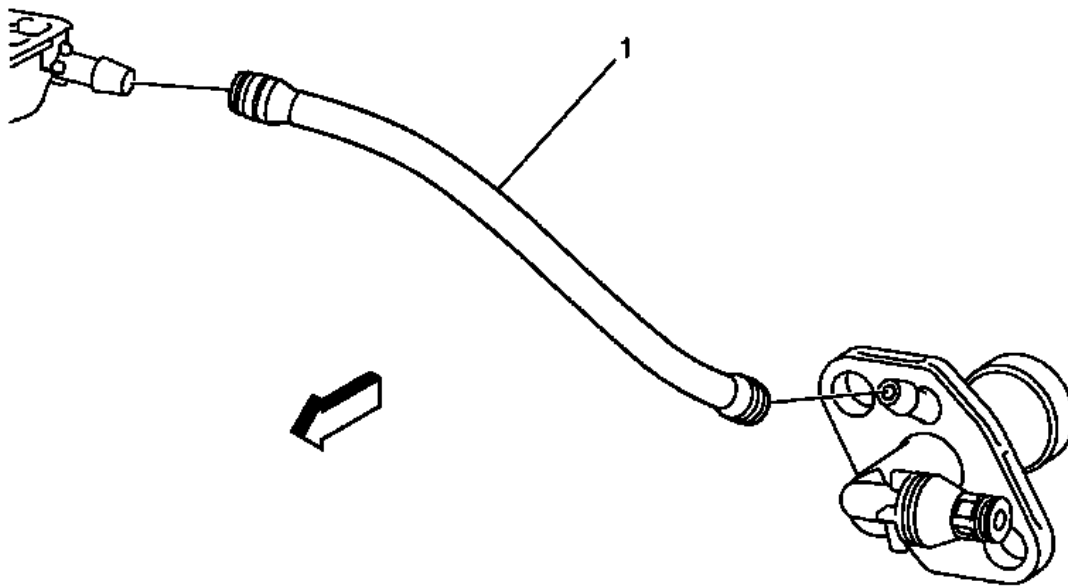


Fig. 17: Hydraulic Clutch Low Pressure Hose
Courtesy of GENERAL MOTORS COMPANY

Hydraulic Clutch Low Pressure Hose Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Reposition the expansion tank to the cooling system. 2. Bleed the clutch system so there is no fluid in the hose. Refer to <u>Hydraulic Clutch System Bleeding</u>. 	
1	Hydraulic Clutch Low Pressure Hose CAUTION: Do not twist or damage the pipe assembly when removing the pipe assembly. Procedure <ol style="list-style-type: none"> 1. Refill the brake fluid container and bleed the clutch. Refer to <u>Hydraulic Clutch System Bleeding</u>. 2. Test the brakes and clutch after replacing the hose.

HYDRAULIC CLUTCH SYSTEM BLEEDING

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Brake fluid must not come in contact with mineral oils and greases. The smallest amount of such could lead to malfunction or breakdown of the clutch.

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

NOTE: The hydraulic clutch actuation must only be bled from "below", i.e. from the bleeder valve.

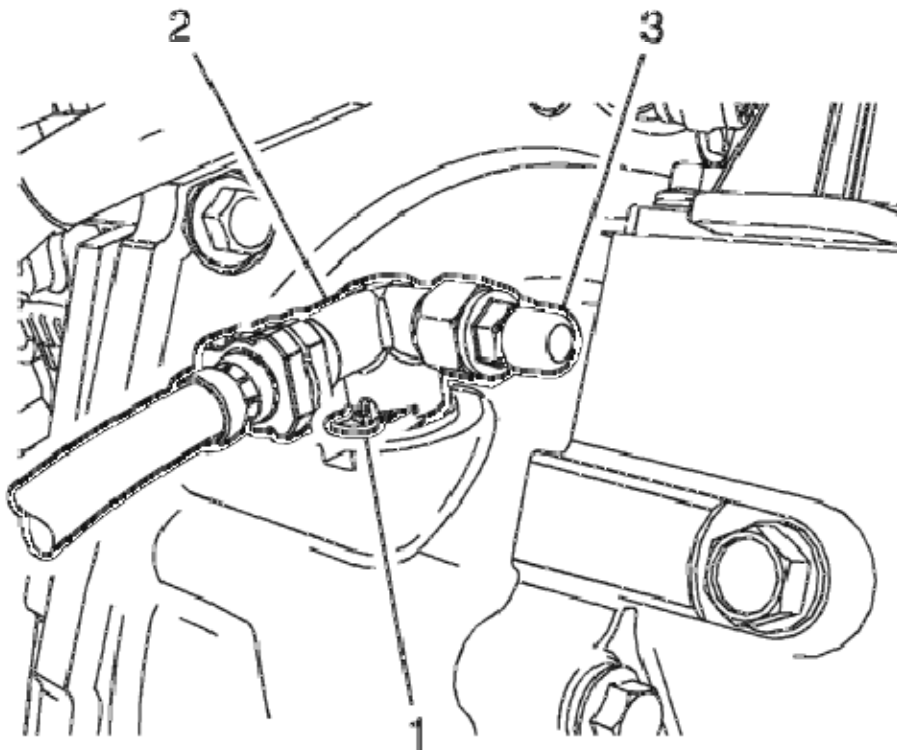


Fig. 18: valve cap

Courtesy of GENERAL MOTORS COMPANY

NOTE: The following operational stages must be undertaken to fill the pressure line between the master cylinder and the clutch actuator cylinder. When bleeding, ensure that the brake fluid reservoir is always full and does not run dry.

1. Bleed pressure line between the clutch master cylinder and the clutch actuator cylinder using the following procedure:

1. Remove the valve cap (3) from the bleeder valve.
2. Fill brake fluid reservoir up to "MAX" marking.
3. Press and hold clutch pedal.
4. Open bleeder valve until air or air/brake fluid mixture emerges.

NOTE: Do not close the bleeder valve too fast.

5. Close the bleeder valve.
 6. Release the clutch pedal slowly.
 7. Wait approximately 5 seconds.
 8. Repeat this bleeding process 4 times.
 9. Tighten bleeder valve .
 10. Push valve cap on to bleeder valve to protect the bleeder valve.
2. Check shifting for ease of movement with vehicle stationary, with engine running and with clutch disengaged.
 3. Road test the vehicle to ensure proper operation.

Undertake road test using varying RPM ranges and frequent gear changes, bring vehicle to operating temperature during this process. Ensure the brake and clutch system is operating correctly.

CLUTCH PEDAL POSITION SENSOR REPLACEMENT

Removal Procedure

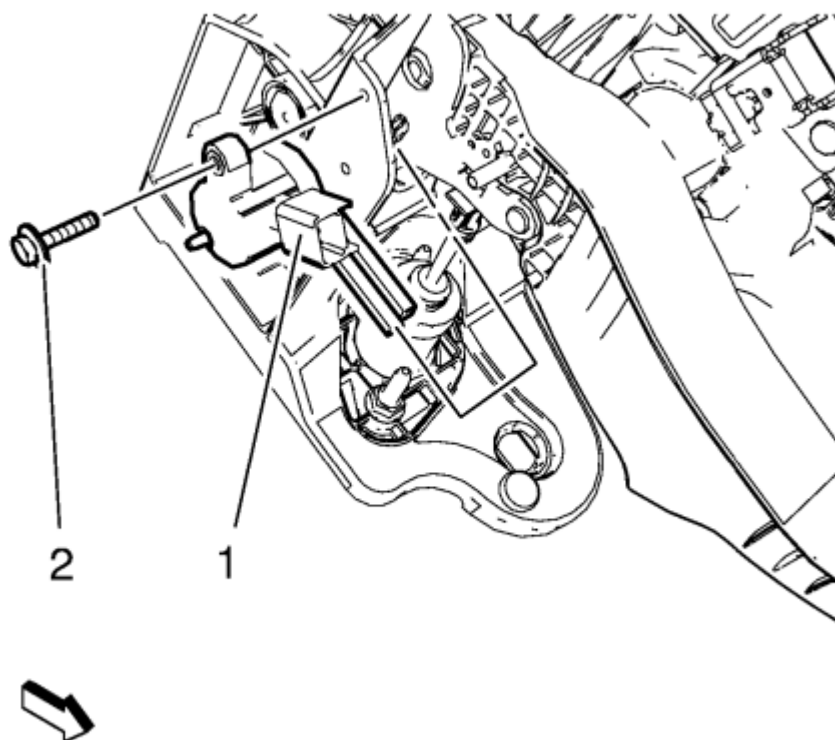


Fig. 19: Clutch Pedal Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect clutch pedal position sensor wiring harness connector.
2. Remove clutch pedal position sensor bolt (2).
3. Remove clutch pedal position sensor (1).

Installation Procedure

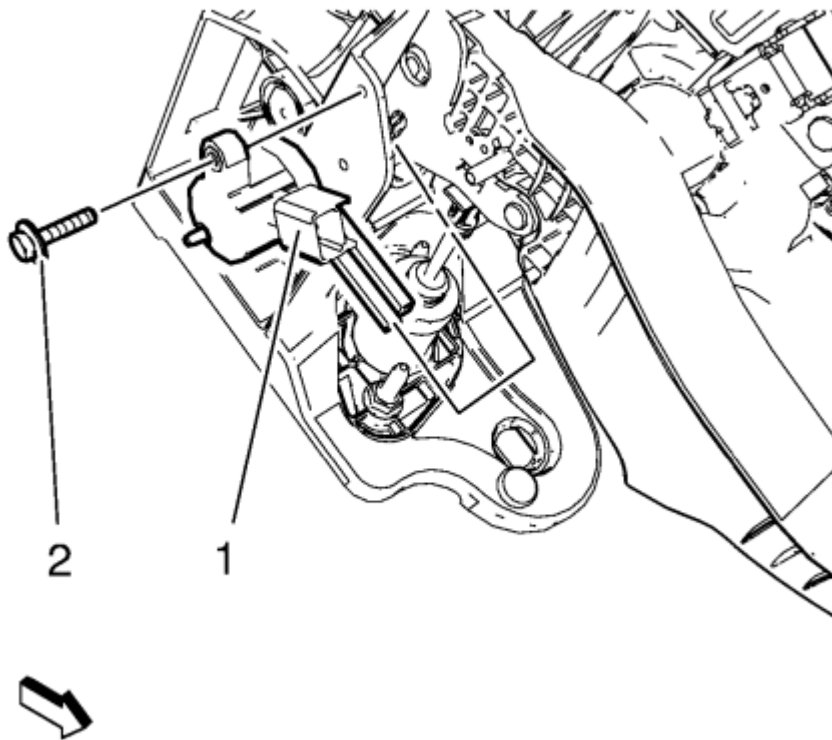


Fig. 20: Clutch Pedal Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install clutch pedal position sensor (1).

CAUTION: Refer to Fastener Caution .

2. Install clutch pedal position sensor bolt (2) and tighten to 3 N.m (27 lb in).
3. Connect clutch pedal position sensor wiring harness connector.
4. Learn clutch pedal position sensor.

CLUTCH ASSEMBLY REPLACEMENT (WITH DT-6263)

Special Tools

- **DT-6263** Remover and Installer
- **DT-6263-25** Centering Drift
- **DT-6263-30** Handle

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the transmission. Refer to Transmission Replacement .

NOTE: To prevent damage to the spring tangs of the thrust plate use DT-6263 remover and installer to remove and install the thrust plate.

Note the different lengths of the brackets for attaching DT-6263 remover and installer to lower engine block. Thrust plate and clutch disc for vehicles with self-adjusting clutch (SAC) are only available in Aftersales as a set.

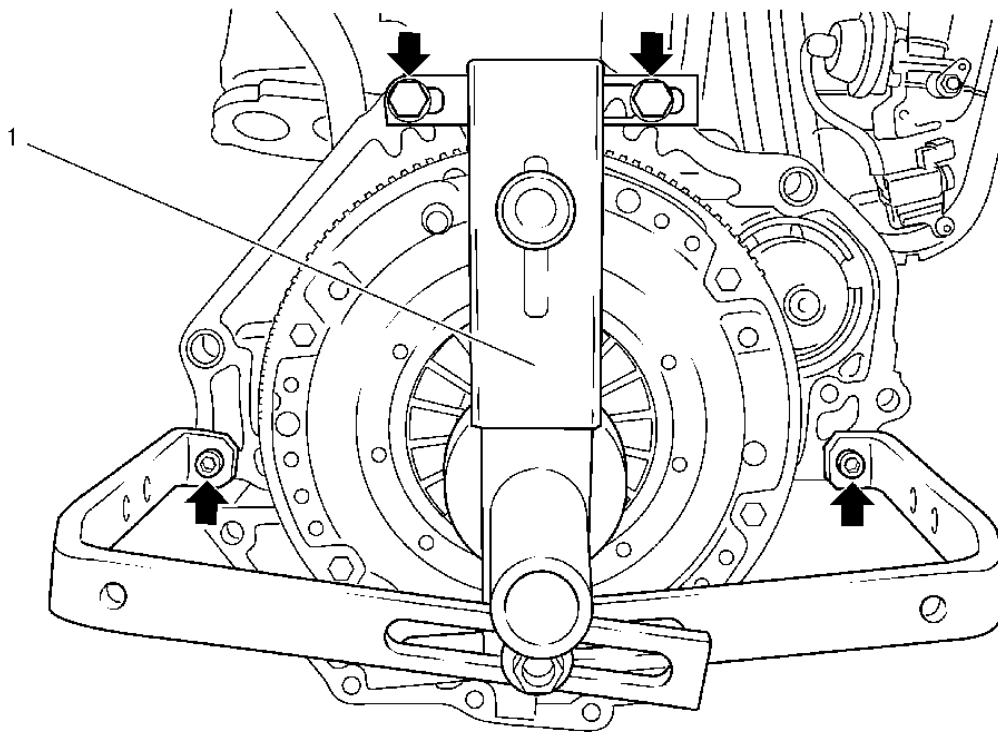


Fig. 21: Clutch Assembly Remover And Installer
Courtesy of GENERAL MOTORS COMPANY

NOTE: DT-6263 remover and installer may only be attached to the engine block and not to the oil pan, do not tighten bolts yet.

2. Attach **DT-6263** remover and installer (1) to engine block.

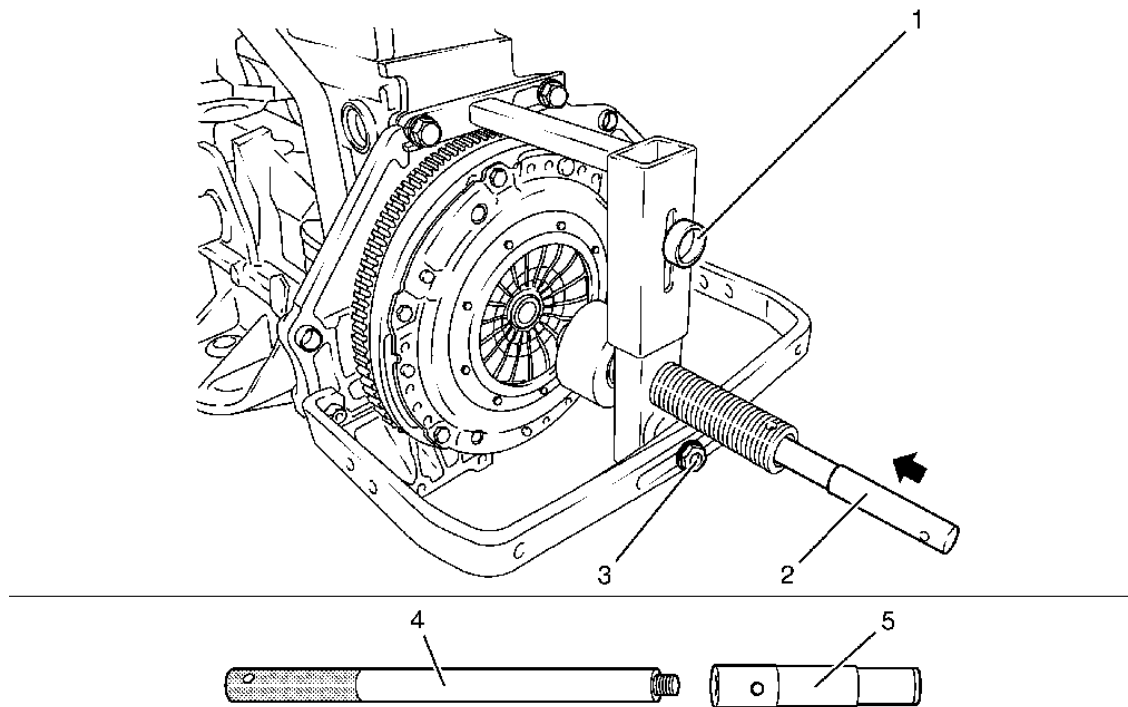


Fig. 22: Engine Block, Clutch Assembly Remover And Installer (DT-6263)
Courtesy of GENERAL MOTORS COMPANY

3. Attach **DT-6263-30** handle (4) to centring drift (5).

CAUTION: Refer to Fastener Caution .

4. Fasten **DT-6263** remover and installer.
 1. Align **DT-6263** remover and installer in center.
 2. Insert centring drift with **DT-6263-30** handle (2) through **DT-6263** remover and installer into clutch plate and crankshaft (center).
 3. Tighten fastener (1).
 4. Tighten fastener (3).
 5. Tighten 4x fastener **DT-6263** remover and installer on engine block.

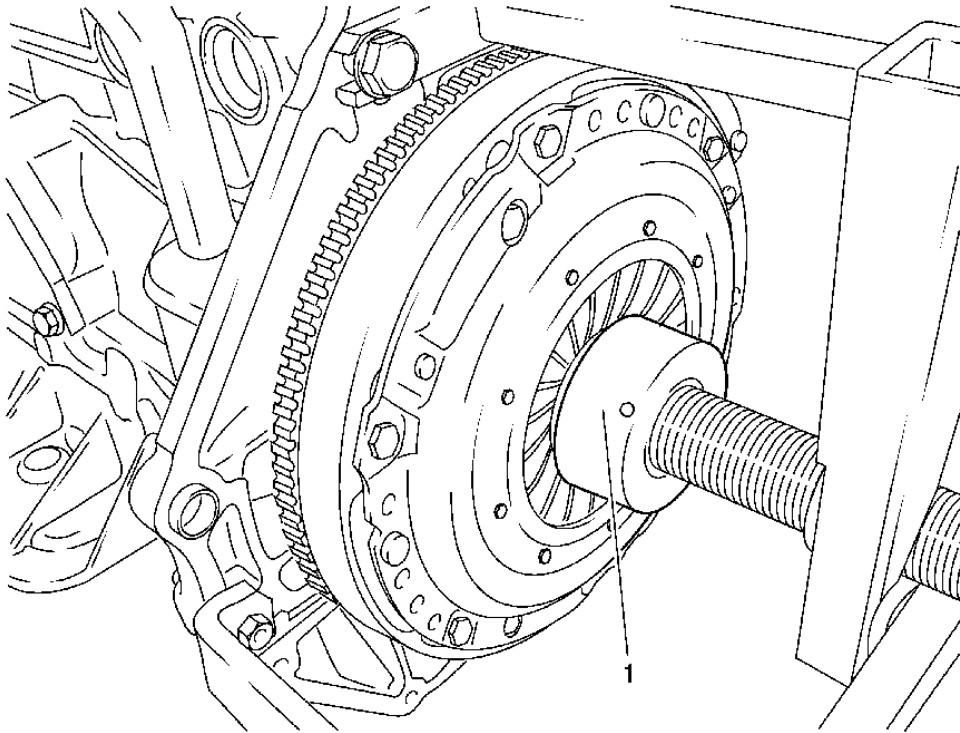


Fig. 23: Relieving Stress On Clutch Disc
Courtesy of GENERAL MOTORS COMPANY

5. Relieve stress on clutch disc.
 1. Move **DT-6263** remover and installer (1) so that it rests against spring tangs of the thrust plate.
 2. Turn **DT-6263** remover and installer clockwise to the stop.

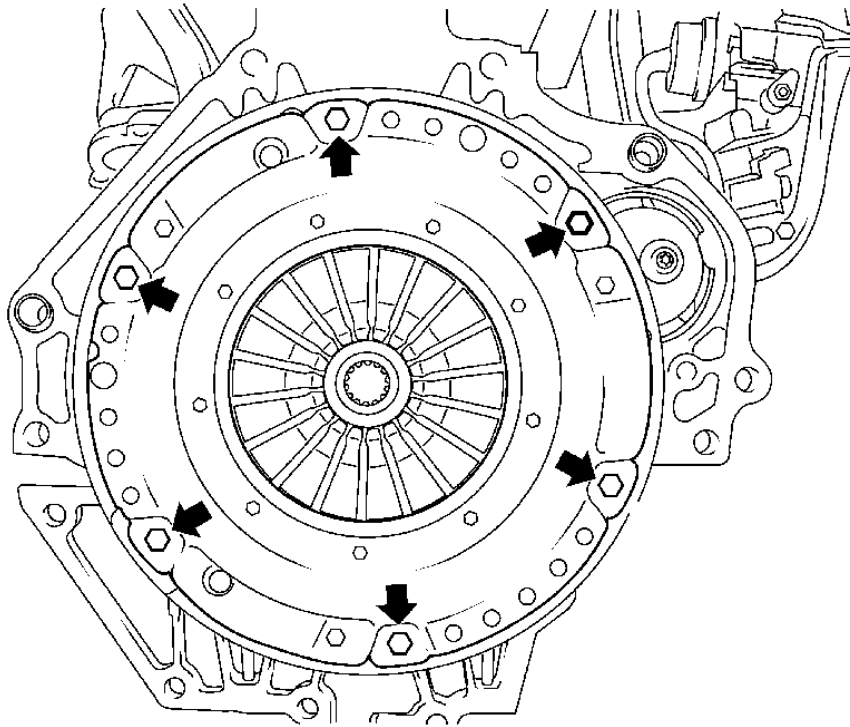


Fig. 24: Thrust Plate Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: Illustration 2156559 gives a better view of the clutch without DT-6263 remover and installer and centring drift with DT-6263-30 handle.

6. Remove thrust plate from flywheel. Remove 6 fasteners.

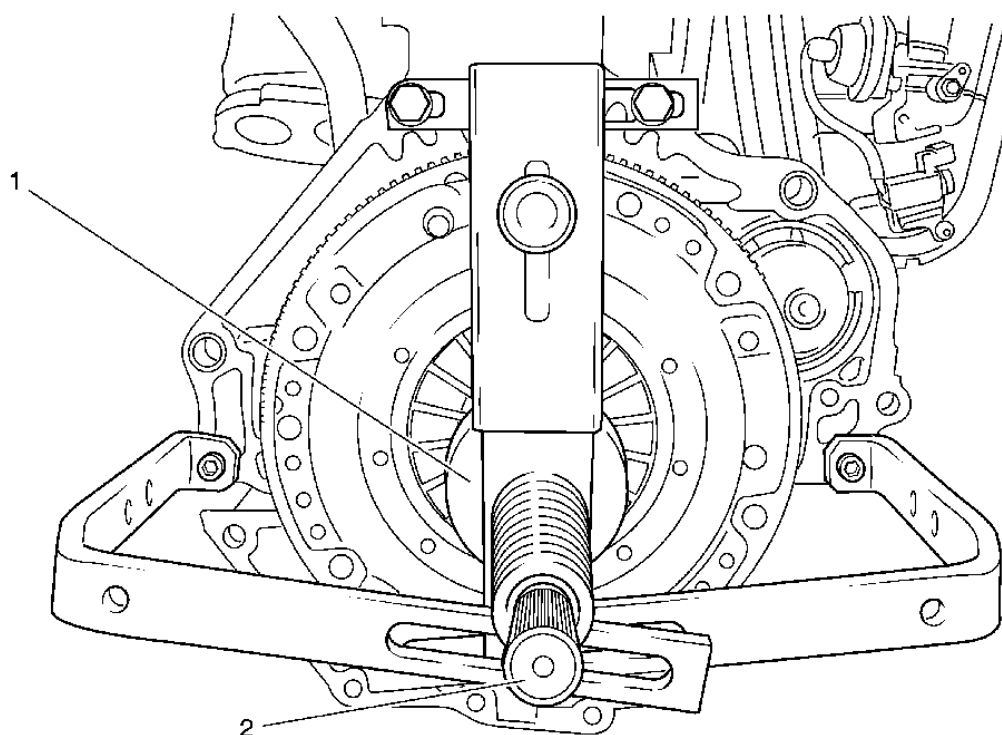


Fig. 25: Attaching Thrust Plate
Courtesy of GENERAL MOTORS COMPANY

7. Detach thrust plate and clutch plate.
 1. Turn **DT-6263** remover and installer (1) anticlockwise to the stop.
 2. Pull out centring drift with **DT-6263-30** handle (2).

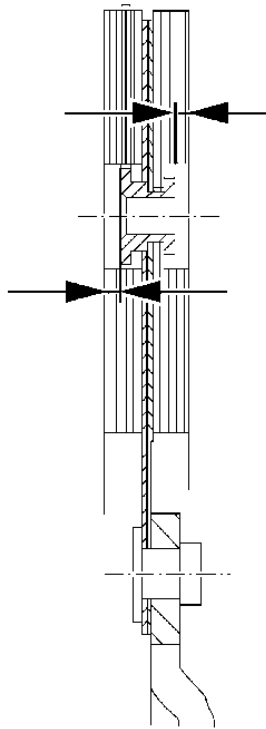


Fig. 26: Inspect Clutch Plate For Excessive Wear
Courtesy of GENERAL MOTORS COMPANY

NOTE: Clutch plates contaminated by foreign bodies (oil, cleaning agent etc.) must be replaced as a matter of principle. Check clutch disc for damage and friction rust in the hub profile and replace if necessary. Do not clean thrust plate and clutch disc with a high pressure cleaner or component washing machine.

8. Check clutch plate for wear: Check the projection of the lining at the clutch lining rivets. The clutch plate must be replaced if the lining projection is less than 0.5 mm. Also, press the clutch plate onto the transmission input shaft and check for ease of movement.

Installation Procedure

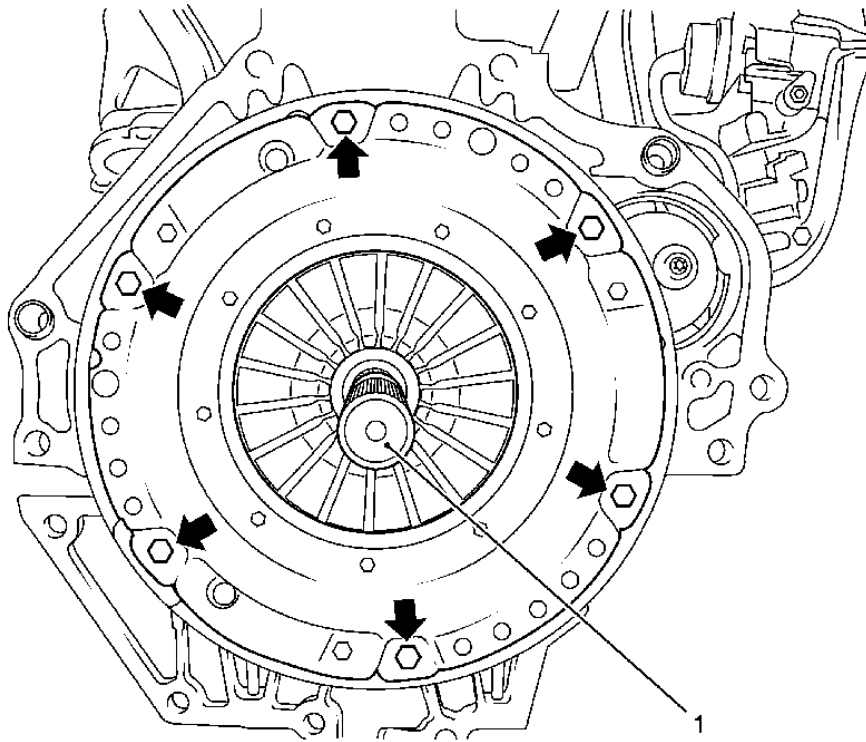


Fig. 27: Thrust Plate Fastener Locations
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lettering "transmission side" faces the transmission.

- Do not tighten bolts yet.
- For a clearer representation, illustration 2156562 shows clutch without centering drift with DT-6263-30 handle.

1. Attach clutch disc and thrust plate to flywheel.

Center thrust plate and clutch plate with centring drift and **DT-6263-30** handle (1).

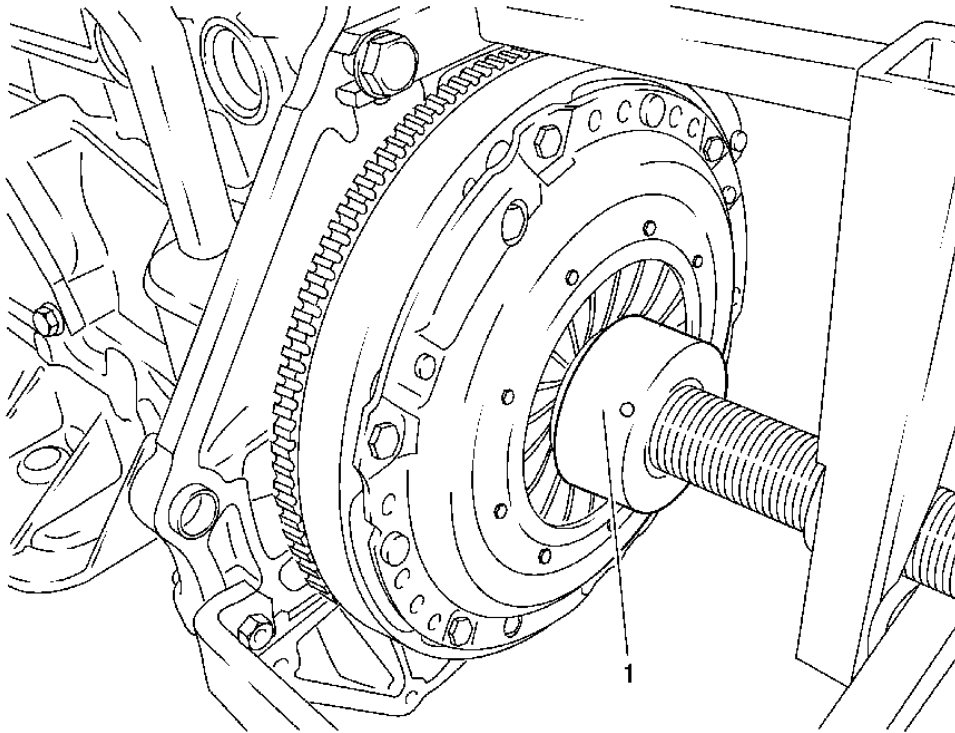


Fig. 28: View Of Remover And Installer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Tighten fastener crosswise.**

2. Attach thrust plate to flywheel and turn **DT-6263** remover and installer (1) clockwise to the stop.
 - Tighten the thrust plate - fastener M7 to 15 N.m (11 lb ft).
 - Tighten the thrust plate - fastener M8 to 22 N.m (16 lb ft).

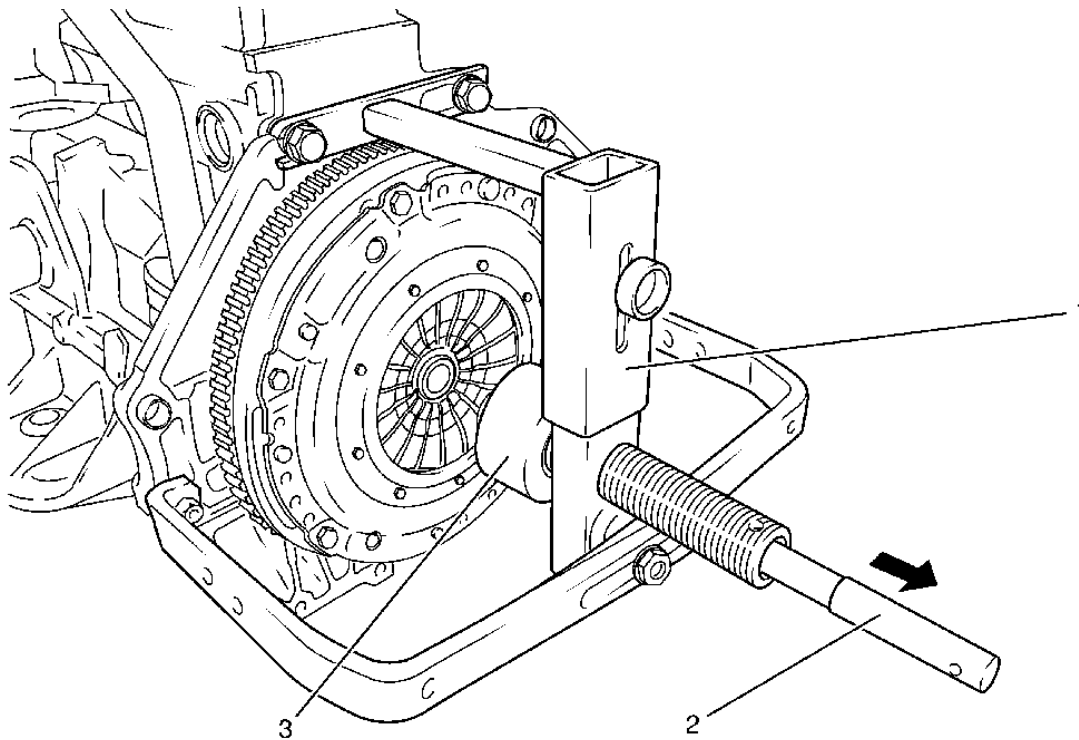


Fig. 29: Clutch Assembly Remover And Installer
Courtesy of GENERAL MOTORS COMPANY

3. Detach **DT-6263** remover and installer (1) from engine block.
 1. Turn **DT-6263** remover and installer (3) anticlockwise to the stop.
 2. Detach centring drift and **DT-6263-30** handle (2).
 3. Remove 4x fastener **DT-6263** remover and installer on engine block.
4. Install the transmission. Refer to **Transmission Replacement** .

CLUTCH RELEASE BEARING REPLACEMENT

Removal Procedure

1. Remove the transmission. Refer to **Transmission Replacement** .

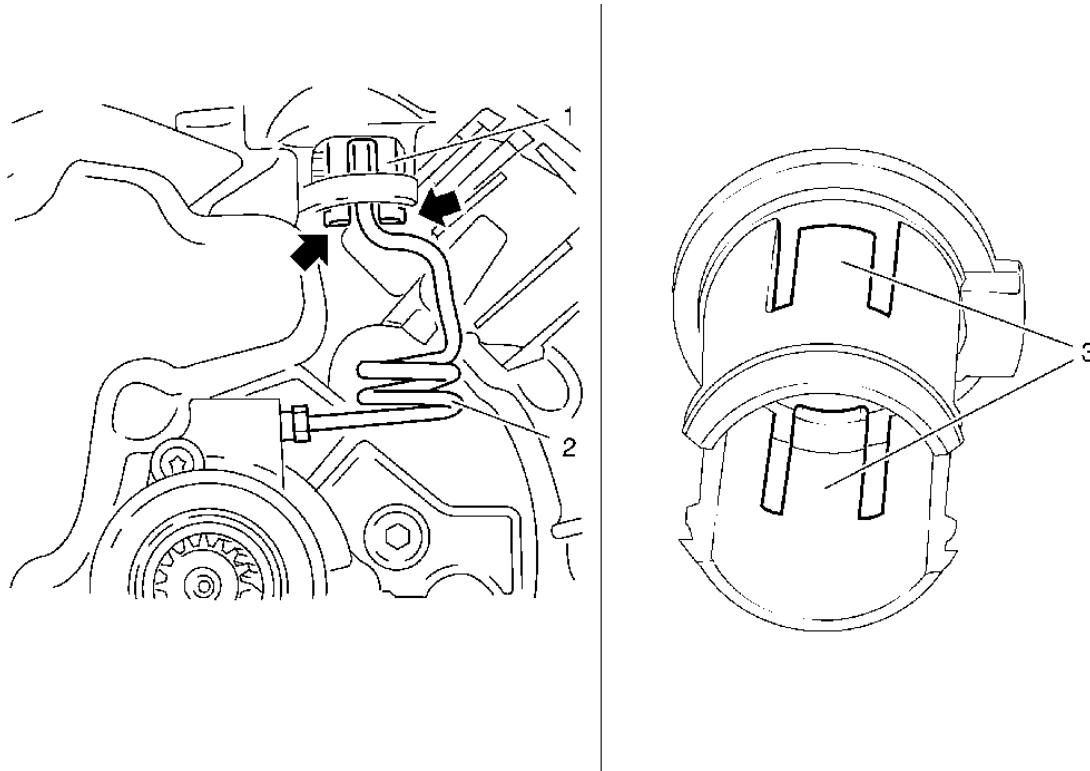


Fig. 30: Clutch Release Bearing And Attached Components
Courtesy of GENERAL MOTORS COMPANY

2. Remove pressure line fastening sleeve (1).
 - Unlatch fastening sleeve for pressure line on clutch housing (arrows).
 - Draw fastening sleeve out of transmission slightly.
 - Detach fastening sleeve for pressure line.
 - Carefully unlatch 2x retaining lug (3).

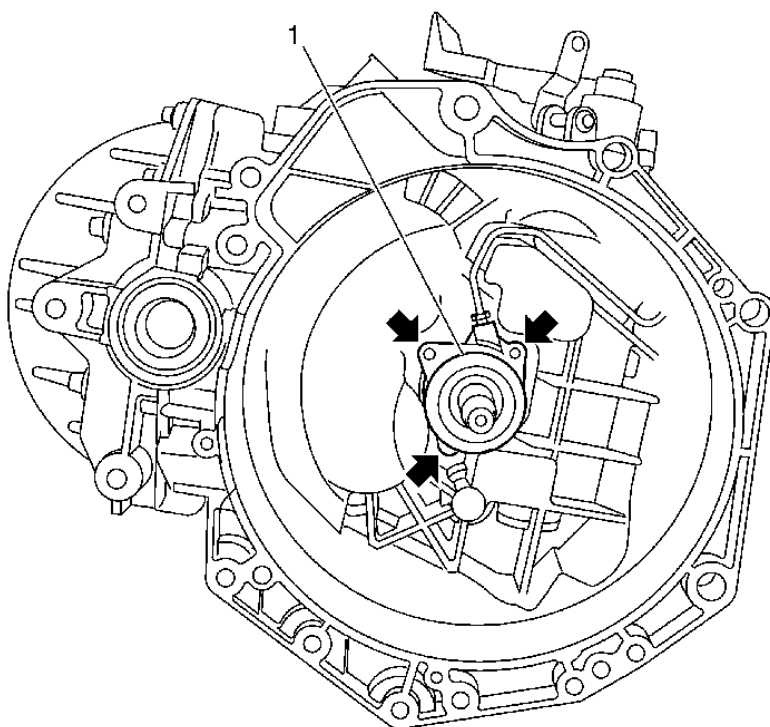


Fig. 31: Central Release With Hydraulic Line
Courtesy of GENERAL MOTORS COMPANY

3. Remove central release (1) with hydraulic line.

Remove 3x fasteners (arrow).

Installation Procedure

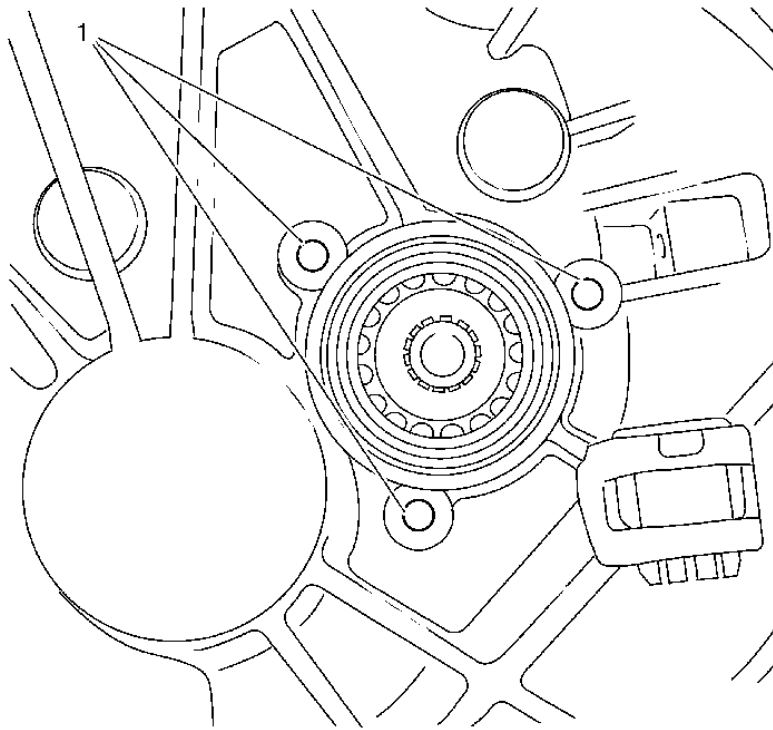


Fig. 32: Central Release Location
Courtesy of GENERAL MOTORS COMPANY

1. Clean 3x thread (1) in transmission.

NOTE: Note installation position.

2. Install fastening sleeve for pressure line.

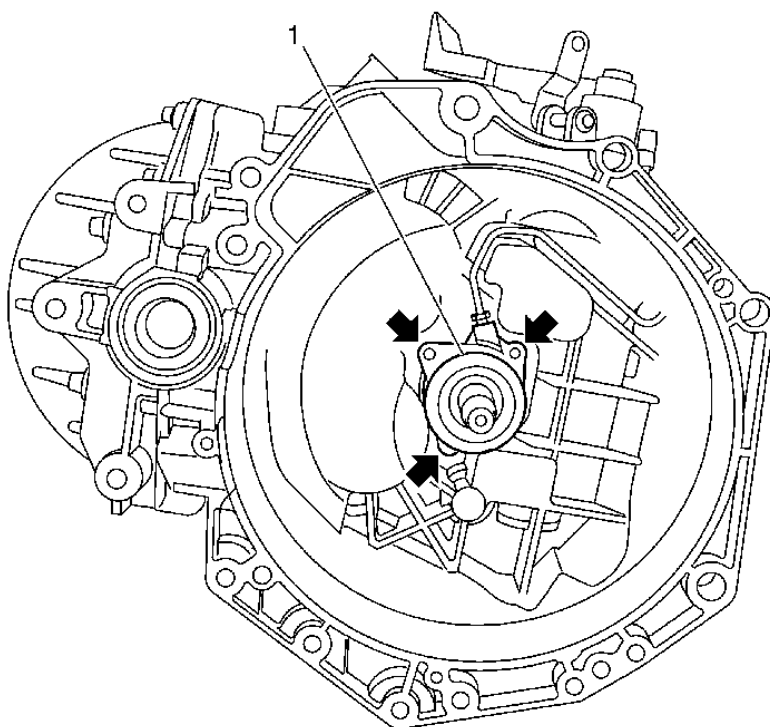


Fig. 33: Central Release And Hydraulic Line Location
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Use new bolts.
- It is essential to avoid pulling the central release at an angle.

3. Install central release (1) with hydraulic line.
 - Clip hydraulic line in sleeve.
 - Lightly coat seal ring in central release with transmission fluid.
 - Preassemble 3 fasteners evenly in contact with the flange.
 - Tighten the 3 fasteners from central release (arrow) to 6 N.m (53.1 lb in).
4. Install the transmission. Refer to **Transmission Replacement** .

CLUTCH ACTUATOR CYLINDER REPLACEMENT

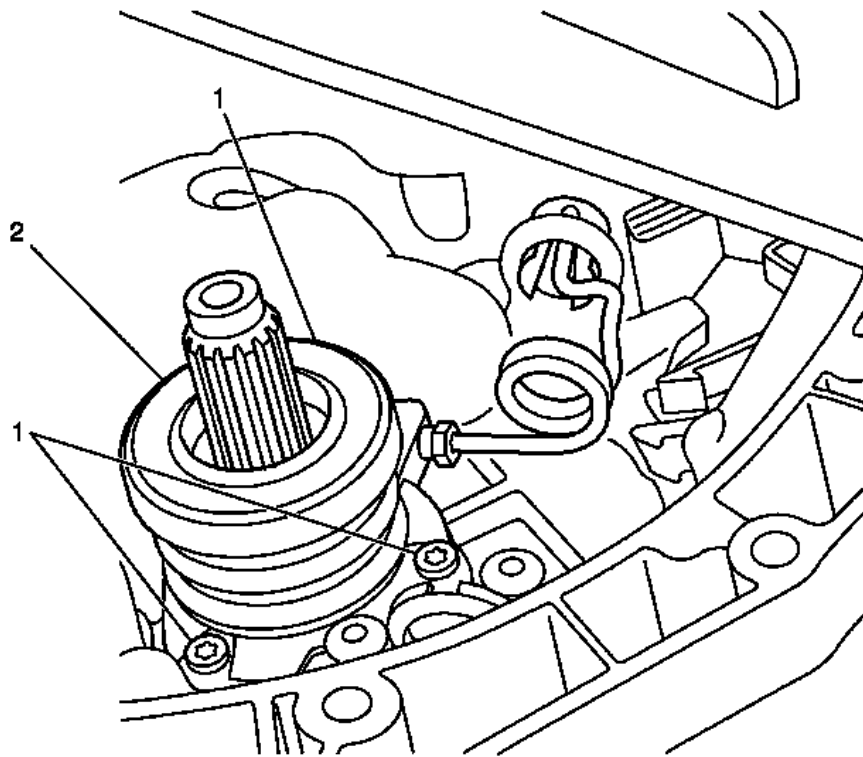


Fig. 34: Clutch Actuator Cylinder & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Clutch Actuator Cylinder Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the transmission. Refer to <u>Transmission Replacement</u> . 3. Valid only for F40: Disconnect the clutch actuator cylinder pipe from the clutch actuator cylinder. Refer to <u>Clutch Actuator Cylinder Pipe Replacement</u>. 	
1	Clutch Actuator Cylinder Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Use the appropriate thread sealant on the fasteners. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> for the appropriate sealant. Tighten 20 N.m (15 lb ft) plus 60 degrees
2	Clutch Actuator Cylinder Procedure

Bleed the clutch actuator cylinder after fitting the gearbox. Refer to **Hydraulic Clutch System Bleeding**.

DESCRIPTION AND OPERATION

CLUTCH SYSTEM DESCRIPTION AND OPERATION

General

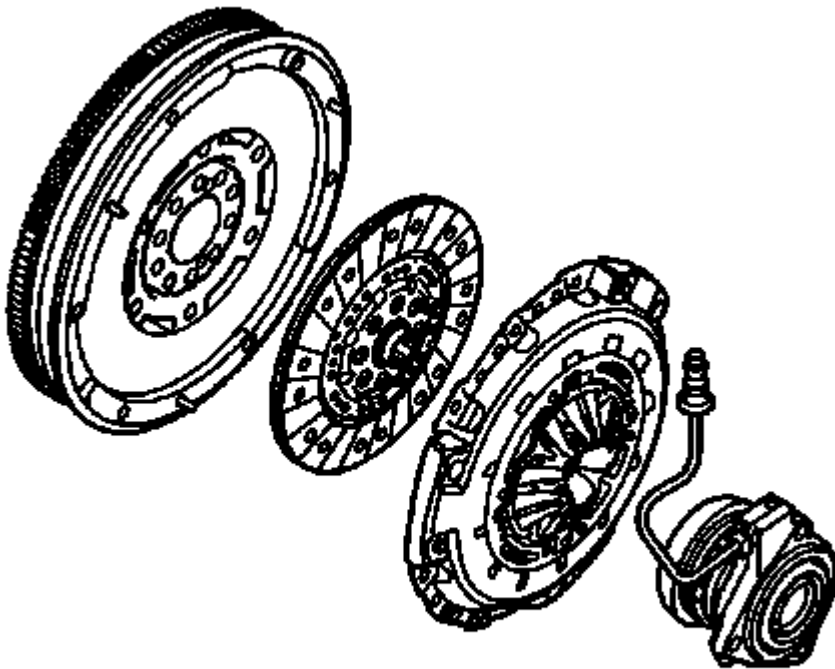


Fig. 35: Pressure Plate

Courtesy of GENERAL MOTORS COMPANY

Power is transmitted from the flywheel on the engine to the input shaft in the gearbox via a driven plate. This power is transmitted by the pressure plate, which is bolted to the flywheel, forcing the friction surface of the driven plate against the flywheel.

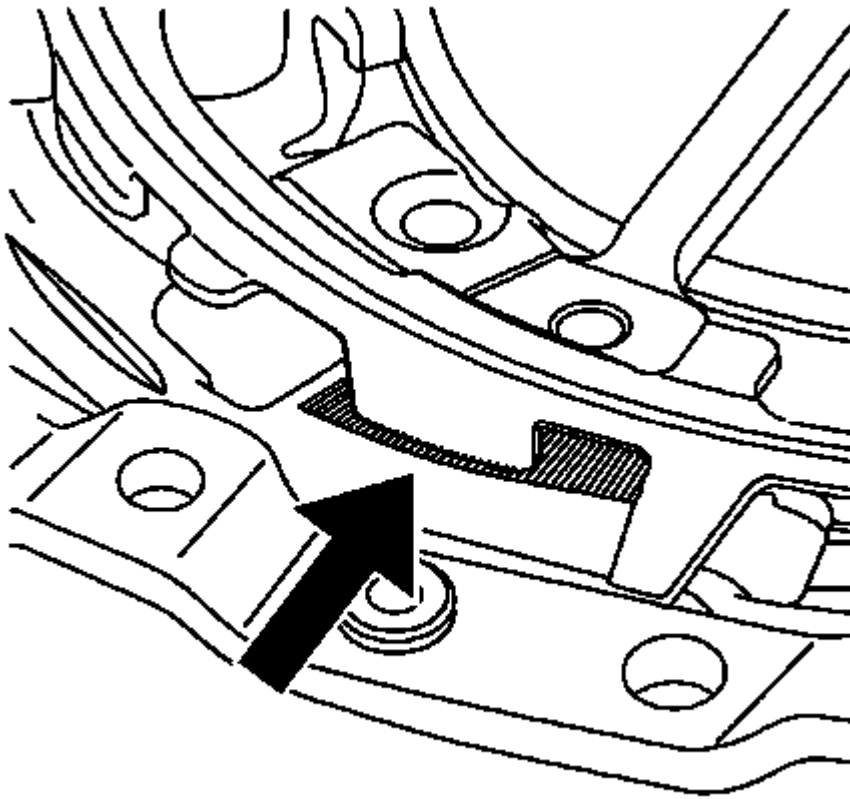


Fig. 36: Driven Plate

Courtesy of GENERAL MOTORS COMPANY

The driven plate is joined to the primary shaft with a splined joint. When the release bearing on the slave cylinder presses on the "fingers" of the diaphragm spring, the fingers will act like levers to release the clamping force of the pressure plate from the driven plate-flywheel. The engine is disengaged from the transmission in this way.

Clutch with Dual-Mass Flywheel

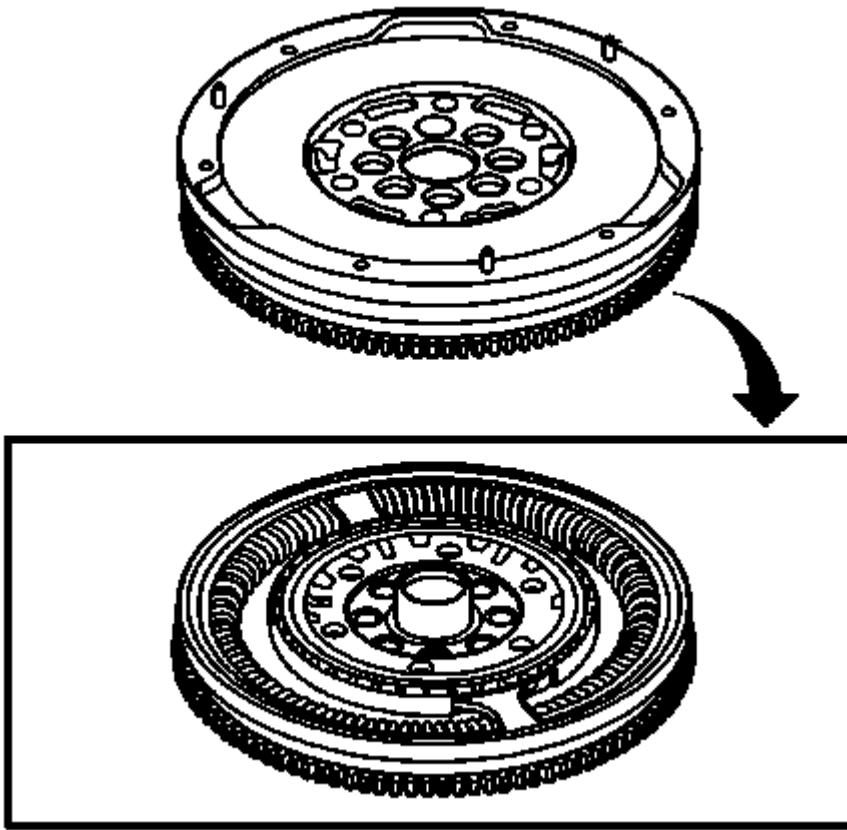


Fig. 37: Clutch Plate
Courtesy of GENERAL MOTORS COMPANY

The ability of modern, high-performance, low-weight engines to absorb vibrations themselves is poor. To reduce noise and improve ride comfort, a dual-mass flywheel has been introduced on some models.

A dual-mass flywheel comprises two separate flywheel masses; a primary and a secondary mass with a spring damper system connecting the two. This almost fully eliminates torsional vibrations in the gearbox and transmission.

The primary section of the dual-mass flywheel is attached to the engine and the secondary mass on the transmission side. These two masses are elastically attached with a spring assembly that absorbs torsional vibrations from the engine.

Wide fluctuations of torque are above all produced during gear changes under load at lower engine speeds, when driving at very low engine speeds when high torque is required and when the engine is started and stopped. These torque peaks are absorbed by the arched springs. At high speeds, the springs are pressed out against the spring housing, reducing their flexation. On the other hand, at low speeds, variations in torque are small, reducing the significance of the outer springs.

Dual-mass flywheels do not have the springs that are normally fitted in the centre of the clutch plate, as the flywheel itself has taken over their role.

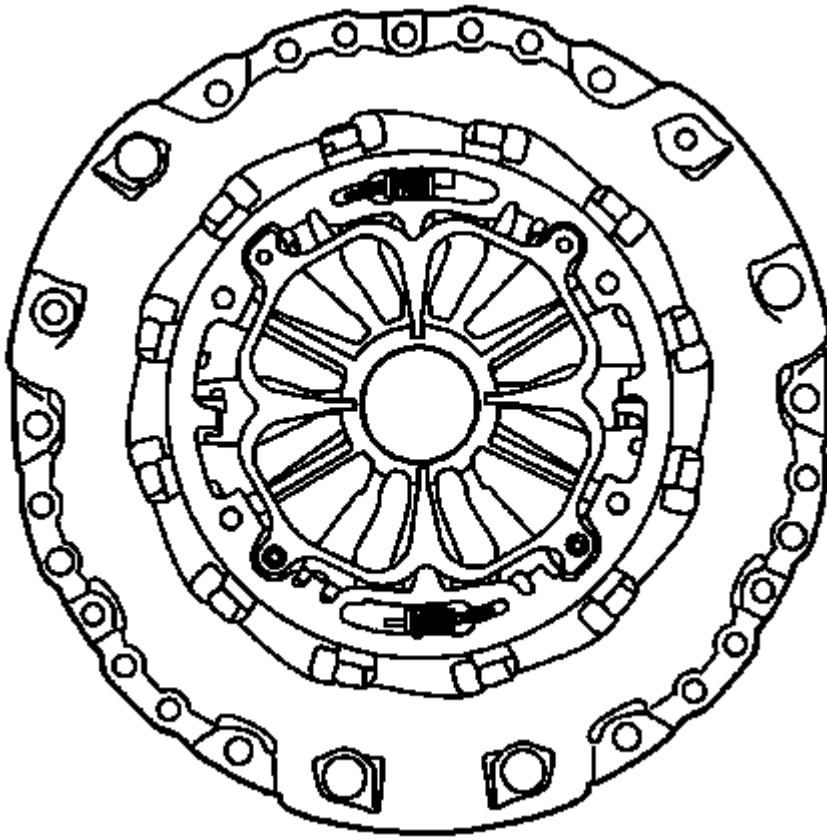


Fig. 38: Clutch with Dual-Mass Flywheel
Courtesy of GENERAL MOTORS COMPANY

The pressure plate is fully self-adjusting, which means that the compression springs acted on by the release bearing are always in the same position relative to the release bearing. The diaphragm spring can move between an adjustment ring and a wear ring.

When the clutch lining wears, the wear ring moves with the pressure surface of the pressure plate. This movement reduces the load on the adjustment ring, which is rotated by two small springs and locked in position by a catch in the pressure plate housing. This means that the diaphragm spring maintains its original position.

When replacing a dual-mass flywheel both the pressure plate and clutch plate centre should be changed as a unit.

HYDRAULIC CLUTCH SYSTEM DESCRIPTION AND OPERATION

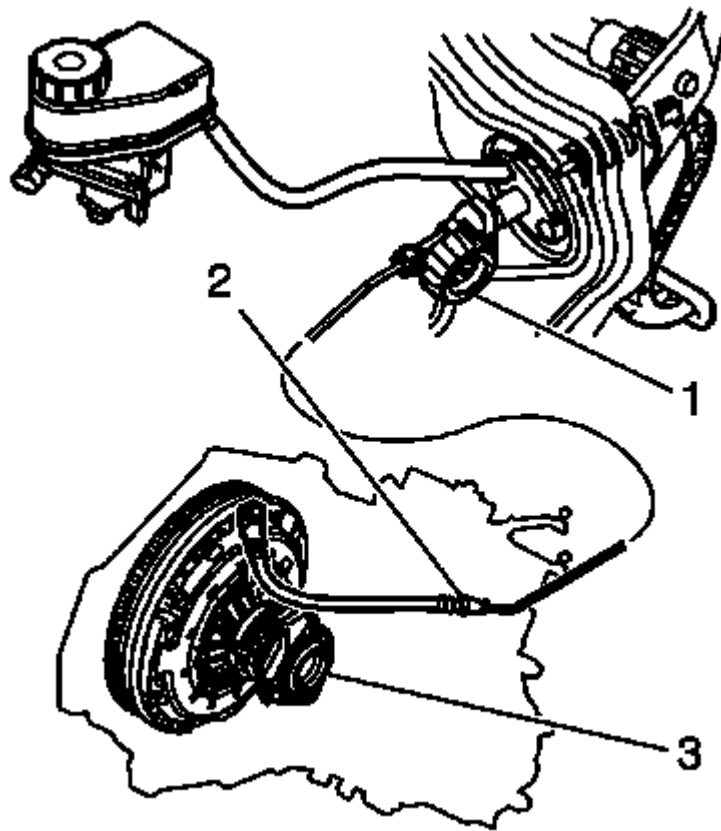


Fig. 39: Master Cylinder And Connecting Pipes
Courtesy of GENERAL MOTORS COMPANY

Clutch operation is hydraulic and fully self-adjusting. The unit comprises:

- Master cylinder (1)
- Connecting pipes (2)
- Slave cylinder (3)

The master cylinder is mounted in the bulkhead and is connected to the clutch pedal via a piston rod.

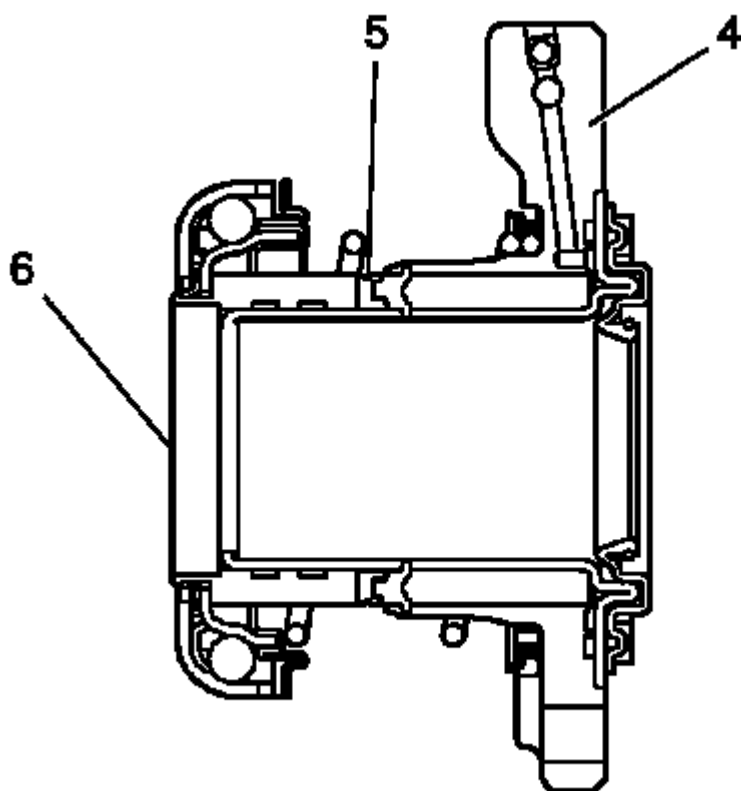


Fig. 40: Cylinder Housing And Split Piston
 Courtesy of GENERAL MOTORS COMPANY

The slave cylinder is an integrated unit mounted in the clutch housing and comprises:

- Cylinder housing (4)
- Split piston (5)
- Fixed release bearing (6)

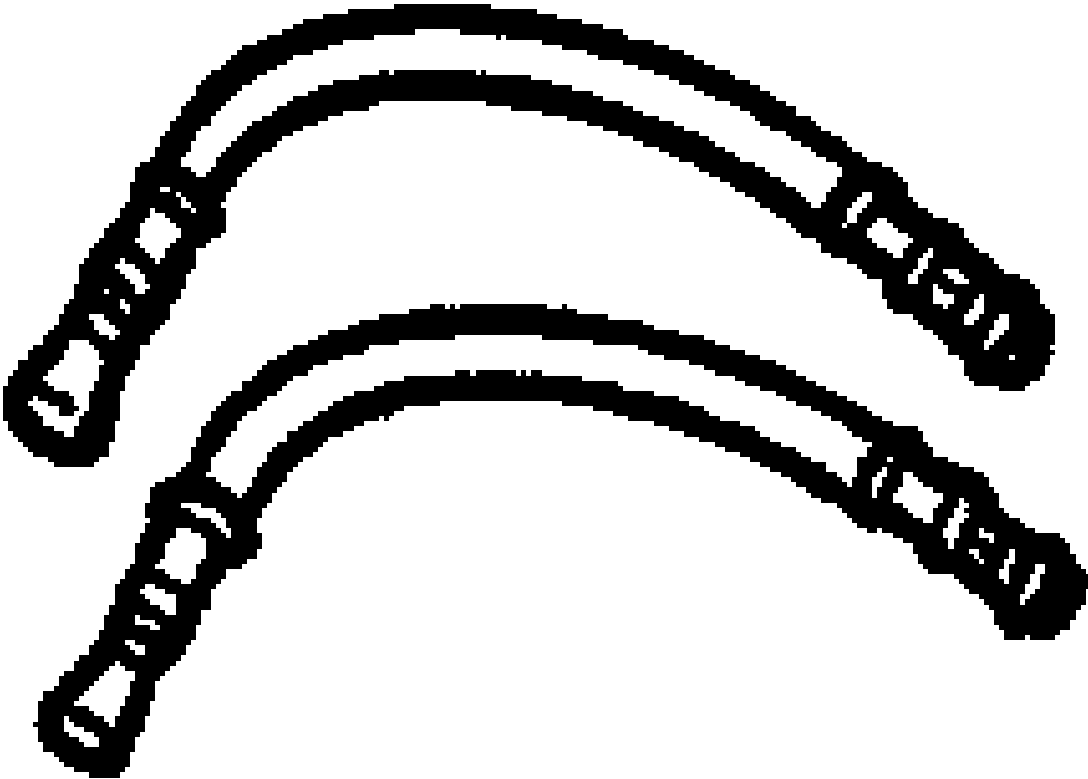
The slave cylinder cannot be disassembled. The hydraulic pressure from the master cylinder presses on the seal, which then pushes the piston and release bearing against the pressure plate. A spring is mounted between the cylinder housing and the release bearing, which means the release bearing, is always pressed against the pressure plate and in this manner reduces the play in the clutch pedal.

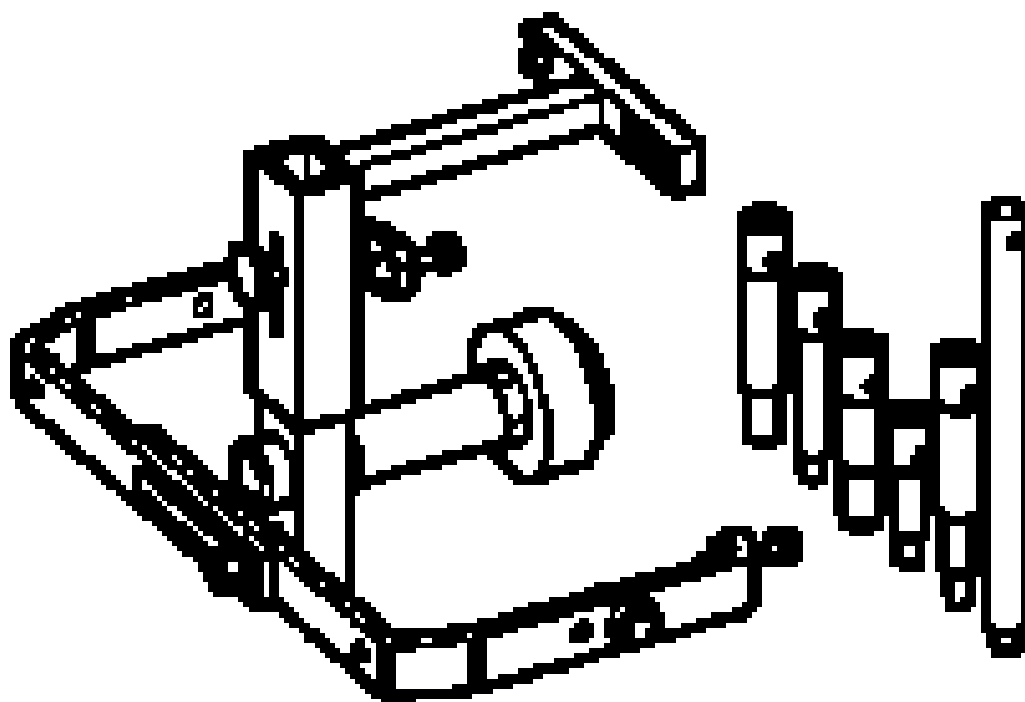
A hydraulic line links the master cylinder and the slave cylinder damper pipe (to reduce pedal vibration) and has a quick-release coupling at each end. The lower quick-release coupling, to the slave cylinder, has a bleed nipple.

SPECIAL TOOLS AND EQUIPMENT

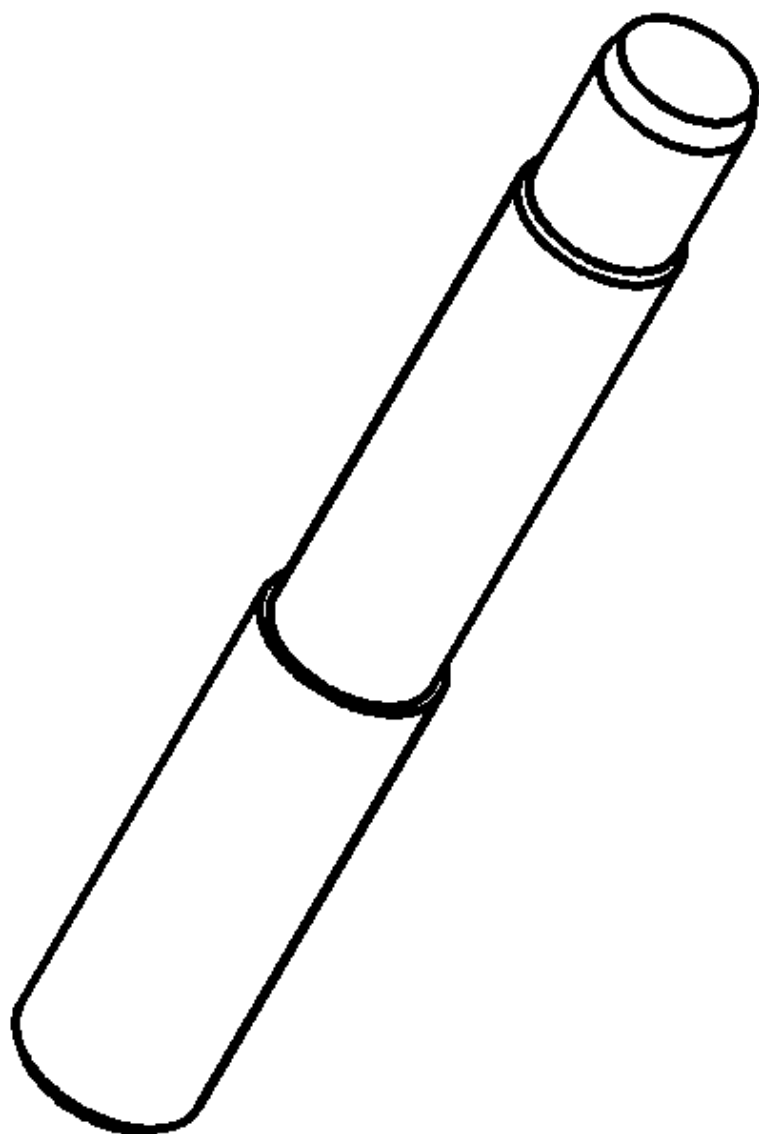
SPECIAL TOOLS

	Tool
--	------

Illustration	Number/Descrip
	<p>DT-6174-A MKM-6174-A Connecting Hose</p>



DT-6263
KM-6263
Remover/Install



DT-50194
Clutch Disc
Alignment Toc

ACCESSORIES & EQUIPMENT

Collision Repair

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Bumper Energy Absorber Fasteners	115 N.m	85 lb ft
Front End Upper Tie Bar Fasteners	22 N.m	16 lb ft

DIMENSIONS - BODY (SEDAN)

Point to Point Measurements

Point-to-point measurements are for reference only. All measurements are given in millimeters. Use these measurements for diagnosing and estimating. Point-to-point measurements are duplicated with tram bar pointers set at equal lengths. All the marks, holes, slots, and fasteners are measured to the center. All dimensions are symmetrical unless otherwise specified.

Engine Compartment

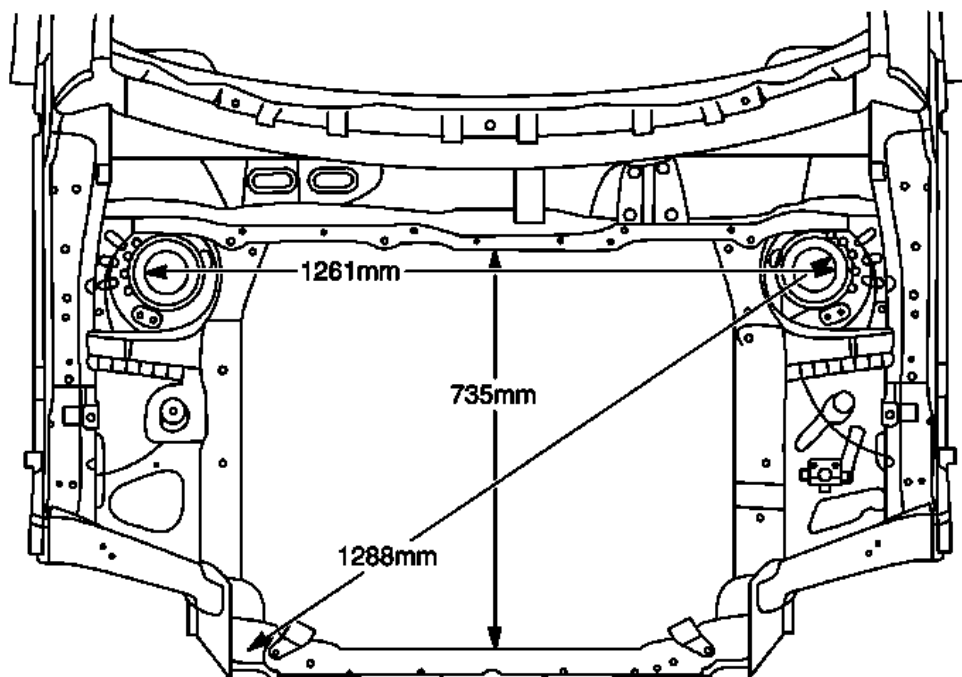


Fig. 1: Engine Compartment Dimensions
Courtesy of GENERAL MOTORS COMPANY

Rear End

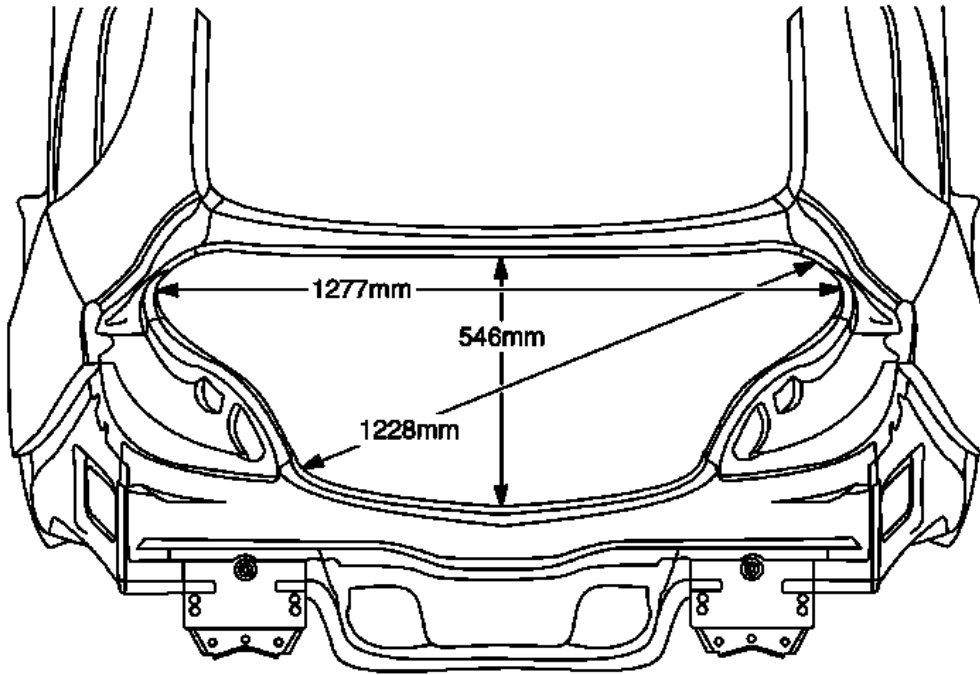


Fig. 2: Rear End Dimensions
Courtesy of GENERAL MOTORS COMPANY

Side

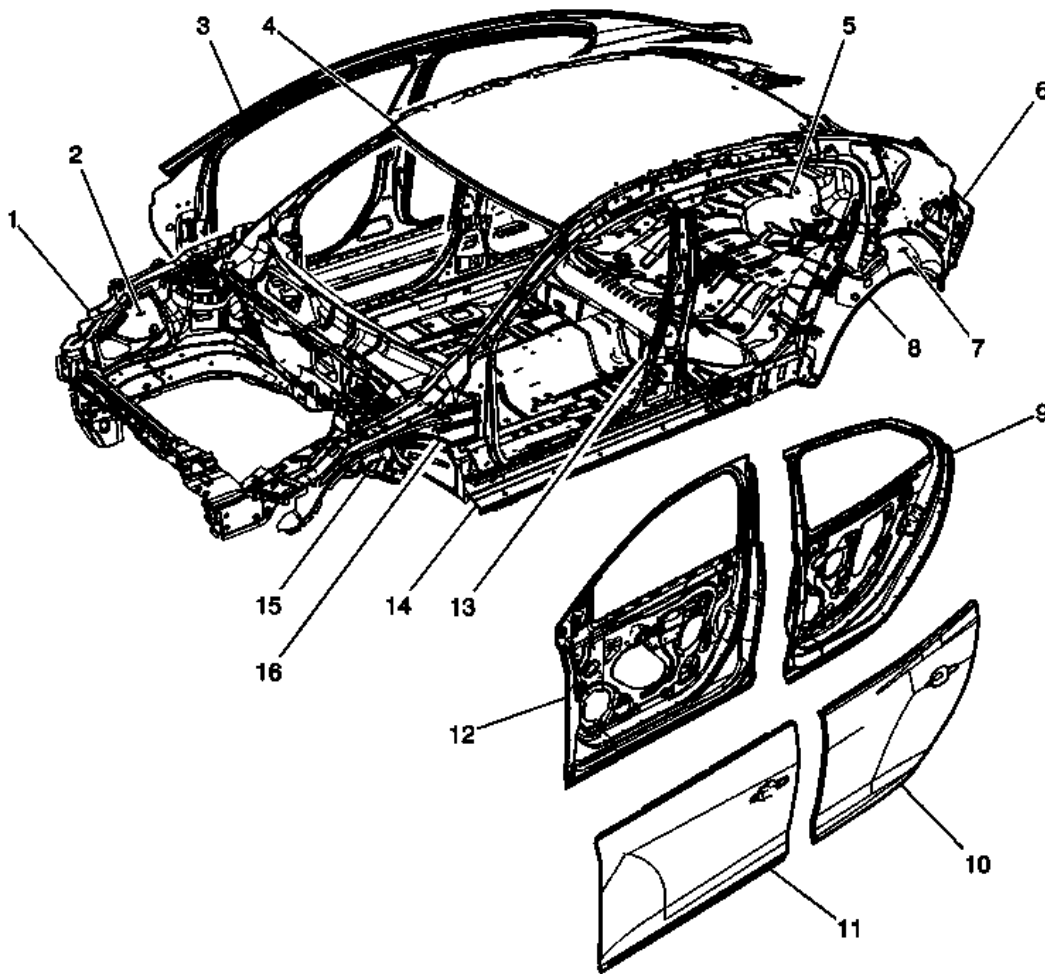


Fig. 4: Body Structure Identification
 Courtesy of GENERAL MOTORS COMPANY

Structure Identification

Number	Description	Material	Procedure
1	Front Compartment Upper Side Rail	<u>Mild Steel</u>	<u>Front Compartment Upper Side Rail Replacement</u>
2	Front Wheelhouse	<u>Mild Steel</u>	<ul style="list-style-type: none"> • <u>Front Wheelhouse Panel Replacement</u> • <u>Front Wheelhouse Front Panel Replacement</u>
3	Outer Bodyside Panel	<u>Mild Steel</u>	<ul style="list-style-type: none"> • <u>Quarter Outer Panel Sectioning</u> • <u>Center Pillar Sectioning - Outer</u>
4	Roof Outer Panel	<u>Mild Steel</u>	<u>Roof Outer Panel Replacement</u>
	Rear Compartment		

5	Panel	<u>Mild Steel</u>	<u>Rear Floor Panel Sectioning</u>
6	Rear End Panel	<u>Mild Steel</u>	<u>Body Rear End Panel Replacement</u>
7	Rear Inner Wheelhouse	<u>Mild Steel</u>	<u>Rear Wheelhouse Inner Panel Replacement</u>
8	Rear Side Rail	<u>High Strength Low Alloy Steel</u>	<u>Underbody Rear Side Rail Replacement</u>
9	Rear Door Inner Reinforcement Beam	<u>Ultra High Strength Steel</u>	Not Serviced
10	Rear Outer Door Panel	<u>Mild Steel</u>	<u>Rear Side Door Outer Panel Replacement</u>
11	Front Outer Door Panel	<u>Mild Steel</u>	<u>Front Side Door Outer Panel Replacement</u>
12	Front Door Inner Reinforcement Beam	<u>Ultra High Strength Steel</u>	Not Serviced
13	Center Pillar Reinforcement	<u>Ultra High Strength Steel</u>	<u>Center Pillar Reinforcement Replacement</u>
14	Rocker Inner Panel	<u>Ultra High Strength Dual Phase Steel</u>	<u>Rocker Inner Panel Reinforcement Replacement</u>
15	Front Compartment Lower Rail	<u>Dual Phase Steel</u>	<u>Underbody Outer Front Side Rail Replacement</u>
16	Front Body Hinge Pillar	<ul style="list-style-type: none"> • <u>High Strength Low Alloy Steel</u> • <u>Mild Steel</u> 	<ul style="list-style-type: none"> • <u>Front Hinge Pillar Body Sectioning (Upper), Front Hinge Pillar Body Sectioning (Lower)</u> • <u>Body Hinge Pillar Lower Reinforcement Replacement</u>

REPAIR INSTRUCTIONS

OVERLAP/BACKING PLATE SECTIONING (WELDING)

WARNING: Refer to Approved Equipment for Collision Repair Warning .

1. Fit the service panel to the vehicle to ensure a proper fit.
2. Measure and mark a line at the sail panel 120 mm (4 3/4 in) from the back glass opening and 70 mm (2 3/4 in) rearward from the rocker panel locating hole edge of the service panel.
3. Cut along the line to trim the service panel.
4. Fabricate a 50 mm (2 in) backer plate so that the panel will fit behind the sectioning joint at the sail panel.
5. Fabricate a 100 mm (4 in) backer plate for the rocker panel.
6. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original panel.
7. Bevel the sail panel and service panel edges at the sectioned area to approximately 10 degrees.

8. Grind a 50 mm (2 in) area of the outer surface on the vehicle to remove any corrosion, E-coat, primers, coatings and galvanizing that may be present.
9. At the section area on the service panel, grind a 50 mm (2 in) area of the back side to remove any corrosion, E-coat, primers, coatings and galvanizing that may be present.
10. Drill plug weld holes approximately 13 mm (1/2 in) from the edge of the cuts the sectioning areas of the service panel and the original panel.
11. Prepare all mating surfaces as necessary.
12. Apply GM-approved weld-thru coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .
13. Position and clamp or screw the backer plate with half of the backer plate exposed at the sectioning joint.

NOTE: Leave a gap of 1 1/2 times the thickness of the metal at the sectioning joint to the original panel.

14. Position the service panel to overlap the backer plate and 1 1/2 times the thickness up to the original panel.
15. Check for proper fit and alignment to the vehicle. Clamp the panels together.
16. Plug weld the backer plate accordingly.
17. Stitch weld along the entire sectioning joint, make 25 mm (1 in) welds along the seam with 25 mm (1 in) gaps between them.
18. Complete the stitch weld.
19. Clean and prepare all welded surfaces of the entire sectioning joint.

NOTE: Always follow the system manufacturer's instructions for application, handling, and curing.

20. Apply a lightweight body filler to the backer plate area.

FRONT BUMPER ENERGY ABSORBER REPLACEMENT (WITH HP6)

Removal Procedure

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: Refer to Approved Equipment for Collision Repair Warning .

WARNING: Refer to Glass and Sheet Metal Handling Warning .

1. Disable the SIR System. Refer to SIR Disabling and Enabling .
2. Inspect the high voltage system. Refer to High Voltage System Inspection .
3. Disable the high voltage system. Refer to High Voltage Disabling .
4. Remove all related panels and components.

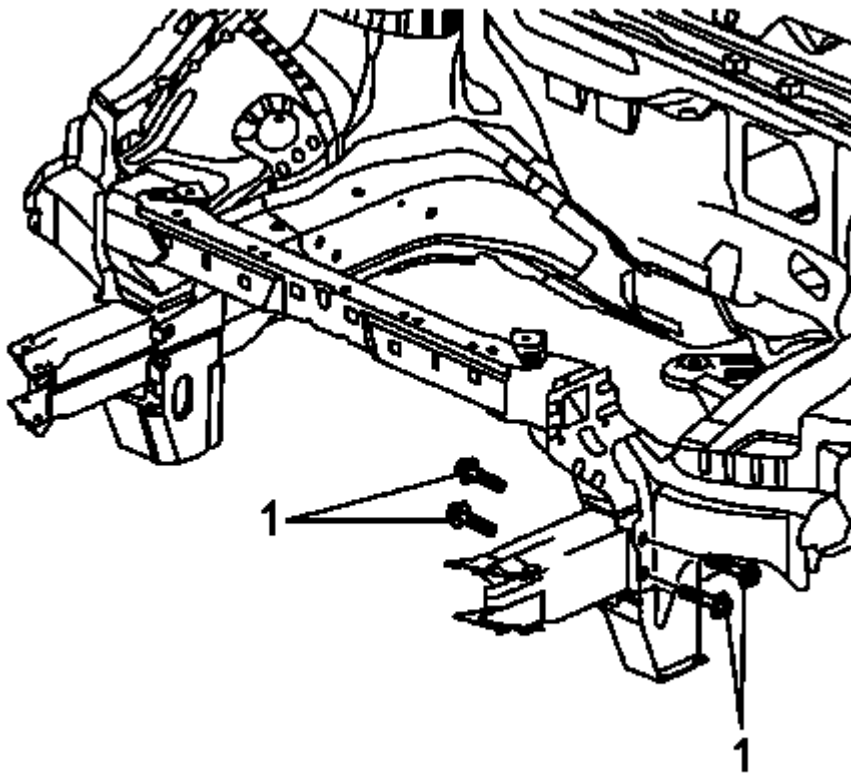


Fig. 5: Front Bumper Energy Absorber Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 front bumper energy absorber fastener (1).
6. Locate and mark all factory welds.

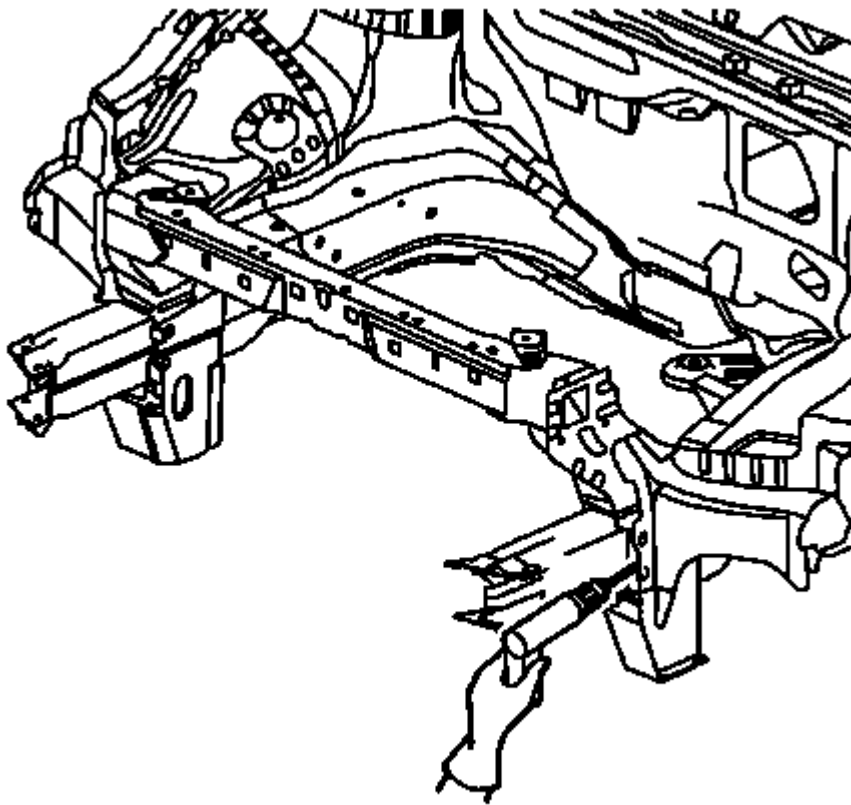


Fig. 6: Identifying Factory Welds
Courtesy of GENERAL MOTORS COMPANY

7. Drill all factory welds.
8. Remove the front bumper energy absorber.

Installation Procedure

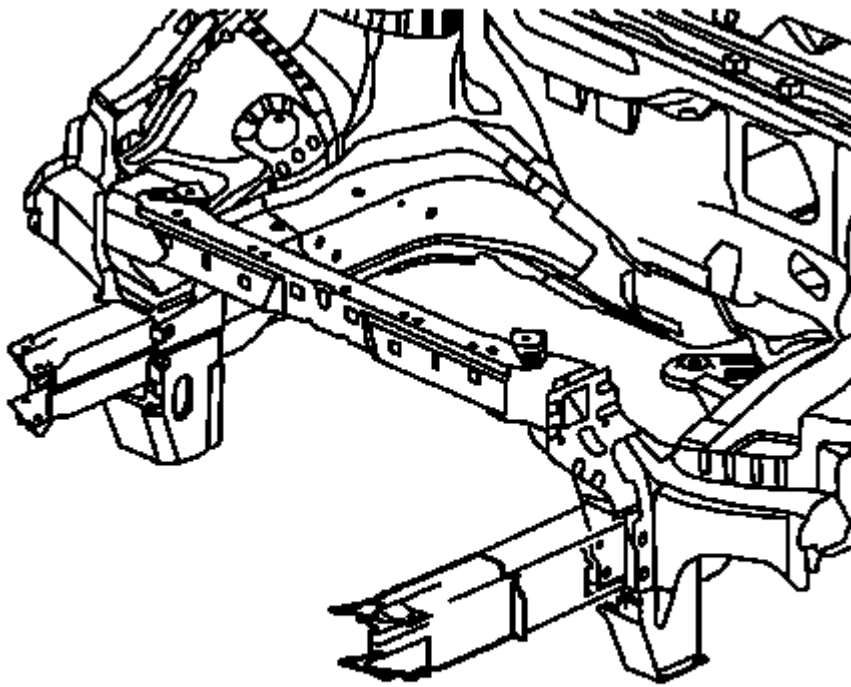


Fig. 7: Front Bumper Energy Absorber
Courtesy of GENERAL MOTORS COMPANY

1. Position the front bumper energy absorber on the vehicle.

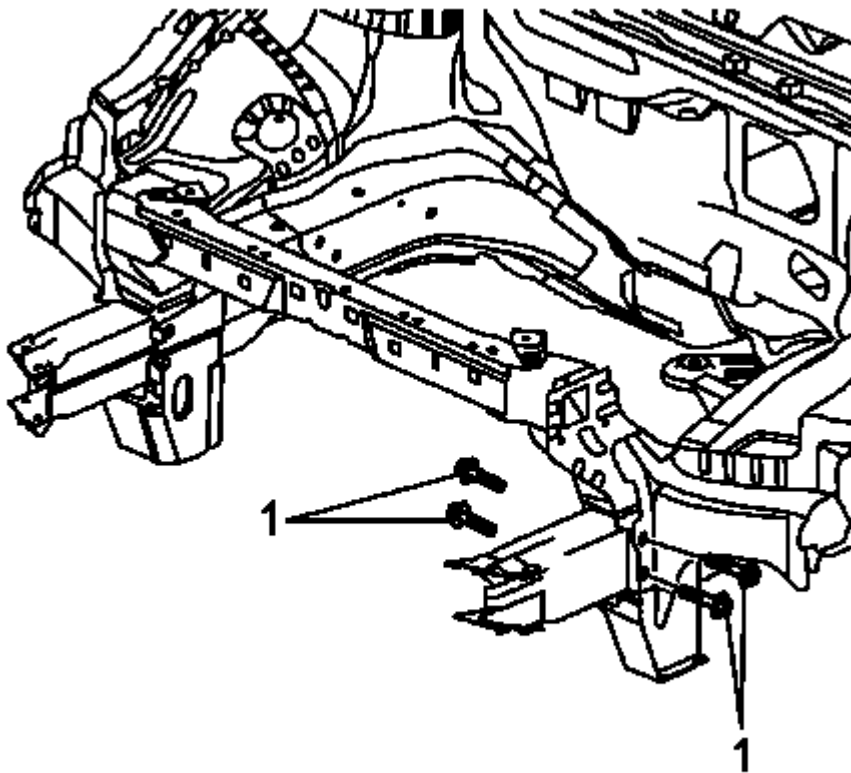


Fig. 8: Front Bumper Energy Absorber Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Use only the original front bumper energy absorber fastener. Replace fastener if damaged.

2. Install the 4 front bumper energy absorber fasteners (1) and tighten to the front compartment front inner side rail 115 N.m (85 lb ft).

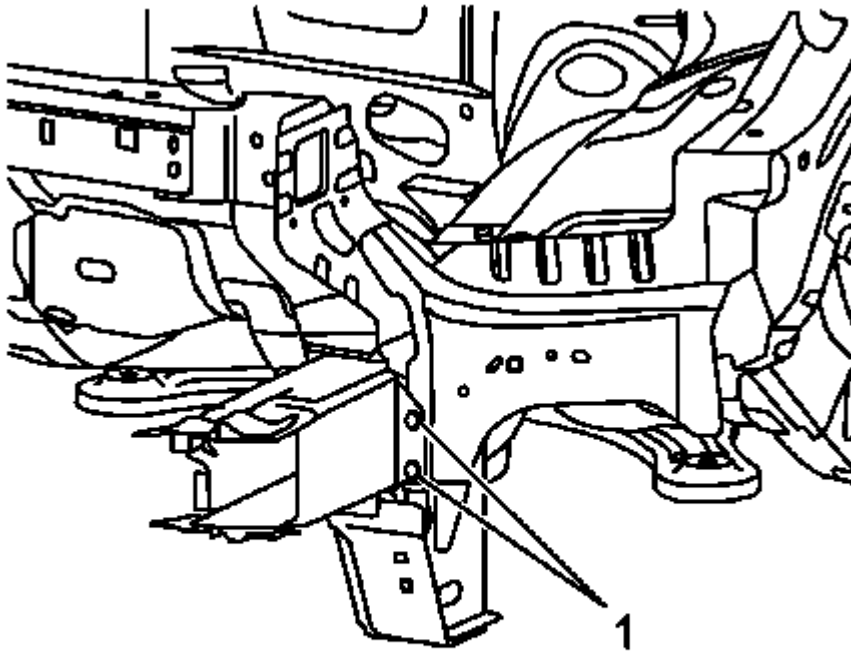


Fig. 9: Identifying Drill Holes

Courtesy of GENERAL MOTORS COMPANY

3. Drill two holes (1) 6 mm (0.24 in) along the edges of the front bumper energy absorber.

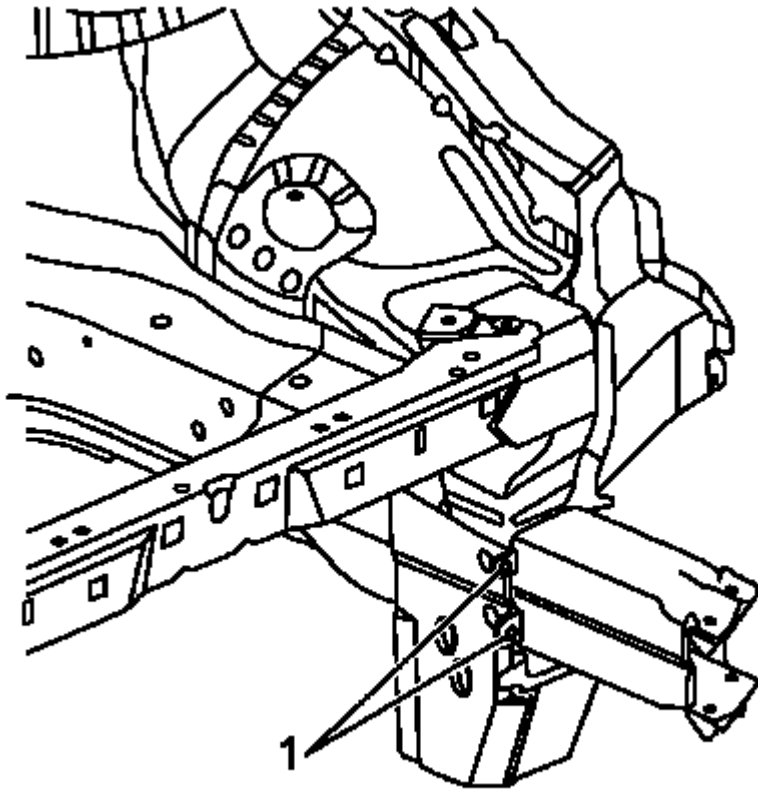


Fig. 10: Two Drill Holes

Courtesy of GENERAL MOTORS COMPANY

4. Drill two holes (1) 6 mm (0.24 in) along the edges of the front bumper energy absorber.

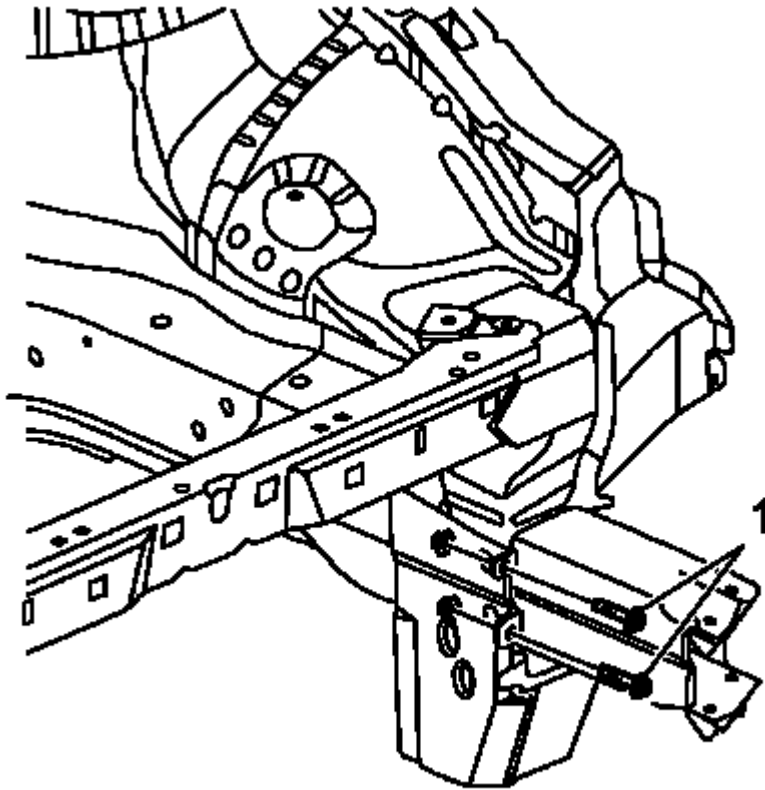


Fig. 11: Front End Upper Tie Bar Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use only the original front end upper tie bar fastener (M6 bolt and nut).
Replace the fastener if damaged.

5. Install the 2 front end upper tie bar fasteners (1) and tighten to the front compartment front inner side rail 22 N.m (16 lb ft).

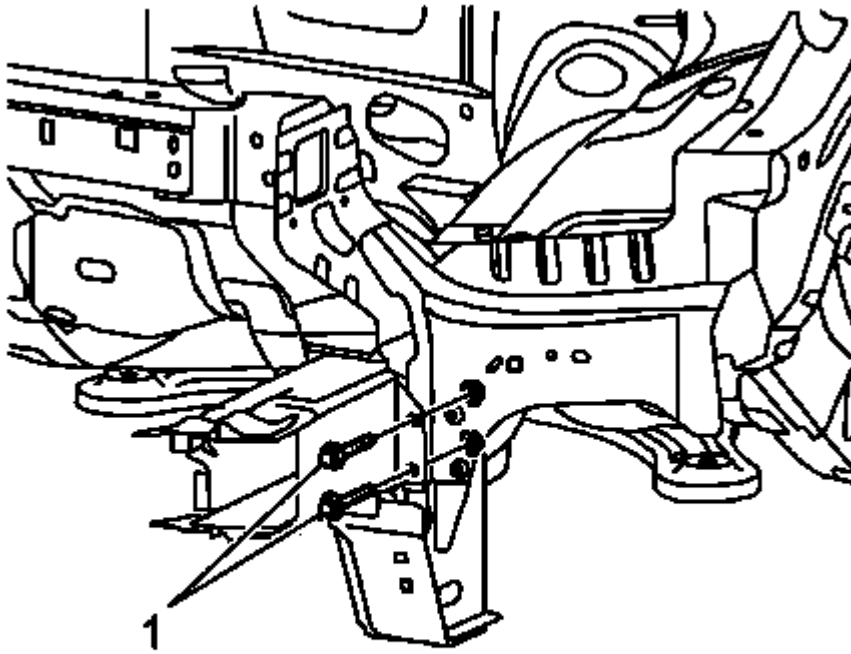


Fig. 12: Upper Front End Tie Bar Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use only the original front end upper tie bar fastener (M6 bolt and nut).
Replace the fastener if damaged.

6. Install the 2 front end upper tie bar fasteners (1) and tighten to the front compartment front inner side rail 22 N.m (16 lb ft).
7. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems .
8. Install all related panels and components.
9. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
10. Enable the high voltage system. Refer to High Voltage Enabling .
11. Enable the SIR system. Refer to SIR Disabling and Enabling .

FRONT BUMPER ENERGY ABSORBER REPLACEMENT (WITHOUT HP6)

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

WARNING: Refer to Glass and Sheet Metal Handling Warning .

1. Disable the SIR System. Refer to SIR Disabling and Enabling .
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove all related panels and components.

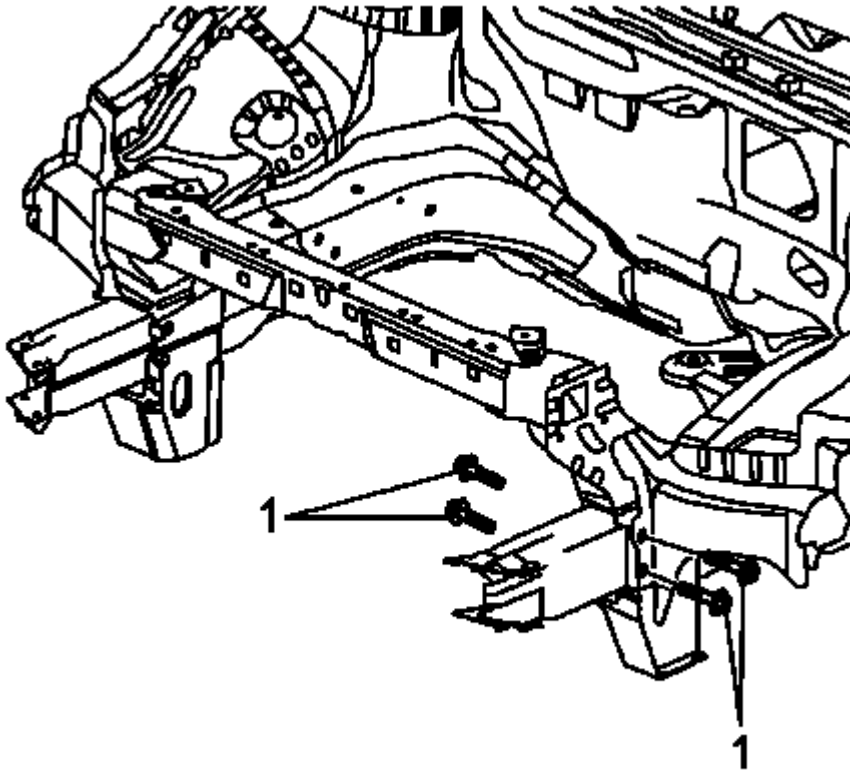


Fig. 13: Front Bumper Energy Absorber Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the 4 front bumper energy absorber fastener (1).
5. Locate and mark all factory welds.

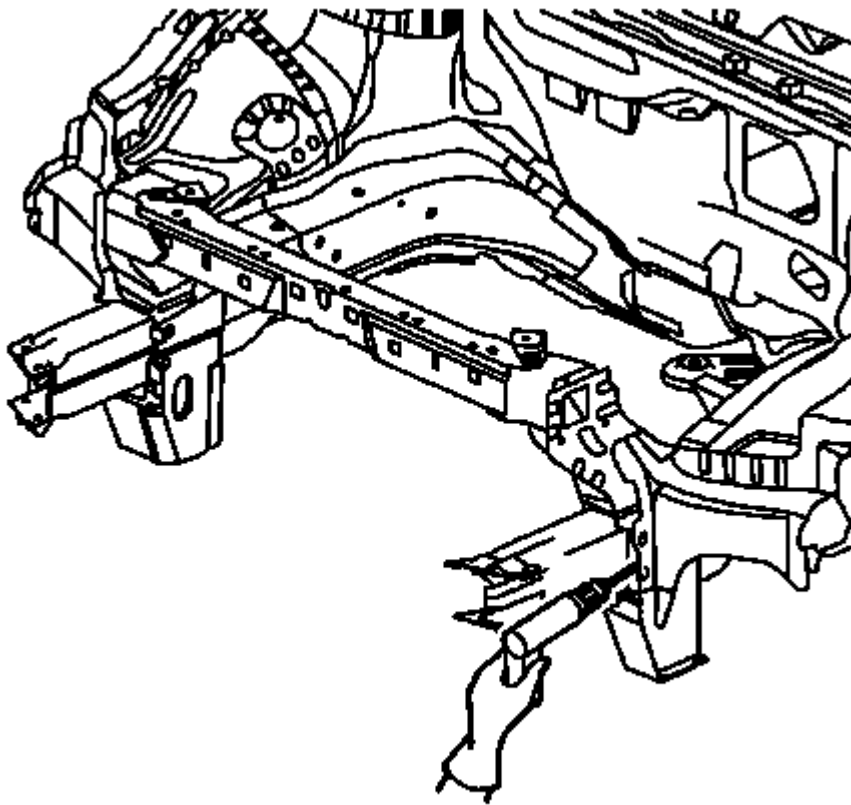


Fig. 14: Identifying Factory Welds
Courtesy of GENERAL MOTORS COMPANY

6. Drill all factory welds.
7. Remove the front bumper energy absorber.

Installation Procedure

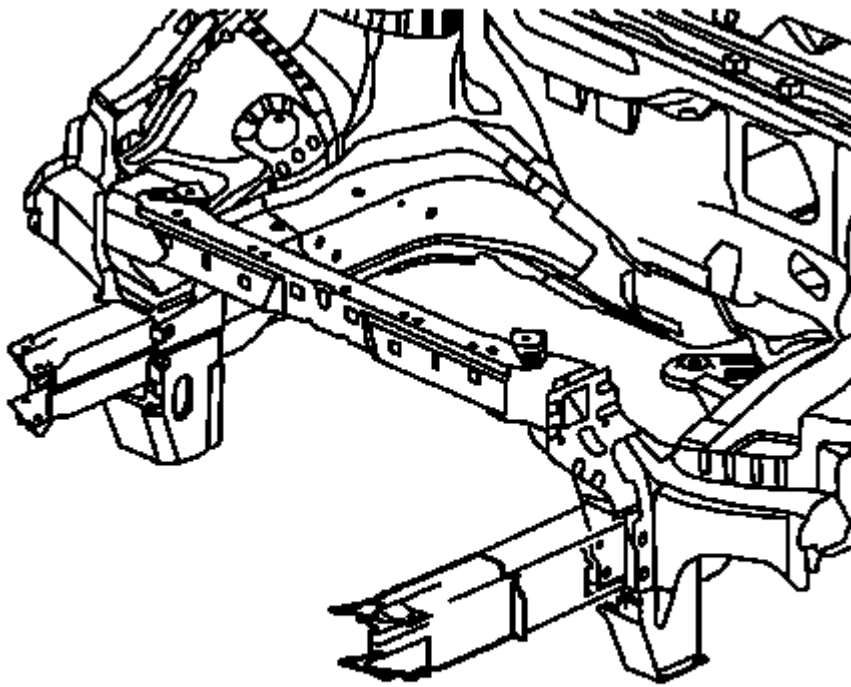


Fig. 15: Front Bumper Energy Absorber
Courtesy of GENERAL MOTORS COMPANY

1. Position the front bumper energy absorber on the vehicle.

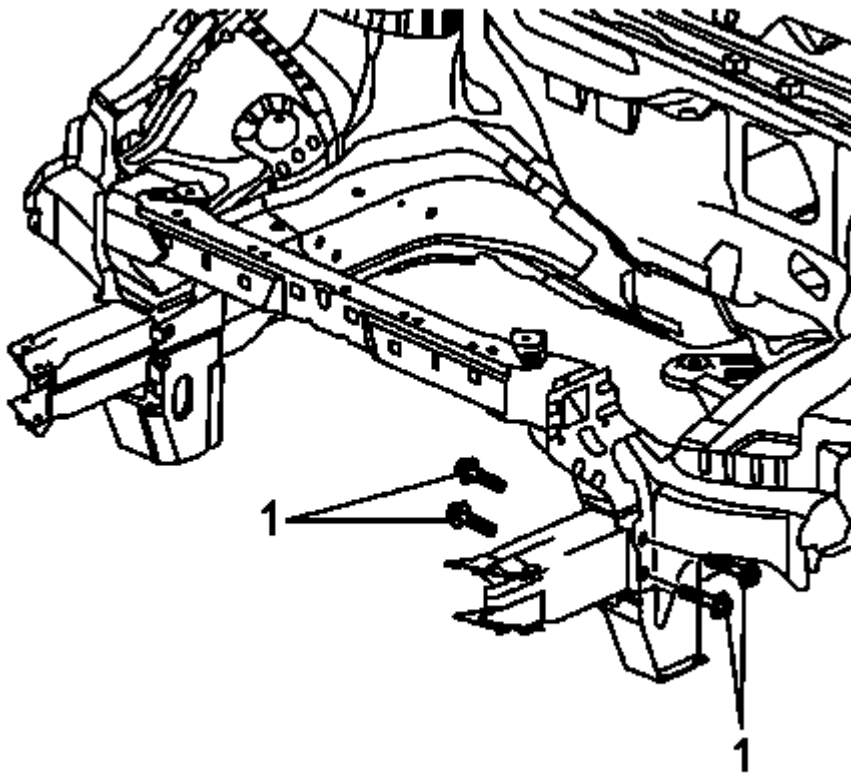


Fig. 16: Front Bumper Energy Absorber Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Use only the original front bumper energy absorber fastener. Replace fastener if damaged.

2. Install the 4 front bumper energy absorber fasteners (1) and tighten to the front compartment front inner side rail 115 N.m (85 lb ft).

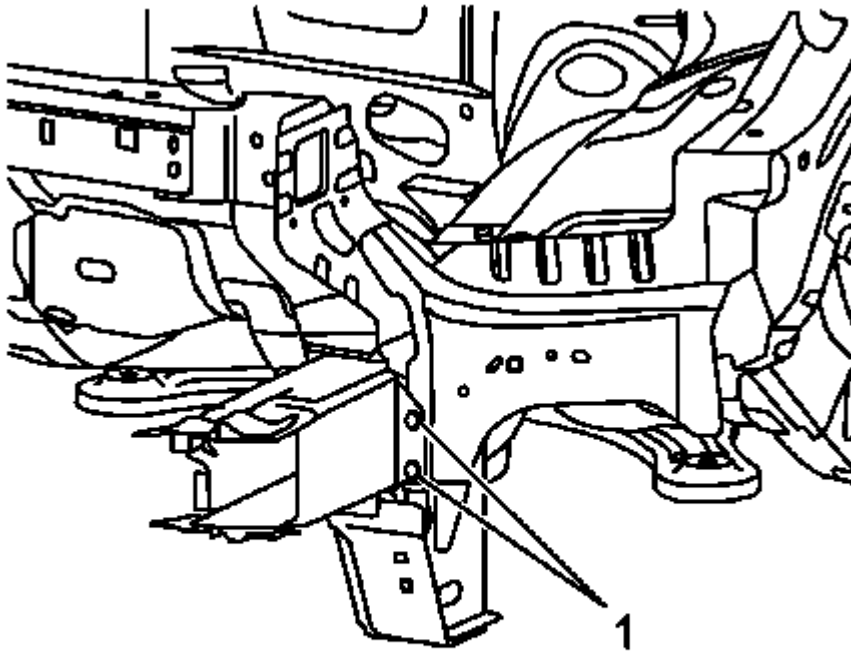


Fig. 17: Identifying Drill Holes

Courtesy of GENERAL MOTORS COMPANY

3. Drill two holes (1) 6 mm (0.24 in) along the edges of the front bumper energy absorber.

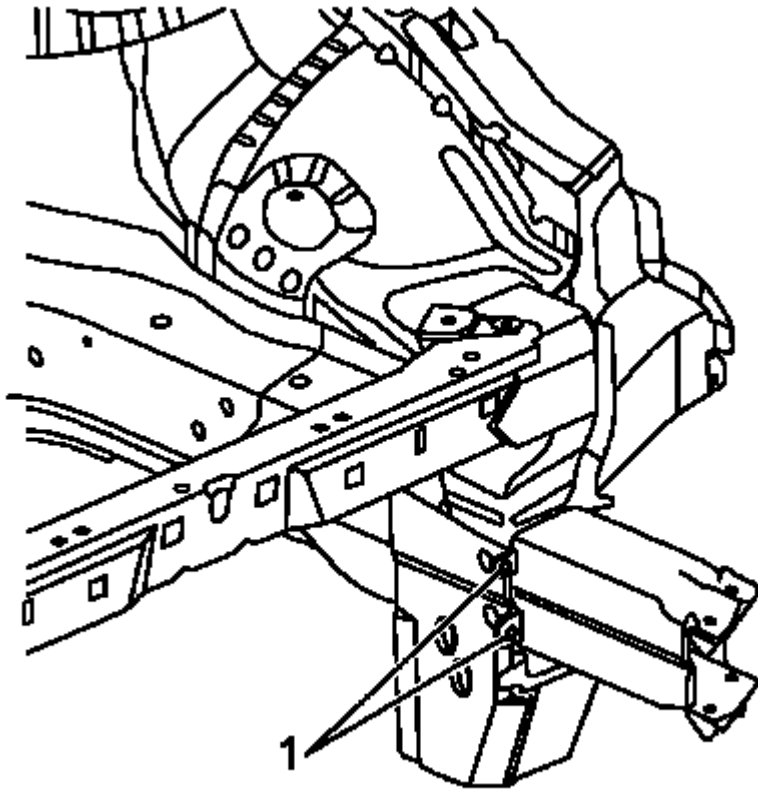


Fig. 18: Two Drill Holes

Courtesy of GENERAL MOTORS COMPANY

4. Drill two holes (1) 6 mm (0.24 in) along the edges of the front bumper energy absorber.

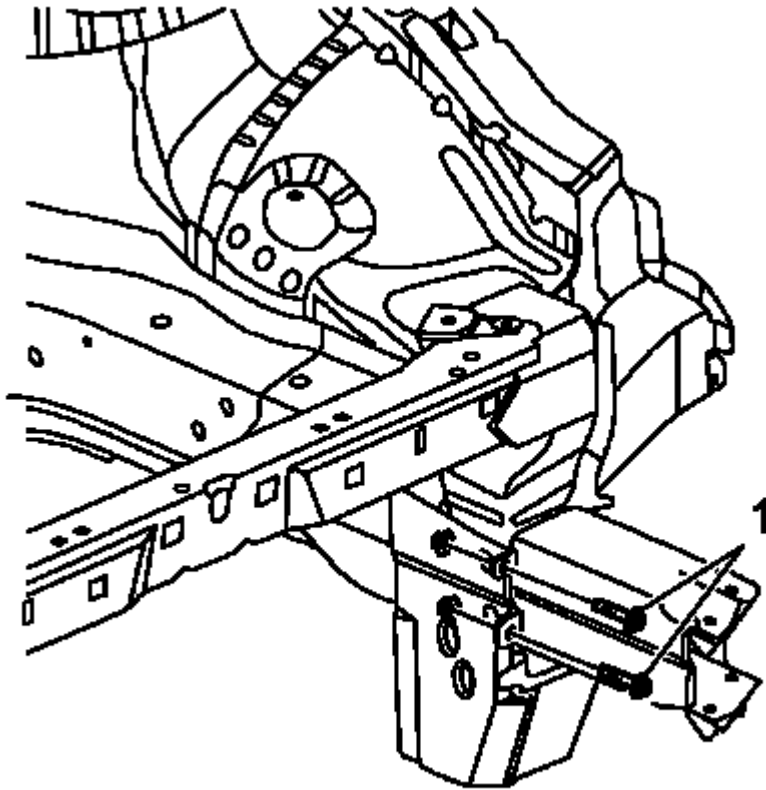


Fig. 19: Front End Upper Tie Bar Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use only the original front end upper tie bar fastener (M6 bolt and nut).
Replace the fastener if damaged.

5. Install the 2 front end upper tie bar fasteners (1) and tighten to the front compartment front inner side rail 22 N.m (16 lb ft).

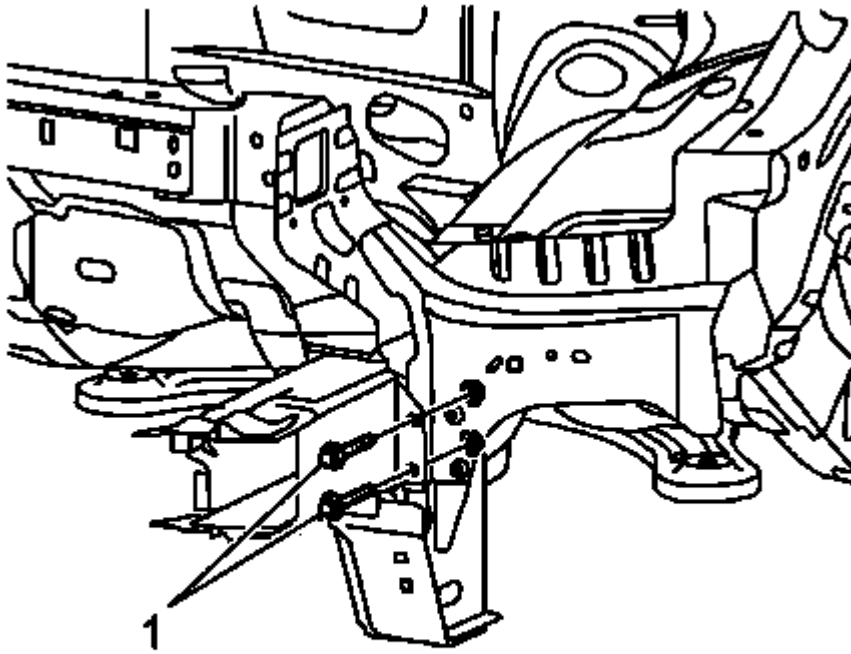


Fig. 20: Upper Front End Tie Bar Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use only the original front end upper tie bar fastener (M6 bolt and nut).
Replace the fastener if damaged.

6. Install the 2 front end upper tie bar fasteners (1) and tighten to the front compartment front inner side rail 22 N.m (16 lb ft).
7. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems .
8. Install all related panels and components.
9. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
10. Enable the SIR system. Refer to SIR Disabling and Enabling .

FRONT WHEELHOUSE FRONT PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

WARNING: Refer to Glass and Sheet Metal Handling Warning .

1. Disable the SIR System. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove all related panels and components.
4. Visually inspect the damage. Repair as much of the damage as possible.
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

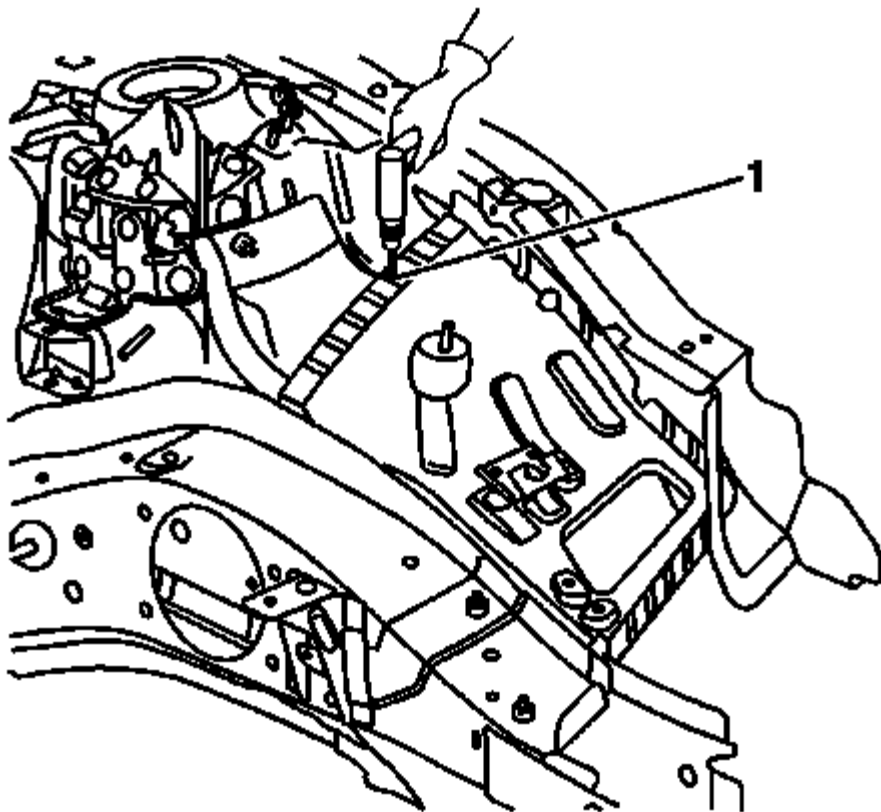


Fig. 21: Drilling Out Front Wheelhouse Front Panel Factory Welds
Courtesy of GENERAL MOTORS COMPANY

6. Locate and mark all the necessary factory welds of the front wheelhouse front panel (1).
7. Drill all factory welds. Note the number and location of welds for installation of the service assembly.
8. Remove the front wheelhouse front panel.

Installation Procedure

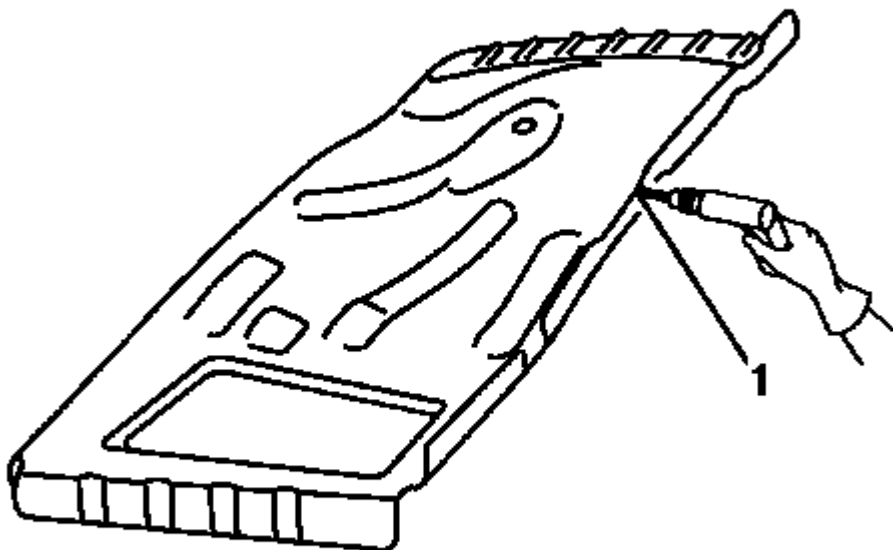


Fig. 22: Drilling 8 mm (5/16 in) Holes For New Front Wheelhouse Front Panel
Courtesy of GENERAL MOTORS COMPANY

1. Drill 8 mm (5/16 in) for plug welding along the edges of the front wheelhouse front panel as noted from the original panel (1).
2. Clean and prepare the attaching surfaces for welding.

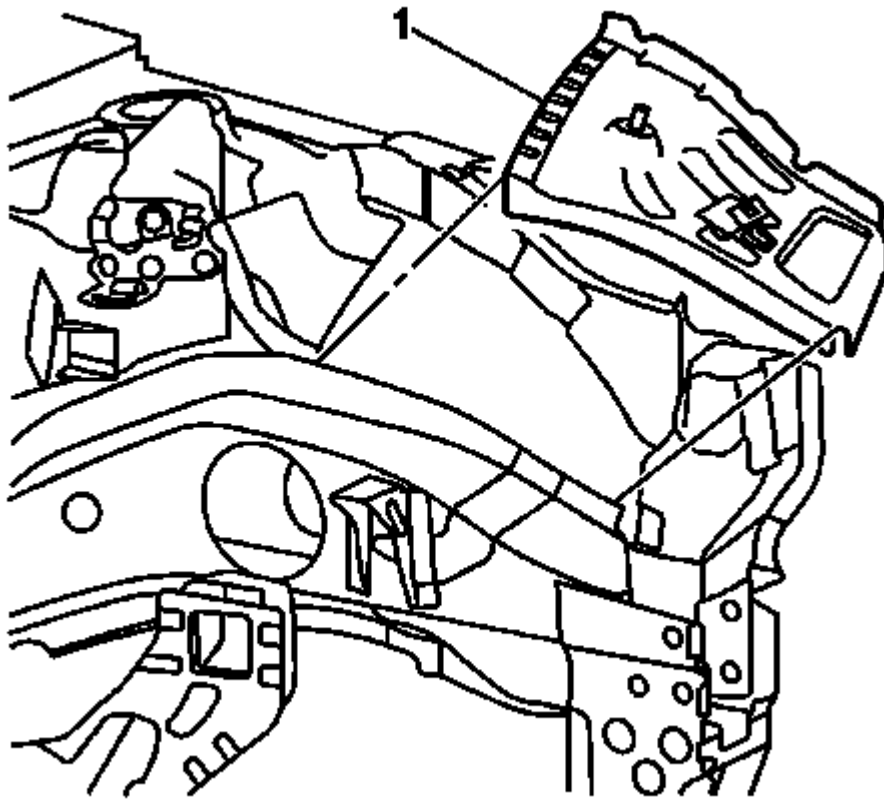


Fig. 23: Front Wheelhouse Front Panel
Courtesy of GENERAL MOTORS COMPANY

3. Position the front wheelhouse front panel on the vehicle (1).
4. Verify the fit of the front wheelhouse front panel.
5. Clamp the front wheelhouse front panel into position.

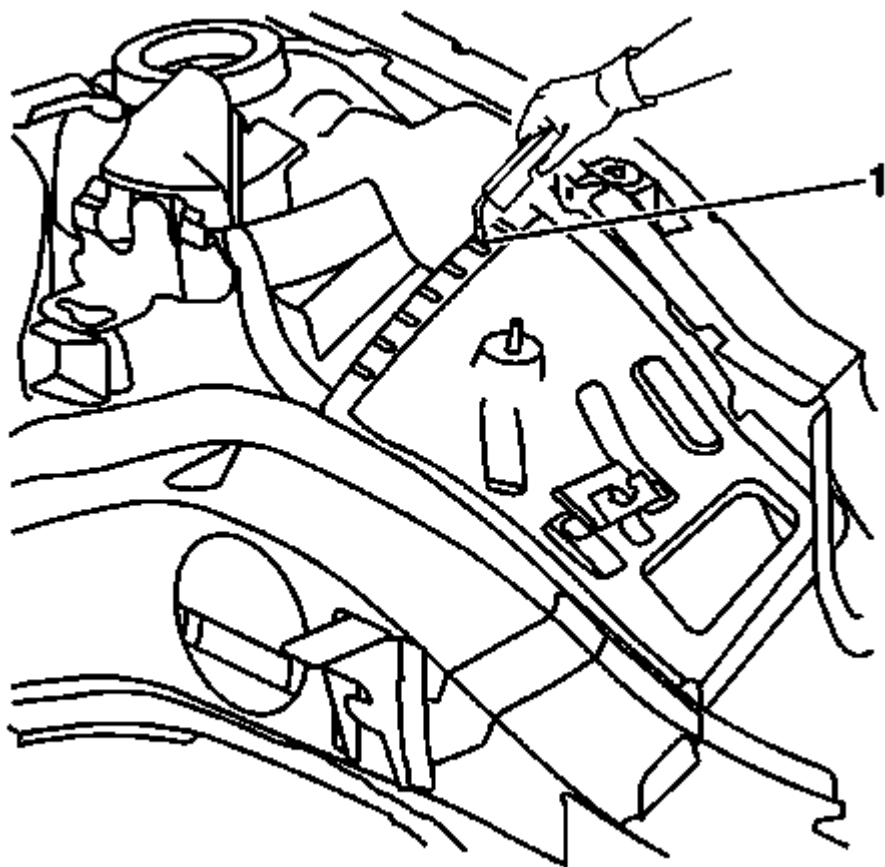


Fig. 24: Welding Front Wheelhouse Front Panel
Courtesy of GENERAL MOTORS COMPANY

6. Plug weld accordingly (1).
7. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
8. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
9. Install all related panels and components.
10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
11. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT WHEELHOUSE PANEL REPLACEMENT

Removal Procedure

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

NOTE: **Sectioning of the front wheelhouse assembly is not recommended. The**

front wheelhouse service panel is serviced as a complete assembly, which includes the upper front strut mounting surface. The upper strut mounting surface is a dimensionally critical area. Use 3-dimensional measuring equipment to locate the front wheelhouse assembly.

3. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .

NOTE: Inspect the front of the cowl for damage. If the metal surface is damaged, the cowl panel must be repaired to restore the structural integrity of the vehicle.

4. Repair as much of the damage as possible.

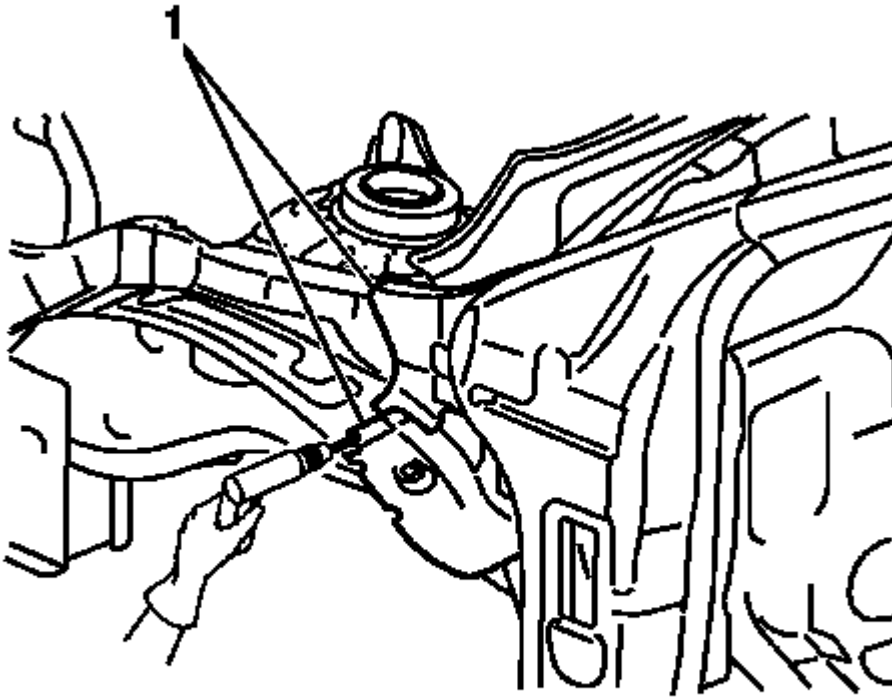


Fig. 25: Drilling Out Front Wheelhouse Panel Factory Welds
Courtesy of GENERAL MOTORS COMPANY

5. Locate, mark, and drill out all factory welds (1). Note the number and location of welds for installation of the service assembly.
6. Remove the front wheelhouse from the vehicle.

Installation Procedure

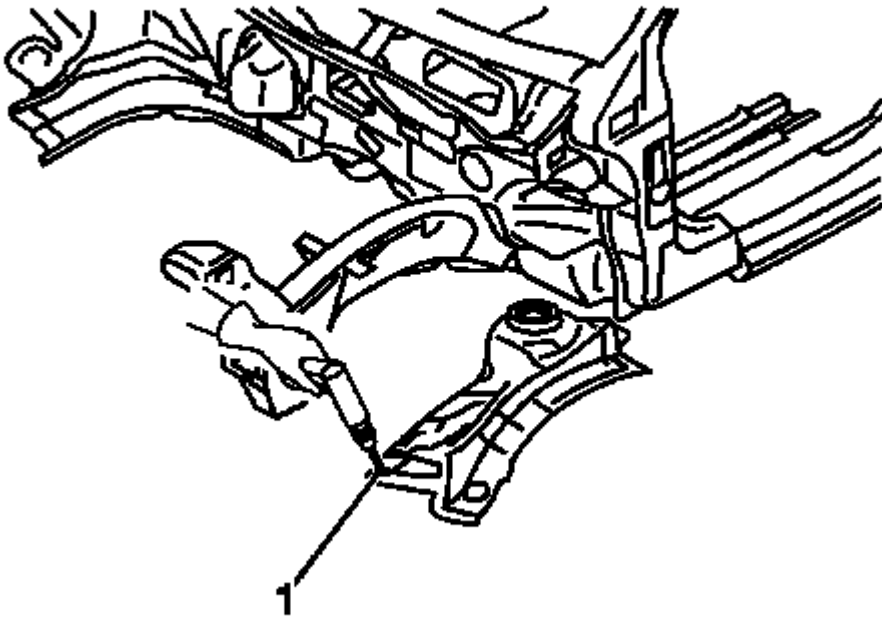


Fig. 26: Drilling Holes In New Front Wheelhouse For Welding
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 40 mm (1 1/2 in).

1. Drill 8 mm (5/16 in) plug weld holes as necessary on service part, in the locations noted from the original assembly (1).
2. Clean and prepare the mating surfaces for welding, as necessary.
3. Apply GM-approved weld-thru coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

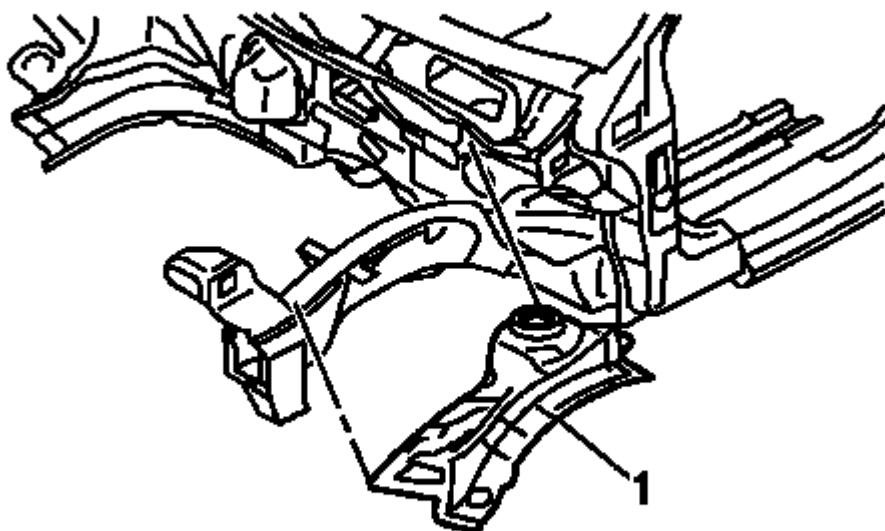


Fig. 27: Front Wheelhouse

Courtesy of GENERAL MOTORS COMPANY

4. Position the service front wheelhouse to the vehicle using 3-dimensional measuring equipment (1). Clamp the front wheelhouse in place.

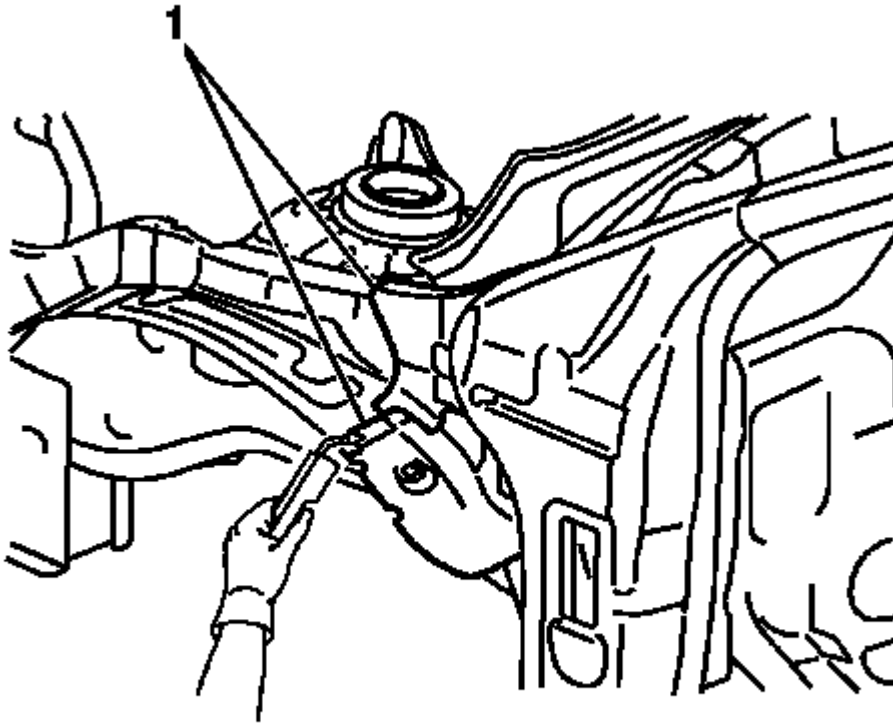


Fig. 28: Welding Front Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

5. When the service assembly is correctly positioned, plug weld accordingly (1).
6. Measure frequently to ensure proper fit and alignment.
7. Clean and prepare all welded surfaces.
8. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
9. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
10. Install all related panels and components.
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
12. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT COMPARTMENT UPPER SIDE RAIL REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove all related panels and components.
4. Repair as much of the damage as possible to factory specifications. Refer to **Dimensions - Body (Sedan)**.
5. Remove the sealers and anti-corrosion materials from the repair area. Refer to **Anti-Corrosion Treatment and Repair** .

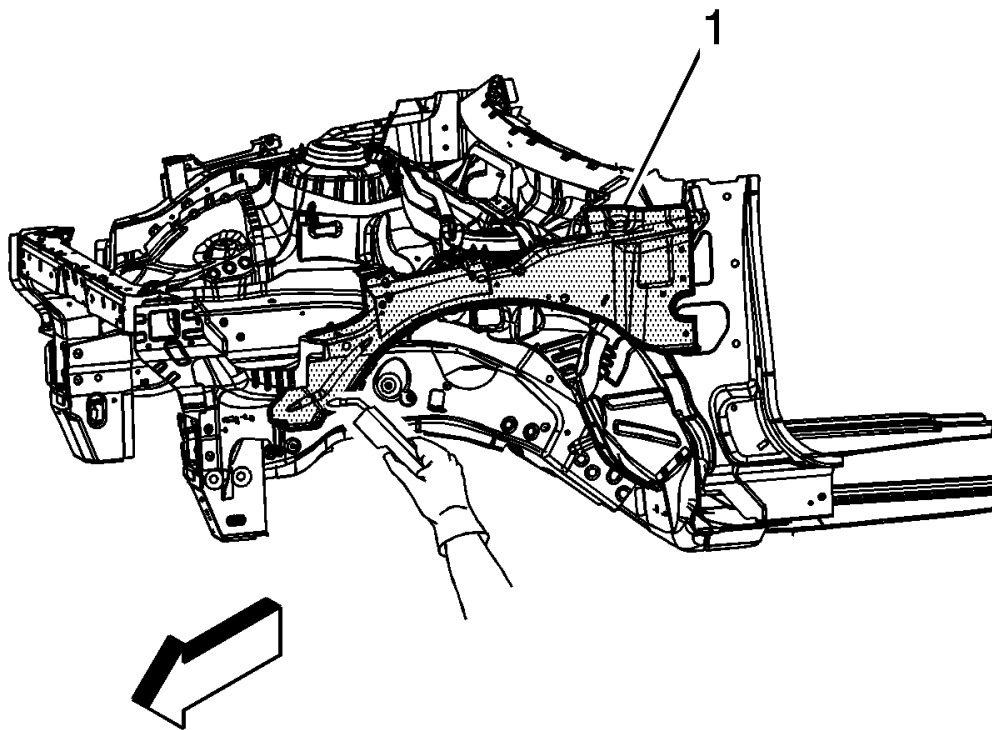


Fig. 29: Welding Upper Rail

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage any inner panels or reinforcements.

6. Locate and drill out all factory welds. Note the number and location of the welds for installation of the front upper rail (1).

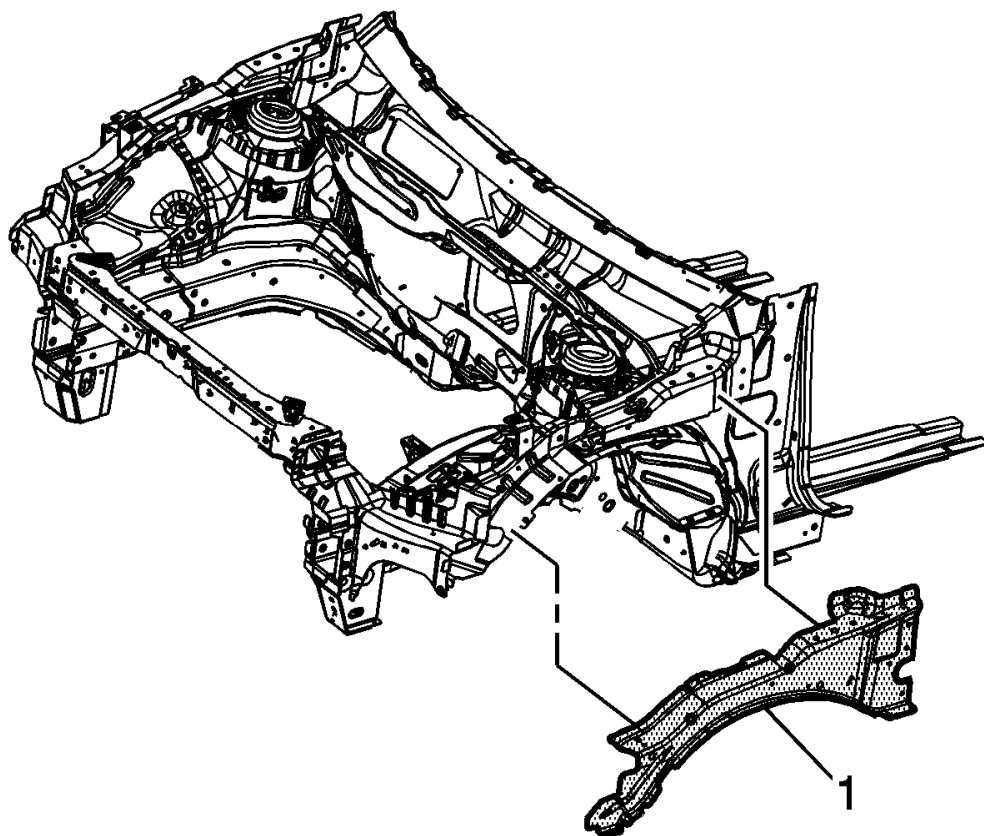


Fig. 30: Upper Rail

Courtesy of GENERAL MOTORS COMPANY

7. Remove the damaged front upper rail (1).

Installation Procedure

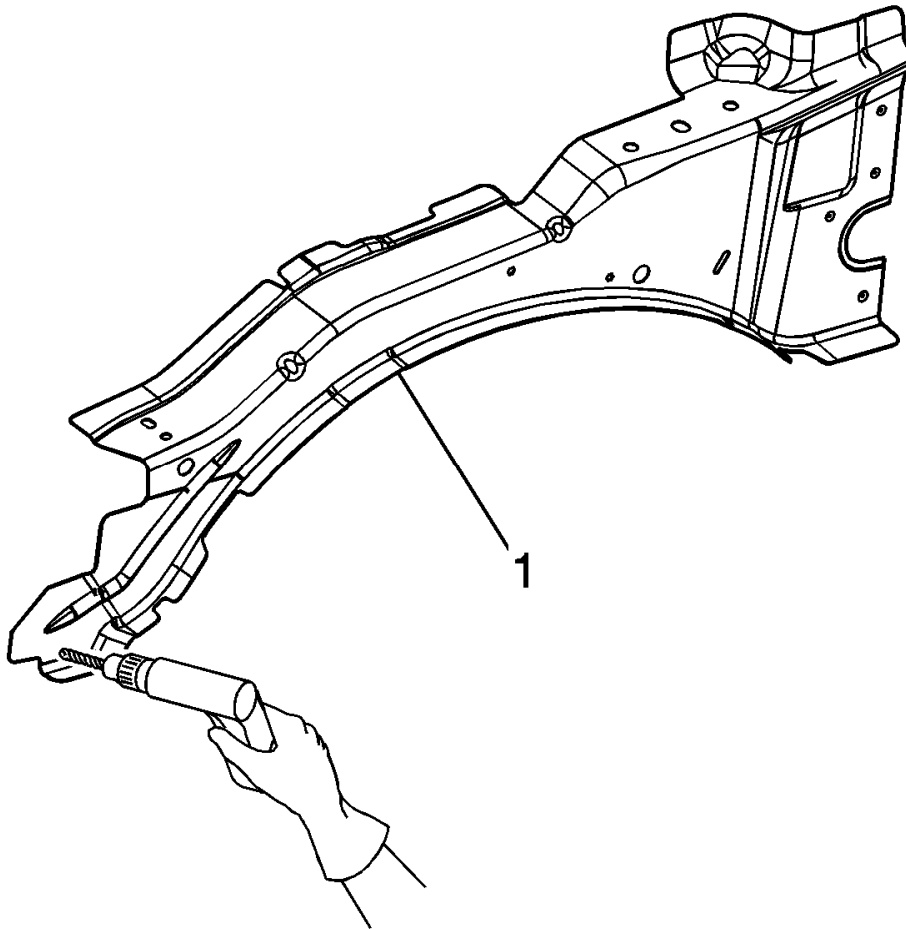


Fig. 31: Drilling Plug Weld Holes In Replacement Upper Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: If you cannot determine the location of the original plug weld holes, space the plug weld holes every 40 mm (1 1/2 in) apart.

1. Drill 8 mm (5/16 in) plug weld holes in the service part as necessary in the locations noted from the original panel (1).
2. Prepare all mating surfaces as necessary.
3. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.

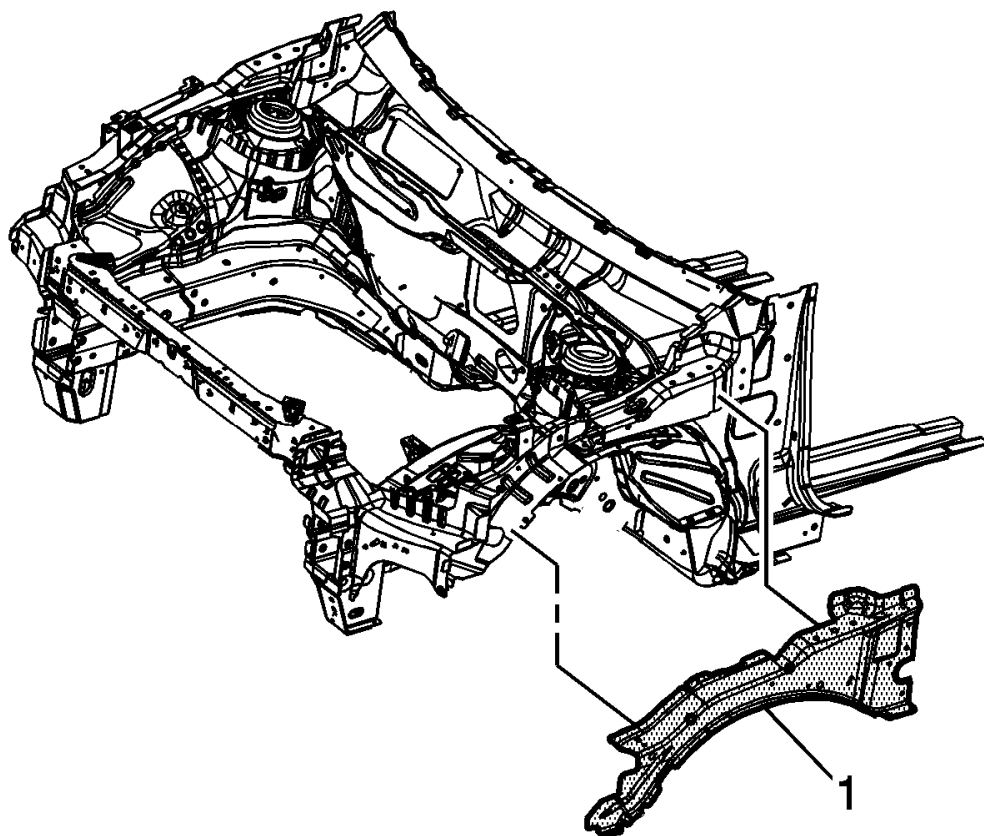


Fig. 32: Upper Rail

Courtesy of GENERAL MOTORS COMPANY

4. Position the front upper rail on the vehicle using 3-dimensional measuring equipment. Clamp the rail in place (1).

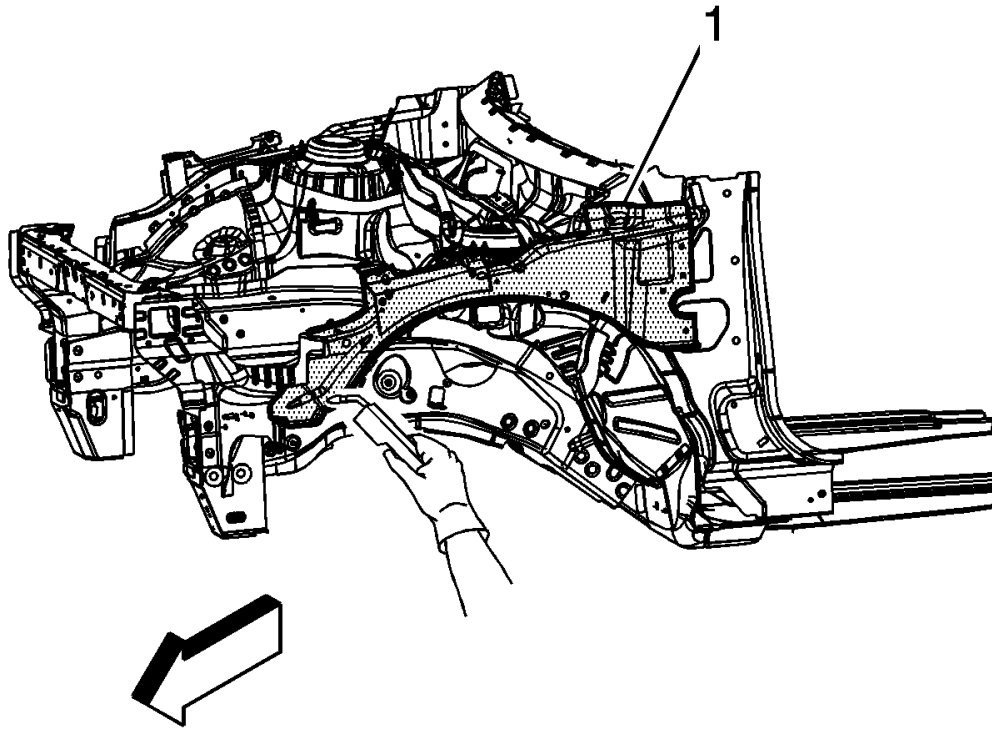


Fig. 33: Welding Upper Rail
Courtesy of GENERAL MOTORS COMPANY

5. Plug weld accordingly (1).
6. Clean and prepare all welded surfaces.
7. Install all related panels and components.
8. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
9. Paint the repair area. Refer to **Basecoat/Clearcoat Paint Systems** .
10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
11. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT COMPARTMENT FRONT HALF RAIL REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

1. Disable the SIR System. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the front compartment upper side rail. Refer to **Front Compartment Upper Side Rail Replacement**.
4. Remove the headlamp mount panel.
5. Remove the front wheelhouse. Refer to **Front Wheelhouse Panel Replacement**.
6. Visually inspect the damage. Repair as much of the damage as possible.
7. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

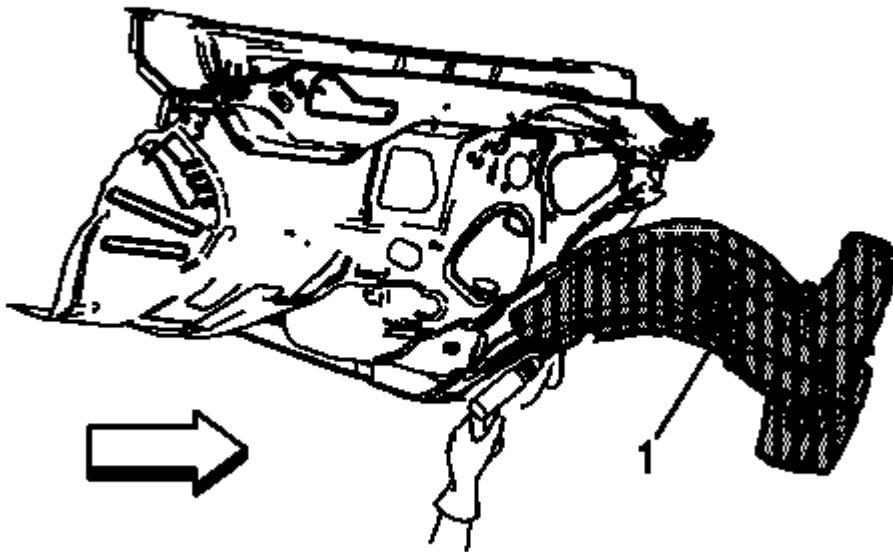


Fig. 34: Drilling Out Front Compartment Front Half Rail Factory Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: Record the number and location of the factory welds for installation of the front compartment front half rail.

8. Locate and drill out all the necessary factory welds (1).

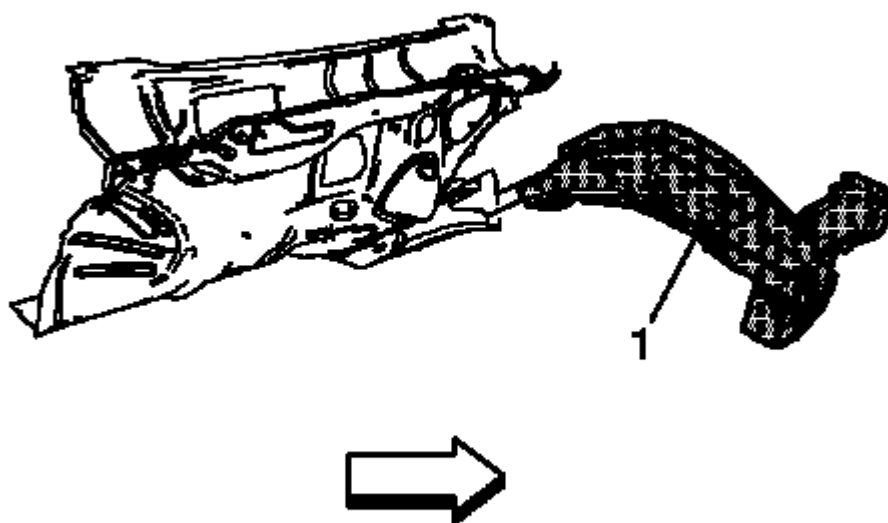


Fig. 35: Front Compartment Front Half Rail
Courtesy of GENERAL MOTORS COMPANY

9. Remove the damaged front compartment front half rail (1).

Installation Procedure

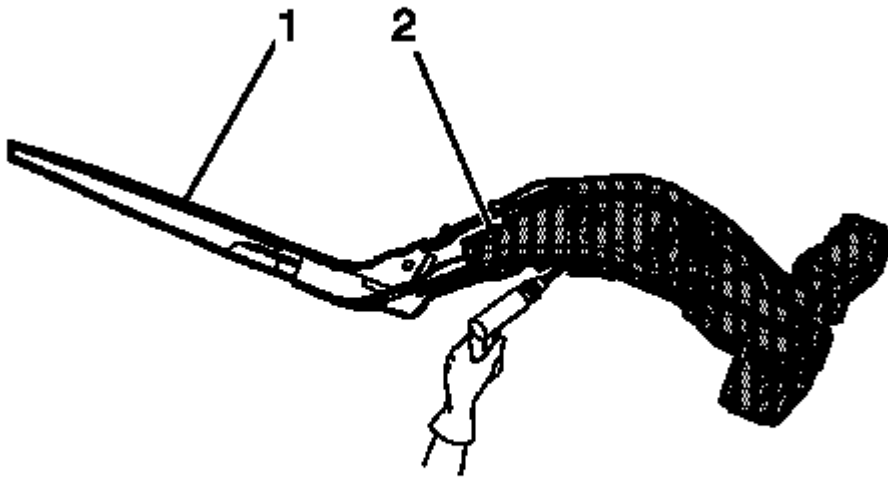


Fig. 36: Drilling Out Front Compartment Front Half Rail Factory Welds
Courtesy of GENERAL MOTORS COMPANY

1. Drill out necessary factory welds on the full service assembly (1) where the front compartment front half rail attaches (2), to the full rail service assembly.

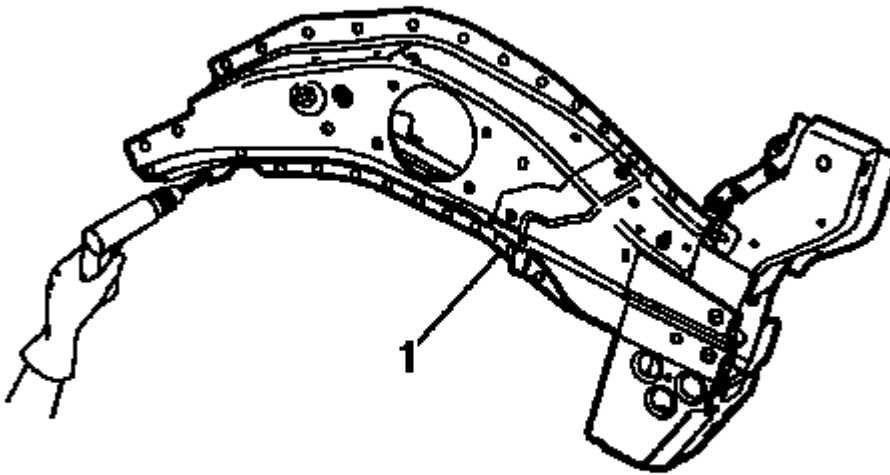


Fig. 37: Drilling Holes In Replacement Front Compartment Front Half Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the location of the original plug weld holes cannot be determined, space the plug weld holes every 40 mm (1 1/2 in) apart.

2. Drill 8 mm (5/16 in) plug weld holes in the service part (1) as necessary in the locations noted from the original panel.
3. Prepare all matting surfaces for welding as necessary.
4. Apply GM-approved Weld-Thru Coating or equivalent to all matting surfaces. Refer to **Anti-Corrosion Treatment and Repair** .
5. Clean and prepare the attaching surfaces for welding.

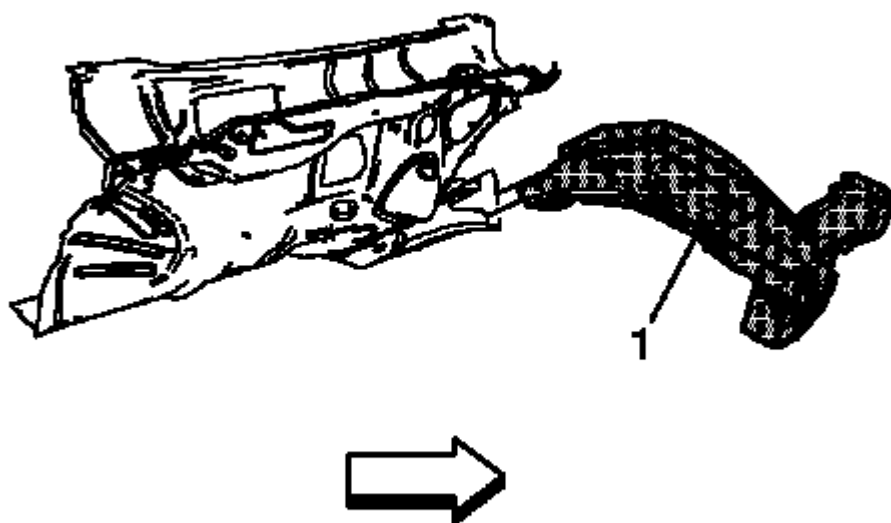


Fig. 38: Front Compartment Front Half Rail
Courtesy of GENERAL MOTORS COMPANY

6. Position the front compartment front half rail on the vehicle (1).
7. Verify the fit of the front compartment front half rail.
8. Clamp the front compartment front half rail into position.

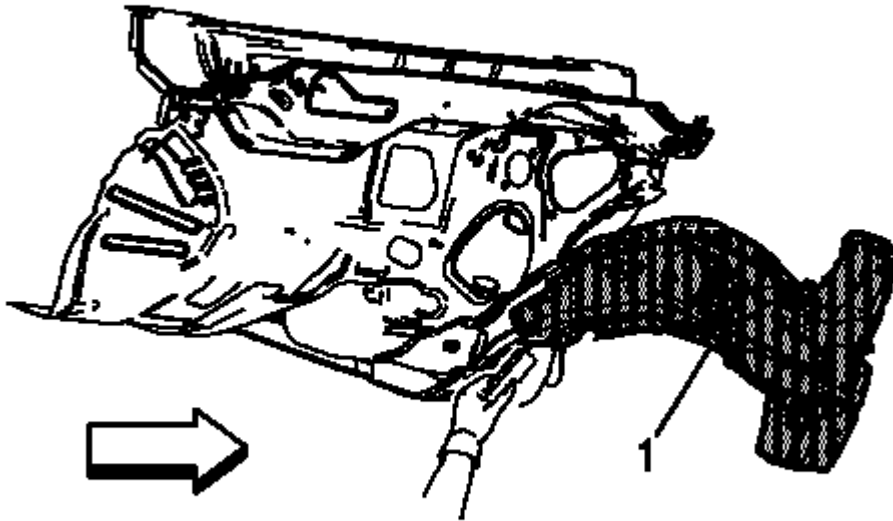


Fig. 39: Welding Front Compartment Front Half Rail
Courtesy of GENERAL MOTORS COMPANY

9. Plug weld accordingly (1).
10. Clean and prepare all of the welded surfaces.
11. Install all of the related panels and components.
12. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
13. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
15. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

UNDERBODY OUTER FRONT SIDE RAIL REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .

2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove all related panels and components.
4. Repair as much of the damage as possible. Refer to **Dimensions - Body (Sedan)**.
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

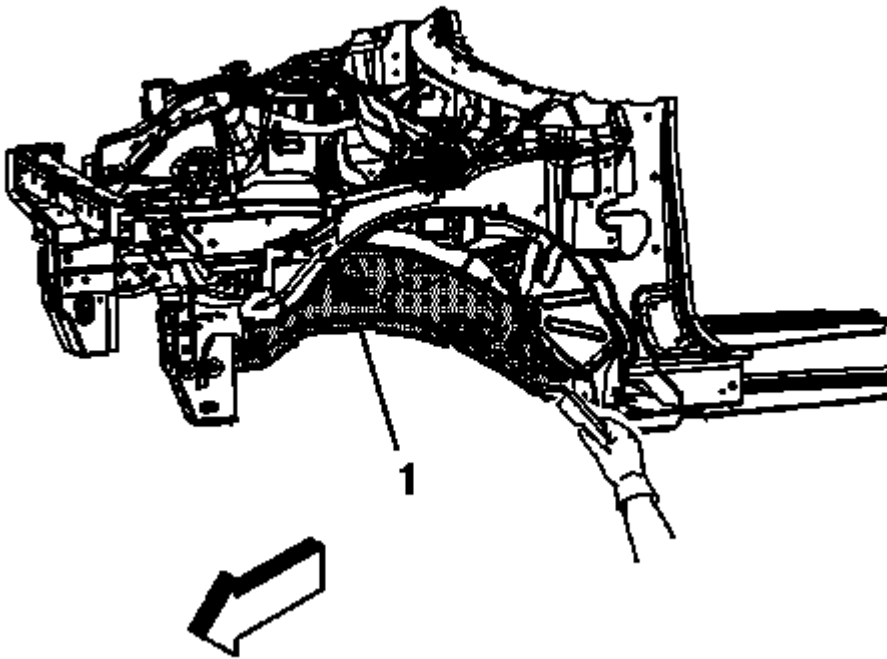


Fig. 40: Welding Outer Rail

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the number and location of the factory welds for installation of the outer rail.

6. Locate and drill out all the necessary factory welds (1).

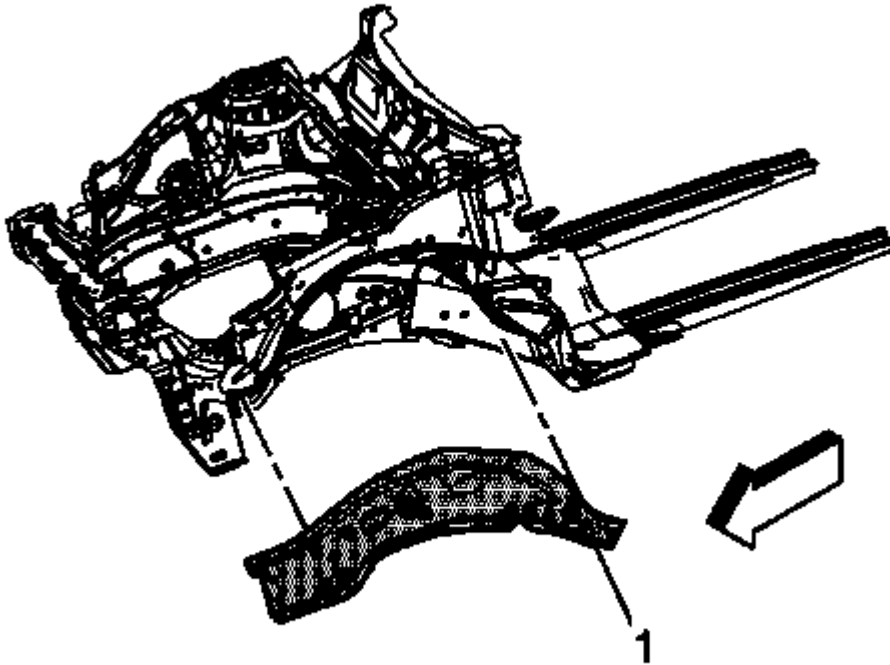


Fig. 41: Outer Rail

Courtesy of GENERAL MOTORS COMPANY

7. Remove the outer rail from the vehicle (1).

Installation Procedure

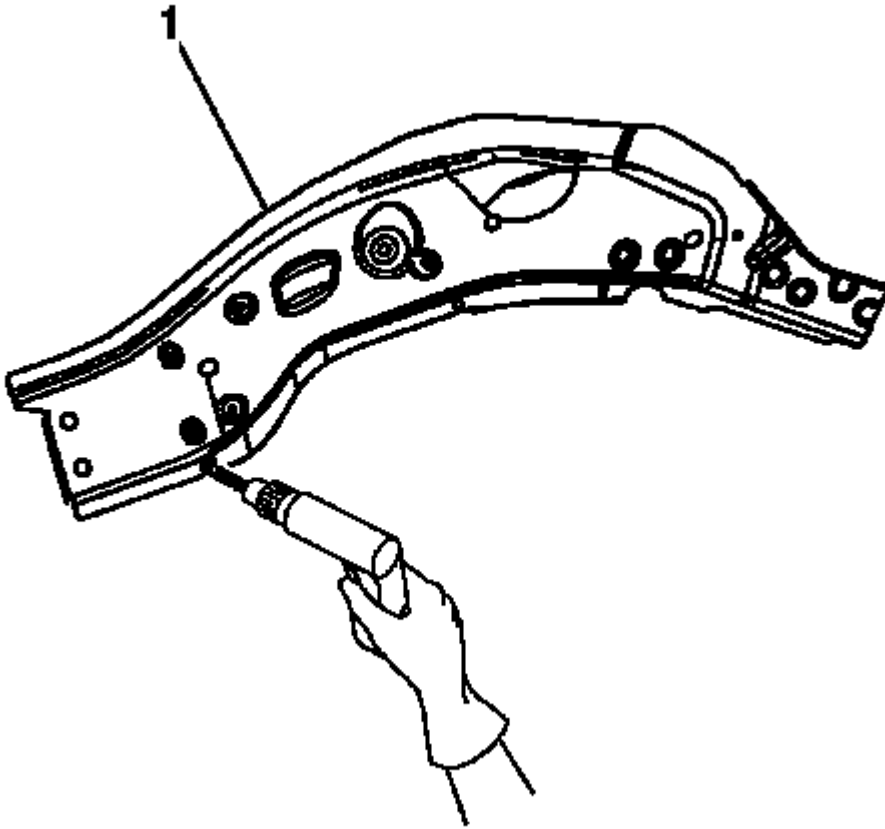


Fig. 42: Drilling Holes In New Outer Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the location of the original plug weld holes can not be determined, space the plug weld holes every 40 mm (1 1/2 in) apart.

1. Drill 8 mm (5/16 in) plug weld holes in the service part as necessary in the locations noted from the original panel (1).
2. Prepare all mating surfaces as necessary.
3. Apply GM-approved Weld-Thru Coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

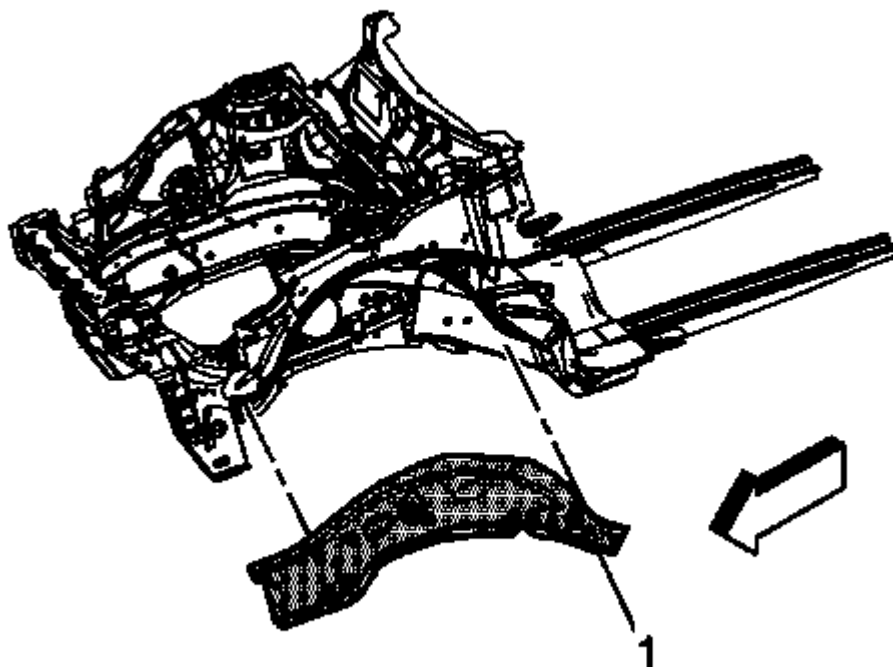


Fig. 43: Outer Rail

Courtesy of GENERAL MOTORS COMPANY

4. Position the outer rail to the vehicle using 3-dimensional measuring equipment. Clamp the outer rail in place (1).

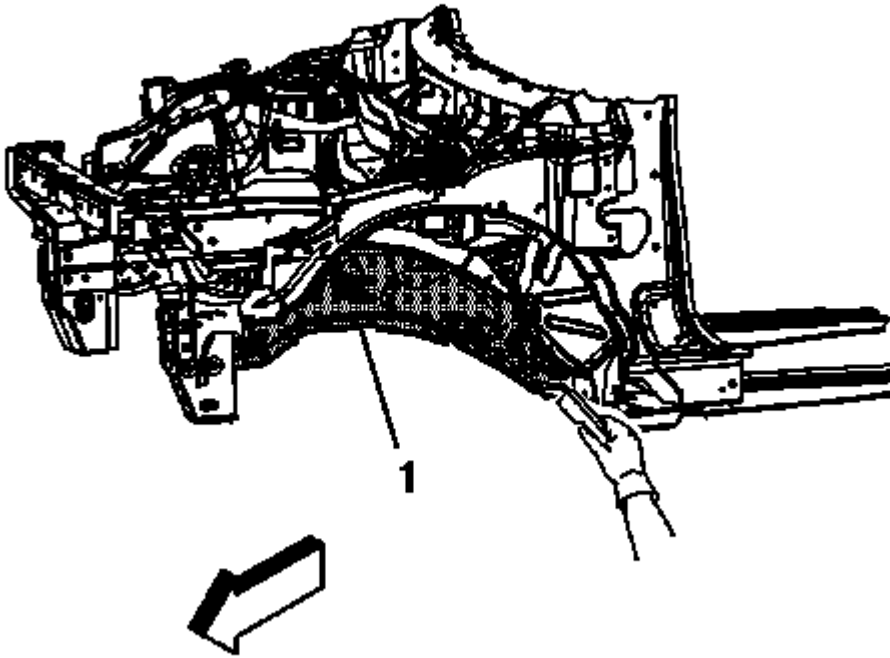


Fig. 44: Welding Outer Rail

Courtesy of GENERAL MOTORS COMPANY

5. Plug weld accordingly (1).
6. Clean and prepare all of the welded surfaces.
7. Install all of the related panels and components.
8. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
9. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
11. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT HINGE PILLAR BODY SECTIONING (UPPER)

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

NOTE: **Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle.**

The body side outer panels are available in one-piece side frames. You can perform any one of these replacement procedures separately or in any combination, depending upon the extent of damage to the vehicle. Stay away from the door and window opening radius areas. Perform sectioning only in straight areas of the openings.

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove all related panels and components.
4. Repair as much of the damaged area as possible. Refer to **Dimensions - Body (Sedan)**.
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

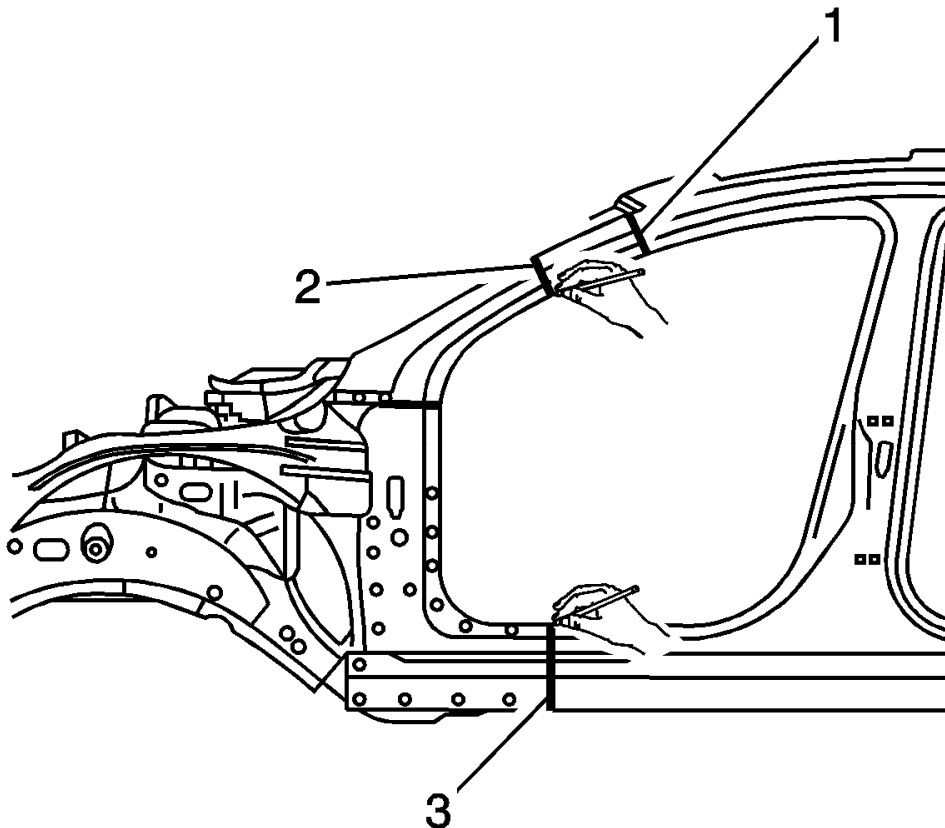


Fig. 45: Measuring And Cutting Location On Front Hinge Pillar
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Sectioning can be done anywhere in the straight area along the rocker panel.**

6. On the "A" Pillar Measure down 300 mm from the roof edge (1). Mark this cut location on the front hinge pillar (2). Mark a cut location in the straight area on the rocker panel (3).

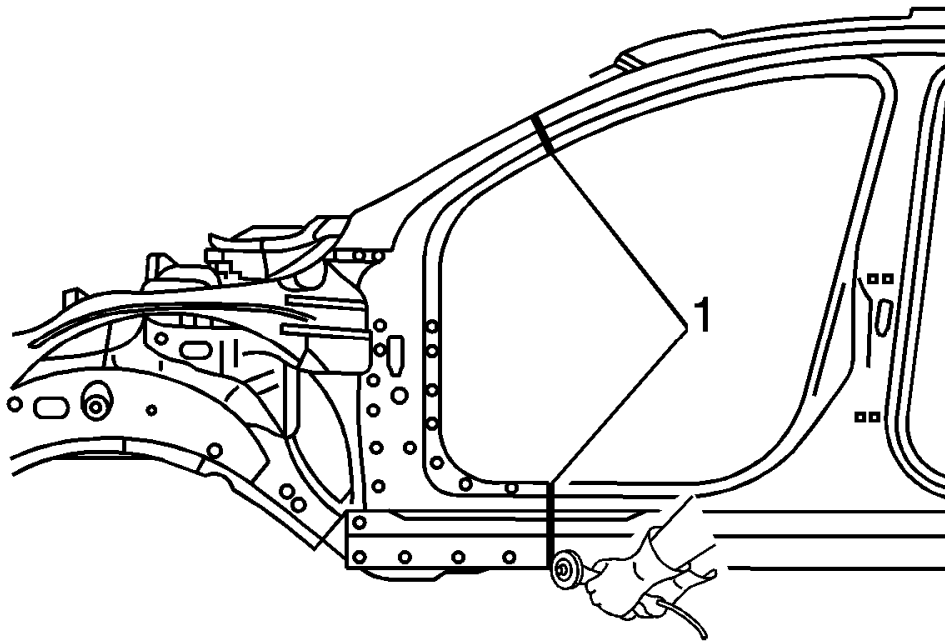


Fig. 46: Identifying Front Hinge Pillar Body Sectioning Area
Courtesy of GENERAL MOTORS COMPANY

7. Cut the front hinge pillar body where sectioning is to be performed (1).
8. Locate and mark all the necessary factory welds of the front hinge pillar body.

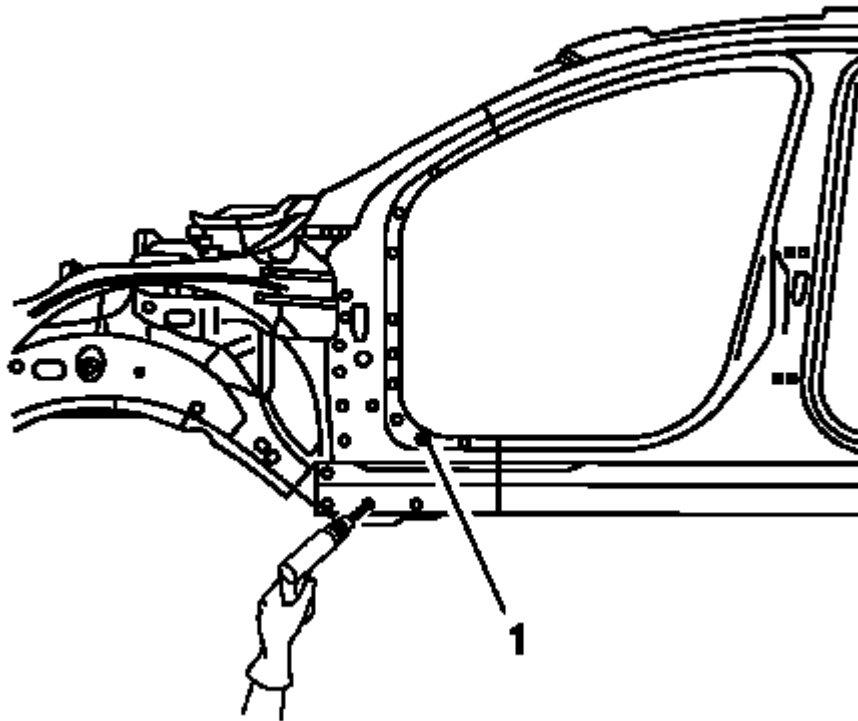


Fig. 47: Drilling Out Factory Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: Record the number and location of welds for installation of the service assembly.

9. Drill out all factory welds (1) The Upper Outer Rail will need to be removed to locate 4 hidden welds on Hinge Pillar Reinforcement.

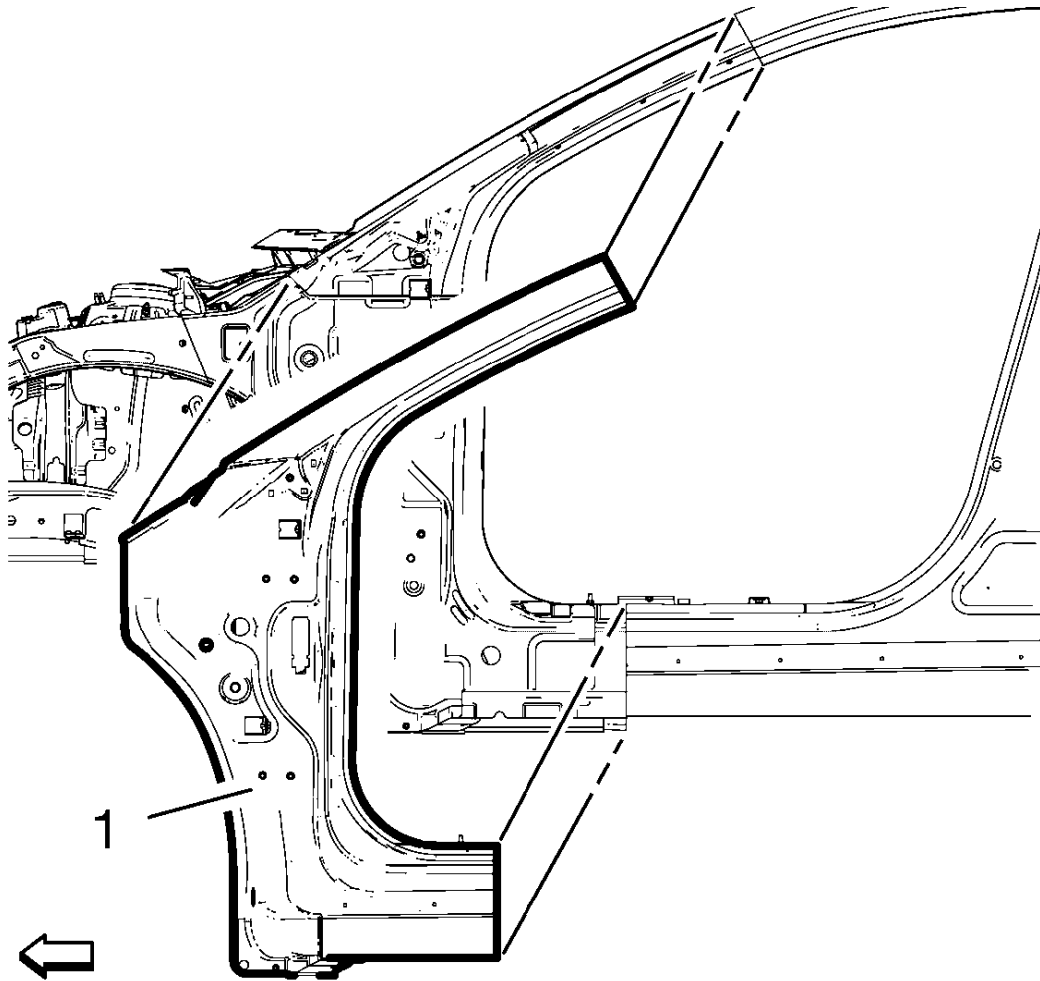


Fig. 48: Front Hinge Pillar Body
Courtesy of GENERAL MOTORS COMPANY

10. Remove the damaged front hinge pillar body (1).

Installation Procedure

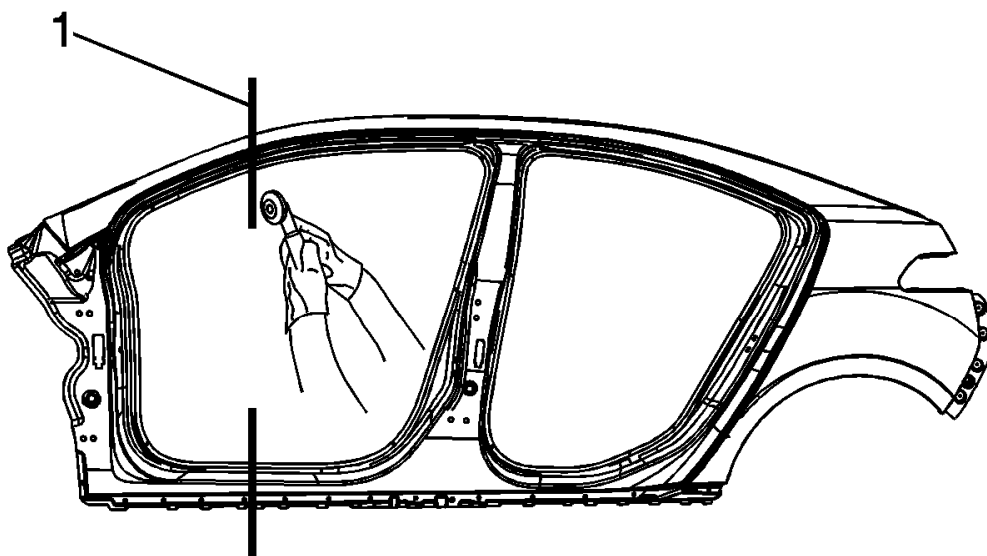


Fig. 49: Cutting Service Part In Corresponding Locations To Overlap Remaining Original Panel
Courtesy of GENERAL MOTORS COMPANY

1. From the service part, cut the panel in corresponding locations to overlap the remaining original panel by 25 mm (1 in) at each joint location (1).

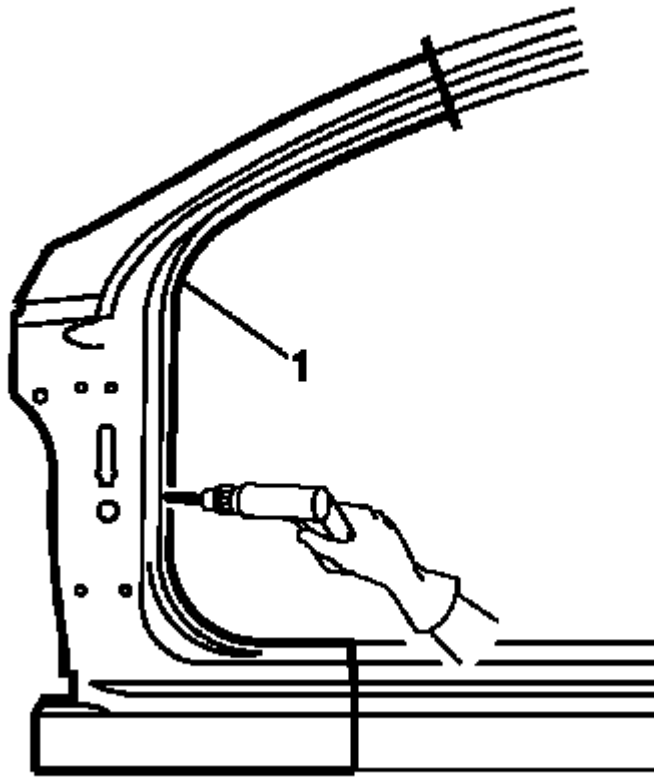


Fig. 50: Drilling 8 mm (5/16 In) Plug Weld Holes In Service Part
Courtesy of GENERAL MOTORS COMPANY

2. Drill 8 mm (5/16 in) plug weld holes in the service part (1), as necessary, in the corresponding locations noted on the original panel and along sectioned joint.
3. Prepare all mating surfaces as necessary.
4. Apply GM approved Weld-Thru Coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

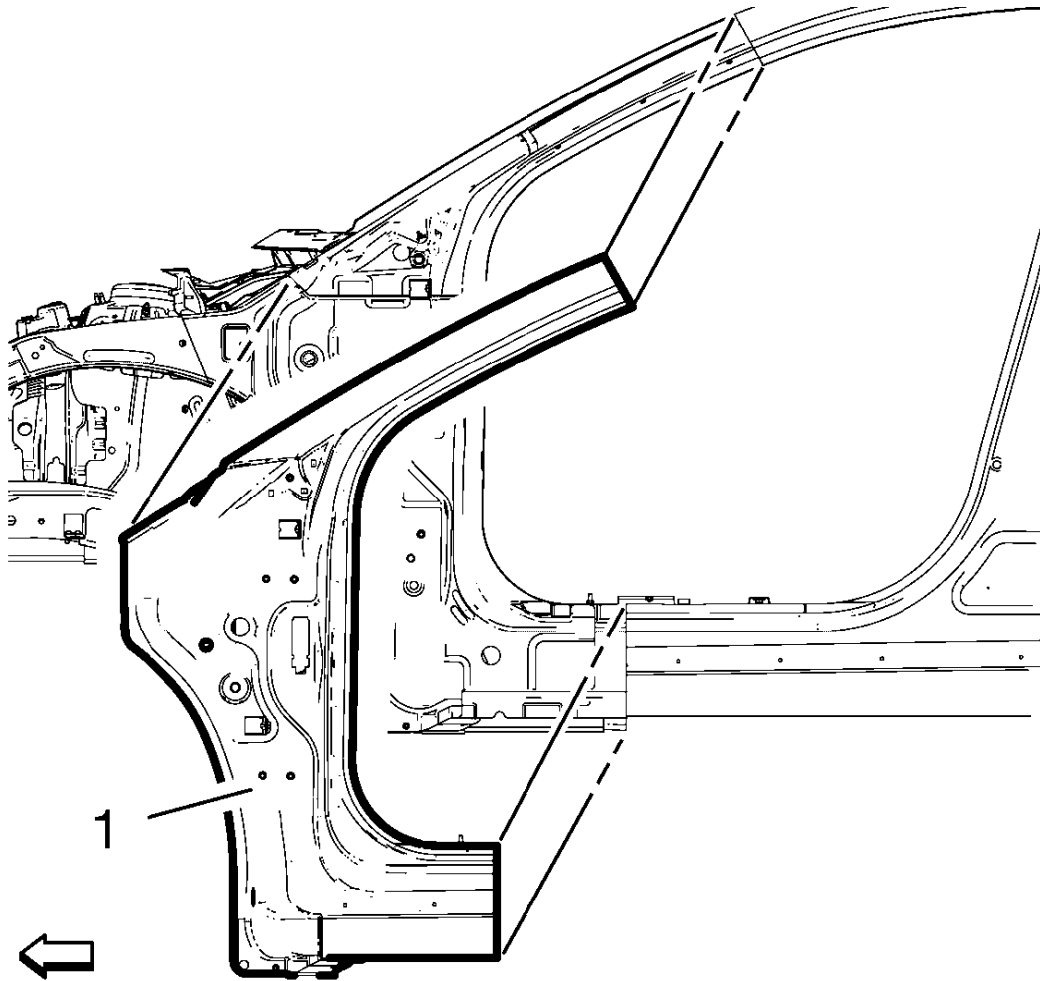


Fig. 51: Front Hinge Pillar Body

Courtesy of GENERAL MOTORS COMPANY

5. Position the outer front pillar to the vehicle using 3-dimensional measuring equipment (1). Clamp the pillar in place.

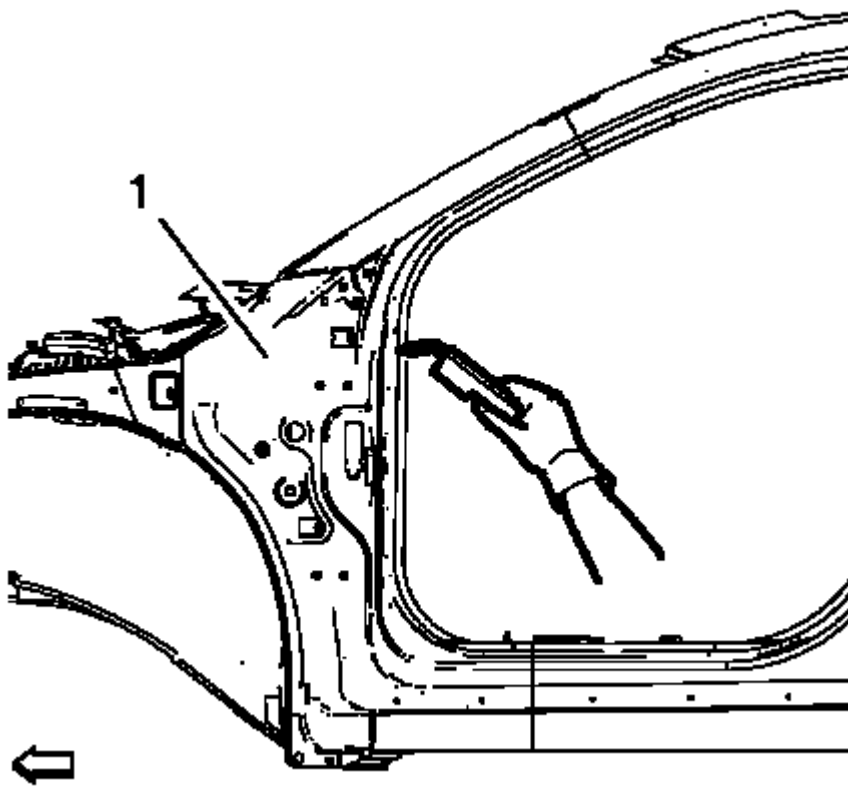


Fig. 52: Welding Front Hinge Pillar Body
Courtesy of GENERAL MOTORS COMPANY

6. Plug weld accordingly (1).

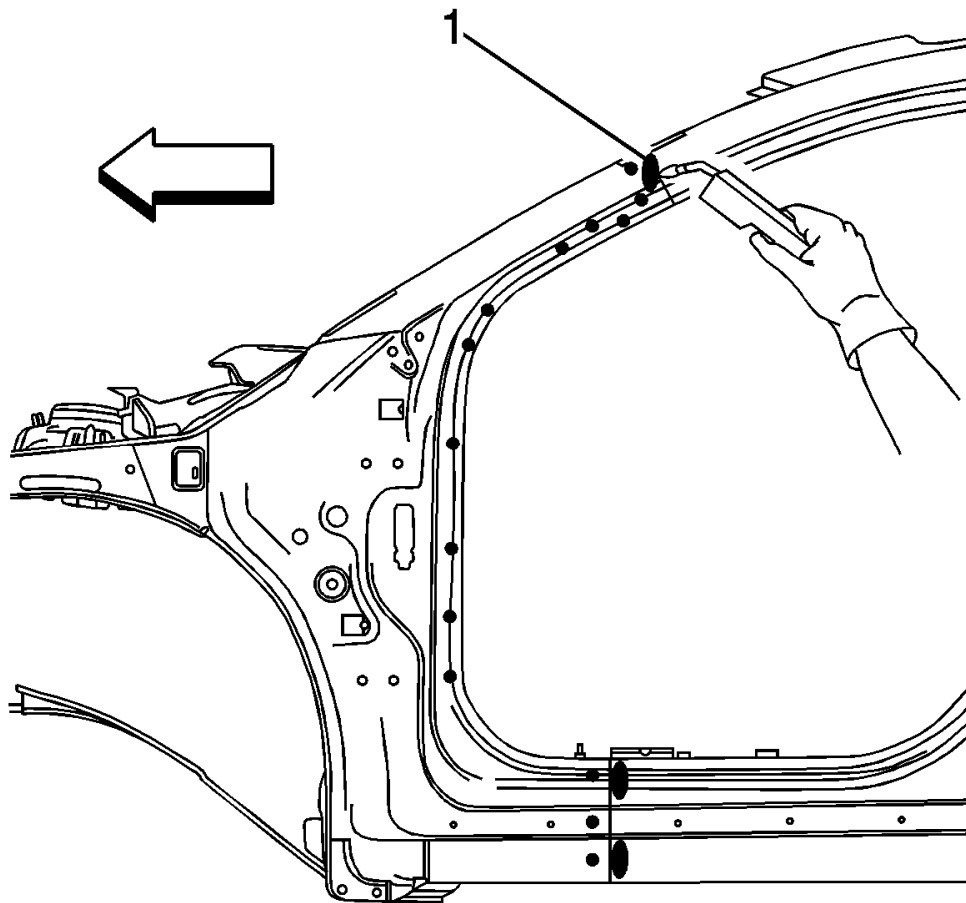


Fig. 53: Stitch Welding Joint

Courtesy of GENERAL MOTORS COMPANY

7. To create a solid weld with minimum heat distortion, make 25 mm (1 in) stitch welds along the seam with 25 mm (1 in) gaps between them. Then go back and complete the stitch weld (1).
8. Clean and prepare all of the welded surfaces.
9. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
10. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
11. Install all of the related panels and components.
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
13. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT HINGE PILLAR BODY SECTIONING (LOWER)

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

NOTE: Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle.

The body side outer panels are available in one-piece side frames. You can perform any one of these replacement procedures separately or in any combination, depending upon the extent of damage to the vehicle. Stay away from the door and window opening radius areas. Perform sectioning only in straight areas of the openings.

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove all related panels and components.
4. Repair as much of the damaged area as possible. Refer to **Dimensions - Body (Sedan)**.
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

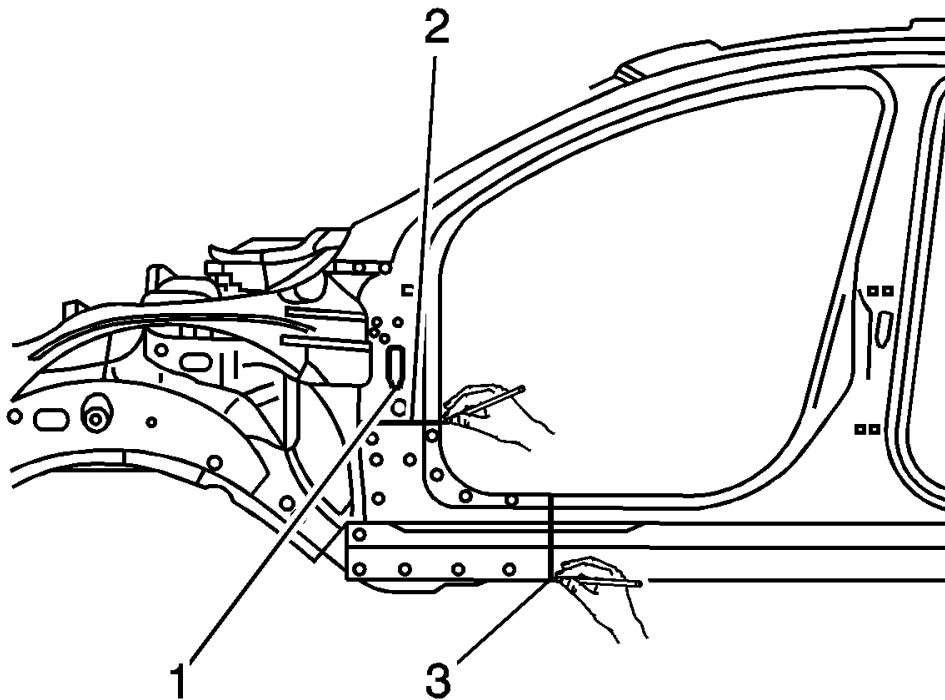


Fig. 54: Sectioning Straight Area Along Rocker Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: Sectioning can be done anywhere in the straight area along the rocker panel.

6. On the "A" Pillar Measure down 120 mm from the door wiring conduit hole lower edge (1). Mark this cut location on the front hinge pillar (2). Mark a cut location in the straight area on the rocker panel (3).

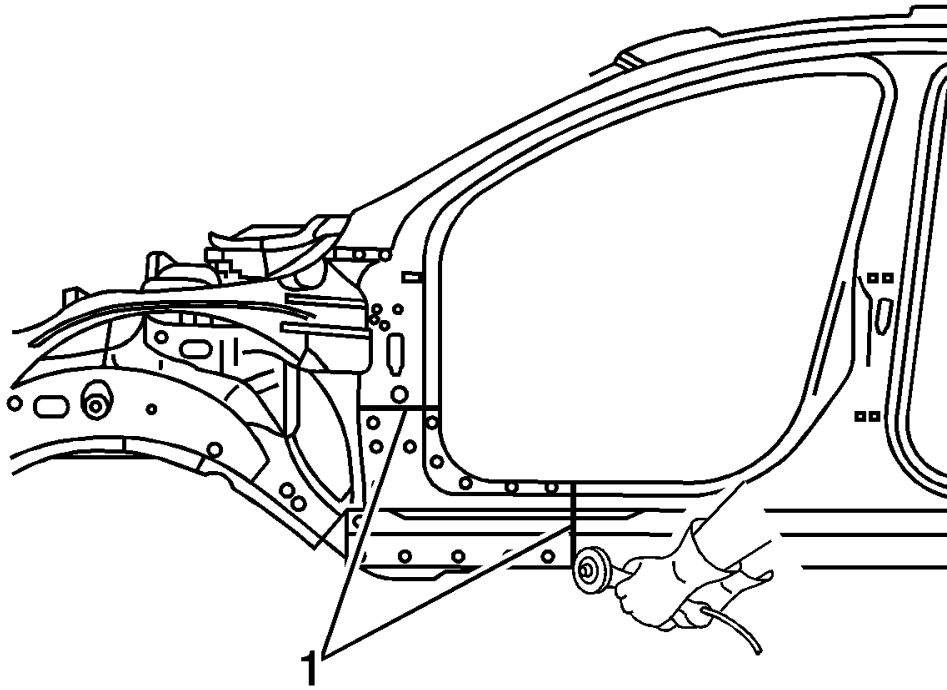


Fig. 55: Cutting Where Sectioning Is Performed
Courtesy of GENERAL MOTORS COMPANY

7. Cut the front hinge pillar body where sectioning is to be performed (1).
8. Locate and mark all the necessary factory welds of the front hinge pillar body.

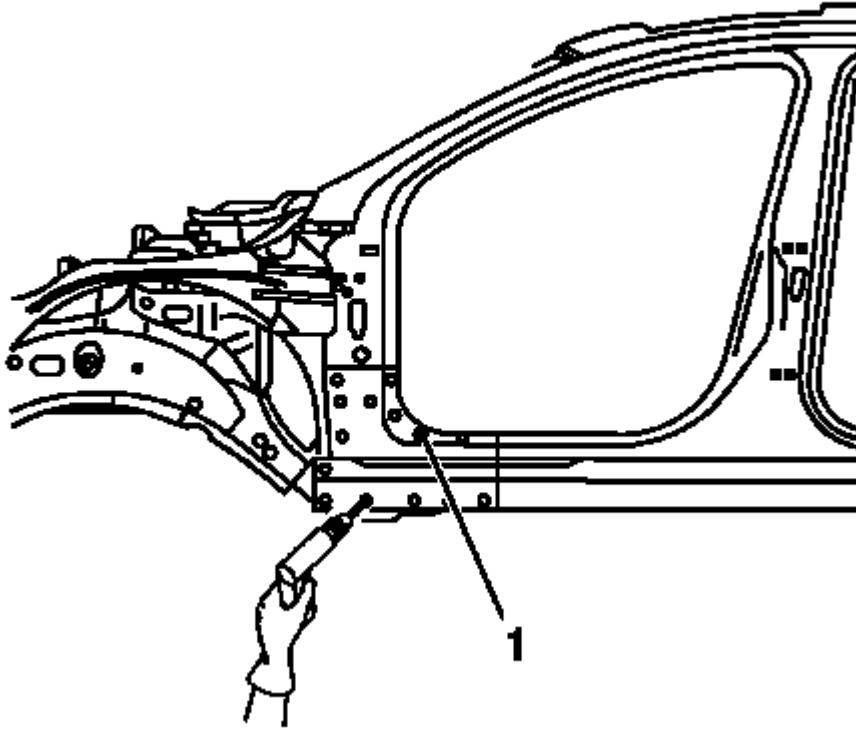


Fig. 56: Drilling Out Factory Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: Record the number and location of welds for installation of the service assembly.

9. Drill out all factory welds (1).
10. Remove the damaged front hinge pillar body.

Installation Procedure

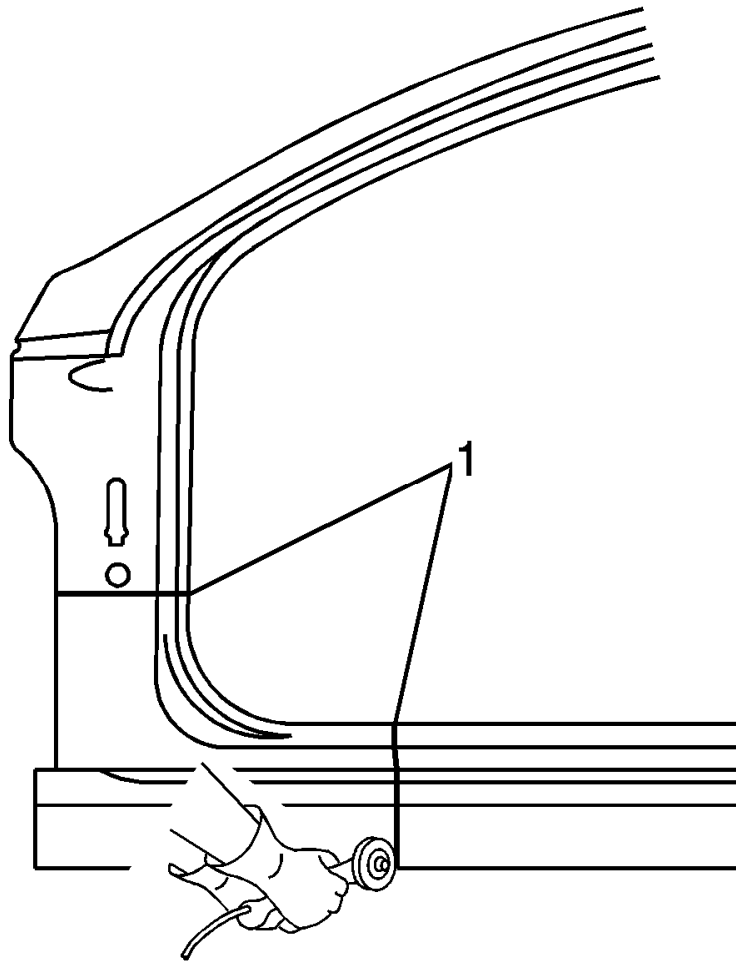


Fig. 57: Cutting Replacement Hinge Pillar
Courtesy of GENERAL MOTORS COMPANY

1. From the service part, cut the panel in corresponding locations to overlap the remaining original panel by 25 mm (1 in) at each joint location (1).

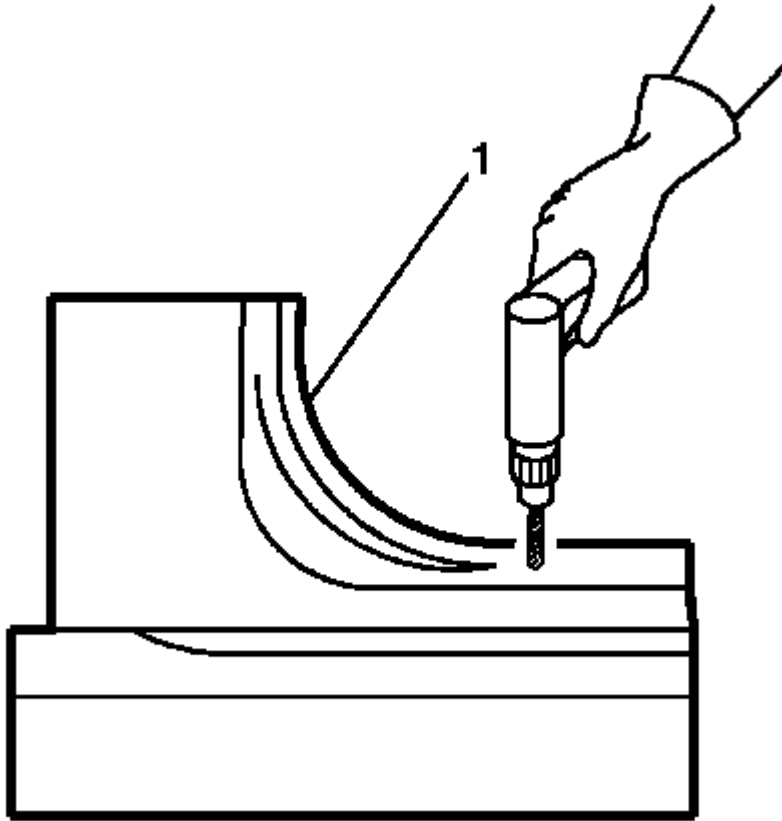


Fig. 58: Drilling Plug Weld Holes

Courtesy of GENERAL MOTORS COMPANY

2. Drill 8 mm (5/16 in) plug weld holes along the sectioning area in the service part, and at the locations noted from the original panel and along sectioned joint (1).
3. Prepare all matting surfaces as necessary.
4. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

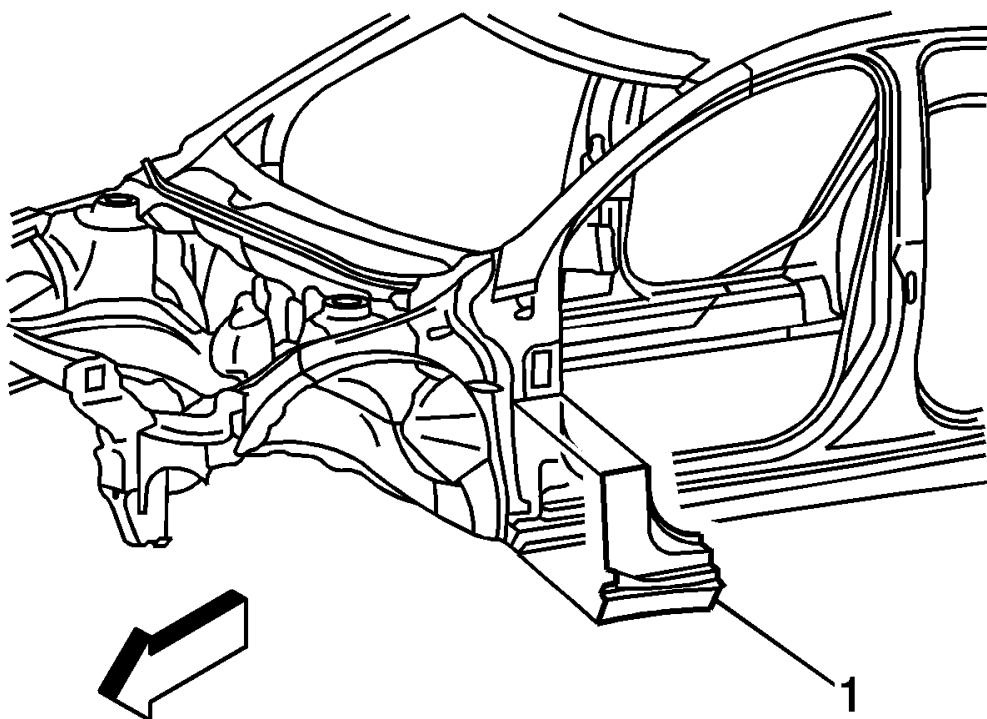


Fig. 59: View Of Outer Front Pillar
Courtesy of GENERAL MOTORS COMPANY

5. Position the outer front pillar to the vehicle using 3-dimensional measuring equipment (1). Clamp the pillar in place.

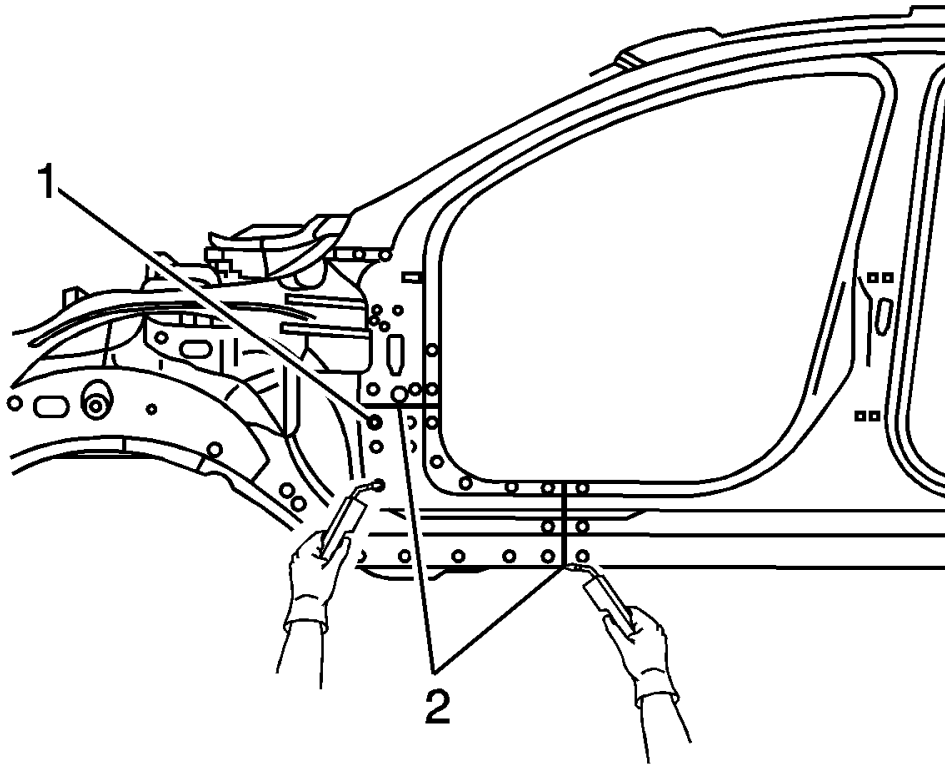


Fig. 60: Welding Outer Front Pillar
Courtesy of GENERAL MOTORS COMPANY

6. Plug weld accordingly (1).
7. To create a solid weld with minimum heat distortion, make a 25 mm (1 in) stitch welds along the seam with 25 mm (1 in) gaps between them. Then go back and complete the stitch weld (2).
8. Clean and prepare all of the welded surfaces.
9. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
10. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
11. Install all of the related panels and components.
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
13. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

BODY HINGE PILLAR LOWER REINFORCEMENT REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

WARNING: Refer to Collision Sectioning Warning .

WARNING: Refer to Glass and Sheet Metal Handling Warning .

1. Disable the SIR System. Refer to SIR Disabling and Enabling .
2. Remove all related panels and components.
3. Visually inspect the damage. Repair as much of the damage as possible.
4. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
5. Section body side outer-hinge pillar area. Refer to Front Hinge Pillar Body Sectioning (Upper), Front Hinge Pillar Body Sectioning (Lower).

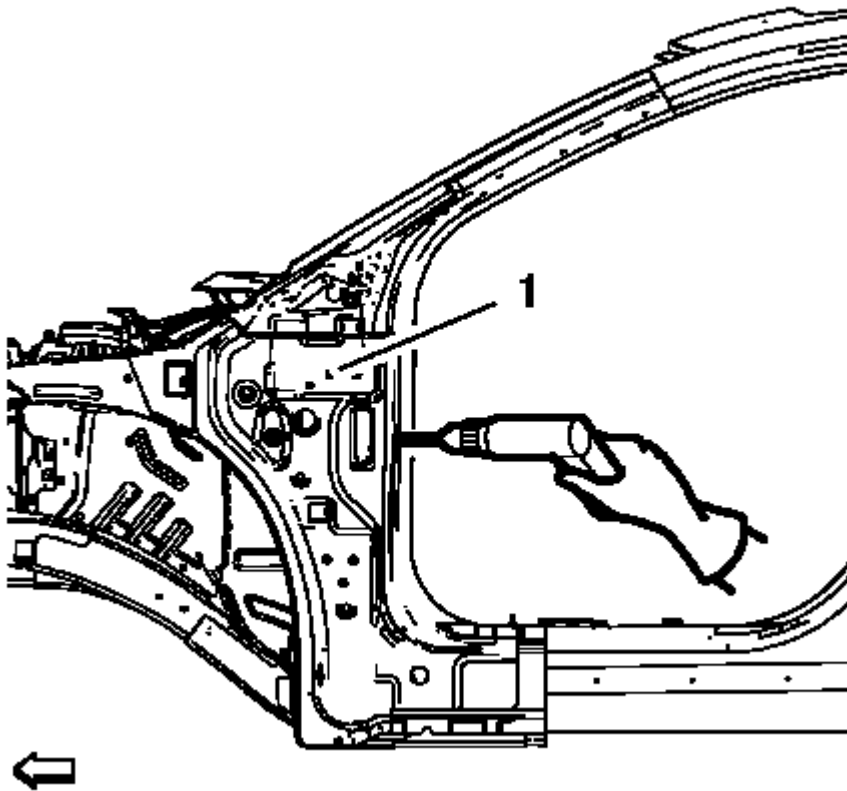


Fig. 61: Drilling Factory Welds Of Body Hinge Pillar Lower Reinforcement
Courtesy of GENERAL MOTORS COMPANY

6. Locate and mark all the necessary factory welds of the body hinge pillar lower reinforcement (1).
7. Drill all factory welds. Note the number and location of welds for installation of the service assembly.

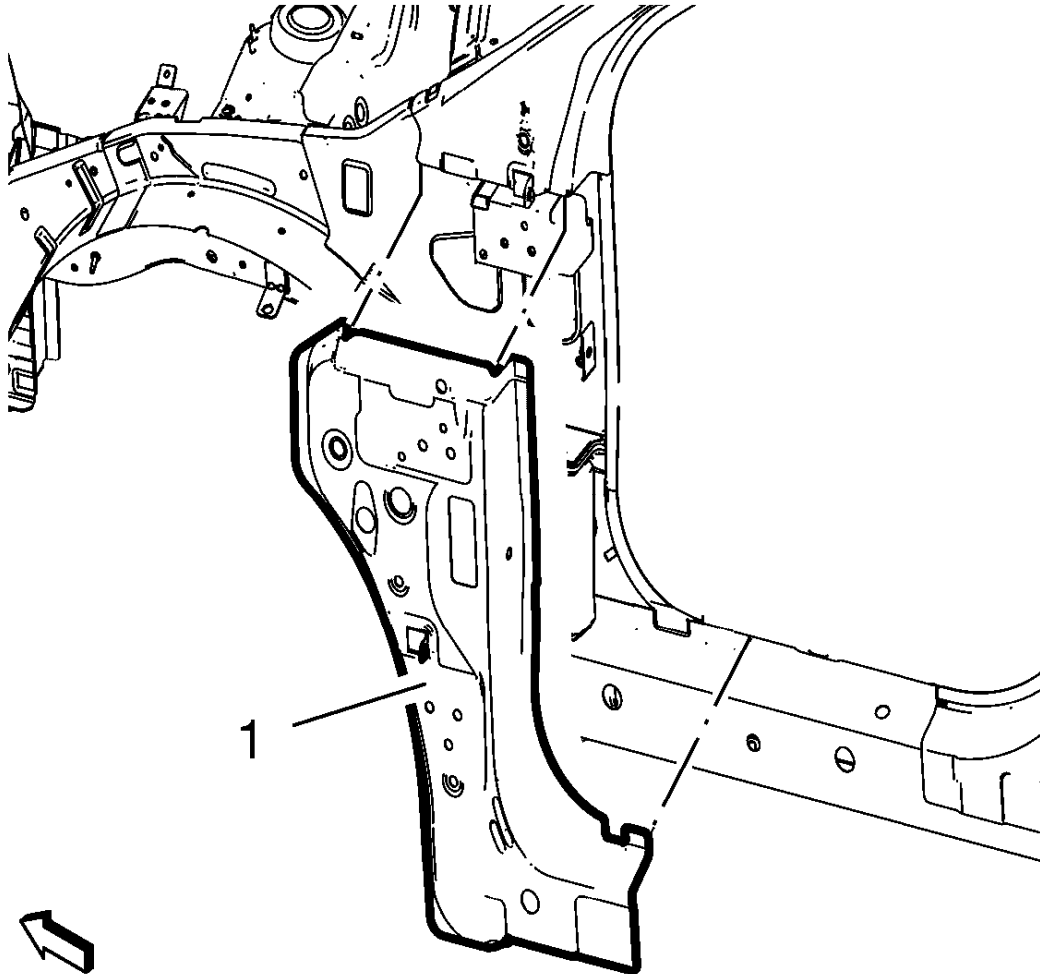


Fig. 62: Body Hinge Pillar Lower Reinforcement
Courtesy of GENERAL MOTORS COMPANY

8. Remove the damaged body hinge pillar lower reinforcement (1).

Installation Procedure

1. Prepare all mating surfaces as necessary.

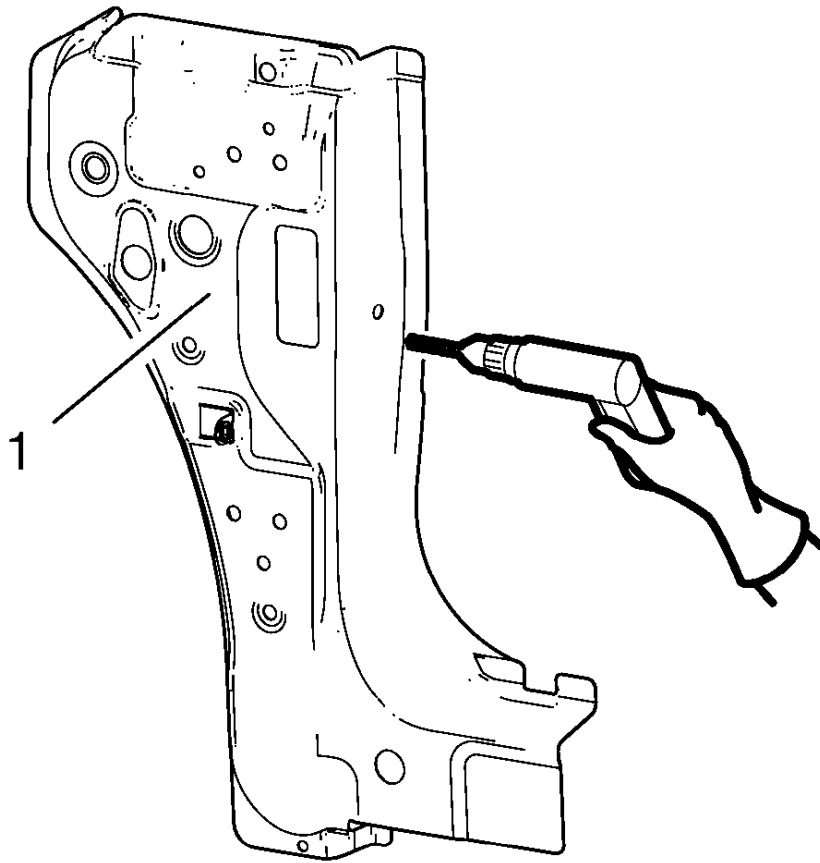


Fig. 63: Drilling Hole For Plug Welding Body Hinge Pillar Lower Reinforcement
Courtesy of GENERAL MOTORS COMPANY

2. Drill 8 mm (5/16 in) for plug welding along the edges of the body hinge pillar lower reinforcement (1) as noted from the original panel.
3. Clean and prepare the attaching surfaces for welding.

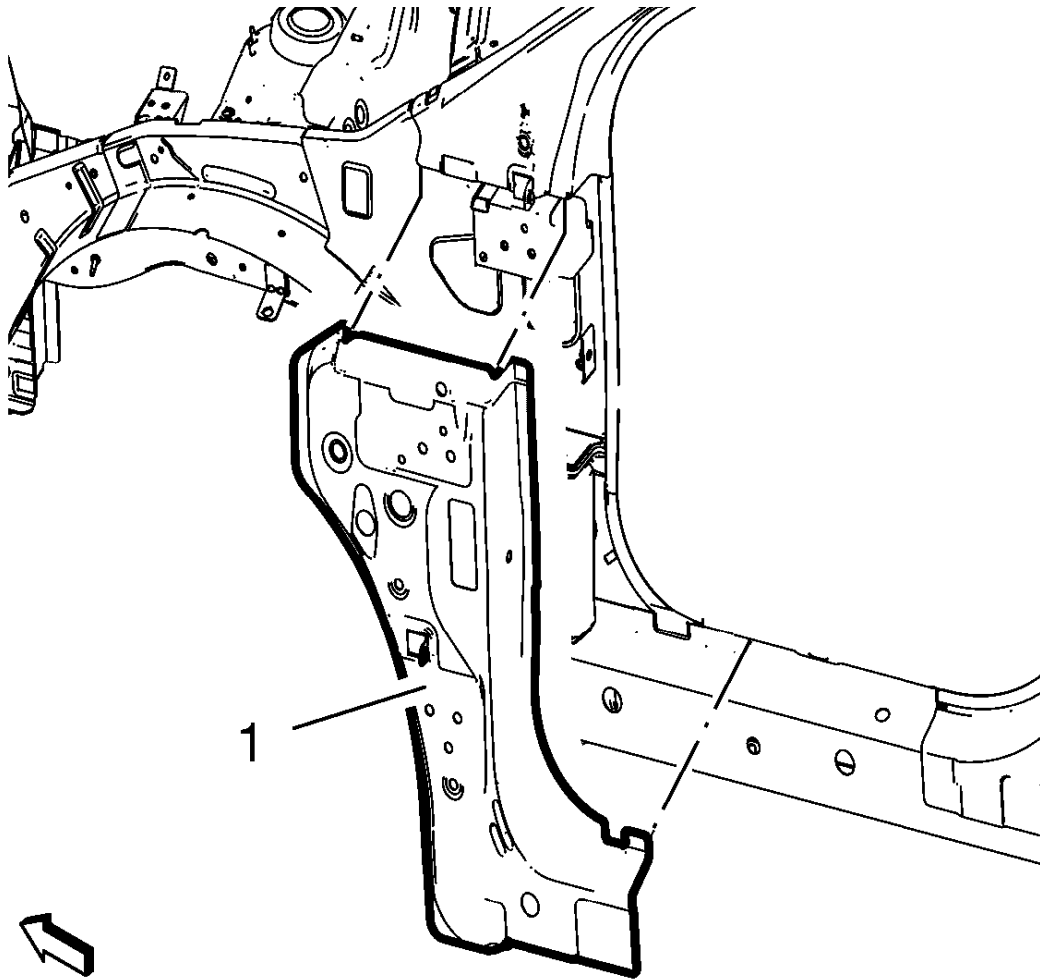


Fig. 64: Body Hinge Pillar Lower Reinforcement
Courtesy of GENERAL MOTORS COMPANY

4. Position the body hinge pillar lower reinforcement (1) on the vehicle.
5. Verify the fit of the body hinge pillar lower reinforcement.
6. Clamp the body hinge pillar lower reinforcement into position.

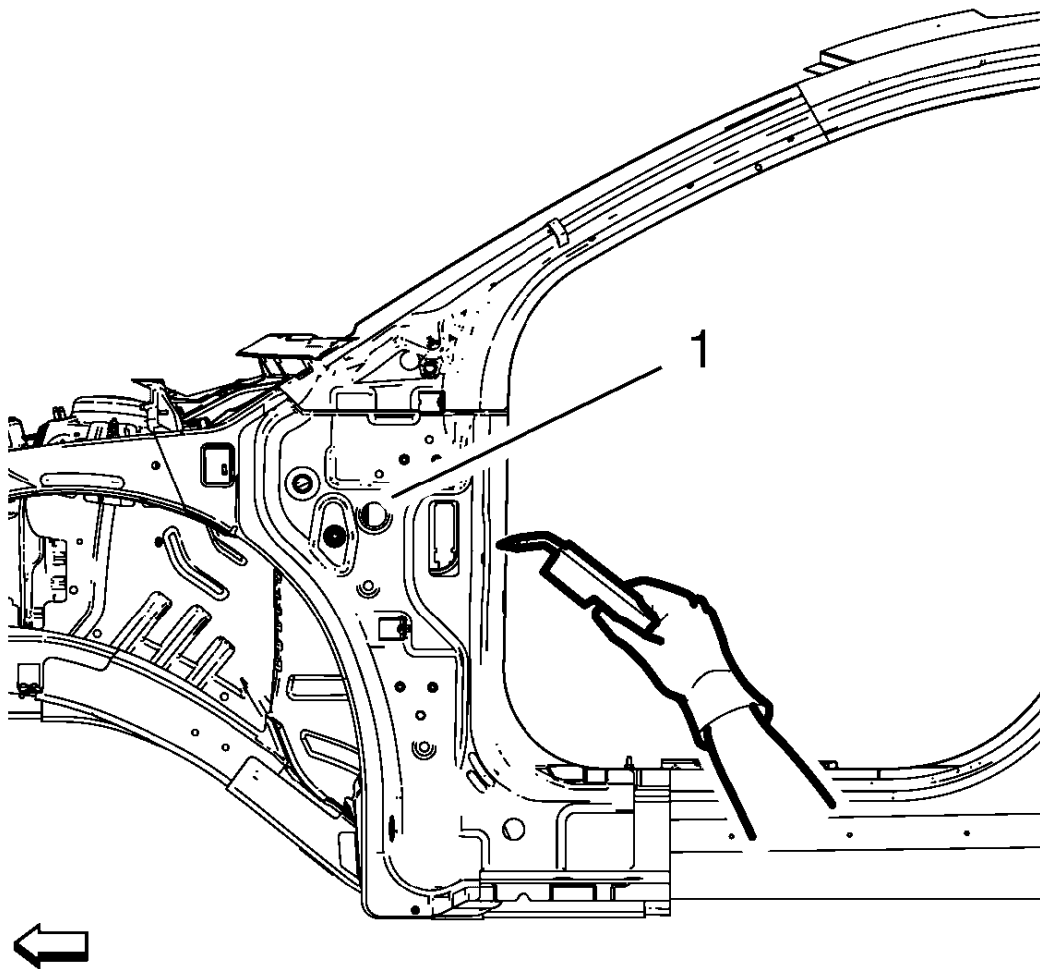


Fig. 65: Welding Body Hinge Pillar Lower Reinforcement
 Courtesy of GENERAL MOTORS COMPANY

7. Plug weld the body hinge pillar lower reinforcement (1) accordingly.
8. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
9. Install the bodyside outer hinge pillar section. Refer to **Front Hinge Pillar Body Sectioning (Upper)**, **Front Hinge Pillar Body Sectioning (Lower)**.
10. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
11. Install all related panels and components.
12. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

ROOF OUTER PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

NOTE: Use care when cutting to protect adjacent panels. Cut inboard of the side frame structure.

1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove all related panels and components.
4. Visually inspect the damage. Repair as much of the damage as possible.
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
6. Locate and mark all factory welds in the front and rear window openings.

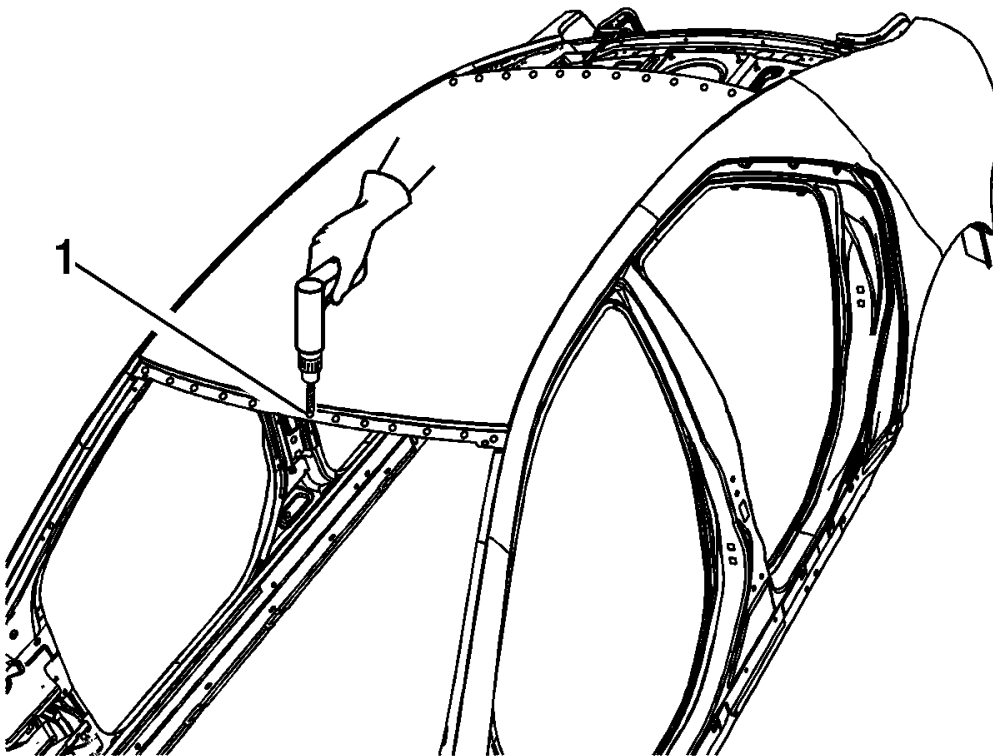


Fig. 66: Drilling Factory Welds
Courtesy of GENERAL MOTORS COMPANY

7. Drill all factory welds (1). Note the number and location of welds for installation of the service assembly.

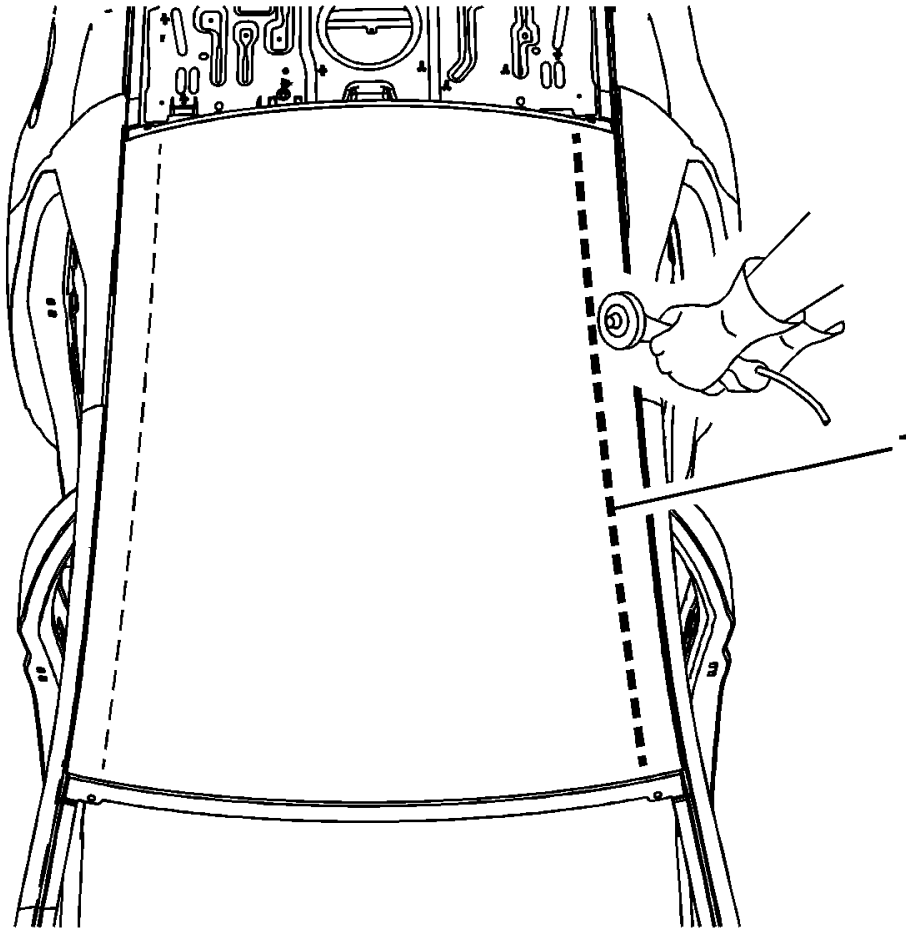


Fig. 67: Cutting Panel 30 mm Inboard Of Roof Edge
Courtesy of GENERAL MOTORS COMPANY

8. On the side rail area of the roof use a cut off wheel or equivalent to cut the panel 30 mm inboard of the roof edge (1).
9. Remove the center portion of the panel.

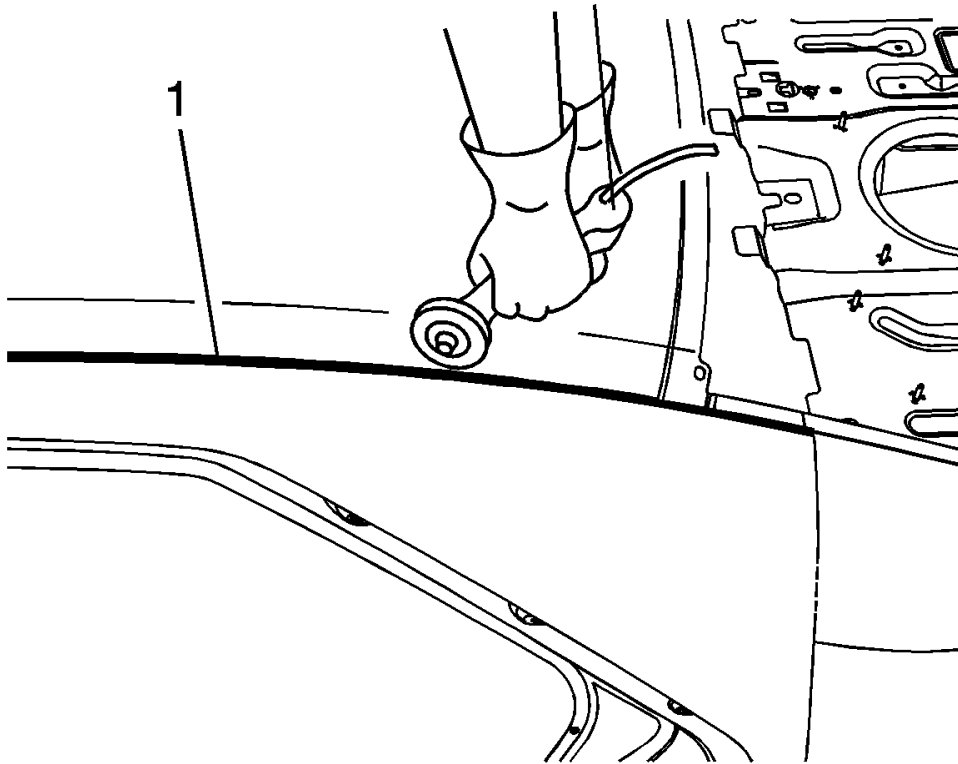


Fig. 68: Grinding Out MIG Braze Joint
Courtesy of GENERAL MOTORS COMPANY

10. To separate the remaining portion of the panel use a cut off wheel or equivalent to grind out the MIG braze joint (1).
11. Remove the remaining portion of the original panel.

Installation Procedure

1. Dry fit the service panel to the vehicle.

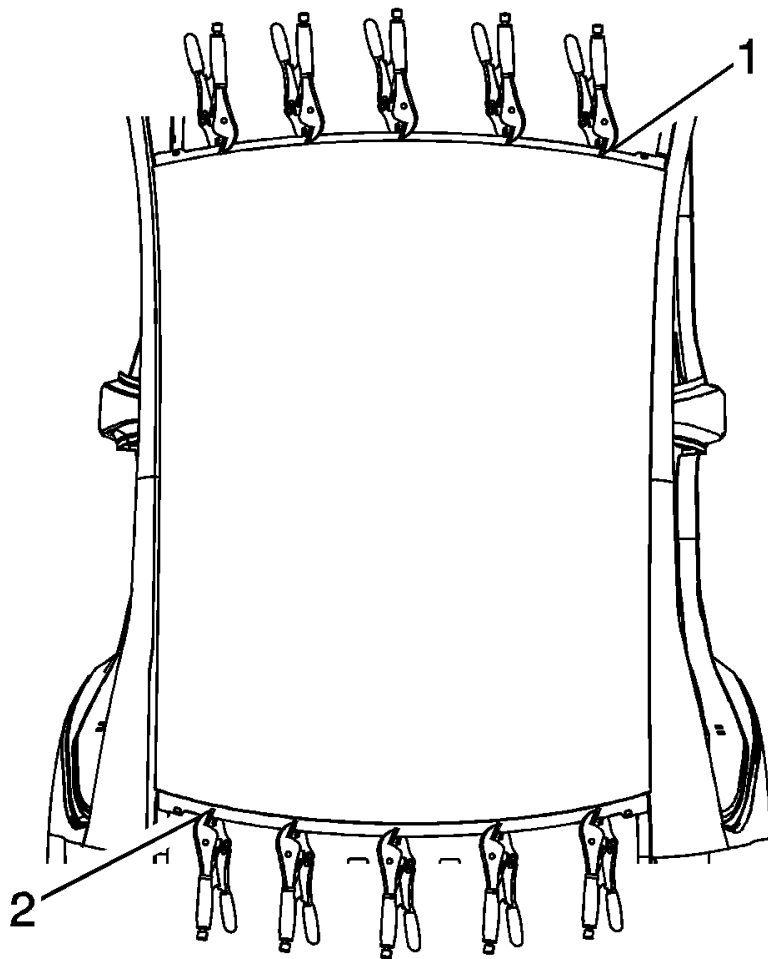


Fig. 69: Clamping Panel Into Position
Courtesy of GENERAL MOTORS COMPANY

2. Clamp the panel into position in the rear window opening (1). Adjust the bow of the roof front to rear. Clamp in place in the windshield opening area (2).

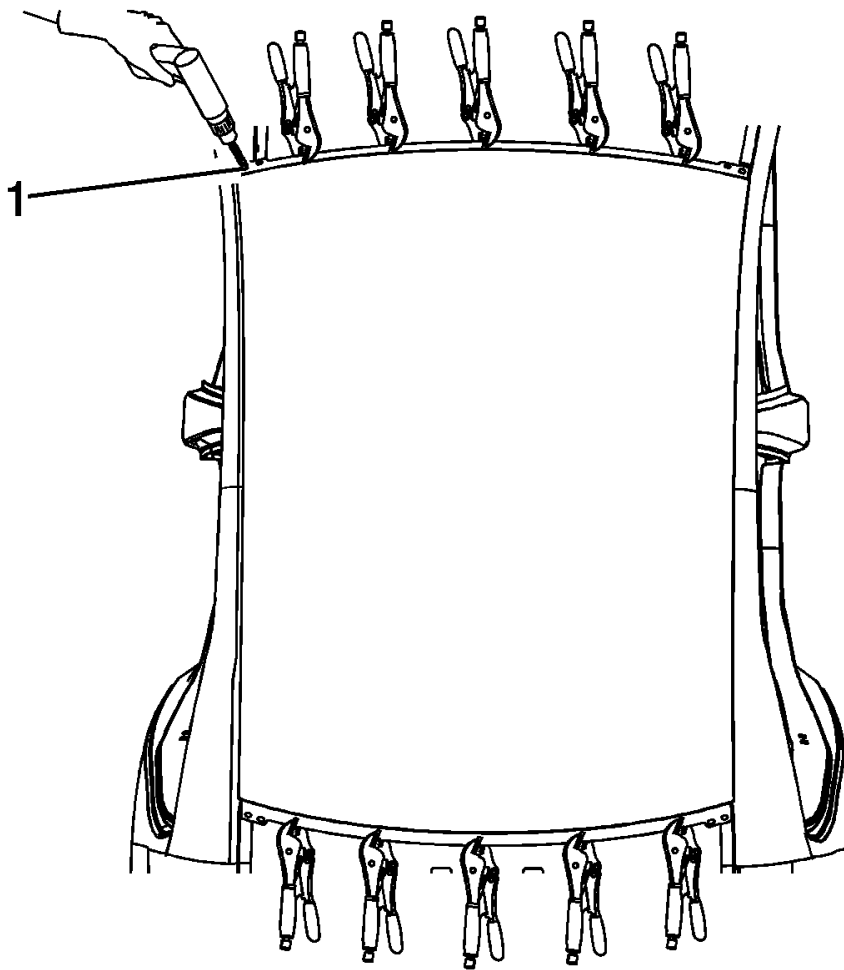


Fig. 70: Drilling 3.2 mm (1/8 in) Hole In Each Corner Of Panel
Courtesy of GENERAL MOTORS COMPANY

3. With the service panel clamped in position drill a 3.2 mm (1/8 in) hole in each corner of the panel in the front and rear window openings (1).
4. Remove the service panel from the vehicle.

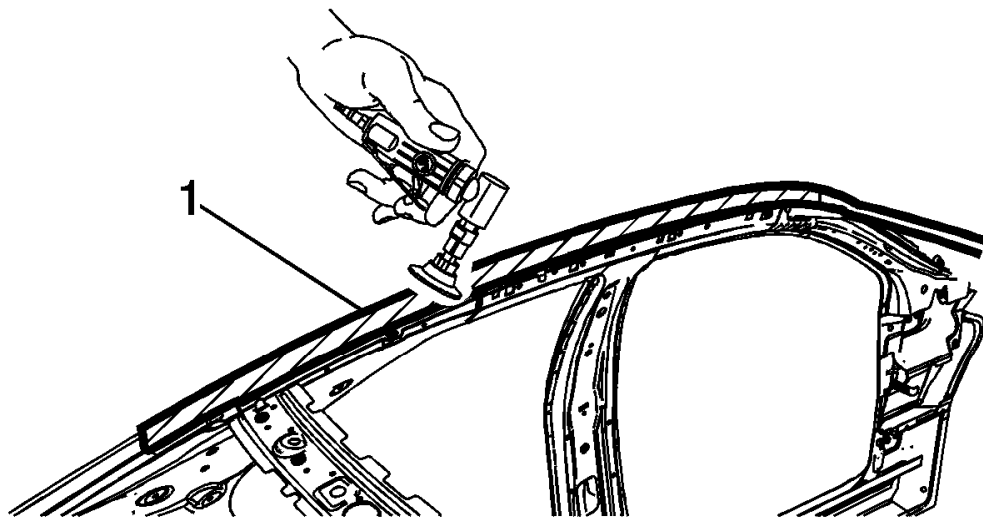


Fig. 71: Preparing Roof Rail Area With Abrasive Wheel
Courtesy of GENERAL MOTORS COMPANY

5. Prepare the roof rail area of the vehicle with a Rol-lock abrasive wheel or equivalent (1).
6. Clean and prepare the front and rear window attaching surfaces for welding. Refer to **Anti-Corrosion Treatment and Repair** .
7. Prepare the roof side rail bond areas. Refer to adhesive manufacturers preparation instructions.

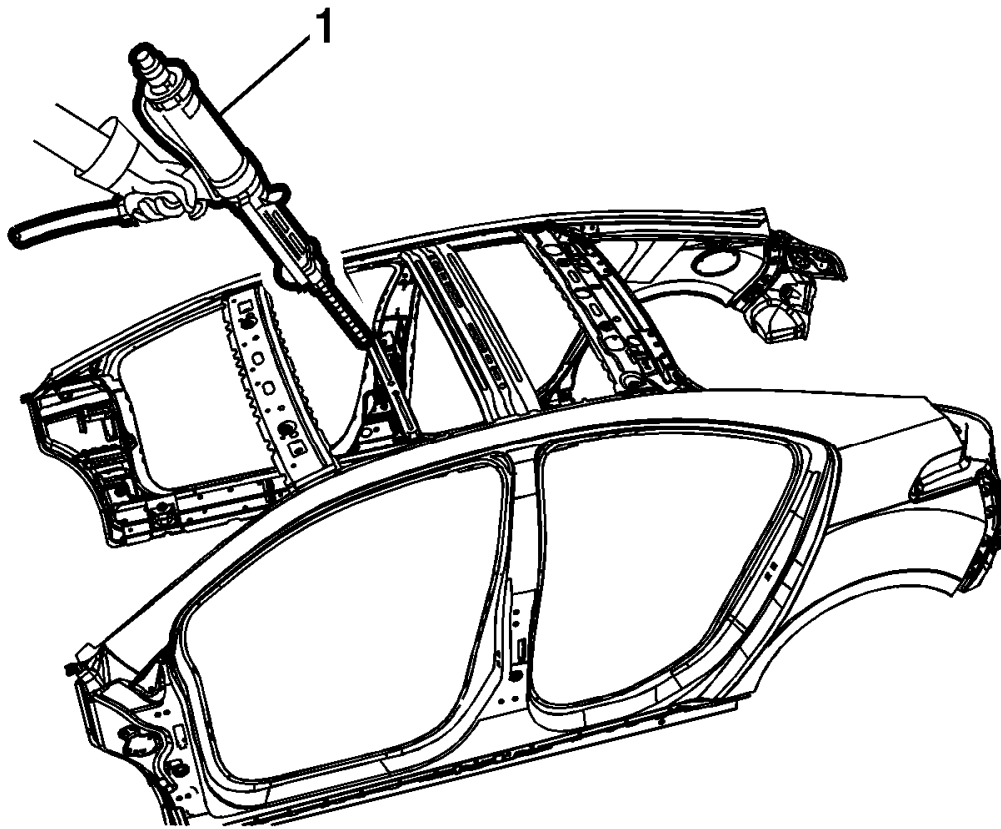


Fig. 72: Applying Fusor Super Flexible Anti-Flutter Foam Fast Set
Courtesy of GENERAL MOTORS COMPANY

8. Apply Fusor super flexible anti-flutter foam fast set (1), or equivalent, to the roof bows in the locations noted from the original panel.

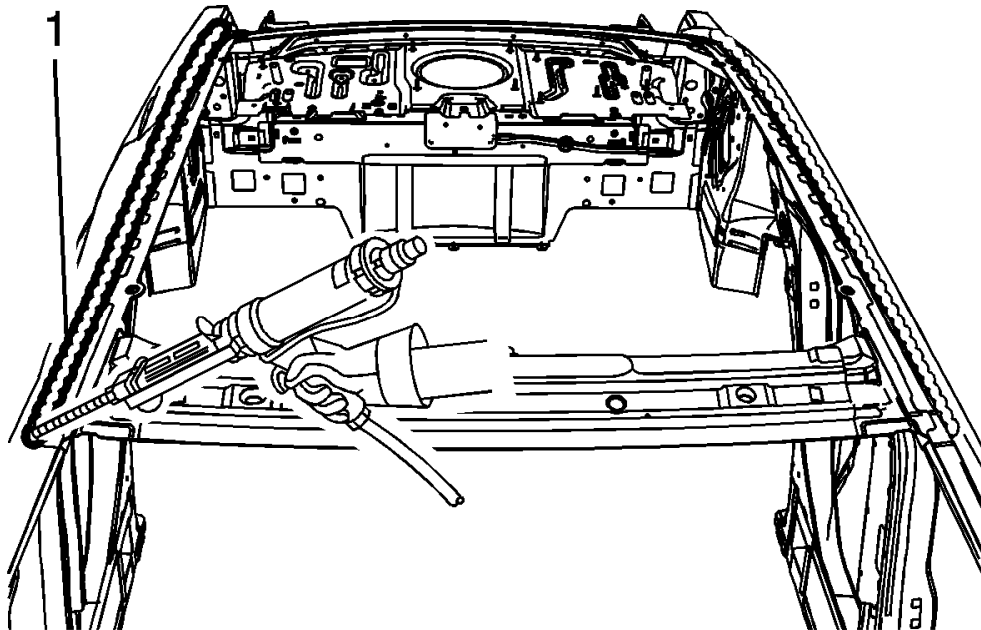


Fig. 73: Applying Bead Of Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

9. Apply a 12 mm (1/2 in) bead of metal panel bonding adhesive **Metal Panel Bonding** to the left and right roof rails (1).
10. With the help of a second person lower the service panel straight down onto the vehicle.

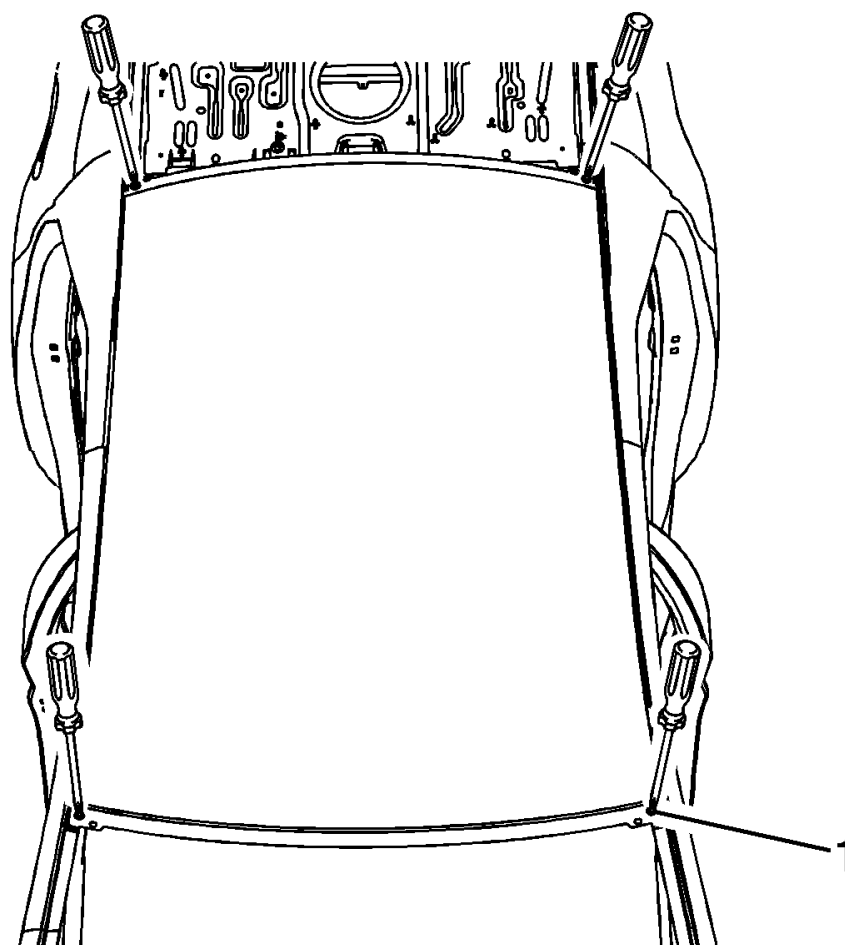


Fig. 74: Aligning Roof Panel With Awls
Courtesy of GENERAL MOTORS COMPANY

NOTE: This step will insure the proper location and contour to the vehicle

11. Insert an awl or equivalent tool into the four holes drilled in the window openings in step 3 (1).
12. Clamp the roof in place in the front and rear window openings.
13. Clean up the excess urethane from the surface.

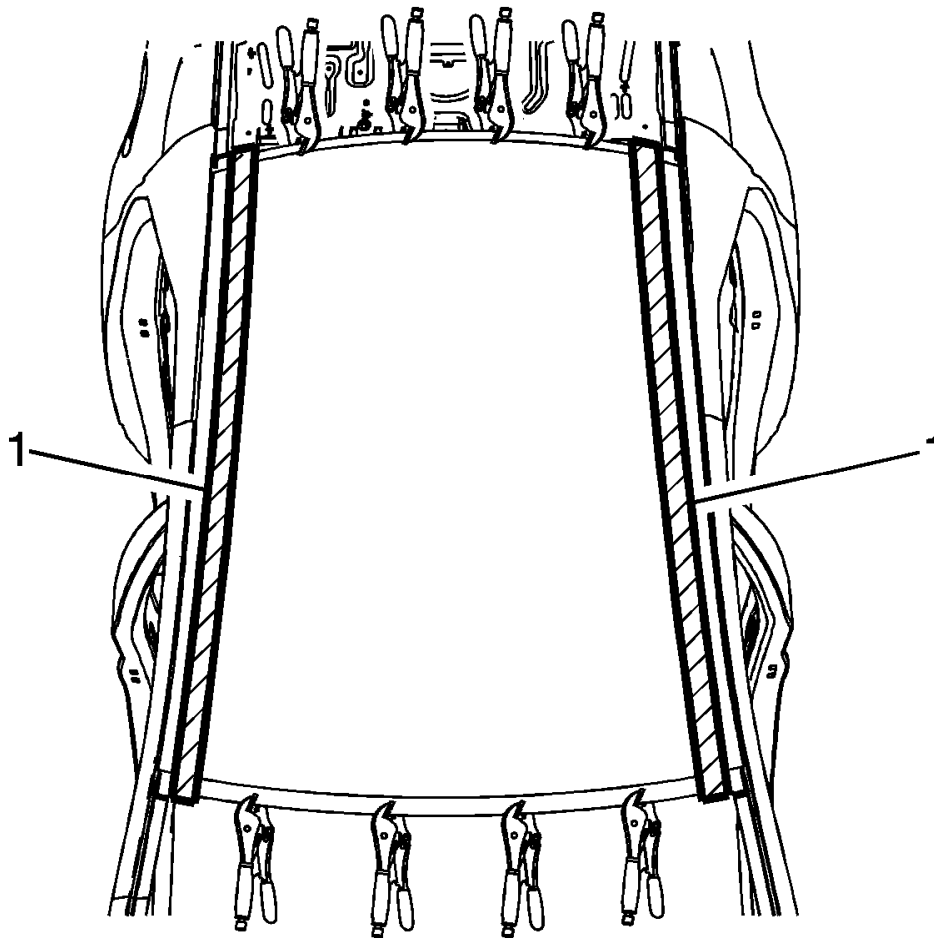


Fig. 75: Installing 25 mm (1 in) Wide Ratchet Strap Across Roof
Courtesy of GENERAL MOTORS COMPANY

14. Install 25 mm (1 in) wide ratchet strap or equivalent across the roof inboard of the bond area (1). Apply light even pressure to the bond area.
15. Allow adhesive to completely cure per manufacturers instructions. Remove the ratchet straps.

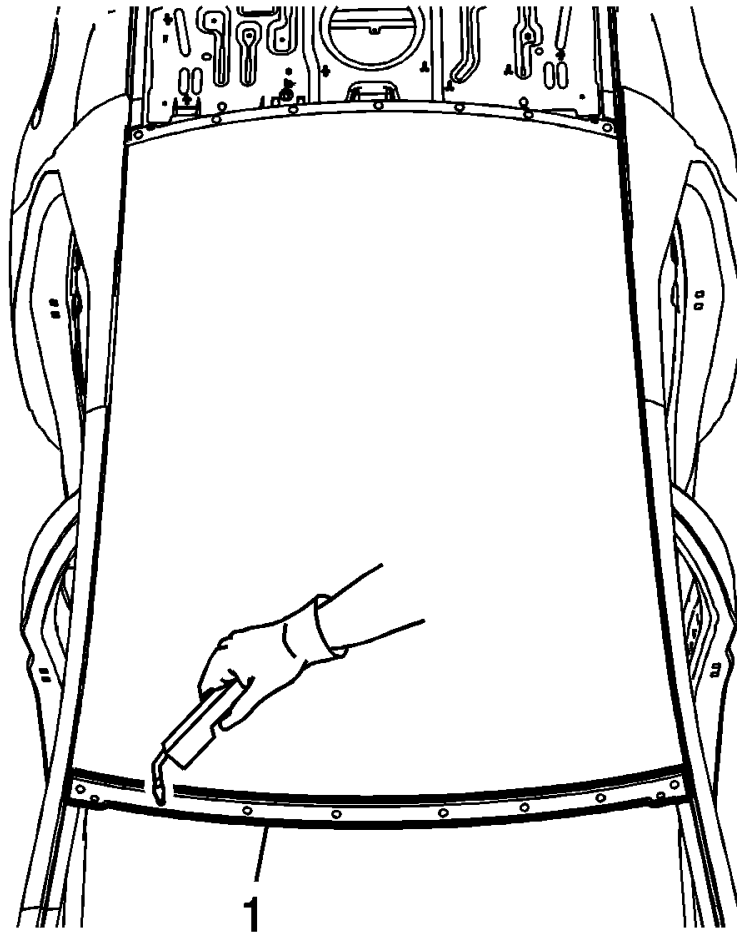


Fig. 76: Plug Weldding Panel

Courtesy of GENERAL MOTORS COMPANY

16. Plug weld accordingly (1). Weld the four holes used for alignment.
17. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
18. Use a high quality seam sealer to fill the gap between the outer roof panel and the body side roof rail. Follow the manufacturers instructions.
19. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
20. Install all related panels and components.
21. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
22. Enable the SIR system. Refer to **SIR Disabling and Enabling**

ROCKER INNER PANEL REINFORCEMENT REPLACEMENT

Removal Procedure

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove all related panels and components.

WARNING: Refer to Approved Equipment for Collision Repair Warning .

NOTE: Failure to replace any damaged reinforcement as described could compromise the structural integrity of the vehicle.

4. Remove the sealers and anti-corrosion materials from the repair area as necessary. Refer to Anti-Corrosion Treatment and Repair .

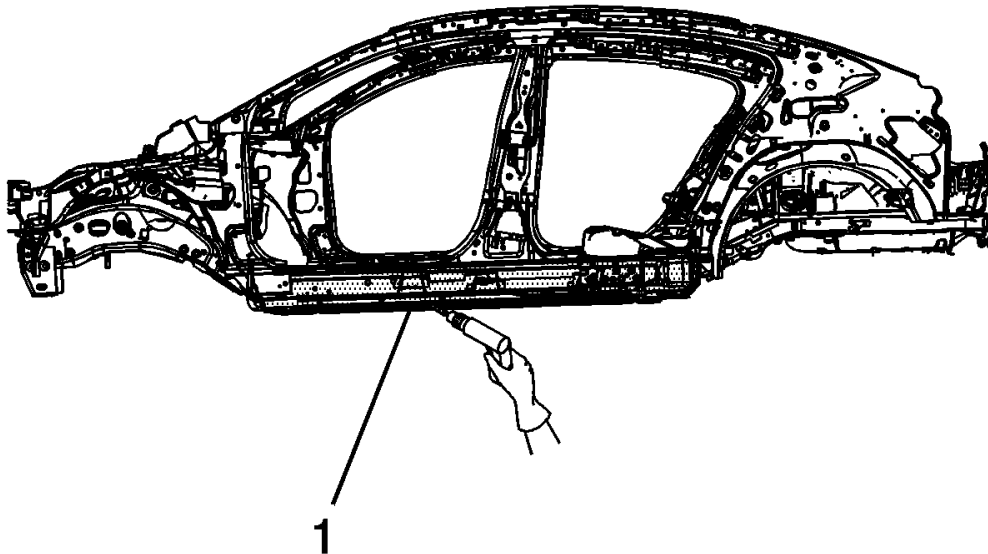


Fig. 77: Drilling Rocker Inner Panel Reinforcement Factory Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: The inner reinforcement is a high strength steel and cannot be sectioned

or altered.

5. Drill out factory welds (1).

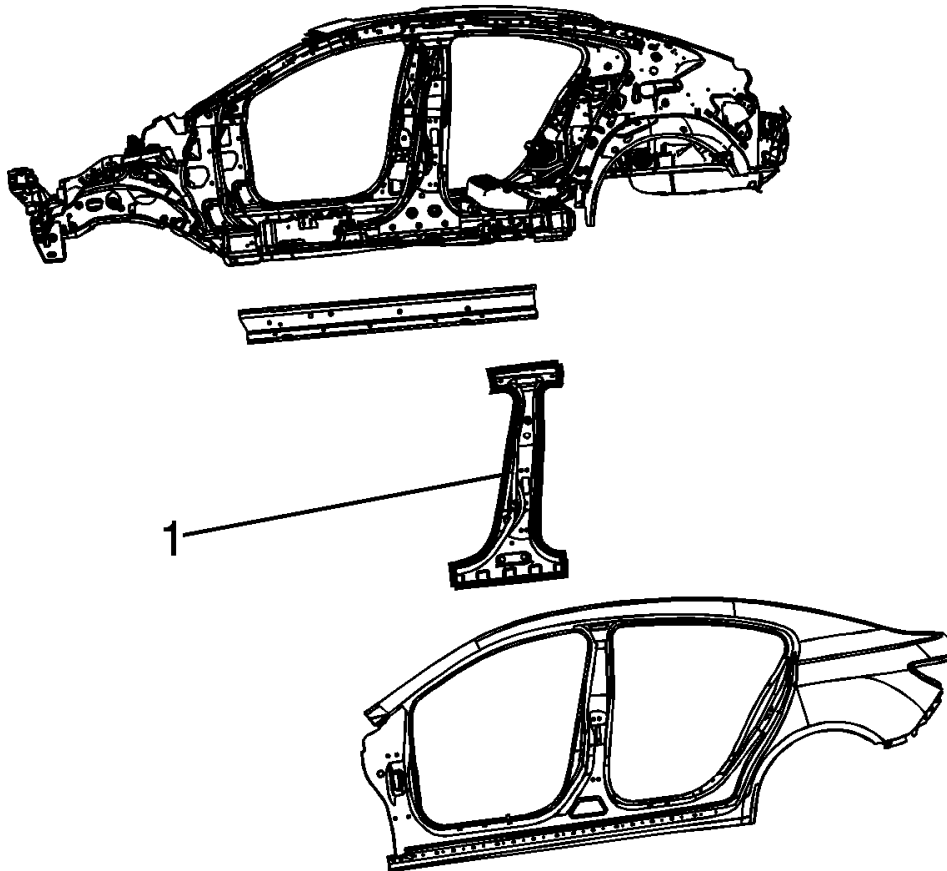


Fig. 78: Center Pillar Reinforcement
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the number and location of the factory welds for installation of reinforcements.

6. After the body side outer panel is removed to gain access to rocker, the center pillar reinforcement must be removed (1).

Installation Procedure

NOTE: If the location of the original plug weld holes cannot be determined, space the plug weld holes every 40 mm (1 1/2 in) apart.

1. Prepare the mating surfaces as necessary.
2. Apply GM approved weld-thru coating or equivalent. Refer to **Anti-Corrosion Treatment and Repair** .
3. Position the rocker reinforcement in place, use 3-dimensional measuring equipment, clamp in place.

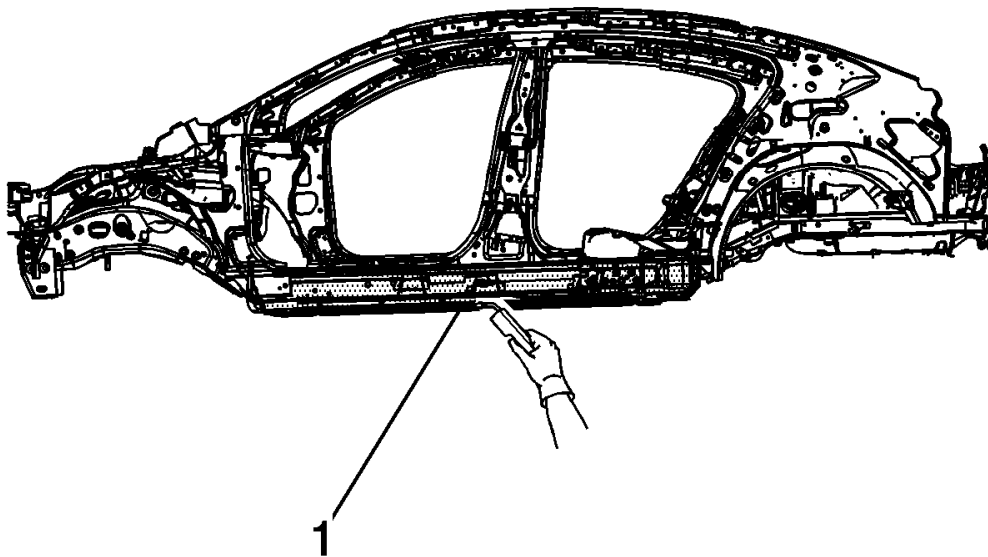


Fig. 79: Welding Rocker Reinforcement
Courtesy of GENERAL MOTORS COMPANY

4. Plug weld accordingly (1).
5. Clean and prepare all of the welded surfaces.
6. Install all of the related panels and components.
7. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
8. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
9. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
10. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

ROCKER OUTER PANEL SECTIONING

NOTE: According to different corrosion warranties, only the regional mandatory joining methods are allowed.

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

WARNING: Refer to Collision Sectioning Warning .

WARNING: Refer to Glass and Sheet Metal Handling Warning .

1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove all related panels and components.
4. Visually inspect the damage. Repair as much of the damage as possible.
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .

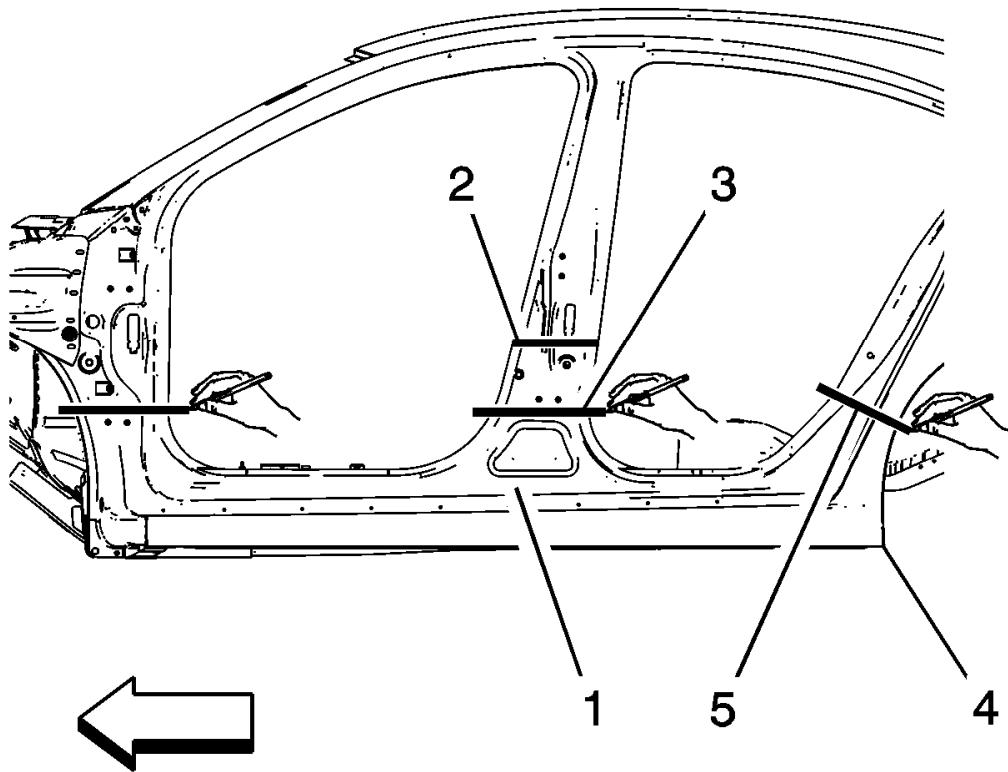


Fig. 80: Rocker Panel Cut Lines

Courtesy of GENERAL MOTORS COMPANY

6. Create cut lines on the rocker outer panel (1). To avoid cutting into hidden reinforcements within the center pillar panel, measure 115 mm down from bottom of electrical conduit hole (2), mark a cut line (3). To avoid a cutting into a sound deadener baffle within the lock pillar panel, measure 350 mm up from the bottom of the rocker panel (4), mark a cut line (5).
7. Perform additional sectioning procedures as needed depending on damage to vehicle. Refer to **Quarter Outer Panel Sectioning**, **Front Hinge Pillar Body Sectioning (Upper)**, **Front Hinge Pillar Body Sectioning (Lower)**, or **Center Pillar Sectioning - Outer**.

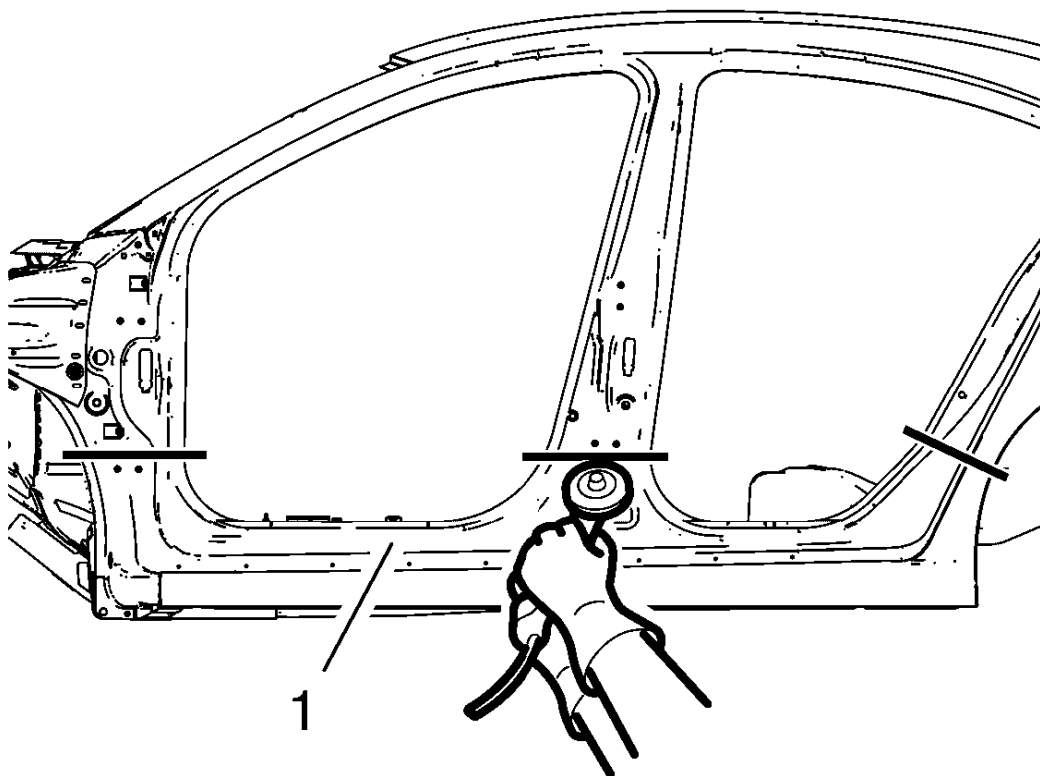


Fig. 81: Cutting Rocker Outer Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage any inner panels or reinforcements.

8. Cut the rocker outer panel (1) where sectioning is to be performed.

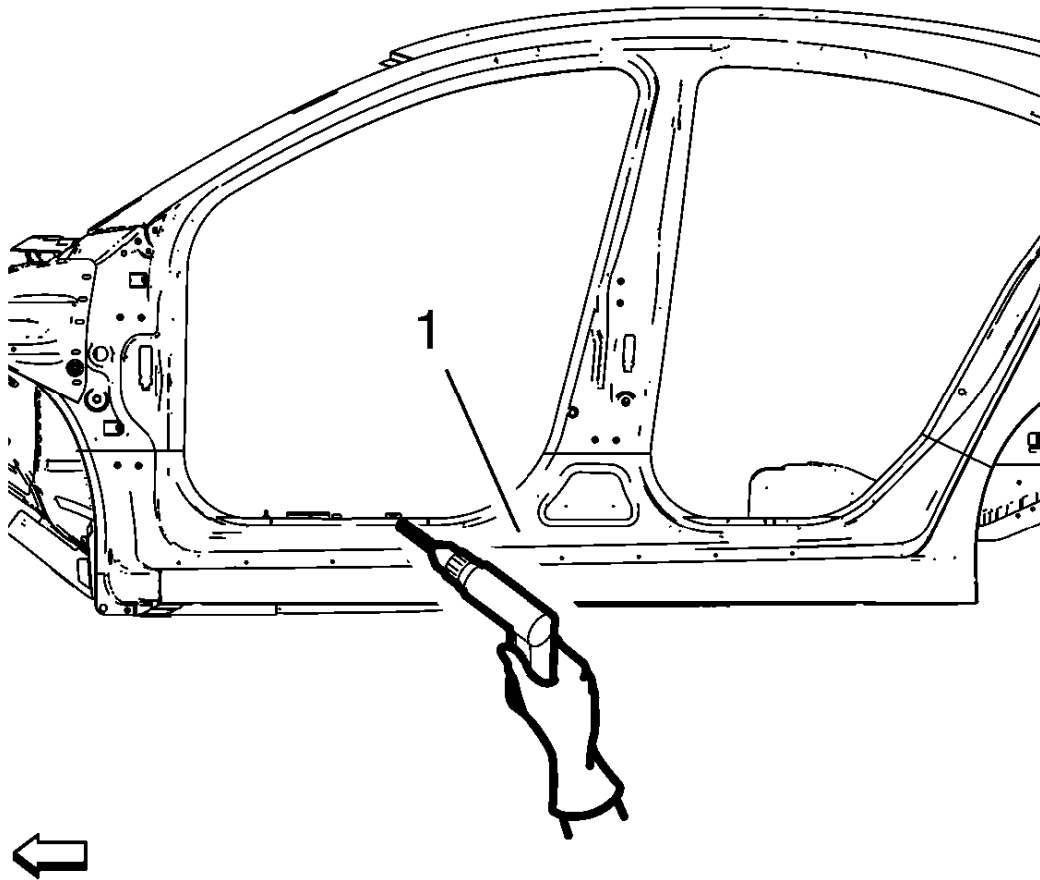


Fig. 82: Drilling Factory Welds Of Rocker Outer Panel
Courtesy of GENERAL MOTORS COMPANY

9. Locate and mark all the necessary factory welds of the rocker outer panel (1).
10. Drill all factory welds.

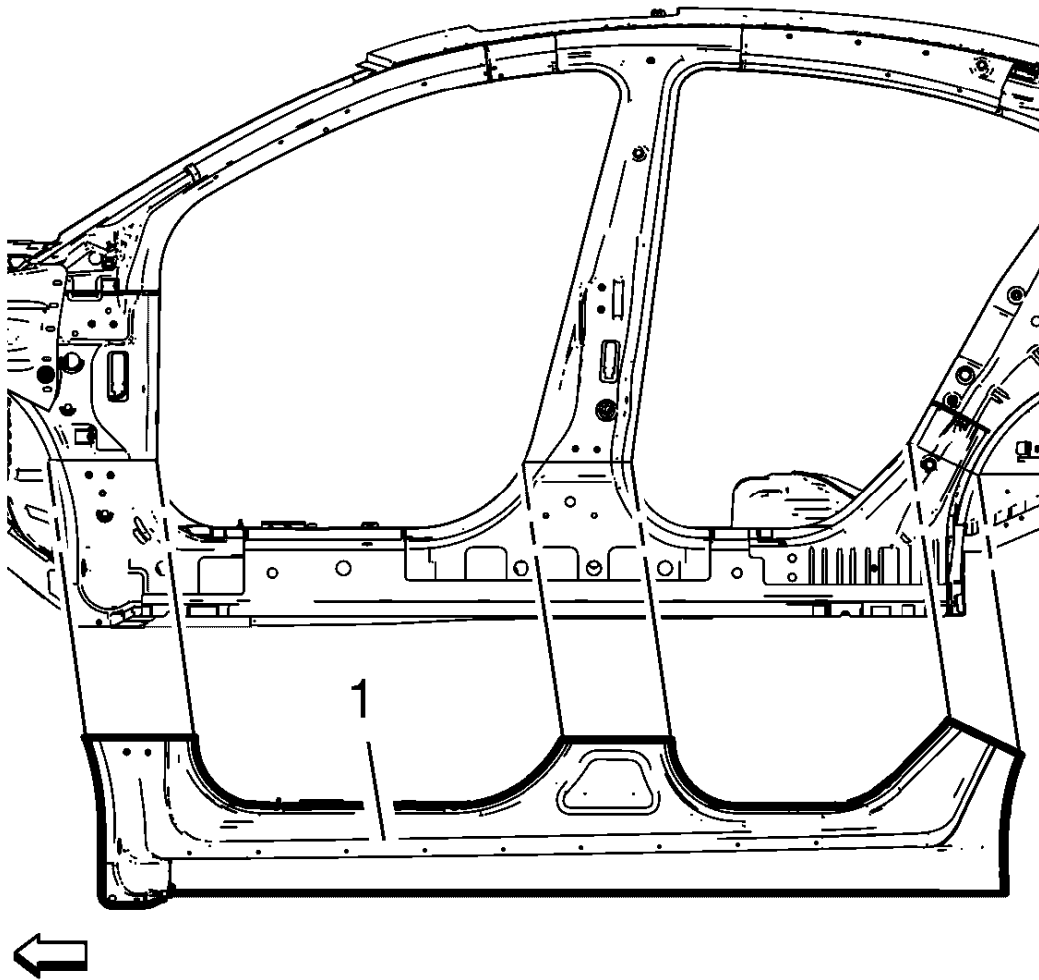


Fig. 83: Rocker Outer Panel

Courtesy of GENERAL MOTORS COMPANY

11. Remove the damaged rocker outer panel (1).

Installation Procedure

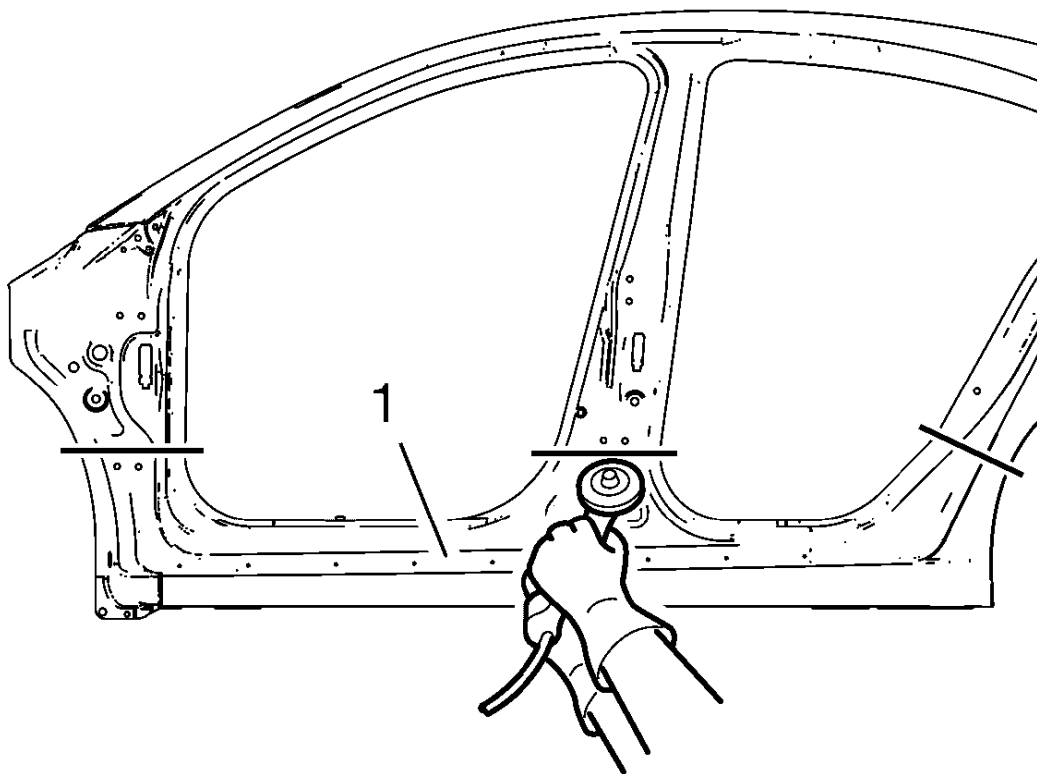


Fig. 84: Cutting Rocker Outer Panel
Courtesy of GENERAL MOTORS COMPANY

1. From the service part (1), cut the panel in corresponding locations to overlap the remaining original panel by 25 mm (1 inch) at each joint location.
2. Prepare all mating surfaces as necessary.

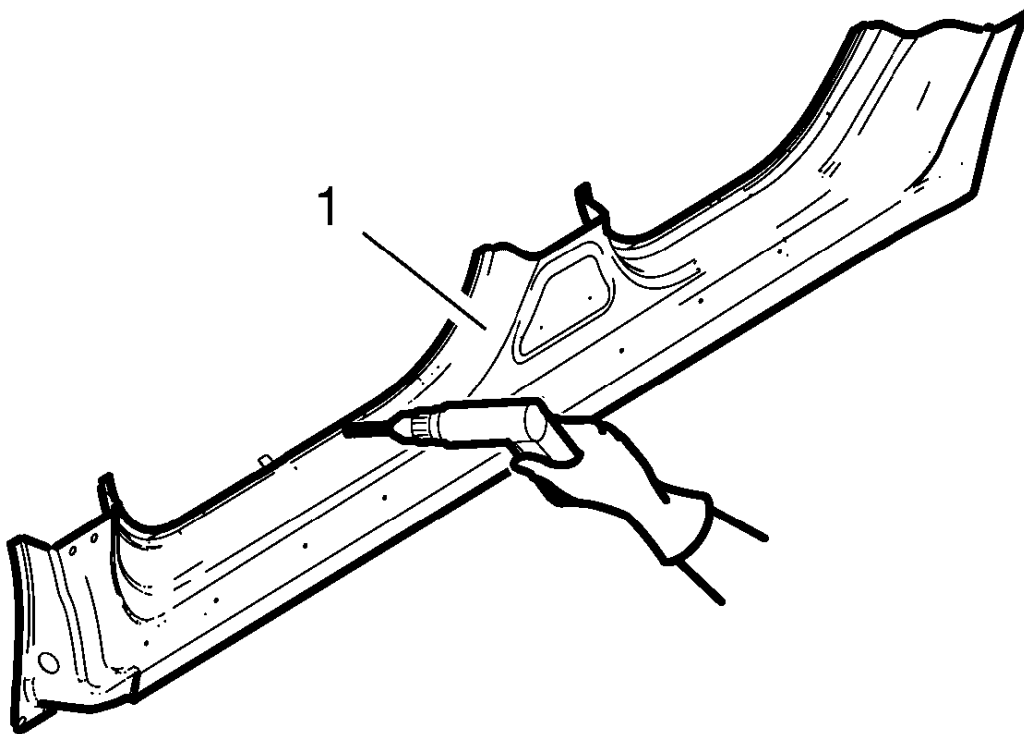


Fig. 85: Drilling Hole For Plug Welding New Rocker Outer Panel
Courtesy of GENERAL MOTORS COMPANY

3. Drill 8 mm (5/16 in) plug weld holes in the service part (1), as necessary, in the corresponding locations noted on the original panel and along sectioned joint.
4. Clean and prepare the attaching surfaces for welding.
5. Apply GM approved Weld-Thru Coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

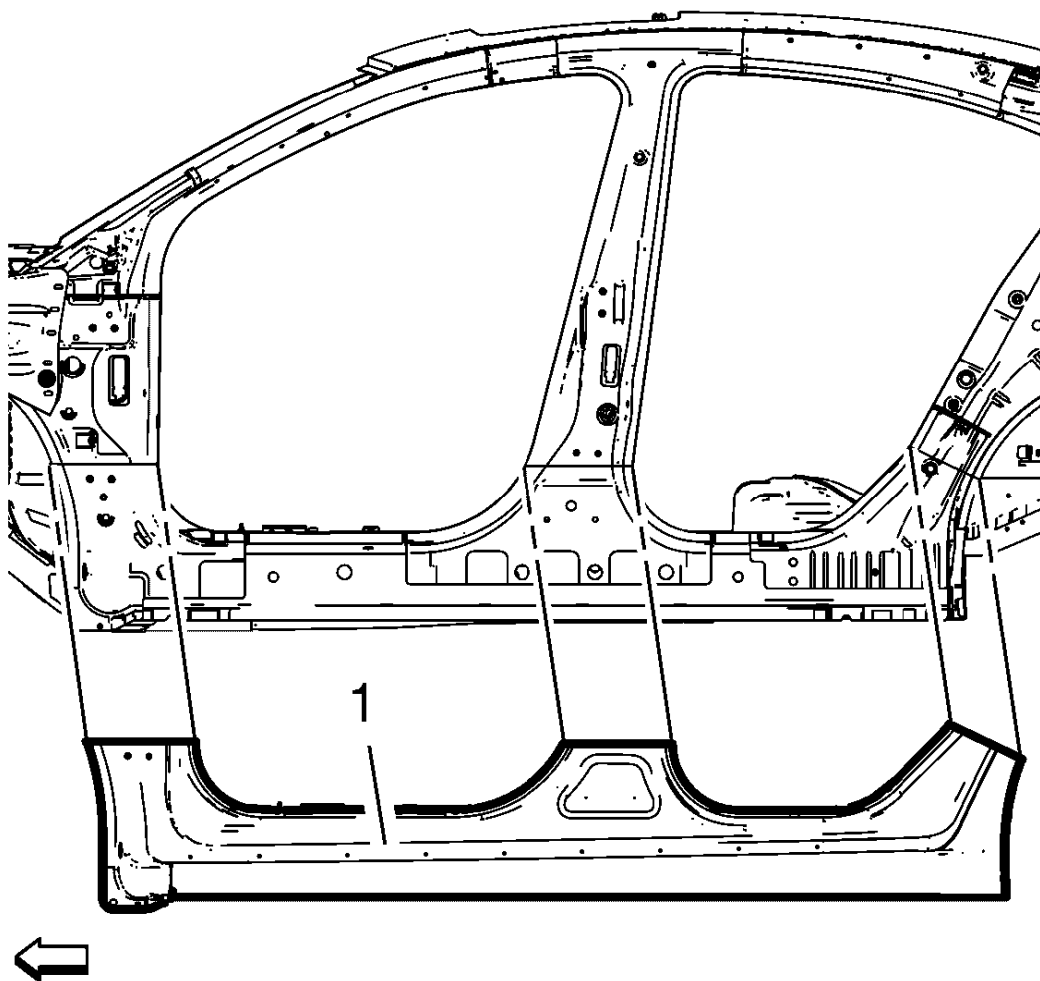


Fig. 86: Rocker Outer Panel

Courtesy of GENERAL MOTORS COMPANY

6. Position the rocker outer panel section (1) to the vehicle using 3-dimensional measuring equipment. Clamp the pillar in place.

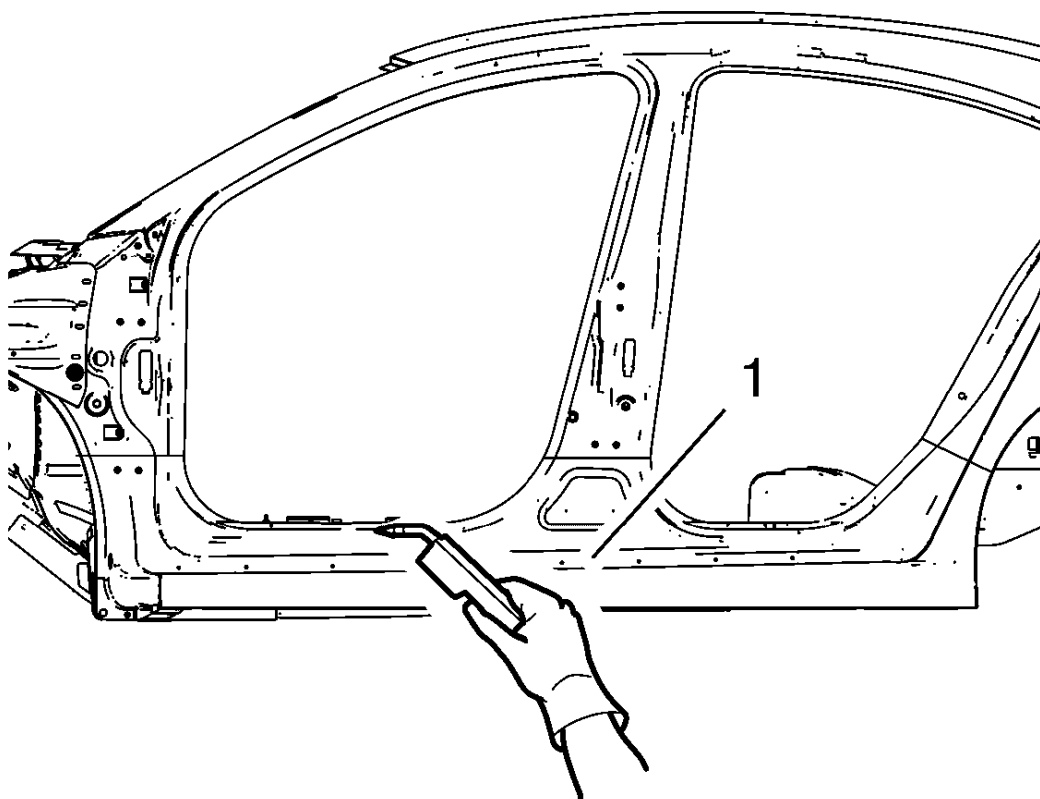


Fig. 87: Welding Rocker Outer Panel
Courtesy of GENERAL MOTORS COMPANY

7. Plug weld the rocker outer panel (1) accordingly.

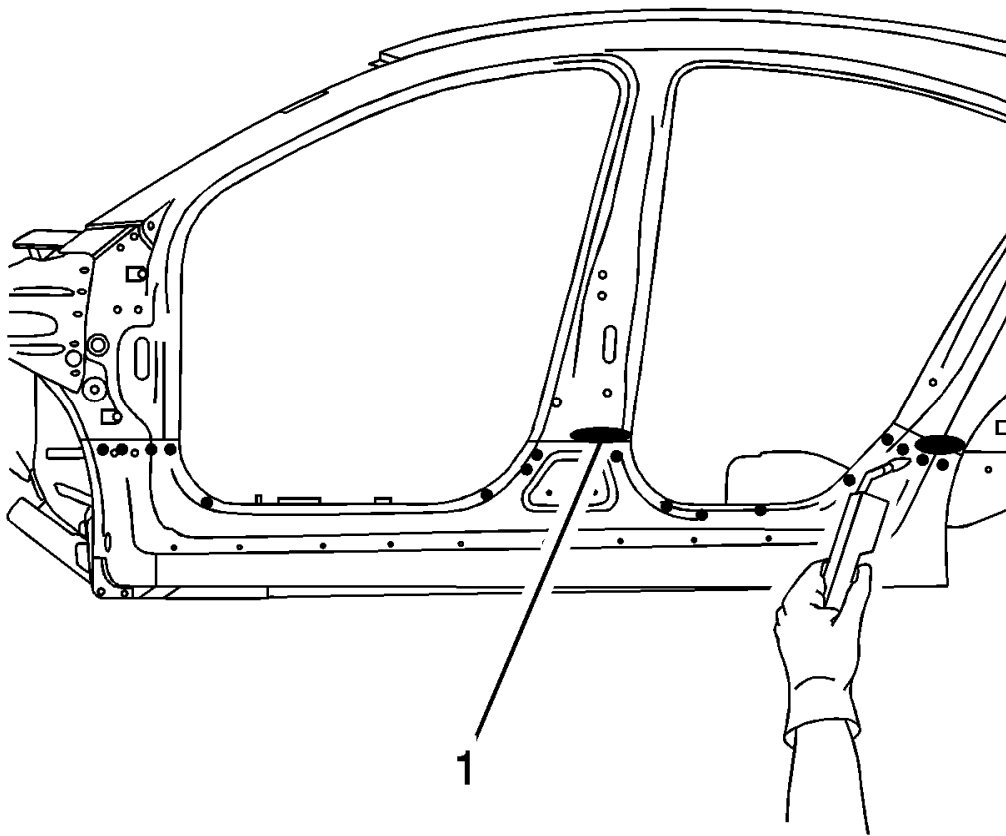


Fig. 88: Welding Replacement Part In Place
Courtesy of GENERAL MOTORS COMPANY

8. To create a solid weld with minimum heat distortion, make 25 mm (1 in) stitch welds along the seam with 25 mm (1 in) gaps between them. Then go back and complete the stitch weld.
9. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
10. Paint the repaired area.
11. Install all related panels and components.
12. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

BODY SIDE INNER PANEL SECTIONING

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

WARNING: Refer to Collision Sectioning Warning .

WARNING: Refer to Glass and Sheet Metal Handling Warning .

1. Disable the SIR System. Refer to SIR Disabling and Enabling .
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove all related panels and components.
4. Visually inspect the damage. Repair as much of the damage as possible.
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .

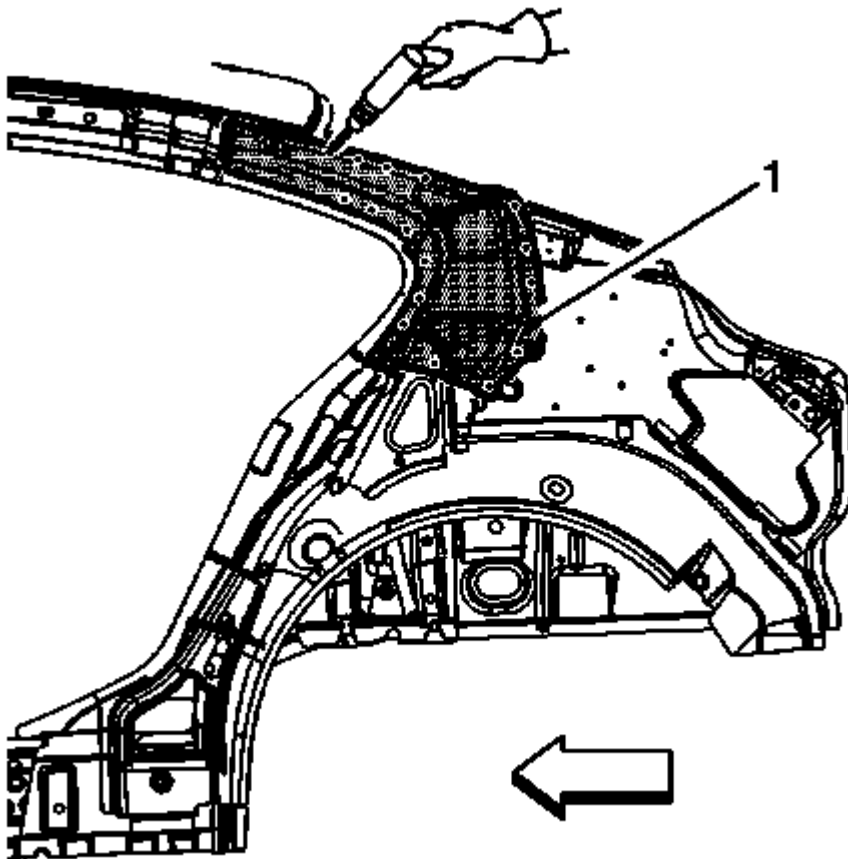


Fig. 89: body lock pillar upper reinforcement
Courtesy of GENERAL MOTORS COMPANY

6. Locate and drill out the necessary factory welds of the body lock pillar upper reinforcement (1). Do not drill out the welds above the roof line. With the body lock pillar upper reinforcement still attached above

the roof line, pry the lower portion of the reinforcement away from the body side inner panel.

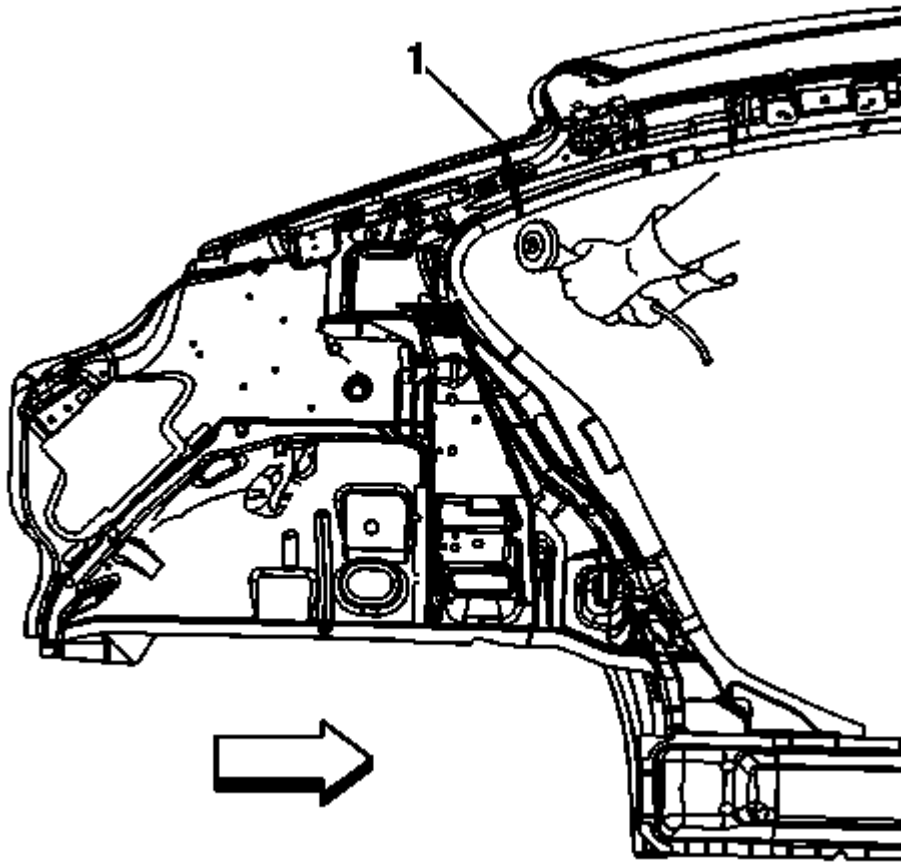


Fig. 90: cutting body side inner panel
Courtesy of GENERAL MOTORS COMPANY

7. From inside of vehicle, cut body side inner panel where sectioning is to be performed (1).

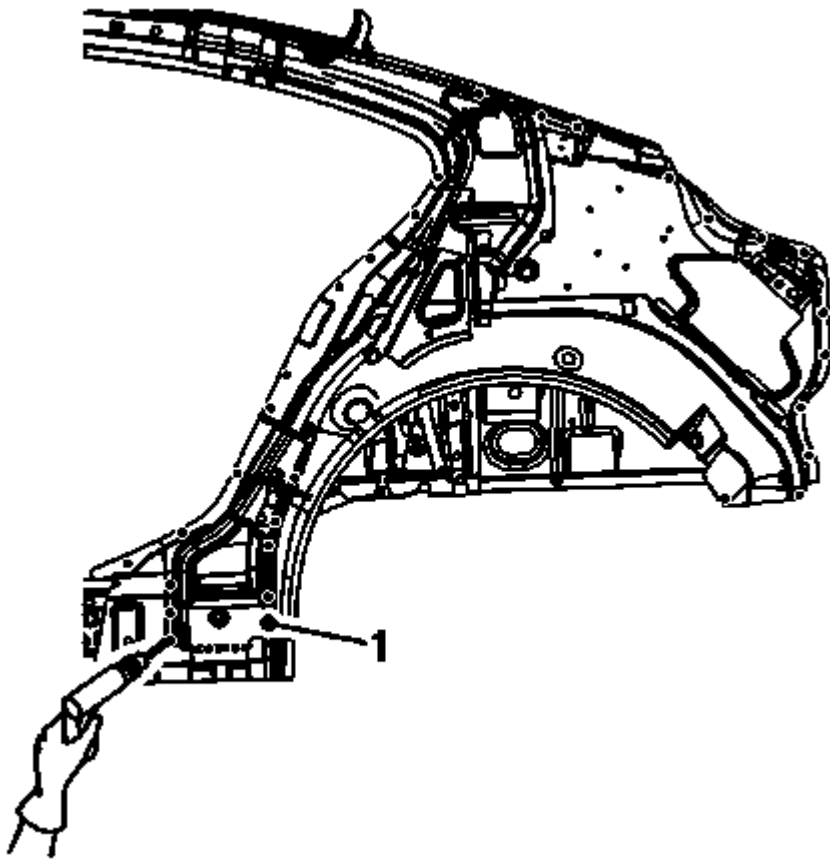


Fig. 91: drilling out welds of body side inner panel
Courtesy of GENERAL MOTORS COMPANY

8. Locate and drill out all necessary welds of the body side inner panel (1)

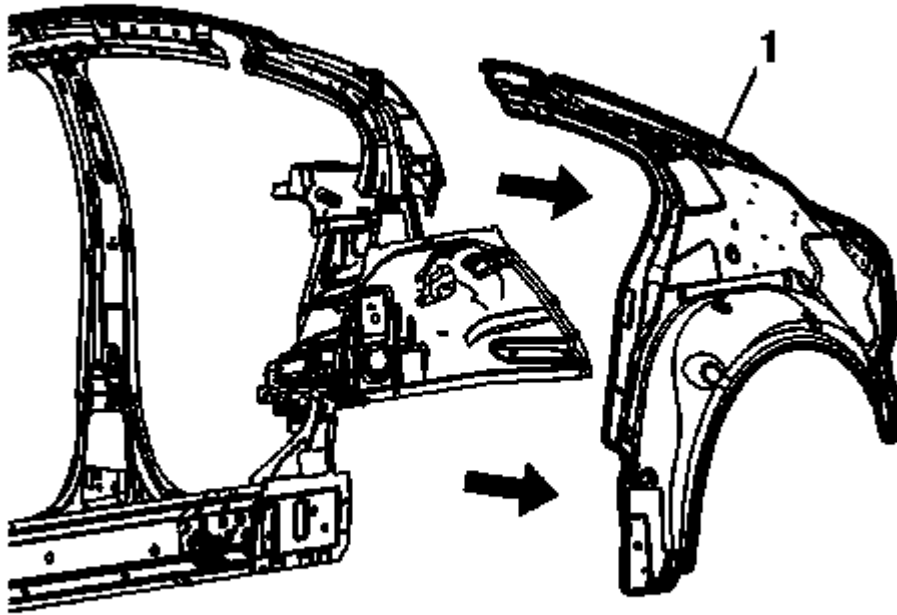


Fig. 92: Removing Damaged Body Side Inner Panel
Courtesy of GENERAL MOTORS COMPANY

9. Remove the damaged body side inner panel (1).

Installation Procedure

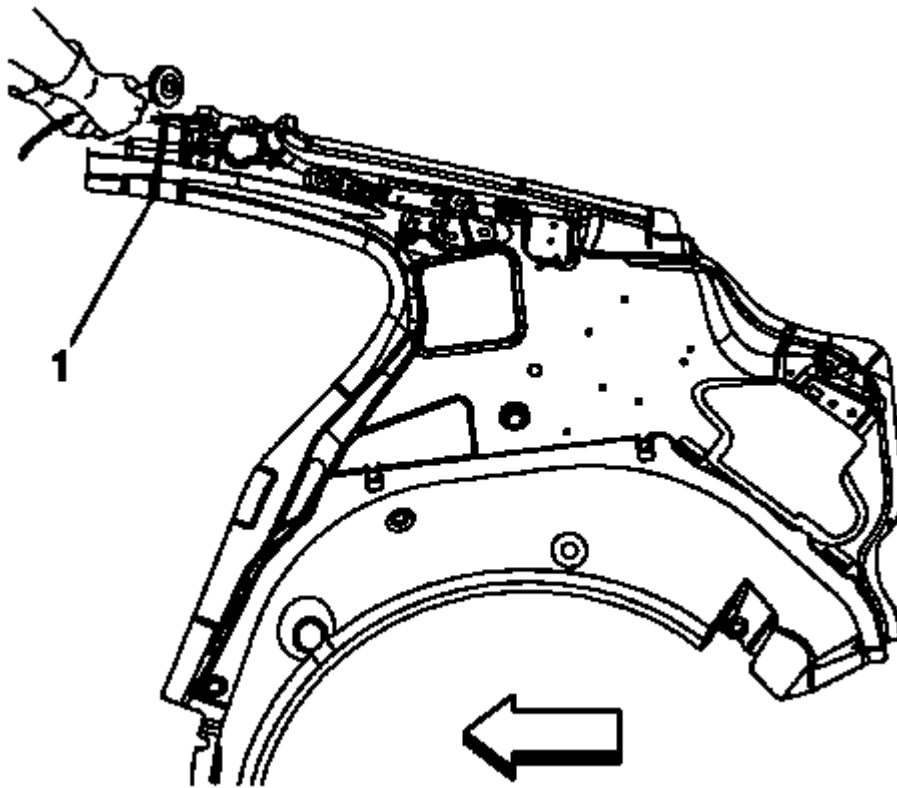


Fig. 93: cutting panel to overlap remaining original panel by 25 mm (1 in)
Courtesy of GENERAL MOTORS COMPANY

1. From the service part, cut the panel in corresponding locations to overlap the remaining original panel by 25 mm (1 in) at each joint location (1).

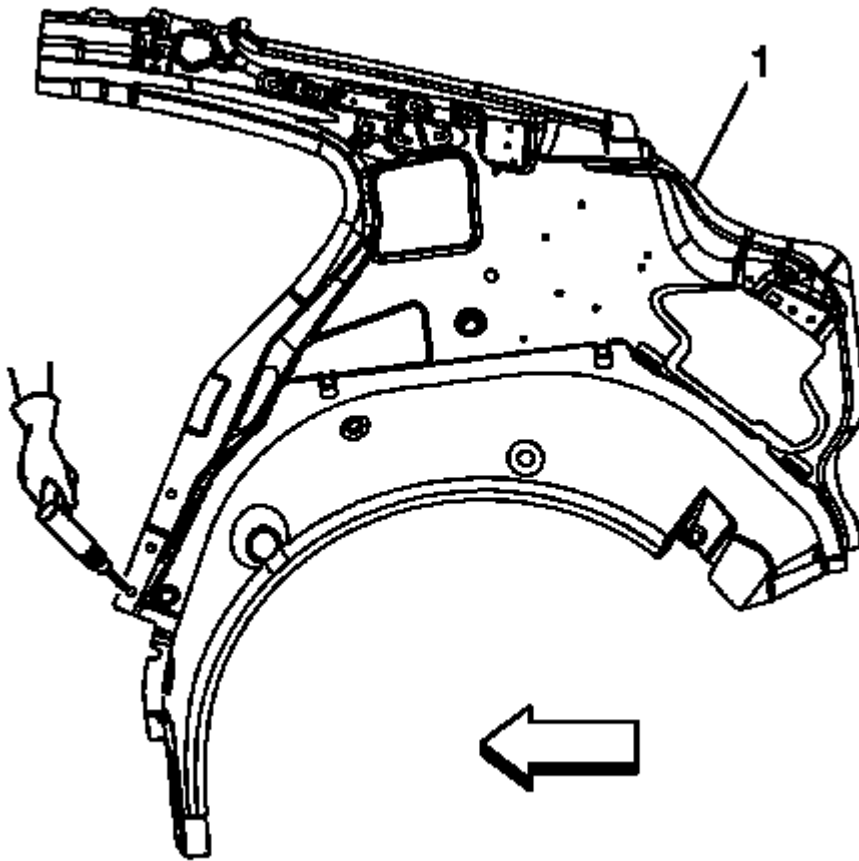


Fig. 94: plugging weld holes in service part
Courtesy of GENERAL MOTORS COMPANY

2. Drill 8 mm (5/16 in) plug weld holes in the service part (1), as necessary, in the corresponding locations noted on the original panel and along sectioned joint.
3. Prepare all matting surfaces for welding, as necessary.
4. Apply GM approved Weld-Thru Coating or equivalent to all matting surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

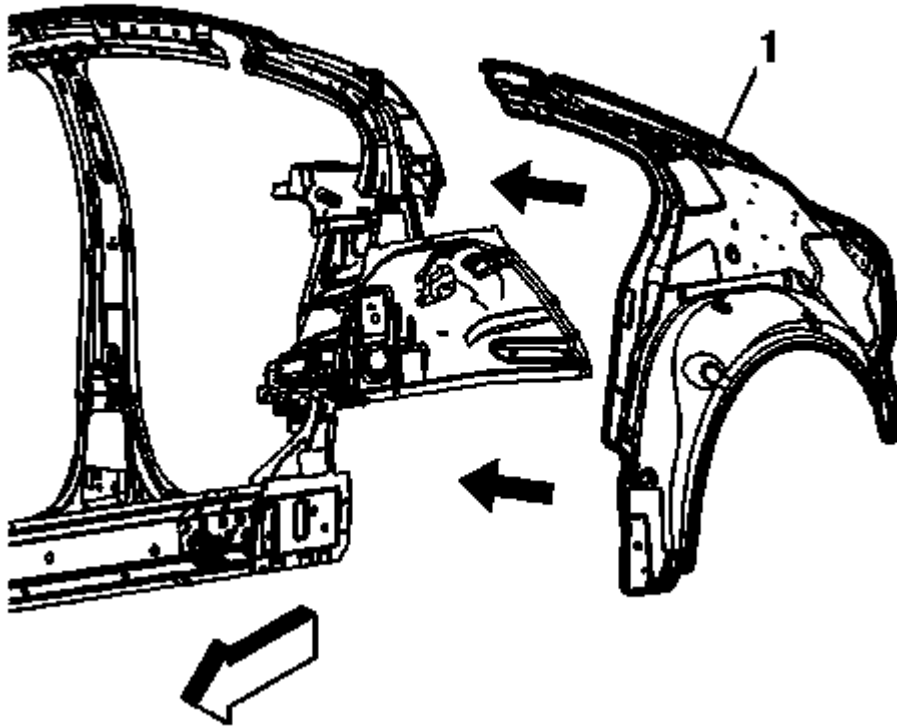


Fig. 95: Positioning body side inner panel
Courtesy of GENERAL MOTORS COMPANY

5. Position the body side inner panel (1) to the vehicle using 3-dimensional measuring equipment. Clamp the panel in place.

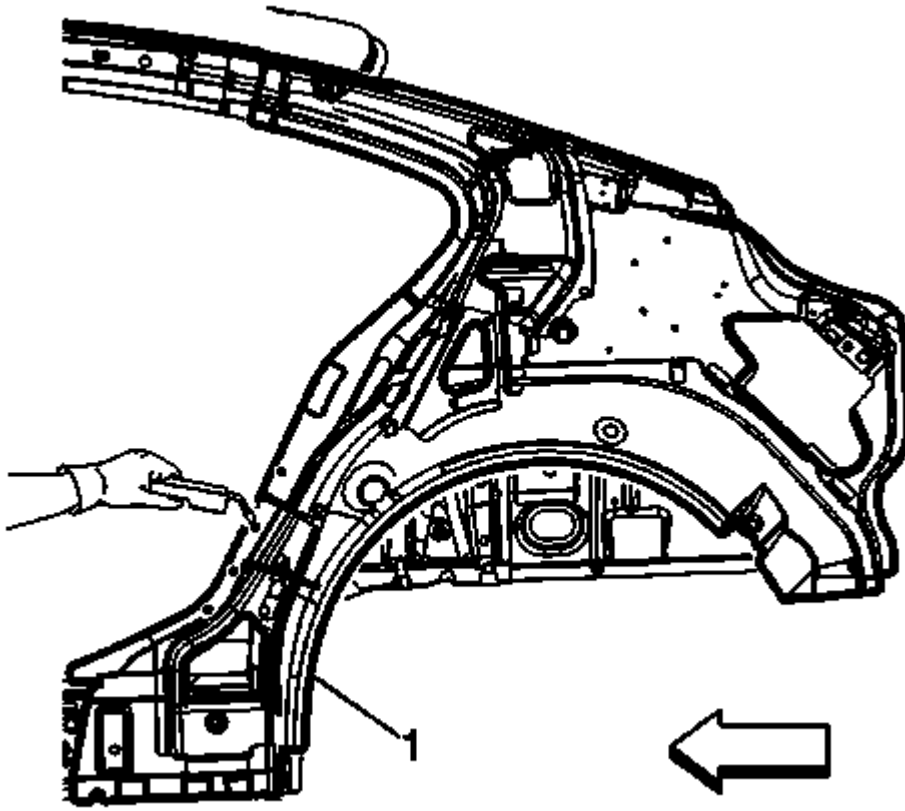


Fig. 96: Plug welding

Courtesy of GENERAL MOTORS COMPANY

6. Plug weld accordingly (1).

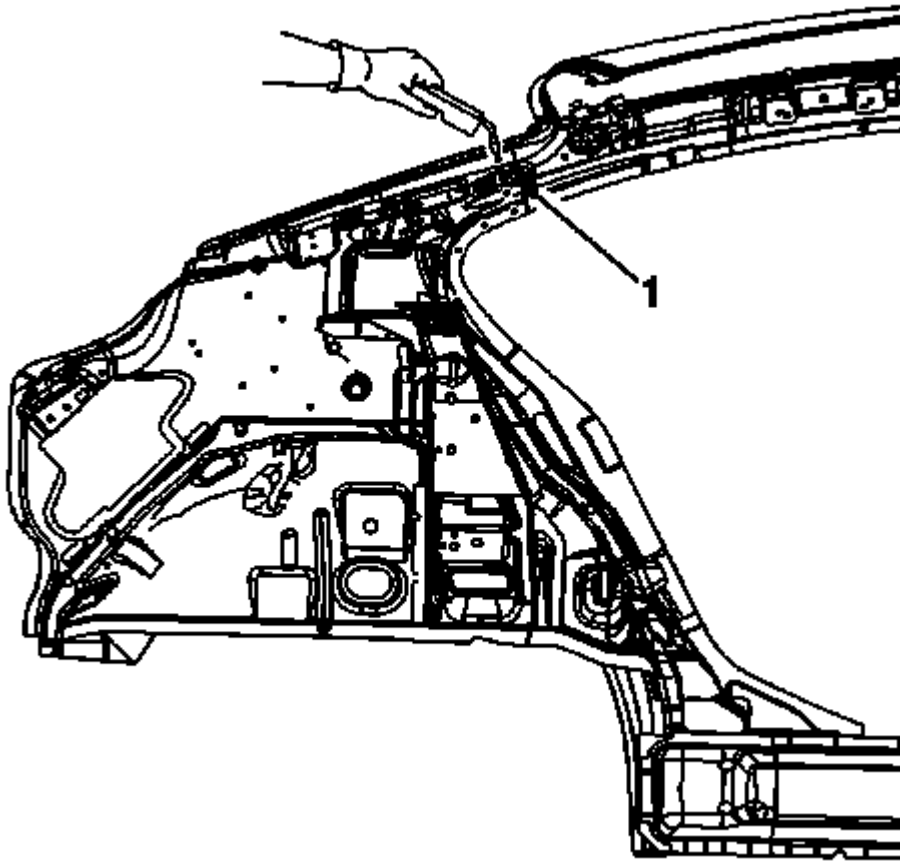


Fig. 97: completing stitch weld

Courtesy of GENERAL MOTORS COMPANY

7. To create a solid weld with minimum heat distortion, make 25 mm (1 in) stitch welds along the seam with 25 mm (1 in) gaps between them. Then go back and complete the stitch weld (1).
8. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
9. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
10. Install all related panels and components.
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
12. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

REAR FLOOR PANEL SECTIONING

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .

2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove all related panels and components.
4. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
5. Repair as much of the damaged area as possible. Refer to **Dimensions - Body (Sedan)**.

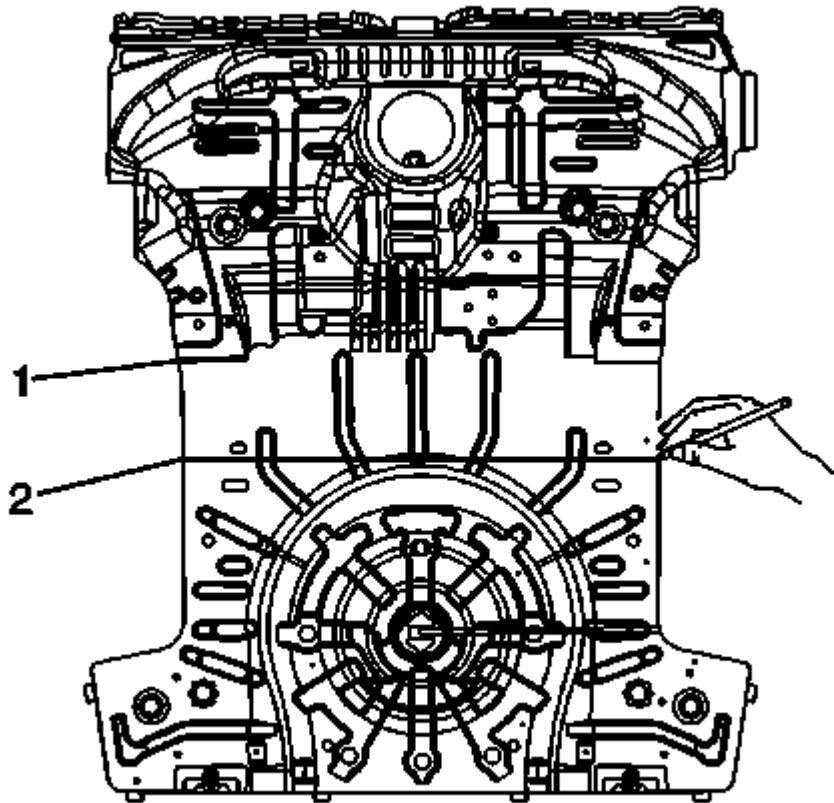


Fig. 98: Marking Rear Compartment Floor Panel Cut Locations
Courtesy of GENERAL MOTORS COMPANY

6. Measure 70 mm rearward from the rear edge of the #5 bar (1). Mark the cut location (2).

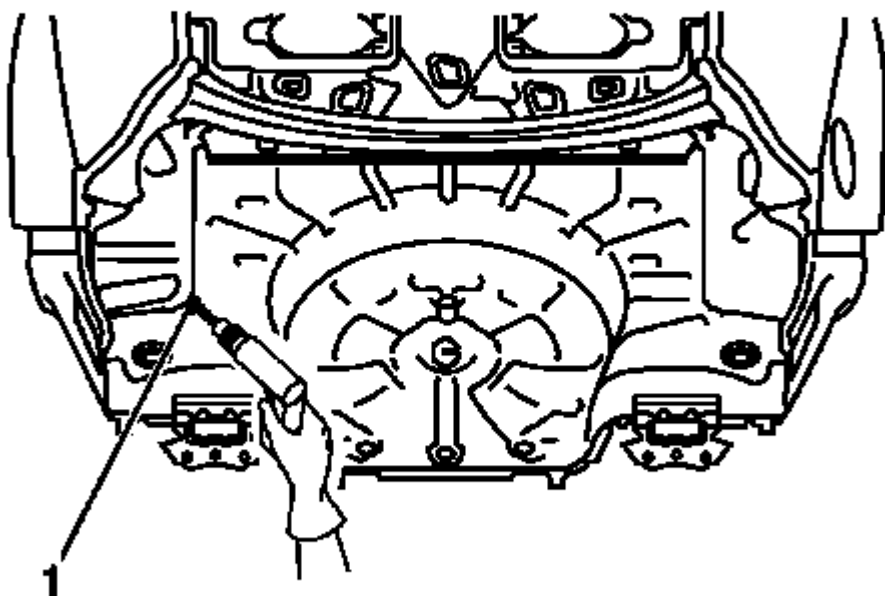


Fig. 99: Drilling Out Rear Compartment Floor Panel Spot Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage any adjacent panels or components when cutting or drilling out spot welds. Record the number and location of welds for installation of the service part.

7. Drill out all factory welds (1).

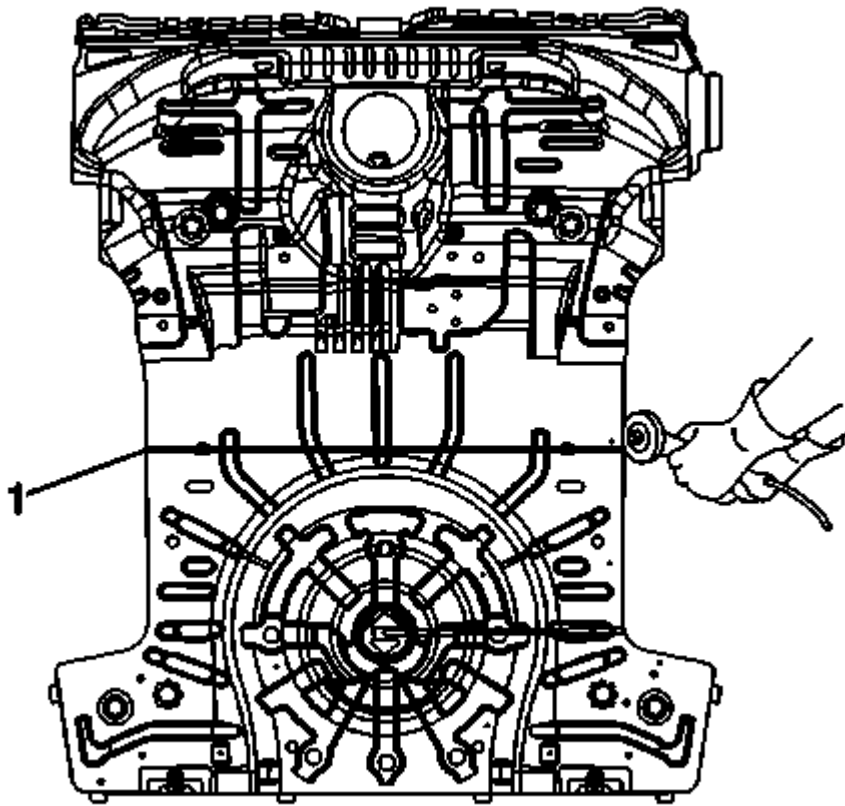


Fig. 100: Cutting Rear Compartment Floor Panel
Courtesy of GENERAL MOTORS COMPANY

8. Cut the rear floor panel accordingly (1).

Installation Procedure

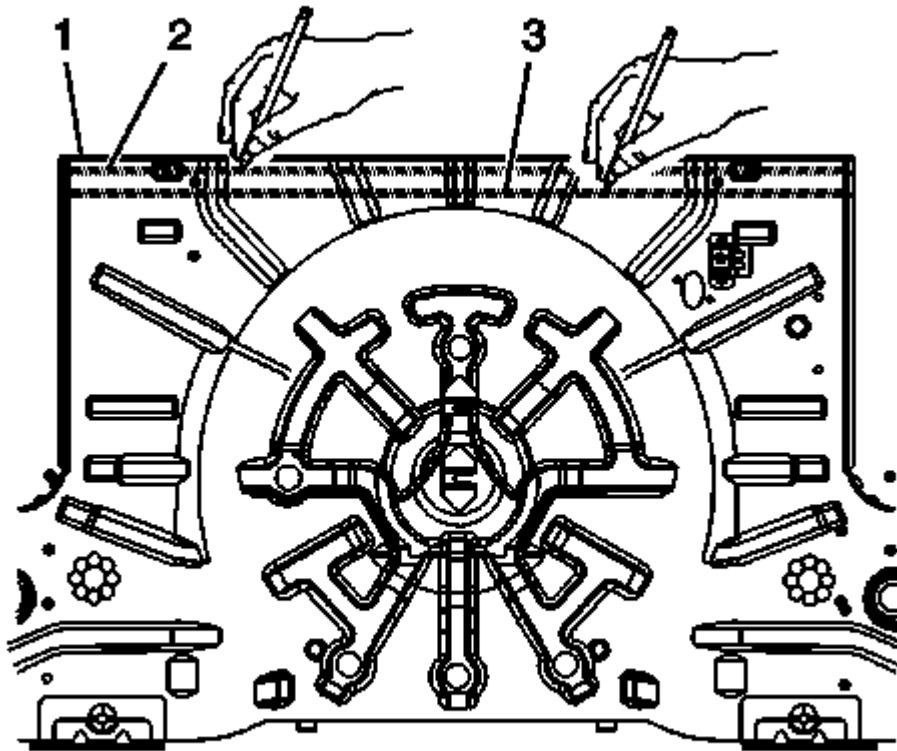


Fig. 101: Marking Rear Compartment Floor Panel For Plug Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: The service part is supplied precut at the proper location for sectioning. The service part will overlap the original floor panel by approximately 50 mm at the cut location. Two rows of evenly staggered plug welds will provide the necessary weld strength for this procedure.

1. Create 2 rows of plug welds in the service part as follows. For the 1st row, measure 13 mm from the front edge of the service part (1). Mark a straight line across the width of the service part (2). For the 2nd row, measure 25 mm from the 1st row. Mark a straight line across the width of the service part (3).

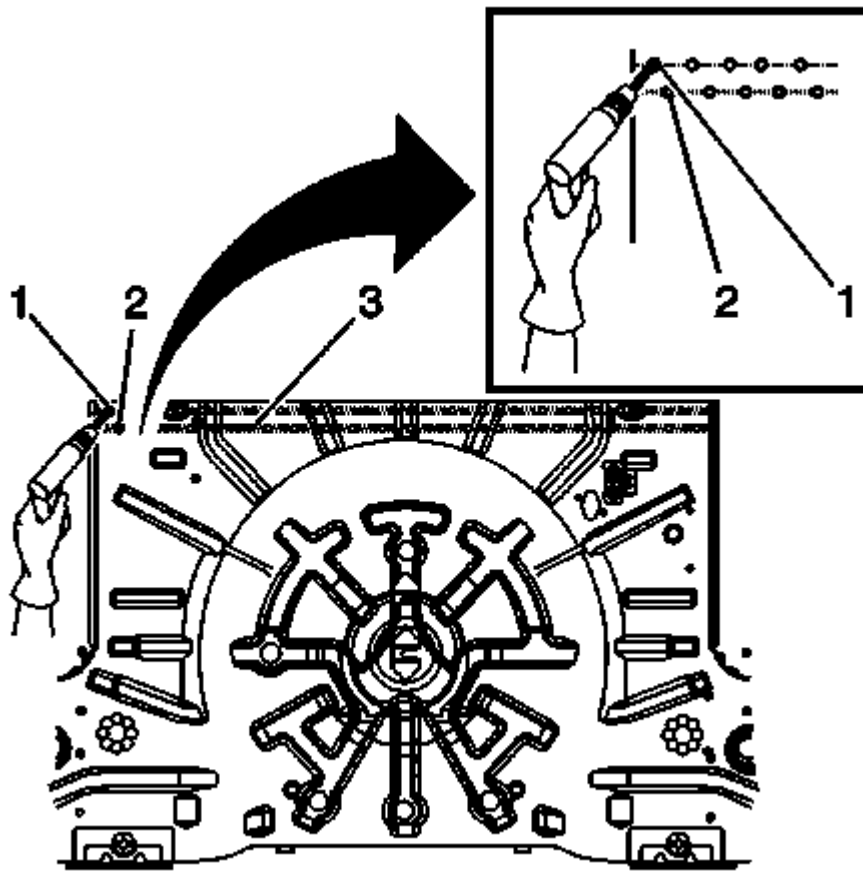


Fig. 102: Drilling 8 mm (5/16 in) Plug Weld Holes In Rear Compartment Floor Panel
 Courtesy of GENERAL MOTORS COMPANY

2. Drill 8 mm (5/16 in) plug weld holes, every 40 mm along the 1st marked row. Locating the first hole 20 mm (1) from the left edge of the service part.
3. Drill 8 mm (5/16 in) plug weld holes, every 40 mm along the 2nd marked row (3). Locate first hole 40 mm (2) from the left edge of the service part.
4. Prepare all mating surfaces for welding, as necessary.
5. Apply GM-approved Weld-Thru Coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .
6. Position the rear floor pan to the vehicle using 3-dimensional measuring equipment. Clamp the part in place.

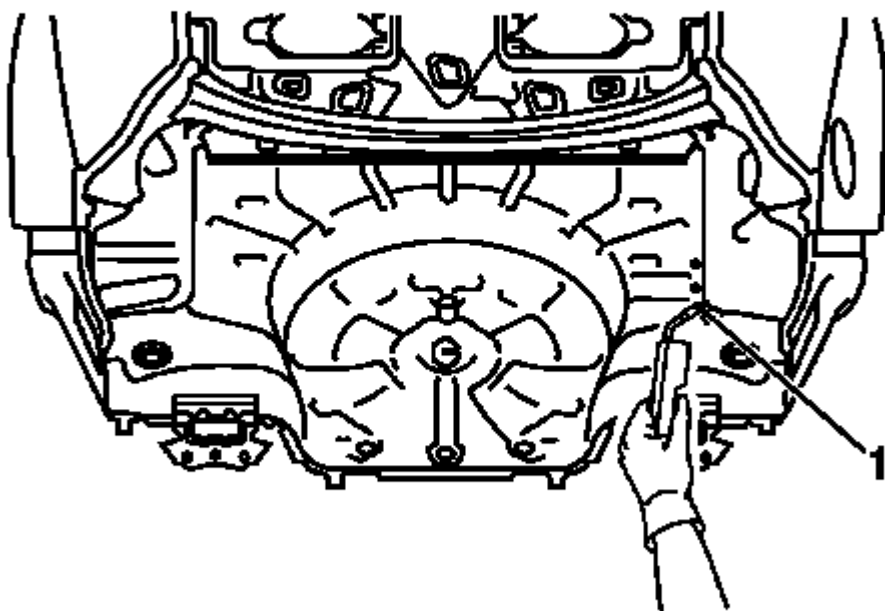


Fig. 103: Welding Rear Compartment Floor Panel
Courtesy of GENERAL MOTORS COMPANY

7. Plug weld accordingly (1).
8. Clean and prepare all welded surfaces for painting.
9. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
10. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
11. Install all related panels and components.
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
13. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

REAR WHEELHOUSE INNER PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .

2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove all related panels and components.
4. Repair as much of the damaged area as possible. Refer to **Dimensions - Body (Sedan)**.
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

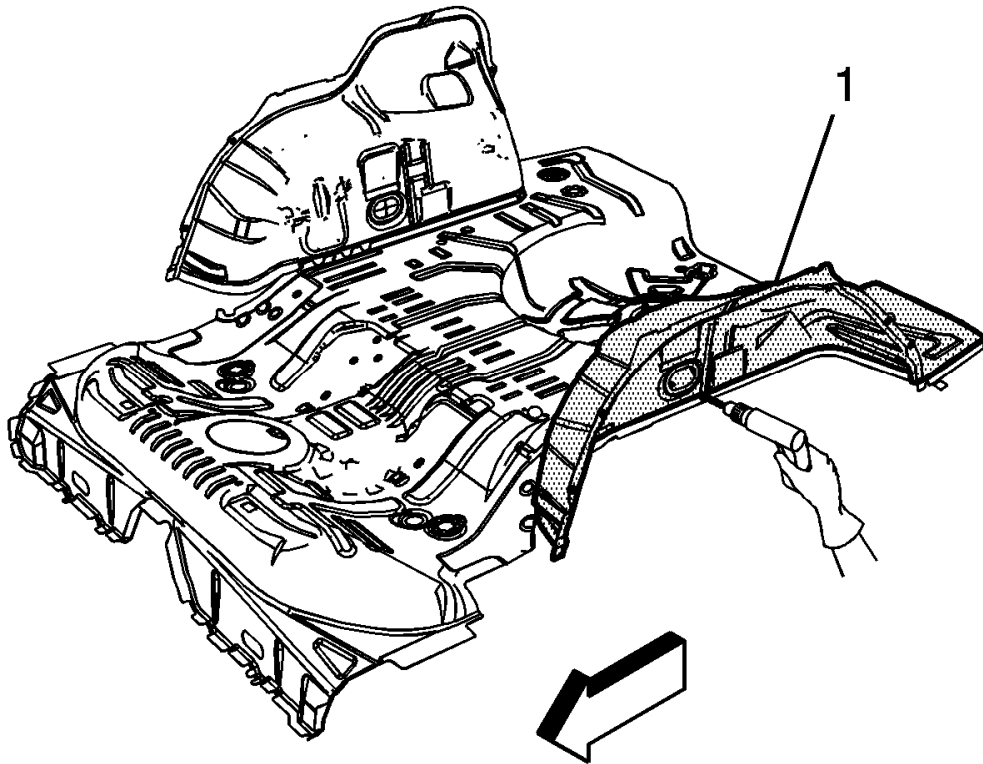


Fig. 104: Drilling Out Rear Inner Wheelhouse Factory Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the number and location of the factory welds for installation of the rear inner wheelhouse.

6. Locate and drill out all the necessary factory welds (1).

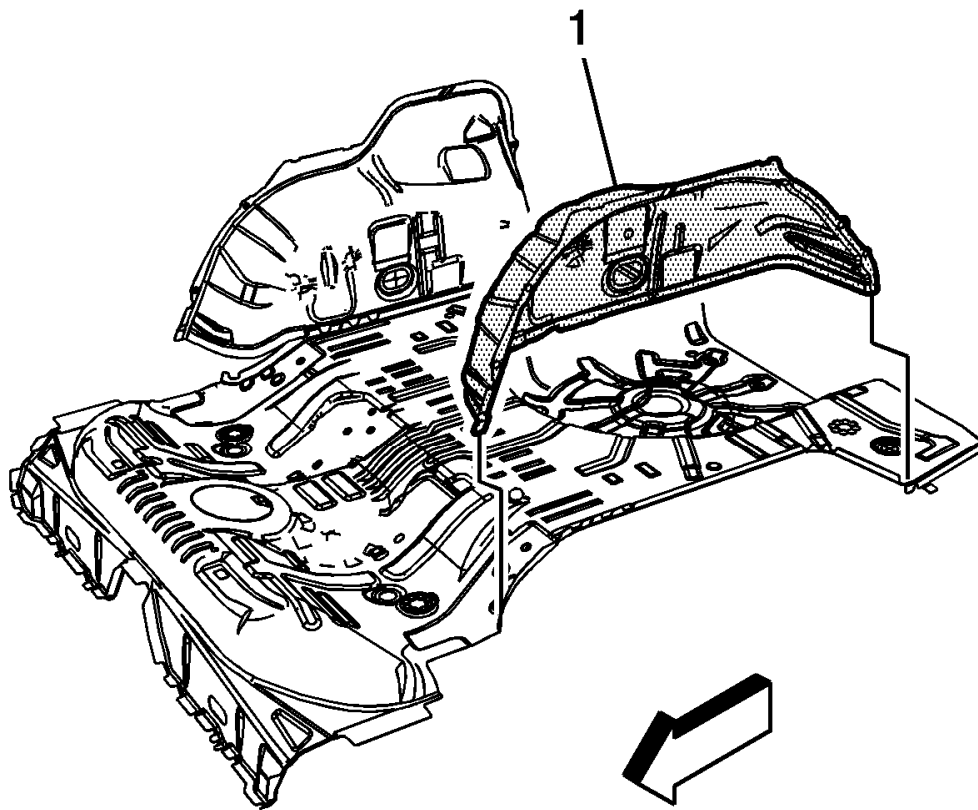


Fig. 105: Rear Inner Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

7. Remove the rear inner wheelhouse (1).

Installation Procedure

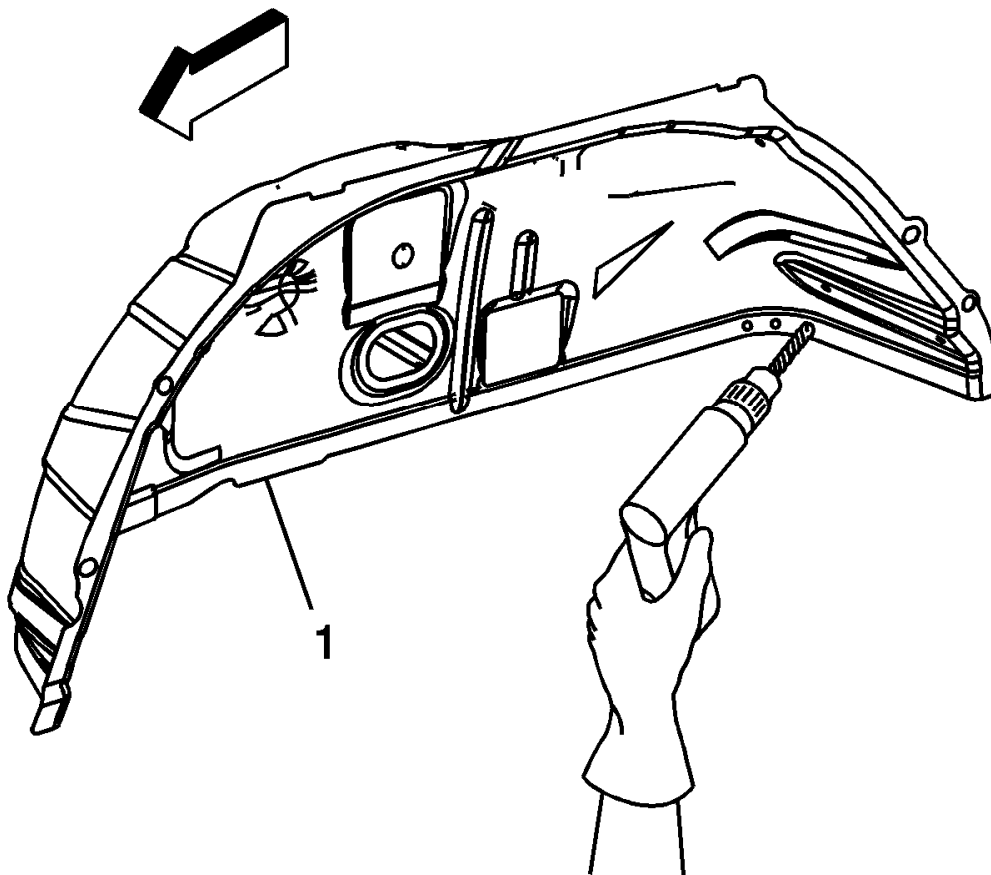


Fig. 106: Drilling Plug Weld Holes In Replacement Rear Inner Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the location of the original plug weld holes can not be determined, space the plug weld holes every 40 mm (1 1/2 in) apart.

1. Drill 8 mm (5/16 in) plug weld holes in the service part as necessary in the locations noted from the original panel (1).
2. Prepare all mating surfaces for welding as necessary.
3. Apply GM-approved Weld-Thru Coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

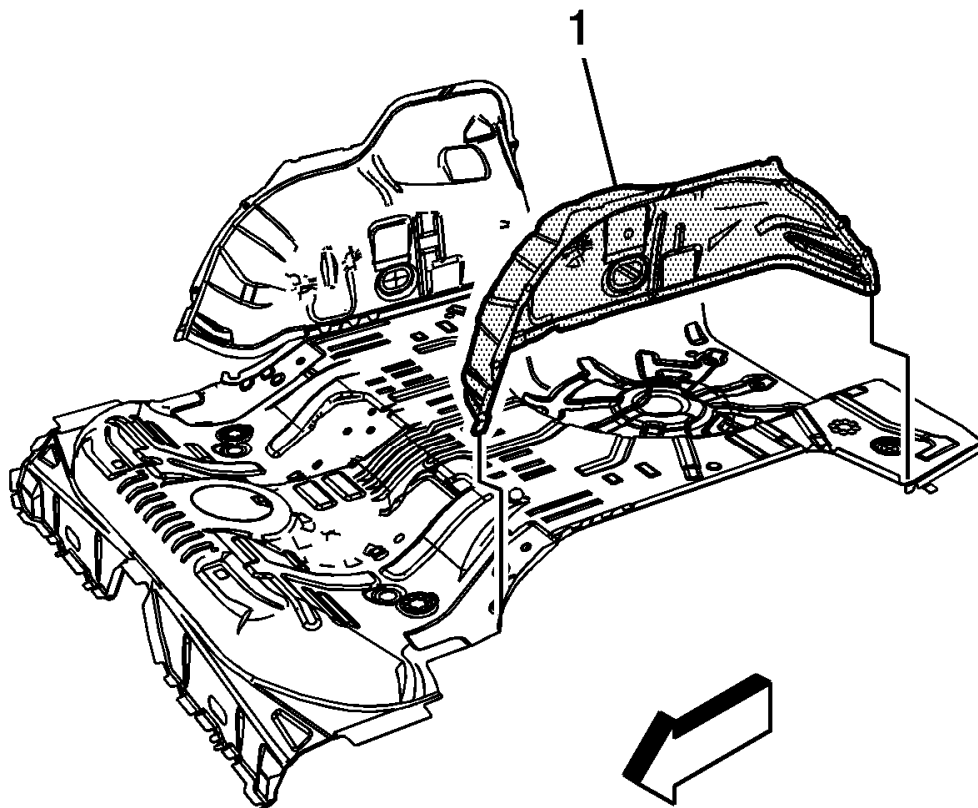


Fig. 107: Rear Inner Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

4. Position the rear inner wheelhouse to the vehicle. Clamp the part in place (1).
5. Plug weld accordingly.
6. Clean and prepare all of the welded surfaces.
7. Install all of the related panels and components.
8. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
9. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
11. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

QUARTER OUTER PANEL SECTIONING

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
3. Restore as much of the damage as possible to factory specifications. Refer to **Dimensions - Body (Sedan)**.
4. Remove all related panels and components.
5. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

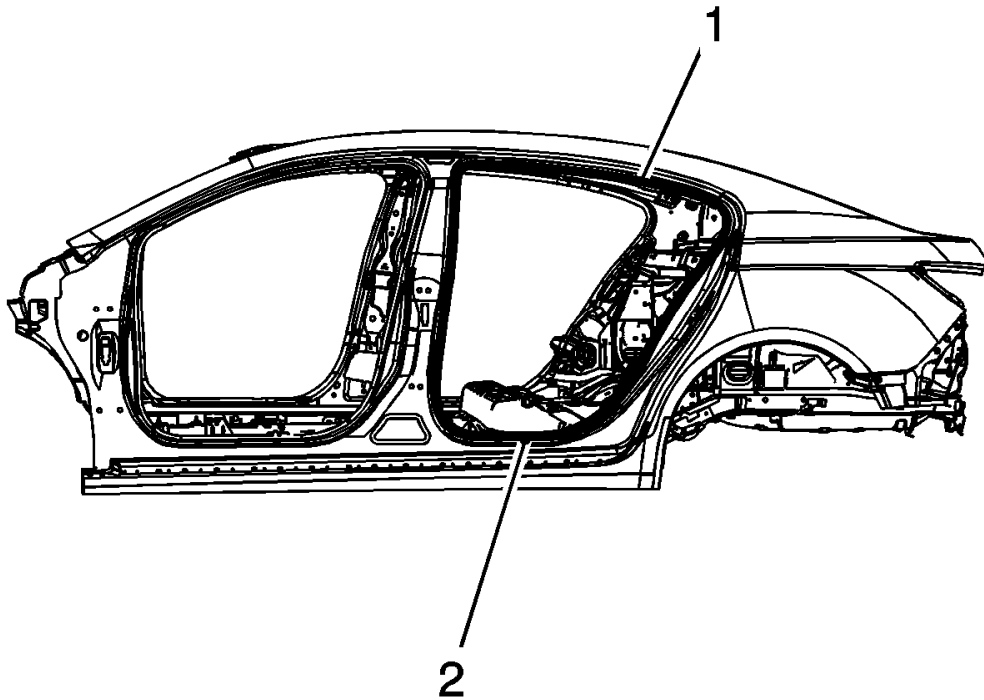


Fig. 108: Quarter Outer Panel Cut Locations
Courtesy of GENERAL MOTORS COMPANY

6. Section the sail panel and the rocker panel.
 - At the sail panel, measure from the back glass opening down 85 mm. Scribe a line. This is the cut location (1).

- Scribe a line on the rocker panel on the flat area between the holes where the molding attaches to the rocker panel. From the third hole rearward, measure 90 mm forward. This is the cut location (2).

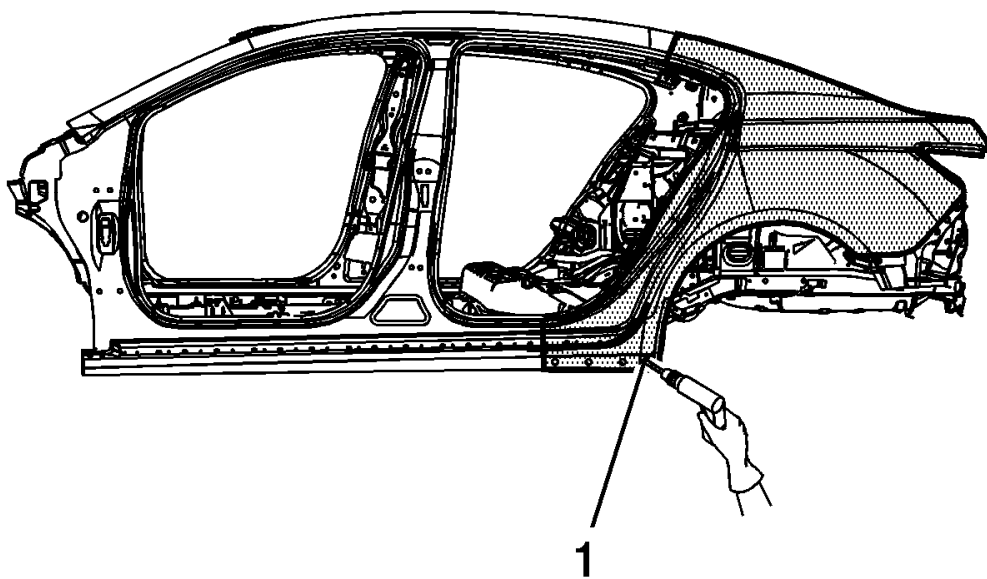


Fig. 109: Drilling Out Quarter Outer Panel Factory Welds
Courtesy of GENERAL MOTORS COMPANY

7. Locate and drill out all factory welds. Note the number and location of welds for installation of the quarter panel (1).

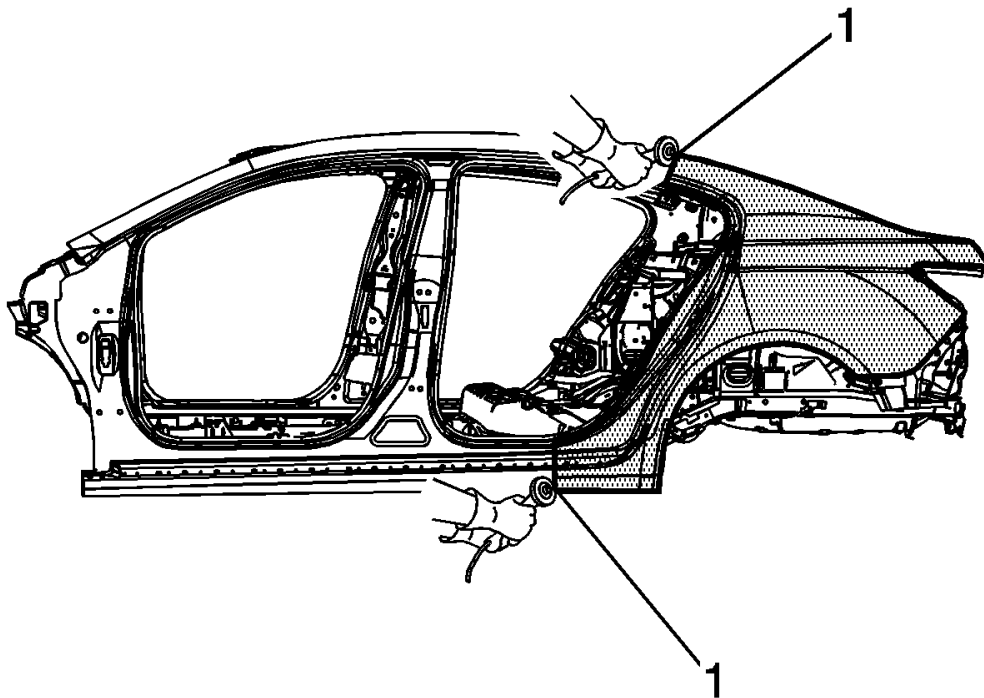


Fig. 110: Cutting Quarter Outer Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage any other panel or reinforcements when cutting at the marked locations.

8. Cut the panel at the marked locations (1).

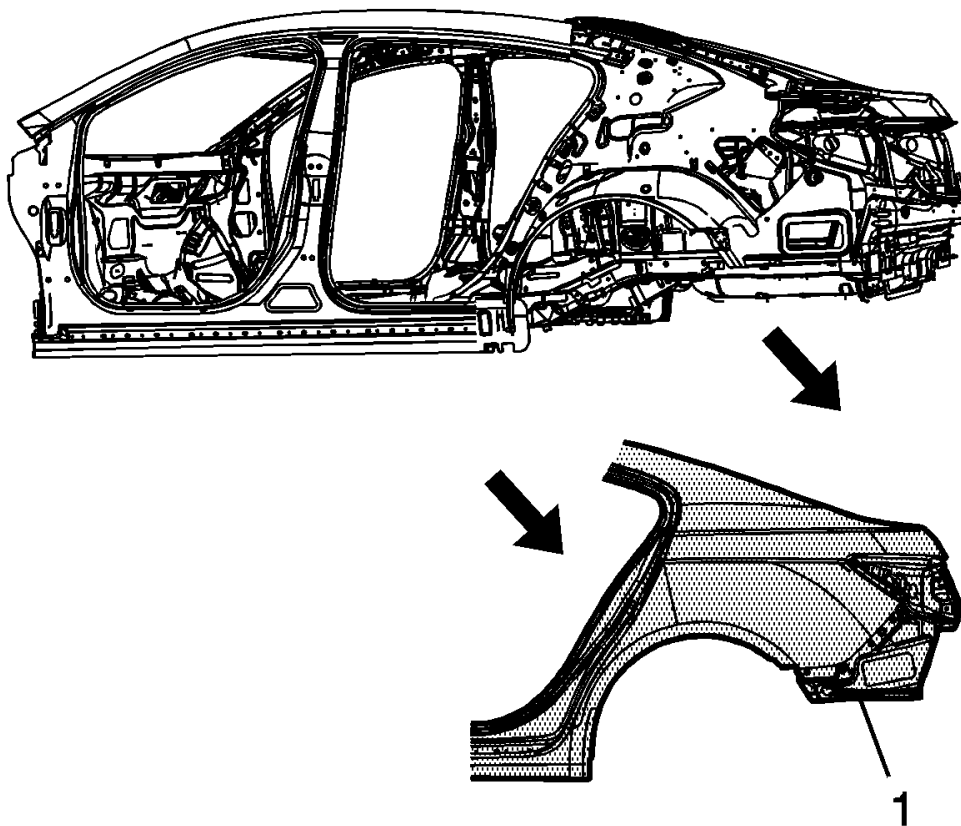


Fig. 111: Quarter Outer Panel
Courtesy of GENERAL MOTORS COMPANY

9. Remove the lower quarter panel (1).

Installation Procedure

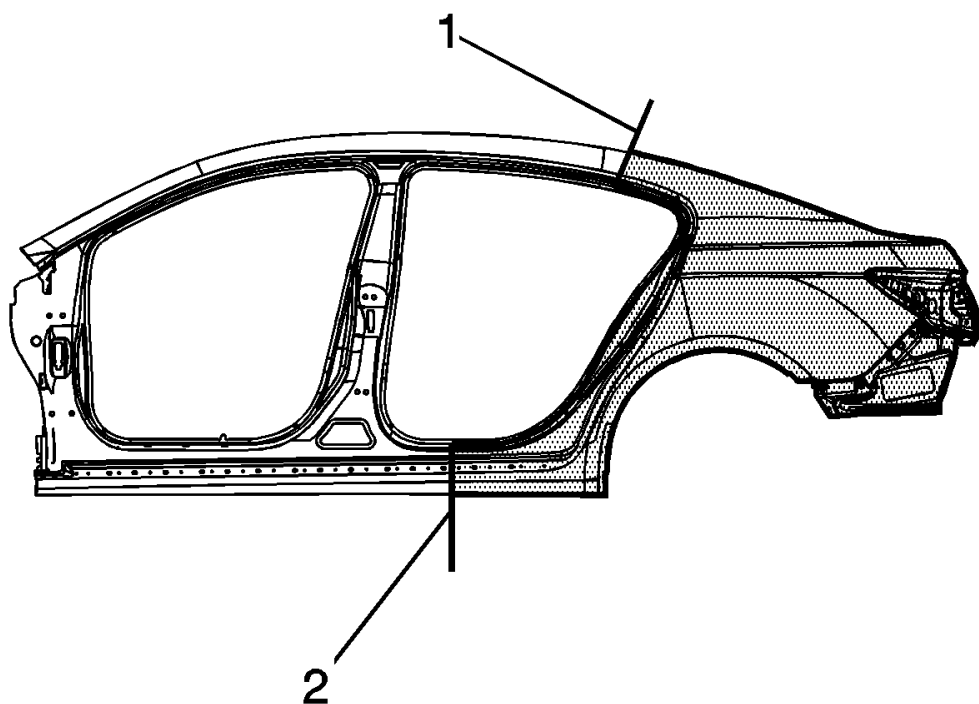


Fig. 112: Marking Cut Lines On Service Quarter Outer Panel
Courtesy of GENERAL MOTORS COMPANY

1. From the service part, cut the panel in corresponding locations to overlap the remaining original panel by 25 mm (1 in) at each joint location (1, 2).

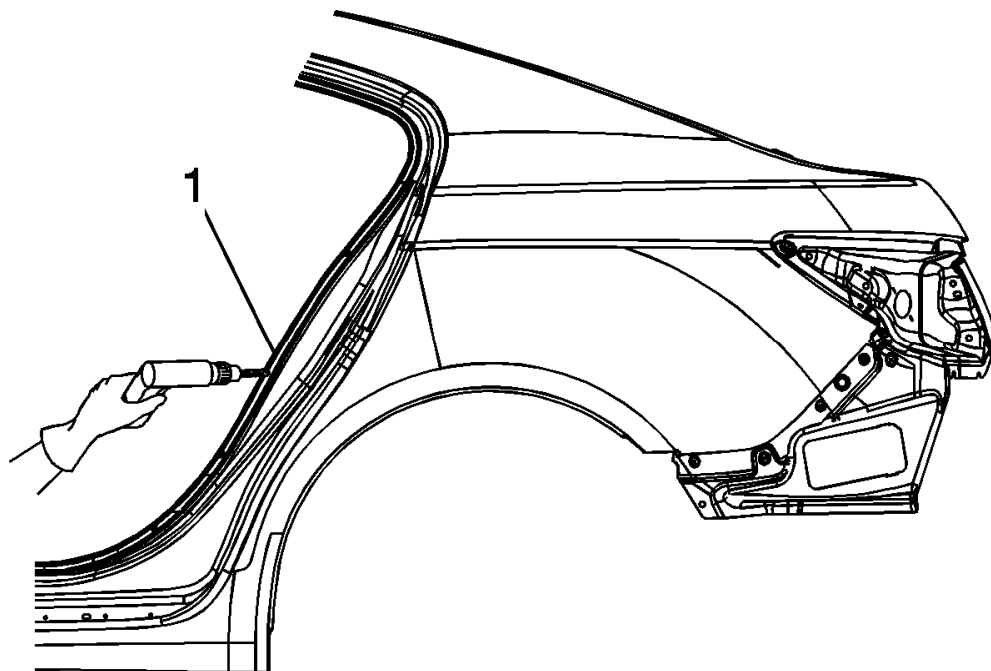


Fig. 113: Drilling Plug Weld Holes In Service Quarter Outer Panel
Courtesy of GENERAL MOTORS COMPANY

2. Drill 8 mm (5/16 in) plug weld holes as necessary in locations noted from the original quarter panel (1).

NOTE: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 40 mm (1 1/2 in) apart.

3. Prepare all mating surfaces for welding, as necessary.
4. Apply GM-approved Weld-Thru coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

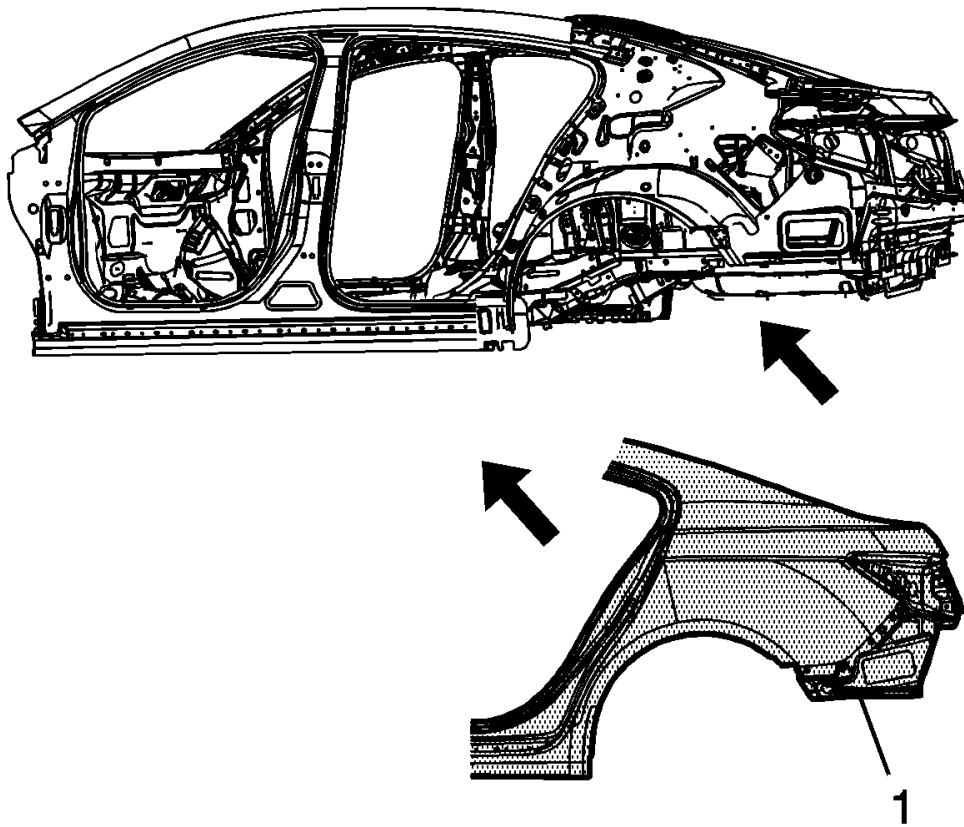


Fig. 114: Quarter Outer Panel

Courtesy of GENERAL MOTORS COMPANY

5. Position the new service panel and clamp in place (1).
6. Perform the sectioning procedure.

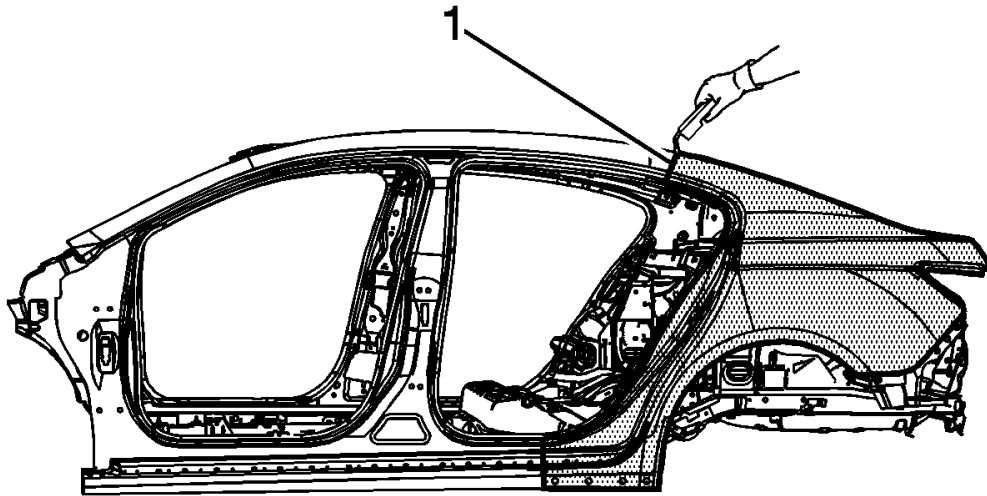


Fig. 115: Welding Quarter Outer Panel
Courtesy of GENERAL MOTORS COMPANY

7. Plug weld accordingly (1).
8. To create a solid weld with the minimum heat distortion, make a 25 mm (1 in) stitch weld along the seam with gaps of 25 mm (1 in) gaps between them. Go back and complete the stitch weld.
9. Clean and prepare all welded surfaces.

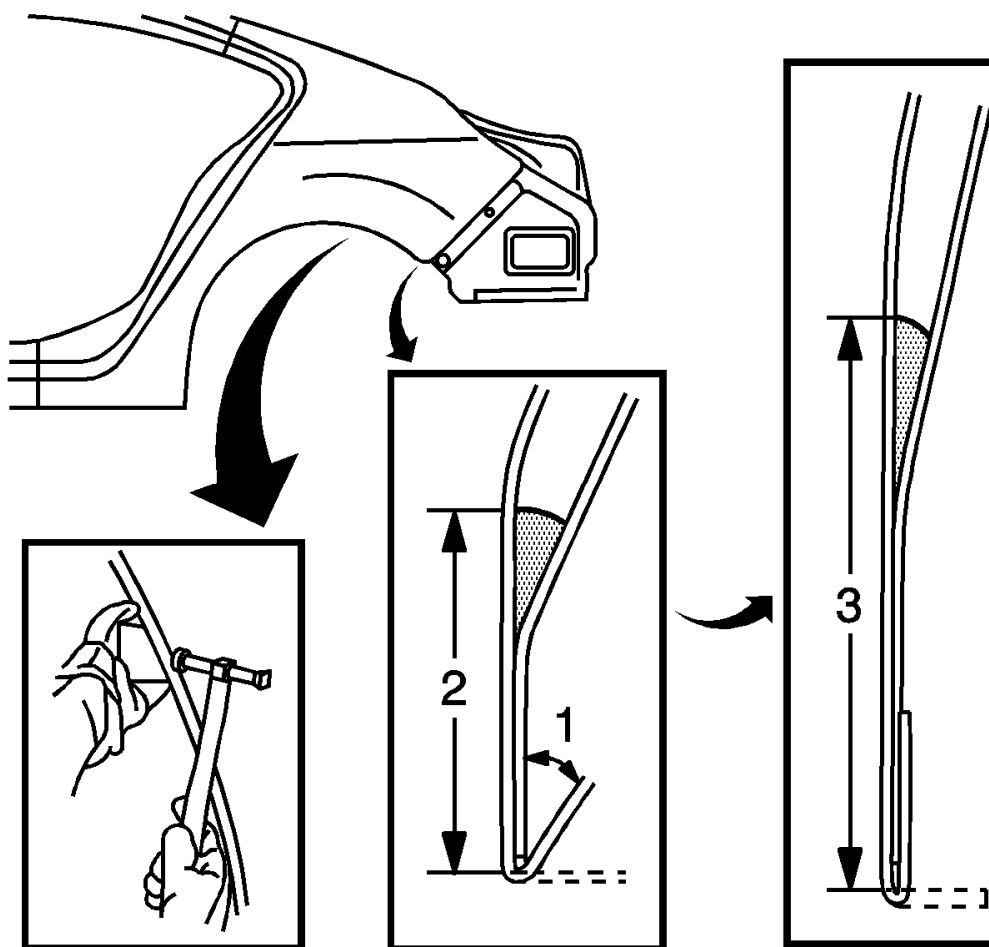


Fig. 116: Pre-Flanging Wheel Housing
 Courtesy of GENERAL MOTORS COMPANY

10. Pre-flange wheel housing. Using flat faced body hammer, bend over the flanged edge 45 degrees (1), at the same time holding a hard rubber block against it. Use structural adhesive in the area (2).
11. Bend the wheel arch (3).
12. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
13. Paint the repair area. Refer to **Basecoat/Clearcoat Paint Systems** .
14. Install all related panels and components.
15. Enable the SIR system. Refer to **SIR Disabling and Enabling** .
16. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

UNDERBODY REAR SIDE RAIL REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

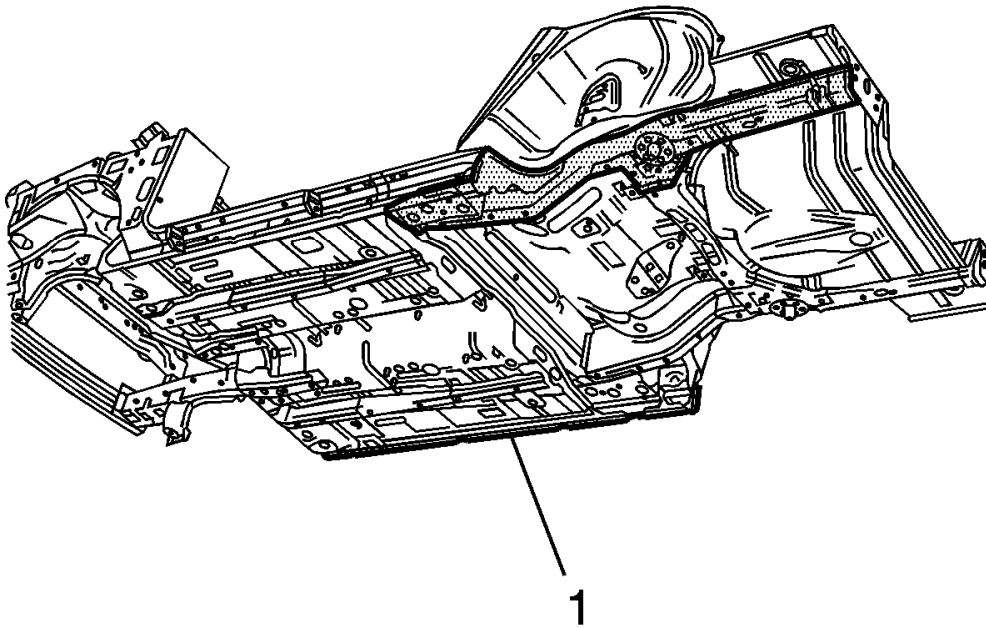


Fig. 117: Underbody Rear Side Rail
Courtesy of GENERAL MOTORS COMPANY

3. Remove all related panels and components (1).
4. Repair as much of the damaged area as possible. Refer to Dimensions - Body (Sedan).
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
6. Remove the inner and outer quarter panel to access the welds from the rail to the inner rocker panel area. Refer to Quarter Outer Panel Sectioning.
7. Remove the filler rocker reinforcement inner panel.

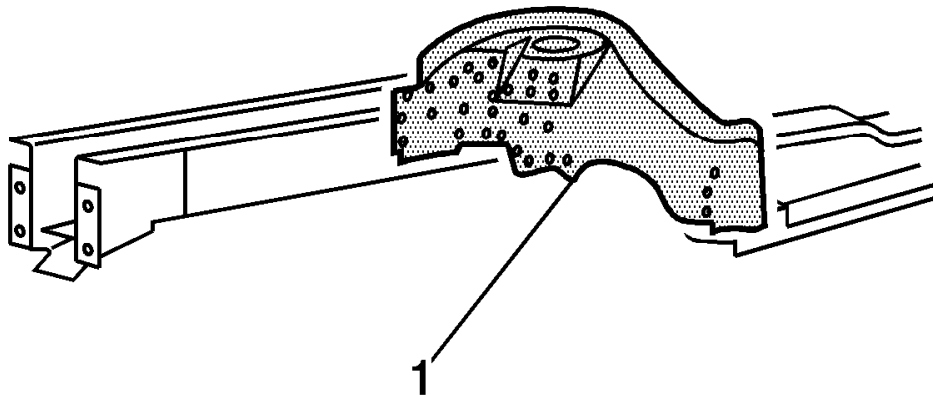


Fig. 118: Removing Shock Reinforcement Wheel House Extension
Courtesy of GENERAL MOTORS COMPANY

8. Remove the shock reinforcement wheel house extension (1).

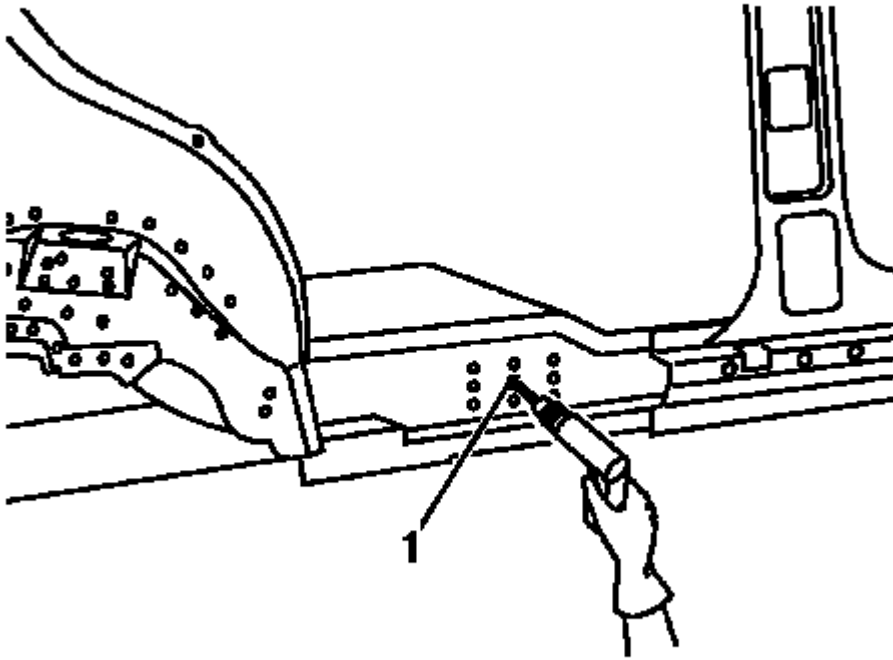


Fig. 119: Drilling Out Factory Welds Under Inner Rocker Reinforcement
Courtesy of GENERAL MOTORS COMPANY

9. Locate and drill out all the necessary factory welds under the inner rocker reinforcement (1).

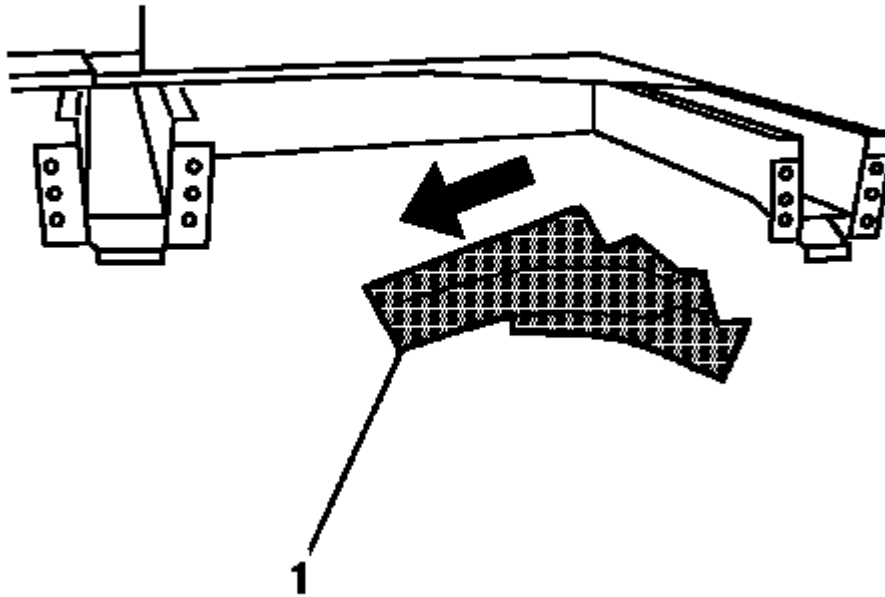


Fig. 120: Locating And Drilling Out All Necessary Factory Welds To Remove Five Bar - Rear Side Underbody Rail (Extended Sedan)
Courtesy of GENERAL MOTORS COMPANY

10. Locate and drill out all necessary factory welds to remove the five bar (1).

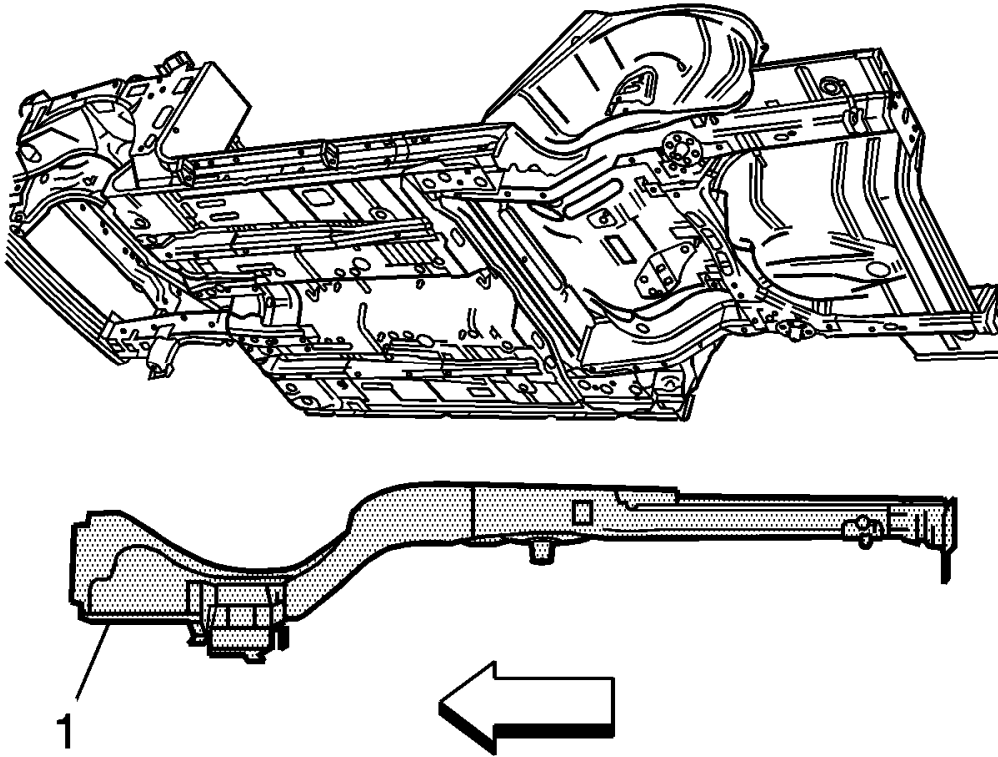


Fig. 121: Underbody Rear Side Rail
Courtesy of GENERAL MOTORS COMPANY

11. Remove the rear rail (1).

Installation Procedure

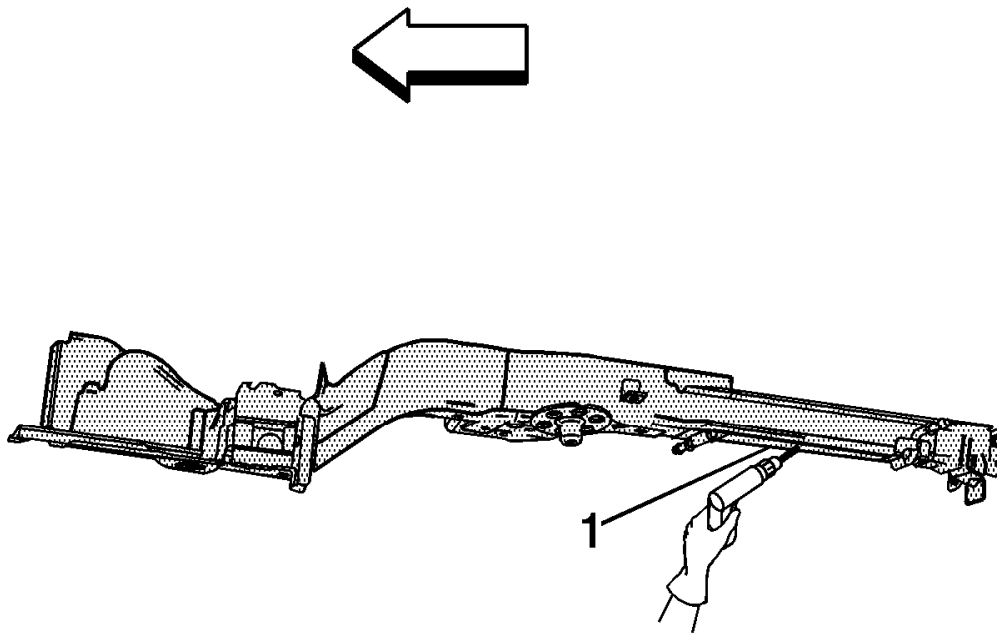


Fig. 122: Drilling Plug Weld Holes In Replacement Underbody Rear Side Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the location of the original plug weld holes cannot be determined, space the plug weld holes every 40 mm (1 1/2 in) apart.

1. Drill 8 mm (5/16 in) plug weld holes in the service part as necessary in the locations noted from the original panel (1).
2. Prepare all mating surfaces for welding as necessary.
3. Apply GM-approved Weld-Thru Coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

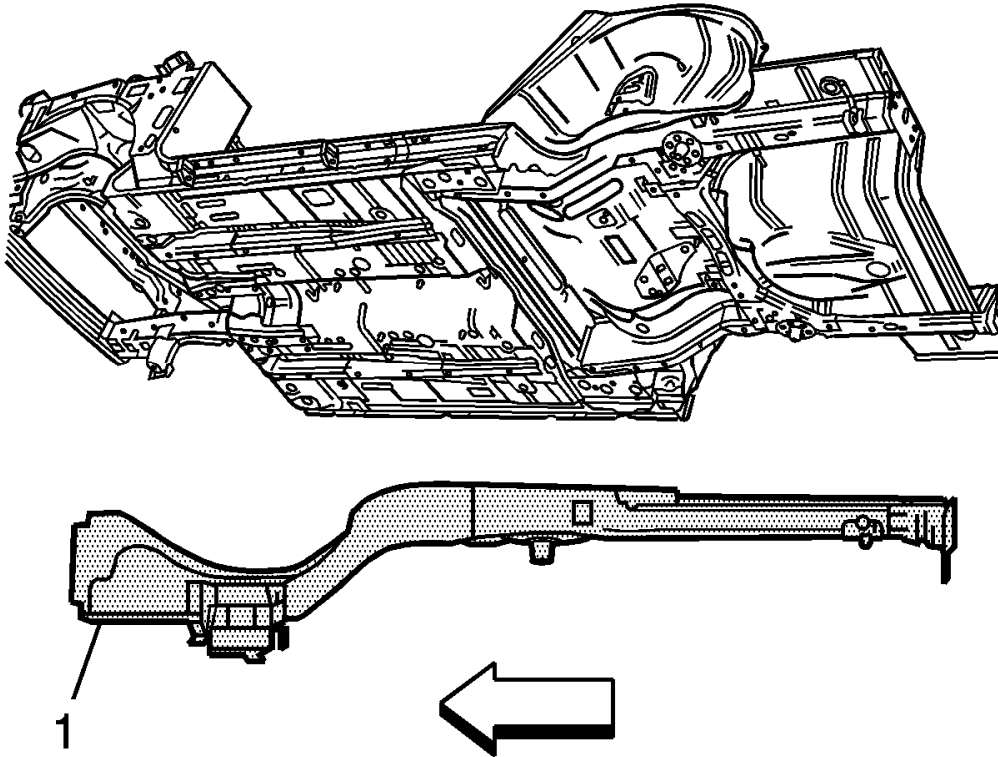


Fig. 123: Underbody Rear Side Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: The service part includes a rear wheelhouse extension.

4. Position the rear rail to the vehicle using 3-dimensional measuring equipment. Clamp the rail in place (1).

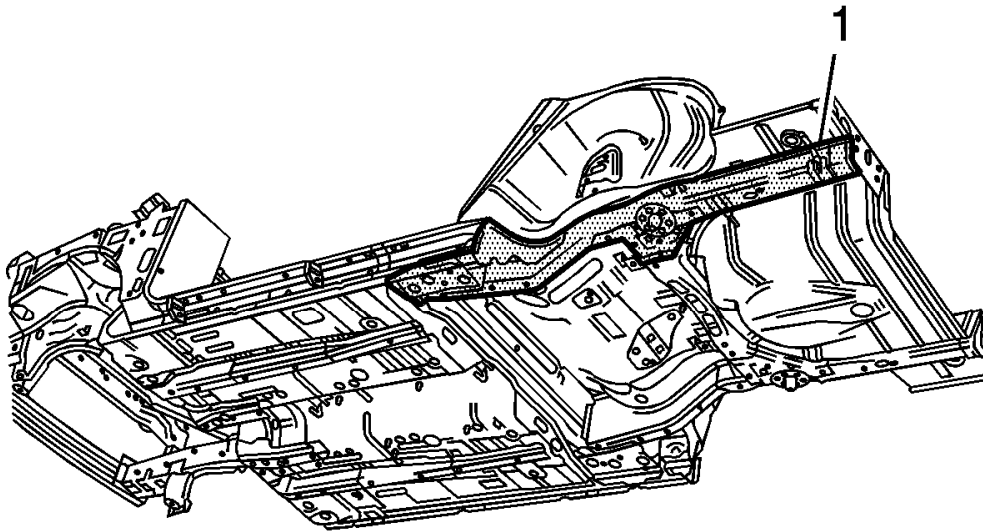


Fig. 124: Underbody Rear Side Rail In Position For Welding
Courtesy of GENERAL MOTORS COMPANY

5. Plug weld accordingly (1).

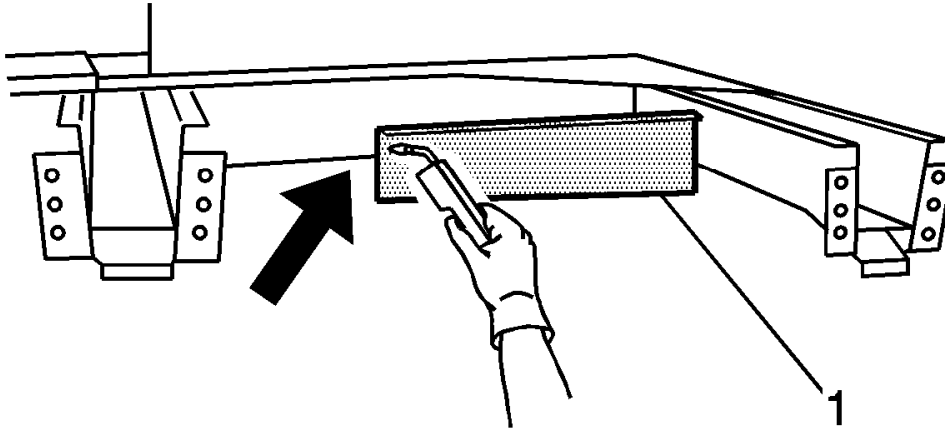


Fig. 125: Install The Five Bar (1) - Rear Side Underbody Rail (Extended Sedan)
Courtesy of GENERAL MOTORS COMPANY

6. Install the five bar (1).

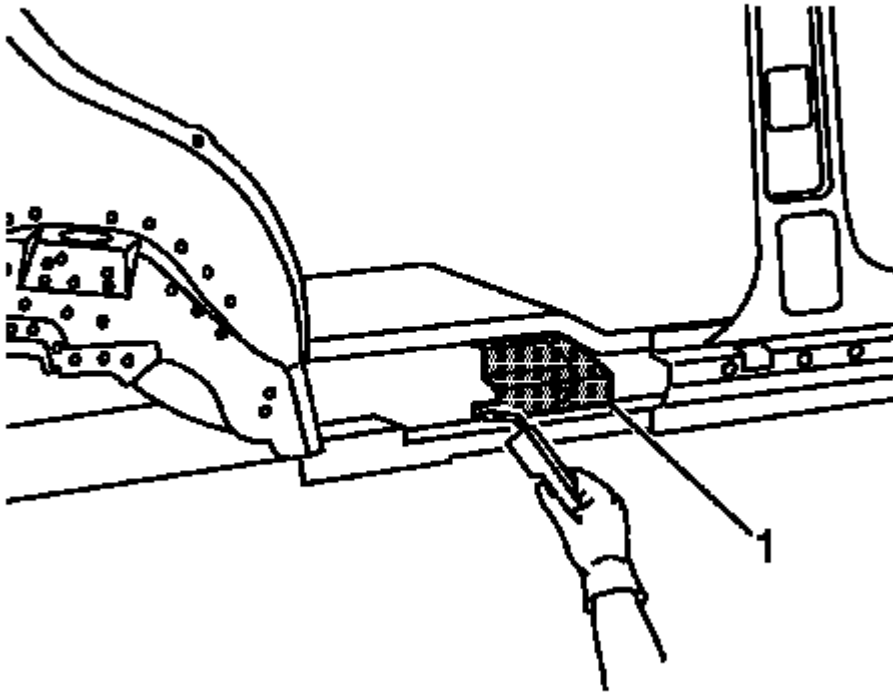


Fig. 126: Installing Rear Rocker Inner Panel Reinforcement (1) - Rear Side Underbody Rail (Extended Sedan)

Courtesy of GENERAL MOTORS COMPANY

7. Install the rear rocker inner panel reinforcement (1).
8. Install the quarter panel.
9. Install the inner panel.
10. Install all of the related panels and components.
11. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
12. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
13. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
14. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

BODY REAR END PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

NOTE: Before beginning the repair, refer to Metal Panel Bonding for proper adhesive applicator preparations and general information.

1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove all related panels and components.
4. Repair as much of the damage as possible. Refer to Dimensions - Body (Sedan).
5. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .

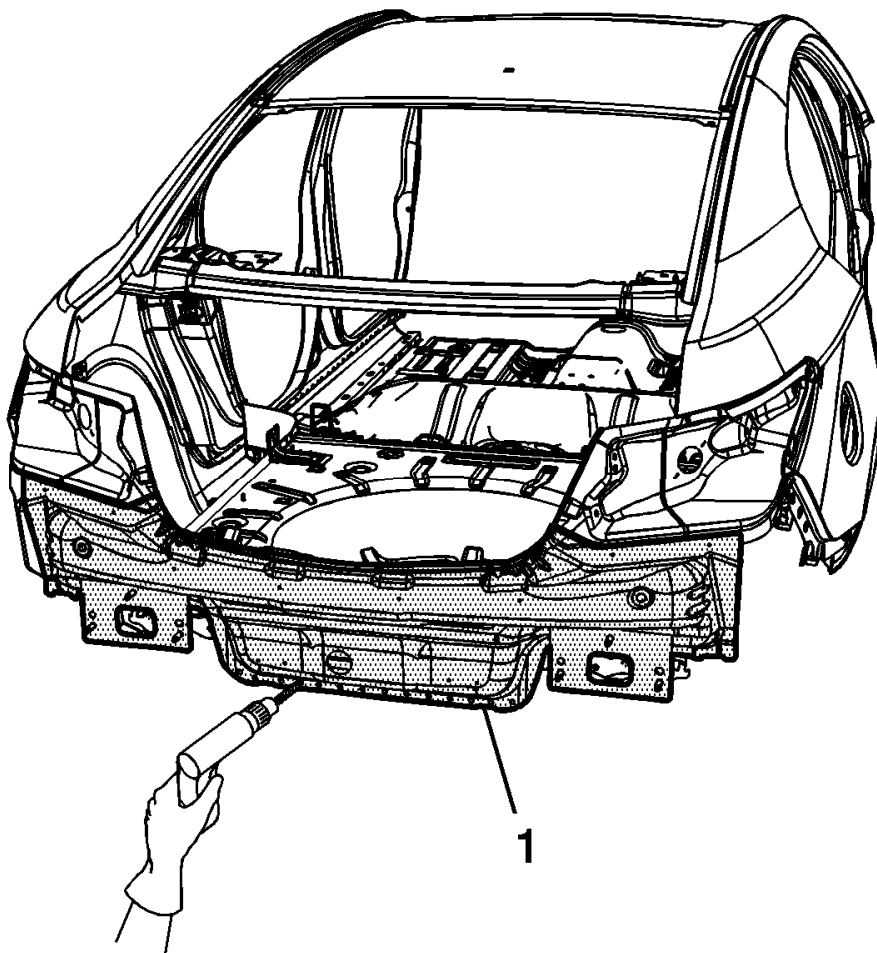


Fig. 127: Drilling Out Body Rear End Panel Factory Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the number and location of the factory welds for installation of the rear end panel.

6. Locate and drill out all the necessary factory welds (1).

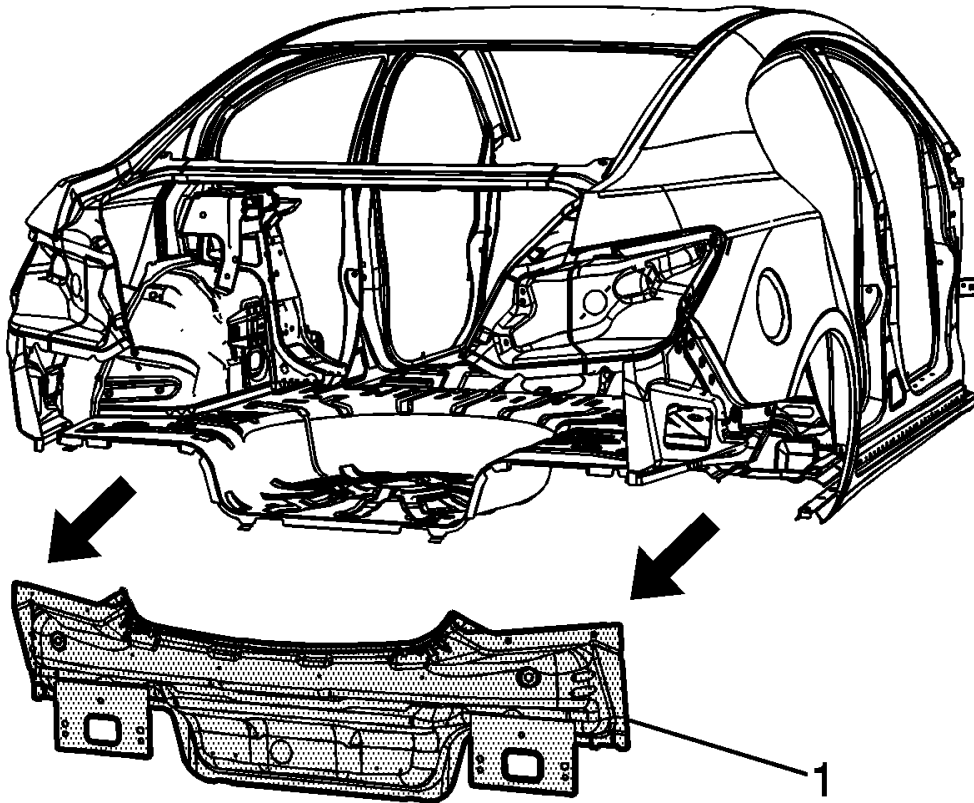


Fig. 128: Rear End Panel

Courtesy of GENERAL MOTORS COMPANY

7. Remove the rear end panel (1).

Installation Procedure

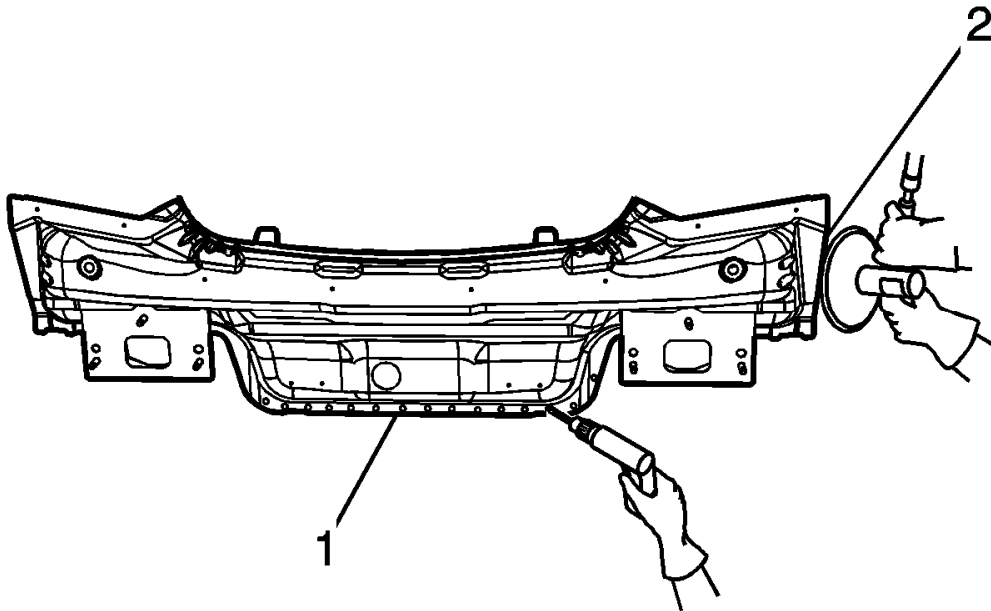


Fig. 129: Drilling Plug Weld Holes Replacement Rear End Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the location of the original plug weld holes can not be determined, space the plug weld holes every 40 mm (1 1/2 in) apart.

1. Drill 8 mm (5/16 in) plug weld holes in the service part as necessary in the locations noted from the original panel (1).
2. Clean and prepare all matting surfaces as necessary (2).

NOTE: Remove excess weld and sealer

3. Apply GM-approved Weld-Thru coating or equivalent to all matting surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

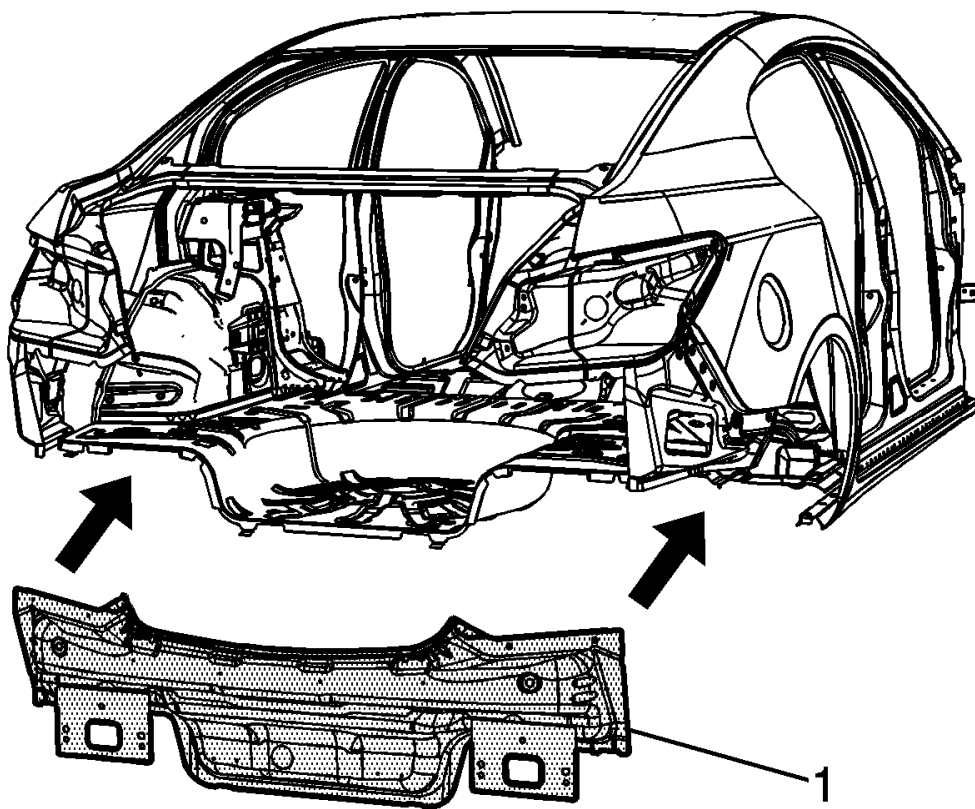


Fig. 130: Rear End Panel

Courtesy of GENERAL MOTORS COMPANY

4. Position the rear end panel on the vehicle. Use 3-dimensional measuring equipment to inspect the panel (1).
5. Clamp the panel in place.

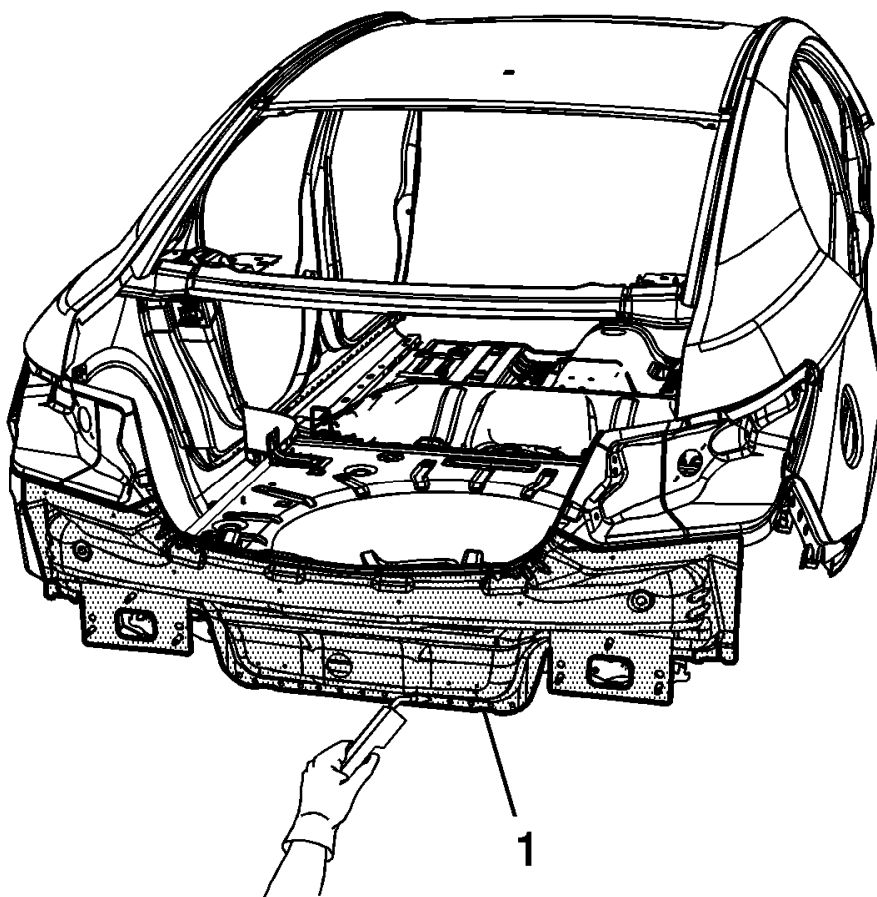


Fig. 131: Welding Rear End Panel
Courtesy of GENERAL MOTORS COMPANY

6. Plug weld accordingly (1).
7. Clean and prepare all of the welded surfaces.
8. Install all of the related panels and components.
9. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
10. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
12. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

CENTER PILLAR INNER PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

WARNING: Refer to Glass and Sheet Metal Handling Warning .

1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Remove all related panels and components.
3. Visually inspect the damage. Repair as much of the damage as possible.
4. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
5. Locate and mark all factory welds.

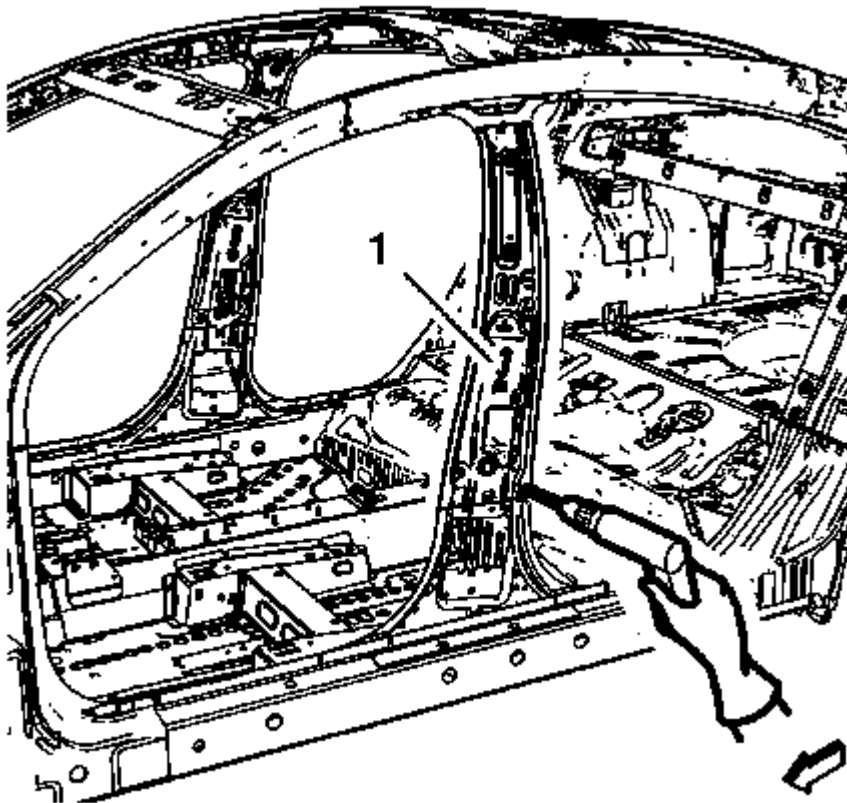


Fig. 132: Drilling Factory Welds From Lower Center Pillar Inner Panel
Courtesy of GENERAL MOTORS COMPANY

6. Drill all factory welds lower of the center pillar inner panel (1). Note the number and location of welds for installation of the service assembly.

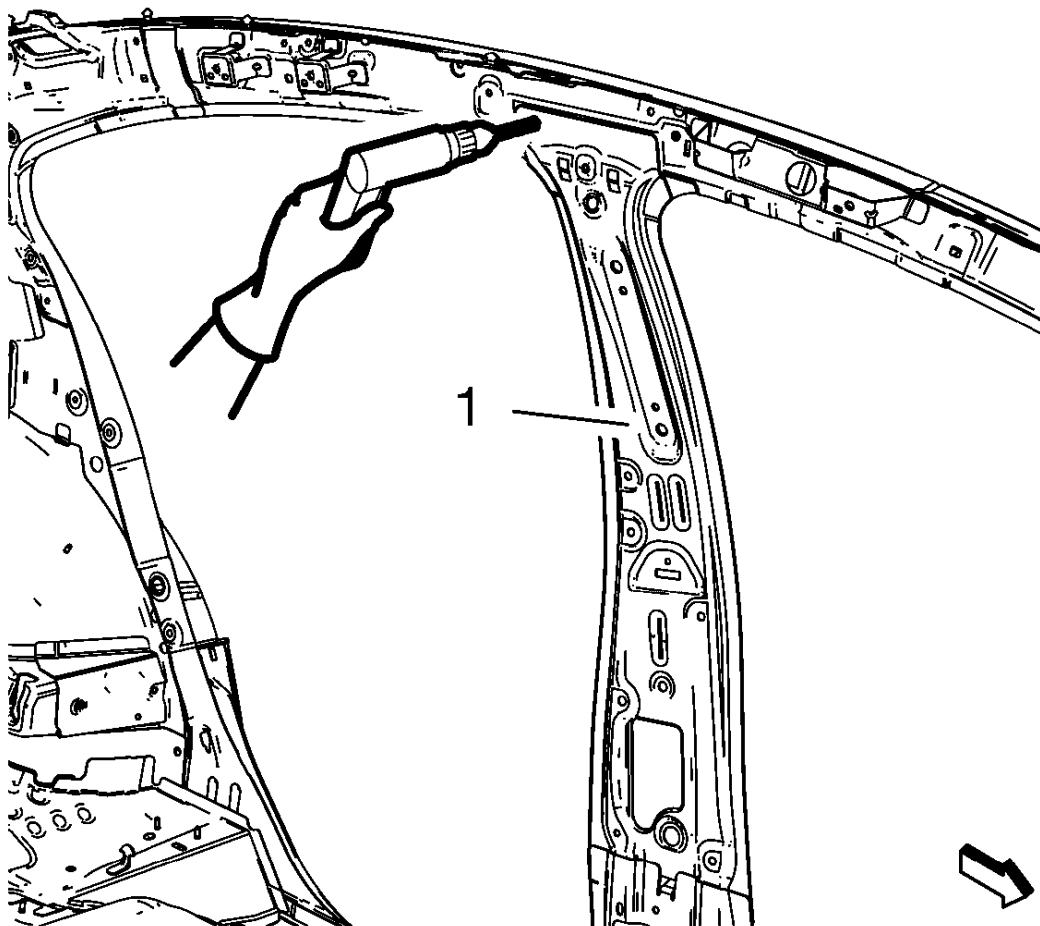


Fig. 133: Drilling Factory Welds From Upper Center Pillar Inner Panel
Courtesy of GENERAL MOTORS COMPANY

7. Drill all factory welds upper of the center pillar inner panel (1). Note the number and location of welds for installation of the service assembly.

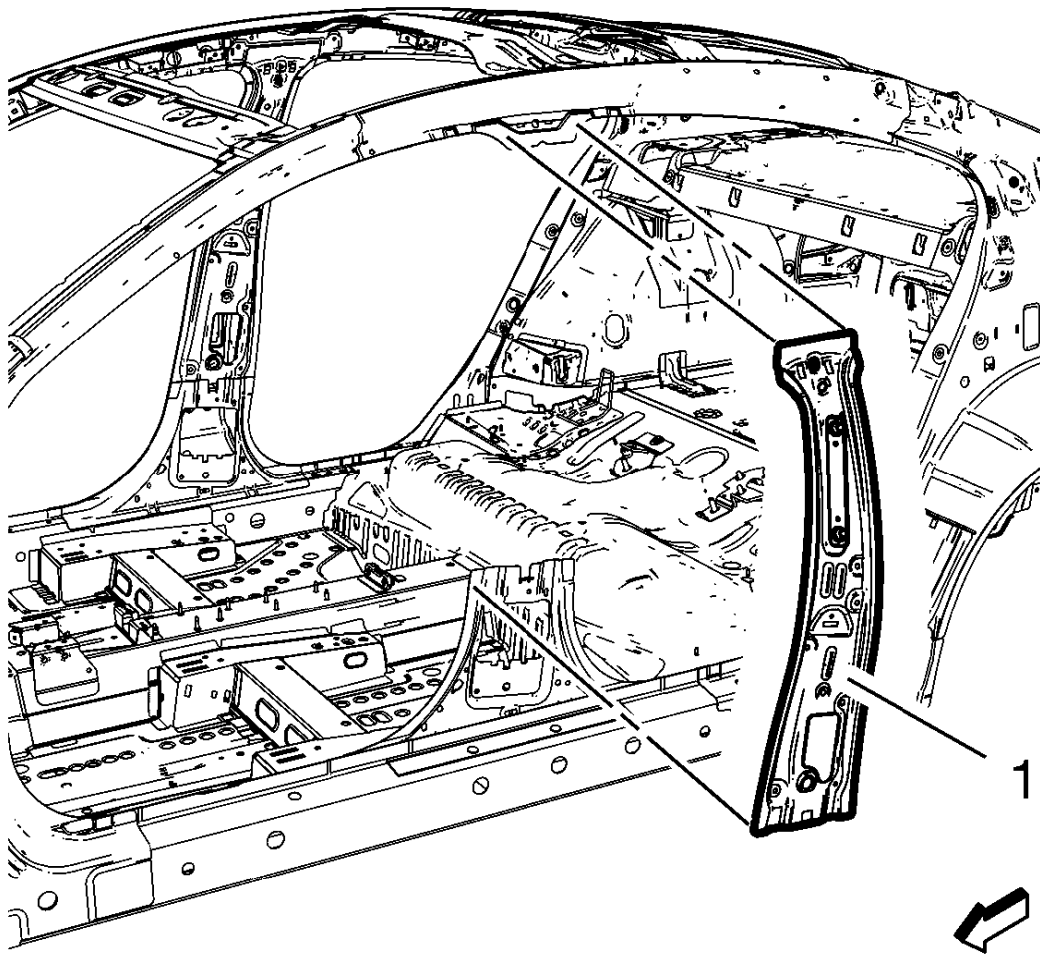


Fig. 134: Center Pillar Inner Panel
Courtesy of GENERAL MOTORS COMPANY

8. Remove the damaged center pillar inner panel (1).

Installation Procedure

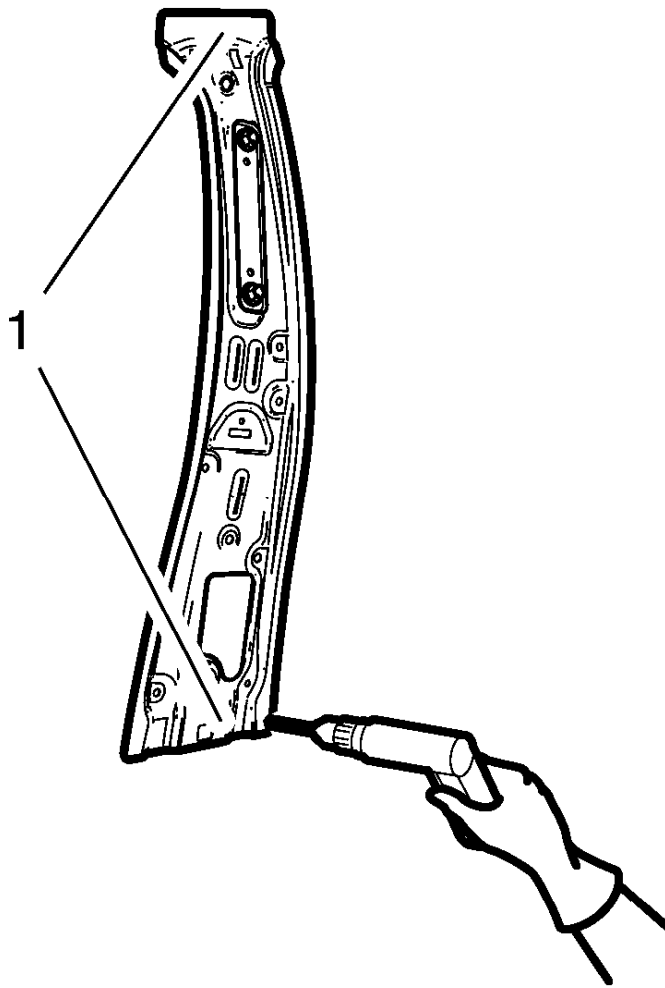


Fig. 135: Drilling Holes Plug Welding Holes In New Center Pillar Inner Panel
Courtesy of GENERAL MOTORS COMPANY

1. Drill 8 mm (5/16 in) for plug welding along the edges of the center pillar inner panel (1) as noted from the original panel.
2. Clean and prepare the attaching surfaces for welding.

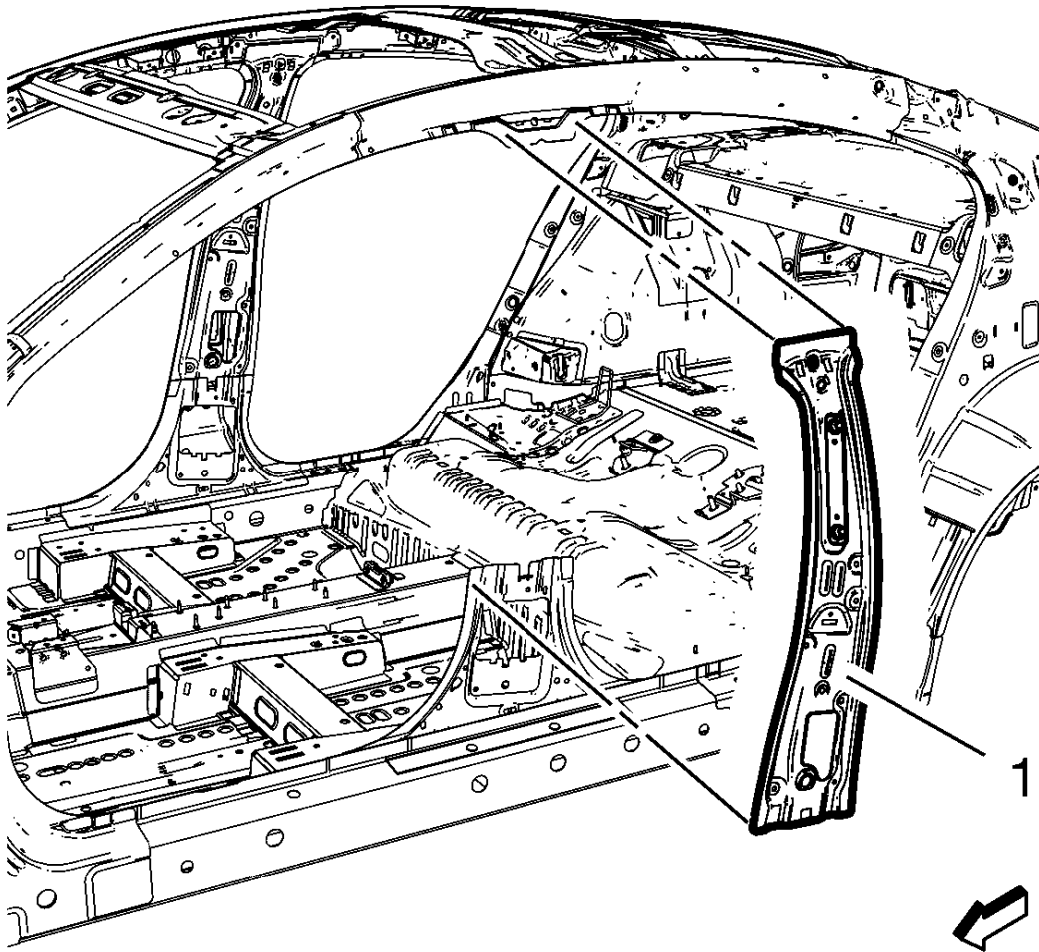


Fig. 136: Center Pillar Inner Panel
Courtesy of GENERAL MOTORS COMPANY

3. Position the center pillar inner panel (1) on the vehicle.
4. Verify the fit of the panel.
5. Clamp the center pillar inner panel into position.

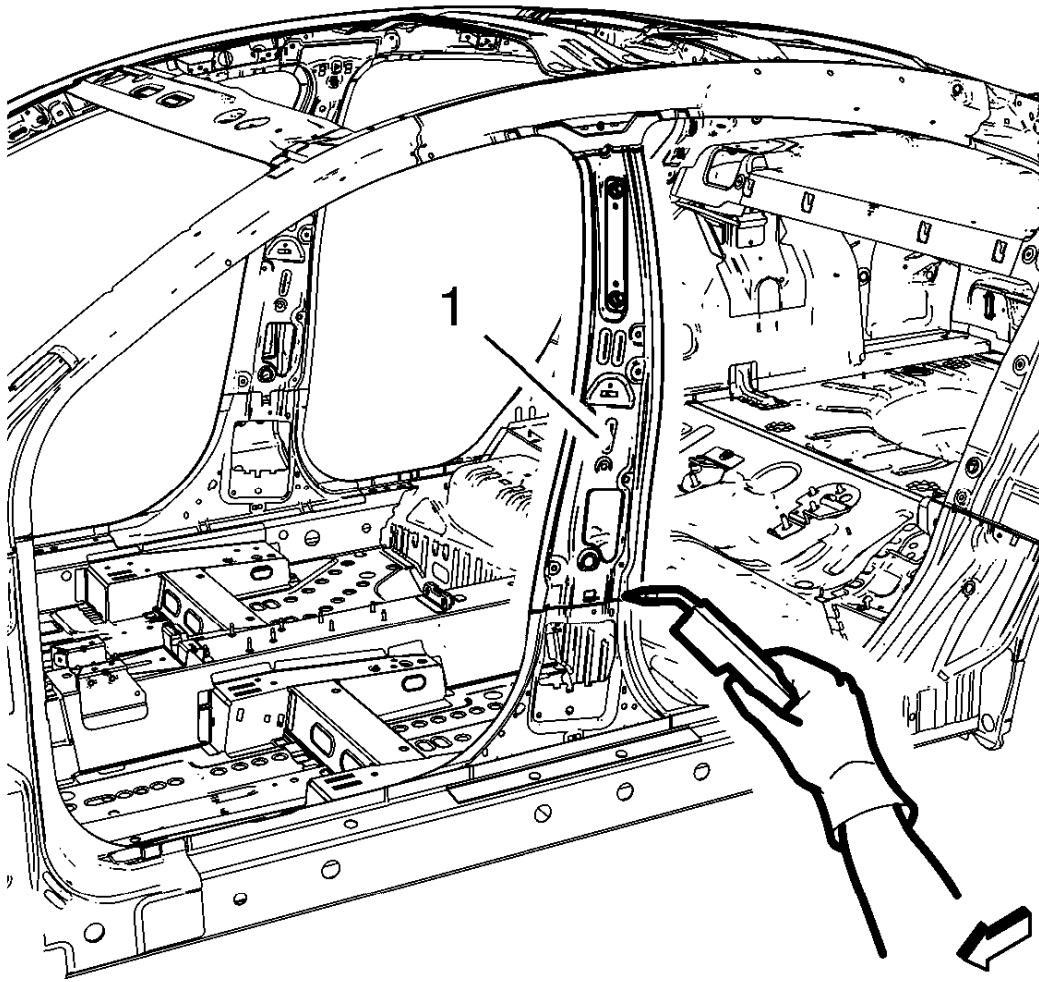


Fig. 137: Welding Upper And Lower Center Pillar Inner Panel
Courtesy of GENERAL MOTORS COMPANY

6. Plug weld accordingly center pillar inner panel (1) upper and lower.
7. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
8. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
9. Install all related panels and components.
10. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

CENTER PILLAR REINFORCEMENT REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

WARNING: Refer to Glass and Sheet Metal Handling Warning .

NOTE: Section in specified areas only. Sectioning outside of these areas may compromise the structural integrity of the vehicle. The door frame can be replaced at factory seams, but requires the removal of the windshield and the roof. The sectioning procedures have been developed as a more cost-effective alternative to complete replacement. The specific area to be sectioned is determined by the extent of the damage to the vehicle.

1. Disable the SIR System. Refer to SIR Disabling and Enabling .
2. Remove all related panels and components.
3. Visually inspect the damage. Repair as much of the damage as possible.
4. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
5. Remove body side center pillar section. Refer to Center Pillar Sectioning - Outer.

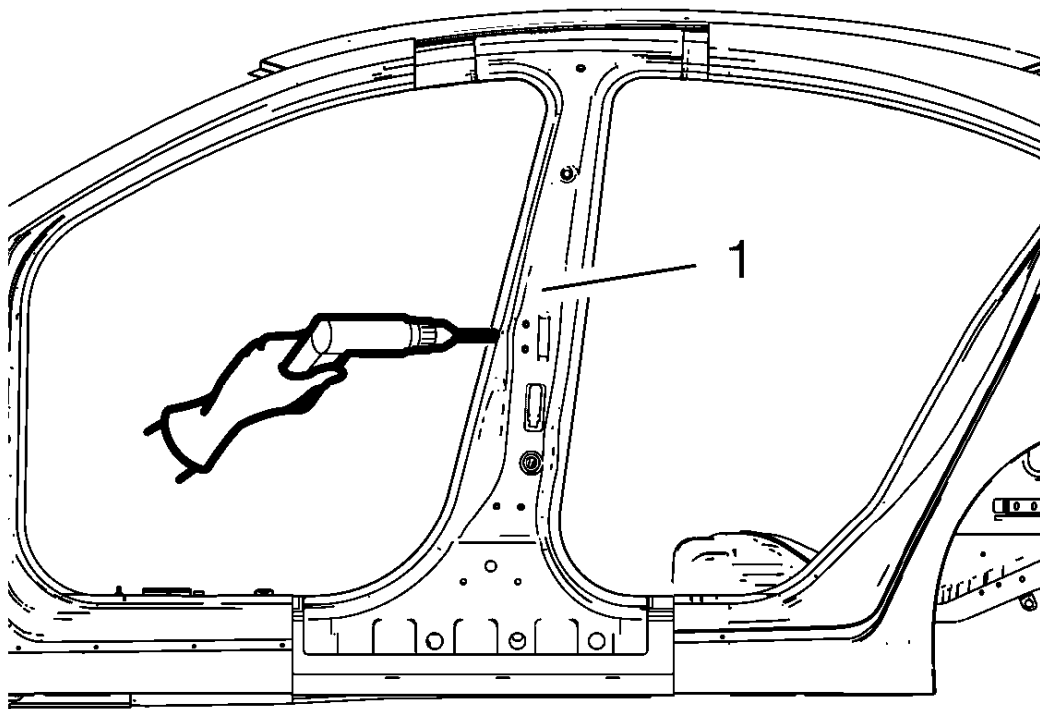


Fig. 138: Drilling Factory Welds Of Center Pillar Reinforcement
Courtesy of GENERAL MOTORS COMPANY

6. Locate and mark all the necessary factory welds of the center pillar reinforcement (1).
7. Drill all factory welds. Note the number and location of welds for installation of the service assembly.

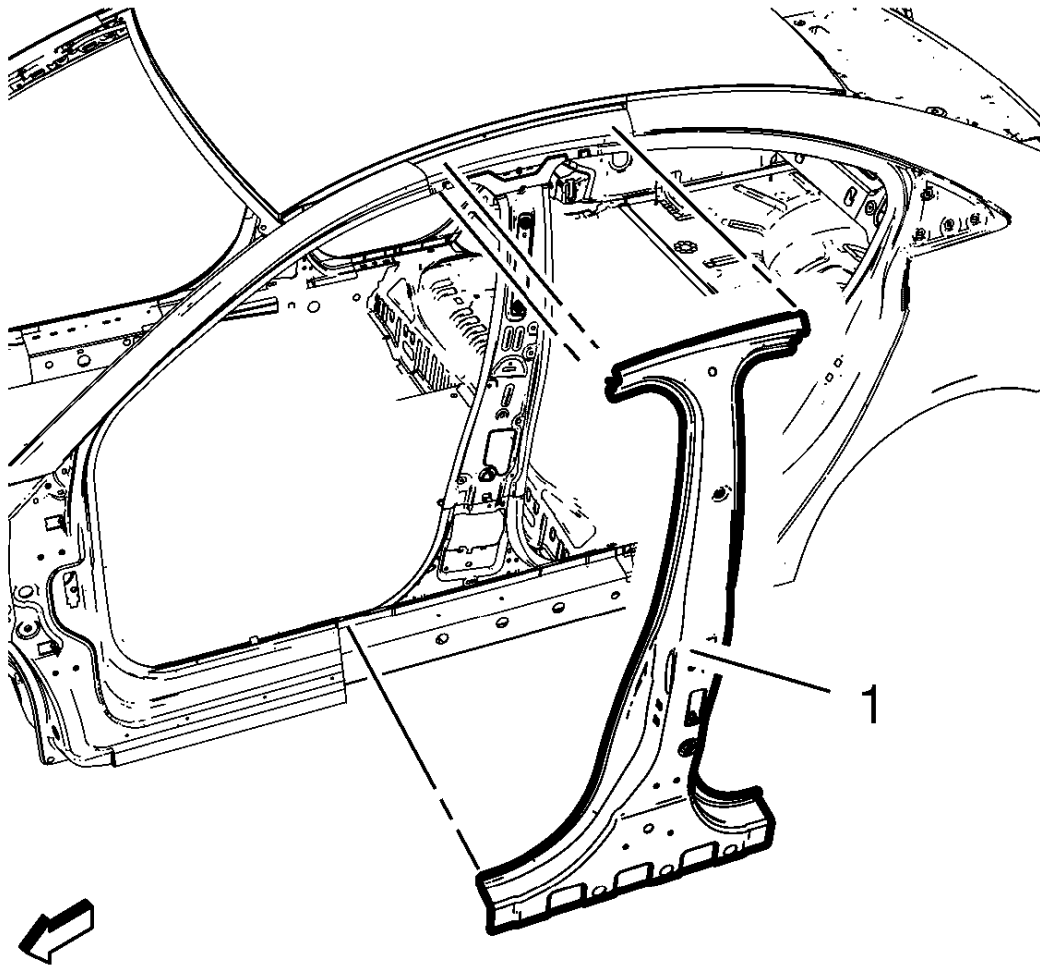


Fig. 139: center pillar reinforcement
Courtesy of GENERAL MOTORS COMPANY

8. Remove the damaged center pillar reinforcement (1).

Installation Procedure

1. Prepare all matting surfaces as necessary.
2. Align the center pillar reinforcement.

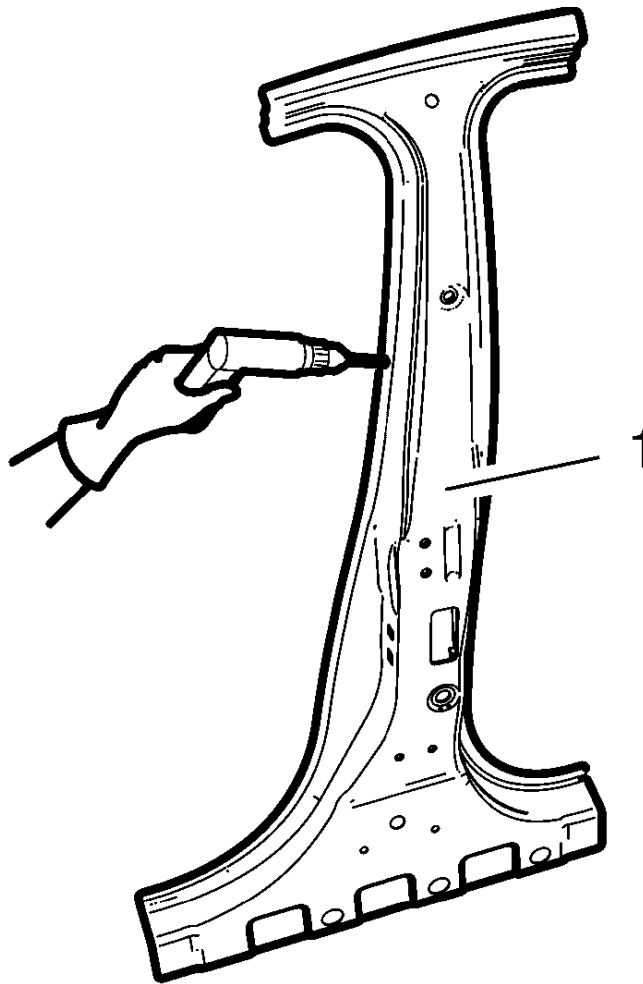


Fig. 140: Drilling Plug Weld Holes For New Center Pillar Reinforcement
Courtesy of GENERAL MOTORS COMPANY

3. Drill 8 mm (5/16 in) for plug welding along the edges of the center pillar reinforcement (1) as noted from the original panel.
4. Clean and prepare the attaching surfaces for welding.

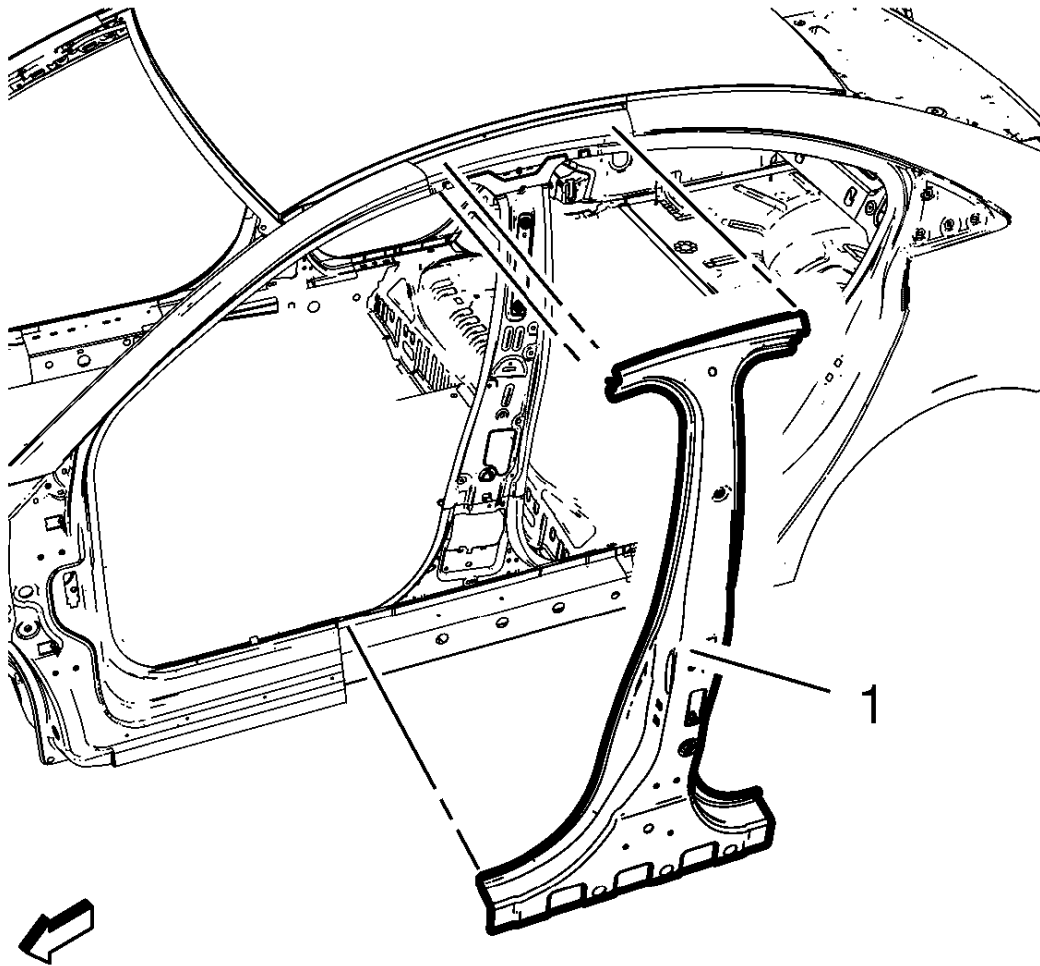


Fig. 141: center pillar reinforcement
Courtesy of GENERAL MOTORS COMPANY

5. Position the center pillar reinforcement (1) on the vehicle using 3-dimensional measuring equipment.
6. Verify the fit of the center pillar reinforcement.
7. Clamp the center pillar reinforcement into position.

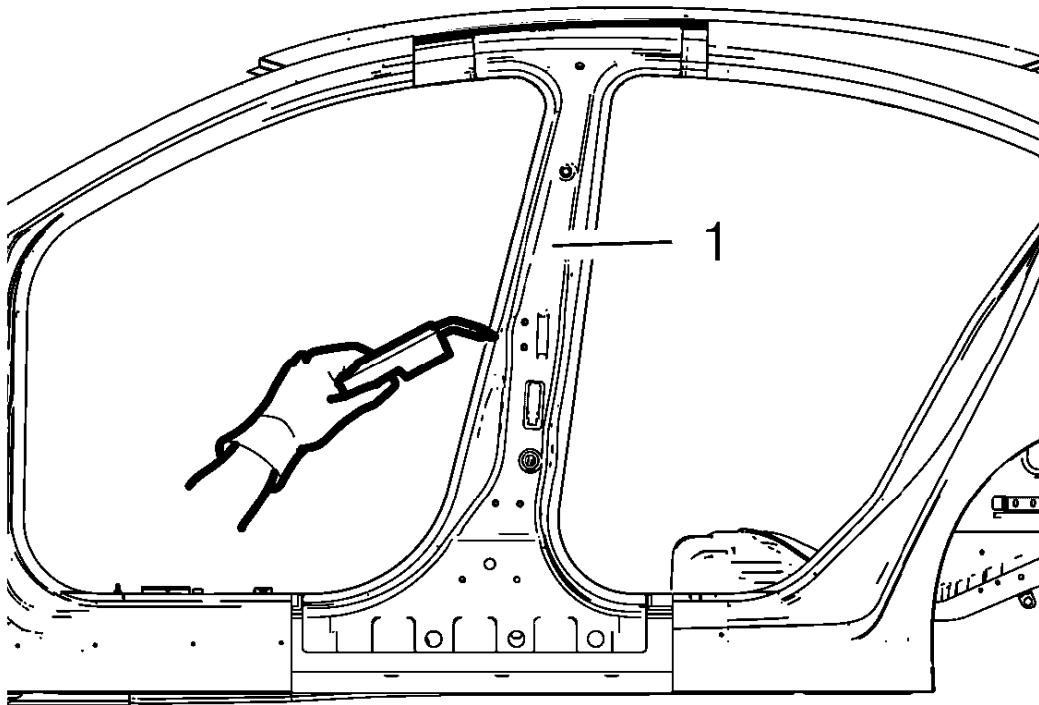


Fig. 142: Welding Center Pillar Reinforcement
Courtesy of GENERAL MOTORS COMPANY

8. Plug weld the center pillar reinforcement (1) accordingly.
9. Complete body side center pillar sectioning. Refer to **Center Pillar Sectioning - Outer**.
10. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
11. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
12. Install all related panels and components.
13. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

CENTER PILLAR SECTIONING - OUTER

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

NOTE: Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle.

NOTE: This procedure was developed to allow full access for the replacement of the center reinforcement pillar replacement since sectioning is not endorsed or recommended to the reinforcement due to the ultra high strength steel [Ultra High Strength Steel](#).

1. Disable the SIR system. Refer to [SIR Disabling and Enabling](#) .
2. Remove all related panels and components.
3. Remove the sealers and anti-corrosion materials from the repair area, as necessary, and note their location. Refer to [Anti-Corrosion Treatment and Repair](#) .
4. Repair as much of the damaged area as possible. Refer to [Dimensions - Body \(Sedan\)](#).

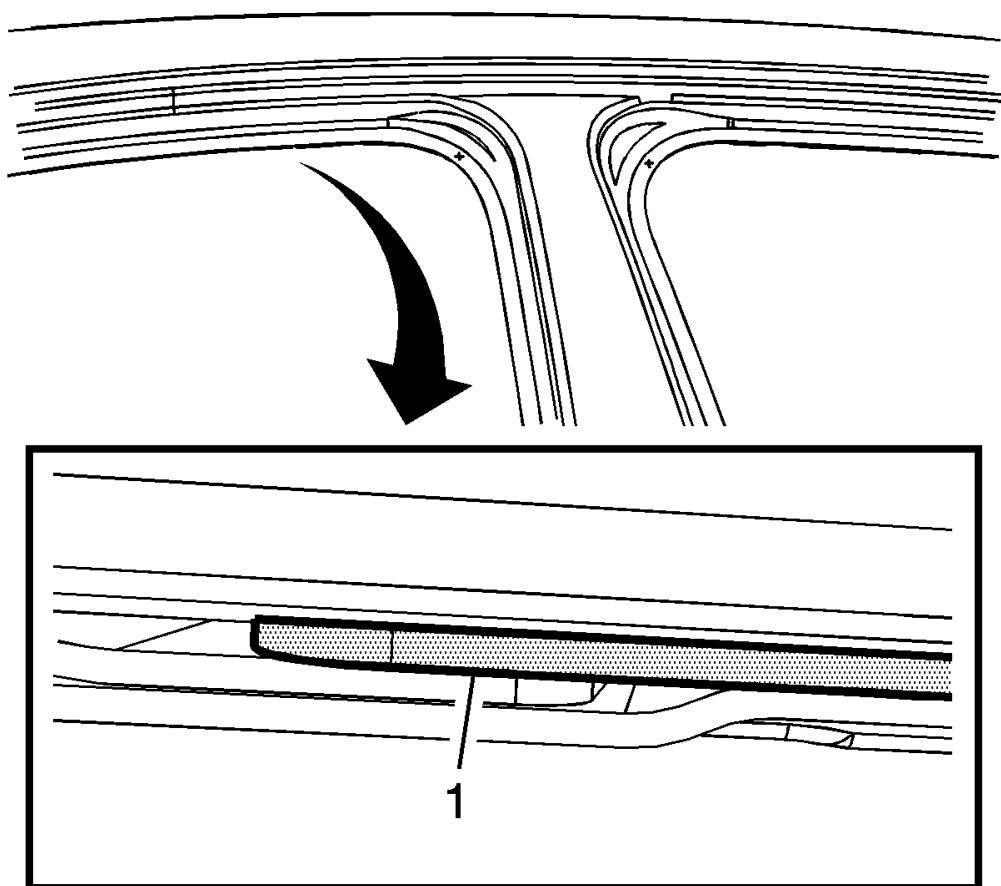


Fig. 143: Removing Weatherstrip

Courtesy of GENERAL MOTORS COMPANY

5. Remove the weatherstrip, observe the flange in the center pillar area. There will be a 3-metal stack-up. The center layer is the center pillar inner reinforcement (1).

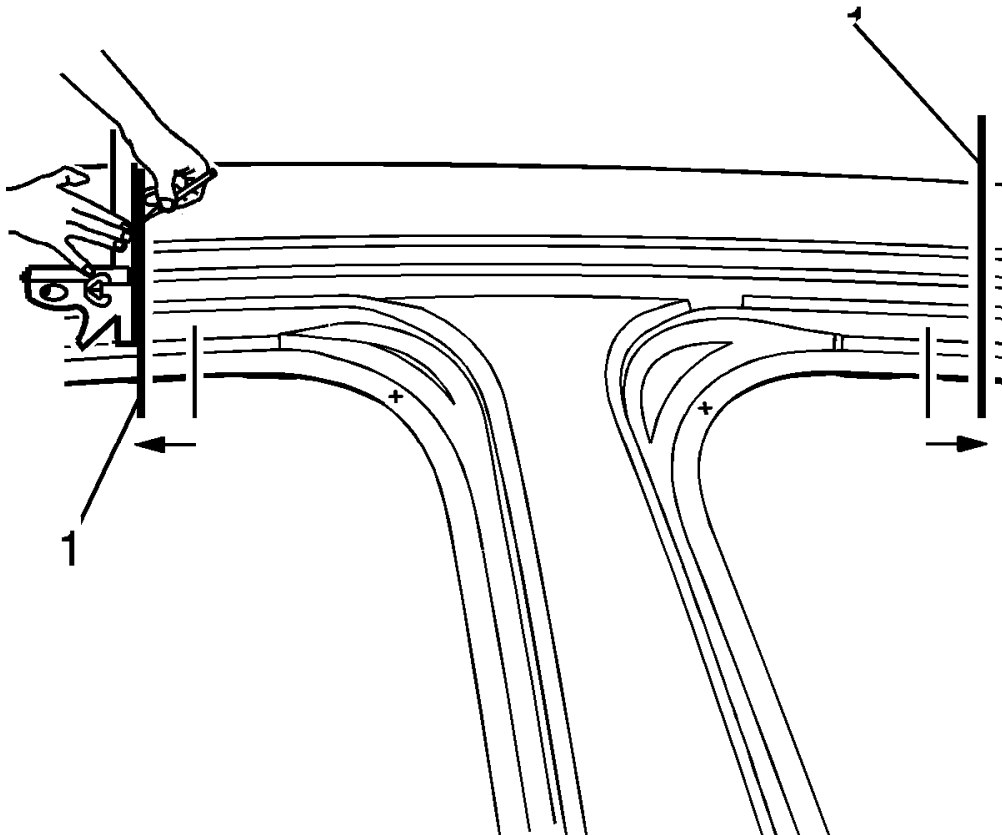


Fig. 144: Vertical Line Marks

Courtesy of GENERAL MOTORS COMPANY

6. Measure 13 mm (1/2 in) from the forward and rearward edges of the center pillar inner reinforcement and mark a vertical line (1).

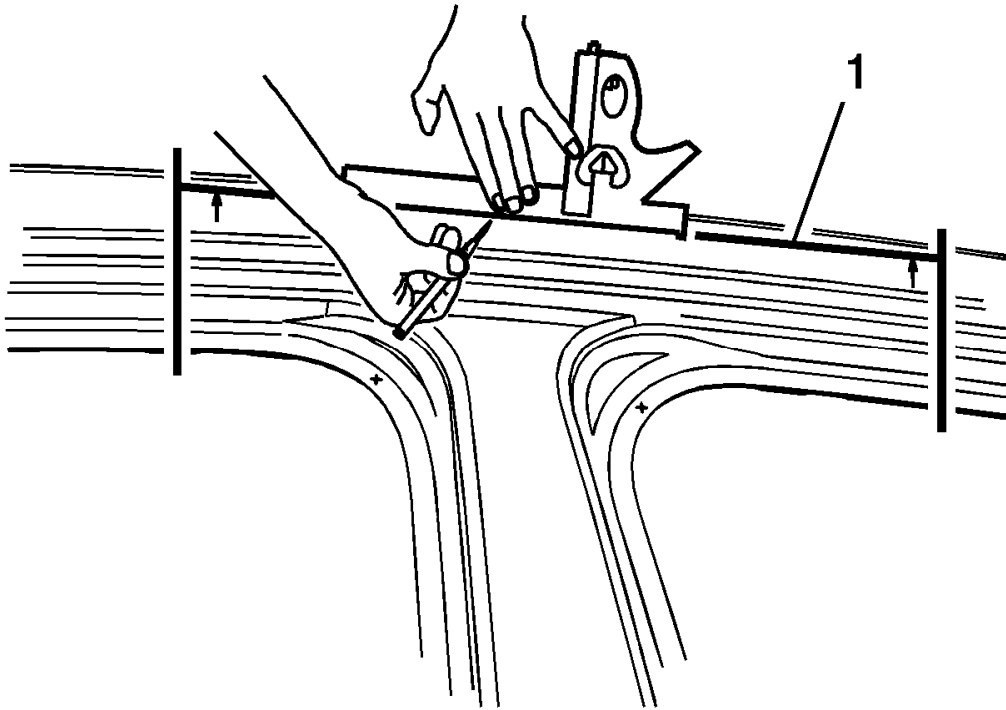


Fig. 145: Measuring Up 1 Inch From Door Opening Feature Line And Mark A Horizontal Line.
Courtesy of GENERAL MOTORS COMPANY

7. Measure down 25 mm (1 in) from the upper edge of the body side outer panel and mark a horizontal line (1). This is the cut line.

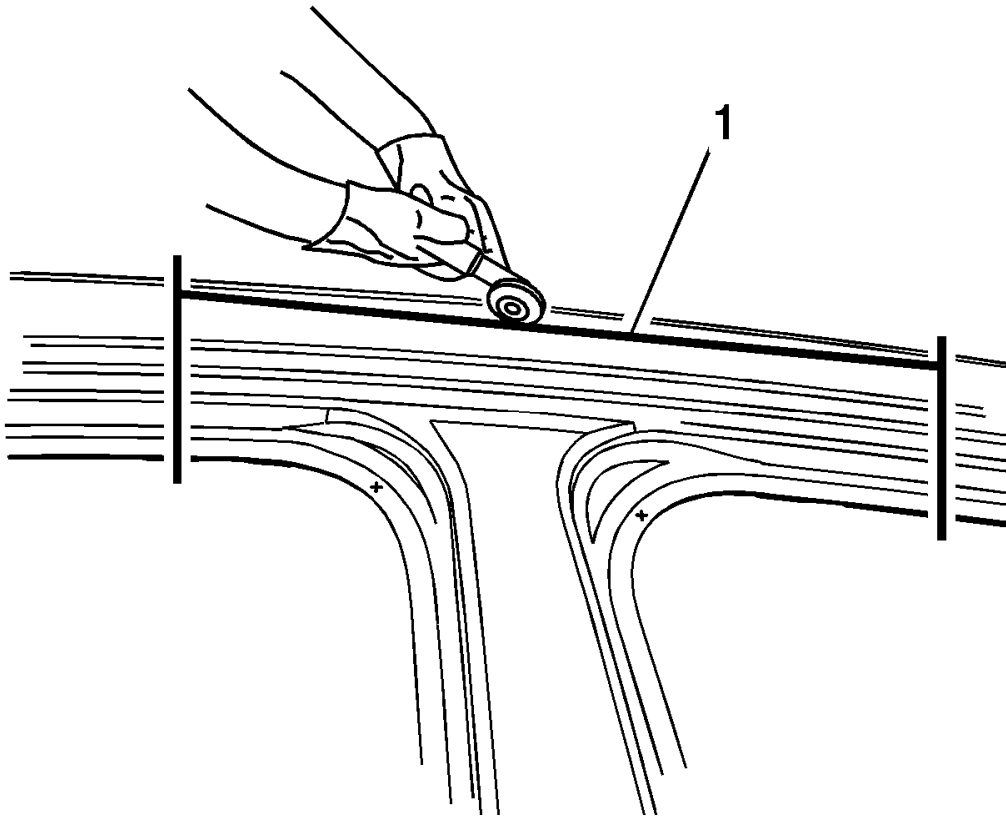


Fig. 146: Cutting Access Window In Center Pillar
Courtesy of GENERAL MOTORS COMPANY

8. Cut access window (1) in the center pillar outer.
9. Perform additional sectioning procedures as needed depending on damage to vehicle. Refer to **Quarter Outer Panel Sectioning**, **Rocker Outer Panel Sectioning**, or **Front Hinge Pillar Body Sectioning (Upper)**, **Front Hinge Pillar Body Sectioning (Lower)**.

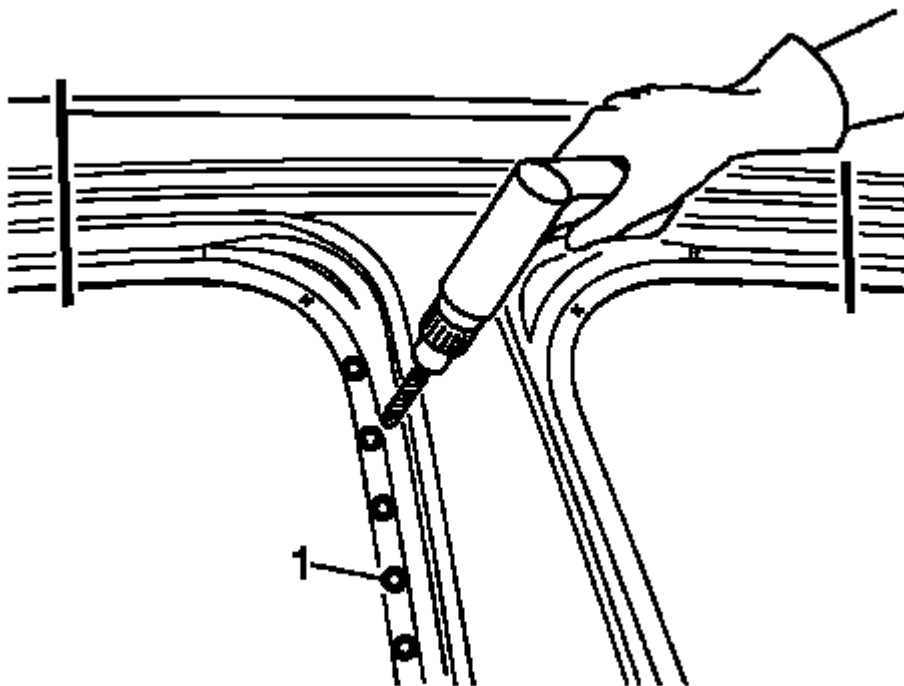


Fig. 147: Locating And Drill Out All Factory Welds
Courtesy of GENERAL MOTORS COMPANY

10. Locate and drill out all factory welds (1). Note the number and location of welds for installation of the service part.

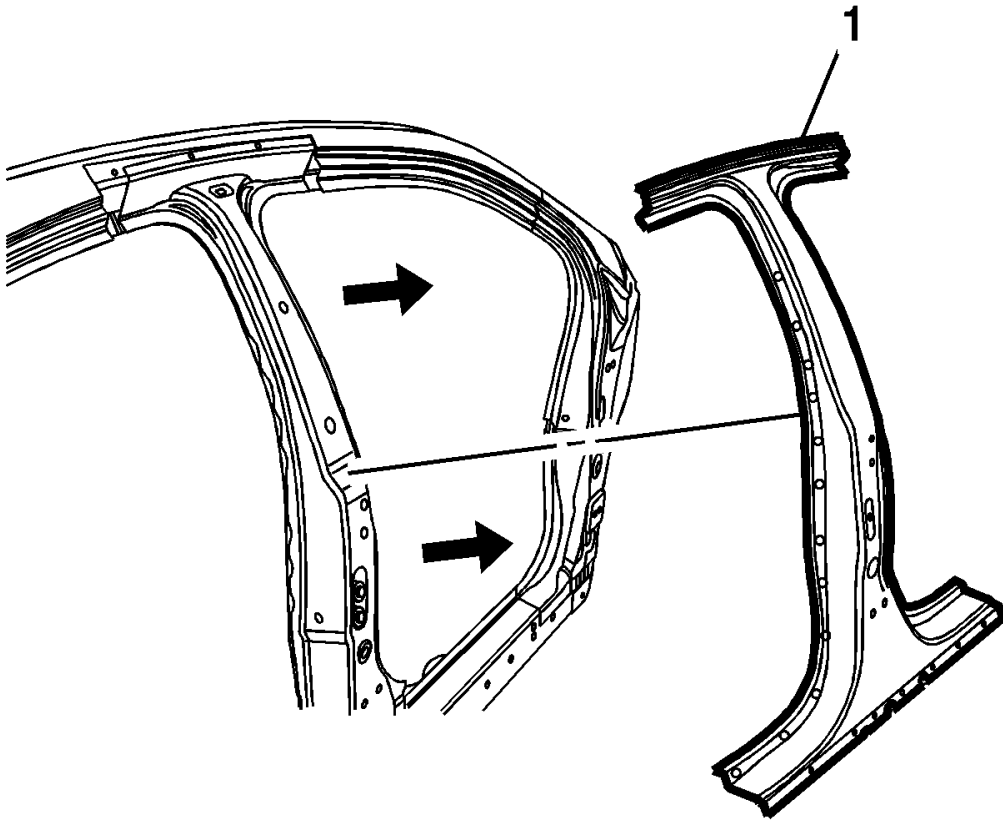


Fig. 148: Removing Damaged Center Pillar Outer Panel Section
Courtesy of GENERAL MOTORS COMPANY

11. Remove the damaged center pillar outer panel section (1).

Installation Procedure

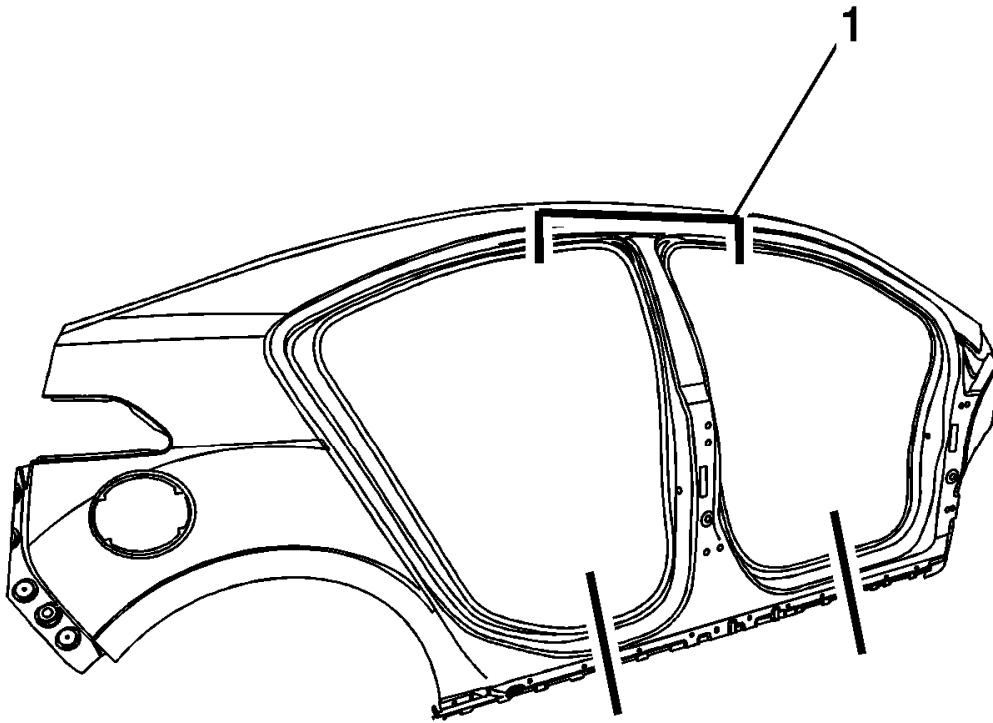


Fig. 149: Cutting Panel In Corresponding Locations
Courtesy of GENERAL MOTORS COMPANY

1. From the service part, cut the panel in corresponding locations to overlap the remaining original panel by 25 mm (1 in) at each joint location (1).

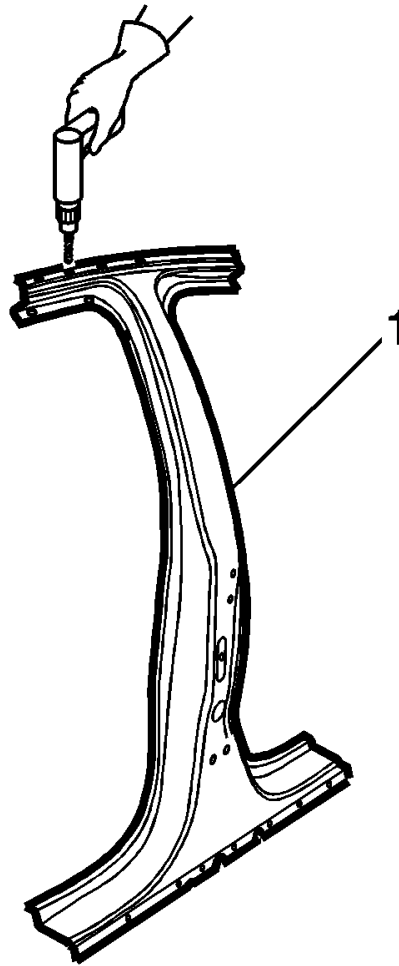


Fig. 150: Drilling Plug Weld Holes In Service Part
Courtesy of GENERAL MOTORS COMPANY

2. Drill 8 mm (5/16 in) plug weld holes in the service part (1), as necessary, in the corresponding locations noted on the original panel and along sectioned joint.
3. Prepare all mating surfaces for welding, as necessary.
4. Apply GM approved Weld-Thru Coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

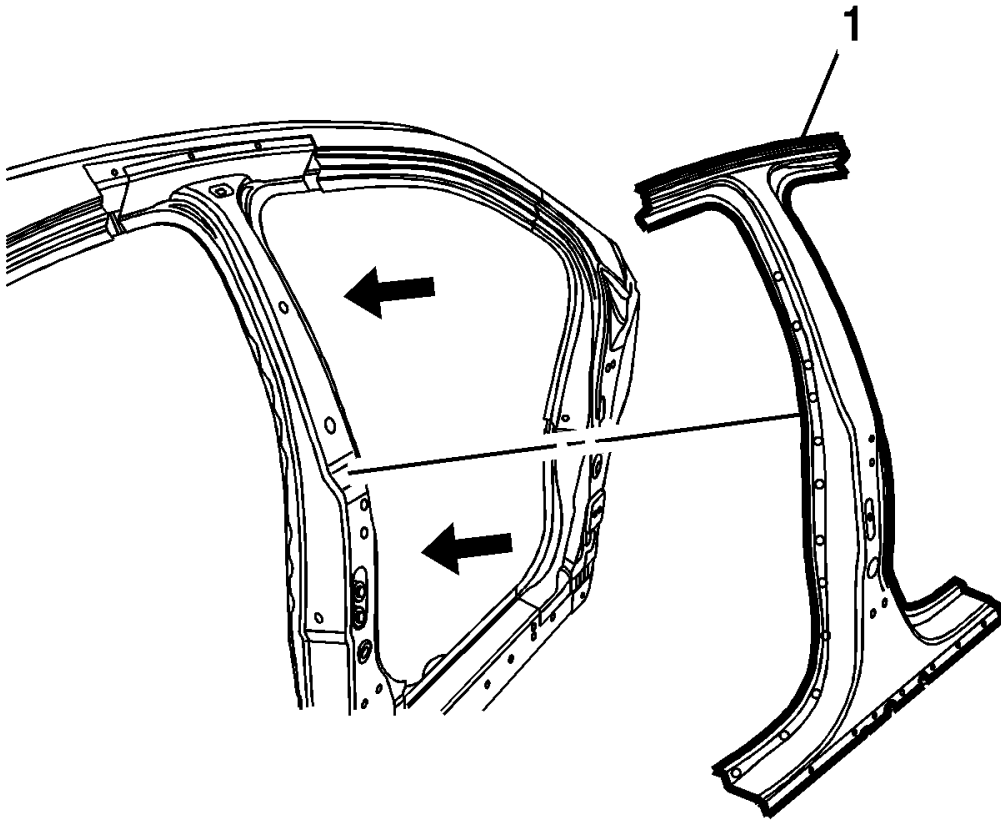


Fig. 151: Positioning Outer Center Pillar
Courtesy of GENERAL MOTORS COMPANY

5. Position the outer center pillar (1) to the vehicle using 3-dimensional measuring equipment. Clamp the pillar in place.

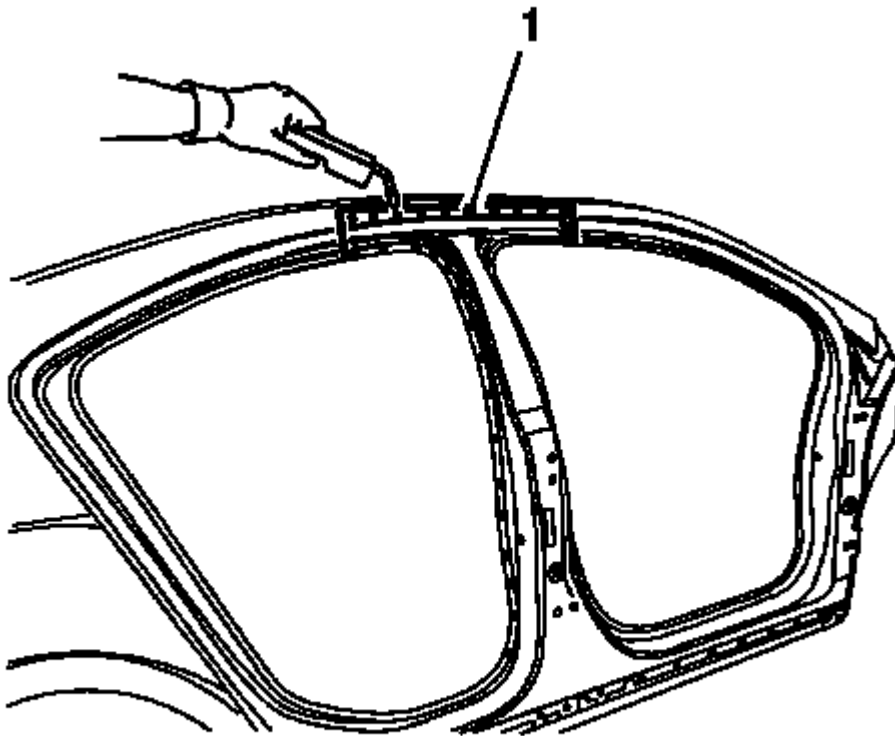


Fig. 152: Plug Welding Outer Center Pillar
Courtesy of GENERAL MOTORS COMPANY

6. Plug weld accordingly (1).

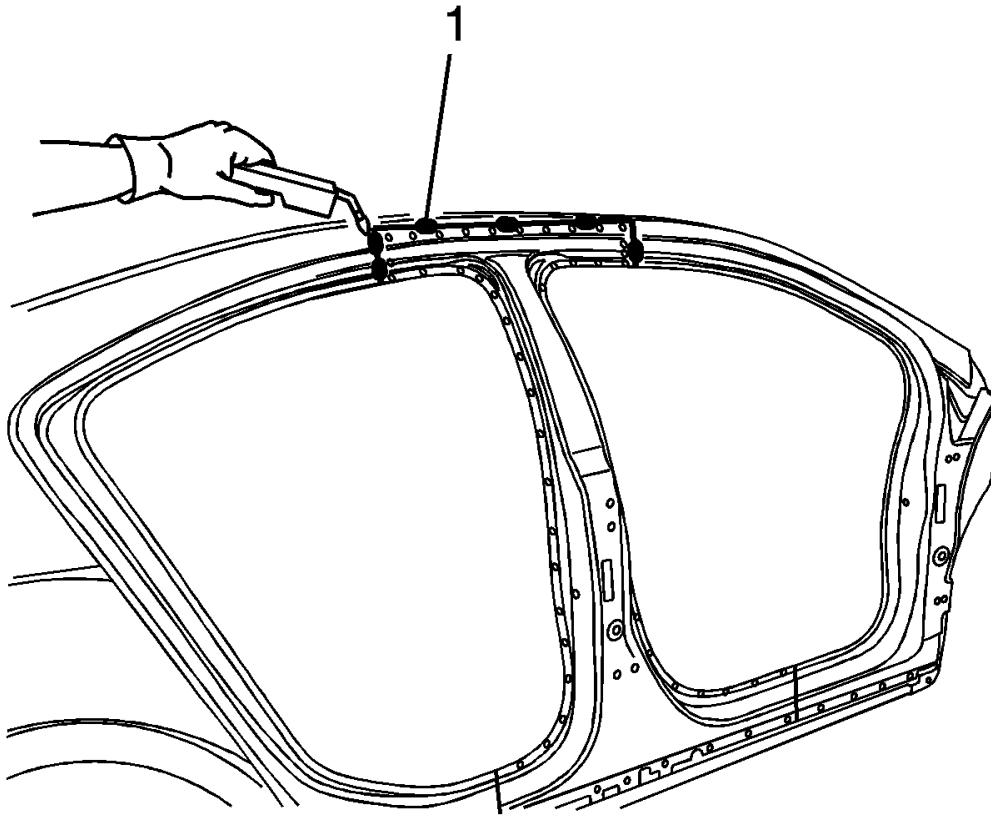


Fig. 153: Installing Outer Center Pillar
Courtesy of GENERAL MOTORS COMPANY

7. To create a solid weld with minimum heat distortion, make a 25 mm (1 in) stitch weld along the seam with gaps of 25 mm (1 in) gaps between them. Go back and complete the stitch weld (1).
8. Clean and prepare all of the welded surfaces.
9. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
10. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
11. Install all of the related panels and components.
12. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT SIDE DOOR OUTER PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

NOTE: Before beginning the repair, refer to **Metal Panel Bonding** for proper adhesive applicator preparations and general information.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
3. Remove the door from the vehicle. Refer to **Front Side Door Replacement** .
4. Remove all related panels and components.

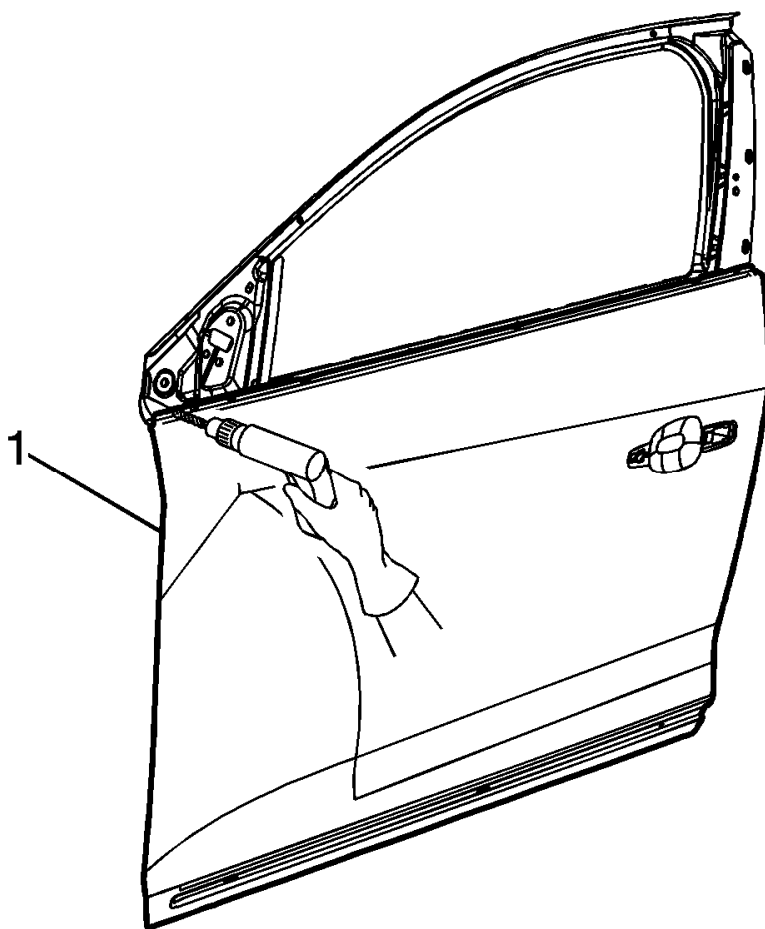


Fig. 154: Drilling Holes in Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

5. Locate and drill out all factory welds. Note the number and location of welds at the upper window frame and mirror locations (1).

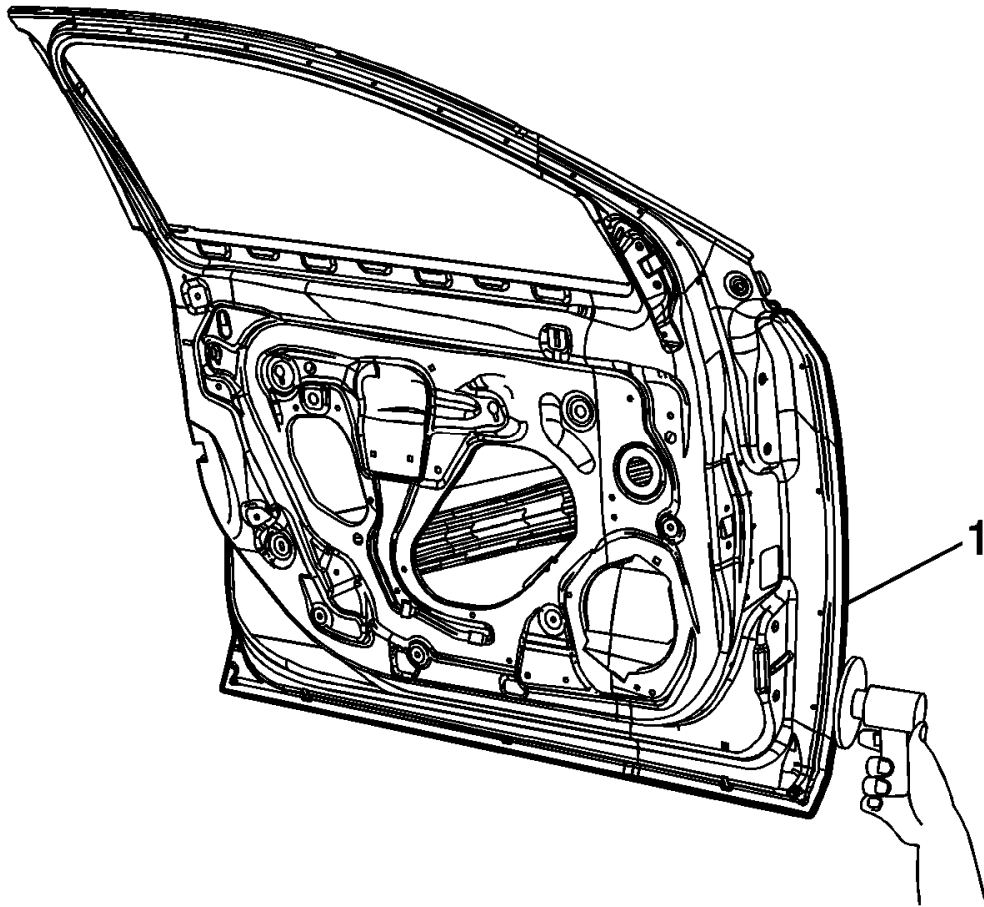


Fig. 155: Grinding Front Side Door Outer Panel Mating Flanges
Courtesy of GENERAL MOTORS COMPANY

6. Grind the edges of the door outer panel to separate the outer door panel from the door shell (1).

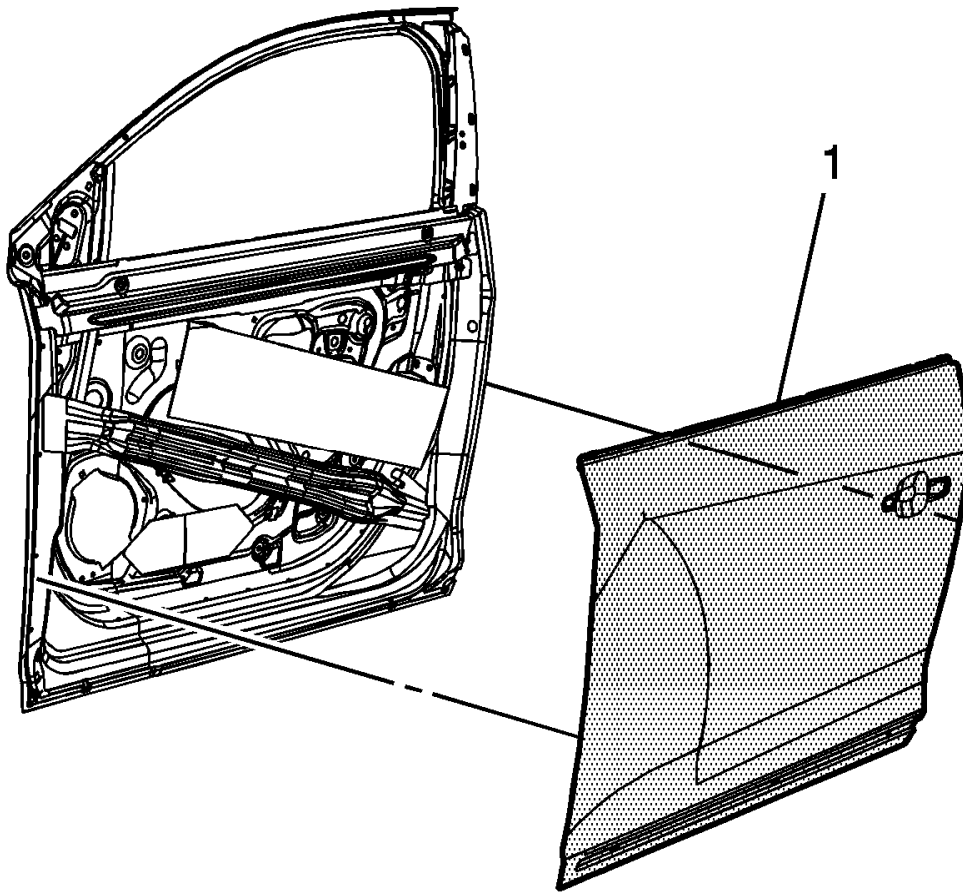


Fig. 156: Front Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

WARNING: Inspection of the door guard beam for damage must be performed before replacement of the door outer panel. If damage to the door guard beam is found the door must be replaced. Failure to do so may compromise the structural integrity of the vehicle and may cause personal injury if the vehicle is involved in a collision.

7. Remove the outer door panel (1).
8. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

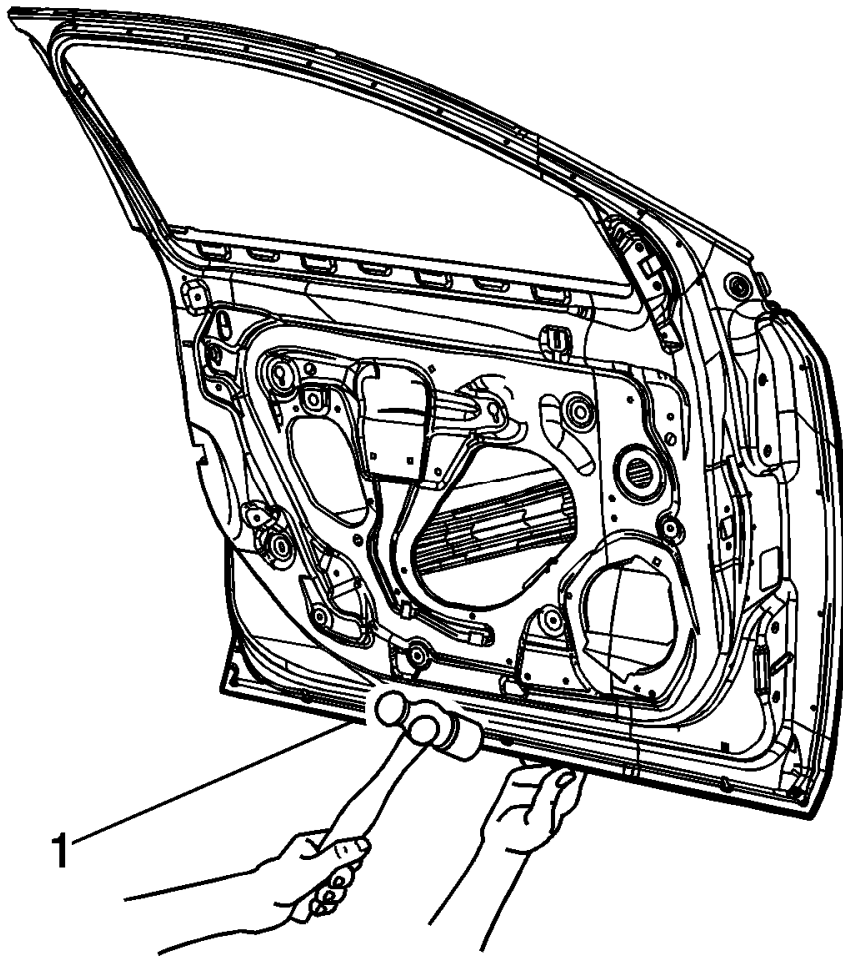


Fig. 157: Straightening Edges Of Front Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

9. Straighten the edges of the door shell (1).

Installation Procedure

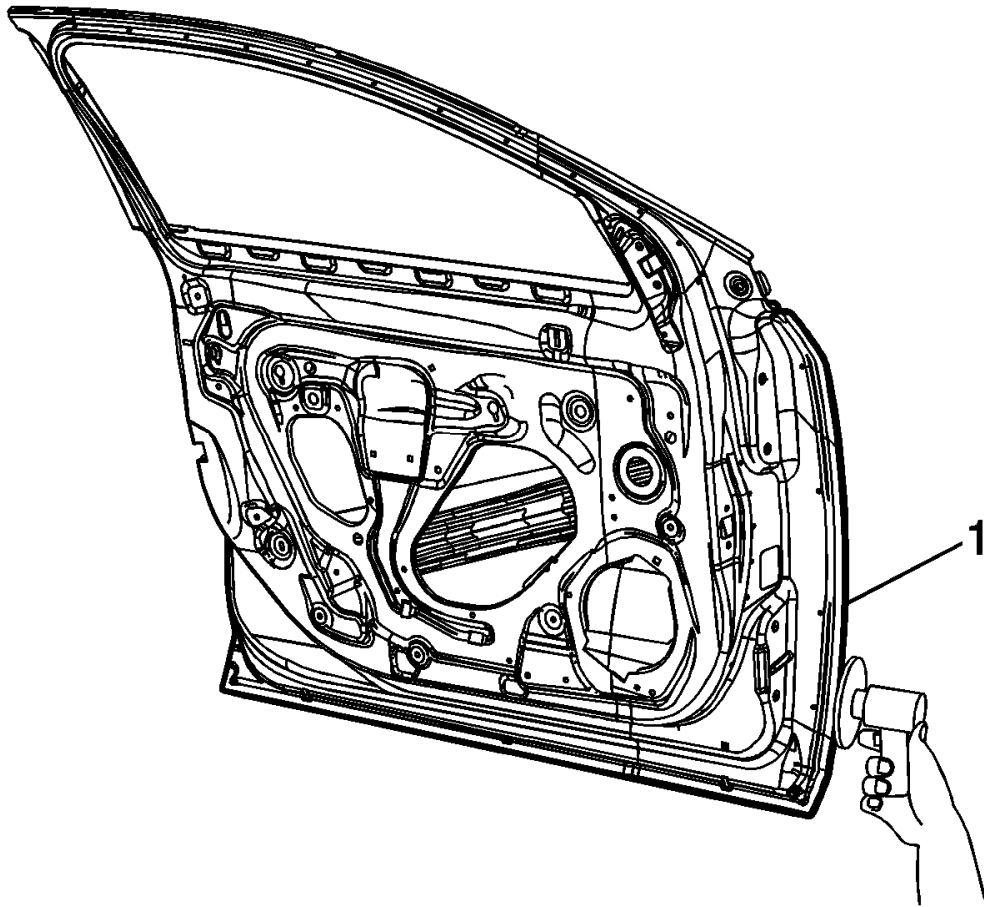


Fig. 158: Grinding Front Side Door Outer Panel Mating Flanges
Courtesy of GENERAL MOTORS COMPANY

1. Using a grinding disk grind the surface of the door shell mating flanges to bare steel (1).

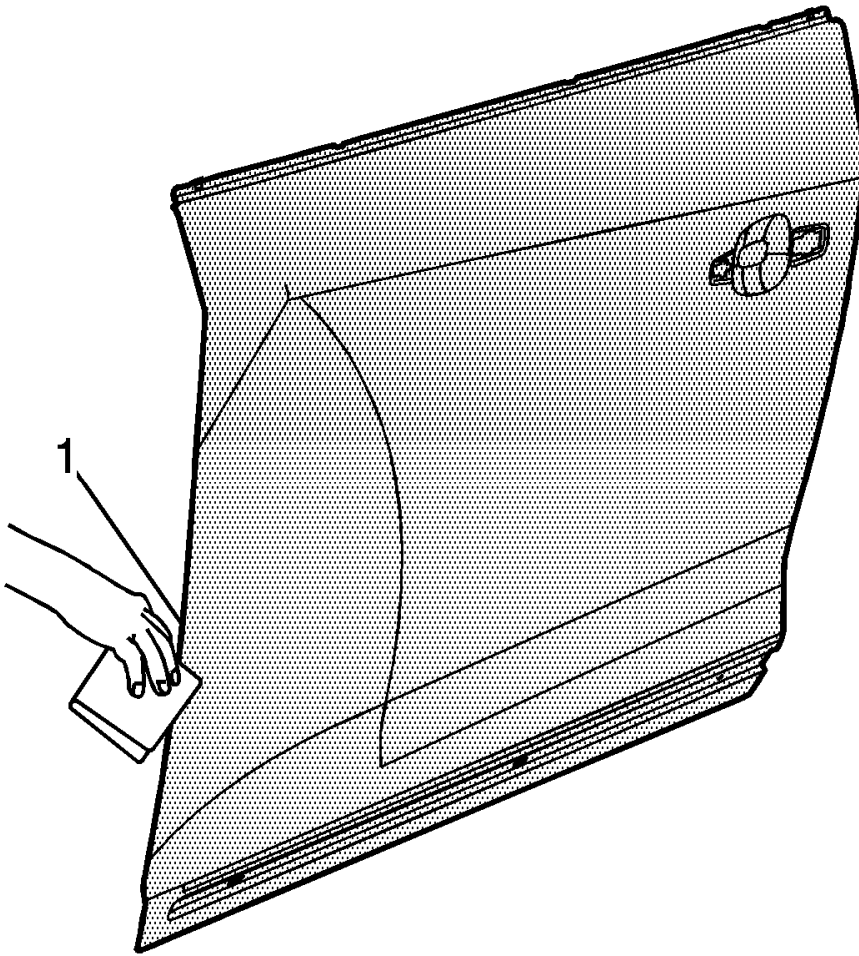


Fig. 159: Scuffing Front Side Door Outer Panel Opposing Mating Surfaces
Courtesy of GENERAL MOTORS COMPANY

2. Scuff the opposing mating surfaces of the door outer panel to remove the gloss of the E-Coat (1).

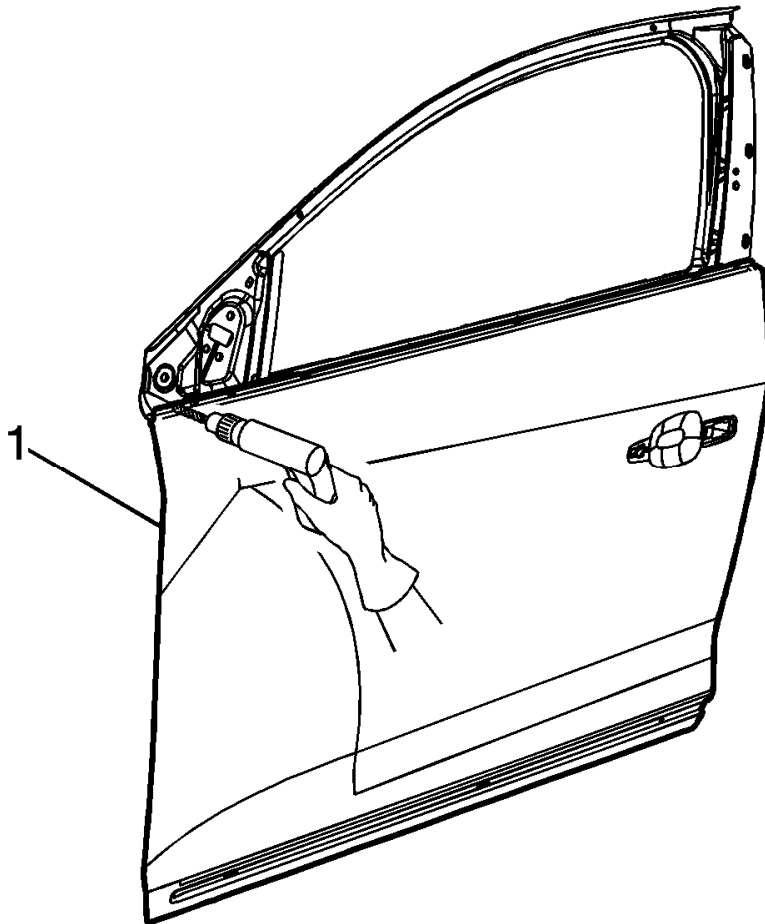


Fig. 160: Drilling Holes in Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

3. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original panel (1).

NOTE: If the location of the original plug-weld holes can not be determined, space plug weld holes every 40 mm (1 in) apart.

4. Clean the mating surfaces.

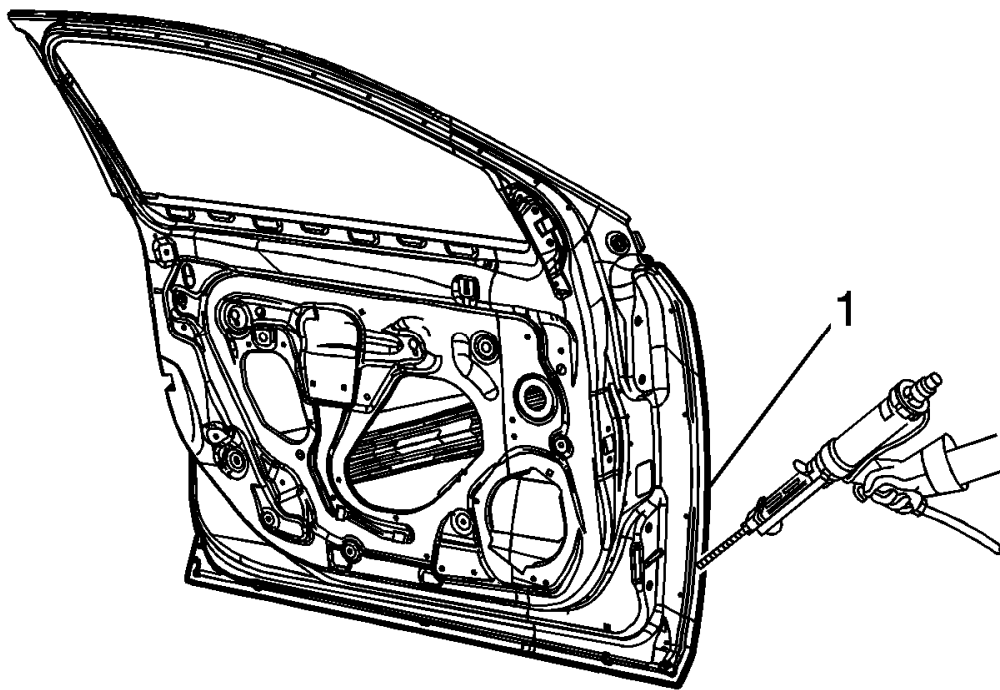


Fig. 161: Applying Bead Of Metal Panel Bonding Adhesive To Front Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow the adhesive to totally cure off the vehicle, as proper alignment of the door outer panel to the door shell will be difficult.

5. Apply a 3-6 mm (1/8-1/4 in) bead of metal panel bonding adhesive to both of the mating surfaces (1).
6. Using a small acid brush, spread a coat of adhesive to cover all the bare metal surfaces to ensure corrosion protection.

NOTE: Do NOT pull the panels apart after joined together. Slide the panels against each other to realign the panels.

7. Apply a 9-13 mm (3/8-1/2 in) bead of metal panel bonding adhesive to the mating surface of the service panel.

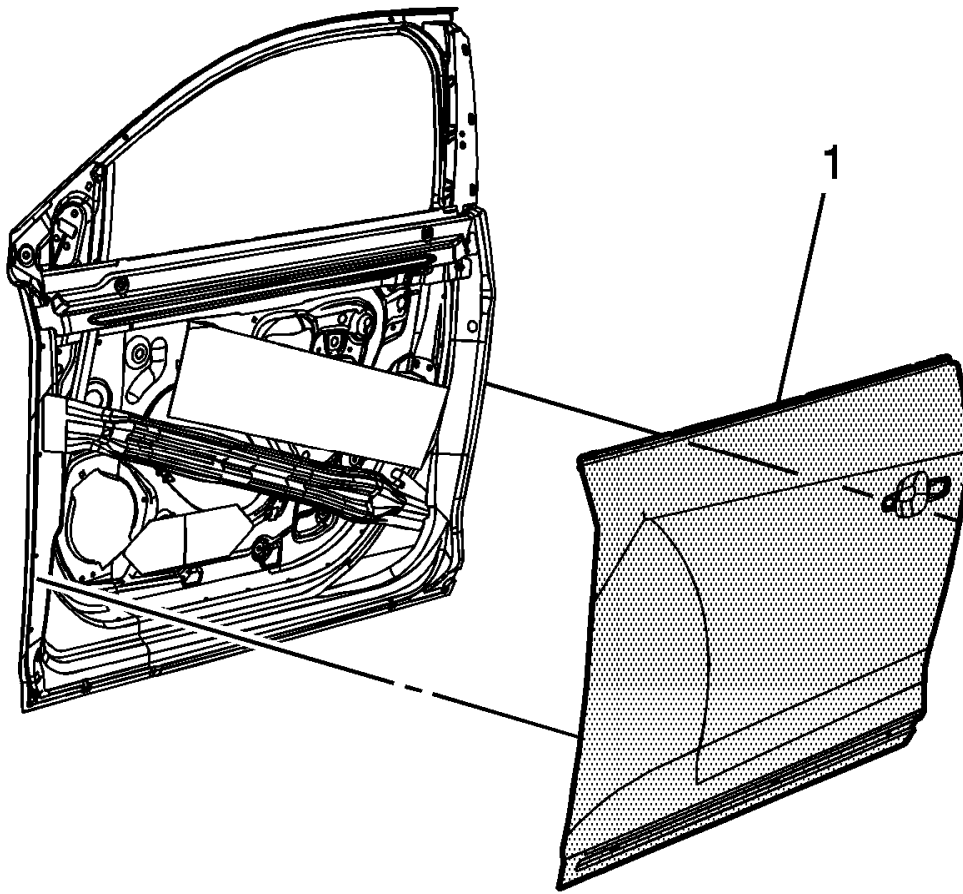


Fig. 162: Front Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

8. Install the door outer panel to the door shell (1).
9. Clamp the door outer panel into position as required.

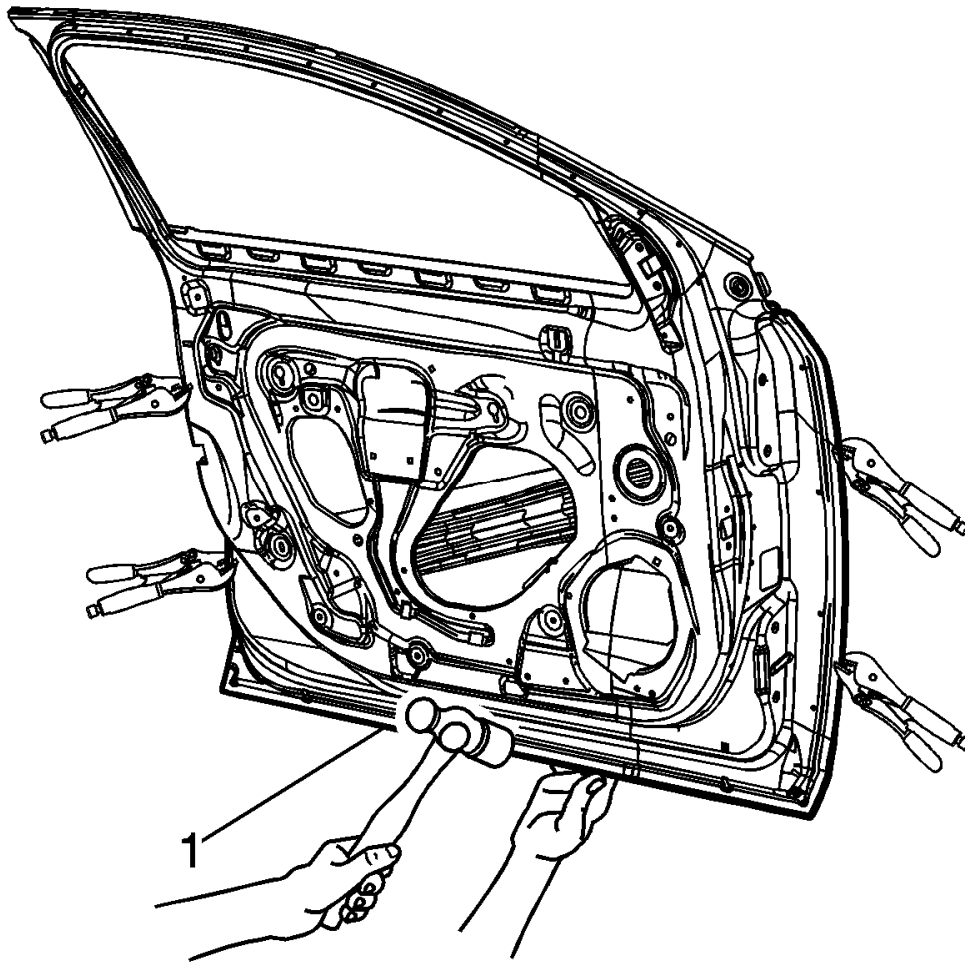


Fig. 163: re-hemming hem flanges around Front Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

10. Using a hammer re-hem the hem flanges around the door shell .

Continue to hammer in stages along the hem flanges (1).

11. Using lacquer thinner remove the excess adhesive from the door panel area.
12. Install the door to the vehicle. Inspect the door outer panel for proper alignment. Adjust the alignment as required. Refer to **Front Side Door Replacement** .

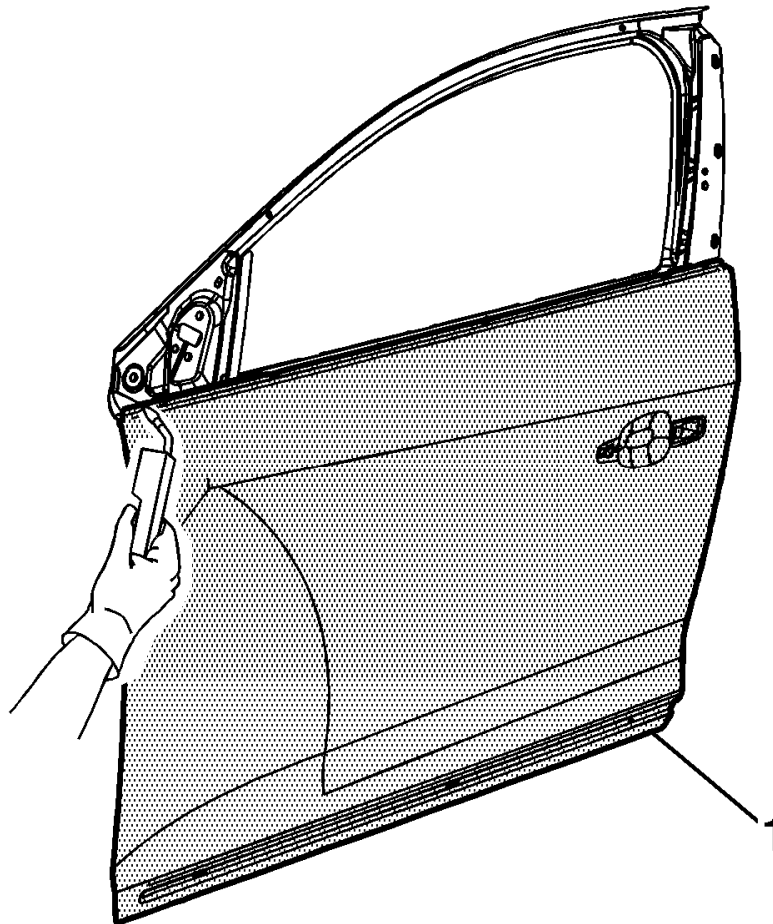


Fig. 164: Welding Front Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

13. Metal-inert gas (MIG) weld the door outer panel to the door frame in the locations noted at the upper door frame (1).
14. Clean and prepare all welded surfaces.

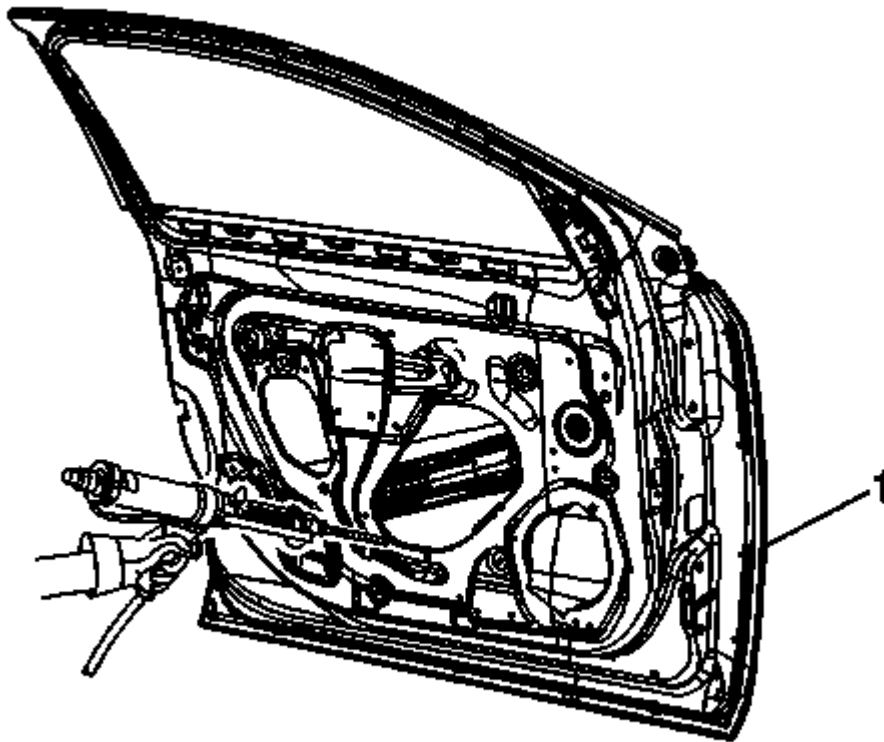


Fig. 165: Applying Fusor Super Flexible Anti-Flutter Foam To Inside Of Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

15. Apply Fusor super flexible anti-flutter foam - fast set, Fusor P/N 121/124 or equivalent in 4-5 evenly spaced locations between the door outer panel and the inner safety beam and the upper belt reinforcement (1).
16. Apply sealers and anti-corrosion materials to the repair area as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
17. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
18. Install all related panels and components.
19. Enable the SIR system. Refer to **SIR Disabling and Enabling** .
20. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

REAR SIDE DOOR OUTER PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to **Approved Equipment for Collision Repair Warning** .

NOTE: Before beginning the repair, refer to Metal Panel Bonding for proper adhesive applicator preparations and general information.

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

WARNING: Refer to SIR Warning .

2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the door from the vehicle. Refer to Front Side Door Replacement , or to Rear Side Door Replacement .

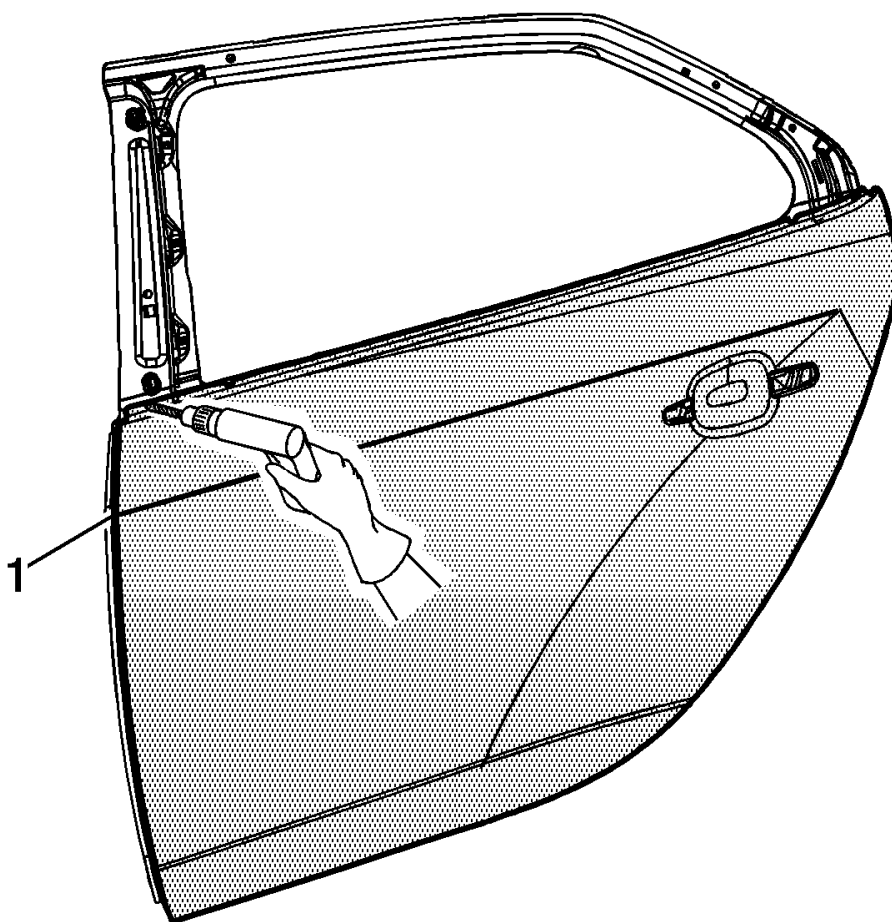


Fig. 166: Drilling Holes in Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

4. Locate and drill out all factory welds. Note the number and location of welds (1).

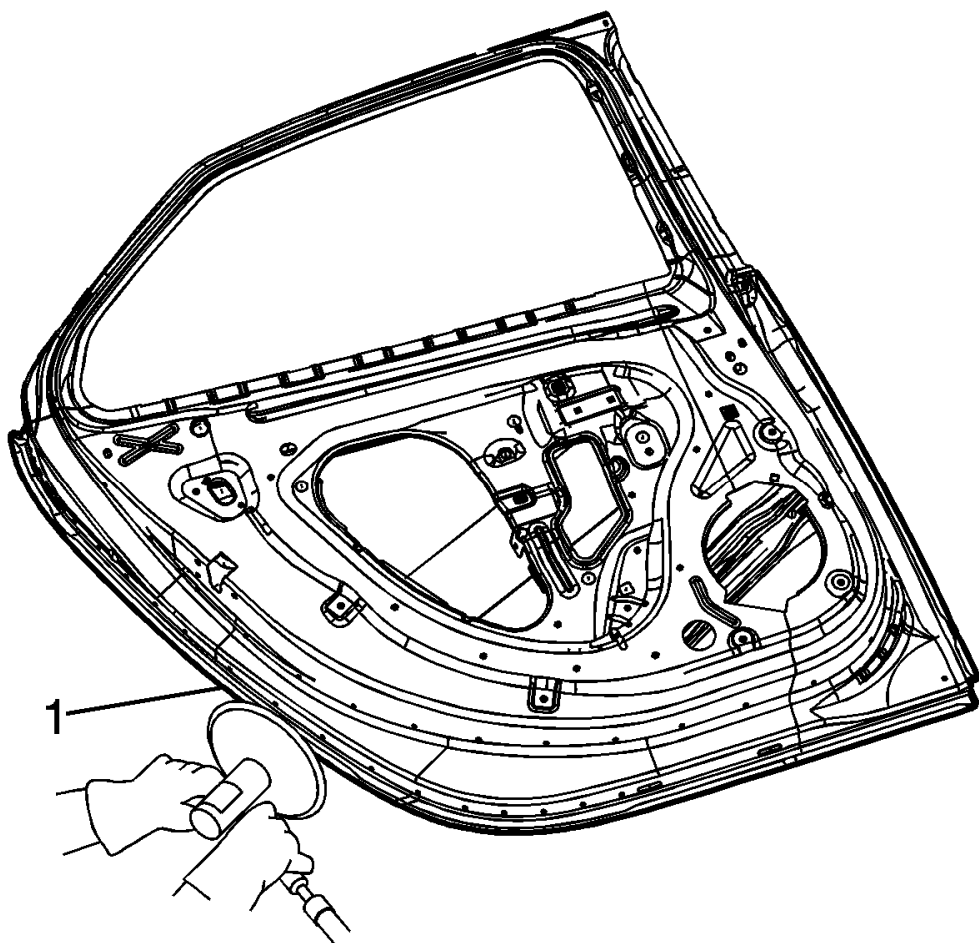


Fig. 167: Grinding Off Edges Of Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

5. Grind the edges of the door outer panel to separate the outer door panel from the door shell (1).

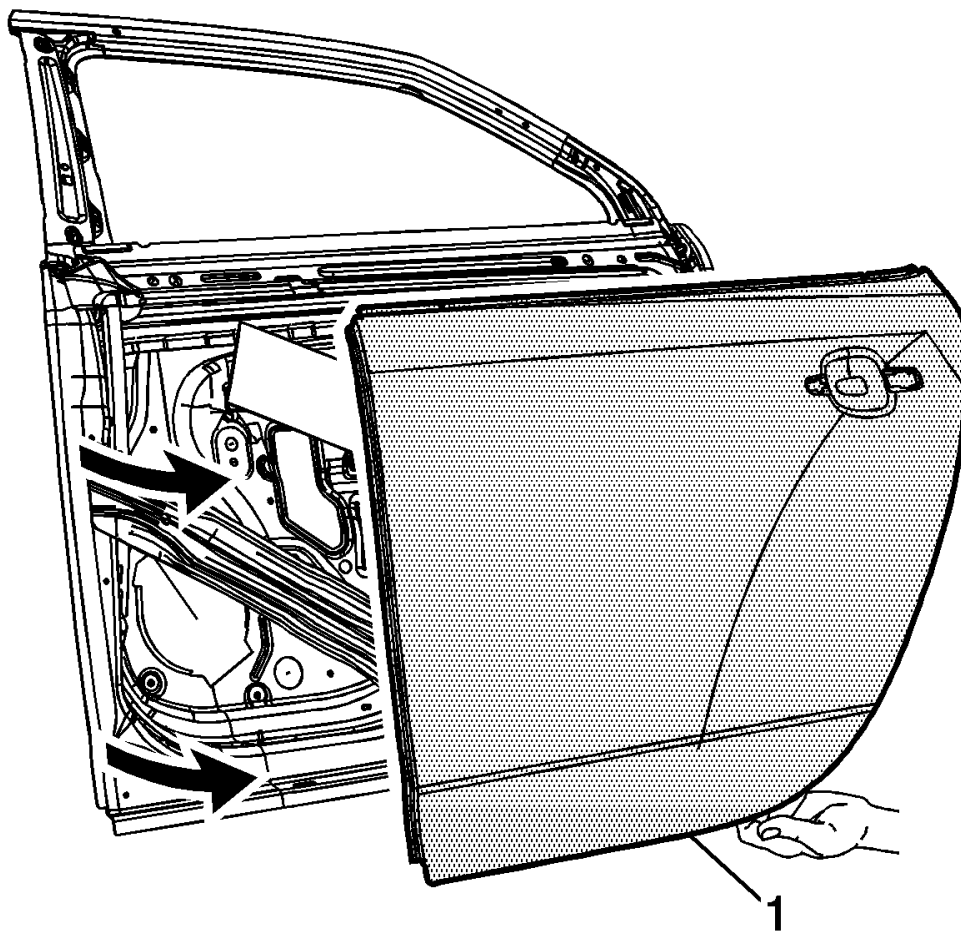


Fig. 168: Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

WARNING: Inspection of the door guard beam for damage must be performed before replacement of the door outer panel. If damage to the door guard beam is found the door must be replaced. Failure to do so may compromise the structural integrity of the vehicle and may cause personal injury if the vehicle is involved in a collision.

6. Remove the outer door panel (1).
7. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

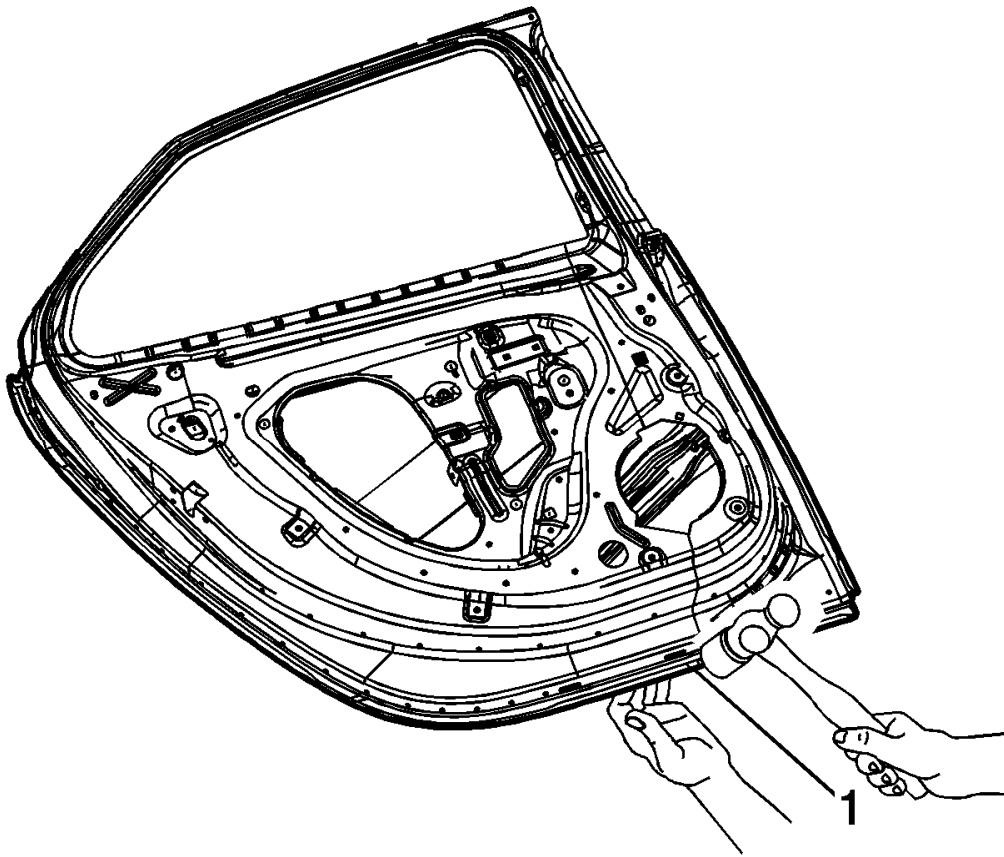


Fig. 169: Straightening Edges Of Door Shell
Courtesy of GENERAL MOTORS COMPANY

8. Straighten the edges of the door shell (1).

Installation Procedure

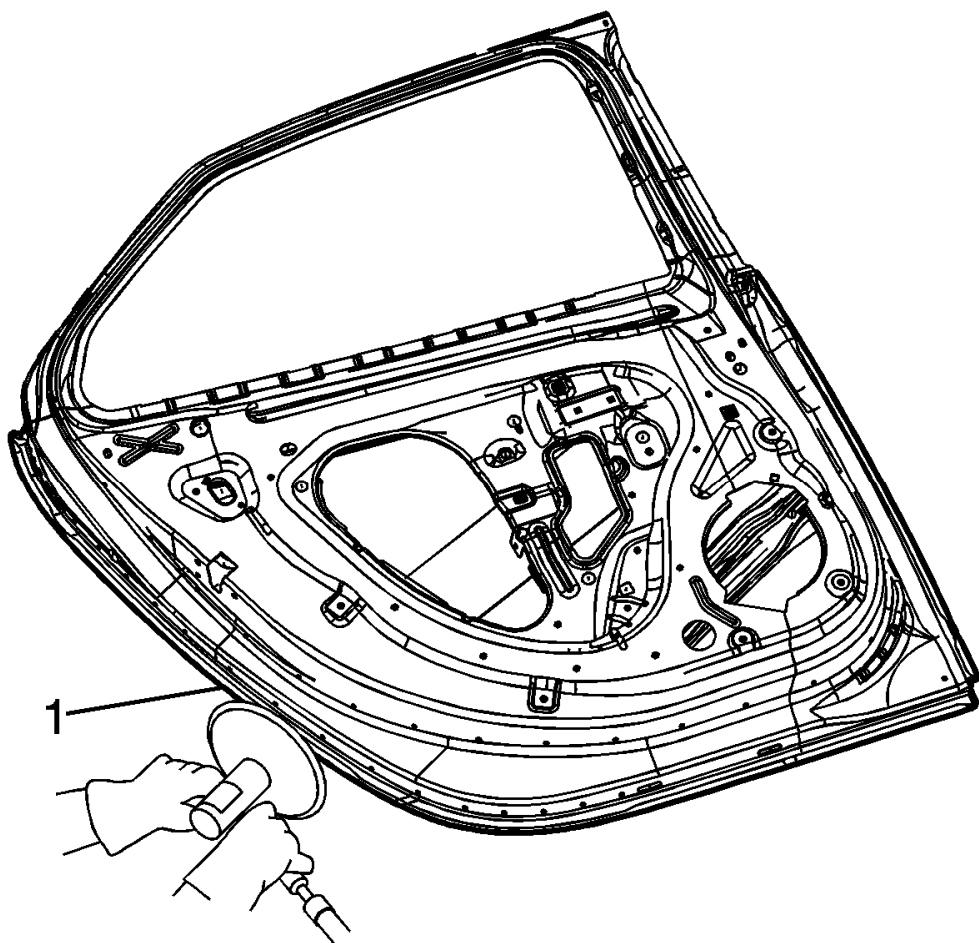


Fig. 170: Grinding Off Edges Of Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

1. Using a grinding disk grind the surface of the door shell mating flanges to bare steel (1).

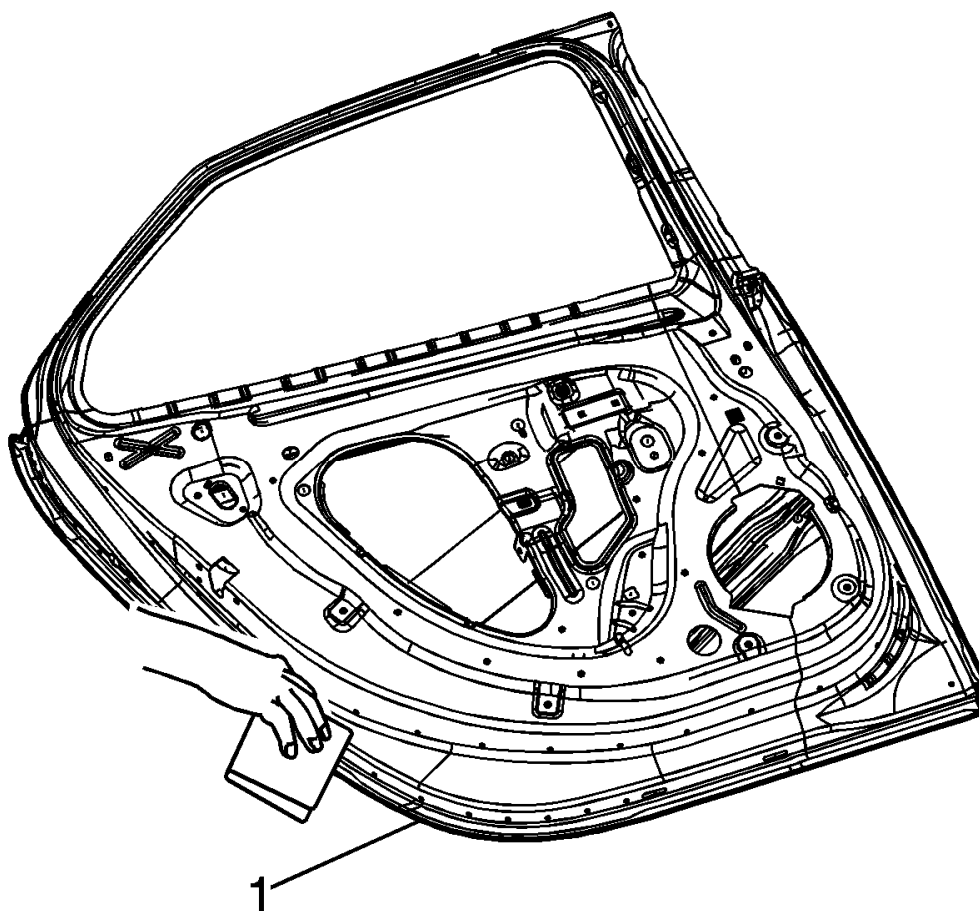


Fig. 171: Scuffing Opposing Mating Surfaces Of Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

2. Scuff the opposing mating surfaces of the door outer panel to remove the gloss of the E-Coat (1).

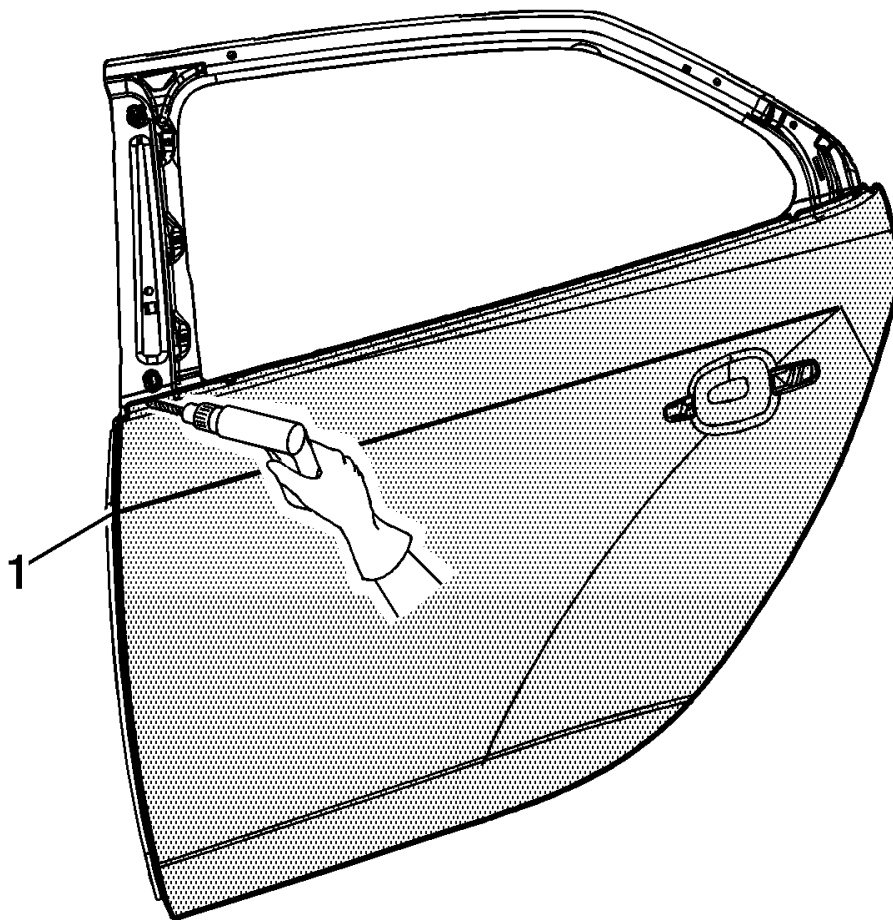


Fig. 172: Drilling Holes in Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

3. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original panel (1).

NOTE: If the location of the original plug welds can not be determined, space the plug weld holes every 40 mm (1 in) apart.

4. Clean the mating surfaces.

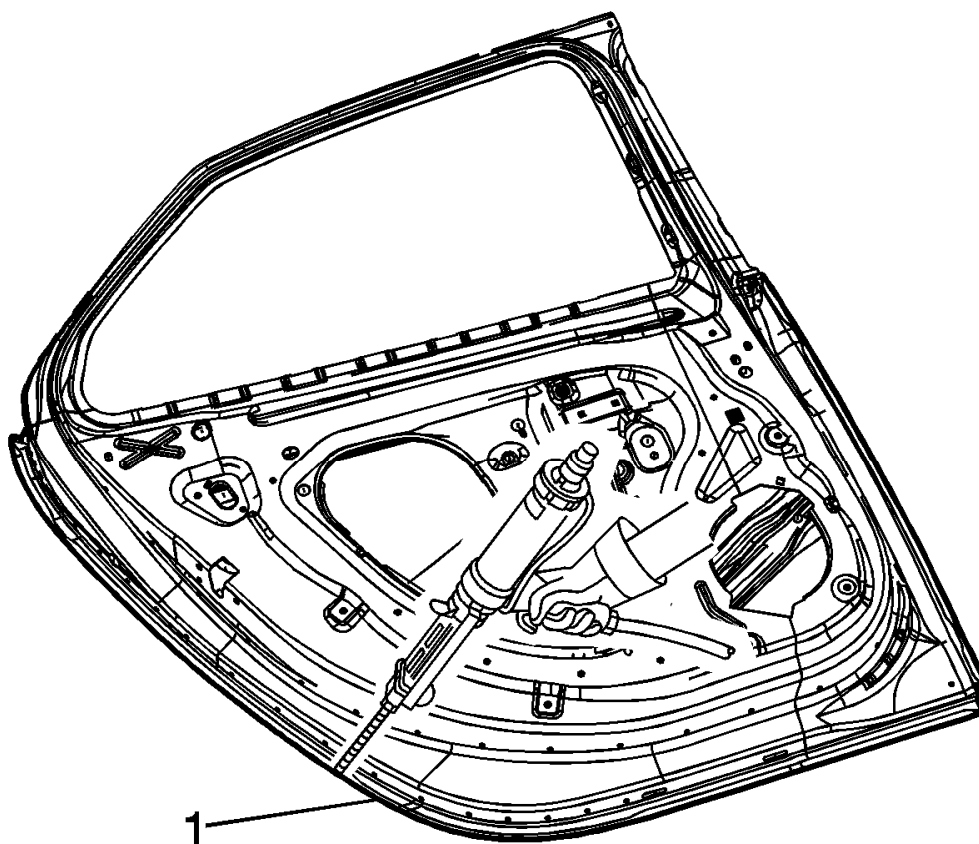


Fig. 173: Applying Metal Panel Bonding Adhesive To Mating Surfaces Of Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: The adhesive has a 40-50 minute working time. Do not allow the adhesive to totally cure off the vehicle, as proper alignment of the door outer panel to the door shell will be difficult.

5. Apply a 3-6 mm (1/8 to 1/4 in) bead of metal panel bonding adhesive to both of the mating surfaces (1).
6. Using a small acid brush, spread a coat of adhesive to cover all the bare metal surfaces to ensure corrosion protection.

NOTE: Do NOT pull the panels apart after joined together. Slide the panels against each other to realign the panels.

7. Apply a 9-13 mm (3/8-1/2 in) bead of metal panel bonding adhesive to the mating surface of the service panel.
8. Install the door outer panel to the door shell.
9. Clamp the door outer panel into position as required.

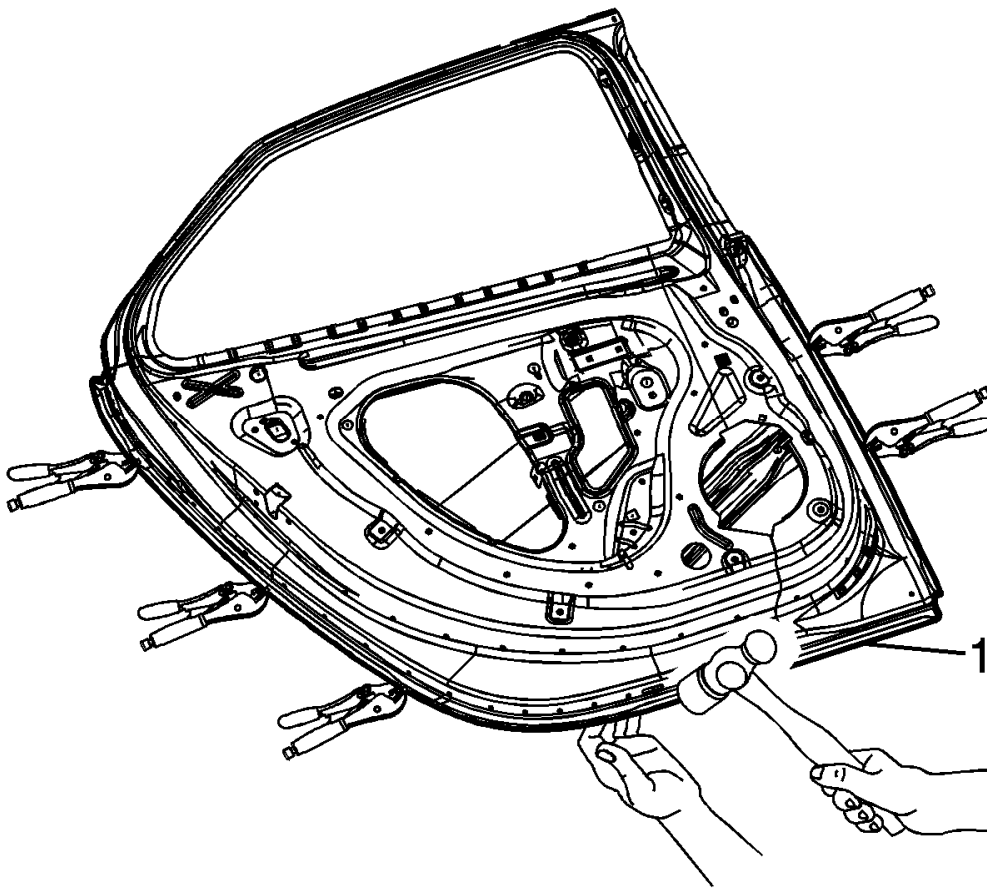


Fig. 174: Re-Hemming Hem Flanges Of Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

10. Using a hammer re-hem the hem flanges around the door shell . Continue to hammer in stages along the hem flanges (1).
11. Using lacquer thinner remove the excess adhesive from the door panel area.
12. Install the door to the vehicle check the door outer panel for proper alignment, adjust the alignment as required.

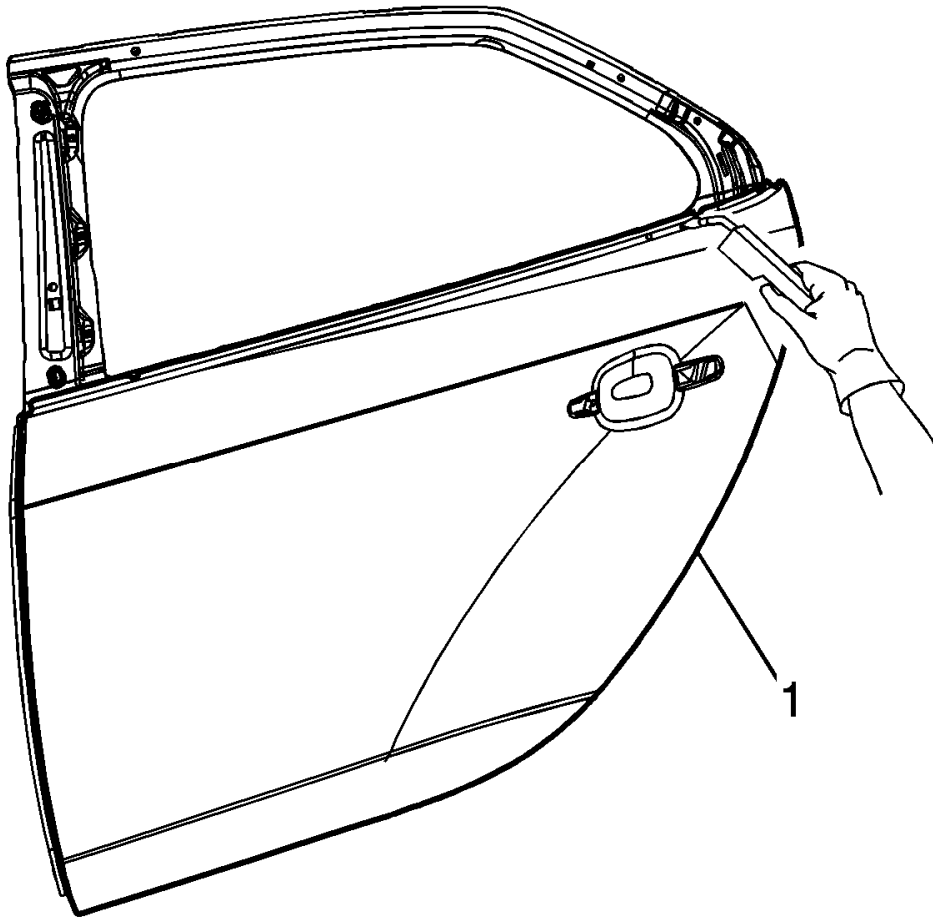


Fig. 175: Welding Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

13. Metal-inert gas (MIG) weld the door outer panel to the door frame in the locations noted at the upper door frame (1).
14. Clean and prepare all welded surfaces.

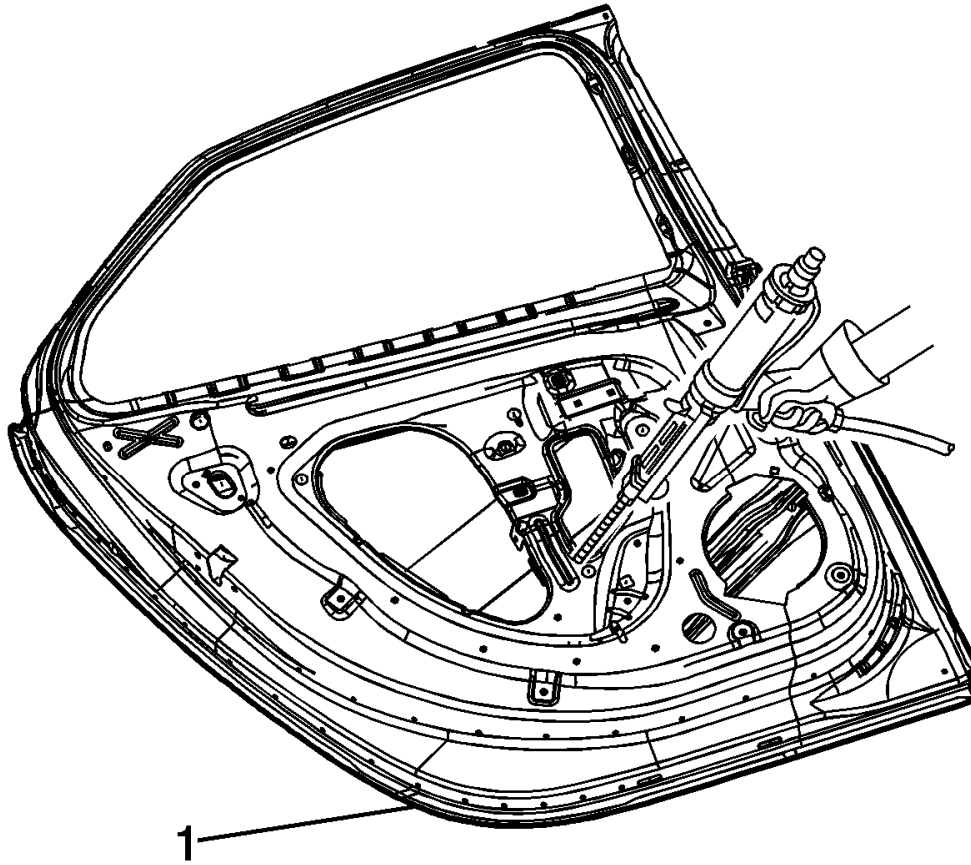


Fig. 176: Applying Fusor Super Flexible Anti-Flutter Foam To Inside Of Side Door Outer Panel
Courtesy of GENERAL MOTORS COMPANY

15. Apply Fusor super flexible anti-flutter foam-fast set, Fusor P/N 121/124 or equivalent in 4-5 evenly spaced locations between the door outer panel and the inner safety beam and the upper belt reinforcement (1).
16. Apply sealers and anti-corrosion materials to the repair area as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
17. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
18. Install all related panels and components.
19. Install the door to the vehicle. Refer to **Front Side Door Replacement** , or to **Rear Side Door Replacement** .
20. Enable the SIR system. Refer to **SIR Disabling and Enabling** .
21. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

RAIL REPLACEMENT - REAR SECTION

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

1. Disable the supplemental inflatable restraint (SIR) System. Refer to SIR Disabling and Enabling .
2. Remove all related panels and components.
3. Repair as much of the damage as possible to factory specifications. Refer to Dimensions - Body (Sedan).
4. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .

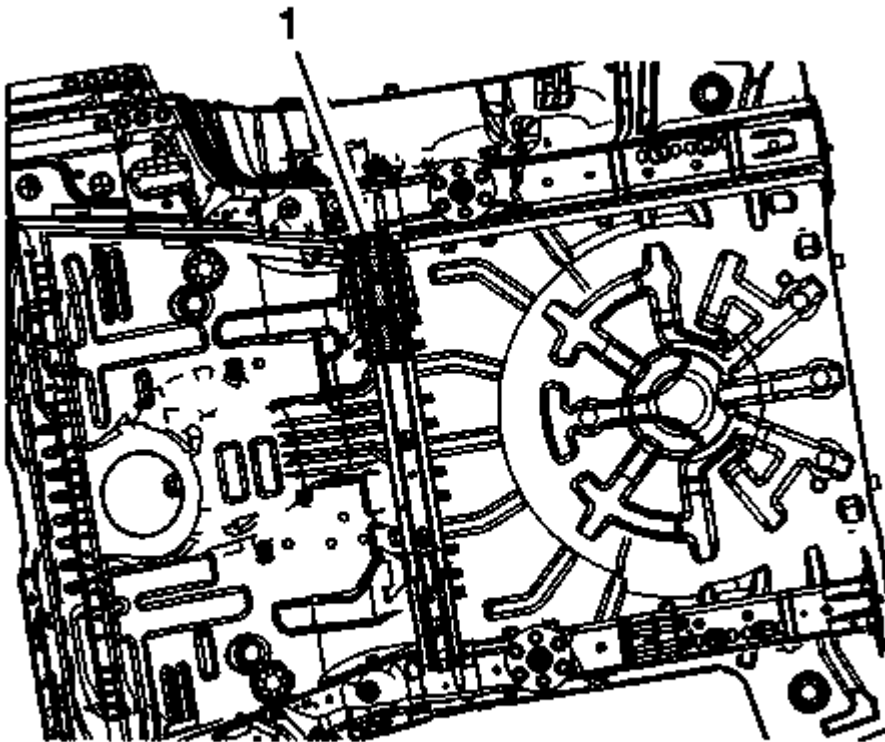


Fig. 177: Locating Factory Welds

Courtesy of GENERAL MOTORS COMPANY

NOTE: To remove the rear rail-rear section, the number five bar extension (1) will have to be removed to gain access to the rail spot welds.

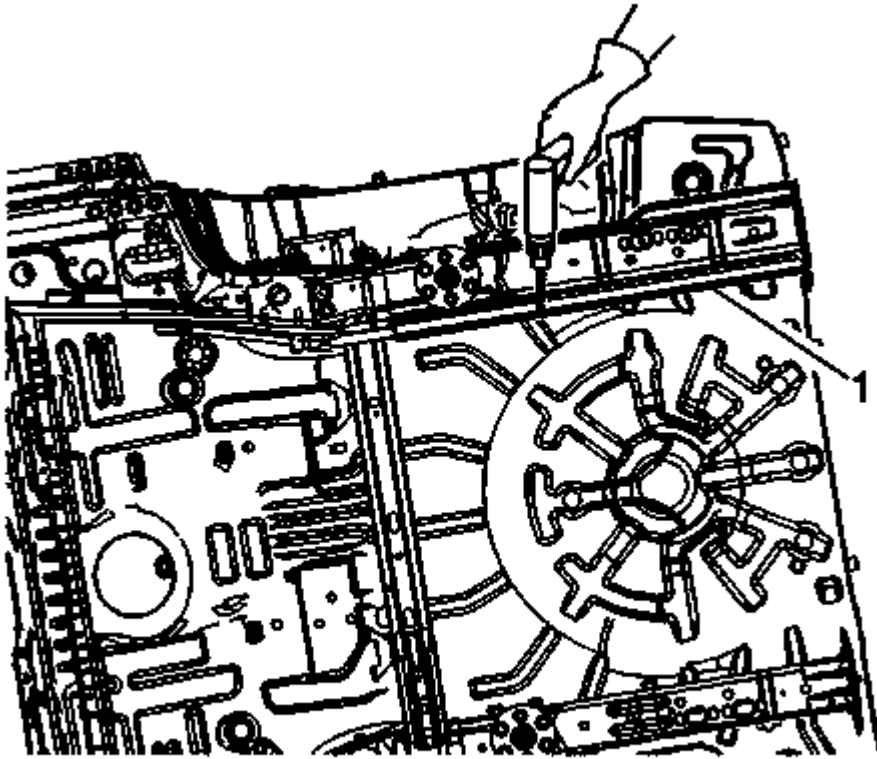


Fig. 178: Locating Factory Welds

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage any inner panels or reinforcements. In areas where structural adhesive is present, heat the area to assist with removing the components.

5. Locate and drill out all factory welds (1). Note the number and location of the welds for installation of the rear rail - rear section.

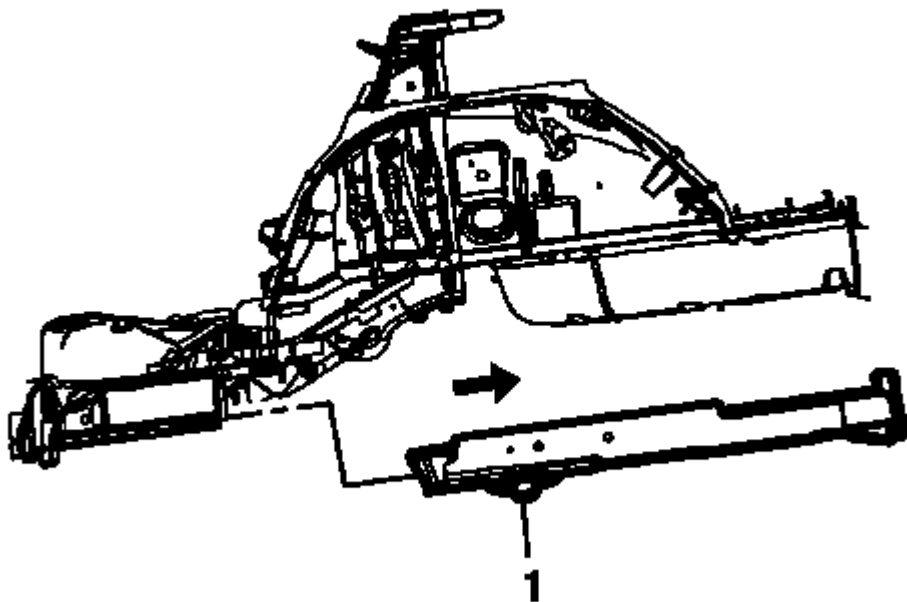


Fig. 179: Removing Rear Rail -- Rear Section
Courtesy of GENERAL MOTORS COMPANY

6. Remove the damaged rear rail - rear section (1).

Installation Procedure

NOTE:

- If the location of the original plug weld holes cannot be determined, space the plug weld holes every 40 mm (1 1/2 in) apart.
- Some panels may have structural weld-thru adhesive. It is necessary to replace the weld-thru adhesive with an additional spot weld between each factory spot weld.

1. Prepare all mating surfaces as necessary.
2. Apply GM-approved Weld-Thru Coating or equivalent to all mating surfaces. Refer to **Anti-Corrosion Treatment and Repair** .

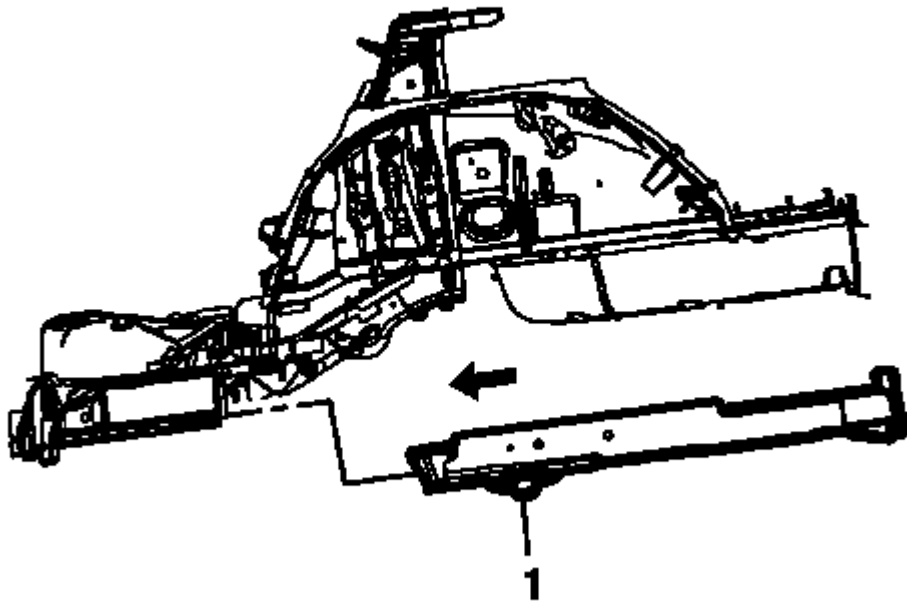


Fig. 180: Rear Rail -- Rear Section
Courtesy of GENERAL MOTORS COMPANY

3. Position the rear rail-rear section (1) to the vehicle using 3-dimensional measuring equipment. Clamp the rear rail lower into place.

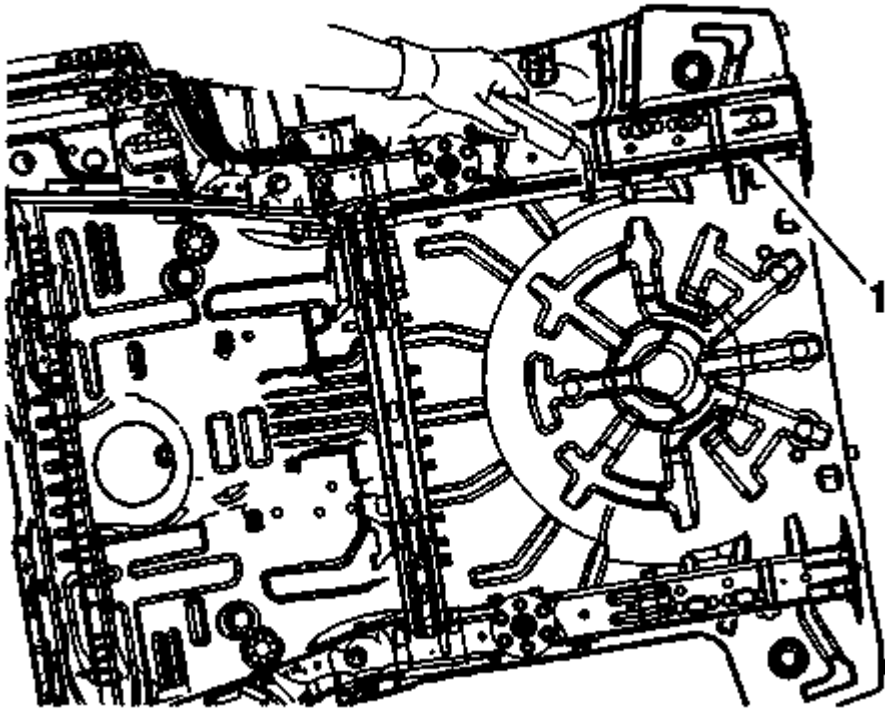


Fig. 181: Plug Welding Rear Rail -- Rear Section
Courtesy of GENERAL MOTORS COMPANY

4. Plug weld accordingly (1).
5. Clean and prepare all welded surfaces.
6. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
7. Paint the repair area. Refer to **Basecoat/Clearcoat Paint Systems** .
8. Install all related panels and components.
9. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

DESCRIPTION AND OPERATION

DUAL PHASE STEEL

This information provides repair recommendations and general guidelines for steel classified as Dual Phase Steel, also known as DP. This type of steel normally has a tensile strength below 780 MPa.

General Motors recommends the following when repairing or replacing this type of steel during collision repair.

NOTE: **The use of heat to repair damage is not recommended for this classification of steel.**

Recommended Repairs

- Cold repairs can be performed on this type of steel, unless the damage includes kinks. If the damage includes kinks, the part should be replaced.
- Sectioning or partial replacement of this type of steel is recommended only at approved locations, in a specific sectioning procedure.
- This type of steel can be used as a sleeve, or backer plate, when recommended in a specific sectioning procedure.
- Squeeze Resistance Spot Welding can be used to replace factory spot welds, where applicable.
- MIG plug welding and MIG stitch welding can be used on this type of steel.
- MIG Brazing can be used on this type of steel.

HIGH STRENGTH LOW ALLOY STEEL

This information provides repair recommendations and general guidelines for steel classified as High Strength Low Alloy Steel, also known as HSLA. This type of steel normally has a tensile strength range from 300-700 MPa.

General Motors recommends the following when repairing or replacing this type of steel during collision repair.

Recommended Repairs

- Cold repairs can be performed on this type of steel, unless the damage includes kinks. If the damage includes kinks, the part should be replaced.
- Controlled use of heat can be used to repair damage, if the heat does not exceed 650°C (1200°F). The heat should be applied a maximum of 2 times, for up to 90 seconds.
- Sectioning or partial replacement of this type of steel is recommended only at approved locations, in a specific sectioning procedure.
- This type of steel can be used as a sleeve, or backer plate, during sectioning procedures.
- Squeeze Resistance Spot Welding can be used to replace factory spot welds, where applicable.
- MIG plug welding and MIG stitch welding can be used on this type of steel.
- MIG Brazing can be used on this type of steel.

METAL PANEL BONDING

This is intended to provide general guidelines for adhesive bonding of exterior panels as an alternative to Metal-Inert Gas (MIG) welding. Panel bonding may be seen as an alternative to MIG welding to provide full panel replacement in regards to collision repair procedures. The benefits of panel bonding is:

- No heat or burn damage when additional welding is not required
- Corrosion protection

- Can act as a sealant
- Improved process for complicated shapes (wheelhouse area)

The General Motors specification for metal bonding adhesives is GM 6449G. The scope of this specification is intended to provide the performance guidelines of structural adhesive systems used to repair (metallic) automotive bodies in the aftermarket. These types of adhesives are intended for use when bonding replacement body panels as an option to welding as the attachment means. GM information outlines the use of room temperature cure acrylic adhesives that contain glass bead technology.

Bonding procedures in general are applicable only to a factory seams type approach.

Sectioning or partial paneling of full panels is not supported by General Motors unless specifically documented in a Service Bulletin or Manual.

Applicable components for this technology are EXTERIOR PANELS ONLY, including door skins, tail panels, roof outer panels and quarter panels.

IMPORTANT: Do not use adhesives for vehicle underbody or upper body structure type repairs such as structural rails, shock/strut towers, floor pans, upper fender rails, body side pillars, door rings-side or rear, rocker panels, unless specifically documented in a GM Service Bulletin or Manual. If in doubt, use only the procedures referenced in the Service Manual for the specific vehicle being repaired.

Always follow the system manufacturer's instructions for application, handling, and curing.

Adhesives currently meeting the performance requirements include General Motors materials and products manufactured by Lord Adhesives. At this time, ONLY the adhesive products listed below meet this guideline:

Metal Panel Bonding

Manufacturer and Part Number	Description
GM P/N 12378566 (US)	Fast Set Panel Bonding Adhesive
GM P/N 88901674 (Canada)	
Lord Fusor P/N 110B/111B	
GM P/N 12378567 (US)	Medium Set Panel Bonding Adhesive
GM P/N 88901675 (Canada)	
Lord Fusor P/N 108B/109B	
3M P/N 8116	Panel Bonding Adhesive
Ashland Plio Grip Panel 60	Panel Bonding Adhesive

MILD STEEL

This information provides repair recommendations and general guidelines for steel classified as Mild Steel. This type of steel normally has a tensile strength less than 270 MPa. This includes the common steel names of:

- Mild Steel
- Bake Hardenable Steel (BH)
- Solid Solution Strengthened Steel

General Motors recommends the following when repairing or replacing this type of steel during collision repair.

Recommended Repairs:

- Cold repairs can be performed on this type of steel, unless the damage includes kinks. If the damage includes kinks, the part should be replaced.
- Controlled use of heat can be used to repair damage, if the heat does not exceed 650°C (1200°F). The heat should be applied a maximum of 2 times, for up to 90 seconds.
- Sectioning or partial replacement of this type of steel is recommended only at approved locations, in a specific sectioning procedure.
- This type of steel can be used as a sleeve, or backer plate, when recommended in a specific sectioning procedure.
- Squeeze Resistance Spot Welding can be used to replace factory spot welds, where applicable
- MIG plug welding and MIG stitch welding can be used on this type of steel.
- MIG Brazing can be used on this type of steel.

ULTRA HIGH STRENGTH DUAL PHASE STEEL

This information provides repair recommendations and general guidelines for steel classified as Ultra High Strength Dual Phase Steel , also known as DPX. This type of steel normally has a tensile strength of 780 MPa, or greater.

General Motors recommends the following when repairing or replacing this type of steel during collision repair.

NOTE:

- **Repair of this type of steel is not recommended.**
- **This type of steel should be replaced at factory joints only. Sectioning or partial replacement is not recommended.**
- **The use of heat to repair damage is not recommended for this type of steel.**
- **Stitch Welding is not recommended for this type of steel (unless replacing a factory installed stitch weld).**
- **This type of steel should not be used as a backing reinforcement or a sleeve for a sectioning joint.**

Recommended Repairs:

- Squeeze Resistance Spot Welding can be used to replace factory spot welds, where applicable.
- MIG plug welding can be used to replace factory spot welds.
- MIG Brazing can be used to replace factory spot welds.

ULTRA HIGH STRENGTH STEEL

This information provides repair recommendations and general guidelines for steel classified as Ultra High Strength Steel, also known as UHSS. This type of steel normally has a tensile strength of 780 MPa, or greater.

This includes the common steel names of

- Ultra High Strength Dual Phase Steel (DPX)
- Martensitic Steel (M)
- Boron/Press Hardened Steel (B)
- Multi-Phase Steel (MP)
- TRIP Steel (TR)

General Motors recommends the following when repairing or replacing this type of steel during collision repair.

NOTE:

- **Repair of this type of steel is not recommended.**
- **This type of steel should be replaced only, at factory joints. Sectioning or partial replacement is not recommended.**
- **The use of heat to repair damage is not recommended for this type of steel.**
- **Stitch Welding is not recommended for this type of steel (unless replacing a factory installed stitch weld).**
- **This type of steel should not be used as a backing reinforcement or a sleeve for a sectioning joint.**

Recommended Repairs

- Squeeze Resistance Spot Welding can be used to replace factory spot welds, where applicable.
- MIG plug welding can be used to replace factory spot welds.
- MIG Brazing can be used to replace factory spot welds.

COMMON SPECS & PROCEDURES

COMMON SPECS & PROCEDURES INDEX

COMMON SPECS & PROCEDURES

System	Specification/Procedure
Air Conditioning	
Service	<u>REFRIGERANT SYSTEM SPECIFICATIONS</u>
Torque	<u>FASTENER TIGHTENING SPECIFICATIONS</u>
Axle Nut/Hub Nut (Front)	
First Pass	111 Ft. Lbs. (150 N.m)
Second Pass	Loosen 45 degrees
Final Pass	184 Ft. Lbs. (250 N.m)
Battery	NA
Brakes	
Bleeding Sequence	RR, LR, RF, LF <u>HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)</u> <u>HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)</u>
Disc Brakes	
Service Specifications	<u>DISC BRAKE COMPONENT SPECIFICATIONS</u>
Torque	<u>FASTENER TIGHTENING SPECIFICATIONS</u>
Charging	
Generator	NA
Torque	<u>FASTENER TIGHTENING SPECIFICATIONS</u>
Drive Belts	
Adjustment	
2.0L	Non-Adjustable Serpentine Belt
2.4L	Non-Adjustable Serpentine Belt
Drive Belt Routing	
2.0L	See Graphic under <u>DRIVE BELT REPLACEMENT</u>
2.4L	See graphic under <u>DRIVE BELT REPLACEMENT (LEA)</u> <u>DRIVE BELT REPLACEMENT (LUK)</u>
Engine Cooling	
General Service Specifications	NA
Radiator Cap Pressure	Pressure rating is shown on the pressure cap.
Thermostat R & I	
2.0L	<u>ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LTG)</u>

2.4L	<u>ENGINE COOLANT THERMOSTAT REPLACEMENT (LUK)</u>	
Water Pump R & I		
2.0L	<u>WATER PUMP REPLACEMENT (LTG)</u>	
2.4L	<u>WATER PUMP REPLACEMENT (LUK)</u>	
Engine Mechanical		
2.0L		
Compression	minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). <u>ENGINE COMPRESSION TEST</u>	
Oil Pressure @700 RPM @ 100°C	20-29 psi (140-200 kPa)	
Overhaul	<u>ENGINE MECHANICAL SPECIFICATIONS</u>	
Torque	<u>FASTENER TIGHTENING SPECIFICATIONS</u>	
2.4L		
Compression	minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). <u>ENGINE COMPRESSION TEST</u>	
Oil pressure Minimum - @1000 RPM @ 90°C (194°F)	30-70 psi (206.84-482.63 kPa)	
Overhaul	<u>ENGINE MECHANICAL SPECIFICATIONS (LEA, OR LUK)</u>	
Torque	<u>FASTENER TIGHTENING SPECIFICATIONS (LEA, OR LUK)</u>	
Fluid Specifications	See FLUIDS under MAINTENANCE/FLUIDS tab. From within Manager or Service Writer, click the "30/60/90 Interval" or "Maint." button.	
Flywheel/Flex Plate/Drive Plate Torque		
2.0L A/T		
First Pass	22 lb ft (30 N.m)	
Final Pass	additional 40 degrees	
2.0L M/T		
First Pass	22 lb ft (30 N.m)	
Final Pass	additional 80 degrees	
2.4L		
First Pass	39 Ft. Lbs. (53 N.m)	
Final Pass	Additional 25 Degrees	
Fuel System		
Pressure Specification	Key on Engine Off Fuel Pressure Sensor Reading 50-94 psi (345-650 kPa) Engine Running Fuel Pressure Sensor Reading 43-58 psi (300-400 kPa)	

Fuel Pressure Test Procedure	
2.0L	<u>CIRCUIT/SYSTEM VERIFICATION</u>
2.4L	<u>CIRCUIT/SYSTEM VERIFICATION</u>
Fuel Filter Location	Fuel filter is an integral part of the in-tank fuel pump module.
Fuel Filter R & I	2.0L <u>FUEL TANK FUEL PUMP MODULE REPLACEMENT (FWD)</u> 2.0L <u>FUEL TANK FUEL PUMP MODULE REPLACEMENT (AWD)</u> 2.4L <u>FUEL TANK FUEL PUMP MODULE REPLACEMENT (NU6 California Emissions)</u> 2.4L <u>FUEL TANK FUEL PUMP MODULE REPLACEMENT (NT7 Federal Emissions)</u>
Ignition	
Firing Order & Cylinder Identification	
2.0L & 2.4L	<u>FIRING ORDER & CYLINDER IDENTIFICATION</u>
Ignition Wires (Resistance)	Engines have coil-on-plug ignition.
Ignition Wires (Routing)	Engines have coil-on-plug ignition.
Spark Plug	
2.0L (Type = Refer to Electronic Parts Catalog)	
Gap	0.037-0.043 In. (0.95-1.10 mm)
Torque	15 Ft. Lbs. (20 N.m)
2.4L (Type = Refer to Electronic Parts Catalog)	
Gap	0.030-0.035 In. (0.75-0.90 mm)
Torque	15 Ft. Lbs. (20 N.m)
Starting	
Starter	NA non-repairable starter motor
Torque	<u>FASTENER TIGHTENING SPECIFICATIONS</u>
Wheel Alignment	
Adjustment Specifications	<u>WHEEL ALIGNMENT SPECIFICATIONS</u>
Torque	<u>FASTENER TIGHTENING SPECIFICATIONS</u>
Wheel & Tire	
Wheel Lug Nut Torque	122 Ft. Lbs. (165 N.m). See Wheel Nut Tightening Sequence illustration under <u>INSTALLATION PROCEDURE</u>

ACCESSORIES & EQUIPMENT

Cruise Control

SCHEMATIC WIRING DIAGRAMS

CRUISE CONTROL SYSTEM WIRING SCHEMATICS

Cruise Control System

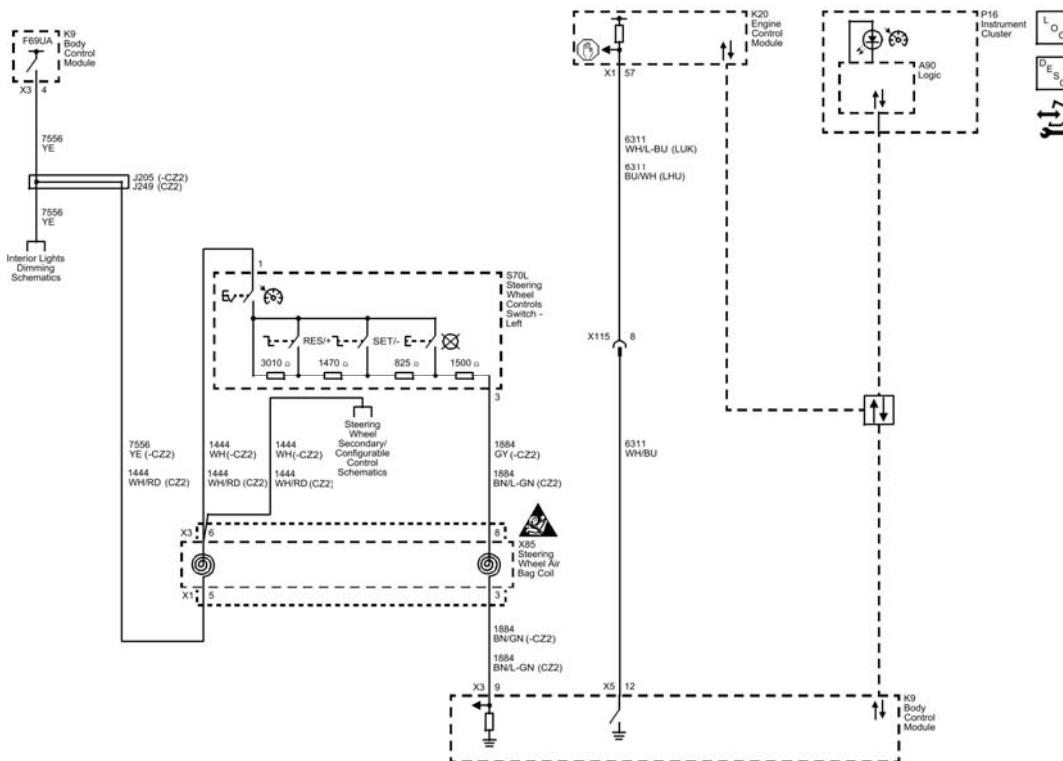


Fig. 1: Cruise Control System
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B3623	DTC B3623 08 Steering Wheel Controls Distance Sensing Cruise Control Gap Up/Down Signal Circuit-Signal Invalid
	DTC B3623 61 Steering Wheel Controls Distance Sensing Cruise Control Gap Up/Down Signal Circuit-Stuck

<u>DTC C0561</u>	DTC C0561 00 System Disabled Information Stored Malfunction
<u>DTC C0565</u>	DTC C0565 00 Vehicle Identification Number Malfunction
<u>DTC C056E (Distance Sensing Cruise Control Module)</u>	DTC C056E 4B Electronic Control Unit Software - Calibration Not Learned
<u>DTC C1002</u>	DTC C1002 00 Distance Sensing Cruise Control Module Performance Malfunction DTC C1002 66 Distance Sensing Cruise Control Module Performance Incorrect Mounting
<u>DTC P0571</u>	DTC P0571 Cruise Control Brake Switch Circuit
<u>DTC P0572 or P0573</u>	DTC P0572 Brake Switch Circuit 1 Low Voltage DTC P0573 Brake Switch Circuit 1 High Voltage
<u>DTC P0575</u>	DTC P0575 Cruise Control Switch Signal Message Counter Incorrect
<u>DTC P0703</u>	DTC P0703 Brake Switch Signal Message Counter Incorrect
<u>DTC P1553</u>	DTC P1553 Distance Sensing Cruise Control Signal Message Counter Incorrect
<u>DTC P15F6 (Distance Sensing Cruise Control Module)</u>	DTC P15F6 Front Object Detection Control Module Torque Request Signal Message Counter Incorrect

DTC B3623: STEERING WHEEL CONTROLS DISTANCE SENSING

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3623 08

Steering Wheel Controls Distance Sensing Cruise Control Gap Up/Down Signal Circuit-Signal Invalid

DTC B3623 61

Steering Wheel Controls Distance Sensing Cruise Control Gap Up/Down Signal Circuit-Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	B3623 08, B3623 61	-	-
Signal	B3623 08,	B3623 08, B3623	1	B3623 08, B3623

	B3623 61	61		61
1. Cruise Control Malfunction				

Circuit/System Description

The adaptive cruise control gap switch is used to select a following gap time (or distance) setting for the adaptive cruise control of far, medium, or near

Conditions for Running the DTC

- The cruise switch is ON.
- The ignition is ON.

Conditions for Setting the DTC

B3623 08

The BCM detects an invalid voltage signal on the adaptive cruise control gap switch signal circuit for 1 s.

B3623 61

The adaptive cruise control gap switch is stuck in one position for 60 s.

Actions Taken When the DTC Sets

B3623

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

B3623

DTC B3623 is a type C DTC.

Conditions for Clearing the DTC

B3623

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

B3623

DTC B3623 is a type C DTC.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Distance Sensing Cruise Control Module Following Distance Setting Parameter changes between Far, Medium or Near when pressing the adaptive cruise control gap switch.
 - **If the parameter does not change**

Refer to Circuit/System Testing.
 - **If the parameter changes**
3. All OK.

Circuit/System Testing

NOTE:

- **An open ignition circuit or fuse before the control module will cause communication DTCs or power mode mismatch DTCs to set against or in the control module. This failure mode will be diagnosed in the no communications diagnostic procedure or power mode mismatch.**
- **This test assumes the ignition circuit has a driver that will open under a high current condition before the fuse opens.**
- **The module driver can open under normal conditions such as battery run**

down protection or a retained accessory power mode.

1. Ignition OFF, disconnect the harness connector at the S70L Steering Wheel Controls Switch-Left, ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 10 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for greater than 100 ohms between the ignition circuit and ground.
 - If 100 ohms or less, repair the short to ground on the circuit.
 - If greater than 100 ohms
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the K9 Body Control Module.
 - **If the test lamp illuminates**
3. Verify the scan tool BCM Cruise Control Switch 2 parameter is Open/High Resistance.
 - **If not Open/High Resistance**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If Open/High Resistance**
4. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the ignition circuit terminal 10.
5. Verify the scan tool BCM Cruise Control Switch 2 parameter displays Short to Battery.
 - **If not Short to Battery**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Short to Battery**
6. Test or replace the S70L Steering Wheel Controls Switch-Left.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup.

DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, OR P162C: CRUISE CONTROL MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3794 08

Cruise Control Function Request Circuit

DTC B3794 61

Cruise Control Function Request Circuit

DTC P0564

Cruise Control Multifunction Switch Circuit

DTC P0565

Cruise Control Switch Circuit

DTC P0567

Cruise Control Resume Switch Circuit

DTC P0568

Cruise Control Set Switch Circuit

DTC P056C

Cruise Control Cancel Switch Circuit

DTC P0580

Cruise Control Multifunction Switch Circuit Low Voltage

DTC P0581

Cruise Control Multifunction Switch Circuit High Voltage

DTC P155A

Cruise Control Switch State Undetermined

DTC P155B

Cruise Control Set/Coast Switch 2 Circuit

DTC P155C

Cruise Control Resume/Acceleration Switch 2 Circuit

DTC P162C

Vehicle Speed Limiting/Warning Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Signal	1	P0564	B3794 08, P0567, P0568	B3794 61, P0564
1. Cruise Control Malfunction				

Circuit/System Description

The cruise control switch is an input to the body control module (BCM). The BCM monitors the cruise control on/off, set/coast, resume/accelerate and cancel switches via the cruise control switch signal circuit in order to detect when the driver has requested to perform a cruise control function. The BCM detects a specific voltage signal on the cruise control switch signal circuit when a switch is applied. The engine control module (ECM) receives the requested cruise control switch function from the BCM via a serial data message.

Conditions for Running the DTC

- The cruise switch is ON.
- The ignition is ON.

Conditions for Setting the DTC

B3794 08

The BCM detects an invalid voltage signal on the cruise control switch signal circuit for 1 s.

B3794 61

Stuck switch for either Resume/Accel or Set/Coast button for 60 s.

P0564, P0565, P0567, P0568, P056C

- The BCM detects an invalid voltage signal on the cruise control switch signal circuit for greater than 2 s and sends a serial data message to the ECM. The ECM sets these DTCs when the message is received.
- The ECM runs this diagnostic continuously.

P0580, P0581

- The ECM detects an invalid voltage signal on the cruise control switch signal circuit.
- The above condition is present for greater than 2 s.
- The ECM runs this diagnostic continuously.

P155A

The ECM is unable to determine the state of the cruise control switch.

P162C

The ECM is unable to determine the state of the vehicle speed limiting switch.

Actions Taken When the DTC Sets

B3794

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A, P162C

DTCs P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A and P162C are type C DTCs

Conditions for Clearing the DTC

B3794

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A, P162C

DTCs P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A and P162C are type C DTCs.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool BCM Cruise Control Switch Status parameter changes between Off and On, Resume and Set when switching between each position on the cruise control switch.
 - **If the parameter does not change**

Refer to Circuit/System Testing.
 - **If the parameter changes**
3. All OK.

Circuit/System Testing

NOTE:

- **An open ignition circuit or fuse before the control module will cause communication DTCs or power mode mismatch DTCs to set against or in the control module. This failure mode will be diagnosed in the no communications diagnostic procedure or power mode mismatch.**
- **This test assumes the ignition circuit has a module driver that will open under a high current condition before the fuse opens.**
- **The module driver can open under normal conditions such as battery run down protection or a retained accessory power mode.**

1. Ignition OFF, disconnect the harness connector at the S70L Steering Wheel Controls Switch-Left, ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 10 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for greater than 100 ohms between the ignition circuit and ground.
 - If 100 ohms or less, repair the short to ground on the circuit.
 - If greater than 100 ohms
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the K9 Body Control Module.
 - **If the test lamp illuminates**
3. Verify the scan tool BCM Cruise Control Switch Status parameter is Open/High Resistance.
 - **If not Open/High Resistance**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 9 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If Open/High Resistance**
4. Install a 3 A fused jumper wire between the signal circuit terminal 9 and the ignition circuit terminal 10.
5. Verify the scan tool BCM Cruise Control Switch Status parameter is Short to Battery.
 - **If not Short to Battery**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 9 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Short to Battery**
6. Test or replace the S70L Steering Wheel Controls Switch-Left.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup.

DTC C0561: SYSTEM DISABLED INFORMATION STORED MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0561 00

System Disabled Information Stored Malfunction

Circuit/System Description

The distance sensing cruise control module has the exclusive function of detecting, tracking and classifying targets within its specified field of view. The distance sensing cruise control module has the ability to detect and react to objects of interest in its detection zone and is critical to the proper operation of the adaptive cruise control system.

Conditions for Running the DTC

Engine is running.

Conditions for Setting the DTC

The mismatch between the vehicle speed information of the front and rear wheels is greater than 15 km/h (9 MPH).

Action Taken When the DTC Sets

- Loss of adaptive cruise control function.
- Service Adaptive Cruise Control message is displayed in the driver information center.

Conditions for Clearing the DTC

The condition responsible for setting the DTC no longer exists.

Diagnostic Aids

When the Service Adaptive Cruise Control message is displayed in the driver information center the disable reason is stored in the scan tool Cruise Control Disengage History parameters.

The scan tool Cruise Control Disengage History parameters are a list of the previous reasons the adaptive cruise control system was disabled. These parameters may help in the diagnosis of an intermittent concern or a customer concern which is the result of normal system operation.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Program the K14 Distance Sensing Cruise Control Module.
2. Road test the vehicle and verify the adaptive cruise control system functions normally and DTC C0561 does not set. Refer to **Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)**.
 - **If DTC C0561 sets**

Refer to Diagnostic Aids and the scan tool Cruise Control Disengage History parameters to determine the cause of the inhibit.

- **If DTC C0561 does not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for distance sensing cruise control module replacement, programming and setup.

DTC C0565: VEHICLE IDENTIFICATION NUMBER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0565 00

Vehicle Identification Number Malfunction

Circuit/System Description

The vehicle identification number (VIN) is programmed into the distance sensing cruise control module during initial programming of the module.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

The distance sensing cruise control module is not properly programmed.

Action Taken When the DTC Sets

- Loss of adaptive cruise control function.
- Service Adaptive Cruise Control message is displayed in the driver information center.

Conditions for Clearing the DTC

The condition responsible for setting the DTC no longer exists.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise

Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC C0565 is not set.
 - **If DTC C0565 is set**
 1. Program the K14 Distance Sensing Cruise Control Module.
 2. Verify the DTC does not set
 - If the DTC sets, replace the K14 Distance Sensing Cruise Control Module.
 - If the DTC does not set
 3. All OK.
 - **If DTC C0565 is not set**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for distance sensing cruise control module replacement, programming and setup

DTC C056E: ELECTRONIC CONTROL UNIT SOFTWARE - CALIBRATION NOT LEARNED (DISTANCE SENSING CRUISE CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C056E 4B

Electronic Control Unit Software - Calibration Not Learned

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The distance sensing cruise control module has detected that the learn procedure has not been performed or completed.

Conditions for Running the DTC

Battery voltage is between 9-16 V and data link communications operate normally.

Conditions for Setting the DTC

The device is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool References

Control Module References for scan tool information

Circuit/System Verification

NOTE: If DTC C056 with failure type byte 4B is the only DTC set, all that should be needed is to perform the distance sensing cruise control module learn procedure.

1. Ignition ON.
2. Verify DTC C056E 4B is not set.
 - If DTC C056E 4B is set
 1. Perform the distance sensing cruise control module learn procedure. Refer to **Distance Sensing Cruise Control Module Learn Procedure**.
 2. Verify the DTC C056E 4B does not set.
 - If the DTC C056E 4B sets, replace the K14 Distance Sensing Cruise Control Module.
 - If the DTC C056E 4B does not set
 - If DTC C056E 4B is not set
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Distance Sensing Cruise Control Module Learn Procedure** for distance sensing cruise control module learn procedure.
- **Forward Range Radar Module Replacement** for K14 Distance Sensing Cruise Control Module replacement.
- **Forward Range Radar Module Alignment** for K14 Distance Sensing Cruise Control Module alignment.
- **Forward Range Radar Module Inspection** for K14 Distance Sensing Cruise Control Module inspection.
- **Control Module References** for device replacement, programming and setup.

DTC C1002: DISTANCE SENSING CRUISE CONTROL MODULE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C1002 00

Distance Sensing Cruise Control Module Performance Malfunction

DTC C1002 66

Distance Sensing Cruise Control Module Performance Incorrect Mounting

Circuit/System Description

The distance sensing cruise control module has the exclusive function of detecting, tracking and classifying targets within its specified field of view. The distance sensing cruise control module has the ability to detect and react to objects of interest in its detection zone and is critical to the proper operation of the adaptive cruise control system. When the distance sensing cruise control module detects that it is out of alignment, DTC C1002 sets.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The alignment angle is outside allowed range.

Action Taken When the DTC Sets

C1002 00

- Loss of adaptive cruise control function.
- Cruise Not Ready message is displayed in the driver information center.

C1002 66

- Loss of adaptive cruise control function.
- Service Adaptive Cruise Control message is displayed in the driver information center.

Conditions for Clearing the DTC

The condition responsible for setting the DTC no longer exists.

Diagnostic Aids

An out of alignment condition may be a result of tampering with the structures/brackets or the adjuster settings of the distance sensing cruise control module. Also, damage to the front section of the vehicle or to the distance sensing cruise control module may cause an out of alignment condition.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Perform the Distance Sensing Cruise Control Service Alignment learn procedure with scan tool.
2. Road test the vehicle and verify the adaptive cruise control system functions normally and DTC C1002 does not set. Refer to **Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)**.
 - **If DTC C1002 sets**
 1. Align the K14 Distance Sensing Cruise Control Module. Refer to **Forward Range Radar Module Alignment**.
 - If alignment cannot be achieved within the limits of the available adjustment, inspect the mounting structures and brackets for damage or tampering and repair as necessary to achieve proper alignment.
 - If alignment is OK
 2. Road test the vehicle and verify the adaptive cruise control system functions normally and DTC C1002 does not set.
 - If DTC C1002 sets, replace the K14 Distance Sensing Cruise Control Module.
 - If DTC C1002 does not set.
 3. All OK.
 - **If DTC C1002 does not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for distance sensing cruise control module replacement, programming and setup.

DTC P0571: CRUISE CONTROL BRAKE SWITCH CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0571

Cruise Control Brake Switch Circuit

Circuit/System Description

The engine control module (ECM) monitors the brake pedal position sensor. When the brake pedal is applied, the ECM detects a predetermined voltage signal. The ECM sends a serial data message to the body control module (BCM) indicating the status of the stop lamps.

This diagnostic test functions on the assumption that a sudden decrease in vehicle speed is caused by a brake pedal application. When the ECM detects that there is a 4.2 km/h (2.6 mph) or greater decrease in vehicle speed within 0.25 s without a transition of the stop lamp switch, the ECM sets DTC P0571.

Conditions for Running the DTC

- The engine speed is greater than 700 RPM.
- The traction control system or the antilock brake system are not active and have not malfunctioned.
- The vehicle speed is greater than 48 km/h (30 mph).
- The diagnostic will disable when the wheel speed is less than 16 km/h (10 mph).

Conditions for Setting the DTC

The BCM detects either a low voltage signal on the stop lamp switch signal circuit when the serial data message from the ECM indicates the brakes are applied, or a high voltage signal on the stop lamp switch signal circuit when the serial data message from the ECM indicates the brakes are not applied.

Actions Taken When the DTC Sets

- The cruise control system is disabled.
- The malfunction indicator lamp (MIL) will not illuminate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

- **Cruise Control Schematics**
- **Exterior Lights Schematics**
- **Antilock Brake System Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no DTCs are set, except DTC P0571.
 - **If any other DTC is set, except DTC P0571**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If only DTC P0571 is set**
3. Replace the K20 Engine Control Module.
4. Verify DTC P0571 does not set when operating the vehicle within the conditions for running the DTC.
 - **If the DTC sets**

Replace the K9 Body Control Module.

- **If the DTC does not set**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming and setup.

DTC P0572 OR P0573: BRAKE SWITCH CIRCUIT 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0572

Brake Switch Circuit 1 Low Voltage

DTC P0573

Brake Switch Circuit 1 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Stop Lamp Switch Signal	C0297 02, P0572	P0572	P0573	P0572, P0573

Circuit/System Description

The stop lamp switch signal circuit is a B+ input from the body control module (BCM) to the engine control module (ECM). The ECM monitors the stop lamp switch circuit to detect when the brake pedal has been applied. The BCM monitors the brake pedal position sensor to determine when the brake pedal is applied. When the brake pedal is applied, the BCM supplies B+ on the stop lamp switch signal circuit and also sends a serial data message to the ECM indicating that the brake pedal has been applied.

Conditions for Running the DTC

- The engine is running.

- Battery voltage is greater than 11.5 V.
- Brakes applied.

Conditions for Setting the DTC

P0572

This DTC will set when the ECM detects a short to ground or an open on the discrete brake signal circuit when the serial data message from the BCM indicates the brakes are applied. This diagnostic will run when the serial data message and the voltage signal on the brake switch signal circuit do not match for 8 out of 10 times, and the condition is present for greater than 2 s.

P0573

This DTC will set when the ECM detects a short to voltage on the discrete brake signal circuit when the serial data message from the BCM indicates the brakes are not applied. This diagnostic will run when the serial data message and the voltage signal on the brake switch signal circuit do not match for 8 out of 10 times, and the condition is present for greater than 2 s.

Actions Taken When the DTC Sets

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
2. Connect a test lamp between the signal circuit terminal 57 and ground.
3. Verify the test lamp turns ON and OFF when pressing and releasing the brake pedal.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If not infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
4. Replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming, and setup.

DTC P0575: CRUISE CONTROL SWITCH SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0575

Cruise Control Switch Signal Message Counter Incorrect

Circuit/System Description

When a cruise control function switch is activated, the body control module (BCM) detects a predetermined voltage. The BCM sends a serial data message to the engine control module (ECM) indicating the function that has been requested.

Conditions for Running the DTC

- The ignition is ON.
- The vehicle speed is greater than 40 km/h (25 MPH) and the cruise control is engaged.

Conditions for Setting the DTC

- The ECM receives an invalid cruise control switch status serial data message from the BCM.
- This diagnostic runs continuously.

Actions Taken When the DTC Sets

DTC P0575 is a type C DTC.

Conditions for Clearing the DTC

DTC P0575 is a type C DTC.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no DTCs are set, except DTC P0575.
 - **If any other DTC is set, except DTC P0575**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If only DTC P0575 is set**
3. Replace the K9 Body Control Module.
 4. Verify DTC P0575 does not set when operating the vehicle within the Conditions for Running the DTC.
 - **If the DTC sets**

Replace the K20 Engine Control Module.

- **If the DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming, and setup.

DTC P0703: BRAKE SWITCH SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0703

Brake Switch Signal Message Counter Incorrect

Circuit/System Description

The body control module (BCM) monitors the brake pedal position sensor. When the brake pedal is applied, the BCM detects a predetermined voltage signal. The BCM sends a serial data message to the engine control module (ECM) indicating the status of the stop lamps.

Conditions for Running the DTC

The engine is ON.

Conditions for Setting the DTC

- The ECM receives an invalid brake pedal status serial data message from the BCM.
- This diagnostic runs continuously.

Actions Taken When the DTC Sets

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no DTCs are set, except DTC P0703.
 - **If any other DTC is set, except DTC P0703**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If only DTC P0703 is set**
3. Replace the K9 Body Control Module.
 4. Verify DTC P0703 does not set when operating the vehicle within the conditions for running the DTC.
 - **If the DTC sets**

Replace the K20 Engine Control Module.

- **If the DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming, and setup.

DTC P1553: DISTANCE SENSING CRUISE CONTROL SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1553

Distance Sensing Cruise Control Signal Message Counter Incorrect

Circuit/System Description

The engine control module (ECM) detects a serial communication failure associated with the adaptive cruise control axle torque request.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

- The ECM detects a serial communication failure associated with the adaptive cruise control axle torque request.
- This diagnostic runs continuously.

Actions Taken When the DTC Sets

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Diagnostic Aid

Both DTCs P1553 and P15F6 can be set by the ECM against the distance sensing cruise control module if the battery voltage drops below 9 volts during a cranking condition. This is a result of the internal microprocessor in the distance sensing cruise control module resetting when subjected to a low voltage condition during cranking. Under this condition, the rolling count signal transmitted to the ECM for the distance sensing cruise control module freezes while the microprocessor is resetting. As a result of the rolling count signal freezing, the ECM may set DTCs P1553 and P15F6 and transition to history within 5 seconds. No driver information center (DIC) service messages or tell-tales will be displayed.

Reference Information

Schematic Reference

- Cruise Control Schematics
- Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Do not replace the K14 Distance Sensing Cruise Control Module or K20 Engine Control Module if DTC P1553 or P15F6 are stored as history DTCs. This is a known issue that has no impact to system function and does not require any additional repair, programming or module replacement.

1. Ignition ON.
2. Verify that no DTCs are set, except DTC P1553.
 - If any other DTC is set, except DTC P1553

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- If only DTC P1553 is set
3. Replace the K14 Distance Sensing Cruise Control Module.
 4. Verify DTC P1553 does not set when operating the vehicle within the conditions for running the DTC.
 - If the DTC sets

Replace the K20 Engine Control Module.

- If the DTC does not set
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for distance sensing cruise control module or ECM replacement, programming, and setup

DTC P15F6: FRONT OBJECT DETECTION CONTROL MODULE TORQUE REQUEST SIGNAL MESSAGE COUNTER INCORRECT (DISTANCE SENSING CRUISE CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P15F6

Front Object Detection Control Module Torque Request Signal Message Counter Incorrect

Circuit/System Description

The distance sensing cruise control module is constantly sending a serial data message to the engine control module requesting engine speed or torque reduction. The engine control module sets DTC P15F6 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned. An intermittent fault in the serial data circuits will cause the engine control module to set DTC P15F6.

Conditions for Running the DTC

Engine running.

Conditions for Setting the DTC

The engine control module detects that the engine speed and torque modification messages from the distance sensing cruise control module are either corrupted or intermittently missing.

Action Taken When the DTC Sets

- The distance sensing cruise control module sends a serial data message to display the appropriate indicator message
- The distance sensing cruise control module features are unavailable.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The engine control module clears the history DTC when a current DTC is not detected in 40 consecutive drive cycles.

Diagnostic Aid

This is an informational DTC set by the engine control module. It is set to provide an indication that the distance sensing cruise control module will not be able to perform as intended. Diagnose any other DTCs first.

Both DTCs P1553 and P15F6 can be set by the ECM against the distance sensing cruise control module if the battery voltage drops below 9 volts during a cranking condition. This is a result of the internal microprocessor in the distance sensing cruise control module resetting when subjected to a low voltage condition during cranking. Under this condition, the rolling count signal transmitted to the ECM for the distance sensing cruise control module freezes while the microprocessor is resetting. As a result of the rolling count signal freezing, the ECM may set DTCs P1553 and P15F6 and transition to history within 5 seconds. No driver information center (DIC) service messages or tell-tales will be displayed.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **DTC P15F6 is an informational DTC.**
- **Diagnose all other K20 Engine Control Module DTCs prior to DTC P15F6.**
- **Do not replace the K14 Distance Sensing Cruise Control Module or K20 Engine Control Module if DTC P1553 or P15F6 are stored as history DTCs. This is a known issue that has no impact to system function and does not require any additional repair, programming or module replacement.**

1. Verify there are no other K20 Engine Control Module or communication DTCs set.
 - **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If a DTC is not set**

2. Complete the diagnosis by looking for an intermittent serial data circuit fault. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** .

- **If an intermittent serial data circuit fault is found**

Repair as necessary.

- **If an intermittent serial circuit fault is not found**

3. Clear DTCs and operate the vehicle in the conditions that the customer experienced.
4. Verify DTC P15F6 does not set.

- **If the DTC sets**

Replace K14 Distance Sensing Cruise Control Module.

- **If the DTC does not set**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for distance sensing cruise control module replacement, programming, and setup.

SYMPTOMS - CRUISE CONTROL

NOTE: **The following steps must be completed before using the symptom tables.**

1. Before using the symptom diagnostic table, perform the **Diagnostic System Check - Vehicle** in order to verify the following conditions:
 - There are no DTCs set.
 - The module can communicate via the serial data.
2. Review the system operation in order to understand the system functions. Refer to **Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)**.

Visual/Physical Inspection

- Inspect for aftermarket devices which can affect the operation of the Cruise Control System. Refer to **Checking Aftermarket Accessories** .
- Inspect the accessible system components or the visible system components for obvious damage or for obvious conditions which can cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
- **Cruise Control Indicator Malfunction**

CRUISE CONTROL INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The instrument cluster illuminates the cruise control engaged indicator based on serial data messages received from the engine control module (ECM). The indicator is commanded ON when the cruise control system is controlling vehicle speed, and turned OFF with the system disengaged.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation, Cruise Control Description and Operation (Adaptive Cruise Control)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the cruise control indicator turns ON and OFF when commanding the All Indicators ON and OFF with a scan tool.
 - **If the indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster.

- **If the indicator turns ON and OFF**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for instrument cluster replacement, programming and setup.

REPAIR INSTRUCTIONS

DISTANCE SENSING CRUISE CONTROL MODULE LEARN PROCEDURE

After replacing and programming the K14 Distance Sensing Cruise Control Module, it is necessary to perform a learn procedure to align the radar. This is indicated to the technician by DTC C056E 4B. The learn procedure is performed while driving the vehicle with the scan tool connected. The learn procedure is initialized using a scan tool and the scan tool must remain connected until the learn procedure is complete. During this time a Vehicle Ahead tell-tale will be displayed on the Instrument Panel Cluster (IPC) and it will flash. Once the learn procedure is complete, the Vehicle Ahead tell-tale on the IPC will turn off.

If the learn procedure is not successful, it could be due to an improper driving environment, a module and bracket assembly bent out of position or an incorrect module mounting. A typical driving environment is usually sufficient to learn the module within 10-30 minutes.

Module Learn Procedure

1. Verify no other DTCs except for C056E 4B Electronic Control Unit Software are present. Repair any other DTCs before performing this learn procedure.
2. Prior to driving the vehicle make sure the surface in front of the distance sensing cruise control module is clean. Also verify the mounting area is not damaged and allows the module to face in the intended direction.
3. Prepare the scan tool to be mobile for the driving phase of the learn procedure. The scan tool needs to stay connected during the driving phase of the learn procedure.

4. Start the engine.
5. Initiate the learn procedure on the scan tool by selecting the Configuration/Reset Functions, then select Distance Sensing Cruise Control Module. The IPC will display "Service Adaptive Cruise Control" and the Vehicle Ahead tell-tale will flash during the procedure. Do not back out of this screen or press any other buttons until the learn procedure is complete.
6. Drive the vehicle within the following conditions for 10-30 minutes or until the learn procedure is complete. The Service Adaptive Cruise Control message and the Vehicle Ahead tell-tale will turn off when the learn procedure is complete.
 - Drive at speeds greater than 50 kph (30 mph).
 - Minimize tight curves.
 - Avoid extreme acceleration or deceleration.
 - Drive in an environment that has stationary objects on the side of the road (street signs, guard rails, mail boxes, fences, etc.).
7. Verify proper learn procedure completion by monitoring the Automatic Alignment Learn Progress parameter on the scan tool. The learn procedure is complete when the Automatic Alignment Learn Progress parameter reaches 100%. Once this parameter reaches 100% the Vehicle Ahead tell-tale and the Service Adaptive Cruise Control messages will turn off.
8. If the Vehicle Ahead tell-tale and the Service Adaptive Cruise Control messages fail to turn off:
 - Verify correct learn procedure operating conditions were followed. If necessary repeat the learn procedure while following the recommended learn procedure operating conditions
 - Verify that DTC C1002 Distance Sensing Cruise Control Module Performance is not set. Repair any DTCs that may have set before repeating the learn procedure..
9. Once the learn procedure is complete drive the vehicle at speeds greater than 40 kph (25 mph) and verify engagement of the adaptive cruise control system. Refer to the owner's manual for instructions on how to engage the adaptive cruise control system.

If Module is Slow to Calibrate

One or more of the following conditions may increase the length of time required to complete the learn procedure:

- Heavy traffic. Following too close behind vehicles for long periods of time (more than 40 minutes).
- Stop and go or very slow traffic.
- Mountain roads.
- Constant sharp curves in roadway.
- No traffic. If no traffic is available, the vehicle ahead may need to be added to support learning.
- Limited or no stationary structures on the side of the road. Structures such as street signs, guard rails, mail boxes and parked cars are needed to complete the learn procedure.
- Driving in tunnels.

CRUISE CONTROL SWITCH REPLACEMENT (GRAND SPORT)

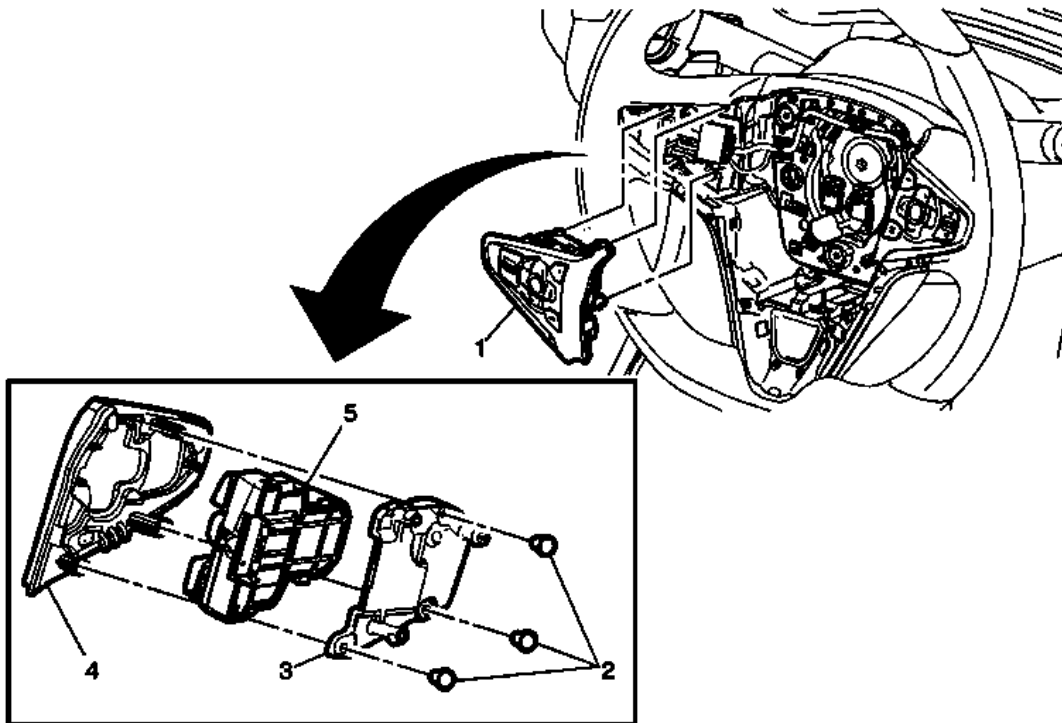


Fig. 2: Cruise Control Switch (Grand Sport)
 Courtesy of GENERAL MOTORS COMPANY

Cruise Control Switch Replacement (Grand Sport)

Callout	Component Name
1	Cruise Control Switch Assembly Procedures 1. Use the appropriate tool to gently release the retaining tabs on the switch assembly bezel. NOTE: Gently release tabs one by one, using care to avoid snapping the tab off. 2. Disconnect the electrical connection.
2	Steering Wheel Switch Bracket Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
3	Steering Wheel Switch Bracket
4	Steering Wheel Switch Bezel
5	Cruise Control Switch

CRUISE CONTROL SWITCH REPLACEMENT (EXCEPT GRAND SPORT)

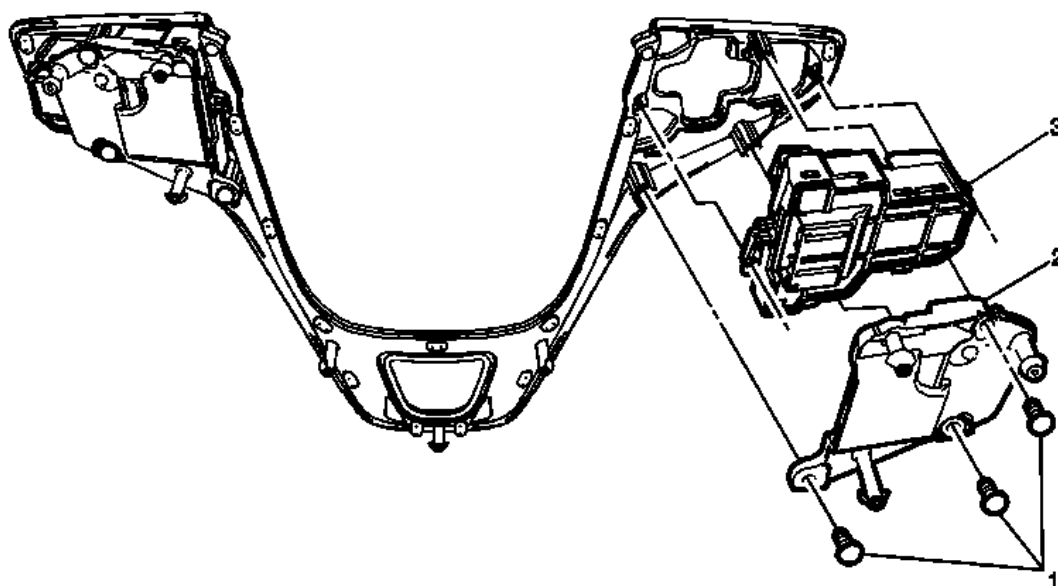


Fig. 3: Cruise Control Switch (Except Grand Sport)
Courtesy of GENERAL MOTORS COMPANY

Cruise Control Switch Replacement (Except Grand Sport)

Callout	Component Name
Preliminary Procedure Remove the steering wheel spoke lower cover. Refer to <u>Steering Wheel Spoke Lower Cover Replacement (Except Grand Sport)</u> .	
1	Steering Wheel Spoke Lower Cover Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
2	Steering Wheel Spoke Lower Cover Bracket
3	Cruise Control Switch

DESCRIPTION AND OPERATION

CRUISE CONTROL DESCRIPTION AND OPERATION

Cruise control is a speed control system that maintains a desired vehicle speed under normal driving conditions at speeds above 40 km/h (25 mph). Steep grades may cause variations in the selected vehicle speeds.

The following are the main components of the Cruise Control System:

- The accelerator pedal
- The brake pedal position (BPP) sensor
- The body control module (BCM)
- The cruise on/off switch
- The cruise control cancel switch
- The + RES switch (equivalent to resume/accel switch)
- The - SET switch (equivalent to set/coast switch)
- The engine control module (ECM)
- The throttle actuator control (TAC) motor
- The vehicle speed sensor

The body control module (BCM) monitors the signal circuit of the cruise control switches, which are located on the steering wheel. The BCM relays the cruise control switch status to the engine control module (ECM) via the serial data circuit. The ECM uses the status of the cruise control switch to determine when to capture and maintain the vehicle speed. The ECM monitors the vehicle speed signal circuit in order to determine the desired vehicle speed.

Voltage is supplied to the cruise control switch via the steering wheel control switch reference voltage circuit supplied by the BCM. The cruise control function switches are arranged in a resistive ladder design, with each cruise control function switch having a different resistance value. The BCM detects a specific voltage value that is associated with the cruise control function switch being activated. The BCM sends a serial data message to the ECM indicating that the on/off switch is active. Similarly, when the normally open + RES switch or the normally open - SET switch are pressed, the switch closes and the BCM detects the predetermined voltage signal on the cruise control resume/accel and set/coast switch signal circuit. The BCM sends a serial data message to the ECM indicating that the + RES switch or the - SET switch is active.

Cruise Control Engaged

The Cruise Control System will engage and adjust vehicle speeds, based on the activation of the following cruise control switches, which are located on the steering wheel:

- On/Off
- + RES
- - SET

To engage the Cruise Control System, ensure that the vehicle speed is above 40.2 km/h (25 mph), turn the cruise On/Off switch ON and momentarily press the - SET switch. The ECM will engage the Cruise Control System and record the vehicle speed. The ECM sends a serial data message to the instrument panel cluster (IPC) in order to illuminate the Cruise Engaged indicator in the IPC. Refer to the vehicle owner's manual for the location and operation of the cruise control On/Off indicators and driver information center (DIC) messages.

Pressing the accelerator pedal while the Cruise Control System is engaged, allows the driver to override the Cruise Control System in order to accelerate the vehicle beyond the current set vehicle speed. When the accelerator pedal is released, the vehicle will decelerate and resume the current set vehicle speed.

The driver can also override the current set vehicle speed via the - SET switch and the + RES switch. When the Cruise Control System is engaged, pressing and holding the - SET switch will allow the vehicle to decelerate from the current set vehicle speed without deactivating the Cruise Control System. When the - SET switch is released, the ECM will record the vehicle speed and maintain the vehicle speed as the new set vehicle speed. When the Cruise Control System is engaged, momentarily pressing the - SET switch will allow the vehicle to decelerate at a vehicle specific calibratable increment, commonly 1.6 km/h (1 mph), each time that the - SET is momentarily pressed, with a minimum vehicle speed of 38 km/h (24 mph). Refer to the vehicle Owner's Manual for more information.

Pressing and holding the + RES switch, when the Cruise Control System is engaged, will allow the vehicle to accelerate to a greater vehicle speed than the current set vehicle speed. When the + RES switch is released, the ECM will record the vehicle speed and maintain the vehicle speed as the new set vehicle speed. When the Cruise Control System is engaged, momentarily pressing the + RES switch will allow the vehicle to accelerate at a vehicle specific calibratable increment, commonly 1.6 km/h (1 mph), each time that the + RES switch is momentarily pressed. Momentarily activating the + RES switch will recall the previous vehicle speed, after the cruise control system has been disengaged by pressing the brake pedal, or CANCEL switch. Refer to the vehicle Owner's Manual for more information.

Cruise Control Disengaged

The engine control module (ECM) disengages the cruise control operation based on the signals from the following switches:

- The brake pedal position (BPP) sensor
- The On/Off switch
- The cruise control cancel switch

The Cruise Control System will disengage when the brake pedal is applied. The body control module (BCM) monitors the BPP sensor via the BPP sensor signal circuit as the voltage signal increases while the pedal is further applied. The ECM monitors the BPP signal through a discrete input and a serial data message signal from the BCM indicating the brake status. When either signal indicates the brake pedal is applied, the ECM will disengage the cruise control system.

The Cruise Control System will also disengage when the cruise control on/off switch is switched OFF, or the cruise control cancel switch is activated. The body control module (BCM) determines when the cruise control cancel switch is activated. When the normally open cancel switch is closed, the BCM detects the predetermined voltage signal on the cruise control function switch circuit. The vehicle speed stored in the memory of the engine control module will be erased when the cruise control On/Off switch is turned OFF, or the ignition switch is turned OFF. The BCM sends a serial data message to the ECM in order to disengage the cruise control system. When the Cruise Control System has been disengaged, the ECM sends a serial message to the instrument panel cluster (IPC) in order to turn OFF the Cruise Engaged indicator.

Every time the Cruise Control System is disengaged, the ECM will keep track of the reason for system disengagement. The last 8 disengagement reasons will be recorded within the ECM memory. The scan tool will display the last 8 Cruise Disengage History parameters, in which one out of approximately 50 possible reasons will be displayed in each of these 8 parameters. For the disengagement reason to be displayed within the scan tool parameter the Cruise Control System is active and disengagement is requested.

When engagement of the system is requested but an engagement inhibit is present, the most recent inhibit reason is recorded in the ECM history. The scan tool will display the most recent inhibit reason, in which one out of approximately 50 possible reasons will be displayed.

Cruise Control Inhibited

The engine control module (ECM) inhibits the cruise control operation when any of the following conditions exist:

- The ECM has not detected a brake pedal activation from the body control module (BCM) this ignition cycle.
- A Cruise Control System DTC has been set.
- The vehicle speed is less than 38.6 km/h (24 mph).
- The vehicle speed is too high.
- The vehicle is in PARK, REVERSE, NEUTRAL, or 1st gear.
- The engine RPM is low.
- The engine RPM is high.
- The system voltage is not between 9 volts and 16 volts.
- The Antilock Brake System (ABS)/Traction Control System (TCS) is active for more than a calibratable time (typically 0.3 to 0.7 seconds).

Cruise Control Inhibit Reasons

This is a general list of inhibit reasons. Not every inhibit reason is applicable to all vehicles. Refer to the scan tool inhibit reason list for the last 8 reasons that have been recorded during the current ignition cycle.

Scan Tool Name	Description	Long Description
ACC BRAKE INOP	Adaptive Cruise Control Automatic Braking Failed	Adaptive Cruise Control Automatic Braking Inoperative
ACC DATA	Serial data fault for Adaptive Cruise Control Throttle Control and Brake Control signals sent by Adaptive Cruise Control module	Adaptive Cruise Control Module serial data fault is active or communication has been lost between ACC module and ECM.
ACC INHIBIT	Adaptive Cruise Control Inhibited	Adaptive Cruise Control Inhibited
ACC OPTION	Adaptive Cruise Control option mismatch	Cruise control type (adaptive cruise or conventional cruise) mismatched between ECM and BCM.
ACCEL RATE	High acceleration	Vehicle acceleration rate is too high.
Accel Time	Rate Limiting Fault	Cruise torque request rate limiting active too long
APP OVERRIDE	Pedal greater than cruise (override)	Driver has overridden cruise control set speed with accelerator pedal for greater than an allowable time.
	Automatic Braking Engine Torque	ECM to EBCM serial data fault is

Auto Brk Data	Request Signal Communication Malfunction	active or communication has been lost between ECM and EBCM.
AXLE RANGE	Rear Axle Low	Rear axle in low range
BPP DATA	DTC P0703 active or maximum time elapsed without receiving valid Brake Pedal Position signal.	Serial data fault is active or communication has been lost with module sending brake pedal apply state
BPP DTC	Brake Pedal Position signal invalid	Brake Pedal Apply Circuit fault has been detected.
BPP Not Learned	Brake Apply Sensor Home Position Not Learned	Brake Pedal Position Sensor Released Position Not Learned.
BRAKE	Brake pedal apply	Brake Pedal was applied.
Brk Ped Press	Brake Pedal Driver Applied Pressure Detected	A Brake Pedal Apply has been detected based on brake pedal pressure as measured by the EBCM.
Calc Eng Torque	Calculated Torque	Engine torque calculation is incorrect.
CANCEL	Cancel switch active	Cancel Switch was depressed.
CLUTCH	Clutch switch active	Clutch Pedal was applied.
COAST DISENGAGE	Coast disengage	Cruise control is in coast mode with the Set/Coast switch depressed and is requesting no throttle
COAST SPEED LOW	Coast below low speed inhibit	Set / Coast switch was depressed. Vehicle slowed below minimum cruise operating speed.
Cruise Brk Inop	Brake System Malfunction	EBCM has detected a failure that does not allow automatic braking to be performed.
CRUISE S/W	Sequence of completion checks	Cruise control software execution error has occurred.
CRUISE SW DATA	Serial data fault (Cruise switch serial communication fault)	Cruise switch serial data fault is active or communication has been lost with module sending cruise switch states
CRUISE SW. OFF	On/Off switch in Off state	Cruise On/Off switch turned Off
DECEL RATE	High deceleration	Vehicle deceleration rate is too high.
DLC OVERRIDE	ALDL	Scan Tool plugged into ALDL connector
DTC SET	Malfunction in PCM/ECM (DTC active)	DTC is active or in history that inhibits cruise control operation.
D WHL SPD HI	Driven Whl Spd Greater (wheel slip detection)	Driven wheel speed greater than Non Driven wheel speed (slip detection)
D WHL SPD LOW	Un-driven Whl speed Greater	Non Driven wheel speed greater than driven wheel speed
ECM INHIBIT	PCM/ECM inhibit (RAM corruption)	ECM internal communication error
ECM RESET	ECM Running Reset	ECM Running Reset occurred

ECT OVERTEMP	Engine metal overtemp active	Engine over temperature. Overheated.
ENG RUN TIME	Engine run time not elapsed	Engine has not been running long enough, typically five seconds.
ENGINE SPEED	Engine speed too low or too high	Engine RPM too low (near stall) or too high (near engine RPM fuel shutoff).
FIRST GEAR	1st Gear	Transmission is engaged in 1st gear
HIGH SPEED	Vehicle speed exceeds high speed threshold	Vehicle speed has exceeded maximum cruise operating speed
HIGH VOLTAGE	Voltage above high voltage threshold	Ignition Voltage High at ECM (typically 18 volts)
ILLEGAL MODE	Illegal cruise mode	Cruise control mode is incorrect based on switch states.
LOST FWD GEAR	Transmission in neutral. Reverse or park	Gear selector not in forward gear
LOW SPEED	Vehicle speed drops below low speed threshold	Vehicle speed dropped below the cruise control minimum operating speed. May be due to hilly terrain and low vehicle speed. Manual transmission gear selection and engine torque may contribute to this disengagement reason.
LOW VOLTAGE	Voltage below low voltage threshold	Ignition Voltage Low at ECM (typically 9 volts)
MEMORY DTC	Memory Failure	Control module memory failure detected.
MPH LIMIT	MPH Limited Fuel (Vehicle overspeed fuel cut-off active)	Vehicle overspeed protection active with fuel cut off active
M/T Gear Changed	Manual transmission out of gear with no clutch pedal apply	Manual transmission shifted to Neutral without clutch pedal being applied.
NONE	None	This disengagement reason may be displayed after a dead battery repair or module replacement.
OVER SET SPEED	Over schedule	Vehicle speed has exceeded driver selected set speed by more than an allowable amount. This may occur while driving down a significant grade or driver overriding cruise while performing a passing maneuver.
PARK BRAKE	Park Brake Switch signal Active	Parking Brake Applied
PEDAL INITIALIZE	Brake before cruise	The brake pedal has not been seen as applied prior to driver request to engage cruise with set switch. A brake pedal apply must be seen before allowing cruise engagement during each key cycle. On a vehicle equipped

		with a manual transmission, a clutch pedal apply may satisfy the brake pedal apply criteria.
PTO ACTIVE	Power Take Off Active	Power Take Off is active.
Ram DTC	Processor Integrity Fault (Ram corruption)	ECM software error has occurred
RPM LIMIT	Injectors Disabled (Engine overspeed fuel cut-off active)	Engine RPM limiter active with fuel cut off active.
S/C ON SPEED HI	Over schedule tap-down	Set/Coast switch selected, vehicle speed is above set speed and does not decrease. May be due to traveling down hill
SIMUL S/C-R/A	SET and RESUME switches simultaneously active	Set/Coast and Resume Accelerate switches pressed simultaneously
SL/W Sys On	Speed Limiter / Warning On/Off switch turned on	Driver has turned on the Speed Limiter/Warning on/off switch. Cruise is disabled / inhibited and cruise on/off switch will be set to OFF.
SW. INVALID	Analog cruise switch input out of range	Cruise switch voltage signal in invalid range
TAC INHIBIT	ETC prevents cruise operation	Electronic Throttle Control has detected a failure in the throttle control hardware
TCS	Traction control active	Traction Control was Active
TRANS DTC	Trans Gear Fault	Transmission DTC is active or in history that inhibits cruise control operation
UNDER SET SPEED	Under schedule	Vehicle speed is below cruise control set speed by more than an allowable amount
VSES	Vehicle stability active	Vehicle Stability Control was active
4WD Low	4WD Low	Transfer case in low range

CRUISE CONTROL DESCRIPTION AND OPERATION (ADAPTIVE CRUISE CONTROL)

Adaptive Cruise Control (ACC)

The Adaptive Cruise Control System (ACC) is an enhanced Cruise Control System with the ability to sense and react to forward traffic. Compared to the common Cruise Control System found on many vehicles, the main functional enhancement of the ACC System is the ability to detect the presence of a vehicle in the path of the ACC vehicle. The ACC retains the existing cruise control feature that controls the vehicle speed to the driver selected speed. However, ACC allows a driver to set and maintain a following distance to the preceding nearest vehicle in the ACC vehicle path. The cruise control vehicle distance sensor module calculates a follow speed limit to ensure an acceptable distance is maintained to the preceding vehicle in front, should one be present. The ACC System automatically adjusts the speed of an ACC vehicle when the vehicle comes up behind a slower travelling vehicle in front. The ACC System applies limited automatic braking and throttle control without

driver input when necessary to maintain the set following distance of the ACC vehicle. The preceding vehicle's speed and acceleration along with the ACC vehicle speed and acceleration and the distance between the two vehicles are factors used by the cruise control vehicle distance sensor module to determine the ACC follow speed limit. The ACC vehicle speeds up to the original driver selected set speed when the pathway becomes clear without driver input.

Adaptive Cruise Control (ACC) System Description

The Adaptive Cruise Control (ACC) System depends on various modules on the vehicle to function and each module performs a function that is critical to the proper operation of the ACC System. ACC will not operate if any components fail. Communication between modules is via the High-Speed GMLAN serial data circuit. The GMLAN utilizes the controller area network (CAN) communications protocol. The following is a functional description of the cruise control vehicle distance sensor module and the other associated components:

Cruise Control Vehicle Distance Sensor Module

The cruise control vehicle distance sensor module contains the radar and the controller. The cruise control vehicle distance sensor module utilizes the radar to identify and classify objects in the road environment. The radar scans the road environment to detect targets within its specified field of view. The controller then makes throttle and/or brake commands to the engine control module (ECM) and electronic brake control module (EBCM) via the GMLAN serial data circuit in order to control the vehicle acceleration/deceleration based on the data from the radar. The ECM and EBCM provide throttle control and automatic braking needed for proper cruise speed adjustment. The following is a list of the cruise control vehicle distance sensor module functions:

- The radar processes the road environment to get data concerning any vehicle ahead of the ACC vehicle. Detection, parameter estimation, tracking, object classification and diagnostics are the primary radar functions. When an object is detected, the controller calculates the object range, range rate, acceleration and azimuth angle parameters.
- The cruise control vehicle distance sensor module performs ACC state processing automatically - distance control or speed control. The ACC System operates in 2 possible states - Cruise or Follow. The normal operating state is Cruise, whereby the vehicle speed is controlled to match the driver selected set speed. When a preceding forward target is identified by the radar, the ACC System will automatically transition into the follow speed state to provide proper lane spacing behind the target vehicle in front. The preceding vehicle's speed and acceleration, with the ACC vehicle speed, acceleration and distance between the two vehicles will be used to determine the ACC follow speed limit. The ACC follow speed limit will ensure that an acceptable distance is maintained to the preceding vehicle.
- The cruise control vehicle distance sensor module determines the follow speed limit for throttle control by the ECM.
- The cruise control vehicle distance sensor module arbitrates the ACC System brake and throttle control between the EBCM and the ECM.
- The cruise control vehicle distance sensor module requests brake light activation during automatic braking.
- The cruise control vehicle distance sensor module provides operational feedback to the vehicle driver. The cruise control vehicle distance sensor module sends signals for telltales and messages to be displayed on the instrument cluster or driver information center.

Body Control Module (BCM)

The following are the ACC System functions provided by the BCM:

- The BCM provides a translating gateway for the high speed GMLAN serial data circuit.
- The BCM reads all cruise control switches and the gap switch. The cruise control vehicle distance sensor module monitors a variety of user operated switches from the BCM switch status information sent via the GMLAN serial data circuit.
- The BCM illuminates the brake light based on a GMLAN message from the cruise control vehicle distance sensor module during automatic braking.
- The BCM measures the brake pedal position and sends brake pedal travel status via GMLAN serial data circuit to the ECM. The ECM disengages the ACC System when the brake is applied by the driver pressing the brake pedal.
- The BCM serves as a gateway to the instrument cluster and driver information center. The BCM will generate visual warnings based on high speed GMLAN serial data messages from the cruise control vehicle distance sensor module.

Engine Control Module (ECM)

The following are the ACC System functions performed by the ECM:

- The ECM provides the electronic throttle control to the ACC System. The ECM is also responsible for determining when a driver is overriding the adaptive cruise control throttle position by pressing the accelerator pedal.
- The ECM processes the cruise control switch requests received via the GMLAN serial data circuit from the BCM. Engaging and disengaging the ACC System are functions performed by the ECM.
- The ECM determines the driver selected vehicle speed. Unless the ACC module requests a lower vehicle speed, the ECM will control the vehicle speed to the driver selected set speed.
- The ECM allows automatic braking without disengaging the ACC.

Antilock Brake System (ABS)

The following are the ACC System functions performed by the EBCM:

- The EBCM controls the operation of the Antilock Brake System.
- The EBCM provides automatic braking for the ACC System. The cruise control vehicle distance sensor module will request vehicle deceleration via high speed GMLAN serial data circuit.
- The EBCM determines when the driver-applied brake pressure is active. The EBCM will communicate this status via the GMLAN serial data circuit to the BCM.
- The EBCM releases vehicle automatic braking when there is a throttle override by the driver pressing the accelerator.
- The EBCM predicts brake temperatures. Due to automatic braking, the brake system may overheat. When the brakes are overheated, the EBCM requests the ACC System to be temporarily shut down by the ECM until the brakes cool to a normal operating temperature.

Refer to **ABS Description and Operation** .

Transmission Control Module (TCM)

The transmission control module (TCM) provides a down shift to protect the brakes. When the TCM detects some driver braking activity or ACC automatic braking activity, the TCM down shifts the vehicle transmission to increase engine braking. This helps reduce braking activity, extend brake pad life and reduce brake system overheating.

Driver Information Center

The driver information center is a part of the instrument cluster and displays the ACC System warning messages. The cruise control vehicle distance sensor module requests messages to be displayed on the driver information center by sending a GMLAN request to the BCM. The BCM sends a GMLAN serial data request to the instrument cluster demanding the display of the warning message. When the message is acknowledged by the driver and the cause of the message resolved, the driver information center turns the message off. The ACC System will not operate if the driver information center fails. The following are the ACC messages that can be displayed on the driver information center:

- Service ACC
- Front Radar Blocked Clean Front of Vehicle

Brake Pedal Position Sensor

The BCM monitors the brake pedal position sensor in order to determine when pressure is being applied to the brake by the driver stepping on the brake pedal. The brake pedal position sensor receives a low reference signal and a 5 V reference from the BCM. When the brake is applied, a signal is applied from the brake pedal position sensor through the brake pedal position sensor signal circuit to the BCM. The BCM utilizes this signal in deciding when to command the activation of the stop lamps. The BCM continuously sends signals via the GMLAN serial data circuit to the EBCM and the ECM reflecting the brake pedal position status. This will include the initial brake travel signal required for the activation of the ACC System. The ACC System will not engage unless the initial brake pedal travel signal is valid and received by the BCM. When the BCM brake pedal position signal indicates that brake pedal pressure is being applied by the driver when the ACC System is engaged, the ECM immediately disengages the ACC System. Re-engaging the ACC System will require the driver pressing the set or resume switch. Refer to **Brake Pedal Position Sensor Calibration** , and to **Exterior Lighting Systems Description and Operation** for more information on the brake pedal pressure sensor.

Accelerator Pedal

Deceleration of the ACC vehicle to maintain a certain distance and speed while a slower moving vehicle is in its path is achieved through throttle control by the ECM and the application of light automatic braking by the EBCM. During automatic braking the ECM is commanded to release the throttle from the currently controlled cruise position by the cruise control vehicle distance sensor module. At the end of automatic braking, the ECM will control the vehicle speed to the current set vehicle speed. Driver throttle override occurs when the driver of the ACC vehicle depresses the accelerator pedal with the intention of requesting greater speed than the current throttle position. An example is an ACC vehicle driver stepping on the accelerator for a passing maneuver. The ECM continuously monitors the throttle and reports a throttle override condition. When no throttle override is present, automatic braking is allowed. When throttle override is detected by the ECM, automatic braking is not allowed to affect the vehicle acceleration.

Cruise Control Switch

The cruise control switch, functionally is a common feature that is shared between the Adaptive Cruise Control (ACC) System and the regular Cruise Control System. The ACC System will not operate if any cruise switch fails. The cruise control switch comprises the following cruise control function switches:

- On/Off switch
- Set/decrease switch
- Resume/increase switch

The cruise control function switches are arranged in a resistive ladder design whereby each switch function is set up with different resistance values. The BCM through the cruise control switch signal circuit detects a predetermined voltage value when any cruise control switch function is activated. The associated cruise control function signal detected by the BCM is then sent to the engine control module (ECM) as a GMLAN serial data circuit message. The ECM on receiving the message provides the cruise control function requested by the BCM. The ECM is responsible for recognizing and responding to cruise control switch requests sent by the BCM. The cruise control function switches are used by the ECM to communicate to the cruise control vehicle distance sensor module the driver selected vehicle speed. The driver selected vehicle speed is communicated through GMLAN serial data circuit to the cruise control vehicle distance sensor module and the BCM. The ACC System engages and adjusts vehicle speeds based on the activation of the following cruise control function switches:

On/Off Switch

The BCM monitors the switch signal circuit in order to determine when the On/Off switch is disabled or activated. The BCM detects a predetermined voltage value on the switch signal circuit. The On/Off switch state is then relayed to the ECM via the GMLAN serial data circuit. The ECM sends the On/Off switch input status to the cruise control vehicle distance sensor module. When the On/Off switch is turned ON, the ACC System enters either a standby enabled or a standby disabled mode. The standby enabled mode indicates that every condition required for the ACC System to function has been met, but the ACC is not engaged. When the ACC is in the standby disabled mode, the conditions necessary for the ACC System to function has not been met. When the On/Off switch is turned OFF, the ACC will enter the disabled mode. The ACC will not activate in the disabled mode.

Set/Decrease Switch

The ACC System is engaged when the ACC On/Off switch is turned ON and the set/decrease switch is momentarily pressed and released. When the set/decrease switch is pressed, the selected vehicle speed is set to the current vehicle speed by the ECM. The vehicle speed must be at or greater than 40 km/h (25 MPH). The selected vehicle speed is displayed by the driver information center. While in the engaged state, the selected vehicle speed and the following distance can be adjusted. Pressing and holding the set/decrease switch, when the ACC System is engaged, will decrease the selected vehicle speed without deactivating the ACC. Momentarily pressing and releasing the set/decrease switch, when the ACC is engaged, decreased the selected vehicle speed by 1.6 km/h (1 MPH) for each time that the set/decrease switch is pressed.

Resume/Increase Switch

The resume/increase switch is used in order to increase the selected vehicle speed when ACC is active. The

amount selected vehicle speed can be increased from the resume/increase switch depends on how long the switch is pressed. The presence of a slower moving vehicle in the path of the ACC vehicle will limit the extent to which the selected vehicle speed can be achieved. If there is no preceding vehicle in front, limiting the ACC vehicle acceleration, then the vehicle speed that is attained is the new selected vehicle speed. The current selected vehicle speed is displayed by the driver information center. Acceleration is terminated when the resume/increase switch is released. Momentarily pressing and releasing the resume/increase switch will allow the selected vehicle to accelerate in at 1.6 km/h (1 MPH) increments for each time that the resume/increase switch is momentarily pressed.

Gap Switch

The gap switch allows the driver to determine how closely the adaptive cruise control (ACC) vehicle follows a target vehicle while ACC is engaged. When the ACC vehicle speed is being limited due to a slower travelling vehicle, the ACC vehicle speed is automatically controlled to the follow speed limit. The gap switch has 3 following distance selections that range from 1-2 s. The gap switch following distance between the ACC vehicle and the target vehicle is expressed in time as opposed to actual distance. The distance maintained for a selected gap will vary based on vehicle speed. The faster the vehicle speed, the further back you will follow. The gap setting can only be adjusted when the ACC System is engaged. The gap switch is hard-wired to the BCM. Based on voltage variations, the BCM is able to read the gap switch selection and communicates the switch status on the GMLAN serial data circuit to the cruise control vehicle distance sensor module. The gap switch is a momentary switch.

The initial push of the gap switch recalls the current setting and activates the display. Subsequent pushes of the gap switch will change the gap setting.

Cruise Indicators and Messages

SERVICE ACC

The cruise control vehicle distance sensor module commands the display of the SERVICE ACC message in the driver information center when it detects a malfunction in the Adaptive cruise control (ACC) System. The cruise control vehicle distance sensor module sends a request to the instrument cluster via the GMLAN serial data circuit to display the SERVICE ACC message in the driver information center. The SERVICE ACC is displayed in the driver information center only when a diagnostic condition is present. When the message is displayed in the driver information center the ACC System disengages.

FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE

The FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE message displays in the driver information center when the cruise control vehicle distance sensor module detects a blockage of the radar. The radar may be blocked by snow, ice, dirt, heavy rain or road spray. In rare instances, a vertically misaligned radar may trigger the activation of the FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE message in the driver information center. The cruise control vehicle distance sensor module commands the display of the FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE message via a GMLAN serial data circuit request to the instrument cluster. When the FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE message is displayed in the driver information center, safely park the vehicle and turn OFF the ignition. Clean the front fascia cover to eliminate the blockage. It may also be necessary to clean both the outside surface of the cover, the inside surface of the cover and the cruise control vehicle distance sensor module surface. It is important to

turn the ignition OFF before cleaning any of the named surfaces. This is because the FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE message may still display in the driver information center after cleaning the three surfaces. Cycling the ignition to OFF for 10 s is necessary to clear the FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE indicator if the indicator remains ON in the driver information center. If the FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE indicator still remains ON after cleaning the radar and cycling the ignition, then the radar alignment will need to be checked and verified. Perform the **Forward Range Radar Module Alignment** , if the radar is misaligned.

Cruise Engaged Indicator

The ACC engaged indicator is displayed in the instrument cluster when the ACC is engaged by pressing the set/decrease switch. When the set/decrease switch is pressed by the driver, the BCM forwards the switch state to the engine control module (ECM) over the GMLAN serial data circuit. The ECM will use the switch input information from the BCM to determine the driver intended vehicle speed. The ECM communicates to the cruise control vehicle distance sensor module over the GMLAN serial data circuit the ACC engaged state and the driver selected speed. When the cruise control vehicle distance sensor module receives the ECM message indicating that ACC is active, the cruise control vehicle distance sensor module commands the display of the ACC engaged indicator via a GMLAN serial data message to the instrument cluster.

Set Speed

The ACC vehicle set speed is displayed at all times in the driver information center when ACC is engaged. The cruise control vehicle distance sensor module set speed display request is sent to the instrument cluster via the GMLAN serial data circuit.

Follow Distance

The driver information center displays the driver selected following distance when ACC is engaged and the gap switch is active. The current follow distance setting is displayed in the driver information center for a few seconds after the gap switch is pressed to increase or decrease the following distance. The cruise control vehicle distance sensor module follow distance display request is sent to the instrument cluster via the GMLAN serial data circuit.

Vehicle Ahead Indicator

The vehicle ahead indicator is displayed in the instrument cluster when the radar identifies an in-path vehicle. The vehicle ahead indicator is a warning to the driver that a vehicle is ahead. The indicator also serves as a feedback to the driver that the radar is functioning properly. The cruise control vehicle distance sensor module commands the display of the vehicle ahead indicator via a GMLAN serial data message to the instrument cluster. The vehicle ahead indicator only displays with the ACC active and may sometimes display for stationary road objects.

Cruise Engaged

The Adaptive Cruise Control (ACC) System will engage and adjust vehicle speeds based on the activation of the following cruise switches:

- On/off

- Set/decrease
- Resume/increase

ACC will not engage if any inhibit criteria is active. Also, the driver must step on the brakes at each ignition cycle before attempting to engage ACC. The engine control module (ECM) looks to the BCM for the brake initial travel achieved signal indicating that the driver has stepped on the brakes before attempting to engage ACC.

The vehicle speed must be above 45 km/h (28 MPH) and below 190 km/h (118 MPH) for the ACC System to be engaged. In the engaged state, the ACC System allows the driver to override the controlled vehicle speed temporarily while still remaining in the engaged state.

Cruise Inhibited

Cruise Control Vehicle Distance Sensor Module Inhibits

The cruise control vehicle distance sensor module inhibits the Adaptive Cruise Control (ACC) System when any of the following conditions exists:

- The SERVICE ACC message is active in the driver information center.
- Initial brake pedal travel signal from brake pedal position sensor is not present
- An ACC System malfunction and/or failure is present.
- The FRONT RADAR BLOCKED CLEAN FRONT of VEHICLE indicator is active in the driver information center.
- An invalid vehicle speed
- The Antilock Brake System (ABS) is active during automatic braking.
- The Cruise Switch failed message from the BCM is sent to the cruise control vehicle distance sensor module.
- Automatic braking failure - A GMLAN signal from the electronic brake control module (EBCM) to the cruise control vehicle distance sensor module indicating an automatic braking failure
- The brakes overheated signal from ABS
- The cruise control vehicle distance sensor module transceiver temperature is hot.
- The driver applied brake pressure.

ECM Inhibits

The ECM inhibits the ACC System operation when any of the following conditions exists:

- The ACC inhibited signal from cruise control vehicle distance sensor module is present.
- The vehicle speed is less than 45 km/h (28 MPH).
- The vehicle speed is greater than 190 km/h (118 MPH).
- Automatic braking failure - A GMLAN signal from EBCM to the ECM indicating an automatic braking failure

- The ACC present signal from the BCM is false.
- The driver applied brake pressure.
- A cruise control switch failure is present.
- The park brake switch signal from the IPM is active.
- A Throttle Actuator Control System failure is present.
- The Traction Control System is active.
- The ABS is active.
- The engine speed protection is active.
- The vehicle speed protection is active.
- The engine speed is too high or too low.
- The automatic transmission is in first gear, Park, Neutral or Reverse.
- The initial brake pedal travel signal from the brake pedal position sensor is not present.
- The system voltage is too low.

Cruise Disengaged

The Adaptive Cruise Control (ACC) System disengages when any of the following occurs:

- The driver depresses the brake pedal.
- The driver turns the ACC On/Off switch OFF.

Pressing the brake pedal while the ACC is engaged will disengage the ACC System.

Other Adaptive Cruise Control (ACC) Features

Mechanical Alignment

When the radar is out of alignment, DTC C1002 is set by the cruise control vehicle distance sensor module. When DTC C1002 is set, it becomes necessary to mechanically align the radar using the special alignment tool. Refer to [DTC C1002](#), . For further information on how to aim and align the radar, refer to **Forward Range Radar Module Alignment**, . An out of alignment condition may be as a result of tampering or damage to the cruise control vehicle distance sensor module mounting structures or the adjuster settings. An out of alignment condition may also be as a result of damage to the front end of the vehicle or merely as a result of wear and tear . Refer to **Forward Range Radar Module Replacement** on how to properly mount and adjust the cruise control vehicle distance sensor module. Performance of the ACC System may be degraded after a cruise control vehicle distance sensor module replacement. Normal vehicle driving will correct the performance of the ACC System.

GENERAL INFORMATION

Dangers, Warnings, and Cautions

INTRODUCTION

DEFINITION OF DANGER, WARNING, CAUTION, AND NOTE

The diagnosis and repair procedures in a GM Service Manual contain both general and specific Dangers, Warnings, Cautions, Notes or Important. GM is dedicated to the presentation of service information that helps the technician to diagnose and repair the systems necessary for the proper operation of the vehicle, however, certain procedures may present a hazard to the technician if they are not followed in the recommended manner. Dangers, Warnings, Cautions and Notes or Important are elements designed to prevent these hazards, however, not all hazards can be foreseen. This information is placed at strategic locations within the service manual. This information is designed to prevent the following from occurring:

- Serious bodily injury or death to the technician
- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper repair or replacement of vehicle components.
- Any warning or caution that appears in this service category is referenced from the individual service categories.

DANGER Defined

When encountering a DANGER, you will be asked to take a necessary action or not to take a prohibited action. If a DANGER is not heeded, the following consequences may occur:

- Serious bodily injury or death to the technician
- Serious bodily injury or death to other technicians in the workplace area

WARNING Defined

When encountering a WARNING, you will be asked to take a necessary action or not to take a prohibited action. If a WARNING is not heeded, the following consequences may occur:

- Serious bodily injury to the technician
- Serious bodily injury to other technicians in the workplace area
- Serious bodily injury to the driver and/or passenger(s) of the vehicle, if the vehicle has been improperly repaired

CAUTION Defined

CAUTIONS call special attention to a necessary action or to a prohibited action. If a CAUTION is not heeded,

the following consequences may occur:

- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper operation or performance of the system or component under repair
- Damage to any systems or components which are dependent upon the proper operation of the system or component under repair
- Improper operation or performance of any systems or components which are dependent upon the proper operation or performance of the system or component under repair
- Damage to fasteners, basic tools, or special tools
- The leakage of coolant, lubricant, or other vital fluids

NOTE or IMPORTANT Defined

NOTE and IMPORTANT statements emphasize a necessary characteristic of a diagnostic or repair procedure. NOTE or IMPORTANT statements are designed to do the following:

- Clarify a procedure
- Present additional information for accomplishing a procedure
- Give insight into the reason or reasons for performing a procedure in the manner recommended
- Present information that will help to accomplish a procedure in a more effective manner
- Present information that gives the technician the benefit of past experience in accomplishing a procedure with greater ease

ABS COMPONENT HANDLING WARNING

WARNING: Certain components in the Antilock Brake System (ABS) are not intended to be serviced individually. Attempting to remove or disconnect certain system components may result in personal injury and/or improper system operation. Only those components with approved removal and installation procedures should be serviced.

APPROVED EQUIPMENT FOR COLLISION REPAIR WARNING

WARNING: To avoid personal injury when exposed to welding flashes or to galvanized (Zinc Oxide) metal toxic fumes while grinding/cutting on any type of metal or sheet molded compound, you must work in a properly ventilated area, wearing an approved respirator, eye protection, earplugs, welding gloves, and protective clothing.

ASSISTANT DRIVING WARNING

WARNING: An assistant should drive the vehicle while the technician checks for the

location of the reported condition. Otherwise, personal injury could result.

BATTERY DISCONNECT WARNING

WARNING: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

BRAKE DUST WARNING

WARNING: Avoid taking the following actions when you service wheel brake parts:

- Do not grind brake linings.
- Do not sand brake linings.
- Do not clean wheel brake parts with a dry brush or with compressed air.

Some models or aftermarket brake parts may contain asbestos fibers which can become airborne in dust. Breathing dust with asbestos fibers may cause serious bodily harm. Use a water-dampened cloth in order to remove any dust on brake parts. Equipment is available commercially in order to perform this washing function. These wet methods prevent fibers from becoming airborne.

BRAKE FLUID IRRITANT WARNING

WARNING: Brake fluid may irritate eyes and skin. In case of contact, take the following actions:

- Eye contact-rinse thoroughly with water.
- Skin contact-wash with soap and water.
- If ingested-consult a physician immediately.

CHECKING HOT TRANSMISSION FLUID THROUGH DRAIN PLUG HOLE WARNING

WARNING: The engine must be running when the transmission fluid fill plug is removed, or excessive fluid loss will occur. Transmission fluid may be hot. Since the actual fluid level is unknown, stand clear when removing the fill plug. Have a container ready to capture any lost fluid. Do not turn the engine off with the fill plug removed, as you can be injured by hot transmission fluid being expelled out of the oil fill opening.

CLEANING SOLVENT WARNING

WARNING: Bodily injury may occur if the cleaning solvent is inhaled or exposed to the skin.

COLLISION SECTIONING WARNING

WARNING: Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle and cause personal injury if the vehicle is in a collision.

CRACKED WINDOW WARNING

WARNING: If a window is cracked but still intact, crisscross the window with masking tape in order to reduce the risk of damage or personal injury.

DEFROSTER OUTLET WARNING

WARNING: If broken glass falls into the defroster outlets, it can be blown into the passenger compartment and cause personal injury.

EXHAUST SERVICE WARNING

WARNING: In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

EYE PROTECTION WARNING

WARNING: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

FOAM SOUND DEADENERS WARNING

WARNING: Foam sound deadeners must be removed from areas within 152.4 mm (6 in) of where flame is to be used for body repairs. When reinstalling foam sound deadeners, avoid inhaling fumes as bodily injury may result.

FUEL AND EVAPORATIVE EMISSION PIPE WARNING

WARNING: In order to reduce the risk of fire and personal injury observe the following items:

- Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes
- Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.
- Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never expose the vehicle to temperatures higher than 115°C (239°F) for more than one hour, or more than 90°C (194°F) for any extended period.
- Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)

FUEL GAUGE LEAK WARNING

WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

FUEL PIPE FITTING WARNING

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

FUEL STORAGE WARNING

WARNING: Do not drain the fuel into an open container. Never store the fuel in an open container due to the possibility of a fire or an explosion.

GASOLINE/GASOLINE VAPORS WARNING

WARNING: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

GLASS AND SHEET METAL HANDLING WARNING

WARNING: When working with any type of glass or sheet metal with exposed or rough edges, wear approved safety glasses and gloves in order to reduce the chance of personal injury.

HALOGEN BULB WARNING

WARNING: Halogen bulbs contain gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing the bulb.
- Leave the lamp switch OFF until the bulb change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Keep dirt and moisture off the bulb.
- Properly dispose of the used bulb.
- Keep halogen bulbs out of the reach of children.

HOT EXHAUST SYSTEM WARNING

WARNING: While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.

MOVING PARTS AND HOT SURFACES WARNING

WARNING: Avoid contact with moving parts and hot surfaces while working around a running engine in order to prevent physical injury.

PARKING BRAKE AND DRIVE WHEELS WARNING

WARNING: Apply the parking brake and block the drive wheels before performing this procedure in order to prevent bodily injury.

PROTECTIVE GOGGLES AND GLOVE WARNING

WARNING: Always wear protective goggles and gloves when removing exhaust parts as falling rust and sharp edges from worn exhaust components could result in serious personal injury.

RELIEVING FUEL PRESSURE WARNING

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

ROAD TEST WARNING

WARNING: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

SAFETY GLASSES AND COMPRESSED AIR WARNING

WARNING: Wear safety glasses when using compressed air in order to prevent eye injury.

SAFETY GLASSES WARNING

WARNING: Wear safety glasses in order to avoid eye damage.

SIR DEPLOYED INFLATOR MODULES ARE HOT WARNING

WARNING: After deployment, the metal surfaces of the SIR component may be very hot. To help avoid a fire or personal injury:

- Allow sufficient time for cooling before touching any metal surface of the SIR component.

- Do not place the deployed SIR component near any flammable objects.

SIR INFLATABLE MODULE DEPLOYMENT OUTSIDE VEHICLE WARNING

WARNING: When you are deploying an inflator module for disposal, perform the deployment procedures in the order listed. Failure to follow the procedures in the order listed may result in personal injury.

SIR INFLATOR MODULE DISPOSAL WARNING

WARNING: In order to prevent accidental deployment and the risk of personal injury, do not dispose of an undeployed inflator module as normal shop waste. Undeployed inflator modules contain substances that could cause severe illness or personal injury if their sealed containers are damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed inflator module. Failure to observe the following disposal methods may be a violation of federal, state, or local laws.

SIR INFLATOR MODULE HANDLING AND STORAGE WARNING

WARNING: When carrying an undeployed inflator module:

- Do not carry the inflator module by the wires or connector.
- Make sure the air bag opening points away from you.

When storing an undeployed inflator module:

- Make sure the air bag opening points away from the surface on which the inflator module rests.
- Provide free space for the air bag to expand in case of an accidental deployment.
- When storing a steering column, do not rest the column with the air bag opening facing down and the column vertical. Lay the column on its side.

Failure to observe these guidelines may result in personal injury.

SIR SEATBELT PRETENSIONER HANDLING WARNING

WARNING: When carrying an undeployed inflatable restraint seat belt retractor pretensioner:

- Do not carry the seat belt pretensioner by the seat belt webbing or pigtail connector, if equipped.

- Carry the seat belt pretensioner by the housing, keeping hands and fingers away from the seat belt webbing.
- Make sure the opening, from which the seat belt webbing extends, faces downward and the seat belt webbing hangs freely.

Failure to observe these guidelines may result in personal injury.

SIR SPECIAL TOOL WARNING

WARNING: Failure to observe the special tool recommendations and instructions could cause SIR deployment, personal injury, or unnecessary SIR system repairs.

SIR WARNING

WARNING: This vehicle is equipped with a Supplemental Inflatable Restraint (SIR) System. Failure to follow the correct procedure could cause the following conditions:

- Air bag deployment
- Personal injury
- Unnecessary SIR system repairs

In order to avoid the above conditions, observe the following guidelines:

- Refer to SIR Component Views in order to determine if you are performing service on or near the SIR components or the SIR wiring.
- If you are performing service on or near the SIR components or the SIR wiring, disable the SIR system. Refer to SIR DISABLING AND ENABLING .

WINDOW RETENTION WARNING

WARNING: When replacing stationary windows, use Urethane Adhesive Kit GM P/N 12346392 (Canadian P/N 10952983), or a urethane adhesive system meeting GM Specification GM3651G, to maintain original installation integrity. Failure to use the urethane adhesive kit will result in poor retention of the window which may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.

WORK STALL TEST WARNING

WARNING: One or more of the following guidelines may apply when performing specific required tests in the work stall:

- When a test requires spinning the drive wheels with the vehicle jacked up, adhere to the following precautions:
 - Do not exceed 56 km/h (35 mph) when spinning one drive wheel with the other drive wheel stopped. This limit is necessary because the speedometer indicates only one-half the actual vehicle speed under these conditions. Personal injury may result from excessive wheel spinning.
 - If all of the drive wheels are spinning at the same speed, do not exceed 112 km/h (70 mph). Personal injury may result from excessive wheel spinning.
 - All persons should stay clear of the rotating components and the balance weight areas in order to avoid possible personal injury.
 - When running an engine in the repair stall for an extended period of time, use care not to overheat the engine and the transmission.
- When a test requires jacking up the vehicle and running with the wheels and brake rotors removed, adhere to the following precautions:
 - Support the suspension at normal ride height.
 - Do not apply the brake with the brake rotors removed.
 - Do not place the transmission in PARK with the drive axles spinning.
 - Turn Off the ignition in order to stop the powertrain components from spinning.
- When running an engine in the work stall, use the exhaust removal system to prevent breathing dangerous gases.

AVOID CHIPPING OR SCRATCHING THE COATING CAUTION

CAUTION: Care should be taken to avoid chipping or scratching the coating when handling the suspension coil spring. Damage to the coating can cause premature failure.

AVOID TOUCHING THE BULB CAUTION

CAUTION: Avoid touching the bulb or letting the bulb come in contact with anything damp. Oil from your skin or moisture on the bulb can cause the bulb to explode when the bulb is turned on. If either comes in contact with the bulb, clean the bulb with alcohol or a suitable degreaser and wipe the bulb dry.

BALL STUD REMOVAL CAUTION

CAUTION: Do not free the ball stud by using a pickle fork or a wedge-type tool. Damage to the seal or bushing may result.

BELT DRESSING CAUTION

CAUTION: Do not use belt dressing on the drive belt. Belt dressing causes the breakdown of the composition of the drive belt. Failure to follow this recommendation will damage the drive belt.

BRAKE CALIPER CAUTION

CAUTION: Support the caliper with a piece of wire to prevent damage to the brake line.

BRAKE FLUID EFFECTS ON PAINT AND ELECTRICAL COMPONENTS CAUTION

CAUTION: Avoid spilling brake fluid onto painted surfaces, electrical connections, wiring, or cables. Brake fluid will damage painted surfaces and cause corrosion to electrical components. If any brake fluid comes in contact with painted surfaces, immediately flush the area with water. If any brake fluid comes in contact with electrical connections, wiring, or cables, use a clean shop cloth to wipe away the fluid.

CLEAN, DRY, LOW PRESSURE GAS SOURCE CAUTION

CAUTION: Use the Evaporative Emission (EVAP) System Tester (EEST) GE 41413-A in order to provide a clean, dry, low pressure nitrogen gas source. Do not substitute any other pressurized source, gas or otherwise. Damage may result to the EVAP system, test equipment or cause a safety risk.

CLEARCOAT/ULTRAVIOLET SCREENERS CAUTION

CAUTION: Removing more than 0.5 mils of the clearcoat can result in early paint failure. The clearcoat contains ultraviolet screeners. Do not finesse sand more than what is required to remove the defect.

COMPONENT FASTENER TIGHTENING CAUTION

CAUTION: Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may

affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.

COVER AND PLUG OPENINGS CAUTION

CAUTION: Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering the open pipes and passages.

DRIVE AXLE CAUTION

CAUTION: Support the lower control arms in the normal horizontal position in order to avoid damage to the drive axles. Do not operate the vehicle in gear with the wheels hanging down at full travel.

DRIVE BELT TENSIONER PIVOT BOLT CAUTION

CAUTION: Failure to properly tighten the drive belt tensioner pivot bolt to the specified torque value will cause the bolt to fail, and also damage to other engine components.

ELECTRIC BELT DRIVE RACK AND PINION STEERING GEAR WIRING HARNESS CAUTION

CAUTION: Ensure the torque sensor wiring harness is fully connected and seated to the electric power steering motor controller module. If the harness connector is not fully engaged, damage to the module will occur when the key is turned on and replacement of the module will be necessary.

ENGINE COOLANT THERMOSTAT HOUSING CAUTION

CAUTION: Use care when performing this procedure. Use of excessive force may damage the coolant thermostat.

EXTERIOR TRIM EMBLEM REMOVAL CAUTION

CAUTION: Use a plastic, flat-bladed tool to prevent paint damage when removing an emblem/name plate.

FASTENER CAUTION

CAUTION: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Do not use paints, lubricants, or corrosion inhibitors on fasteners, or fastener joint surfaces, unless specified. These coatings affect fastener torque and joint clamping

force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems. When using fasteners that are threaded directly into plastic, use extreme care not to strip the mating plastic part(s). Use hand tools only, and do not use any kind of impact or power tools. Fastener should be hand tightened, fully seated, and not stripped.

FUEL AND EVAPORATIVE EMISSION HOSE/PIPE CONNECTION CLEANING CAUTION

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- The fuel pipe connections
- The hose connections
- The areas surrounding the connections

HEATED OXYGEN AND OXYGEN SENSOR CAUTION

CAUTION: Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged.

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Ensure the sensor or vehicle lead wires are not bent sharply or

kinked. Sharp bends or kinks could block the reference air path through the lead wire.

- Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.
- Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using Packard's Crimp and Splice Seals Terminal Repair Kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

HEATED OXYGEN SENSOR RESISTANCE LEARN RESET CAUTION

CAUTION: When replacing the HO2S perform the following:

- A code clear with a scan tool, regardless of whether or not a DTC is set
- HO2S heater resistance learn reset with a scan tool, where available

Perform the above in order to reset the HO2S resistance learned value and avoid possible HO2S failure.

OBDII SYMBOL DESCRIPTION CAUTION

CAUTION: The OBD II symbol is used on the circuit diagrams in order to alert the technician that the circuit is essential for proper OBD II emission control circuit operation. Any circuit which fails and causes the malfunction indicator lamp (MIL) to turn ON, or causes emissions-related component damage, is identified as an OBD II circuit.

PAINT DAMAGE CAUTION

CAUTION: To avoid paint damage, protect the area surrounding the part which you are removing or installing.

PIPE WRENCH POSITIONING CAUTION

CAUTION: The pipe wrench must be placed at the valve end of the steering gear and positioned up against the inner tie rod housing. Placing the pipe wrench in any other location will cause damage to the steering gear.

POWER STEERING HOSE DISCONNECTED CAUTION

CAUTION: Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.

SILICON CONTAMINATION OF HEATED OXYGEN SENSORS CAUTION

CAUTION: Contamination of the oxygen sensor can result from the use of an inappropriate RTV sealant (not oxygen sensor safe) or excessive engine coolant or oil consumption. Remove the HO2S and visually inspect the portion of the sensor exposed to the exhaust stream in order to check for contamination. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Silicon contamination causes a high but false HO2S signal voltage (rich exhaust indication). The control module will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem. Eliminate the source of contamination before replacing the oxygen sensor.

STEERING GEAR PRELOAD ADJUSTMENT CAUTION

CAUTION: Do not change the steering gear preload adjustment before moving the inner tie rod from the steering gear. Changing the steering gear preload adjustment before moving the inner tie rod could result in damage to the pinion and the steering gear.

STEERING WHEEL IN THE FULL TURN POSITION CAUTION

CAUTION: Do not hold the steering wheel in the full turn position longer than 5 seconds, as damage to the steering pump may result.

STEERING WHEEL STRAIGHT AND COLUMN LOCKED CAUTION

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- The steering column
- The intermediate shaft(s)
- The steering gear

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible

damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

TEST PROBE CAUTION

CAUTION: Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the EL-35616 GM Approved Terminal Test Probe Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the EL-35616 GM Approved Terminal Test Probe Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the EL-35616 GM Approved Terminal Test Probe Kit label on the inside of the EL-35616 GM Approved Terminal Test Probe Kit for the correct adapter along with the connector end view.

THREE-WAY CATALYTIC CONVERTER DAMAGE CAUTION

CAUTION: In order to avoid damaging the replacement three-way catalytic converter, correct the engine misfire or mechanical fault before replacing the three-way catalytic converter.

TORQUE REACTION AGAINST TIMING DRIVE CHAIN CAUTION

CAUTION: A wrench must be used on the hex of the camshaft when loosening or tightening in order to prevent component damage. Failure to prevent the torque reaction against the timing drive chain can lead to timing drive chain failure.

TRANSMISSION FLUID VENT CAP REMOVAL CAUTION

CAUTION: The fluid vent cap must be removed before checking the fluid level, in order to ensure the proper level. Improper fluid level may damage the transmission.

TRANSMISSION OVERFILL CAUTION

CAUTION: Check the transmission fluid level immediately after adding fluid and before vehicle operation. Do not overfill the transmission. An overfilled transmission may result in foaming or fluid to be expelled out the vent

tube when the vehicle is operated. Overfilling will result in possible damage to the transmission.

USING PROPER POWER STEERING FLUID CAUTION

CAUTION: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

VALVE LIFTER PRIMING CAUTION

CAUTION: Ensure each valve lifter is filled with clean engine oil and the valve lifter does not tip over (plunger down) before the installation of the valve lifters. The loss of oil in the valve lifter lower pressure chamber or the dry stroking/cycling of the valve lifter plunger will allow air to travel into the high pressure chamber of the valve lifter. Air in the high pressure chamber of the valve lifter may not be purged causing extensive engine component damage.

WINDOW EDGE DAMAGE CAUTION

CAUTION: Avoid damage to the window from impacting objects due to an exposed edge. The window must be 1 mm (0.025 in) below the surface of the sheet metal to avoid window damage.

ACCESSORIES & EQUIPMENT

Data Communications - Description and Operation

DESCRIPTION AND OPERATION

BODY CONTROL SYSTEM DESCRIPTION AND OPERATION

The body control system consists of the body control module (BCM), communications, and various input and outputs. Some inputs, outputs and messages require other modules to interact with the BCM. The BCM also has discrete input and output terminals to control the vehicle's body functions. The BCM is wired to the high speed GMLAN serial data bus, low speed GMLAN serial data bus and Multiple LIN buses and acts as a gateway between them.

Power Mode Master

This vehicle body control module (BCM) functions as the power mode master (PMM). The ignition switch is a low current switch with multiple discrete ignition switch signals to the PMM for determining the power mode that will be sent over the serial data circuits to the other modules that need this information; the PMM will activate relays and other direct outputs of the PMM as needed. Refer to **Power Mode Description and Operation** for a complete description of power mode functions.

Gateway

The body control module (BCM) in this vehicle functions as a gateway or translator. The purpose of the gateway is to translate serial data messages between the GMLAN high speed bus and the GMLAN low speed bus for communication between the various modules. The gateway will interact with each network according to that network's transmission protocol.

All communication between the BCM and a scan tool is on the high speed GMLAN serial data circuits. A lost communication DTC typically is set in modules other than the module with a communication failure.

Body Control

The various body control module (BCM) input and output circuits are illustrated in the corresponding functional areas on the BCM electrical schematics. Refer to the **Body Control System Schematics** for more detailed information.

DATA LINK COMMUNICATIONS DESCRIPTION AND OPERATION

NOTE: This is an overview of different serial data buses used by GM devices to communicate with each others. Use **Data Communication Schematics** to find out which serial data buses are configured for a specific vehicle.

Circuit Description

There are many components in a vehicle that rely on information from other sources, transmit information to

other sources, or both. Serial data communication networks provide a reliable, cost effective, way for various components of the vehicle to "talk" to one another and share information.

GM uses a number of different communication buses to insure the timely and efficient exchange of information between devices. When compared to each other, some of these buses are different in nature as far as speed, signal characteristics, and behavior. An example of this is the High Speed GMLAN and Low Speed GMLAN buses.

On the other hand, when other buses are compared to each other they have similar characteristics and simply operate in parallel. In this case they are used to group together components which have high interaction. Examples are the High Speed GMLAN, Powertrain Expansion, and Chassis Expansion buses. This allows them to communicate with each other on a bus with reduced message congestion insuring faster and the more timely exchange of information than if all vehicle devices were on a single bus.

The majority of information that exists within a given network generally stays local; however some information will have to be shared on other networks. Control modules designated as Gateway's perform the function of transferring information between the various buses. A Gateway module is connected to at least 2 buses and will interact with each network according to its message strategy and transmission models.

GMLAN provides the capability for a receiving device to monitor message transmissions from other devices in order to determine if messages of interest are not being received. The primary purpose is to allow reasonable default values to be substituted for the information no longer being received. Additionally, a device may set a Diagnostic Trouble Code to indicate that the device it is expecting information from is no longer communicating.

High Speed GMLAN Circuit Description

A High Speed GMLAN Bus is used where data needs to be exchanged at a high enough rate to minimize the delay between the occurrence of a change in sensor value and the reception of this information by a control device using the information to adjust vehicle system performance.

The High Speed GMLAN serial data network consists of two twisted wires. One signal circuit is identified as GMLAN-High and the other signal circuit is identified as GMLAN-Low. At each end of the data bus there is a 120 ohms termination resistor between the GMLAN-High and GMLAN-Low circuits.

Data symbols (1's and 0's) are transmitted sequentially at a rate of 500 Kbit/s. The data to be transmitted over the bus is represented by the voltage difference between the GMLAN-High signal voltage and the GMLAN-Low signal voltage.

When the two wire bus is at rest the GMLAN-High and GMLAN-Low signal circuits are not being driven and this represents a logic "1". In this state both signal circuits are at the same voltage of 2.5 V. The differential voltage is approximately 0 V.

When a logic "0" is to be transmitted, the GMLAN-High signal circuit is driven higher to about 3.5 V and the GMLAN-Low circuit is driven lower to about 1.5 V. The differential voltage becomes approximately 2.0 (+/- 0.5) V.

Chassis High Speed GMLAN Circuit Description

The GMLAN Chassis Expansion Bus is basically a copy of the High Speed GMLAN Bus except that its use is reserved for chassis components. This implementation splits message congestion between two parallel buses helping to insure timely message transmission and reception. Sometimes communication is required between the Chassis Expansion Bus and the primary High Speed GMLAN Bus. This is accomplished by using the K17 Electronic Brake Control Module (EBCM) as the Gateway module. Since the High Speed GMLAN Chassis Expansion Bus and primary High Speed GMLAN Bus operate in the same manner, the diagnostics for each are similar.

Object High Speed GMLAN Circuit Description

The GMLAN Object Bus is basically a copy of the High Speed GMLAN Bus except that its use is reserved for the enhanced safety system. This implementation is used to isolate the heavy communication among the enhanced safety system devices from the other vehicle buses, reducing congestion. The K124 Active Safety Control Module is connected to the Object Bus as well as the Primary High Speed GMLAN Bus, the Chassis Expansion Bus, and the Low Speed GMLAN Bus. The K124 Active Safety Control Module acts as a Gateway module for all required communication between the Object Bus devices and devices on these other vehicle buses. The GMLAN Object Bus operates in the same manner as the Chassis Expansion and Primary High Speed buses and so the diagnostics are similar. The Object Bus is physically partitioned into a Front Object Bus and a Rear Object Bus with each partition having its own communication enable circuit to activate the partition, but functional operation of both is identical. The Front Object Bus standard devices are the K124 Active Safety Control Module, the K109 Frontview Camera Module, and the B233B Radar Sensor Module - Long Range. The Front Object Bus optional devices are the B233LF Radar Sensor Module - Short Range Left Front and the B233RF Radar Sensor Module - Short Range Right Front. The Rear Object Bus is optional and when present will have the K124 Active Safety Control Module and B233R Radar Sensor Module - Short Range Rear on the bus, and optionally the Radar Sensor Module - Short Range Right Rear. All Object Bus components are powered by the K124 Active Safety Control Module via the communication enable circuits, except the K109 Frontview Camera Module which is powered directly by battery.

Media Oriented Systems Transport (MOST) Circuit Description

The MOST Infotainment network is a dedicated high speed multimedia streaming data bus independent from GMLAN. The MOST bus will be configured in a physical hardwired loop with each device within the bus sends and receives data on an assigned MOST addresses in a set order. Each device on the MOST bus will be required to have twisted pair copper wires (2 transmit TX, 2 receive RX, and 1 electronic control line which is a 12 V wakeup signal line). The A11 Radio is the MOST Master and will monitor the bus for vehicle configuration, Infotainment data messages and errors on the bus. The MOST initialization consists of a short 100 ms low voltage pulse on the electronic control line (or MOST control line) connected to all devices contained on the MOST ring. This wakeup message once received by each device, will first respond with a generic device response. Once these initial responses on the MOST bus are reported successfully without error to the A11 Radio, the second data request will record the MOST device addresses, their functionality requirements and capabilities within. The A11 Radio will learn this information and also record the address node sequence on the MOST bus at this point. This node address list will now be stored within the A11 Radio as the MOST bus configuration (called "Last Working MOST ID of Node 1 - 9" on scan tool data display).

When MOST receive, transmit, or control line faults are detected, transmit/receive messages will not received as expected from the wakeup request. The A11 Radio and the K74 Human Machine Interface Control Module will then perform diagnostics to isolate these MOST faults. If the MOST control line is shorted low to 0 V for excess amount of time, the A11 Radio will set a U2098 DTC and K74 Human Machine Interface Control

Module will set a U0029 02 DTC. At this point the MOST bus will be unable to communicate until the shorted MOST control line is repaired.

Once the shorted MOST control line diagnostics pass, the A11 Radio will attempt to resend the initial short pulse attempts up to 3 times on the MOST control line. If the expected responses are not received, the A11 Radio continues into a failure mode setting a U0028 DTC and will continue on to send one 300 ms long pulse, which will enable the furthest upstream transmitting device to become the surrogate MOST Master in this MOST fault/diagnostic mode. When the A11 Radio receives this new MOST Master identity, the surrogate MOST master device can be identified based on scan tool data parameter "Surrogate MOST Master Node Upstream Position". The scan tool should be used to determine the MOST bus configuration and direction by utilizing the "Last Working MOST ID of Node 1 - 9" parameters from the A11 Radio data display. When a fault is present, it will indicate the newly enabled "Surrogate MOST Master Node Upstream Position" from the A11 Radio. This will assist in determining where the MOST bus/control is at fault. The MOST device upstream from the surrogate MOST master device, transmit, receive, or control lines will be the suspect areas for diagnostics at this point. These faults can be associated with any of the MOST transmit, receive, or control line twisted copper wires or possibly an internal device fault.

The K74 Human Machine Interface Control Module will set a U0029 00 DTC when it diagnoses a MOST bus not communicating properly after one attempt. When the DTC U0029 00 is set by the K74 Human Machine Interface Control Module without the corresponding DTC U0028 from the A11 Radio, it will be an indication of an intermittent wiring/device condition.

CAN Graphical Interface (CGI) Circuit Description

This bus is used by the Entertainment sub-system to transfer high-rate display graphics between the A11 Radio and the P17 Info Display Module and/or Radio/HVAC Control. The electrical characteristics of the CAN Graphical Interface (CGI) Bus are very similar to the High Speed GMLAN Bus. The message strategy and construction of messages are different however. Sometimes communication is required between the CAN Graphical Interface Bus and the Low Speed GMLAN Bus. This is accomplished by using the A11 Radio as the Gateway module. Since the CAN Graphical Interface Bus and primary High Speed GMLAN Bus have similar electrical characteristics, the diagnostics for each are similar.

In the case where the P17 Info Display Module and Radio/HVAC Control are separate devices the P17 Info Display Module is responsible for passing information between the A11 Radio and the Radio/HVAC Control. The A11 Radio interfaces only with the P17 Info Display Module and the P17 Info Display Module then communicates with the Radio/HVAC Control through a Local Interconnect Network (LIN) interface.

A bus wake up signal will be generated by the A11 Radio or by the P17 Info Display Module when the system functionality is required. The communication function of the CAN Graphical Interface shall be enabled or disabled based on the voltage level of the Center Stack Wake. The network will stay awake as long as the circuit voltage is driven low, to less than 1.5 V. Communications are disabled with a high circuit voltage around 5.0 V.

The A11 Radio can execute a warm reset of the P17 Info Display Module if the P17 Info Display Module fails to respond to the A11 Radio's request. The Center Stack Reset is a low-asserted pull down output (less than 1.5 V) from the A11 Radio to the P17 Info Display Module and has the same electrical characteristics as those for the Center Stack Wake signal defined above.

Mid Speed GMLAN Circuit Description

The Mid Speed GMLAN Bus is very similar to the High Speed GMLAN Bus except that it uses a slower transmission rate of 125 Kbit/s. This bus is intended for use where the system response time demands that a large amount of data be transmitted in a relatively short amount of time, such as updating a graphics display. As such it has usually been used for infotainment applications. Sometimes communication is required between the Low Speed GMLAN Bus and the Mid Speed GMLAN Bus. This is accomplished by using the A11 Radio as the Gateway module. Since the Mid Speed GMLAN Bus and primary High Speed GMLAN Bus operate in a similar manner, the diagnostics for each are similar.

Low Speed GMLAN Circuit Description

Low Speed GMLAN Bus is used in applications where a high data rate is not required which allows for the use of less complex components. It is typically used for operator controlled functions where the response time requirements are slower than those required for dynamic vehicle control.

The Low Speed GMLAN Serial Data Network consists of a single wire, ground referenced bus with high side voltage drive. During on road vehicle operation data symbols (1's and 0's) are transmitted sequentially at the normal rate of 33.3 Kbit/s. For component programming only, a special high speed data mode of 83.3 Kbit/s may be used.

Unlike the high speed dual wire networks, the single wire low speed network does not use terminating resistors at either end of the network.

The data symbols to be transmitted over the bus are represented by different voltage signals on the bus. When the Low Speed GMLAN Bus is at rest and is not being driven, there is a low signal voltage of approximately 0.2 V. This represents a logic "1". When a logic "0" is to be transmitted, the signal voltage is driven higher to around 4.0 V or higher.

Local Interconnect Network (LIN) Circuit Description

The Local Interconnect Network (LIN) Bus consists of a single wire with a transmission rate of 10.417 Kbit/s. This bus is used to exchange information between a master control module and other smart devices which provide supporting functionality. This type of configuration does not require the capacity or speed of either a High Speed GMLAN Bus or Low Speed GMLAN Bus and is thus relatively simpler.

The data symbols (1's and 0's) to be transmitted are represented by different voltage levels on the communication bus. When the LIN Bus is at rest and is not being driven, the signal is in a high voltage state of approximately V_{batt} . This represents a logic "1". When a logic "0" is to be transmitted, the signal voltage is driven low to about ground (0.0 V).

Communication Enable Circuit Description

Devices on High Speed GMLAN Bus enable or disable communication based on the voltage level of the communication enable circuit. When the circuit voltage is high (around 12 V), communications are enabled. When the circuit is low, communications are disabled.

Data Link Connector (DLC)

The X84 Data Link Connector (DLC) is a standardized 16-cavity connector. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

- Pin 1 Low speed GMLAN communications terminal
- Pin 2 Class 2 communications terminal
- Pin 3 Mid speed GMLAN serial bus (+) terminal or Object high speed GMLAN serial bus (+) terminal
- Pin 4 Scan tool power ground terminal
- Pin 5 Common signal ground terminal
- Pin 6 High speed GMLAN serial data bus (+) terminal
- Pin 7 Keyword communications terminal
- Pin 11 Mid speed GMLAN serial bus (-) terminal or Object high speed GMLAN serial bus (-) terminal
- Pin 12 Chassis high speed GMLAN serial bus (+) terminal
- Pin 13 Chassis high speed GMLAN serial bus (-) terminal
- Pin 14 High speed GMLAN serial data bus (-) terminal
- Pin 16 Scan tool power, battery positive voltage terminal

Serial Data Reference

The scan tool communicates over the various buses on the vehicle. When a scan tool is installed on a vehicle, the scan tool will try to communicate with every device that could be optioned into the vehicle. If an option is not installed on the vehicle, the scan tool will display No Comm (or Not Connected) for that optional device. In order to avert misdiagnoses of No Communication with a specific device, refer to **Data Link References** for a list of devices, the buses they communicate with, and the RPO codes for a specific device.

ACCESSORIES & EQUIPMENT

Data Communications - Diagnostic Code Index

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B1000</u>	DTC B1000 Electronic Control Unit
<u>DTC B1001</u>	DTC B1001 Option Configuration
<u>DTC B101D</u>	DTC B101D Electronic Control Unit Hardware
<u>DTC B101E</u>	DTC B101E Electronic Control Unit Software
<u>DTC C056D</u>	DTC C056D Electronic Control Unit Hardware
<u>DTC C056E</u>	DTC C056E Electronic Control Unit Software
<u>DTC P0601-P0606, P060A, P062F, or P262B</u>	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P0605 Control Module Programming Read Only Memory Performance DTC P0606 Control Module Processor Performance DTC P060A Control Module Monitoring Processor Performance DTC P062F Control Module Long Term Memory Performance DTC P262B Control Module Power Off Timer Performance
<u>DTC U0001</u>	DTC U0001 00 High Speed CAN Communication Bus Malfunction
<u>DTC U0020</u>	DTC U0020 Low Speed CAN Bus
<u>DTC U0028</u>	DTC U0028 MOST Bus
<u>DTC U0029</u>	DTC U0029 MOST Bus Performance
<u>DTC U0073 or U2100</u>	DTC U0073 Control Module Communication Bus A Off DTC U2100 CAN Bus Communication
<u>DTC U0074 (Chassis Expansion Bus)</u>	DTC U0074 Control Module Communication Bus B Off
<u>DTC U0074 (Powertrain Expansion Bus with HP6)</u>	DTC U0074 00 Control Module Communication Powertrain Expansion CAN Bus Off Malfunction
<u>DTC U0074 (Mid Speed GMLAN)</u>	DTC U0074 Control Module Communication Bus B Off
<u>DTC U0074 (Powertrain Expansion Bus without HP6)</u>	DTC U0074 00 Control Module Communication Powertrain Expansion CAN Bus Off Malfunction
<u>DTC U0078</u>	DTC U0078 Control Module Communication Low Speed CAN Bus Off
<u>DTC U0100-U02FF (without HP6)</u>	See <u>Control Module U Code List</u>
<u>DTC U0100-U02FF (with HP6)</u>	See <u>Control Module U Code List</u>
<u>DTC U0300-U0336</u>	See <u>Control Module U Code List</u>

<u>DTC U0400-U05FF</u>	See <u>Control Module U Code List</u>
<u>DTC U1500-U15FF</u>	See <u>Control Module U Code List</u>
<u>DTC U180B</u>	DTC U180B 00 Battery Energy Control Module High Speed CAN Bus Off Malfunction
<u>DTC U1811</u>	DTC U1811 00 Battery Energy Control Module Powertrain Expansion CAN Bus Off Malfunction
<u>DTC U1814</u>	DTC U1814 Powertrain Wake-Up Communication Circuit
<u>DTC U1817</u>	DTC U1817 00 Lost Communication with Hybrid Powertrain Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U1818</u>	DTC U1818 00 Lost Communication with Engine Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U182A</u>	DTC U182A 00 Hybrid Powertrain Control Module Lost Communication with Battery Energy Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U1831</u>	DTC U1831 00 Drive Motor Control Module 1 Lost Communication with Hybrid Powertrain Control Module Malfunction
<u>DTC U1844</u>	DTC U1844 00 Battery Energy Control Module Lost Communication with Hybrid Powertrain Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U1845 or U1846</u>	DTC U1845 00 Drive Motor Control Module 1 Lost Communication with Hybrid Powertrain Control Module Malfunction
<u>DTC U1847</u>	DTC U1847 00 Drive Motor Control Module 1 Lost Communication with Battery Energy Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U1875</u>	DTC U1875 00 Drive Motor Control Module 1 Lost Communication with Battery Energy Control Module Malfunction
<u>DTC U1876</u>	DTC U1876 00 Drive Motor Control Module 1 Lost Communication with Engine Control Module Malfunction
<u>DTC U1885</u>	DTC U1885 00 Battery Energy Control Module Lost Communication with Hybrid Powertrain Control Module Malfunction
<u>DTC U1886</u>	DTC U1886 00 Battery Energy Control Module Lost Communication with Engine Control Module Malfunction
<u>DTC U18A2</u>	DTC U18A2 Lost Communication with Fuel Pump Driver Control Module
<u>DTC U18A6</u>	DTC U18A6 Lost Communication with Right Object Detection Control Module on Dedicated Bus 1
<u>DTC U18B9-U18BF</u>	DTC U18B9 Primary High Speed CAN Bus Subnet Configuration List DTC U18BF Secondary High Speed CAN Bus Subnet Configuration List
<u>DTC U1901</u>	DTC U1901 00 Lost Communication With Front Controls Multifunction Interface Module Malfunction
<u>DTC U2098</u>	DTC U2098 00 MOST Communication Enable Circuit Malfunction DTC U2098 02 MOST Communication Enable Circuit Short to Ground
<u>DTC U2099</u>	DTC U2099 High Speed Communication Enable Circuit
<u>DTC U2616</u>	DTC U2616 Fuel Pump Driver Control Module Lost Communication

	with ECM
<u>DTC U2101</u>	DTC U2101 CAN Bus Maximum List of Control Modules
<u>DTC U2160-U2231</u>	See <u>Control Module U Code List</u>

ACCESSORIES & EQUIPMENT

Data Communications - Diagnostic Information and Procedures

DIAGNOSTIC INFORMATION AND PROCEDURES

CONTROL MODULE U CODE LIST

This list includes all Data Communications related U-code DTCs in alphanumeric order with descriptors for all devices. Not all DTCs listed will be applicable to all vehicles.

For symptom byte information, refer to **Symptom Byte List** .

Control Module U Code List

DTC	DTC Descriptor
U0001	High Speed CAN Bus Malfunction
U0002	High Speed CAN Bus
U0009	High Speed CAN Bus [-] Shorted to Bus [+]
U0020	Low Speed CAN Bus
U0028	MOST Bus
U0029	MOST Bus Performance
U0073	Control Module Communication Bus A Off
U0074	Control Module Communication Bus B Off
U0075	Control Module Communication Object Detection CAN Bus Off
U0077	Control Module Communication Chassis Expansion CAN Bus Off
U0078	Control Module Communication Low Speed CAN Bus Off
U007A	Control Module Communication High Voltage Energy Management CAN Bus Off
U0100	Lost Communication With Engine Control Module
U0101	Lost Communication With Transmission Control Module
U0102	Lost Communication with Transfer Case Control Module
U0103	Lost Communication with Shift Lever Module
U0104	Lost Communication With Cruise Control Module
U0105	Lost Communication with Fuel Injector Control Module
U0106	Lost Communication with Glow Plug Control Module
U0109	Lost Communication with Fuel Pump Control Module (<i>2013 and prior</i>)
	Lost Communication with Chassis Control Module (<i>2014 and beyond</i>)
U010E	Lost Communication with Reductant Sensor Module
U010F	Lost Communication with Air Conditioning Control Module
U0111	Lost Communication with Battery Energy Control Module
U0112	Lost Communication with Battery Energy Control Module
U0115	Lost Communication with Engine Control Module B
U0117	Lost Communication With Power Take-Off Control Module
U0121	Lost Communication With Electronic Brake Control Module

U0122	Lost Communication With Vehicle Stability Control Module
U0123	Lost Communication with Yaw Rate Sensor Module
U0125	Lost Communication With Multi-axis Acceleration Sensor Module
U0126	Lost Communication With Steering Wheel Angle Sensor Module
U0128	Lost Communication With Park Brake Control Module
U0129	Lost Communication with Brake System Control Module
U012A	Lost Communication With Chassis Control Module
U0130	Lost Communication With Electric Power Steering Control Module
U0131	Lost Communication With Power Steering Control Module
U0132	Lost Communication With Suspension Control Module
U0133	Lost Communication With Air Suspension Control Module
U0136	Lost Communication With Differential Control Module - Rear
U0137	Lost Communication with Trailer Brake Control Module
U0139	Lost Communication With Suspension Control Module
U0140	Lost Communication With Body Control Module
U0146	Lost Communication with Infotainment Gateway Module
U0151	Lost Communication With Inflatable Restraint Sensing and Diagnostic Module
U0155	Lost Communication With Instrument Cluster
U0158	Lost Communication With Head-Up Display
U0159	Lost Communication With Parking Assist Control Module
U0160	Lost Communication With Chime Alarm Control Module
U0164	Lost Communication with HVAC Control Module
U0166	Lost Communication with Auxiliary Heater Control Module
U0167	Lost Communication with Immobilizer Control Module
U0168	Lost Communication With Keyless Entry Control Module
U016B	Lost Communication with Electric A/C Compressor Control Module
U0170	Lost Communication with Passenger Presence Detection Sensor Module
U0181	Lost Communication With Headlamp Leveling Control Module
U0182	Lost Communication With Lighting Control Module - Front
U0184	Lost Communication With Radio
U0186	Lost Communication With Speaker Amplifier Module
U0196	Lost Communication With Rear Audio Control Module
U0191	Lost Communication With Television
U0193	Lost Communication With Digital Radio Receiver Control Module
U0197	Lost Communication With Telephone Control Module
U0198	Lost Communication With Telematic Control Module
U0201	Lost Communication With Transfer Case Control Module
U0203	Lost Communication With Left Rear Door Switch Panel Control Module
U0204	Lost Communication With Right Rear Door Switch Panel Control Module
U0207	Lost Communication With Moveable Roof Control Module
U0208	Lost Communication with Seat Memory Control Module

	Lost Communication With Front Seat Heating Control Module
U0210	Lost Communication With Rear Seat Heating Control Module
U0230	Lost Communication With Liftgate Control Module
U0232	Lost Communication with Side Object Detection Control Module - Left
U0233	Lost Communication with Side Object Detection Control Module - Right
U0236	Lost Communication With Steering Column Lock Module
U0237	Lost Communication With Multimedia Player Interface Module
U023A	Lost Communication With Vehicle Direction Camera Control Module (<i>without UGN</i>)
	Lost Communication With Active Safety Control Module (<i>with UGN</i>)
U0248	Lost Communication with Remote Accessory Module
U0249	Lost Communication with Entertainment Control Module - Rear
U0250	Lost Communication with Impact Classification System Module
U0252	Lost Communication With Trailer Interface Control Module
U0254	Lost Communication With Remote Start Module
U0255	Lost Communication With Info Display Module
U0256	Lost Communication With Infotainment Faceplate Control Module
U0257	Lost Communication With Info Display Module/Infotainment Faceplate Control Module
U025B	Lost Communication with Special Purpose Vehicle Control Module "C"
U0264	Lost Communication With Camera Module - Rear
U0265	Lost Communication with Left Front Short Range Radar Sensor Module
U0268	Lost Communication with Right Front Short Range Radar Sensor Module
U0269	Lost Communication with Front Long Range Object Sensor
U026A	Lost Communication with Frontview Camera Module
U026B	Lost Communication with Rear Short Range Object Sensor
U0293	Lost Communication with Hybrid/EV Powertrain Control Module
U029D	Lost Communication with NOx Sensor 1 Module
U029E	Lost Communication with NOx Sensor 2 Module
U02A3	Lost Communication With Particulate Matter Sensor Module
U0301	Software Incompatibility with Engine Control Module
U0302	Software Incompatibility with Transmission Control Module
U0305	Software Incompatibility With Cruise Control Module
U0315	Software Incompatibility with Electronic Brake Control Module
U0401	Invalid Data Received From Engine Control Module
U0402	Invalid Data Received From Transmission Control Module
U0403	Invalid Data Received From Transfer Case Control Module
U0405	Invalid Data Received From Cruise Control Module
U0415	Invalid Data Received From Electronic Brake Control Module
U0416	Invalid Data Received From Vehicle Dynamics Control Module
U0417	Invalid Data Received From Park Brake Control Module

U0418	Invalid Data Received From Brake System Control Module
U0420	Invalid Data Received From Power Steering Control Module
U0421	Invalid Data Received From Suspension Control Module
U0422	Invalid Data Received From Body Control Module
U0423	Invalid Data Received From Instrument Cluster
U0424	Invalid Data Received From HVAC Control Module
U0428	Invalid Data Received From Steering Wheel Angle Sensor Module
U042B	Invalid Data Received From Chassis Control Module
U0431	Invalid Data Received From Body Control Module "A"
U0432	Invalid Data Received From Multi-axis Acceleration Sensor Module
U0437	Invalid Data Received From Differential Control Module - Rear
U0438	Invalid Data Received From Trailer Brake Control Module
U0452	Invalid Data Received From Inflatable Restraint Sensing and Diagnostic Module
U045A	Invalid Data Received From Parking Assist Control Module "A"
U0465	Invalid Data Received From Power Take-Off Control Module
U0499	Invalid Data Received From Telematic Control Module
U0513	Invalid Data Received From Yaw Rate Sensor Module
U053B	Invalid Data Received From Active Safety Control Module
U056B	Invalid Data Received From Camera Module - Front
U0594	Invalid Data Received From Hybrid/EV Powertrain Control Module
U1501	LIN Bus 1
U1502	LIN Bus 2
U1505	LIN Bus 5
U1509	LIN Bus 9
	P17 Info Display Module Lost Communication With K33 HVAC Control Module
U150E	LIN Bus 14
U150F	LIN Bus 15
U1510	(K9 Body Control Module) LIN Bus 1 Lost Communication With Device 0 (B67 Ultrasonic Intrusion Sensor)
	(K33 HVAC Control Module) LIN Bus 1 Lost Communication With Device 0 (A26 HVAC Controls)
	(A11 Radio) LIN Bus 1 Lost Communication with Device 0 (A20 Radio/HVAC Control)
	(P16 Instrument Cluster) LIN Bus 1 Lost Communication with Device 0 (S70R Steering Wheel Controls Switch - Right)
U1511	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 1 (or 6) Lost Communication With Device 1 (E13L Headlamp - Left)
	(K40 Seat Memory Control Module) LIN Bus 1 Lost Communication With Device 1 (K99 Steering Column Position Control Module)
U1512	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 1 (or 6) Lost Communication With Device 2 (E13R Headlamp - Right)
U1513	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN

	Bus 1 (or 6) Lost Communication With Device 3 (E13L Headlamp - Left)
U1514	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 1 (or 6) Lost Communication With Device 4 (E13R Headlamp - Right)
U1515	(K9 Body Control Module) LIN Bus 1 Lost Communication With Device 5 (M75 Windshield Wiper Motor)
U1516	(K9 Body Control Module) LIN Bus 1 Lost Communication With Device 6 (B110 Battery Sensor Module)
U1517	(K9 Body Control Module) LIN Bus 1 Lost Communication With Device 7 (K62 Sunroof Sunshade Motor Module)
U1518	(P16 Instrument Cluster) LIN Bus 1 Lost Communication with Device 8 (P29 Head-Up Display)
U1519	(K40 Seat Memory Control Module) LIN Bus 1 Lost Communication With Device 9 (S52 Outside Rearview Mirror Switch)
	(K40 Seat Memory Control Module) LIN Bus 1 Lost Communication With Device 9 (K96 Mirror Control Module / K96L Mirror Control Module - Left)
U151A	(K9 Body Control Module) LIN Bus 1 Lost Communication With Device 10 (B117 Rain Sensor)
U151B	(K9 Body Control Module) LIN Bus 1 Lost Communication With Device 11 (K61 Sunroof Control Module)
	(K40 Seat Memory Control Module) LIN Bus 1 Lost Communication With Device 11 (S79P Window Switch - Passenger)
U151C	(K33 HVAC Control Module) LIN Bus 1 Lost Communication With Device 0 (K33A HVAC Control Module - Auxiliary)
U1520	(K9 Body Control Module) LIN Bus 2 Lost Communication With Device 0 (P25 Power Sounder Content Theft Deterrent Alarm Module)
U1521	(K9 Body Control Module) LIN Bus 2 Lost Communication with Device 1 (S48E Multifunction Switch - Center Console)
	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 2 (or 7) Lost Communication With Device 1 (E13L Headlamp - Left)
U1522	(K9 Body Control Module) LIN Bus 2 Lost Communication With Device 2 (K65 Tire Pressure Indicator Module / B178 Tire Pressure Sensor Locator Module)
	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 2 (or 7) Lost Communication With Device 2 (E13R Headlamp - Right)
U1523	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 2 (or 7) Lost Communication With Device 3 (E13L Headlamp - Left)
U1524	(K9 Body Control Module) LIN Bus 2 Lost Communication With Device 4 (K29F Seat Heating Control Module - Front)
	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 2 (or 7) Lost Communication With Device 4 (E13R Headlamp - Right)
U1526	(K9 Body Control Module) LIN Bus 2 Lost Communication With Device 6 (K29R Seat Heating Control Module - Rear)
U152C	(K9 Body Control Module) LIN Bus 2 Lost Communication With Device 12 (K18 Compass Module)
U152D	(K9 Body Control Module) LIN Bus 2 Lost Communication With Device 13 (P2

	Transmission Shift Lever Position Indicator)
U1530	(K9 Body Control Module) LIN Bus 3 Lost Communication With Device 0 (M74P Window Motor - Passenger)
U1531	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 3 Lost Communication with Device 1 (E13LA Headlamp Assembly - Left)
U1532	(K26 Headlamp Control Module / K28 Headlamp Leveling Control Module) LIN Bus 3 Lost Communication with Device 2 (E13RA Headlamp Assembly - Right)
U1534	(K9 Body Control Module) LIN Bus 3 Lost Communication With Device 4 (M74D Window Motor - Driver)
U1538	(K9 Body Control Module) LIN Bus 3 Lost Communication With Device 8 (S79D Window Switch - Driver)
U153A	(K9 Body Control Module) LIN Bus 3 Lost Communication With Device 10 (S79P Window Switch - Passenger)
U1540	(K9 Body Control Module) LIN Bus 4 Lost Communication With Device 0 (M74RR Window Motor - Right Rear)
U1544	(K9 Body Control Module) LIN Bus 4 Lost Communication With Device 4 (M74LR Window Motor - Left Rear)
U1548	(K9 Body Control Module) LIN Bus 4 Lost Communication With Device 8 (S79LR Window Switch - Left Rear)
U154A	(K9 Body Control Module) LIN Bus 4 Lost Communication With Device 10 (S79RR Window Switch - Right Rear)
U154B	(K9 Body Control Module) LIN Bus 4 Lost Communication With Device 11 (K49 Rear Seat Control Module)
U1550	(K9 Body Control Module) LIN Bus 5 Lost Communication with Device 0 (S31D Seat Heating and Cooling Switch - Driver)
U1556	(K38 Chassis Control Module) LIN Bus 5 Lost Communication with Device 6 (K133 Trailer Brake Power Control Module)
U1558	(K9 Body Control Module) LIN Bus 5 Lost Communication with Device 8 (S31P Seat Heating and Cooling Switch - Passenger)
U15E1	(A11 Radio) LIN Bus 14 Lost Communication with Device 1 (A26 HVAC Controls)
U15E3	(A11 Radio) LIN Bus 14 Lost Communication with Device 3
U15F0	(K74 Human Interface Control Module) LIN Bus 15 Lost Communication with Device 0 (P17 Info Display Module)
U1793	14V Power Module Lost Communication with Hybrid/EV Powertrain Control Module on Powertrain Expansion Communication Bus
U1795	14V Power Module Powertrain Expansion Communication Bus Off
U179A	Lost Communication with Hybrid/EV Powertrain Control Module 2
U1803	Lost Communication with Hybrid/EV Powertrain Control Module 2
U1804	Lost Communication with Inside Rearview Mirror Control Module
U1806	Battery Energy Control Module High Voltage Energy Management CAN Bus Off
U1807	Battery Charger Control Module High Voltage Energy Management CAN Bus Off
U180A	Electric A/C Compressor Control Module High Speed CAN Bus Off
U180B	Battery Energy Control Module High Speed CAN Bus Off

U180C	Battery Charger Control Module High Speed CAN Bus Off
U180D	Electronic Brake Control Module Chassis Expansion CAN Bus Off
U1811	Battery Energy Control Module Powertrain Expansion CAN Bus Off
U1814	Powertrain Wake-Up Communication Circuit
U1815	Lost Communication with Drive Motor Control Module 1 on Bus B
U1816	Lost Communication with Drive Motor Control Module B on Bus B
U1817	Lost Communication with Hybrid/EV Powertrain Control Module on Powertrain Expansion CAN Bus
U1818	Lost Communication with Engine Control Module on Powertrain Expansion Communication Bus
U1821	Lost Communication with 14V Power Module on Powertrain Expansion Communication Bus
U1826	Lost Communication with Multi-Axis Acceleration Sensor Module on Powertrain Expansion CAN Bus
U1827	Lost Communication with Steering Angle Sensor Module on Powertrain Expansion CAN Bus
U182A	Hybrid/EV Powertrain Control Module Lost Communication with Battery Energy Control Module on Powertrain Expansion CAN Bus
U182D	Lost Communication with Hybrid/EV Powertrain Control Module 2 on Powertrain Expansion Communication Bus
U182E	Drive Motor Control Module 1 Lost Communication with Hybrid/EV Powertrain Control Module 2 on Powertrain Expansion Communication Bus
U182F	Drive Motor Control Module 2 Lost Communication with Hybrid/EV Powertrain Control Module 2 on Powertrain Expansion Communication Bus
U1831	Drive Motor Control Module 1 Lost Communication with Hybrid/EV Powertrain Control Module on Powertrain Expansion CAN Bus
U1833	Lost Communication with Electronic Brake Control Module on Chassis Expansion CAN Bus
U1838	Lost Communication with Battery Charger Control Module on High Voltage Energy Management CAN Bus
U1839	Auxiliary Transmission Fluid Pump Control Module Lost Communication with Engine Control Module
U183A	Lost Communication with Telematics Communication Interface Control Module on High Speed CAN Bus
U183B	Auxiliary Transmission Fluid Pump Control Module Lost Communication with Transmission Control Module
U183C	Auxiliary Transmission Fluid Pump Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2 on Powertrain Expansion Communication Bus
U183E	Lost Communication with Telematics Communication Interface Control Module on Low Speed CAN Bus
U1844	Battery Energy Control Module Lost Communication with Hybrid/EV Powertrain Control Module on Bus B
	Drive Motor Control Module 1 Lost Communication with Hybrid/EV Powertrain

U1845	Control Module
U1846	Drive Motor Control Module 2 Lost Communication with Hybrid/EV Powertrain Control Module
U1847	Drive Motor Control Module 1 Lost Communication with Battery Energy Control Module on Powertrain Expansion CAN Bus
U1849	Drive Motor Control Module 1 Lost Communication with Transmission Control Module
U184A	Lost Communication with Body Control Module on Low Speed CAN Bus
U184B	Lost Communication with Remote Heater and Air Conditioning Control Module on Low Speed CAN Bus
U184C	Lost Communication with Instrument Cluster on Low Speed CAN Bus
U184D	Lost Communication with Radio on Low Speed CAN Bus
U184E	Lost Communication with Inflatable Restraint Sensing and Diagnostic Module on Low Speed CAN Bus
U184F	Electric A/C Compressor Control Module Lost Communication with Engine Control Module
U1850	Drive Motor Control Module 2 Lost Communication with Transmission Control Module
U1858	Electronic Brake Control Module Lost Communication with Hybrid/EV Powertrain Control Module on Chassis Expansion CAN Bus
U185A	Lost Communication with Battery Energy Control Module on High Voltage Energy Management CAN Bus
U185B	Battery Energy Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2 on High Voltage Energy Management CAN Bus
U185C	Battery Charger Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2 on High Voltage Energy Management CAN Bus
U185D	Fuel Injector Control Module Lost Communication with Engine Control Module
U185E	Fuel Injector Control Module Lost Communication with Body Control Module
U1860	Electric A/C Compressor Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2
U1861	Battery Charger Control Module Lost Communication with Engine Control Module
U186A	Electronic Brake Control Module Lost Communication with Engine Control Module
U186B	Electronic Brake Control Module Lost Communication with Transmission Control Module
U1875	Drive Motor Control Module 1 Lost Communication with Battery Energy Control Module
U1876	Drive Motor Control Module 1 Lost Communication with Engine Control Module
U1879	Drive Motor Control Module 2 Lost Communication with Engine Control Module
U1885	Battery Energy Control Module Lost Communication with Hybrid/EV Powertrain Control Module
U1886	Battery Energy Control Module Lost Communication with Engine Control Module
	Hybrid/EV Powertrain Control Module Lost Communication with Battery Energy

U1888	Control Module
U18A1	Lost Communication with Coolant Temperature Control Module on High Voltage Energy Management CAN Bus
U18A2	Lost Communication with Fuel Pump Driver Control Module
U18A3	Lost Communication with Human Machine Interface Control Module
U18A4	Lost Communication with Hybrid/EV Battery DC Charging Communications Gateway Module on High Voltage Energy Management CAN Bus
U18A5	Lost Communication with Fuel Injector Control Module on Powertrain Expansion CAN Bus
U18A6	Lost Communication with Right Object Detection Control Module on Dedicated Bus 1
U18B9	Primary High Speed CAN Bus Subnet Configuration List
U18BF	Secondary High Speed CAN Bus Subnet Configuration List
U1900	Lost Communication With Speech to Text Interface Module
U1901	Lost Communication with Infotainment Multifunction Switch Module
U2098	MOST Communication Enable Circuit
U2099	High Speed Communication Enable Circuit
U209E	Object Detection Control Module High Speed Communication Enable Circuit 1
U209F	Object Detection Control Module High Speed Communication Enable Circuit 2
U2100	CAN Bus Communication
U2101	CAN Bus Maximum List of Control Modules
U2103	Fewer Controllers On Bus Than Programmed
U2105	Lost Communication with Engine Control Module
U2106	Lost Communication with Transmission Control Module
U2107	Lost Communication with Body Control Module
U2108	Lost Communication with Electronic Brake Control Module
U2125	Lost Communication with Telematic Unit
U2127	Lost Communication with Front HVAC Control Module
U2139	Lost Communication with Column Integration Module
U2144	Lost Communication with Distance Sensing Cruise Control Module
U216A	Lost Communication with Front Object Detection Control Module
U216B	Lost Communication with Rear Object Detection Control Module
U2176	Lost Communication with Power Take-Off Control Module
U2178	Lost Communication With Trailer Interface Control Module
U2400	Fuel Injector Control Module High Speed CAN Bus Off
U2401	Battery Energy Control Module Dedicated Bus 1 Off
U2501	Invalid Data Received From Hybrid/EV Powertrain Control Module 2
U2502	Invalid Data Received From Electronic Brake Control Module on Chassis Expansion CAN Bus
U2503	Invalid Data Received From Object Detection Control Module
U2504	Invalid Data Received From Trailer Brake Driver Control Module
	Invalid Data Received from Human Machine Interface Control Module on MOST

U2505	Bus
U2506	Invalid Data Received From Dual Battery Control Module
U2507	Invalid Data Received from Instrument Cluster on MOST Bus
U2508	Invalid Data Received from Audio Amplifier on MOST Bus
U2602	Battery Energy Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2
U2603	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 1
U2604	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 2
U2605	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 3
U2606	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 4
U2608	Electric A/C Compressor Control Module Lost Communication with Hybrid/EV Powertrain Control Module
U2609	Battery Charger Control Module Lost Communication with Hybrid/EV Powertrain Control Module
U2611	Auxiliary Transmission Fluid Pump Control Module Lost Communication with Hybrid/EV Powertrain Control Module
U2612	Battery Charger Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2
U2613	Drive Motor 1 Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2
U2614	Drive Motor 2 Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2
U2615	Auxiliary Transmission Fluid Pump Control Module Lost Communication with Hybrid/EV Powertrain Control Module 2
U2616	Fuel Pump Driver Control Module Lost Communication with ECM
U2617	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 5
U2618	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 6
U2619	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 7
U2620	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 8
U2621	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 9
U2622	Battery Energy Control Module Lost Communication with Hybrid/EV Battery Interface Control Module 10

DTC B1000

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1000

Electronic Control Unit

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The internal fault detection is handled inside the device. The symptom byte information is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

The device runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

The device has detected an internal malfunction.

Action Taken When the DTC Sets

The device refuses all additional inputs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- This DTC may be stored as a history DTC without affecting the operation of the device.
- If stored only as a history DTC and not retrieved as a current DTC, do not replace the device.
- If this DTC is retrieved as both a current and history DTC, replace the device that set the DTC.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B1000 is not set.
 - **If DTC B1000 is set**

Replace the device that set the DTC.

- **If DTC B1000 is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC B1001

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1001

Option Configuration

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Some devices must be configured with serial numbers, vehicle options, or other information. If a device was not properly configured after installation that device may set DTC B1001. The symptom byte information is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

Battery voltage is between 9-16 V and data link communications operate normally.

Conditions for Setting the DTC

The device is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B1001 is not set.
 - **If DTC B1001 is set**
 1. Program the device that set the DTC.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the device that set the DTC.
 - If the DTC does not set
 - 3. All OK.
 - **If DTC B1001 is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC B101D

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B101D

Electronic Control Unit Hardware

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The internal fault detection is handled inside the device. The symptom byte information is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

- The device runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.
- The keyless entry control module will set this DTC with symptom byte 39 when the keyless entry control module antenna is activated.

Conditions for Setting the DTC

The device has detected an internal malfunction.

Action Taken When the DTC Sets

The device refuses all additional inputs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- This DTC may be stored as a history DTC without affecting the operation of the device.
- Do not replace a device based only on DTC B101D being set in history with the exception of the following devices:
 - K36 Inflatable Restraint Sensing and Diagnostic Module (SDM)
 - K85 Passenger Presence Detection Module
- If DTC B101D is set as current, replace the appropriate device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B101D is not set.
 - **If DTC B101D is set with symptom byte 43**
 1. Program the device that set the DTC.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the device that set the DTC.
 - If the DTC does not set
 3. All OK.
 - **If DTC B101D is set with any symptom byte, except symptom byte 43**

Replace the device that set the DTC.
 - **If DTC B101D is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC B101E

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B101E

Electronic Control Unit Software

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Some devices must be configured with specific software, serial numbers, vehicle options, or other information. If a device was not properly configured after installation that module may set DTC B101E. The symptom byte information is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

Battery voltage is between 9-16 V and data link communications operate normally.

Conditions for Setting the DTC

The device is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0028 or U0029 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Verify DTC B101E is not set.
 - **If DTC B101E is set**
 1. Program the device that set the DTC.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the device that set the DTC.
 - If the DTC does not set
 - 3. All OK.
 - **If DTC B101E is not set**
 4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC C056D

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C056D

Electronic Control Unit Hardware

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The internal fault detection is handled inside the device. The symptom byte information is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

The device runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

The device has detected an internal malfunction.

Action Taken When the DTC Sets

The device refuses all additional inputs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- This DTC may be stored as a history DTC without affecting the operation of the device.
- If stored only as a history DTC and not retrieved as a current DTC, do not replace the device.
- If this DTC is retrieved as both a current and history DTC, replace the device that set the DTC.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC C056D is not set.
 - **If DTC C056D is set in a device that can be programmed**
 1. Program the device that set the DTC.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the device that set the DTC.
 - If the DTC does not set
 3. All OK.
 - **If DTC C056D is set in a device that cannot be programmed**

Replace the device that set the DTC.
 - **If DTC C056D is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC C056E

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C056E

Electronic Control Unit Software

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Some devices must be configured with specific software, serial numbers, vehicle options, or other information. If a device was not properly configured after installation that module may set DTC C056E. The symptom byte information is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

Battery voltage is between 9-16 V and data link communications operate normally.

Conditions for Setting the DTC

The device is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

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Data Communication Schematics

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool References

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC C056E is not set.
 - **If DTC C056E is set**
 1. Program the device that set the DTC.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the device that set the DTC.
 - If the DTC does not set
 3. All OK.
 - **If DTC C056E is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC P0601-P0606, P060A, P062F, OR P262B

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0605

Control Module Programming Read Only Memory Performance

DTC P0606

Control Module Processor Performance

DTC P060A

Control Module Monitoring Processor Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P262B

Control Module Power Off Timer Performance

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the device. This diagnostic also addresses if the device is not programmed. The device monitors its ability to read and write to the memory. It also monitors a timing function. No external circuits are involved.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is greater than 9.5 V.

Conditions for Setting the DTC

The device detects an internal malfunction or incomplete programming.

Action Taken When the DTC Sets

DTCs P0601-P0606, P060A, P062F, and P262B are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0601-P0606, P060A, P062F, and P262B are Type A DTCs.

Diagnostic Aids

If stored only as a history DTC and not retrieved as a current DTC, do not replace the device.

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool References

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0602 is not set.
 - **If DTC P0602 is set**
 1. Program the device that set the DTC.
 2. Verify that the DTC does not set.

- If the DTC sets, replace the device that set the DTC.
- If the DTC does not set

3. All OK.

- **If DTC P0602 is not set**

3. Verify that DTC P0601, P0603, P0604, P0605, P0606, P060A, P062F, or P262B is not set.

- **If any of the DTCs are set**

Replace the device that set the DTC.

- **If none of the DTCs are set**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC U0001

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0001 00

High Speed CAN Communication Bus Malfunction

Circuit Description

Devices connected to the GMLAN serial data circuits monitor for serial data communications on the GMLAN network during normal vehicle operation. Operating information and commands are exchanged among the devices. Each device on GMLAN network maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and will decrease with error-free messages. If the transmit error counter value exceeds 255 the device removes itself from the network and a DTC U0001 will be set.

Conditions for Running the DTC

- System voltage is in the normal operating voltage range.
- The vehicle power mode requires serial data communication to occur.

Conditions for Setting the DTC

A certain number of no valid transmitted messages on the GMLAN serial data circuits are detected by the device.

Action Taken When the DTC Sets

- The device suspends all message transmission.
- The device uses default values for all parameters received on the GMLAN serial data circuits.
- The device inhibits the setting of all other GMLAN communication DTCs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Circuit/System Verification

This DTC may not be retrieved with a current status. Diagnosis is accomplished via the symptom, Scan Tool Does Not Communicate with High Speed GMLAN Device. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** in order to isolate an intermittent condition caused by a short on the GMLAN serial data circuits.

DTC U0020

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC U0020

Low Speed CAN Bus

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Devices connected to the GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have programmed information about what messages are needed to be exchanged on the serial data circuits. The messages are also supervised and some periodic messages are used by the receiver device as an availability indication of the transmitter device.

Conditions for Running the DTCs

- Supply voltage to the devices is in the normal operating range.
- The vehicle power mode requires serial data communication to occur.
- The DTC U2100 does not have a current status.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTCs Sets

The device uses a default value for the missing parameter.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Circuit/System Verification

Diagnosis of this DTC is accomplished via the symptom or an additional DTC. Refer to **Scan Tool Does Not Communicate with Low Speed GMLAN Device**, or **Diagnostic Trouble Code (DTC) List - Vehicle** .

DTC U0028

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0028

MOST Bus

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U0100-U02FF,	U0100-U02FF,	-	-

	U0028 00	U0028 00		
Ignition	U0100-U02FF, U1814, U2099, U0028 00	U0100-U02FF, U0028 00	-	-
MOST Control	U2098 00, U2098 02, U0029 02	U0028 00	U2098 00, U2098 02	-
MOST Bus Serial Data (+)	U0028 00	U0028 00	U0028 00	-
MOST Bus Serial Data (-)	U0028 00	U0028 00	U0028 00	-
Ground	-	U0100-U02FF, U0028 00	-	-

Circuit/System Description

The Media Oriented Systems Transport (MOST) Infotainment network is a dedicated high speed multimedia streaming data bus independent from GMLAN. The MOST bus will be configured in a physical hardwired loop with each device within the bus sends and receives data on an assigned MOST addresses in a set order. Each device on the MOST bus will be required to have twisted pair copper wires (2 transmit TX, 2 receive RX, and 1 electronic control line which is a 12 V wake up signal line). The A11 Radio is the MOST Master and will monitor the bus for vehicle configuration, Infotainment data messages and errors on the bus. The MOST initialization consists of a short 100 ms low voltage pulse on the electronic control line connected to all devices contained on the MOST ring. When the MOST devices receive this wakeup message, they will respond with a generic device response. Once these initial responses on the MOST bus are reported successfully without error to the A11 Radio, the second data request will record the device MOST device addresses, their functionality requirements and capabilities within. The A11 Radio will learn this information and also record the address node sequence on the MOST bus at this point. This node address list will now be stored within the A11 Radio as the MOST bus configuration (called "Last Working MOST ID of Node 1-9" on scan tool data display).

When MOST receive, transmit, or control line faults are detected, transmit/receive messages will not received as expected from the wakeup request. The A11 Radio and the K74 Human Machine Interface Control Module will then perform diagnostics to isolate these MOST faults. If the MOST control line is shorted low to 0 V for excess amount of time, the A11 Radio will set a U2098 DTC and K74 Human Machine Interface Control Module will set a U0029 02 DTC. At this point the MOST bus will be unable to communicate until the shorted MOST control line is repaired.

Once the shorted MOST control line diagnostics pass, the A11 Radio will attempt to resend the initial short pulse attempts up to 3 times on the MOST control line. If the expected responses are not received, the A11 Radio continues into a failure mode setting a U0028 DTC and will continue on to send one 300 ms long pulse, which will enable the furthest upstream transmitting device to become the surrogate MOST Master in this MOST fault/diagnostic mode. When the A11 Radio receives this new MOST Master identity, the surrogate MOST master device can be identified based on scan tool data parameter "Surrogate MOST Master Node Upstream Position". The scan tool should be used to determine the MOST bus configuration and direction by utilizing the "Last Working MOST ID of Node 1 - 9" parameters from the A11 Radio data display. When a fault is present, it will indicate the newly enabled "Surrogate MOST Master Node Upstream Position" from the A11 Radio. This will assist in determining where the MOST bus/control is at fault. The MOST device upstream from the surrogate MOST master device, transmit, receive, or control lines will be the suspect areas for diagnostics at this point. These faults can be associated with any of the MOST transmit, receive, or control line twisted copper

wires or possibly an internal device fault.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The ignition is ON.
- The Radio is ON.

Conditions for Setting the DTC

A fault occurs on the transmit, receive, or electronic control lines.

Action Taken When the DTC Sets

Some or all of the infotainment system may be inoperative.

Conditions for Clearing the DTC

The MOST initialization is successful without errors and the MOST bus is locked.

Diagnostic Aids

- Use A11 Radio's scan tool data display to determine the Surrogate MOST Master by interpreting the "Surrogate MOST Master Node Upstream Position" parameter and determine the MOST bus configuration from "Last Working MOST ID of Node 1-9" parameters.
- If the MOST bus configuration is A11 Radio > K74 Human Machine Interface Control Module > S136 Infotainment Control Touchpad > T3 Audio Amplifier > P16 Instrument Cluster > A33 Media Disc Player and back to A11 Radio. The A11 Radio's scan tool data display will be shown as followed:
 - Last Working MOST ID of Node 1: Radio
 - Last Working MOST ID of Node 2: Human Machine Interface Control Module
 - Last Working MOST ID of Node 3: Infotainment Control Touchpad
 - Last Working MOST ID of Node 4: Audio Amplifier
 - Last Working MOST ID of Node 5: Instrument Cluster
 - Last Working MOST ID of Node 6: Media Disc Player
- After a ring break diagnostic session, the A11 Radio, which is the MOST bus master, indicates a ring break was detected and sets DTC U0028. The "Surrogate MOST Master Node Upstream Position" parameter will now be available in the A11 Radio's scan tool data display. Starting from the bottom of the MOST device list, count upward to determine the surrogate MOST Master device. The MOST ring break will be found upstream from the surrogate MOST Master since this will be the node which timed out and initiated the MOST node assignments during the MOST ring break.
 - If the Surrogate MOST Master Node Upstream Position value is 0, the Surrogate MOST Master is also the A11 Radio. The MOST ring break is either at the A33 Media Disc Player or between the A11 Radio and the A33 Media Disc Player.
 - If the Surrogate MOST Master Node Upstream Position value is 1, the Surrogate MOST Master is the A33 Media Disc Player which is 1 node upstream from the A11 Radio. The MOST ring break is

either at the P16 Instrument Cluster or between the A33 Media Disc Player and the P16 Instrument Cluster.

- If the Surrogate MOST Master Node Upstream Position value is 2, the Surrogate MOST Master is the P16 Instrument Cluster which is 2 nodes upstream from the A11 Radio. The MOST ring break is either at the T3 Audio Amplifier or between the P16 Instrument Cluster and the T3 Audio Amplifier.
- If the Surrogate MOST Master Node Upstream Position value is 3, the Surrogate MOST Master is the T3 Audio Amplifier which is 3 nodes upstream from the A11 Radio. The MOST ring break is either at the S136 Infotainment Control Touchpad or between the T3 Audio Amplifier and the S136 Infotainment Control Touchpad.
- If the Surrogate MOST Master Node Upstream Position value is 4, the Surrogate MOST Master is the S136 Infotainment Control Touchpad which is 4 nodes upstream from the A11 Radio. The MOST ring break is either at the K74 Human Machine Interface Control Module or between the S136 Infotainment Control Touchpad and the K74 Human Machine Interface Control Module.
- If the Surrogate MOST Master Node Upstream Position value is 5, the Surrogate MOST Master is the K74 Human Machine Interface Control Module which is 5 nodes upstream from the A11 Radio. The MOST ring break is between the K74 Human Machine Interface Control Module and the A11 Radio.
- The Last Working MOST ID of Node 1-9 may be reset to None after an ignition cycle when there is a fault on the MOST bus. In this case, use the MOST bus configuration from the schematics and eliminate optional devices that are not available for a particular vehicle from that configuration. Each vehicle may have a different MOST bus configuration depending on the optional contents.
- In the case of a valid optional device being installed, DTC U0028 may set because of the change in the node assignment list. Be sure to clear the DTC after the installation is finished.
- An open in the MOST control line or a fault in the MOST transmit/receive lines will cause DTC U0028 to be set.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON. Radio ON.
2. Verify DTC U0100-U02FF is set.
 - **If the DTC is set**

Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- **If the DTC is not set**
3. Verify DTC U2098 or DTC U0029 02 is set.
 - **If any of the DTCs are set**

Refer to **DTC U2098**.

- **If none of the DTCs are set**
4. Verify DTC U0028 is set.
 - **If the DTC is set**
 1. Access the A11 Radio's Last Working MOST ID of Node 1-9 parameters with a scan tool to view MOST device location IDs and MOST bus configuration.
 2. Access the A11 Radio's Surrogate MOST Master Node Upstream Position parameter with a scan tool to determine the surrogate MOST Master device and where the MOST ring break occurs. For more information, refer to Diagnostic Aids section.
 3. Refer to Circuit/System Testing.
 - **If the DTC is not set**
 5. All OK.

Circuit/System Testing

NOTE: The MOST devices on both sides of the MOST ring break point will need to be disconnected to isolate a circuit fault.

Use the schematic to identify the following:

- The MOST bus configuration and MOST device locations on the MOST serial data circuits

- **Each MOST device's electronic control line and serial data circuit terminals**

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connectors at the MOST device upstream from the surrogate MOST Master device where the MOST ring break occurs. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.

- **If the test lamp illuminates**

7. Ignition ON.

8. Test for 9-13 V between the MOST control circuit at the MOST device connectors that was just disconnected and ground.

- **If less than 9 V**

1. Ignition OFF, disconnect the harness connectors at the A11 Radio.

2. Test for less than 2 ohms in the MOST control circuit end to end between the MOST device that was just disconnected and the A11 Radio.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the A11 Radio.

- **If greater than 13 V**

1. Ignition OFF, disconnect the harness connectors at the A11 Radio.

2. Test for less than 1 V between the MOST control circuit and ground.

- If 1 V or greater, repair the short to voltage in the circuit.

- If less than 1 V, replace the A11 Radio.

- **If between 9-13 V**

9. Ignition OFF, disconnect the harness connectors at the surrogate MOST Master device, ignition ON. The following tests will be performed on the MOST serial data circuits between the two MOST devices that were just disconnected.

10. Test for less than 1 V between each MOST serial data circuit and ground.

- **If any serial data circuit are 1 V or greater**

Repair the short to voltage in the circuit.

- **If each serial data circuit are less than 1 V**

11. Ignition OFF, test for infinite resistance between each MOST serial data circuit and ground.

- **If any serial data circuit are less than infinite resistance**

Repair the short to ground in the circuit.

- **If each serial data circuit are infinite resistance**

12. Test for infinite resistance between each pair of the MOST serial data circuits.

- **If any pair of serial data circuits are less than infinite resistance**

Repair a short together in the circuit.

- **If each pair of serial data circuits are infinite resistance**

13. Test for less than 2 ohms in each MOST serial data circuit end to end.

- **If any serial data circuit are 2 ohms or greater**

Repair the open/high resistance in the circuit between the two MOST devices.

- **If each serial data circuit are less than 2 ohms**

14. Replace the MOST device upstream from the surrogate MOST Master device where the MOST ring break occurs.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U0029

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0029

MOST Bus Performance

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The Media Oriented Systems Transport (MOST) bus master device shall set DTC U0029 when the MOST bus interruptions lasts long enough to interrupt MOST communication and functions, but not long enough to break the MOST bus ring.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The ignition is ON.
- The Radio is ON.

Conditions for Setting the DTC

A current DTC sets when MOST bus communication has been interrupted more than 10 times during the monitoring cycle period.

Action Taken When the DTC Sets

Some or all of the infotainment system may be inoperative for brief periods of time.

Conditions for Clearing the DTC

A current DTC is cleared when MOST bus communication interruptions are no longer detected and the Number of MOST Communication Breaks counter remains at 0.

Diagnostic Aids

This is an intermittent connection detection DTC. All MOST device connectors should be checked for poor connections on both MOST bus circuits.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON. Radio ON.
2. Verify DTC U0028 is set.
 - **If the DTC is set**

Refer to **DTC U0028**.

- **If the DTC is not set**
- 3. Verify DTC U0029 is not set with symptom byte 02.
 - **If DTC U0029 is set with symptom byte 02**

Refer to **DTC U2098**.

- **If DTC U0029 is set with other symptom bytes except 02**
- 4. Refer to **Testing for Intermittent Conditions and Poor Connections** to test for an intermittent condition.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U0073 OR U2100

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC U0073

Control Module Communication Bus A Off

DTC U2100

CAN Bus Communication

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The serial data circuits are used to communicate information between the devices. The serial data circuits also connect directly to the data link connector (DLC).

Conditions for Running the DTCs

- Supply voltage to the devices is in the normal operating range.
- The vehicle power mode requires serial data communications.

Conditions for Setting the DTC

The device setting the DTC has attempted to establish communications on the serial data circuits more than 3 times in 5 s.

Action Taken When the DTCs Sets

- The device suspends all message transmission.
- The device uses default values for all parameters received on the serial data circuits.
- In the transmission control module, DTC U0073 will cause the transmission to go into default gears.
- In the engine control module and transmission control module, DTC U0073 will cause the malfunction indicator lamp (MIL) to illuminate.
- If equipped with eAssist, DTC U0073 in the hybrid powertrain control module is a type B DTC and will cause the malfunction indicator lamp to illuminate and result in the engine operating in conventional engine mode and will maintain 14 V module operation.
- The device inhibits the setting of all other communication DTCs.

Conditions for Clearing the DTC

- The engine control module or transmission control module turns OFF the MIL after 4 consecutive ignition cycles that the diagnostic runs and does not fail.
- If equipped with eAssist, the hybrid powertrain control module turns off the MIL after the diagnostic runs and does not fail during subsequent ignition cycles. Normal operation will resume 5 s after subsequent ignition cycle.
- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Circuit/System Verification

1. Refer to **Data Link References** to determine which serial data communication system is used for a specific device.
2. This DTC may not be retrieved with a current status. Diagnosis is accomplished using the symptom. Refer to **Symptoms - Data Communications**.

DTC U0074 (CHASSIS EXPANSION BUS)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0074

Control Module Communication Bus B Off

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Chassis High Speed GMLAN Serial Data (+)	U0074	U0074, U0100-U02FF*	U0074	-
Chassis High Speed GMLAN Serial Data (-)	U0074	U0074, U0100-U02FF*	U0074	-
Ground (DLC, terminal 5)	-	1	-	-
* An open between the data link connector (DLC) and the first splice/device will only affect the communication with the scan tool. The devices will still communicate. An open in only one chassis high speed GMLAN serial data circuit may allow degraded communication between the devices. 1. No communication with any chassis high speed GMLAN device.				

Circuit/System Description

The devices connected to the chassis high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices when the ignition switch is in any position other than OFF. The chassis high speed GMLAN serial data bus uses terminating resistors that are in parallel with the chassis high speed GMLAN (+) and (-) circuits.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

Specific subsystems will not function.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Use the **Data Link References** to identify the chassis high speed GMLAN devices.
- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a device reporting a U code. The U code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with the chassis high speed GMLAN serial data system inoperative. This condition is due to those devices using multiple serial data communication systems.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC).
- Some devices may not have internal protection for specific voltage outputs and may open a battery positive voltage or ignition voltage source fuse. If a voltage input fuse is open and no short is found in that circuit, ensure that no device output voltage circuit is shorted to ground before replacing the device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify two or more devices are not communicating on the chassis high speed GMLAN serial data circuit. Refer to **Data Link References** to determine how many devices should be communicating on the bus.
 - **If only one device is not communicating**

Refer to Circuit/System Testing - Testing the Device Circuits.

- **If two or more devices are not communicating**
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. Disconnect the scan tool from the X84 Data Link Connector. The following tests will be done at the X84 Data Link Connector. It may take up to 2 minutes for all vehicle systems to power down.
 4. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
 5. Ignition ON.
 6. Test for less than 4.5 V between the serial data circuits listed below and ground:
 - Chassis high speed GMLAN serial data terminal 12
 - Chassis high speed GMLAN serial data terminal 13
 - **If 4.5 V or greater**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Voltage.

- **If less than 4.5 V**
7. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.

8. Test for greater than 100 ohms between the serial data circuits listed below and ground:

- Chassis high speed GMLAN serial data terminal 12
- Chassis high speed GMLAN serial data terminal 13
- **If 100 ohms or less**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Ground.

- **If greater than 100 ohms**

9. Test for 50-70 ohms between the serial data circuit terminals 12 and 13:

- **If less than 35 ohms**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short between the Circuits.

- **If between 35-50 ohms**

There may be a third terminating resistor between the serial data circuits. This can happen if the incorrect device is installed. Some devices are available with and without the terminating resistors installed to reduce the need of terminating resistors in the wiring harness. Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short between the Circuits.

- **If greater than 70 ohms but less than infinite**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for an Open/High Resistance.

- **If infinite resistance**

Repair the open/high resistance in the circuit between the X84 Data Link Connector and the first splice/device in the serial data circuit.

- **If between 50-70 ohms**

10. Refer to Circuit/System Testing - Testing the Device Circuits.

Circuit/System Testing

NOTE: Each device may need to be disconnected to isolate a circuit fault.

Use the schematic to identify the following:

- **Chassis high speed GMLAN devices the vehicle is equipped with**
- **Chassis high speed GMLAN serial data circuit terminating resistors**
- **Device locations on the chassis high speed GMLAN serial data circuits**
- **Each device's ground, B+, ignition, and chassis high speed GMLAN serial data circuit terminals**

Some devices with an internal terminating resistor have a loop in the harness that connects the internal terminating resistor to the serial data circuit. When wired this way, test these loop circuits for the appropriate failure mode short to voltage, short to ground, or open/high resistance prior to replacing the device for each of the following tests.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at an easily accessible device, ignition ON.
2. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 10 ohms, replace the device that was disconnected.
 - **If any serial data circuit is greater than 4.5 V**
3. Ignition OFF, disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to voltage, ignition ON.
4. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 10 ohms, replace the device that was disconnected.
 - **If any serial data circuit is greater than 4.5 V**
5. Repeat step 3 until one of the following conditions are isolated:
 - A short to voltage on the serial data circuit between two devices or splice packs, if equipped.
 - A short to voltage on the serial data circuit between a device and a terminating resistor.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at an easily accessible device.
3. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 100 ohms or greater**

Replace the device that was disconnected.

- **If any serial data circuit is less than 100 ohms**

4. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to ground.
5. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.

- **If both serial data circuits are 100 ohms or greater**

Replace the device that was disconnected.

- **If any serial data circuit is less than 100 ohms**

6. Repeat step 4 until one of the following conditions are isolated:
 - A short to ground on the serial data circuit between two devices or splice packs, if equipped.
 - A short to ground on the serial data circuit between a device and a terminating resistor.
 - A short to ground on the serial data circuit between the X84 Data Link Connector and the first device or splice pack.

Testing the Serial Data Circuits for a Short between the Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at an easily accessible device that is not communicating.
3. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**

4. Connect the harness connectors at the device that was disconnected.
5. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted together.
6. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**

7. Repeat step 4 until one of the following conditions are isolated:
 - Serial data circuits shorted together between two devices or splice packs, if equipped.

- Serial data circuits shorted together between a device and a terminating resistor.
- Serial data circuits shorted together between the X84 Data Link Connector and the first device or splice pack.
- A shorted terminating resistor.

Testing the Serial Data Circuits for an Open/High Resistance

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at an easily accessible device that is not communicating.
3. Test for less than 130 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

4. Connect the harness connectors at the device that was disconnected.
5. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at another device, in the direction of the circuit with the open/high resistance.
6. Test for less than 130 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

7. Repeat step 4 until one of the following conditions are isolated:
 - An open/high resistance on the serial data circuit between two devices or splice packs, if equipped.
 - An open/high resistance on the serial data circuit between a device and a terminating resistor.
 - An open/high resistance terminating resistor.

Testing the Device Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors at an easily accessible device that is not communicating.
3. Test for less than 10 ohms between each ground circuit terminal and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
- 4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
- 5. Ignition ON.
- 6. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which has a fuse in the circuit, and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
- 7. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the control module that controls the ignition circuit.

○ **If the test lamp illuminates**

8. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
9. Test for less than 130 ohms between each pair of chassis high speed GMLAN serial data circuits at the device connector that was just disconnected.

○ **If any pair of serial data circuits is greater than 130 ohms**

Repair the open/high resistance in the serial data circuits between the disconnected device and the circuit splice in the serial data circuits.

○ **If each pair of serial data circuits is 130 ohms or less**

10. Replace the device that was disconnected.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U0074 (POWERTRAIN EXPANSION BUS WITH HP6)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0074 00

Control Module Communication Powertrain Expansion CAN Bus Off Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Powertrain High Speed GMLAN Serial Data (+)	U0074	U0074	U0074	-
Powertrain High Speed GMLAN Serial Data (-)	U0074	U0074	U0074	-

Circuit/System Description

The devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices when the ignition switch is in any position other than OFF. The powertrain high speed GMLAN serial data bus uses terminating resistors that are in parallel with the powertrain high speed GMLAN (+) and (-) circuits.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The vehicle power mode requires serial data communications.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received for more than 450 ms.

Action Taken When the DTC Sets

- DTC U0074 is a type B DTC.
- DTC U0074 in the hybrid powertrain control module will cause the malfunction indicator lamp (MIL) to illuminate and result in the engine operating in conventional engine mode and will maintain 14 V power operation.

Conditions for Clearing the DTC

- DTC U0074 is a type B DTC.
- The hybrid powertrain control module turns off the MIL after the diagnostic runs and does not fail during subsequent ignition cycles. Normal operation will resume 5 seconds after subsequent ignition cycle.

Diagnostic Aids

- Use the **Data Link References** to identify the powertrain high speed GMLAN devices.
- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-

initialize at the same time.

- If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a device reporting a U code. The U code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with the powertrain high speed GMLAN serial data system inoperative. This condition is due to those devices using multiple serial data communication systems.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC).
- Some devices may not have internal protection for specific voltage outputs and may open a battery positive voltage or ignition voltage source fuse. If a voltage input fuse is open and no short is found in that circuit, ensure that no device output voltage circuit is shorted to ground before replacing the device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0606 is not set.
 - **If DTC P0606 is set**

Refer to **DTC P0601-P0606, P060A, P062F, or P262B.**

- **If DTC P0606 is not set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and

serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: Each device may need to be disconnected to isolate a circuit fault.

Use the schematic to identify the following:

- Powertrain high speed GMLAN devices the vehicle is equipped with
- Powertrain high speed GMLAN serial data circuit terminating resistors
- Device locations on the powertrain high speed GMLAN serial data circuits
- Each device's ground, B+, ignition, and powertrain high speed GMLAN serial data circuit terminals

Some devices with an internal terminating resistor have a loop in the harness that connects the internal terminating resistor to the serial data circuit. When wired this way, test these loop circuits for the appropriate failure mode short to voltage, short to ground, or open/high resistance prior to replacing the device for each of the following tests.

1. Perform the High Voltage Disabling procedure. Refer to **High Voltage Disabling** .
2. Reconnect the 12 V battery.
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connectors with the powertrain high speed GMLAN serial data circuits at an easily accessible device that is not communicating. It may take up to 2 minutes for all vehicle systems to power down. Refer to **Data Link References** to determine which devices are on the powertrain expansion bus.
4. Ignition ON.
5. Test for less than 4.5 V between each powertrain high speed GMLAN serial data circuit at the device that was just disconnected and ground.
 - **If 4.5 V or greater**

Refer to Testing the Serial Data Circuits for a Short to Voltage.

- **If less than 4.5 V**
6. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
 7. Test for greater than 100 ohms between each powertrain high speed GMLAN serial data circuit at the device that was just disconnected and ground.
 - **If 100 ohms or less**

Refer to Testing the Serial Data Circuits for a Short to Ground.

- **If greater than 100 ohms**

8. Test for 110-130 ohms between each pair of the powertrain high speed GMLAN serial data circuits at the device that was just disconnected:

- **If less than 110 ohms**

Refer to Testing the Serial Data Circuits for a Short between the Circuits.

- **If greater than 130 ohms**

Refer to Testing the Serial Data Circuits for an Open/High Resistance.

- **If between 110-130 ohms**

9. Refer to Testing the Device Circuits.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the harness connectors with the powertrain high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to voltage, ignition ON.
2. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 10 ohms, replace the device that was disconnected.
 - **If any serial data circuit is greater than 4.5 V**
3. Repeat step 1 until one of the following conditions are isolated:
 - A short to voltage on the serial data circuit between two devices or splice packs, if equipped.
 - A short to voltage on the serial data circuit between a device and a terminating resistor.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the powertrain high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to ground.
3. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 100 ohms or greater**

Replace the device that was disconnected.
 - **If any serial data circuit is less than 100 ohms**
4. Repeat step 1 until one of the following conditions are isolated:

- A short to ground on the serial data circuit between two devices or splice packs, if equipped.
- A short to ground on the serial data circuit between a device and a terminating resistor.

Testing the Serial Data Circuits for a Short between the Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Connect the harness connectors at the device that was previously disconnected.
3. Disconnect the harness connectors with the powertrain high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted together.
4. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.
 - **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**
5. Repeat step 1 until one of the following conditions are isolated:
 - Serial data circuits shorted together between two devices or splice packs, if equipped.
 - Serial data circuits shorted together between a device and a terminating resistor.
 - A shorted terminating resistor.

Testing the Serial Data Circuits for an Open/High Resistance

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Connect the harness connectors at the device that was previously disconnected.
3. Disconnect the harness connectors with the powertrain high speed GMLAN serial data circuits at another device, in the direction of the circuit with the open/high resistance.
4. Test for less than 130 ohms between each pair of the serial data circuits at the device connector that was just disconnected.
 - **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**
5. Repeat step 1 until one of the following conditions are isolated:
 - An open/high resistance on the serial data circuit between two devices or splice packs, if equipped.
 - An open/high resistance on the serial data circuit between a device and a terminating resistor.
 - An open/high resistance terminating resistor.

Testing the Device Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal at the device that was just disconnected and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
4. Ignition ON.
5. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which has a fuse in the circuit, and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
6. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.

- **If the test lamp illuminates**

7. Replace the device that was disconnected.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U0074 (MID SPEED GMLAN)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0074

Control Module Communication Bus B Off

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Mid Speed GMLAN Serial Data (+)	U0074	U0074, U0100-U02FF*	U0074	-
Mid Speed GMLAN Serial Data (-)	U0074	U0074, U0100-U02FF*	U0074	-
Ground (DLC, terminal 5)	-	1	-	-

* An open between the data link connector (DLC) and the first splice/device will only affect the communication with the scan tool. The devices will still communicate. An open in only one mid speed GMLAN serial data circuit may allow degraded communication between the devices.

1. No communication with any mid speed GMLAN device.

Circuit/System Description

The devices connected to the mid speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices when the ignition switch is in any position other than OFF. The mid speed GMLAN serial data bus uses terminating resistors that are in parallel with the mid speed GMLAN (+) and (-) circuits.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

Specific subsystems will not function.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Use the **Data Link References** to identify the mid speed GMLAN devices.
- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.

- If a loss-of-communication U code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a device reporting a U code. The U code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with the mid speed GMLAN serial data system inoperative. This condition is due to those devices using multiple serial data communication systems.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC).
- Some devices may not have internal protection for specific voltage outputs and may open a battery positive voltage or ignition voltage source fuse. If a voltage input fuse is open and no short is found in that circuit, ensure that no device output voltage circuit is shorted to ground before replacing the device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

2. Verify two or more devices are not communicating on the mid speed GMLAN serial data circuit. Refer to **Data Link References** to determine how many devices should be communicating on the bus.

- **If only one device is not communicating**

Refer to Circuit/System Testing - Testing the Device Circuits.

- **If two or more devices are not communicating**

3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. Disconnect the scan tool from the X84 Data Link Connector. The following tests will be done at the X84 Data Link Connector. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
5. Ignition ON.
6. Test for less than 4.5 V between the serial data circuits listed below and ground:
 - Mid speed GMLAN serial data terminal 3
 - Mid speed GMLAN serial data terminal 11
 - **If 4.5 V or greater**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Voltage.

- **If less than 4.5 V**

7. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
8. Test for greater than 100 ohms between the serial data circuits listed below and ground:
 - Mid speed GMLAN serial data terminal 3
 - Mid speed GMLAN serial data terminal 11
 - **If 100 ohms or less**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Ground.

- **If greater than 100 ohms**

9. Test for 50-70 ohms between the serial data circuit terminals 3 and 11:
 - **If less than 35 ohms**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short between the Circuits.

- **If between 35-50 ohms**

There may be a third terminating resistor between the serial data circuits. This can happen if the incorrect device is installed. Some devices are available with and without the terminating resistors installed to reduce the need of terminating resistors in the wiring harness. Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short between the Circuits.

- **If greater than 70 ohms but less than infinite**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for an Open/High Resistance.

- **If infinite resistance**

Repair the open/high resistance in the circuit between the X84 data link connector and the first splice/device in the serial data circuit.

- **If between 50-70 ohms**

10. Refer to Circuit/System Testing - Testing the Device Circuits.

Circuit/System Testing

NOTE: Each device may need to be disconnected to isolate a circuit fault.

Use the schematic to identify the following:

- **Mid speed GMLAN devices the vehicle is equipped with**
- **Mid speed GMLAN serial data circuit terminating resistors**
- **Device locations on the mid speed GMLAN serial data circuits**
- **Each device's ground, B+, ignition, and mid speed GMLAN serial data circuit terminals**

Some devices with an internal terminating resistor have a loop in the harness that connects the internal terminating resistor to the serial data circuit. When wired this way, test these loop circuits for the appropriate failure mode short to voltage, short to ground, or open/high resistance prior to replacing the device for each of the following tests.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the harness connectors with the mid speed GMLAN serial data circuits at an easily accessible device, ignition ON.
2. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.

- If less than 10 ohms, replace the device that was disconnected.
- **If any serial data circuit is greater than 4.5 V**
- 3. Ignition OFF, disconnect the harness connectors with the mid speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to voltage, ignition ON.
- 4. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 10 ohms, replace the device that was disconnected.
 - **If any serial data circuit is greater than 4.5 V**
- 5. Repeat step 3 until one of the following conditions are isolated:
 - A short to voltage on the serial data circuit between two devices or splice packs, if equipped.
 - A short to voltage on the serial data circuit between a device and a terminating resistor.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the mid speed GMLAN serial data circuits at an easily accessible device.
3. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 100 ohms or greater**

Replace the device that was disconnected.
 - **If any serial data circuit is less than 100 ohms**
4. Disconnect the harness connectors with the mid speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to ground.
5. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If both serial data circuits are 100 ohms or greater**

Replace the device that was disconnected.
 - **If any serial data circuit is less than 100 ohms**
6. Repeat step 4 until one of the following conditions are isolated:
 - A short to ground on the serial data circuit between two devices or splice packs, if equipped.
 - A short to ground on the serial data circuit between a device and a terminating resistor.

- A short to ground on the serial data circuit between the X84 Data Link Connector and the first device or splice pack.

Testing the Serial Data Circuits for a Short between the Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the mid speed GMLAN serial data circuits at an easily accessible device that is not communicating.
3. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**

4. Connect the harness connectors at the device that was disconnected.
5. Disconnect the harness connectors with the mid speed GMLAN serial data circuits at another device, in the direction of the circuit shorted together.
6. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**

7. Repeat step 4 until one of the following conditions are isolated:
 - Serial data circuits shorted together between two devices or splice packs, if equipped.
 - Serial data circuits shorted together between a device and a terminating resistor.
 - Serial data circuits shorted together between the X84 Data Link Connector and the first device or splice pack.
 - A shorted terminating resistor.

Testing the Serial Data Circuits for an Open/High Resistance

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the mid speed GMLAN serial data circuits at an easily accessible device that is not communicating.
3. Test for less than 130 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

4. Connect the harness connectors at the device that was disconnected.
5. Disconnect the harness connectors with the mid speed GMLAN serial data circuits at another device, in the direction of the circuit with the open/high resistance.
6. Test for less than 130 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

7. Repeat step 4 until one of the following conditions are isolated:
 - An open/high resistance on the serial data circuit between two devices or splice packs, if equipped.
 - An open/high resistance on the serial data circuit between a device and a terminating resistor.
 - An open/high resistance terminating resistor.

Testing the Device Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors at an easily accessible device that is not communicating.
3. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
5. Ignition ON.
 6. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which has a fuse in the circuit, and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
 7. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
 - **If the test lamp illuminates**
 8. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
 9. Test for less than 130 ohms between each pair of mid speed GMLAN serial data circuits at the device connector that was just disconnected.
 - **If any pair of serial data circuits is greater than 130 ohms**

Repair the open/high resistance in the serial data circuits between the disconnected device and the circuit splice in the serial data circuits.
 - **If each pair of serial data circuits is 130 ohms or less**
 10. Replace the device that was disconnected.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U0074 (POWERTRAIN EXPANSION BUS WITHOUT HP6)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0074 00

Control Module Communication Powertrain Expansion CAN Bus Off Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Powertrain High Speed CAN Serial Data (+)	U0074	U0074	U0074	-
Powertrain High Speed CAN Serial Data (-)	U0074	U0074	U0074	-

Circuit/System Description

The devices connected to the powertrain high speed CAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices when the ignition switch is in any position other than OFF. The powertrain high speed CAN serial data bus uses terminating resistors that are in parallel with the powertrain high speed CAN (+) and (-) circuits.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The vehicle power mode requires serial data communications.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received for more than 450 ms.

Action Taken When the DTC Sets

DTC U0074 is a type B DTC.

Conditions for Clearing the DTC

DTC U0074 is a type B DTC.

Diagnostic Aids

- Use the **Data Link References** to identify the powertrain high speed CAN devices.
- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a device reporting a U code. The U code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with the powertrain high speed CAN serial data system inoperative. This condition is due to those devices using multiple serial data communication systems.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC).
- Some devices may not have internal protection for specific voltage outputs and may open a battery positive voltage or ignition voltage source fuse. If a voltage input fuse is open and no short is found in that circuit, ensure that no device output voltage circuit is shorted to ground before replacing the device.

Reference Information

Schematic Reference

- **Data Communication Schematics**

- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: Each device may need to be disconnected to isolate a circuit fault.

Use the schematic to identify the following:

- Powertrain high speed CAN devices the vehicle is equipped with
- Powertrain high speed CAN serial data circuit terminating resistors
- Device locations on the powertrain high speed CAN serial data circuits
- Each device's ground, B+, ignition, and powertrain high speed CAN serial data circuit terminals

Some devices with an internal terminating resistor have a loop in the harness that connects the internal terminating resistor to the serial data circuit. When wired this way, test these loop circuits for the appropriate failure mode short to voltage, short to ground, or open/high resistance prior to replacing the device for each of the following tests.

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connectors with the powertrain high speed CAN serial data

circuits at an easily accessible device that is not communicating. It may take up to 2 minutes for all vehicle systems to power down. Refer to **Data Link References** to determine which devices are on the powertrain expansion bus.

2. Ignition ON.
3. Test for less than 4.5 V between each powertrain high speed CAN serial data circuit at the device that was just disconnected and ground.
 - **If 4.5 V or greater**

Refer to Testing the Serial Data Circuits for a Short to Voltage.

- **If less than 4.5 V**
4. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
 5. Test for greater than 100 ohms between each powertrain high speed CAN serial data circuit at the device that was just disconnected and ground.
 - **If 100 ohms or less**

Refer to Testing the Serial Data Circuits for a Short to Ground.

- **If greater than 100 ohms**
6. Test for 110-130 ohms between each pair of the powertrain high speed CAN serial data circuits at the device that was just disconnected:
 - **If less than 110 ohms**

Refer to Testing the Serial Data Circuits for a Short between the Circuits.

- **If greater than 130 ohms**

Refer to Testing the Serial Data Circuits for an Open/High Resistance.

- **If between 110-130 ohms**
7. Refer to Testing the Device Circuits.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the harness connectors with the powertrain high speed CAN serial data circuits at another device, in the direction of the circuit shorted to voltage, ignition ON.
2. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.

- If less than 10 ohms, replace the device that was disconnected.
 - **If any serial data circuit is greater than 4.5 V**
3. Repeat step 1 until one of the following conditions are isolated:
 - A short to voltage on the serial data circuit between two devices or splice packs, if equipped.
 - A short to voltage on the serial data circuit between a device and a terminating resistor.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the powertrain high speed CAN serial data circuits at another device, in the direction of the circuit shorted to ground.
3. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 100 ohms or greater**

Replace the device that was disconnected.

- **If any serial data circuit is less than 100 ohms**
4. Repeat step 1 until one of the following conditions are isolated:
 - A short to ground on the serial data circuit between two devices or splice packs, if equipped.
 - A short to ground on the serial data circuit between a device and a terminating resistor.

Testing the Serial Data Circuits for a Short between the Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Connect the harness connectors at the device that was previously disconnected.
3. Disconnect the harness connectors with the powertrain high speed CAN serial data circuits at another device, in the direction of the circuit shorted together.
4. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.
 - **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**
5. Repeat step 1 until one of the following conditions are isolated:
 - Serial data circuits shorted together between two devices or splice packs, if equipped.
 - Serial data circuits shorted together between a device and a terminating resistor.
 - A shorted terminating resistor.

Testing the Serial Data Circuits for an Open/High Resistance

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Connect the harness connectors at the device that was previously disconnected.
3. Disconnect the harness connectors with the powertrain high speed CAN serial data circuits at another device, in the direction of the circuit with the open/high resistance.
4. Test for less than 130 ohms between each pair of the serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

5. Repeat step 1 until one of the following conditions are isolated:
 - An open/high resistance on the serial data circuit between two devices or splice packs, if equipped.
 - An open/high resistance on the serial data circuit between a device and a terminating resistor.
 - An open/high resistance terminating resistor.

Testing the Device Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal at the device that was just disconnected and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
- 4. Ignition ON.
- 5. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which has a fuse in the circuit, and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 - 1. Ignition OFF.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
- 6. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
 - 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
 - **If the test lamp illuminates**
- 7. Replace the device that was disconnected.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U0078

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0078

Control Module Communication Low Speed CAN Bus Off

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The low speed GMLAN serial data bus is used to communicate information between the devices. The serial data is transmitted over a single wire to the appropriate devices. The low speed GMLAN serial data circuits also connect directly to the data link connector (DLC).

Conditions for Running the DTC

- Supply voltage to the devices are in the normal operating range.
- The vehicle power mode requires serial data communications.

Conditions for Setting the DTC

The device setting the DTC has attempted to establish communications on the serial data circuits more than 3 times in 5 s.

Action Taken When the DTC Sets

- The device suspends all message transmission.
- The device uses default values for all parameters received on the serial data circuits.
- The device inhibits the setting of all other communication DTCs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U0078 is not set.
 - **If DTC U0078 is set**

Refer to **Scan Tool Does Not Communicate with Low Speed GMLAN Device.**

- If DTC U0078 is not set

3. All OK

DTC U0100-U02FF (WITHOUT HP6)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

For device DTC descriptors, refer to **Control Module U Code List.**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U0100-U02FF	U0100-U02FF	-	-
Ignition	U0100-U02FF, U1814, U2099	U0100-U02FF	-	-
Object High Speed GMLAN Serial Data (+)	U0075	U0100-U02FF	U0075	-
Object High Speed GMLAN Serial Data (-)	U0075	U0100-U02FF	U0075	-
Chassis High Speed GMLAN Serial Data (+)	U0074, U0077	U0100-U02FF	U0074, U0077	-
Chassis High Speed GMLAN Serial Data (-)	U0074, U0077	U0100-U02FF	U0074, U0077	-
Mid Speed GMLAN Serial Data (+)	U0074	U0100-U02FF	U0074	-
Mid Speed GMLAN Serial Data (-)	U0074	U0100-U02FF	U0074	-
High Speed GMLAN Serial Data (+)	U0073, 2	U0100-U02FF	U0073, 2	-
High Speed GMLAN Serial Data (-)	U0073, 2	U0100-U02FF	U0073, 2	-
Low Speed GMLAN Serial Data	U0078, 1	U0100-U02FF	U0078, 1	-
Ground	-	U0100-U02FF	-	-
1. Scan tool does not communicate with most low speed GMLAN device 2. Scan tool does not communicate with most high speed GMLAN device				

Circuit/System Description

The serial data circuit is the means by which the devices in the vehicle communicate with each other. Once the scan tool is connected to the serial data circuit through the data link connector (DLC), the scan tool can be used to monitor each device for diagnostic purposes and to check for DTCs. When the ignition switch is in RUN, each device communicating on the serial data circuit sends a state of health message to ensure that the device is operating properly. When a device stops communicating on the serial data circuit, for example if the device loses power or ground, the state of health message it normally sends on the serial data circuit disappears. Other devices on the serial data circuit, which expect to receive that state of health message, detect its absence; those devices in turn set a DTC associated with the loss of state of health of the non-communicating device. The DTC is unique to the device which is not communicating and one or more devices may set the same exact code. A loss of serial data communications DTC does not represent a failure of the devices that contain the stored code.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

- Specific subsystems will not function.
- DTC U0100 in the transmission control module will cause the transmission to go into default gears.
- Both DTC U0100 in the transmission control module and DTC U0101 in the engine control module will cause the MIL to illuminate.

Conditions for Clearing the DTC

- The engine control module or transmission control module turns OFF the MIL after 4 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.

- A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
- Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
- If a loss-of-communication U code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with either the low or high speed GMLAN serial data system inoperative. This condition is due to those devices using multiple serial data communication systems.
- Use **Data Link References** to determine what serial data communications the device uses.
- Some devices may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the device.
- Some intermittent communication concerns may be caused by fretting corrosion on the serial data circuit terminals. Inspect all connectors at the device that set the communication DTC, the device that the communication DTC was set against, and any inline harness connectors between the two devices. Do not replace a device based only on fretting corrosion. Refer to bulletin 09-06-03-004 for assistance with the diagnosis and repair of this condition, if applicable.
- This diagnostic can be used for any device that is not communicating, regardless of the type of serial data circuit it is connected to, providing the vehicle is equipped with the device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Determine the device that is not communicating. Refer to **Control Module U Code List**.
2. Verify that DTC U0073, U2100, U0074, U0078, U1814, U2099, B1325, B1330, B1370, B1380, B1424, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.

- **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

3. Verify that DTC U0125 and DTC U0126 are not set together.

- **If both of the DTCs are set together**

Refer to **Scan Tool Does Not Communicate with Chassis High Speed GMLAN Device**.

- **If both of the DTCs are not set together**

4. Engine running for 10 s.

5. Ignition ON, engine OFF, verify that DTC U0100-U02FF is not set.

- **If the DTC U0100-U02FF is set in any device, except the K17 Electronic Brake Control Module**

Refer to Circuit/System Testing.

- **If the DTC U0100-U02FF is set in the K17 Electronic Brake Control Module with any symptom byte, except symptom bytes 71, 72, and 74**

Refer to Circuit/System Testing.

- **If the DTC U0100-U02FF is set in the K17 Electronic Brake Control Module with symptom byte 71, 72, or 74 along with other DTCs set**

Diagnose all other DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If the DTC U0100-U02FF is set in the K17 Electronic Brake Control Module with symptom byte 71, 72, or 74 and without other DTCs set**

1. Program the K17 Electronic Brake Control Module.

2. Verify the DTC does not set.
 - If the DTC sets, replace the K17 Electronic Brake Control Module.
 - If the DTC does not set
3. All OK.
 - **If the DTC U0100-U02FF is not set**
6. All OK.

Circuit/System Testing

NOTE: **Use the schematics and connector end views to identify the device's ground, B+, ignition, accessory wakeup serial data, serial data communication enable, and serial data circuit terminals.**

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. Disconnect all the harness connectors at the device that is not communicating. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
1. Ignition OFF.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
7. Ignition ON.
8. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
 - **If the test lamp illuminates**

NOTE: This test step is only applicable to a low speed GMLAN device.

9. Test for less than 4.5 V between each low speed GMLAN serial data circuit terminal and ground.
 - **If 4.5 V or greater**

Refer to **Scan Tool Does Not Communicate with Low Speed GMLAN Device** to test for a short to voltage in the serial data circuit.

- **If less than 4.5 V**
10. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
 11. Test for less than 2 ohms in each of the serial data circuits end to end between the device harness connector and the X84 Data Link Connector terminals listed below.
 - Low speed GMLAN serial data circuit terminal 1
 - High speed GMLAN serial data circuit terminal 6 or 14
 - Mid speed GMLAN serial data circuit terminal 3 or 11

- Chassis high speed GMLAN serial data circuit terminal 12 or 13
- Object high speed GMLAN serial data circuit terminal 3 or 11
- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the non communicating device and the device setting the DTC or a serial data splice pack.

- **If less than 2 ohms**

NOTE: **The following test step is only applicable to a high speed GMLAN device with 2 pairs of serial data circuits or a high speed GMLAN device with an internal terminating resistor.**

12. Test for 110-130 ohms between each pair of high speed GMLAN serial data circuits.

- **If less than 110 ohms**

Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** to test for a short to ground or a short between the serial data circuits.

- **If greater than 130 ohms**

Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** to test for an open/high resistance in the serial data circuit.

- **If between 110-130 ohms**

13. Replace the device that is not communicating.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U0100-U02FF (WITH HP6)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

For device DTC descriptors, refer to **Control Module U Code List**.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U0100-U02FF	U0100-U02FF	-	-
Ignition	U0100-U02FF, U1814, U2099	U0100-U02FF	-	-
Chassis High Speed GMLAN Serial Data (+)	U0074, U0077	U0100-U02FF	U0074, U0077	-
Chassis High Speed GMLAN Serial Data (-)	U0074, U0077	U0100-U02FF	U0074, U0077	-
Mid Speed GMLAN Serial Data (+)	U0074	U0100-U02FF	U0074	-
Mid Speed GMLAN Serial Data (-)	U0074	U0100-U02FF	U0074	-
High Speed GMLAN Serial Data (+)	U0073, 2	U0100-U02FF	U0073, 2	-
High Speed GMLAN Serial Data (-)	U0073, 2	U0100-U02FF	U0073, 2	-
Low Speed GMLAN Serial Data	U0078, 1	U0100-U02FF	U0078, 1	-
Ground	-	U0100-U02FF	-	-
1. Scan tool does not communicate with most low speed GMLAN device 2. Scan tool does not communicate with most high speed GMLAN device				

Circuit/System Description

The serial data circuit is the means by which the devices in the vehicle communicate with each other. Once the scan tool is connected to the serial data circuit through the data link connector (DLC), the scan tool can be used to monitor each device for diagnostic purposes and to check for DTCs. When the ignition switch is in RUN, each device communicating on the serial data circuit sends a state of health message to ensure that the device is operating properly. When a device stops communicating on the serial data circuit, for example if the device loses power or ground, the state of health message it normally sends on the serial data circuit disappears. Other devices on the serial data circuit, which expect to receive that state of health message, detect its absence; those devices in turn set a DTC associated with the loss of state of health of the non-communicating device. The DTC is unique to the device which is not communicating and one or more devices may set the same exact code. A loss of serial data communications DTC does not represent a failure of the devices that contain the stored code.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

- Specific subsystems will not function.
- DTC U0100 in the transmission control module will cause the transmission to go into default gears.
- Both DTC U0100 in the transmission control module and DTC U0101 in the engine control module will cause the MIL to illuminate.
- DTC U0100 and/or U0101 in the hybrid powetrain control module will cause the malfunction indicator lamp (MIL) to illuminate and the engine to operate in conventional mode.

Conditions for Clearing the DTC

- The engine control module or transmission control module turns OFF the MIL after 4 consecutive ignition cycles that the diagnostic runs and does not fail.
- The hybrid powertrain control module DTC clears when the malfunction is no longer present. The hybrid operation returns to normal after an ignition cycle and ignition off for greater than 5 seconds.
- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with either the low or high speed GMLAN serial data system inoperative. This condition is due to those devices using multiple serial

data communication systems.

- Use **Data Link References** to determine what serial data communications the device uses.
- Some devices may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the device.
- Some intermittent communication concerns may be caused by fretting corrosion on the serial data circuit terminals. Inspect all connectors at the device that set the communication DTC, the device that the communication DTC was set against, and any inline harness connectors between the two devices. Do not replace a device based only on fretting corrosion. Refer to bulletin 09-06-03-004 for assistance with the diagnosis and repair of this condition, if applicable.
- This diagnostic can be used for any device that is not communicating, regardless of the type of serial data circuit it is connected to, providing the vehicle is equipped with the device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Electrical Information Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Determine the device that is not communicating. Refer to **Control Module U Code List**.
2. Verify that DTC U0073, U2100, U0074, U0078, U1814, U2099, B1325, B1330, B1370, B1380, B1424, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

3. Verify that DTCs U0125 and U0126 are not set.

- **If both of the DTCs are set together**

Refer to **Scan Tool Does Not Communicate with Chassis High Speed GMLAN Device.**

- **If both of the DTCs are not set together**

4. Engine running for 10 seconds.

5. Ignition ON, engine OFF, verify that DTC U0100-U02FF is not set.

- **If the DTC U0100-U02FF is set in any device, except the electronic brake control module**

Refer to Circuit/System Testing.

- **If the DTC U0100-U02FF is set in the electronic brake control module with any symptom byte, except symptom bytes 71, 72, and 74**

Refer to Circuit/System Testing.

- **If the DTC U0100-U02FF is set in the electronic brake control module with symptom byte 71, 72, or 74 along with other DTCs set**

Diagnose all other DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If the DTC U0100-U02FF is set in the electronic brake control module with symptom byte 71, 72, or 74 and without other DTCs set**

1. Program the electronic brake control module.

2. Verify the DTC does not set.

- If the DTC sets, replace the K17 electronic brake control module.

- If the DTC does not set

3. All OK.

- **If the DTC U0100-U02FF is not set**

6. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- **Identify how to disable high voltage.**

- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: Use the schematic to identify the following:

- Devices the vehicle is equipped with
 - Device locations on the serial data circuit
 - The device's ground, B+, ignition, ground, accessory wakeup serial data, serial data communication enable, and serial data circuit terminals
1. Perform the High Voltage Disabling procedure before proceeding with this diagnostic if the non communicating control module is a high voltage module from the following list. Refer to **High Voltage Disabling** .
 - K16 Battery Energy Control Module
 - K59 Starter/Generator Control Module
 2. If high voltage disabling is required, reconnect the 12 V battery after performing the high voltage disabling procedure.
 3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect all the harness connectors at the device that is not communicating. It may take up to 2 minutes for all vehicle systems to power down.

4. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
5. Ignition ON.
6. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
7. Ignition ON.
8. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
9. Ignition ON.
10. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition

circuit.

2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
- **If the test lamp illuminates**

NOTE: This test step is only applicable to low speed GMLAN devices.

11. Test for less than 4.5 V between each low speed GMLAN serial data circuit terminal and ground.
 - **If 4.5 V or greater**

Refer to **Scan Tool Does Not Communicate with Low Speed GMLAN Device** to test for a short to voltage in the serial data circuit.

- **If less than 4.5 V**
12. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
 13. Test for less than 2 ohms in each of the serial data circuits end to end between the device harness connector and the X84 data link connector terminals listed below.
 - Low speed GMLAN serial data circuit terminal 1
 - High speed GMLAN serial data circuit terminal 6 or 14
 - Mid speed GMLAN serial data circuit terminal 3 or 11
 - Chassis high speed GMLAN serial data circuit terminal 12 or 13
- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the non communicating device and the device setting the DTC or a serial data splice pack.

- **If less than 2 ohms**

NOTE: The following test step is only applicable to high speed GMLAN devices.

14. Test for 110-130 ohms between each pair of high speed GMLAN serial data circuits.
 - **If less than 110 ohms**

Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** to test for a short to ground or a short between the serial data circuits.

- **If greater than 130 ohms**

Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** to test for an open/high resistance in the serial data circuit.

- **If between 110-130 ohms**

15. Replace the device that is not communicating.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U0300-U0336

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

Refer to **Control Module U Code List**.

Circuit/System Description

Some devices must be configured with specific software, serial numbers, vehicle options, or other information. If a device was not properly configured after installation that device may set the appropriate communication DTCs. No external circuit diagnosis is involved.

Conditions for Running the DTC

Battery voltage is between 9-16 V and data link communications operate normally.

Conditions for Setting the DTC

The device is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U0300-U0336 is not set.
 - **If DTC U0300-U0336 is set**
 1. Program the device specified by the DTC descriptor.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the device specified by the DTC descriptor.
 - If the DTC does not set
 - 3. All OK.
 - **If DTC U0300-U0336 is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC U0400-U05FF

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

Refer to **Control Module U Code List**.

Circuit/System Description

Some devices are constantly receiving information from other devices through serial data communication network. The invalid data code will be set when a receiving device detects a discrepancy in information it receives from another device causing its integrity to be questioned. The symptom byte listed in the DTC Descriptor is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

Battery voltage is between 9-16 V and data link communications operate normally.

Conditions for Setting the DTC

The device is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running for 10 s.
2. Ignition ON, engine OFF, verify DTC U0400-U05FF is not set.
 - **If DTC U0400-U05FF is set along with other DTCs set**

Diagnose all other DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If DTC U0400-U05FF is set without other DTCs set**
 1. Program the device specified by the DTC descriptor.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the appropriate device.
 - If the DTC does not set
 3. All OK.
 - **If DTC U0400-U05FF is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC U1500-U15FF

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

For device DTC descriptors, refer to **Control Module U Code List**.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1500-U15BF	U1500-U15BF	-	-
Ignition	U1500-U15BF	U1500-U15BF	-	-
LIN Serial Data	U1500-U15BF	U1500-U15BF	U1500-U15BF	-
Ground	-	U1500-U15BF	-	-

Circuit/System Description

The serial data is transmitted over a Local Interconnect Network (LIN) single wire network circuit bus between a master control module and other LIN devices within a particular subsystem. If serial data communication is lost between any of the LIN devices on the LIN bus network, a no communication code against the non-communicating LIN device will be set. A master control module is the one that reports the non communication code.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

Specific subsystems will not function.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U code present. However, there is no associated "current" or "active" status. Loss of communication U codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.

- A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
- Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
- If a loss of communication U code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U code.
- Do not replace a device reporting a U code. The U code identifies which device needs to be diagnosed for a communication issue.
- Communication will be available between the master control module and the scan tool if there is a loss of communications with any of the other LIN devices on the LIN bus network.
- Some devices may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the device.
- Some intermittent communication concerns may be caused by fretting corrosion on the serial data circuit terminals. Inspect all connectors at the device that set the communication DTC, the device that the communication DTC was set against, and any inline harness connectors between the two devices. Do not replace a device based only on fretting corrosion. Refer to bulletin 09-06-03-004 for assistance with the diagnosis and repair of this condition, if applicable.
- An open in the LIN bus serial data circuit between the splice pack and a LIN device will only affect that specific LIN device. This type of failure will set a loss of communication DTC for each LIN device affected and the other LIN devices will still communicate.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Determine the LIN device that is not communicating. Refer to **Control Module U Code List**.
2. Verify that DTC B1325, B1330, B1370, B1380, B1424, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Verify that DTC U0100-U02FF is not set.
 - **If any of the DTCs are set**

Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- **If none of the DTCs are set**
4. Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: Use the schematic to identify the following:

- **The master control module and the LIN devices on the same LIN serial data circuit**
- **The master control module's LIN serial data circuit terminal and the LIN device's B+, ignition, ground, and LIN serial data circuit terminals**

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. Disconnect the harness connector at a LIN device that is not communicating. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify a test lamp illuminates between each B+ circuit terminal and ground, if equipped.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 - 1. Ignition OFF.
 - 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected LIN device.
 - **If the test lamp illuminates**
- 5. Ignition ON.
- 6. Verify a test lamp illuminates between each ignition circuit terminal and ground, if equipped.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 - 1. Ignition OFF.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected LIN device.
 - **If the test lamp illuminates**
- 7. Ignition ON.
- 8. Verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground, if equipped.
 - **If the test lamp does not illuminate**
 - 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the control module that controls the ignition circuit.
- **If the test lamp illuminates**

9. Ignition ON.

NOTE: For accurate voltage reading, disconnect the battery charger prior to performing the following test step.

10. Test for 2-13 V between the LIN serial data circuit terminal and ground.

- **If less than 2 V**

1. Ignition OFF, disconnect the harness connector at the control module setting the DTC and all LIN devices that share the same LIN serial data circuit.
2. Test for infinite resistance between the serial data circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the serial data circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
4. Reconnect the control module that set the DTC, ignition ON.
5. Test for 2-13 V between the LIN serial data circuit terminal and ground.
 - If less than 2 V, replace the control module setting the DTC.
 - If greater than 2 V, replace the LIN device that causes a current DTC to set when connected.

- **If greater than 13 V**

1. Ignition OFF, disconnect the harness connector at the control module setting the DTC and all LIN devices that share the same LIN serial data circuit.
2. Ignition ON.
3. Test for less than 1 V between the serial data circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
4. Ignition OFF, reconnect the control module that set the DTC, ignition ON.
5. Test for 2-13 V between the LIN serial data circuit terminal and ground.
 - If greater than 13 V, replace the control module setting the DTC.
 - If less than 13 V, replace the LIN device that causes a current DTC to set when connected.

- **If between 2-13 V**

11. Replace the disconnected LIN device.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**

- **Control Module References** for device replacement, programming and setup

DTC U180B

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U180B 00

Battery Energy Control Module High Speed CAN Bus Off Malfunction

Circuit/System Description

The high speed GMLAN serial data circuits are serial data buses used to communicate information between the devices. The high speed GMLAN serial data circuits connect directly to the data link connector (DLC) for programming purposes.

This diagnostic is used to check the high speed GMLAN communication bus status.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is greater than 8.8 V.

Conditions for Setting the DTC

The device setting the DTC has attempted to establish communications on the serial data circuits for more than 1.4 seconds without success.

Action Taken When the DTC Sets

The DTC U180B is a type B DTC.

Conditions for Clearing the DTC

The DTC U180B is a type B DTC.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool References

Control Module References for scan tool information

Circuit/System Verification

Diagnosis is accomplished using the symptom. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device**.

DTC U1811

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1811 00

Battery Energy Control Module Powertrain Expansion CAN Bus Off Malfunction

Circuit/System Description

The powertrain high speed GMLAN serial data circuits are serial data buses used to communicate information between the devices.

This diagnostic is used to check the powertrain high speed GMLAN communication bus status.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is greater than 8.8 V.

Conditions for Setting the DTC

The device setting the DTC has attempted to establish communications on the serial data circuits for more than 1.4 seconds without success.

Action Taken When the DTC Sets

The DTC U1811 is a type B DTC.

Conditions for Clearing the DTC

The DTC U1811 is a type B DTC.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool References

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U1811 is not set.
 - **If DTC U1811 is set**

Refer to **DTC U0074 (Chassis Expansion Bus)**, **DTC U0074 (Powertrain Expansion Bus with HP6)**, **DTC U0074 (Mid Speed GMLAN)**, **DTC U0074 (Powertrain Expansion Bus without HP6)**.

- **If DTC U1811 is not set**
3. All OK

DTC U1814

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1814

Powertrain Wake-Up Communication Circuit

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	U1814 02*	U0100-U02FF	-	-
* Vehicle may not start.				

Circuit/System Description

The body control module (BCM) activates the ignition circuit, when the ignition key is in ACC, ON or START. The ignition circuit wakes up the devices for serial data bus communication.

Conditions for Running the DTC

- The system voltage is between 9-16 V.

- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

The BCM senses a short to ground on the ignition circuit.

Action Taken When the DTC Sets

- The output command is turned off while the malfunction is present.
- The devices use a default value for the missing parameters until the next ignition cycle.
- The device(s) is never signaled. Therefore, the specific subsystem(s) will not function.
- The vehicle will not start while the circuit is shorted to ground.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: Use the schematic to determine which devices are on the K9 Body Control Module's ignition circuit terminal 22 X4. Use the connector end view to identify the ignition circuit terminal for each of those devices.

1. Ignition OFF, disconnect the harness connectors at an easily accessible device that shares the K9 Body Control Module's ignition circuit terminal 22 X4. Ignition ON.
2. Verify that the DTC U1814 remains current.
 - **If the DTC becomes history**

Replace the device that was just disconnected.
 - **If the DTC remains current**
3. With the prior devices disconnected, repeat steps 1 and 2 for each device on the ignition circuit except the K9 Body Control Module.
4. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
5. Test for infinite resistance between the ignition circuit terminal 22 X4 at the K9 Body Control Module and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
6. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1817

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1817 00

Lost Communication with Hybrid Powertrain Control Module on Powertrain Expansion CAN Bus Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1817	U1817	-	-
Ignition	U1814, U1817	U1817	-	-
Powertrain High Speed GMLAN Serial Data (+)	U0074*	U0074, U1817*	U0074*	-
Powertrain High Speed GMLAN Serial Data (-)	U0074*	U0074, U1817*	U0074*	-
Ground	-	U1817*	-	-
* Other DTCs may set with this fault.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

The motor control module and the hybrid powertrain control module are all internal to the starter/generator control module. All circuits to the hybrid powertrain control module are also internal to the starter/generator control module.

Communication diagnostics for the serial data, including device power and ground as well as the wakeup circuits for the motor control module and the hybrid powertrain control module are all diagnosed from external sources only to the starter/generator control module connector because any circuit fault condition within the starter/generator control module will cause a complete replacement.

Conditions for Running the DTC

- The system voltage is more than 10 V.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

DTC U1817 is a type A DTC.

Conditions for Clearing the DTC

DTC U1817 is a type A DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0293 is not set.
 - **If DTC U0293 is set**
3. Verify that DTC U0074, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **DTC U0100-U02FF (without HP6), DTC U0100-U02FF (with HP6).**

- **If DTC U0293 is not set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle .**

- **If none of the DTCs are set**

4. Verify that DTCs U1818, U182A, U1844, and U1847 are not set.
 - **If all of those DTCs are set together**

Refer to **DTC U0074 (Chassis Expansion Bus), DTC U0074 (Powertrain Expansion Bus with HP6), DTC U0074 (Mid Speed GMLAN), DTC U0074 (Powertrain Expansion Bus without HP6).**

- **If all of those DTCs are not set together**

5. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: Use the schematic to identify the following:

- The device location on the powertrain high speed GMLAN serial data circuits
- The device B+, ignition, ground, accessory wake up serial data, and serial data circuit terminals.

1. Perform the High Voltage Disabling procedure. Refer to High Voltage Disabling .
2. Reconnect the 12 V battery.
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet)

away from vehicle. Disconnect the low voltage harness connector at the K59 starter/generator control module. It may take up to 2 minutes for all vehicle systems to power down.

4. Test for less than 10 ohms between the K59 starter/generator control module case and ground.
 - **If 10 ohms or greater**

Check the ground connection at the housing.

- **If less than 10 ohms**

5. Ignition ON.

6. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.

2. Test for less than 2 ohms in the B+ circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.

2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K59 starter/generator control module.

- **If the test lamp illuminates**

7. Ignition ON.

8. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.

2. Test for less than 2 ohms in the ignition circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.

2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K59 starter/generator control module.

- **If the test lamp illuminates**

9. Ignition ON.

10. If equipped, verify that a test lamp illuminates between the ignition circuit terminal, which is controlled by a control module, and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition

circuit.

2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
- **If the test lamp illuminates**

11. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the device setting the DTC. It may take up to 2 minutes for all vehicle systems to power down.
12. Test for less than 2 ohms in each powertrain high speed GMLAN serial data circuit between the K59 starter/generator control module and the device setting the DTC.
 - **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K59 starter/generator control module and the device setting the DTC.

- **If less than 2 ohms**

13. Replace the K59 starter/generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1818

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1818 00

Lost Communication with Engine Control Module on Powertrain Expansion CAN Bus Malfunction

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1818	U1818	-	-
Ignition	U1814, U1818	U1818	-	-
Powertrain High Speed GMLAN Serial Data (+)	U0074*	U0074, U1818*	U0074*	-
Powertrain High Speed GMLAN Serial Data (-)	U0074*	U0074, U1818*	U0074*	-
Ground	-	U1818	-	-
* Other DTCs may set with this fault.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

Conditions for Running the DTC

- The system voltage is greater than 9.5 V.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received for more than 500 ms.

Action Taken When the DTC Sets

DTC U1818 is a type B DTC.

Conditions for Clearing the DTC

DTC U1818 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of- communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:

- A device on the data communication circuit was disconnected while the communication circuit is awake.
- Power to one or more devices was interrupted during diagnosis.
- A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
- Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
- If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0100 is not set.
 - **If DTC U0100 is set**

Refer to **DTC U0100-U02FF (without HP6), DTC U0100-U02FF (with HP6).**

- **If DTC U0100 is not set**
3. Verify that DTC U0074, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle .**

- **If none of the DTCs are set**
4. Verify that DTCs U1817, U182A, U1844, and U1847 are not set.
 - **If all of those DTCs are set together**

Refer to **DTC U0074 (Chassis Expansion Bus), DTC U0074 (Powertrain Expansion Bus with HP6), DTC U0074 (Mid Speed GMLAN), DTC U0074 (Powertrain Expansion Bus without HP6).**

- **If all of those DTCs are not set together**
5. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must

be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

NOTE: Use the schematic to identify the following:

- **The device location on the powertrain high speed GMLAN serial data circuits**
 - **The device B+, ignition, ground, accessory wake up serial data 2 and serial data circuit terminals**
1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connector at the K20 engine control module. It may take up to 2 minutes for all vehicle systems to power down.
 2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
 3. Ignition ON.
 4. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 engine control module.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 engine control module.
 - **If the test lamp illuminates**
7. Ignition ON.
8. If equipped, verify that a test lamp illuminates between the ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
 - **If the test lamp illuminates**
9. If the device setting the DTC is a high voltage component, perform the High Voltage Disabling procedure. Refer to **High Voltage Disabling** .
10. Reconnect the 12 V battery if the High Voltage Disabling procedure is performed.
11. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the device setting the DTC. It may take up to 2 minutes for all vehicle systems to power down.
12. Test for less than 2 ohms in each serial data circuit between the K20 engine control module and the device setting the DTC.

- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K20 engine control module and the device setting the DTC.

- **If less than 2 ohms**

13. Replace the K20 engine control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U182A

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U182A 00

Hybrid Powertrain Control Module Lost Communication with Battery Energy Control Module on Powertrain Expansion CAN Bus Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U182A*	U182A	-	-
Ignition	U1814, U182A*	U182A	-	-
Powertrain High Speed GMLAN Serial Data (+)	U0074*	U0074, U182A*	U0074*	-
Powertrain High Speed GMLAN Serial Data (-)	U0074*	U0074, U182A*	U0074*	-
Ground	-	U182A*	-	-
* Multiple DTCs may be set and multiple symptoms including a no start condition may occur.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

Conditions for Running the DTC

The system voltage is greater than 9.5 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received for more than 3 seconds.

Action Taken When the DTC Sets

DTC U182A is a type B DTC.

Conditions for Clearing the DTC

DTC U182A is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for

a communication issue.

- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0293 is not set.
 - **If DTC U0293 is set**

Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- **If DTC U0293 is not set**

3. Verify that DTC U0073, U0074, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.

- **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

4. Verify that DTCs U1817, U1818, U1844, and U1847 are not set.

- **If all of those DTCs are set together**

Refer to **DTC U0074 (Chassis Expansion Bus)**, **DTC U0074 (Powertrain Expansion Bus with HP6)**, **DTC U0074 (Mid Speed GMLAN)**, **DTC U0074 (Powertrain Expansion Bus without HP6)**.

- **If all of those DTCs are not set together**

5. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether

the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: Use the schematic to identify the following:

- The device locations on powertrain high speed GMLAN serial data circuits
- The device B+, ignition, ground, accessory wake up serial data, and serial data circuit terminals

1. Perform the High Voltage Disabling procedure. Refer to High Voltage Disabling.
2. Reconnect the 12 V battery.
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the low voltage harness connector at the K16 battery energy control module. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 10 ohms between the K16 battery energy control module case and ground.
 - **If 10 ohms or greater**

Check the ground connection at the housing.

- **If less than 10 ohms**
5. Ignition ON.
 6. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the low voltage harness connectors at the K59 starter/generator control module.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 starter/generator control module.
 - **If the test lamp illuminates**

7. Ignition ON.
8. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the low voltage harness connectors at the K59 starter/generator control module.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 starter/generator control module.
 - **If the test lamp illuminates**
9. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the K59 starter/generator control module. It may take up to 2 minutes for all vehicle systems to power down.
10. Test for less than 2 ohms in each powertrain high speed GMLAN serial data circuit between the K16 battery energy control module and the K59 starter/generator control module.
 - **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K16 battery energy control module and the K59 starter/generator control module.

- **If less than 2 ohms**
11. Replace the K16 battery energy control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1831

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC U1831 00

Drive Motor Control Module 1 Lost Communication with Hybrid Powertrain Control Module Malfunction

Circuit/System Description

The motor control module and the hybrid powertrain control module are all internal to the starter/generator control module. The hybrid powertrain control module sends out diagnostic trouble code information to other devices regarding the motor control module. All circuits to the hybrid powertrain control module and motor control module are also internal to the starter/generator control module and replaced as a single component.

Communication diagnostics for the serial data, including device power and ground as well as the wakeup circuits for motor control module and the hybrid powertrain control module are all diagnosed from external sources only to the starter/generator control module connector because any circuit fault condition within the starter/generator control module will cause a complete replacement.

Conditions for Running the DTC

- The system voltage is greater than 9.5 V.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received for more than 500 ms.

Action Taken When the DTC Sets

The DTC U1831 is a type B DTC.

Conditions for Clearing the DTC

The DTC U1831 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-

initialize at the same time.

- If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.
- If DTC U1831 is only set current in the hybrid powertrain control module, the starter/generator control module must be replaced due to all circuits between the hybrid powertrain control module and motor control module being internal to the starter/generator control module.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify that DTC U0293 is not set.
 - **If DTC U0293 is set**

Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- **If DTC U0293 is not set**
3. Verify that DTC U1831 is not set current.
 - **If DTC U1831 is set current**

Replace the K59 starter/generator control module.

- **If DTC U1831 is not set**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1844

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1844 00

Battery Energy Control Module Lost Communication with Hybrid Powertrain Control Module on Powertrain Expansion CAN Bus Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1844*	U1844	-	-
Ignition	U1814, U1844*	U1844*	-	-
Powertrain High Speed GMLAN Serial Data (+)	U0074*	U0074, U1844*	U0074*	-
Powertrain High Speed GMLAN Serial Data (-)	U0074*	U0074, U1844*	U0074*	-
Ground	-	U1844*	-	-
* Other modules/DTCs may set with this fault and multiple symptoms including a no start condition may occur.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

This diagnostic is used to check the loss of communication with hybrid powertrain control module on powertrain high speed GMLAN bus. The battery energy control module supervises a periodic serial data message to check the communication status of the hybrid powertrain control module. If this message is not received within 3 seconds, then this DTC is set.

Conditions for Running the DTC

- The system voltage is greater than 8.8 V.
- The DTC U1811 is not set.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received within 3 seconds.

Action Taken When the DTC Sets

The DTC U1844 is a type B DTC.

Conditions for Clearing the DTC

The DTC U1844 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0293 is not set.
 - **If DTC U0293 is set**

Refer to **DTC U0100-U02FF (without HP6), DTC U0100-U02FF (with HP6).**

- **If DTC U0293 is not set**
3. Verify that DTC U0073, U0074, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle .**

- **If none of the DTCs are set**
4. 3. Verify that DTCs U1817, U1818, U182A, and U1847 are not set.
 - **If all of those DTCs are set together**

Refer to **DTC U0074 (Chassis Expansion Bus), DTC U0074 (Powertrain Expansion Bus with HP6), DTC U0074 (Mid Speed GMLAN), DTC U0074 (Powertrain Expansion Bus without HP6).**

- **If all of those DTCs are not set together**
5. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection

Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: Use the schematic to identify the following:

- The device location on the powertrain high speed GMLAN serial data circuits
- The device B+, ignition, ground, accessory wake up serial data, and serial data circuit terminals

1. Perform the High Voltage Disabling procedure. Refer to **High Voltage Disabling**.
2. Reconnect the 12 V battery.
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the low voltage harness connector at the K59 starter/generator control module. It may take up to 2 minutes for all vehicle systems to power down.

4. Test for less than 10 ohms between the K59 starter/generator control module case and ground.
 - **If 10 ohms or greater**

Check the ground connection at the housing.

- **If less than 10 ohms**

5. Ignition ON.

6. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.

2. Test for less than 2 ohms in the B+ circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.

2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K59 starter/generator control module.

- **If the test lamp illuminates**

7. Ignition ON.

8. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.

2. Test for less than 2 ohms in the ignition circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.

2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K59 starter/generator control module.

- **If the test lamp illuminates**

9. Ignition ON.

10. If equipped, verify that a test lamp illuminates between the ignition circuit terminal, which is controlled by a control module, and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.

2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
 - **If the test lamp illuminates**
- 11. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the K16 battery energy control module. It may take up to 2 minutes for all vehicle systems to power down.
- 12. Test for less than 2 ohms in each powertrain high speed GMLAN serial data circuit between the K59 starter/generator control module and the K16 battery energy control module.
 - **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K59 starter/generator control module and the K16 battery energy control module.
 - **If less than 2 ohms**
- 13. Replace the K59 starter/generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1845 OR U1846

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC U1845 00

Drive Motor Control Module 1 Lost Communication with Hybrid Powertrain Control Module
Malfunction

Circuit/System Description

The motor control module and the hybrid powertrain control module are all internal to the starter/generator

control module. The hybrid powertrain control module sends out diagnostic trouble code information to other devices regarding the motor control module. All circuits to the hybrid powertrain control module and motor control module are also internal to the starter/generator control module and replaced as a single component.

Communication diagnostics for the serial data, including device power and ground as well as the wakeup circuits for motor control module and the hybrid powertrain control module are all diagnosed from external sources only to the starter/generator control module connector because any circuit fault condition within the starter/generator control module will cause a complete replacement.

Conditions for Running the DTC

- The system voltage is greater than 9.5 V.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received for more than 500 ms.

Action Taken When the DTC Sets

The DTC U1845 is a type B DTC.

Conditions for Clearing the DTC

The DTC U1845 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or

corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.

- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.
- If DTC U1845 is only set current in the hybrid powertrain control module, the starter/generator control module must be replaced due to all circuits between the hybrid powertrain control module and motor control module being internal to the starter/generator control module.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are

identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify that DTC U0293 is not set.
 - If DTC U0293 is set

Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- If DTC U0293 is not set
3. Verify that DTC U1845 is not set current.
 - If DTC U1845 is set current

Replace the K59 starter/generator control module.

- If DTC U1845 is not set
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1847

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1847 00

Drive Motor Control Module 1 Lost Communication with Battery Energy Control Module on Powertrain Expansion CAN Bus Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1847*	U1847	-	-

Ignition	U1814, U1847*	U1847*	-	-
Powertrain High Speed GMLAN Serial Data (+)	U0074*	U0074, U1847*	U0074*	-
Powertrain High Speed GMLAN Serial Data (-)	U0074*	U0074, U1847*	U0074*	-
Ground	-	U1847*	-	-
* Other modules/DTCs may set with this fault and multiple symptoms including a no start condition may occur.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is greater than 9.5 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received for more than 500 ms.

Action Taken When the DTC Sets

The DTC U1847 is a type B DTC.

Conditions for Clearing the DTC

The DTC U1847 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of- communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.

- Power to one or more devices was interrupted during diagnosis.
- A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
- Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
- If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0293 is not set.
 - **If DTC U0293 is set**

Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- **If DTC U0293 is not set**
3. Verify that DTC U0073, U0074, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
4. Verify that DTCs U1817, U1818, U182A, and U1844 are not set.
 - **If all of those DTCs are set together**

Refer to **DTC U0074 (Chassis Expansion Bus)**, **DTC U0074 (Powertrain Expansion Bus with HP6)**, **DTC U0074 (Mid Speed GMLAN)**, **DTC U0074 (Powertrain Expansion Bus without HP6)**.

- **If all of those DTCs are not set together**
5. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: Use the schematic to identify the following:

- **The device location on the powertrain high speed GMLAN serial data circuits**
- **The device B+, ignition, ground, accessory wake up serial data, and serial data circuit terminals**

1. Perform the High Voltage Disabling procedure. Refer to **High Voltage Disabling** .
2. Reconnect the 12 V battery.
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the low voltage harness connector at the K16 battery energy control module. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 10 ohms between the K16 battery energy control module case and ground.
 - **If 10 ohms or greater**

Check the ground connection at the housing.

- **If less than 10 ohms**
5. Ignition ON.
 6. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the low voltage harness connectors at the K59 starter/generator control module.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 starter/generator control module.
 - **If the test lamp illuminates**
7. Ignition ON.
8. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate**
 - 1. Ignition OFF, disconnect the low voltage harness connectors at the K59 starter/generator control module.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 starter/generator control module.
 - **If the test lamp illuminates**
9. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the K59 starter/generator control module. It may take up to 2 minutes for all vehicle systems to power down.
10. Test for less than 2 ohms in each powertrain high speed GMLAN serial data circuit between the K16 battery energy control module and the K59 starter/generator control module.
 - **If 2 ohms or greater**
 - Repair the open/high resistance in the serial data circuit between the K16 battery energy control module and the K59 starter/generator control module.
 - **If less than 2 ohms**
11. Replace the K16 battery energy control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1875

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1875 00

Drive Motor Control Module 1 Lost Communication with Battery Energy Control Module Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1875*	U1875	-	-
Ignition	U1814, U1875*	U1875*	-	-
High Speed GMLAN Serial Data (+)	U0073*	U0073, U1875*	U0073*	-
High Speed GMLAN Serial Data (-)	U0073*	U0073, U1875*	U0073*	-
Ground	-	U1875*	-	-
* Other modules/DTCs may set with this fault and multiple symptoms including a no start condition may occur.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is greater than 9.5 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received within 3 seconds.

Action Taken When the DTC Sets

The DTC U1875 is a type B DTC.

Conditions for Clearing the DTC

The DTC U1875 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0293 is not set.
 - **If DTC U0293 is set**

Refer to **DTC U0100-U02FF (without HP6), DTC U0100-U02FF (with HP6)**.
 - **If DTC U0293 is not set**
3. Verify that DTC U0073, U0074, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If none of the DTCs are set**
4. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection

Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: Use the schematic to identify the following:

- **The device location on the high speed GMLAN serial data circuits**
- **The device B+, ignition, ground, accessory wake up serial data, and serial data circuit terminals**

1. Perform the High Voltage Disabling procedure. Refer to **High Voltage Disabling**.
2. Reconnect the 12 V battery.
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the low voltage harness connector at the K16 battery energy control module. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 10 ohms between the K16 battery energy control module case and ground.

- **If 10 ohms or greater**

Check the ground connection at the housing.

- **If less than 10 ohms**

5. Ignition ON.

6. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the low voltage harness connectors at the K59 starter/generator control module.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 starter/generator control module.

- **If the test lamp illuminates**

7. Ignition ON.

8. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the low voltage harness connectors at the K59 starter/generator control module.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 starter/generator control module.

- **If the test lamp illuminates**

9. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the K59 starter/generator control module. It may take up to 2 minutes for all vehicle systems to power down.

10. Test for less than 2 ohms in each serial data circuit between the K16 battery energy control module and the K59 starter/generator control module.

- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K16 battery energy control module and the K59 starter/generator control module.

- **If less than 2 ohms**

11. Replace the K16 battery energy control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1876

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1876 00

Drive Motor Control Module 1 Lost Communication with Engine Control Module Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1876	U1876	-	-
Ignition	U1814, U1876*	U1876	-	-
High Speed GMLAN Serial Data (+)	U0073*	U0073, U1876*	U0073*	-
High Speed GMLAN Serial Data (-)	U0073*	U0073, U1876*	U0073*	-
Ground	-	U1876	-	-
* Other DTCs may set with this fault.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

Conditions for Running the DTC

- The system voltage is greater than 9.5 V.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received for more than 500 ms.

Action Taken When the DTC Sets

DTC U1876 is a type B DTC.

Conditions for Clearing the DTC

DTC U1876 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control

circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Data Link Communications Description and Operation

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0100 is not set.
 - **If DTC U0100 is set**

Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- **If DTC U0100 is not set**
3. Verify that DTC U0073, U0074, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

4. Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: Use the schematic to identify the following:

- **The device location on the high speed GMLAN serial data circuits**
- **The device B+, ignition, ground, accessory wake up serial data 2 and serial data circuit terminals**

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connector at the K20 engine control module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 engine control module.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.

2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
1. Ignition OFF.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 engine control module.
 - **If the test lamp illuminates**
7. Ignition ON.
8. If equipped, verify that a test lamp illuminates between the ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
 - **If the test lamp illuminates**
9. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the K59 starter/generator control module. It may take up to 2 minutes for all vehicle systems to power down.
10. Test for less than 2 ohms in each serial data circuit between the K20 engine control module and the K59 starter/generator control module.
 - **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K20 engine control module and the K59 starter/generator control module.

 - **If less than 2 ohms**
11. Replace the K20 engine control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1885

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1885 00

Battery Energy Control Module Lost Communication with Hybrid Powertrain Control Module Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1885*	U1885	-	-
Ignition	U1814, U1885*	U1885*	-	-
High Speed GMLAN Serial Data (+)	U0073*	U0073, U1885*	U0073*	-
High Speed GMLAN Serial Data (-)	U0073*	U0073, U1885*	U0073*	-
Ground	-	U1885*	-	-
* Other modules/DTCs may set with this fault and multiple symptoms including a no start condition may occur.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

This diagnostic is used to check the loss of communication with hybrid powertrain control module on high speed GMLAN bus. The battery energy control module supervises a periodic serial data message to check the communication status of the hybrid powertrain control module. If this message is not received within 3 seconds, then this DTC is set.

Conditions for Running the DTC

- The system voltage is greater than 8.8 V.

- The DTC U180B is not set.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received within 3 seconds.

Action Taken When the DTC Sets

The DTC U1885 is a type B DTC.

Conditions for Clearing the DTC

The DTC U1885 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0293 is not set.
 - **If DTC U0293 is set**

Refer to **DTC U0100-U02FF (without HP6), DTC U0100-U02FF (with HP6).**
 - **If DTC U0293 is not set**
3. Verify that DTC U0073, U0074, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle .**

- If none of the DTCs are set
4. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: Use the schematic to identify the following:

- The device location on the high speed GMLAN serial data circuits
- The device B+, ignition, ground, accessory wake up serial data, and serial data circuit terminals

1. Perform the High Voltage Disabling procedure. Refer to **High Voltage Disabling** .
2. Reconnect the 12 V battery.
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the low voltage harness connector at the K59 starter/generator control module. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 10 ohms between the K59 starter/generator control module case and ground.
 - **If 10 ohms or greater**

Check the ground connection at the housing.

- **If less than 10 ohms**
5. Ignition ON.
 6. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K59 starter/generator control module.
 - **If the test lamp illuminates**
 7. Ignition ON.
 8. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K59 starter/generator control module.
 - **If the test lamp illuminates**
 9. Ignition ON.
 10. If equipped, verify that a test lamp illuminates between the ignition circuit terminal, which is controlled

by a control module, and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.

- **If the test lamp illuminates**

11. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the K16 battery energy control module. It may take up to 2 minutes for all vehicle systems to power down.
12. Test for less than 2 ohms in each serial data circuit between the K59 starter/generator control module and the K16 battery energy control module.
 - **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K59 starter/generator control module and the K16 battery energy control module.

- **If less than 2 ohms**

13. Replace the K59 starter/generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U1886

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1886 00

Battery Energy Control Module Lost Communication with Engine Control Module Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U1886	U1886	-	-
Ignition	U1814, U1886*	U1886	-	-
High Speed GMLAN Serial Data (+)	U0073*	U1886*	U0073*	-
High Speed GMLAN Serial Data (-)	U0073*	U1886*	U0073*	-
Ground	-	U1886	-	-
* Other DTCs may set with this fault.				

Circuit/System Description

Devices connected to the powertrain high speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

Conditions for Running the DTC

- The system voltage is greater than 8.8 V.
- The DTC U180B is not set.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

DTC U1886 is a type B DTC.

Conditions for Clearing the DTC

DTC U1886 is a type B DTC.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of- communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:

- A device on the data communication circuit was disconnected while the communication circuit is awake.
- Power to one or more devices was interrupted during diagnosis.
- A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
- Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
- If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0100 or U0293 is not set.
 - **If any of the DTCs are set**

Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- **If none of the DTCs are set**
3. Verify that DTC U0073, U1814, B1428, B1370, B1380, B1440, B1441, B1325, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
4. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V

with leather protectors.

- Visually and functionally inspect the gloves before use.
- Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

NOTE: Use the schematic to identify the following:

- The device location on the high speed GMLAN serial data circuits
- The device B+, ignition, ground, accessory wake up serial data, and serial data circuit terminals

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connector at the K20 engine control module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 engine control module.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, verify that a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
1. Ignition OFF.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 engine control module.
 - **If the test lamp illuminates**
7. Ignition ON.
8. If equipped, verify that a test lamp illuminates between the ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
 - **If the test lamp illuminates**
9. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the K59 starter/generator control module. It may take up to 2 minutes for all vehicle systems to power down.
10. Test for less than 2 ohms in each serial data circuit between the K20 engine control module and the K59 starter/generator control module.
 - **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K20 engine control module and the K59 starter/generator control module.
 - **If less than 2 ohms**
11. Perform the High Voltage Disabling procedure. Refer to **High Voltage Disabling** .
12. Reconnect the 12 V battery.
13. Ignition OFF and all vehicle systems OFF, all keys at least 3 meters away from vehicle, all access doors closed. Disconnect the low voltage harness connector at the K16 battery energy control module.
14. Test for less than 2 ohms in each serial data circuit between the K59 starter/generator control module and the K16 battery energy control module.

- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the K59 starter/generator control module and the K16 battery energy control module.

- **If less than 2 ohms**

15. Replace the K20 engine control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U18A2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC U18A2

Lost Communication with Fuel Pump Driver Control Module

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U18A2	U18A2	-	-
Ignition	U18A2	U18A2	-	-
Accessory Wake Up Serial Data	U1814, U2099	U18A2	-	-
Powertrain High Speed GMLAN Serial Data (+)	U0074*	U0074*	U0074*	-
Powertrain High Speed GMLAN Serial Data (-)	U0074*	U0074*	U0074*	-
Ground	-	U18A2	-	-
* Other DTCs may set with this fault.				

Circuit/System Description

Devices connected to the serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

Specific subsystems will not function.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or

corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.

- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0073, U0074, U0075, U0076, U0077, U0078, U2100, U1814, U2099, B1325, B1330, B1370, B1380, B1424, B1428, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

3. Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: **Use the schematics and connector end views to identify the device's ground, B+, ignition, accessory wake up serial data, and serial data circuit terminals.**

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connectors at the K111 Fuel Pump Driver Control Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K111 Fuel Pump Driver Control Module.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K111 Fuel Pump Driver Control Module.
 - **If the test lamp illuminates**
- 7. Ignition ON.
- 8. If equipped, verify a test lamp illuminates between the accessory wakeup serial data circuit terminal and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connectors at the K9 Body Control Module.
 2. Test for infinite resistance between the accessory wakeup serial data circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the accessory wakeup serial data circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
 - 9. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connectors at the device setting the DTC. It may take up to 2 minutes for all vehicle systems to power down.
 - 10. Test for less than 2 ohms in each serial data circuits end to end between the K111 Fuel Pump Driver Control Module and the device setting the DTC.
 - **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit.
 - **If less than 2 ohms**
 - 11. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U18A6

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U18A6

Lost Communication with Right Object Detection Control Module on Dedicated Bus 1

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U18A6	U18A6	-	-
Communication Enable	U18A6	U18A6	-	-
Serial Data (+)	U18A6	U18A6	U18A6	-
Serial Data (-)	U18A6	U18A6	U18A6	-
Ground	-	U18A6	-	-

Circuit/System Description

The side object sensor modules use radar to determine the presence of objects nearby. The left side object sensor is the master that communicates on serial data. There is a private communication network between the left and right sensors. The scan tool can communicate only with the left sensor. Side blind zone alert is active when the vehicle is out of park or the parking brake is off on manual transmission vehicles. If a vehicle is detected in the side blind zone, the warning symbols will illuminate on the appropriate side. The warning symbols will vary brightness based on the ambient light conditions. When an object is detected in the left side blind zone, the side object sensor module sends a message to the right sensor through serial data. The right sensor then supplies voltage to illuminate the visual indicator on the left side outside rear view mirror. When an object is detected in the right side blind zone, the right side object sensor will supply a voltage to illuminate the visual indicator on the right side outside rear view mirror.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

Specific subsystems will not function.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 40, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Object Detection Schematics**
- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Object Detection Description and Operation (with Lane Departure Warning, UFL) , Object Detection Description and Operation (with Forward Collision Alert, UEU) , Object Detection Description and Operation (with Rearview Camera, UVC) , Object Detection Description and Operation (with Side Blind Zone, UFT) , Object Detection Description and Operation (with Lane Change Assist, UKC) , Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG) , Object Detection Description and Operation (with Front and Rear Park Assist, UD5) , Object Detection Description and Operation (with Rear Park Assist, UD7)**
- **Data Link Communications Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC U0073, U0078, B1325, B1330, B1370, B1380, B1424, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
- 2. Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: Use the schematics and connector end views to identify the device's ground, B+, and serial data circuit terminals.

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 min for all vehicle systems to power down. Disconnect the harness connector at the B218R Side Object Sensor Module - Right.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the B218R Side Object Sensor Module - Right.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, test for at least 6 V between the communication enable circuit terminal and ground.
 - **If less than 6 V**
 1. Ignition OFF, disconnect the harness connectors at the B218L Side Object Sensor Module - Left.
 2. Test for infinite resistance between the communication enable circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the communication enable circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the B218L Side Object Sensor Module - Left.
 - **If 6 V or greater**
7. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 min for all vehicle systems to power down. Disconnect the harness connector at the B218L Side Object Sensor Module - Left.
8. Test for less than 1 V between each serial data circuits and ground.
- **If 1 V or greater**
- Repair the short to voltage in the serial data circuit.
- **If less than 1 V**
9. Test for infinite resistance between each serial data circuits and ground.
- **If less than infinite resistance**
- Repair the short to ground in the serial data circuit.
- **If infinite resistance**
10. Test for infinite resistance between 2 serial data circuits.
- **If less than infinite resistance**
- Repair the short together between the serial data circuits.
- **If infinite resistance**
11. Test for less than 2 ohms in each of the serial data circuits end to end between the B218L Side Object Sensor Module - Left and the B218R Side Object Sensor Module - Right.
- **If 2 ohms or greater**
- Repair the open/high resistance in the serial data circuit.
- **If less than 2 ohms**
12. Replace the B218R Side Object Sensor Module - Right.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U18B9-U18BF

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U18B9

Primary High Speed CAN Bus Subnet Configuration List

DTC U18BF

Secondary High Speed CAN Bus Subnet Configuration List

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Devices on the high speed GMLAN serial data bus and the chassis high speed GMLAN serial data bus must be programmed with software that specifically identifies the correct type and quantity of devices on the bus based on RPO configuration. If a device was not properly configured after installation, the appropriate U Code may be set for that device. No external circuit diagnosis is involved.

Conditions for Running the DTC

- Voltage supplied to the device is in the normal operating voltage range.
- The vehicle power mode requires serial data communication to occur.

Conditions for Setting the DTC

- The device is not configured properly.
- Control unit recognises a programming error.
- CAN-Bus configuration is invalid

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Description and Operation

Data Link Communications Description and Operation

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U18B9-U18BF is not set.
 - **If DTC U18B9-U18BF is set along with other DTCs set**

Diagnose all other DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If DTC U18B9-U18BF is set without other DTCs set**

1. Program the device that set the DTC.
2. Ignition OFF, remove the scan tool, open and close the driver door. Wait 60 s.
3. Verify the DTC does not set.
 - If the DTC sets, replace the appropriate device.
 - If the DTC does not set
4. All OK.
 - **If DTC U18B9-U18BF is not set**

3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC U1901

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1901 00

Lost Communication With Front Controls Multifunction Interface Module Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Serial Data	U1901 00	U1901 00	U1901 00	-
Ground	-	1	-	-
1. S56 Radio Control Multifunction Switch Malfunction				

Circuit/System Description

The Radio interfaces only with the Info Display Module and the Info Display Module communicates with the Radio/HVAC Control through a Linear Interconnect Network (LIN) interface. The Info Display Module is responsible for passing information between the Radio and the Radio/HVAC Control.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

Radio detects an invalid signal from S56 Radio Control Multifunction Switch.

Action Taken When the DTC Sets

Radio menu navigation and control will not function with the multifunction controller.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Radio/Navigation System Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Data Link Communications Description and Operation**
- **Radio/Audio System Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE:

- **Terminal and connector identifiers will be different depending on the individual device being tested. Use Schematic Reference and Connector End View Reference to identify device's connector, B+, ground, and serial data circuit terminals.**
- **A loss of serial data communications DTC does not represent a failure of the master control module that set it.**

1. Ignition OFF, disconnect the harness connector at the S56 Radio Control Multifunction Switch.
2. Test for less than 10 ohms between the ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify a test lamp illuminates between the B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S56 Radio Control Multifunction Switch.
 - **If the test lamp illuminates**
- 5. Ignition ON.
- 6. Test for 2-12 V between the serial data circuit terminal and ground.
 - **If less than 2 V**
 1. Ignition OFF, disconnect the harness connector at the A22 Radio Controls.
 2. Test for infinite resistance between the serial data circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the serial data circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
 4. Replace the A22 Radio Controls.
 - **If greater than 12 V**
 1. Ignition OFF, disconnect the harness connector at the A22 Radio Controls.
 2. Ignition ON.
 3. Test for less than 1 V between the serial data circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 4. Replace the A22 Radio Controls.
 - **If between 2-12 V**
- 7. Replace the S56 Radio Control Multifunction Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Audio Multifunction Control Replacement**
- **Control Module References** for device replacement, programming and setup

DTC U2098

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U2098 00

MOST Communication Enable Circuit Malfunction

DTC U2098 02

MOST Communication Enable Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
MOST Control	U2098 00, U2098 02, U0029 02	U0028 00	-	-

Circuit/System Description

When the ignition is ON, the A11 Radio initializes the Media Oriented Systems Transport (MOST) bus by sending a short 100 ms low voltage pulse on the electronic control line (or MOST control line) connected to all devices contained on the MOST ring. When MOST receive, transmit, or control line faults are detected, transmit/receive messages will not be received as expected from the wakeup request. The A11 Radio and the K74 Human Machine Interface Control Module will then perform diagnostics to isolate these MOST faults. If the MOST control line is shorted low to 0 V for an excess amount of time, the A11 Radio will set a U2098 DTC and K74 Human Machine Interface Control Module will set a U0029 02 DTC. At this point the MOST bus will be unable to communicate until the shorted MOST control line is repaired.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The ignition is ON.
- The Radio is ON.

Conditions for Setting the DTC

- The Radio senses a short to ground on the MOST control circuit.
- A current DTC is set when a MOST control circuit initialization is invoked and the circuit is detected to be pulled low (0 V) for longer than 1 second.

Action Taken When the DTC Sets

Many or all entertainment components may not function properly.

Conditions for Clearing the DTC

The DTC current status is cleared upon a successful MOST control circuit initialization occurs and the circuit is no longer pulled low.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: Use the schematics to determine which MOST devices are on the A11 Radio's MOST control circuit 6 X2. Use the connector end views to identify the MOST control circuit terminal for each of those MOST devices.

1. Ignition OFF, disconnect the harness connectors at an easily accessible MOST device that shares the A11 Radio's MOST control circuit 6 X2. Ignition ON.
2. Verify that the DTC U2098 or DTC U0029 02 remains current.

- **If the DTC becomes history**

Replace the MOST device that was just disconnected.

- **If the DTC remains current**

3. With the prior devices disconnected, repeat steps 1 and 2 for each MOST device on the MOST control circuit except the A11 Radio.
4. Ignition OFF, disconnect the X2 harness connector at the A11 Radio.
5. Test for infinite resistance between the MOST control circuit terminal 6 X2 at the A11 Radio and ground.

- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

6. Replace the A11 Radio.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U2099

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U2099

High Speed Communication Enable Circuit

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	U2099*	U0100-U02FF	U0100-U02FF	-
* Vehicle may not start.				

Circuit/System Description

The body control module (BCM) activates the ignition circuit, when the ignition key is in ACC, ON or START. The ignition circuit wakes up the devices for serial data bus communication.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

The BCM senses a short to ground on the ignition circuit.

Action Taken When the DTC Sets

- The output command is turned off while the malfunction is present.
- The devices use a default value for the missing parameters until the next ignition cycle.
- The device(s) is never signaled. Therefore, the specific subsystem(s) will not function.
- The vehicle will not start while the circuit is shorted to ground.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: Use the schematic to determine which devices are on the K9 Body Control Module's ignition circuit terminal 23 X4. Use the connector end view to identify the ignition circuit terminal for each of those devices.

1. Ignition OFF, disconnect the harness connectors at an easily accessible device that shares the K9 Body Control Module's ignition circuit terminal 23 X4. Ignition ON.
2. Verify that the DTC U2099 remains current.

- **If the DTC becomes history**

Replace the device that was just disconnected.

- **If the DTC remains current**

3. With the prior devices disconnected, repeat steps 1 and 2 for each device on the ignition circuit except the K9 Body Control Module.
4. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
5. Test for infinite resistance between the ignition circuit terminal 23 X4 at the K9 Body Control Module and ground.

- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

6. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U2616

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC U2616

Fuel Pump Driver Control Module Lost Communication with ECM

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U2616, U0100	U2616, U0100	-	-
Ignition	U2616, U0100	U2616, U0100	-	-
Accessory Wake Up Serial Data	U1814, U2099	U2616, U0100	-	-
Powertrain High Speed GMLAN Serial Data (+)	U0074*	U0074*	U0074*	-
Powertrain High Speed GMLAN Serial Data (-)	U0074*	U0074*	U0074*	-
Ground	-	U2616, U0100	-	-
* Other DTCs may set with this fault.				

Circuit/System Description

Devices connected to the serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

Specific subsystems will not function.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to the device using multiple GMLAN busses.
- Use **Data Link References** to determine what GMLAN serial data communications the non communicating device uses.
- The device may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the non communicating device.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC U0073, U0074, U0075, U0076, U0077, U0078, U2100, U1814, U2099, B1325, B1330, B1370, B1380, B1424, B1428, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If none of the DTCs are set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: **Use the schematics and connector end views to identify the device's ground, B+, ignition, accessory wake up serial data, and serial data circuit terminals.**

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connectors at the K20 Engine Control Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp illuminates**
7. Ignition ON.
8. If equipped, verify a test lamp illuminates between the accessory wakeup serial data circuit terminal and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connectors at the K9 Body Control Module.
 2. Test for infinite resistance between the accessory wakeup serial data circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 3. Test for less than 2 ohms in the accessory wakeup serial data circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
- **If the test lamp illuminates**
- 9. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the harness connectors at the K111 Fuel Pump Driver Control Module. It may take up to 2 minutes for all vehicle systems to power down.
- 10. Test for less than 2 ohms in each serial data circuits end to end between the K20 Engine Control Module and the K111 Fuel Pump Driver Control Module.
 - **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit.

- **If less than 2 ohms**
- 11. Replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DTC U2101

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U2101

CAN Bus Maximum List of Control Modules

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Some devices must be programmed with software that specifically identifies the correct type and quantity of devices on the serial data bus based on RPO configuration. If a device was not properly configured after installation, the appropriate U Code may be set for that device. No external circuit diagnosis is involved.

Conditions for Running the DTC

- The system voltage is in the normal operating voltage range.
- The vehicle power mode requires serial data communication to occur.

Conditions for Setting the DTC

- The device is not configured properly.
- Control unit recognizes a programming error.
- CAN Bus configuration is invalid.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON.

2. Verify DTC U2101 is not set.
 - **If DTC U2101 is set along with other DTCs set**

Diagnose all other DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If DTC U2101 is set without other DTCs set**
 1. Program the device that set the DTC.
 2. Clear the DTC.
 3. Ignition OFF, remove the scan tool, open and close the driver door. Wait 60 s.
 4. Verify the DTC does not set.
 - If the DTC sets, replace the appropriate device.
 - If the DTC does not set
 5. All OK.
 - **If DTC U2101 is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for device replacement, programming and setup

DTC U2160-U2231

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

For device DTC descriptors, refer to **Control Module U Code List**.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U2160-U2231	U2160-U2231	-	-
Ignition	U2160-U2231, U1814, U2099	U2160-U2231	-	-
Object High Speed GMLAN Serial Data (+)	U0075	U2160-U2231	U0075	-

Object High Speed GMLAN Serial Data (-)	U0075	U2160-U2231	U0075	-
Chassis High Speed GMLAN Serial Data (+)	U0074, U0077	U2160-U2231	U0074, U0077	-
Chassis High Speed GMLAN Serial Data (-)	U0074, U0077	U2160-U2231	U0074, U0077	-
Mid Speed GMLAN Serial Data (+)	U0074	U2160-U2231	U0074	-
Mid Speed GMLAN Serial Data (-)	U0074	U2160-U2231	U0074	-
High Speed GMLAN Serial Data (+)	U0073, 2	U2160-U2231	U0073, 2	-
High Speed GMLAN Serial Data (-)	U0073, 2	U2160-U2231	U0073, 2	-
Low Speed GMLAN Serial Data	U0078, 1	U2160-U2231	U0078, 1	-
Ground	-	U2160-U2231	-	-
1. Scan tool does not communicate with most low speed GMLAN device 2. Scan tool does not communicate with most high speed GMLAN device				

Circuit/System Description

Devices connected to the serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the devices. The devices have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver device as an availability indication of the transmitter device. Each message contains the identification number of the transmitter device. A loss of serial data communications DTC does not represent a failure of the devices that contain the stored code.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter device availability has not been received.

Action Taken When the DTC Sets

Specific subsystems will not function.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the device ignition cycle counter reaches the reset threshold of 50, without a

repeat of the malfunction.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A device may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between devices can be temporary with no apparent symptom or complaint; this does not mean the device is faulty. Do not replace a device based only on a history U-code.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with either the low or high speed GMLAN serial data system inoperative. This condition is due to those devices using multiple serial data communication systems.
- Use **Data Link References** to determine what serial data communications the device uses.
- Some devices may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the device.
- Some intermittent communication concerns may be caused by fretting corrosion on the serial data circuit terminals. Inspect all connectors at the device that set the communication DTC, the device that the communication DTC was set against, and any inline harness connectors between the two devices. Do not replace a device based only on fretting corrosion. Refer to bulletin 09-06-03-004 for assistance with the diagnosis and repair of this condition, if applicable.
- This diagnostic can be used for any device that is not communicating, regardless of the type of serial data circuit it is connected to, providing the vehicle is equipped with the device.

Reference Information

Schematic Reference

- **Data Communication Schematics**

- **Control Module References**

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Determine the device that is not communicating. Refer to **Control Module U Code List**.
2. Verify that DTC U0073, U2100, U0074, U0078, U1814, U2099, B1325, B1330, B1370, B1380, B1424, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: **Use the schematics and connector end views to identify the device's ground, B+, ignition, accessory wakeup serial data, serial data communication enable, and serial data circuit terminals.**

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. Disconnect all the harness connectors at the device that is not communicating. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
5. Ignition ON.
6. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
7. Ignition ON.
8. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
- **If the test lamp illuminates**

NOTE: **This test step is only applicable to a low speed GMLAN device.**

- 9. Test for less than 4.5 V between each low speed GMLAN serial data circuit terminal and ground.
 - **If 4.5 V or greater**

Refer to **Scan Tool Does Not Communicate with Low Speed GMLAN Device** to test for a short to voltage in the serial data circuit.

- **If less than 4.5 V**
- 10. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 min for all vehicle systems to power down.
- 11. Test for less than 2 ohms in each of the serial data circuits end to end between the device harness connector and the X84 Data Link Connector terminals listed below.
 - Low speed GMLAN serial data circuit terminal 1
 - High speed GMLAN serial data circuit terminal 6 or 14
 - Mid speed GMLAN serial data circuit terminal 3 or 11
 - Chassis high speed GMLAN serial data circuit terminal 12 or 13
 - Object high speed GMLAN serial data circuit terminal 3 or 11
- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit between the non communicating device and the device setting the DTC or a serial data splice pack.

- **If less than 2 ohms**

NOTE: **The following test step is only applicable to a high speed GMLAN device with 2 pairs of serial data circuits or a high speed GMLAN device with an internal terminating resistor.**

- 12. Test for 110-130 ohms between each pair of high speed GMLAN serial data circuits.
 - **If less than 110 ohms**

Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** to test for a short to ground or a short between the serial data circuits.

- **If greater than 130 ohms**

Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** to test for an open/high resistance in the serial data circuit.

- **If between 110-130 ohms**

13. Replace the device that is not communicating.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

SYMPTOMS - DATA COMMUNICATIONS

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no Diagnostic Trouble Codes (DTC) set.
 - The devices can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Data Link Communications Description and Operation** .

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Scan Tool Does Not Power Up**
- **Scan Tool Does Not Communicate with High Speed GMLAN Device**
- **Scan Tool Does Not Communicate with Low Speed GMLAN Device**

SCAN TOOL DOES NOT POWER UP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Data Link Connector B+	1	1	-	-
Data Link Connector Ground	-	1	-	-
1. Scan Tool Does Not Power Up				

Circuit/System Description

The data link connector (DLC) is a standardized 16 cavity connector. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

- Scan tool B+ voltage at terminal 16
- Scan tool ground at terminal 4
- Common ground at terminal 5

Diagnostic Aids

- The scan tool will power up with the ignition OFF. Some devices however, will not communicate unless the ignition is ON and the power mode master device sends the appropriate power mode message.
- If the B+ circuit, ground circuits, and connections of the data link connector are functioning properly, the malfunction must be due to the scan tool.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 2 ohms between each of the X84 Data Link Connector ground circuit terminals listed below and ground.
 - Ground circuit terminal 4
 - Ground circuit terminal 5
 - **If 2 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 2 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 16 at the X84 Data Link Connector and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - **If the test lamp illuminates**
5. Refer to the scan tool user guide.

SCAN TOOL DOES NOT COMMUNICATE WITH CHASSIS HIGH SPEED GMLAN DEVICE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Chassis High Speed GMLAN Serial Data (+)	1	U0100-U02FF*	1	-
Chassis High Speed GMLAN Serial Data (-)	1	U0100-U02FF*	1	-
Ground (DLC, terminal 5)	-	1	-	-
* No communications with one or more chassis high speed GMLAN devices. An open in only one chassis high speed GMLAN serial data circuit may allow degraded communication between the devices. An open between the data link connector (DLC) and the first splice/device will only affect the communication with the scan tool. The devices will still communicate. 1. No communication with any chassis high speed GMLAN device.				

Circuit/System Description

The chassis high speed GMLAN bus functions the same as the primary high speed GMLAN bus, and the two buses operate in parallel. The chassis high speed GMLAN bus is added to reduce message congestion on the primary high speed bus. Since the chassis high speed GMLAN bus and primary high speed GMLAN bus operate in the same manner, the diagnostics for each are the same.

The serial data is transmitted on two twisted wires that allow speeds up to 500 kbit/s. The twisted pair is terminated with two 120 ohms resistors, one is internal to the electronic brake control module and the other can be a separate resistor in a connector assembly or in another device. The resistors are used as the load for the chassis high speed GMLAN bus during normal vehicle operation. The chassis high speed GMLAN is a differential bus. The chassis high speed GMLAN serial data bus (+) and chassis high speed GMLAN serial data (-) are driven to opposite extremes from a rest or idle level of approximately 2.5 V. Driving the lines to their extremes, adds 1 V to the chassis high speed GMLAN serial data bus (+) circuit and subtracts 1 V from the chassis high speed GMLAN serial data bus (-) circuit. If serial data is lost, devices will set a no communication code against the non-communicating device. Note that a loss of serial data DTC does not represent a failure of the device that set it.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:

- A device on the data communication circuit was disconnected while the communication circuit is awake.
- Power to one or more devices was interrupted during diagnosis.
- A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
- Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
- If a loss-of-communication U code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a device reporting a U code. The U code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with one or more GMLAN serial data systems inoperative. This condition is due to those devices using multiple serial data communication systems.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC).

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify two or more devices are not communicating on the chassis high speed GMLAN serial data circuit. Refer to **Data Link References** to determine how many devices should be communicating on the bus.
 - **If only one device is not communicating**

Refer to Circuit/System Testing - Testing the Device Circuits.

- **If two or more devices are not communicating**
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. Disconnect the scan tool from the X84 Data Link Connector. The following tests will be done at the X84 Data Link Connector. It may take up to 2 minutes for all vehicle systems to power down.
 4. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
 5. Ignition ON.
 6. Test for less than 4.5 V between the serial data circuits listed below and ground.
 - Terminal 12
 - Terminal 13
 - **If 4.5 V or greater**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Voltage.

- **If less than 4.5 V**
7. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
 8. Test for greater than 100 ohms between the serial data circuits listed below and ground.
 - Terminal 12
 - Terminal 13
 - **If 100 ohms or less**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Ground.

- **If greater than 100 ohms**
9. Test for 50-70 ohms between the serial data circuit terminals 12 and 13.

- **If less than 35 ohms**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short between the Circuits.

- **If between 35-50 ohms**

There may be a third terminating resistor between the serial data circuits. This can happen if the incorrect device is installed. Some devices are available with and without the terminating resistors installed to reduce the need of terminating resistors in the wiring harness. Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short between the Circuits.

- **If greater than 70 ohms but less than infinite**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for an Open/High Resistance.

- **If infinite resistance**

Repair the open/high resistance in the circuit between the X84 Data Link Connector and the first splice/device in the serial data circuit.

- **If between 50-70 ohms**

10. Refer to Circuit/System Testing - Testing the Device Circuits.

Circuit/System Testing

NOTE: Each device may need to be disconnected to isolate a circuit fault.

Use the schematic to identify the following:

- **Chassis high speed GMLAN devices the vehicle is equipped with**
- **Chassis high speed GMLAN serial data circuit terminating resistors**
- **Device locations on the chassis high speed GMLAN serial data circuits**
- **Each device's ground, B+, ignition, and chassis high speed GMLAN serial data circuit terminals**

Some devices with an internal terminating resistor have a loop in the harness that connects the internal terminating resistor to the serial data circuit. When wired this way, test these loop circuits for the appropriate failure mode short to voltage, short to ground, or open/high resistance prior to replacing the device for each of the following tests.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at an easily accessible device, ignition ON.

2. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 10 ohms, replace the device that was disconnected.
 - **If any serial data circuit is greater than 4.5 V**
3. Ignition OFF, disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to voltage, ignition ON.
4. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 10 ohms, replace the device that was disconnected.
 - **If any serial data circuit is greater than 4.5 V**
5. Repeat step 3 until one of the following conditions are isolated:
 - A short to voltage on the serial data circuit between two devices or splice packs, if equipped.
 - A short to voltage on the serial data circuit between a device and a terminating resistor.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at an easily accessible device.
3. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 100 ohms or greater**

Replace the device that was disconnected.
 - **If any serial data circuit is less than 100 ohms**
4. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to ground.
5. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If both serial data circuits are 100 ohms or greater**

Replace the device that was disconnected.

- **If any serial data circuit is less than 100 ohms**

6. Repeat step 4 until one of the following conditions are isolated:
 - A short to ground on the serial data circuit between two devices or splice packs, if equipped.
 - A short to ground on the serial data circuit between a device and a terminating resistor.
 - A short to ground on the serial data circuit between the X84 Data Link Connector and the first device or splice pack.

Testing the Serial Data Circuits for a Short between the Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at an easily accessible device that is not communicating.
3. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.
 - **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**

4. Connect the harness connectors at the device that was disconnected.
5. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted together.
6. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.
 - **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**

7. Repeat step 4 until one of the following conditions are isolated:
 - Serial data circuits shorted together between two devices or splice packs, if equipped.
 - Serial data circuits shorted together between a device and a terminating resistor.
 - Serial data circuits shorted together between the X84 Data Link Connector and the first device or splice pack.
 - A shorted terminating resistor.

Testing the Serial Data Circuits for an Open/High Resistance

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.

2. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at an easily accessible device that is not communicating.
3. Test for less than 130 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuit is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

4. Connect the harness connectors at the device that was disconnected.
5. Disconnect the harness connectors with the chassis high speed GMLAN serial data circuits at another device, in the direction of the circuit with the open/high resistance.
6. Test for less than 130 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

7. Repeat step 4 until one of the following conditions are isolated:
 - An open/high resistance on the serial data circuit between two devices or splice packs, if equipped.
 - An open/high resistance on the serial data circuit between a device and a terminating resistor.
 - An open/high resistance terminating resistor.

Testing the Device Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors at an easily accessible device that is not communicating.
3. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
- 1. Ignition OFF.
- 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
- **If the test lamp illuminates**
- 5. Ignition ON.
- 6. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which has a fuse in the circuit, and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
- 1. Ignition OFF.
- 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
- **If the test lamp does not illuminate and the circuit fuse is open**
- 1. Ignition OFF.
- 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
- **If the test lamp illuminates**
- 7. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
- 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
- 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
- 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
- **If the test lamp illuminates**
- 8. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
- 9. Test for less than 130 ohms between each pair of chassis high speed GMLAN serial data circuits at the device connector that was just disconnected.
 - **If any pair of serial data circuits is greater than 130 ohms**

Repair the open/high resistance in the serial data circuits between the disconnected device and the circuit splice in the serial data circuits.

- **If each pair of serial data circuits is 130 ohms or less**

10. Replace the device that was disconnected.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

SCAN TOOL DOES NOT COMMUNICATE WITH HIGH SPEED GMLAN DEVICE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Speed GMLAN Serial Data (+)	1	U0100-U02FF*	1	-
High Speed GMLAN Serial Data (-)	1	U0100-U02FF*	1	-
Ground (DLC, terminal 5)	-	1	-	-
* No communications with one or more high speed GMLAN devices. An open in only one high speed GMLAN serial data circuit may allow degraded communication between the devices. An open between the data link connector (DLC) and the first splice/device will only affect the communication with the scan tool. The devices will still communicate. 1. No communication with any high speed GMLAN device				

Circuit/System Description

The serial data is transmitted on two twisted wires that allow speeds up to 500 Kb/s. The twisted pair is terminated with two 120 ohms resistors, one is internal to the engine control module (ECM) and the other can be a separate resistor in a connector assembly or in another device. The resistors are used as the load for the High Speed GMLAN bus during normal vehicle operation. The high speed GMLAN is a differential bus. The high speed GMLAN serial data bus (+) and high speed GMLAN serial data (-) are driven to opposite extremes from a rest or idle level of approximately 2.5 V. Driving the lines to their extremes, adds 1 V to the high speed GMLAN serial data bus (+) circuit and subtracts 1 V from the high speed GMLAN serial data bus (-) circuit. If serial data is lost, devices will set a no communication code against the non-communicating device. Note that a

loss of serial data DTC does not represent a failure of the device that set it.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis.
 - A low battery condition was present, so some devices stop communicating when battery voltage drops below a certain threshold.
 - Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
 - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a device reporting a U code. The U code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between some devices and the scan tool with the high speed GMLAN serial data system inoperative. This condition is due to those devices using multiple serial data communication systems.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle.
- The engine will not start when there is a total malfunction of the high speed GMLAN serial data bus.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC) and no low speed GMLAN communications with the scan tool.
- These conditions may be caused by the installation of an aftermarket navigation radio module (see bulletins). Some customers may comment of one or more of the following concerns:
 - Vehicle will not crank
 - Vehicle cranks but will not start
 - Vehicle stability enhancement system warning lights and messages
 - PRNDL gear indicator position errors

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify two or more devices are not communicating on the high speed GMLAN serial data circuit. Refer to **Data Link References** to determine how many devices should be communicating on the bus.
 - **If only one device is not communicating**

Refer to Circuit/System Testing - Testing the Device Circuits.

- **If two or more devices are not communicating**
3. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. Disconnect the scan tool from the X84 data link connector. The following tests will be done at the X84 data link connector. It may take up to 2 minutes for all vehicle systems to power down.
 4. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
 5. Ignition ON.
 6. Test for less than 4.5 V between the serial data circuits listed below and ground.
 - Terminal 6

- Terminal 14
- **If 4.5 V or greater**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Voltage.

- **If less than 4.5 V**

7. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
8. Test for greater than 100 ohms between the serial data circuits listed below and ground.
 - Terminal 6
 - Terminal 14
 - **If 100 ohms or less**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Ground.

- **If greater than 100 ohms**

9. Test for 50-70 ohms between the serial data circuit terminals 6 and 14.
 - **If less than 35 ohms**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short between the Circuits.

- **If between 35-50 ohms**

There may be a third terminating resistor between the serial data circuits. This can happen if the incorrect device is installed. Some devices are available with and without the terminating resistors installed to reduce the need of terminating resistors in the wiring harness. Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short between the Circuits.

- **If greater than 70 ohms but less than infinite**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for an Open/High Resistance.

- **If infinite resistance**

Refer to Circuit/System Testing - Testing the Data Link Connector Serial Data Circuits for an Open/High Resistance.

- **If between 50-70 ohms**

10. Refer to Circuit/System Testing - Testing the Device Circuits.

Circuit/System Testing

NOTE: Each device may need to be disconnected to isolate a circuit fault.

Use the schematic to identify the following:

- **High speed GMLAN devices the vehicle is equipped with**
- **High speed GMLAN serial data circuit terminating resistors**
- **Device locations on the high speed GMLAN serial data circuits**
- **Each device's ground, B+, ignition, and high speed GMLAN serial data circuit terminals**

Some devices with an internal terminating resistor have a loop in the harness that connects the internal terminating resistor to the serial data circuit. When wired this way, test these loop circuits for the appropriate failure mode short to voltage, short to ground, or open/high resistance prior to replacing the device for each of the following tests.

Testing the Data Link Connector Serial Data Circuits for an Open/High Resistance

1. Ignition OFF, disconnect the harness connectors at the K9 body control module.
2. Test for less than 2 ohms in each serial data circuit between the X84 data link connector and the K9 body control module.
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 ohms**
3. Test for less than 2 ohms in each serial data circuit between the K9 body control module and the first splice or splice pack.
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 ohms**
4. Replace the K9 body control module.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible device, ignition ON.
2. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.

- If less than 10 ohms, replace the device that was disconnected.
- **If any serial data circuit is greater than 4.5 V**
- 3. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to voltage, ignition ON.
- 4. Test for greater than 4.5 V between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 4.5 V or less**
 1. Ignition OFF.
 2. Test for less than 10 ohms between each of the device's ground circuit terminals and ground.
 - If 10 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 10 ohms, replace the device that was disconnected.
 - **If any serial data circuit is greater than 4.5 V**
- 5. Repeat step 3 until one of the following conditions are isolated:
 - A short to voltage on the serial data circuit between two devices or splice packs, if equipped.
 - A short to voltage on the serial data circuit between a device and a terminating resistor.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible device.
3. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If each serial data circuit is 100 ohms or greater**

Replace the device that was disconnected.
 - **If any serial data circuit is less than 100 ohms**
4. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted to ground.
5. Test for greater than 100 ohms between each serial data circuit at the device connector that was just disconnected and ground.
 - **If both serial data circuits are 100 ohms or greater**

Replace the device that was disconnected.
 - **If any serial data circuit is less than 100 ohms**
6. Repeat step 4 until one of the following conditions are isolated:
 - A short to ground on the serial data circuit between two devices or splice packs, if equipped.
 - A short to ground on the serial data circuit between a device and a terminating resistor.

- A short to ground on the serial data circuit between the X84 data link connector and the first device or splice pack.

Testing the Serial Data Circuits for a Short between the Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible device that is not communicating.
3. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**

4. Connect the harness connectors at the device that was disconnected.
5. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another device, in the direction of the circuit shorted together.
6. Test for greater than 110 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 110 ohms or greater**

Replace the device that was disconnected.

- **If any pair of serial data circuits is less than 110 ohms**

7. Repeat step 4 until one of the following conditions are isolated:
 - Serial data circuits shorted together between two devices or splice packs, if equipped.
 - Serial data circuits shorted together between a device and a terminating resistor.
 - Serial data circuits shorted together between the X84 data link connector and the first device or splice pack.
 - A shorted terminating resistor.

Testing the Serial Data Circuits for an Open/High Resistance

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible device that is not communicating.
3. Test for less than 130 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

4. Connect the harness connectors at the device that was disconnected.
5. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another device, in the direction of the circuit with the open/high resistance.
6. Test for less than 130 ohms between each pair of serial data circuits at the device connector that was just disconnected.

- **If each pair of serial data circuits is 130 ohms or less**

Replace the device that was disconnected.

- **If any pair of serial data circuits is greater than 130 ohms**

7. Repeat step 4 until one of the following conditions are isolated:
 - An open/high resistance on the serial data circuit between two devices or splice packs, if equipped.
 - An open/high resistance on the serial data circuit between a device and a terminating resistor.
 - An open/high resistance terminating resistor.

Testing the Device Circuits

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
2. Disconnect the harness connectors at an easily accessible device that is not communicating.
3. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
4. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
- 5. Ignition ON.
- 6. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which has a fuse in the circuit, and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 - 1. Ignition OFF.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the disconnected device.
 - **If the test lamp illuminates**
- 7. If equipped, verify a test lamp illuminates between each ignition circuit terminal, which is controlled by a control module, and ground.
 - **If the test lamp does not illuminate**
 - 1. Ignition OFF, disconnect the harness connectors at the control module that controls the ignition circuit.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the control module that controls the ignition circuit.
 - **If the test lamp illuminates**
- 8. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters (9.8 feet) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
- 9. Test for less than 130 ohms between each pair of high speed GMLAN serial data circuits at the device connector that was just disconnected.
 - **If any pair of serial data circuits is greater than 130 ohms**
 - Repair the open/high resistance in the serial data circuits between the disconnected device and the circuit splice in the serial data circuits.
 - **If each pair of serial data circuits is 130 ohms or less**
- 10. Replace the device that was disconnected.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

SCAN TOOL DOES NOT COMMUNICATE WITH LOW SPEED GMLAN DEVICE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Speed GMLAN Serial Data	1	U0100-U02FF*	1	-
Ground (DLC, terminal 5)	-	1*	-	-
* An open between the data link connector (DLC) and the first splice pack/device will only affect the communication with the scan tool.				
1. No communication with any low speed GMLAN device				

Circuit/System Description

The serial data is transmitted over a single wire to the appropriate devices. The transmission speed for GMLAN low speed is up to 83.33 kbit/s. Under normal vehicle operating conditions, the speed of the bus is 33.33 kbit/s. The devices toggle the serial data circuit between 0-5 V during normal communications. To wake the devices connected to the low speed GMLAN serial data circuit, a voltage wake up pulse of 10 V is sent out. If serial data is lost, devices will set a no communication code against the non-communicating device. A loss of serial data communications DTC does not represent a failure of the device that set it.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of- communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
 - A device on the data communication circuit was disconnected while the communication circuit is awake.
 - Power to one or more devices was interrupted during diagnosis
 - A low battery condition was present, so some devices stop communicating when battery voltage

drops below a certain threshold.

- Battery power was restored to the vehicle and devices on the communication circuit did not all re-initialize at the same time.
- If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a device reporting a U-code. The U-code identifies which device needs to be diagnosed for a communication issue.
- Communication may be available between the device and the scan tool with the low speed GMLAN serial data system inoperative. This condition is due to the device using both the high and low speed GMLAN systems.
- An open in the low speed GMLAN serial data circuit between the splice pack and a device will only affect that specific device. This type of failure will set a loss of communication DTC for each device affected, and the other devices will still communicate.
- An open in the data link connector (DLC) ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle.
- The engine may not start when there is a total malfunction of the low speed GMLAN serial data circuit.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC) and no low speed LAN communications with the scan tool.
- These conditions may be caused by the installation of an aftermarket navigation radio device (see bulletins). Some customers may comment of one or more of the following concerns:
 - Vehicle will not crank
 - Vehicle cranks but will not start
 - Vehicle stability enhancement system warning lights and messages
 - PRNDL gear indicator position errors

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Use the schematic to identify the following:

- **Devices the vehicle is equipped with**
- **Device and splice pack locations on the low speed GMLAN serial data circuit**
- **The low speed GMLAN serial data circuit terminals for each device or splice pack**

1. Attempt to communicate with all devices on the low speed GMLAN serial data circuit. Refer to **Data Link References**.
2. Verify which devices are communicating on the low speed GMLAN serial data circuit.
 - **If only one device is not communicating**

Diagnose that device only. Refer to **DTC U0100-U02FF (without HP6)**, **DTC U0100-U02FF (with HP6)**.

- **If one or more devices are communicating but not all**

Refer to Circuit/System Testing - Testing the Serial Data Circuit for an Open/High Resistance.

- **If none of the devices are communicating**

3. Ignition OFF, all access doors closed, all vehicle systems OFF, all keys at least 3 m (9.8 ft) away from vehicle. Disconnect the scan tool from the X84 Data Link Connector. The following tests will be done at the X84 Data Link Connector. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
5. Ignition ON.
6. Test for less than 4.5 V between the serial data circuit terminal 1 and ground.

- **If 4.5 V or greater**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Voltage.

- **If less than 4.5 V**

7. Ignition OFF, all access doors closed, all vehicle systems OFF, all keys at least 3 m (9.8 ft) away from vehicle. It may take up to 2 minutes for all vehicle systems to power down.
8. Test for greater than 100 ohms between the serial data circuit terminal 1 and ground.

- **If 100 ohms or less**

Refer to Circuit/System Testing - Testing the Serial Data Circuits for a Short to Ground.

- **If greater than 100 ohms**

9. Disconnect the appropriate harness connector at the first splice pack closest in the circuit to the X84 Data Link Connector.
10. Test for less than 2 ohms between the X84 Data Link Connector's serial data circuit terminal 1 and the splice pack harness connector's serial data input terminal.

- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit.

- **If less than 2 ohms**

11. Replace the splice pack.

Circuit/System Testing

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the appropriate harness connectors at all low speed GMLAN serial data splice packs, ignition ON.
2. Test for less than 4.5 V between the serial data circuit terminal 1 at the X84 Data Link Connector and ground.

- **If 4.5 V or greater**

Repair the short to voltage on the serial data circuit.

- **If less than 4.5 V**

3. Test for less than 4.5 V between each low speed GMLAN serial data circuit at a splice pack and ground.

- **If any serial data circuit is greater than 4.5 V**

1. Ignition OFF, disconnect all devices on the failed serial data circuit, ignition ON.
2. Test for less than 1 V between each section of the failed serial data circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V

3. Connect the splice pack and connect the first device on the failed serial data circuit, ignition ON.
4. Verify the scan tool communicates or not with the low speed GMLAN serial data circuit.
 - If the scan tool does not communicate, replace the device that was just connected.
 - If the scan tool communicates and there are more devices to connect, connect the next device and repeat step 3.4.
 - If the scan tool communicates and there are no more devices to connect
5. All OK.
 - **If all serial data circuits are less than 4.5 V**

4. All OK.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from vehicle. Disconnect the appropriate harness connectors at all low speed GMLAN serial data splice packs.
2. Test for infinite resistance between the serial data circuit terminal 1 at the X84 Data Link Connector and ground.
 - **If less than infinite resistance**

Repair the short to ground on the serial data circuit.

- **If infinite resistance**
3. Test for greater than 100 ohms between each low speed GMLAN serial data circuit at a splice pack and ground.
 - **If any serial data circuit is 100 ohms or less**
 1. Disconnect all devices on the failed serial data circuit.
 2. Test for greater than 2 ohms between each section of the failed serial data circuit and ground.
 - If 2 ohms or less, repair the short to ground in the circuit.
 - If greater than 2 ohms
 3. Connect the splice pack and connect the first device on the failed serial data circuit, ignition ON.
 4. Verify the scan tool communicates or not with the low speed GMLAN serial data circuit.
 - If the scan tool does not communicate, replace the device that was just connected.
 - If the scan tool communicates and there are more devices to connect, connect the next device and repeat step 3.4.
 - If the scan tool communicates and there are no more devices to connect
 5. All OK.
 - **If all serial data circuits are greater than 100 ohms**
 4. All OK.

Testing the Serial Data Circuit for an Open/High Resistance

1. Ignition OFF and all vehicle systems OFF, disconnect the splice pack containing the devices that are not communicating on the low speed GMLAN serial data circuit.
2. Test for less than 2 ohms between the X84 Data Link Connector terminal 1 and the disconnected splice pack.

- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit.

- **If less than 2 ohms**

3. Disconnect all devices on the failed serial data circuit.
4. Test for less than 2 ohms between each section of the failed serial data circuit end to end.

- **If 2 ohms or greater**

Repair the open/high resistance in the serial data circuit.

- **If less than 2 ohms**

5. Connect the splice pack and connect the first device on the failed serial data circuit.
6. Verify if the device communicates or not with the scan tool.

- **If the device does not communicates**

Replace the device.

- **If the device communicates and there are more devices to connect**

Connect the next device on the failed serial data circuit and repeat step 6.

- **If all devices are connected and communicating**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for device replacement, programming and setup

DATA LINK REFERENCES

This table identifies which serial data link that a particular device uses for in-vehicle data transmission. Some devices may use more than one data link to communicate. Some devices may have multiple communication circuits passing through them without actively communicating on that data link. This table is used to assist in correcting a communication malfunction. Not all devices listed will be applicable to all vehicles. Refer to the schematics to determine which devices apply. For the description and operation of these serial data communication circuits, refer to **Data Link Communications Description and Operation** .

Data Link References

Code	Device	Data Link Type	Diagnostic Procedure
Schematic Reference: <u>Data Communication Schematics</u>			
A11	Radio	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
A22	Radio Controls	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
A26	HVAC Controls	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
B99	Steering Wheel Angle Sensor	Chassis High Speed GMLAN	<u>Scan Tool Does Not Communicate with Chassis High Speed GMLAN Device</u>
B119	Multi-axis Acceleration Sensor	Chassis High Speed GMLAN	<u>Scan Tool Does Not Communicate with Chassis High Speed GMLAN Device</u>
K9	Body Control Module	<ul style="list-style-type: none"> • High Speed GMLAN • Low Speed GMLAN • Local Interconnect Network (LIN) 	<ul style="list-style-type: none"> • <u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u> • <u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u> • <u>DTC U1500-U15FF</u>
K16	Battery Energy Control Module	<ul style="list-style-type: none"> • High Speed GMLAN • Powertrain Expansion Bus (with HP6) 	<ul style="list-style-type: none"> • <u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u> • <u>DTC U0074 (Chassis Expansion Bus), DTC U0074 (Powertrain Expansion Bus with HP6), DTC U0074 (Mid Speed GMLAN), DTC U0074 (Powertrain Expansion Bus without HP6) (with HP6)</u>
K17	Electronic Brake Control Module	<ul style="list-style-type: none"> • High Speed GMLAN • Chassis High Speed GMLAN 	<ul style="list-style-type: none"> • <u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u> • <u>Scan Tool Does Not Communicate with Chassis High Speed</u>

			<u>GMLAN Device</u>
K19	Suspension Control Module	<ul style="list-style-type: none"> • High Speed GMLAN • Chassis High Speed GMLAN 	<ul style="list-style-type: none"> • <u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u> • <u>Scan Tool Does Not Communicate with Chassis High Speed GMLAN Device</u>
K20	Engine Control Module	<ul style="list-style-type: none"> • High Speed GMLAN • Powertrain Expansion Bus (with HP6) 	<ul style="list-style-type: none"> • <u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u> • <u>DTC U0074 (Chassis Expansion Bus), DTC U0074 (Powertrain Expansion Bus with HP6), DTC U0074 (Mid Speed GMLAN), DTC U0074 (Powertrain Expansion Bus without HP6) (with HP6)</u>
K27	Fuel Pump Control Module	High Speed GMLAN	<u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u>
K29	Seat Heating Control Module	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
K33	HVAC Control Module	<ul style="list-style-type: none"> • Low Speed GMLAN • Local Interconnect Network (LIN) 	<ul style="list-style-type: none"> • <u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u> • <u>DTC U1500-U15FF</u>
K36	Inflatable Restraint Sensing and Diagnostic Module	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
K41	Front and Rear Parking Assist Control Module	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
K41R	Rear Parking Assist Control Module	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
K43	Power Steering Control Module	High Speed GMLAN	<u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u>

K59	Starter/Generator Control Module	<ul style="list-style-type: none"> • High Speed GMLAN • Powertrain Expansion Bus (with HP6) 	<ul style="list-style-type: none"> • <u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u> • <u>DTC U0074 (Chassis Expansion Bus), DTC U0074 (Powertrain Expansion Bus with HP6), DTC U0074 (Mid Speed GMLAN), DTC U0074 (Powertrain Expansion Bus without HP6) (with HP6)</u>
K71	Transmission Control Module	High Speed GMLAN	<u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u>
K73	Telematics Communication Interface Control Module	<ul style="list-style-type: none"> • High Speed GMLAN • Low Speed GMLAN 	<ul style="list-style-type: none"> • <u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u> • <u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
K83	Parking Brake Control Module	High Speed GMLAN	<u>Scan Tool Does Not Communicate with High Speed GMLAN Device</u>
K84	Keyless Entry Control Module	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
K85	Passenger Presence Detection Module	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
K89	Immobilizer Control Module	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
K111	Fuel Pump Driver Control Module	Powertrain Expansion Bus (without HP6)	<u>DTC U0074 (Chassis Expansion Bus), DTC U0074 (Powertrain Expansion Bus with HP6), DTC U0074 (Mid Speed GMLAN), DTC U0074 (Powertrain Expansion Bus without HP6) (without HP6)</u>
M69	Sunroof Motor	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
M74D	Window Motor - Driver	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>

M74P	Window Motor - Passenger	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
P2	Transmission Shift Lever Position Indicator	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
P16	Instrument Cluster	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>
P17	Info Display Module	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
S56	Radio Control Multifunction Switch	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
S79D	Window Switch - Driver	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
S79LR	Window Switch - Left Rear	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
S79RR	Window Switch - Right Rear	Local Interconnect Network (LIN)	<u>DTC U1500-U15FF</u>
T11	Multimedia Player Interface Module	Low Speed GMLAN	<u>Scan Tool Does Not Communicate with Low Speed GMLAN Device</u>

ACCESSORIES & EQUIPMENT

Data Communications - Fastener Tightening Specifications

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Body Control Module Bracket Fastener	9 N.m	80 lb in

ACCESSORIES & EQUIPMENT

Data Communications - Repair Instructions

REPAIR INSTRUCTIONS

BODY CONTROL MODULE REPLACEMENT (LEFT HAND DRIVE)

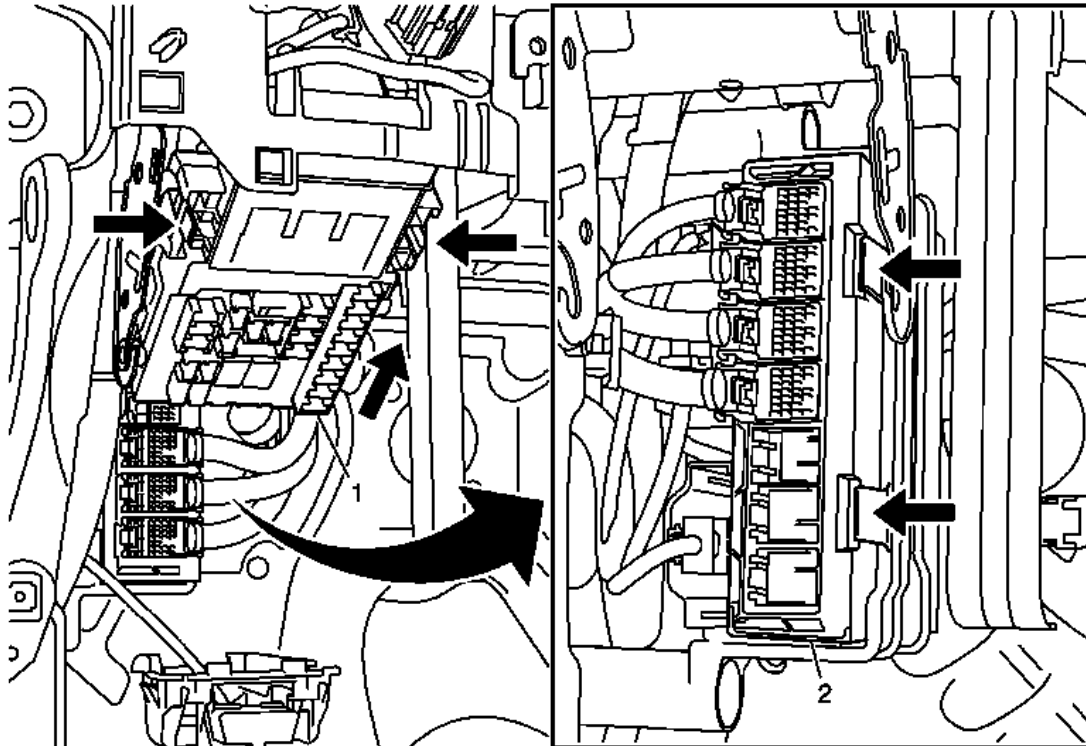


Fig. 1: Body Control Module (Left Hand Drive)
Courtesy of GENERAL MOTORS COMPANY

Body Control Module Replacement (Left Hand Drive)

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower trim panel- left side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> .	
1	Inner Electrical Center Procedure <ol style="list-style-type: none">1. Disconnect the lower three electrical connectors on the body control module.2. Clip out the inner electrical center.
	Body Control Module Procedure

2

1. Disconnect the upper four electrical connectors on the body control module.
2. Pull out the body control module of the bracket.
3. For programming and set up information, refer to **Control Module References** .

BODY CONTROL MODULE BRACKET REPLACEMENT

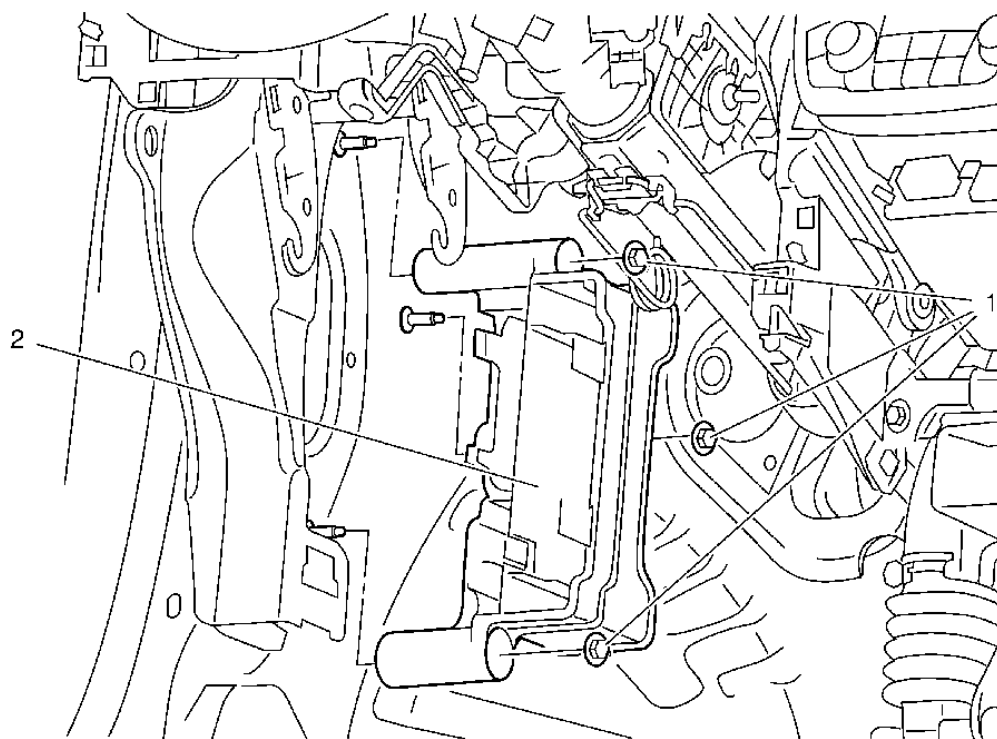


Fig. 2: Body Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

Body Control Module Bracket Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Remove the body control module. Refer to <u>Body Control Module Replacement (Left Hand Drive)</u>.2. Remove the headlamp control module. Refer to <u>Headlamp Control Module Replacement</u> .3. Remove the floor air outlet duct - left side. Refer to <u>Floor Air Outlet Duct Replacement - Left Side</u> .	
1	Body Control Module Bracket Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 9 N.m (80 lb in)
2	Body Control Module Bracket

ACCESSORIES & EQUIPMENT

Data Communications - Schematic and Routing Diagrams

SCHEMATIC WIRING DIAGRAMS

DATA COMMUNICATION WIRING SCHEMATICS

Low Speed GMLAN

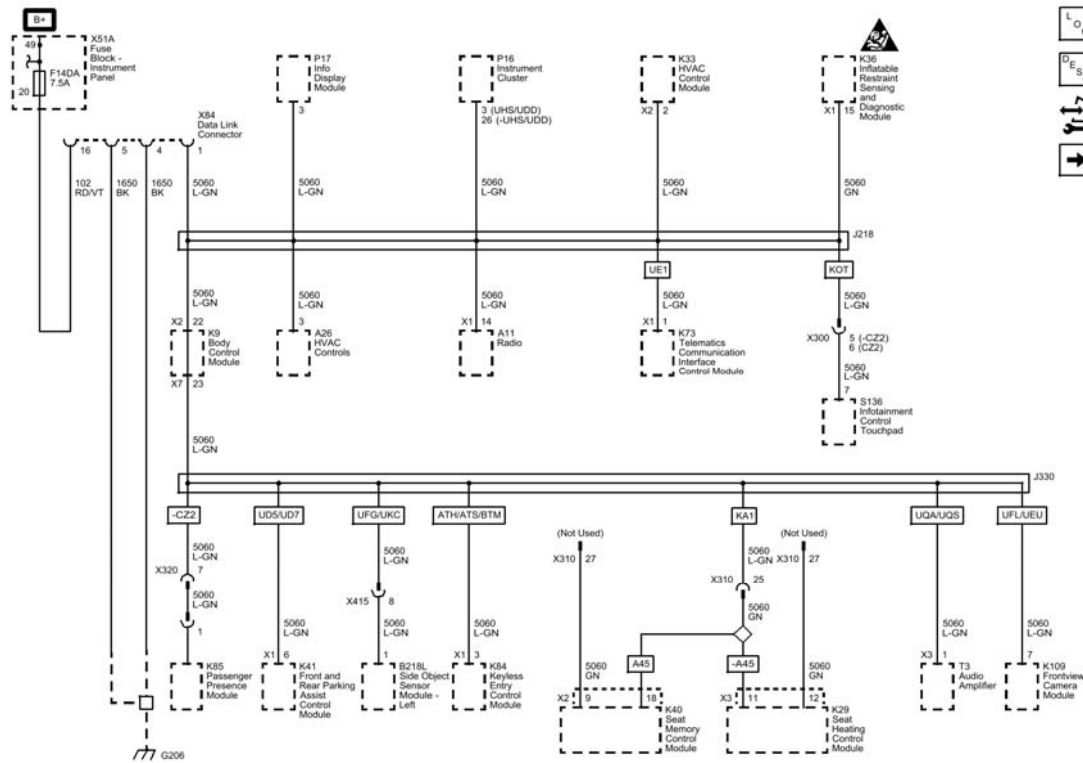


Fig. 1: Low Speed GMLAN
Courtesy of GENERAL MOTORS COMPANY

High Speed GMLAN (1 of 2) (except CZ2)

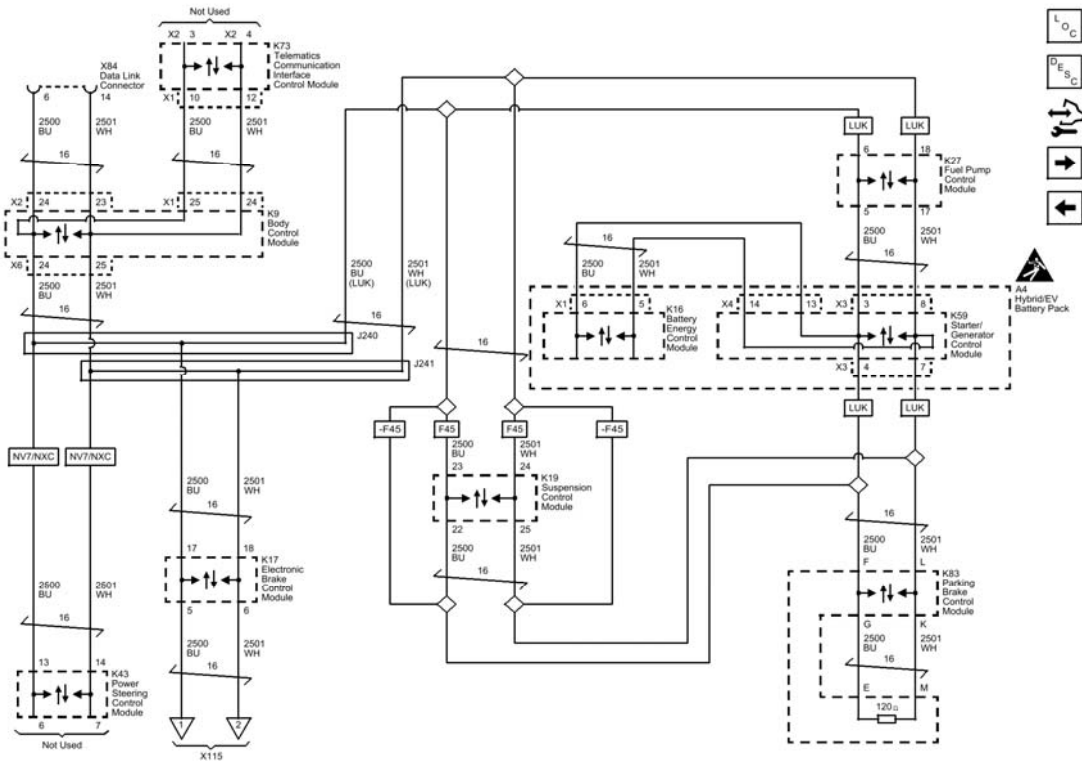


Fig. 2: High Speed GMLAN (1 of 2) (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

High Speed GMLAN (2 of 2) (except CZ2)

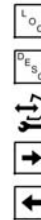
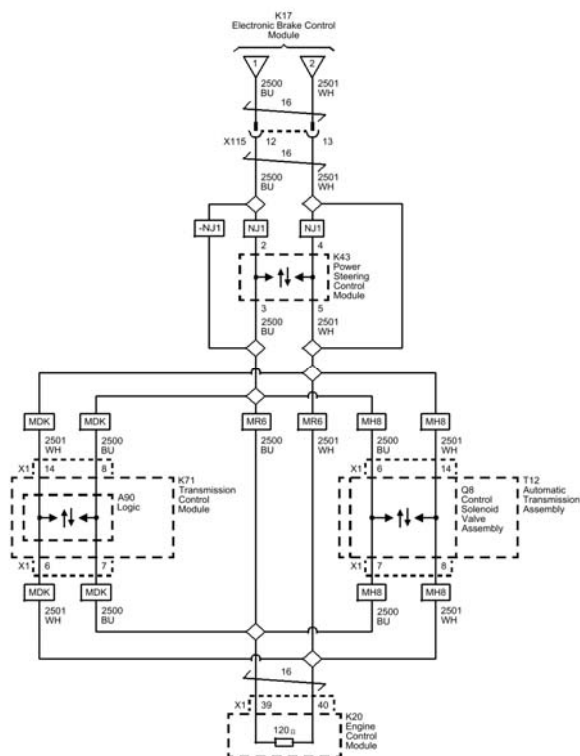


Fig. 3: High Speed GMLAN (2 of 2) (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

High Speed GMLAN CE Bus (except CZ2)

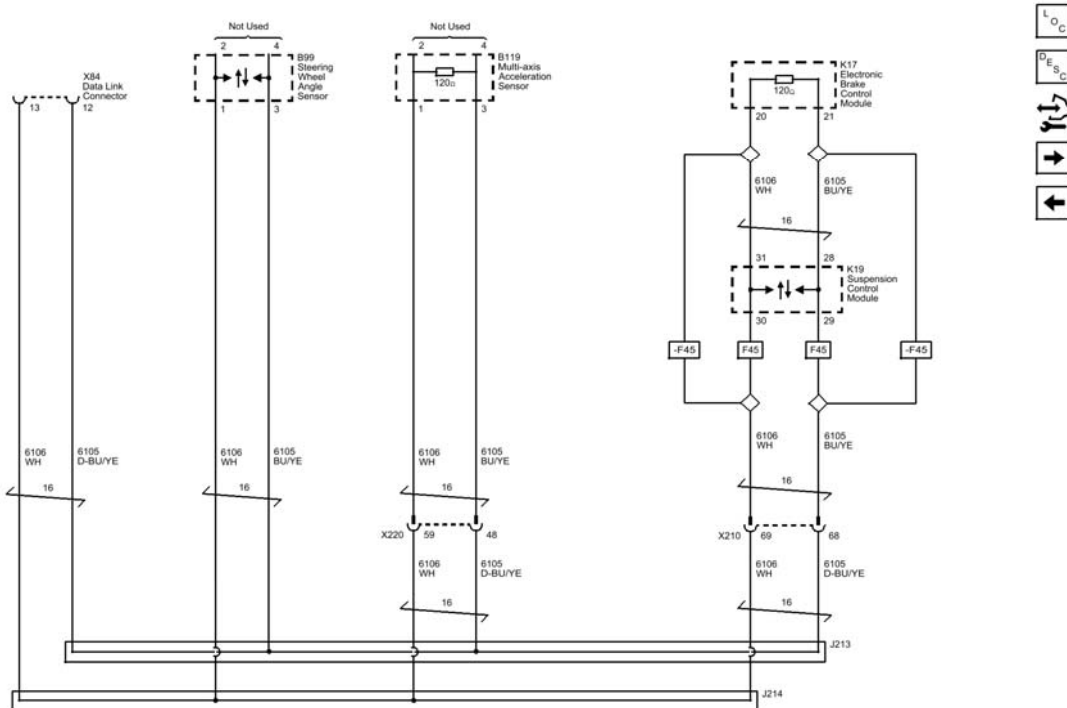


Fig. 4: High Speed GMLAN CE Bus (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Communications Enable (except CZ2)

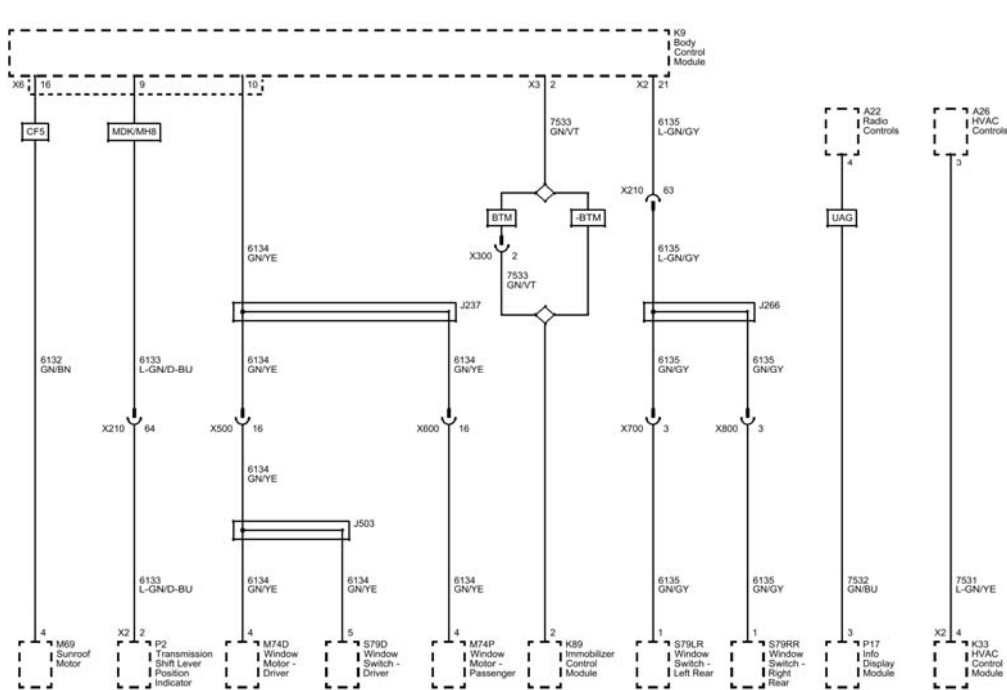


Fig. 6: Linear Interconnect Network (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Low and Mid Speed GMLAN (CZ2)

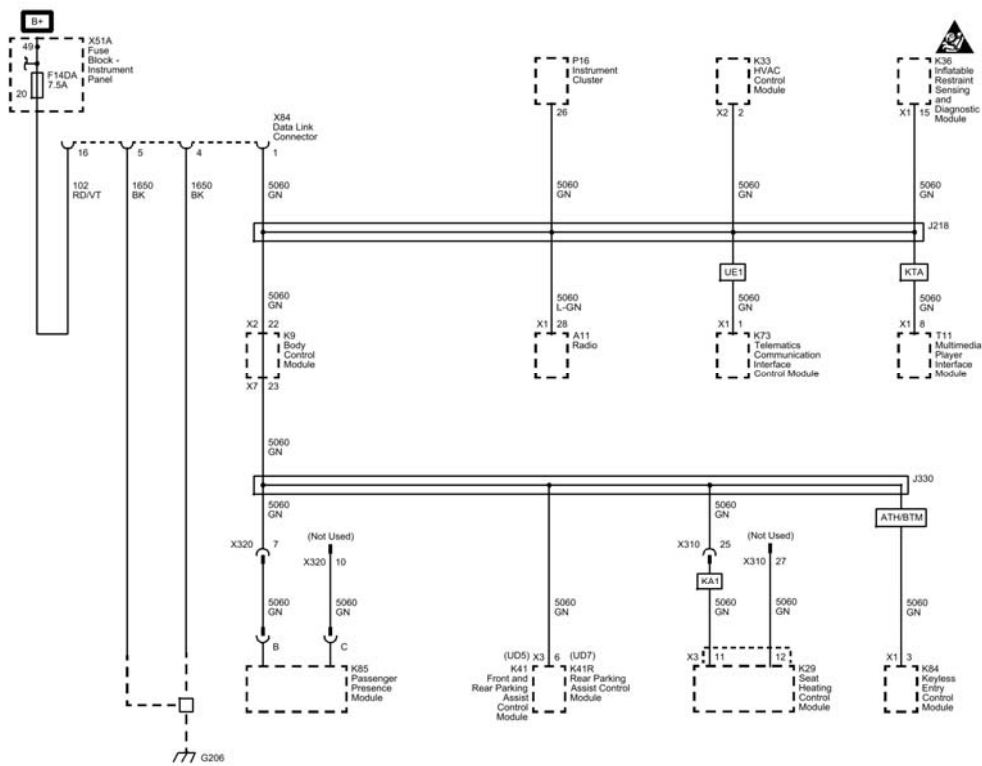


Fig. 7: Low and Mid Speed GMLAN (CZ2)
Courtesy of GENERAL MOTORS COMPANY

High Speed GMLAN (CZ2)

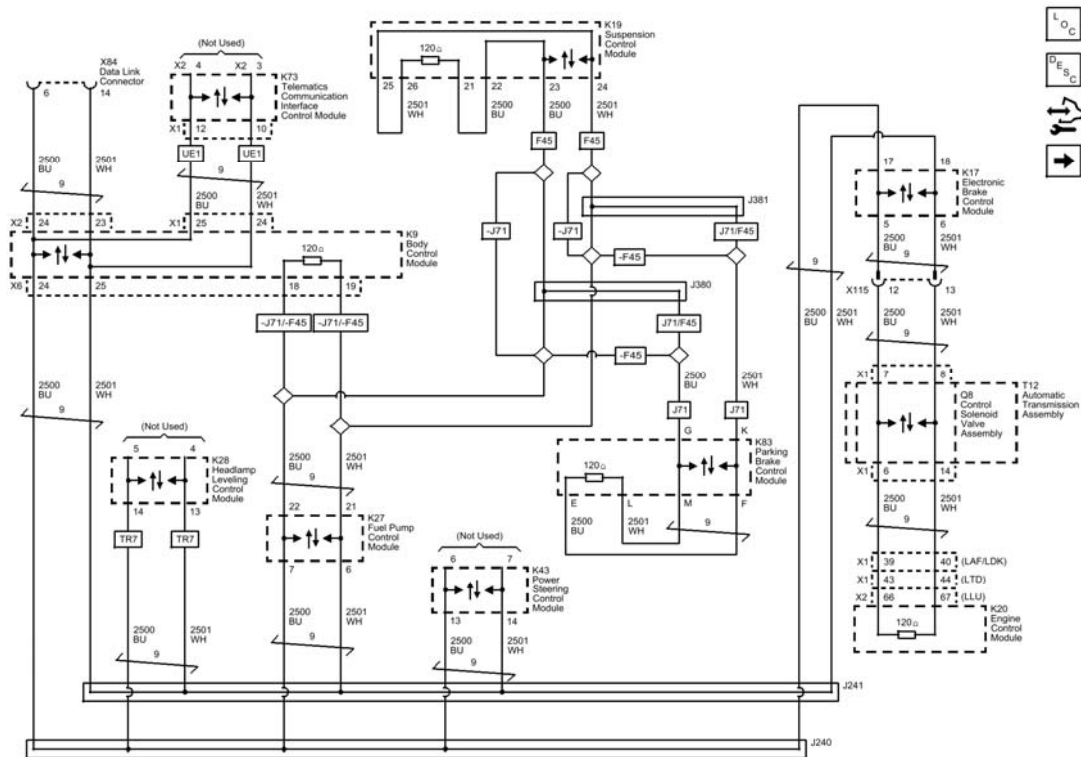


Fig. 8: High Speed GMLAN (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Powertrain High Speed GMLAN (LHU/LAF/LDK)

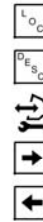
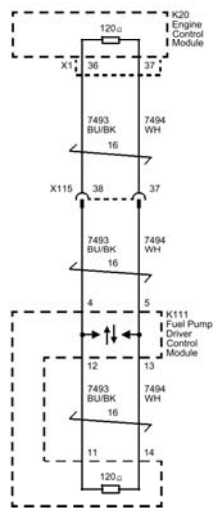


Fig. 9: Powertrain High Speed GMLAN (LHU/LAF/LDK)
Courtesy of GENERAL MOTORS COMPANY

Chassis High Speed GMLAN (CZ2)

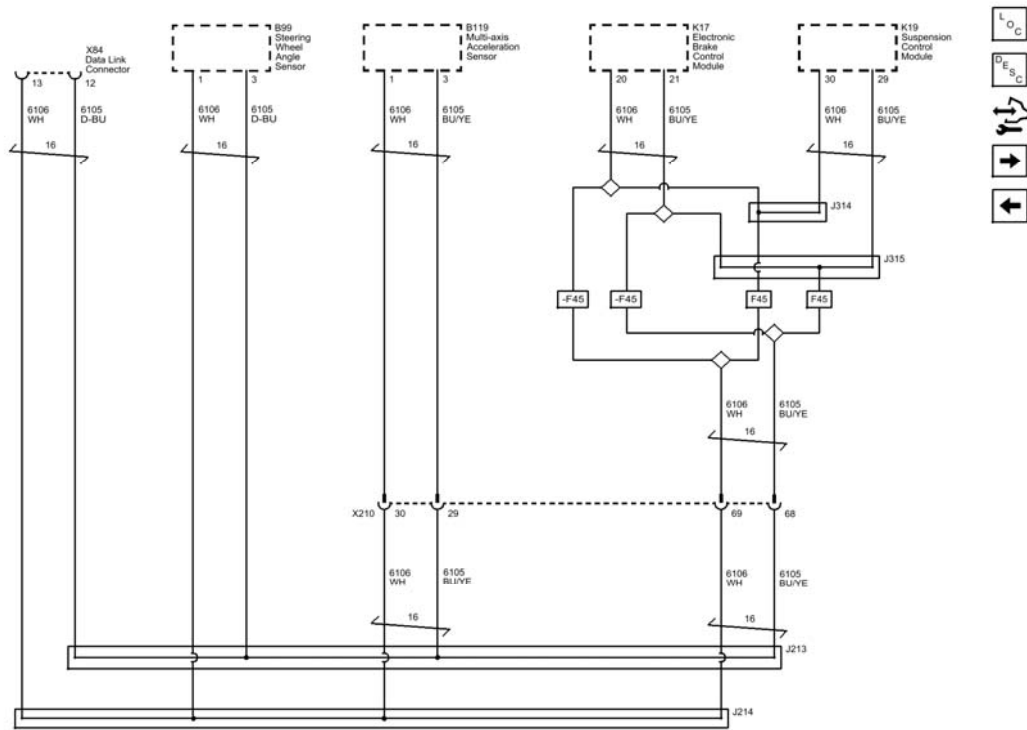


Fig. 10: Chassis High Speed GMLAN (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Communications Enable (CZ2)

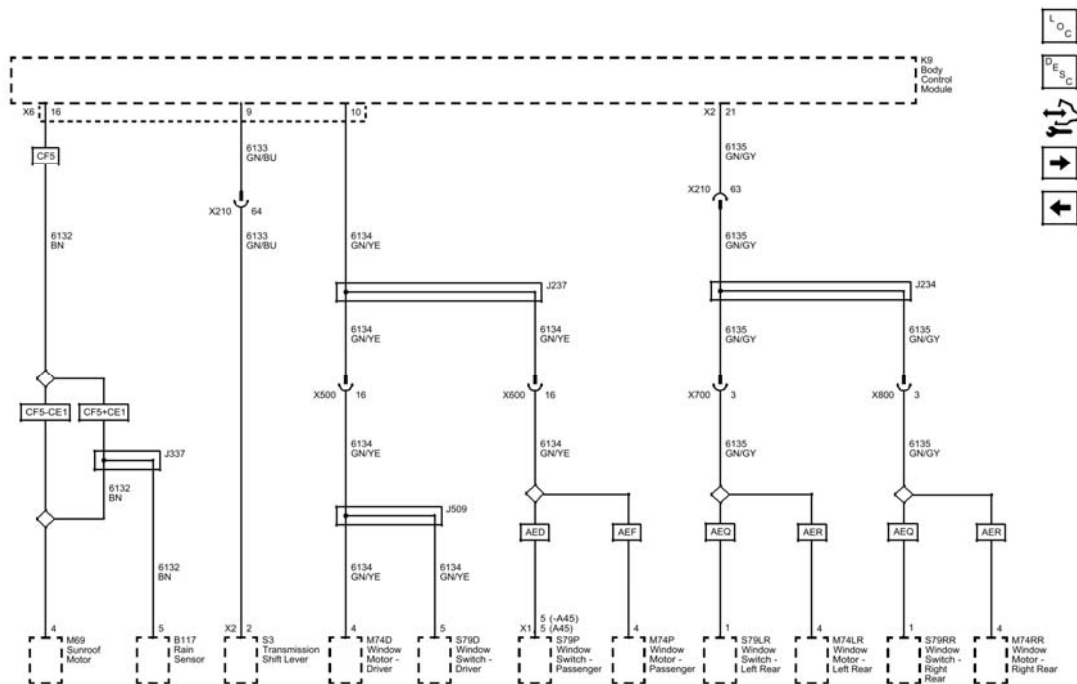


Fig. 12: Local Interconnect Network (LIN) Bus (1 of 2) (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Local Interconnect Network (LIN) Bus (2 of 2) (CZ2)

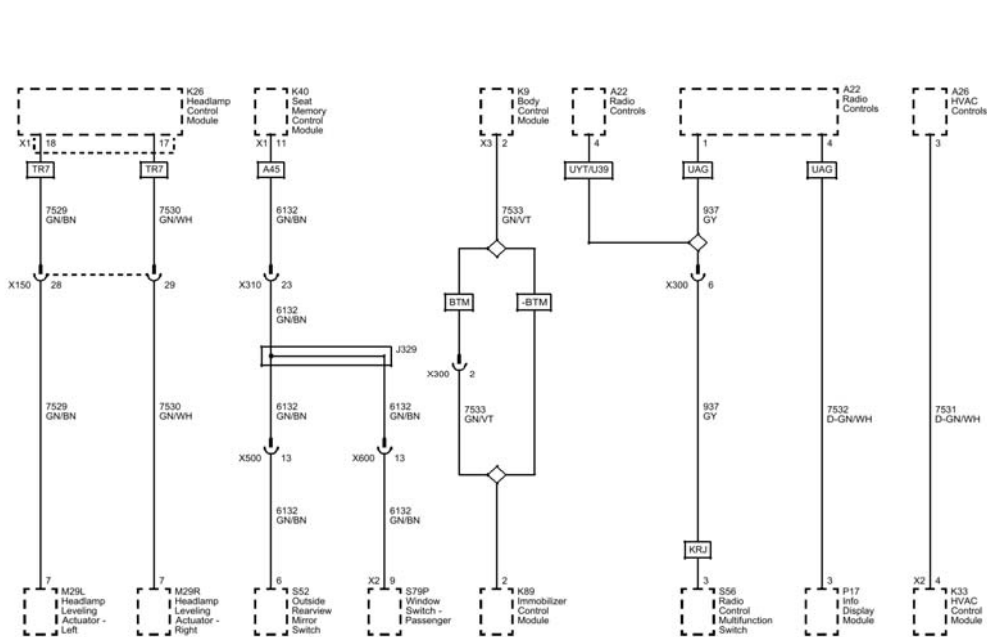


Fig. 13: Local Interconnect Network (LIN) Bus (2 of 2) (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

BODY CONTROL SYSTEM WIRING SCHEMATICS

Power, Ground, and Serial Data

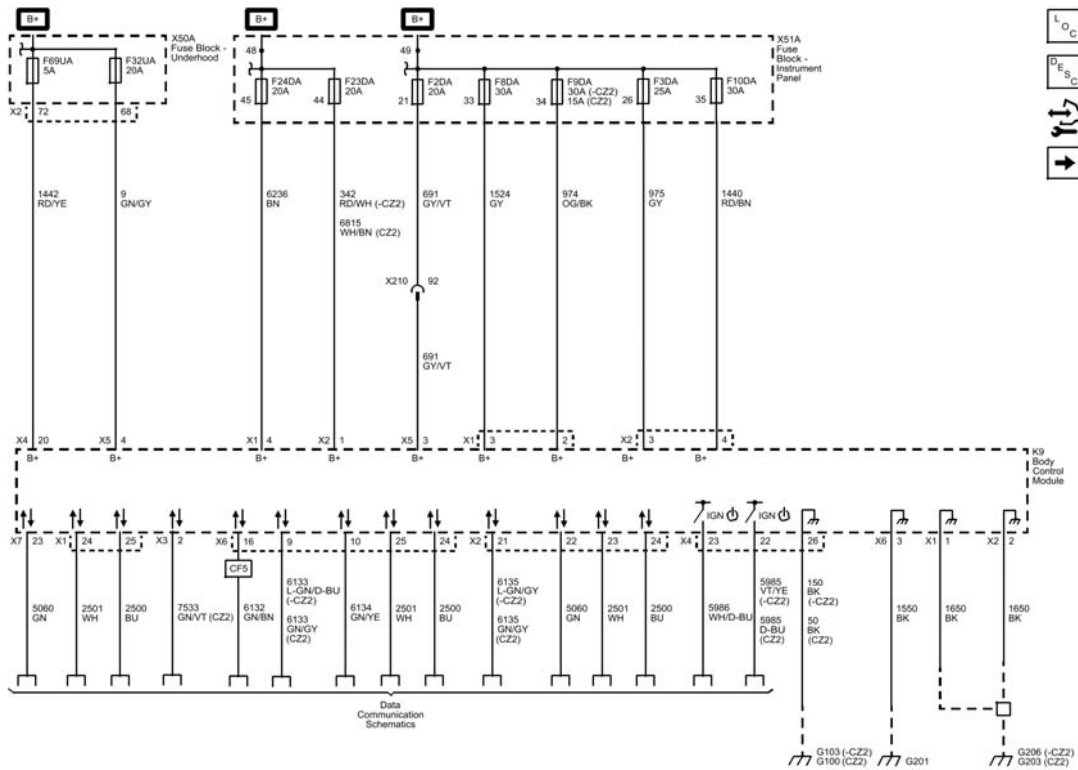


Fig. 14: Power, Ground, and Serial Data
Courtesy of GENERAL MOTORS COMPANY

Subsystem References (1 of 3)

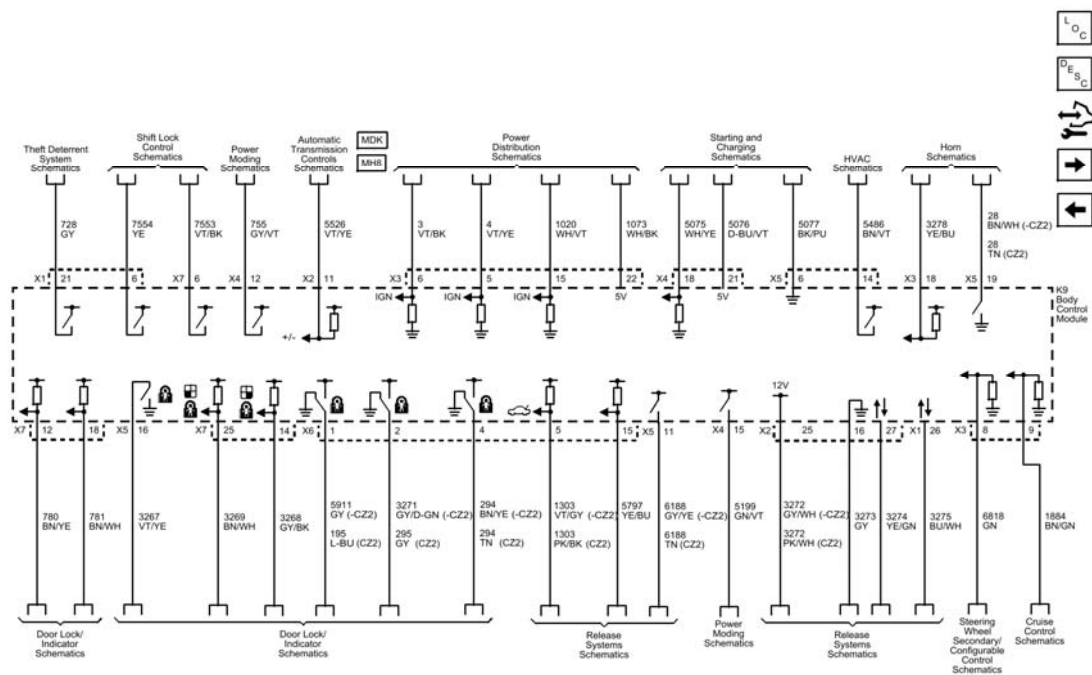
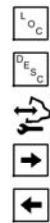


Fig. 15: Subsystem References (1 of 3)
Courtesy of GENERAL MOTORS COMPANY

Subsystem References (2 of 3)



Subsystem References (3 of 3)

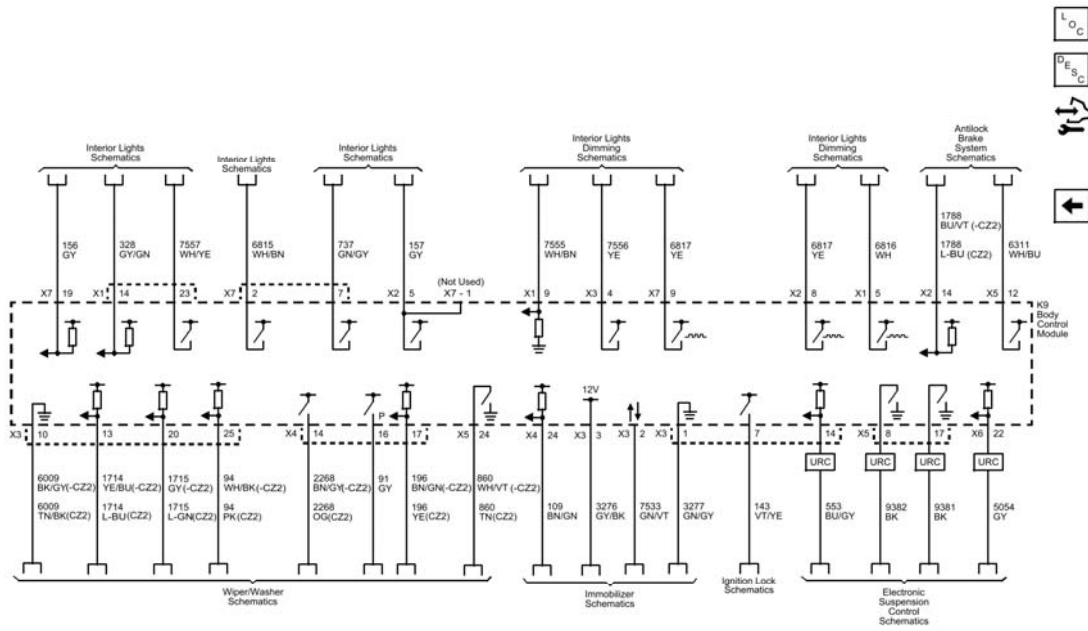


Fig. 17: Subsystem References (3 of 3)
Courtesy of GENERAL MOTORS COMPANY

ELECTRICAL

Wiring Systems and Power Management - Diagnostic Information and Procedures

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B097B

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B097B

Power Mode Start Switch Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 3	B097B 02*	B097B 05*	B097B 05*	-
Signal - Terminal 6	B097B 02	B097B 04	B097B 04	-
Low Reference	-	B097B 05*	-	-
Ground	-	B097B 04	-	-
* DTC set in keyless entry control module				

Circuit/System Description

The ignition mode switch has two LEDs that indicate the vehicle power mode. When the vehicle is in the off mode, both LEDs will be off. Pressing the ignition mode switch button once (without the brake pedal applied), the vehicle enters the accessory mode and the amber LED (Accessory) will illuminate. The accessory mode has a 5 min timeout to reduce battery drain. Pressing the ignition mode switch button a s time (without the brake pedal applied), the vehicle enters the run/start mode (without the engine running) and the green LED (Run/Start) will illuminate. Pressing and holding the push button start switch for up to 10 s will place the vehicle in run/start mode (without the vehicle running) and the green LED (Run/Start) will illuminate. With the ignition off (with the brake pedal applied), pressing the ignition mode switch button once, the vehicle will enter run/start mode and the green LED (run/start) will illuminate. This will start the engine. Both LEDs have the voltage supplied from the body control module (BCM). The ignition mode switch sends the ignition mode switch status to the keyless entry control module and to the BCM. The keyless entry control module sends a redundant signal to the BCM with the ignition mode switch status.

The ignition mode switch contains two individual switches that provide redundant switch inputs to both the BCM and the keyless entry control module. The BCM supplies the ignition mode switch a constant B+ signal. The BCM monitors this signal to determine if the switch is released or pressed. When the ignition mode switch is not pressed, voltage on the signal circuit is pulled down through two resistors in the switch. When the ignition mode switch is pressed, voltage on the signal circuit is pulled down through only one resistor, changing the voltage seen at the BCM and indicating that the ignition mode switch is pressed.

The keyless entry control module monitors voltage on the switch in the same manner as the BCM, but monitors the switch located in the ignition mode switch.

Conditions for Running the DTC

Control module voltage is 9-16 V.

Conditions for Setting the DTC

B097B 00

- The voltage seen at the BCM monitored switch does not match the voltage seen at the keyless entry control module monitored switch.
- The above condition exists for more than 1 s.

B097B 02

- The control module detects a short to ground in the ignition mode switch signal circuit.
- The above condition exists for more than 1 s.

B097B 04

- The control module detects a open in the ignition mode switch signal circuit.
- The above condition exists for more than 1 s.

B097B 05

- The control module detects an open in the ignition mode switch signal circuit.
- The above condition exists for more than 1 s.

B097B 08

- The control module detects a change in the ignition mode without observing a switch press.
- The above condition occurs 4 consecutive times.

B097B 61

- The control module detects a continuously closed ignition mode switch.
- The above condition exists for more than 1 min.

Action Taken When the DTC Sets

No action is taken.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears after 40 consecutive module ignition cycles without a repeat of the malfunction.

Reference Information

Schematic Reference

- **Power Moding Schematics**
- **Power Distribution Schematics**

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC B097B 08 or B097B 61 is not set.
 - **If either DTC is set**

Test or replace the S38 Ignition Mode Switch.

- **If the DTCs are not set**
2. Verify the green LED illuminates when the S38 Ignition Mode Switch is pressed and held for at least 10 s, with the brake pedal released.
 - **If the green LED does not illuminate**

Refer to Circuit/System Testing.

- **If the green LED illuminates**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all systems OFF, disconnect the harness connector at the S38 Ignition Mode Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Test for less than 10 ohms between the low reference circuit terminal 7 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If less than 10 ohms**
4. Connect the S38 Ignition Mode Switch, ignition ON.
5. Disconnect the S38 Ignition Mode Switch.
6. Verify the scan tool Body Control Module Push Button Ignition Switch Voltage parameter is greater than 11 V.
 - **If 11 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If greater than 11 V**
7. Install a 3 A fused jumper wire between the signal circuit terminal 6 and ground.
8. Verify the scan tool Body Control Module Push Button Ignition Switch Voltage parameter is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V

3. Test for less than 2 ohms in signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K9 Body Control Module.

- **If less than 1 V**

9. Connect the harness connector at the S38 Ignition Mode Switch.

10. Verify the scan tool Body Control Module Push Button Ignition Switch Voltage parameter is 8-10 V, with the S38 Ignition Mode Switch released.

- **If not between 8-10 V**

Test or replace the S38 Ignition Mode Switch.

- **If between 8-10 V**

11. Verify the scan tool Body Control Module Push Button Ignition Switch Voltage parameter is 4-7 V, with the S38 Ignition Mode Switch pressed.

- **If not between 4-7 V**

Test or replace the S38 Ignition Mode Switch.

- **If between 4-7 V**

12. Disconnect the X1 harness connector at the K84 Keyless Entry Control Module.

13. Test for infinite resistance between the signal circuit terminal 11 and ground.

- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

14. Ignition ON.

15. Test for less than 1 V between the signal circuit terminal 11 and ground.

- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

16. Test for 4.5-5.5 kohms between the signal circuit terminal 11 and the low reference circuit terminal 12, with the S38 Ignition Mode Switch released.

- **If not between 4.5-5.5 kohms**

1. Ignition OFF.

2. Test for less than 2 ohms in signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, test or replace the S38 Ignition Mode Switch.

- **If between 4.5-5.5 kohms**

17. Test for 1-1.5 kohms between the signal circuit terminal 11 and the low reference circuit terminal 12, with the S38 Ignition Mode Switch pressed.

- **If not between 1-1.5 kohms**

Test or replace the S38 Ignition Mode Switch.

- **If between 1-1.5 kohms**

18. Replace the K84 Keyless Entry Control Module.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S38 Ignition Mode Switch.
2. Test for 4.5-5.5 kohms between the terminals listed below with the S38 Ignition Mode Switch released,
 - Signal terminal 6 and ground terminal 4
 - Signal terminal 3 and low reference terminal 7

- **If not between 4.5-5.5 kohms**

Replace the S38 Ignition Mode Switch.

- **If between 4.5-5.5 kohms**

3. Test for 1-1.5 kohms between the terminals listed below with the S38 Ignition Mode Switch pressed.
 - Signal terminal 6 and ground terminal 4
 - Signal terminal 3 and low reference terminal 7

- **If not between 1-1.5 kohms**

Replace the S38 Ignition Mode Switch.

- **If between 1-1.5 kohms**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition and Start Switch Replacement (Without BTM) , Ignition and Start Switch Replacement (With BTM)**
- **Control Module References** for body control module or keyless entry control module replacement, programming and setup.

DTC B097C

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B097C

Power Mode Run/Start Indicator Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	B097C 02	1	2	-
Ground	-	1	-	-
1. Ignition mode switch indicator always off 2. Ignition mode switch indicator always on				

Circuit/System Description

The ignition mode switch has two LED's that indicate the vehicle power mode. When the vehicle is in the off mode, both LED's will be off. Pressing the ignition mode switch button once (without the brake pedal applied), the vehicle enters the accessory mode and the amber LED (Accessory) will illuminate. The accessory mode has a 5 min timeout to reduce battery drain. Pressing and holding the push button start switch for up to 10 s will place the vehicle in run/start mode (without the vehicle running) and the green LED (Run/Start) will illuminate. With the ignition off (with the brake pedal applied), pressing the ignition mode switch button once, the vehicle will enter run/start mode and the green LED (run/start) will illuminate. This will start the engine. Both LED's have the voltage supplied from the body control module (BCM). The ignition mode switch sends the ignition mode switch status to the keyless entry control module and to the BCM. The keyless entry control module sends a redundant signal to the BCM with the ignition mode switch status.

The ignition mode switch contains two individual switches that provide redundant switch inputs to both the BCM and the keyless entry control module. The BCM supplies the ignition mode switch a constant B+ signal. The BCM monitors this signal to determine if the switch is released or pressed. When the ignition mode switch is not pressed, voltage on the signal circuit is pulled down through two resistors in the switch. When the ignition mode switch is pressed, voltage on the signal circuit is pulled down through only one resistor, changing the voltage seen at the BCM and indicating that the ignition mode switch is pressed.

The keyless entry control module monitors voltage on the switch in the same manner as the BCM, but monitors the second switch located in the ignition mode switch.

Conditions for Running the DTC

Control module voltage is 9-16 V

Conditions for Setting the DTC

B097C 02

- The BCM detects a short to ground in the control circuit.
- The above condition exists for more than 1 min.

Action Taken When the DTC Sets

The BCM disables the control output.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module power mode cycle counter reaches 40, without a repeat of the malfunction.

Reference Information

Schematic Reference

Power Distribution Schematics

Connector End View Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the green LED turns ON and OFF when commanding the Run/Start Power Mode Indicator On and Off with the scan tool.

- **If the green LED does not turn ON and OFF**

Refer to Circuit/System Testing.

- **If the green LED turns ON and OFF**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S38 Ignition Mode Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connections.
 - **If less than 10 ohms**
3. Connect the harness connector at the S38 Ignition Mode Switch.
4. Ignition ON, disconnect the harness connector at the S38 Ignition Mode Switch.
5. Test for less than 1 V between control circuit terminal 5 and ground while commanding Run/Start Power Mode Indicator Off with the scan tool.
 - **If 1 V or greater**
 1. Disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If less than 1 V**
6. Test for greater than 3 V between the control circuit terminal 5 and ground while commanding Run/Start Power Mode Indicator On with the scan tool.
 - **If 3 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 Body Control Module.
 - **If 3 V or greater**
7. Test or replace the S38 Ignition Mode Switch.

Component Testing

1. Ignition OFF, disconnect the harness at the S38 Ignition Mode Switch.
2. Connect a jumper wire between the S38 Ignition Mode Switch terminal 4 and ground.
3. Connect a 3 A fused jumper wire between the S38 Ignition Mode Switch terminal 5 and B+.
4. Verify the green LED illuminates.
 - **If the LED does not illuminate**

Replace the S38 Ignition Mode Switch.

- **If the LED illuminates**
5. Connect a 3 A fused jumper wire between the S38 Ignition Mode Switch terminal 2 and B+.
 6. Verify the amber LED illuminates.
 - **If the LED does not illuminate**

Replace the S38 Ignition Mode Switch.

- **If the LED illuminates**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition and Start Switch Replacement (Without BTM)** , **Ignition and Start Switch Replacement (With BTM)**
- **Control Module References** for body control module replacement, programming and setup.

DTC B1370 (INSTRUMENT CLUSTER)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1370

Control Module Ignition On and Start Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Instrument Cluster Ignition (Instrument Cluster Terminal 31)	B1370 06	B1370 06	B1370 01	-

Circuit/System Description

The vehicle power mode master is the body control module (BCM). The ignition switch is a low current switch with multiple discrete circuits to the BCM.

The power mode master will activate relays and other direct outputs of the power mode master as needed according to the calculated power mode. Some relays controlled by the BCM are switched ignition voltage outputs that are pass through circuits within the BCM directly from the ignition switch. If these circuits short to ground, the B+ circuit fuse to the ignition switch will open.

Conditions for Running the DTC

B1370 01

Ignition switch is in the Accessory position.

B1370 06

Ignition switch is in the Accessory, Run, or Crank positions.

Conditions for Setting the DTC

B1370 01

Ignition circuit is shorted to voltage.

B1370 06

- Ignition circuit is open.
- Ignition or ignition main relay circuit is shorted to ground.
- B+ circuit of the ignition main relay is open or shorted to ground.
- Ignition main relay control circuit open, including relay coil and ground.

Action Taken When the DTC Sets

The instrument cluster still functions except the malfunction indicator light is always off.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

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- **Instrument Cluster Description and Operation**
- **Power Mode Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC B144B or B1380 is not set.
 - **If DTC B144B or B1380 is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If DTC B144B or B1380 is not set**

2. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
2. Verify that a test lamp does not illuminate between the ignition circuit terminal 31 and ground.

- **If the test lamp illuminates**

Repair the short to voltage on the ignition circuit.

- **If the test lamp does not illuminate**

3. Ignition ON.
4. Verify that a test lamp illuminates between the ignition terminal 31 and ground.
 - **If the test lamp does not illuminate and the Ignition fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, refer to **Power Mode Mismatch**.
 - **If the test lamp does not illuminate and the Ignition fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the P16 Instrument Cluster.
 - **If the test lamp illuminates**
 - 5. Replace the P16 Instrument Cluster.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for instrument cluster replacement, programming and setup.

DTC B1370-B1379, B1380-B1389, OR B1440-B1443

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1370

Control Module Ignition ON and Start Circuit

DTC B1380

Control Module Ignition Accessory Circuit

DTC B1441

Control Module Ignition OFF, Run, and Start Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ terminal 2	B1370 04, B1380 04	B1370 04, B1380 04	-	-
Ignition Terminal 1	B1370 04, B1380 04	B1370 04, B1380 04	B1370 01	-
Ignition Terminal 3	B1370 04, B1380 04	B1380 04	B1380 01	-
Ignition Terminal 4	B1370 04, B1380 04, B1441 04	B1441 04	B1441 01	-
5 V Reference	-	1	-	-
1. Power mode mismatch				

Circuit/System Description

The vehicle power mode master is the body control module (BCM). The ignition switch is a low current switch with multiple discrete circuits to the BCM. The BCM logic uses the ignition switch positions to identify the operator's desired power mode and activate specific discrete signals, and serial data messages for the operation of different subsystems as necessary. Other modules which have switched voltage inputs may operate in a default mode if the power mode master serial data message does not match what the individual module can detect from its own connections.

The power mode master will activate relays and other direct outputs of the power mode master as needed according to the calculated power mode. Some relays controlled by the BCM are switched ignition voltage outputs that are pass through circuits within the BCM directly from the ignition switch. If these circuits short to ground, the B+ circuit fuse to the ignition switch will open.

Conditions for Running the DTC

B1370 01, B1370 04

Ignition switch is in the RUN or CRANK positions.

B1380 01, B1380 04

Ignition switch is in the RUN or ACCESSORY positions.

B1441 01, B1441 04

Ignition switch is in the CRANK position.

Conditions for Setting the DTC

B1370 01

Ignition circuit is shorted to voltage.

B1370 04

- Ignition circuit is open.
- Ignition, accessory, or off/run/crank circuit shorted to ground.
- B+ circuit of the ignition switch is open or shorted to ground.
- Ignition relay control circuit open, including relay coil and ground.

B1380 01

Ignition, accessory circuit is shorted to voltage.

B1380 04

- Ignition, accessory circuit is open.
- Ignition, accessory, or off/run/crank circuit shorted to ground.
- B+ circuit of the ignition switch is open or shorted to ground.

B1441 01

Ignition, off/run/crank signal circuit is shorted to voltage.

B1441 04

Ignition, off/run/crank signal circuit is open.

Actions Taken When the DTC Sets

- The BCM operates in a fail-safe power mode dependent on the last valid power mode detected and the state of the engine run flag data on the serial data communications circuits.
- The other modules on the vehicle operate in a fail-safe power mode dependent on the last valid power mode transmitted by the BCM and the state of the engine run flag on the serial data communications circuits.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.

- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

An open in the ignition switch B+ circuit or circuit fuse will cause the key in ignition warning chime to be inoperative.

Reference Information

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Power Distribution Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC U1814 is not set.
 - **If DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If DTC is not set**
2. Ignition ON.
3. Verify the scan tool power mode parameters change when cycling the S39 Ignition Switch between OFF, ACCESSORY, ON, and CRANK.
 - **If the power mode parameters do not change**

Refer to Circuit/System Testing.

- **If the power mode parameters change**

4. All OK.

Circuit/System Testing

1. Ignition ON, disconnect the harness connector at the S39 Ignition Switch while the ignition is ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on one of the following circuits listed below:

NOTE: To help isolate a short to ground, it may be necessary to disconnect modules that are connected to the following circuits:

-
- B+ circuit terminal 2
- Ignition circuit terminal 1
- Ignition circuit terminal 3
- Ignition circuit terminal 4

- **If the test lamp illuminates**

3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 6 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
- **If between 4.8-5.2 V**
 5. Connect the harness connector at the S39 Ignition Switch.
 6. Ignition OFF.
 7. Disconnect the X3 harness connector at the K9 Body Control Module, ignition ON.
 8. Verify a test lamp illuminates between each of the ignition circuits listed below and ground:
 - Ignition circuit terminal 5
 - Ignition circuit terminal 6
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuits listed below and ground.
 - Ignition circuit terminal 5
 - Ignition circuit terminal 6
 - Ignition circuit terminal 15
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
 9. Ignition OFF with the key in.
 10. Verify a test lamp illuminates between ignition circuit terminal 15 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF with the key out, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF with the key out remove the test lamp.
 2. Test for infinite resistance between the ignition circuit terminal 15 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.

- **If the test lamp illuminates**

11. Connect the X3 harness connector at the K9 Body Control Module, ignition ON.
 12. Disconnect the harness connector at the S39 Ignition Switch.
 13. Test for less than 1 V between each of the ignition circuits listed below and ground.
 - Ignition circuit terminal 1
 - Ignition circuit terminal 3
 - Ignition circuit terminal 4
- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

14. Test or replace the S39 Ignition Switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S39 Ignition Switch.
2. Using the Resistance Test below, verify the resistance between the terminals listed below match for each S39 Ignition Switch position.
 - **If any reading is other than specified**

Replace the S39 Ignition Switch.

- **If the readings match**

3. All OK.

Resistance Test

Ignition Switch Position	Terminals 1 and 2	Terminals 2 and 3	Terminals 2 and 4	Terminals 2 and 6	Terminals 4 and 6
OFF Key Out	Infinite	Infinite	Infinite	Infinite	Infinite
OFF Key In	Infinite	Infinite	<5.0 ohms	Infinite	Infinite
ACCESSORY	Infinite	<5.0 ohms	Infinite	Infinite	Infinite
ON/RUN	<5.0 ohms	<5.0 ohms	Infinite	Infinite	<5.0 ohms
CRANK	<5.0 ohms	Infinite	Infinite	Infinite	1275-1325 ohms

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition and Start Switch Replacement (Without BTM)** , **Ignition and Start Switch Replacement (With BTM)**
- **Control Module References** for body control module replacement, programming and setup.

DTC B1445

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1445

Control Module Voltage Output Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Control	B1445 02	B1445 04	B1445 01	-

Circuit/System Description

The body control module (BCM) controls the retained accessory power relay through the control circuit by applying voltage to the retained accessory power relay coil control circuit. The retained accessory power relay is energized when the ignition switch is in the ACCESSORY or the ON position.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The DTC can only set when the output is actively being requested by the module.

Conditions for Setting the DTC

The DTC will set only when the module requests the output and there is a short to ground in the ignition voltage circuit.

Action Taken When the DTC Sets

The module output driver will be shut down and not supply voltage to the circuit.

Conditions for Clearing the DTC

- The current DTC will clear when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Reference Information

Schematic Reference

Power Distribution Schematics

Connector End View Reference

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Retained Accessory Power Description and Operation

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the KR76 Retained Accessory Power Relay clicks ON and OFF when commanding the Accessory/Retained Accessory Power Relay On and Off with a scan tool.
 - **If the KR76 Retained Accessory Power Relay does not click ON and OFF**

Refer to Circuit/System Testing.

- **If the KR76 Retained Accessory Power Relay clicks ON and OFF**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR76 Retained Accessory Power Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 11 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON, connect a test lamp between the control circuit terminal 13 and ground circuit terminal 11.
 4. Verify the test lamp turns ON and OFF when commanding the Accessory/Retained Accessory Power Relay On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
 5. Test or replace the KR76 Retained Accessory Power Relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for body control module replacement, programming and setup.

DTC B144A

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B144A

RUN Power Relay Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Control	B144A 02	-	-	-

Circuit/System Description

The body control module (BCM) feeds the ignition circuit by applying voltage when the vehicle is in the Ignition ON mode.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The DTC can only run when the output is activated.

Conditions for Setting the DTC

The BCM detects a short to ground in the ignition circuit.

Action Taken When the DTC Sets

The module output driver will be shut down and not supply voltage to the ignition circuit.

Conditions for Clearing the DTC

- The current DTC will clear when the module request for the output is removed or the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the HVAC control module scan tool Ignition Signal parameter is 12.6-15V.
 - **If not between 12.6-15 V**

Refer to Circuit/System Testing.
 - **If between 12.6-15 V**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X2 harness connector at the K33 HVAC Control Module.
2. Connect a test lamp between the ignition circuit terminal 9 and ground, Ignition ON.
3. Verify the test lamp turns ON and OFF when commanding the Auxiliary Ignition Run Relay On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.

2. Test for less than 1 V between the ignition circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
4. Test or replace the K33 HVAC Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module or HVAC control module replacement, programming and setup.

DTC B144B

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B144B

Run/Crank Power Relay Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	B144B 02*	B144B 04*	B144B 01*	-
Control	B144B 02**	1	2	-
Ground	-	B144B 04	-	-
1. No Start 2. Engine will continue to run after the ignition is turned OFF * DTC set in keyless entry control module ** DTC Set in BCM				

Circuit/System Description

The body control module (BCM) controls the ignition main relay through the control circuit by applying voltage to the ignition run/crank relay coil control circuit. The ignition main relay is energized when the ignition is in

the ON, CRANK positions, or when a remote start is requested.

The keyless entry control module controls the backup power for the ignition main relay through the control circuit by applying voltage to the ignition circuit. This circuit is a pass-thru in the BCM and will energize the ignition circuit when the vehicle is in the ON, CRANK positions or when a remote start is requested.

Conditions for Running the DTC

System voltage greater than 9 V.

Conditions for Setting the DTC

B144B 01

The ignition output is not active and a short to battery is detected 3 consecutive times on the ignition voltage circuit.

B144B 02

A short to ground is detected on the ignition run/crank relay coil control circuit.

B144B 04

The ignition output is not active and an open is detected 20 consecutive times on the ignition voltage circuit.

Action Taken When the DTC Sets

B144B 01, B144B 04

No action is taken.

B144B 02

The ignition main relay is deactivated when the fault is set. After 100 ms, the ignition main relay will be activated. If the fault is still set, the relay will be deactivated. The ignition main relay will again be activated after 100 ms. If this also results in a fault, the ignition main relay will be deactivated until a new ignition request is received.

Conditions for Clearing the DTC

- The current DTC will clear when the malfunction is no longer present and an ignition request is received.
- A history DTC will clear after 40 malfunction-free ignition cycles.

Diagnostic Aids

A short to ground on the ignition run/crank relay coil control circuit will cause the engine to remain running after the mode is changed to OFF.

An open on the ignition run/crank relay coil control circuit will cause a no CRANK condition.

Reference Information

Schematic Reference

Power Moding Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the KR73 Ignition Main Relay turns ON and OFF when commanding the Run/Crank relay On and Off with a scan tool.

- **If the KR73 Ignition Main Relay does not turn ON and OFF**

Refer to Circuit/System Testing.

- **If the KR73 Ignition Main Relay turns ON and OFF**

3. All OK.

Circuit/System Testing

Without BTM

1. Ignition OFF and all vehicle systems OFF, disconnect the KR73 Ignition Main Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 85 and ground.

- **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**
- 3. Ignition ON, connect a test lamp between the control circuit terminal 86 and ground circuit terminal 85.
- 4. Verify the test lamp turns ON and OFF when commanding the Run/Crank relay On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
- 5. Test or replace the KR73 Ignition Main Relay.

With BTM

1. Ignition ON, disconnect the X2 harness connector at the K84 Keyless Entry Control Module.
2. Verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is good and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K84 Keyless Entry Control Module.

- **If the test lamp illuminates**

3. Ignition OFF, connect the X2 harness connector at the K84 Keyless Entry Control Module and disconnect the X3 harness connector at the K9 Body Control Module.
4. Test for less than 1 V between the ignition circuit terminal 6 and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

5. Ignition ON.
6. Verify a test lamp illuminates between the ignition circuit terminal 6 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If the test lamp illuminates**
 7. Ignition OFF, remove the test lamp, connect the X3 harness connector at the K9 Body Control Module.
 8. Ignition OFF and all vehicle systems OFF, disconnect the KR73 Ignition Main Relay. It may take up to 2 min for all vehicle systems to power down.
 9. Test for less than 10 ohms between the ground circuit terminal 85 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
10. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
11. Verify the test lamp turns ON and OFF when commanding the Run/Crank relay On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance.
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
- 12. Test or replace the KR73 Ignition Main Relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for body control module or keyless entry control module replacement, programming and setup.

DTC B1451

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1451

Accessory Power Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	B1451 02	B1451 04	B1451 01	-

Circuit/System Description

The keyless entry control module provides as a backup control for the ignition power circuit, by applying voltage to the ignition power circuit. The ignition power circuit is energized when the vehicle power mode is in ACCESSORY mode or Ignition ON mode.

Conditions for Running the DTC

B1451 01, B1451 04

- Vehicle power mode is Ignition OFF
- Module is awake
- DTC B1451 not already set
- System voltage between 6 and 16 V

B1451 02

- Vehicle power mode is ACCESSORY or Ignition ON mode
- Module is awake
- The DTC is only run when the output is active
- DTC B1451 is not already set
- System voltage between 6 and 16 V

Conditions for Setting the DTC

B1451 01

Ignition output is not active and a short to battery is detected 3 consecutive times.

B1451 02

Ignition output is active and a short to ground is detected 3 consecutive times.

B1451 04

Ignition output is not active and an open circuit is detected 20 consecutive times.

Action Taken When the DTC Sets

B1451 02

The ignition output is deactivated when a short to ground is detected. After 100 ms the output is activated again. This happens 3 times and then the output is deactivated until a new ACCESSORY or Ignition ON mode request is received.

B1451 01, B1451 04

No action is taken.

Conditions for Clearing the DTC

- The current DTC will clear when the malfunction is no longer present during a DTC check.
- A history DTC clears when the module power mode cycle counter reaches the reset threshold of 40, without a repeat of the malfunction.

Diagnostic Aids

- A short to voltage in the ignition control circuit will keep the vehicle modules awake, which can drain the vehicle's battery.
- A short to ground in the extension of this circuit through the body control module can back feed to the keyless entry control module. Check for a short to ground on the ignition circuit on the other side of the ignition pass thru, in the body control module, before replacing the body control module.

Reference Information

Schematic Reference

- **Power Distribution Schematics**
- **Remote Function Schematics**
- **Body Control System Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC U1814 or B1380 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

2. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition ON, disconnect the X2 harness connector at the K84 Keyless Entry Control Module.
2. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is good and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K84 Keyless Entry Control Module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X2 harness connector at the K84 Keyless Entry Control Module and disconnect the X3 harness connector at the K9 Body Control Module.
4. Test for less than 1 V between the ignition circuit terminal 5 and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.
 - **If less than 1 V**
5. Ignition ON.
6. Verify a test lamp illuminates between the ignition circuit terminal 5 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If the test lamp illuminates**
7. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for keyless entry control module or body control module replacement, programming and setup.

DTC P2534 OR P2535

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2534

Ignition On/Start Switch Circuit Low Voltage

DTC P2535

Ignition On/Start Switch Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2534	P2534	P2535	-
Ground	-	P2534	-	-

Circuit/System Description

The body control module (BCM) controls the ignition main relay through the control circuit by applying voltage to the circuit. The control module samples the system voltage on the Ignition 1 voltage circuit from the ignition main relay every 0.1 s.

Conditions for Running the DTC

P2534

The control module ignition voltage signal is valid, with the ignition ON.

P2535

The control module ignition voltage signal is valid, with the ignition OFF.

Conditions for Setting the DTC

P2534

The control module detects 6 V or less on the ignition voltage circuit, with the ignition turned ON.

P2535

The control module detects greater than 6 V or greater on the ignition voltage circuit, with the ignition turned OFF.

Action Taken When the DTC Sets

P2534

DTC P2534 is a Type A DTC.

P2535

DTC P2535 is a Type A DTC.

Conditions for Clearing the DTC

DTCs P2534 and P2535 are Type A DTCs.

Diagnostic Aids

A short to voltage in the ignition circuit will keep the vehicle modules awake, which can drain the vehicle's battery.

Reference Information

Schematic Reference

Power Distribution Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Description and Operation

Power Mode Description and Operation

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify DTC B144B is not set.

- **If the DTC is set**

Refer to **DTC B144B**.

- **If the DTC is not set**

3. Verify the scan tool control module Ignition 1 Signal parameter is between 12.6-15 V.

- **If not between 12.6-15 V**

Refer to Circuit/System Testing.

- **If between 12.6-15 V**

4. Verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Circuit/System Testing

1. Ignition OFF, and all vehicle systems OFF, disconnect the appropriate harness connector at the control module setting the DTC.
2. Test for less than 1 V between the ignition circuit terminal and ground.

- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

3. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, refer to **Power Mode Mismatch**.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF remove the test lamp
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - **If the test lamp illuminates**
- 5. Replace the control module setting the DTC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for control module replacement, programming, and setup.

DTC P2537

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2537

Ignition Accessory Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2537, U1814, U2099	P2537	-	-

Circuit/System Description

The control module continuously monitors the voltage on the Ignition Accessory/Run circuit from the body control module (BCM). When the ignition is in the ACCESSORY or RUN position, the BCM sends a 12 V wake up signal to the control module. This wake up signal allows the control module to power up and start

functioning before the engine is started.

Conditions for Running the DTC

The ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

The control module detects the Ignition Accessory/Run circuit is less than 6 V for 1 min.

Action Taken When the DTC Sets

DTC P2537 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2537 is a Type B DTC.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Data Link Communications Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC U1814 or U2099 is not set.

- **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

2. Ignition in the ACCESSORY position.
3. Verify the scan tool BCM Accessory Relay Command parameter is Active.

- **If the parameter is not Active**

Refer to **Power Mode Mismatch**.

- **If the parameter is Active**

4. Ignition ON.
5. Verify the scan tool BCM Accessory Relay Command parameter is Active.

- **If the parameter is not Active**

Refer to **Power Mode Mismatch**.

- **If the parameter is Active**

6. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the control module setting the DTC.
2. Ignition ON.
3. Verify a test lamp illuminates between the accessory wake up serial data circuit and ground.
 - **If the test lamp does not illuminate.**
 1. Ignition OFF remove the test lamp, disconnect the X4 connector at the K9 Body Control Module.
 2. Test for less than 2 ohms on the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
4. Replace the control module setting the DTC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for control module replacement, programming, and setup.

SYMPTOMS - WIRING SYSTEMS

NOTE: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
 - **Electronic Park Lock Description and Operation**
 - **Power Mode Description and Operation**
 - **Retained Accessory Power Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to **Checking Aftermarket Accessories**.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Ignition Can/Cannot Be Turned Off with Transmission in Any Gear (With BTM/ATH), Ignition Can/Cannot Be Turned Off with Transmission in Any Gear (Without BTM/ATH)**
- **Ignition Mode Switch Indicator Malfunction**
- **Power Mode Mismatch**
- **Retained Accessory Power Malfunction**
- **Vehicle Will Not Change Power Mode**

IGNITION CAN/CANNOT BE TURNED OFF WITH TRANSMISSION IN ANY GEAR (WITH BTM/ATH)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	2	1	-	-
Ground	-	1	-	-
1. Ignition will not turn to OFF with vehicle in park 2. Ignition will turn to OFF with vehicle out of park				

Circuit/System Description

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an electronic park lock system. The electronic park lock system purpose is to prevent the ignition from being switched to the OFF position when the transmission is in any position other than Park and the vehicle may still be moving. The electronic park lock system incorporates the park position switch that located in the A/T shift lock control switch. When the transmission shift selector is in Park, the park position switch closes and the BCM allows the ignition to be turned OFF.

If the vehicle is not in Park, the ignition will return to ACC/ACCESSORY and display the message SHIFT TO PARK in the Driver Information Center. When the vehicle is shifted into Park, the ignition system will switch to OFF.

Diagnostic Aids

- Verify that the transmission shift selector indicator matches the position of the gear shift lever while selecting between the Park, Reverse, Drive and Low positions.

Reference Information

Schematic Reference

Ignition Lock Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Park Lock Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Body Control Module In Park Switch Status parameter changes between On and Off when shifting the S3 Transmission Shift Lever in and out of Park.
 - **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S3 Transmission Shift Lever. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Body Control Module In Park Switch Status parameter is Off.
 - **If not Off**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Off**
5. Install a 3 A fused jumper wire between the signal circuit terminal 6 and the ground circuit terminal 2.
6. Verify the scan tool Body Control Module In Park Switch Status parameter is On.
 - **If not On**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If On**

- 7. Test or replace the S3 Transmission Shift Lever.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Transmission Control Replacement**
- **Control Module References** for body control module replacement, programming, and setup.

IGNITION CAN/CANNOT BE TURNED OFF WITH TRANSMISSION IN ANY GEAR (WITHOUT BTM/ATH)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Control	2	1	-	-
Ground	-	1	-	-
1. Ignition key will not turn to OFF with vehicle in park. 2. Ignition key will turn to OFF with vehicle out of park.				

Circuit/System Description

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an electronic park lock system. The electronic park lock system purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The electronic park lock system consists of an ignition lock cylinder solenoid, and a park position switch that is located in the A/T shift lock control switch. The ignition lock cylinder solenoid contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when it is not energized. The park position switch receives voltage from the body control module (BCM) when the ignition is turned ON. When the transmission shift selector is in PARK, the park position switch closes and energizes the key capture solenoid actuator retracting the pin, allowing the ignition switch to be turned OFF. If vehicle power is lost, power is lost to the ignition switch, the ignition switch has a fault, and/or the transmission

is not in the Park position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

Diagnostic Aids

- Verify that the transmission shift selector indicator matches the position of the gear shift lever while selecting between the Park, Reverse, Drive and Low positions.
- Lost power to the ignition switch or a faulty ignition switch can prevent the ignition key from turning to the lock position and prevent ignition key removal from the column.

Reference Information

Schematic Reference

Ignition Lock Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Park Lock Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition OFF, gear shift selector in PARK, ignition ON.
2. Verify that S39 Ignition Switch can be rotated to the ON position.
 - **If the ignition switch cannot be rotated to the ON position and Ignition Key Cannot Be Removed from the Ignition Lock Cylinder has NOT been performed**

Refer to **Ignition Key Cannot Be Removed from the Ignition Lock Cylinder**.

- **If the ignition switch can not be rotated to the ON position and Ignition Key Cannot Be Removed from the Ignition Lock Cylinder has been performed**

Refer to Circuit/System Testing.

- **If the ignition switch can be rotated to the ON position**

3. Ignition ON, gear shift selector in NEUTRAL, ignition OFF.
4. Verify that the S39 Ignition Switch cannot be rotated to the LOCK position.
 - **If the ignition switch can be rotated to the LOCK position and Ignition Key Cannot Be Removed from the Ignition Lock Cylinder has NOT been performed**

Refer to **Ignition Key Cannot Be Removed from the Ignition Lock Cylinder**.

- **If the ignition switch can be rotated to the LOCK position and Ignition Key Cannot Be Removed from the Ignition Lock Cylinder has been performed**

Refer to Circuit/System Testing.

- **If the ignition switch cannot be rotated to the LOCK position**

5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S3 Transmission Shift Lever. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition OFF, connect the harness connector at the S3 Transmission Shift Lever. Disconnect the harness connector at the M93 Key Capture Solenoid Actuator, ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 1 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp illuminates**
5. Verify that a test lamp does not illuminate between the ignition circuit terminal 1 and the control circuit terminal 2 with the gear shift selector in NEUTRAL .
 - **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S3 Transmission Shift Lever.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S3 Transmission Shift Lever.
 - **If the test lamp does not illuminate**
6. Verify that a test lamp illuminates between the ignition circuit terminal 1 and the control circuit terminal 2, with the gear shift selector in PARK.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the S3 Transmission Shift Lever.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the S3 Transmission Shift Lever.
 - **If the test lamp illuminates**
7. Test or replace the M93 Key Capture Solenoid Actuator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Transmission Control Replacement**
- **Ignition Lock Cylinder Replacement**
- **Control Module References** for body control module replacement, programming, and setup

IGNITION MODE SWITCH INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	2	2	1	-
Ground	-	2	-	-
1. Ignition mode switch indicator always On 2. Ignition mode switch indicator inoperative				

Circuit/System Description

The ignition mode switch has two LED's that indicate the vehicle power mode. When the vehicle is in the off mode, both LED's will be off. Pressing the ignition mode switch button once (without the brake pedal applied), the vehicle enters the accessory mode and the amber LED (ACCESSORY) will illuminate. The accessory mode has a 5 min timeout to reduce battery drain. With the ignition OFF, pressing and holding the push button start switch for at least 10 s will place the vehicle in run/start mode (without the vehicle running) and the green LED (RUN/START) will illuminate. With the ignition OFF (with the brake pedal applied), pressing the ignition mode switch button once, the vehicle will enter run/start mode and the green LED (RUN/START) will illuminate. This will start the engine. With the engine running and while the vehicle is in P (Park), pressing the ignition mode switch once will turn the ignition OFF. If the vehicle is not in Park, the ignition will return to ACCESSORY and display the message SHIFT TO PARK in the Driver Information Center. When the vehicle is shifted into Park, the ignition system will then switch to OFF. Both LED's have the voltage supplied from the body control module (BCM). The ignition mode switch sends the ignition mode switch status to the keyless entry control module and to the BCM. The keyless entry control module sends a redundant signal to the BCM with the ignition mode switch status.

Reference Information

Schematic Reference

- **Power Distribution Schematics**
- **Power Moding Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the green LED turns ON and OFF when commanding the Run/Start Power Mode Indicator On and Off with the scan tool.

- **If the green LED does not turn ON and OFF**

Refer to Circuit/System Testing - Green LED Test.

- **If the green LED turns ON and OFF**

3. Verify the amber LED turns ON and OFF when commanding the Accessory Power Mode Indicator On and Off with the scan tool.

- **If the amber LED does not turn ON and OFF**

Refer to Circuit/System Testing - Amber LED Test.

- **If the amber LED turns ON and OFF**

4. All OK.

Circuit/System Testing

Green LED Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S38 Ignition Mode Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connections.
 - **If less than 10 ohms**
3. Connect the harness connector at the S38 Ignition Mode Switch.
4. Ignition ON, disconnect the harness connector at the S38 Ignition Mode Switch.
5. Test for less than 1 V between control circuit terminal 5 and ground while commanding Run/Start Power Mode Indicator Off with the scan tool.
 - **If 1 V or greater**
 1. Disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If less than 1 V**
6. Test for greater than 3 V between the control circuit terminal 5 and ground while commanding Run/Start Power Mode Indicator On with the scan tool.
 - **If 3 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.

2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If 3 V or greater**
7. Test or replace the S38 Ignition Mode Switch.

Amber LED Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S38 Ignition Mode Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connections.
 - **If less than 10 ohms**
3. Connect the harness connector at the S38 Ignition Mode Switch.
4. Ignition ON, disconnect the harness connector at the S38 Ignition Mode Switch.
5. Test for less than 1 V between control circuit terminal 2 and ground while commanding Accessory Power Mode Indicator Off with the scan tool.
 - **If 1 V or greater**
 1. Disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If less than 1 V**
6. Test for greater than 3 V between the control circuit terminal 2 and ground while commanding Accessory Power Mode Indicator On with the scan tool.
 - **If 3 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 Body Control Module.
 - **If 3 V or greater**
7. Test or replace the S38 Ignition Mode Switch.

Component Testing

1. Ignition OFF, disconnect the harness at the S38 Ignition Mode Switch.
2. Connect a jumper wire between the S38 Ignition Mode Switch terminal 4 and ground.
3. Connect a 3 A fused jumper wire between the S38 Ignition Mode Switch terminal 5 and B+.
4. Verify the green LED illuminates.
 - **If the LED does not illuminate**

Replace the S38 Ignition Mode Switch.

- **If the LED illuminates**
5. Connect a 3 A fused jumper wire between the S38 Ignition Mode Switch terminal 2 and B+.
 6. Verify the amber LED illuminates.
 - **If the LED does not illuminate**

Replace the S38 Ignition Mode Switch.

- **If the LED illuminates**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition and Start Switch Replacement (Without BTM) , Ignition and Start Switch Replacement (With BTM)**
- **Control Module References** for body control module replacement, programming and setup.

POWER MODE MISMATCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The body control module (BCM) controls the ignition main and retained accessory power relays by applying voltage to their individual relay control circuits. The ignition main relay is energized when the ignition is in the

ON or the CRANK position. The retained accessory power relay is energized during all power modes, except OFF-awake and CRANK. The relay is also energized for approximately 10 min after shutting the ignition OFF, provided no door is opened.

The engine control module (ECM) controls the engine controls the ignition relay by applying voltage to the engine controls relay control circuit.

Diagnostic Aids

A short to voltage on the ignition main relay coil control will cause the engine to remain running after the mode is changed to OFF.

Reference Information

Schematic Reference

- **Power Distribution Schematics**
- **Power Moding Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Use schematics to determine which ignition relay supplies the ignition feed for the appropriate devices. Use the connector end view to identify the ignition circuit terminal for each of those devices.

1. Ignition ON.
2. Verify that the appropriate devices controlled by the KR76 Retained Accessory Power Relay turn ON and

OFF when commanding the Accessory/Retained Accessory Power Relay On and Off with a scan tool.

- **If the devices do not turn ON and OFF**

Refer to Circuit/System Testing - Diagnostic A.

- **If the devices turn ON and OFF**

3. Verify that the appropriate devices controlled by the KR74 Ignition Main Relay turn ON and OFF when switching the ignition between ON and OFF.

- **If the devices do not turn ON and OFF**

Refer to Circuit/System Testing - Diagnostic B.

- **If the devices turn ON and OFF**

4. Verify that the appropriate devices controlled by the KR75 Engine Controls Ignition Relay turn ON and OFF when switching the ignition between ON and OFF.

- **If the devices do not turn ON and OFF**

Refer to Circuit/System Testing - Diagnostic C.

- **If the devices turn ON and OFF**

5. All OK.

Circuit/System Testing

Diagnostic A

1. Ignition OFF and all vehicle systems OFF, disconnect the KR76 Retained Accessory Power Relay. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 10 ohms between the ground circuit terminal 11 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.

4. Verify a test lamp illuminates between the B+ circuit terminal 15 and ground.

- **If the test lamp does not illuminate**

Replace the X51A Fuse Block - Instrument Panel

- **If the test lamp illuminates**

5. Connect a test lamp between the control circuit terminal 13 and the ground circuit terminal 11.

6. Verify the test lamp turns ON and OFF when commanding the Accessory/Retained Accessory Power Relay On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
7. Verify that a test lamp does not illuminate between the ignition circuit terminal 15 and ground.
 - **If the test lamp illuminates**

Repair the short to voltage on the ignition circuit
 - **If the test lamp does not illuminate**
8. Ignition ON, connect a 40 A fused jumper wire between the B+ circuit terminal 15 and the ignition circuit terminal 14.
9. Verify device is activated.
 - **If the device does not activate**
 1. Ignition OFF, disconnect the harness connector at the device.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the device.
 - **If the device activates**
10. Test or replace the KR76 Retained Accessory Power Relay.

Diagnostic B

1. Ignition OFF and all vehicle systems OFF, disconnect the KR74 Ignition Main Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 85 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate**

Replace the X50A Fuse Block - Underhood

- **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
 6. Verify the test lamp turns ON and OFF when switching the ignition ON and OFF.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
 7. Verify that a test lamp does not illuminate between the ignition circuit terminal 87 and ground.
 - **If the test lamp illuminates**

Repair the short to voltage on the ignition circuit.

- **If the test lamp does not illuminate**

8. Ignition ON, connect a 40 A fused jumper wire between the B+ circuit terminal 30 and the ignition circuit terminal 87.
9. Verify the device is activated.
 - **If the device is not activated**
 1. Ignition OFF, disconnect the harness connector at the device.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the device.
 - **If the device activates**
10. Test or replace the KR74 Ignition Main Relay.

Diagnostic C

1. Ignition OFF and all vehicle systems OFF, disconnect the KR75 Engine Controls Ignition Relay, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate**

Replace the X50A Fuse Block - Underhood
 - **If the test lamp illuminates**
3. Verify a test lamp illuminates between the B+ circuit terminal 85 and ground.
 - **If the test lamp does not illuminate**

Replace the X50A Fuse Block - Underhood
 - **If the test lamp illuminates**
4. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
5. Verify the test lamp turns ON and OFF when switching the ignition ON and OFF.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K20 Engine Control Module.
- **If the test lamp is always ON**
- 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
- 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
- **If the test lamp turns ON and OFF**
- 6. Verify a test lamp does not illuminate between the ignition circuit terminal 87 and ground.
 - **If the test lamp illuminates**
 - Repair the short to voltage on the circuit.
 - **If the test lamp does not illuminate**
- 7. Ignition ON, connect a 40 A fused jumper wire between the B+ circuit terminal 30 and the ignition circuit terminal 87.
- 8. Verify device is activated.
 - **If the device does not activate**
 - 1. Ignition OFF, disconnect the harness connector at the device.
 - 2. Test for infinite resistance between the ignition circuit terminal 87 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the device.
 - **If the device activates**
- 9. Test or replace the KR75 Engine Controls Ignition Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70-150 ohms between terminals (85 or 1) and (86 or 2).
 - **If less than 70 or greater than 150 ohms**
 - Replace the relay.
 - **If between 70-150 ohms**
3. Test for infinite resistance between the terminals listed below:
 - (30 or 3) and (86 or 2)

- (30 or 3) and (87 or 5)
- (30 or 3) and (85 or 1)
- (85 or 1) and (87 or 5)
- (86 or 2) and (87 or 5)
- **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal (85 or 1) and 12 V. Install a jumper wire between relay terminal (86 or 2) and ground.
5. Test for less than 5.0 ohms between terminals (30 or 3) and (87 or 5).
 - **If 5.0 ohms or greater**

Replace the relay.

- **If less than 5.0 ohms**

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for the appropriate module replacement, programming and setup.

RETAINED ACCESSORY POWER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+	1	1	1	-
Relay Switch Ignition	1	1	1, 2	-
Relay Coil Control	B1445 02	1	1	-
Relay Coil Ground	-	1	-	-
1. Retained Accessory Power Malfunction				

2. Retained Accessory Power Relay Always ON

Circuit/System Description

The body control module (BCM) controls the retained accessory power relay through the control circuit by applying voltage to the retained accessory power relay coil control circuit. The retained accessory power relay is energized when the ignition switch is in the ACCESSORY or the ON position.

Reference Information

Schematic Reference

Power Distribution Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Retained Accessory Power Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Use schematics to determine which devices are on the K9 Body Control Module's ignition circuit terminal 12 X4 or controlled by the KR76 Retained Accessory Power Relay. Use the connector end view to identify the ignition circuit terminal for each of those devices.

1. Ignition ON.
2. Verify the appropriate devices controlled by the KR76 Retained Accessory Power Relay turn ON and OFF when commanding the Accessory/Retained Accessory Power Relay On and Off with a scan tool.
 - **If the devices do not turn ON and OFF**

Refer to Circuit/System Testing

- **If the devices turn ON and OFF**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR76 Retained Accessory Power Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 11 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 15 and ground.
 - **If the test lamp does not illuminate**

Replace the X51A Fuse Block - Instrument Panel

- **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 13 and the ground circuit terminal 11.
 6. Verify the test lamp turns ON and OFF when commanding the Accessory/Retained Accessory Power Relay On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
 7. Connect the KR76 Retained Accessory Power Relay.
 8. Disconnect the appropriate X80 Accessory Power Receptacle.

9. Ignition OFF.
10. Verify that a test lamp does not illuminate between each of the ignition circuits listed below and ground.
 - X80H Accessory Power Receptacle - Console Center - Ignition circuit terminal A
 - X80G Accessory Power receptacle - Instrument Panel - Ignition circuit terminal A
 - **If the test lamp illuminates**

Repair the short to voltage on the ignition circuit.
 - **If the test lamp does not illuminate**
11. Ignition ON.
12. Verify that a test lamp illuminates between each of the ignition circuits listed below and ground.
 - X80H Accessory Power Receptacle - Console Center - Ignition circuit terminal A
 - X80G Accessory Power receptacle - Instrument Panel - Ignition circuit terminal A
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the KR76 Retained Accessory Power Relay.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the appropriate X80 Accessory Power Receptacle.
 - **If the test lamp illuminates**
13. Test or replace the appropriate X80 Accessory Power Receptacle.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70-150 ohms between terminals (85 or 1) and (86 or 2).
 - **If less than 70 or greater than 150 ohms**

Replace the relay.
 - **If between 70-150 ohms**
3. Test for infinite resistance between the terminals listed below:
 - (30 or 3) and (86 or 2)
 - (30 or 3) and (87 or 5)

- (30 or 3) and (85 or 1)
- (85 or 1) and (87 or 5)
- (86 or 2) and (87 or 5)
- **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal (85 or 1) and 12 V. Install a jumper wire between relay terminal (86 or 2) and ground.
5. Test for less than 5.0 ohms between terminals (30 or 3) and (87 or 5).
 - **If 5.0 ohms or greater**

Replace the relay.

- **If less than 5.0 ohms**

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Accessory Power Receptacle Replacement**
- **Control Module References** for the body control module replacement, programming and setup.

VEHICLE WILL NOT CHANGE POWER MODE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ terminal 2	B1370 04, B1380 04	B1370 04, B1380 04	-	-
Ignition Terminal 1	B1370 04, B1380 04	B1370 04, B1380 04	B1370 01	-
Ignition Terminal 3	B1370 04, B1380 04	B1380 04	B1380 01	-

Ignition Terminal 4	B1370 04, B1380 04, B1441 04	B1441 04	B1441 04	-
Signal - Terminal 3	B097B 02*	B097B 05*	B097B 05*	-
Signal - Terminal 6	2	B097B 05*	2	-
5 V Reference	-	2	-	-
Low Reference	-	B097B 05*	-	-
Ground	-	1	-	-
* DTC set in keyless entry control module 1. Ignition mode switch indicator always Off 2. Power mode mismatch				

Circuit/System Description

Without ATH/BTM

The vehicle power mode master is the body control module (BCM). The ignition switch is a low current switch with multiple discrete circuits to the BCM. The BCM logic uses the ignition switch positions to identify the operator's desired power mode and activate specific discrete signals, and serial data messages for the operation of different subsystems as necessary. Other modules which have switched voltage inputs may operate in a default mode if the power mode master serial data message does not match what the individual module can detect from its own connections.

The power mode master will activate relays and other direct outputs of the power mode master as needed according to the calculated power mode. Some relays controlled by the BCM are switched ignition voltage outputs that are pass through circuits within the BCM directly from the ignition switch. If these circuits short to ground, the B+ circuit fuse to the ignition switch will open.

With ATH/BTM

The ignition mode switch has 2 LED's that indicate the vehicle power mode. When the vehicle is in the off mode, both LED's will be off. Pressing the ignition mode switch button once (without the brake pedal applied), the vehicle enters the accessory mode and the amber LED (ACC) will illuminate. The accessory mode has a 5 min timeout to reduce battery drain. Pressing the ignition mode switch button a second time (without the brake pedal applied), the vehicle enters the run/start mode (without the engine running) and the green LED (Run/Start) will illuminate. Pressing and holding the push button start switch for up to 10 s, will place the vehicle in run/start mode (without the vehicle running) and the green LED (Run/Start) will illuminate. With the ignition off (with the brake pedal applied), pressing the ignition mode switch button once, the vehicle will enter run/start mode and the green LED (run/start) will illuminate. This will start the engine. Both LED's have the voltage supplied from the BCM. The ignition mode switch sends the ignition mode switch status to the keyless entry control module and to the BCM. The keyless entry control module sends a redundant signal to the BCM with the ignition mode switch status.

The ignition mode switch contains two individual switches that provides redundant switch inputs to both the BCM and the keyless entry control module. The BCM supplies the ignition mode switch a constant B+ signal. The BCM monitors this signal to determine if the switch is released or pressed. When the ignition mode switch is not pressed, voltage on the signal circuit is pulled down through two resistors in the switch. When the ignition

mode switch is pressed, voltage on the signal circuit is pulled down through only one resistor, changing the voltage seen at the BCM and indicating that the ignition mode switch is pressed.

The keyless entry control module monitors voltage on the switch in the same manner as the BCM, but monitors the second switch located in the ignition mode switch. The keyless entry control module also controls the backup power for the ignition main relay through the control circuit by applying voltage to the ignition voltage circuit. This circuit is a pass-thru in the BCM and will energize the ignition circuit when the vehicle is in Service Mode, the vehicle is ON, or when a remote start is requested.

Reference Information

Schematic Reference

- **Power Distribution Schematics**
- **Power Moding Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Without ATH/BTM

1. Ignition ON.
2. Verify the scan tool power mode parameters change when cycling the S39 Ignition Switch between OFF, ACCESSORY, ON, and CRANK.
 - **If the parameters do not change**

Refer to Circuit/System Testing - Without ATH/BTM.

- **If the parameters change**

3. All OK.

With ATH/BTM

1. Verify DTC B097B 08 or B097B 61 are not set.

- **If either DTC is set**

Test or replace the S38 Ignition Mode Switch.

- **If the DTCs are not set**

2. Verify the green LED illuminates when the S38 Ignition Mode Switch is pressed and held for up to 10 s, with the brake pedal released.

- **If the green LED does not illuminate**

Refer to Circuit/System Testing - With ATH/BTM.

- **If the green LED illuminates**

3. All OK.

Circuit/System Testing

Without ATH/BTM

1. Ignition ON, disconnect the harness connector at the S39 Ignition Switch while the ignition is ON.

2. Verify a test lamp illuminates between the B+ circuit terminal 2 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp.

2. Test for less than 2 ohms in the B+ circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp.

2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on one of the following circuits listed below:

NOTE: To help isolate a short to ground, it may be necessary to disconnect modules that are connected to the following circuits:

-
- B+ circuit terminal 2

- Ignition circuit terminal 1
 - Ignition circuit terminal 3
 - Ignition circuit terminal 4
- **If the test lamp illuminates**
- 3. Ignition ON.
- 4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 6 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If between 4.8-5.2 V**
- 5. Connect the harness connector at the S39 Ignition Switch.
- 6. Ignition OFF.
- 7. Disconnect the X3 harness connector at the K9 Body Control Module, ignition ON.
- 8. Verify a test lamp illuminates between each of the ignition circuits listed below and ground:
 - Ignition circuit terminal 5
 - Ignition circuit terminal 6
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
- 9. Ignition OFF with the key in.

10. Verify a test lamp illuminates between ignition circuit terminal 15 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF with the key out, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF with the key out remove the test lamp.
 2. Test for infinite resistance between the ignition circuit terminal 15 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
11. Connect the X3 harness connector at the K9 Body Control Module, ignition ON.
12. Disconnect the harness connector at the S39 Ignition Switch.
13. Test for less than 1 V between each of the ignition circuits listed below and ground:
 - Ignition circuit terminal 1
 - Ignition circuit terminal 3
 - Ignition circuit terminal 4
 - **If 1 V or greater**

Repair the short to voltage on the circuit.
 - **If less than 1 V**
14. Test or replace the S39 Ignition Switch.

With ATH/BTM

1. Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the S38 Ignition Mode Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Test for less than 10 ohms between the low reference circuit terminal 7 and ground.
 - **If 10 ohms or greater**
 1. Vehicle OFF.

2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If less than 10 ohms**
4. Connect the S38 Ignition Mode Switch, ignition ON.
5. Disconnect the S38 Ignition Mode Switch.
6. Verify the scan tool K9 Body Control Module Push Button Ignition Switch Voltage parameter is greater than 11 V.
 - **If 11 V or less**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If greater than 11 V**
 - 7. Install a 3 A fused jumper wire between the signal circuit terminal 6 and ground.
 - 8. Verify the scan tool K9 Body Control Module Push Button Ignition Switch Voltage parameter is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If less than 1 V**
 - 9. Connect the harness connector at the S38 Ignition Mode Switch.
 - 10. Verify the scan tool K9 Body Control Module Push Button Ignition Switch Voltage parameter is 8-10 V, with the S38 Ignition Mode Switch released.
 - **If not between 8-10 V**

Test or replace the S38 Ignition Mode Switch.

 - **If between 8-10 V**
 - 11. Verify the scan tool K9 Body Control Module Push Button Ignition Switch Voltage parameter is 4-7 V, with the S38 Ignition Mode Switch pressed.
 - **If not between 4-7 V**

Test or replace the S38 Ignition Mode Switch.

- **If between 4-7 V**

12. Disconnect the X1 harness connector at the K84 Keyless Entry Control Module.

13. Test for infinite resistance between the signal circuit terminal 11 and ground.

- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

14. Ignition ON.

15. Test for less than 1 V between the signal circuit terminal 11 and ground.

- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

16. Test for 4.5-5.5 kohms between the signal circuit terminal 11 and the low reference circuit terminal 12, with the S38 Ignition Mode Switch released.

- **If not between 4.5-5.5 kohms**

1. Vehicle OFF, disconnect the harness connector at the S38 Ignition Mode Switch.

2. Test for less than 2 ohms in the signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, test or replace the S38 Ignition Mode Switch.

- **If between 4.5-5.5 kohms**

17. Test for 1-1.5 kohms between the signal circuit terminal 11 and the low reference circuit terminal 12, with the S38 Ignition Mode Switch pressed.

- **If not between 1-1.5 kohms**

Test or replace the S38 Ignition Mode Switch.

- **If between 1-1.5 kohms**

18. Replace the K84 Keyless Entry Control Module.

Component Testing

S39 Ignition Switch

1. Ignition OFF, disconnect the X1 harness connector at the S39 Ignition Switch.

2. Using the Resistance Test below, verify the resistance between the terminals listed below match for each S39 Ignition Switch Position.

- **If any reading is other than specified**

Replace the S39 Ignition Switch.

- If the readings match

3. All OK.

Resistance Test

Ignition Switch Position	Terminals 1 and 2	Terminals 2 and 3	Terminals 2 and 4	Terminals 2 and 6	Terminals 4 and 6
OFF Key Out	Infinite	Infinite	Infinite	Infinite	Infinite
OFF Key In	Infinite	Infinite	<5.0 ohms	Infinite	Infinite
Accessory	Infinite	<5.0 ohms	Infinite	Infinite	Infinite
Run	<5.0 ohms	<5.0 ohms	Infinite	Infinite	<5.0 ohms
Start	<5.0 ohms	Infinite	Infinite	Infinite	1275-1325 ohms

S38 Ignition Mode Switch

1. Ignition OFF, disconnect the harness connector at the S38 Ignition Mode Switch.
2. With the S38 Ignition Mode Switch released, test for 4.5-5.5 kohms between the terminals listed below:
 - Signal terminal 6 and ground terminal 4
 - Signal terminal 3 and low reference terminal 7
 - If not between 4.5-5.5 kohms

Replace the S38 Ignition Mode Switch

- If between 4.5-5.5 kohms

3. With the S38 Ignition Mode Switch pressed, test for 1-1.5 kohms between the terminals listed below:
 - Signal terminal 6 and ground terminal 4
 - Signal terminal 3 and low reference terminal 7
 - If not between 1-1.5 kohms

Replace the S38 Ignition Mode Switch.

- If between 1-1.5 kohms

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition and Start Switch Replacement (Without BTM) , Ignition and Start Switch Replacement (With BTM)**
- **Control Module References** for body control module or keyless entry control module replacement, programming and setup.

GENERAL ELECTRICAL DIAGNOSIS

Basic Knowledge Required

Without a basic knowledge of electricity, it will be difficult to use the diagnostic procedures contained in the service manual. You should understand the basic theory of electricity, and know the meaning of voltage (V), current (A), and resistance (ohms). You should also be able to read and understand a wiring diagram, as well as understand what happens in a circuit with an open or a shorted wire.

CHECKING AFTERMARKET ACCESSORIES

WARNING: Refer to SIR Warning .

CAUTION: The OBD II symbol is used on the circuit diagrams in order to alert the technician that the circuit is essential for proper OBD II emission control circuit operation. Any circuit which fails and causes the malfunction indicator lamp (MIL) to turn ON, or causes emissions-related component damage, is identified as an OBD II circuit.

Do not connect aftermarket accessories into the following circuits:

- SIR circuits, all such circuits are indicated on circuit diagrams with the SIR symbol.
- OBD II circuits, all such circuits are indicated on circuit diagrams with the OBD II symbol.

Always check for aftermarket accessories (non-OEM) as the first step in diagnosing electrical problems. If the vehicle is so equipped, disconnect the system to verify that these add-on accessories are not the cause of the problems.

Possible causes of vehicle problems related to aftermarket accessories include:

- Power feeds connected to points other than the battery
- Antenna location
- Transceiver wiring located too close to vehicle electronic modules or wiring
- Poor shielding or poor connectors on antenna feed line
- Check for recent service bulletins detailing installation guidelines for aftermarket accessories.

CIRCUIT TESTING

The Circuit Testing section contains the following diagnostic testing information. Using this information along with the diagnostic procedures will identify the cause of the electrical malfunction.

- Using Connector Test Adapters
- Probing Electrical Connectors
- Troubleshooting with a Digital Multimeter
- Troubleshooting with a Test Lamp

- Using Fused Jumper Wires
- Measuring Voltage
- Measuring Voltage Drop
- Measuring Frequency
- Testing Ground and Low Reference Circuits
- Testing for Continuity
- Testing for Short to Ground
- Testing for a Short to Voltage
- Testing for Intermittent Conditions and Poor Connections
- Inducing Intermittent Fault Conditions
- Testing for Electrical Intermittents
- Scan Tool Snapshot Procedure
- Circuit Protection - Fuses
- Circuit Protection - Circuit Breakers
- Circuit Protection - Fusible Links

USING CONNECTOR TEST ADAPTERS

Special Tools

- **EL-35616** Terminal Test Probe Kit
- **EL-38125-550** Terminal Release Tool Kit

For equivalent regional tools, refer to Special Tools .

CAUTION: Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the EL-35616 GM Approved Terminal Test Probe Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the EL-35616 GM Approved Terminal Test Probe Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the EL-35616 GM Approved Terminal Test Probe Kit label on the inside of the EL-35616 GM Approved Terminal Test Probe Kit for the correct adapter along with the connector end view.

PROBING ELECTRICAL CONNECTORS

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to Special Tools .

NOTE: Always be sure to reinstall the connector position assurance (CPA) and terminal position assurance (TPA) when reconnecting connectors or replacing terminals.

Front probe

Disconnect the connector and probe the terminals from the mating side (front) of the connector.

CAUTION: Refer to Test Probe Caution .

NOTE: When probing female 0.64 terminals, it is important to use the correct adapter. There have been some revisions to the test adapter for 0.64 terminals. The proper adapter for 0.64 terminals is the J-35616-64B which has a gold terminal and a black wire between the base and tip. Failure to use the proper test adapter may result in damage to the terminal being tested and improper diagnosis.

NOTE: The proper adapter for probing the terminals for fuses, relays, or diodes in an electrical center is J-35616-35. Using any other tool or adapter may damage the terminal being tested.

Refer to the following table as a guide in selecting the correct test adapter for front probing connectors:

Test Adapter	Description
J-35616-2A	150 Male Probe Adapter (gray)
J-35616-3	150 Female Probe Adapter (gray)
J-35616-4A	280 Male Probe Adapter (purple)
J-35616-5	280 Female Probe Adapter (purple)
J-35616-6	100W Male (round) Probe Adapter (brown)
J-35616-7	100W Female (round) Probe Adapter (brown)
J-35616-8	Weather Pack Male Probe Adapter (orange)
J-35616-9	Weather Pack Female Probe Adapter (orange)
J-35616-10	100W Male (round) Probe Adapter (green)
J-35616-11	100W Female (round) Probe Adapter (green)
J-35616-12	130 Male Probe Adapter (blue)
J-35616-13	130 Female Probe Adapter (blue)
J-35616-14	150 Male Probe Adapter (green)

J-35616-16	100 Male Probe Adapter (lt green)
J-35616-17	100 Female Probe Adapter (lt green)
J-35616-18	220 Male Probe Adapter (black)
J-35616-19	220 Female Probe Adapter (black)
J-35616-21	950 Female Probe Adapter (red)
J-35616-22	950 Male Probe Adapter (red)
J-35616-31	500 Male Probe Adapter (orange)
J-35616-32	500 Female Probe Adapter (orange)
J-35616-33	160/180 Male Probe Adapter (yellow)
J-35616-34	160/180 Female Probe Adapter (yellow)
J-35616-35	280 Male Probe Adapter (violet)
J-35616-40	480 Male Probe Adapter (dk blue)
J-35616-41	480 Female Probe Adapter (dk blue)
J-35616-42	630 Male Probe Adapter (red)
J-35616-43	630 Female Probe Adapter (red)
J-35616-44	800 Male Probe Adapter (yellow)
J-35616-45	800 Female Probe Adapter (yellow)
J-35616-54	280 Male (round) Probe Adapter (tan)
J-35616-55	280 Female (round) Probe Adapter (tan)
J-35616-64B	0.64 Male Probe Adapter (lt blue)
J-35616-65B	0.64 Female Probe Adapter (lt blue)
J-35616-66	150 Male (round) Probe Adapter (yellow)
J-35616-67	150 Female (round) Probe Adapter (yellow)

Backprobe

NOTE:

- Backprobe connector terminals only when specifically required in diagnostic procedures.
- Do not backprobe a sealed (Weather Pack®) connector, less than a 280 series Metri-Pack connector, a Micro-Pack connector, or a flat wire connector.
- Backprobing can be a source of damage to connector terminals. Use care in order to avoid deforming the terminal, either by forcing the test probe too far into the cavity or by using too large of a test probe.
- After backprobing any connector, inspect for terminal damage. If terminal damage is suspected, test for proper terminal contact.

Do not disconnect the connector and probe the terminals from the harness side (back) of the connector.

TROUBLESHOOTING WITH A DIGITAL MULTIMETER

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to **Special Tools** .

CAUTION: Refer to Test Probe Caution .

Digital Multimeter (DMM) Basic Requirements

Service information is validated using digital multimeters that meet or exceed the following requirements. Using a multimeter that does not meet these basic requirements may give inaccurate readings which could lead to an incorrect diagnosis.

Display and Settings

1. Four digits displayed
2. Voltage, current, resistance, frequency, diode test settings, and min-max function
3. Display positive and negative values

Voltage

1. Have at least 10 Mohms input impedance
2. Test a DC voltage range of 0.1-1000 V.
3. Test an AC voltage range of 0.1-1000 V.

Current

1. Test a DC current range of 0.1 μ A-10 A.
2. Test an AC current range of 0.1 μ A-10 A.

Resistance

Test a resistance range of 0.1 ohms-40 Mohms and displays infinite for a value greater than 40 Mohms (O.L. (Over-load))

Frequency

Test for a frequency range of 0.5 Hz-199 k Hz

Diode Test

1. Apply at least 1 mA when performing the diode bias test
2. Display the break over voltage drop (0-3 V) of a forward biased diode
3. Display infinite (O.L. (Over-load)) when a diode is reverse biased

Min-Max Readings

1. Can update at a 25 ms sample rate
2. Saves and displays minimum and maximum values

NOTE: **Circuits which include any solid state control modules, such as the engine control module (ECM), should only be tested with a 10 Mohms or higher impedance digital multimeter such as the EL-39200.**

The DMM instruction manual is a good source of information and should be read thoroughly upon receipt of the DMM as well as kept on hand for future reference.

A DMM should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present if the impedance is low enough, a DMM indicates how much voltage is present. In other words, if there is not enough current, the test lamp will not illuminate even though voltage is present.

The ohmmeter function on a DMM shows how much resistance exists between 2 points along a circuit. Low resistance in a circuit means good continuity.

NOTE: **Disconnect the power feed from the suspect circuit when measuring resistance with a DMM. This prevents incorrect readings. DMMs apply such a small voltage to measure resistance that the presence of voltages can upset a resistance reading.**

Diodes and solid state components in a circuit can cause a DMM to display a false reading. To find out if a component is affecting a measurement take a reading once, then reverse the leads and take a second reading. If the readings differ the solid state component is affecting the measurement.

Following are examples of the various methods of connecting the DMM to the circuit to be tested:

- Probe both ends of the connector and either hold the leads in place while manipulating the connector or tape the leads to the harness for continuous monitoring while you perform other operations or test driving. Refer to [Probing Electrical Connectors](#).
- Disconnect the harness at both ends of the suspected circuit where it connects either to a component or to other harnesses.
- If the system that is being diagnosed has a specified pinout or breakout box, it may be used in order to simplify connecting the DMM to the circuit or for testing multiple circuits quickly.

TROUBLESHOOTING WITH A TEST LAMP

Special Tools

EL-35616-200 Test Light - Probe Kit

For equivalent regional tools, refer to [Special Tools](#) .

CAUTION: Refer to Test Probe Caution .

A test lamp can simply and quickly test a low impedance circuit for voltage. A Digital Multimeter (DMM) should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present if the impedance is low enough, a DMM indicates how much voltage is present. In other words, if there is not enough current, the test lamp will not illuminate even though voltage is present.

The **EL-35616-200** kit is Micro-Pack compatible and comprised of a 12 V light bulb with an attached pair of leads.

To properly operate this tool use the following procedures.

When testing for voltage:

1. Attach one lead to ground.
2. Touch the other lead to various points along the circuit where voltage should be present.
3. When the bulb illuminates, there is voltage at the point being tested.

When testing for ground:

1. Attach one lead to battery positive voltage.
2. Touch the other lead to various points along the circuit where ground should be present.
3. When the bulb illuminates, there is ground at the point being tested.

USING FUSED JUMPER WIRES

Special Tools

EL 35616-20F Fused Jumper Wire

For equivalent regional tools, refer to Special Tools .

NOTE: **A fused jumper may not protect solid state components from being damaged.**

Fig. 1: X102 Forward Lamp Harness to Fan Control Module Harness
Courtesy of GENERAL MOTORS COMPANY

The **EL 35616-20F** Fused Jumper Wire includes banana jack connectors that provide adaptation to most connectors without damage. This fused jumper wire is supplied with a 20 A fuse which may not be suitable for some circuits. Do not use a fuse with a higher rating than the fuse that protects the circuit being tested.

MEASURING VOLTAGE

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to **Special Tools** .

CAUTION: Refer to Test Probe Caution .

The following procedure measures the voltage at a selected point in a circuit.

1. Disconnect the electrical harness connector for the circuit being tested, if necessary.
2. Enable the circuit and/or system being tested. Use the following methods:
 - Turn ON the ignition, with the engine OFF.
 - Turn ON the engine.
 - Turn ON the circuit and/or system with a scan tool in Output Controls.
 - Turn ON the switch for the circuit and/or system being tested.
3. Select the V (AC) or V (DC) position on the Digital Multimeter (DMM).
4. Connect the positive lead of the DMM to the point of the circuit to be tested.
5. Connect the negative lead of the DMM to a good ground.
6. The DMM displays the voltage measured at that point.

MEASURING VOLTAGE DROP

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to **Special Tools** .

CAUTION: Refer to Test Probe Caution .

The following procedure determines the difference in voltage potential between 2 points.

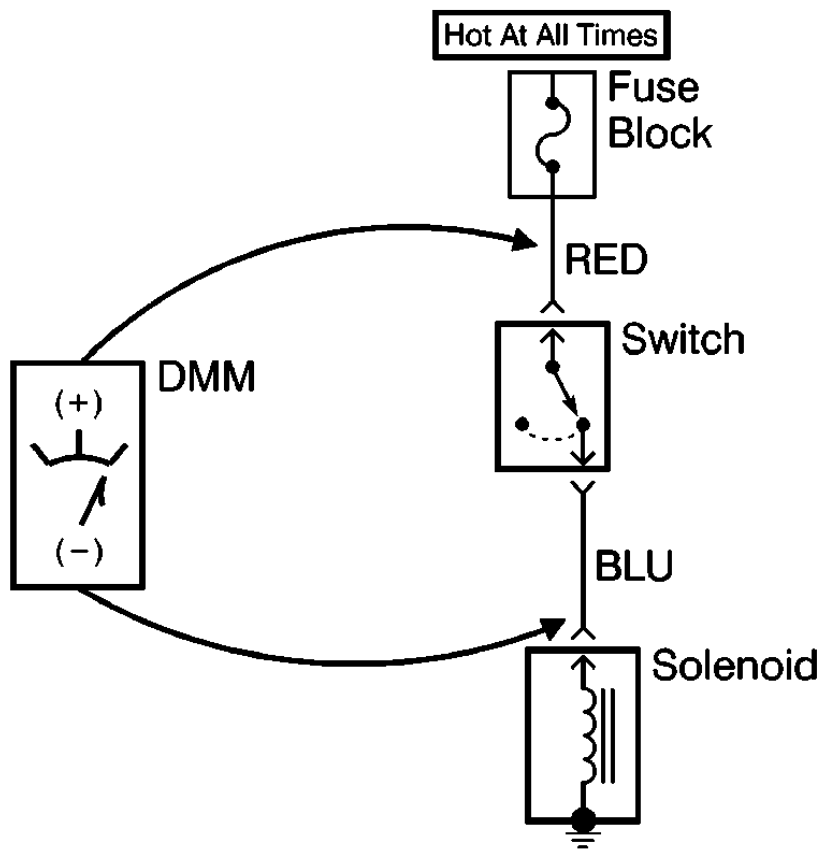


Fig. 2: Measuring Voltage Drop
 Courtesy of GENERAL MOTORS COMPANY

1. Set the Digital Multimeter (DMM) to the V (DC) position.
2. Connect the positive lead of the DMM to one point of the circuit to be tested.
3. Connect the negative lead of the DMM to the other point of the circuit.
4. Operate the circuit.
5. The DMM displays the difference in voltage between the 2 points.

MEASURING FREQUENCY

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to **Special Tools** .

CAUTION: Refer to Test Probe Caution .

The following procedure determines the frequency of a signal.

NOTE: Connecting the Digital Multimeter (DMM) to the circuit before pressing the Hz button will allow the DMM to autorange to an appropriate range.

1. Apply power to the circuit.
2. Set the DMM to the V (AC) position.
3. Connect the positive lead of the DMM to the circuit to be tested.
4. Connect the negative lead of the DMM to a good ground.
5. Set to Hz on the DMM.
6. The DMM will display the frequency measured.

TESTING GROUND AND LOW REFERENCE CIRCUITS

Because a test lamp can light with up to 200 ohms in a ground or low reference circuit they are not recommended to be used for this type of test. A low impedance test lamp can light and indicate the circuit is good when there is as much as 20-30 ohms present, while a high impedance test lamp can light with up to 200 ohms present in the circuit. This is why the Digital Multi-Meter (DMM) is used when validating a ground or low reference circuit continuity.

When using the DMM there are many vehicle conditions that can affect the ground and low reference continuity testing. If these conditions are not met, a ground or low reference circuit test can fail on a good circuit. This may cause longer diagnosis time and incorrect component replacement.

Any current flow through a ground or low reference circuit, while being tested, will skew the DMM continuity reading, or display a reading higher than when there is no current flowing. Performing a ground or low reference circuit continuity test, in reference to the vehicles battery negative terminal, will have the highest risk of failing a good ground or low reference circuit test than any other ground reference point. The best ground test points would be a control module housing (if the control modules housing is metal and grounded), door jamb striker (if attached to metal), under dash metal frame work, engine block, or body ground studs (other than where the negative battery cable is attached).

A typical DMM ground or low reference circuit continuity reading can be as high as 100 ohms with the ignition ON, and drop to 15-25 ohms after the ignition is turned OFF. The reading will drop below 10 ohms after 30-40 seconds, then below 5 ohms after 60 seconds. Once the vehicle completely goes to sleep (generally 3-10 minutes) the reading will drop below 0.3 ohms.

The following list of conditions may need to be met to ensure a valid continuity reading on a ground or low reference circuit:

- Ignition OFF
- Key out of the ignition switch (when not equipped with keyless entry and remote start)

- Retained Accessory Power (RAP) OFF (open and close the driver door after ignition OFF)
- Battery charger set at a 2 A or less charge rate
- Scan tool not communicating with any vehicle control module (in some cases it may need to be disconnected from the DLC)
- All entry doors closed
- Headlamps OFF (auto headlamps disabled)
- Any delay lighting OFF
- HVAC after blow OFF
- Any accessory that can work when the ignition is OFF
- Wait up to 60 seconds (after all other listed conditions are met)

Activating the DOOR LOCK function with a key fob can greatly reduce the time to achieve a valid ground or low reference continuity test result.

TESTING FOR CONTINUITY

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to **Special Tools** .

CAUTION: Refer to Test Probe Caution .

The following procedures verify good continuity in a circuit.

With a Digital Multimeter (DMM)

1. Set the DMM to the ohms position.
2. Disconnect the power feed (i.e. fuse, control module) from the suspect circuit.
3. Disconnect the load.
4. Select the MIN MAX function on the DMM.
5. Connect one lead of the DMM to one end of the circuit to be tested.
6. Connect the other lead of the DMM to the other end of the circuit.
7. If the DMM displays low or no resistance, the circuit has good continuity.

With a Test Lamp

NOTE: Only use the test lamp procedure on low impedance power and ground circuits.

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.

2. Disconnect the load.
3. Connect one lead of the test lamp to one end of the circuit to be tested.
4. Connect the other lead of the test lamp to battery positive voltage.
5. Connect the other end of the circuit to ground.
6. If the test lamp illuminates (full intensity), then the circuit has good continuity.

TESTING FOR SHORT TO GROUND

CAUTION: Refer to Test Probe Caution .

The following procedures test for a short to ground in a circuit.

With a Digital Multimeter (DMM)

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Set the rotary dial of the DMM to the ohms position.
4. Connect one lead of the DMM to one end of the circuit to be tested.
5. Connect the other lead of the DMM to a good ground.
6. If the DMM does NOT display infinite resistance (OL), there is a short to ground in the circuit.

With a Test Lamp

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to battery positive voltage.
4. Connect the other lead of the test lamp to one end of the circuit to be tested.
5. If the test lamp illuminates, there is a short to ground in the circuit.

Fuse Powering Several Loads

1. Review the system schematic and locate the fuse that is open.
2. Open the first connector or switch leading from the fuse to each load.
3. Connect a DMM across the fuse terminals (be sure that the fuse is powered).
 - When the DMM displays voltage the short is in the wiring leading to the first connector or switch.
 - If the DMM does not display voltage refer to the next step.
4. Close each connector or switch until the DMM displays voltage in order to find which circuit is shorted.

TESTING FOR A SHORT TO VOLTAGE

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to **Special Tools** .

CAUTION: Refer to Test Probe Caution .

The following procedure tests for a short to voltage in a circuit.

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Set the Digital Multimeter (DMM) to the V (DC) position.
4. Connect the positive lead of the DMM to one end of the circuit to be tested.
5. Connect the negative lead of the DMM to a good ground.
6. Turn ON the ignition and operate all accessories.
7. If the voltage measured is greater than 1 V, there is a short to voltage in the circuit.

TESTING FOR INTERMITTENT CONDITIONS AND POOR CONNECTIONS

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to **Special Tools** .

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- Poor terminal to wire connection - Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components

- Refer to **Inducing Intermittent Fault Conditions** in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to **Testing for Electrical Intermittents** for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to **Scan Tool Snapshot Procedure** for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Terminal Fretting

Some intermittent conditions can be caused by wire terminal fretting corrosion. Fretting corrosion is a build-up of insulating, oxidized wear debris that can form when there is a small motion between electrical contacts. The oxidized wear debris can pile up enough at the electrical contact spots that the electrical resistance across the connection increases. Movement between the contacting surfaces as small as 10 to 100 microns can cause fretting. To put this in perspective, a sheet of paper is about 100 microns thick, so fretting motion is small and hard to see. Vibration and thermal expansion/contraction are the main sources that create fretting motion. Since vehicles vibrate and can experience large temperature swings, they are a good source for fretting motion. Tin, copper, nickel, and iron surfaces are all susceptible to fretting corrosion. Fretting corrosion can be difficult to see but it looks like small, dark smudges on the terminals contact surface.

To correct a fretting condition disconnect the suspect connector and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to both sides of the connector terminals. Then reconnect the connector and wipe away any excess lubricant. This will correct the additional terminal contact resistance due to the terminal fretting corrosion.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the **EL-35616** kit when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center. Use the **EL-35616** kit to test for proper terminal contact. Failure to use the **EL-35616** kit can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal/terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire Connectors

There are no serviceable parts for flat wire connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter into the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to **Circuit Testing**, and **Power Distribution Schematics**.
- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to **Circuit Testing**, and **Ground Distribution Schematics**.

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.

- If the intermittent is related to heat, review the data for a relationship with the following:
 - High ambient temperatures
 - Underhood/engine generated heat
 - Circuit generated heat due to a poor connection, or high electrical load
 - Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
 - Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
 - The condition only occurs on a cold start.
 - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to **Inducing Intermittent Fault Conditions** in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:

- A mis-routed harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. - These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch - These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. - These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to **Checking Aftermarket Accessories**.
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
 - A new service control module is installed.
 - A control module from another vehicle is installed.
 - Revised software/calibration files have been released for this vehicle.

NOTE: **DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module.**

This is not an effective repair for any type of concern.

- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to **Control Module References** for replacement, setup, and programming.

INDUCING INTERMITTENT FAULT CONDITIONS

Special Tools

J-25070 Heat Gun

For equivalent regional tools, refer to **Special Tools** .

Many intermittent open or shorted circuits are affected by harness/connector movement that is caused by vibration, engine torque, bumps/rough pavement, etc. In order to duplicate the customer's concern, it may be necessary to manipulate the wiring harness if the malfunction appears to be vibration related. Manipulation of a circuit can consist of a wide variety of actions, including:

- Wiggling the harness
- Disconnecting a connector and reconnecting
- Stressing the mechanical connection of a connector
- Pulling on the harness or wire in order to identify a separation/break inside the insulation
- Relocating a harness or wires

All these actions should be performed with some goal in mind. For instance, with a scan tool connected, wiggling the wires may uncover a faulty input to the control module. The snapshot option would be appropriate here. Refer to **Scan Tool Snapshot Procedure**. Another option is, with the component commanded ON and OFF by the scan tool, to move related connectors and wiring and observe the component operation. With the engine running, move related connectors and wiring while monitoring engine operation. If harness or connector movement affects the data displayed, component/system operation, or engine operation, inspect and repair the harness/connections as necessary.

You may need to load the vehicle in order to duplicate the concern. This may require the use of weights, floor jacks, jackstands, frame machines, etc. In these cases you are attempting to duplicate the concern by manipulating the suspension or frame. This method is useful in finding harnesses that are too short and their connectors pull apart enough to cause a poor connection. A DMM set to the Min/Max mode and connected to the suspect circuit while testing can yield desirable results. Refer to **Testing for Electrical Intermittents**.

Certainly, using the senses of sight, smell, and hearing while manipulating the circuit can provide good results as well.

There may be instances where circuit manipulation alone will not meet the required criteria for the fault condition to appear. In such cases it may be necessary to expose the suspect circuit to other conditions while manipulating the harness. Such conditions would include high moisture conditions, along with exceptionally high or low temperatures. The following discusses how to expose the circuit to these kinds of conditions.

High Temperature Conditions

If the complaint tends to be heat related, you can simulate the condition using the **J-25070** heat gun.

Using the heat gun, you can heat up the suspected area or component. Manipulate the harnesses under high temperature conditions while monitoring the scan tool or DMM to locate the fault condition.

The high temperature condition may be achieved simply by test driving the vehicle at normal operating temperature. If a heat gun is unavailable, consider this option to enhance your diagnosis. This option does not allow for the same control, however.

Low Temperature Conditions

Depending on the nature of the fault condition, placing a fan in front of the vehicle while the vehicle is in the shade can have the desired effect.

If this is unsuccessful, use local cooling treatments such as ice or a venturi type nozzle (one that provides hot or cold air). This type of tool is capable of producing air stream temperatures down to -18°C (0°F) from one end and $+71^{\circ}\text{C}$ (160°F) from the other. This is ideally suited for localized cooling needs. In addition, circuit cooling spray can be used to cool down a component or circuit.

Once the vehicle, component, or harness has been sufficiently cooled, manipulate the harness or components in an effort to duplicate the concern.

Duplicating Failure Conditions

- If none of the previous tests are successful, attempt to duplicate and/or capture the failure conditions.
- Freeze Frame/Failure Records data, where applicable, contains the conditions that were present when the DTC set.
 1. Review and record Freeze Frame/Failure Records data.
 2. Clear the DTCs using the scan tool.
 3. Turn the key to OFF and wait 15 seconds.
 4. Operate the vehicle under the same conditions that were noted in Freeze Frame/Failure Records data, as closely as possible. The vehicle must also be operating within the Conditions for Running the DTC. Refer to Conditions for Running the DTC in the supporting text if a DTC is being diagnosed.
 5. Monitor DTC Status for the DTC being tested. The scan tool will indicate Ran, when the enabling conditions have been satisfied long enough for the DTC to run. The scan tool will also indicate whether the DTC passed or failed.
- An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the concern occurs, may help you locate the concern.

TESTING FOR ELECTRICAL INTERMITTENTS

Special Tools

EL-39200 Digital Multimeter

For equivalent regional tools, refer to **Special Tools** .

Perform the following procedures while wiggling the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the test equipment.

- **Testing for Short to Ground**
- **Testing for Continuity**
- **Testing for a Short to Voltage**

If the fault is not identified, perform the procedure below using the MIN MAX feature on the **EL-39200** digital multimeter (DMM). This feature allows you to manipulate the circuit without having to watch the DMM. The DMM will generate an audible tone when a change is detected.

NOTE: **The DMM must be used in order to perform the following procedure since the DMM can monitor current, resistance or voltage while recording the minimum (MIN), and maximum (MAX) values measured.**

1. Connect the DMM to both sides of a suspected connector (still connected), or from one end of a suspected circuit to the other. Refer to **Troubleshooting with a Digital Multimeter** for information on connecting the DMM to the circuit.
2. Set the DMM to the V (AC) or V (DC) position.
3. Select the voltage range feature of the DMM in order to select the desired voltage range.

NOTE: **The 100 ms RECORD mode is the length of time an input must stay at a new value in order to record the full change.**

4. Select the MIN MAX function of the DMM. The DMM displays the 100 ms RECORD and emits an audible tone (beep).
5. Simulate the condition that is potentially causing the intermittent connection, either by wiggling the connections or the wiring, test driving, or performing other operations. Refer to **Inducing Intermittent Fault Conditions**.
6. Listen for the audible Min Max Alert which indicates that a new minimum or maximum value has been recorded.
7. Press the MIN MAX button until the MAX value is displayed and note the value.
8. Press the MIN MAX button until the MIN value is displayed and note the value.
9. Determine the difference between the MIN and MAX values.
 - If the variation between the recorded MIN and MAX voltage values is 1 V or greater an intermittent open or high resistance condition exists. Repair the condition as necessary.
 - If the variation between the recorded MIN and MAX voltage values is less than 1 V, an intermittent open or high resistance condition does not exist.

SCAN TOOL SNAPSHOT PROCEDURE

Using Snapshots in Global Diagnostic System (GDS)

Overview

A snapshot is a recording of what a control module on the vehicle was receiving for information while the snapshot is being made. A snapshot may be used to analyze the data during the time a vehicle condition is current. This allows you to concentrate on making the condition occur, rather than trying to view all the data in anticipation of the fault. In GDS 2, snapshots are automatically recorded whenever the user views Module Diagnostics, Vehicle Diagnostics and/or Systems Diagnostics. Module Diagnostics includes DTC Data, Identification Information, Data Display, Control Functions and Configuration/Reset Functions. Vehicle Diagnostics includes Vehicle Wide DTCs. Systems Diagnostics includes Inspection/Maintenance Status and Inspection/Maintenance Information.

Snapshot Replay

The Snapshot Replay function allows reviews of previously recorded vehicle snapshot data. This information can be used in analysis of vehicle problems and detection of trigger error conditions. The graph function can be used to compare parameters to see if a component is functioning properly. Recorded snapshots can be selected for viewing by the following two methods:

- From the Home Page, click on Review Stored Data. In the Snapshot Select Page, highlight the vehicle in the upper pane and highlight the desired snapshot in the lower pane, then click the Select Snapshot button.
- The user can view a snapshot without ending a current on-vehicle diagnostic session by clicking the Module button (when active) or Back button until the Session Manager is displayed in the menu. This is used when a user is viewing live data and wants the quickest way to review the data. Click on the Session Manager button. Highlight the desired snapshot in the lower pane and click Select Snapshot

View Selections

The following information can be selected in the tabs at the top of the screen:

- Line Graph - Displays information from the snapshot file in graph view. The current value of the parameters is displayed on the screen. Use the buttons on the right side to modify the graph data.
- Diagnostic Data Display - Displays incoming information from the snapshot file. The current value of the parameters is displayed on the screen. Use the buttons on the right side to modify the data.
- DTC Display - This tab will be displayed when a DTC is current or the status has changed. The tab will not be displayed when there are no DTCs.
- Bookmarks - If bookmarks are present, this displays the Type, Description and Time of automatic and manually generated bookmarks.
- System Information - Displays the GDS 2 Software Version and MDI Serial Number used when the snapshot was recorded.
- Selected Vehicle Configuration - Displays vehicle options information.

Snapshot Replay Functions

To review the snapshot there are buttons at the bottom of the window to control the cursor. From left to right the buttons are:

- Return to Frame 0 - This button returns the cursor to frame 0.
- Stop - This button pauses or stops the cursor. Click the Play button to resume.
- Play - This button starts the replay of the data.
- Play Speed - This button changes the speed between 1x, 2x, 4x and 8x.
- Back 1 Frame - This button moves the cursor back 1 frame.
- Forward 1 Frame - This button moves the cursor forward 1 frame.
- Previous Bookmark - This button moves the cursor to the previous bookmark.
- Next Bookmark - This button moves the cursor forward 1 bookmark.

CIRCUIT PROTECTION - FUSES

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to **Special Tools** .

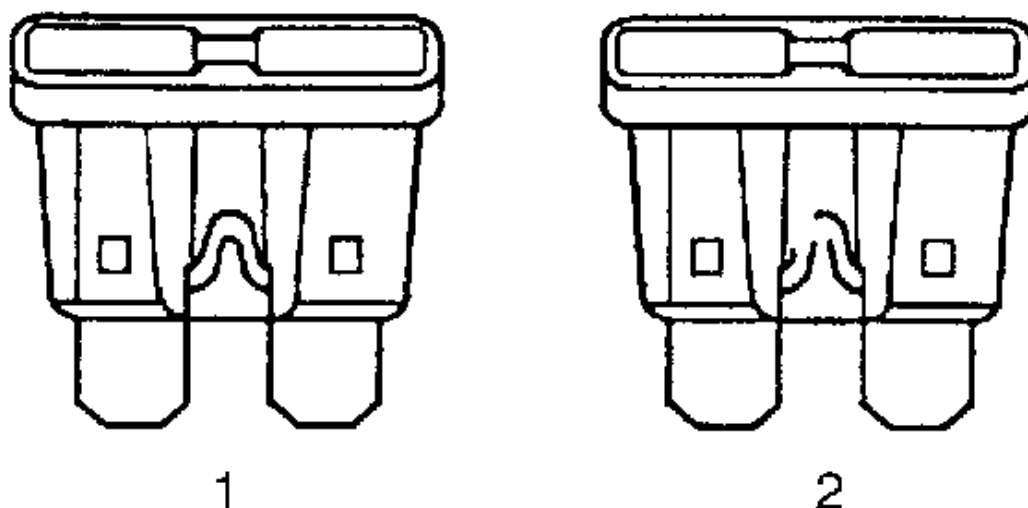


Fig. 3: Identifying Open Fuse Element
 Courtesy of GENERAL MOTORS COMPANY

The fuse is the most common method of an automotive wiring circuit protection. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt and create an open or incomplete circuit. Fuses are a one time protection device and must be replaced each time the circuit is overloaded. To determine if a fuse is open, remove the suspected fuse and examine if the element in the fuse is broken (2). If not broken (1), also check for continuity using a Digital Multimeter (DMM) or a continuity tester. If the element is broken or continuity is suspect, replace the fuse with one of equal current rating.

Fuse Types

Current Rating Amperes	Color
Auto Fuses, Mini Fuses	
2	Gray
3	Violet

5	Tan
7.5	Brown
10	Red
15	Blue
20	Yellow
25	White or Natural
30	Green
Maxi Fuses	
20	Yellow
30	Light Green
40	Orange or Amber
60	Blue
50	Red
J-Case Fuses	
20	Blue
30	Pink
40	Green
50	Red
60	Yellow
Midi Fuses	
80	Black
Mega Fuses	
100	Black
150	Black
200	Black

CIRCUIT PROTECTION - CIRCUIT BREAKERS

A circuit breaker is a protective device that is designed to open the circuit when a current load is in excess of the rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals. Two types of circuit breakers are used.

Circuit Breaker

This type opens when excessive current passes through it for a period of time. It closes again after a few seconds, and if the cause of the high current is still present, it will open again. The circuit breaker will continue to cycle open and closed until the condition causing the high current is removed.

Positive Temperature Coefficient (PTC) Circuit Breaker

This type greatly increases its resistance when excessive current passes through it. The excessive current heats the PTC device, as the device heats its resistance increases. Eventually the resistance gets so high that the circuit is effectively open. Unlike the ordinary circuit breaker the PTC unit will not reset until the circuit is opened, by removing the voltage from its terminals. Once the voltage is removed the circuit

breaker will re-close within a second or 2.

CIRCUIT PROTECTION - FUSIBLE LINKS

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to **Special Tools** .

NOTE: **When repairing a fusible link, fusible links cut longer than 225 mm (approximately 9 in) will not provide sufficient overload protection.**

Fusible link is wire designed to melt and break continuity when excessive current is applied. It is often located between or near the battery and starter or electrical center. Use a continuity tester or a Digital Multimeter (DMM) at each end of the wire containing the fusible link in order to determine if it is broken. If broken, it must be replaced with fusible link of the same gauge size.

WIRING REPAIRS

The Wiring Repairs section contains the following types of wiring repair information. Using these elements together will make wiring repair faster and easier:

- **Testing for Intermittent Conditions and Poor Connections**
- **Flat Wire Repairs**
- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **High Temperature Wiring Repairs**
- **Heated Oxygen Sensor Wiring Repairs**
- **Splicing Copper Wire Using Splice Sleeves**
- **Splicing Twisted or Shielded Cable**
- **Splicing Inline Harness Diodes**
- **SIR/SRS Wiring Repairs**

REPAIRING DAMAGED WIRE INSULATION

If the wire insulation has been chafed, or broken, enough to show the conductive portion of the wire, and the wire is not damaged, determine the length of insulation that needs to be repaired. If the repair is less than 280 mm (11 in), cut the wire within the damaged area. Then slide the appropriate heat shrink tubing (listed below) over the wire, and repair the wire by splicing the wires together. Refer to **Splicing Copper Wire Using Splice Sleeves**. Once the wire is spliced together slide heat shrink tubing over the damaged area and apply heat to seal the repaired wire.

If the wire is damaged, or the damaged area is larger than 280 mm (11 in), then replace the damaged wire by splicing in a new section of wire. Refer to **Splicing Copper Wire Using Splice Sleeves**.

Heat Shrink Tubing Selection

GM Part Number	Diameter		Description	Color	Length	
	Metric	English			Metric	English
12355003	9.5 mm	0.375 in	Tubing, Shrink 3/8	Black	305 mm	12 in
12355005	12.7 mm	0.5 in	Tubing, Shrink 1/2	Black	305 mm	12 in
12355011	19.1 mm	0.75 in	Tubing, Shrink 3/4	Black	305 mm	12 in
12355008	25.4 mm	1.0 in	Tubing, Shrink 1.00	Black	305 mm	12 in

Wire Size Conversion

Metric Wire Sizes (mm 2)	AWG Sizes
0.13	26
0.21	24
0.32	22
0.52	20
0.83	18
1.31	16
2.09	14
3.31	12
5.27	10
8.37	8
13.3	6
21.2	4
33.6	2
53.5	1/0

COAXIAL CABLE REPAIRS

The GM global coaxial cable repair strategy uses coaxial cables, connectors and jumpers to repair coaxial cables. The intent is to install the new service cable in vehicle, but removal of the old cable is not necessary. There are several repair scenarios:

- New cables, jumpers, and connector housing are required.
- Only new cables are required while it is possible to reuse the existing connector housing in vehicle. A jumper may or may not be needed.
- Only new connector housing are required, while it is possible to reuse the existing cable in the vehicle.
- A new cable would need to be installed from source to destination and by-pass the inline connector in some cases when an inline connector is unrepairable (Example: a cracked male end of a 1-way connector).

Coaxial Cable Kits

Four different kits will be available to repair coaxial cables. Components of each kit cannot be ordered separately from the kit.

- **Communication Interface Module Antenna Cable Kit** (Kit # 13581174) is used to repair Cellular coaxial cables. This kit uses RG58 low loss coaxial cables that are available in four lengths. The coaxial cables can be attached together in various lengths to closely match the length of the faulty/damaged coaxial cable.
- **Digital Radio and Vehicle Locator Antenna Coaxial Cable Kit** (Kit # 13581173) is used to repair XM and GPS coaxial cables. For vehicles that have a combined GPS and Cellular/OnStar signal on one cable, use Kit # 13581174. This kit uses RG316 low loss coaxial cables that are available in three lengths. The coaxial cables can be attached together in various lengths to closely match the length of the faulty/damaged coaxial cable.
- **Digital Radio, Mobile Telephone and Vehicle Locator Antenna Coaxial Cable Kit** (Kit # 19119056) is used with OnStar, XM, and GPS cables. This kit consists of jumpers and connectors. The jumpers are used to adapt different types of connectors together (to attach 2-way and 3-way connector onto the long 7, 5, and 3 foot cables). The connectors are used to replace existing connectors. The 1-way and 2-way connectors in the kit are in water-blue color (different than what the vehicle is built with) and are non-keyed (universal fit). The 3-way connectors in the kit are in the same color as in the vehicle.
- **Communication Interface Module Antenna Cable Kit** (Kit # 22803854) is used for the OnStar module on some vehicles built before the 2011 model year.

Coaxial Cable Repair Kits

Repair Kit Name		Description
Communication Interface Module Antenna Cable Kit (Kit # 13581174)		RG58 coaxial cable with female/female connectors - 7ft/2.1m
		RG58 coaxial cable with female/male connectors - 5ft/1.5m
		RG58 coaxial cable with female/male connectors - 3.5ft/1.1m
		RG58 coaxial cable with female/male connectors - 3.5ft/1.1m
Digital Radio and Vehicle Locator Antenna Coaxial Cable Kit (Kit # 13581173)		RG316 coaxial cable with female/female connectors - 7ft/2.1m
		RG316 coaxial cable with female/male connectors - 5ft/1.5m
		RG316 coaxial cable with female/male connectors - 3.5ft/1.1m
	3-way Gen 1 sub-kit	1-way to 3-way Gen 1 jumper for female connector - Part # 13581154 - 4in/10cm
		1-way to 3-way Gen 1 jumper for male connector - Part # 19119052 - 4in/10cm
		White female connector

Digital Radio, Mobile Telephone and Vehicle Locator Antenna Coaxial Cable Kit (Kit # 19119056)		White male connector
		Blue female connector
		Blue male connector
	3-way Gen 2 sub-kit	1-way to 3-way Gen 2 jumper for female connector - Part # 13581155 - 4in/10cm 1-way to 3-way Gen 2 jumper for male connector - Part # 19119058 - 4in/10cm
		Tan female connector
		Tan male connector
		Gray female connector
		Gray male connector
		1-way to 2-way Gen 1 jumper for female connector - Part # 13581156 - 4in/10cm
		Water-blue female connector
	2-way Gen 1 sub-kit	1-way to 2-way Gen 2 jumper for female connector - Part # 13581157 - 4in/10cm
		1-way to 2-way Gen 2 jumper for male connector - Part # 13581158 - 4in/10cm
		Water-blue female connector
		Water-blue male connector
	2-way Gen 2 sub-kit (wide)	1-way to 2-way Gen 2 and 3 jumper for female connector - Part # 13582468 - 4in/10cm
		Use the 1-way to 2-way Gen 2 jumper for female connector 19119058 - 4in/10cm from the 2-way Gen 2 sub-kit.
		Water-blue female connector
		Water-blue male connector
	2-way Gen 2 and 3 sub-kit (narrow)	
	Right-angle jumper with water-blue universal 1-way connector - 4in/10cm	
Communication Interface Module Antenna Cable Kit (Kit # 22803854)		1-way to mini UHF jumper - 4in/10cm

Connector Housing Repair Procedure

The connector housings (available in Digital Radio, Mobile Telephone and Vehicle Locator Antenna Coaxial Cable Kit) are available for 1-way housings, 2-way housings and 3-way housings. Determine the connector housing required:

1-way housing

No change to the service coaxial cable is necessary in order to install the new coaxial cable into the vehicle.

2-way housing

A 4-inch jumper is required.

1. Determine the appropriate generation (1, 2, or 3) and/or size (12.7mm or 8mm) of the 2-way housing that is in the vehicle.
2. Remove the faulty/damaged coaxial cable from the 2-way connector housing by removing the terminal position assurance (TPA) from the connector housing and then slide the cable out of the connector.

Fig. 4: Connector Housing

Courtesy of GENERAL MOTORS COMPANY

3. Install the new service coaxial cable into the vehicle. Use the 4-inch jumper for the appropriate 2-way connector housing to connect the new service coaxial cable to the connector housing.

4. If the issue is found to be the connector housing and not cable, a new connector housing may be installed while reusing all other components.

3-way housing

A 4-inch jumper is required.

1. Determine the appropriate generation (1 or 2) and keyed 3-way connector housing based on the connector housing color.
2. Note the locations of each of the cables in 3-way housing, as it is important for new cables be placed in the appropriate terminal location in the new connector. The connector housing colors are not interchangeable.
3. Remove the faulty/damaged coaxial cable from the 3-way connector housing by using a pair of side/diagonal cutters to nip and break away the housing.

Fig. 5: Using Side/Diagonal Cutters To Nip And Break Away Connector Housing
Courtesy of GENERAL MOTORS COMPANY

4. Use caution not to damage the conductive ends of the coaxial cables inside the connector housing. Do not bend or force the terminal out or it could be damaged.

Fig. 6: Service Coaxial Cable And 3-Way Connector Housing
Courtesy of GENERAL MOTORS COMPANY

5. Install the new service coaxial cable into the vehicle. Use the 4-inch jumper for the appropriate color 3-way connector housing to connect the new service coaxial cable to the new 3-way connector housing.
6. If the issue is found to be the connector housing and not cable, a new connector housing may be installed while reusing all other components.

Coaxial Cable Repair Procedure

1. Identify the faulty/damaged coaxial cable.
2. Disconnect the faulty/damaged coaxial cable and leave it in the vehicle.
3. Identify the type of coaxial cable to be replaced and match up with the appropriate pieces to repair the damaged coaxial cable. Match up the type of coaxial cable, cable length and connector types. In some cases there may be extra length of cable left over.

Fig. 7: Coaxial Cable

Courtesy of GENERAL MOTORS COMPANY

NOTE: **Avoid routing the new coaxial cable near sharp edges that can damage the new coaxial cable.**

4. Install the new coaxial cable in the vehicle.

Use tie-straps to attach the new service coaxial cable to existing harnesses or brackets. Use felt tape/foam to reduce rattles, as necessary.

NOTE: **To avoid permanent damage, do not pinch the cable or bend it tighter than a 2 inch (5 centimeter) radius.**

5. Remove the faulty/damaged connectors, if applicable.
6. Install new connectors or jumpers, as needed. Refer to Connector Housing Repair Procedure.
7. Verify the repair by operating the system with the engine running.

FLAT WIRE REPAIRS

The flat wire within the flex wiring harness is not serviceable. If an open or short exists within the flex wiring harness the complete harness must be replaced.

FOLDED-OVER WIRE REPAIR

Special Tools

EL-38125-10 Splice Sleeve Crimping Tool

For equivalent regional tools, refer to **Special Tools** .

The GM global wire repair strategy uses connector assemblies (pigtails) and terminated leads to repair wiring harnesses.

To reduce and manage GM Service Parts proliferation, the service pigtails and terminated leads are designed with the largest wire gauge size that can be held by either the terminal or the connector housing.

The folded over wire repair technique, in which the copper wire strands are folded over before being installed into a splice sleeve, allows the service part to be used when repairing a smaller gauge size wire in a vehicle. This technique has passed all GM testing standards.

Fig. 8: View Of Stripped Wires In Splice Sleeve Connector
Courtesy of GENERAL MOTORS COMPANY

The larger harness size wires (1) will be placed in one side of the splice sleeve and match the splice sleeve closely in size. The wires are moved into the splice sleeve until they hit the stop (4) in the splice sleeve. The smaller harness size wires (2) will be placed in the other side of the splice sleeve. The smaller harness size wires will be folded over (3) to match up with the splice sleeve size.

Use the folded over wire repair for:

NOTE: **Increasing the amount of copper strands in the smaller gauge size will allow for a better crimp**

- Splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes)

NOTE: **Vehicle side needs to be of same or less gauge size (not greater than the service part's gauge size)**

- Splicing wires of different gauges

Use the Service Information (SI) connector end-views to determine:

- Gauge size of wiring harness
- Recommended Repair: Terminated Lead or Pigtail

The following table lists the acceptable variance within the gauge size

Folded-Over Wire Selection Table

Harness Wire Gauge		Connector Assembly (Pigtail) or Terminated Lead Wire Gauge Size			
-		Salmon Color Splice Sleeve		Blue Color Splice Sleeve	Yellow Color Splice Sleeve
Metric	-	0.35 mm	0.5-0.8 mm	1.0-2.0 mm	3.0-5.0 mm
-	Wire Gauge (AWG)	22	20-18	16-14	12-10
0.13 mm	26	Fold Over Wire	Fold Over Wire	Fold Over Wire	Not Acceptable
0.22 mm	24	Fold Over Wire	Fold Over Wire	Fold Over Wire	Not Acceptable
0.35 mm	22	Fold Over Wire	Fold Over Wire	Fold Over Wire	Not Acceptable
0.5 mm	20	Not Acceptable	Wire to Wire	Fold Over Wire	Not Acceptable
0.75 mm	-	Not Acceptable	Wire to Wire	Fold Over Wire	Not Acceptable
0.8 mm	18	Not Acceptable	Wire to Wire	Fold Over Wire	Not Acceptable
1.0 mm	16	Not Acceptable	Wire to Wire	Fold Over Wire	Not Acceptable
1.5 mm	-	Not Acceptable	Not Acceptable	Wire to Wire	Fold Over Wire
2.0 mm	14	Not Acceptable	Not Acceptable	Wire to Wire	Fold Over Wire
2.5 mm	-	Not Acceptable	Not Acceptable	Wire to Wire	Fold Over Wire
3.0-5.0 mm	12-10	Not Acceptable	Not Acceptable	Not Acceptable	Wire to Wire

Example

For an IP Harness of 0.22 mm (24 gauge on left side of table) wire size, the SI connector end-view recommends a pigtail with leads of 0.8 mm (18 gauge on the top of the table) with a salmon colored DuraSeal splice sleeve of 0.5-1.0 mm (20-16 gauge).

Follow these steps to use the folded over wire (1) technique on an IP Harness.

Fig. 9: View Of Stripped Wires

Courtesy of GENERAL MOTORS COMPANY

Strip twice the amount of insulation on the smaller (1) wire (IP Harness is the lower wire) than normally required. Normally, the terminated leads have 5 mm of insulation stripped off the wire.

Fig. 10: Splice Sleeve Crimping Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use EL-38125-10 splice sleeve crimping tool.

1. For wiring repair, refer to **Splicing Copper Wire Using Splice Sleeves.**

Fig. 11: View Of Twisted And Folded Wire To Length
Courtesy of GENERAL MOTORS COMPANY

2. Twist the wires before you fold them over to prevent the wire strands from opening up. Fold over the copper wire strands of the smaller (1) gauge wire so that it is the same length as the non-folded wire.

Fig. 12: View Of Folded Wire & Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

3. Insert the folded over wire (1) into the splice sleeve.

Fig. 13: Crimping The Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

4. Use the proper crimp tool to crimp the splice sleeve to the smaller wire (harness side of repair). Complete the crimp as usual (using the heat tool to shrink the tube).

HIGH TEMPERATURE WIRING REPAIRS

NOTE: **All wiring repairs need to be 200 mm from the heat zone. Areas of consideration would be any area located near the exhaust manifolds, catalytic converter, exhaust pipes, and turbocharged engines.**

Items Required

- DuraSeal splice sleeves to crimp and seal connections
- High temperature SCT1 shrink tubing to protect the splice sleeves
- Terminated leads or pigtails
- The correct tools to remove the terminals from the connectors

Use high temperature bulk wire rated at 150°C (302°F) continuous temperature of the same or larger gauge size as the original wire when repair damage wire. Also replace any reflective tape that you remove during the repair.

High Temperature Wiring

Wiring that is exposed to high temperatures, 135°C (275°F) or higher, for prolonged periods of time may use materials i.e. wires, connectors, and shielding that has a higher heat rating than typical wiring. When making a repair in a high temperature area observe the following:

- Use high temperature bulk wire rated at 150°C (302°F) continuous temperature to replace any damaged wire.
- Replace any heat shielding that is removed.
- Cover any DuraSeal splice sleeves with SCT1 shrink tubing.
- After making a wiring repair, ensure that the location of the wiring is not moved closer to the heat source.

Identifying High Temperature Wiring

NOTE: **High temperature areas would be areas located near exhaust manifolds, catalytic converters, exhaust pipes, and turbocharged engines.**

Wiring that is exposed to high temperature, 135°C (275°F) or higher, for prolonged periods of time need special considerations when making wiring repairs. Areas that may be exposed to higher temperatures can be identified by heat resistant materials that are being used in those areas. These materials may include heat reflective tape, moon tape, and high temperature shrink tubing. Also conduit and other protective coverings may be used. Because conduit or similar coverings are used throughout the vehicle regardless of the temperature, it may be necessary for the technician to determine if an area is exposed to excessive heat before making a wiring repair.

HEATED OXYGEN SENSOR WIRING REPAIRS

CAUTION: Do not solder repairs under any circumstances as this could result in the air reference being obstructed.

If the heated oxygen sensor pigtail wiring, connector, or terminal is damaged the entire oxygen sensor assembly must be replaced. Do not attempt to repair the wiring, connector, or terminals. In order for the sensor to function properly it must have a clean air reference. This clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors or terminals could result in the obstruction of the air reference and degrade oxygen sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor, causing poor performance. Also, the sensor pigtail and harness wires must not be damaged in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Neither the sensor nor vehicle lead wires should be bent sharply or kinked. Sharp bends, kinks, etc., could

block the reference air path through the lead wire.

- Do not remove or defeat the oxygen sensor ground wire (where applicable). Vehicles that utilize the ground wire sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will also cause poor engine performance.
- To prevent damage due to water intrusion, be sure that the peripheral seal remains intact on the vehicle harness connector.

SPLICING COPPER WIRE USING SPLICE SLEEVES

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool
- **J-38125-5A** Ultra Torch Special Tool
- **J-38125-8** Splice Sleeve Crimping Tool

For equivalent regional tools, refer to **Special Tools** .

NOTE: **The DuraSeal splice sleeves have the following 2 critical features:**

- **A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.**
- **A cross hatched (knurled) core crimp provides the necessary low resistance contact integrity for these sensitive, low energy circuits.**

Use only DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except Tefzel and coaxial. Use DuraSeal splice sleeves where there are special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

Splice Sleeve Selection

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm ² / (AWG)
	3 Crimp Nests	4 Crimp Nests	
Salmon (Yellow-Pink) 19168446	Red (1) or Red/Green (1)	Red (2)	0.5-0.8/(18-20)
Blue 19168447	Blue (2)	Blue (3)	1.0-2.0/(14-16)
Yellow 19168448	Yellow (3)	Yellow (4)	3.0-5.0/(10-12)

NOTE: **You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.**

1. Open the harness by removing any tape:
 - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in

order to avoid wire insulation damage.

- Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
- Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.

2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

3. Strip the insulation:

- When adding a length of wire to the existing harness, use the same size wire as the original wire.
- Perform one of the following items in order to find the correct wire size:
 - Find the wire on the schematic and convert to regional wiring gauge size.
 - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
- Strip approximately 5.0 mm (0.20 in) of insulation from each wire to be spliced.
- Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
- If the wire is damaged, repeat this procedure after removing the damaged section.

4. For high temperature wiring, slide a section of high temperature SCT1 shrink tubing down the length of wire to be spliced. Ensure that the shrink tubing will not interfere with the splice procedure.
5. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.

Fig. 14: View Of Crimping Tool

Courtesy of GENERAL MOTORS COMPANY

6. The **EL-38125-10** splice sleeve crimping tool has four crimp nests. The largest crimp nest (4) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (3) is used for crimping 14 and 16 gauge wires. The third largest crimp nest (2) is used for crimping 18 and 20 gauge wires. The smallest crimp nest (1) is used for crimping 22 to 26 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.

Fig. 15: Identifying Splice Crimp Tool Nests Terminal Identification
Courtesy of GENERAL MOTORS COMPANY

7. The **J-38125-8** splice sleeve crimping tool has three crimp nests. The largest crimp nest (3) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (2) is used for crimping 14 and 16 gauge wires. The smallest crimp nest (1) is used for crimping 18 to 20 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.
8. Use the splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. For the four crimp nest tool, use the three largest crimp nests to crimp the splice sleeves. For the three crimp nest tool, use all three crimp nests to crimp the splice sleeves. Use the four and three crimp tool diagrams (above) and the table (farther above) to match the splice sleeve with the correct crimp nest. The crimp tool diagram callout numbers match the numbers in the table (under crimp tool nest color).

Fig. 16: Identifying Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

9. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.



Fig. 17: Identifying Crimped Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

10. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop.
11. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 6 for the opposite end of the splice.



Fig. 18: Identifying Heated Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

12. Using the heat torch, apply heat to the crimped area of the barrel.
13. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

High Temperature Wiring Repairs

Use the following procedures to perform high temperature wiring repairs:

1. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
2. Using the heat torch, apply heat to the high temperature heat shrink tubing.

3. Gradually move the heat from the center to the open end of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.
4. Replace any reflective tape and clips that may have been removed during the repair.

SPLICING TWISTED OR SHIELDED CABLE

Twisted/shielded cable is used in order to protect wiring from electrical noise. Two-conductor cable of this construction is used between the radio and the Delco-Bose® speaker/amplifier units and other applications where low level, sensitive signals must be carried. Follow the instructions below in order to repair the twisted/shielded cable.

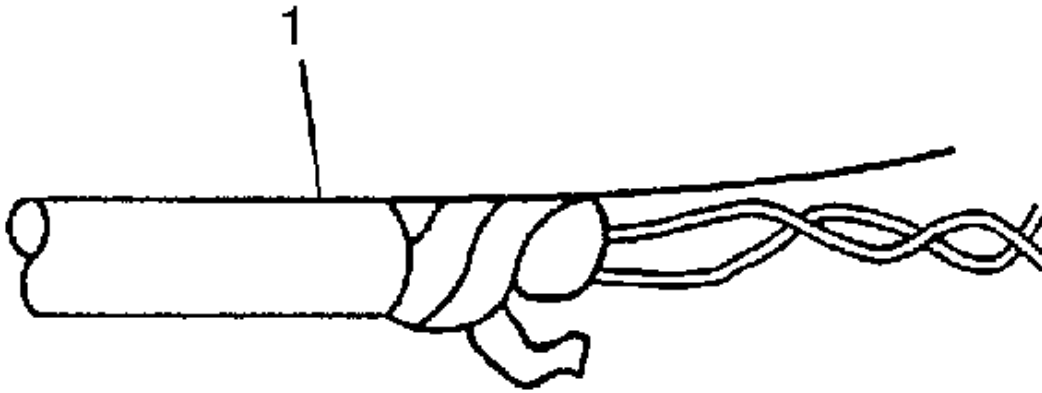


Fig. 19: View Of Outer Wiring Jacket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the outer jacket (1). Use care not to cut into the drain wire of the mylar tape.
2. Unwrap the tape. Do not remove the tape. Use the tape in order to rewrap the twisted conductors after the splice is made.



Fig. 20: Preparing The Splice

Courtesy of GENERAL MOTORS COMPANY

3. Prepare the splice. Untwist the conductors and follow the instructions for **Splicing Copper Wire Using Splice Sleeves**. Staggering the splices by 65 mm (2.5 in) is recommended.

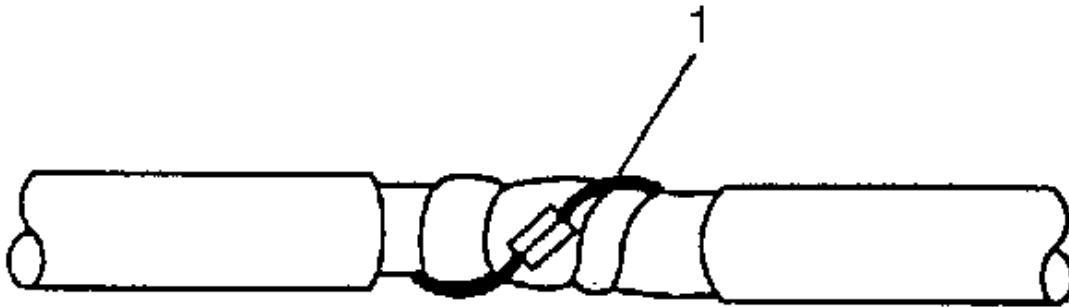


Fig. 21: Identifying Diode On Wire
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Apply the mylar tape with the aluminum side inward. This ensures good electrical contact with the drain wire.**

4. Re-assemble the cable.
 - Rewrap the conductors with the mylar tape. If the mylar tape is damaged, use 3M product AL-36FR to replace the damaged mylar tape.
 - Use caution not to wrap the drain wire in the tape (1).
 - Follow the splicing instructions for copper wire and splice the drain wire.
 - Wrap the drain wire around the conductors and tape with electrical tape to replace the outer insulation.



Fig. 22: View Of Repaired Wire Covered With Electrical Tape
Courtesy of GENERAL MOTORS COMPANY

5. Tape over the entire cable. Use a winding motion when you apply the tape.

SPLICING INLINE HARNESS DIODES

Many vehicle electrical systems use a diode to isolate circuits and protect the components from voltage spikes. When installing a new diode use the following procedure.

1. Open the harness.
 - If the harness is taped, remove the tape.
 - To avoid wiring insulation damage, use a sewing seam ripper (available from sewing supply stores) in order to cut open the harness.
 - If the harness has a black plastic conduit, pull out the diode.

2. If the diode is taped to the harness, remove all of the tape.
3. Check and record the current flow direction and orientation of diode.
4. Remove the inoperative diode from the harness with a suitable soldering tool.

NOTE: **If the diode is located next to a connector terminal remove the terminal(s) from the connector to prevent damage from the soldering tool.**

5. Carefully strip away a section of insulation next to the old soldered portion of the wire(s). Do not remove any more than is needed to attach the new diode.
6. Check current flow direction of the new diode, being sure to install the diode with correct bias. Reference the appropriate service manual wiring schematic to obtain the correct diode installation position.
7. Attach the new diode to the wire(s) using 60/40 rosin core solder. Before soldering attach some heat sinks (aluminum alligator clips) across the diode wire ends to protect the diode from excessive heat. Follow the manufacturer's instruction for the soldering equipment.
8. Reinstall terminal(s) into the connector body if previously removed.

NOTE: **To prevent shorts to ground and water intrusion, completely cover all exposed wire and diode attachment points with tape.**

9. Tape the diode to the harness or connector using electrical tape.

SIR/SRS WIRING REPAIRS

NOTE: **Refer to SIR Service Precautions .**

For **European** regions - If the SIR/SRS wiring, connector, or terminal is damaged, the affected wiring harness must be replaced. Do not attempt to repair the wiring, connector, or terminals. Any attempt to repair the wires, connectors, or terminals could result in performance problems of the SIR/SRS System. Operations on restraint systems must only be performed by trained and qualified personnel.

Special Tools

EL-38125-10 Splice Sleeve Crimping Tool

For equivalent regional tools, refer to **Special Tools** .

The Supplemental Inflatable Restraint (SIR) System/Supplemental Restraint System (SRS) requires special wiring repair procedures due to the sensitive nature of the circuitry. Follow the specific procedures and instructions when working with the SIR/SRS, and the wiring components, such as connectors and terminals.

SIR/SRS Connector Repair (Plastic Body and Terminal Metal Pin)

NOTE: **Do not use the terminals in the kit in order to replace damaged SIR/SRS system terminals. Use either an SIR/SRS pigtail or a terminated lead from the SIR Repair Kit Tray.**

The terminals in the SIR/SRS system are made with a special plating. This plating provides the necessary contact integrity for the sensitive, low energy circuits.

Pigtail repair packs are available for SIR/SRS connectors with eight or less terminals. Only the connector body is available for connectors with more than eight terminals. Terminated leads can be used to replace damaged terminals when replacing the connector body.

SIR/SRS Component Wire Pigtail Repair

NOTE: **Do not make wire, connector, or terminal repairs on components with wire pigtails.**

A wire pigtail is a wire or wires attached directly to the device, not by a connector. If a wiring pigtail is damaged, you must replace the entire component, with pigtail. The inflatable restraint steering wheel module coil is an example of a pigtail component.

SIR/SRS Wire Repair

CAUTION: Do not install more than 2 DuraSeal splice sleeves per SIR deployment loop. A deployment loop consists of both wires from the K36 Inflatable Restraint Sensing and Diagnostic Module to the deployable component. If more than 2 DuraSeal splice sleeves are required for any SIR deployment loop, the complete circuit of the loop must be replaced. More than 2 DuraSeal splice sleeves per deployment loop may increase the resistance in the circuit causing a DTC to be set.

NOTE: **Refer to Wiring Repairs in the service information connector end views or the vehicle schematics in order to determine the correct wire size for the circuit you are repairing. You must obtain this information in order to ensure circuit integrity.**

If any wire except the pigtail is damaged, repair the wire by splicing in a new section of wire of the same gauge size (0.5 mm, 0.8 mm, 1.0 mm etc.). Use the DuraSeal splice sleeves and **EL-38125-10** splice sleeve crimping tool. For wiring repair, refer to **Splicing Copper Wire Using Splice Sleeves**.

For connector position assurance (CPA), refer to **Connector Position Assurance Locks**.

For terminal position assurance (TPA), refer to **Terminal Position Assurance Locks**.

CONNECTOR REPAIRS

Connector Repairs contains a list of all connector repairs. The connector repairs are listed by the connector manufacturer and then by connector type. If the technician cannot identify the manufacturer of the connector, refer to Identifying Connectors below. Knowing the connector manufacturer will assist in finding the correct connector repair from the following list:

- **Connector Position Assurance Locks**

- Terminal Position Assurance Locks
- AFL/EPC Connectors
- Bosch Connectors (BSK), Bosch Connectors (0.64), Bosch Connectors (2.8 JPT), Bosch Connectors (ECM)
- Delphi Connectors (Weather Pack), Delphi Connectors (Pull To Seat), Delphi Connectors (Push To Seat), Delphi Connectors (12-Way), Delphi Connectors (Micro .64), Delphi Connectors (Steering Gear), Delphi Connectors (Micro-Pack 100W)
- FCI Connectors (Lever Lock), FCI Connectors (SIR)
- FEP Connectors (Steering Gear)
- JST Connectors
- Kostal Connectors (Glow Plug Control Module), Kostal Connectors (Transmission)
- Molex Connectors
- Sumitomo Connectors
- Tyco/AMP Connectors (Sensor), Tyco/AMP Connectors (SIR), Tyco/AMP Connectors (Door Module), Tyco/AMP Connectors (102-Way Inline), Tyco/AMP Connectors (0.25 Cap), Tyco/AMP Connectors (Seat), Tyco/AMP Connectors (CM 42-Way), Tyco/AMP Connectors (43-Way)
- Yazaki Connectors (2-Way), Yazaki Connectors (16-Way)
- Repairing Connector Terminals (Terminated Lead Repair), Repairing Connector Terminals (Terminal Repair)

Connector Anatomy

Fig. 23: Connector Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Connector Positive Assurance (CPA)
2	Assist Lever
3	Wiredress Cover
4	Seal Strain/Relief
5	Slide Left Hand
6	Slide Right Hand
7	Terminal Positive Assurance (TPA)
8	Terminal Positive Assurance (TPA)
9	Connector Seal
10	Connector Housing
11	Inner Connector

Identifying Connectors

Knowing the connector manufacturer is helpful when trying to locating the correct connector repair procedure. There are many different connector designs used on GM vehicles and it is sometimes difficult to identify the connector manufacturer. The information in this document should help with the identification of connector manufactures.

The following connector manufacturers make most of the connectors found in GM vehicles:

- AFL/EPC (Alcoa Fujikura Ltd./Engineered Plastics Components)
- Bosch
- Delphi
- FCI (Framatome Connectors International)
- JAE (Japan Aviation Electronics)
- JST (Japan Solderless Terminals)
- Kostal
- Molex
- Sumitomo
- Tyco/AMP
- Yazaki

Identifying the manufacturer of a connector is often difficult. When trying to determine the manufacturer of a connector, look for specific identifying marks that are unique to that connector supplier. Most of these identify marks are hard to find or see. Check the connector carefully and refer to the information below for pictures and descriptions of connector identification markings.

Fig. 24: View Of EPC Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- Most of AFL's connectors have EPC on their connector body. Some of the smaller connectors will not have any markings on them.

Fig. 25: View Of Bosch Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- In some cases Bosch will actually be printed on the connector. If Bosch does not appear on the connector, look for the Bosch logo. The Bosch logo is a circle with a blunted arrow inside. This logo can appear anywhere on the connector and is often very small.

Fig. 26: View Of PED Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- In some cases Delphi will actually be printed on the connector. If Delphi is not printed on the connector, look for PED. In both cases there is no specific orientation for Delphi or PED and they can appear anywhere on the connector.

Fig. 27: View Of FCI Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- FCI connectors may have the FCI logo on their connectors. The logo is the letters FCI with an "A" above it.

Fig. 28: View Of JAF Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- JAE connector have JAE in small letters on their connectors.

Fig. 29: View Of JST Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- JST connectors have JST in small letters on their connectors, similar to that above. The location of the logo will vary with the connector size and style.

Fig. 30: View Of Kostel Connector Identifier
Courtesy of GENERAL MOTORS COMPANY

- Kostel has an "LK" with a circle around it. These connector are usually used as a transmissions connection.

Fig. 31: View Of Molex Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

Fig. 32: View Of Sumitono Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- Most Molex connectors will have the Molex logo on the dresscover of the connector. In some cases the connectors may have MX followed by another letter. The third letter indicates where the connector was made. A connector with MXD is a Molex connector made in Detroit.

Sumitomo has a unique symbol on their connector and possibly a part number. The symbol is similar to that of a diamond lying on its side, similar to that shown. The logo could appear anywhere but the most common place is at the wire side of the housing.

- Tyco/AMP has many different and unique connector designs. Some may or may not have identifiable marks on them.

Fig. 33: View Of Yazaki Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- Yazaki has a wedge or arrow shape, similar to that shown.

CONNECTOR POSITION ASSURANCE LOCKS

The connector position assurance (CPA) is a small plastic insert that fits through the locking tabs of the connector. CPAs are used in various connectors throughout the vehicle. CPAs are also used in all SIR system electrical connectors. The CPA ensures that the connector halves cannot vibrate apart. You must have the CPA in place in order to ensure good contact between the mating terminals of the connector.

TERMINAL POSITION ASSURANCE LOCKS

The terminal position assurance (TPA) insert resembles the plastic combs used in the control module connectors. The TPA keeps the terminal securely seated in the connector body. Do not remove the TPA from the connector body unless you remove a terminal for replacement. If the TPA is removed, be sure to reinstall it before reconnecting the connector.

AFL/EPC CONNECTORS

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool
- **J-38125-216** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from the connector.

Fig. 34: View Of Bolt On Connector Cover
Courtesy of GENERAL MOTORS COMPANY

Fig. 35: Identifying Connector Position Assurance (CPA)
Courtesy of GENERAL MOTORS COMPANY

1. For connectors with a bolt in the dress cover, turn the bolt counterclockwise to remove the connector from the component.
2. Locate the connector position assurance (CPA) on the top of the wire dress cover. Slide the CPA forward.

Fig. 36: Identifying Lever Lock & Lever Lock Release Tab
Courtesy of GENERAL MOTORS COMPANY

3. Slide the lever lock forward while pressing down on the lever lock release tab.

Fig. 37: View Showing Depressing Lever Lock Release Tab
Courtesy of GENERAL MOTORS COMPANY

4. View showing depressing of the lever lock release tab.

Fig. 38: View of connector in released position
Courtesy of GENERAL MOTORS COMPANY

5. View of connector in released position.
6. Disconnect the connector from the component.
7. Locate the dress cover locking tabs at the corners of the dress cover. Use a small flat-blade tool to release the locking tabs and remove the dress cover.

Fig. 39: View Of Connector In Released Position
Courtesy of GENERAL MOTORS COMPANY

8. Release the rear lower half of the wiredress cover.

Fig. 40: Identifying Tabs Holding Wiredress Cover
Courtesy of GENERAL MOTORS COMPANY

9. Release the tabs that are holding the wiredress cover to the connector body.
10. Remove the nose piece by inserting a small flat-blade tool into the slots on both ends of the connector body. Gently pry the nose piece out of the connector. J-38125-216 can also be used to remove the nose piece.

Fig. 41: Identifying Special Tool - J 38125-12A
Courtesy of GENERAL MOTORS COMPANY

11. Use the J-38125-12A tool to release the terminals by lifting the terminal retaining tabs on the inside of the connector.

Fig. 42: Identifying J 38125-12A Removal Tool
Courtesy of GENERAL MOTORS COMPANY

12. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
13. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
14. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

BOSCH CONNECTORS (BSK)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-561** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Disconnect the connector from the component.
2. Remove the wire dress cover, if necessary.
3. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

Fig. 43: View Of Bosch Connector Terminals (BSK)
Courtesy of GENERAL MOTORS COMPANY

4. Insert the J-38125-561 tool into the 2 cavities on each side of the terminal at the front of the connector and push until you feel the tool disengage the terminal retainers.
5. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and

reconnect the connector bodies.

BOSCH CONNECTORS (0.64)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-560** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Locate the lever lock on the wire dress cover. While pressing the lock, pull the lever over and past the lock until the lever is at the end of its travel.
2. Disconnect the connector from the component.
3. Pull the rubber boot that covers the wires back to expose the end of the connector dress cover.
4. Place the connector locking lever in the center of the connector.

Fig. 44: View Of Flat-Bladed Tool Being Inserted Between Cover & Connector Body
Courtesy of GENERAL MOTORS COMPANY

5. Locate the 2 dress cover locking tabs that are on the wire end of the connector. Insert a small flat-bladed tool between the cover and connector body and pry up.

Fig. 45: View Of Flat-Bladed Tool Between Cover & Connector End
Courtesy of GENERAL MOTORS COMPANY

6. Locate the 2 dress cover locking tabs located on the opposite side of the connector. Insert a small flat-bladed tool between the cover at the connector end and pry up.
7. Remove the dress cover.
8. Cut the tie wrap on the wire bundle.

Fig. 46: View Of Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

9. Remove the terminal position assurance (TPA) by inserting a small flat-bladed tool into the small slot in the end of the slider and pushing on the TPA until it comes out of the connector. When the TPA exits the opposite side of the connector, grasp the TPA and pull it completely out of the connector.
10. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

Fig. 47: View Of J 38125-560 Being Inserted Into Triangular Cavities
Courtesy of GENERAL MOTORS COMPANY

11. Insert the J-38125-560 into the 2 triangular cavities on each side of the terminal at the front of the connector.
12. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
13. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair), Repairing Connector Terminals (Terminal Repair)** procedure.
14. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

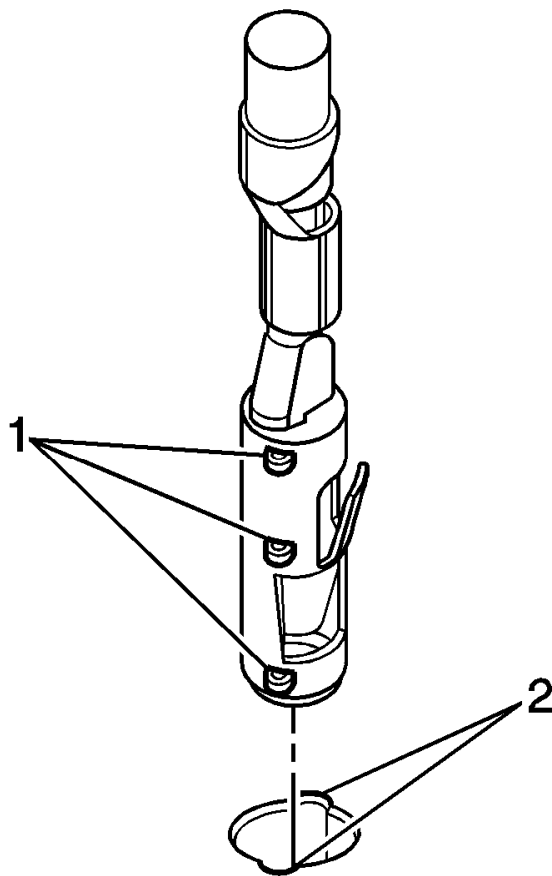


Fig. 48: Aligning Coding Lugs With Connector Coding Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Prior to installation the terminal must be aligned so the (1) coding lugs align with the (2) coding grooves on the connector.
2. Once the terminal is aligned, slide the terminal into the cavity until the retainer has engaged in the cavity of the connector.
3. Slide the TPA in the connector body and seat it using a small flat bladed tool. The TPA is seated when it is flush with the contact housing.
4. Secure the wires to the connector body using a tie wrap and replace the dress cover and grommet.

BOSCH CONNECTORS (2.8 JPT)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-557** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Pull out the slider on the connector position assurance (CPA) until it is at the end of its travel.
2. Disconnect the connector from the component.
3. Remove the wire dress cover, if necessary.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

Fig. 49: View Of Bosch Connector Terminals (2.8 JPT)
Courtesy of GENERAL MOTORS COMPANY

5. Insert the J-38125-557 into the 2 cavities on each side of the terminal at the front of the connector and push until you feel the tool disengage the terminal retainers.
6. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
7. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.

8. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

BOSCH CONNECTORS (ECM)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-213** Terminal Release Tool
- **J-38125-556** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Locate the assist lever on the top of the connector. Move the assist lever to the forward position.

Fig. 51: Identifying Assist Lever In Forward Position
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the connector from the component.

Fig. 52: View Of Releasing Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Locate the dress cover locking tabs at the corners of the connector. Use a small flat-blade tool to release the locking tabs and remove the dress cover.

Fig. 53: View Of Terminal Positive Assurance (TPA) Connector
Courtesy of GENERAL MOTORS COMPANY

4. The terminal positive assurance (TPA) is located in the front of the connector.

Fig. 54: View Of Removing TPA From Connector
Courtesy of GENERAL MOTORS COMPANY

5. Use a small flat-blade tool to remove TPA from the connector.

Fig. 55: View Of Special Tools And Terminals
Courtesy of GENERAL MOTORS COMPANY

6. Use the J-38125-213 or the J-38125-556 tool to release the terminals by inserting the tool into the terminal release cavity.
7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair), Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

NOTE: **Ensure that the dress cover and connector body are both in the released position before reassembling. Failure to do so may cause damage to the connector and component.**

10. Reconnect the connector bodies.

DELPHI CONNECTORS (WEATHER PACK)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-10A** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

The following is the proper procedure for the repair of Weather Pack® Connectors.

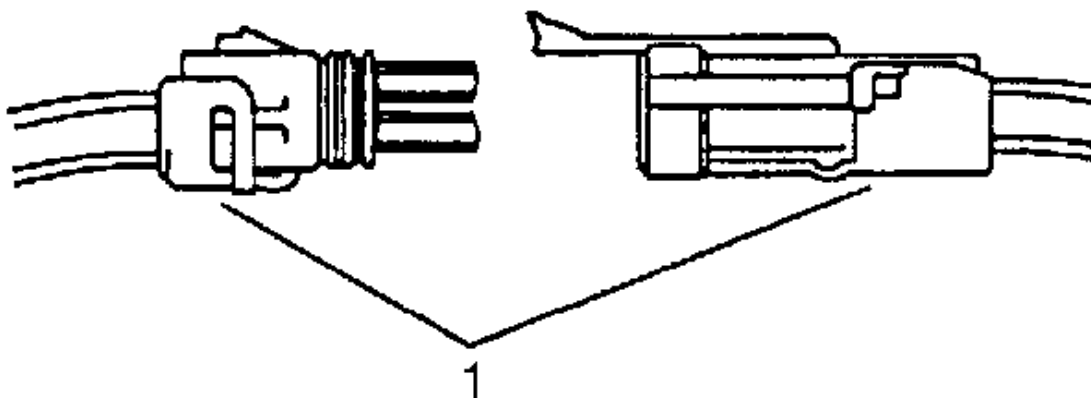


Fig. 56: View Of Connector Halves

Courtesy of GENERAL MOTORS COMPANY

1. Separate the connector halves (1).
2. Open the secondary lock. A secondary lock aids in terminal retention and is usually molded to the connector (1).
3. Grasp the wire and push the terminal to the forward most position. Hold the wire in this position.

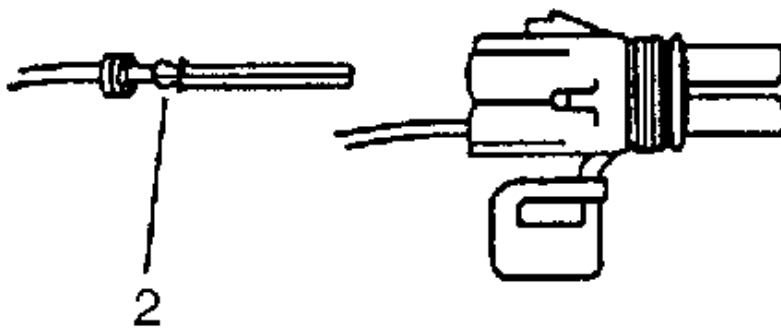
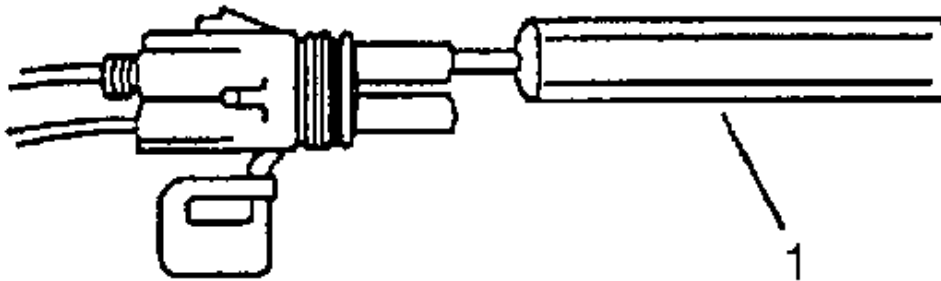


Fig. 57: Identifying Removal Tool & Terminal
Courtesy of GENERAL MOTORS COMPANY

4. Insert the Weather Pack® terminal removal tool J-38125-10A into the front (mating end) of the connector cavity until it rests on the cavity shoulder (1).
5. Gently pull on the wire to remove the terminal through the back of the connector (2).

NOTE: **Never use force to remove a terminal from a connector.**

6. Inspect the terminal and connector for damage. Repair as necessary. Refer to **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)**.
7. Reform the lock tang (2) and reset terminal in connector body.
8. Close secondary locks and join connector halves.
9. Verify that circuit is complete and working satisfactorily.
10. Perform system check.
11. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
12. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

DELPHI CONNECTORS (PUSH TO SEAT)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Follow the steps below in order to repair push to seat connectors.

1. Remove the terminal position assurance (TPA) device, the connector position assurance (CPA) device, and/or the secondary lock.

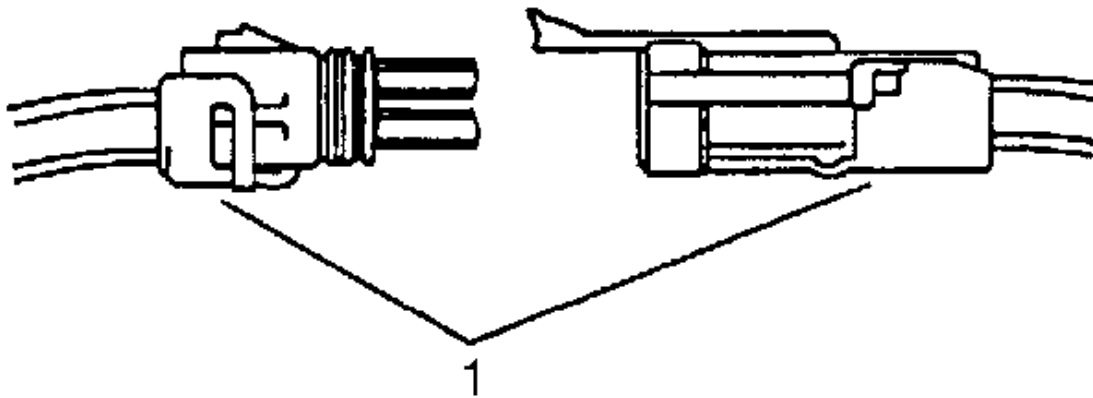


Fig. 58: View Of Connector Halves
Courtesy of GENERAL MOTORS COMPANY

2. Separate the connector halves (1).

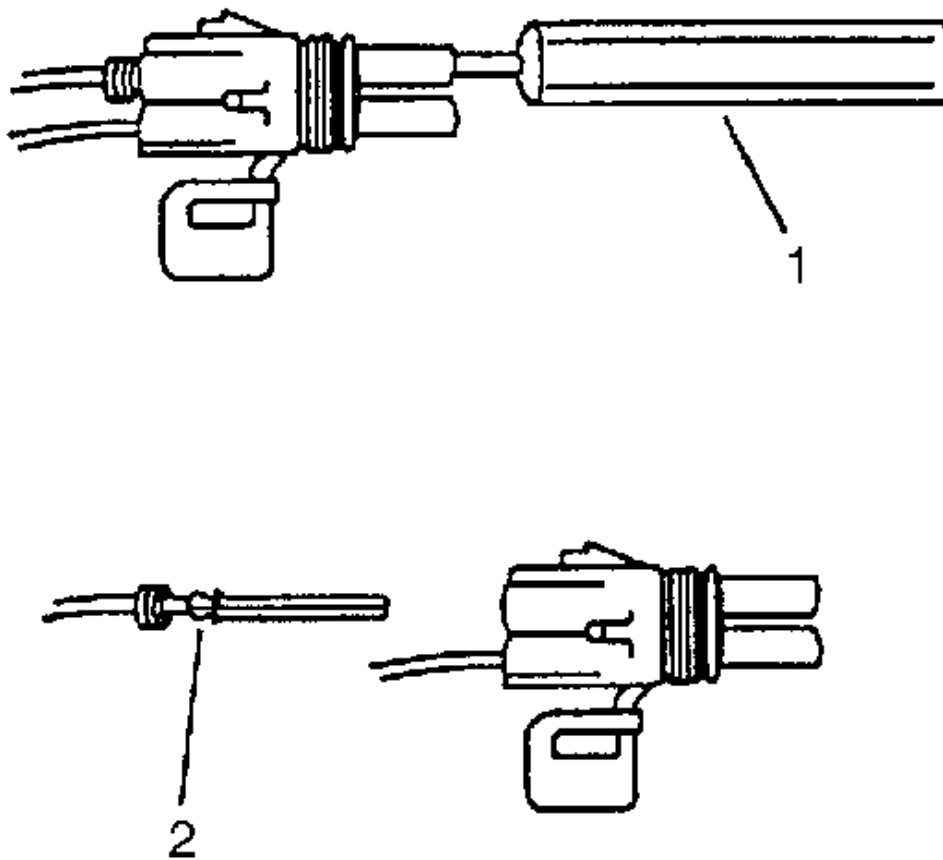


Fig. 59: Identifying Removal Tool & Terminal
Courtesy of GENERAL MOTORS COMPANY

3. Use the proper pick or removal tool (1) in order to release the terminal.
4. Gently pull the cable and the terminal (2) out of the back of the connector.

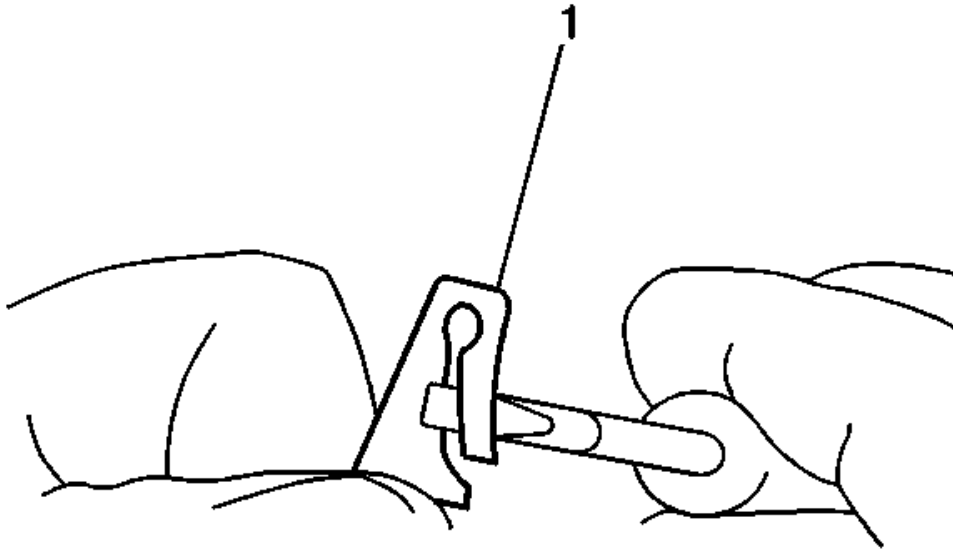


Fig. 60: Identifying Locking Device
Courtesy of GENERAL MOTORS COMPANY

5. Re-form the locking device if you are going to reuse the terminal (1).
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

1. In order to reuse a terminal or lead assembly, refer to **Wiring Repairs**.
2. Ensure that the cable seal is kept on the terminal side of the splice.
3. Insert the lead from the back until it catches.
4. Install the TPA, CPA, and/or the secondary locks.

DELPHI CONNECTORS (PULL TO SEAT)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

If the terminal is visibly damaged or is suspected of having a faulty connection, the terminal should be replaced.

Fig. 61: Aligning Removal Tool - Delphi (Pull To Seat) **Courtesy of GENERAL MOTORS COMPANY**

Follow the steps below in order to repair pull-to-seat connectors:

1. Remove the connector position assurance (CPA) device and/or the secondary lock.
2. Disconnect the connector from the component or separate the connectors for in-line connectors.

3. Remove the terminal position assurance (TPA) device.
4. Review the connector end view to determine the proper test probe and release tool.
5. Insert the release tool into the front of the connector body.
6. Grasp the wire at the back of the connector body and gently push the terminal out the front of the connector body.
7. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
8. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

1. Align the terminal and pull the wire from the back of the connector in order to seat the terminal.
2. If the connector is outside of the passenger compartment, apply dielectric grease to the connector.
3. Install the TPA, CPA, and/or the secondary locks.

DELPHI CONNECTORS (MICRO-PACK 100W)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

There are 2 styles of Micro-Pack 100W connectors. These connectors are very similar but use different terminals and have some minor physical differences also.

Fig. 62: Identifying Micro-Pack 100W First & Second Connector Designs
Courtesy of GENERAL MOTORS COMPANY

The first connector design of the Micro-Pack 100W (1) has a white connector interface that holds the terminals. The second design of the Micro-Pack 100W (2) has a gray interface to hold the terminals. Also, the first design has terminal cavities that are further apart (3 mm centerline) and offset from the other row of terminal cavities in the connector. The second design has terminal cavities that are closer together (2.54 mm centerline) and aligned vertically. One other way to identify the second design is the thin strip of material that runs along the outside of the cavities.

Fig. 63: Identifying Micro-Pack 100W Short & Long Terminals
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are 2 styles of Micro-Pack 100W terminals which are very similar. Ensure that you have the correct terminal before crimping the new terminal to the wire. The first design connector uses the longer terminal (1) that has a raised area in front of the recess in the terminal. The second design connector uses the shorter terminal without the raised area.

Follow the steps below in order to remove terminals from Micro-Pack 100W connectors. Some Micro-Pack 100W connector disassembly procedures will vary. Use this procedure as a guide.

1. Disconnect the connector from the component.

Fig. 64: Locating Nose Piece Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

2. Locate the nose piece locking tabs that are positioned on the side of the connector nose piece. The connector nose piece acts as a terminal positive assurance (TPA) and may be referred to as such.

Fig. 65: Loosening Nose Piece Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Use a small flat-blade tool to push in one of the locking tabs while gently pulling on the same side of the nose piece.
4. Repeat the procedure for the other locking tab and remove the nose piece.
5. Remove the wire dress cover. The following is a general procedure for wire dress cover removal. Use this procedure as a guide, some dress cover removal procedures may vary.

Fig. 66: Squeezing Cover Locking Legs
Courtesy of GENERAL MOTORS COMPANY

6. Use fingers to squeeze the 2 locking legs of the cover.

Fig. 67: Unseating Locking Leg

Courtesy of GENERAL MOTORS COMPANY

7. Apply pressure and gently rock the cover until one locking leg is unseated.

Fig. 68: Removing Cover

Courtesy of GENERAL MOTORS COMPANY

8. Continue to apply pressure and rock the cover until the second locking leg is unseated. Repeat procedure for the other side of the dress cover and remove the cover.

Fig. 69: Identifying Terminal Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

9. Use J-38125-12A to gently lift the terminal retaining tab while gently pulling the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
10. If the terminal is severely bent or damaged, it may be possible on some connectors to push the wire out of the front of the connector instead of pulling it through. This will prevent damage to the internal seals of the connector. Once the terminal is pushed out of the connector, cut the wire as close to the terminal as possible and pull the wire through the connector.
11. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
12. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

After the terminal is crimped to the wire perform the following procedure in order to replace Micro-Pack 100 terminals.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the Terminal Removal Procedure.

DELPHI CONNECTORS (MICRO .64)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-21** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from Micro .64 connectors.

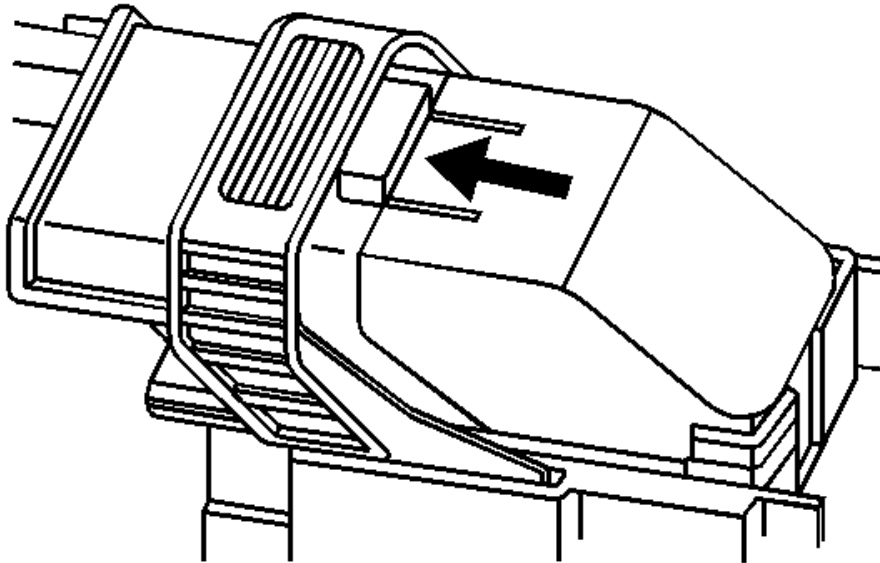


Fig. 70: Identifying Wire Dress Cover Lever Lock
Courtesy of GENERAL MOTORS COMPANY

Fig. 71: View Of Typical Micro 64 Connector
Courtesy of GENERAL MOTORS COMPANY

Fig. 72: Depressing Lock And Pulling Lever
Courtesy of GENERAL MOTORS COMPANY

Fig. 73: View Of Connector When Released From Component
Courtesy of GENERAL MOTORS COMPANY

Fig. 74: View Of Another Type Of Micro 64 Connector
Courtesy of GENERAL MOTORS COMPANY

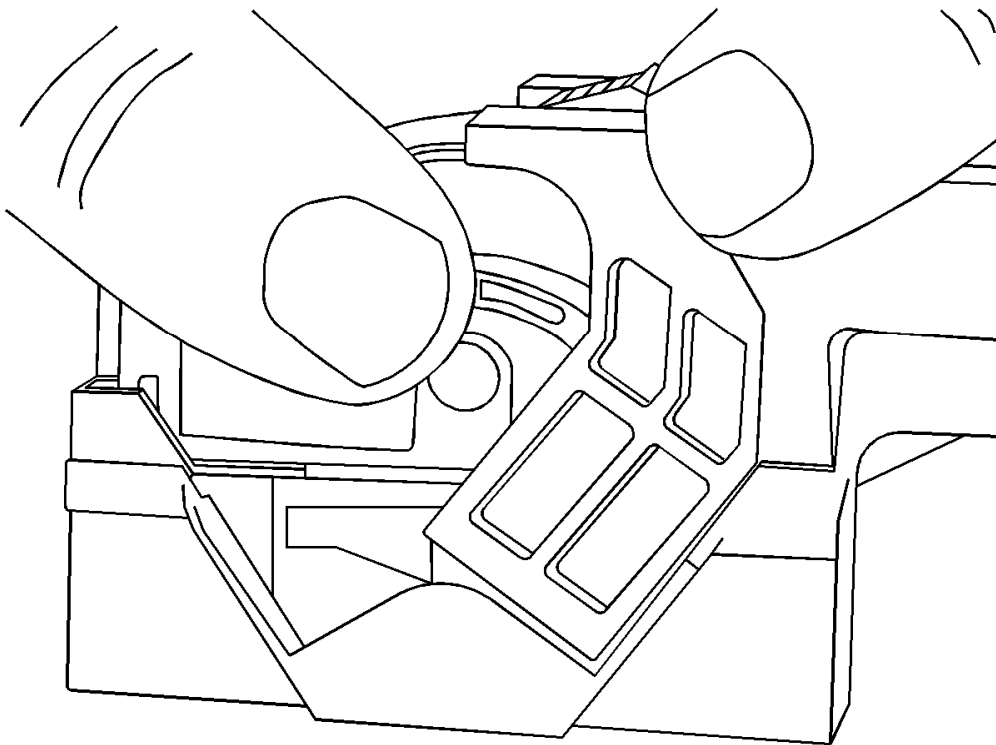


Fig. 75: Locating Locks On Both Sides Of Wiredress Cover
Courtesy of GENERAL MOTORS COMPANY

Fig. 76: View Of Connector When Released From Component
Courtesy of GENERAL MOTORS COMPANY

1. Locate the lever lock on the wire dress cover. While depressing the lock, pull the lever over and past the lock. The lever lock may be located on the top or sides of the wire dress cover.

View of a typical Micro 64 connector.

Depress the lock and pull the lever over and past the lock.

View of the connector when released from the component.

View of another type of Micro 64 connector.

Depress the locks that are located on both sides of the wire dress cover and pull the lever over and past the locks.

View of the connector when released from the component.

2. Disconnect the connector from the component.

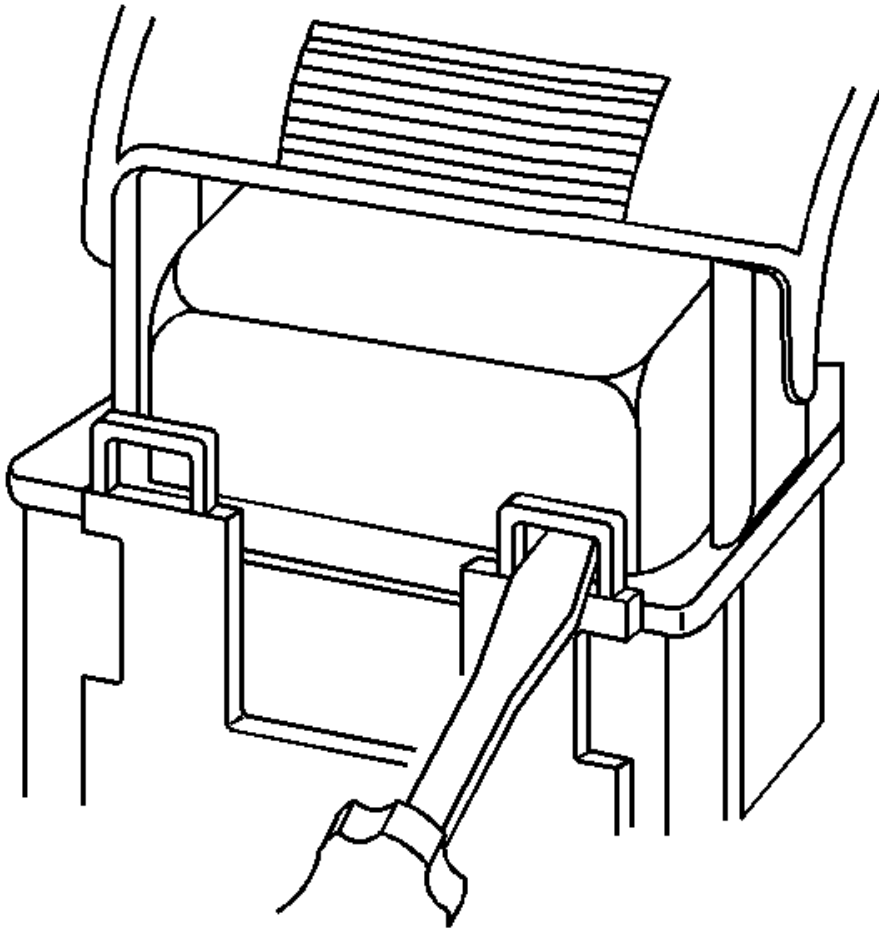


Fig. 77: View Of Releasing Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Locate the dress cover locking tabs at the front of the connector. Using a small flat-blade tool push down on one of the locking tabs and pull the cover up until the dress cover releases. Repeat this procedure for the other locking tab.
4. Once the front 2 locks are unlocked, lift the front of the dress cover and pull it forward.

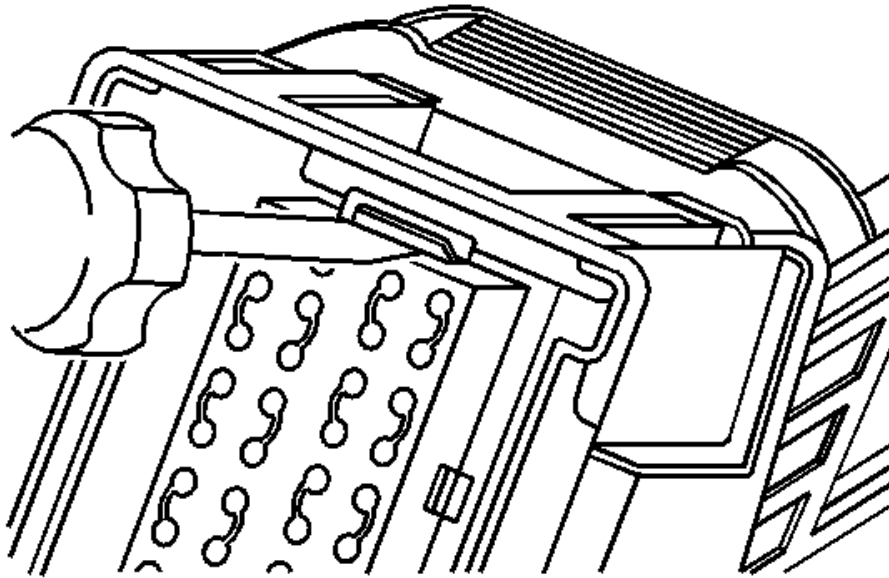


Fig. 78: View Of Removing Terminal Position Assurance
Courtesy of GENERAL MOTORS COMPANY

NOTE: Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.

5. Remove the TPA by inserting a small flat-blade tool into the small slot on the TPA and pushing down until the TPA releases. Gently pry the TPA out of the connector.

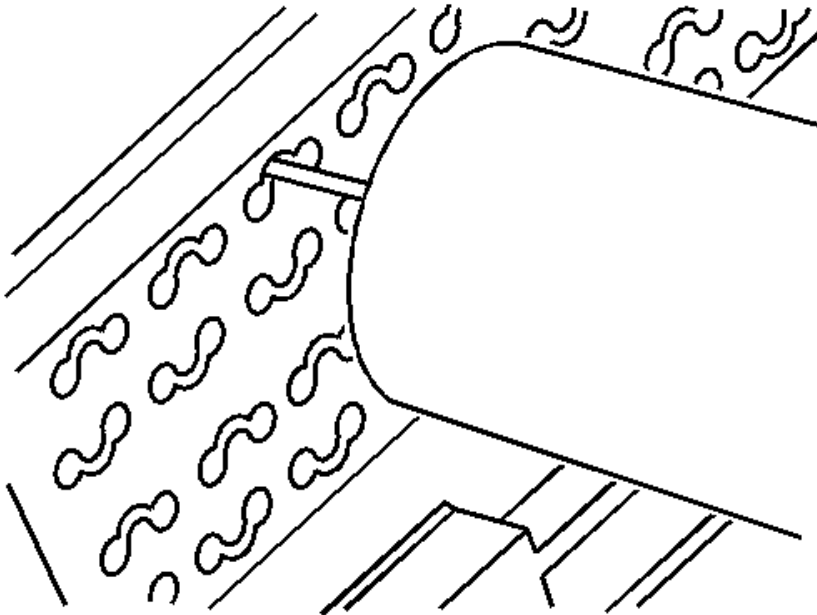


Fig. 79: Identifying Terminal Release Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Be careful not to angle or rock the J-38125-21 tool when inserting it into the connector or the tool may break.

6. Insert the J-38125-21 tool into the round canal between the terminals cavities at the front of the connector.

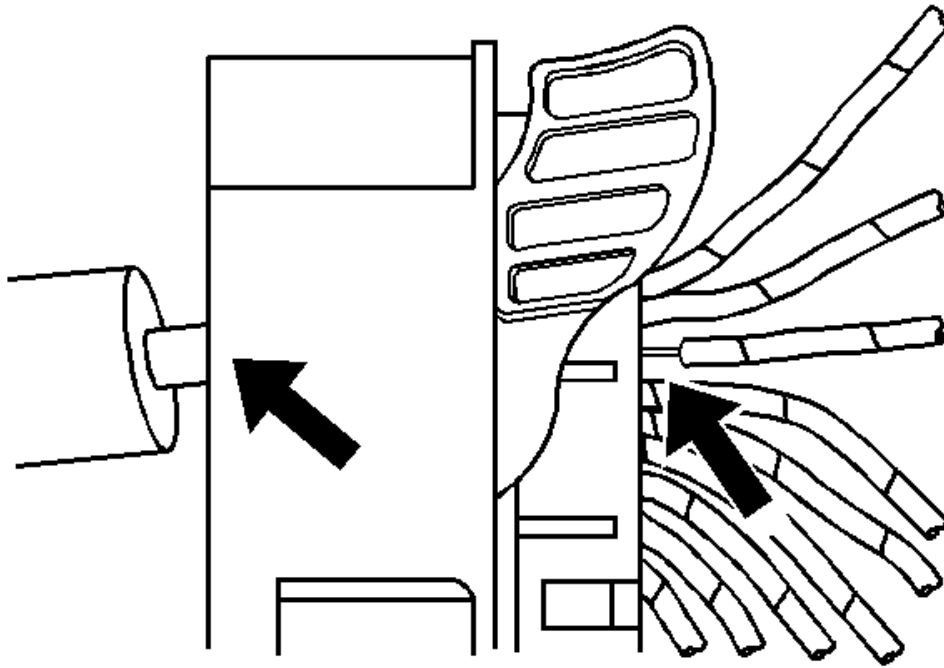


Fig. 80: View Of Removing Wire From Back Of Connector
Courtesy of GENERAL MOTORS COMPANY

7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

DELPHI CONNECTORS (12-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from the connector.

Fig. 81: Identifying Lever Lock

Courtesy of GENERAL MOTORS COMPANY

1. Locate the lever lock on the wire dress cover. Remove the connector position assurance (CPA) and slide the lever lock away from the connector body.
2. Disconnect the connector from the component.

Fig. 82: Identifying Dress Cover Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Locate the dress cover locking tabs on the dress cover of the connector. Using a small flat-blade tool release all of the locking tabs.

Fig. 83: Identifying Lower Wire Dress Cover Locking Tab
Courtesy of GENERAL MOTORS COMPANY

4. Release the lower wire dress cover locking tab.

Fig. 84: Identifying Upper Wire Dress Cover Locking Tab
Courtesy of GENERAL MOTORS COMPANY

5. Release the upper wire dress cover locking tab.
6. Once the locks are unlocked, lift the dress cover off.

Fig. 85: View Of TPA Being Pried Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.**

7. Remove the TPA by inserting a small flat-blade tool into the locking tabs on both sides of the TPA . Gently pry the TPA out of the connector.

Fig. 86: Removing Nose Piece

Courtesy of GENERAL MOTORS COMPANY

8. Remove the nose piece by inserting a small flat-blade tool into the locking tabs on both sides of the nose piece. Gently pry the nose piece out of the connector.

Fig. 87: View Of Installing J 38125-12A Into Terminal Release Cavity
Courtesy of GENERAL MOTORS COMPANY

9. Insert the J-38125-12A tool to release the terminals by inserting the tool into the terminal release cavity.

Fig. 88: Pulling Wire Out Of Back Of Connector
Courtesy of GENERAL MOTORS COMPANY

10. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
11. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
12. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

DELPHI CONNECTORS (STEERING GEAR)

Removal Procedure

Fig. 89: Releasing Locking Tab On Connector
Courtesy of GENERAL MOTORS COMPANY

1. Use a small flat-bladed tool to release the locking tab on the connector.

Fig. 90: Releasing Connector

Courtesy of GENERAL MOTORS COMPANY

2. Push down the locking tab to release the connector. The small flat-bladed tool may need to be pushed down and angled back slightly to depress the locking tab. Pull on the connector body while releasing the locking tab to disconnect the connector.

FCI CONNECTORS (LEVER LOCK)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-556** Terminal Release Tool
- **J-38125-560** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from the connector.

Fig. 91: Identifying Release Tab

Courtesy of GENERAL MOTORS COMPANY

1. Slide the lever lock forward while pressing down on the lever lock release tab.
2. The release tab is located on the top of the wiredress cover.

Fig. 92: View Of Connector In Released Position
Courtesy of GENERAL MOTORS COMPANY

3. View of connector in released position.
4. Disconnect the connector from the component.
5. Locate the dress cover locking tabs at the corners of the dress cover. Use a small flat-blade tool to release the locking tabs and remove the dress cover.

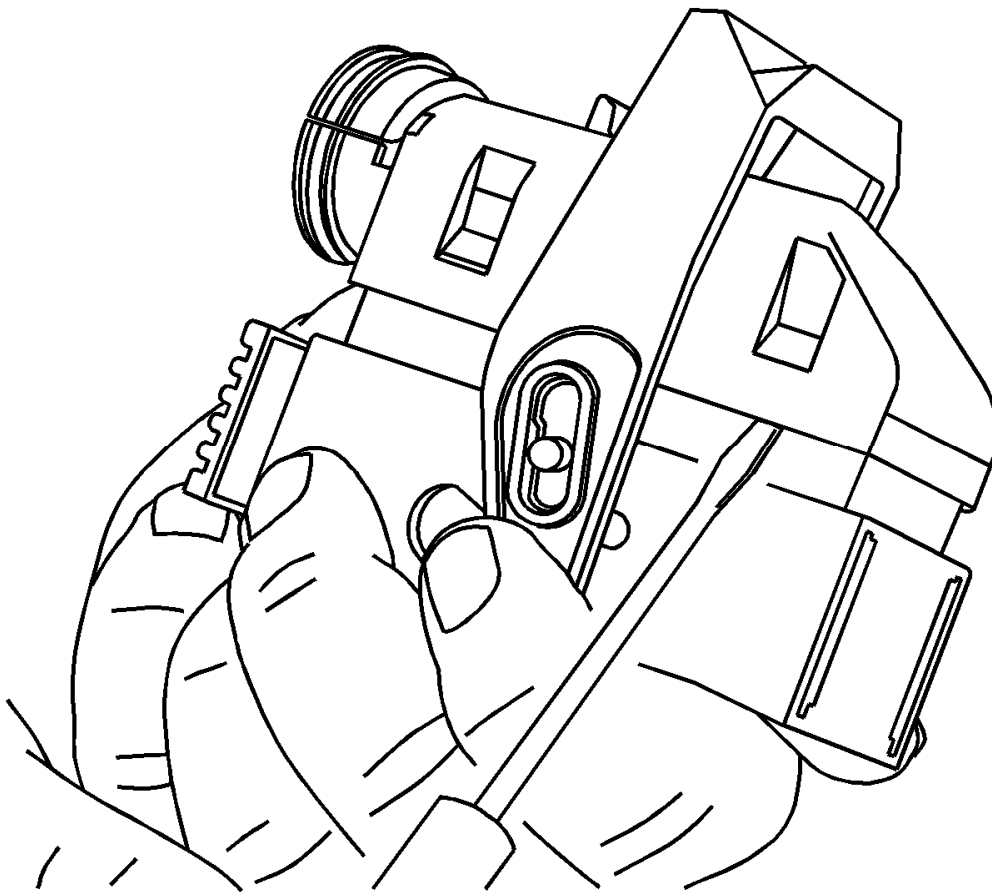


Fig. 93: View Of Sliding Terminal Position Assurance (TPA) Up One Notch
Courtesy of GENERAL MOTORS COMPANY

6. Use a small flat-blade tool to slide the terminal position assurance (TPA) up one notch on both ends of the connector. The TPA is located underneath the wire dress cover.

Fig. 94: View Of Releasing Terminals
Courtesy of GENERAL MOTORS COMPANY

7. For the larger terminals insert the J-38125-556 tool to release the terminals by inserting the tool into the terminal release cavity. For the smaller terminals insert the J-38125-560 tool to release the terminals by inserting the tool into the terminal release cavity.

Fig. 95: View Of Wire Being Pulled Out Of Back Of Connector While Holding Removal Tool In Place

Courtesy of GENERAL MOTORS COMPANY

8. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
9. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
10. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

FCI CONNECTORS (SIR)

Removal Procedure

NOTE: The orange or yellow connector position assurance (CPA) must be released first to disconnect or to connect the connector.

Fig. 96: View Of Lifting Orange CPA
Courtesy of GENERAL MOTORS COMPANY

1. Lift the orange or yellow CPA vertically (avoid lifting on an angle to the connector) approximately 4 mm to release the connector. Use a small flat-bladed tool to help release the CPA. The CPA may also be released manually without any tools.

Fig. 97: Grabbing Connector On Both Sides
Courtesy of GENERAL MOTORS COMPANY

2. Grab the connector on both sides and lift vertically to disconnect the connector.

Installation Procedure

Fig. 98: Orange CPA

Courtesy of GENERAL MOTORS COMPANY

1. The CPA should be approximately 4 mm above the yellow cover before installing the connector. If not, use a small flat-bladed tool to help release the CPA. The CPA may also be released manually without any tools.

Fig. 99: Seating Connector Sub-Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Line up the connector key tabs with the initiator key slots. Grab the connector on both sides and push down into the initiator connector sub assembly until fully seated.

Fig. 100: Pushing CPA Down

Courtesy of GENERAL MOTORS COMPANY

3. After the connector is fully seated, push the CPA down with your thumb until the CPA is touching the yellow cover on the connector.

FEP CONNECTORS (STEERING GEAR)

Removal Procedure

Fig. 101: Releasing Locking Tab On Connector
Courtesy of GENERAL MOTORS COMPANY

1. Use a flat-bladed tool to release the locking tab on the connector.

Fig. 102: Twisting Flat-Bladed Tool To Push Top Of Locking Tab Inward
Courtesy of GENERAL MOTORS COMPANY

2. Option 1: Twist the flat-bladed tool to push the top of the locking tab inward while pulling the connector body out.

Fig. 103: Using Flat-Bladed Tool To Depress Locking Tab
Courtesy of GENERAL MOTORS COMPANY

3. Option 2: Pry using the flat-bladed tool to depress the locking tab while pulling the connector body out.

JST CONNECTORS

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-553** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

The JST connector family consists of seven unique connector housings differentiated by color and keying. This connector family is designed to use both 0.64 and 2.8 sized terminals.

JST BCM Connector

GM Service Part #	Color
88988806	Gray
88988837	Brown
88988838	Lt Green
88988839	Natural
88988840	Lt Blue
88988841	Black
88988842	Pink

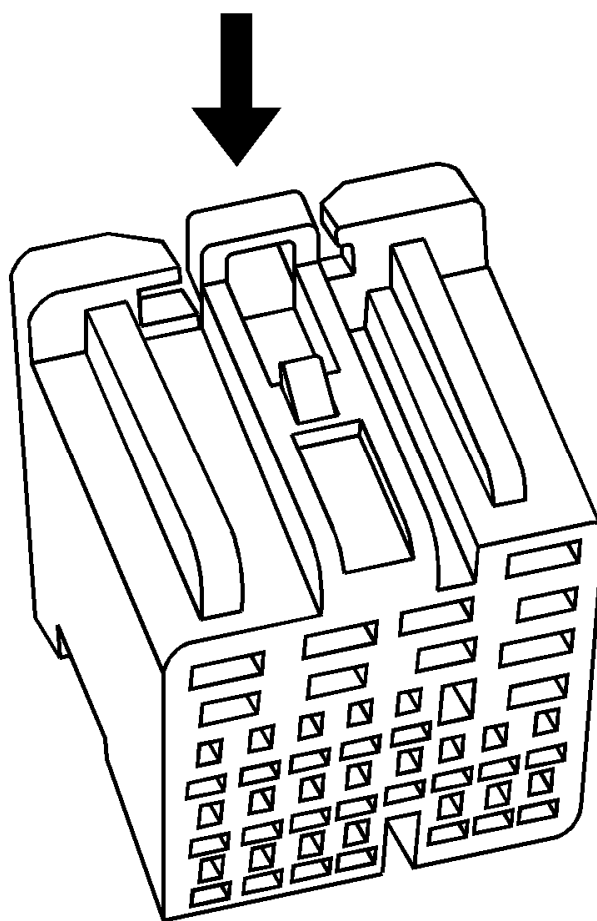


Fig. 104: Identifying Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

1. While depressing the lock, remove the connector from the component.

Fig. 105: Identifying TPA On Both Sides Of Connector
Courtesy of GENERAL MOTORS COMPANY

2. Unlock the terminal position assurance (TPA):
 - Position connector as shown (above) and locate TPA staging cavities.

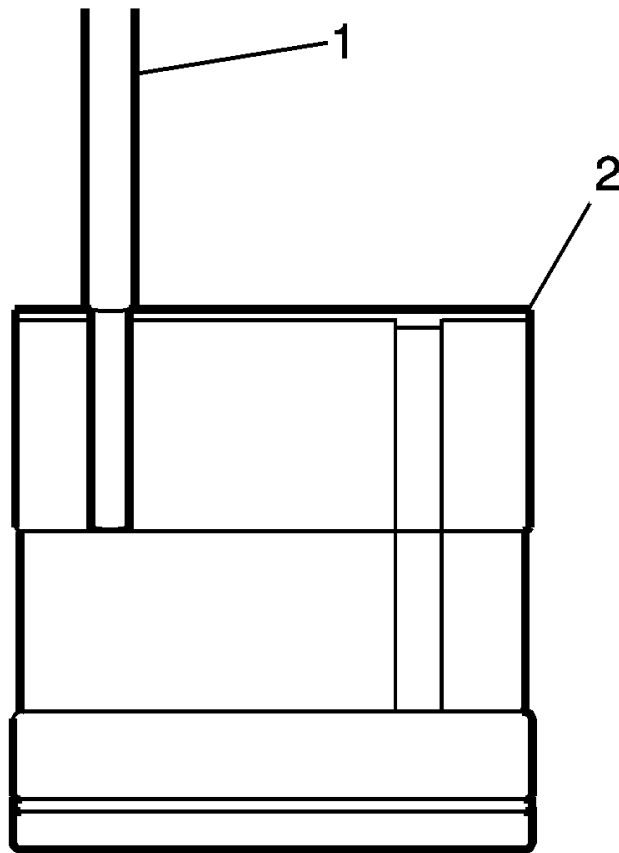


Fig. 106: Terminal Release Tool J-38125-553
Courtesy of GENERAL MOTORS COMPANY

- Using connector terminal release tool J-38125-553 (1) lift the TPA into the staged position. Perform this step on both sides of the TPA.

Fig. 107: TPA In Staged Position
Courtesy of GENERAL MOTORS COMPANY

- You will feel the TPA click into place when fully extended into the staged position. The figure above shows the TPA (1) in the staged position.

Fig. 108: Connector Terminal Release Tool J-38125-553
Courtesy of GENERAL MOTORS COMPANY

3. Release the terminal from the connector:
 - Position the connector as shown (above) and locate the terminal release entry canal (1) of the suspect terminal.
 - Insert the connector terminal release tool J-38125-553 into the entry canal with the angled side of the tool facing the connector wall containing cavity 4 (2).

Fig. 109: Identifying Connector Lance And TPA
Courtesy of GENERAL MOTORS COMPANY

- The cavity on the left (1) is a 2.8 mm² cavity and the cavity on the right (2) is a 0.64 mm² cavity.
 - Place the tip of the connector terminal release tool onto the connector lance (3) and deflect the lance to the right (5) to release the lock. Hold this released position.
 - Holding the lance in the released position, slightly pull on the suspect terminal to remove it from the connector housing. The side TPA (4) is a secondary lock.
4. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
 5. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

KOSTAL CONNECTORS (GLOW PLUG CONTROL MODULE)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit

- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-24** Terminal Release Tool
- **J-38125-560** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Fig. 110: View Of Typical Kostal Connector
Courtesy of GENERAL MOTORS COMPANY

View of typical connector.

Fig. 111: View Of Connector In Released Position
Courtesy of GENERAL MOTORS COMPANY

View of connector in released position.

1. Locate the assist lever at the back of the connector. Move the assist lever to the rear position.
2. Disconnect the connector from the component.

Fig. 112: Using Small Flat-Blade Tool To Remove Dress Cover
Courtesy of GENERAL MOTORS COMPANY

3. Use a small flat-blade tool to remove the dress cover.

Fig. 113: Sliding Dress Cover Forward & Off Of Kostal Connector (Glow Plug Control Module)
Courtesy of GENERAL MOTORS COMPANY

4. Slide the dress cover forward and off of the connector.

Fig. 114: Locating TPA In Front & Rear Of Connector
Courtesy of GENERAL MOTORS COMPANY

5. The terminal positive assurance (TPA) is located in the front and rear of the connector.

NOTE: **The front TPA cannot be removed from the connector. Only move it to the preset position.**

6. Use a small flat-blade tool to move the front TPA to the preset position, outboard approximately 0.125 in. (3 mm).

Fig. 115: Using Small Flat-Blade Tool To Remove Rear TPA
Courtesy of GENERAL MOTORS COMPANY

7. Use a small flat-blade tool to completely remove the rear TPA from the connector.

Fig. 116: Releasing Terminals

Courtesy of GENERAL MOTORS COMPANY

8. Use the J-38125-24 or the J-38125-560 tool to release the terminals by inserting the tool into the terminal release cavity.
9. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
10. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.

KOSTAL CONNECTORS (TRANSMISSION)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-28** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Fig. 117: View Of Connector & Lock
Courtesy of GENERAL MOTORS COMPANY

1. While depressing the lock, twist and remove the connector from the component.

Fig. 118: View Of Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

2. Locate the terminal position assurance (TPA).

Fig. 119: View Of TPA & Flat-Bladed Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The TPA cannot be removed from the connector while there are terminals present in the connector body.**

3. Use a small flat-blade tool to push the TPA until it bottoms out.

Fig. 120: Releasing Terminals

Courtesy of GENERAL MOTORS COMPANY

4. Use the J-38125-28 tool to release the terminals by inserting the tool into the terminal cavity as shown in the graphic.
5. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.

Terminal Insertion Procedure

After the terminal is replaced, perform the following procedure in order to insert the terminal.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.

Fig. 121: Locating Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

3. Locate the TPA.

Fig. 122: View Of TPA & Flat-Bladed Tool
Courtesy of GENERAL MOTORS COMPANY

4. Use a small flat-blade tool to push the TPA until it bottoms out.

Fig. 123: View Of Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

5. Ensure the TPA is fully seated. The TPA should be centered and flush with the connector body when viewed.

MOLEX CONNECTORS

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-213** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Locate the connector position assurance (CPA) on the top of the wire dress cover. Slide the CPA forward.

Fig. 124: Identifying Lever Lock Release Tab
Courtesy of GENERAL MOTORS COMPANY

2. Slide the lever lock forward while pressing down on the lever lock release tab.

Fig. 125: View Of Lever In Full Forward Position
Courtesy of GENERAL MOTORS COMPANY

3. The lever should be in the full forward position.

Fig. 126: View Of CPA Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the connector from the component.

Fig. 127: View Of Dress Cover

Courtesy of GENERAL MOTORS COMPANY

5. Remove the dress cover by using a flat bladed tool to release the dress cover locking tabs and lift up on the dress cover.
6. Cut the tie wrap that holds the wires to the connector body.

Fig. 128: Prying One Side Of Nose Piece
Courtesy of GENERAL MOTORS COMPANY

7. Use a small flat-blade tool to pry one side of the nose piece up to the pre-stage position. When the nose piece is in the pre-staged position, the nose piece will be raised above the connector body the length of the step in the nose piece.

Fig. 129: Prying Side Of Nose Piece
Courtesy of GENERAL MOTORS COMPANY

8. Use a small flat-blade tool to pry the other side of the piece to the pre-stage position. If the nose piece is higher than the first step in the nose piece, gently push down on the nose piece until it meets with resistance from the connector body, you should feel the nose piece click into position.

Fig. 130: View Of J38125-213 & Small Terminal Release Hole
Courtesy of GENERAL MOTORS COMPANY

9. Insert the J-38125-213 into the small terminal release hole on the nose piece and gently pull on the back of the wire.
10. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
11. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gauge size.
4. Refer to **Splicing Copper Wire Using Splice Sleeves**.

Terminal Insertion Procedure

After the terminal is replaced, perform the following procedure in order to insert the terminal.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Insure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the connector disassembly procedure.

SUMITOMO CONNECTORS

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool
- **J-38125-552** Terminal Release Tool
- **J-38125-553** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Fig. 131: Identifying Lever Lock
Courtesy of GENERAL MOTORS COMPANY

Fig. 132: View Of Lever Lock In Forward Position
Courtesy of GENERAL MOTORS COMPANY

1. Slide the lever lock forward while pressing down on the lever lock release tab.
2. Disconnect the connector from the component.

Fig. 133: View Of Connector Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Remove the dress cover by using a flat-blade tool to release the connector locking tabs and pulling off the dress cover.

Fig. 134: Inserting J-38125-12A (12094429) Into Single Retainer Slot
Courtesy of GENERAL MOTORS COMPANY

4. Relieve the tension on the nose piece retainers by inserting J-38125-12A into the single retainer slot on the end of the nose piece and gently prying out the locking tab. Repeat the process for both of the nose piece locking tabs on the opposite side of the nose piece.

Fig. 135: Pulling Up Nose Piece

Courtesy of GENERAL MOTORS COMPANY

5. Once the nose piece retainers are relaxed, use the J-38125-552 to pull up the nose piece by hooking the tool under the nose piece and pulling up. The nose piece should raise slightly.

Fig. 136: Pulling Up Other End Of Nose Piece
Courtesy of GENERAL MOTORS COMPANY

6. On the opposite side of the nose piece, use the J-38125-552 pull up the nose piece by hooking the tool under the nose piece and pulling up. The nose piece should release completely. If the nose piece does not come off, repeat the procedure on the opposite side.

Fig. 137: View Of Terminal & Entry Canal
Courtesy of GENERAL MOTORS COMPANY

7. The illustration above identifies the entry canal where the terminal release tool will be inserted, and the terminal cavity.
 - Terminal (1)
 - Entry Canal (2)

Fig. 138: Inserting J-38125-553 (15315247) Tool Into Entry Canal
Courtesy of GENERAL MOTORS COMPANY

8. Insert the J-38125-553 tool into the entry canal and pry up on the terminal retainer. The terminal retainer is a small plastic piece on the top of the terminal. The terminal retainer must be held up while the terminal is pulled out of the connector.

Fig. 139: Cutaway View Of Connector
Courtesy of GENERAL MOTORS COMPANY

9. The illustration shows a cutaway view of the connector to aid the technician in releasing the terminal retainer.
10. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
11. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

After the terminal is replaced, perform the following procedure in order to insert the terminal.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the connector disassembly procedure.

TYCO/AMP CONNECTORS (CM 42-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Locate the connector position assurance (CPA) on the connector body and pull the CPA out. The CPA is on the wire harness side of connector.
2. Disconnect the connector from the component.

3. Use a small flat-bladed tool to gently pry off the dress cover by inserting the tool under the cover opposite the harness side and prying up.
4. Remove the cover.

Fig. 141: View Of Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

5. Using a small flat-bladed tool, push on the side of the nose piece retainer while pushing the nose piece forward with your thumb. This will release the terminal position assurance (TPA).

Fig. 142: View Of Inserting J 38125-12A Into Terminal Release Cavity
Courtesy of GENERAL MOTORS COMPANY

6. Insert the **J-38125-12A** tool into the corresponding terminal release cavity. The release cavities are the 2 center rows of cavities on one half of the connector.

Fig. 143: Identifying Special Tool & Release Cavity
Courtesy of GENERAL MOTORS COMPANY

7. Pressing the **J-38125-12A** tool in the release cavity of the terminal you are removing, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair), Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (SENSOR)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-11A** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Disconnect the connector from the component.

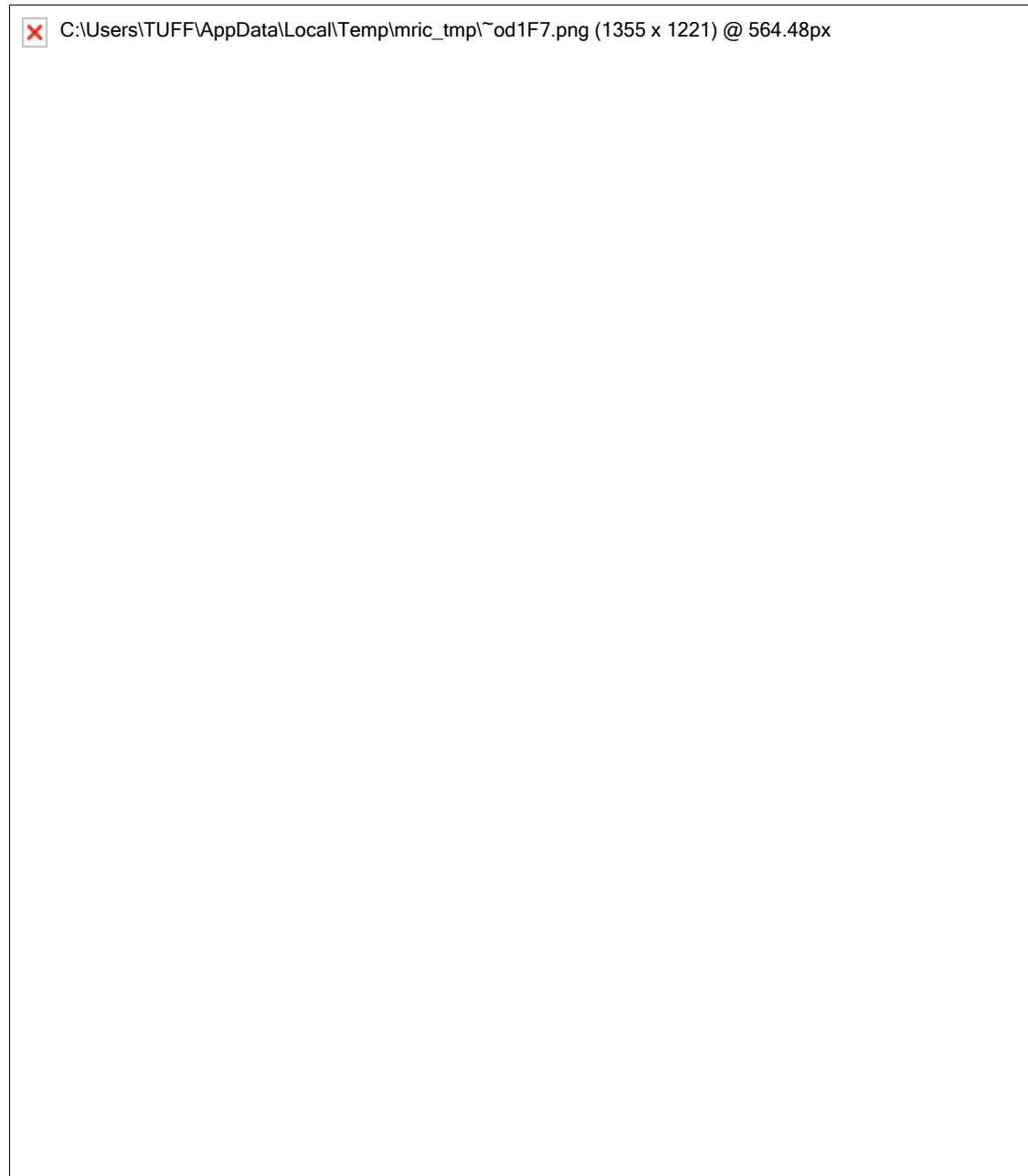


Fig. 144: View Of Inserting Special Tool Into Lower Right Face Cavity
Courtesy of GENERAL MOTORS COMPANY

2. Insert the J-38125-11A tool into the cavity on the lower right hand face of the connector until the terminal release tang access panel slides over.


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Fig. 145: Pushing Wire Side Of Terminal Toward Connector
Courtesy of GENERAL MOTORS COMPANY

3. Ensure that the terminal release tang access panel is in the correct location to access the terminals.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.


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Fig. 146: View Of Inserting Tool Into Terminal Release Tang Access Slot (Sensor)
Courtesy of GENERAL MOTORS COMPANY

5. Insert the J-38125-11A into the terminal release tang access slot located behind the access panel of the connector and press down on the terminal while carefully pulling the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (0.25 CAP)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-24** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Disconnect the connector from the component by pressing down on the connector position assurance (CPA).


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Fig. 147: Releasing TPA Using Small Flat-Bladed Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The TPA on this connector cannot be removed unless the terminals are removed first. The TPA will come out of the connector body, but only slightly. When the TPA is slightly raised the terminals can be removed. Using excessive force to remove the TPA with the terminals still in the connector will damage the connector.**

2. Use a small flat-bladed tool to release the terminal position assurance (TPA) by inserting the tool in the small recess on the side of the connector and pushing up until the TPA releases from the connector body.

The TPA should raise just slightly. Do not try to remove the TPA.

3. Repeat the process for the other side of the connector.

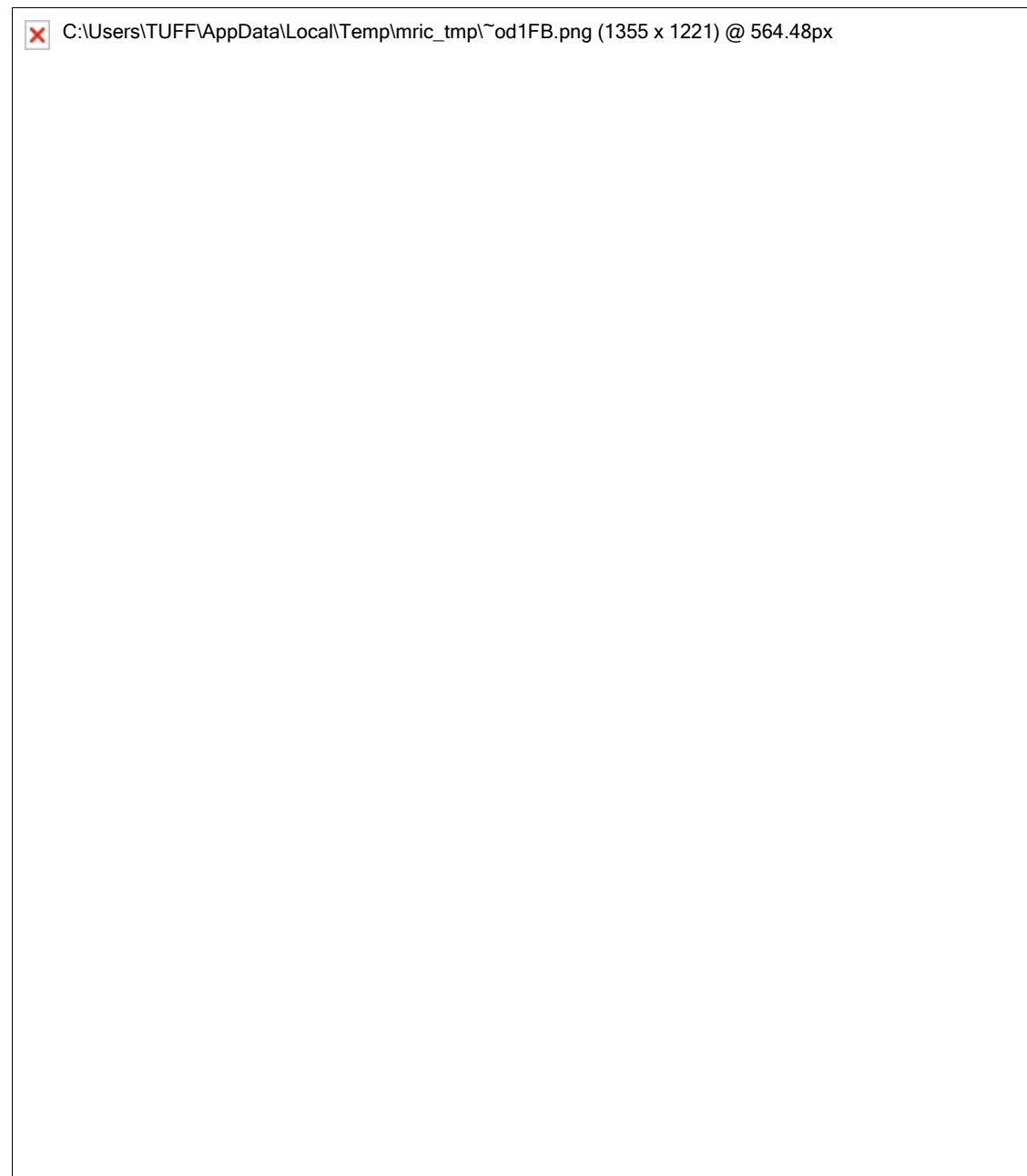


Fig. 148: View Of Terminal Position Assurance
Courtesy of GENERAL MOTORS COMPANY

4. Ensure that the TPA is in the proper position to remove the terminals.



Fig. 149: Identifying Special Tool & Release Cavity
Courtesy of GENERAL MOTORS COMPANY

5. While pushing the terminal forward, insert the J-38125-24 in the release cavity above the terminal you are removing, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair), Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (43-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

- **J-38125-13A** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from the connector.

1. Locate the lever lock on the wire dress cover. Slide the lever lock away from the connector body.
2. Disconnect the connector from the component.
3. Locate the dress cover locking tabs on the dress cover of the connector. Using a small flat-bladed tool release all of the locking tabs.
4. Once the locks are unlocked, lift the dress cover off.


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Fig. 150: Releasing TPA

Courtesy of GENERAL MOTORS COMPANY

NOTE: Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.

5. Release the TPA by inserting a small flat-bladed tool into the blue locking tabs on both ends of the connector. Gently slide the TPA up to the released position on both ends.


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Fig. 151: View Of Inserting Tool Into Terminal Release Cavity
Courtesy of GENERAL MOTORS COMPANY


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Fig. 152: View Of Release Tool Being Used For Larger Terminals
Courtesy of GENERAL MOTORS COMPANY


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Fig. 153: View Of Release Tool Being Used For Larger Terminals
Courtesy of GENERAL MOTORS COMPANY


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Fig. 154: View Of Release Tool Being Used For Smaller Terminals
Courtesy of GENERAL MOTORS COMPANY

6. For the larger terminals insert the **J-38125-13A** tool to release the terminals by inserting the tool into the terminal release cavity. For the smaller terminals insert the **J-38125-12A** tool to release the terminals by inserting the tool into the terminal release cavity.

View of the release tool being used for the larger terminals.

View of the release tool being used for the larger terminals.

View of the release tool being used for the smaller terminals.

7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (DOOR MODULE)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure


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Fig. 155: Side View Of Tyco/AMP Connector
Courtesy of GENERAL MOTORS COMPANY

Side view of connector.


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Fig. 156: Top View Of Tyco/AMP Connector
Courtesy of GENERAL MOTORS COMPANY

View of top of connector.

1. Locate the assist lever and lock on the top of the connector.


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Fig. 157: View Of Depressing Lock & Pulling Assist Lever
Courtesy of GENERAL MOTORS COMPANY

2. While depressing the lock, pull the lever over and past the lock.


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Fig. 158: View Of Component Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the connector from the component.



Fig. 159: Identifying Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

4. Locate the dress cover locking tabs at the rear of the connector. Use a small flat-blade tool to release the locking tabs. Repeat this procedure for the other locking tab.


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Fig. 160: Sliding Inner Connector Out Of Connector Housing
Courtesy of GENERAL MOTORS COMPANY

5. Once the locking tabs are unlocked, slide the inner connector out of the rear of the connector housing.


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Fig. 161: Releasing Terminals

Courtesy of GENERAL MOTORS COMPANY

6. Use the J-38125-12A tool to release the terminals by pressing on the tang.
7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (102-WAY INLINE)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-11A** Terminal Release Tool
- **J-38125-212** Terminal Release Tool
- **J-38125-216** Terminal Release Tool
- **J-38125-221** Terminal Release Tool
- **J-38125-560** Terminal Release Tool
- **J-38125-566** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure


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Fig. 162: View Of Typical Connector In Assembled Position
Courtesy of GENERAL MOTORS COMPANY

View of a typical connector in the assembled position.


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Fig. 163: View Of Locking Lever At 90 Degrees From Connector Body
Courtesy of GENERAL MOTORS COMPANY

1. Pull the locking lever to the 90 degree position from the connector body.


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Fig. 164: Assembled View Of Connector - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

2. With the locking lever in the 90 degree position and the male connector body separated, it can be slid outward for removal.


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Fig. 165: Sliding Male Connector Body Away From Guide Plates
Courtesy of GENERAL MOTORS COMPANY

3. Slide the male connector body out away from the guide plates.

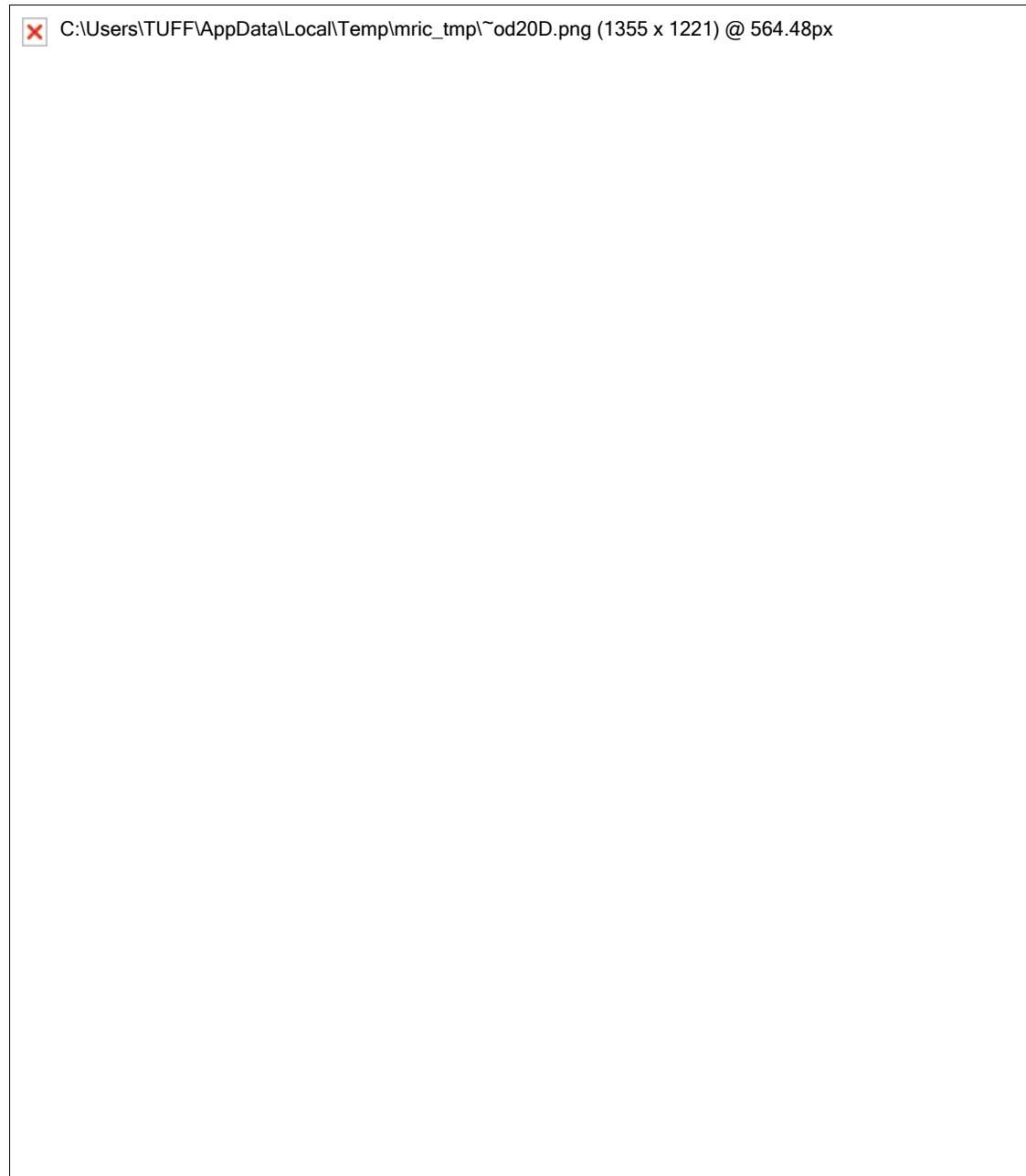


Fig. 166: View of Terminal Release Tool J-38125-566 and TPA
Courtesy of GENERAL MOTORS COMPANY

NOTE: During assembly the terminal position assurance (TPA) will not fully seat if any terminal is not fully seated.

4. Using terminal release tool J-38125-11A or equivalent, remove the TPA from the connector body.


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Fig. 167: Using Terminal Release Tool J 38125-566 to Release Lock Tabs
Courtesy of GENERAL MOTORS COMPANY

5. Using terminal release tool J-38125-566, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

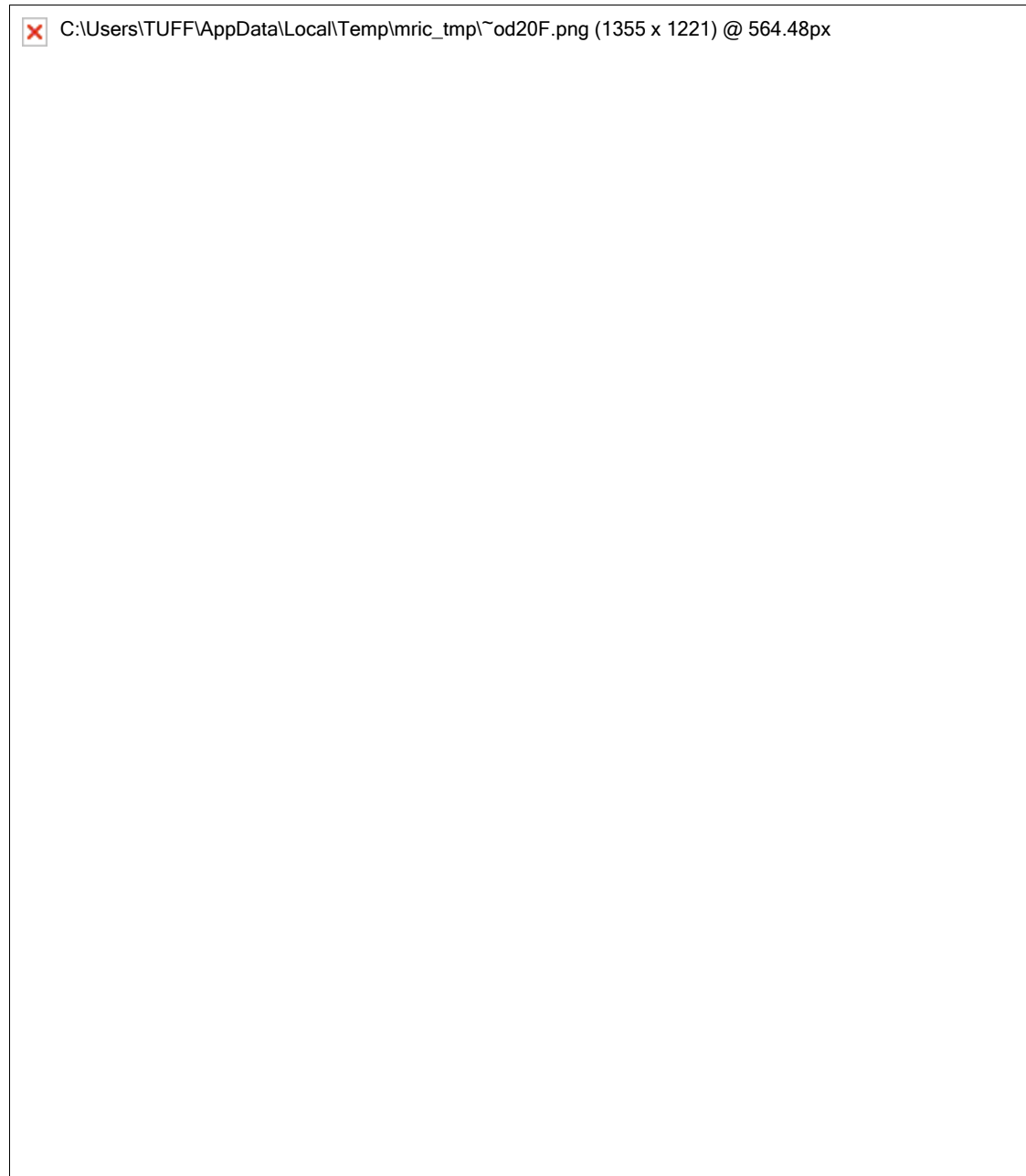


Fig. 168: Using Terminal Release Tool J-38125-221
Courtesy of GENERAL MOTORS COMPANY

6. Using terminal release tool J-38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.


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Fig. 169: Releasing Lock Tabs

Courtesy of GENERAL MOTORS COMPANY

7. Using terminal release tool J-38125-221, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.


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Fig. 170: View Of Female Connector Body - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

8. The female connector body may have an additional connector hooked to the edge of the body. Use terminal release tool J-38125-11A or equivalent to release the locking tab and slide the connector off the female body.


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Fig. 171: Moving Locking Lever 180 Degrees From The Connected Position - Tyco/AMP (102-Way Inline)

Courtesy of GENERAL MOTORS COMPANY

9. Move the locking lever 180 degrees from the connected position.


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Fig. 172: Removing Guide Plates From Connector Body
Courtesy of GENERAL MOTORS COMPANY

10. With the locking lever in the 180 degree position the guide plates can be removed from the connector body.

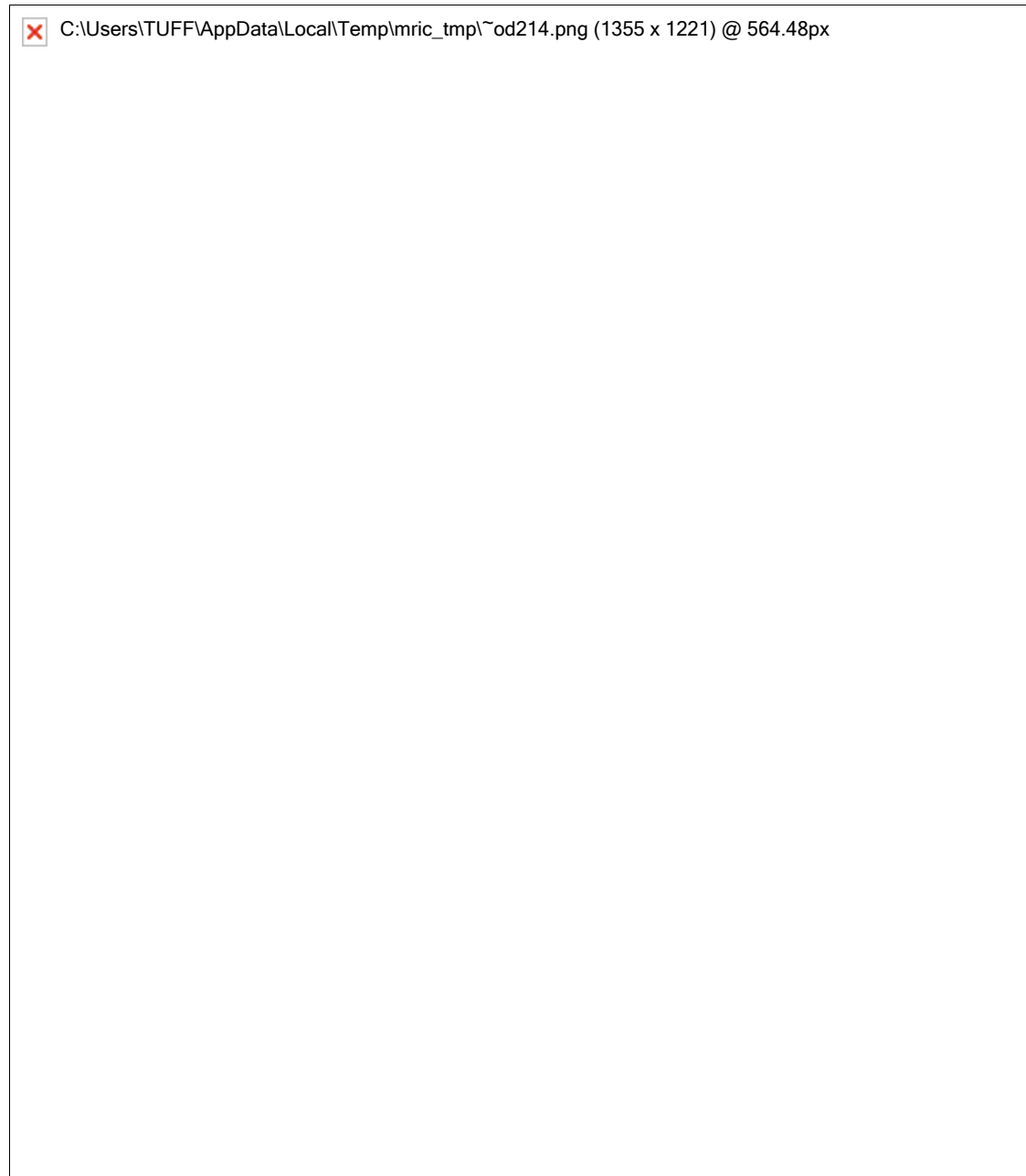


Fig. 173: Removing TPA

Courtesy of GENERAL MOTORS COMPANY

NOTE: During assembly the TPA will not fully seat if any terminal is not fully seated.

11. Using terminal release tool J-38125-11A or equivalent, remove the TPA from the connector body.


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Fig. 174: Lifting Terminal Plate Past Terminals
Courtesy of GENERAL MOTORS COMPANY

12. Using terminal release tool J-38125-216, lift the terminal plate past the terminals and out of the connector body cavity.


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Fig. 175: View Of Terminal Plate
Courtesy of GENERAL MOTORS COMPANY

13. Terminal plate will bind slightly on each corner.

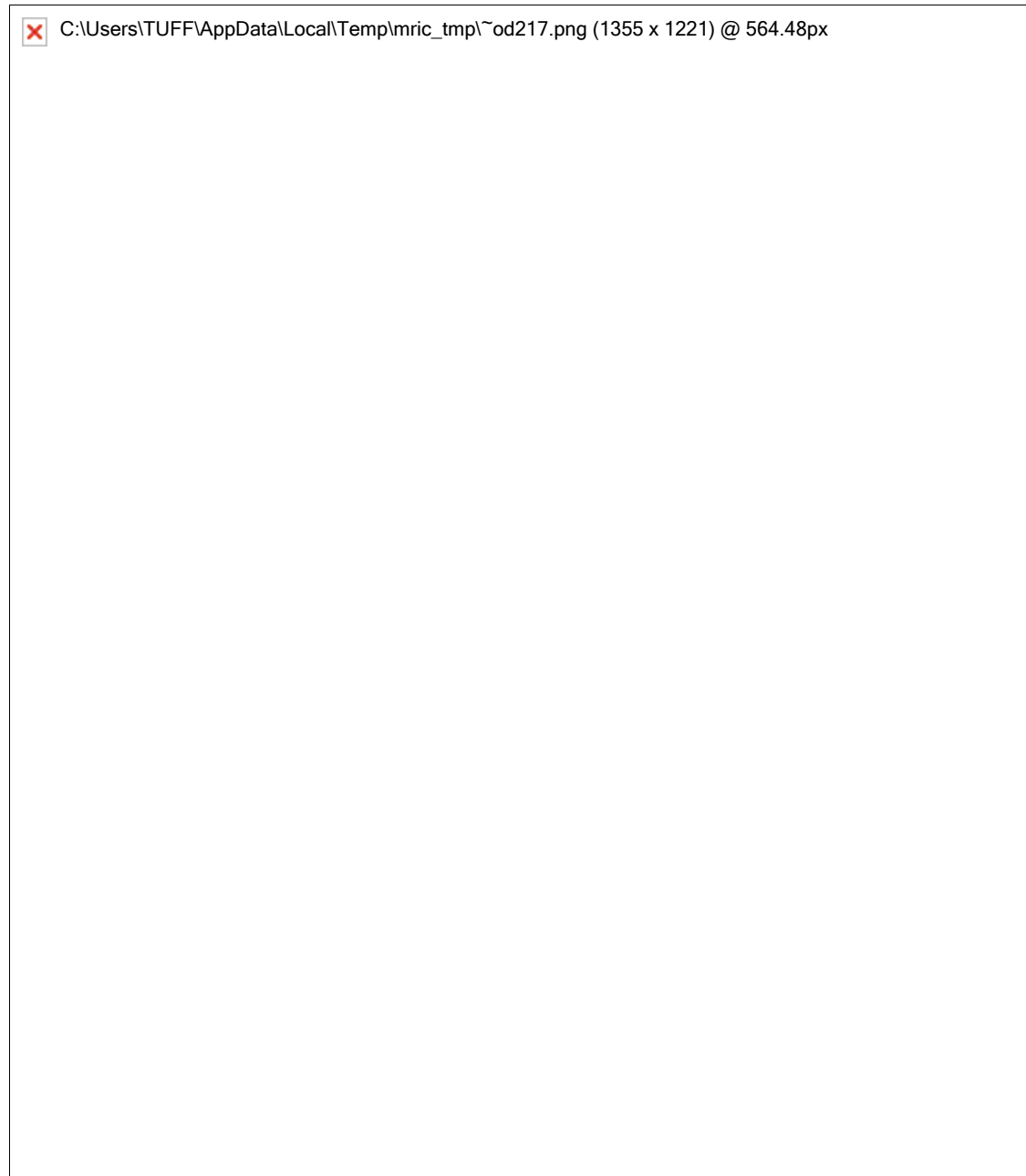


Fig. 176: View of Using Terminal Release Tool J 38125-221 to Release Lock Tabs
Courtesy of GENERAL MOTORS COMPANY

14. Using terminal release tool J-38125-221, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.


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Fig. 177: View of Pressing Prongs On Each Side Of Terminal Using J 38125-212
Courtesy of GENERAL MOTORS COMPANY

15. Using terminal release tool J-38125-212, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.


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Fig. 178: Pressing Prongs On Each Side Of Terminal - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

16. Using terminal release tool J-38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.


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Fig. 179: View Of Terminal Plate
Courtesy of GENERAL MOTORS COMPANY

17. Press the terminal plate back into the female connector to the preset position. The plate will bind slightly on each corner.


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Fig. 180: Aligning Guide Plates To Mesh With Locking Lever Gears
Courtesy of GENERAL MOTORS COMPANY

18. With the locking lever in the 180 degree position, align the guide plates to mesh with the gears on the locking lever.


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Fig. 181: Sliding Male Connector Body Away From Guide Plates
Courtesy of GENERAL MOTORS COMPANY

19. Slide the male connector body back inward toward the guide plates.


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Fig. 182: Assembled View Of Connector - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

20. With the locking lever in the 90 degree position and the male connector body connected, it can be slid inward for assembly.


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Fig. 183: View Of Typical Connector In Assembled Position
Courtesy of GENERAL MOTORS COMPANY

21. Move the lever into the locked position or in the assembled position. This will pull the male connector down into the female connector.
22. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
23. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (SEAT)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-11A** Terminal Release Tool
- **J-38125-212** Terminal Release Tool
- **J-38125-556** Terminal Release Tool
- **J-38125-560** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure


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Fig. 184: Locating Locking Slide Lever
Courtesy of GENERAL MOTORS COMPANY

1. Grasp the locking slide lever and pull outward from the end of the connector.


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Fig. 185: Pulling Slide Lever Out Of Mating Connector
Courtesy of GENERAL MOTORS COMPANY

2. As the slide lever is pulled out the mating connector is lifted from the seated position.


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Fig. 186: Pushing TPA Tabs Into Connector Body
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Terminal position assurance (TPA) is keyed and can only be inserted in one direction.**

3. Using terminal release tool J-38125-11A or equivalent, push the TPA tabs into the connector body.


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Fig. 187: Pulling TPA From Connector Body
Courtesy of GENERAL MOTORS COMPANY

4. Pull the TPA from the connector body.


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Fig. 188: Releasing Connector Wire Dress Cover Locking Tab
Courtesy of GENERAL MOTORS COMPANY

5. Using terminal release tool J-38125-11A or equivalent, release the connector wire dress cover locking tab.


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Fig. 189: Lifting Connector Wire Dress Cover From Connector Body
Courtesy of GENERAL MOTORS COMPANY

6. With the lock tab released, lift the connector wire dress cover from the connector body.

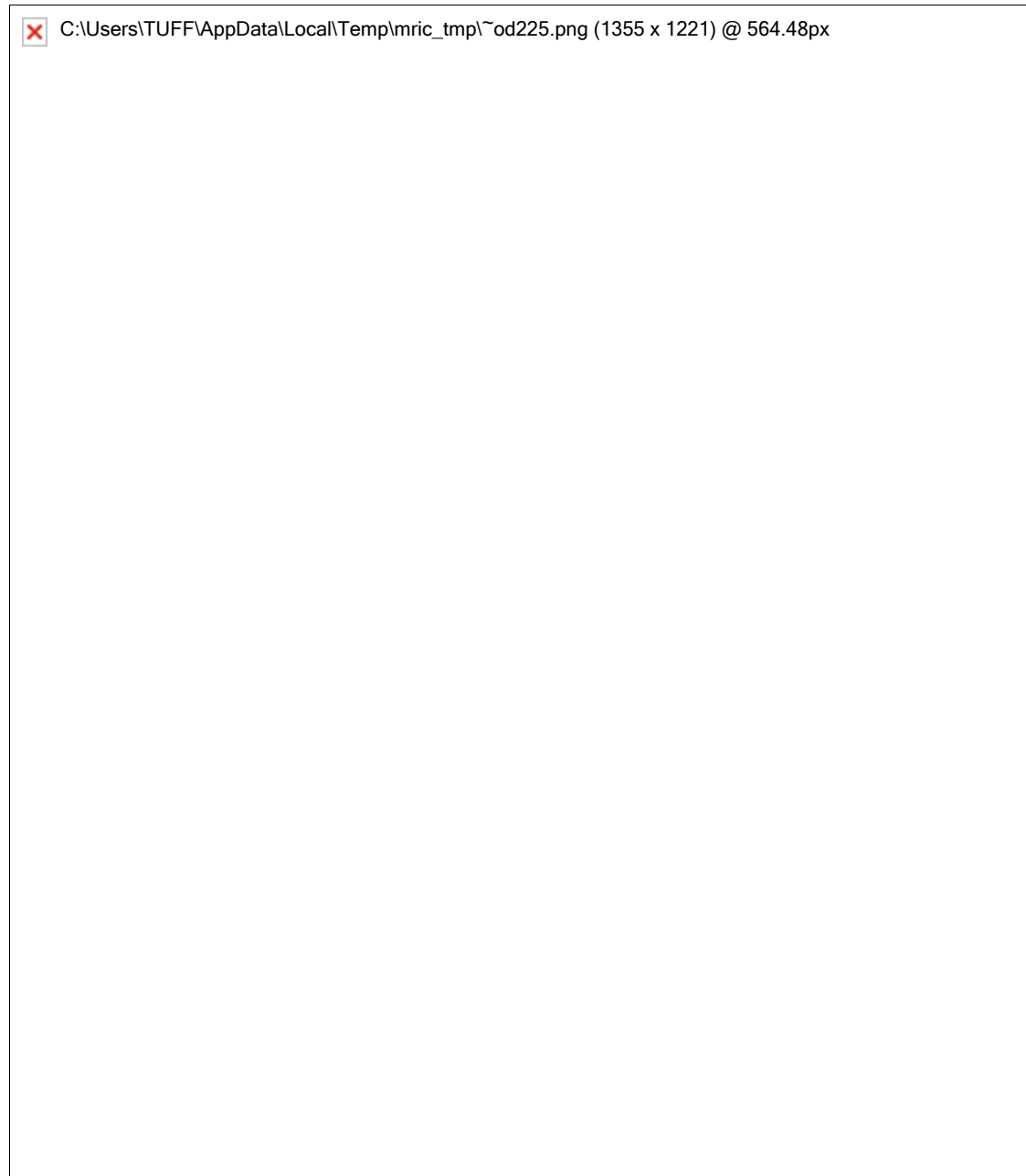


Fig. 190: Using Terminal Release Tool J-38125-212
Courtesy of GENERAL MOTORS COMPANY

7. Using terminal release tool J-38125-212, press the prongs into the holes each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



Fig. 191: Using Terminal Release Tool J-38125-560
Courtesy of GENERAL MOTORS COMPANY

8. Using terminal release tool J-38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.


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Fig. 192: Using Terminal Release Tool J-38125-556
Courtesy of GENERAL MOTORS COMPANY

9. Using terminal release tool J-38125-556, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.
10. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
11. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (SIR)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-11A** Terminal Release Tool
- **J-38125-215A** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure


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Fig. 193: Sliding Red CPA Away From Connector Lever
Courtesy of GENERAL MOTORS COMPANY

1. Using your thumbs press down and slide the red CPA away from the connector lever.

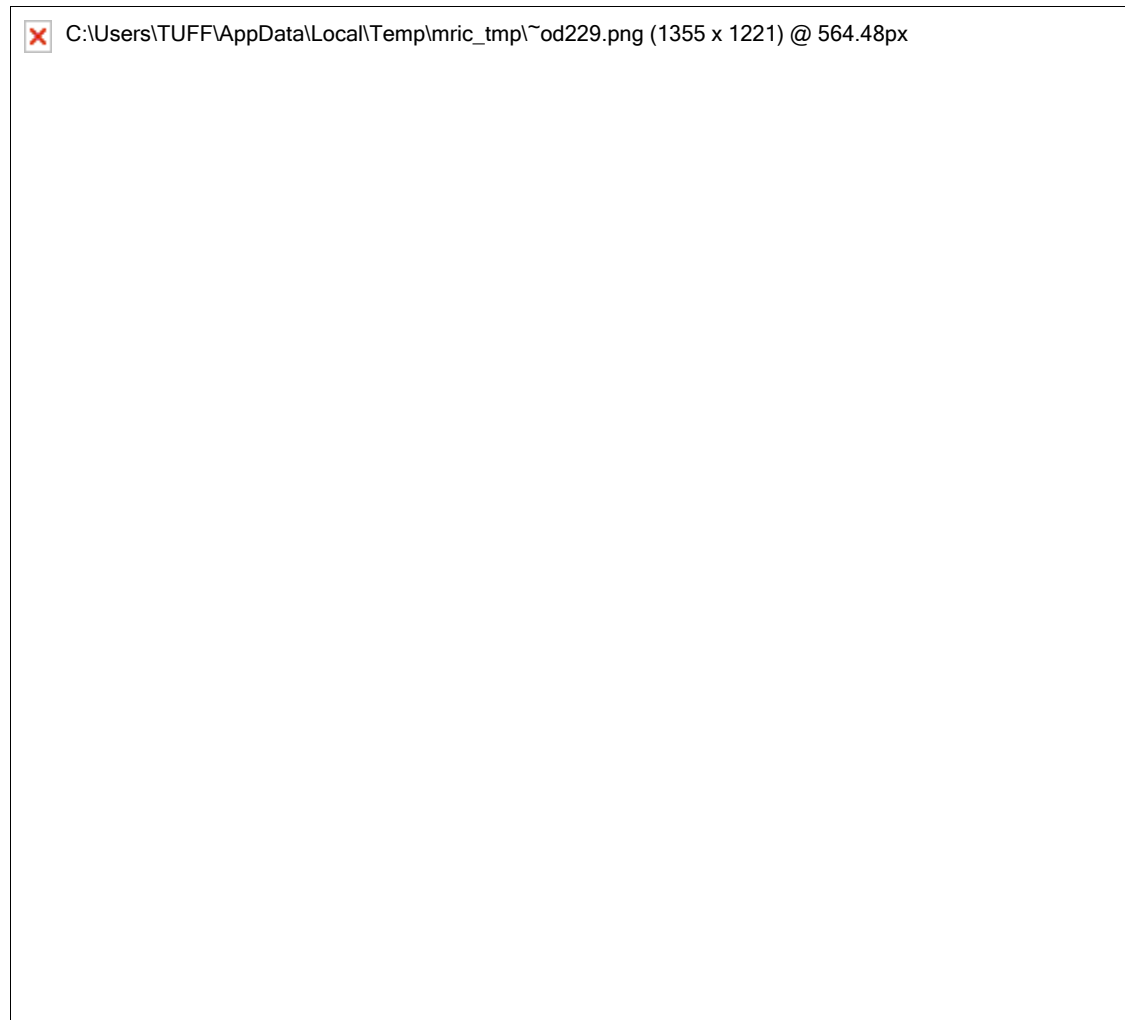


Fig. 194: Pressing Down On Locking Tab - Tyco/AMP Connectors (SIR)
Courtesy of GENERAL MOTORS COMPANY

2. Using your thumb press down on the locking tab and move the lever to the released position.


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Fig. 195: Releasing Wire Dress Cover Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Using terminal tool J-38125-11A or equivalent, release the wire dress cover locking tabs.


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Fig. 196: Pivoting Connector Wire Dress Cover
Courtesy of GENERAL MOTORS COMPANY

4. Pivot connector wire dress cover while removing from the connector body.


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Fig. 197: Using Terminal Tool 12094430
Courtesy of GENERAL MOTORS COMPANY

5. Using terminal tool J-38125-11A or equivalent, remove the TPA by lifting straight off the connector body.


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Fig. 198: View of Terminal Release Tool J-38125-215A & Rear of Connector Body
Courtesy of GENERAL MOTORS COMPANY

6. Using terminal release tool J-38125-215A, place the tip of the tool on the outside edge next to the terminal and depress the lock tab and remove the rear of the connector body.

Terminal Repair Procedure

Use the appropriate terminal and crimper in order to replace the terminal.

YAZAKI CONNECTORS (2-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-553** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure

1. Disconnect the connector from the component.


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Fig. 199: Identifying Terminal Position Assurance (Yakazi)
Courtesy of GENERAL MOTORS COMPANY

2. Insert a small flat-blade tool in the slot below the front loaded terminal position assurance (TPA) and pry up.
3. Remove the TPA by pulling it out of the connector.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.


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Fig. 200: View Of Inserting Tool Into Terminal Cavity (Yakazi)
Courtesy of GENERAL MOTORS COMPANY

5. Insert the J-38125-553 on a slight upward angle into the cavity below the terminal to be removed. Ensure that the pointed on the end of the tool is facing the bottom of the terminal and it stays in contact with the terminal until it stops on the plastic terminal retainer.


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Fig. 201: View Of Pulling Terminal Out Of Connector (Yakazi)
Courtesy of GENERAL MOTORS COMPANY

6. Gently pry the plastic terminal retainer down and carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
7. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
8. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

YAZAKI CONNECTORS (16-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-215** Terminal Release Tool

For equivalent regional tools, refer to **Special Tools** .

Terminal Removal Procedure


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Fig. 202: Pulling Two Connector Halves Apart
Courtesy of GENERAL MOTORS COMPANY

1. While depressing the lock, pull the two connector halves apart.

NOTE: **The terminal position assurance (TPA) is fragile and may break if not done carefully.**

2. Use a small flat-blade tool to very carefully push the TPA towards the face of the connector on both sides of the connector.


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Fig. 203: View Of Male Connector Half & Female Terminals
Courtesy of GENERAL MOTORS COMPANY

3. View of the male half of the connector with female terminals.


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Fig. 204: View Of Female Half Of Connector With Male Terminals
Courtesy of GENERAL MOTORS COMPANY

4. View of the female half of the connector with male terminals.
5. Use the J-38125-215 tool to release the terminals by inserting the tool into the terminal release cavity.


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Fig. 205: Using Removal Tool On Female Half Of Connector
Courtesy of GENERAL MOTORS COMPANY

6. View of the female half of the connector with male terminals.



Fig. 206: Using Removal Tool On Male Half Of Connector
Courtesy of GENERAL MOTORS COMPANY

7. View of the male half of the connector with female terminals.
8. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
9. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
10. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

REPAIRING CONNECTOR TERMINALS (TERMINATED LEAD REPAIR)

Special Tools

EL-38125-10 Splice Sleeve Crimp Tool

For equivalent regional tools, refer to **Special Tools** .

NOTE: All repairs near the engine manifold, turbo engine and all exhaust pipes should follow the High Temperature Wiring Repairs procedures.

For high temperature wiring repairs, refer to **High Temperature Wiring Repairs**.

Terminated leads are terminals that are crimped onto wires. The terminated lead can be used throughout the vehicle since it is designed for temperatures up to 150°C. The length of the wire is 450 mm.

1. Use the connector end view to identify the correct terminated lead.
2. The terminated lead package should include a DuraSeal splice sleeve. If not, use the chart to in Splicing Copper Wire Using Splice Sleeves to identify the correct DuraSeal splice sleeve, refer to **Splicing Copper Wire Using Splice Sleeves**.

REPAIRING CONNECTOR TERMINALS (TERMINAL REPAIR)

Special Tools

- **J-38125-580** Terminal Repair Kit
- **J-38125-6** Crimp Tool
- **J-38125-7** Crimp Tool
- **J-38125-8** Crimp Tool
- **J-38125-64** Crimp Tool
- **J-38125-101** Crimp Tool
- **J-38125-641** Crimp Tool
- **J-38125-642** Crimp Tool
- **J-38125-643** Crimp Tool

For equivalent regional tools, refer to **Special Tools** .

Use the following repair procedures to repair each type of terminal:

- For push to seat terminals, refer to **Delphi Connectors (Weather Pack)**, **Delphi Connectors (Pull To Seat)**, **Delphi Connectors (Push To Seat)**, **Delphi Connectors (12-Way)**, **Delphi Connectors (Micro .64)**, **Delphi Connectors (Steering Gear)**, **Delphi Connectors (Micro-Pack 100W)**.
- For pull to seat terminals, refer to **Delphi Connectors (Weather Pack)**, **Delphi Connectors (Pull To Seat)**, **Delphi Connectors (Push To Seat)**, **Delphi Connectors (12-Way)**, **Delphi Connectors (Micro .64)**, **Delphi Connectors (Steering Gear)**, **Delphi Connectors (Micro-Pack 100W)**.

NOTE: The first step for all terminal repairs is to find the connector end view in SI.

Cable Seal Terminals

1. Cut off the terminal between the core and the insulation crimp to minimize any wire loss.
2. Remove the old seal.

3. Apply the correct cable seal, per the wire gauge size, from the kit. Slide the seal back along the wire to enable removal of the insulation.
4. To minimize wire loss, remove only the insulation required.
5. Using the connector end view, determine the correct crimp tool and crimp jaw.
6. Align the seal with the end of the cable insulation.
7. Position the stripped wire and seal in the terminal.
8. Hand Crimp the core wings first.
9. Hand Crimp the insulation wings around the seal and the cable.
10. Solder all of the hand crimp terminals except the Micro-Pack 100 and 0.64 sizes.

Unsealed Terminals

1. Cut off the terminal between the core and the insulation crimp to minimize any wire loss.
2. To minimize wire loss, remove only the insulation required.
3. Position the stripped wire in the terminal.
4. Hand Crimp the core wings first.
5. Hand Crimp the insulation wings around the cable.
6. Solder all of the hand crimp terminals except the Micro-Pack 100 and 0.64 sizes.

Micro-Pack 100W Size Terminal

The Micro-Pack 100W connectors have small terminals that are difficult to handle and hold when crimping. In order to aid the technician when crimping these terminals, a new crimping tool was developed. The J 38125-101 (W jaw) crimping tool was developed to crimp Micro-Pack 100W terminals. The J 38125-101 (W jaw) crimping tool has a terminal holding block that will hold the terminal in place while the terminal is being crimped. After the terminal is removed from the connector perform the following procedure in order to repair Micro-Pack 100 terminals.

1. Cut the wire as close to the terminal as possible.

NOTE: **After cutting the damaged terminal from the wire, determine if the remaining wire is long enough to reach the connector without putting a strain on the wire. If the wire is not long enough, splice a small length of the same gauge wire to the existing wire, then crimp the new terminal on the added wire.**

2. Strip 5 mm (3/16 in) of insulation from the wire.


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Fig. 207: Identifying Crimping Tool Spring Loaded Locator
Courtesy of GENERAL MOTORS COMPANY

3. Depress the spring loaded locator of the J 38125-101 (W jaw) crimping tool until the terminal holder is completely visible.


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Fig. 208: Locating Terminal In Crimping Tool
Courtesy of GENERAL MOTORS COMPANY

4. Insert the terminal into the crimp tool until the core wings are flush with the anvil on the crimp tool. Be sure that the wings are pointed toward the crimp tool former and release the spring locator. The locator will hold the terminal in place. Inspect the alignment of the terminal wings with the crimp tool former. If the terminal wings are wider than the crimp tool former, remove the terminal and bend the terminal wings in slightly.
5. Place stripped wire into terminal.
6. Crimp the new terminal to the wire. If a jam occurs, press the emergency release to open applicator.

Micro 0.64 Size Terminal

The Micro 64 connectors have small terminals that are difficult to handle and hold when crimping. In order to aid the technician when crimping these terminals, a new crimping tool was developed. The J 38125-64 (M jaw) was developed to crimp Micro 64 terminals. The J-38125-64 crimping tool has a terminal holding block that will hold the terminal in place while the terminal is being crimped. The J-38125-64 crimping tool is also designed to crimp both the wire and the insulation at the same time.

After the terminal is removed from the connector perform the following procedure in order to repair Micro 64 terminals.

NOTE: **After cutting the damaged terminal from the wire, determine if the remaining wire is long enough to reach the connector without putting a strain on the wire. If the wire is not long enough, splice a small length of the same gauge wire to the existing wire, then crimp the new terminal on the added wire.**

1. Cut the wire as close to the damaged terminal as possible.
2. Strip 5 mm (3/16 in) of insulation from the wire.


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Fig. 209: Identifying Crimping Tool Spring Loaded Locator
Courtesy of GENERAL MOTORS COMPANY

3. Depress the spring loaded locator of the crimping tool until the terminal holder is completely visible.


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Fig. 210: Identifying Terminal Holder
Courtesy of GENERAL MOTORS COMPANY

4. Insert terminal into the appropriate terminal holder until it hits bottom and stops. The correct terminal holder is determined by the wire size. Also ensure that the terminals wings are pointing towards the former on the tool and the release locator.
5. Insert the stripped cable into the terminal. Insulation should be visible on both sides of the terminal insulation wings.
6. Compress the handles until the ratchet automatically releases.
7. Place the terminal into the appropriate cavity and assemble the connector.

TERMINAL REMOVAL

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **EL-35616** Terminal Test Probe Kit

For equivalent regional tools, refer to **Special Tools** .

NOTE: **All repairs near the engine manifold, turbo engine and all exhaust pipes should follow the High Temperature Wiring Repair procedures.**

1. Find the appropriate connector end view within the connector end view section. The connector end view has the following information:
 - Diagnostic probe tool
 - Terminal release tool
 - Terminal/terminated lead part numbers

NOTE: **Not using the proper test kit probe may cause damage to the terminal(s) that are probed.**

2. Determine if a terminal is damaged.
 - Locate the diagnostic probe tool from the connector end view. The connector end view describes the color and part number to help the technician find and use the correct tool.
 - Connect the probe tool to the Digital Multimeter.
 - Insert the probe tool into the cavity and follow the procedures from the **Troubleshooting with a Digital Multimeter**.
3. Disconnect the connector body to perform the repair.
4. Use the following procedure to remove the terminal from the connector body.

NOTE: **Several procedures for specific connector bodies are called out in the Wiring Repairs section.**

- The terminal position assurance (TPA) and connector position assurance (CPA) should be removed before releasing the terminal for the connector body.
- Look at the connector end view to locate the cavity of the damaged terminal and find the proper terminal release tool from the terminal release tool kit.

NOTE: **Using the incorrect terminal release tool can damage the connector body.**

NOTE: **Some terminals have a lever that must be disengaged before the**

terminal can be released.

- Insert the terminal release tool into the cavity.

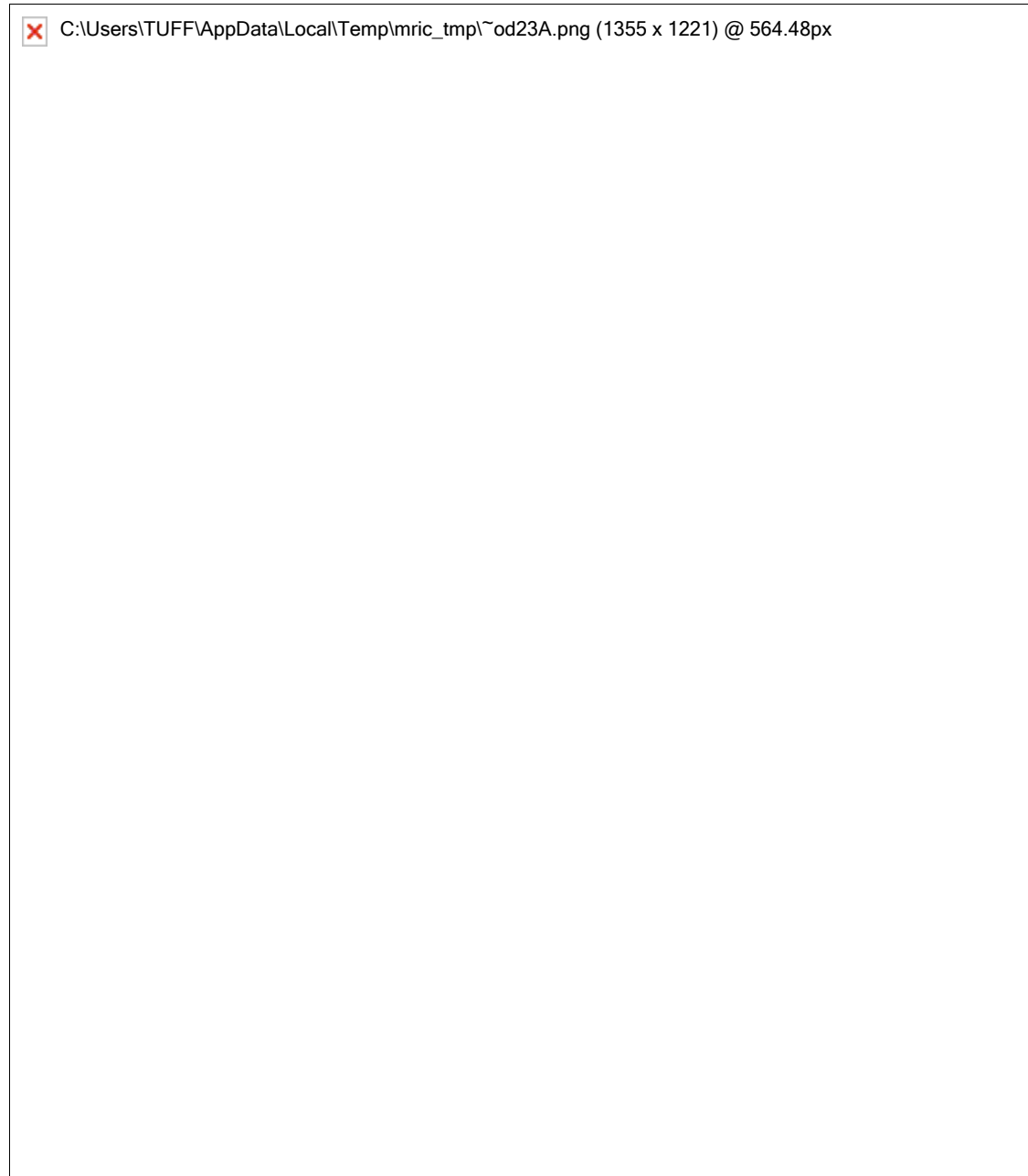


Fig. 211: Gently Pulling Wire Out Of Back Of Connector
Courtesy of GENERAL MOTORS COMPANY

5. Gently pull the wire out of the back of the connector.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)**, **Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and

reconnect the connector bodies.

IGNITION KEY CANNOT BE REMOVED FROM THE IGNITION LOCK CYLINDER

Ignition Key Cannot Be Removed from the Ignition Lock Cylinder

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Steering Wheel and Column</u>
2	Verify the ignition key cannot be removed from the ignition lock cylinder. Is the ignition key stuck in the lock cylinder?	Go to Step 3	System OK
3	Is the vehicle equipped with a manual transmission?	Go to Step 8	Go to Step 4
4	Turn the ignition key to the OFF position. Can the ignition key be turned to the OFF position and be removed?	Go to Step 8	Go to Step 5
5	Verify the adjustment of the shift control linkage. Refer to <u>Range Selector Lever Cable Adjustment</u> . Can the ignition key be turned to the OFF position and be removed?	System OK	Go to Step 6
6	Inspect for a faulty ignition lock cylinder. Is the ignition lock cylinder damaged?	Go to Step 8	Go to Step 7
7	Inspect the ignition/start switch housing. Is the housing worn, damaged or loose?	Go to Step 9	Go to Step 10
8	Replace the ignition lock cylinder. Refer to <u>Ignition Lock Cylinder Replacement</u> . Did you complete the repair?	Go to Step 10	-
9	Replace the ignition/start switch housing. Refer to <u>Ignition and Start Switch Housing Replacement</u> . Did you complete the repair?	Go to Step 10	-
10	Operate the system to verify the repair. Did you correct the condition?	System OK	-

IGNITION KEY CANNOT TURN OR STICKS IN ANY POSITION

Ignition Key Cannot Turn or Sticks in Any Position

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column System Description and perform the necessary inspections?	Go to Step 2	Go to <u>Steering Wheel and Column Description and Operation</u>
2	Verify that the ignition key sticks or cannot turn in any position. Is the key functioning correctly?	System OK	Go to Step 3
	Inspect for an incorrect, worn, or damaged ignition		

3	key. Is the ignition key incorrect, worn, or damaged?	Go to Step 7	Go to Step 4
4	Inspect for a faulty ignition lock cylinder. Is the ignition lock cylinder damaged?	Go to Step 8	Go to Step 5
5	Inspect the ignition and start switch assembly for damage. Is the ignition and start switch assembly damaged?	Go to Step 9	Go to Step 6
6	Inspect the ignition and start switch housing for looseness. Is the ignition and start switch housing loose?	Go to Step 10	Go to Step 11
7	Replace the ignition key. Did you complete the repair?	Go to Step 11	-
8	Replace the ignition lock cylinder. Refer to <u>Ignition Lock Cylinder Replacement</u> . Did you complete the repair?	Go to Step 11	-
9	Replace the ignition and start switch. Refer to <u>Ignition and Start Switch Replacement (Without BTM) , Ignition and Start Switch Replacement (With BTM)</u> . Did you complete the repair?	Go to Step 11	-
10	Tighten or replace the ignition and start switch housing. Refer to <u>Ignition and Start Switch Housing Replacement</u> Did you complete the repair?	Go to Step 11	-
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

Brakes

Disc Brakes

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Caliper Bolt - J64	40 N.m + 90 degrees	30 lb ft + 90 degrees
Brake Caliper Bracket Bolt - Front	150 N.m + 45 degrees + 15 degrees	111 lb ft + 45 degrees + 15 degrees
Brake Caliper Bracket Bolt - Rear	100 N.m + 60 degrees	74 lb ft + 60 degrees
Brake Caliper Guide Pin Bolt - Front and Rear	27 N.m	20 lb ft
Brake Hose Fitting Bolt - Front and Rear	40 N.m	30 lb ft
Brake Rotor Bolt - Front	7 N.m	62 lb in
Brake Rotor Bolt - Rear	10 N.m	89 lb in

DISC BRAKE COMPONENT SPECIFICATIONS

Disc Brake Component Specifications

Application	Specification	
	Metric	English
Front Brakes		
• Brake Rotor Diameter (J60)	296.0 mm	11.65 in
• Brake Rotor Diameter (J61)	321.0 mm	12.63 in
• Brake Rotor Diameter (J64)	355.0 mm	13.976 in
• Brake Rotor Discard Thickness* (J60, J61)	27.0 mm	1.07 in
• Brake Rotor Discard Thickness* (J64)	30.0 mm	1.181 in
• Brake Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
• Brake Rotor Maximum Allowable Scoring	1.50 mm	0.059 in
• Brake Rotor Maximum Allowable Thickness Variation	0.006 mm	0.00024 in
• Brake Rotor Thickness New (J60, J61)	30.0 mm	1.18 in
• Brake Rotor Thickness New (J64)	32.0 mm	1.26 in
Rear Brakes		
• Brake Rotor Diameter (J60)	292.0 mm	11.50 in

• Brake Rotor Diameter (J61, J64)	315.0 mm	12.40 in
• Brake Rotor Discard Thickness* (J60)	10.00 mm	0.395 in
• Brake Rotor Discard Thickness* (J61, J64)	21.00 mm	0.827 in
• Brake Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
• Brake Rotor Maximum Allowable Scoring	1.50 mm	0.059 in
• Brake Rotor Maximum Allowable Thickness Variation	0.006 mm	0.00024 in
• Brake Rotor Thickness- New (J60)	12 mm	0.472 in
• Brake Rotor Thickness- New (J61, J64)	23.0 mm	0.905 in
*All brake rotors have a discard dimension cast into them. Replace any rotor that does not meet this specification. After refinishing the rotor, replace any rotor that does not meet the discard thickness specification.		

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Brake Caliper Bracket Bolts	Threadlocker	89021297	10953488

DIAGNOSTIC INFORMATION AND PROCEDURES

BRAKE ROTOR THICKNESS MEASUREMENT

WARNING: Refer to Brake Dust Warning .

1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to **Front Disc Brake Pads Replacement (J60, J61)**, **Front Disc Brake Pads Replacement (J64)**, and/or **Rear Disc Brake Pads Replacement**.
2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.

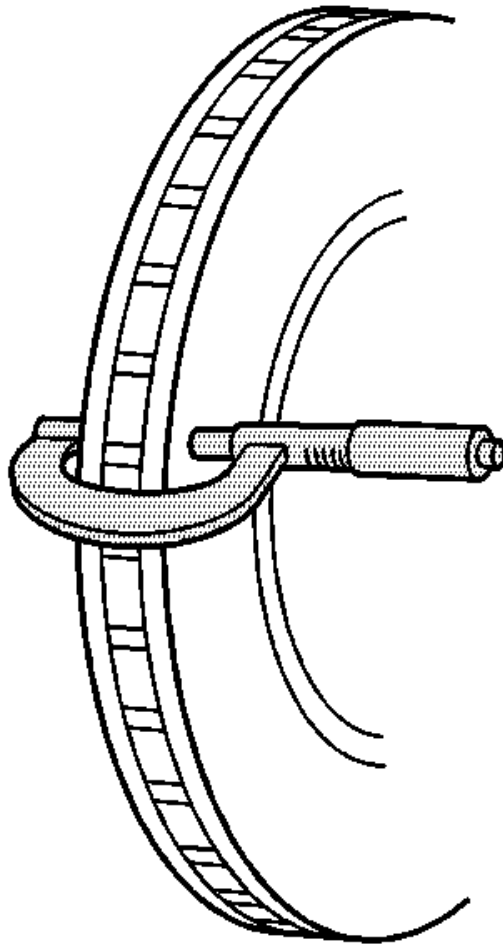


Fig. 1: Measuring Brake Rotor Thickness
Courtesy of GENERAL MOTORS COMPANY

3. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the lowest thickness of the brake rotor at 4 or more points, equally spaced around the rotor.

Ensure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outside edge of the rotor, about 13 mm (1/2 in), for each measurement.

4. Compare the lowest thickness measurement recorded to the brake rotor discard thickness specifications. Refer to **Disc Brake Component Specifications**.
5. If the lowest thickness measurement of the brake rotor is above the discard thickness specification, the brake rotor may be refinished, depending upon surface and wear conditions which may be present.
6. If the lowest thickness measurement of the brake rotor is at or below the discard thickness specification, the rotor requires replacement. Refer to **Front Brake Rotor Replacement (J60, J61)**, **Front Brake Rotor Replacement (J64)**, and/or **Rear Brake Rotor Replacement**.

BRAKE ROTOR THICKNESS VARIATION MEASUREMENT

WARNING: Refer to Brake Dust Warning .

NOTE: Any disc brake rotor that exhibits thickness variation exceeding the maximum acceptable level must be refinished or replaced. Thickness variation exceeding the maximum acceptable level can cause brake pulsation.

1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to Front Disc Brake Pads Replacement (J60, J61), Front Disc Brake Pads Replacement (J64), and/or Rear Disc Brake Pads Replacement.
2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.

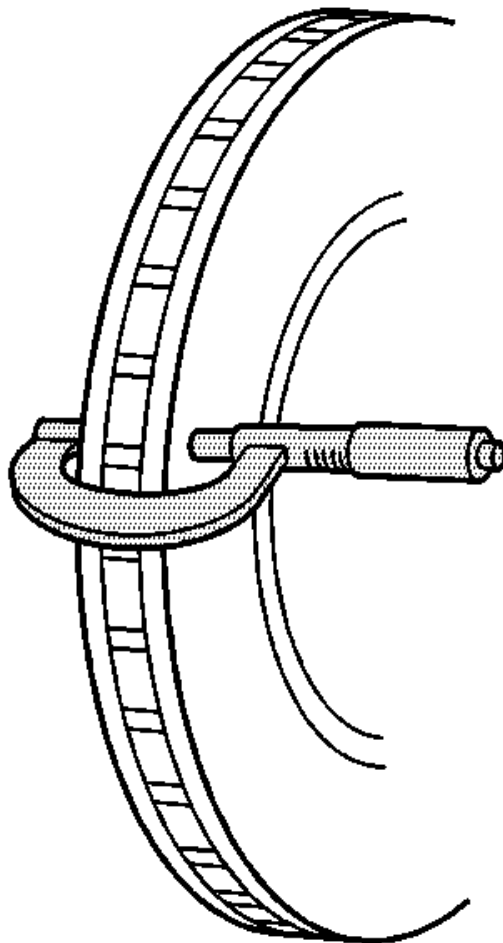


Fig. 2: Measuring Brake Rotor Thickness
Courtesy of GENERAL MOTORS COMPANY

3. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the thickness of the brake rotor at 4 or more points, evenly spaced around the rotor.

Ensure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outer edge of the rotor, about 13 mm (1/2 in), for each measurement.

4. Calculate the difference between the highest and lowest thickness measurements recorded to obtain the amount of thickness variation.
5. Compare the thickness variation measurement to the following specification:

Specification

Brake rotor maximum allowable thickness variation: 0.006 mm (0.00024 in)

NOTE: **Whenever a brake rotor is refinished or replaced, the assembled lateral runout (LRO) of the rotor must be measured to ensure optimum performance of the disc brakes.**

6. If the brake rotor thickness variation measurement exceeds the specification, the rotor requires refinishing or replacement.

BRAKE ROTOR SURFACE AND WEAR INSPECTION

WARNING: Refer to **Brake Dust Warning** .

1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to **Front Disc Brake Pads Replacement (J60, J61)**, **Front Disc Brake Pads Replacement (J64)**, and/or **Rear Disc Brake Pads Replacement**.
2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
3. Inspect the friction surfaces of the brake rotor for the following Braking Surface Conditions:
 - Heavy rust and/or pitting

Light surface rust can be removed with an abrasive disc. Heavy surface rust and/or pitting must be removed by refinishing the rotor.

- Cracks and/or heat spots
 - Excessive blueing discoloration
4. If the friction surfaces of the brake rotor exhibit one or more of the Braking Surface Conditions, the rotor requires refinishing or replacement.

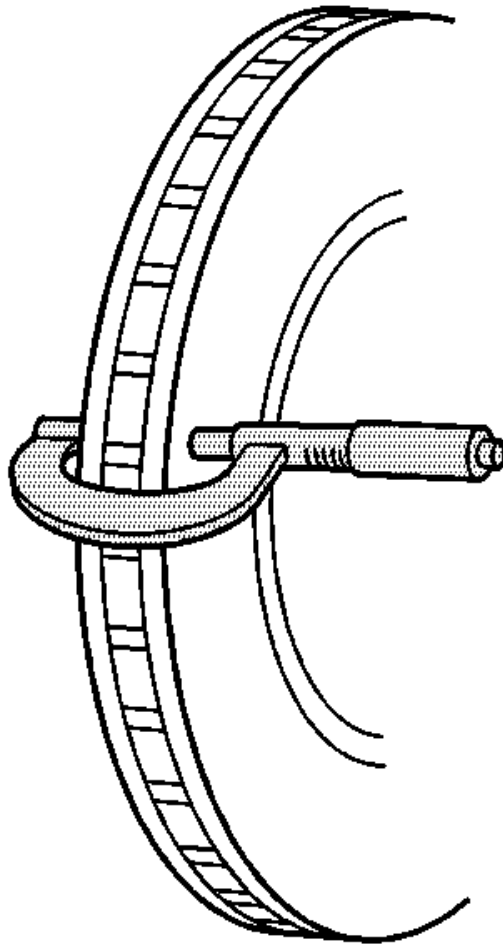


Fig. 3: Measuring Brake Rotor Thickness
Courtesy of GENERAL MOTORS COMPANY

5. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the scoring depth of any grooves present on the rotor friction surfaces.
6. Compare the groove scoring depth recorded to the following specification:

Specification

Brake rotor maximum allowable scoring: 1.50 mm (0.059 in)

7. If the brake rotor scoring depth exceeds the specification, or if an excessive amount of scoring is present, the rotor requires refinishing or replacement.

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT MEASUREMENT

Special Tools

- **CH-41013** Rotor Resurfacing Kit

- **CH-42450-A** Wheel Hub Resurfacing Kit
- **CH-45101** Hub and Wheel Runout Gauge
- **CH-45101-100** Conical Brake Rotor Washers

For equivalent regional tools, refer to **Special Tools**.

WARNING: Refer to **Brake Dust Warning** .

NOTE:

- **Brake rotor assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4,800-11,300 km (3,000-7,000 mi).**
- **Brake rotor thickness variation MUST be checked BEFORE checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to **Brake Rotor Thickness Variation Measurement**.**

1. Matchmark the position of the brake rotor to the wheel studs if this has not been done already.

NOTE:

Whenever the brake rotor has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake rotor mating surfaces. Failure to do this may result in excessive assembled lateral runout (LRO) of the brake rotor, which could lead to brake pulsation.

2. Inspect the mating surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles, corrosion, rust, or debris remaining. If the wheel hub/axle flange and/or if the brake rotor mating surfaces exhibit these conditions, perform the following steps:
 1. Remove the brake rotor from the vehicle. Refer to **Front Brake Rotor Replacement (J60, J61)**, **Front Brake Rotor Replacement (J64)**, and/or **Rear Brake Rotor Replacement**.
 2. Using the **CH-42450-A** wheel hub resurfacing kit , thoroughly clean any rust or corrosion from the mating surface of the hub/axle flange.
 3. Using the **CH-41013** rotor resurfacing kit , thoroughly clean any rust or corrosion from the mating surface of the brake rotor.
 4. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
3. Install the rotor to the hub/axle flange using the matchmark made prior to removal.

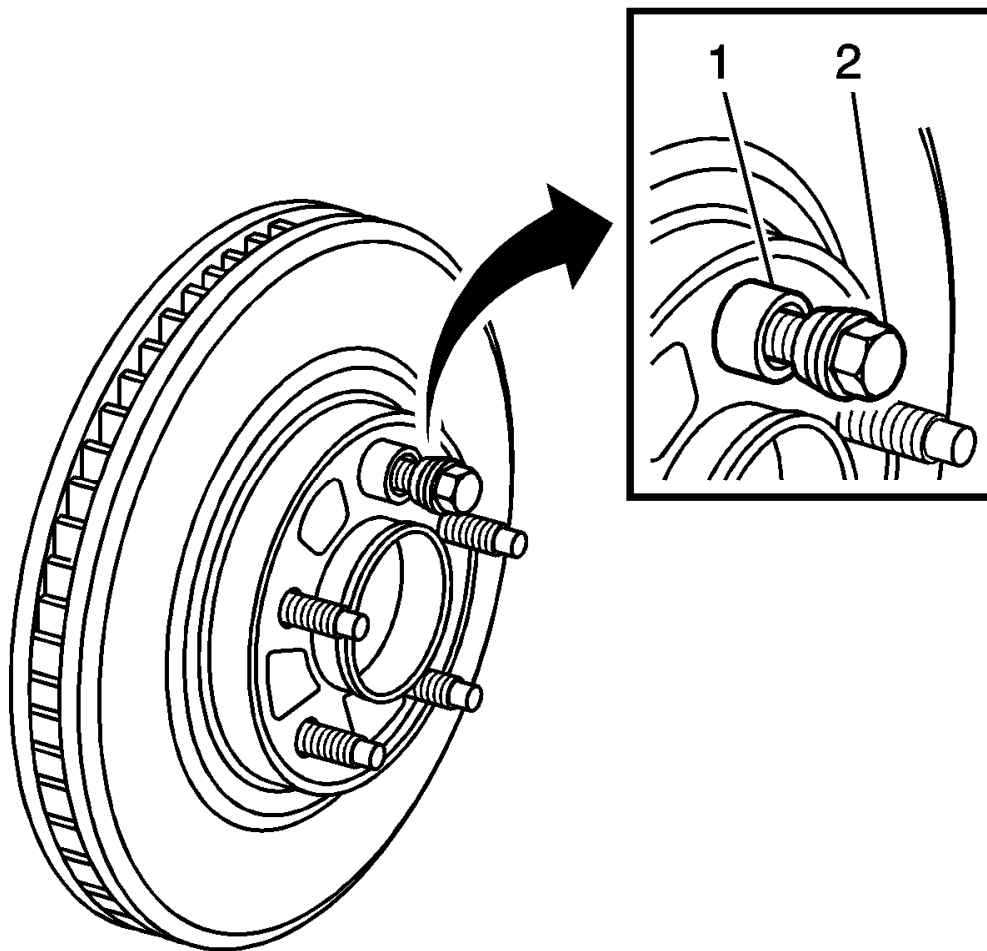


Fig. 4: Identifying Special Tool J 45101-100 & Lug Nut
Courtesy of GENERAL MOTORS COMPANY

4. Hold the rotor firmly in place against the hub/axle flange and install one of the **CH-45101-100** conical brake rotor washers (1), and one lug nut (2) onto the upper-most wheel stud.
5. Continue to hold the rotor secure and tighten the lug nut firmly by hand.

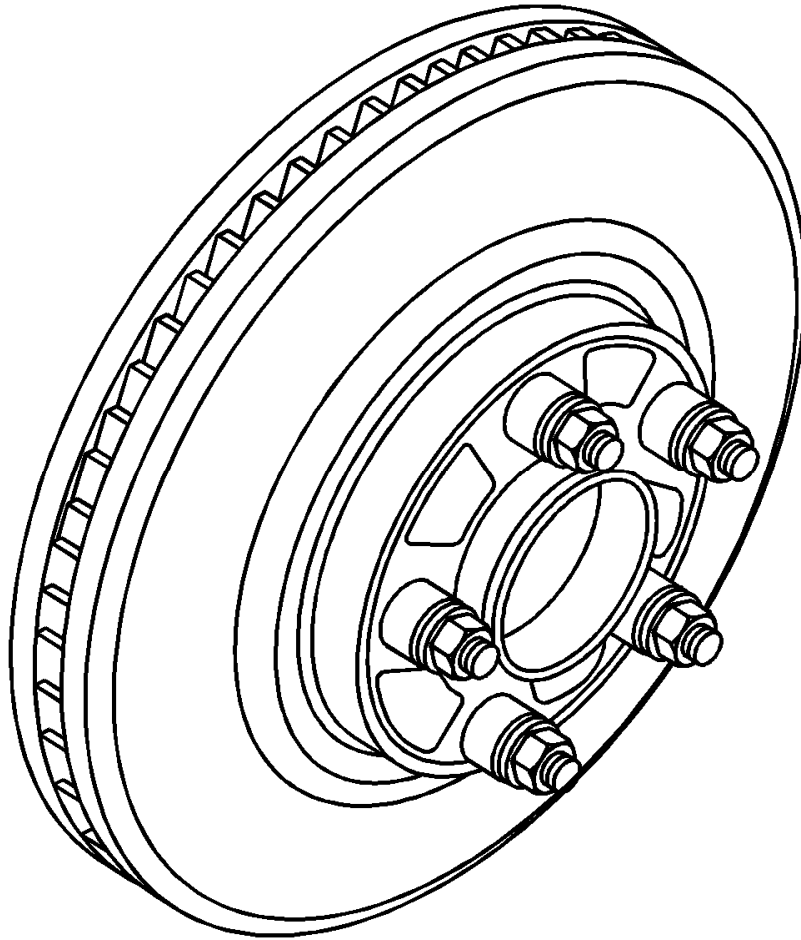


Fig. 5: Identifying All Special Tools J 45101-100s & Lug Nuts
Courtesy of GENERAL MOTORS COMPANY

6. Install the remaining **CH-45101-100** conical brake rotor washers and lug nuts onto the wheel studs and tighten the nuts firmly by hand in a star-pattern.
7. Tighten the lug nuts in a star-pattern to specification. Refer to **Tire and Wheel Removal and Installation** .
8. If the brake rotor has been REFINISHED or REPLACED with a new rotor, proceed to step 14.
9. If the brake rotor meets the following criteria, proceed to step 10.
 - The rotor is within specifications and is being REUSED.
 - The rotor has NOT been refinished.
 - The rotor does NOT exhibit thickness variation exceeding the maximum allowable level.

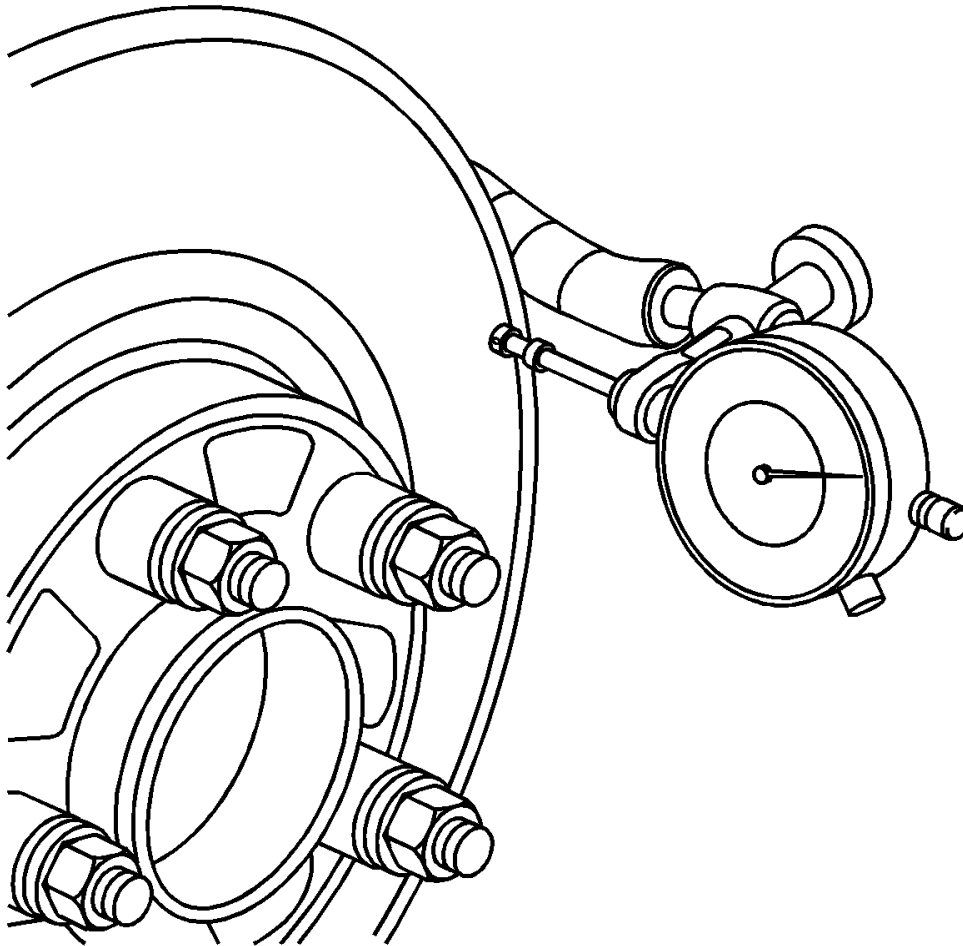


Fig. 6: Using Dial Indicator To Measure Lateral Runout
Courtesy of GENERAL MOTORS COMPANY

10. Mount a dial indicator, **CH-45101** hub and wheel runout gauge , or equivalent, to the steering knuckle and position the indicator button so it contacts the brake rotor friction surface at a 90 degree angle, approximately 13 mm (0.5 in) from the outer edge of the rotor.
11. Measure and record the assembled LRO of the brake rotor.
 1. Rotate the rotor until the lowest reading is displayed on the indicator dial, then set the dial to zero.
 2. Rotate the rotor until the highest reading is displayed on the dial.
 3. Mark the location of the high spot relative to the nearest wheel stud, or studs.
 4. Measure and record the amount of LRO.
12. Compare the brake rotor assembled LRO to the following specification:

Specification

- Front brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)
- Rear brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)

13. If the brake rotor assembled LRO is within specifications, proceed to step 18.

If the brake rotor assembled LRO exceeds the specification, refinish the rotor to ensure true parallelism. Refer to **Brake Rotor Refinishing**. After refinishing the rotor, proceed to step 14.

14. Mount a dial indicator, **CH-45101** hub and wheel runout gauge , or equivalent, to the steering knuckle and position the indicator button so it contacts the brake rotor friction surface at a 90 degree angle, approximately 13 mm (0.5 in) from the outer edge of the rotor.
15. Measure and record the assembled LRO of the brake rotor.
1. Rotate the rotor until the lowest reading is displayed on the indicator dial, then set the dial to zero.
 2. Rotate the rotor until the highest reading is displayed on the dial.
 3. Mark the location of the high spot relative to the nearest wheel stud, or studs.
 4. Measure and record the amount of LRO.
16. Compare the brake rotor assembled LRO to the following specification:

Specification

- Front brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)
 - Rear brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)
17. If the brake rotor assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to **Brake Rotor Assembled Lateral Runout Correction**.
18. If the brake rotor assembled LRO measurement is within specification, install the brake caliper and depress the brake pedal several times to secure the rotor in place before removing the **CH-45101-100** conical brake rotor washers and the lug nuts.

BRAKE PAD INSPECTION

WARNING: Refer to **Brake Dust Warning** .

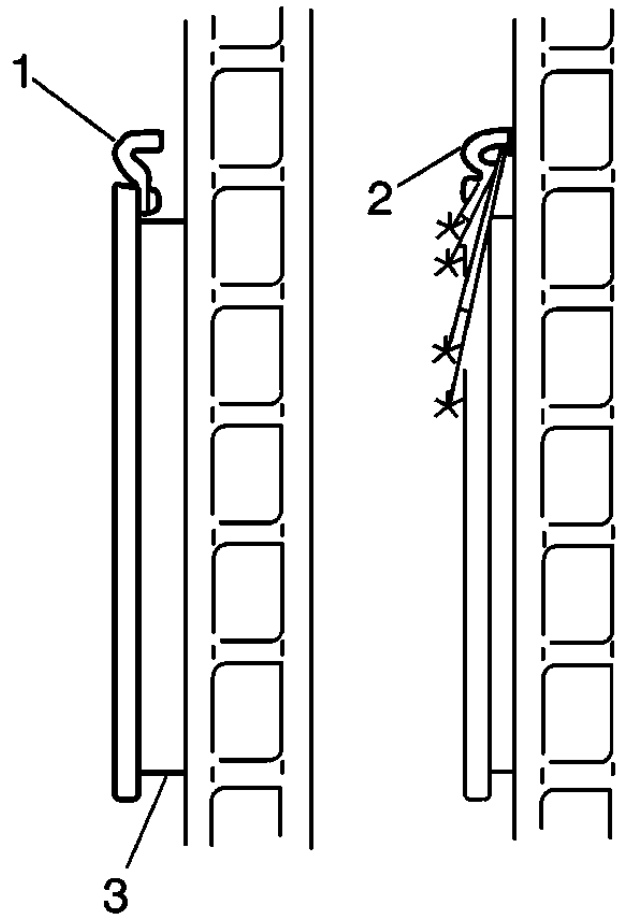


Fig. 7: View Of Brake Pads & Audible Wear Sensors
Courtesy of GENERAL MOTORS COMPANY

- Inspect the disc brake pads at regular intervals, or whenever the tire and wheel assemblies are removed from the vehicle.
- If replacement is necessary, always replace disc brake pads in axle sets.
- Inspect both edges of the disc brake pad friction surfaces (3). The highest rate of wear normally occurs at the trailing edge of the disc brake pads.
- Inspect the thickness of the disc brake pads (3) in order to ensure that they have not worn prematurely. The disc brake pad wear should be approximately even per axle set.
- Both front and rear disc brake pads have integral, audible wear sensors (1). When the disc brake pad wear reaches the minimum allowable thickness, the wear sensor contacts the disc brake rotor (2). The wear indicator will then produce an audible, high-pitched warning noise during wheel rotation.
- Replace the disc brake pads when the friction surface (3) is worn to within 2 mm (0.08 in) of the mounting plates.
- Remove the brake calipers and inspect the friction surfaces of the inner and outer disc brake pads to

ensure that they are level. Place the disc brake pad friction surfaces together and measure the gap between the surfaces. If more than 0.13 mm (0.005 in) gap exists midway between the length of the disc brake pads, replace the disc brake pads.

- Verify that any disc brake pad shims that may be required are in place and not damaged or excessively corroded. Replace any missing or damaged shims in order to preserve proper disc brake performance.
- Replace the disc brake pads if any have separated from the mounting plates.
- Inspect the disc brake pads friction surfaces for cracks, fractures, or damage which may cause noise or otherwise impair disc brake performance.

BRAKE CALIPER INSPECTION

WARNING: Refer to Brake Dust Warning .

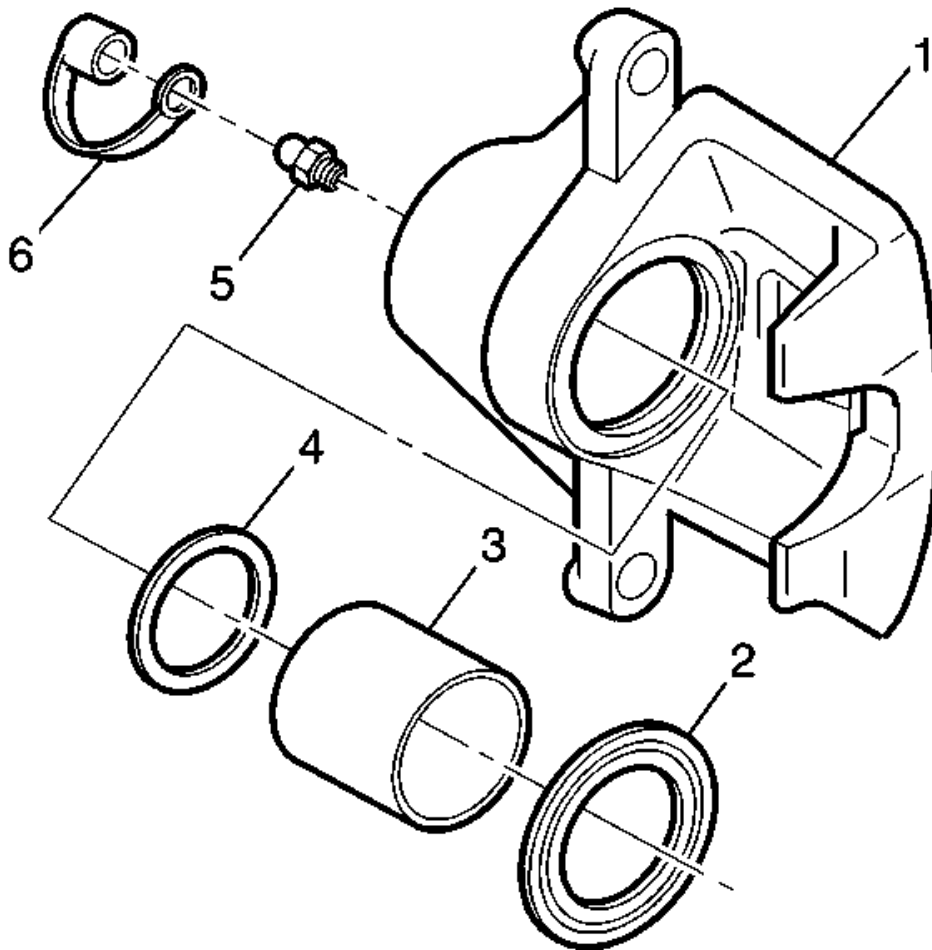


Fig. 8: Exploded View Of Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the brake caliper housing (1) for cracks, excess wear, and/or damage. If any of these conditions are present, the brake caliper requires replacement.
2. Inspect the caliper piston dust boot seal (2) for cracks, tears, cuts, deterioration and/or improper seating in the caliper body. If any of these conditions are present, the brake caliper requires overhaul or replacement.
3. Inspect for brake fluid leakage around the caliper piston dust boot seal (2) and on the disc brake pads. If there is any evidence of brake fluid leakage, the brake caliper requires overhaul or replacement.

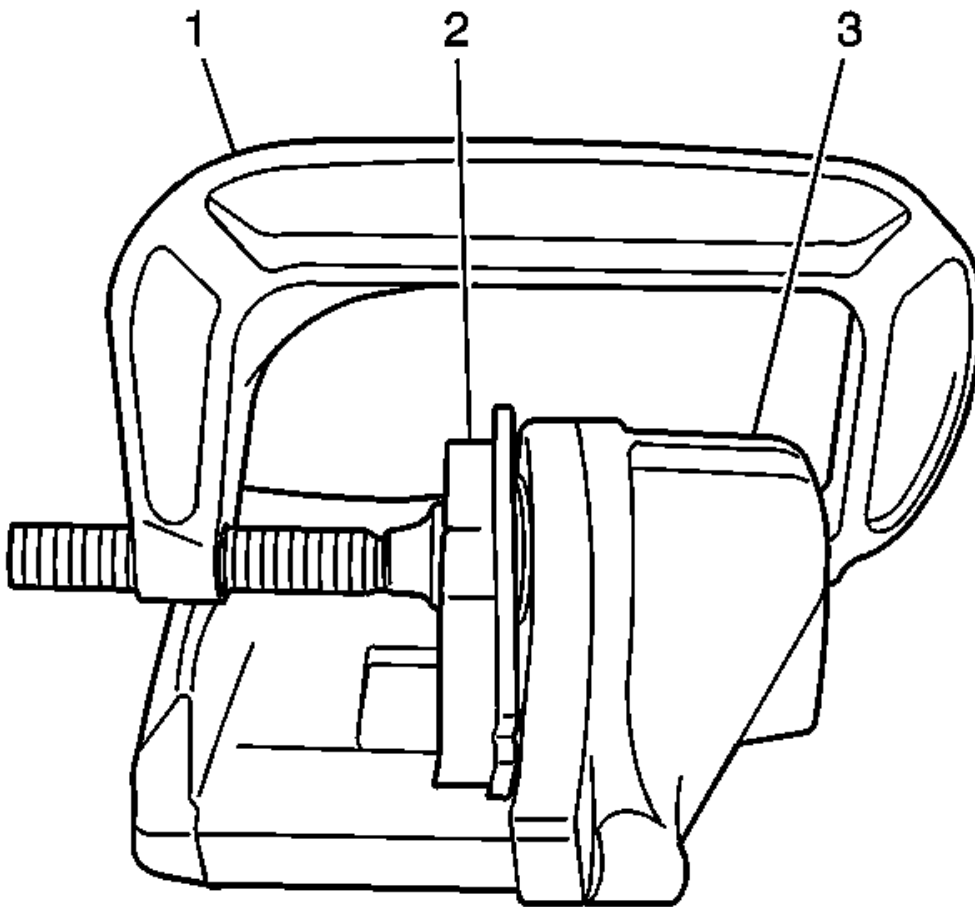


Fig. 9: Compressing Caliper Piston
Courtesy of GENERAL MOTORS COMPANY

4. Inspect for smooth and complete travel of the caliper pistons into the caliper bores:

The movement of the caliper pistons into the caliper bores should be smooth and even. If the caliper piston is frozen or difficult to bottom, the caliper requires overhaul or replacement.

- For single piston caliper applications, insert a discarded inner brake pad (2) or block of wood in front of the piston. Using a large C-clamp (1) installed over the body of the caliper (3) and against

the brake pad or block of wood, slowly bottom the piston in the bore.

- For dual piston caliper applications, insert a discarded inner brake pad (2) or block of wood in front of the pistons. Using 2 large C-clamps (1) installed over the body of the caliper (3) and against the brake pad or block of wood, slowly bottom the pistons evenly into the bores.

FRONT DISC BRAKE MOUNTING AND HARDWARE INSPECTION

WARNING: Refer to Brake Dust Warning .

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level then no brake fluid needs to be removed from the reservoir before proceeding.
3. If the brake fluid level is higher than midway between the maximum-full point and the minimum allowable level then remove brake fluid to the midway point before proceeding.
4. Raise and support the vehicle. Refer Lifting and Jacking the Vehicle .
5. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .

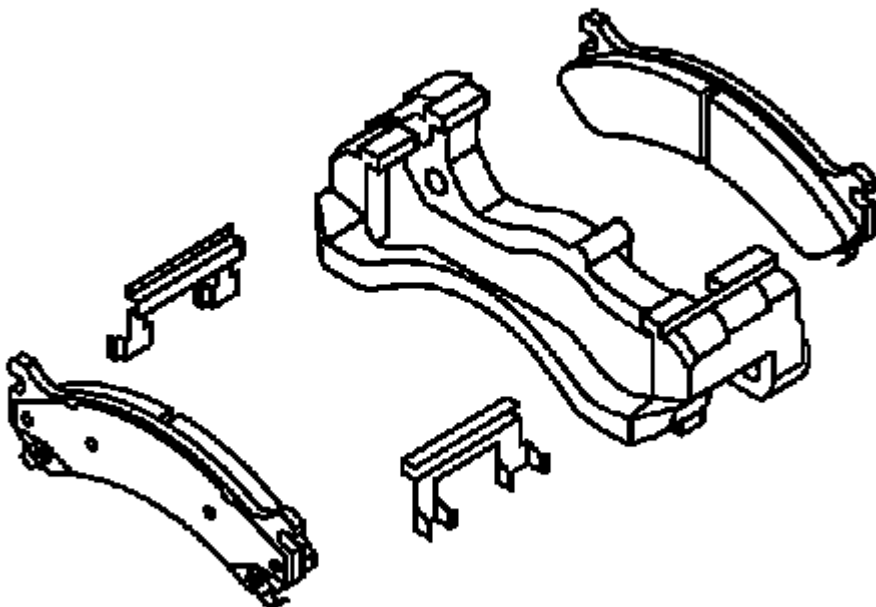


Fig. 10: View Of Disc Brake Pads & Brake Caliper Mounting Bracket

Courtesy of GENERAL MOTORS COMPANY

6. Grasp the brake caliper housing and try to move the brake caliper housing up/down and forward/reverse in relation to the brake caliper mounting bracket. If excessive looseness is observed the brake caliper bracket bushings and/or the brake caliper mounting bolts may need to be replaced.
7. Compress the front caliper pistons.
 - Install a large C-clamp over the top of the caliper housing and against the back of the outboard pad.
 - Slowly tighten the C-clamp until the pistons are pushed completely into the caliper bores.
 - Remove the C-clamp from the caliper.
8. With the pistons compressed into the caliper bores, grasp the brake caliper housing and slide it back and forth on the brake caliper mounting bolts. Check for smooth operation. If the brake caliper housing slide force is high or the brake caliper housing does not slide smoothly, inspect the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings for wear or damage. If wear or damage conditions are found, replacement of the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings is necessary.
9. Remove the brake caliper mounting bolts from the brake caliper mounting bracket and support the brake caliper using heavy mechanics wire. Do Not remove the hydraulic brake hose from the caliper. Refer to **Front Brake Caliper Replacement (J60, J61), Front Brake Caliper Replacement (J64).**
10. Remove the disc brake pads from the brake caliper mounting bracket.
11. Inspect the disc brake pad mounting hardware for the following:
 - Missing mounting hardware
 - Excessive corrosion
 - Bent mounting tabs
 - Looseness at the brake caliper mounting bracket
 - Looseness at the disc brake pads
 - Excessive contaminants in the brake caliper mounting bracket surface and threads.
12. If any of the conditions listed are found, the disc brake pad mounting hardware requires replacement.
13. Ensure the disc brake pads are held firmly in place on the brake caliper mounting bracket, yet slide easily on the mounting hardware without binding.

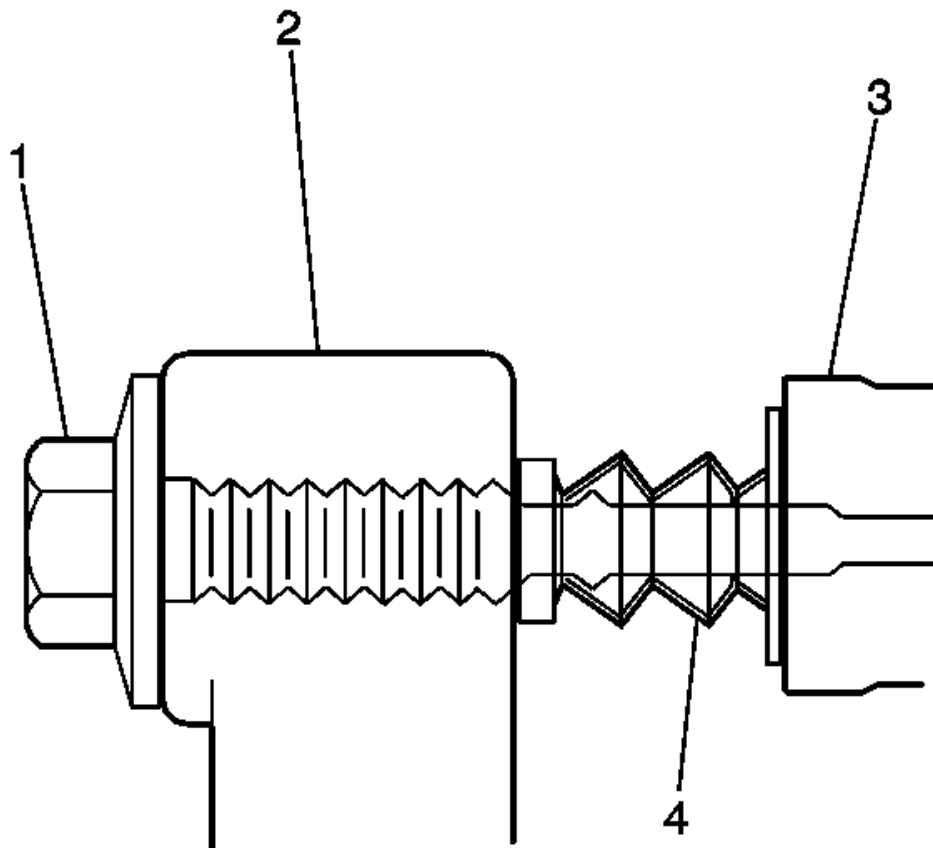


Fig. 11: View Of Caliper, Pin, Boots & Caliper Mounting Bracket
Courtesy of GENERAL MOTORS COMPANY

14. Inspect the caliper bolts (1) for the following:
 - Binding
 - Seizing
 - Looseness in the brake caliper mounting bracket (3)
 - Bent or damaged brake caliper mounting bolts
 - Cracked or torn boots (4)
 - Missing boots
 - Bent or damaged brake caliper mounting bracket (3)
15. If any of the conditions listed are found then the brake caliper mounting hardware requires replacement.
16. Install the disc brake pads to the brake caliper mounting bracket.
17. Install the disc brake caliper to the brake caliper mounting bracket. Refer to **Front Brake Caliper Replacement (J60, J61)**, **Front Brake Caliper Replacement (J64)**.

REAR DISC BRAKE MOUNTING AND HARDWARE INSPECTION

WARNING: Refer to Brake Dust Warning .

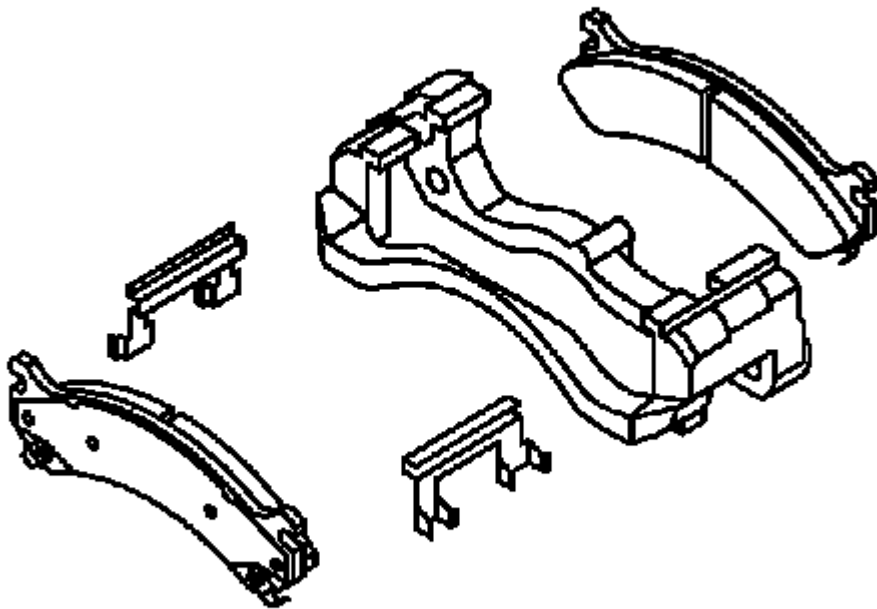


Fig. 12: View Of Disc Brake Pads & Brake Caliper Mounting Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the disc brake caliper from the caliper mounting bracket.
2. Remove the disc brake pads from the caliper mounting bracket.
3. Inspect the disc brake pad mounting hardware for the following:
 - Missing mounting hardware
 - Excessive corrosion
 - Bent mounting tabs
 - Looseness at the caliper mounting bracket
 - Looseness at the disc brake pads
4. If any of the conditions listed are found, the disc brake pad mounting hardware requires replacement.
5. Ensure the disc brake pads are held firmly in place on the caliper mounting bracket, yet slide easily on the

mounting hardware without binding.

6. Install the disc brake pads to the caliper mounting bracket.
7. Install the disc brake caliper to the mounting bracket.

REPAIR INSTRUCTIONS

FRONT DISC BRAKE PADS REPLACEMENT (J60, J61)

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

NOTE: **Always replace disc brake pads in axle sets.**

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level, no brake fluid needs to be removed before proceeding.
3. If the brake fluid level is higher than midway between the maximum-full point and the minimum allowable level, remove brake fluid to the midway point before proceeding.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
6. Place a large C-clamp over the brake caliper body and against the outer brake pad.
7. Using the C-clamp, compress the brake caliper piston fully into the brake caliper bore.

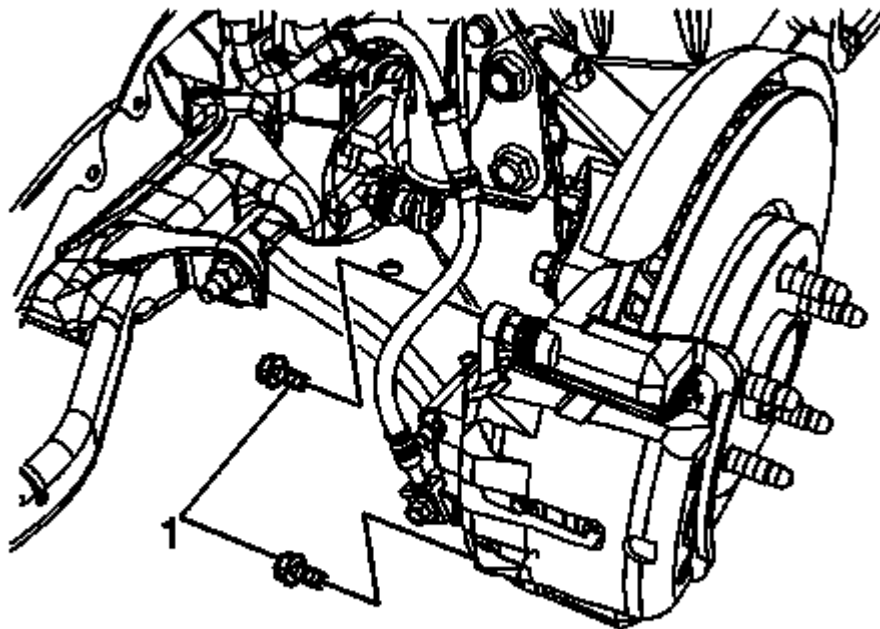


Fig. 13: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- DO NOT use any air tools to remove or install the guide pin bolts. Use hand tools ONLY.
- Install an open end wrench to hold the caliper guide pin in line with the brake caliper while removing or installing the caliper guide pin bolt. DO NOT allow the open end wrench to come in contact with the brake caliper. Allowing the open end wrench to come in contact with the brake caliper will cause a pulsation when the brakes are applied.

8. Using a backup wrench to hold the brake caliper guide pins stationary, remove the brake caliper guide pin bolts (1).

CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

9. Remove the caliper and support the caliper with heavy mechanics wire.

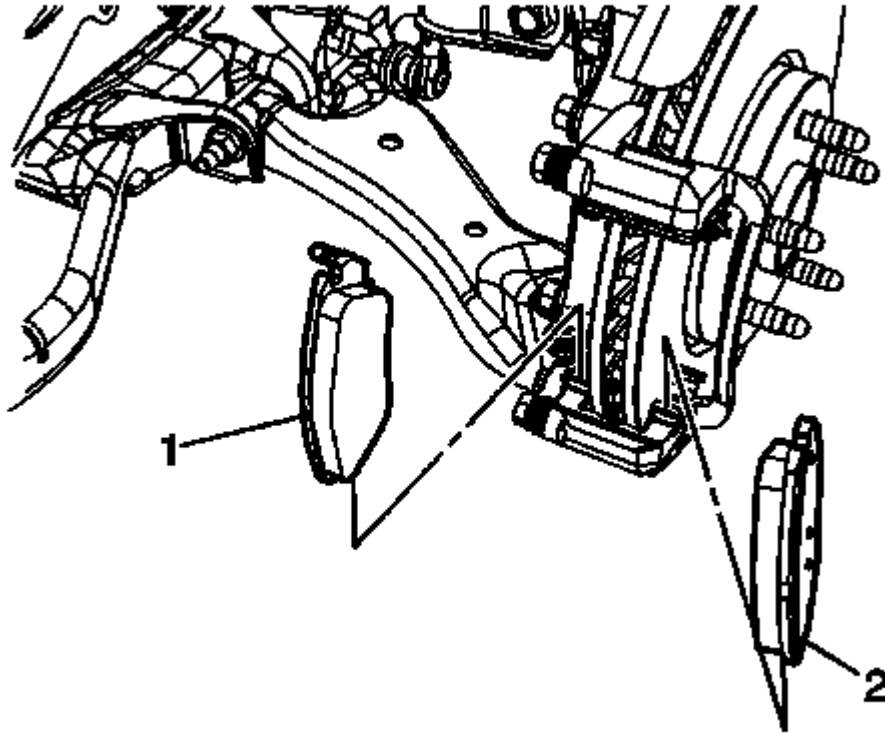


Fig. 14: Inner & Outer Brake Pads
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the location of the brake pad wear sensor for correct installation.

10. Remove the inner brake pad (1) and the outer brake pad (2).

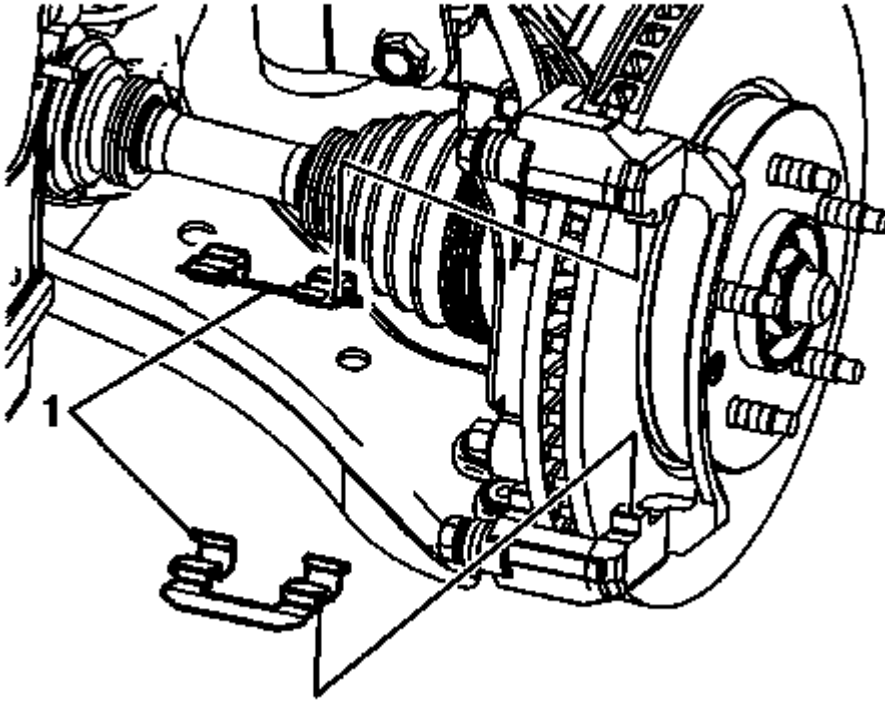


Fig. 15: Brake Pad Shims

Courtesy of GENERAL MOTORS COMPANY

11. Remove the upper and lower brake pad springs (1).
12. If installing new brake pads, discard the springs.

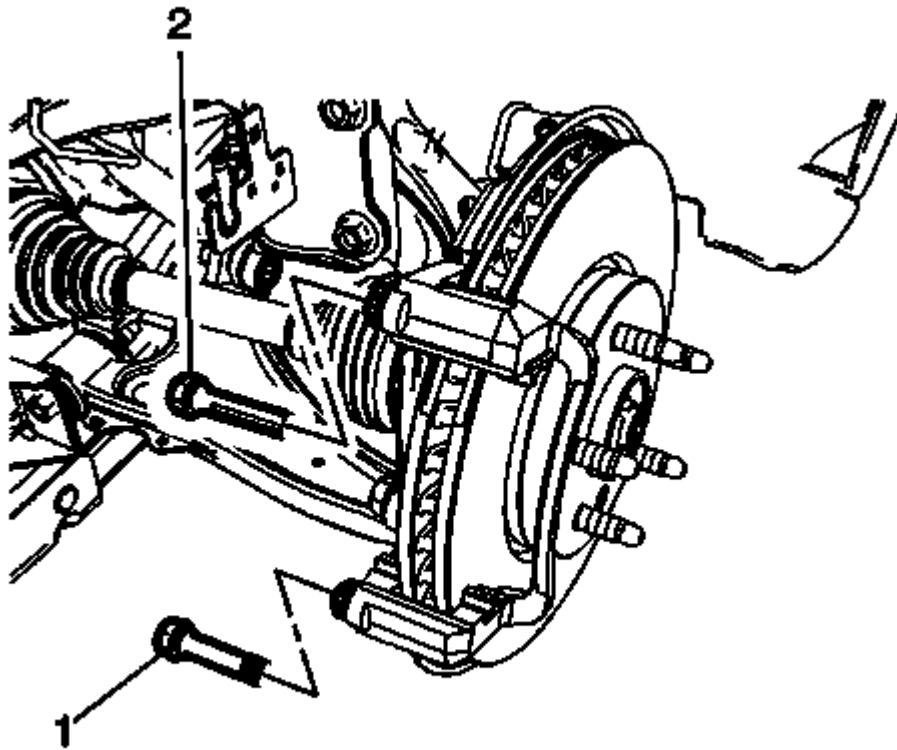


Fig. 16: Brake Caliper Guide Pins
Courtesy of GENERAL MOTORS COMPANY

NOTE: The lower brake caliper guide pin is equipped with a bushing and must be installed in the same location.

13. Remove the lower brake caliper guide pin (1).
14. Remove the upper brake caliper guide pin (2).

Installation Procedure

1. Inspect the brake caliper guide pins and guide pin seals for damage and replace, if necessary.
2. Remove any grease or debris from the brake caliper guide pins, guide pin seals, and guide pin bores in the brake caliper bracket with a clean shop cloth.
3. Apply a light coating of high temperature, silicone brake lubricant to the brake caliper bracket guide pin bores, the inner portion of the guide pin seals, and the brake caliper guide pins.

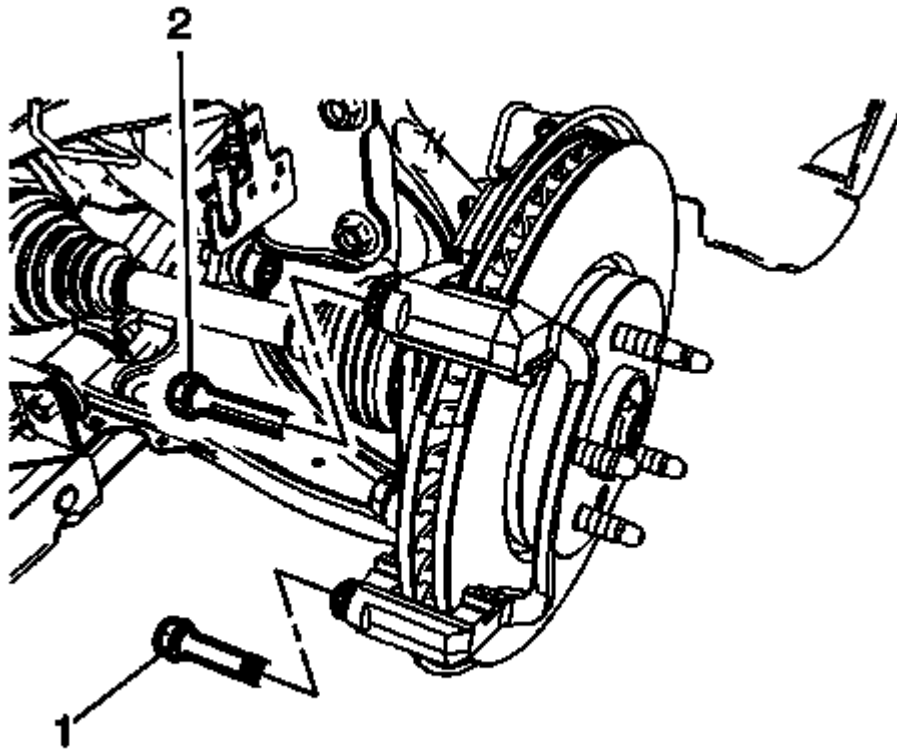


Fig. 17: Brake Caliper Guide Pins
Courtesy of GENERAL MOTORS COMPANY

NOTE: The lower brake caliper guide pin is equipped with a bushing and must be installed in the same location.

4. Install the lower brake caliper guide pin (1).
5. Seat the brake caliper guide pin seal in the groove of the brake caliper guide pin.
6. Install the upper brake caliper guide pin (2).
7. Seat the brake caliper guide pin seal in the groove of the brake caliper guide pin.

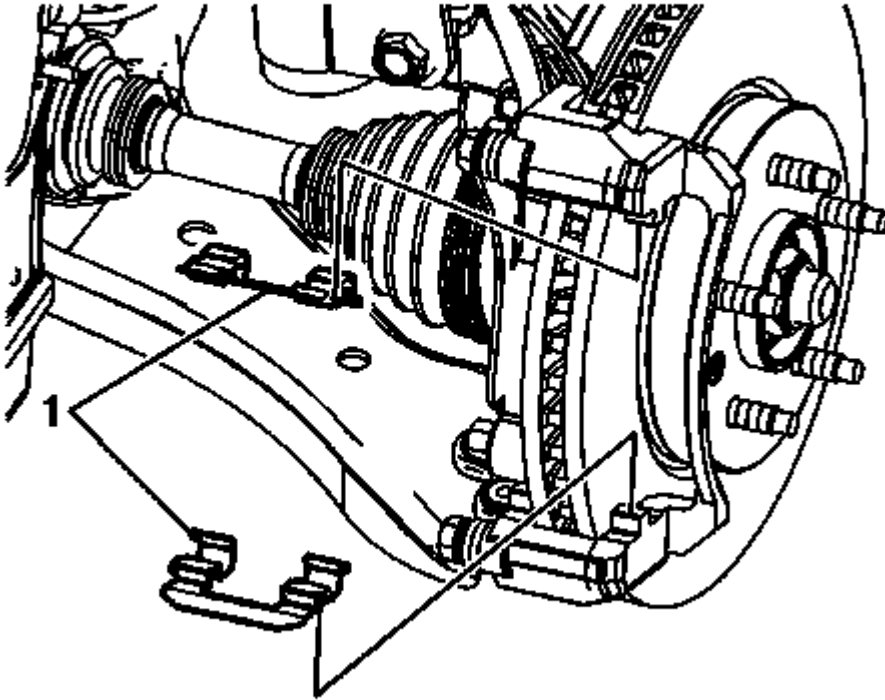


Fig. 18: Brake Pad Shims

Courtesy of GENERAL MOTORS COMPANY

NOTE: If installing new brake pads, install new springs.

8. Install the upper and lower brake pad springs (1).

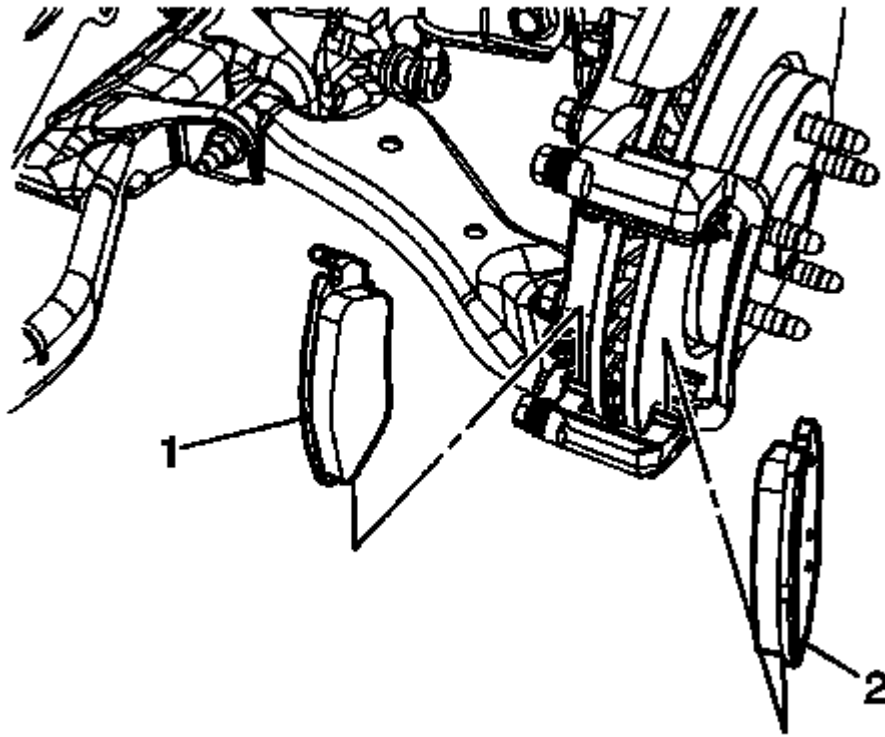


Fig. 19: Inner & Outer Brake Pads
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the location of the brake pad wear sensor for correct installation.**

9. Install the inner brake pad (1) and the outer brake pad (2).
10. Position the brake caliper to the brake caliper bracket.

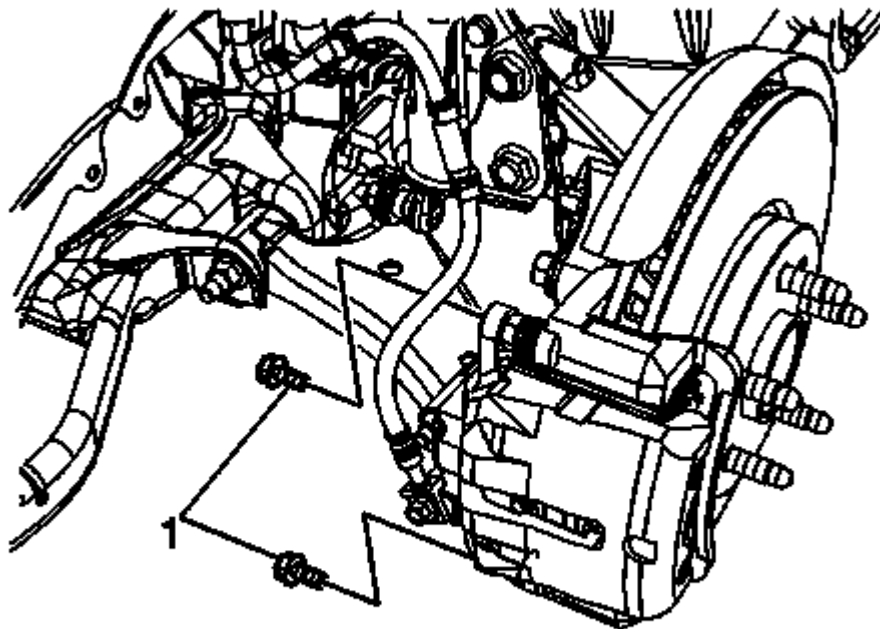


Fig. 20: Brake Caliper Guide Pin Bolts
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Using a backup wrench to hold the brake caliper guide pins stationary, install the brake caliper guide pin bolts (1) and tighten to 27 N.m (20 lb ft).
12. Install the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
13. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
14. Slowly release the brake pedal.
15. Wait 15 seconds, then repeat steps 13-14 until a firm brake pedal is obtained. This will properly seat the brake caliper piston and brake pads.
16. Fill the master cylinder reservoir. Refer to Master Cylinder Reservoir Filling .
17. Burnish the brake pads and rotors. Refer to Brake Pad and Rotor Burnishing.

FRONT DISC BRAKE PADS REPLACEMENT (J64)

WARNING: Refer to Brake Dust Warning .

NOTE: Always replace disc brake pads in axle sets.

Removal Procedure

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level, no brake fluid needs to be removed from the reservoir before proceeding.
3. If the brake fluid level is higher than midway between the maximum-full point and the minimum allowable level, remove brake fluid to the midway point before proceeding.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

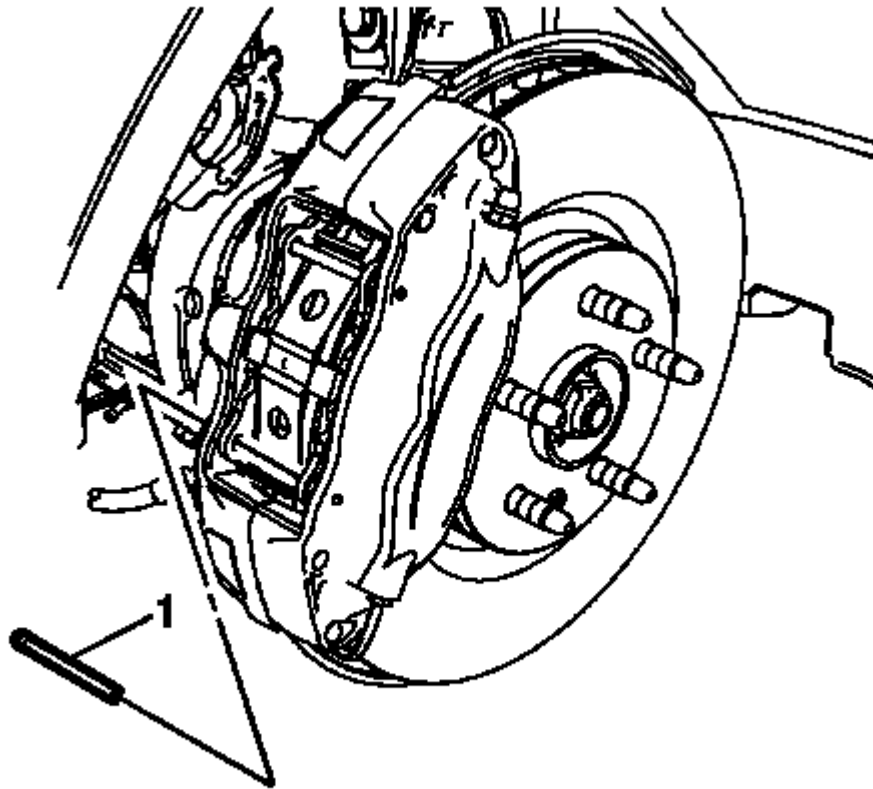


Fig. 21: Lower Brake Caliper Pin
Courtesy of GENERAL MOTORS COMPANY

6. Hold the end of the brake pad spring down and carefully drive out the lower brake caliper pin (1) from the brake caliper.

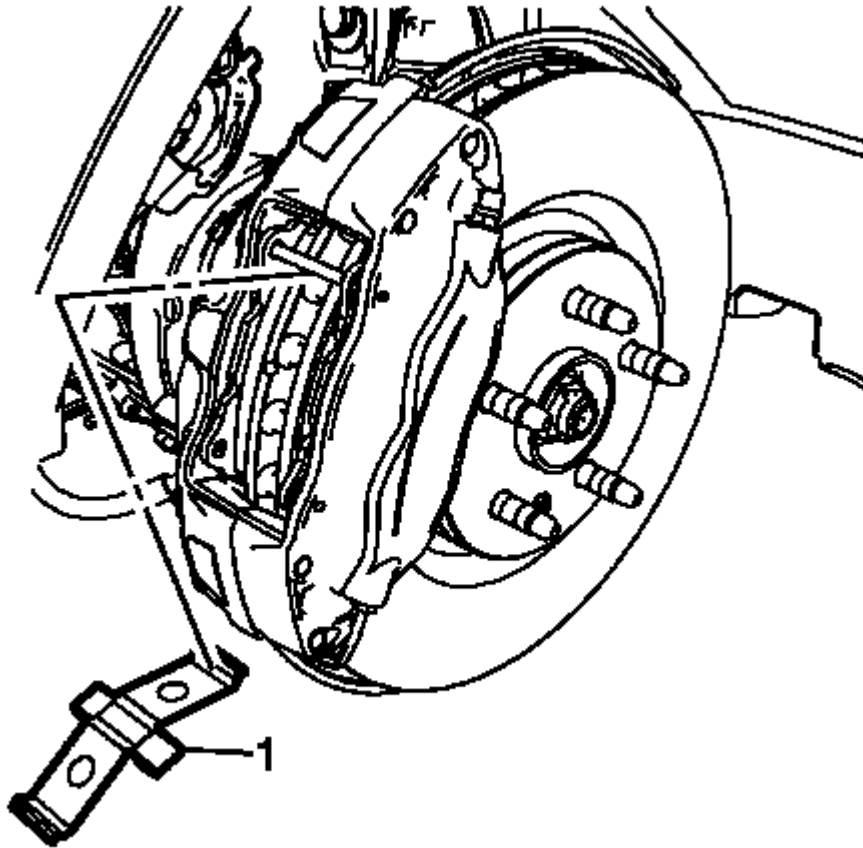


Fig. 22: Brake Pad Spring

Courtesy of GENERAL MOTORS COMPANY

7. Remove the brake pad spring (1).

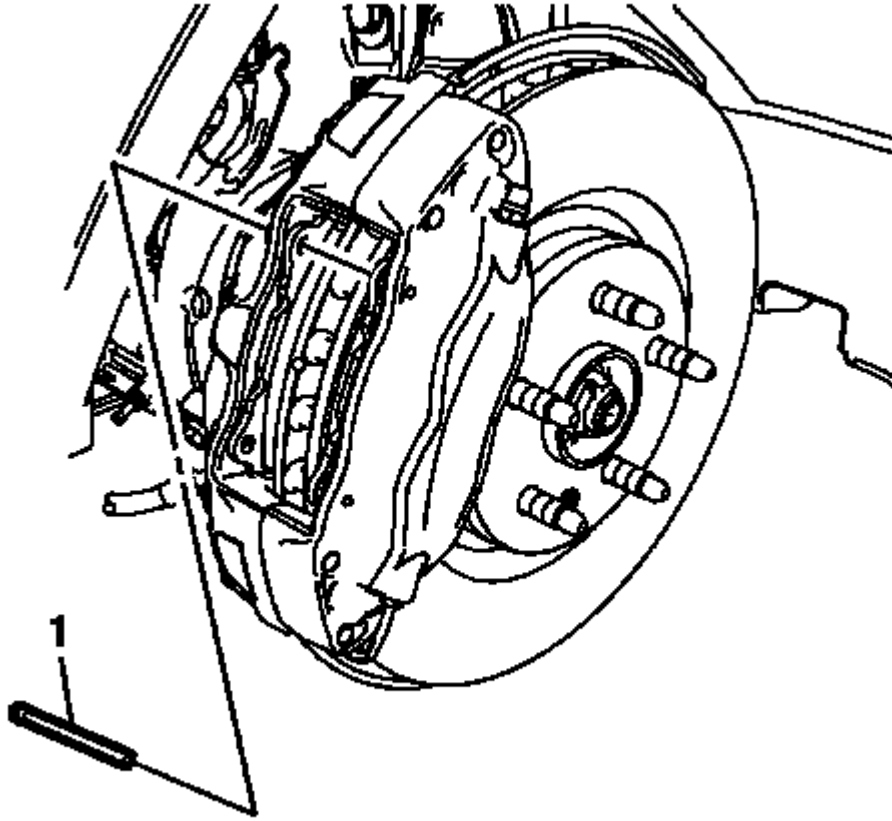


Fig. 23: Upper Brake Caliper Pin
Courtesy of GENERAL MOTORS COMPANY

8. Carefully drive out the upper brake pad pin (1) from the brake caliper.
9. Using a spreader tool, carefully push the brake caliper pistons into the caliper bores until fully seated.

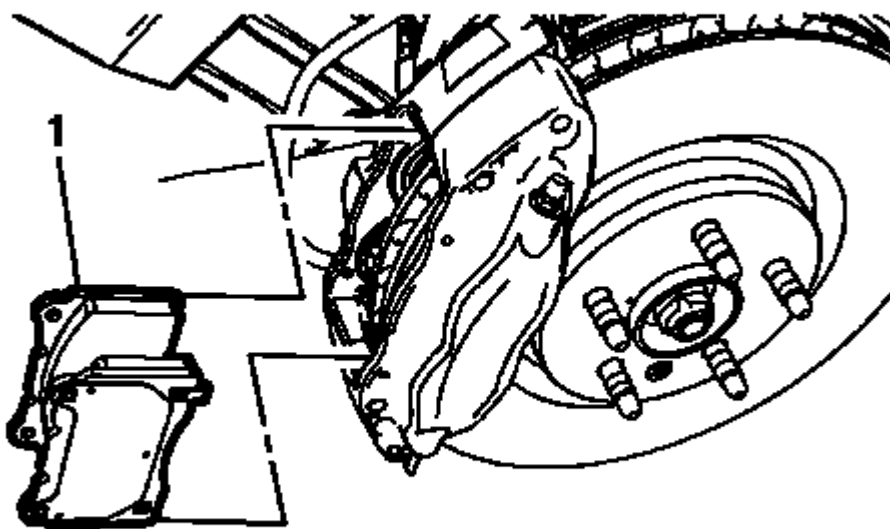


Fig. 24: Brake Pads

Courtesy of GENERAL MOTORS COMPANY

10. Remove the brake pads (1).

Installation Procedure

1. Inspect the brake caliper pins and brake pad springs for damage or excessive corrosion and replace, if necessary.

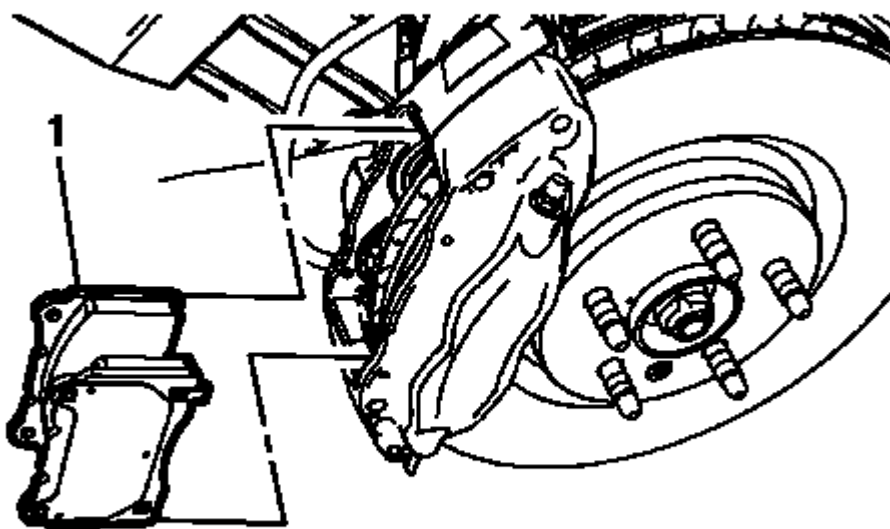


Fig. 25: Brake Pads

Courtesy of GENERAL MOTORS COMPANY

2. Install the brake pads (1).

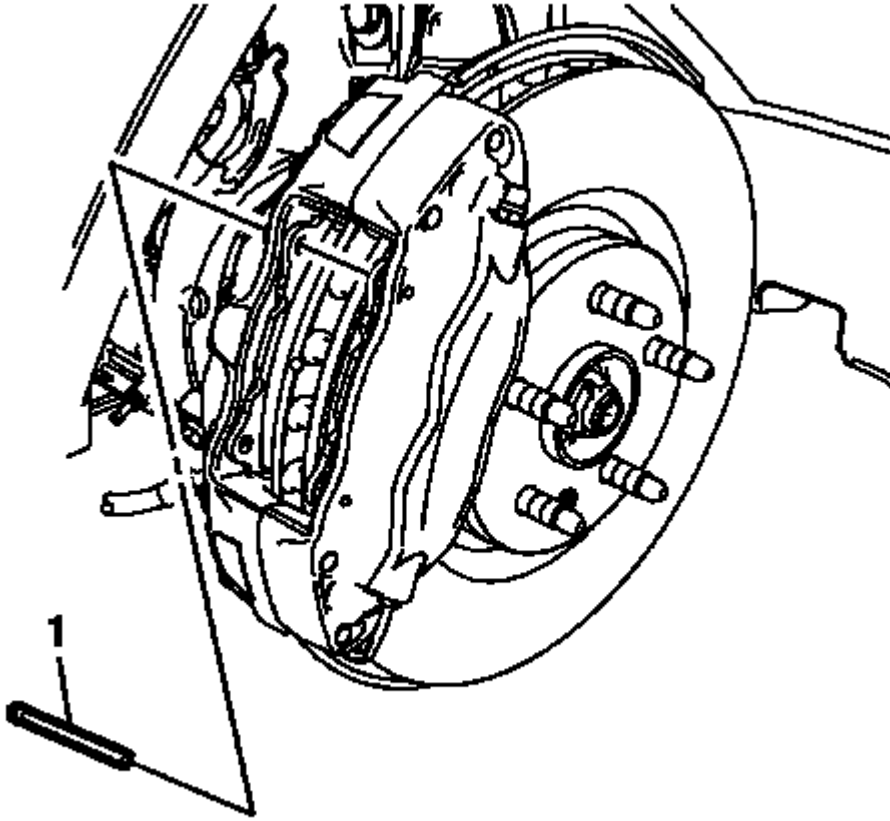


Fig. 26: Upper Brake Caliper Pin
Courtesy of GENERAL MOTORS COMPANY

3. Carefully drive the upper brake caliper pin (1) into the brake caliper.
4. Ensure the brake caliper pin is fully seated in the brake caliper.

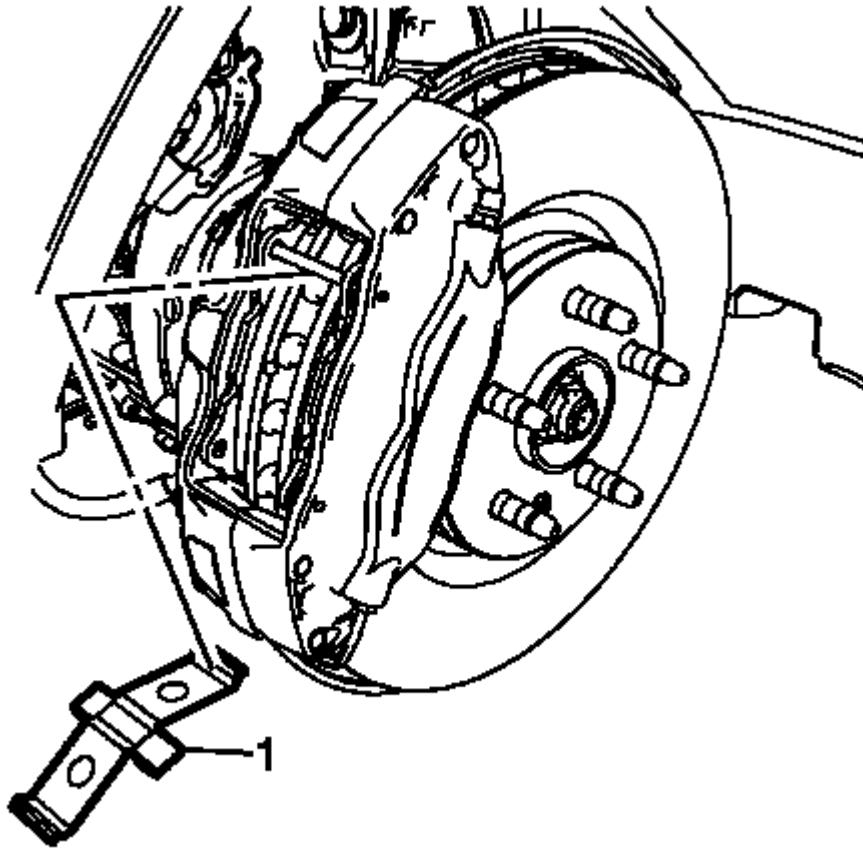


Fig. 27: Brake Pad Spring

Courtesy of GENERAL MOTORS COMPANY

5. Install the brake pad spring (1).

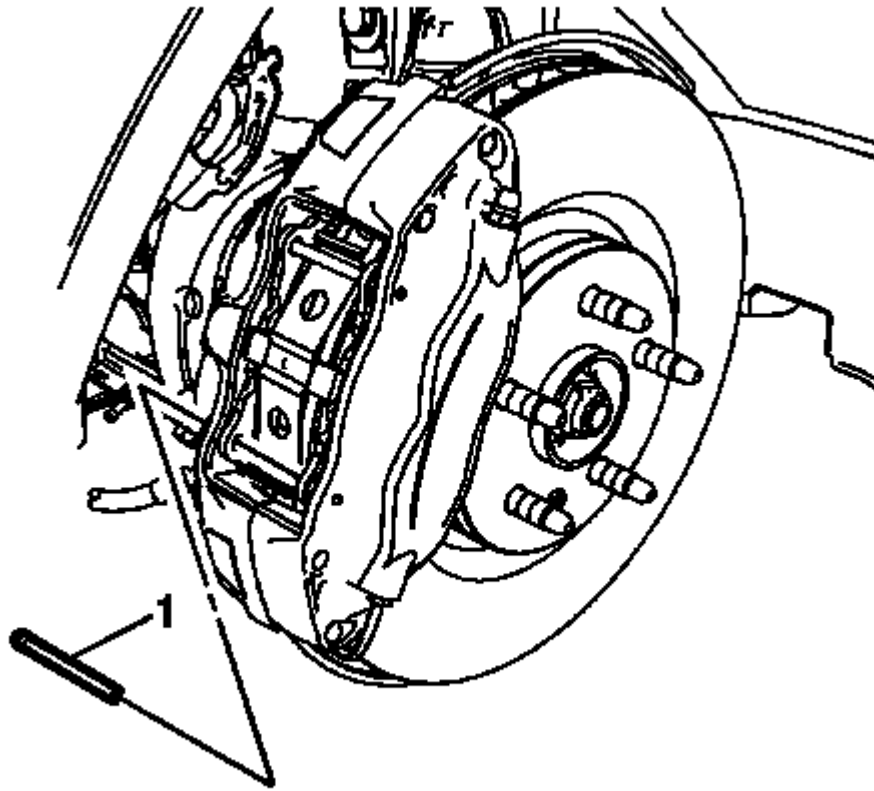


Fig. 28: Lower Brake Caliper Pin

Courtesy of GENERAL MOTORS COMPANY

6. Hold the end of the brake pad spring down and carefully drive the lower brake caliper pin (1) into the brake caliper.
7. Ensure the brake caliper pin is fully seated in the brake caliper.
8. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
9. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
10. Slowly release the brake pedal.
11. Wait 15 seconds, then repeat steps 9 and 10 until a firm brake pedal apply is obtained. This will properly seat the brake caliper pistons and brake pads.
12. Fill the brake master cylinder reservoir to the proper level. Refer to **Master Cylinder Reservoir Filling** .
13. Burnish the brake pads and rotors. Refer to **Brake Pad and Rotor Burnishing**.

REAR DISC BRAKE PADS REPLACEMENT

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

NOTE: **Always replace disc brake pads in axle sets.**

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level, no brake fluid needs to be removed before proceeding.
3. If the brake fluid level is higher than midway between the maximum-full point and the minimum allowable level, remove brake fluid to the midway point before proceeding.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

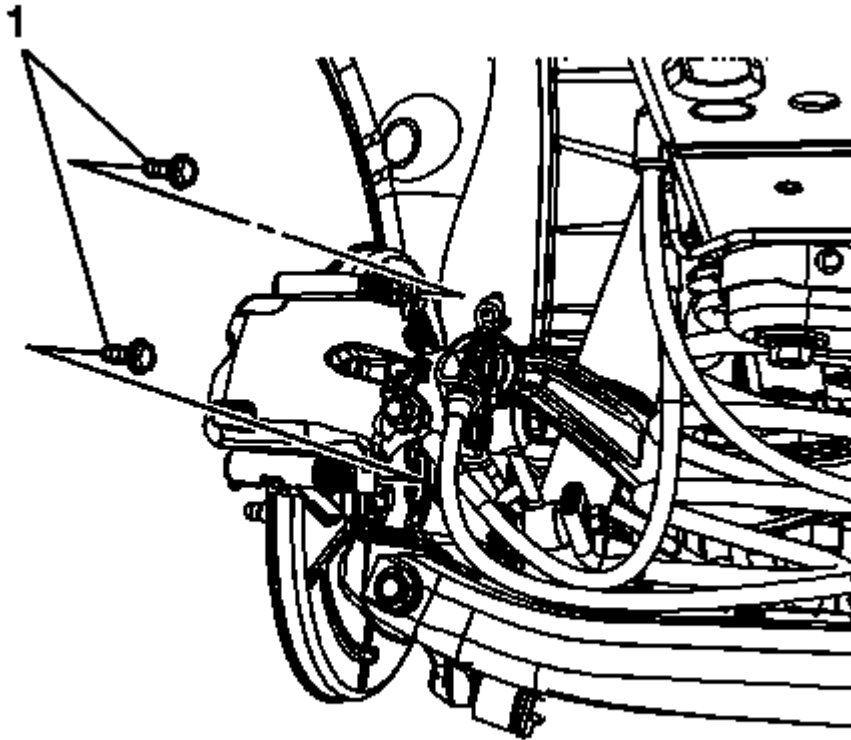


Fig. 29: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **DO NOT** use any air tools to remove or install the guide pin bolts. Use hand tools **ONLY**
- Install an open end wrench to hold the caliper guide pin in line with the brake caliper while removing or installing the caliper guide pin bolt. **DO NOT** allow the open end wrench to come in contact with the

brake caliper. Allowing the open end wrench to come in contact with the brake caliper will cause a pulsation when the brakes are applied.

6. Using a backup wrench to hold the brake caliper guide pin stationary, remove the brake caliper guide pin bolts (1).

CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

7. Remove the brake caliper from the brake caliper bracket and support with heavy mechanics wire.

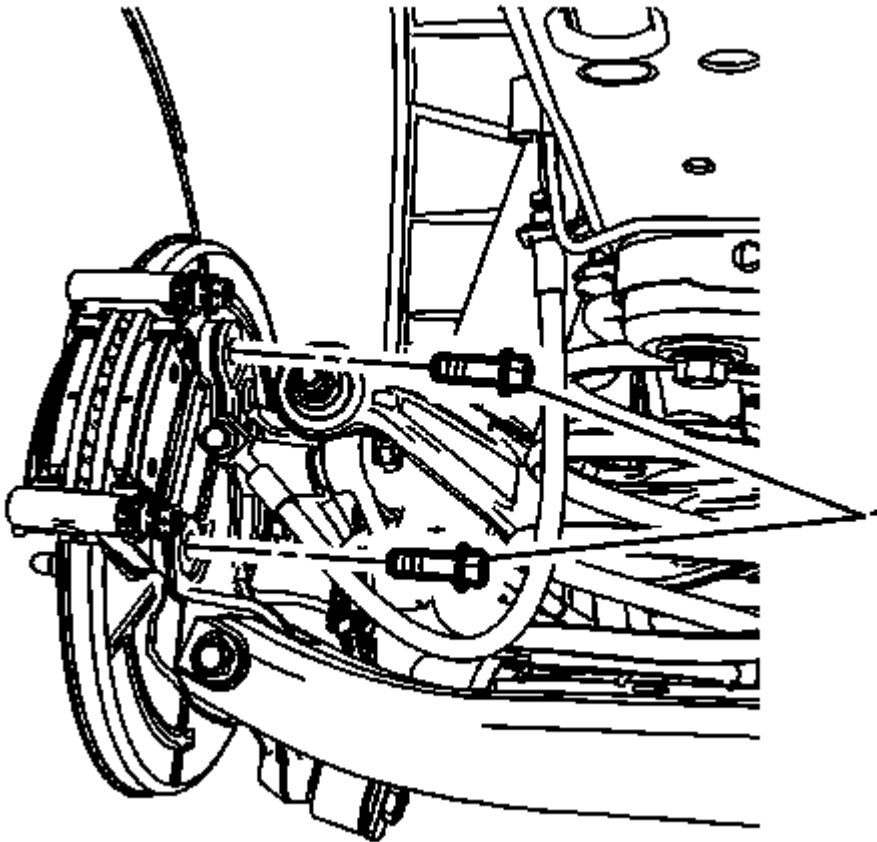


Fig. 30: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the brake caliper bracket bolts (1).

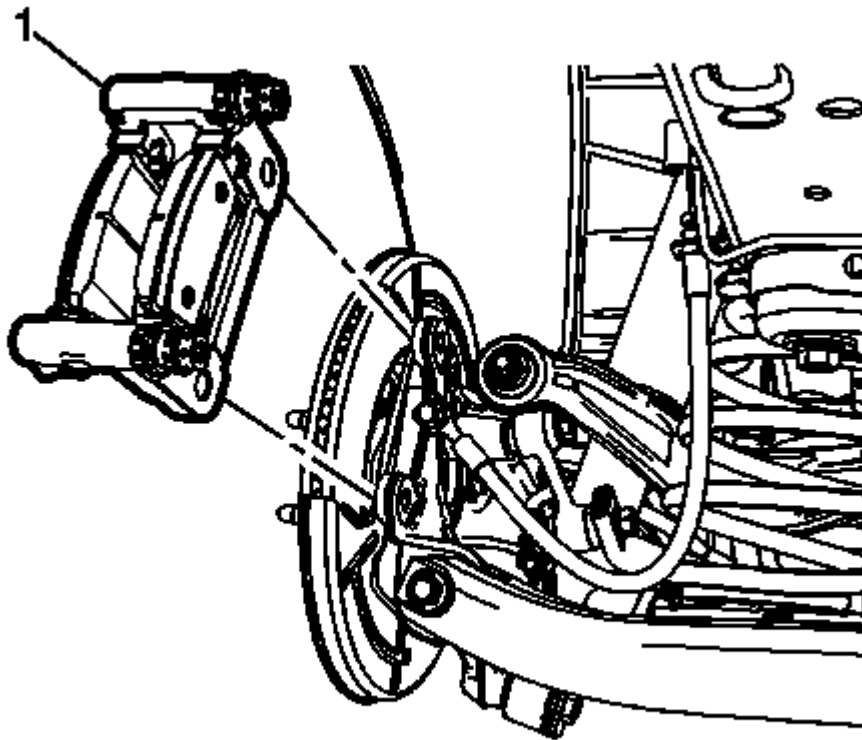


Fig. 31: Brake Caliper Bracket Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Remove the brake caliper bracket assembly (1).

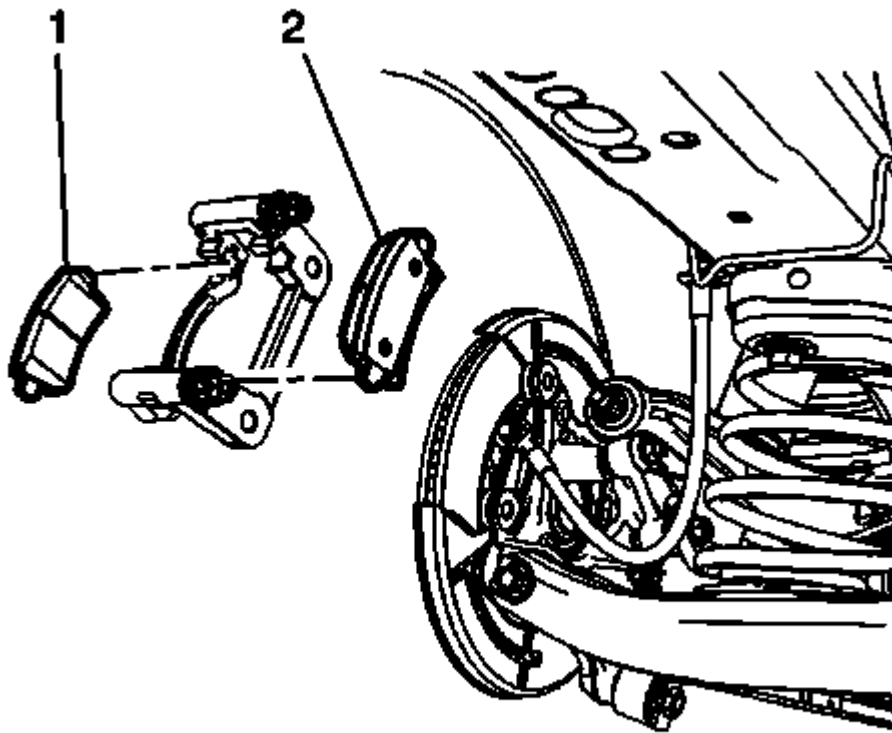


Fig. 32: Outer Brake Pad

Courtesy of GENERAL MOTORS COMPANY

10. Remove the outer brake pad (1).

NOTE: The inner brake pad is equipped with the wear sensor.

11. Remove the inner brake pad (2).

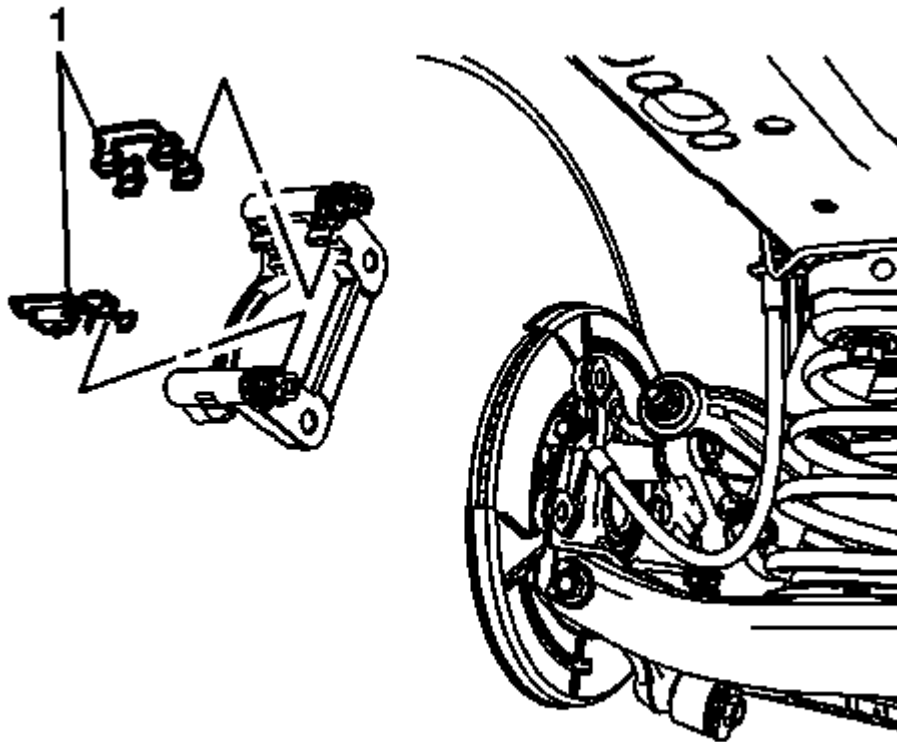


Fig. 33: Lower Brake Pad Springs
Courtesy of GENERAL MOTORS COMPANY

12. Remove the upper and lower brake pad springs (1).
13. If installing new brake pads, discard the springs.

Installation Procedure

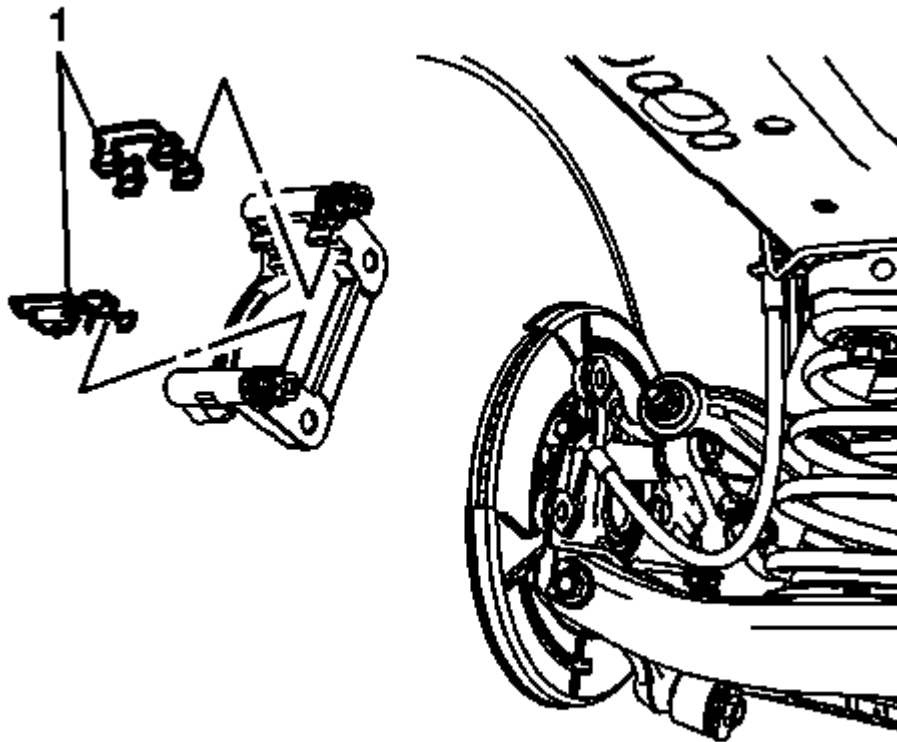


Fig. 34: Lower Brake Pad Springs
Courtesy of GENERAL MOTORS COMPANY

NOTE: If installing new brake pads, install new springs.

1. Install new brake pad springs (1).

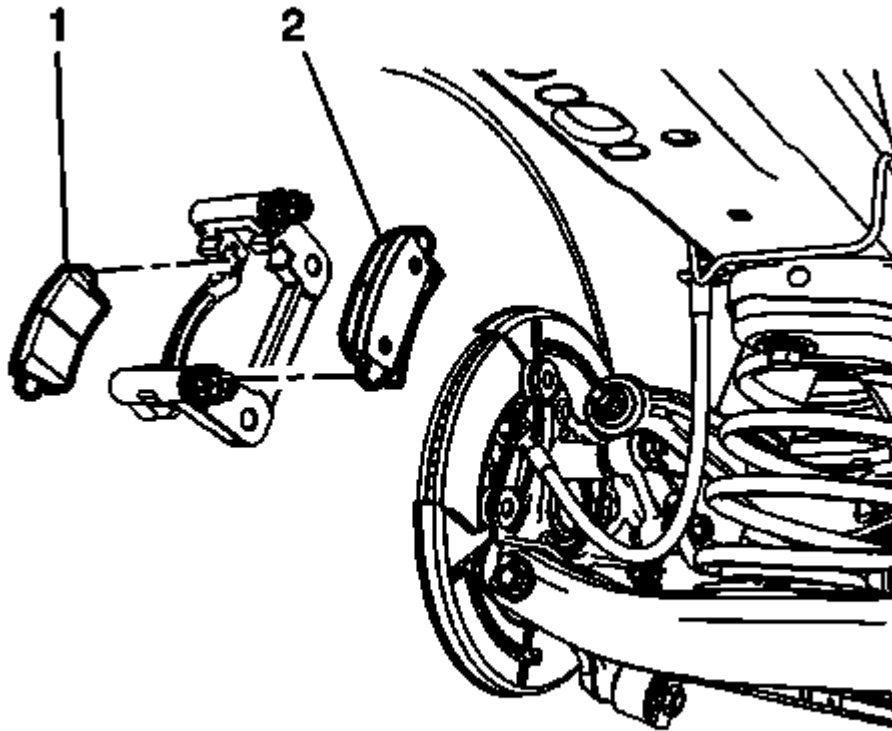


Fig. 35: Outer Brake Pad

Courtesy of GENERAL MOTORS COMPANY

2. Install the outer brake pad (1).

NOTE: **The inner brake pad is equipped with the wear sensor.**

3. Install the inner brake pad (2).
4. Prepare the brake caliper bracket bolts and the bracket threaded holes for assembly:
 - Thoroughly clean the residue from the bolt threads with denatured alcohol or equivalent and allow to dry.
 - Thoroughly clean the residue from the threaded holes with denatured alcohol or equivalent and allow to dry.
 - Apply threadlocker to 2/3 of the threaded length of the caliper bracket bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers**
 - Ensure there are no gaps in the threadlocker along the length of the filled area of the bolts.
 - Allow the threadlocker to cure approximately 10 minutes before installation.

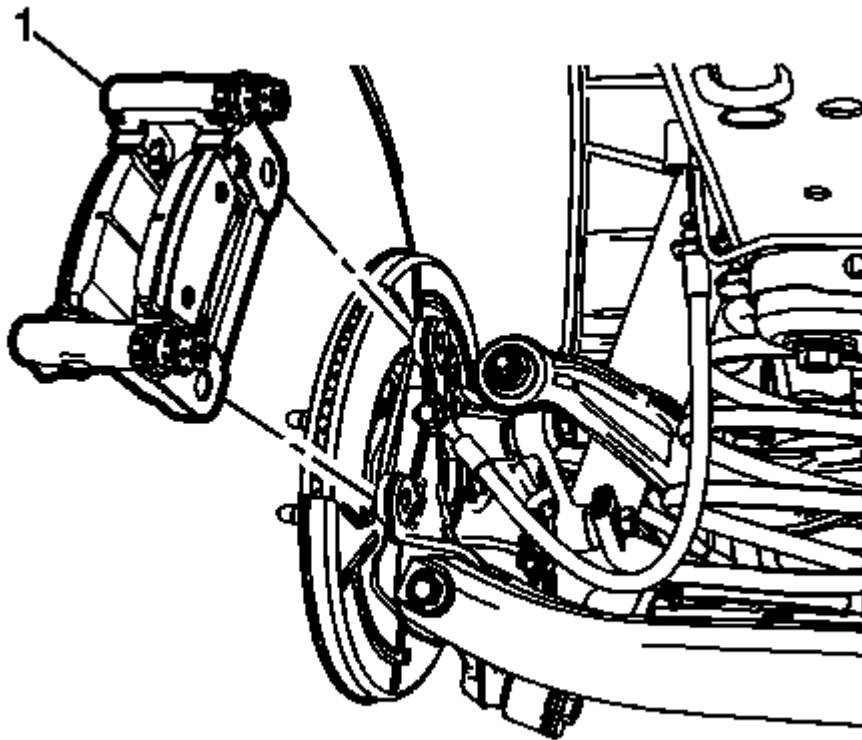


Fig. 36: Brake Caliper Bracket Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Install the brake caliper bracket assembly (1).

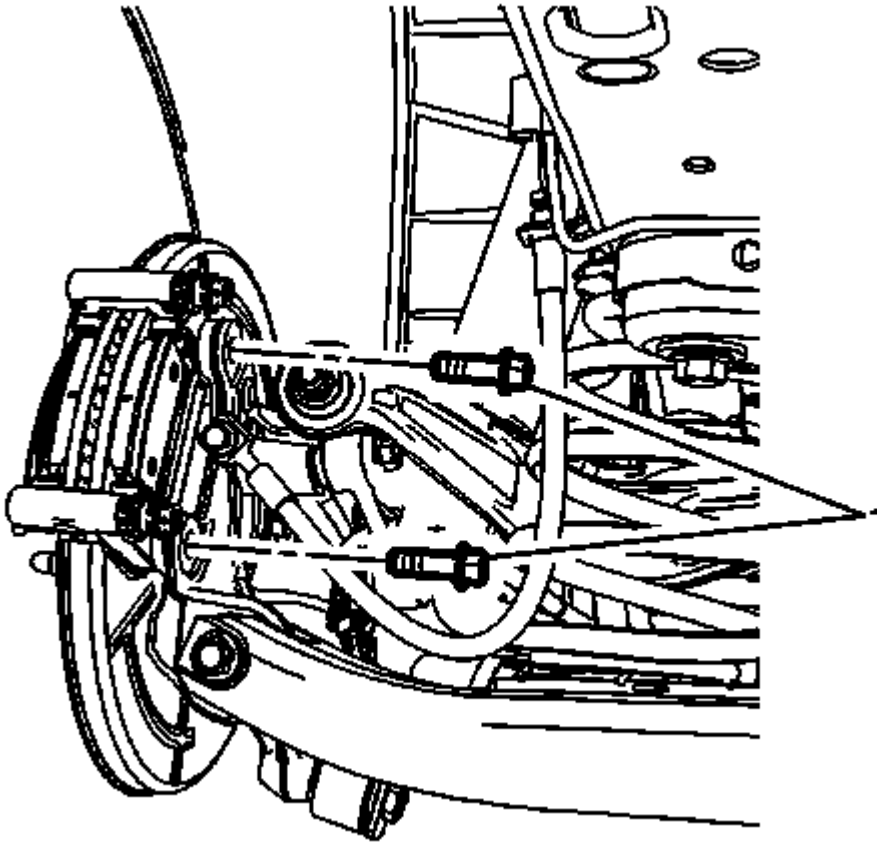


Fig. 37: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Install the brake caliper bracket bolts (1) and tighten to 100 N.m (74 lb ft) + 60 degrees).
7. Using an appropriate brake caliper piston spanner tool, slowly rotate the brake caliper piston clockwise while applying inward pressure to the brake caliper piston until the piston is fully seated in the brake caliper housing.
8. Ensure the notches in the brake caliper piston align correctly with the pins on the inner disc brake pad.

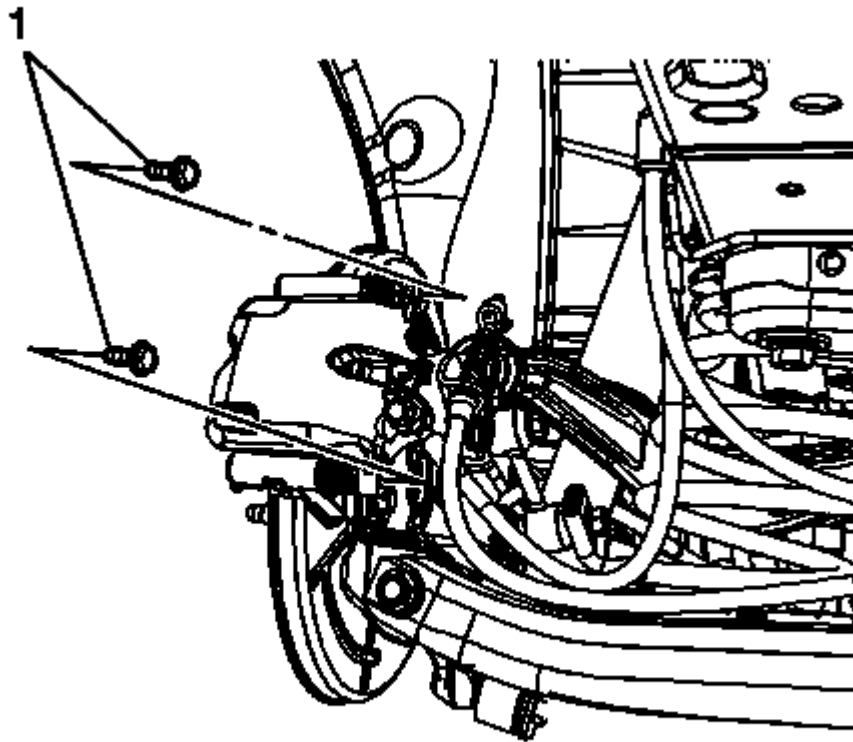


Fig. 38: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the brake caliper to the brake caliper bracket.
10. Using a backup wrench to hold the brake caliper guide pin stationary, install the brake caliper guide pin bolts (1) and tighten to 27 N.m (20 lb ft).
11. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
12. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
13. Slowly release the brake pedal.
14. Wait 15 seconds, then repeat steps 12-13 until a firm brake pedal is obtained. This will properly seat the brake caliper piston and brake pads.
15. Fill the master cylinder reservoir. Refer to **Master Cylinder Reservoir Filling** .
16. Burnish the brake pads and rotors. Refer to **Brake Pad and Rotor Burnishing**.

BRAKE PAD AND ROTOR BURNISHING

WARNING: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

Burnishing the brake pads and brake rotors is necessary in order to ensure that the braking surfaces are properly prepared after service has been performed on the disc brake system.

This procedure should be performed whenever the disc brake rotors have been refinished or replaced, and/or whenever the disc brake pads have been replaced.

1. Select a smooth road with little or no traffic.
2. Accelerate the vehicle to 48 km/h (30 mph).

NOTE: **Use care to avoid overheating the brakes while performing this step.**

3. Using moderate to firm pressure, apply the brakes to bring the vehicle to a stop. Do not allow the brakes to lock.
4. Repeat steps 2 and 3 until approximately 20 stops have been completed. Allow sufficient cooling periods between stops in order to properly burnish the brake pads and rotors.

FRONT BRAKE CALIPER REPLACEMENT (J60, J61)

Removal Procedure

WARNING: Refer to Brake Dust Warning .

WARNING: Refer to Brake Fluid Irritant Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .

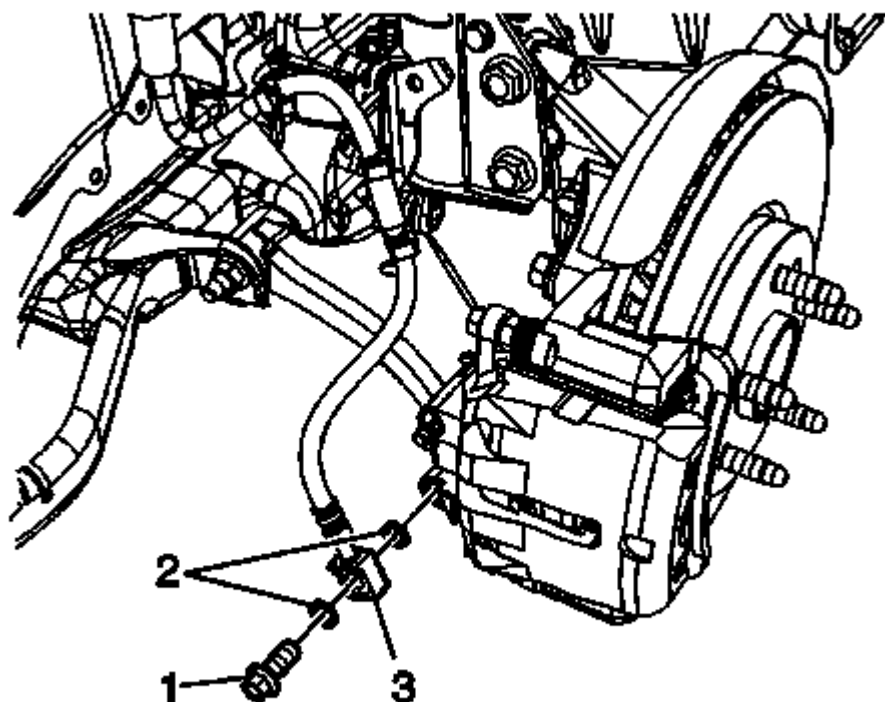


Fig. 39: Brake Hose, Fitting Bolt & Fitting Gaskets
Courtesy of GENERAL MOTORS COMPANY

3. Remove the brake hose fitting bolt (1).

NOTE: **Do not reuse the brake hose fitting gaskets.**

4. Remove and discard the brake hose fitting gaskets (2) from the brake hose fitting (3).
5. Cap the brake hose fitting to prevent brake fluid loss and contamination.

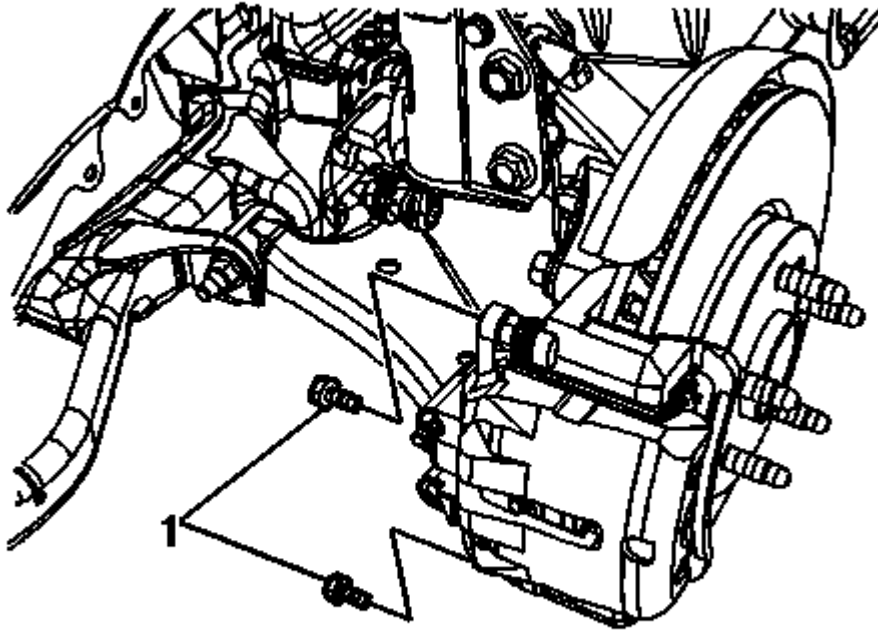


Fig. 40: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **DO NOT** use any air tools to remove or install the guide pin bolts. Use hand tools **ONLY**.
- Install an open end wrench to hold the caliper guide pin in line with the brake caliper while removing or installing the caliper guide pin bolt. **DO NOT** allow the open end wrench to come in contact with the brake caliper. Allowing the open end wrench to come in contact with the brake caliper will cause a pulsation when the brakes are applied.

6. Using a backup wrench to hold the brake caliper guide pin stationary, remove the brake caliper guide pin bolts (1).
7. Remove the brake caliper.

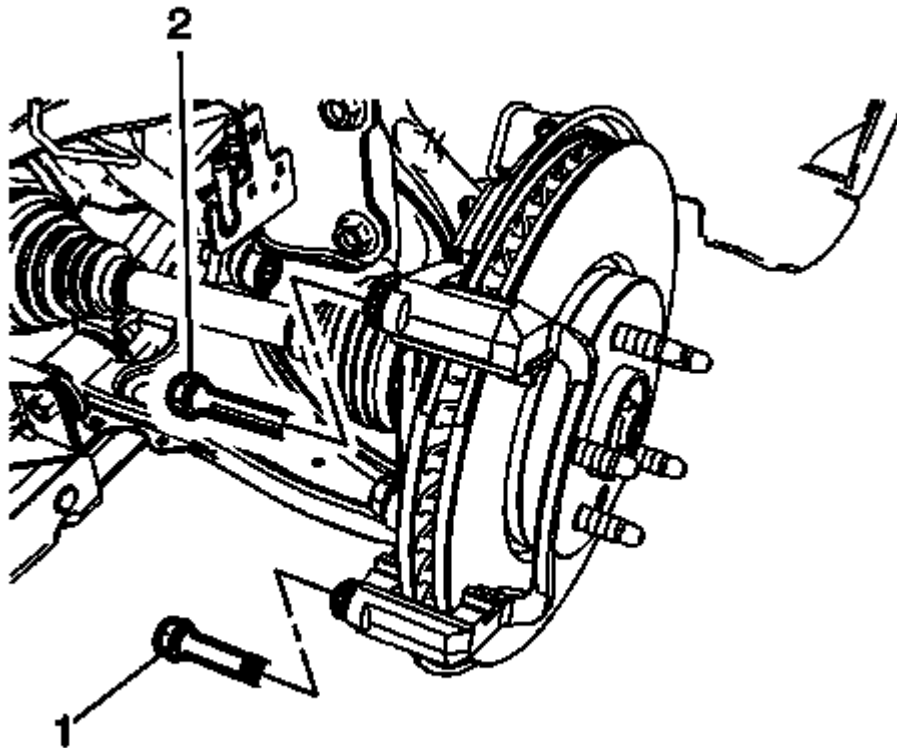


Fig. 41: Brake Caliper Guide Pins
Courtesy of GENERAL MOTORS COMPANY

NOTE: The lower brake caliper guide pin is equipped with a bushing and must be installed in the same location.

8. Remove the lower brake caliper guide pin (1).
9. Remove the upper brake caliper guide pin (2).

Installation Procedure

1. Inspect the brake caliper guide pins and guide pin seals for damage and replace, if necessary.
2. Remove any grease or debris from the brake caliper guide pins, guide pin seals, and guide pin bores in the brake caliper bracket with a clean shop cloth.
3. Apply a light coating of high temperature, silicone brake lubricant to the brake caliper bracket guide pin bores, the inner portion of the guide pin seals, and the brake caliper guide pins.

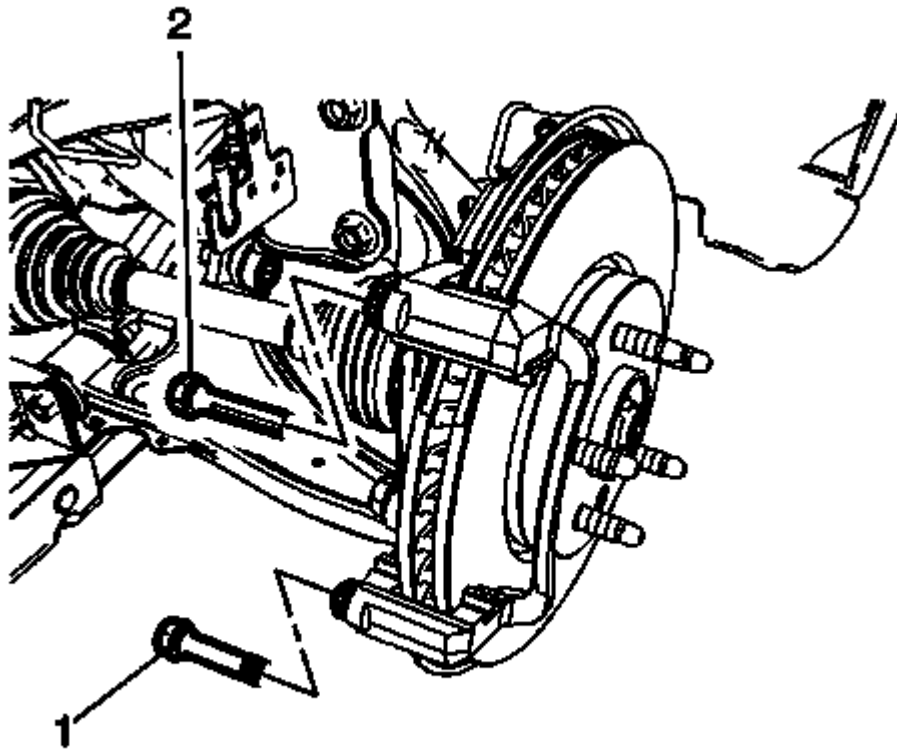


Fig. 42: Brake Caliper Guide Pins
Courtesy of GENERAL MOTORS COMPANY

NOTE: The lower brake caliper guide pin is equipped with a bushing and must be installed in the same location.

4. Install the lower brake caliper guide pin (1).
5. Seat the brake caliper guide pin seal in the groove of the brake caliper guide pin.
6. Install the upper brake caliper guide pin (2).
7. Seat the brake caliper guide pin seal in the groove of the brake caliper guide pin.

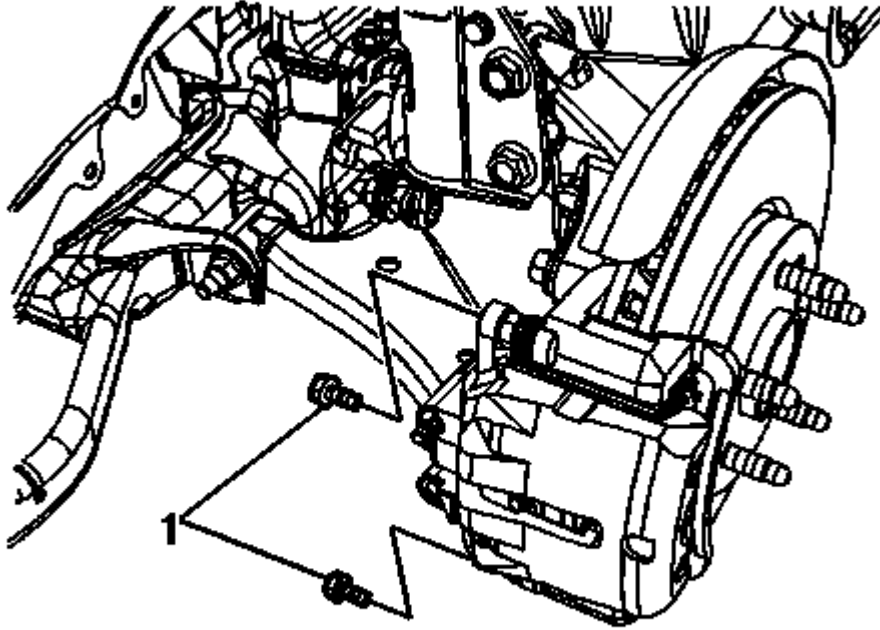


Fig. 43: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the brake caliper.

CAUTION: Refer to Fastener Caution .

9. Hold the brake caliper guide pin stationary and install the brake caliper guide pin bolts (1) and tighten to 27 N.m (20 lb ft).

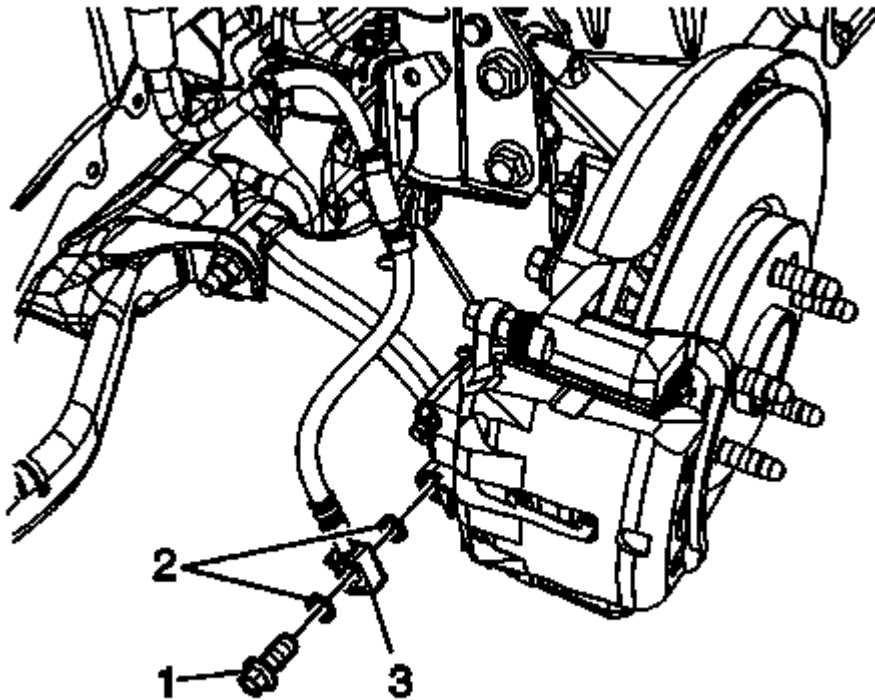


Fig. 44: Brake Hose, Fitting Bolt & Fitting Gaskets
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install new brake hose fitting gaskets.

10. Assemble the brake hose fitting bolt (1) and the 2 new brake hose fitting gaskets (2) to the brake hose fitting (3).
11. Install the brake hose assembly and tighten the brake hose fitting bolt to 40 N.m (30 lb ft).
12. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** , **Hydraulic Brake System Bleeding (Pressure)** .
13. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

FRONT BRAKE CALIPER REPLACEMENT (J64)

Removal Procedure

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level, no brake fluid needs to be removed from the reservoir before proceeding.
3. If the brake fluid level is higher than midway between the maximum-full point and the minimum allowable level, remove brake fluid to the midway point before proceeding.
4. Remove the front disc brake pads. Refer to **Front Disc Brake Pads Replacement (J64)**.

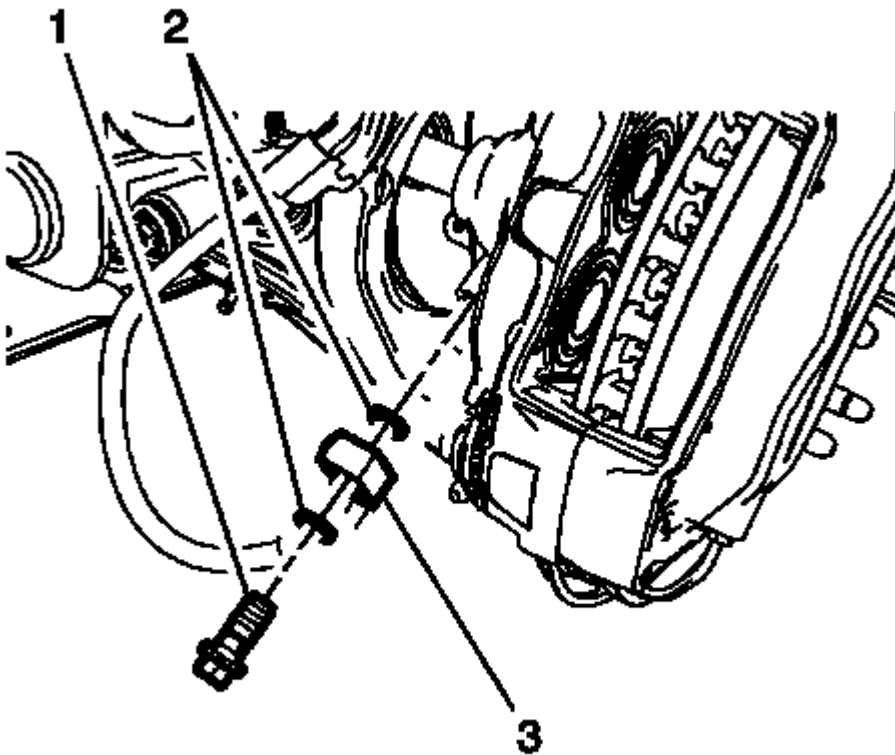


Fig. 45: Brake Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake hose fitting bolt (1).
6. Cap the brake caliper inlet port to prevent brake fluid loss and contamination.

NOTE: **Do not reuse the brake hose fitting gaskets.**

7. Remove and discard the brake hose fitting gaskets (2) from the brake hose (3).
8. Cap the brake hose fitting to prevent brake fluid loss and contamination.

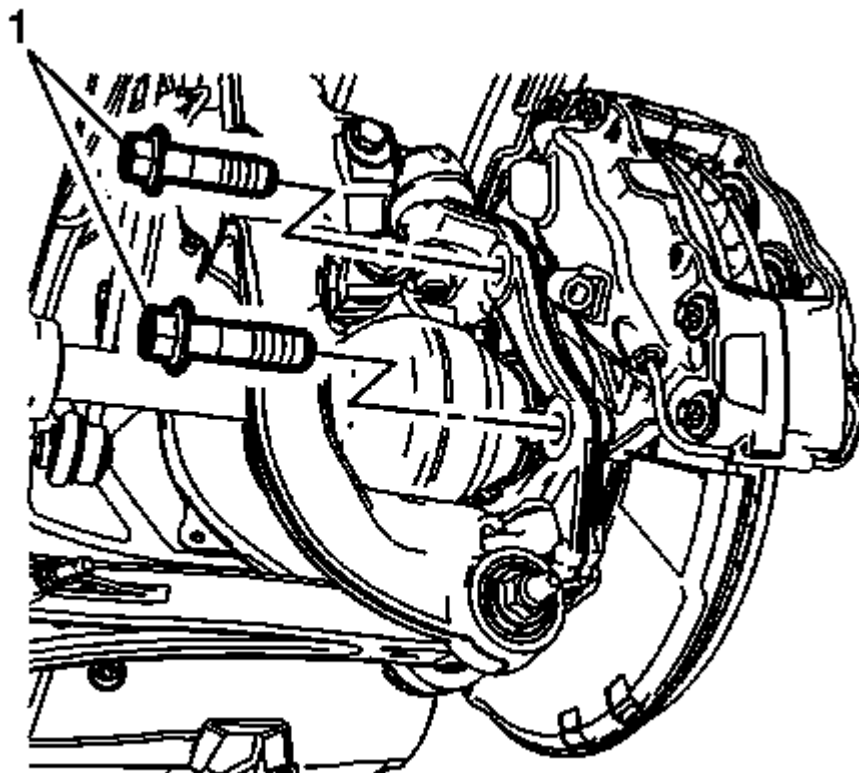


Fig. 46: Brake Caliper Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: The brake caliper bolts must be replaced any time they are removed. Do not reuse the brake caliper bolts.

9. Remove and discard the brake caliper bolts (1).
10. Remove the brake caliper.

Installation Procedure

1. Install the brake caliper to the steering knuckle.

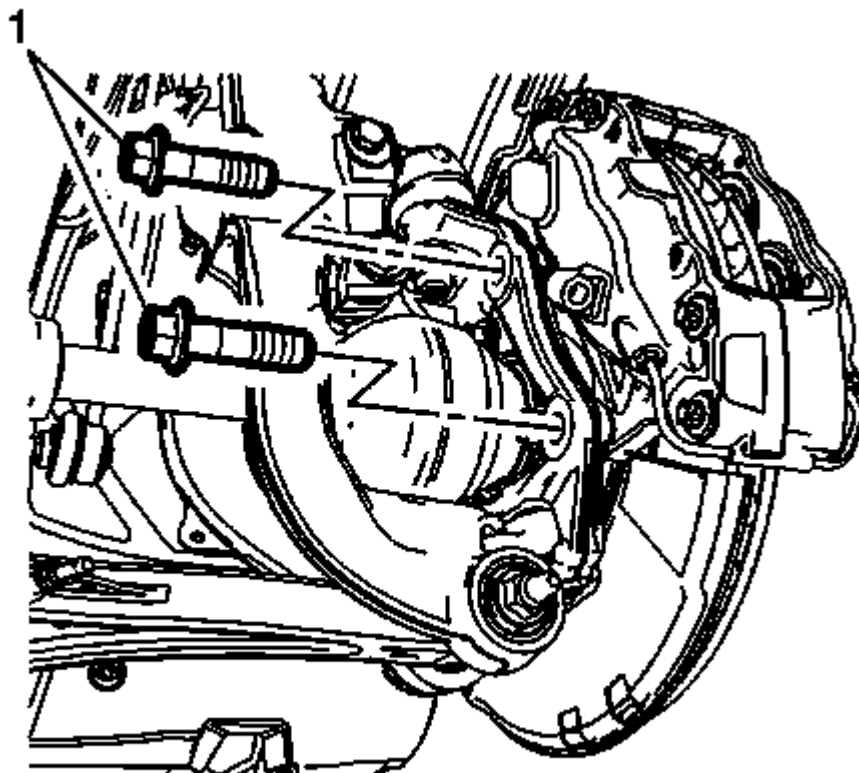


Fig. 47: Brake Caliper Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: The brake bolts must be replaced any time they are removed.

2. Install 2 new brake caliper bolts (1) and tighten to 40 N.m (30 lb ft) + 90 degrees.

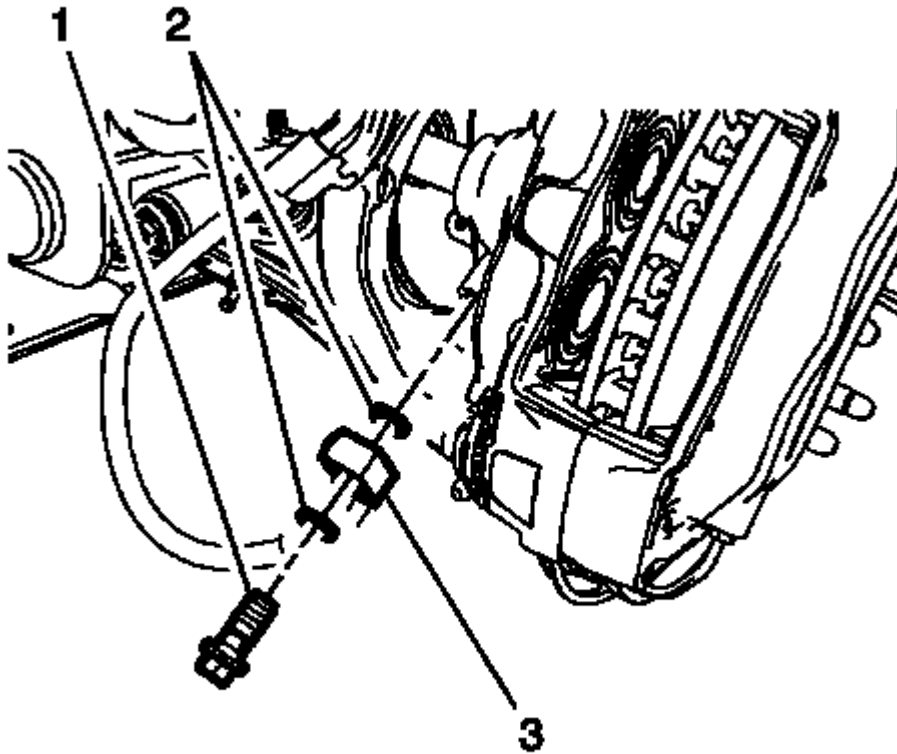


Fig. 48: Brake Hose Fitting Bolt

Courtesy of GENERAL MOTORS COMPANY

3. Assemble the brake hose fitting bolt (1) and the 2 new brake hose fitting gaskets (2) to the brake hose (3).
4. Install the brake hose assembly to the brake caliper and tighten the brake hose fitting bolt to 40 N.m (30 lb ft).
5. Install the front disc brake pads. Refer to **Front Disc Brake Pads Replacement (J64)**.
6. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** , **Hydraulic Brake System Bleeding (Pressure)** .

REAR BRAKE CALIPER REPLACEMENT

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

WARNING: Refer to **Brake Fluid Irritant Warning** .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
3. Disable the parking brake cable adjuster. Refer to Parking Brake Cable Adjuster Disabling .

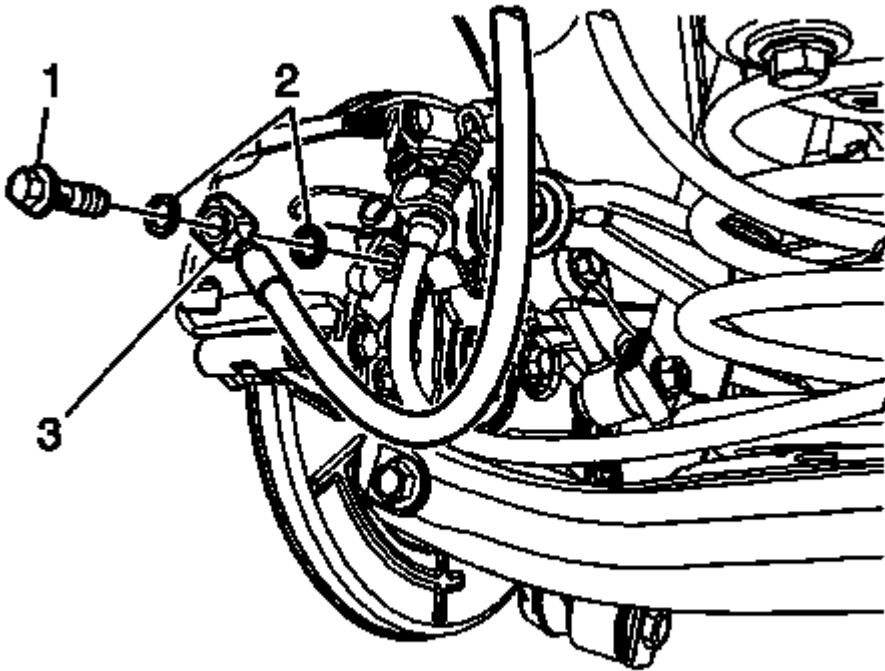


Fig. 49: Brake Hose Fitting Components
Courtesy of GENERAL MOTORS COMPANY

4. Remove the brake hose fitting bolt (1).

NOTE: **Do not reuse the brake hose fitting gaskets.**

5. Remove and discard the brake hose fitting gaskets (2) from the brake hose (3).
6. Plug the brake hose fitting to prevent brake fluid loss and contamination.

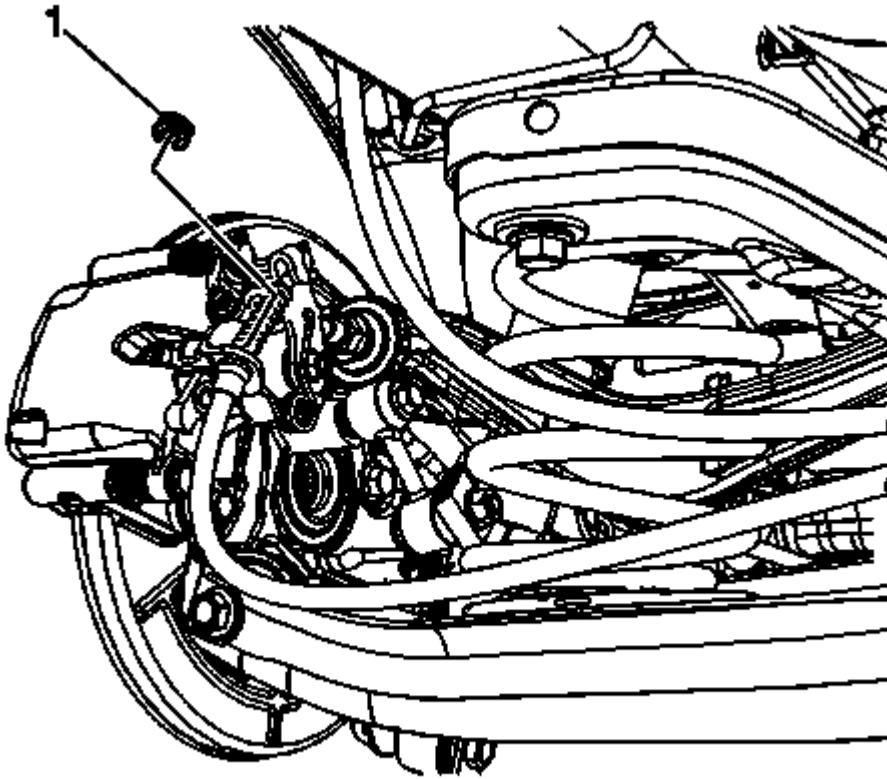


Fig. 50: Parking Brake Cable Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Remove the parking brake cable retainer (1).
8. Disconnect the parking brake cable from the actuator lever.
9. Remove the parking brake cable from the cable bracket and position the parking brake cable end aside.

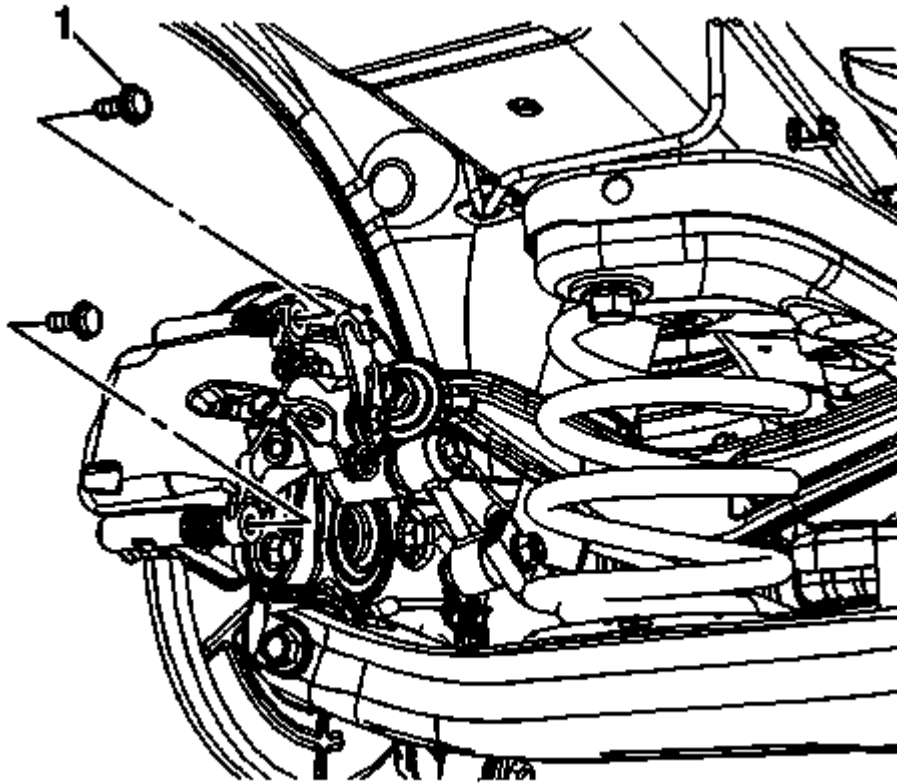


Fig. 51: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **DO NOT** use any air tools to remove or install the guide pin bolts. Use hand tools **ONLY**
- Install an open end wrench to hold the caliper guide pin in line with the brake caliper while removing or installing the caliper guide pin bolt. **DO NOT** allow the open end wrench to come in contact with the brake caliper. Allowing the open end wrench to come in contact with the brake caliper will cause a pulsation when the brakes are applied.

10. Using a backup wrench to hold the brake caliper guide pin stationary, remove the brake caliper guide pin bolts (1).
11. Remove the brake caliper.

Installation Procedure

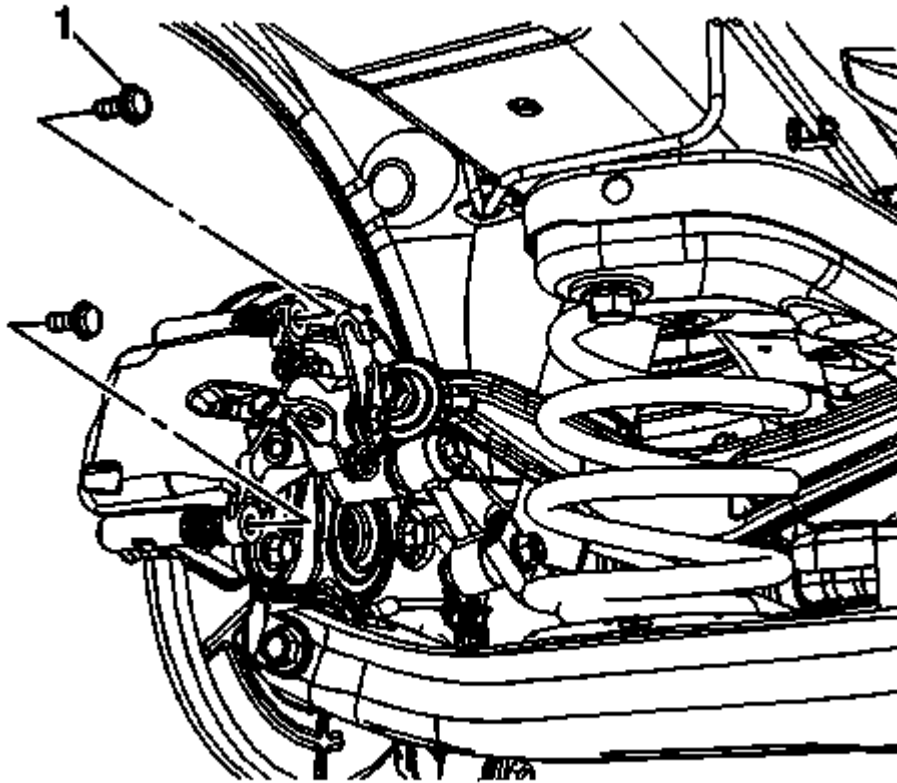


Fig. 52: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the brake caliper.

CAUTION: Refer to Fastener Caution .

2. Using a backup wrench to hold the brake caliper guide pin stationary, install the brake caliper guide pin bolts (1) and tighten to 27 N.m (20 lb ft).

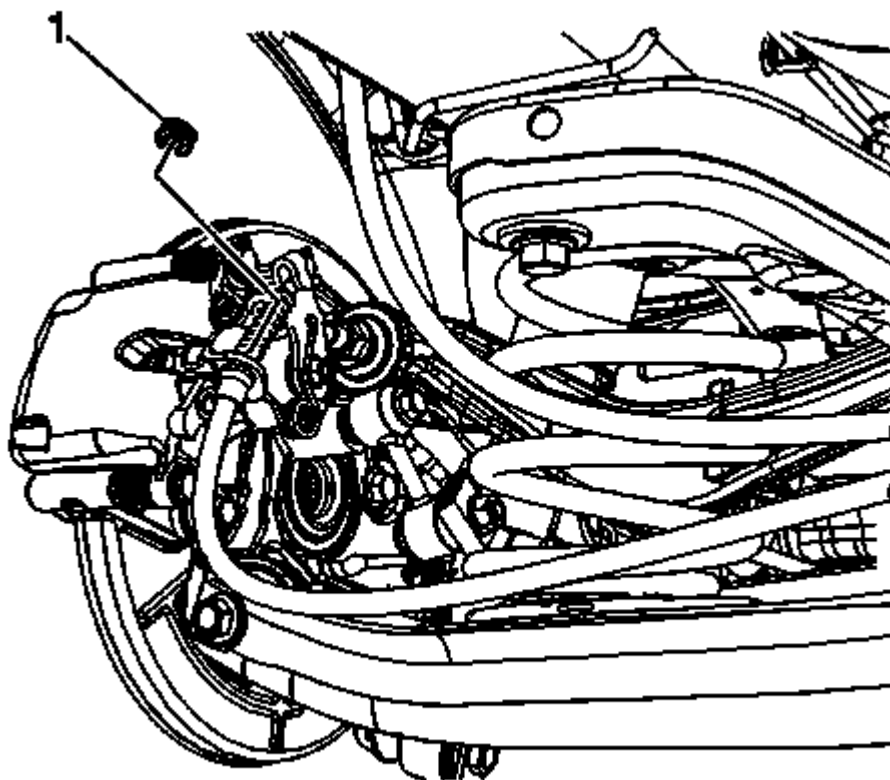


Fig. 53: Parking Brake Cable Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Install the parking brake cable to the cable bracket.
4. Connect the parking brake cable to the actuator lever.
5. Install the parking brake cable retainer (1).

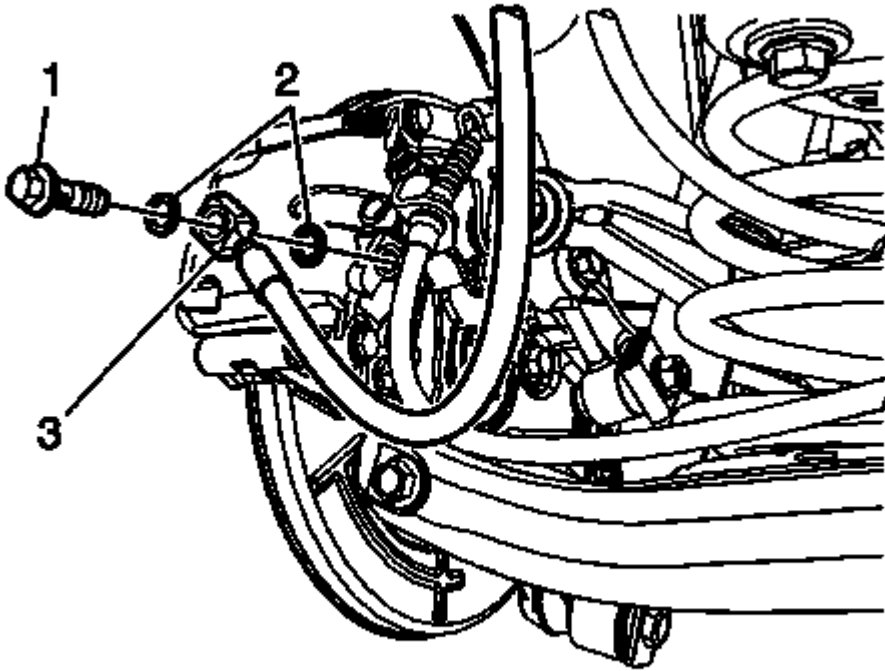


Fig. 54: Brake Hose Fitting Components
Courtesy of GENERAL MOTORS COMPANY

6. Assemble the brake hose fitting bolt (1) and the 2 new brake hose fitting gaskets (2) to the brake hose (3).
7. Install the brake hose assembly to the brake caliper and tighten the fitting bolt to 40 N.m (30 lb ft).
8. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** , **Hydraulic Brake System Bleeding (Pressure)** .
9. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

FRONT BRAKE CALIPER BRACKET REPLACEMENT

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

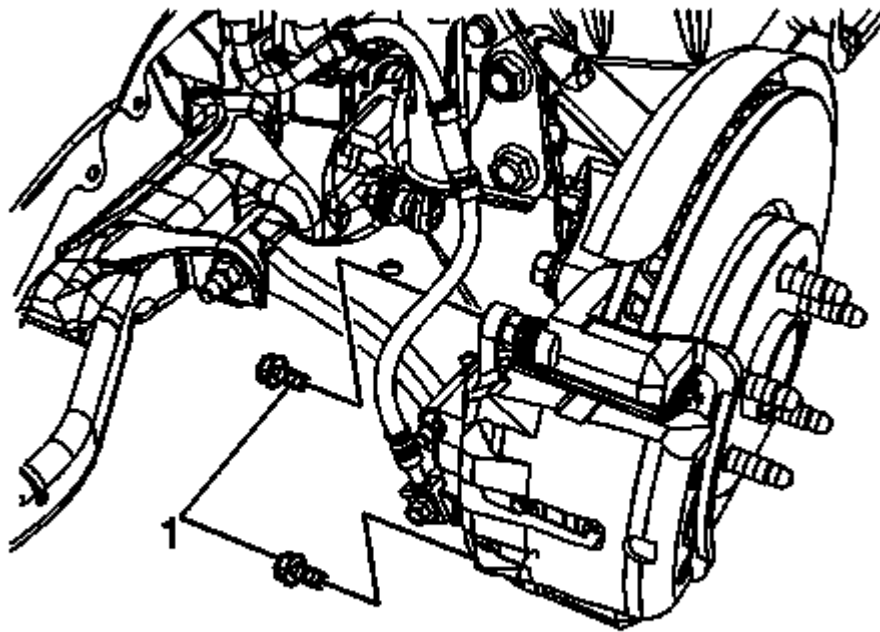


Fig. 55: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **DO NOT** use any air tools to remove or install the guide pin bolts. Use hand tools **ONLY**.
- Install an open end wrench to hold the caliper guide pin in line with the brake caliper while removing or installing the caliper guide pin bolt. **DO NOT** allow the open end wrench to come in contact with the brake caliper. Allowing the open end wrench to come in contact with the brake caliper will cause a pulsation when the brakes are applied.

3. Hold the brake caliper guide pin stationary and remove the brake caliper guide pin bolts (1).

CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

4. Remove the brake caliper and support with heavy mechanics wire or equivalent.

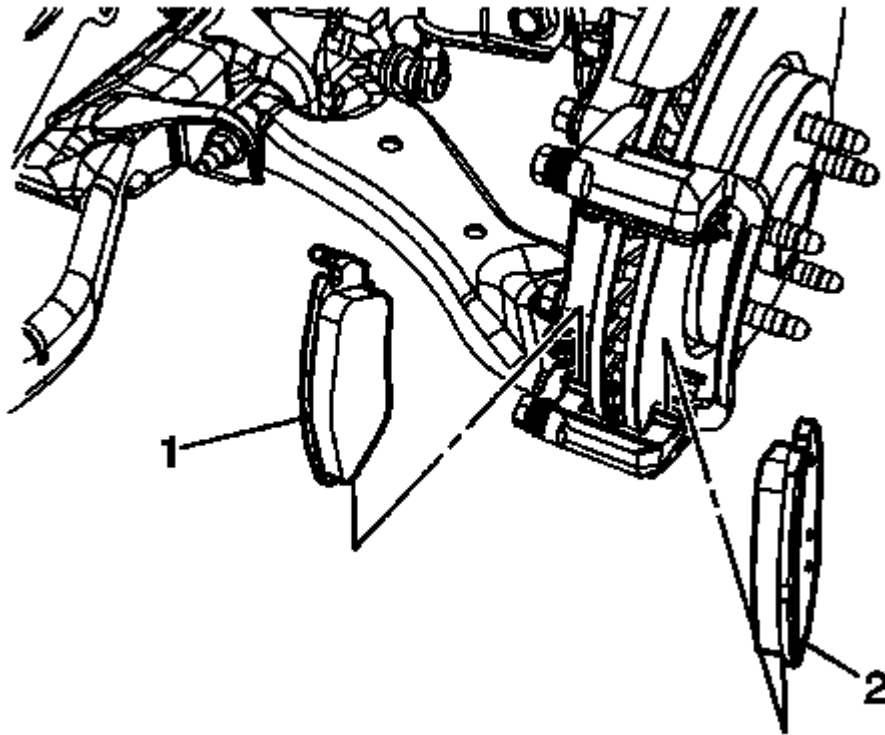


Fig. 56: Inner & Outer Brake Pads
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the location of the wear sensor for correct installation.**

5. Remove the inner brake pad (1).
6. Remove the outer brake pad (2).

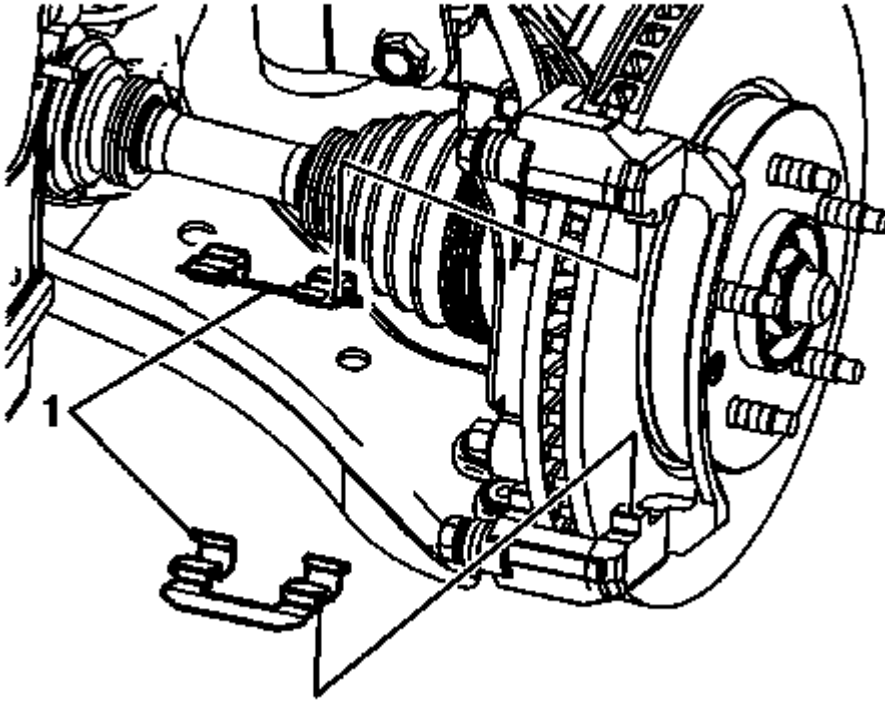


Fig. 57: Brake Pad Shims

Courtesy of GENERAL MOTORS COMPANY

7. Remove the brake pad springs (1).

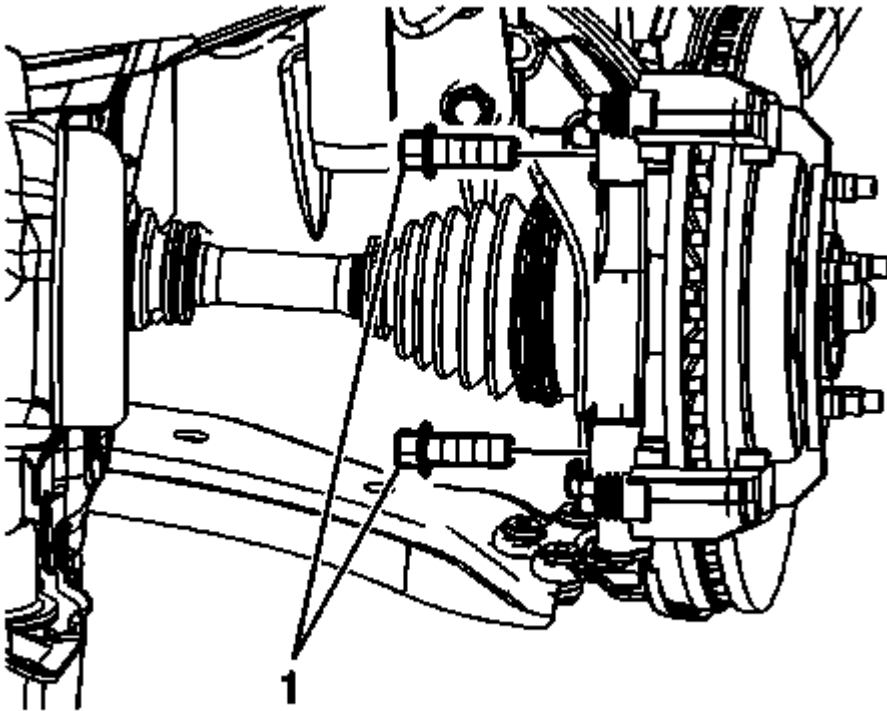


Fig. 58: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not reuse the brake caliper bracket bolts.**

8. Remove and discard the brake caliper bracket bolts (1).

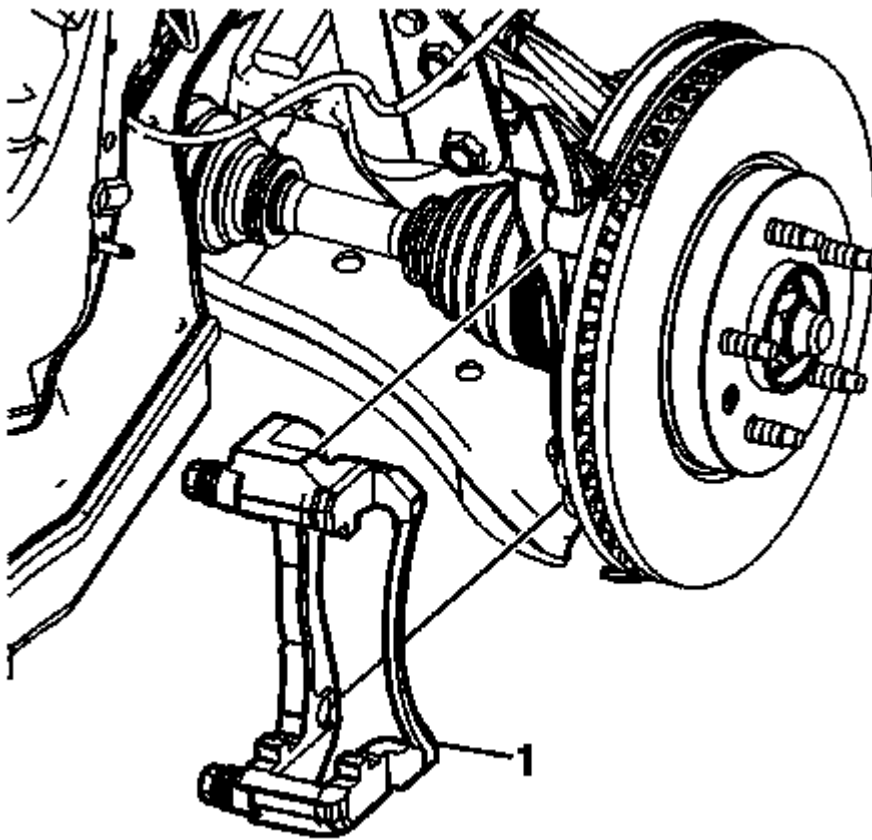


Fig. 59: Brake Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

9. Remove the brake caliper bracket (1).

Installation Procedure

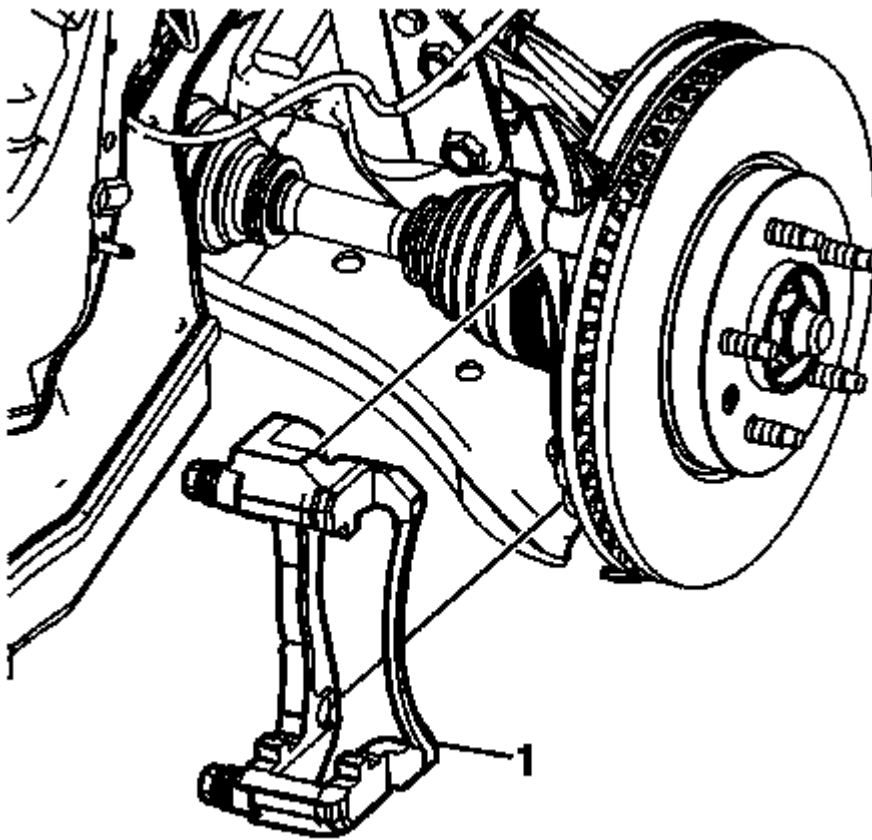


Fig. 60: Brake Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install the brake caliper bracket (1).
2. Prepare the brake caliper bracket bolts and the bracket threaded holes for assembly:
 - Thoroughly clean the residue from the bolt threads with denatured alcohol or equivalent and allow to dry.
 - Thoroughly clean the residue from the threaded holes with denatured alcohol or equivalent and allow to dry.
 - Apply threadlocker to 2/3 of the threaded length of the caliper bracket bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** ,
 - Ensure there are no gaps in the threadlocker along the length of the filled area of the bolts.
 - Allow the threadlocker to cure approximately 10 minutes before installation.

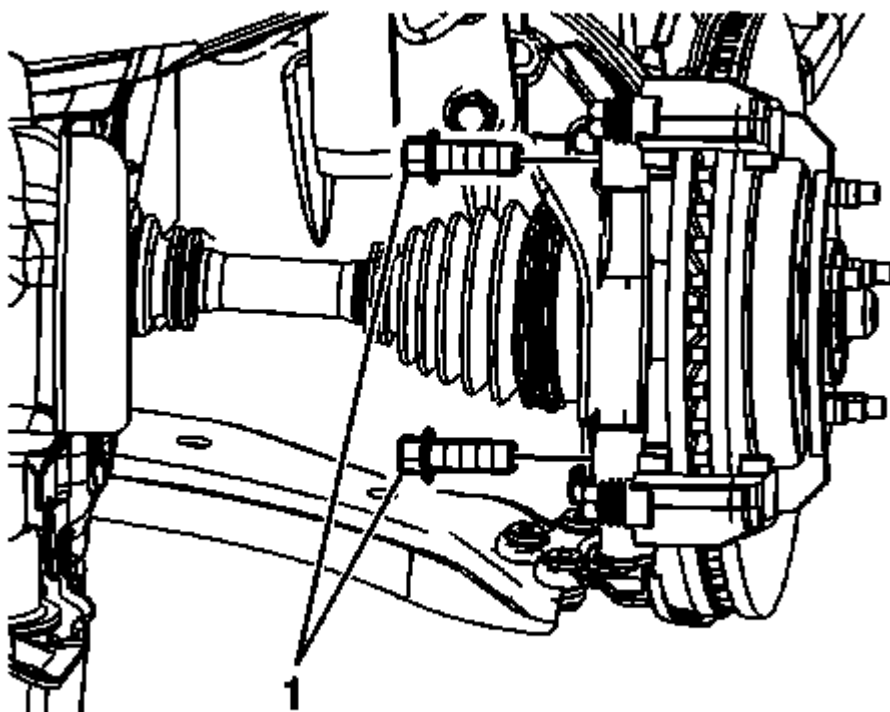


Fig. 61: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install 2 new brake caliper bracket bolts (1) and tighten to 150 N.m (111 lb ft) + 45 degrees + 15 degrees.

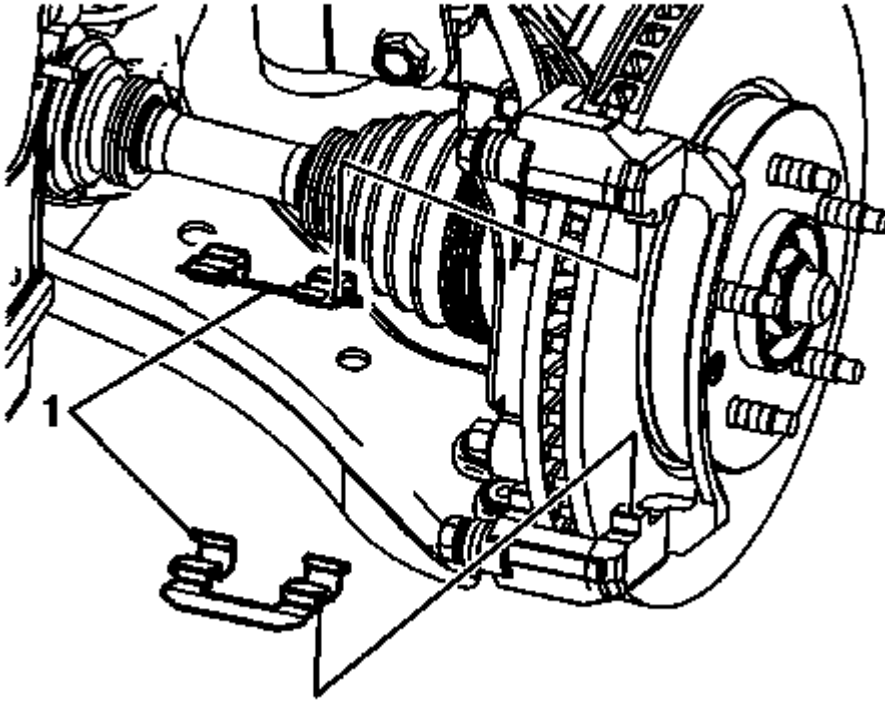


Fig. 62: Brake Pad Shims

Courtesy of GENERAL MOTORS COMPANY

4. Install the brake pad springs (1).

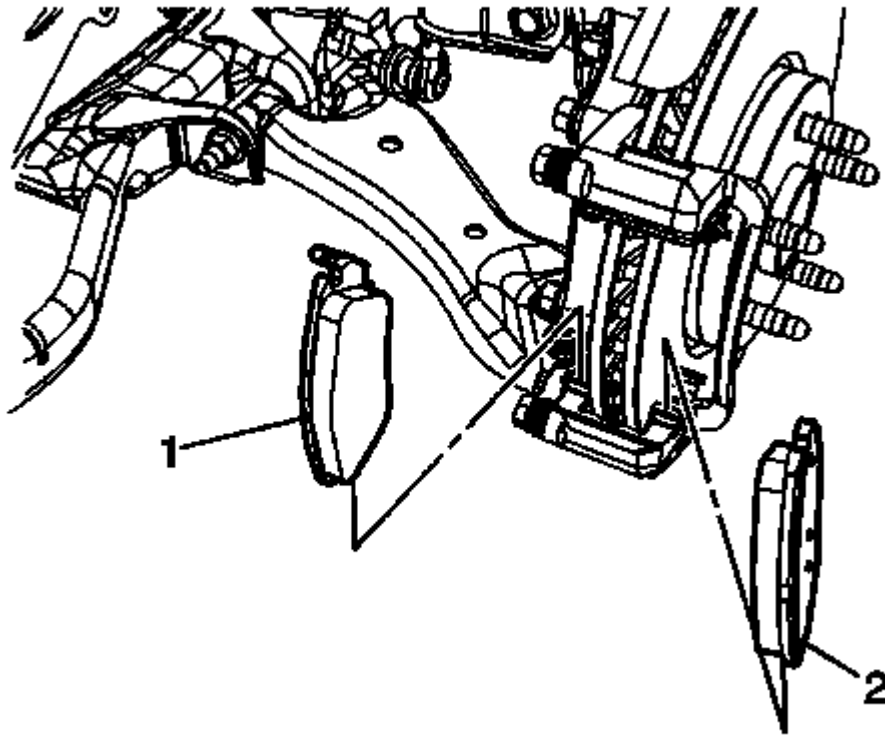


Fig. 63: Inner & Outer Brake Pads
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the location of the wear sensor for correct installation.**

5. Install the inner brake pad (1).
6. Install the outer brake pad (2).
7. Position the brake caliper to the bracket.

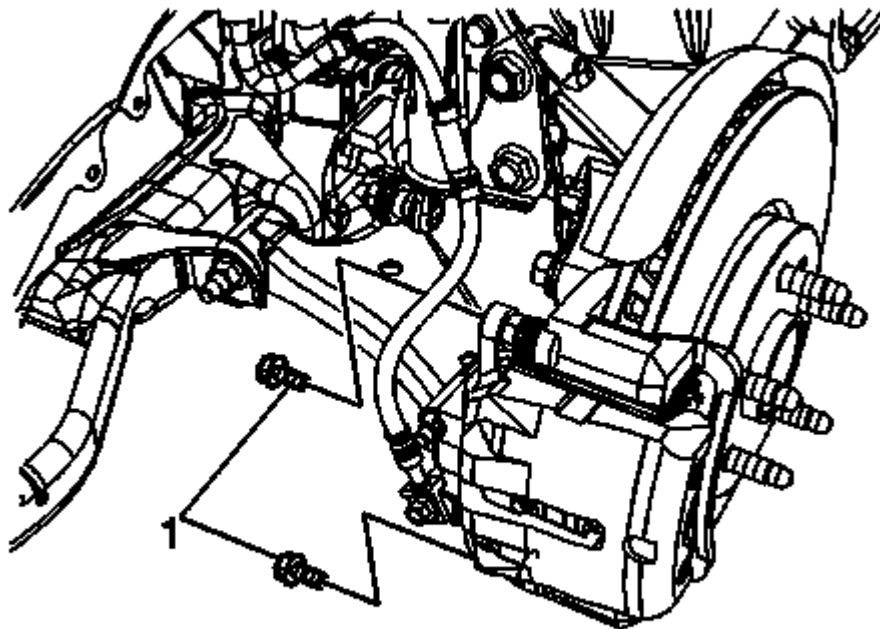


Fig. 64: Brake Caliper Guide Pin Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Hold the brake caliper guide pins stationary and tighten the brake caliper guide pin bolts (1) to 27 N.m (20 lb ft).
9. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
10. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
11. Slowly release the brake pedal.
12. Wait 15 seconds, then repeat steps 10-11 until a firm brake pedal is obtained. This will properly seat the brake caliper piston and brake pads.

REAR BRAKE CALIPER BRACKET REPLACEMENT

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

3. Remove the rear disc brake pads. Refer to Rear Disc Brake Pads Replacement.

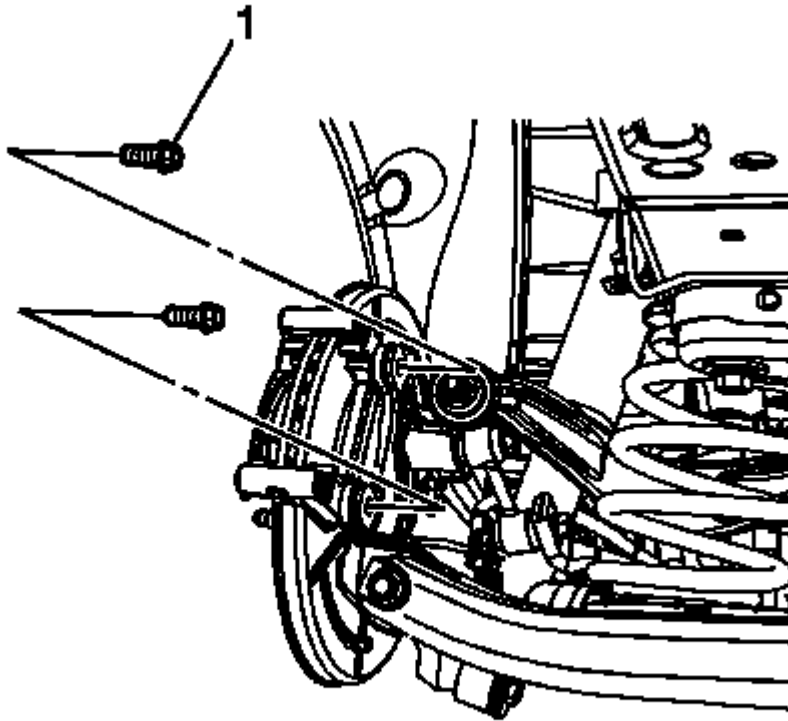


Fig. 65: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not reuse the brake caliper bracket bolts.

4. Remove and discard the brake caliper bracket bolts (1).

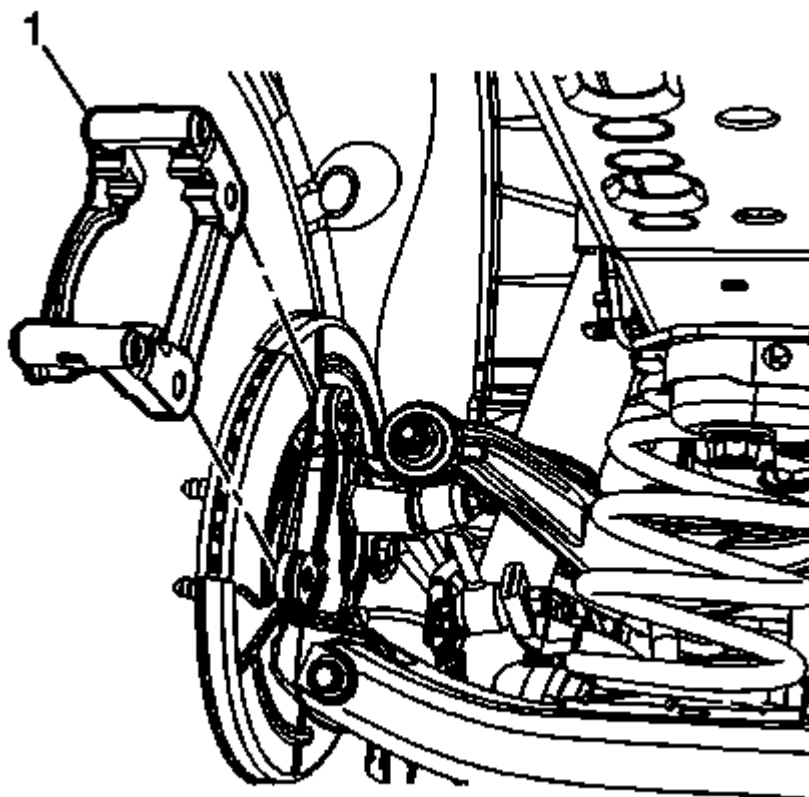


Fig. 66: Brake Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake caliper bracket (1).

Installation Procedure

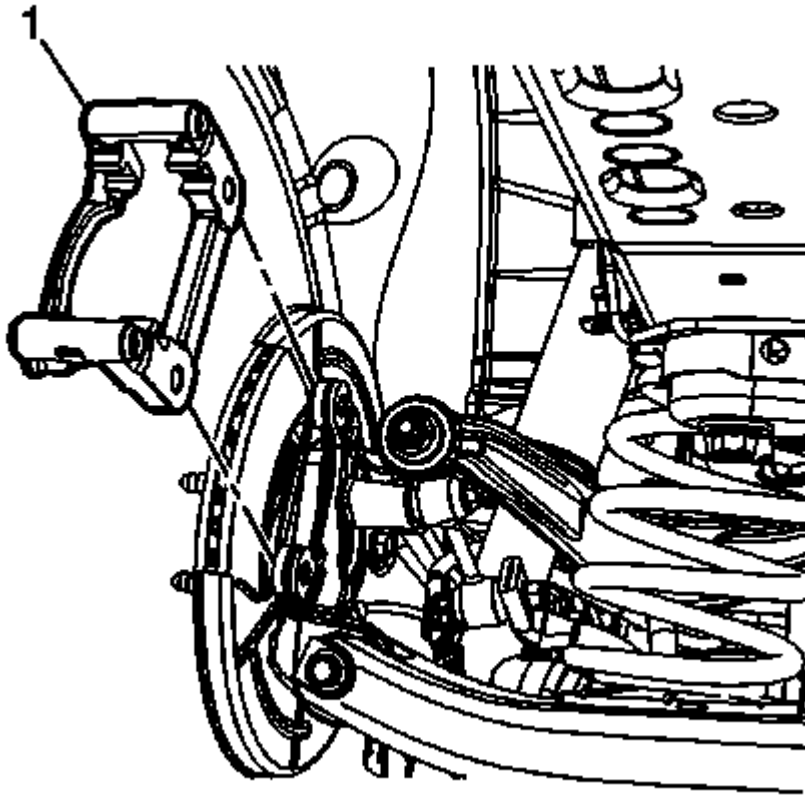


Fig. 67: Brake Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install the brake caliper bracket (1).
2. Prepare the brake caliper bracket bolts and the bracket threaded holes for assembly:
 - Thoroughly clean the residue from the bolt threads with denatured alcohol or equivalent and allow to dry.
 - Thoroughly clean the residue from the threaded holes with denatured alcohol or equivalent and allow to dry.
 - Apply threadlocker to 2/3 of the threaded length of the caliper bracket bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** ,
 - Ensure there are no gaps in the threadlocker along the length of the filled area of the bolts.
 - Allow the threadlocker to cure approximately 10 minutes before installation.

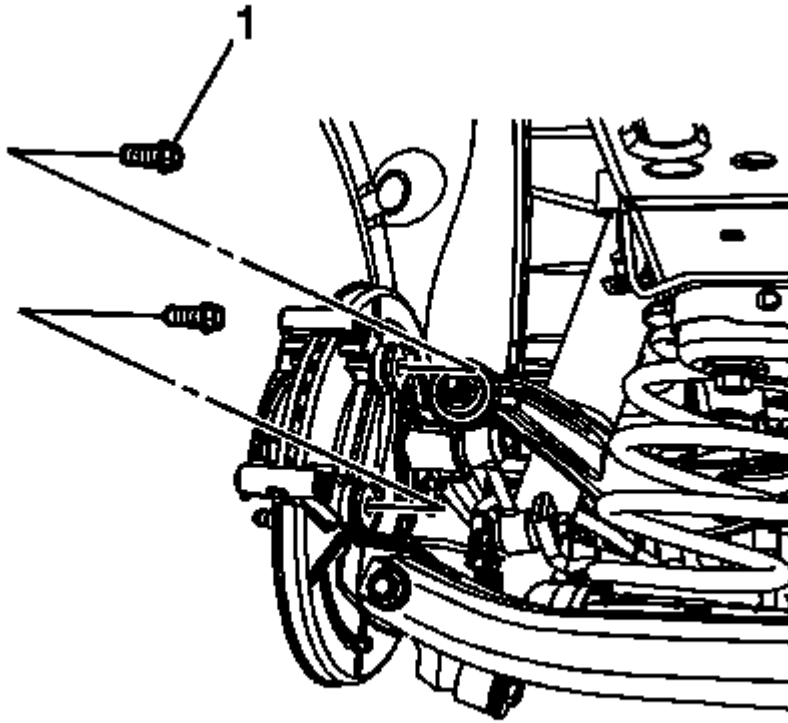


Fig. 68: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Do not reuse the brake caliper bracket bolts.

3. Install new brake caliper bracket bolts (1) and tighten to 100 N.m (74 lb ft) + 60 degrees.
4. Install the rear disc brake pads. Refer to **Rear Disc Brake Pads Replacement**.
5. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
6. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
7. Slowly release the brake pedal.
8. Wait 15 seconds, then repeat steps 6-7 until a firm brake pedal is obtained. This will properly seat the brake caliper piston and brake pads.

FRONT BRAKE ROTOR REPLACEMENT (J60, J61)

Special Tools

- **CH-41013** Rotor Resurfacing Kit
- **CH-42450-A** Wheel Hub Resurfacing Kit

For equivalent regional tools, refer to Special Tools.

Removal Procedure

WARNING: Refer to Brake Dust Warning .

NOTE: It is not necessary to replace brake rotors in axle sets.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .

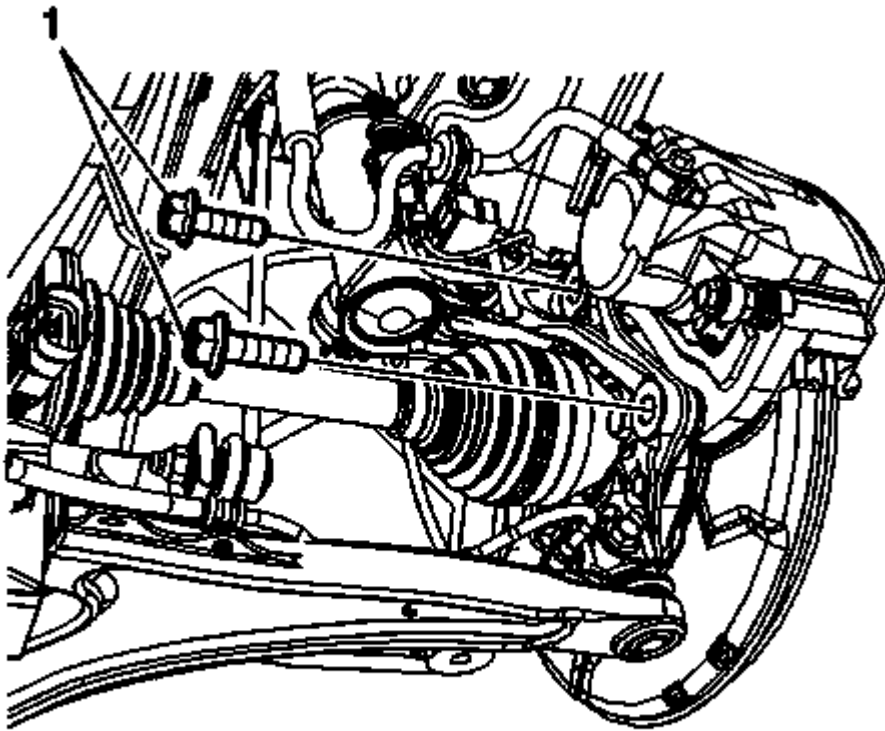


Fig. 69: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not reuse the brake caliper bracket bolts.

3. Remove and discard the brake caliper bracket bolts (1).

CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

4. Remove the brake caliper and bracket as an assembly and support with heavy mechanics wire or equivalent.

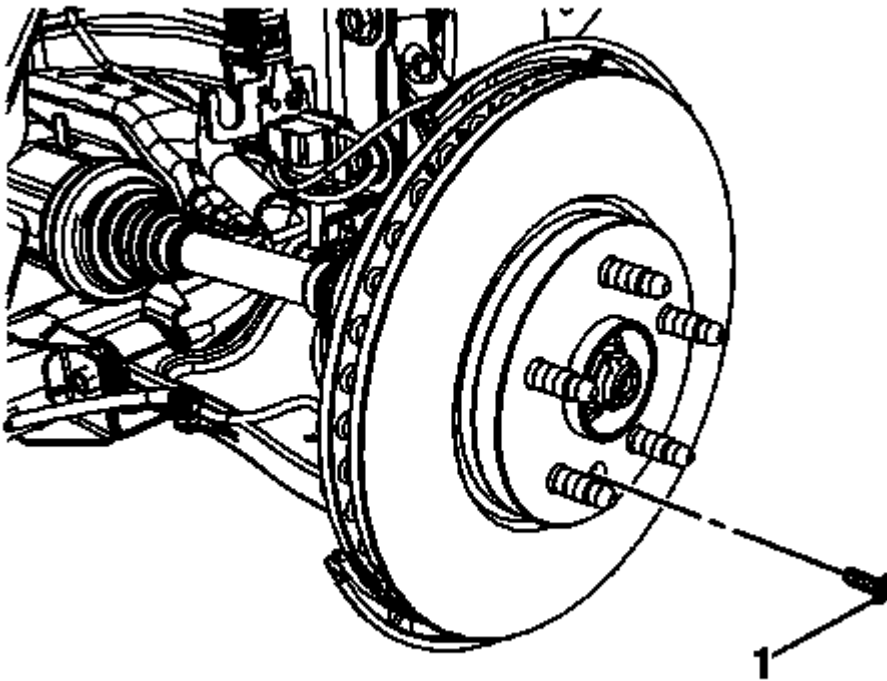


Fig. 70: Brake Rotor Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake rotor bolt (1).

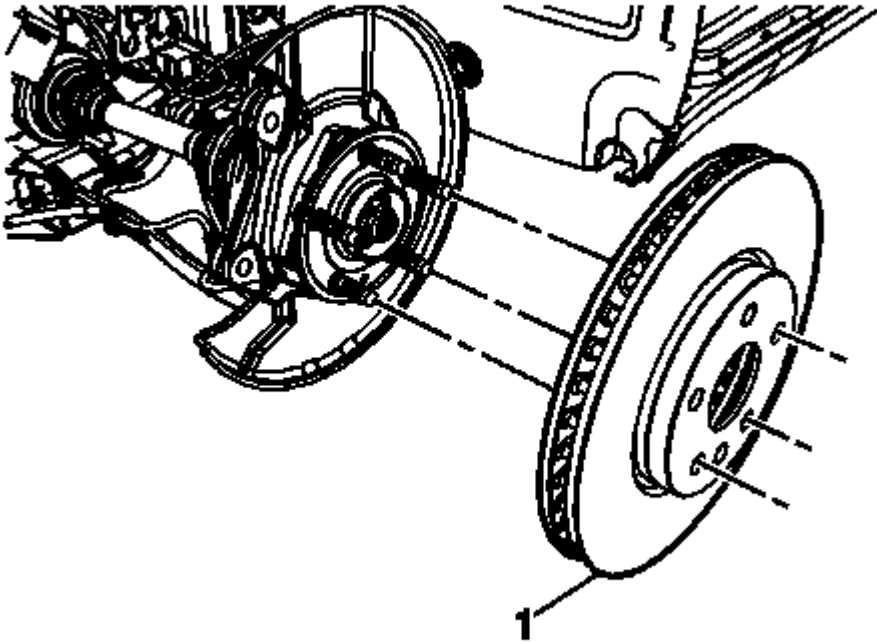


Fig. 71: Brake Rotor
Courtesy of GENERAL MOTORS COMPANY

6. Remove the brake rotor (1).

Installation Procedure

1. If installing a new brake rotor, clean the friction surfaces of the brake rotor with denatured alcohol.
2. Using the **CH-42450-A** Wheel Hub Resurfacing Kit , thoroughly clean any rust or corrosion from the mating surface of the hub/axle flange.
3. Using the **CH-41013** Rotor Resurfacing Kit , thoroughly clean any rust or corrosion from the mating surface of the rotor to the hub/axle flange.

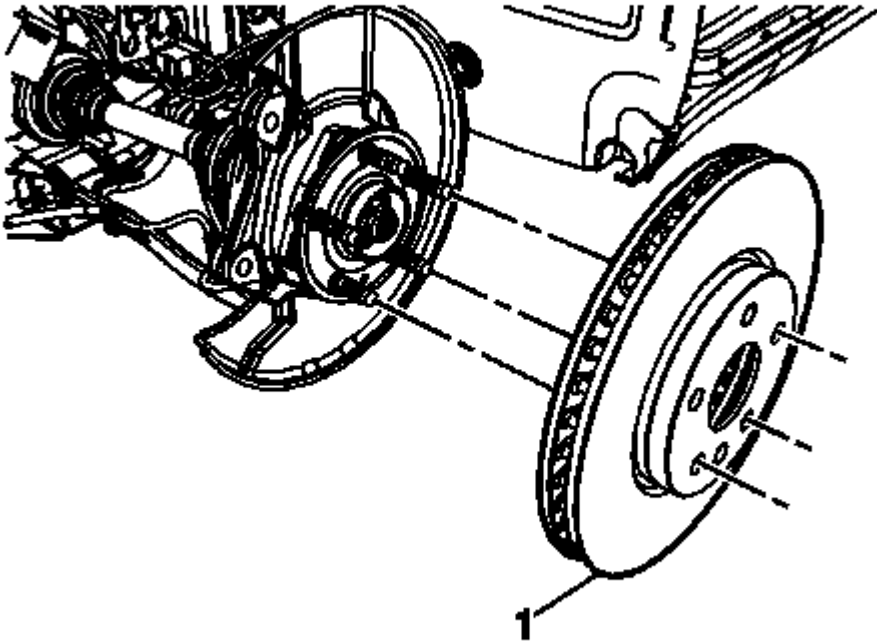


Fig. 72: Brake Rotor

Courtesy of GENERAL MOTORS COMPANY

4. Install the brake rotor (1).

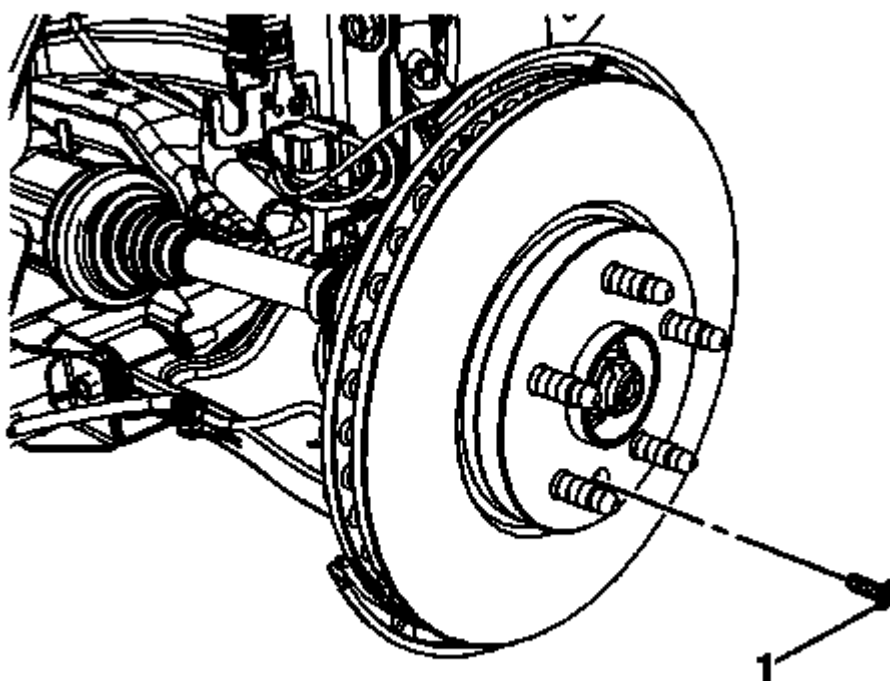


Fig. 73: Brake Rotor Bolt

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the brake rotor bolt (1) and tighten to 7 N.m (62 lb in).

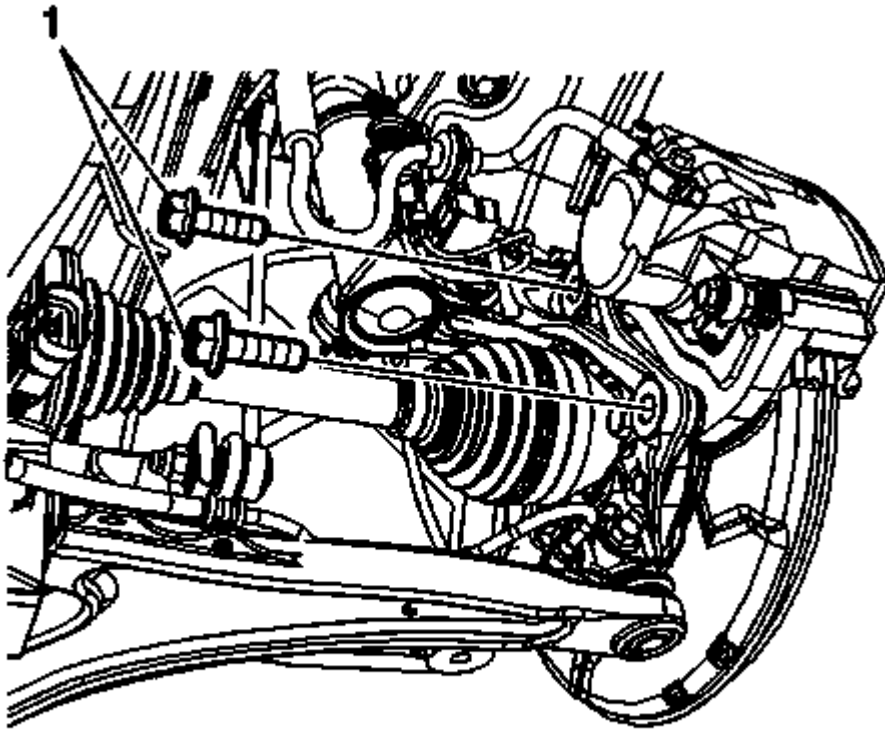


Fig. 74: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Position the brake caliper and bracket assembly to the steering knuckle.
7. Install new brake caliper bracket bolts (1) and tighten to 150 N.m (111 lb ft) +45 degrees + 15 degrees.
8. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
9. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
10. Slowly release the brake pedal.
11. Wait 15 seconds, then repeat steps 9-10 until a firm brake pedal is obtained. This will properly seat the brake caliper piston and brake pads.
12. Burnish the brake pads and rotors. Refer to **Brake Pad and Rotor Burnishing**.

FRONT BRAKE ROTOR REPLACEMENT (J64)

Special Tools

- **CH-41013** Rotor Resurfacing Kit
- **CH-42450-A** Wheel Hub Resurfacing Kit

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

WARNING: Refer to Brake Dust Warning .

NOTE: It is not necessary to replace brake rotors in axle sets.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .

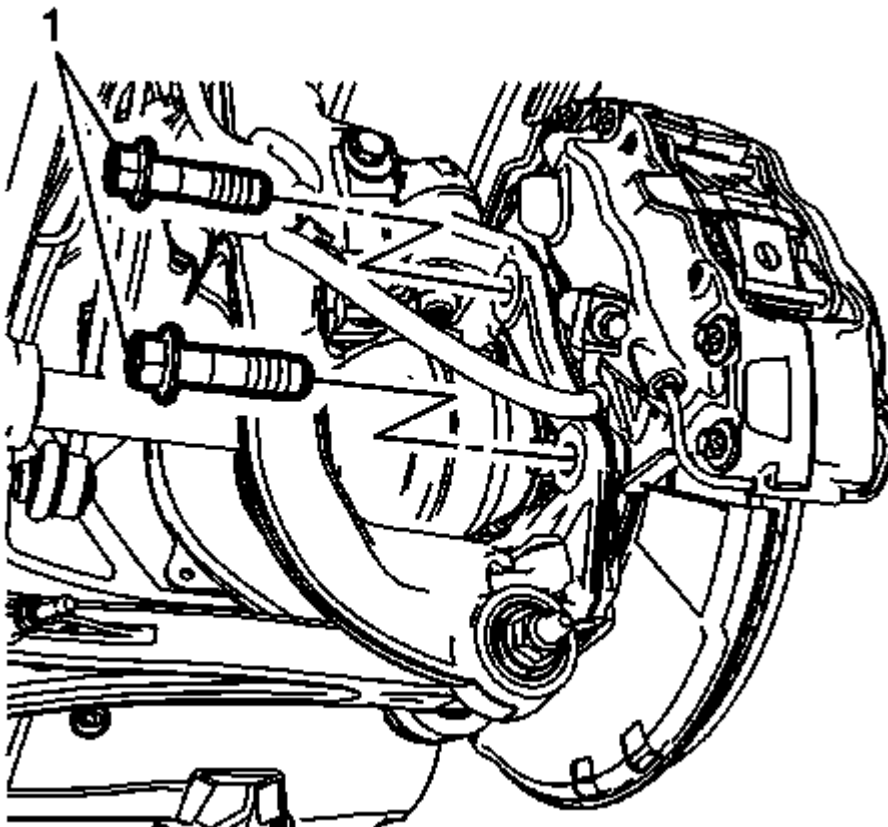


Fig. 75: Brake Caliper Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: The brake caliper bolts must be replaced any time they are removed. Do not reuse the disc brake caliper bolts.

3. Remove and discard the brake caliper bolts (1).

CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible

brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

4. Remove the brake caliper assembly and support with heavy mechanics wire or equivalent.

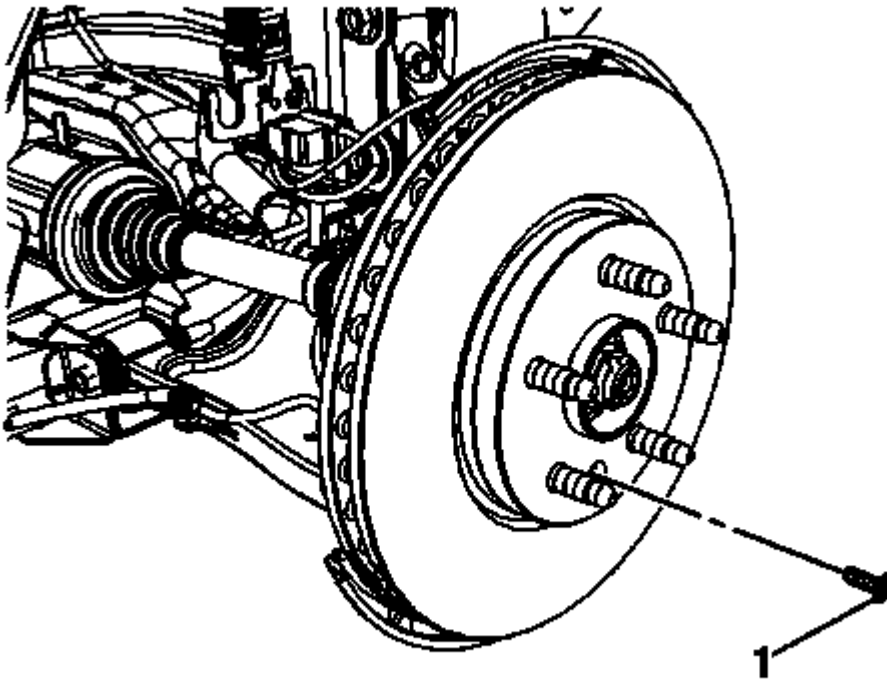


Fig. 76: Brake Rotor Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake rotor bolt (1).

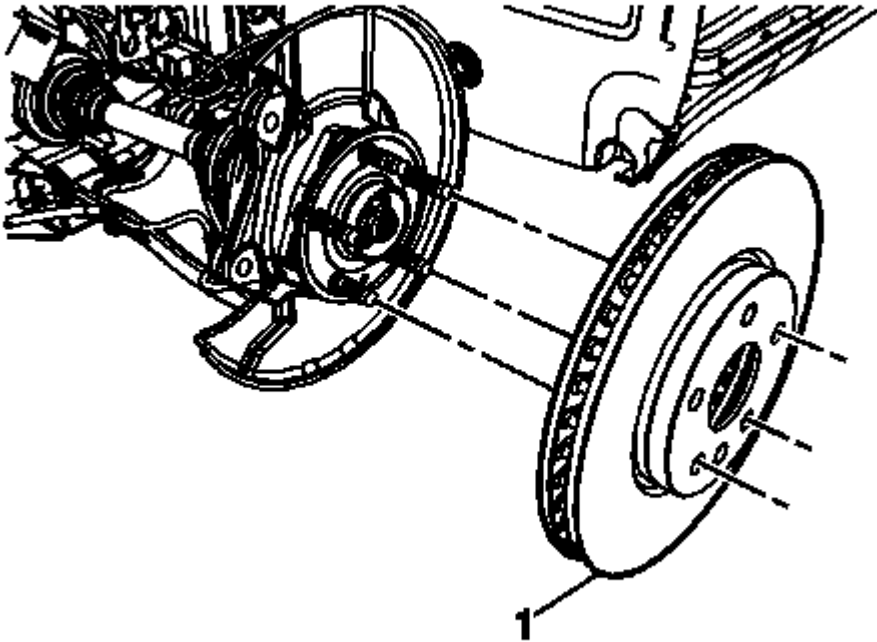


Fig. 77: Brake Rotor

Courtesy of GENERAL MOTORS COMPANY

6. Remove the brake rotor (1).

Installation Procedure

NOTE: Whenever the brake rotor has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake rotor mating surfaces. Failure to do this may result in excessive assembled lateral runout (LRO) of the brake rotor, which could lead to brake pulsation.

1. Using the **CH-42450-A** Wheel Hub Resurfacing Kit , thoroughly clean any rust or corrosion from the mating surface of the hub/axle flange.
2. Using the **CH-41013** Rotor Resurfacing Kit , thoroughly clean any rust or corrosion from the mating surface and mounting surface of the brake rotor.

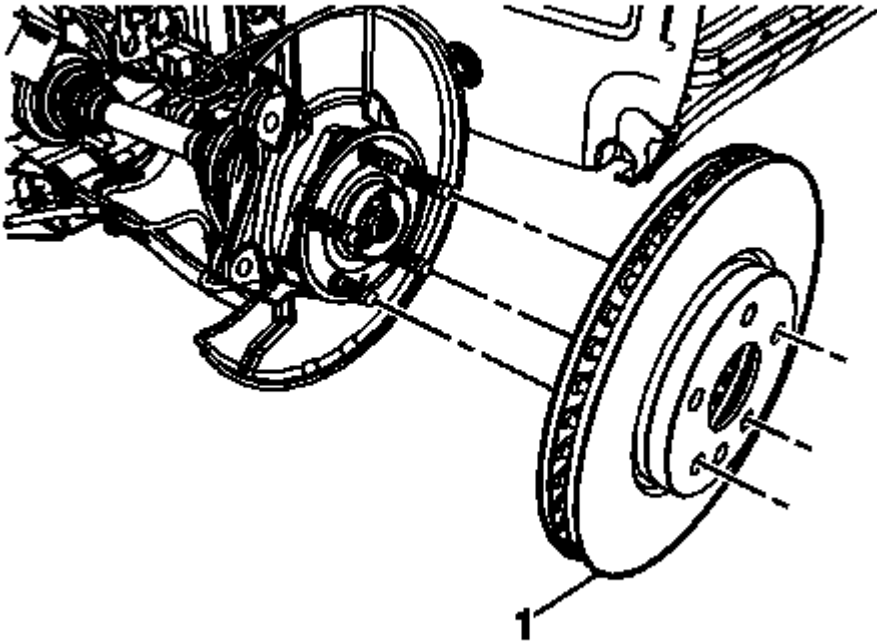


Fig. 78: Brake Rotor

Courtesy of GENERAL MOTORS COMPANY

3. Install the brake rotor (1).

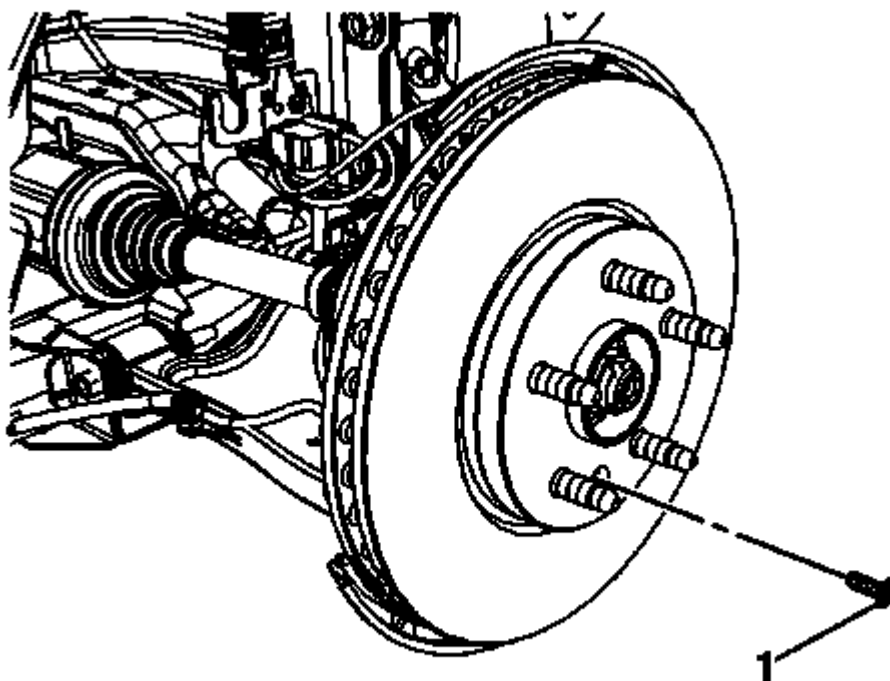


Fig. 79: Brake Rotor Bolt

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the brake rotor bolt (1) and tighten to 7 N.m (62 lb in).
5. Position the brake caliper assembly to the steering knuckle.

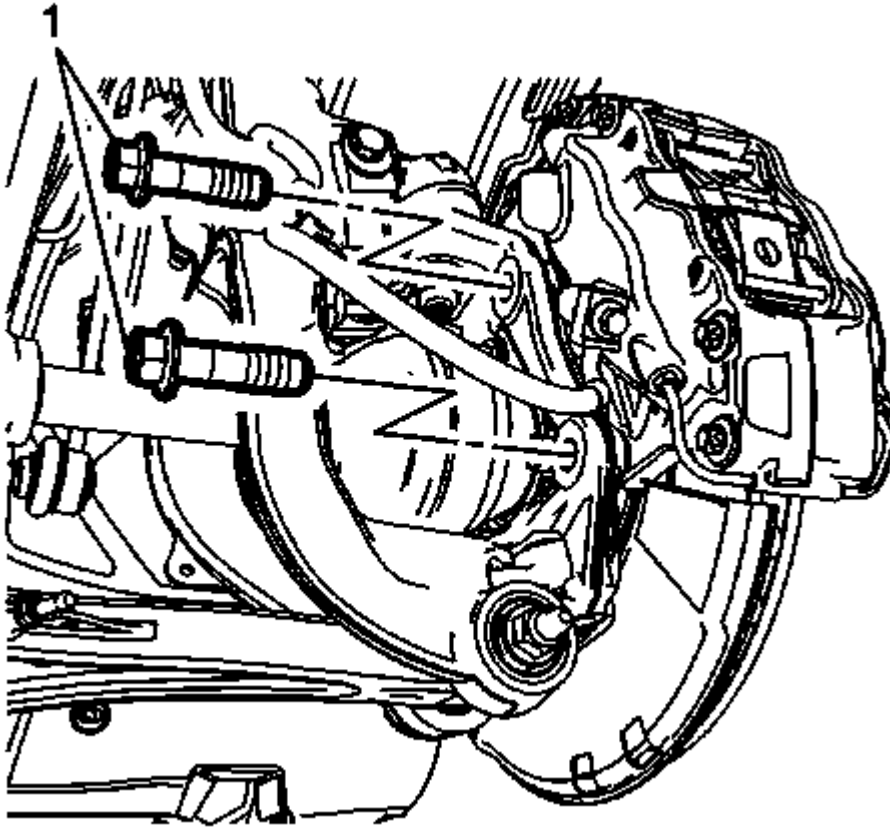


Fig. 80: Brake Caliper Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Install new brake caliper bolts any time the bolts are removed.

6. Install 2 new brake caliper bolts (1) and tighten to 40 N.m (30 lb ft) + 90 degrees.
7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.
8. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
9. Slowly release the brake pedal.
10. Wait 15 seconds, then repeat steps 8-9 until a firm brake pedal is obtained. This will properly seat the brake caliper piston and brake pads.
11. If the brake rotor was refinished or replaced, or if new brake pads were installed, burnish the brake pads and rotors. Refer to **Brake Pad and Rotor Burnishing**.

REAR BRAKE ROTOR REPLACEMENT

Special Tools

- CH-41013 Rotor Resurfacing Kit
- CH-42450-A Wheel Hub Resurfacing Kit

For equivalent regional tools, refer to Special Tools.

Removal Procedure

WARNING: Refer to Brake Dust Warning .

NOTE: It is not necessary to replace brake rotors in axle sets.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .

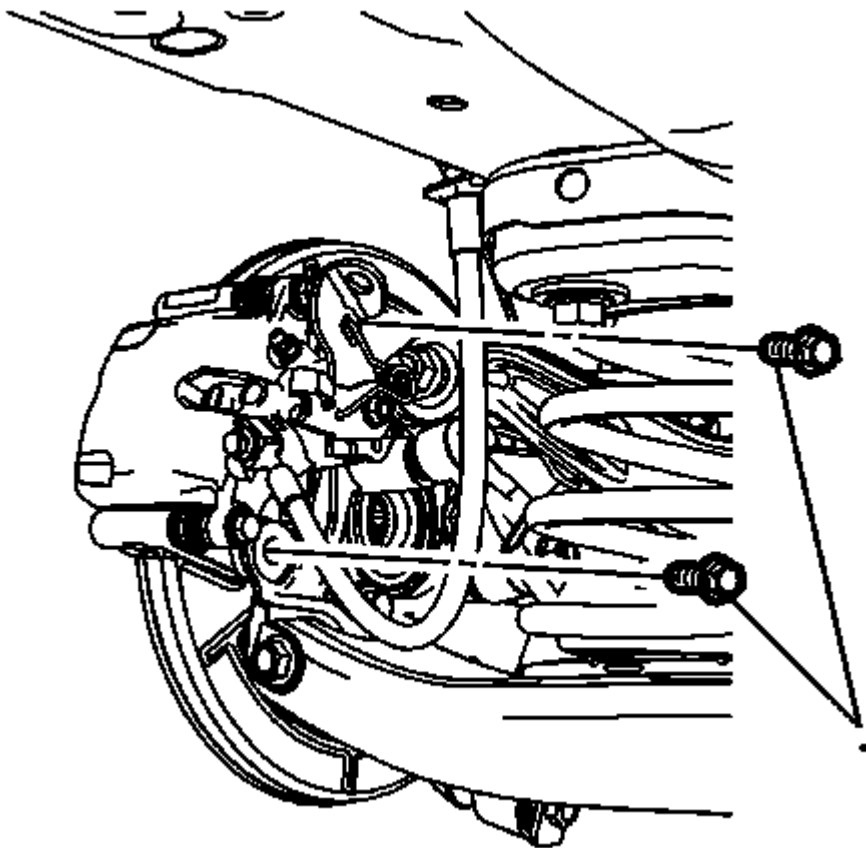


Fig. 81: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not reuse the brake caliper bracket bolts.

3. Remove and discard the brake caliper bracket bolts (1).

CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent,

whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

4. Remove the brake caliper and bracket assembly and support with heavy mechanics wire or equivalent.

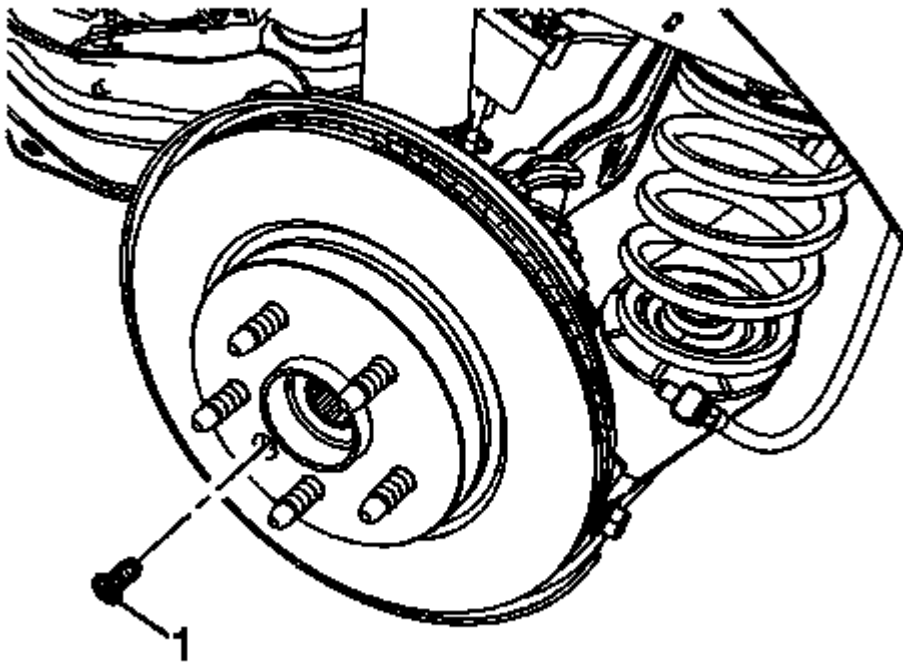


Fig. 82: Brake Rotor Bolt

Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake rotor bolt (1).

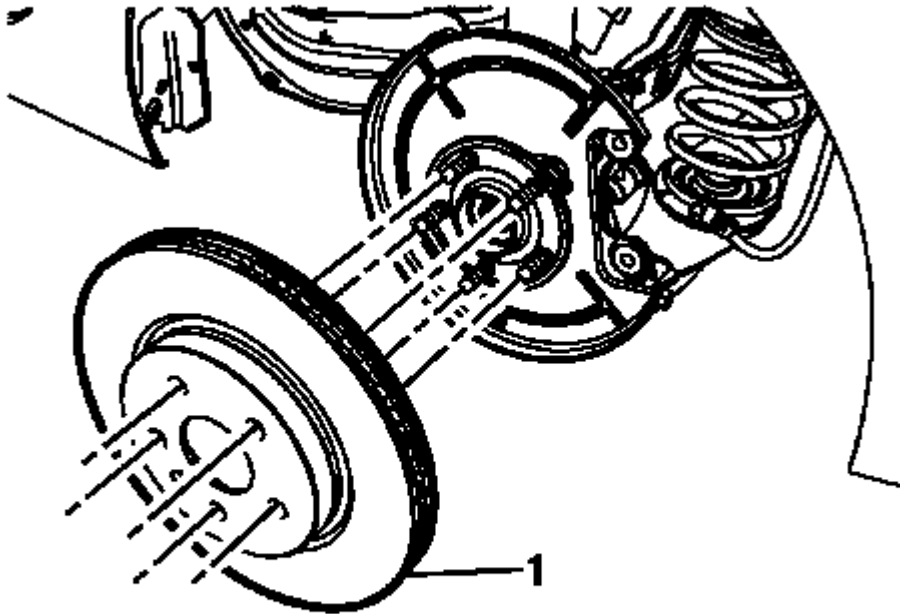


Fig. 83: Rear Brake Rotor
Courtesy of GENERAL MOTORS COMPANY

6. Remove the rear brake rotor (1).

Installation Procedure

1. If installing a new brake rotor, clean the friction surfaces of the brake rotor with denatured alcohol or equivalent.
2. Using the **CH-42450-A** wheel hub resurfacing kit , thoroughly clean any rust or corrosion from the mating surface of the hub/axle flange.
3. Using the **CH-41013** rotor resurfacing kit , thoroughly clean any rust or corrosion from the mating surface of the rotor to the hub/axle flange.

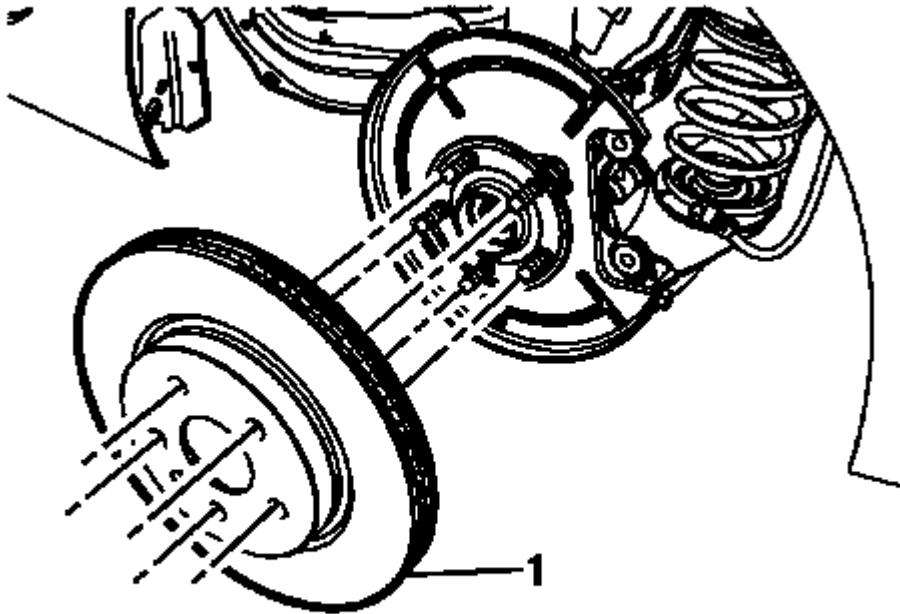


Fig. 84: Rear Brake Rotor

Courtesy of GENERAL MOTORS COMPANY

4. Install the rear brake rotor (1).

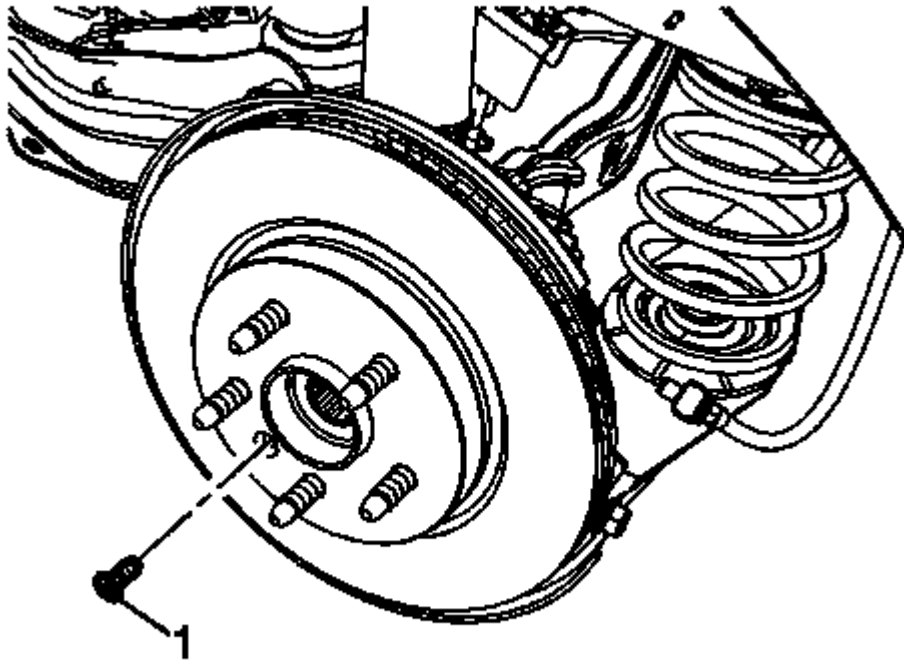


Fig. 85: Brake Rotor Bolt

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the brake rotor bolt (1) and tighten to 10 N.m (89 lb in).
6. Install the brake caliper and bracket assembly.

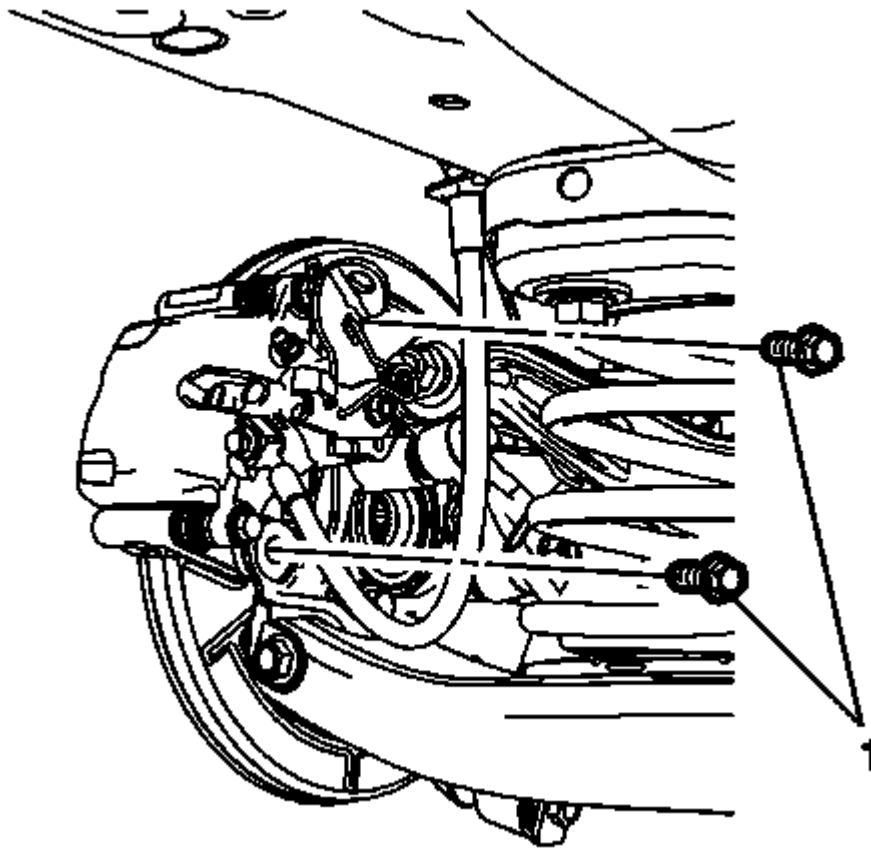


Fig. 86: Brake Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not reuse the brake caliper bracket bolts.

7. Install new brake caliper bracket bolts (1) and tighten to 100 N.m + 60 degrees (74 lb ft + 60 degrees).
8. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
9. Burnish the brake pads and rotors. Refer to **Brake Pad and Rotor Burnishing**.

FRONT BRAKE SHIELD REPLACEMENT

Removal Procedure

WARNING: Do not use a service jack in locations other than those specified to lift this vehicle. Lifting the vehicle with a jack in those other locations could cause the vehicle to slip off the jack and roll; this could cause injury or death.

WARNING: Refer to **Brake Dust Warning** .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the front wheel bearing and hub assembly. Refer to **Front Wheel Bearing and Hub Replacement (GNB)** , **Front Wheel Bearing and Hub Replacement (GNA)** .

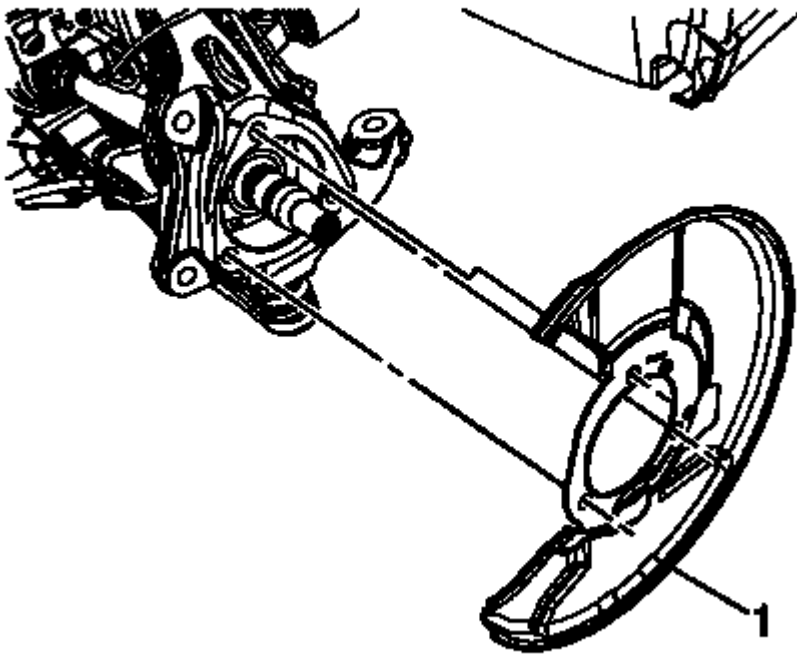


Fig. 87: Front Brake Shield

Courtesy of GENERAL MOTORS COMPANY

4. Remove the front brake shield (1).

Installation Procedure

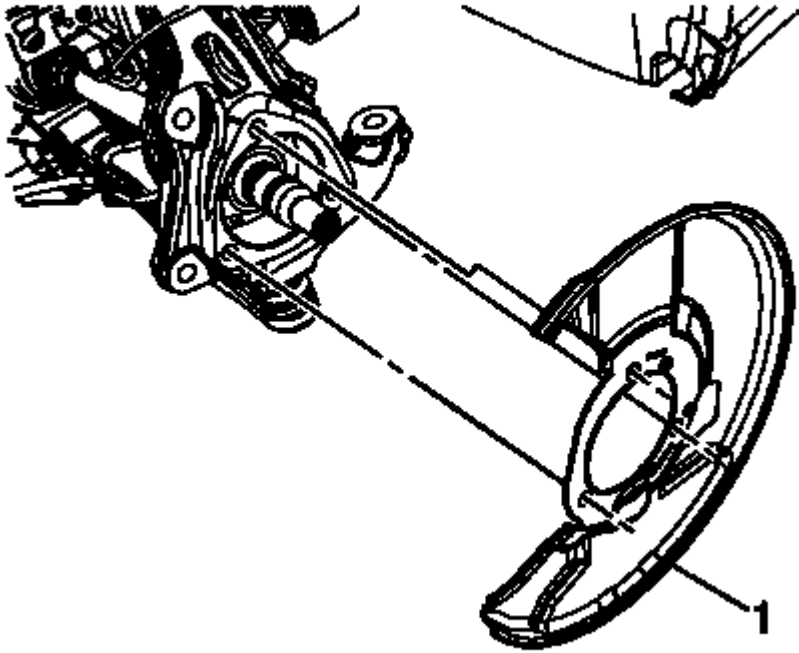


Fig. 88: Front Brake Shield

Courtesy of GENERAL MOTORS COMPANY

1. Install the front brake shield (1).
2. Install the front wheel bearing and hub assembly. Refer to **Front Wheel Bearing and Hub Replacement (GNB)** , **Front Wheel Bearing and Hub Replacement (GNA)** .
3. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

REAR BRAKE SHIELD REPLACEMENT

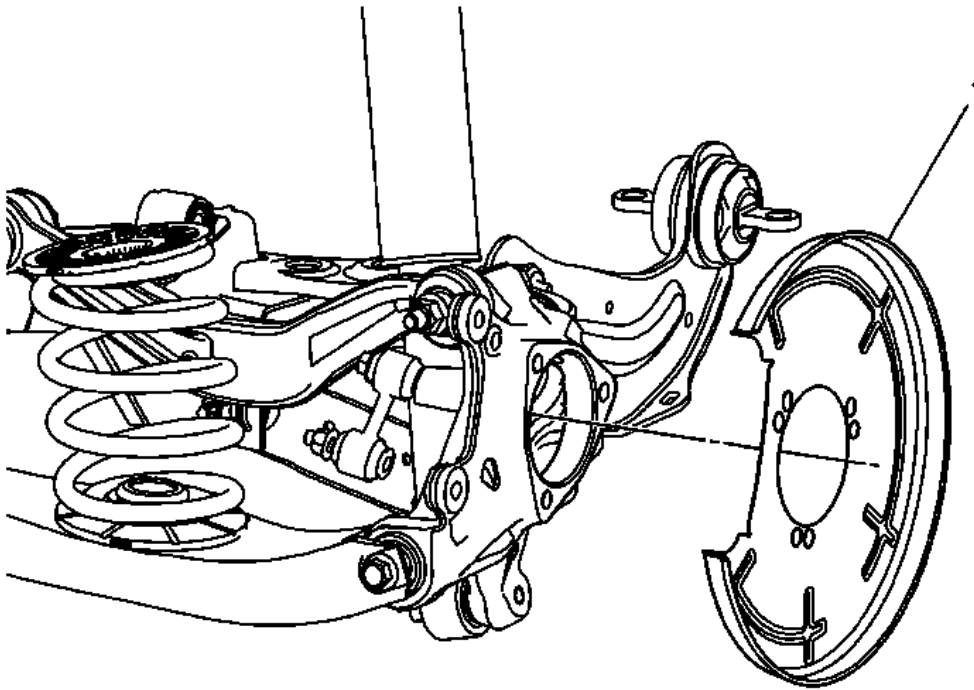


Fig. 89: Rear Brake Shield

Courtesy of GENERAL MOTORS COMPANY

Rear Brake Shield Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Remove the wheel hub assembly. Refer to <u>Rear Wheel Bearing and Hub Replacement</u> , <u>Rear Wheel Bearing and Hub Replacement (GNE)</u> . 	
1	Rear Brake Shield

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT CORRECTION

NOTE:

- Brake rotor thickness variation **MUST** be checked **BEFORE** checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.
- Brake rotor assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4 800-11 300 km (3,000-7,000 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.

Review the following acceptable methods for bringing the brake rotor assembled LRO to within specifications. Determine which method to use for the specific vehicle being repaired.

- The indexing method of correcting assembled LRO is most effective when the LRO specification is only exceeded by a relatively small amount: 0.025-0.127 mm (0.001-0.005 in). Indexing is used to achieve the best possible match of high spots to low spots between related components. Refer to **Brake Rotor Assembled Lateral Runout Correction - Indexing**.
- The correction plate method of correcting assembled LRO involves the addition of a tapered plate between the brake rotor and the hub/axle flange. The correction plate method can be used to correct LRO that exceeds the specification by up to 0.23 mm (0.009 in). Refer to **Brake Rotor Assembled Lateral Runout Correction - Correction Plates**.
- The on-vehicle brake lathe method is used to bring the LRO to within specifications through compensating for LRO while refinishing the brake rotor. Refer to **Brake Rotor Assembled Lateral Runout Correction - On Vehicle Lathe**.

If the assembled LRO cannot be corrected using these methods, then other components must be suspected as causing and/or contributing to the LRO concern.

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT CORRECTION - INDEXING

NOTE: **This Procedure is not used in Europe**

Special Tools

CH-45101-100 Conical Brake Rotor Washers

For equivalent regional tools, refer to **Special Tools**.

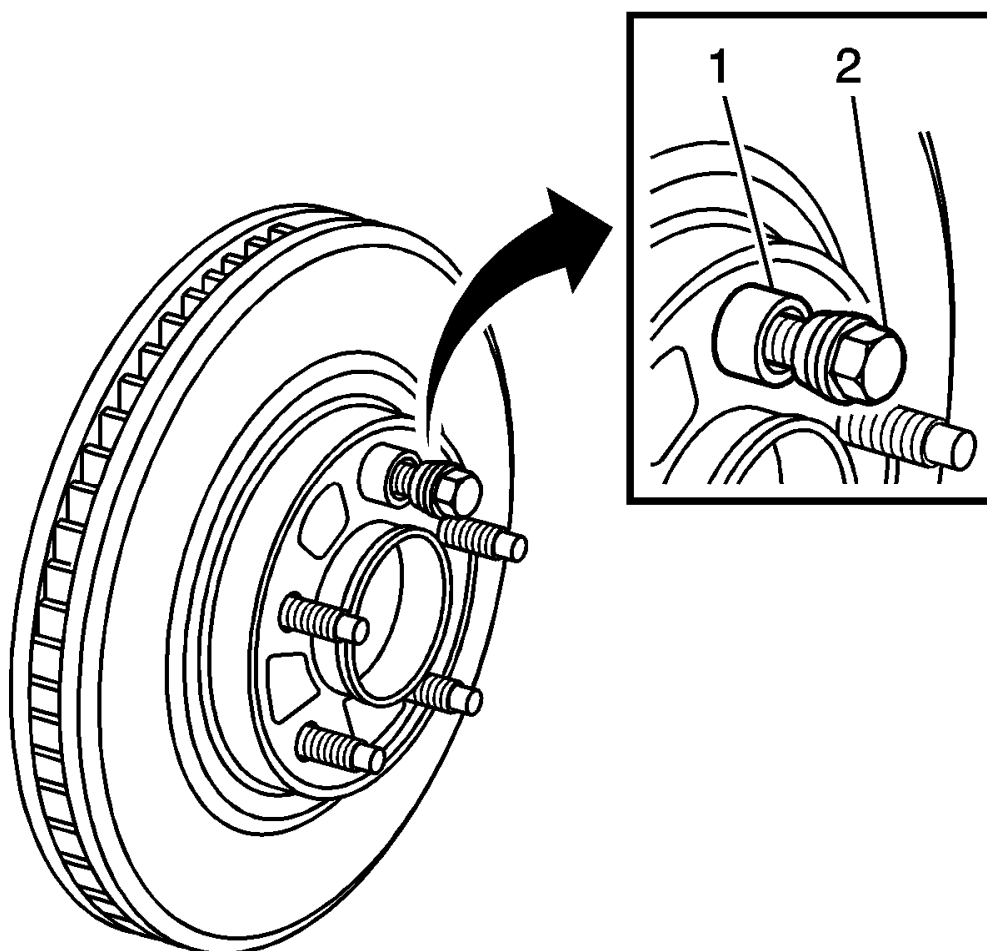


Fig. 90: Conical Brake Rotor Washers & Lug Nut
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Dust Warning .

NOTE:

- Brake rotor thickness variation **MUST** be checked **BEFORE** checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.
- Brake rotor assembled LRO exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4,800-11,300 km (3,000-7,000 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.

1. Remove the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts that were installed during the assembled LRO measurement procedure.

2. Inspect the mating surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles or debris remaining.
3. Index the brake rotor in a different orientation to the hub/axle flange.
4. Hold the rotor firmly in place against the hub/axle flange and install one of the **CH-45101-100** Conical Brake Rotor Washers (1) and one lug nut (2) onto the upper-most wheel stud.
5. Continue to hold the rotor secure and tighten the lug nut firmly by hand.

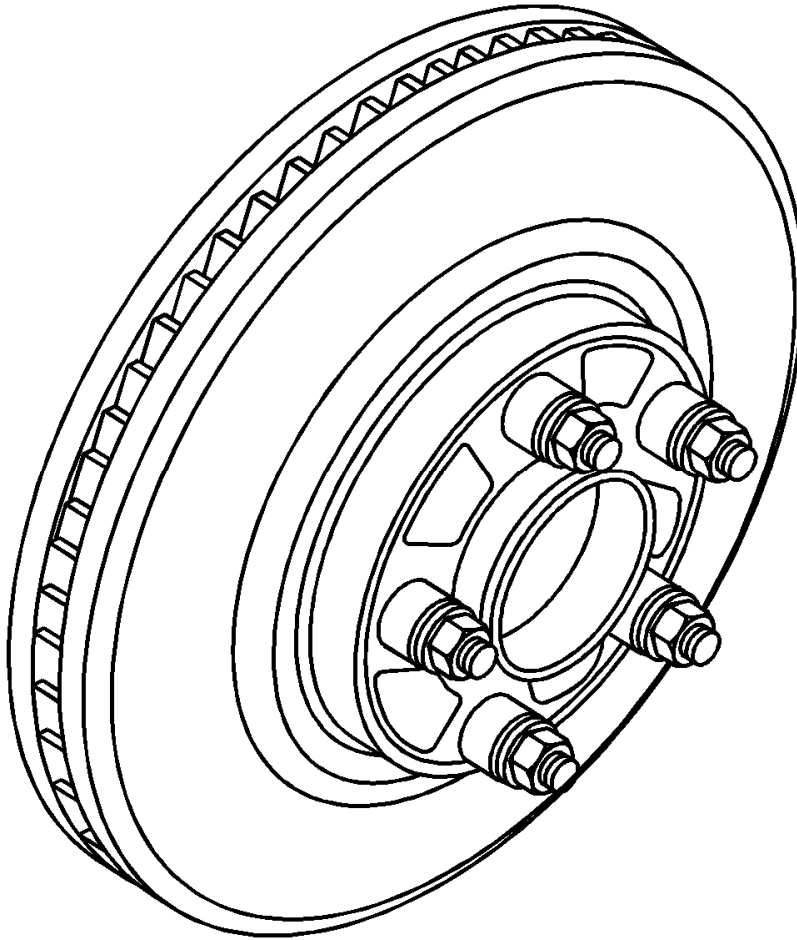


Fig. 91: Conical Brake Rotor Washers & Lug Nuts
Courtesy of GENERAL MOTORS COMPANY

6. Install the remaining **CH-45101-100** Conical Brake Rotor Washers and lug nuts onto the wheel studs and tighten the nuts firmly by hand in a star-pattern.
7. Tighten the lug nuts in a star-pattern to specification, in order to properly secure the rotor. Refer to **Tire and Wheel Removal and Installation** .
8. Measure the assembled LRO of the brake rotor. Refer to **Brake Rotor Assembled Lateral Runout Measurement**.
9. Compare the amount of change between this measurement and the original measurement.

10. If this measurement is within specifications, proceed to step 14.
11. If this measurement still exceeds specifications, repeat steps 1-9 until the best assembled LRO measurement is obtained.
12. Matchmark the final location of the rotor to the wheel studs if the orientation is different than it was originally.
13. If the brake rotor assembled LRO measurement still exceeds the maximum allowable specification, refer to **Brake Rotor Assembled Lateral Runout Correction**.
14. If the brake rotor assembled LRO is within specification, install the brake caliper and depress the brake pedal several times to secure the rotor in place before removing the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts.

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT CORRECTION - CORRECTION PLATES

NOTE: **This procedure not used in Europe**

Special Tools

CH-45101-100 Conical Brake Rotor Washers

For equivalent regional tools, refer to **Special Tools**.

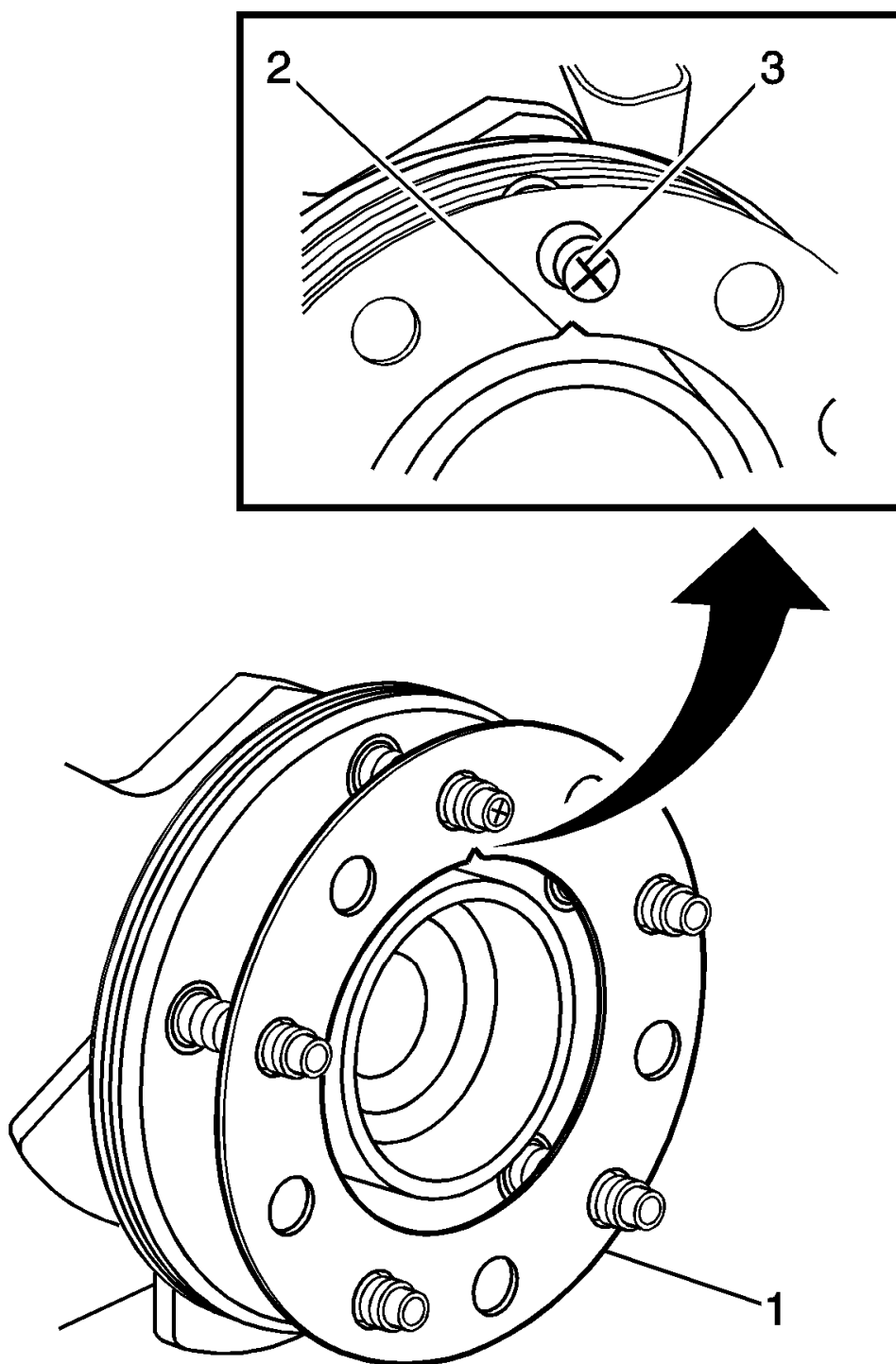


Fig. 92: Identifying Correction Plate, High Spot Mark & V-Shaped Notch
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Dust Warning .

NOTE:

- **Brake rotor thickness variation MUST be checked BEFORE checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.**
- **Brake rotor assembled LRO exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4,800-11,300 km (3,000-7,000 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.**

1. Rotate the brake rotor to position the high spot, identified and marked during the brake rotor assembled LRO measurement procedure, to face upward.
2. Remove the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts that were installed during the assembled LRO measurement procedure and/or the indexing correction procedure.
3. Inspect the mounting surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles or debris remaining.
4. Select the correction plate, following the manufacturer's instructions, which has a specification closest to the assembled LRO measurement.

For example: If the assembled LRO measurement was 0.076 mm (0.003 in), the 0.076 mm (0.003 in) correction plate would be used. If the measurement was 0.127 mm (0.005 in), the 0.152 mm (0.006 in) correction plate would be used.

5. Determine the positioning for the correction plate (1) using the high spot mark (3) made during the brake rotor assembled LRO measurement procedure.

NOTE:

- **Do NOT install used correction plates in an attempt to correct brake rotor assembled LRO.**
- **Do NOT stack up, or install more than one correction plate onto one hub/axle flange location, in an attempt to correct brake rotor assembled LRO.**

6. Install the correction plate (1) onto the hub/axle flange, with the V-shaped notch (2) orientated to align with the high spot mark (3), that was positioned to face upward.

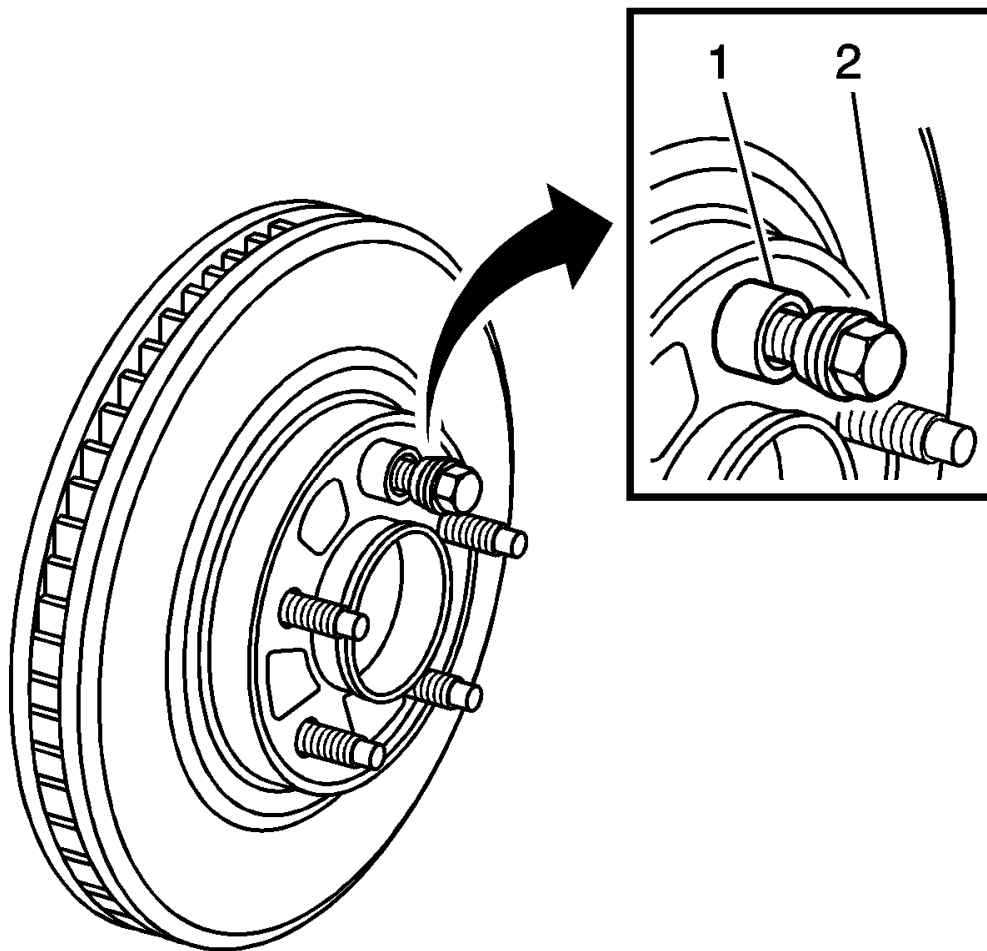


Fig. 93: Conical Brake Rotor Washers & Lug Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install the brake rotor to the hub/axle flange. Use the matchmark made prior to removal for proper orientation to the flange.
8. Hold the rotor firmly in place against the hub/axle flange and install one of the **CH-45101-100** Conical Brake Rotor Washers (1) and one lug nut (2) onto the upper-most wheel stud.
9. Continue to hold the rotor secure and tighten the lug nut firmly by hand.

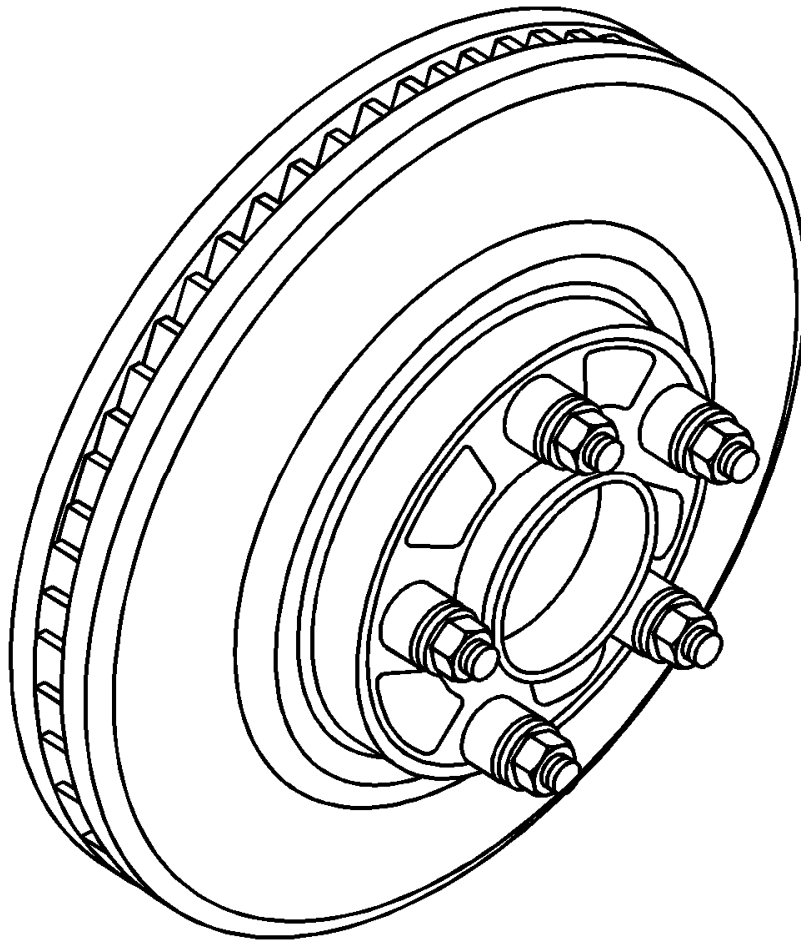


Fig. 94: Conical Brake Rotor Washers & Lug Nuts
Courtesy of GENERAL MOTORS COMPANY

10. Install the remaining **CH-45101-100** Conical Brake Rotor Washers and lug nuts onto the wheel studs and tighten the nuts firmly by hand in a star-pattern.
11. Tighten the lug nuts in a star-pattern to specification, in order to properly secure the rotor. Refer to **Tire and Wheel Removal and Installation** .
12. Measure the assembled LRO of the brake rotor. Refer to **Brake Rotor Assembled Lateral Runout Measurement**.
13. If the brake rotor assembled LRO measurement still exceeds the maximum allowable specification, refer to **Brake Rotor Assembled Lateral Runout Correction**.
14. If the brake rotor assembled LRO measurement is within specification, install the brake caliper and depress the brake pedal several times to secure the rotor in place before removing the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts.

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT CORRECTION - ON VEHICLE LATHE

NOTE: This procedure is not used in Europe.

Special Tools

CH-45101-100 Conical Brake Rotor Washers

For equivalent regional tools, refer to Special Tools.

WARNING: Refer to Brake Dust Warning .

NOTE:

- Brake rotor thickness variation **MUST** be checked **BEFORE** checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.
- Brake rotor assembled LRO exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4 800-11 300 km (3,000-7,000 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.

1. Ensure that the caliper and caliper bracket that are already being supported, are clear from contacting any rotating components, such as the brake rotor.
2. Remove the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts that were installed during the assembled LRO measurement procedure and/or the indexing correction procedure.
3. Inspect the mounting surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles or debris remaining.
4. Set up the lathe, following the manufacturer's instructions.
5. Refinish the brake rotor, following the brake lathe manufacturer's instructions.
6. After each successive cut, inspect the brake rotor thickness. Refer to Brake Rotor Thickness Measurement.
7. If at any time the brake rotor exceeds the minimum allowable thickness after refinish specification, the brake rotor must be replaced. After replacing the rotor, proceed to step 10.
8. After refinishing the brake rotor, use the following procedure in order to obtain the desired non-directional finish:
 1. Follow the brake lathe manufacturer's recommended speed setting for applying a non-directional finish.
 2. Using moderate pressure, apply the non-directional finish:
 - If the lathe is equipped with a non-directional finishing tool, apply the finish with 120-grit aluminum oxide sandpaper.
 - If the lathe is not equipped with a non-directional finishing tool, apply the finish with a sanding block and 150-grit aluminum oxide sandpaper.
 3. After applying a non-directional finish, clean each friction surface of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
9. Remove the lathe from the vehicle.

10. Measure the assembled LRO of the brake rotor. Refer to **Brake Rotor Assembled Lateral Runout Measurement**.
11. If the brake rotor assembled LRO measurement still exceeds the maximum allowable specification, refer to **Brake Rotor Assembled Lateral Runout Correction**.
12. If the brake rotor assembled LRO is within specification, install the brake caliper and depress the brake pedal several times to secure the rotor in place before removing the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts.

BRAKE ROTOR REFINISHING

Special Tools

- **CH-41013** Rotor Resurfacing Kit
- **CH-42450-A** Wheel Hub Resurfacing Kit

For equivalent regional tools, refer to **Special Tools**.

WARNING: Refer to **Brake Dust Warning** .

NOTE:

- The disc brake rotors do not require refinishing as part of routine brake system service. New disc brake rotors do not require refinishing.

Do not refinish disc brake rotors in an attempt to correct the following conditions:

- **Brake system noise - squeal, growl, groan**
- **Uneven and/or premature disc brake pad wear**
- **Superficial or cosmetic corrosion/rust of the disc brake rotor friction surface**
- **Scoring of the disc brake rotor friction surface less than the maximum allowable specification**
- **Before refinishing a brake rotor, the rotor MUST first be checked for adequate thickness to allow the rotor to be refinished and remain above the minimum allowable thickness after refinish specification. Refer to Brake Rotor Thickness Measurement.**

Disc brake rotors should only be refinished if they have adequate thickness to be refinished and if one or more of the following conditions exist:

- **Thickness variation in excess of the maximum allowable specification**
- **Excessive corrosion/rust and/or pitting**

- Cracks and/or heat spots
- Excessive blueing discoloration
- Scoring of the disc brake rotor surface in excess of the maximum allowable specification
- Disc brake rotors may need to be refinished as part of the process for correcting brake rotor assembled lateral runout (LRO) that exceeds the maximum allowable specification.

NOTE: If the vehicle is equipped with cross-drilled rotors, use a lathe with positive rake tooling. This setup requires less cutting pressure, which will result in less vibration, and a better surface finish. Also, use a vibration dampener when cutting. Otherwise, refinish according to the following instructions.

NOTE: Whenever the brake rotor has been separated from the hub/axle flange, clean any rust or contaminants from the hub/axle flange and the brake rotor mating surfaces. Failure to do this may result in increased assembled lateral runout (LRO) of the brake rotor, which could lead to brake pulsation.

1. Using the **CH-42450-A** Wheel Hub Resurfacing Kit , thoroughly clean any rust or corrosion from the mating surface of the hub/axle flange.
2. Using the **CH-41013** Rotor Resurfacing Kit , thoroughly clean any rust or corrosion from the mating surface and mounting surface of the brake rotor.
3. Inspect the mating surfaces of the hub/axle flange and the rotor to ensure that there are no foreign particles or debris remaining.
4. Mount the brake rotor to the brake lathe according to the lathe manufacturer's instructions, ensuring that all mounting attachments and adapters are clean and free of debris.
5. Ensure that any vibration dampening attachments are securely in place.
6. With the brake lathe running, slowly bring in the cutting tools until they just contact the brake rotor friction surfaces.
7. Observe the witness mark on the brake rotor. If the witness mark extends approximately three-quarters or more of the way around the brake rotor friction surface on each side, the brake rotor is properly mounted to the lathe.
8. If the witness mark does not extend three-quarters or more of the way around the brake rotor, re-mount the rotor to the lathe.
9. Following the brake lathe manufacturer's instructions, refinish the brake rotor.
10. After each successive cut, inspect the brake rotor thickness. Refer to **Brake Rotor Thickness Measurement**.
11. If at any time the brake rotor exceeds the minimum allowable thickness after refinish specification, the brake rotor must be replaced.
12. After refinishing the brake rotor, use the following procedure in order to obtain the desired non-directional finish:

1. Follow the brake lathe manufacturer's recommended speed setting for applying a non-directional finish.
2. Using moderate pressure, apply the non-directional finish:
 - If the lathe is equipped with a non-directional finishing tool, apply the finish with 120-grit aluminum oxide sandpaper.
 - If the lathe is not equipped with a non-directional finishing tool, apply the finish with a sanding block and 150-grit aluminum oxide sandpaper.

NOTE: **Thoroughly cleaning the brake rotor will prevent the possible transfer of finite metal dust left as a by-product of machining to the brake pad material during the burnishing process, thereby reducing the possibility for brake squeal or other brake noises to occur.**

3. After applying a non-directional finish, clean each friction surface of the brake rotor with a solution of mild dish washing detergent and water, or a GM approved brake cleaner and a clean shop towel to remove metal particles remaining from machining. Repeat the cleaning process if necessary to remove all metal particles.
13. Remove the brake rotor from the brake lathe.
14. Measure the assembled LRO of the brake rotor to ensure optimum performance of the disc brakes. Refer to **Brake Rotor Assembled Lateral Runout Measurement**.
15. If the brake rotor assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to **Brake Rotor Assembled Lateral Runout Correction**.

DESCRIPTION AND OPERATION

DISC BRAKE SYSTEM DESCRIPTION AND OPERATION

System Component Description

The disc brake system consists of the following components:

Disc Brake Pads

Applies mechanical output force from the hydraulic brake calipers to friction surfaces of brake rotors.

Disc Brake Rotors

Uses mechanical output force applied to friction surfaces from the disc brake pads to slow speed of tire and wheel assembly rotation.

Disc Brake Pad Hardware

Secures disc brake pads firmly in proper relationship to the hydraulic brake calipers. Enables a sliding motion of brake pads when mechanical output force is applied.

Disc Brake Caliper Hardware

Provides mounting for hydraulic brake caliper and secures the caliper firmly in proper relationship to caliper bracket. Enables a sliding motion of the brake caliper to the brake pads when mechanical output force is applied.

Disc Brake Caliper Hardware (J64)

The hydraulic brake caliper is secured by two bolts to the steering knuckle. Four hydraulic pistons enables a sliding motion of the brake pads when mechanical output force is applied.

System Operation

J60, J61, J62

Mechanical output force is applied from the hydraulic brake caliper pistons to the inner brake pads. As the pistons press the inner brake pads outward, the caliper housings draw the outer brake pads inward. This allows the output force to be equally distributed. The brake pads apply the output force to the friction surfaces on both sides of the brake rotors, which slows the rotation of the tire and wheel assemblies. The correct function of both the brake pad and brake caliper hardware is essential for even distribution of braking force.

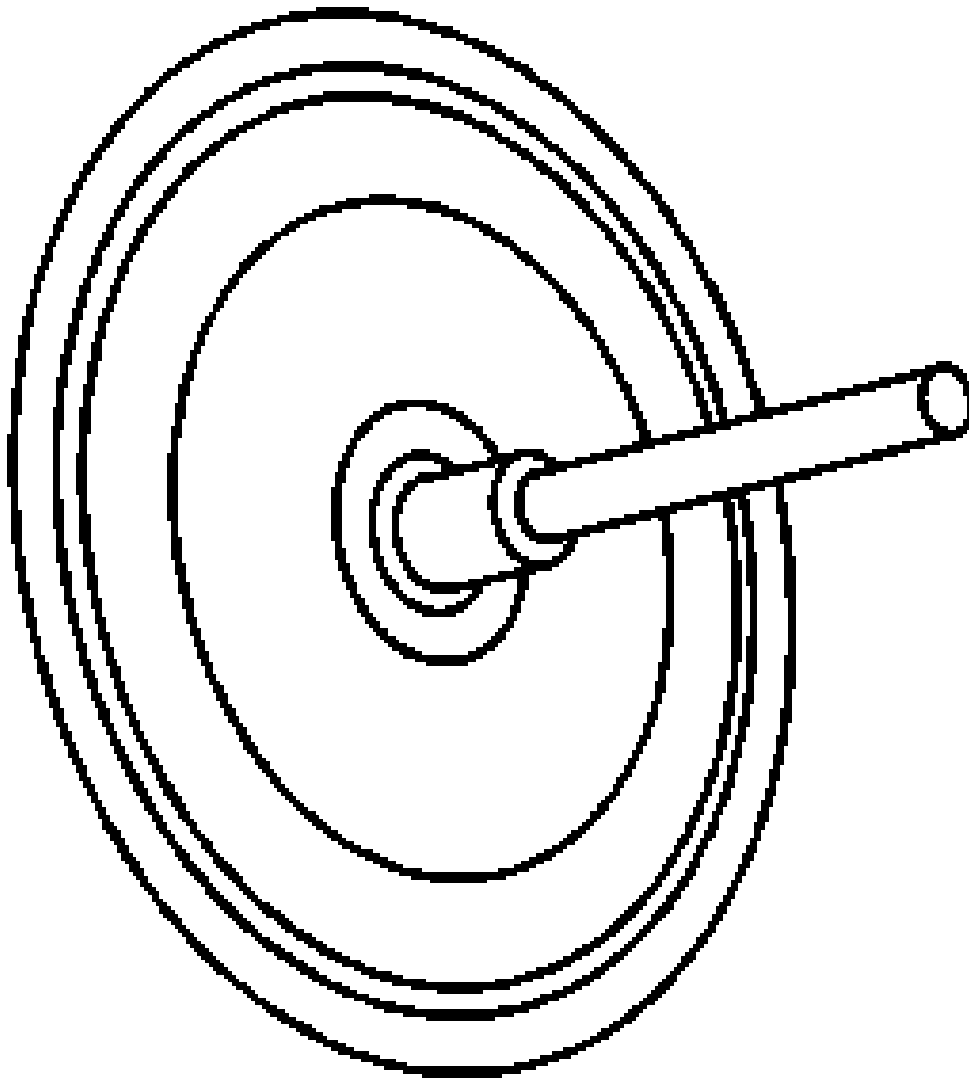
J64:

Mechanical output force is applied from the hydraulic brake caliper 4 pistons, two pistons on each side of the caliper. They are connected hydraulically by a brake pipe. The hydraulic pressure press the brake pads outwards. The brake pads apply the output force to the friction surface on both sides of the rotors, which slows the rotation of tire and wheel assemblies. The correct function of both the brake pad and brake caliper hardware is essential for even distribution of braking force.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

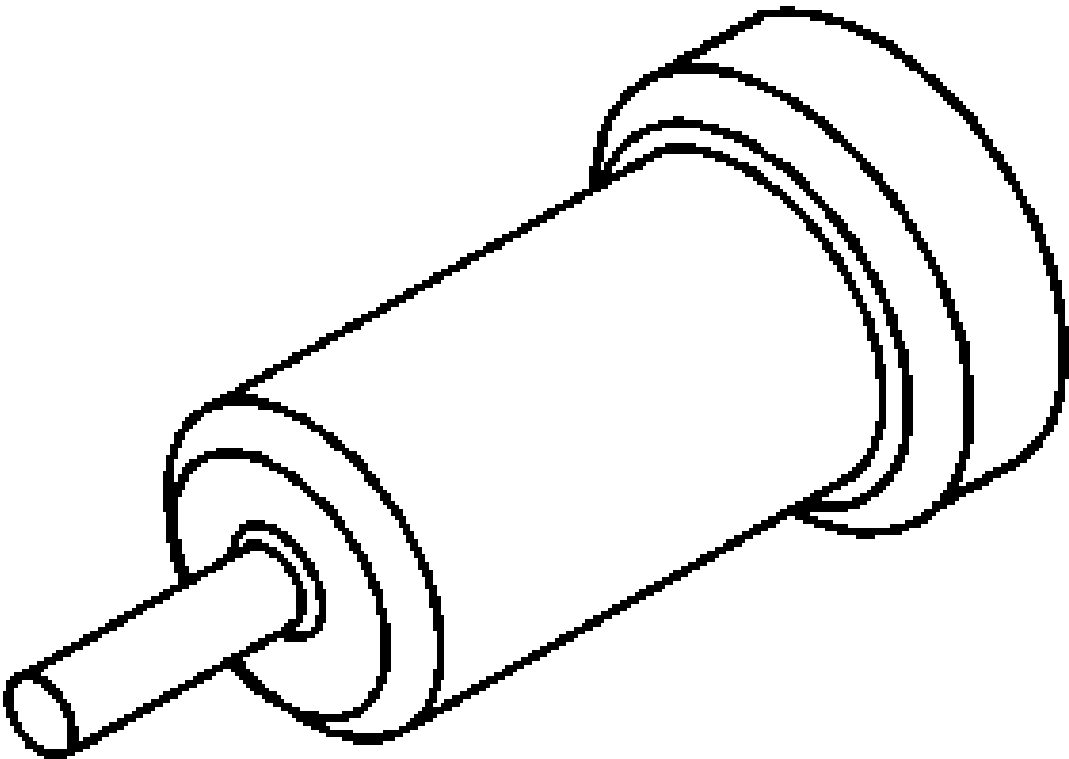
Illustration	Tool Number/ Description



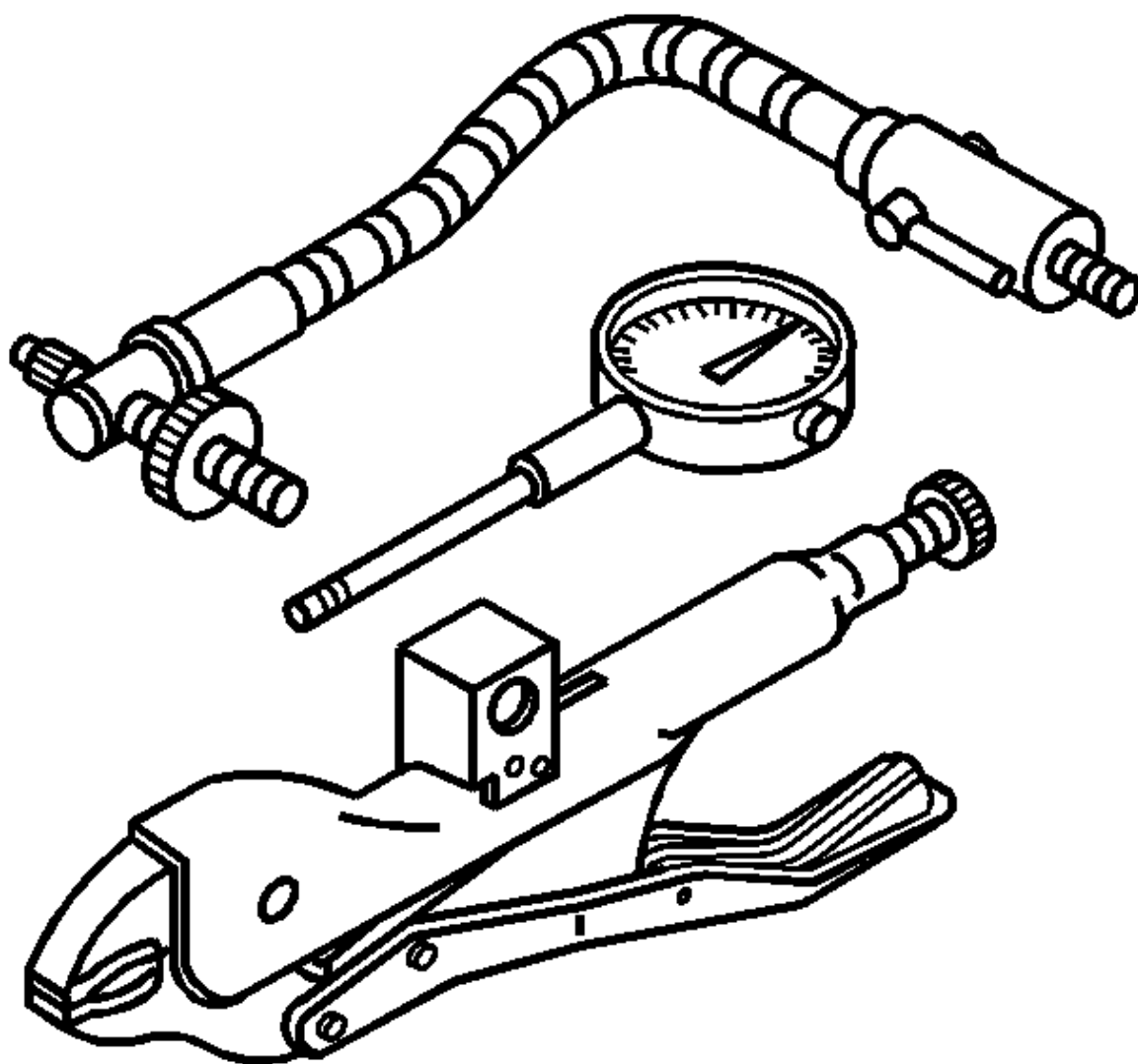
CH 41013
J 41013
Rotor
Resurfacing
Kit
Not used in
Europe

CH 42450-

A
J 42450-A
Wheel Hub
Resurfacing
Kit
Not used in
Europe

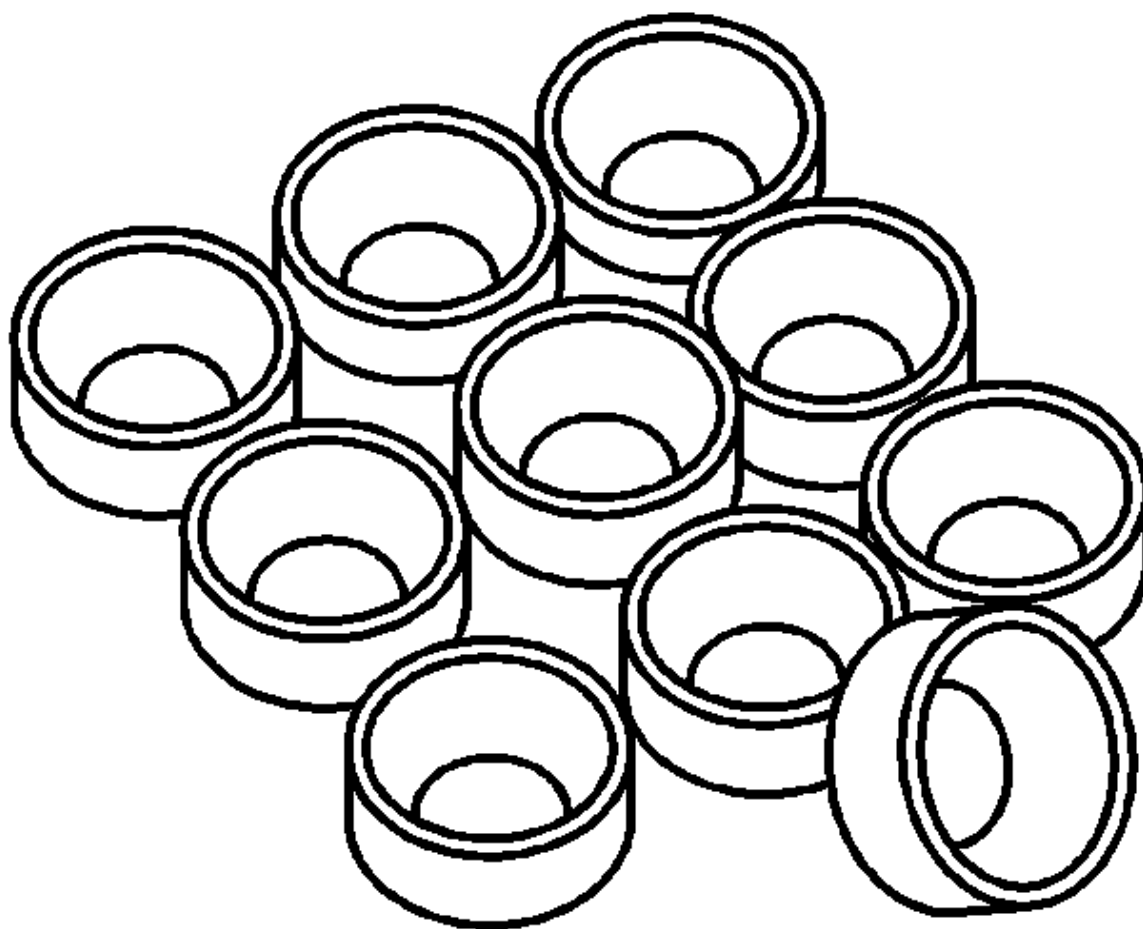


J 45101
Hub and
Wheel
Runout
Gauge
Not used in
Europe



CH 45101-

100
J 45101-
100
Conical
Brake Rotor
Washers
Not used in
Europe



ACCESSORIES & EQUIPMENT

Displays and Gauges

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Drivers Information Display Fasteners	2 N.m	18 lb in
Instrument Cluster Heads Up Display Fasteners	2.5 N.m	22 lb in
Instrument Panel Cluster Fasteners	2.5 N.m	22 lb in

AMBIENT AIR TEMPERATURE SENSOR RESISTANCE

Ambient Air Temperature Sensor Resistance

Temperature		Ambient Air Temp Sensor	Ambient Air Temp Sensor (Min)	Ambient Air Temp Sensor (Max)
°C	°F	(kohms)	(kohms)	(kohms)
-40	-40	169.4	158.46	181.19
-30	-22	88.74	83.39	94.47
-20	-4	48.58	47.19	50.02
-10	14	27.67	26.93	28.44
0	32	16.33	15.92	16.75
10	50	9.95	9.71	10.19
20	68	6.24	6.1	6.38
30	86	4.02	3.94	4.11
40	104	2.66	2.61	2.71
50	122	1.8	1.73	1.87
60	140	1.24	1.2	1.29

SCHEMATIC WIRING DIAGRAMS

INSTRUMENT CLUSTER WIRING SCHEMATICS

Gauges (Except CZ2)

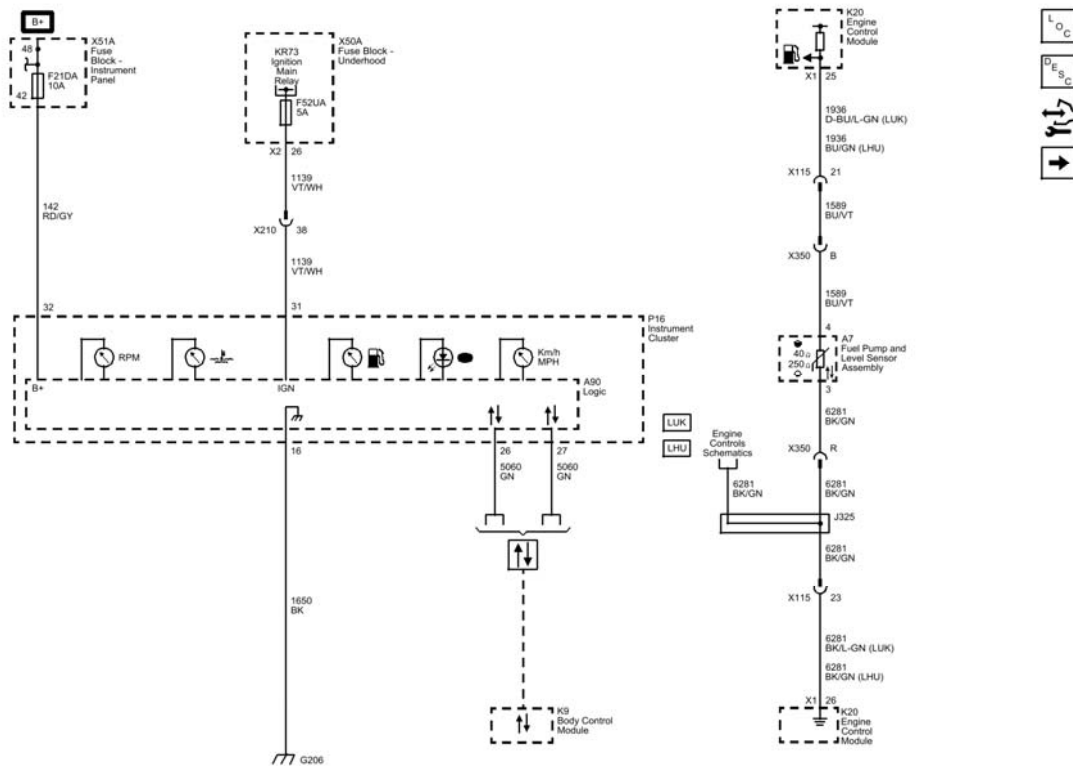


Fig. 1: Gauges (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Gauges (CZ2)

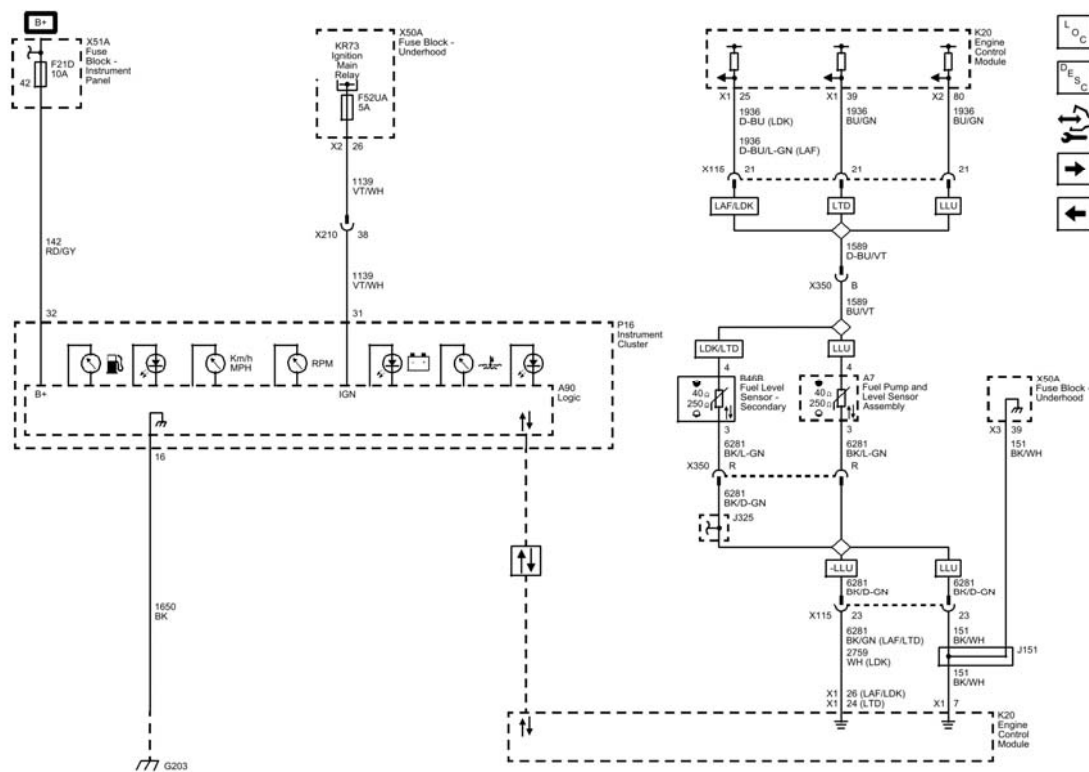


Fig. 2: Gauges (CZ2)

Courtesy of GENERAL MOTORS COMPANY

Indicators

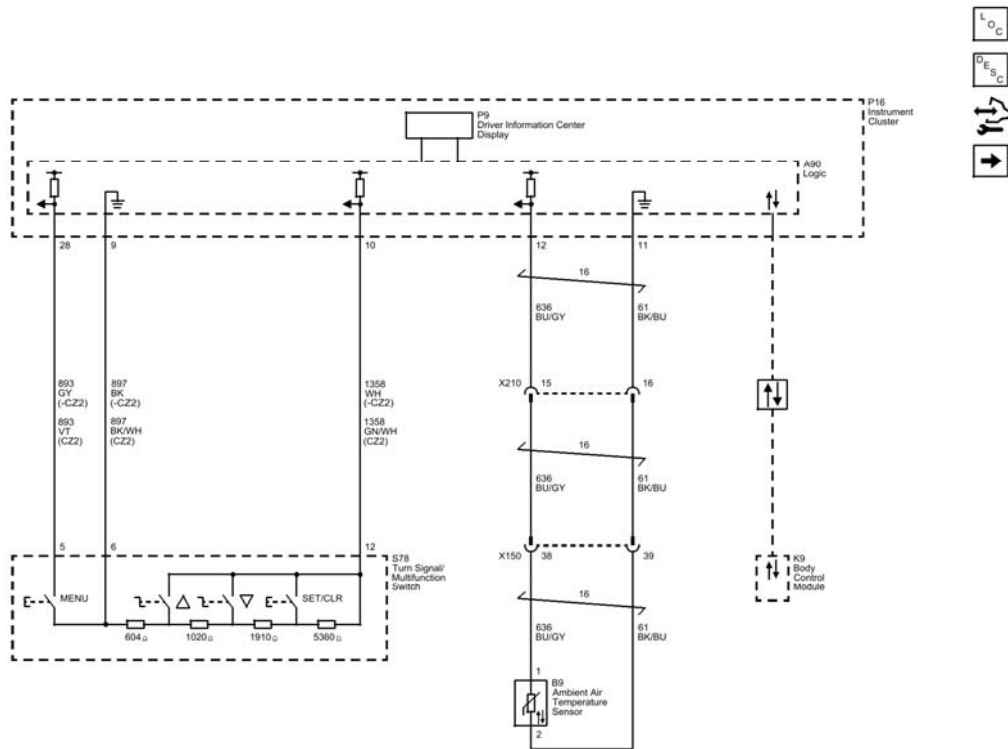


Fig. 5: Driver Information
Courtesy of GENERAL MOTORS COMPANY

Radio Display (without Navigation/CZ2)



Radio Display (with Navigation/CZ2)

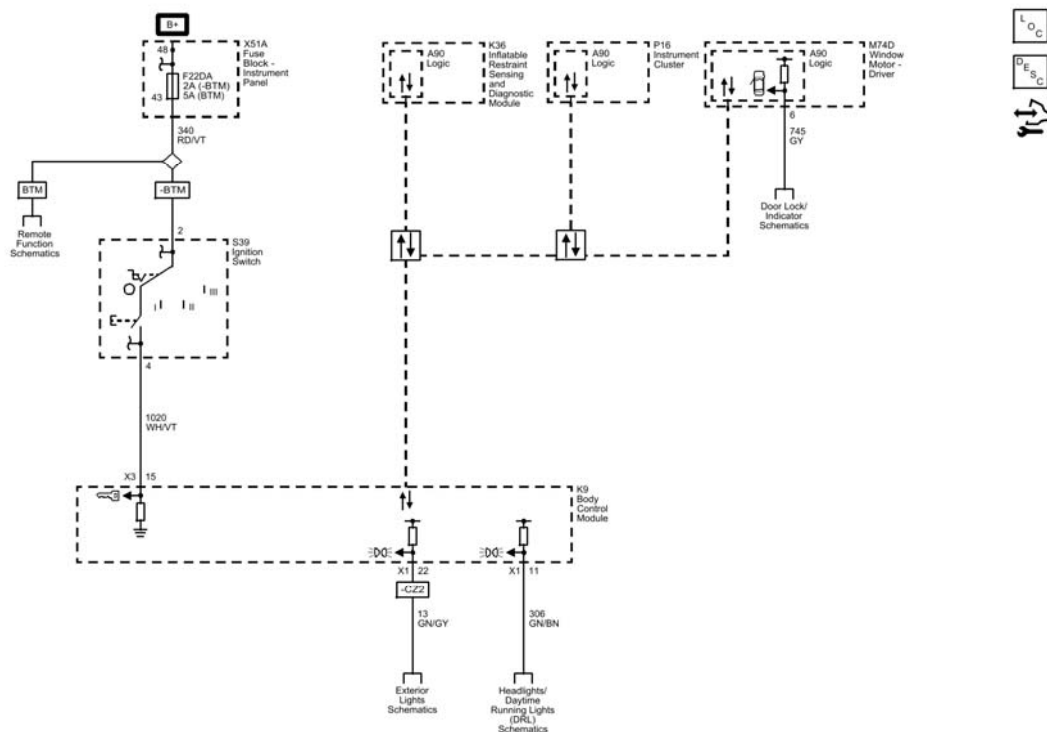


Fig. 8: Audible Warnings

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B0158</u>	DTC B0158 02 Ambient Air Temperature Sensor Circuit Short to Ground DTC B0158 05 Ambient Air Temperature Sensor Circuit High Voltage/Open
<u>DTC B0550</u>	DTC B0550 32 Odometer Circuit General Memory Malfunction
<u>DTC B071F</u>	DTC B071F 39 Transmission Range Indicator Internal Malfunction
<u>DTC B0931</u>	DTC B0931 39 Compass Circuit Internal Malfunction
<u>DTC B097D</u>	DTC B097D 01 Transmission Sport Mode Indicator Circuit Short to Battery
<u>DTC B097F</u>	DTC B097F 01 Transmission Tow Mode Indicator Circuit Short to Battery
<u>DTC B124F</u>	DTC B124F 41 Universal Serial Bus (USB) Programming Files Not Available DTC B124F 42 Universal Serial Bus (USB) Programming Not Programmed DTC B124F 44 Universal Serial Bus (USB) Programming Security Access Not Activated DTC B124F 4A Universal Serial Bus (USB) Programming Security Checksum Error

<u>DTC B3567</u>	DTC B3567 01 Info Display Select Switch Circuit Short to Battery DTC B3567 02 Info Display Select Switch Circuit Short to Ground DTC B3567 04 Info Display Select Switch Circuit Open DTC B3567 59 Info Display Select Switch Circuit Protection Time-Out
<u>DTC P0461-P0464, P2066, P2067, or P2068</u>	DTC P0461 Fuel Level Sensor Performance DTC P0462 Fuel Level Sensor Circuit Low Voltage DTC P0463 Fuel Level Sensor Circuit High Voltage DTC P0464 Fuel Level Sensor Circuit Intermittent DTC P2066 Fuel Level Sensor 2 Performance DTC P2067 Fuel Level Sensor 2 Circuit Low Voltage DTC P2068 Fuel Level Sensor 2 Circuit High Voltage
<u>DTC P0520 (LEA, LTG, LUK)</u>	DTC P0520 Engine Oil Pressure Switch Circuit
<u>DTC P0521, P0522, or P0523</u>	DTC P0521 Engine Oil Pressure Sensor Performance DTC P0522 Engine Oil Pressure Sensor Circuit Low Voltage. DTC P0523 Engine Oil Pressure Sensor Circuit High Voltage

DTC B0158: AMBIENT AIR TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0158 02

Ambient Air Temperature Sensor Circuit Short to Ground

DTC B0158 05

Ambient Air Temperature Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B0158 02	B0158 05	B0158 05	-
Low Reference	-	B0158 05	-	-

Circuit/System Description

The instrument cluster monitors the ambient air temperature sensor with a low reference circuit and signal circuit. The instrument cluster monitors the voltage drop across the sensor, which is inversely proportional to

temperature. When the ambient air temperature is cold, the resistance of the sensor is high. When the ambient air temperature is warm, the resistance of the sensors is low. The instrument cluster converts the voltage value to a temperature value and displays the temperature.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

B0158 02

The instrument cluster detects the sensor signal is more than 88°C (190°F) .

B0158 05

The instrument cluster detects the sensor signal is less than -40°C (-40°F).

Action Taken When the DTC Sets

The instrument cluster uses a default air temperature value for further calculations. The instrument cluster will display -°C (-°F). A/C compressor engagement may be disabled.

Conditions for Clearing the DTC

The DTC will become history if the instrument cluster no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Ambient Air Temperature parameter is between -40°C (-40°F) and +88°C (+190°F) and changes with air temperature changes.
 - **If not between -40°C (-40°F) and +88°C (+190°F) or changes with air temperature changes**

Refer to Circuit/System Testing.

- **If between -40°C (-40°F) and +88°C (+190°F) and changes with air temperature changes**
3. Perform the Instrument Cluster Ambient Air Temperature Instant Update special function with the scan tool
 4. Verify the scan tool Ambient Air Temperature parameter is within five degrees of actual ambient air temperature.
 - **If not within five degrees of actual ambient air temperature**

Refer to Circuit/System Testing.

- **If within five degrees of actual ambient air temperature**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B9 Ambient Air Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal B (or 2) and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Ambient Air Temperature parameter is greater than 98%.
 - **If 98% or less**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 2. Test for infinite resistance between the signal circuit terminal A (or 1) and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the P16 Instrument Cluster.
 - **If greater than 98%**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal A (or 1) and the low reference circuit terminal B (or 2).
- 6. Verify the scan tool Ambient Air Temperature parameter is less than 8%.
 - **If 8% or greater**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
 - **If less than 8%**
- 7. Test or replace the B9 Ambient Air Temperature Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Displays and Gauges Component Replacement Reference**
- **Control Module References** for instrument cluster replacement, programming and setup

DTC B0550: ODOMETER CIRCUIT GENERAL MEMORY MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B0550 32

Odometer Circuit General Memory Malfunction

Circuit/System Description

The instrument cluster is equipped with an odometer that indicate the distance traveled by the vehicle. This information is also stored in the body control module. In addition to storing the odometer value for the vehicle, the instrument cluster and the body control module both store the vehicle VIN. Software checks are performed

to ensure these modules, and their stored odometer information, can not be moved or transferred between different vehicles.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The body control module has detected an internal memory malfunction.

Action Taken When the DTC Sets

The DTC is stored in the body control module memory.

Conditions for Clearing the DTC

The body control module no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

2. Verify DTC B0550 is not set.
 - **If the DTC is set**
 1. Program the K9 Body Control Module.
 2. Verify the DTC is not set.
 - If the DTC is set, replace the K9 Body Control Module.
 - If the DTC is not set
 3. All OK.
 - **If the DTC is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module replacement, programming and setup

DTC B071F: TRANSMISSION RANGE INDICATOR INTERNAL MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B071F 39

Transmission Range Indicator Internal Malfunction

Circuit/System Description

The transmission shift lever position indicator is located on the center console and indicates the current transmission shift level position. The transmission shift lever position indicator receives power and ground and is controlled by the body control module (BCM) via serial data.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The BCM has detected an internal malfunction in the transmission shift lever position indicator

Action Taken When the DTC Sets

No action is taken

Conditions for Clearing the DTC

The DTC will become history if the BCM no longer detects a malfunction

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B071F 39 is not set.
 - **If the DTC is set**

Replace the P2 Transmission Shift Lever Position Indicator.

- **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Displays and Gauges Component Replacement Reference**
- **Transmission Control Replacement** with MHH or MH7
- **Transmission Control Replacement** with M7W

DTC B0931: COMPASS CIRCUIT INTERNAL MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B0931 39

Compass Circuit Internal Malfunction

Circuit/System Description

The compass module receives vehicle directional information. The compass module receives power and ground and communicates with the body control module (BCM) via serial data.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The BCM has detected an internal malfunction in the compass module

Action Taken When the DTC Sets

No action is taken

Conditions for Clearing the DTC

The DTC will become history if the BCM no longer detects a malfunction

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B0931 39 is not set.
 - **If the DTC is set**

Replace the K18 Compass Module.

- **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Displays and Gauges Component Replacement Reference

DTC B097D: TRANSMISSION SPORT MODE INDICATOR CIRCUIT SHORT TO BATTERY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B097D 01

Transmission Sport Mode Indicator Circuit Short to Battery

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Sport Mode Indicator Control	1	1	B097D 01	-
1. Sport Mode Indicator Malfunction				

Circuit/System Description

The Sport Mode Switch and sport mode LED are combined into one switch component. The body control module (BCM) monitors the status of the Sport Mode Switch. When the sport mode switch is pressed, the BCM will request the Suspension Control Module, Transmission Control Module (TCM) and Engine Control Module (ECM) via serial data to control the vehicle ride characteristic according to the selected mode. The BCM will command the sport mode LED ON to notify the driver of the selected mode.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The BCM detects a short to voltage on the indicator control circuit.

Action Taken When the DTC Sets

DTC B097D 01 is stored in the BCM memory.

Conditions for Clearing the DTC

The BCM no longer detects a malfunction.

Reference Information

Schematic Reference

Electronic Suspension Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Driver Information Center (DIC) Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Observe the sport mode LED while pressing and releasing the Sport Mode Switch. Verify the sport mode LED turns ON and OFF.

- **If LED does not turn ON and OFF**

Proceed to Circuit/System Testing.

- **If LED turns ON and OFF**

2. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S48A Multifunction Switch - Instrument Panel. Ignition ON.

2. Test for less than 1V between the control circuit terminal 6 and ground.

- **If 1 V or greater**

1. Ignition OFF, disconnect the harness connector X5 at the K9 Body Control Module.

2. Test for less than 1V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage in the circuit.

- If less than 1V, replace the K9 Body Control Module.

- **If less than 1 V**

3. Verify a test lamp illuminates between the B+ circuit terminal 3 and ground.

- **If the test lamp does not illuminate and the circuit fuse is OK**

1. Ignition OFF.

2. Test for less than 2 ohms in the B+ circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.

2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, K9 Body Control Module.
- **If the test lamp illuminates**
- 4. Connect a test lamp between the control circuit terminal 6 and B+, ignition ON.
- 5. Verify the test lamp turns ON and OFF when commanding the Sport Mode Switch Indicator Active and Inactive with a scan tool.
 - **If the test lamp is always ON**
 - 1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
 - 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module
 - **If the test lamp is always OFF**
 - 1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module.
 - 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the control circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
- 6. Test or replace the S48A Multifunction Switch - Instrument Panel.

Component Testing

1. Ignition OFF, disconnect the S48A Multifunction Switch - Instrument Panel.
2. Install a 10 A fused jumper between the Sport Mode Switch terminal 3 and 12 V. Install a jumper wire between the S48A Multifunction Switch - Instrument Panel terminal 6 and ground. The indicator LED should illuminate.
 - **If the sport mode switch indicator does not illuminate**
 - Replace the S48A Multifunction Switch - Instrument Panel.
 - **If the sport mode switch indicator does illuminates**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Displays and Gauges Component Replacement Reference

- **Accessory Switch Replacement**
- **Control Module References** for BCM replacement, setup and programming

DTC B097F: TRANSMISSION TOW MODE INDICATOR CIRCUIT SHORT TO BATTERY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B097F 01

Transmission Tow Mode Indicator Circuit Short to Battery

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Tour Mode Indicator Control	1	1	B097F 01	-
1. Tour Mode indicator Malfunction				

Circuit/System Description

The Tour Mode Switch and tour mode LED are combined into one switch component. The body control module (BCM) monitors the status of the Tour Mode Switch. When the tour mode switch is pressed, the BCM will request the Suspension Control Module, Transmission Control Module (TCM) and Engine Control Module (ECM) via serial data to control the vehicle ride characteristic according to the selected mode. The BCM will command the tour mode LED ON to notify the driver of the selected mode.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The BCM detects a short to voltage on the indicator control circuit.

Action Taken When the DTC Sets

DTC B097F 01 is stored in the BCM memory.

Conditions for Clearing the DTC

The BCM no longer detects a malfunction.

Reference Information

Schematic Reference

Electronic Suspension Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Driver Information Center (DIC) Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Observe the tour mode LED while pressing and releasing the Tour Mode Switch. Verify the tour mode LED turns ON and OFF.
 - **If LED does not turn ON and OFF**

Proceed to Circuit/System Testing.
 - **If LED turns ON and OFF**
2. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S48A Multifunction Switch - Instrument Panel. Ignition ON.
2. Test for less than 1V between the control circuit terminal 8 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector X5 at the K9 Body Control Module.
 2. Test for less than 1V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1V, replace the K9 Body Control Module.
 - **If less than 1 V**
3. Verify a test lamp illuminates between the B+ circuit terminal 3 and ground.

- **If the test lamp does not illuminate and the circuit fuse is OK**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, K9 Body Control Module.
 - **If the test lamp illuminates**
- 4. Connect a test lamp between the control circuit terminal 8 and B+, ignition ON.
- 5. Verify the test lamp turns ON and OFF when commanding the Tour Switch Indicator Active and Inactive with a scan tool.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the control circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
- 6. Test or replace the S48A Multifunction Switch - Instrument Panel.

Component Testing

1. Ignition OFF, disconnect the S48A Multifunction Switch - Instrument Panel.
2. Install a 10 A fused jumper between the Tour Mode Switch terminal 3 and 12 V. Install a jumper wire between the S48A Multifunction Switch - Instrument Panel terminal 8 and ground. The indicator LED should illuminate.
 - **If the tour mode switch indicator does not illuminate**

Replace the S48A Multifunction Switch - Instrument Panel.
 - **If the tour mode switch indicator does illuminates**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Displays and Gauges Component Replacement Reference

- **Accessory Switch Replacement**
- **Control Module References** for BCM replacement, setup and programming

DTC B124F: UNIVERSAL SERIAL BUS (USB) PROGRAMMING

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B124F 41

Universal Serial Bus (USB) Programming Files Not Available

DTC B124F 42

Universal Serial Bus (USB) Programming Not Programmed

DTC B124F 44

Universal Serial Bus (USB) Programming Security Access Not Activated

DTC B124F 4A

Universal Serial Bus (USB) Programming Security Checksum Error

Circuit/System Description

The instrument cluster can communicate with other devices on a Media Oriented Systems Transport (MOST) protocol and through the USB port. Software checks are performed to ensure the internal MOST circuitry is operating properly.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The instrument cluster has detected an internal memory malfunction.

Action Taken When the DTC Sets

The DTC is stored in the instrument cluster memory.

Conditions for Clearing the DTC

The instrument cluster no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B124F is not set.
 - **If the DTC is set**
 1. Program the P16 Instrument Cluster.
 2. Verify the DTC is not set.
 - If the DTC is set, replace the P16 Instrument Cluster.
 - If the DTC is not set
3. All OK.

- If the DTC is not set

3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for instrument cluster replacement, programming and setup

DTC B3567: INFO DISPLAY SELECT SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3567 01

Info Display Select Switch Circuit Short to Battery

DTC B3567 02

Info Display Select Switch Circuit Short to Ground

DTC B3567 04

Info Display Select Switch Circuit Open

DTC B3567 59

Info Display Select Switch Circuit Protection Time-Out

Circuit/System Description

The driver information center switch is a multiplexed switch. Battery power is provided to the driver information center switch via the instrument cluster. The driver information center switch signal circuit is pulled up to battery voltage in the instrument cluster. The instrument cluster also provides the driver information center switch with a low reference. The switch input to the instrument cluster is pulled low when a switch is activated. The driver information center switch is a momentary contact switch that connects a series of resistors in a resistor ladder format. The instrument cluster monitors the driver information center switch signal circuit to determine the driver information center switch inputs. Each switch state Menu, Up, Down, Clear corresponds to a certain resistance value. The instrument cluster determines the switch pressed by the voltage drop across the resistors.

Conditions for Running the DTC

- The ignition is in OFF, ACCESSORY or RUN position.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

B3567 01

The instrument cluster detects that the driver information center switch signal circuit is shorted to battery.

B3567 02

The instrument cluster detects that the driver information center switch signal circuit is shorted to ground.

B3567 04

The instrument cluster detects that the driver information center switch signal circuit is open.

B3567 59

The instrument cluster detects that the driver information center switch is stuck.

Action Taken When the DTC Sets

The instrument cluster ignores the driver information center switch inputs.

Conditions for Clearing the DTC

The DTC will become history if the instrument cluster no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Driver Information Center (DIC) Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the driver information center set, up and down function changes when pressing the set, up or down switch.
 - **If the driver information center does not change**

Refer to Set, Up and Down Switch Malfunction
 - **If the driver information center changes**
3. Verify the driver information center menu function changes when pressing the menu switch.
 - **If the driver information center does not change**

Refer to Menu Switch Malfunction
 - **If the driver information center changes**
4. All OK.

Circuit/System Testing

Menu Switch Malfunction

1. Ignition ON.
2. Test for 4.8-5.2 V between the signal circuit terminal 5 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
 - **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the P16 Instrument Cluster.
 - **If between 4.8-5.2 V**
3. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**

Repair the open/high resistance in the circuit

- **If less than 10 ohms**
4. Test or replace the S78 Turn Signal/Multifunction Switch.

Set, Up and Down Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the S78 Turn Signal/Multifunction Switch, ignition ON.
2. Test for less than 10 ohms between the low reference circuit terminal 6 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
 - **If less than 10 ohms**
3. Test for 9.8-12.2 V between the signal circuit terminal 12 and ground.
 - **If less than 9.8 V**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
 - **If greater than 12.2 V**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the P16 Instrument Cluster.
 - **If between 9.8-12.2 V**

4. Test or replace the S78 Turn Signal/Multifunction Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Turn Signal Switch Replacement**
- **Control Module References** for instrument cluster replacement, programming and setup

DTC P0461-P0464, P2066, P2067, OR P2068: FUEL LEVEL SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0461

Fuel Level Sensor Performance

DTC P0462

Fuel Level Sensor Circuit Low Voltage

DTC P0463

Fuel Level Sensor Circuit High Voltage

DTC P0464

Fuel Level Sensor Circuit Intermittent

DTC P2066

Fuel Level Sensor 2 Performance

DTC P2067

Fuel Level Sensor 2 Circuit Low Voltage

DTC P2068

Fuel Level Sensor 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	P2068	P2068	P2066
Low Reference	-	1	P0463, P0464, P2068	P0461, P2066
1. Fuel Gauge Malfunction				

Circuit/System Description

The primary fuel level sensor and the secondary fuel level sensor change resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sensor and the secondary fuel level sensor in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level sensors are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sensor and the secondary fuel level sensor. When the fuel tank is empty, the resistances of the fuel level sensors are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sensor and the secondary fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via the serial data circuit to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

- The engine is running
- The system voltage is between 11-16 V

Conditions for Setting the DTC

P0461 or P2066

- The ECM detects a change in fuel level of less than a specified amount (typically 3-10 L or 0.8-2.6 gal) over a specified driving distance (typically 240-320 km or 150-200 miles).

P0462 or P2067

- The signal voltage is less than 0.25 V.
- The above conditions must be met for 5 seconds.

P0463 or P2068

- The signal voltage is greater than 4.7 V.
- The above conditions must be met for 5 seconds.

P0464

- The fuel level change is greater than 10%.
- The above conditions must be met for 30 seconds.
- DTC P0464 runs and fails 2 out of 3 test cycles.

Action Taken When the DTC Sets

- P0461, P0462, P0463, P0464, P2066, P2067 and P2068 are Type B DTCs
- The fuel gauge defaults to empty
- The low fuel indicator illuminates

Conditions for Clearing the DTC

- P0461, P0462, P0463, P0464, P2066, P2067 and P2068 are Type B DTCs
- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Without UDV

1. Ignition ON.
2. Verify the fuel level gauge sweeps when performing the scan tool Instrument Cluster Gauge Sweep control function.
 - **If the fuel level gauge does not sweep**

Replace the P16 Instrument Cluster
 - **If the fuel level gauge sweeps**
3. Verify the low fuel level indicator turns ON and OFF when commanding the scan tool All Indicators control function ON and OFF.
 - **If the low fuel level indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster
 - **If the low fuel level indicator turns ON and OFF**
4. Verify the scan tool Fuel Level Sensor parameter is between 0.5-3.5 V and varies with fuel level.
 - **If not between 0.5-3.5 V or does not vary with fuel level**

Refer to Circuit/System Testing
 - **If between 0.5-3.5 V and varies with fuel level**
5. All OK.

With UDV

1. Ignition ON.
2. Verify the scan tool Fuel Level Sensor parameter is between 0.5-3.5 V and varies with fuel level.
 - **If not between 0.5-3.5 V or does not vary with fuel level**

Refer to Circuit/System Testing
 - **If between 0.5-3.5 V and varies with fuel level**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 3 and ground.
 - **If 10 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Fuel Level Sensor parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 4.8 V**
5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
6. Verify the scan tool Fuel Level Sensor parameter is less than 0.2 V.
 - **If 0.2 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 0.2 V**
7. Test or replace the fuel level sensor

Component Testing

1. Ignition OFF, remove the fuel level sensor.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal 4 and the low reference terminal 3.
3. Test for a minimum resistance value of 37-43 ohms and a maximum value of 245-255 ohms without any spikes or dropouts.
 - **If minimum resistance is not 37-43 ohms, maximum resistance is not 245-255 ohms, or if there are any spikes or dropouts**

Replace the fuel level sensor.

- If minimum resistance is 37-43 ohms, maximum resistance is 245-255 ohms, and if there are no spikes or dropouts

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for Engine Control Module or Instrument Cluster replacement, programming, and setup

DTC P0520: ENGINE OIL PRESSURE SWITCH CIRCUIT (LEA, LTG, LUK)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0520

Engine Oil Pressure Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Signal	1	P0520	1
1. Engine Oil Pressure Indicator Malfunction			

Typical Scan Tool Data

ECM - Engine Oil Pressure Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: OK			
Signal	Low	OK	OK

Circuit/System Description

The engine oil pressure switch is a normally closed switch that opens with the proper oil pressure. With the ignition switch turned ON and the engine not running, the engine control module (ECM) should detect a low signal voltage input. With the engine running, the engine oil pressure switch opens and the ECM should detect a high signal voltage input. When the oil pressure is low, the ECM sends a message via serial data to the body control module (BCM). The BCM then sends a message via serial data to the instrument cluster requesting the

engine oil pressure indicator turned ON.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

- The ECM detects that the engine oil pressure switch signal circuit is pulled low.
- The above condition is present for greater than 10 sec.

Action Taken When the DTC Sets

The instrument cluster illuminates the service vehicle soon indicator and the oil pressure low indicator.

Conditions for Clearing the DTC

The DTC becomes history when the conditions for setting the DTC are no longer present.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**
- **Driver Information Center (DIC) Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Engine Oil Pressure parameter is Low.
 - **If not Low**

Refer to Circuit/System Testing.

- **If Low**
3. Engine running.
 4. Verify the scan tool Engine Oil Pressure parameter is OK.
 - **If not OK**

Refer to Circuit/System Testing.

- **If OK**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B37 Engine Oil Pressure Switch, ignition ON.
2. Verify the scan tool Engine Oil Pressure Switch parameter is OK.
 - **If not OK**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 (or A) and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If OK**
3. Install a 3 A fused jumper wire between the signal circuit terminal 1 (or A) and ground.
4. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
 - **If not Low**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If Low**

5. Test or replace the B37 Engine Oil Pressure Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Engine Oil Pressure Switch Replacement**
- **Control Module References** for ECM replacement, programming and setup

DTC P0521, P0522, OR P0523: ENGINE OIL PRESSURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0521

Engine Oil Pressure Sensor Performance

DTC P0522

Engine Oil Pressure Sensor Circuit Low Voltage.

DTC P0523

Engine Oil Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Engine Oil Pressure 5 V Reference	P0522	1	P0522	P0523	P0521
Engine Oil Pressure Sensor Signal	P0522	1	P0522	P0523	P0521
Low Reference	-	1	P0523	-	P0521
1. Engine Oil Pressure Indicator Malfunction					

Circuit/System Description

The engine oil pressure sensor changes voltage based on the engine oil pressure. The engine oil pressure sensor

is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5 V reference circuit. The engine control module (ECM) supplies 5 V to the engine oil pressure sensor via the 5 V reference circuit and provides ground via the low reference circuit. The ECM monitors the signal circuit of the engine oil pressure sensor to determine if the engine oil pressure sensor voltage is within the normal operating range of approximately 1-4 V. When the engine oil pressure is high, the engine oil pressure sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the engine oil pressure sensor voltage is low and the ECM senses a low signal voltage. The ECM sends the engine oil pressure information to the instrument cluster via serial data. The instrument cluster will illuminate or display the engine oil pressure indicator when the engine oil pressure is low.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

P0521

The ECM detects that the difference between the predicted oil pressure and the actual oil pressure is either less than 47 kPa (6.8 psi) or greater than 50 kPa (7.3 psi).

P0522

- The ECM detects that the engine oil pressure sensor signal circuit is less than 0.2 V.
- The above condition is present for greater than 10 s.

P0523

- The ECM detects that the engine oil pressure sensor signal circuit is greater than 4.8 V.
- The above condition is present for greater than 10 s.

Action Taken When the DTC Sets

- The ECM records the operating conditions at the time the diagnostics test fails. The ECM displays this information in the Failure Records on the scan tool.
- The instrument cluster illuminates the engine oil pressure indicator.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Indicator/Warning Message Description and Operation**
- **Instrument Cluster Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

With UDD

1. Ignition ON.
2. Verify the engine oil pressure indicator turns on and off when commanding the All Indicators ON and OFF with a scan tool.
 - **If the engine oil pressure indicator does not turn on and off.**

Replace the P16 Instrument Cluster.

- **If the engine oil pressure indicator turns on and off**
3. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
 - **If not Low**

Refer to Circuit/System Testing.

- **If Low**
4. Engine running.
 5. Verify the scan tool Engine Oil Pressure Switch parameter is OK.
 - **If not OK**

Refer to Circuit/System Testing.

- **If OK**

6. All OK.

With UDV or UHS

1. Ignition ON.
2. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
 - **If not Low**

Refer to Circuit/System Testing.

- **If Low**

3. Engine running.
4. Verify the scan tool Engine Oil Pressure Switch parameter is OK.
 - **If not OK**

Refer to Circuit/System Testing.

- **If OK**

5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B37B Engine Oil Pressure Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
- 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
- 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**
- 5. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
 - **If not Low**
- 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
- 2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If Low**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
- 7. Verify the scan tool Engine Oil Pressure Switch parameter is OK.
 - **If not OK**
- 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
- **If OK**
- 8. Test or replace the B37B Engine Oil Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Displays and Gauges Component Replacement Reference

Control Module References for instrument cluster or engine control module replacement, programming, and setup

DISPLAYS AND GAUGES COMPONENT REPLACEMENT REFERENCE

DISPLAYS AND GAUGES COMPONENT REPLACEMENT REFERENCE

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Component	Repair Instruction
B9 Ambient Air Temperature Sensor	<u>Ambient Air Temperature Sensor Replacement</u>
B37 Engine Oil Pressure Switch	<u>ENGINE OIL PRESSURE SWITCH REPLACEMENT</u> 2.4L LEA or LUK engine
B46 Fuel Level Sensor	{ 2.4L LEA or LUK engine <u>FUEL LEVEL SENSOR REPLACEMENT</u> Or 2.0L LTG engine <u>FUEL LEVEL SENSOR REPLACEMENT</u>
K20 Engine Control Module	2.4L LEA or LUK engine <u>ENGINE CONTROL MODULE REPLACEMENT</u> or 2.0L LTG engine <u>ENGINE CONTROL MODULE REPLACEMENT</u>
P2 Transmission Shift Lever Position Indicator	6T40 MHH or MH8 <u>TRANSMISSION CONTROL REPLACEMENT</u> or 6T70 M7U or M7W <u>TRANSMISSION CONTROL REPLACEMENT</u>
S39 Ignition Switch	<u>IGNITION AND START SWITCH REPLACEMENT (WITH BTM)</u> or <u>IGNITION AND START SWITCH REPLACEMENT (WITHOUT BTM)</u>
S48A Multifunction Switch - Instrument Panel	<u>Accessory Switch Replacement</u>
S78 Turn Signal/Multifunction Switch	<u>TURN SIGNAL SWITCH REPLACEMENT</u>
Oil Pressure Diagnosis and Testing	2.4L LEA/LUK engine <u>OIL PRESSURE DIAGNOSIS AND TESTING</u> or <u>OIL PRESSURE DIAGNOSIS AND TESTING</u> 2.0L LTG engine

SYMPTOMS - DISPLAYS AND GAUGES

NOTE: The following steps must be completed before using the symptom diagnostic tables.

- Before using the symptom diagnostic tables, perform the **Diagnostic System Check - Vehicle** in order to determine that there are no DTCs set, and that the control modules can communicate via the serial data link.
- Review the system operation in order to understand the system functions. Refer to the following description and operations:
 - **Instrument Cluster Description and Operation**
 - **Indicator/Warning Message Description and Operation**
 - **Driver Information Center (DIC) Description and Operation**
 - **Audible Warnings Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which can affect the operation of the instrument panel cluster or the audible warning systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the accessible system components or the visible system components for obvious damage or for obvious conditions which can cause the symptom.
- Inspect for the proper fluid levels.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Fuel Gauge Malfunction (FWD)**
- **Engine Oil Pressure Indicator Malfunction (LKW), Engine Oil Pressure Indicator Malfunction (LEA, LTG, LUK)**
- **Outside Air Temperature Display Malfunction**

CHARGE INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine Control Module (ECM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON signal circuit. The ECM should detect low voltage on the generator turn on signal circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn on signal circuit. The ECM performs key ON and RUN tests to determine the status of the generator turn on signal circuit. If a malfunction is detected the ECM will illuminate the charge indicator in the instrument cluster.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Indicator/Warning Message Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, engine running.
2. Verify the scan tool Battery Voltage parameter is between 12.5-15.5 V.
 - **If not 12.5-15.5 V**

Refer to **Charging System Test** .

- **If 12.5-15.5 V**
3. Verify the charge indicator turns on and off when commanding the All Indicators test ON and OFF with the scan tool.
 - **If the charge indicator always stays on or always stays off**

Replace the P16 Instrument Cluster.

- **If the charge indicator turns on and off as commanded**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Instrument Cluster replacement, programming, and setup

CHIME MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The radio generates the audible warnings. The instrument cluster, the body control module (BCM), the inflatable restraint sensing and diagnostic module (SDM) or the object alarm module request audible warnings via serial data.

Reference Information

Schematic Reference

Audible Warnings Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Audible Warnings Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Before performing this diagnostics, make sure no indicators are illuminated after the instrument cluster performs a lamp test. If any indicators are illuminated after the bulb test, perform the indicator diagnostics before this diagnostics.

1. Ignition ON.
2. Verify all the radio speakers operate by adjust the radio balance and fade to each speaker.
 - If any speaker does not operate properly

Refer to **Speaker Malfunction (U65)** , **Speaker Malfunction (UQA)** .

- **If the speakers operate properly**

3. Verify the scan tool Driver Seat Belt Status and Passenger Seat Belt Status parameters are Buckled when both front seat belts are buckled.

- **If not Buckled**

Refer to **Seat Belt Indicator Malfunction - Driver** .

- **If buckled**

4. Verify the scan tool Headlamp On Switch parameter is Inactive when the headlamps are OFF.

- **If not Inactive**

Refer to **Headlamps Malfunction** .

- **If Inactive**

5. Verify the scan tool Park Lamps Switch parameter is Inactive when the park lamp switch is OFF.

- **If not Inactive**

Refer to **Park, License, and/or Tail Lamps Malfunction** .

- **If Inactive**

6. Verify the scan tool Left Turn Signal Switch and Right Turn Signal Switch parameters are Inactive while the turn signal switch is OFF.

- **If not Inactive**

Refer to **Turn Signal Lamps and/or Indicators Malfunction** .

- **If Inactive**

7. Verify the scan tool Park Brake Switch parameter is Inactive when the park brake is OFF.

- **If not Inactive**

Refer to **Park Brake System Diagnosis** .

- **If Inactive**

8. Verify that all scan tool parameters listed below are Inactive when all the doors are closed.

- Driver Door Ajar Switch
- Passenger Door Ajar Switch
- Left Rear Door Ajar Switch
- Right Rear Door Ajar Switch

- **If not Inactive**

Refer to **Door Ajar Indicator Malfunction** .

- **If Inactive**

9. Verify the scan tool Key in Ignition Status parameter is Inactive when the key is out of the ignition.

- **If not Inactive**

Refer to Circuit/System Testing.

- **If Active**

10. All OK

Circuit/System Testing

1. Ignition ON, disconnect the harness connector at the S39 Ignition Switch while the ignition is ON.

2. Verify a test lamp illuminates between the B+ circuit terminal 2 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

Test for less than 2 ohms in the B+ circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

2. Test for infinite resistance between the signal circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K9 Body Control Module.

- **If the test lamp illuminates**

3. Verify the scan tool Key in Ignition Status parameter is Inactive.

- **If not Inactive**

1. Disconnect the X3 harness connector at the K9 Body Control Module.

2. Test for less than 1 V between the signal circuit terminal 4 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K9 Body Control Module.

- **If Inactive**

4. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the B+ circuit terminal 2.

5. Verify the scan tool Key in Ignition Status parameter is Active.

- **If not Active**

1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.

2. Test for less than 2 ohms in the signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
6. Test or replace the S39 Ignition Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or Radio replacement, programming and setup

DRIVER INFORMATION CENTER SWITCH MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The driver information center switches are multiplexed switches that are part of the Turn Signal/Multifunction Switch.

The Instrument Cluster provides 5 volts to the MENU switch. The MENU switch is a momentary contact switch that is provided ground through the Turn Signal/Multifunction Switch ground circuit.

The Instrument Cluster provides battery voltage to the UP, DOWN, SET switches. The UP, DOWN, SET switch signal circuits are pulled up to battery voltage in the Instrument Cluster. The Instrument Cluster also provides the UP, DOWN, SET switches with a low reference circuit. The UP, DOWN, SET switch signal circuit is pulled low when a switch is activated. The driver information center UP, DOWN, SET switches are momentary contact switches that connect a series of resistors in a resistor ladder format. The instrument cluster monitors the driver information center UP, DOWN, SET switch signal circuit to determine the switch position. Each switch state - UP, DOWN, SET- corresponds to a certain resistance value. The instrument cluster determines the switch pressed by the voltage drop across the resistors.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Driver Information Center (DIC) Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the driver information center set, up and down function changes when pressing the set, up or down switch.
 - **If the driver information center does not change**

Refer to Set, Up and Down Switch Malfunction
 - **If the driver information center changes**
3. Verify the driver information center menu function changes when pressing the menu switch.
 - **If the driver information center does not change**

Refer to Menu Switch Malfunction
 - **If the driver information center changes**
4. All OK.

Circuit/System Testing

Menu Switch Malfunction

1. Ignition ON.
2. Test for 4.8-5.2 V between the signal circuit terminal 5 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the P16 instrument cluster.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the P16 instrument cluster.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the P16 instrument cluster, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the P16 instrument cluster.

- **If between 4.8-5.2 V**

3. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**

Repair the open/high resistance in the circuit

- **If less than 10 ohms**

4. Test or replace the S78 Turn Signal/ Multifunction Switch.

Set, Up and Down Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the S78 Turn Signal/ Multifunction Switch, ignition ON.
2. Test for less than 10 ohms between the low reference circuit terminal 6 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the P16 instrument cluster.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 instrument cluster.
 - **If less than 10 ohms**
3. Test for 9.8-12.2 V between the signal circuit terminal 12 and ground.
 - **If less than 9.8 V**
 1. Ignition OFF, disconnect the harness connector at the P16 instrument cluster.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 instrument cluster.
 - **If greater than 12.2 V**
 1. Ignition OFF, disconnect the harness connector at the P16 instrument cluster, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the P16 instrument cluster.
- **If between 9.8-12.2 V**

4. Test or replace the S78 Turn Signal/ Multifunction Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Turn Signal Switch Replacement**
- **Control Module References** for the instrument cluster replacement, programming and setup

ENGINE OIL PRESSURE INDICATOR MALFUNCTION (LTG)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0521

Engine Oil Pressure Sensor Performance

DTC P0522

Engine Oil Pressure Sensor Circuit Low Voltage.

DTC P0523

Engine Oil Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Engine Oil Pressure 5 V Reference	P0522	1	P0522	P0523	P0521
Engine Oil Pressure Sensor Signal	P0522	1	P0522	P0523	P0521
Low Reference	-	1	P0523	-	P0521
1. Engine Oil Pressure Indicator Malfunction					

Circuit/System Description

The engine oil pressure sensor changes voltage based on the engine oil pressure. The engine oil pressure sensor is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5 V reference circuit. The engine control module (ECM) supplies 5 V to the engine oil pressure sensor via the 5 V reference circuit and provides ground via the low reference circuit. The ECM monitors the signal circuit of the engine oil pressure sensor to determine if the engine oil pressure sensor voltage is within the normal operating range of approximately 1-4 V. When the engine oil pressure is high, the engine oil pressure sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the engine oil pressure sensor voltage is low and the ECM senses a low signal voltage. The ECM sends the engine oil pressure information to the instrument cluster via serial data. The instrument cluster will illuminate or display the engine oil pressure indicator when the engine oil pressure is low.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

P0521

The ECM detects that the difference between the predicted oil pressure and the actual oil pressure is either less than 47 kPa (6.8 psi) or greater than 50 kPa (7.3 psi).

P0522

- The ECM detects that the engine oil pressure sensor signal circuit is less than 0.2 V.
- The above condition is present for greater than 10 s.

P0523

- The ECM detects that the engine oil pressure sensor signal circuit is greater than 4.8 V.
- The above condition is present for greater than 10 s.

Action Taken When the DTC Sets

- The ECM records the operating conditions at the time the diagnostics test fails. The ECM displays this information in the Failure Records on the scan tool.
- The instrument cluster illuminates the engine oil pressure indicator.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Indicator/Warning Message Description and Operation**
- **Instrument Cluster Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

With UDD

1. Ignition ON.
2. Verify the engine oil pressure indicator turns on and off when commanding the All Indicators ON and OFF with a scan tool.
 - **If the engine oil pressure indicator does not turn on and off.**

Replace the P16 Instrument Cluster.

- **If the engine oil pressure indicator turns on and off**
3. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
 - **If not Low**

Refer to Circuit/System Testing.

- **If Low**
4. Engine running.
 5. Verify the scan tool Engine Oil Pressure Switch parameter is OK.

- **If not OK**

Refer to Circuit/System Testing.

- **If OK**

6. All OK.

With UDV or UHS

1. Ignition ON.
2. Verify the scan tool Engine Oil Pressure Switch parameter is Low.

- **If not Low**

Refer to Circuit/System Testing.

- **If Low**

3. Engine running.
4. Verify the scan tool Engine Oil Pressure Switch parameter is OK.

- **If not OK**

Refer to Circuit/System Testing.

- **If OK**

5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B37B Engine Oil Pressure Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.

- **If 10 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If less than 10 ohms**

3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**
- 5. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
 - **If not Low**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If Low**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
- 7. Verify the scan tool Engine Oil Pressure Switch parameter is OK.
 - **If not OK**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If OK**
- 8. Test or replace the B37B Engine Oil Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Displays and Gauges Component Replacement Reference

Control Module References for instrument cluster or engine control module replacement, programming, and setup

ENGINE OIL PRESSURE INDICATOR MALFUNCTION (LEA, LUK)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0520

Engine Oil Pressure Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Signal	1	P0520	1
1. Engine Oil Pressure Indicator Malfunction			

Typical Scan Tool Data

ECM - Engine Oil Pressure Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: OK			
Signal	Low	OK	OK

Circuit/System Description

The engine oil pressure switch is a normally closed switch that opens with the proper oil pressure. With the ignition switch turned ON and the engine not running, the engine control module (ECM) should detect a low signal voltage input. With the engine running, the engine oil pressure switch opens and the ECM should detect a high signal voltage input. When the oil pressure is low, the ECM sends a message via serial data to the body control module (BCM). The BCM then sends a message via serial data to the instrument cluster requesting the engine oil pressure indicator turned ON.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

- The ECM detects that the engine oil pressure switch signal circuit is pulled low.
- The above condition is present for greater than 10 sec.

Action Taken When the DTC Sets

The instrument cluster illuminates the service vehicle soon indicator and the oil pressure low indicator.

Conditions for Clearing the DTC

The DTC becomes history when the conditions for setting the DTC are no longer present.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**
- **Driver Information Center (DIC) Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Engine Oil Pressure parameter is Low.
 - **If not Low**

Refer to Circuit/System Testing.

- **If Low**
- 3. Engine running.
- 4. Verify the scan tool Engine Oil Pressure parameter is OK.
- **If not OK**

Refer to Circuit/System Testing.

- **If OK**
- 5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B37 Engine Oil Pressure Switch, ignition ON.
2. Verify the scan tool Engine Oil Pressure Switch parameter is OK.
 - **If not OK**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 (or A) and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If OK**
3. Install a 3 A fused jumper wire between the signal circuit terminal 1 (or A) and ground.
4. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
 - **If not Low**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Low**
5. Test or replace the B37 Engine Oil Pressure Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Displays and Gauges Component Replacement Reference

- **Engine Oil Pressure Switch Replacement**
- **Control Module References** for ECM replacement, programming and setup

FUEL GAUGE MALFUNCTION (FWD)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0461

Fuel Level Sensor Performance

DTC P0462

Fuel Level Sensor Circuit Low Voltage

DTC P0463

Fuel Level Sensor Circuit High Voltage

DTC P0464

Fuel Level Sensor Circuit Intermittent

DTC P2066

Fuel Level Sensor 2 Performance

DTC P2067

Fuel Level Sensor 2 Circuit Low Voltage

DTC P2068

Fuel Level Sensor 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	P2068	P2068	P2066
Low Reference	-	1	P0463, P0464, P2068	P0461, P2066

1. Fuel Gauge Malfunction

Circuit/System Description

The primary fuel level sensor and the secondary fuel level sensor change resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sensor and the secondary fuel level sensor in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level sensors are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sensor and the secondary fuel level sensor. When the fuel tank is empty, the resistances of the fuel level sensors are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sensor and the secondary fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via the serial data circuit to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

- The engine is running
- The system voltage is between 11-16 V

Conditions for Setting the DTC

P0461 or P2066

- The ECM detects a change in fuel level of less than a specified amount (typically 3-10 L or 0.8-2.6 gal) over a specified driving distance (typically 240-320 km or 150-200 miles).

P0462 or P2067

- The signal voltage is less than 0.25 V.
- The above conditions must be met for 5 seconds.

P0463 or P2068

- The signal voltage is greater than 4.7 V.
- The above conditions must be met for 5 seconds.

P0464

- The fuel level change is greater than 10%.
- The above conditions must be met for 30 seconds.
- DTC P0464 runs and fails 2 out of 3 test cycles.

Action Taken When the DTC Sets

- P0461, P0462, P0463, P0464, P2066, P2067 and P2068 are Type B DTCs
- The fuel gauge defaults to empty

- The low fuel indicator illuminates

Conditions for Clearing the DTC

- P0461, P0462, P0463, P0464, P2066, P2067 and P2068 are Type B DTCs
- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

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Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Without UDV

1. Ignition ON.
2. Verify the fuel level gauge sweeps when performing the scan tool Instrument Cluster Gauge Sweep control function.
 - **If the fuel level gauge does not sweep**

Replace the P16 Instrument Cluster

- **If the fuel level gauge sweeps**

3. Verify the low fuel level indicator turns ON and OFF when commanding the scan tool All Indicators control function ON and OFF.

- **If the low fuel level indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster

- **If the low fuel level indicator turns ON and OFF**

4. Verify the scan tool Fuel Level Sensor parameter is between 0.5-3.5 V and varies with fuel level.

- **If not between 0.5-3.5 V or does not vary with fuel level**

Refer to Circuit/System Testing

- **If between 0.5-3.5 V and varies with fuel level**

5. All OK.

With UDV

1. Ignition ON.
2. Verify the scan tool Fuel Level Sensor parameter is between 0.5-3.5 V and varies with fuel level.

- **If not between 0.5-3.5 V or does not vary with fuel level**

Refer to Circuit/System Testing

- **If between 0.5-3.5 V and varies with fuel level**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 3 and ground.

- **If 10 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If less than 10 ohms**

3. Ignition ON.
4. Verify the scan tool Fuel Level Sensor parameter is greater than 4.8 V.
 - **If 4.8 V or less**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 4.8 V**
5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
6. Verify the scan tool Fuel Level Sensor parameter is less than 0.2 V.
 - **If 0.2 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 0.2 V**
7. Test or replace the fuel level sensor

Component Testing

1. Ignition OFF, remove the fuel level sensor.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal 4 and the low reference terminal 3.
3. Test for a minimum resistance value of 37-43 ohms and a maximum value of 245-255 ohms without any spikes or dropouts.
 - **If minimum resistance is not 37-43 ohms, maximum resistance is not 245-255 ohms, or if there are any spikes or dropouts**

Replace the fuel level sensor.
 - **If minimum resistance is 37-43 ohms, maximum resistance is 245-255 ohms, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Displays and Gauges Component Replacement Reference

- **Control Module References** for Engine Control Module or Instrument Cluster replacement, programming, and setup

INSTRUMENT CLUSTER GAUGES MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The instrument cluster displays the engine coolant temperature, fuel level, vehicle speed and the engine speed based on the information from the engine control module (ECM). The ECM sends information via a serial data to the body control module (BCM). The BCM then sends the information via serial data to the instrument cluster to display the engine coolant temperature, fuel level, the engine speed, the vehicle speed and the distance travelled, either in kilometers or miles, based on the vehicle requirements.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

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Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify no DTC is set.

- **If any DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs are set**

2. Ignition ON, perform the Instrument Cluster Gauge Sweep test with the scan tool, verify that all gauges sweep from their low to high position.

- **If any gauge does not sweep**

Replace the P16 Instrument Cluster.

- **If all gauges sweep**

3. Drive the vehicle, verify the gauge values matches the values on the scan tool.

- **If the values do not match**

Replace the P16 Instrument Cluster .

- **If the values match the scan tool**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Instrument Cluster or ECM replacement, programming, and setup.

OUTSIDE AIR TEMPERATURE DISPLAY MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0158 02

Ambient Air Temperature Sensor Circuit Short to Ground

DTC B0158 05

Ambient Air Temperature Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B0158 02	B0158 05	B0158 05	-
Low Reference	-	B0158 05	-	-

Circuit/System Description

The instrument cluster monitors the ambient air temperature sensor with a low reference circuit and signal circuit. The instrument cluster monitors the voltage drop across the sensor, which is inversely proportional to temperature. When the ambient air temperature is cold, the resistance of the sensor is high. When the ambient air temperature is warm, the resistance of the sensors is low. The instrument cluster converts the voltage value to a temperature value and displays the temperature.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

B0158 02

The instrument cluster detects the sensor signal is more than 88°C (190°F) .

B0158 05

The instrument cluster detects the sensor signal is less than -40°C (-40°F).

Action Taken When the DTC Sets

The instrument cluster uses a default air temperature value for further calculations. The instrument cluster will display -°C (-°F). A/C compressor engagement may be disabled.

Conditions for Clearing the DTC

The DTC will become history if the instrument cluster no longer detects a malfunction.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

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Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Ambient Air Temperature parameter is between -40°C (-40°F) and +88°C (+190°F) and changes with air temperature changes.
 - **If not between -40°C (-40°F) and +88°C (+190°F) or changes with air temperature changes**

Refer to Circuit/System Testing.

- **If between -40°C (-40°F) and +88°C (+190°F) and changes with air temperature changes**
3. Perform the Instrument Cluster Ambient Air Temperature Instant Update special function with the scan tool
 4. Verify the scan tool Ambient Air Temperature parameter is within five degrees of actual ambient air temperature.
 - **If not within five degrees of actual ambient air temperature**

Refer to Circuit/System Testing.

- **If within five degrees of actual ambient air temperature**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B9 Ambient Air Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal B (or 2) and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 2. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the scan tool Ambient Air Temperature parameter is greater than 98%.
 - **If 98% or less**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 2. Test for infinite resistance between the signal circuit terminal A (or 1) and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the P16 Instrument Cluster.
 - **If greater than 98%**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal A (or 1) and the low reference circuit terminal B (or 2).
- 6. Verify the scan tool Ambient Air Temperature parameter is less than 8%.
 - **If 8% or greater**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
 - **If less than 8%**
- 7. Test or replace the B9 Ambient Air Temperature Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Displays and Gauges Component Replacement Reference

- **Ambient Air Temperature Sensor Replacement**
- **Control Module References** for instrument cluster replacement, programming and setup

SPEEDOMETER AND/OR ODOMETER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The instrument cluster displays the engine coolant temperature, fuel level, vehicle speed and the engine speed based on the information from the engine control module (ECM). The ECM sends information via serial data to the body control module (BCM). The BCM then sends the information via serial data to the instrument cluster to display the engine coolant temperature, fuel level, the engine speed, the vehicle speed and the distance travelled, either in kilometers or miles, based on the vehicle requirements. The instrument cluster will display dashes when its VIN does not match the VIN received from the BCM.

Diagnostic Aids

If the VIN mismatch is corrected the odometer will once again be displayed in the instrument cluster. If the vehicle is driven for a calibrated distance with a VIN mismatch, it will cause the instrument cluster odometer to enter into an error mode and lock itself. When this occurs the dashes will remain on the display even after correcting the VIN mismatch. The vehicle odometer status data display on the scan tool can be used to identify a locked odometer. The only way to unlock the instrument cluster (clear the dashes from the display) is to perform an SPS programming event. Failure to follow the diagnostic and programming procedures may result in either an improper odometer value or a module replacement.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify no DTC is set.

- **If any DTC is set**

Diagnose DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs are set**

2. Ignition ON.

3. Verify the speedometer sweeps from low to high position when performing the Speedometer Sweep Test with the scan tool.

- **If speedometer does not sweep**

Replace the P16 Instrument Cluster.

- **If speedometer sweeps properly**

4. Verify the speedometer gauge value matches the scan tool Vehicle Speed parameter while driving the vehicle.

- **If the values do not match**

Replace the P16 Instrument Cluster.

- **If the speedometer value matches the scan tool parameter**

5. Verify the odometer display and the displayed distance counts up while driving the vehicle.

- **If the odometer displays only "----" (dashes)**

Refer to Circuit/System Testing.

- **If the odometer display does not count up**

Replace the P16 Instrument Cluster.

- **If speedometer sweeps and displays the correct value, and the odometer display counts up**

6. All OK.

Circuit/System Testing

NOTE: If there are multiple modules not original to the vehicle and are not new correctly configured service parts, SPS may not be able to properly read or recover the vehicle odometer value. Follow government rules and documentation (including vehicle identification) regarding inaccurate/unknown odometer values.

Perform circuit/system verification first.

Correcting VIN mismatch: Instrument Cluster is Showing "----" (Dashes) odometer is still unlocked

1. Verify the scan tool Odometer Status parameter is Unlocked.

- **If the reading is Locked**

Refer to correcting VIN mismatch - odometer locked.

- **If the reading is Unlocked**

2. Verify the scan tool BCM VIN parameter matches the vehicle's VIN placard.

- **If the VIN does not match**

Reprogram the BCM, then proceed to Step 3.

- **If the VIN matches**

3. Verify the scan tool Instrument Cluster VIN parameter matches the vehicle's VIN placard.

- **If the VIN does not match**

Reprogram the instrument cluster. Then proceed with step 4.

- **If the VIN matches**

4. Ignition ON.

5. Verify the instrument cluster is displaying the correct value.

- **If the instrument cluster is still displaying "----" (dashes)**

Replace the P16 Instrument Cluster.

6. All OK.

Correcting VIN mismatch: Instrument Cluster is Showing "----" (Dashes) odometer is locked

1. Verify the scan tool Odometer Status parameter is Locked.

- **If the reading is Unlocked**

Refer to Correcting VIN mismatch - odometer unlocked.

- **If the reading is Locked**

2. Verify the scan tool Instrument Cluster VIN parameter matches the vehicle's VIN placard.

- **If the VIN does not match**

Reprogram the Instrument Cluster. Then proceed with step 3.

- **If the VIN matches**

3. Perform the BCM setup procedure in SPS.

4. Ignition ON.

5. Verify the instrument cluster is displaying the correct value.

- If the instrument cluster is still displaying "----" (dashes)

Replace the P16 Instrument Cluster.

- If instrument cluster is displaying the correct value

6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for Instrument Cluster, BCM or ECM replacement, programming, and setup.

REPAIR INSTRUCTIONS

AMBIENT AIR TEMPERATURE SENSOR REPLACEMENT

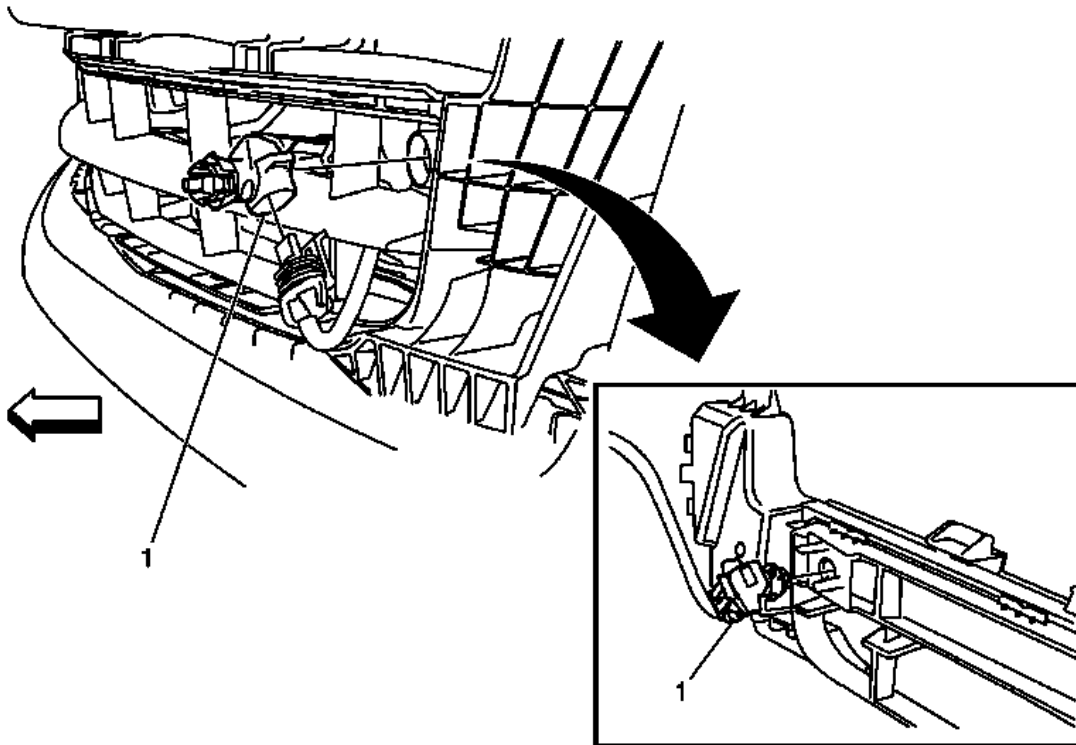


Fig. 9: Ambient Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Ambient Air Temperature Sensor Replacement

Callout	Component Name
1	Ambient Air Temperature Sensor Procedure Disconnect the electrical connector.

INSTRUMENT CLUSTER REPLACEMENT

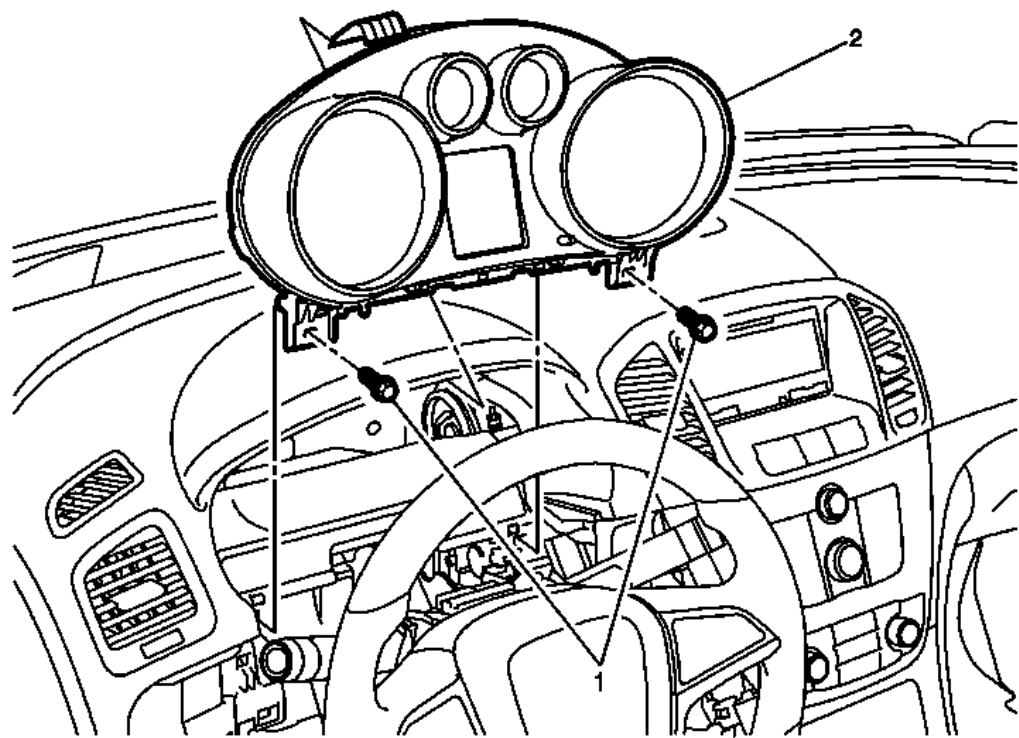


Fig. 10: Instrument Cluster Assembly & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Instrument Cluster Replacement

Callout	Component Name
Preliminary Procedures	
<div>1. Remove the left side instrument panel lower trim panel. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> .</div> <div>2. Remove the steering column upper trim cover from the instrument panel. Refer to <u>Steering Column Trim Cover Replacement</u> .</div>	
1	<div>Instrument Cluster Assembly Fastener (Qty: 2)</div> <div>CAUTION: Refer to <u>Fastener Caution</u> .</div> <div>Tighten 2.5 N.m (22 lb in)</div>
	<div>Instrument Cluster Assembly</div> <div>Procedure</div>

- | | |
|---|--|
| 2 | <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Remove the instrument cluster by pulling outward on the lower end of the cluster to release the tab. 3. For programming and set up information refer to <u>Control Module References</u> . |
|---|--|

ACCESSORY SWITCH REPLACEMENT

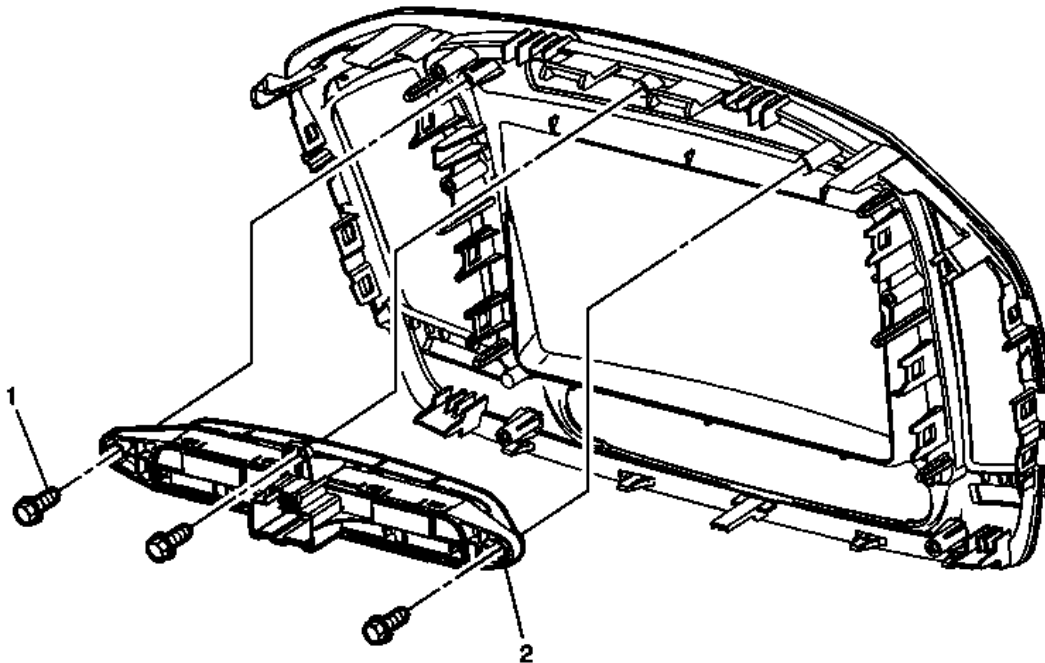


Fig. 11: Accessory Switch
 Courtesy of GENERAL MOTORS COMPANY

Accessory Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel upper center trim panel. Refer to <u>Instrument Panel Upper Center Trim Panel Replacement</u> .	
1	Accessory Switch Panel Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10.75 N.m (95 lb in)
2	Accessory Switch

DESCRIPTION AND OPERATION

AUDIBLE WARNINGS DESCRIPTION AND OPERATION

The audible warnings alert the driver of a system concern or a critical vehicle condition. The radio generates the audible warnings through the speakers. The radio receives audible warning requests via serial data. If the radio receives multiple audible warning requests, the warning with the highest priority sounds first. Different audible warnings may sound with a different frequency or a different chime pattern, depending on the system or module making the request. The chime volume may be selectable through vehicle personalization.

Audible Warnings or Chimes

The following is a list of common audible warnings or chimes. For additional chimes or complete system description, refer to the appropriate system's Description and Operation or the vehicle owner's manual.

- **Driver Seat Belt Reminder** - If the vehicle is started and the seat belt is unbuckled, the BCM requests the radio sound a chime to indicate that the belt is unbuckled. This is accompanied by a flashing driver seat belt indicator on the instrument cluster. If the belt remains unbuckled, the chime cycle may continue multiple times if the vehicle is driven and the indicator will remain on solid.
- **Passenger Seat Belt Reminder** - If the passenger presence system determines that there is an occupant in the passenger seat and the vehicle is started with the passenger seat belt unbuckled, the BCM requests the radio sound a chime to indicate that the belt is unbuckled. This is accompanied by a flashing passenger seat belt indicator. If the belt remains unbuckled, the chime cycle may continue multiple times if the vehicle is driven and the indicator will remain on solid. If an object is placed on the passenger seat, the passenger presence system may interpret this as a passenger occupying the seat. Because the passenger seat belt is unbuckled, the passenger seat belt reminder chime will sound. To correct this, remove the object from the passenger seat.
- **Exterior Lamps On Warning** - If the exterior lamps are left on after the ignition is turned off and the driver door is opened, the BCM will request the radio sound a chime as an indicator that the exterior lamps are on.
- **Electric Parking Brake** - If the electric parking brake switch is pressed while the vehicle is in motion, the parking brake control module will request the radio sound a chime. To release the parking brake, the brake pedal must be pressed when the electric parking brake switch is pressed. If the brake pedal is not pressed, the parking brake control module will request the radio sound a chime. A message will also appear on the driver information center.
- **Delayed Locking** - If the keyless entry transmitter is not in the vehicle and the door lock switch is pressed with the driver door open, the BCM will request the radio sound a chime three times to indicate that the vehicle has entered a delayed locking state. The doors will automatically lock five seconds after the last door is closed.
- **Object Detection** - The object detection system sends various chime requests to the radio during normal operation.

Additional Warnings

The following warnings have an associated instrument cluster indicator or driver information center message:

- Turn Signal Indicators - The radio activates the audible warning as requested by the BCM.
- Vehicle Overspeed Message - The radio activates the audible warning as requested by the BCM.
- Fuel Level Low Message - The radio activates the audible warning as requested by the BCM.
- Oil Pressure Indicator - The radio activates the audible warning as requested by the BCM.
- Tire Pressure Low Indicator - The radio activates the audible warning as requested by the BCM.
- Antilock Brake Indicator - The radio activates the audible warning as requested by the electronic brake control module.
- Engine Cooling System Messages - The radio activates the audible warning as requested by the engine control module.
- Transmission Messages - The radio activates the audible warning as requested by the transmission control module.

DRIVER INFORMATION CENTER (DIC) DESCRIPTION AND OPERATION

The driver information center is located in the lower middle portion of the instrument cluster, between the speedometer and the tachometer. The driver information center displays information about the vehicle and allows the operator to access applications. It also displays warning messages if a system problem is detected.

The driver information center is made up of three distinct display zones. In the middle is an interactive application display zone. The application display zone allows access to the navigation application, audio application, phone application, or settings application. To the left and right are interactive information display zones. The information display zone contains multiple pages that display traditional vehicle information. The vehicle odometer and PRNDL are displayed at all times in the lower portion of each information display zone.

Each of the displays zones can be selected and their associated pages scrolled through using the steering wheel mounted driver information display switch.

INDICATOR/WARNING MESSAGE DESCRIPTION AND OPERATION

INDICATOR LIGHT ON

Refer to the OWNER'S MANUAL for the descriptions and explanations of all indicator lights.

For diagnosis and repair information related to an indicator light refer to the System Diagnosis and the Description of Operation that the message relates to.

MESSAGE DISPLAYED

Refer to the OWNER'S MANUAL for descriptions and explanations of all messages displayed.

For diagnosis and repair information related to a displayed message refer to the System Diagnosis and the Description of Operation that the message relates to.

CHANGE TIMING BELT MESSAGE

The Instrument Cluster monitors the odometer mileage to determine when timing belt (if equipped) replacement

may be necessary. After the vehicle has accumulated approximately 100,000 miles (160,000 kilometers), the Instrument Cluster may display the CHANGE TIMING BELT message. After the engine timing belt has been replaced, reset the CHANGE TIMING BELT message by locating and removing the fuses that supply power to the Instrument Cluster for two minutes.

BRAKES OVERHEATED

The Electronic Brake Control Module monitors brake usage and compares it to an internal thermal model to determine if the brakes could become overheated. If the Electronic Brake Control Module determines the brakes pads have exceeded a desirable temperature based on the thermal model, it sends a serial data message to the Instrument Cluster to display the BRAKES OVERHEATED message. The message remains displayed until the estimated temperature returns to a desirable range.

INSTRUMENT CLUSTER DESCRIPTION AND OPERATION

Instrument Cluster

The instrument cluster is a multifunction module that provides the vehicle operator with information that is critical to vehicle operation, such as vehicle speed, engine RPM, and coolant temperature, using analog gauges. The instrument cluster also provides the operator with operational warnings and message through various indicators and the driver information center. The driver information center is a full color multifunction display that is located in the instrument cluster. The driver information center is also tightly integrated with the vehicle's infotainment system and is highly reconfigurable.

Displays and Gauges Block Diagram

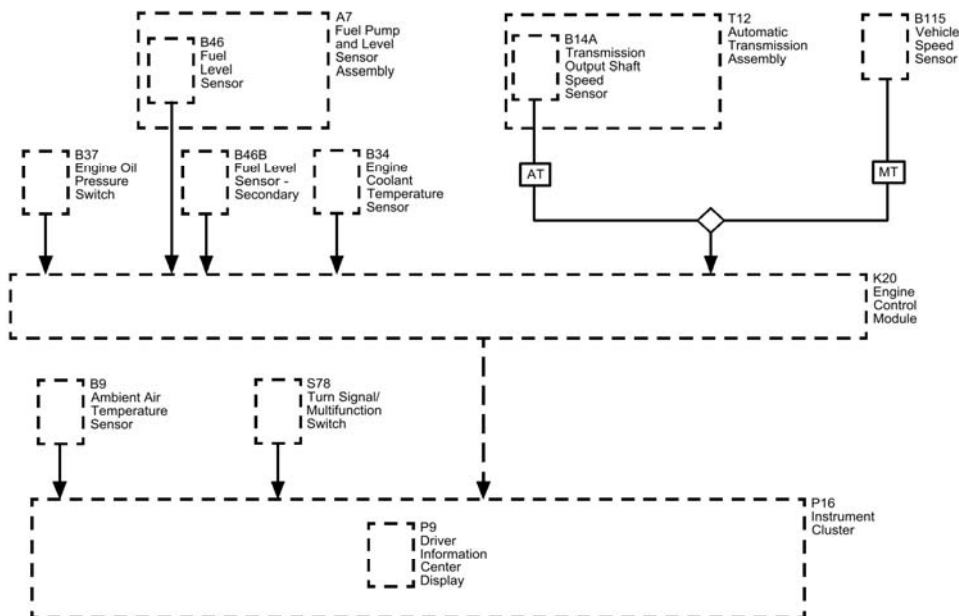


Fig. 12: Displays and Gauges Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
HW	Hard-Wired
DA	Serial Data
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
AT	Automatic Transmission
MT	Manual Transmission
P16	P16 Instrument Cluster
P9	P9 Driver Information Center Display
S78	S78 Turn Signal/Multifunction Switch
B9	B9 Ambient Air Temperature Sensor
B14A	B14A Transmission Output Shaft Speed Sensor
T12	T12 Automatic Transmission Assembly
B115	B115 Vehicle Speed Sensor
K20	K20 Engine Control Module
B46	B46 Fuel Level Sensor
A7	A7 Fuel Pump and Level Sensor Assembly
B37	B37 Engine Oil Pressure Switch
B46B	B46B Fuel Level Sensor - Secondary
B34	B34 Engine Coolant Temperature Sensor

Indicators and Warning Messages

Refer to **Indicator/Warning Message Description and Operation.**

Engine Coolant Temperature Gauge

The instrument cluster displays the engine coolant temperature as determined by the engine control module (ECM). The ECM sends the engine coolant temperature information via serial data to the body control module (BCM). The BCM then sends the information via a serial data to the instrument cluster to display the engine coolant temperature.

Fuel Level Gauge

The instrument cluster displays the fuel level based on the information from the ECM. The ECM converts the data from the fuel level sensors to a fuel level signal. The ECM sends the fuel level signal via serial data to the BCM. The BCM then sends the information via serial data to the instrument cluster to display the fuel level. If

the fuel level falls under 11% the instrument cluster will illuminate the low fuel level indicator. The fuel gauge defaults to empty if:

- The ECM detects a malfunction in the fuel level sensor circuit.
- The BCM detects a loss of serial data communications with the ECM.
- The instrument cluster detects a loss of serial data communications with the BCM.

Speedometer

The instrument cluster displays the vehicle speed based on the information from the ECM. The ECM sends the vehicle speed information via serial data to the BCM. The BCM then sends the vehicle speed information via serial data to the instrument cluster to display the vehicle speed.

Odometer

The instrument cluster displays the vehicle odometer in the driver information center. The ECM send a distance rolling count message via serial data to the body control module (BCM). The BCM uses this information to calculate the vehicle odometer. This odometer value is then sent to the instrument cluster. The instrument cluster does not calculate the odometer.

The odometer value is stored in multiple modules. The instrument cluster is a secondary storage module for the odometer, while the BCM is the primary storage and accumulator.

In addition to storing the odometer value for the vehicle, the instrument cluster and the BCM store the VIN. Software checks are performed to ensure these modules, and their stored odometer information, can not be move or transferred between different vehicles.

Tachometer

The instrument cluster displays the engine speed based on the information from the ECM. The ECM converts the data from the crankshaft position sensor to an engine revolution signal. The ECM sends the engine speed information via serial data to the BCM. The BCM then sends the information via serial data to the instrument cluster to display the engine speed.

Compass

The vehicle compass information is gather through the compass module. The compass module determines vehicle direction and communicates this with the BCM through serial data. The BCM sends the compass information to the instrument cluster via serial data, where it is displayed.

Driver Information Center Display

The driver information center is located In the lower middle of the instrument cluster. Its is a multifunction full-color LCD intended to display additional information, such as an odometer or messages. The driver information center is divided into three displays zones and is controlled using the steering wheel mounted driver information center select switch. For further information, refer to **Driver Information Center (DIC) Description and Operation**.

ELECTRICAL

Wiring Systems and Power Management - Door Component Views

DOOR COMPONENT VIEWS

DRIVER DOOR COMPONENTS

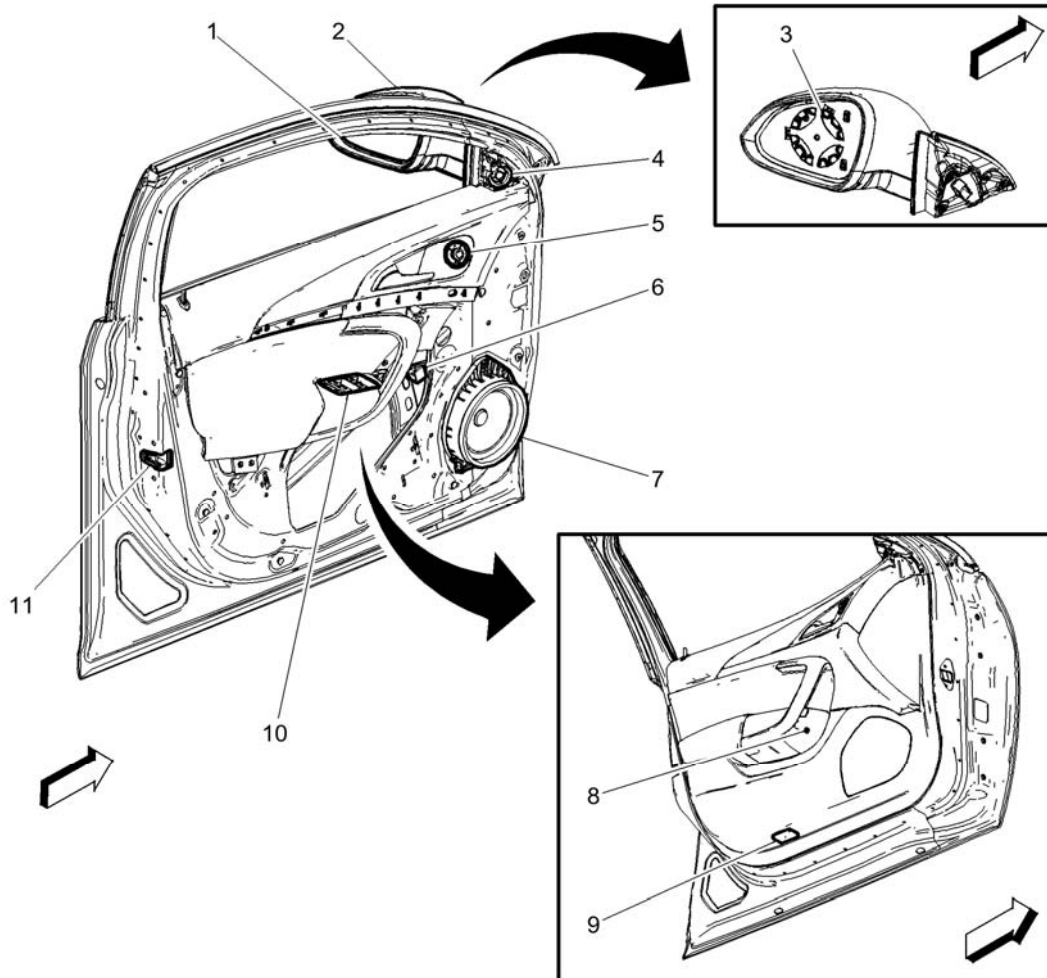


Fig. 1: Driver Door Components

Courtesy of GENERAL MOTORS COMPANY

Items

1: E17D Outside Rearview Mirror Glass - Driver E17D Outside Rearview Mirror Glass - Driver X1
E17D Outside Rearview Mirror Glass - Driver X2

2: A9A Outside Rearview Mirror - Driver A9A Outside Rearview Mirror - Driver CZ2

3: M77D Outside Rearview Mirror Motor - Driver M77D Outside Rearview Mirror Motor - Driver

4: P19H Speaker - Left Front Tweeter P19H Speaker - Left Front Tweeter

- 5: S52 Outside Rearview Mirror Switch S52 Outside Rearview Mirror Switch
 6: M74D Window Motor - Driver M74D Window Motor - Driver
 7: P19AG Speaker - Left Front Door P19AG Speaker - Left Front Door
 8: E55D Flood Lamp - Driver Door Pocket E55D Flood Lamp - Driver Door Pocket
 9: E8D Door Courtesy Lamp - Driver E8D Door Courtesy Lamp - Driver
 10: S79D Window Switch - Driver S79D Window Switch - Driver (CZ2) S79D Window Switch - Driver (except CZ2)
 11: A23D Door Latch Assembly - Driver A23D Door Latch Assembly - Driver

PASSENGER DOOR COMPONENTS

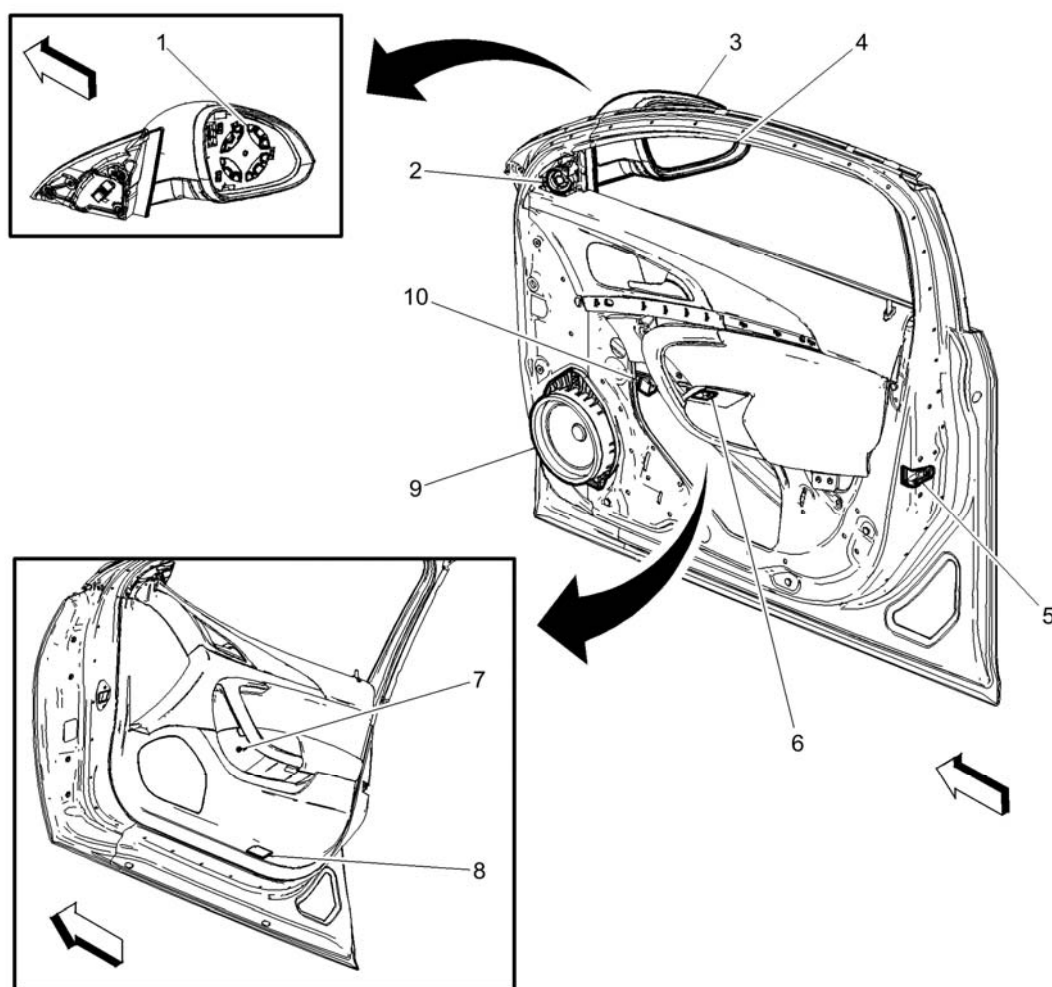


Fig. 2: Passenger Door Components
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1: M77P Outside Rearview Mirror Motor - Passenger M77P Outside Rearview Mirror Motor - Passenger

2: P19V Speaker - Right Front Tweeter **P19V Speaker - Right Front Tweeter**
3: A9B Outside Rearview Mirror - Passenger **A9B Outside Rearview Mirror - Passenger CZ2**
4: E17P Outside Rearview Mirror Glass - Passenger **E17P Outside Rearview Mirror Glass - Passenger X1 E17P Outside Rearview Mirror Glass - Passenger X2**
5: A23P Door Latch Assembly - Passenger **A23P Door Latch Assembly - Passenger**
6: S79P Window Switch - Passenger **S79P Window Switch - Passenger (AEF except CZ2) S79P Window Switch - Passenger (CZ2 with AEF/AED except A45) S79P Window Switch - Passenger X2 (CZ2 with A45)**
7: E55P Flood Lamp - Passenger Door Pocket **E55P Flood Lamp - Passenger Door Pocket**
8: E8P Door Courtesy Lamp - Passenger **E8P Door Courtesy Lamp - Passenger**
9: P19AH Speaker - Right Front Door **P19AH Speaker - Right Front Door (U65/CZ2) P19AH Speaker - Right Front Door (UQS/CZ2) P19AH Speaker - Right Front Door except CZ2**
10: M74P Window Motor - Passenger **M74P Window Motor - Passenger (AEF)**

LEFT REAR DOOR COMPONENTS

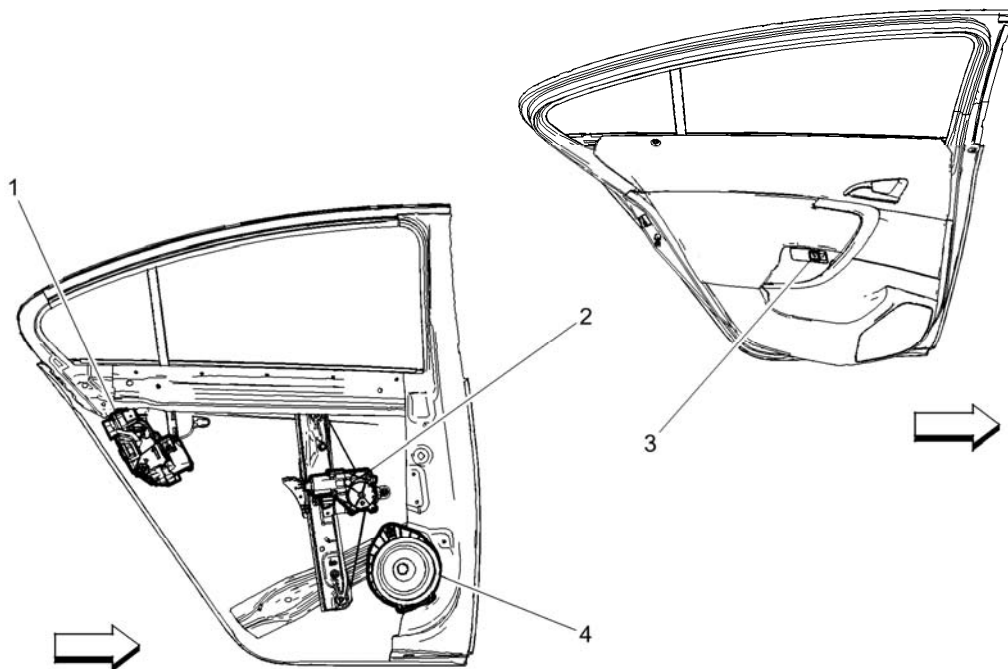


Fig. 3: Left Rear Door Components
 Courtesy of GENERAL MOTORS COMPANY

Items
1: A23LR Door Latch Assembly - Left Rear <u>A23LR Door Latch Assembly - Left Rear</u>
2: M74LR Window Motor - Left Rear <u>M74LR Window Motor - Left Rear (CZ2 with AEQ) M74LR Window Motor - Left Rear (AEQ except CZ2)</u>
3: S79LR Window Switch - Left Rear <u>S79LR Window Switch - Left Rear (AEQ) S79LR Window</u>

Switch - Left Rear (AER)

4: P19AL Speaker - Left Rear Door P19AL Speaker - Left Rear Door

RIGHT REAR DOOR COMPONENTS

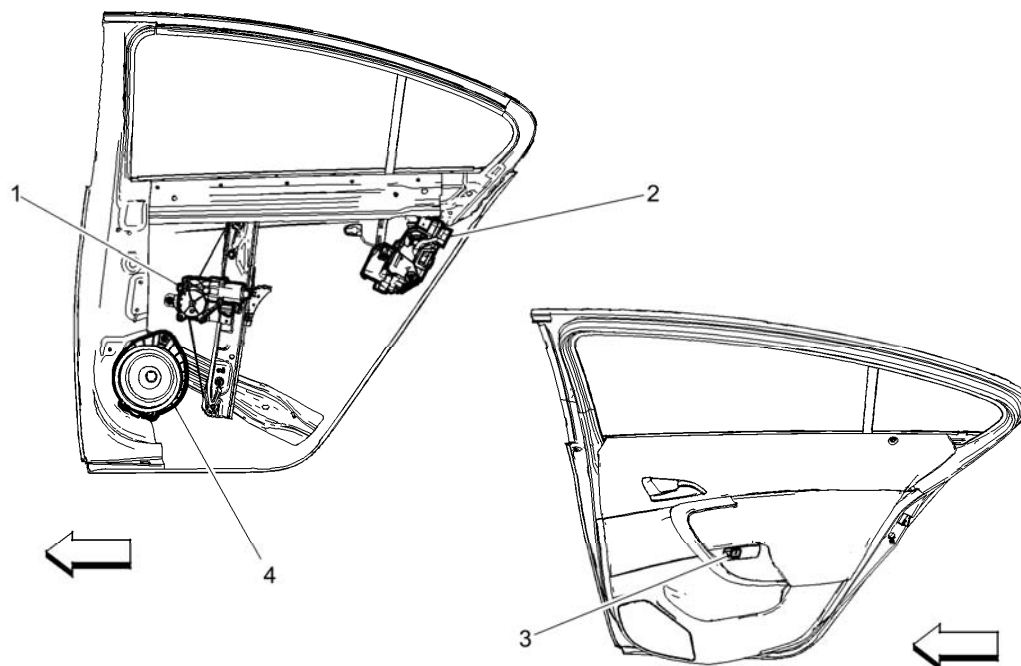


Fig. 4: Right Rear Door Components

Courtesy of GENERAL MOTORS COMPANY

Items

1: M74RR Window Motor - Right Rear M74RR Window Motor - Right Rear (CZ2 with AEQ)

M74RR Window Motor - Right Rear (AEQ except CZ2)

2: A23RR Door Latch Assembly - Right Rear A23RR Door Latch Assembly - Right Rear

3: S79RR Window Switch - Right Rear S79RR Window Switch - Right Rear (AEQ) S79RR Window Switch - Right Rear (AER)

4: P19AM Speaker - Right Rear Door P19AM Speaker - Right Rear Door

DTC INDEX

ANTILOCK BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

ANTILOCK BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B2745</u>	Traction Control Switch Circuit Short to Ground
<u>DTC C0035, C0040, C0045, or C0050</u>	Wheel Speed Sensor
<u>DTC C0110</u>	Pump Motor Circuit
<u>DTC C0131</u>	Traction Control System Pressure
<u>DTC C0161</u>	Antilock Braking System Brake Switch
<u>DTC C0186, C0187, C0196, or C0287 (Without KSG)</u>	Lateral Acceleration Sensor/Multi-Axis Acceleration Sensor/Yaw Rate Signal/Longitudinal Acceleration Sensor
<u>DTC C0187, C018B, C0196, C019B, C0287, or C0297 (With KSG)</u>	Lateral Acceleration Sensor/Yaw Rate Signal/Longitudinal Acceleration Sensor
<u>DTC C018C</u>	Multi-Axis Acceleration Sensor Module - Incorrect Component Installed
<u>DTC C0242</u>	Engine Control Module Indicated Traction Control
<u>DTC C0245</u>	Wheel Speed Sensor Frequency Malfunction
<u>DTC C0252</u>	Vehicle Stability Control Module Sensors Correlation Malfunction
<u>DTC C0274, C0275, or C0280</u>	Isolation Valve/Dump Valve/Stability System Active Too Long
<u>DTC C0460 or C0710</u>	Steering Position Sensor
<u>DTC C0552</u>	Improper Shutdown
<u>DTC C0558</u>	Calibration Data Calibration Not Learned
<u>DTC C0569</u>	System Configuration Malfunction
<u>DTC C1207-C1210, C1221-C1228, or C1232-C1235</u>	Wheel Speed Sensor
<u>DTC P0856</u>	Wheel Speed Sensor
<u>DTC P15F8</u>	Automatic Braking Engine Torque Request Signal Message Counter Incorrect

AUTOMATIC TRANSMISSION - 6T40 (MHH, MHK) - DIAGNOSTIC TROUBLE CODES

AUTOMATIC TRANSMISSION - 6T40 (MHH, MHK) - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC P0601, P0603, P0604, or P062F</u>	DTC P0601 Control Module Read Only Memory Performance DTC P0603 Control Module Long Term Memory Reset

	DTC P0604 Control Module Random Access Memory Performance DTC P062F Control Module Long Term Memory Performance
<u>DTC P0634</u>	DTC P0634 Control Module Overtemperature
<u>DTC P0658 or P0659</u>	DTC P0658 Actuator High Control Circuit Group 1 Low Voltage DTC P0659 Actuator High Control Circuit Group 1 High Voltage
<u>DTC P0667, P0668, or P0669</u>	DTC P0667 Control Module Temperature Sensor Performance DTC P0668 Control Module Temperature Sensor Circuit Low Voltage DTC P0669 Control Module Temperature Sensor Circuit High Voltage
<u>DTC P06AC, P06AD, or P06AE</u>	DTC P06AC Control Module Power Up Temperature Sensor Performance DTC P06AD Control Module Power Up Temperature Sensor Circuit Low Voltage DTC P06AE Control Module Power Up Temperature Sensor Circuit High Voltage
<u>DTC P0711-P0713</u>	DTC P0711 Transmission Fluid Temperature Sensor Performance DTC P0712 Transmission Fluid Temperature Sensor Circuit Low Voltage DTC P0713 Transmission Fluid Temperature Sensor Circuit High Voltage
<u>DTC P0716, P0717, P07BF, or P07C0</u>	DTC P0716 Input Speed Sensor Performance DTC P0717 Input Speed Sensor Circuit No Signal DTC P07BF Input Speed Sensor Circuit Low Voltage DTC P07C0 Input Speed Sensor Circuit High Voltage
<u>DTC P0722, P0723, P077C, or P077D</u>	DTC P0722 Output Speed Sensor Circuit No Signal DTC P0723 Output Speed Sensor Circuit Intermittent DTC P077C Output Speed Sensor Circuit Low Voltage DTC P077D Output Speed Sensor Circuit High Voltage
<u>DTC P0741 or P0742</u>	DTC P0741 Torque Converter Clutch (TCC) System Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P0742 Torque Converter Clutch (TCC) System Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P0751 or P0752</u>	DTC P0751 Shift Solenoid Valve 1 Performance - Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P0752 Shift Solenoid Valve 1 Performance - Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P0776 or P0777</u>	DTC P0776 Pressure Control Solenoid Valve 2 Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P0777 Pressure Control Solenoid Valve 2 Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P0796 or P0797</u>	DTC P0796 Pressure Control Solenoid Valve 3 Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P0797 Pressure Control Solenoid Valve 3 Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P0815, P0816, or P0826</u>	DTC P0815 Upshift Switch Circuit DTC P0816 Downshift Switch Circuit DTC P0826 Up and Down Shift Switch Circuit
<u>DTC P0850-P0852</u>	DTC P0850 Park/Neutral Position Switch Circuit DTC P0851 Park/Neutral Position Switch Circuit Low Voltage DTC P0852 Park/Neutral Position Switch Circuit High Voltage

<u>DTC P0961-P0963</u>	DTC P0961 Line Pressure Control Solenoid Valve Performance DTC P0962 Line Pressure Control Solenoid Valve Control Circuit Low Voltage DTC P0963 Line Pressure Control Solenoid Valve Control Circuit High Voltage
<u>DTC P0965-P0967</u>	DTC P0965 Pressure Control Solenoid Valve 2 Performance DTC P0966 Pressure Control Solenoid Valve 2 Control Circuit Low Voltage DTC P0967 Pressure Control Solenoid Valve 2 Control Circuit High Voltage
<u>DTC P0969-P0971</u>	DTC P0969 Pressure Control Solenoid Valve 3 Performance DTC P0970 Pressure Control Solenoid Valve 3 Control Circuit Low Voltage DTC P0971 Pressure Control Solenoid Valve 3 Control Circuit High Voltage
<u>DTC P0973 or P0974</u>	DTC P0973 Shift Solenoid Valve 1 Control Circuit Low Voltage DTC P0974 Shift Solenoid Valve 1 Control Circuit High Voltage
<u>DTC P1761</u>	DTC P1761 Up and Down Shift Switch Signal Message Counter Incorrect
<u>DTC P1762</u>	DTC P1762 Transmission Mode Switch Signal Message Counter Incorrect
<u>DTC P182E or P1915</u>	DTC P182E Internal Mode Switch Indicates Invalid Range DTC P1915 Internal Mode Switch Does Not Indicate Park/Neutral During Start
<u>DTC P1876</u>	DTC P1876 Up and Down Shift Enable Switch Circuit Low Voltage
<u>DTC P2714 or P2715</u>	DTC P2714 Pressure Control Solenoid Valve 4 Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P2715 Pressure Control Solenoid Valve 4 Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P2719-P2721</u>	DTC P2719 Pressure Control Solenoid Valve 4 Performance DTC P2720 Pressure Control Solenoid Valve 4 Control Circuit Low Voltage DTC P2721 Pressure Control Solenoid Valve 4 Control Circuit High Voltage
<u>DTC P2723 or P2724</u>	DTC P2723 Pressure Control Solenoid Valve 5 Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P2724 Pressure Control Solenoid Valve 5 Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P2728-P2730</u>	DTC P2728 Pressure Control Solenoid Valve 5 Performance DTC P2729 Pressure Control Solenoid Valve 5 Control Circuit Low Voltage DTC P2730 Pressure Control Solenoid Valve 5 Control Circuit High Voltage
<u>DTC P2762, P2763, or P2764</u>	DTC P2762 Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Performance DTC P2763 Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit High Voltage DTC P2764 Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit Low Voltage

AUTOMATIC TRANSMISSION - 6T70 (M7U M7W) - DIAGNOSTIC TROUBLE CODES

AUTOMATIC TRANSMISSION - 6T70 (M7U M7W) - DIAGNOSTIC TROUBLE CODES

DTC	Description
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<u>DTC P0601-P0604 or P062F</u>	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P062F Control Module Long Term Memory Performance
<u>DTC P0634</u>	DTC P0634 Control Module Overtemperature
<u>DTC P0658 or P0659</u>	DTC P0658 Actuator High Control Circuit Group 1 Low Voltage DTC P0659 Actuator High Control Circuit Group 1 High Voltage
<u>DTC P0667, P0668, or P0669</u>	DTC P0667 Control Module Temperature Sensor Performance DTC P0668 Control Module Temperature Sensor Circuit Low Voltage DTC P0669 Control Module Temperature Sensor Circuit High Voltage
<u>DTC P06AC-P06AE</u>	DTC P06AC Control Module Power Up Temperature Sensor Performance DTC P06AD Control Module Power Up Temperature Sensor Circuit Low Voltage DTC P06AE Control Module Power Up Temperature Sensor Circuit High Voltage
<u>DTC P0711-P0713</u>	DTC P0711 Transmission Fluid Temperature Sensor Performance DTC P0712 Transmission Fluid Temperature Sensor Circuit Low Voltage DTC P0713 Transmission Fluid Temperature Sensor Circuit High Voltage
<u>DTC P0716 or P0717</u>	DTC P0716 Input Speed Sensor Performance DTC P0717 Input Speed Sensor Circuit No Signal
<u>DTC P071D</u>	DTC P071D Transmission Sport Mode Switch Circuit
<u>DTC P0722 or P0723</u>	DTC P0722 Output Speed Sensor Circuit No Signal DTC P0723 Output Speed Sensor Circuit Intermittent
<u>DTC P0741 or P0742</u>	DTC P0741 Torque Converter Clutch (TCC) System Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P0742 Torque Converter Clutch (TCC) System Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P0751 or P0752</u>	DTC P0751 Shift Solenoid Valve 1 Performance - Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P0752 Shift Solenoid Valve 1 Performance - Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P0756</u>	DTC P0756 Shift Solenoid Valve 2 Performance - Stuck Off - Transmission Hydraulic/Mechanical Performance
<u>DTC P0776 or P0777</u>	DTC P0776 Pressure Control Solenoid Valve 2 Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P0777 Pressure Control Solenoid Valve 2 Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P0796 or P0797</u>	DTC P0796 Pressure Control Solenoid Valve 3 Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P0797 Pressure Control Solenoid Valve 3 Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P0815, P0816, or P0826</u>	DTC P0815 Upshift Switch Circuit DTC P0816 Downshift Switch Circuit DTC P0826 Up and Down Shift Switch Circuit

<u>DTC P0851</u>	DTC P0851 Park/Neutral Position Switch Circuit Low Voltage
<u>DTC P0961-P0963</u>	DTC P0961 Line Pressure Control Solenoid Valve Performance DTC P0962 Line Pressure Control Solenoid Valve Control Circuit Low Voltage DTC P0963 Line Pressure Control Solenoid Valve Control Circuit High Voltage
<u>DTC P0965-P0967</u>	DTC P0965 Pressure Control Solenoid Valve 2 Performance DTC P0966 Pressure Control Solenoid Valve 2 Control Circuit Low Voltage DTC P0967 Pressure Control Solenoid Valve 2 Control Circuit High Voltage
<u>DTC P0969-P0971</u>	DTC P0969 Pressure Control Solenoid Valve 3 Performance DTC P0970 Pressure Control Solenoid Valve 3 Control Circuit Low Voltage DTC P0971 Pressure Control Solenoid Valve 3 Control Circuit High Voltage
<u>DTC P0973 or P0974</u>	DTC P0973 Shift Solenoid Valve 1 Control Circuit Low Voltage DTC P0974 Shift Solenoid Valve 1 Control Circuit High Voltage
<u>DTC P0976 or P0977</u>	DTC P0976 Shift Solenoid Valve 2 Control Circuit Low Voltage DTC P0977 Shift Solenoid Valve 2 Control Circuit High Voltage
<u>DTC P1761</u>	DTC P1761 Up and Down Shift Switch Signal Message Counter Incorrect
<u>DTC P1762</u>	DTC P1762 Transmission Mode Switch Signal Message Counter Incorrect
<u>DTC P182E or P1915</u>	DTC P182E Internal Mode Switch Indicates Invalid Range DTC P1915 Internal Mode Switch Does Not Indicate Park/Neutral During Start
<u>DTC P1876</u>	DTC P1876 Up and Down Shift Enable Switch Circuit Low Voltage
<u>DTC P2714 or P2715</u>	DTC P2714 Pressure Control Solenoid Valve 4 Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P2715 Pressure Control Solenoid Valve 4 Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P2719-P2721</u>	DTC P2719 Pressure Control Solenoid Valve 4 Performance DTC P2720 Pressure Control Solenoid Valve 4 Control Circuit Low Voltage DTC P2721 Pressure Control Solenoid Valve 4 Control Circuit High Voltage
<u>DTC P2723 or P2724</u>	DTC P2723 Pressure Control Solenoid Valve 5 Stuck Off - Transmission Hydraulic/Mechanical Performance DTC P2724 Pressure Control Solenoid Valve 5 Stuck On - Transmission Hydraulic/Mechanical Performance
<u>DTC P2728-P2730</u>	DTC P2728 Pressure Control Solenoid Valve 5 Performance DTC P2729 Pressure Control Solenoid Valve 5 Control Circuit Low Voltage DTC P2730 Pressure Control Solenoid Valve 5 Control Circuit High Voltage
<u>DTC P2762, P2763, or P2764</u>	DTC P2762 Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Performance DTC P2763 Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit High Voltage DTC P2764 Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit Low Voltage

BATTERY, CHARGING SYSTEM AND STARTING SYSTEM - DIAGNOSTIC TROUBLE CODES

BATTERY, CHARGING SYSTEM AND STARTING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B1325, B1327, B1328, B1330, B1517, C0800, C0805, C0895, C0899, C0900, P0560, P0562, P0563, P129B, or P129C</u>	Power Circuit Voltage
<u>DTC B1516</u>	Battery Current Sensor
<u>DTC B151A</u>	Battery Capacity Performance
<u>DTC B1527</u>	Parasitic Load
<u>DTC P0615, P0616, or P0617</u>	Starter Relay
<u>DTC P0621</u>	Generator L-Terminal Circuit
<u>DTC P0622</u>	Generator F-Terminal Circuit
<u>DTC P0625 or P0626</u>	Generator F-Terminal Circuit Voltage

BATTERY, CHARGING SYSTEM AND STARTING SYSTEM - HYBRID (HP6) - DIAGNOSTIC TROUBLE CODES**BATTERY, CHARGING SYSTEM AND STARTING SYSTEM - HYBRID (HP6) - DIAGNOSTIC TROUBLE CODES**

DTC	Description
<u>DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563</u>	Device Power Circuit

BOLTED EXTERIOR BODY PANELS AND CLOSURES - DIAGNOSTIC TROUBLE CODES**BOLTED EXTERIOR BODY PANELS AND CLOSURES - DIAGNOSTIC TROUBLE CODES**

DTC	Description
<u>DTC B3006</u>	Hood Ajar Circuit
<u>DTC P257D-P257F</u>	Engine Hood Switch

CELLULAR SYSTEM, ENTERTAINMENT SYSTEM, AND NAVIGATION SYSTEM - DIAGNOSTIC TROUBLE CODES**CELLULAR SYSTEM, ENTERTAINMENT SYSTEM, AND NAVIGATION SYSTEM - DIAGNOSTIC TROUBLE CODES**

DTC	Description
<u>DTC B0997</u>	Auxiliary Electronic Control Unit
<u>DTC B1024 (Human Machine Interface Control Module)</u>	Circuit Board Temperature Sensor
<u>DTC B1024 (Audio Amplifier)</u>	Circuit Board Temperature Sensor Above Maximum Threshold

<u>DTC B1025-B1135 (UQA)</u>	Audio Output 1-7 Circuits
<u>DTC B1025-B1135 (U65)</u>	Audio Output Circuit
<u>DTC B124F</u>	Universal Serial Bus (USB) Programming
<u>DTC B124B</u>	USB 1 Circuit
<u>DTC B124C</u>	USB 2 Circuit
<u>DTC B125A</u>	Antenna Signal Circuit
<u>DTC B125C</u>	Satellite Antenna Circuit
<u>DTC B1271</u>	Theft Protection Active
<u>DTC B127E</u>	Front Video Display Output Signal
<u>DTC B12A7</u>	Optical Media Drive
<u>DTC B12A8</u>	Optical Media Drive Theft Locked
<u>DTC B1446 or B1447</u>	Backup Power Source
<u>DTC B2455</u>	Cellular Phone Microphone
<u>DTC B2462</u>	Global Positioning System Signal
<u>DTC B2470</u>	Cellular Phone Antenna
<u>DTC B2476 or B2482</u>	Cellular Phone Select Service Switch
<u>DTC B2485</u>	Wireless Communication (BT) Antenna

CRUISE CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

CRUISE CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B3623</u>	Steering Wheel Controls Distance Sensing
<u>DTC C0561</u>	System Disabled Information Stored Malfunction
<u>DTC C0565</u>	Vehicle Identification Number Malfunction
<u>DTC C056E (Distance Sensing Cruise Control Module)</u>	Electronic Control Unit Software - Calibration Not Learned
<u>DTC C1002</u>	Distance Sensing Cruise Control Module
<u>DTC P0571</u>	Cruise Control Brake Switch Circuit
<u>DTC P0572 or P0573</u>	Brake Switch Circuit 1
<u>DTC P0575</u>	Cruise Control Switch Signal Message Counter Incorrect
<u>DTC P0703</u>	Brake Switch Signal Message Counter Incorrect
<u>DTC P1553</u>	Distance Sensing Cruise Control Signal Message Counter Incorrect
<u>DTC P15F6 (Distance Sensing Cruise Control Module)</u>	Front Object Detection Control Module Torque Request Signal Message Counter Incorrect

DATA COMMUNICATION SYSTEM - DIAGNOSTIC TROUBLE CODES

DATA COMMUNICATION SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
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<u>DTC B1000</u>	DTC B1000 Electronic Control Unit
<u>DTC B1001</u>	DTC B1001 Option Configuration
<u>DTC B101D</u>	DTC B101D Electronic Control Unit Hardware
<u>DTC B101E</u>	DTC B101E Electronic Control Unit Software
<u>DTC C056D</u>	DTC C056D Electronic Control Unit Hardware
<u>DTC C056E</u>	DTC C056E Electronic Control Unit Software
<u>DTC P0601-P0606, P060A, P062F, or P262B</u>	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P0605 Control Module Programming Read Only Memory Performance DTC P0606 Control Module Processor Performance DTC P060A Control Module Monitoring Processor Performance DTC P062F Control Module Long Term Memory Performance DTC P262B Control Module Power Off Timer Performance
<u>DTC U0001</u>	DTC U0001 00 High Speed CAN Communication Bus Malfunction
<u>DTC U0020</u>	DTC U0020 Low Speed CAN Bus
<u>DTC U0028</u>	DTC U0028 MOST Bus
<u>DTC U0029</u>	DTC U0029 MOST Bus Performance
<u>DTC U0073 or U2100</u>	DTC U0073 Control Module Communication Bus A Off DTC U2100 CAN Bus Communication
<u>DTC U0074 (Chassis Expansion Bus)</u>	DTC U0074 Control Module Communication Bus B Off
<u>DTC U0074 (Powertrain Expansion Bus with HP6)</u>	DTC U0074 00 Control Module Communication Powertrain Expansion CAN Bus Off Malfunction
<u>DTC U0074 (Mid Speed GMLAN)</u>	DTC U0074 Control Module Communication Bus B Off
<u>DTC U0074 (Powertrain Expansion Bus without HP6)</u>	DTC U0074 00 Control Module Communication Powertrain Expansion CAN Bus Off Malfunction
<u>DTC U0078</u>	DTC U0078 Control Module Communication Low Speed CAN Bus Off
<u>DTC U0100-U02FF (without HP6)</u>	See <u>Control Module U Code List</u>
<u>DTC U0100-U02FF (with HP6)</u>	See <u>Control Module U Code List</u>
<u>DTC U0300-U0336</u>	See <u>Control Module U Code List</u>
<u>DTC U0400-U05FF</u>	See <u>Control Module U Code List</u>
<u>DTC U1500-U15FF</u>	See <u>Control Module U Code List</u>
<u>DTC U180B</u>	DTC U180B 00 Battery Energy Control Module High Speed CAN Bus Off Malfunction
<u>DTC U1811</u>	DTC U1811 00 Battery Energy Control Module Powertrain Expansion CAN Bus Off Malfunction
<u>DTC U1814</u>	DTC U1814 Powertrain Wake-Up Communication Circuit
<u>DTC U1817</u>	DTC U1817 00 Lost Communication with Hybrid Powertrain Control

	Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U1818</u>	DTC U1818 00 Lost Communication with Engine Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U182A</u>	DTC U182A 00 Hybrid Powertrain Control Module Lost Communication with Battery Energy Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U1831</u>	DTC U1831 00 Drive Motor Control Module 1 Lost Communication with Hybrid Powertrain Control Module Malfunction
<u>DTC U1844</u>	DTC U1844 00 Battery Energy Control Module Lost Communication with Hybrid Powertrain Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U1845 or U1846</u>	DTC U1845 00 Drive Motor Control Module 1 Lost Communication with Hybrid Powertrain Control Module Malfunction
<u>DTC U1847</u>	DTC U1847 00 Drive Motor Control Module 1 Lost Communication with Battery Energy Control Module on Powertrain Expansion CAN Bus Malfunction
<u>DTC U1875</u>	DTC U1875 00 Drive Motor Control Module 1 Lost Communication with Battery Energy Control Module Malfunction
<u>DTC U1876</u>	DTC U1876 00 Drive Motor Control Module 1 Lost Communication with Engine Control Module Malfunction
<u>DTC U1885</u>	DTC U1885 00 Battery Energy Control Module Lost Communication with Hybrid Powertrain Control Module Malfunction
<u>DTC U1886</u>	DTC U1886 00 Battery Energy Control Module Lost Communication with Engine Control Module Malfunction
<u>DTC U18A2</u>	DTC U18A2 Lost Communication with Fuel Pump Driver Control Module
<u>DTC U18A6</u>	DTC U18A6 Lost Communication with Right Object Detection Control Module on Dedicated Bus 1
<u>DTC U18B9-U18BF</u>	DTC U18B9 Primary High Speed CAN Bus Subnet Configuration List DTC U18BF Secondary High Speed CAN Bus Subnet Configuration List
<u>DTC U1901</u>	DTC U1901 00 Lost Communication With Front Controls Multifunction Interface Module Malfunction
<u>DTC U2098</u>	DTC U2098 00 MOST Communication Enable Circuit Malfunction DTC U2098 02 MOST Communication Enable Circuit Short to Ground
<u>DTC U2099</u>	DTC U2099 High Speed Communication Enable Circuit
<u>DTC U2616</u>	DTC U2616 Fuel Pump Driver Control Module Lost Communication with ECM
<u>DTC U2101</u>	DTC U2101 CAN Bus Maximum List of Control Modules
<u>DTC U2160-U2231</u>	See <u>Control Module U Code List</u>

ENGINE CONTROLS/FUEL - 2.0L (LTG) - DIAGNOSTIC TROUBLE CODES

ENGINE CONTROLS/FUEL - 2.0L (LTG) - DIAGNOSTIC TROUBLE CODES

DTC	Description
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<u>DTC P0010, P0013, or P2088-P2091</u>	DTC P0010 Intake Camshaft Position Actuator Solenoid Valve Control Circuit DTC P0013 Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit DTC P2088 Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage DTC P2089 Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage DTC P2090 Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage DTC P2091 Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage
<u>DTC P0011 or P0014</u>	DTC P0011 Intake Camshaft Position System Performance DTC P0014 Exhaust Camshaft Position System Performance
<u>DTC P0016 or P0017</u>	DTC P0016 Crankshaft Position - Intake Camshaft Position Not Plausible DTC P0017 Crankshaft Position - Exhaust Camshaft Position Not Plausible
<u>DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, or P0141</u>	DTC P0030 HO2S Heater Control Circuit Sensor 1 DTC P0031 HO2S Heater Control Circuit Low Voltage Sensor 1 DTC P0032 HO2S Heater Control Circuit High Voltage Sensor 1 DTC P0036 HO2S Heater Control Circuit Sensor 2 DTC P0037 HO2S Heater Control Circuit Low Voltage Sensor 2 DTC P0038 HO2S Heater Control Circuit High Voltage Sensor 2 DTC P0053 HO2S Heater Resistance Sensor 1 DTC P0054 HO2S Heater Resistance Sensor 2 DTC P0135 HO2S Heater Performance Sensor 1 DTC P0141 HO2S Heater Performance Sensor 2
<u>DTC P0033-P0035</u>	DTC P0033 Turbocharger Bypass Solenoid Valve Control Circuit DTC P0034 Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage DTC P0035 Turbocharger Bypass Solenoid Valve Control Circuit High Voltage
<u>DTC P0068 or P1101</u>	DTC P0068 Throttle Body Air Flow Performance DTC P1101 Intake Air Flow System Performance
<u>DTC P0089, P00C6, P228C, or P228D</u>	DTC P0089 Fuel Pressure Regulator Performance DTC P00C6 Fuel Rail Pressure Low During Engine Cranking DTC P228C Fuel Pressure Regulator Control Performance - Low Pressure DTC P228D Fuel Pressure Regulator Control Performance - High Pressure
<u>DTC P0090-P0092, P00C8, P00C9, or P00CA</u>	DTC P0090 Fuel Pressure Regulator Control Circuit DTC P0091 Fuel Pressure Regulator Control Circuit Low Voltage DTC P0092 Fuel Pressure Regulator Control Circuit High Voltage DTC P00C8 Fuel Pressure Regulator High Control Circuit DTC P00C9 Fuel Pressure Regulator High Control Circuit Low Voltage DTC P00CA Fuel Pressure Regulator High Control Circuit High Voltage
<u>DTC P0096 or P0111</u>	DTC P0096 Intake Air Temperature (IAT) Sensor 2 Performance DTC P0111 Intake Air Temperature (IAT) Sensor 1 Performance
<u>DTC P0097, P0098, or</u>	DTC P0097 Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

<u>P0099</u>	DTC P0098 Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage DTC P0099 Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent
<u>DTC P00C7 (LTG)</u>	DTC P00C7 Intake Air Pressure Measurement System - Multiple Sensors Not Plausible
<u>DTC P00E9</u>	DTC P00E9 Intake Air Temperature (IAT) Sensor 3 Circuit Performance
<u>DTC P00EA-P00EC</u>	DTC P00EA Intake Air Temperature (IAT) Sensor 3 Circuit Low Voltage DTC P00EB Intake Air Temperature (IAT) Sensor 3 Circuit High Voltage DTC P00EC Intake Air Temperature (IAT) Sensor 3 Circuit Erratic
<u>DTC P00F4-P00F6</u>	DTC P00F4 Intake Air Humidity Sensor Circuit Low Voltage DTC P00F5 Intake Air Humidity Sensor Circuit High Voltage DTC P00F6 Intake Air Humidity Sensor Circuit Erratic
<u>DTC P0101</u>	DTC P0101 Mass Air Flow (MAF) Sensor Performance
<u>DTC P0102 or P0103</u>	DTC P0102 Mass Air Flow (MAF) Sensor Circuit Low Frequency DTC P0103 Mass Air Flow (MAF) Sensor Circuit High Frequency
<u>DTC P0106</u>	DTC P0106 Manifold Absolute Pressure (MAP) Sensor Performance
<u>DTC P0107 or P0108</u>	DTC P0107 Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage DTC P0108 Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage
<u>DTC P0112, P0113, or P0114</u>	DTC P0112 Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage DTC P0113 Intake Air Temperature (IAT) Sensor 1 Circuit High Voltage DTC P0114 Intake Air Temperature (IAT) Sensor 1 Circuit Intermittent
<u>DTC P0116</u>	DTC P0116 Engine Coolant Temperature (ECT) Sensor Performance
<u>DTC P0117, P0118, or P0119</u>	DTC P0117 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage DTC P0118 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage DTC P0119 Engine Coolant Temperature (ECT) Sensor Circuit Intermittent
<u>DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135</u>	DTC P0121 Throttle Position Sensor 1 Performance DTC P0122 Throttle Position Sensor 1 Circuit Low Voltage DTC P0123 Throttle Position Sensor 1 Circuit High Voltage DTC P0222 Throttle Position Sensor 2 Circuit Low Voltage DTC P0223 Throttle Position Sensor 2 Circuit High Voltage DTC P16A0 Sensor Communication Circuit Low Voltage DTC P16A1 Sensor Communication Circuit High Voltage DTC P16A2 Sensor Communication Circuit Performance DTC P2135 Throttle Position Sensors 1-2 Not Plausible
<u>DTC P0128</u>	DTC P0128 Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature
<u>DTC P0131, P0132, P0134, P0137, P0138, P0140, or P2A00</u>	DTC P0131 HO2S Circuit Low Voltage Sensor 1 DTC P0132 HO2S Circuit High Voltage Sensor 1 DTC P0134 HO2S Circuit Insufficient Activity Sensor 1 DTC P0137 HO2S Circuit Low Voltage Sensor 2 DTC P0138 HO2S Circuit High Voltage Sensor 2 DTC P0140 HO2S Circuit Insufficient Activity Sensor 2 DTC P2A00 HO2S Performance Sensor 1
<u>DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270,</u>	DTC P0133 HO2S Slow Response Sensor 1 DTC P013A HO2S Slow Response Rich to Lean Sensor 2 DTC P013B HO2S Slow Response Lean to Rich Sensor 2

<u>or P2271</u>	DTC P013E HO2S Delayed Response Rich to Lean Sensor 2 DTC P013F HO2S Delayed Response Lean to Rich Sensor 2 DTC P015A HO2S Delayed Response Rich to Lean Sensor 1 DTC P015B HO2S Delayed Response Lean to Rich Sensor 1 DTC P2270 HO2S Signal Stuck Lean Sensor 2 DTC P2271 HO2S Signal Stuck Rich Sensor 2
<u>DTC P0171 or P0172</u>	DTC P0171 Fuel Trim System Lean DTC P0172 Fuel Trim System Rich
<u>DTC P018B-P018D</u>	DTC P018B Fuel Pressure Sensor Performance DTC P018C Fuel Pressure Sensor Circuit Low Voltage DTC P018D Fuel Pressure Sensor Circuit High Voltage
<u>DTC P0191, P0192, or P0193</u>	DTC P0191 Fuel Rail Pressure Sensor Performance DTC P0192 Fuel Rail Pressure Sensor Circuit Low Voltage DTC P0193 Fuel Rail Pressure Sensor Circuit High Voltage
<u>DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157</u>	DTC P0201 Cylinder 1 Injector Control Circuit DTC P0202 Cylinder 2 Injector Control Circuit DTC P0203 Cylinder 3 Injector Control Circuit DTC P0204 Cylinder 4 Injector Control Circuit DTC P0261 Cylinder 1 Injector Control Circuit Low Voltage DTC P0262 Cylinder 1 Injector Control Circuit High Voltage DTC P0264 Cylinder 2 Injector Control Circuit Low Voltage DTC P0265 Cylinder 2 Injector Control Circuit High Voltage DTC P0267 Cylinder 3 Injector Control Circuit Low Voltage DTC P0268 Cylinder 3 Injector Control Circuit High Voltage DTC P0270 Cylinder 4 Injector Control Circuit Low Voltage DTC P0271 Cylinder 4 Injector Control Circuit High Voltage DTC P1248 Cylinder 1 Injector High Control Circuit Shorted to Control Circuit DTC P1249 Cylinder 2 Injector High Control Circuit Shorted to Control Circuit DTC P124A Cylinder 3 Injector High Control Circuit Shorted to Control Circuit DTC P124B Cylinder 4 Injector High Control Circuit Shorted to Control Circuit DTC P2147 Cylinder 1 Injector High Control Circuit Low Voltage DTC P2148 Cylinder 1 Injector High Control Circuit High Voltage DTC P2150 Cylinder 2 Injector High Control Circuit Low Voltage DTC P2151 Cylinder 2 Injector High Control Circuit High Voltage DTC P2153 Cylinder 3 Injector High Control Circuit Low Voltage DTC P2154 Cylinder 3 Injector High Control Circuit High Voltage DTC P2156 Cylinder 4 Injector High Control Circuit Low Voltage DTC P2157 Cylinder 4 Injector High Control Circuit High Voltage
<u>DTC P0231, P0232, or P023F</u>	DTC P0231 Fuel Pump Control Circuit Low Voltage DTC P0232 Fuel Pump Control Circuit High Voltage DTC P023F Fuel Pump Control Circuit
<u>DTC P0234 or P0299</u>	DTC P0234 Engine Overboost DTC P0299 Engine Underboost

<u>DTC P0236</u>	DTC P0236 Turbocharger Boost Sensor Performance
<u>DTC P0237 or P0238</u>	DTC P0237 Turbocharger Boost Sensor Circuit Low Voltage DTC P0238 Turbocharger Boost Sensor Circuit High Voltage
<u>DTC P0243, P0245, or P0246</u>	DTC P0243 Turbocharger Wastegate Solenoid Valve Control Circuit DTC P0245 Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage DTC P0246 Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage
<u>DTC P0300-P0304</u>	DTC P0300 Engine Misfire Detected DTC P0301 Cylinder 1 Misfire Detected DTC P0302 Cylinder 2 Misfire Detected DTC P0303 Cylinder 3 Misfire Detected DTC P0304 Cylinder 4 Misfire Detected
<u>DTC P0315</u>	DTC P0315 Crankshaft Position System Variation Not Learned
<u>DTC P0324, P0326, P0331, P06B6, or P06B7</u>	DTC P0324 Knock Sensor System Performance DTC P0326 Knock Sensor 1 Performance DTC P0331 Knock Sensor 2 Performance DTC P06B6 Control Module Knock Sensor Processor 1 Performance DTC P06B7 Control Module Knock Sensor Processor 2 Performance
<u>DTC P0325, P0327, P0328, P0330, P0332, or P0333</u>	DTC P0325 Knock Sensor 1 Circuit DTC P0327 Knock Sensor 1 Circuit Low Voltage DTC P0328 Knock Sensor 1 Circuit High Voltage DTC P0330 Knock Sensor 2 Circuit DTC P0332 Knock Sensor 2 Circuit Low Voltage DTC P0333 Knock Sensor 2 Circuit High Voltage
<u>DTC P0335 or P0336</u>	DTC P0335 Crankshaft Position Sensor Circuit DTC P0336 Crankshaft Position Sensor Performance
<u>DTC P0340, P0341, P0365, or P0366</u>	DTC P0340 Intake Camshaft Position Sensor Circuit DTC P0341 Intake Camshaft Position Sensor Performance DTC P0365 Exhaust Camshaft Position Sensor Circuit DTC P0366 Exhaust Camshaft Position Sensor Performance
<u>DTC P0351-P0354, P2300, P2301, P2303, P2304, P2306, P2307, P2309, or P2310</u>	DTC P0351 Ignition Coil 1 Control Circuit DTC P0352 Ignition Coil 2 Control Circuit DTC P0353 Ignition Coil 3 Control Circuit DTC P0354 Ignition Coil 4 Control Circuit DTC P2300 Ignition Coil 1 Control Circuit Low Voltage DTC P2301 Ignition Coil 1 Control Circuit High Voltage DTC P2303 Ignition Coil 2 Control Circuit Low Voltage DTC P2304 Ignition Coil 2 Control Circuit High Voltage DTC P2306 Ignition Coil 3 Control Circuit Low Voltage DTC P2307 Ignition Coil 3 Control Circuit High Voltage DTC P2309 Ignition Coil 4 Control Circuit Low Voltage DTC P2310 Ignition Coil 4 Control Circuit High Voltage
<u>DTC P0420</u>	DTC P0420 Catalyst System Low Efficiency
<u>DTC P0442</u>	DTC P0442 Evaporative Emission (EVAP) System Small Leak Detected
<u>DTC P0443, P0458, or</u>	DTC P0443 Evaporative Emission (EVAP) Purge Solenoid Valve Control

<u>P0459</u>	Circuit DTC P0458 Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit Low Voltage DTC P0459 Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit High Voltage
<u>DTC P0446</u>	DTC P0446 Evaporative Emission (EVAP) Vent System Performance
<u>DTC P0449, P0498, or P0499</u>	DTC P0449 Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit DTC P0498 Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit Low Voltage DTC P0499 Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit High Voltage
<u>DTC P0451-P0454</u>	DTC P0451 Fuel Tank Pressure Sensor Performance DTC P0452 Fuel Tank Pressure Sensor Circuit Low Voltage DTC P0453 Fuel Tank Pressure Sensor Circuit High Voltage DTC P0454 Fuel Tank Pressure Sensor Circuit Intermittent
<u>DTC P0455</u>	DTC P0455 Evaporative Emission (EVAP) System Large Leak Detected
<u>DTC P0496</u>	DTC P0496 Evaporative Emission (EVAP) System Flow During Non-Purge
<u>DTC P0506 or P0507</u>	DTC P0506 Idle Speed Low DTC P0507 Idle Speed High
<u>DTC P050D</u>	DTC P050D Cold Start Rough Idle
<u>DTC P057B-P057D</u>	DTC P057B Brake Pedal Position Sensor Performance DTC P057C Brake Pedal Position Sensor Circuit Low Voltage DTC P057D Brake Pedal Position Sensor Circuit High Voltage
<u>DTC P05CC or P05CE</u>	DTC P05CC Cold Start Intake Camshaft Position System Performance DTC P05CE Cold Start Exhaust Camshaft Position System Performance
<u>DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)</u>	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P0606 Control Module Processor Performance DTC P062B Control Module Fuel Injector Control Performance DTC P062F Control Module Long Term Memory Performance DTC P0630 VIN Not Programmed or Mismatched - Engine Control Module (ECM) DTC P16F3 Control Module Redundant Memory Performance DTC P262B Control Module Power Off Timer Performance
<u>DTC P0628</u>	DTC P0628 Fuel Pump Enable Circuit Low Voltage
<u>DTC P0641, P0651, P0697, or P06A3 (ECM)</u>	DTC P0641 5V Reference 1 Circuit DTC P0651 5V Reference 2 Circuit DTC P0697 5V Reference 3 Circuit DTC P06A3 5V Reference 4 Circuit
<u>DTC P0650, P263A, or P263B</u>	DTC P0650 Malfunction Indicator Lamp (MIL) Control Circuit Open DTC P263A Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage DTC P263B Malfunction Indicator Lamp (MIL) Control Circuit High Voltage
<u>DTC P0685-P0687,</u>	DTC P0685 Engine Controls Ignition Relay Control Circuit

<u>P0689, P0690, or P1682</u>	DTC P0686 Engine Controls Ignition Relay Control Circuit Low Voltage DTC P0687 Engine Controls Ignition Relay Control Circuit High Voltage DTC P0689 Engine Controls Ignition Relay Feedback Circuit Low Voltage DTC P0690 Engine Controls Ignition Relay Feedback Circuit High Voltage DTC P1682 Ignition 1 Switch Circuit 2
<u>DTC P0700</u>	DTC P0700 Transmission Control Module Requested MIL Illumination
<u>DTC P1255</u>	DTC P1255 Fuel Pump Control Module Driver High Temperature
<u>DTC P129B or P129C</u>	DTC P129B Fuel Pump Driver Control Module System Voltage Low DTC P129C Fuel Pump Driver Control Module System Voltage High
<u>DTC P129D</u>	DTC P129D Fuel Pump Driver Control Module Ignition 1 Switch Circuit Low Voltage
<u>DTC P129E</u>	DTC P129E Fuel Pump Driver Control Module Signal Message Counter Incorrect
<u>DTC P12A6</u>	DTC P12A6 Fuel Pump Driver Control Module Enable Circuit Performance
<u>DTC P12A8</u>	DTC P12A8 Fuel Pump Control Signal Message Counter Incorrect
<u>DTC P135A</u>	DTC P135A Ignition Coil Supply Voltage Circuit Bank 1
<u>DTC P1400</u>	DTC P1400 Cold Start Emission Reduction Control System
<u>DTC P150C</u>	DTC P150C Transmission Control Module Engine Speed Request Signal Message Counter Incorrect
<u>DTC P1516, P2101, P2119, or P2176</u>	DTC P1516 Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance DTC P2101 Throttle Actuator Position Performance DTC P2119 Throttle Closed Position Performance DTC P2176 Minimum Throttle Position Not Learned
<u>DTC P163A</u>	DTC P163A Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance
<u>DTC P2096</u>	DTC P2096 Post Catalyst Fuel Trim System Low Limit
<u>DTC P2097</u>	DTC P2097 Post Catalyst Fuel Trim System High Limit
<u>DTC P2122, P2123, P2127, P2128, or P2138</u>	DTC P2122 Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage DTC P2123 Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage DTC P2127 Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage DTC P2128 Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage DTC P2138 Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible
<u>DTC P2199</u>	DTC P2199 Intake Air Temperature (IAT) Sensor 1-2 Not Plausible
<u>DTC P219A</u>	DTC P219A Fuel Trim Cylinder Balance
<u>DTC P2227-P2230</u>	DTC P2227 Barometric Pressure (BARO) Sensor Performance DTC P2228 Barometric Pressure (BARO) Sensor Circuit Low Voltage DTC P2229 Barometric Pressure (BARO) Sensor Circuit High Voltage DTC P2230 Barometric Pressure (BARO) Sensor Circuit Erratic
<u>DTC P2261</u>	DTC P2261 Turbocharger Bypass Valve Stuck
<u>DTC P2544</u>	DTC P2544 Transmission Torque Request Signal Message Counter Incorrect
<u>DTC P2635</u>	DTC P2635 Fuel Pump Flow Performance

ENGINE CONTROLS/FUEL - 2.4L (LEA, LUK) - DIAGNOSTIC TROUBLE

CODES

ENGINE CONTROLS/FUEL - 2.4L (LEA, LUK) - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC P0010, P0013, or P2088-P2091</u>	DTC P0010 Intake Camshaft Position Actuator Solenoid Valve Control Circuit DTC P0013 Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit DTC P2088 Intake Camshaft Position Actuator Solenoid Control Circuit Low Voltage DTC P2089 Intake Camshaft Position Actuator Solenoid Control Circuit High Voltage DTC P2090 Exhaust Camshaft Position Actuator Solenoid Control Circuit Low Voltage DTC P2091 Exhaust Camshaft Position Actuator Solenoid Control Circuit High Voltage
<u>DTC P0011 or P0014</u>	DTC P0011 Intake Camshaft Position System Performance DTC P0014 Exhaust Camshaft Position System Performance
<u>DTC P0016 or P0017</u>	DTC P0016 Crankshaft Position - Intake Camshaft Position Not Plausible DTC P0017 Crankshaft Position - Exhaust Camshaft Position Not Plausible
<u>DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, or P0141</u>	DTC P0030 HO2S Heater Control Circuit Sensor 1 DTC P0031 HO2S Heater Control Circuit Low Voltage Sensor 1 DTC P0032 HO2S Heater Control Circuit High Voltage Sensor 1 DTC P0036 HO2S Heater Control Circuit Sensor 2 DTC P0037 HO2S Heater Control Circuit Low Voltage Sensor 2 DTC P0038 HO2S Heater Control Circuit High Voltage Sensor 2 DTC P0053 HO2S Heater Resistance Sensor 1 DTC P0054 HO2S Heater Resistance Sensor 2 DTC P0135 HO2S Heater Performance Sensor 1 DTC P0141 HO2S Heater Performance Sensor 2
<u>DTC P0068 or P1101</u>	DTC P0068 Throttle Body Air Flow Performance DTC P1101 Intake Air Flow System Performance
<u>DTC P0089, P00C6, P228C, or P228D (LUK)</u>	DTC P0089 Fuel Pressure Regulator Performance DTC P00C6 Fuel Rail Pressure Low During Engine Cranking DTC P228C Fuel Pressure Regulator Control Performance - Low Pressure DTC P228D Fuel Pressure Regulator Control Performance - High Pressure
<u>DTC P0089, P00C6, P228C, or P228D (LEA)</u>	DTC P0089 Fuel Pressure Regulator Performance DTC P00C6 Fuel Rail Pressure Low During Engine Cranking DTC P228C Fuel Pressure Regulator Control Performance - Low Pressure DTC P228D Fuel Pressure Regulator Control Performance - High Pressure
<u>DTC P0090-P0092, P00C8, P00C9, or P00CA</u>	DTC P0090 Fuel Pressure Regulator Control Circuit DTC P0091 Fuel Pressure Regulator Control Circuit Low Voltage DTC P0092 Fuel Pressure Regulator Control Circuit High Voltage DTC P00C8 Fuel Pressure Regulator High Control Circuit DTC P00C9 Fuel Pressure Regulator High Control Circuit Low Voltage DTC P00CA Fuel Pressure Regulator High Control Circuit High Voltage

<u>DTC P0096 or P0111 (With LEA)</u>	DTC P0096 Intake Air Temperature (IAT) Sensor 2 Performance DTC P0111 Intake Air Temperature (IAT) Sensor 1 Performance
<u>DTC P0097, P0098, or P0099 (With LEA)</u>	DTC P0097 Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage DTC P0098 Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage DTC P0099 Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent
<u>DTC P0101 (With LEA)</u>	DTC P0101 Mass Air Flow (MAF) Sensor Performance
<u>DTC P0101 (With LUK)</u>	DTC P0101 Mass Air Flow (MAF) Sensor Performance
<u>DTC P0102 or P0103 (With LEA)</u>	DTC P0102 Mass Air Flow (MAF) Sensor Circuit Low Frequency DTC P0103 Mass Air Flow (MAF) Sensor Circuit High Frequency
<u>DTC P0102 or P0103 (With LUK)</u>	DTC P0102 Mass Air Flow (MAF) Sensor Circuit Low Frequency DTC P0103 Mass Air Flow (MAF) Sensor Circuit High Frequency
<u>DTC P0106</u>	DTC P0106 Manifold Absolute Pressure (MAP) Sensor Performance
<u>DTC P0107 or P0108</u>	DTC P0107 Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage DTC P0108 Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage
<u>DTC P0111 (With LUK)</u>	DTC P0111 Intake Air Temperature (IAT) Sensor Performance
<u>DTC P0112, P0113, or P0114 (With LEA)</u>	DTC P0112 Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage DTC P0113 Intake Air Temperature (IAT) Sensor 1 Circuit High Voltage DTC P0114 Intake Air Temperature (IAT) Sensor 1 Circuit Intermittent
<u>DTC P0112, P0113, or P0114 (With LUK)</u>	DTC P0112 Intake Air Temperature (IAT) Sensor Circuit Low Voltage DTC P0113 Intake Air Temperature (IAT) Sensor Circuit High Voltage DTC P0114 Intake Air Temperature (IAT) Sensor Circuit Intermittent
<u>DTC P0116 (LEA)</u>	DTC P0116 Engine Coolant Temperature (ECT) Sensor Performance
<u>DTC P0116 (LUK)</u>	DTC P0116 Engine Coolant Temperature (ECT) Sensor Performance
<u>DTC P0117 or P0118 (LUK)</u>	DTC P0117 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage DTC P0118 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage DTC P0119 Engine Coolant Temperature (ECT) Sensor Circuit Intermittent
<u>DTC P0117 or P0118 (LEA)</u>	DTC P0117 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage DTC P0118 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage DTC P0119 Engine Coolant Temperature (ECT) Sensor Circuit Intermittent
<u>DTC P0119</u>	DTC P0119 Engine Coolant Temperature (ECT) Sensor Circuit Intermittent
<u>DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135</u>	DTC P0121 Throttle Position Sensor 1 Performance DTC P0122 Throttle Position Sensor 1 Circuit Low Voltage DTC P0123 Throttle Position Sensor 1 Circuit High Voltage DTC P0222 Throttle Position Sensor 2 Circuit Low Voltage DTC P0223 Throttle Position Sensor 2 Circuit High Voltage DTC P16A0 Sensor Communication Circuit Low Voltage DTC P16A1 Sensor Communication Circuit High Voltage DTC P16A2 Sensor Communication Circuit Performance DTC P2135 Throttle Position Sensors 1-2 Not Plausible

<u>DTC P0128</u>	DTC P0128 Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature
<u>DTC P0131, P0132, P0134, P0137, P0138, P0140, or P2A00</u>	DTC P0131 HO2S Circuit Low Voltage Sensor 1 DTC P0132 HO2S Circuit High Voltage Sensor 1 DTC P0134 HO2S Circuit Insufficient Activity Sensor 1 DTC P0137 HO2S Circuit Low Voltage Sensor 2 DTC P0138 HO2S Circuit High Voltage Sensor 2 DTC P0140 HO2S Circuit Insufficient Activity Sensor 2 DTC P2A00 HO2S Performance Sensor 1
<u>DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271</u>	DTC P0133 HO2S Slow Response Sensor 1 DTC P013A HO2S Slow Response Rich to Lean Sensor 2 DTC P013B HO2S Slow Response Lean to Rich Sensor 2 DTC P013E HO2S Delayed Response Rich to Lean Sensor 2 DTC P013F HO2S Delayed Response Lean to Rich Sensor 2 DTC P015A HO2S Delayed Response Rich to Lean Sensor 1 DTC P015B HO2S Delayed Response Lean to Rich Sensor 1 DTC P2270 HO2S Signal Stuck Lean Sensor 2 DTC P2271 HO2S Signal Stuck Rich Sensor 2
<u>DTC P0171 or P0172</u>	DTC P0171 Fuel Trim System Lean DTC P0172 Fuel Trim System Rich
<u>DTC P018B-P018D (Chassis Control Module)</u>	DTC P018B Fuel Pressure Sensor Performance DTC P018C Fuel Pressure Sensor Circuit Low Voltage DTC P018D Fuel Pressure Sensor Circuit High Voltage
<u>DTC P018B-P018D (Fuel Pump Power Control Module)</u>	DTC P018B Fuel Pressure Sensor Performance DTC P018C Fuel Pressure Sensor Circuit Low Voltage DTC P018D Fuel Pressure Sensor Circuit High Voltage
<u>DTC P0191</u>	DTC P0191 Fuel Rail Pressure Sensor Performance
<u>DTC P0192 or P0193</u>	DTC P0192 Fuel Rail Pressure Sensor Circuit Low Voltage DTC P0193 Fuel Rail Pressure Sensor Circuit High Voltage
<u>DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157</u>	DTC P0201 Cylinder 1 Injector Control Circuit DTC P0202 Cylinder 2 Injector Control Circuit DTC P0203 Cylinder 3 Injector Control Circuit DTC P0204 Cylinder 4 Injector Control Circuit DTC P0261 Cylinder 1 Injector Control Circuit Low Voltage DTC P0262 Cylinder 1 Injector Control Circuit High Voltage DTC P0264 Cylinder 2 Injector Control Circuit Low Voltage DTC P0265 Cylinder 2 Injector Control Circuit High Voltage DTC P0267 Cylinder 3 Injector Control Circuit Low Voltage DTC P0268 Cylinder 3 Injector Control Circuit High Voltage DTC P0270 Cylinder 4 Injector Control Circuit Low Voltage DTC P0271 Cylinder 4 Injector Control Circuit High Voltage DTC P1248 Cylinder 1 Injector High Control Circuit Shorted to Control Circuit DTC P1249 Cylinder 2 Injector High Control Circuit Shorted to Control Circuit DTC P124A Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

	DTC P124B Cylinder 4 Injector High Control Circuit Shorted to Control Circuit DTC P2147 Cylinder 1 Injector High Control Circuit Low Voltage DTC P2148 Cylinder 1 Injector High Control Circuit High Voltage DTC P2150 Cylinder 2 Injector High Control Circuit Low Voltage DTC P2151 Cylinder 2 Injector High Control Circuit High Voltage DTC P2153 Cylinder 3 Injector High Control Circuit Low Voltage DTC P2154 Cylinder 3 Injector High Control Circuit High Voltage DTC P2156 Cylinder 4 Injector High Control Circuit Low Voltage DTC P2157 Cylinder 4 Injector High Control Circuit High Voltage
<u>DTC P0231, P0232, or P023F (Chassis Control Module)</u>	DTC P0231 Fuel Pump Control Circuit Low Voltage DTC P0232 Fuel Pump Control Circuit High Voltage DTC P023F Fuel Pump Control Circuit
<u>DTC P0231, P0232, or P023F (Fuel Pump Power Control Module)</u>	DTC P0231 Fuel Pump Control Circuit Low Voltage DTC P0232 Fuel Pump Control Circuit High Voltage DTC P023F Fuel Pump Control Circuit
<u>DTC P025A (Chassis Control Module)</u>	DTC P025A Fuel Pump Control Module Enable Circuit
<u>DTC P0300-P0304</u>	DTC P0300 Engine Misfire Detected DTC P0301 Cylinder 1 Misfire Detected DTC P0302 Cylinder 2 Misfire Detected DTC P0303 Cylinder 3 Misfire Detected DTC P0304 Cylinder 4 Misfire Detected
<u>DTC P0315</u>	DTC P0315 Crankshaft Position System Variation Not Learned
<u>DTC P0324, P0326, or P06B6</u>	DTC P0324 Knock Sensor System Performance DTC P0326 Knock Sensor Performance DTC P06B6 Control Module Knock Sensor Processor Performance
<u>DTC P0325, P0327, or P0328</u>	DTC P0325 Knock Sensor Circuit DTC P0327 Knock Sensor Circuit Low Voltage DTC P0328 Knock Sensor Circuit High Voltage
<u>DTC P0335 or P0336</u>	DTC P0335 Crankshaft Position Sensor Circuit DTC P0336 Crankshaft Position Sensor Performance
<u>DTC P0340, P0341, P0365, or P0366</u>	DTC P0340 Intake Camshaft Position Sensor Circuit DTC P0341 Intake Camshaft Position Sensor Performance DTC P0365 Exhaust Camshaft Position Sensor Circuit DTC P0366 Exhaust Camshaft Position Sensor Performance
<u>DTC P0351-P0354, P2300, P2301, P2303, P2304, P2306, P2307, P2309, or P2310</u>	DTC P0351 Ignition Coil 1 Control Circuit DTC P0352 Ignition Coil 2 Control Circuit DTC P0353 Ignition Coil 3 Control Circuit DTC P0354 Ignition Coil 4 Control Circuit DTC P2300 Ignition Coil 1 Control Circuit Low Voltage DTC P2301 Ignition Coil 1 Control Circuit High Voltage DTC P2303 Ignition Coil 2 Control Circuit Low Voltage DTC P2304 Ignition Coil 2 Control Circuit High Voltage DTC P2306 Ignition Coil 3 Control Circuit Low Voltage DTC P2307 Ignition Coil 3 Control Circuit High Voltage

	DTC P2309 Ignition Coil 4 Control Circuit Low Voltage DTC P2310 Ignition Coil 4 Control Circuit High Voltage
<u>DTC P0411</u>	DTC P0411 Secondary Air Injection System Incorrect Air Flow Detected
<u>DTC P0412, P041F, or P044F</u>	DTC P0412 Secondary Air Injection Valve Control Circuit DTC P041F Secondary Air Injection Valve Control Circuit Low Voltage DTC P044F Secondary Air Injection Valve Control Circuit High Voltage
<u>DTC P0418, P2257, or P2258</u>	DTC P0418 Secondary Air Injection Pump Relay Control Circuit DTC P2257 Secondary Air Pump Relay Control Circuit Low Voltage DTC P2258 Secondary Air Injection Pump Relay Circuit High Voltage
<u>DTC P0420 (LUK)</u>	DTC P0420 Catalyst System Low Efficiency
<u>DTC P0420 (LEA)</u>	DTC P0420 Catalyst System Low Efficiency
<u>DTC P0442</u>	DTC P0442 Evaporative Emission (EVAP) System Small Leak Detected
<u>DTC P0443, P0458, or P0459</u>	DTC P0443 Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit DTC P0458 Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit Low Voltage DTC P0459 Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit High Voltage
<u>DTC P0446</u>	DTC P0446 Evaporative Emission (EVAP) Vent System Performance
<u>DTC P0449, P0498, or P0499</u>	DTC P0449 Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit DTC P0498 Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit Low Voltage DTC P0499 Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit High Voltage
<u>DTC P0451-P0454</u>	DTC P0451 Fuel Tank Pressure Sensor Performance DTC P0452 Fuel Tank Pressure Sensor Circuit Low Voltage DTC P0453 Fuel Tank Pressure Sensor Circuit High Voltage DTC P0454 Fuel Tank Pressure Sensor Circuit Intermittent
<u>DTC P0455</u>	DTC P0455 Evaporative Emission (EVAP) System Large Leak Detected
<u>DTC P0496</u>	DTC P0496 Evaporative Emission (EVAP) System Flow During Non-Purge
<u>DTC P0506 or P0507</u>	DTC P0506 Idle Speed Low DTC P0507 Idle Speed High
<u>DTC P050D</u>	DTC P050D Cold Start Rough Idle
<u>DTC P057B-P057D</u>	DTC P057B Brake Pedal Position Sensor Performance DTC P057C Brake Pedal Position Sensor Circuit Low Voltage DTC P057D Brake Pedal Position Sensor Circuit High Voltage
<u>DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)</u>	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P0606 Control Module Processor Performance DTC P062B Control Module Fuel Injector Control Performance DTC P062F Control Module Long Term Memory Performance

	DTC P0630 VIN Not Programmed or Mismatched - Engine Control Module (ECM) DTC P16F3 Control Module Redundant Memory Performance DTC P262B Control Module Power Off Timer Performance
<u>DTC P0601-P0606, P060A, P062F, or P262B (Chassis Control Module)</u>	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P0606 Control Module Processor Performance DTC P062F Control Module Long Term Memory Performance
<u>DTC P0628 (LEA)</u>	DTC P0628 Fuel Pump Enable Circuit Low Voltage
<u>DTC P0628 (LUK)</u>	DTC P0628 Fuel Pump Enable Circuit Low Voltage
<u>DTC P0641, P0651, P0697, or P06A3 (ECM)</u>	DTC P0641 5V Reference 1 Circuit DTC P0651 5V Reference 2 Circuit DTC P0697 5V Reference 3 Circuit DTC P06A3 5V Reference 4 Circuit
<u>DTC P0641 or P06A6 (Chassis Control Module)</u>	DTC P0641 5 V Reference Circuit DTC P06A6 5 V Reference 1 Performance
<u>DTC P0650, P263A, or P263B</u>	DTC P0650 Malfunction Indicator Lamp (MIL) Control Circuit DTC P263A Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage DTC P263B Malfunction Indicator Lamp (MIL) Control Circuit High Voltage
<u>DTC P0685-P0687, P0689, P0690, or P1682</u>	DTC P0685 Engine Controls Ignition Relay Control Circuit DTC P0686 Engine Controls Ignition Relay Control Circuit Low Voltage DTC P0687 Engine Controls Ignition Relay Control Circuit High Voltage DTC P0689 Engine Controls Ignition Relay Feedback Circuit Low Voltage DTC P0690 Engine Controls Ignition Relay Feedback Circuit High Voltage DTC P1682 Ignition 1 Switch Circuit 2
<u>DTC P069E</u>	DTC P069E Fuel Pump Control Module Requested MIL Illumination
<u>DTC P0700</u>	DTC P0700 Transmission Control Module Requested MIL Illumination
<u>DTC P0AC4</u>	DTC P0AC4 Hybrid/EV Powertrain Control Module Requested MIL Illumination
<u>DTC P11C2-P11C4 (With LEA)</u>	DTC P11C2 Intake Air Humidity Sensor Circuit Low Voltage DTC P11C3 Intake Air Humidity Sensor Circuit High Voltage DTC P11C4 Intake Air Humidity Sensor Circuit Erratic
<u>DTC P1255 (Fuel Pump Power Control Module)</u>	DTC P1255 Fuel Pump Control Module Driver Over Temperature
<u>DTC P1255 or P064A (Chassis Control Module)</u>	DTC P064A Fuel Pump Control Module Performance DTC P1255 Fuel Pump Control Module Driver High Temperature
<u>DTC P129B or P129C (Fuel Pump Power Control Module)</u>	DTC P129B Fuel Pump Driver Control Module System Voltage Low Voltage DTC P129C Fuel Pump Driver Control Module System Voltage High Voltage
<u>DTC P129D (Fuel Pump</u>	DTC P129D Fuel Pump Driver Control Module Ignition On/Start Switch

<u>Power Control Module)</u>	Circuit Low Voltage
<u>DTC P12A6 (Fuel Pump Power Control Module)</u>	DTC P12A6 Fuel Pump Driver Control Module Enable Circuit Performance
<u>DTC P129E</u>	DTC P129E Fuel Pump Driver Control Module Signal Message Counter Incorrect
<u>DTC P12A8</u>	DTC P12A8 Fuel Pump Control Signal Message Counter Incorrect
<u>DTC P135A</u>	DTC P135A Ignition Coil Supply Voltage Circuit Bank 1
<u>DTC P1400</u>	DTC P1400 Cold Start Emission Reduction Control System
<u>DTC P150C</u>	DTC P150C Transmission Control Module Engine Speed Request Signal Message Counter Incorrect
<u>DTC P1516, P2101, P2119, or P2176</u>	DTC P1516 Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance DTC P2101 Throttle Actuator Position Performance DTC P2119 Throttle Closed Position Performance DTC P2176 Minimum Throttle Position Not Learned
<u>DTC P15F2</u>	DTC P15F2 Engine Torque Command Signal Message Counter Incorrect
<u>DTC P15F9</u>	DTC P15F9 Hybrid/EV System Engine Speed Control Intervention Request Type Signal Message Counter Incorrect
<u>DTC P15FB</u>	DTC P15FB Brake Pedal Position Sensor Signal Message Counter Incorrect
<u>DTC P163A</u>	DTC P163A Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance
<u>DTC P2096</u>	DTC P2096 Post Catalyst Fuel Trim System Low Limit Bank 1
<u>DTC P2097</u>	DTC P2097 Post Catalyst Fuel Trim System High Limit Bank 1
<u>DTC P2122, P2123, P2127, P2128, or P2138</u>	DTC P2122 Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage DTC P2123 Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage DTC P2127 Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage DTC P2128 Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage DTC P2138 Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible
<u>DTC P2199 (With LEA)</u>	DTC P2199 Intake Air Temperature (IAT) Sensor 1-2 Correlation
<u>DTC P219A</u>	DTC P219A Fuel Trim Cylinder Balance
<u>DTC P2227-P2230</u>	DTC P2227 Barometric Pressure (BARO) Sensor Performance DTC P2228 Barometric Pressure (BARO) Sensor Circuit Low Voltage DTC P2229 Barometric Pressure (BARO) Sensor Circuit High Voltage DTC P2230 Barometric Pressure (BARO) Sensor Circuit Erratic
<u>DTC P2430, P2431, P2435, or P2436</u>	DTC P2430 Secondary Air Injection System Pressure Sensor Circuit - Bank 1 (Left Hand) DTC P2431 Secondary Air Injection System Pressure Sensor Performance - Bank 1 (Left Hand) DTC P2435 Secondary Air Injection System Pressure Sensor Circuit Bank 2 - (Right Hand) DTC P2436 Secondary Air Injection System Pressure Sensor Performance

	Bank 2 - (Right Hand)
<u>DTC P2432, P2433, P2437, or P2438</u>	DTC P2432 Secondary Air Injection System Pressure Sensor Circuit Low Voltage - Bank 1 (Left Hand) DTC P2433 Secondary Air Injection System Pressure Sensor Circuit High Voltage - Bank 1 (Left Hand) DTC P2437 Secondary Air Injection System Pressure Sensor Circuit Low Voltage Bank 2 - (Right Hand) DTC P2438 Secondary Air Injection System Pressure Sensor Circuit High Voltage Bank 2 - (Right Hand)
<u>DTC P2440</u>	DTC P2440 Secondary Air Injection System Cut-Off Valve Stuck Open
<u>DTC P2444</u>	DTC P2444 Secondary Air Injection System Pump Stuck On
<u>DTC P2534 or P2535 (Chassis Control Module)</u>	DTC P2534 Ignition On/Start Switch Circuit Low Voltage DTC P2535 Ignition On/Start Switch Circuit High Voltage
<u>DTC P2544</u>	DTC P2544 Transmission Torque Request Signal Message Counter Incorrect
<u>DTC P2635 (Chassis Control Module)</u>	DTC P2635 Fuel Pump Flow Performance
<u>DTC P2635 (Fuel Pump Power Control Module)</u>	DTC P2635 Fuel Pump Flow Performance

ENGINE COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

ENGINE COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC P0480, P0481, P0691, P0692, P0693, or P0694</u>	Cooling Fan Relay

FIXED AND MOVEABLE WINDOWS - DIAGNOSTIC TROUBLE CODES

FIXED AND MOVEABLE WINDOWS - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B0283</u>	Rear Defrost Circuit
<u>DTC B316B, B317A, B318A, or B319A</u>	Rear Defrost Circuit
<u>DTC B3205 or B3210</u>	Window Motor

HORN SYSTEM - DIAGNOSTIC TROUBLE CODES

HORN SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B2750</u>	Horn Relay Secondary Circuit

HVAC SYSTEM - AUTOMATIC - DIAGNOSTIC TROUBLE CODES

HVAC SYSTEM - AUTOMATIC - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B0163</u>	Passenger Compartment Temperature Sensor
<u>DTC B0173, B0178, B0509, B0514 or B3933</u>	Duct Air Temperature Sensor/Evaporator Temperature Sensor
<u>DTC B0183</u>	Solar Load Sensor
<u>DTC B0193</u>	Front Blower Motor
<u>DTC B0223, B022A, B0233, B023A, B0408, or B0418</u>	Recirculate Position/Air Flow Control/HVAC Actuators/Temperature Control
<u>DTC B269A, B269C, or B269D</u>	Heater Coolant Pump
<u>DTC B393B</u>	Air Conditioning Compressor Valve
<u>DTC P0532 or P0533</u>	Air Conditioning (A/C) Refrigerant Pressure Sensor
<u>DTC P0645, P0646, or P0647</u>	Air Conditioning (A/C) Compressor Clutch Relay

HYBRID/EV CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

HYBRID/EV CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC P057B-P057E</u>	Brake Pedal Position Sensor
<u>DTC P0601-P0604, P0606, P061B, P062F, or P262B (Hybrid Powertrain Control Module)</u>	Control Module Memory
<u>DTC P0697</u>	5V Reference 3 Circuit
<u>DTC P06AF</u>	Torque Management System Performance - Forced Engine Shutdown
<u>DTC P06B1 or P06B2</u>	Sensor Supply Positive Voltage
<u>DTC P0A1B, P1A50, P1A51, P1ADC, or P1EB6</u>	Drive Motor Control Module Memory
<u>DTC P0A2B-P0A2D</u>	Drive Motor Temperature Sensor
<u>DTC P0A2F</u>	Drive Motor High Temperature
<u>DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, or P1B03</u>	Drive Motor Position Sensor
<u>DTC P0A78</u>	Drive Motor Inverter Performance
<u>DTC P0A88 or P0A89</u>	Power Module Input Current Sensor: 14V Power Module Input Current Sensor
<u>DTC P0A8D or P0A8E</u>	14V Power Module System Voltage
<u>DTC P0A8F</u>	14V Power Module System Voltage Performance
<u>DTC P0A90</u>	Drive Motor Performance
<u>DTC P0AB9</u>	Hybrid/EV System Performance
<u>DTC P0AEE, P0AEF, or P0AF0</u>	Drive Motor Inverter Temperature Sensor
<u>DTC P0B09</u>	Auxiliary Transmission Fluid Pump Supply Voltage Relay Control Circuit
<u>DTC P0BE6-P0BE8, P0BEE, P0BEF, or P0BF0</u>	Drive Motor Phase U/W Current Sensor
<u>DTC P0BFD</u>	Drive Motor Phase U-V-W Not Plausible

<u>DTC P0C01</u>	Drive Motor High Current
<u>DTC P0C05</u>	Drive Motor Phase U-V-W Circuits
<u>DTC P0C0B</u>	Drive Motor Inverter Supply Voltage Circuit
<u>DTC P0C11</u>	Drive Motor Inverter Phase U High Temperature
<u>DTC P0C19</u>	Drive Motor Torque Delivered Performance
<u>DTC P0C76</u>	Hybrid/EV Battery System High Voltage Present
<u>DTC P0C9E or P0C9F</u>	Power Module Output Current Sensor
<u>DTC P0CA2</u>	14V Power Module Step Down Voltage Performance
<u>DTC P0CC5</u>	14V Power Module Input-Output Current Sensors Not Plausible
<u>DTC P15F0</u>	Engine Torque Delivered Signal Message Counter Incorrect
<u>DTC P15F4</u>	Drive Motor Torque Delivered Signal Message Counter Incorrect
<u>DTC P15F5</u>	Crankshaft Torque Command Signal Message Counter Incorrect
<u>DTC P16F3</u>	Control Module Redundant Memory Performance
<u>DTC P1A56</u>	Hybrid/EV System Voltage Discharge Circuit
<u>DTC P1A6F</u>	Drive Motor No Crank at Restart
<u>DTC P1A71-P1A73</u>	Power Module Temperature Sensor 2
<u>DTC P1A90-P1A92</u>	Power Module Temperature Sensor 1
<u>DTC P1ADE or P1ADF</u>	Drive Motor Control Module System Voltage
<u>DTC P1AE8 or P1AE9</u>	Drive Motor Control Module Hybrid/EV Battery Voltage
<u>DTC P1AEC or P1AEE</u>	Drive Motor Control Module Hybrid/EV Battery System Voltage
<u>DTC P1AF0</u>	Drive Motor Control Module Hybrid/EV Battery Voltage System Isolation Lost
<u>DTC P1AF4 or P1AF5</u>	Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1
<u>DTC P1B0B or P1B0C</u>	Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2
<u>DTC P1B0D</u>	Drive Motor Control Module Drive Motor Overspeed
<u>DTC P1B41</u>	Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Performance
<u>DTC P1E0A</u>	Drive Motor Control Module Torque Calculation Performance
<u>DTC P1E3B</u>	Drive Motor Rotor High Temperature
<u>DTC P1E3C</u>	Drive Motor Rotor High Temperature
<u>DTC P2534 or P2535</u>	Ignition On/Start Switch
<u>DTC P2537</u>	Ignition Accessory Switch Circuit Low Voltage

DTC P2797

Auxiliary Transmission Fluid Pump Performance

HYBRID/EV COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

HYBRID/EV COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC P0AAD-P0AAF</u>	Hybrid/EV Battery Pack Air Temperature Sensor
<u>DTC P0A7E</u>	Hybrid/EV Battery Pack High Temperature
<u>DTC P0A81-P0A85, P0BC8-P0BCA, or P0D64-P0D66</u>	Drive Motor Battery Cooling Blower Malfunction
<u>DTC P0A9C-P0A9E, P0AC6-P0AC8, P0ACB-P0ACD, P0AE9-P0AEB, P0BC3-P0BC5, or P0C34-P0C36</u>	Hybrid/EV Battery Temperature Sensor 1-6
<u>DTC P0C32</u>	Hybrid/EV Battery Pack Cooling System Performance
<u>DTC P0CC1-P0CC4</u>	Generator Control Module Coolant Pump Malfunction
<u>DTC P0CBD-P0CBF</u>	Drive Motor Coolant Temperature Sensor

HYBRID/EV ENERGY STORAGE SYSTEM - DIAGNOSTIC TROUBLE CODES

HYBRID/EV ENERGY STORAGE SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC P0641</u>	5V Reference 1 Circuit
<u>DTC P0651, P0A0C, or P0A0D</u>	5V Reference 2 Circuit/High Voltage System Interlock Circuit 1 Voltage
<u>DTC P0A1F, P1A01, P1A05, P1A06, or P1A5C</u>	Battery Energy Control Module
<u>DTC P0A80</u>	Replace Hybrid/EV Battery Pack
<u>DTC P0AA6</u>	Hybrid/EV Battery Voltage System Isolation Lost
<u>DTC P0AA8-P0AAA</u>	Hybrid/EV Battery Voltage Isolation Sensing
<u>DTC P0ABB, P0ABC, or P0ABD</u>	Hybrid/EV Battery Voltage Sensor
<u>DTC P0AC1, P0AC2, P1A07, or P1EBA</u>	Hybrid/EV Battery Current Sensor
<u>DTC P0ADB or P0ADC</u>	Hybrid/EV Battery Positive Contactor Control Circuit Voltage
<u>DTC P0AE6 or P0AE7</u>	Hybrid/EV Battery Precharge Contactor Control Circuit Voltage
<u>DTC P0AF8</u>	Hybrid/EV System Voltage
<u>DTC P0AFA or P0AFB</u>	Hybrid/EV Battery System Voltage
<u>DTC P0B3B-P0BBB, P1B16-P1B2D, P1B3D, or P1B3E</u>	Hybrid/EV Battery 1-32
<u>DTC P0BBE</u>	Hybrid/EV Battery Pack Voltage
<u>DTC P0C77 or P0C78</u>	Hybrid/EV Battery System Precharge Time
<u>DTC P1A0C</u>	Battery Energy Control Module System Voltage

	Low Voltage
<u>DTC P1A5D</u>	Battery Energy Control Module 5V Reference 2 Circuit
<u>DTC P1A5E or P1A5F</u>	Battery Energy Control Module Ignition On/Start Switch
<u>DTC P1A60</u>	Battery Energy Control Module Ignition Accessory Switch Circuit Low Voltage
<u>DTC P1B11</u>	Drive Motor Control Module Hybrid/EV AC Voltage System Isolation Lost
<u>DTC P1B33-P1B39</u>	Battery Energy Control Module Hybrid/EV Battery Voltage Balance
<u>DTC P1B3F or P1B40</u>	High Voltage System Interlock Circuit 2
<u>DTC P1E0C or P1E0D</u>	Hybrid/EV Battery Voltage Isolation Sensing Circuit 2
<u>DTC P1E0F-P1E11</u>	Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1
<u>DTC P1E12-P1E14</u>	Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2
<u>DTC P1E3D</u>	Control Module Calculated Hybrid/EV Battery Performance
<u>DTC P1EAA</u>	Hybrid/EV Battery Voltage Balance Processor Multiplexer Performance
<u>DTC P1EAB</u>	Battery Energy Control Module Hybrid/EV Battery Cell High Voltage
<u>DTC P1EAC</u>	Hybrid/EV Battery Cell Overvoltage Signal Circuit Performance
<u>DTC P1EC0</u>	Hybrid/EV Battery System Contactor(s) Stuck Open

HYDRAULIC BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

HYDRAULIC BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC C0267</u>	Low Brake Fluid Indicated
<u>DTC C0273</u>	Brake Fluid Level Switch Circuit
<u>DTC C027B</u>	Brake Booster Electric Vacuum Pump
<u>DTC C0299</u>	Brake Booster Large Vacuum Leak Detected Too Many Transitions
<u>DTC C025E</u>	Brake Booster Vacuum Sensor Circuit

IMMOBILIZER SYSTEM - DIAGNOSTIC TROUBLE CODES

IMMOBILIZER SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description

<u>DTC B2955 (with BTM)</u>	Security Sensor Data Circuit
<u>DTC B2955 (without BTM)</u>	Security Sensor Data Circuit
<u>DTC B302A</u>	Mobile Telephone Communications Interface Requested Immobilization
<u>DTC B3031</u>	Security Controller In Learn Mode
<u>DTC B3055</u>	No Transponder Modulation or No Transponder
<u>DTC B305C</u>	Immobilizer Transponder of Wrong Type Programmed
<u>DTC B3060</u>	Unprogrammed Transponder Identification Code Received
<u>DTC B389A</u>	Environment Identification
<u>DTC B3902</u>	Incorrect Immobilizer Identifier Received
<u>DTC B3935</u>	Transponder Authentication
<u>DTC B3976</u>	Unconfigured Transponder
<u>DTC B3984</u>	Device 1 Environment Identifier Not Programmable
<u>DTC P0513</u>	Immobilizer Key Incorrect
<u>DTC P0633</u>	Immobilizer Key Not Programmed
<u>DTC P162B</u>	Remote Vehicle Speed Limiting Signal Message Counter Incorrect
<u>DTC P1631</u>	Immobilizer Fuel Enable Signal Not Correct
<u>DTC P1649</u>	Immobilizer Security Code Not Programmed

INSTRUMENT PANEL SYSTEM DISPLAYS AND GAUGES - DIAGNOSTIC TROUBLE CODES

INSTRUMENT PANEL SYSTEM DISPLAYS AND GAUGES - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B0158</u>	Ambient Air Temperature Sensor
<u>DTC B0550</u>	Odometer Circuit General Memory Malfunction
<u>DTC B071F</u>	Transmission Range Indicator Internal Malfunction
<u>DTC B0931</u>	Compass Circuit Internal Malfunction
<u>DTC B097D</u>	Transmission Sport Mode Indicator Circuit Short to Battery
<u>DTC B097F</u>	Transmission Tow Mode Indicator Circuit Short to Battery
<u>DTC B124F</u>	Universal Serial Bus (USB) Programming
<u>DTC B3567</u>	Info Display Select Switch
<u>DTC P0461-P0464, P2066, P2067, or P2068</u>	Fuel Level Sensor
<u>DTC P0520</u>	Engine Oil Pressure Switch Circuit (LEA, LTG, LUK)
<u>DTC P0521, P0522, or P0523</u>	Engine Oil Pressure Sensor

KEYLESS ENTRY SYSTEM AND REMOTE FUNCTIONS - DIAGNOSTIC TROUBLE CODES

KEYLESS ENTRY SYSTEM AND REMOTE FUNCTIONS - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B3101</u>	Keyless Entry Data Link Circuit
<u>DTC B3105</u>	Keyless Entry Transmitters
<u>DTC B3106</u>	Keyless Entry Data Link
<u>DTC B3109-B3113</u>	Keyless Entry Transmitter 1-5 Battery
<u>DTC B310D-B310F</u>	Keyless Entry Transmitter 6-8 Battery
<u>DTC B3119</u>	Keyless Entry Antenna 1
<u>DTC B3120</u>	Keyless Entry Antenna 2
<u>DTC B3121</u>	Keyless Entry Antenna 3
<u>DTC B3122</u>	Keyless Entry Antenna 4
<u>DTC B3123</u>	Keyless Entry Antenna 5
<u>DTC B3124</u>	Keyless Entry Antenna 6

LIGHTING SYSTEM - DIAGNOSTIC TROUBLE CODES

LIGHTING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B096A</u>	DTC B096A 01 Hazard Lamps Switch Backlighting Circuit Short to Battery DTC B096A 02 Hazard Lamps Switch Backlighting Circuit Short to Ground DTC B096A 04 Hazard Lamps Switch Backlighting Circuit Open
<u>DTC B1405, B1529, or B257B</u>	DTC B1405 02 Control Module Voltage Reference Output 2 Circuit Short to Ground DTC B1405 03 Control Module Voltage Reference Output 2 Circuit Low Voltage DTC B1405 07 Control Module Voltage Reference Output 2 Circuit High Voltage DTC B1529 03 Control Module Voltage Reference Output 5 Circuit Low Voltage DTC B1529 07 Control Module Voltage Reference Output 5 Circuit High Voltage DTC B257B 03 Lighting Control Switch Signal Low Voltage DTC B257B 07 Lighting Control Switch Signal High Voltage
<u>DTC B1461 or B1462</u>	DTC B1461 00 Left Headlamp Horizontal Motor Circuit Malfunction DTC B1462 00 Right Headlamp Horizontal Motor Circuit Malfunction
<u>DTC B1480</u>	DTC B1480 02 Battery Rundown Protection Circuit Short to Ground
<u>DTC B2530</u>	DTC B2530 01 Front Fog Lamps Control Circuit Short to Battery DTC B2530 02 Front Fog Lamps Control Circuit Short to Ground DTC B2530 04 Front Fog Lamps Control Circuit Open
<u>DTC B2545</u>	DTC B2545 01 Backup Lamps Circuit Short to Battery DTC B2545 02 Backup Lamps Circuit Short to Ground

	DTC B2545 04 Backup Lamps Circuit Open
<u>DTC B255D</u>	DTC B255D 02 Passenger Compartment Lamp Control 2 Circuit Short to Ground
<u>DTC B2570</u>	DTC B2570 02 Trunk Lamp Control Circuit Short to Ground
<u>DTC B2575 or B2699</u>	DTC B2575 01 Headlamps Control Circuit Short to Battery DTC B2575 02 Headlamps Control Circuit Short to Ground DTC B2575 04 Headlamps Control Circuit Open DTC B2699 01 Right Headlamp Control Circuit Short to Battery DTC B2699 02 Right Headlamp Control Circuit Short to Ground DTC B2699 04 Right Headlamp Control Circuit Open
<u>DTC B257A</u>	DTC B257A 00 Headlamp Switch Input Signals Correlation Malfunction
<u>DTC B257C or B257D</u>	DTC B257C 00 Left Headlamp Assembly Malfunction DTC B257D 00 Right Headlamp Assembly Malfunction
<u>DTC B2580</u>	DTC B2580 01 Headlamp High Beam Control Circuit Short to Battery DTC B2580 02 Headlamp High Beam Control Circuit Short to Ground DTC B2580 04 Headlamp High Beam Control Circuit Open
<u>DTC B2585 or B3867</u>	DTC B2585 01 Left Park Lamps Control Circuit Short to Battery DTC B2585 02 Left Park Lamps Control Circuit Short to Ground DTC B2585 04 Left Park Lamps Control Circuit Open DTC B3867 01 Right Park Lamps Control Circuit Short to Battery DTC B3867 02 Right Park Lamps Control Circuit Short to Ground DTC B3867 04 Right Park Lamps Control Circuit Open
<u>DTC B258A</u>	DTC B258A 01 Low Beam Control Circuit Short to Battery DTC B258A 02 Low Beam Control Circuit Short to Ground DTC B258A 04 Low Beam Control Circuit Open
<u>DTC B259A or B259B</u>	DTC B259A 01 Left Cornering Lamp Relay Control Circuit Short to Battery DTC B259B 01 Right Cornering Lamp Relay Control Circuit Short to Battery
<u>DTC B2600 or B2605</u>	DTC B2600 01 Left Daytime Running Lamps Control Circuit short to Battery DTC B2600 02 Left Daytime Running Lamps Control Circuit Short to Ground DTC B2600 04 Left Daytime Running Lamps Control Circuit Open DTC B2605 01 Right Daytime Running Lamps Control Circuit short to Battery DTC B2605 02 Right Daytime Running Lamps Control Circuit Short to Ground DTC B2605 04 Right Daytime Running Lamps Control Circuit Open
<u>DTC B2610</u>	DTC B2610 02 Passenger Compartment Dimming 1 Circuit Short to Ground
<u>DTC B2615</u>	DTC B2615 02 Passenger Compartment Dimming 2 Circuit Short to Ground
<u>DTC B2625</u>	DTC B2625 02 Display Dimming Pulse Width Modulation Output Circuit Short to Ground
<u>DTC B2645</u>	DTC B2645 03 Ambient Light Sensor Circuit Low Voltage DTC B2645 07 Ambient Light Sensor Circuit High Voltage
<u>DTC B3410 or B3420</u>	DTC B3410 01 AHLDFront Axle Sensor Signal Circuit Short to Battery

	DTC B3410 06 AHLD Front Axle Sensor Signal Circuit Low Voltage/Open DTC B3420 01 AHLD Rear Axle Sensor Signal Circuit Short to Battery DTC B3420 06 AHLD Rear Axle Sensor Signal Circuit Low Voltage/Open
<u>DTC B3415</u>	DTC B3415 01 AHLD Front Axle Sensor Supply Circuit Short to Battery DTC B3415 02 AHLD Front Axle Sensor Supply Circuit Short to Ground
<u>DTC B3435 or B3440</u>	DTC B3435 00 AHLD Left Servo Driver Circuit DTC B3435 03 AHLD Left Servo Driver Circuit Short to Ground DTC B3440 00 AHLD Right Servo Driver Circuit DTC B3440 03 AHLD Right Servo Driver Circuit Short to Ground
<u>DTC B3596</u>	DTC B3596 00 Hazard Lamps Request Circuit Malfunction
<u>DTC B3650</u>	DTC B3650 08 High Beam Request Signal Circuit Performance - Signal Invalid
<u>DTC B3806</u>	DTC B3806 00 High Beam and Headlamp Flash Select Circuit Malfunction
<u>DTC B3883</u>	DTC B3883 01 License Plate Lamp Circuit Short to Battery DTC B3883 02 License Plate Lamp Circuit Short to Ground DTC B3883 04 License Plate Lamp Circuit Open
<u>DTC B3948 or B3949</u>	DTC B3948 01 Left Front Turn Signal Circuit Short to Battery DTC B3948 02 Left Front Turn Signal Circuit Short to Ground DTC B3948 04 Left Front Turn Signal Circuit Open DTC B3949 01 Right Front Turn Signal Circuit Short to Battery DTC B3949 02 Right Front Turn Signal Circuit Short to Ground DTC B3949 04 Right Front Turn Signal Circuit Open
<u>DTC B3950 or B3951</u>	DTC B3950 01 Left Rear Turn Signal Circuit Short to Battery DTC B3950 02 Left Rear Turn Signal Circuit Short to Ground DTC B3950 04 Left Rear Turn Signal Circuit Open DTC B3951 01 Right Rear Turn Signal Circuit Short to Battery DTC B3951 02 Right Rear Turn Signal Circuit Short to Ground DTC B3951 04 Right Rear Turn Signal Circuit Open
<u>DTC C0010</u>	DTC C0010 5A Reverse Gear Signal Circuit Not Plausible
<u>DTC C0277 or C0890</u>	DTC C0277 06 Brake Pedal Position Sensor Circuit Low Voltage/Open DTC C0277 07 Brake Pedal Position Sensor Circuit High Voltage DTC C0277 09 Brake Pedal Position Sensor Circuit Too Fast Transitions DTC C0277 4B Brake Pedal Position Sensor Circuit Calibration Not Learned DTC C0890 03 Control Module Voltage Reference Output 3 Circuit Low Voltage DTC C0890 07 Control Module Voltage Reference Output 3 Circuit High Voltage
<u>DTC C0297</u>	DTC C0297 02 Brake Applied Output Circuit Short to Ground

MANUAL TRANSMISSION - F40 (MR6) - DIAGNOSTIC TROUBLE CODES

MANUAL TRANSMISSION - F40 (MR6) - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC P0502 or P0503</u>	Vehicle Speed Sensor
<u>DTC P0806-P0808</u>	Clutch Pedal Position (CPP) Sensor

DTC P080A

Clutch Pedal Position (CPP) Not Learned

MIRROR SYSTEM - DIAGNOSTIC TROUBLE CODES

MIRROR SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B154A or B154B</u>	Mirror Internal Malfunction

OBJECT DETECTION SYSTEM - PARK ASSIST SYSTEM - DIAGNOSTIC TROUBLE CODES

OBJECT DETECTION SYSTEM - PARK ASSIST SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B094C</u>	Right Side Object Detection Control Module
<u>DTC B0954, B0955, B0956, or B0957</u>	Parking Assist Front Sensor
<u>DTC B0958, B0959, B0960, or B0961</u>	Parking Assist Rear Sensor
<u>DTC B0967 or B0968</u>	Parking Assist On/Off Switch
<u>DTC B0987</u>	Vehicle Direction Camera Indicator
<u>DTC B1011</u>	System Disabled Information Stored Malfunction
<u>DTC B1015</u>	Vehicle Identification Number Information Malfunction
<u>DTC B1405 (with rear park assist)</u>	Control Module Voltage Reference Output 2
<u>DTC B1405 (with front and rear park assist)</u>	Control Module Voltage Reference Output 2
<u>DTC B356A</u>	Vehicle Direction Warning Switch
<u>DTC P15F6</u>	Front Object Detection Control Module Torque Request Signal Message Counter Incorrect

PARKING BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

PARKING BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC C028A, C028B, or C028F</u>	Park Brake Motor/Park Brake Solenoid Actuator
<u>DTC C027D or C028D</u>	Park Brake Slip/Park Brake Pad
<u>DTC C0293</u>	Park Brake Switch
<u>DTC C0298</u>	Park Brake Unlatch Switch
<u>DTC C0558</u>	Calibration Data
<u>DTC C0561</u>	System Disabled Information Stored Invalid Data
<u>DTC C056D</u>	Electronic Control Unit Hardware
<u>DTC C056E</u>	Electronic Control Unit Software
<u>DTC C0574</u>	Printed Circuit Board Temperature Sensor

POWER DOOR LOCK SYSTEM AND RELEASE SYSTEMS - DIAGNOSTIC

TROUBLE CODES

POWER DOOR LOCK SYSTEM AND RELEASE SYSTEMS - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B1474 or B384</u>	Exterior Door Handle Switch
<u>DTC B1534 or B1535</u>	Rear Door Handle Switch
<u>DTC B2494</u>	Liftgate Handle Switch Circuit Short to Ground
<u>DTC B2730</u>	Interior Trunk Lid Unlatch Switch Circuit Malfunction
<u>DTC B297B or B297C</u>	Door Open Switch
<u>DTC B3125, B3130, or B3135</u>	Driver Door Only Unlock/All Doors lock and Unlock
<u>DTC B3140, B3145, B3150, or B3155</u>	Front Door lock/Unlock Switch
<u>DTC B3265</u>	Trunk Lid Unlatch Output Circuit Short to Ground
<u>DTC B3618</u>	Exterior Liftgate Unlatch Switch Circuit Malfunction
<u>DTC B3930</u>	Exterior Liftgate Unlatch Switch Circuit Malfunction

POWER SEAT SYSTEM - DIAGNOSTIC TROUBLE CODES

POWER SEAT SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820</u>	Driver Seat Switch
<u>DTC B1825, B2355, B2365, or B2375</u>	Driver Seat Position Sensor
<u>DTC B3920</u>	Driver Seat Motors Group 1

POWER STEERING SYSTEM - DIAGNOSTIC TROUBLE CODES

POWER STEERING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC C005B</u>	Power Steering Softstops Learn (NJ1)
<u>DTC C0176</u>	Control Module Temperature Sensor High Temperature (NJ1)
<u>DTC C044A</u>	Steering System Engine Speed Signal Circuit Invalid Data (NJ1)
<u>DTC C0450</u>	Steering Assist Control Actuator (NV7)
<u>DTC C0456 (NJ1)</u>	Steering Assist Control Actuator
<u>DTC C0475 (NJ1)</u>	Electric Steering Motor
<u>DTC C047A (NJ1)</u>	Electric Steering Motor Position Sensor
<u>DTC C0544</u>	Steering Wheel Angle Sensor (NJ1)
<u>DTC C0545</u>	Steering Wheel Torque Sensor (NJ1)
<u>DTC C055C</u>	Steering Gear Performance (NJ1)

<u>DTC C0565</u>	Vehicle Identification Number Not Plausible (NJ1)
<u>DTC C0569</u>	System Configuration Incorrect Component Installed (NJ1)
<u>DTC C0710 (NJ1, NJ2, NV7)</u>	Steering Position Signal Invalid Data

REAR DRIVE AXLE SYSTEM - DIAGNOSTIC TROUBLE CODES

REAR DRIVE AXLE SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC C0393</u>	Rear Differential Clutch Solenoid Valve Control Circuit High Current
<u>DTC C039F</u>	AWD Torque Signal
<u>DTC C0402</u>	Transfer Case Solenoid Valve
<u>DTC C0403</u>	AWD Oil Filter Reverse Valve Stuck Open
<u>DTC C0406</u>	Transfer Case Solenoid Valve Control Circuit High Current
<u>DTC C0407</u>	AWD Oil Pump Motor
<u>DTC C0408</u>	Rear Differential Clutch Solenoid Valve
<u>DTC C0574</u>	Printed Circuit Board Temperature Sensor

SEAT HEATING SYSTEM AND COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

SEAT HEATING SYSTEM AND COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B1925 or B2170</u>	Seat Cushion Heater Sensor (With Memory A45)
<u>DTC B1925 or B2170</u>	Seat Cushion Heater Sensor (Without Memory A45)
<u>DTC B2345</u>	Seat Heater Disable Circuit Low Voltage High/Temperature (With Memory A45)
<u>DTC B2345</u>	Seat Heater Disable Circuit Low Voltage/High Temperature (Without Memory A45)
<u>DTC B2425 or B2430</u>	Seat Cushion Heater (With Memory A45)
<u>DTC B2425 or B2430</u>	Seat Cushion Heater (Without Memory A45)
<u>DTC B242A</u>	Seat Heaters Common Circuit (With Memory A45)
<u>DTC B242A</u>	Seat Heaters Common Circuit (Without Memory A45)

SECONDARY AND CONFIGURABLE CUSTOMER CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

SECONDARY AND CONFIGURABLE CUSTOMER CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

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DTC	Description
<u>DTC B1295</u>	Steering Wheel Controls Group 2 Signal Circuit High Voltage
<u>DTC B1405</u>	Control Module Voltage Reference Output 2
<u>DTC B1529</u>	Control Module Voltage Reference Output 5
<u>DTC B3622</u>	Steering Wheel Controls Signal Circuit High Voltage

SHIFT LOCK CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

SHIFT LOCK CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B270A</u>	Park Lock Solenoid Control Circuit Short to Battery

SUNROOF SYSTEM - DIAGNOSTIC TROUBLE CODES

SUNROOF SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B3664</u>	Sunroof Position Select Switch High Signal Circuit
<u>DTC B3697</u>	Sunroof Actuator Malfunction
<u>DTC B369C</u>	Sunroof Tilt Position Select Switch

SUPPLEMENTAL INFLATABLE RESTRAINT SYSTEM - DIAGNOSTIC TROUBLE CODES

SUPPLEMENTAL INFLATABLE RESTRAINT SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B0012 or B0013</u>	Driver Steering Wheel Air Bag Deployment Loop
<u>DTC B0014, B0021, B0031, or B0038</u>	Seat Side Air Bag Deployment Loop
<u>DTC B0015, B001A, B001B, or B0022</u>	Seat Belt Retractor Pretensioner Deployment Loop
<u>DTC B0016, B0018, B0023, or B0025</u>	Roof Rail Air Bag Deployment Loop
<u>DTC B0019 or B0020</u>	Passenger Instrument Panel Air Bag Deployment Loop
<u>DTC B0052</u>	Deployment Commanded
<u>DTC B0074</u>	Passenger Presence Sensor
<u>DTC B0081</u>	Passenger Presence Module (SDM)
<u>DTC B0081</u>	Passenger Presence Module
<u>DTC B0083 or B0084</u>	Front Impact Sensor
<u>DTC B0085 or B0088</u>	Front Side Impact Sensor
<u>DTC B0086 or B0087</u>	Side Impact Sensor
<u>DTC B067F or B0680</u>	Passenger Air Bag On Indicator
<u>DTC B1001</u>	Option Configuration (Inflatable Restraint Sensing and Diagnostic Module)

<u>DTC B1001</u>	Option Configuration Error (Passenger Presence System)
<u>DTC B1019</u>	System Configuration Error

SUSPENSION CONTROL SYSTEM - SUSPENSION DAMPING - DIAGNOSTIC TROUBLE CODES

SUSPENSION CONTROL SYSTEM - SUSPENSION DAMPING - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC C0000</u>	Vehicle Speed Information Circuit Invalid Data
<u>DTC C0575, C0580, C0585, or C0590</u>	Damper Actuator
<u>DTC C0595, C0600, or C0605</u>	Acceleration Sensor
<u>DTC C0670 or C0675</u>	Acceleration or Position Sensor
<u>DTC C0720</u>	Engine Torque Management Feedback Signal Invalid Data
<u>DTC C0870</u>	Control Module Voltage Reference Output Circuit

TIRE PRESSURE MONITORING SYSTEM - DIAGNOSTIC TROUBLE CODES

TIRE PRESSURE MONITORING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC C0569</u>	System Configuration Malfunction
<u>DTC C0750, C0755, C0760, or C0765</u>	Tire Pressure Sensor
<u>DTC C0775</u>	Tire Pressure Monitoring System Sensors

WIPER SYSTEM AND WASHER SYSTEM - DIAGNOSTIC TROUBLE CODES

WIPER SYSTEM AND WASHER SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B370A</u>	Rain Sensor Internal Malfunction
<u>DTC B3715 or B3875</u>	Windshield Wiper Relay
<u>DTC B3810</u>	Windshield Wiper Relay
<u>DTC B3873</u>	Front Washer Relay

WIRING SYSTEMS AND POWER MANAGEMENT - DIAGNOSTIC TROUBLE CODES

WIRING SYSTEMS AND POWER MANAGEMENT - DIAGNOSTIC TROUBLE CODES

DTC	Description
<u>DTC B097B</u>	DTC B097B Power Mode Start Switch Circuit
<u>DTC B097C</u>	DTC B097C Power Mode Run/Start Indicator Circuit
<u>DTC B1370 (Instrument</u>	DTC B1370 Control Module Ignition On and Start Circuit

<u>Cluster)</u>	
<u>DTC B1370-B1379, B1380-B1389, or B1440-B1443</u>	DTC B1370 Control Module Ignition ON and Start Circuit DTC B1380 Control Module Ignition Accessory Circuit DTC B1441 Control Module Ignition OFF, Run, and Start Circuit
<u>DTC B1445</u>	DTC B1445 Control Module Voltage Output Circuit
<u>DTC B144A</u>	DTC B144A RUN Power Relay Circuit
<u>DTC B144B</u>	DTC B144B Run/Crank Power Relay Circuit
<u>DTC B1451</u>	DTC B1451 Accessory Power Circuit
<u>DTC P2534 or P2535</u>	DTC P2534 Ignition On/Start Switch Circuit Low Voltage DTC P2535 Ignition On/Start Switch Circuit High Voltage
<u>DTC P2537</u>	DTC P2537 Ignition Accessory Switch Circuit Low Voltage

ELECTRICAL

Wiring Systems and Power Management - Electrical Center Identification View

ELECTRICAL CENTER IDENTIFICATION VIEWS

X70A RELAY BLOCK - UNDERHOOD TOP VIEW (LDK)

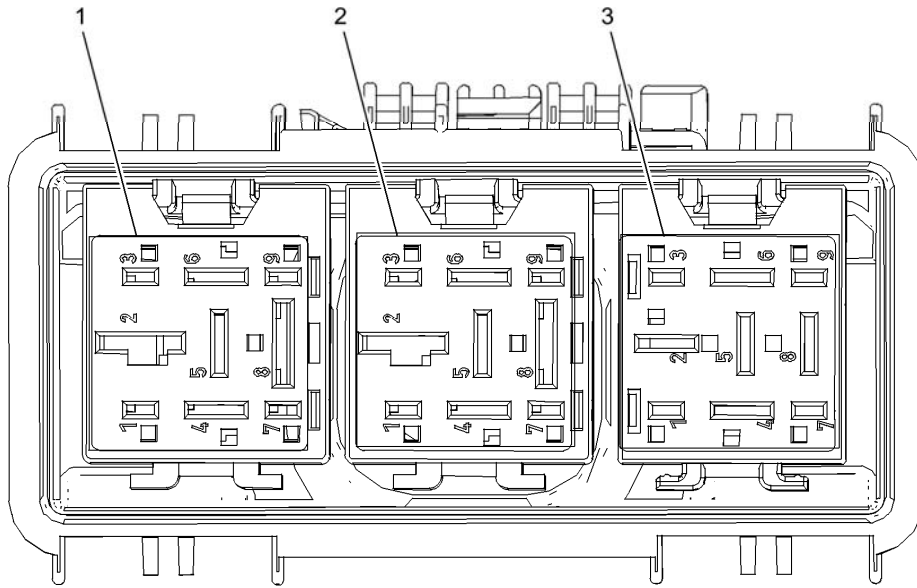


Fig. 1: X70A Relay Block -- Underhood Top View (LDK)
Courtesy of GENERAL MOTORS COMPANY

X70A Relay Block - Underhood Usage

No.	Device Label Name	Device Assigned Name	Rating	Description
1	-	KR20G Cooling Fan Left Low Speed Relay	-	G10L Cooling Fan Motor - Left
2	-	KR20H Cooling Fan Right Low Speed Relay	-	G10R Cooling Fan Motor - Right
3	-	KR20L Cooling Fan Speed Control 2 Relay	-	G10L Cooling Fan Motor - Left, G10R Cooling Fan Motor - Right

KR20G COOLING FAN LEFT LOW SPEED RELAY (LDK)

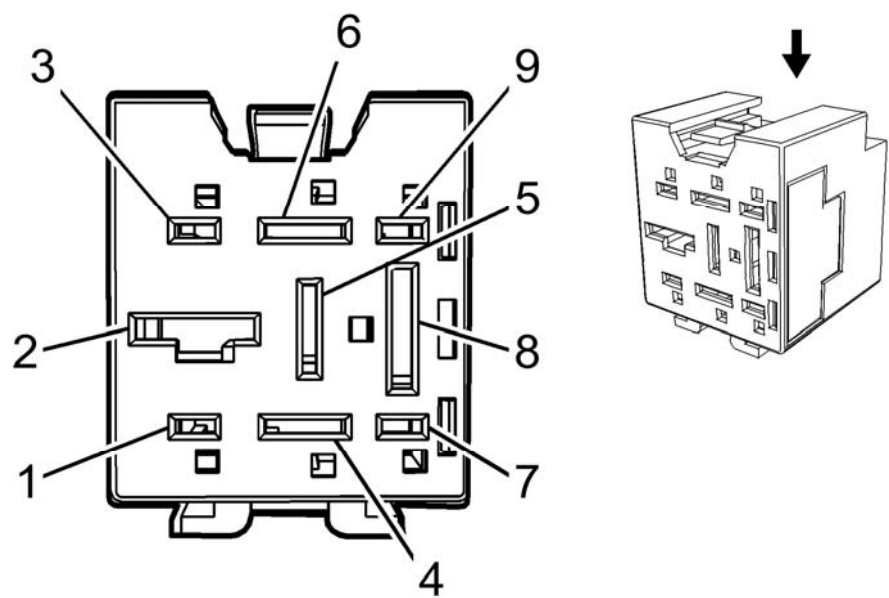


Fig. 2: KR20H Cooling Fan Right Low Speed Relay (LDK)
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information			
<ul style="list-style-type: none">• Harness: Engine Cooling• OEM Connector: 90491221• Service Connector: Service by Harness - See Part Catalog• Description: 9-Way F Metri-Pack 280/630 Series (RD)			
Terminal Part Information			
<ul style="list-style-type: none">• Terminated Lead: Service by Harness -- See Part Catalog• Release Tool: Not Available• Diagnostic Test Probe: Not Available			

KR20G Cooling Fan Left Low Speed Relay (LDK)

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	6 WH/BK	2366	Cooling Fan Control Relay Speed Signal
3	-	-	Not Used
4	0.75 VT/WH	839	Run/Crank Ignition 1 Voltage
5	-	-	Not Used

6	0.75 RD/BU	1042	Battery Positive Voltage
7	-	-	Not Used
8	6 BU/VT	2364	Cooling Fan Speed Signal
9	-	-	Not Used

KR20H COOLING FAN RIGHT LOW SPEED RELAY (LDK)

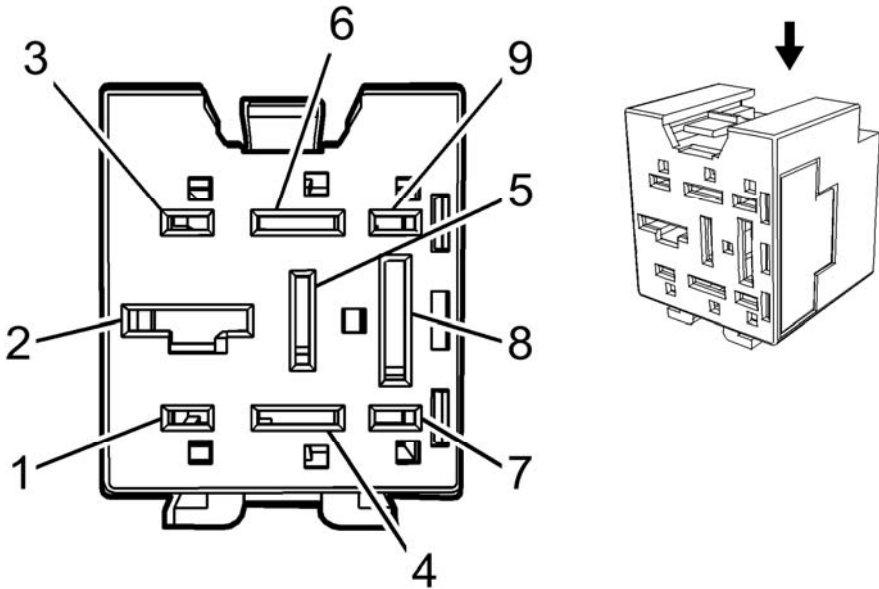


Fig. 3: KR20H Cooling Fan Right Low Speed Relay (LDK)
 Courtesy of GENERAL MOTORS COMPANY

<p>Connector Part Information</p> <ul style="list-style-type: none"> • Harness: Engine Cooling • OEM Connector: 90356384 • Service Connector: Service by Harness - See Part Catalog • Description: 9-Way F Metri-Pack 280/630 Series (BK) <p>Terminal Part Information</p> <ul style="list-style-type: none"> • Terminated Lead: Service by Harness - See Parts Catalog • Release Tool: Not Available • Diagnostic Test Probe: Not Available

KR20H Cooling Fan Right Low Speed Relay (LDK)

Pin	Wire	Circuit	Function
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1	-	-	Not Used
2	6 BN/YE	473	High Speed Cooling Fan Relay Control
3	-	-	Not Used
4	0.75 VT/WH	839	Run/Crank Ignition 1 Voltage
5	-	-	Not Used
6	0.75 RD/BU	1042	Battery Positive Voltage
7	-	-	Not Used
8	6 GN	7625	Cooling Fan Motor Supply Voltage (4)
9	-	-	Not Used

KR20L COOLING FAN SPEED CONTROL 2 RELAY (LDK)

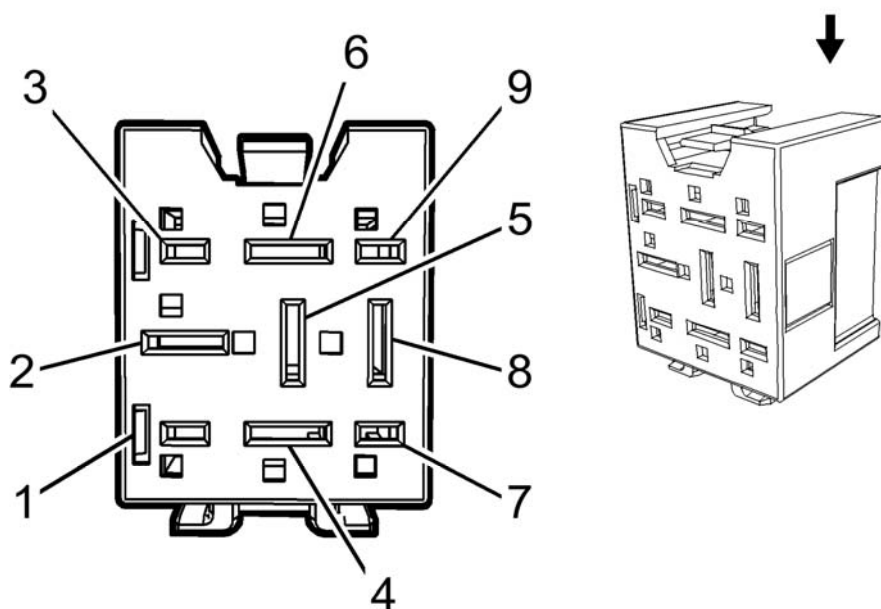


Fig. 4: KR20L Cooling Fan Speed Control 2 Relay (LDK)
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness: Engine Cooling
- OEM Connector: 90491230
- Service Connector: Service by Harness - See Part Catalog
- Description: 9-Way F Metri-Pack 280/630 Series (BN)

Terminal Part Information

- Terminated Lead: Service by Harness - See Parts Catalog

- Release Tool: Not Available
- Diagnostic Test Probe: Not Available

KR20L Cooling Fan Speed Control 2 Relay (LDK)

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	6 BK/GN	504	Cooling Fan Motor Low Reference
3	-	-	Not Used
4	0.75 VT/WH	839	Run/Crank Ignition 1 Voltage
5	6 BU/VT	2364	Cooling Fan Speed Signal
6	0.75 RD/BU	1042	Battery Positive Voltage
7	-	-	Not Used
8	6 BK	1250	Ground
9	-	-	Not Used

X70A RELAY BLOCK - UNDERHOOD TOP VIEW (LHU)

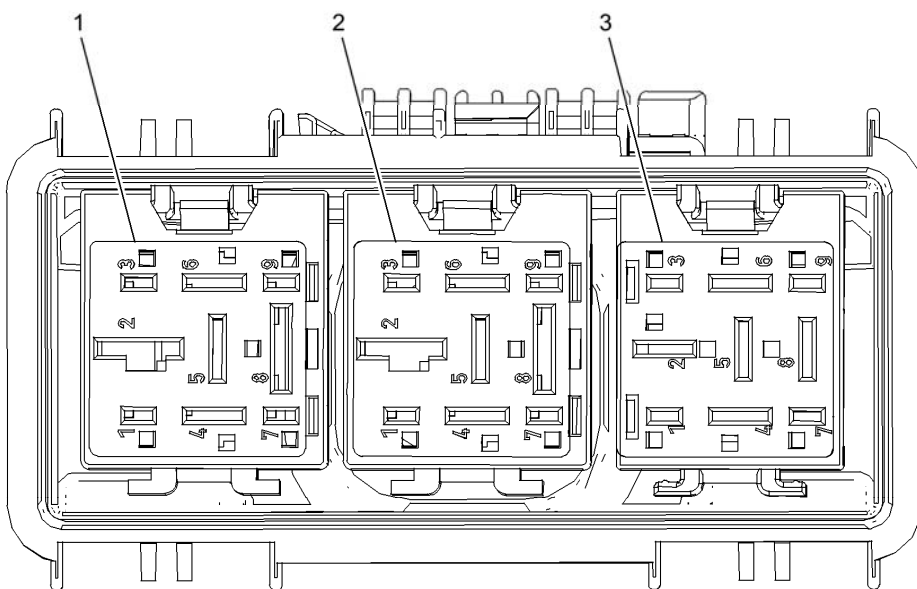


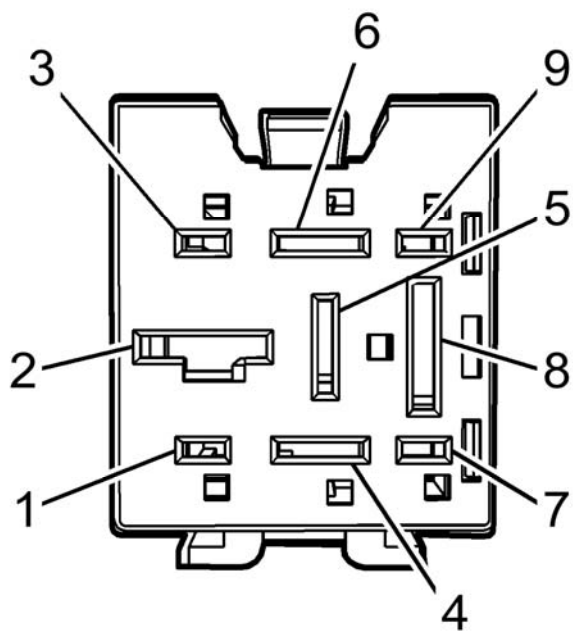
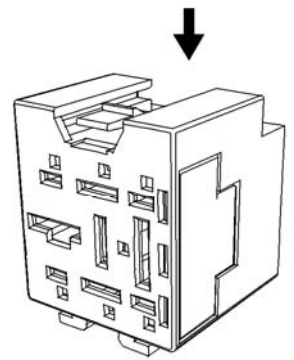
Fig. 5: X70A Relay Block - Underhood Top View (LHU)
 Courtesy of GENERAL MOTORS COMPANY

X70A Relay Block - Underhood Usage (LHU)

No.	Device Label Name	Device Assigned Name	Rating	Description
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1	-	KR20M Cooling Fan Left Medium Speed Relay	-	G10L Cooling Fan Motor - Left, G10R Cooling Fan Motor - Right
2	-	KR20N Cooling Fan Right Medium Speed Relay	-	G10R Cooling Fan Motor - Right
3	-	KR20L Cooling Fan Speed Control 2 Relay	-	G10L Cooling Fan Motor - Left, G10R Cooling Fan Motor - Right

KR20M COOLING FAN LEFT MEDIUM SPEED RELAY (LHU)

Connector Part Information

- Harness Type: Cooling Fan
- OEM Connector: 90491221
- Service Connector: Service by Harness - See Part Catalog
- Description: 9-Way F Metri-Pack 280/630 Series (RD)

Terminal Part Information

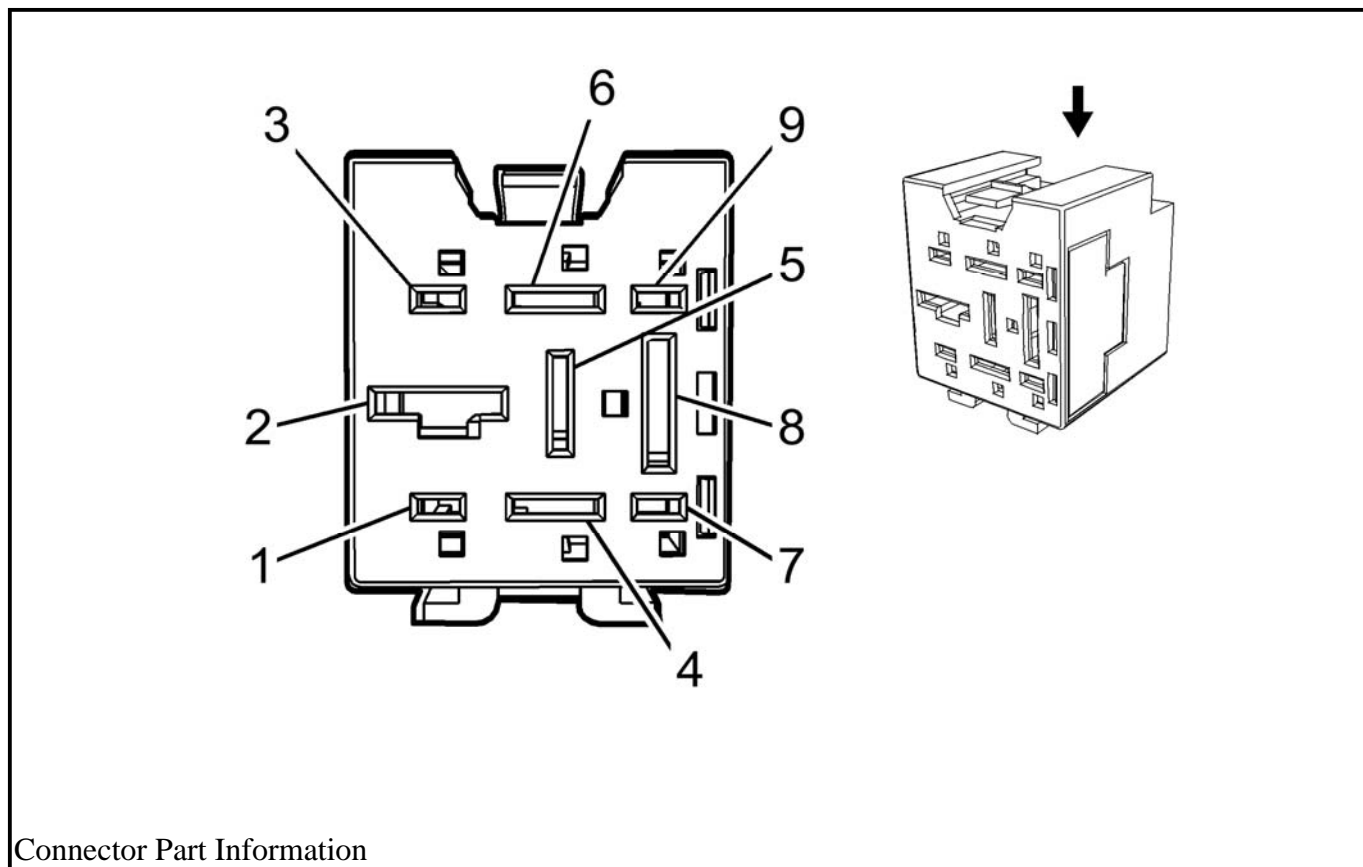
Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
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I	Service by Harness - See Part Catalog	Pending	Not Available	Service by Harness - See Part Catalog	Service by Harness - See Part Catalog	Not Available	Not Available
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KR20M Cooling Fan Left Medium Speed Relay (LHU)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	-	-	-	Not Occupied	-	-
2	6	RD/WH	1040	Battery Positive Voltage	I	-
3	-	-	-	Not Occupied	-	-
4	0.75	VT/BU	5290	Powertrain Main Relay Fused Supply (1)	I	-
5	-	-	-	Not Occupied	-	-
6	0.75	BN/YE	5128	Cooling Fan Relay Coil Control	I	-
7	-	-	-	Not Occupied	-	-
8	6	WH/BU	409	Cooling Fan Motor Supply Voltage (1)	I	-
9	-	-	-	Not Occupied	-	-

KR20N COOLING FAN RIGHT MEDIUM SPEED RELAY (LHU)



Connector Part Information

- Harness Type: Cooling Fan
- OEM Connector: 90356384
- Service Connector: Service by Harness - See Part Catalog
- Description: 9-Way F Metri-Pack 280/630 Series (BK)

Terminal Part Information

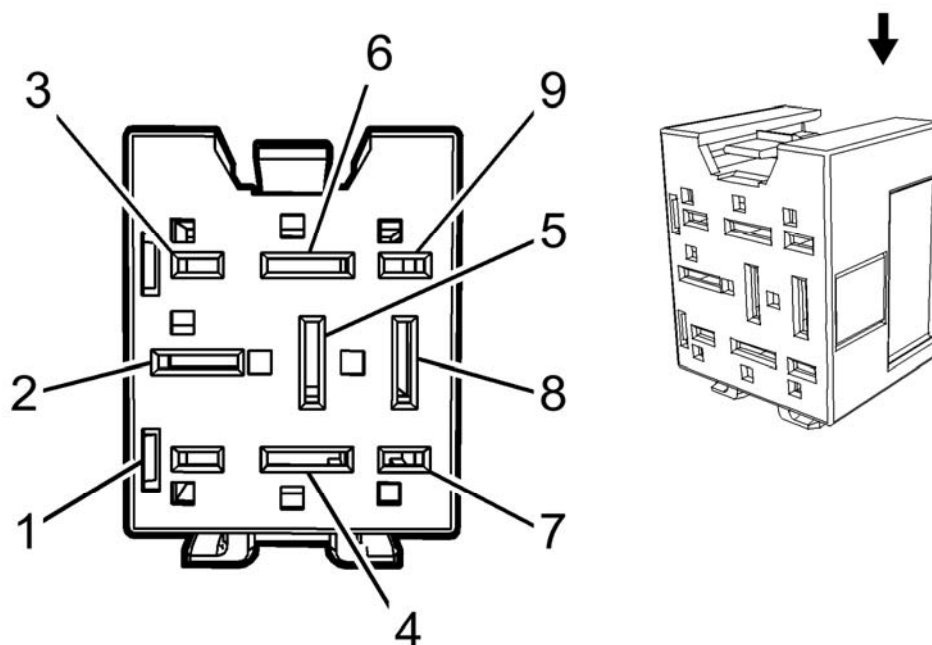
Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Service by Harness - See Part Catalog	Pending	Not Available	Service by Harness - See Part Catalog	Service by Harness - See Part Catalog	Not Available	Not Available

KR20N Cooling Fan Right Medium Speed Relay (LHU)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	-	-	-	Not Occupied	-	-
2	6	RD/WH	1040	Battery Positive Voltage	I	-
3	-	-	-	Not Occupied	-	-
4	0.75	VT/BU	5290	Powertrain Main Relay Fused Supply (1)	I	-
5	-	-	-	Not Occupied	-	-
6	0.75	BN/YE	5128	Cooling Fan Relay Coil Control	I	-
7	-	-	-	Not Occupied	-	-
8	6	GY	532	Cooling Fan Motor Supply Voltage (2)	I	-
9	-	-	-	Not Occupied	-	-

KR20L COOLING FAN SPEED CONTROL 2 RELAY (LHU)

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Connector Part Information

- Harness Type: Cooling Fan
- OEM Connector: 90491230
- Service Connector: Service by Harness - See Part Catalog
- Description: 9-Way F Metri-Pack 280/630 Series (BN)

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Service by Harness - See Part Catalog	Pending	Not Available	Service by Harness - See Part Catalog	Service by Harness - See Part Catalog	Not Available	Not Available

KR20L Cooling Fan Speed Control 2 Relay (LHU)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	-	-	-	Not Occupied	-	-
2	6	GN/BK	504	Cooling Fan Motor Return	I	-
3	-	-	-	Not Occupied	-	-
4	0.75	VT/BU	5290	Powertrain Main Relay Fused	I	-

				Supply (1)		
5	6	GY	532	Cooling Fan Motor Supply Voltage (2)	I	-
6	0.75	BN/YE	5128	Cooling Fan Relay Coil Control	I	-
7	-	-	-	Not Occupied	-	-
8	6	BK	1250	Ground	I	-
9	-	-	-	Not Occupied	-	-

X50A FUSE BLOCK - UNDERHOOD FUSE AND RELAY LABEL (WITHOUT HP6 OR NJ1)

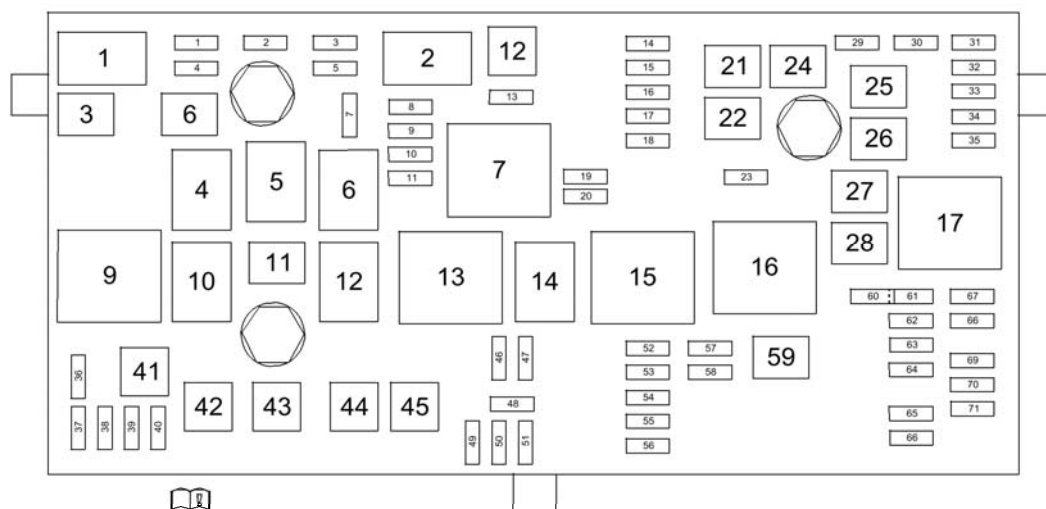


Fig. 6: X50A Fuse Block - Underhood Label (without HP6 or NJ1)
Courtesy of GENERAL MOTORS COMPANY

X50A FUSE BLOCK - UNDERHOOD FUSE AND RELAY LABEL (WITH HP6 OR NJ1)

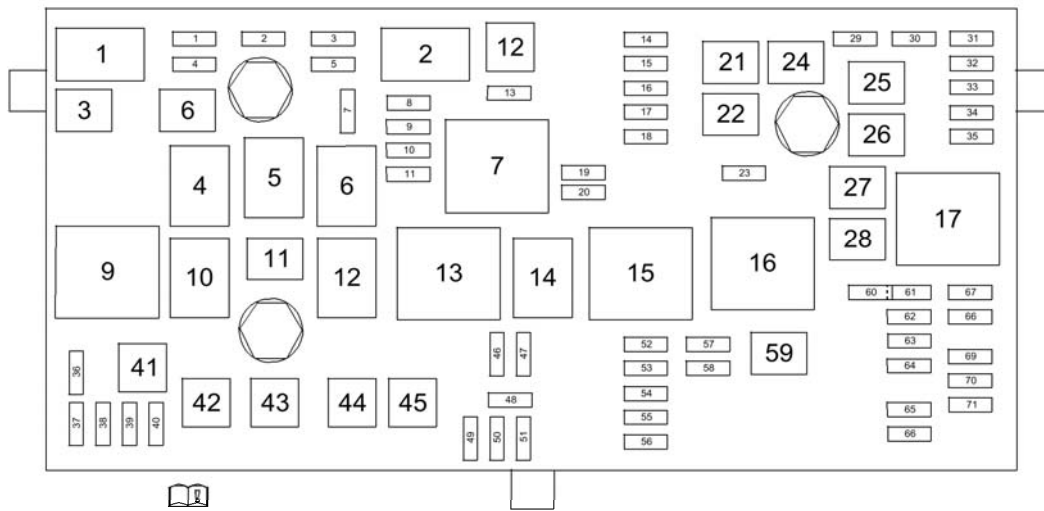


Fig. 7: X50A Fuse Block - Underhood Label (with HP6 or NJ1)
Courtesy of GENERAL MOTORS COMPANY

X50A FUSE BLOCK - UNDERHOOD FUSE AND RELAY LABEL (CZ2)

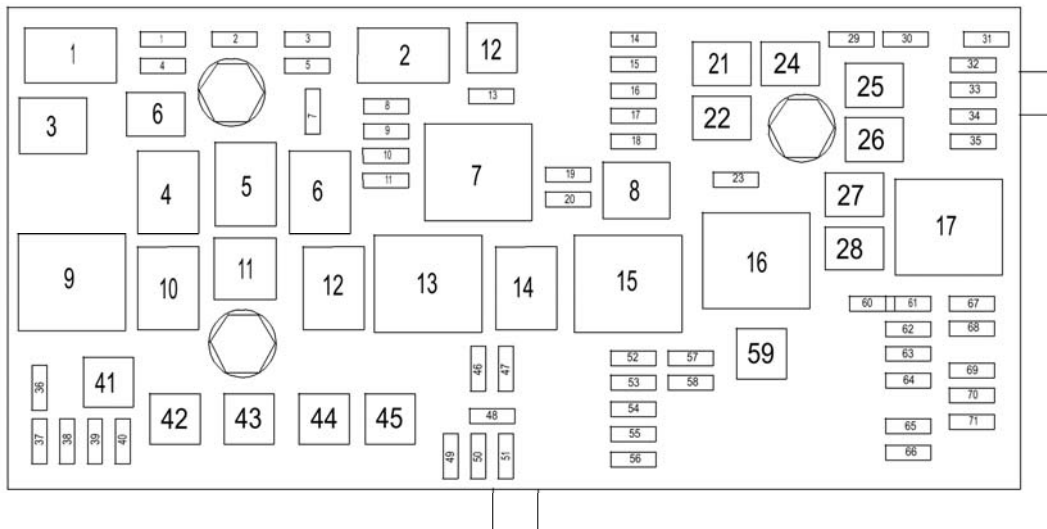


Fig. 8: X50A Fuse Block -- Underhood Label (CZ2)
Courtesy of GENERAL MOTORS COMPANY

X50A FUSE BLOCK - UNDERHOOD TOP VIEW (WITHOUT HP6 OR NJ1)

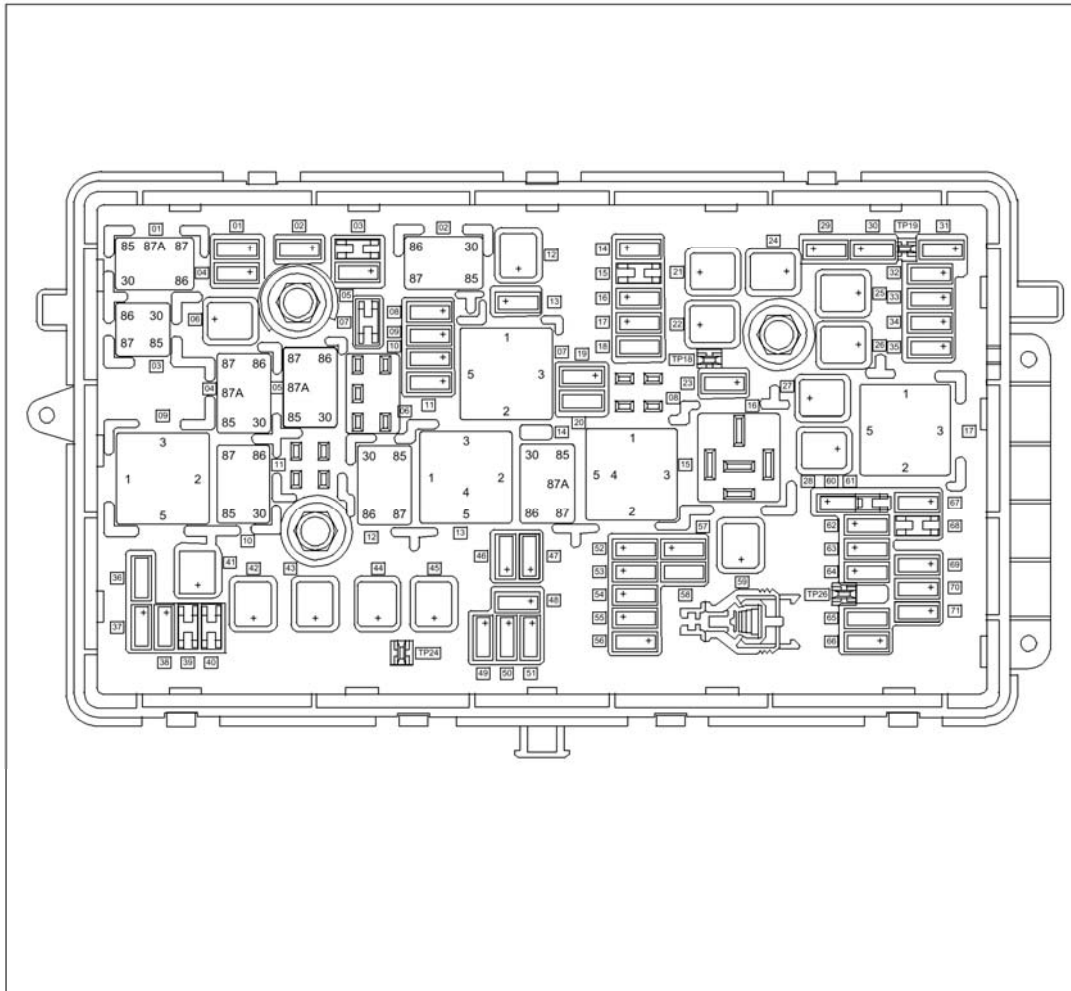


Fig. 9: X50A Fuse Block - Underhood Top View (without HP6 or NJ1)
 Courtesy of GENERAL MOTORS COMPANY

X50A Fuse Block - Underhood Usage (without HP6 or NJ1)

No.	Device Label Name	Device Assigned Name	Rating	Description
Fuses				
1	1	F1UA Fuse	15A	K71 Transmission Control Module (MDK), Q8 Control Solenoid Valve Assembly (MH8, MHH or MHK)
2	2	F2UA Fuse	15A	K20 Engine Control Module
3	3	F3UA Fuse	-	Not Occupied
4	4	F4UA Fuse	-	Not Occupied
5	5	F5UA Fuse	15A	K20 Engine Control Module, K71 Transmission Control Module (MDK), Q8 Control Solenoid Valve Assembly (MH8, MHH, or MHK)

6	6	F6UA Fuse	30A	KR12B Windshield Wiper Relay, KR12C Windshield Wiper Speed Control Relay
7	7	F7UA Fuse	-	Not Occupied
8	8	F8UA Fuse	15A	Not Occupied
9	9	F9UA Fuse	15A	K20 Engine Control Module, T8A Ignition Coil 1, T8B Ignition Coil 2, T8C Ignition Coil 3, T8D Ignition Coil 4
10	10	F10UA Fuse	20A	K20 Engine Control Module
11	11	F11UA Fuse	10A	B52A Heated Oxygen Sensor 1 (LHU), B52B Heated Oxygen Sensor 2 (LHU), Q12 Evaporative Emission Purge Solenoid Valve (LHU), Q40 Turbocharger Bypass Solenoid Valve (LHU), Q42 Turbocharger Wastegate Solenoid Valve (LHU)
12	12	F12UA Fuse	30A	KR27 Starter Relay
13	13	F13UA Fuse	7.5A	K27 Fuel Pump Control Module
14	14	F14UA Fuse	15A	Not Occupied
15	15	F15UA Fuse	-	Not Occupied
16	16	F16UA Fuse	7.5A	K32 Steering Wheel Heating Control Module (UVD)
17	17	F17UA Fuse	5A	K36 Inflatable Restraint Sensing and Diagnostic Module
18	18	F18UA Fuse	-	Not Occupied
19	19	F19UA Fuse	-	Not Occupied
20	20	F20UA Fuse	-	Not Occupied
21	21	F21UA Fuse	30A	S79LR Window Switch - Left Rear (AEQ), S79RR Window Switch - Right Rear (AEQ), M74LR Window Motor - Left Rear (AER), M74RR Window Motor - Right Rear (AER)
22	22	F22UA Fuse	30A	K17 Electronic Brake Control Module
23	23	F23UA Fuse	10A	K43 Power Steering Control Module (NXC)
24	24	F24UA Fuse	30A	M74D Window Motor - Driver, M74P Window Motor - Passenger (AEF), S79P Window Switch - Passenger (AED)
25	25	F25UA Fuse	30A	T1 Accessory DC/AC Power Inverter Module (KI6)
26	26	F26UA Fuse	60A	K17 Electronic Brake Control Module
27	27	F27UA Fuse	30A	K83 Parking Brake Control Module
28	28	F28UA Fuse	40A	R14L Rear Window Defogger Noise Filter - Left
29	29	F29UA Fuse	15A	S65D Seat Lumbar Support Switch - Driver (APG)

30	30	F30UA Fuse	15A	S65P Seat Lumbar Support Switch - Passenger (APH)
31	31	F31UA Fuse	10A	Not Occupied
32	32	F32UA Fuse	20A	A10 Inside Rearview Mirror, E5A Backup Lamp - Left, E5B Backup Lamp - Right, E5AM Stop/Turn Signal Lamp - Left, K9 Body Control Module, S2 Transmission Manual Shift Switch
33	33	F33UA Fuse	25A	K29 Seat Heating Control Module
34	34	F34UA Fuse	25A	M69 Sunroof Motor (CF5)
35	35	F35UA Fuse	30A	T3 Audio Amplifier (UQA)
36	36	F36UA Fuse	-	Not Occupied
37	37	F37UA Fuse	10A	E4F Headlamp - Right High Beam (T4A), M28R High Beam Solenoid Actuator - Right (T4F)
38	38	F38UA Fuse	10A	E4E Headlamp - Left High Beam (T4A) , M28L High Beam Solenoid Actuator - Left (T4F)
39	39	F39UA Fuse	-	Not Occupied
40	40	F40UA Fuse	-	Not Occupied
41	41	F41UA Fuse	-	Not Occupied
42	42	F42UA Fuse	40A	G10L Cooling Fan Motor - Left (LHU), G10R Cooling Fan Motor - Right (LHU), KR20C Cooling Fan Low Speed Relay (LHU), KR20M Cooling Fan Left Medium Speed Relay (LHU)
43	43	F43UA Fuse	60A	Not Occupied
44	44	F44UA Fuse	-	Not Occupied
45	45	F45UA Fuse	60A	G10R Cooling Fan Motor - Right (LHU), KR20D Cooling Fan High Speed Relay (LHU), KR20N Cooling Fan Right Medium Speed Relay (LHU)
46	46	F46UA Fuse	10A	KR20E Cooling Fan Speed Control Relay, KR20F Cooling Fan Relay (LHU), KR20L Cooling Fan Speed Control 2 Relay (LHU), KR20M Cooling Fan Left Medium Speed Relay (LHU), KR20N Cooling Fan Right Medium Speed Relay (LHU), KR26 Secondary Air Injection Solenoid Valve Relay (NU6)
47	47	F47UA Fuse	-	Not Occupied
48	48	F48UA Fuse	15A	E29LF Fog Lamp - Left Front, E29RF Fog Lamp - Right Front
49	49	F49UA Fuse	15A	T7R Headlamp Ballast - Right (T4F)
50	50	F50UA Fuse	15A	T7L Headlamp Ballast - Left (T4F)

51	51	F51UA Fuse	15 A	P13 Horn Assembly
52	52	F52UA Fuse	5A	P16 Instrument Cluster
53	53	F53UA Fuse	10A	A10 Inside Rearview Mirror
54	54	F54UA Fuse	5A	Not Occupied
55	55	F55UA Fuse	7.5A	S79D Window Switch - Driver, S52 Outside Rearview Mirror Switch
56	56	F56UA Fuse	15A	G24 Windshield Washer Pump
57	57	F57UA Fuse	15A	Not Occupied
58	58	F58UA Fuse	-	Not Occupied
59	59	F59UA Fuse	30A	G21 Secondary Air Injection Pump (NU6), KR25 Secondary Air Injection Pump Relay (NU6)
60	60	F60UA Fuse	7.5A	E17D Outside Rearview Mirror Glass - Driver, E17P Outside Rearview Mirror Glass - Passenger
61	61	F61UA Fuse	-	Not Occupied
62	62	F62UA Fuse	10A	Q13 Evaporative Emission Vent Solenoid Valve
63	63	F63UA Fuse	-	Not Occupied
64	64	F64UA Fuse	-	Not Occupied
65	65	F65UA Fuse	-	Not Occupied
66	66	F66UA Fuse	-	Not Occupied
67	67	F67UA Fuse	20A	K27 Fuel Pump Control Module
68	68	F68UA Fuse	-	Not Occupied
69	69	F69UA Fuse	5A	K9 Body Control Module, S30 Headlamp Switch, S70L Steering Wheel Controls Switch - Left, S70R Steering Wheel Controls Switch - Right
70	70	F70UA Fuse	5A	Not Occupied
71	71	F71UA Fuse	5A	Not Occupied
Relays				
1	1	-	-	Not Occupied
2	2	KR27 Starter Relay	-	M64 Starter Motor
3	3	KR20F Cooling Fan Relay	-	KR20E Cooling Fan Speed Control Relay (LHU), KR20L Cooling Fan Speed Control 2 Relay (LHU), KR20M Cooling Fan Left Medium Speed Relay (LHU), KR20N Cooling Fan Right Medium Speed Relay (LHU)
4	4	KR12C Windshield Wiper Speed Control Relay	-	M75 Windshield Wiper Motor
		KR12B		

5	5	Windshield Wiper Relay	-	M75 Windshield Wiper Motor
6	6	KR26 Secondary Air Injection Solenoid Valve Relay	-	Q29 Secondary Air Injection Solenoid Valve (NU6)
7	7	KR75 Engine Controls Ignition Relay	-	F9UA, F10UA, F11UA, F46UA, F47UA Fuses, KR25 Secondary Air Injection Pump Relay (NU6)
8	8	-	-	Not Occupied
9	9	KR20C Cooling Fan Low Speed Relay	-	G10L Cooling Fan Motor - Left (LHU)
10	10	-	-	Not Occupied
11	11	-	-	Not Occupied
12	12	KR20E Cooling Fan Speed Control Relay	-	KR20D Cooling Fan High Speed Relay (LHU)
13	13	KR20D Cooling Fan High Speed Relay	-	G10R Cooling Fan Motor - Right (LHU)
14	14	KR49 Headlamp Low Beam Relay	-	F49UA (T4F), F50UA (T4F) Fuses
15	15	KR73 Ignition Main Relay	-	F5UA, F13UA, F16UA, F17UA, F18UA, F52UA, F53UA, F54UA, F57UA Fuses
16	16	KR25 Secondary Air Injection Pump Relay	-	G21 Secondary Air Injection Pump (NU6)
17	17	KR5 Rear Defogger Relay	-	E17D Outside Rearview Mirror Glass - Driver, E17P Outside Rearview Mirror Glass - Passenger, R14L Rear Window Defogger Noise Filter - Left

NOTE:

Relays listed below are non-serviceable Printed Circuit Board (PCB) relays and are internal to the block.

-	-	KR3 Horn Relay	-	F51UA Fuse
-	-	KR11 Windshield Washer Pump Relay	-	F56UA Fuse
-	-	KR46 Front Fog Lamp Relay	-	F48UA Fuse
-	-	KR48 Headlamp High Beam Relay	-	F37UA, F38UA Fuses
-	-	KR95B Rear Compartment Lid	-	M40 Rear Compartment Lid Latch, TP18

		Unlatch Relay		
-	-	KR97 Door Lock Relay	-	A23D Door Latch Assembly - Driver, A23LR Door Latch Assembly - Left Rear, A23P Door Latch Assembly - Passenger, A23RR Door Latch Assembly - Right Rear
NOTE: Item listed below is a Release Systems diagnostic test point.				
TP18	-	TP18	-	KR95B Rear Compartment Lid Unlatch Relay
NOTE: Items listed below are diagnostic testing points.				
TP19	-	TP19	-	Not Occupied
TP24	-	TP24	-	Not Occupied
TP26	-	TP26	-	Not Occupied

X50A FUSE BLOCK - UNDERHOOD TOP VIEW (WITH HP6 OR NJ1)

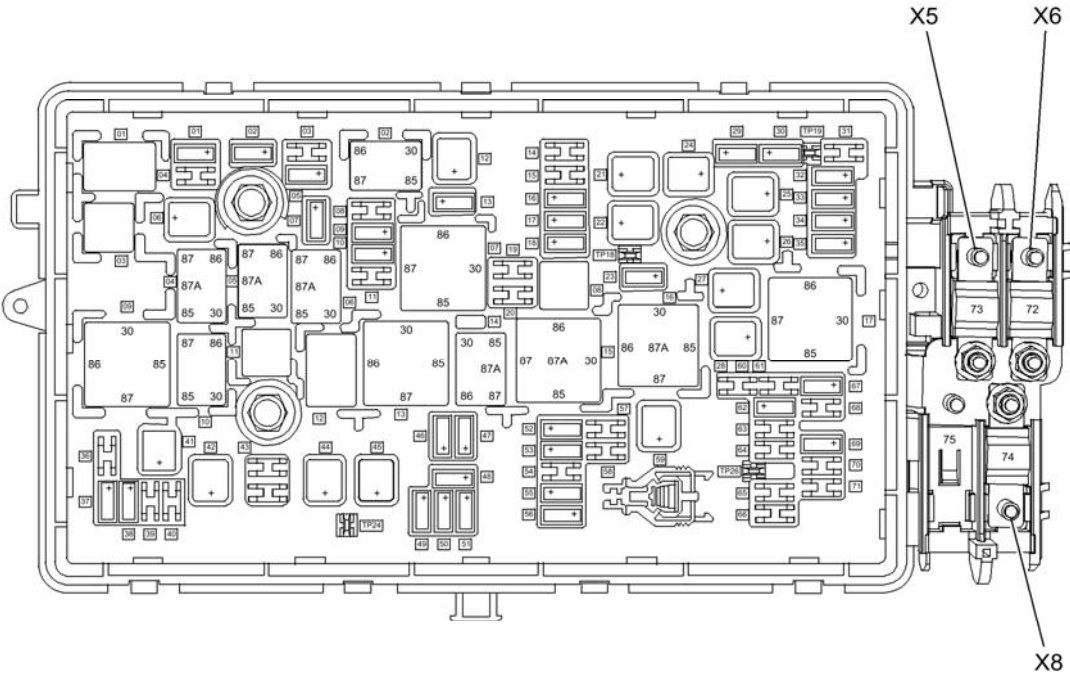


Fig. 10: X50A Fuse Block - Underhood Top View (with HP6 or NJ1)

Courtesy of GENERAL MOTORS COMPANY

X50A Fuse Block - Underhood Usage (HP6 or NJ1)

No.	Device Label Name	Device Assigned Name	Rating	Description
<i>Fuses</i>				
1	1	F1UA Fuse	15A	K71 Transmission Control Module (MDK), Q8 Control Solenoid Valve Assembly (MH8, MHH or MHK)
2	2	F2UA Fuse	15A	K20 Engine Control Module
3	3	F3UA Fuse	-	Not Occupied
4	4	F4UA Fuse	-	Not Occupied
5	5	F5UA Fuse	15A	K20 Engine Control Module, K71 Transmission Control Module (MDK), Q8 Control Solenoid Valve Assembly (MH8, MHH, or MHK)
6	6	F6UA Fuse	30A	KR12B Windshield Wiper Relay, KR12C Windshield Wiper Speed Control Relay
7	7	F7UA Fuse	7.5A	K59 Starter/Generator Control Module (LUK)
8	8	F8UA Fuse	15A	Not Occupied
9	9	F9UA Fuse	15A	K20 Engine Control Module, T8A Ignition Coil 1, T8B Ignition Coil 2, T8C Ignition Coil 3, T8D Ignition Coil 4
10	10	F10UA Fuse	20A	K20 Engine Control Module
11	11	F11UA Fuse	-	Not Occupied
12	12	F12UA Fuse	30A	KR27 Starter Relay
13	13	F13UA Fuse	7.5A	K27 Fuel Pump Control Module
14	14	F14UA Fuse	15A	Not Occupied
15	15	F15UA Fuse	-	Not Occupied
16	16	F16UA Fuse	7.5A	K32 Steering Wheel Heating Control Module (UVD)
17	17	F17UA Fuse	5A	K36 Inflatable Restraint Sensing and Diagnostic Module
18	18	F18UA Fuse	15A	K59 Starter/Generator Control Module (LUK)
19	19	F19UA Fuse	-	Not Occupied
20	20	F20UA Fuse	-	Not Occupied
21	21	F21UA Fuse	30A	S79LR Window Switch - Left Rear (AEQ), S79RR Window Switch - Right Rear (AEQ), M74LR Window Motor - Left Rear (AER), M74RR Window Motor - Right Rear (AER)

22	22	F22UA Fuse	30A	K17 Electronic Brake Control Module
23	23	F23UA Fuse	10A	K43 Power Steering Control Module (NXC)
24	24	F24UA Fuse	30A	M74D Window Motor - Driver, M74P Window Motor - Passenger (AEF), S79P Window Switch - Passenger (AED)
25	25	F25UA Fuse	30A	T1 Accessory DC/AC Power Inverter Module (KI6)
26	26	F26UA Fuse	60A	K17 Electronic Brake Control Module
27	27	F27UA Fuse	30A	K83 Parking Brake Control Module
28	28	F28UA Fuse	40A	R14L Rear Window Defogger Noise Filter - Left
29	29	F29UA Fuse	15A	S65D Seat Lumbar Support Switch - Driver (APG)
30	30	F30UA Fuse	15A	S65P Seat Lumbar Support Switch - Passenger (APH)
31	31	F31UA Fuse	10A	Not Occupied
32	32	F32UA Fuse	20A	A10 Inside Rearview Mirror, E5A Backup Lamp - Left, E5B Backup Lamp - Right, E5AM Stop/Turn Signal Lamp - Left, K9 Body Control Module, S2 Transmission Manual Shift Switch
33	33	F33UA Fuse	25A	K29 Seat Heating Control Module
34	34	F34UA Fuse	25A	M69 Sunroof Motor (CF5)
35	35	F35UA Fuse	30A	T3 Audio Amplifier (UQA)
36	36	F36UA Fuse	-	Not Occupied
37	37	F37UA Fuse	10A	E4F Headlamp - Right High Beam (T4A), M28R High Beam Solenoid Actuator - Right (T4F)
38	38	F38UA Fuse	10A	E4E Headlamp - Left High Beam (T4A) , M28L High Beam Solenoid Actuator - Left (T4F)
39	39	F39UA Fuse	-	Not Occupied
40	40	F40UA Fuse	-	Not Occupied
41	41	F41UA Fuse	30A	KR14 Brake Booster Pump Motor Relay (LUK)
42	42	F42UA Fuse	30A	Not Occupied
43	43	F43UA Fuse	60A	Not Occupied
44	44	F44UA Fuse	25A	KR86 Transmission Fluid Pump Relay - Auxiliary (HP6)
45	45	F45UA Fuse	60A	G10L Cooling Fan Motor - Left (LUK), G10R Cooling Fan Motor - Right (LUK), KR20C Cooling Fan Low Speed Relay (LUK), KR20J Cooling Fan Left High

				Speed Relay (LUK)
46	46	F46UA Fuse	10A	KR20C Cooling Fan Low Speed Relay (LUK), KR20E Cooling Fan Speed Control Relay, KR26 Secondary Air Injection Solenoid Valve Relay (NU6)
47	47	F47UA Fuse	10A	Not Occupied
48	48	F48UA Fuse	15A	E29LF Fog Lamp - Left Front, E29RF Fog Lamp - Right Front
49	49	F49UA Fuse	15A	T7R Headlamp Ballast - Right (T4F)
50	50	F50UA Fuse	15A	T7L Headlamp Ballast - Left (T4F)
51	51	F51UA Fuse	15 A	P13 Horn Assembly
52	52	F52UA Fuse	5A	P16 Instrument Cluster
53	53	F53UA Fuse	10A	A10 Inside Rearview Mirror
54	54	F54UA Fuse	5A	Not Occupied
55	55	F55UA Fuse	7.5A	S79D Window Switch - Driver, S52 Outside Rearview Mirror Switch
56	56	F56UA Fuse	15A	G24 Windshield Washer Pump
57	57	F57UA Fuse	15A	Not Occupied
58	58	F58UA Fuse	-	Not Occupied
59	59	F59UA Fuse	30A	G21 Secondary Air Injection Pump (NU6), KR25 Secondary Air Injection Pump Relay (NU6)
60	60	F60UA Fuse	7.5A	E17D Outside Rearview Mirror Glass - Driver, E17P Outside Rearview Mirror Glass - Passenger
61	61	F61UA Fuse	-	Not Occupied
62	62	F62UA Fuse	10A	Q13 Evaporative Emission Vent Solenoid Valve
63	63	F63UA Fuse	-	Not Occupied
64	64	F64UA Fuse	-	Not Occupied
65	65	F65UA Fuse	-	Not Occupied
66	66	F66UA Fuse	-	Not Occupied
67	67	F67UA Fuse	20A	K27 Fuel Pump Control Module
68	68	F68UA Fuse	-	Not Occupied
69	69	F69UA Fuse	5A	K9 Body Control Module, S30 Headlamp Switch, S70L Steering Wheel Controls Switch - Left, S70R Steering Wheel Controls Switch - Right
70	70	F70UA Fuse	5A	Not Occupied
71	71	F71UA Fuse	5A	Not Occupied
72	-	F72UB Fuse	-	Not Occupied
73	-	F73UB Fuse	175A	K59 Starter/Generator Control Module (NP6)

74	-	F74UB Fuse	80A	K43 Power Steering Control Module (NJ7)
75	-	F75UB Fuse	-	Not Occupied
Relays				
1	1	-	-	Not Occupied
2	2	KR27 Starter Relay	-	M64 Starter Motor
3	3	-	-	Not Occupied
4	4	KR12C Windshield Wiper Speed Control Relay	-	M75 Windshield Wiper Motor
5	5	KR12B Windshield Wiper Relay	-	M75 Windshield Wiper Motor
6	6	KR26 Secondary Air Injection Solenoid Valve Relay	-	Q29 Secondary Air Injection Solenoid Valve (NU6)
7	7	KR75 Engine Controls Ignition Relay	-	F9UA, F10UA, F11UA, F46UA, F47UA Fuses, KR25 Secondary Air Injection Pump Relay (NU6)
8	8	-	-	Not Occupied
9	9	KR20K Cooling Fan Right High Speed Relay	-	G10R Cooling Fan Motor - Right (LUK)
10	10	KR20C Cooling Fan Low Speed Relay	-	G10L Cooling Fan Motor - Left (LUK), G10R Cooling Fan Motor - Right (LUK)
11	11	KR86 Transmission Fluid Pump Relay - Auxiliary	-	G5 Transmission Fluid Pump - Auxiliary (HP6)
12	12	-	-	Not Occupied
13	13	KR20J Cooling Fan Left High Speed Relay	-	G10L Cooling Fan Motor - Left (LUK)
14	14	KR49 Headlamp Low Beam Relay	-	F49UA (T4F), F50UA (T4F) Fuses
15	15	KR73 Ignition Main Relay	-	F5UA, F13UA, F16UA, F17UA, F18UA, F52UA, F53UA, F54UA, F57UA Fuses
16	16	KR25 Secondary Air Injection Pump Relay	-	G21 Secondary Air Injection Pump (NU6)
17	17	KR5 Rear Defogger Relay	-	E17D Outside Rearview Mirror Glass - Driver, E17P Outside Rearview Mirror Glass - Passenger, R14L Rear Window Defogger Noise Filter - Left
NOTE: Relays listed below are non-serviceable Printed Circuit Board (PCB) relays and are internal to the				

block.

-	-	KR3 Horn Relay	-	F51UA Fuse
-	-	KR11 Windshield Washer Pump Relay	-	F56UA Fuse
-	-	KR46 Front Fog Lamp Relay	-	F48UA Fuse
-	-	KR48 Headlamp High Beam Relay	-	F37UA, F38UA Fuses
-	-	KR95B Rear Compartment Lid Unlatch Relay	-	M40 Rear Compartment Lid Latch, TP18
-	-	KR97 Door Lock Relay	-	A23D Door Latch Assembly - Driver, A23LR Door Latch Assembly - Left Rear, A23P Door Latch Assembly - Passenger, A23RR Door Latch Assembly - Right Rear

NOTE:

Item listed below is a Release Systems diagnostic test point.

TP18	-	TP18	-	KR95B Rear Compartment Lid Unlatch Relay
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NOTE:

Items listed below are diagnostic testing points.

TP19	-	TP19	-	Not Occupied
TP24	-	TP24	-	Not Occupied
TP26	-	TP26	-	Not Occupied

X50A FUSE BLOCK - UNDERHOOD TOP VIEW (CZ2)

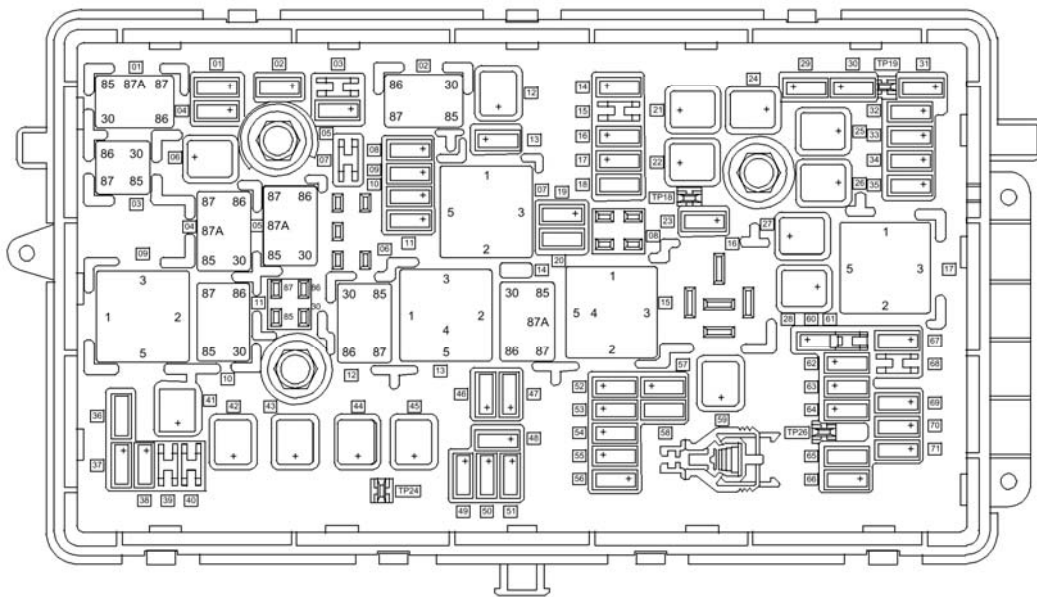


Fig. 11: X50A Fuse Block - Underhood Top View (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

X50A Fuse Block - Underhood Top View Usage (CZ2)

No.	Device Label Name	Device Assigned Name	Rating	Description
Fuses				
1	1	F1UA Fuse	15A	K71 Transmission Control Module
2	2	F2UA Fuse	15A	K20 Engine Control Module
3	3	F3UA	-	Not Occupied
4	4	F4UA	-	Not Occupied
5	5	F5UA Fuse	15A	K20 Engine Control Module, K71 Transmission Control Module
6	6	F6UA Fuse	30A	KR12B Windshield Wiper Relay, KR12C Windshield Wiper Speed Control Relay
7	7	F7UA	-	Not Occupied
				Q17A Fuel Injector 1 (LTD), Q17B Fuel

8	8	F8UA Fuse	15A	Injector 2 (LTD), Q17C Fuel Injector 3 (LTD), Q17D Fuel Injector 4 (LTD)
9	9	F9UA Fuse	15A	K20 Engine Control Module (LAF/LDK), K35 Ignition Coil Module (LLU), T8A Ignition Coil 1(without LLU), T8B Ignition Coil 2 (without LLU), T8C Ignition Coil 3 (without LLU), T8D Ignition Coil 4 (without LLU), Q17A Fuel Injector 1 (LLU), Q17B Fuel Injector 2 (LLU), Q17C Fuel Injector 3 (LLU), Q17D Fuel Injector 4 (LLU)
10	10	F10UA Fuse	20A	K20 Engine Control Module
11	11	F11UA Fuse	10A	B52A Heated Oxygen Sensor 1 (LLU), B52B Heated Oxygen Sensor 2 (LLU), B75B Mass Air Flow/Intake Air Temperature Sensor (LDK), Q12 Evaporative Emission Purge Solenoid Valve (LLU), Q40 Turbocharger Bypass Solenoid Valve (LLU), Q42 Turbocharger Wastegate Solenoid Valve (LLU)
12	12	F12UA Fuse	30A	KR27 Starter Relay
13	13	F13UA Fuse	7.5A	E45 Positive Crankcase Ventilation Heater (LLU), K27 Fuel Pump Control Module (LAF/LDK), Q8 Control Solenoid Valve Assembly
14	14	F14UA Fuse	-	Not Occupied
15	15	F15UA Fuse	-	Not Occupied
16	16	F16UA Fuse	7.5A	B19C Brake Booster Vacuum Switch, B75B Mass Air Flow/Intake Air Temperature Sensor (LLU), B108 Air Quality Sensor
17	17	F17UA Fuse	5A	K36 Inflatable Restraint Sensing and Diagnostic Module
18	18	F18UA Fuse	15A	K26 Headlamp Control Module (T4F or TR7)
19	19	F19UA Fuse	10A	E13L Headlamp - Left (TT6 or TR6), E13R Headlamp - Right (TT6 or TR6)
20	20	F20UA Fuse	20A	KR23A Fuel Pump Relay (LLU)
21	21	F21UA Fuse	30A	S79LR Window Switch - Left Rear (AEQ), S79RR Window Switch - Right Rear (AEQ), M74LR Window Motor - Left Rear (AER), M74RR Window Motor - Right Rear (AER)
22	22	F22UA Fuse	50A	K17 Electronic Brake Control Module
23	23	F23UA Fuse	10A	K43 Power Steering Control Module
24	24	F24UA Fuse	30A	M74D Window Motor - Driver, M74P Window Motor - Passenger (AEF), S79P Window Switch - Passenger (AED)

25	25	F25UA Fuse	-	Not Occupied
26	26	F26UA Fuse	60A	K17 Electronic Brake Control Module
27	27	F27UA Fuse	30A	K83 Parking Brake Control Module (J71)
28	28	F28UA Fuse	40A	E18 Rear Defogger Grid
29	29	F29UA Fuse	15A	S65D Seat Lumbar Support Switch - Driver (AF6)
30	30	F30UA Fuse	15A	S65P Seat Lumbar Support Switch - Passenger (APH)
31	31	F31UA Fuse	10A	Not Occupied
32	32	F32UA Fuse	20A	K9 Body Control Module
33	33	F33UA Fuse	25A	K29 Seat Heating Control Module (without A45), K40 Seat Memory Control Module (A45)
34	34	F34UA Fuse	25A	K61 Sunroof Control Module (CF5)
35	35	F35UA Fuse	30A	T3 Audio Amplifier (UQS)
36	36	F36UA Fuse	-	Not Occupied
37	37	F37UA Fuse	10A	E13R Headlamp - Right
38	38	F38UA Fuse	10A	E13L Headlamp - Left
39	39	F39UA Fuse	-	Not Occupied
40	40	F40UA Fuse	-	Not Occupied
41	41	F41UA Fuse	30A	K84 Keyless Entry Control Module (BTM)
42	42	F42UA Fuse	40A	KR20C Cooling Fan Low Speed Relay, KR20G Cooling Fan Left Low Speed Relay (LDK), KR20P Cooling Fan Medium Speed Relay (without LDK)
43	43	F43UA Fuse	30A	KR14 Brake Booster Pump Motor Relay (without LDK)
44	44	F44UA Fuse	25A	KR2 Headlamp Washer Pump Relay (CE4)
45	45	F45UA Fuse	50A	KR20D Cooling Fan High Speed Relay, KR20H Cooling Fan Right Low Speed Relay (LDK)
46	46	F46UA Fuse	10A	KR20C Cooling Fan Low Speed Relay, KR20E Cooling Fan Speed Control Relay, KR20F Cooling Fan Relay, KR20G Cooling Fan Left Low Speed Relay (LDK), KR20H Cooling Fan Right Low Speed Relay (LDK), KR20L Cooling Fan Speed Control 2 Relay (LDK)
47	47	F47UA Fuse	10A	B52A Heated Oxygen Sensor 1 (without LLU), B52B Heated Oxygen Sensor 2 (without LLU), B75B Mass Air Flow/Intake Air Temperature Sensor (LAF/LTD), Q12 Evaporative Emission Purge Solenoid Valve (without LLU), Q40 Turbocharger Bypass

				Solenoid Valve (LDK), Q42 Turbocharger Wastegate Solenoid Valve (LDK)
48	48	F48UA Fuse	15A	E29LF Fog Lamp - Left Front, E29RF Fog Lamp - Right Front
49	49	F49UA Fuse	15A	E4H Headlamp - Right Low Beam (T4F)
50	50	F50UA Fuse	15A	E4G Headlamp - Left Low Beam (T4F)
51	51	F51UA Fuse	15A	P12 Horn
52	52	F52UA Fuse	5A	P16 Instrument Cluster
53	53	F53UA Fuse	10A	A10 Inside Rearview Mirror, E13L Headlamp - Left (TT6), E13R Headlamp - Right (TT6), M73A Seat Blower Motor - Driver Back, M73B Seat Blower Motor - Passenger Back, M73C Seat Blower Motor - Driver Cushion, M73D Seat Blower Motor - Passenger Cushion,
54	54	F54UA Fuse	5A	S30 Headlamp Switch (TR6)
55	55	F55UA Fuse	7.5A	S52 Outside Rearview Mirror Switch, S79D Window Switch - Driver, S79P Window Switch - Passenger (A45)
56	56	F56UA Fuse	15A	G24 Windshield Washer Pump
57	57	F57UA Fuse	-	Not Occupied
58	58	F58UA Fuse	-	Not Occupied
59	59	F59UA Fuse	-	Not Occupied
60	60	F60UA Fuse	7.5A	A9A Outside Rearview Mirror - Driver, A9B Outside Rearview Mirror - Passenger
61	61	F61UA Fuse	-	Not Occupied
62	62	F62UA Fuse	-	Not Occupied
63	63	F63UA Fuse	-	Not Occupied
64	64	F64UA Fuse	5A	K26 Headlamp Control Module (TT2 or T4F)
65	65	F65UA Fuse	-	Not Occupied
66	66	F66UA Fuse	-	Not Occupied
67	67	F67UA Fuse	20A	K27 Fuel Pump Control Module
68	68	F68UA Fuse	-	Not Occupied
69	69	F69UA Fuse	5A	K9 Body Control Module
70	70	F70UA Fuse	5A	B117 Rain Sensor (CE1)
71	71	F71UA Fuse	-	Not Occupied
72	72	F72UA Fuse	-	Not Occupied
73	73	F73UA Fuse	-	Not Occupied
74	74	F74UA Fuse	80A	K43 Power Steering Control Module (NJ1)
75	75	F75UA Fuse	-	Not Occupied
Relays				
1	-	-	-	Not Occupied

2	-	KR27 Starter Relay	-	M64 Starter Motor
3	-	KR20F Cooling Fan Relay	-	KR20C Cooling Fan Low Speed Relay (without LDK), KR20E Cooling Fan Speed Control Relay, KR20L Cooling Fan Speed Control 2 Relay (LDK), KR20M Cooling Fan Left Medium Speed Relay (LDK), KR20N Cooling Fan Right Medium Speed Relay (LDK)
4	-	KR12C Windshield Wiper Speed Control Relay	-	M75 Windshield Wiper Motor
5	-	KR12B Windshield Wiper Relay	-	KR12C Windshield Wiper Speed Control Relay, M75 Windshield Wiper Motor
6	-	-	-	Not Occupied
7	-	KR75 Engine Controls Ignition Relay	-	F8UA, F9UA, F10UA, F11UA (LLU), F46UA, F47UA (LDK/LTD) Fuses, KR20C Cooling Fan Low Speed Relay (LDK), KR20P Cooling Fan Medium Speed Relay (without LDK)
8	-	KR23A Fuel Pump Relay	-	A7 Fuel Pump and Level Sensor Assembly
9	-	KR20P Cooling Fan Medium Speed Relay	-	G10 Cooling Fan Motor (without LDK)
9	-	-	-	Not Occupied
10	-	KR20C Cooling Fan Low Speed Relay	-	G10L Cooling Fan Motor - Left (LDK), G10 Cooling Fan Motor (without LDK)
11	-	KR2 Headlamp Washer Pump Relay	-	G16 Headlamp Washer Pump (CE4)
12	-	KR20E Cooling Fan Speed Control Relay	-	KR20D Cooling Fan High Speed Relay (LDK), KR20D Cooling Fan High Speed Relay (without LDK)
13	-	KR20D Cooling Fan High Speed Relay	-	G10R Cooling Fan Motor - Right (LDK), G10 Cooling Fan Motor (without LDK)
13	-	-	-	Not Occupied
14	-	KR49 Headlamp Low Beam Relay	-	F49UA and F50UA Fuses (TT6)
15	-	KR73 Ignition Main Relay	-	F5UA, F13UA, F16UA, F17UA, F18UA, F19UA, F20UA (LLU), F52UA, F53UA,

				F54UA Fuses
16	-	-	-	Not Occupied
17	-	KR5 Rear Window Defogger Relay	-	F28UA and F60UA Fuses
NOTE: Relays listed below are non-serviceable printed circuit board (PCB) relays and are internal to the block.				
-	-	KR3 Horn Relay	-	F51UA Fuse
-	-	KR11 Windshield Washer Pump Relay	-	F56UA Fuse
-	-	KR46 Front Fog Lamp Relay	-	F48UA Fuse
-	-	KR48 Headlamp High Beam Relay	-	F37UA and F38UA Fuses
-	-	KR91 Door Lock/Unlock Relay	-	A23D Door Latch Assembly - Driver, A23P Door Latch Assembly - Passenger, A23LR Door Latch Assembly - Left Rear, A23RR Door Latch Assembly - Right Rear
-	-	KR101 Theft Deterrent Security Siren Relay	-	F65UA Fuse (If Equipped)
Note: Item listed below is a Release Systems diagnostic test point				
TP18	-	TP18	-	KR95B Rear Compartment Lid Unlatch Relay
Note: Items listed below are diagnostic testing points				
TP19	-	TP19	-	Not Occupied
TP24	-	TP24	-	Not Occupied
TP26	-	TP26	-	Not Occupied

X50A FUSE BLOCK - UNDERHOOD BOTTOM VIEW (WITHOUT HP6 OR NJ1)

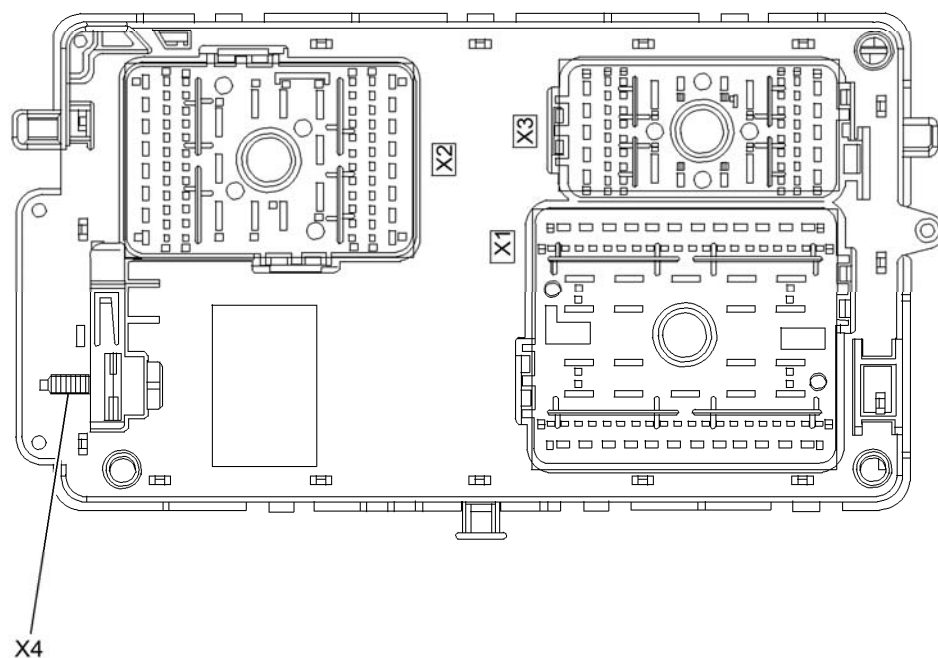


Fig. 12: X50A Fuse Block - Underhood - Bottom View (without HP6 or NJ1)
Courtesy of GENERAL MOTORS COMPANY

X50A FUSE BLOCK - UNDERHOOD BOTTOM VIEW (HP6 OR NJ1)

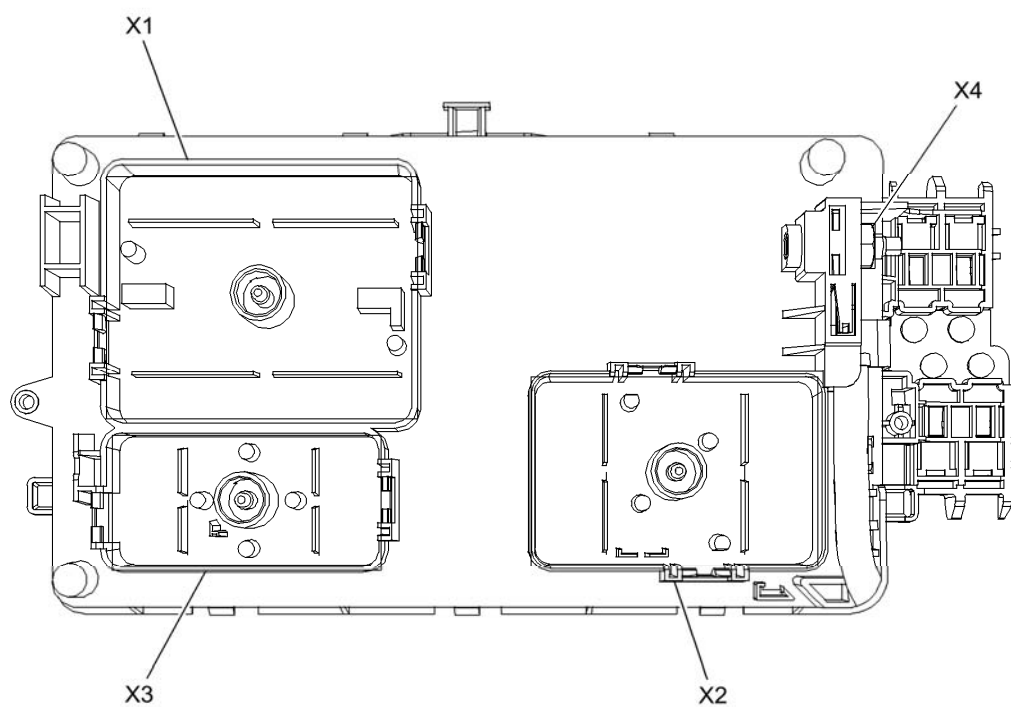


Fig. 13: X50A Fuse Block - Underhood Bottom View (HP6 or NJ1)
Courtesy of GENERAL MOTORS COMPANY

X50A FUSE BLOCK - UNDERHOOD BOTTOM VIEW (CZ2)

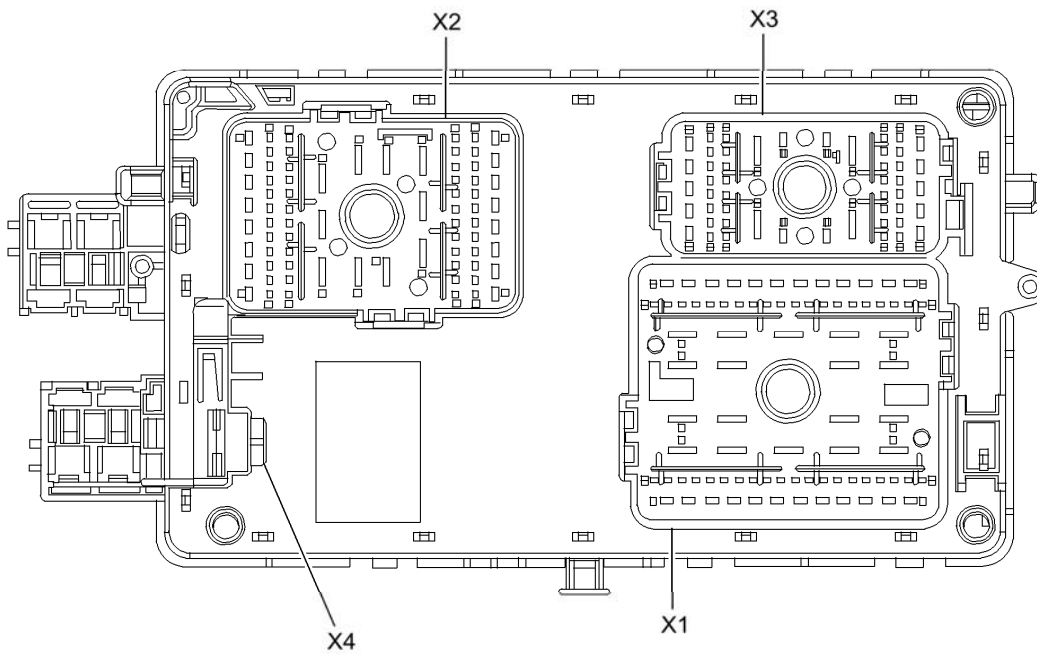
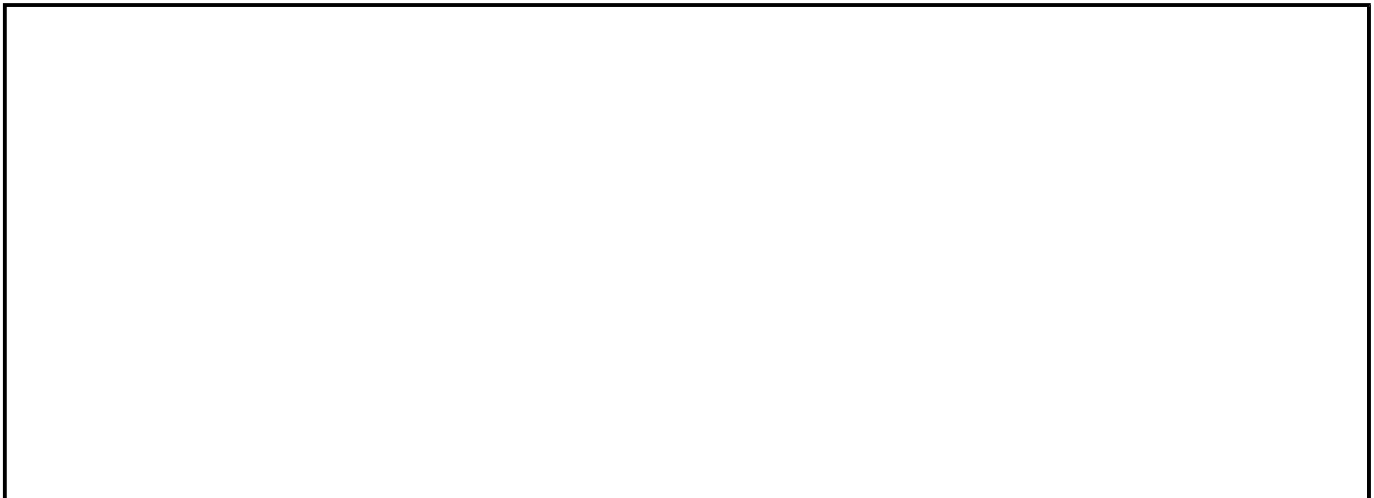
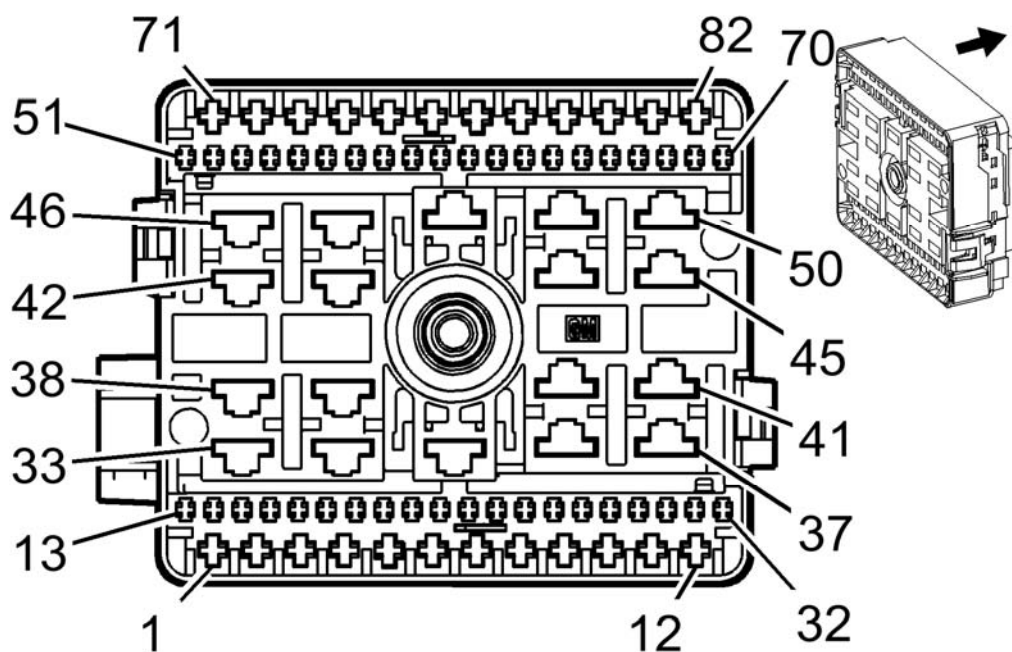


Fig. 14: X50A Fuse Block - Underhood Bottom View (CZ2)
Courtesy of GENERAL MOTORS COMPANY

X50A FUSE BLOCK - UNDERHOOD X1 (EXCEPT CZ2)





Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 13262028
- Service Connector: 13576528
- Description: 82-Way F DSQ 1.5 2.8 Metri-Pack 800 Series (BK)

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Pending	Pending	Pending	Pending	Pending	Pending	Pending
II	Pending	J-35616-14 (GN)	J-38125-560	962943-5	16	E	A
III	Pending	J-35616-44 (YE)	12150860	12110127	19	F	G

X50A Fuse Block - Underhood X1 (except CZ2)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1-7	-	-	-	Not Occupied	-	-
8	1.5	YE	712	Left Headlamp Low Beam Supply Voltage	-	T4F

9-10	-	-	-	Not Occupied	-	-
11	1	BN/GY	29	Horn Control	II	-
12	1.5	YE	312	Right Headlamp Low Beam Supply Voltage	-	T4F
13	1.5	WH	311	Right Headlamp High Beam Supply Voltage	I	-
14	1.5	WH	711	Left Headlamp High Beam Supply Voltage	I	-
15-19	-	-	-	Not Occupied	-	-
20	0.75 0.75	VT/BU YE/RD	5290 5290	Powertrain Main Relay Fused Supply (1) Powertrain Main Relay Fused Supply (1)	II	LUK LHU
21-29	-	-	-	Not Occupied	-	-
30	1	GY/VT	228	Windshield Washer Pump Control	II	-
31	1.5	BN/VT	2234	Front Fog Lamp Supply Voltage	I	T3U
32-33	-	-	-	Not Occupied	-	-
34	6	YE/RD	302	Battery Positive Voltage	-	LH
35	2.5	RD/VT	1940	Battery Positive Voltage	-	BTM
36	-	-	-	Not Occupied	-	-
37	4 6	RD/WH YE/RD	1040 1040	Battery Positive Voltage Battery Positive Voltage	III	LUK LHU
38	2.5	RD/VT	1940	Battery Positive Voltage	III	LUK
39-40	-	-	-	Not Occupied	-	-
41	4	BK	1350	Ground	III	LUK
42	-	-	-	Not Occupied	-	-
43	4	RD/WH	1040	Battery Positive Voltage	III	LUK
44	-	-	-	Not Occupied	-	-
45	4	YE/RD	532	Cooling Fan Motor Supply Voltage (2)	III	LUK
46	4 6	YE/RD YE/RD	532 5358	Cooling Fan Motor Supply Voltage (2) Cooling Fan Motor Supply Voltage (3)	III	LU LHU
47	4	YE/RD	409	Cooling Fan Motor Supply Voltage (1)	III	LUK
48-49	-	-	-	Not Occupied	-	-
50	4 6	GN/BK YE/RD	504 7625	Cooling Fan Motor Return Cooling Fan Motor Supply Voltage (4)	III	LUK LHU
51	-	-	-	Not Occupied	-	-
52	0.75 0.75	GN/VT YE/RD	335 5128	Low Speed Cooling Fan Relay Control	II	LUK LHU

				Cooling Fan Relay Coil Control		
53	0.5	BN/RD	2700	5-Volt Reference	II	-
54	-	-	-	Not Occupied	-	-
55	0.5	BK/BN	5514	Low Reference	II	-
56	-	-	-	Not Occupied	-	-
57	0.5	GN	380	A/C Refrigerant Pressure Sensor Signal	II	-
58-63	-	-	-	Not Occupied	-	-
64	0.75	GN/VT	335	Low Speed Cooling Fan Relay Control	II	LUK
65	-	-	-	Not Occupied	-	-
66	0.75	YE/RD	5290	Powertrain Main Relay Fused Supply (1)	-	LHU
67	0.75	WH	2368	Cooling Fan Control Signal	-	LHU
68	0.75 0.75	VT/BU WH	5290 2368	Powertrain Main Relay Fused Supply (1) Cooling Fan Control Signal	II	LUK LHU
69-70	-	-	-	Not Occupied	-	-
71	2.5	BK	1350	Ground	I	-
72	2.5	WH	92	Windshield Wiper Motor High Speed Control	I	-
73	2.5	YE/BN	95	Windshield Wiper Motor Low Speed Control	I	-
74	2.5	BK	1350	Ground	I	-
75	2.5	GN/WH	2968	Transmission Auxiliary Oil Pump Control	-	HP6
76-77	-	-	-	Not Occupied	-	-
78	1	RD/GN	3140	Battery Positive Voltage	-	HP6
79-82	-	-	-	Not Occupied	-	-

X50A FUSE BLOCK - UNDERHOOD X1 (CZ2)

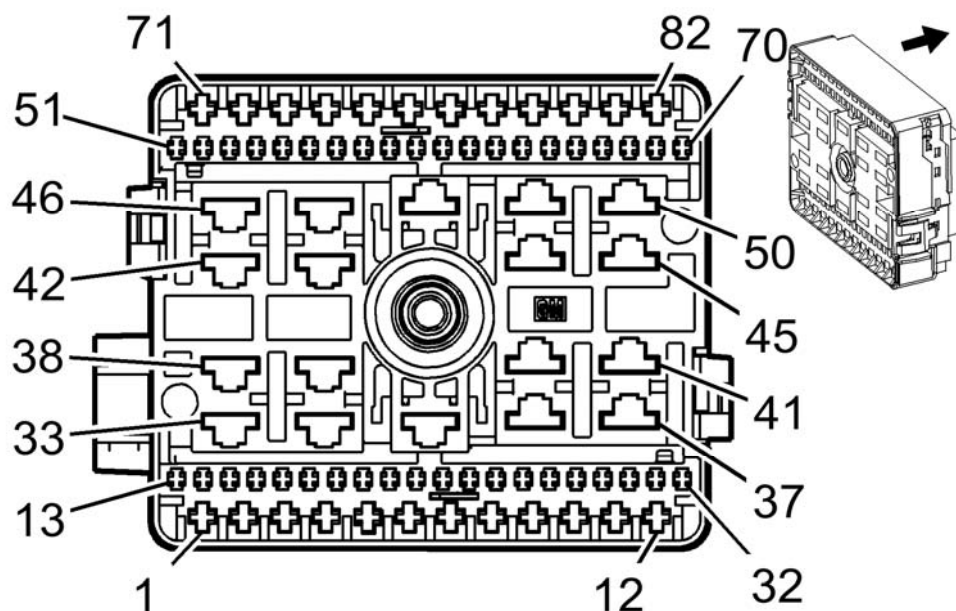


Fig. 15: X50A Fuse Block -- Underhood X1 (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 13262028
- Service Connector: 13576528
- Description: 82-Way F DSQ 1.5 2.8 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: 8, 12, 71-75
- Terminated Lead: 13327116
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Pins: 11, 81
- Terminated Lead: 13575780
- Release Tool: J-38125-36
- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 13-14, 31, 69
- Terminated Lead: 13327115
- Release Tool: J-38125-3C

- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 20, 30, 52, 66-68
- Terminated Lead: 13575774
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Pins: 34, 37, 43, 46, 50
- Terminated Lead: 13575718
- Release Tool: J-38125-3C
- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 35, 38
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Pins: 46-47
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Pins: 53-57, 65
- Terminated Lead: 13575773
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)

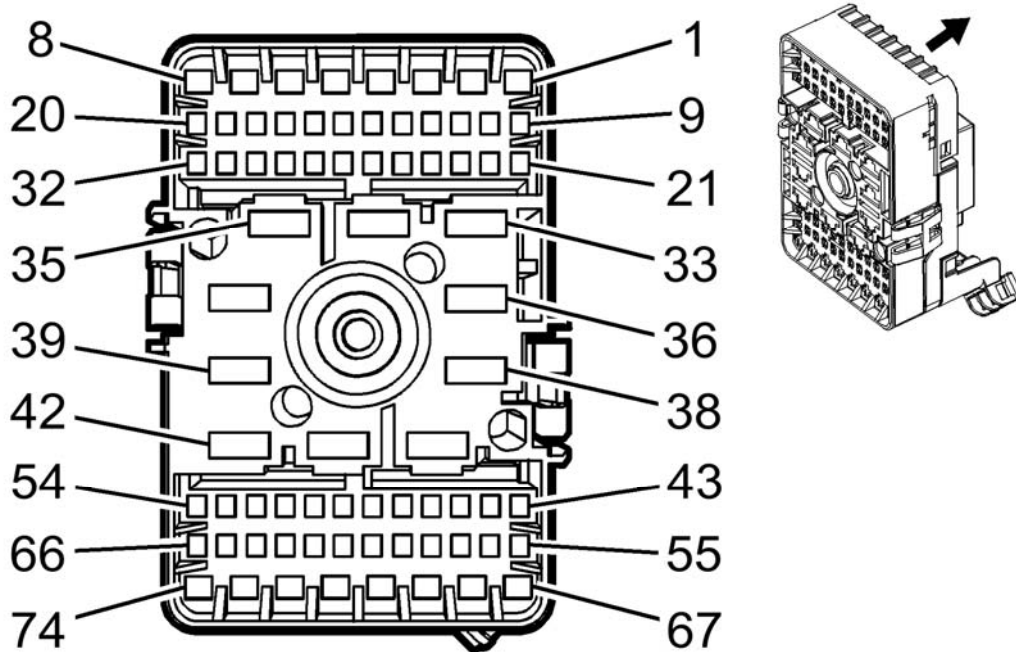
X50A Fuse Block - Underhood X1 (CZ2)

Pin	Wire	Circuit	Function
1-7	-	-	Not Used
8	1.5 YE	1201	Headlamp Low Beam
9-10	-	-	Not Used
11	1 BN/GY	29	Horn Control
12	1.5 YE	1201	Headlamp Low Beam
13	1.5 WH	311	Right Headlamp High Beam Control
14	1.5 WH	711	Left Headlamp High Beam Control
15-19	-	-	Not Used
20	0.75 RD/BU	999	Ignition Voltage (without LDK)
	0.75 VT/GN	839	Run/Crank Ignition 1 Voltage (LDK)
21-29	-	-	Not Used
30	1 GY/VT	228	Windshield Washer Pump Control

31	1.5 BN/VT	2234	Front Fog Lamp Control
32-33	-	-	Not Used
34	6 BN/YE	473	High Speed Cooling Fan Relay Control (LDK)
	6 WH/BK	2366	Cooling Fan Control Relay Speed Signal (without LDK)
35	2.5 RD/VT	1940	Battery Positive Voltage (LAF/LLU)
36	-	-	Not Used
37	6 WH/BK	2366	Cooling Fan Control Relay Speed Signal (LDK)
38	2.5 RD/GN	3140	Battery Positive Voltage (BTM)
39-42	-	-	Not Used
43	6 WH/BK	2366	Cooling Fan Control Relay Speed Signal (without LDK)
44-45	-	-	Not Used
46	6 GY	532	Cooling Fan Motor Control (2)
47	4 WH/BU	409	Cooling Fan Motor Control (1) (without LDK)
48-49	-	-	Not Used
50	6 WH/BU	409	Cooling Fan Motor Control (1) (LDK)
	6 YE	5358	Cooling Fan Motor Control (3) (without LDK)
51	-	-	Not Used
52	0.75 RD/GY	1042	Cooling Fan Control Relay Speed Signal (LDK)
53	0.5 BN/RD	2700	A/C Pressure Sensor 5V Reference
54	0.5BK/GY	2261	A/C Refrigerant Low Temperature Sensor Low Reference (LLU)
55	0.5 BK/BN	5514	A/C Refrigerant Pressure Sensor Low Reference
56	0.5 WH/BU	732	A/C Refrigerant High Temperature Sensor Signal (LLU)
57	0.5D- GN	380	A/C Refrigerant Pressure Sensor Signal (without LLU)
58-64	-	-	Not Used
65	0.5 VT/WH	2839	Ignition Voltage
66	0.75 RD/BU	999	Run/Crank Ignition 1 Voltage (without LDK)
	0.75 VT/GN	839	Run/Crank Ignition 1 Voltage (LDK)
67	0.75 D-GN	7625	Cooling Fan Motor Supply Voltage
68	0.75 D-GN	7625	Cooling Fan Motor Supply Voltage
69	1.5 BN/YE	189	Headlamp Leveling Motor Control (TR7)
70	-	-	Not Used

71	2.5 BK	1350	Ground
72	2.5 WH	92	Windshield Wiper Motor High Speed Control
73	2.5 YE/BN	95	Windshield Wiper Motor Low Speed Control
74	2.5 BK	1350	Ground
75	2.5 VT	1197	Headlamp Washer Pump Control (CE4)
76-80	-	-	Not Used
81	0.5 VT/GY	1039	Ignition Voltage (KU1/KU3)
82	0.5 VT/BK	339	Run/Crank Ignition 1 Voltage (TR6)

X50A FUSE BLOCK - UNDERHOOD X2 (EXCEPT CZ2)



Connector Part Information

- Harness Type: Body
- OEM Connector: 13262027
- Service Connector: 13576544
- Description: 74-Way F DSQ 1.5 2.8 Metri-Pack 800 Series (BK)

Terminal Part Information

Terminal	Terminated	Diagnostic	Terminal Removal	Service	Tray	Core	Insulation
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Type ID	Lead	Test Probe	Tool	Terminal		Crimp	Crimp
I	Pending	J-35616-35 (VT)	J-38125-36	2-964284-1	25	E	A
II	Pending	J-35616-44 (YE)	12150860	12110127	19	F	G
III	Pending	Pending	Pending	Pending	Pending	Pending	Pending

X50A Fuse Block - Underhood X2 (except CZ2)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	2.5	RD/VT	1140	Battery Positive Voltage	-	T4F
2	1.0	RD/YE	240	Battery Positive Voltage	-	HP6
3	0.5	VT/WH	2022	Coolant Pump Control	-	HP6
4	0.75	BK	2350	Ground	-	-
5	0.75	BU/WH	6128	Rear Compartment Unlatch Motor Unlatch Control	-	-
6-7	-	-	-	Not Occupied	-	-
8	2.5	RD/VT	1140	Battery Positive Voltage	-	T4F
9	.75	BU/WH	6128	Rear Compartment Unlatch Motor Unlatch Control	-	-
10	0.75	BN/GN	59	A/C Compressor Clutch Supply Voltage	-	LHU
11	0.35	GY/YE	2014	Coolant Pump Relay Coil Control	-	HP6
12	0.75	BU/YE	6795	Trunk Motor Release Control 2	-	-
13	0.5	GY/YE	6188	Trunk Motor Release Control	-	-
14	0.5	VT/BK	2939	Run/Crank Ignition 1 Voltage	I	-
15	0.5	VT/BK	1239	Run/Crank Ignition 1 Voltage	-	HP6
16	0.5	VT/BU	5294	Powertrain Main Relay Fused Supply (5)	-	FHS
17	0.5	GN/VT	5199	Run/Crank Relay Coil Control	I	-
18	-	-	-	Not Occupied	-	-
19	0.5	BN/WH	1317	Fog Lamp Relay Control	I	T3U
20	0.5 0.75	RD/BU RD/BN	840 440	Battery Positive Voltage Battery Positive Voltage	-	HP6 NU6
21	0.5	RD/BU	1240	Battery Positive Voltage	-	LHU
22	0.5	GY	91	Windshield Wiper Motor Relay Coil Supply Voltage	I	-
23	0.5	VT/BN	241	Run Ignition 3 Voltage	I	UVD
24	0.5	BN/YE	1970	Headlamp Low Beam Relay Control	-	T4F
25	0.5	BN/WH	28	Horn Relay Control	I	-
26	0.5	VT/WH	1139	Run/Crank Ignition 1 Voltage	I	-
27	0.75	RD/YE	240	Battery Positive Voltage	-	NV7 or NXC

28	0.5	RD/GY	2840	Battery Positive Voltage	I	-
29	0.5	VT/BN	241	Run Ignition 3 Voltage	-	-
30	1.5	GY/BU	415	Air Injection Reaction Solenoid Supply Voltage	-	NU6
31	0.75	VT/GN	39	Run/Crank Ignition 1 Voltage	I	DD8
32	-	-	-	Not Occupied	-	-
33	4	RD/BN	2940	Battery Positive Voltage	II	-
34	2.5	RD/GN	1542	Battery Positive Voltage	II	-
35	-	-	-	Not Occupied	-	-
36	4	RD/GN	1540	Battery Positive Voltage	II	-
37	4	BN/YE	78	Air Injection Reaction Pump Supply Voltage	-	NU6
38	-	-	-	Not Occupied	-	-
39	4	BN/VT	293	Rear Defog Element Supply Voltage	II	-
40	2.5	RD/BU	1340	Battery Positive Voltage	II	KI6
41	6	RD/BU	1640	Battery Positive Voltage	III	-
42	4	RD/BU	42	Battery Positive Voltage	II	-
43	0.5	GY	5127	After Boil Heater Relay Control	-	HP6
44	1	RD/VT	1640	Battery Positive Voltage	I	-
45	0.5	WH/VT	860	Front Windshield Wiper Switch High Signal	I	-
46	0.5	GY/BK	2967	Transmission Auxiliary Oil Pump Relay Control	-	HP6
47	0.5 0.5	RD/BU VT/BU	840 5294	Battery Positive Voltage Powertrain Main Relay Fused Supply (5)	-	HP6 NU6
48-55	-	-	-	Not Occupied	-	-
56	1	RD/VT	1640	Battery Positive Voltage	I	APH
57	-	-	-	Not Occupied	-	-
58	0.5	BN/VT	1969	Headlamp High Beam Relay Control	I	-
59	0.5	BU/BN	421	Air Injection Reaction Solenoid Relay Coil Control	-	NU6
60	0.5	BN/GY	2268	Windshield Washer Relay Control	I	-
61	0.5	BN/VT	193	Rear Defog Relay Control	I	-
62	0.75	BN/YE	2267	Mirror Heating Element Supply Voltage	I	-
63	0.5	RD/BU	840	Battery Positive Voltage	-	HP6
64-66	-	-	-	Not Occupied	-	-
67	0.5	RD/BU	1240	Battery Positive Voltage	-	LHU
68	2.5	GN/GY	9	Battery Positive Voltage	III	-
69	2.5	RD/WH	2040	Battery Positive Voltage	III	KA1

70	2.5	RD/WH	742	Battery Positive Voltage	III	CF5
71	2.5	RD/VT	3740	Battery Positive Voltage	III	UQA
72	0.5	RD/YE	1442	Battery Positive Voltage	I	-
73	0.75	BU	5372	Canister Valve Solenoid	I	-
74	2.5	RD/GY	1740	Battery Positive Voltage	III	-

X50A FUSE BLOCK - UNDERHOOD X2 (CZ2)

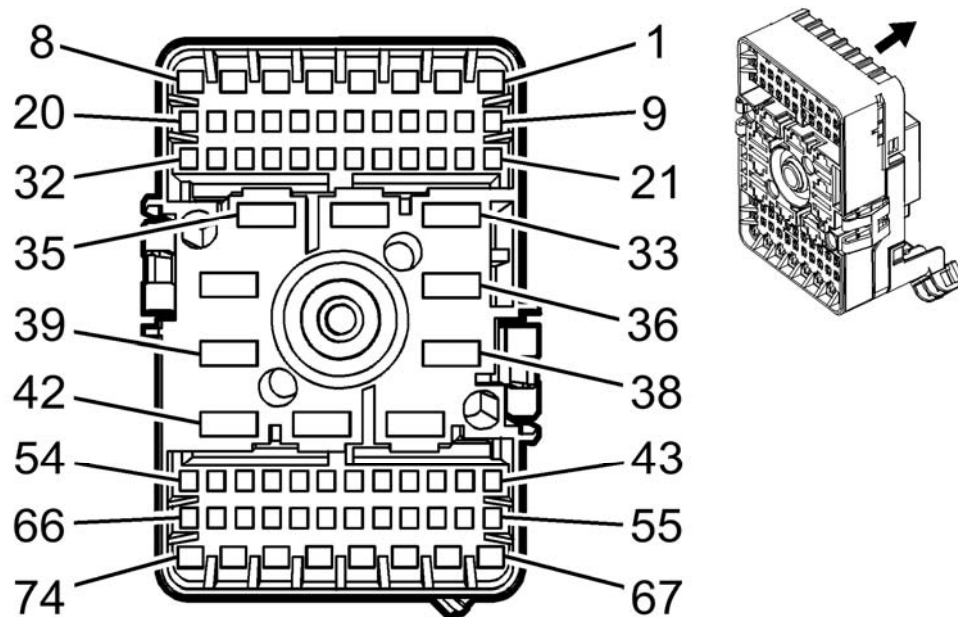


Fig. 16: X50A Fuse Block - Underhood X2 (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Body
- OEM Connector: 13262027
- Service Connector: 13576544
- Description: 74-Way F 1.5/2.8 DSQ Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: 1-8, 67-74
- Terminated Lead: 13327116
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)

- Pins: 9-32, 43-66
 - Terminated Lead: 15345994
 - Release Tool: J-38125-560
 - Diagnostic Test Probe: J-35616-14 (GN)
-
- Pins: 33, 42
 - Terminated Lead: 13575718
 - Release Tool: J-38125-560
 - Diagnostic Test Probe: J-35616-14 (GN)

X50A Fuse Block - Underhood X2

Pin	Wire	Circuit	Function
1	2.5 RD/BN	1140	Battery Positive Voltage (TT4/T4F)
2-5	-	-	Not Used
6	2.5 GY	120	Fuel Pump Control
7	-	-	Not Used
8	2.5 RD/BN	1140	Battery Positive Voltage (TT4/T4F)
9	-	-	Not Used
10	0.75 BN/GN	59	A/C Compressor Clutch Control
11-13	-	-	Not Used
14	0.5 VT/BK	2939	Run/Crank Ignition 1 Voltage
15	1.5 RD/VT	1640	Battery Positive Voltage (TT4/T4F)
16	-	-	Not Used
17	0.5 BN/VT	1594	Ignition 3 Relay Control
18	-	-	Not Used
19	0.5 BN/WH	1317	Fog Lamp Relay Control
20	1.5 YE	312	Right Headlamp Low Beam Control (TT4)
21	-	-	Not Used
22	0.5 GY	91	Windshield Wiper Motor Relay Coil Control
23	0.75 VT/BK	339	Run/Crank Ignition 1 Voltage
24	0.5 D-GN/WH	5462	Daytime Running Lamp Override Signal (T4F)
	0.5 GY/VT	6560	Left Cornering Lamp Relay Control (TT4)
25	0.5 BN/WH	28	Horn Relay Control
26	0.5 VT/WH	1139	Run/Crank Ignition 1 Voltage
27	0.75 RD	240	Battery Positive Voltage
28	0.5 RD/GY	2840	Battery Positive Voltage
29-30	-	-	Not Used
31	0.75 VT/GN	39	Ignition Voltage (DD8)
32	-	-	Not Used
33	4 RD/BN	2940	Battery Positive Voltage

34	2.5 RD/BU	1542	Battery Positive Voltage
35	-	-	Not Used
36	4 RD/GN	1540	Battery Positive Voltage
37-38	-	-	Not Used
39	4 BN/VT	293	Rear Defog Element Control
40	-	-	Not Used
41	6 RD/VT	1640	Battery Positive Voltage
42	4 RD/WH	1040	Battery Positive Voltage (J71)
43	0.5 BU/BN	6561	Right Cornering Lamp Relay Control (TT4)
44	1 RD/VT	1640	Battery Positive Voltage (APG)
45	0.5 WH/VT	860	Front Windshield Wiper Switch High Signal
46	0.5 YE/BU	2282	Headlamp Washer Relay Control (CE4)
47	1 RD/BU	1240	Battery Positive Voltage (TT4)
48	0.5 BK/PU	6165	All Door Deadbolt Motor Lock Control
49	0.5 GY	7599	Siren Control
50	0.75 GY	5911	Door Lock Actuator Lock Control 2 (AF8)
51	-	-	Not Used
52	0.75 D-BU/WH	195	Door Lock Control
53	0.75 BN	5910	Door Double Lock Actuator Lock Control (AF8)
54-55	-	-	Not Used
56	1 D-GN/GY	1640	Battery Positive Voltage (APH)
57	-	-	Not Used
58	0.5 BN/VT	1969	Headlamp High Beam Relay Control
59	-	-	Not Used
60	0.5 BN/GY	2268	Windshield Washer Relay Control
61	0.5 BN/VT	193	Rear Defog Relay Control
62	0.75 BN/YE	2267	Mirror Heating Element Control
63	0.5 VT/GY	139	Ignition Voltage (TT4/T4F)
64	0.75 RD/BN	440	Battery Positive Voltage (CE1)
65-67	-	-	Not Used
68	2.5 D-GN/GY	9	Park Lamp Control
69	2.5 RD/WH	2040	Battery Positive Voltage (KA1-A45)
70	2.5 RD/GN	742	Battery Positive Voltage
71	2.5 RD/YE	3740	Battery Positive Voltage (UQS)
72	0.5 RD/YE	1442	Battery Positive Voltage
73	-	-	Not Used
74	2.5 RD/GY	1740	Battery Positive Voltage (LDK/LTD)

X50A FUSE BLOCK - UNDERHOOD X3 (LDK)

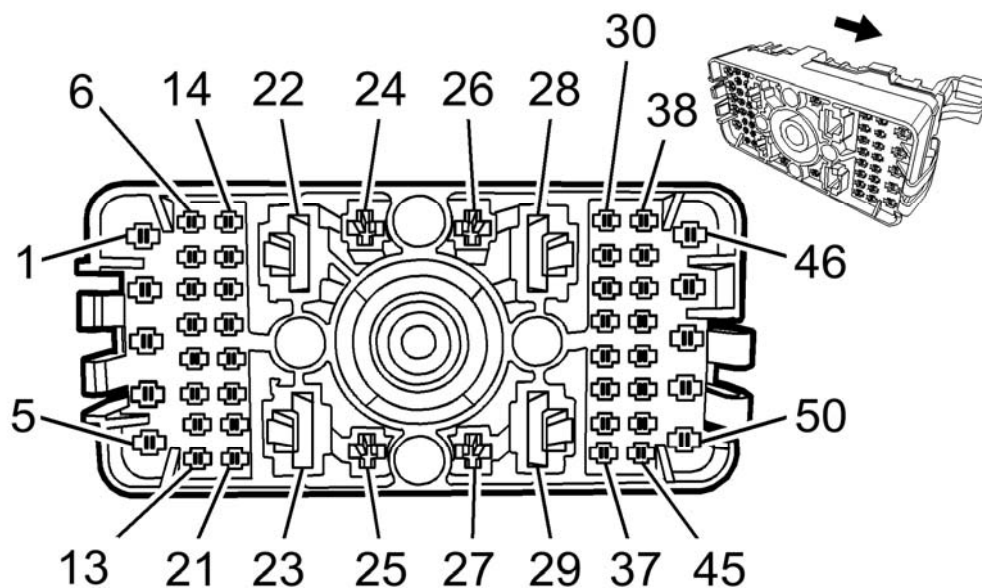


Fig. 17: X50A Fuse Block -- Underhood X3 Connector (LDK)
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Engine
- OEM Connector: 13732282
- Service Connector: 13505902
- Description: 50-Way F DSQ 1.5 2.8 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: 1-2, 5
- Terminated Lead: 13327116
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Pins: 4, 46, 49
- Terminated Lead: 15409039
- Release Tool: J-38125-36
- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 6, 37

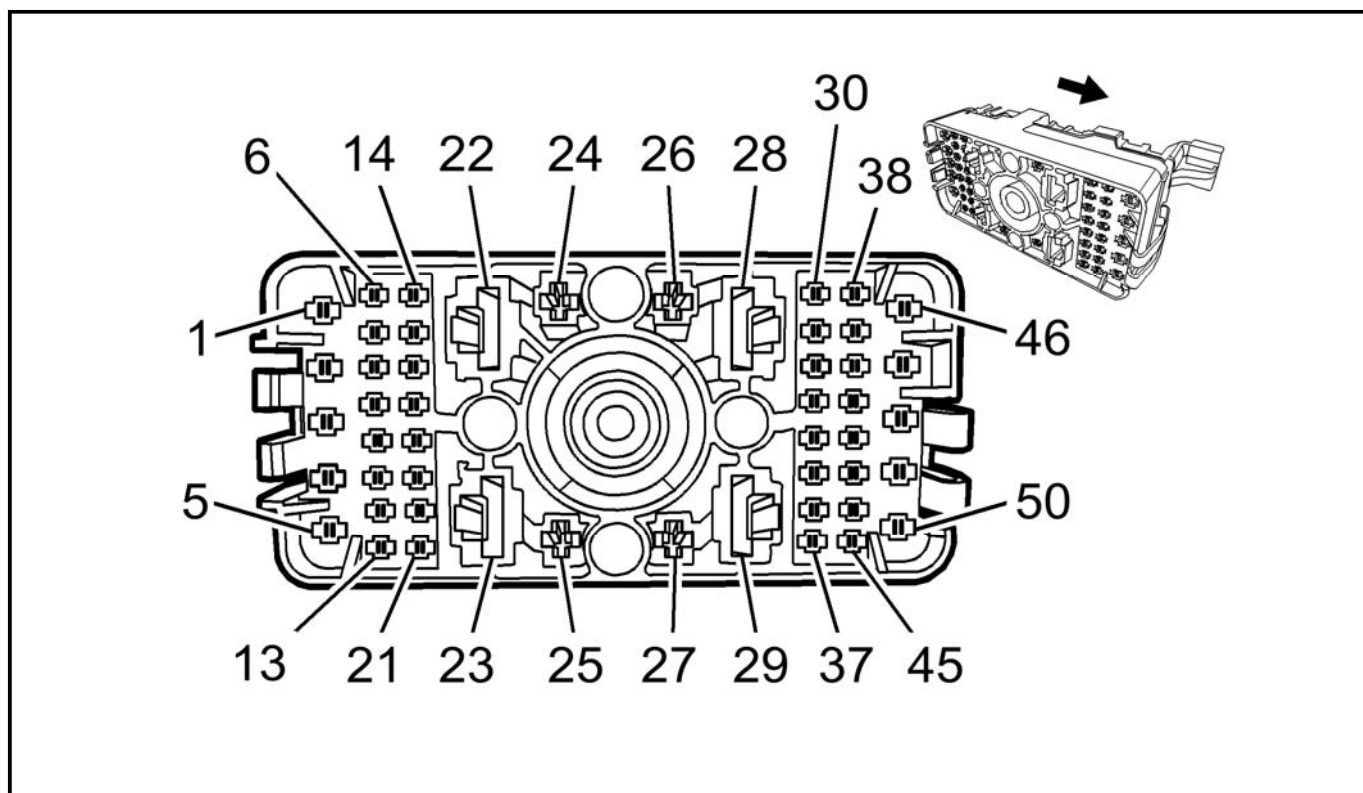
- Terminated Lead: 13327115
- Release Tool: J-38125-36
- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 7, 11, 15, 17, 20-21, 32, 34, 38-39
- Terminated Lead: 15345988
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)

X50A Fuse Block - Underhood X3 (LDK)

Pin	Wire	Circuit	Function
1	2.5 PK/BK	5290	Powertrain Main Relay Fused Supply (1)
2	2.5 PK/BK	5291	Powertrain Main Relay Fused Supply (2)
3	-	-	Not Used
4	0.5 BK	39	Ignition Voltage
5	2.5 YE	6	Starter Solenoid Crank Voltage
6	1.5 PK/BK	5293	Powertrain Main Relay Fused Supply (4)
7	0.5 PK/BK	5294	Powertrain Main Relay Fused Supply (4)
8-10	-	-	Not Used
11	0.5 VT/WH	6386	Starter Enable Relay (PPEI 3) Control
12-14	-	-	Not Used
15	0.5 D-BU	473	High Speed Cooling Fan Relay Control
16	-	-	Not Used
17	0.5 YE	5991	Engine Main Relay Coil Control
18-19	-	-	Not Used
20	0.5 PK	139	Ignition Voltage
21	0.5 BK	150	Ground
22-26	-	-	Not Used
27	0.5 RD/WH	140	Battery Positive Voltage
28-31	-	-	Not Used
32	0.5 OG/BK	380	A/C Refrigerant Pressure Sensor Signal
33	-	-	Not Used
34	0.5 D-GN/WH	459	A/C Compressor Clutch Relay Control
35-36	-	-	Not Used
37	1.5 RD	40	Battery Positive Voltage (MH8)
38	0.5 GY	2700	A/C Pressure Sensor 5 Volt Reference
39	0.5 WH	5514	A/C Refrigerant Pressure Sensor Low Reference
40-45	-	-	Not Used
46	0.5 D-BU	473	High Speed Cooling Fan Relay Control
47-48	-	-	Not Used

49	0.5 D-GN	335	Low Speed Cooling Fan Relay Control
50	-	-	Not Used

X50A FUSE BLOCK - UNDERHOOD X3 (LHU)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13262029
- Service Connector: 13505902
- Description: 50-Way F 1.5/2.8 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: 1-5, 24-27, 46-50
- Terminated Lead: Pending
- Release Tool: J-38125-36
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available
- Pins: 6-21, 30-45
- Terminated Lead: Pending
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

X50A Fuse Block - Underhood X3 (LHU)

Pin	Size	Color	Circuit	Function	Option
1	2.5	VT/BU	5290	Powertrain Main Relay Fused Supply (1)	-
2	2.5	VT/BU	5291	Powertrain Main Relay Fused Supply (2)	-
3	-	-	-	Not Occupied	-
4	0.5	VT/GN	39	Run/Crank Ignition 1 Voltage	-
5	2.5	YE	6	Starter Solenoid Crank Voltage	-
6	1.5	VT/BU	5293	Powertrain Main Relay Fused Supply (4)	-
7	0.5	VT/BU	5294	Powertrain Main Relay Fused Supply (5)	-
8-10	-	-	-	Not Occupied	-
11	0.5	VT/GY	6386	Starter Enable Relay (PPEI 3) Control	-
12-14	-	-	-	Not Occupied	-
15	0.5	BN/YE	473	High Speed Cooling Fan Relay Control	-
16	-	-	-	Not Occupied	-
17	0.5	YE	5991	Powertrain Relay Coil Control	-
18-19	-	-	-	Not Occupied	-
20	0.5	VT/GY	139	Run/Crank Ignition 1 Voltage	-
21	0.5	BK	2650	Ground	-
22-26	-	-	-	Not Occupied	-
27	0.5	RD/WH	140	Battery Positive Voltage	-
28-31	-	-	-	Not Occupied	-
32	0.5	GN	380	A/C Refrigerant Pressure Sensor Signal	-
33	-	-	-	Not Occupied	-
34	0.5	WH/GY	459	A/C Compressor Clutch Relay Control	-
35-36	-	-	-	Not Occupied	-
37	1.5	RD/GN	40	Battery Positive Voltage	MDk or MHK
38	0.5	BN/RD	2700	5-Volt Reference	-
39	0.5	BK/BN	5514	Low Reference	-
40-45	-	-	-	Not Occupied	-
46	0.5	BN/YE	473	High Speed Cooling Fan Relay Control	-
47-48	-	-	-	Not Occupied	-
49	0.5	GN/VT	335	Low Speed Cooling Fan Relay Control	-
50	-	-	-	Not Occupied	-

X50A FUSE BLOCK - UNDERHOOD X3 (LLU)

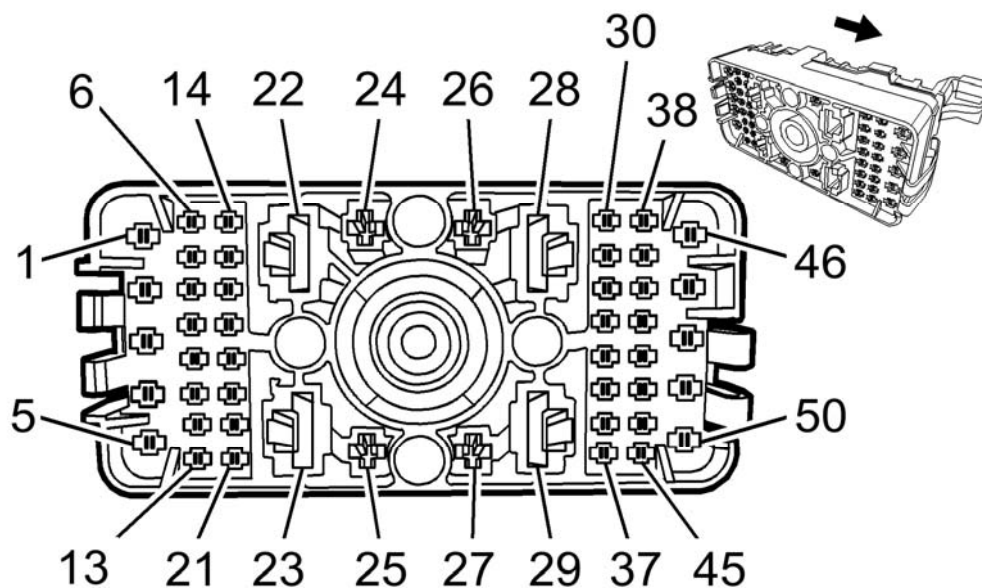


Fig. 18: X50A Fuse Block -- Underhood X3 Connector (LLU)
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Engine
- OEM Connector: 13732282
- Service Connector: 13505902
- Description: 50-Way F DSQ 1.5 2.8 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: 1-2, 5
- Terminated Lead: 13327116
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Pins: 4, 27, 46, 49
- Terminated Lead: 15409037
- Release Tool: J-38125-36
- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 7
- Terminated Lead: 13327115
- Release Tool: J-38125-36

- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 8
- Terminated Lead: 15345994
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Pins: 9, 11, 13, 15, 17, 20-21, 32, 34, 38-39
- Terminated Lead: 15345998
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)

X50A Fuse Block - Underhood X3 Connector (LLU)

Pin	Wire	Circuit	Function
1	2.5 RD/BU	5291	Powertrain Main Relay Fused Supply (2)
2	1.5 RD/BU	5290	Powertrain Main Relay Fused Supply (1)
3	-	-	Not Used
4	0.75 VT/GY	339	Ignition Voltage
5	2.5 YE	6	Starter Solenoid Crank Voltage
6	-	-	Not Used
7	1.5 RD/WH	5291	Powertrain Main Relay Fused Supply (2)
8	0.5 VT/GY	239	Ignition Voltage (D)
9	0.5 BK	150	Ground
10	-	-	Not Used
11	0.5 VT/RD	447	Starter Relay Coil Control
12	-	-	Not Used
13	0.5 GN/GY	465	Fuel Pump Primary Relay Control
14	-	-	Not Used
15	0.5 BN/YE	473	High Speed Cooling Fan Relay Control
16	-	-	Not Used
17	0.5 BN/WH	5069	Engine Main Relay Coil Control
18-19	-	-	Not Used
20	0.5 VT/BU	139	Ignition Voltage (D)
21	0.5 BK	150	Ground
22-26	-	-	Not Used
27	0.5 RD/WH	140	Battery Positive Voltage
28-31	-	-	Not Used
32	0.5 GN	380	A/C Refrigerant Pressure Sensor Signal
33	-	-	Not Used
34	0.5 WH/GY	459	A/C Compressor Clutch Relay Control
35-37	-	-	Not Used

38	0.5 BN/RD	2700	A/C Pressure Sensor 5V Reference
39	0.5 BK/WH	151	Signal Ground
40-45	-	-	Not Used
46	0.5 BN/YE	473	High Speed Cooling Fan Relay Control
47-48	-	-	Not Used
49	0.5 GN/VT	335	Low Speed Cooling Fan Relay Control
50	-	-	Not Used

X50A FUSE BLOCK - UNDERHOOD X3 (LTD)

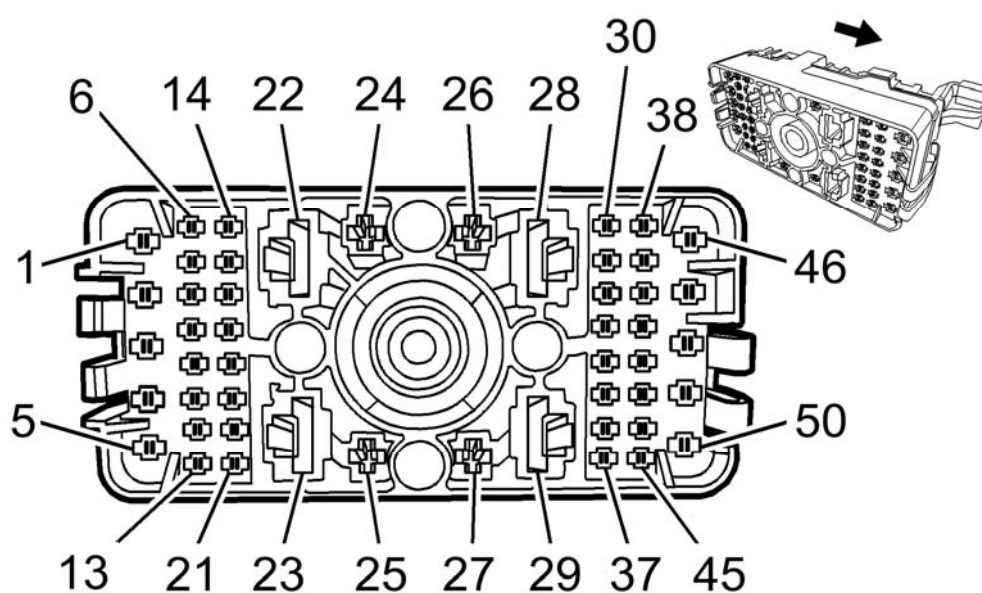


Fig. 19: X50A Fuse Block -- Underhood X3 Connector (LTD)
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Engine
- OEM Connector: 13732282
- Service Connector: 13505902
- Description: 50-Way F DSQ 1.5 2.8 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: 1-4, 27, 49

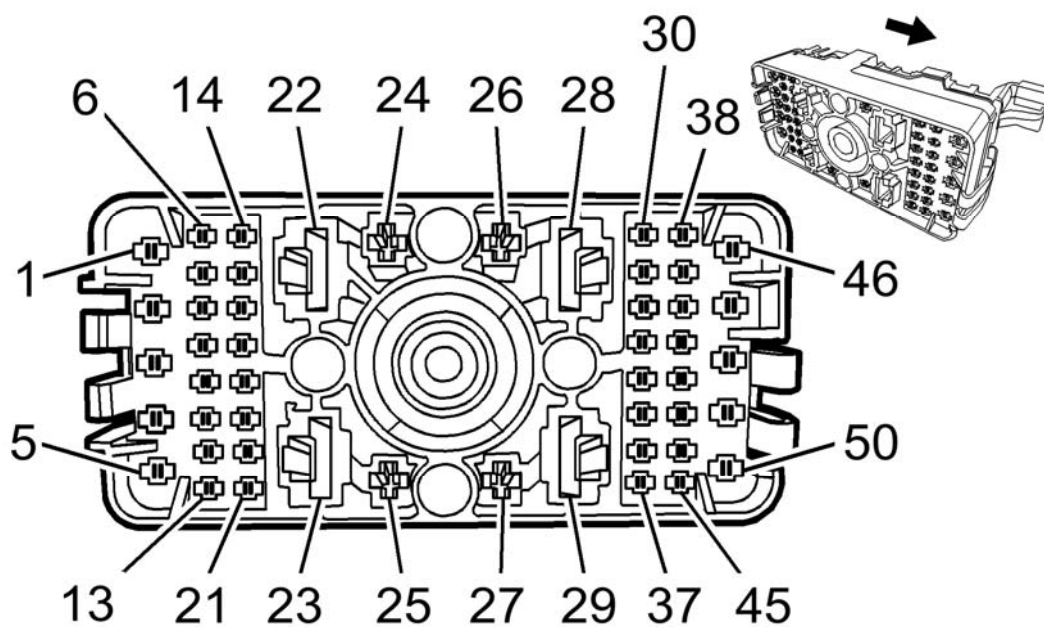
- Terminated Lead: 15409039
 - Release Tool: J-38125-36
 - Diagnostic Test Probe: J-35616-35 (VT)
-
- Pins: 5
 - Terminated Lead: 13327116
 - Release Tool: J-38125-560
 - Diagnostic Test Probe: J-35616-14 (GN)
-
- Pins: 6, 37
 - Terminated Lead: 13575774
 - Release Tool: J-38125-560
 - Diagnostic Test Probe: J-35616-14 (GN)
-
- Pins: 9, 11, 13, 15, 17, 20-21, 32, 38-39
 - Terminated Lead: 15345994
 - Release Tool: J-38125-560
 - Diagnostic Test Probe: J-35616-14 (GN)
-
- Pins: 46
 - Terminated Lead: 13575541
 - Release Tool: J-38125-36
 - Diagnostic Test Probe: J-35616-35 (VT)

X50A Fuse Block - Underhood X3 (LTD)

Pin	Wire	Circuit	Function
1	0.75 VT/BU	5290	Powertrain Main Relay Fused Supply (1)
2	0.75 VT/BU	5291	Powertrain Main Relay Fused Supply (2)
3	0.5 VT/BU	5292	Ignition Voltage
4	0.5 BK/VT	2139	Run/Crank Ignition 1 Voltage (MH8)
5	2.5 YE	6	Starter Solenoid Crank Voltage
6	0.75 VT/BU	5293	Powertrain Main Relay Fused Supply (4)
7-8	-	-	Not Used
9	0.5 BK	2650	Ground
10	-	-	Not Used
11	0.5 VT/GY	6386	Starter Enable Relay (PPEI 3) Control
12	-	-	Not Used
13	0.5 GN/GY	465	Fuel Pump Primary Relay Control
14	-	-	Not Used
15	0.5 BN/YE	473	High Speed Cooling Fan Relay Control
16	-	-	Not Used

17	0.5 YE	5991	Powertrain Relay Coil Control
18-19	-	-	Not Used
20	0.5 VT/GN	439	Ignition Voltage
21	0.5 BK	2650	Ground
27	0.75 RD/BN	440	Battery Positive Voltage
28-31	-	-	Not Used
32	0.5 GN	380	A/C Refrigerant Pressure Sensor Signal
37	1 RD/GN	1840	Battery Positive Voltage
38	0.5 BN/RD	2700	A/C Pressure Sensor 5V Reference
39	0.5 BK/BN	5514	A/C Refrigerant Pressure Sensor Low Reference
40-45	-	-	Not Used
46	0.5 BN/YE	473	High Speed Cooling Fan Relay Control
	0.5 BN/YE	473	High Speed Cooling Fan Relay Control
47-48	-	-	Not Used
49	0.5 GN/VT	335	Low Speed Cooling Fan Relay Control

X50A FUSE BLOCK - UNDERHOOD X3 (LUK)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13732282

- Service Connector: 13505902
- Description: 50-Way F 1.5/2.8 Metri-Pack 800 Series (BK)

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	13575780	J-35616-35 (VT)	J-38125-36	2-964284-1	25	E	A
II	13575541	J-35616-35 (VT)	J-38125-36	4-965999-1	25	C	A
III	13327116	J-35616-35 (VT)	J-38125-36	Not Available	Not Available	Not Available	Not Available
IV	Pins: 6, 10-11, 12, 15-18, 20 - 13575773	J-35616-14 (GN)	J-38125-560	962943-5	16	E	A

X50A Fuse Block - Underhood X3 (LUK)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	1	VT/BU	5290	Powertrain Main Relay Fused Supply (1)	I	-
2	2.5	VT/BU	5291	Powertrain Main Relay Fused Supply (2)	I	-
3	-	-	-	Not Occupied	-	-
4	0.5	VT/GN	2139	Run/Crank Ignition 1 Voltage	II	-
5	2.5	YE	6	Starter Solenoid Crank Voltage	III	-
6	0.5	VT/D-BU	5293	Powertrain Main Relay Fused Supply (4)	IV	-
7-9	-	-	-	Not Occupied	-	-
10	0.5	GY	5127	After Boil Heater Relay Control	IV	-
11	0.5	VT/GY	6386	Starter Enable Relay (PPEI 3) Control	IV	-
12	0.5	GN/BU	436	Air Injection Reaction Pump Relay Coil Control	IV	NU6
13-14	-	-	-	Not Occupied	-	-
15	0.5	BN/YE	473	High Speed Cooling Fan Relay Control	IV	-
16	0.5	YE/BU	5126	After Boil Heater Pump	IV	-
17	0.5	YE	5991	Powertrain Relay Coil Control	IV	-
18	0.5	GN/VT	335	Low Speed Cooling Fan Relay Control	IV	-
19	-	-	-	Not Occupied	-	-

20	0.5	VT/L-GN	439	Run/Crank Ignition 1 Voltage	IV	-
21	0.5	BK	2650	Ground	-	-
22-26	-	-	-	Not Occupied	-	-
27	0.5	RD/BN	440	Battery Positive Voltage	I	-
28-31	-	-	-	Not Occupied	-	-
32	0.5	GN	380	A/C Refrigerant Pressure Sensor Signal	IV	-
33	-	-	-	Not Occupied	-	-
34	0.5	WH/GY	459	A/C Compressor Clutch Relay Control	-	-
35-36	-	-	-	Not Occupied	-	-
37	1.5	RD/GN	1840	Battery Positive Voltage	IV	-
38	0.5	BN/RD	2700	5-Volt Reference	IV	-
39	0.5	BK/BN	5514	Low Reference	IV	-
40-45	-	-	-	Not Occupied	-	-
46	0.5	BN/YE	473	High Speed Cooling Fan Relay Control	II	-
47-48	-	-	-	Not Occupied	-	-
49	0.5	GN/VT	335	Low Speed Cooling Fan Relay Control	II	-
	0.5	GN/VT	335	Low Speed Cooling Fan Relay Control		-
50	0.75	BN/GN	59	A/C Compressor Clutch Supply Voltage	-	-

X50A FUSE BLOCK - UNDERHOOD X4

Connector Part Information

- Harness Type: Fuse Block - Underhood
- OEM Connector: Not Available
- Service Connector: Not Available
- Description: Ring Terminal

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Service by Harness - See Part Catalog	No Tool Required	No Tool Required	Not Available	Not Available	Not Available	Not Available

X50A Fuse Block - Underhood X4

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	35	RD/WH	4042	Battery Positive Voltage	I	-

X50A FUSE BLOCK - UNDERHOOD X5 (HP6)

Connector Part Information							
<ul style="list-style-type: none">• Harness Type: High Voltage - High Current• OEM Connector: Not Available• Service Connector: Not Available• Description: Ring Terminal							

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Service by Harness - See Part Catalog	No Tool Required	No Tool Required	Not Available	Not Available	Not Available	Not Available

X50A Fuse Block - Underhood X5 (HP6)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
A	15	RD/YE	2	Battery Positive Voltage	I	-

X50A FUSE BLOCK - UNDERHOOD X6 (NJ1)

Connector Part Information							
<ul style="list-style-type: none">• Harness Type: Power Steering• OEM Connector: Not Available• Service Connector: Not Available• Description: Ring Terminal							

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
	Service by	No Tool	No Tool	Not	Not	Not	Not

I	Harness - See Part Catalog	Required	Required	Available	Available	Available	Available
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X50A Fuse Block - Underhood X6 (NJ1)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
A	10	RD/YE	1142	Battery Positive Voltage	I	-

X50D FUSE BLOCK - BATTERY TOP VIEW

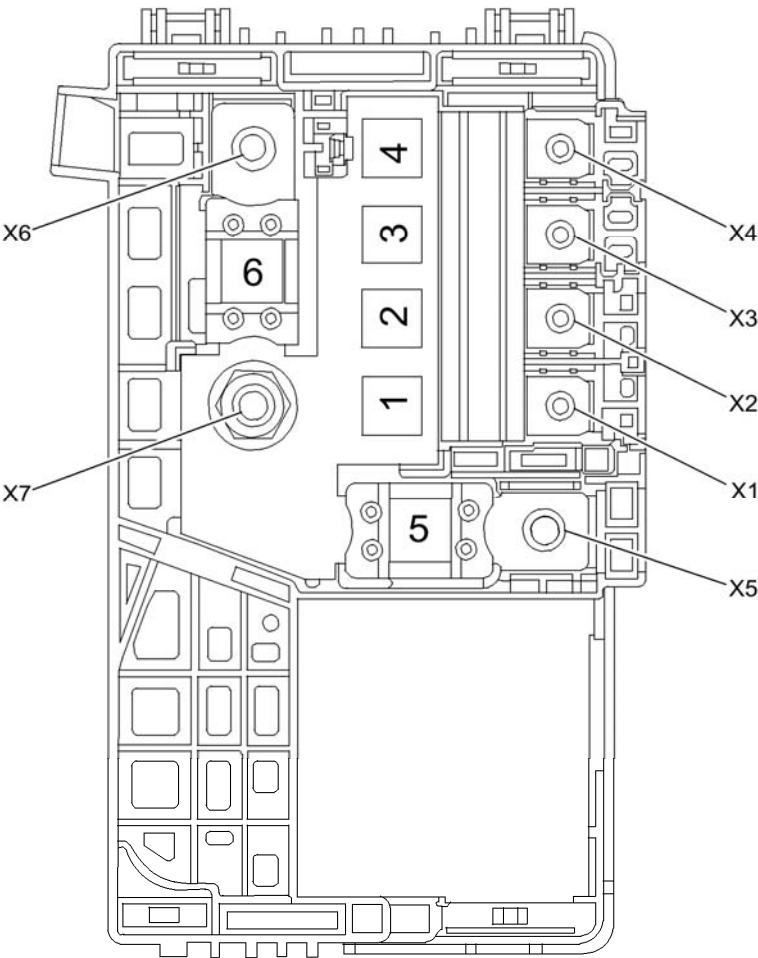


Fig. 20: X50D Fuse Block-- Battery Top View
 Courtesy of GENERAL MOTORS COMPANY

X50D Fuse Block - Battery Usage

No.	Device Label Name	Device Assigned Name	Rating	Description
1	-	F1UB Fuse	100A	X51A Fuse Block - Instrument Panel

2	-	F2UB Fuse	100A	X51A Fuse Block - Instrument Panel
3	-	F3UB Fuse	100A	Not Used
4	-	F4UB Fuse	100A	NotUsed
5	-	F5UB Fuse	250A	X50A Fuse Block - Underhood
6	-	F6UB Fuse	300A (except LHU) 250A (LHU)	G13 Generator (except LHU) G13 Generator (LHU), M64 Starter Motor (LHU)

X50D FUSE BLOCK - BATTERY X1

Connector Part Information

- Harness: Body
- OEM Connector: Not Available
- Service Connector: Not Available
- Description: Ring Terminal

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Service by Harness - See Part Catalog	No Tool Required	No Tool Required	Not Available	Not Available	Not Available	Not Available

X50D Fuse Block - Battery X1

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	10	RD/BK	5142	Battery Positive Voltage	I	-

X50D FUSE BLOCK - BATTERY X2

Connector Part Information

- Harness: Body
- OEM Connector: Not Available
- Service Connector: Not Available
- Description: Ring Terminal

Terminal Part Information

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Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Service by Harness - See Part Catalog	No Tool Required	No Tool Required	Not Available	Not Available	Not Available	Not Available

X50D Fuse Block - Battery X2

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
2	10	RD/BU	5140	Battery Positive Voltage	I	-

X50D FUSE BLOCK - BATTERY X5

Connector Part Information

- Harness: Fuse Block- Underhood
- OEM Connector: Not Available
- Service Connector: Not Available
- Description: Ring Terminal

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Service by Harness - See Part Catalog	No Tool Required	No Tool Required	Not Available	Not Available	Not Available	Not Available

X50D Fuse Block - Battery X5

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
A	35	RD/WH	4042	Battery Positive Voltage	I	-

X50D FUSE BLOCK - BATTERY X6 (EXCEPT CZ2)

Connector Part Information

- Harness Type: Starter and Generator (LHU)
- Harness Type: Starter (LUK)
- OEM Connector: Not Available

- Service Connector: Not Available
- Description: Ring Terminal

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Service by Harness - See Part Catalog	No Tool Required	No Tool Required	Not Available	Not Available	Not Available	Not Available

X50D Fuse Block - Battery X6 (except CZ2)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
A	25	RD	2	Battery Positive Voltage	I	LHU

X50D FUSE BLOCK - BATTERY X6 (CZ2)

Terminal Part Information

- Harness: Body
- Description: Ring Terminal
- Terminated Lead: Service by Harness - See Part Catalog
- Release Tool: No Tool Required
- Diagnostic Test Probe: No Tool Required

X50D Fuse Block - Battery X6 (CZ2)

Pin	Wire	Circuit	Function
1	35 RD	1	Battery Positive Voltage

X50D FUSE BLOCK - BATTERY X7 (EXCEPT CZ2)

Connector Part Information

- Harness: Battery (+)
- OEM Connector: Not Available
- Service Connector: Not Available
- Description: Battery Ring Terminal

Terminal Part Information

Terminal	Terminated	Diagnostic	Terminal	Service		Core	Insulation
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Type ID	Lead	Test Probe	Removal Tool	Terminal	Tray	Crimp	Crimp
I	Service by Harness - See Part Catalog	No Tool Required	No Tool Required	Not Available	Not Available	Not Available	Not Available

X50D Fuse Block - Battery X7 (except CZ2)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
A	25	RD	2	Battery Positive Voltage	I	LHU

X50D FUSE BLOCK - BATTERY X7 (CZ2)

Terminal Part Information <ul style="list-style-type: none"> • Harness: Body • Description: Ring Terminal • Terminated Lead: Service by Harness - See Part Catalog • Release Tool: No Tool Required • Diagnostic Test Probe: No Tool Required 						
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X50D Fuse Block - Battery X7 (CZ2)

Pin	Wire	Circuit	Function
1	35 RD/YE	2	Battery Positive Voltage

X51A FUSE BLOCK - INSTRUMENT PANEL TOP VIEW FUSES (EXCEPT CZ2)

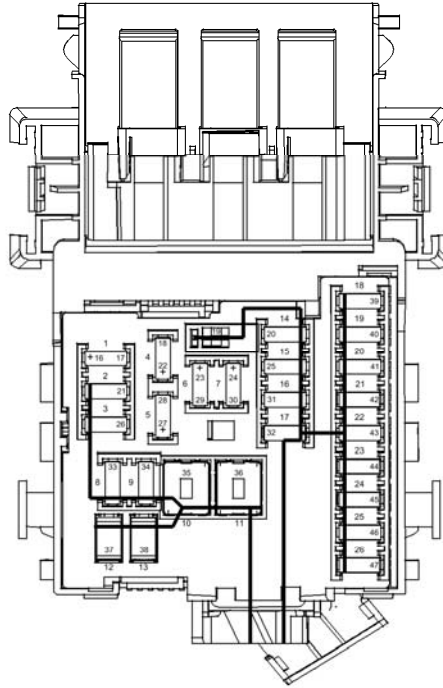


Fig. 21: X51A Fuse Block - Instrument Panel Top View Fuses (except CZ2)
 Courtesy of GENERAL MOTORS COMPANY

X51A Fuse Block - Instrument Panel Fuse Usage

No.	Device Name	Device Assigned Name	Rating	Description
1	1	F1DA Fuse	10A	K19 Suspension Control Module (F45)S25 Garage Door Opener (UG1)
2	2	F2DA Fuse	20A	A3L Sunshade - Left, A3R Sunshade - Right, E5AN Stop/Turn Signal Lamp - Right, E27 Instrument Panel Compartment Lamp, E37D Dome/Reading Lamps - Overhead Console, E37R Dome/Reading Lamps - Rear, K9 Body Control Module
3	3	F3DA Fuse	25A	E2LF Side Marker Lamp - Left Front, E4N Park/Turn Signal Lamp - Left (T4A), E4P Park/Turn Signal Lamp - Right (T4A), E4RF Turn Signal Lamp - Right Front, E4Z Turn Signal Repeater Lamp - Right, E5AK Tail Lamp - Left Outer, E5G Tail Lamp - Left Inner, K9 Body Control Module, KR12B Windshield Wiper Relay, X80G Accessory Power Receptacle - Instrument Panel
4	4	F4DA Fuse	20A	A11 Radio
				A22 Radio Controls, K41R Rear Parking

5	5	F5DA Fuse	10A	Assist Control Module (UD7), P17 Info Display Module, S56 Radio Multifunction Switch (KRJ), T11 Multimedia Player Interface Module (KTA), X83A Auxiliary Audio Input with Memory Card Receptacle (UEW)
6	6	F6DA Fuse	20A	X80G Accessory Power Receptacle - Instrument Panel
7	7	F7DA Fuse	20A	X80H Accessory Power Receptacle - Center Console
8	8	F8DA Fuse	30A	E4G Headlamp - Left Low Beam (T4A), E4J Park Lamp - Left Front (T4F), K9 Body Control Module
9	9	F9DA Fuse	30A	E4H Headlamp - Right Low Beam (T4A), E4K Park Lamp - Right Front (T4F), K9 Body Control Module
10	10	F10DA Fuse	30A	A23D Door Latch Assembly - Driver, A23LR Door Latch Assembly - Left Rear, A23P Door Latch Assembly - Passenger, A23RR Door Latch Assembly - Right Rear, K9 Body Control Module, M97 Fuel Door Lock Actuator
11	11	F11DA Fuse	40A	K8 Blower Control Module
12	12	F12DA Circuit Breaker	25A	S64P Seat Adjuster Switch - Passenger (A6C or AG2)
13	13	F13DA Circuit Breaker	25A	S64D Seat Adjuster Switch - Driver (AG1)
14	14	F14DA Fuse	7.5A	X84 Data Link Connector
15	15	F15DA Fuse	10A	K36 Inflatable Restraint Sensing and Diagnostic Module
16	16	F16DA Fuse	-	Not Occupied
17	17	F17DA Fuse	10A	A26 HVAC Controls, K33 HVAC Control Module
18	18	F18DA Fuse	30A	F1DA, Fuse, F4DA Fuse, F5DA Fuse
19	19	F19DA Fuse	-	Not Occupied
20	20	F20DA Fuse	5A	K85 Passenger Presence Detection Module
21	21	F21DA Fuse	10A	P16 Instrument Cluster
22	22	F22DA Fuse	2A	K84 Keyless Entry Control Module (BTM), S39 Ignition Switch (without BTM)
				B10B Ambient Light/Sunload Sensor, E6 Center High Mounted Stop Lamp, E7L License Plate Lamp - Left, E7R License Plate Lamp - Right, E8D Door Courtesy Lamp - Driver, E8J Instrument Panel Courtesy Lamp - Left, E8K Instrument Panel

23	23	F23DA Fuse	20A	Courtesy Lamp - Right, E8P Door Courtesy Lamp - Passenger, E37D Dome/Reading Lamps -- Overhead Console, E37R Dome/Reading Lamps - Rear, E55D Door Compartment Flood Lamp - Driver, E55P Door Compartment Flood Lamp - Passenger, K9 Body Control Module, KR11 Windshield Washer Pump Relay, KR95B Rear Compartment Lid Unlatch Relay, S52 Outside Rearview Mirror Switch, S72 Sunroof Switch (CF5), S79D Window Switch - Driver, S79P Window Switch - Passenger, S88 Sunroof Tilt Switch (CF5)
24	24	F24DA Fuse	20A	E2RF Side Marker Lamp - Right Front, E4LF Turn Signal Lamp - Left Front, E4N Park/Turn Signal Lamp - Left (T4A), E4P Park/Turn Signal Lamp - Right (T4A), E4Y Turn Signal Repeater Lamp - Left, E5AL Tail Lamp - Right Outer, E5H Tail Lamp - Right Inner, E8S Rear Compartment Courtesy Lamp, K9 Body Control Module, K33 HVAC Control Module, KR76 Retained Accessory Power Relay, M93 Key Capture Solenoid Actuator, P2 Transmission Shift Lever Position Indicator (MDK, MH8, MHH or MHK), S2 Transmission Manual Shift Switch (MDK, MH8, MHH or MHK), S30 Headlamp Switch, S48C Multifunction Switch 1 - Instrument Panel, S48D Multifunction Switch 2 - Instrument Panel, S70L Steering Wheel Controls Switch - Left, S70R Steering Wheel Controls Switch - Right, S91 Park Brake Control Switch, S107 Parking Assist On/Off Switch (UD5 or UD7), X81 Accessory Power Receptacle - 110V AC (KI6 or KIU)
25	25	F25DA Fuse	5A	K73 Telematics Communication Interface Control Module
26	26	F26DA Fuse	-	Not Occupied

X51A FUSE BLOCK - INSTRUMENT PANEL TOP VIEW FUSES (CZ2)

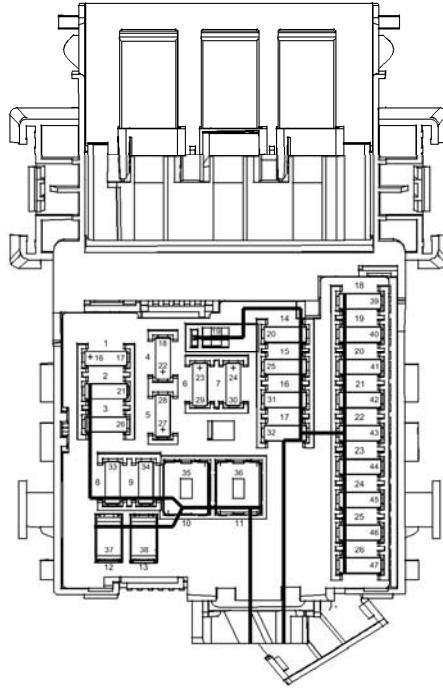


Fig. 22: X51A Fuse Block - Instrument Panel Top View Fuses (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

X51A Fuse Block - Instrument Panel Fuses Usage (CZ2)

No.	Device Label Name	Device Assigned Name	Rating	Description
1	-	F1DA Fuse	10A	K82 Mobile Telephone Control Module (UPF), K19 Suspension Control Module (F45)
2	-	F2DA Fuse	20A	K9 Body Control Module
3	-	F3DA Fuse	25A	K9 Body Control Module
4	-	F4DA Fuse	20A	A11 Radio
5	-	F5DA Fuse	10A	K41R Rear Parking Assist Control Module, S48E Multifunction Switch - Center Console, P17 Info Display Module
6	-	F6DA Fuse	20A	E32 Cigarette Lighter Receptacle
7	-	F7DA Fuse	20A	X80H Accessory Power Receptacle - Center Console (KD4), E32R Cigarette Lighter Receptacle - Rear
8	-	F8DA Fuse	30A	K9 Body Control Module
9	-	F9DA Fuse	30A	K9 Body Control Module
10	-	F10DA Fuse	30A	K9 Body Control Module
11	-	F11DA Fuse	40A	K8 Blower Motor Control Module
12	-	F12DA Fuse	25A	S64P Seat Adjuster Switch - Passenger

13	-	F13DA Fuse	25A	S64D Seat Adjuster Switch - Driver (without A45), K40 Seat Memory Control Module (A45)
14	-	F14DA Fuse	7.5A	X84 Data Link Connector
15	-	F15DA Fuse	10A	K36 Inflatable Restraint Sensing and Diagnostic Module
16	-	F16DA Fuse	10A	KR95B Rear Compartment Lid Unlatch Relay
17	-	F17DA Fuse	10A	K33 HVAC Control Module, A20 Radio/HVAC Controls
18	-	Not Used	-	Not Used
19	-	F19DA Fuse	5A	K40 Seat Memory Control Module (A45)
20	-	Not Used	-	Not Used
21	-	F21DA Fuse	10A	P16 Instrument Cluster
22	-	F22DA Fuse	2A	S39 Ignition Switch (without BTM), K84 Keyless Entry Control Module (BTM)
23	-	F23DA Fuse	20A	K9 Body Control Module
24	-	F24DA Fuse	20A	K9 Body Control Module
25	-	F25DA Fuse	20A	K73 Telematics Communication Interface Control Module (UE1)
26	-	Not Used	-	Not Used

X51A FUSE BLOCK - INSTRUMENT PANEL TOP VIEW RELAYS (EXCEPT CZ2)

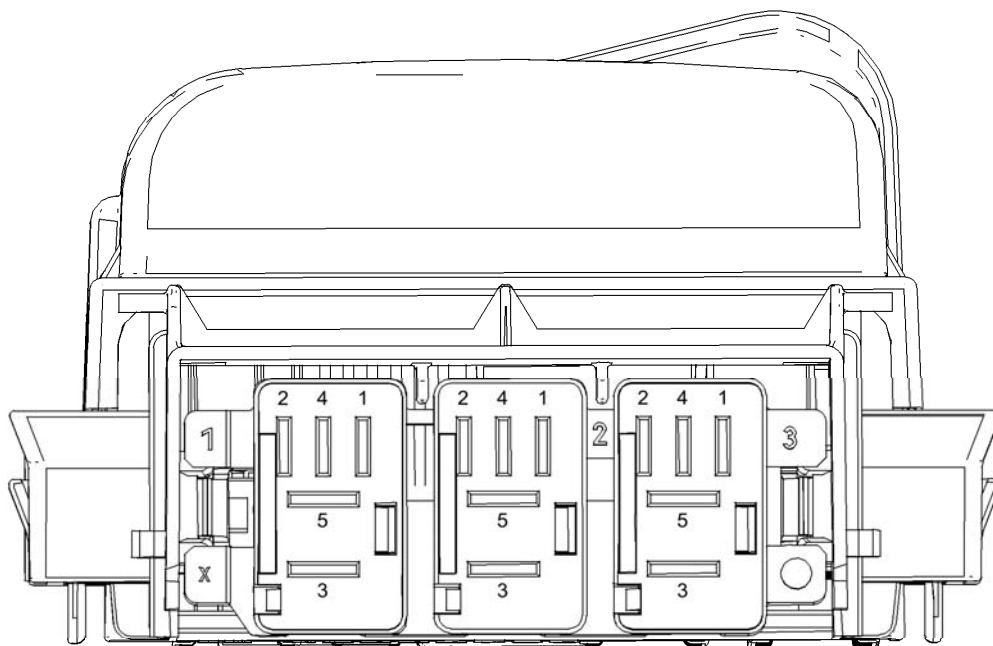


Fig. 23: X51A Fuse Block -- Instrument Panel Top View Relays (except CZ2)
 Courtesy of GENERAL MOTORS COMPANY

X51A Fuse Block - Instrument Panel Relay Usage

No.	Device Label Name	Device Assigned Name	Rating	Description
1	-	KR113 Child Security Lock Disable Relay	-	A23 LR Door Latch Assembly - Left Rear, A23 RR Door Latch Assembly - Right Rear
2	-	-	-	Not Used
3	-	KR76 Retained Accessory Power Relay	-	F6DA, F7DA Fuses

X51A FUSE BLOCK - INSTRUMENT PANEL TOP VIEW RELAYS (CZ2)

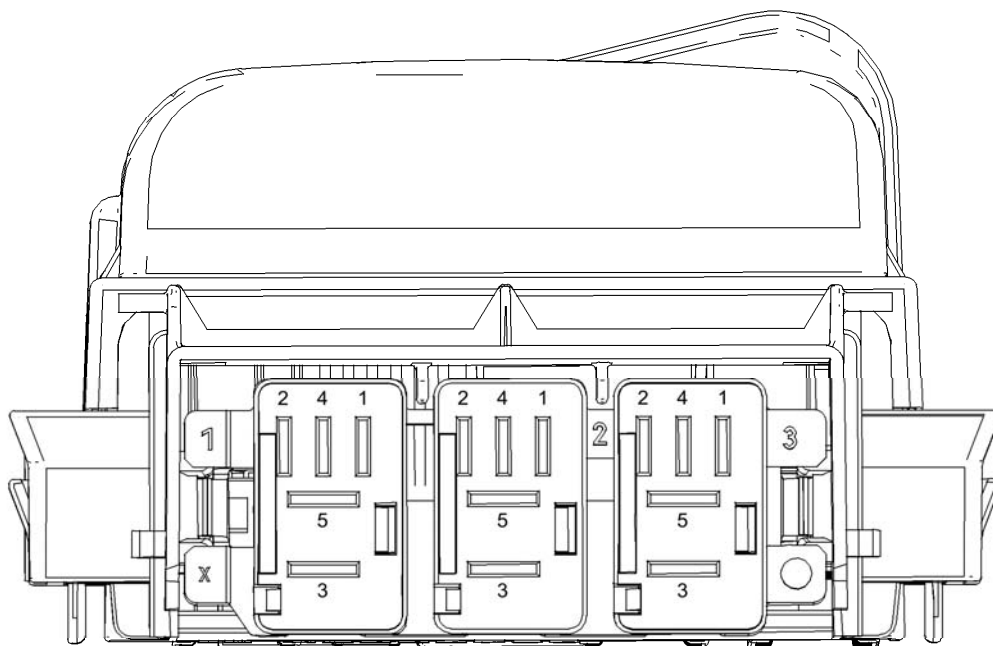


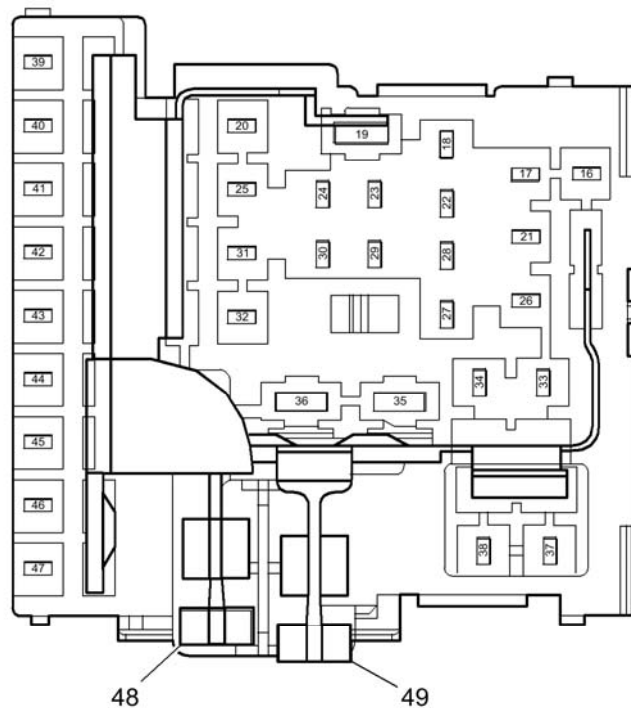
Fig. 24: X51A Fuse Block -- Instrument Panel Top View Relays (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

X51A Fuse Block - Instrument Panel Relay Usage (CZ2)

No.	Device Label Name	Device Assigned Name	Rating	Description
1	-	KR95B Rear Compartment Lid Unlatch Relay	-	M40 Rear Compartment Lid Latch
2	-	-	-	Not Used
3	-	KR76 Retained Accessory Power Relay	-	X80H Accessory Power Receptacle - Center Console, E32R Cigarette Lighter Receptacle - Rear, E32F Cigarette Lighter Receptacle - Front

X51A FUSE BLOCK - INSTRUMENT PANEL BOTTOM VIEW FUSES (EXCEPT CZ2)

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Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13595188
- Service Connector: Service by Harness - See Part Catalog
- Description: 32-Way Fuse Block (GY)

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	13327182	J-35616-35 (VT)	J-38125-38	13595182-1	13595182-1	E	A
II	13327183	J-35616-35 (VT)	J-38125-38	2-964284-1	25	E	A
III	13327183	J-35616-35 (VT)	J-38125-38	4-965999-1	25	4	A
IV	13327178	J-35616-43 (RD)	J-38125-11A	15343823	19	G	G

V	13587366	J-35616-44 (YE)	J-38125- 221	15343823	19	G	G
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X51A Fuse Block - Instrument Panel Bottom View Fuses (except CZ2)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
16	2.5	RD/VT	3140	Battery Positive Voltage	I	-
17	0.75	RD/VT	542	Battery Positive Voltage	-	F45 or UG1
18	2.5	RD/GN	40	Battery Positive Voltage	I	-
19	6	RD/GN	3140	Battery Positive Voltage	I	-
20	0.5	RD/VT	102	Battery Positive Voltage	II	-
21	1.5	GY/VT	691	Headlamp Low Beam Relay Control	III	-
22	2.5	RD/VT	3140	Battery Positive Voltage	I	-
23	2.5	VT/YE	43	Accessory Voltage	I	-
24	2.5	VT/YE	43	Accessory Voltage	I	-
25	0.75	RD/YE	2	Battery Positive Voltage	II	-
26	2.5	GY	975	Battery Positive Voltage	I	-
27	2.5	RD/VT	3140	Battery Positive Voltage	I	-
28	0.75	RD/GN	3140	Battery Positive Voltage	II	-
29	2.5	VT/RD	801	Retained Accessory Power Fuse Supply Voltage	I	-
30	2.5	VT	801	Retained Accessory Power Fuse Supply Voltage	I	-
31	-	-	-	Not Occupied	-	-
32	0.75	RD/GN	242	Battery Positive Voltage	II	-
33	2.5	GY	1524	Battery Positive Voltage	I	-
34	2.5	OG/BK	974	Battery Positive Voltage	I	-
35	2.5	RD/BN	1440	Battery Positive Voltage	IV	-
36	6	RD/BN	202	Battery Positive Voltage	I	-
37	2.5	RD/VT	740	Battery Positive Voltage	I	A6C or AG2
38	2.5	RD/D-BU	702	Battery Positive Voltage	I	AG1
39	2.5	RD/GN	3140	Battery Positive Voltage	I	-
40	-	-	-	Not Occupied	-	-
41	0.5	RD/GY	402	Battery Positive Voltage	II	-
42	0.75	RD/GY	142	Battery Positive Voltage	II	-
43	0.5	RD/VT	340	Battery Positive Voltage	II	-
44	1.5	RD/WH	342	Battery Positive Voltage	III	-
45	1.5	BN	6136	Battery Positive Voltage	III	-
46	0.5 0.5	RD/GY RD/GY	142 402	Battery Positive Voltage Battery Positive Voltage	II	-
47	-	-	-	Not Occupied	-	-

48	10	RD/BK	5140	Battery Positive Voltage	V	-
49	10	RD/BU	5140	Battery Positive Voltage	V	-

X51A FUSE BLOCK - INSTRUMENT PANEL BOTTOM VIEW FUSES

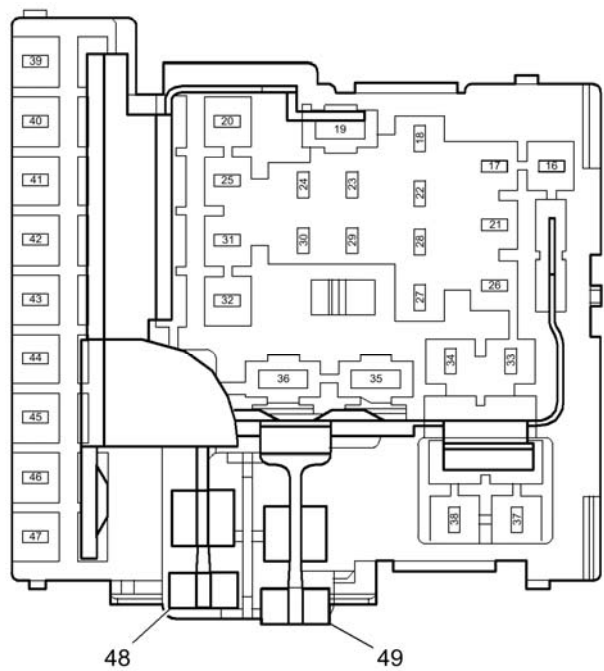


Fig. 25: X51A Fuse Block - Instrument Panel Bottom View Fuses
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information
<ul style="list-style-type: none">• Harness Type: Instrument Panel• OEM Connector: 13595188• Service Connector: Service by Harness - See Part Catalog• Description: 32-Way Fuse Block (GY)
Terminal Part Information
<ul style="list-style-type: none">• Pins: 16-18, 20-34, 39-45• Terminated Lead: 13327182• Release Tool: J-38125-38• Diagnostic Test Probe: J-35616-35 (VT)
<ul style="list-style-type: none">• Pins: 19, 35-38, 47• Terminated Lead: 13327183

- Release Tool: J-38125-38
- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 48, 49
- Terminated Lead: 13327153
- Release Tool: J-38125-221
- Diagnostic Test Probe: J-35616-44 (YE)

Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13595188
- Service Connector: Service by Harness - See Part Catalog
- Description: 32-Way Fuse Block (GY)

Terminal Part Information

- Pins: 16-18, 20-34, 39-45
- Terminated Lead: 13327182
- Release Tool: J-38125-38
- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 19, 35-38, 47
- Terminated Lead: 13327183
- Release Tool: J-38125-38
- Diagnostic Test Probe: J-35616-35 (VT)
- Pins: 48, 49
- Terminated Lead: 13327153
- Release Tool: J-38125-221
- Diagnostic Test Probe: J-35616-44 (YE)

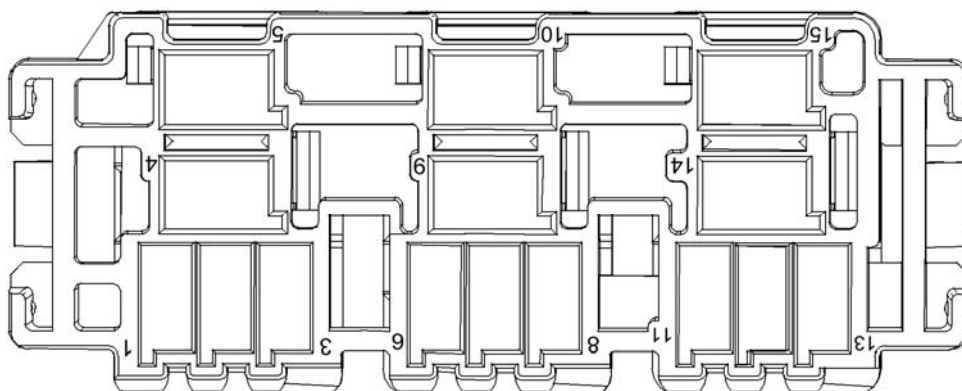
X51A Fuse Block - Instrument Panel Wire Entry Fuses (CZ2)

Pin	Wire	Circuit	Function
16	0.5 RD/GN	3140	Battery Positive Voltage
17	0.5 RD/WH	1040	Battery Positive Voltage (F45/UPF)
18	1.0 RD/GN	40	Battery Positive Voltage
19	3.0 RD/GN	3140	Battery Positive Voltage
20	0.5 RD/VT	102	Battery Positive Voltage
21	0.8 GY/VT	691	Headlamp Low Beam Relay Control
22	1.0 RD/GN	3140	Battery Positive Voltage
23	1.0 VT/YE	43	Accessory Voltage

24	1.0 VT/YE	43	Accessory Voltage
25	0.5 RD/YE	2	Battery Positive Voltage
26	0.8 GY	975	Battery Positive Voltage
27	0.5 RD/GN	3140	Battery Positive Voltage
28	1.0 RD/GN	3140	Battery Positive Voltage
29	1.0 VT	801	Retained Accessory Power Fuse Supply Voltage
30	1.0 VT	801	Retained Accessory Power Fuse Supply Voltage
31	0.5 BU/WH	6128	Trunk Release Enable Relay Switch Supply Voltage
32	0.5 RD/GN	242	Battery Positive Voltage
33	0.8 GY	1524	Backup Lamp Supply Voltage Signal
34	0.8 OG/BK	974	Battery Positive Voltage
35	3.0 RD/BN	1440	Battery Positive Voltage
36	5.0 RD/WH	1040	Battery Positive Voltage
37	3.0 RD/YE	740	Battery Positive Voltage
38	3.0 RD/BN	702	Battery Positive Voltage
39	-	-	Not Used
40	0.5 RD/WH	2040	Battery Positive Voltage (A45)
41	-	-	Not Used
42	0.5 RD/GY	142	Battery Positive Voltage
43	0.5 RD/VT	340	Battery Positive Voltage (without BTM)
44	0.5 WH/BN	6815	Inadvertent Power Control
45	0.5 BN	6136	Supply Voltage
46	0.8 RD/WH	1040	Battery Positive Voltage (CJ4)
	0.8 RD/WH	1040	Battery Positive Voltage (CJ4)
47	-	-	Not Used
48	10 RD/BK	5140	Battery Positive Voltage
49	10 RD/BU	5140	Battery Positive Voltage

X51A FUSE BLOCK - INSTRUMENT PANEL BOTTOM VIEW RELAYS (EXCEPT CZ2)





Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13595183
- Description: 15-Way Relay Block (BK)

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Pending	Not Available	Not Available	13595182	Not Available	Pending	Pending
II	Pending	J-35616-42 (RD)	12094430	15344769	23	F	G

X51A Fuse Block - Instrument Panel Bottom View Relays (except CZ2)

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	0.5	BK	1650	Ground	I	-
2	0.75	GY	295	Door Lock Actuator Lock Control	I	-
3	0.5	VT/YE	3267	Child Security Lock Relay Control	I	-
4	0.75	WH/BU	3266	Child Security Lock Motor Unlock Control	I	-
5	0.75	GY/GN	3271	Door Lock Control (2)	I	-
6-10	-	-	-	Not Occupied	-	-
11	0.5	BK	1650	Ground	I	-
12	-	-	-	Not Occupied	-	-
13	0.5	GY/VT	755	RAP Relay Coil Control	I	-

14	4	VT/YE	43	Accessory Voltage	II	-
15	4	RD/GN	3140	Battery Positive Voltage	II	-

X51A FUSE BLOCK - INSTRUMENT PANEL BOTTOM VIEW RELAYS (CZ2)

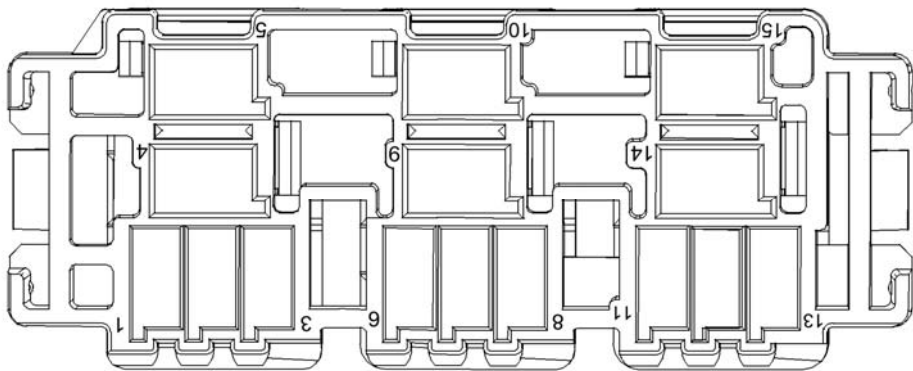


Fig. 26: X51A Fuse Block -- Instrument Panel Bottom View Relays (CZ2)
Courtesy of GENERAL MOTORS COMPANY

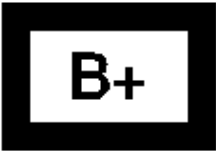
ELECTRICAL

Wiring Systems and Power Management - Schematic Wiring Diagrams - Electrical Schematic Symbols

SCHEMATIC AND ROUTING DIAGRAMS

ELECTRICAL SCHEMATIC SYMBOLS

Voltage Indicators

Symbol	Description
	Battery Voltage




Ignition
Switch- Off
Position



Ignition
Switch-
Accessory
Position

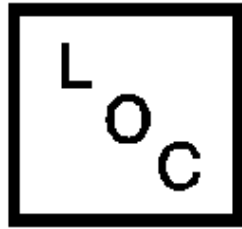


Ignition
Switch-
Run
Position

<div></div>	Ignition Switch- Start Position
--	--


General Icons

Symbol	Description



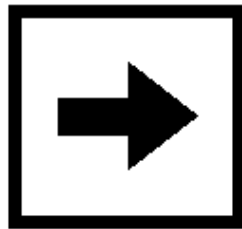
Master
Component List
Icon
This icon is used
on the schematic
to link to the
Master Electrical
Component List.

Description and

<div></div>	<div><p>Operation Icon This icon is used on the schematic to link to the Description and Operation of that particular system.</p></div>
	<div><p>Computer Programming Icon This icon is used</p></div>

on the schematic
to link to Control
Module
References,
which identifies
which
components need
programming
upon
replacement.





Next Schematic
Page Icon
This icon is used
on the schematic
to navigate to the
next schematic in
the subsystem.

Previous

Schematic Page
Icon
This icon is used
on the schematic
to navigate to the
previous
schematic in the
subsystem.



Supplemental
Inflatable
Restraint (SIR) or
Supplemental



Restraint System (SRS) Icon
This icon is used to alert the technician that the system contains SIR/SRS components that require certain precautions before servicing.

Information Icon



This icon is used to alert the technician that there is additional information that will aid in servicing a system.

Danger Icon
This icon is intended to alert the technician that a component within the system



contains labeling with the same icon.

This icon is used when a source component has potential for 60 volts DC or greater or has potential for 42 volts AC or greater.

High Voltage Icon

This icon is intended to alert the technician that a component



within the system contains labeling with the same icon.

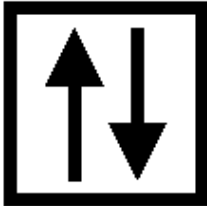
This icon is used when a component/circuit has potential for 60 volts DC or greater or has potential for 42 volts AC or greater.

Caution Icon
This icon is used to advise the technician to use



caution when servicing this component. This icon may be used when a component/circuit has a voltage range potential between 30-60 volts DC or 15-42 volts AC.

Functional Serial Data Communication
This icon is used to show the

<div></div>		technician that the serial data circuit detail is shown incomplete. It also provides an active link to the Data Communication Schematics where the circuit is shown complete.
		

Switch Position Icons

Symbol	Description



Generic Up
Arrows



Generic
Down
Arrows



Generic
Left Arrows



Generic
Right
Arrows



Generic
Express
Down
Arrows



On/Off Icon




Generic
Lock Icon



Generic
Unlock
Icon

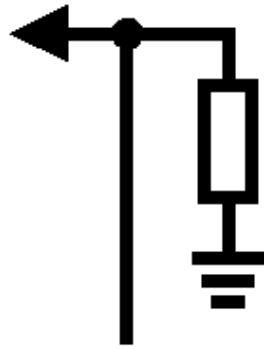
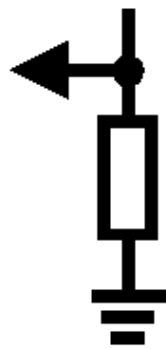


Generic
Window
Switch
Positions- 4
Door

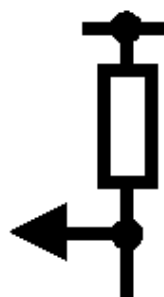
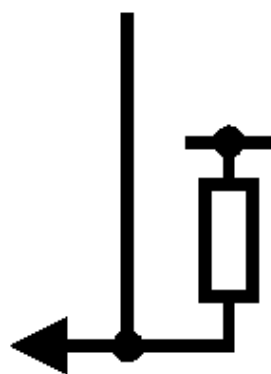
	Generic Window Switch Positions- 2 Door
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Module Circuit Function Icons

Symbol	Description



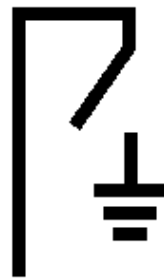
I/O Pull-
Down
Resistors (-)



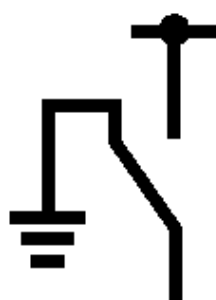
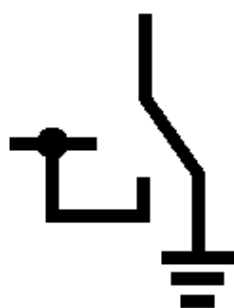
I/O Pull-Up
Resistors (+)




I/O High-Side Drive Switch (+)



I/O Low-Side Drive Switch (+)



I/O
Bidirectional
Switch (+/-)

	Pulse-Width Modulation Symbol

<div>B+</div>		<div>Battery Voltage</div>

IGN

Ignition
Voltage

5V		Voltage Reference

5V AC

A/C Voltage

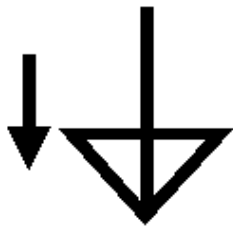


Low
Reference

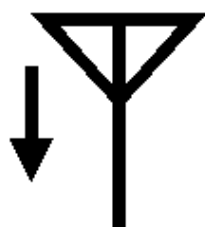


Ground


<div></div>		Serial Data



Antenna
Signal- In



Antenna
Signal- Out

	Brake Apply
---	-------------

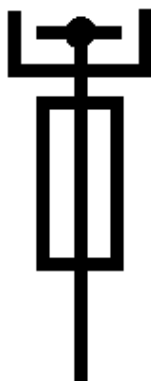
Harness Components

Symbol	Description



Fuse

PWR/TRN Relay



Fuse
Supplied by
a Relay



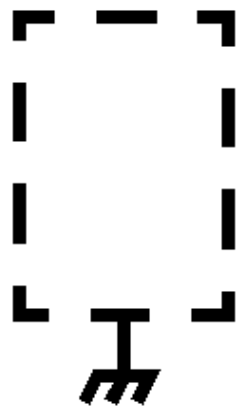
Circuit
Breaker



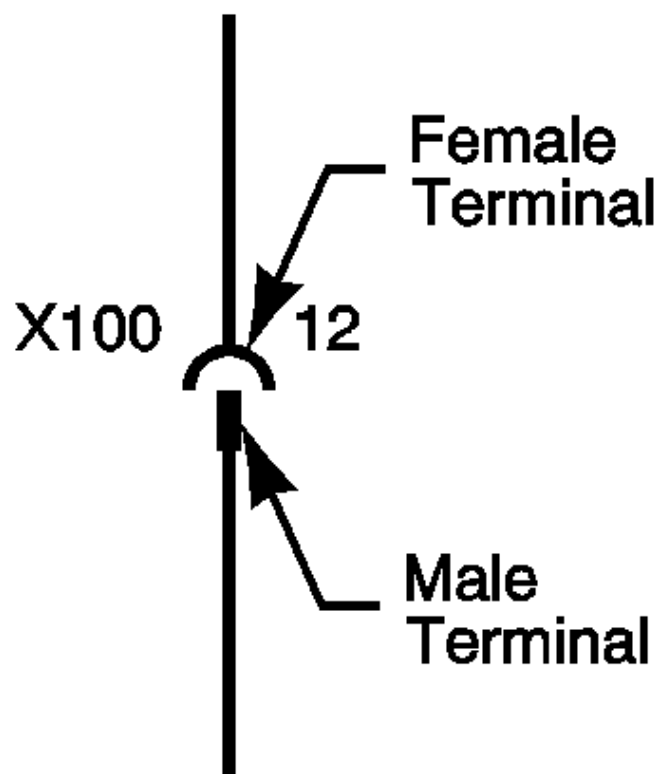
Fusible Link



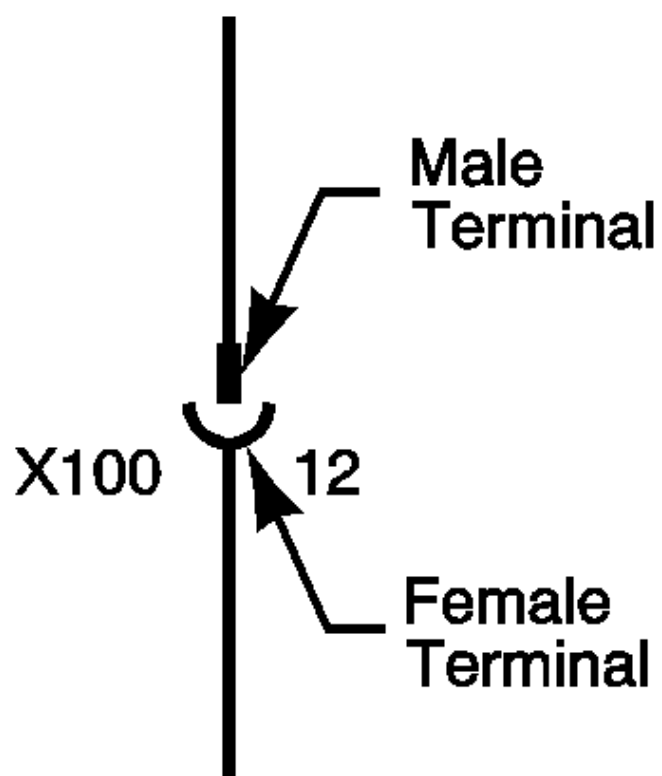
Ground



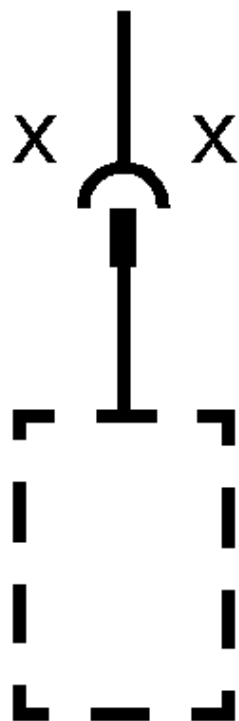
Case
Ground



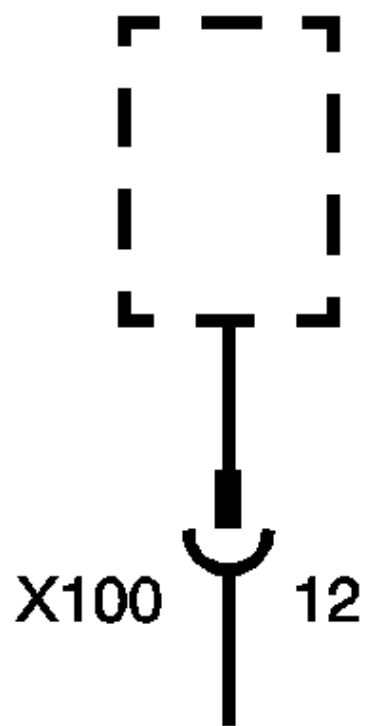
Inline
Harness
Connector



Inline
Harness
Connector





Pigtail
Connection

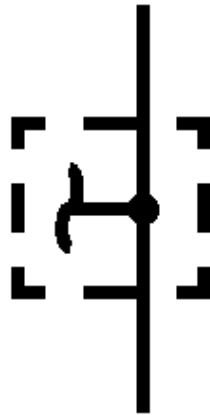


Pigtail
Connection



Provisional
or
Diagnostic
Connector

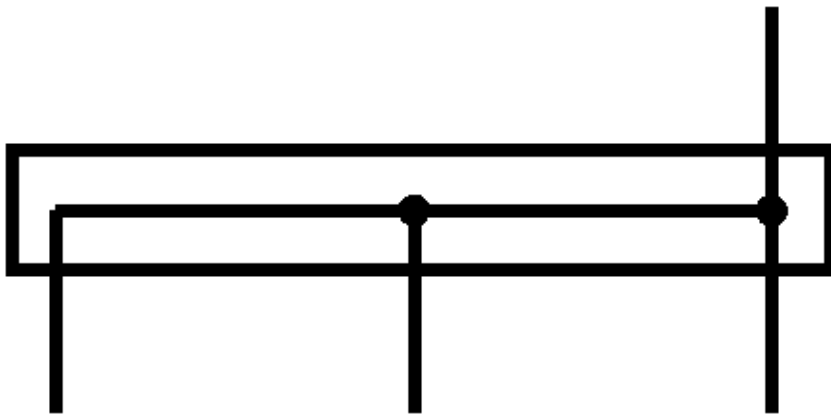
 	<p>Blunt Cut Wire</p>



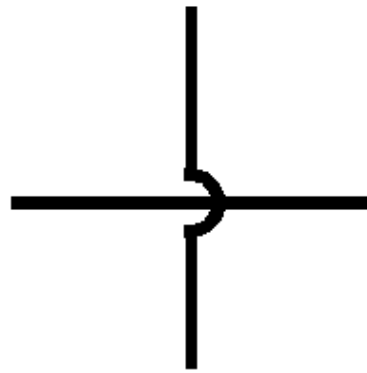
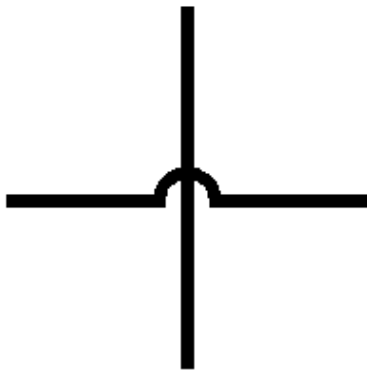
Incomplete
Physical
Splice



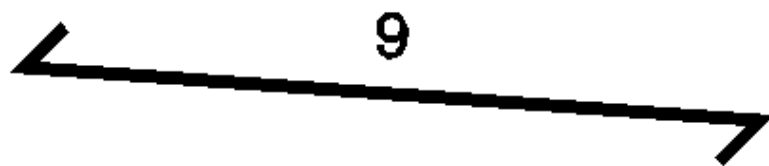
Complete
Physical
Splice- 2
Wires



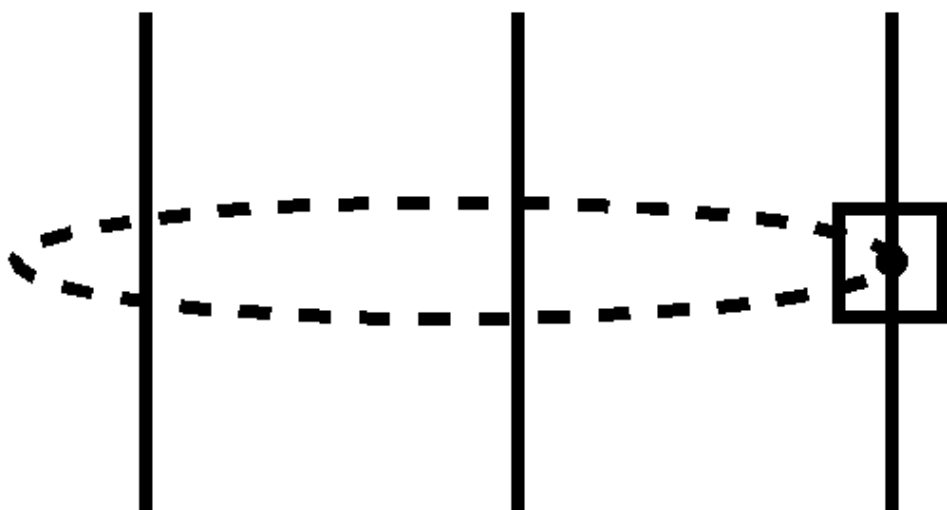
Complete
Physical
Splice- 3 or
more wires



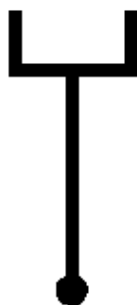
Wire
Crosses



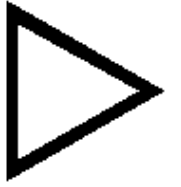
Twisted
Wires



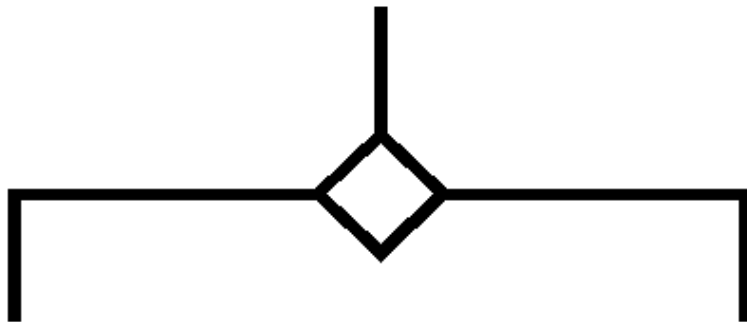
Shield



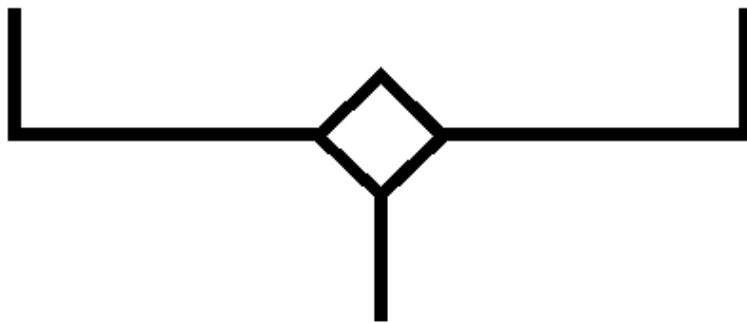
Circuit
References

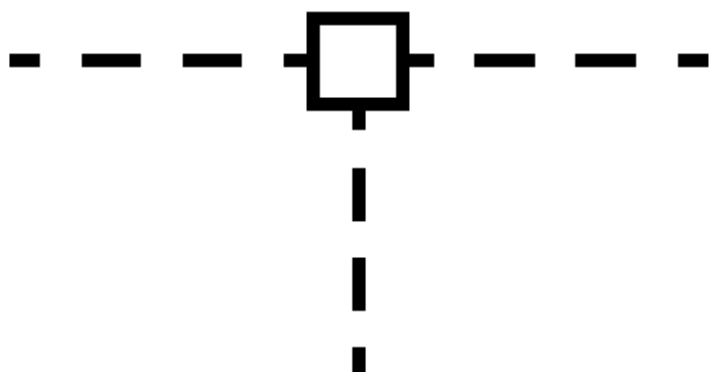


Circuit
Continuation
Arrowheads

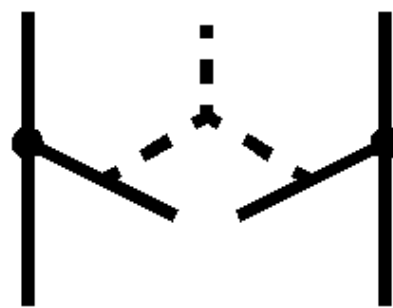
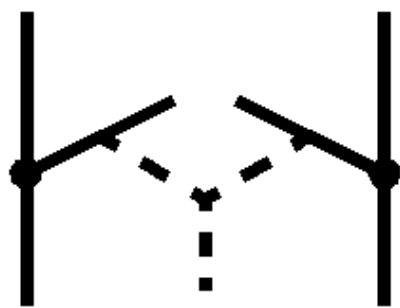


Option
Breakpoint





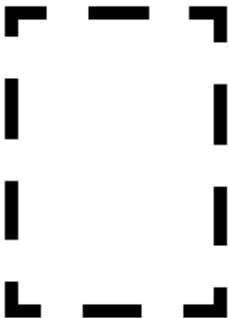
Ground
Circuit
Connection

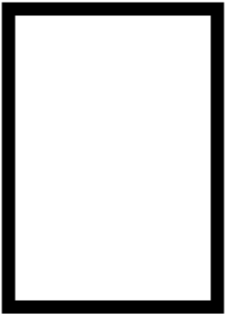


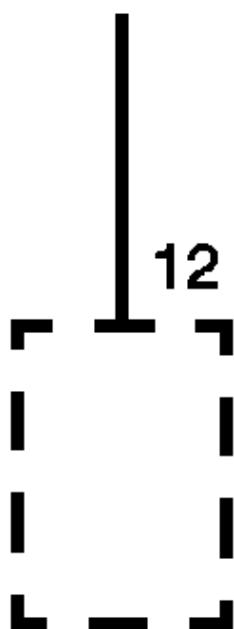
Connector
Shorting
Clip

Component Parts

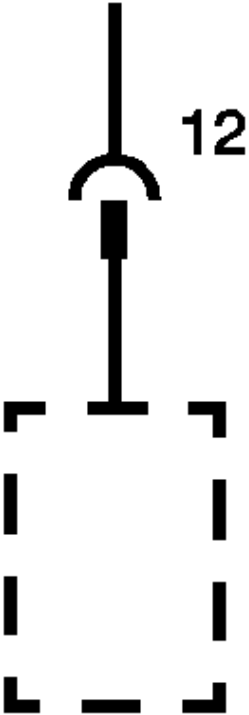
Symbol	Description

<div></div>	<div>Partial Component When a component is represented in a dashed box, the component or its wiring is not shown in its entirety.</div>
	<div>Entire Component When a</div>

	<p>component is represented in a solid box the component or its wiring is shown in its entirety.</p>

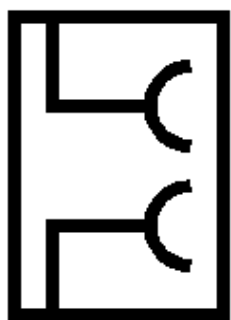


Connector
Directly
Attached to
Component

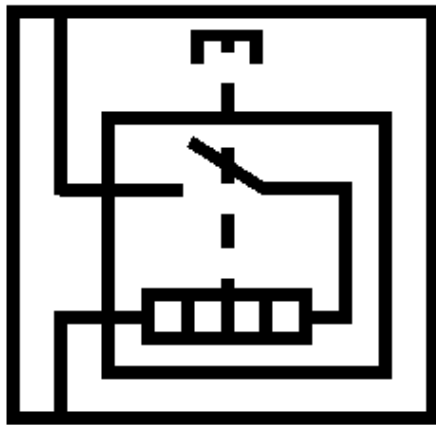
	Pigtail Connector
--	----------------------

Switches and Relays

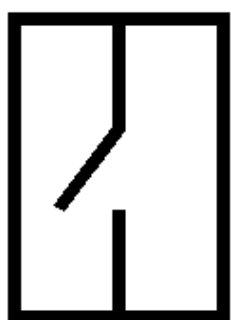
Symbol	Description



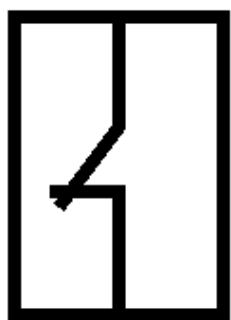
Accessory
Power Outlet



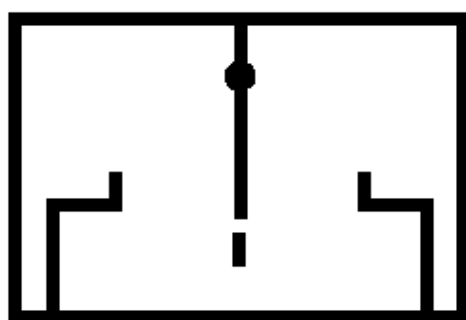
Cigar
Lighter



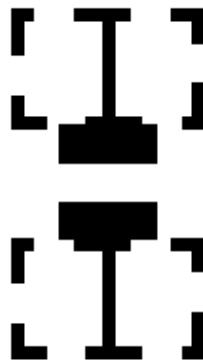
Switch- 2
Position
Normally
Open



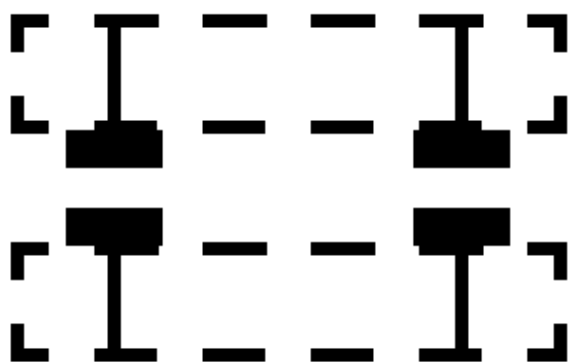
Switch- 2
Position
Normally
Closed



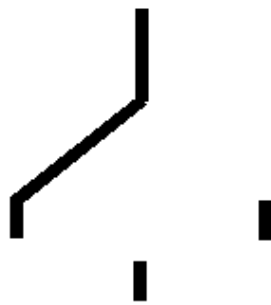
Switch-
Rocker



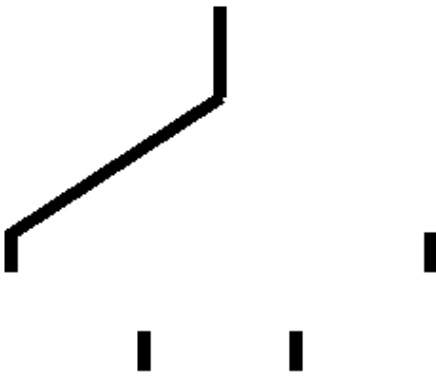
Switch-
Contact
Plate (1
Wire)

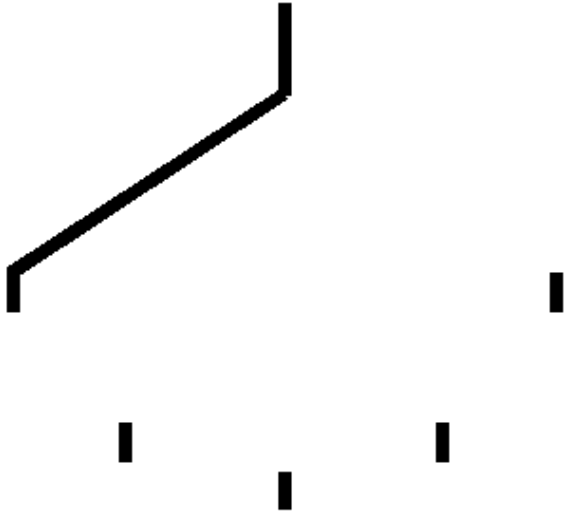


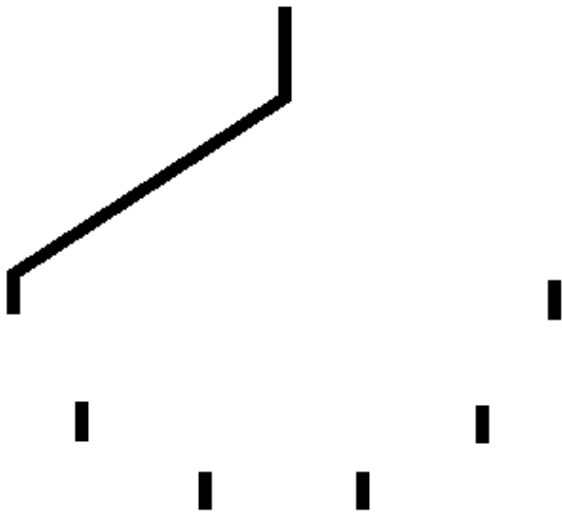
Switch-
Contact
Plate (2
Wire)



Switch- 3
Position

	<p>Switch- 4 Position</p>

	<p>Switch- 5 Position</p>

 <p>The diagram shows a mechanical switch assembly. A thick black line represents the main switch lever, which is angled upwards from left to right. At its left end, there is a small vertical rectangular contact. Below this lever, there are five small vertical rectangular components arranged in a slightly curved line from left to right. These appear to be secondary contacts or indicators. The entire assembly is rendered in black lines on a white background.</p>	<p>Switch- 6 Position</p>

E - - -

Switch
Actuator-
Push
(Momentary)

EV--


Switch
Actuator-
Push
(Latching)

] - - -

Switch
Actuator-
Pull
(Momentary)



Switch
Actuator-
Pull
(Latching)

	Switch Actuator- Rotate (Momentary)



Switch
Actuator-
Rotate
(Latching)

F - - -

Switch
Actuator-
Slide
(Momentary)



Switch
Actuator-
Slide
(Latching)



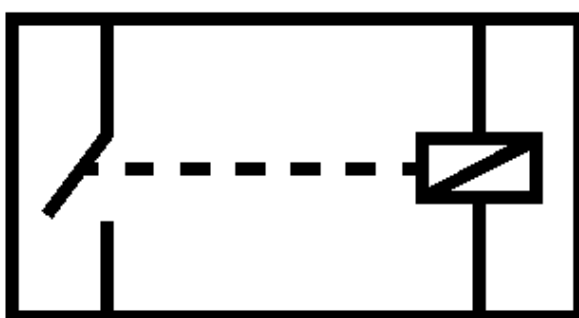
Switch
Actuator-
Pressure
(Momentary)



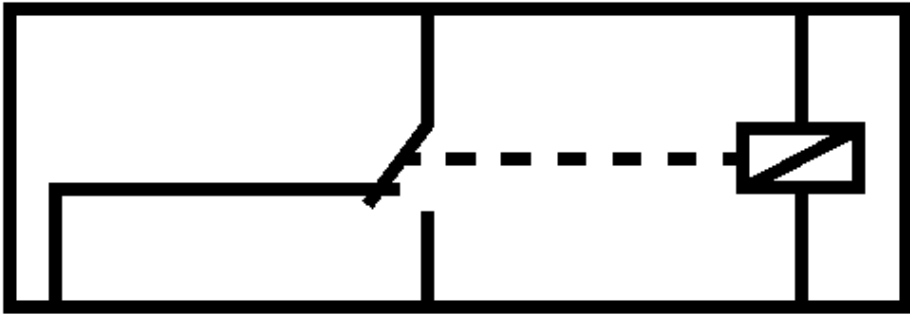
Switch
Actuator-
Temperature
(Momentary)



Switch
Actuator-
Volume
(Latching)



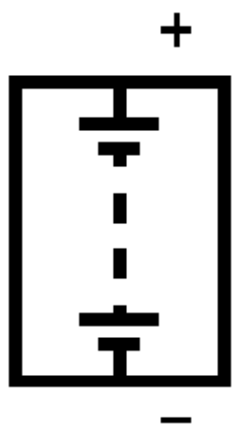
4-Pin Single
Pole/Throw
Relay-
Normally
Open



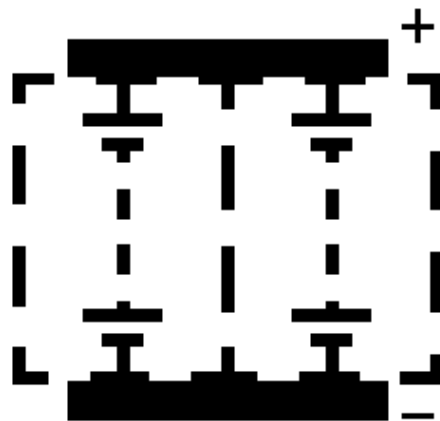
5-Pin Relay-
Normally
Closed

Devices and Sensors

Symbol	Description



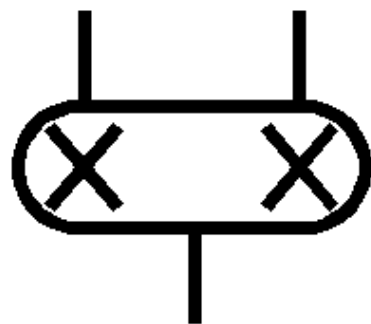
Battery



Battery
Assembly-
Hybrid



Single
Filament
Light Bulb



Double
Filament
Light Bulb



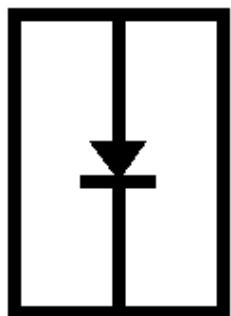
Light
Emitting
Diode
(LED)



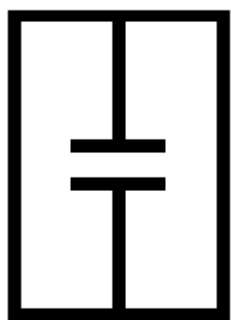
Photo
Sensor



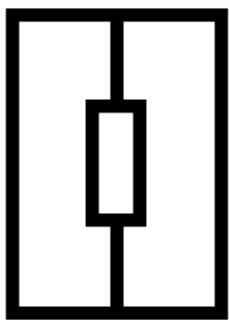
Gauge



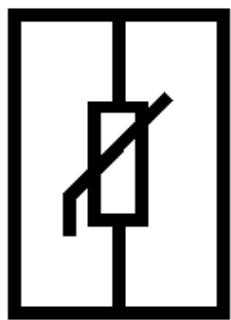
Diode



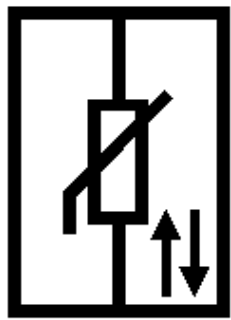
Capacitor



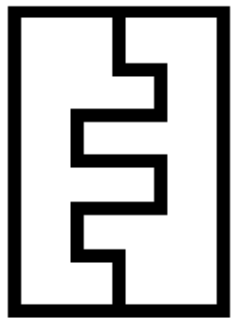
Resistor



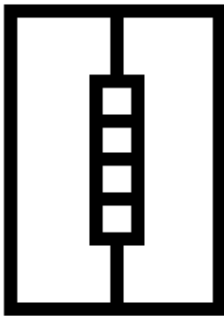
Variable
Resistor



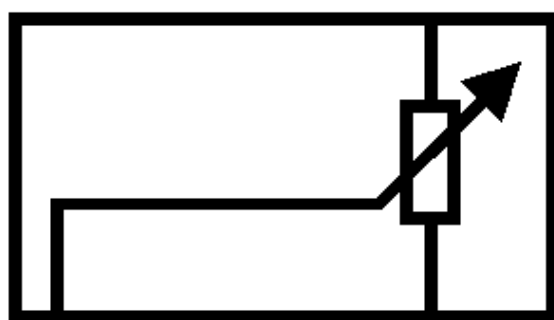
Variable
Resistor-
NTC



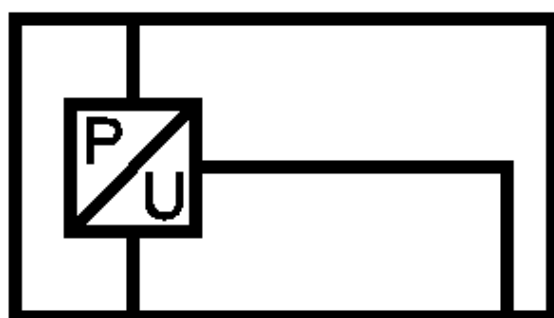
Breakable
Wire



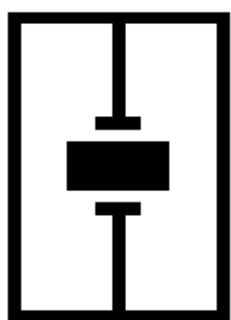
Heating
Element



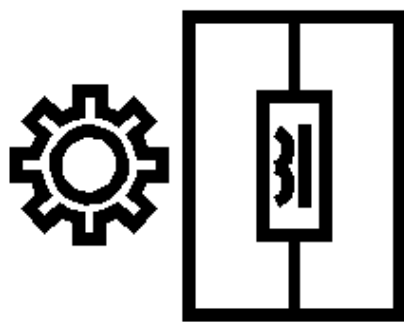
Position
Sensor



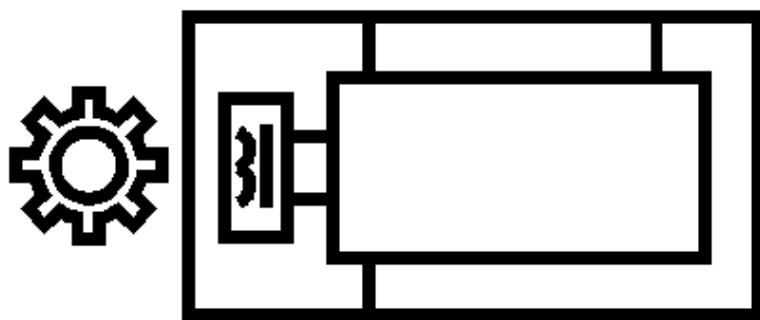
Pressure
Sensor



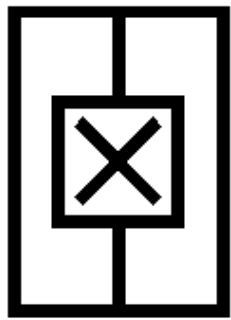
Knock
Sensor



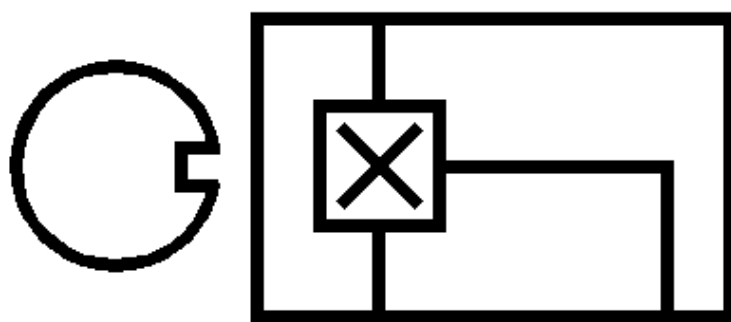
Inductive
Type
Sensor- 2-
Wire



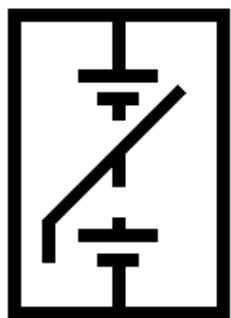
Inductive
Type
Sensor- 3-
Wire



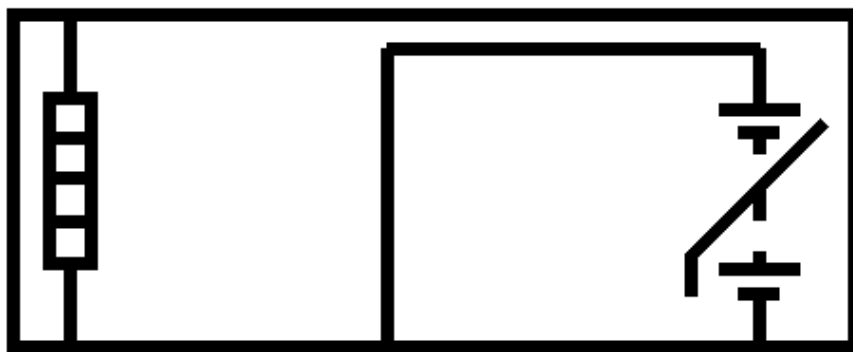
Hall Effect
Sensor- 2-
Wire



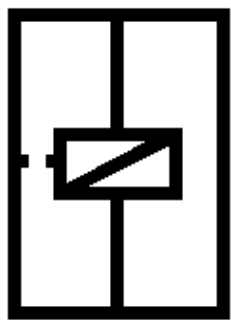
Hall Effect
Sensor- 3-
Wire



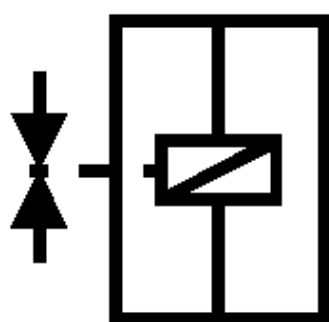
Oxygen
Sensor- 2-
Wire



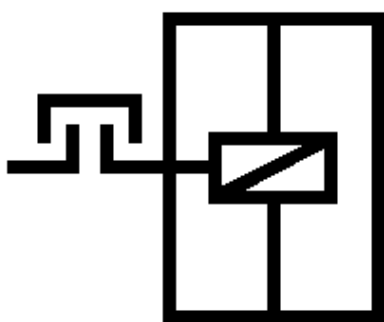
Heated
Oxygen
Sensor- 4-
Wire



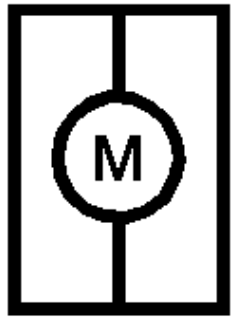
Solenoid-
Actuator



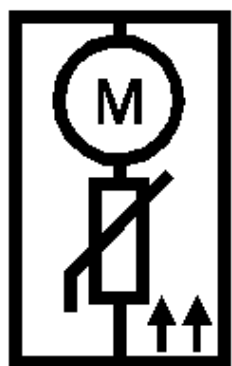
Solenoid-
Valve



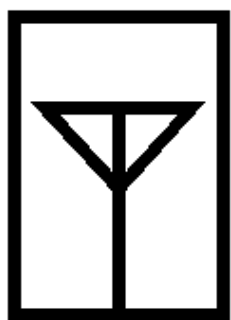
Clutch



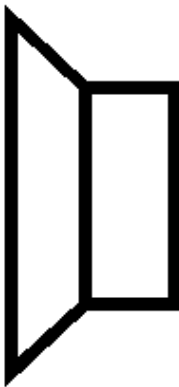
Motor



Motor with
PTC



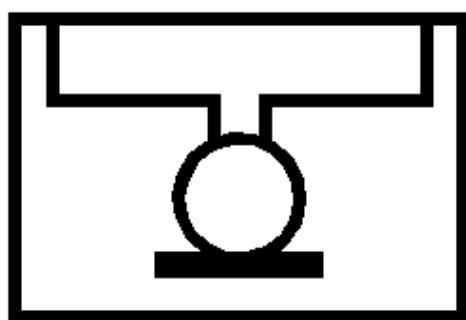
Antenna



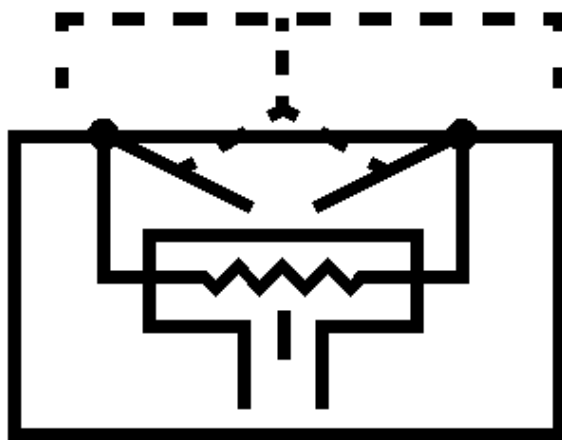
Speaker



Horn



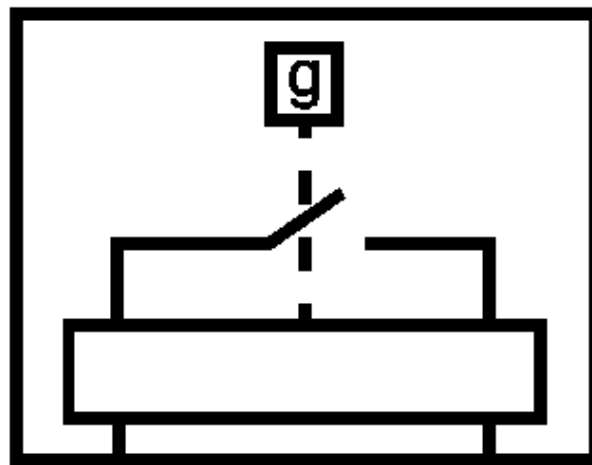
Microphone



Airbag



SIR Coil



SIR Impact
Sensor

SUSPENSION

Electronic Suspension Control

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Electronic Suspension Control Module Fastener	9 N.m	80 lb in
Electronic Suspension Front Vertical Accelerator Fastener	9 N.m	80 lb in
Electronic Suspension Rear Position Sensor Replacement Fastener	6 N.m	53 lb in

SCHEMATIC WIRING DIAGRAMS

ELECTRONIC SUSPENSION CONTROL WIRING SCHEMATICS

Power, Ground, and Serial Data

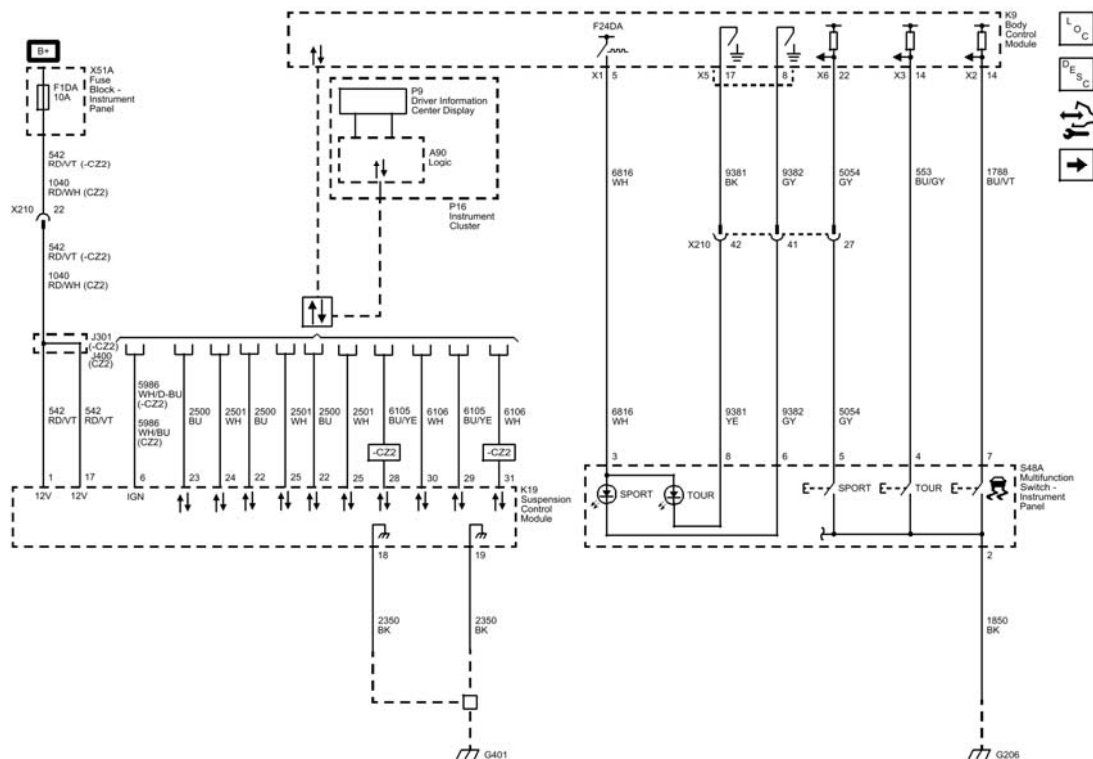


Fig. 1: Power, Ground, and Serial Data
 Courtesy of GENERAL MOTORS COMPANY

Sensors

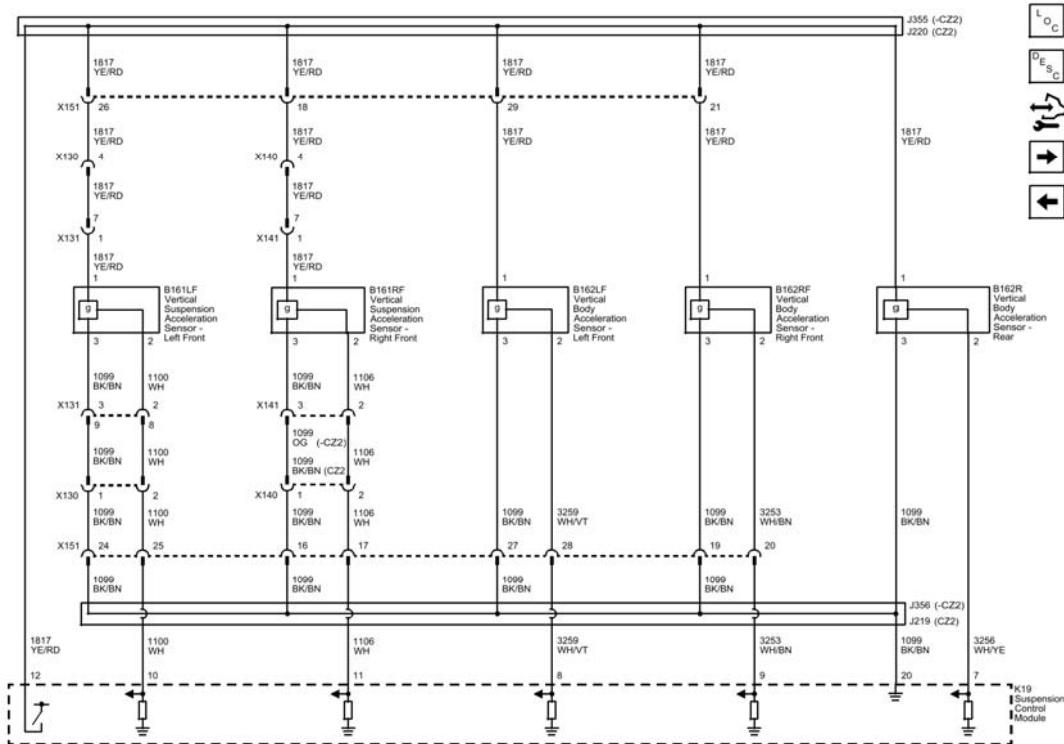


Fig. 2: Sensors
 Courtesy of GENERAL MOTORS COMPANY

Actuators

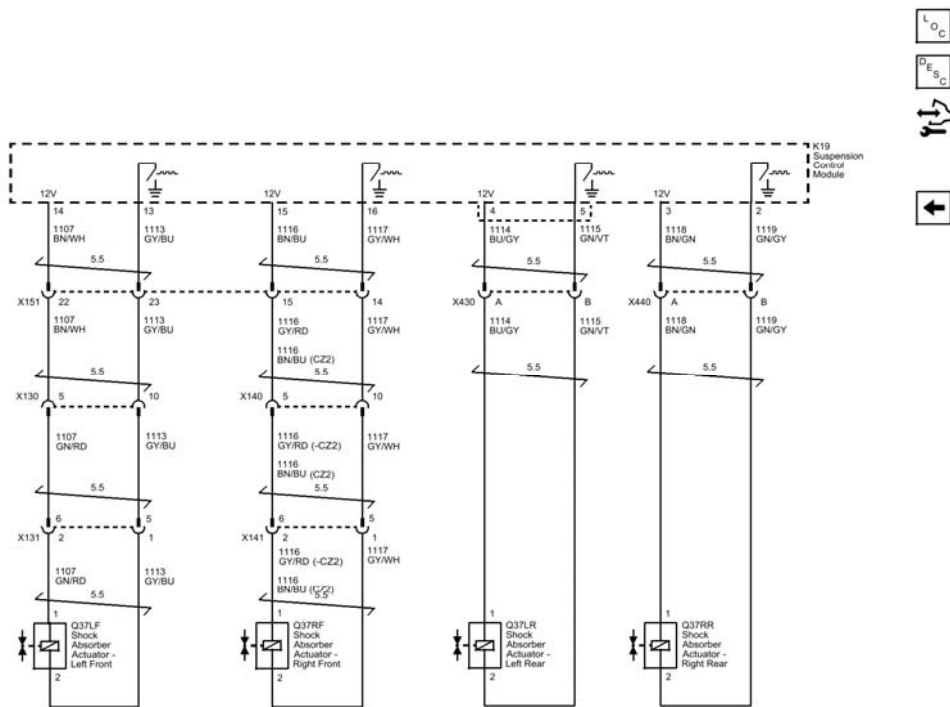


Fig. 3: Actuators
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC C0000</u>	DTC C0000 71 Vehicle Speed Information Circuit Invalid Data
<u>DTC C0575, C0580, C0585, or C0590</u>	DTC C0575 02 Left Front Damper Actuator Circuit Short to Ground DTC C0575 04 Left Front Damper Actuator Circuit Open DTC C0575 0F Left Front Damper Actuator Circuit Signal Erratic DTC C0580 02 Right Front Damper Actuator Circuit Short to Ground DTC C0580 04 Right Front Damper Actuator Circuit Open DTC C0580 0F Right Front Damper Actuator Circuit Signal Erratic DTC C0585 02 Left Rear Damper Actuator Circuit Short to Ground DTC C0585 04 Left Rear Damper Actuator Circuit Open DTC C0585 0F Left Rear Damper Actuator Circuit Signal Erratic DTC C0590 02 Right Rear Damper Actuator Circuit Short to Ground DTC C0590 04 Right Rear Damper Actuator Circuit Open DTC C0590 0F Right Rear Damper Actuator Circuit Signal Erratic
<u>DTC C0595, C0600, or</u>	DTC C0595 02 Left Front Acceleration Sensor Circuit Short to Ground

<u>C0605</u>	DTC C0595 05 Left Front Acceleration Sensor Circuit High Voltage/Open DTC C0595 0A Left Front Acceleration Sensor Circuit Too Slow Transitions DTC C0600 02 Right Front Acceleration Sensor Circuit Short to Ground DTC C0600 05 Right Front Acceleration Sensor Circuit High Voltage/Open DTC C0600 0A Right Front Acceleration Sensor Circuit Too Slow Transitions DTC C0605 02 Left Rear Acceleration Sensor Circuit Short to Ground DTC C0605 05 Left Rear Acceleration Sensor Circuit High Voltage/Open DTC C0605 0A Left Rear Acceleration Sensor Circuit Too Slow Transitions
<u>DTC C0670 or C0675</u>	DTC C0670 02 Left Front Acceleration or Position Sensor Circuit Short to Ground DTC C0670 05 Left Front Acceleration or Position Sensor Circuit High Voltage/Open DTC C0670 0A Left Front Acceleration or Position Sensor Circuit Too Slow Transitions DTC C0675 02 Right Front Acceleration or Position Sensor Circuit Short to Ground DTC C0675 05 Right Front Acceleration or Position Sensor Circuit High Voltage/Open DTC C0675 0A Right Front Acceleration or Position Sensor Circuit Too Slow Transitions
<u>DTC C0720</u>	DTC C0720 71 Engine Torque Management Feedback Signal Invalid Data
<u>DTC C0870</u>	DTC C0870 03 Control Module Voltage Reference Output Circuit Low Voltage DTC C0870 07 Control Module Voltage Reference Output Circuit High Voltage

DTC C0000: VEHICLE SPEED INFORMATION CIRCUIT INVALID DATA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0000 71

Vehicle Speed Information Circuit Invalid Data

Circuit/System Description

The wheel speeds are detected by active wheel speed sensors. Each wheel speed sensor receives a 12 V reference voltage from the electronic brake control module (EBCM) and provides an alternating current square wave signal to the EBCM. As the wheel spins, the EBCM uses the frequency of the square wave signal to calculate the wheel speed. The EBCM sends the wheel speed information as a high speed controller area network (CAN) serial data message. Modules connected to the high speed CAN circuit monitor for the vehicle

speed information.

Conditions for Running the DTC

System voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the wheel speed serial data has not been received.

Action Taken When the DTC Sets

The electronic suspension control is disabled for the duration of the ignition cycle.

Conditions for Clearing the DTC

A current DTC clears when the diagnostic runs and passes.

Reference Information

Schematic Reference

Electronic Suspension Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Suspension Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool EBCM Wheel Speed Sensor parameters. The parameters displayed should be within 1.6 km/h (1 MPH) on all sensors when driving in a straight line at a speed greater than 20 km/h (13

MPH).

Circuit/System Testing

1. Ignition ON, verify that DTC C0035, C0040, C0045, or C0050 is not present in the K17 Electronic Brake Control Module.
 - If any listed DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Replace the K19 Suspension Control Module and verify the DTC does not reset.
 - If the DTC resets, replace the K17 Electronic Brake Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for module replacement, programming, and setup

DTC C0575, C0580, C0585, OR C0590: DAMPER ACTUATOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0575 02

Left Front Damper Actuator Circuit Short to Ground

DTC C0575 04

Left Front Damper Actuator Circuit Open

DTC C0575 0F

Left Front Damper Actuator Circuit Signal Erratic

DTC C0580 02

Right Front Damper Actuator Circuit Short to Ground

DTC C0580 04

Right Front Damper Actuator Circuit Open

DTC C0580 0F

Right Front Damper Actuator Circuit Signal Erratic

DTC C0585 02

Left Rear Damper Actuator Circuit Short to Ground

DTC C0585 04

Left Rear Damper Actuator Circuit Open

DTC C0585 0F

Left Rear Damper Actuator Circuit Signal Erratic

DTC C0590 02

Right Rear Damper Actuator Circuit Short to Ground

DTC C0590 04

Right Rear Damper Actuator Circuit Open

DTC C0590 0F

Right Rear Damper Actuator Circuit Signal Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Damper Actuator Control High	C0575 02	C0575 04	C0575 02	C0575 0F
Right Front Damper Actuator Control High	C0580 02	C0580 04	C0580 02	C0580 0F
Left Rear Damper Actuator Control High	C0585 02	C0585 04	C0585 02	C0585 0F
Right Rear Damper Actuator Control High	C0590 02	C0590 04	C0590 02	C0590 0F
Left Front Damper Actuator Control Low	C0575 02	C0575 04	C0575 04	C0575 0F
Right Front Damper Actuator Control Low	C0580 02	C0580 04	C0580 04	C0580 0F
Left Rear Damper Actuator Control Low	C0585 02	C0585 04	C0585 04	C0585 0F

Right Rear Damper Actuator Control Low	C0590 02	C0590 04	C0590 04	C0590 0F
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Circuit/System Description

The suspension control module commands variable levels of current to each shock absorber actuator in response to rough road, braking or abrupt steering maneuver driving conditions. The current variation is performed by pulse width modulation (PWM) of the system voltage. The suspension control module continuously measures the actual current of each actuator. When a deviation between commanded and actual current is detected, a DTC is set.

Conditions for Running the DTC

System voltage is between 9-16 V.

Conditions for Setting the DTC

C0575 02, C0580 02, C0585 02, and C0590 02

- A short to voltage or short to ground on the control high circuit is detected.
- A short to ground on the control low circuit is detected.

C0575 04, C0580 04, C0585 04, and C0590 04

- An open circuit on the control high or control low circuit is detected.
- A short to voltage on the control low circuit is detected.

C0575 0F, C0580 0F, C0585 0F, and C0590 0F

An erratic current on the actuator circuit is detected.

Action Taken When the DTC Sets

- The electronic suspension control is disabled for the duration of the ignition cycle.
- The driver information center displays the SERVICE SUSPENSION SYSTEM message.

Conditions for Clearing the DTC

- A present DTC will clear on the next consecutive malfunction-free ignition cycle.
- A history DTC will clear after 41 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Electronic Suspension Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Suspension Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, with a scan tool, command the Damper Actuator Increase and Decrease while observing the Damper Actuator Command parameter. The parameter should vary between 0-1 000 mA. Listen/feel the Q37 Shock Absorber Actuator. The component should activate when changing between the commanded states.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Q37 Shock Absorber Actuator.
2. Perform this setup step in the following order:
 1. Connect a test lamp and ammeter in series between both Q37 Shock Absorber Actuator harness connector control circuit terminals.
 2. Ignition ON, with a scan tool, attempt to clear all K19 Suspension Control Module DTCs (codes may not clear).
3. With a scan tool, command the Damper Actuator to Increase the amperage to approximately 400 mA and Decrease to 0 mA while comparing the ammeter displayed values and scan tool Damper Actuator Command parameter displayed values. Verify the following:
 - The test lamp is illuminated.
 - The ammeter displayed values and scan tool Damper Actuator Command parameter displayed values change and are simultaneously within 15 mA of each other.
 - If the test lamp is not illuminated and/or the values are not within the specified range, test both control circuits for a short to voltage, short to ground, or open/high resistance. If all circuits test normal, replace the K19 Suspension Control Module.
4. If all circuits test normal, test or replace the Q37 Shock Absorber Actuator.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the appropriate Q37 Shock Absorber Actuator.
2. Test for 2-3 ohms between the Q37 Shock Absorber Actuator control terminals.
 - If not within the specified range, replace the Q37 Shock Absorber Actuator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Strut, Strut Component, or Spring Replacement (GNA, GNB)**
- **Shock Absorber Replacement (GNC)** , **Shock Absorber Replacement (GNE)**
- **Control Module References** for suspension control module replacement, programming, and setup

DTC C0595, C0600, OR C0605: ACCELERATION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0595 02

Left Front Acceleration Sensor Circuit Short to Ground

DTC C0595 05

Left Front Acceleration Sensor Circuit High Voltage/Open

DTC C0595 0A

Left Front Acceleration Sensor Circuit Too Slow Transitions

DTC C0600 02

Right Front Acceleration Sensor Circuit Short to Ground

DTC C0600 05

Right Front Acceleration Sensor Circuit High Voltage/Open

DTC C0600 0A

Right Front Acceleration Sensor Circuit Too Slow Transitions

DTC C0605 02

Left Rear Acceleration Sensor Circuit Short to Ground

DTC C0605 05

Left Rear Acceleration Sensor Circuit High Voltage/Open

DTC C0605 0A

Left Rear Acceleration Sensor Circuit Too Slow Transitions

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Body Acceleration Sensor 5V Reference	C0870 03	C0595 05	C0870 07	-
Right Front Body Acceleration Sensor 5V Reference	C0870 03	C0600 05	C0870 07	-
Rear Body Acceleration Sensor 5V Reference	C0870 03	C0605 05	C0870 07	-
Left Front Body Acceleration Sensor Signal	C0595 02	C0595 05	C0595 05, C0870 07	C0595 0A
Right Front Body Acceleration Sensor Signal	C0600 02	C0600 05	C0600 05, C0870 07	C0600 0A
Rear Body Acceleration Sensor Signal	C0605 02	C0605 05	C0605 05, C0870 07	C0605 0A
Left Front Body Acceleration Sensor Low Reference	-	C0595 05	-	-
Right Front Body Acceleration Sensor Low Reference	-	C0600 05	-	-
Rear Body Acceleration Sensor Low Reference	-	C0605 05	-	-

Circuit/System Description

The suspension control module supplies a 5 V reference voltage and a low reference to each body acceleration sensor. The body acceleration sensors supply a signal of 0.5-4.5 V to the suspension control module.

Conditions for Running the DTC

System voltage is between 9-16 V

Conditions for Setting the DTC

C0595 02, C0600 02, and C0605 02

The signal voltage is less than 0.5 V for 1.5 s

C0595 05, C0600 05, and C0605 05

The signal voltage is greater than 4.5 V for 1.5 s

C0595 0A, C0600 0A, and C0605 0A

- The number of signal changes is less than specified value for 2.5 s.
- Vehicle speed is greater than 30 km/h (19 MPH)

Action Taken When the DTC Sets

- The electronic suspension control is disabled for the duration of the ignition cycle.
- The driver information center displays the SERVICE SUSPENSION SYSTEM message.

Conditions for Clearing the DTC

- A present DTC will clear on the next consecutive malfunction-free ignition cycle.
- A history DTC will clear after 41 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Electronic Suspension Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Suspension Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Vertical Body Acceleration parameters. The parameters should be 0 m/s².

Circuit/System Testing

1. Ignition ON, verify that DTC C0870 is not present.
 - If the DTC is present, refer to **DTC C0870** to diagnose that DTC prior to this diagnostic.
2. Ignition OFF, disconnect the harness connector at the appropriate B162 Vertical Body Acceleration Sensor.
3. Open/Close doors, and wait 60 s. Test for less than 5 ohms between the low reference circuit terminal 3 and ground.
 - If greater than the specified value, test the low reference circuit for short to voltage or an open/high resistance. If the circuit tests normal, replace the K19 Suspension Control Module.
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - If less than the specified value, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K19 Suspension Control Module.
 - If greater than the specified value, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K19 Suspension Control Module.
5. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K19 Suspension Control Module.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K19 Suspension Control Module.
6. If all circuits test normal, replace the affected B162 Vertical Body Acceleration Sensor.
7. Verify the DTC does not reset. If the DTC resets, replace the K19 Suspension Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Electronic Suspension Body Front Vertical Accelerometer Replacement - Upper**
- **Electronic Suspension Rear Position Sensor Replacement**
- **Control Module References** for suspension control module replacement, programming, and setup

DTC C0670 OR C0675: ACCELERATION OR POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0670 02

Left Front Acceleration or Position Sensor Circuit Short to Ground

DTC C0670 05

Left Front Acceleration or Position Sensor Circuit High Voltage/Open

DTC C0670 0A

Left Front Acceleration or Position Sensor Circuit Too Slow Transitions

DTC C0675 02

Right Front Acceleration or Position Sensor Circuit Short to Ground

DTC C0675 05

Right Front Acceleration or Position Sensor Circuit High Voltage/Open

DTC C0675 0A

Right Front Acceleration or Position Sensor Circuit Too Slow Transitions

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Vertical Suspension Acceleration Sensor 5V Reference	C0870 03	C0670 05	C0870 07	-
Right Front Vertical Suspension Acceleration Sensor 5V Reference	C0870 03	C0675 05	C0870 07	-
Left Front Vertical Suspension Acceleration Sensor Signal	C0670 02	C0670 05	C0670 05, C0870 07	C0670 0A
Right Front Vertical Suspension Acceleration Sensor Signal	C0675 02	C0675 05	C0675 05, C0870 07	C0675 0A
Left Front Vertical Suspension Acceleration Sensor Low Reference	-	C0670 05	-	-

Right Front Vertical Suspension Acceleration Sensor Low Reference	-	C0675 05	-	-
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Circuit/System Description

The suspension control module supplies a 5 V reference voltage and a low reference to each vertical suspension acceleration sensor. The vertical suspension acceleration sensors supply a signal of 0.5-4.5 V to the suspension control module.

Conditions for Running the DTC

System voltage is between 9-16 V.

Conditions for Setting the DTC

C0670 02 and C0675 02

The signal voltage is less than 0.5 V for 1.5 s.

C0670 05 and C0675 05

The signal voltage is greater than 4.5 V for 1.5 s.

C0670 0A and C0675 0A

- The number of signal changes is less than specified value for 2.5 s.
- Vehicle speed is greater than 30 km/h (19 MPH).

Action Taken When the DTC Sets

- The electronic suspension control is disabled for the duration of the ignition cycle.
- The driver information center displays the SERVICE SUSPENSION SYSTEM message.

Conditions for Clearing the DTC

- A present DTC will clear on the next consecutive malfunction-free ignition cycle.
- A history DTC will clear after 41 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Electronic Suspension Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Suspension Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Vertical Wheel Acceleration parameters. The parameters should be 0 m/s² when the vehicle is parked on a level surface.

Circuit/System Testing

1. Ignition ON, verify that DTC C0870 is not present.
 - If the DTC is present, refer to **DTC C0870** to diagnose that DTC prior to this diagnostic.
2. Ignition OFF, disconnect the harness connector at the appropriate B161 Vertical Suspension Acceleration Sensor.
3. Ignition OFF, open/close doors, and wait 60 s. Test for less than 5 ohms between the low reference circuit terminal 3 and ground.
 - If greater than the specified value, test the low reference circuit for short to voltage or an open/high resistance. If the circuit tests normal, replace the K19 Suspension Control Module.
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K19 Suspension Control Module.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K19 Suspension Control Module.
5. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K19 Suspension Control Module.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K19 Suspension Control Module.
6. If all circuits test normal, replace the B161 Vertical Suspension Acceleration Sensor. Verify the DTC does not reset. If the DTC resets, replace the K19 Suspension Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Electronic Suspension Wheel Front Vertical Accelerometer Replacement - Lower**
- **Control Module References** for suspension control module replacement, programming, and setup

DTC C0720: ENGINE TORQUE MANAGEMENT FEEDBACK SIGNAL INVALID DATA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0720 71

Engine Torque Management Feedback Signal Invalid Data

Circuit/System Description

The suspension control module receives high speed controller area network (CAN) message inputs from the engine control module (ECM) identifying the actual engine torque. The suspension control module utilizes this signal to control the vehicle ride characteristics.

Conditions for Running the DTC

System voltage is between 9-16 V

Conditions for Setting the DTC

The suspension control module received invalid serial data from the ECM.

Action Taken When the DTC Sets

The electronic suspension control is disabled for the duration of the ignition cycle.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 41 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Electronic Suspension Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Suspension Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify that no DTCs are present in the ECM.
 - If any DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** to diagnose that DTC prior to this diagnostic.
2. Replace the K19 Suspension Control Module control module and verify the DTC does not reset.
 - If the DTC resets replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control module replacement, programming, and setup

DTC C0870: CONTROL MODULE VOLTAGE REFERENCE OUTPUT CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0870 03

Control Module Voltage Reference Output Circuit Low Voltage

DTC C0870 07

Control Module Voltage Reference Output Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	C0870 03	C0595 05, C0600 05, C0605 05, C0670 05, C0675 05	C0870 07	-
Low Reference	-	C0595 05, C0600 05, C0605 05, C0670 05, C0675 05	-	-

Circuit/System Description

The suspension control module supplies a 5 V reference voltage and a low reference to each body acceleration sensor and vertical suspension acceleration sensor. The body acceleration sensors and vertical suspension acceleration sensors supply a signal of 0.5-4.5 V to the suspension control module.

Conditions for Running the DTC

System voltage is between 9-16 V.

Conditions for Setting the DTC

C0870 03

The suspension control module detected a short to ground on the 5 V reference circuit for 1.5 s.

C0870 07

The suspension control module detected a short to voltage on the 5 V reference circuit for 1.5 s.

Action Taken When the DTC Sets

- The electronic suspension control is disabled for the duration of the ignition cycle.
- The driver information center displays the SERVICE SUSPENSION SYSTEM message.

Conditions for Clearing the DTC

- A present DTC will clear on the next consecutive malfunction-free ignition cycle.

- A history DTC will clear after 41 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Electronic Suspension Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Suspension Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Suspension Position Sensor 5 V Reference parameter. The parameter should be 4.8-5.2 V.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors at all 5 vertical body and suspension acceleration sensors.
2. Ignition ON, test for 4.8-5.2 V between any one of the 5 V reference circuits terminal and ground.
 - If less than the specified range, test all of the 5 V reference circuits for a short to ground. If the circuits test normal, replace the K19 Suspension Control Module.
 - If greater than the specified range, test all of the 5 V reference circuits for a short to voltage. If the circuits test normal, replace the K19 Suspension Control Module.
3. Test for 4.8-5.2 V between all 5 vertical body and suspension acceleration sensor signal circuits terminals and ground.
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K19 Suspension Control Module.

- If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K19 Suspension Control Module.
- 4. Reconnect each acceleration sensor, one at a time, cycling the ignition OFF and then ON between each connection while observing the scan tool Suspension Position Sensor 5 V Reference parameter. Verify the parameter is between 4.8-5.2 V.
 - If not within the specified range when a particular acceleration sensor is connected, replace that sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Electronic Suspension Body Front Vertical Accelerometer Replacement - Upper**
- **Electronic Suspension Wheel Front Vertical Accelerometer Replacement - Lower**
- **Electronic Suspension Rear Position Sensor Replacement**
- **Control Module References** for suspension control module replacement, programming, and setup

REPAIR INSTRUCTIONS

ELECTRONIC SUSPENSION BODY FRONT VERTICAL ACCELEROMETER REPLACEMENT - UPPER

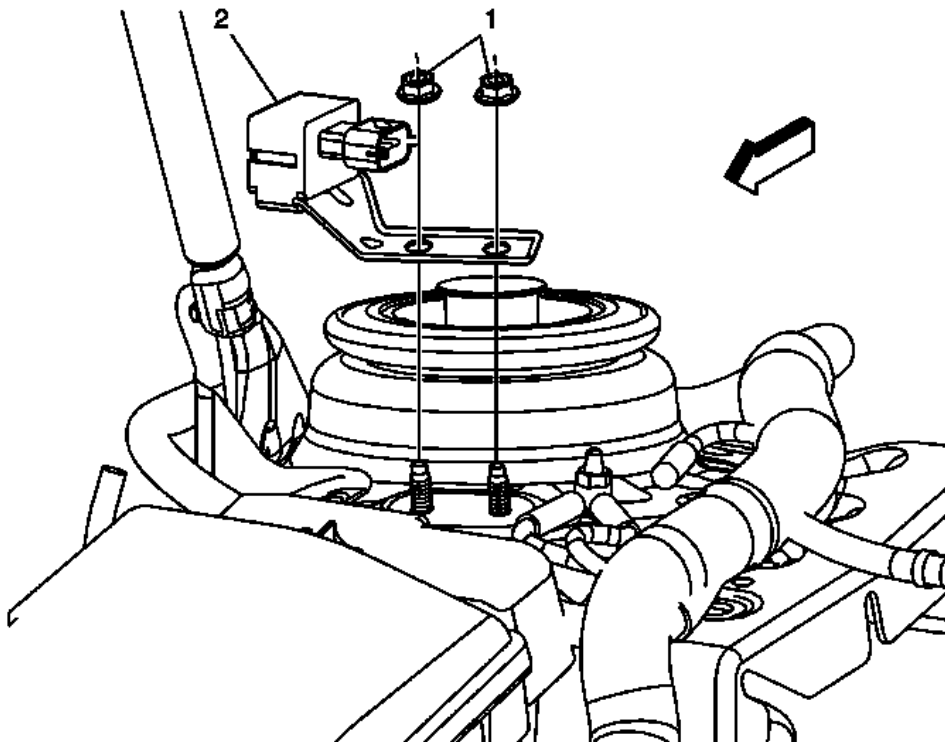


Fig. 4: View Of Electronic Suspension Front Vertical Accelerometer - Upper
Courtesy of GENERAL MOTORS COMPANY

Electronic Suspension Body Front Vertical Accelerometer Replacement - Upper

Callout	Component Name
1	Electronic Suspension Front Upper Position Sensor Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> Tighten 9 N.m (80 lb in)
2	Electronic Suspension Front Vertical Accelerometer Procedure Disconnect the connector from the sensor.

ELECTRONIC SUSPENSION WHEEL FRONT VERTICAL ACCELEROMETER REPLACEMENT - LOWER

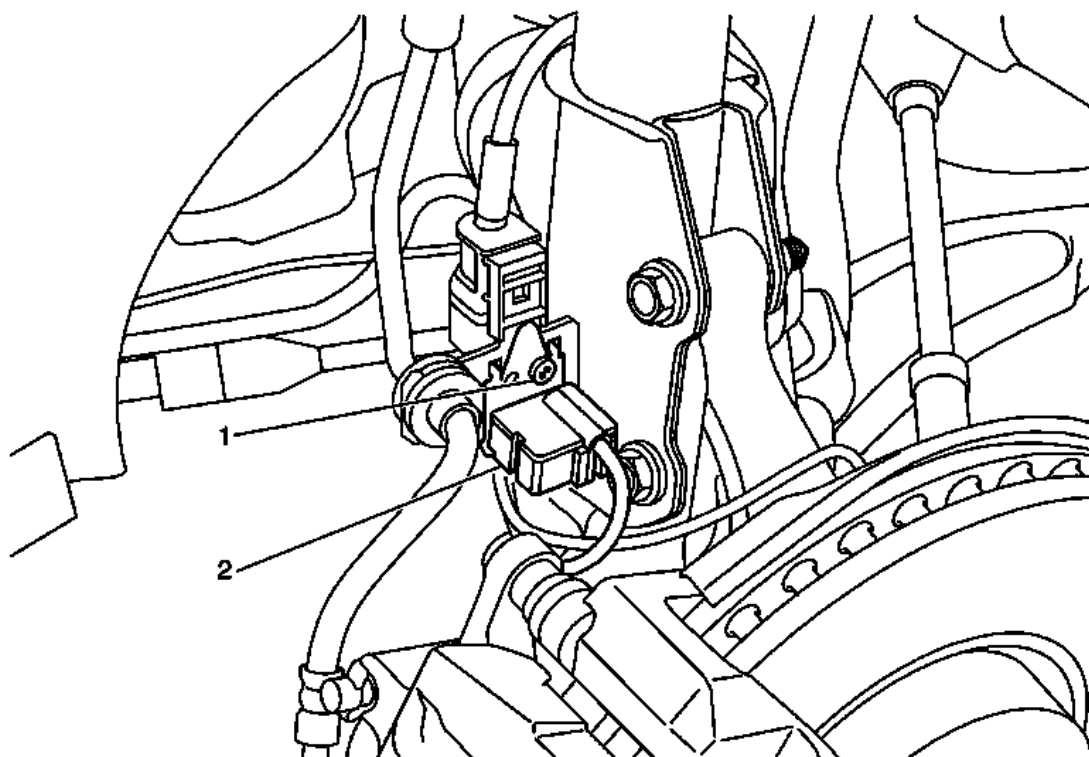


Fig. 5: View Of Electronic Suspension Front Vertical Accelerometer - Lower
Courtesy of GENERAL MOTORS COMPANY

Electronic Suspension Wheel Front Vertical Accelerometer Replacement - Lower

Callout	Component Name
Preliminary Procedure	
1.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .

2. Remove the front tire and wheel assemblies.
3. Unlock and disconnect the wheel speed sensor harness electrical connector. Refer to **Electronic Suspension Position Sensor Front Jumper Harness Disconnection** .

1	<p>Electronic Suspension Front Position Sensor Fastener</p> <p>CAUTION: Refer to <u>Fastener Caution</u></p> <p>Tighten 9 N.m (80 lb in)</p>
2	Electronic Suspension Front Vertical Accelerometer

ELECTRONIC SUSPENSION CONTROL MODULE REPLACEMENT

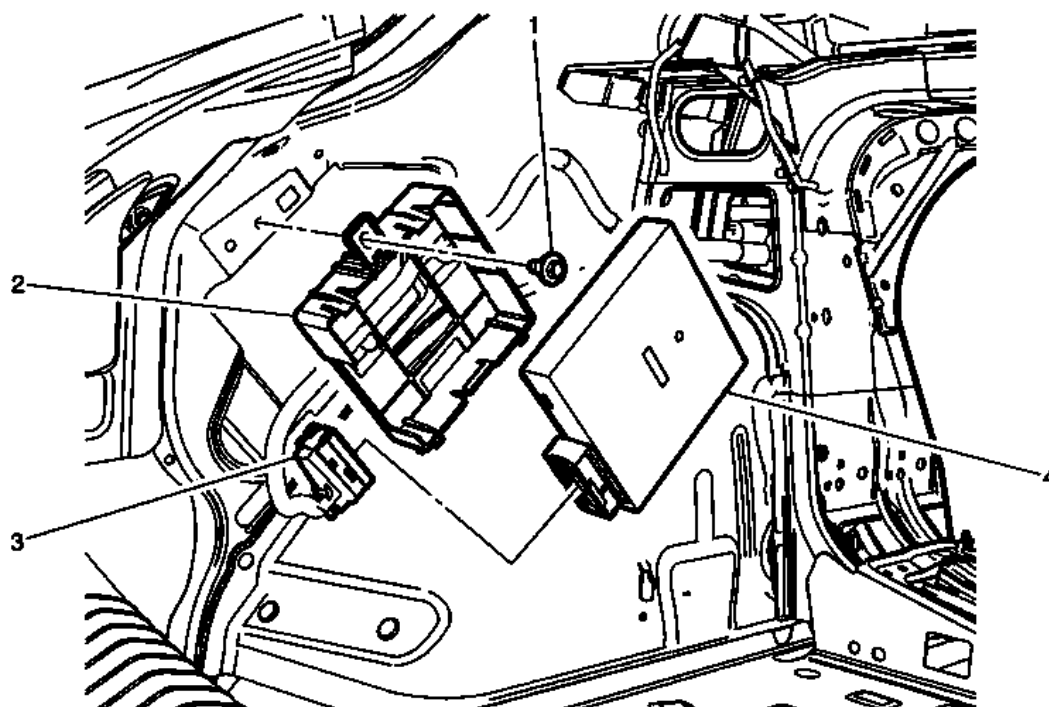


Fig. 6: Electronic Suspension Control Module Components
Courtesy of GENERAL MOTORS COMPANY

Electronic Suspension Control Module Replacement

Callout	Component Name
<p>Preliminary Procedure Remove the left side luggage compartment trim. Refer to <u>Rear Compartment Side Trim Panel Replacement (without HP6)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .</p>	

1	Electronic Suspension Control Module Bracket Bolt
	CAUTION: Refer to <u>Fastener Caution</u> .
	Tighten 9 (80 lb in)
2	Electronic Suspension Control Module Bracket
3	Electronic Suspension Control Module Electrical Harness Connector
4	Electronic Suspension Control Module Procedure For programming and setup information, refer to <u>Control Module References</u> .

ELECTRONIC SUSPENSION REAR POSITION SENSOR REPLACEMENT

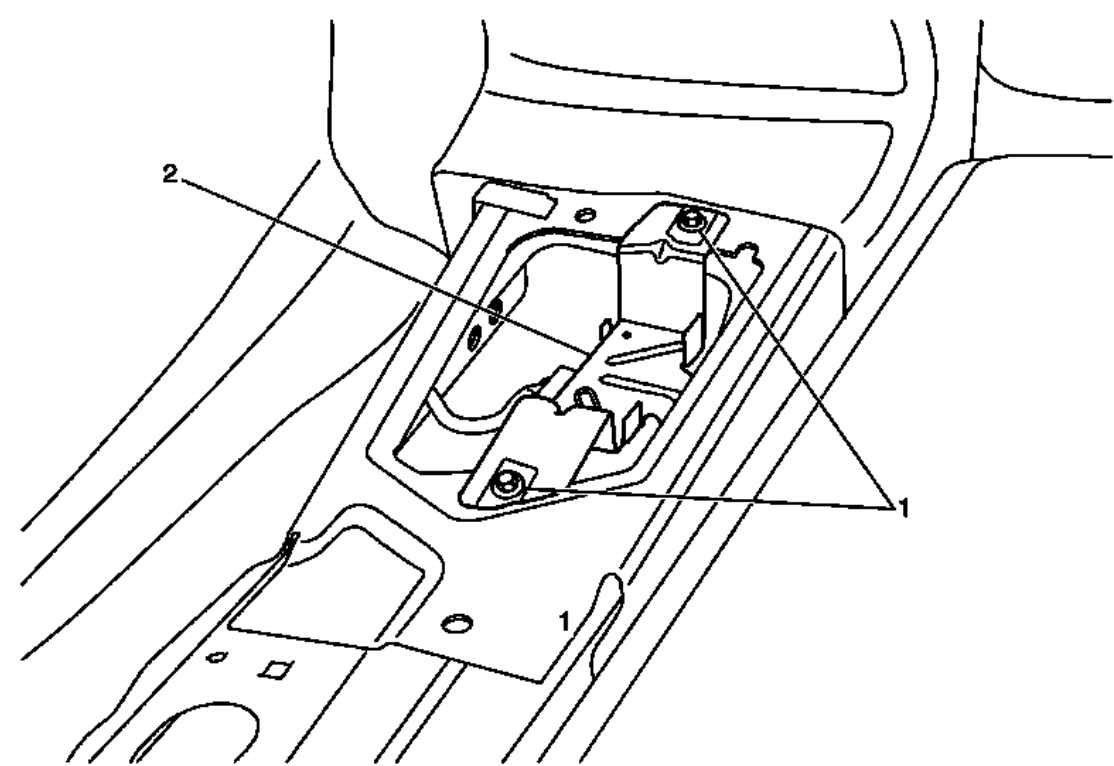


Fig. 7: Identifying Electronic Suspension Rear Position Sensor & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Electronic Suspension Rear Position Sensor Replacement

Callout	Component Name
Preliminary Procedure	
1.	Folder the back on left side of the backseat.

2. Lift the front left side of the luggage compartment trim floor panel and also the damping material.	
1	<p>Electronic Suspension Rear Position Sensor Replacement Fastener (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 6 N.m(53 lb in)</p>
2	Electronic Suspension Rear Position Sensor

DESCRIPTION AND OPERATION

ELECTRONIC SUSPENSION CONTROL DESCRIPTION AND OPERATION

Electronic Suspension Control Block Diagram

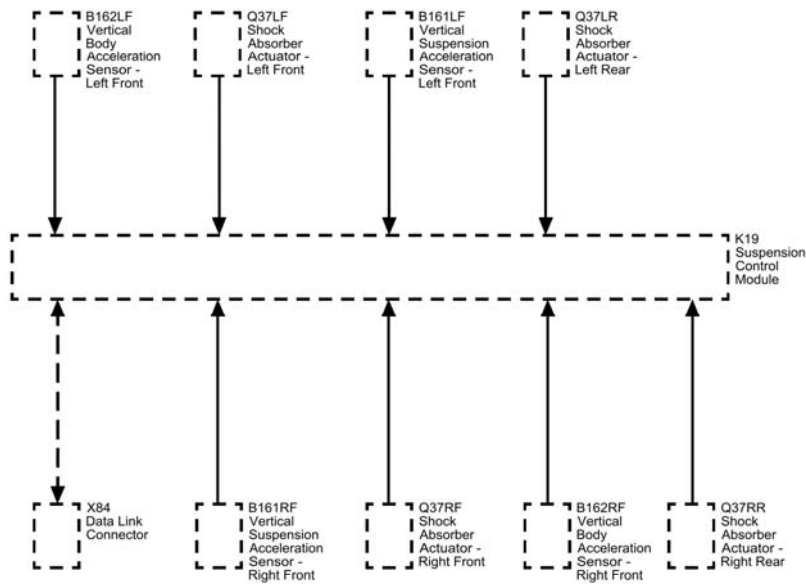


Fig. 8: Electronic Suspension Control Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
DD	Serial Data - GMLAN High Speed
Q37LF	Q37LF Shock Absorber Actuator - Left Front
Q37LR	Q37LR Shock Absorber Actuator - Left Rear
K19	K19 Suspension Control Module
X84	X84 Data Link Connector
Q37RF	Q37RF Shock Absorber Actuator - Right Front
Q37RR	Q37RR Shock Absorber Actuator - Right Rear
B162LF	B162LF Vertical Body Acceleration Sensor - Left Front
B161LF	B161LF Vertical Suspension Acceleration Sensor - Left Front
B161RF	B161RF Vertical Suspension Acceleration Sensor - Right Front
B162RF	B162RF Vertical Body Acceleration Sensor - Right Front

The electronic suspension control system individually controls the damping force of each of the 4 shock absorbers in order to keep the vehicle body as calm as possible. Changes of the damping forces can be accomplished within milliseconds. Suspension characteristics can be changed at any time by activating the sport mode or tour mode.

The electronic suspension control system consists of the following major components:

- The suspension control module
- Three vertical body acceleration sensors
- Two front vertical suspension acceleration sensors
- Four shock absorber actuators which are integrated within the shock absorbers

The suspension control module controls the damping forces according to the following factors:

- Vehicle speed
- Steering wheel position
- Engine torque
- Brake pressure

- Body and front wheels vertical acceleration

The suspension control module evaluates these inputs in order to separately control the shock absorbers, providing an enhanced ride and comfort level over the widest possible range of operating conditions.

Suspension Control Module

The suspension control module controls the system functions and detects failures. The suspension control module receives input information by vertical acceleration sensors that are directly connected to the module and by other systems through the serial data line. The suspension control module commands variable levels of current to each shock absorber actuator.

Vertical Acceleration Sensors

The suspension control module supplies a common 5 V reference and a ground circuit to each of the five vertical acceleration sensor. The vertical acceleration sensors supply a signal of 0.5-4.5 V to the suspension control module.

The three vertical body acceleration sensors are mounted left front, right front and rear. The two front vertical suspension acceleration sensors are mounted at the strut.

Shock Absorber Actuators

The shock absorber actuators are integrated within the shock absorbers. The electronic suspension control system uses a proportional valve that is located in the external bypass of the displacement module.

Adjustment is performed by current control. The current consumption is 0-1.8 A. The actuators respond to commands of the suspension control module within milliseconds.

Driver Information Center Message

The electronic suspension control system does not have a malfunction indicator, but uses the instrument cluster for the display functions instead. When the suspension control module detects a fault that sets a DTC, it sends a message on the serial data line to the instrument cluster, which will display the following message:

SERVICE SUSPENSION SYSTEM

The suspension control module has the ability to store DTCs as current or history codes. Most electronic suspension control system malfunctions will display a message in the instrument cluster and set a DTC. As long as the DTC is present, the message will be displayed.

The suspension control module uses an ignition cycling diagnostic approach. Actions taken when a fault is detected will remain until the ignition is turned OFF, even if the fault condition is not present anymore.

If a fault is no longer present, the DTC will be stored as a history code. After 41 consecutive malfunction-free ignition cycles the DTC will be deleted.

GENERAL INFORMATION

Electrostatic Discharge (ESD) Warning - Basic Information

*** PLEASE READ THIS FIRST ***

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

INTRODUCTION

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

All Electrostatic Discharge (ESD) sensitive components contain solid state circuits (transistors, diodes, semiconductors) that may become damaged when contacted with an electrostatic charge. The following information applies to all ESD sensitive devices. The ESD symbol shown in Fig. **Fig. 1** may be used on schematics to indicate which components are ESD sensitive. See **Fig. 1**. Although different manufactures may display different symbols to represent ESD sensitive devices, the handling and measuring precautions and procedures are the same.



Fig. 1: Sample ESD Symbol

HANDLING STATIC-SENSITIVE CIRCUITS/DEVICES

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

When handling an electronic part that is ESD sensitive, the technician should follow these guidelines to reduce any possible electrostatic charge build-up on the technician's body and the electronic part.

1. Always touch a known good ground source before handling the part. This should be repeated while handling the part and more frequently after sitting down from a standing position, sliding across the seat or walking a distance.

2. Avoid touching electrical terminals of the part, unless instructed by a diagnostic procedure.
3. DO NOT open the package of a new part until it is time to install the part.
4. Before removing the part from its package, ground the package to a known good ground source.

CHECKING STATIC-SENSITIVE CIRCUITS/DEVICES

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

1. Solid State circuits in electronic devices are shown greatly simplified in schematics. See **Fig. 2**. Due to the simplification of the electronic devices on the schematic, resistance measurements could be misleading or could lead to an electrostatic discharge. Always follow the recommended diagnostic procedure.

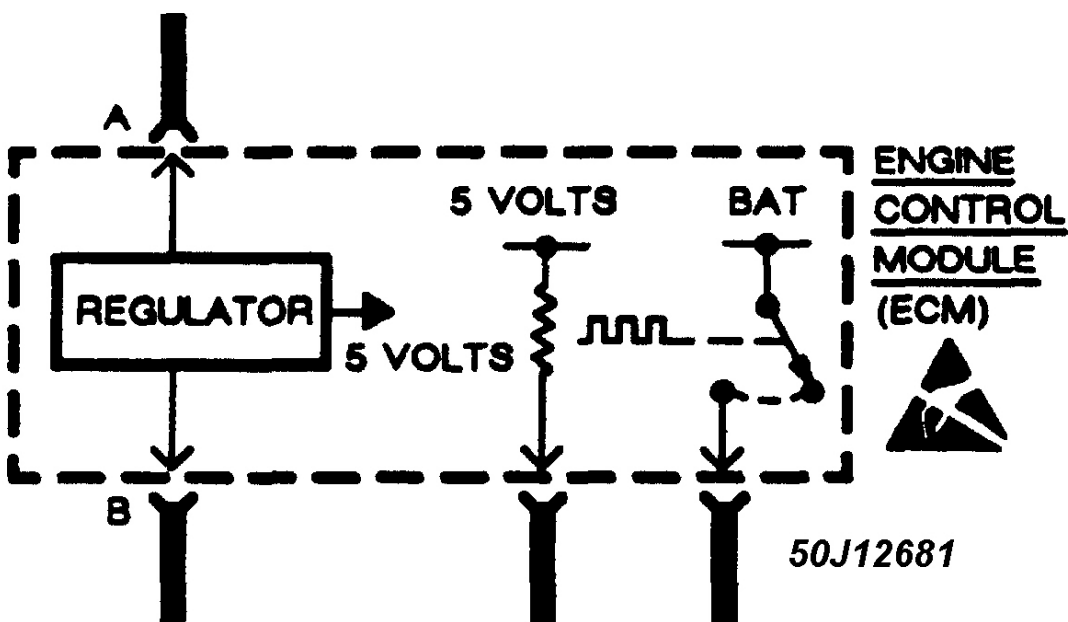


Fig. 2: Sample Schematic Showing Typical ESD Sensitive Device

2. Only measure resistance at the terminals of the devices when instructed by the recommended diagnostic procedure.
3. When using a voltmeter, be sure to connect the ground lead first.

EMISSION APPLICATIONS

EMISSION APPLICATIONS

Engine & Fuel System	(1) Emission Control Systems & Devices	EGR Test No.
2.0L (122") 4-Cyl. DI Turbo	PCV, (2) EVAP, TWC, FR, (2) SPK, (3) HO2S, CEC, (2) MIL, EVAP-CPCSV, EVAP-CVCSV, EVAP-FVTS, EVAP-ORVR, EVAP-VC	...
2.4L (143") 4-Cyl. DI Hybrid	PCV, (2) EVAP, TWC, FR, AIS, (2) SPK, (3) HO2S, CEC, (2) MIL, EVAP-CPCSV, EVAP-CVCSV, EVAP-FVTS, EVAP-ORVR, EVAP-VC	...
<p>(1) Major emission control systems and devices are listed in bold type. Components and other related devices are listed in light type.</p> <p>(2) PCM-controlled.</p> <p>(3) Equipped with 2.</p>		

ENGINE

Engine Cooling

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Coolant Crossover Pipe Fastener	10 N.m	89 lb in
Engine Coolant Air Bleed Pipe Fastener LTG)	10 N.m	89 lb in
Engine Coolant Fan Motor Fastener	10 N.m	89 lb in
Engine Coolant Thermostat Fastener (LUK)	10 N.m	89 lb in
Radiator Drain Cock	2 N.m	18 lb in
Thermostat Bypass Pipe Fasteners (LTG)	10 N.m	89 lb in
Thermostat Cover Fastener (LUK)	10 N.m	89 lb in
Thermostat Housing Fastener (LUK, LTG)	10 N.m	89 lb in
Water Inlet Fastener (LDK, LUK)	10 N.m	89 lb in
Water Outlet Fastener (LTG)	12 N.m	9 lb ft
Water Pump Access Hole Cover Fastener (LUK)	25 N.m	18 lb ft
Water Pump Fastener (LUK, LTG)	25 N.m	18 lb ft
Water Pump Sprocket Fasteners (LUK)	10 N.m	89 lb in
Turbocharger Coolant Feed Pipe Banjo Bolt (LTG)	35 N.m	26 lb ft
Turbocharger Coolant Feed Pipe Fastener (LTG)	10 N.m	89 lb in
Turbocharger Coolant Return Pipe Banjo Bolt (LTG)	35 N.m	26 lb ft
Turbocharger Coolant Return Pipe Fastener (LTG)	10 N.m	89 lb in

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Extended Life Coolant Leak Detection Dye	Dye	89022219	89022220
DEX-COOL	Coolant	12346290	10953464

SCHEMATIC WIRING DIAGRAMS

ENGINE HEATING/COOLING WIRING SCHEMATICS

Electric Cooling Fans (LUK)

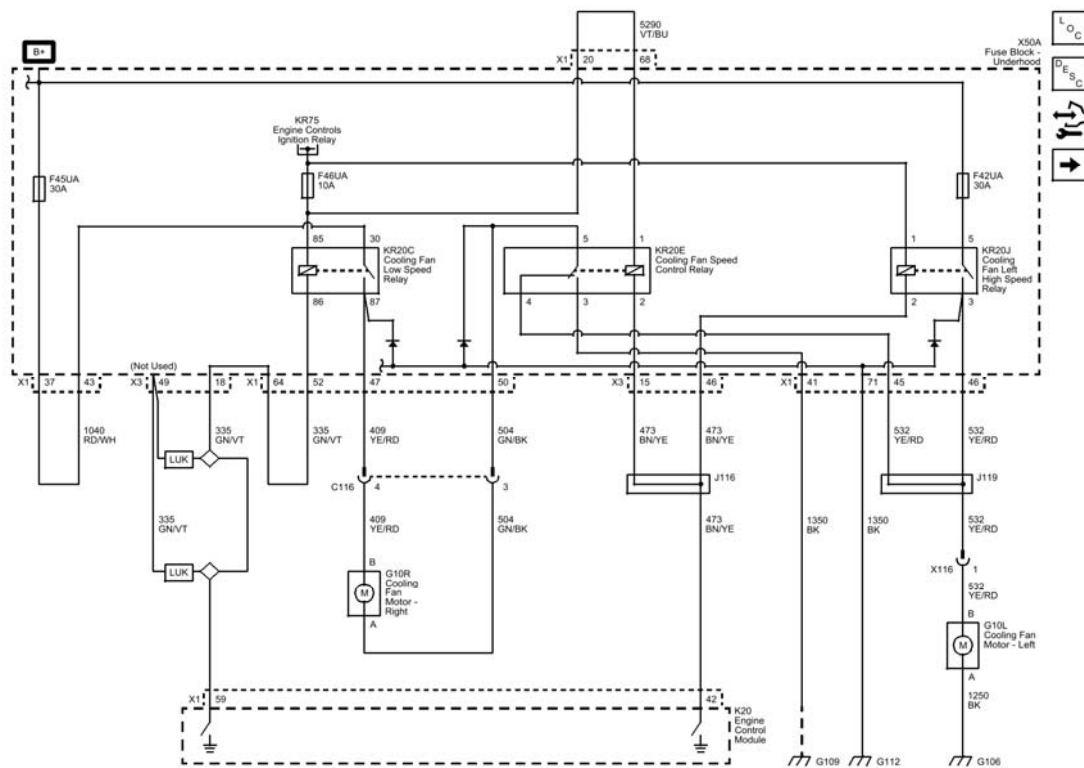


Fig. 1: Electric Cooling Fans (LUK)
Courtesy of GENERAL MOTORS COMPANY

Electric Cooling Fan Controls (LHU)

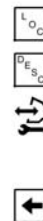
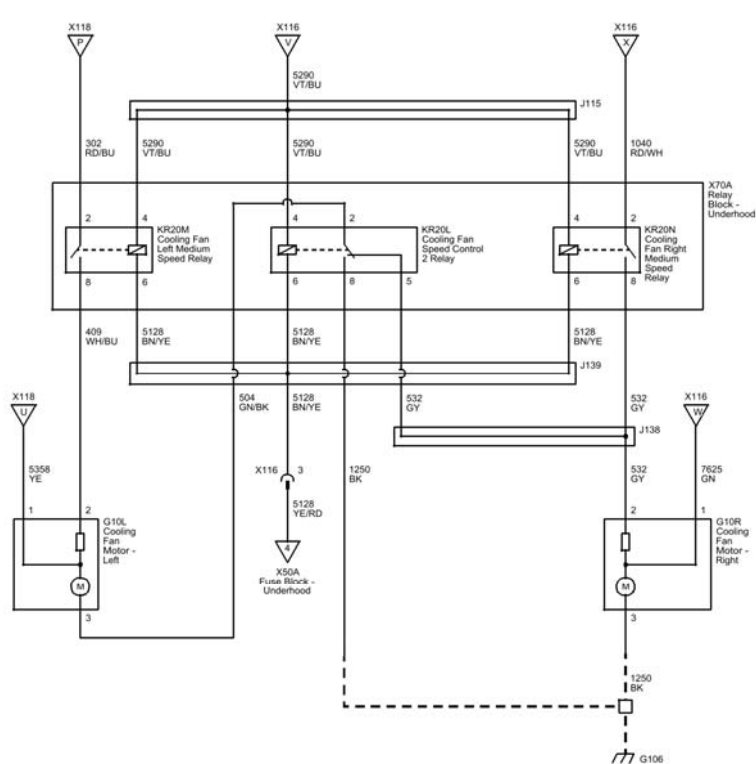


Fig. 3: Electric Cooling Fan Motors (LHU)
 Courtesy of GENERAL MOTORS COMPANY

Heater Coolant Pump (HP6)

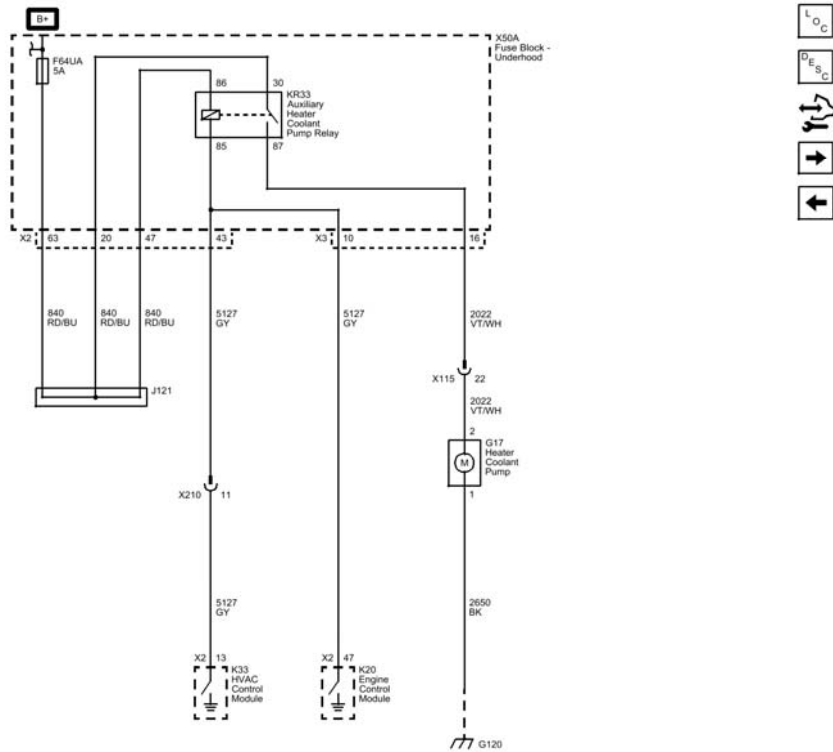


Fig. 4: Heater Coolant Pump (HP6)
 Courtesy of GENERAL MOTORS COMPANY

Dual Fan Controls (LDK)

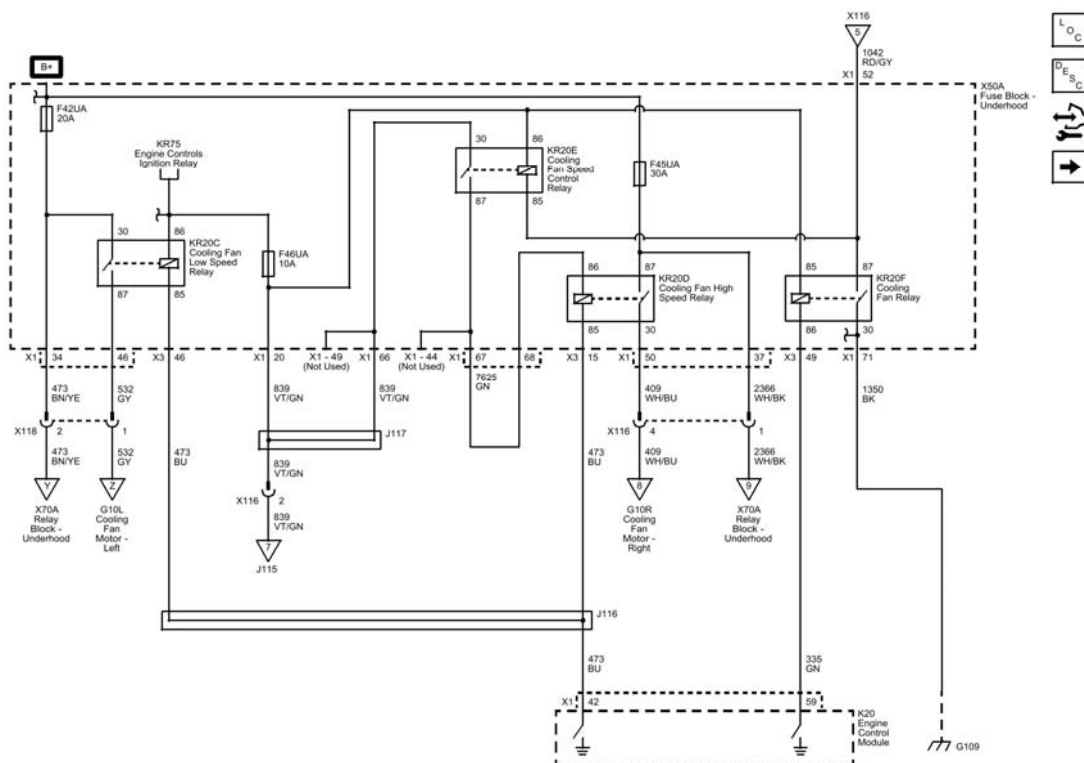


Fig. 5: Dual Fan Controls (LDK)
Courtesy of GENERAL MOTORS COMPANY

Dual Fan Motors (LDK)

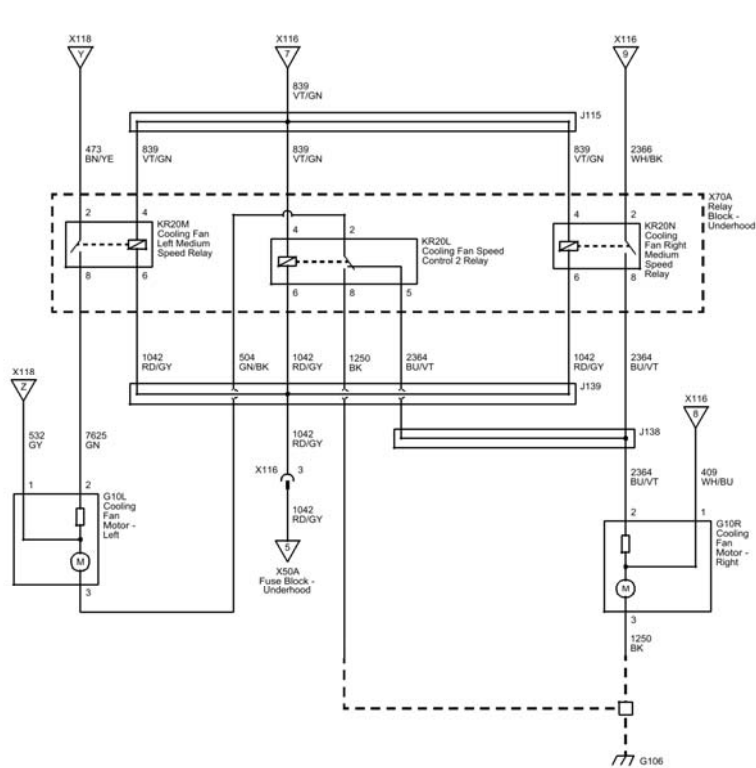


Fig. 6: Dual Fan Motors (LDK)
 Courtesy of GENERAL MOTORS COMPANY

Single Fan (LLU/LAF/LTD)

DTC Descriptors

DTC P0480

Cooling Fan Relay 1 Control Circuit

DTC P0481

Cooling Fan Relays 2 and 3 Control Circuit

DTC P0691

Cooling Fan Relay 1 Control Circuit Low Voltage

DTC P0692

Cooling Fan Relay 1 Control Circuit High Voltage

DTC P0693

Cooling Fan Relays 2 and 3 Control Circuit Low Voltage

DTC P0694

Cooling Fan Relays 2 and 3 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0480	P0480, P0481	-	-
Relay Switch B+	1	1	-	-
Low Speed Cooling Fan Relay Control	P0691	P0480, P0691	P0692	-
High Speed Cooling Fan Relay Control	P0693	P0481 or 1	P0694	-
Cooling Fan Speed Control Relay Control	P0693	P0481 or 1	P0694	-
Relay Controlled Output	1	1	2	-
1. Fan(s) inoperative without a DTC 2. Fan(s) always ON without a DTC				

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON

in either high speed or low speed, depending on cooling requirements. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Conditions for Running the DTC

- The ignition voltage is greater than 11 volts.
- The ECM driver transitions from ON to OFF or from OFF to ON.
- DTCs P0480, P0481, P0691, P0692, P0693, and P0694 run continuously when the conditions above are met.

Conditions for Setting the DTC

The commanded state of the ECM driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates both fans at a low speed
 - Cooling Fan Relays 2 and 3 operates one fan at a high speed
 - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification Views**

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify an audible click is heard or felt from each cooling fan relay when commanding the cooling fans ON and OFF with a scan tool.
 - **If a click is not heard or felt at one or more of the relays**

Refer to Circuit/System Testing

- **If a click is heard or felt at each of the relays**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect all of the cooling fan relays. Ignition ON.

NOTE: **The following tests must be performed on all three fan relay circuits.**

2. Verify that a test lamp illuminates between ground and a relay coil ignition circuit terminal listed below:
 - KR20C Cooling Fan Low Speed Relay terminal 85/2
 - KR20D Cooling Fan High Speed Relay terminal 86/1
 - KR20E Cooling Fan Speed Control Relay terminal 86/1
 - **If the test lamp does not illuminate**
 1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit of the appropriate cooling fan relay, end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Remove the test lamp.
 2. Test for infinite resistance between the appropriate cooling fan relay ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance test or replace the appropriate cooling fan relay.
 - **If the test lamp illuminates**
3. Ignition ON.

NOTE: The following tests must be performed on all three fan relay circuits.

4. Connect a DMM, set on the diode setting, between ground and a relay control circuit terminal listed below:
 - KR20C cooling fan low speed relay terminal 86/1
 - KR20D cooling fan high speed relay terminal 85/2
 - KR20E cooling fan speed control relay terminal 85/2
5. Verify the DMM reading is greater than 2.5 V or displays O.L with the cooling fan relays commanded OFF with a scan tool.
 - **If 2.5 V or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the appropriate relay coil control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 2.5 V or displays O.L.**
6. Verify the DMM reading is less than 1 V when commanding the cooling fan relays ON with a scan tool.
 - **If greater than 1 V or displays OL.**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the appropriate cooling fan relay control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V.
- 3. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
- 4. Test for less than 2 ohms in the appropriate cooling fan relay control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
- **If less than 1 V**
- 7. Test or replace the appropriate cooling fan relay.

Component Testing

1. Ignition OFF.
2. Disconnect a cooling fan relay.
3. Test for 70-110 ohms between terminals 85/2 and 86/1.
 - **If less than 70 ohms or greater than 110 ohms**

Replace the cooling fan relay.

- **If between 70-110 ohms**
- 4. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87

OR

- 3 and 2
- 3 and 5
- 3 and 1
- 1 and 5
- **If less than infinite resistance**

Replace the cooling fan relay.

- **If infinite resistance**

NOTE: This test only applies to the speed control relay.

5. Test for less than 2 ohms between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
 - **If 2 ohms or greater**

Replace the KR20E Cooling Fan Speed Control Relay.

- **If less than 2 ohms**

6. Install a 20 A fused jumper wire between relay terminal 85 or 2 and 12 V.
7. Install a jumper wire between relay terminal 86 or 1 and ground.
8. Test for less than 2 ohms between terminals 3/30 and 5/87.

- **If 2 ohms or greater**

Replace the cooling fan relay.

- **If less than 2 ohms**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for ECM replacement, setup, and programming

SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

- Perform **Diagnostic System Check - Vehicle** and verify all of the following items:
 - Engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
 - There are no diagnostic trouble codes (DTCs) stored.
 - Scan tool data is within a normal operating range.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.
- Locate the correct symptom. Perform the tests and inspections associated with the symptom.

Review the entire cooling system operation in order to familiarize yourself with the system functions. Refer to **Cooling Fan Description and Operation**, and **Cooling System Description and Operation**.

Visual/Physical Inspection

CAUTION: Use the connector test adapter kit EL-35616-F for any test that requires probing the following items:

- **The control module harness connectors**
- **The electrical center fuse/relay cavities**
- **The component terminals**
- **The component harness connector**

Using this kit will prevent damage caused by the improper probing of connector terminals.

Several of the symptom procedures call for a careful visual and physical inspection. This can lead to correcting a condition without further tests and can save time. This inspection should include the following:

- Ensure that the control module grounds are clean, tight, and correctly located.
- Inspect cooling system hoses and pipes for splits, kinks, and improper connections. Inspect thoroughly for any type of leak or restriction.
- Inspect for a dirty or restricted radiator or HVAC condenser.
- Inspect for aftermarket devices which could affect the operation of the cooling system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the coolant recovery reservoir for proper coolant level.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movement of a component. Refer to the following for a list to help isolate an intermittent condition:

- Water intrusion in connectors, terminals, or components
- Poor connector mating
- Terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness' that are routed too tight, or chaffed circuits
- High or low ambient temperatures
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in components or circuits due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surface
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge

- Incorrect installation of non-factory, aftermarket, or after factory add on accessories

If an intermittent fault is detected, refer to **Testing for Intermittent Conditions and Poor Connections** for specific strategies in diagnosing intermittent conditions.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Cooling Fan Always On**
- **Cooling Fan Inoperative**
- **Engine Overheating**
- **Loss of Coolant**
- **Thermostat Diagnosis**
- **Engine Fails To Reach Normal Operating Temperature**

COOLING FAN ALWAYS ON

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates both fans at a low speed
 - Cooling Fan Relays 2 and 3 operates one fan at a high speed
 - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed
- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fans ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the temperature versus resistance tables in the appropriate Engine Controls subsection.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification Views**

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.
 - **If a DTC is set**

Refer to **DTC P0480, P0481, P0691, P0692, P0693, or P0694.**

- **If no DTC is set**
3. Verify the scan tool parameters listed below display OFF:
 - Cooling Fan Relay 1 Command
 - Cooling Fan Relays 2 and 3 Command
 - **If a scan tool parameter displays ON**

Refer to Diagnostic Aids and **Symptoms - Engine Cooling** for further diagnosis.

- **If both scan tool parameters display OFF**
4. Verify that the fans are not activated.

- **If a fan is operating**

Refer to Circuit/System Testing.

- **If both fans are OFF**

5. All OK

Circuit/System Testing

Both Cooling Fans Always ON

1. Ignition OFF, disconnect KR20C Cooling Fan Low Speed Relay, ignition ON.
2. Verify that both cooling fans are OFF.
 - **If the cooling fans are ON**
 1. Ignition OFF, disconnect the harness connector at the G10R Cooling Fan Motor-Right, ignition ON.
 2. Test for less than 1 V between KR20C Cooling Fan Low Speed Relay terminal 87/5 and ground.
 - If 1 V or greater, repair the short to voltage in the relay controlled output circuit.
 - **If the cooling fans are OFF**
3. Test or replace the KR20C Cooling Fan Low Speed Relay.

One Cooling Fan Always ON

1. Ignition OFF, disconnect the KR20D Cooling Fan High Speed Relay, ignition ON.
2. Verify the cooling fan is OFF.
 - **If the cooling fan is ON**
 1. Ignition OFF, disconnect the harness connector at the G10L Cooling Fan Motor-Left, ignition ON.
 2. Test for less than 1 V between KR20D Cooling Fan High Speed Relay terminal 30/3 and ground.
 - If 1 V or greater, repair the short to voltage in the relay controlled output circuit.
 - **If the cooling fan is OFF**
3. Test or replace the KR20D Cooling Fan High Speed Relay.

Component Testing

1. Ignition OFF.
2. Disconnect a KR20 Cooling Fan Relay.
3. Test for 70-110 ohms between terminals 85/2 and 86/1.
 - **If less than 70 ohms or greater than 110 ohms**

Replace the KR20 cooling fan relay.

- **If between 70-110 ohms**

4. Test for infinite resistance between the following terminals:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

OR

- 3 and 2
- 3 and 5
- 3 and 1
- 1 and 5
- **If less than infinite resistance**

Replace the KR20 Cooling Fan Relay.

- **If infinite resistance**

NOTE: This test only applies to the speed control relay.

5. Test for less than 2 ohms between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.

- **If 2 ohms or greater**

Replace the KR20E Cooling Fan Speed Control Relay.

- **If less than 2 ohms**

6. Install a 20 A fused jumper wire between relay terminal 85 or 2 and 12 V.

7. Install a jumper wire between relay terminal 86 or 1 and ground.

8. Test for less than 2 ohms between terminals 3/30 and 5/87.

- **If 2 ohms or greater**

Replace the KR20 Cooling Fan Relay.

- **If less than 2 ohms**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Relay Replacement (Within an Electrical Center) , **Relay Replacement (Attached to Wire Harness)**

COOLING FAN INOPERATIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
 - Cooling Fan Relay 1 operates both fans at a low speed
 - Cooling Fan Relays 2 and 3 operates one fan at a high speed
 - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

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- **Electrical Center Identification Views**

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.
 - **If a DTC is set**

Refer to **DTC P0480, P0481, P0691, P0692, P0693, or P0694.**

- **If no DTCs is set**
3. Verify that both cooling fans turn ON and OFF and operate at low and high speed, when commanding the appropriate cooling fan relays ON and OFF with a scan tool.
 - **If a cooling fan does not operate**

Refer to Circuit/System Testing

- **If both cooling fans operate**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect all of the KR20 Cooling Fan Relays.
2. Verify a test lamp illuminates between ground and the B+ circuit terminals listed below:
 - KR20C Cooling Fan Low Speed Relay B+ circuit terminal 85/1
 - KR20C Cooling Fan Low Speed Relay B+ circuit terminal 30/3
 - KR20D Cooling Fan High Speed Relay B+ circuit terminal 87/5
 - KR20D Cooling Fan High Speed Relay B+ circuit terminal 86/2
 - KR20E Cooling Fan Speed Control Relay B+ circuit terminal 86/2
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Disconnect the appropriate cooling fan fuse.
 2. Test for less than 2 ohms between the fuse and the appropriate relay B+ circuit terminal, end to end.
 - If 2 ohms or greater, repair the open/high resistance in the B+ circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Connect a DMM to the appropriate relay B+ circuit terminal.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the B+ circuit.
 - If infinite resistance
 3. Disconnect the harness connector at the appropriate G10 Cooling Fan Motor.
 4. Test for infinite resistance between the appropriate relay controlled output circuit terminal and ground.
 - KR20C Cooling Fan Low Speed Relay output circuit terminal 87/5

- KR20D Cooling Fan High Speed Relay output circuit terminal 30/3
 - KR20E Cooling Fan Speed Control Relay circuit terminal 30/3
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the appropriate G10 Cooling Fan Motor.
- **If the test lamp illuminates**
- 3. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G10L Cooling Fan Motor-Left. It may take up to 2 minutes for all vehicle systems to power down.
- 4. Test for less than 5 ohms between the circuits listed below and ground:
 - G10L Cooling Fan Motor-Left terminal A
 - KR20E Cooling Fan Speed Control Relay terminal 87/5
 - **If 5 ohms or greater**
 1. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
 2. Test for less than 2 ohms in the appropriate ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
- 5. Connect the harness connector at the G10L Cooling Fan Motor-Left.
- 6. Connect a 50 A fused jumper between the KR20D Cooling Fan High Speed Relay terminals 30/3 and 87/5.
- 7. Verify the G10L Cooling Fan Motor-Left is activated at high speed.
 - **If the cooling fan does not activate or jumper fuse opens**
 1. Disconnect the harness connector at the G10L Cooling Fan Motor-Left.
 2. Test for less than 2 ohms in the circuit between KR20D Cooling Fan High Speed Relay terminal 30/3 and the G10L Cooling Fan Motor-Left terminal B.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the G10L Cooling Fan Motor-Left.
 - **If the cooling fan activates**
- 8. Connect a fused jumper between the KR20E Cooling Fan Speed Control Relay switch circuit terminal 30/3 and the ground circuit terminal 87/5.
- 9. Connect a 40 A fused jumper between the KR20C Cooling Fan Low Speed Relay terminals 30/3 and 87/5.
- 10. Verify the G10R Cooling Fan Motor-Right is activated at high speed.
 - **If the cooling fan does not activate**
 1. Disconnect the harness connector at the G10R Cooling Fan Motor-Right.
 2. Test for less than 2 ohms in the circuit between KR20C Cooling Fan Low Speed Relay terminal 87/5 and the G10R Cooling Fan Motor-Right terminal B.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms

3. Test for less than 2 ohms in the circuit between KR20E Cooling Fan Speed Control Relay terminal 30/3 and the G10R Cooling Fan Motor-Right terminal A.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the G10R Cooling Fan Motor-Right.
 - **If the cooling fan activates**
11. Install the KR20E Cooling Fan Speed Control Relay.
12. Verify both fan motors activate at low speed.
 - **If both cooling fans do not activate at low speed**
 1. Disconnect both cooling fan motor harness connectors and the KR20E Cooling Fan Speed Control Relay.
 2. Test for less than 2 ohms in circuit between KR20E Cooling Fan Speed Control Relay terminal 87A/4 and the G10L Cooling Fan Motor-Left terminal B.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
 3. Test for infinite resistance between KR20E Cooling Fan Speed Control Relay terminal listed below and ground.
 - KR20E Cooling Fan Speed Control Relay terminal 30/3
 - KR20E Cooling Fan Speed Control Relay terminal 87A/4
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite, replace the KR20E cooling fan speed control relay.
 - **If both cooling fans activate**
13. Test or replace the cooling fan relay listed below as appropriate:
 - KR20C Cooling Fan Low Speed Relay
 - KR20D Cooling Fan High Speed Relay

Component Testing

1. Ignition OFF.
2. Disconnect a KR20 Cooling Fan Relay.
3. Test for 70-110 ohms between terminals 85/2 and 86/1.
 - **If less than 70 ohms or greater than 110 ohms**

Replace the KR20 cooling fan relay.
 - **If between 70-110 ohms**
4. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87

OR

- 3 and 2
- 3 and 5
- 3 and 1
- 1 and 5
- **If less than infinite resistance**

Replace the KR20 Cooling Fan Relay.

- **If infinite resistance**

NOTE: This test only applies to the speed control relay.

5. Test for less than 2 ohms between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
 - **If 2 ohms or greater**

Replace the KR20E Cooling Fan Speed Control Relay.

- **If less than 2 ohms**

6. Install a 20 A fused jumper wire between relay terminal 85 or 2 and 12 V.
7. Install a jumper wire between relay terminal 86 or 1 and ground.
8. Test for less than 2 ohms between terminals 3/30 and 87/5.
 - **If 2 ohms or greater**

Replace the KR20 Cooling Fan Relay.

- **If less than 2 ohms**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Engine Coolant Fan Shroud Replacement (LUK)**, **Engine Coolant Fan Shroud Replacement (LTG)**, **Engine Coolant Fan Shroud Replacement (LEA)**

ENGINE OVERHEATING

Engine Overheating

Step	Action	Yes	No
DEFINITION: The engine temperature lamp comes on and stays on, or temperature gauge shows hot, or coolant overflows from the surge tank onto the ground while the engine is running.			

1	Check for a loss of coolant. Refer to <u>Loss of Coolant</u> . Is there a loss of coolant?	Go to Step 2	Go to Step 3
2	Fill the system to the specified level. Does the engine still overheat?	Go to Step 3	System OK
3	Check for kinked or pinched surge tank hoses, especially at the radiator. Are any surge tank hoses kinked or pinched?	Go to Step 4	Go to Step 5
4	1. Relieve any kinks by rerouting the hoses. 2. Replace the hoses, if necessary. Does the engine still overheat?	Go to Step 5	System OK
5	Check for loose, missing, or damaged radiator air seals or deflectors. Are there any loose, missing, or damaged radiator air seals or deflectors?	Go to Step 6	Go to Step 7
6	Repair or replace any loose, missing, or damaged radiator air seals or deflectors. Does the engine still overheat?	Go to Step 7	System OK
7	Check the coolant concentration. Does the coolant concentration test correctly?	Go to Step 9	Go to Step 8
8	Replace the coolant, if necessary. Does the engine still overheat?	Go to Step 9	System OK
9	NOTE: Use the correct pressure cap. Check the system for loss of pressure. Refer to <u>Pressure Cap Testing</u> . Is there a loss of pressure?	Go to Step 10	Go to Step 11
10	Repair any leaks, as necessary. Does the engine still overheat?	Go to Step 11	System OK
11	Check for a faulty engine coolant temperature sensor. Is the engine coolant temperature sensor faulty?	Go to Step 12	Go to Step 13
12	Replace the engine coolant temperature sensor. Refer to <u>Engine Coolant Temperature Sensor Replacement</u> , for the 2.0L engine or <u>Engine Coolant Temperature Sensor Replacement</u> for the 2.4L engine. Does the engine still overheat?	Go to Step 13	System OK
13	Check the radiator for any air flow obstructions or bent fins. Is there any airflow obstruction or bent fins?	Go to Step 14	Go to Step 15
14	1. Remove or relocate add-on parts that block air flow to the radiator. 2. Clean any debris from the radiator core.		

	Does the engine still overheat?	Go to Step 15	System OK
15	Check for any blocked cooling system passages. Are there any blocked cooling system passages?	Go to Step 16	Go to Step 17
16	1. Remove any obstruction. 2. Flush the cooling system, as required. 3. Refill the coolant. Does the engine still overheat?	Go to Step 17	System OK
17	Check for an inoperative cooling fan. Is the cooling fan inoperative?	Go to Step 18	Go to Step 19
18	Replace the cooling fan. Refer to <u>Engine Coolant Fan Replacement (LUK)</u> , <u>Engine Coolant Fan Replacement (LTG)</u> . Does the engine still overheat?	Go to Step 19	System OK
19	Check for a thermostat that is stuck closed. Refer to <u>Thermostat Diagnosis</u> . Is the thermostat stuck closed?	Go to Step 20	Go to Step 21
20	Replace the thermostat. Refer <u>Engine Coolant Thermostat Replacement (LUK)</u> . Does the engine still overheat?	Go to Step 21	System OK
21	Check for a faulty water pump. The impeller blades may be eroded or broken. Is the water pump faulty?	Go to Step 22	-
22	Replace the water pump. Refer to <u>Water Pump Replacement (LTG)</u> , <u>Water Pump Replacement (LUK)</u> . Does the engine still overheat?	-	System OK

LOSS OF COOLANT

Loss of Coolant

Step	Action	Yes	No
DEFINITION: The cooling system is losing coolant either internally or externally.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to <u>Symptoms - Engine Cooling</u>
2	Repair any present DTCs. Refer to <u>Diagnostic System Check - Vehicle</u> . Is the action complete?	Go to Step 3	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to Step 5	Go to Step 4
4	Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . Is the action complete?	Go to Step 5	-

5	If the engine is suspected to have a coolant leak into a cylinder, the coolant can hydraulically lock the engine. Does the engine crankshaft rotate?	Go to Step 6	Go to Step 28
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to Step 29	Go to Step 7
7	Extended operation with a low coolant level can cause engine internal component failure. Is the engine knocking?	Go to Step 31	Go to Step 8
8	<ol style="list-style-type: none"> 1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust pipe. <p>Is a heavy white smoke present from the exhaust pipe?</p>	Go to Step 9	Go to Step 10
9	<ul style="list-style-type: none"> • Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. • Condensation in the exhaust system can cause an odorless white smoke during engine warm up. <p>Does the white smoke have a burning coolant type odor?</p>	Go to Step 30	Go to Step 10
10	<p>WARNING: Refer to <u>Moving Parts and Hot Surfaces Warning</u> .</p> <p>With the engine idling, inspect the surge tank. Does the surge tank discharge coolant while the engine is idling?</p>	Go to Step 15	Go to Step 11
11	<p>Visually inspect the hoses, pipes and hose clamps at the following locations:</p> <ul style="list-style-type: none"> • Coolant surge tank • Heater core • Radiator <p>Are any of the hoses, clamps or pipes leaking?</p>	Go to Step 22	Go to Step 12
12	<p>Visually inspect the following components:</p> <ul style="list-style-type: none"> • The coolant pressure cap • The core plugs • The cylinder head gaskets • The engine block • The intake manifold 		

	<ul style="list-style-type: none"> • The radiator • The thermostat housing • The water pump 		
	Are any of the listed components leaking?	Go to Step 22	Go to Step 13
13	<ol style="list-style-type: none"> 1. Pressure test the cooling system. Refer to <u>Cooling System Leak Testing</u>. 2. With the cooling system pressurized, visually inspect the components listed in steps 11 and 12. 		
	Are any leaks present?	Go to Step 22	Go to Step 14
14	Pressure test the coolant pressure cap. Refer to <u>Pressure Cap Testing</u> .		
	Does the coolant pressure cap hold pressure?	Go to Step 16	Go to Step 23
15	Pressure test the coolant pressure cap. Refer to <u>Pressure Cap Testing</u> .		
	Does the coolant pressure cap hold pressure?	Go to Step 32	Go to Step 23
16	Inspect for the following conditions: <ul style="list-style-type: none"> • A coolant smell inside of the vehicle • Coolant in the HVAC module drain tube • Coolant on the vehicle floor covering near the HVAC module 		
	Is coolant present?	Go to Step 24	Go to Step 17
17	<ol style="list-style-type: none"> 1. Add 30 ml (1 oz) of Extended Life Coolant Leak Detection Dye to the cooling system for each 15 liters (4 gallons) of coolant. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>, and <u>Approximate Fluid Capacities</u>. 2. Start the vehicle and allow the engine to reach normal operating temperature. 3. Shut the engine off. 4. Use J 42220 Universal 12V Leak Detection Lamp to visually inspect the components listed in steps 11 and 12. 		
	Are any leaks present?	Go to Step 22	Go to Step 18
	Use J 42220 Universal 12V Leak Detection Lamp to inspect for the following conditions:		

18	<ul style="list-style-type: none"> • Coolant dye in the HVAC module drain tube • Coolant dye on the vehicle floor covering near the HVAC module 		
	Is coolant dye present?	Go to Step 24	Go to Step 19
19	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is there a milky substance on under the oil fill cap?	Go to Step 20	Go to Step 21
20	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is there a milky substance on the engine oil fluid level indicator?	Go to Step 30	Go to Step 21
21	Inspect the automatic transmission oil fluid level indicator, if equipped, for a gray/white milky substance. Is there a milky substance on the automatic transmission fluid level indicator?	Go to Step 25	Go to Step 33
22	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to Step 33	-
23	Replace the coolant pressure cap. Is the repair complete?	Go to Step 33	-
24	Replace the heater core. Refer to <u>Heater Core Replacement (LHD)</u> . Is the repair complete?	Go to Step 33	-
25	<ol style="list-style-type: none"> 1. Remove the transmission oil cooler lines from the radiator. 2. Pressure test the cooling system. Refer to <u>Cooling System Leak Testing</u>. 3. Inspect the transmission oil cooler for coolant. 		
	Is coolant present?	Go to Step 26	Go to Step 27
26	<ol style="list-style-type: none"> 1. Replace the radiator. Refer to <u>Radiator Replacement (LUK)</u>, <u>Radiator Replacement (LTG)</u>, <u>Radiator Replacement (LEA)</u>. 2. Service the automatic transmission. Refer to <u>Engine Coolant/Water in Transmission</u> 		-
	Is the repair complete?	Go to Step 33	
27	Install the cooler lines to the radiator. Is the action complete?	Go to Step 33	-
28	Repair the engine no crank condition. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u>		-

	Is the repair complete?	Go to Step 33	
29	Repair the engine overheating condition. Refer to <u>Engine Overheating</u> . Is the repair complete?	Go to Step 33	-
30	Repair the engine internal coolant leak. Refer to <u>Coolant in Combustion Chamber</u> , or <u>Coolant in Engine Oil</u> Is the repair complete?	Go to Step 33	-
31	Repair the engine knock. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u> Is the repair complete?	Go to Step 33	-
32	Repair the combustion pressure in the cooling system problem. Refer to <u>Coolant in Combustion Chamber</u> Is the repair complete?	Go to Step 33	-
33	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

THERMOSTAT DIAGNOSIS

Thermostat Diagnosis

Step	Action	Yes	No
1	1. Ensure that the cooling system is full. 2. Allow the engine to cool. 3. Start the engine. 4. Turn the air conditioning system off. 5. Inspect the engine cooling fan(s). Is the electric cooling fan on?	Go to Step 2	Go to Step 3
2	1. Diagnose and repair the cooling fan system. Refer to <u>Cooling Fan Inoperative</u> . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 3	System OK
3	Install the Scan Tool to the DLC. Compare the Scan Tool coolant temperature reading to the I/P cluster coolant temperature. Is the I/P cluster coolant temperature close to the reading on the Scan Tool?	Go to Step 5	Go to Step 4
4	1. Diagnose and repair the coolant temperature gauge system. 2. Verify the customer complaint.		

	Does the engine still fail to reach normal operating temperature?	Go to Step 5	System OK
5	Inspect the thermostat for correct operation. Refer to <u>Engine Fails To Reach Normal Operating Temperature</u> . Is the thermostat operating correctly?	System OK	Go to Step 6
6	1. Replace the thermostat. Refer to <u>Engine Coolant Thermostat Replacement (LUK)</u> . 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 1	System OK

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

Special Tools

GE 24731 Tempil Stick

For equivalent regional tools, refer to **Special Tools**.

Use one of the following procedures in testing for a malfunctioning thermostat.

Thermostat Test Procedure Using Tempil Sticks

The coolant thermostat can be tested using a temperature (tempil) stick. The temperature stick is a pencil like device. It has a wax material containing certain chemicals which melt at a given temperature. Take a 87°C (188°F) tempil stick or a 97°C (206°F) tempil stick and rub it on the thermostat housing. Temperature sticks can be used to determine a thermostat's operating range.

1. Use a **GE 24731** Tempil Stick in order to find the opening and the closing temperatures of the coolant thermostat.
 - The 188 tempil stick melts at 87°C (188°F). The thermostat should begin to open.
 - The 206 tempil stick melts at 97°C (206°F). The thermostat should be fully open.
2. Replace the coolant thermostat if it does not operate properly between this temperature range.

Thermostat Test Procedure Using Glycol

Inspect the operation of the thermostat by hanging the thermostat on a hook in a 50/50 percent solution of DEX-COOL® and clean drinkable water.

In order to inspect if the thermostat valve is opening properly, perform the following test:

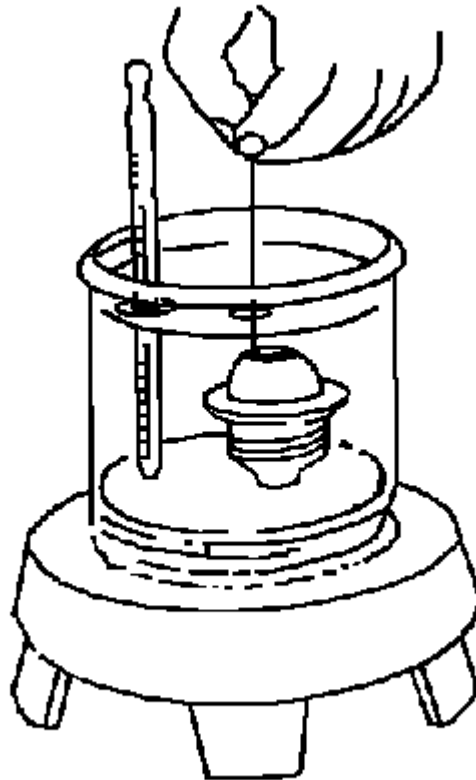


Fig. 8: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS COMPANY

1. Completely submerge the thermostat in the glycol solution. The solution should be 11°C (22°F) above the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should open.

In order to inspect if the thermostat valve is closing properly, perform the following test:

1. Completely submerge the thermostat in a glycol solution. The solution should be 6°C (10°F) below the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should close completely.

PRESSURE CAP TESTING

Special Tools

- **EN-24460-A** Cooling System Pressure Tester
- **GE-42401-A** Radiator Cap/Surge Tank Test Adapter

For equivalent regional tools, Refer to **Special Tools**

Pressure Cap Testing

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the pressure cap.
2. Wash the pressure cap sealing surface with water.

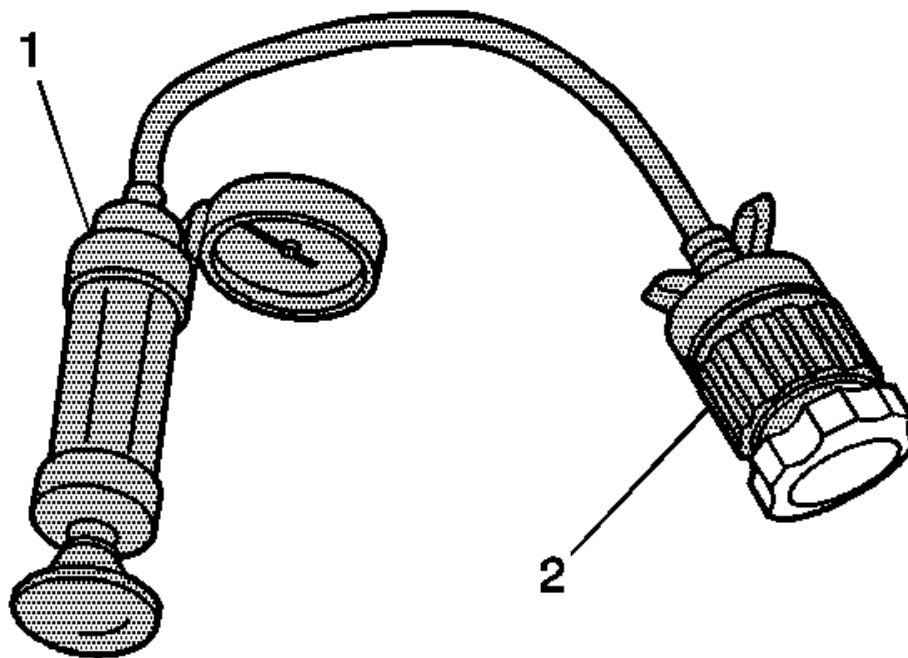


Fig. 9: Identifying Pressure Cap Testing Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate J-42401-1 and pressure cap o-rings with coolant and press cap to seat o-ring on J-42401-1 before turning to engage threads.

3. Use the **EN-24460-A** Cooling System Pressure Tester (1) with **GE-42401-A** Radiator Cap / Surge Tank Test Adapter (2) in order to test the pressure cap.

4. Test the pressure cap for the following conditions:

- Pressure release when the **EN-24460-A** Cooling System Pressure Tester exceeds the pressure rating of the pressure cap.
- Maintain the rated pressure for at least 10 seconds.

Note the rate of pressure loss.

5. Replace the pressure cap under the following conditions:

- The pressure cap does not release pressure which exceeds the rated pressure of the cap.
- The pressure cap does not hold the rated pressure.

COOLING SYSTEM LEAK TESTING

Special Tools

- **EN-24460-A** Cooling System Pressure Tester
- **GE-42401-3** Radiator Cap / Surge Tank Test Adapter

For equivalent regional tools, Refer to **Special Tools**

Cooling System Leak Testing

WARNING: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

WARNING: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

1. Remove the pressure cap.
2. Test the operation of the pressure cap. Refer to **Pressure Cap Testing**.
3. Wash the pressure cap mating surface with water.

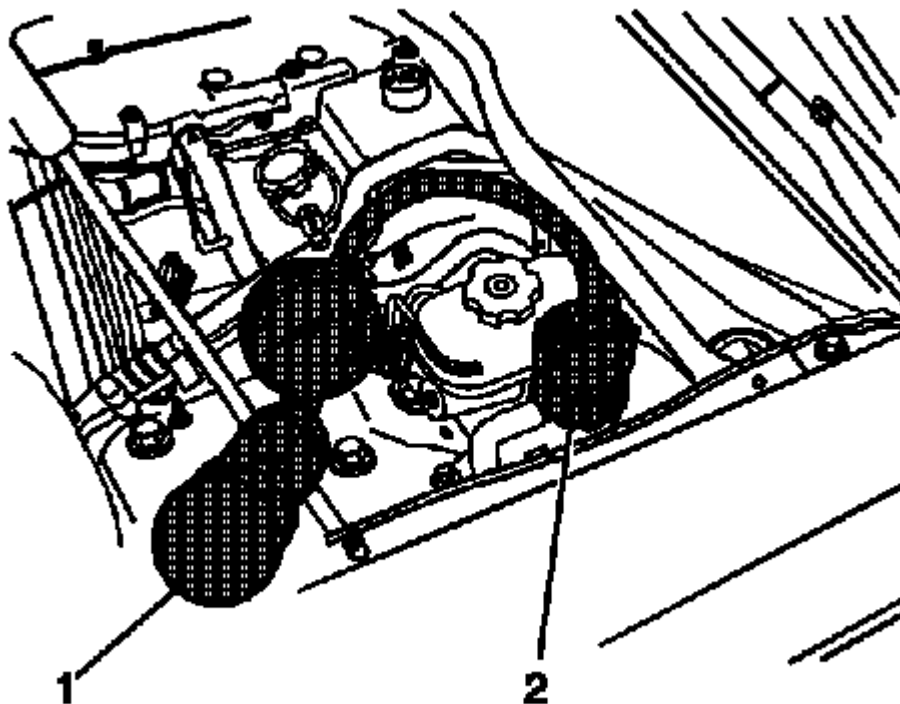


Fig. 10: Applying Pressure To Cooling System
Courtesy of GENERAL MOTORS COMPANY

4. Use the **EN-24460-A** Cooling System Pressure Tester (1) with **GE-42401-3** Radiator Cap / Surge Tank Test Adapter (2) in order to apply pressure to the cooling system.

Do not exceed the pressure cap rating.

5. The cooling system should hold the rated pressure for at least 2 minutes.

Observe the gauge for any pressure loss.

6. Repair any leaks as required.

REPAIR INSTRUCTIONS

COOLING SYSTEM DRAINING AND FILLING (STATIC FILL)

Special Tools

J 26568 Coolant and Battery Fluid Tester

Draining Procedure

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the coolant pressure cap from the radiator surge tank.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Place a drain pan under the drain cock.

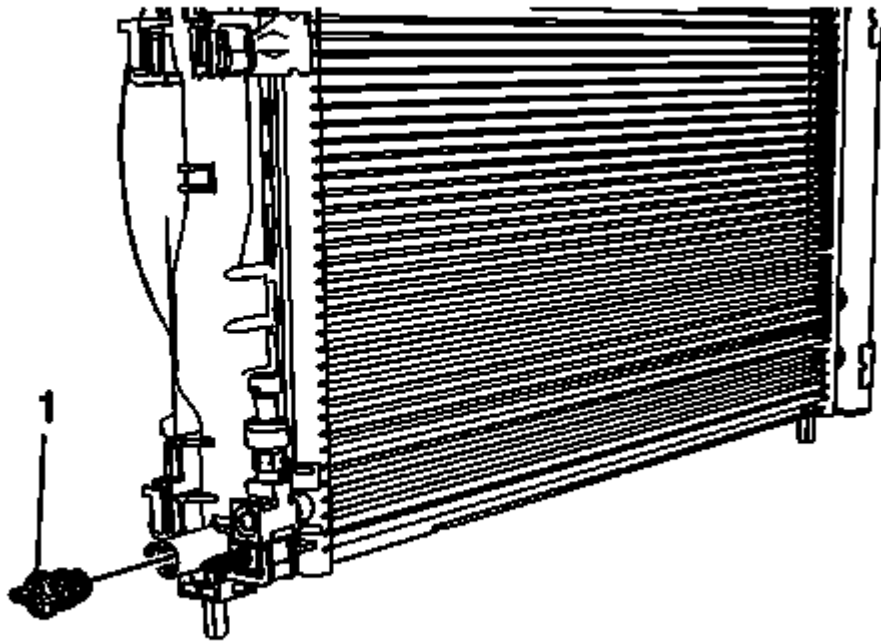


Fig. 11: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the radiator drain cock.
5. Drain the cooling system.
6. Lower the vehicle.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.

- Discolored-Follow the flush procedure. Refer to **Flushing**.

Filling Procedure

CAUTION: The procedure below must be followed. Improper coolant level could result in a low or high coolant level condition, causing engine damage.

1. Raise and support the vehicle.

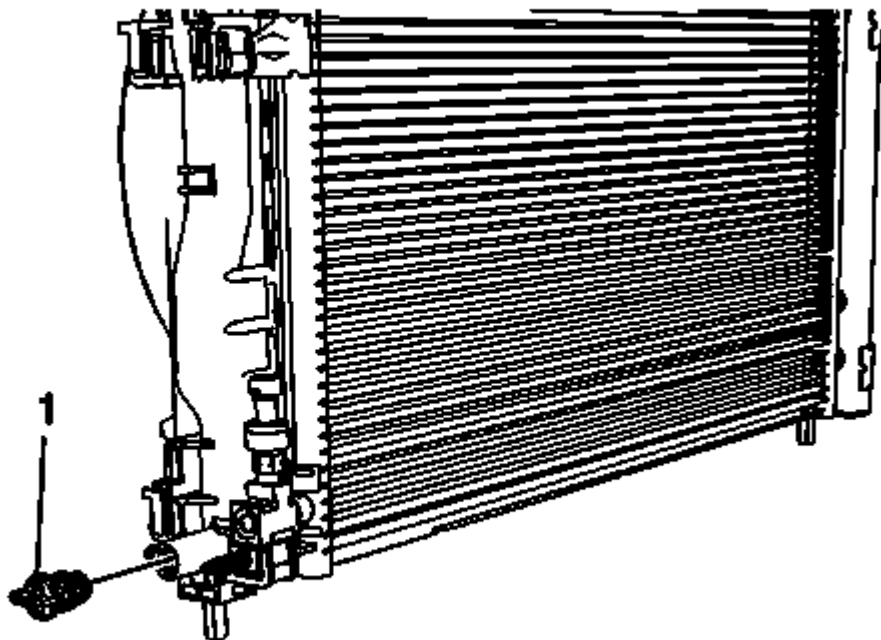


Fig. 12: Radiator Drain Cock

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

2. Tighten the radiator drain cock to 2 N.m (18 lb in).
3. Lower the vehicle.

NOTE: Use a 50/50 mixture of DEX-COOL antifreeze and clean drinkable water.

4. Slowly fill the radiator with a 50/50 coolant mixture until the coolant level reaches the base of the radiator surge tank. Refer to **Approximate Fluid Capacities** .
5. Allow 30 seconds for the coolant level to stabilize and continue to fill the coolant filler neck until the level stabilizes for at least 2 minutes.
6. Start the engine and allow the engine to idle in PARK or NEUTRAL with the parking brake engaged.
7. Slowly fill the coolant mixture until the level stabilizes at the base of the radiator surge tank.
8. Install the coolant pressure cap.
9. Raise the engine RPM to 2500 rpm for 30-40 seconds.
10. Shut the engine OFF.
11. Allow the engine to cool, remove coolant fill cap and repeat steps 4-10 until the coolant level has completely stabilized within the radiator surge tank.
12. Inspect the concentration of the engine coolant using the **J 26568** Coolant and Battery Fluid Tester
13. Inspect and if necessary, fill the coolant reservoir bottle as necessary.
14. Rinse away any excess coolant from the engine and the engine compartment
15. Inspect the cooling system for leaks.
16. Top off the radiator surge tank if necessary.

COOLING SYSTEM DRAINING AND FILLING (GE 47716)

Special Tools

- **J 26568** Coolant and Battery Fluid Tester
- **J 42401** Radiator Cap and Surge Tank Test Adapter
- **GE-47716** Vac N Fill Coolant Refill Tool

Draining Procedure

WARNING: With a pressurized cooling system, the coolant temperature in the radiator can be considerably higher than the boiling point of the solution at atmospheric pressure. Removal of the surge tank cap, while the cooling system is hot and under high pressure, causes the solution to boil instantaneously with explosive force. This will cause the solution to spew out over the engine, the fenders, and the person removing the cap. Serious bodily injury may result.

1. Remove the coolant pressure cap.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Place a drain pan under the drain cock.
4. Remove the radiator drain cock.

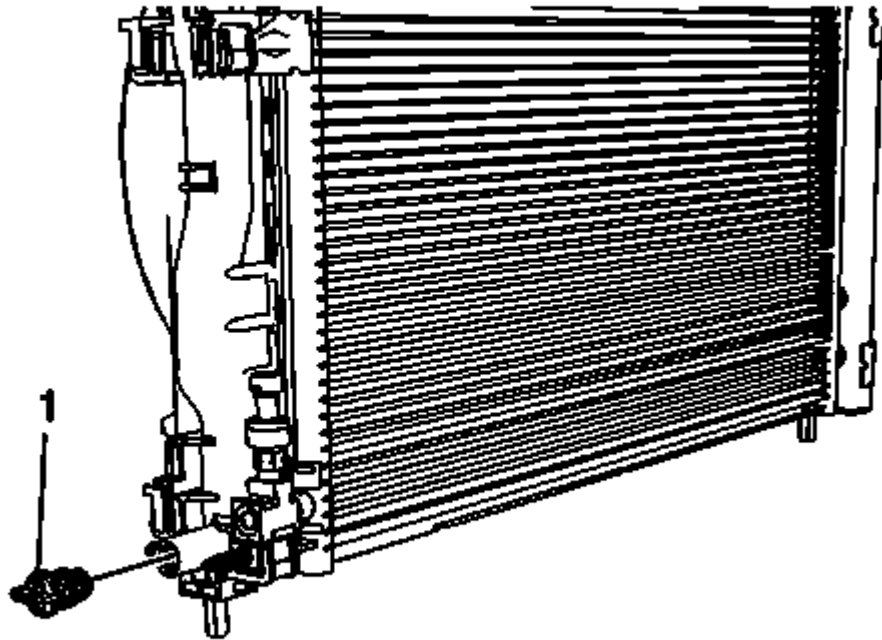


Fig. 13: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

5. Drain the cooling system.
6. Lower the vehicle.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
 - Normal in appearance-Follow the filling procedure.
 - Discolored-Follow the flush procedure. Refer to **Flushing**.

Vac-N-Fill Procedure

1. Install the **J 42401** Radiator Cap and Surge Tank Test Adapter onto the coolant surge tank.

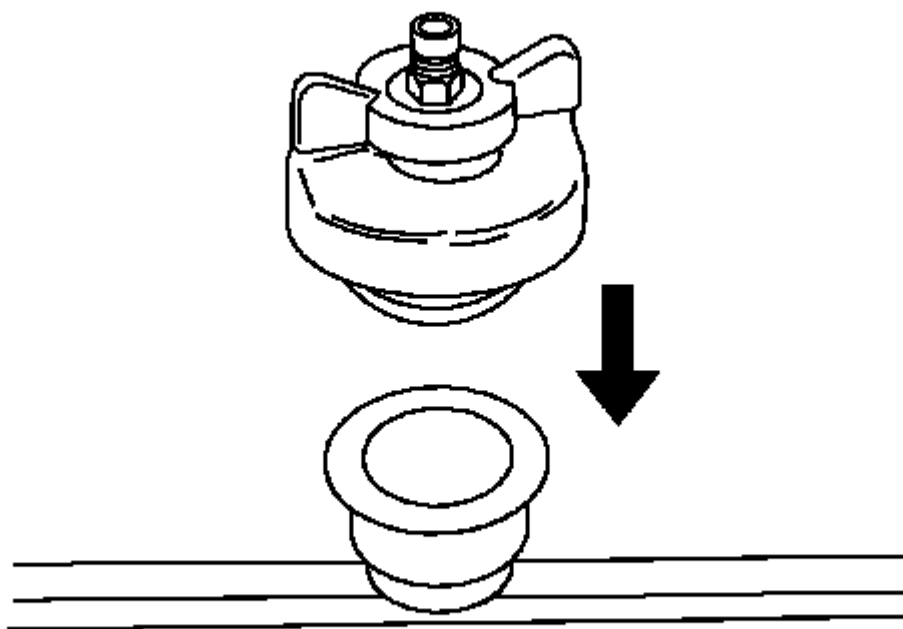


Fig. 14: Identifying Vac-N-Fill Cap
Courtesy of GENERAL MOTORS COMPANY

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

2. Attach the Vac N Fill cap to the **J 42401** Radiator Cap and Surge Tank Test Adapter.

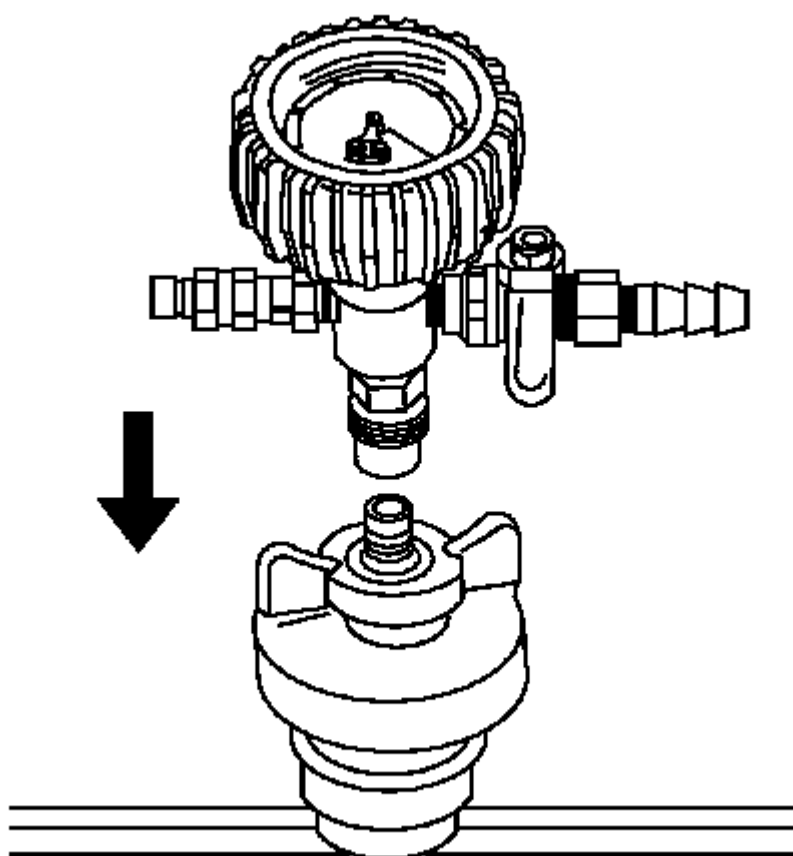


Fig. 15: Attaching The Vacuum Gage Assembly To The Vac-N-Fill Cap
Courtesy of GENERAL MOTORS COMPANY

3. Attach the vacuum gauge assembly to the Vac N Fill cap.

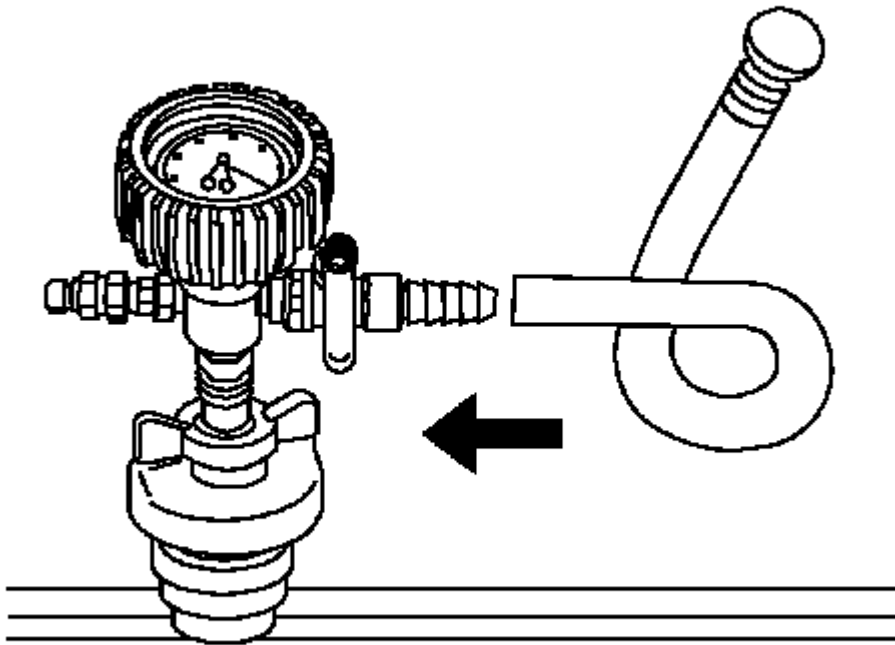


Fig. 16: Attaching Fill Hose To Barb Fitting On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Attach the fill hose to the barb fitting on the vacuum gauge assembly.

Ensure that the valve is closed.

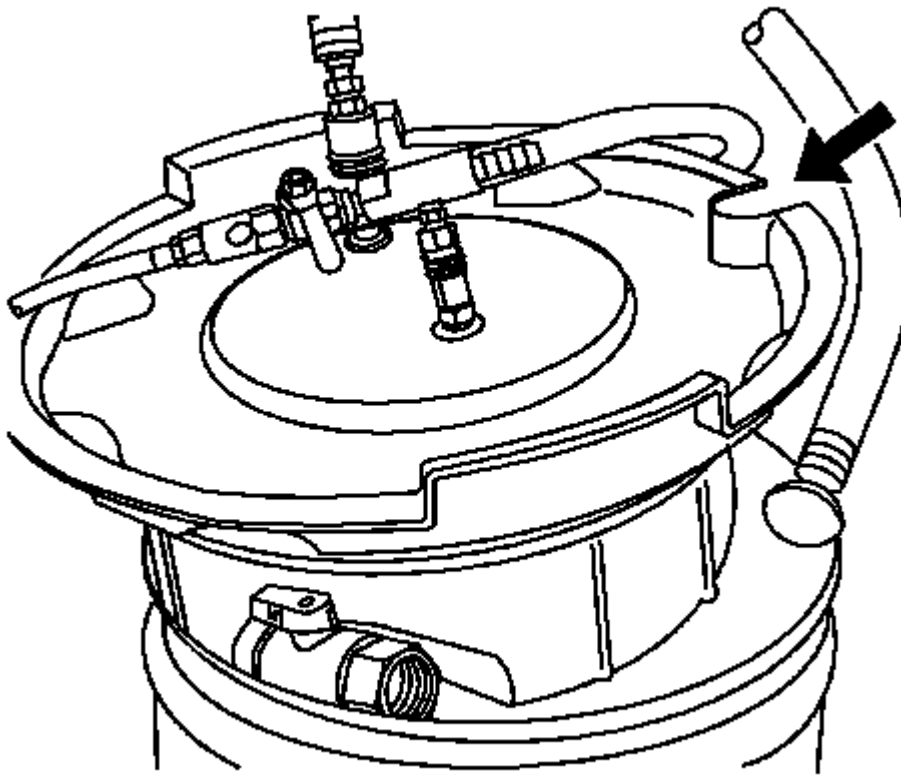


Fig. 17: View Of Graduated Reservoir & Hose
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a 50/50 mixture of DEX-COOL antifreeze and clean, drinkable water.

Always use more coolant than necessary. This will eliminate air from being drawn into the cooling system.

5. Pour the coolant mixture into the graduated reservoir.
6. Place the fill hose in the graduated reservoir.

NOTE: Prior to installing the vacuum tank onto the graduated reservoir, ensure that the drain valve located on the bottom of the tank is closed.

7. Install the vacuum tank on the graduated reservoir with the fill hose routed through the cut-out area in the vacuum tank.

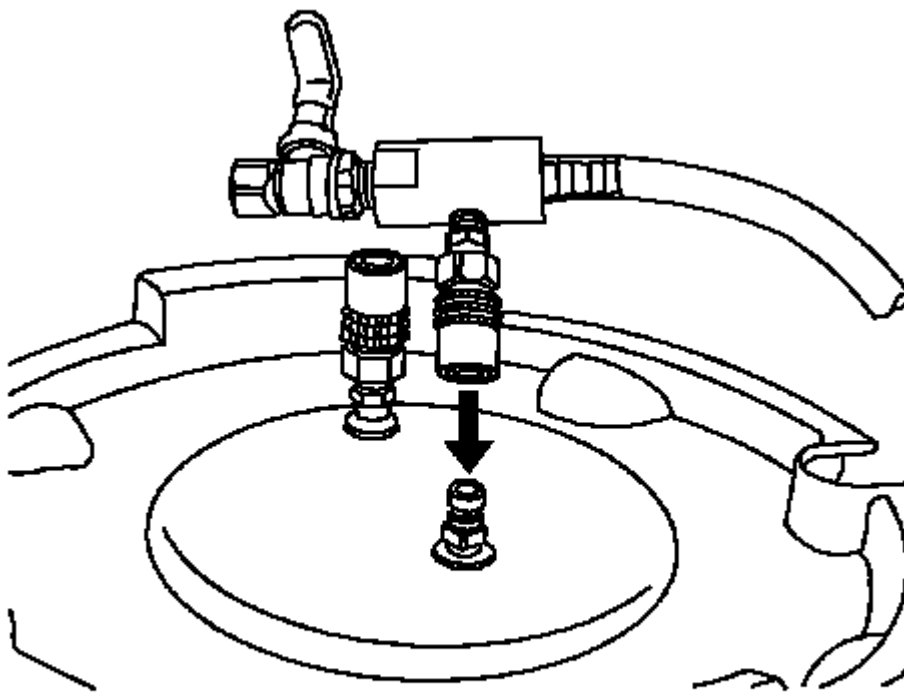


Fig. 18: View Of Venturi Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS COMPANY

8. Attach the venturi assembly to the vacuum tank.

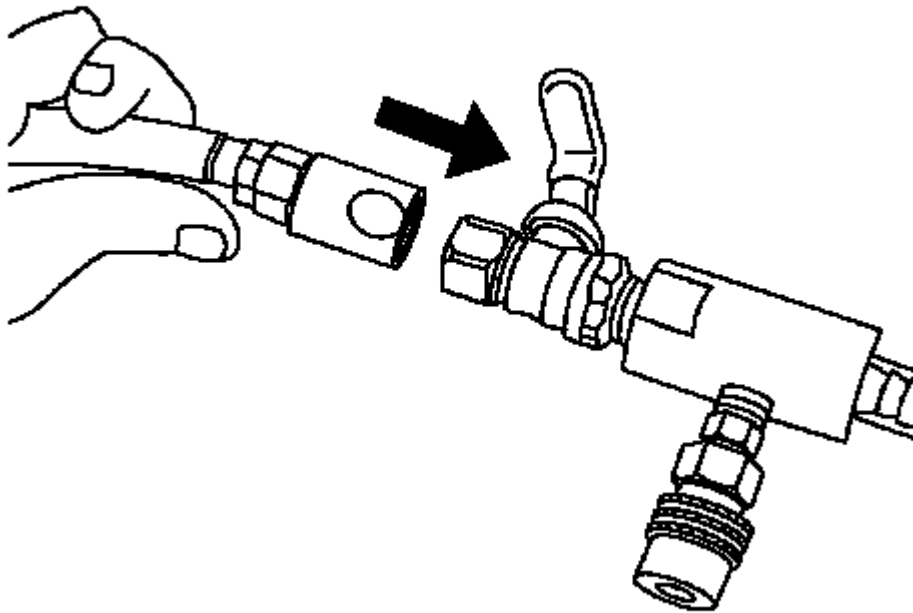


Fig. 19: View Of Shop Air Hose & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Attach a shop air hose to the venturi assembly.

Ensure the valve on the venturi assembly is closed.

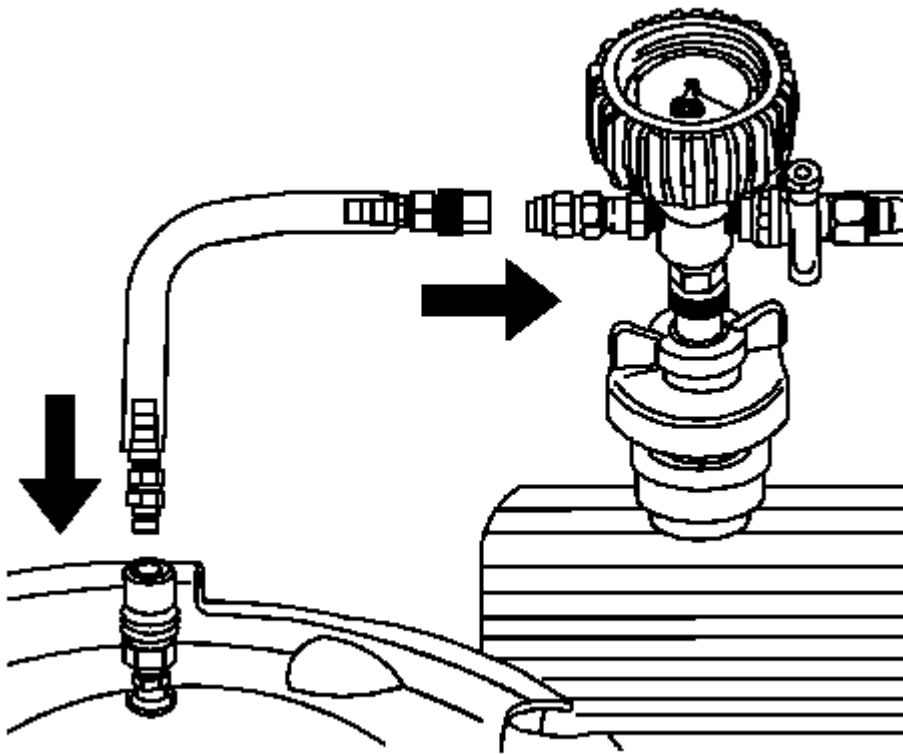


Fig. 20: Attaching Vacuum Hose To Vacuum Gauge Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS COMPANY

10. Attach the vacuum hose to the vacuum gauge assembly and the vacuum tank.

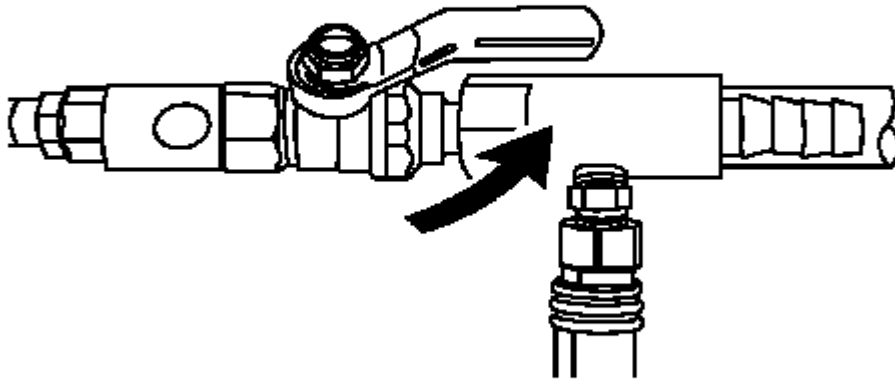


Fig. 21: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Open the valve on the venturi assembly. The vacuum gauge will begin to rise and a hissing noise will be present.

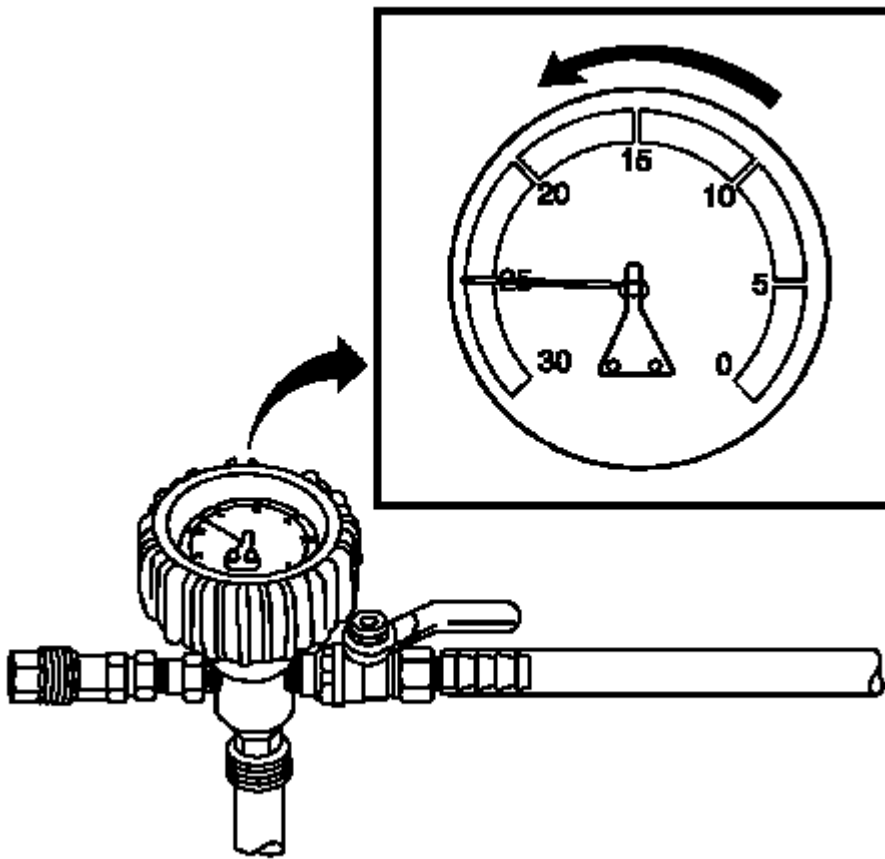


Fig. 22: View Of Vacuum Gauge
Courtesy of GENERAL MOTORS COMPANY

12. Continue to draw vacuum until the needle stops rising. This should be 610-660 mm Hg (24-26 in Hg).
Cooling hoses may start to collapse. This is normal due to vacuum draw.
13. To aid in the fill process, position the graduated reservoir above the coolant fill port.

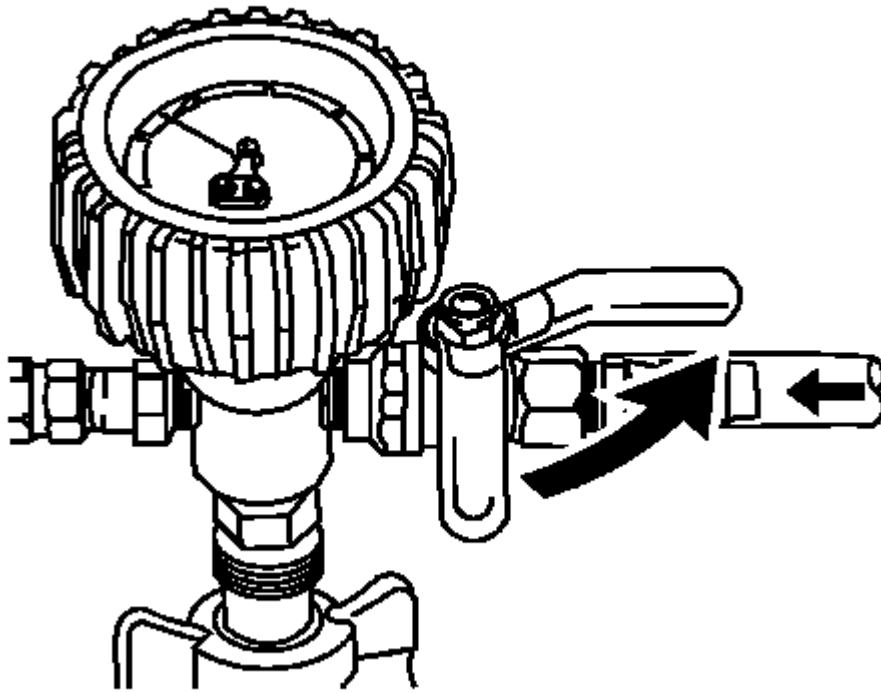


Fig. 23: Identifying Valve On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS COMPANY

14. Slowly open the valve on the vacuum gauge assembly. When the coolant reaches the top of the fill hose, close the valve. This will eliminate air from the fill hose.
15. Close the valve on the venturi assembly.
16. If there is a suspected leak in the cooling system, allow the system to stabilize under vacuum and monitor for vacuum loss.

If vacuum loss is observed, refer to **Loss of Coolant**.

17. Open the valve on the vacuum gauge assembly. The vacuum gauge will drop as coolant is drawn into the system.

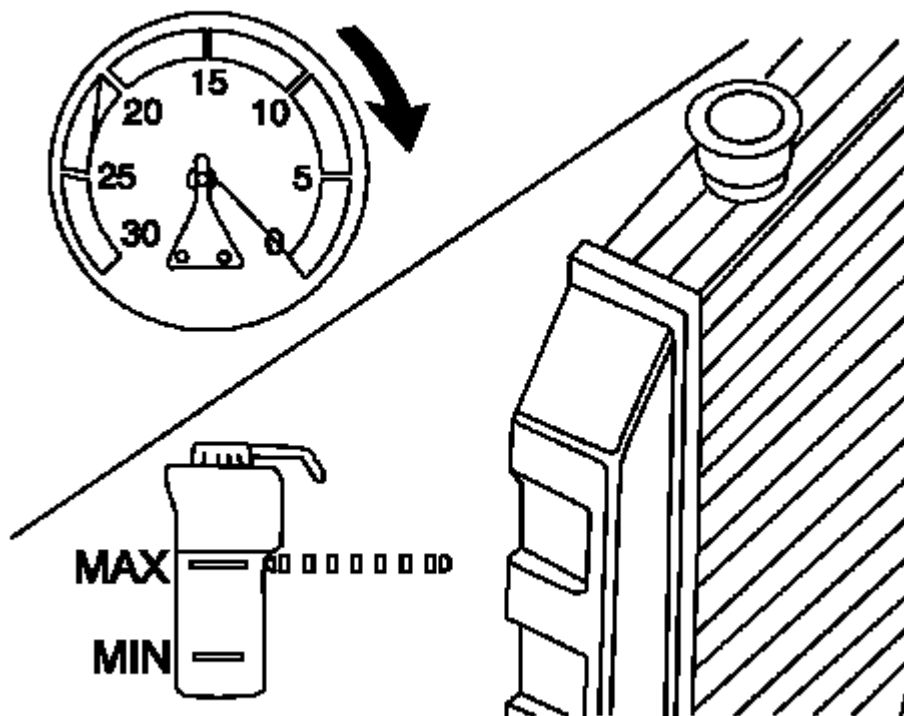


Fig. 24: View Of Vacuum Gauge & Radiator
Courtesy of GENERAL MOTORS COMPANY

18. Once the vacuum gauge reaches zero, close the valve on the vacuum gauge assembly and repeat steps 11-17.
19. Detach the Vac N Fill cap from the **J 42401** Radiator Cap and Surge Tank Test Adapter.
20. Remove the **J 42401** Radiator Cap and Surge Tank Test Adapter from the coolant surge tank.
21. Add coolant to the system as necessary.
22. Inspect the concentration of the coolant mixture using **J 26568** Coolant and Battery Fluid Tester.

NOTE: After filling the cooling system, the extraction hose can be used to remove excess coolant to achieve the proper coolant level.

23. Detach the vacuum hose from the vacuum gauge assembly.

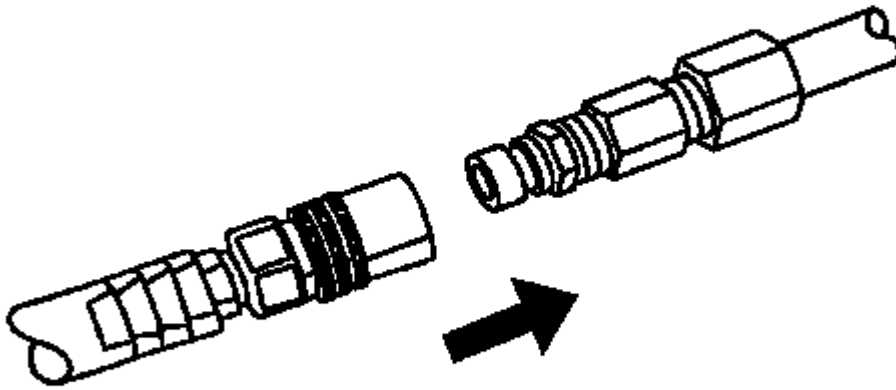


Fig. 25: Attaching Extraction Hose To Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

24. Attach the extraction hose to the vacuum hose.

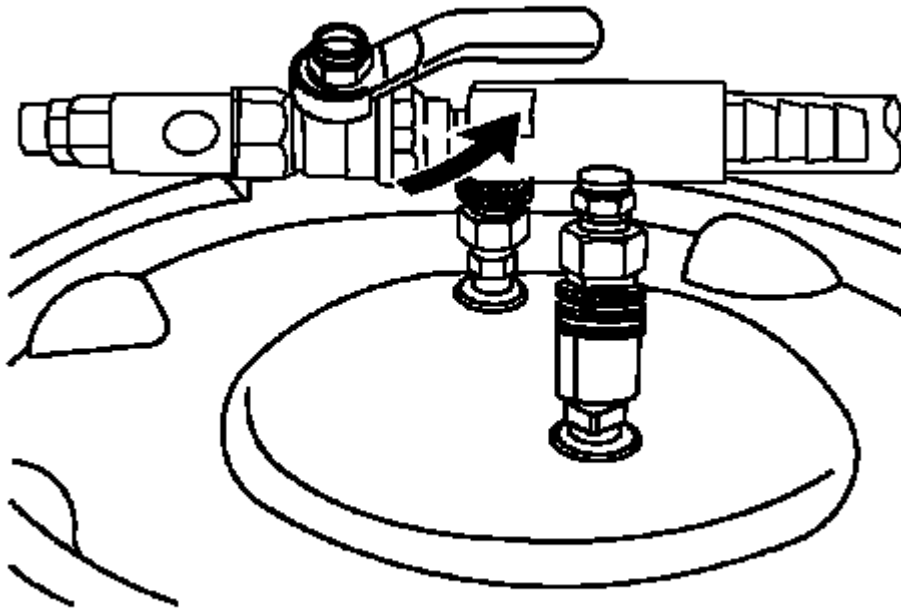


Fig. 26: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

25. Open the valve on the venturi assembly to start a vacuum draw.

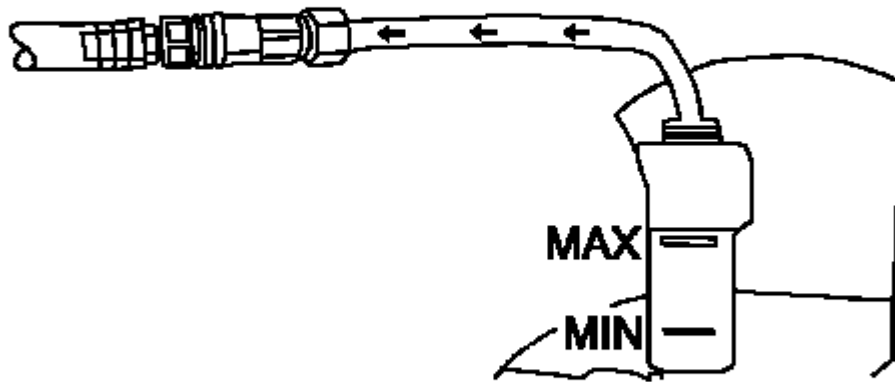


Fig. 27: Using Extraction Hose To Draw Out Coolant
Courtesy of GENERAL MOTORS COMPANY

26. Use the extraction hose to draw out coolant to the proper level.
27. The vacuum tank has a drain valve on the bottom of the tank. Open the valve to drain coolant from the vacuum tank into a suitable container for disposal.
28. Install the surge tank cap.

FLUSHING

NOTE: Do not use a chemical flush.

Store used coolant in the proper manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.

Various methods and equipment can be used to flush the cooling system. If special equipment is used, such as a back flusher, follow the manufacturer's instruction. Always remove the thermostat before flushing the cooling system.

When the cooling system becomes contaminated, the cooling system should be flushed thoroughly to remove the contaminants before the engine is seriously damaged.

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LUK)**, **Radiator Surge Tank Replacement (LTG)**.
3. Clean and flush the radiator surge tank with clean, drinkable water.
4. Install the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LUK)**, **Radiator Surge Tank Replacement (LTG)**.
5. Follow the drain and fill procedure using only clean, drinkable water. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
6. Run the engine for 20 minutes.
7. Stop the engine.
8. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
9. Repeat the procedure if necessary, until the fluid is nearly colorless.
10. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

RADIATOR SURGE TANK REPLACEMENT (LUK)

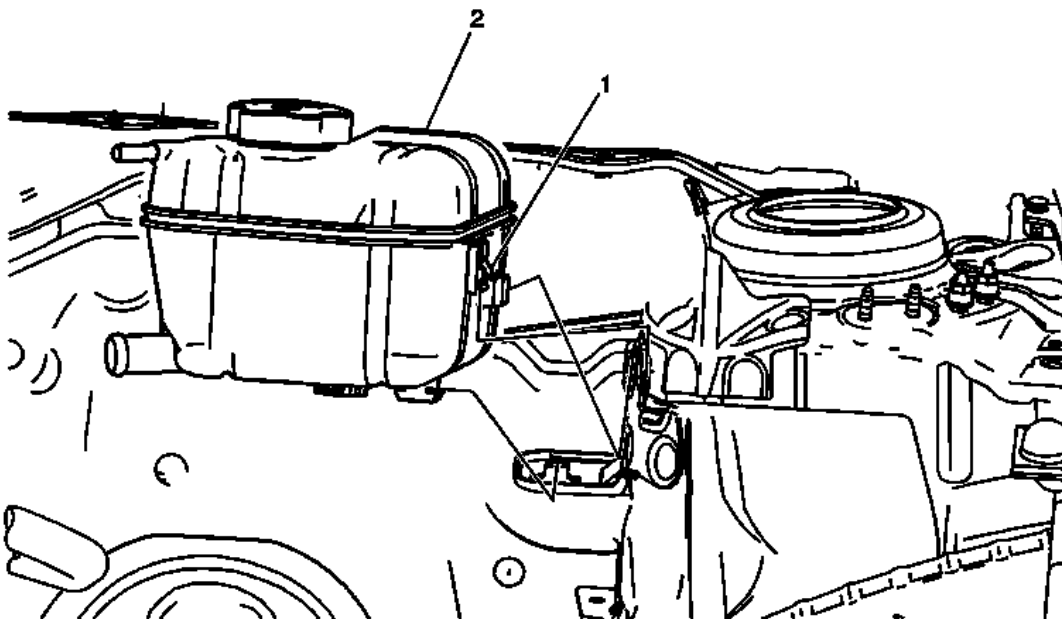


Fig. 28: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u> 2. Remove the radiator surge tank inlet hose. 3. Remove the radiator surge tank outlet hose. Refer to <u>Radiator Surge Tank Outlet Hose Replacement (LUK)</u> 	
1	Radiator Surge Tank Retainer
2	Radiator Surge Tank Procedure Slide the surge tank forward towards the front of the car to remove from brackets.

RADIATOR SURGE TANK REPLACEMENT (LTG)

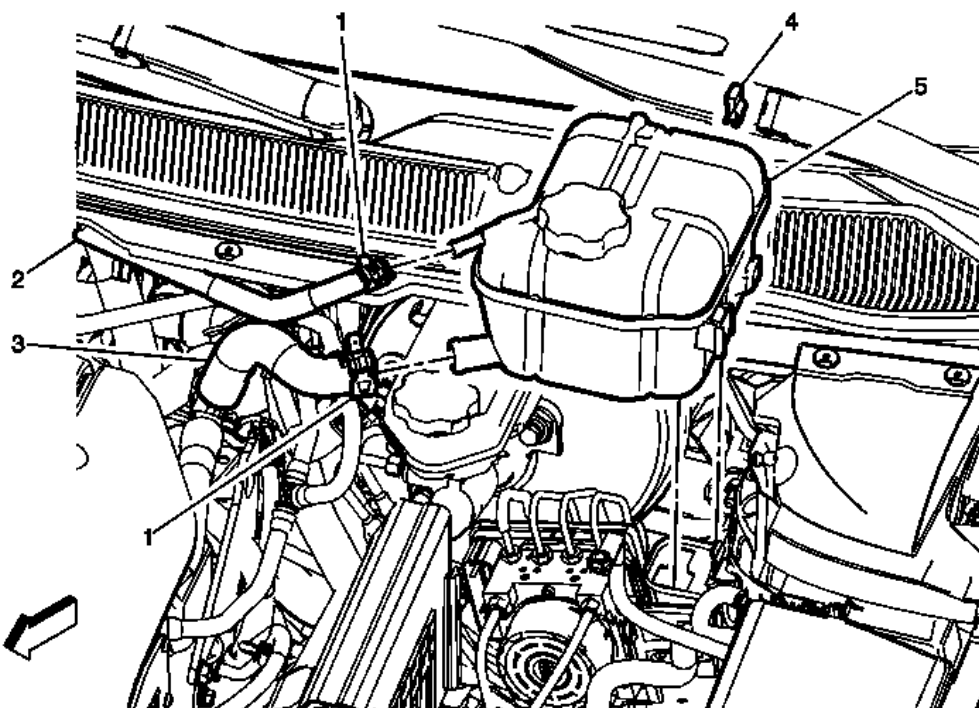


Fig. 29: Radiator Surge Tank (LTG)

Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Replacement (LTG)

Callout	Component Name
Preliminary Procedure	
Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	

1	Radiator Surge Tank Hose Clamp (Qty: 2) Procedure Reposition the radiator surge tank hose clamps using BO-38185 Hose Clamp Pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Surge Tank Inlet Hose
3	Heater Outlet Hose
4	Radiator Surge Tank Bracket Clip Procedure Lift the surge tank clip from the radiator surge tank and bracket.
5	Radiator Surge Tank Procedure <ol style="list-style-type: none"> 1. Slide the radiator surge tank forward and lift out of the radiator surge tank bracket. 2. After installation, fill the coolant reservoir to the proper level. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716). 3. Inspect cooling system for leaks.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LTG)

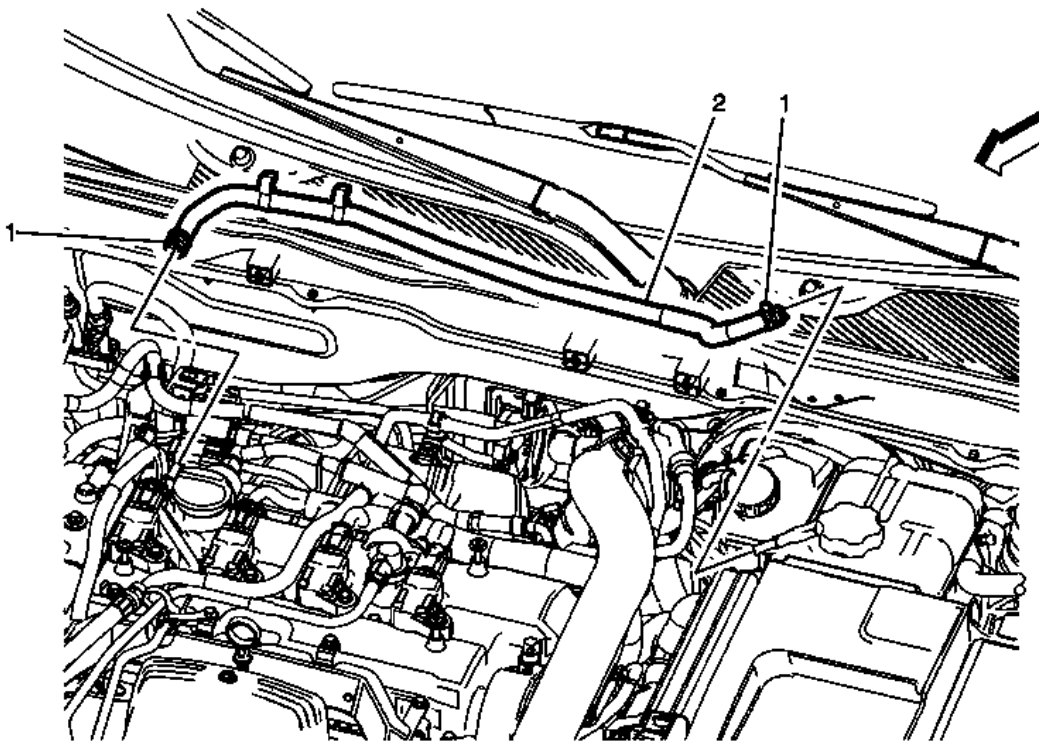


Fig. 30: Radiator Surge Tank Inlet Hose (LTG)
Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 2) Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
2	Radiator Surge Tank Inlet Hose Procedure <ol style="list-style-type: none"> 1. Remove the radiator surge tank inlet hose retaining clips from the fuel feed front pipe. 2. After installation, fill the coolant reservoir to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u> 3. Inspect cooling system for leaks.

RADIATOR SURGE TANK INLET HOSE REPLACEMENT (LEA)

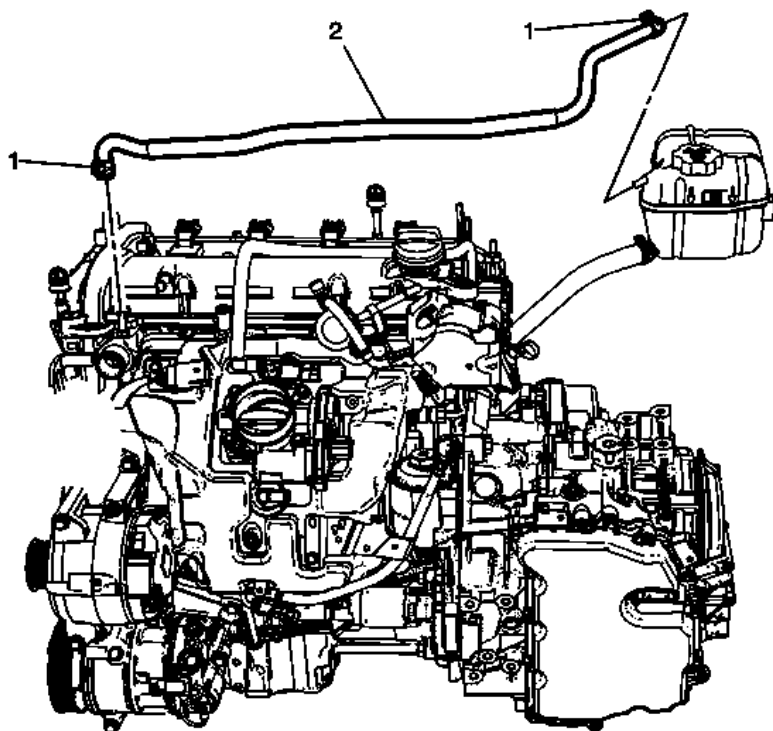


Fig. 31: Radiator Surge Tank Inlet Hose (LEA)

Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Inlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u> 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 	
1	Radiator Surge Tank Inlet Hose Clamp (Qty: 2) Procedure Disengage tension on the radiator surge tank inlet hose clamps using BO-38185 pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Surge Tank Inlet Hose Procedure Disconnect the retaining clip holding the radiator surge tank inlet hose to the high pressure fuel pump bracket.

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT (LUK)

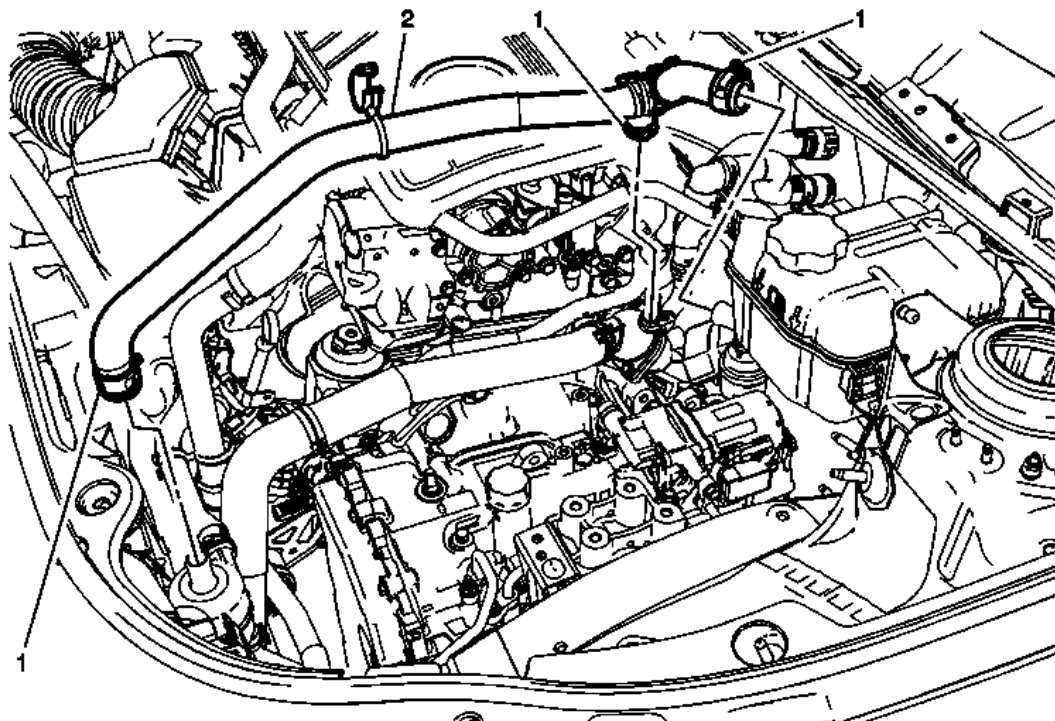


Fig. 32: Radiator Surge Tank Outlet Hose (LUK)

Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Outlet Hose Replacement (LUK)

Callout	Component Name
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Preliminary Procedures

Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).

1	Radiator Surge Tank Outlet Hose Clamp (Qty: 3)
2	Radiator Surge Tank Outlet Hose

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT (LEA)

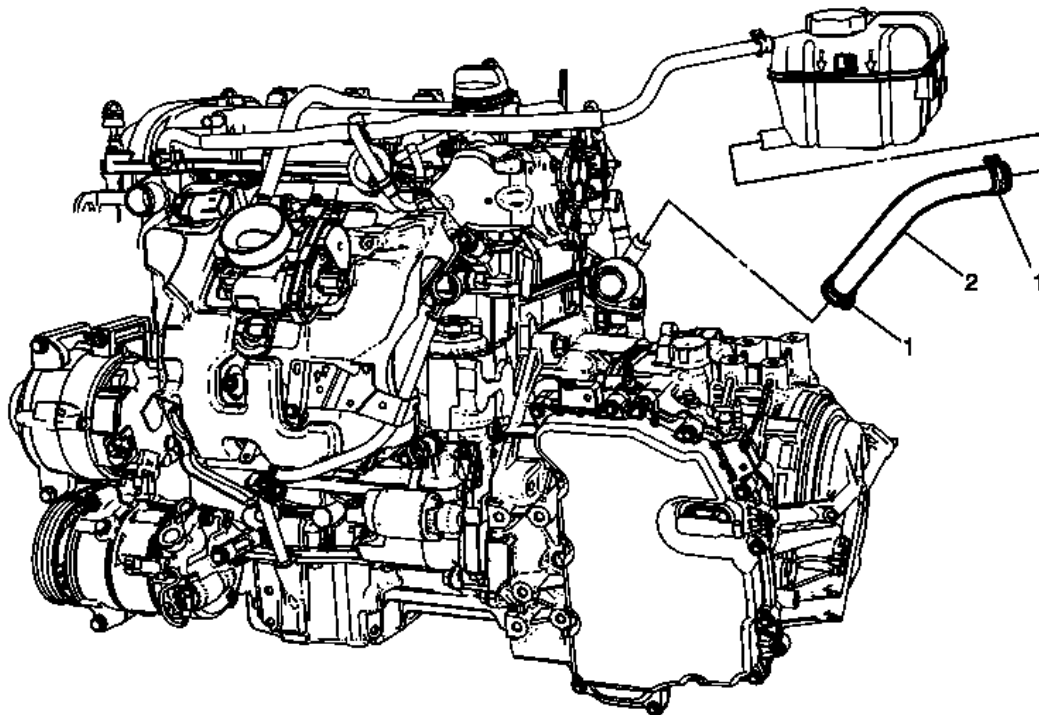


Fig. 33: Radiator Surge Tank Outlet Hose (LEA)

Courtesy of GENERAL MOTORS COMPANY

Radiator Surge Tank Outlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Radiator Surge Tank Outlet Hose Clamps (Qty: 2) Procedure Reposition the radiator surge tank outlet hose clamp using BO-38185 pliers Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Surge Tank Outlet Hose

RADIATOR INLET HOSE REPLACEMENT (LUK)

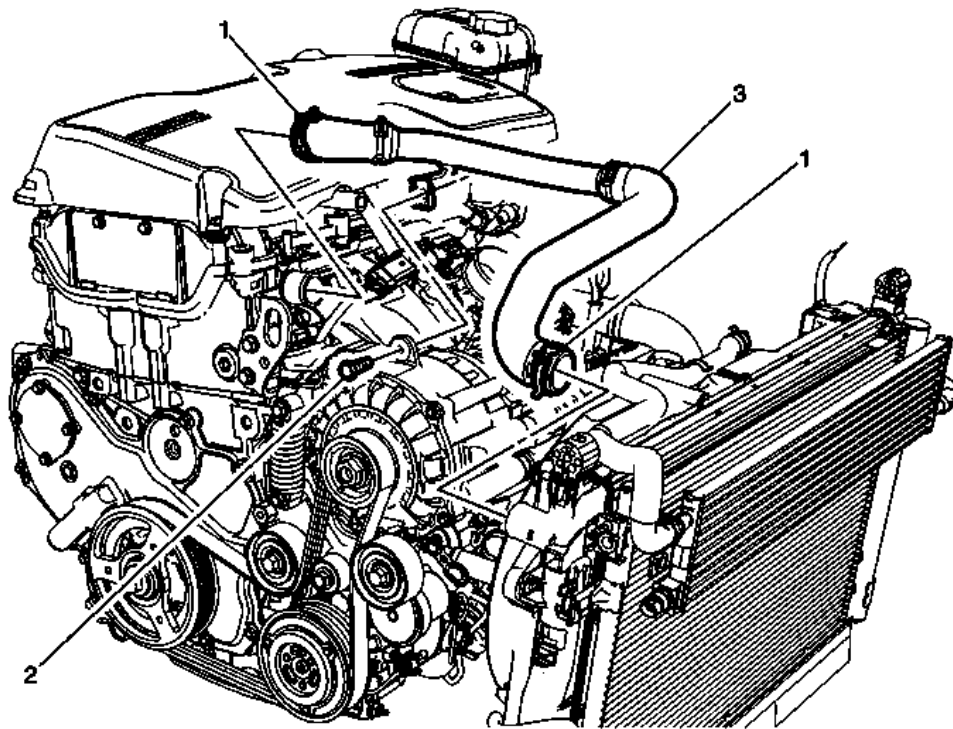


Fig. 34: Radiator Inlet Hose & Clamps (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LUK)

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Radiator Inlet Hose Clamps (Qty: 2)
2	Radiator Inlet Hose Support Bracket Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 25 (18 lb ft)
3	Radiator Inlet Hose

RADIATOR INLET HOSE REPLACEMENT (LTG)

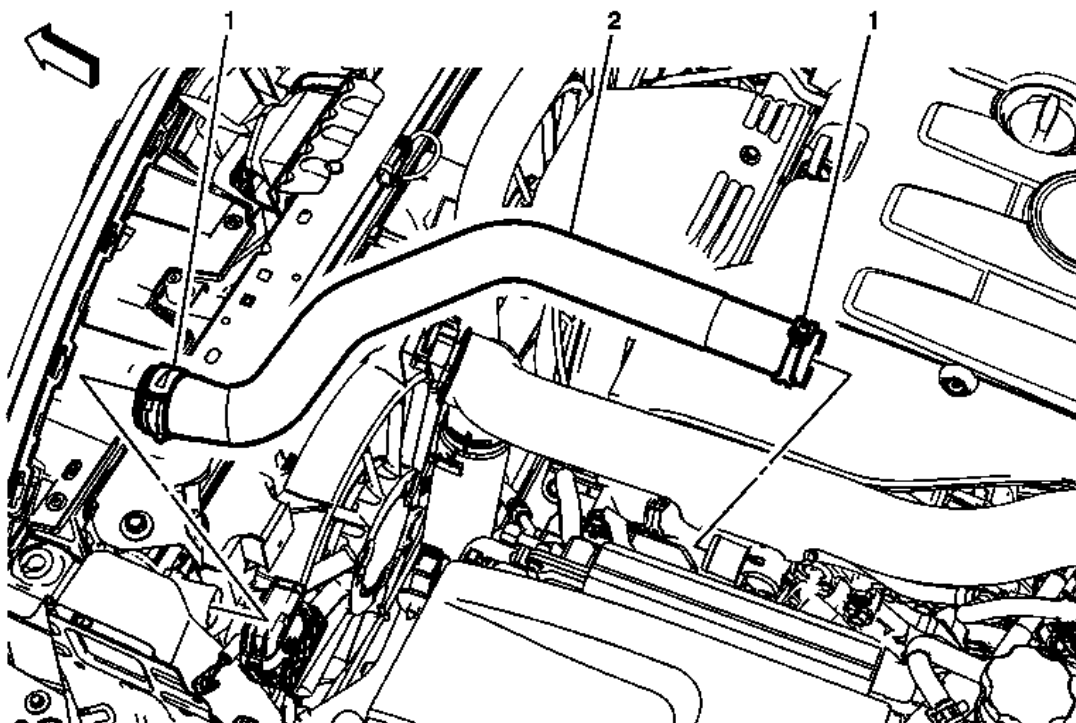


Fig. 35: Radiator Inlet Hose (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 	
1	Radiator Inlet Hose Clamp (Qty: 2) Procedure Reposition the radiator inlet hose clamps using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Inlet Hose Procedure <ol style="list-style-type: none"> 1. Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect the cooling system for leaks.

RADIATOR INLET HOSE REPLACEMENT (LEA)

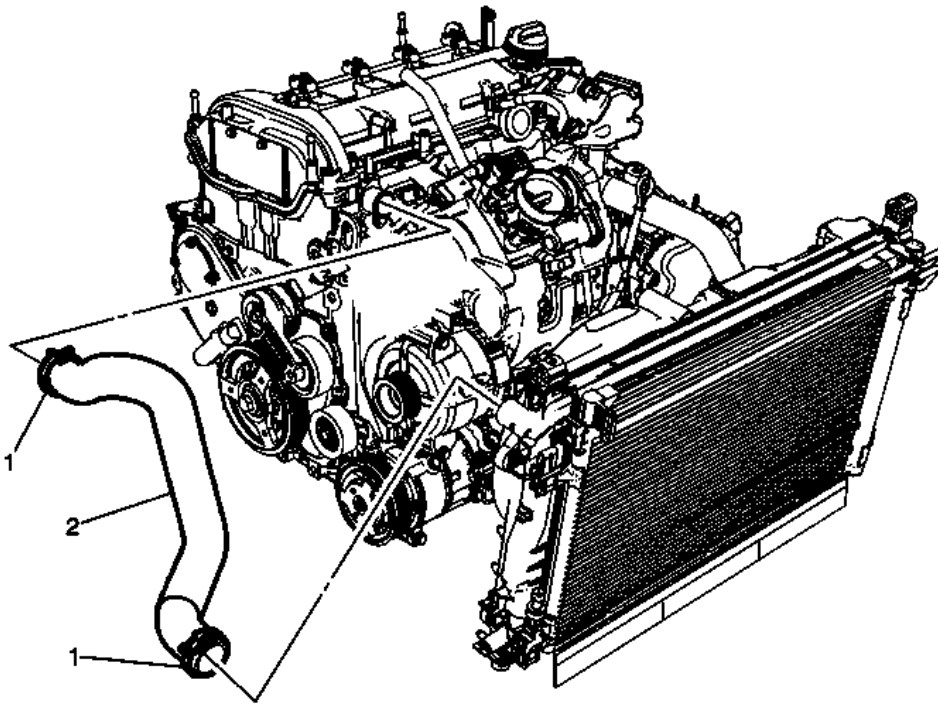


Fig. 36: Radiator Inlet Hose (LEA)
Courtesy of GENERAL MOTORS COMPANY

Radiator Inlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u>. 	
1	Radiator Inlet Hose Clamp Procedure Reposition the radiator inlet hose clamp using BO-38185 pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Inlet Hose

RADIATOR OUTLET HOSE REPLACEMENT (LUK)

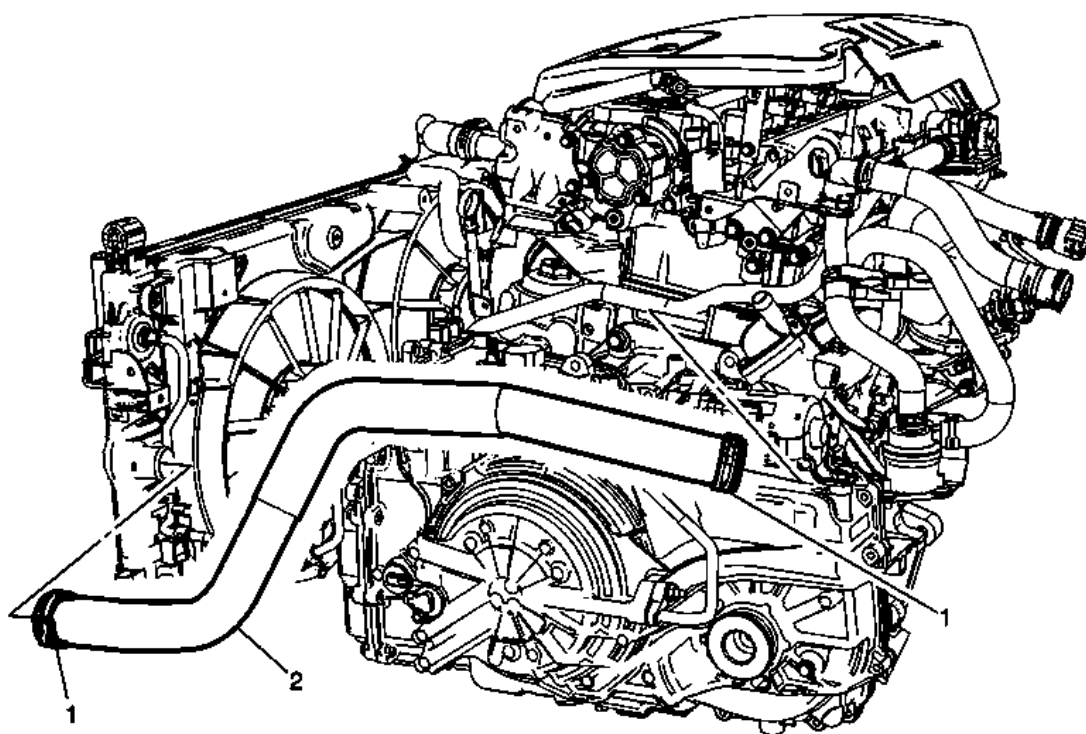


Fig. 37: Radiator Outlet Hose & Clamps (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Reposition the engine control module out of the way. Refer to <u>Engine Control Module Replacement</u> . 3. Reposition the drive motor battery coolant air separator out of the way. Refer to <u>Drive Motor Battery Coolant/Air Separator Replacement</u> .	
1	Radiator Outlet Hose Clamps
2	Radiator Outlet Hose

RADIATOR OUTLET HOSE REPLACEMENT (LTG)

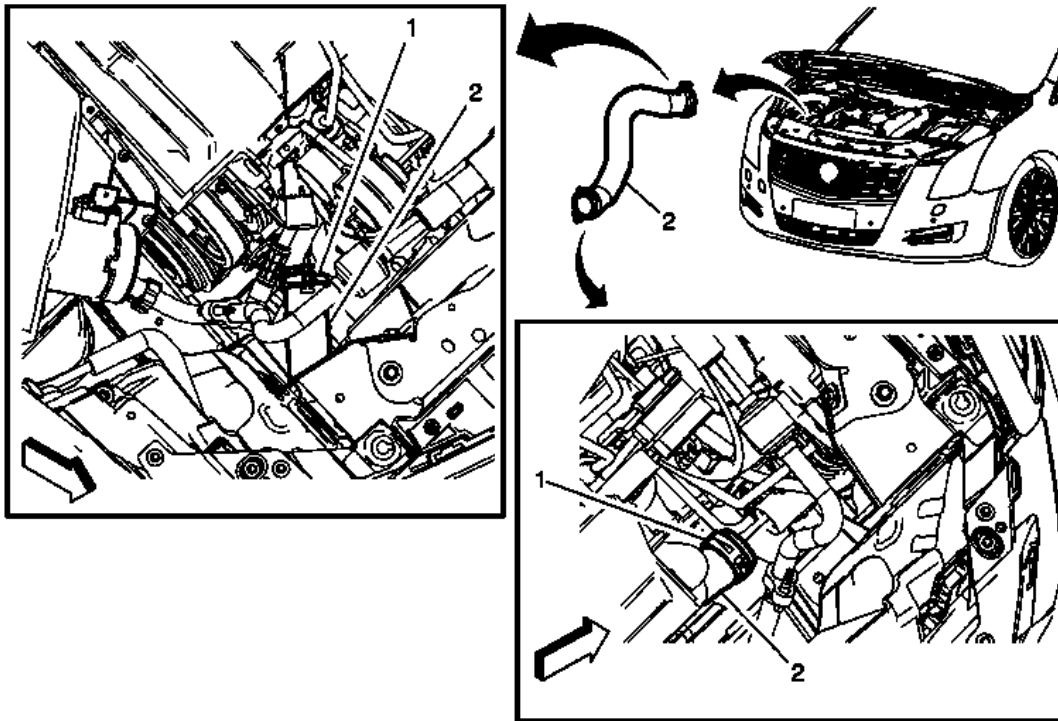


Fig. 38: Radiator Outlet Hose (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedure	
1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 2. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Radiator Outlet Hose Clamp (Qty: 2) Procedure Reposition the radiator outlet hose clamps using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Outlet Hose Procedure <ol style="list-style-type: none"> 1. Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Inspect the cooling system for leaks. Refer to <u>Cooling System Leak Testing</u>.

RADIATOR OUTLET HOSE REPLACEMENT (LEA)

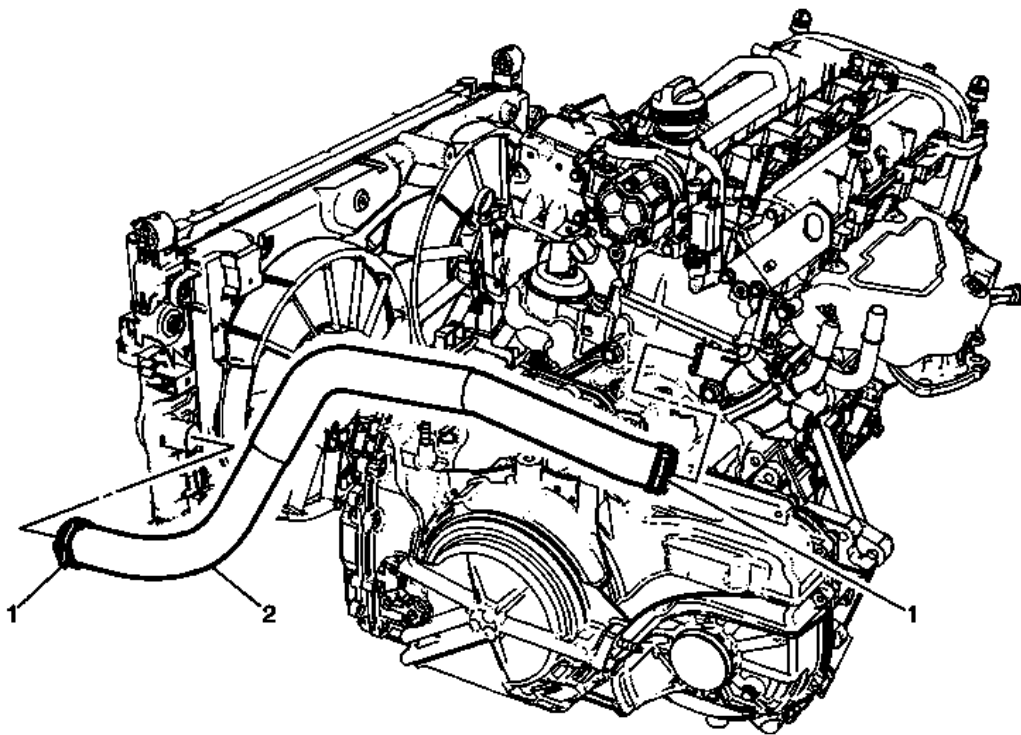


Fig. 39: Radiator Outlet Hose (LEA)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Outlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Unclip radiator outlet hose from bracket.	
1	Radiator Outlet Hose Clamp Procedure Reposition the radiator outlet hose clamp using BO-38185 pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
2	Radiator Outlet Hose

RADIATOR LOWER BRACKET REPLACEMENT (LTG)

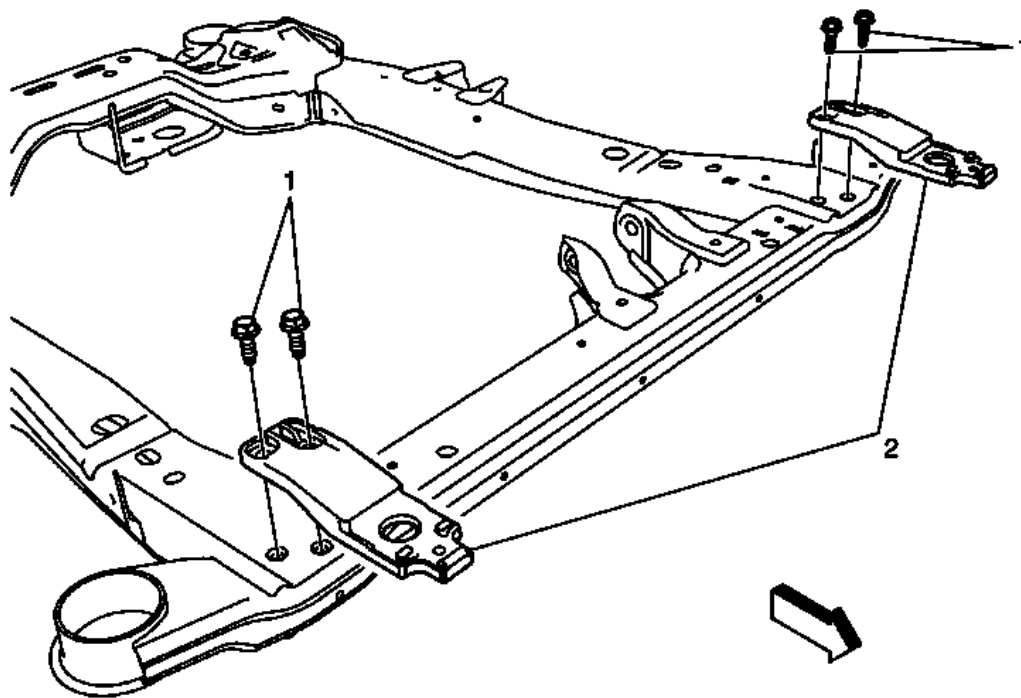


Fig. 40: Radiator Support Bracket (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Lower Bracket Replacement (LTG)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> . 2. Support the radiator. 	
1	Radiator Lower Bracket Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 (16 lb ft)
2	Radiator Lower Bracket (Qty: 2)

RADIATOR UPPER BRACKET REPLACEMENT (LTG)

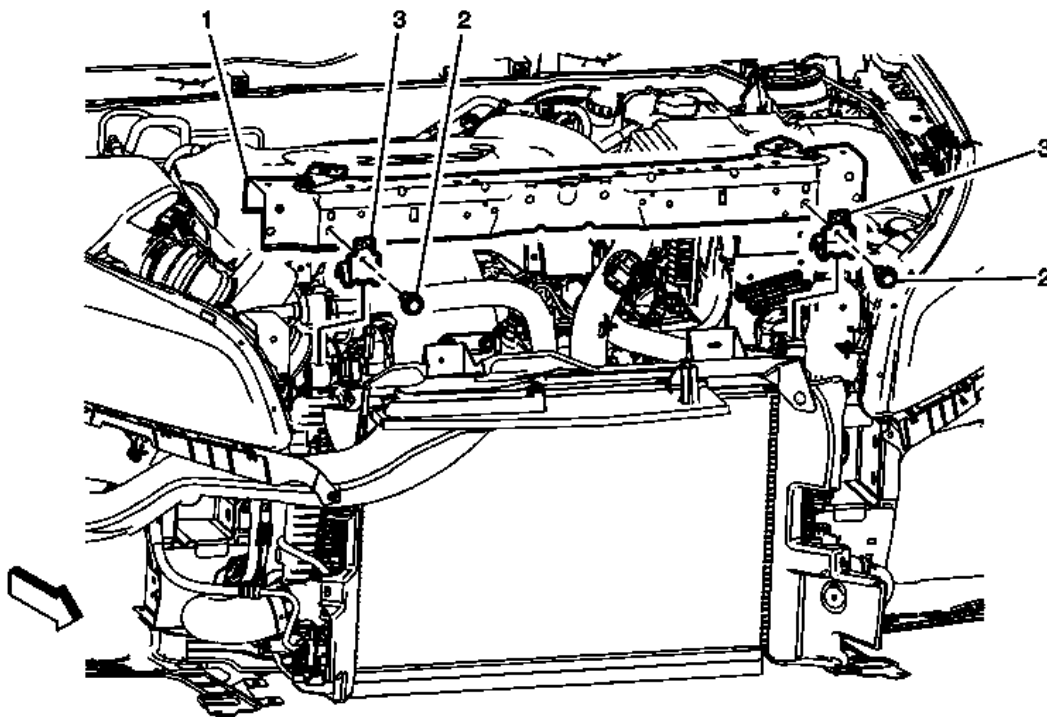


Fig. 41: Radiator Upper Brackets (LTG)

Courtesy of GENERAL MOTORS COMPANY

Radiator Upper Bracket Replacement (LTG)

Callout	Component Name
1	<p>Front End Upper Tie Bar</p> <p>Procedure Remove the front end upper tie bar. Refer to <u>Front End Upper Tie Bar Replacement</u> .</p>
2	<p>Radiator Upper Bracket Bolt (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 22 (16 lb ft)</p>
3	Radiator Upper Bracket (Qty: 2)

ENGINE COOLANT FAN REPLACEMENT (LUK)

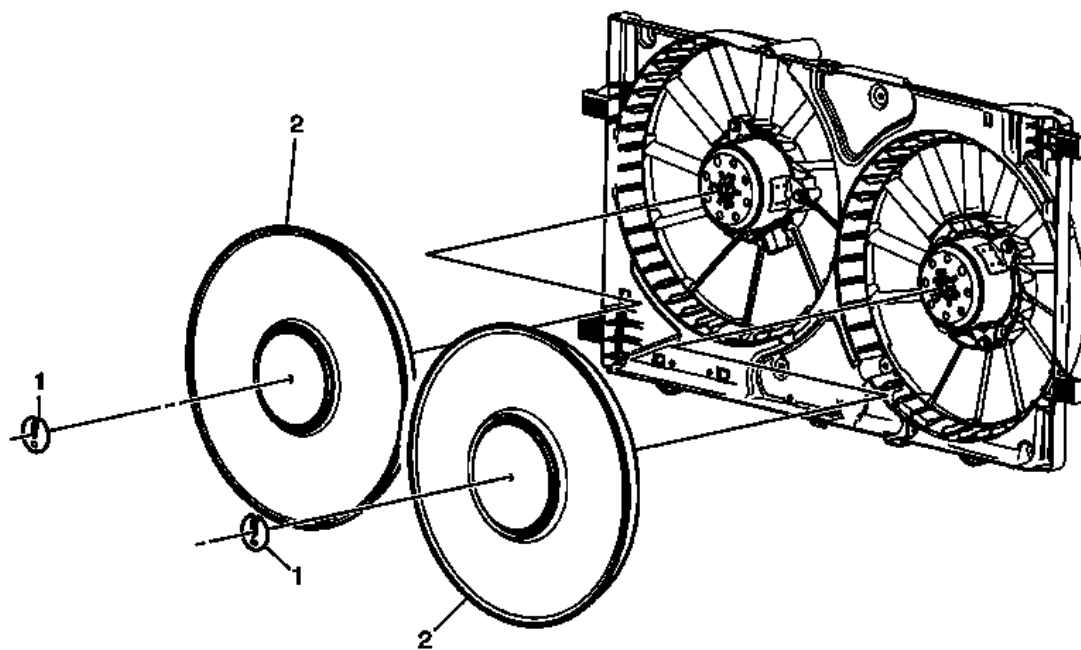


Fig. 42: Engine Coolant Fan (LUK)

Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
Remove the engine coolant fan shroud. Refer to Engine Coolant Fan Shroud Replacement (LUK) .	
1	Engine Coolant Fan Retainer (Qty: 2)
2	Engine Coolant Fan (Qty: 2)

ENGINE COOLANT FAN REPLACEMENT (LTG)

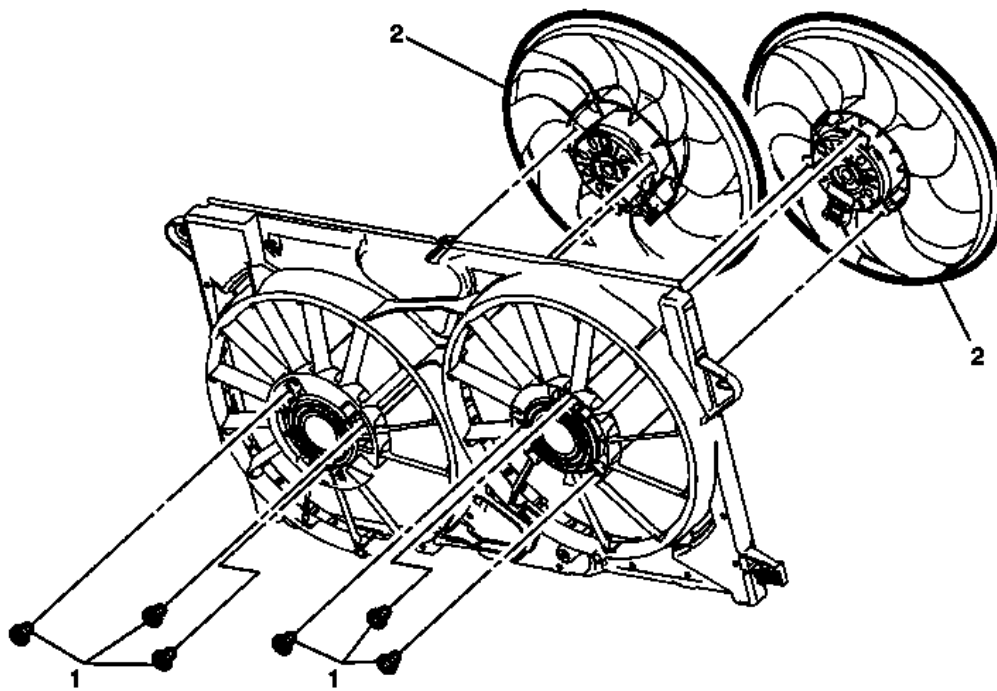


Fig. 43: Engine Coolant Fans & Fasteners (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Replacement (LTG)

Callout	Component Name
Preliminary Procedure Remove the engine coolant fan shroud from the vehicle. Refer to <u>Engine Coolant Fan Shroud Replacement (LTG)</u> .	
1	Engine Coolant Fan Fastener (Qty: 6) (Qty: 3 Per Fan Assembly) CAUTION: Refer to <u>Fastener Caution</u> .
2	Engine Coolant Fan (Qty: 2)

ENGINE COOLANT FAN MOTOR REPLACEMENT (LUK)

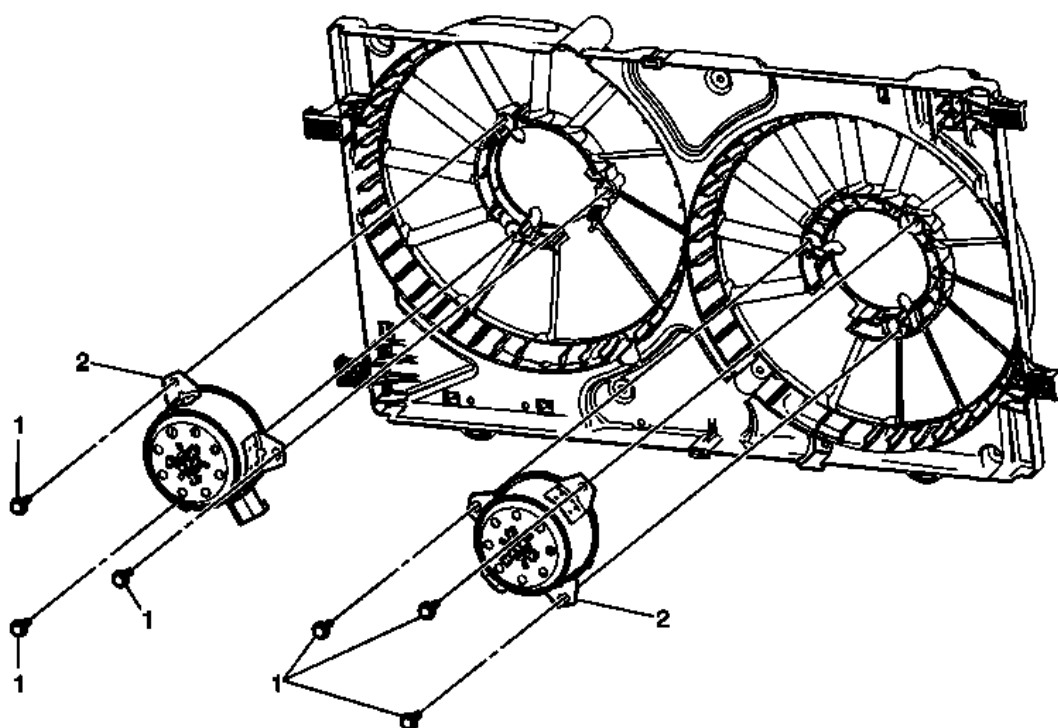


Fig. 44: Engine Coolant Fan Motor (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Motor Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
Remove the engine coolant fan. Refer to <u>Engine Coolant Fan Replacement (LUK)</u> .	
1	Engine Coolant Fan Motor Bolt (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Engine Coolant Fan Motor (Qty: 2)

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LTG)

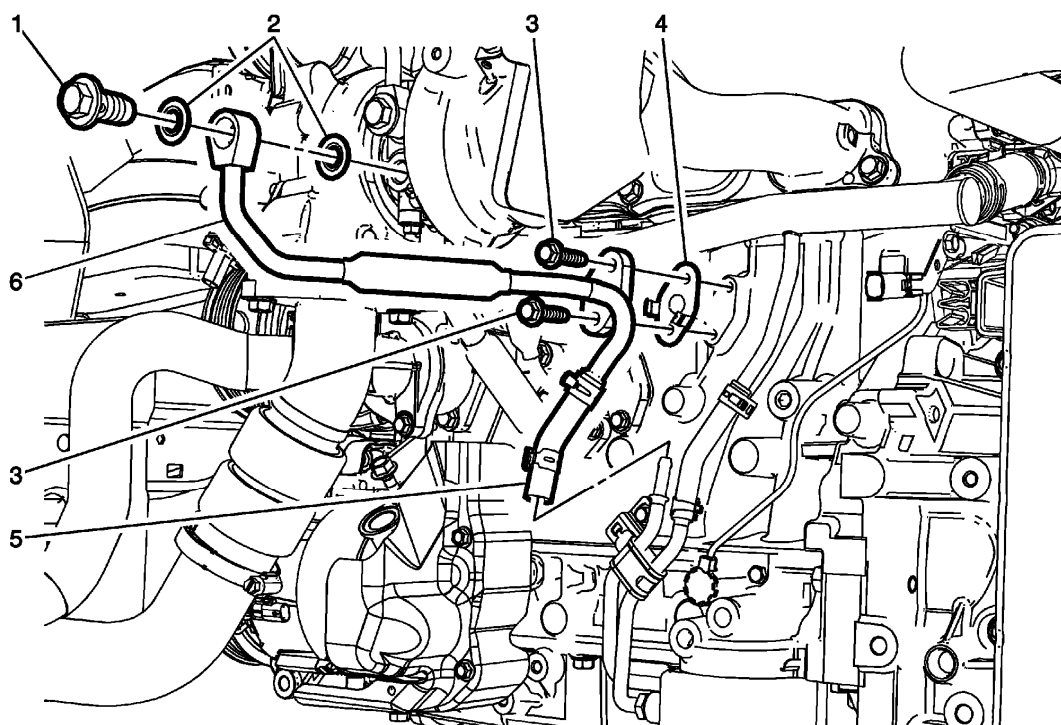


Fig. 45: Turbocharger Coolant Feed Pipe (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Feed Pipe Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716). 2. Remove the catalytic converter. Refer to Catalytic Converter Replacement (LTG). 3. Remove the engine mount bracket heat shield. 	
NOTE: Replace hose clamp if necessary.	
Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .	
1	Turbocharger Coolant Feed Pipe Bolt Tighten 35 (26 lb ft)
2	Turbocharger Coolant Feed Pipe Washer (Qty: 2) NOTE: Install 2 NEW washers.
	Turbocharger Coolant Feed Pipe Fastener (Qty: 2)

3	CAUTION: Refer to <u>Fastener Caution</u> .
	Tighten: 10 (89 lb in)
4	Gasket
5	Hose Clamp
6	Turbocharger Coolant Feed Pipe

TURBOCHARGER COOLANT RETURN PIPE REPLACEMENT (LTG)

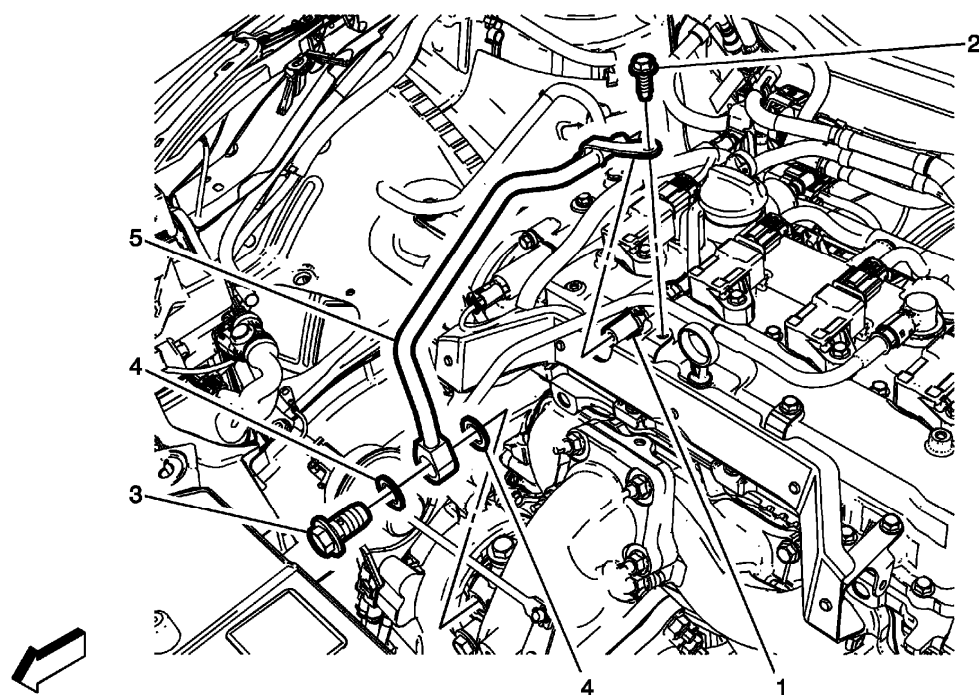


Fig. 46: Turbocharger Coolant Return Pipe (LTG)
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Return Pipe Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .
2.	Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .
3.	Remove the turbocharger heat shield. Refer to <u>Turbocharger Heat Shield Replacement</u> .

NOTE:

Replace hose clamp if necessary.

Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to **Special Tools** .

1	Engine Coolant Air Bleed Hose
2	<p>Turbocharger Coolant Return Pipe Fastener</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten: 10 (89 lb in)</p>
3	<p>Turbocharger Coolant Return Pipe Bolt</p> <p>Tighten 35 N.m (26 lb ft)</p>
4	<p>Turbocharger Coolant Return Pipe Washer (Qty: 2)</p> <p>NOTE: Install 2 NEW washers.</p>
5	Turbocharger Coolant Return Pipe

THERMOSTAT BYPASS HOSE REPLACEMENT (LTG)**Special Tools**

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the battery tray. Refer to **Battery Tray Replacement** .

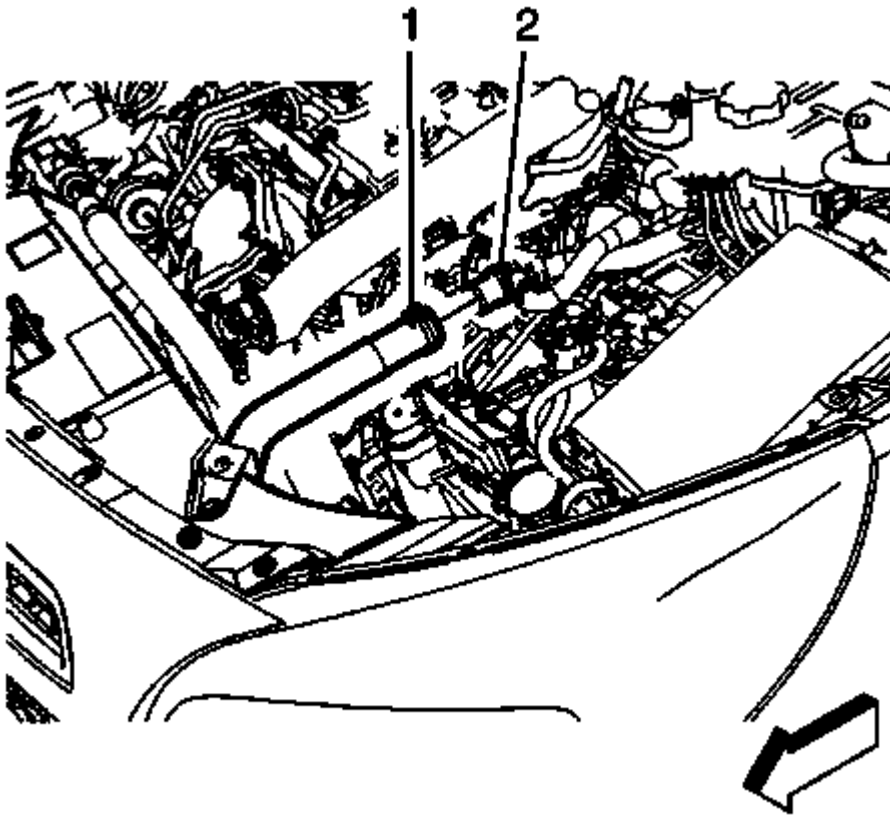


Fig. 47: Radiator Inlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator inlet hose (1) from the water outlet (2).

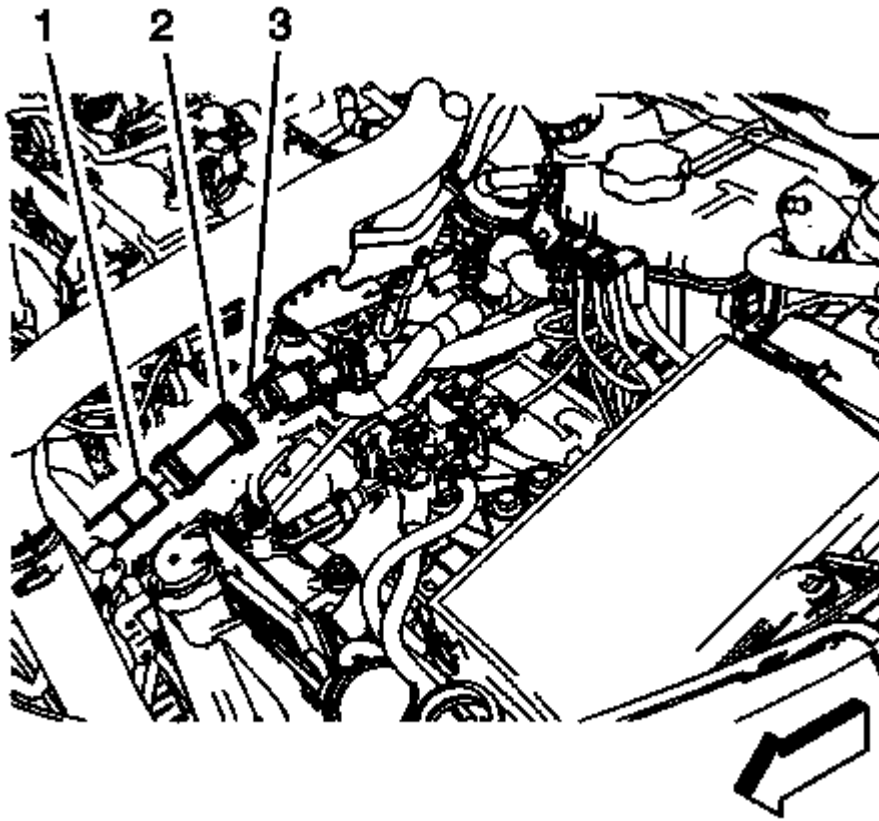


Fig. 48: Thermostat Bypass Hose And Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Remove the thermostat bypass hose (2) from the thermostat bypass pipe (1) and the water outlet (3).

Installation Procedure

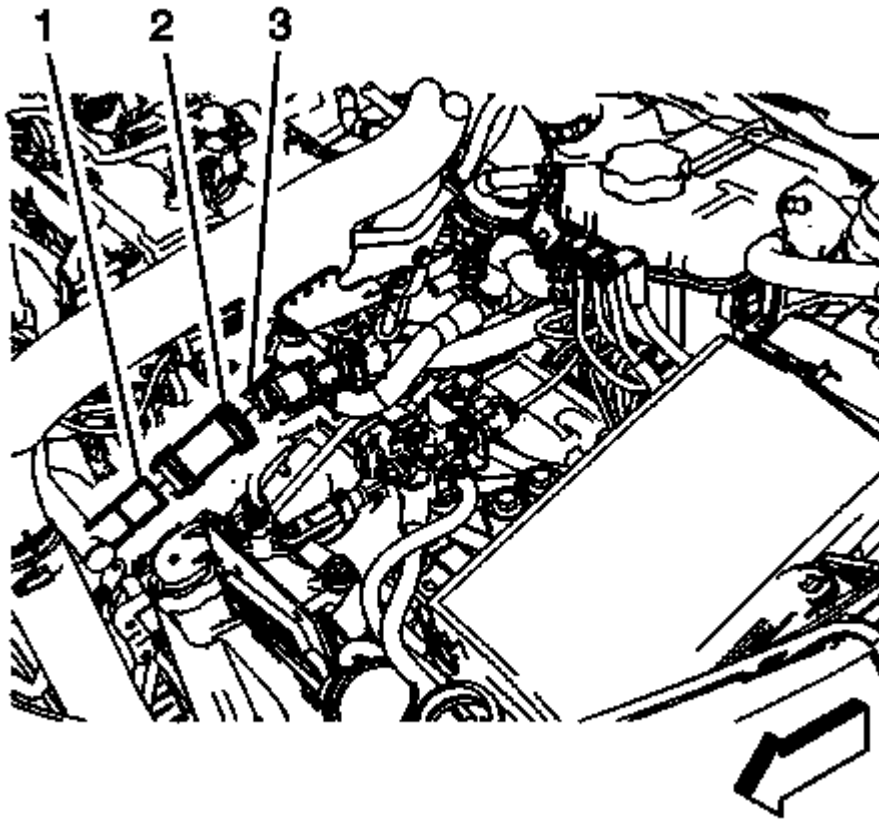


Fig. 49: Thermostat Bypass Hose And Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install the thermostat bypass hose (2) to the thermostat bypass pipe (1) and the water outlet (3).

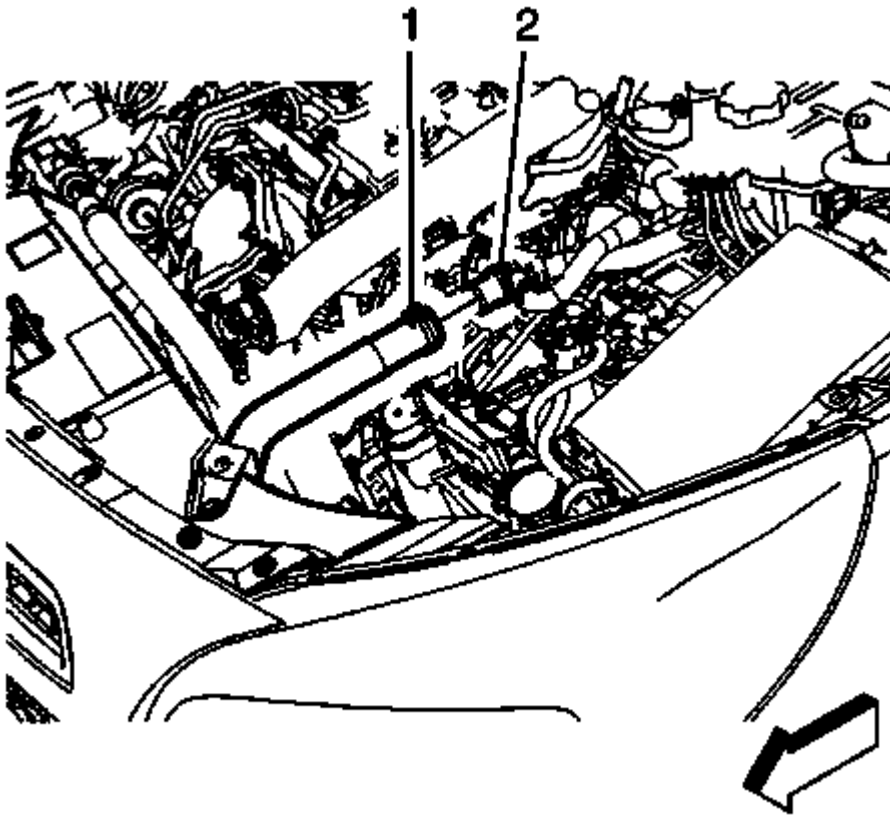


Fig. 50: Radiator Inlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

2. Install the radiator inlet hose (1) to the water outlet (2).
3. Install the battery tray. Refer to **Battery Tray Replacement** .
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
5. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
6. Start the engine and check for coolant leaks.

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LTG)

Removal Procedure

Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to **Special Tools** .

NOTE: The thermostat and thermostat housing are serviced as an assembly.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).
2. Remove the exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement (LTG).

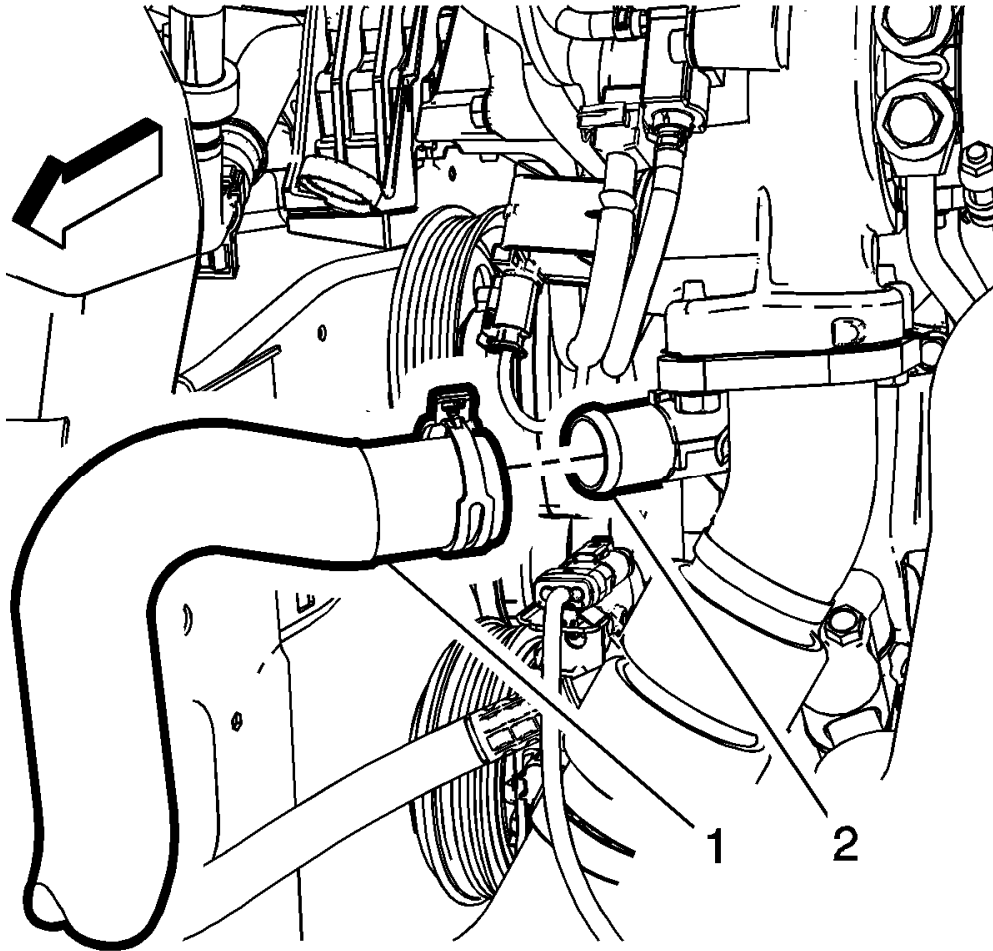


Fig. 51: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose (1) from the engine coolant thermostat housing (2).

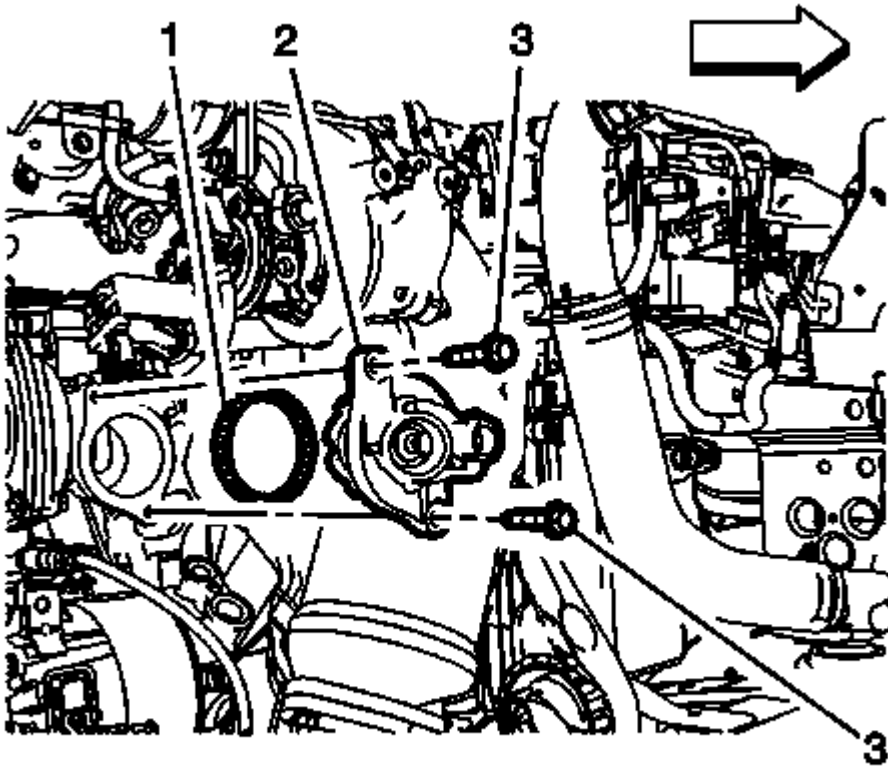


Fig. 52: Engine Coolant Thermostat Housing Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine coolant thermostat housing fasteners (3) and remove the engine coolant thermostat housing (2).
5. Discard the engine coolant thermostat housing seal (1).

Installation Procedure

1. Clean the sealing surfaces.

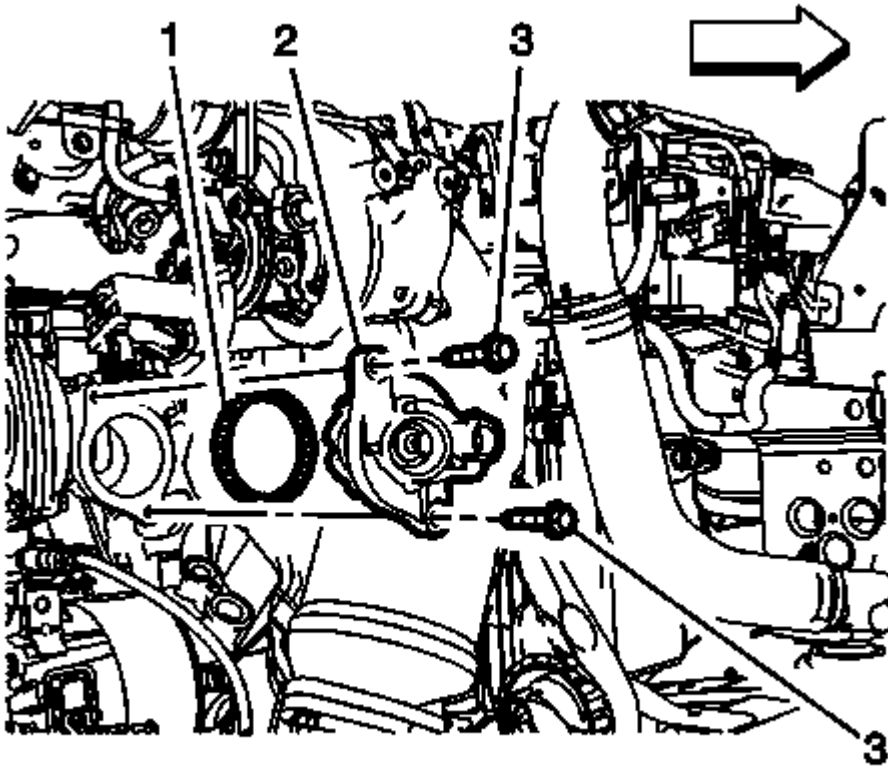


Fig. 53: Engine Coolant Thermostat Housing Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the engine coolant thermostat housing (2) with a NEW seal (1) and tighten the fasteners (3) to 10 (89 lb in).

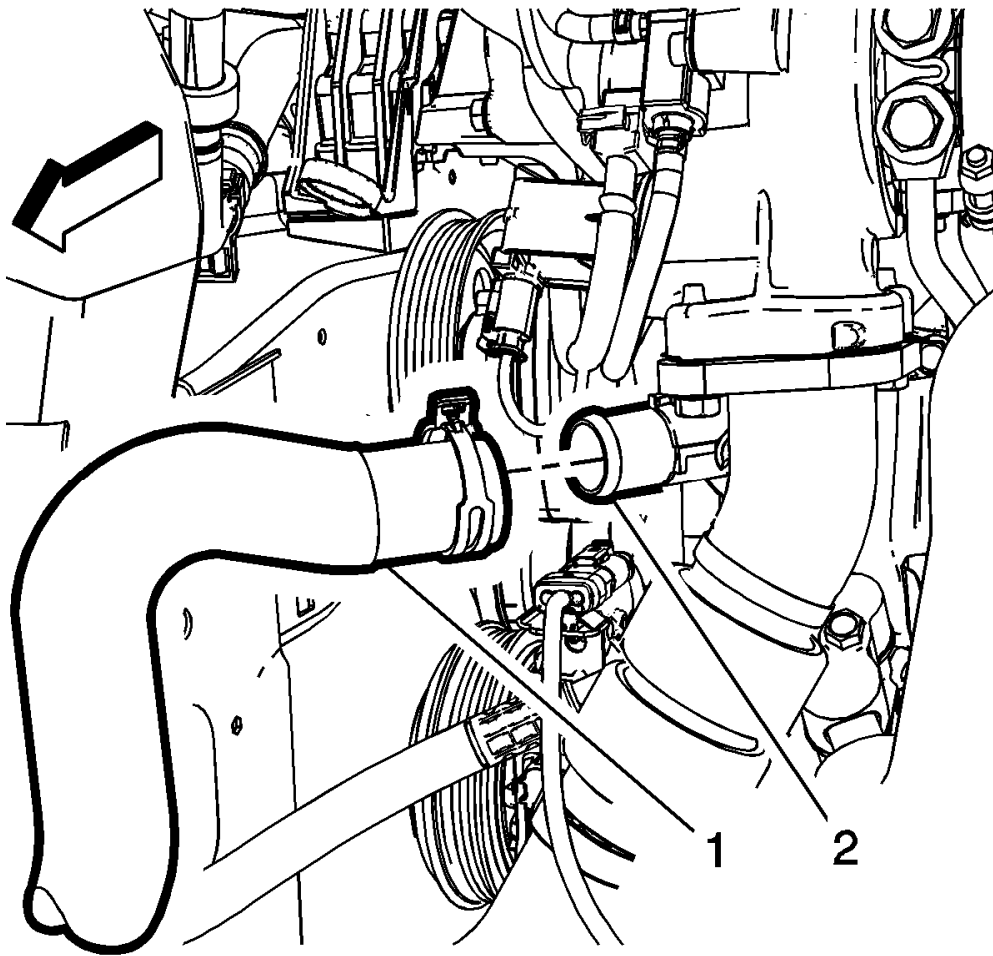


Fig. 54: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

3. Install the radiator outlet hose (1) to the engine coolant thermostat housing (2).
4. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)**.
5. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
6. Start the engine and check for coolant leaks.

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LUK)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
2. Remove the transmission rear mount. Refer to **Transmission Rear Mount Replacement**.

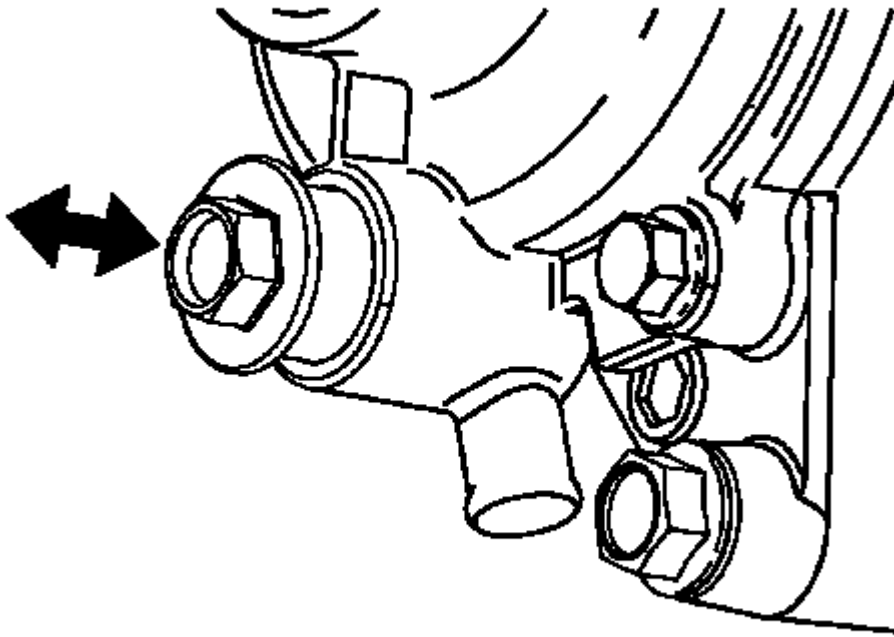


Fig. 55: Opening Water Pump Drain Plug
Courtesy of GENERAL MOTORS COMPANY

NOTE: A drain has been provided at the bottom of the water pump for engine block coolant drainage.

3. Drain the coolant from the engine block at the water pump drain. After the coolant has drained, tighten the drain bolt.

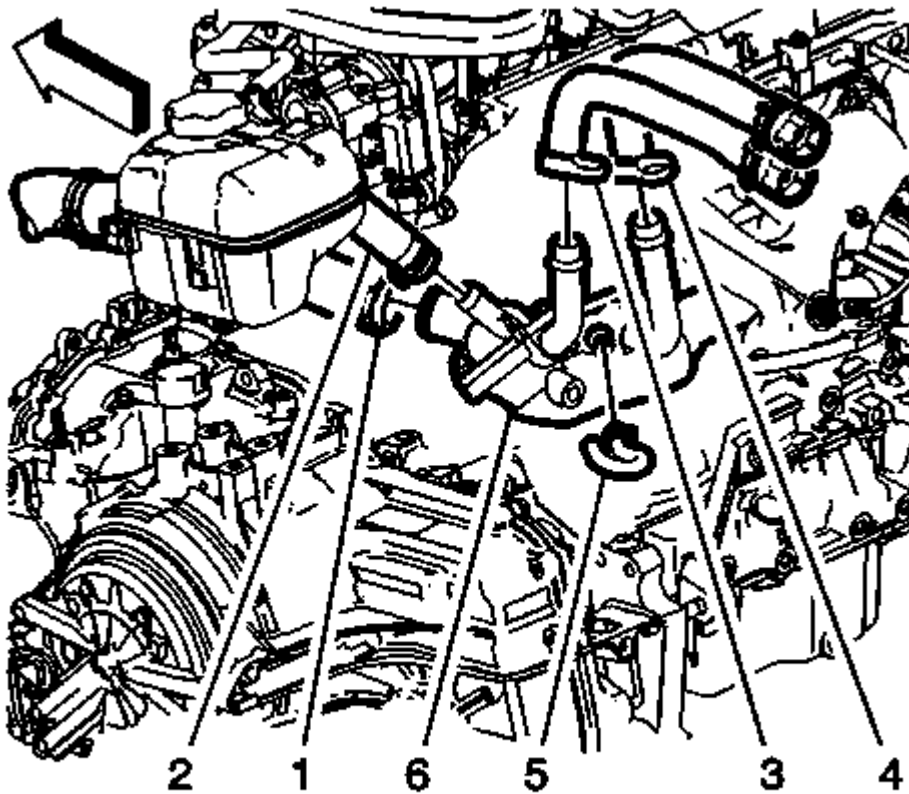


Fig. 56: Thermostat Housing

Courtesy of GENERAL MOTORS COMPANY

4. Remove the following hoses from the thermostat housing (6):
 - Radiator Outlet Hose (1)
 - Surge Tank Hose (2)
 - Heater Outlet Hose (3)
 - Heater Inlet Hose (4)
5. Disconnect the Engine Coolant Temperature (ECT) sensor (5).

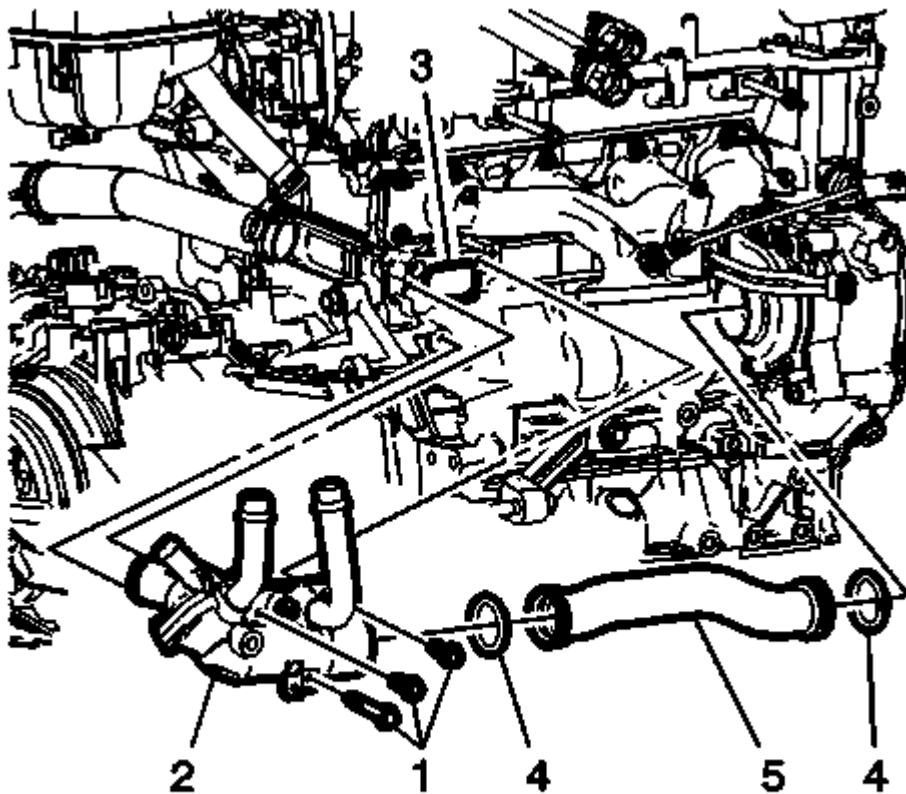


Fig. 57: Thermostat Housing Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the thermostat housing fasteners (1).

NOTE: **Twist the water transfer pipe while pulling in order to remove it from the water pump.**

7. Remove the thermostat housing (2) from the vehicle.
8. Remove the water transfer pipe (5) from the thermostat housing, if necessary.
9. Remove and discard the water transfer pipe O-ring seals (4) and the thermostat housing seal (3).

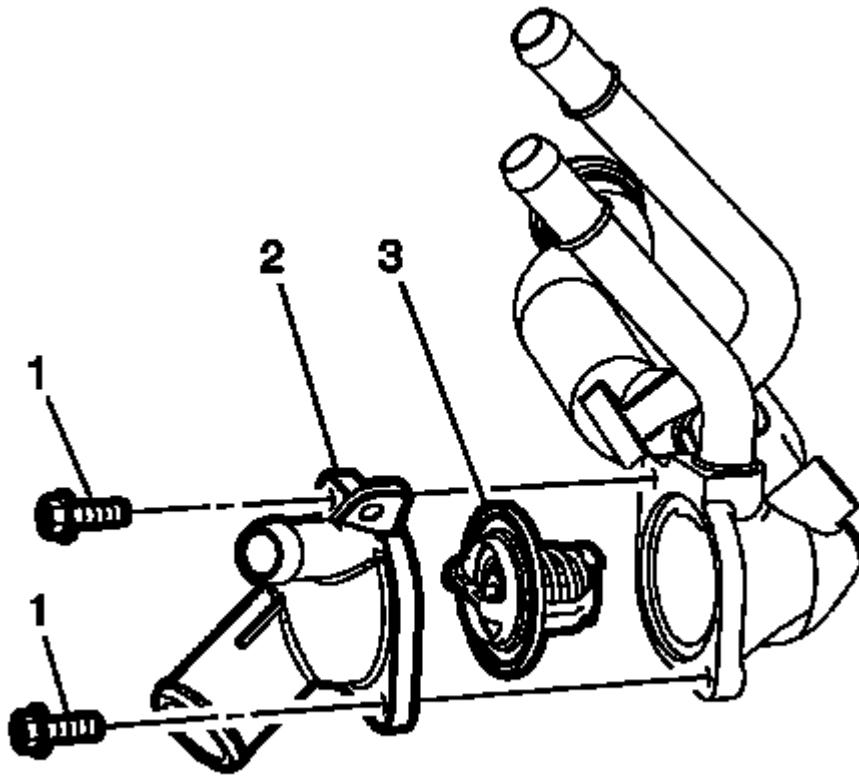


Fig. 58: Thermostat Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the thermostat cover fasteners (1) and cover (2), if necessary.
11. Remove the thermostat (3), if necessary.
12. Remove and discard the thermostat cover O-ring seal, if necessary.
13. Remove all debris and thread sealant from the engine coolant temperature (ECT) sensor and bolt holes if the housing is being re-used.

Installation Procedure

1. If installing a NEW thermostat housing transfer the thermostat, water inlet and the ECT sensor.

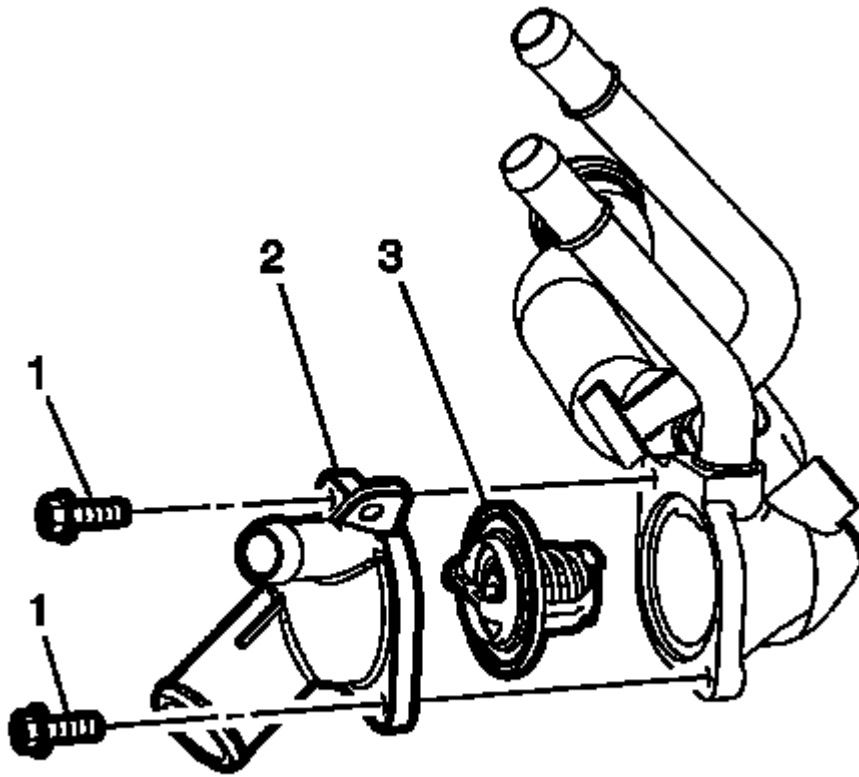


Fig. 59: Thermostat Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW thermostat cover O-ring seal into the recess groove.
3. Install the thermostat (3), if necessary.

CAUTION: Refer to Fastener Caution .

4. Install the thermostat cover fasteners (1), if necessary and tighten to 10 N.m (89 lb in).
5. Install a NEW thermostat housing to engine gasket onto the thermostat housing.
6. Load the thermostat housing assembly into position.

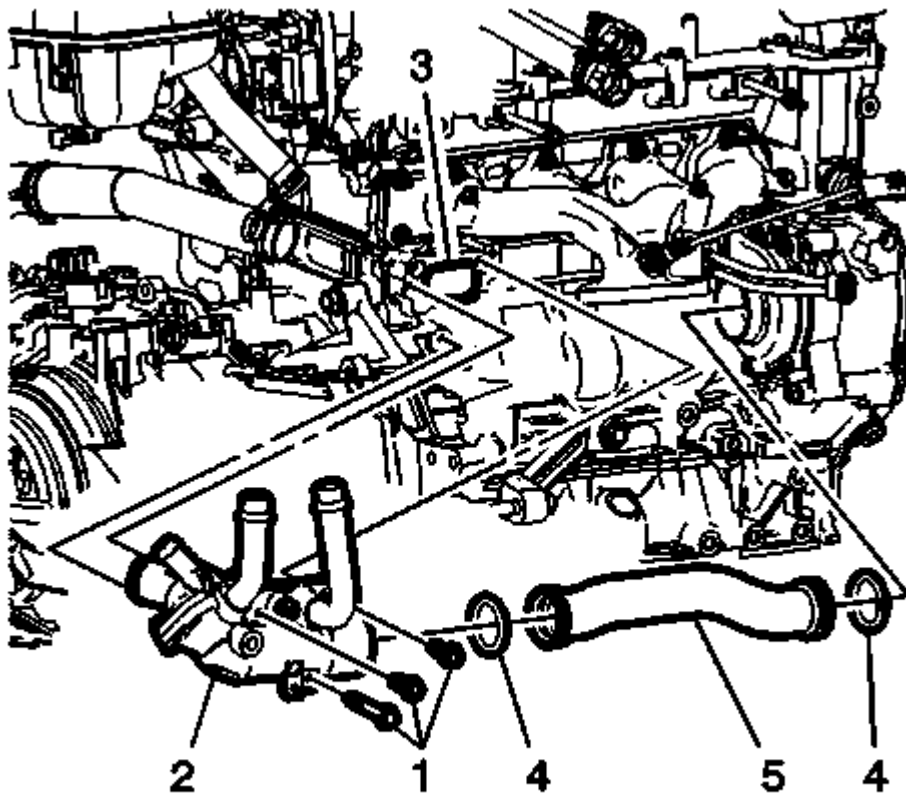


Fig. 60: Thermostat Housing Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: The water feed pipe seals can be lightly lubricated with coolant to aid during installation.

7. Install NEW O-ring seals (4) onto the water feed pipe (5).

NOTE: Lubricate the O-rings with coolant ONLY.

8. Install the water feed pipe (5) into the thermostat housing aligning locator tab.
9. Align the water pipe (5) to water pump.
10. Seat the water feed O-ring seal by pushing inward toward the water pump. Take care not to tear or damage the O-ring.
11. Position the thermostat housing (2) against the engine with a NEW seal (3).
12. Install the thermostat housing fasteners (1) and tighten to 10 N.m (89 lb in).
13. Install the ECT sensor, if necessary and tighten to 20 N.m (15 lb ft).

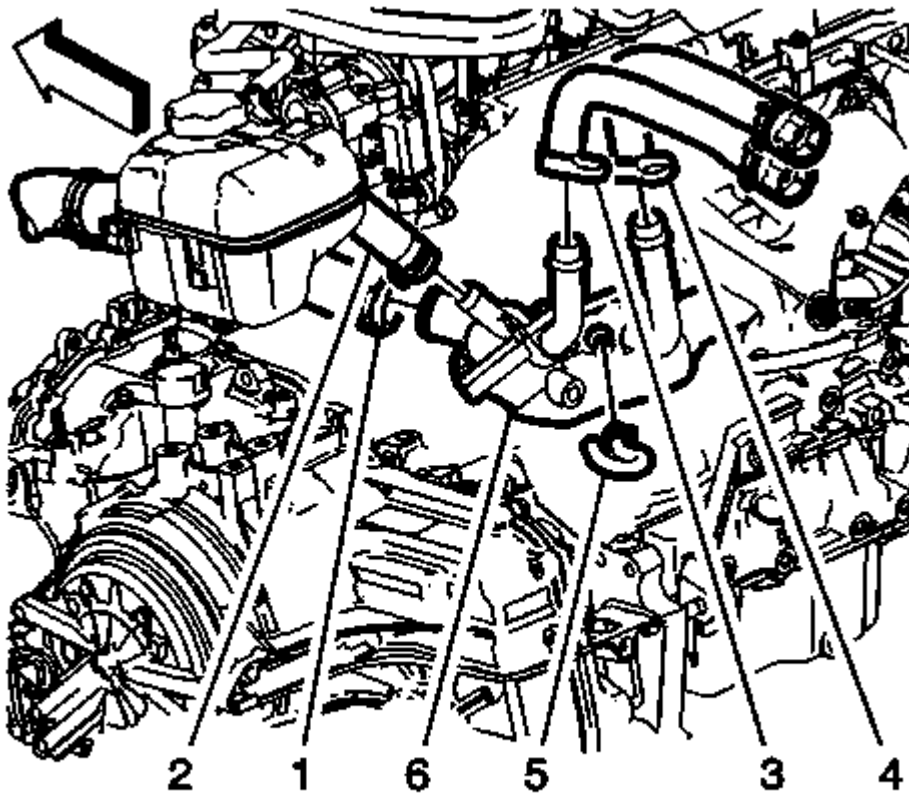


Fig. 61: Thermostat Housing

Courtesy of GENERAL MOTORS COMPANY

14. Install the following hoses from the thermostat housing (6):
 - Radiator Outlet Hose (1)
 - Surge Tank Hose (2)
 - Heater Outlet Hose (3)
 - Heater Inlet Hose (4)
15. Connect the Engine Coolant Temperature (ECT) sensor (5).

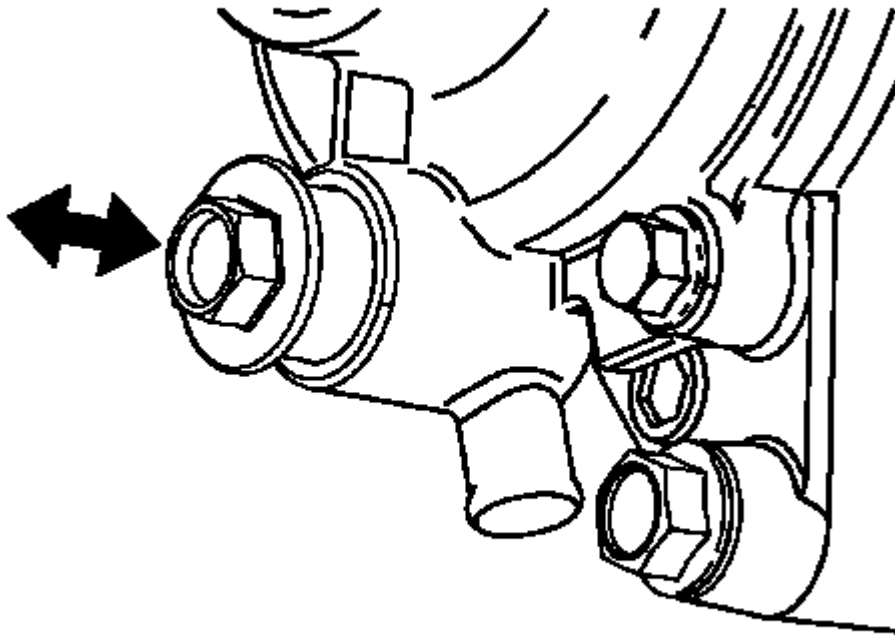


Fig. 62: Opening Water Pump Drain Plug
Courtesy of GENERAL MOTORS COMPANY

16. Verify the drain valves at the radiator and water pump are closed.
17. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

ENGINE COOLANT THERMOSTAT REPLACEMENT (LUK)

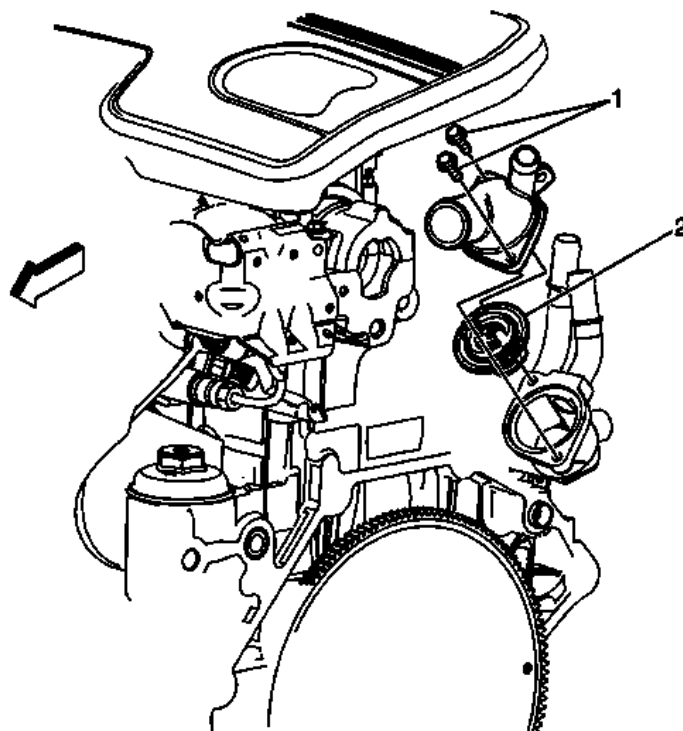


Fig. 63: Engine Coolant Thermostat (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Thermostat Replacement (LUK)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Draining the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Disconnect the radiator outlet hose from the water inlet housing. 3. Disconnect the radiator surge tank hose from the water inlet housing. Refer to <u>Radiator Surge Tank Outlet Hose Replacement (LUK)</u>. 	
1	Engine Coolant Thermostat Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (88 lb in)
2	Engine Coolant Thermostat

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LTG)

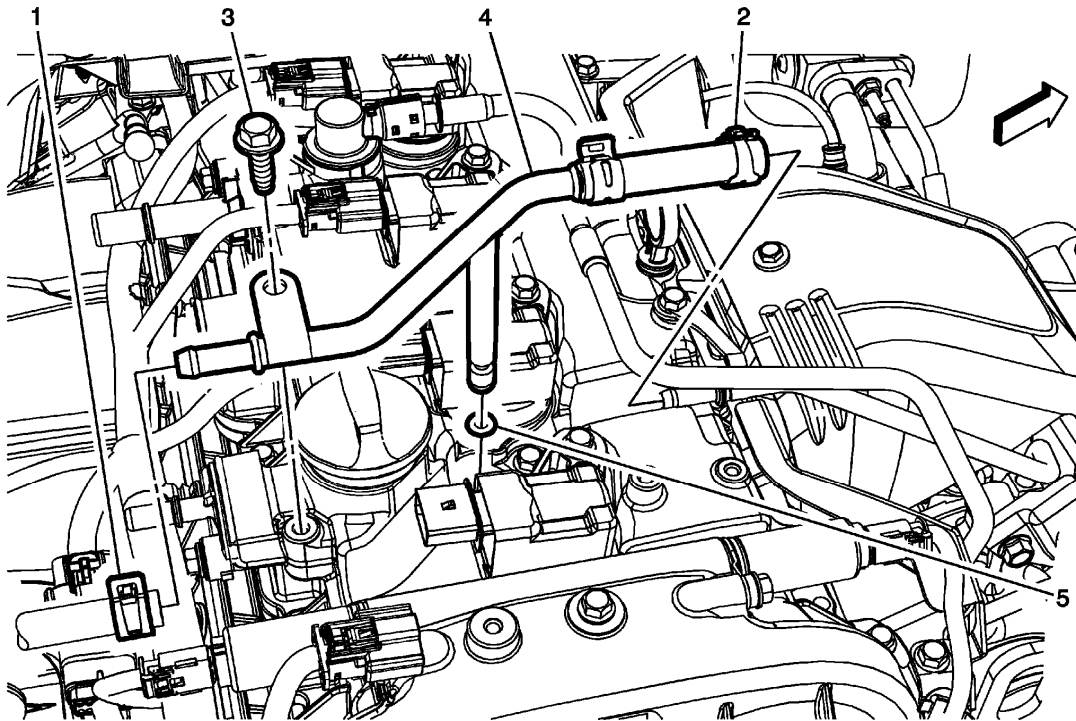


Fig. 64: Engine Coolant Air Bleed Pipe (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Air Bleed Pipe Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u>, <u>Cooling System Draining and Filling (GE 47716)</u>. 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 3. Remove the positive crankcase ventilation hose/pipe/tube. Refer to <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)</u>. 4. Disconnect the electrical wiring harness connector from the ignition coil. 	
NOTE: Replace hose clamps if necessary.	
Special Tools BO-38185 Hose Clamp PliersFor equivalent regional tools, refer to <u>Special Tools</u> .	
1	Surge Tank Vent Hose Clamp
2	Engine Coolant Air Bleed Hose Clamp
	Engine Coolant Air Bleed Pipe Fastener
CAUTION:	

3	Refer to Fastener Caution . Tighten: 10 (89 lb in)
4	Engine Coolant Air Bleed Pipe
5	Seal NOTE: Install NEW seal

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (LTG)

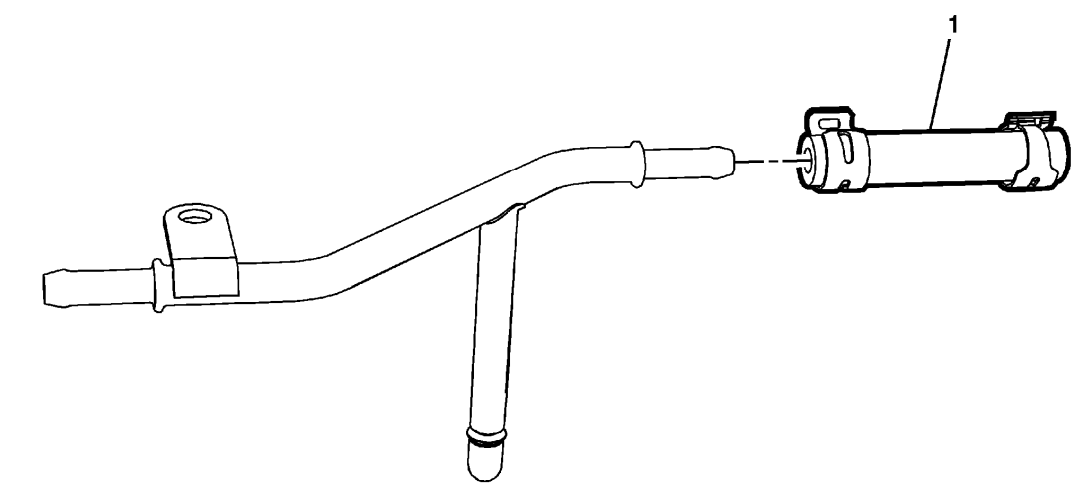


Fig. 65: Engine Coolant Air Bleed Hose (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Air Bleed Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedure	
Remove the engine coolant air bleed pipe. Refer to Engine Coolant Air Bleed Pipe Replacement (LTG) .	
Special Tools	
BO-38185 Hose Clamp Pliers	
For equivalent regional tools, refer to Special Tools .	

1

Engine Coolant Air Bleed Hose

NOTE:

Replace hose clamps if necessary.

WATER OUTLET REPLACEMENT (LTG)

Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the battery tray. Refer to **Battery Tray Replacement** .

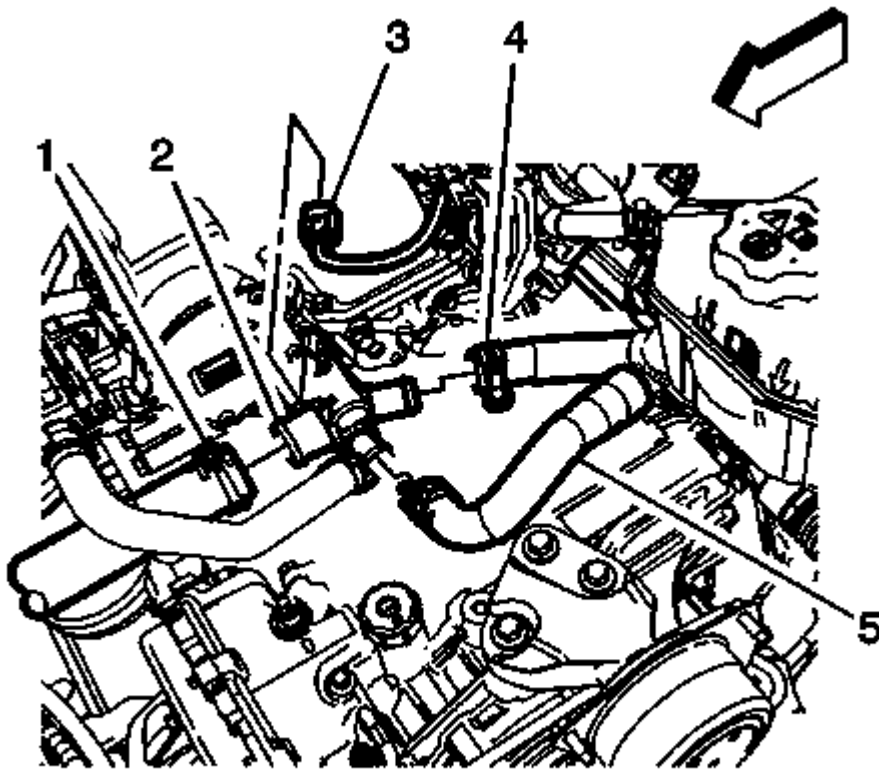


Fig. 66: Engine Coolant Temperature (ECT) Sensor Connector

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the engine coolant temperature (ECT) sensor connector (3) from the water outlet (2).
5. Remove the following hoses from the water outlet:
 - Radiator inlet hose (1).
 - Heater inlet hose (4).
 - Heater outlet hose (5).
6. Remove the secondary air injection inlet hose.

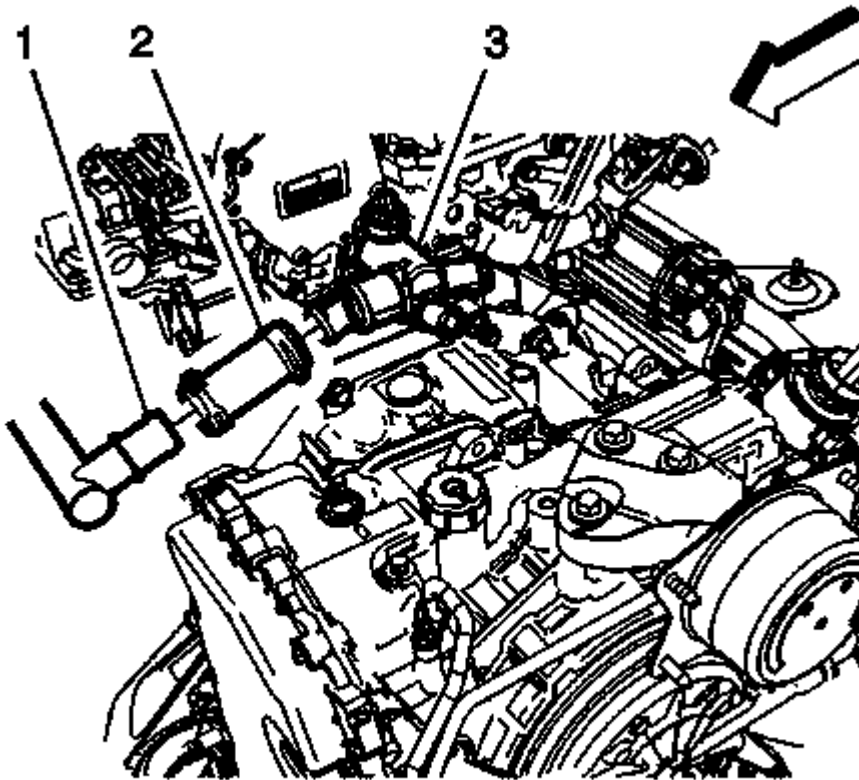


Fig. 67: Thermostat Bypass Hose

Courtesy of GENERAL MOTORS COMPANY

7. Remove the thermostat bypass hose (2) from the water outlet (3).

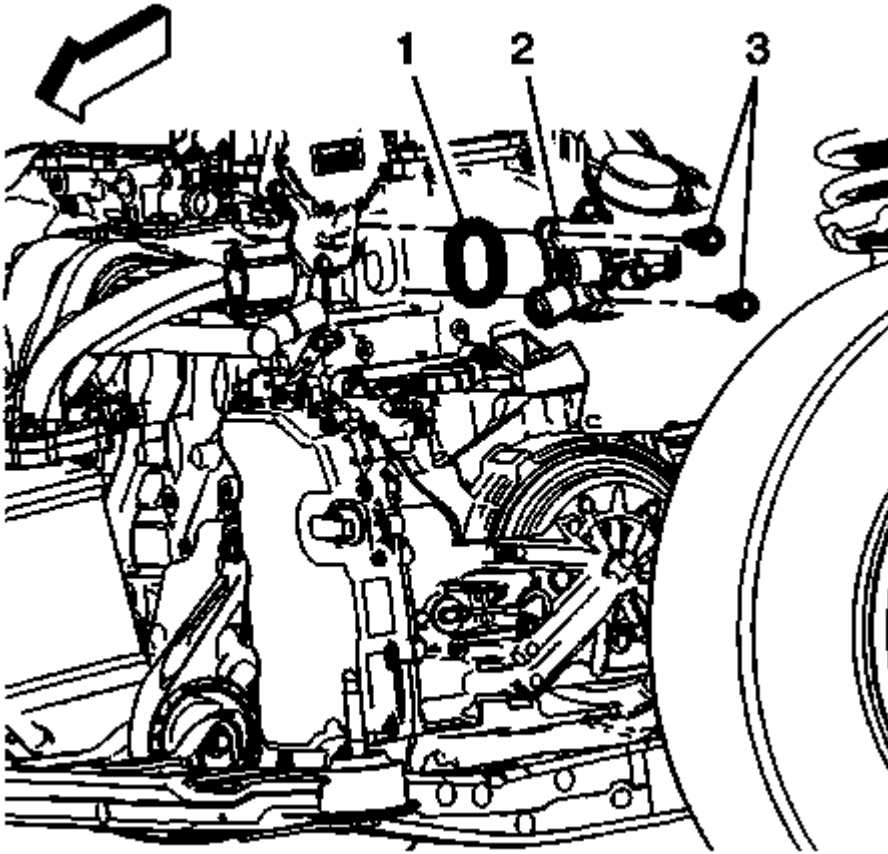


Fig. 68: Water Outlet Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the water outlet fasteners (1) and remove the water outlet (2).
9. Discard the water outlet seal (1).

Installation Procedure

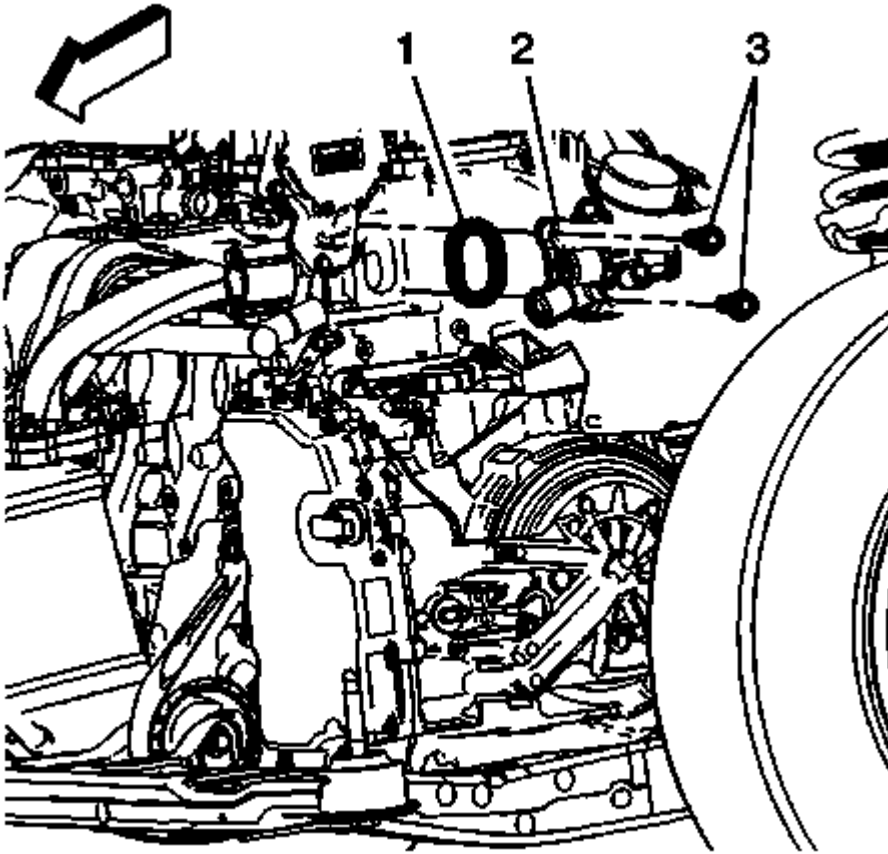


Fig. 69: Water Outlet Fasteners

Courtesy of GENERAL MOTORS COMPANY

1. Install the water outlet (2) into position with a NEW seal (1).

CAUTION: Refer to Fastener Caution .

2. Install the water outlet fasteners (3) and tighten to 12 (106 lb in).

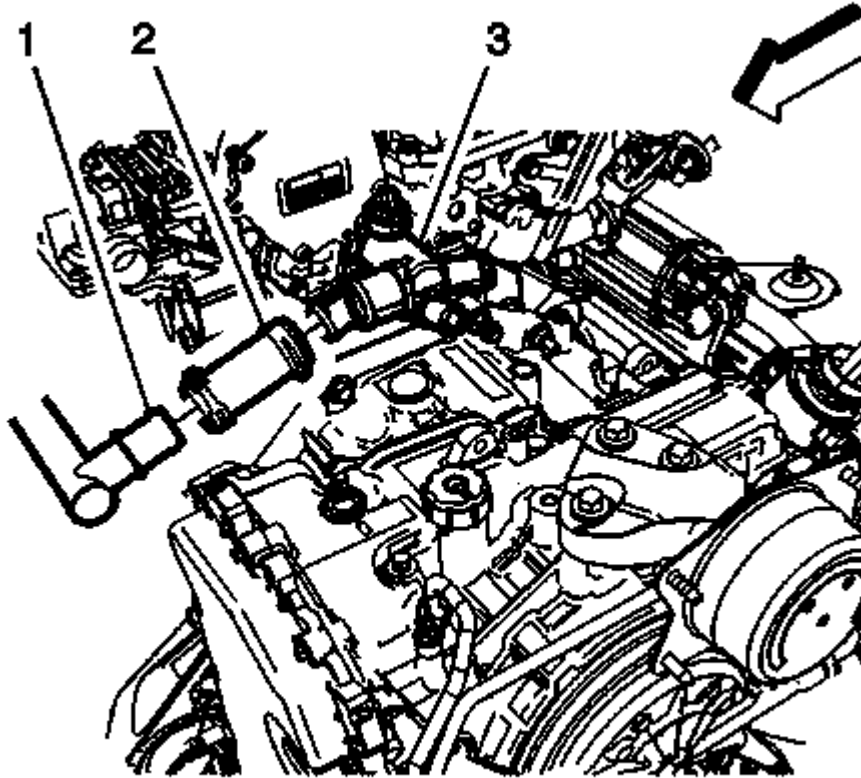


Fig. 70: Thermostat Bypass Hose

Courtesy of GENERAL MOTORS COMPANY

3. Install the thermostat bypass hose (2) to the water outlet (3).
4. Install the secondary air injection inlet hose.

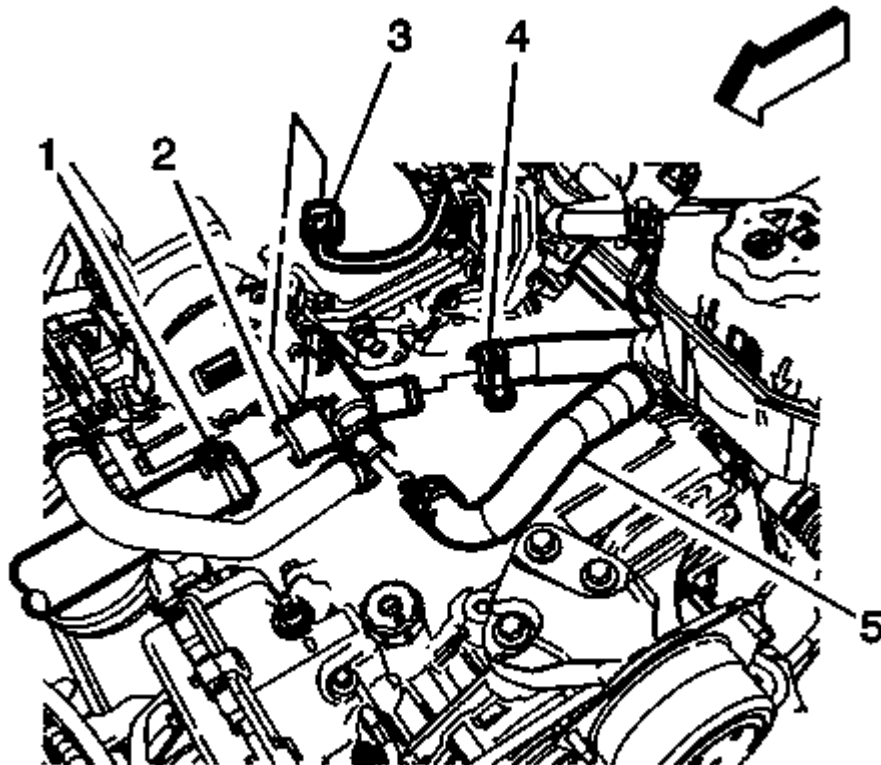


Fig. 71: Engine Coolant Temperature (ECT) Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect the engine coolant temperature (ECT) sensor connector (3) to the water outlet (2).
6. Install the following hoses to the water outlet:
 - Radiator inlet hose (1).
 - Heater inlet hose (4).
 - Heater outlet hose (5).
7. Install the battery tray. Refer to **Battery Tray Replacement** .
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
10. Start the engine and check for coolant leaks.

THERMOSTAT BYPASS PIPE REPLACEMENT (LTG)

Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .
4. Remove the battery tray. Refer to **Battery Tray Replacement** .

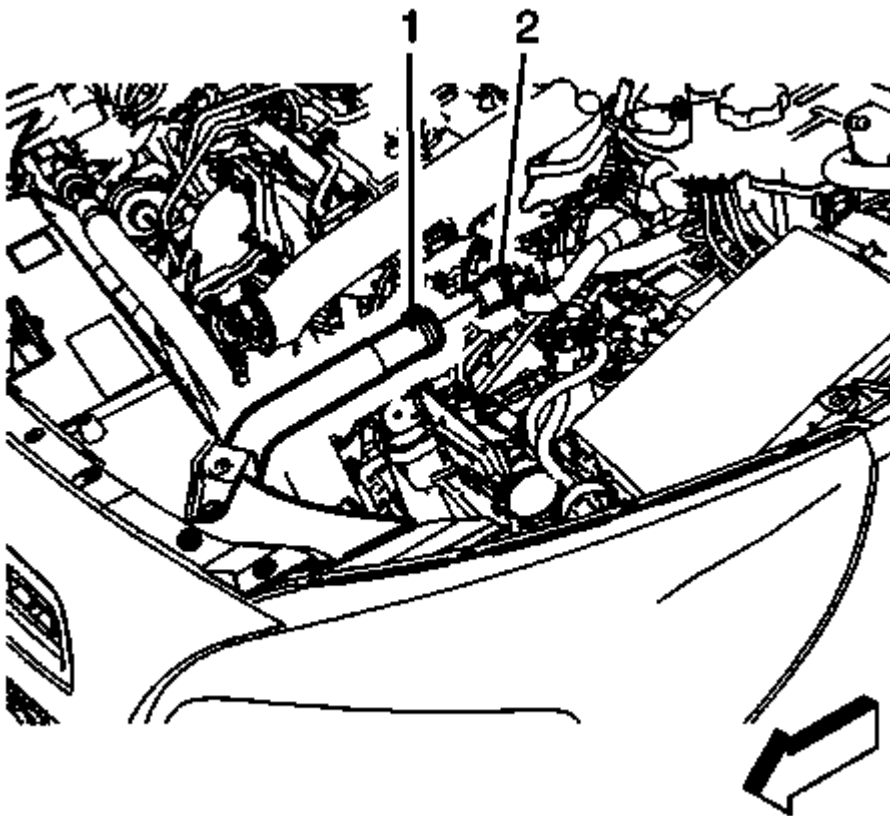


Fig. 72: Radiator Inlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

5. Remove the radiator inlet hose (1) from the water outlet (2).

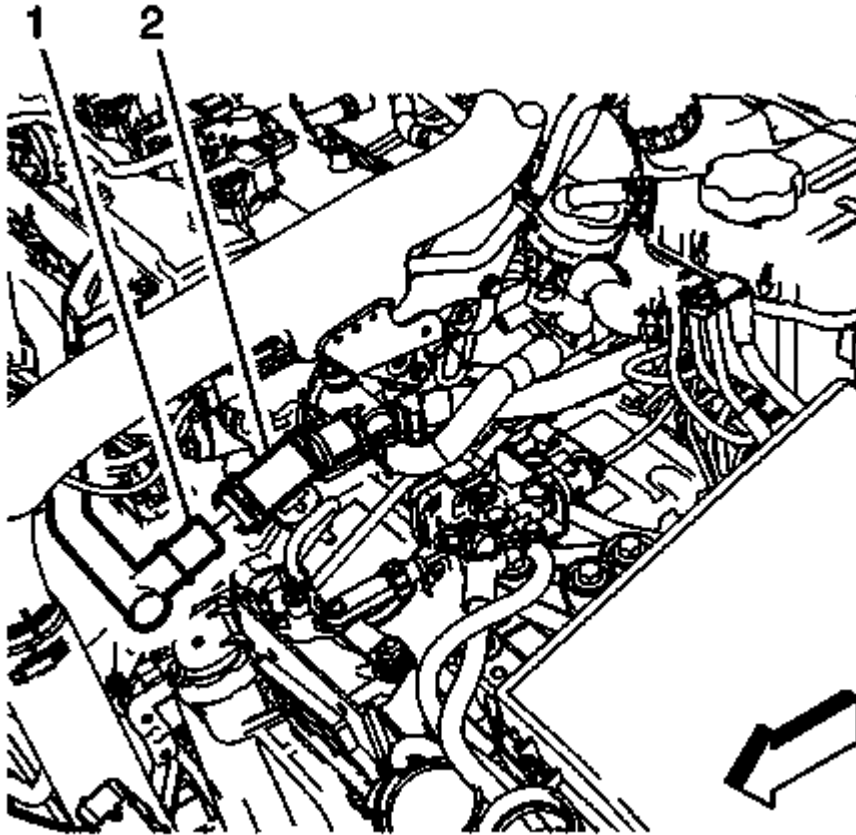


Fig. 73: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove the thermostat bypass hose (2) from the thermostat bypass pipe (1).

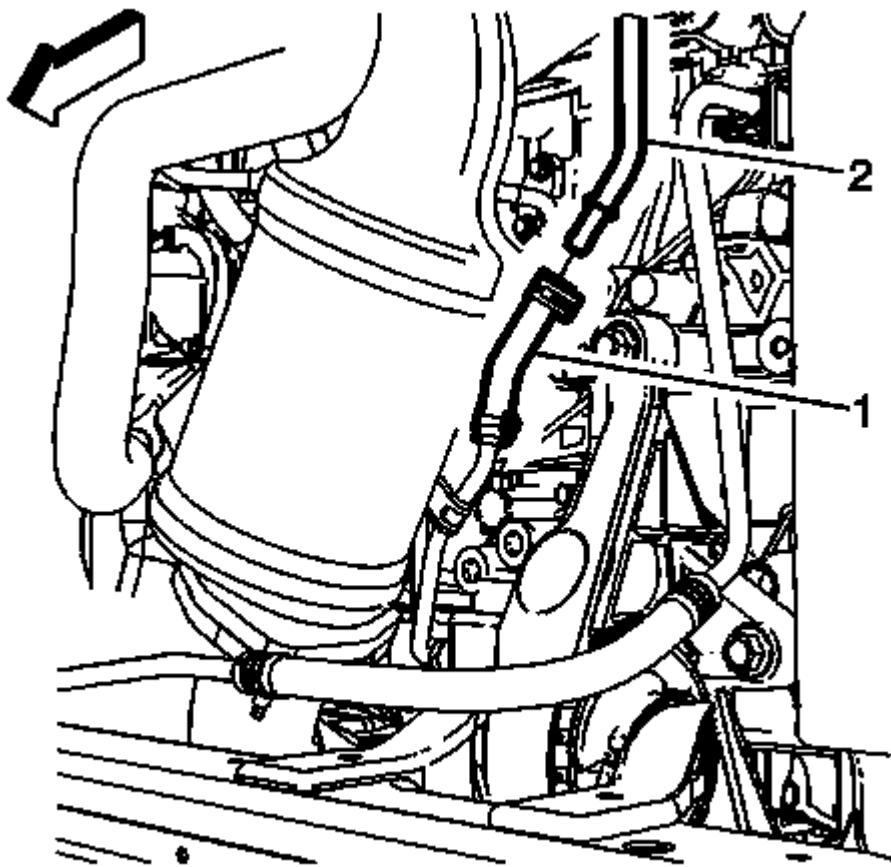


Fig. 74: Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove the hose (1) from the thermostat bypass pipe (2).

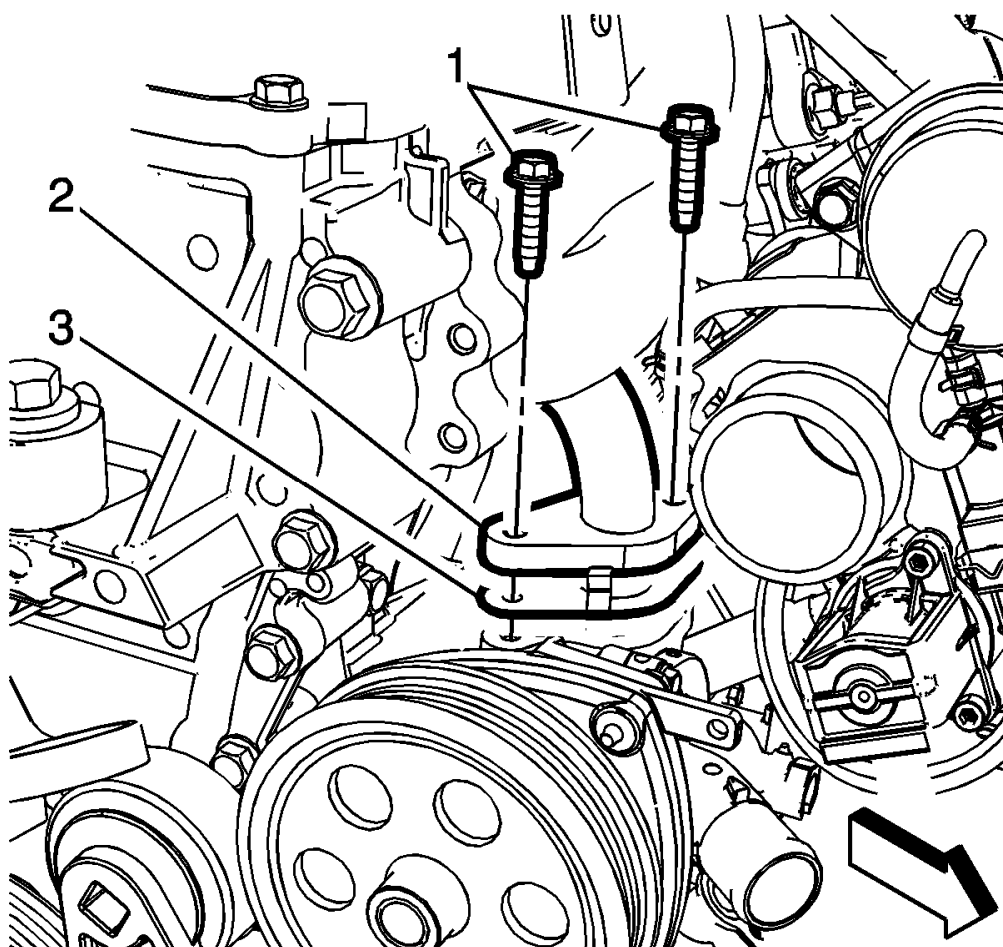


Fig. 75: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the thermostat bypass pipe fasteners (1).
9. Remove the thermostat bypass pipe (2) and discard the gasket (3).

Installation Procedure

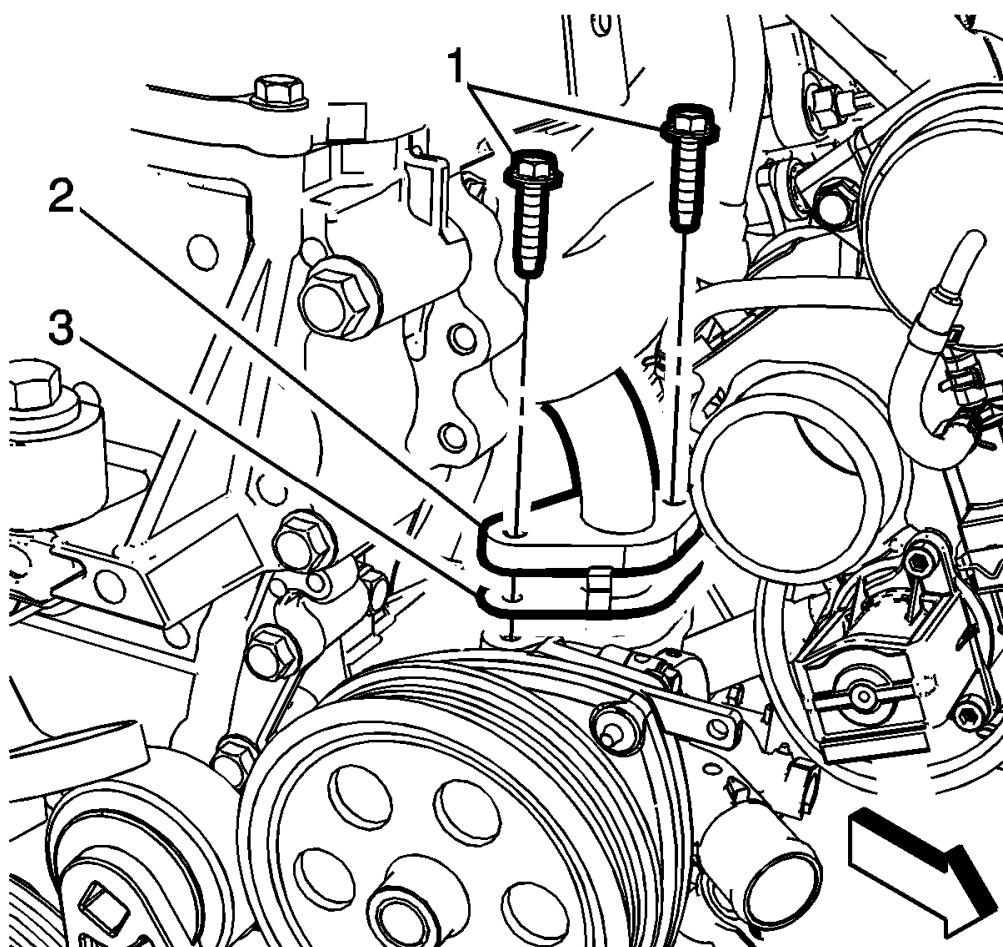


Fig. 76: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the thermostat bypass pipe (2) into position with a NEW gasket (3).

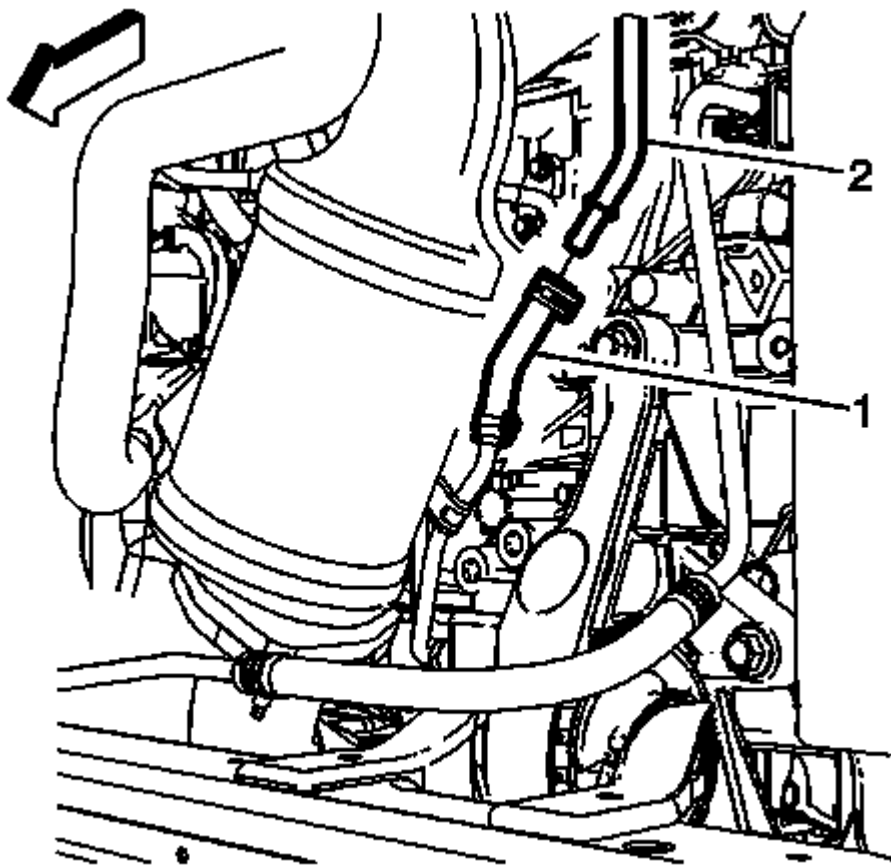


Fig. 77: Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

NOTE: Replace hose clamps if necessary.

2. Install the hose (1) on the thermostat bypass pipe (2).

CAUTION: Refer to Fastener Caution .

3. Install the thermostat bypass pipe fasteners (1) and tighten to 10 (89 lb in).

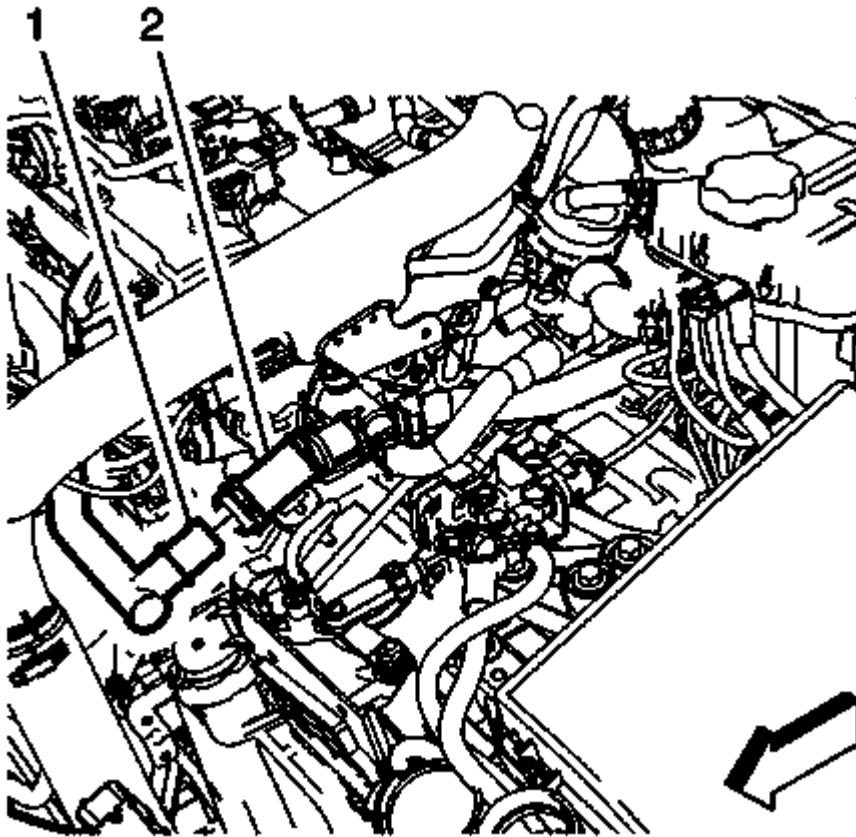


Fig. 78: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

4. Install the thermostat bypass hose (2) on the thermostat bypass pipe (1).

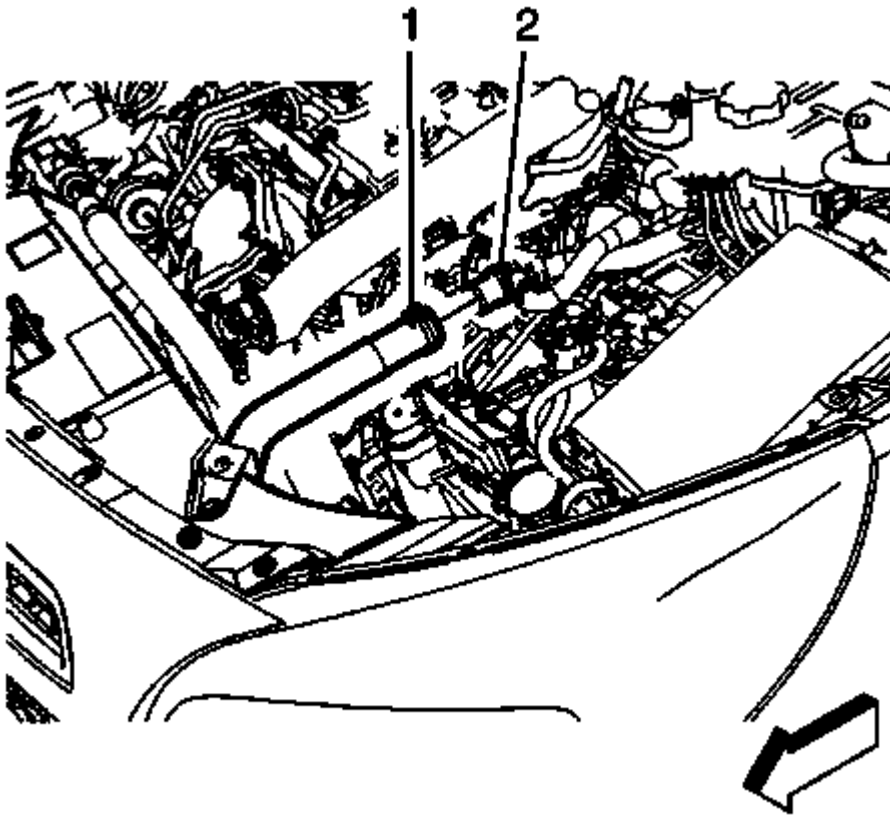


Fig. 79: Radiator Inlet Hose And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

5. Install the radiator inlet hose (1) to the water outlet (2).
6. Install the battery tray. Refer to **Battery Tray Replacement** .
7. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
10. Start the engine and check for coolant leaks.

WATER PUMP REPLACEMENT (LTG)

Special Tools

BO-38185 Hose Clamp Pliers

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716).
2. Remove the drive belt. Refer to Drive Belt Replacement.
3. Remove the exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement (LTG).

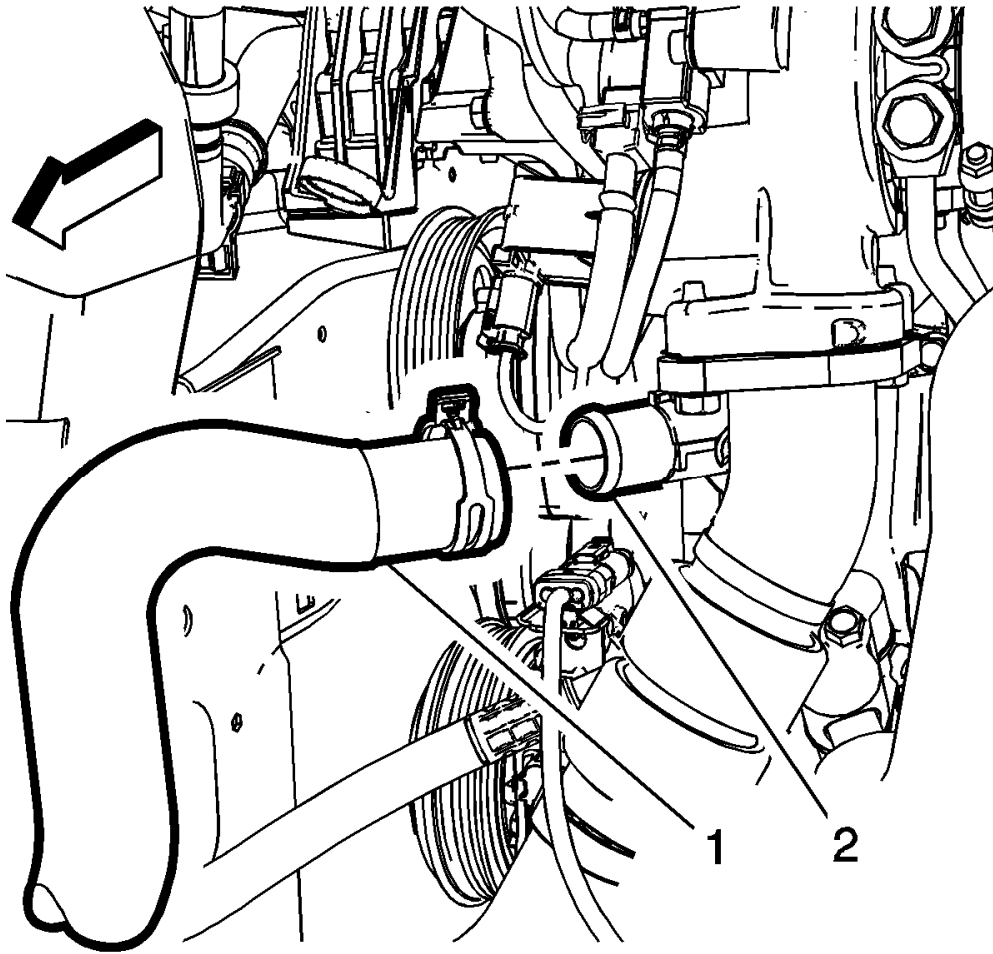


Fig. 80: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

4. Using the BO-38185 hose clamp pliers, remove the radiator outlet hose (1) from the water outlet (2).

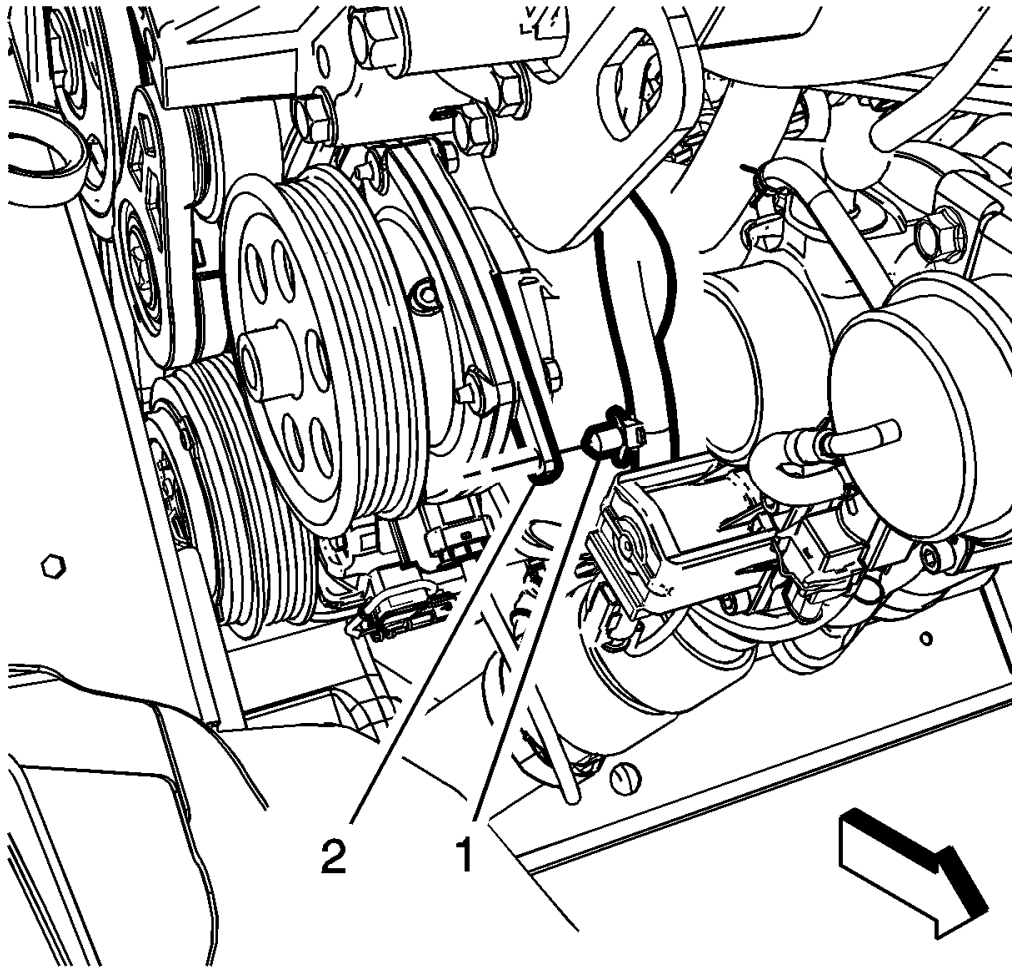


Fig. 81: Engine Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine harness retainer (1) from the water pump (2) .

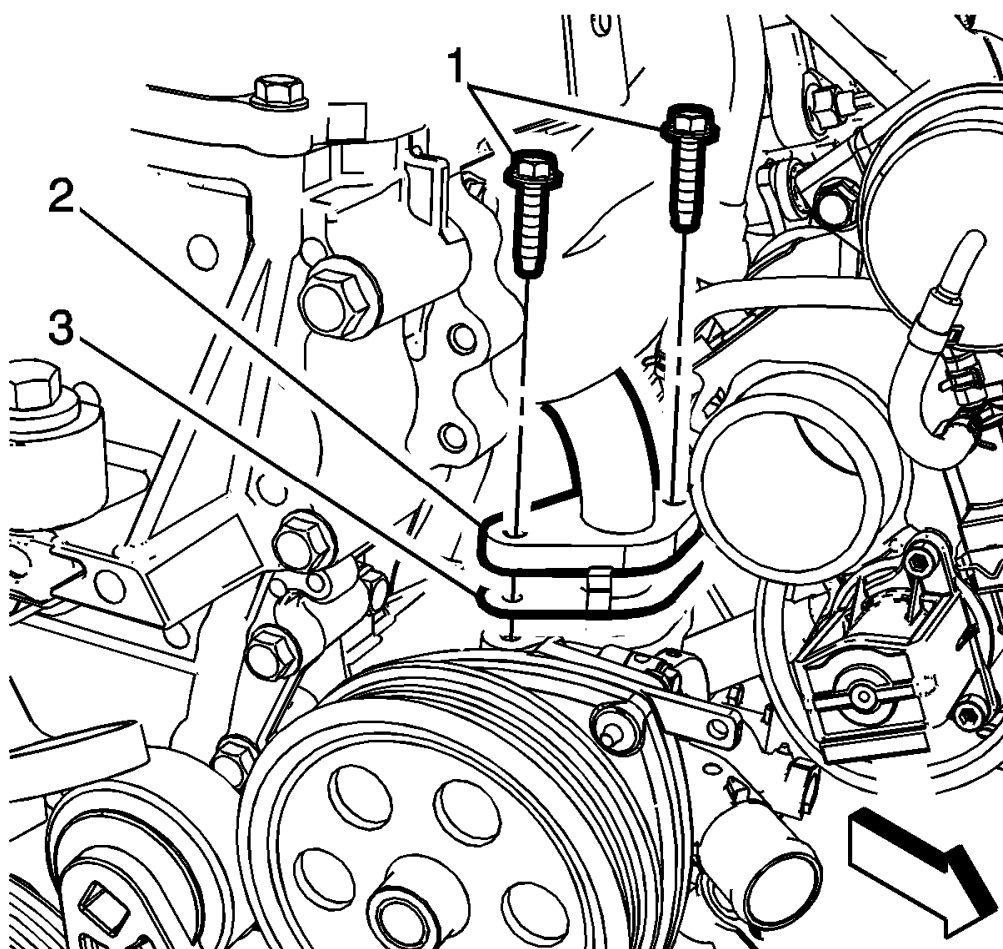


Fig. 82: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the thermostat bypass pipe fasteners (1) and remove the thermostat bypass pipe (2) from the water pump.
7. Discard the thermostat bypass pipe gasket (3).

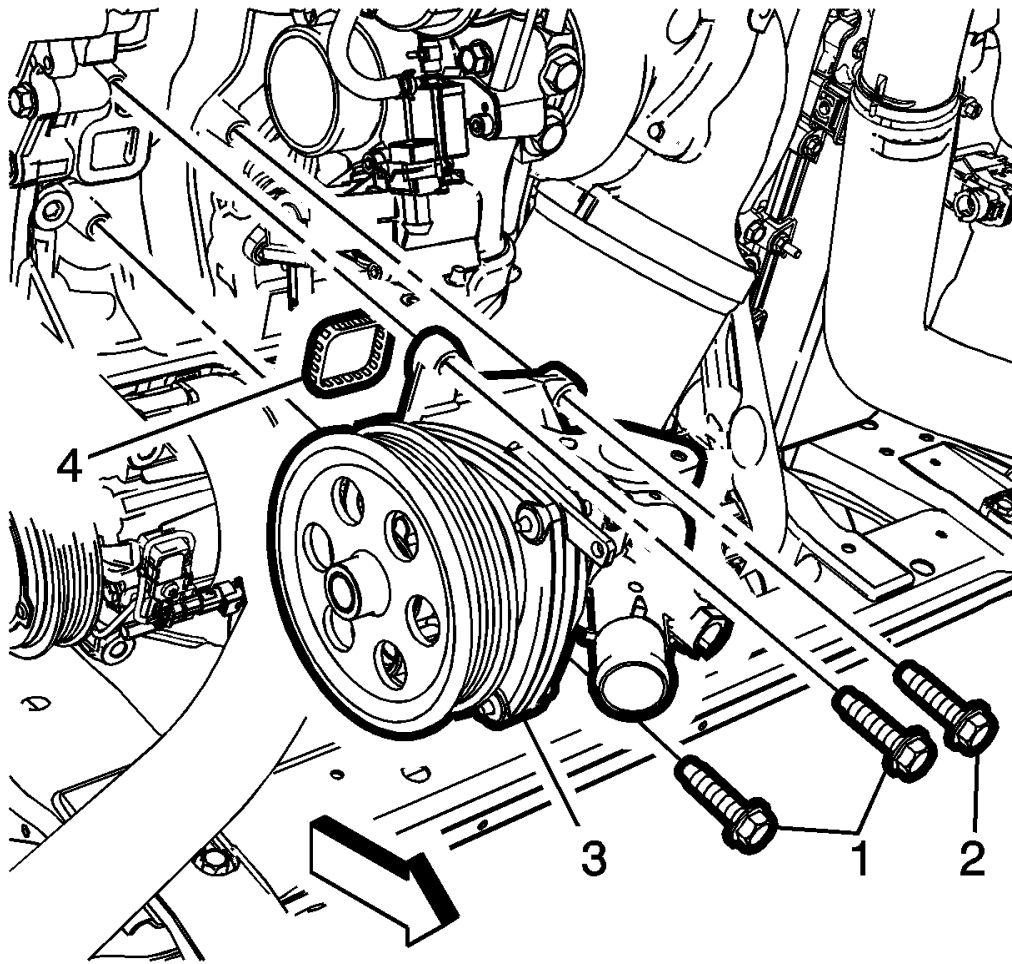


Fig. 83: Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the water pump fasteners (1) and (2) remove the water pump (3).
9. Discard the water pump seal (4).

Installation Procedure

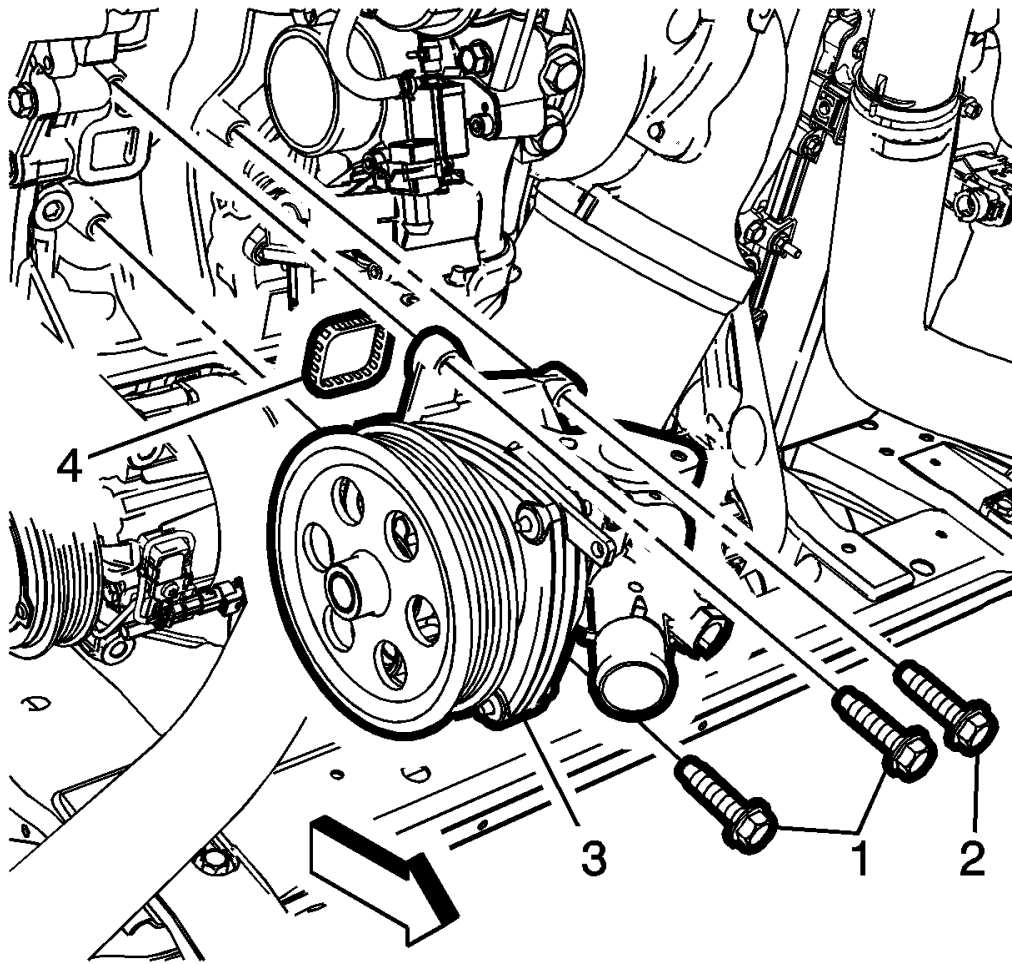


Fig. 84: Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the water pump (3) into position with a NEW water pump seal (4) and hand tighten the bolts.
2. Tighten (1) bolts to 25 (18 lb ft).
3. Tighten (2) bolt to 25 (18 lb ft).

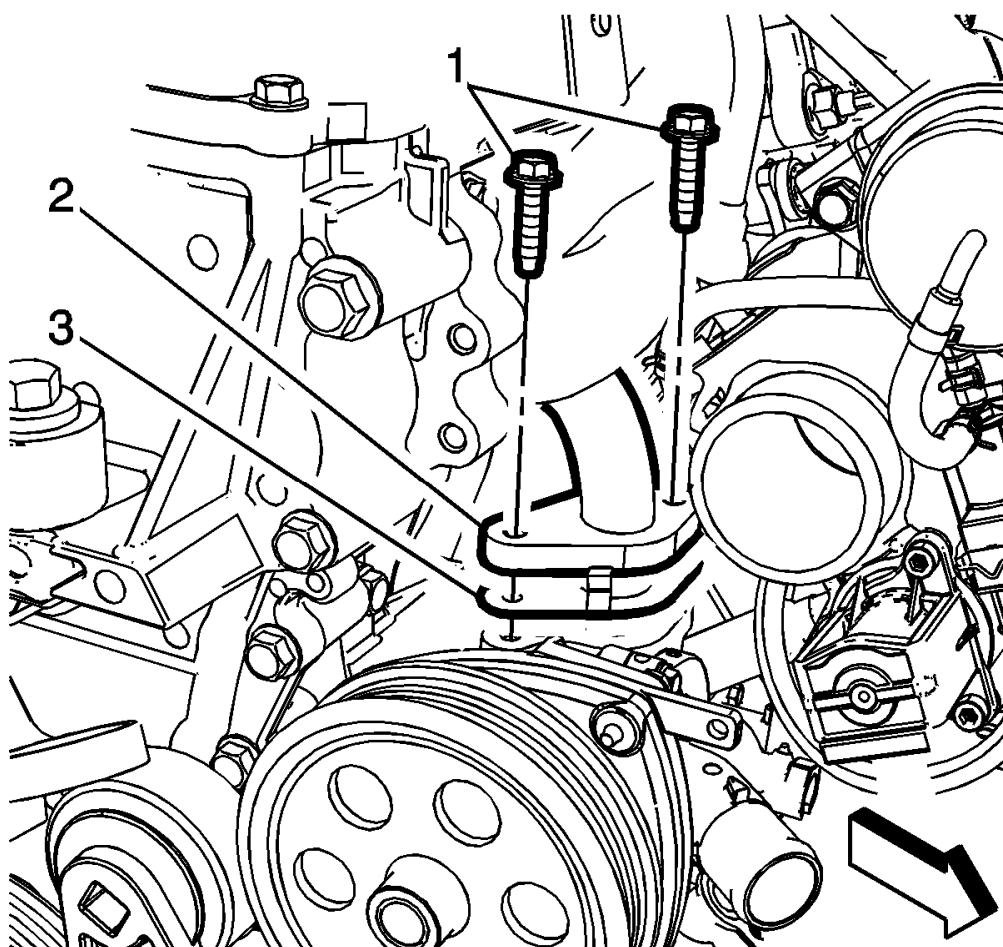


Fig. 85: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the thermostat bypass pipe (2) to the water pump with a NEW gasket (3) and tighten the fasteners (1) to 10 (89 lb in).

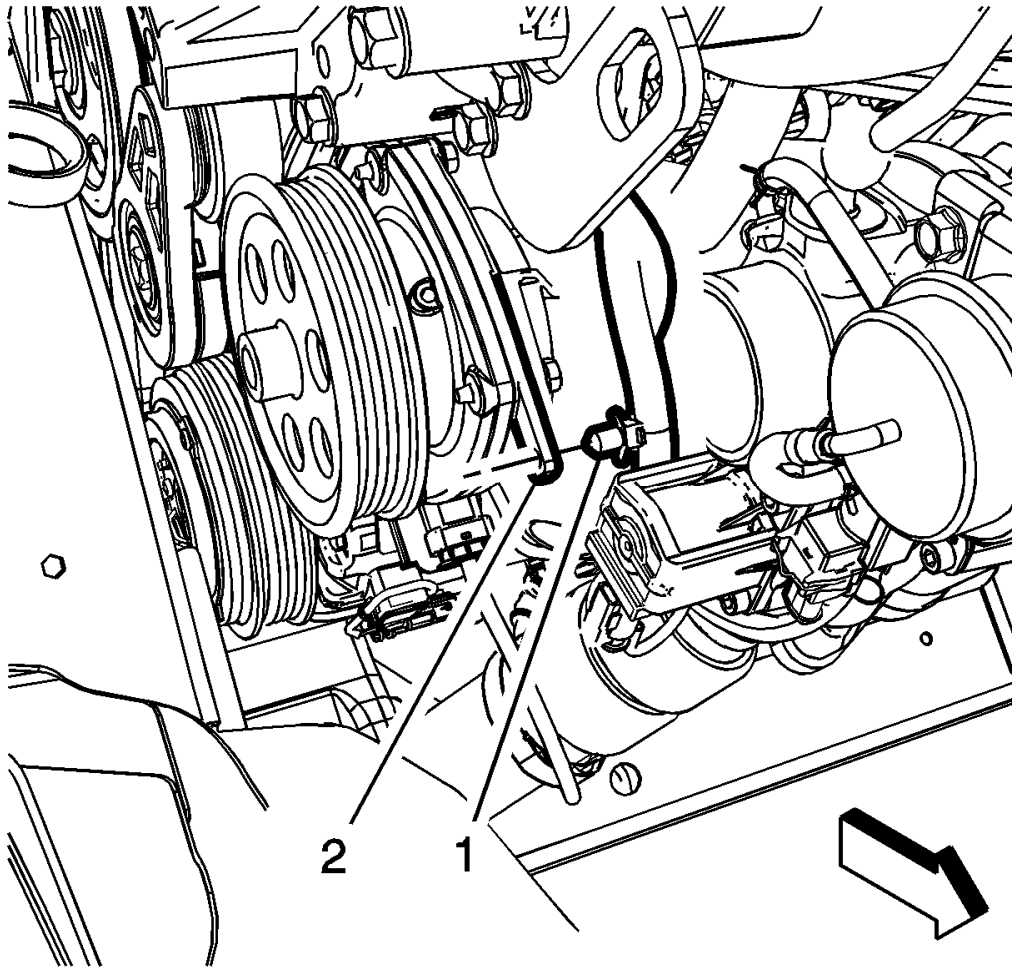


Fig. 86: Engine Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Install the engine wiring harness retainer (1) to the water pump (2).

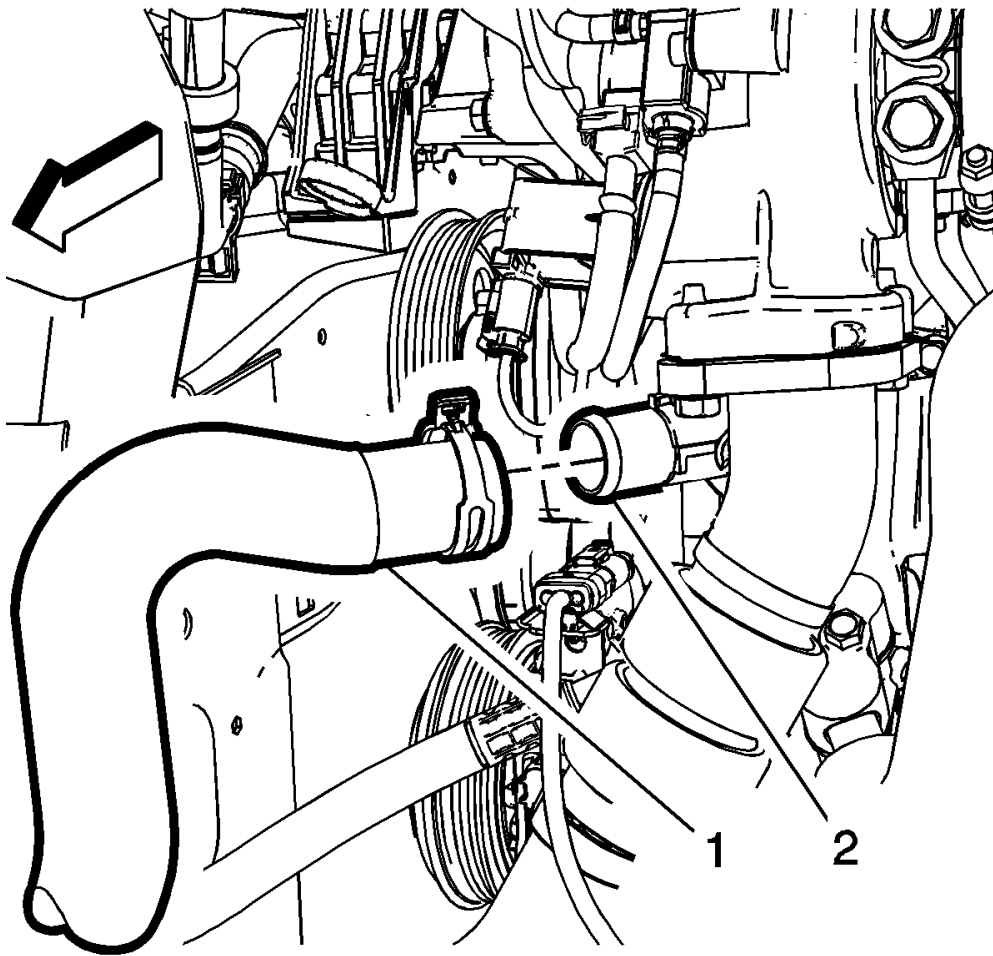


Fig. 87: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

6. Using the BO-38185 hose clamp pliers, install the radiator outlet hose (1) to the water outlet (2).
7. Install the drive belt. Refer to **Drive Belt Replacement** .
8. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
10. Start the engine and check for coolant leaks.

WATER PUMP REPLACEMENT (LUK)

Special Tools

EN-43651 Water Pump Holding Tool

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUK)** .
4. If equipped, remove the coolant heater.
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LUK)** .
6. Remove the engine coolant thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement (LUK)**.

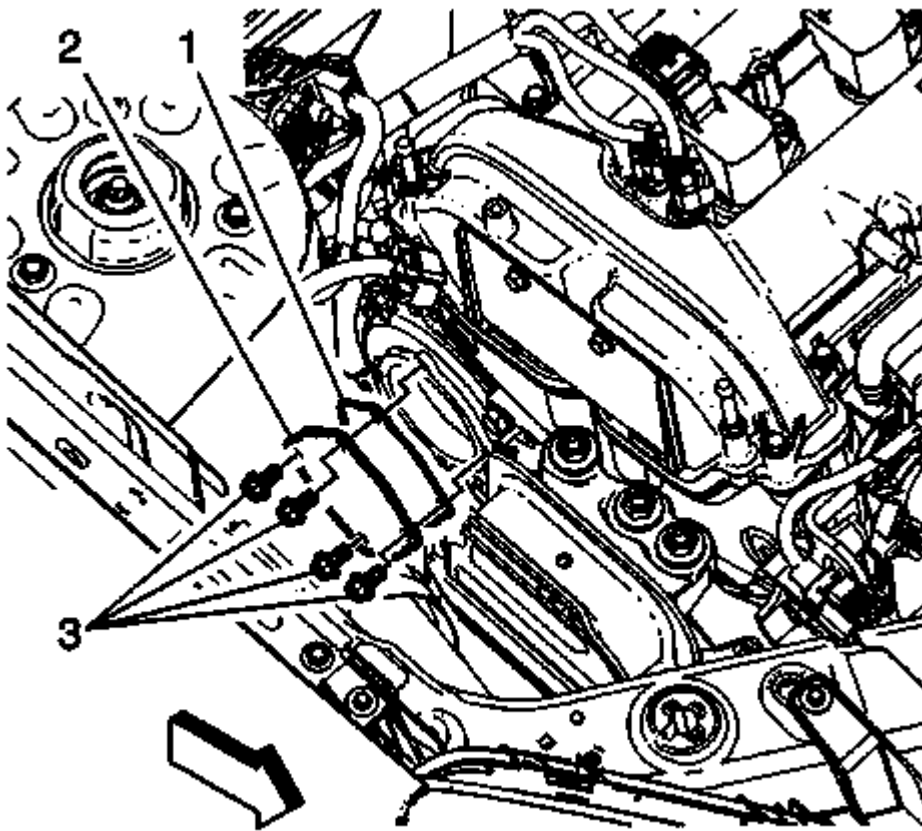


Fig. 88: Water Pump Cover, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

7. Remove the water pump cover (2), fasteners (3) and gasket (1) from the engine front cover.

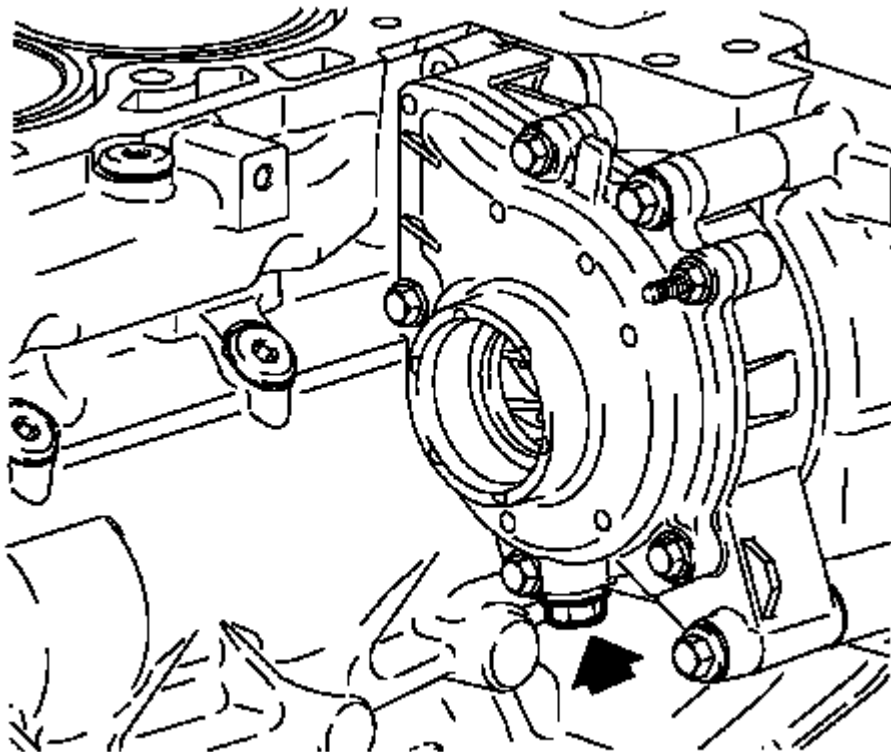


Fig. 89: Locating Water Pump Drain Plug (L61)
Courtesy of GENERAL MOTORS COMPANY

NOTE: A drain plug has been provided at the bottom of the water pump assembly for additional coolant drainage from the engine block and water pump.

8. Drain the coolant from the water pump using the plug at the bottom of the pump. Install the plug when finished.

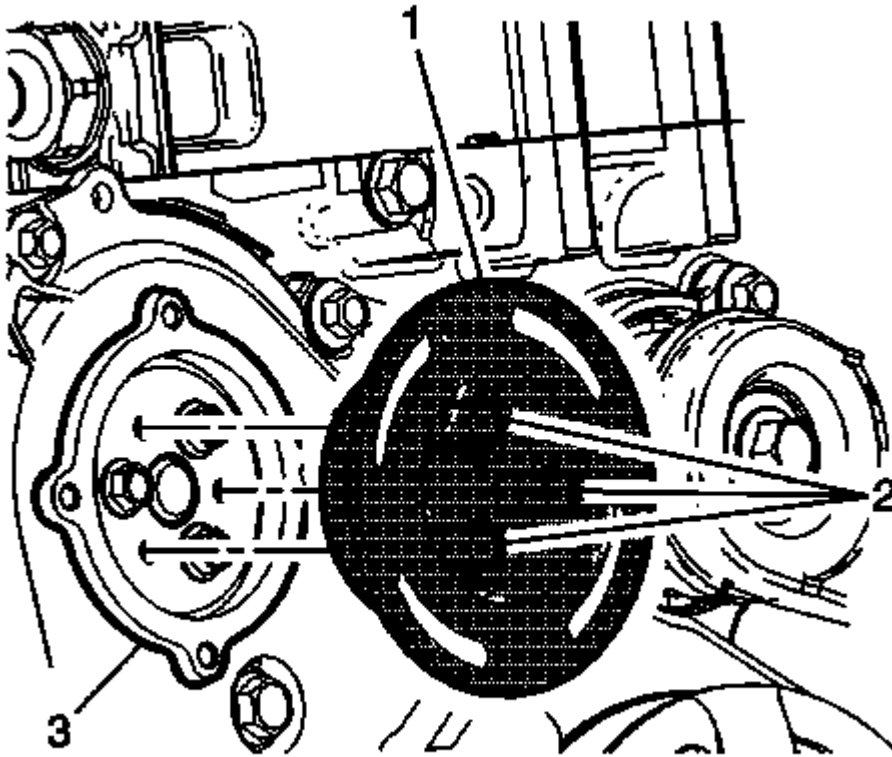


Fig. 90: Water Pump Holding Tool And Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: The water pump holding tool supports the sprocket and chain during water pump service. The tool must be used or the balance shaft must be re-timed.

9. Align the **EN-43651** water pump holding tool (1) with the threads on the water pump sprocket. Tighten the water pump holding tool fasteners (2).

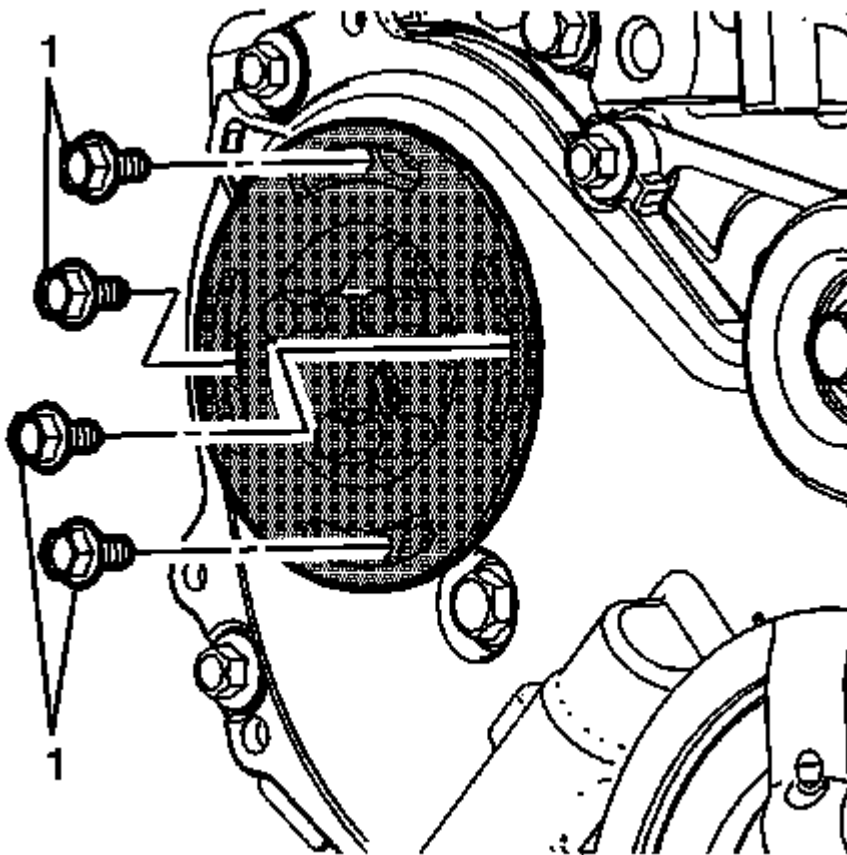


Fig. 91: Water Pump Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Secure the water pump holding tool with the previously removed water pump cover fasteners (1) into the engine front cover.

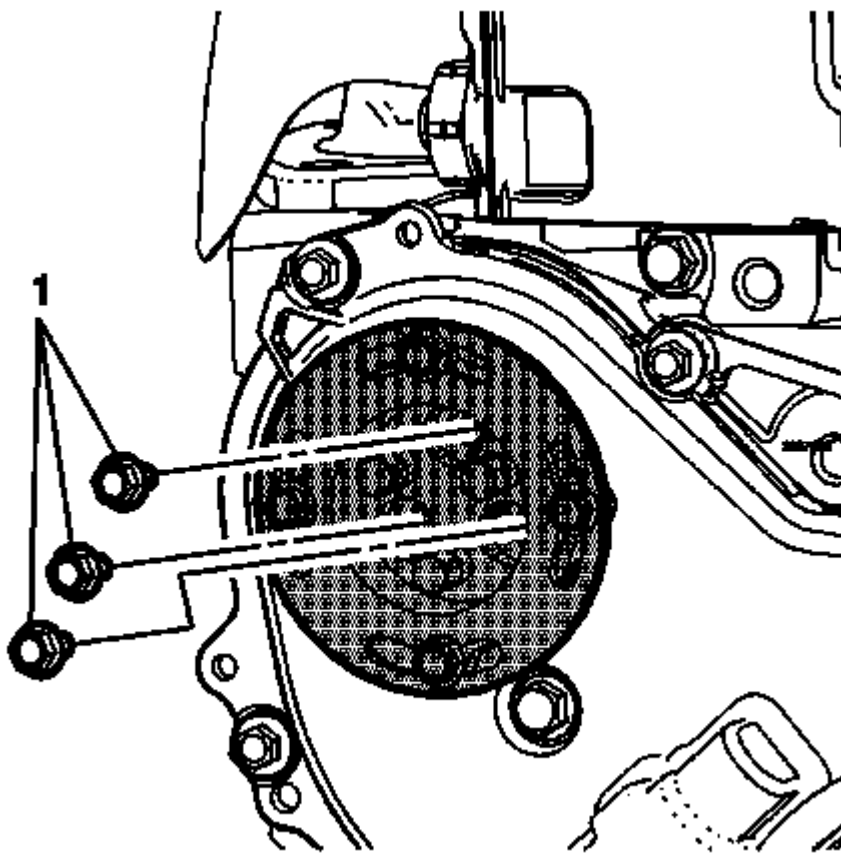


Fig. 92: Water Pump Sprocket To Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

11. Remove the water pump sprocket to water pump fasteners (1).

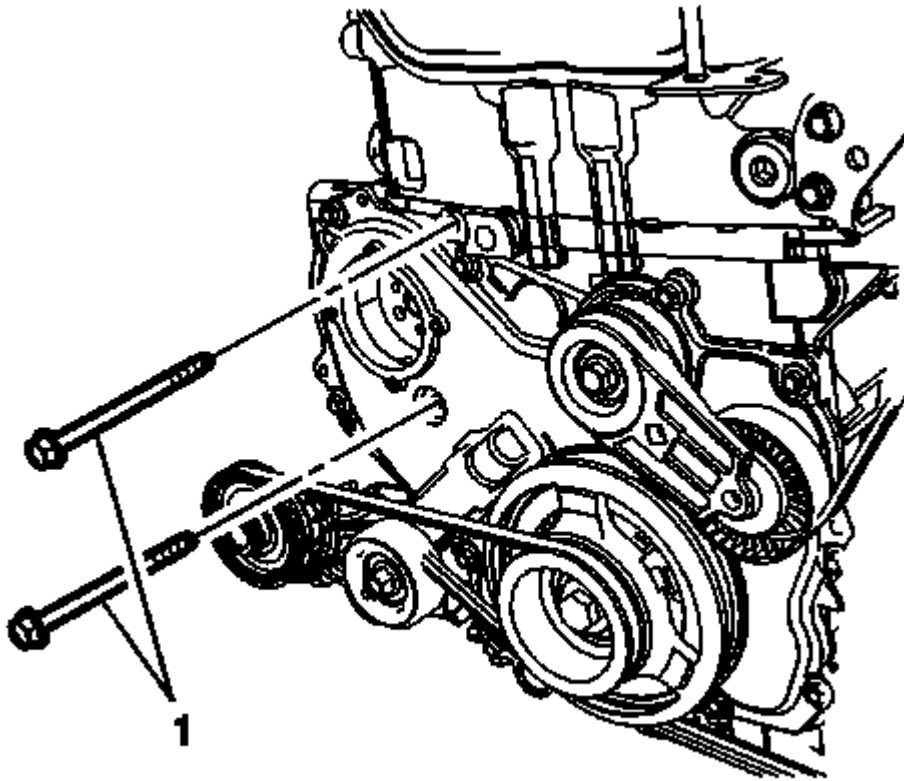


Fig. 93: Water Pump Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Be sure to remove both water pump bolts from the front of the engine block.

12. Remove the front water pump fasteners (1).

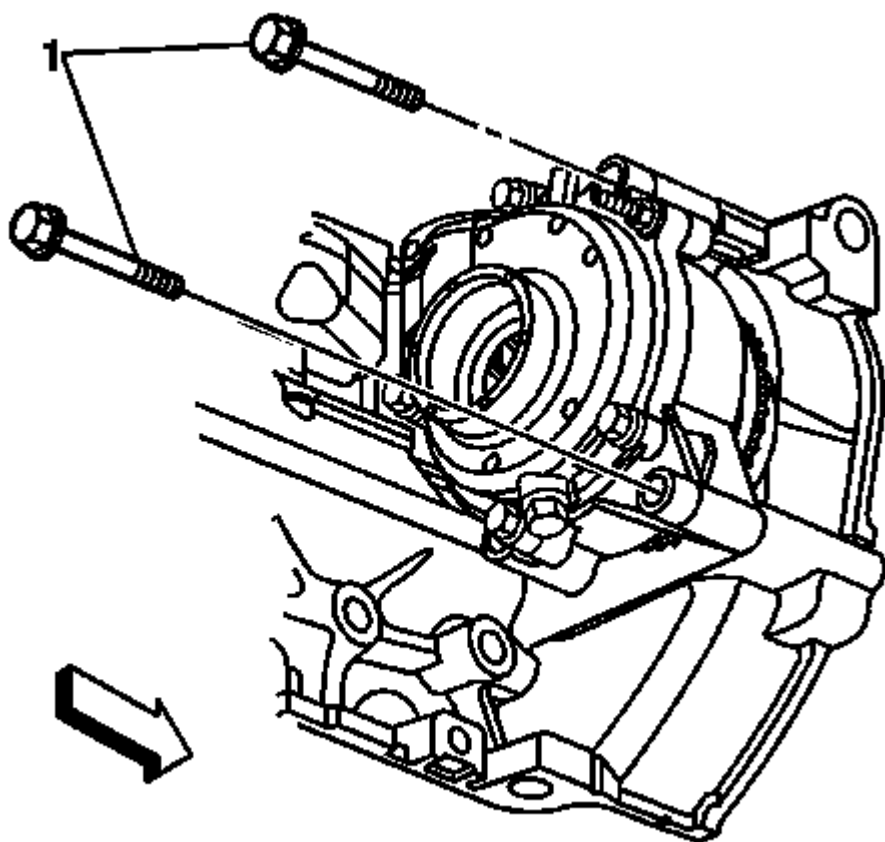


Fig. 94: Identifying Rear Water Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the rear water pump fasteners (1).

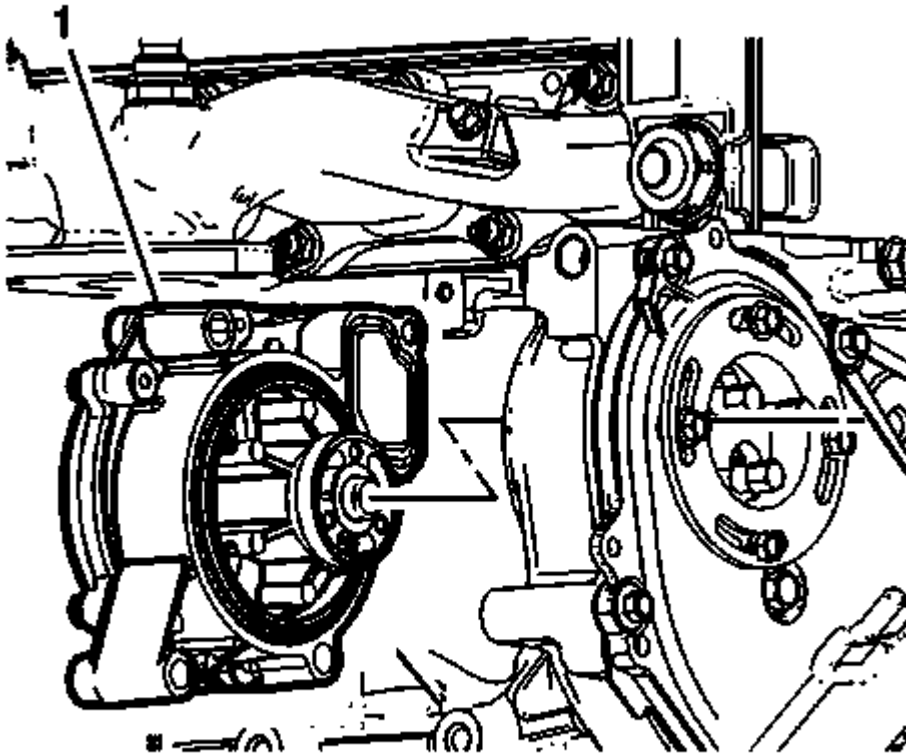


Fig. 95: Water Pump
Courtesy of GENERAL MOTORS COMPANY

14. Remove the water pump (1).

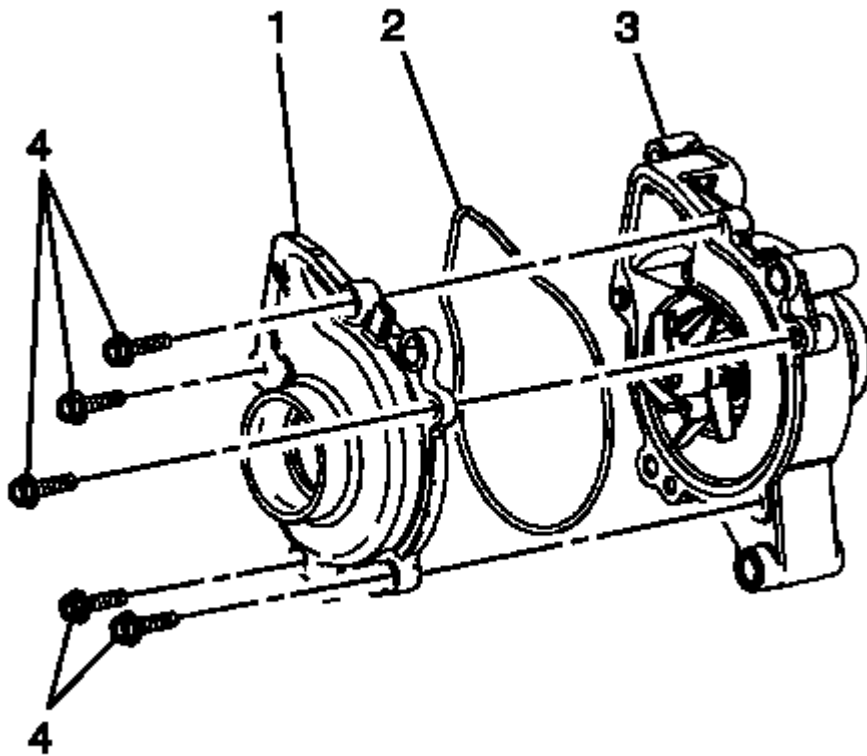


Fig. 96: Water Pump, Water Pump Cover, Rear Cover Fasteners And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

15. If replacing the water pump cover remove the water pump rear cover fasteners (4).
16. Separate the water pump cover (1) from the water pump (3).
17. Remove and discard the water pump O-ring seal (2).

Installation Procedure

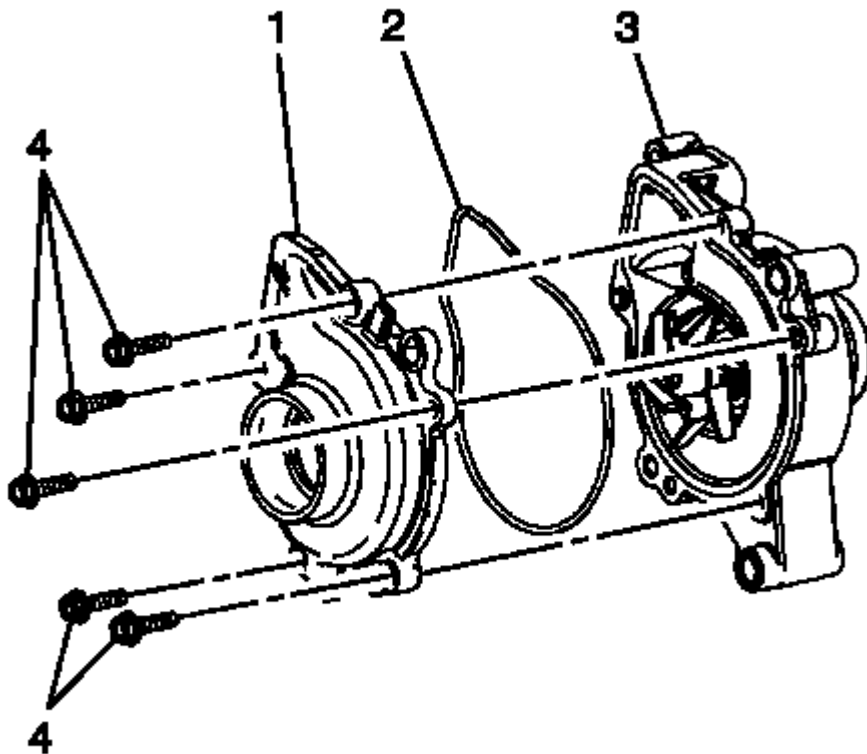


Fig. 97: Water Pump, Water Pump Cover, Rear Cover Fasteners And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. If replacing the water pump cover (1), install a new O-ring (2) to the water pump (3) and tighten the fasteners (4) to 25 N.m (18 lb ft).

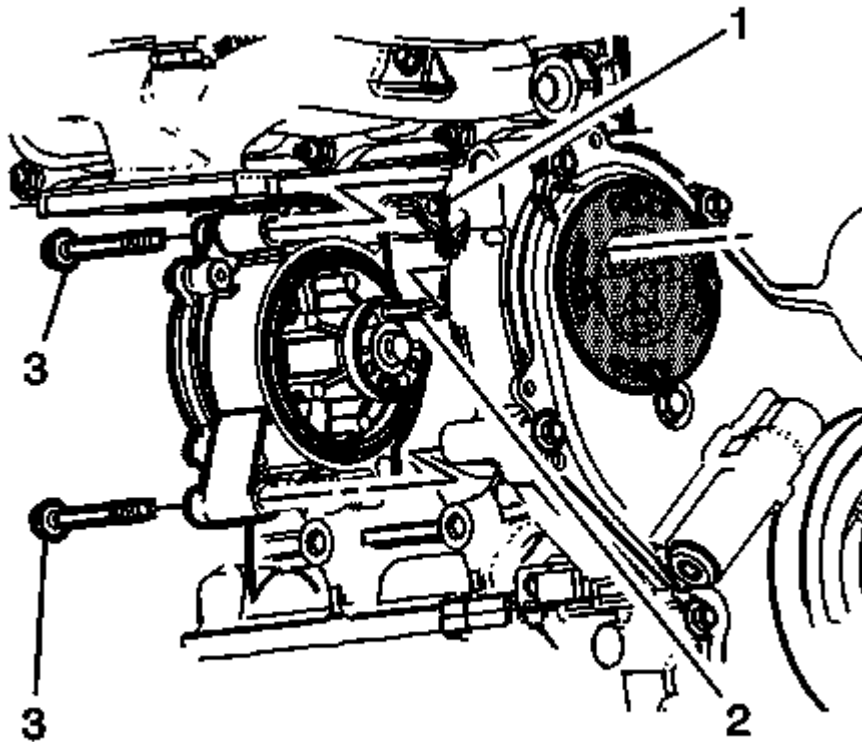


Fig. 98: Water Pump, Guide Pin And Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: A guide pin can be created to aid in water pump alignment. Use a M 6 m x 6 mm x 50.8 mm stud (2 in). Thread the pin into the water pump sprocket.

2. Using a guide pin (2), align the pin with the water pump holding tool.
3. Position the water pump (1) against the engine block and hand tighten the water pump fasteners (3).

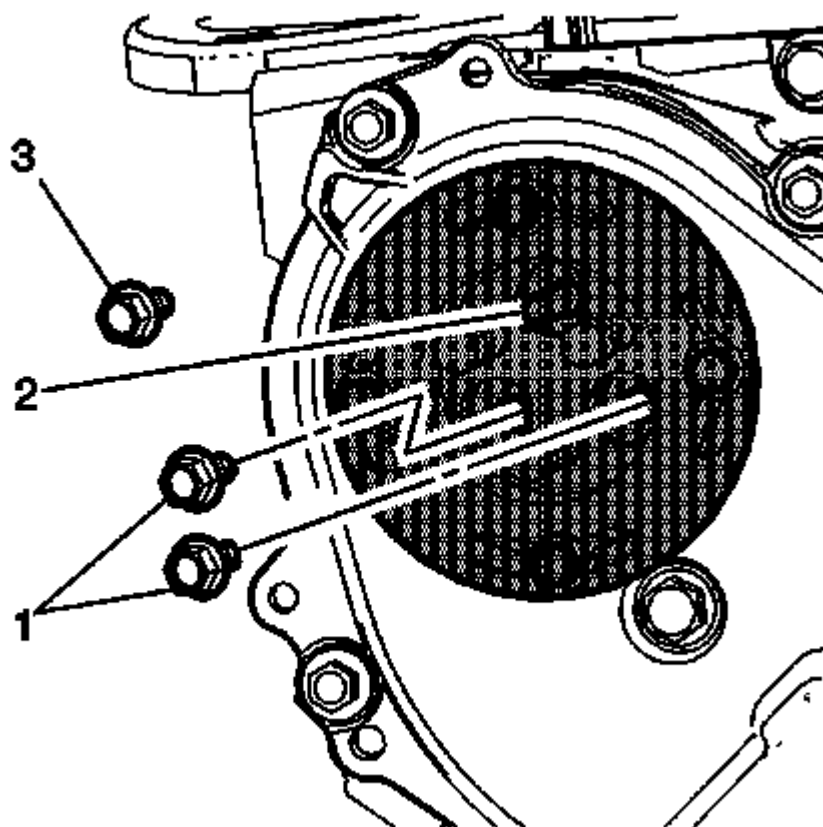


Fig. 99: Water Pump Sprocket To Water Pump Fasteners And Guide Pin
Courtesy of GENERAL MOTORS COMPANY

4. Install 2 water pump sprocket to water pump fasteners (1). After the fasteners are snug, remove the guide pin (2) and install the 3rd fastener (3) and tighten to 10 N.m (89 lb in).

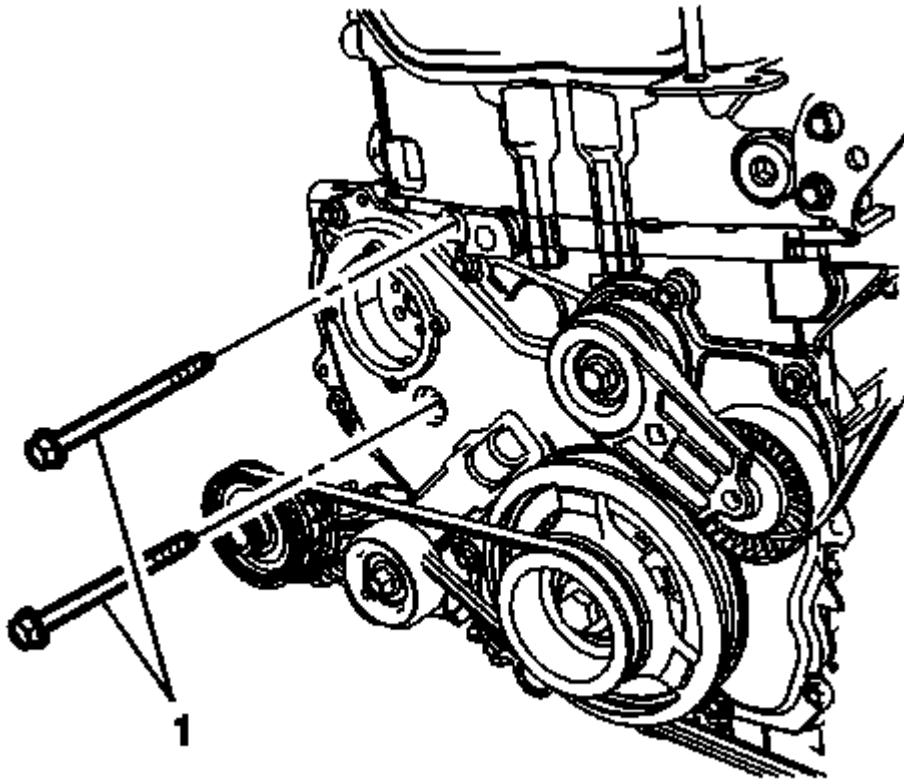


Fig. 100: Water Pump Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Install the water pump fasteners (1) at the front of the engine. Hand tighten at this time.
6. Tighten the water pump fasteners at the front and rear of the water pump to 25 N.m (18 lb ft).

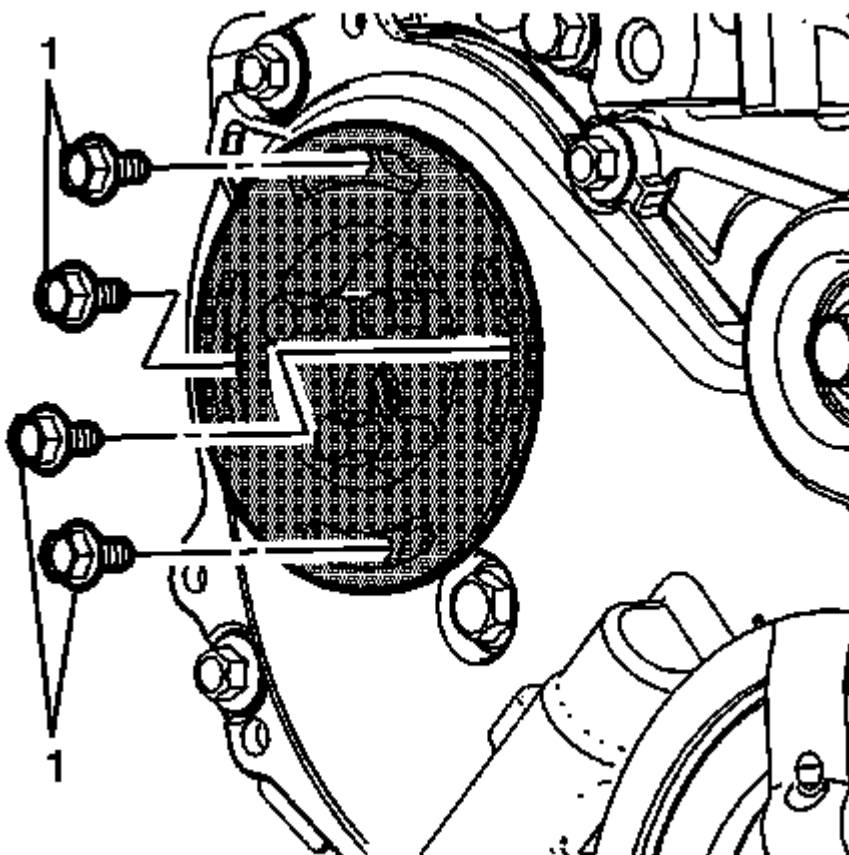


Fig. 101: Water Pump Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the water pump cover fasteners (1) from the engine front cover and water pump holding tool.

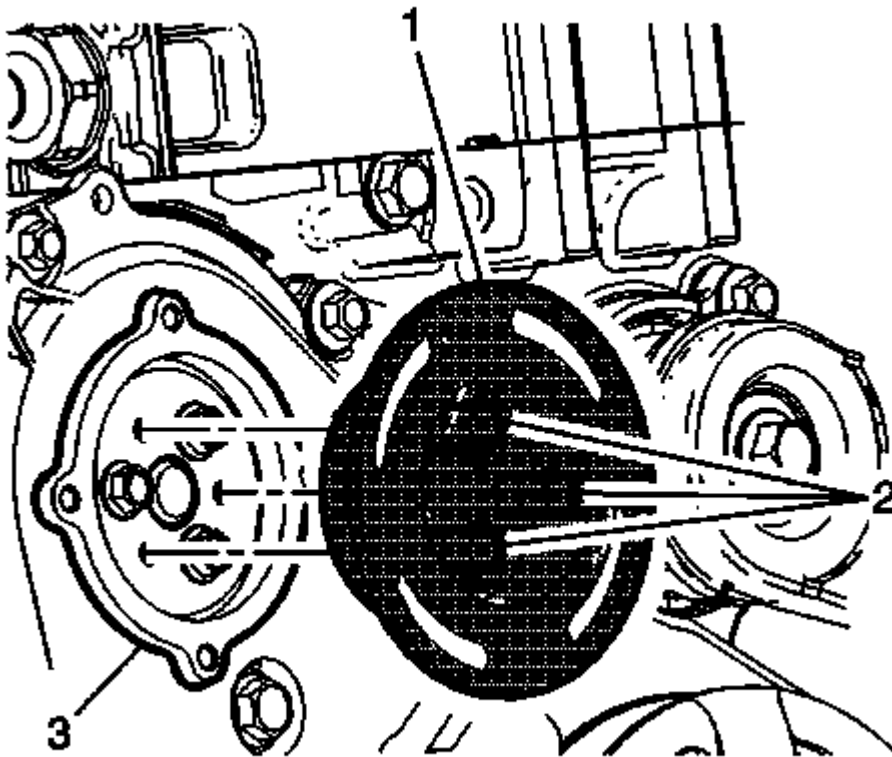


Fig. 102: Water Pump Holding Tool And Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **EN-43651** water pump holding tool (1) from the water pump sprocket.

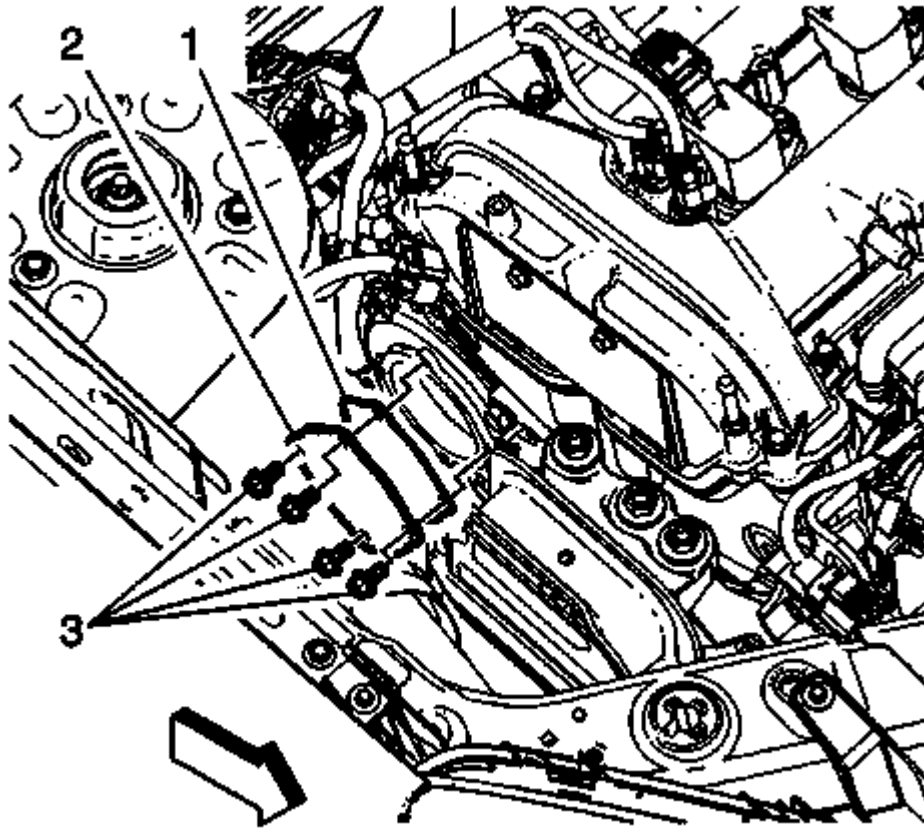


Fig. 103: Water Pump Cover, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

9. Install the water pump access plate (2) gasket (1) and fasteners (3) and tighten to 10 N.m (89 lb in).
10. If equipped, Install the coolant heater.
11. Install the engine coolant thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement (LUK)**.
12. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LUK)** .
13. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUK)** .
14. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
15. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
16. Refill the coolant system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

RADIATOR DRAIN COCK REPLACEMENT (LUK)

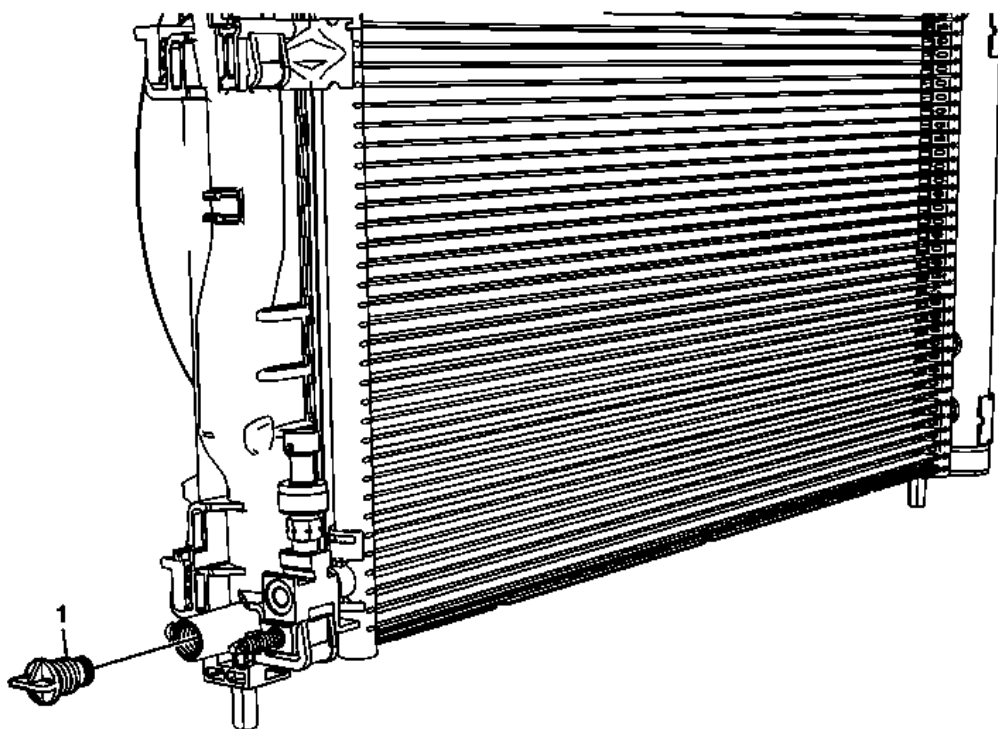


Fig. 104: Radiator Drain Cock (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Drain Cock Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. To gain access to the drain cock reposition the right front wheelhouse liner. 3. Place a drain pan under the right side of the radiator.	
1	Radiator Drain Cock 1. Attach a drain hose to the radiator drain port to guide the coolant into the drain pan. 2. Fill the coolant to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .

RADIATOR DRAIN COCK REPLACEMENT (LTG)

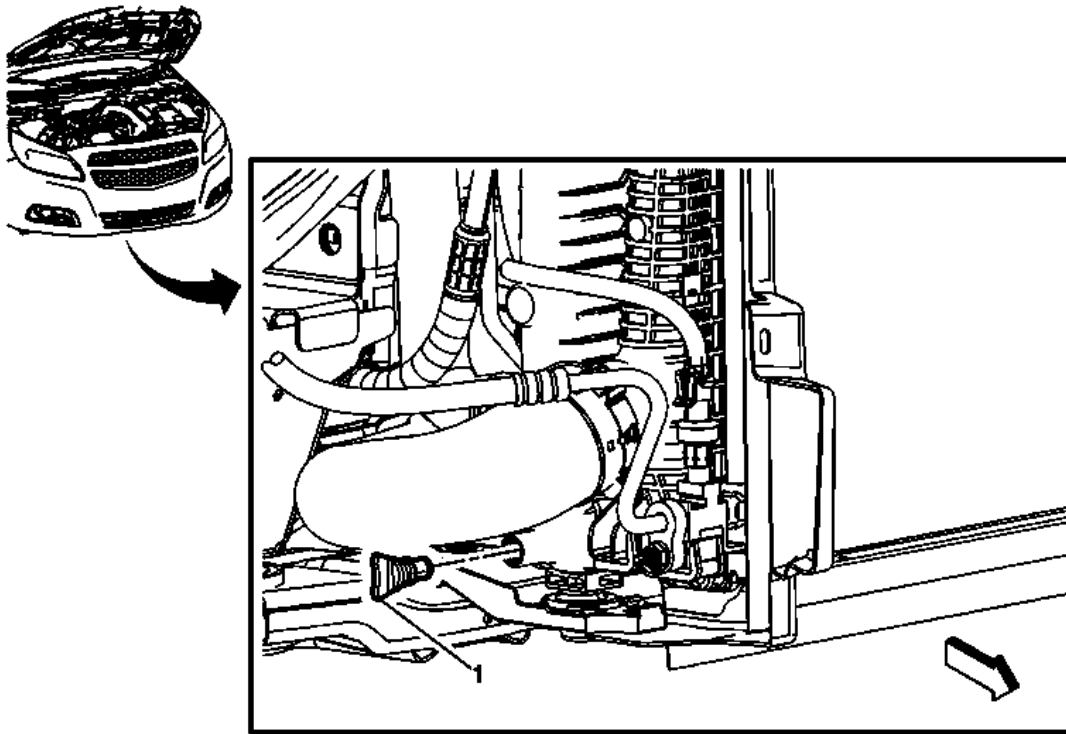


Fig. 105: Radiator Drain Cock (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Drain Cock Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> 2. Place a drain pan under the right side of the radiator.	
1	Radiator Drain Cock NOTE: Attach a drain hose to the radiator drain port to guide the coolant into the drain pan. Procedure Fill the coolant to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .

ENGINE COOLANT FAN SHROUD REPLACEMENT (LUK)

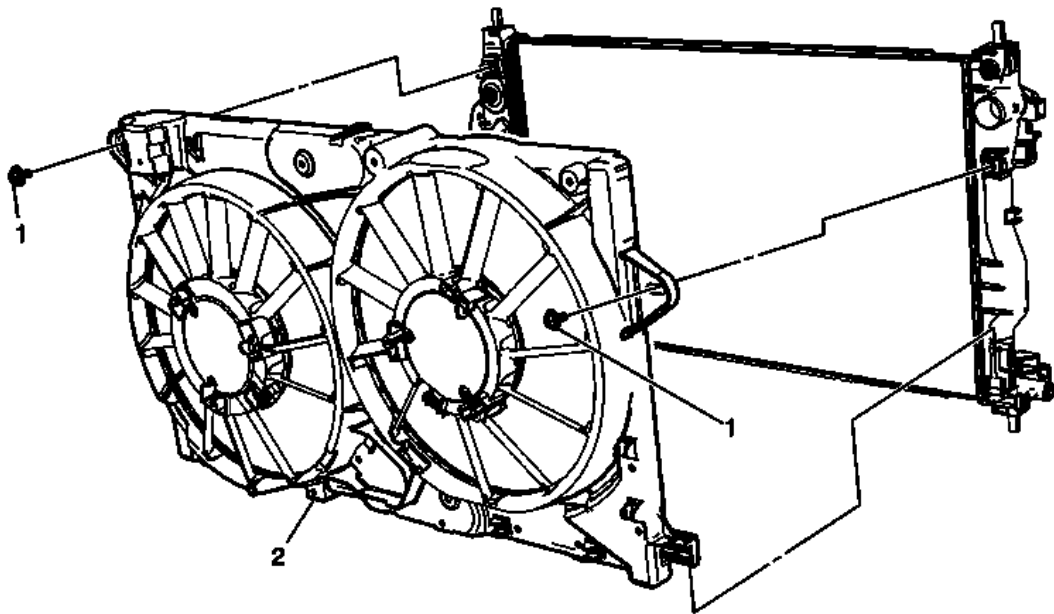
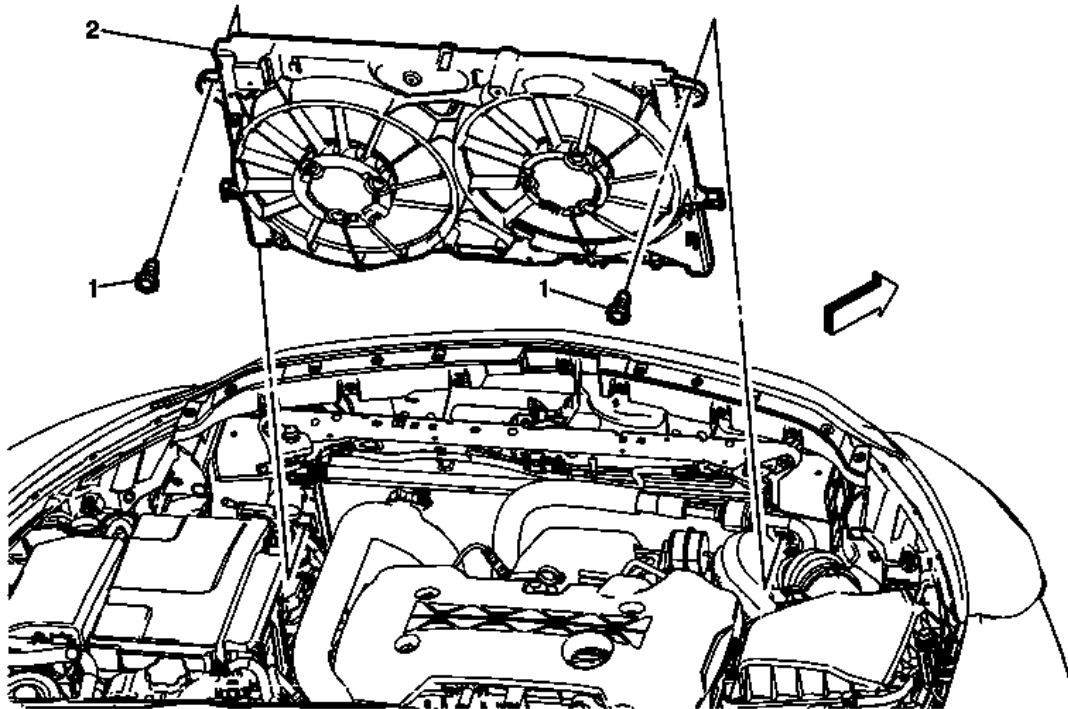


Fig. 106: Engine Coolant Fan Shroud (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LUK)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 2. Remove the radiator outlet hose from the radiator. Refer to <u>Radiator Outlet Hose Replacement (LUK)</u>. 3. Disconnect the drive motor battery coolant/air separator from the cooling fan shroud. Refer to <u>Drive Motor Battery Coolant/Air Separator Replacement</u> . 4. Disconnect the auxiliary radiator outlet hose from the generator. Refer to <u>Auxiliary Radiator Outlet Hose Replacement</u> . 5. Disconnect the engine coolant fan motor electrical connectors. 6. Unclip all wiring harness that are connected to the shroud. 	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (88 lb in)

ENGINE COOLANT FAN SHROUD REPLACEMENT (LTG)**Fig. 107: Engine Coolant Fan Shroud (LTG)**

Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the radiator inlet hose from the radiator. Refer to <u>Radiator Inlet Hose Replacement (LTG)</u>. 2. Disconnect the engine coolant fan motor electrical connectors. 3. Unclip the wiring harness from the shroud. 4. Release the transmission lines from the fan shroud retainers. 	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Engine Coolant Fan Shroud Procedure Tilt the engine coolant fan shroud towards the engine and lift it off the radiator.

ENGINE COOLANT FAN SHROUD REPLACEMENT (LEA)

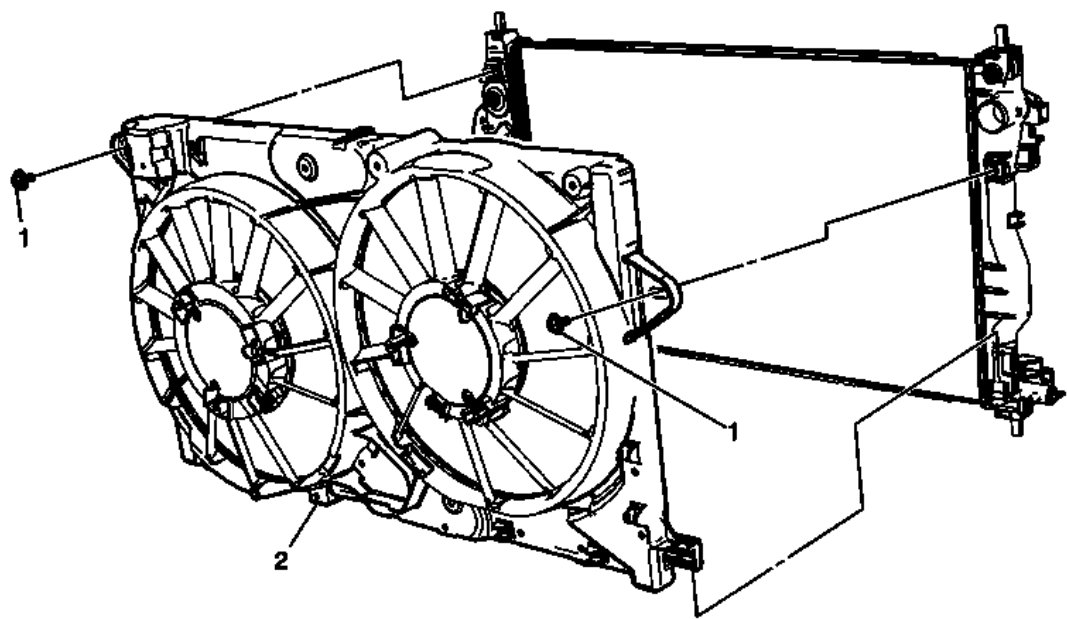


Fig. 108: Engine Coolant Fan Shroud (LUK)
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Fan Shroud Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
2. Remove the radiator outlet hose. Refer to <u>Radiator Outlet Hose Replacement (LEA)</u> .	
3. Remove the transmission fluid cooler hoses. Refer to <u>Fluid Cooler Inlet Hose Replacement (MHH)</u> , and <u>Fluid Cooler Outlet Hose Replacement (MHH)</u> .	
4. Disconnect the engine coolant fan motor electrical connectors.	
5. Unclip all wiring harness that are connected to the shroud.	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (88 lb in)
	Engine Coolant Fan Shroud

2	Procedure <ol style="list-style-type: none"> 1. Release the 2 tabs at the lower retainers allowing the shroud to slide upward. 2. Reposition the A/C condenser and compressor hose without discharging the system.
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RADIATOR REPLACEMENT (LUK)

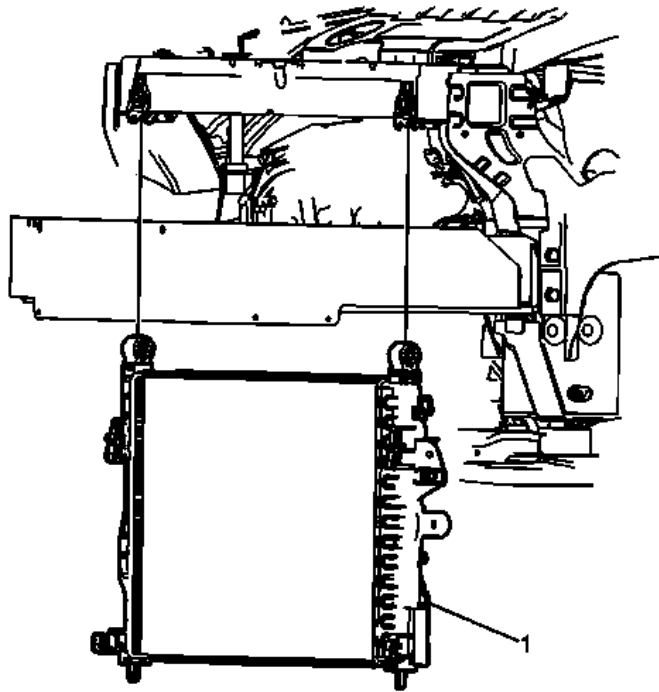


Fig. 109: Radiator (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill), Cooling System Draining and Filling (GE 47716). 2. Remove the radiator inlet hose from the radiator. Refer to Radiator Inlet Hose Replacement (LUK). 3. Remove the radiator outlet hose from the radiator. Refer to Radiator Outlet Hose Replacement (LUK). 4. Remove transmission fluid cooler inlet and outlet hoses from the radiator. Refer to Fluid Cooler Inlet Hose Replacement (MHH) , and Fluid Cooler Outlet Hose Replacement (MHH) . 5. Reposition and secure the A/C condenser with the auxiliary radiator to the impact bar without 	

disconnecting the lines. Refer to **Air Conditioning Condenser Replacement (LUK)** .

6. Disconnect the engine coolant fan harness electrical connectors.

7. Remove the radiator support brackets. Refer to **Radiator Support Bracket Replacement (LUK)**.

1

**Radiator
Procedure**

Remove the engine coolant fan shroud from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LUK)**.

RADIATOR REPLACEMENT (LTG)

Removal Procedure

1. Drain the engine cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.

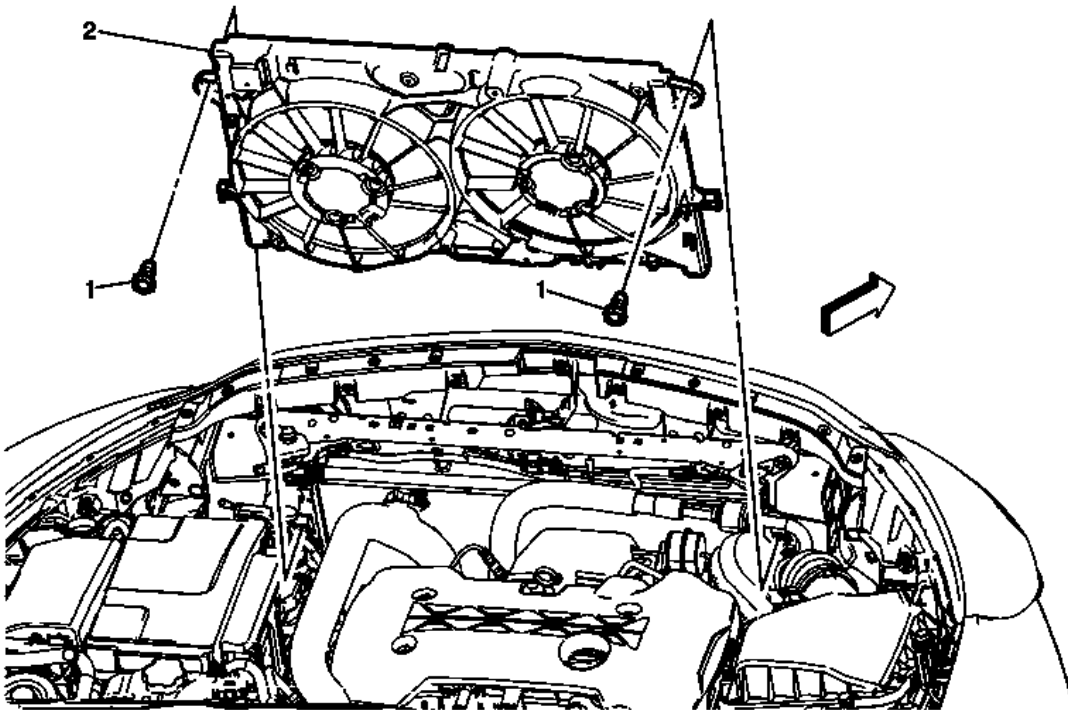


Fig. 110: Engine Coolant Fan Shroud (LTG)
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine coolant fan shroud (2) from the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LTG)**.

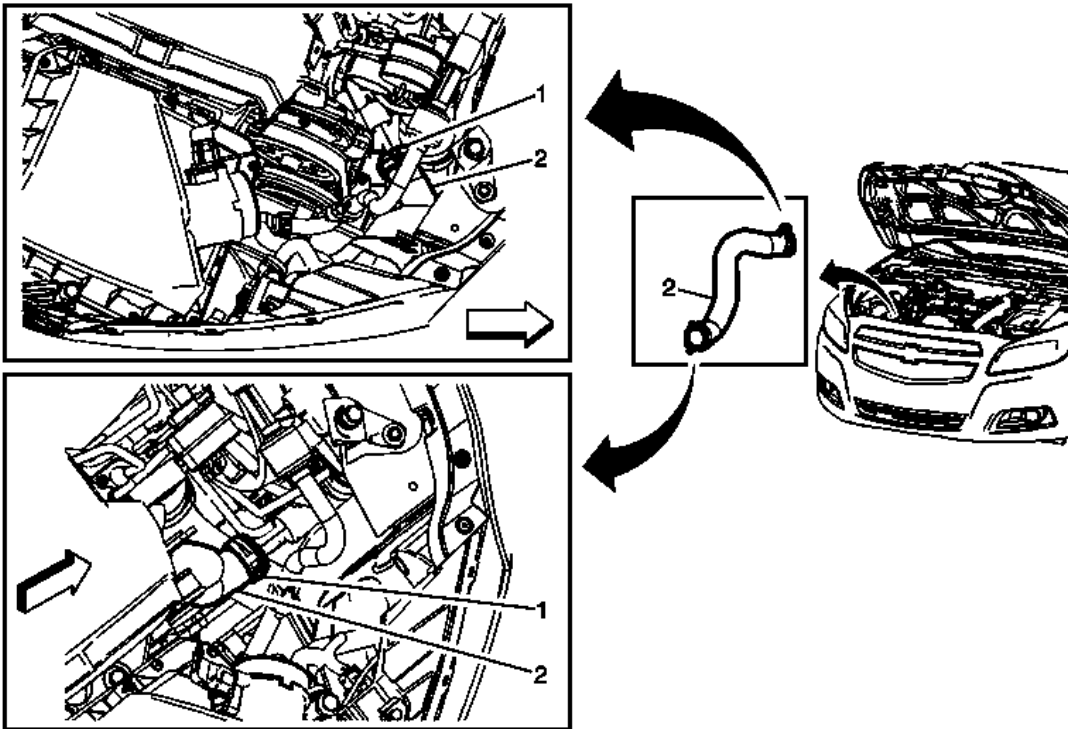


Fig. 111: Radiator Outlet Hose & Clamps (LTG)
Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose (2) from the radiator. Refer to **Radiator Outlet Hose Replacement (LTG)**.

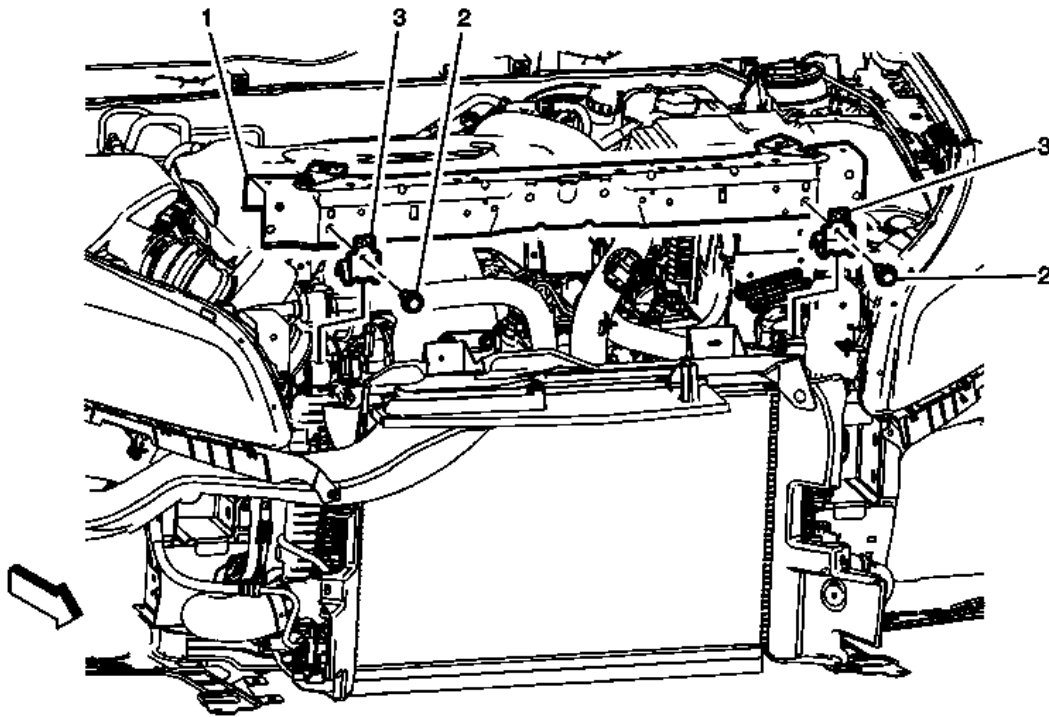


Fig. 112: Radiator Upper Brackets (LTG)
 Courtesy of GENERAL MOTORS COMPANY

4. Remove the radiator upper brackets (3). Refer to **Radiator Upper Bracket Replacement (LTG)**.

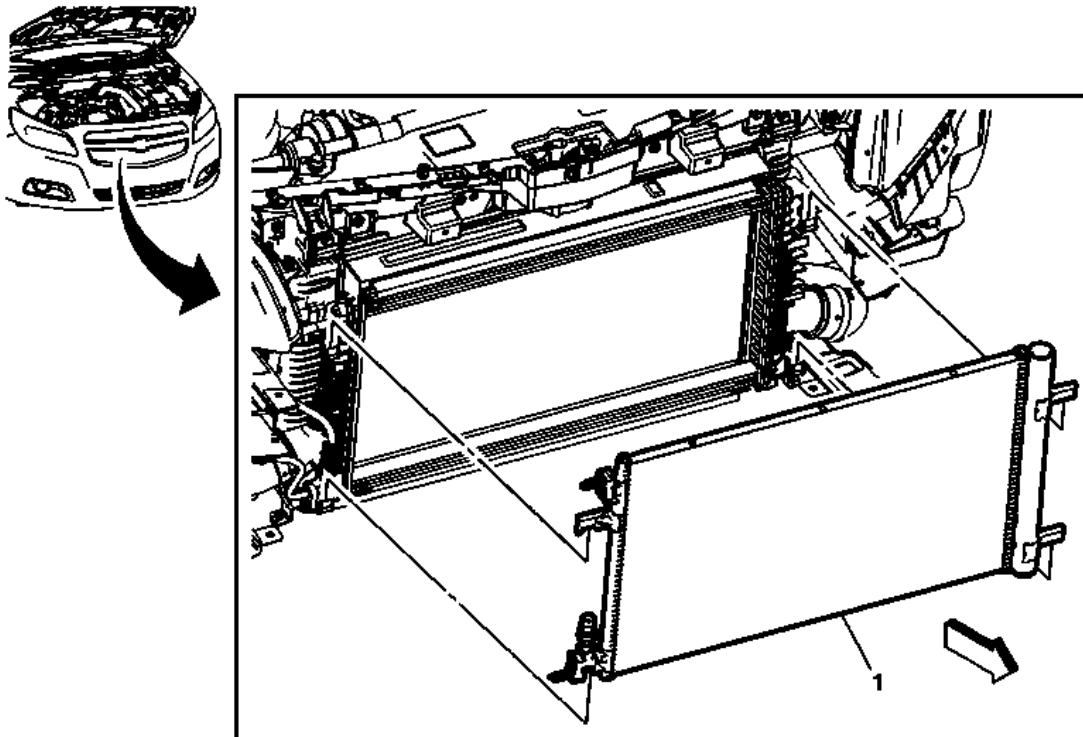


Fig. 113: Air Conditioning Condenser (LTG)
Courtesy of GENERAL MOTORS COMPANY

5. Remove the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LTG)** , **Air Conditioning Condenser Replacement (LUK)** .

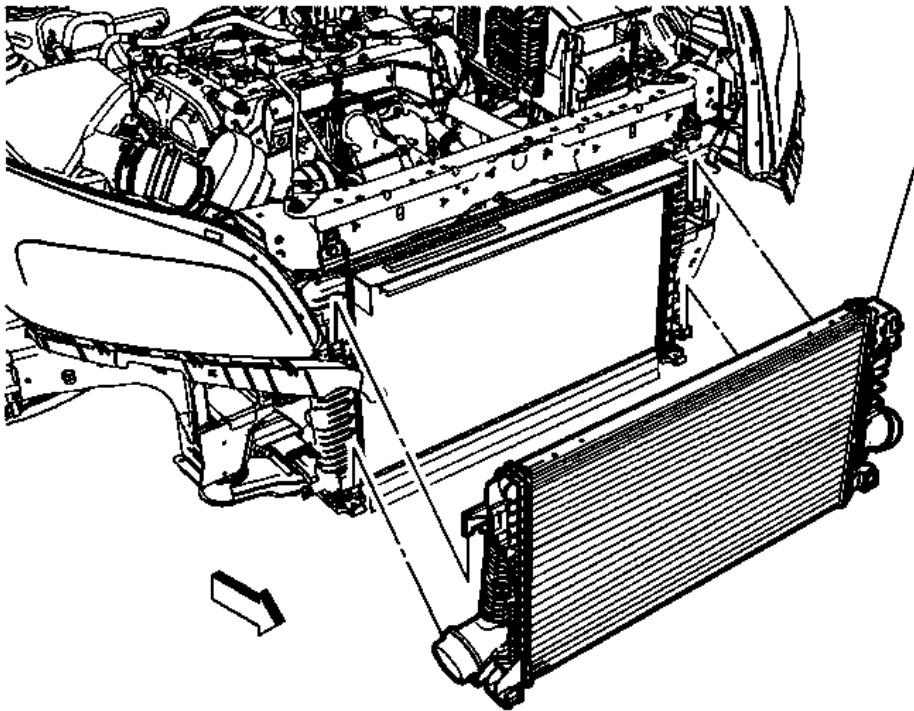


Fig. 114: Charge Air Cooler Radiator
Courtesy of GENERAL MOTORS COMPANY

6. Remove the charge air cooler radiator (1). Refer to **Charge Air Cooler Radiator Replacement** .

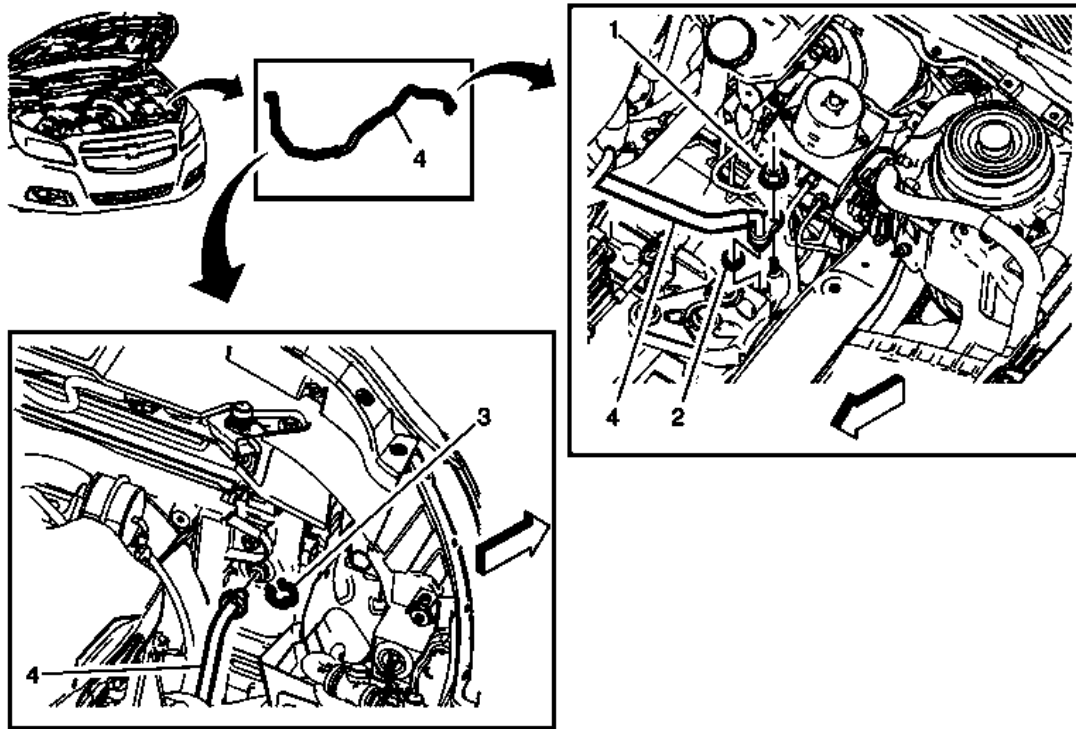


Fig. 115: Transmission Fluid Cooler Outlet Pipe And Radiator (LTG)
Courtesy of GENERAL MOTORS COMPANY

7. Remove the transmission fluid cooler outlet pipe from the radiator. Refer to **Transmission Fluid Cooler Outlet Pipe Replacement (M7U)** .

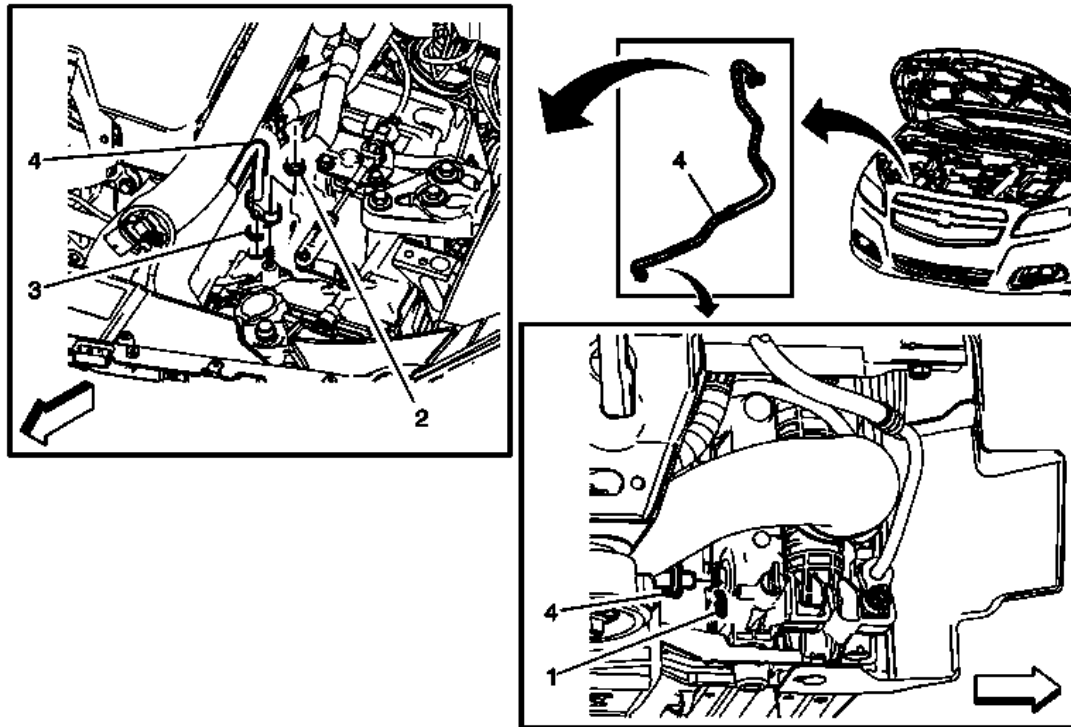


Fig. 116: Transmission Fluid Cooler Inlet Pipe & Components (LTG)
Courtesy of GENERAL MOTORS COMPANY

8. Remove the transmission fluid cooler inlet pipe from the radiator. Refer to **Transmission Fluid Cooler Inlet Pipe Replacement (M7U)** .
9. Remove the radiator air seal.

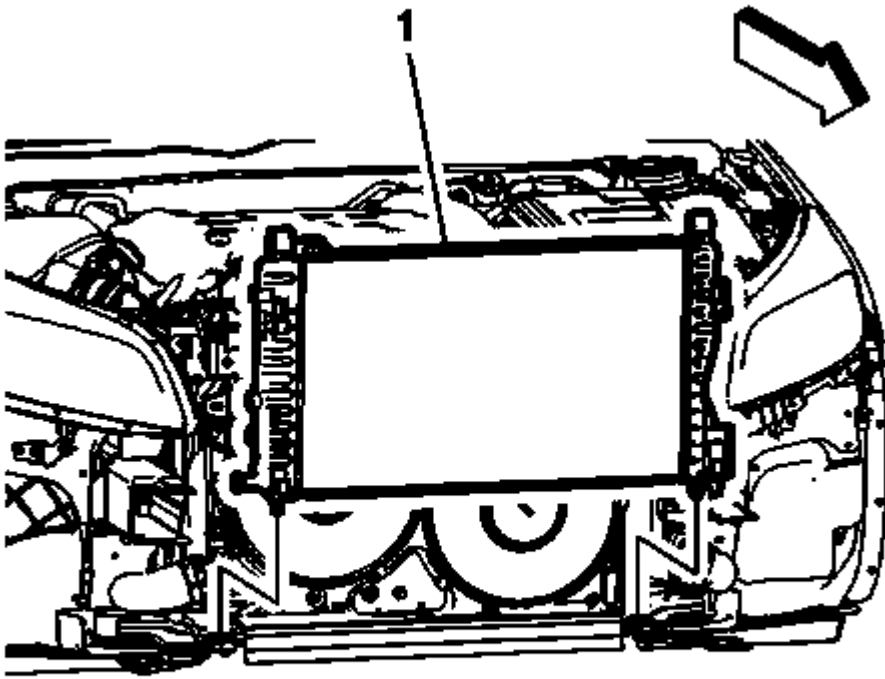


Fig. 117: Radiator

Courtesy of GENERAL MOTORS COMPANY

10. Tilt the radiator (1) forward, lift up to remove the radiator assembly.

Installation Procedure

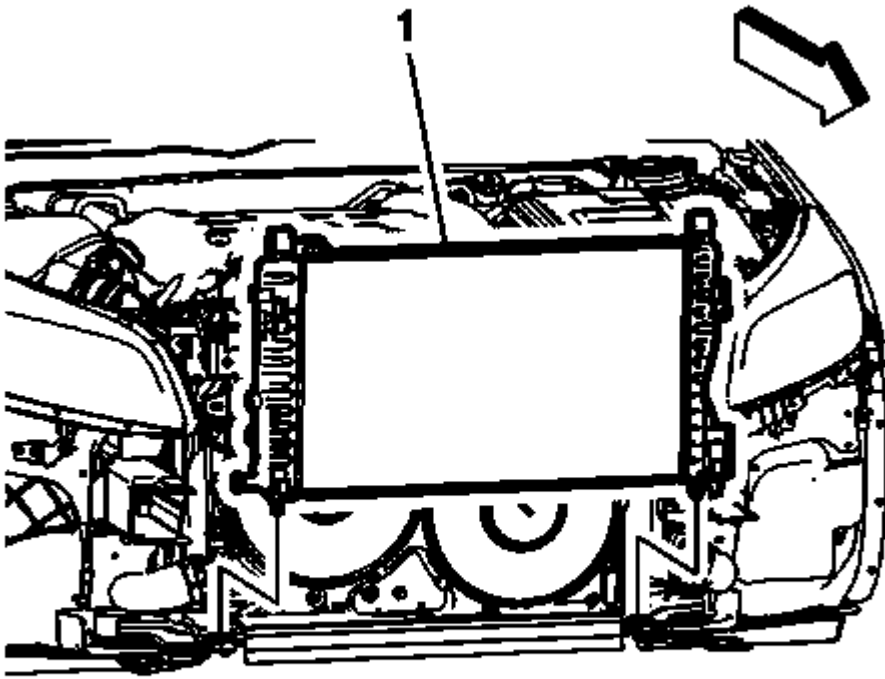


Fig. 118: Radiator

Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator assembly (1).
2. Install the radiator air seal.

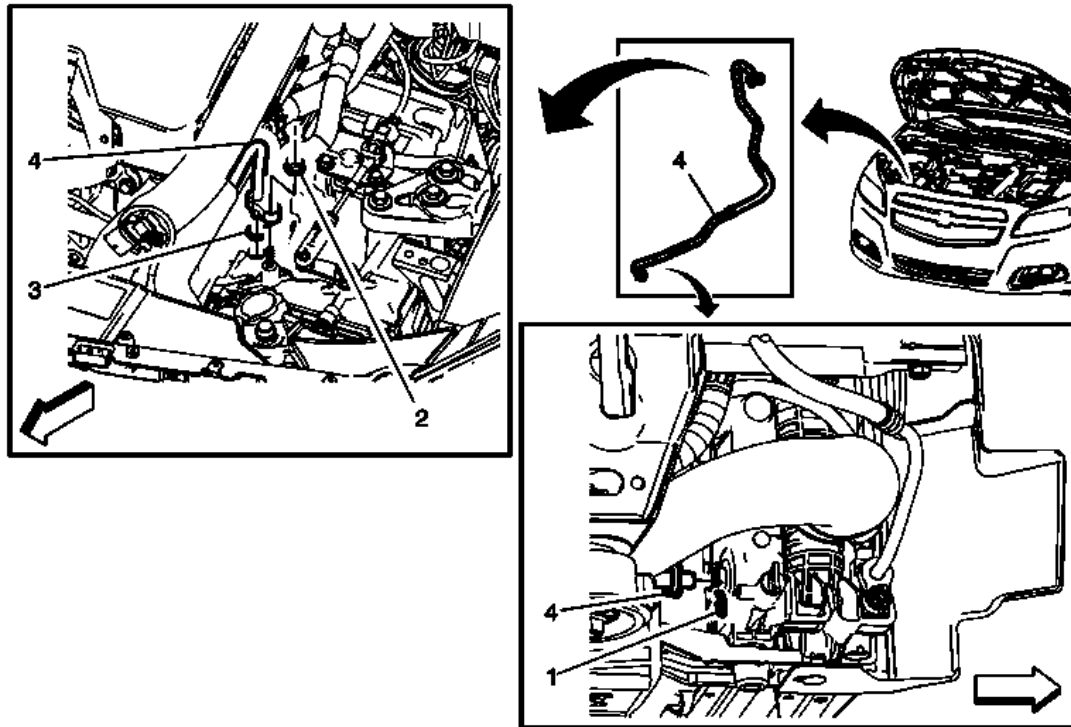


Fig. 119: Transmission Fluid Cooler Inlet Pipe & Components (LTG)
Courtesy of GENERAL MOTORS COMPANY

3. Install the transmission fluid cooler inlet pipe to the radiator. Refer to **Transmission Fluid Cooler Inlet Pipe Replacement (M7U)** .

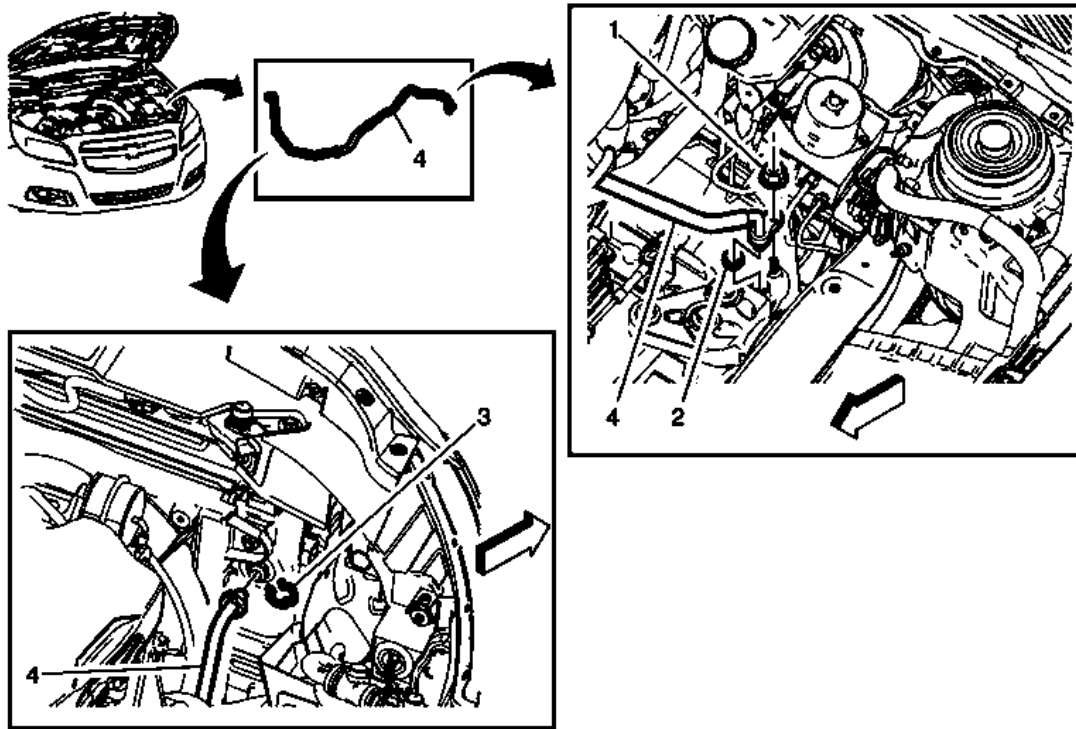


Fig. 120: Transmission Fluid Cooler Outlet Pipe And Radiator (LTG)
Courtesy of GENERAL MOTORS COMPANY

4. Install the transmission fluid cooler outlet pipe to the radiator. Refer to **Transmission Fluid Cooler Outlet Pipe Replacement (M7U)** .

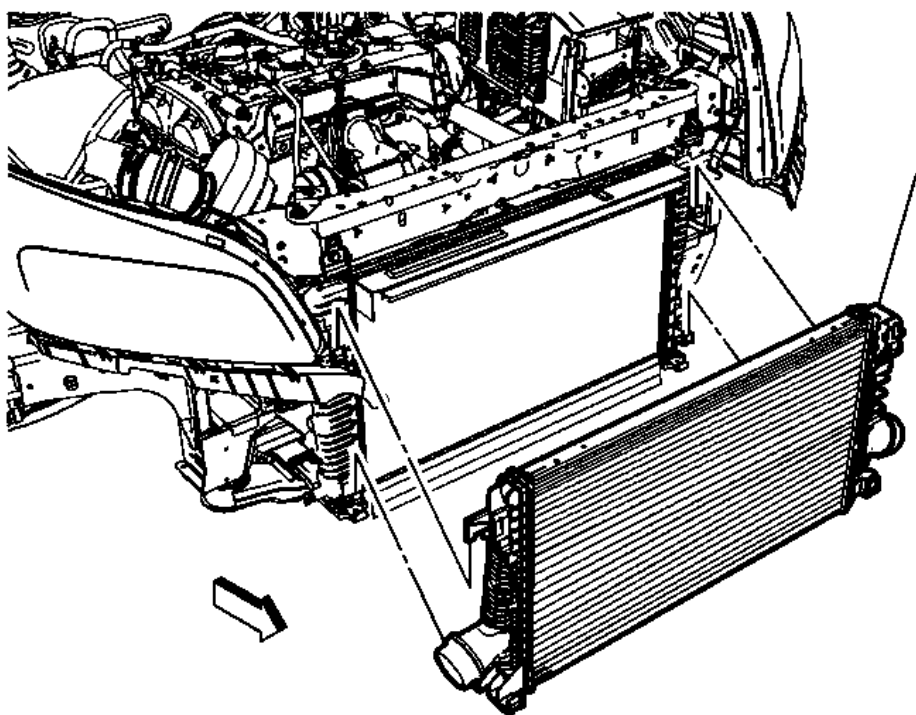


Fig. 121: Charge Air Cooler Radiator
 Courtesy of GENERAL MOTORS COMPANY

5. Install the charge air cooler radiator (1). Refer to [Charge Air Cooler Radiator Replacement](#) .

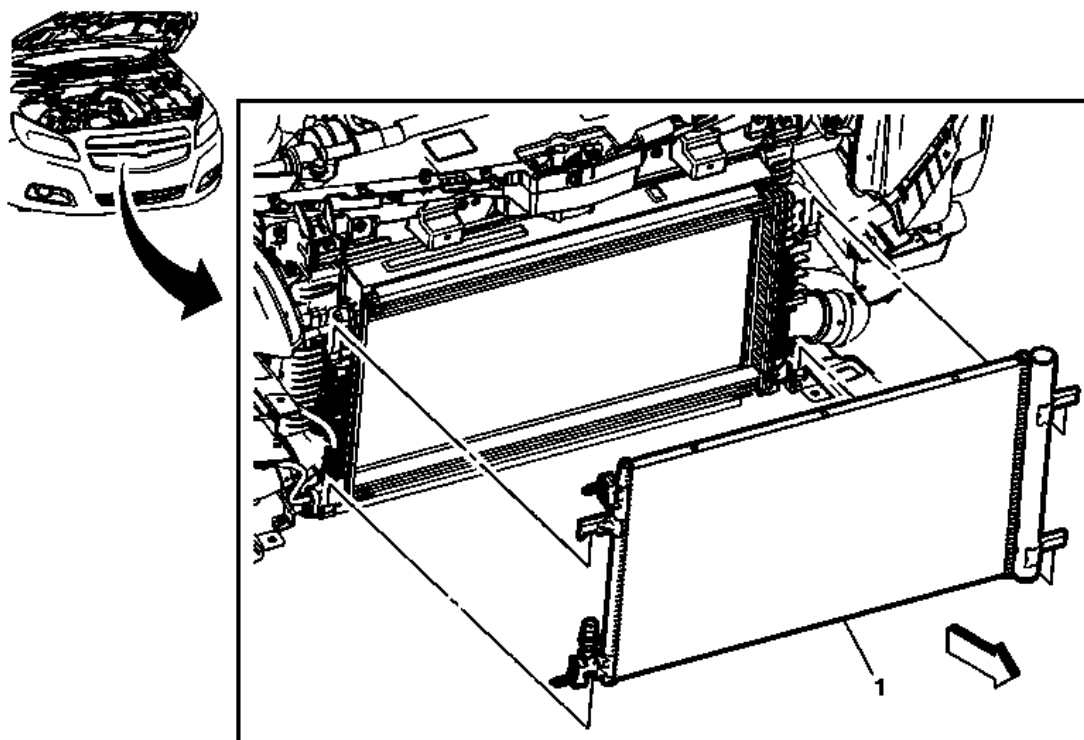


Fig. 122: Air Conditioning Condenser (LTG)
Courtesy of GENERAL MOTORS COMPANY

6. Install the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LTG)**.

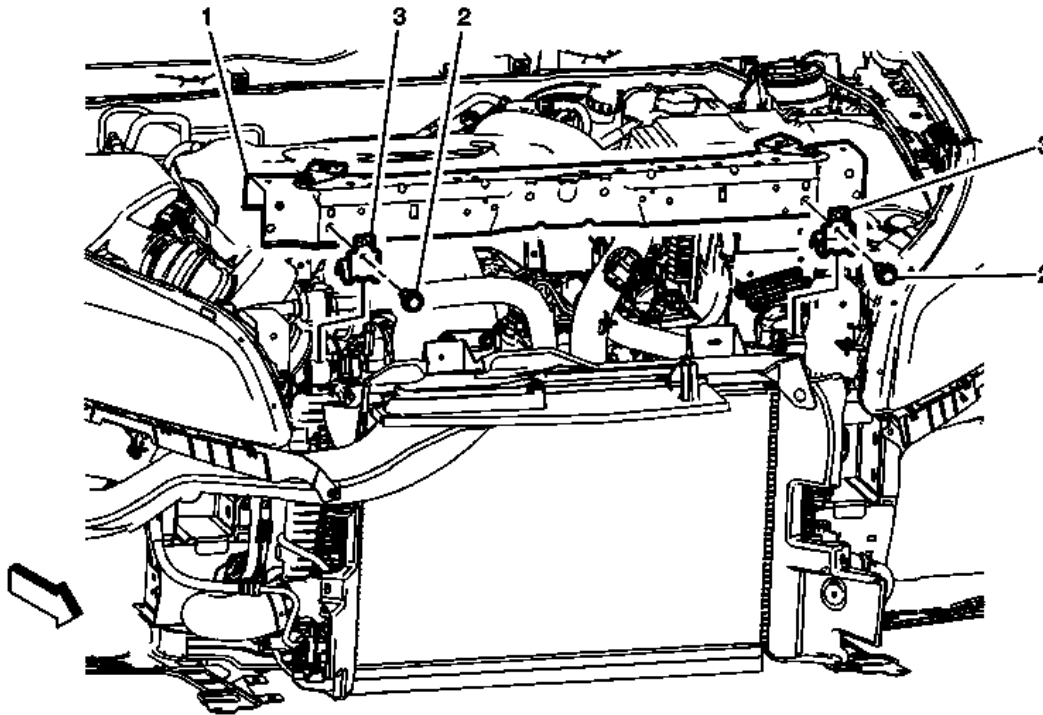


Fig. 123: Radiator Upper Brackets (LTG)
Courtesy of GENERAL MOTORS COMPANY

7. Install the radiator upper brackets (3). Refer to **Radiator Upper Bracket Replacement (LTG)**.

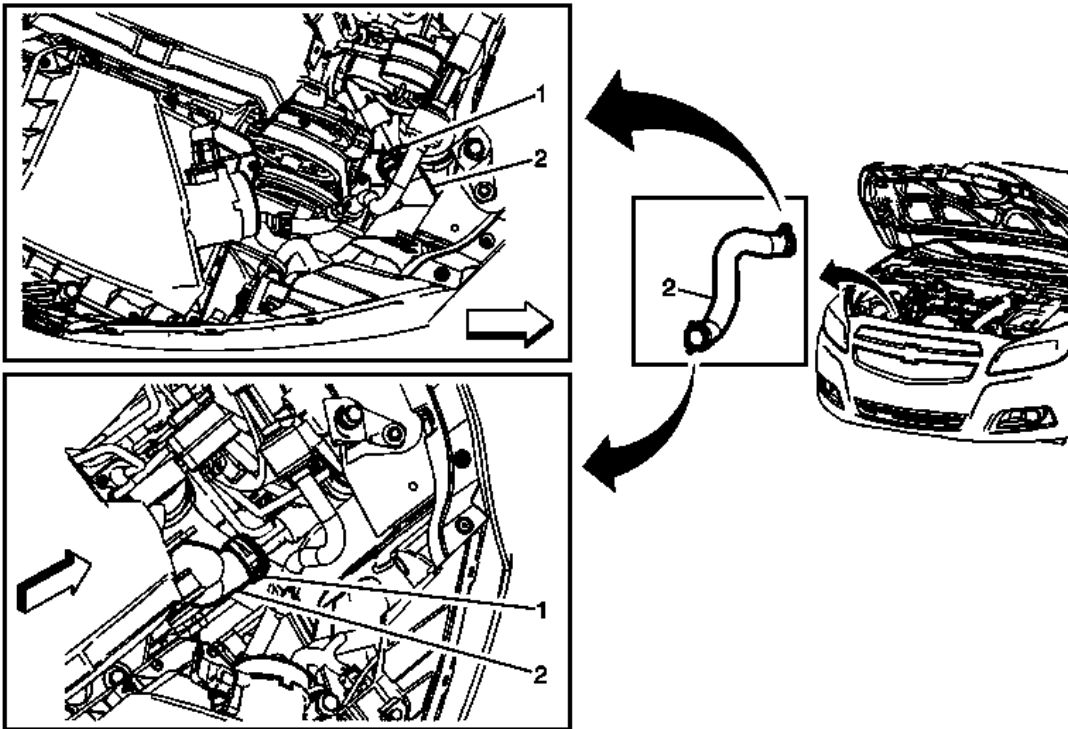


Fig. 124: Radiator Outlet Hose & Clamps (LTG)
 Courtesy of GENERAL MOTORS COMPANY

8. Install the radiator outlet hose (2) to the radiator. Refer to **Radiator Outlet Hose Replacement (LTG)**.

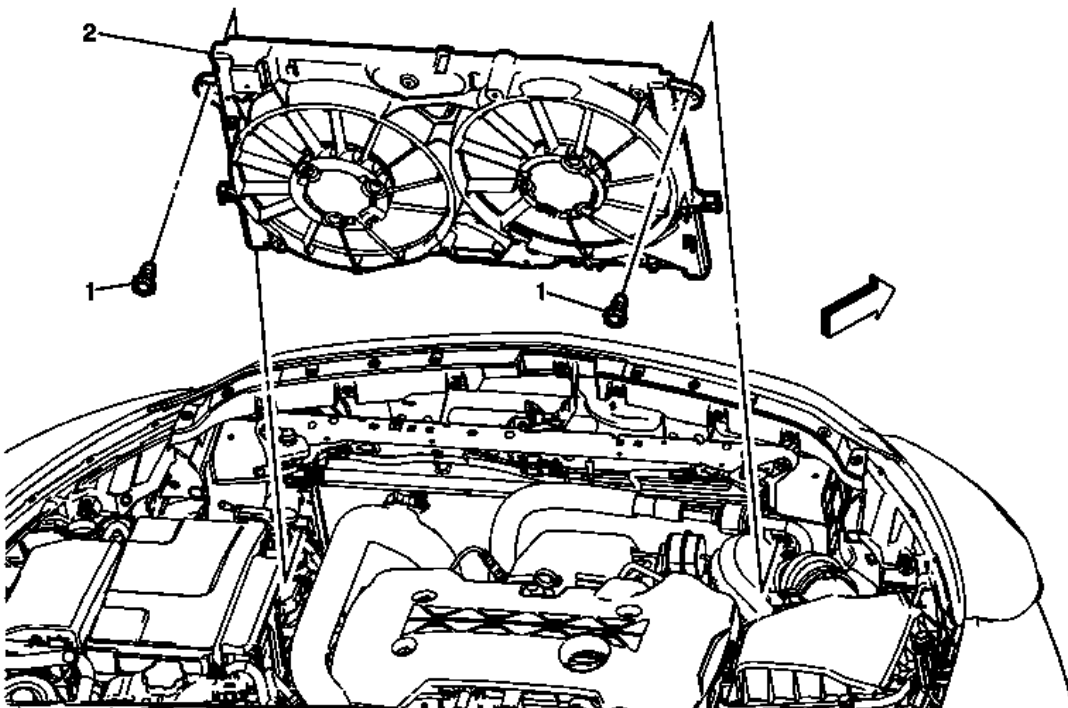


Fig. 125: Engine Coolant Fan Shroud (LTG)
 Courtesy of GENERAL MOTORS COMPANY

9. Install the engine coolant fan shroud (2) to the radiator. Refer to **Engine Coolant Fan Shroud Replacement (LTG)**.
10. Fill the engine cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
11. Check the cooling system for leaks. Refer to **Cooling System Leak Testing**.

RADIATOR REPLACEMENT (LEA)

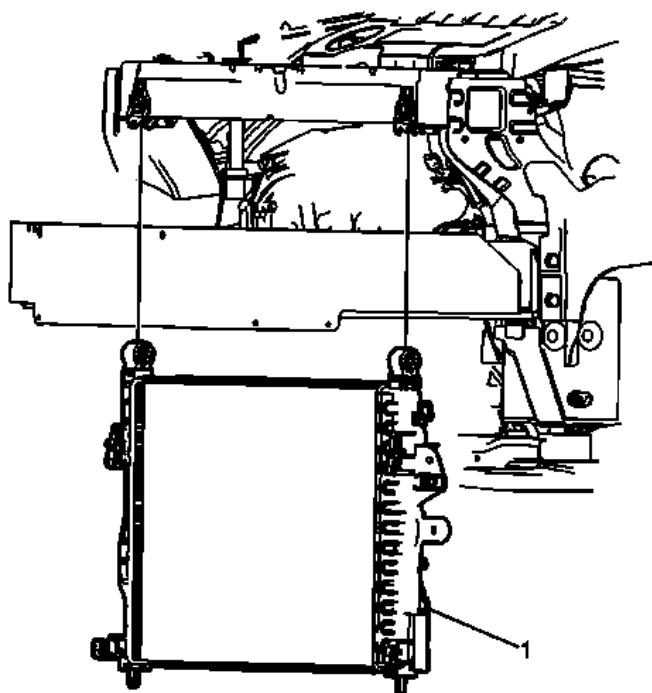


Fig. 126: Radiator (LEA)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
1.	Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .
2.	Remove the radiator inlet hose. Refer to <u>Radiator Inlet Hose Replacement (LEA)</u> .
3.	Remove the radiator outlet hose. Refer to <u>Radiator Outlet Hose Replacement (LEA)</u> .
4.	Remove transmission oil cooler lines. Refer to <u>Fluid Cooler Inlet Hose Replacement (MHH)</u> , and <u>Fluid Cooler Outlet Hose Replacement (MHH)</u> .

5. Reposition and secure the A/C condenser to the impact bar without disconnecting the lines. Refer to <u>Air Conditioning Condenser Replacement (LTG)</u> , <u>Air Conditioning Condenser Replacement (LUK)</u> . 6. Disconnect the engine coolant fan harness electrical connectors. 7. Remove the radiator support brackets.	
1	Radiator Procedure Remove the engine coolant fan shroud from the radiator. Refer to <u>Engine Coolant Fan Shroud Replacement (LEA)</u> .

RADIATOR SUPPORT BRACKET REPLACEMENT (LUK)

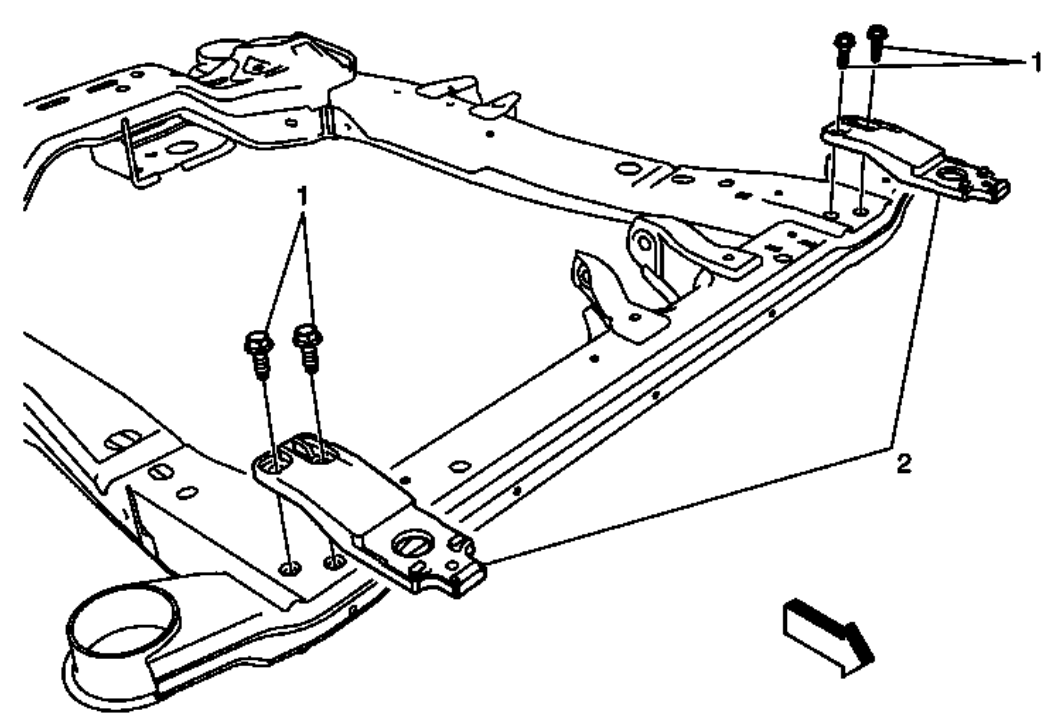


Fig. 127: Radiator Support Bracket (LUK)
Courtesy of GENERAL MOTORS COMPANY

Radiator Support Bracket Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
1. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> 2. Support the radiator.	
	Radiator Support Bracket Fastener (Qty: 4)
	CAUTION:

1	Refer to Fastener Caution . Tighten 25 N.m (18 lb ft)
2	Radiator Support Bracket (Qty: 2)

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (LEFT LUK)

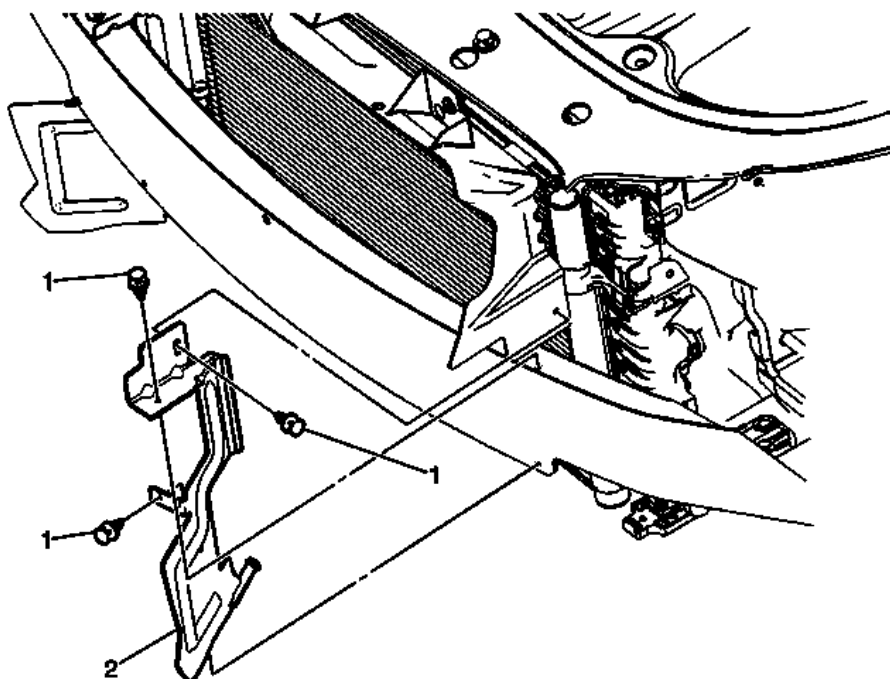


Fig. 128: Radiator Air Side Baffle & Deflector (Left)

Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Baffle and Deflector Replacement (Left LUK)

Callout	Component Name
Preliminary Procedures	
Remove the front fascia. Refer to Front Bumper Fascia Replacement	
1	Radiator Air Side Baffle and Deflector Retainers (Qty 3)
2	Radiator Air Side Baffle and Deflector

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (RIGHT LUK)

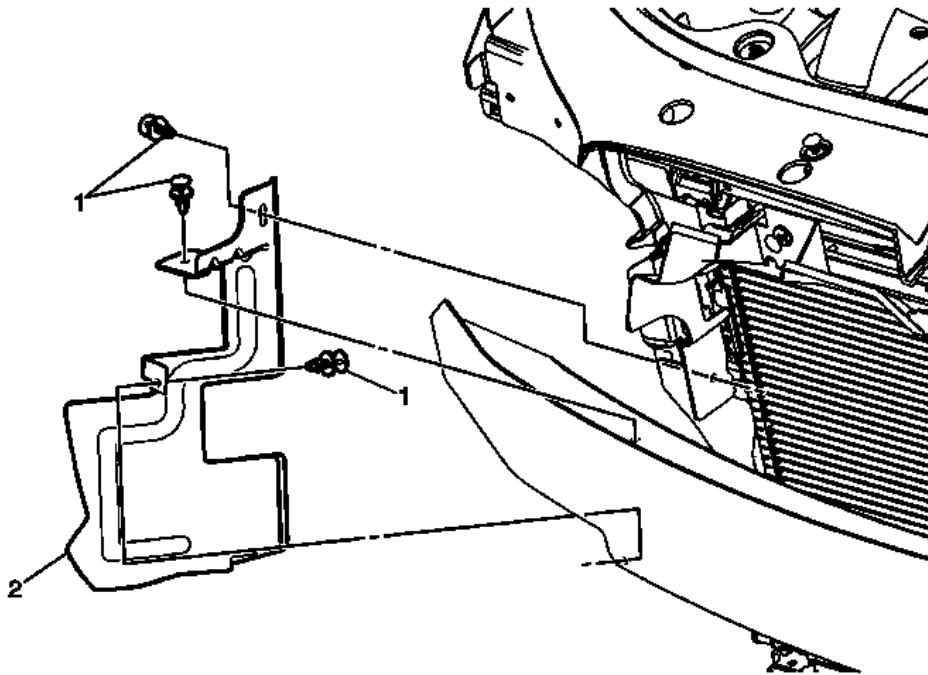


Fig. 129: Radiator Air Side Baffle & Deflector (Right)
Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Baffle and Deflector Replacement (Right LUK)

Callout	Component Name
Preliminary Procedures	
Remove the front fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Radiator Air Side Baffle and Deflector Retainer (Qty: 3)
2	Radiator Air Side Baffle and Deflector

RADIATOR AIR SIDE UPPER BAFFLE REPLACEMENT (LEFT LTG)

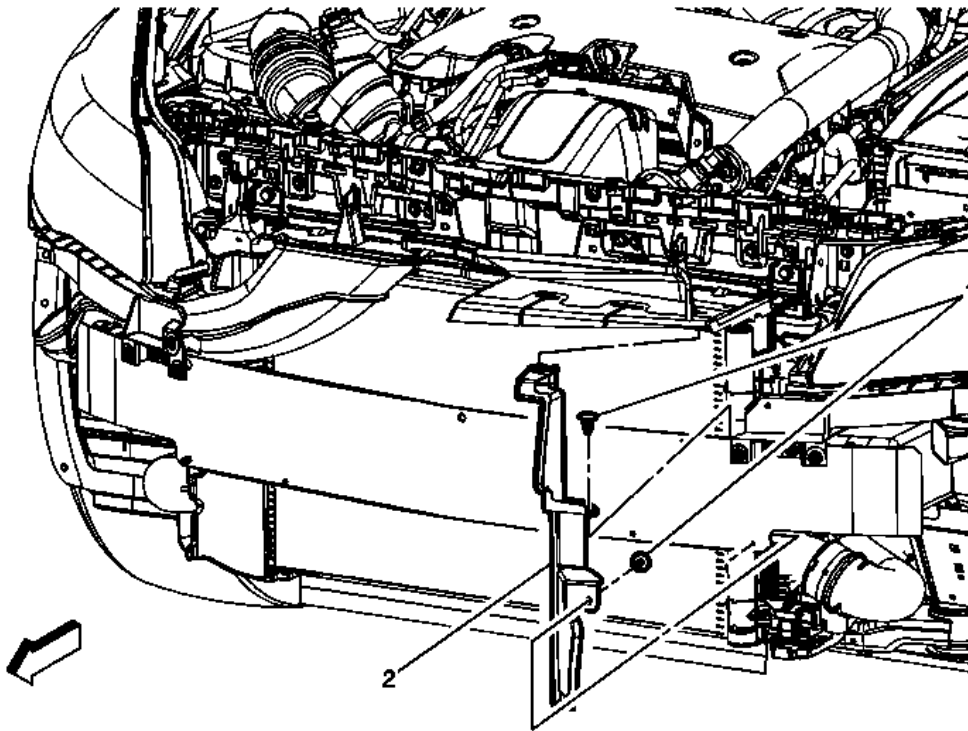


Fig. 130: Radiator Air Side Upper Baffle (Left LTG)

Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Upper Baffle Replacement (Left LTG)

Callout	Component Name
Preliminary Procedure	
Remove the front fascia. Refer to Front Bumper Fascia Replacement .	
1	Radiator Air Side Upper Baffle Retainer (Qty: 2)
2	Radiator Air Side Upper Baffle
Procedure	
Unclip the radiator air side upper baffle from the radiator air upper baffle and deflector.	

RADIATOR AIR SIDE UPPER BAFFLE REPLACEMENT (RIGHT LTG)

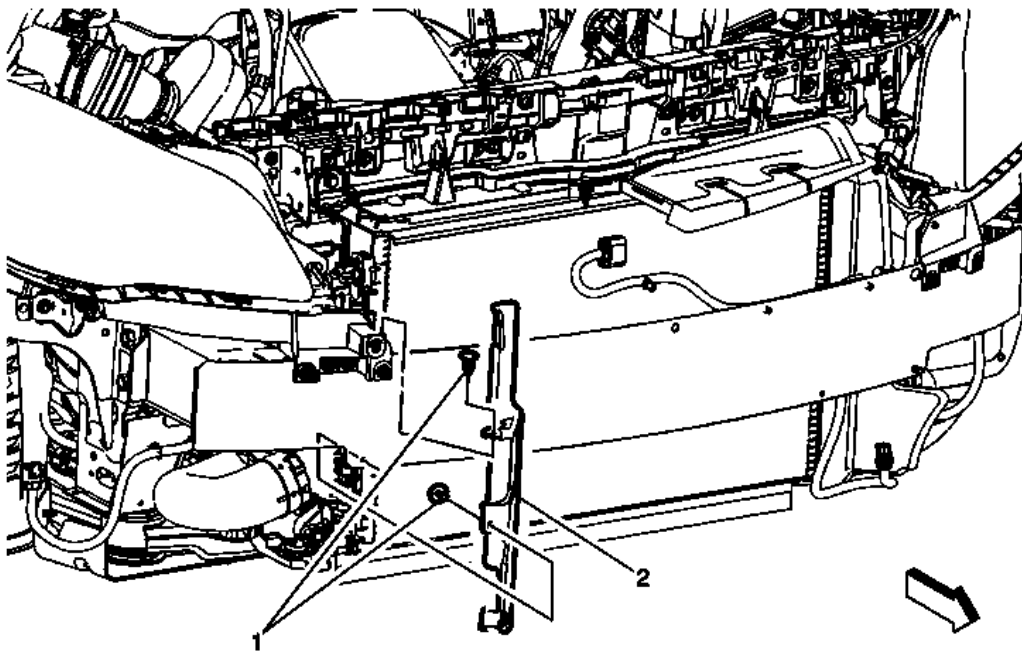


Fig. 131: Radiator Air Side Upper Baffle (Right LTG)

Courtesy of GENERAL MOTORS COMPANY

Radiator Air Side Upper Baffle Replacement (Right LTG)

Callout	Component Name
Preliminary Procedures	
Remove the front fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Radiator Air Side Upper Baffle Retainer (Qty: 2)
2	Radiator Air Side Upper Baffle

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT (LUK)

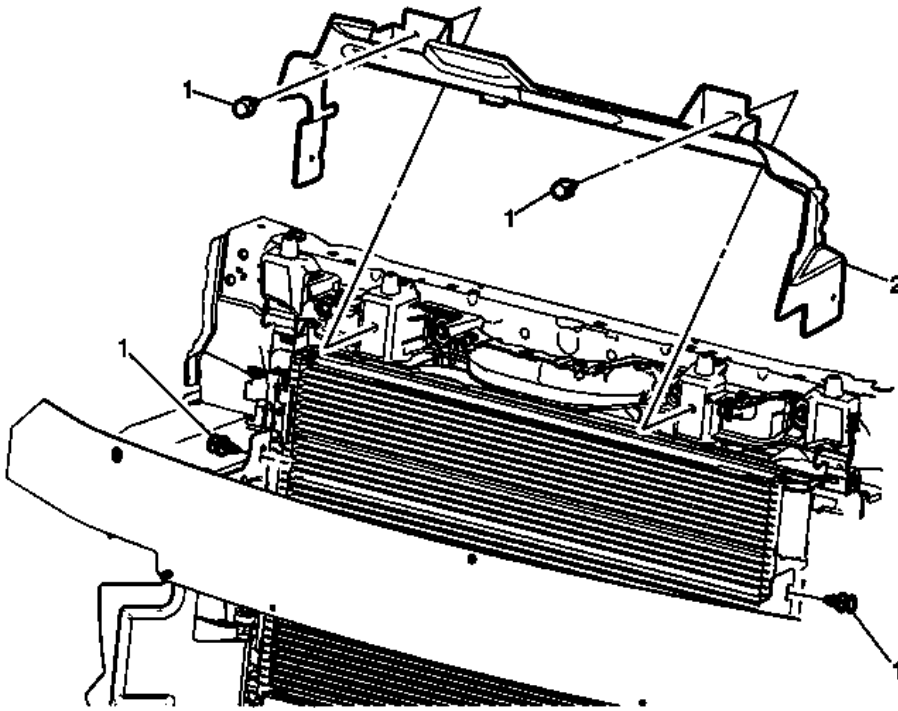


Fig. 132: Radiator Air Upper Baffle & Deflector (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Air Upper Baffle and Deflector Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
1. Remove the front fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
2. Remove the air cleaner inlet duct. Refer to <u>Air Cleaner Inlet Duct Replacement</u> .	
1	Radiator Air Upper Baffle and Deflector Retainer (Qty 4)
2	Radiator Air Upper Baffle and Deflector

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT (LTG)

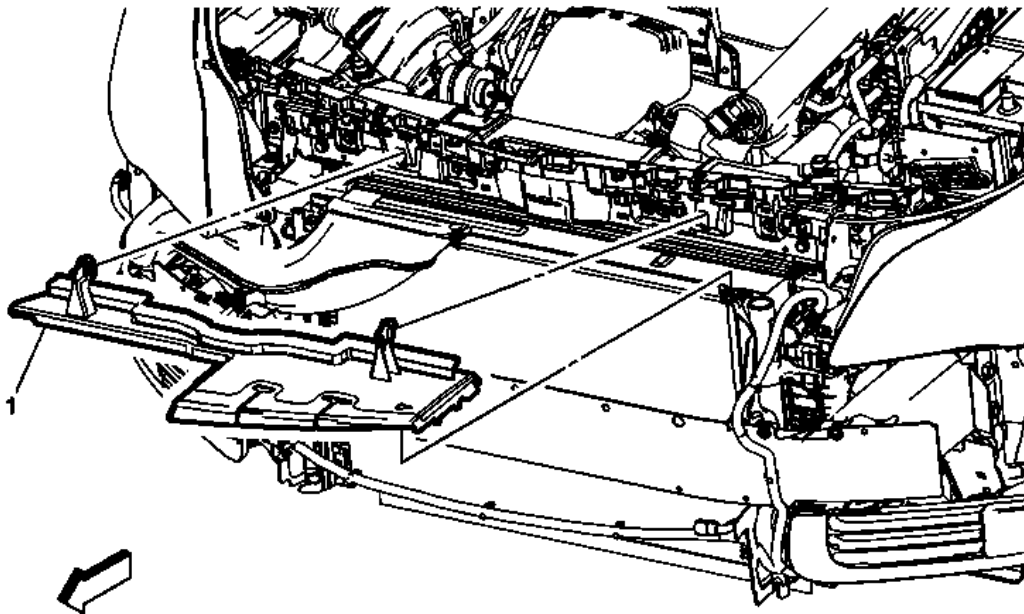


Fig. 133: Radiator Air Upper Baffle and Deflector (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Radiator Air Upper Baffle and Deflector Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
1. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> . 2. Remove the front intake air duct deflector. Refer to <u>Front Intake Air Duct Deflector Replacement</u> . 3. Remove the air cleaner inlet duct. Refer to <u>Air Cleaner Inlet Duct Replacement</u> .	
1	Radiator Air Upper Baffle and Deflector Procedure Unclip the left radiator air side upper baffle from the radiator air upper baffle and deflector.

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

System Overview

The engine cooling fan system consists of 2 electric cooling fans and 3 fan relays. The cooling fan relays are arranged in a series/parallel (S/P) configuration. This allows the engine control module (ECM) to operate both fans together at low or high speeds using 2 fan control circuits. The underhood fuse block supplies the cooling fan relays with B+ at the switch side, and ignition voltage at the coil side of the relays through separate fuses.

When the cooling fans are commanded ON, the ECM grounds the appropriate relay control circuit, which energizes the relay coil. The magnetic field, created within the relay by the energized relay coil, overcomes the spring tension of the bi-metal switch armature causing the relay switch to close. When the relay switch closes, B+ is supplied to the cooling fan motor through the relay controlled output circuit, causing the cooling fan motors to operate. A dedicated ground is supplied to the cooling motors to complete the circuit.

Low Speed Operation

The ECM supplies a ground to the coil side of the cooling fan low speed relay. This energizes the coil and applies voltage directly to the right cooling fan through the switch side of the low speed relay. The right cooling fan is connected in series to the left cooling fan through the de-energized cooling fan speed control relay. The result is a series circuit that operates both fans at low speed.

High Speed Operation

The ECM supplies a ground to the coil side of the cooling fan low speed relay, the cooling fan speed control relay, and the cooling fan-left high speed relay. When energized, the left high speed fan relay applies voltage directly to the left cooling fan through the switch side of the relay. Simultaneously, the low speed fan relay and the cooling fan speed control relay provide ignition voltage and a direct path to ground for the right cooling fan. During high speed fan operation, both engine cooling fans have their own dedicated ground path. The result is a parallel circuit that operates both fans at high speed.

COOLING SYSTEM DESCRIPTION AND OPERATION

Engine Coolant Indicators

- The instrument panel cluster (IPC) shows the engine temperature on the temperature gauge. The value is sent on the data communication line from engine control module (ECM). When the coolant temperature is more than 128°C (262°F) IPC receives a discrete input from ECM requesting illumination.
- The IPC performs the display test at the start of each ignition cycle. The IPC illuminates the TEMP indicator.

Coolant Level Control

The engine cooling system contains an engine coolant level switch to alert the driver in the event of a low coolant level. When the engine coolant level in the surge tank falls below a certain level, the coolant level switch opens. When the body control module (BCM) detects an open or a high voltage level on the coolant level indicator control circuit, for at least 10 seconds, it will send a GM LAN message to the driver information center (DIC) requesting display of the low coolant level message. There is approximately a 10-second delay before the BCM sends the GM LAN message to prevent the message from being displayed, due to coolant sloshing in the surge tank.

Coolant Heater

The optional engine coolant heater operates using AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather. The coolant heater helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. A weather shield on

the cord is provided to protect the plug when not in use.

Cooling System

The cooling system's function is to maintain an efficient engine operating temperature during all engine speeds and operating conditions. The cooling system is designed to remove approximately one-third of the heat produced by the burning of the air-fuel mixture. When the engine is cold, the coolant does not flow to the radiator until the thermostat opens. This allows the engine to warm quickly.

Cooling Cycle

Coolant flows from the radiator outlet and into the water pump inlet. Some coolant flows from the water pump, to the heater core, then back to the water pump. This provides the passenger compartment with heat and defrost capability as the coolant warms up.

Coolant also flows from the water pump outlet and into the engine block. In the engine block, the coolant circulates through the water jackets surrounding the cylinders where the coolant absorbs heat.

The coolant then flows through the cylinder head gasket openings and into the cylinder heads. In the cylinder heads, the coolant flows through the water jackets surrounding the combustion chambers and valve seats, where the coolant absorbs additional heat.

Coolant is also directed to the throttle body. There the coolant circulates through passages in the casting. During initial start up, the coolant assists in warming the throttle body.

From the cylinder heads, the coolant flows to the thermostat. The flow of coolant will either be stopped at the thermostat until the engine reaches normal operating temperature, or the coolant will flow through the thermostat and into the radiator where the coolant is cooled. At this point, the coolant flow cycle is completed.

Efficient operation of the cooling system requires proper functioning of all cooling system components. The cooling system consists of the following components.

Coolant

The engine coolant is a solution made up of a 50/50 mixture of drinking water and anti-freeze. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger consisting of a core and 2 tanks. The aluminum core is a tube and fin crossflow design that extends from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer to the atmosphere.

The inlet and outlet tanks are a molded, high temperature, nylon reinforced plastic material. A high temperature rubber gasket seals the tank flange edge to the aluminum core. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminum header at each end of the core.

The radiator also has a drain cock located in the bottom of the left hand tank. The drain cock unit includes the drain cock and drain cock seal.

Heat is removed from the coolant as the coolant passes through the radiator. The fins on the core transfer heat from the coolant passing through the tubes. Air passing between the fins absorbs the heat and cools the coolant.

Pressure Cap

The pressure cap seals and pressurizes the cooling system. The cap contains a blow off, or pressure valve and a vacuum, or an atmospheric valve:

- The pressure valve is held against the seat by a spring that protects the radiator by relieving pressure that exceeds 15 psi.
- The vacuum valve is held against the seat by a spring that permits opening of the valve to relieve vacuum created when the cooling system cools. The vacuum, if not relieved, might cause the radiator to collapse.

The pressure cap allows the cooling system pressure to build up when the temperature increases. As the pressure builds, the boiling point of the coolant increases. Therefore, the engine coolant can be safely run at a temperature much higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant becomes, the faster the heat transfers from the radiator into the cooler air.

The pressure in the cooling system can get too high. When the pressure exceeds the strength of the spring, the pressure valve rises, venting the excess pressure.

As the engine cools, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open. This equalizes the pressure in the cooling system with the atmospheric pressure, preventing the radiator from collapsing.

Coolant Recovery System

The coolant recovery system consists of a plastic coolant recovery reservoir and overflow tube. The recovery reservoir is also called a recovery tank or expansion tank. This tank is partially filled with coolant and is connected to the radiator fill neck with the overflow tube. Coolant can flow back and forth between the radiator and the reservoir.

In effect, a cooling system with a coolant recovery reservoir is a closed system. When the pressure within the cooling system gets too high, the pressure valve in the pressure cap will open. This allows the coolant, which has expanded due to heat, to flow through the overflow tube and into the recovery reservoir. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum opens the vacuum valve in the pressure cap, allowing some of the coolant in the reservoir to be siphoned back into the radiator. Under normal operating conditions, no coolant is lost. Although the coolant level in the recovery reservoir goes up and down, the radiator and cooling system are kept full. An advantage to using a coolant recovery reservoir is the elimination of almost all air bubbles from the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Air Baffles and Seals

The cooling system uses deflectors, air baffles and air seals to increase cooling system capability. Deflectors are installed under the vehicle to redirect airflow beneath the vehicle and through the radiator to increase engine cooling. Air baffles are also used to direct airflow through the radiator and increase cooling capability. Air seals prevent air from bypassing the radiator and A/C condenser, and prevent recirculation of hot air for better hot weather cooling and A/C condenser performance.

Water Pump

The water pump is a centrifugal vane impeller type pump. The pump consists of a housing with coolant inlet and outlet passages and an impeller. The impeller is a flat plate mounted on the pump shaft with a series of flat or curved blades or vanes. When the impeller rotates, the coolant between the vanes is thrown outward by centrifugal force. The impeller shaft is supported by one or more sealed bearings, which never need to be lubricated. With a sealed bearing, grease cannot leak out, and dirt and water cannot get in.

The water pump circulates coolant throughout the cooling system. The pump is driven by the crankshaft from the drive belt.

Thermostat

The thermostat is a coolant flow control component, whose purpose is to regulate the operating temperature of the engine. The thermostat utilizes a temperature sensitive wax-pellet element, which connects to a valve through a piston. Heating is causing the element to expand and exert pressure against a rubber diaphragm. This pressure forces the valve to open. Cooling causes the element to contract. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 91°C (195°F), the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches 91°C (195°F), the thermostat valve will open. The switch point will differ a little depending on engine. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after opening. This restriction creates a pressure difference which prevents cavitations at the water pump and forces coolant to circulate through the engine block.

For some engines a solenoid thermostat controlled by the ECM will open and close the circulation.

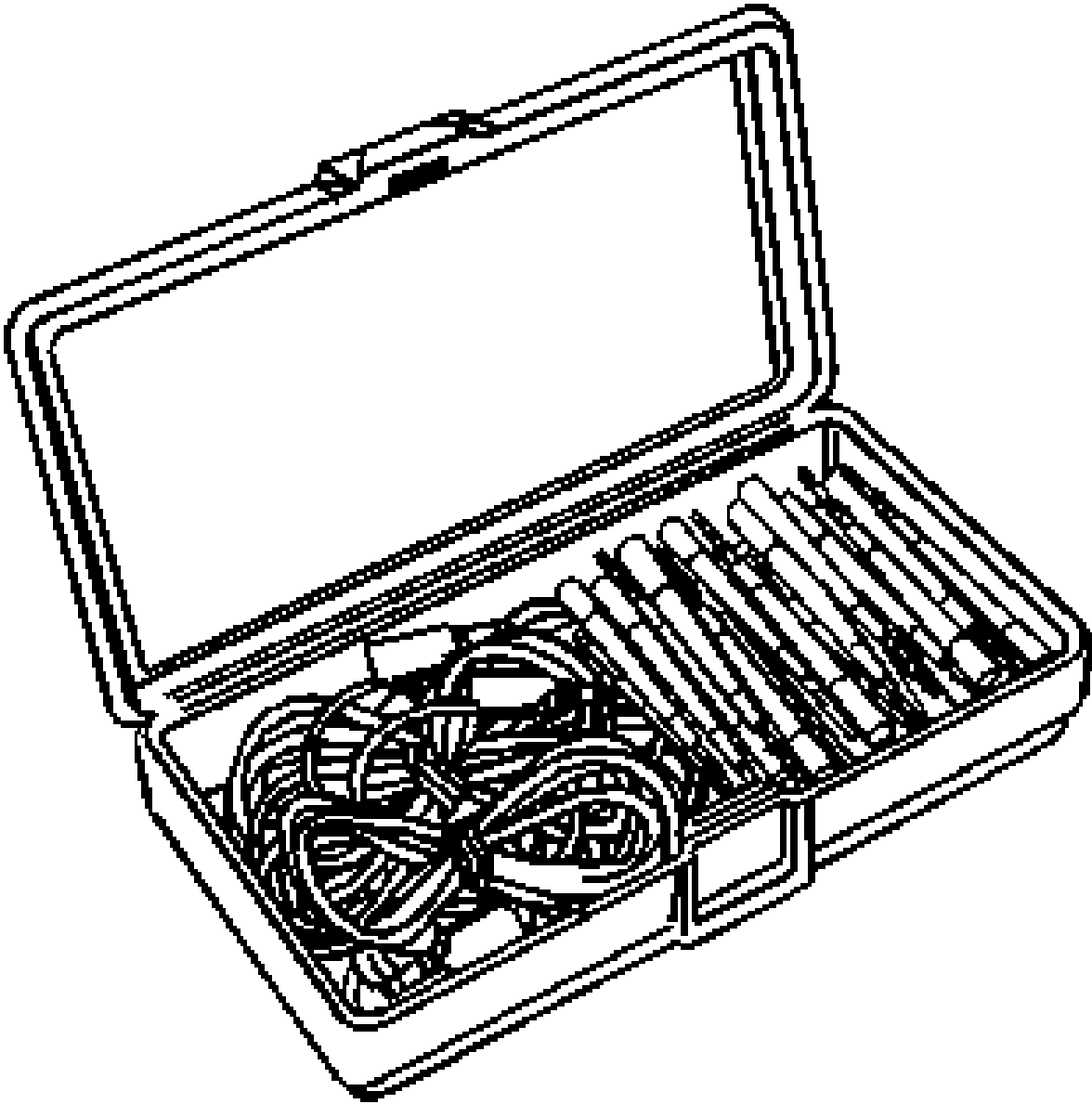
Transmission Oil Cooler

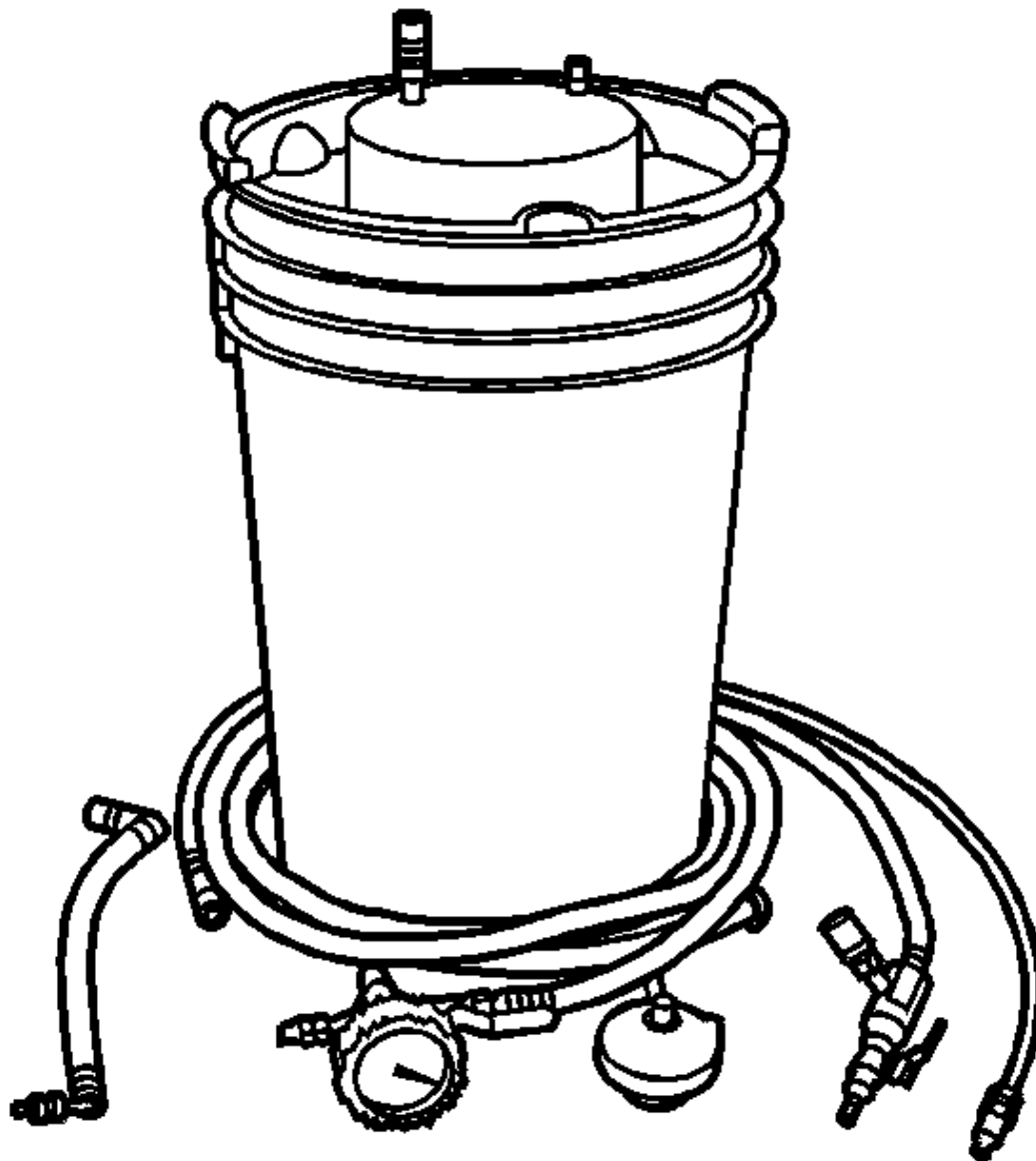
The transmission oil cooler is a heat exchanger and is located inside the right side end tank of the radiator. The transmission fluid temperature is regulated by the temperature of the engine coolant that surrounds the oil cooler as the transmission fluid passes through the cooler.

The transmission oil pump circulates the fluid through the feed line to the oil cooler. The fluid then flows through the cooler while the engine coolant absorbs heat from the fluid. The fluid is then pumped through the return line to the transmission.

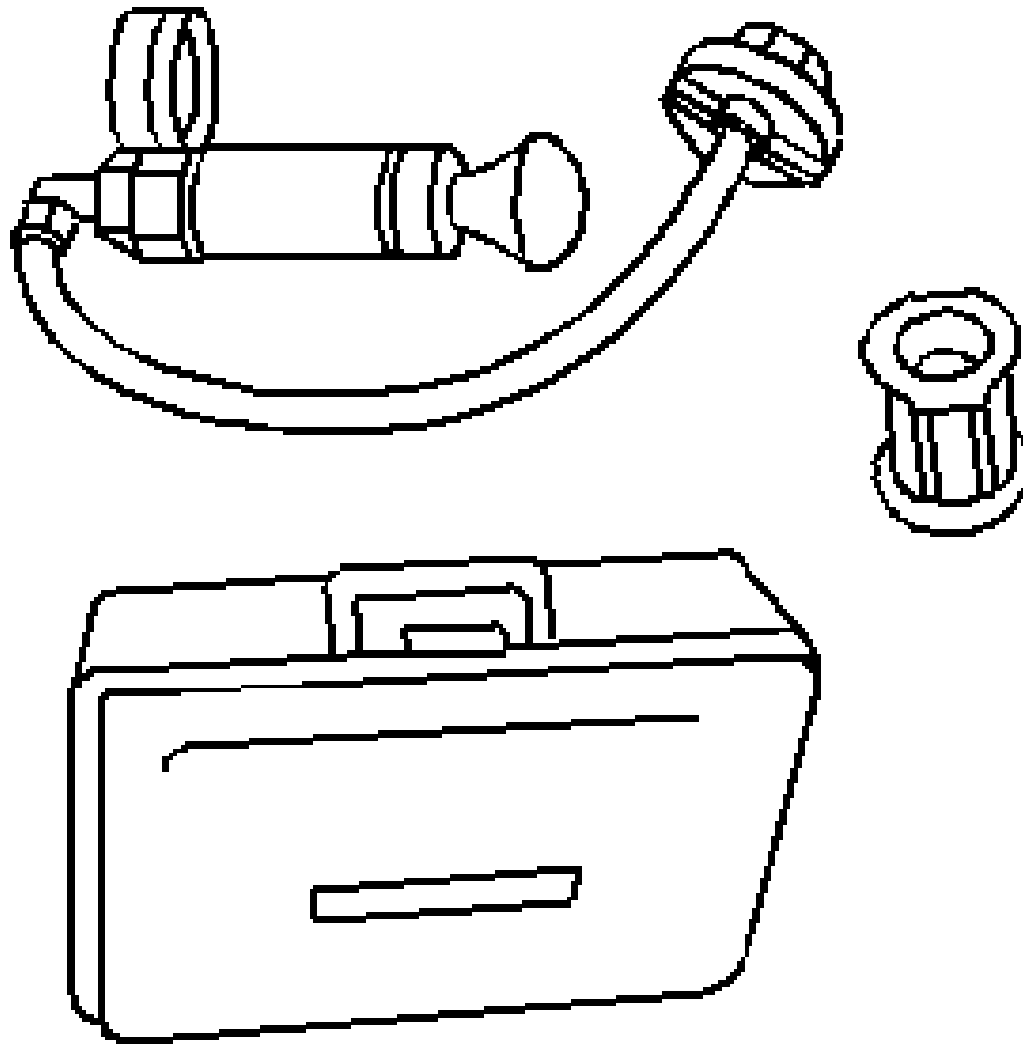
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

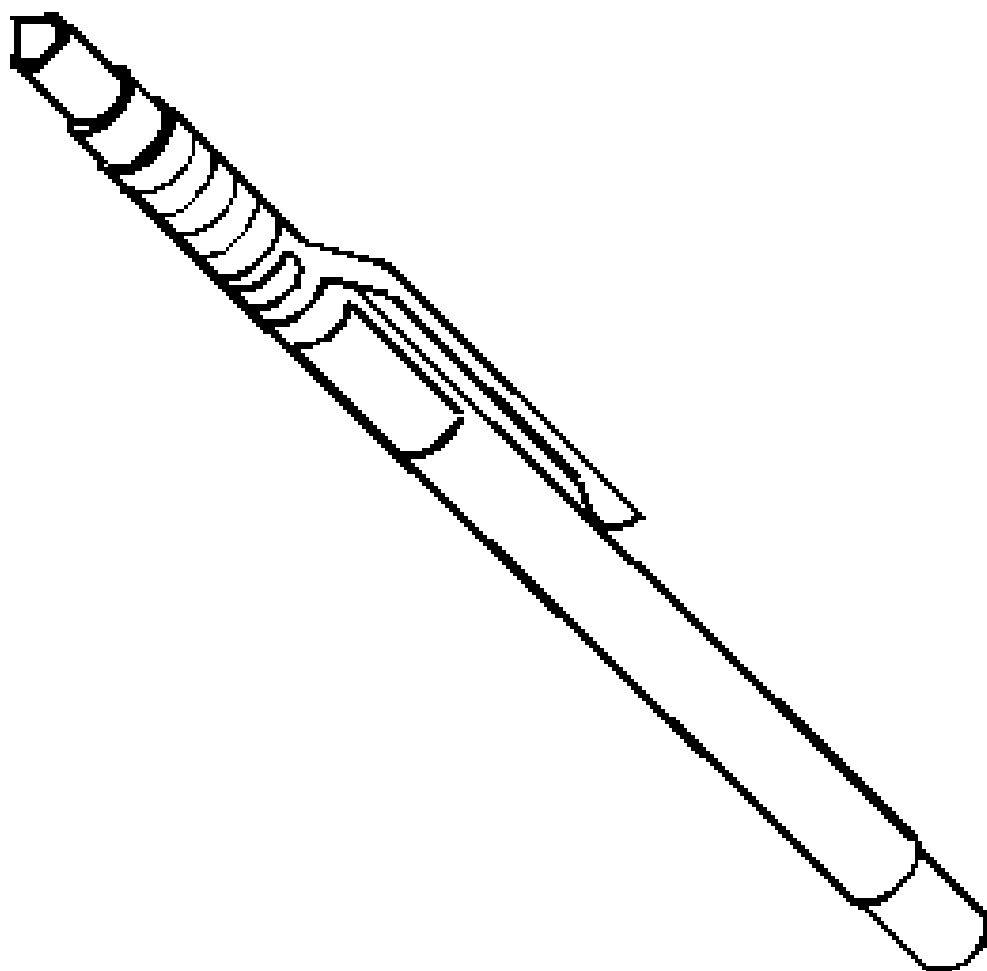
Illustration	Tool Number/ Description
	EL-35616-F J-35616-F Connector Test Adapter Kit



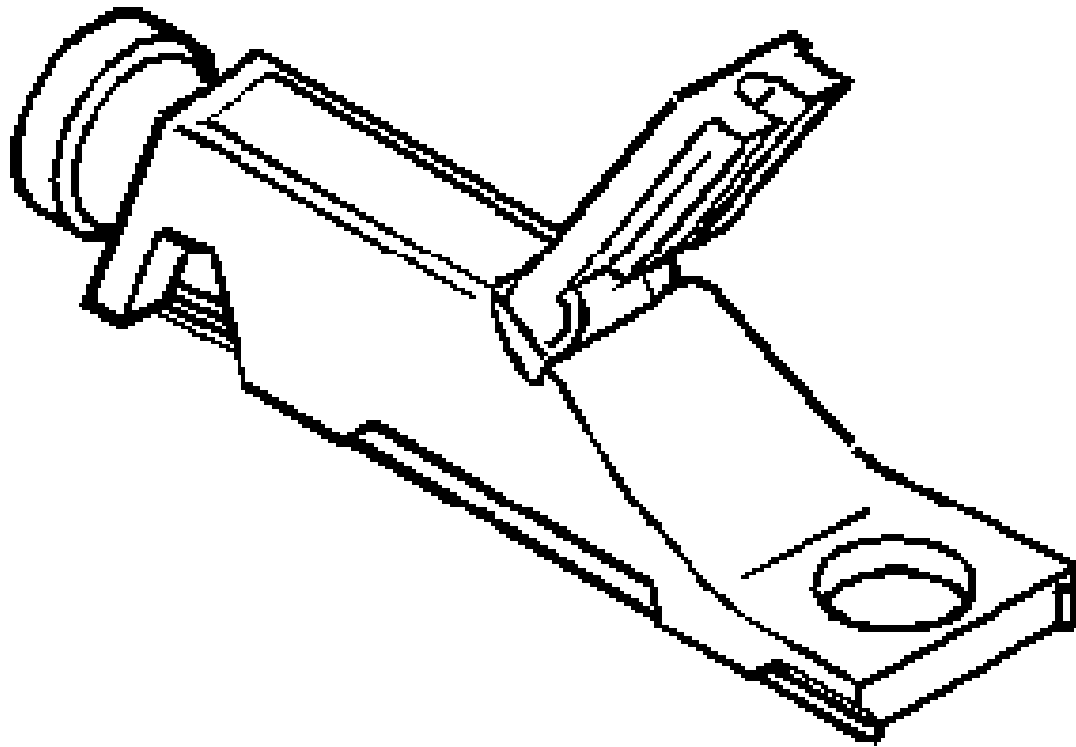
GE 47716
Vac N Fill
Coolant
Refill Tool



EN 24460-
A
J 24460-01
Cooling
System
Pressure
Tester

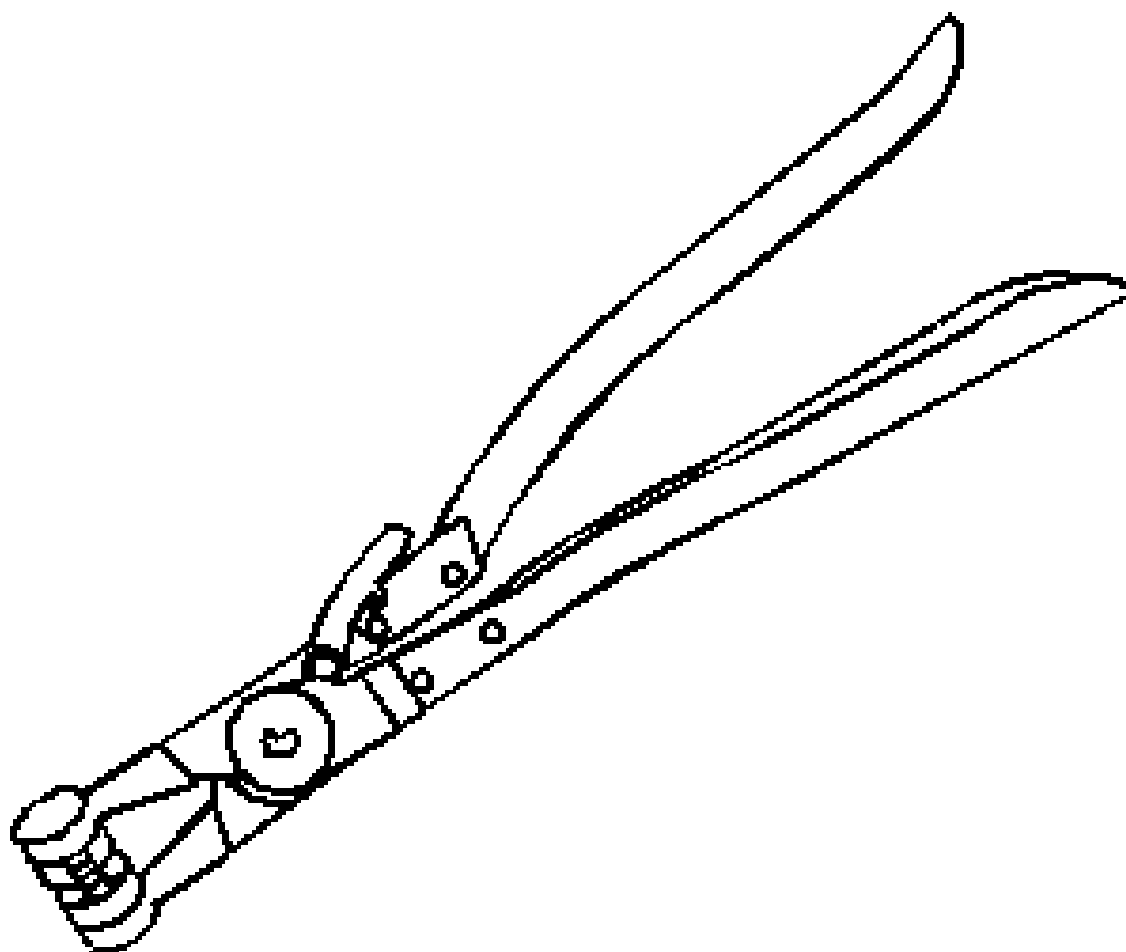


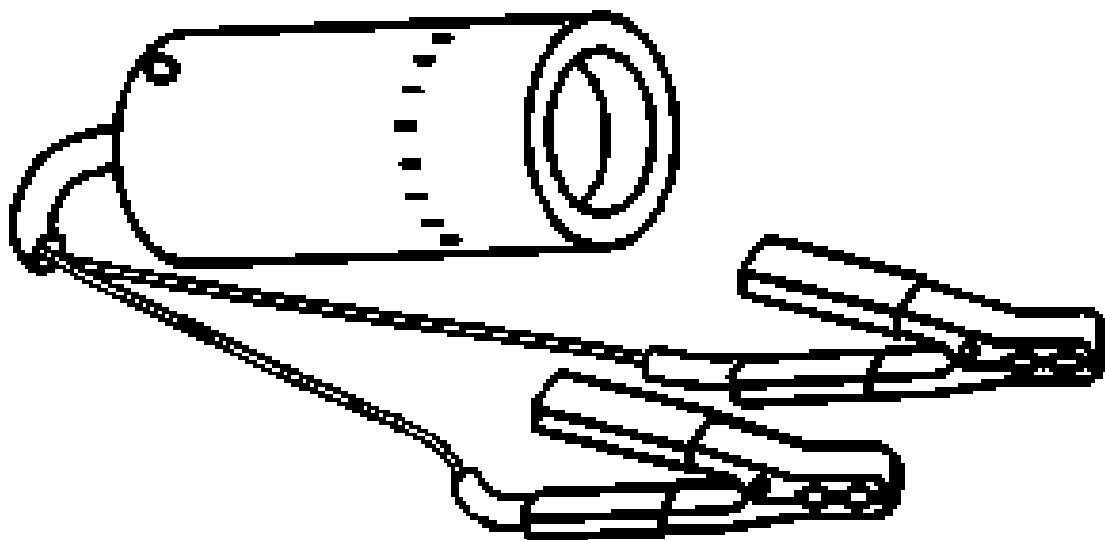
GE 24731
J 24731
Tempil
Stick



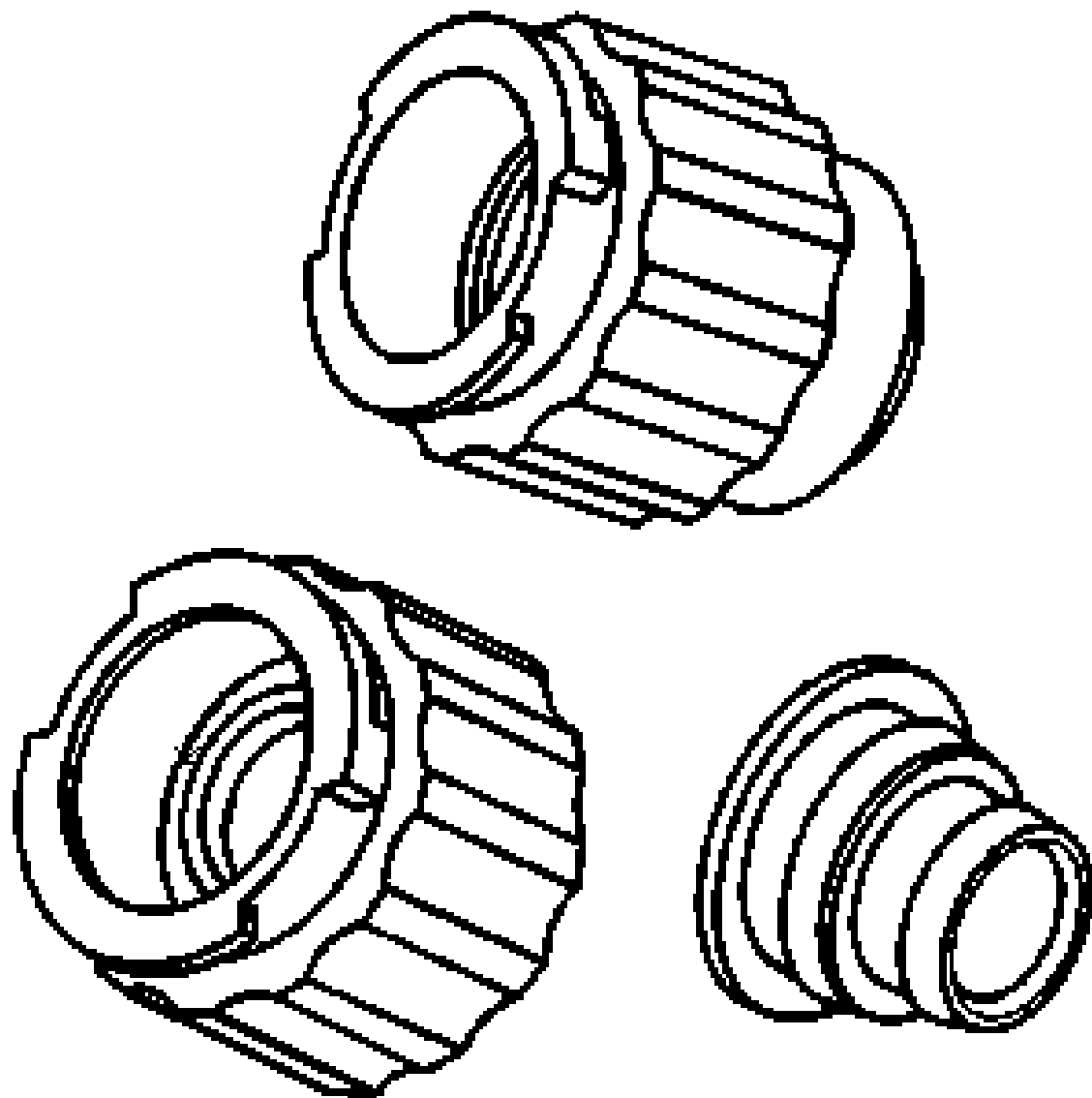
GE 26568
J 26568
Coolant and
Battery
Fluid Tester

BO 38185
J 38185
Hose
Clamp
Pliers

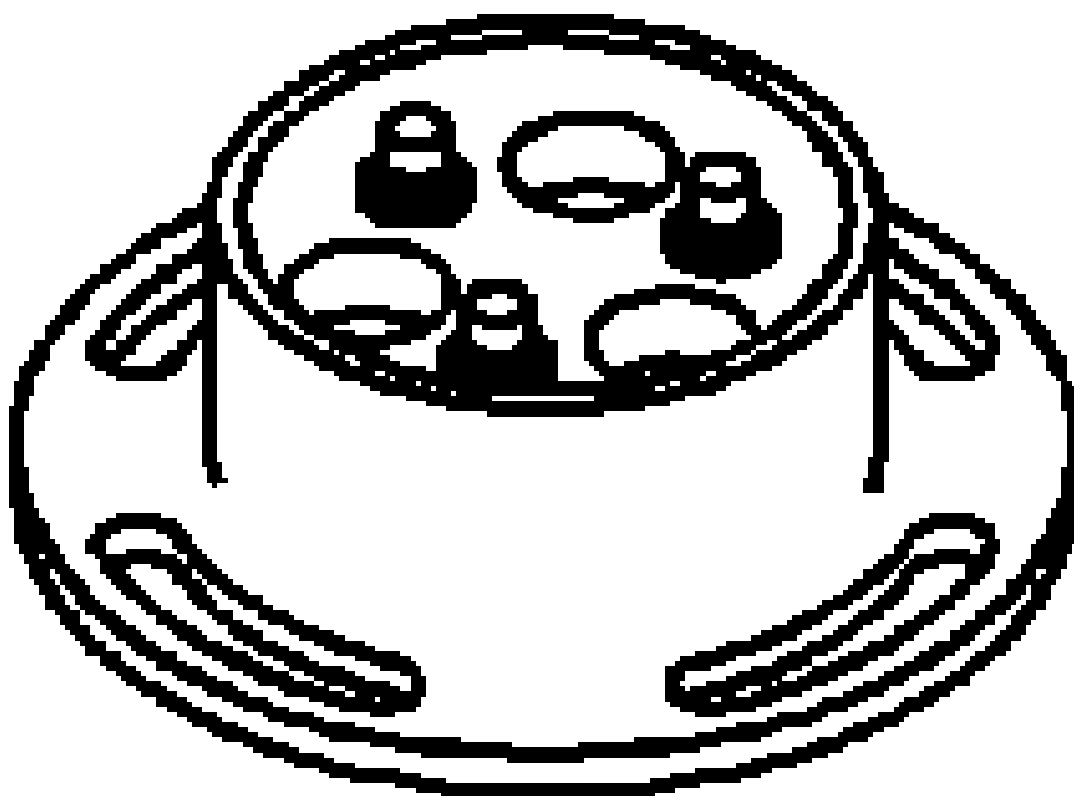




GE 42220
J 42220
Universal
12V Leak
Detection
Lamp



GE 42401
A
J 42401
Radiator
Cap and
Surge Tank
Test
Adapter



EN 43651
J 43651
Water
Pump
Holding
Tool

Engine

Engine Exhaust

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Catalytic Converter Brace Fastener (LUK)	22 N.m	16 lb ft
Catalytic Converter Brace Fastener (LTG Lower)	22 N.m	16 lb ft
Catalytic Converter Brace Fastener (LTG Upper)	22 N.m	16 lb ft
Catalytic Converter Brace Bracket Fastener (LTG)	22 N.m	16 lb ft
Catalytic Converter-to-Exhaust Manifold Fastener (LUK)	50 N.m	37 lb ft
Catalytic Converter-to-Exhaust Front Pipe Fastener (LUK, LTG)	25 N.m	18 lb ft
Catalytic Converter-to-Turbocharger Fasteners (LTG)	22 N.m	16 lb ft
Exhaust Front Pipe Hanger Bracket Fastener (LUK)	60 N.m	44 lb ft
Exhaust Front Pipe Hanger Bracket Fastener (LTG)	22 N.m	16 lb ft
Exhaust Front Pipe-to-Muffler Fastener (LUK, LTG)	18 N.m	13 lb ft
Exhaust Isolator Fastener (LTG)	35 N.m	26 lb ft
Exhaust Manifold Fastener (LTG)	20 N.m	15 lb ft
Exhaust Manifold Fastener (LUK)	14 N.m	10 lb ft
Exhaust Manifold Heat Shield Fastener (LUK)	10 N.m	89 lb in
Exhaust Manifold Heat Shield Fastener (LTG)	14 N.m	10 lb ft
Exhaust Rear Muffler Heat Shield Fastener (LTG)	1.5 N.m	13 lb in
Exhaust Rear Pipe Hanger Bracket Fastener	20 N.m	15 lb ft
Turbocharger Studs (LTG)	10 N.m	89 lb in

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Anti-Seize	Lubricant	88862477	88862478

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - ENGINE EXHAUST

- Review the exhaust system description in order to familiarize yourself with the exhaust system

components and the intended function of the components. Refer to **Exhaust System Description**.

- All diagnostics on a vehicle should follow a logical process. Strategy Based Diagnostics is a uniform approach for repairing all systems. The diagnostic flow is the place to start when repairs are necessary and may always be used in order to resolve a system problem. For a detailed explanation, refer to **Strategy Based Diagnosis** .

Visual/Physical Inspection

- Inspect for aftermarket or non-OEM devices such as, but not limited to; tailpipe extensions, headers, and exhaust cutouts. Any aftermarket exhaust system devices could affect the operation and proper performance of the exhaust system.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, engine temperature, engine load, and frequency of concern.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause any symptom.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating as designed.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Loss of power - Refer to **Restricted Exhaust**.
- Poor acceleration - Refer to **Restricted Exhaust**.
- Poor fuel economy - Refer to **Restricted Exhaust**.
- Excessive smoke diesel - Refer to **Restricted Exhaust**.
- Exhaust hissing noise - Refer to **Exhaust Leakage**.
- Exhaust popping noise - Refer to **Exhaust Leakage**.
- Exhaust rattle noise - Refer to **Exhaust Noise**.
- Loud exhaust noise - Refer to **Exhaust Noise**.
- Exhaust buzz, groan, hum noise - Refer to **Exhaust Noise**.

RESTRICTED EXHAUST

Special Tools

J-35314-A Exhaust Back Pressure Gauge

Refer to **Special Tools**.

Diagnostic Aids

WARNING: Refer to Hot Exhaust System Warning .

For dual exhaust systems a quick check of exhaust flow will help determine which side of the exhaust system is restricted. The side that has less exhaust flow is the side that will be suspect, and diagnosis should begin there.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4

The exhaust system has very low back pressure under normal conditions. If the exhaust system is restricted, a significant increase in the exhaust pressure is noticed on the **J-35314-A** gauge.

Removing the HO2S sensor may set a DTC. When finishing this diagnostic table, be sure to clear all codes.

5

This step will isolate the catalytic converter from the remainder of the exhaust system.

8

Confirming that the condition has been fixed is essential. If the symptom still exists and the vehicle has a dual exhaust system, proceed to step 2 and repeat diagnostic procedure on the opposite exhaust pipe.

Restricted Exhaust

Step	Action	Value(s)	Yes	No
1	Did you verify the customers complaint?	-	Go to Step 2	-
2	Did you review the exhaust symptoms diagnostic information and perform the necessary inspections?	-	Go to Step 3	Go to Symptoms - Engine Exhaust
3	Is the system equipped with dual exhaust?	-	Go to Diagnostic Aids	Go to Step 4
4	<ol style="list-style-type: none">1. Remove the heated oxygen sensor (HO2S) that is in front of the catalytic converter. Refer to the appropriate procedure. Refer to Heated Oxygen Sensor Replacement - Sensor 1 , for the 2.0L engine or Heated Oxygen Sensor Replacement - Sensor 1 for the 2.4L engine.2. Install the J-35314-A Exhaust Back Pressure Gauge in place of the HO2S sensor.	9 kPa (1.25 psi)		

	<ol style="list-style-type: none"> 3. Start the engine. 4. Increase and monitor the engine speed at 2,500 RPM. 5. Observe the exhaust system back pressure reading on the gauge. <p>Does the reading exceed the specified value?</p>		Go to Step 5	Go to Step 8
5	<ol style="list-style-type: none"> 1. Turn the engine OFF and place the ignition in the lock position. 2. Remove the J-35314-A gauge. 3. Reinstall the HO2S sensor. Refer to <u>Heated Oxygen Sensor Replacement - Sensor 1</u> , for the 2.0L engine or <u>Heated Oxygen Sensor Replacement - Sensor 1</u> for the 2.4L engine. . 4. Remove the post-catalyst HO2S sensor. Refer to the appropriate procedure. Refer to <u>HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 2</u> , for the 2.0L engine or <u>Heated Oxygen Sensor Replacement - Sensor 2</u> for the 2.4L engine. 5. Install the J-35314-A gauge in place of the post HO2S sensor. 6. Start the engine. 7. Increase and monitor the engine speed at 2,500 RPM. 8. Observe the exhaust system back pressure reading on the gauge. <p>Does the reading exceed the specified value?</p>	9 kPa (1.25 psi)	Go to Step 6	Go to Step 7
6	<p>Inspect the exhaust system for the following conditions:</p> <ul style="list-style-type: none"> • Secondary catalytic converter restricted • Damage in the exhaust pipe • Debris in the exhaust pipe • Muffler or resonator internal failure • Two-layer exhaust pipe separation <p>Did you find and correct the condition?</p>	-	Go to Step 8	
	Replace the catalytic converter. Refer to			

7	Catalytic Converter Replacement (LTG). Catalytic Converter Replacement (LUK). Did you find and correct the condition?	-	Go to Step 8	-
8	1. Remove the J-35314-A gauge. 2. Reinstall the applicable HO2S sensor. Refer to the appropriate procedure: <ul style="list-style-type: none"> • Heated Oxygen Sensor Replacement - Sensor 1 for the 2.0L engine • Heated Oxygen Sensor Replacement - Sensor 2 for the 2.0L engine • Heated Oxygen Sensor Replacement - Sensor 1 for the 2.4L engine • Heated Oxygen Sensor Replacement - Sensor 2 for the 2.4L engine 3. Clear any codes. 4. Road test the vehicle in order to verify the repair. Did you correct the condition?	-	System OK	Go to Step 2

EXHAUST LEAKAGE

Exhaust Leakage

Condition	Action
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
DEFINITION: An exhaust leak may show stains at the area of the leak. The leak may be felt by holding a hand close to the suspected areas or using a smoke pencil. The leak may make a popping or hissing noise. Refer to <u>Symptoms - Engine Exhaust</u> prior to beginning this table.	
Misaligned or improperly installed exhaust system components	<ul style="list-style-type: none"> • Align and tighten the exhaust system components to the specifications. Refer to <u>Fastener Tightening Specifications</u>. • Ensure the exhaust hangers are in the proper locations and not loose.
Exhaust leaks at the following connections: <ul style="list-style-type: none"> • Exhaust manifold to pipe • Flanges 	Tighten the components to the specifications. Refer to <u>Fastener Tightening Specifications</u> .

<ul style="list-style-type: none"> • Pipe clamps 	
Seals or gaskets leaking; <ul style="list-style-type: none"> • Exhaust manifold to cylinder head • Exhaust pipes to exhaust manifold • Catalytic converter connection 	Replace the leaking seal or gasket. Refer to the affected components procedure for service.
Irregularities at the mating surfaces on the flange connections	Repair as required or replace the affected component. Refer to the affected components procedure for service.
Catalytic Converter cracked or broken	Replace the catalytic converter. Refer to <u>Catalytic Converter Replacement (LTG)</u> , <u>Catalytic Converter Replacement (LUK)</u> .
Exhaust system component connection welds leaking	Replace the leaking component. Refer to the affected component's procedure for service.
Muffler or resonator, if equipped, damaged or leaking at the seams	Replace the affected muffler or resonator, if equipped. Refer to <u>Exhaust Muffler Replacement (Dual)</u> , <u>Exhaust Muffler Replacement (Single)</u> .

EXHAUST NOISE

Exhaust Noise

Condition	Action
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
DEFINITION: An audible or physical noise due to a faulty component or damaged components causing a loose or misaligned exhaust system resulting in a rattle or vibration noise, i.e. buzz, groan, hum. Refer to <u>Symptoms - Engine Exhaust</u> prior to beginning this table.	
Popping or hissing noise	Exhaust leak-Refer to <u>Exhaust Leakage</u> .
Loud exhaust	1. Compare to a known good vehicle. 2. Inspect for a damaged or failed muffler or resonator, if equipped. 3. Replace the faulty muffler or resonator (if equipped). Refer to <u>Exhaust Muffler Replacement (Dual)</u> , <u>Exhaust Muffler Replacement (Single)</u> .
External rattle or vibration noise	1. Inspect for a bent or loose hanger, loose heat shield, or loose clamp. 2. Inspect for a exhaust pipe causing interference. 3. Repair or replace the affected component. Refer to the affected component's service procedure.
Internal rattle	1. Test the components by tapping with a rubber mallet to confirm a rattle.

2. Replace the faulty catalytic converter, resonator, if equipped, or muffler. Refer to Exhaust Muffler Replacement (Dual), Exhaust Muffler Replacement (Single).

REPAIR INSTRUCTIONS

EXHAUST MANIFOLD REPLACEMENT (LUK/LEA)

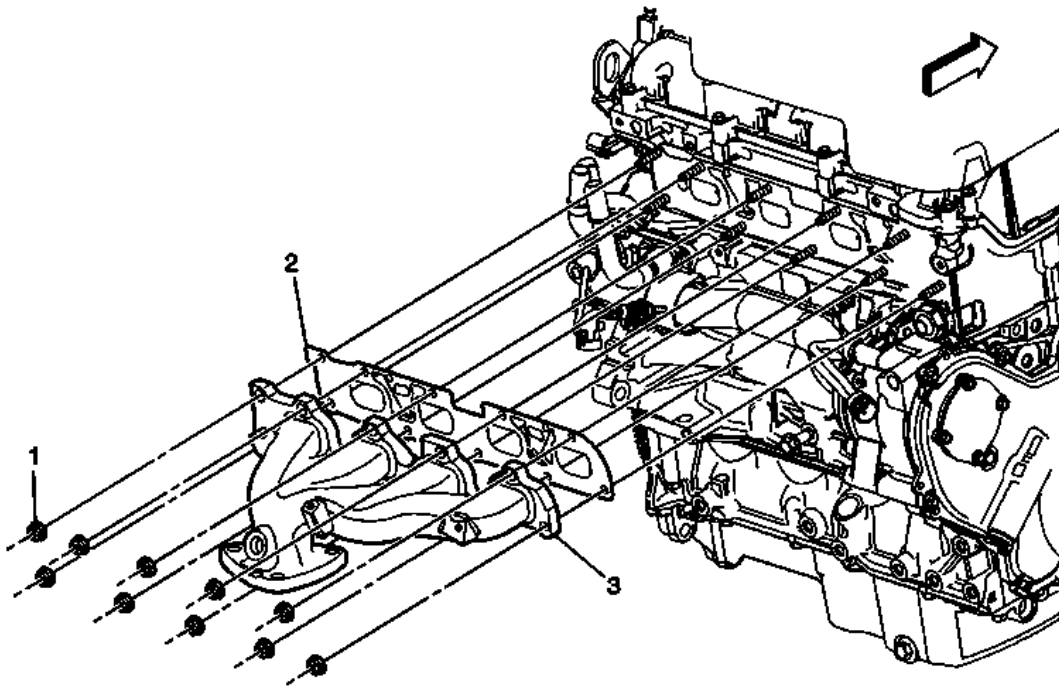


Fig. 1: Exhaust Manifold (LUK/LEA)
Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Replacement (LUK/LEA)

Callout	Component Name
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
Preliminary Procedures	
1. Remove the catalytic converter. Refer to <u>Catalytic Converter Replacement (LUK)</u> .	
2. Remove the secondary air injection pipe (LEA), if equipped. Refer to <u>Secondary Air Injection Pipe Replacement (LEA)</u> .	
3. Remove both secondary air injection valves (LUK), if equipped. Refer to <u>SECONDARY AIR INJECTION CHECK VALVE REPLACEMENT - LEFT SIDE (LUK)</u> and <u>SECONDARY AIR INJECTION CHECK VALVE REPLACEMENT - RIGHT SIDE (LUK)</u> <u>Secondary Air</u>	

Injection Check Valve Replacement (LEA) .

4. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUK)**.
5. Remove the exhaust manifold heated oxygen sensor. Refer to **Heated Oxygen Sensor Replacement - Sensor 1** .

1	<p>Exhaust Manifold Nut (Qty: 10)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten</p> <ul style="list-style-type: none">• First Pass: 14 (10 lb ft)• Final Pass: 14 (10 lb ft)
2	<p>Exhaust Manifold Gasket</p> <p>NOTE: Replace with a NEW exhaust manifold gasket.</p> <p>Procedure Remove the secondary air injection check valve pipe adapters (LUK), if equipped. Refer to <u>Secondary Air Injection Check Valve Pipe Adapter Replacement - Left Side (LUK)</u> .</p>
3	<p>Exhaust Manifold</p> <p>Procedure</p> <ol style="list-style-type: none">1. Remove and discard the exhaust manifold gasket.2. Clean any exhaust manifold gasket debris from the cylinder head and exhaust manifold.3. Install new exhaust manifold gasket.4. Tighten the exhaust manifold nuts working from the center out.

EXHAUST MANIFOLD REPLACEMENT (LTG)

Removal Procedure

WARNING: Refer to **Exhaust Service Warning** .

WARNING: Refer to **Eye Protection Warning** .

1. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)**.
2. Remove the turbocharger. Refer to **Turbocharger Replacement**.
3. Remove the exhaust manifold brace.

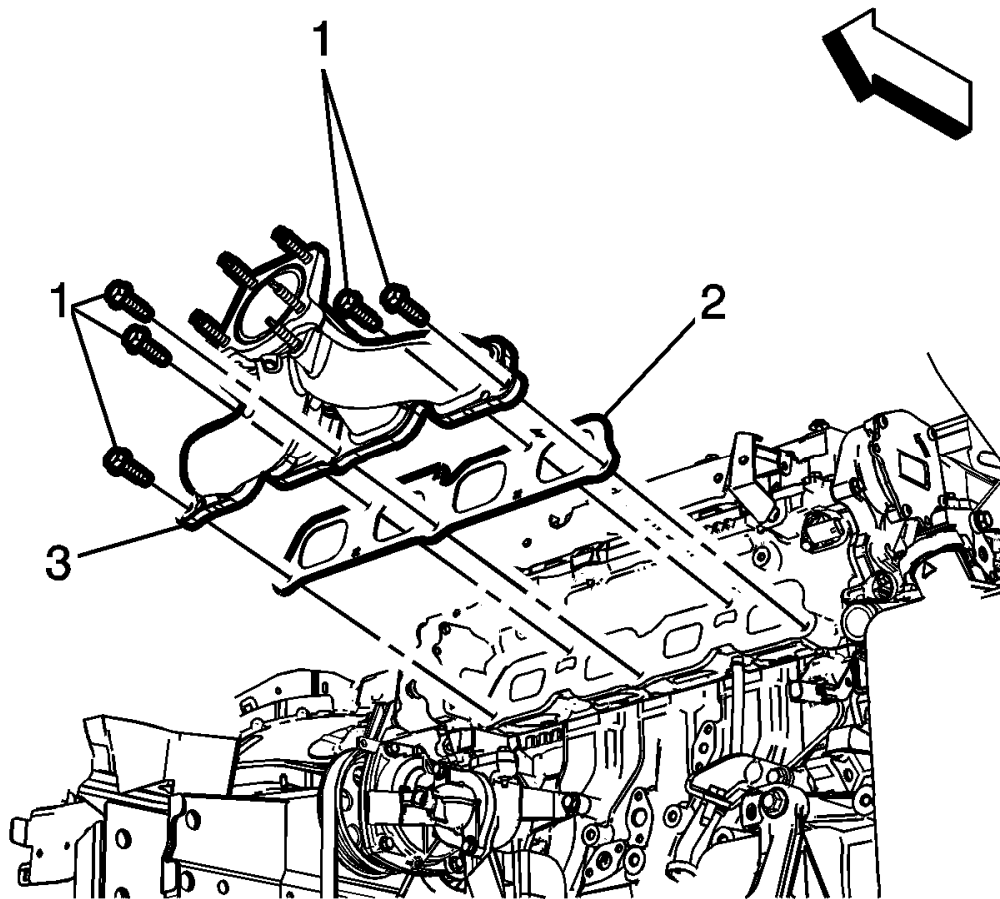


Fig. 2: Exhaust Manifold Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the exhaust manifold fasteners (1) and discard.
5. Remove the exhaust manifold (3) and discard the exhaust manifold gasket (2).

Installation Procedure

1. Clean all mating surfaces.

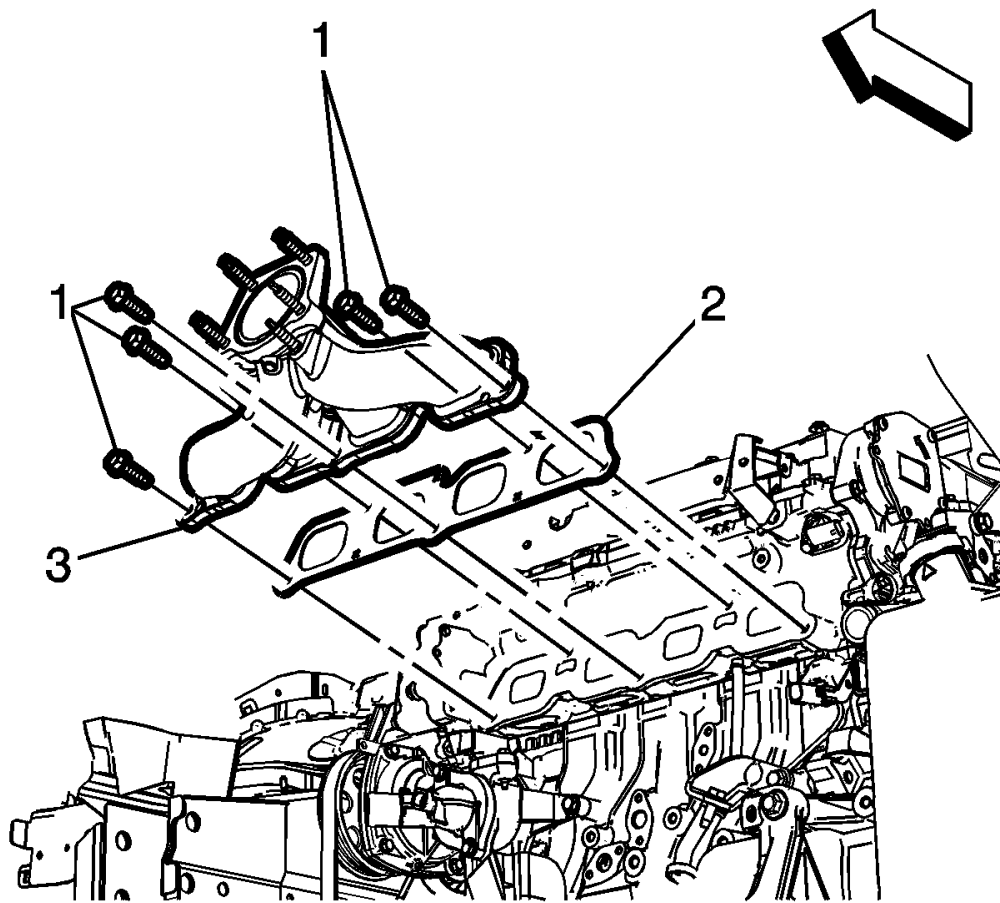


Fig. 3: Exhaust Manifold Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Install the exhaust manifold (3) to the cylinder head with a NEW gasket (2).

NOTE: Fasteners have adhesive patch and must be tightened to final torque within 5 minutes.

3. Install NEW fasteners (1) and hand tighten.

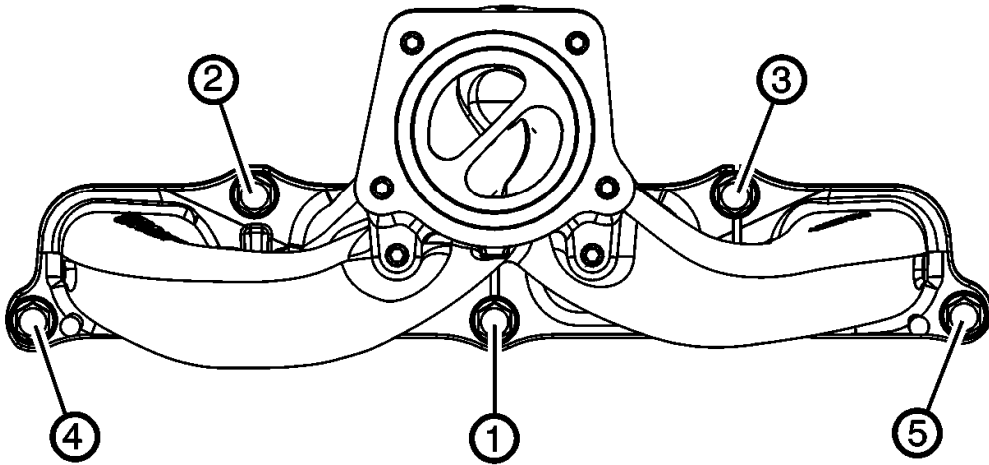


Fig. 4: Cylinder Head Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the exhaust manifold fasteners in 3 passes in the sequence shown to 20 (15 lb ft).
5. Install the exhaust manifold brace.
6. Install the turbocharger. Refer to **Turbocharger Replacement** .
7. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)**.

EXHAUST FRONT PIPE REPLACEMENT (LTG)

Removal Procedure

WARNING: Refer to Moving Parts and Hot Surfaces Warning .

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

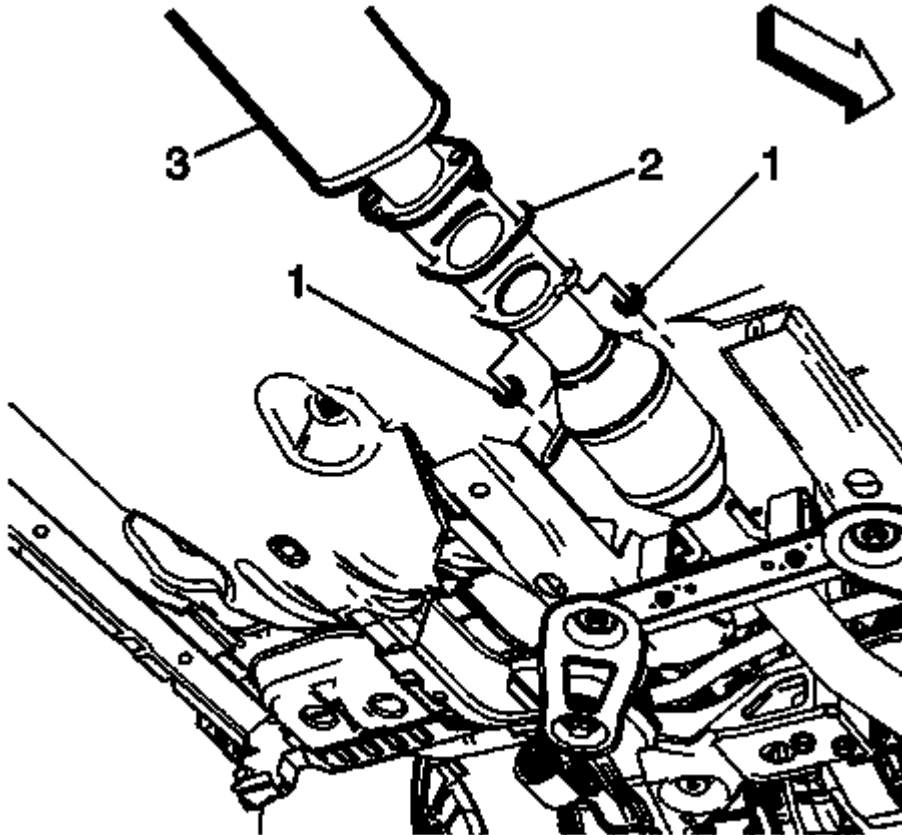


Fig. 5: Exhaust Front Pipe And Exhaust Muffler Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Remove the exhaust front pipe to the exhaust muffler fasteners (1) and discard the exhaust gasket (2).
3. Support the exhaust muffler (3) with mechanics wire.

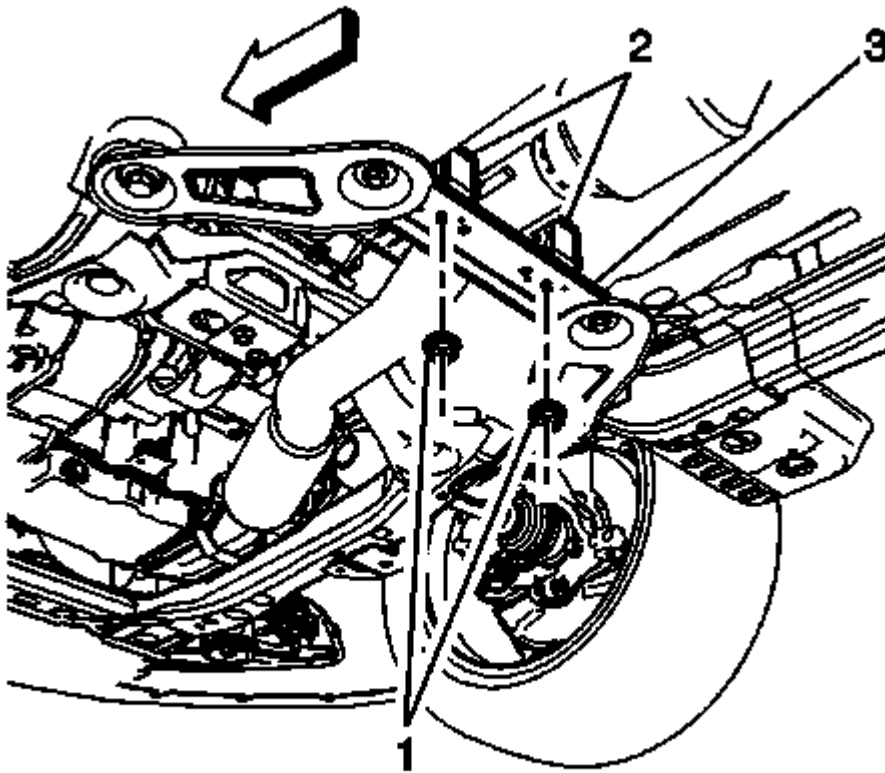


Fig. 6: Fasteners And Exhaust Isolators
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fasteners (1) securing the exhaust isolators (2) to the front hanger bracket (3).

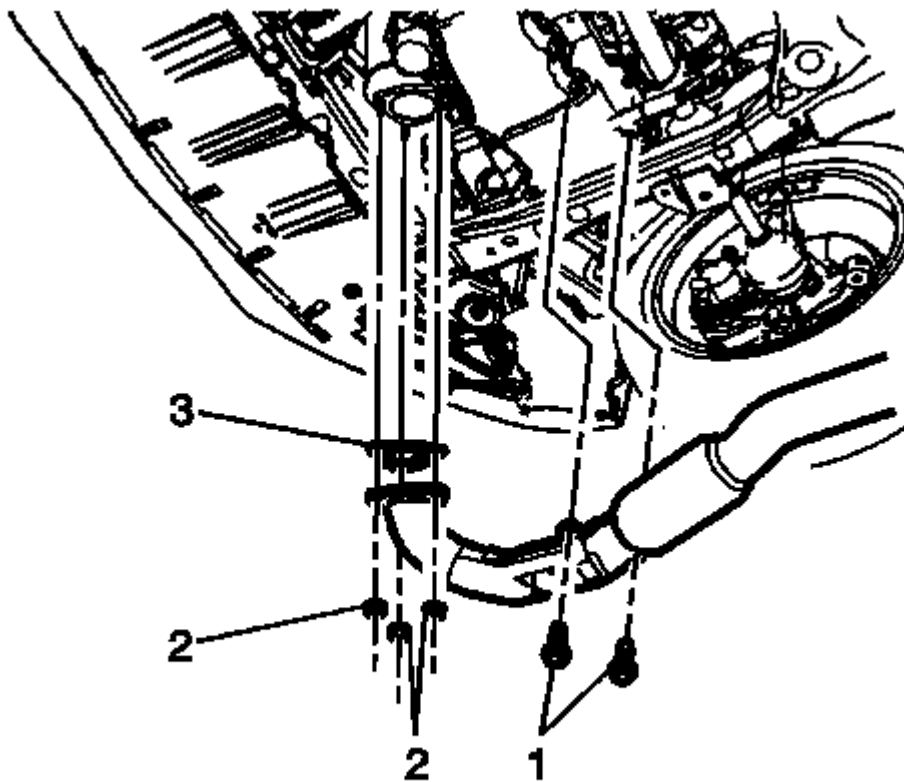


Fig. 7: Catalytic Converter Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the catalytic converter fasteners (2) and discard the exhaust gasket (3).
6. Remove the exhaust front pipe bracket fasteners (1).

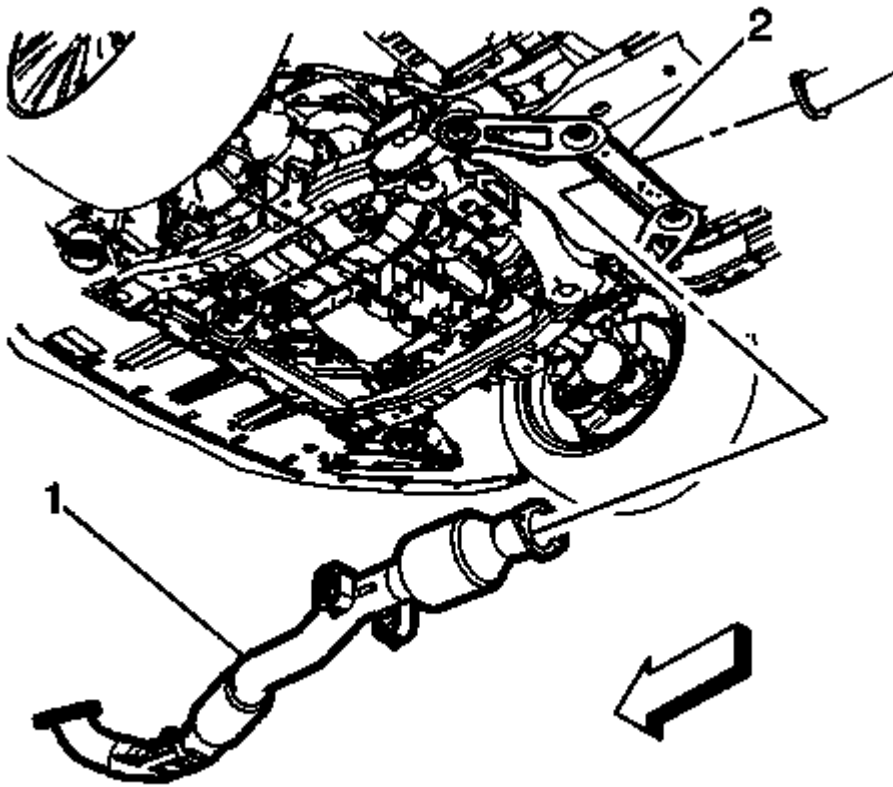


Fig. 8: Exhaust Front Pipe

Courtesy of GENERAL MOTORS COMPANY

7. Slide the exhaust front pipe (1) from above the front hanger bracket (2) and lower the exhaust front pipe to the floor.

Installation Procedure

1. Clean the exhaust front pipe mating surfaces.

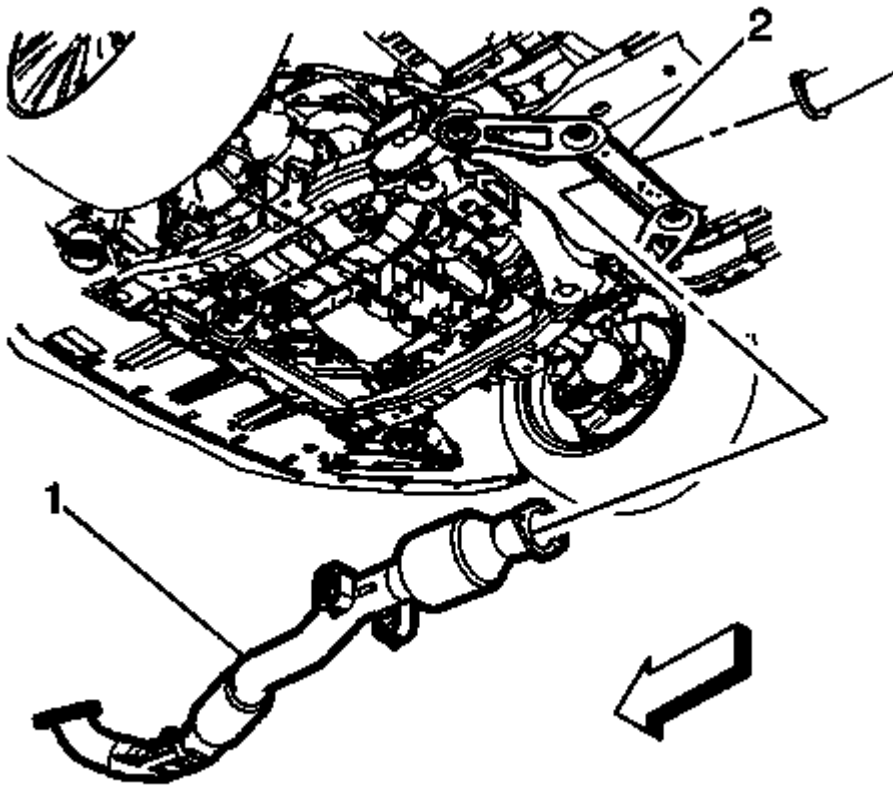


Fig. 9: Exhaust Front Pipe

Courtesy of GENERAL MOTORS COMPANY

2. Install the exhaust front pipe (1) into position above the exhaust front hanger bracket (2).

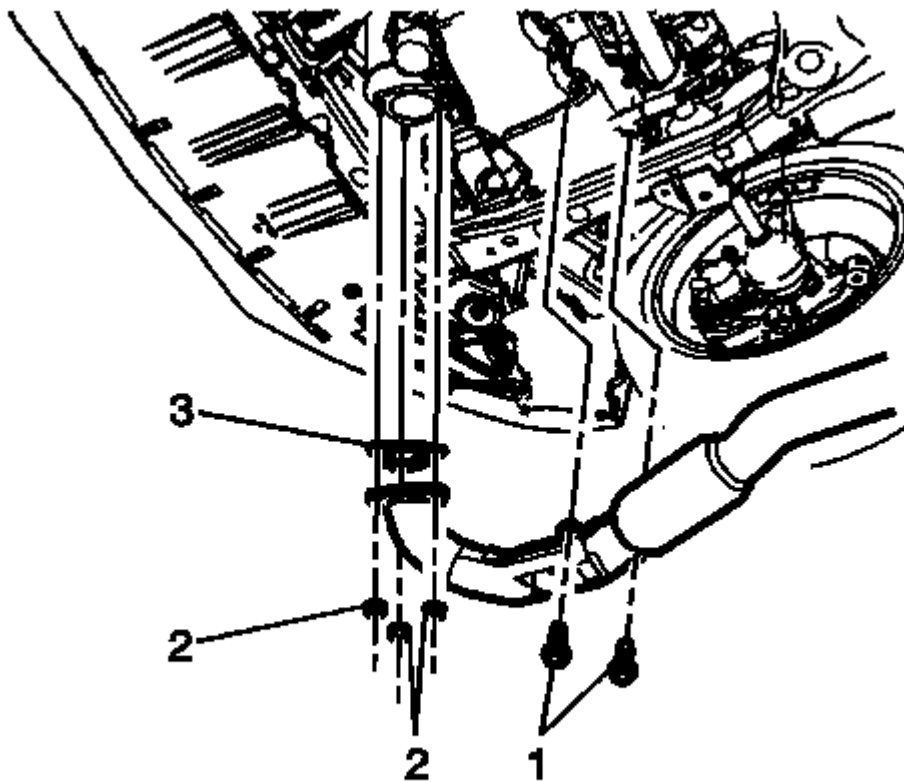


Fig. 10: Catalytic Converter Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the exhaust front pipe to the catalytic converter with a NEW gasket (3) and tighten the fasteners (2) to 25 (18 lb ft).
4. Install the exhaust front pipe bracket fasteners (1) and tighten to 22 (16 lb ft).

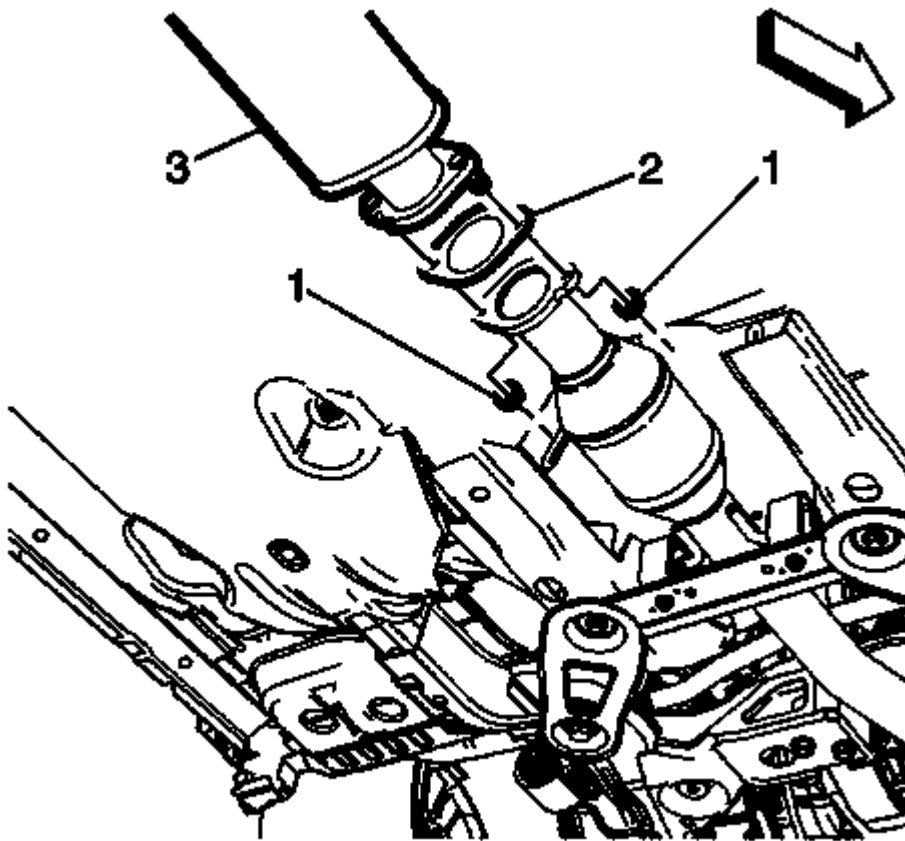


Fig. 11: Exhaust Front Pipe And Exhaust Muffler Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Install the exhaust front pipe to the muffler (3) with a NEW gasket (2) and tighten the fasteners (1) to 18 (13 lb ft).

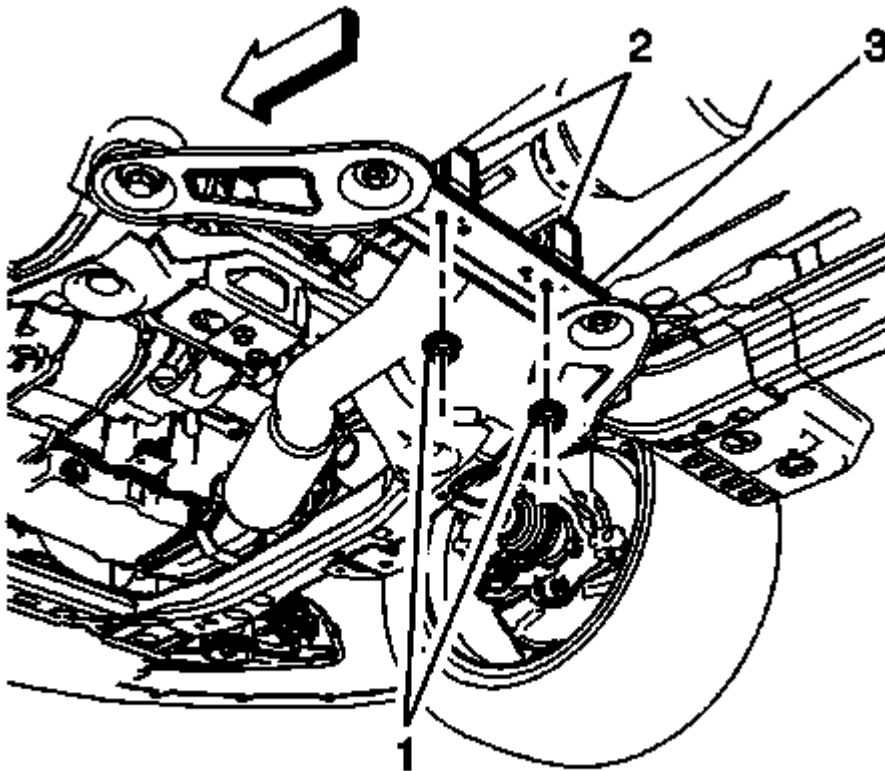


Fig. 12: Fasteners And Exhaust Isolators
Courtesy of GENERAL MOTORS COMPANY

6. Install the exhaust isolator fasteners (1) and tighten to 35 (26 lb ft).
7. Lower the vehicle.
8. Start the engine and check for exhaust leaks.

EXHAUST FRONT PIPE REPLACEMENT (LUK)

Removal Procedure

WARNING: Refer to Hot Exhaust System Warning .

WARNING: Refer to Safety Glasses Warning .

1. Disconnect the oxygen sensors after the catalytic converter.

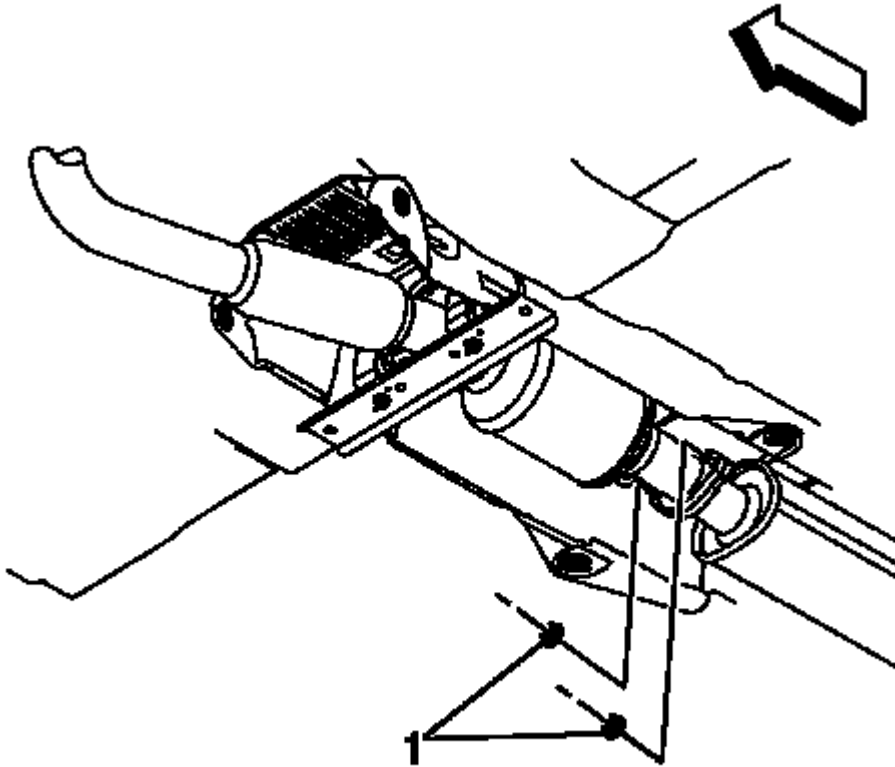


Fig. 13: Front Exhaust Nuts At Rear Muffler Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Remove the front exhaust nuts (1) from the rear muffler pipe.
3. Support the exhaust muffler with a suitable jack or mechanics wire.

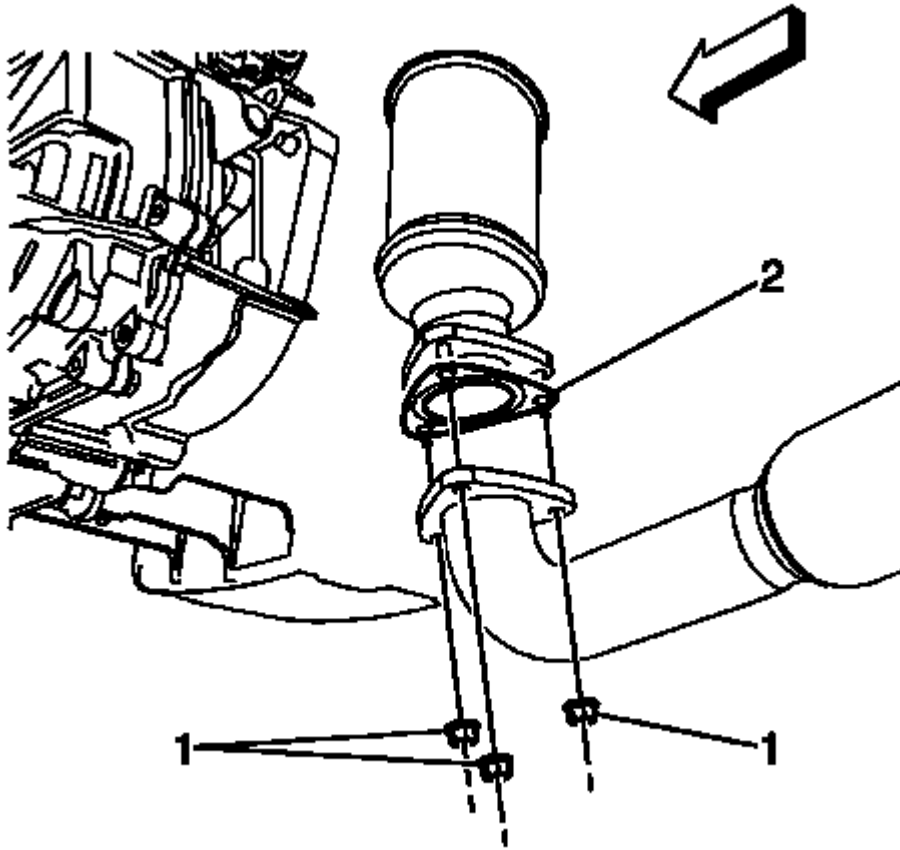


Fig. 14: Lower Catalytic Converter, Nuts And Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Remove the nuts (1) and gasket (2) from the lower catalytic converter.

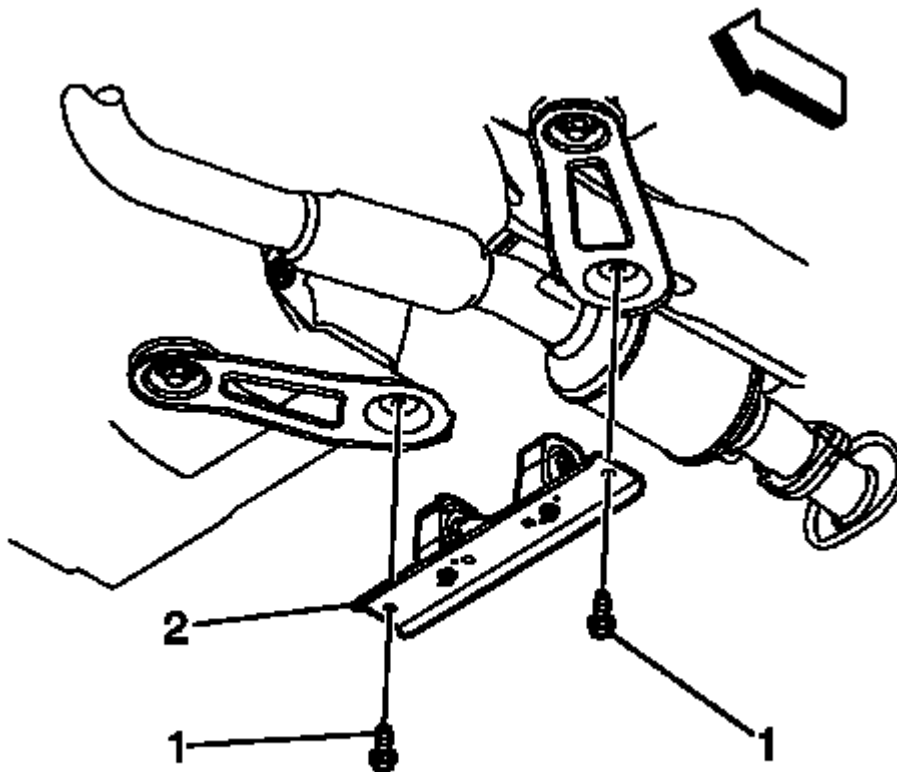


Fig. 15: Front Exhaust Pipe Hanger Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the bolts (1) from the front exhaust pipe hanger bracket (2).

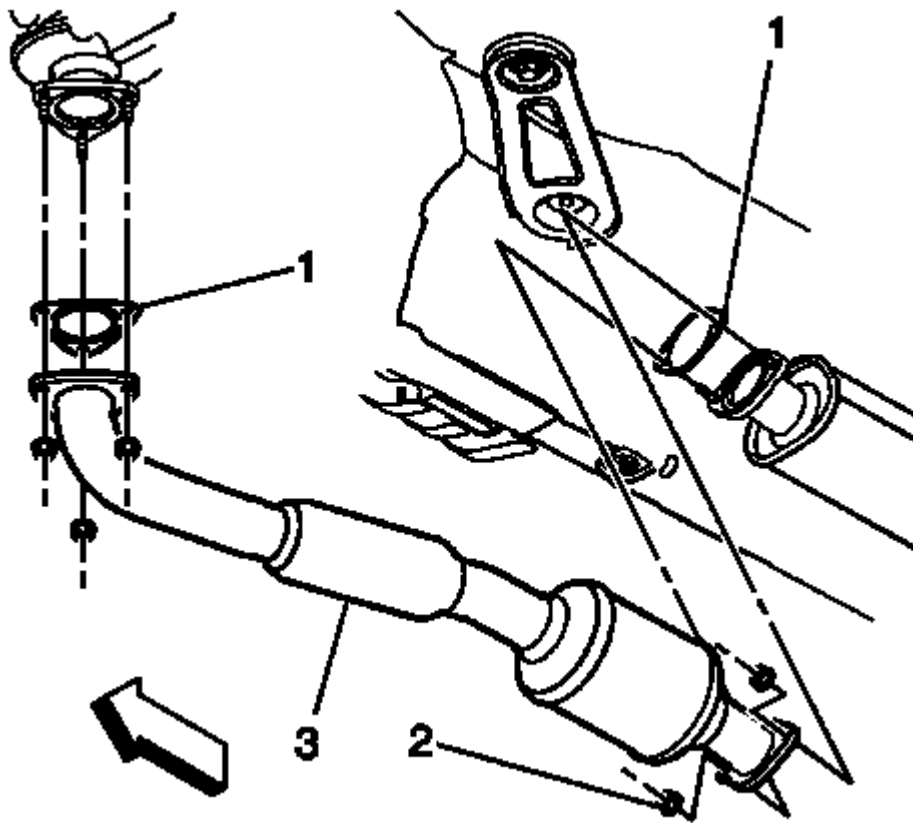


Fig. 16: Front Exhaust Pipe Components
Courtesy of GENERAL MOTORS COMPANY

6. Carefully lower the front exhaust pipe (3).

Installation Procedure

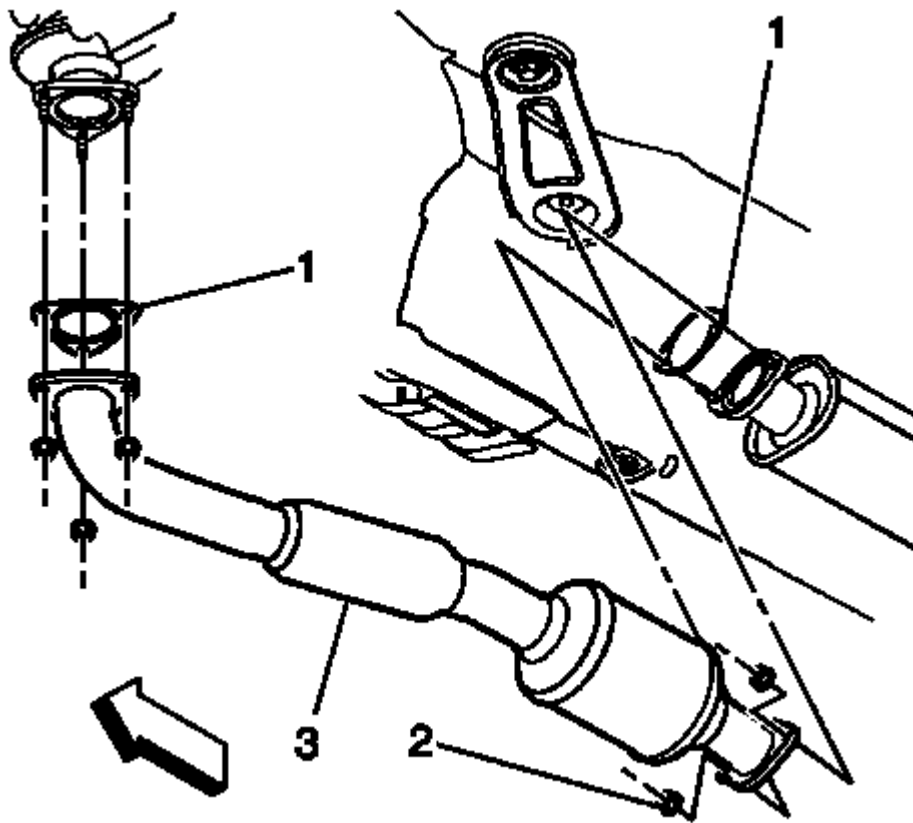


Fig. 17: Front Exhaust Pipe Components
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the front exhaust pipe nuts (2) and gasket (1), to the rear muffler pipe and tighten to 18 N.m (13 lb ft).

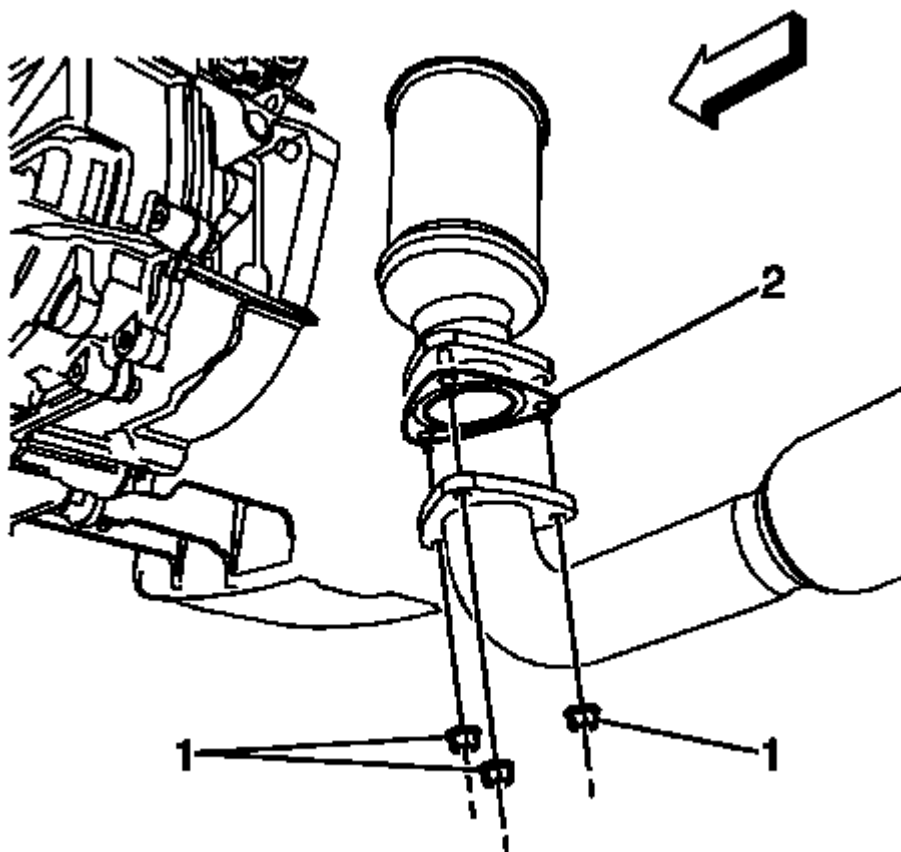


Fig. 18: Lower Catalytic Converter, Nuts And Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Install the nuts (1) of the front exhaust pipe to the lower catalytic converter and tighten to 25 N.m (18 lb ft).

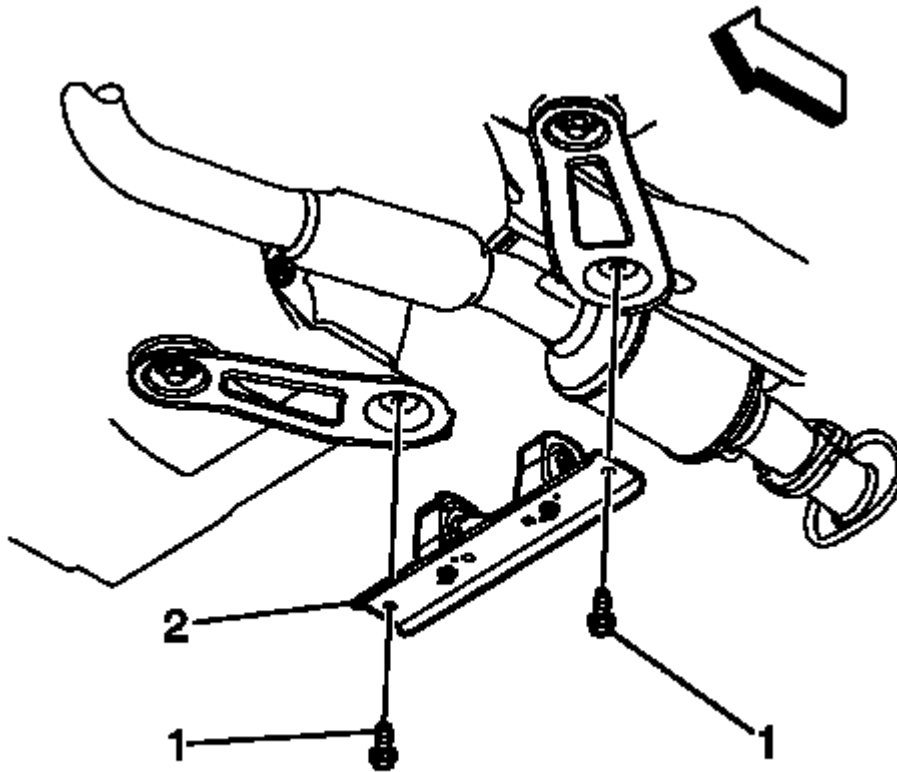


Fig. 19: Front Exhaust Pipe Hanger Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the bolts (1) to the front exhaust pipe hanger bracket (2) and tighten to 60 N.m (44 lb ft).
4. Connect the oxygen sensor electrical sensors.
5. Inspect the exhaust system for leaks.

EXHAUST FRONT PIPE REPLACEMENT (LTG AWD)

Removal Procedure

WARNING: Refer to Exhaust Service Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the heated oxygen sensor, sensor 2. Refer to Heated Oxygen Sensor Replacement - Sensor 2 .

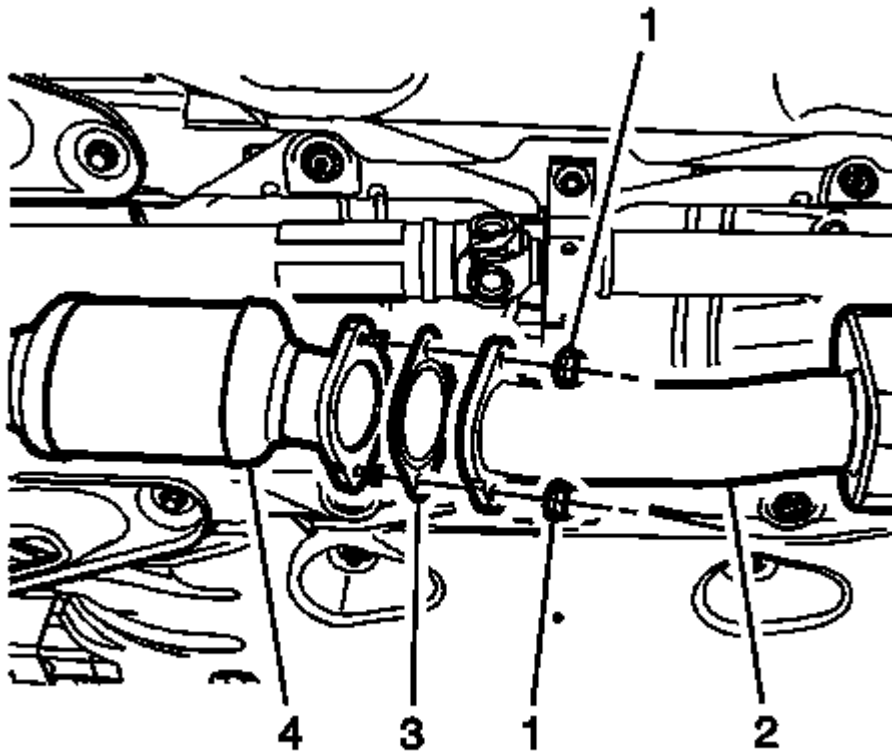


Fig. 20: Fasteners Securing Rear Muffler To Exhaust Front Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fasteners (1) securing the rear muffler (2) to the exhaust front pipe (4) and discard the exhaust gasket (3).

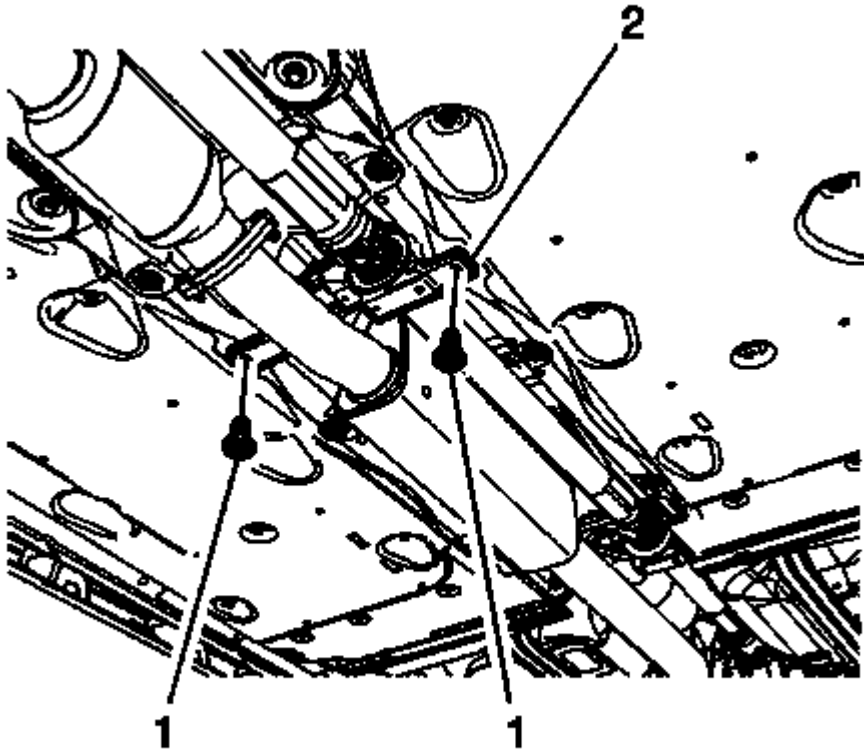


Fig. 21: Prop Shaft Bearing Bracket
Courtesy of GENERAL MOTORS COMPANY

4. If equipped with AWD, to aid in removing the exhaust front pipe hanger bracket, remove the fasteners (1) from the prop shaft bearing bracket (2) and allow the prop shaft to hang down.

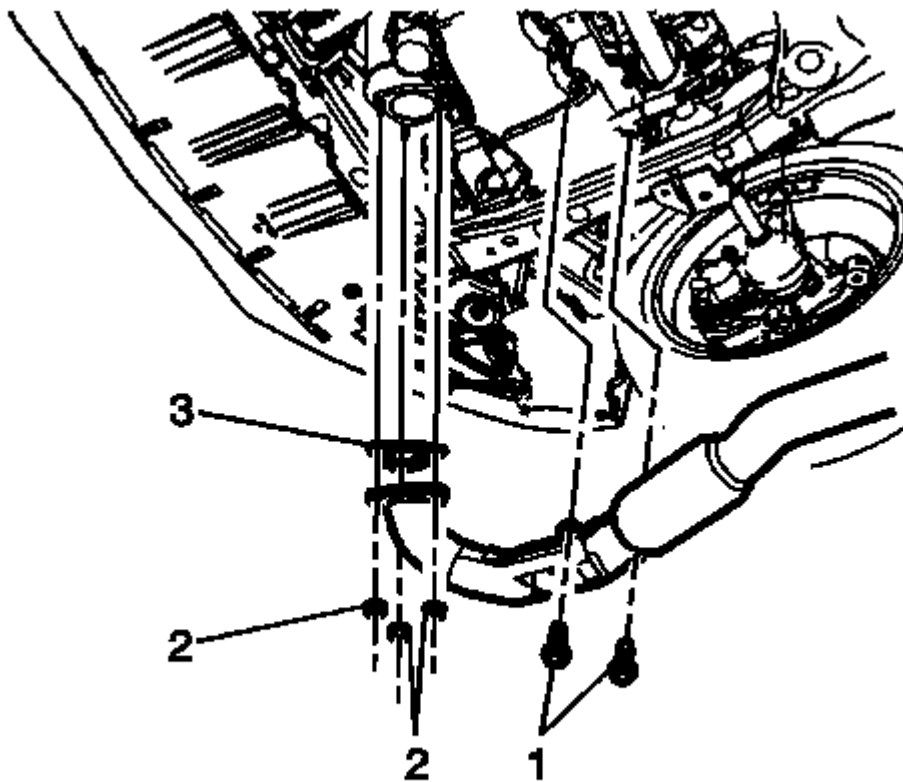


Fig. 22: Catalytic Converter Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the exhaust front pipe fasteners (2) from the front catalytic converter and DISCARD the exhaust gasket (3).
6. Remove the exhaust front pipe bracket fasteners (1).

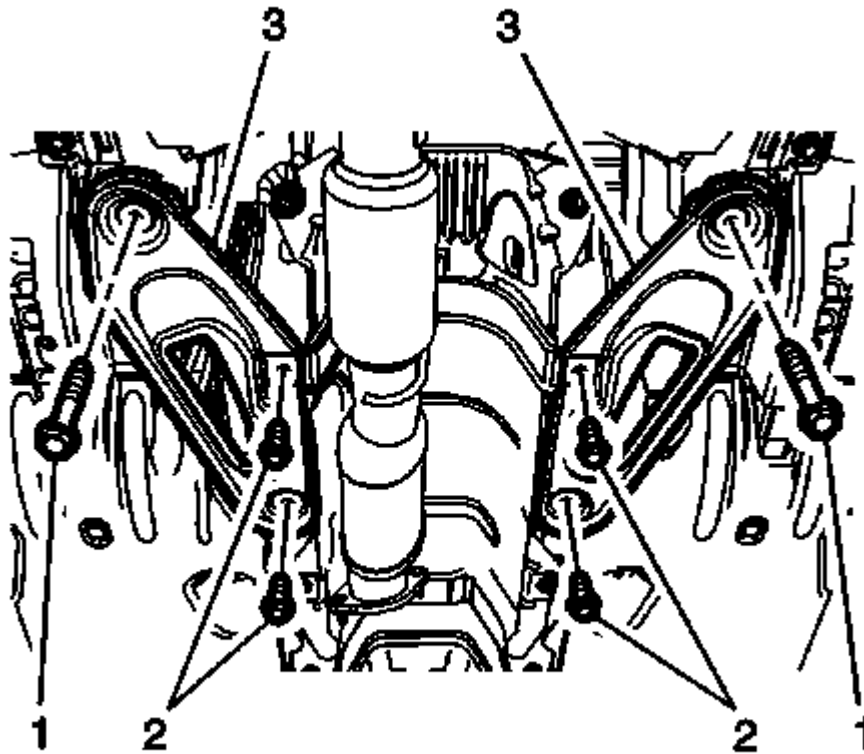


Fig. 23: Left And Right Drivetrain And Front Suspension Frame Support
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the frame cradle fasteners (1) and remove the remaining fasteners (2) of the left and right drivetrain and front suspension frame support (3).

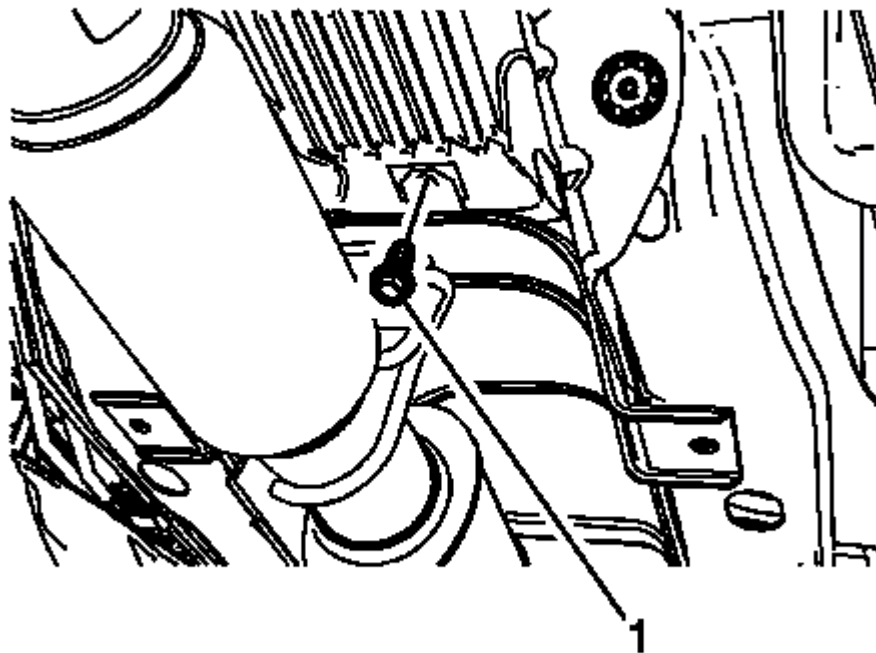


Fig. 24: Exhaust Pipe Front Hanger Bracket Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Remove the exhaust pipe front hanger bracket fastener (1).
9. Lower the exhaust front pipe.
10. Discard the exhaust gaskets.
11. If replacing the exhaust front pipe, remove the exhaust pipe front hanger insulator bracket.

Installation Procedure

1. If replacing the exhaust front pipe, install the exhaust pipe front hanger insulator bracket.

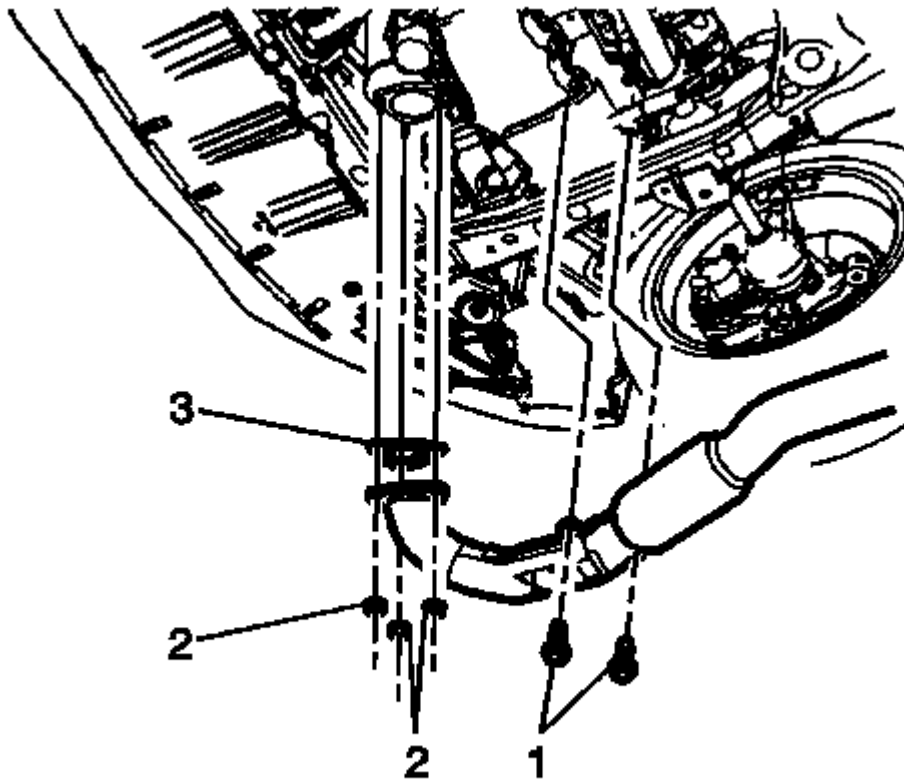


Fig. 25: Catalytic Converter Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Position the exhaust front pipe to the vehicle.

CAUTION: Refer to Fastener Caution .

3. Install the catalytic converter exhaust front pipe fasteners (2) using a NEW gasket (3) and tighten to 25 (18 lb ft).
4. Install the exhaust front pipe bracket fasteners (1) using and tighten to 22 (16 lb ft).

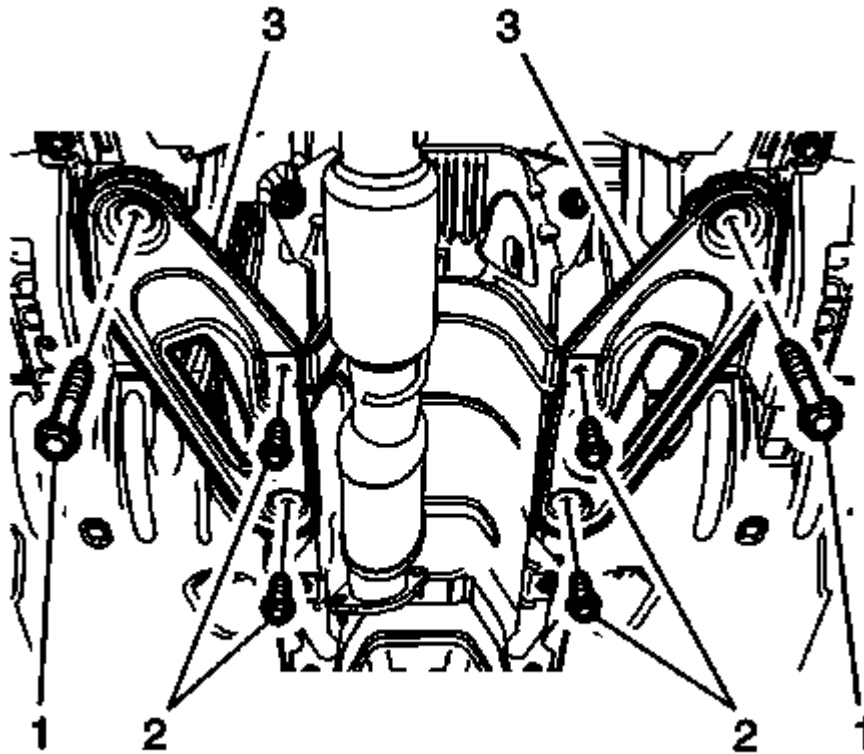


Fig. 26: Left And Right Drivetrain And Front Suspension Frame Supports
Courtesy of GENERAL MOTORS COMPANY

5. Install the fasteners (2) to the left and right drivetrain and front suspension frame supports (3) and tighten to 35 (26 lb ft).
6. Tighten the front fastener (1) to 160 (118 lb ft).

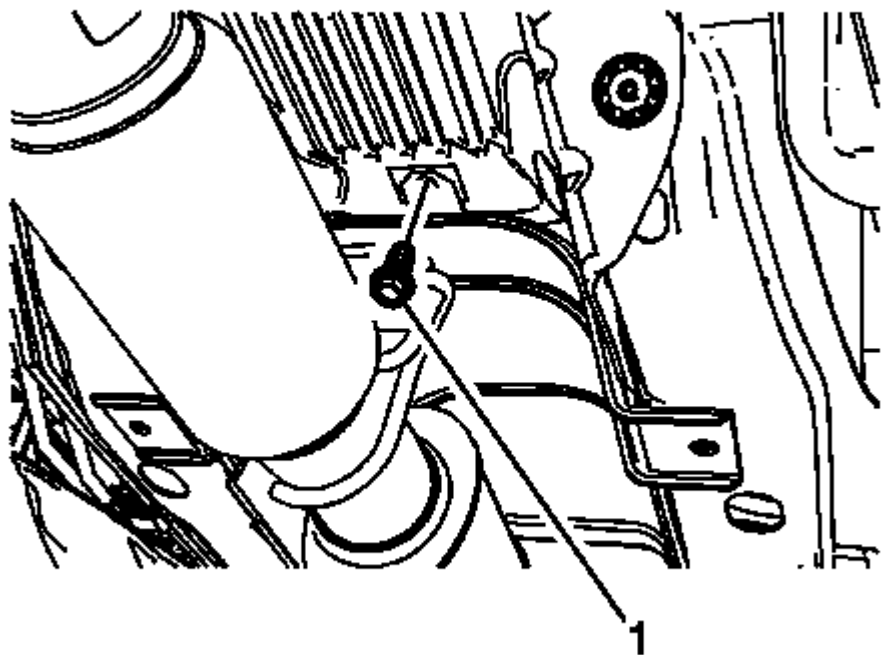


Fig. 27: Exhaust Pipe Front Hanger Bracket Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Install the exhaust pipe front hanger bracket fastener (1) and tighten to 22 (16 lb ft).

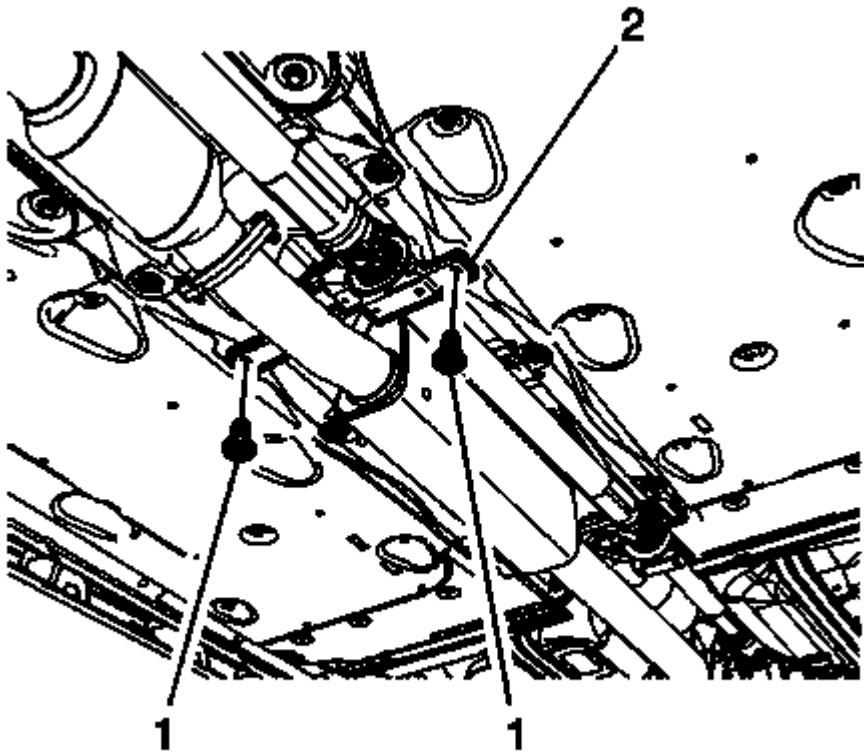


Fig. 28: Prop Shaft Bearing Bracket

Courtesy of GENERAL MOTORS COMPANY

8. If equipped with AWD, install the fasteners (1) to the prop shaft bearing bracket (2) and tighten to 22 (16 lb ft).

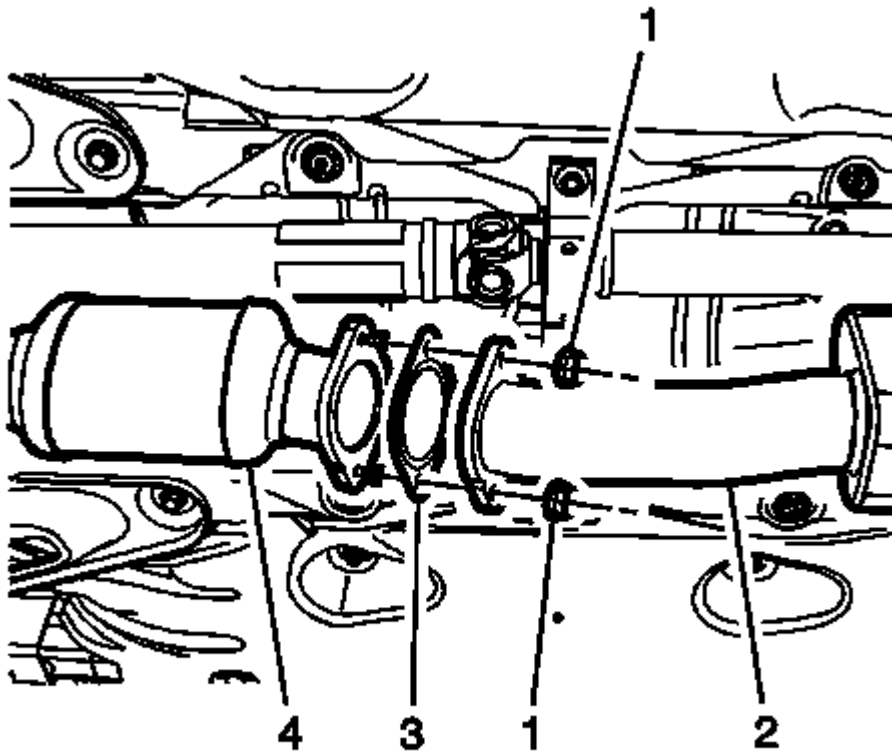


Fig. 29: Fasteners Securing Rear Muffler To Exhaust Front Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Install the fasteners (1) securing the rear muffler (2) to the exhaust front pipe (4) using a NEW exhaust gasket (3). Tighten the fasteners to 18 (13 lb ft).
10. Install the heated oxygen sensor, sensor 2. Refer to **Heated Oxygen Sensor Replacement - Sensor 2**.
11. Lower the vehicle.
12. Start the engine and check for exhaust leaks.

CATALYTIC CONVERTER REPLACEMENT (LTG)

Removal Procedure

WARNING: Refer to **Exhaust Service Warning** .

WARNING: Refer to **Protective Goggles and Glove Warning** .

1. Disconnect the heated oxygen sensor - 1. Refer to **Heated Oxygen Sensor Replacement - Sensor 1** .

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

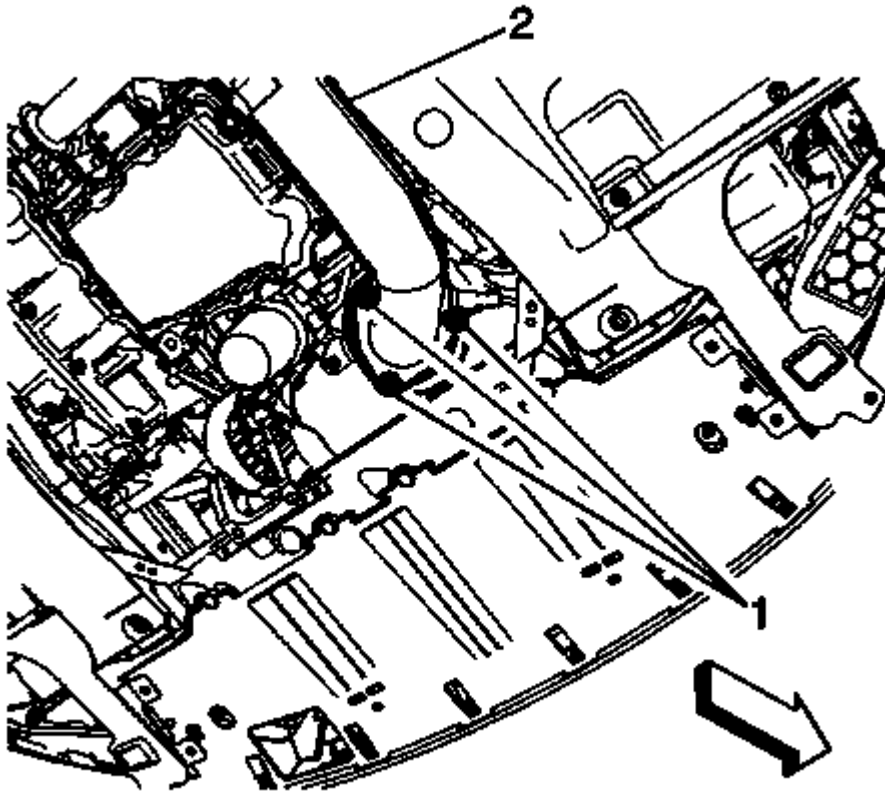


Fig. 30: Fasteners And Exhaust Front Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 3 fasteners (1) securing the exhaust front pipe (2) to the catalytic converter.

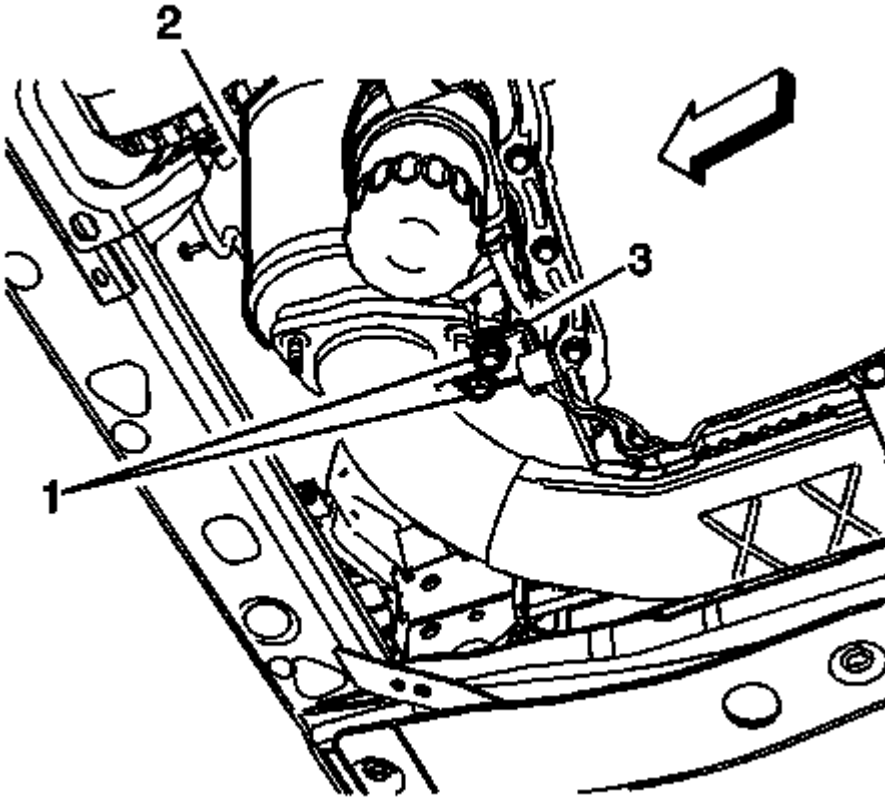


Fig. 31: Catalytic Converter Brace Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the catalytic converter bracket fasteners (1) and remove the catalytic converter bracket (3).
5. Lower the vehicle.

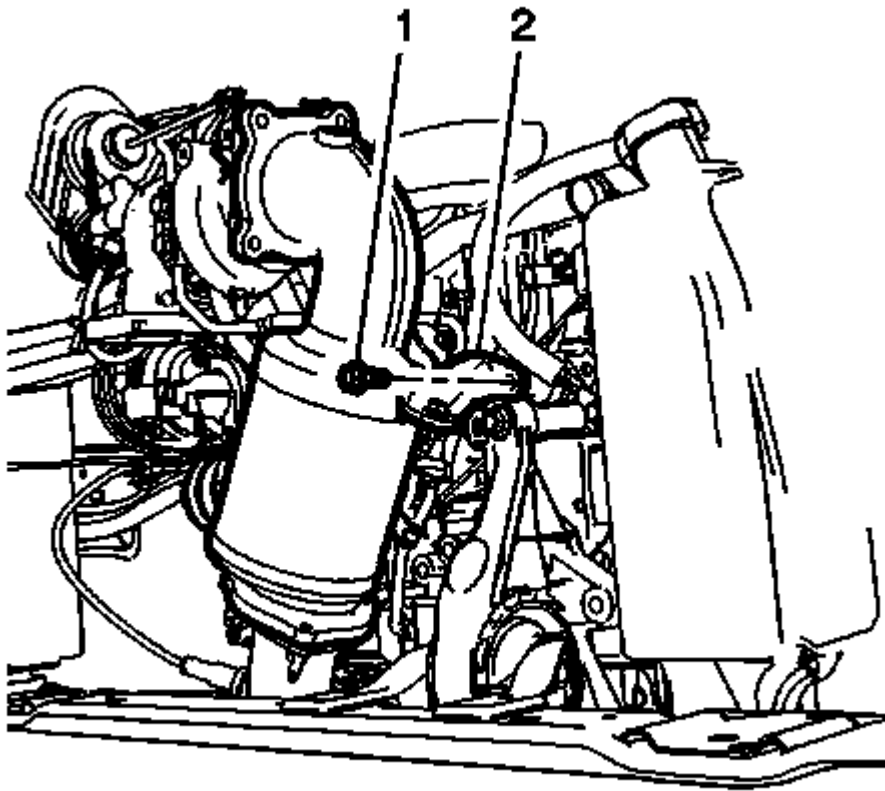


Fig. 32: Catalytic Converter Brace Bracket Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Remove the catalytic converter brace bracket fasteners (1).
7. Remove the catalytic converter brace bracket (2) securing the catalytic converter to the engine block.

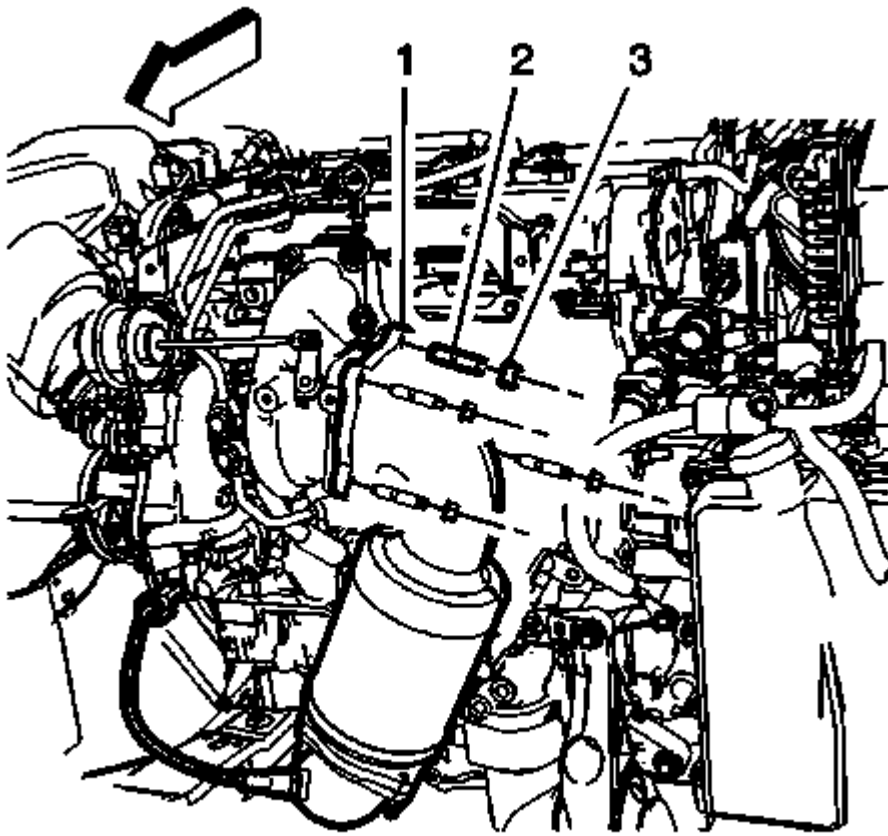


Fig. 33: Fasteners And Catalytic Converter
Courtesy of GENERAL MOTORS COMPANY

8. Remove the 4 fasteners (3) securing the catalytic converter (1) to the turbocharger.
9. Inspect the exhaust manifold studs (2) for damage and replace as necessary.

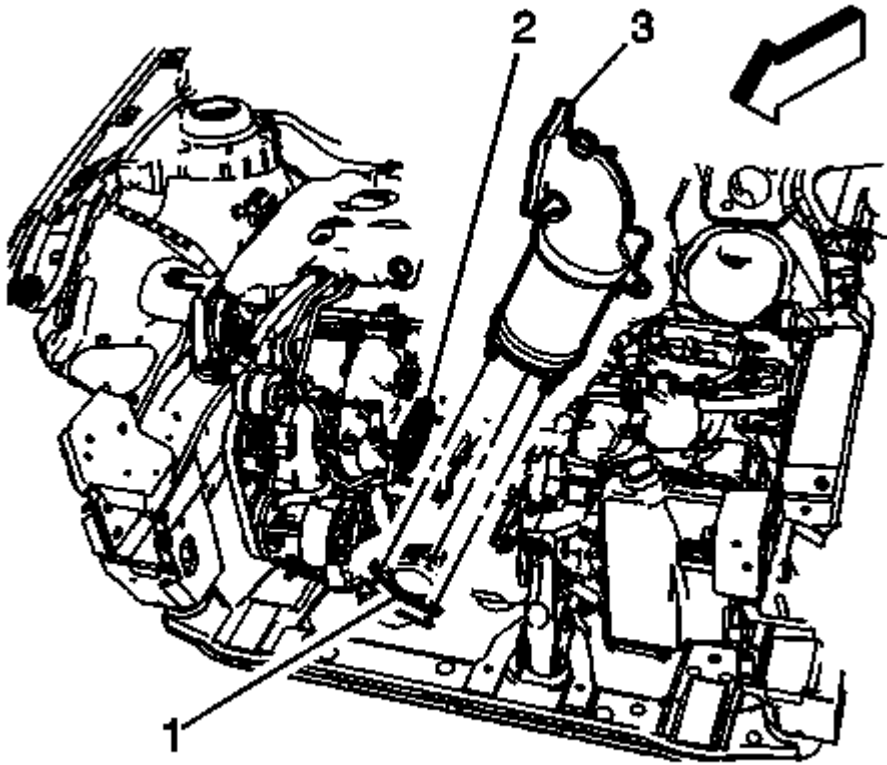


Fig. 34: Catalytic Converter

Courtesy of GENERAL MOTORS COMPANY

10. Remove the catalytic converter (3) from the engine compartment.
11. Discard the turbocharger seal (2) and the exhaust front pipe gasket (1).
12. If replacing the catalytic converter, transfer the catalytic converter brace to the NEW catalytic converter.

Installation Procedure

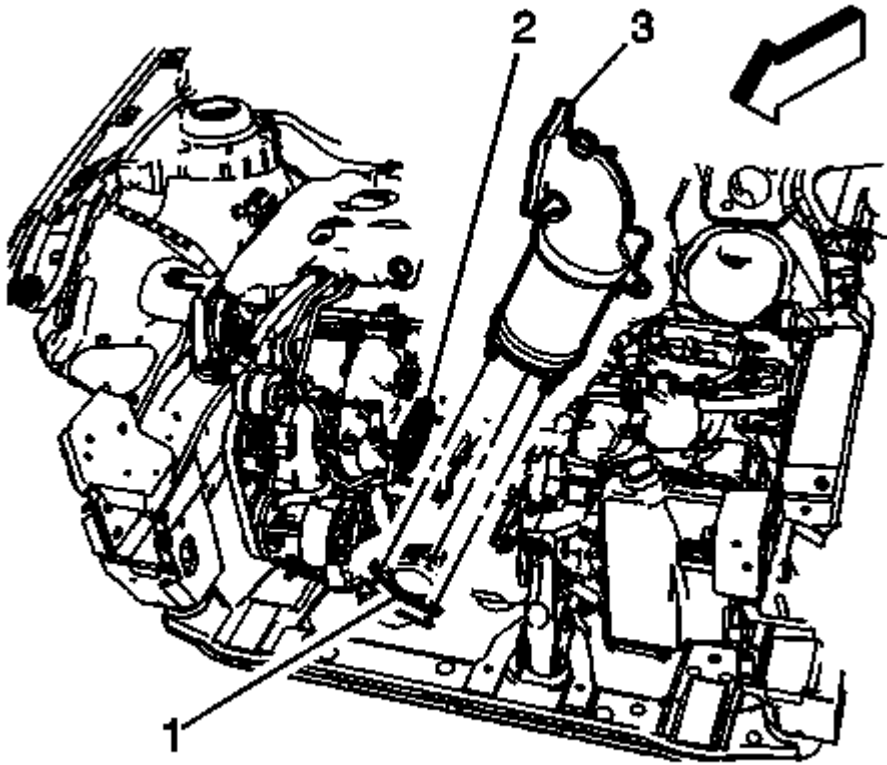


Fig. 35: Catalytic Converter

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) to the turbocharger and a NEW gasket (1) to the exhaust front pipe.
2. Install the catalytic converter (3) into the exhaust front pipe flange and the turbocharger.

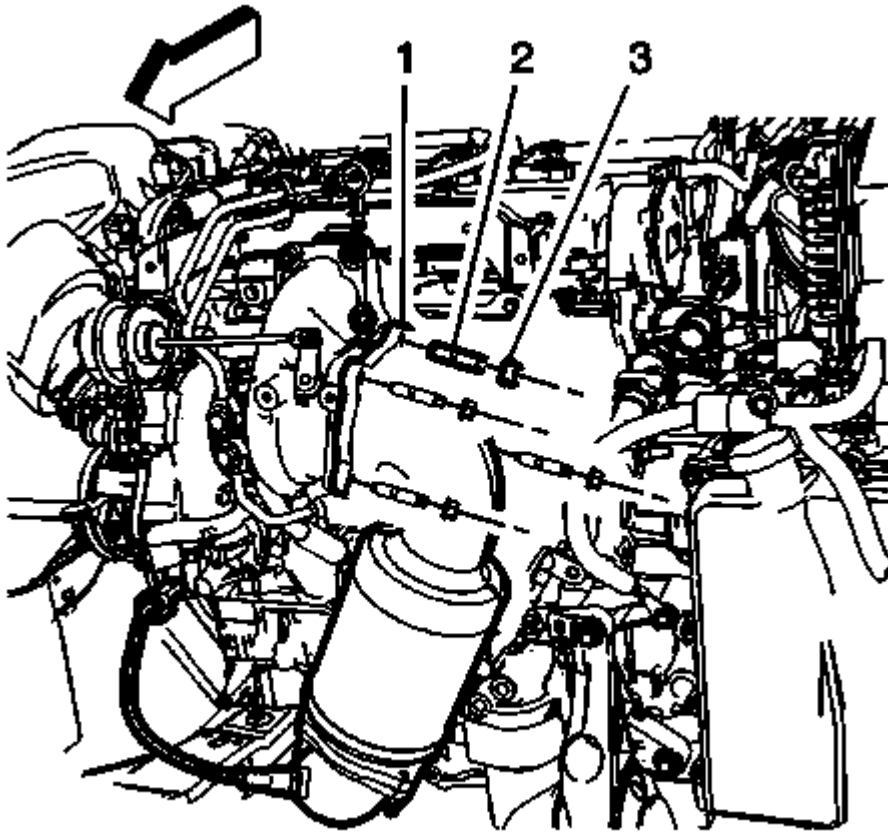


Fig. 36: Fasteners And Catalytic Converter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. If replacing, install the turbocharger studs (2) and tighten to 10 (89 lb in).
4. Install the turbocharger fasteners (3) and tighten in a criss-cross pattern to 22 (16 lb ft).

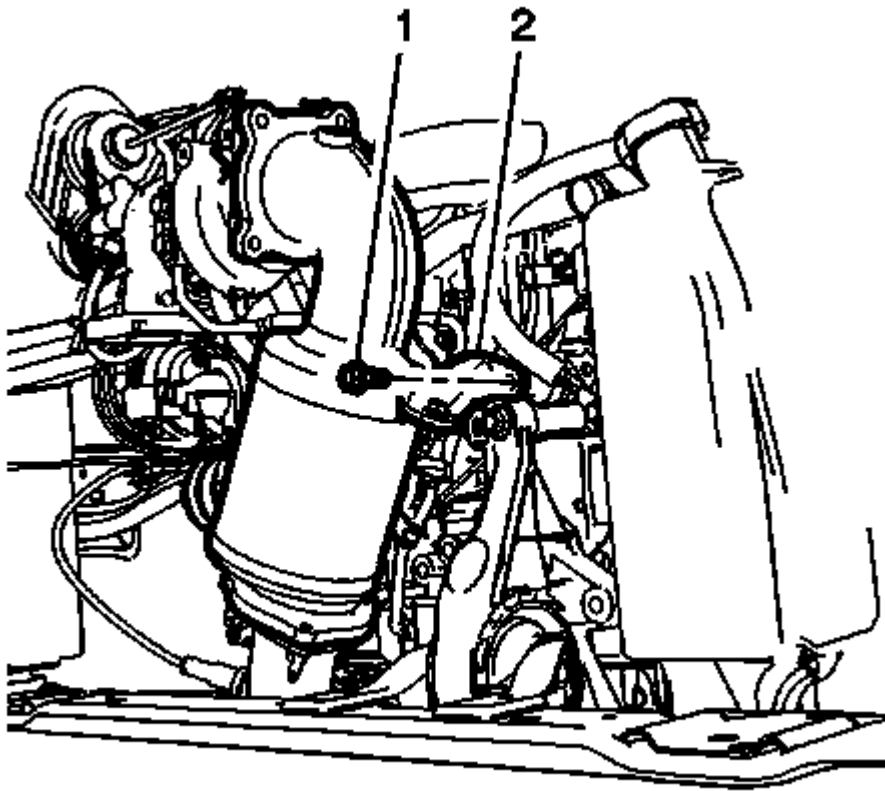


Fig. 37: Catalytic Converter Brace Bracket Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Position the catalytic converter brace bracket (2), to the engine block, and tighten the fastener (1) to 22 (16 lb ft).
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

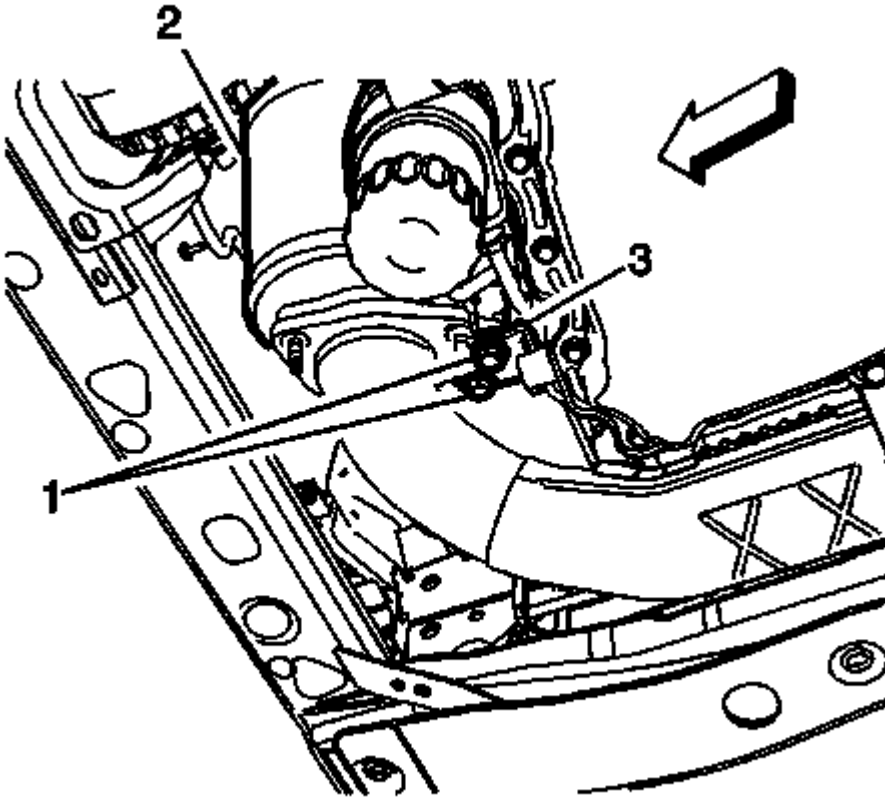


Fig. 38: Catalytic Converter Brace Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Install the catalytic converter bracket and fasteners (1) and tighten to 25 (18 lb ft).

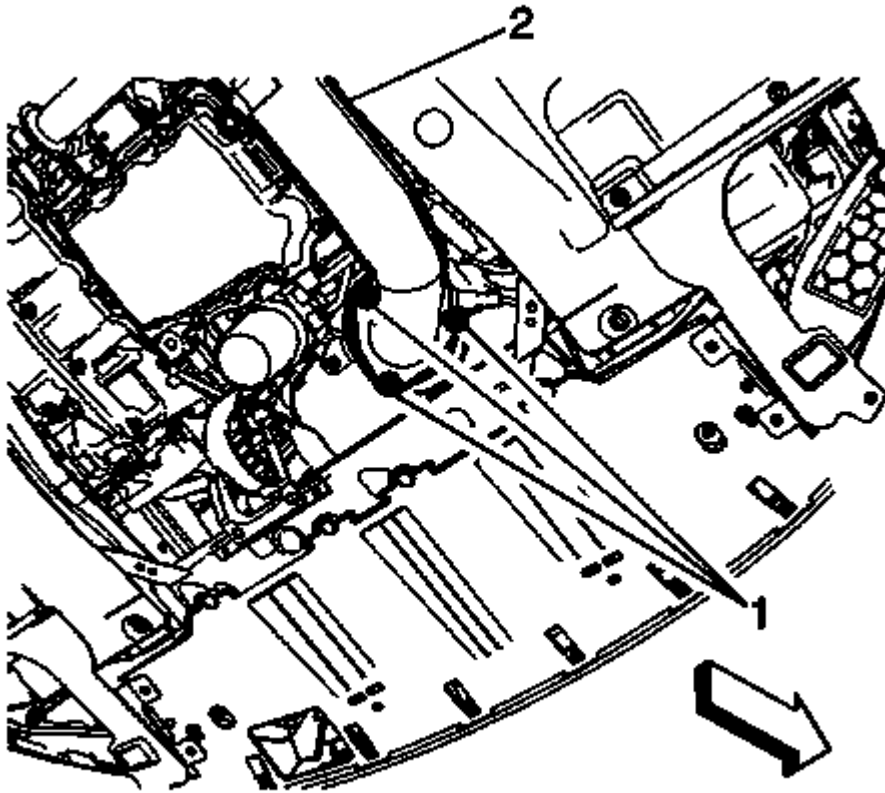


Fig. 39: Fasteners And Exhaust Front Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Install the catalytic converter fasteners (1) and tighten to 28 (21 lb ft).
9. Lower the vehicle.
10. Connect the heated oxygen sensor - 1. Refer to **Heated Oxygen Sensor Replacement - Sensor 1**.
11. Start the engine and check for exhaust leaks.

CATALYTIC CONVERTER REPLACEMENT (LUK)

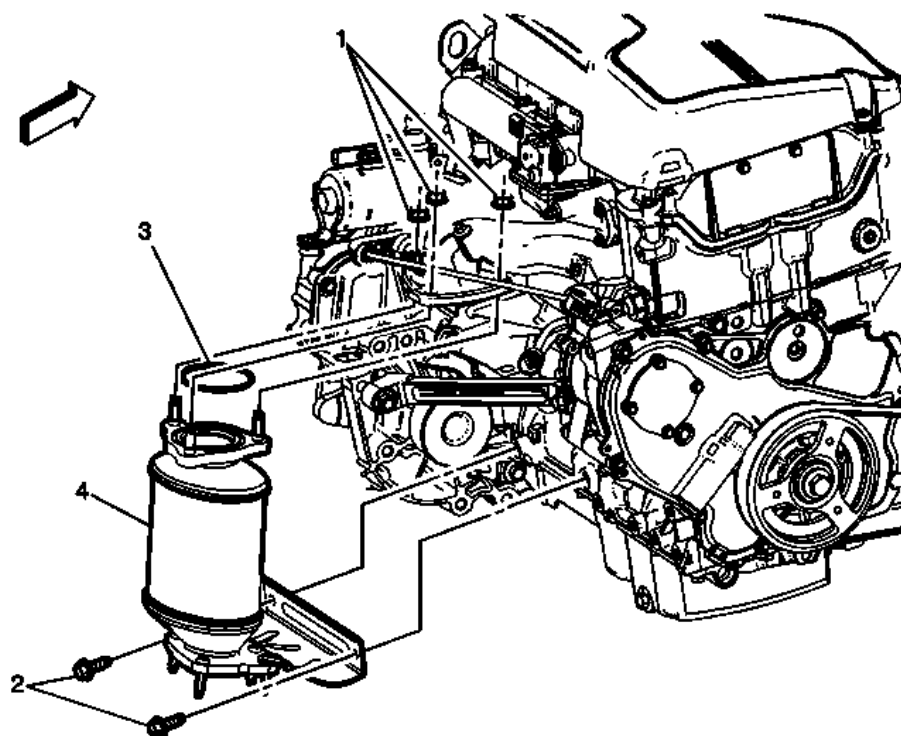


Fig. 40: Catalytic Converter Components (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Catalytic Converter Replacement (LUK)

Callout	Component Name
WARNING: Refer to <u>Exhaust Service Warning</u> .	
WARNING: Refer to <u>Eye Protection Warning</u> .	
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the exhaust front pipe. Refer to <u>Exhaust Front Pipe Replacement (LUK)</u> .	
1	Catalytic Converter Fasteners (Qty: 3) Tighten 50 (36 lb ft)
2	Catalytic Converter Brace Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 58 (43 lb ft)
3	Exhaust Seal
4	Catalytic Converter

CATALYTIC CONVERTER BRACE REPLACEMENT (LUK)

Removal Procedure

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

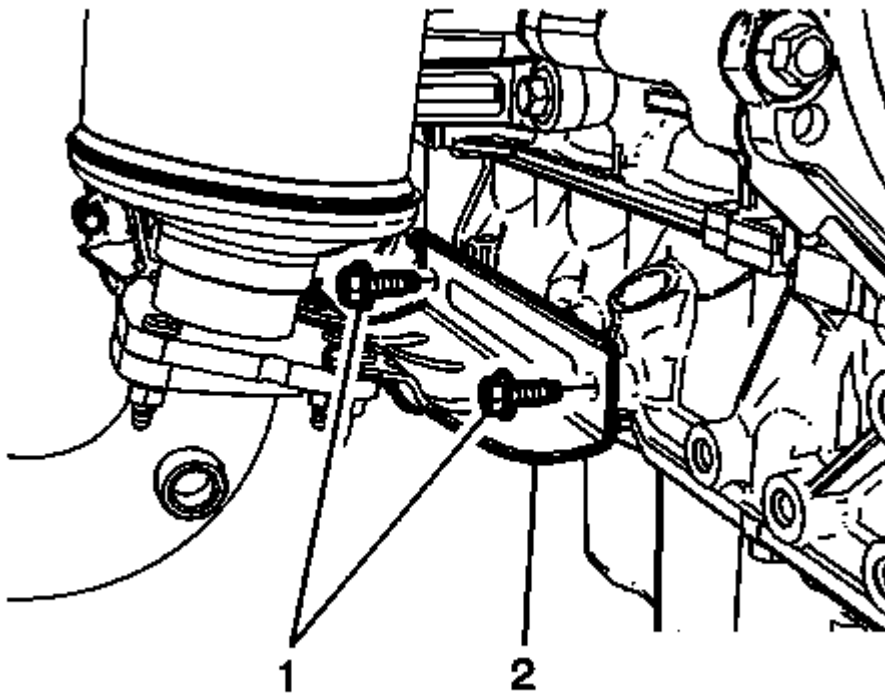


Fig. 41: Catalytic Converter Brace
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fasteners (1) securing the catalytic converter brace (2) to the engine.

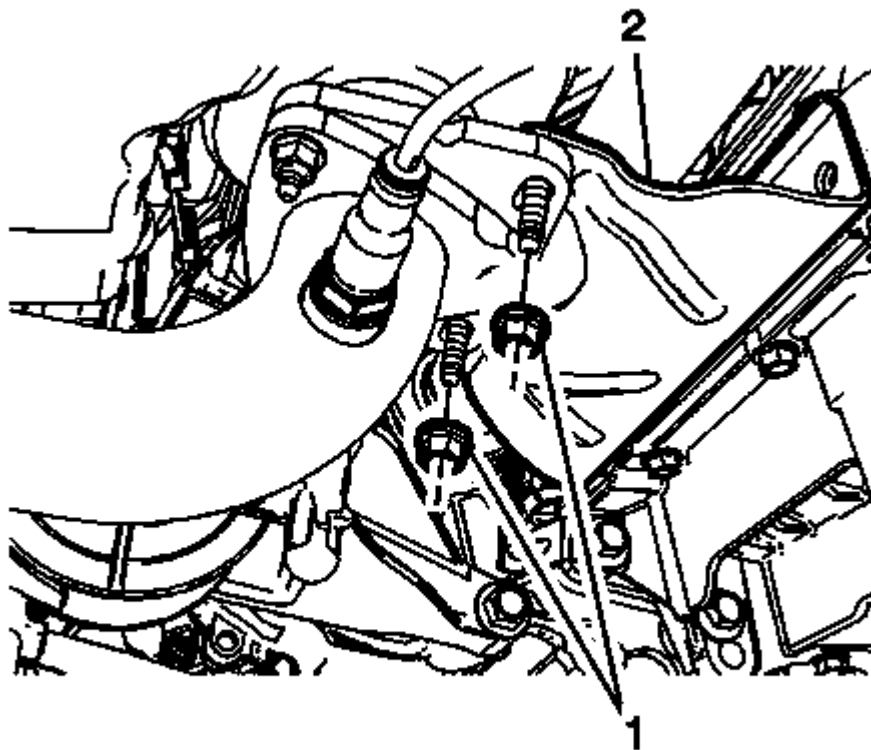


Fig. 42: Fasteners Securing Catalytic Converter Brace To Catalytic Converter
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fasteners (1) securing the catalytic converter brace (2) to the catalytic converter.

Installation Procedure

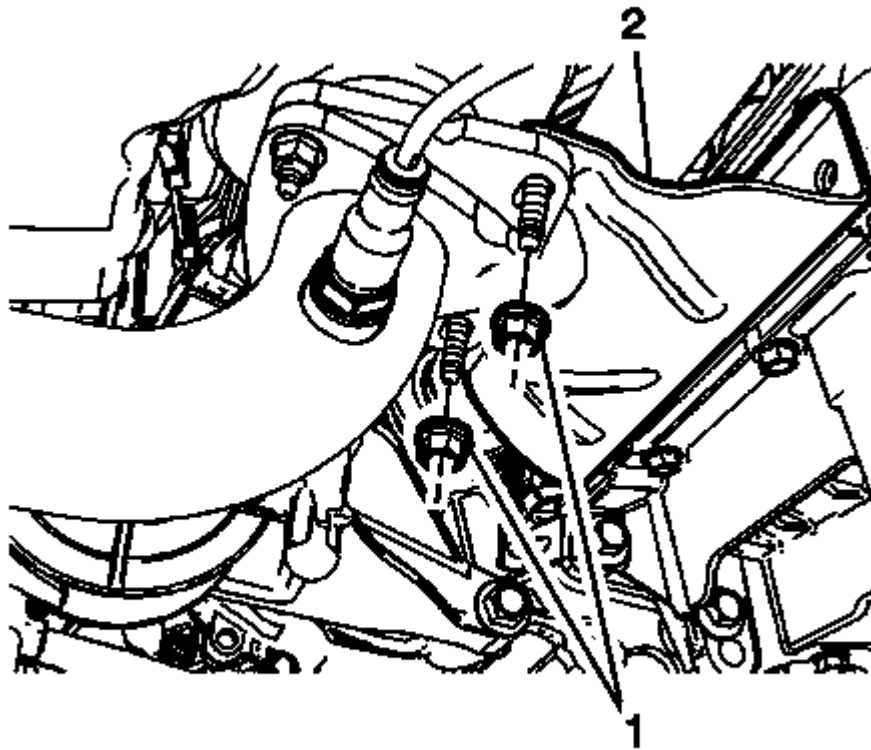


Fig. 43: Fasteners Securing Catalytic Converter Brace To Catalytic Converter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the fasteners (1) securing the catalytic converter brace (2) to the catalytic converter and tighten to 22 (16 lb ft).

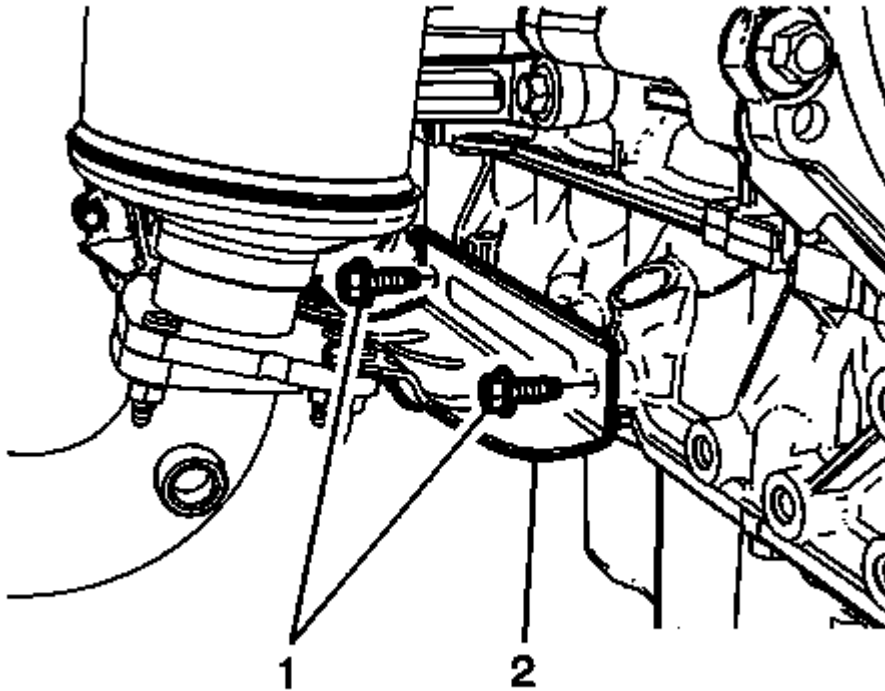


Fig. 44: Catalytic Converter Brace
Courtesy of GENERAL MOTORS COMPANY

2. Install the fasteners (1) securing the catalytic converter brace (2) to the engine and tighten to 22 (16 lb ft).
3. Lower the vehicle.

CATALYTIC CONVERTER BRACE REPLACEMENT (LTG LOWER)

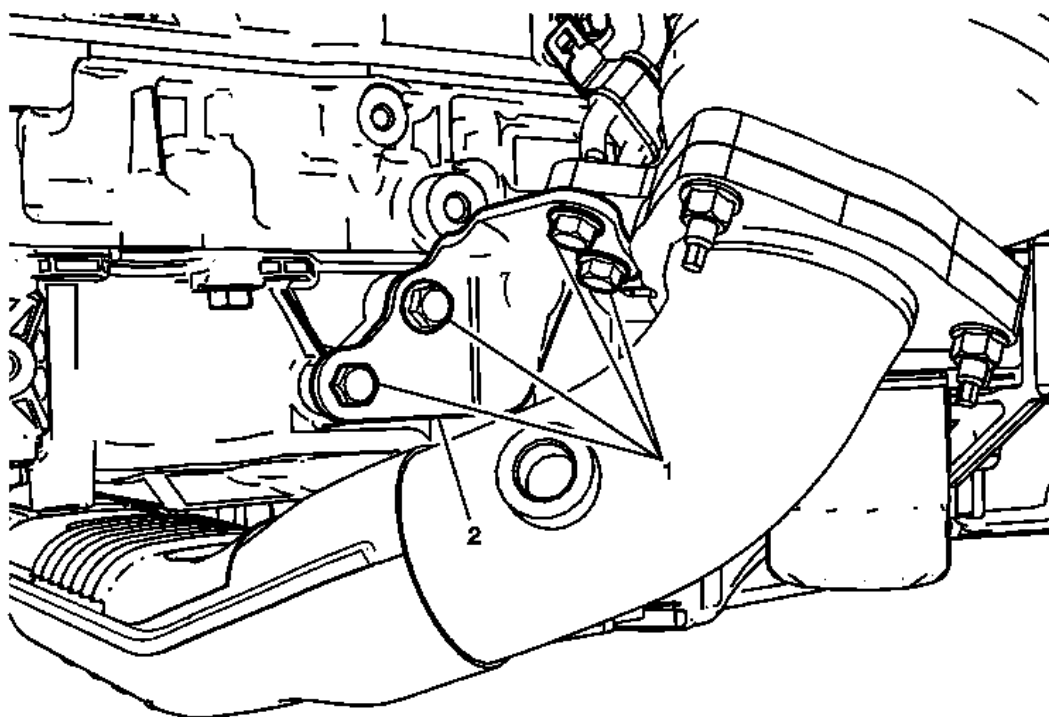


Fig. 45: Catalytic Converter Brace (LTG Lower)
 Courtesy of GENERAL MOTORS COMPANY

Catalytic Converter Brace Replacement (LTG Lower)

Callout	Component Name
Preliminary Procedure	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Catalytic Converter Brace Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 (16 lb ft)
2	Catalytic Converter Brace

CATALYTIC CONVERTER BRACE REPLACEMENT (LTG UPPER)

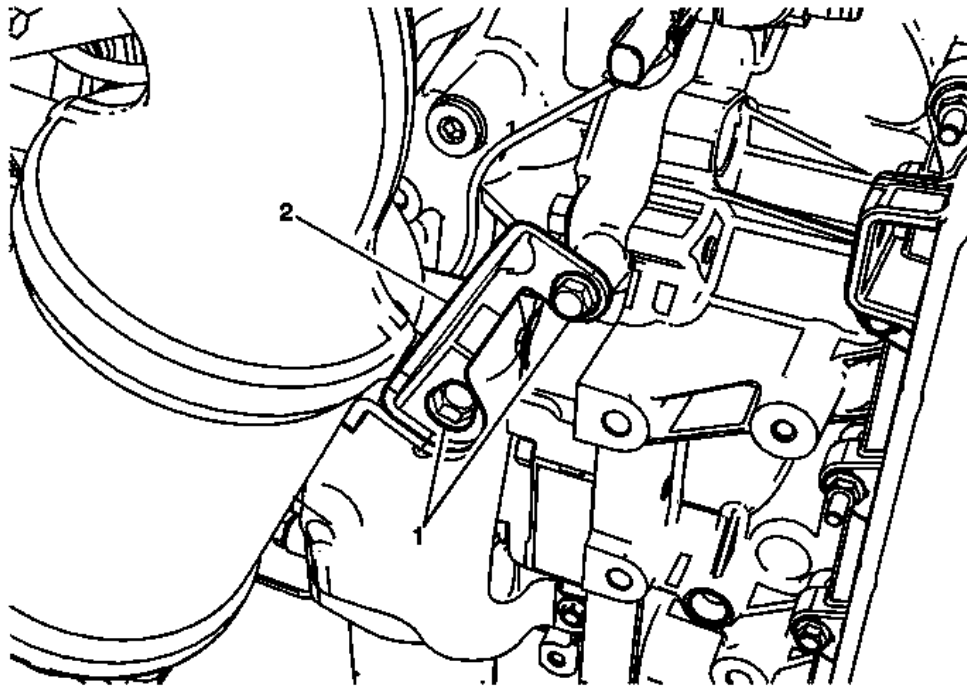


Fig. 46: Catalytic Converter Brace (LTG Upper)
 Courtesy of GENERAL MOTORS COMPANY

Catalytic Converter Brace Replacement (LTG Upper)

Callout	Component Name
1	Catalytic Converter Brace Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 (16 lb ft)
2	Catalytic Converter Brace

EXHAUST MUFFLER REPLACEMENT (DUAL)

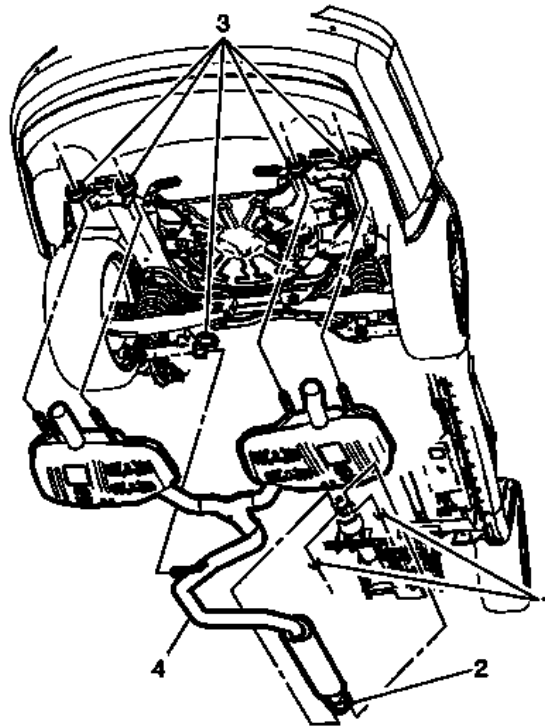


Fig. 47: Exhaust Muffler (Dual)
 Courtesy of GENERAL MOTORS COMPANY

Exhaust Muffler Replacement (Dual)

Callout	Component Name
WARNING: Refer to <u>Eye Protection Warning</u> .	
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
Preliminary Procedure Lift and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Rear Exhaust Muffler to Exhaust Front Pipe Nut (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 18 N.m (13 lb ft)
2	Exhaust Gasket NOTE: Replace exhaust gasket with a NEW exhaust gasket.

3	Exhaust Isolator NOTE: Clean and lubricate exhaust isolators for ease of installation.
4	Exhaust Muffler

EXHAUST MUFFLER REPLACEMENT (SINGLE)

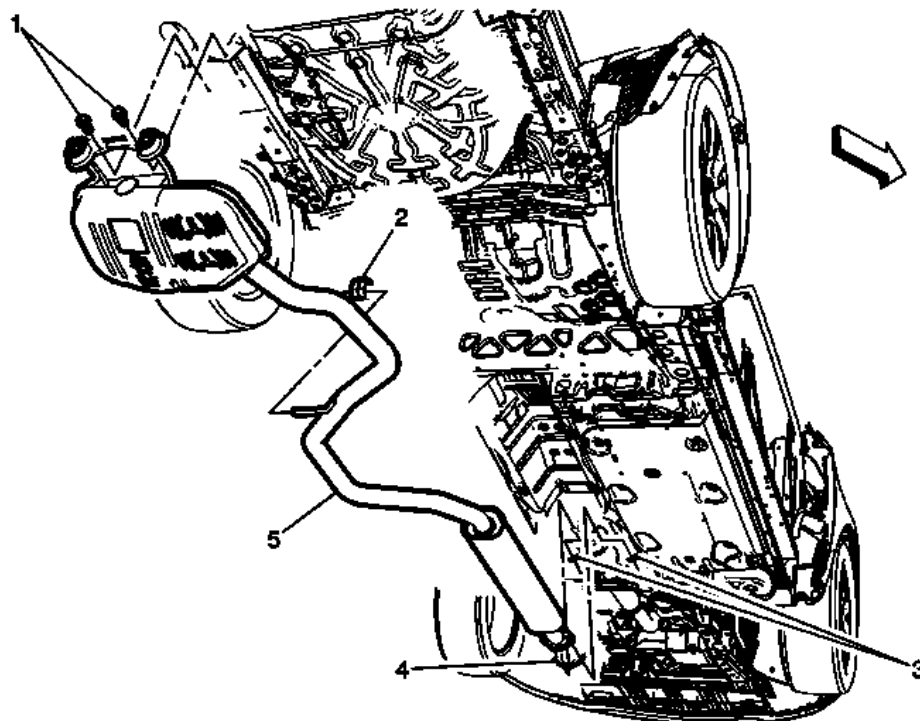


Fig. 48: Exhaust Muffler (Single)
Courtesy of GENERAL MOTORS COMPANY

Exhaust Muffler Replacement (Single)

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Exhaust Muffler Rear Hanger Fastener (Qty: 2) WARNING: Refer to <u>Eye Protection Warning</u> . WARNING: Refer to <u>Hot Exhaust System Warning</u> . CAUTION:

	Refer to <u>Fastener Caution</u> .
	Tighten 22 N.m (16 lb ft)
2	Exhaust Isolator
3	Exhaust Front Pipe Fastener Tighten 18 N.m (13 lb ft)
4	Exhaust Gasket NOTE: Replace the gasket with a NEW gasket.
5	Exhaust Muffler with Resonator

EXHAUST MUFFLER CENTER HEAT SHIELD REPLACEMENT

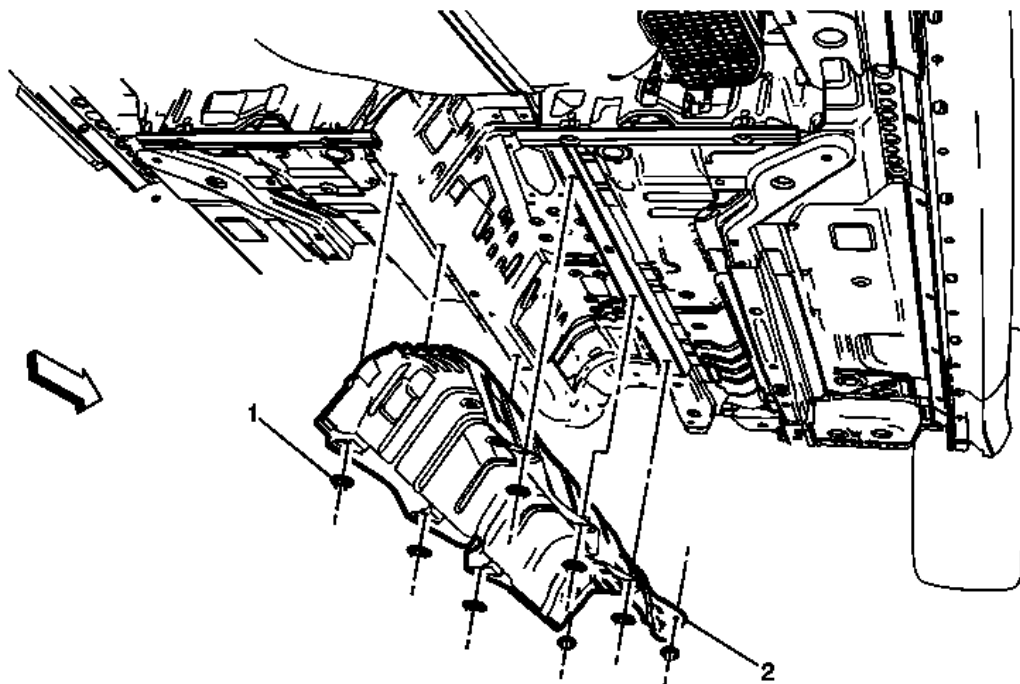


Fig. 49: Exhaust Muffler Center Heat Shield & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Exhaust Muffler Center Heat Shield Replacement

Callout	Component Name
Preliminary Procedures	

1. Remove the exhaust muffler. Refer to **Exhaust Muffler Replacement (Dual)**, **Exhaust Muffler Replacement (Single)**.
2. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG)**, **Exhaust Front Pipe Replacement (LUK)**, **Exhaust Front Pipe Replacement (LTG AWD)**.

1	Fastener (Qty: 8)
2	Exhaust Pipe Heat Shield

FUEL TANK HEAT SHIELD REPLACEMENT

Removal Procedure

1. Relieve the fuel system pressure. Refer to **FUEL PRESSURE RELIEF** for 2.0L or **FUEL PRESSURE RELIEF** for 2.4L.
2. Drain the fuel tank. Refer to **FUEL TANK DRAINING** for 2.0L or **FUEL TANK DRAINING (NON E-85)** or **FUEL TANK DRAINING (E-85)** for 2.4L.
3. Remove the right rear wheel. Refer to **Tire and Wheel Removal and Installation** .
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the exhaust rear muffler. .

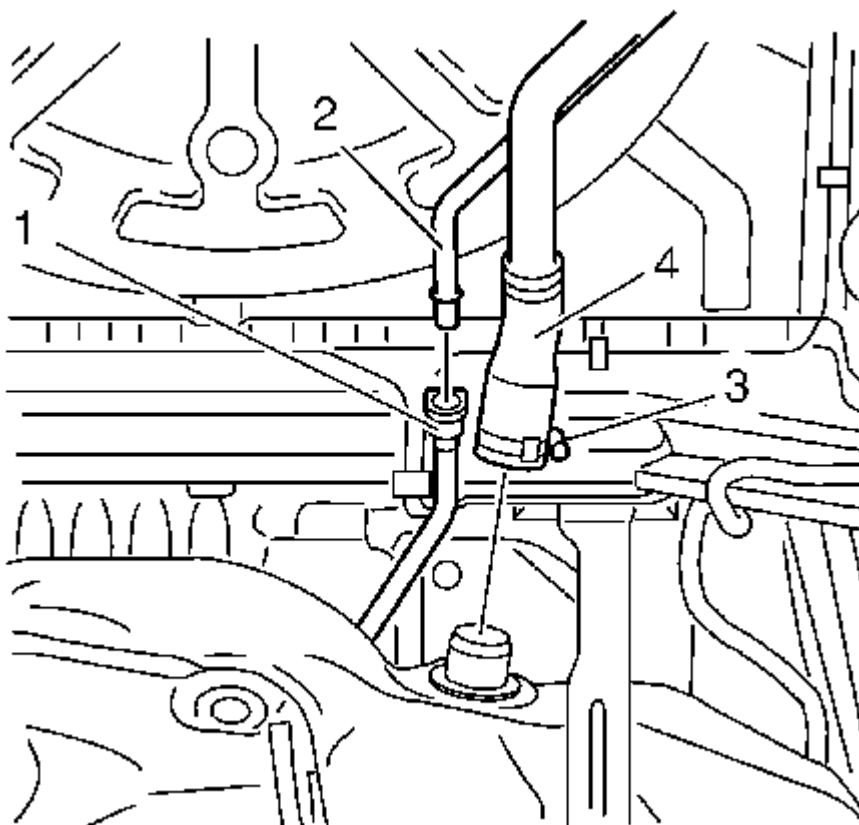


Fig. 50: Chassis Fuel Feed Pipe, Quick Connect Fitting, Fuel Pipe & Retainer

Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the fuel tank filler pipe quick connect fitting (1) from the chassis fuel feed pipe (2).
7. Disconnect the fuel tank filler pipe retainer (3) from the chassis fuel pipe (4).

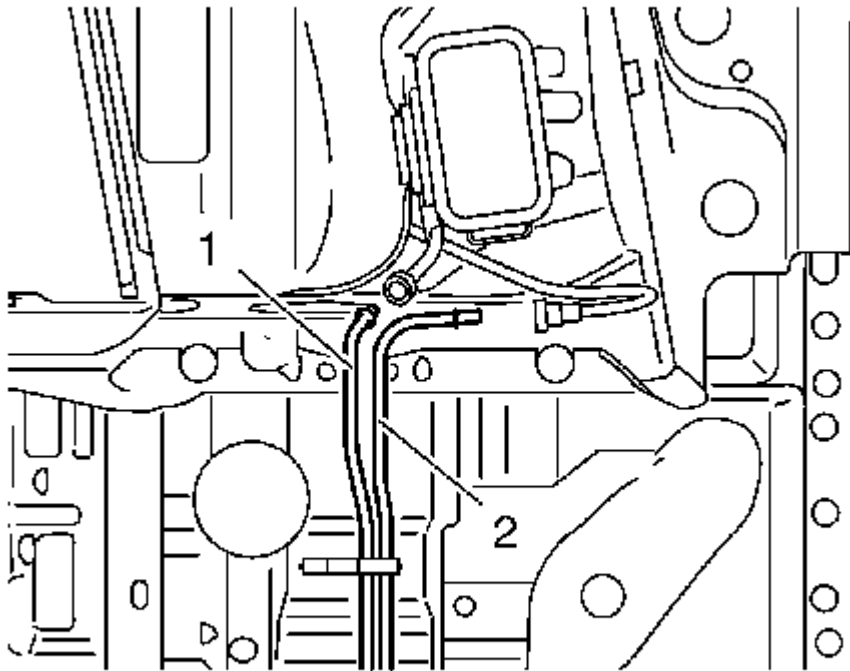


Fig. 51: Evaporative Emission Canister Purge Pipe & Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the evaporative emission canister purge pipe (1).
9. Disconnect the fuel feed pipe (2).

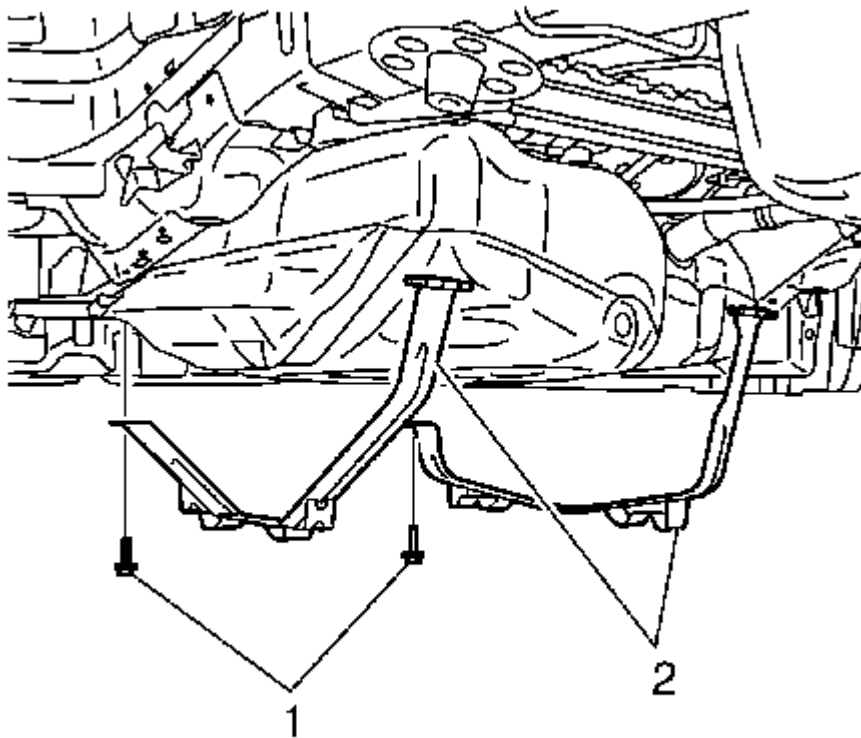


Fig. 52: Fuel Tank Straps & Fastener
Courtesy of GENERAL MOTORS COMPANY

10. Have assistants support either side of the fuel tank.
11. Place a suitable adjustable jack under the fuel tank.
12. Remove fuel tank strap fastener (1) and straps (2).
13. Have the assistants rest the fuel tank on the adjustable jack.

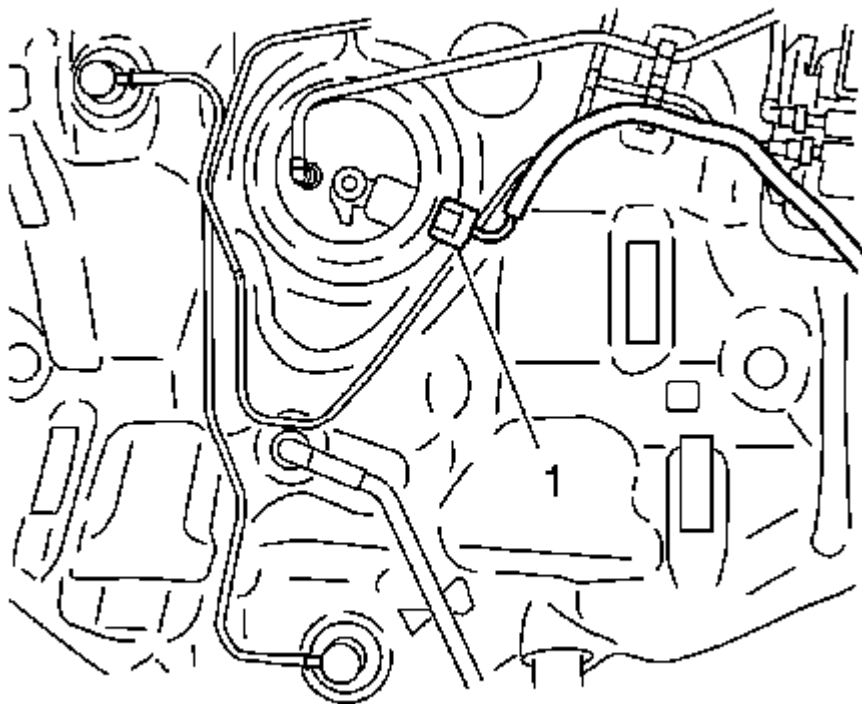


Fig. 53: Fuel Pump Module Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the fuel tank fuel pump module wiring harness electrical connector (1), from the fuel tank fuel pump module.
15. Once the tank is clear of the frame, lower the fuel tank down and remove forward toward the right side of the vehicle.

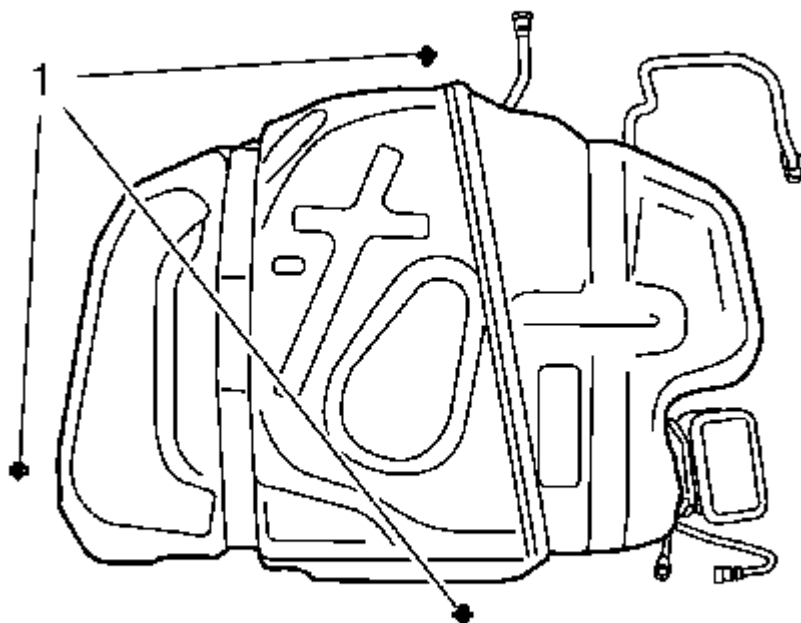


Fig. 54: Fuel Tank Shield Retainer
Courtesy of GENERAL MOTORS COMPANY

16. Detach the fuel tank shield retainer (1).

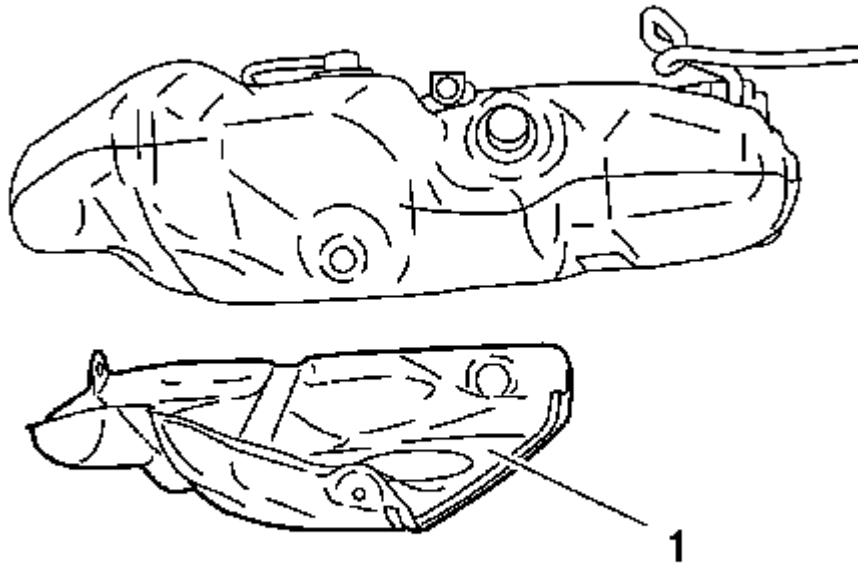


Fig. 55: Fuel Tank Shield

Courtesy of GENERAL MOTORS COMPANY

17. Remove the fuel tank shield (1).

Installation Procedure

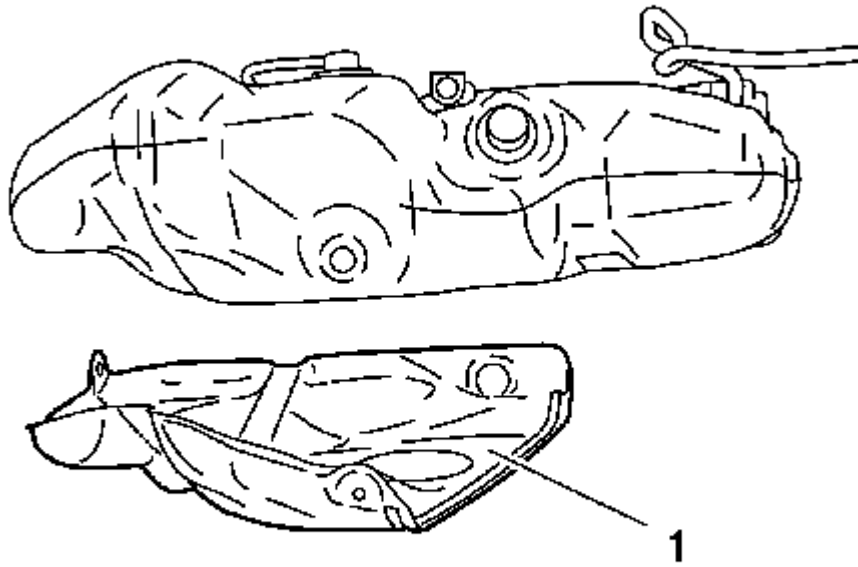


Fig. 56: Fuel Tank Shield

Courtesy of GENERAL MOTORS COMPANY

1. Attach the fuel tank shield (1).

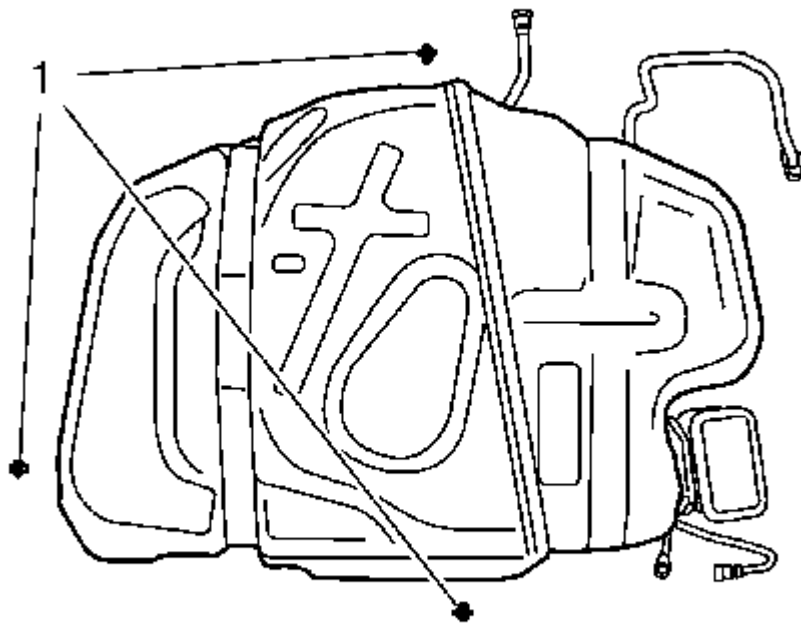


Fig. 57: Fuel Tank Shield Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Insert the fuel tank shield retainer (1).
3. Have assistants support either side of the fuel tank.
4. Place a suitable adjustable jack under the fuel tank.
5. Have the assistants rest the fuel tank on the adjustable jack.
6. Once the tank is clear of the frame, upper the fuel tank high.

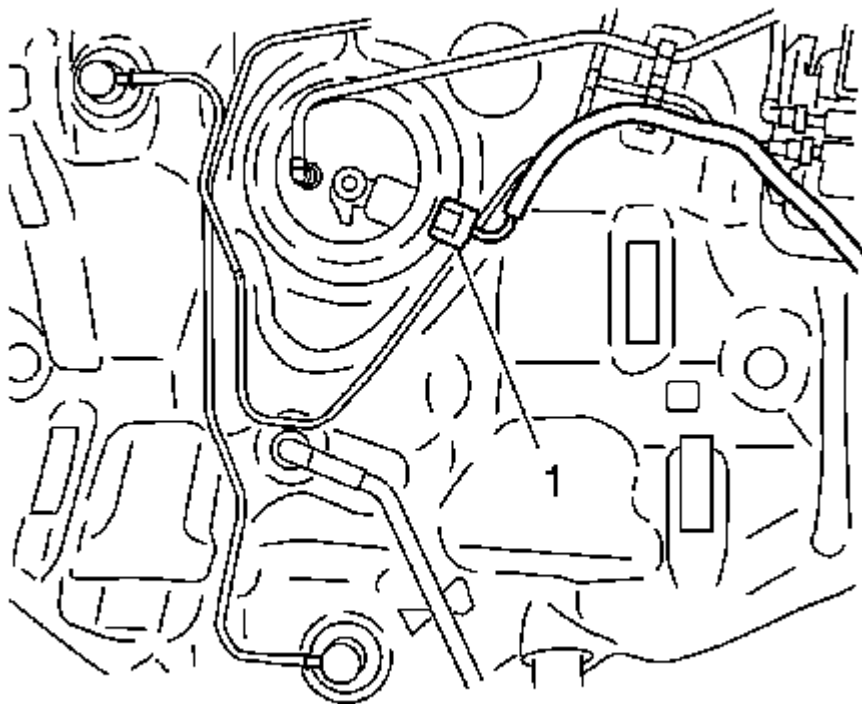


Fig. 58: Fuel Pump Module Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the fuel tank fuel pump module wiring harness electrical connector (1), from the fuel tank fuel pump module.

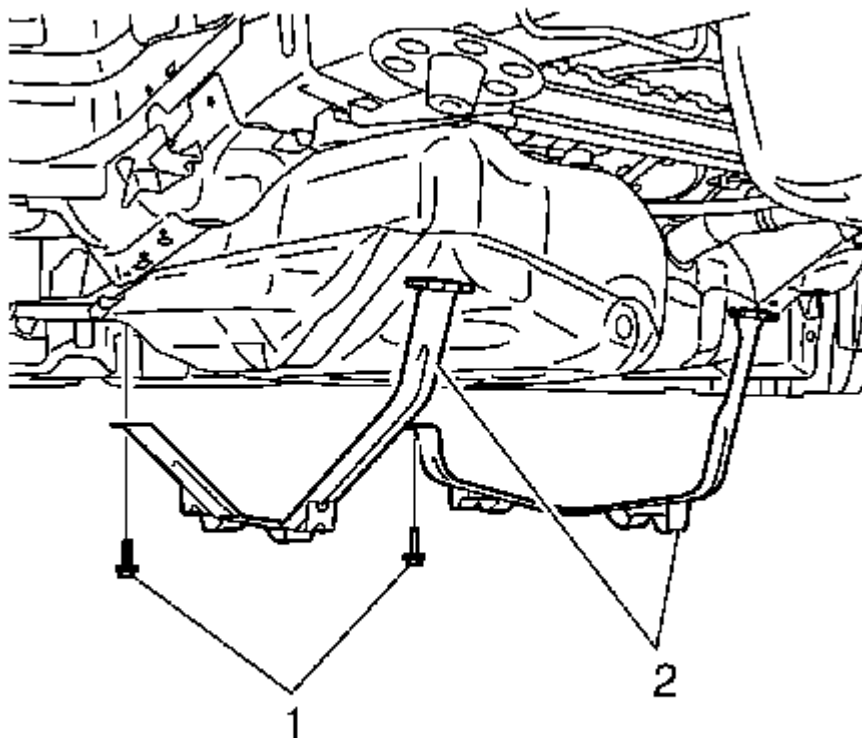


Fig. 59: Fuel Tank Straps & Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Install the fuel tank straps fastener (2) and fastener (1).

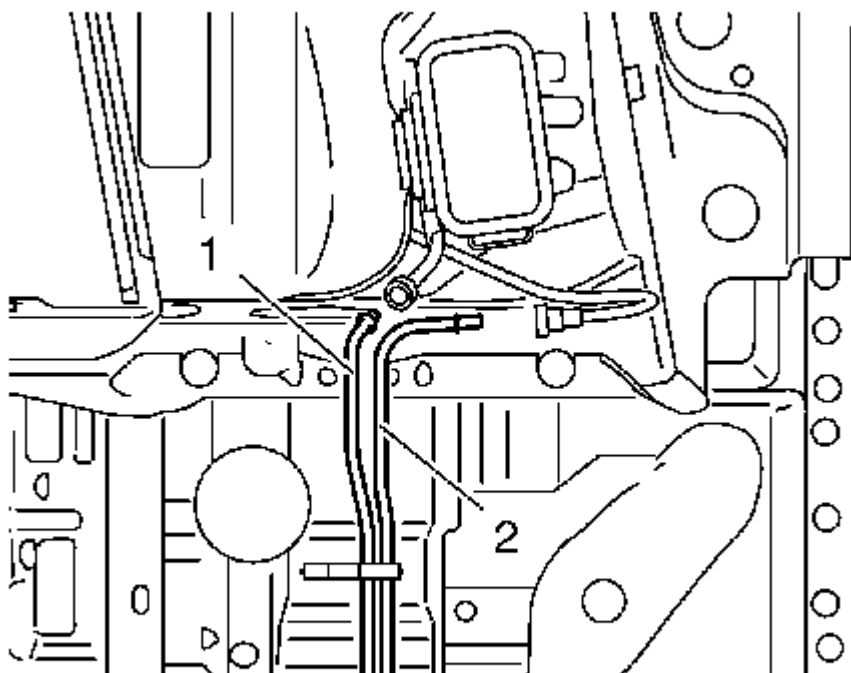


Fig. 60: Evaporative Emission Canister Purge Pipe & Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Connect the evaporative emission canister purge pipe (1)..
10. Connect the fuel feed pipe (2).

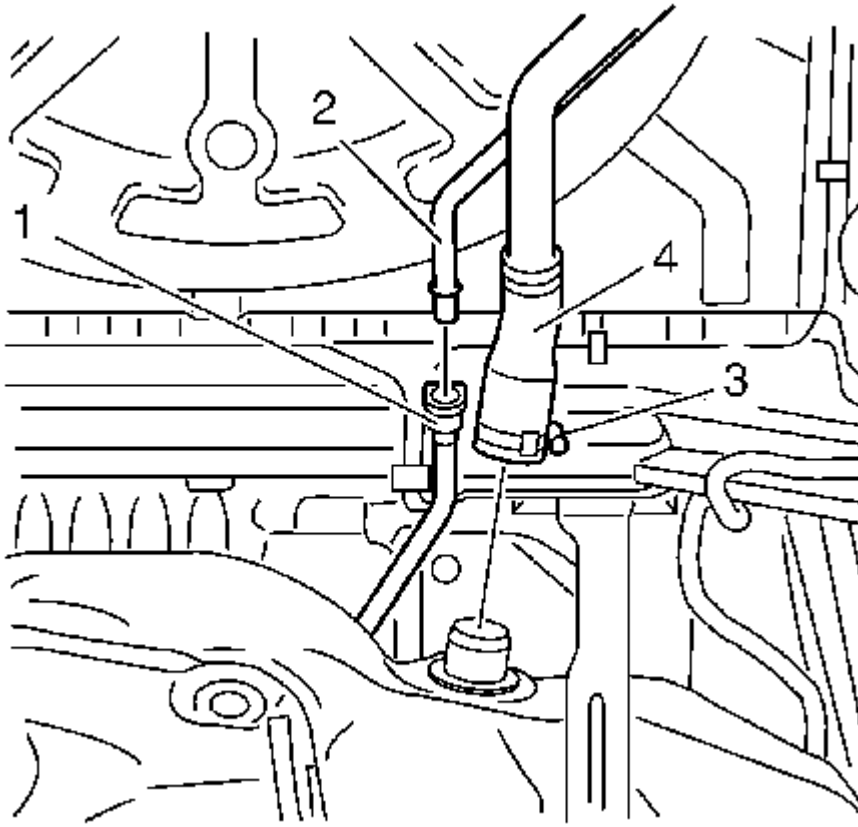


Fig. 61: Chassis Fuel Feed Pipe, Quick Connect Fitting, Fuel Pipe & Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Connect the fuel tank feed pipe (2) and lock quick connect fitting (1).

CAUTION: Refer to Fastener Caution .

12. Connect the fuel tank filler pipe (4) to the filler pipe retainer (3) and tighten to 4 N.m (35 lb in).
13. Refill the fuel tank.

EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT (LUK)

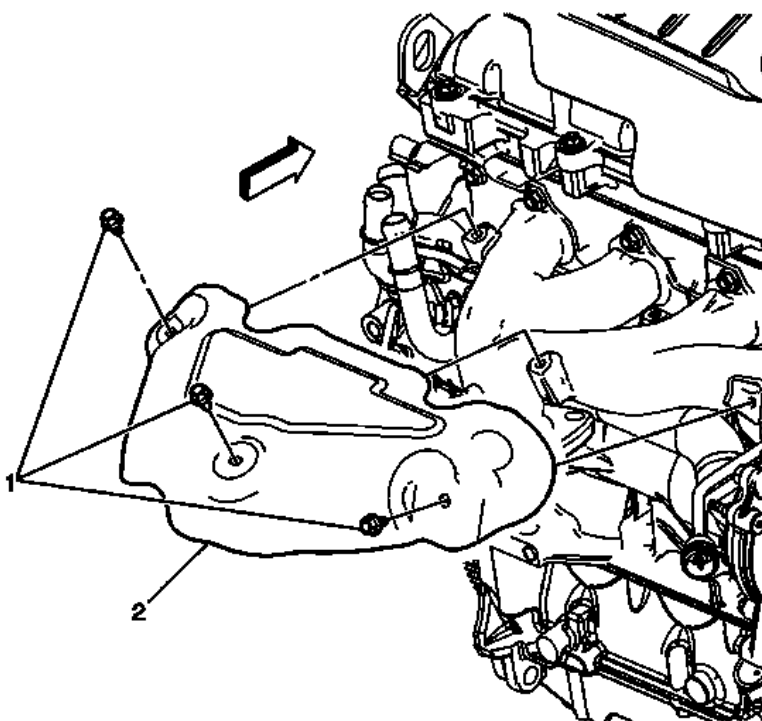


Fig. 62: View Of Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Heat Shield Replacement (LUK)

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Exhaust Manifold Heat Shield Bolt (Qty: 3) WARNING: Refer to <u>Hot Exhaust System Warning</u> . CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Exhaust Manifold Heat Shield

EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT (LTG)

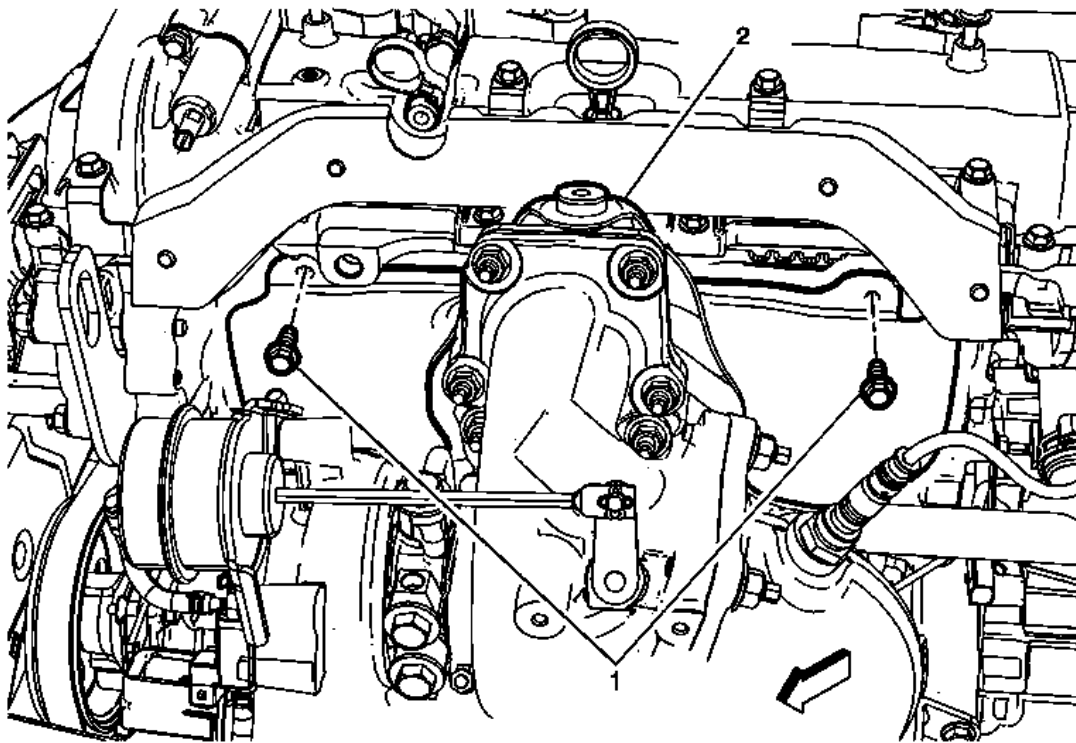


Fig. 63: Exhaust Manifold Heat Shield (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Heat Shield Replacement (LTG)

Callout	Component Name
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
Preliminary Procedure <ol style="list-style-type: none"> 1. Remove the turbocharger heat shield. See <u>TURBOCHARGER HEAT SHIELD REPLACEMENT</u> 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 3. Remove the turbocharger. Refer to <u>Turbocharger Replacement</u> 	
1	Exhaust Manifold Heat Shield Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 14 (10 lb ft)
2	Exhaust Manifold Heat Shield

EXHAUST REAR MUFFLER HEAT SHIELD REPLACEMENT (LEFT OUTER-LUK)

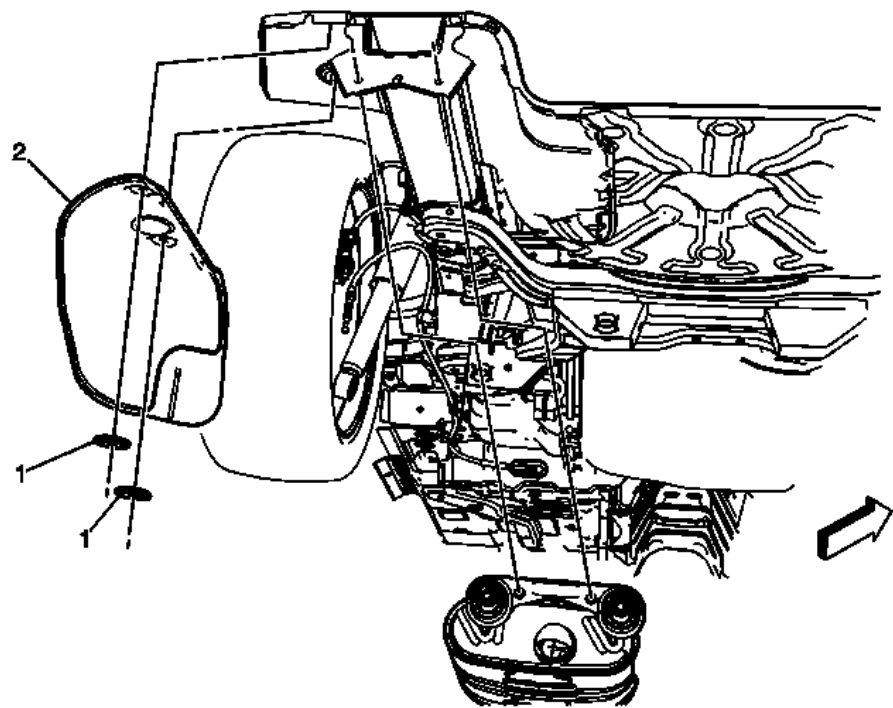


Fig. 64: Exhaust Rear Muffler Heat Shield (Left Rear Outer)
Courtesy of GENERAL MOTORS COMPANY

Exhaust Rear Muffler Heat Shield Replacement (Left Outer-LUK)

Callout	Component Name
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
Preliminary Procedure Unclip heat shield from fender liner.	
1	Heat Shield Retainer (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 1.5 N.m (13 lb in)
2	Heat Shield - Left Rear Corner

EXHAUST REAR MUFFLER HEAT SHIELD REPLACEMENT (LEFT REAR INNER)

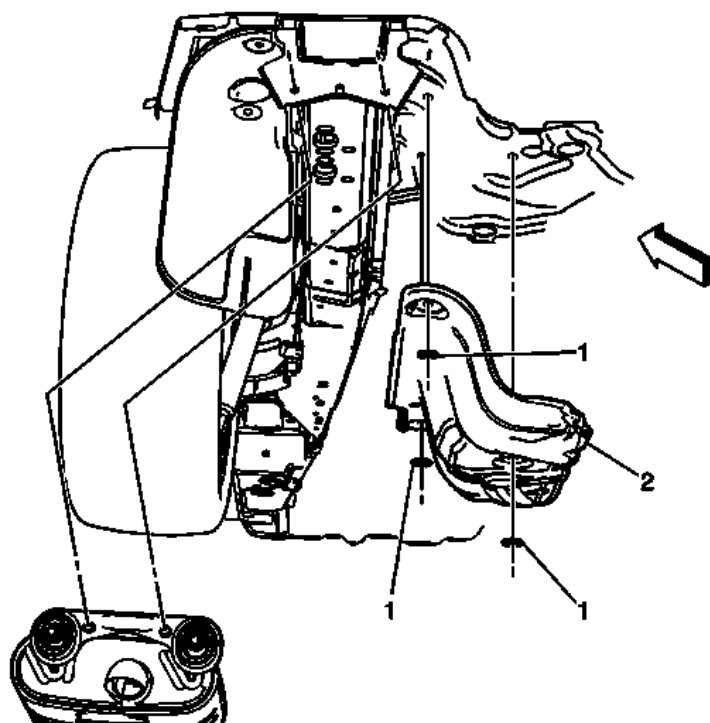


Fig. 65: Exhaust Rear Muffler Heat Shield (Left Rear Inner)

Courtesy of GENERAL MOTORS COMPANY

Exhaust Rear Muffler Heat Shield Replacement (Left Rear Inner)

Callout	Component Name
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
Preliminary Procedure Remove the exhaust muffler. Refer to <u>Exhaust Muffler Replacement (Dual)</u> , <u>Exhaust Muffler Replacement (Single)</u> .	
1	Heat Shield Retainer (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 1.5 N.m (13 lb in)
2	Heat Shield - Left Inner

EXHAUST REAR MUFFLER HEAT SHIELD REPLACEMENT (RIGHT REAR INNER)

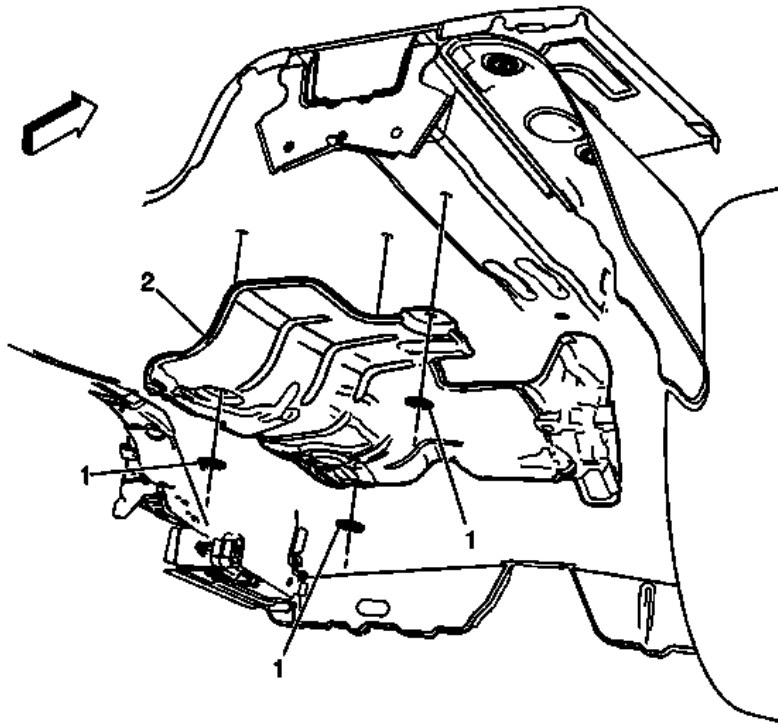


Fig. 66: Exhaust Rear Muffler Heat Shield (Right Rear Inner)
 Courtesy of GENERAL MOTORS COMPANY

Exhaust Rear Muffler Heat Shield Replacement (Right Rear Inner)

Callout	Component Name
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
Preliminary Procedure Remove the exhaust muffler. Refer to <u>Exhaust Muffler Replacement (Dual)</u> , <u>Exhaust Muffler Replacement (Single)</u> .	
1	Exhaust Heat Shield Retainer (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 1.5 N.m (13 lb in)
2	Heat Shield - Inner Right Rear

EXHAUST REAR MUFFLER HEAT SHIELD REPLACEMENT (RIGHT REAR CORNER)

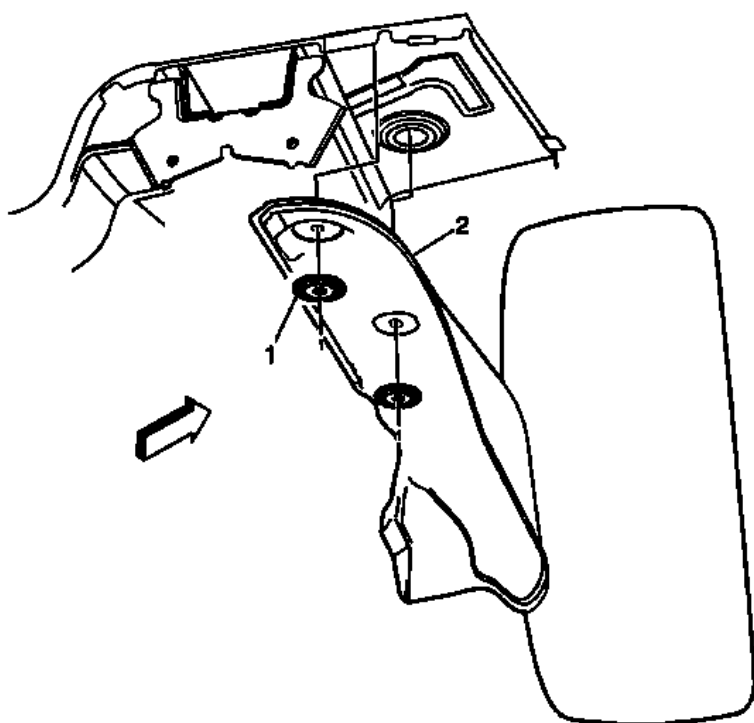


Fig. 67: Exhaust Rear Muffler Heat Shield (Right Rear Corner)

Courtesy of GENERAL MOTORS COMPANY

Exhaust Rear Muffler Heat Shield Replacement (Right Rear Corner)

Callout	Component Name
WARNING: Refer to <u>Hot Exhaust System Warning</u> .	
Preliminary Procedure Unclip heat shield from fender liner.	
1	Heat Shield Retainer (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 1.5 N.m (13 lb in)
2	Heat Shield - Right Rear

DESCRIPTION AND OPERATION

EXHAUST SYSTEM DESCRIPTION

NOTE: Use of non-OEM parts may cause driveability concerns.

The exhaust system carries exhaust gases, treated by the catalytic converter, through a resonator, if applicable and into the exhaust muffler where exhaust noise is lessened.

In order to secure the exhaust pipe to the exhaust manifold, a flange and seal-joint coupling is utilized. The exhaust system may utilize a slip-joint coupling design with a clamp and a U-bolt or a flange connection with a gasket.

Exhaust hangers and rubber insulators help to support the weight of the exhaust pipe along with insulating any exhaust system vibration, rattle, or noise.

Exhaust hangers also space the exhaust system away from the underbody of the vehicle and allows the exhaust system to expand as the exhaust system warms up.

Exhaust heat shields are used to protect the body and other components from damage due to the heat from the exhaust system.

The exhaust system may be comprised of the following components:

- Exhaust manifold
- Exhaust pipes
- Catalytic converters
- Exhaust muffler
- Exhaust resonator, if equipped
- Exhaust tail pipe, if equipped
- Exhaust hangers
- Exhaust heat shields

Resonator

Some exhaust systems are equipped with a resonator. The resonator, located either before or after the muffler, allows the use of mufflers with less back pressure. Resonators are used when vehicle characteristics require specific exhaust tuning.

Catalytic Converter

The catalytic converter is an emission control device used to reduce hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) pollutants from the exhaust gas.

The catalytic converter is comprised of a ceramic monolith substrate, supported in insulation and housed within a sheet metal shell. The substrate may be washcoated with 3 noble metals:

- Platinum (Pt)
- Palladium (Pd)
- Rhodium (Rh)

The catalyst in the catalytic converter is not serviceable.

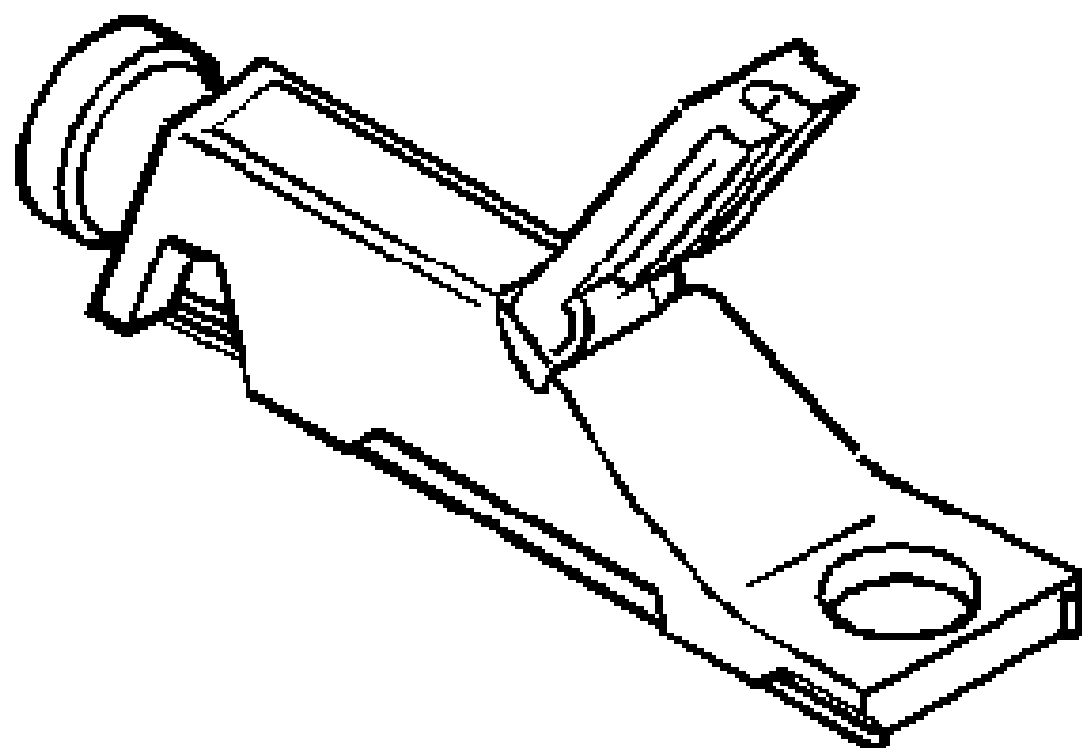
Muffler

The exhaust muffler reduces the noise levels of the engine exhaust by the use of tuning tubes. The tuning tubes create channels inside the exhaust muffler that lower the sound levels created by the combustion of the engine.

SPECIAL TOOLS AND EQUIPMENT

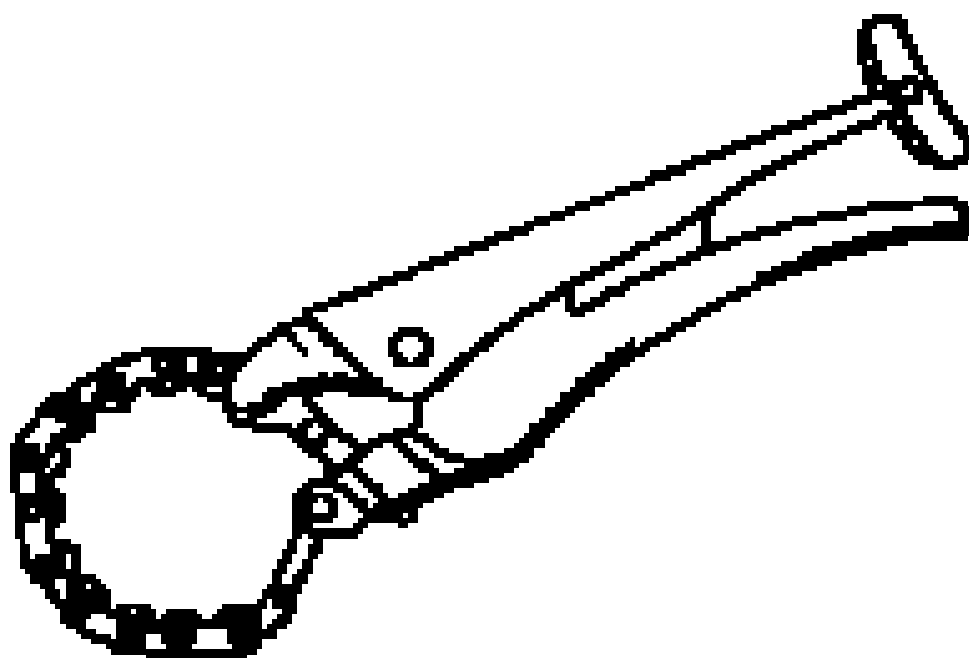
SPECIAL TOOLS

Illustration	Tool Number/Descrip
	EN-35314-A J-35314-A Exhaust Back Pressure Gaug



CH-6179
KM-6179
Heated Oxygen
Sensor
Remover/Install

CH-6614
MKM-6614
83 95 667
Chain-type Pipe
Cutter



Engine

Engine Mechanical - 2.0L (LTG) - Component Locator

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Camshaft Cover and Components

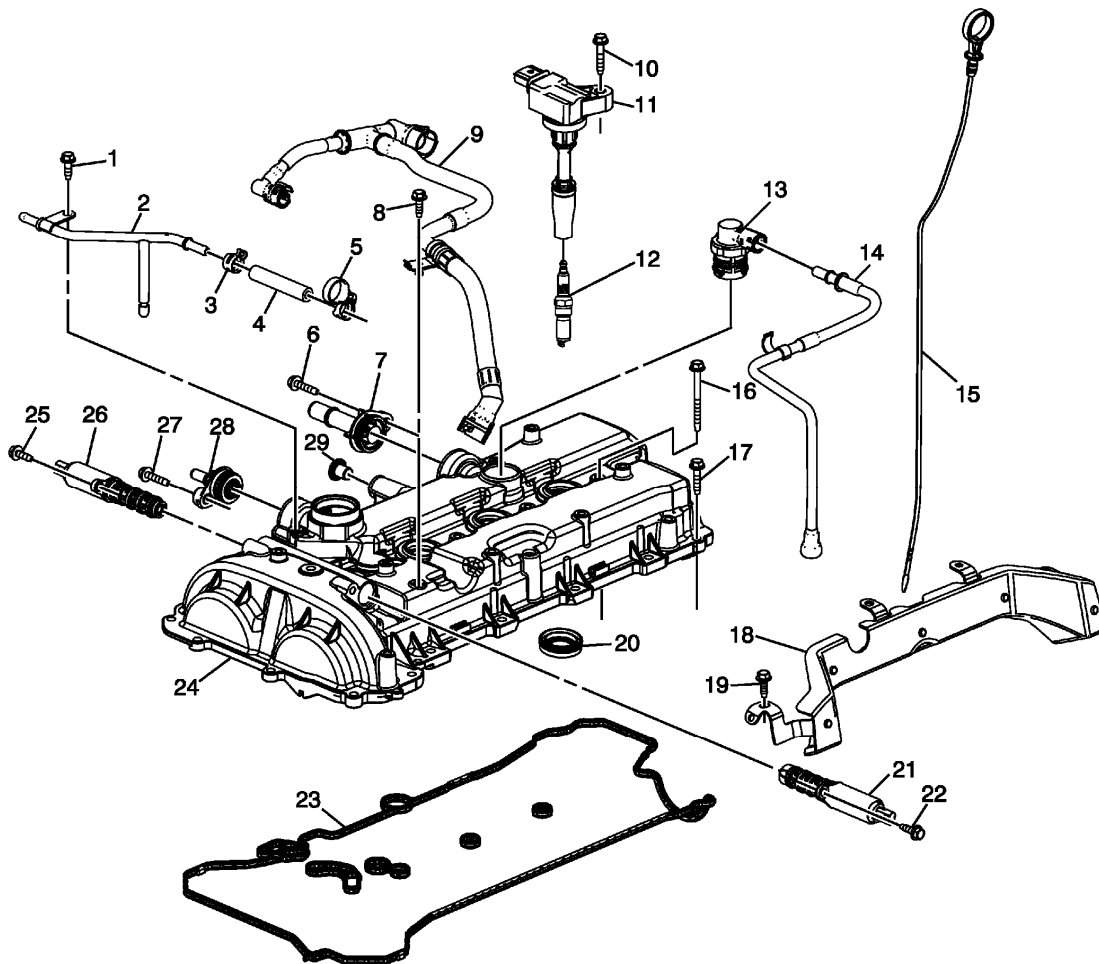


Fig. 1: Camshaft Cover and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Coolant Air Bleed Pipe Bolt
2	Engine Coolant Air Bleed Pipe
3	Engine Coolant Air Bleed Hose Clamp
4	Engine Coolant Air Bleed Hose

5	Engine Coolant Air Bleed Hose Clamp
6	PCV Valve Bolt
7	PCV Valve
8	PCV Tube Assembly Bolt
9	PCV Tube Assembly
10	Ignition Coil Bolt
11	Ignition Coil
12	Spark Plug
13	PCV Valve Assembly
14	PCV Tube Assembly
15	Oil Level Indicator
16	Camshaft Cover Bolt
17	Camshaft Cover Bolt
18	Camshaft Housing Cover Heat Shield
19	Camshaft Housing Cover Heat Shield Bolt
20	Spark Plug Shield Seal
21	Camshaft Position Actuator Control Solenoid Valve - Exhaust
22	Camshaft Position Actuator Control Solenoid Valve Bolt - Exhaust
23	Camshaft Cover Gasket
24	Camshaft Cover
25	Camshaft Position Actuator Control Solenoid Valve Bolt - Intake
26	Camshaft Position Actuator Control Solenoid Valve - Intake
27	PCV Valve Bolt
28	PCV Valve
29	Camshaft Cover Plug

Cylinder Head and Components

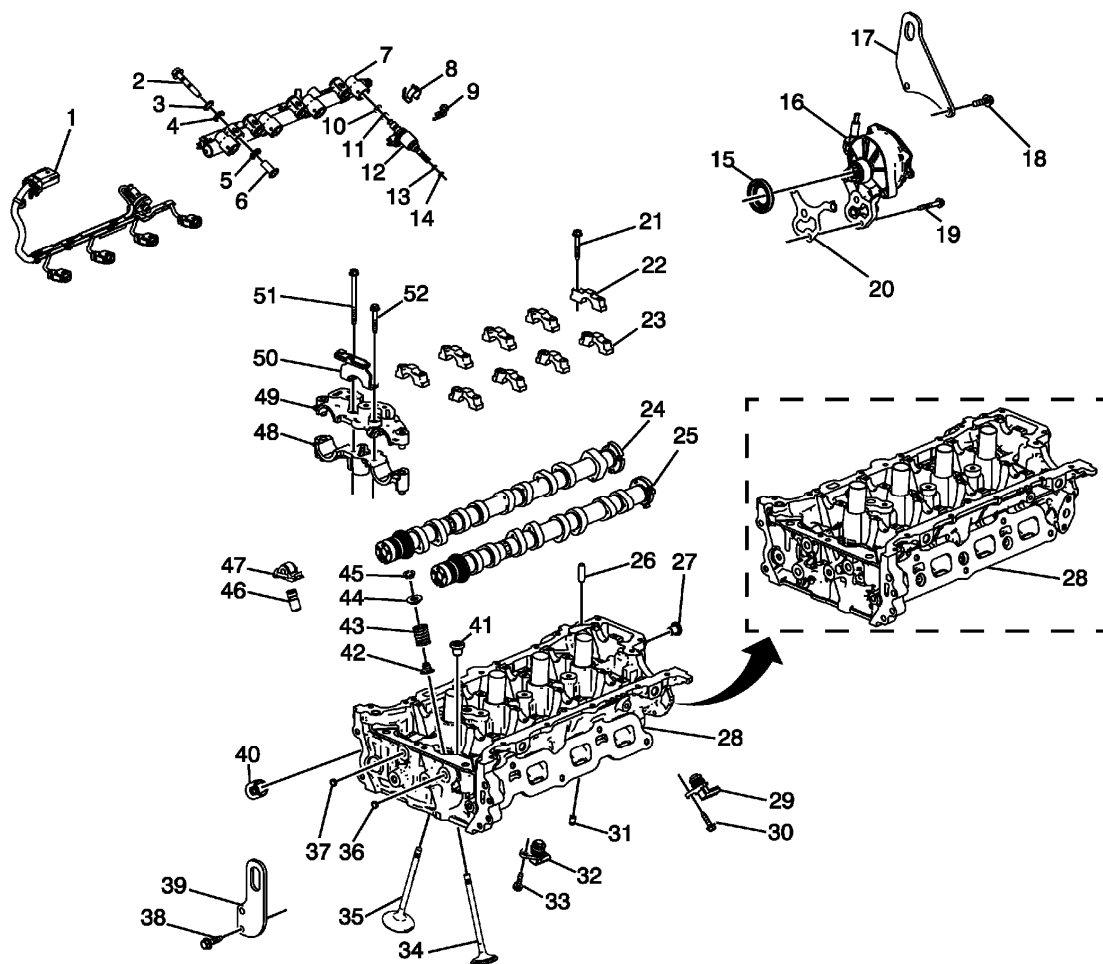


Fig. 2: Cylinder Head and Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Injector Wiring Harness
2	Fuel Injection Fuel Rail Bolt
3	Fuel Rail Insulator Bushing
4	Fuel Rail Insulator Washer
5	Fuel Rail Insulator Washer
6	Fuel Rail Insulator Sleeve
7	Fuel Injection Fuel Rail
8	Fuel Injector Holding Clamp
9	Fuel Injector Retainer
10	Fuel Injection Fuel Rail O-Ring Seal
11	Fuel Injector Seal Spacer
12	Direct Fuel Injector Assembly
13	Fuel Injector Nozzle Housing Seal

14	Fuel Injector Nozzle Housing Seal
15	Vacuum Pump Seal
16	Vacuum Pump Assembly
17	Engine Rear Lift Bracket
18	Engine Rear Lift Bracket Bolt
19	Vacuum Pump Bolt
20	Vacuum Pump Gasket
21	Camshaft Bearing Cap Bolt
22	Camshaft Bearing Cap
23	Camshaft Bearing Cap
24	Intake Camshaft
25	Exhaust Camshaft
26	Cylinder Head Locating Pin
27	Cylinder Head Oil Gallery Plug
28	Cylinder Head
29	Camshaft Position Sensor
30	Camshaft Position Sensor Bolt
31	Cylinder Head Oil Gallery Restrictor
32	Camshaft Position Sensor
33	Camshaft Position Sensor Bolt
34	Intake Valve
35	Exhaust Valve
36	Cylinder Head Oil Gallery Plug
37	Cylinder Head Oil Gallery Plug
38	Engine Front Lift Bracket Bolt
39	Engine Front Lift Bracket
40	Valve Lifter Follower
41	Cylinder Head Core Hole Plug
42	Valve Stem Oil Seal
43	Valve Spring
44	Valve Spring Retainer
45	Valve Stem Key
46	Hydraulic Valve Lash Adjuster
47	Valve Rocker Arm
48	Camshaft Bearing Front Lower Cap
49	Camshaft Bearing Front Cap
50	Timing Chain Cam to Cam Guide
51	Camshaft Bearing Cap Bolt
52	Timing Chain Guide Bolt

Intake Manifold and Components

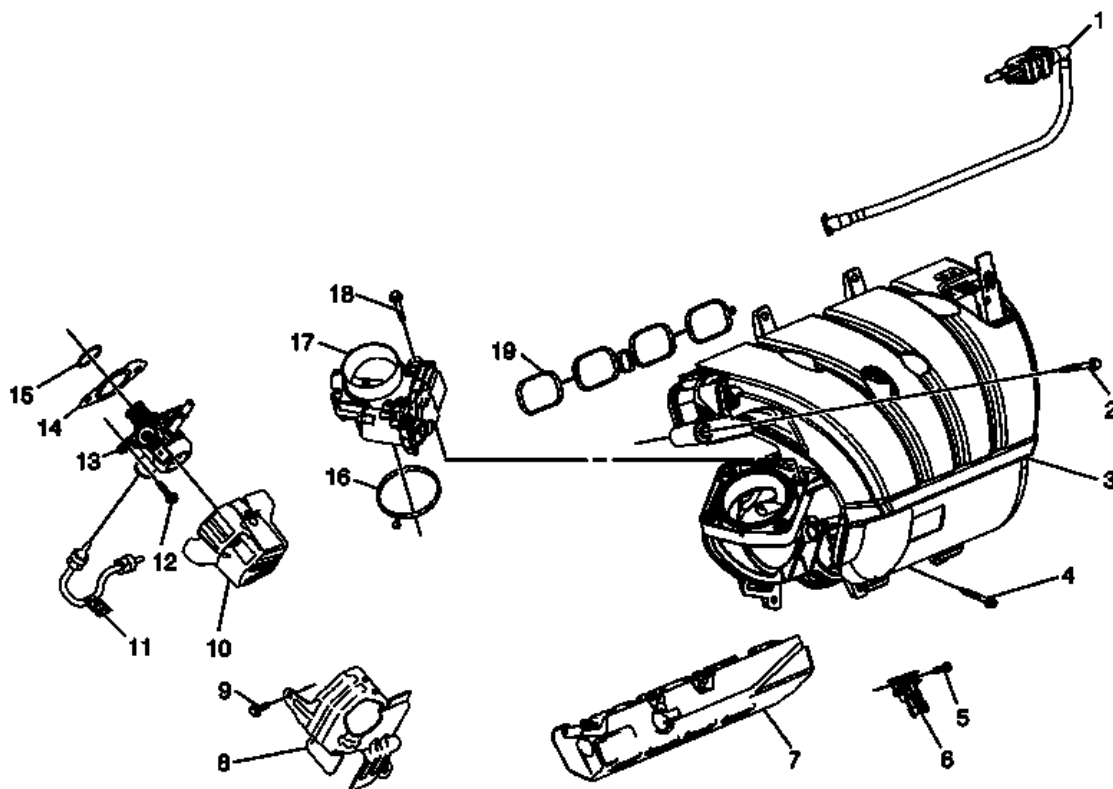


Fig. 3: Intake Manifold and Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Evaporative Emission Canister Purge Valve Assembly
2	Intake Manifold Bolt
3	Intake Manifold
4	Intake Manifold Bolt
5	Manifold Absolute Pressure (MAP) Sensor Bolt
6	Manifold Absolute Pressure (MAP) Sensor
7	Fuel Rail Noise Shield
8	Fuel Pump Cover
9	Fuel Pump Cover Bolt
10	Fuel Pump Insulator
11	Fuel Feed Intermediate Pipe Assembly
12	Fuel Pump Bolt
13	Fuel Pump

14	Fuel Pump Housing Gasket
15	Fuel Pump Housing O-Ring Seal
16	Throttle Body Assembly Gasket
17	Throttle Body Assembly
18	Throttle Body Assembly Bolt
19	Intake Manifold Gasket

Turbocharger and Components

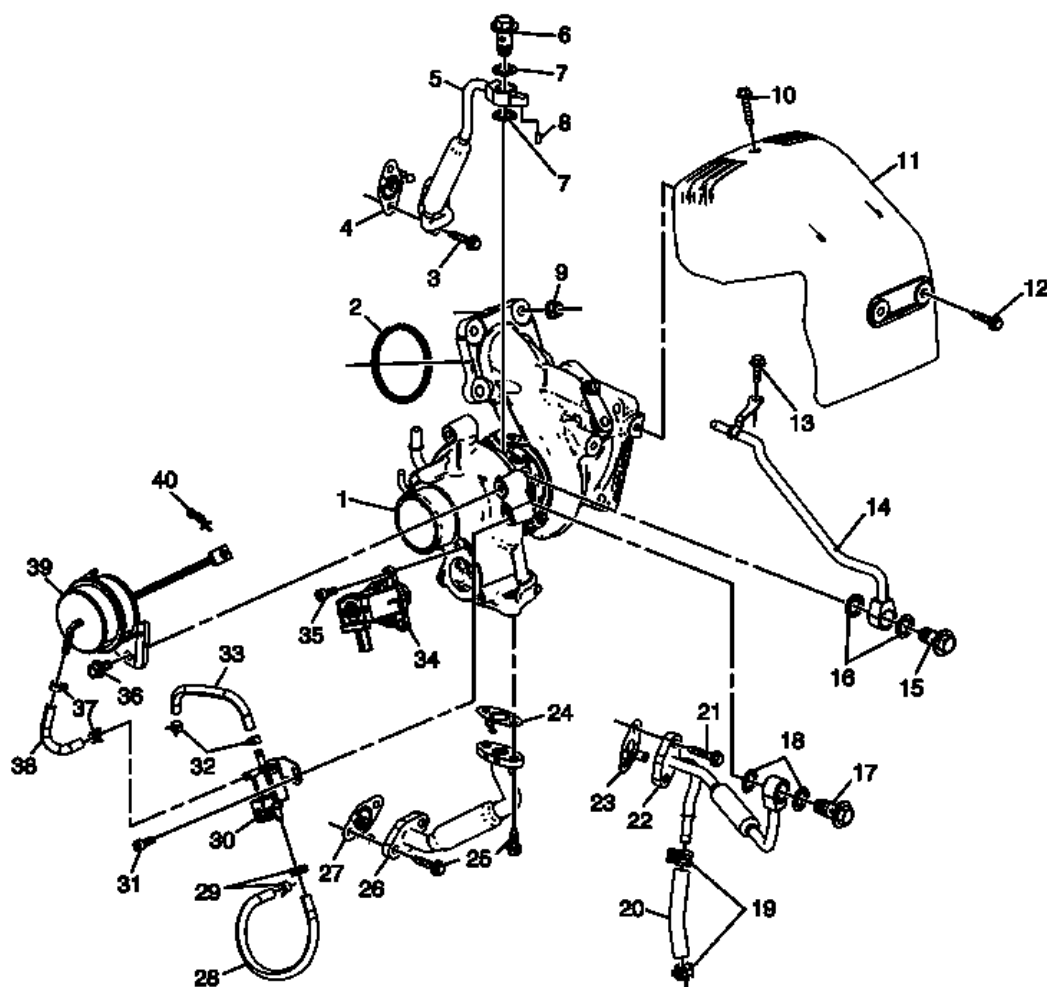


Fig. 4: Turbocharger and Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Gasket
2	Turbocharger Oil Feed Pipe Bolt
3	Turbocharger Oil Feed Pipe Gasket
4	Turbocharger Oil Feed Pipe Assembly

5	Turbocharger Oil Feed Pipe Bolt
6	Turbocharger Oil Feed Pipe Washer
7	Turbocharger Oil Feed Pipe Anti-Rotate Roll Pin
8	Turbocharger Nut
9	Turbocharger
10	Turbocharger Heat Shield Bolt
11	Turbocharger Heat Shield
12	Turbocharger Heat Shield Bolt
13	Turbocharger Coolant Return Pipe Bolt
14	Turbocharger Coolant Return Pipe Assembly
15	Turbocharger Coolant Return Pipe Bolt
16	Turbocharger Coolant Return Pipe Washer
17	Turbocharger Coolant Feed Pipe Bolt
18	Turbocharger Coolant Feed Pipe Washer
19	Turbocharger Coolant Feed Hose Clamp
20	Turbocharger Coolant Feed Hose
21	Turbocharger Coolant Feed Pipe Bolt
22	Turbocharger Coolant Feed Pipe Assembly
23	Turbocharger Coolant Feed Pipe Gasket
24	Turbocharger Oil Return Pipe Gasket
25	Turbocharger Oil Return Pipe Bolt
26	Turbocharger Oil Return Pipe Assembly
27	Turbocharger Oil Return Pipe Gasket
28	Turbocharger Wastegate Regulator Solenoid Valve Hose
29	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp
30	Turbocharger Wastegate Regulator Solenoid Valve
31	Turbocharger Wastegate Regulator Solenoid Valve Bolt
32	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp
33	Turbocharger Wastegate Regulator Solenoid Valve Hose
34	Turbocharger Air Bypass Valve Solenoid
35	Turbocharger Air Bypass Valve Solenoid Bolt
36	Turbocharger Wastegate Actuator Bolt
37	Turbocharger Wastegate Actuator Hose Clamp
38	Turbocharger Wastegate Actuator Hose
39	Turbocharger Wastegate Actuator
40	Turbocharger Wastegate Actuator Arm Retaining Clip

Exhaust Manifold and Components

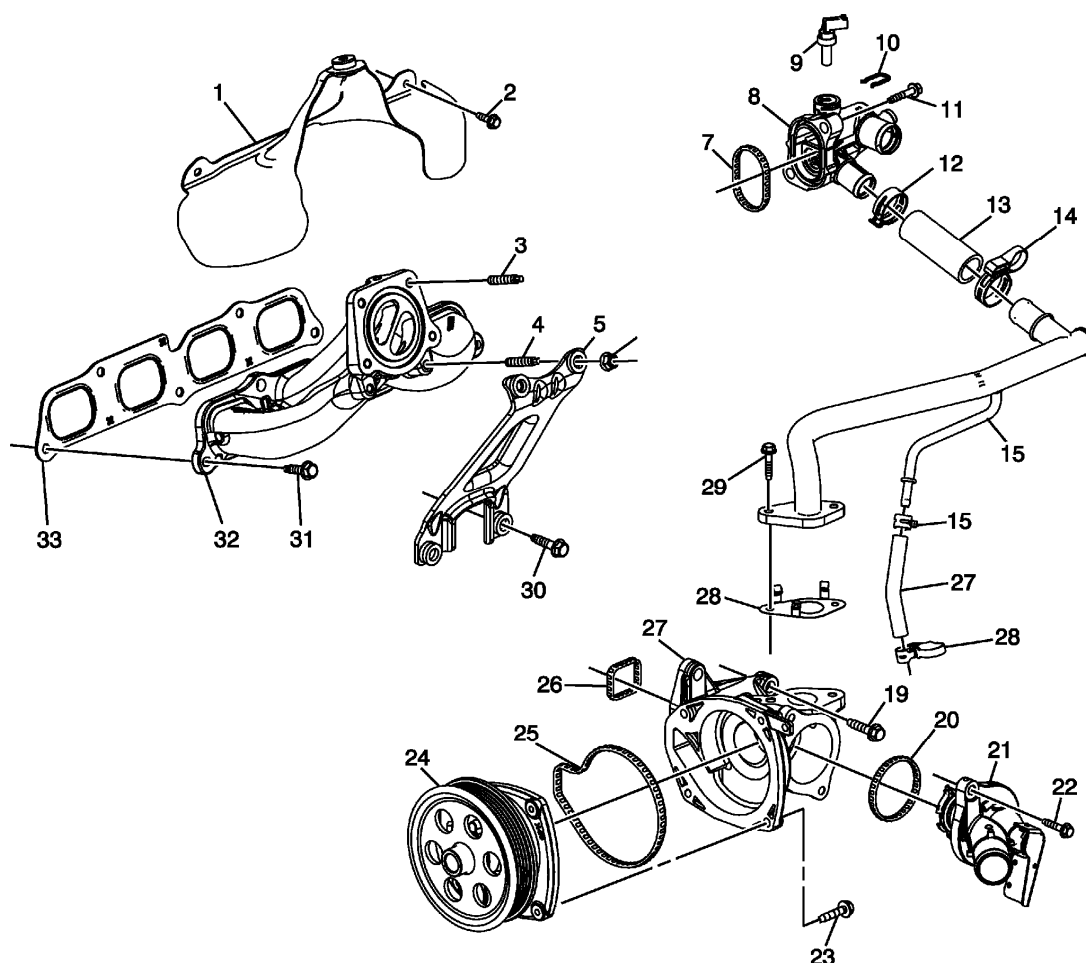


Fig. 5: Exhaust Manifold and Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Exhaust Manifold Heat Shield
2	Exhaust Manifold Heat Shield Bolt
3	Exhaust Manifold Stud
4	Exhaust Manifold Stud
5	Exhaust Manifold Brace
6	Exhaust Manifold Brace Nut
7	Water Outlet Gasket
8	Water Outlet
9	Engine Coolant Temperature Sensor
10	Engine Coolant Temperature Sensor Retainer
11	Water Outlet Bolt
12	Thermal Bypass Hose Clamp
13	Thermal Bypass Hose

14	Thermal Bypass Hose Clamp
15	Thermal Bypass Pipe
16	Engine Oil Cooler Coolant Outlet Hose Clamp
17	Engine Oil Cooler Coolant Outlet Hose
18	Engine Oil Cooler Coolant Outlet Hose Clamp
19	Water Pump Bolt
20	Engine Coolant Thermostat Housing Gasket
21	Engine Coolant Thermostat Housing
22	Engine Coolant Thermostat Housing Bolt
23	Water Pump Housing Bolt
24	Water Pump Front Housing
25	Water Pump Inlet Gasket
26	Water Pump Gasket
27	Water Pump Rear Housing
28	Thermal Bypass Pipe Gasket
29	Thermal Bypass Pipe Bolt
30	Exhaust Manifold Brace Bolt
31	Exhaust Manifold Bolt
32	Exhaust Manifold
33	Exhaust Manifold Gasket

Engine Block and Components

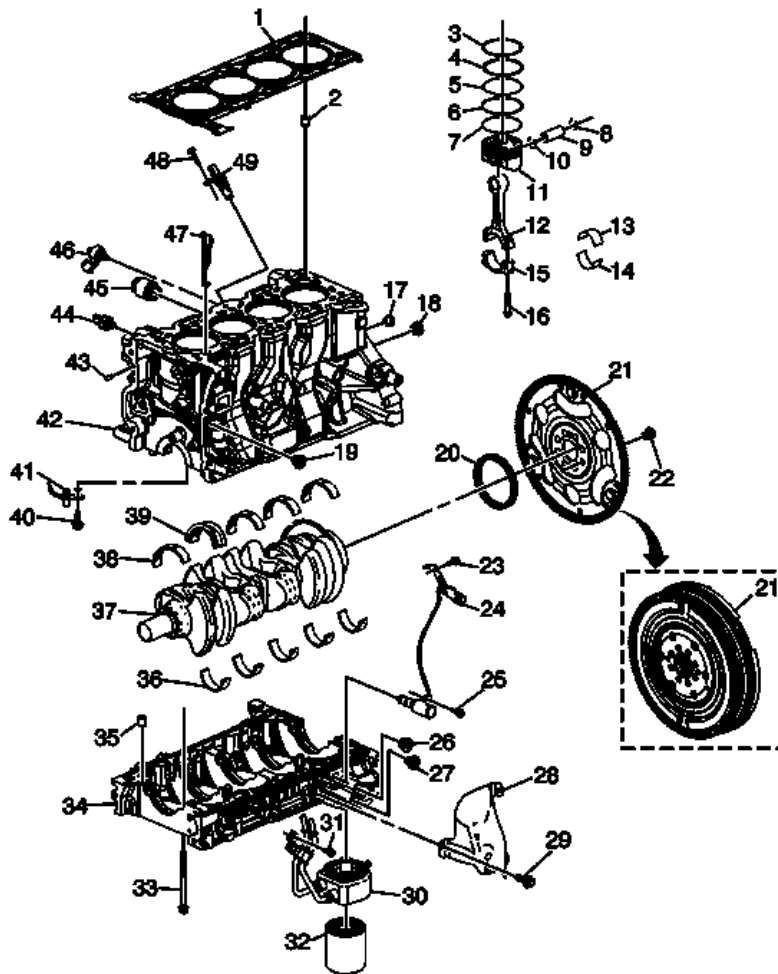


Fig. 6: Engine Block and Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Cylinder Head Gasket
2	Cylinder Head Locating Pin
3	Piston Upper Compression Ring
4	Piston Lower Compression Ring
5	Piston Oil Ring Rail
6	Piston Oil Ring Rail Spacer
7	Piston Oil Ring Rail
8	Piston Pin Retainer
9	Piston Pin
10	Piston Pin Retainer
11	Piston
12	Connecting Rod
13	Connecting Rod Bearing

14	Connecting Rod Bearing
15	Connecting Rod Cap
16	Connecting Rod Bolt
17	Engine Block Oil Gallery Plug
18	Engine Block Oil Gallery Plug
19	Engine Block Oil Gallery Plug
20	Crankshaft Rear Oil Seal
21	Automatic Transmission Flex Plate
22	Automatic Transmission Flex Plate Bolt
23	Oil Pump Flow Control Valve Assembly Bolt
24	Oil Pump Flow Control Valve Assembly
25	Oil Pump Flow Control Valve Assembly Bolt
26	Engine Block Oil Gallery Plug
27	Engine Block Oil Gallery Plug
28	Oil Pump and Compressor Heat Shield
29	Oil Pump and Compressor Heat Shield Bolt
30	Engine Oil Cooler Assembly
31	Engine Oil Cooler Assembly Bolt
32	Oil Filter
33	Lower Crankcase Bolt
34	Lower Crankcase
35	Lower Crankcase Locating Pin
36	Crankshaft Lower Bearing
37	Crankshaft
38	Crankshaft Upper Bearing
39	Crankshaft Upper Thrust Bearing
40	Piston Oil Nozzle Bolt
41	Piston Oil Nozzle
42	Engine Block
43	Engine Front Cover Locating Pin
44	Engine Oil Pressure Sensor
45	Engine Coolant Heater
46	Knock Sensor
47	Engine Block Coolant Baffle
48	Crankshaft Position Sensor Bolt
49	Crankshaft Position Sensor

Upper and Lower Oil Pan and Components

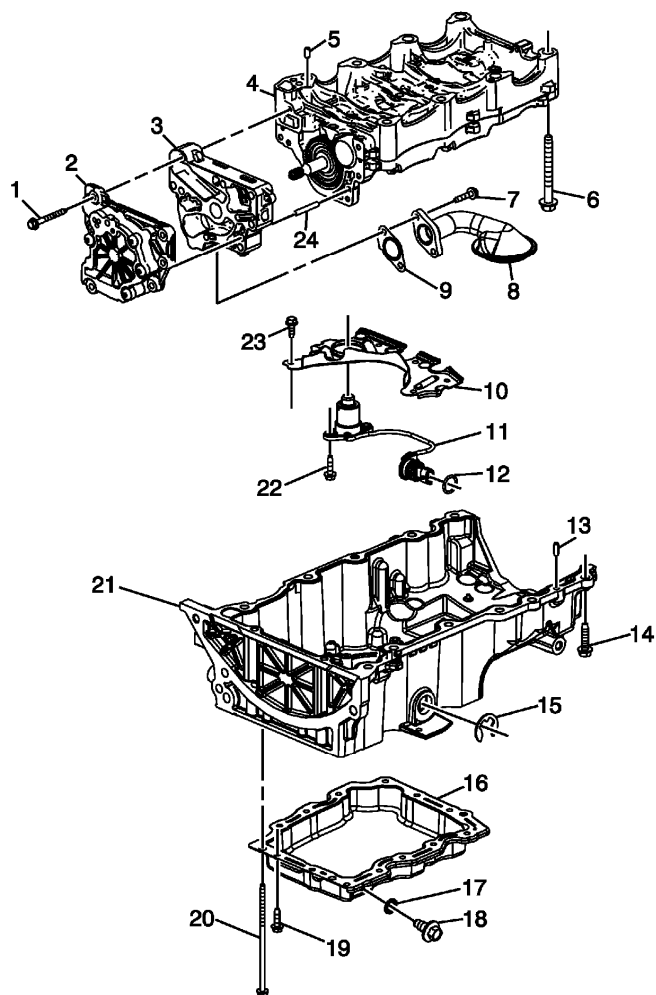


Fig. 7: Upper and Lower Oil Pan and Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pump Assembly Bolt
2	Oil Pump Assembly
3	Oil Pump Cover
4	Balancer Shaft Module
5	Balancer Shaft Housing Locating Pin
6	Balancer Shaft Housing Bolt
7	Oil Pump Suction Pipe Bolt
8	Oil Pump Screen Assembly with Suction Pipe
9	Oil Pump Screen Gasket
10	Oil Pan Baffle
11	Engine Oil Level Indicator Switch
12	Engine Oil Level Indicator Seal
13	Oil Pan Locating Pin

14	Oil Pan Bolt
15	Engine Oil Level Sensor Lead Clip
16	Lower Oil Pan
17	Oil Pan Drain Plug Seal
18	Oil Pan Drain Plug
19	Oil Pan Bolt
20	Oil Pan Bolt
21	Upper Oil Pan
22	Engine Oil Level Indicator Switch Bolt
23	Oil Pan Baffle Bolt
24	Oil Pump Locating Pin

Timing Chain and Components

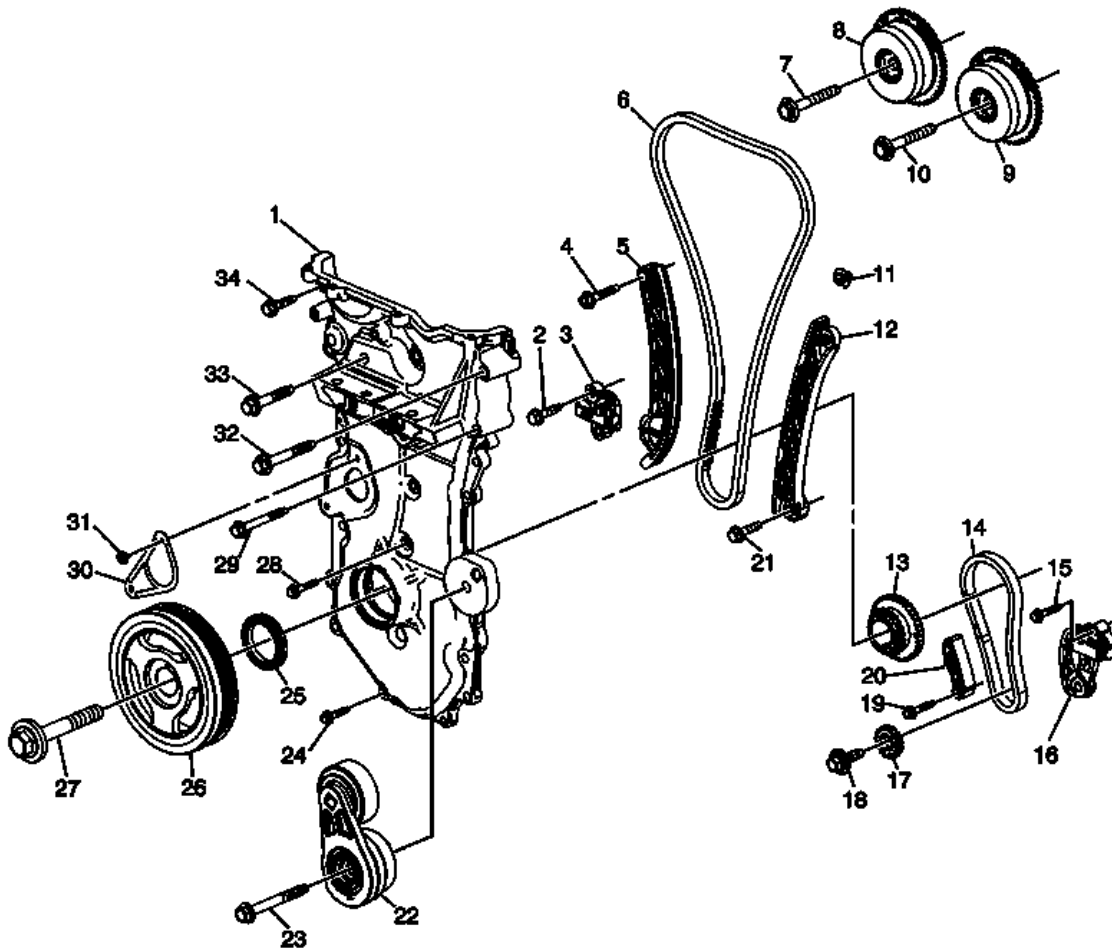


Fig. 8: Timing Chain and Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Front Cover
2	Timing Chain Tensioner Bolt
3	Timing Chain Tensioner
4	Timing Chain Tensioner Pivot Arm Bolt
5	Timing Chain Tensioner Pivot Arm
6	Timing Chain
7	Camshaft Position Actuator Bolt
8	Intake Camshaft Position Actuator
9	Exhaust Camshaft Position Actuator
10	Camshaft Position Actuator Bolt
11	Timing Chain Oil Nozzle
12	Timing Chain Guide
13	Crankshaft Sprocket
14	Balancer Chain
15	Balancer Chain Tensioner Bolt
16	Balancer Chain Tensioner
17	Balancer Shaft Driven Sprocket
18	Balancer Shaft Sprocket Bolt
19	Balancer Chain Guide Bolt
20	Balancer Chain Guide
21	Timing Chain Guide Bolt
22	Drive Belt Tensioner
23	Drive Belt Tensioner Bolt
24	Engine Front Cover Bolt
25	Crankshaft Front Oil Seal
26	Crankshaft Balancer
27	Crankshaft Balancer Bolt
28	Engine Front Cover Bolt
29	Engine Front Cover Bolt
30	Timing Chain Tensioner Cover
31	Timing Chain Tensioner Cover Bolt
32	Engine Front Cover Bolt
33	Engine Front Cover Bolt
34	Engine Front Cover Bolt

ENGINE IDENTIFICATION

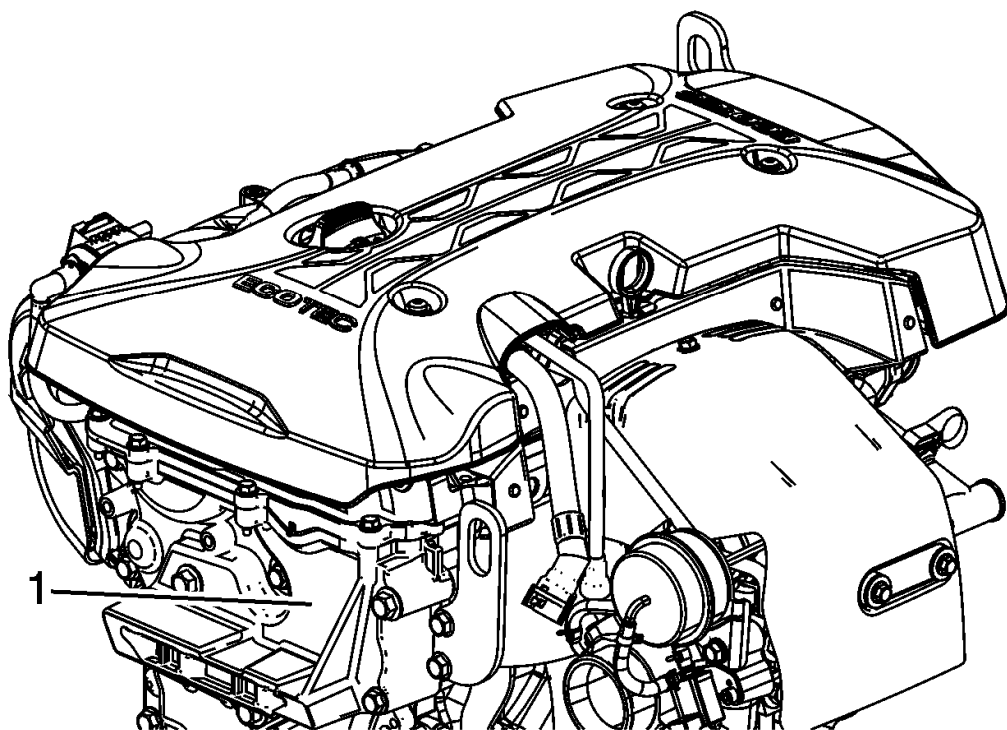


Fig. 9: Engine Identification (LTG)
Courtesy of GENERAL MOTORS COMPANY

Identification can be made through the use of the Engine Traceability label (1) on the engine.

Engine

Engine Mechanical - 2.0L (LTG) - Description and Operation

DESCRIPTION AND OPERATION

TURBOCHARGER SYSTEM DESCRIPTION

Turbocharger Description and Operation

A turbocharger is a compressor that is used to increase the power output of an engine by increasing the mass of the oxygen and therefore the fuel entering the engine. A turbocharger is mounted either to the exhaust manifold or directly to the head. The turbine is driven by the energy generated by the flow of the exhaust gases. The turbine is connected by a shaft to the compressor which is mounted in the induction system of the engine. The centrifugal compressor blades compress the intake air above atmospheric pressure, thereby increasing the density of the air entering the engine.

The turbocharger incorporates a wastegate that is controlled by a pressure differential that is determined by the engine control module (ECM) by means of a PWM solenoid, in order to control boost pressure. A compressor recirculation valve, also controlled by the ECM, prevents compressor surging and damage by opening during sudden throttle closures. When the recirculation valve is opened it allows the air to recirculate back to the turbocharger compressor inlet.

The turbocharger is connected to the engine oiling system by a supply and drain pipe. Oil is required for the bearing system function and also serves to carry some heat from the turbocharger. There is a cooling system circuit in the turbocharger that further reduces operating temperatures and passively dissipates bearing housing heat away from the turbocharger on shut down.

Charge Air Cooler Description

The turbocharger engine system is supported by an air-to-air charge air cooler system, which uses fresh air drawn through a heat exchanger to reduce the temperature of the hot compressed air exiting the turbo compressor, prior to delivery to the engine combustion system. Inlet air temperature can be reduced by up to 100°C (180°F), enhancing performance because cooler air is denser in oxygen and promotes optimal combustion. The charge air cooler is connected to the turbocharger and to the throttle body by flexible ductwork that requires the use of special high torque fastening clamps. In order to prevent any type of air leak when servicing the ductwork, the tightening specifications, cleanliness and proper positioning of the clamps is critical, and must be strictly adhered to.

Benefits of Dual Cam Phasing

The camshafts of the Ecotec 2.0 liter turbocharged engine have camshaft position sensors and camshaft position actuators that the ECM uses to accurately control the continuously variable intake and exhaust valve timing. This allows the combustion process to be optimized by the ECM to increase the response of the turbocharger, providing a more immediate feeling of power to the driver.

Benefits of Gasoline Direct Injection

In the Ecotec 2.0 liter turbocharged engine, the fuel is introduced directly into the combustion chamber during the intake stroke. As the piston approaches top-dead center, the mixture is ignited by the spark plug, thereby giving the name spark ignition direct injection. Direct injection allows the mixture to be leaner, with less fuel and more air at full power, and allows a slightly higher compression ratio, resulting in improved fuel consumption at part and full throttle.

The fact that the fuel is injected after the exhaust valve closes allows particularly high valve overlap values in certain engine operating ranges. This enhances the turbocharger response time. This would not be possible in a port fuel injection engine due to the fact that unburned fuel would escape through the open exhaust valve.

Direct injection's precise fuel delivery enables more complete combustion which reduces emissions particularly on cold starts.

Electronic Vacuum Pump

The purpose of the electronic vacuum pump, if equipped, is to keep the vacuum in the brake booster at an acceptable level under various operating conditions. The ECM monitors the input signal from the brake booster pressure sensor. When the vacuum in the brake booster is not in an acceptable range the control module will command the relay ON that controls the vacuum pump.

Recommendations for Service

The turbocharger is designed so that it does not require any special maintenance, and inspection is limited to a few periodic procedures. To ensure that the turbocharger's lifetime corresponds to that of the engine, the following engine manufacturer's service instructions must be strictly adhered to:

- Oil and filter change intervals
- Air filter change intervals
- Engine coolant change intervals
- Ignition system maintenance
- Injection system maintenance

The following causes are responsible for a majority of all turbocharger failures:

- Misdiagnosis of a non-failed turbocharger
- Penetration of foreign bodies into the turbine or the compressor
- Dirt or contaminants in the oil
- Inadequate oil supply and/or pressure
- Clogged oil return
- Higher than normal exhaust gas temperatures due to improper operation of the following:
 - The ignition system
 - The fuel injection system
 - The exhaust system

These failures can be avoided by regular maintenance.

CRANKCASE VENTILATION SYSTEM DESCRIPTION

General Description

A crankcase ventilation system is used to consume crankcase vapors in the combustion process instead of venting them to atmosphere. Fresh air from the intake system is supplied to the crankcase, mixed with blow by gases and then passed through a calibrated orifice into the intake manifold.

Operation

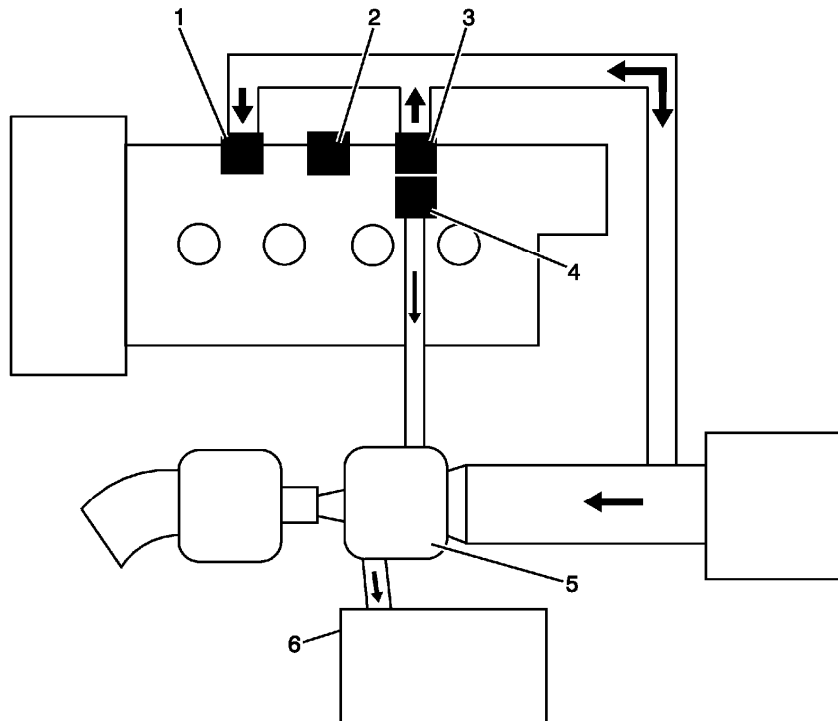


Fig. 1: Crankcase Ventilation System Components And Operational Diagram (LTG)
Courtesy of GENERAL MOTORS COMPANY

The primary control is through the positive crankcase ventilation (PCV) valve (2) which meters the flow at a rate depending on intake manifold vacuum. The PCV valve is an integral part of the camshaft cover. Fresh air is introduced to the engine through PVC (1) under normal operating conditions. If abnormal operating conditions occur, the system is designed to allow excessive amounts of blow by gases to back flow through the crankcase vent valve (3) into the intake system to be consumed by normal combustion.

Only on turbocharged engines, there is a one way valve (2) in the camshaft cover in order to prevent the crankcase from being pressurized by positive pressure in the intake manifold when the turbocharger is in operation. When the turbocharger is operational, the pressure in the intake manifold can exceed atmospheric pressure which, without the one way valve, would force oil and PCV gases out of the camshaft cover and into the induction system, via the hose to the camshaft cover. This can cause coking of the throttle body and induction system, and can reduce the efficiency of both combustion and the intercooler system, in normal operation the PCV gases are drawn into the air stream post intercooler (6). However, when the turbo is spooled up the turbo can become the vacuum source for the vent system. PVC#4 controls the max. flow so the crankcase

stays at a normal vacuum during normal operating conditions.

Results of Incorrect Operation

A plugged orifice may cause the following conditions:

- Rough idle
- Stalling or slow idle speed
- Oil leaks
- Sludge in engine

A leaking orifice may cause the following conditions:

- Rough idle
- Stalling
- High idle speed

ENGINE COMPONENT DESCRIPTION

Engine Description

Cylinder Block

The cylinder block is constructed of aluminum alloy by precision sand-casting. The block has 5 crankshaft bearings with the thrust bearing located on the second bearing from the front of the engine. The cylinder block incorporates a bedplate design that forms an upper and lower crankcase. This design promotes cylinder block rigidity and reduced noise and vibration.

Crankshaft

The crankshaft is cast nodular iron with 8 counterweights. The number 8 counterweight is also the ignition system reluctor wheel. The main bearing journals are cross-drilled, and the upper bearings are grooved. The crankshaft has a slip fit balance shaft drive sprocket. Number 2 main bearing is the thrust bearing. The crankshaft balancer is used to control torsional vibration.

Connecting Rod and Piston

The connecting rods are powdered metal. The connecting rod incorporates the floating piston pin. The pistons are cast aluminum. The piston rings are of a low tension type to reduce friction. The top compression ring is ductile steel with a molybdenum facing and phosphate coated sides. The second compression ring is gray iron. The oil ring is a 3-piece spring construction with chromium plating for applications without a turbocharger. For applications with turbocharger, the oil ring is a 3-piece spring construction with nitride plating.

Oil Pan

The oil pan is die cast aluminum. The oil pan includes an attachment to the transmission to provide additional

structural support.

Balance Shaft Assembly

The dual balancer shaft assembly is mounted to the lower crankcase located within the oil pan. The balance shafts are driven by a single inverted tooth chain that also drives the oil pump. The chain is tensioned by a hydraulic tensioner that is supplied pressure by the engine oil pump. This design promotes the maximum effectiveness of the balance shaft system and reduces noise and vibration.

Cylinder Head

The cylinder head is a semi-permanent mold. Pressed-in powdered metal valve guides and valve seat insets are used. The cylinder head incorporates camshaft journals and camshaft caps. The fuel injection nozzle is located in the intake port. The high pressure fuel pump is mounted on intake side. The secondary air injection valve is mounted to the exhaust side of cylinder head for applications without a turbocharger.

Valves

There are 2 intake and 2 exhaust valves per cylinder. Rotators are used on all of the intake valves. The rotators are located at the bottom of the valve spring to reduce valve train reciprocating mass. Positive valve stem seals are used on all valves.

Camshaft

Two camshafts are used, one for all intake valves and high pressure fuel pump, the other for all exhaust valves and mechanical vacuum pump. The camshafts are cast iron.

Valve Lash Adjusters

The valve train uses a roller finger follower acted on by a hydraulic lash adjuster. The roller finger follower reduces friction and noise.

Camshaft Cover

The camshaft cover has a steel crankcase ventilation baffling incorporated. The camshaft cover has mounting locations for the ignition system.

Camshaft Drive

A roller chain is used for camshaft drive. There is a tensioner and active guide used on the slack side of the chain to control chain motion and noise. The chain drive promotes long valve train life and low maintenance.

Intake and Exhaust Manifold

The intake manifold is made of composite plastic. The exhaust manifold is cast iron. The intake manifold incorporates a distribution and control system for positive crankcase ventilation (PCV) gases. The exhaust manifold is a dual plane design that promotes good low end torque and performance.

Mechanical Thermostat

The mechanical thermostat is positioned between the engine and the radiator. Its purpose is to control the flow of coolant to the radiator. The thermostat will not allow coolant flow through the radiator when cold, coolant flow occurs when the engine has warmed up. Once the engine reaches its operating temperature, generally about 95°C (203°F), the thermostat opens. This actuation of the thermostat starts to occur at 82°C (180°F), when the heated wax contained within a cylinder melts and rapidly expands, pushing the rod and valve assembly out of the cylinder, opening the valve. The temperature dependent actuation of the thermostat allows the engine to warm up as quickly as possible, the thermostat reduces engine wear, deposits and emissions. The open thermostat now allows the coolant to flow through the engine cooling circuit to maintain optimal operation temperatures, which is achieved by directing the hot coolant through the radiator for cooling and recirculation.

Variable Flow Oil Pump Assembly

The oil pump assembly is located within the oil pan. The oil pump assembly is fastened directly to the rear of the balancer shaft assembly and is driven by the rotation of the balance shaft spline.

The oil pump assembly possesses variable flow capability which is made possible by a shift of the circular vane arrangement and the actuation of an oil control valve assembly guided by the ECM. The variable flow capability of the pump optimizes oil flow to the engine components when needed. During performance maneuvers and acceleration the oil pump operates in a steady high pressure state. However, during steady low load touring speeds on level terrain the oil pump operates in a steady low pressure state.

The ECM guided "on" and "off" actuation of the oil control valve assembly allows the chamber to be pressurized which takes the switch from high to low pressure mode. The high pressure state of the chamber compressing the spring and shifting the center of the circular vane arrangement nearer to that of the balancer drive shaft, decreasing the difference of the volume of oil contained between each vane. It is this small variation in volume which produces the steady low pressure flow. It is in this mode that the pump behaves as a smaller pump.

Advantages of variable flow oil pumping modes:

- The high performance steady pressure mode is where engine temperatures and friction are reduced because the pump only delivers the oil that the engine requires.
- The low load touring steady pressure mode is where the volume of oil flow is reduced to even more efficient levels when engine requirements allow. This efficiency reduces the resistance on reciprocating component, allowing engine revolutions with less power resulting in fuel economy savings.

LUBRICATION DESCRIPTION

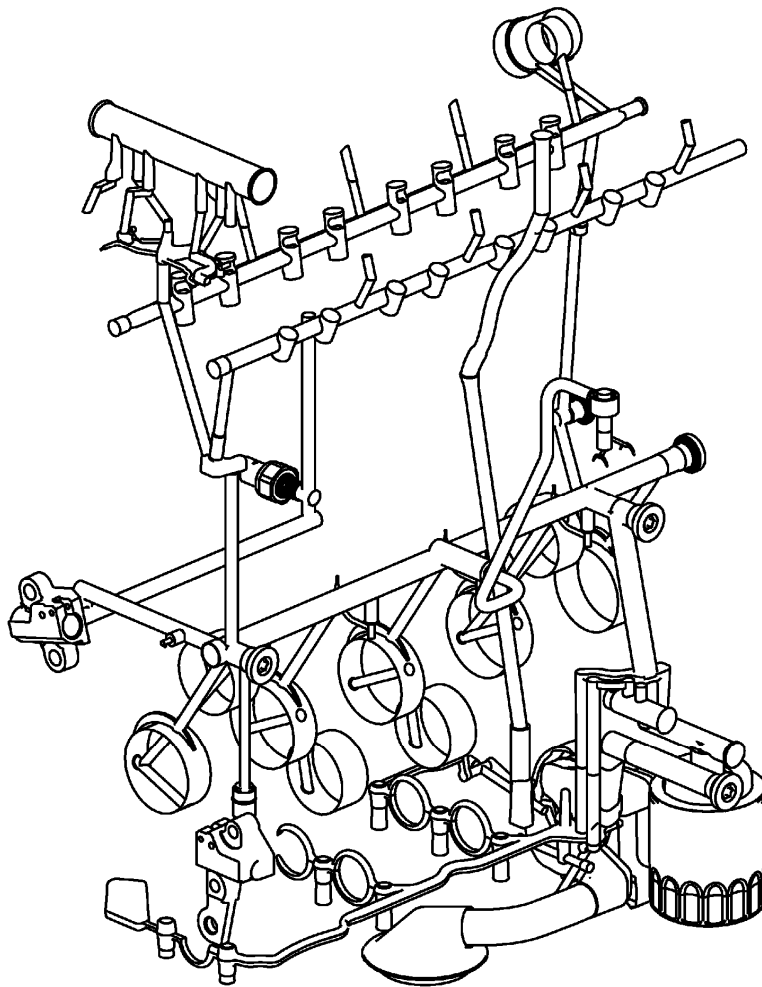


Fig. 2: Lubrication System (LTG)
Courtesy of GENERAL MOTORS COMPANY

Oil is applied under pressure to the crankshaft, connecting rods, balance shaft assembly, camshaft bearing surfaces, rocker arms, valve lash adjusters and timing chain hydraulic tensioner. All other moving parts are lubricated by gravity flow or splash. Oil enters the oil pump through a fixed inlet screen. The oil pump is driven by the balancer shaft assembly's sprocket. The oil pump body is attached to the rear of balancer shaft assembly. The pressurized oil passes through the cylinder head assembly restrictor orifice into the cylinder head's OCV and routed through passages cast into the camshaft cover assembly to each camshaft feed gallery and camshaft drip rail. OCV actuates the 2-Step intake rocker arm assemblies to control valve travel. The oil filter is a metal canister type. A by-pass valve in the filter assembly allows continuous oil flow in case the oil filter should become restricted. Oil then enters the gallery where it is distributed to the balance shafts, crankshaft, camshafts and camshaft timing chain oiler nozzle. The connecting rod bearings are oiled by constant oil flow passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. The pressurized oil passes through the cylinder head restrictor orifice into the cylinder head and then into each camshaft feed gallery. Cast passages feed each hydraulic element adjuster and drilled passages feed each camshaft bearing surface, rocker arm, and drip rail. An engine oil pressure switch or sensor is installed at the end. Oil returns to the oil pan through passages cast into the cylinder head. The timing chain lubrication drains directly into the oil pan.

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished, and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces during initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

SEPARATING PARTS

NOTE:

- **Disassembly of the piston, press fit design piston pin, and connecting rod may create scoring or damage to the piston pin and piston pin bore. If the piston, pin, and connecting rod have been disassembled, replace the components as an assembly.**
- **Many internal engine components will develop specific wear patterns on their friction surfaces.**
- **When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.**

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod to the crankshaft journal
- Connecting rod to the bearing cap

A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.

- Crankshaft main and connecting rod bearings
- Camshaft and valve lash adjusters
- Valve lash adjusters, lash adjuster guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

REPLACING ENGINE GASKETS

Special Tools

EN-28410 Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

Gasket Reuse and Applying Sealants

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the **EN-28410** remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.
 - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
 - This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tightened.
- Tighten bolts to specifications. Do not overtighten.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) SEALANT

Room Temperature Vulcanizing sealant is specified for use. The correct sealer and amount must be used in the proper location to prevent oil leaks. Use only the specific sealer or the equivalent as recommended in the

service procedure.

Room Temperature Vulcanizing (RTV) Sealer

- RTV sealant hardens when exposed to air. This type sealer is used where 2 rigid parts, such as the lower crankcase and the engine block, are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

- Apply RTV to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause damage when the bolt is tightened.
- Assemble components while RTV is still wet, within 3 minutes. Do not wait for RTV to skin over.
- Tighten bolts to specifications. Do not overtighten.

TOOLS AND EQUIPMENT

Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

Engine

Engine Mechanical - 2.0L (LTG) - Diagnostic Information and Procedures

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P06DA-P06DC

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06DA

Engine Oil Pressure Control Solenoid Valve Control Circuit

DTC P06DB

Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P06DC

Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open / High Resistance	Short to Voltage	Signal Performance
Ignition	P0031, P0132, P0134, P0135, P0137, P0443, P0597, P0598, P06DB	P06DA	-	-
Control	P06DB	P06DC	P06DC	P06DD, P06DE

Circuit/System Description

The engine oil pressure control solenoid is a two port solenoid valve used to control engine oil pressure inside the mechanical engine oil pump. The ECM controls the commanded states of the engine oil pressure control solenoid with the following ECM input's.

- Engine Speed

- Engine Oil Temperature (calculated from the Engine Coolant Temperature Sensor)
- Engine Oil Pressure
- Engine Run Time

With the engine oil pressure control solenoid commanded Off, engine oil pressure is higher. When commanded On engine oil pressure is lower. The purpose of this diagnostic is to isolate an electrical problem with the engine oil pressure control solenoid or wiring.

Conditions for Running the DTC

- The system voltage is greater than 11 V.
- DTC P06DA, P06DB or P06DC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25 s.

Action Taken When the DTC Sets

- DTC P06DB is a Type A DTC.
- DTC P06DA and P06DC are Type B DTCs.
- ECM commands the engine oil pressure control solenoid valve OFF.
- ECM commands Reduced Engine Power.

Conditions for Clearing the MIL/DTC

- DTC P06DB is a Type A DTC.
- DTC P06DA and P06DC are Type B DTCs.

Reference Information

Schematic Reference

Engine Mechanical Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Engine Oil Pressure Control Solenoid Valve ON and OFF with a scan tool.
 - Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
 - Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status
 - Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 4. Verify the DTC does not set.
 - **If any DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q44 Engine Oil Pressure Control Solenoid Valve, ignition ON.
2. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp.

NOTE: **An internal short in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.**

2. Test for infinite resistance between the ignition circuit and ground

- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance, test all the components connected to fuse and replace as necessary.

- **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the ignition circuit terminal 1 and the control circuit terminal 2.

- **If the test lamp illuminates**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **If the test lamp does not illuminate**

4. Remove the test lamp, command the Q44 Engine Oil Pressure Control Solenoid Valve ON with a scan tool.

5. Verify the scan tool Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status parameter displays OK.

- **If OK is not displayed**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.

2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.

7. Verify the scan tool Engine Oil Pressure Control Solenoid Valve Circuit High Voltage Test Status parameter is displaying Malfunction when commanding the Engine Oil Pressure Control Solenoid Valve ON with a scan tool.

- **If Malfunction is not displayed**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 ohms in the control circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms replace the K20 Engine Control Module.

- **If Malfunction is displayed**

8. Test or replace the Q44 Engine Oil Pressure Control Solenoid Valve.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the Q44 Engine Oil Pressure Control Solenoid Valve.
2. Test for 10-30 ohms between the control terminal 2 and the ignition voltage terminal 1.
 - **If not between 10.0-30.0 ohms**

Replace the Q44 Engine Oil Pressure Control Solenoid Valve.

- **If between 10.0-30.0 ohms**
3. Test for infinite resistance between each terminal and the Q44 Engine Oil Pressure Control Solenoid Valve housing.
 - **If not OL**

Replace the Q44 Engine Oil Pressure Control Solenoid Valve.

- **If OL**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Oil Pump Flow Control Valve Replacement** Engine Oil Pressure Control Solenoid Valve Replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P06DD OR P06DE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06DD

Engine Oil Pressure Control Solenoid Valve Stuck Off

DTC P06DE

Engine Oil Pressure Control Solenoid Valve Stuck On

Circuit/System Description

The engine oil pressure control solenoid is a two port solenoid valve used to control engine oil pressure inside the mechanical engine oil pump. The ECM controls the commanded states of the engine oil pressure control solenoid with the following ECM input's.

- Engine Speed
- Engine Oil Temperature (calculated from the Engine Coolant Temperature Sensor)
- Engine Oil Pressure
- Engine Run Time

With the engine oil pressure control solenoid commanded Off, engine oil pressure is higher. When commanded On engine oil pressure is lower. The purpose of this diagnostic is to isolate either a stuck on or stuck off engine oil pressure control solenoid.

Conditions for Running the DTC

P06DD

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DD, P06DE, P111E, P2227, P2228, P2229 or P2230 is not set.
- Engine speed within range of 1,500 RPM to 2,500 RPM.

P06DE

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DD, P06DE, P111E, P2227, P2228, P2229 or P2230 is not set.
- Engine running for greater than 20 s.
- Engine speed is within range of 1500 RPM to 2500 RPM.
- Engine oil pressure control solenoid in low pressure for greater than 1.5 s.

Conditions for Setting the DTC

P06DD or P06DE

Engine oil pressure is above or below a calibrated amount during the time the solenoid is changing from ON to OFF states.

Action Taken When the DTC Sets

P06DD

DTC P06DD is a Type B DTC.

P06DE

DTC P06DE is a Type A DTC.

Conditions for Clearing the DTC

P06DD

DTC P06DD is a Type B DTC.

P06DE

DTC P06DE is a Type A DTC.

Reference Information

Schematic Reference

Engine Mechanical Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify correct engine oil level and condition. Refer to **Engine Mechanical Specifications** .
2. Engine Running, increase and maintain the engine speed at 1,800 RPM.

NOTE: **Selecting the scan tool line graph function may make it easier to identify Engine Oil Pressure changes.**

3. Verify the scan tool Engine Oil Pressure parameter changes greater than 30 kPa (4 PSI) when

commanding the Engine Oil Pressure Control Solenoid On and Off.

- **If the parameter does not change**

Replace the Q44 Engine Oil Pressure Control Solenoid.

- **If the parameter changes**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to **Oil Pressure Diagnosis and Testing**.

- **If the DTC does not set**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Oil Pump Flow Control Valve Replacement Engine Oil Pressure Control Solenoid Replacement

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **Disassembled Views** , **Engine Component Description** , and **Lubrication Description** .

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Base Engine Misfire without Internal Engine Noises
- Base Engine Misfire with Abnormal Internal Lower Engine Noises
- Base Engine Misfire with Abnormal Valve Train Noise
- Base Engine Misfire with Coolant Consumption
- Base Engine Misfire with Excessive Oil Consumption
- Engine Noise on Start-Up, but Only Lasting a Few Seconds
- Upper Engine Noise, Regardless of Engine Speed
- Lower Engine Noise, Regardless of Engine Speed
- Engine Noise Under Load
- Engine Will Not Crank - Crankshaft Will Not Rotate
- Engine Compression Test
- Turbocharger Leaking Fluids Externally
- Turbocharger Noise
- Turbocharger Smoke or Smell
- Turbocharger Loss of Boost Pressure
- Oil Consumption Diagnosis
- Oil Pressure Diagnosis and Testing
- Oil Leak Diagnosis
- Drive Belt Chirping, Squeal, and Whine Diagnosis
- Drive Belt Rumbling and Vibration Diagnosis
- Drive Belt Falls Off and Excessive Wear Diagnosis
- Drive Belt Tensioner Diagnosis

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Base Engine Misfire without Internal Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt.

Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, and repair or replace as required.
A loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Improperly installed or damaged MAP sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Damage to the MAP sensor housing	Replace the intake manifold.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lash adjusters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression.	<ul style="list-style-type: none"> • Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace the oil pump as required. • Replace the oil control valve solenoid as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	<ul style="list-style-type: none"> • Inspect for spark plugs saturated by coolant. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> • Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>.

	<ul style="list-style-type: none"> • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
<p>A damaged crankshaft reluctor wheel</p> <p>A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage.</p> <ul style="list-style-type: none"> • Systems with electronic communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of generating a P0300 DTC or P0336. 	<p>Replace the sensor and/or crankshaft as required.</p>

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
<p>Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt</p> <p>Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine, and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.</p>	<p>Replace the drive belt.</p>
<p>Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout</p> <p>A misfire code may be present without an actual misfire condition.</p>	<p>Inspect the components, repair or replace as required.</p>
<p>Loose or improperly installed engine flywheel or crankshaft balancer</p> <p>A misfire code may be present without an actual misfire condition.</p>	<p>Repair or replace the flywheel and/or balancer as required.</p>
<p>Worn piston rings</p> <p>Oil consumption may or may not cause the engine</p>	<ul style="list-style-type: none"> • Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression.

to misfire.	<p>Refer to <u>Engine Compression Test</u>.</p> <ul style="list-style-type: none"> • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.
Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft, and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact within the rocker arm assembly.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft, valve lash adjusters, and roller finger followers.
Sticking valve lash adjusters	Replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	<ol style="list-style-type: none"> 1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to <u>Camshaft Position Actuator and Camshaft Replacement - Intake</u> , or <u>Camshaft Position Actuator and Camshaft Replacement - Exhaust</u> .

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Base Engine Misfire with Coolant Consumption

Cause	Correction
Faulty cylinder head gasket and/or cracking, or other damage to the cylinder head and engine block	<ul style="list-style-type: none"> • Inspect for spark plugs saturated by coolant.

cooling system passages.
Coolant consumption may or may not cause the engine to overheat.

- Perform a cylinder leak down test.
- Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket.
- Repair or replace as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Base Engine Misfire with Excessive Oil Consumption

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	<ul style="list-style-type: none"> • Inspect the spark plugs for oil deposits. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> • Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.

ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

Engine Noise on Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	<ol style="list-style-type: none"> 1. Drain the oil. 2. Install the correct viscosity oil.
High valve lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	<ol style="list-style-type: none"> 1. Inspect the thrust bearing and crankshaft. 2. Repair or replace as required.
Damaged or faulty oil filter by-pass valve	<ol style="list-style-type: none"> 1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	<ol style="list-style-type: none"> 1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to Oil Pressure Diagnosis and Testing. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator.

Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake** , or **Camshaft Position Actuator and Camshaft Replacement - Exhaust** .

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> • Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace as required.
Worn valve rocker arm	Replace the valve rocker arm.
Improper lubrication to the valve rocker arms	Inspect the following components, and repair or replace as required: <ul style="list-style-type: none"> • The valve rocker arm • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty valve lash adjusters	Replace the valve lash adjusters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn, damaged, or faulty timing chain tensioners	Replace tensioners
Worn engine camshaft lobes	<ul style="list-style-type: none"> • Inspect the engine camshaft lobes. • Replace the camshaft and valve lash adjusters as required.
Worn valve guides or valve stems	Inspect the following components, and repair as required: <ul style="list-style-type: none"> • The valves • The valve guides
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components, and repair as required: <ul style="list-style-type: none"> • The valves • The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> • Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace damaged components as required.
Worn accessory drive components - abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt and/or misalignment of system components	<ol style="list-style-type: none"> 1. Inspect the accessory drive system. 2. Repair or replace as required.
Loose or damaged crankshaft balancer	<ol style="list-style-type: none"> 1. Inspect the crankshaft balancer. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to <u>Symptoms - Engine Controls</u> .
Loose torque converter bolts	<ol style="list-style-type: none"> 1. Inspect the torque converter bolts and flywheel. 2. Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen - an oil pan that has been damaged, may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	<ol style="list-style-type: none"> 1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace as required.
Oil pump screen loose, damaged or restricted	<ol style="list-style-type: none"> 1. Inspect the oil pump screen. 2. Repair or replace as required.
Excessive piston-to-cylinder bore clearance	<ol style="list-style-type: none"> 1. Inspect the piston and cylinder bore. 2. Repair as required.
Excessive piston pin-to-bore clearance	<ol style="list-style-type: none"> 1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace as required.
Excessive connecting rod bearing clearance	<p>Inspect the following components, and repair as required:</p> <ul style="list-style-type: none"> • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	<p>Inspect the following components, and repair as required:</p> <ul style="list-style-type: none"> • The crankshaft bearings • The crankshaft journals
Incorrect piston, piston pin, and connecting rod	<ol style="list-style-type: none"> 1. Verify the pistons, piston pins and connecting

installation - pistons must be installed with the mark or dimple on the top of the piston, facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.

- rods are installed correctly.
2. Repair as required.

ENGINE NOISE UNDER LOAD

Engine Noise Under Load

Cause	Correction
Low oil pressure	<ol style="list-style-type: none"> 1. Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition. Refer to <u>Symptoms - Engine Controls</u> .
Loose torque converter bolts	<ol style="list-style-type: none"> 1. Inspect the torque converter bolts and flywheel. 2. Repair as required.
Cracked flywheel, automatic transmission	<ol style="list-style-type: none"> 1. Inspect the flywheel bolts and flywheel. 2. Repair as required.
Excessive connecting rod bearing clearance	<p>Inspect the following components, and repair as required:</p> <ul style="list-style-type: none"> • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	<p>Inspect the following components, and repair as required:</p> <ul style="list-style-type: none"> • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	<ol style="list-style-type: none"> 1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to <u>Camshaft Position Actuator Intake Solenoid Valve Replacement</u>, or <u>Camshaft Position Actuator Exhaust Solenoid Valve Replacement</u>.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component	<ol style="list-style-type: none">1. Remove accessory drive belts.2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder <ul style="list-style-type: none">• Coolant/antifreeze in cylinder• Oil in cylinder• Fuel in cylinder	<ol style="list-style-type: none">1. Remove spark plugs and check for fluid.2. Inspect for broken head gasket.3. Inspect for cracked engine block or cylinder head.4. Inspect for a sticking fuel injector.5. Inspect for cracked cylinder wall.
Seized automatic transmission torque converter	<ol style="list-style-type: none">1. Remove the torque converter bolts.2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	<ol style="list-style-type: none">1. Disengage the clutch.2. Rotate crankshaft by hand at the balancer or flywheel location.
Broken timing chain and/or gears	<ol style="list-style-type: none">1. Inspect timing chain and gears.2. Repair as required.
Seized balance shaft	<ol style="list-style-type: none">1. Inspect balance shaft.2. Repair as required.
Material in cylinder <ul style="list-style-type: none">• Broken valve• Piston material• Foreign material• Cracked cylinder wall	<ol style="list-style-type: none">1. Inspect cylinder for damaged components and/or foreign materials.2. Inspect for fallen cylinder wall.3. Repair or replace as required.
Seized crankshaft or connecting rod bearings	<ol style="list-style-type: none">1. Inspect crankshaft and connecting rod bearings.2. Inspect for fallen cylinder wall.3. Repair as required.
Bent or broken connecting rod	<ol style="list-style-type: none">1. Inspect connecting rods.2. Repair as required.
Broken crankshaft	<ol style="list-style-type: none">1. Inspect crankshaft.2. Repair as required.

COOLANT IN COMBUSTION CHAMBER

Coolant in Combustion Chamber

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage.	
<ol style="list-style-type: none">1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u>.2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore.3. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component.4. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>.	
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> , and <u>Cylinder Head Replacement</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cylinder head or block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Coolant in Engine Oil

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil "overfill" condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.	
<ol style="list-style-type: none">1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u>.2. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component.3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block with low compression may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>.	
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> , and <u>Cylinder Head Replacement</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> .

Cracked cylinder head	Replace the cylinder head and gasket.
Cylinder head or block porosity	Replace the components as required.

ENGINE COMPRESSION TEST

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.
4. Remove all spark plugs.
5. Turn the ignition to the ON position.
6. Depress the accelerator pedal to position the throttle plate wide open.
7. Start with the compression gauge at zero and crank the engine through 4 compression strokes, 4 puffs.
8. Measure the compression for each cylinder. Record the readings.
9. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.
10. The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any 1 cylinder is 1 035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). ($1\ 035 \times 70\% = 725$) ($150 \times 70\% = 105$).
 - Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
 - Piston Rings Leaking - Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.
 - Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
 - If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

TURBOCHARGER LEAKING FLUIDS EXTERNALLY

Turbocharger Leaking Fluids Externally

Condition	Action
Leaking Coolant from Coolant interfaces; Feed and/or Return Pipe	<ul style="list-style-type: none"> • Inspect Seal Surfaces on Bearing Housing, Pipes, and Banjo Bolt • If Turbo Seal Surface is damaged replace turbo • If Pipe Seal Surface is damaged replace Pipe • If Banjo Bolt Seal Surface is damaged replace Banjo Bolt • Reassemble with new seals in all cases
Leaking Coolant from area other than Coolant interfaces; NOT Feed and/or Return Pipe	Replace component that is leaking
Leaking Oil from Oil interfaces; Feed and/or	

Return Pipe	<ul style="list-style-type: none"> • Inspect Seal Surfaces on Bearing Housing, Pipes, and Bolts • If Turbo Seal Surface is damaged replace turbo • If Pipe Seal Surface is damaged replace Pipe • If Bolt Seal Surface is damaged replace Bolt • Reassemble with new seals in all cases
Oil on Compressor Cover	<ul style="list-style-type: none"> • Check for correct PCV System functionality, refer to <u>Crankcase Ventilation System Inspection/Diagnosis</u> • Check Turbocharger Oil Drain Pipe for restriction • Check PCV connection in Compressor Housing, inspect O-ring • Check Fresh Air Duct connection at Compressor inlet, look for damage and replace if necessary • Check Compressor Outlet connection, look for damage and replace if necessary
All Other External Turbocharger Leaks	Replace Turbocharger

TURBOCHARGER NOISE

Some noise is normal. Compare to a known good vehicle.

Turbocharger Noise

Condition	Action
Compressor Inlet leaks or Obstructions	Inspect for leaks or obstructions in the Turbocharger inlet.
Compressor Outlet Leaks or Obstruction	Inspect for leaks or obstructions in the Turbocharger outlet.
Charge Air Cooler and Engine Intake system Leaks or Obstructions	<ul style="list-style-type: none"> • Inspect for leaks • Inspect for obstructions
Damaged Electric Recirculation Valve	<ul style="list-style-type: none"> • Check Seal to Compressor Cover • Check DTCs for Bypass/Recirculation codes, replace if necessary
Compressor/Turbine Wheel Damage - Bent or Broken Blades	Replace the Turbocharger.
Compressor/Turbine Wheel to Housing contact	Replace the Turbocharger.

TURBOCHARGER SMOKE OR SMELL

Turbocharger Smoke or Smell

Condition	Action
Oil or Coolant Leak	Correct the leak.

Exhaust Leak	<ul style="list-style-type: none"> • Inspect Gaskets and Sealing Surfaces • Correct Leak • Look for external cracks in Turbocharger components <p>NOTE: Cracks in the Turbine Inlet Partition Wall are acceptable.</p> <ul style="list-style-type: none"> • Replace turbocharger assembly if external cracks found
Nearby Component Out of Position/Touching Turbocharger	Check for Turbine housing for contact with nearby components.

TURBOCHARGER LOSS OF BOOST PRESSURE

Turbocharger Loss of Boost Pressure

Condition	Action
Perceived Loss of Boost	<ul style="list-style-type: none"> • Check DTC codes • No Codes Present - Do not replace Turbocharger

CYLINDER LEAKAGE TEST

Special Tools

EN 35667-A Cylinder Head Leakdown Tester

For equivalent regional tools, refer to **Special Tools** .

NOTE: **A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High leakage may indicate one or more of the following:**

- Worn or burnt valves
- Broken valve springs
- Stuck valve lash adjusters
- Incorrect valve lash/adjustment
- Damaged piston
- Worn piston rings
- Worn or scored cylinder bore
- Damaged cylinder head gasket
- Cracked or damaged cylinder head

- Cracked or damaged engine block

WARNING: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** in Engine Controls.
3. Rotate the crankshaft to place the piston in the cylinder being tested at Top Dead Center (TDC) of the compression stroke.
4. Install the **EN 35667-A** tester or equivalent.

NOTE: It may be necessary to hold the crankshaft balancer bolt to prevent the engine from rotating.

5. Apply shop air pressure to the **EN 35667-A** tester and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
 - Air leakage sounds at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
 - Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
 - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a

damaged cylinder head.

- Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.

7. Perform the leakage test on the remaining cylinders and record the values.

ENGINE OIL LEVEL SENSOR DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Engine Oil Level Sensor Signal	2	1	-
Engine Oil Level Sensor Ground	-	1	-
1. DIC message Engine Oil Level Low always ON 2. DIC message Engine Oil Level Low always OFF			

Typical Scan Tool Data

Engine Oil Level Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON Parameter Normal Range: OK			
Engine Oil Level Sensor/Switch Signal	OK	Low	OK
Engine Oil Level Sensor/Switch Ground	-	Low	-

Circuit/System Description

The engine oil level sensor/switch is normally-closed with proper engine oil level. The switch opens when the engine oil level drops below a calibrated level. The engine control module (ECM) monitors the engine oil level signal circuit when the ignition is ON, and the engine is OFF. With the switch in the closed position, the ECM detects a low voltage on the signal circuit. With the switch in the open position, the ECM detects a high voltage on the signal circuit. When high voltage is detected on the signal circuit, the ECM will send a serial data message to the instrument panel cluster (IPC). The IPC will then display a message on the driver information center (DIC) or illuminate a low engine oil level lamp.

The following information determines the message sent from the ECM to the IPC:

- The Low Engine Oil Level message lamp is displayed only after the ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 minutes to

greater than 50 minutes, depending on engine oil temperatures.

- The Low Engine Oil Level message is turned OFF when the ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 seconds, followed by an ignition ON event for less than 1 second.

Reference Information

Schematic Reference

- **Engine Mechanical Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Verify proper engine oil level.
 - **If not at proper level**

Add oil as necessary.
 - **If at proper level**
2. Ignition ON, verify the scan tool Engine Oil Level parameter reads OK.
 - **If not OK**

Refer to Circuit/System Testing.

- **If OK**
- 3. All OK.

Circuit/System Testing

NOTE: **Verify proper engine oil level before continuing with diagnosis.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B35 Engine Oil Level Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the ground circuit terminal 1 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Ignition ON.
4. Verify the scan tool Engine Oil Level Switch parameter reads Low.
 - **If the Engine Oil Level Switch parameter reads OK**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the Engine Oil Level Switch parameter reads Low**

NOTE: **If a short to voltage is found on the signal circuit, the fuse in the 3A jumper wire will open.**

5. Install a 3A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 1.
6. Verify the scan tool Engine Oil Level Switch parameter reads OK.
 - **If the Engine Oil Level Switch parameter reads Low**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If the Engine Oil Level Switch parameter reads OK**
7. Test or replace the B35 Engine Oil Level Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Engine Oil Level Indicator Switch Replacement (FWD)** , **Engine Oil Level Indicator Switch Replacement (AWD)**
- **Control Module References** for the ECM replacement, programming, and setup

OIL CONSUMPTION DIAGNOSIS

Excessive oil consumption, not due to leaks, is the use of 0.9 L (1 qt) or greater of engine oil within 3 200 kilometers (2,000 miles). The causes of excessive oil consumption include the following conditions:

- External oil leaks

Tighten bolts and/or replace gaskets and oil seals as necessary.

- Incorrect oil level or improper reading of oil level indicator

With the vehicle on a level surface, allow adequate drain down time and inspect for the correct oil level.

- Improper oil viscosity

Use recommended SAE viscosity for the prevailing temperatures.

- Continuous high speed driving and/or severe usage
- Crankcase ventilation system restrictions or malfunctioning components
- Valve guides and/or valve stem oil seals worn, or the seal omitted

Ream guides and install oversize service valves and/or new valve stem oil seals.

- Piston rings broken, improperly installed, worn, or not seated properly

Allow adequate time for rings to seat. Replace broken or worn rings, as necessary.

- Piston improperly installed or mis-fitted

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **CH-48027** Digital Pressure Gauge
- **EN-21867-850** Oil Pressure Gauge Adapter

For equivalent regional tools, refer to **Special Tools** .

1. With the vehicle on a level surface, allow adequate drain down time of 2-3 minutes and measure for a low oil level.

Add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.

2. Run the engine, and verify low, or no oil pressure on the vehicle gauge or light.

Listen for a noisy valve train or a knocking noise.

3. Inspect for the following:

- Correct oil filter with anti-drain back feature and O-ring on the cylinder block side of the filter
- Oil diluted by moisture or unburned fuel mixtures
- Improper oil viscosity for the expected temperature
- Incorrect or malfunctioning oil pressure sender
- Incorrect or malfunctioning oil pressure gauge
- Plugged oil filter
- Malfunctioning oil bypass valve

4. Remove the oil pressure sender or another engine block oil gallery plug.

5. Install **EN-21867-850** adapter and **CH-48027** gauge and measure the engine oil pressure.

6. Compare the readings to specifications. Refer to **Engine Mechanical Specifications** .

7. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:

- Correct oil filter with anti-drain back feature and O-ring on the cylinder block side of the filter
- Oil pump worn or dirty

Refer to **Balancer With Oil Pump Shaft Cleaning and Inspection** .

- Oil pump screen loose, plugged, or damaged
- Oil pump screen O-ring seal missing or damaged
- Malfunctioning oil control valve solenoid
- Excessive bearing clearance

Refer to **Crankshaft and Bearing Cleaning and Inspection** .

- Cracked, porous or restricted oil galleries
- Oil gallery plugs missing or incorrectly installed

Refer to **Engine Block Assemble** .

- Broken lash adjusters

OIL LEAK DIAGNOSIS

Oil Leak Diagnosis

Step	Action	Yes	No
DEFINITION: You can repair most fluid leaks by first, visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.			
1	<ol style="list-style-type: none"> 1. Operate the vehicle until it reaches normal operating temperature. Refer to <u>Engine Mechanical Specifications</u> . 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Check for drippings. <p>Are drippings present?</p>	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 4
4	<ol style="list-style-type: none"> 1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 5
5	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings 		

	<ul style="list-style-type: none"> • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 6
6	<ol style="list-style-type: none"> 1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 7
7	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 8
8	<p>Use EN 28428-E Dye and Light Kit , in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool.</p> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 9
9	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	System OK
	<ol style="list-style-type: none"> 1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas: 		

10	<ul style="list-style-type: none"> • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces <p>2. Inspect the engine for customer modifications.</p> <p>Is there mechanical damage, or customer modifications to the engine?</p>	Go to Step 11	System OK
11	<p>Repair or replace all damaged or modified components.</p> <p>Did you complete the repair?</p>	Go to Step 1	-

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Special Tools

EN 23951 Valve Manometer

For equivalent regional tools, refer to **Special Tools** .

1. Verify clean air cleaner.
2. Verify oil fill cap is in place.
3. Verify oil level indicator is installed.
4. Remove the oil level indicator. Install a **EN 23951** valve manometer or equivalent, into the oil level indicator hole.
5. Start the engine.
6. Check for slight vacuum. The vacuum level should be less than 3.377 kPa (1 in Hg).
7. If vacuum is higher, inspect and verify that the clean air hose from cam cover to air intake is not blocked or kinked.
8. If vacuum is in the normal range, remove the PCV line from the fresh air valve near oil fill cap. Block fresh air valve and also plug the fresh air hose. Vacuum should increase on the manometer. If held too long, vacuum will be drawn through the crankshaft seals creating a sucking sound.
9. If vacuum does not increase, the orifice in the camshaft cover assembly could be plugged. The valve is between the camshaft cover assembly and the cylinder head assembly.
10. If there is zero vacuum or pressure, verify compression of the engine.

11. If compression is normal, check for a blocked orifice at the camshaft cover assembly. Clean the orifice.
12. The hose from valve cover to the turbo is also for the positive crankcase ventilation (PCV) and is used for PCV flow under normal operation and only PCV flow during turbo boost conditions. If the hose is plugged, replace the PCV hose assembly and PCV fitting assembly at the turbocharger.

Concern	Action
External Oil Leak	Inspect for any of the following conditions: <ul style="list-style-type: none"> • Plugged air intake system • Plugged positive crankcase ventilation (PCV) orifice/check valve in the camshaft cover assembly • Plugged or kinked PCV hoses • Damaged or incorrectly installed PCV hoses • Excessive crankcase pressure • Plugged PCV hose from camshaft cover to turbocharger
Rough Idle	Inspect for any of the following conditions: <ul style="list-style-type: none"> • Plugged or incorrectly installed air intake system • Plugged PCV orifice/check valve in the camshaft cover assembly • Plugged or kinked PCV hoses • Leaking or damaged PCV hoses • Leaking PCV hose from camshaft cover to turbocharger
Stalling or Slow Idle Speed	Inspect for any of the following conditions: <ul style="list-style-type: none"> • Plugged air intake system • Plugged PCV orifice in the camshaft cover assembly • Plugged or kinked PCV hoses • Leaking or damaged PCV hoses • Leaking PCV hose from camshaft cover to turbocharger
High Idle Speed	Inspect for any of the following conditions: <ul style="list-style-type: none"> • Air intake system incorrectly installed • Leaking or damaged PCV hoses
	Inspect for any of the following conditions: <ul style="list-style-type: none"> • Plugged or incorrectly installed air intake system

Sludge in the Engine	<ul style="list-style-type: none"> • Plugged PCV orifice in the camshaft cover assembly • Plugged or kinked PCV hoses • Plugged PCV hose from camshaft cover to turbocharger
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DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.
- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.

3

The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4

Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.

6

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from

a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

10

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.

12

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

14

This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.

15

This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.

16

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

17

This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.

19

Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

Drive Belt Chirping, Squeal, and Whine Diagnosis

Step	Action	Yes	No

CAUTION:

Refer to **Belt Dressing Caution** .

DEFINITION: The following items are indications of chirping:

- A high pitched noise that is heard once per revolution of the drive belt or a pulley.
- Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.

DEFINITION: The following items are indications of drive belt squeal:

- A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs.
- The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.

DEFINITION: The following items are indications of drive belt whine:

- A high pitched continuous noise.
- The noise may be caused by an accessory drive component failed bearing.

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squeal or whine noise still exist?	Go to <u>Symptoms - Engine Mechanical</u>	Go to Step 4
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13. Do the belt grooves have pilling?	Go to Step 5	Go to Step 6
	Clean the drive belt pulleys with a suitable wire		

5	brush. Did you complete the repair?	Go to Step 20	Go to Step 6
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to Step 7	Go to Step 8
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to Step 20	Go to Step 8
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to Step 9	Go to Step 10
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to Step 20	Go to Step 10
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to Step 11	Go to Step 12
11	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> .</p> <p>2. Replace any improper or missing fasteners.</p> <p>Did you complete the repair?</p>	Go to Step 20	Go to Step 12
12	Inspect for a bent pulley. Did you find the condition?	Go to Step 18	Go to Step 19
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to Step 20	Go to Step 14
14	Test the drive belt tensioner for proper operation. Refer to <u>Drive Belt Replacement</u> . Did you find and correct the condition?	Go to Step 20	Go to Step 15
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to Step 20	Go to Step 16
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 20	Go to Step 17
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 20	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to Step 20	Go to Step 19
19	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

The drive belt may have a rumbling condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belts are installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

3

This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4

Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt or felt as a lump in the belt.

5

Small amounts of pilling is normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.

9

Inspecting of the fasteners can eliminate the possibility that the wrong bolt, nut, spacer, or washer was installed.

11

This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.

12

Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

Drive Belt Rumbling and Vibration Diagnosis

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The following items are indications of drive belt rumbling: <ul style="list-style-type: none">• A low pitch tapping, knocking, or thumping noise heard at or just above idle.• Heard once per revolution of the drive belt or a pulley.• Rumbling may be caused from:<ul style="list-style-type: none">◦ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove◦ The separation of the drive belt◦ A damaged drive belt			
DEFINITION: The following items are indications of drive belt vibration: <ul style="list-style-type: none">• The vibration is engine-speed related.• The vibration may be sensitive to accessory load.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds.	Go to <u>Symptoms -</u>	

	3. Repeat this test if necessary by removing the remaining belt(s).	<u>Engine Mechanical</u> or <u>Vibration Analysis - Engine</u>	
	Does the rumbling or vibration still exist?		Go to Step 4
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to <u>Drive Belt Replacement</u> . Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?	Go to Step 8	Go to Step 9
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 9
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 10	Go to Step 11
10	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace improper or missing fasteners. Did you complete the repair?	Go to Step 13	Go to Step 11
11	Inspect for a bent water pump shaft. Refer to <u>Water Pump Replacement (LTG)</u> , <u>Water Pump Replacement (LUK)</u> . Did you find and correct the condition?	Go to Step 13	Go to Step 12
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 13	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

If the drive belt repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.

An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate properly.

If the drive belt is the incorrect length, the drive belt tensioner may not keep the proper tension on the drive belt.

Excessive wear on a drive belt is usually caused by an incorrect installation or the wrong drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.

Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall off.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

This inspection is to verify the condition of the drive belt. Damage may of occurred to the drive belt when the drive belt fell off. The drive belt may of been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plys.

4

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.

5

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

6

Accessory drive component brackets that are bent or cracked will let the drive belt fall off.

7

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut , spacer, or washer was installed. Missing. loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

13

The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.

14

The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

15

This inspection is to verify the drive belt is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

Drive Belt Falls Off and Excessive Wear Diagnosis

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u> .
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	CAUTION: Refer to <u>Fastener Caution</u> 1. Tighten any loose fasteners. Refer to <u>Fastener</u>		

	<u>Tightening Specifications</u> . 2. Replace improper or missing fasteners.		
	Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to <u>Drive Belt Replacement</u> . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <u>Drive Belt Replacement</u> . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2
13	Inspect the drive belt for the proper installation. Refer to <u>Drive Belt Replacement</u> . Did you find this condition?	Go to Step 16	Go to Step 14
14	Inspect for the proper drive belt. Did you find this condition?	Go to Step 16	Go to Step 15
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 17	Go to Diagnostic Aids
16	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?	Go to Step 17	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

Drive Belt Tensioner Diagnosis

Step	Action	Yes	No
1	1. Remove the drive belt. Refer to <u>Drive Belt Replacement</u> . 2. Inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to Step 6	Go to Step 2
2	Rotate the drive belt tensioner pulleys. Do the pulleys rotate without any unusual resistance or binding?	Go to Step 3	Go to Step 6
	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in		

3	order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10 percent of the second torque reading?	Go to Step 4	Go to Step 6
4	Inspect tensioner for indication of oil leaks. Does it show signs of oil leaking?	Go to Step 6	Go to Step 5
5	Remove top tensioner bolt, above hydraulic tensioner and verify tensioner assembly moves about center pivot by applying light force. Does the tensioner Asm move without binding?	System OK	Go to Step 6
6	Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement</u> . Is the repair complete?	System OK	-

Engine

Engine Mechanical - 2.0L (LTG) - Repair Instructions - Off Vehicle

REPAIR INSTRUCTIONS - OFF VEHICLE

DRAINING FLUIDS AND OIL FILTER REMOVAL

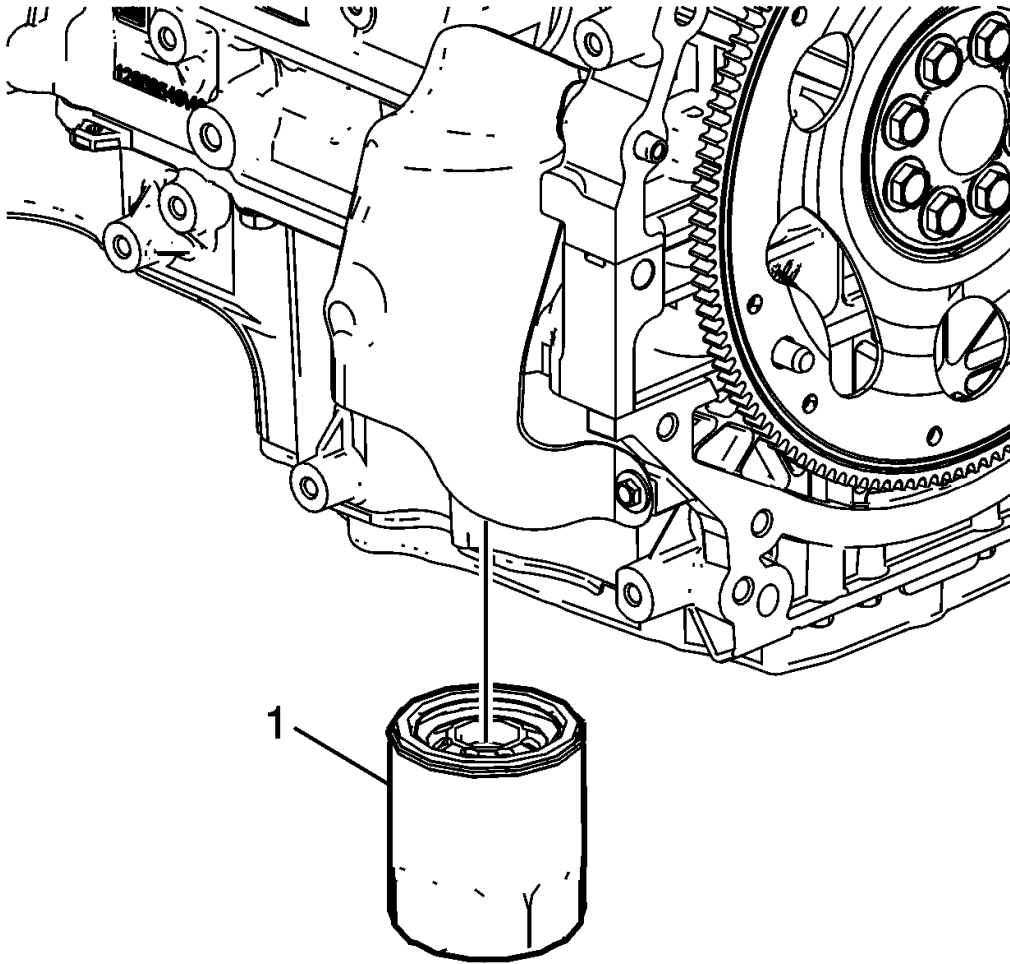


Fig. 1: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil filter (1). Remove the oil pan drain plug and allow the oil to drain out.
2. Clean the oil filter housing in the engine block.

CAUTION: Refer to Fastener Caution .

3. Install the oil pan drain plug and tighten to 25 N.m (18 lb ft).

4. If cleaning or repairing the engine block, it is not necessary to reinstall the plug.

CRANKSHAFT BALANCER REMOVAL

Special Tools

- **EN-41816** Crankshaft Balancer Remover
- **EN-41816-A** Crankshaft End Protector
- **EN 50792** Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

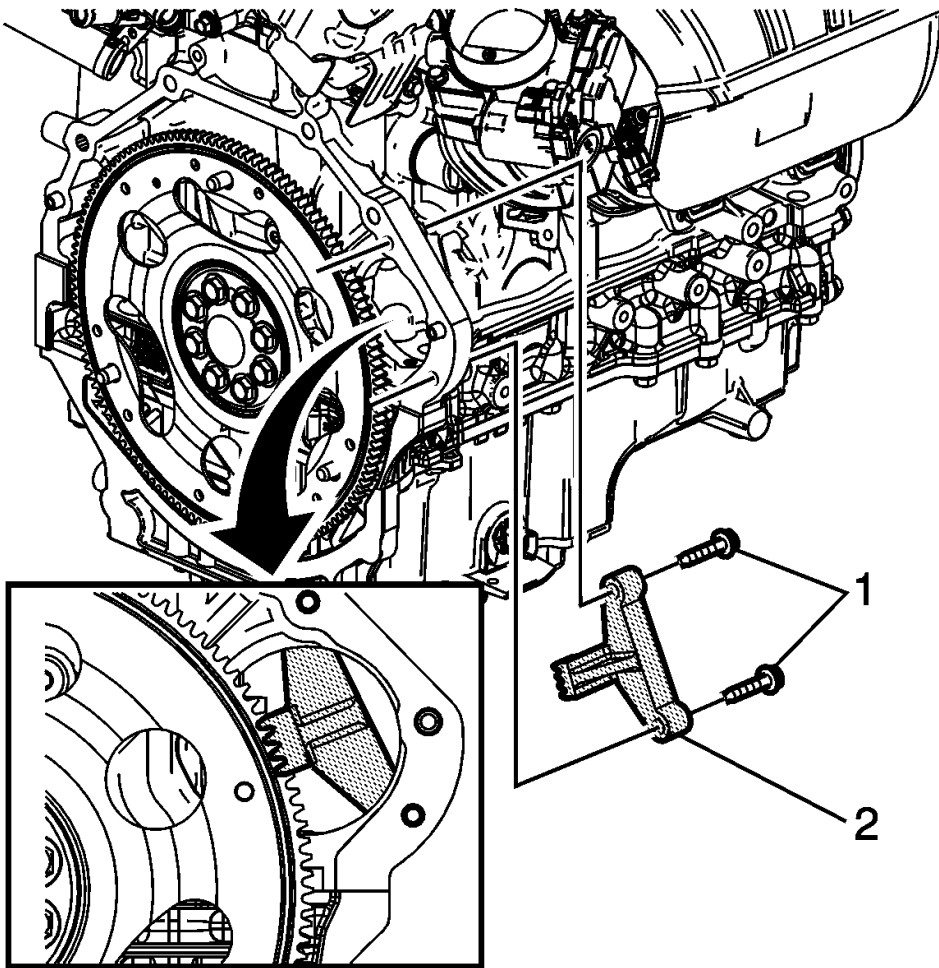


Fig. 2: Starter Motor Bolts

Courtesy of GENERAL MOTORS COMPANY

1. To prevent crankshaft rotation, install **EN 50792** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

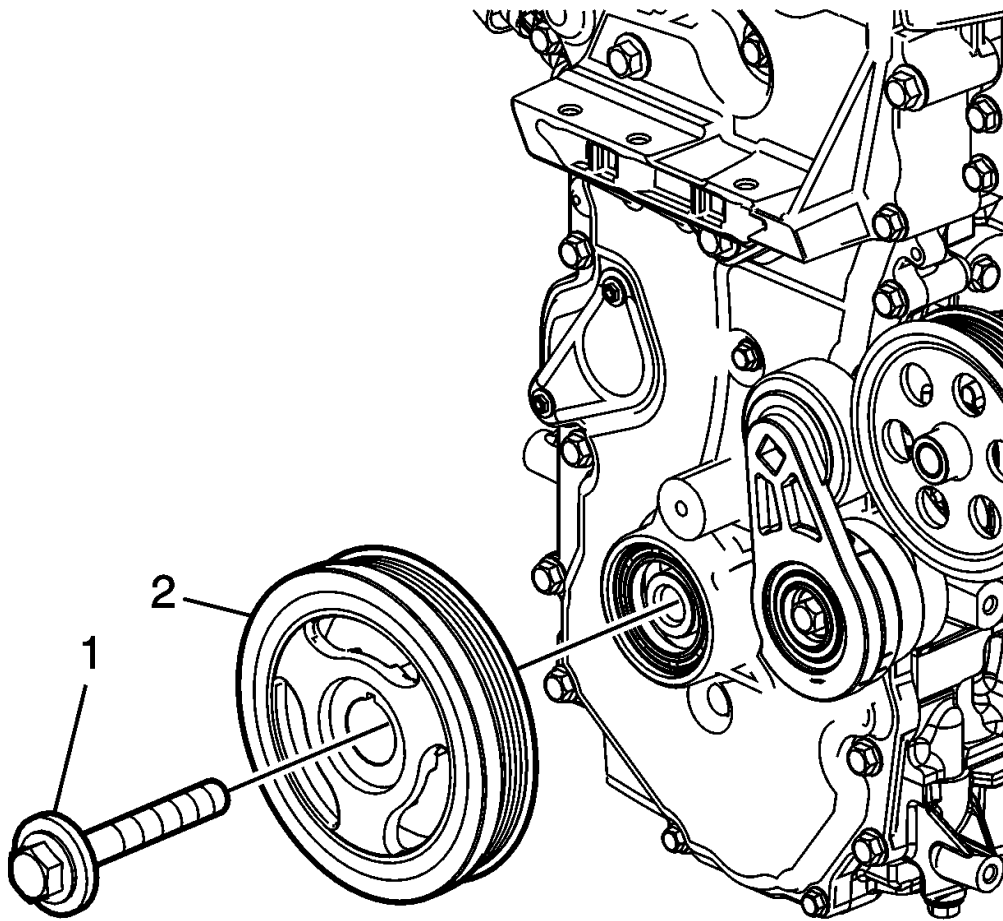


Fig. 3: Crankshaft Balancer

Courtesy of GENERAL MOTORS COMPANY

2. Remove and discard the crankshaft balancer bolt (1) and washer.
3. Install **EN-41816-A** protector to protect the crankshaft end during balancer removal.
4. Using **EN-41816** remover , remove the balancer (2).
5. Remove the special tools.

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

Special Tools

EN 50792 Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

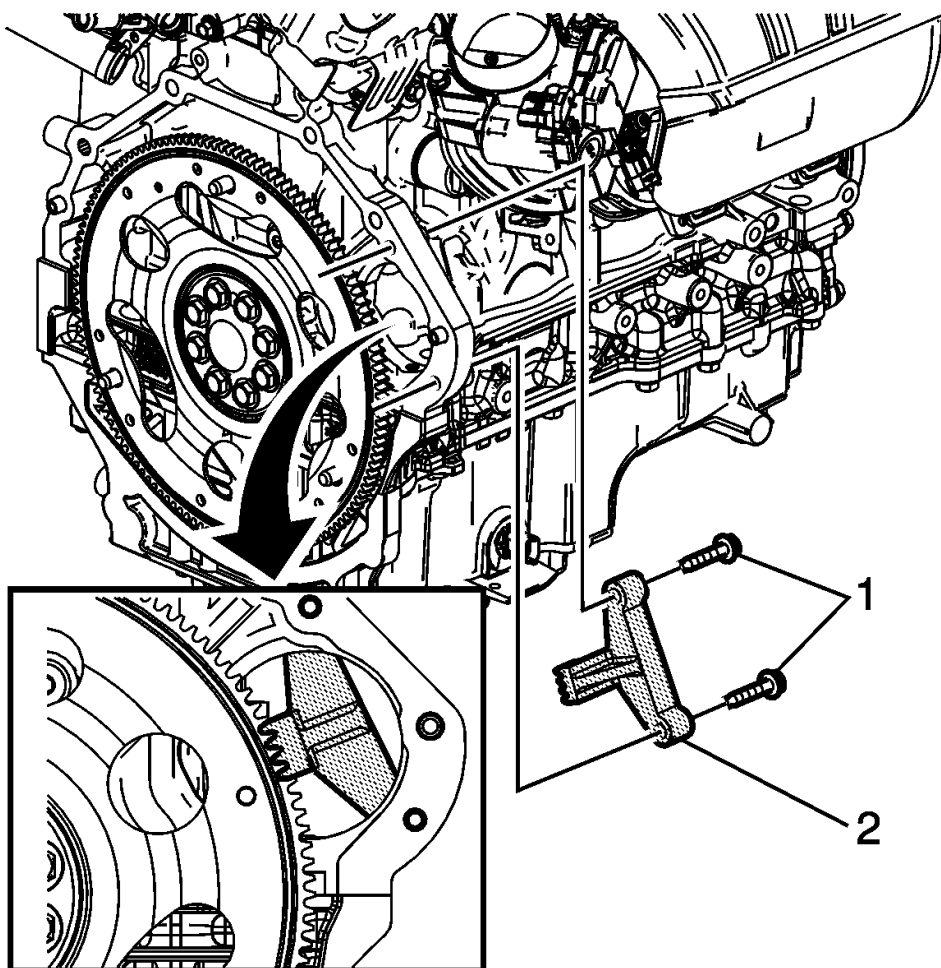


Fig. 4: Starter Motor Bolts

Courtesy of GENERAL MOTORS COMPANY

1. To prevent crankshaft rotation, install **EN 50792** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

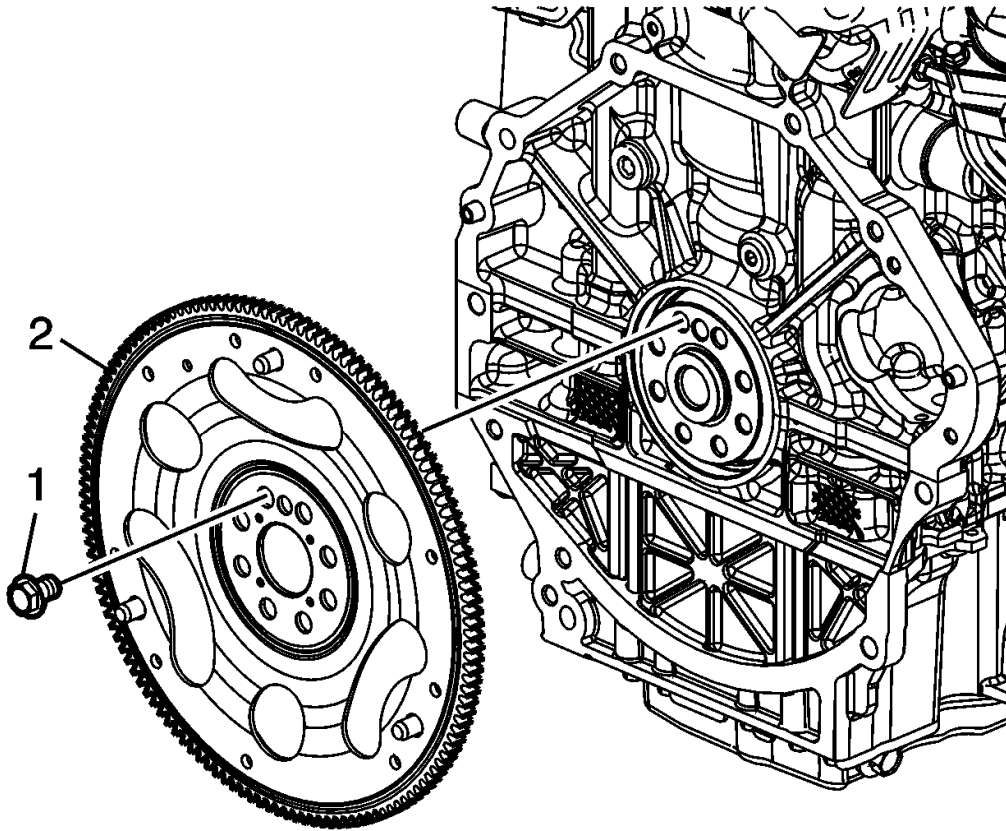


Fig. 5: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove and discard the flywheel attaching bolts (1).
3. Remove the flywheel (2).
4. Remove **EN 50792** holding tool.

INTAKE MANIFOLD REMOVAL

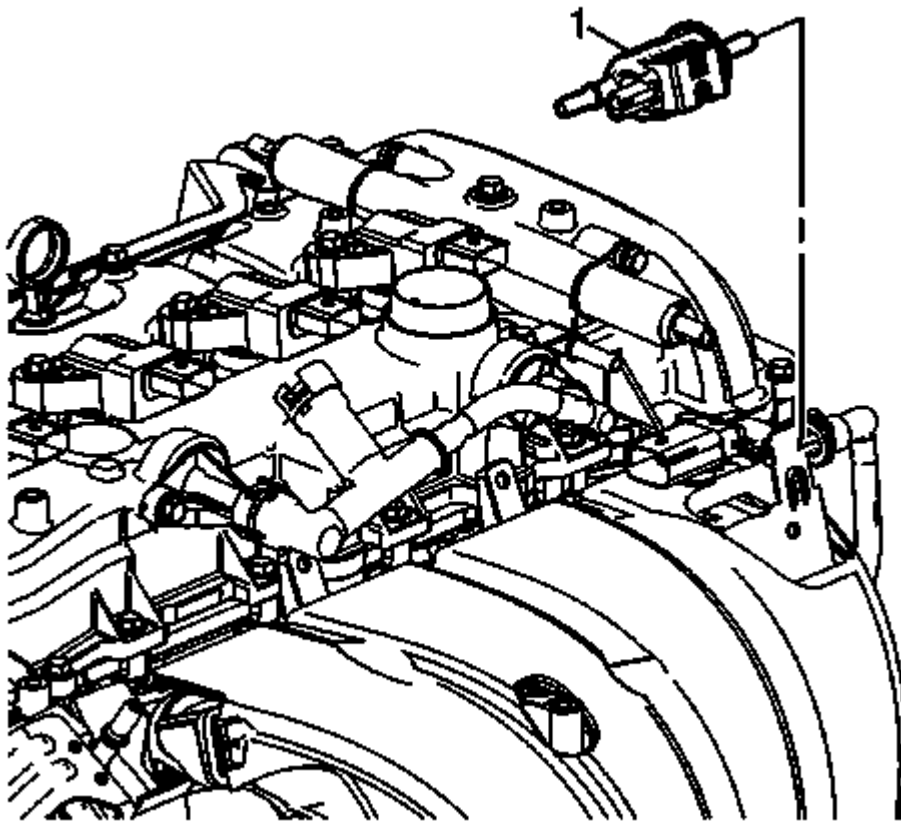


Fig. 6: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Never attempt to remove the intake manifold from a hot engine, allow the engine to cool to ambient temperature. The intake manifold can be damaged if it is removed when the engine is hot.

1. Remove the EVAP canister valve (1).

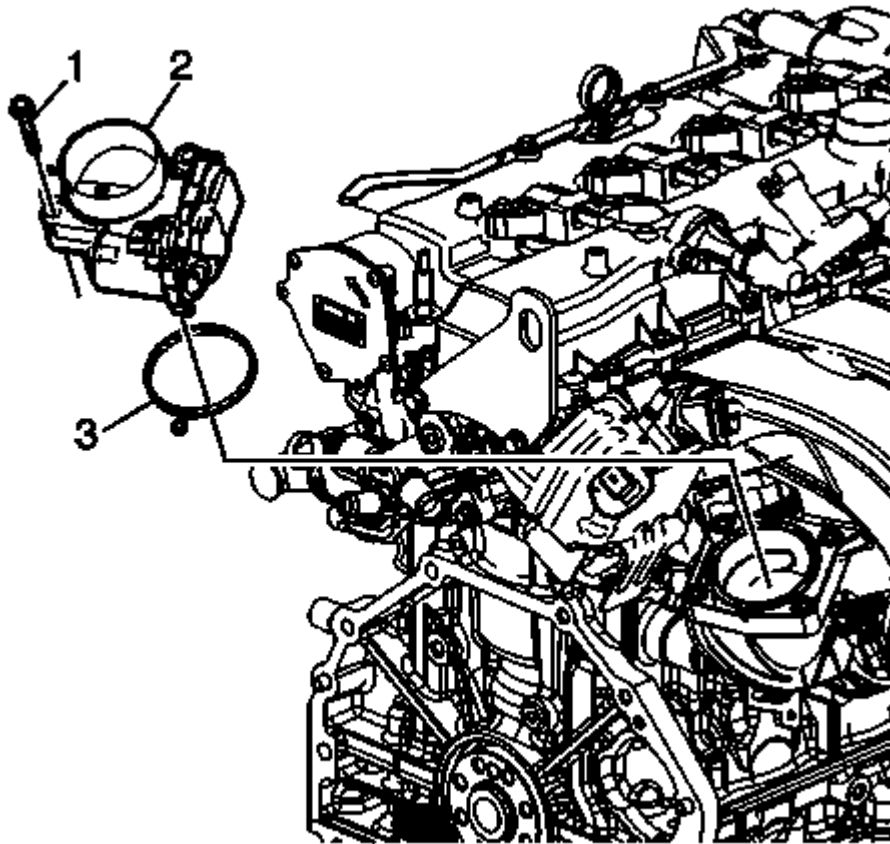


Fig. 7: Throttle Body Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Remove the throttle body bolts (1).
3. Remove the throttle body (2) and seal (3).

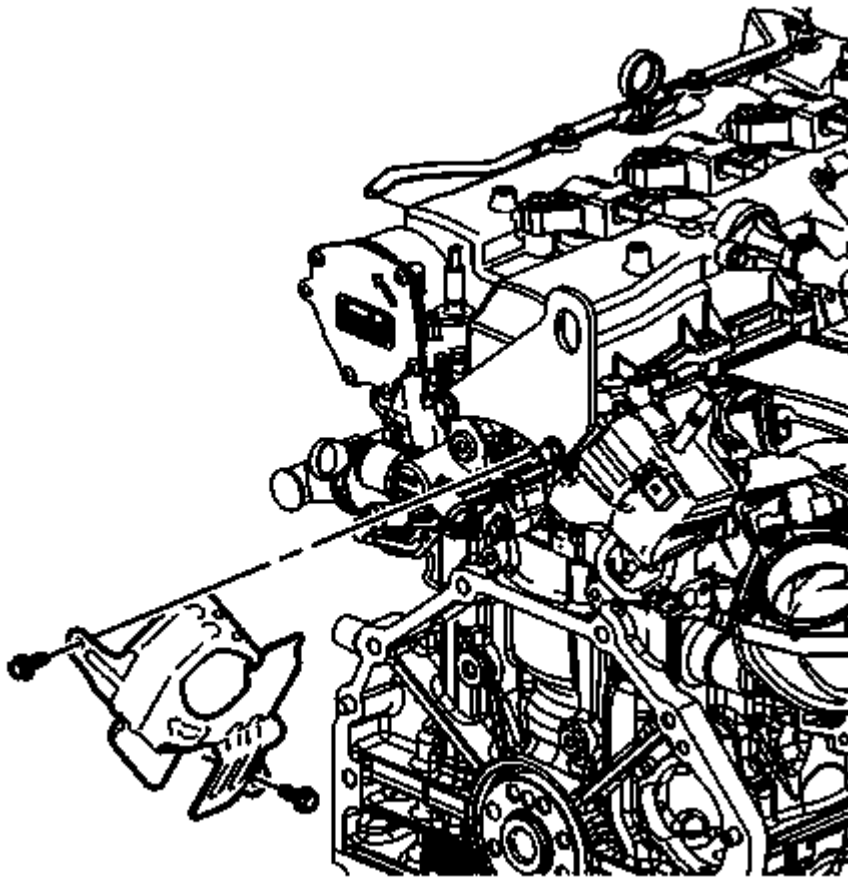


Fig. 8: Fuel Pump Cover Bolts And Cover
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel pump cover bolts and cover.

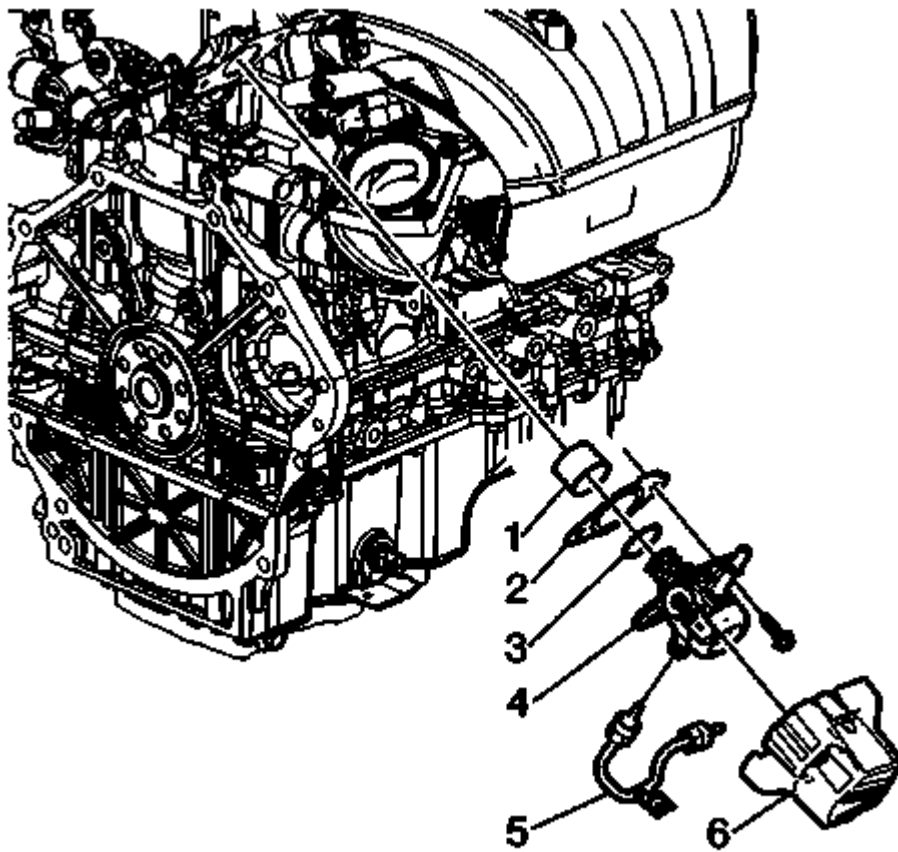


Fig. 9: Fuel Pump Insulator

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel pump insulator (6).

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. **ALWAYS** depressurize the fuel system before removing components that are under high fuel pressure.

6. Remove and discard the fuel feed intermediate pipe (5).
7. Remove the fuel pump bolts.
8. Remove the fuel pump (4), O-ring (3), and gasket (2). Discard the O-ring and gasket.
9. Remove the valve lifter follower (1).

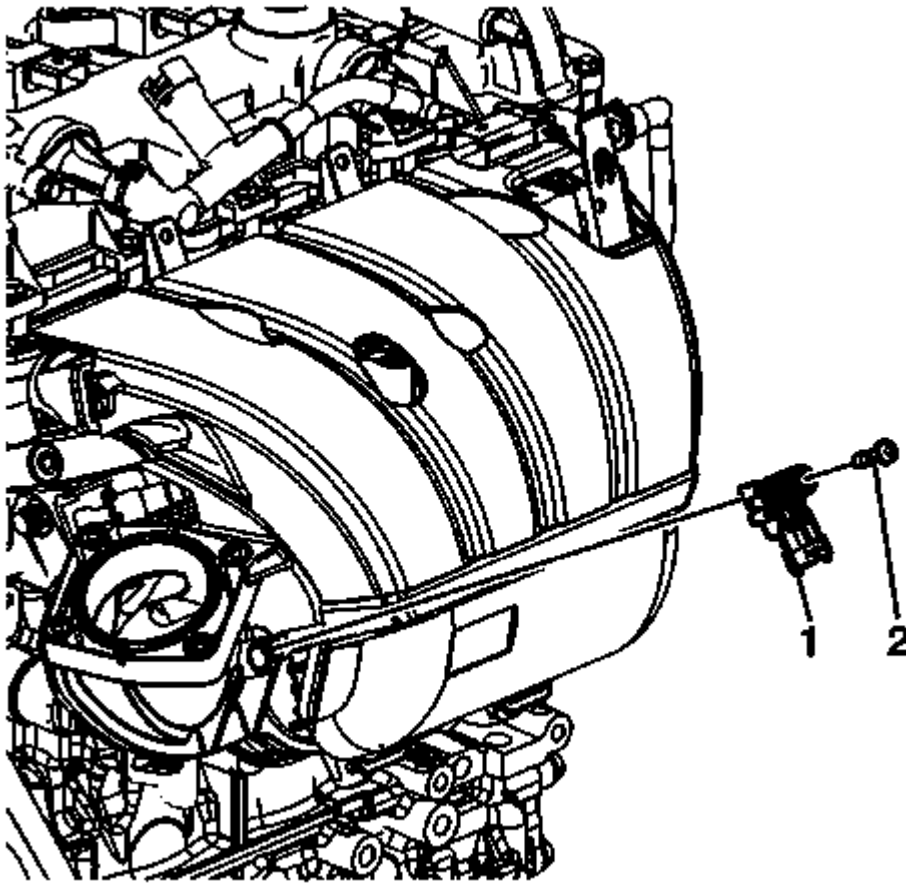


Fig. 10: MAP Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the MAP sensor (1) and bolt (2).

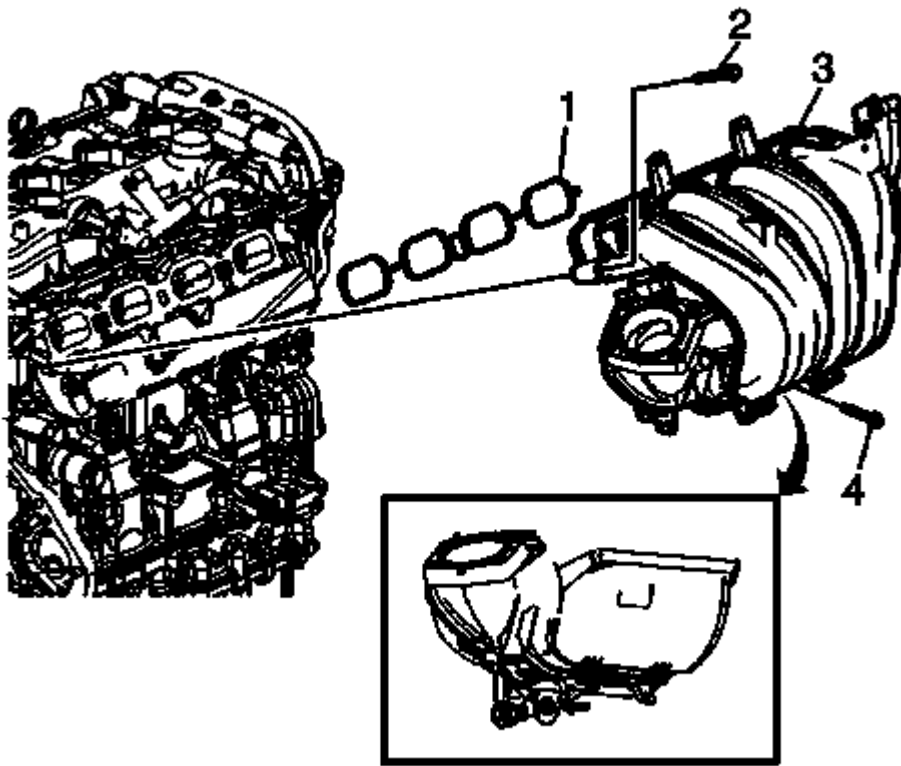


Fig. 11: Intake Manifold And Gasket
Courtesy of GENERAL MOTORS COMPANY

11. Remove the intake manifold retaining bolts (2, 4).
12. Remove the intake manifold (3) and gasket (1).
13. If the intake manifold needs to be replaced, transfer the throttle body to the new intake manifold.

TURBOCHARGER REMOVAL

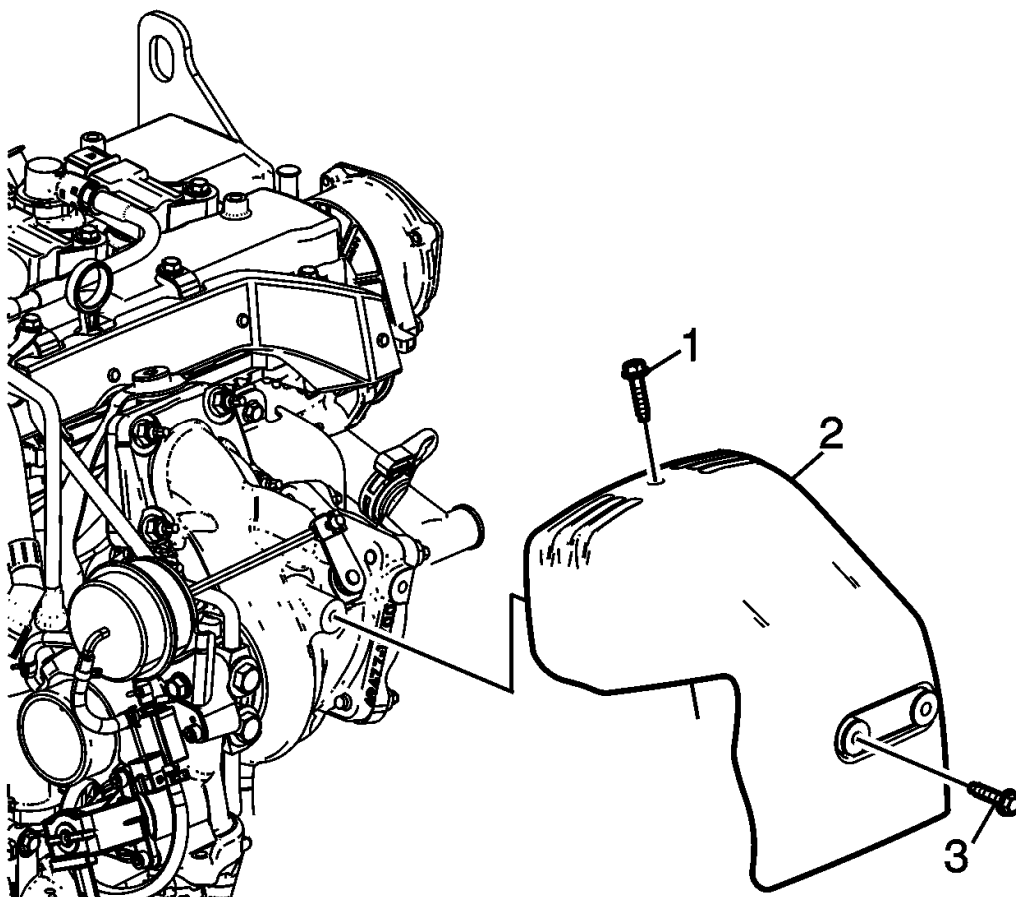


Fig. 12: Turbocharger Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: In the event that a bolt breaks upon removal of components, perform an extraction of the broken bolt.

1. Remove the turbocharger heat shield bolts (1, 3).
2. Remove the turbocharger heat shield (2).

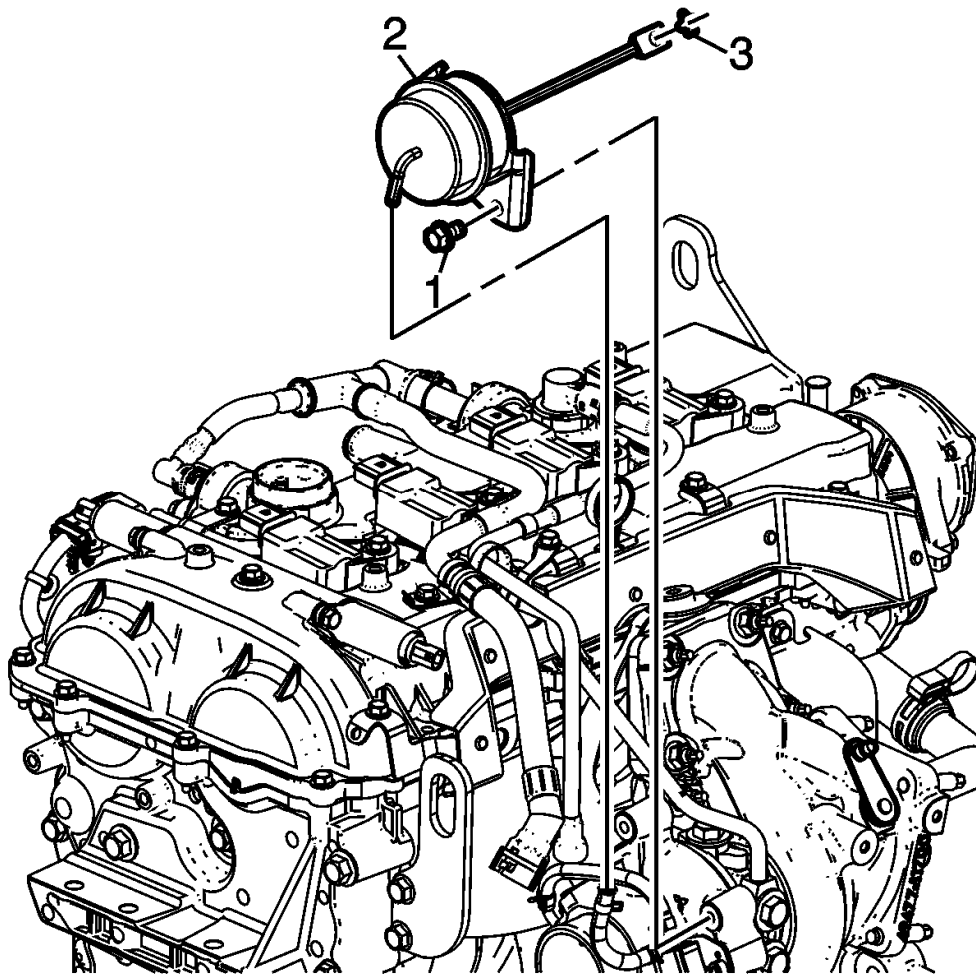


Fig. 13: Turbocharger Wastegate Actuator Arm Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove the turbocharger wastegate actuator arm retainer (3).
4. Remove the turbocharger wastegate actuator bolts (1) and actuator (2).

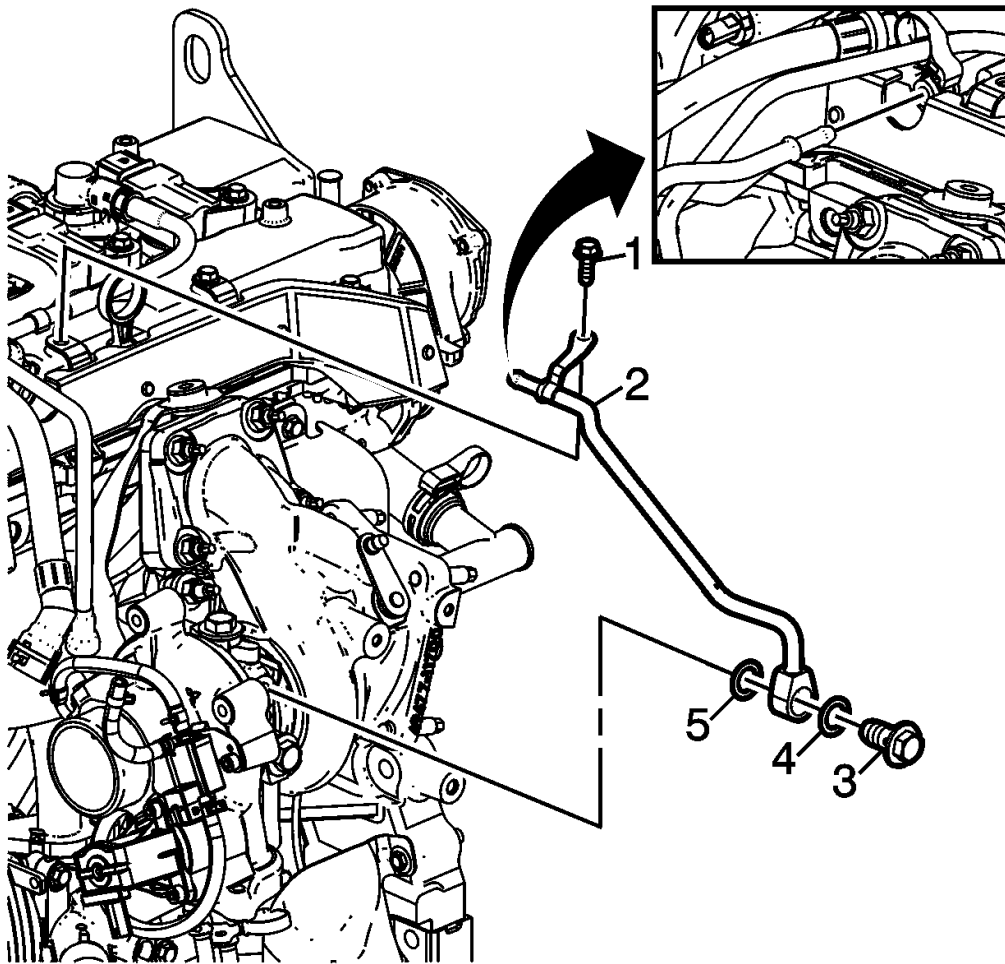


Fig. 14: Camshaft Cover Heat Shield Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft cover heat shield bolt (1) that retains the turbocharger coolant return pipe (2) at the camshaft cover.
6. Disconnect the turbocharger coolant return pipe from the air bleed hose.
7. Remove the turbocharger coolant return pipe bolt (3).
8. Remove the turbocharger coolant return pipe (2) and washers (4, 5). Discard the washers.

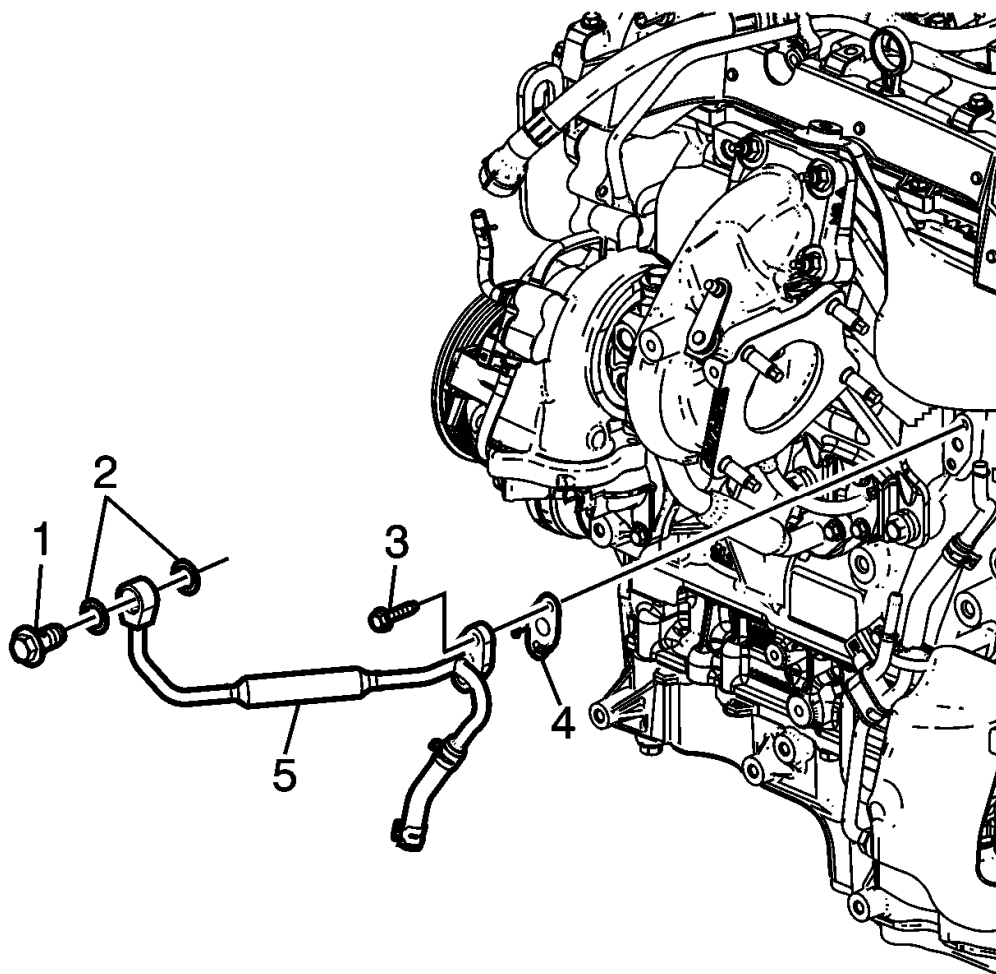


Fig. 15: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the turbocharger coolant feed pipe bolts (1, 3).
10. Disconnect the turbocharger coolant feed pipe hose from the engine oil cooler.
11. Remove the turbocharger coolant feed pipe gasket (4) and discard.
12. Remove the turbocharger coolant feed pipe (5) and washers (2). Discard the washers.

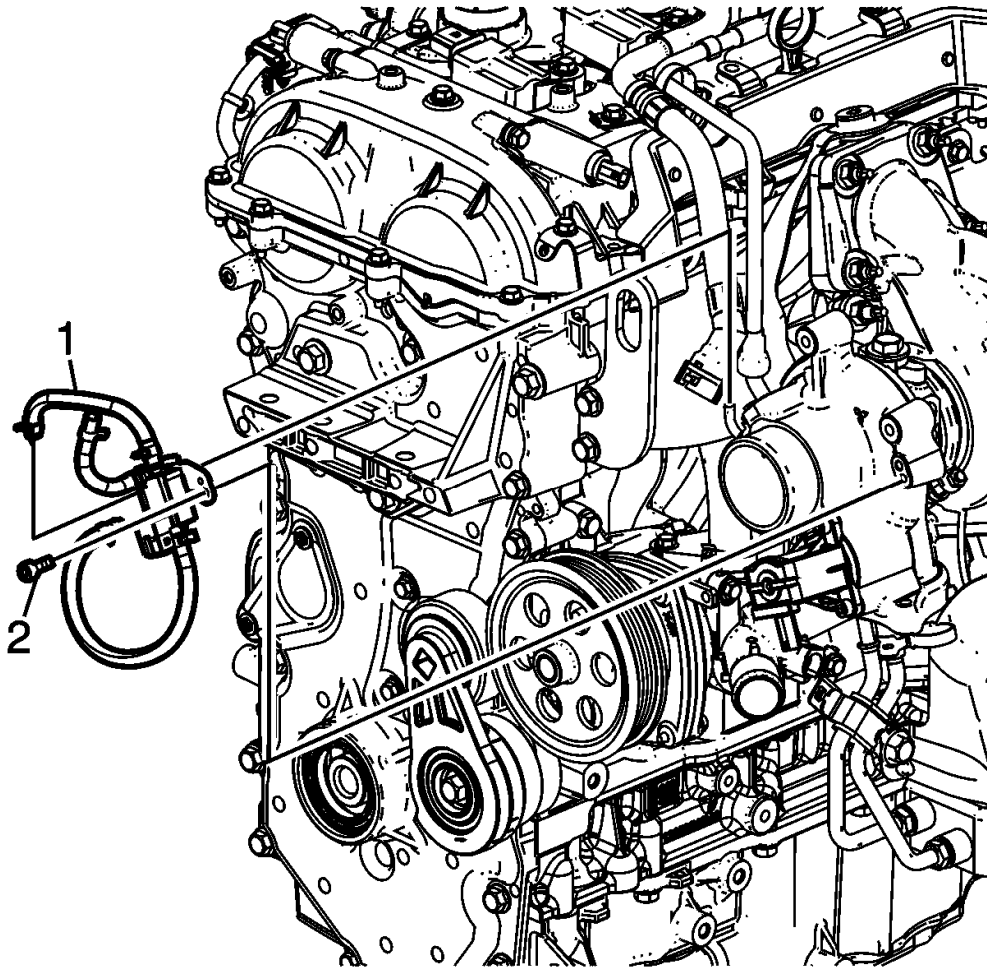


Fig. 16: Turbocharger Wastegate Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the turbocharger wastegate regulator solenoid valve hoses from the turbocharger.
14. Remove the turbocharger wastegate regulator solenoid valve bracket bolt (2).
15. Remove the turbocharger wastegate regulator solenoid valve (1).

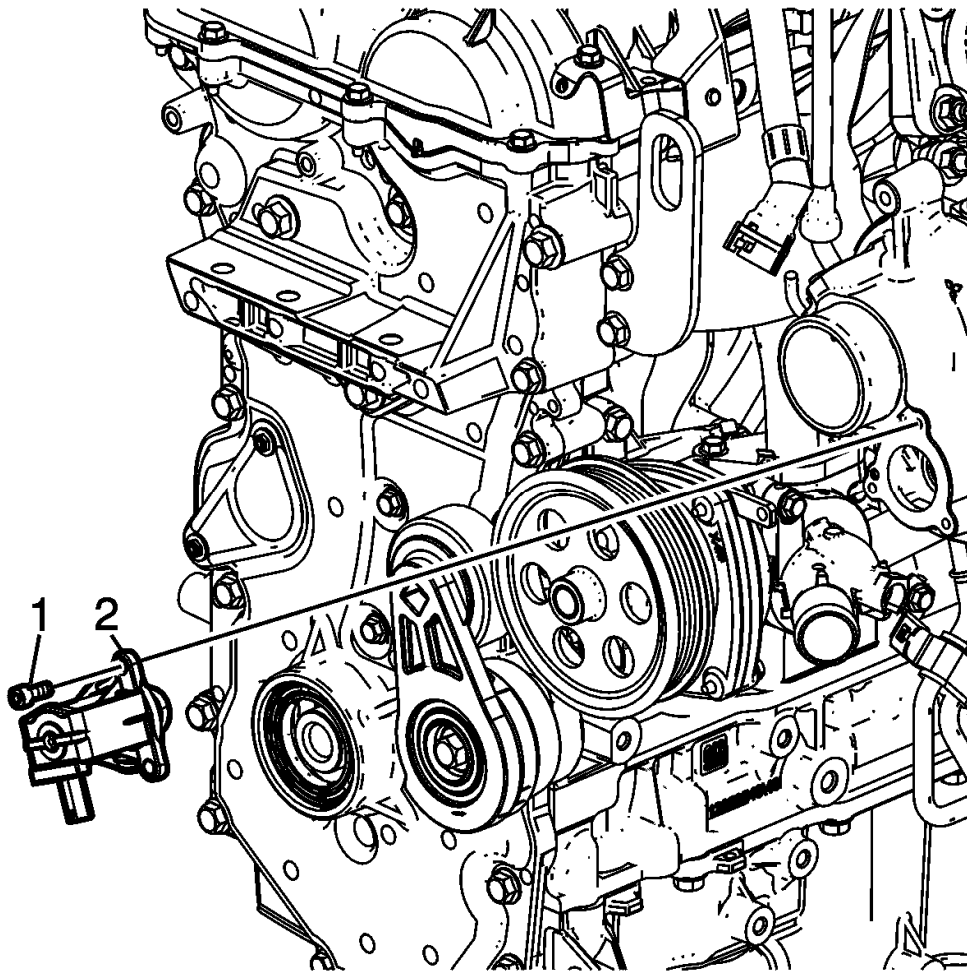


Fig. 17: Turbocharger Bypass Valve Solenoid Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Remove the turbocharger bypass valve solenoid bolts (1).
17. Remove the turbocharger bypass valve solenoid (2).

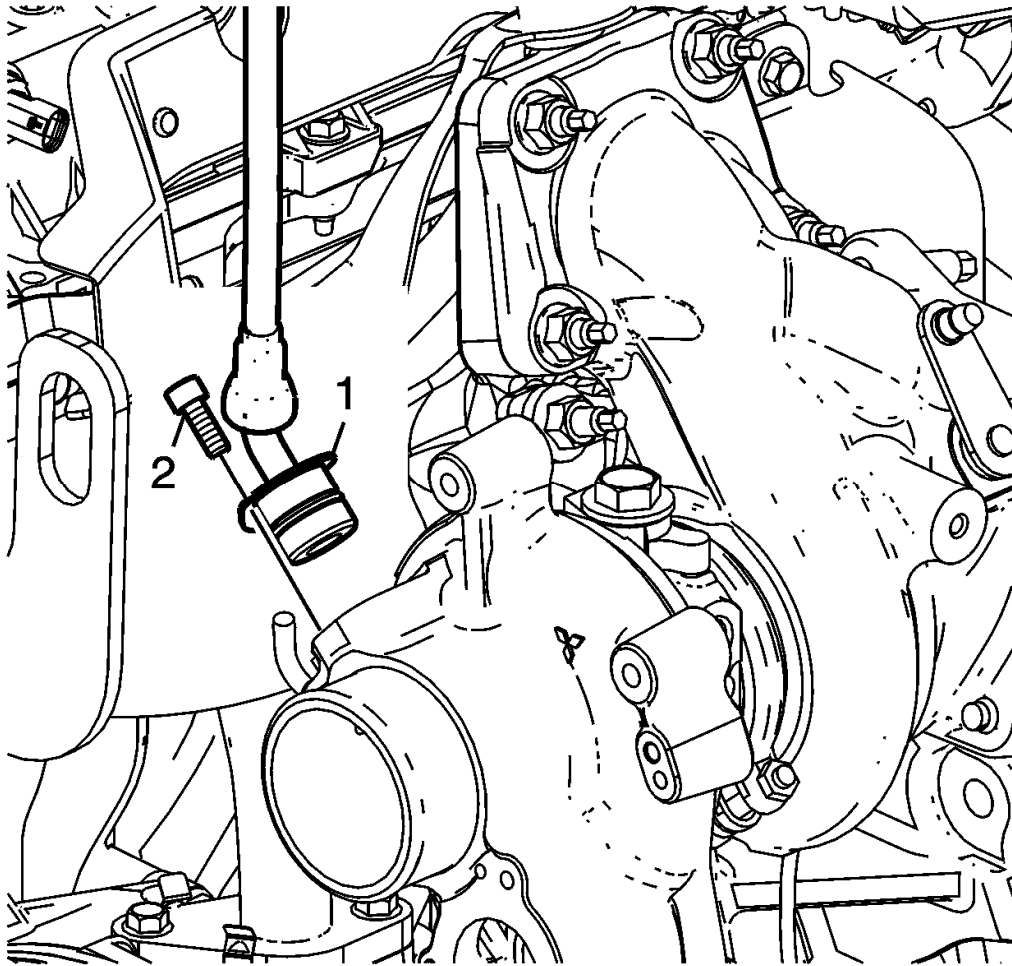


Fig. 18: PCV Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not disturb the joint between the PCV hose and PCV hose fitting at the turbocharger. This is a permanent connection.

18. Remove the PCV hose fitting bolt (2). Disconnect the PCV hose fitting (1) with the PCV hose attached from the turbocharger.

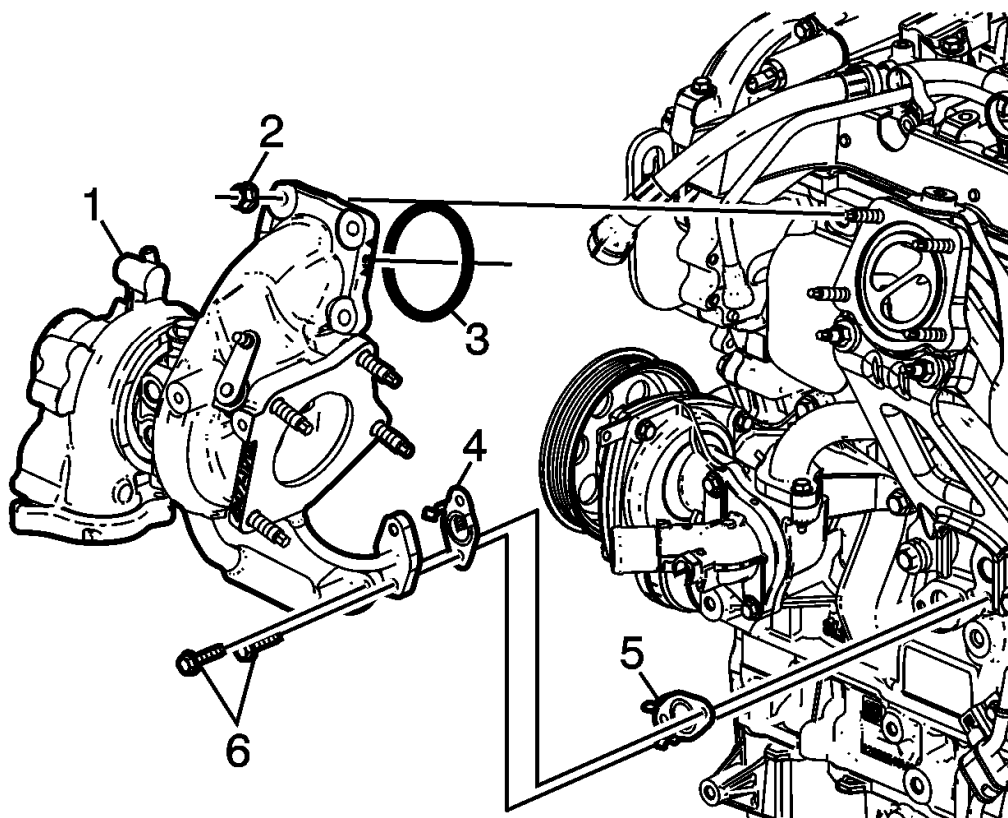


Fig. 19: Turbocharger Nuts

Courtesy of GENERAL MOTORS COMPANY

19. Remove the turbocharger nuts (2) and discard.
20. Remove the turbocharger oil feed and return pipe bolts (6) at the engine block.
21. Remove the turbocharger (1) with the oil return pipe and oil feed pipe attached.
22. Remove the turbocharger oil feed and oil return pipe gaskets (4, 5) and discard.
23. Remove the turbocharger gasket (3) and discard.

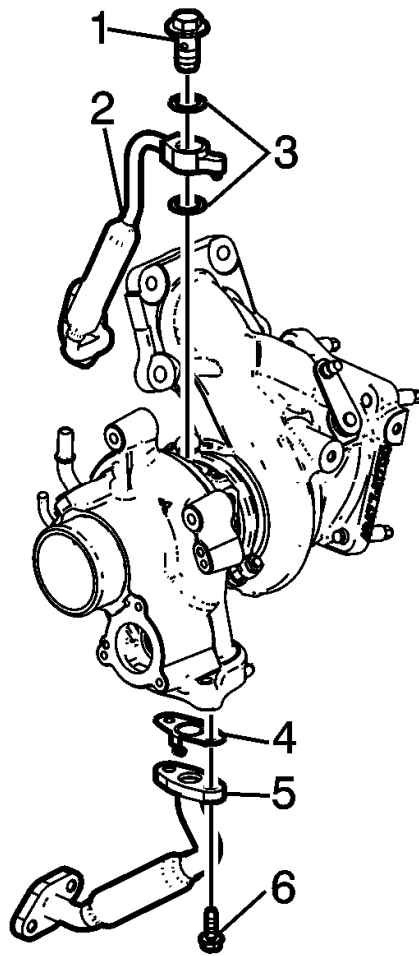


Fig. 20: Turbocharger Oil Feed Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

24. Remove the turbocharger oil feed pipe bolt (1) from the turbocharger.
25. Remove the turbocharger oil feed pipe (2) and washers (3). Discard the washers.
26. Remove the turbocharger oil return pipe bolts (6).
27. Remove the turbocharger oil return pipe (5).
28. Remove and discard the turbocharger oil return pipe gasket (4).
29. Clean and inspect the turbocharger and components. Refer to **Turbocharger Cleaning and Inspection**.

EXHAUST MANIFOLD REMOVAL

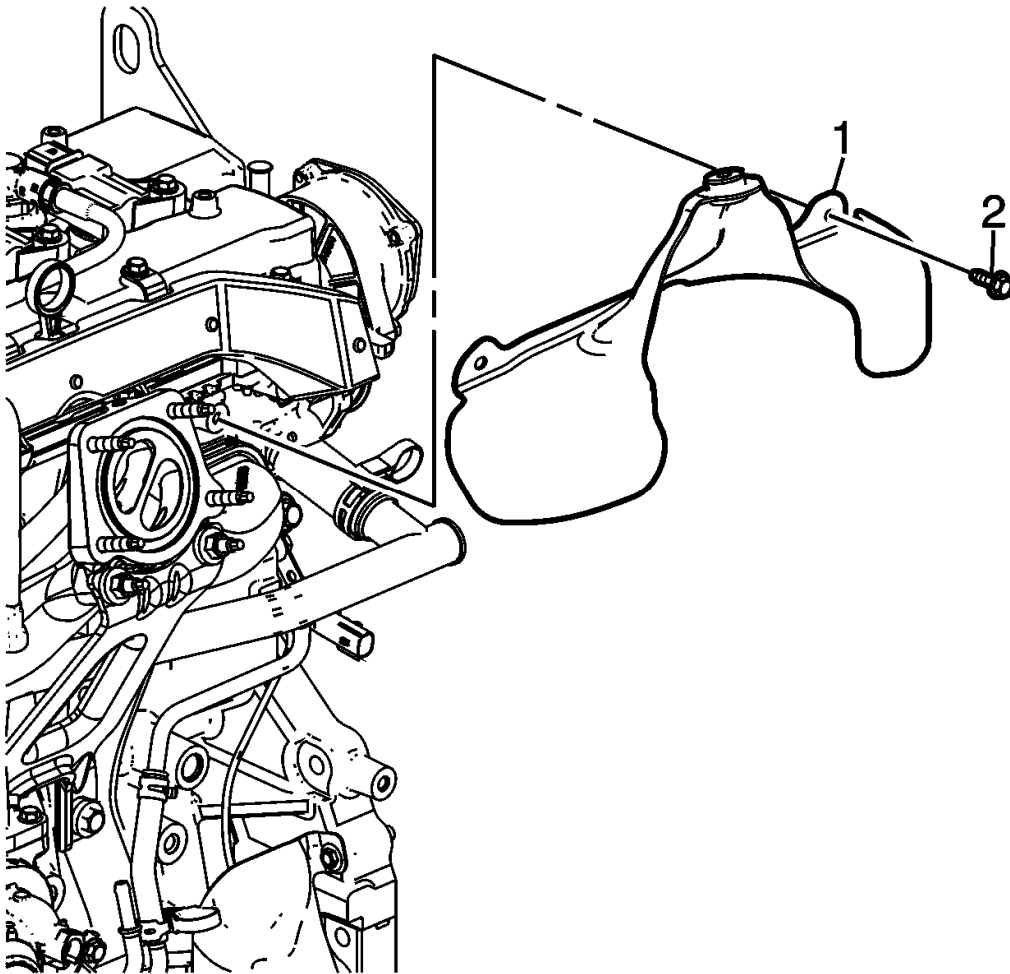


Fig. 21: Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: In the event that a bolt breaks upon removal of components, perform an extraction of the broken bolt.

1. Remove the exhaust manifold heat shield bolts (2).
2. Remove the exhaust manifold heat shield (1).

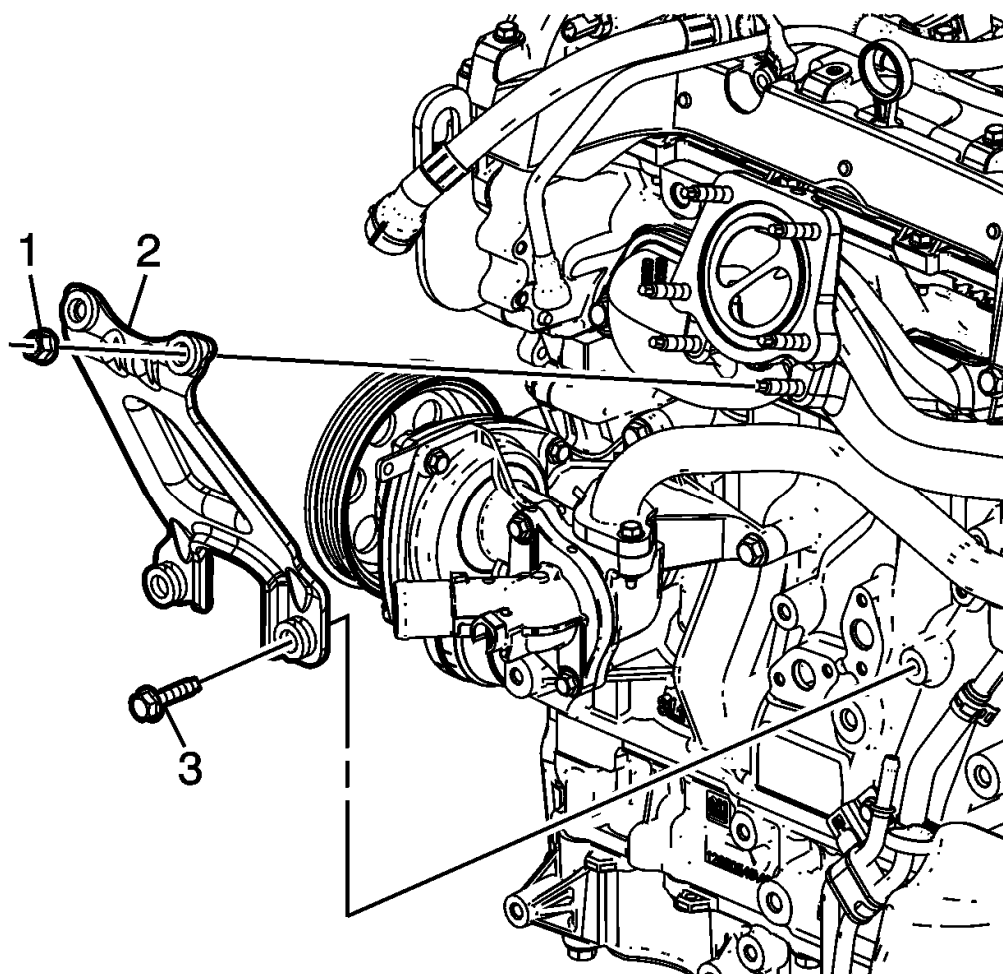


Fig. 22: Exhaust Manifold Brace Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the exhaust manifold brace nuts (1) and discard.
4. Remove the exhaust manifold brace bolts (3).
5. Remove the exhaust manifold brace (2).

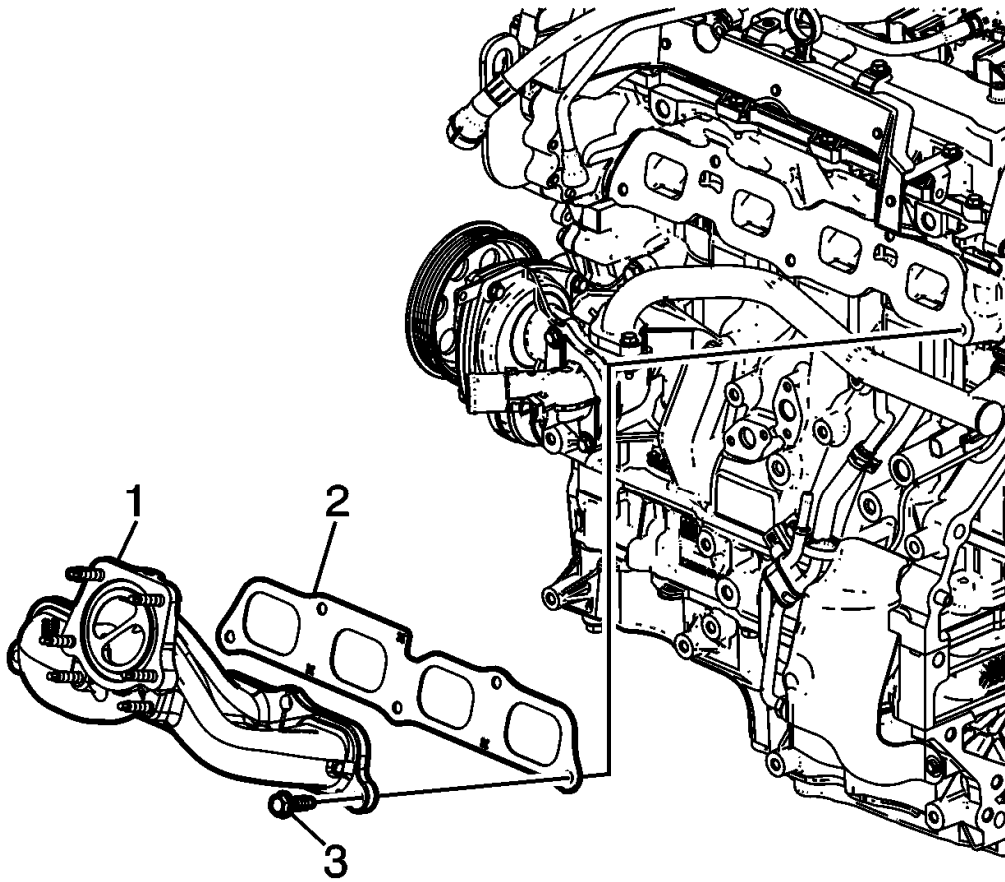


Fig. 23: Exhaust Manifold And Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the exhaust manifold to cylinder head bolts (3).
7. Remove the exhaust manifold (1).
8. Remove and discard the exhaust manifold gasket (2).
9. Clean all of the sealing surfaces.

SECONDARY AIR INJECTION CHECK VALVE REMOVAL

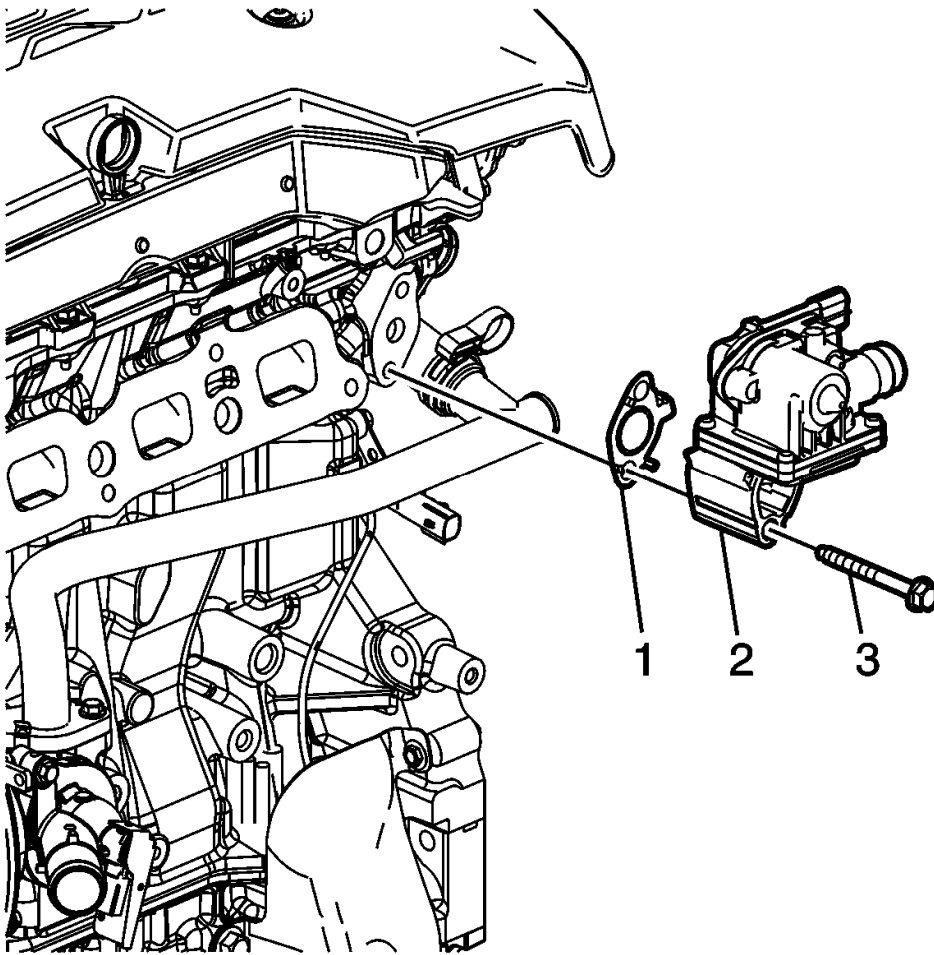


Fig. 24: Secondary Air Injection Check Valve Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the secondary air injection check valve bolts (3).
2. Remove the secondary air injection check valve assembly (2).
3. Remove and discard the check valve gasket (1).

FUEL RAIL AND INJECTORS REMOVAL

Special Tools

EN-49248 Fuel Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools**

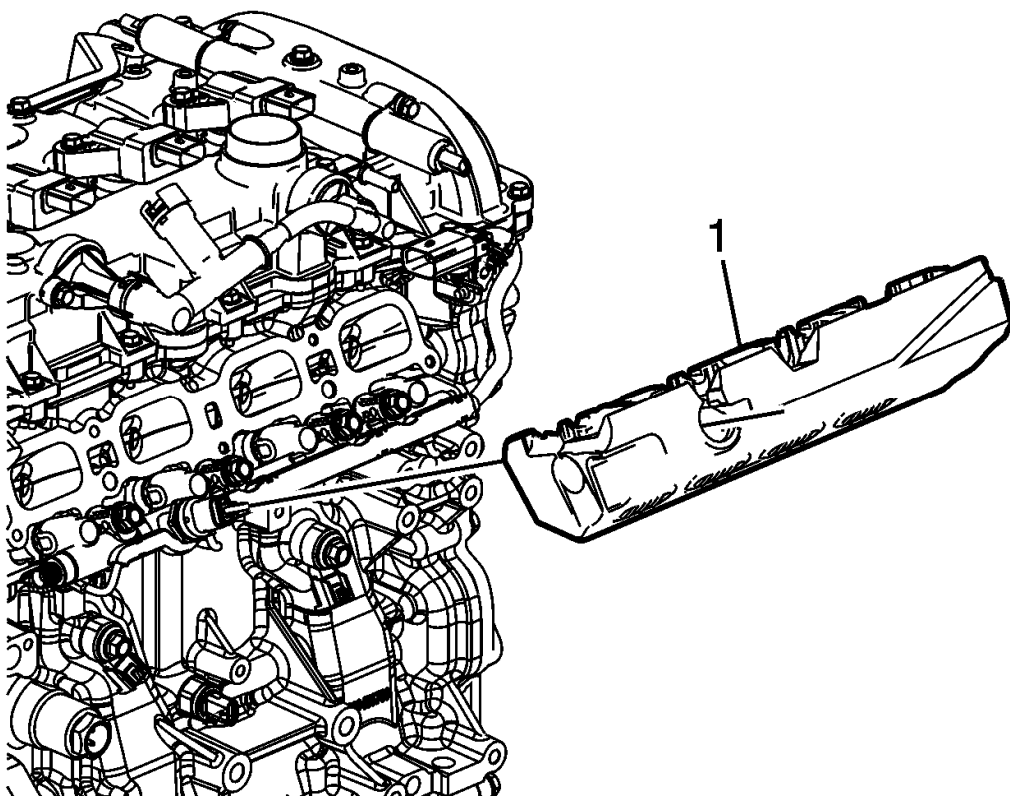


Fig. 25: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injection fuel rail noise shield (1).

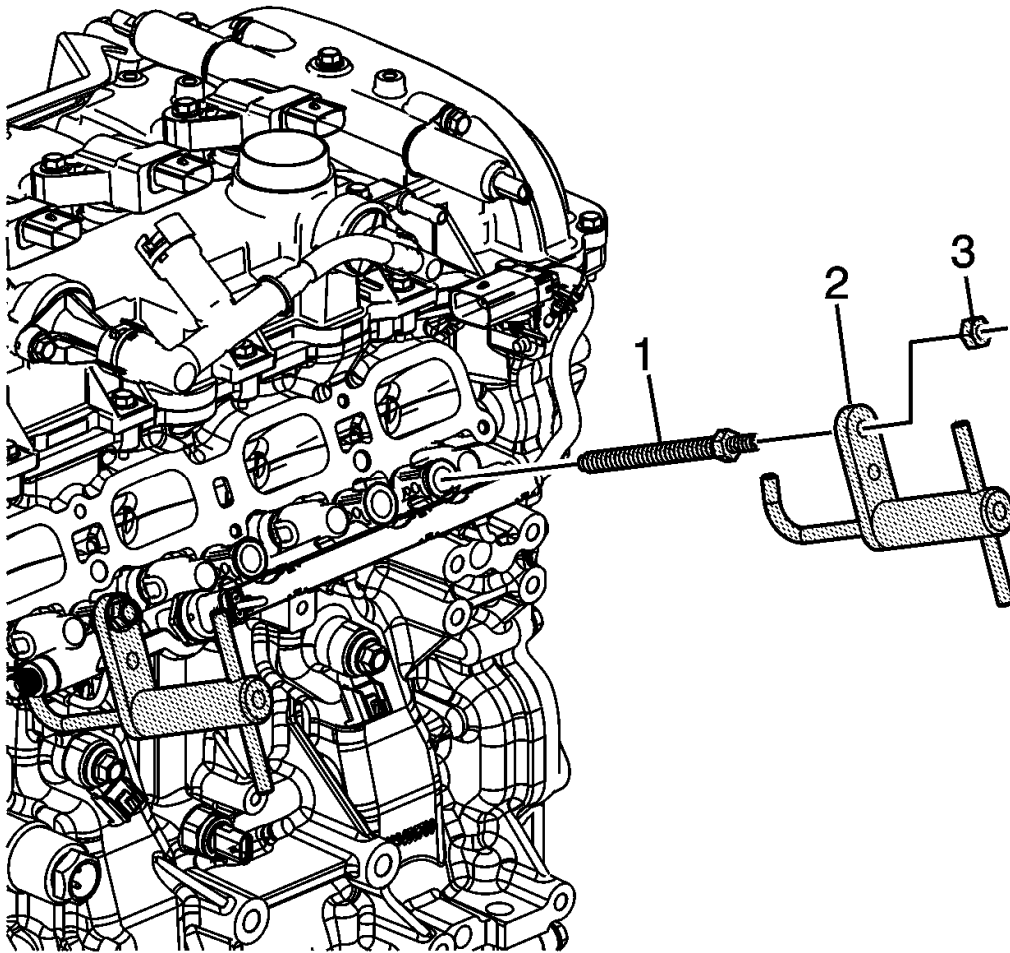


Fig. 26: Identifying Fuel Rail Assembly Remover Studs
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical harness from the fuel rail harness connection.
3. Remove the fuel rail assembly retaining bolts and upper rubber grommet, if necessary.

NOTE: Use care to avoid contact with the fuel rail harness during special tool installation and fuel rail removal.

4. Install **EN-49248** studs (1) into the 2 outermost fuel rail assembly retaining bolt locations. Tighten the studs to 22 N.m (16 lb ft).
5. Install **EN-49248** remover (2) onto each stud, and engage the hooks to the fuel rail. Install the nuts (3) retaining the remover onto the studs and tighten until snug.

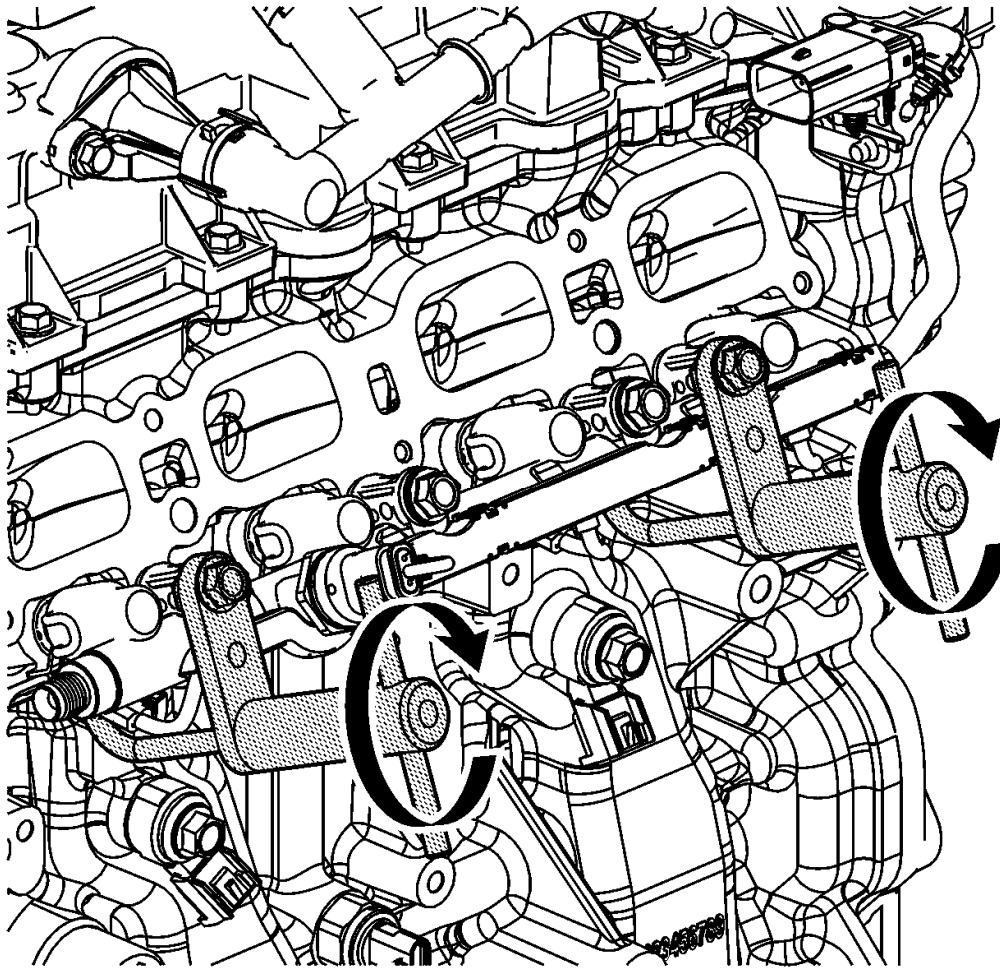


Fig. 27: Fuel Rail Assembly Using Fuel Rail Assembly Remover
Courtesy of GENERAL MOTORS COMPANY

NOTE: EN-49248 will assist in the proper removal of the fuel rail assembly. Ensure that the following conditions are met:

- Turn the handles simultaneously in order to pull the fuel rail straight out along the fuel injector axis.
- DO NOT twist when pulling out on the fuel rail and injector assembly.

6. Using **EN-49248** remover , remove the fuel rail assembly.

CAMSHAFT COVER REMOVAL

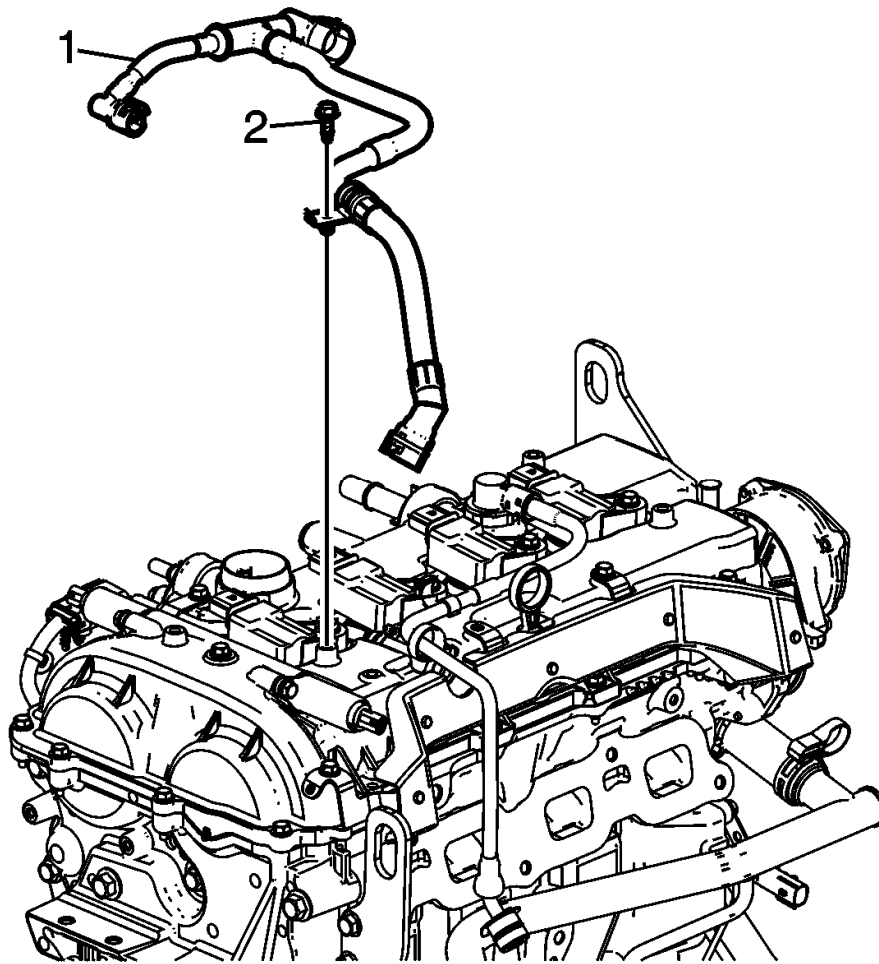


Fig. 28: PCV Hose Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the PCV hose bolt (2) from the camshaft cover.
2. Disconnect the PCV tube assembly (1) at the quick-connect fittings.

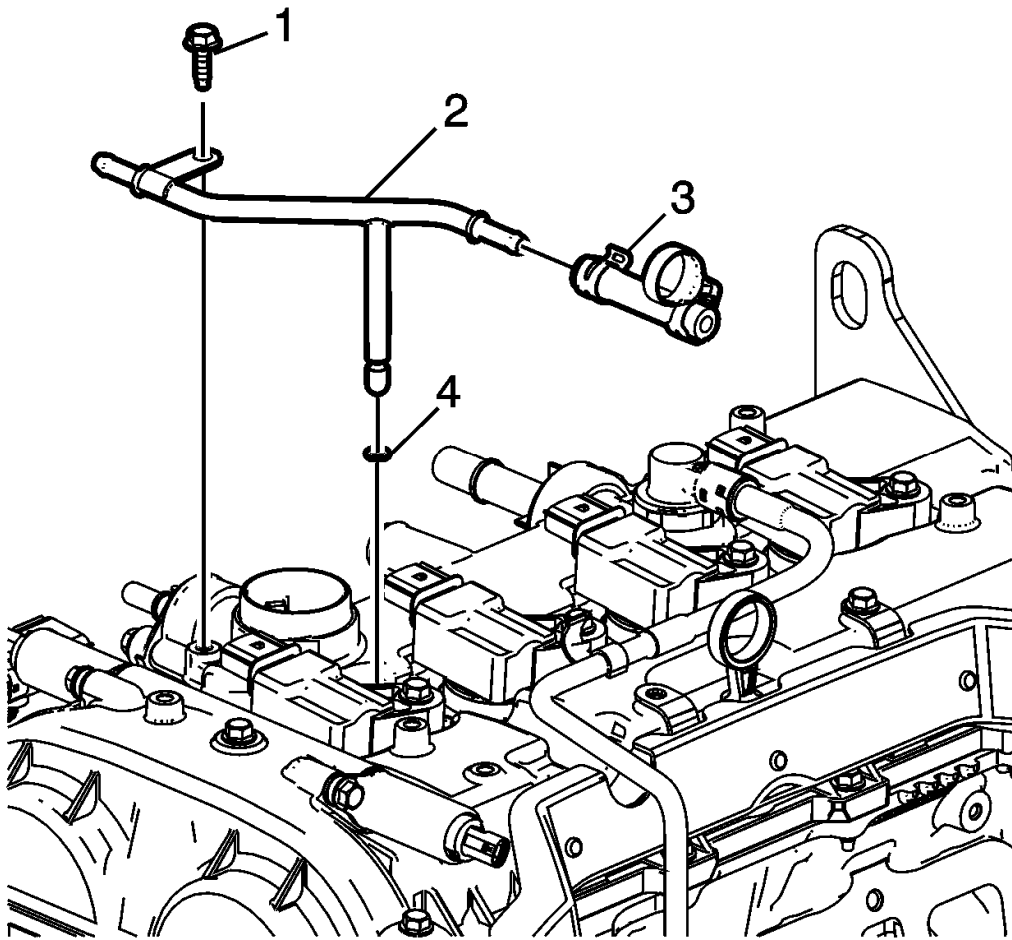


Fig. 29: Engine Coolant Air Bleed Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine coolant air bleed pipe bolt (1).
4. Remove the engine coolant air bleed pipe (2), hose (3), and O-ring (4). Inspect O-ring and discard if necessary.

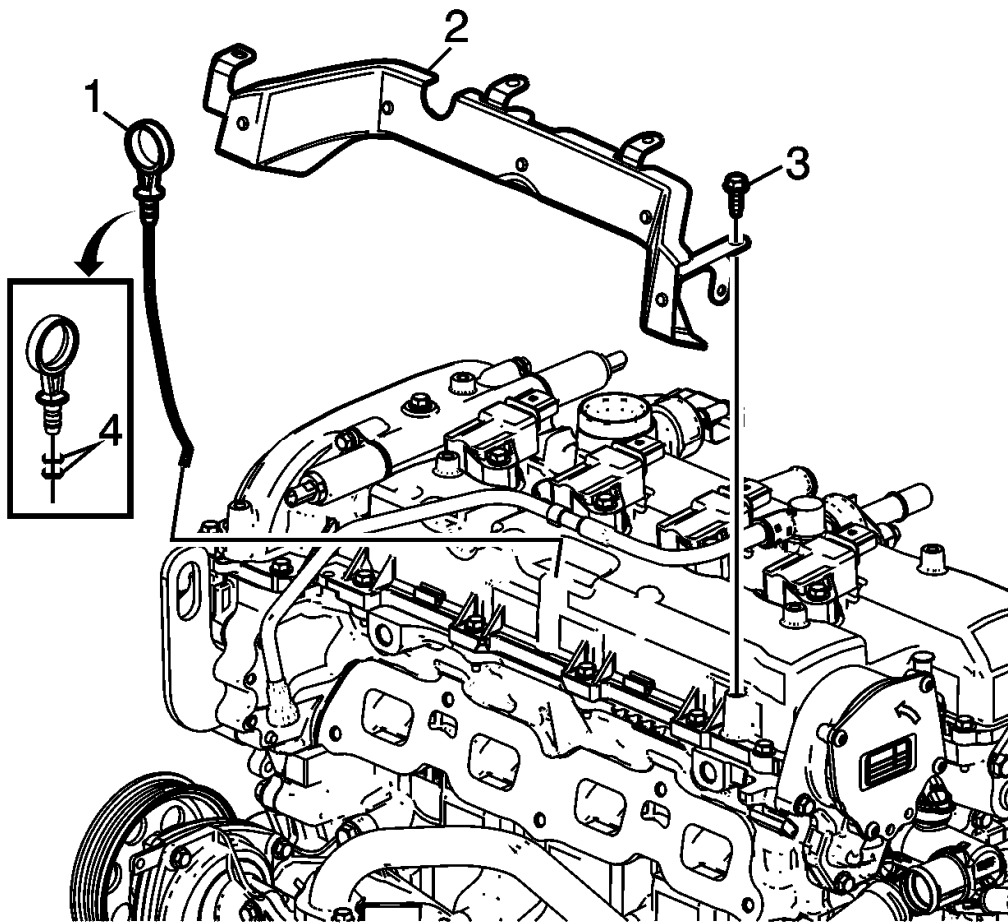


Fig. 30: Camshaft Cover Heat Shield
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil level indicator (1). Inspect and replace the oil indicator O-ring seals (4), if necessary.
6. Remove the camshaft cover heat shield (2) and bolts (3).

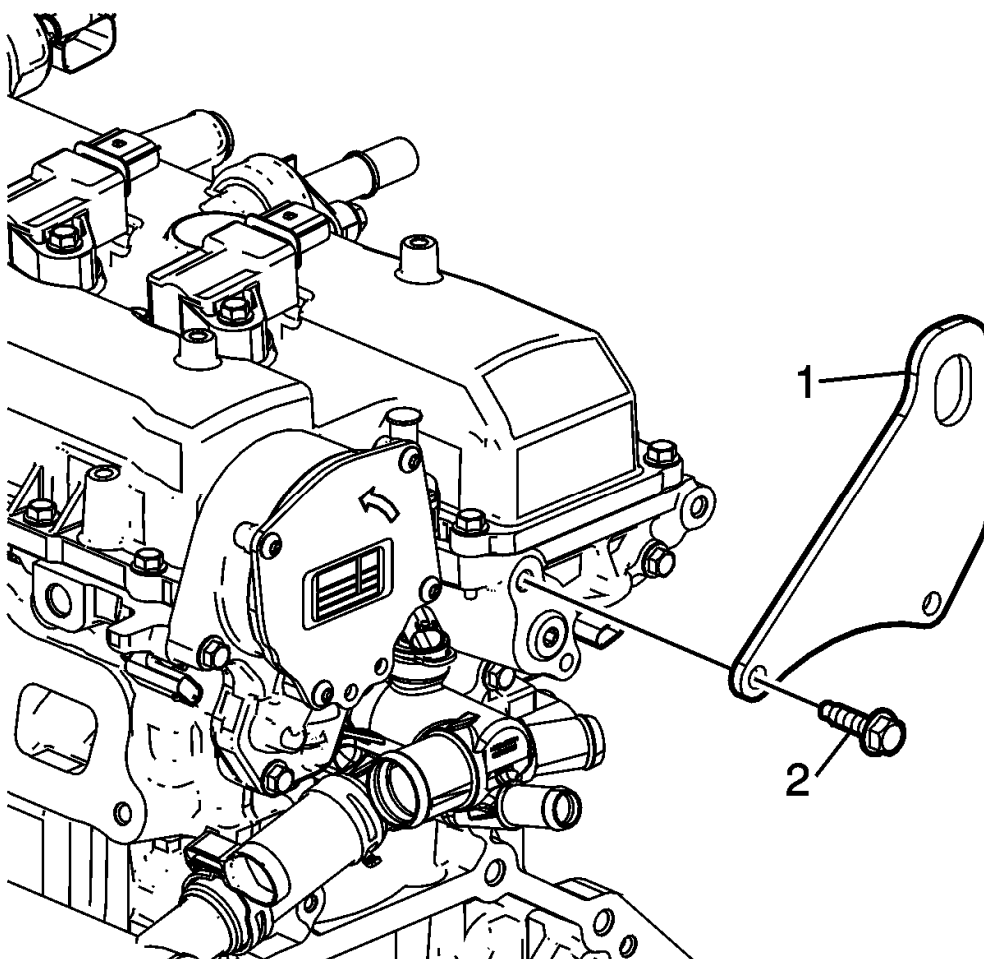


Fig. 31: Rear Lift Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the rear lift bracket (1) and bolts (2).

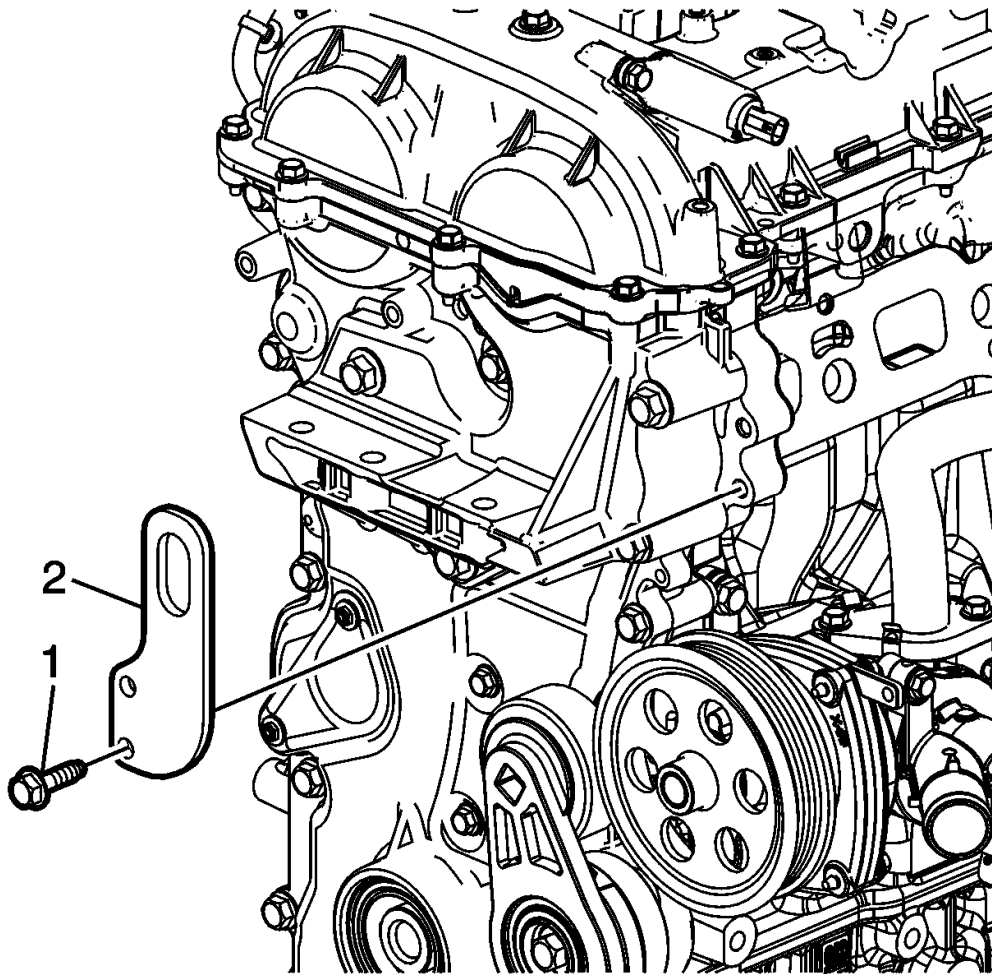


Fig. 32: Front Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

8. Remove the front lift bracket (2) and bolts (1).

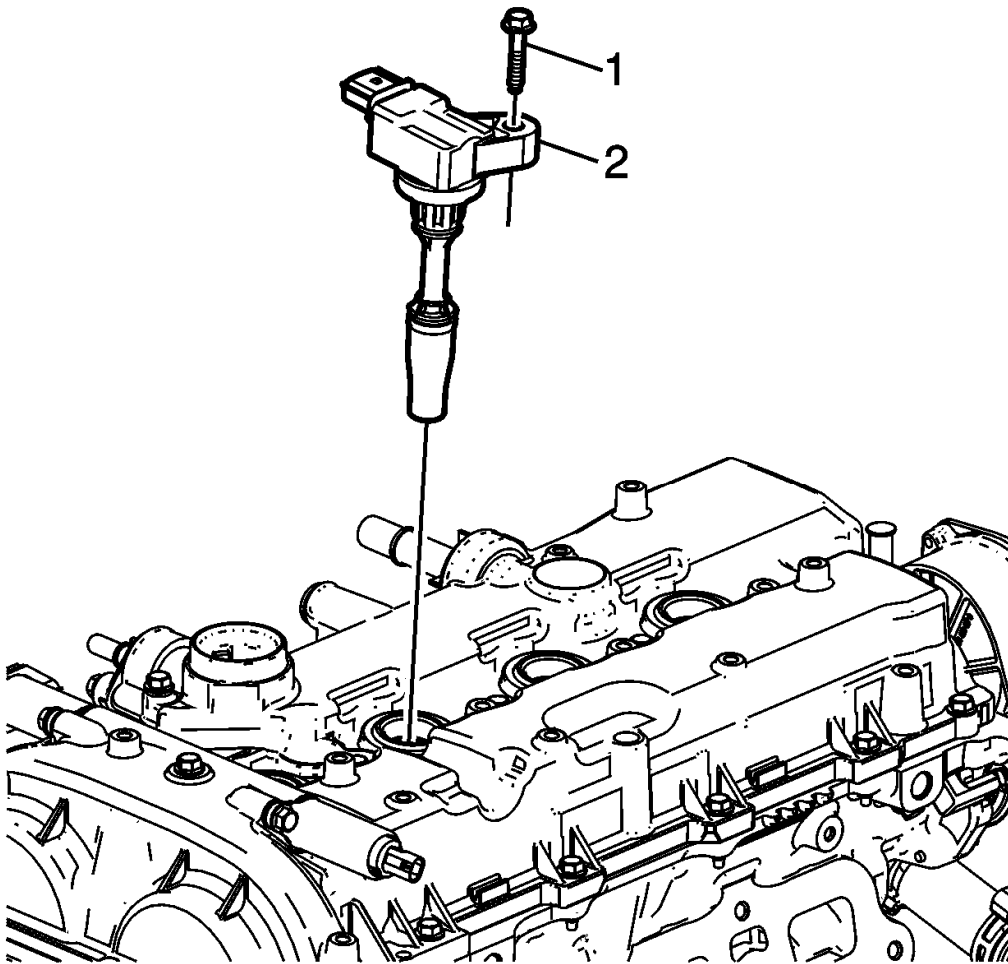


Fig. 33: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the ignition coils (2) and bolts (1).

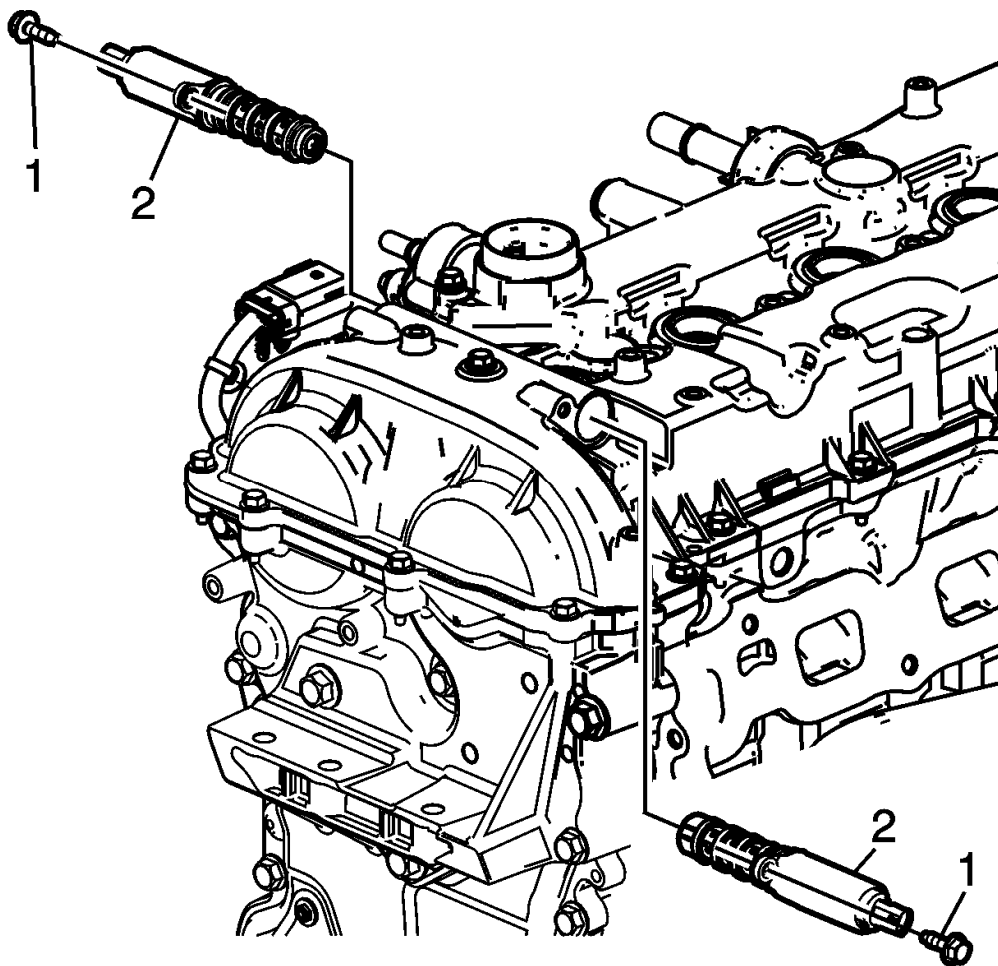


Fig. 34: Camshaft Position Actuator Control Solenoid Valves
Courtesy of GENERAL MOTORS COMPANY

10. Remove the camshaft position actuator control solenoid valves (2) and bolts (1).

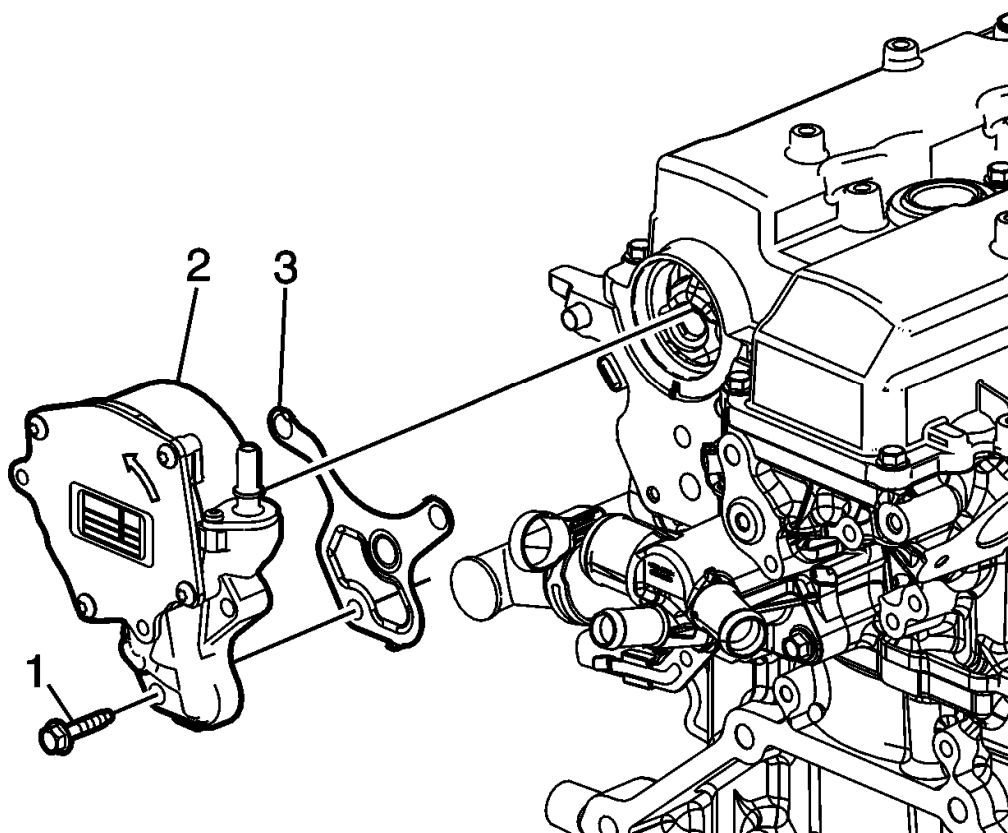


Fig. 35: Vacuum Assembly And Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the vacuum assembly (2) and bolts (1).
12. Remove the vacuum assembly gasket (3) and discard.

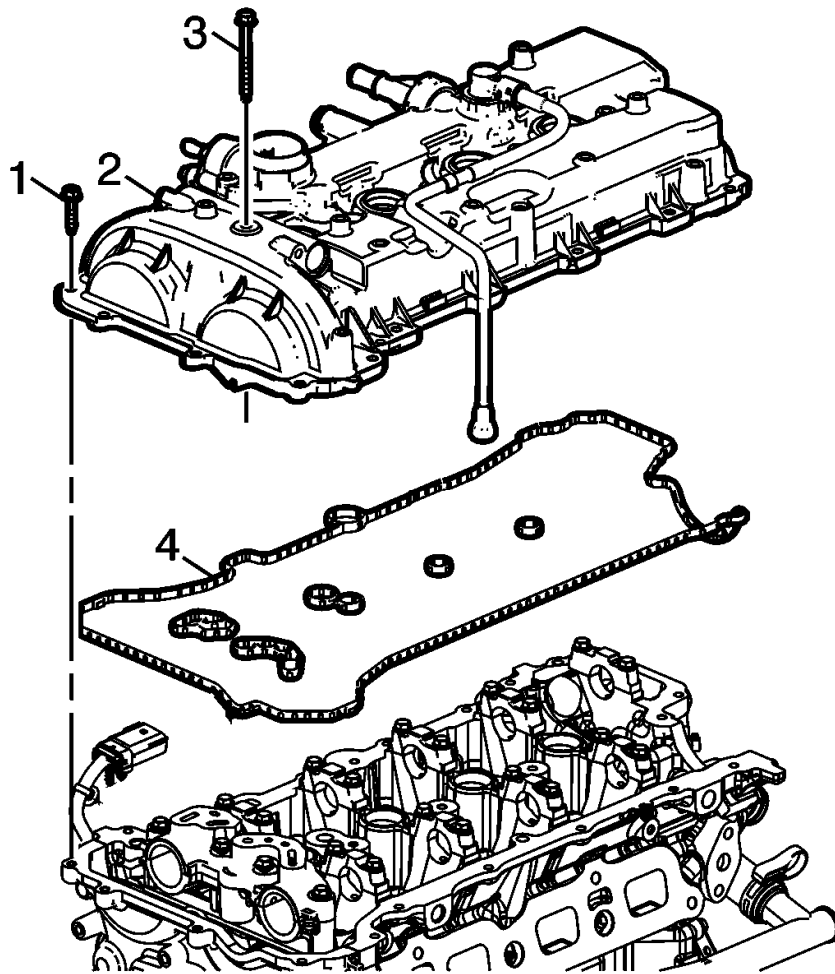


Fig. 36: Camshaft Cover Assembly
Courtesy of GENERAL MOTORS COMPANY

13. Remove the camshaft cover assembly (2).
14. Remove and discard the camshaft cover gasket (4).

ENGINE FRONT COVER REMOVAL (LTG)

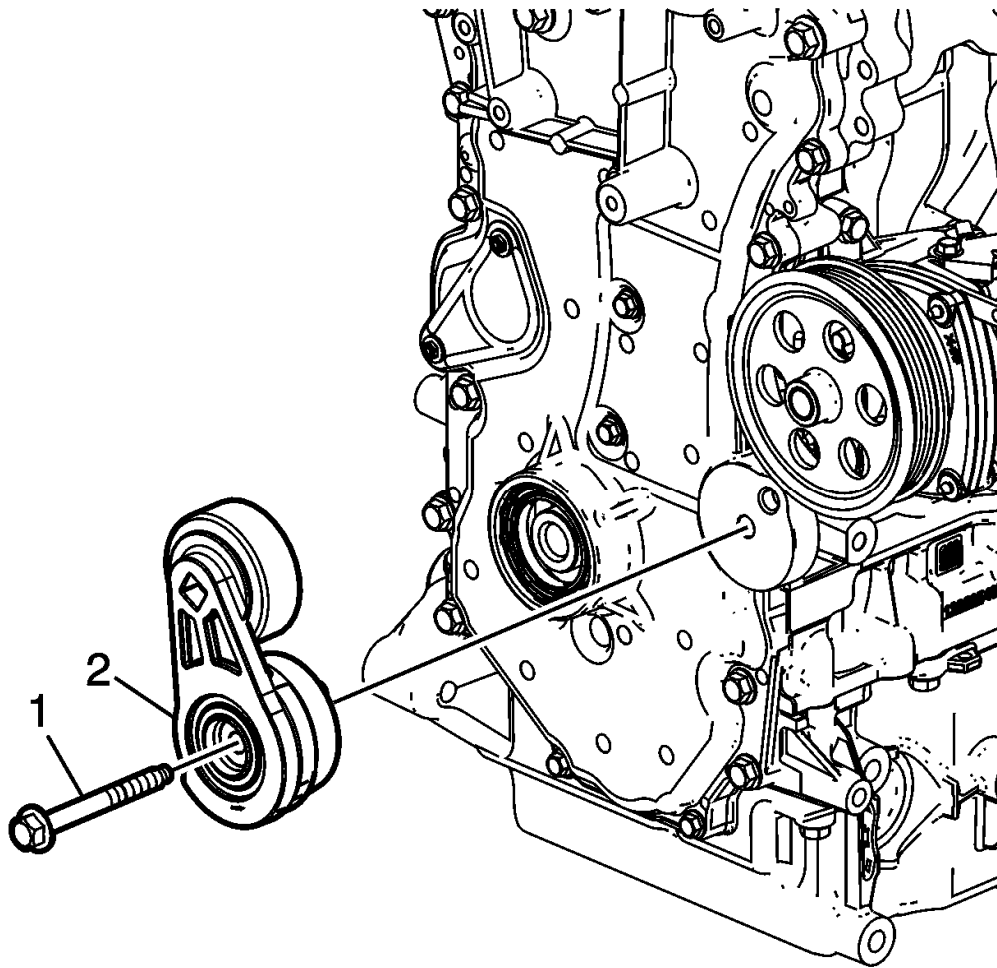


Fig. 37: Accessory Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Remove the accessory drive belt tensioner bolt (1).
2. Remove the accessory drive belt tensioner (2).

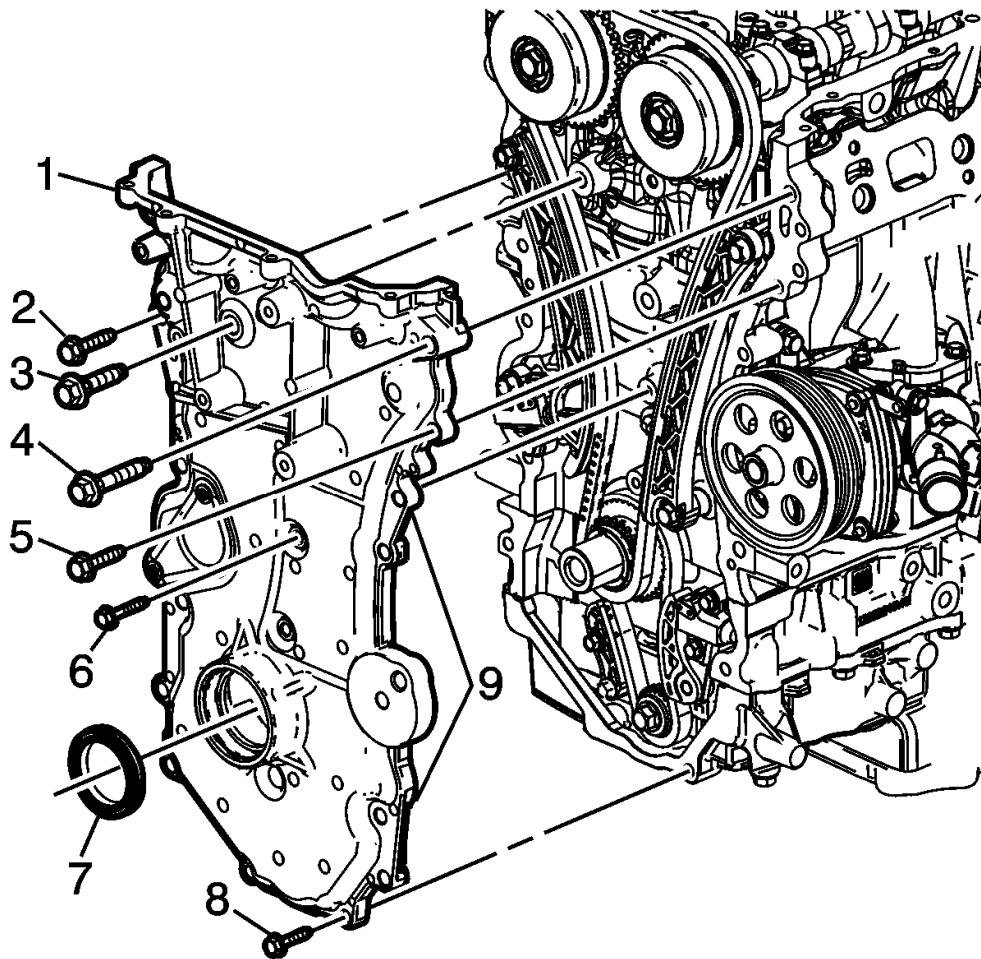


Fig. 38: Exploded View Of Engine Front Cover And Components
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine front cover bolts (2-6, 8).
4. Remove the engine front cover (1).
5. Remove the front oil seal (7) with an appropriate tool.

CAMSHAFT TIMING CHAIN AND TENSIONER REMOVAL

Special Tools

EN 50837 Timing Chain Tensioner Retraction Tool

For equivalent regional tools, refer to **Special Tools** .

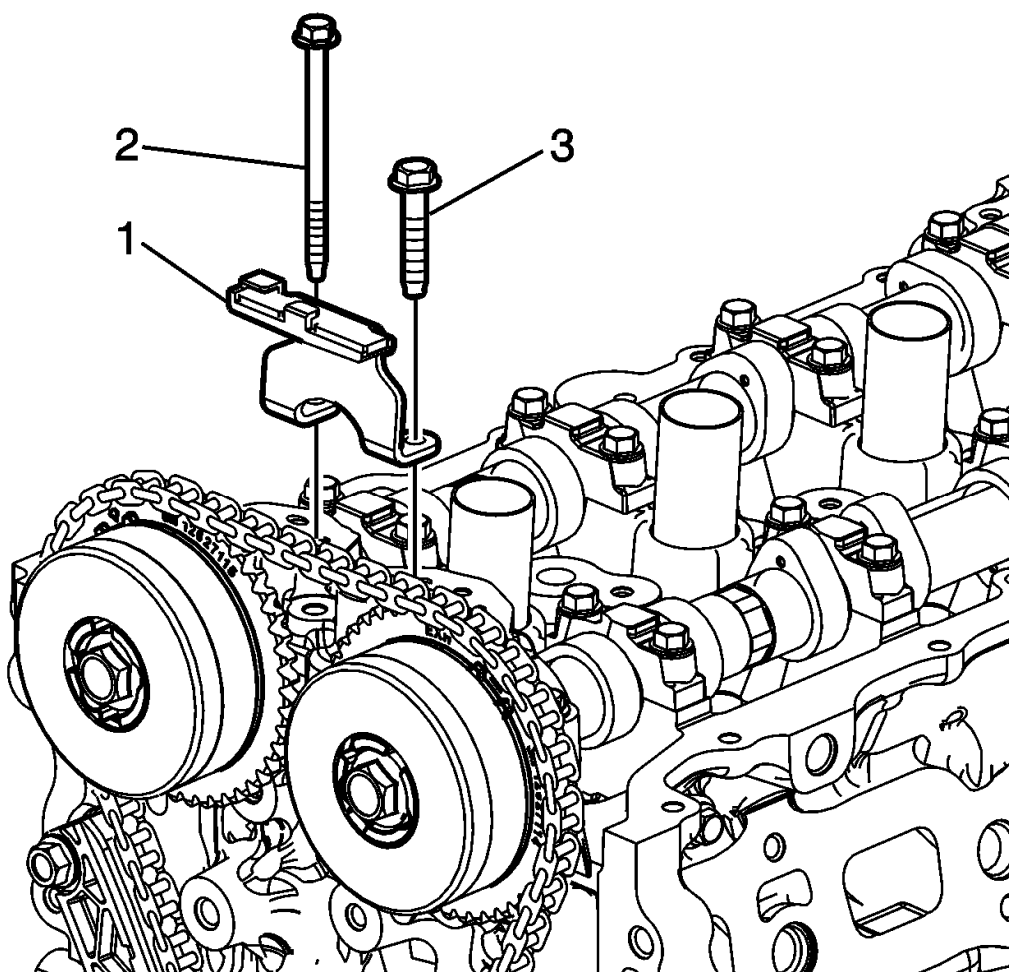


Fig. 39: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the upper timing chain guide bolts (2, 3).
2. Remove the upper timing chain guide (1).

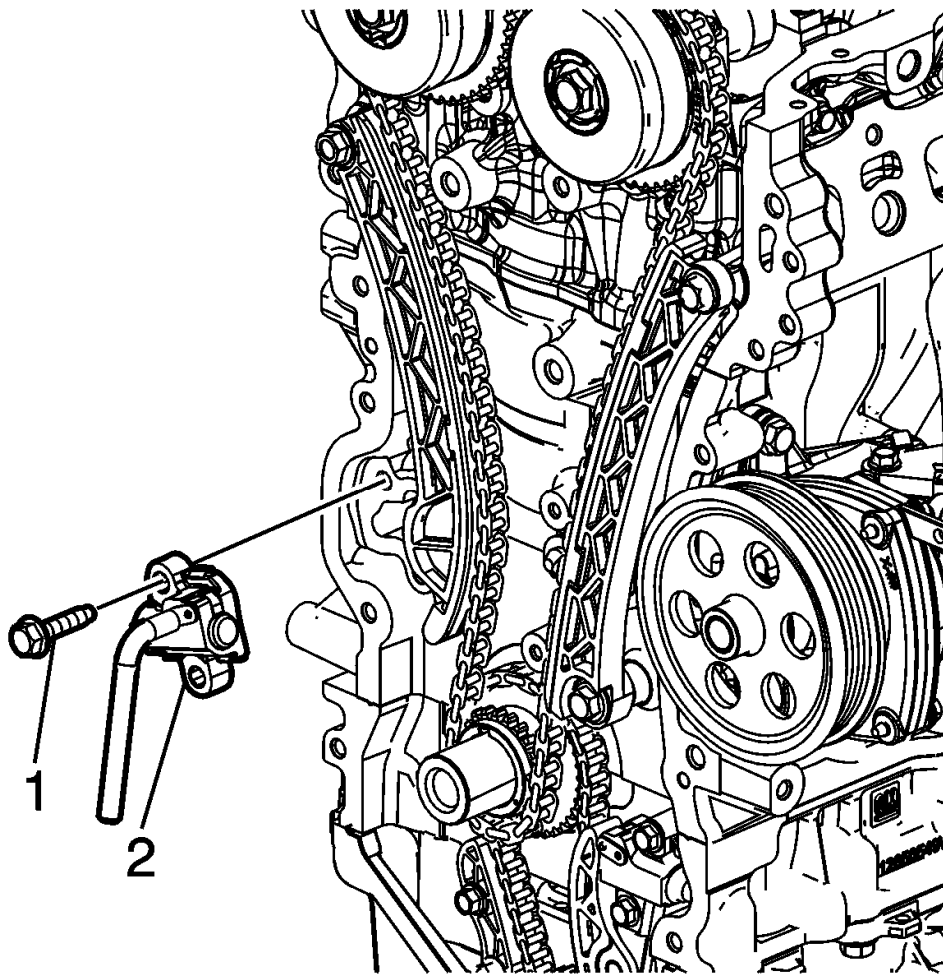


Fig. 40: Timing Chain Tensioner Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the timing chain tensioner bolts (1) and timing chain tensioner (2).
4. Compress and lock the tensioner using **EN-50837** retention tool.
 1. Insert **EN-50837** retention tool into the lever arm and push in a counterclockwise direction.
 2. Compress the tensioner while holding lever arm.
 3. Relax the force on the lever and tensioner slightly, allowing the tensioner to extend 3 ratchet clicks, and then hold in place.
 4. Pull lever clockwise using **EN-50837** retention tool until the hole in the lever aligns with the hole in the tensioner assembly. Push the point of **EN-50837** retention tool through the lever and into the tensioner assembly.

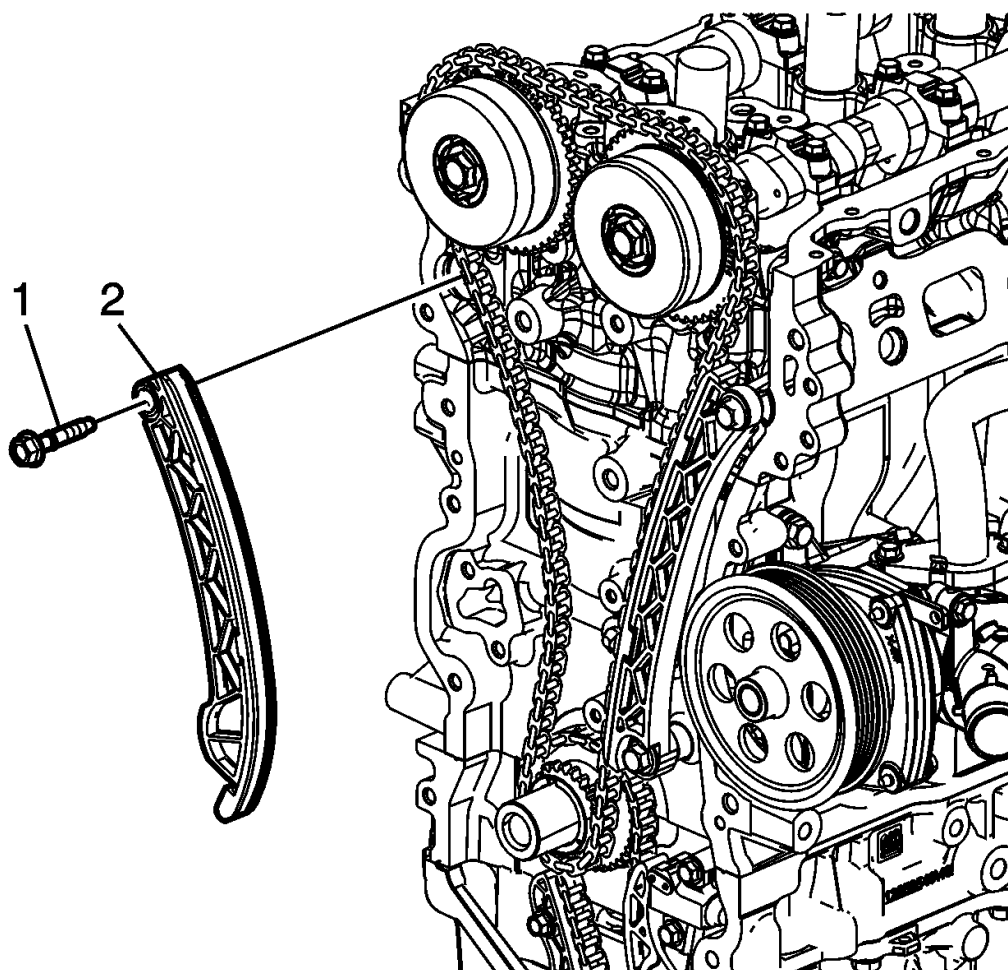


Fig. 41: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the timing chain tensioner pivot arm bolt (1).
6. Remove the timing chain tensioner pivot arm (2).

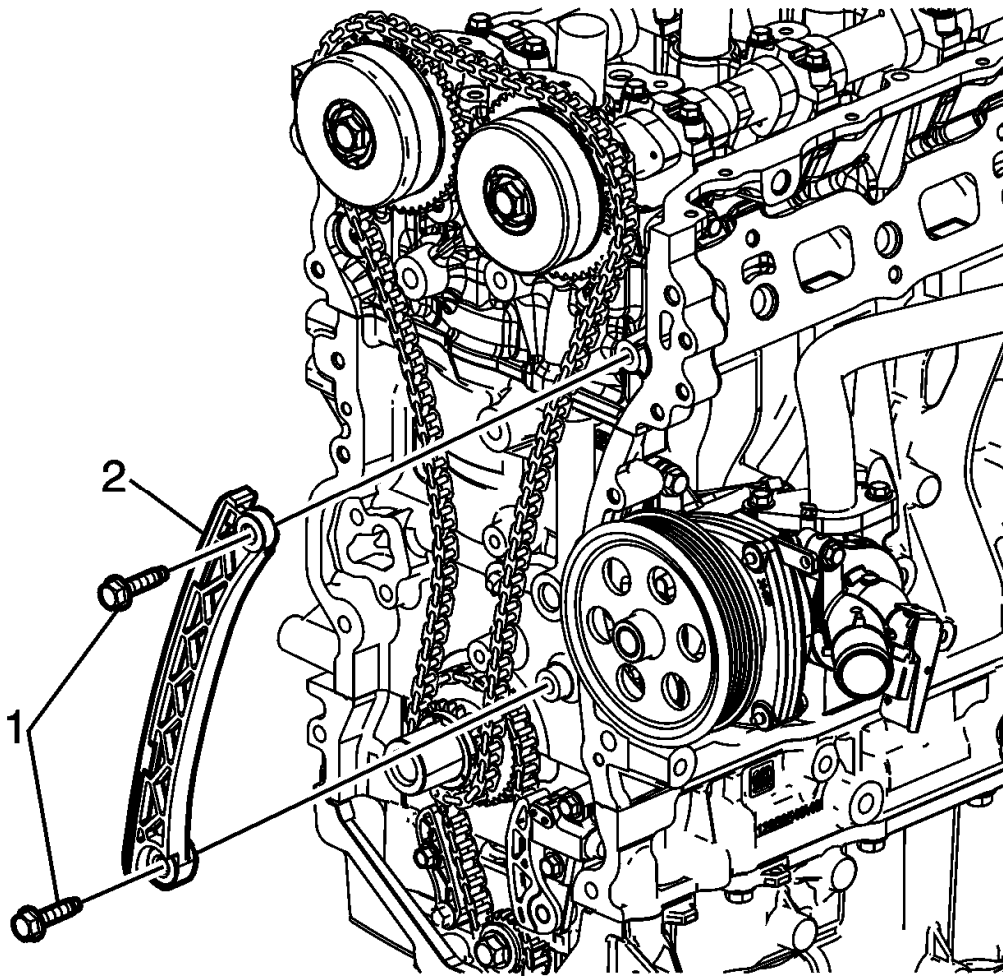


Fig. 42: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain guide bolts (1).
8. Remove the timing chain guide (2).

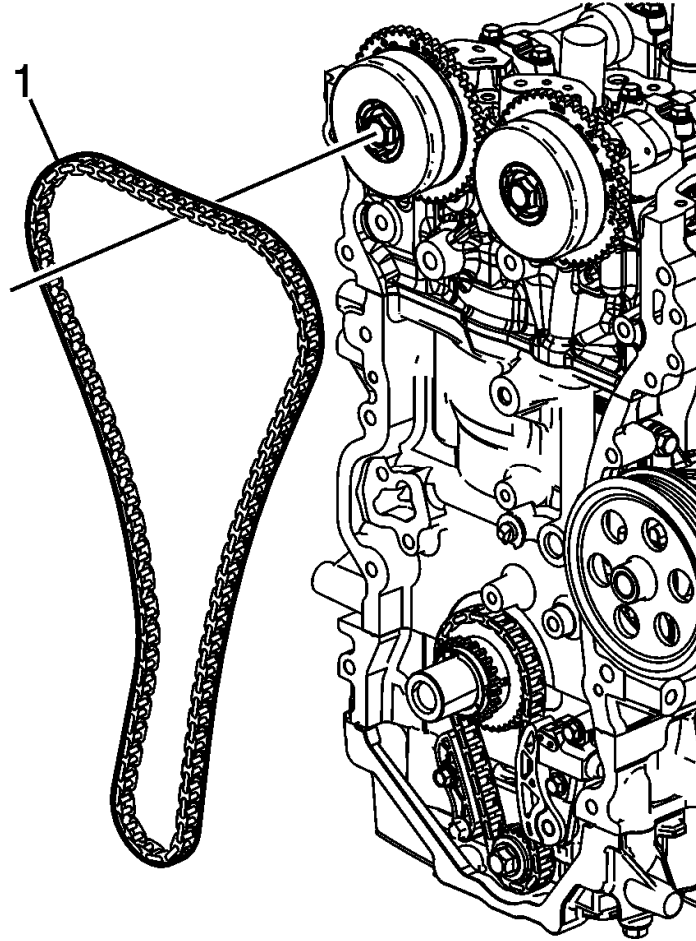


Fig. 43: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain (1).

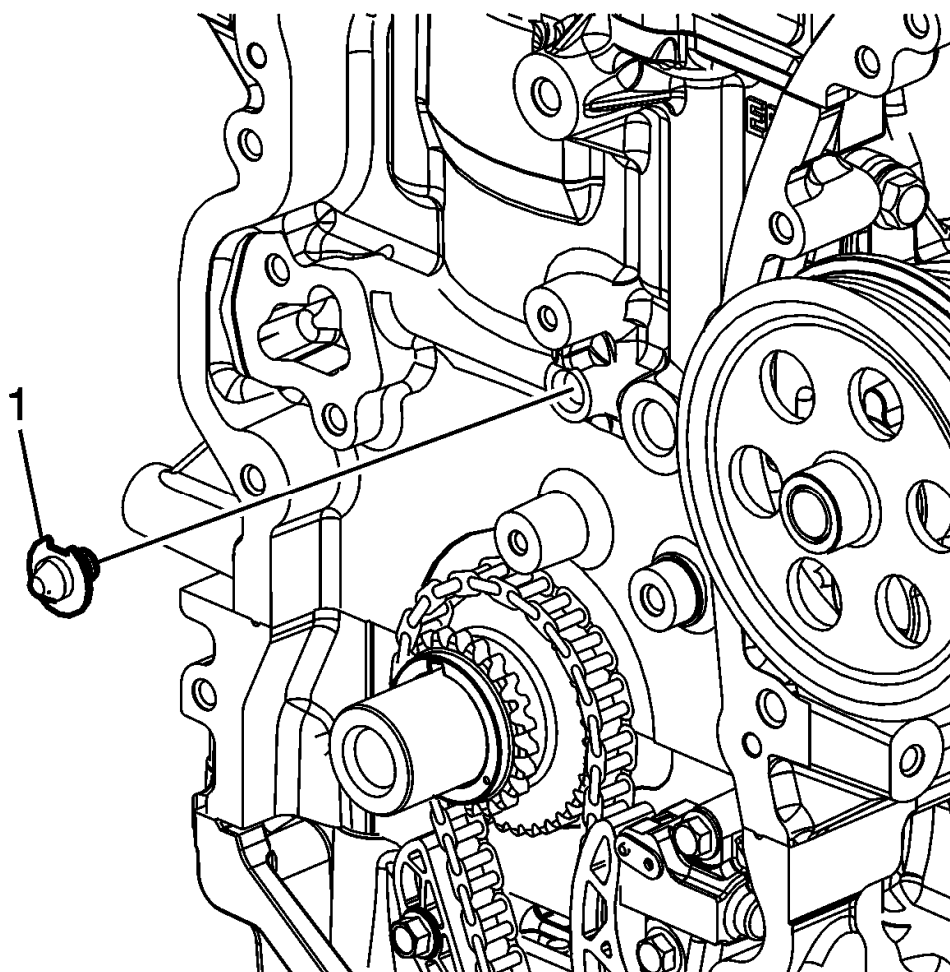


Fig. 44: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain oil nozzle (1).

OIL PAN REMOVAL

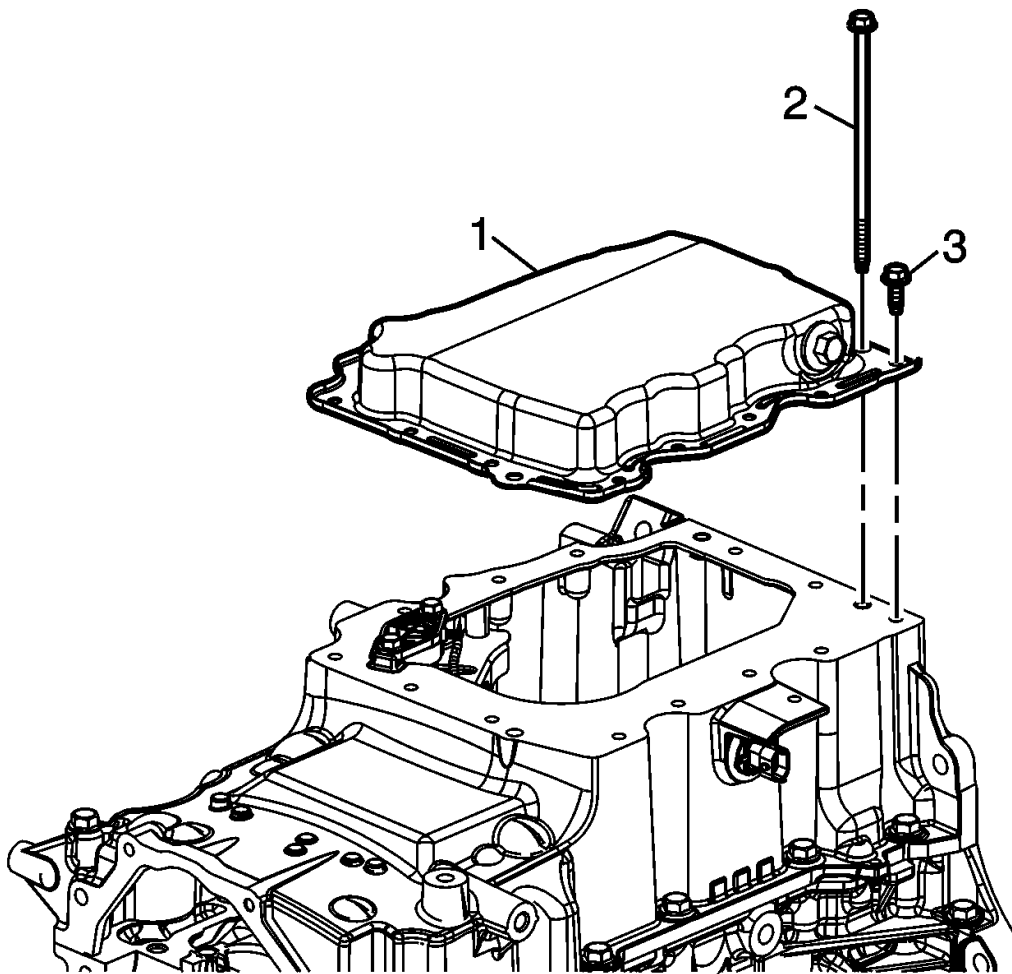


Fig. 45: Lower Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the lower oil pan bolts (3) and two oil pan to lower crankcase bolts (2).
2. Remove the lower oil pan (1).

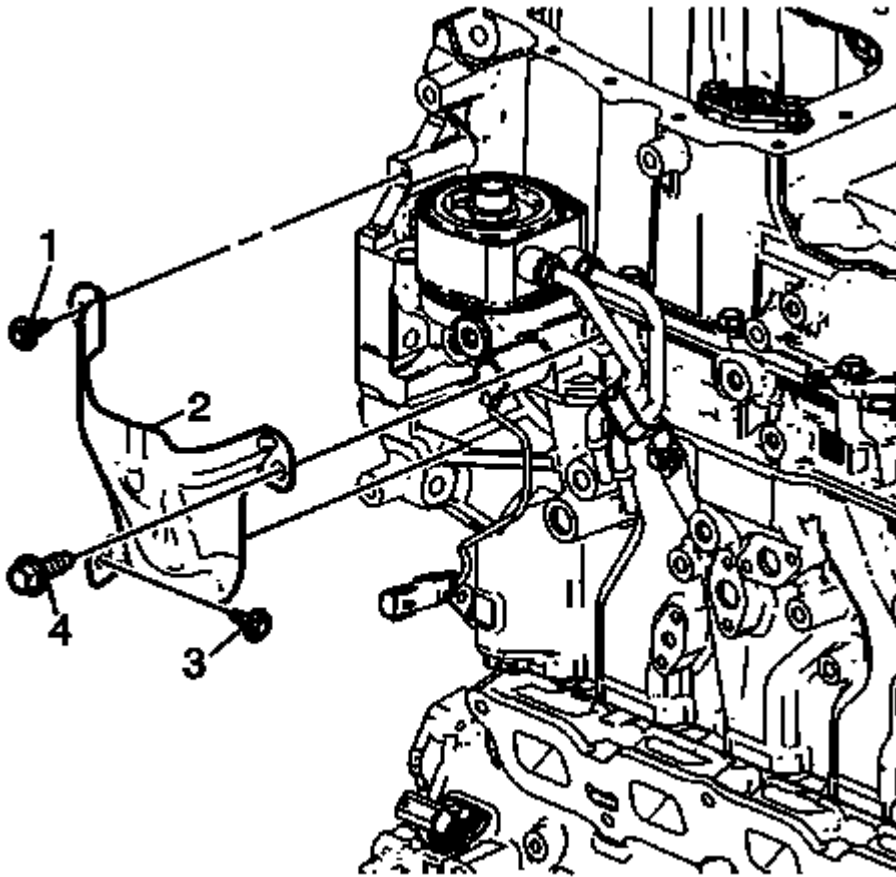


Fig. 46: Oil Pump Flow Control Valve Cover
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pump flow control valve cover (2) and bolts (1, 3, 4).

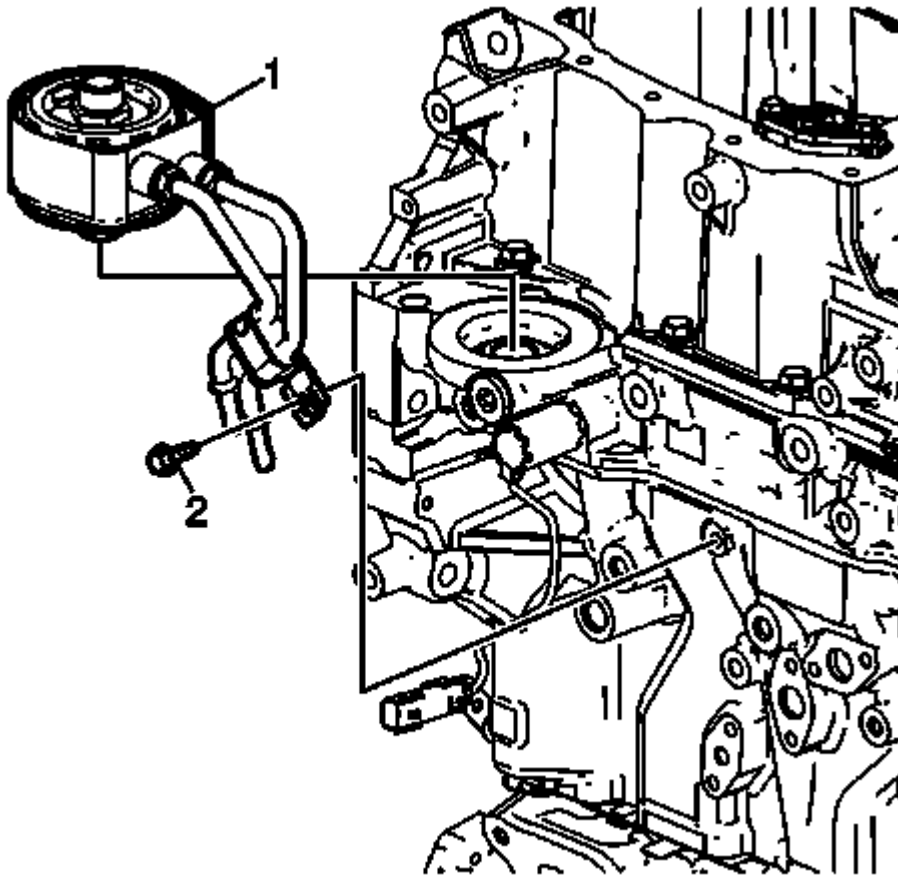


Fig. 47: Engine Oil Cooler And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil cooler (1) and bolts (2).

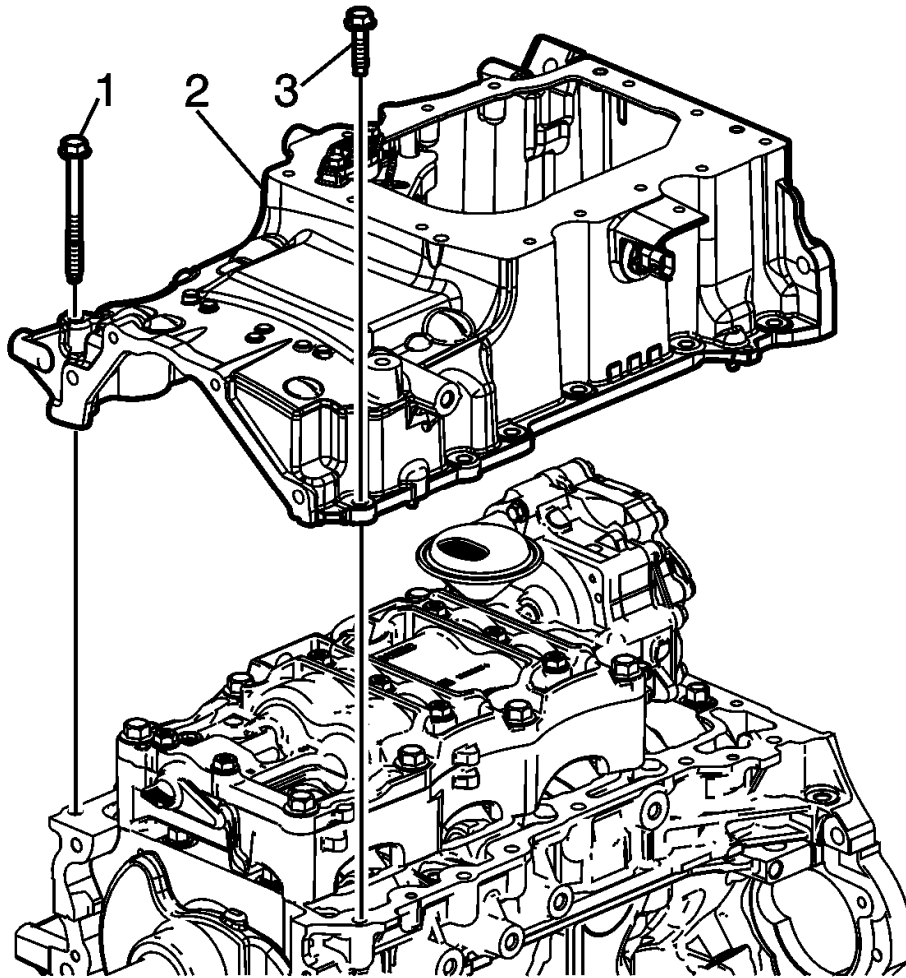


Fig. 48: upper oil pan and bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the upper oil pan (2) and bolts (1, 3).

BALANCER CHAIN, SPROCKET, AND TENSIONER REMOVAL

Special Tools

EN-50837 Timing Chain Tensioner Retraction Tool

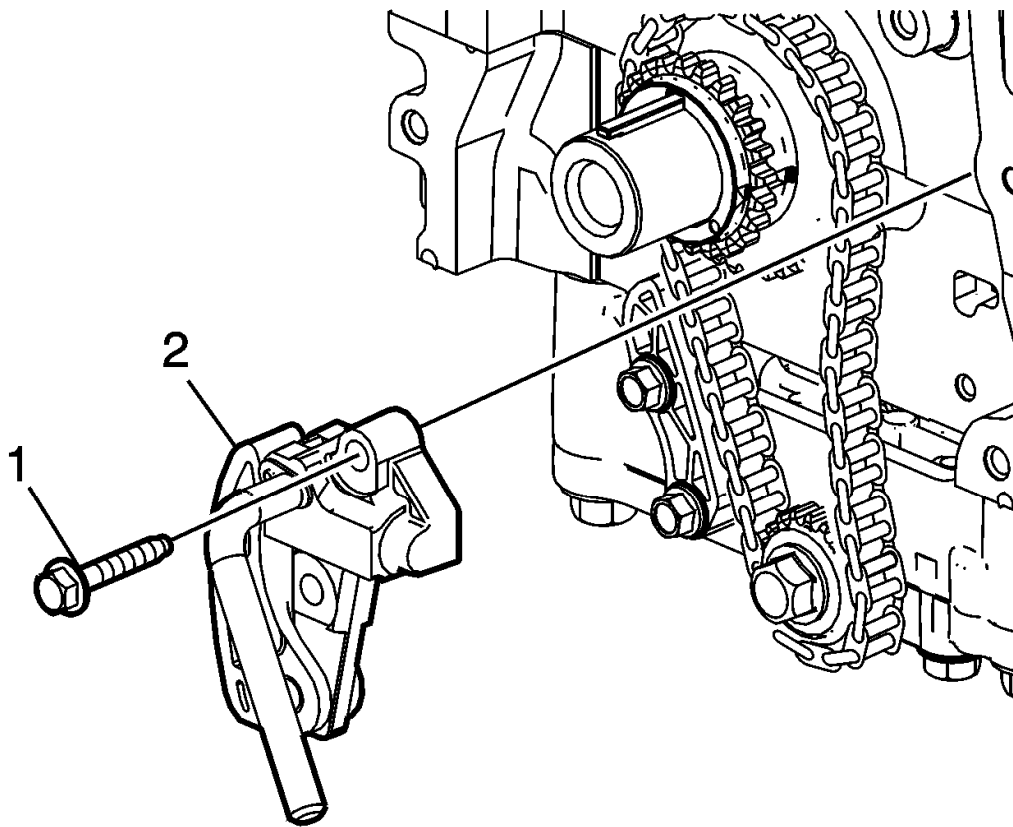


Fig. 49: Balancer Chain Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the balancer chain tensioner bolt (1).
2. Remove the balancer chain tensioner (2).
3. Compress and lock the tensioner using **EN-50837** retention tool.
 1. Insert **EN-50837** retention tool into the lever arm and push in a counterclockwise direction.
 2. Compress the tensioner while holding lever arm.
 3. Relax the force on the lever and tensioner slightly, allowing the tensioner to extend 3 ratchet clicks, and then hold in place.
 4. Pull lever clockwise using **EN-50837** retention tool until the hole in the lever aligns with the hole in the tensioner assembly. Push the point of **EN-50837** retention tool through the lever and into the tensioner assembly.

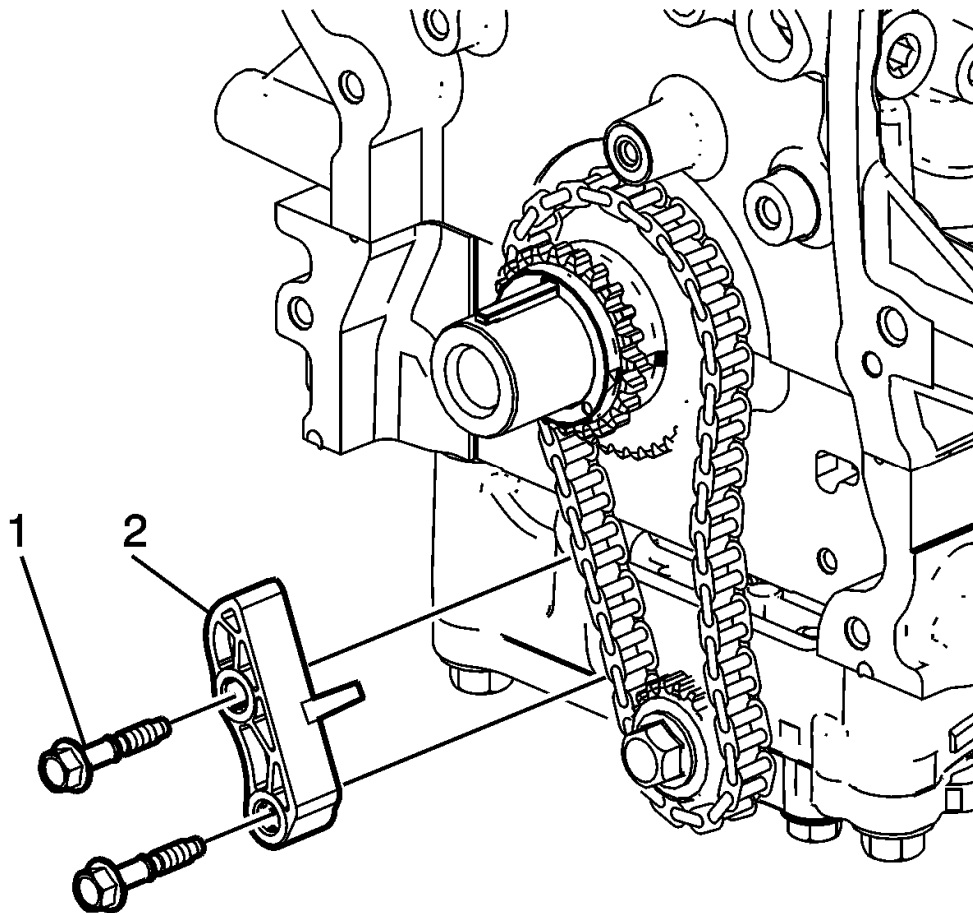


Fig. 50: Balancer Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the balancer chain guide bolt (1).
5. Remove the balancer chain guide (2).

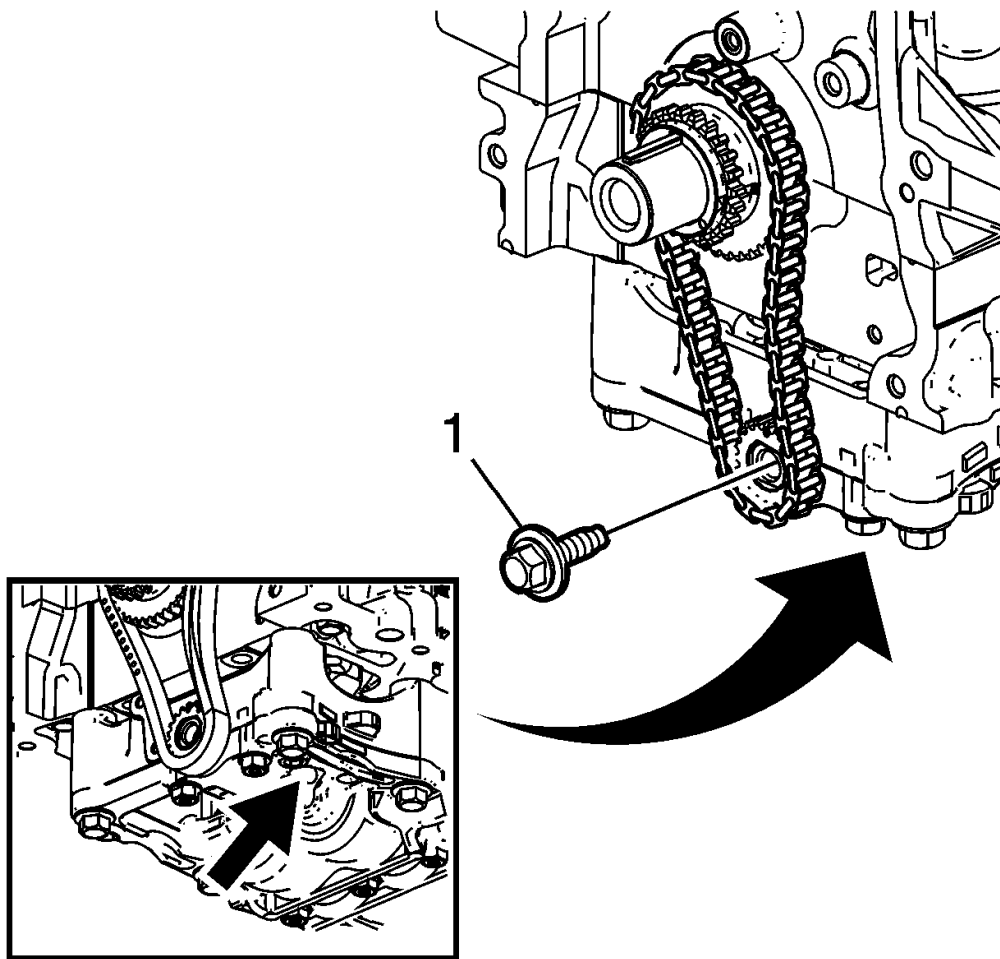


Fig. 51: Balancer Shaft Driven Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Use an 18 mm open end wrench over flat on balance shaft while loosening balancer shaft sprocket bolt. Remove and discard the balancer shaft driven sprocket bolt (1).

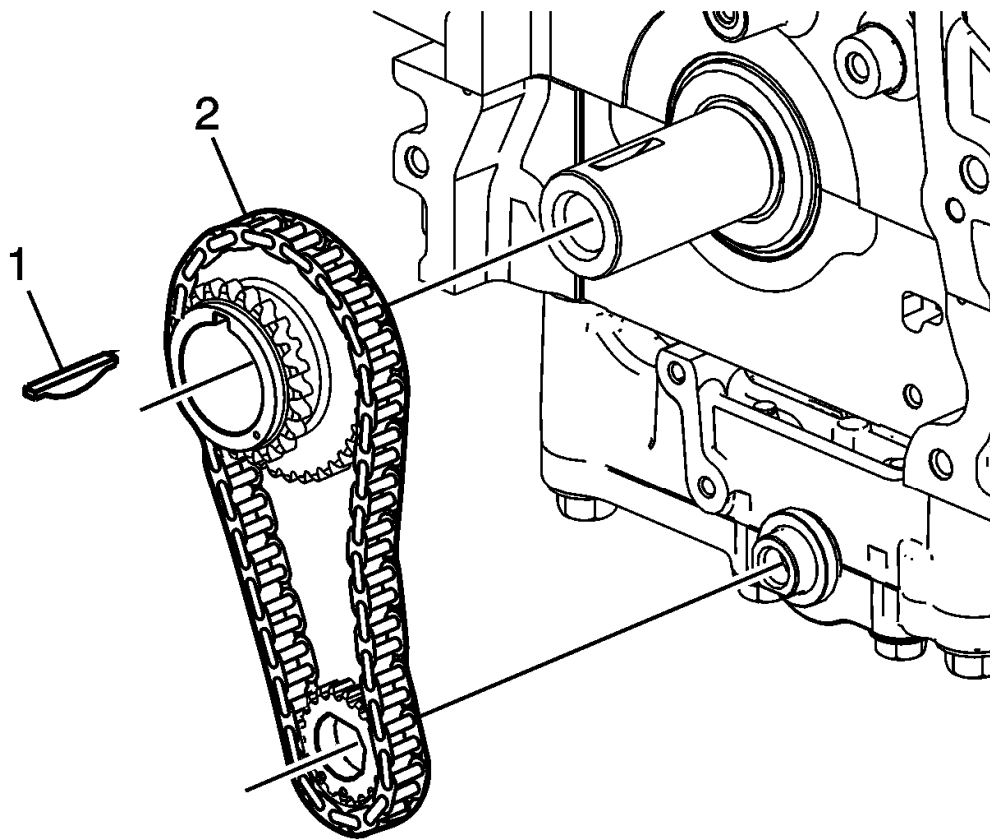


Fig. 52: Balancer Shaft Driven Sprocket And Balancer Chain
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft key (1).
8. Remove the crankshaft sprocket, balancer shaft driven sprocket, and balancer chain (2) simultaneously.

INTAKE AND EXHAUST CAMSHAFT, BEARING CAP, AND LASH ADJUSTER REMOVAL

Intake Camshaft and Components Removal

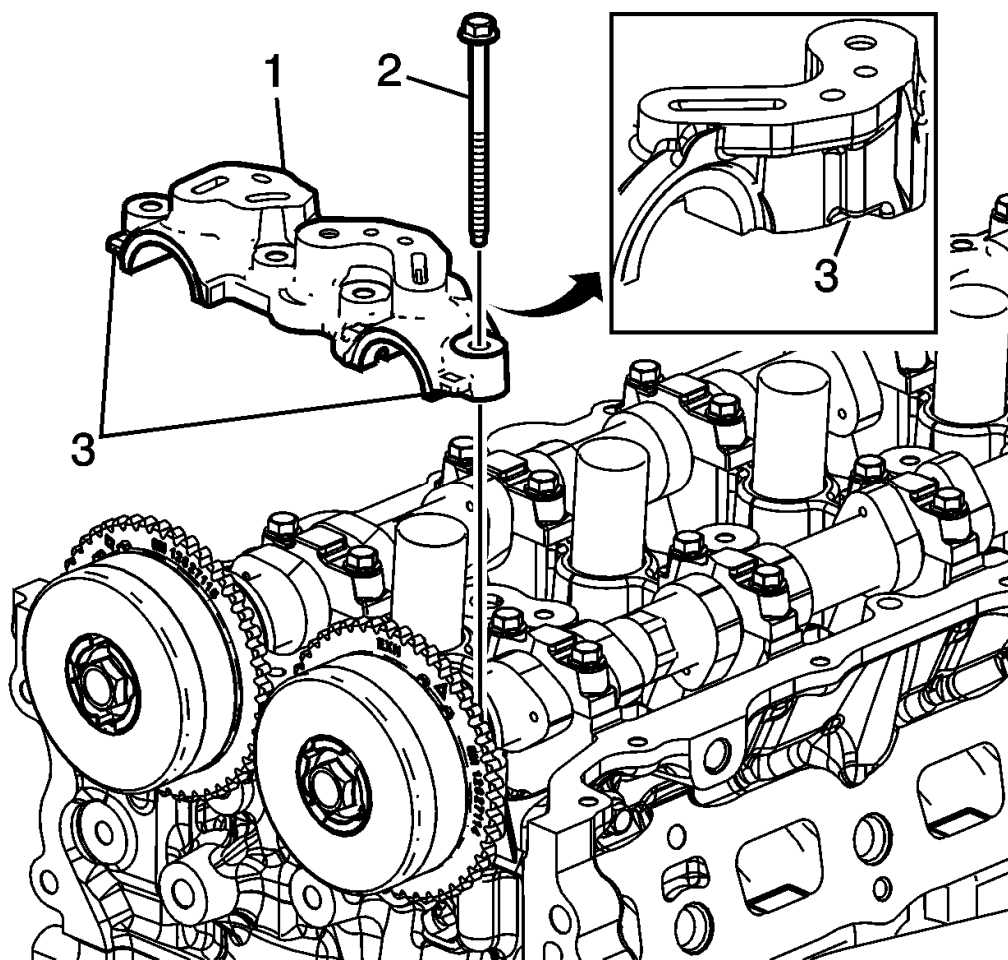


Fig. 53: Camshaft Front Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the camshaft front bearing cap bolts (2).

NOTE:

- Locate the pry points (3) on the camshaft front bearing cap.
- When using the pry points to remove the front bearing cap, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.
- Use 2 pry tools simultaneously to pry the upper front bearing cap away from the lower bearing cap evenly.

2. Using suitable pry tools, remove the camshaft front bearing cap (1)

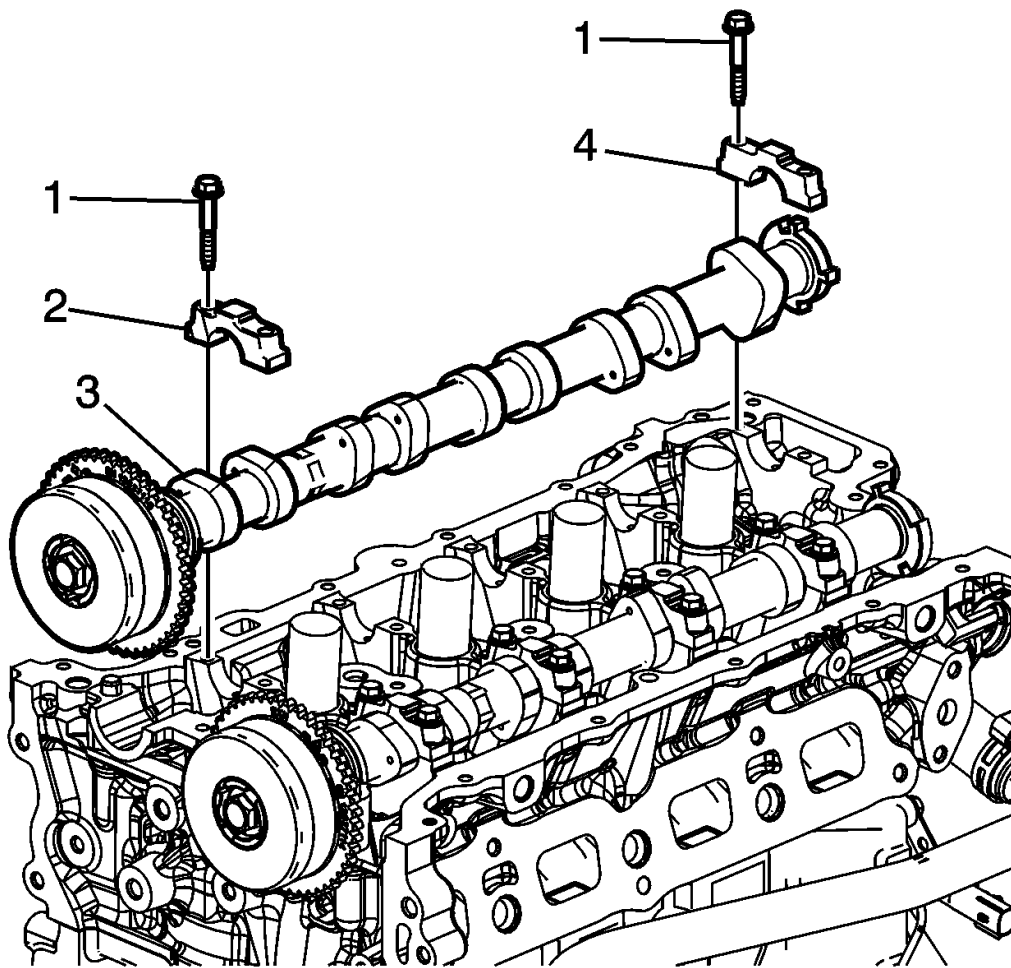


Fig. 54: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

3. Mark the intake camshaft rear cap to ensure it is installed in the same position. Remove the intake camshaft bearing rear cap bolts (1) and cap (4).

NOTE: Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

4. Mark the camshaft caps (2) to ensure they are installed in the same position.
5. Remove the intake camshaft cap bolts (1).
6. Remove the camshaft caps (2).
7. Remove the intake camshaft (3).

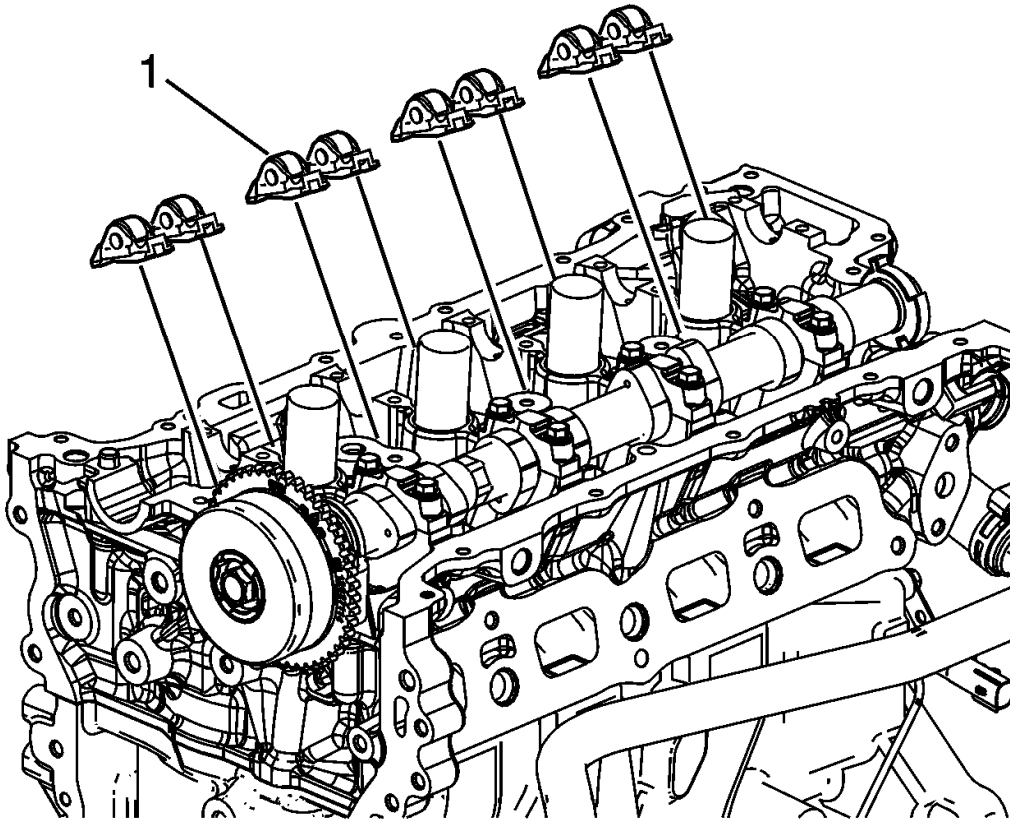


Fig. 55: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the roller finger followers and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

8. Remove the intake camshaft roller finger followers (1).

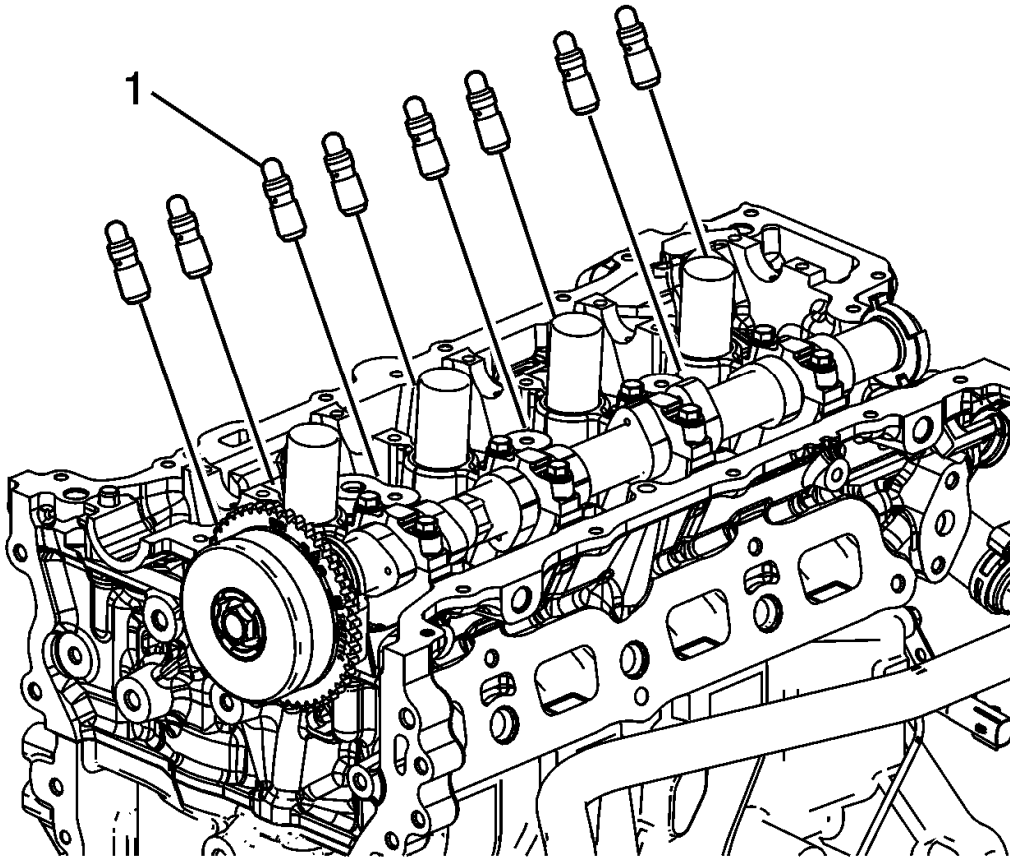


Fig. 56: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

9. Remove the hydraulic lash adjusters (1).

Exhaust Camshaft and Components Removal

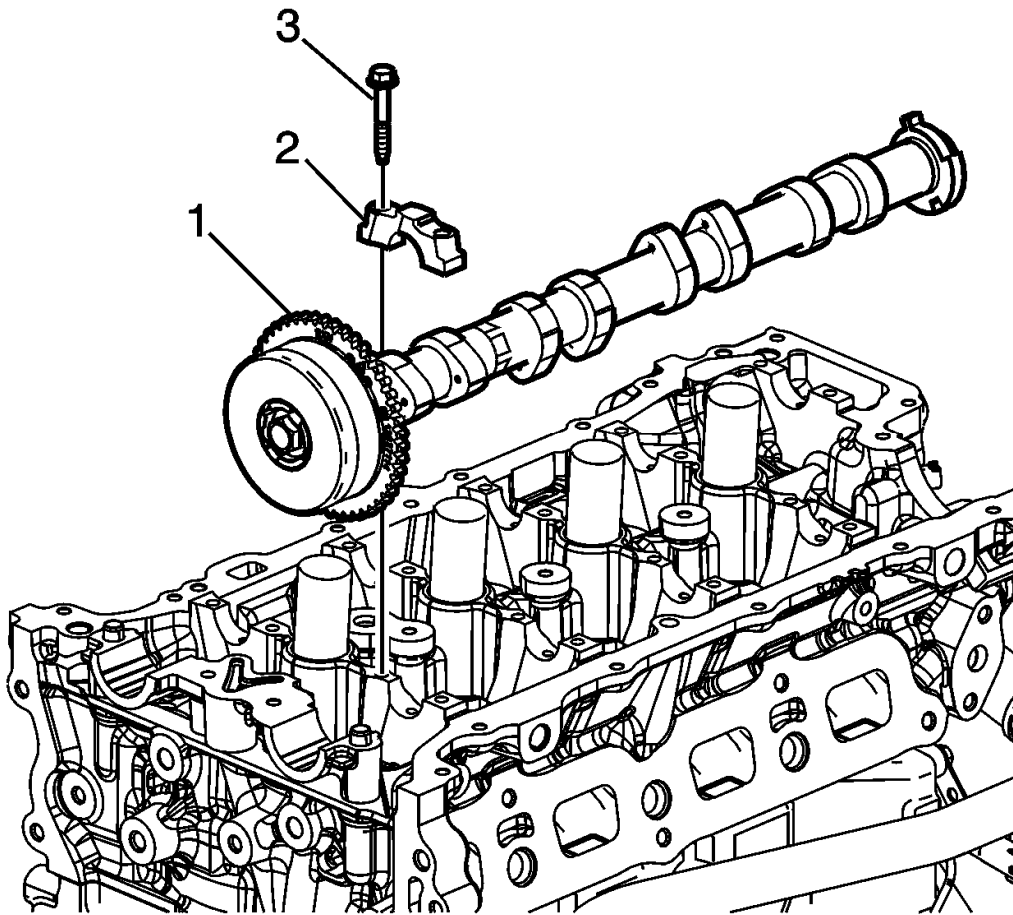


Fig. 57: Mark Camshaft Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

1. Mark camshaft caps (2) to ensure they are installed in the same position.
2. Remove the exhaust camshaft cap bolts (3).
3. Remove the camshaft caps (2) ensuring they are marked and refitted in same position on assembly.
4. Remove the exhaust camshaft (1).

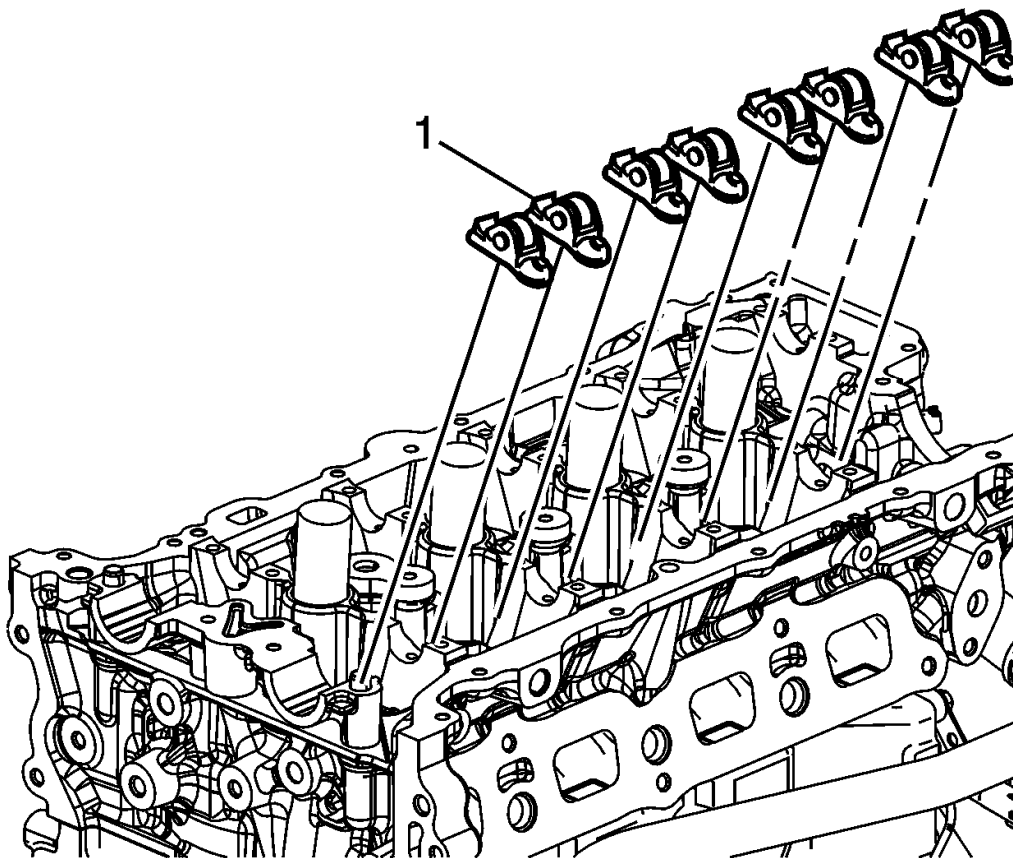


Fig. 58: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the roller finger followers and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

5. Remove the exhaust camshaft roller finger followers (1).

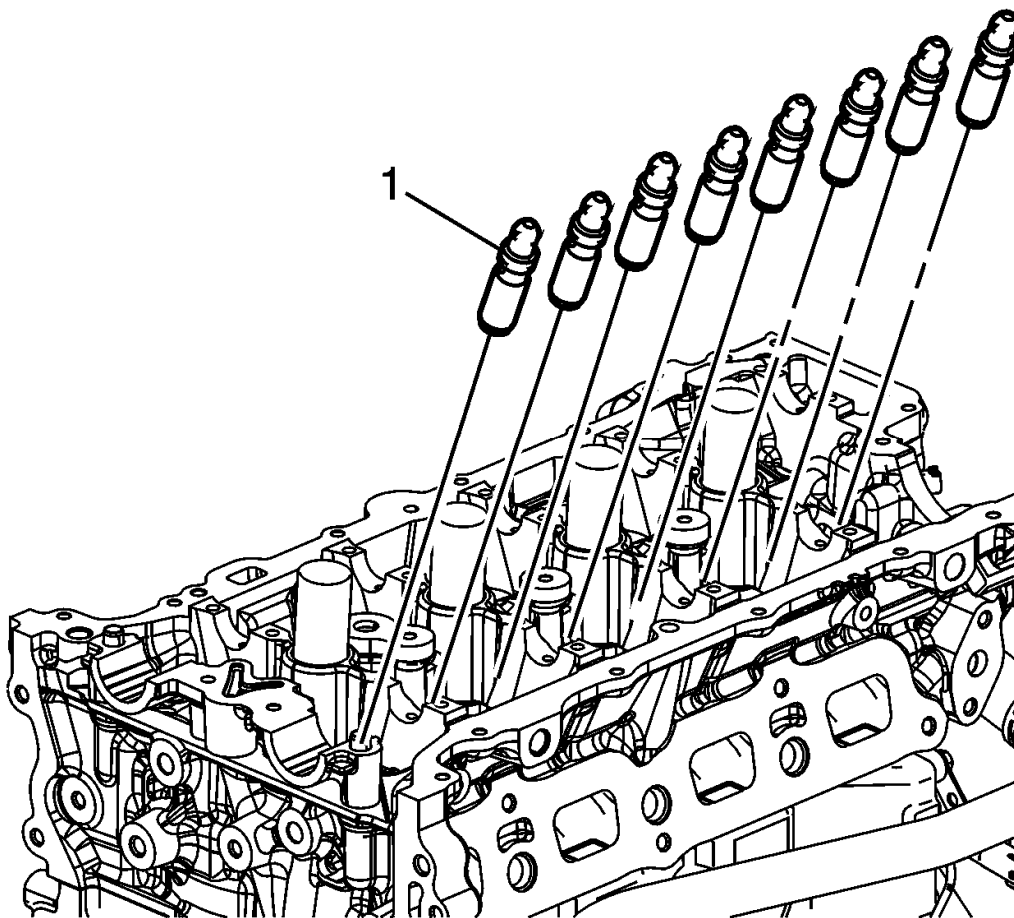


Fig. 59: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

6. Remove the hydraulic lash adjusters (1).

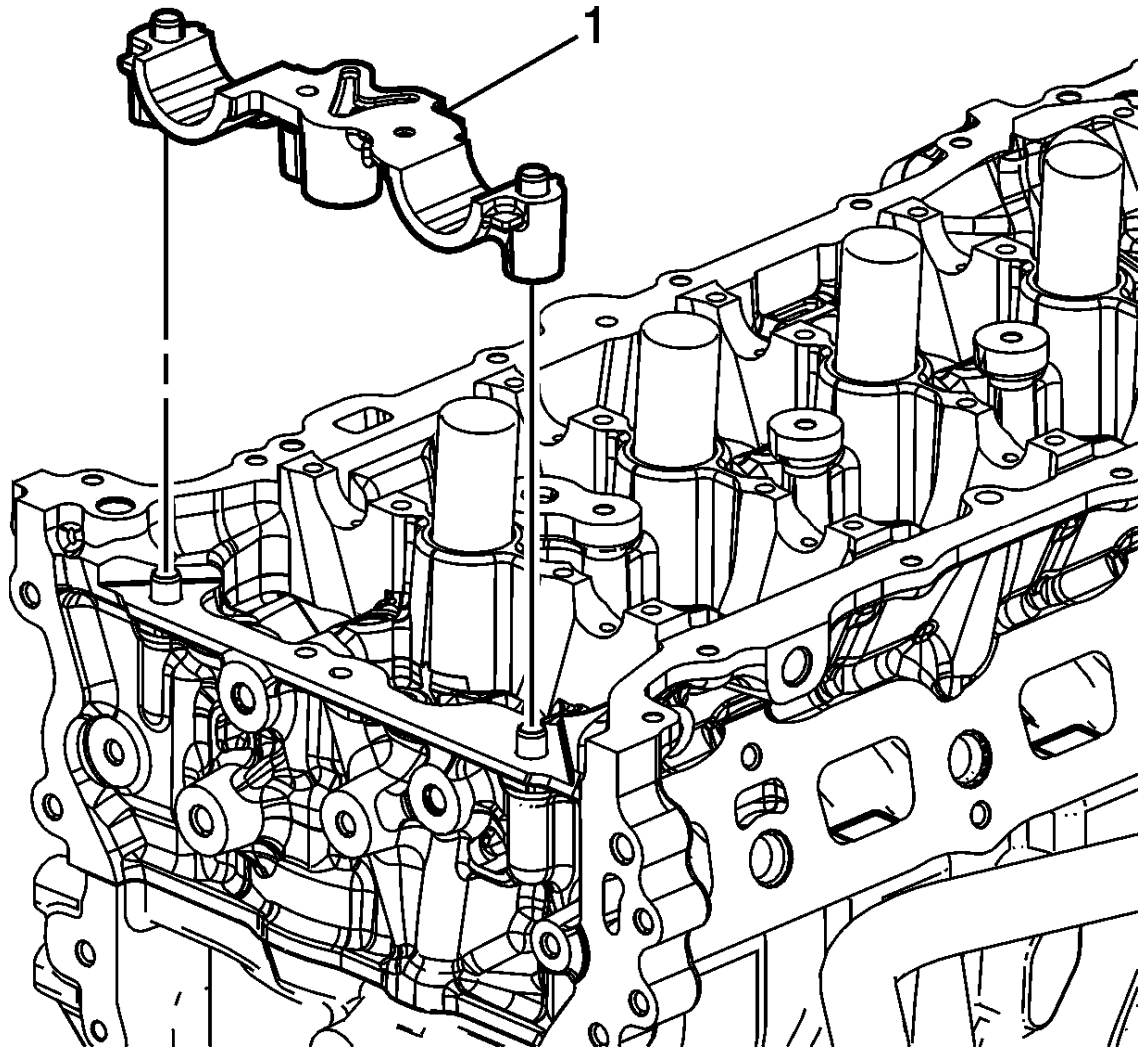


Fig. 60: Camshaft Bearing Lower Front Cap
Courtesy of GENERAL MOTORS COMPANY

7. Remove the camshaft bearing lower front cap (1).

WATER PUMP REMOVAL

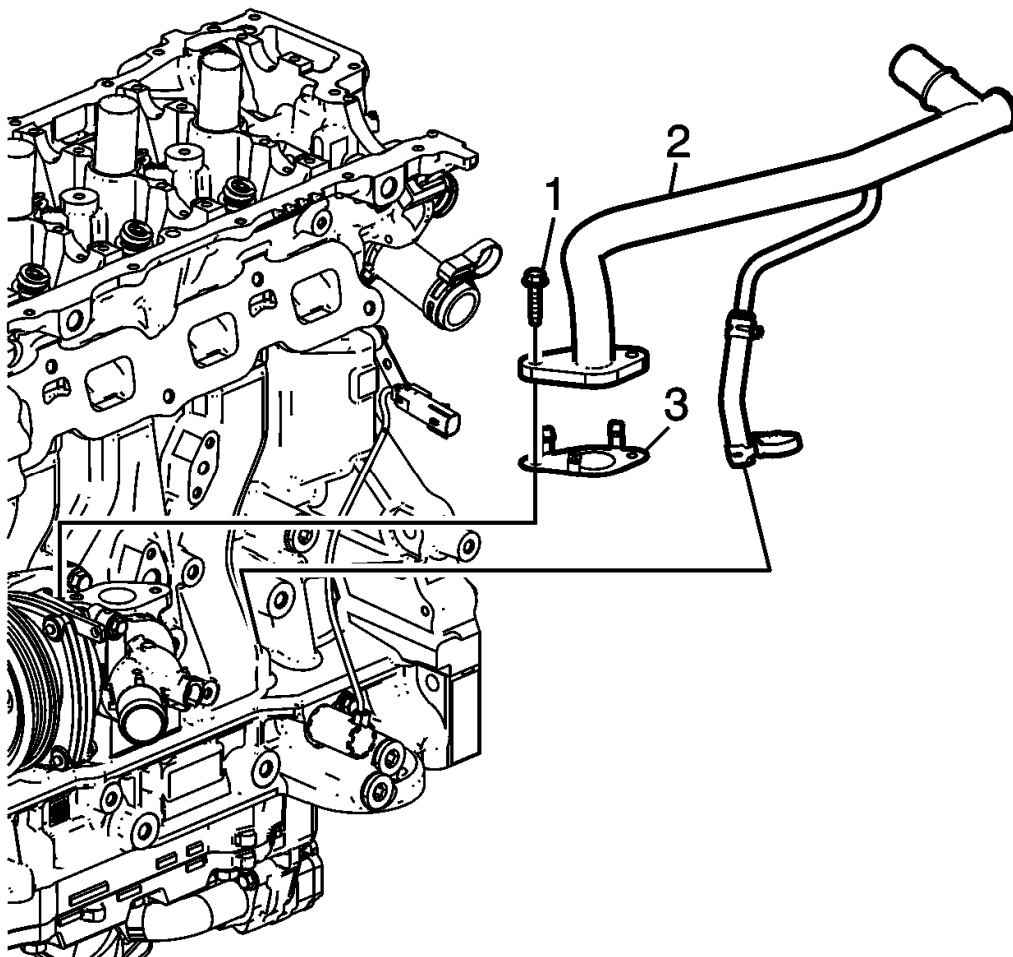


Fig. 61: Thermal Bypass Pipe Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the thermal bypass hose at the engine oil cooler.
2. Remove the thermal bypass pipe bolts (1) at the water pump assembly.
3. Disconnect the pipe from the water outlet assembly.
4. Remove the thermal bypass pipe (2) and gasket (3) from the water pump assembly. Discard the gasket.

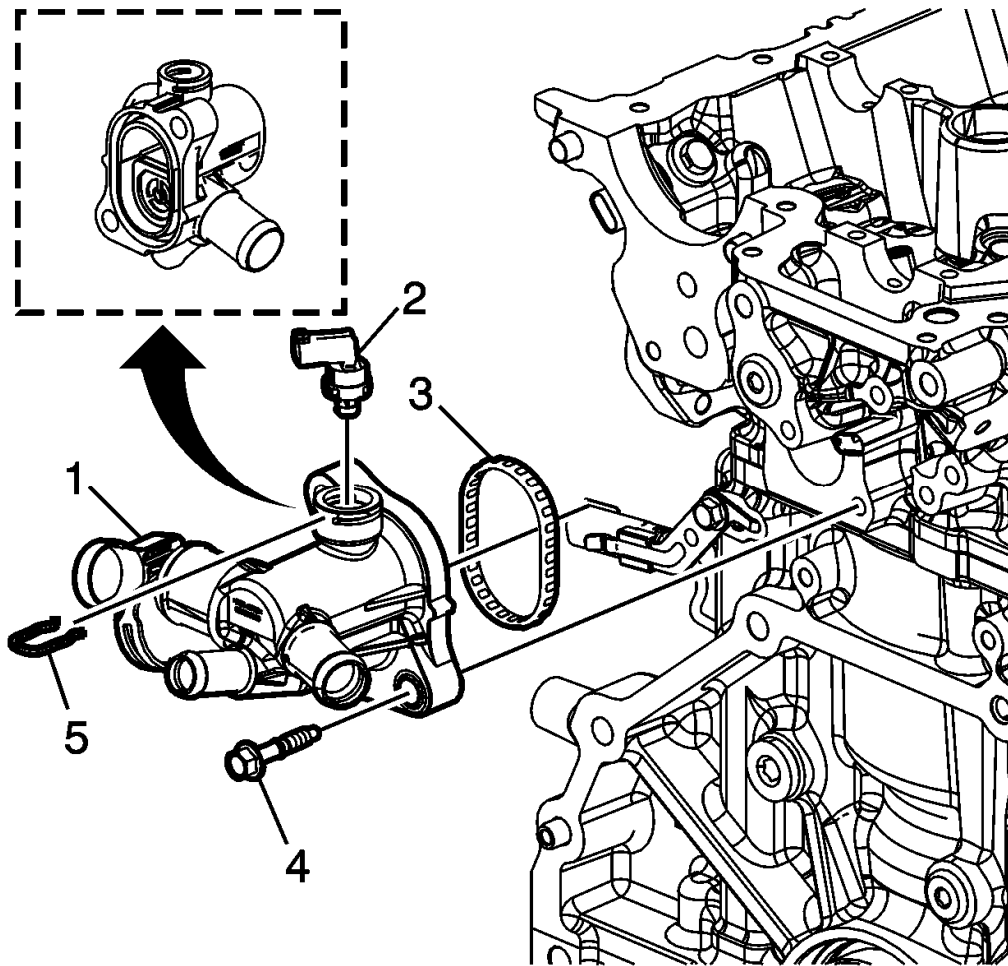


Fig. 62: Retaining Clip And Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the retaining clip (5) and engine coolant temperature sensor (2).
6. Remove the water outlet assembly (1), bolts (4), and gasket seal (3). Discard the gasket.

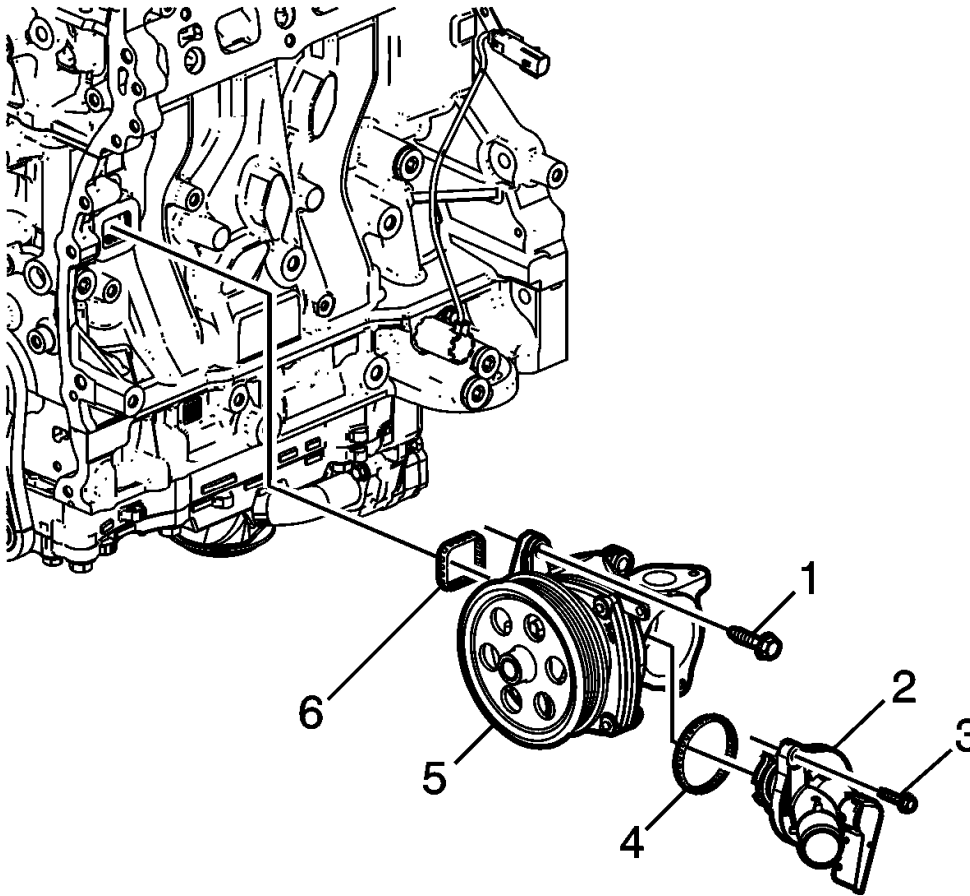


Fig. 63: Thermostat Assembly And Gasket Seal
Courtesy of GENERAL MOTORS COMPANY

7. Remove the thermostat assembly (2), bolts (3), and gasket seal (4). Discard the gasket.
8. Remove the water pump assembly (5), bolts (1), and seal (6). Discard the seal.

CYLINDER HEAD REMOVAL

Special Tools

EN 38188 Cylinder Head Broken Bolt Extractor Kit

For equivalent regional tools, refer to **Special Tools** .

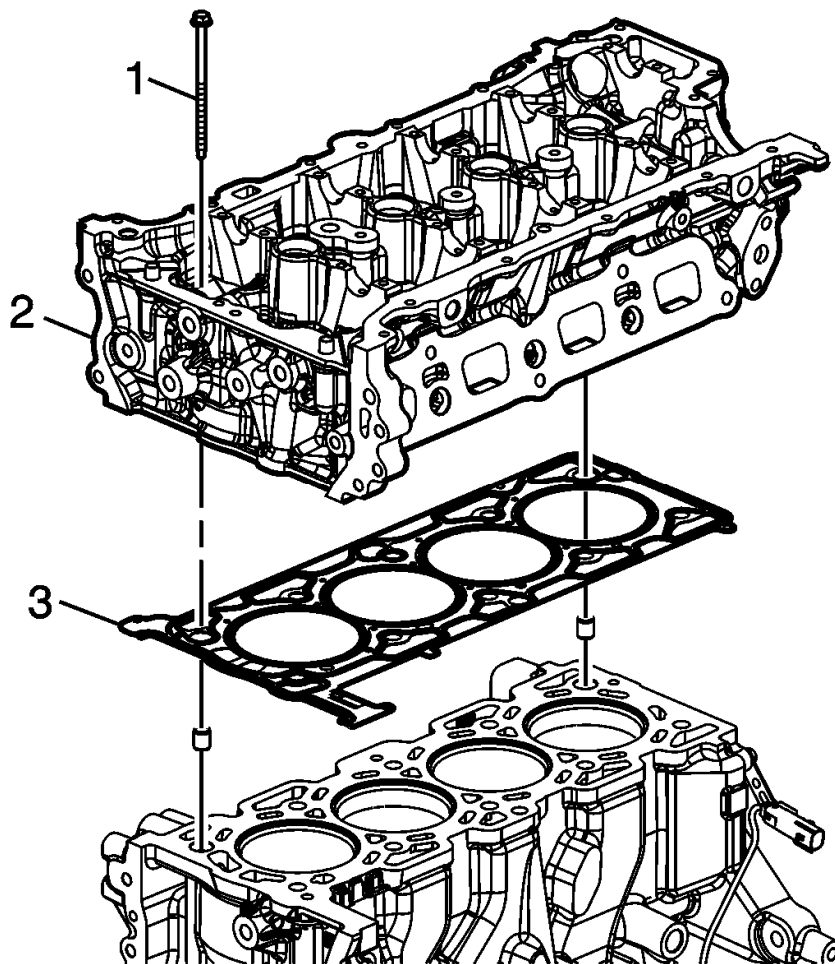


Fig. 64: Cylinder Head Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Remove and discard the cylinder head bolts (1).

CAUTION: In order to prevent damage to the valves and injectors during cylinder head removal, set the cylinder head on blocks.

2. Remove the cylinder head (2).
3. Remove the cylinder head gasket (3).
4. Inspect the cylinder head locating pins. Remove the locating pins and discard, if necessary.
5. Clean all of the gasket surfaces.
6. Use the following procedures when cleaning the cylinder head and cylinder block surfaces:
 - Use a razor blade gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge any surface.

NOTE: Do not use any other method or technique to clean these gasket

surfaces.

- Use a new razor blade for each cylinder head and cylinder block.

NOTE: Be careful not to gouge or scratch the gasket surfaces. Do not gouge or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.

- Hold the razor blade as parallel to the gasket surface as possible.

NOTE: Do not use a tap to clean the cylinder head bolt holes.

7. Clean the old sealer/lube and dirt from the bolt holes.
8. Clean the bolt holes with a nylon bristle brush.

WARNING: Wear safety glasses to avoid injury when using compressed air or any cleaning solvent. Bodily injury may occur if fumes are inhaled or if skin is exposed to chemicals.

9. When cleaning the cylinder head bolt holes use a suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun to reach the bottom of the holes.
10. Remove any broken long cylinder head bolts using the **EN 38188** kit.

BALANCER WITH OIL PUMP SHAFT REMOVAL

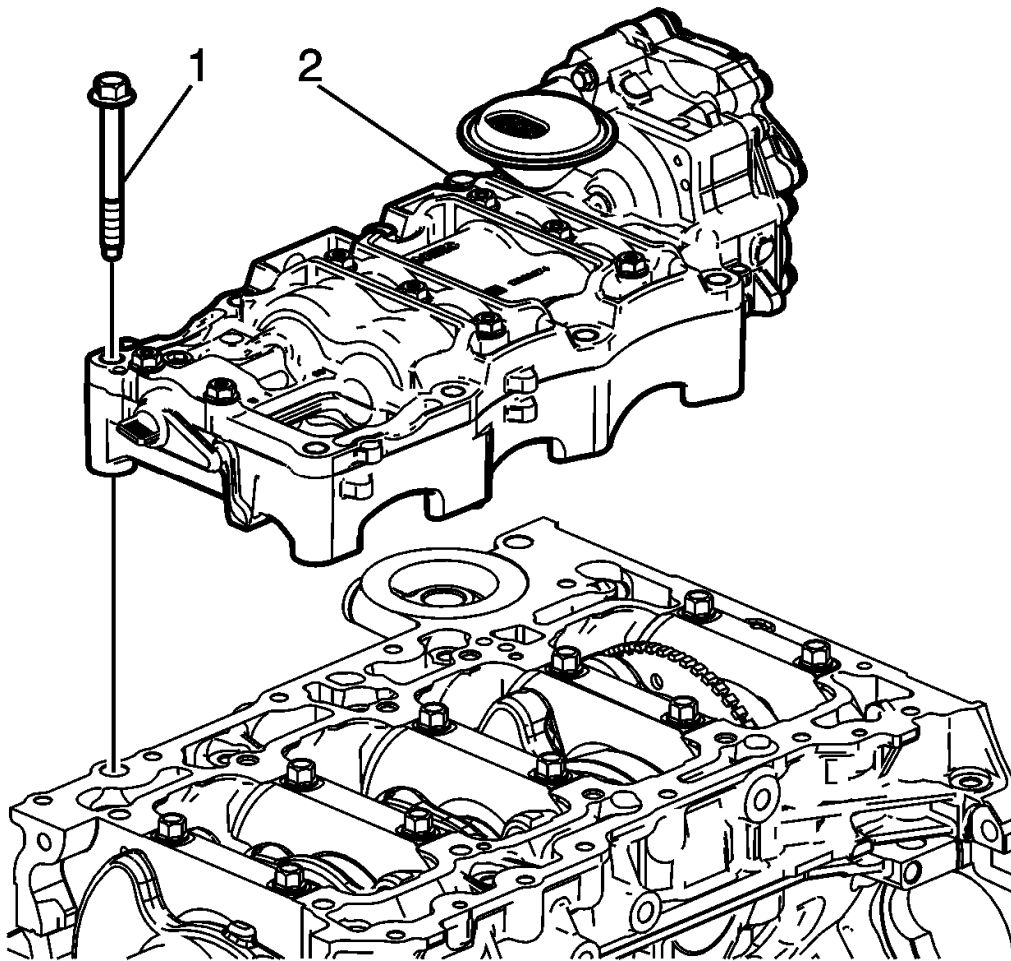


Fig. 65: Balancer And Oil Pump Shaft Assembly Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the balancer and oil pump shaft assembly bolts (1).
2. Remove the balancer and oil pump shaft assembly (2).

PISTON, CONNECTING ROD, AND BEARING REMOVAL

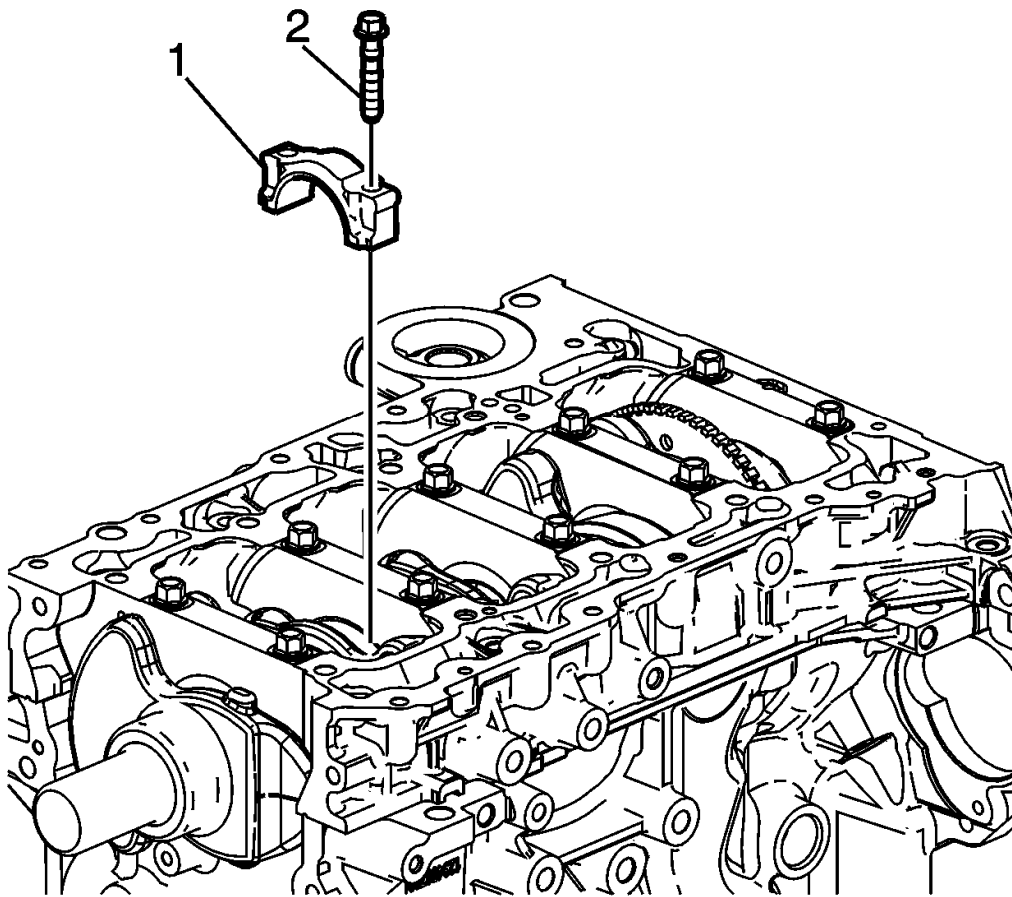


Fig. 66: Connecting Rod Cap

Courtesy of GENERAL MOTORS COMPANY

1. Rotate the crankshaft to a position where the connecting rod bolts are the most accessible.
2. Mark the connecting rod and cap with the cylinder position. Also mark their orientation. This will ensure the caps and connecting rods are re-assembled properly.
3. Remove any ridge at the top of the cylinder bore to avoid damage to the piston ring lands.
4. Remove and discard the connecting rod bolts (2).
5. Remove the connecting rod cap (1).

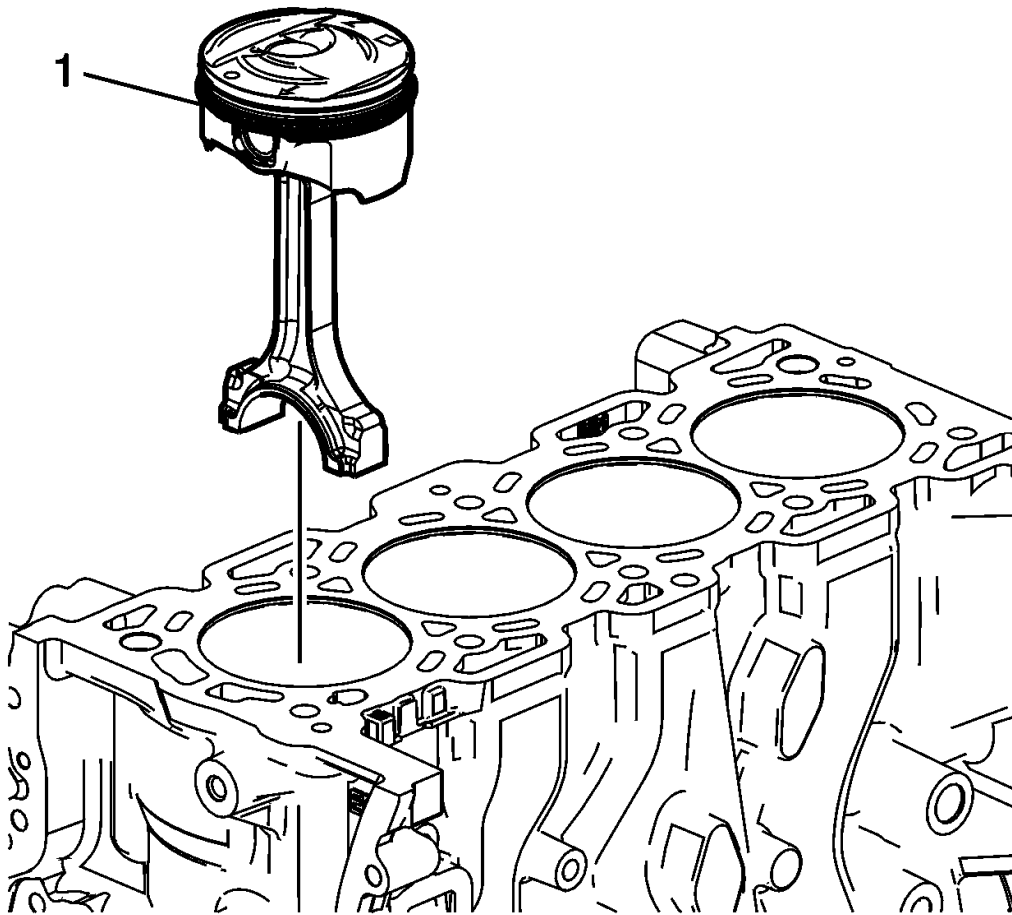


Fig. 67: Piston And Connecting Rod Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Remove the piston and connecting rod assembly (1).

LOWER CRANKCASE REMOVAL

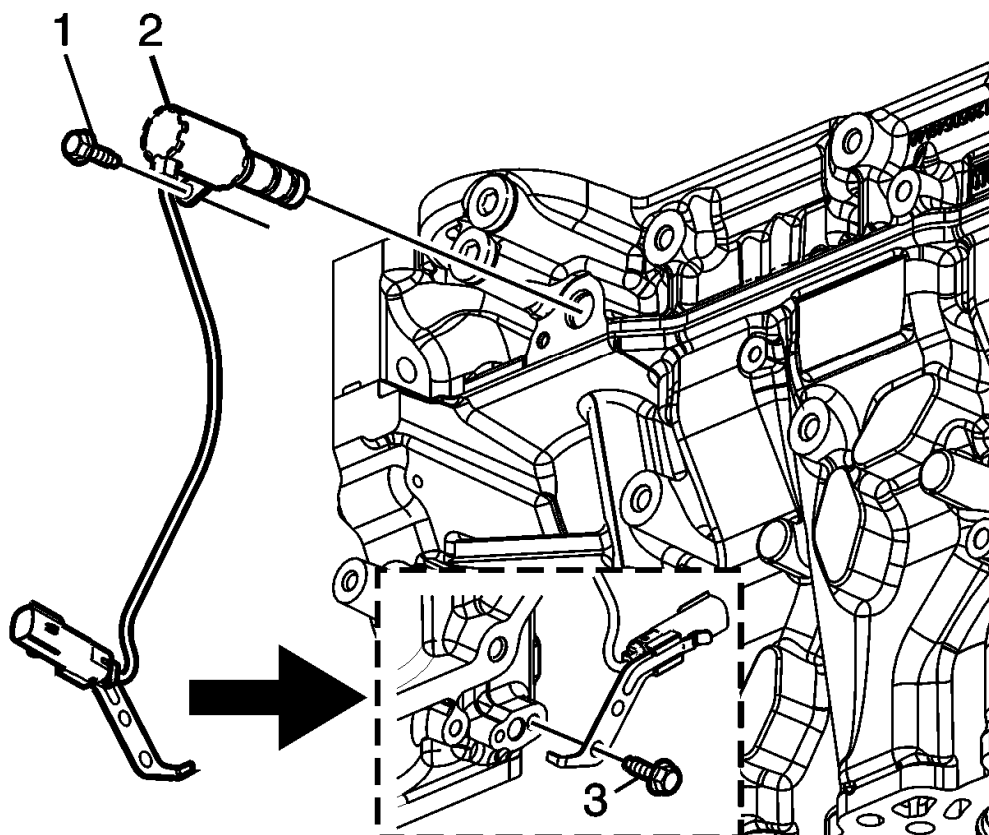


Fig. 68: Oil Pump Flow Control Valve And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pump flow control valve (2) and bolts (1, 3).

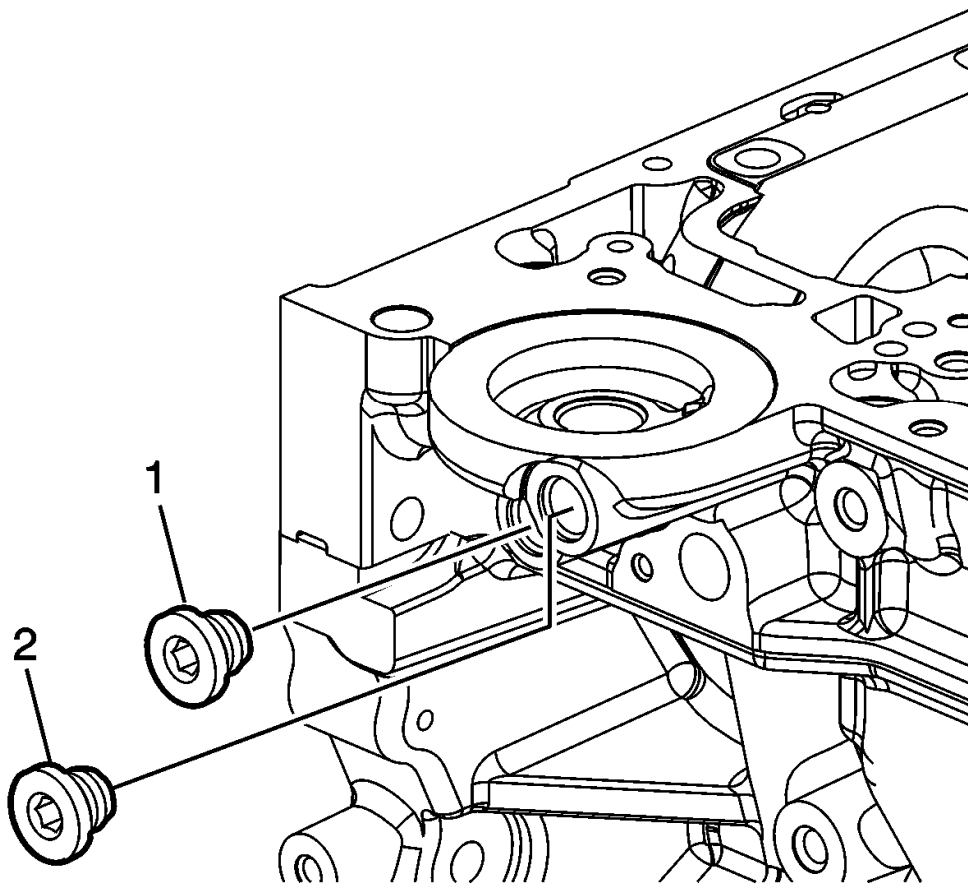


Fig. 69: Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil gallery plugs (1, 2).

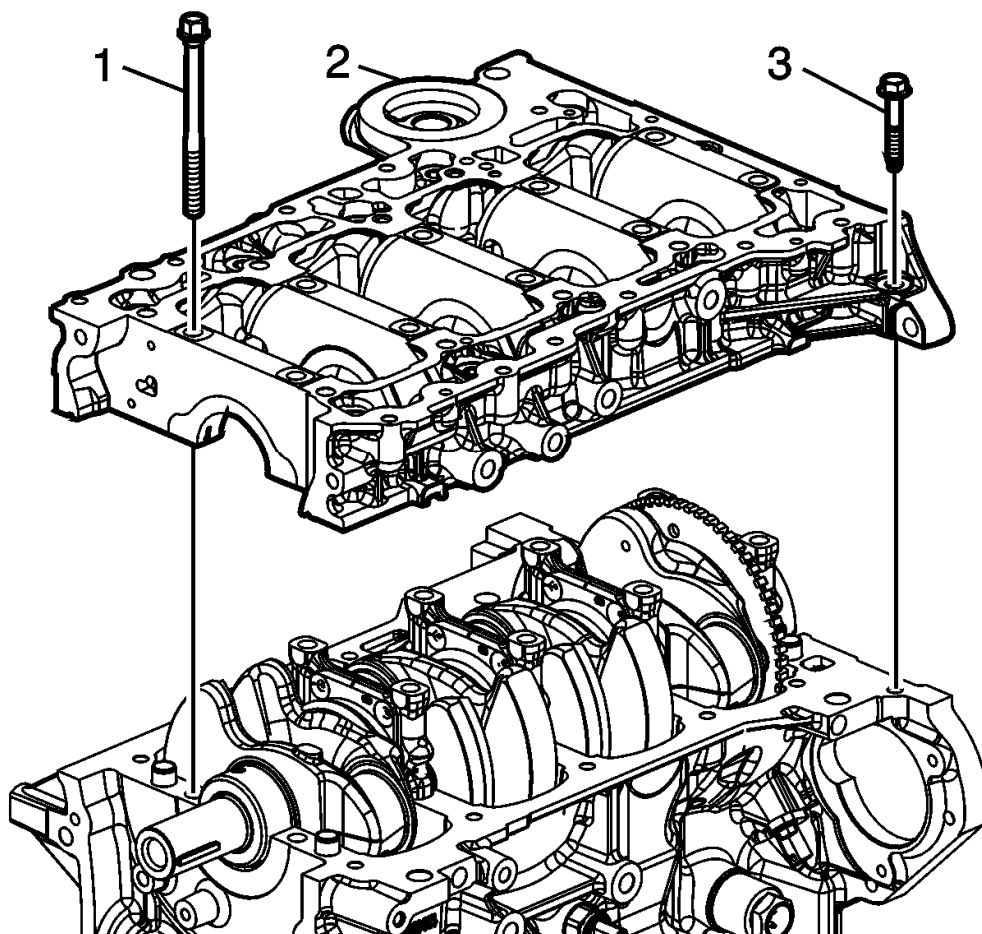


Fig. 70: Lower Crankcase Perimeter Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the lower crankcase perimeter bolts (3).
4. Remove and discard the crankshaft bearing bolts (1).
5. Gently separate the lower crankcase (2) from the block.

CRANKSHAFT AND BEARING REMOVAL

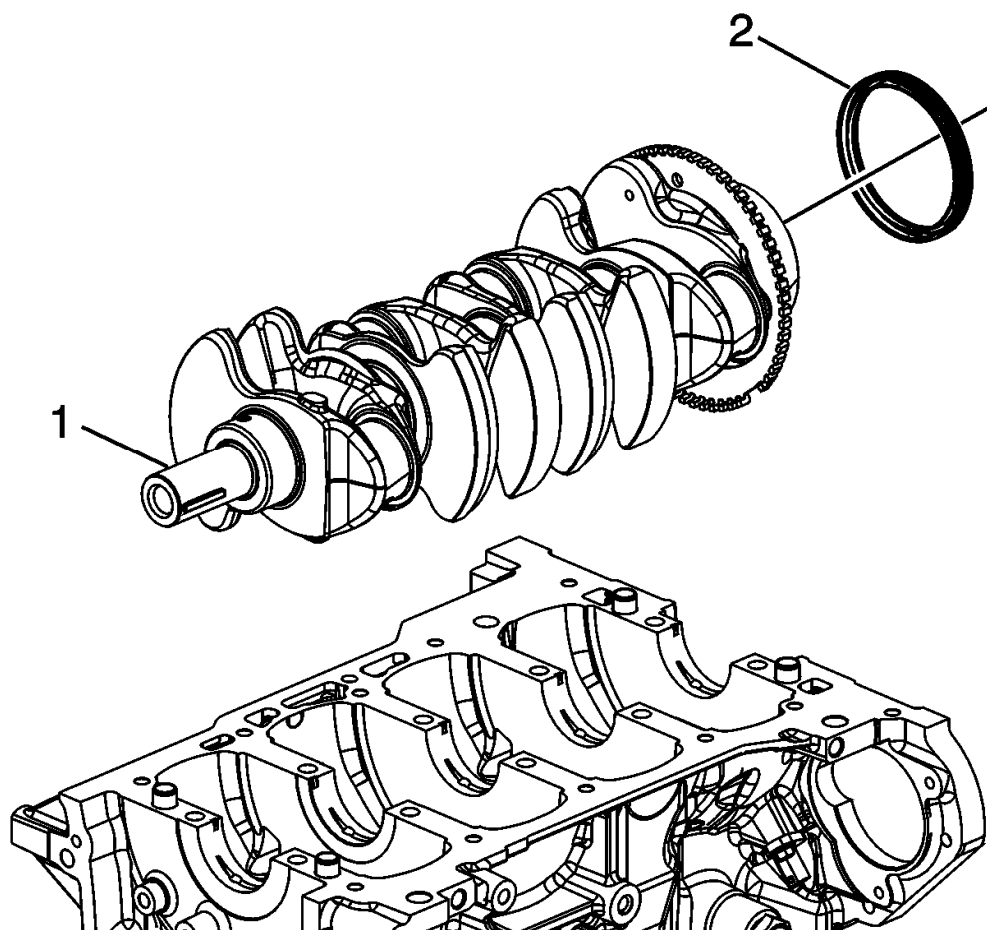


Fig. 71: Crankshaft

Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft (1) from the block.
2. Remove the crankshaft rear oil seal (2) from the block and discard.

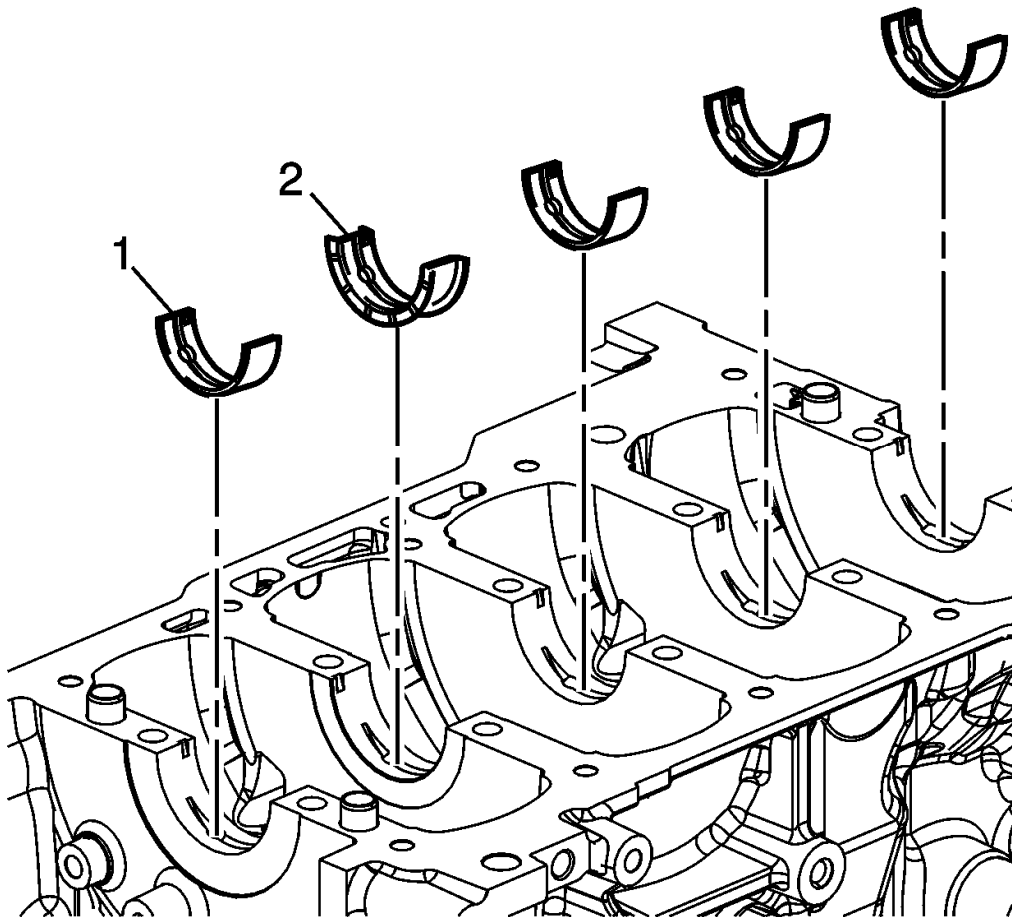


Fig. 72: Crankshaft Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.

3. Remove the crankshaft upper bearings (1) and the crankshaft upper thrust bearing (2) from the block.

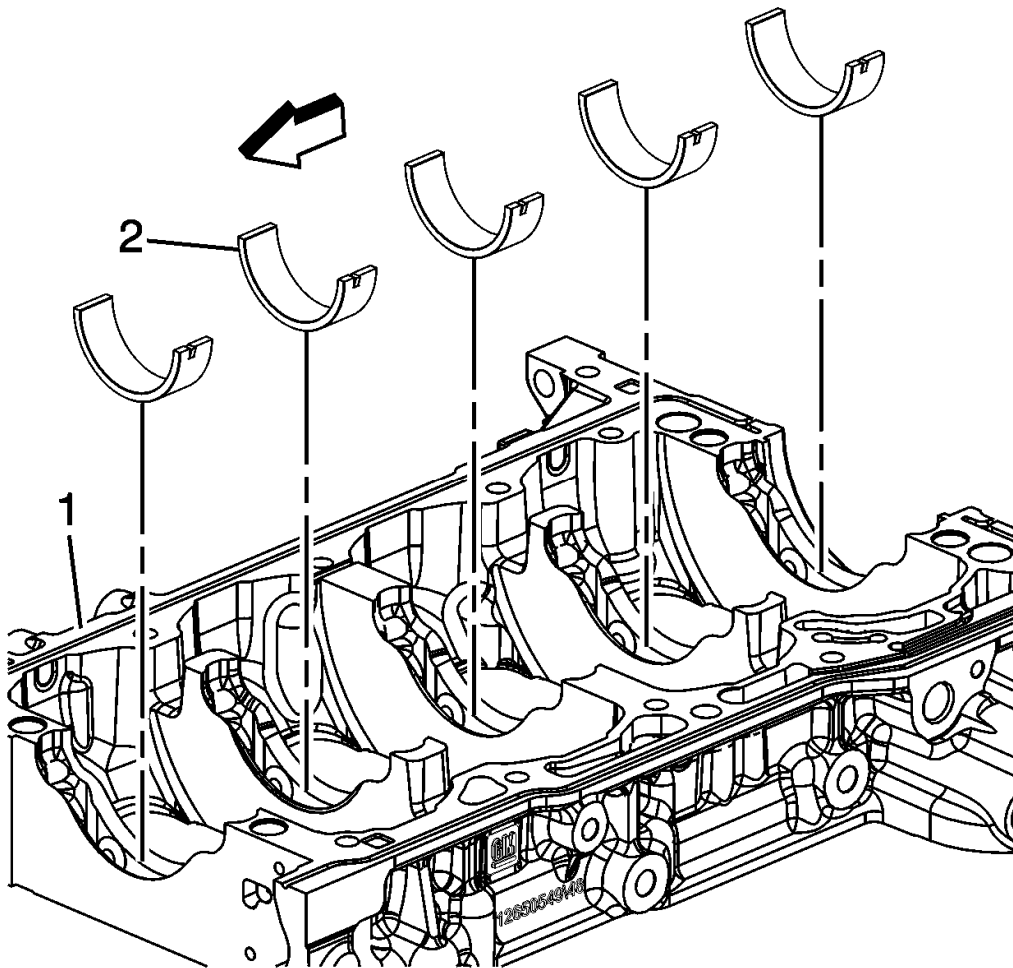


Fig. 73: Crankshaft Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft lower bearings (2) from the lower crankcase (1).
5. Clean the oil, sludge, and carbon.
6. Inspect the oil passages for obstructions.
7. Inspect the threads.
8. Inspect the bearing journals and the thrust surfaces for the following conditions:
 - Cracks
 - Chips
 - Gouges
 - Roughness
 - Grooves
 - Overheating (discoloration)
9. Inspect the corresponding bearing inserts for imbedded foreign material. If foreign material exists find the cause and repair it.

NOTE: Replace the crankshaft if cracks, severe gouges or burned spots are found. Slight roughness may be removed with a fine polishing cloth soaked in clean engine oil. Burrs may be removed with a fine oil stone.

10. Measure the crankshaft journals. Use a micrometer or dial indicator to measure the taper and runout. Note the result for the later selection of bearing inserts. If not within limits the crankshaft must be replaced.

Note the location of the main bearing high spots. If they are not in line, the crankshaft is bent and must be replaced.

ENGINE BLOCK DISASSEMBLE

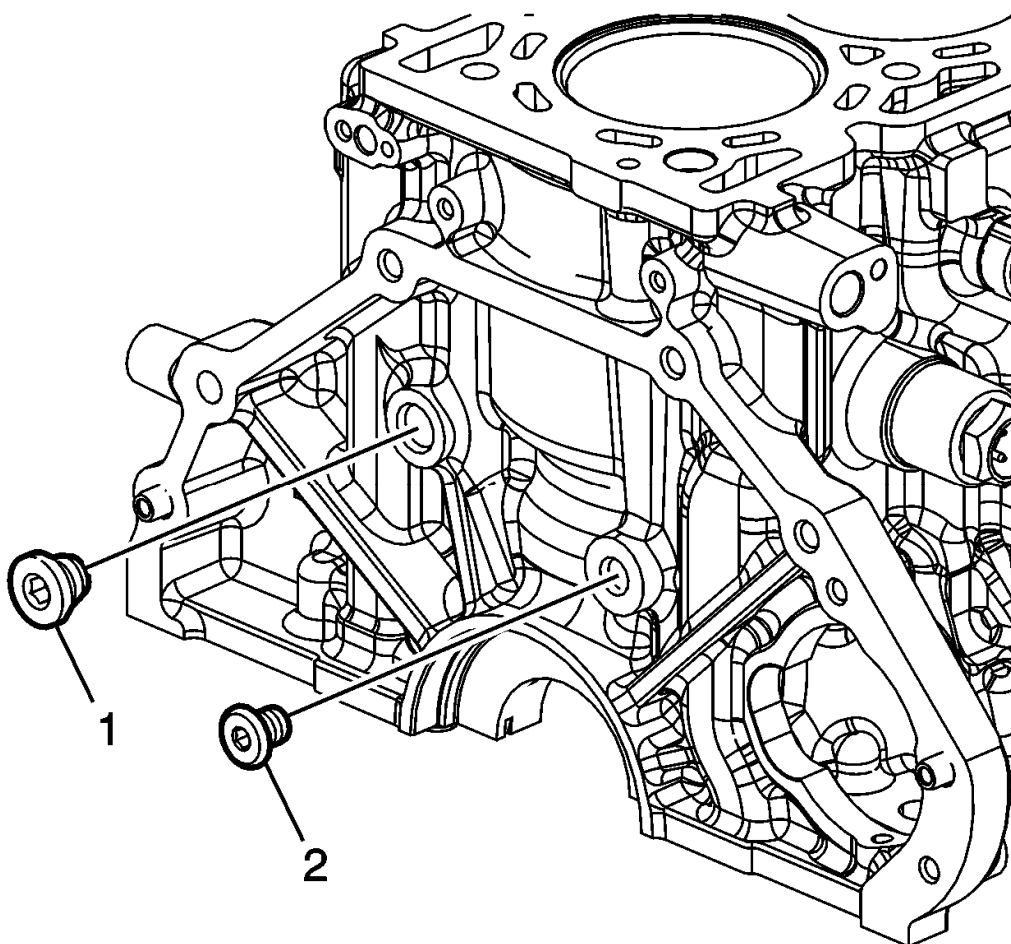


Fig. 74: Engine Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine oil gallery plugs (1, 2) from the rear of the block.

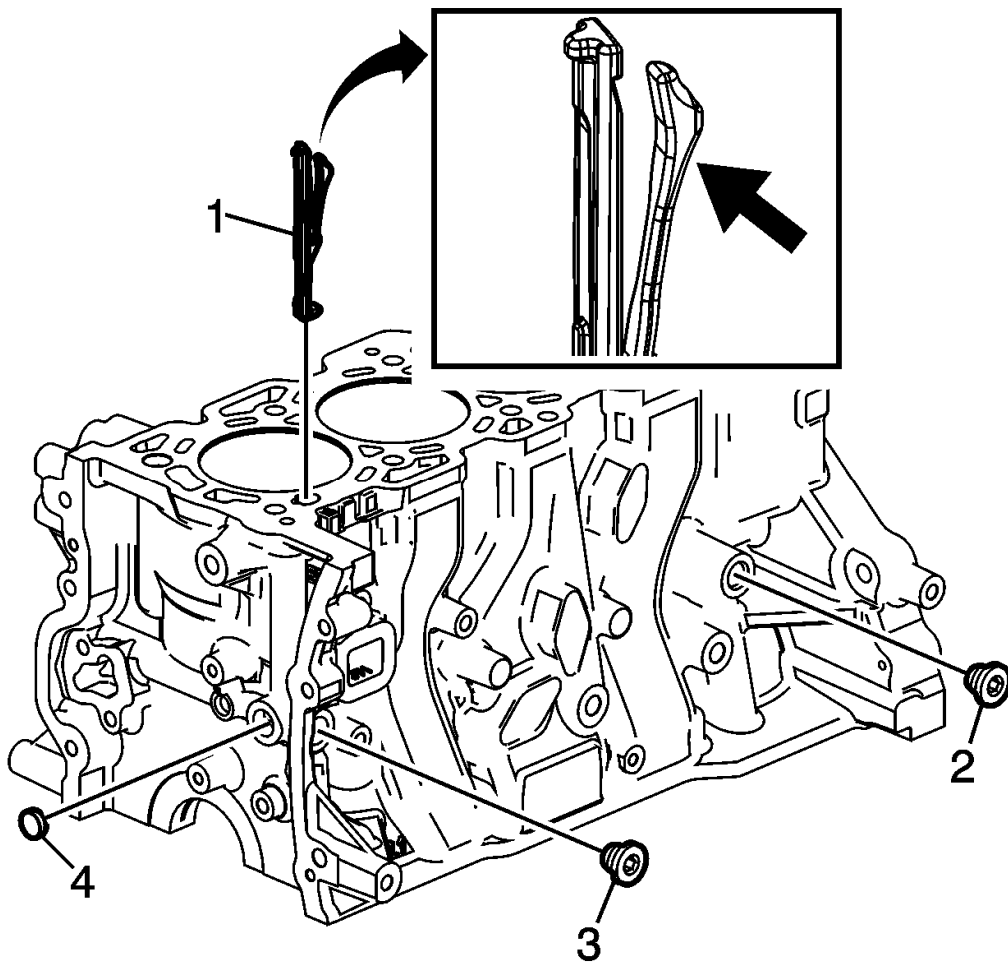


Fig. 75: Engine Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil gallery plugs (2, 3, 4) from the left side and front of of the block.
3. Use a suitable hook tool to catch the clip feature and gently remove the engine oil baffle (1).

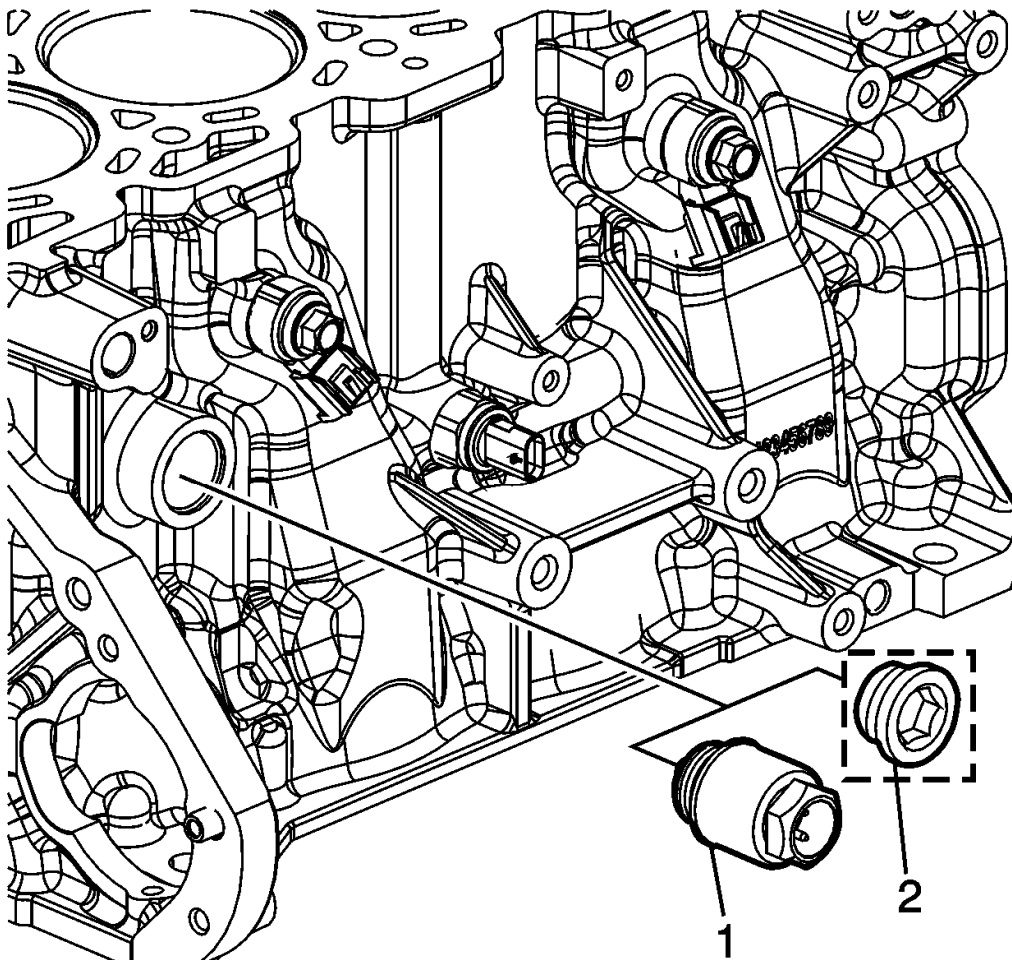


Fig. 76: Engine Coolant Heater
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine coolant heater (1), if equipped. Remove the engine coolant heater hole plug (2) if the heater is not present.

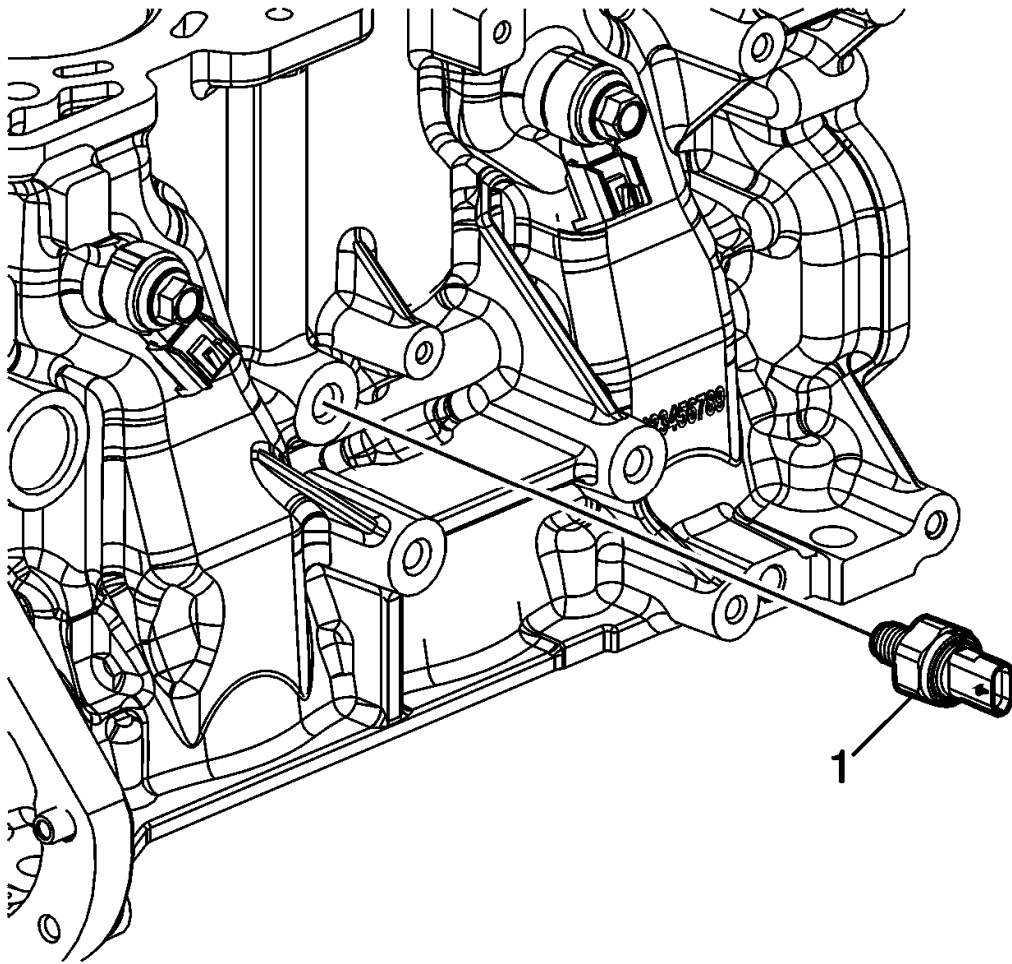


Fig. 77: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine oil pressure sensor (1).

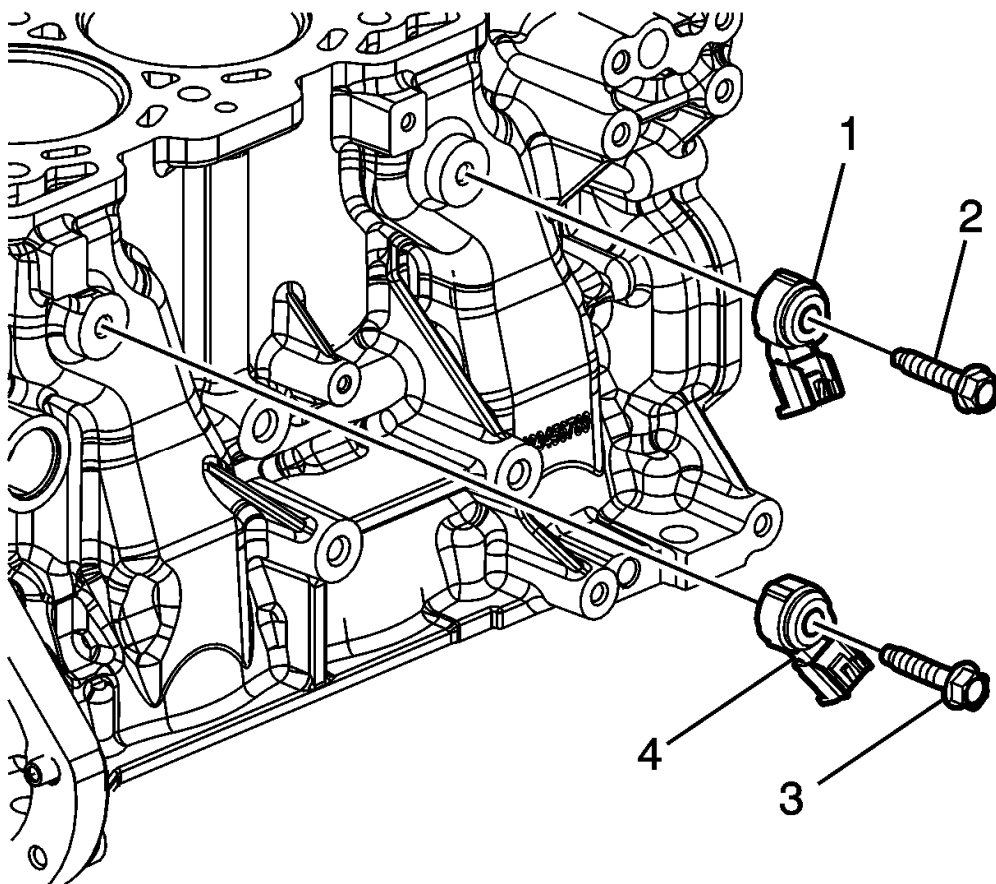


Fig. 78: Knock Sensors And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the knock sensors (1, 4) and bolts (2, 3).

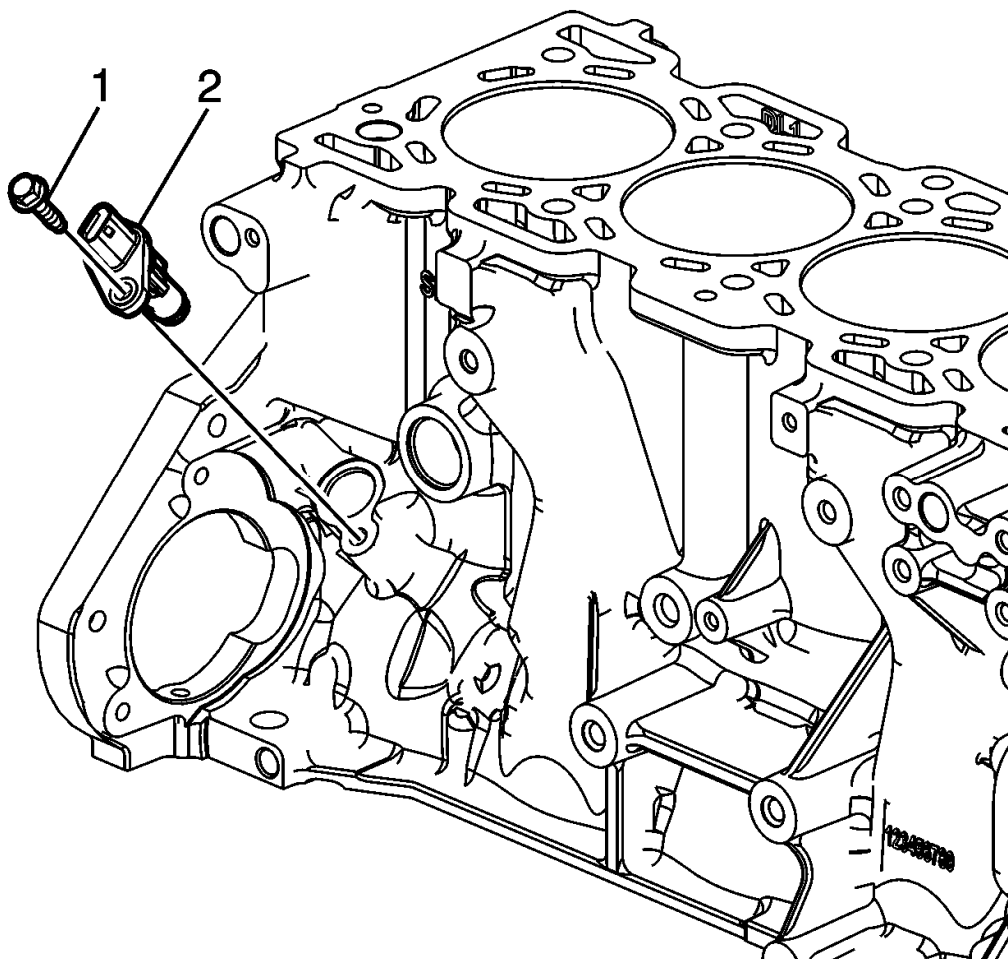


Fig. 79: Crankshaft Position (CKP) Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft position (CKP) sensor (2) and bolt (1).

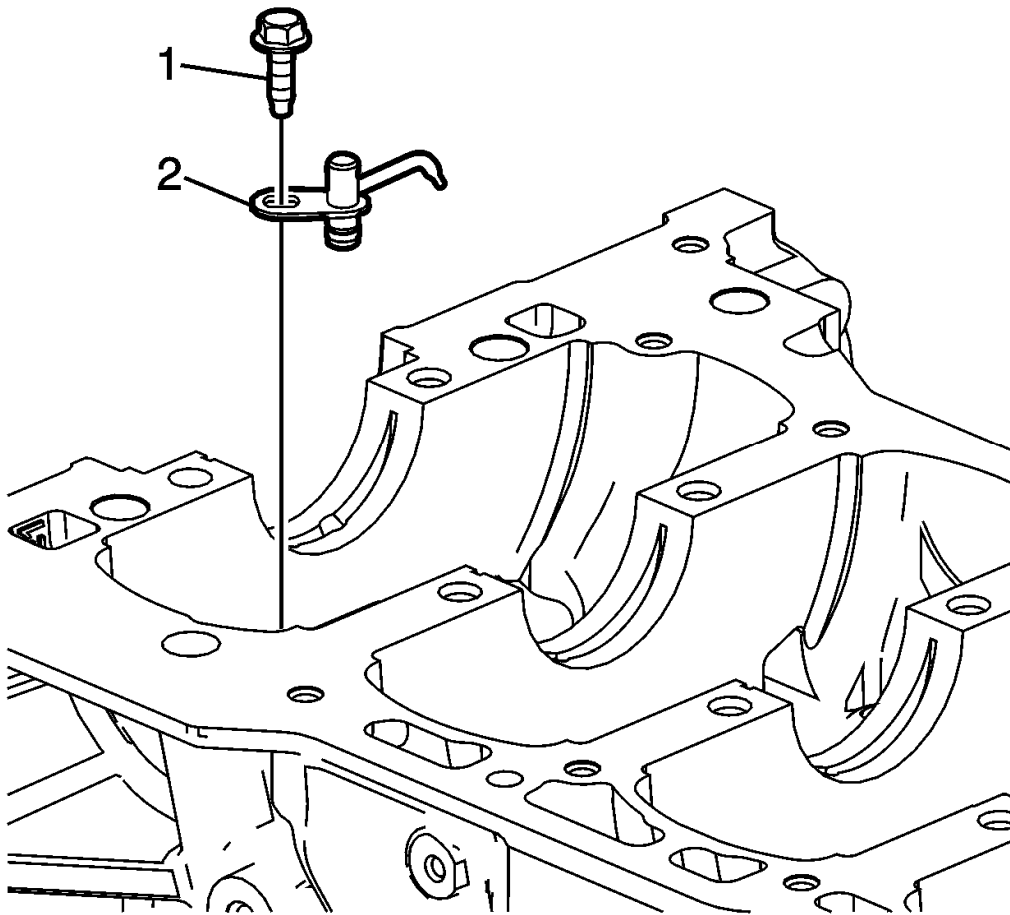


Fig. 80: Piston Oil Nozzle Assembly Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Loosen the piston oil nozzle assembly bolt (1) and remove the piston oil nozzle assembly (2).

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **EN-8087** Cylinder Bore Gauge
- **GE-7872** Magnetic Base Dial Indicator

For equivalent regional tools, refer to **Special Tools** .

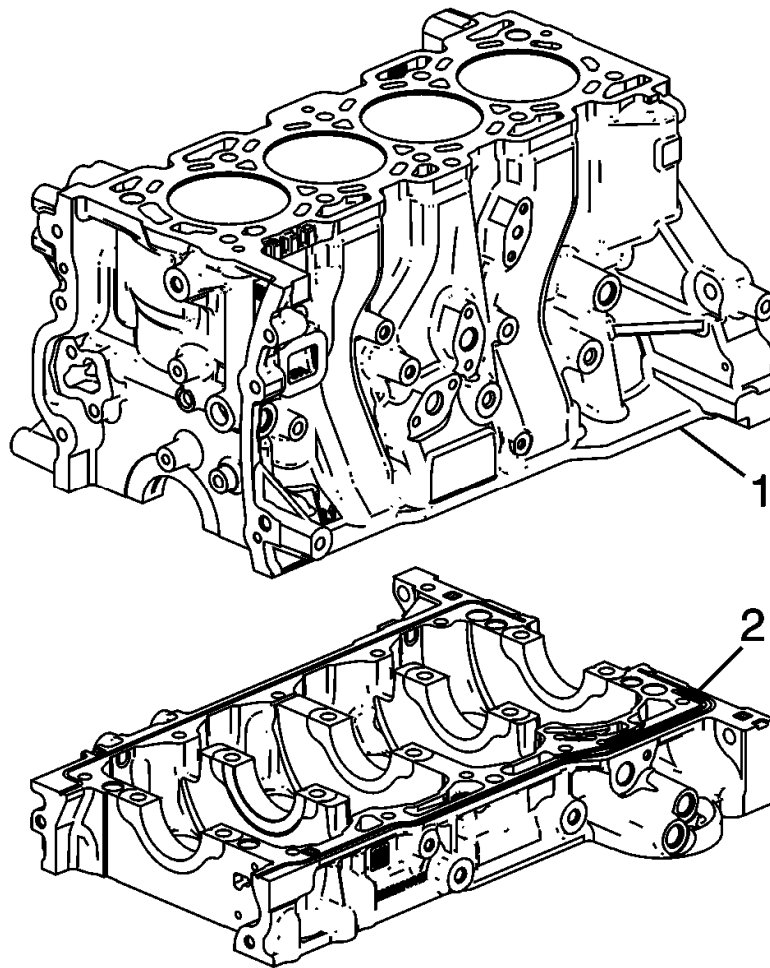


Fig. 81: Sealing Material And Engine Block
Courtesy of GENERAL MOTORS COMPANY

1. Clean the sealing material from the engine block (1) and lower crankcase (2) gasket mating surfaces with a suitable tool.
2. Clean the engine block and lower crankcase in a cleaning tank with solvent appropriate for aluminum.
3. Flush the engine block with clean water or steam.
4. Clean the oil passages.
5. Clean the blind holes.
6. Inspect the cylinder bores for glazing. If the bore is glazed but otherwise serviceable, refer to Deglazing Procedure in **Cylinder Boring and Honing**.
7. Spray the cylinder bores and the machined surfaces with engine oil.
8. Inspect the threaded holes. Clean the threaded holes with a rifle brush. If necessary, drill out the holes and install thread inserts. Refer to **Thread Repair**.

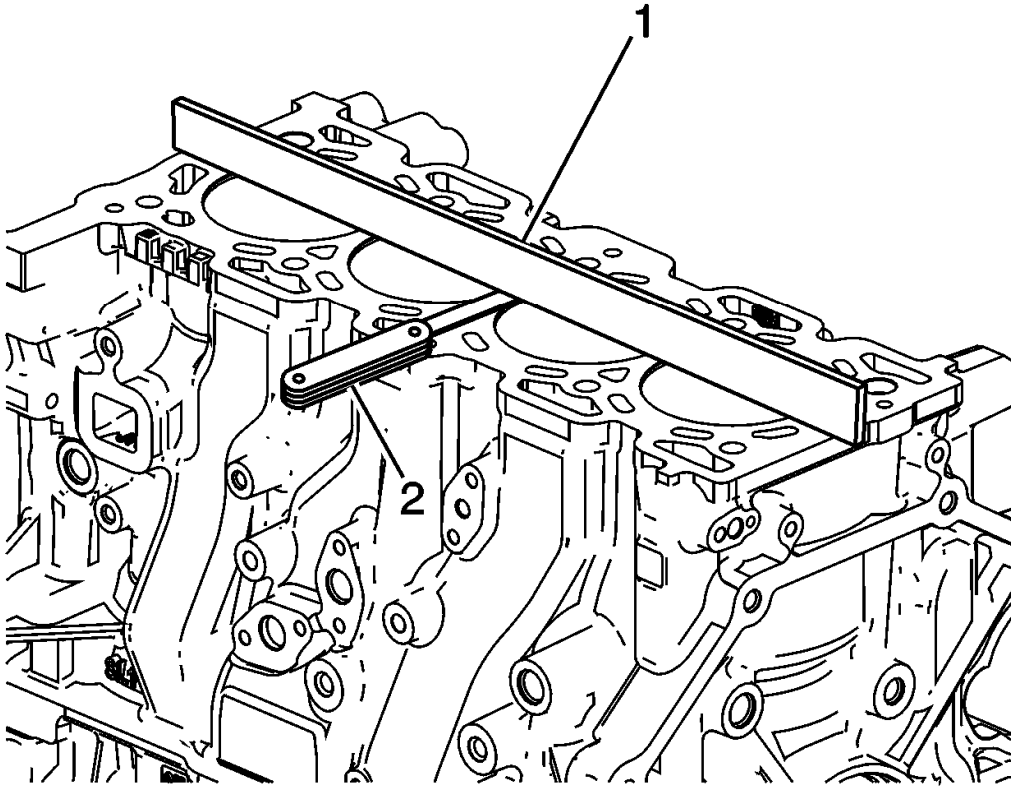


Fig. 82: Using Straight Edge
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not attempt to machine the lower crankcase to engine block surfaces.**

9. Use a straight edge (1) and a feeler gauge (2) to check the deck surface for flatness. Carefully machine minor irregularities. Replace the block if more than 0.254 mm (0.010 in) must be removed.
10. Inspect the oil pan rail for nicks. Inspect the front cover attaching area for nicks. Use a flat mill file to remove any nicks.

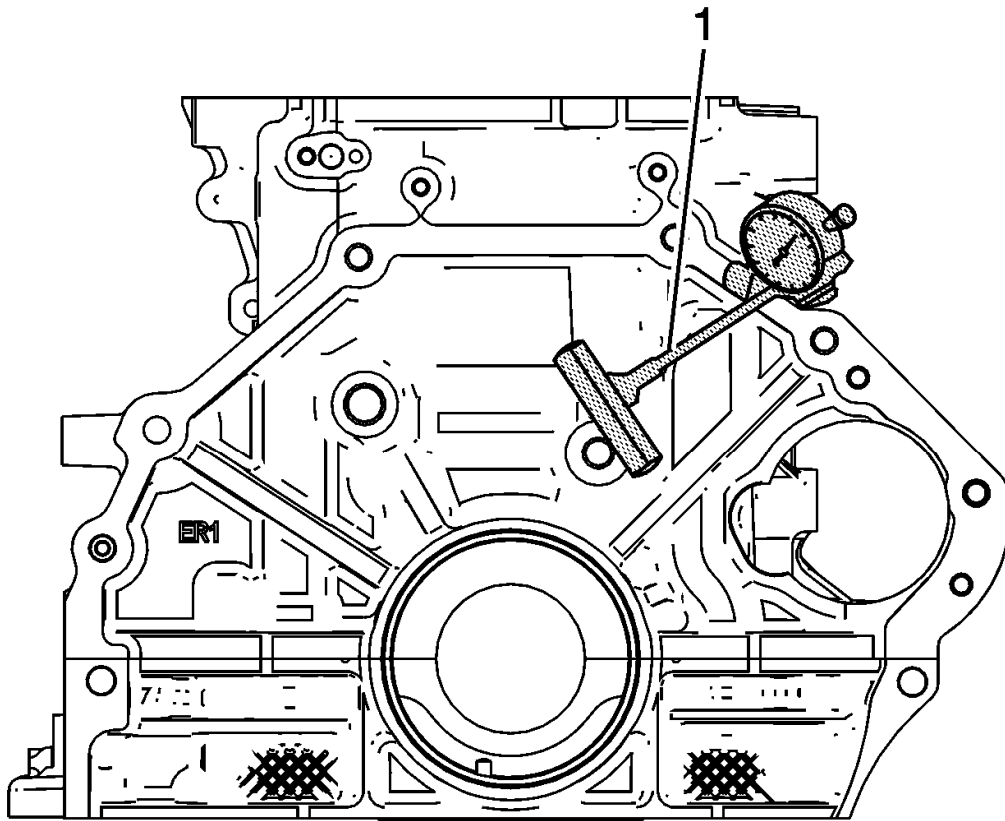


Fig. 83: Measuring Crankshaft Flange Runout Using Dial Indicator
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the mating surfaces of the transmission face.

CAUTION: A broken flywheel may result if the transmission case mating surface is not flat.

12. Use the following procedure in order to measure the engine block flange runout at the mounting bolt hole bosses:
 1. Temporarily install the crankshaft and upper bearings. Measure the crankshaft flange runout using the **GE-7872** dial indicator (1)
 2. Hold the gauge plate flat against the crankshaft flange.
 3. Place the dial indicator stem on the transmission mounting bolt hole boss. Set the indicator to 0.
 4. Record the readings obtained from all of the bolt hole bosses. The measurements should not vary more than 0.203 mm (0.008 in).
 5. Recheck the crankshaft flange runout if the readings vary more than 0.203 mm (0.008 in).

6. Remove the crankshaft and bearings.

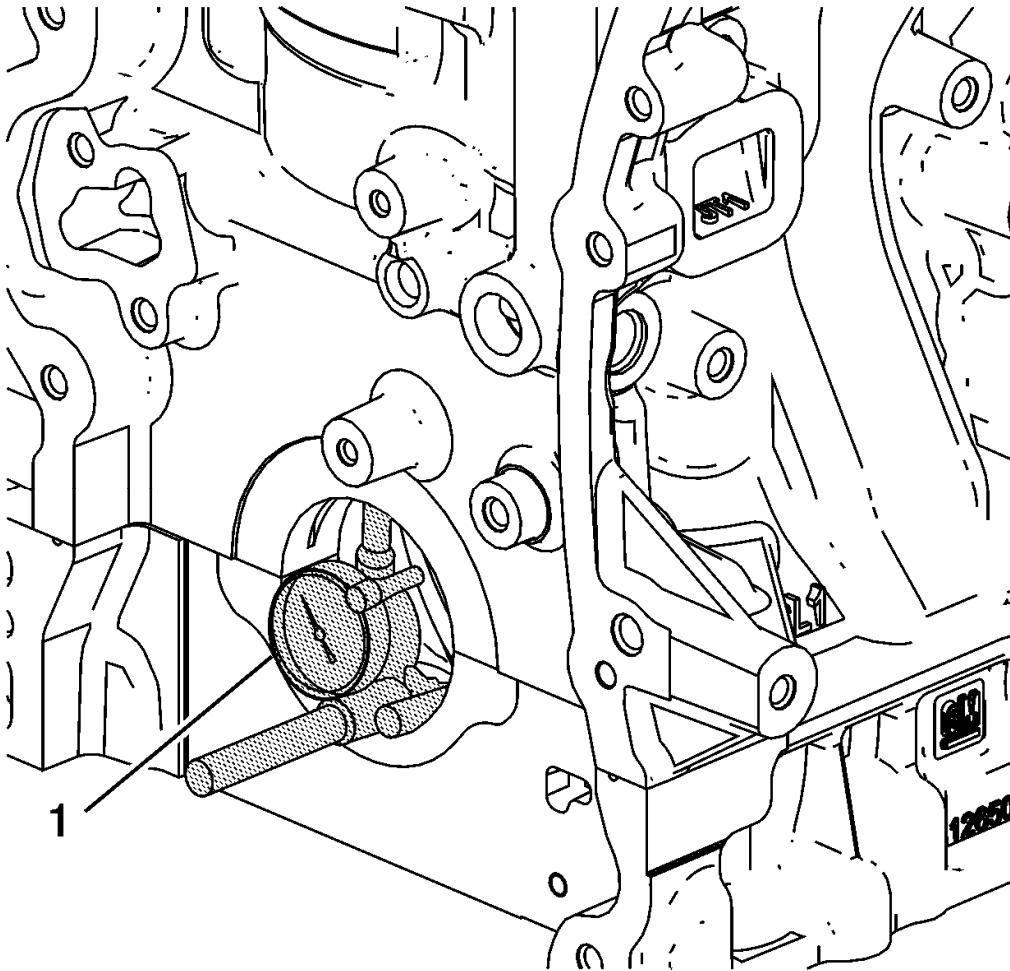


Fig. 84: Cylinder Bore Gauge
Courtesy of GENERAL MOTORS COMPANY

13. Install the bed plate and bolts. Tighten the bed plate bolts to specification.
14. Inspect the crankshaft main bearing bores. Use the **EN-8087** gauge (1) to measure the bearing bore concentricity and alignment. Refer to **Engine Mechanical Specifications** .
15. Replace the engine block and bed plate if the crankshaft bearing bores are out of specification.
16. Remove the bed plate.

Measuring Cylinder Bore Diameter

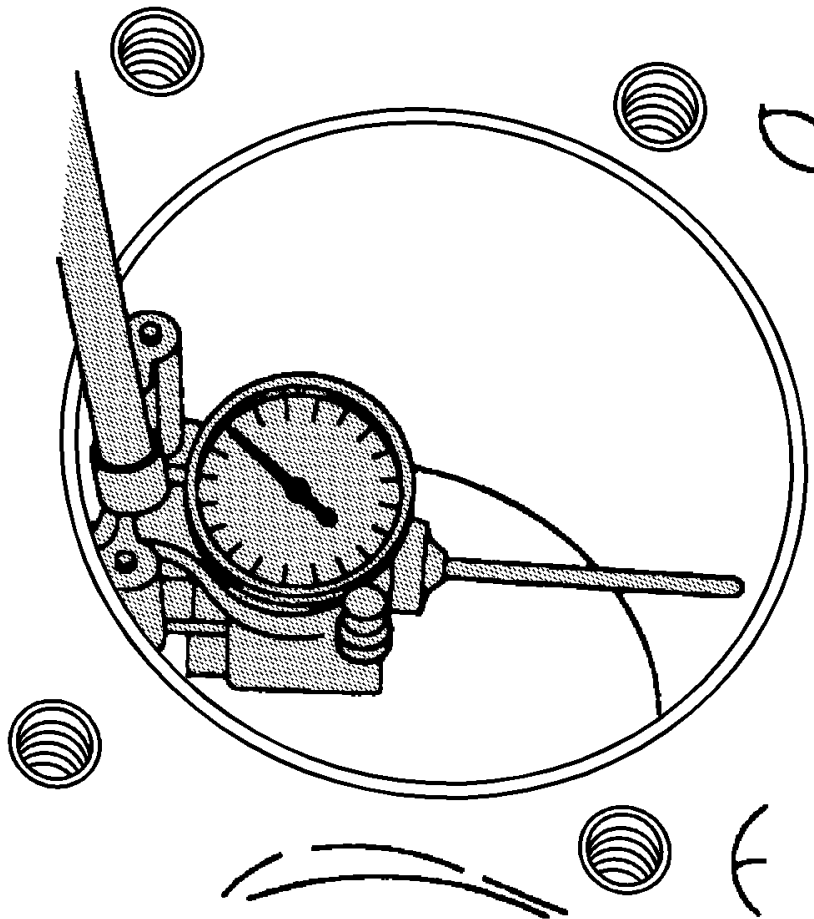


Fig. 85: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

1. Measure the cylinder bore diameter 35 mm (1.378 in) from the deck face using the **EN-8087** gauge.
2. Compare your results with the **Engine Mechanical Specifications** , . If the cylinder diameter exceeds the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service. Refer to **Cylinder Boring and Honing**.

Measuring Cylinder Bore Taper

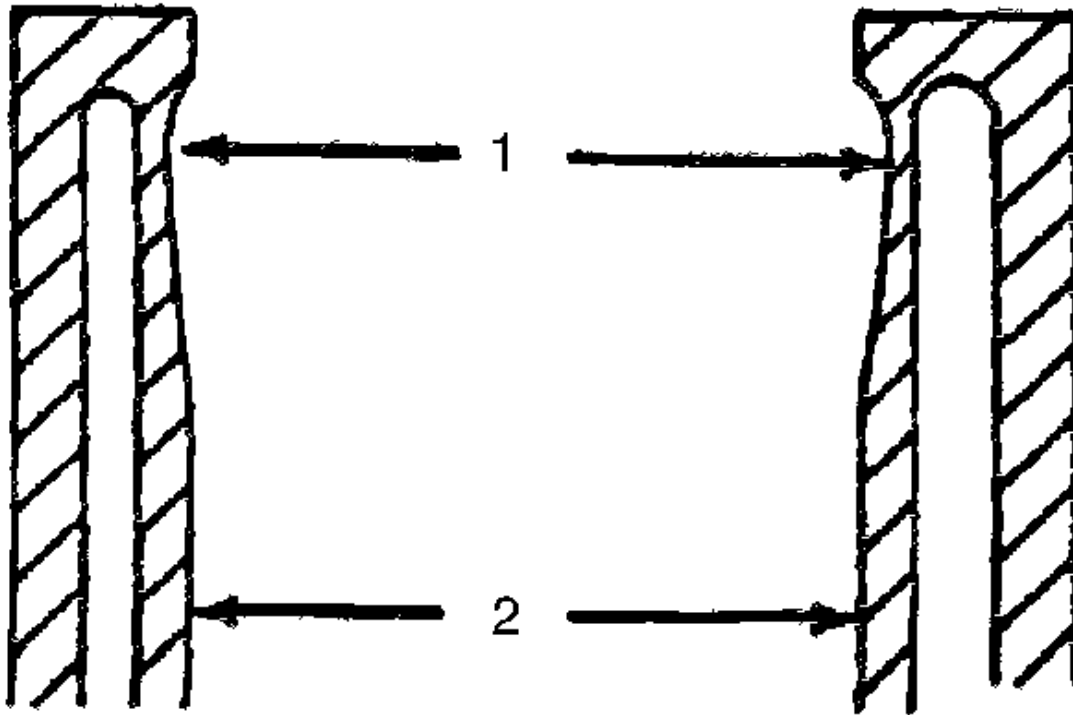


Fig. 86: Measuring Head Gasket Dimensions
Courtesy of GENERAL MOTORS COMPANY

1. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 10 mm (0.394 in) below the deck surface (1) and record your measurement.
2. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 125 mm (4.921 in) below the deck surface (2) and record your measurement.
3. Calculate the difference between the 2 measurements. The result will be the cylinder taper.
4. Compare your results with the **Engine Mechanical Specifications** , . If the cylinders exceed the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service. Refer to **Cylinder Boring and Honing**.

Measuring Cylinder Bore Out-of-Round

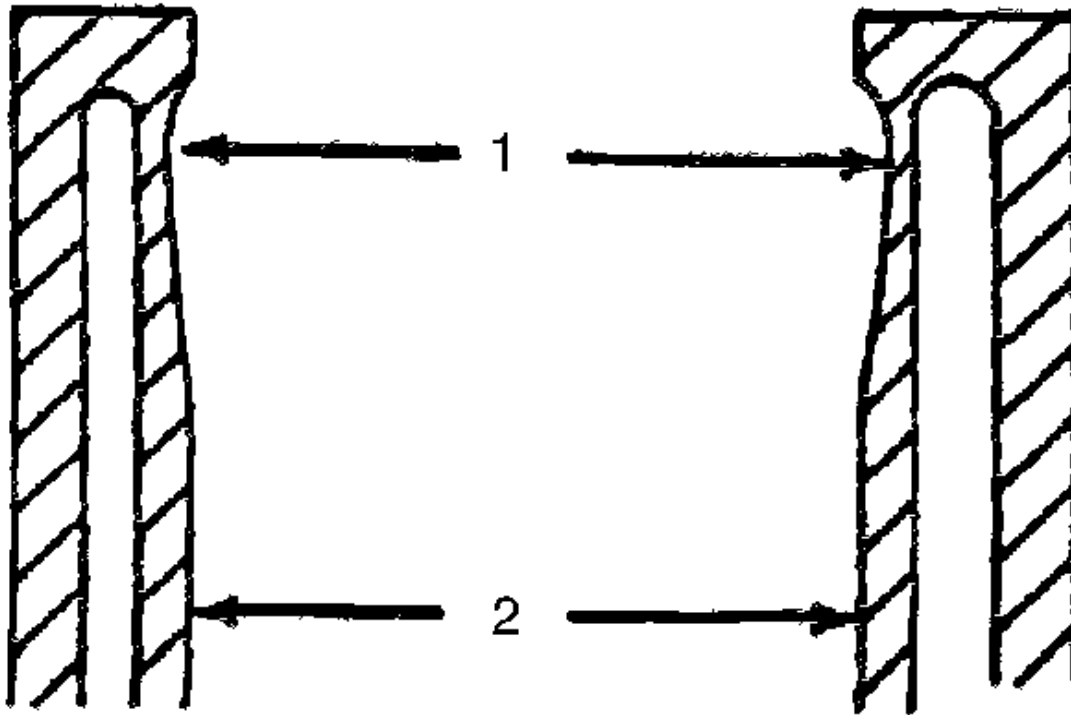


Fig. 87: Measuring Head Gasket Dimensions
Courtesy of GENERAL MOTORS COMPANY

1. Measure both the thrust and non-thrust cylinder diameter at 10 mm (0.394 in) below the deck surface (1). Record your measurements.
2. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the upper end of the cylinder.
3. Measure both the thrust and non-thrust cylinder diameter at 125 mm (4.921 in) below the deck surface (2). Record your measurements.
4. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the lower end of the cylinder.
5. Compare your results with the **Engine Mechanical Specifications** , . If the cylinders exceed these specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service. Refer to **Cylinder Boring and Honing**.

CYLINDER BORING AND HONING

Boring Procedure

1. Measure all pistons with a micrometer to determine the cylinder bore diameter. Refer to **Engine Block Cleaning and Inspection**.
2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block, removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned or tilted and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.
4. When you bore the cylinders, ensure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.
5. When you take the final cut with a boring bar, leave 0.075 mm (0.003 in) on the cylinder bore diameter for the finish honing and fit of the piston.

Honing Procedure

NOTE: **Fine vertical scratches made by the ring ends do not, by themselves, cause excessive oil consumption. Do not hone the cylinder in order to remove these scratches.**

1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.

NOTE: **All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.**

2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.
3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100-grit stone.

NOTE: **A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.**

4. Perform final cylinder honing with a 240-grit stone and obtain a 45 degree cross hatch pattern.
5. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
6. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.
7. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not

allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.

8. Perform final measurements of the piston and the cylinder bore.
9. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
10. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure

1. If the bore is glazed but otherwise serviceable, lightly break the glaze with a hone. Replace the piston rings. Refer to **Piston, Connecting Rod, and Bearing Installation**.

NOTE: **A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.**

2. Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240-grit stone of silicone carbide, or equivalent, material when performing the deglazing procedure.
 1. The honing stones must be clean, sharp, and straight.
 2. Move the hone slowly up and down to produce a 45 degree cross-hatch pattern.
 3. Clean the bore thoroughly with soap and water.
 4. Dry the bore.
 5. Rub clean engine oil in the bore.
 6. Re-measure the bore.
3. If the cylinder bore is out of specification, the cylinder bore may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.
4. If honing is not required, clean the cylinder bores with hot water and detergent. Apply clean engine oil to the bore after washing and drying the bore.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

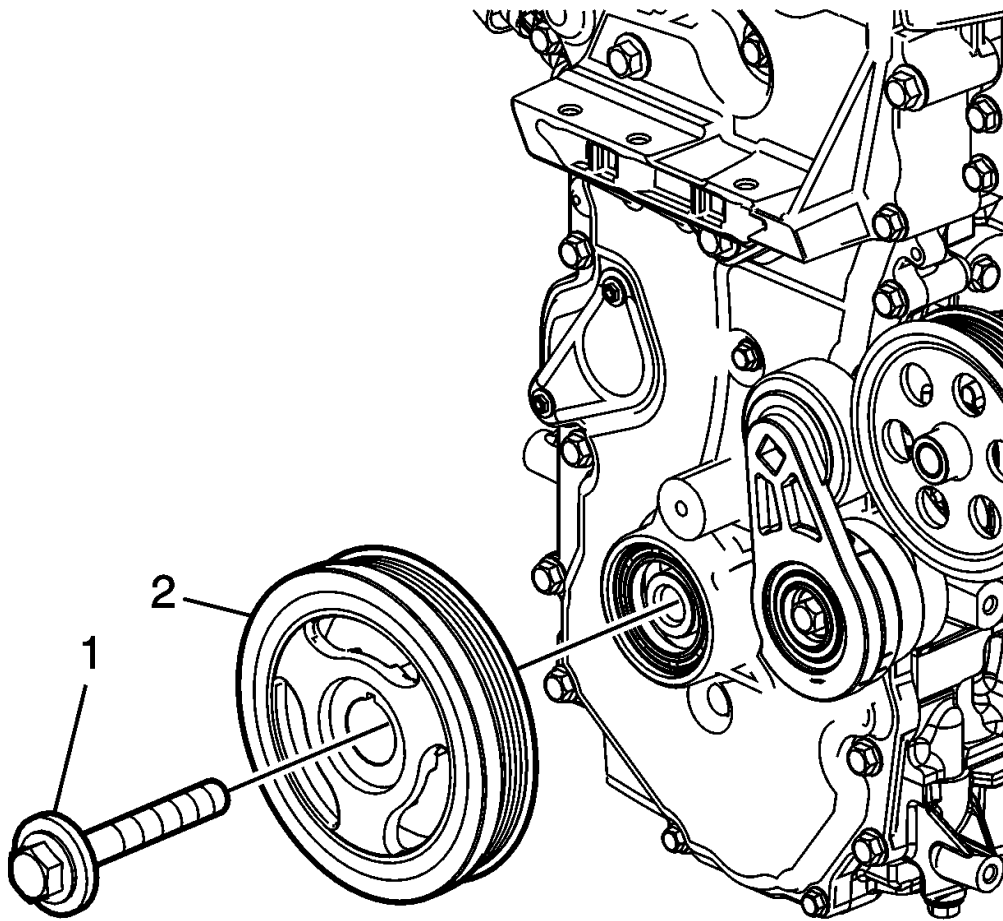


Fig. 88: Crankshaft Balancer

Courtesy of GENERAL MOTORS COMPANY

1. Clean the crankshaft balancer (2).
2. Clean the belt grooves of all dirt or debris with a wire brush.

WARNING: Refer to Safety Glasses Warning .

3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following:
 - Worn, grooved, or damaged hub seal surface.
 - A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

NOTE: In order for the belt to track properly, the belt grooves should be free of all dirt or debris.

- Dirty or damaged belt grooves

The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.

- Minor imperfections may be removed with a fine file.
- Worn, chunking or deteriorated rubber between the hub and pulley.

AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION

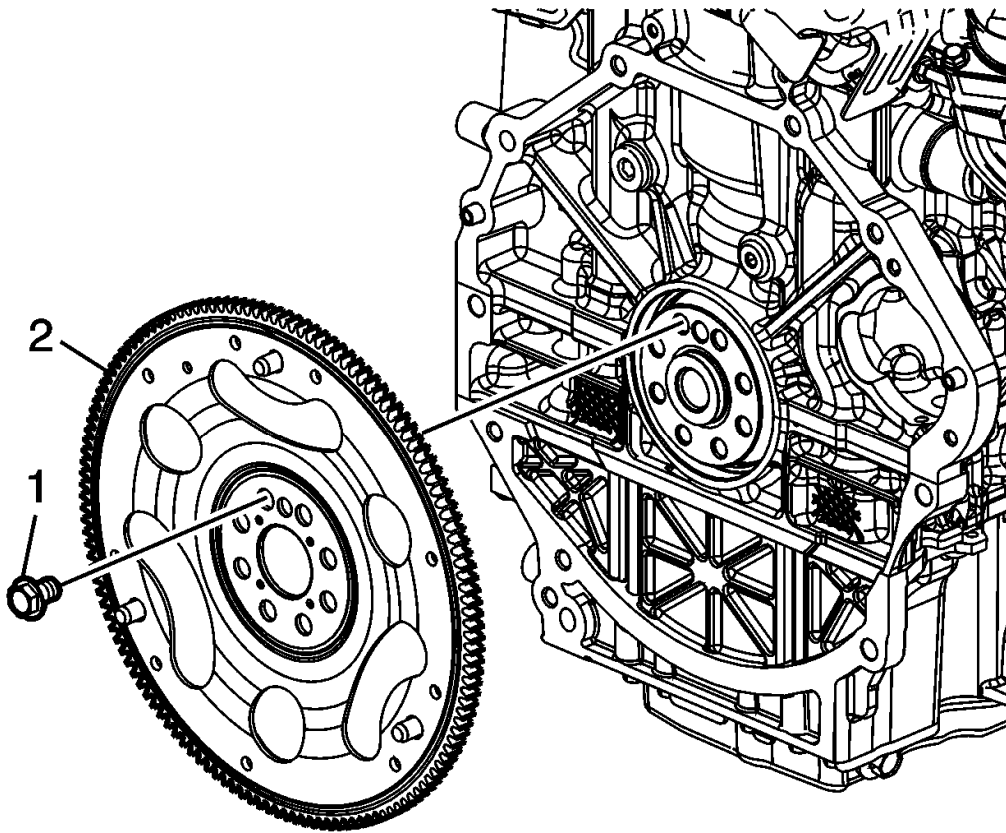


Fig. 89: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Clean the flywheel (2) in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the flywheel with compressed air.
3. Inspect the flywheel for the following:
 - Damaged ring gear teeth.
 - Stress cracks around the flywheel-to-crankshaft bolt hole locations.
 - Weight saving holes.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

GE-7872 Magnetic Base Dial Indicator Set

For equivalent regional tools, refer to **Special Tools** .

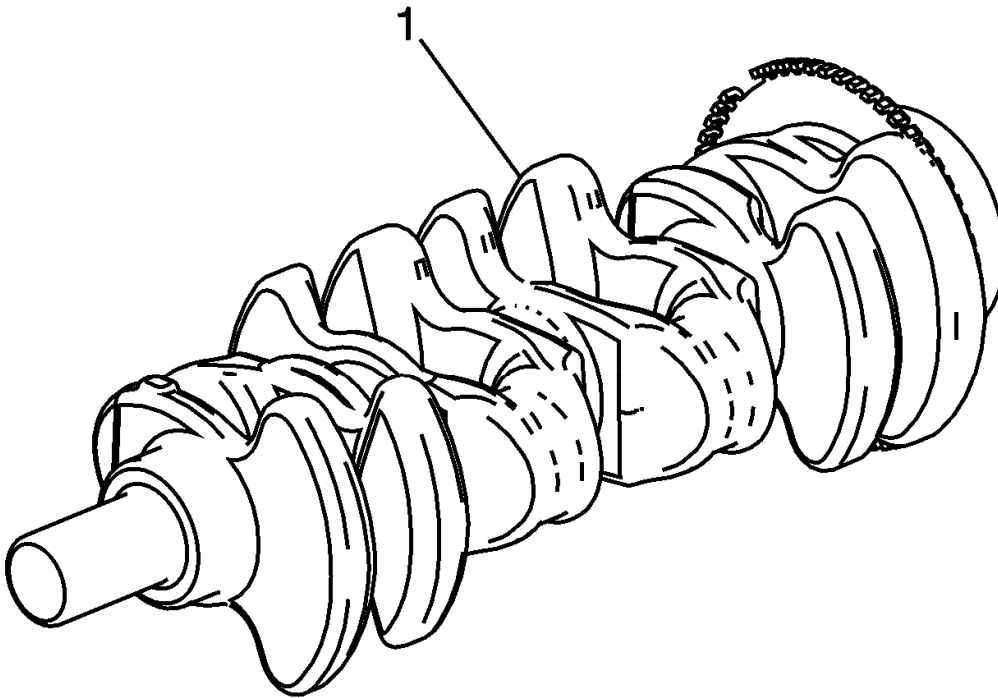


Fig. 90: Measuring Bearing Clearance Using Method A
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position reluctor ring. Damage to the teeth of the crankshaft position reluctor ring may affect on-board diagnostic (OBD) II system performance.

1. Clean the crankshaft (1) with solvent.
2. Thoroughly clean all oil passages and inspect for restrictions or burrs.

WARNING: Refer to Safety Glasses Warning .

3. Dry the crankshaft with compressed air.

NOTE: Reluctor ring teeth should not have imperfections on the rising or falling edges.

Imperfections of the reluctor ring teeth may effect OBD II system performance.

4. Perform a visual inspection of the crankshaft for damage.
5. Inspect the crankshaft journals for wear. The journals should be smooth, with no signs of scoring, wear, or damage.
6. Inspect the crankshaft journals for grooves or scoring.
7. Inspect the crankshaft journals for scratches or wear.
8. Inspect the crankshaft journals for pitting or imbedded bearing material.
9. Measure the crankshaft journals for out-of-round.
10. Measure the crankshaft journals for taper.

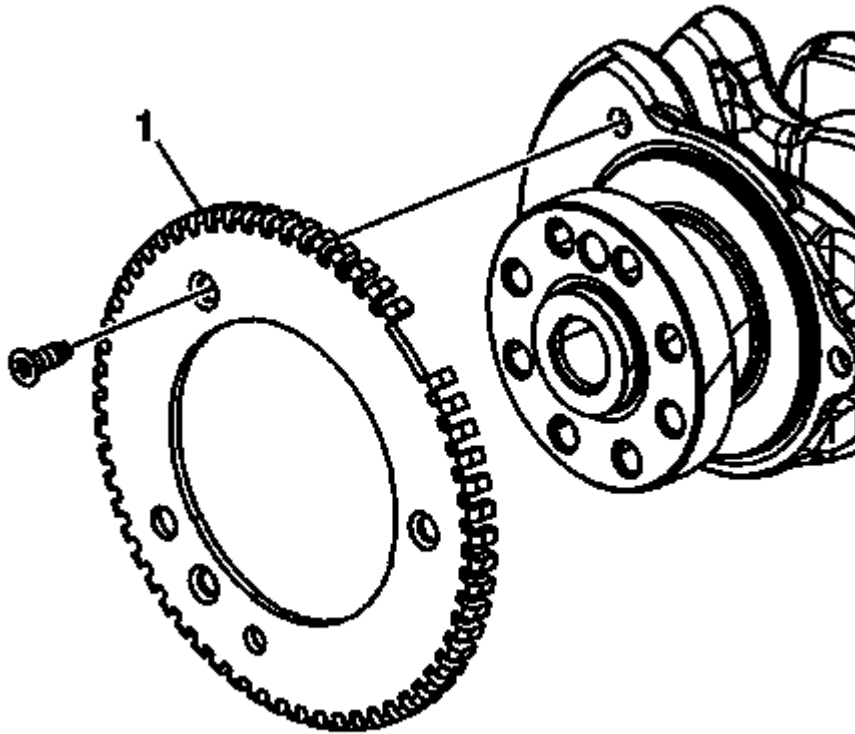


Fig. 91: Crankshaft Position Reluctor Ring
Courtesy of GENERAL MOTORS COMPANY

11. The crankshaft position reluctor ring (1) may be replaced if damaged. Tighten the crankshaft position reluctor ring bolts to 15 N.m (11 lb ft).

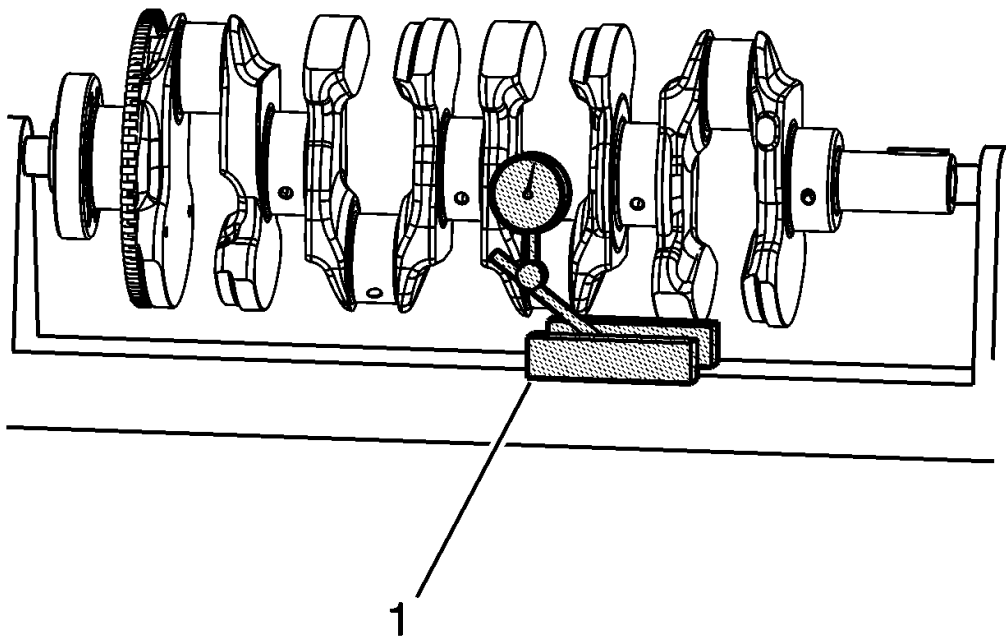


Fig. 92: Magnetic Base Dial Indicator Set
Courtesy of GENERAL MOTORS COMPANY

12. Measure the crankshaft runout.

Using wooden V-blocks, support the crankshaft on the front and rear journals.

13. Use the **GE-7872** indicator (1) in order to measure the crankshaft runout at the front and rear intermediate journals.
14. Use the **GE-7872** indicator in order to measure the runout of the crankshaft rear flange.
15. Replace the crankshaft if the measurements are not within specifications.

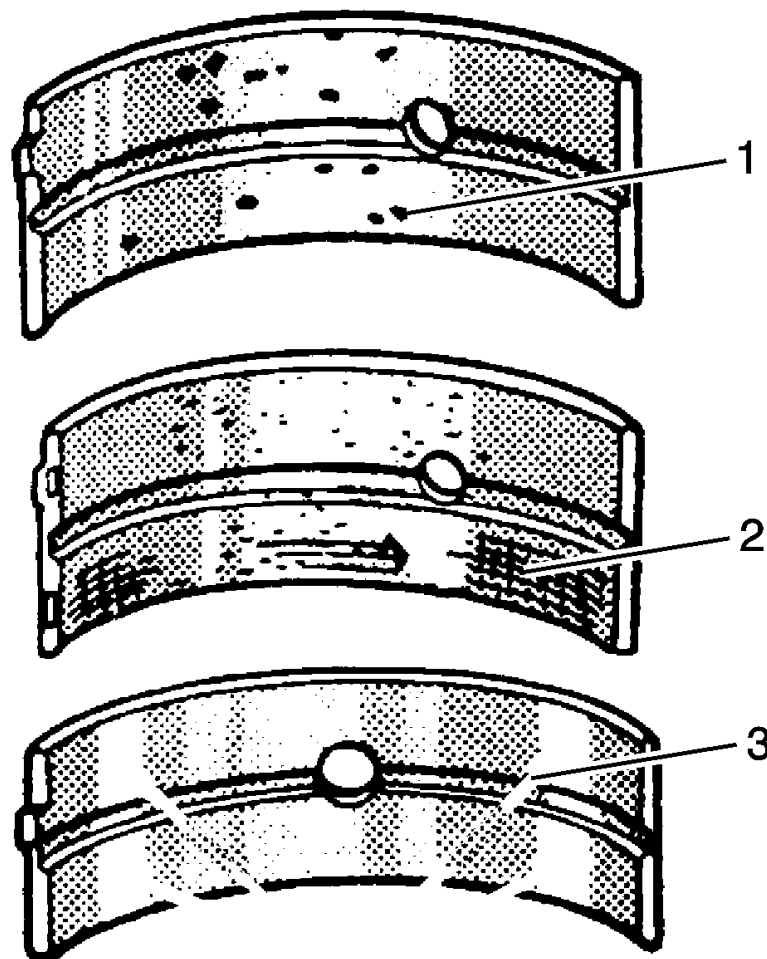


Fig. 93: Identifying Crankshaft Bearings For Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

NOTE: Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.

16. Inspect crankshaft bearings for craters or pockets (1). Flattened sections on the bearing halves also indicate fatigue.
17. Inspect the crankshaft bearings for excessive scoring or discoloration (2).
18. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.
19. Inspect the crankshaft bearings for improper seating indicated by bright, polished sections of the bearing (3).

If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

PISTON AND CONNECTING ROD DISASSEMBLE

Special Tools

- **EN-46745** Piston Pin Clip Remover/Installer
- **EN-46745-4** Piston Pin Clip Remover/Installer Adapter

For equivalent regional tools, refer to **Special Tools** .

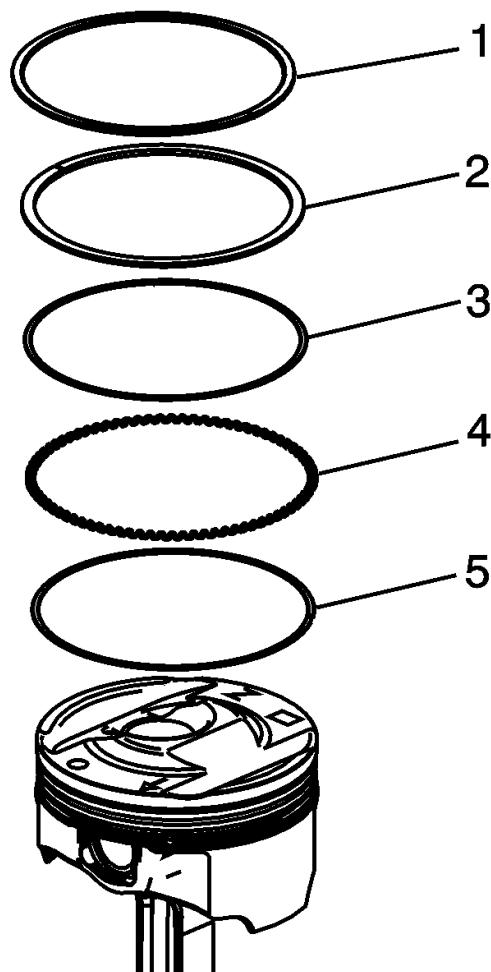


Fig. 94: Piston Rings

Courtesy of GENERAL MOTORS COMPANY

WARNING: Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.

1. Disassemble the piston rings (1, 2, 3, 4, 5). Use a suitable tool to expand the rings. The piston rings must not be reused.

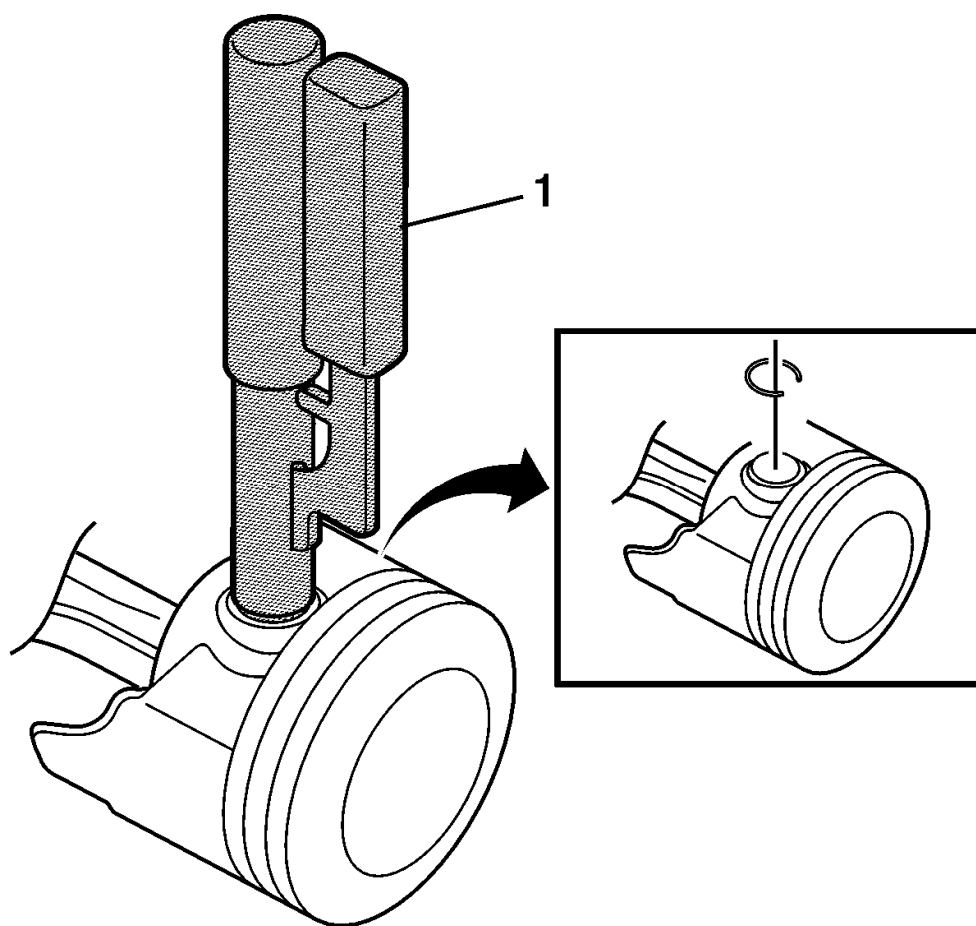


Fig. 95: View of Piston Pin Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Two retainers hold the piston pins in place. No special tools are required to remove the piston pins. Ensure that the piston pin is not damaged. Do not reuse the retainers.

2. Remove the piston pin retainers using the **EN-46745** remover (1) and **EN-46745-4** adapter.

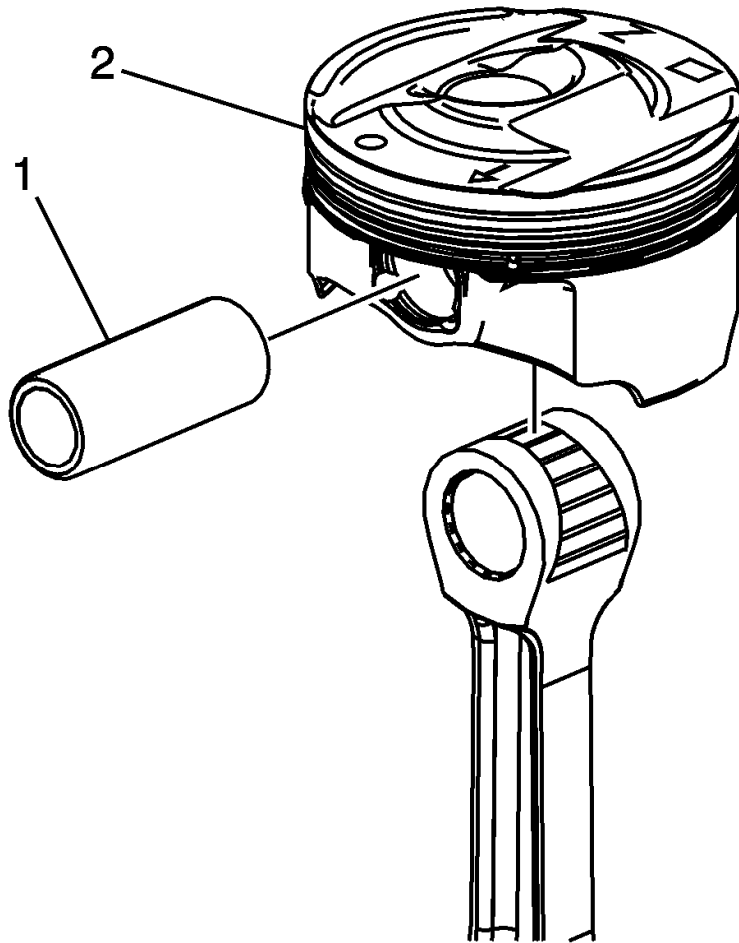


Fig. 96: Piston Pin And Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

3. Remove the piston pin (1) and the connecting rod (3) from the piston (2).

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

Connecting Rod Measurement

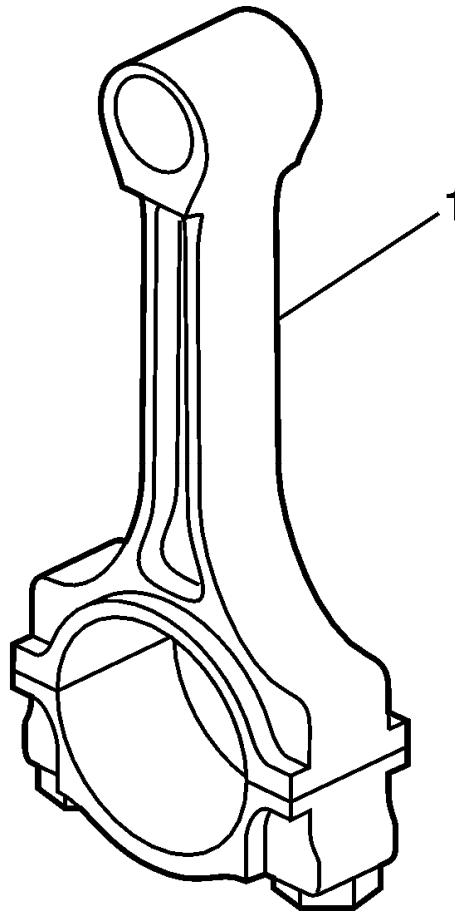


Fig. 97: Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

1. Clean the connecting rods (1) in solvent and dry with compressed air.
2. Inspect the connecting rods for the following:
 - Signs of being twisted, bent, nicked, or cracked
 - Scratches or abrasion on the rod bearing seating surface
3. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper. DO NOT scrape the rod or rod cap.
4. If the beam of the rod is scratched or has other damage replace the connecting rod.
5. Measure the piston pin to connecting rod bore using the following procedure:
 1. Using an outside micrometer, take two measurements of the piston pin in the area of the connecting rod contact.
 2. Using an inside micrometer, measure the connecting rod piston pin bore.
 3. Subtract the piston pin diameter from the piston pin bore diameter.
 4. The clearance should not be more than 0.021 mm (0.0008 in).

6. If there is excessive clearance, replace the piston pin.
7. If there is still excessive clearance, replace the connecting rod.

Piston Measurement

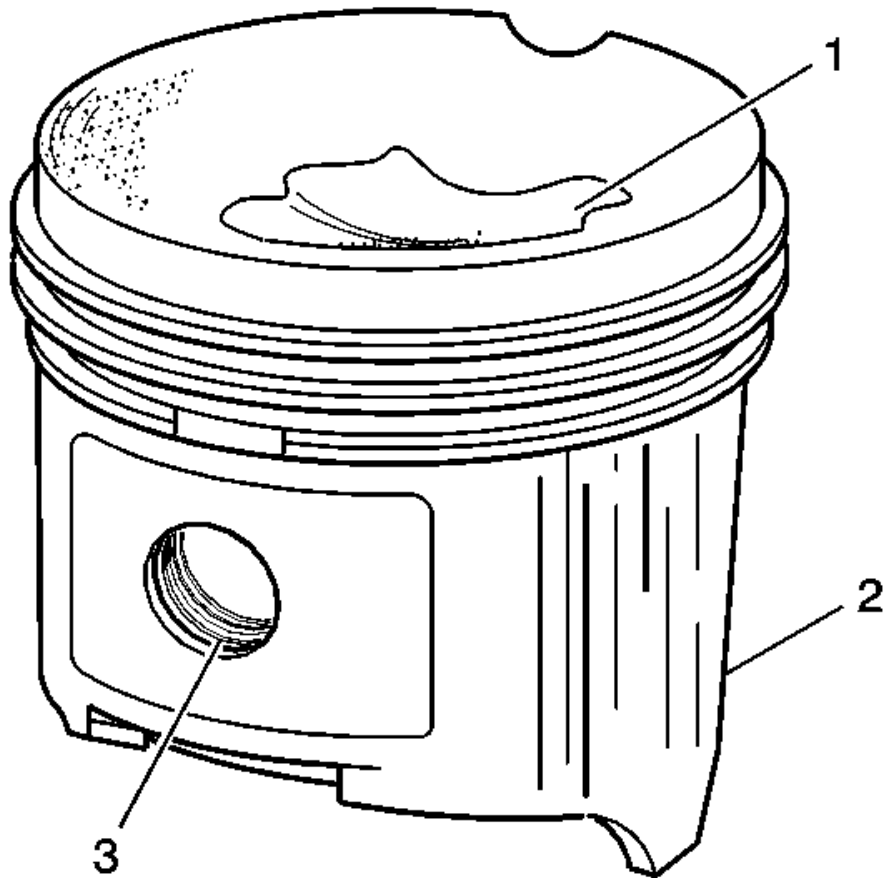


Fig. 98: Identifying Piston Damage Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Clean the piston skirts and the pins with a cleaning solvent. DO NOT wire brush any part of the piston.
2. Clean the piston ring grooves with a groove cleaner. Make sure oil ring holes and slots are clean.
3. Inspect the pistons for the following conditions:
 - Cracked ring lands, skirts, or pin bosses
 - Ring grooves for nicks, burrs that may cause binding
 - Warped or worn ring lands
 - Eroded areas at the top of the piston (1)
 - Scuffed or damaged skirts (2)

- Worn piston pin bores (3)
4. Replace pistons that show any signs or damage or excessive wear.
 5. Measure the piston pin bore to piston pin clearances using the following procedure:
 1. Piston pin bores and pins must be free of varnish or scuffing.
 2. Use an outside micrometer to measure the piston pin in the piston contact areas.
 3. Using an inside micrometer, measure the piston pin bore.
 4. Subtract the measurement of the piston pin bore from the piston pin. The clearance should be within 0.002-0.012 mm (0.00007-0.00047 in).
 5. If the clearance is excessive, determine which component is out of specification.

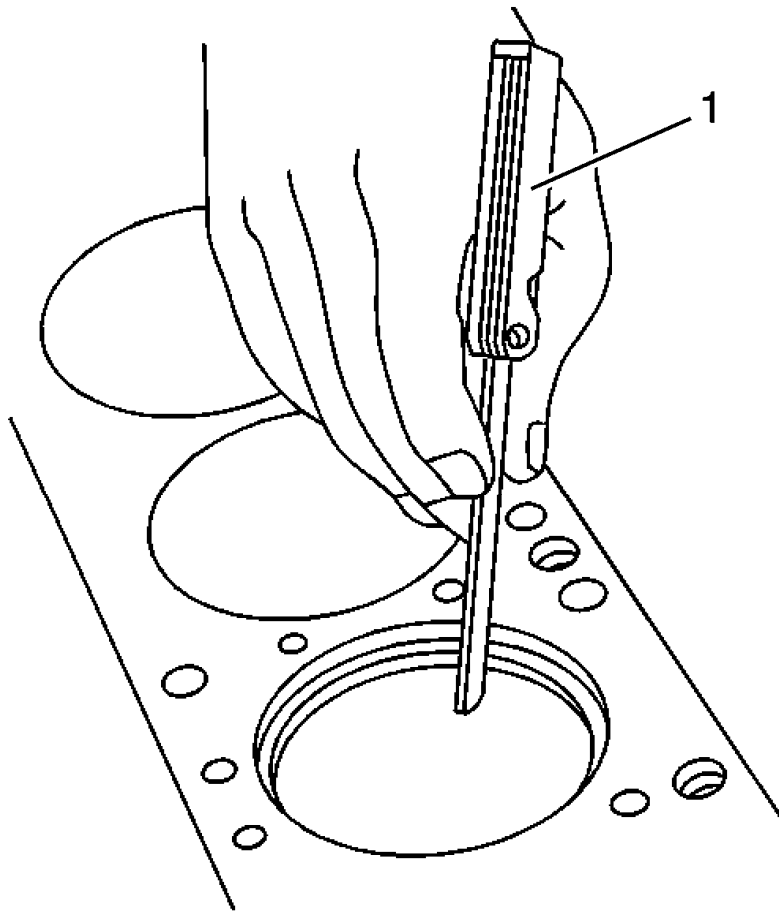


Fig. 99: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS COMPANY

6. Measure the piston ring end gap using the following procedure:
 1. Place the piston ring in the area of the bore where the piston ring will travel (approximately 25 mm or 1 inch down from the deck surface). Be sure the ring is square with the cylinder bore by

positioning the ring with the piston head.

2. Measure the end gap of the piston ring with feeler gauges (1). Compare the measurements with those provided below:
 - The top compression ring end gap should be 0.20-0.40 mm (0.0060-0.015 in).
 - The second compression ring end gap should be 0.35-0.55 mm (0.0137-0.0216 in).
 - The oil ring end gap should be 0.25-0.76 mm (0.0098-0.029 in).
3. If the clearance exceeds the provided specifications, the piston rings must be replaced.
4. Repeat the procedure for all the piston rings.

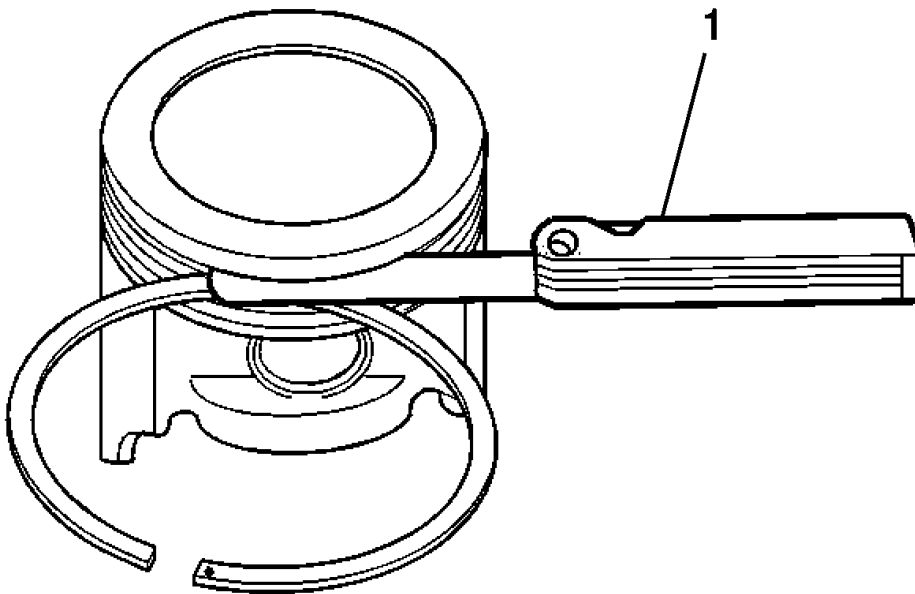


Fig. 100: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS COMPANY

7. Measure the piston ring side clearance using the following procedure:
 1. Roll the piston ring entirely around the piston ring groove. If any binding is caused by a distorted piston ring, replace the ring.
 2. With the piston ring on the piston, use feeler gauges (1) to check clearance at multiple locations.

3. The clearance between the surface of the top piston ring and the ring land should be no greater than 0.075 mm (0.0030 in).
4. If the clearance is greater than specifications, replace the piston ring.
5. If the new ring does not reduce the top ring side clearance to 0.075 mm (0.0030 in) or less, install a new piston.
8. The top compression ring may be installed with either side up. There is a locating dimple on the 2nd compression ring near the end for identification of the top side. Install the 2nd compression ring with the dimple facing up.
9. The clearance between the surface of the second piston ring and the ring land should be no greater than 0.069 mm (0.0026 in).
10. If the new ring does not reduce the clearance to 0.069 mm (0.0026 in) or less, install a new piston.

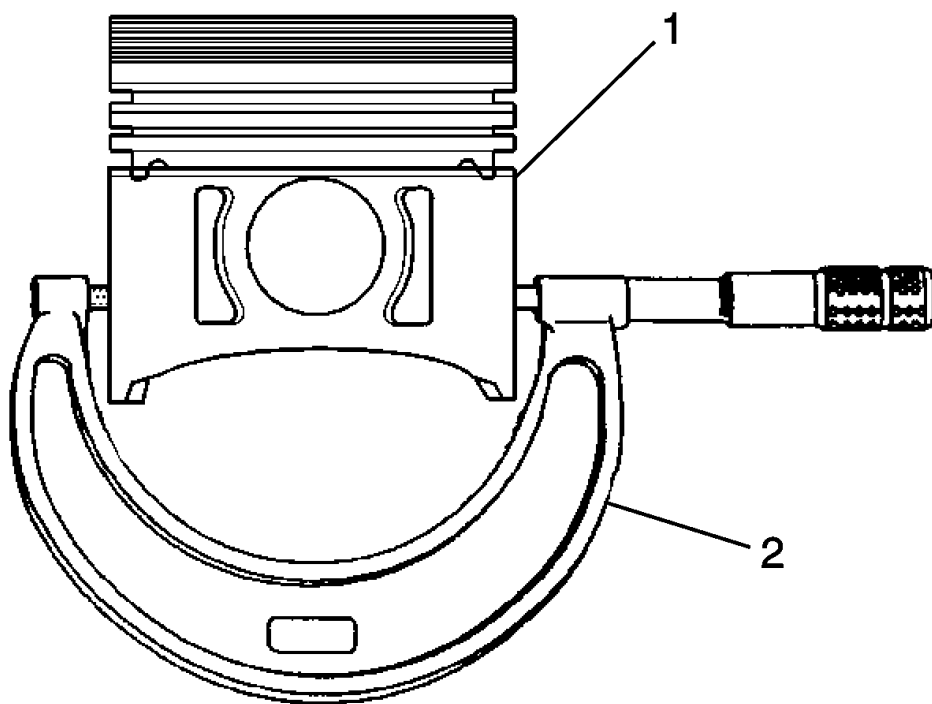


Fig. 101: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

11. Measure piston width using the following procedure:

1. Using an outside micrometer (2), measure the width of the piston 14.5 mm (0.570 in) above the bottom of the piston skirt at the thrust surface perpendicular to the centerline of the piston pin.
 2. Compare the measurement of the piston to its original cylinder by subtracting the piston width from the cylinder diameter.
 3. The proper clearance specification for the piston is 0.010-0.041 mm (0.0006-0.0016 in).
12. If the clearance obtained through measurement is greater than these specifications and the cylinder bores are within specification, replace the piston (1).

Piston Selection

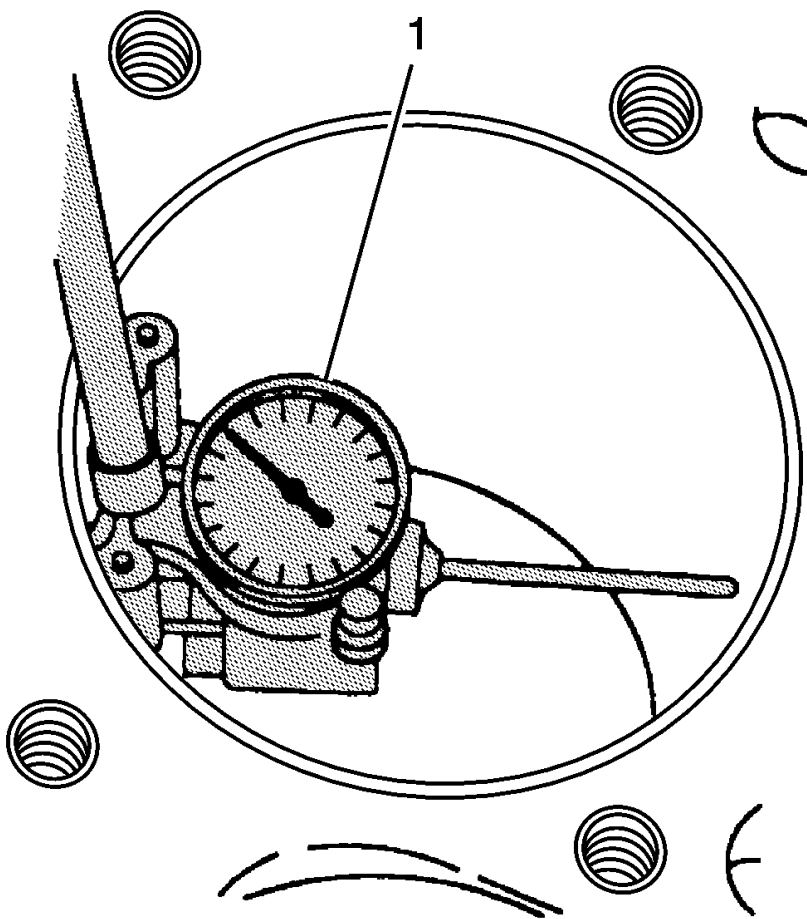


Fig. 102: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

NOTE: Measurements of all components should be taken with the components at normal room temperature.

For proper piston fit, the engine block cylinder bores must not have excessive wear or taper.

A used piston and pin set may be reinstalled if, after cleaning and inspection, they are within specifications.

1. Inspect the engine block cylinder bore. Refer to **Engine Block Cleaning and Inspection**.
2. Inspect the piston and the piston pin.
3. Use a bore gauge (1) and measure the cylinder bore diameter. Measure at a point 64 mm (2.5 in) from the top of the cylinder bore.

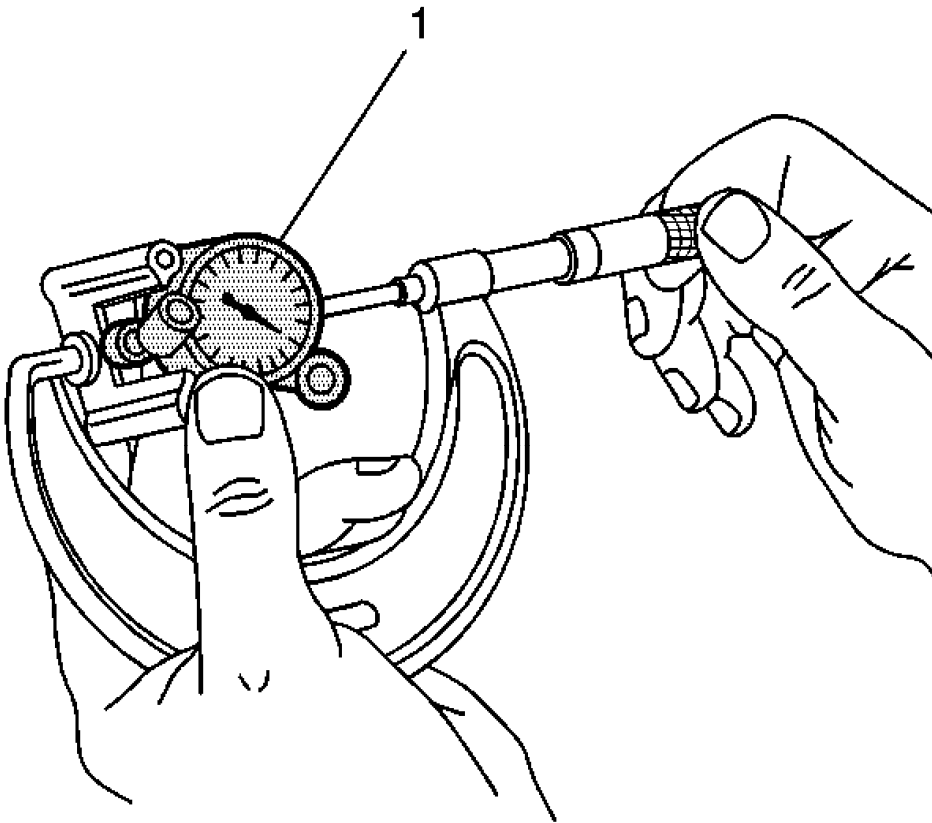


Fig. 103: Measuring Bore Gauge
Courtesy of GENERAL MOTORS COMPANY

4. Measure the bore gauge with a micrometer (1) and record the reading.

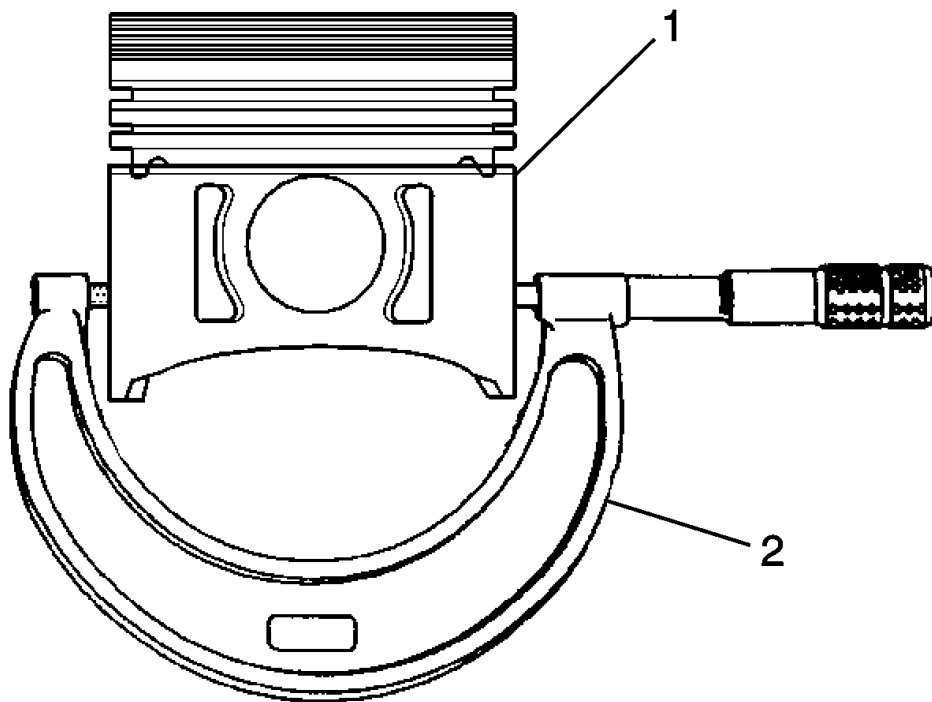


Fig. 104: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

5. With a micrometer (2) or caliper at a right angle to the piston (1), measure the piston 14 mm (0.570 in) from the bottom of the skirt.
6. Subtract the piston diameter from the cylinder bore diameter in order to determine piston-to-bore clearance.
7. For proper piston-to-bore clearance. Refer to **Engine Mechanical Specifications** .
8. If the proper clearance cannot be obtained, select another piston and measure for the clearances.
9. If the proper fit cannot be obtained, hone the cylinder bore or replace the cylinder block.
10. When the piston-to-cylinder bore clearance is within specifications, mark the top of the piston using a permanent marker for installation to the proper cylinder. Refer to **Separating Parts** .

PISTON AND CONNECTING ROD ASSEMBLE

Special Tools

- **EN-46745** Piston Pin Clip Remover/Installer
- **EN-46745-4** Piston Pin Clip Remover/Installer Adapter

For equivalent regional tools, refer to **Special Tools** .

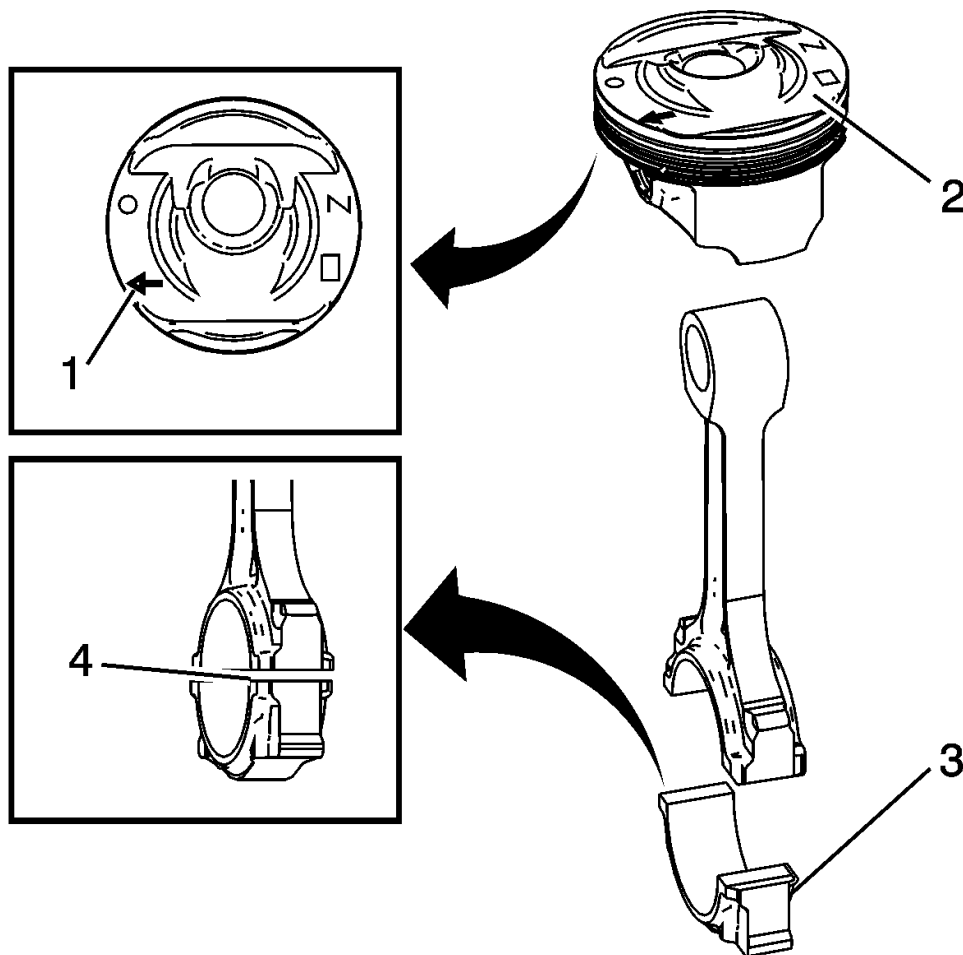


Fig. 105: Connecting Rod And Piston
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the piston onto the connecting rod with the arrow on top of the piston oriented to the same side as the cast feature at the split line of the connecting rod.

1. The arrow (1), on the top of the piston, must go to the front of the block.
2. The feature at the split line (4), located on one side of the connecting rod, must go to the front of the block.
3. Assemble the connecting rod (3) and the piston (2).

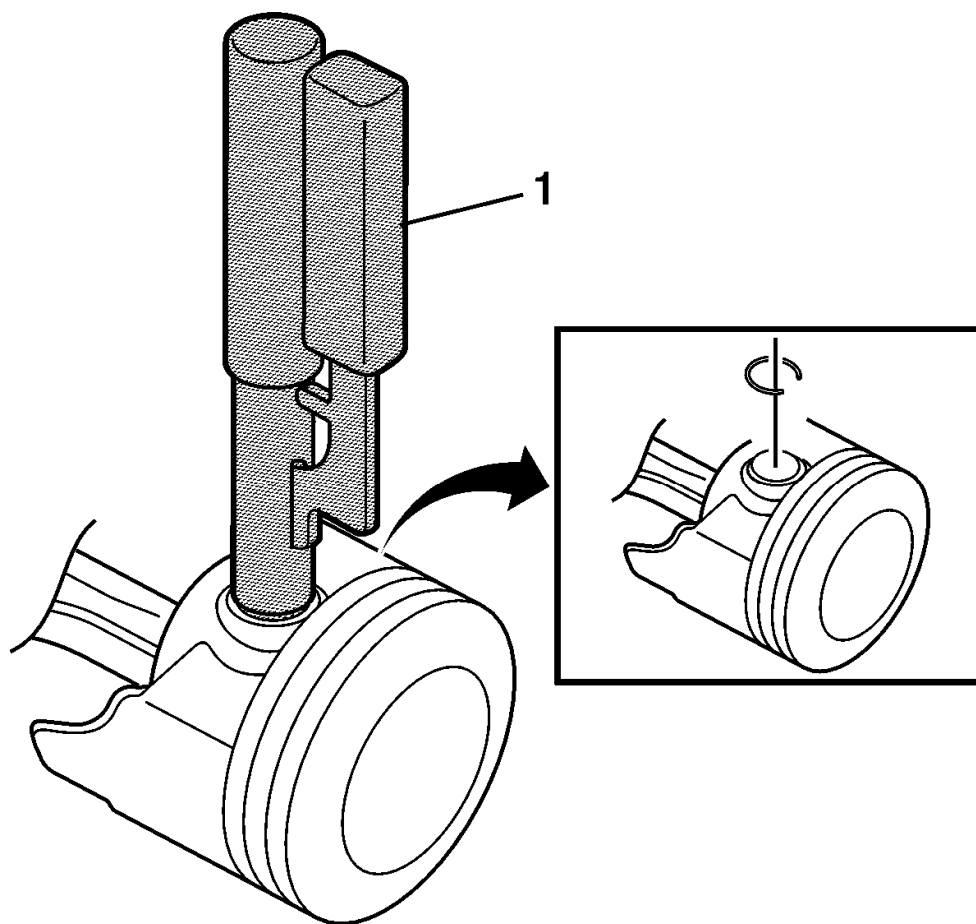


Fig. 106: View of Piston Pin Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Install the piston pin retainers correctly in the retaining groove during assembly in order to avoid engine damage.

NOTE: Use NEW retainers.

4. Use the following procedure to assemble the piston pin and the retainer:
 1. Coat the piston pin with oil.
 2. Install one side of one NEW piston pin retainer into the retaining groove using **EN-46745** installer and **EN-46745-4** adapter. Rotate the retainer until it is fully seated in the groove.
 3. Install the connecting rod and the piston pin.

Push the piston pin until it bottoms in the previously installed retainer.

4. Install the second NEW piston pin retainer, using **EN-46745** installer (1) and **EN-46745-4** adapter.

5. Ensure that the piston moves freely.

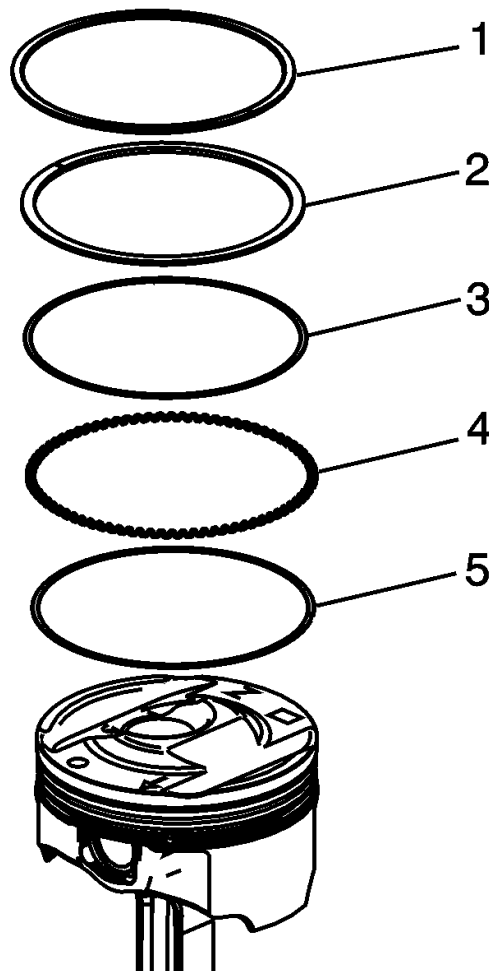


Fig. 107: Piston Rings

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

5. Install the following components of the oil control ring assembly:
 1. The piston oil ring rail (5)
 2. The piston oil ring rail spacer (4)
 3. The second piston oil ring rail (3)
6. Install the piston lower compression ring (2). Place the manufacturer's mark facing up.
7. Install the piston upper compression ring (1).

CAMSHAFT ASSEMBLY DISASSEMBLE

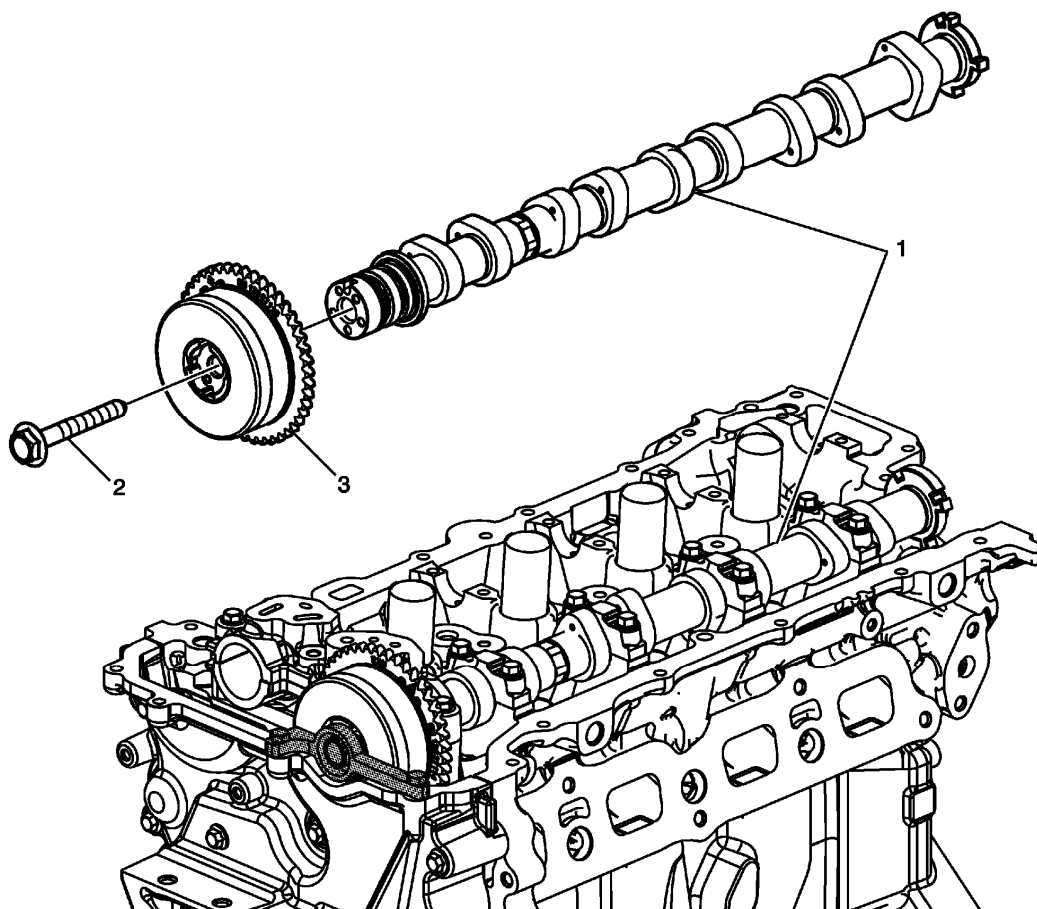


Fig. 108: Camshaft Assembly
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Assembly Disassemble

Callout	Component Name
Preliminary Procedures	
1.	Temporarily install the cylinder head to the engine block, with the engine block securely attached to a mounting device.
2.	Temporarily install the engine front cover to the cylinder head, using the upper bolts to hold the cover in position.
3.	Install one of the camshafts in the exhaust camshaft position on the cylinder head.
4.	Install the camshaft bearing front upper cap and bolts.
5.	Install the camshaft bearing caps and bolts.
6.	Install EN-50793 locking tool onto the camshaft actuator and engine front cover.
7.	The camshaft actuator bolt can now be loosened and the actuator removed from the camshaft. Repeat preliminary procedure for the remaining camshaft assembly.

1	Camshaft, Intake and Exhaust
2	Camshaft Position Actuator Bolt NOTE: Discard the bolt. Special Tools EN-50793 Camshaft Actuator Locking Tool For equivalent regional tools, refer to <u>Special Tools</u> .
3	Camshaft Position Actuator, Intake and Exhaust

CAMSHAFT CLEANING AND INSPECTION

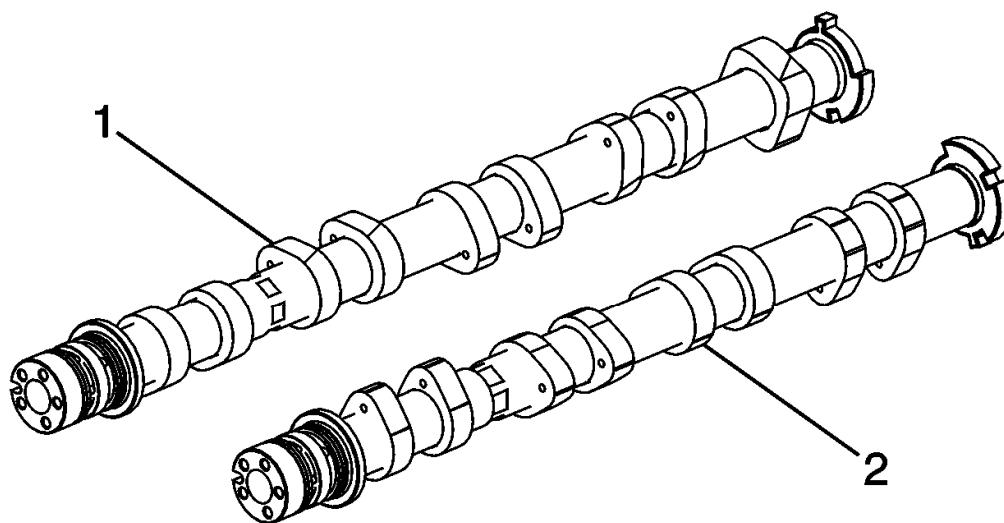


Fig. 109: Camshaft Journals And Lobes
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft journals and lobes for wear or scoring.

2. Inspect the camshaft sprocket alignment notch for damage.
3. Wash the camshafts (1, 2) in solvent.
4. Oil the camshafts.

CAMSHAFT ASSEMBLY ASSEMBLE

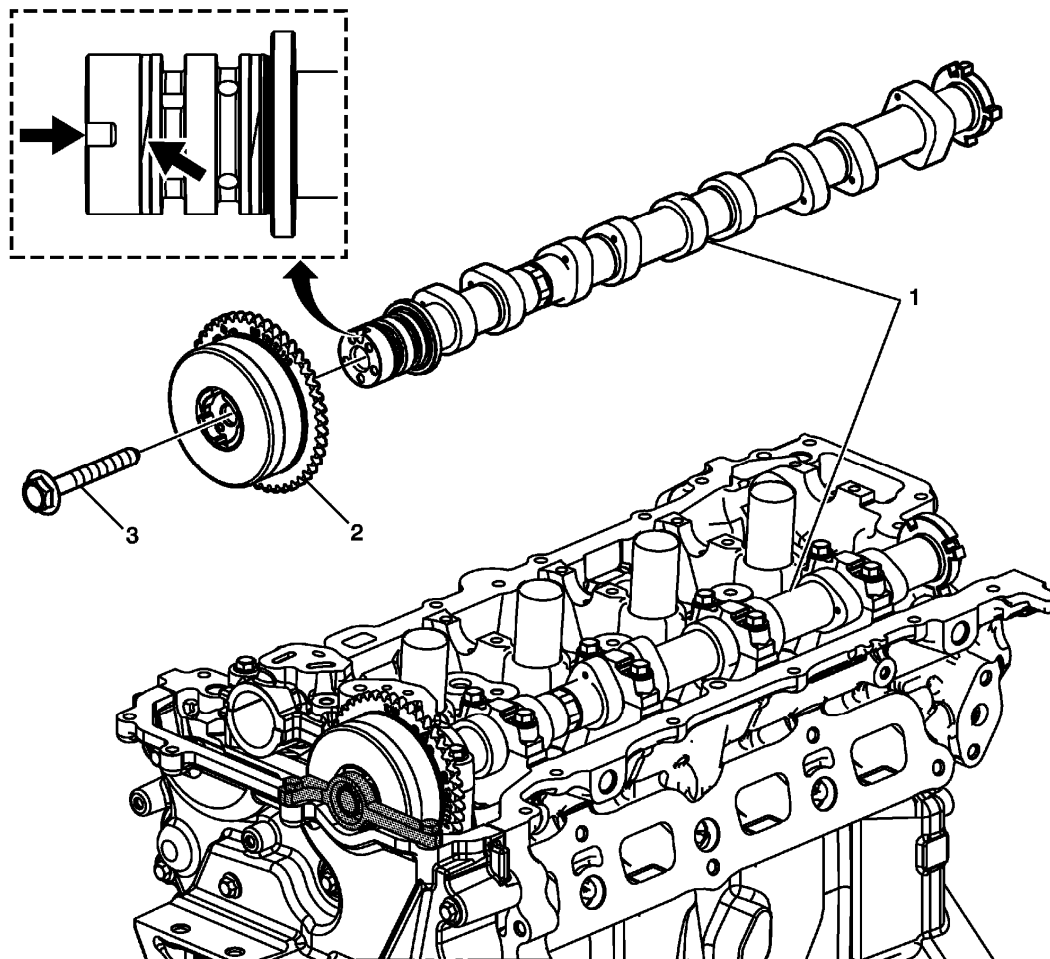


Fig. 110: Camshaft Assembly (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Assembly Assemble

Callout	Component Name
Preliminary Procedures	
1.	Temporarily install the cylinder head to the engine block, with the engine block securely attached to a mounting device.
2.	Temporarily install the engine front cover to the cylinder head, using the upper bolts to hold the cover in position.
3.	Install one of the camshafts in the exhaust camshaft position on the cylinder head.

4. Install the camshaft bearing front upper cap and bolts.
5. Install the camshaft bearing caps and bolts.
6. Install the appropriate actuator for the camshaft currently installed on the cylinder head.
7. Install **EN-50793** locking tool onto the camshaft actuator and engine front cover.
8. The camshaft actuator bolt can now be installed and tightened to final specification. Repeat preliminary procedure for the remaining camshaft assembly.

1	<p>Camshaft, Intake and Exhaust</p> <p>NOTE: Ensure that the oil seal near the front of the camshaft is rotated so that the split line on the oil seal is aligned with the notch, and both the notch and split line are at 12 O'clock when installed on the cylinder head.</p>
2	<p>Camshaft Position Actuator, Intake and Exhaust</p> <p>NOTE: Upon camshaft assembly, ensure the camshaft actuator pin aligns with the camshaft notch. The actuator, camshaft, and bolt can be assembled by hand and then placed on the cylinder head for final torque.</p>
3	<p>Camshaft Position Actuator Bolt</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.</p> <p>Tighten 30 (22 lb ft) plus 100 Degrees.</p> <p>Special Tools EN-50793 Camshaft Actuator Locking Tool For equivalent regional tools, refer to <u>Special Tools</u> .</p>

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER CLEANING AND INSPECTION

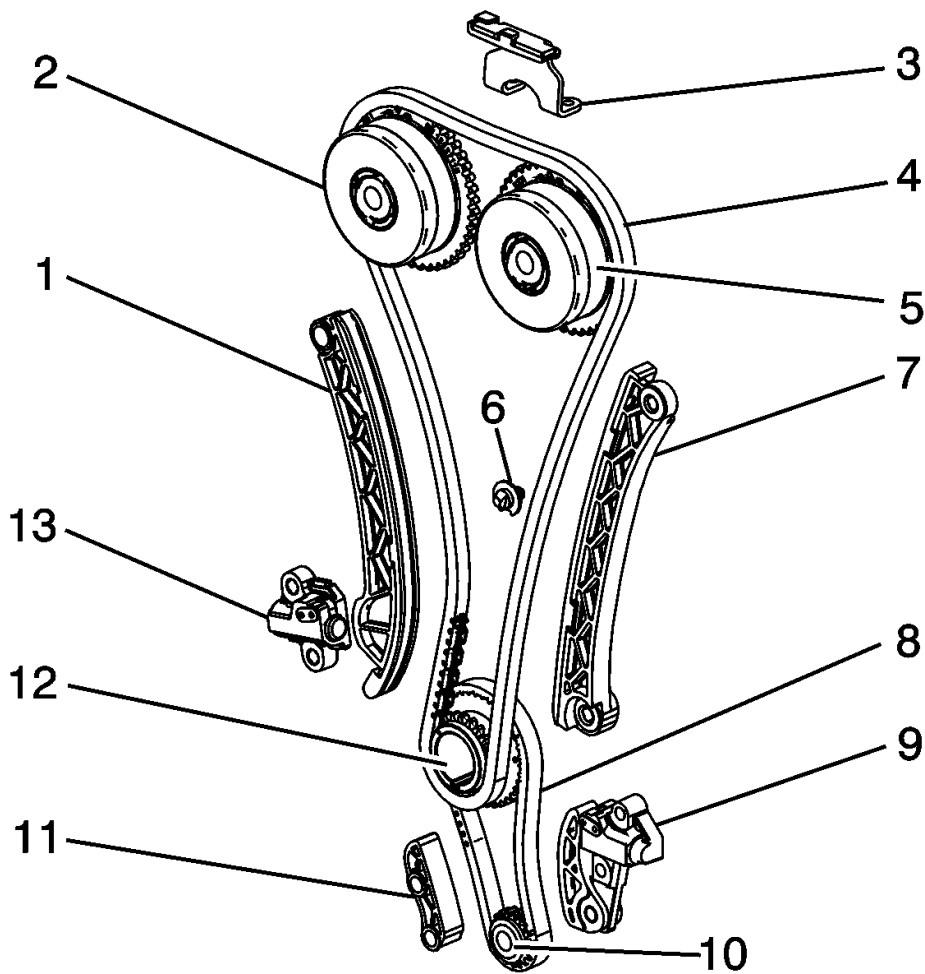


Fig. 111: Camshaft Timing Chain, Sprocket, And Tensioner
 Courtesy of GENERAL MOTORS COMPANY

1. Inspect the timing chain guides (3, 7) and timing chain tensioner pivot arm (1) for cracking or wear.
2. Replace the timing chain guides if wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface.
3. Inspect the timing chain tensioner (13) shoe for wear.
4. Replace the timing chain tensioner if shoe wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface.
5. Inspect the timing chain (4) and actuators (2, 5) for wear.
6. Inspect the camshaft actuator faces for signs of movement.
7. Inspect the camshaft actuator teeth and chain for signs of excessive wear, chipping, or seizure of the timing chain links.
8. Inspect the timing chain oil nozzle (6) for collapse or cracks at the bolt boss. Discard and replace the oil nozzle body if it is damaged.
9. Verify oil nozzle oil flow with compressed air.
10. Inspect the timing chain tensioner (13) for scoring or free movement.

11. Inspect the timing chain tensioner washer. If damaged, replace the timing chain tensioner.
12. Inspect the crankshaft sprocket (12) for excessive wear or chipping.
13. Inspect the balancer chain (8) for wear.
14. Inspect the balancer chain guide (11) for wear.
15. Inspect the balancer chain tensioner (9) for wear.
16. Inspect the balancer shaft driven sprocket (10) for wear or chipping.

CYLINDER HEAD DISASSEMBLE

Special Tools

- **EN-50717** Valve Spring Compressor
- **EN-36017** Valve Seal Remover
- **EN-43963** Valve Spring Compressor (off car)

For equivalent regional tools, refer to **Special Tools** .

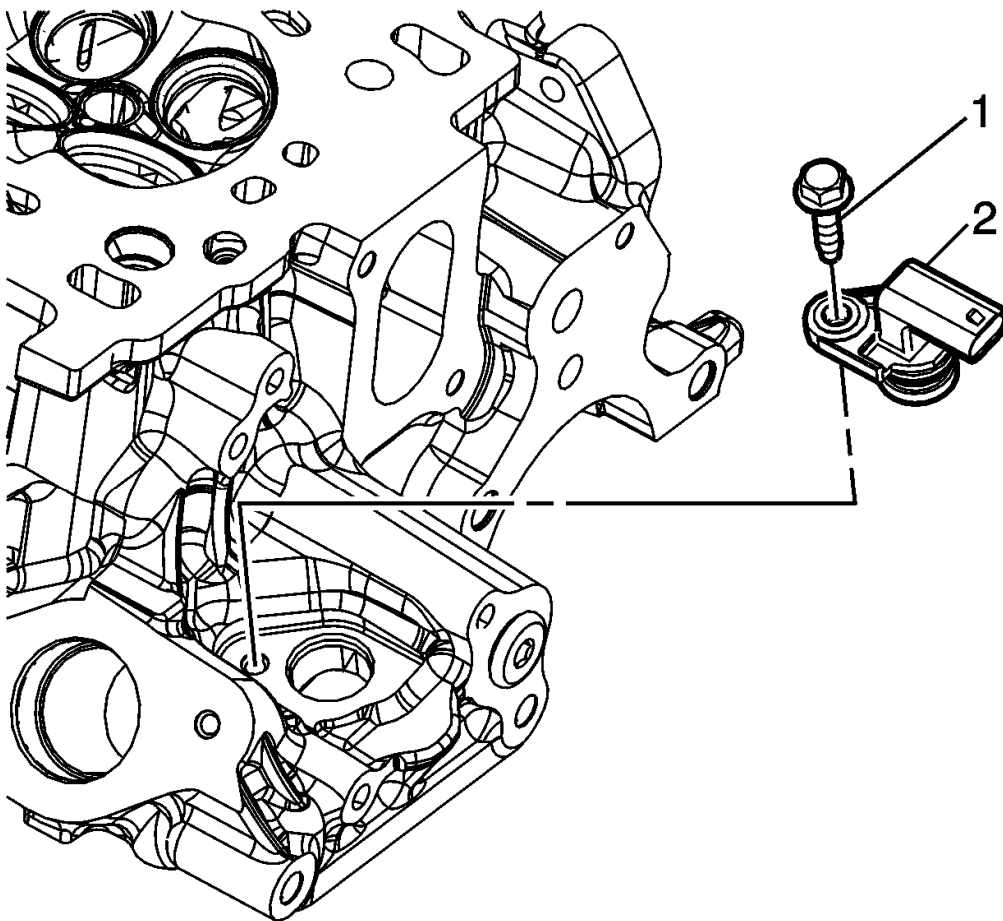


Fig. 112: Intake Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake camshaft position sensor (2) and bolt (1).

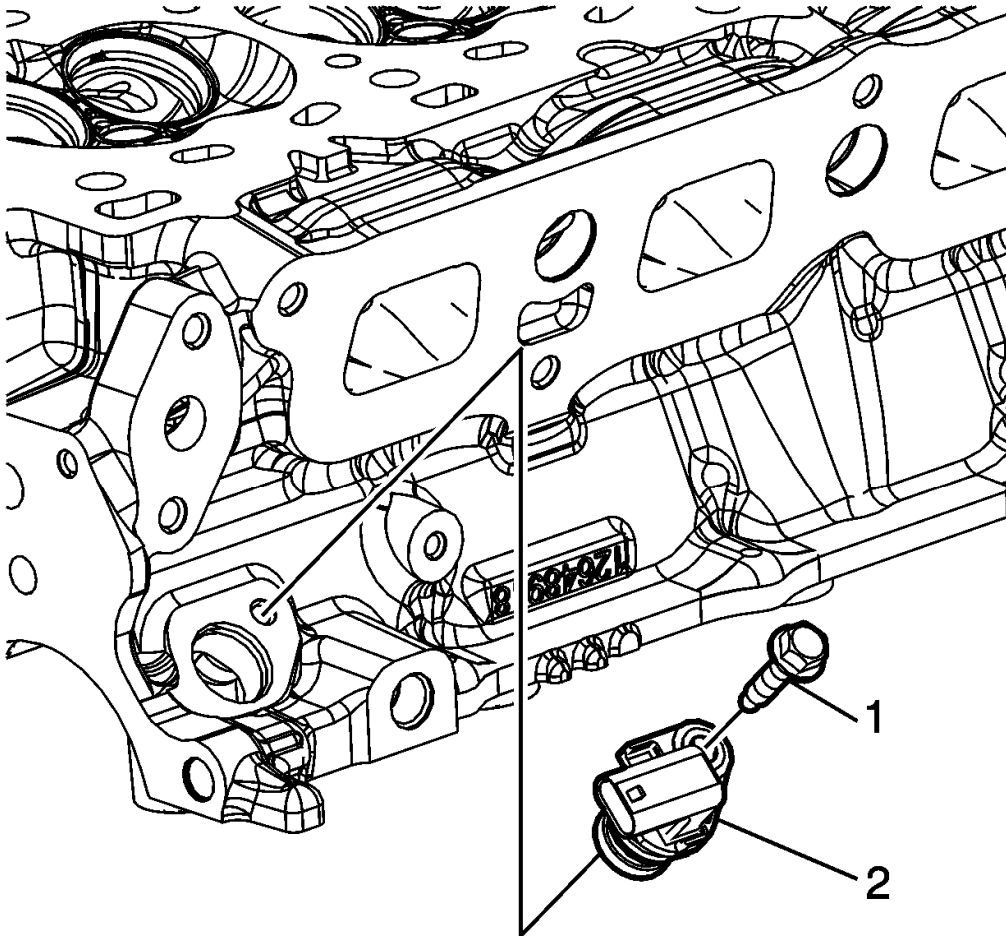


Fig. 113: Exhaust Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the exhaust camshaft position sensor (2) and bolt (1).

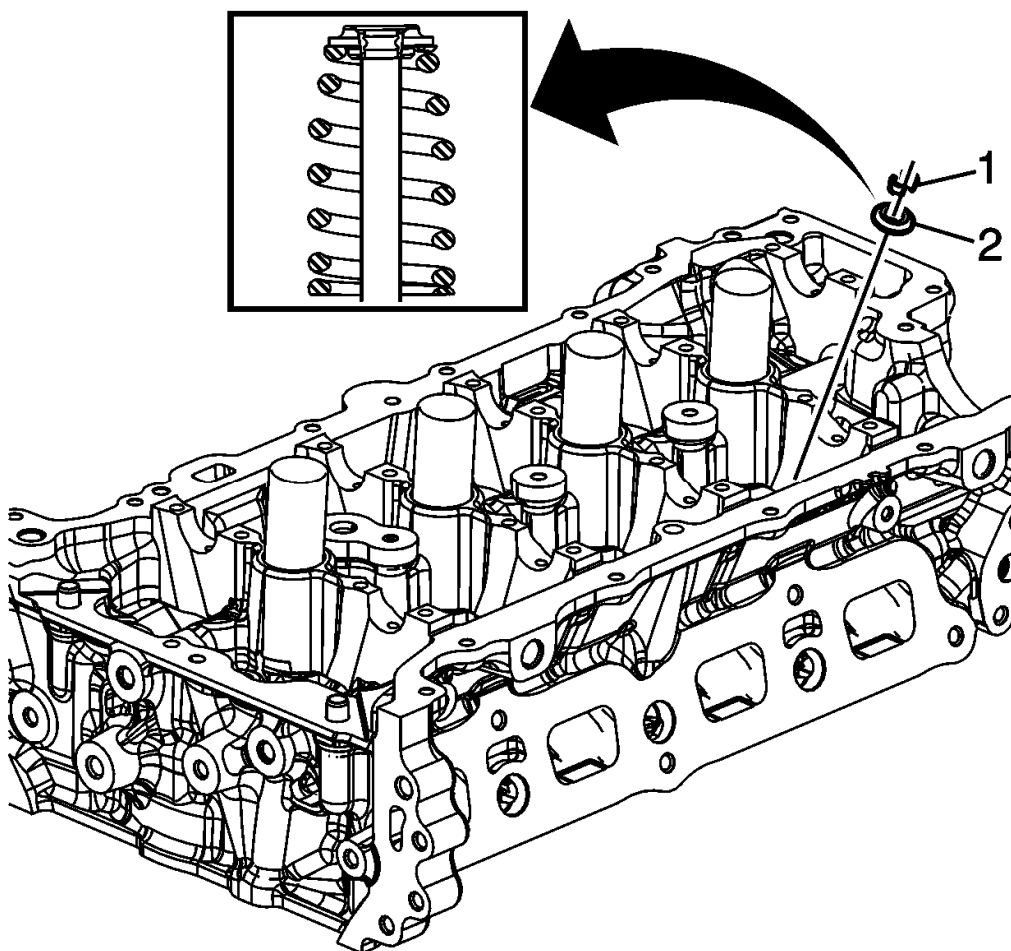


Fig. 114: Valve Keys, Springs, And Retainers
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

NOTE: Ensure that the valve train components are kept together and identified in order for proper installation in their original position.

3. Perform the following procedure to remove the valve keys, springs, and retainers:
 1. Using the **EN-50717** fixture and the **EN-43963** compressor adapter , compress the valve spring.
 2. Remove the valve keys (1).
 3. Slowly release the compression from the valve spring assembly.
 4. Remove the retainer (2).

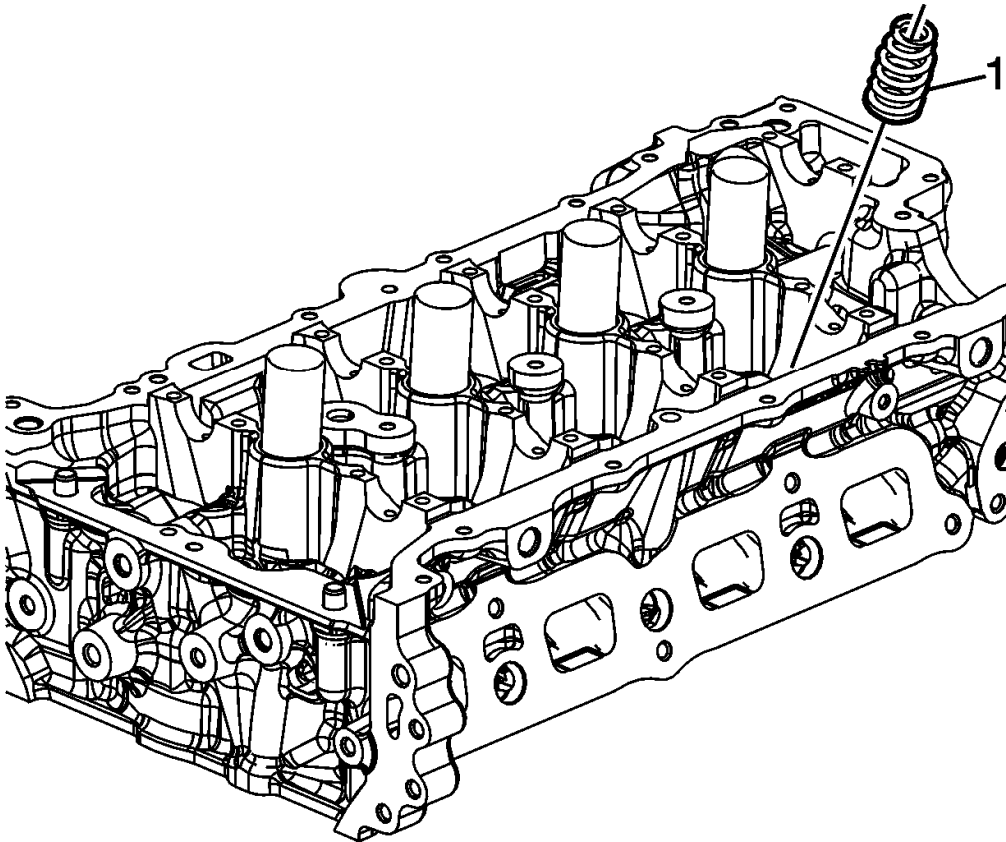


Fig. 115: Springs
Courtesy of GENERAL MOTORS COMPANY

4. Remove the springs (1).

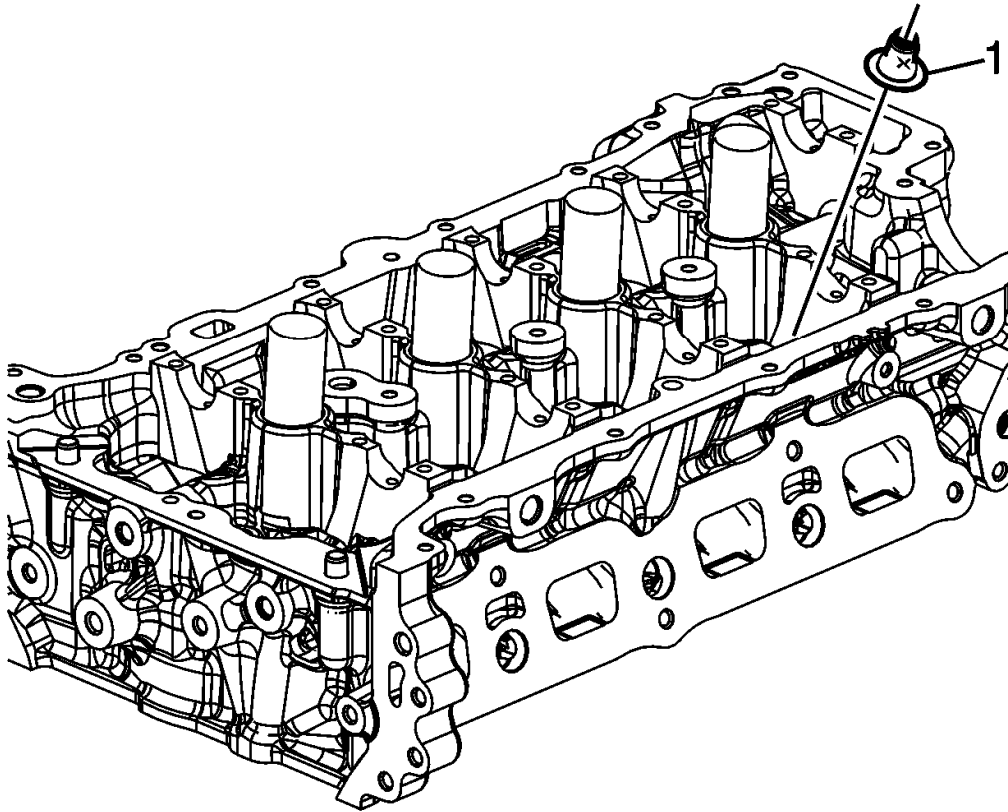


Fig. 116: Valve Seals
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not damage the valve guide. Remove any burrs that have formed at the key groove by chamfering the valve stem with an oil stone or a file.

5. Using **EN-36017** remover , remove the valve seals (1). Discard the seals, do not reuse.

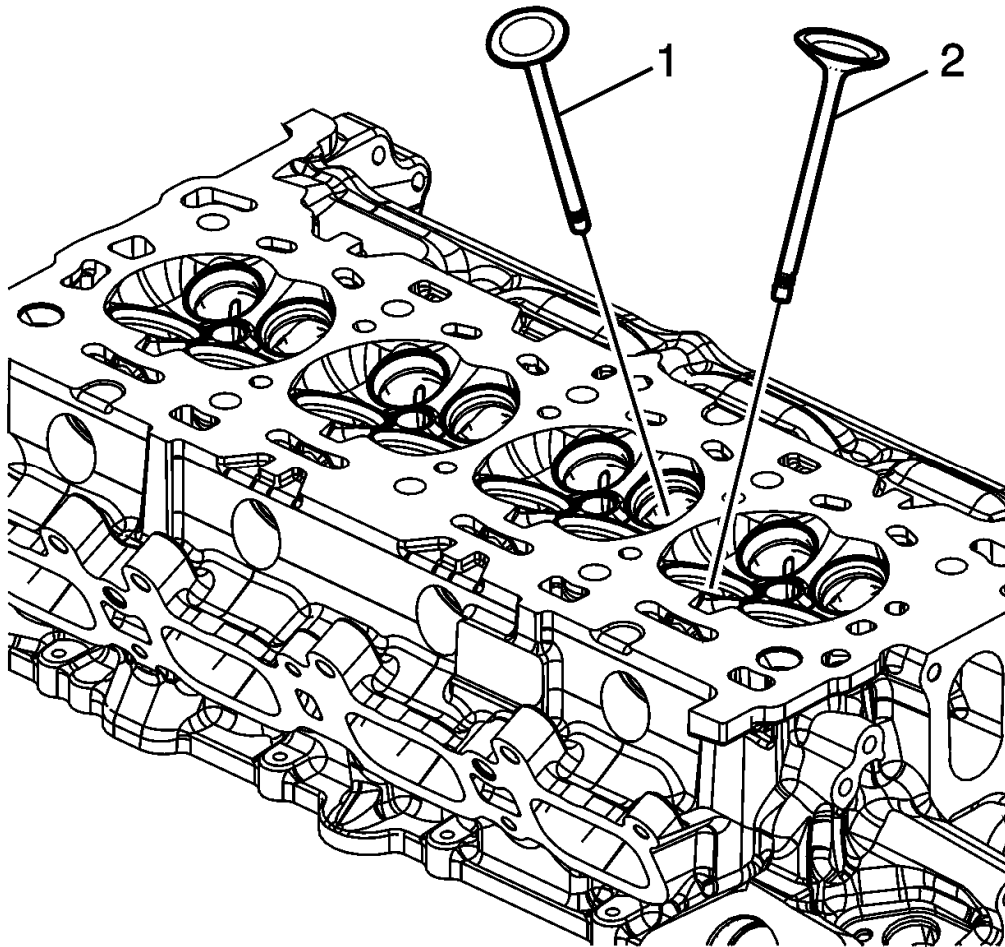


Fig. 117: Valves
Courtesy of GENERAL MOTORS COMPANY

6. Remove the valves (1, 2).

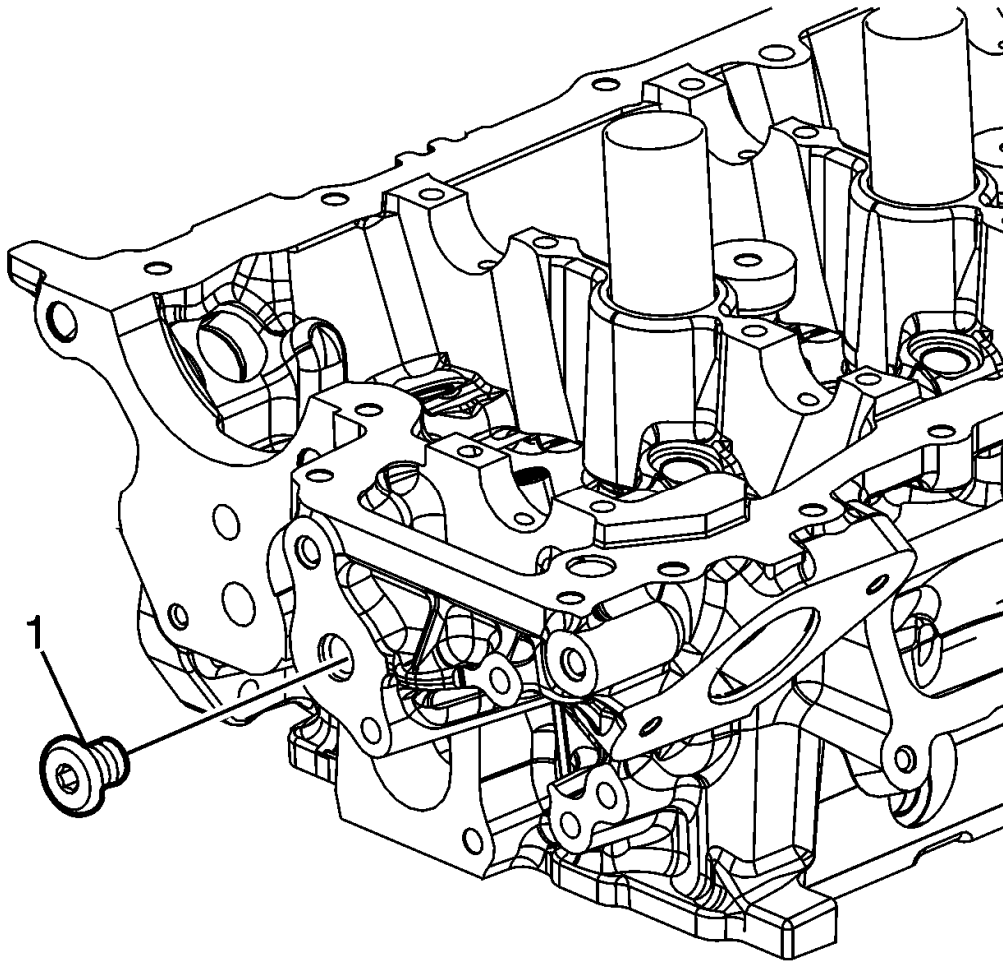


Fig. 118: Cylinder Head Plug
Courtesy of GENERAL MOTORS COMPANY

7. Remove the cylinder head plug (1).

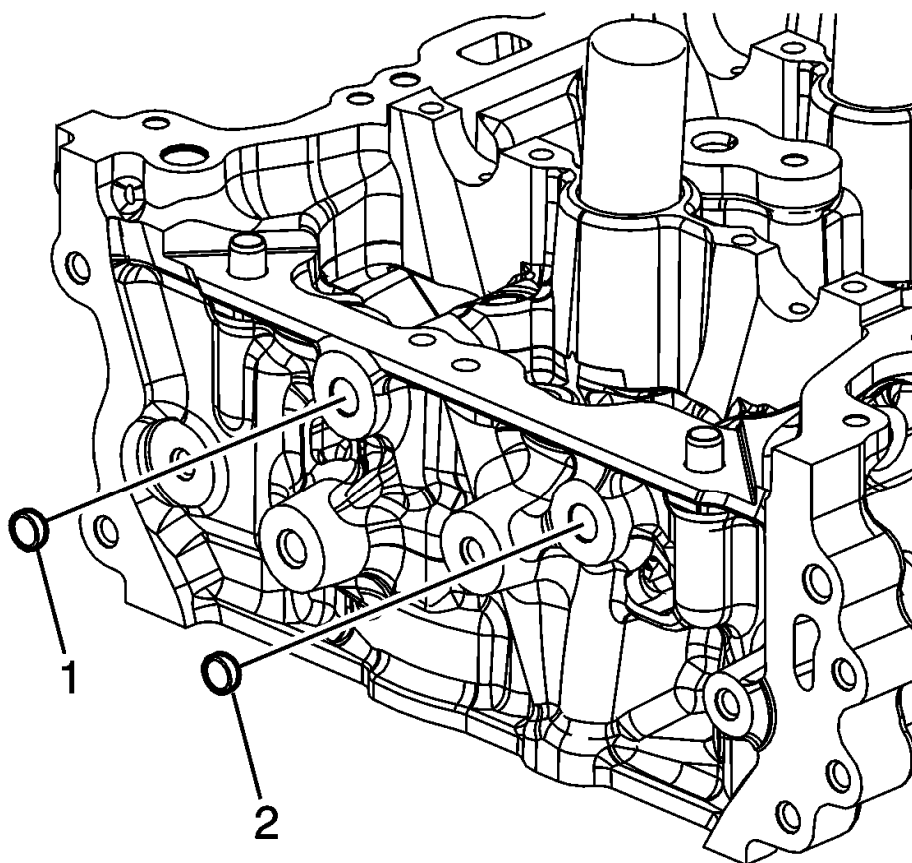


Fig. 119: Cylinder Head Plugs
Courtesy of GENERAL MOTORS COMPANY

8. Remove the cylinder head plugs (1, 2).

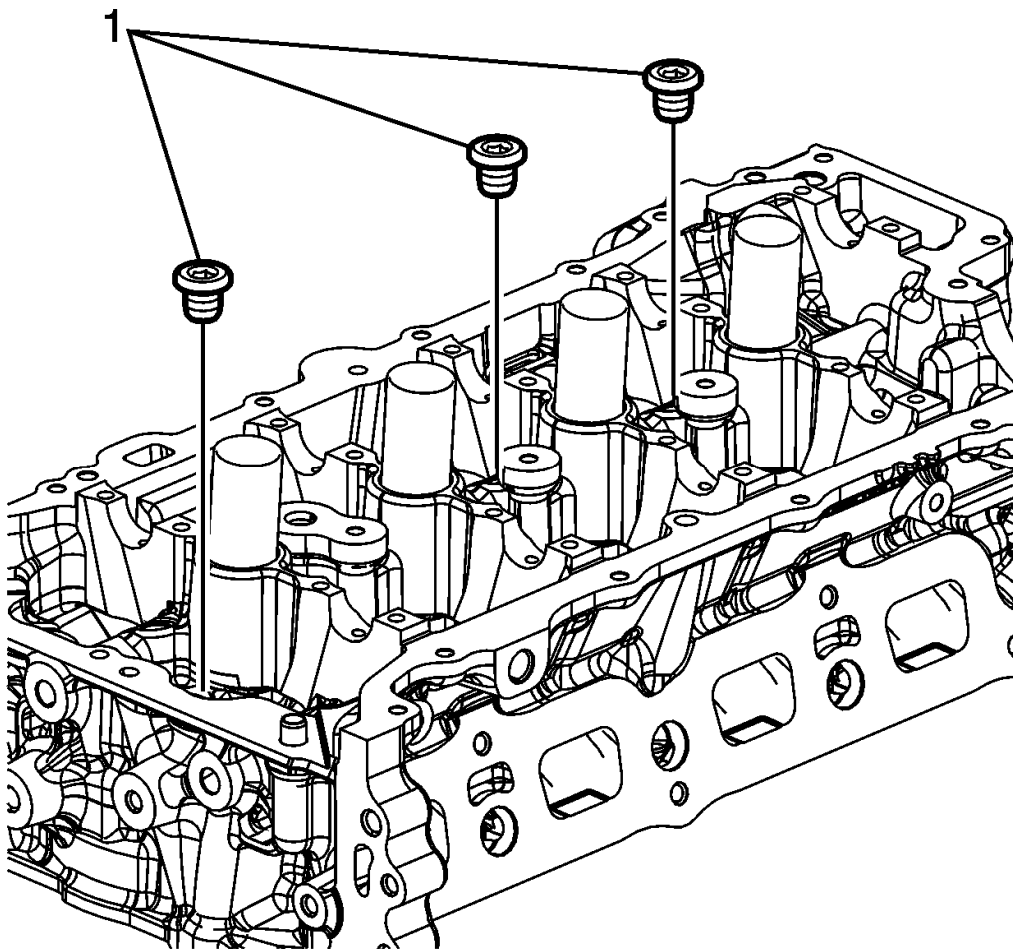


Fig. 120: Cylinder Head Plugs
Courtesy of GENERAL MOTORS COMPANY

9. Remove the cylinder head plugs (1).

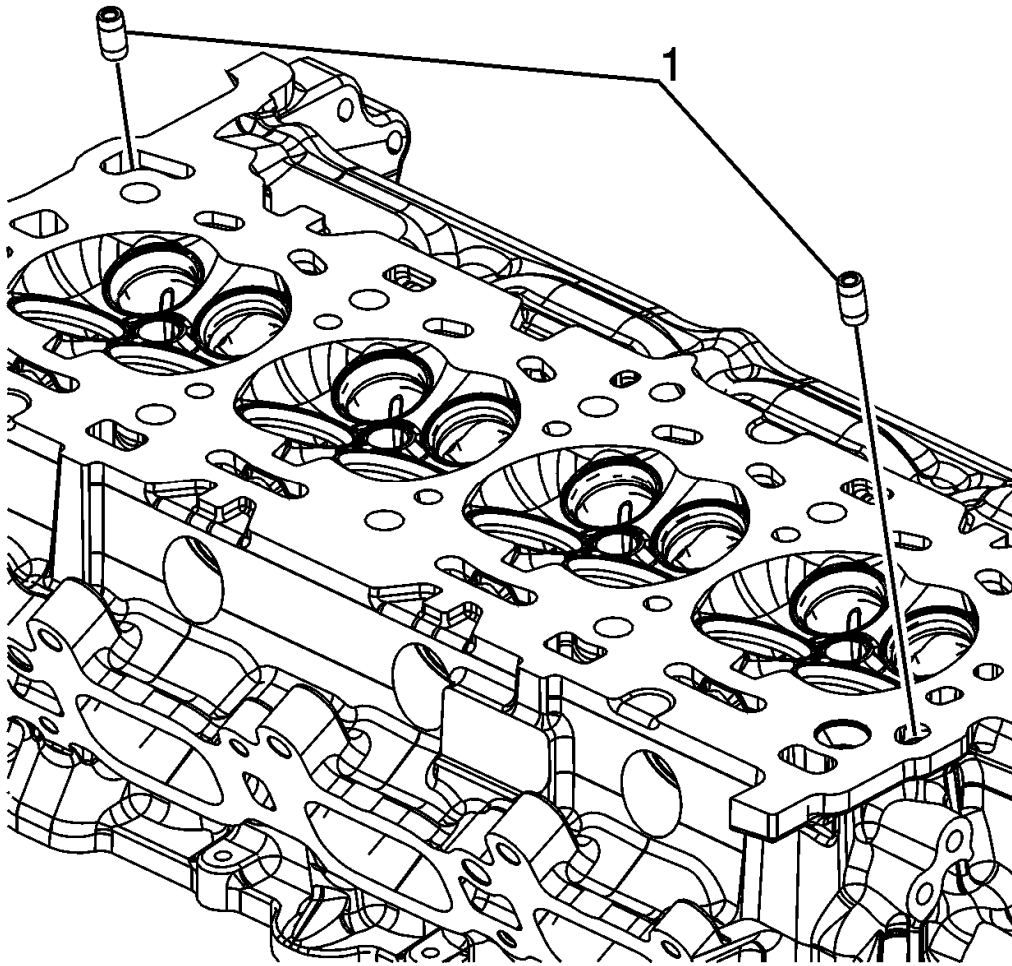


Fig. 121: Cylinder Head Oil Gallery Restrictors
Courtesy of GENERAL MOTORS COMPANY

10. Remove the cylinder head oil gallery restrictors (1).

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **EN 22738-B** Valve Spring Tester
- **EN-28410** Gasket Remover
- **EN-39358** Spark Plug Socket
- **GE 7872** Magnetic Base Dial Indicator

For equivalent regional tools, refer to **Special Tools** .

Valve Cleaning and Inspection

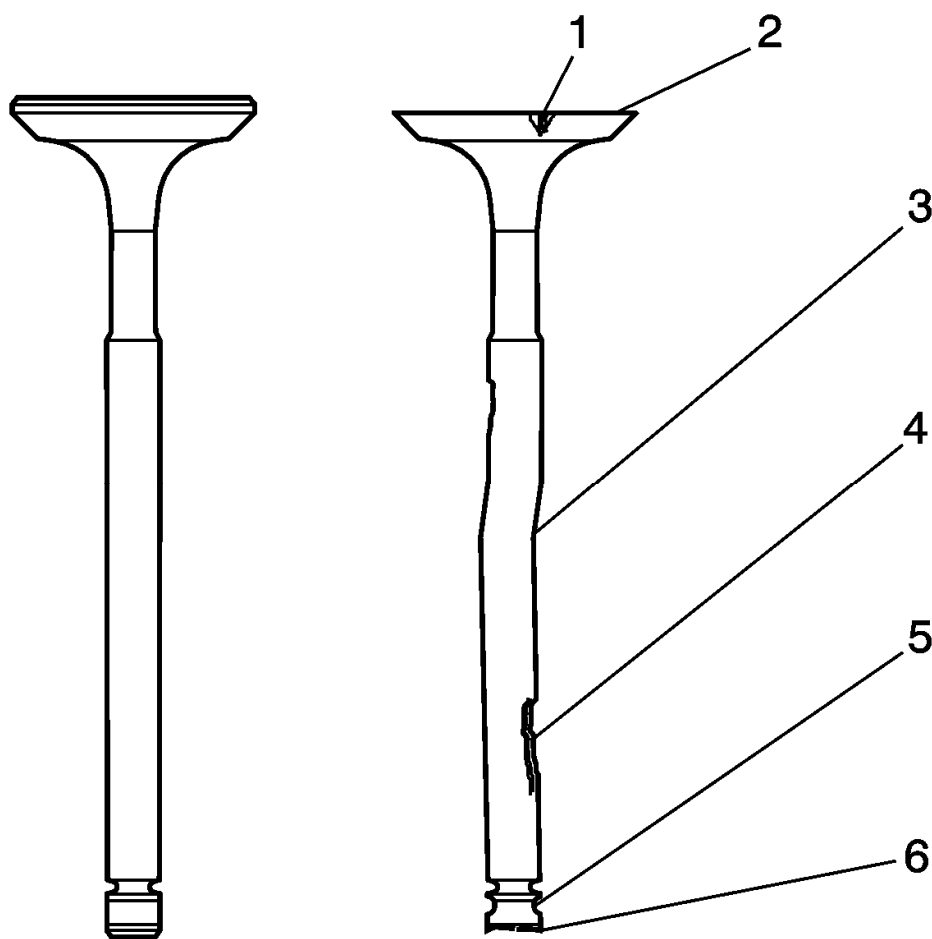


Fig. 122: Valve Inspection Areas

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use a wire brush on any part of the valve stem.

NOTE: Do not grind or condition the intake valve. If the intake valve is out of specification, replace the valve.

1. Clean the valves of carbon, oil and varnish. Use a soft bristle wire brush to clean any carbon build-up from the valve head. Varnish can be removed by soaking in Parts Immersion Solvent. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Clean the valve guides.
3. Inspect the valve stem for pitting or wear (4).
4. Inspect the valve key groove for chipping or wear (5). Replace the valve if chipped or worn.
5. Inspect the valve face for burning or cracking (1). If pieces are broken off, inspect the corresponding piston and cylinder head area for damage.
6. Inspect the valve stem for burrs and scratches. Burrs and minor scratches may be removed with an oil

stone.

7. Inspect the valve stem for straightness (3) and the valve head for bending or distortion using V blocks. Bent or distorted valves must be replaced.
8. Clean the deposits from the valve face. Inspect the valve face for grooving.
9. Replace the valve if the face is grooved. Valve faces cannot be machined. If worn, or damaged, the valves must be replaced.
10. Replace the valve if the valve head O.D. and chamfer (2) is worn or out of specification. Refer to **Valve and Seat Grinding**.
11. The valves may be lightly lapped to the valve seats.
12. Replace the valve if the valve tip (6) is worn.
13. If no apparent wear, pitting, grooving, or distortion is present, perform the valve measurement and reconditioning procedure to verify valve specification. Refer to **Valve and Seat Grinding**.

Valve Guide Measurement

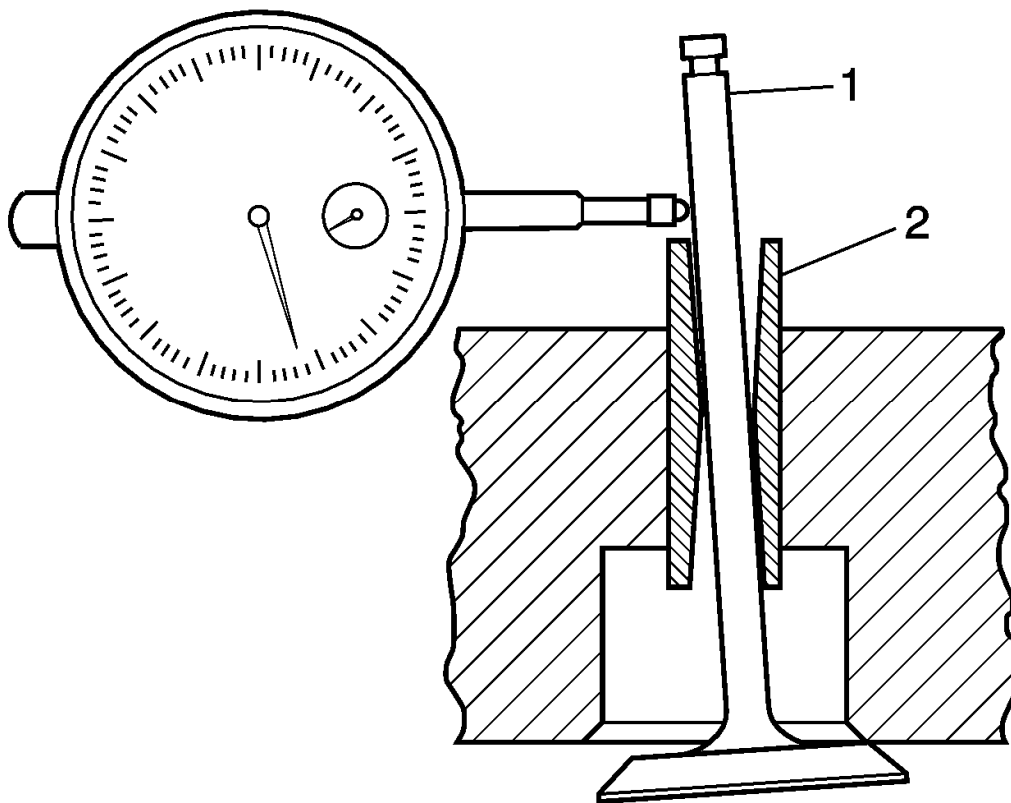


Fig. 123: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve stem (1)-to-guide (2) clearance. Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.
2. Clamp the **GE 7872** dial indicator to the cylinder head at the camshaft cover rail.
3. Locate the dial indicator so that the movement of the valve stem from side to side, crossways to the cylinder head, will cause a direct movement of the indicator stem. The dial indicator stem must contact the side of the valve stem just above the valve guide.
4. Drop the valve head about 0.064 mm (0.0025 in) off the valve seat.
5. Use light pressure when moving the valve stem from side to side in order to obtain a clearance reading. Refer to **Engine Mechanical Specifications** for proper clearance.

NOTE: **Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.**

6. If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, replace the cylinder head.

Valve Spring Cleaning and Inspection

1. Clean the valve springs in solvent.

WARNING: Refer to **Safety Glasses Warning** .

2. Dry the valve springs with compressed air.
3. Inspect the valve springs for broken coils or coil ends.

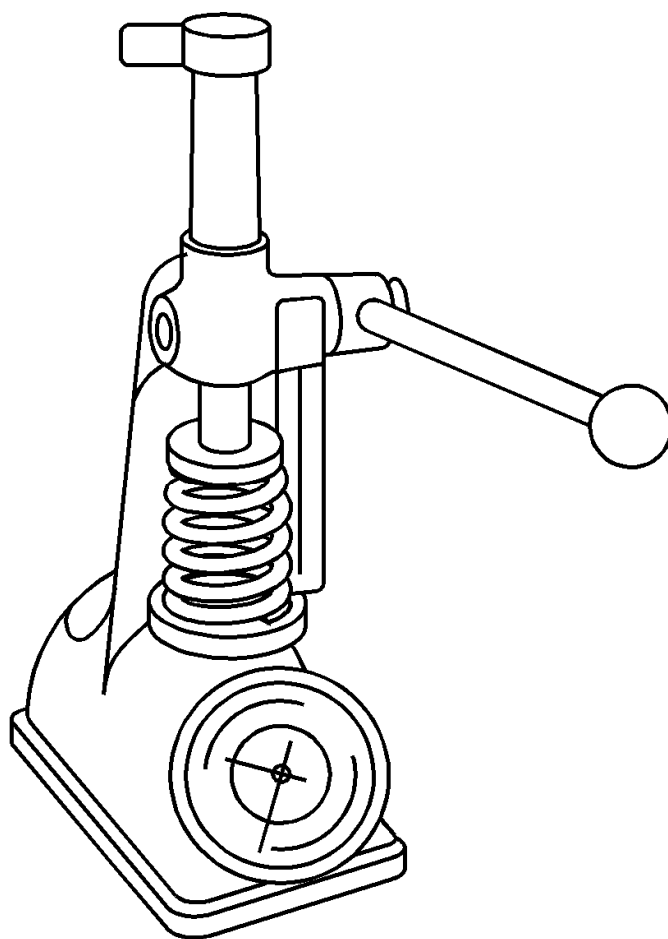


Fig. 124: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS COMPANY

4. Measure the valve spring tension using the **EN 22738-B** tester. Refer to **Engine Mechanical Specifications**
5. If low valve spring load is found, replace the valve springs. **DO NOT** use shims to increase spring load. The use of shims can cause the valve spring to bottom out before the camshaft lobe is at peak lift.

Valve Rocker Arm Cleaning and Inspection

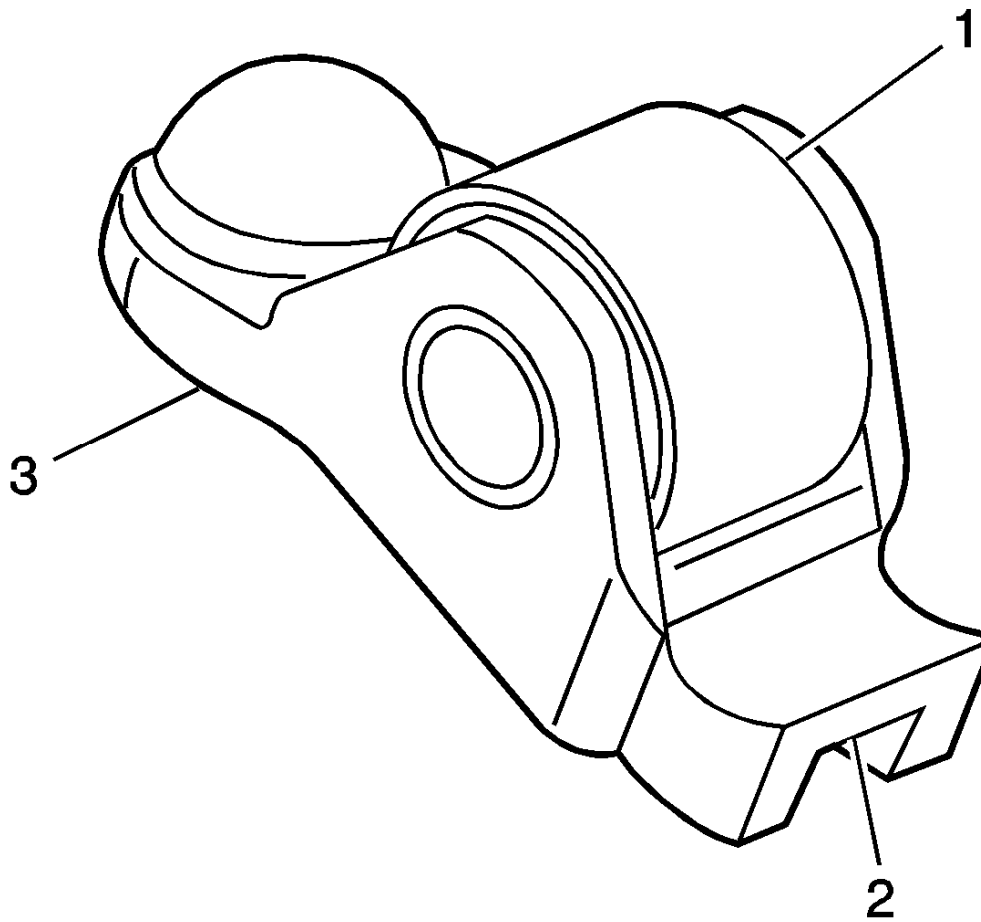


Fig. 125: Inspecting Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft follower roller (1) for the following:
 - Flat spots
 - Excessive scoring and pitting
 - Ensure the roller spins freely
2. Inspect the camshaft follower valve tip area (2).
3. Inspect the camshaft follower stationary hydraulic lash adjuster (SHLA) pivot area (3).
4. Replace the camshaft follower or followers as necessary.

Cylinder Head and Gasket Surface Cleaning and Inspection

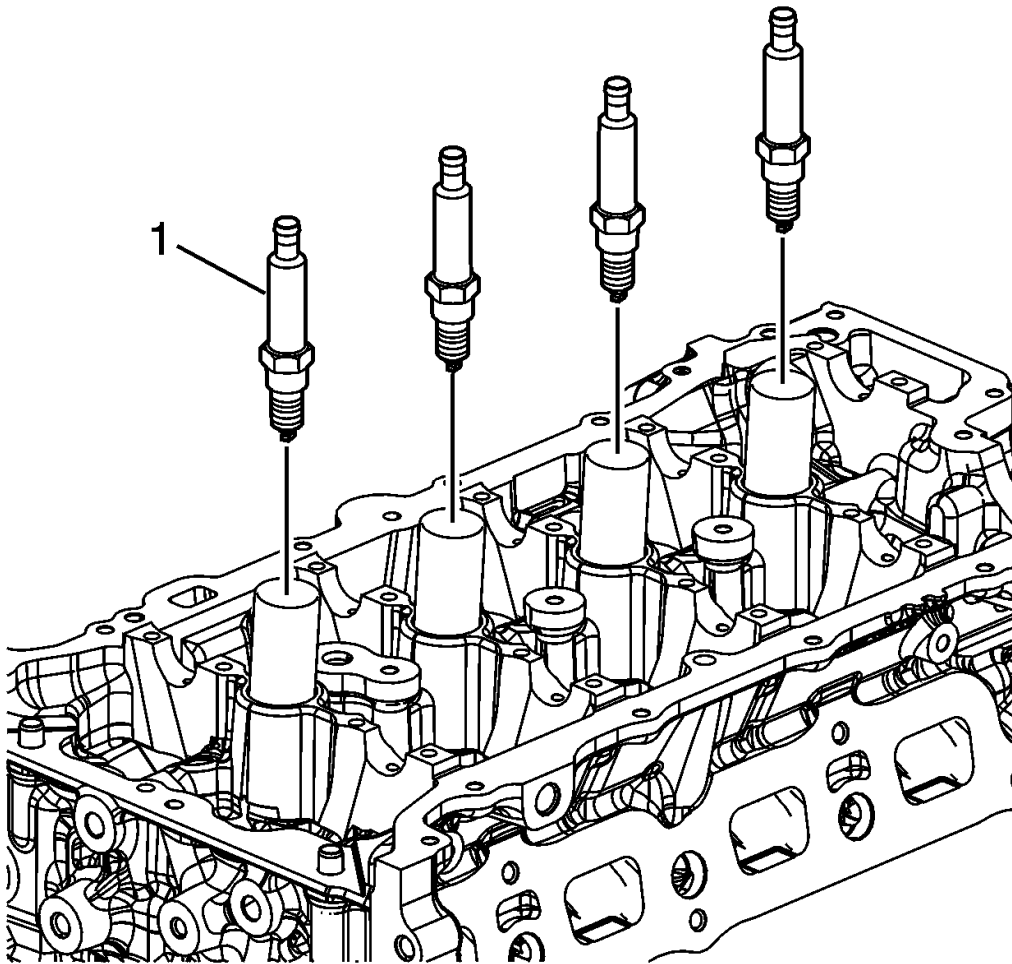


Fig. 126: Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

1. Remove the spark plugs (1) using **EN-39358** socket.
2. Inspect the cylinder head gasket and mating surfaces for leaks, corrosion and blow-by. If the gasket has failed, use the following faults to determine the cause:
 1. Improper installation
 2. Loose or warped cylinder head
 3. Missing, off location or not fully seated dowel pins
 4. Corrosion in the seal area around the coolant passages
 5. Chips or debris in the cylinder head bolt holes
 6. Bolt holes in the cylinder block not drilled or tapped deep enough

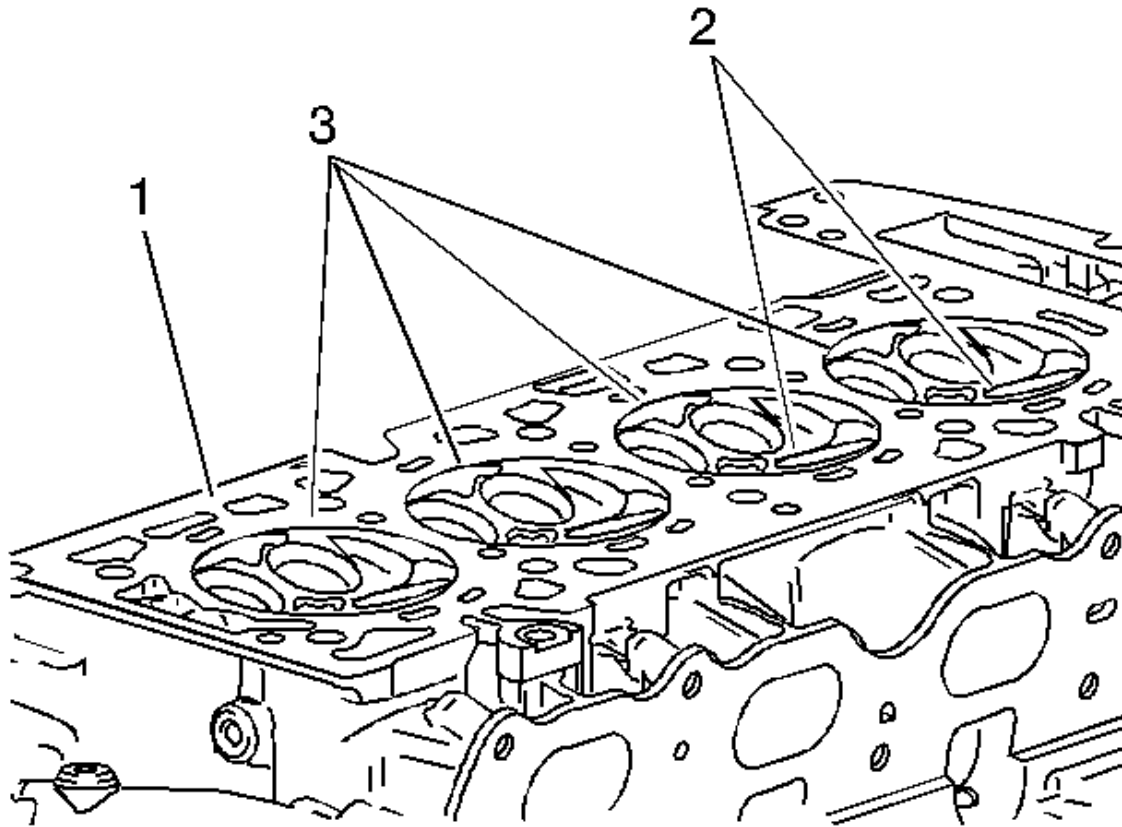


Fig. 127: Locating Combustion Chambers
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the cylinder head gasket surface.
 - Cylinder head may be reused if corrosion is found only outside a 4 mm (0.375 in) band around each combustion chamber (1).
 - Replace the cylinder head if the area between the valve seats is cracked (2).
 - Replace the cylinder head if corrosion has been found inside a 4 mm (0.375 in) band around each combustion chamber (3).

NOTE: **Do not use a wire brush on any gasket sealing surface.**

4. Remove the sealant from the rear cap mating surface with **EN-28410** remover. Care must be used to avoid gouging or scraping the sealing surfaces.
5. Clean the cylinder head. Remove all varnish, soot and carbon to the bare metal.

6. Clean the valve guides.
7. Clean the threaded holes. Use a nylon bristle brush.
8. Clean the remains of the sealer from the plug holes.
9. Inspect the cylinder head for cracks. Check between the valve seats and in the exhaust ports.

NOTE: **Do not attempt to weld the cylinder head, replace it.**

10. Inspect the cylinder head deck for corrosion, sand inclusions and blow holes.

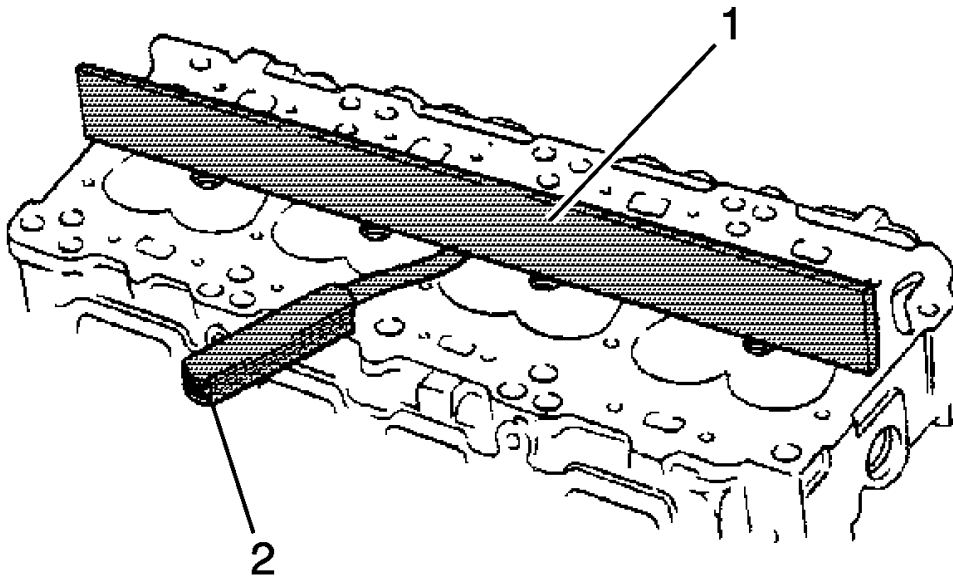


Fig. 128: Checking Cylinder Head Deck Surface For Flatness
Courtesy of GENERAL MOTORS COMPANY

11. Using a straight edge (1) and feeler gauge (2), inspect the cylinder head deck surface for flatness. Refer to **Engine Mechanical Specifications** . If the cylinder head is out of specification, replace the cylinder head. Do not machine the cylinder head.
12. Inspect all the threaded holes for damage. Threads may be reconditioned with thread inserts.
13. Inspect the sealing surfaces.

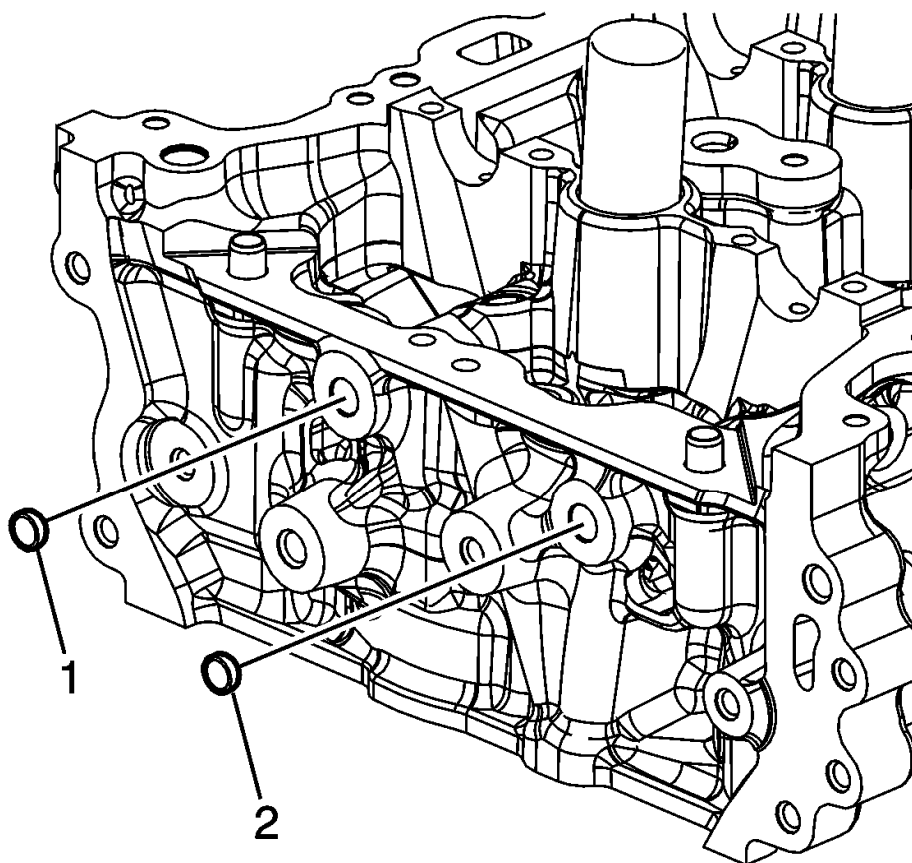


Fig. 129: Cylinder Head Plugs

Courtesy of GENERAL MOTORS COMPANY

14. Inspect the cylinder head plugs (1, 2) and verify the oil orifice is clear and free of debris.

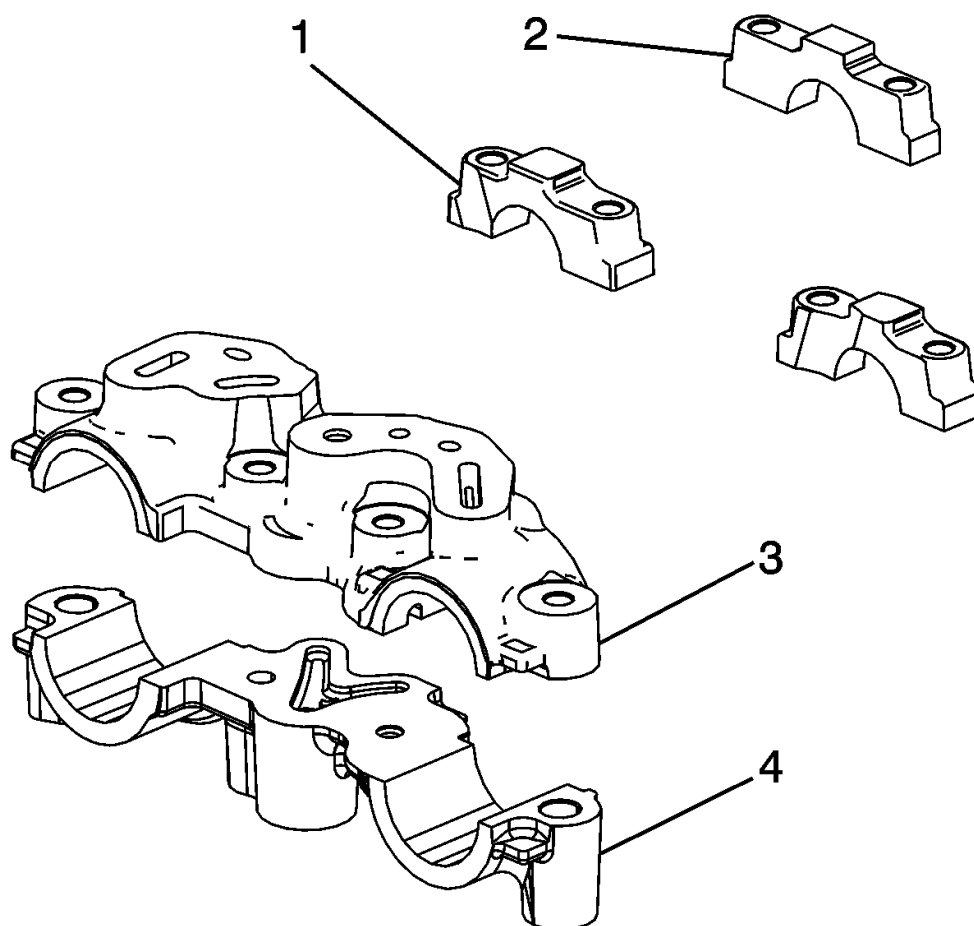


Fig. 130: Intake Camshaft Bearing Rear Cap
Courtesy of GENERAL MOTORS COMPANY

15. Inspect the intake camshaft bearing rear cap (2) for damage.
16. Inspect the camshaft bearing caps (1) for damage.
17. Inspect the camshaft front upper and lower bearing caps (3, 4) for damage.

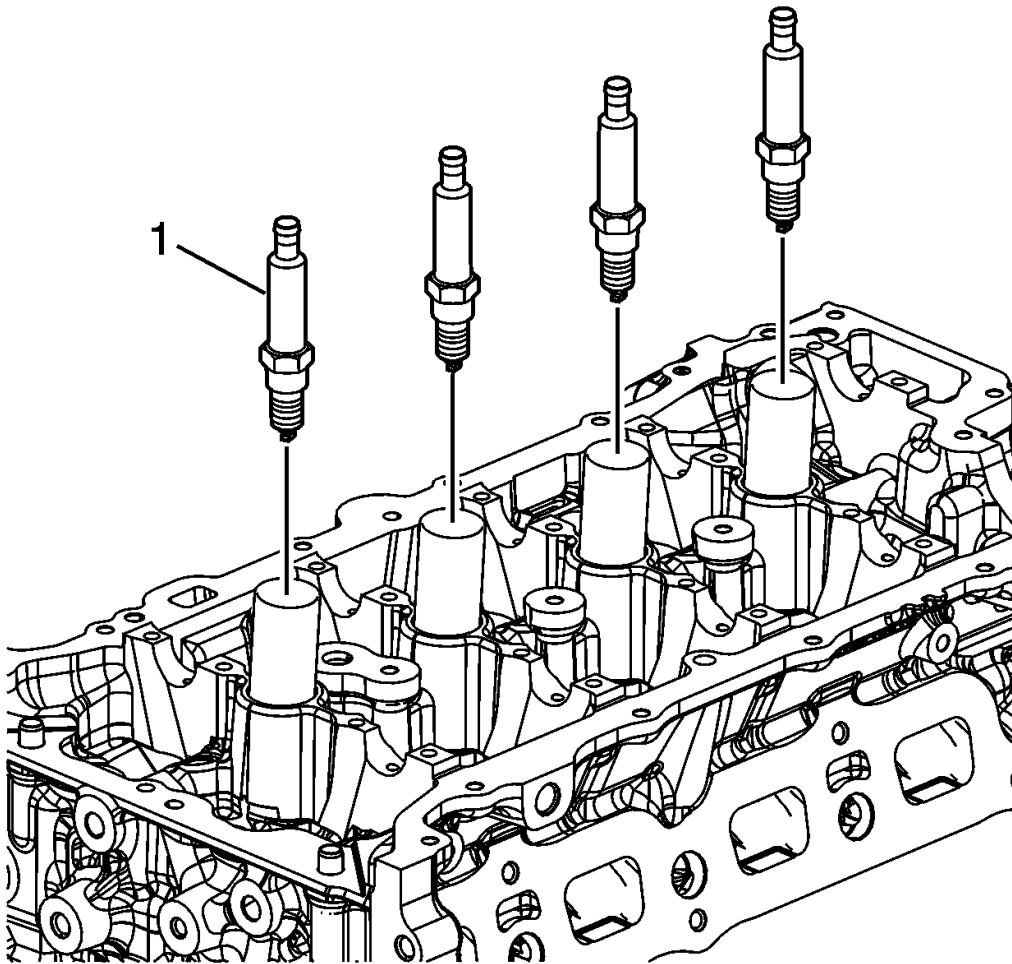


Fig. 131: Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

18. Install the spark plugs (1) using **EN-39358** socket. Tighten the plugs to 20 N.m (15 lb ft).

VALVE AND SEAT GRINDING

Valve Measurement and Reconditioning Overview

- Proper valve service is critical to engine performance. Therefore, all detailed measurement procedures must be followed to identify components that are out of specification.
- If the measurement procedures reveal that the valve or valve seat must be reconditioned, it is critical to perform the measurement procedures after reconditioning.

Valve Seat Width Measurement Procedure

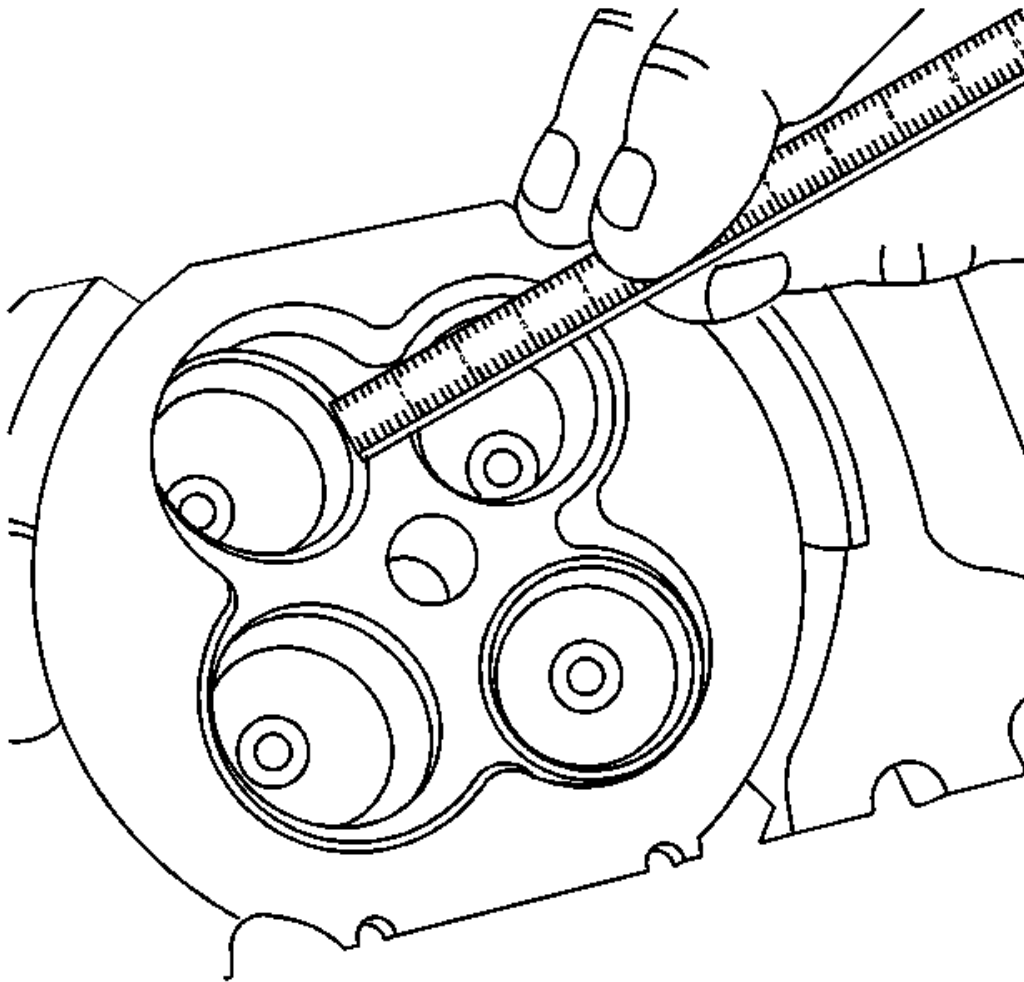


Fig. 132: Checking Valve Seat Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve seat width in the cylinder head using a proper scale.

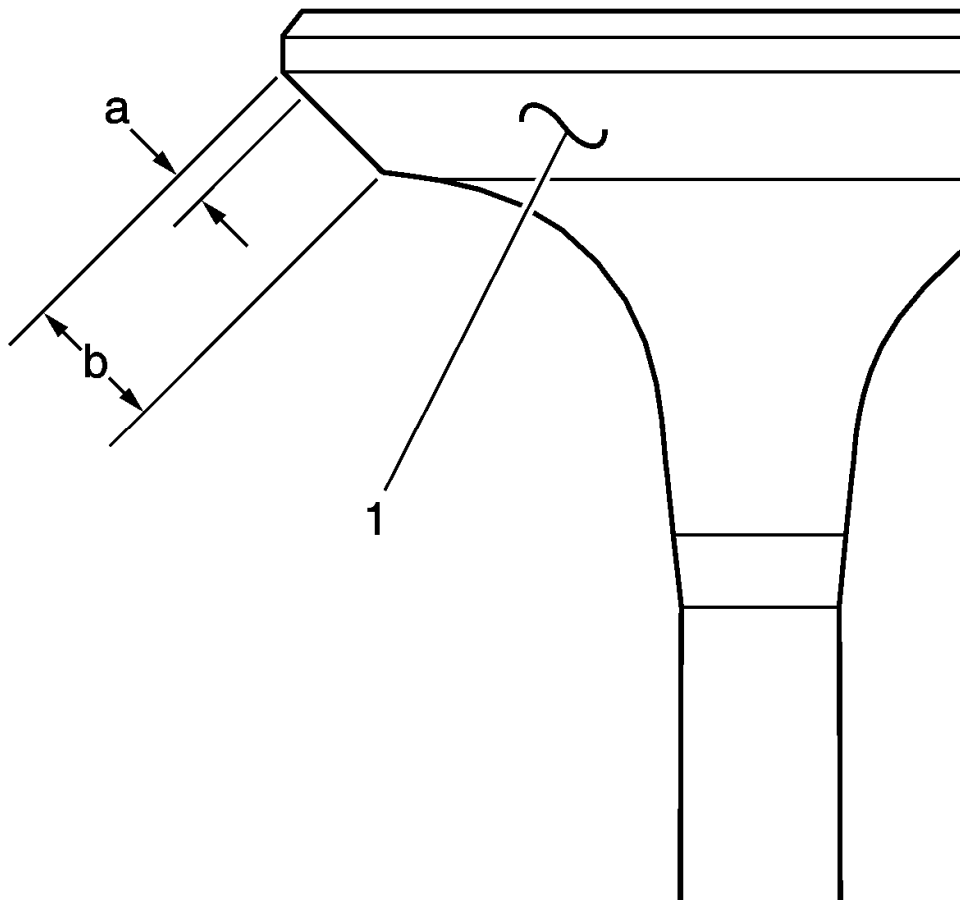


Fig. 133: Valve Face Seat width
 Courtesy of GENERAL MOTORS COMPANY

2. Measure the seat width (b) on the valve face (1) using a proper scale.

NOTE: The seat contact area must be at least 0.5 mm (0.020 in) from the outer diameter, margin (a), of the valve. If the contact area is too close to the margins, the seat must be reconditioned to move the contact area away from the margin.

3. Compare your measurements with the specifications listed in Engine Mechanical Specifications .
4. If the seat widths are acceptable, check the valve seat roundness using the Valve Seat Roundness Measurement Procedure.
5. If the seat width is not acceptable, you must grind the valve seat using the Valve and Seat Reconditioning Procedure to bring the width back into specification. Proper valve seat width is critical to providing the correct amount of valve heat dissipation.

Valve Seat Roundness Measurement Procedure

1. Measure the valve seat roundness using a dial indicator attached to a tapered pilot installed in the guide. The pilot should have a slight bind when installed in the guide.

CAUTION: The correct size pilot must be used. Do not use adjustable diameter pilots. Adjustable pilots may damage the valve guides.

2. Compare your measurements with the specifications listed in Engine Mechanical Specifications .
3. If the valve seat exceeds the roundness specification, you must grind the valve and valve seat using the Valve and Seat Reconditioning Procedure.
4. If new valves are being used, the valve seat roundness must be within 0.05 mm (0.002 in).

Valve Head O.D. and Chamfer Measurement Procedure

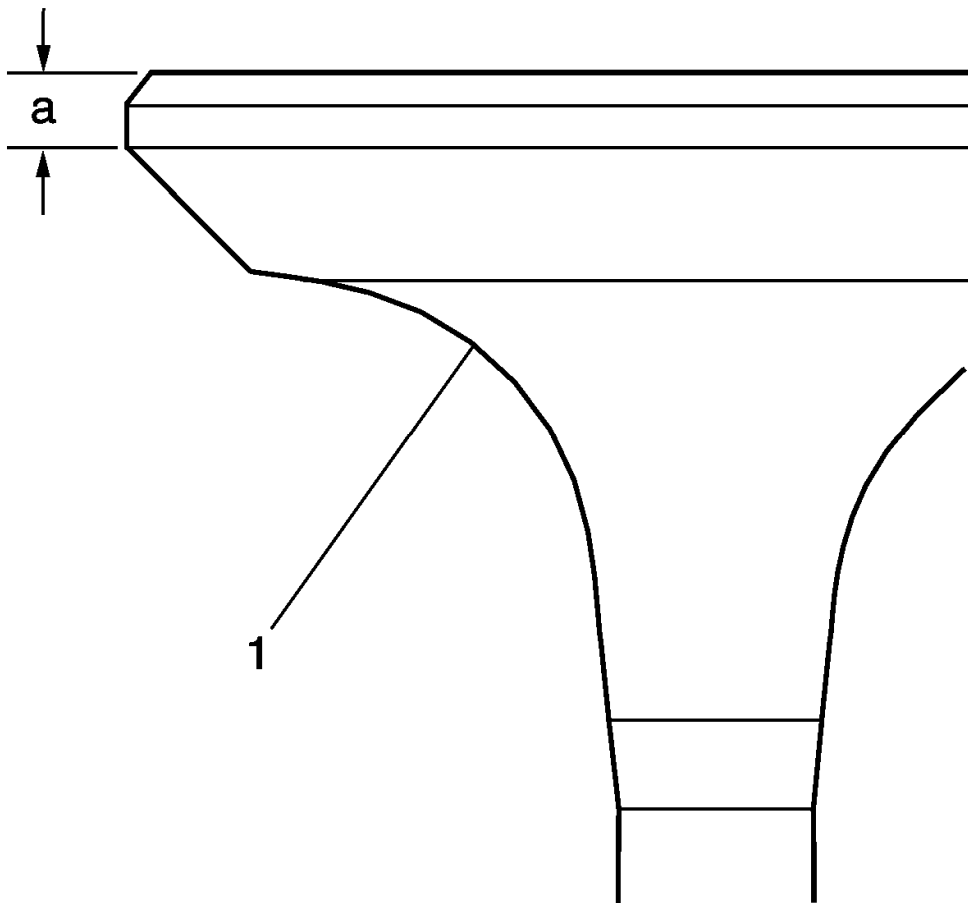


Fig. 134: View Of Valve Head O.D. & Chamfer
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve head O.D. and chamfer (a) using an appropriate scale. Refer to Engine Mechanical Specifications .

2. If the valve head O.D. and chamfer is within specification, test the valve (1) for seat concentricity using the Valve-to-Seat Concentricity Measurement Procedure. Reinspect the valve head O.D. and chamfer after completing the concentricity measurement if valve seat reconditioning is performed.

Valve-to-Seat Concentricity Measurement Procedure

NOTE:

- Checking the valve-to-seat concentricity determines whether the valve and seat are sealing properly.
- You must measure the valve face and the valve seat to ensure proper valve sealing.

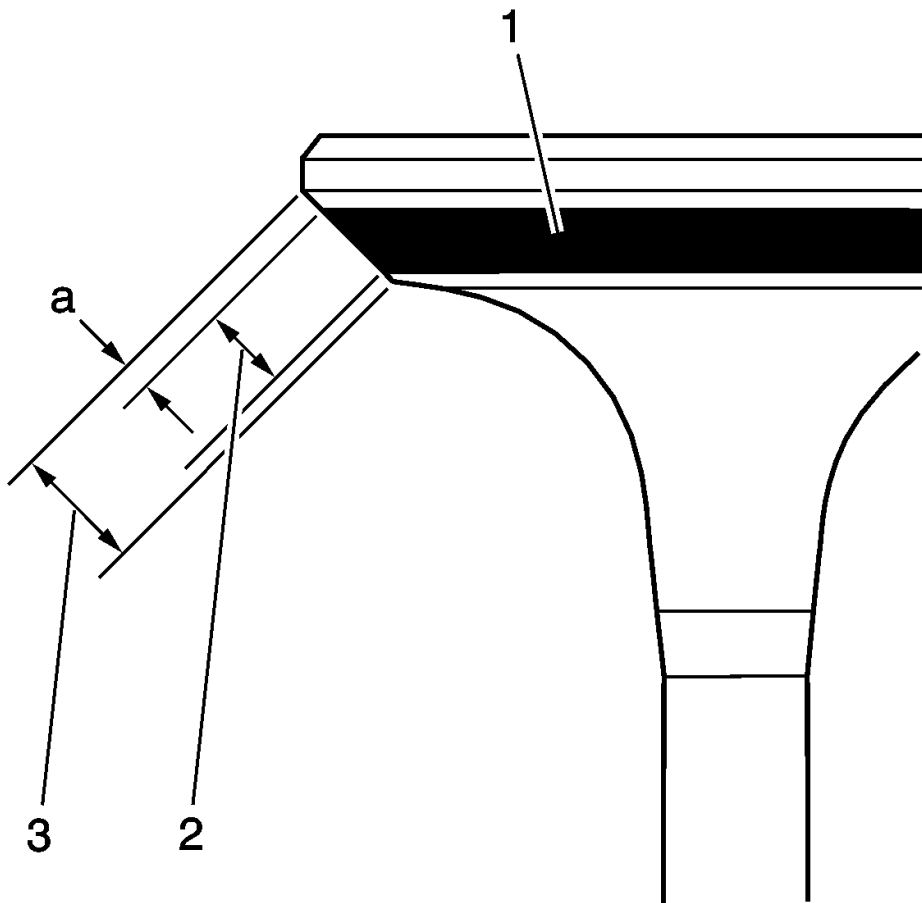


Fig. 135: Inspecting Valve Face
Courtesy of GENERAL MOTORS COMPANY

1. Coat the valve face (3) lightly with blue dye (1).
2. Install the valve in the cylinder head.
3. Turn the valve against the seat with enough pressure to wear off the dye.

4. Remove the valve from the cylinder head.

5. Inspect the valve face.

- If the valve face is concentric, providing a proper seal, with the valve stem, a continuous mark (2) will be made around the entire face.

NOTE: The wear mark **MUST** be at least 0.5 mm (0.020 in) from the outer diameter, the margin (a), of the valve. If the wear mark is too close to the margin, the seat must be reconditioned to move the contact area away from the margin.

NOTE: Do not grind or condition the intake valve. If the intake valve is out of specification, replace the valve.

- If the face is not concentric with the stem, the mark will NOT be continuous around the valve face. The valve should be refaced or replaced and the seat must be reconditioned using the Valve and Seat Reconditioning Procedure.

Valve and Seat Reconditioning Procedure

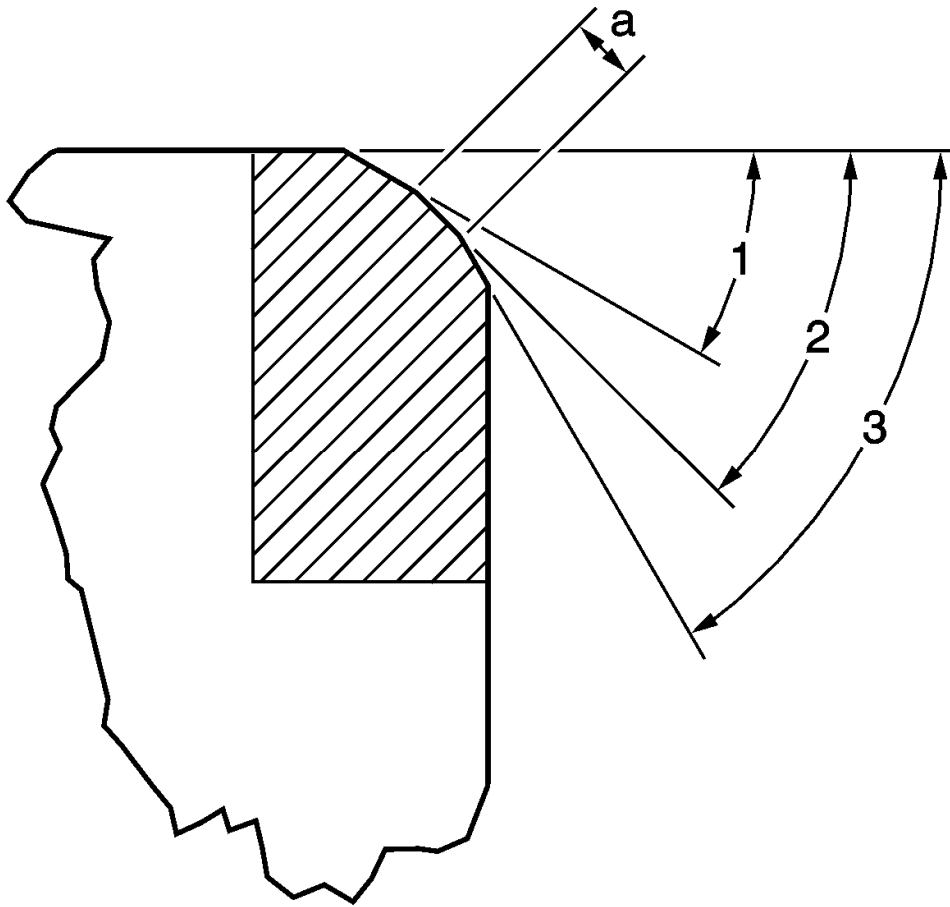


Fig. 136: Valve Seating Surface Angle
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- If the valve seat width, roundness or concentricity is beyond specifications, you must grind the seats in order to ensure proper heat dissipation and prevent the build up of carbon on the seats.
- It is necessary to reface the valve if seat reconditioning is required unless a new valve is used.

1. Grind the valve seating surface (a) to the proper angle specification (2) listed in **Engine Mechanical Specifications** .
2. Grind the valve relief surface to the proper angle specification (1) listed in **Engine Mechanical Specifications** , to correctly position the valve seating surface (a) to the valve.
3. Grind the valve undercut surface to the proper angle specification (3) listed in **Engine Mechanical Specifications** , to narrow the valve seating surface width (a) to the specifications listed in **Engine Mechanical Specifications** .

NOTE: **Do not grind or condition the intake valve. If the intake valve seat has been reconditioned, replace the corresponding intake valve.**

4. Replace the intake valve if it is out of specification. Refer to **Engine Mechanical Specifications** .
5. If the original exhaust valve is being used, grind the valve to the specifications listed in **Engine Mechanical Specifications** . Measure the valve head O.D. and chamfer again after grinding using the Valve Head O.D. and Chamfer Measurement Procedure. Replace the exhaust valve if it is out of specification. New valves do not require grinding.
6. When grinding the valves and seats, grind off as little material as possible. Cutting valve seat results in lowering the valve spring pressure.
7. Install the valve in the cylinder head.
 - If you are using refaced exhaust valves, lap the valves into the seats with a fine grinding compound. The refacing and reseating operations should leave the refinished surfaces smooth and true so that minimal lapping is required. Excessive lapping will groove the valve face and prevent a good seat when hot.
 - Be sure to clean any remaining lapping compound from the valve and seat with solvent and compressed air prior to final assembly.
8. After obtaining the proper valve seat width in the cylinder head, you must re-measure the valve stem height using the Valve Stem Height Measurement Procedure.
9. If the valve stem height is acceptable, test the seats for concentricity using the Valve-to-Seat Concentricity Measurement Procedure.

Valve Stem Height Measurement Procedure

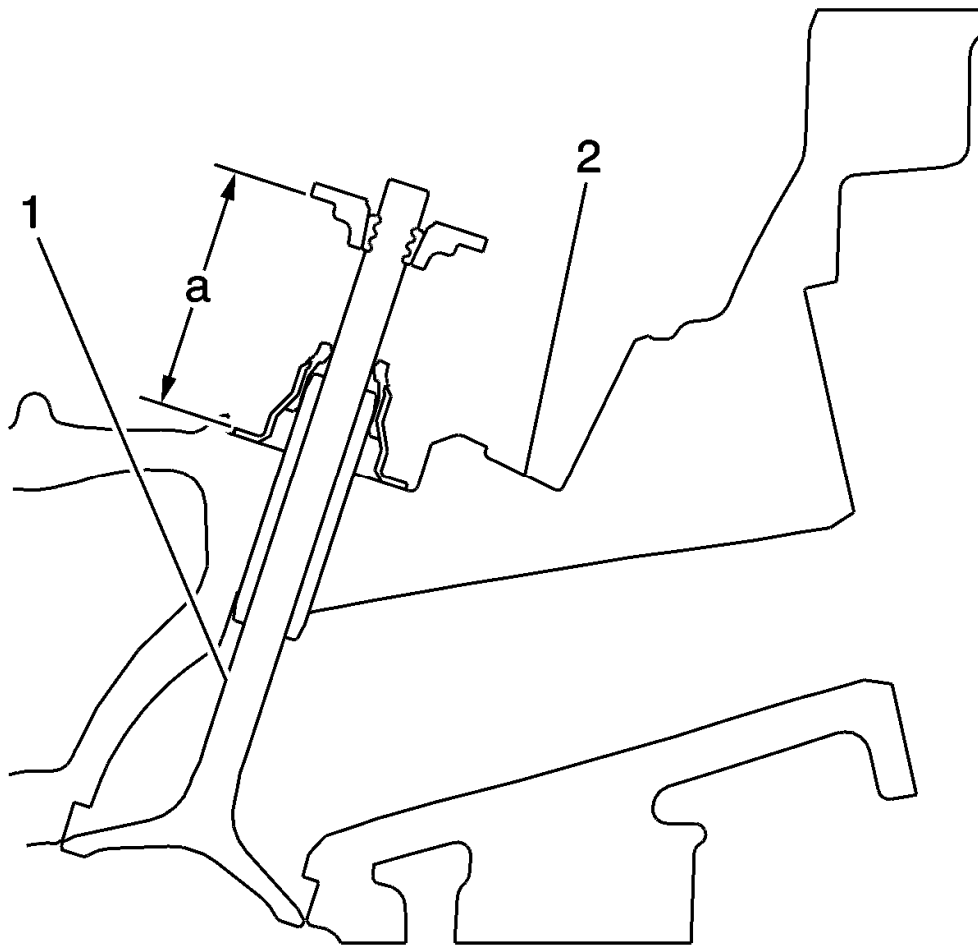


Fig. 137: Valve Stem Height Measurement
Courtesy of GENERAL MOTORS COMPANY

NOTE: To determine the valve stem height measurement, measure from the valve spring seat to the valve spring retainer.

1. Install the valve (1) into the valve guide in the cylinder head (2).
2. Ensure the valve is seated to the cylinder head valve seat.
3. Install the valve stem oil seal.
4. Install the valve spring retainer and valve stem locks.
5. Measure the distance (a) between the valve seal lip to the bottom of the valve spring retainer. Refer to **Engine Mechanical Specifications**.
6. If the maximum height specification is exceeded, a new valve should be installed and the valve stem height re-measured.

CAUTION: DO NOT grind the valve stem tip. The tip of the valve is hardened and grinding the tip will eliminate the hardened surface causing

premature wear and possible engine damage.

CAUTION: DO NOT use shims in order to adjust valve stem height. The use of shims will cause the valve spring to bottom out before the camshaft lobe is at peak lift and engine damage could result.

7. If the valve stem height still exceeds the maximum height specification, the cylinder head must be replaced.

CYLINDER HEAD ASSEMBLE

Special Tools

- **EN-50717** Valve Spring Compressor
- **EN-9666** Valve Spring Tester
- **EN-43963** Valve Spring Compressor (off car)

For equivalent regional tools, refer to **Special Tools** .

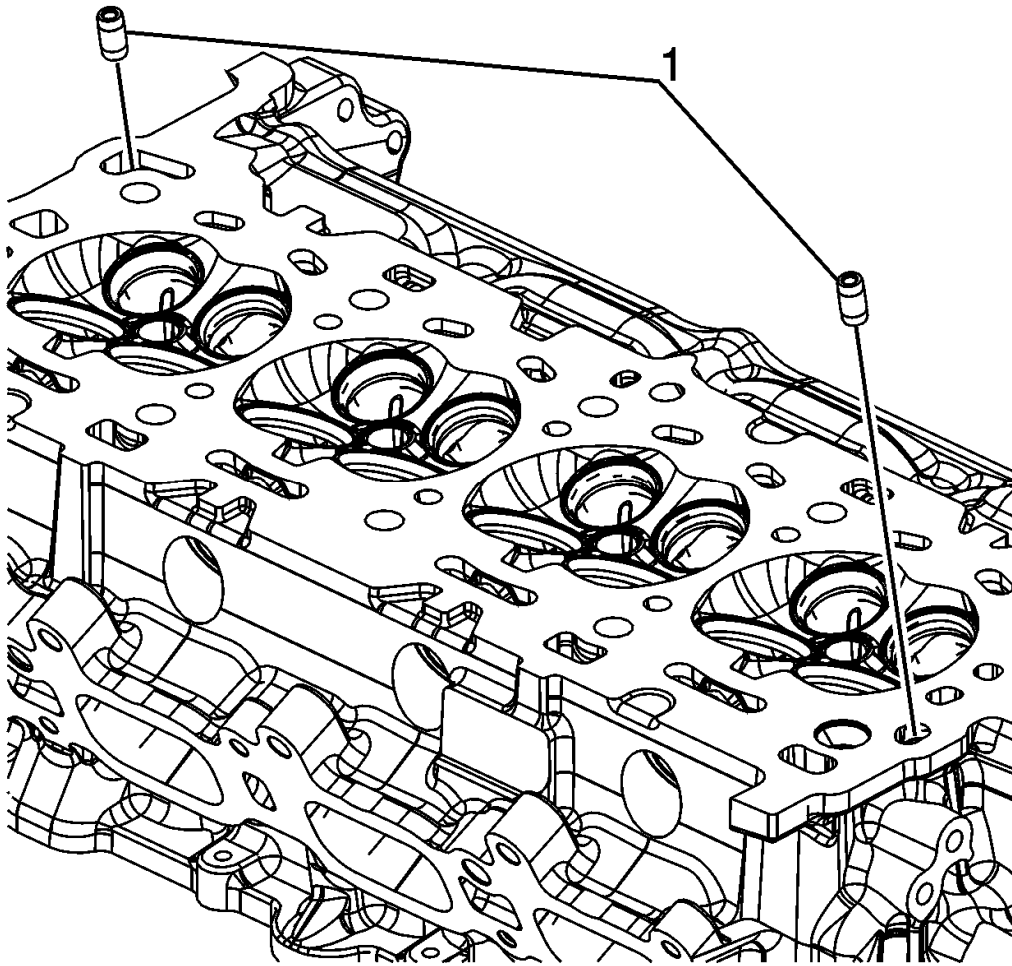


Fig. 138: Cylinder Head Oil Gallery Restrictors
Courtesy of GENERAL MOTORS COMPANY

1. Install the cylinder head oil gallery restrictors (1).

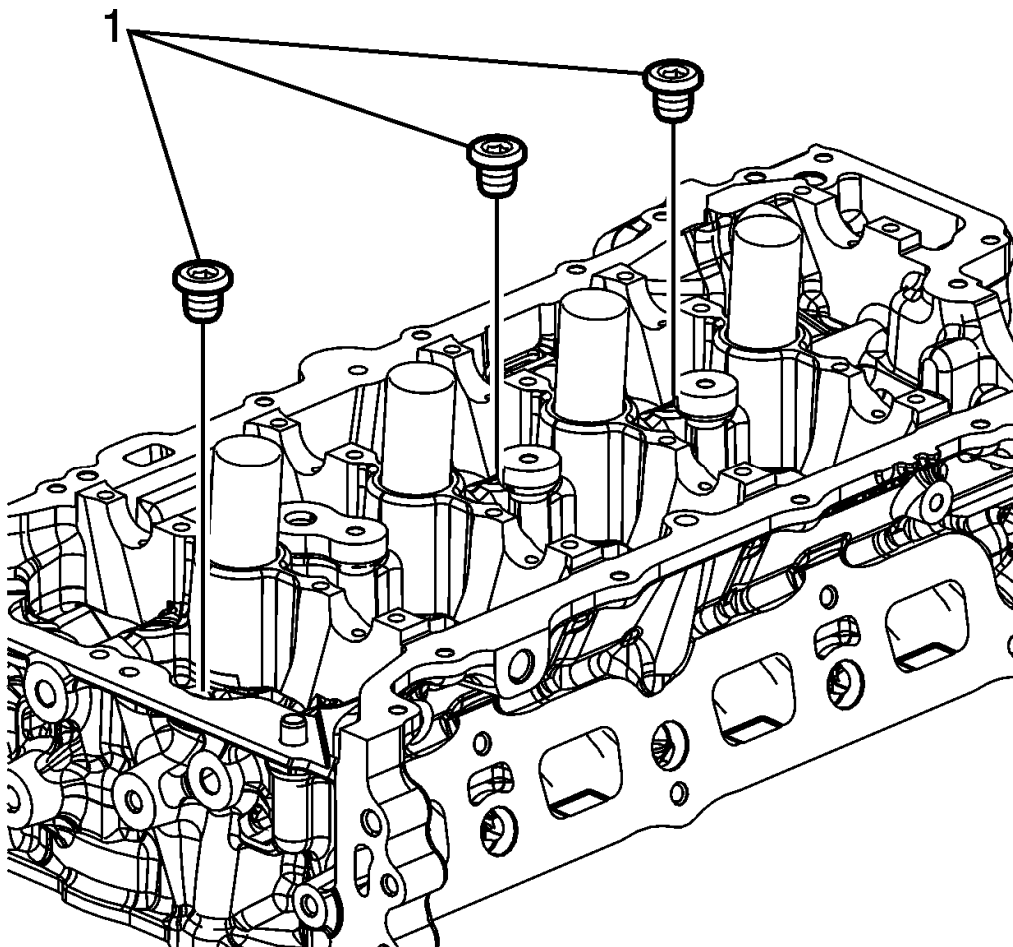


Fig. 139: Cylinder Head Plugs

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

CAUTION: In order to avoid damage, install the spark plugs after the cylinder head has been installed on the engine.

2. Install NEW cylinder head plugs. Coat the plugs with sealer. Refer to Adhesives, Fluids, Lubricants, and Sealers .
3. Install the water jacket hole plugs (1) in the top of the cylinder head. Tighten the plugs to 50 N.m (37 lb ft).

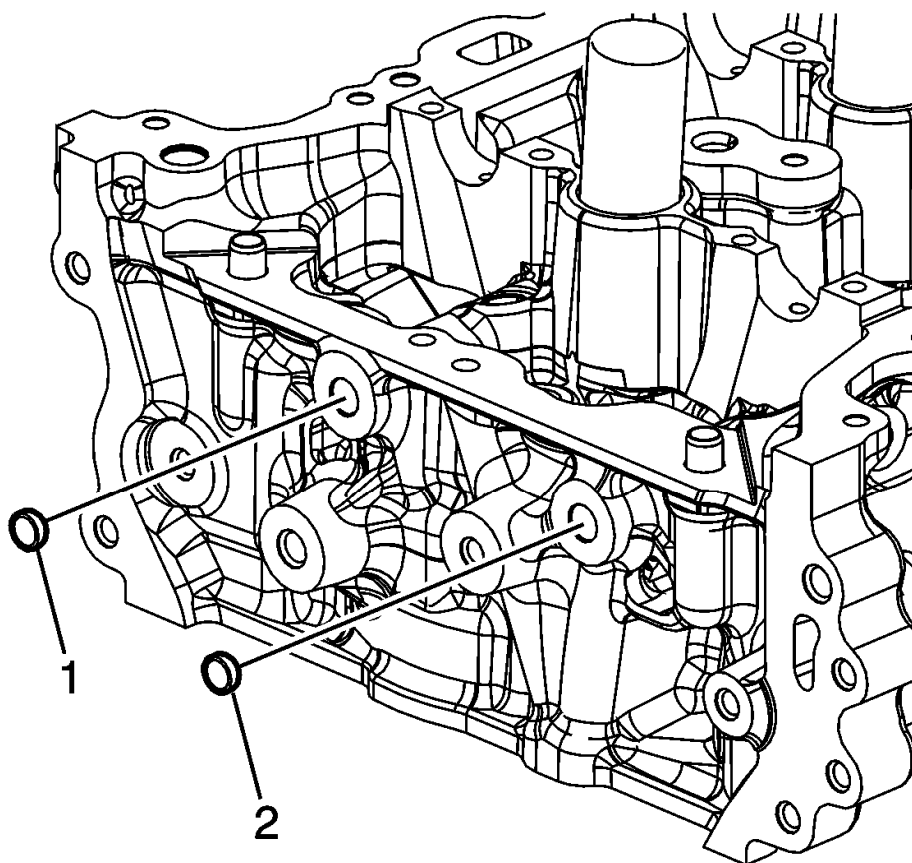


Fig. 140: Cylinder Head Plugs

Courtesy of GENERAL MOTORS COMPANY

4. Install the oil gallery plugs (1, 2) in the front of the cylinder head.

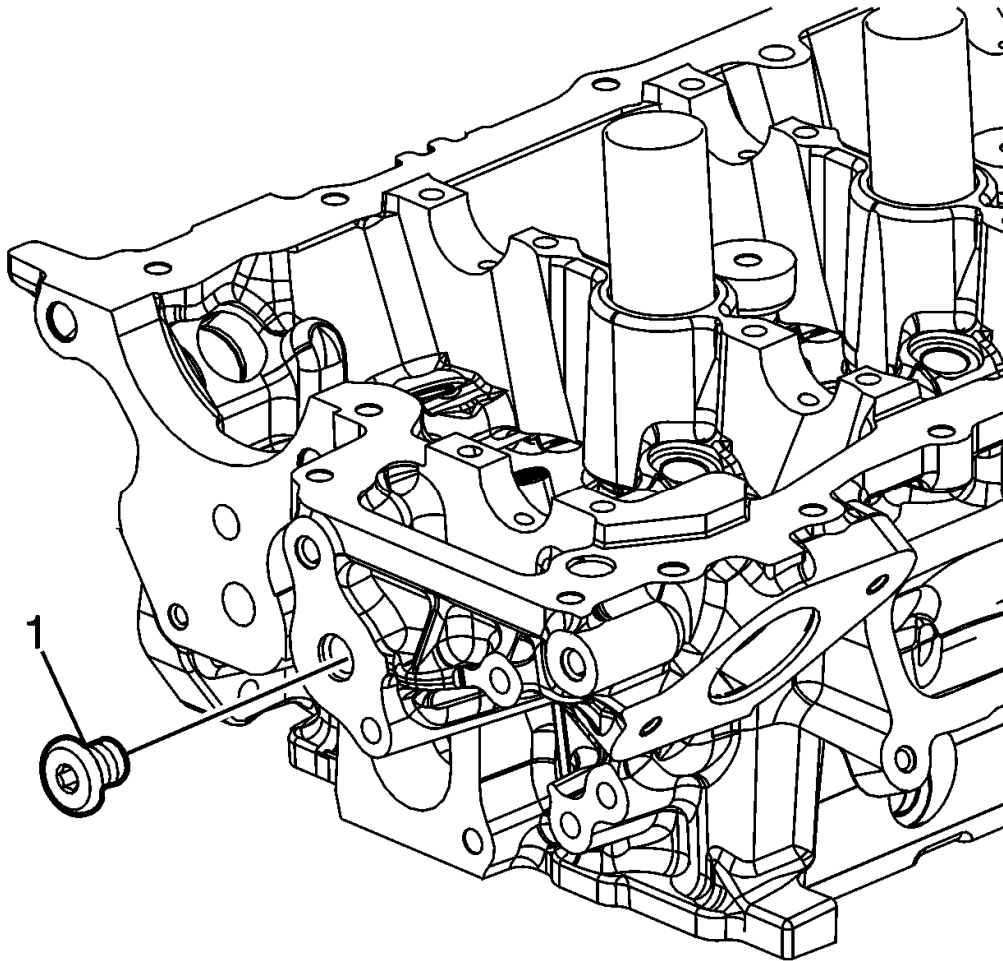


Fig. 141: Cylinder Head Plug
Courtesy of GENERAL MOTORS COMPANY

5. Install the oil gallery plug (1) in the rear of the cylinder head. Tighten the plug to 40 N.m (30 lb ft).
6. Inspect the valve springs for the following conditions:
 - Expanded height
 - Unparallel spring ends
 - Spring tension using **EN-9666** tester
 - Any distorted springs should be replaced

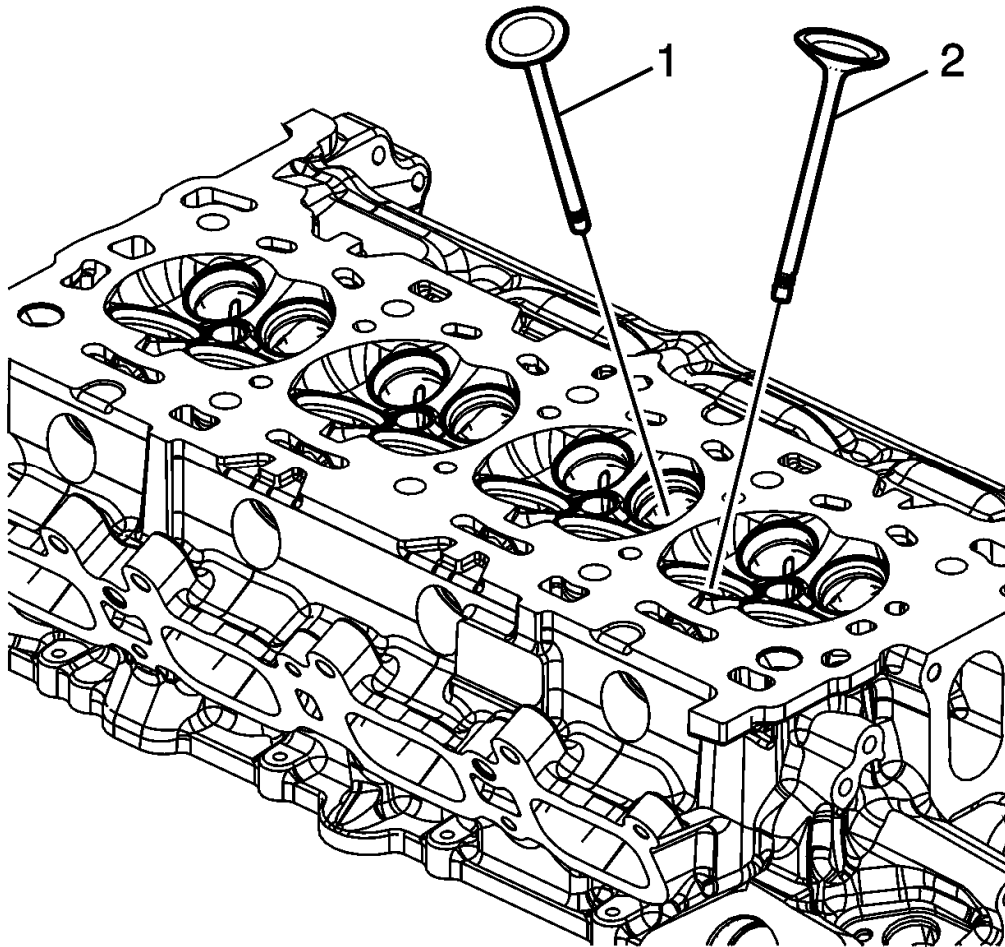


Fig. 142: Valves

Courtesy of GENERAL MOTORS COMPANY

7. Inspect the valves and the valve seats. Refer to **Valve and Seat Grinding**.
8. Install the valves (1, 2). Replace the valves, if required.

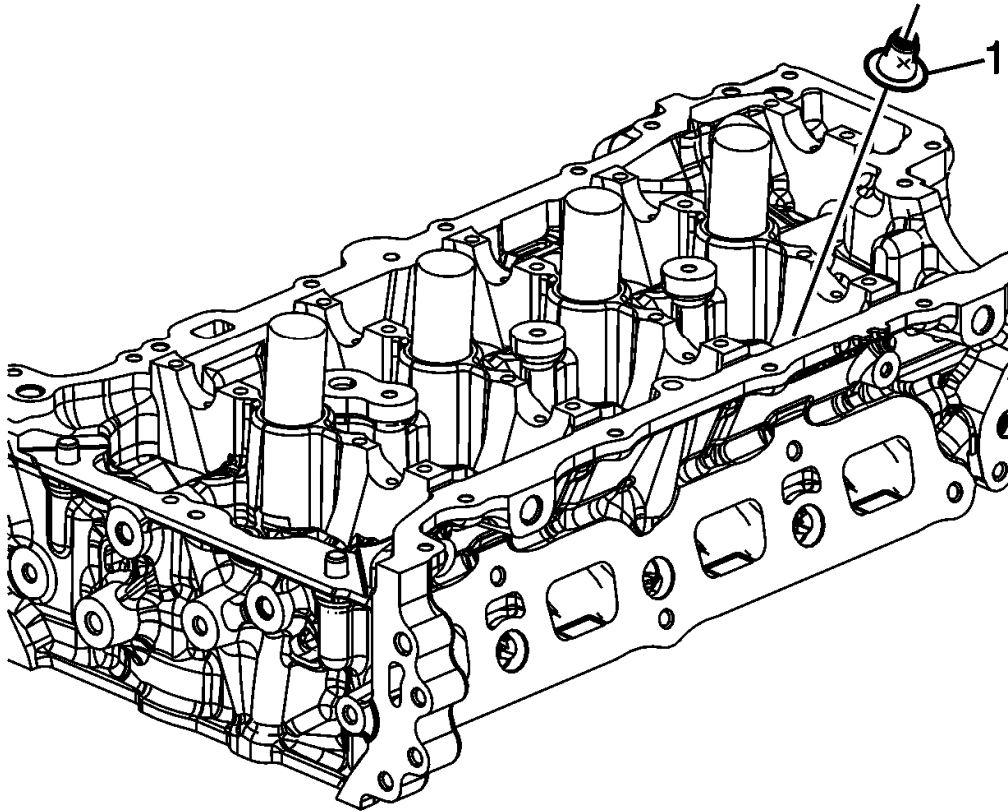


Fig. 143: Valve Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: Always use NEW valve stem oil seals when assembling the cylinder head.

9. Install the NEW valve seals (1). Fully seat the seals on the valve guides.

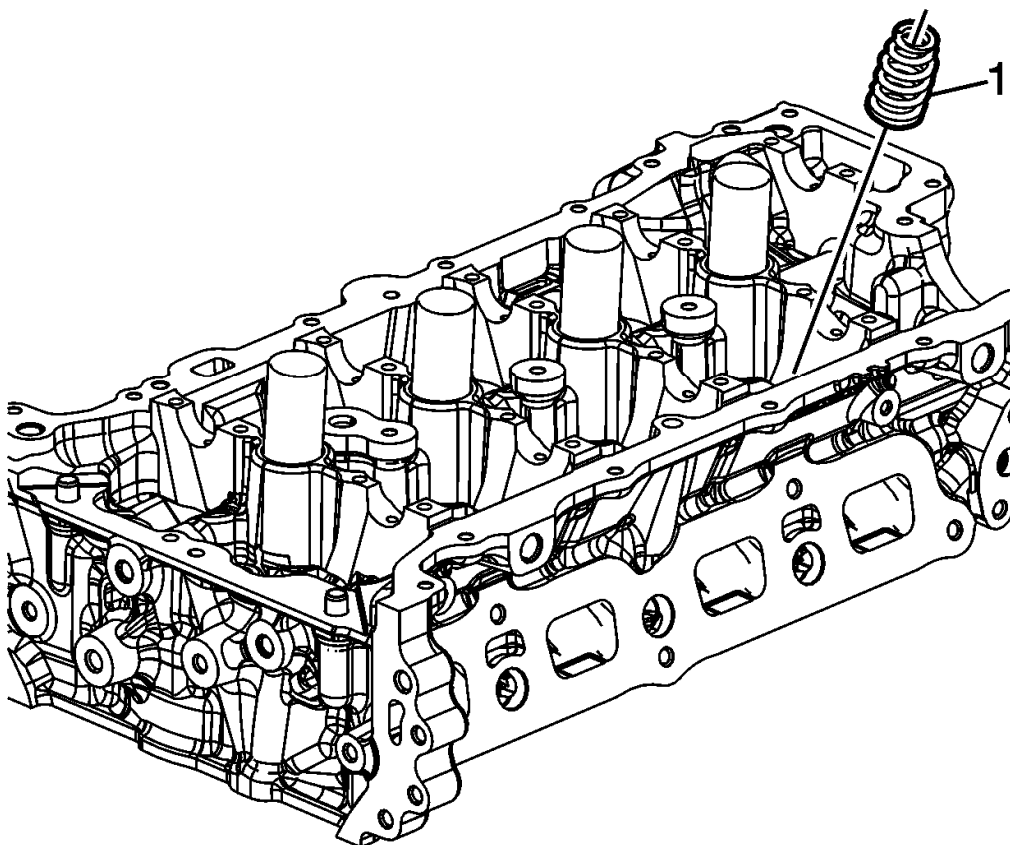


Fig. 144: Springs
Courtesy of GENERAL MOTORS COMPANY

10. Install the springs (1).

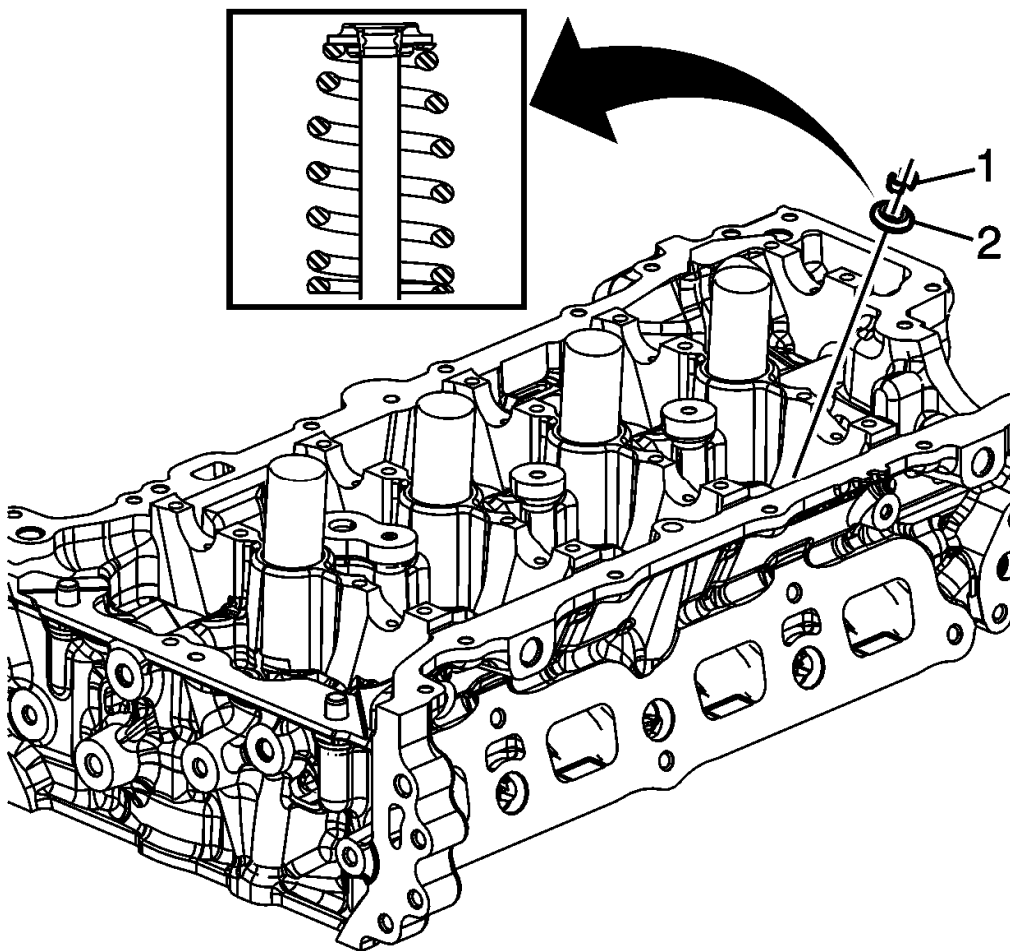


Fig. 145: Valve Keys, Springs, And Retainers
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

11. Install the retainers and keys using the following procedure:
 1. Install the retainer (2).
 2. Using the **EN-50717** compressor and the **EN-43963** adapter , compress the valve spring.

3. Install the valve keys (1).
4. Slowly release the compression from the valve/spring assembly.
5. Inspect for proper valve key seating.

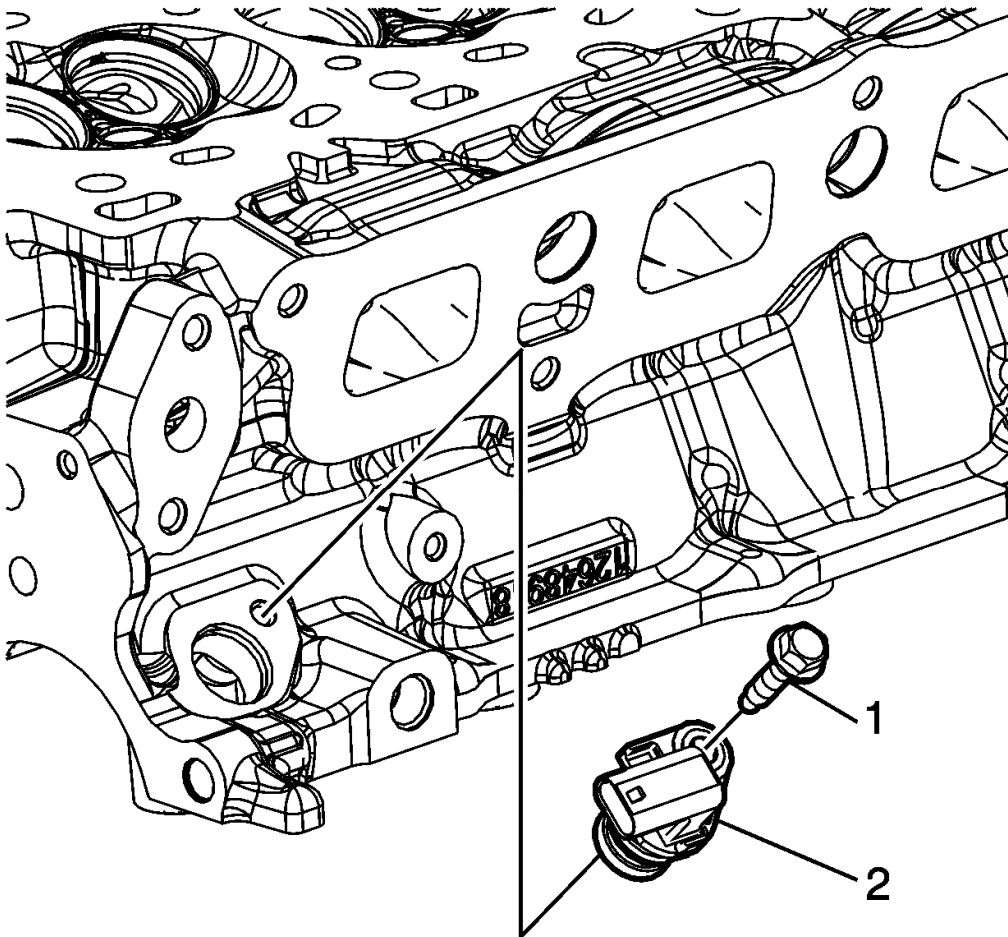


Fig. 146: Exhaust Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Lubricate the camshaft position sensor O-ring with clean engine oil.

CAUTION: Refer to Fastener Caution .

13. Install the exhaust camshaft position sensor (2) and bolt (1). Tighten the bolt to 10 N.m (89 lb in).

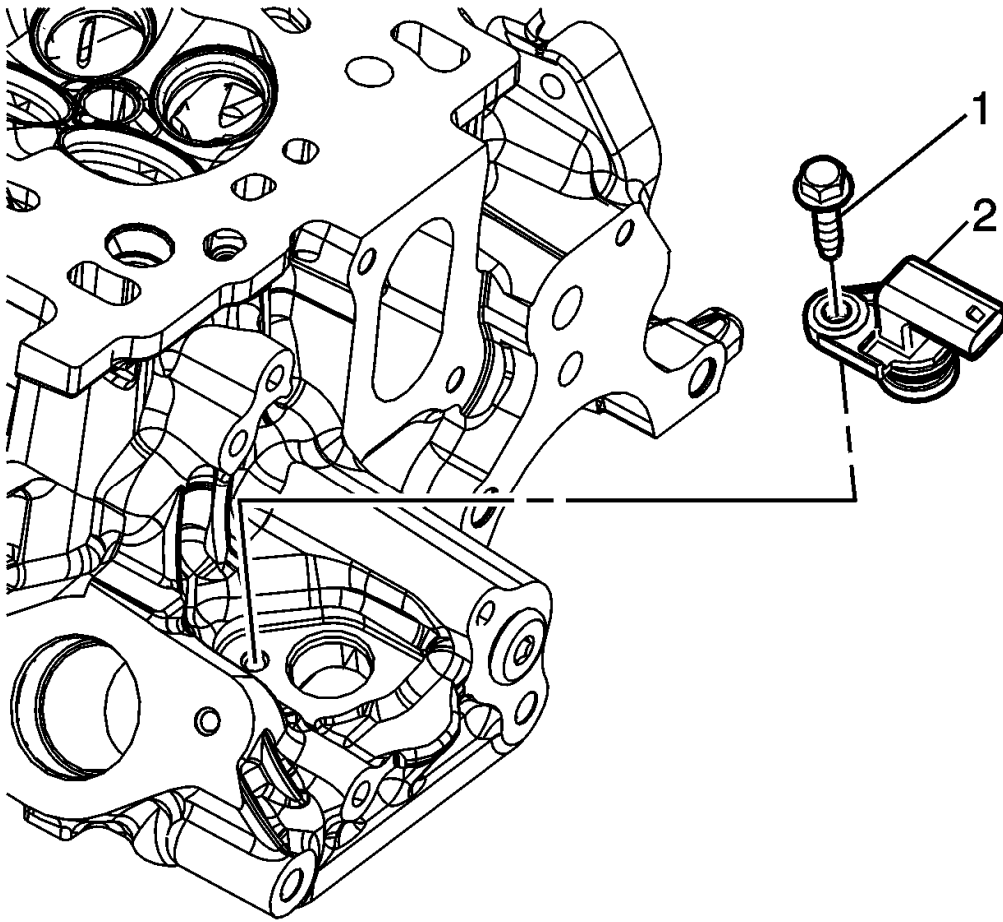


Fig. 147: Intake Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Lubricate the camshaft position sensor O-ring with clean engine oil.
15. Install the intake camshaft position sensor (2) and bolt (1). Tighten the bolt to 10 N.m (89 lb in).

BALANCER WITH OIL PUMP SHAFT DISASSEMBLE

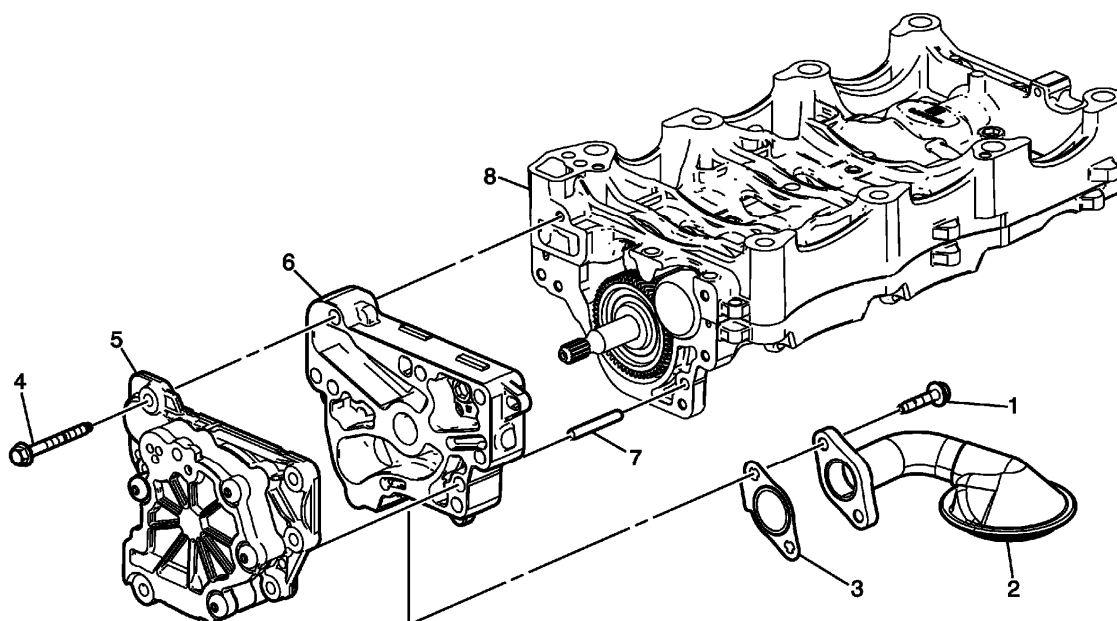


Fig. 148: Balancer With Oil Pump Shaft
 Courtesy of GENERAL MOTORS COMPANY

Balancer With Oil Pump Shaft Disassemble

Callout	Component Name
1	Oil Pump Suction Pipe Bolt
2	Oil Pump Screen Assembly with Suction Pipe
3	Oil Pump Screen Gasket NOTE: Discard the gasket.
4	Oil Pump Assembly Bolt
5	Oil Pump Assembly
6	Oil Pump Cover
7	Oil Pump Locating Pin
8	Balancer Shaft Module

BALANCER WITH OIL PUMP SHAFT CLEANING AND INSPECTION

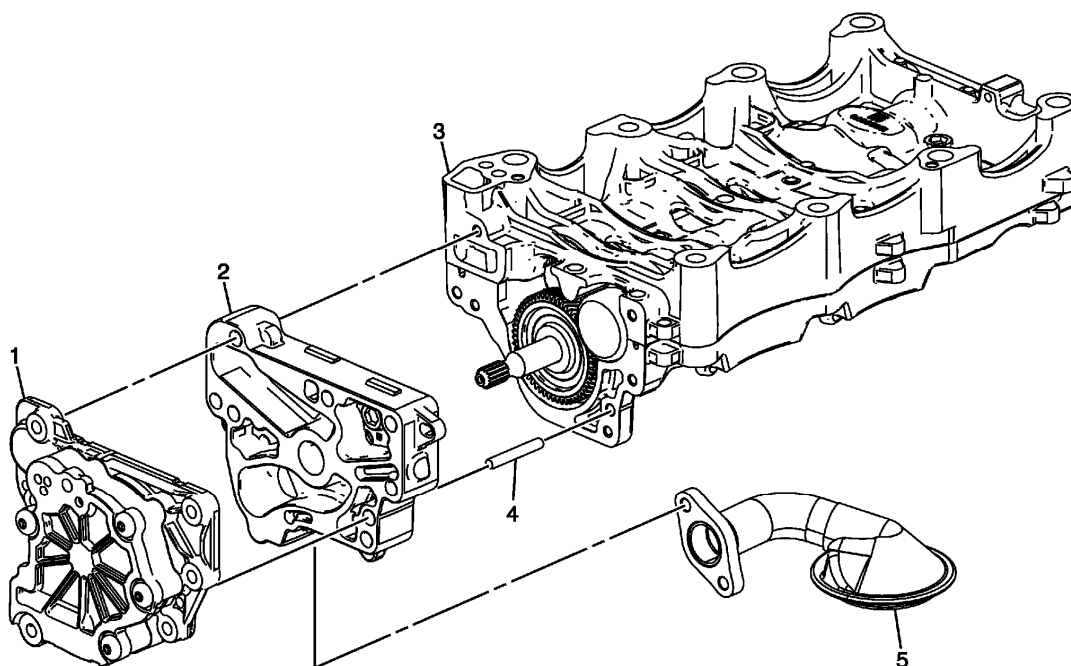


Fig. 149: Balancer With Oil Pump Shaft
 Courtesy of GENERAL MOTORS COMPANY

Balancer With Oil Pump Shaft Cleaning and Inspection

Callout	Component Name
Preliminary Procedures	
1. Completely inspect the balancer with oil pump shaft assembly and components. 2. Clean all mating surfaces. 3. Inspect all threaded holes for damage. 4. Inspect the oil pump screen assembly.	
1	Oil Pump Assembly
2	Oil Pump Cover
3	Balancer Shaft Module
4	Oil Pump Locating Pin
5	Oil Pump Screen Assembly with Suction Pipe

BALANCER WITH OIL PUMP SHAFT ASSEMBLE

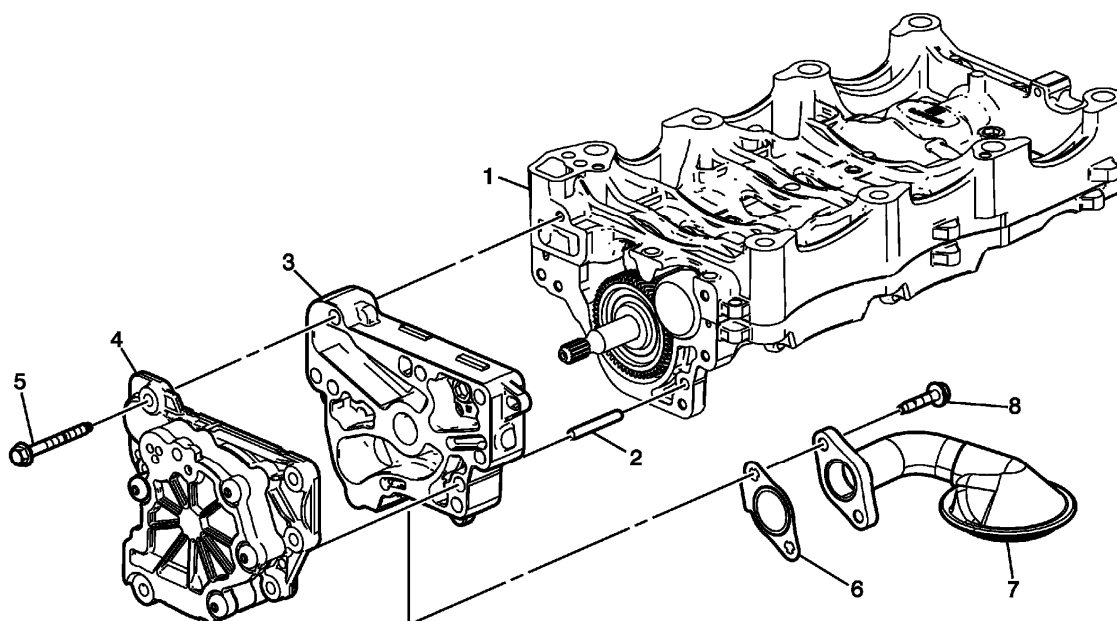


Fig. 150: Balancer Shaft Module, Oil Pump Locating Pin And Oil Pump Assembly
 Courtesy of GENERAL MOTORS COMPANY

Balancer With Oil Pump Shaft Assemble

Callout	Component Name
1	Balancer Shaft Module
2	Oil Pump Locating Pin
3	Oil Pump Cover
4	Oil Pump Assembly
5	Oil Pump Assembly Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
6	Oil Pump Screen Gasket NOTE: Use NEW gasket.
7	Oil Pump Screen Assembly with Suction Pipe
8	Oil Pump Suction Pipe Bolt Tighten 10 (89 lb in)

CAMSHAFT COVER CLEANING AND INSPECTION

Camshaft Cover - Right Side

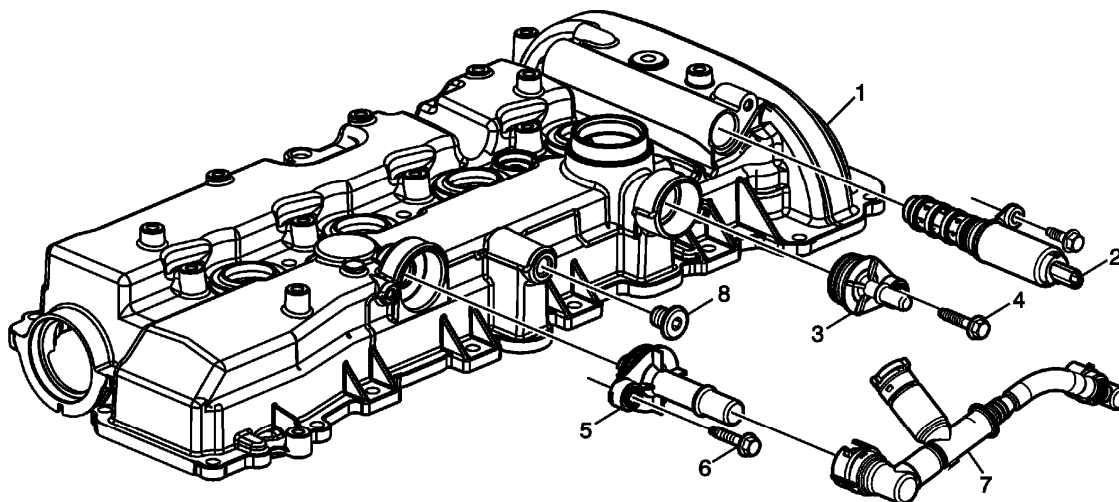


Fig. 151: Camshaft Cover -- Right Side
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover - Right Side

Callout	Component Name
Preliminary Procedure Thoroughly clean the camshaft cover and mating surfaces. Inspect each component, O-rings, and fasteners, and replace as necessary.	
1	Camshaft Cover
2	Camshaft Position Actuator Control Solenoid Valve - Intake
3	PCV Valve
4	PCV Valve Bolt
	CAUTION: Refer to Fastener Caution .
	Tighten 10 N.m (89 lb in)
5	PCV Valve
	PCV Valve Bolt

6	Tighten 10 N.m (89 lb in)
7	PCV Tube Assembly NOTE: Component may vary by model.
8	Camshaft Cover Plug Tighten 35 N.m (26 lb ft)

Camshaft Cover - Left Side

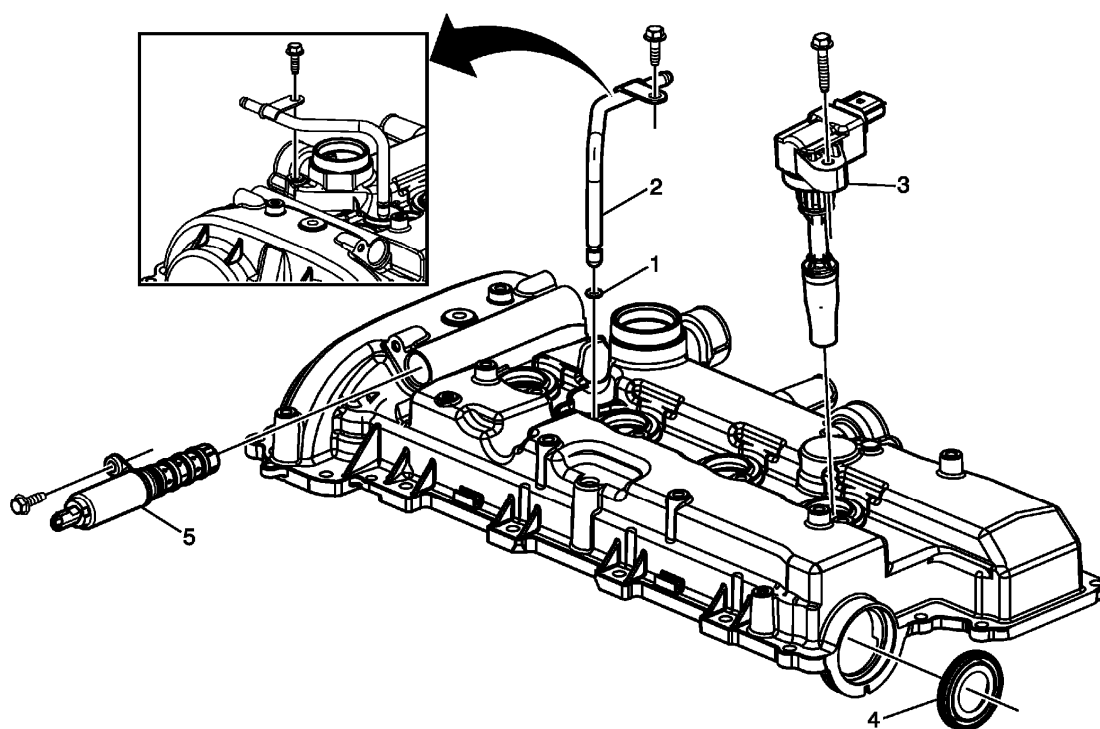


Fig. 152: Camshaft Cover -- Left Side
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover - Left Side

Callout	Component Name
Preliminary Procedure	
Inspect each component, O-rings, and fasteners, and replace as necessary.	
1	Engine Coolant Air Bleed Pipe O-Ring
2	Engine Coolant Air Bleed Pipe NOTE: Component may vary by model.

3	Ignition Coil
4	Vacuum Pump Seal Special Tools DT 45866 Input Shaft Seal Installer For equivalent regional tools, refer to Special Tools .
5	Camshaft Position Actuator Control Solenoid Valve

Camshaft Cover - PCV Valve Components for Turbocharger Models

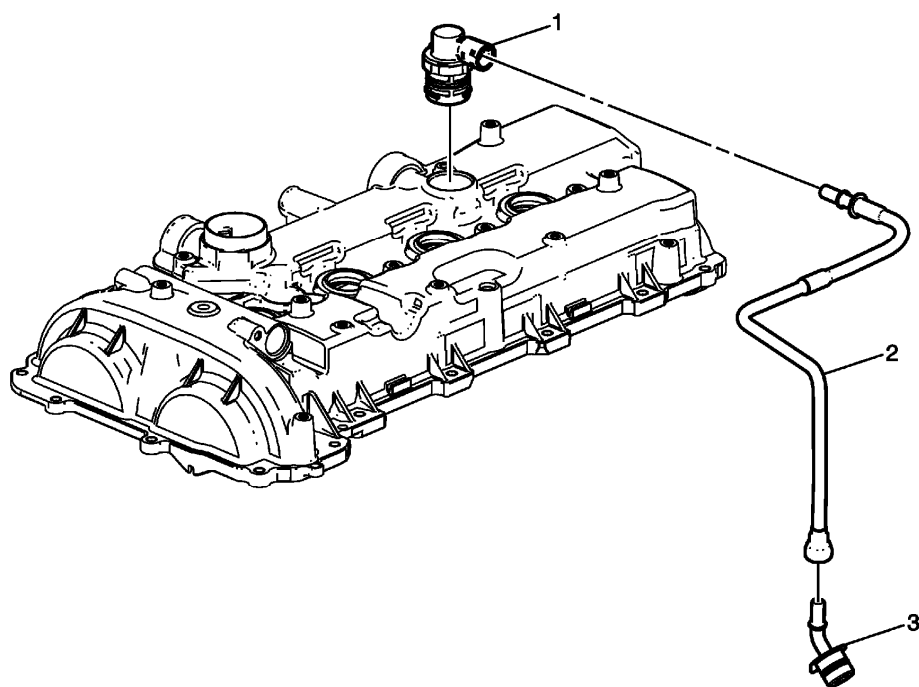


Fig. 153: Camshaft Cover -- PCV Valve Components for Turbocharger Models
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover - PCV Valve Components for Turbocharger Models

Callout	Component Name
Preliminary Procedure Inspect each component while attached to the camshaft cover. Do not remove the PCV components unless inspection indicates a suspect component. Replace the PCV valve, PCV tube assembly, and PCV hose fitting as an assembly. The connections between these components are permanent.	
1	PCV Valve NOTE: When the PCV valve is removed, small particles of the valve will break and fall into the cover.

	Procedure Inspect the PCV valve. If the PCV valve is suspect, use a suitable tool to pry the valve off of the cover. Retrieve any particles that fall onto the baffle in the cover. Discard the valve and particles.
2	PCV Tube Assembly
3	PCV Hose Fitting

Camshaft Cover - Bottom

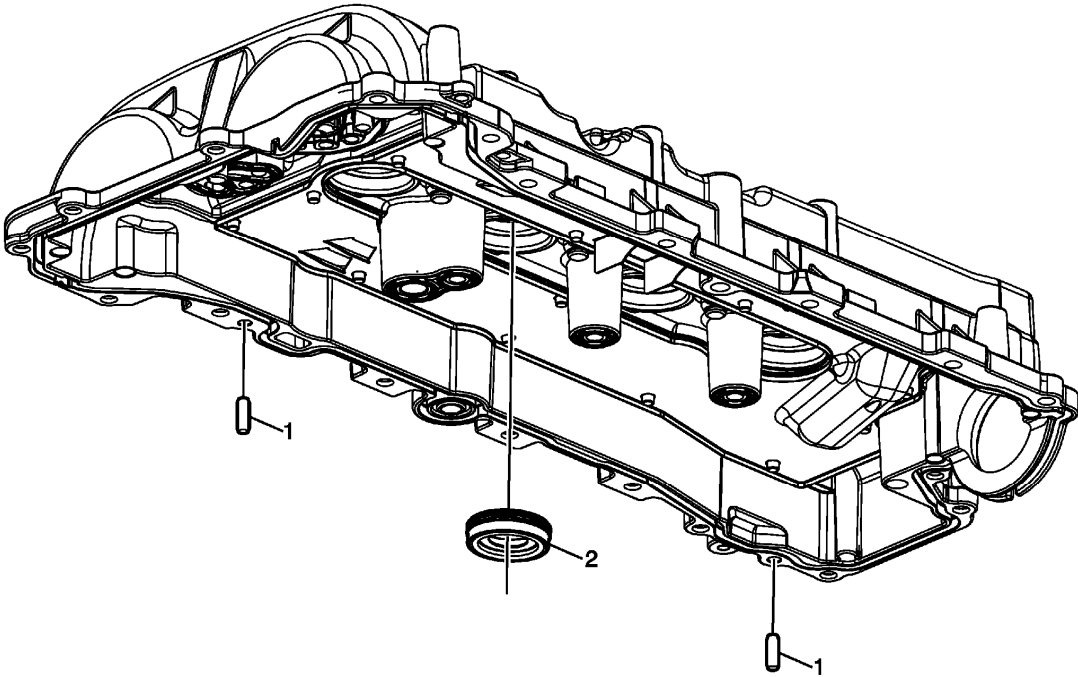


Fig. 154: Camshaft Cover Pins & Seal -- Bottom
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover - Bottom

Callout	Component Name
Preliminary Procedure Inspect each component, O-rings, and fasteners, and replace as necessary.	
1	Camshaft Cover Locating Pin
2	Spark Plug Shield Seal Special Tools EN 34115 Sprocket Bearing Installer For equivalent regional tools, refer to Special Tools .

TURBOCHARGER CLEANING AND INSPECTION

Turbocharger and Components

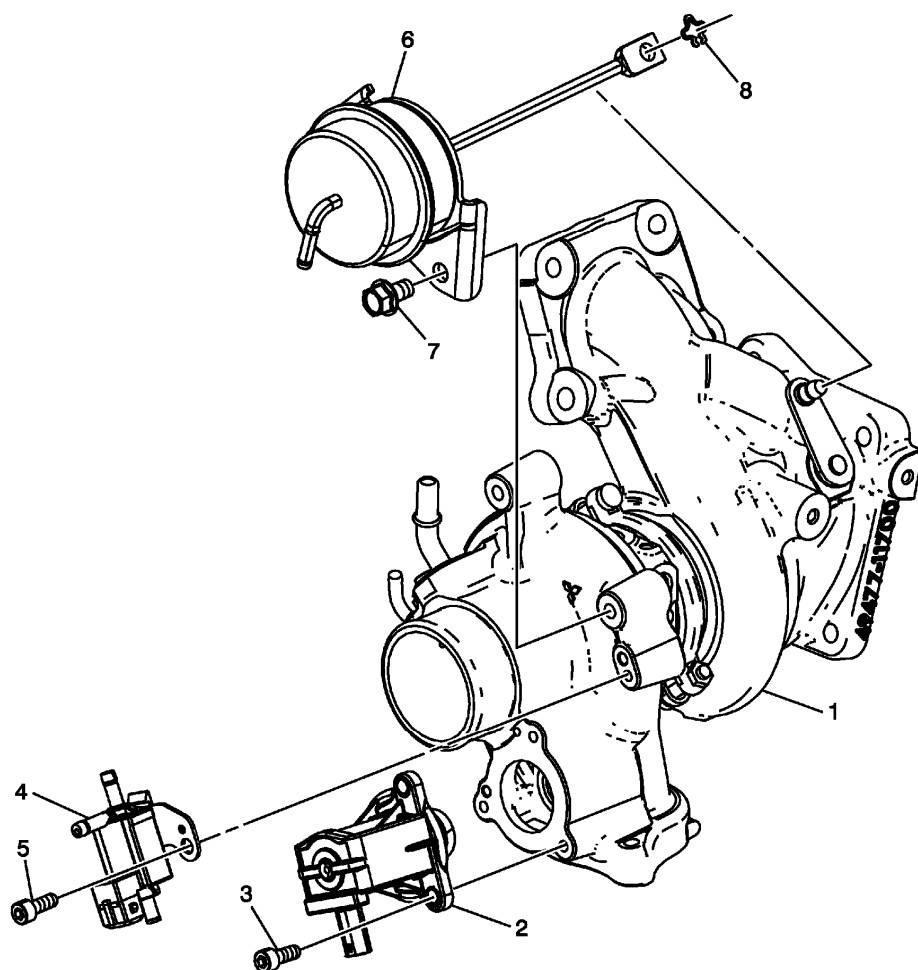


Fig. 155: Turbocharger and Components
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger and Components

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Completely inspect the turbocharger and all other engine components that may cause similar conditions before replacing the turbocharger. Refer to <u>Symptoms - Engine Mechanical</u> . 2. Clean all mating surfaces. 3. Inspect all threaded holes for damage. 4. Inspect the compressor and turbine blades for bent or broken conditions, and foreign material. PCV fluids and combustion product buildup are common and not a sign of failure. Replace the turbocharger if damage is found. 	
1	Turbocharger
2	Turbocharger Bypass Valve Solenoid
	NOTE:

	Inspect the bypass valve solenoid for damage. Replace if necessary.
3	Turbocharger Bypass Valve Solenoid Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 8 N.m (71 lb in)
4	Turbocharger Wastegate Regulator Solenoid Valve NOTE: Inspect the solenoid valve and bracket for damage only. Do not disassemble solenoid valve from bracket. Replace if necessary.
5	Turbocharger Wastegate Regulator Solenoid Valve Bracket Bolt Tighten 8 N.m (71 lb in)
6	Turbocharger Wastegate Actuator NOTE: Inspect the wastegate actuator rod for damage or tampering. Replace the wastegate actuator if damage is found.
7	Turbocharger Wastegate Actuator Bolt Tighten 8 N.m (71 lb in)
8	Turbocharger Wastegate Actuator Arm Retainer

Turbocharger Inlet and Wastegate Regulator Solenoid Hoses

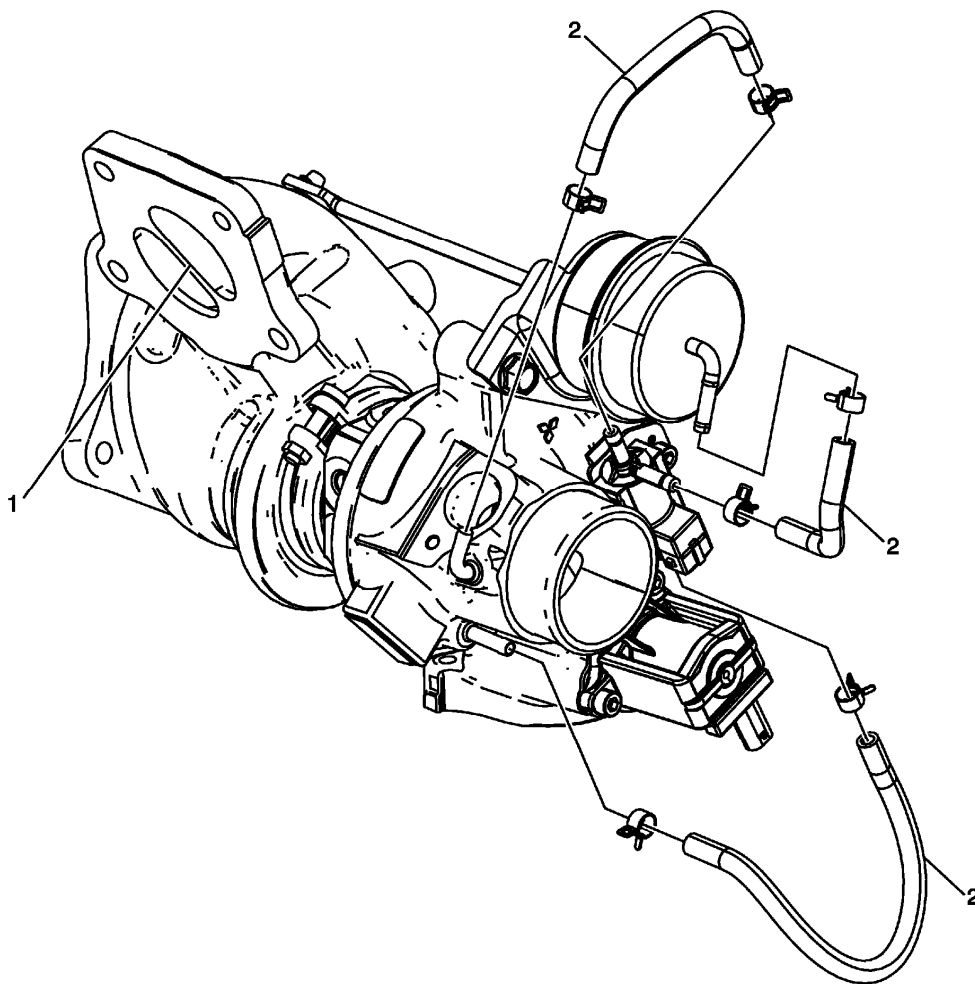


Fig. 156: Turbocharger Inlet and Wastegate Regulator Solenoid Hoses
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Inlet and Wastegate Regulator Solenoid Hoses

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Inspect the turbocharger compressor inlet, compressor outlet, turbine inlet, and turbine outlet surfaces for damage. Replace the turbocharger if damage is found. 2. Inspect the turbocharger wastegate regulator solenoid hoses for damage. Replace the hoses if necessary. 	
1	Turbocharger Inlet Flange Partition Wall NOTE: Do not replace the turbocharger if cracks are found on the turbocharger inlet flange partition wall. Replacement should only be performed if external leaks are present or a section is loose or missing.
2	Turbocharger Wastegate Regulator Solenoid Hoses

FUEL RAIL AND INJECTORS CLEANING AND INSPECTION

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-48266** Fuel Injector Seal Installer and Sizer
- **EN-50791** Fuel Injector Nozzle Installer

For equivalent regional tools, refer to **Special Tools** .

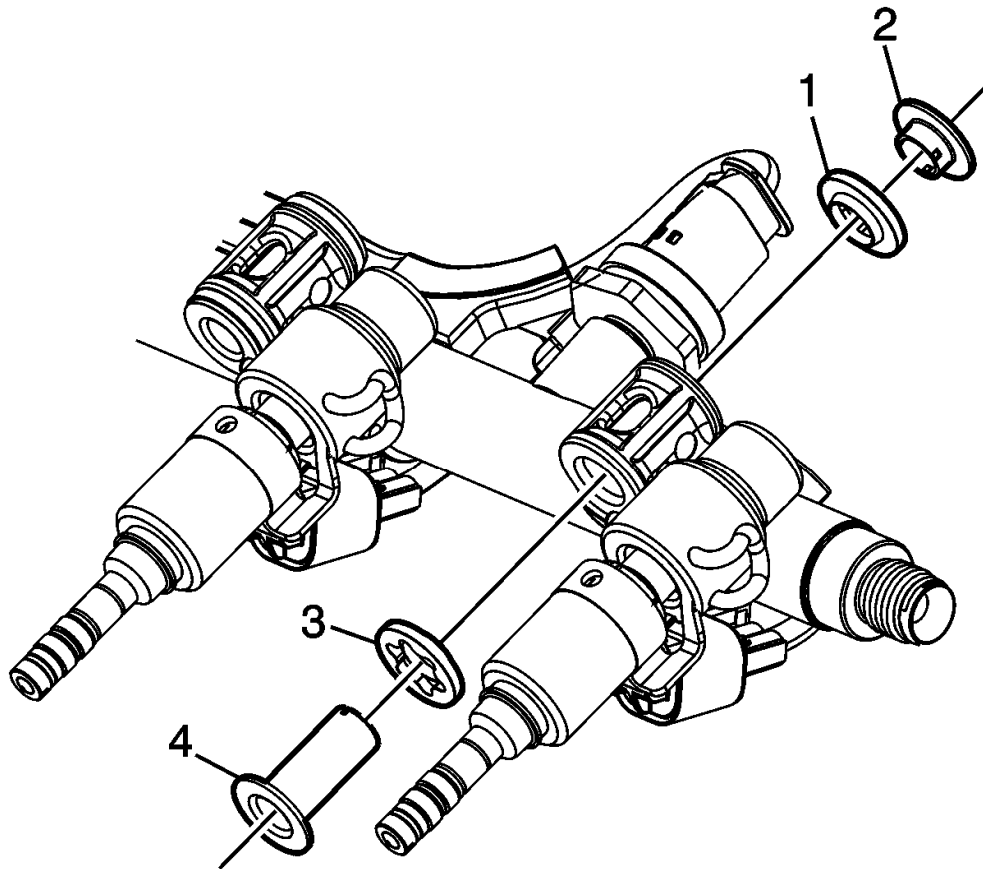


Fig. 157: Fuel Rail Insulator Assemblies
Courtesy of GENERAL MOTORS COMPANY

1. Remove and inspect the fuel rail insulator assemblies (1-4). Replace the entire assembly if any components show signs of wear or the insulators (4) show the following conditions:
 - Dry or cracked appearance
 - Flattened or misshapen appearance

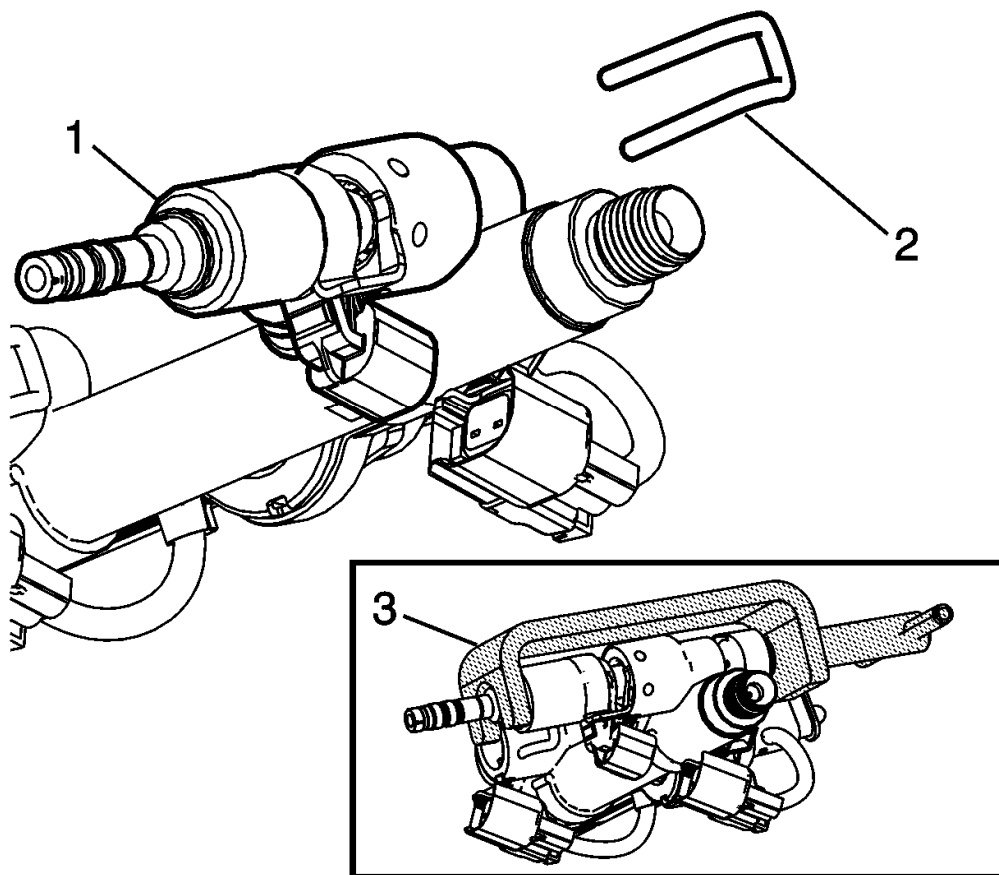


Fig. 158: Fuel Injector And Retaining Pin
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical connections from the fuel injectors.
3. Use **EN-50791** installer (3) to compress the fuel injector (1), and relieve pressure on the retaining pin (2). Remove the fuel injector retaining pin (2). Remove **EN-50791** installer once the retaining pin is removed.

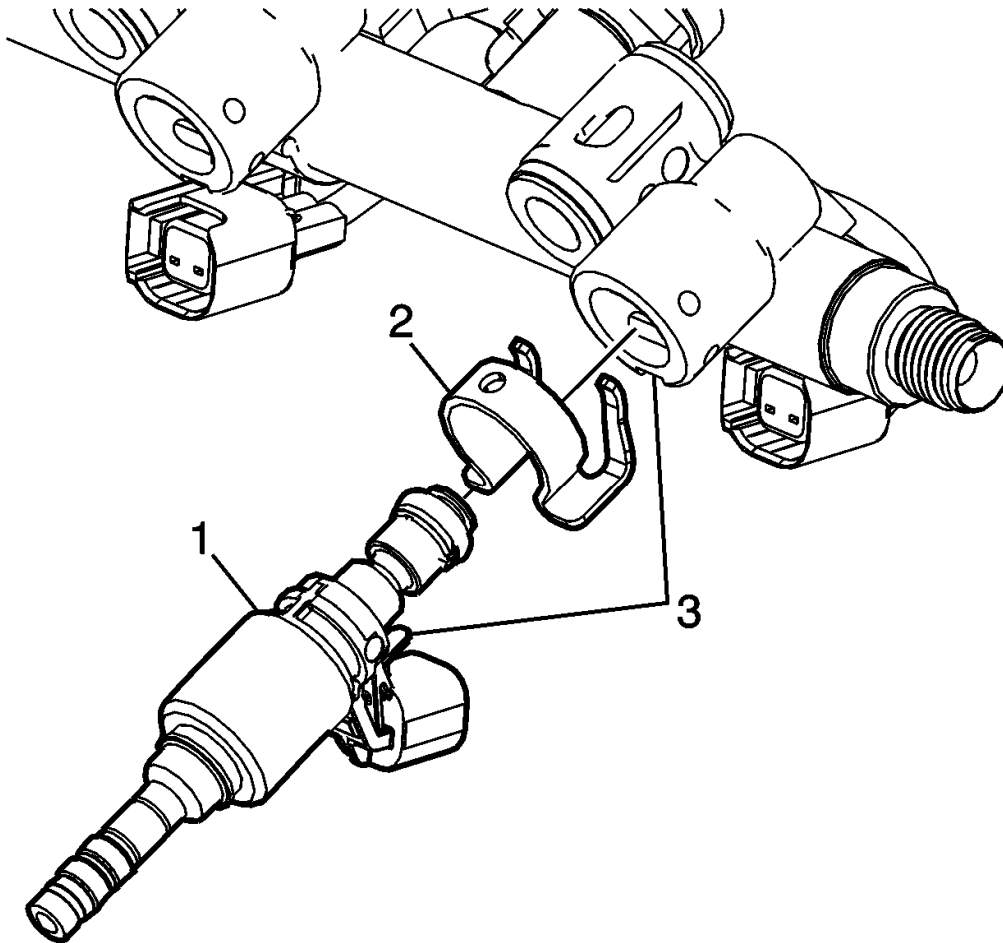


Fig. 159: Injectors And Fuel Rail Slot
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Support the fuel injector at the widest point. Support the fuel rail along the bottom.**

- **DO NOT support or hold the fuel injector by the tip or connector**
 - **DO NOT tilt or excessively twist the injector during removal**
4. Remove the injectors (1) from the fuel rail by pulling straight out along the fuel injector axis. Slight rotation of the fuel injector is acceptable as long as excessive force is not applied to the fuel injector tab while engaged in the fuel rail slot (3).
 5. Remove the fuel injector holding clamp (2) from the rear of the fuel injector.

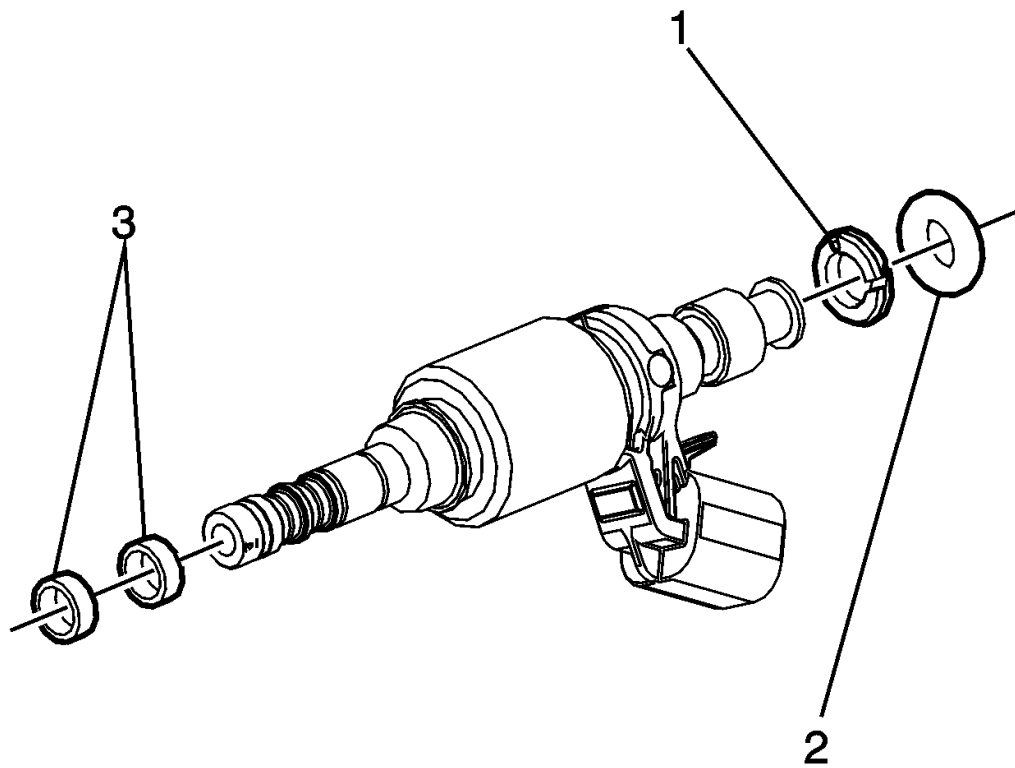


Fig. 160: Fuel Injector O-ring And Plastic Spacer
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the fuel injector O-ring (2) and plastic spacer (1).
7. Remove and discard the fuel injector seals (3).

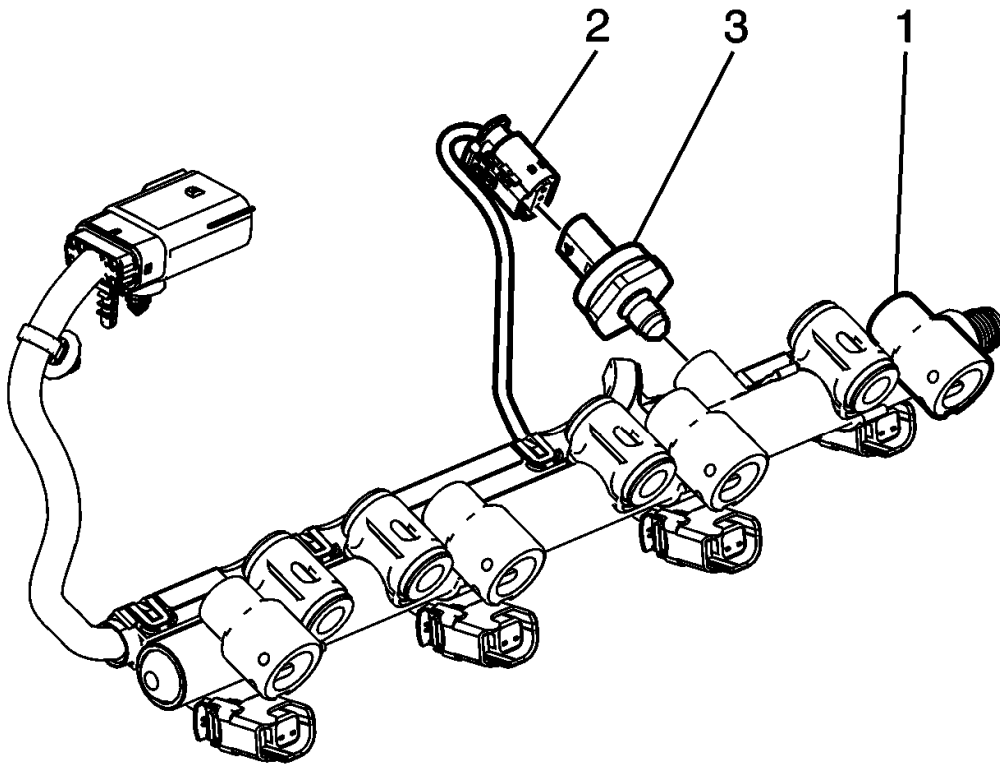


Fig. 161: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not soak or submerge the fuel rail or injectors in solvent. Do not use solvent on the fuel rail label.

8. Clean the exterior of the fuel rail (1) and injectors in solvent.
9. Using **EN-47909** cleaning kit , clean the fuel injector bores and sleeves.
10. Inspect the fuel rail and components for the following conditions:
 - Damage, debris, or restrictions to the fuel rail
 - Damage, debris, or restrictions to the fuel ports in the fuel rail
 - Damage to the mounting area for the fuel rail
 - Damage to the fuel rail mounting bolts
 - Damage to the threads on the fuel rail fuel feed fitting
11. Replace the fuel rail if any damage is found. Do not attempt to repair a fuel rail.

CAUTION: Refer to Fastener Caution .

NOTE: Remove and inspect the fuel pressure sensor only if the sensor is suspect.

12. Inspect the fuel pressure sensor (3) for damage.
 1. Disconnect the harness connector (2) from the fuel pressure sensor.
 2. Remove the fuel pressure sensor. Dry the fuel pressure sensor bore in the fuel rail with a lint free cloth. The bore should be free of fuel, debris, and burrs.
 3. Lubricate the fuel rail fuel pressure sensor bore with clean engine oil.
 4. Lubricate the threads and sealing area on the fuel pressure sensor with clean engine oil.
 5. Install the fuel pressure sensor hand tight.
 6. Remove the fuel pressure sensor and re-lubricate the bore, threads, and sealing area.
 7. Install the fuel pressure sensor and tighten to 33 N.m (25 lb ft).
 8. Connect the harness connector to the fuel pressure sensor.

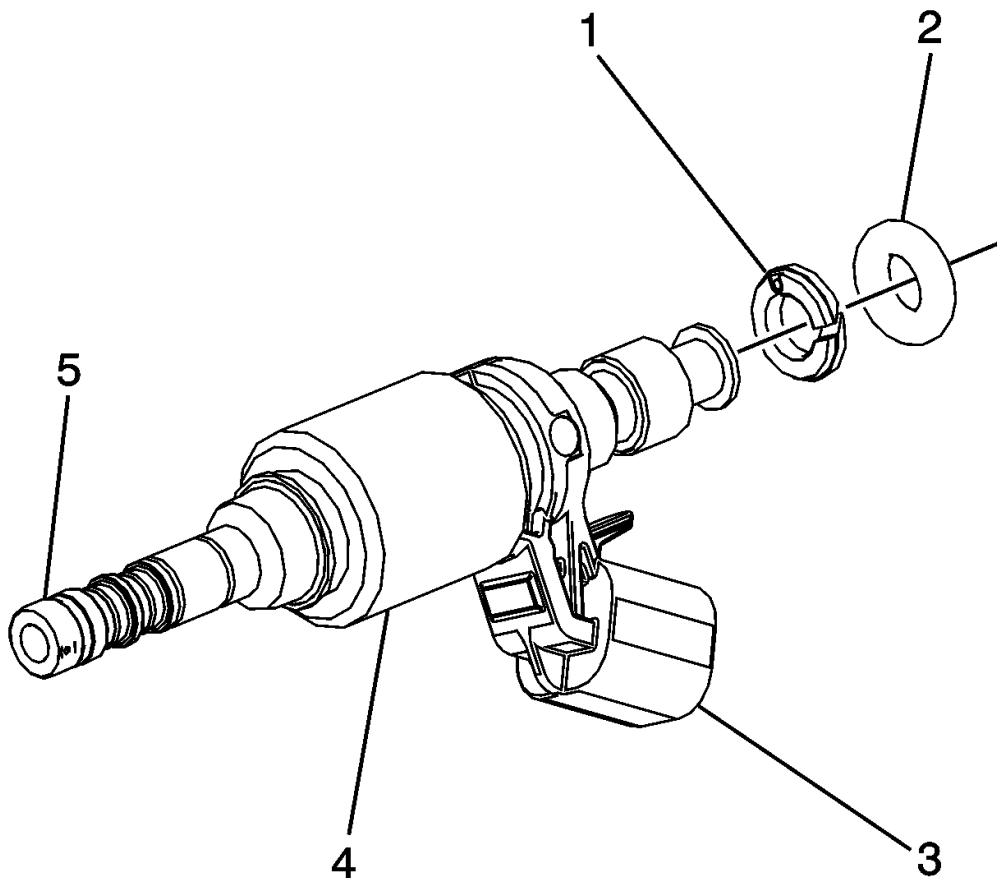


Fig. 162: Fuel Injector Connector

Courtesy of GENERAL MOTORS COMPANY

13. Inspect the fuel injectors for the following conditions:
 - Damage to the fuel injector connector (3)
 - Damage to the fuel injector harness connector
 - Damage to the fuel injector tip (5)
 - Damage to the fuel injector (4)
14. Replace the fuel injector if any damage is found. Do not attempt to repair a fuel injector.
15. Install the a new fuel injector spacer (1).
16. Lubricate the new O-ring (2) with clean, silicone-free 5W30 engine oil.
17. Install the O-ring on the injector.

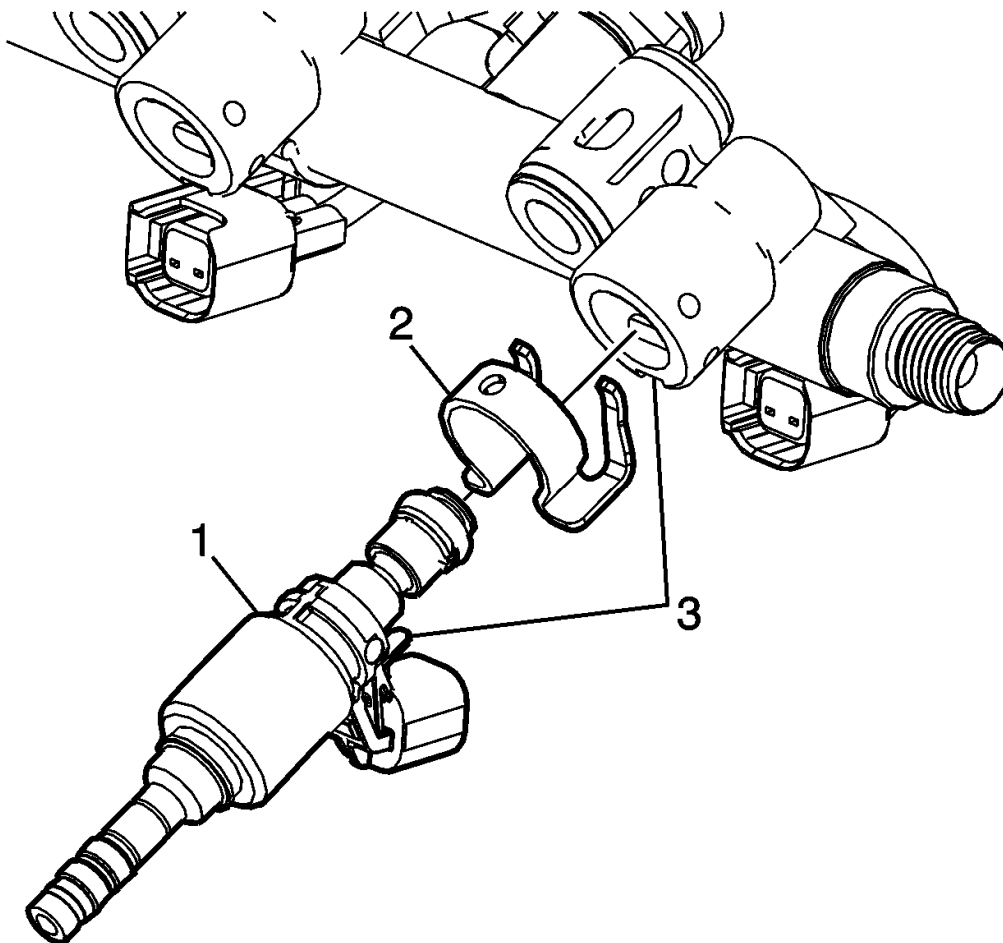


Fig. 163: Injectors And Fuel Rail Slot
Courtesy of GENERAL MOTORS COMPANY

18. Install the fuel injector holding clamp (2) onto the rear of the fuel injector.
19. Hand install fuel injectors (1) to the fuel rail, carefully aligning the fuel injector tab to the slot in the fuel

rail (3).

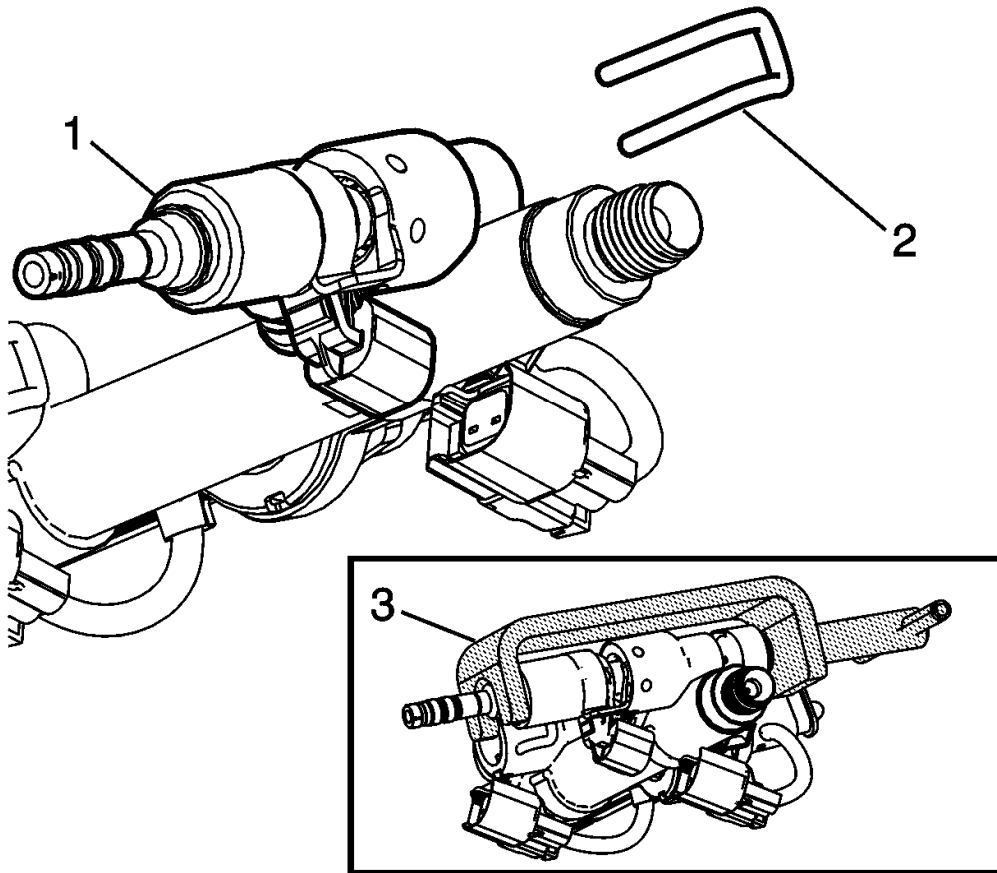


Fig. 164: Fuel Injector And Retaining Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE: The injector must be fully installed and properly aligned with the fuel rail before installing the retaining pin.

20. Using **EN-50791** installer (3), compress the fuel injector (1) into the fuel rail.
21. Ensure the fuel injector is fully seated in the fuel rail, and install the fuel injector retaining pin (4).
22. Ensure the fuel injector retaining pin is fully seated in the fuel rail. Remove **EN-50791** installer. Repeat process until all fuel injectors are properly installed to the fuel rail.

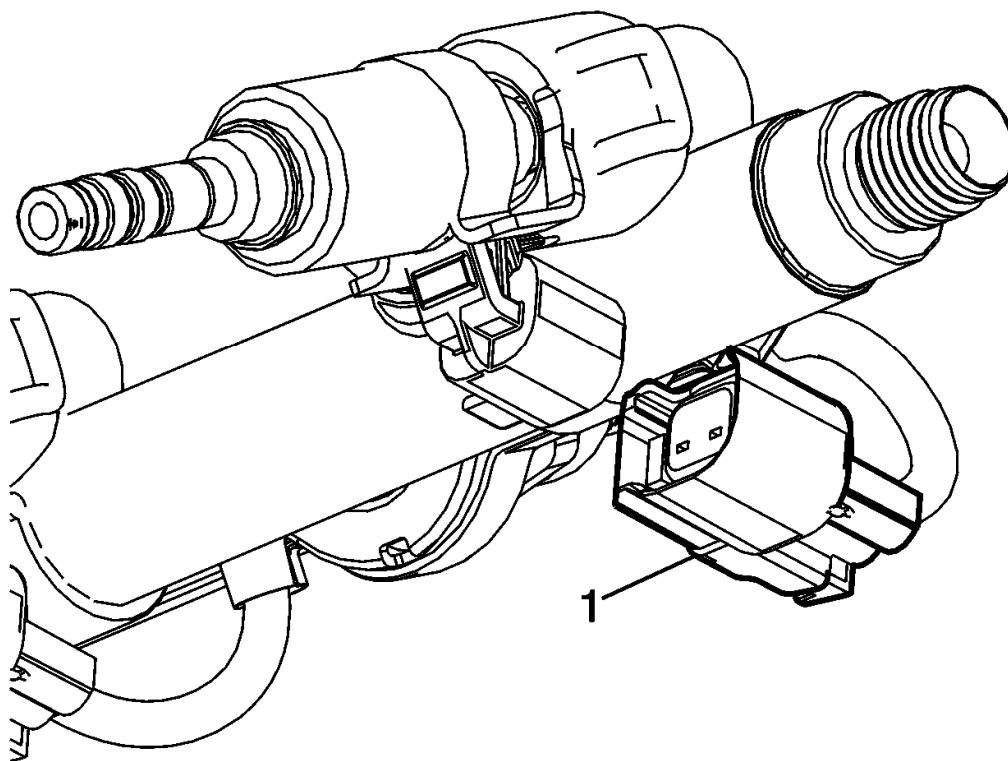


Fig. 165: Fuel Rail Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

23. Connect the electrical connection to the fuel rail.
24. Connect the fuel rail harness connectors (1) to the fuel injectors.

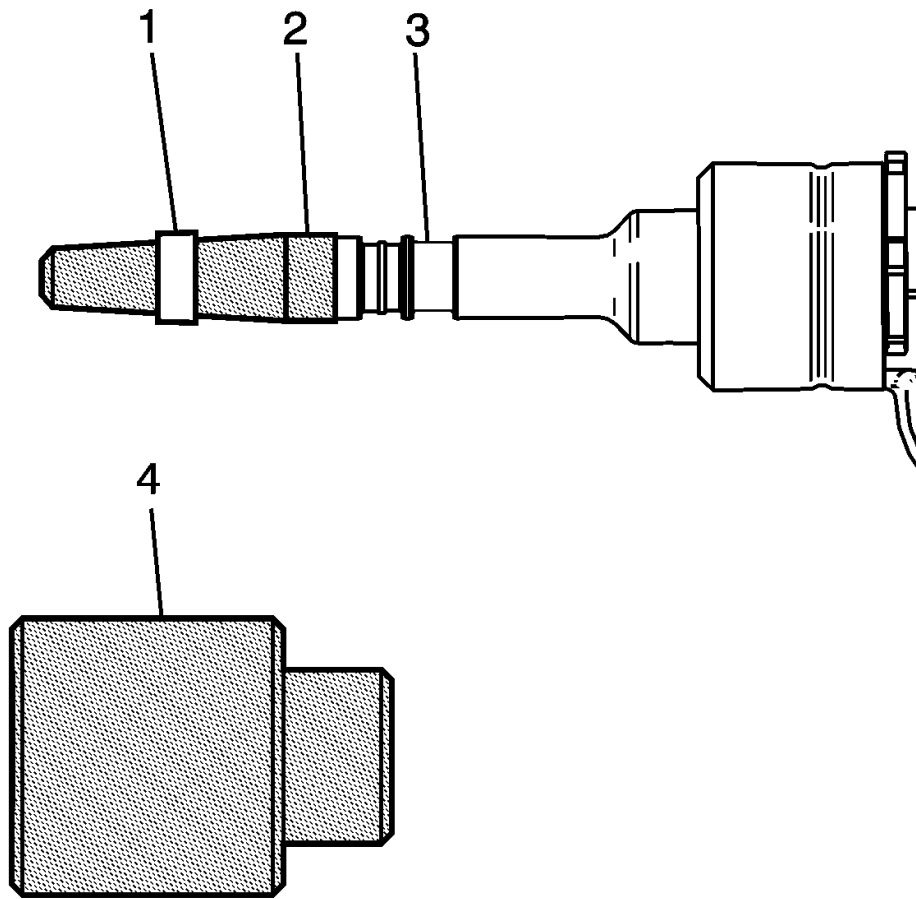


Fig. 166: Second Recessed Area And NEW Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any type of lubricant when installing the NEW seals on the fuel injector tip.

25. Install **EN-48266** protector (2) onto the fuel injector tip. Place a NEW seal (1) on **EN-48266** protector.
26. Install a seal into the second recessed area (3) of the fuel injector.
27. Compress the seal with your fingers, then resize the seal using the **EN-48266** sizer (4).
28. Place a second NEW seal (1) on **EN-48266** protector.
29. Install the seal into the first recessed area of the fuel injector.
30. Compress the seal with your fingers, then resize the seal using the **EN-48266** sizer (4).

INTAKE MANIFOLD CLEANING AND INSPECTION

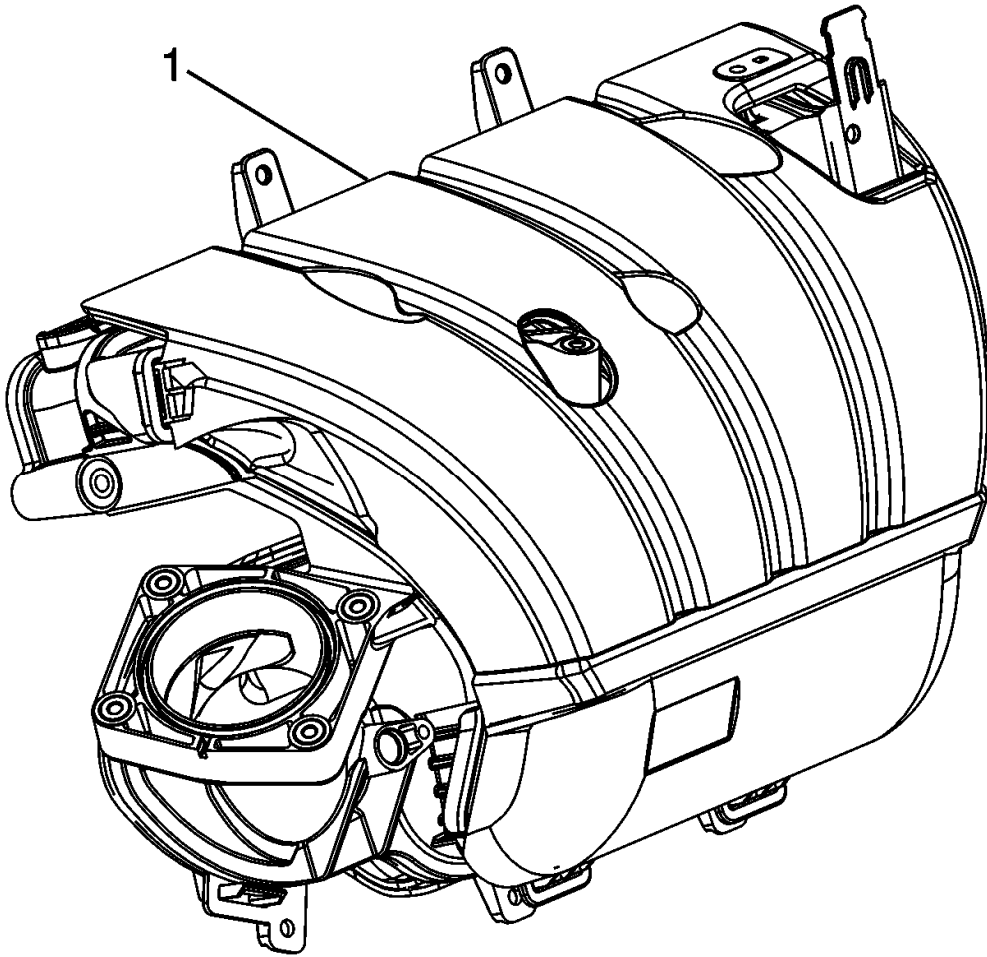


Fig. 167: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

1. Clean the intake manifold (1) mating surfaces.
2. Inspect the intake manifold for damage.
3. Inspect the intake manifold for cracks near metallic inserts.

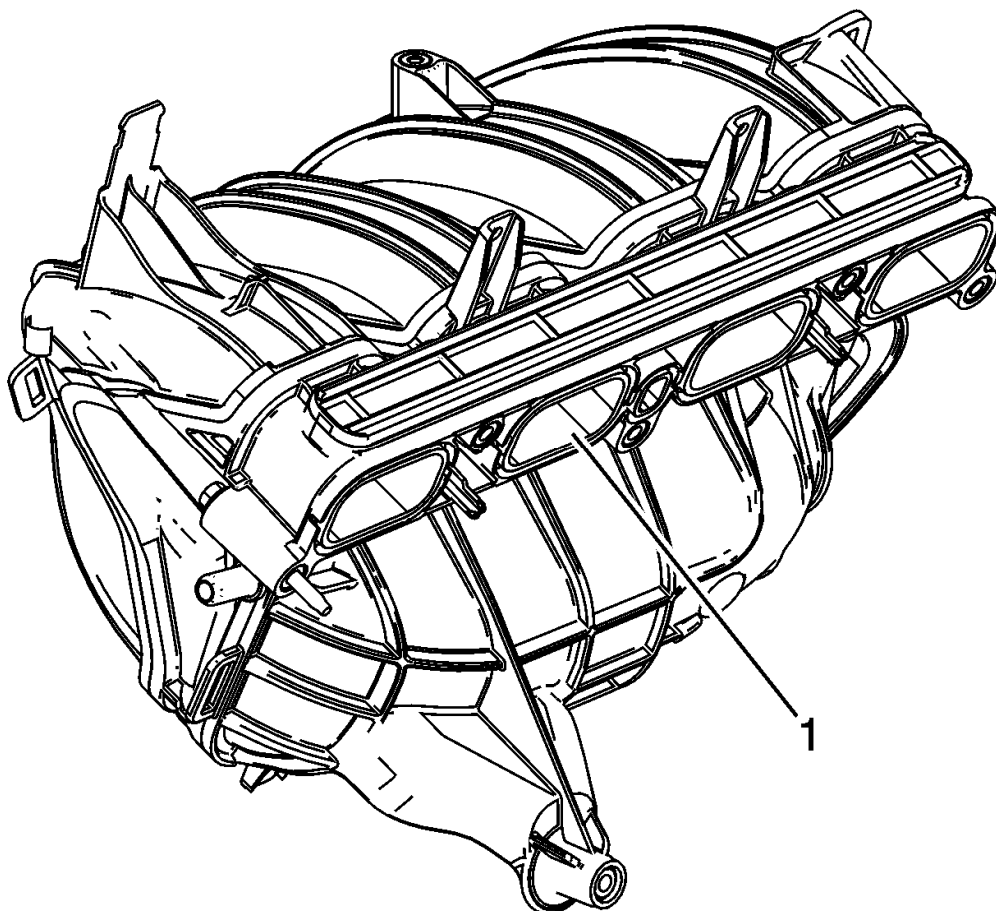


Fig. 168: Crankcase Ventilation Passages
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the crankcase ventilation passages (1) in the intake manifold face for blockage.

WARNING: Refer to Safety Glasses Warning .

5. Clean the crankcase ventilation passages with compressed air if necessary. Use a maximum of 172 kPa (25 psi) of air pressure.
6. Replace the intake manifold as necessary.

EXHAUST MANIFOLD CLEANING AND INSPECTION

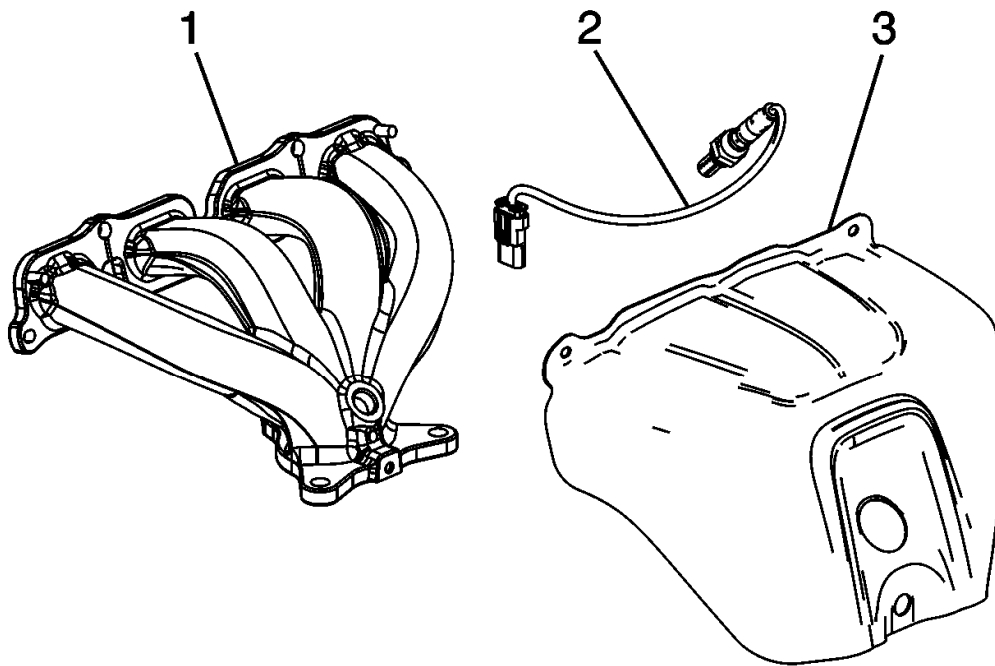


Fig. 169: Exhaust Manifold And Oxygen Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Do not reuse the exhaust manifold-to-cylinder head gaskets. Upon installation of the exhaust manifold, install a **NEW** gasket. An improperly installed gasket or leaking exhaust system may effect On-Board Diagnostics (OBD) II system performance.
- Remove the oxygen sensor prior to cleaning the manifold. Do not submerge the oxygen sensor in cleaning solvent.

1. Remove the oxygen sensor (2) from the manifold.
2. Clean the exhaust manifold (1) in solvent.

WARNING: Refer to Safety Glasses Warning .

3. Dry the exhaust manifold with compressed air.

4. Inspect the exhaust manifold (1) for damage.
5. Inspect the heat shield (3) for damage.

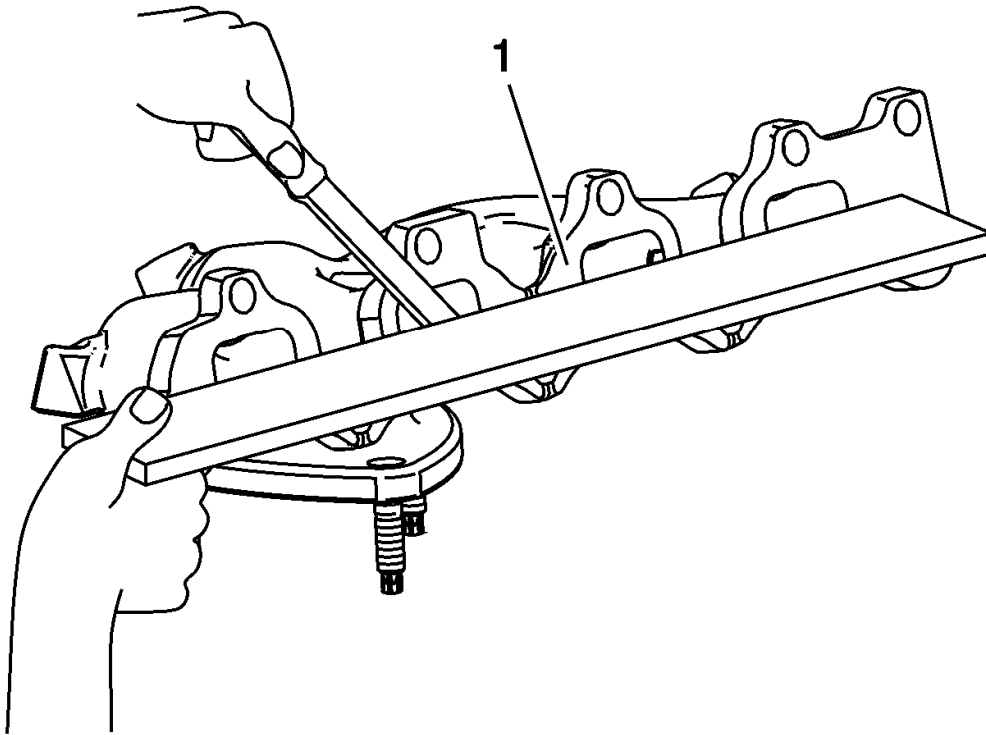


Fig. 170: Measuring Exhaust Manifold Mounting Face
Courtesy of GENERAL MOTORS COMPANY

6. Use a straight edge and a feeler gauge and measure the exhaust manifold mounting face (1) for warpage.

An exhaust manifold face with warpage in excess of 0.25 mm (0.0100 in) may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

OIL PAN CLEANING AND INSPECTION

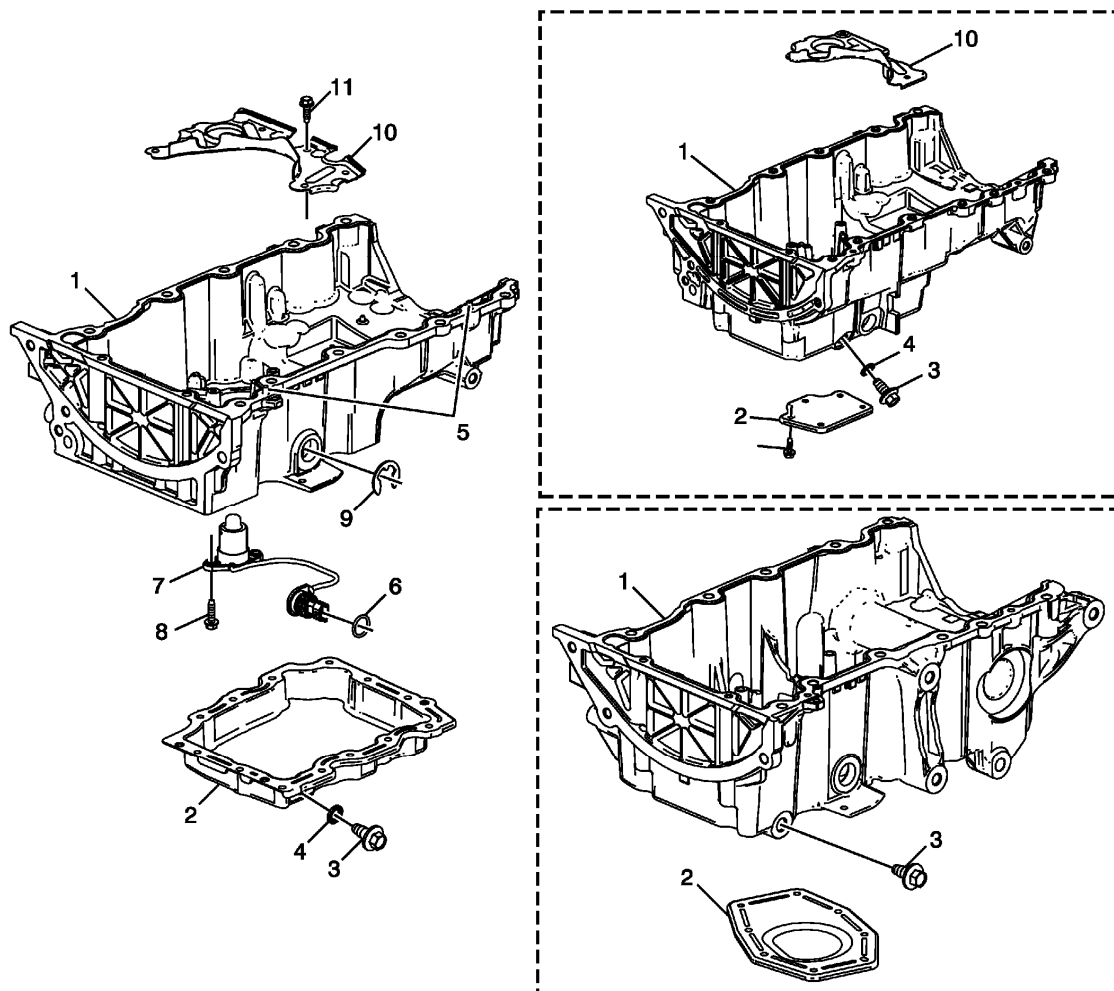


Fig. 171: Oil Pan Cleaning And Inspection
 Courtesy of GENERAL MOTORS COMPANY

Oil Pan Cleaning and Inspection

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none"> 1. Thoroughly clean the oil pans and mating surfaces. Inspect each component, O-rings, and fasteners, and replace as necessary. 2. Remove all sludge and oil deposits. 3. Inspect the oil pan for cracking near the pan rail and the transmission mounting points. 4. Inspect the oil pan for cracking resulting from impact or flying road debris. 	
1	Upper Oil Pan
	NOTE: Component may vary depending on model.
	Lower Oil Pan

2	NOTE: Component may vary depending on model.
3	Engine Oil Drain Plug
4	Engine Oil Drain Plug Washer
5	Oil Pan Locating Pins NOTE: It is not necessary to remove the locating pins unless the inspection indicates replacement.
6	Engine Oil Level Indicator Switch O-ring Seal
7	Engine Oil Level Indicator Switch
8	Engine Oil Level Indicator Switch Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
9	Engine Oil Level Indicator Switch Connector Retainer
10	Oil Pan Baffle
11	Oil Pan Baffle Bolt Tighten 10 N.m (89 lb in)

THREAD REPAIR

Special Tools

- **EN 42385-700** High Feature Thread Repair Kit
- **EN 42385-850** Thread Repair Kit
- **EN 42385-880** Head Bolt Thread Repair Adapter Kit

For equivalent regional tools, refer to **Special Tools** .

General Thread Repair

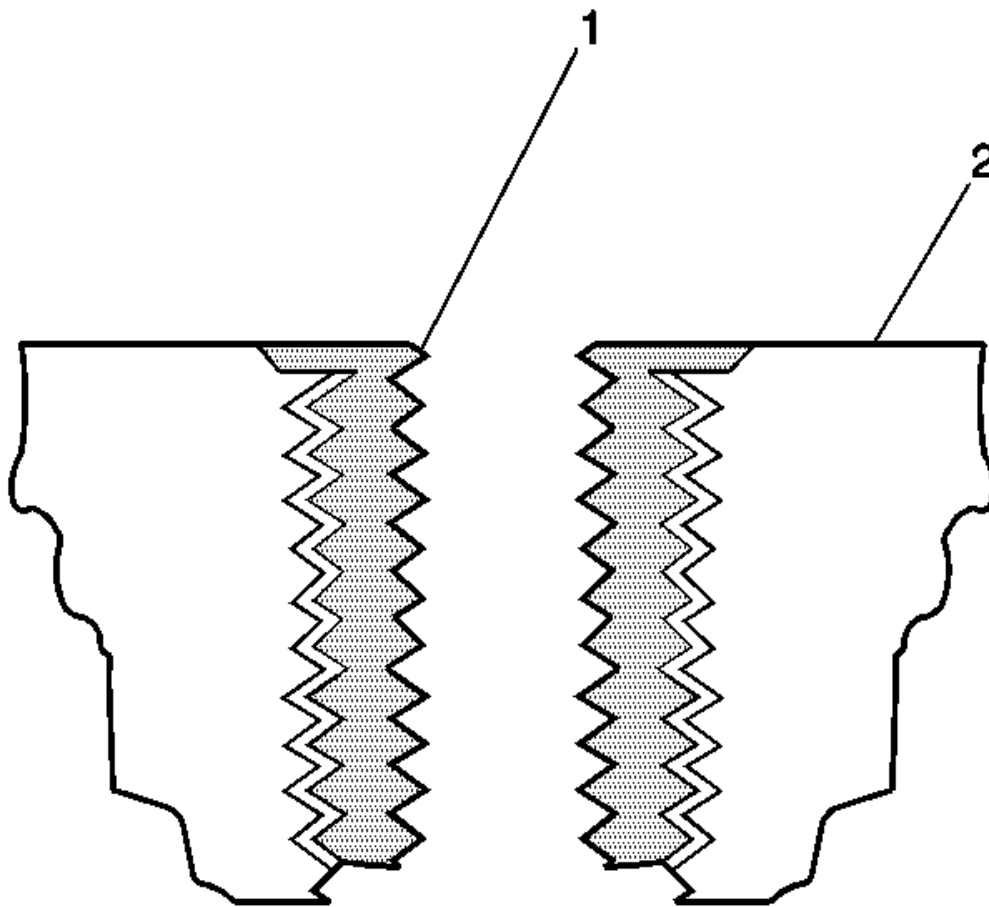


Fig. 172: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.

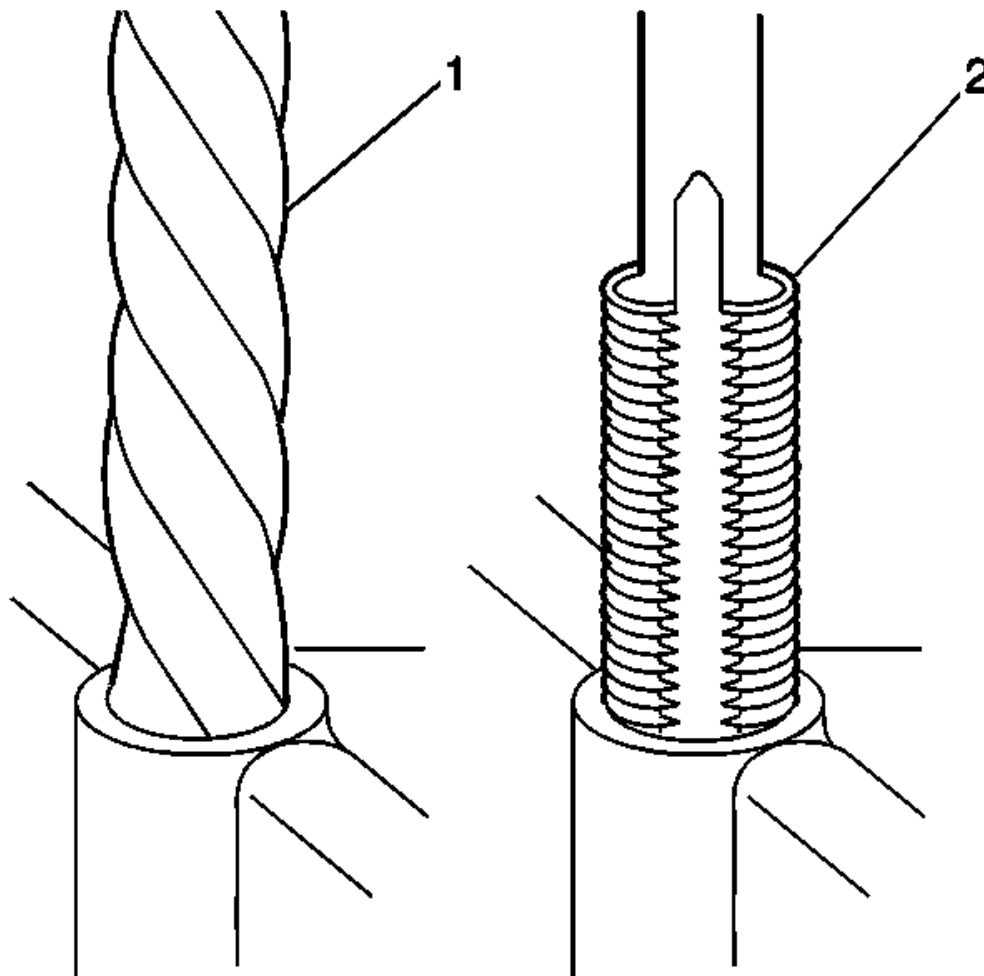


Fig. 173: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

NOTE: The use of a cutting fluid, WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers .

Driver oil MUST be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

1. Drill out the threads of the damaged hole (1).
 - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
 - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
 - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Using compressed air, clean out any chips.

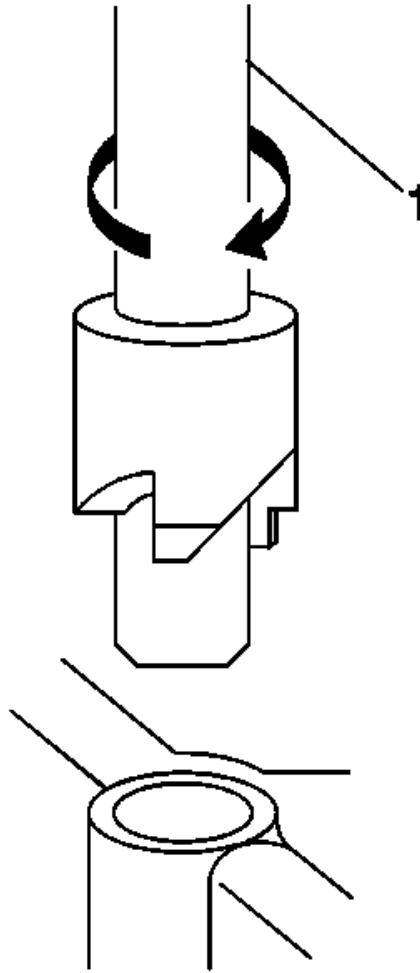


Fig. 174: Identifying Tool Used To Counterbore The Hole
Courtesy of GENERAL MOTORS COMPANY

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

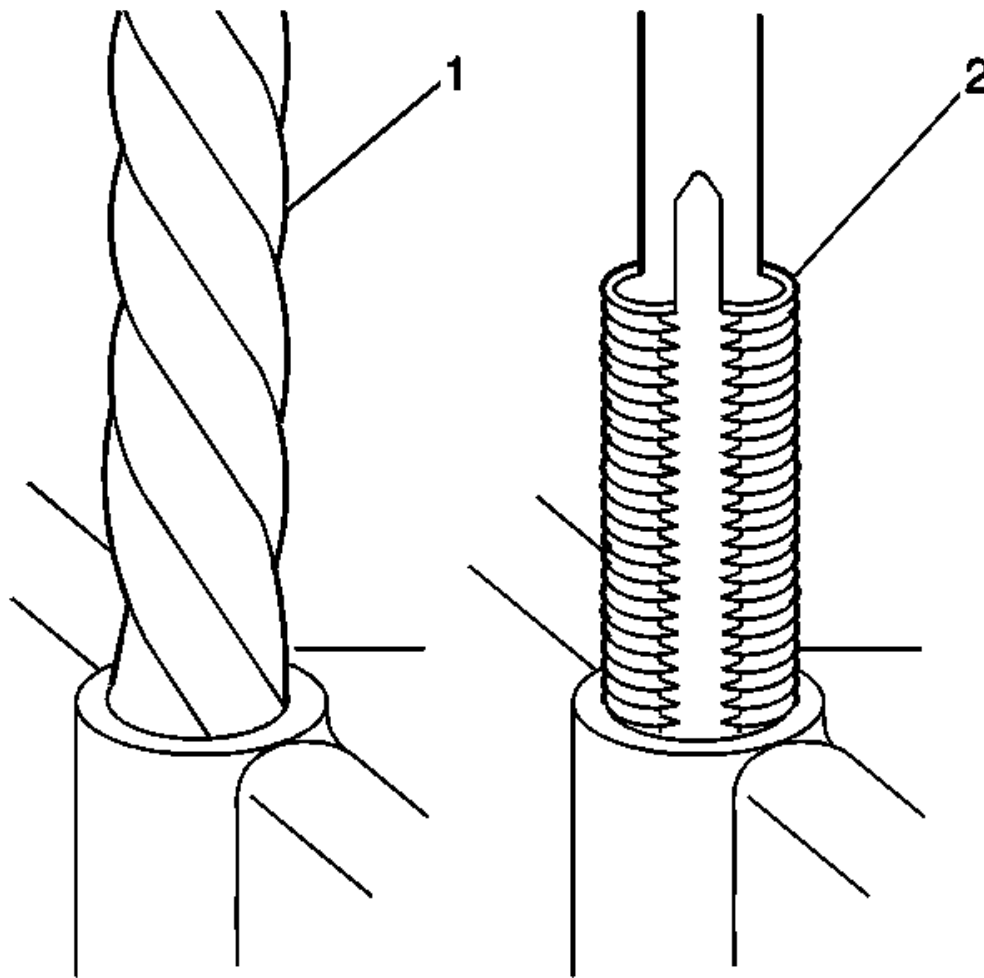


Fig. 175: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

5. Using a tap wrench (2), tap the threads of the drilled hole.
 - M6 inserts require a minimum tap depth of 15 mm (0.59 in).
 - M8 inserts require a minimum tap depth of 20 mm (0.79 in).
 - M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).

WARNING: Refer to Safety Glasses and Compressed Air Warning .

WARNING: Refer to Cleaning Solvent Warning .

6. Using compressed air, clean out any chips.

7. Spray cleaner into the hole. Refer to Adhesives, Fluids, Lubricants, and Sealers .
8. Using compressed air, clean any cutting oil and chips out of the hole.

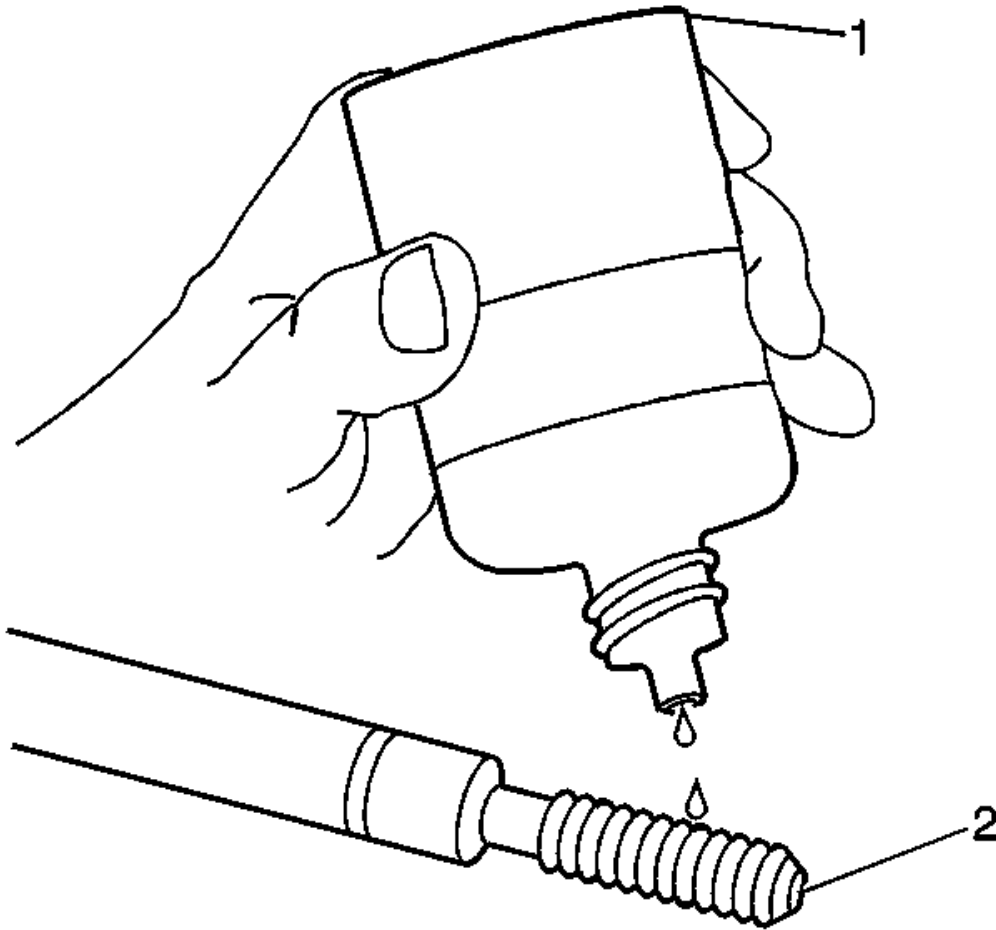


Fig. 176: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).

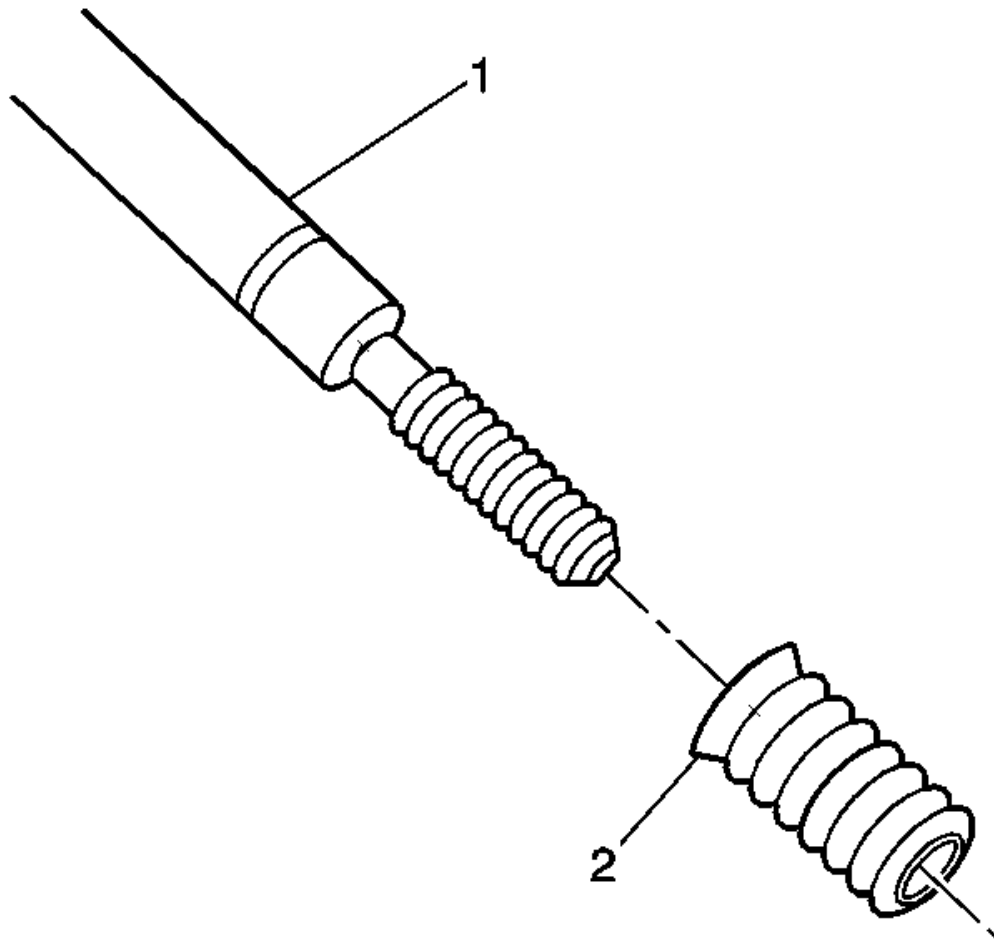


Fig. 177: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

10. Install the insert (2) onto the driver tool (1).

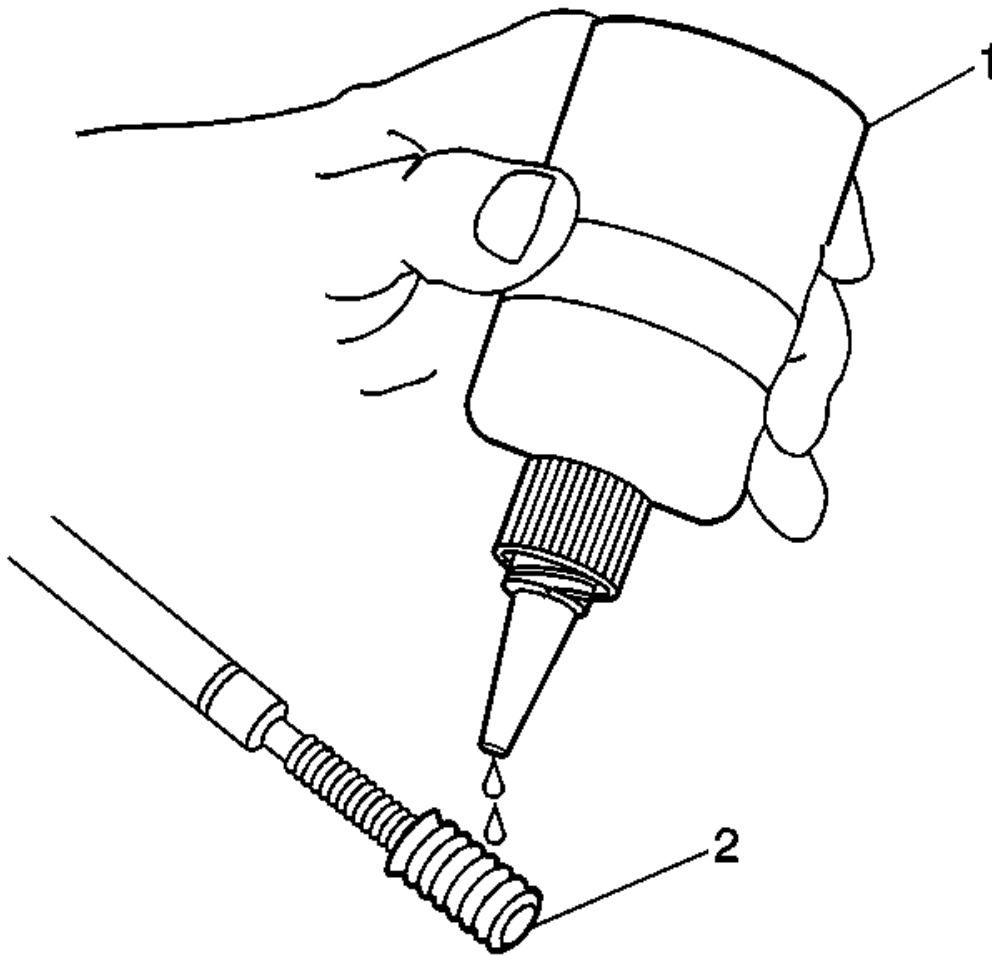


Fig. 178: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

11. Apply threadlock LOCTITE™ 277, EN 42385-109 (1) loctite , or equivalent to the insert OD threads (2).

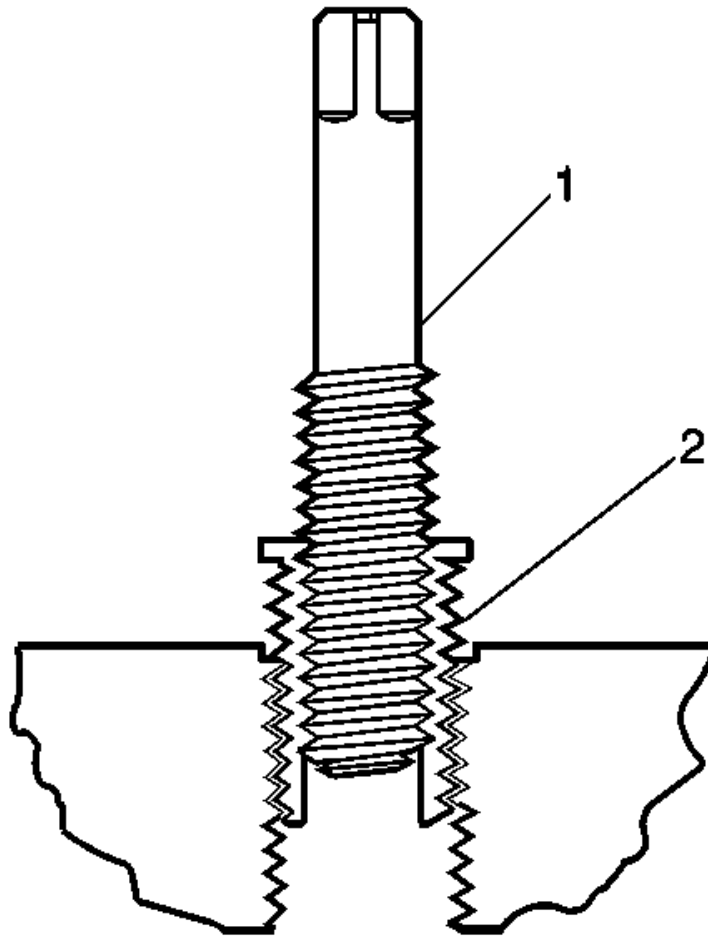


Fig. 179: View Of Insert In Tapped Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

12. Install the insert (2) into the hole.

Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

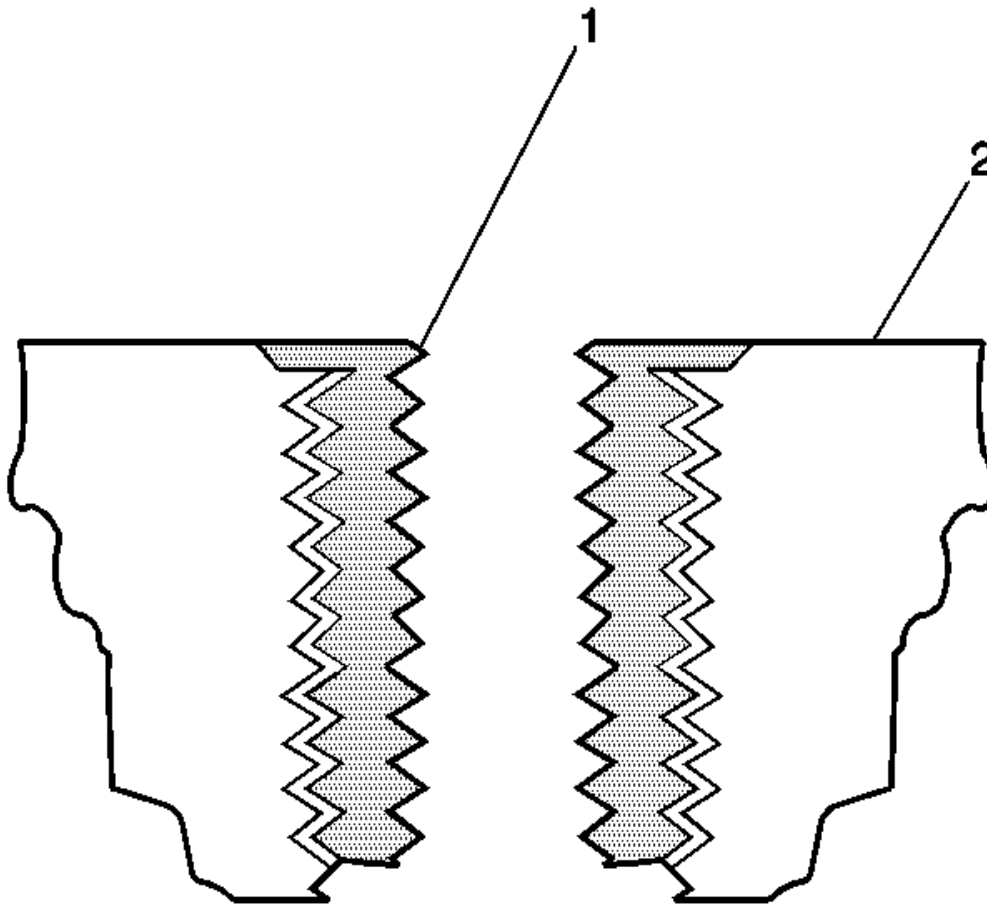


Fig. 180: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

13. Inspect the insert for proper installation into the hole.

A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

Cylinder Head Bolt Hole Thread Repair

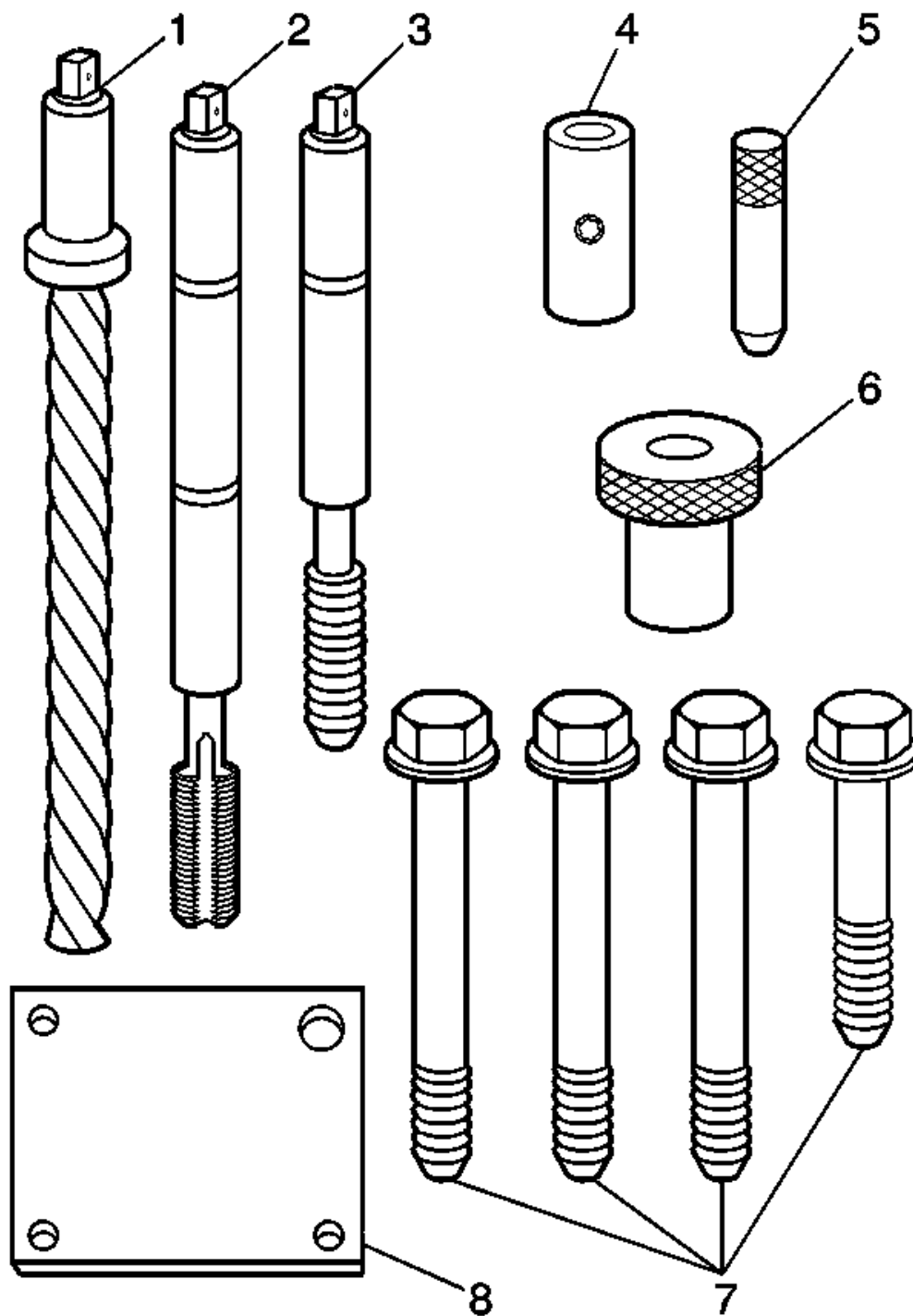


Fig. 181: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The tools listed may not necessarily represent the exact tools used for the procedure.

1. The cylinder head bolt hole thread repair kit consists of the following items:

- Drill (1)
- Tap (2)
- Installer (3)
- Sleeve (4)
- Alignment Pin (5)
- Bushing (6)
- Bolts (7)
- Fixture Plate (8)

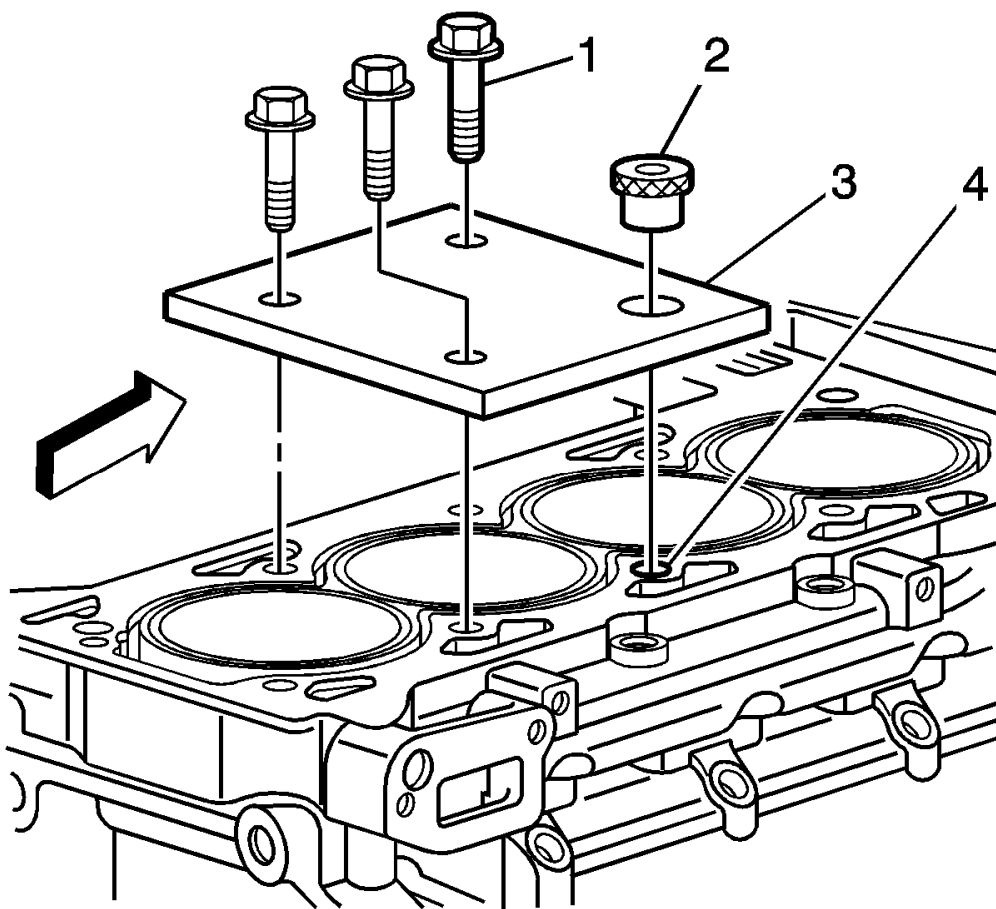


Fig. 182: Installing Fixture Plate, Bolts, & Bushing
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses and Compressed Air Warning .

NOTE: The use of a cutting fluid, WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers .

Driver oil **MUST** be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

Position the fixture plate and bushing over the hole that is to be repaired (4).

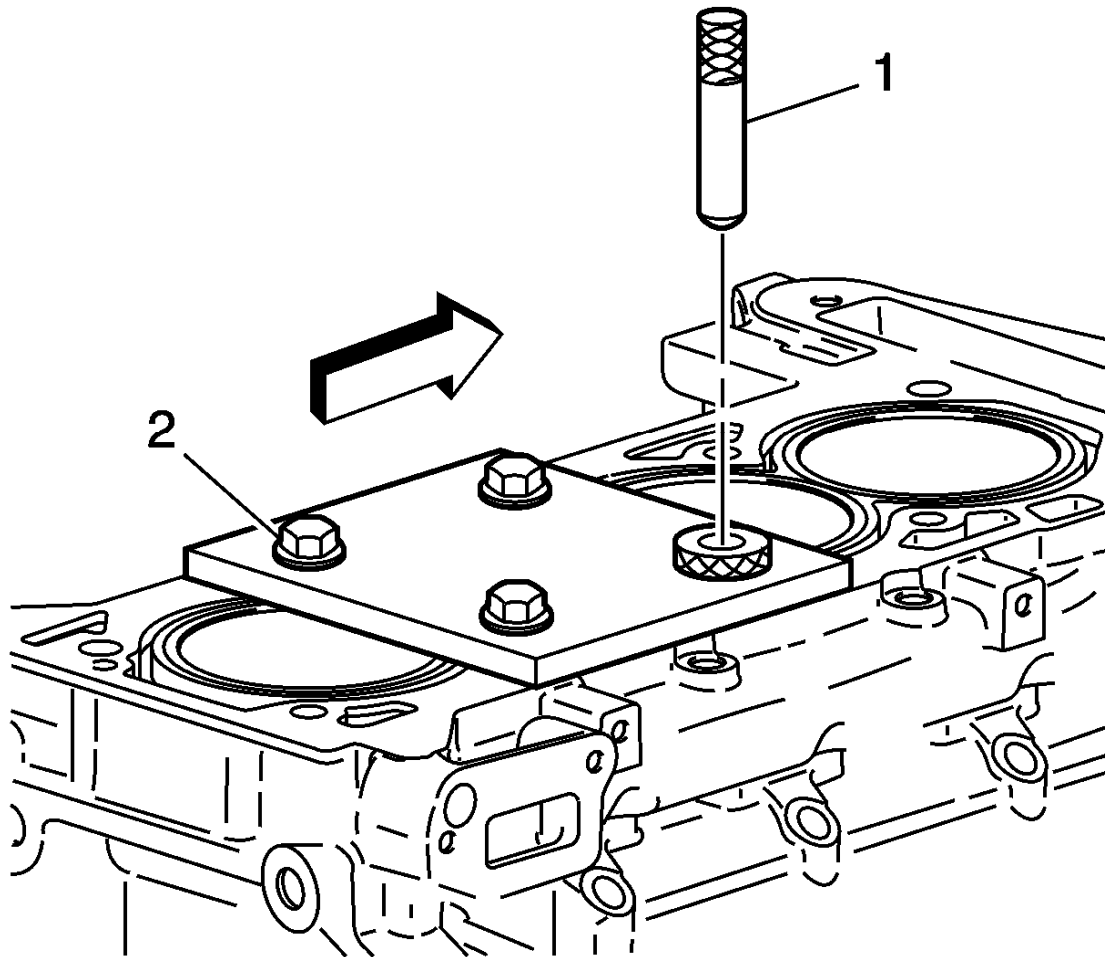


Fig. 183: Identifying Alignment Pin

Courtesy of GENERAL MOTORS COMPANY

3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.

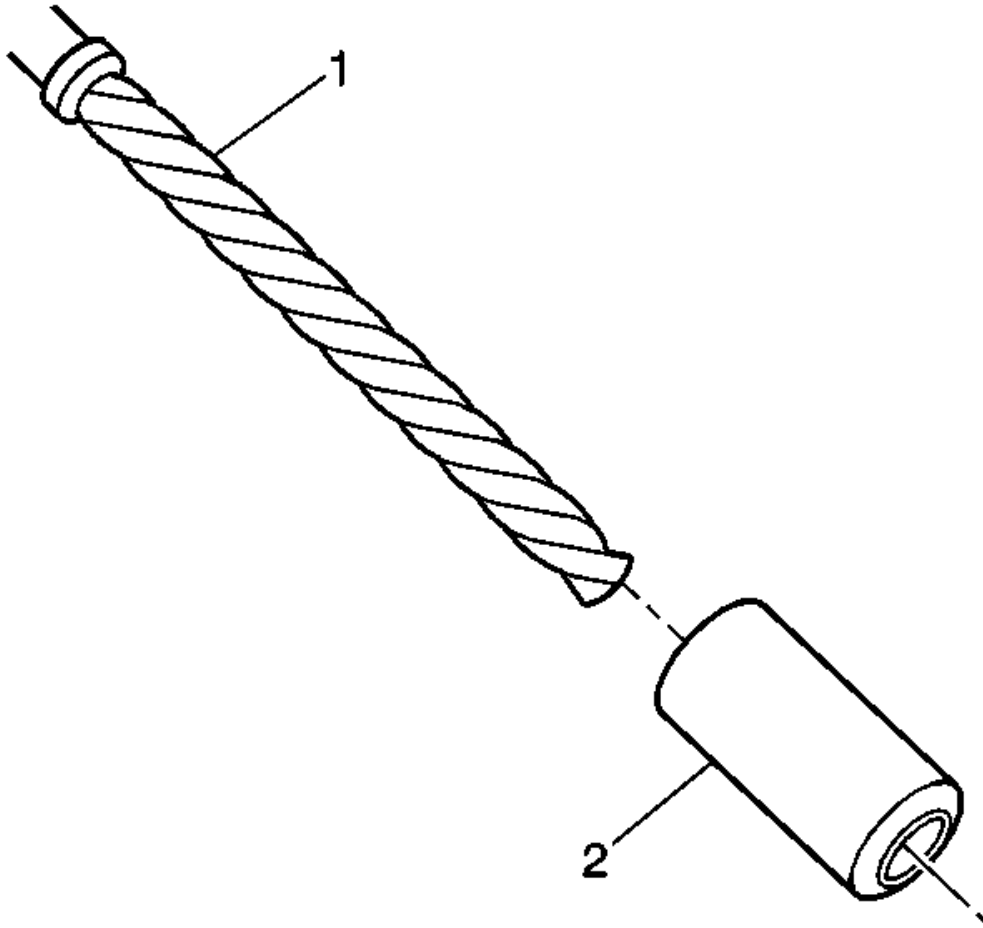


Fig. 184: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS COMPANY

6. Install the sleeve (2) onto the drill (1), if required.

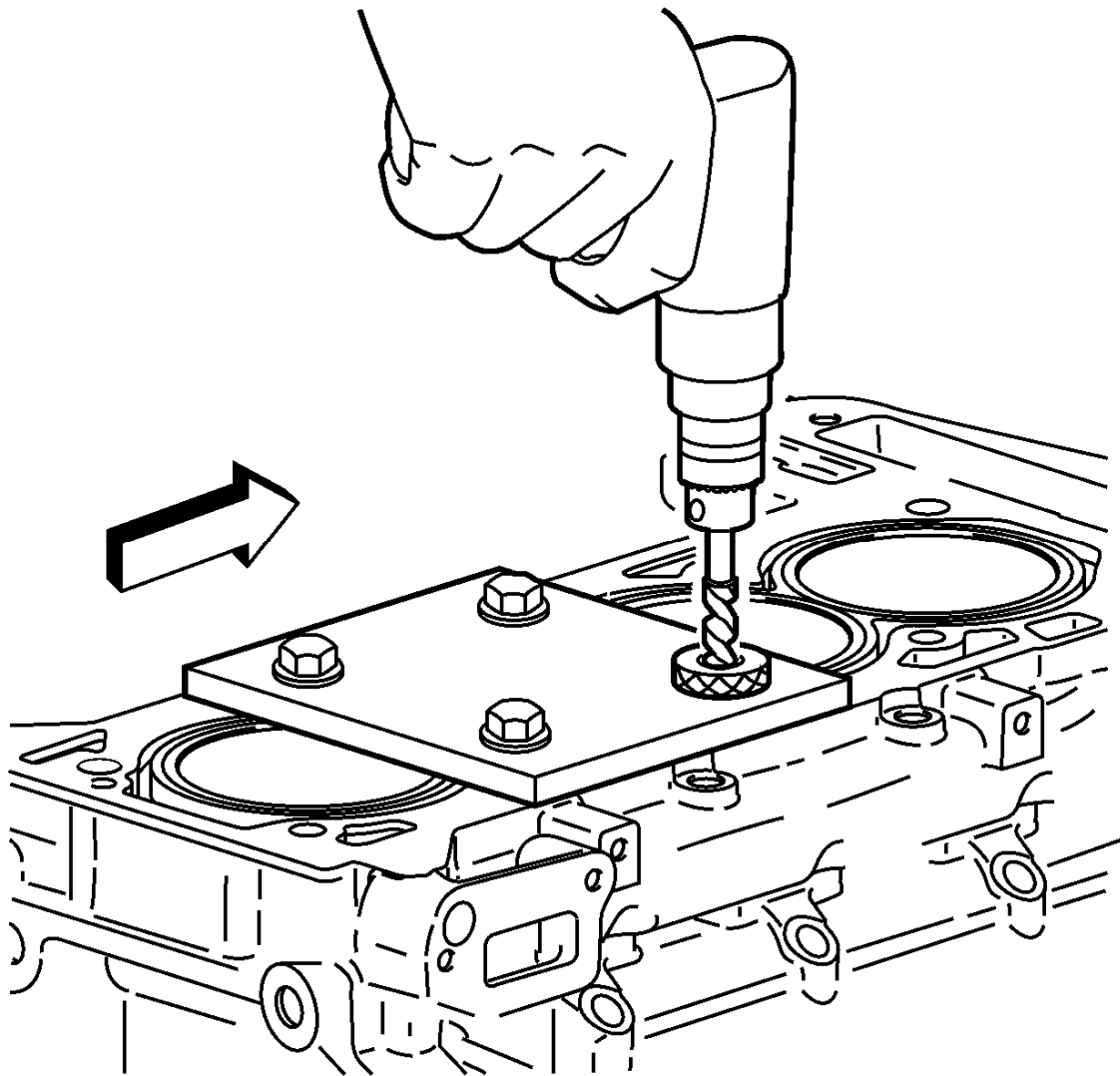


Fig. 185: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

7. Drill out the threads of the damaged hole.

Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

8. Using compressed air, clean out any chips.

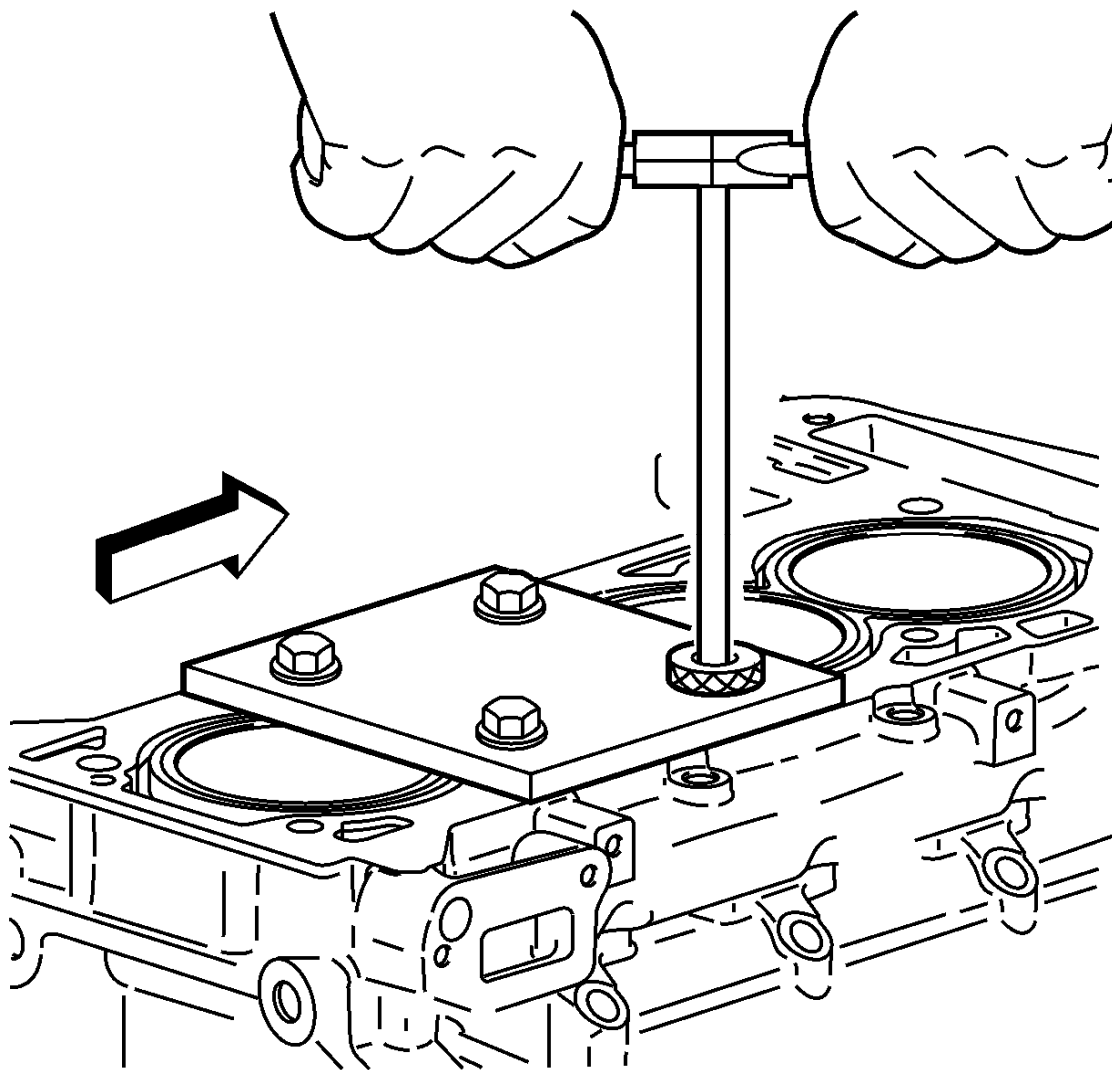


Fig. 186: Tapping Threads Of Drilled Hole With Tap Wrench
Courtesy of GENERAL MOTORS COMPANY

9. Using a tap wrench, tap the threads of the drilled hole.

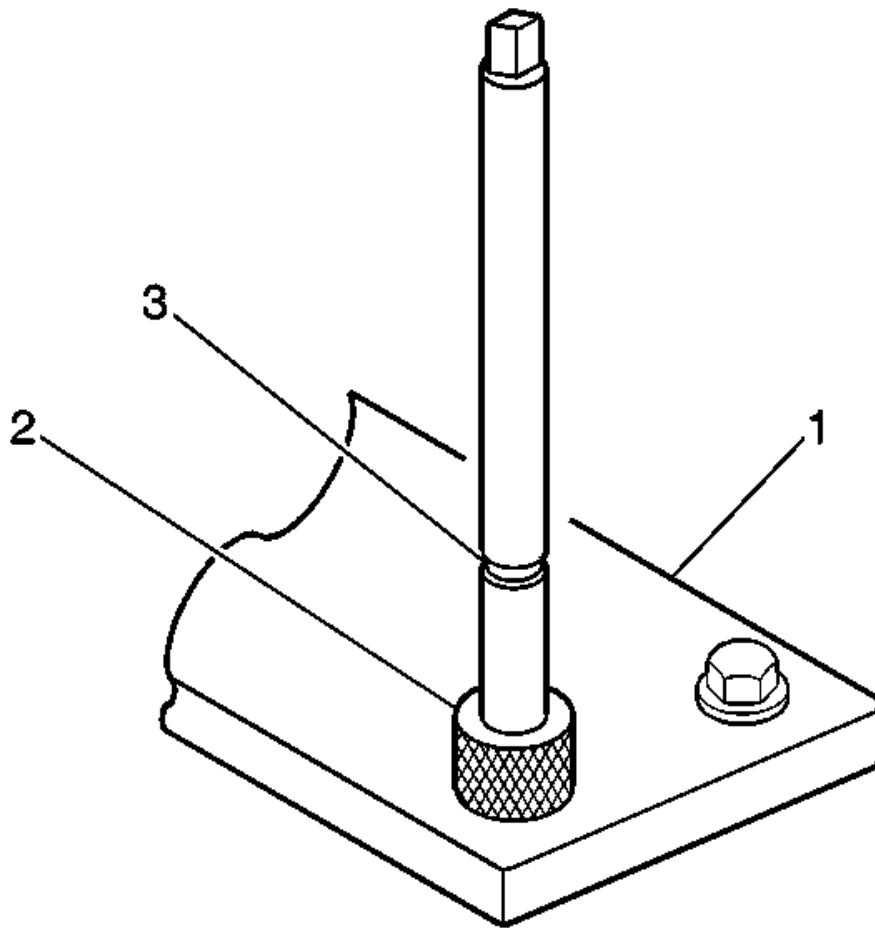


Fig. 187: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

10. Using a TAP wrench, tap the threads of the drilled hole.

In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (3) on the tap align with the top of the drill bushing (2).

11. Remove the fixture plate (1), bushing (2), and bolts.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

WARNING: Refer to Cleaning Solvent Warning .

12. Using compressed air, clean out any chips.
13. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
14. Using compressed air, clean any cutting oil and chips out of the hole.

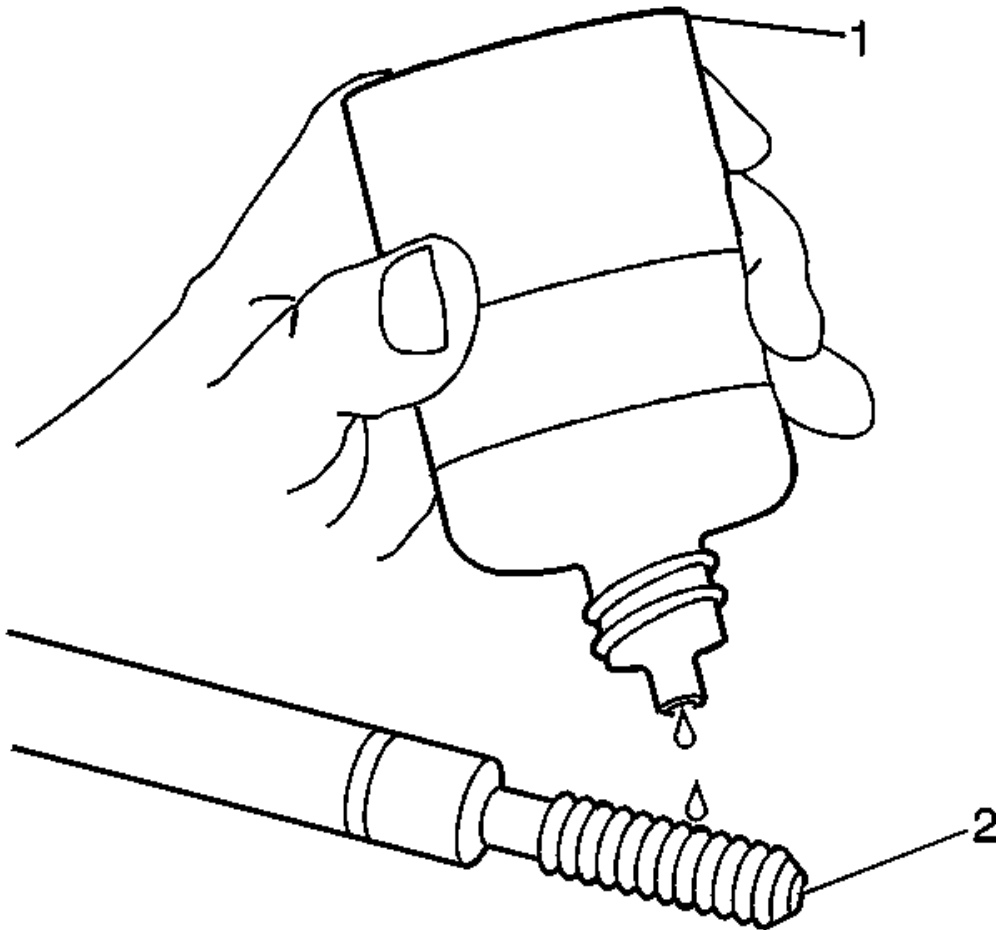


Fig. 188: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

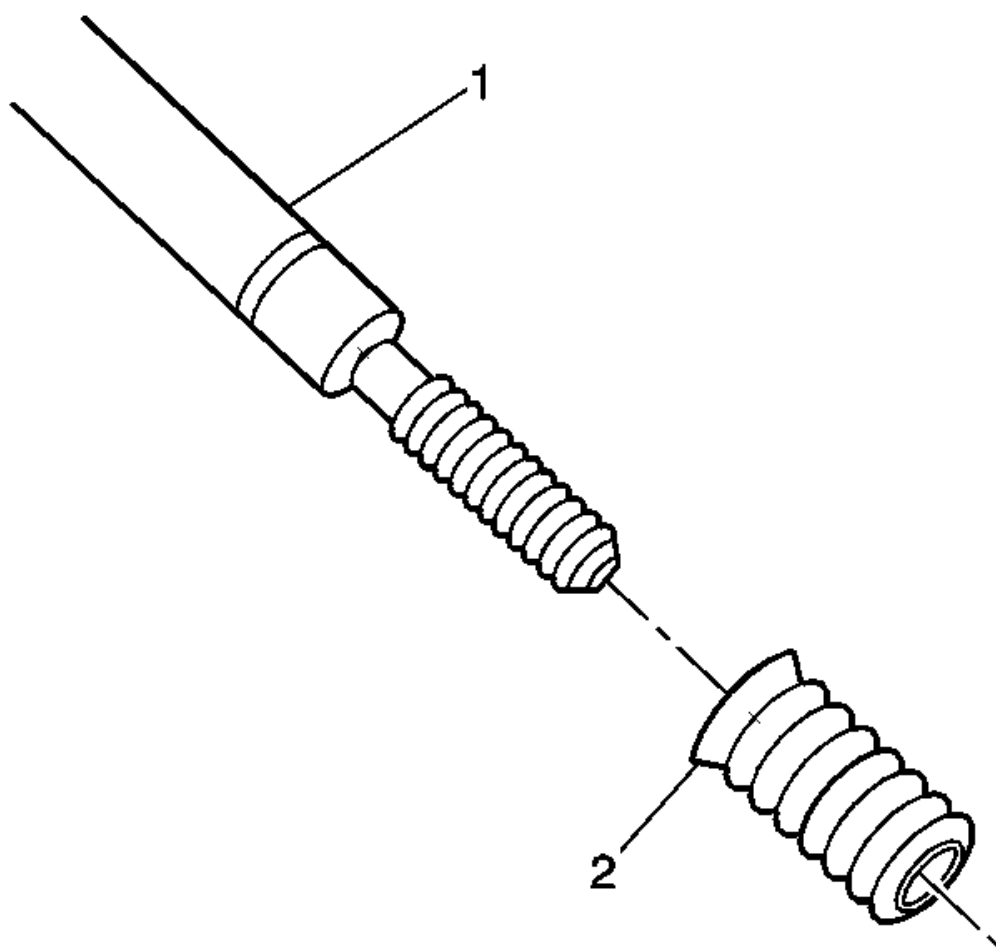


Fig. 189: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert (2) onto the driver tool (1).

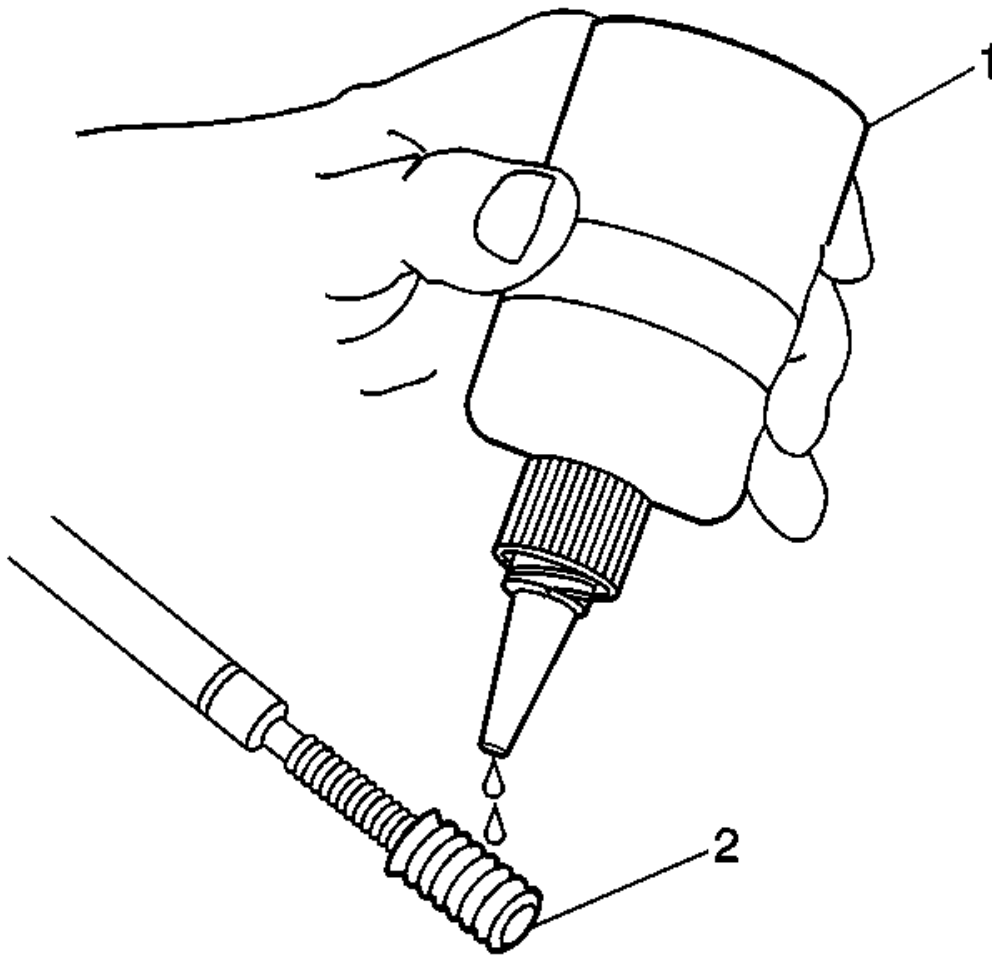


Fig. 190: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

17. Apply threadlock LOCTITE™ 277, EN 42385-109 loctite (1), or equivalent to the insert OD threads (2).

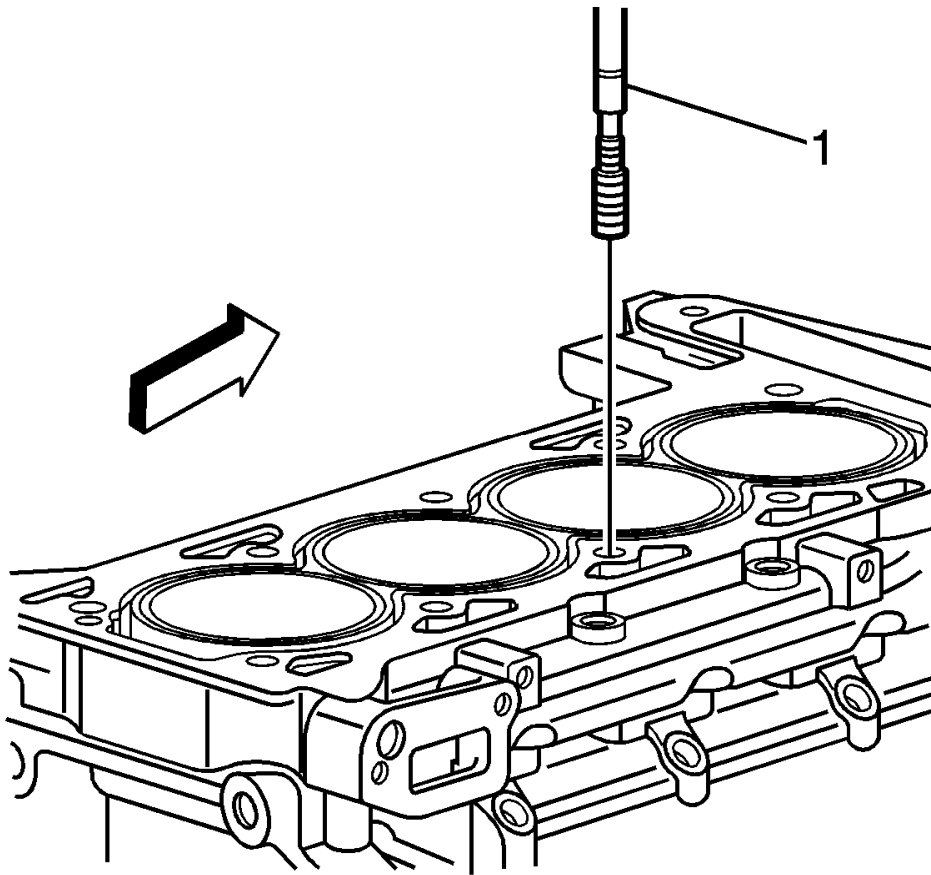


Fig. 191: Installing & Inserting Driver Into Hole
Courtesy of GENERAL MOTORS COMPANY

18. Install the insert and driver (1) into the hole.

Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

SERVICE PRIOR TO ASSEMBLY

The importance of cleanliness during assembly cannot be overstated. Dirt or debris will cause engine damage. An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This

is considered standard shop practice even if not specifically stated.

Lubricate all moving parts with engine oil or a specified assembly lubricant. This will provide lubrication for initial start up.

ENGINE BLOCK ASSEMBLE

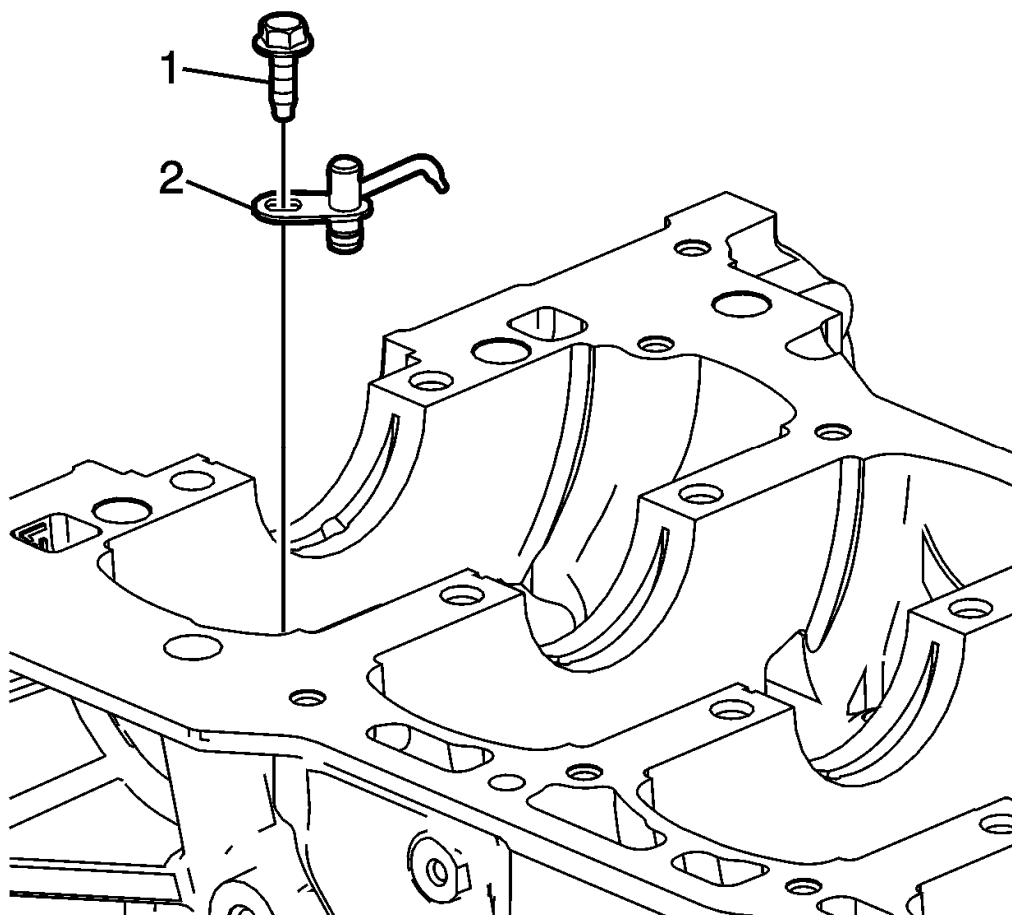


Fig. 192: Piston Oil Nozzle Assembly Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the piston oil nozzle assemblies (2), if equipped.

CAUTION: Refer to Fastener Caution .

2. Install the piston oil nozzle bolts (1) and tighten to 10 N.m (89 lb in).

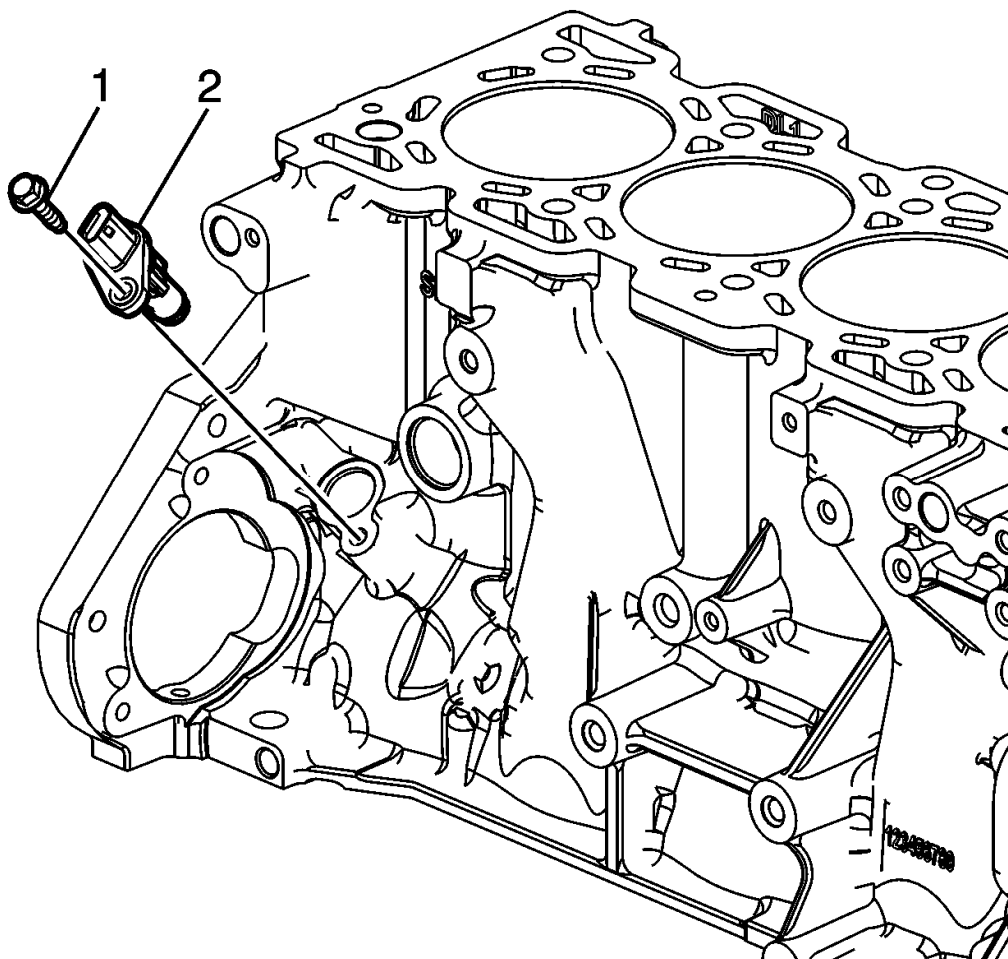


Fig. 193: Crankshaft Position (CKP) Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the crankshaft position sensor O-ring with engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

CAUTION: Refer to **Component Fastener Tightening Caution** .

4. Install the crankshaft position sensor (2) and bolt (1) and tighten to 10 N.m (89 lb in).

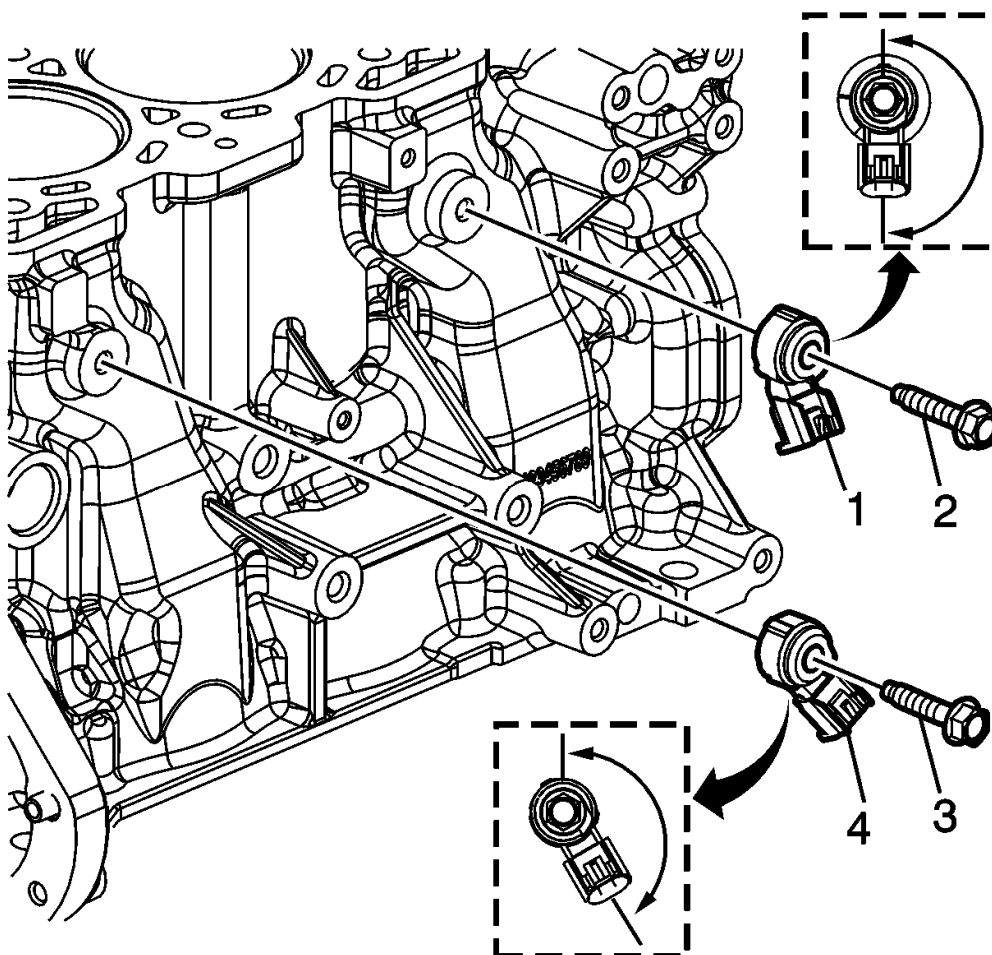


Fig. 194: Knock Sensor

Courtesy of GENERAL MOTORS COMPANY

5. Install the knock sensor (1) at 6 O' clock. Install the bolt (2) and tighten to 25 N.m (18 lb ft).
6. Install the knock sensor (4) at 5 O' clock. Install the bolt (3) and tighten to 25 N.m (18 lb ft).

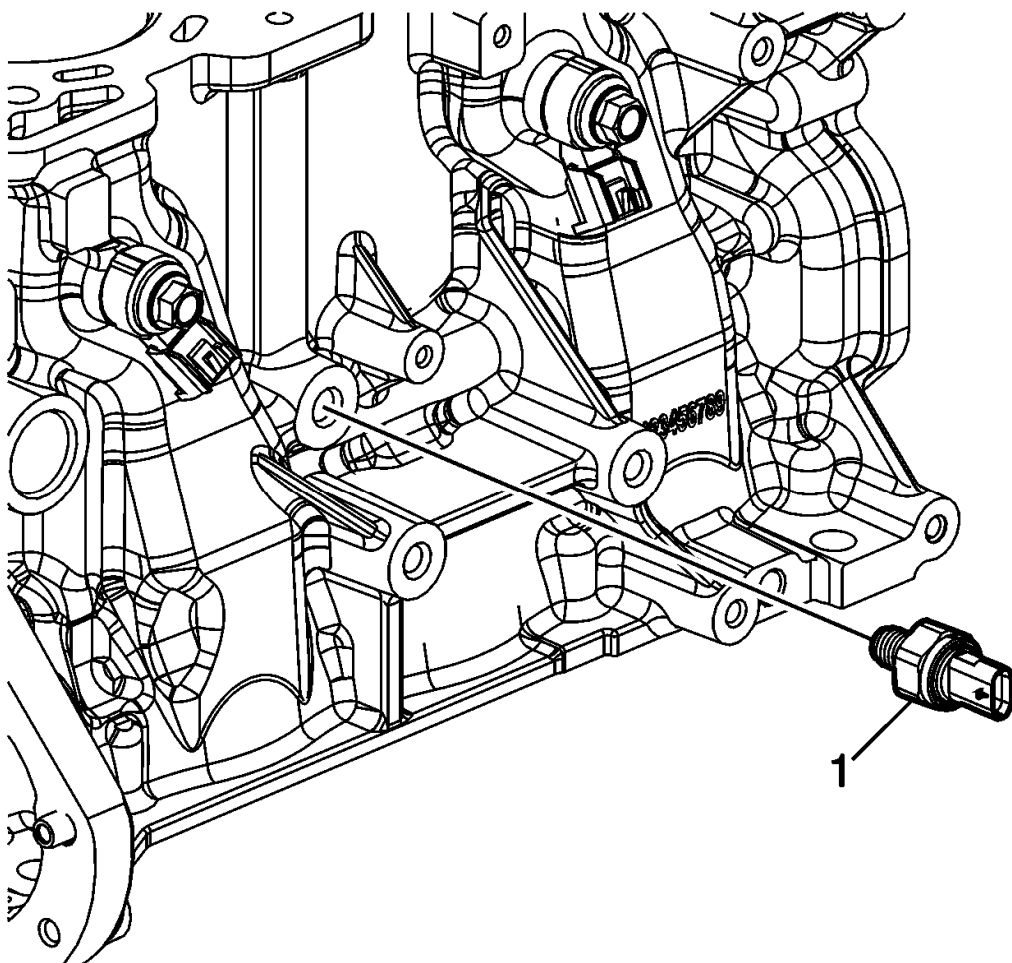


Fig. 195: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Install the engine oil pressure sensor (1) and tighten to 27 N.m (20 lb ft).

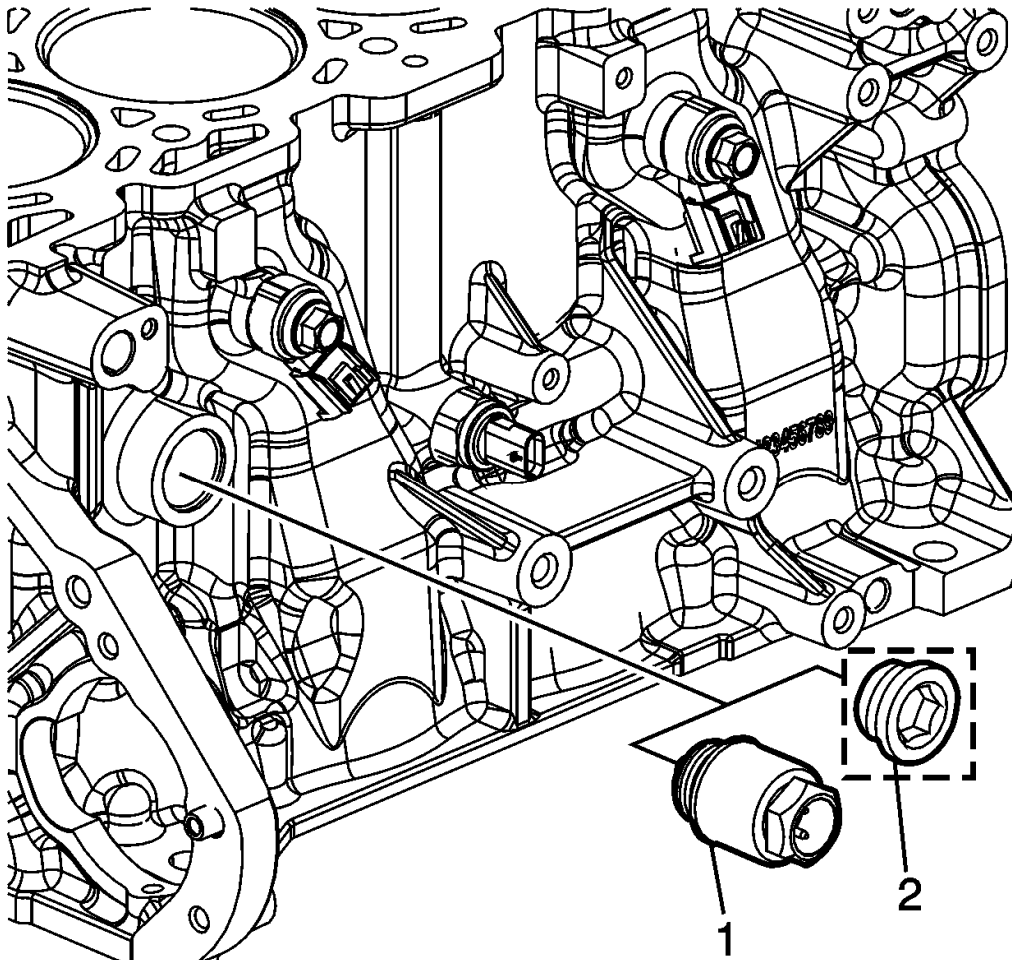


Fig. 196: Engine Coolant Heater
Courtesy of GENERAL MOTORS COMPANY

8. Install the engine coolant heater assembly (1), if equipped. Tighten the assembly to 50 N.m (37 lb ft).
9. If the engine coolant heater assembly is not equipped, install the engine coolant heater hole plug (2). Tighten the plug to 60 N.m (44 lb ft).

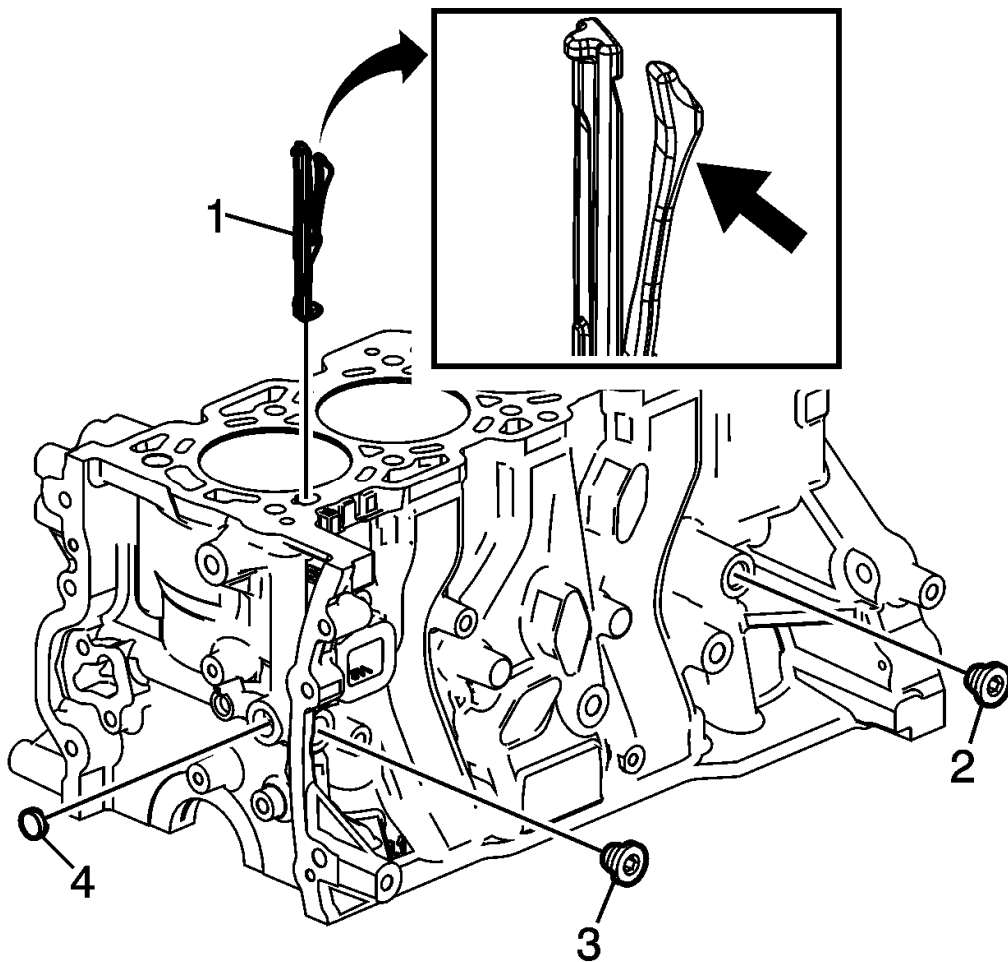


Fig. 197: Engine Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

10. Apply sealant to all plugs prior to installation. Refer to Adhesives, Fluids, Lubricants, and Sealers .
11. Install the engine oil gallery cup plug (4).
12. Install the engine oil gallery plugs (2, 3), with sealant, and tighten to 65 N.m (48 lb ft).

NOTE: Always install the baffle with the forked end pointed up. Do not force the baffle into place. Aligning the shape of the orifice and the baffle, and gently depressing the clip will allow the baffle to easily drop into place.

13. Carefully align and install the engine oil baffle (1).

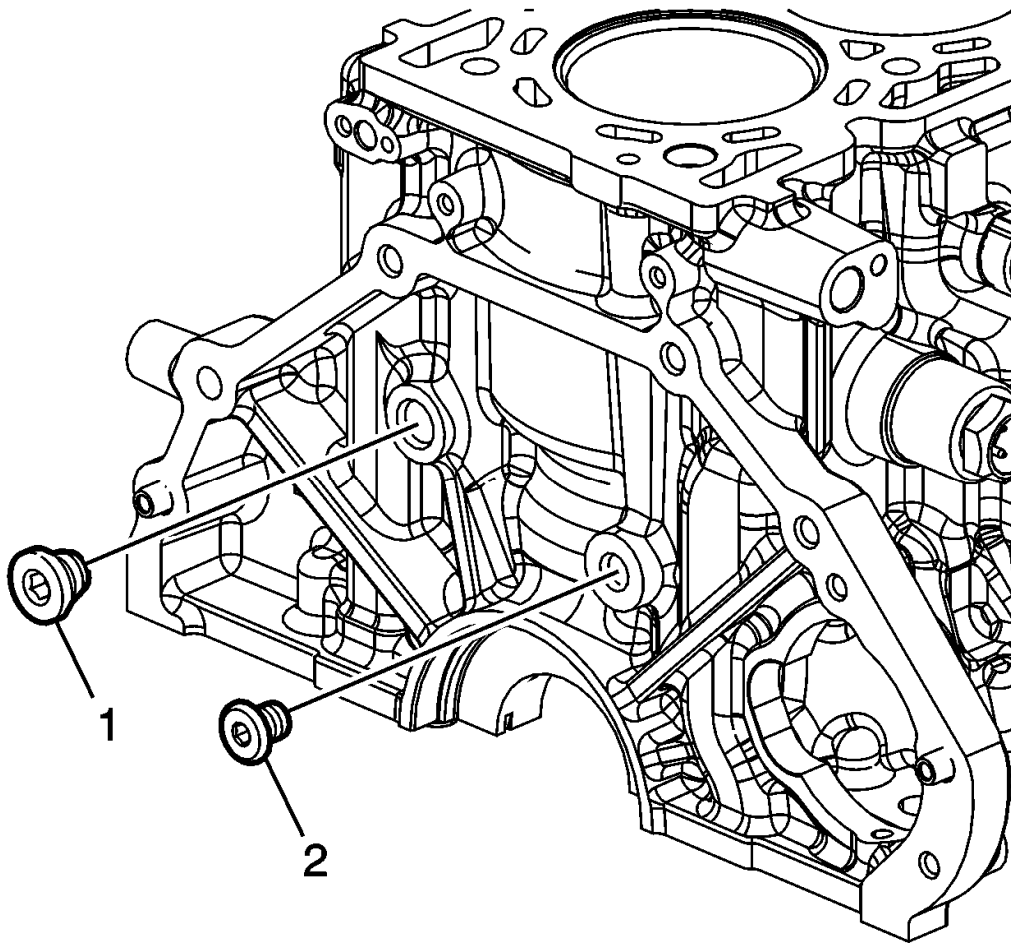


Fig. 198: Engine Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

14. Install the engine oil gallery plug (1), with sealant, and tighten to 65 N.m (48 lb ft).
15. Install the engine oil gallery plug (2), with sealant, and tighten to 40 N.m (30 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

- **EN-8087** Cylinder Bore Checking Gauge
- **EN 45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

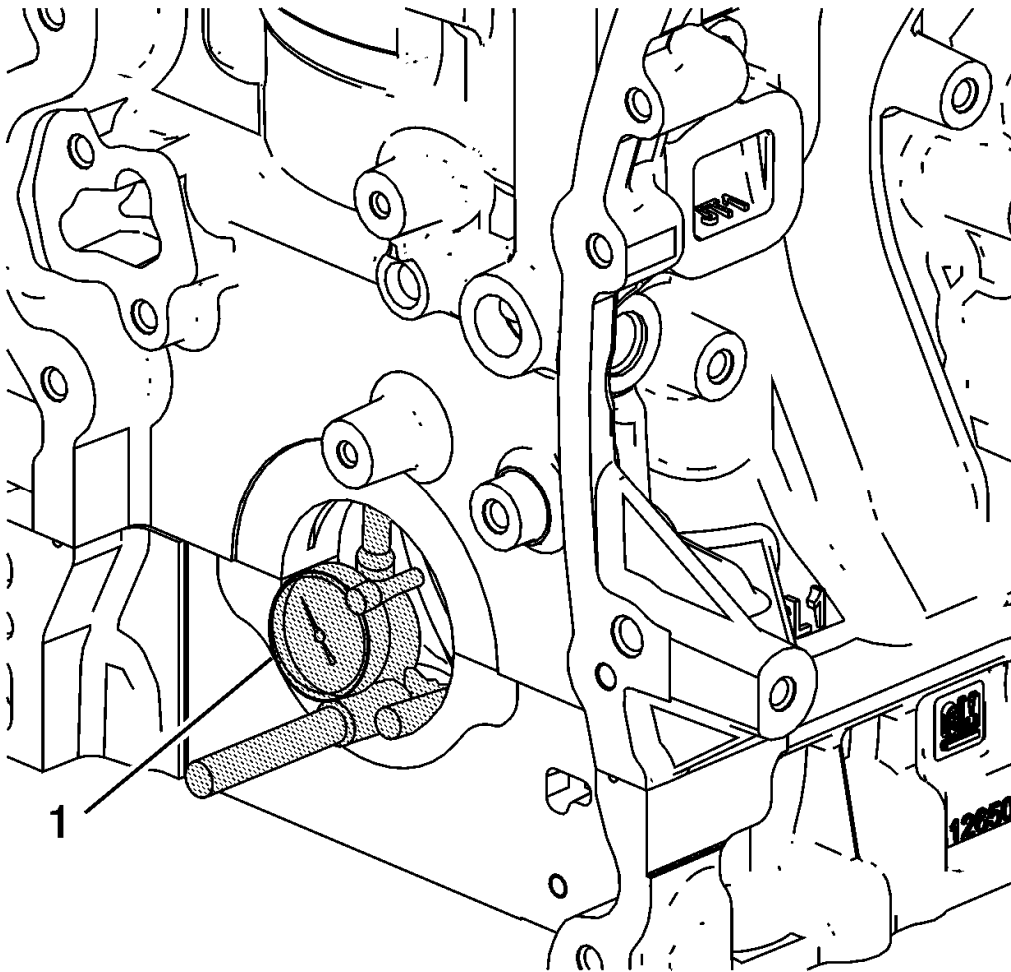


Fig. 199: Cylinder Bore Checking Gauge
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.
- If crankshaft bearing failure is due to other than normal wear, investigate the cause. Inspect the crankshaft or connecting rod bearing bores.

Inspect the connecting rod bearing bores or crankshaft main bearing bores using the following procedure:

- Tighten the bedplate to specification using the **EN 45059** meter.
- Measure the bearing bore for taper and out-of-round using the **EN-8087** gauge (1).
- No taper or out-of-round should exist.

Bearing Selection

1. Measure the bearing clearance to determine the correct replacement bearing insert size. There are two

methods to measure bearing clearance. Method A gives more reliable results and is preferred.

- Method A yields measurement from which the bearing clearance can be computed.
- Method B yields the bearing clearance directly. Method B does not give any indication of bearing run-out.

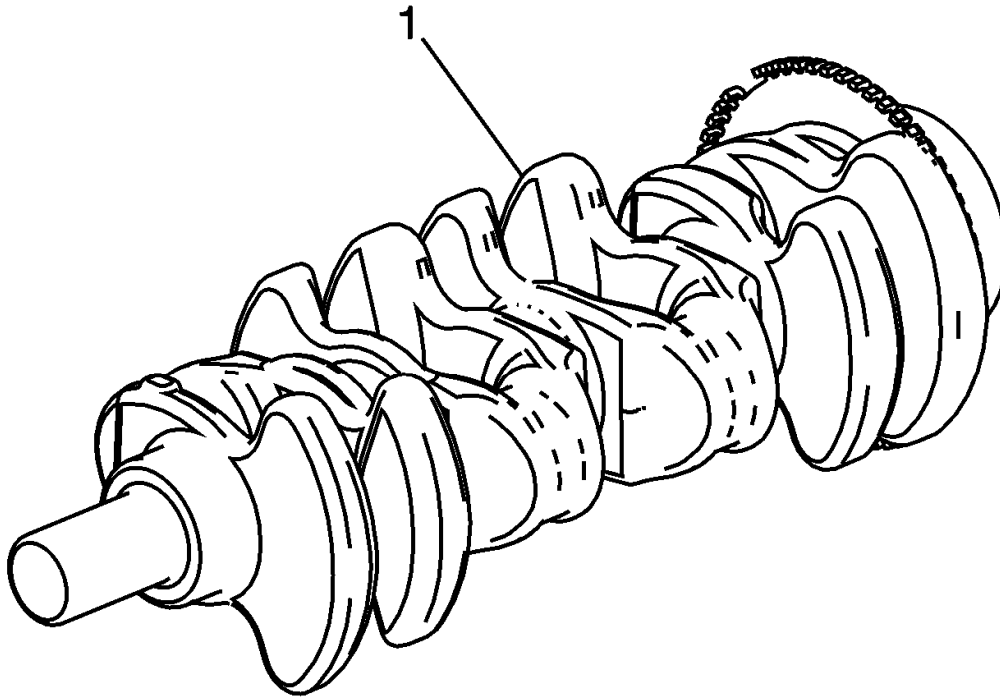


Fig. 200: Measuring Bearing Clearance Using Method A
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not mix inserts of different nominal size in the same bearing bore.

2. To measure bearing clearance using Method A, use the following procedure:
 1. Measure the crankshaft bearing journal diameter with a micrometer in several places, 90 degrees apart. Average the measurements.
 2. Measure the crankshaft bearing journal taper and runout.
 3. Install the lower crankcase and tighten the bearing cap bolts to specification.
 4. Measure bearing inside diameter (ID) in several places 90 degrees apart, average measurements.
 5. Subtract journal measurement from bearing ID measurement to determine clearance.

6. Determine whether clearance is within specification.
7. If out of specification, choose different inserts.
8. Measure the connecting rod inside diameter in the same direction as the length of the rod with an inside micrometer.
9. Measure the crankshaft main bearing inside diameter with an inside micrometer.

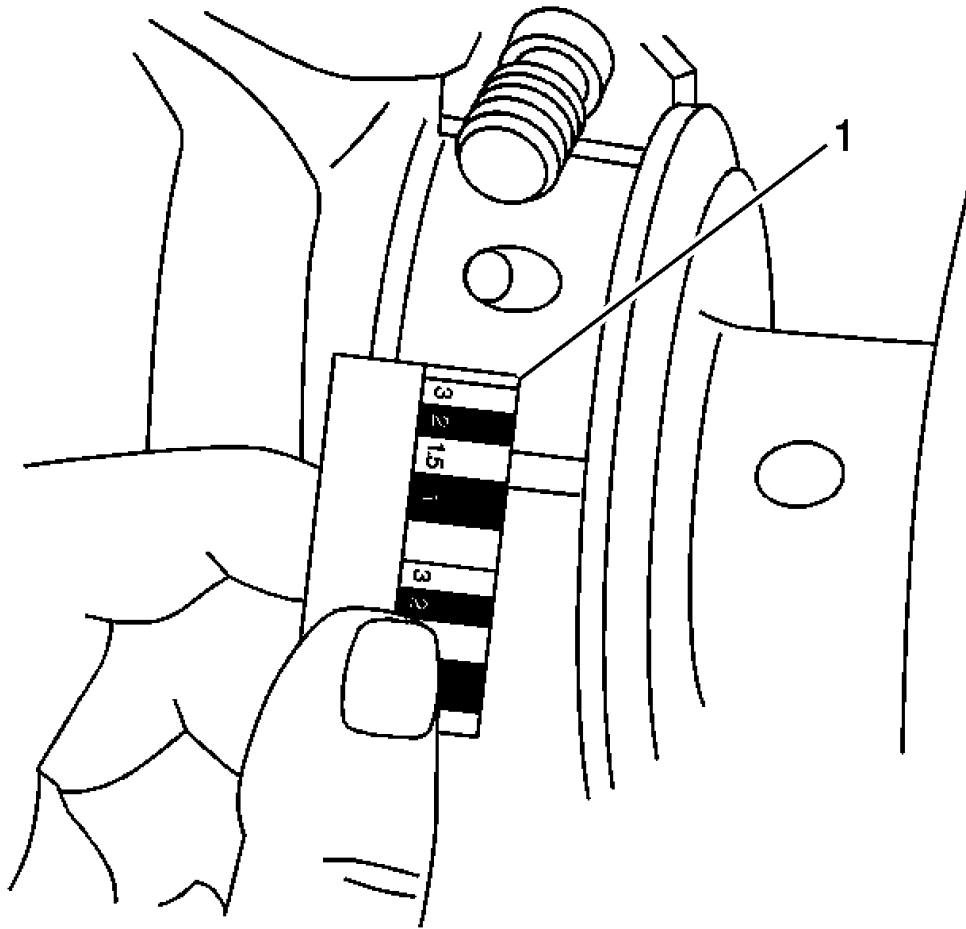


Fig. 201: Measuring Bearing Clearance Using Method B
Courtesy of GENERAL MOTORS COMPANY

3. To measure bearing clearance using Method B, use the following procedure:
 1. Clean the used bearing inserts.
 2. Install the used bearing inserts.
 3. Place a piece of gaging plastic across the entire bearing width at 90 degrees to block/lower crankcase split line.
 4. Install the bearing caps.

CAUTION: In order to prevent the possibility of cylinder block or crankshaft bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead, or a leather mallet before the attaching bolts are installed. Do not use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.

5. Install the bearing cap bolts to specification.

NOTE: **Do not rotate the crankshaft.**

6. Remove the bearing cap, leaving the gauging plastic in place. It does not matter whether the gauging plastic adheres to the journal or to the bearing cap.
7. Measure the gauging plastic at its widest point with the scale (1) printed on the gauging plastic package.
8. Remove the gauging plastic.

Crankshaft Installation

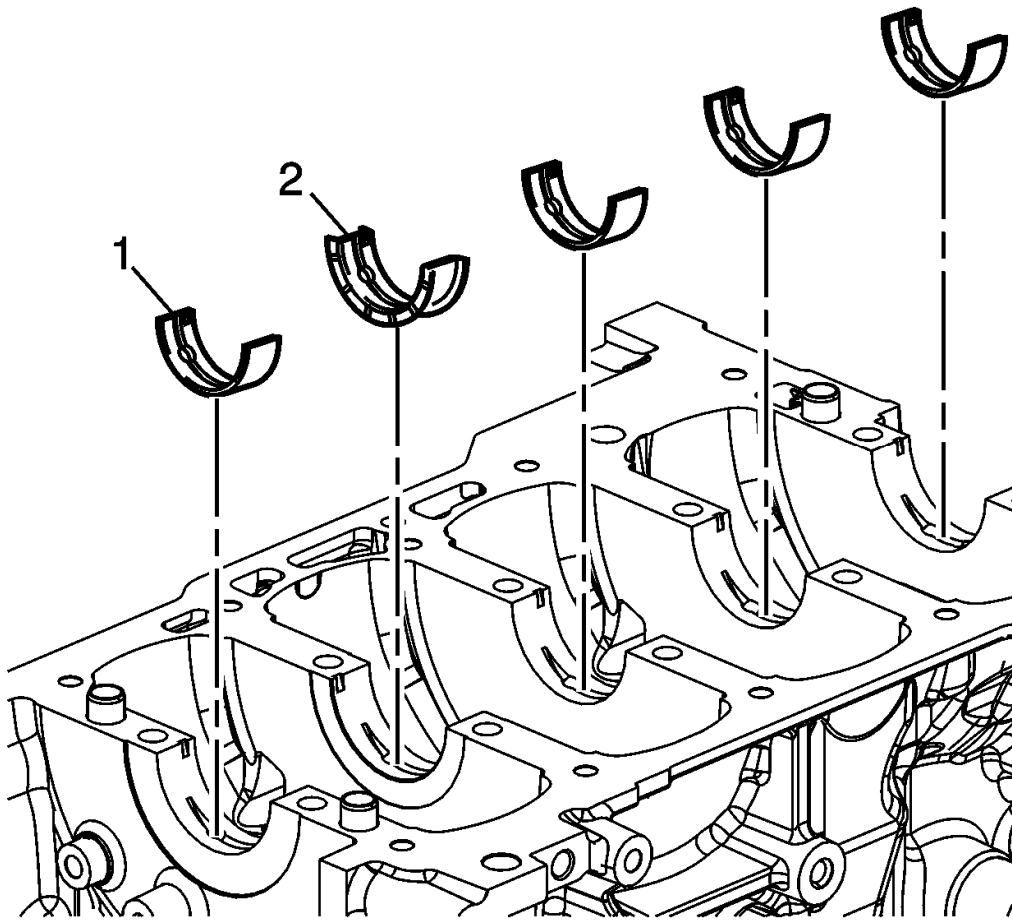


Fig. 202: Crankshaft Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.

1. Install the upper crankshaft bearings (1) and lubricate bearing surfaces with engine oil.
2. Install the crankshaft upper thrust bearing (3) and lubricate bearing surfaces with engine oil.

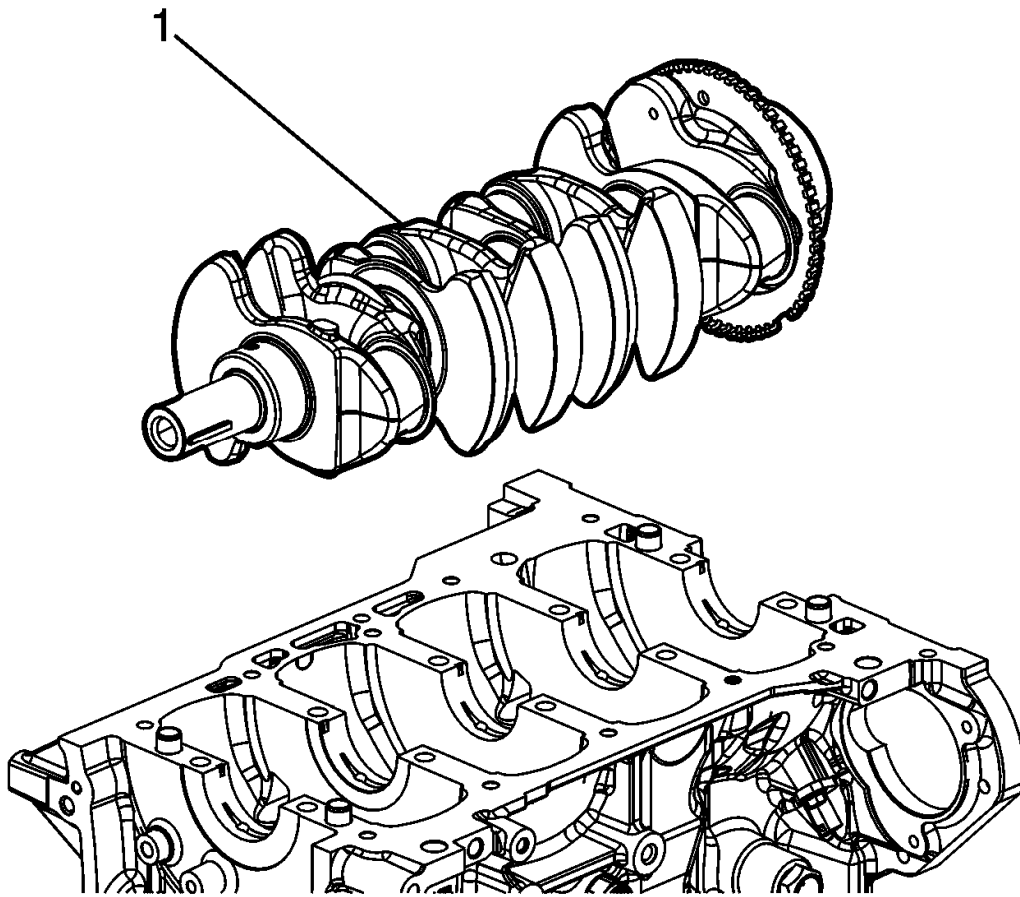


Fig. 203: Crankshaft
Courtesy of GENERAL MOTORS COMPANY

3. Install the crankshaft (1) on the journals.

LOWER CRANKCASE INSTALLATION

Special Tools

- **EN 45059** Angle Meter
- **EN-51380** Seal Installer

For equivalent regional tools, refer to **Special Tools** .

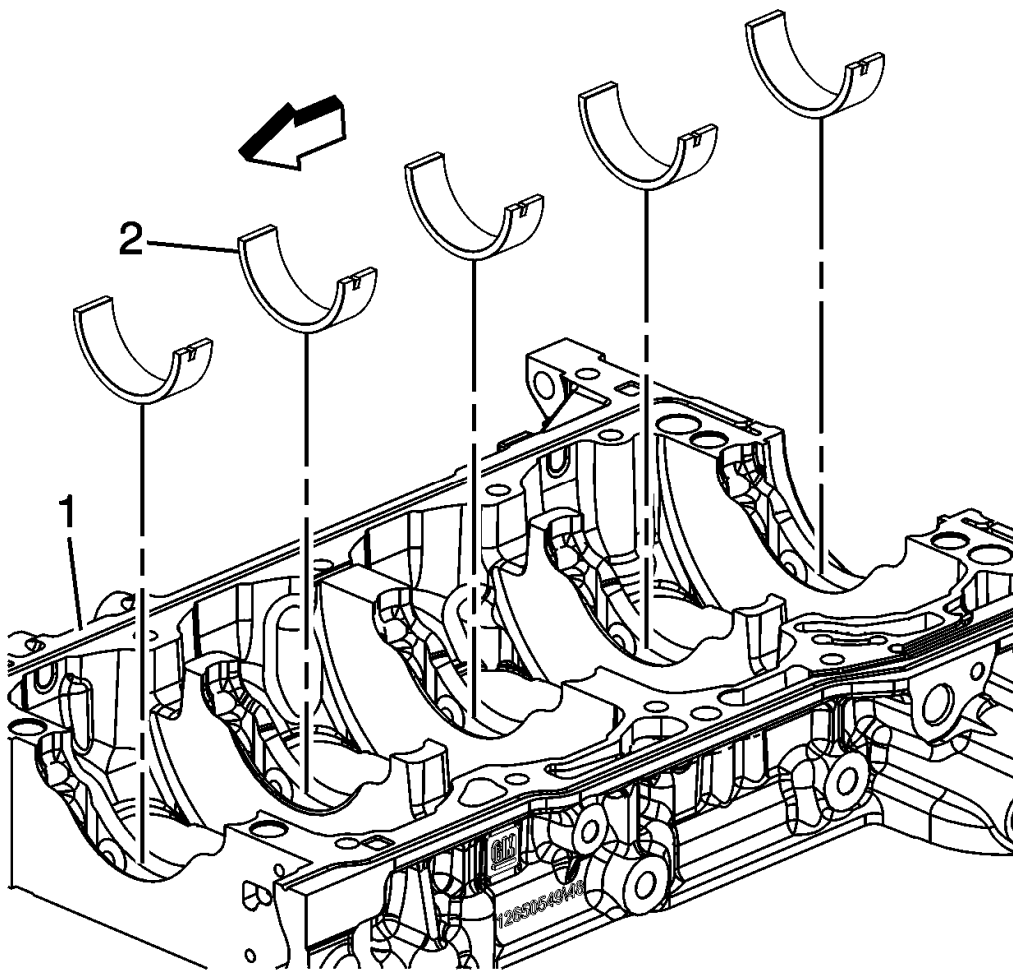


Fig. 204: Crankshaft Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.

1. Install the lower bearing halves (2), without grooves, into the lower crankcase (1). Apply oil to bearing surfaces.

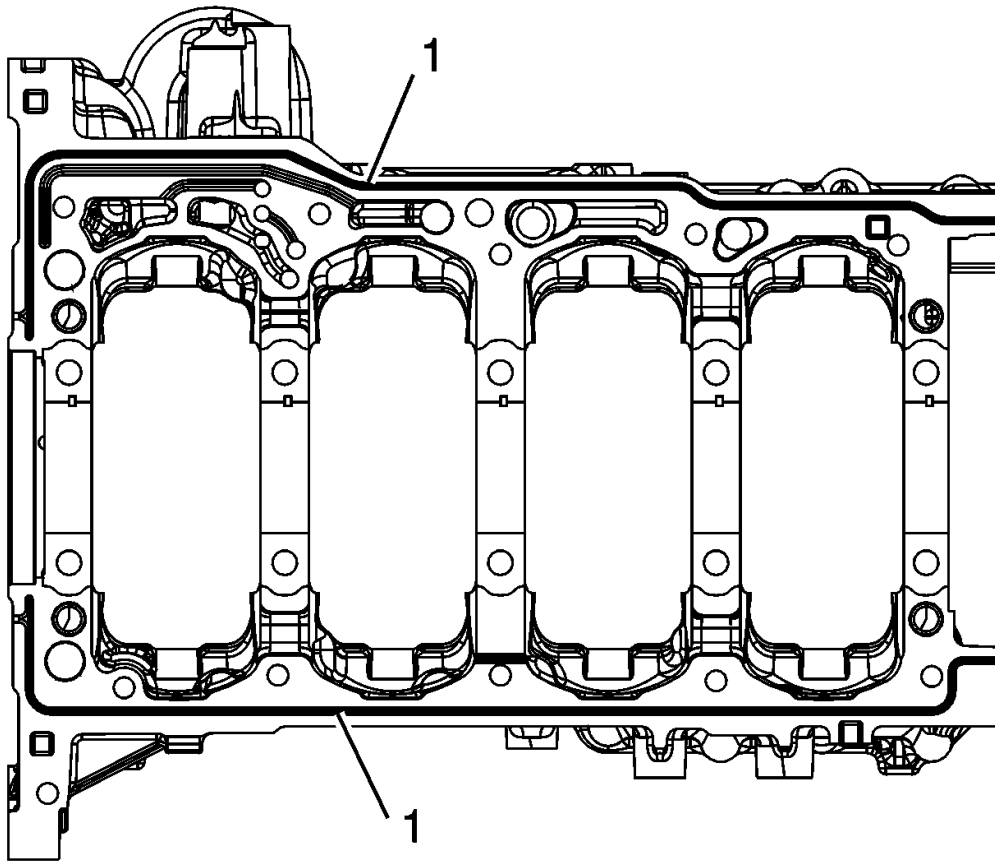


Fig. 205: Applying Bead Of Sealer Directly In Groove
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The block assembly surface must be free of contamination prior to applying the sealer.
- Install and align the bedplate to block within 20 minutes of applying the sealer.
- The bedplate must be fastened to final torque specification within 60 minutes of applying the sealer.

2. Apply a 4.25 mm bead of sealer directly in the groove (1) of the block to bedplate mating surfaces. Refer to Adhesives, Fluids, Lubricants, and Sealers .

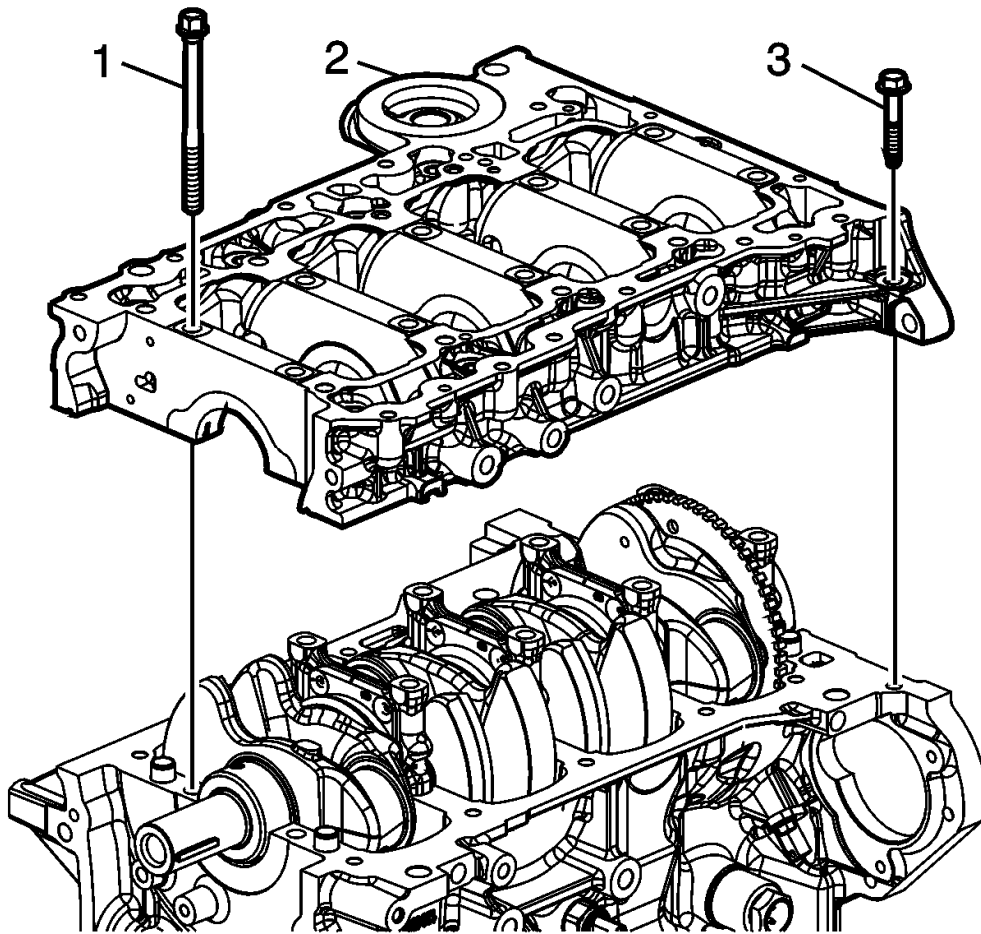


Fig. 206: Lower Crankcase Perimeter Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the lower crankcase (2). Tap gently into place with a suitable tool if necessary. Ensure it is aligned properly on the dowels.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

4. Install the NEW crankshaft bearing bolts (1) finger tight.
5. Install NEW lower crankcase perimeter bolts (3) finger tight.

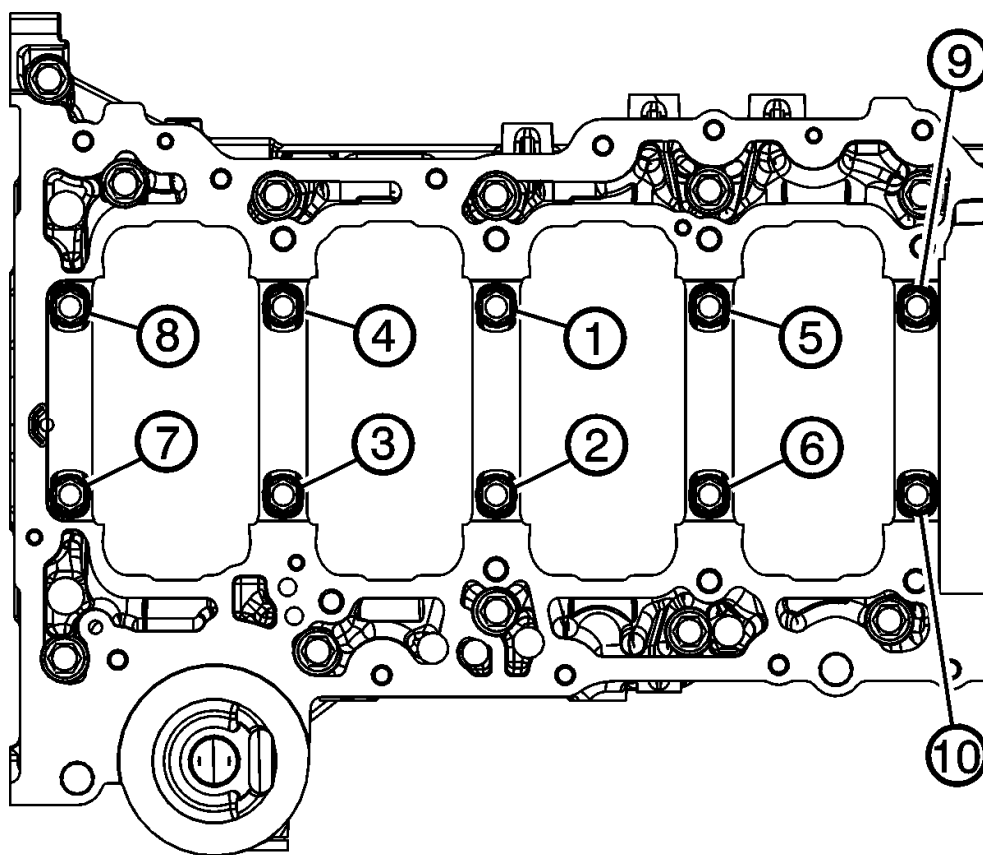


Fig. 207: Crankshaft Bearing Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the crankshaft bearing bolts in sequence using the following procedure:
 1. Tighten the crankshaft bearing bolts a first pass in sequence to 20 N.m (15 lb ft).
 2. Tighten the crankshaft bearing bolts a final pass in sequence using the **EN 45059** meter an additional 140 degrees.

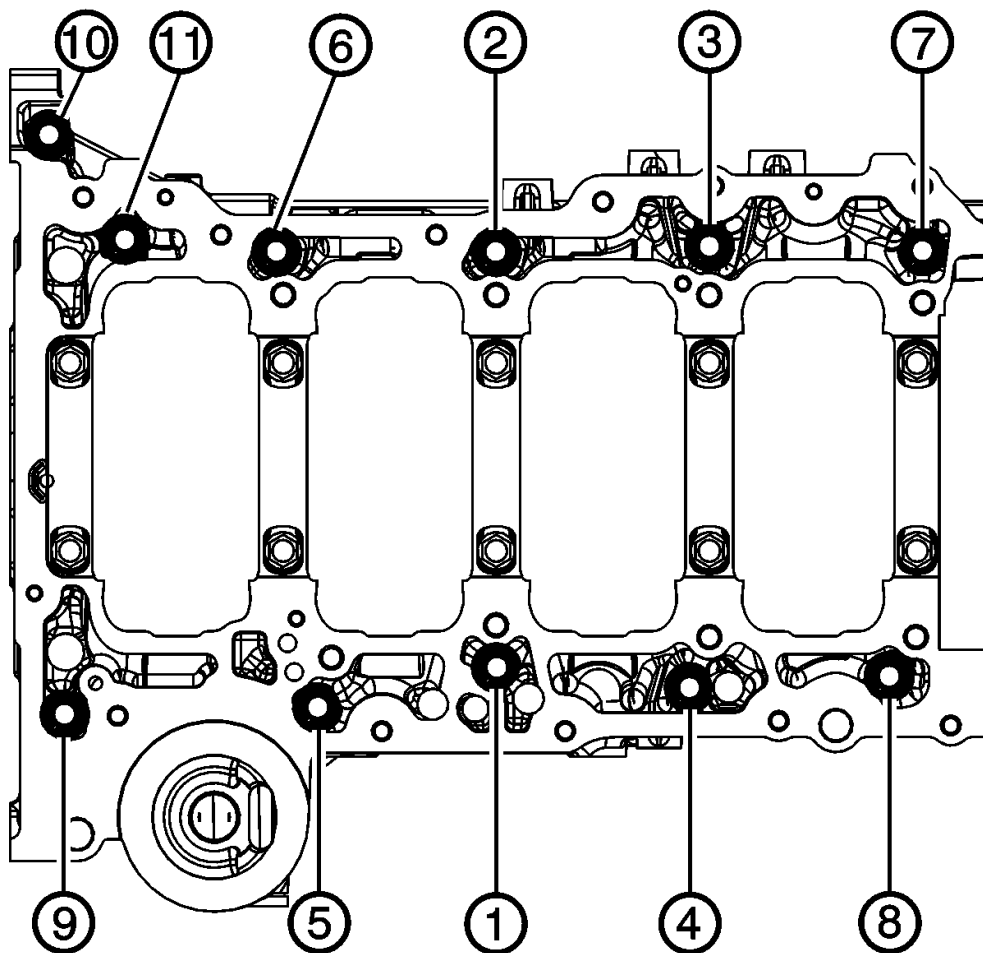


Fig. 208: Lower Crankcase Perimeter Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the lower crankcase perimeter bolts in sequence to 25 N.m (18 lb ft).

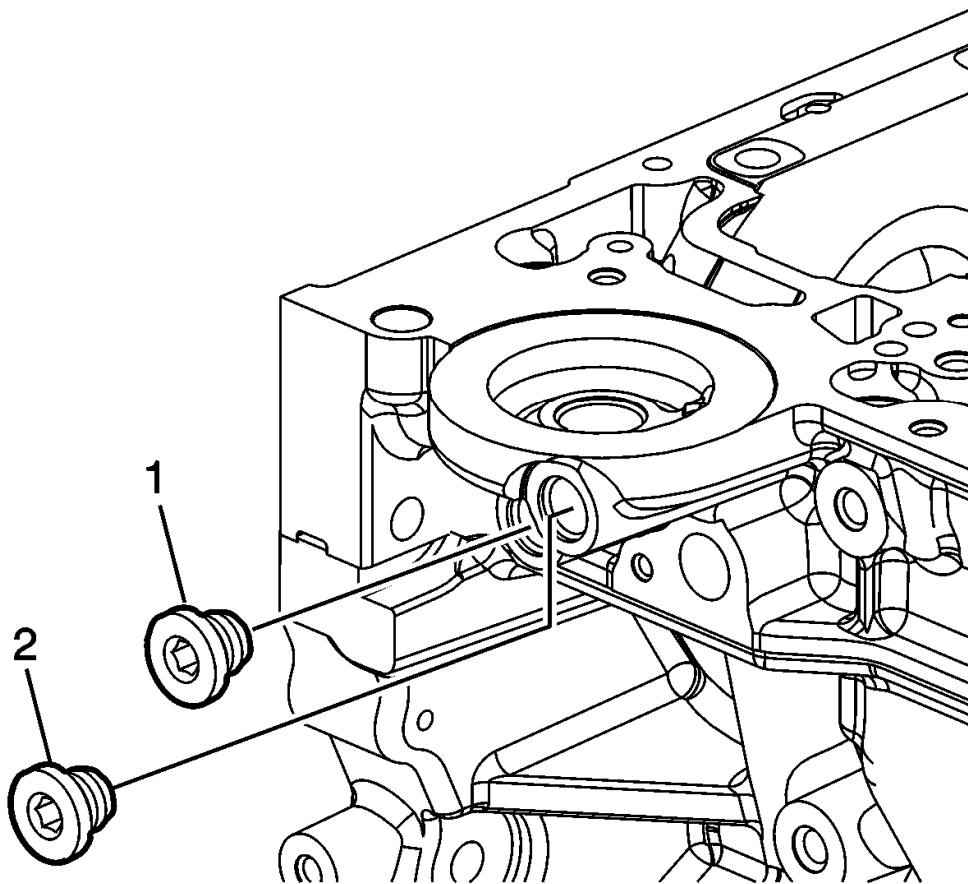


Fig. 209: Oil Gallery Plugs

Courtesy of GENERAL MOTORS COMPANY

8. Install the engine oil gallery plugs (1, 2). Tighten the plugs to 65 N.m (48 lb ft).

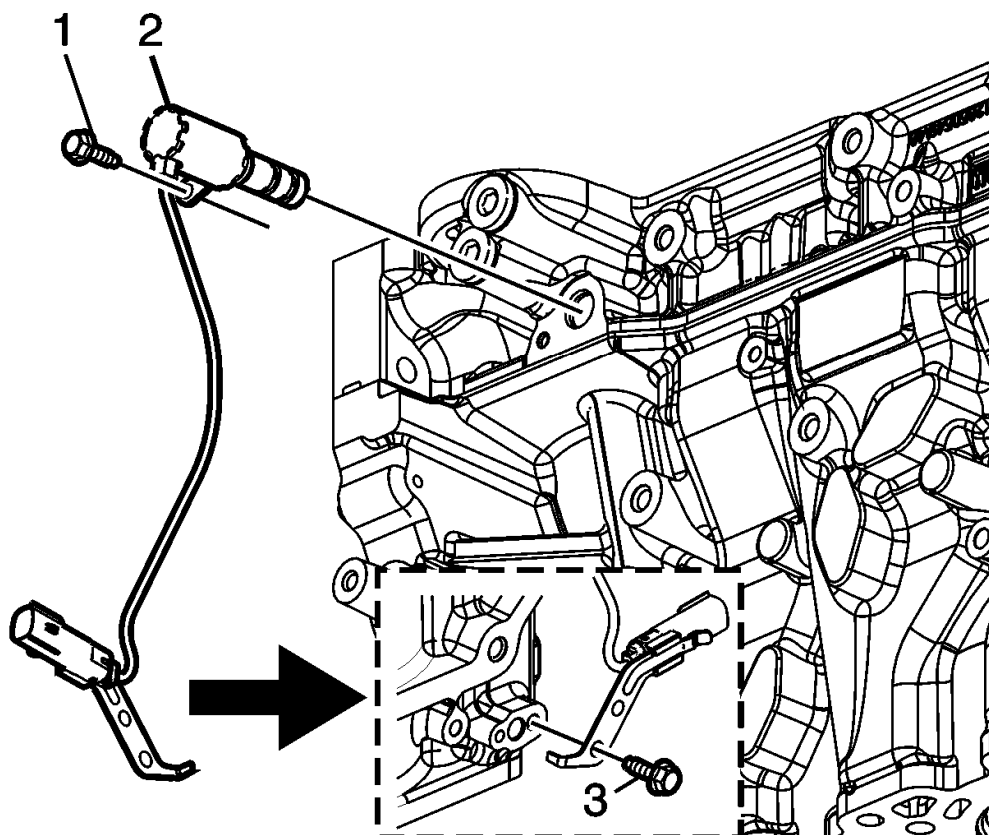


Fig. 210: Oil Pump Flow Control Valve And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the oil pump flow control valve (2) and bolts (1, 3). tighten the bolts to 10 N.m (89 lb in).

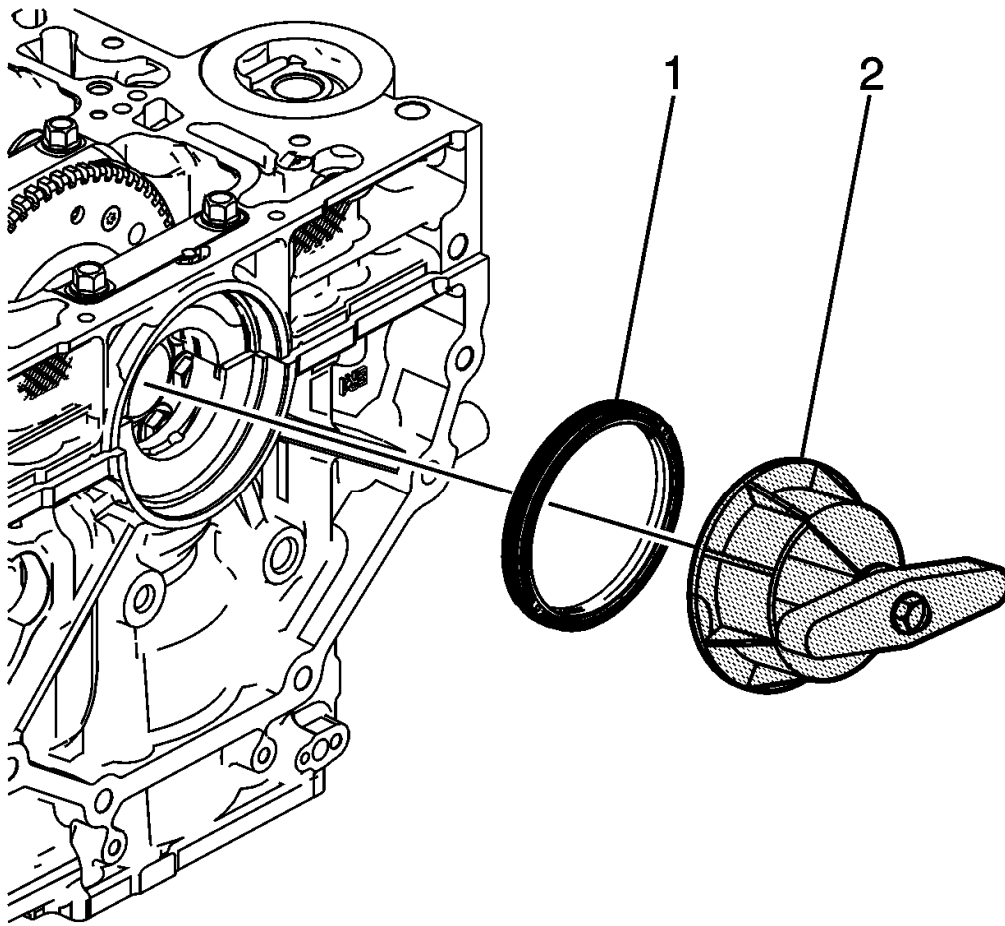


Fig. 211: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

10. Using **EN-51380** installer (2), install the crankshaft rear oil seal (1) flush or recessed up to 0.5 mm to block.
11. Rotate the crankshaft to ensure that it moves freely and does not bind.
12. Measure and record the crankshaft endplay. Refer to **Engine Mechanical Specifications** .

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

NOTE: **This procedure is not used in Europe.**

Special Tools

- **EN-8037** Ring Compressor
- **EN-43966** Connecting Rod Guides
- **EN 45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

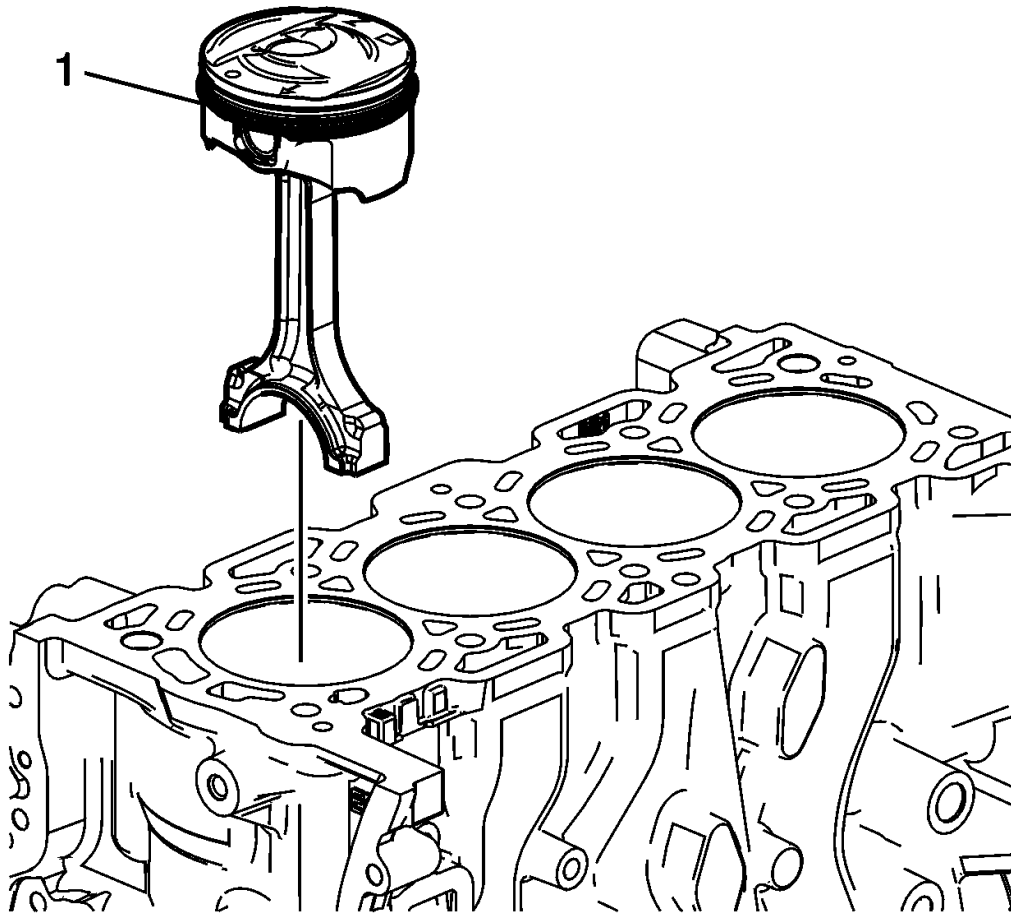


Fig. 212: Piston And Connecting Rod Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: The connecting rods and caps must be installed in the same order and orientation in which they were removed. If new connecting rods are required, the connecting rod is provided as an assembly, and the upper rod will need to be disassembled from the lower cap.

1. Install the connecting rod bearings. Use NEW bearings.

NOTE: The connecting rod bearing anti-rotation tab grooves are to point toward the right-hand side of the engine.

1. Install the bearing inserts into the connecting rod and the connecting rod cap.
2. Lubricate the connecting rod bearings with engine oil.
2. Install the **EN-43966** guides (2) into the connecting rod bolt holes. This protects the crankshaft journal

during piston and connecting rod installation.

3. Install **EN-8037** compressor , piston (1), and the connecting rod to the correct bore.
 1. Stagger each piston ring end gap equally around the piston.
 2. Lubricate the piston and the piston rings with engine oil.
 3. Do not disturb the piston ring end gap location.
 4. The piston must be installed so that the arrow mark on the top of the piston points to the front of the engine.
 5. Lubricate the engine bore with engine oil, then place the piston in its matching bore.
 6. Tap the piston into its bore with a hammer handle. Guide the connecting rod to the connecting rod journal while tapping the piston into place.
 7. Hold the **EN-8037** compressor against the engine block until all the rings have entered the cylinder bore.
 8. Remove the connecting rod guides from the connecting rod bolt holes.

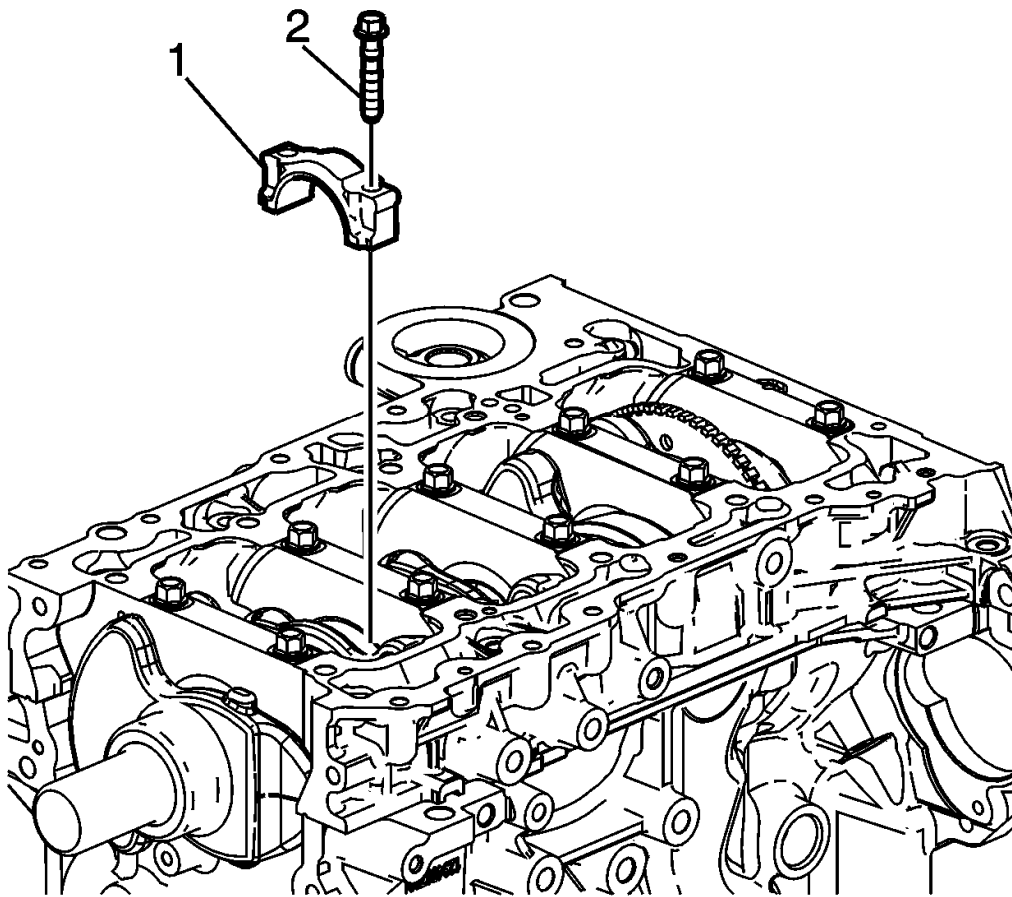


Fig. 213: Connecting Rod Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the connecting rod cap is properly oriented on the connecting rod.

4. Install the connecting rod cap (1).

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

5. Install the NEW connecting rod bolts (2).
 1. Tighten all the connecting rod bolts a first pass to 25 N.m (18 lb ft).
 2. Tighten all the connecting rod bolts a final pass an additional 110 degrees using the **EN 45059** meter.
6. Install the remaining connecting rods and piston assemblies.

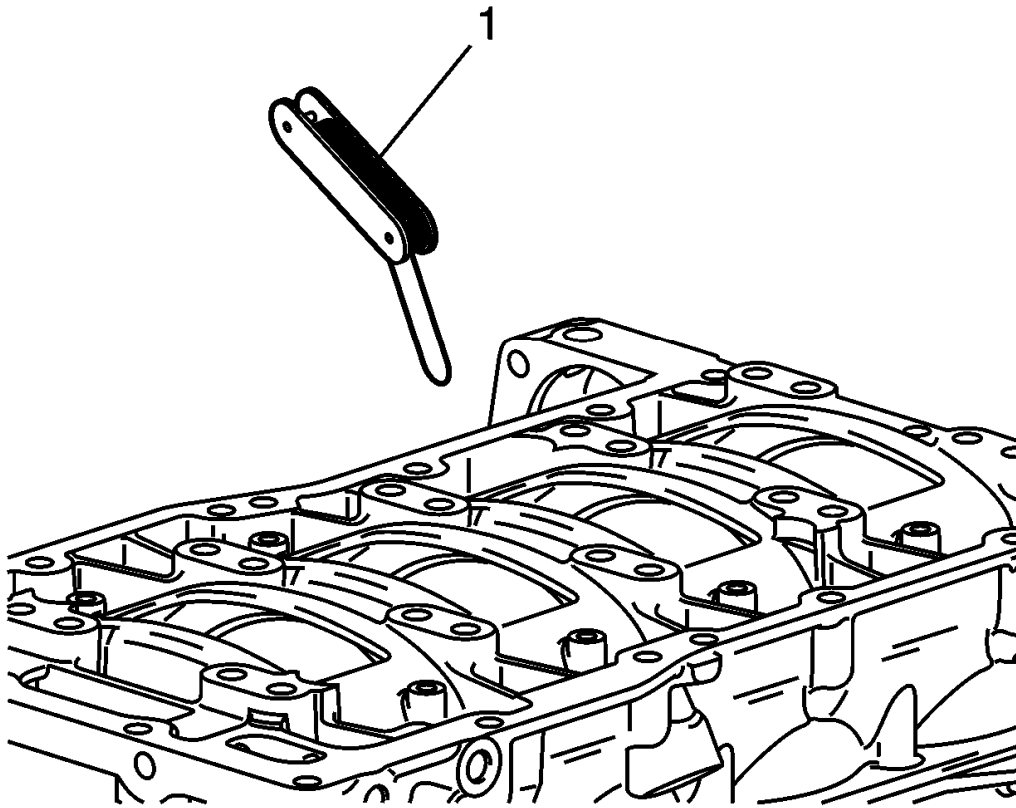


Fig. 214: View of Checking Rod Side Clearance With Feeler Gage
Courtesy of GENERAL MOTORS COMPANY

NOTE: Rotate the crankshaft to ensure that it moves freely and does not bind.

7. Measure the connecting rod side clearance with a feeler gauge (1). Refer to **Engine Mechanical Specifications** .
8. Measure the piston deck height. Refer to **Engine Mechanical Specifications** .

BALANCER WITH OIL PUMP SHAFT INSTALLATION

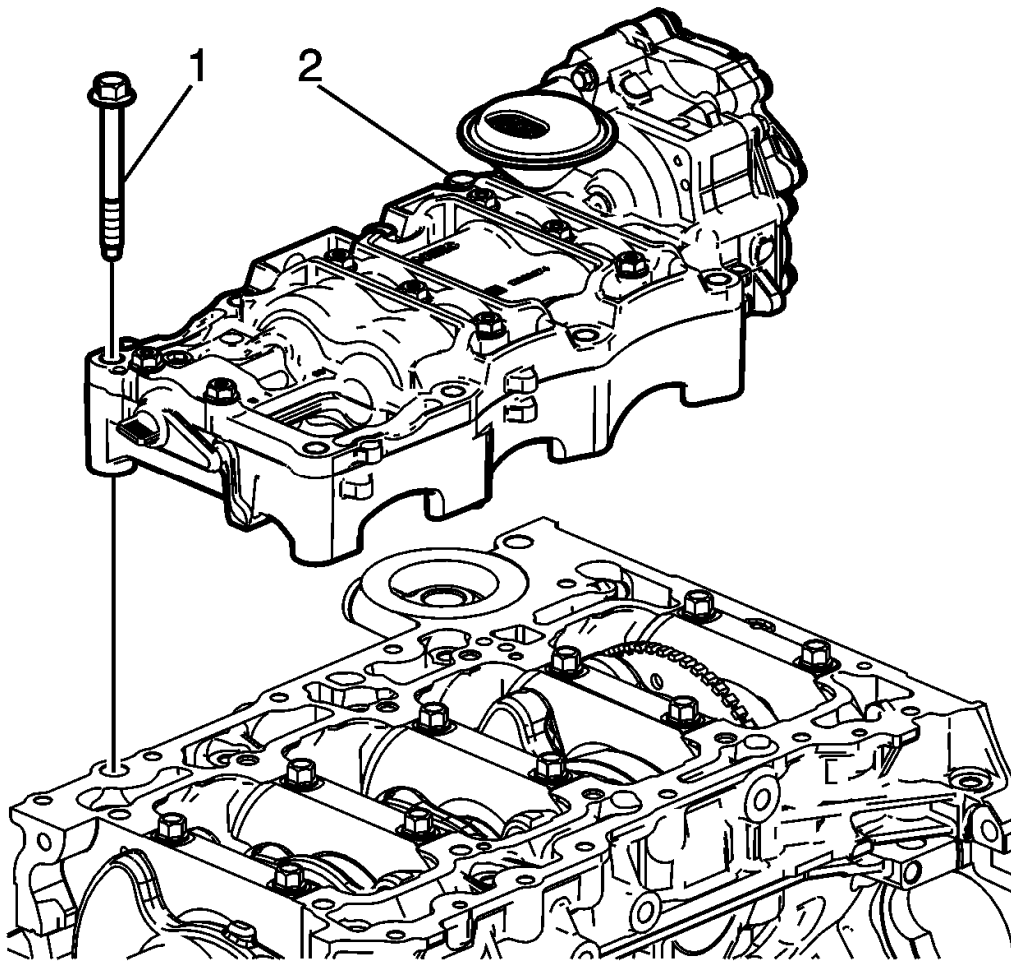


Fig. 215: Balancer And Oil Pump Shaft Assembly Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the balancer and oil pump shaft assembly (2).
2. Install the balancer and oil pump shaft assembly bolts (1) finger tight.

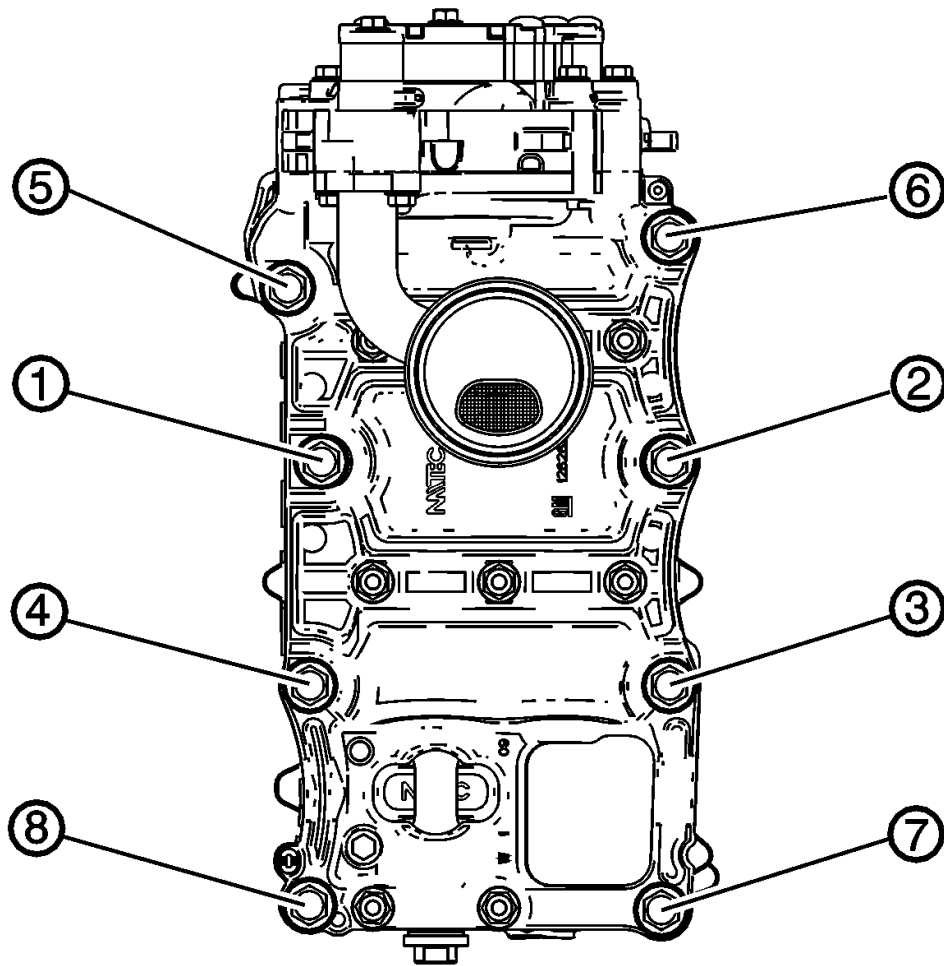


Fig. 216: Balancer And Oil Pump Shaft Assembly Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

3. Tighten the bolts twice in sequence to 58 N.m (43 lb ft).

CYLINDER HEAD INSTALLATION

Special Tools

EN 45059 Angle Meter

For equivalent regional tools, refer to **Special Tools**

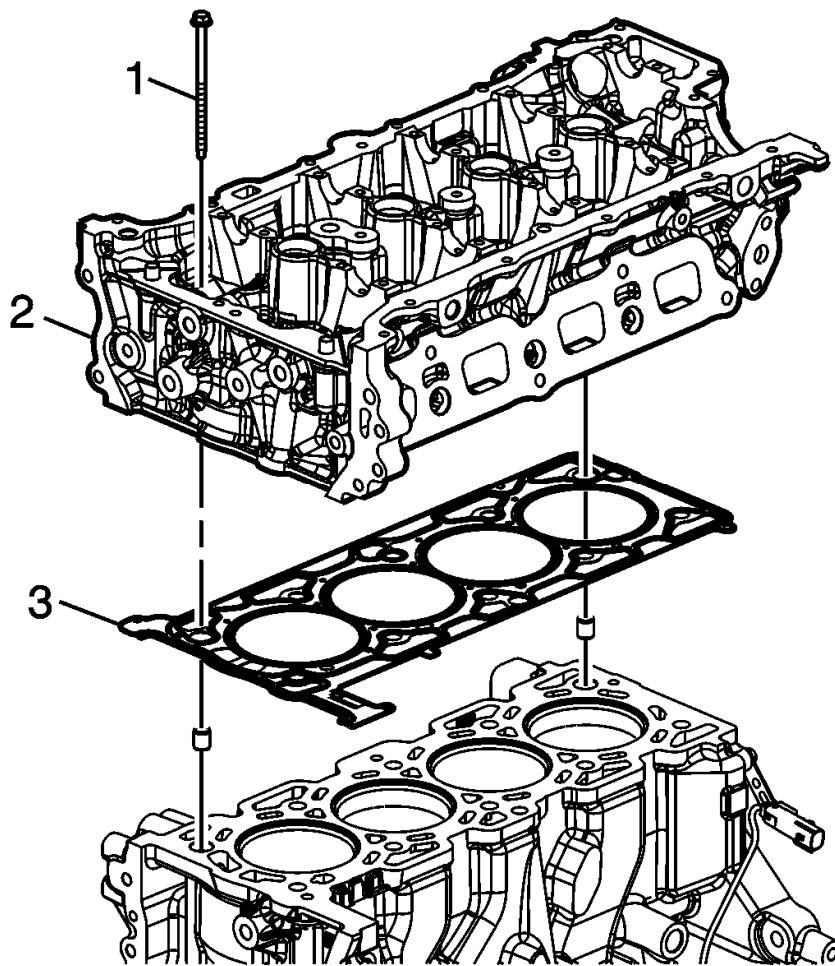


Fig. 217: Cylinder Head Gasket

Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use any sealing material. Ensure that all mating surfaces are clean and free of debris.**

1. If necessary, install NEW cylinder head locating pins.
2. Install the cylinder head gasket (3) to the block.
3. Install the cylinder head (2). Ensure the number 1 cylinder is at top dead center (TDC). The key on the crankshaft should be on top in the 12 o'clock position.

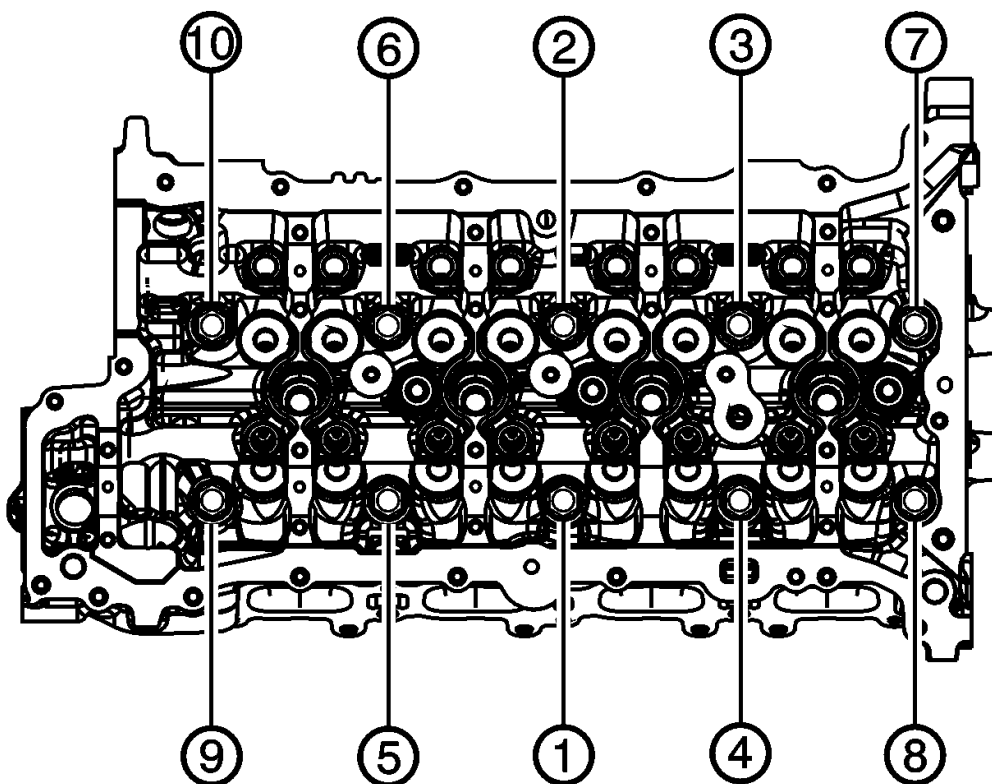


Fig. 218: Cylinder Head Gasket And Cylinder Head
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

4. Install the NEW cylinder head bolts.
 1. Tighten the bolts in sequence to 30 N.m (22 lb ft).
 2. Tighten the bolts an additional 190 degrees in sequence using the **EN 45059** meter.

WATER PUMP INSTALLATION

Prior to installing the water pump, read the entire procedure. Pay special attention to avoid part damage and to ensure proper sealing.

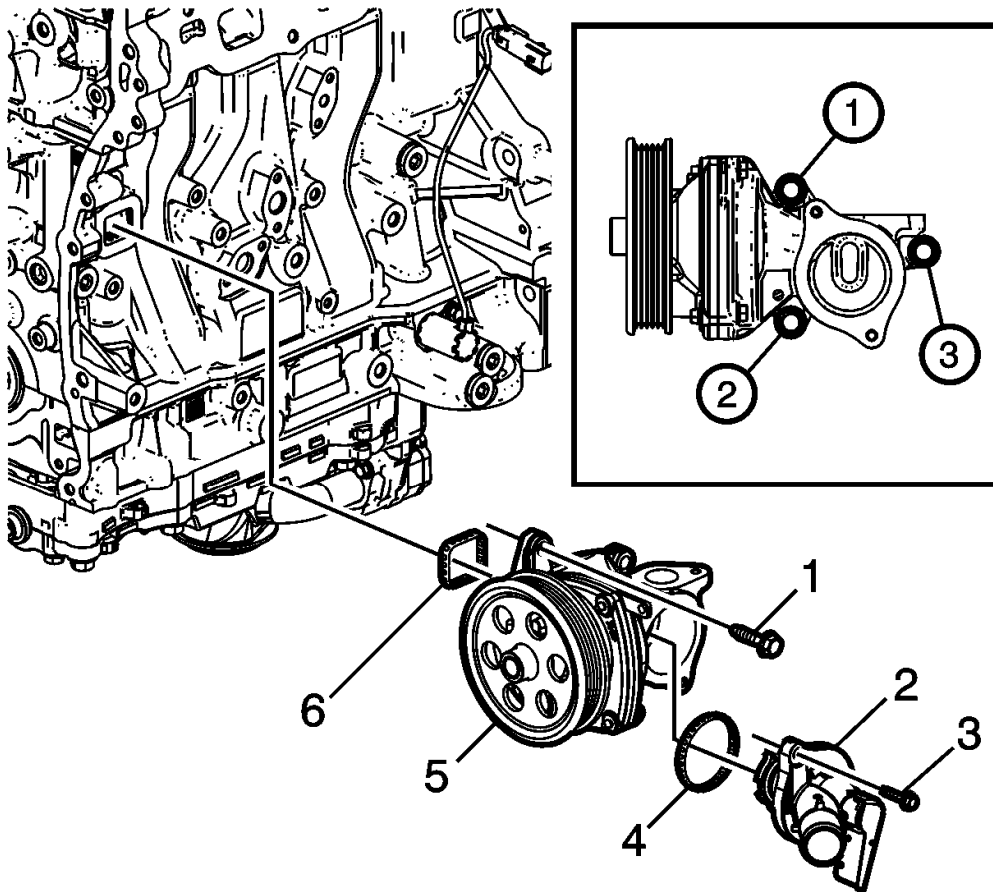


Fig. 219: Water Pump Gasket And Water Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW water pump gasket (6) and the water pump assembly (5).
2. Install the water pump bolts (1). Finger tighten the bolts.

CAUTION: Refer to Fastener Caution .

NOTE: The sequence allows the fasteners closest to compress the seal.

3. Tighten the water pump bolts in sequence to 25 N.m (18 lb ft).
4. Install a NEW thermostat assembly gasket (4) and the thermostat assembly (2).
5. Install the thermostat assembly bolts (3) and tighten to 10 N.m (89 lb in).

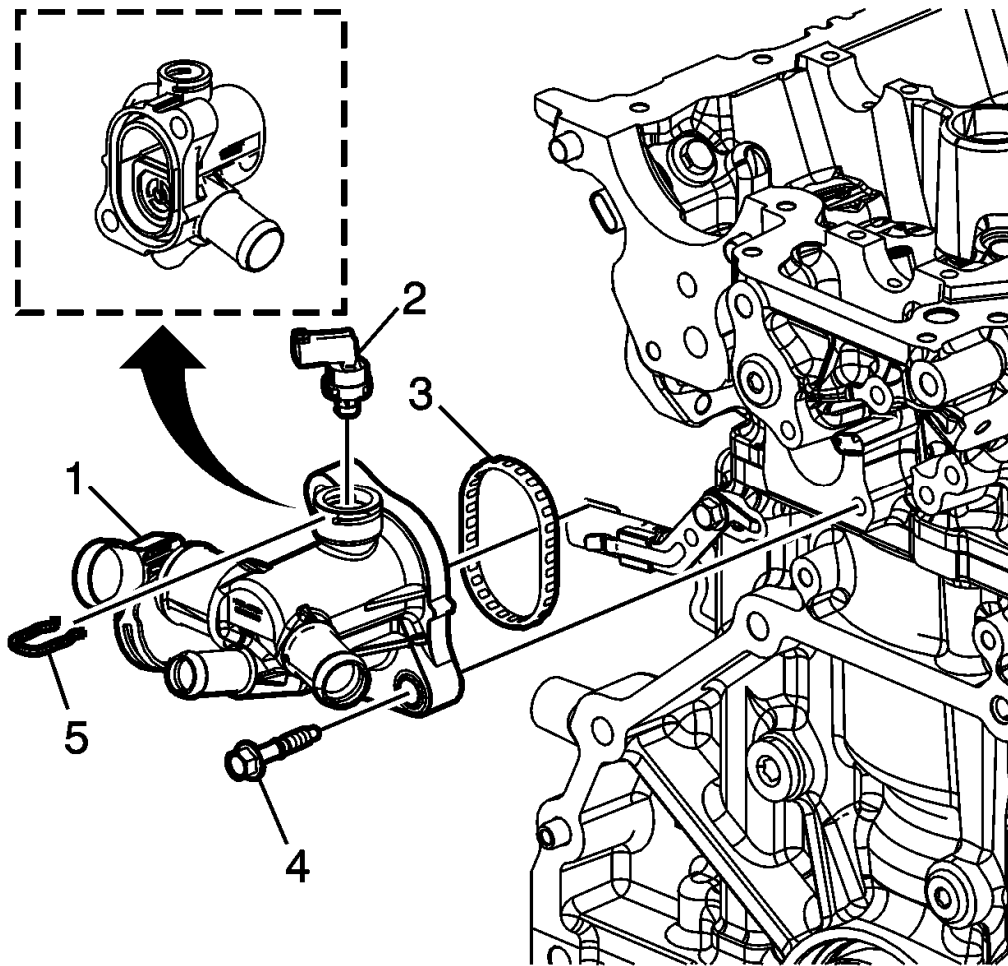


Fig. 220: Retaining Clip And Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

6. Install a NEW water outlet assembly gasket (3), and the water outlet assembly (1).
7. Install the water outlet assembly bolts (4) and tighten to 10 N.m (89 lb in).
8. Install the engine coolant temperature sensor (2).
9. Install the engine coolant temperature sensor retaining clip (5).

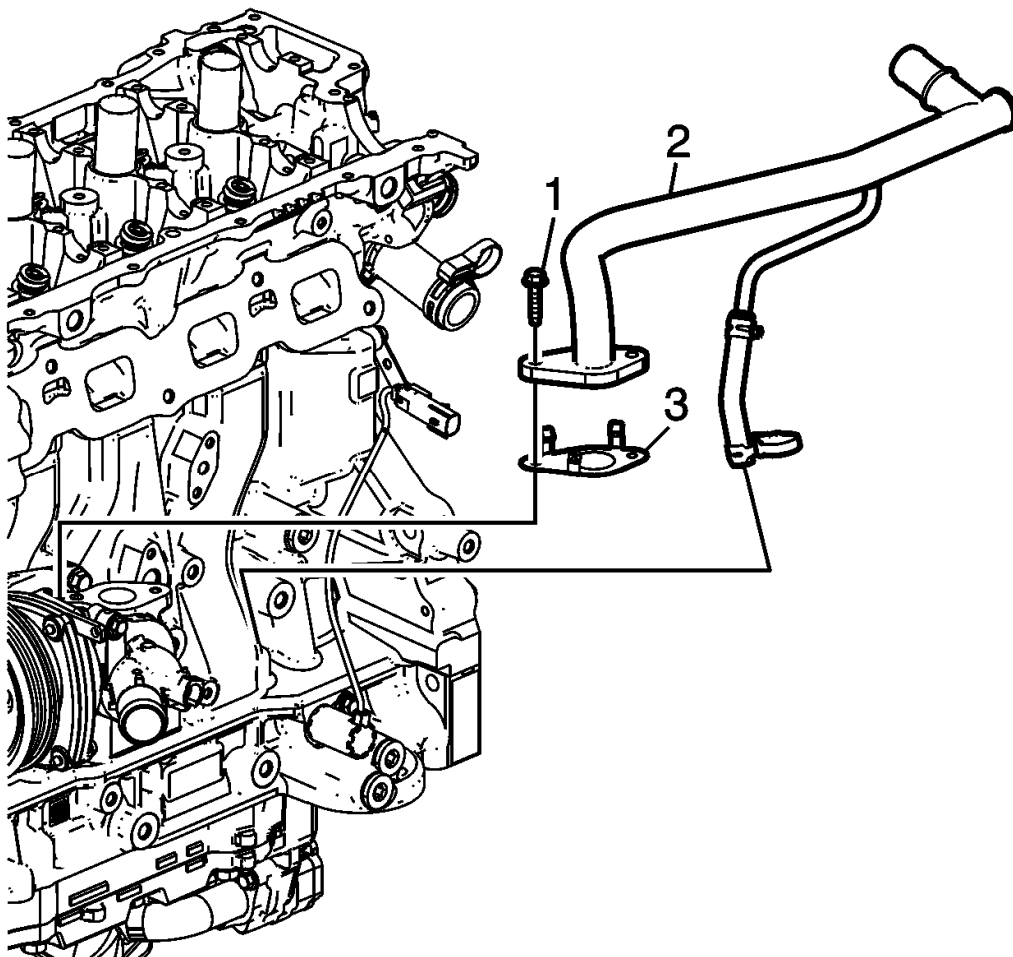


Fig. 221: Thermal Bypass Pipe Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Connect the thermal bypass pipe (2) to the water outlet assembly.
11. Connect the thermal bypass hose to the engine oil cooler.
12. Install a NEW thermal bypass pipe gasket (3) on the thermal bypass pipe. Install the thermal bypass pipe to the water pump assembly. Install the bolts (1) and tighten to 10 N.m (89 lb in).

INTAKE AND EXHAUST CAMSHAFT, BEARING CAP, AND LASH ADJUSTER INSTALLATION

Exhaust Camshaft Installation

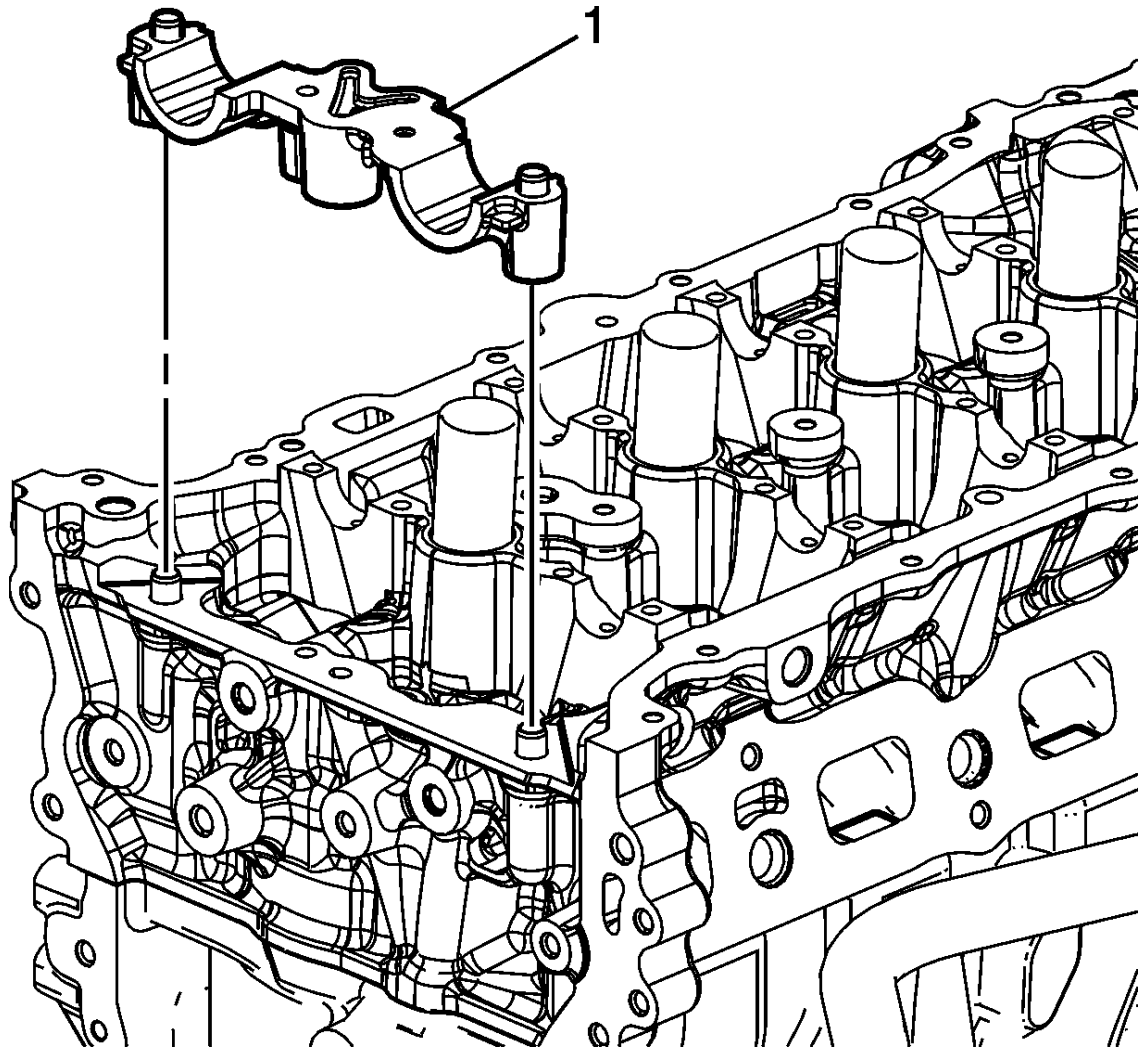


Fig. 222: Camshaft Bearing Lower Front Cap
Courtesy of GENERAL MOTORS COMPANY

1. Install the camshaft bearing lower front cap (1).

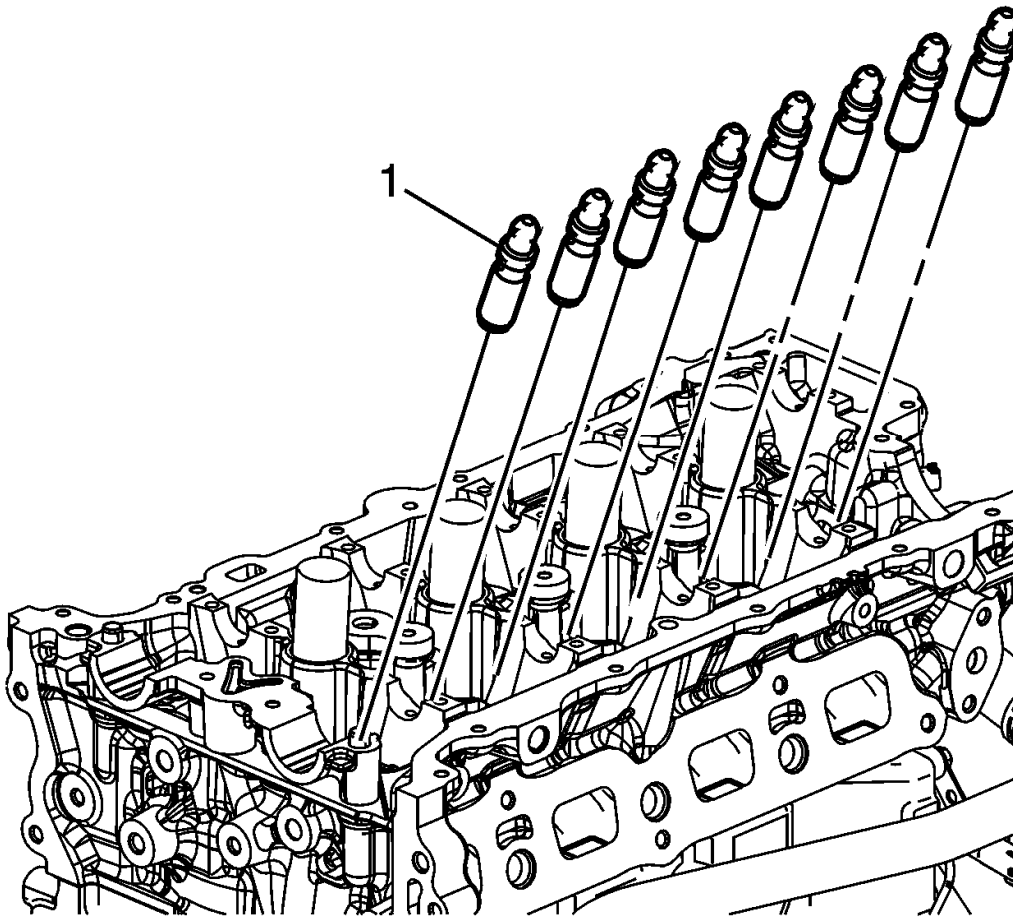


Fig. 223: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.

2. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to Adhesives, Fluids, Lubricants, and Sealers .

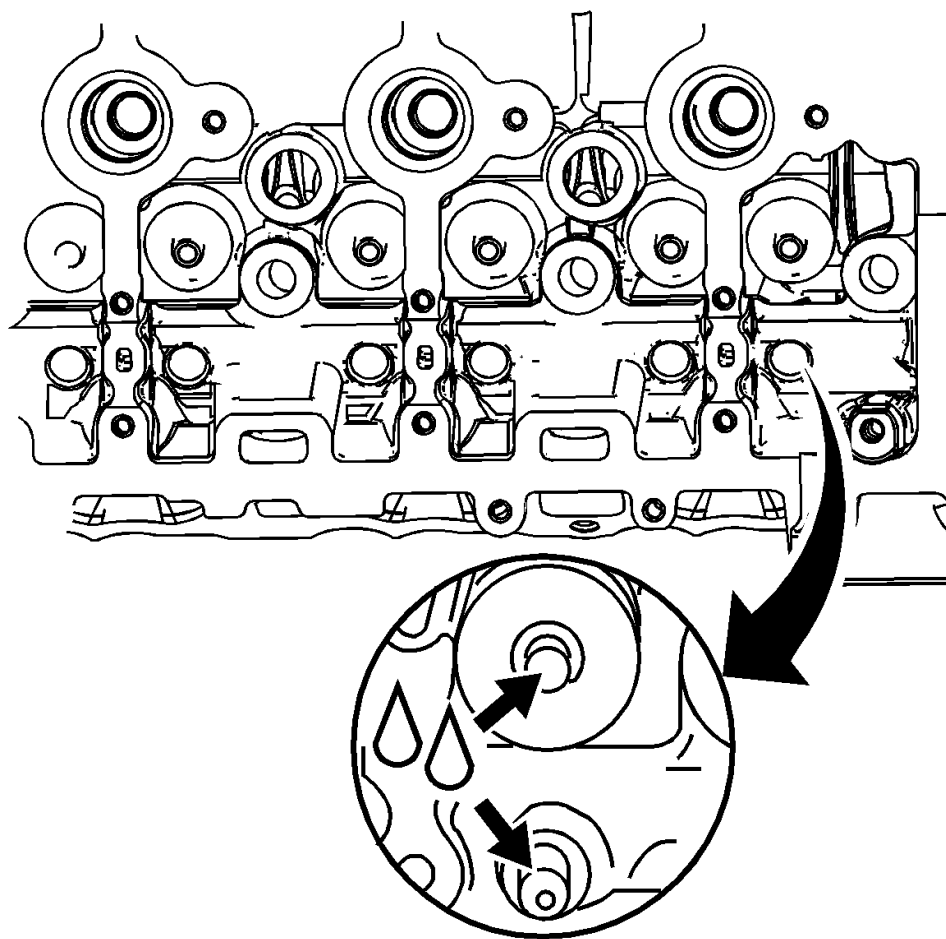


Fig. 224: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

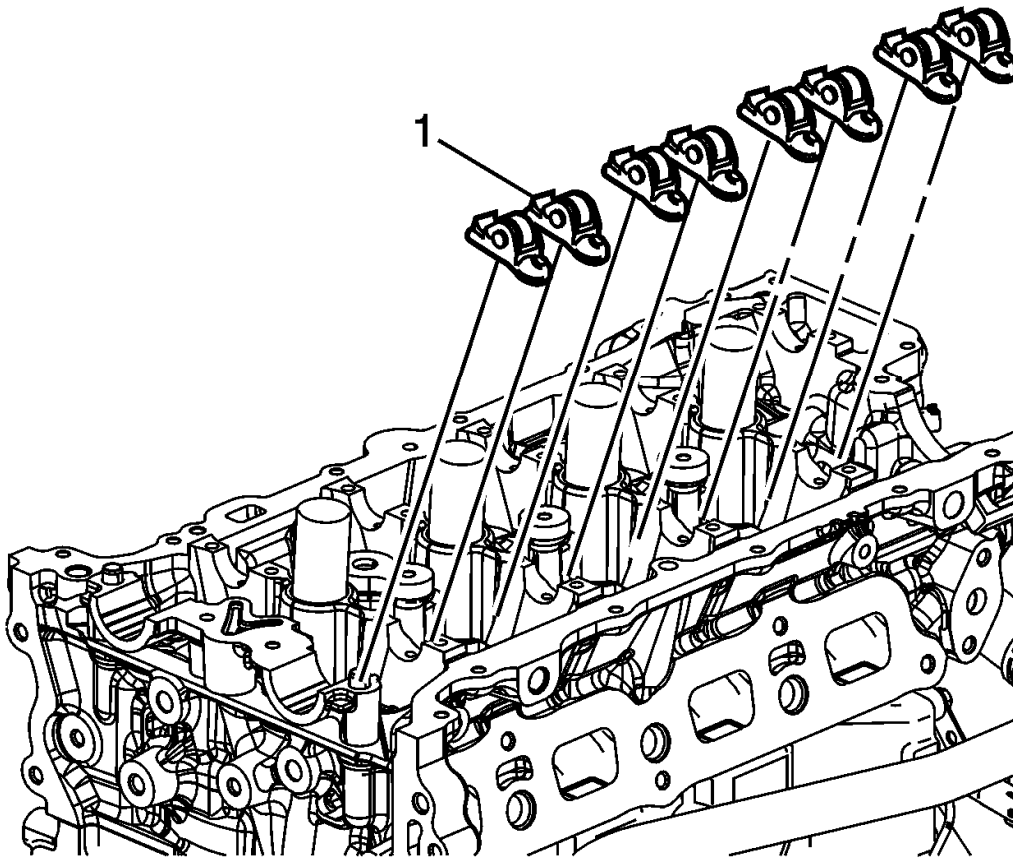


Fig. 225: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.

NOTE: Pre-oil roller bearings before installation.

4. Lubricate the roller bearings with valve rocker arm lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
5. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

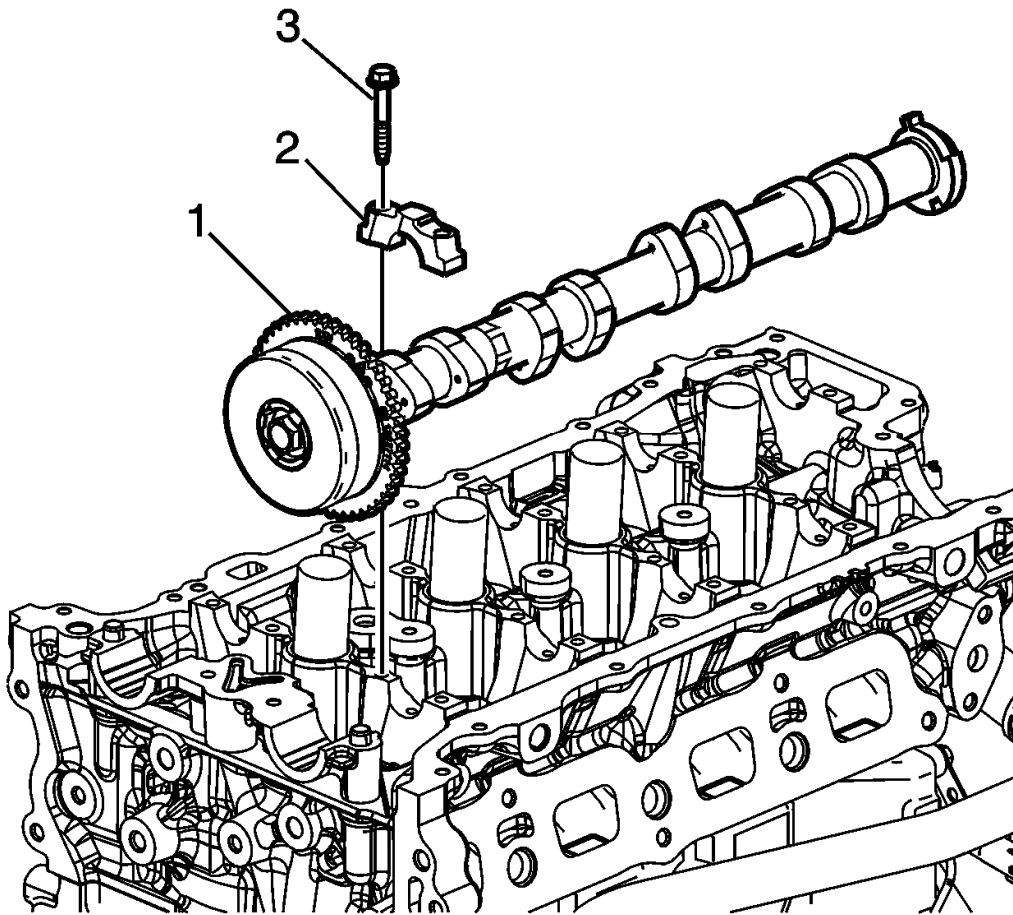


Fig. 226: Mark Camshaft Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

6. Lubricate the exhaust camshaft lobes and journals with camshaft lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
7. Set the exhaust camshaft (1) on top of the rocker arms in the camshaft bearing journals with the actuator timing mark at approximately the 1 O'clock position.

NOTE:

- Do not apply final torque at this time. Camshaft cap final torque is applied in sequence when all caps are installed on both intake and exhaust camshafts.
- To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

8. Install the camshaft cap bolts (3) into the camshaft caps (2).

9. Install the camshaft caps (2) and hand start the camshaft cap bolts (3).

Intake Camshaft Installation

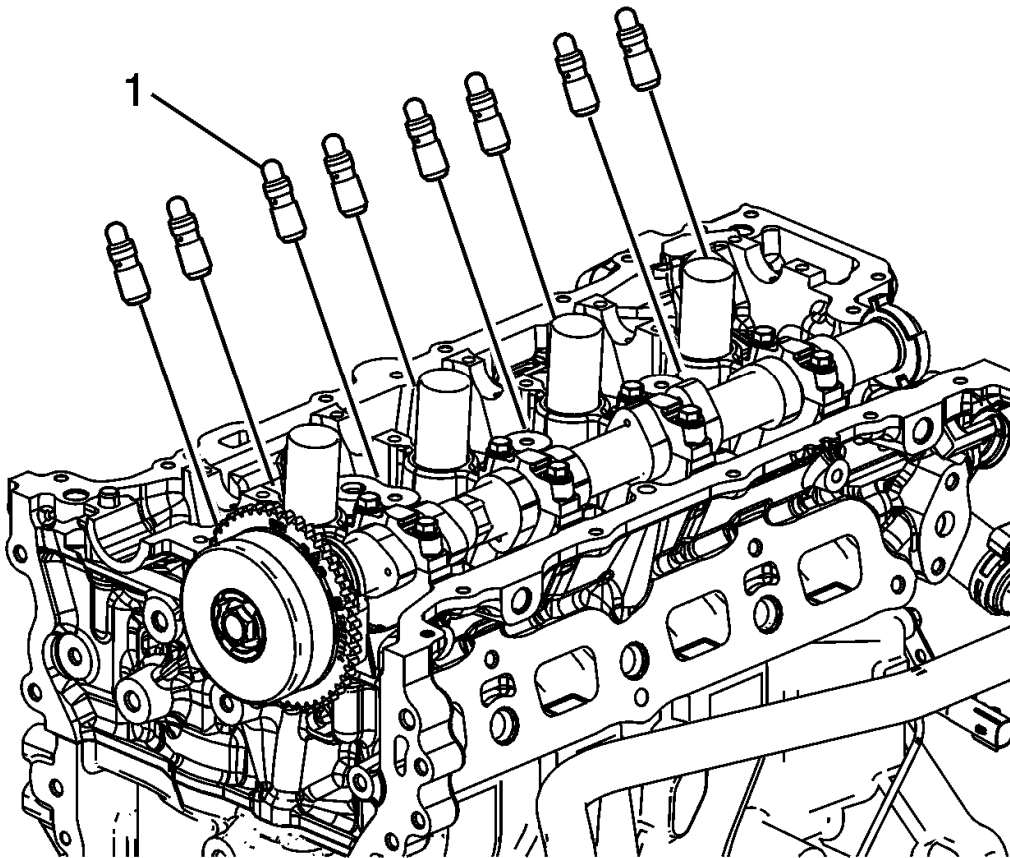


Fig. 227: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to Adhesives, Fluids, Lubricants, and Sealers .

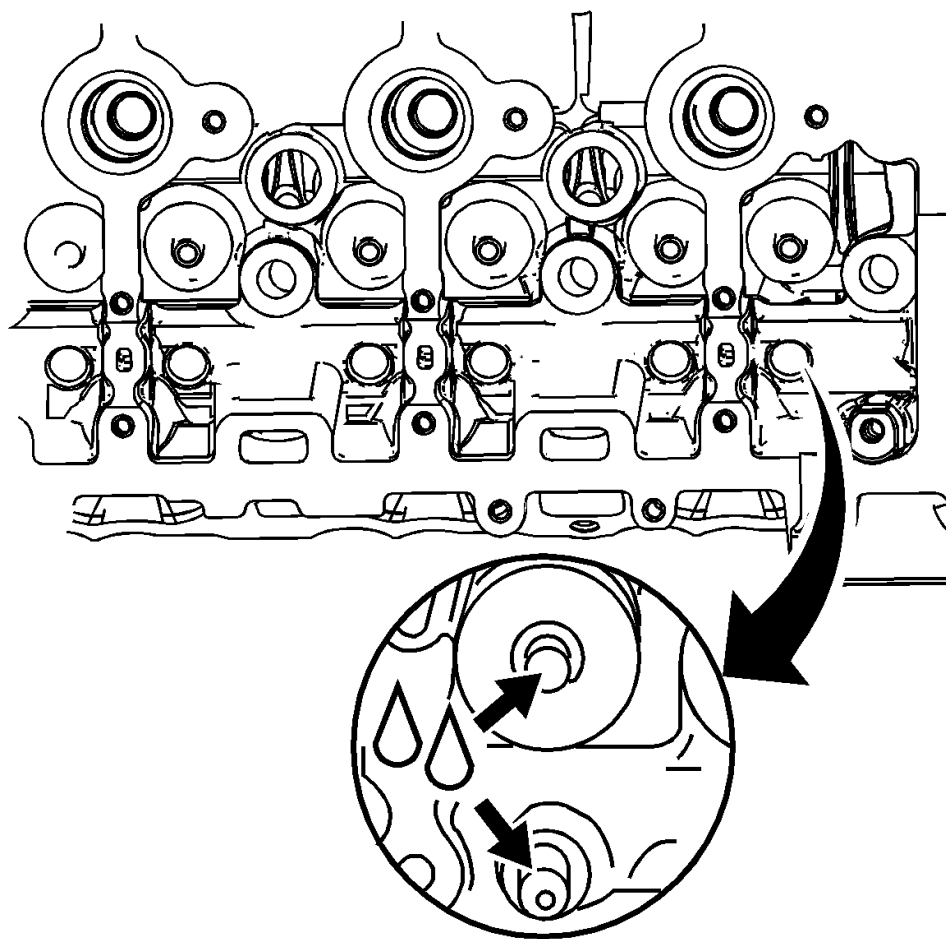


Fig. 228: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

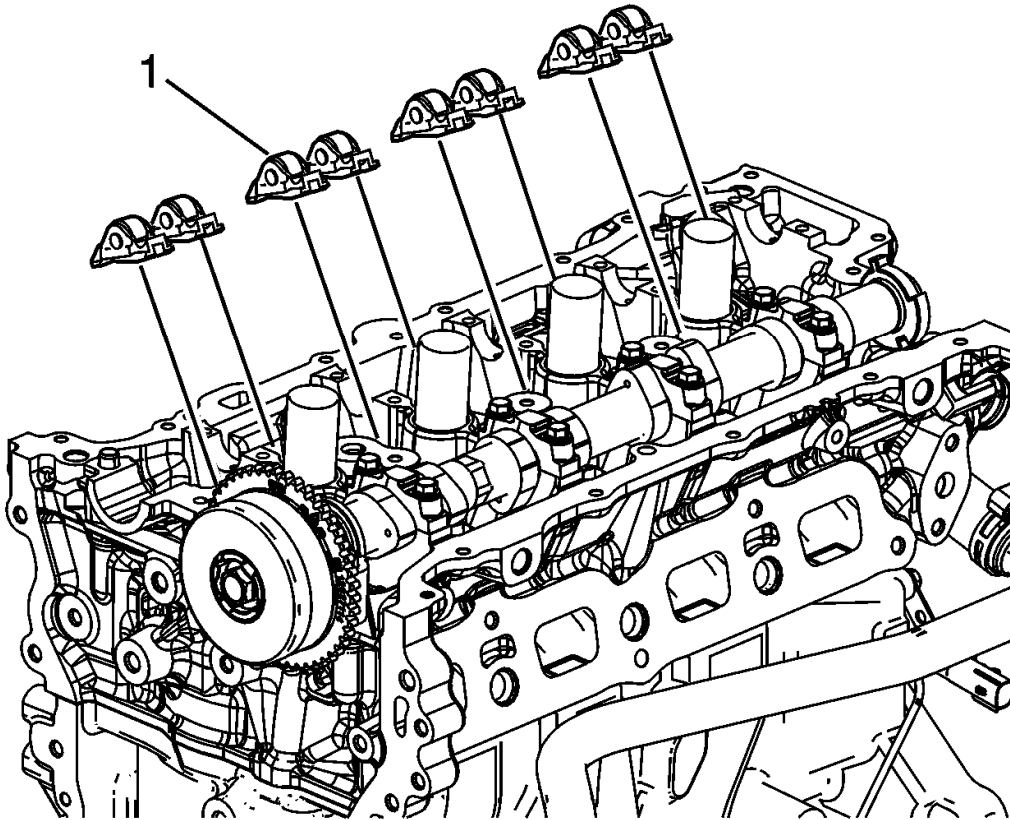


Fig. 229: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.

NOTE: Pre-oil roller bearings before installation.

3. Lubricate the roller bearings with valve rocker arm lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

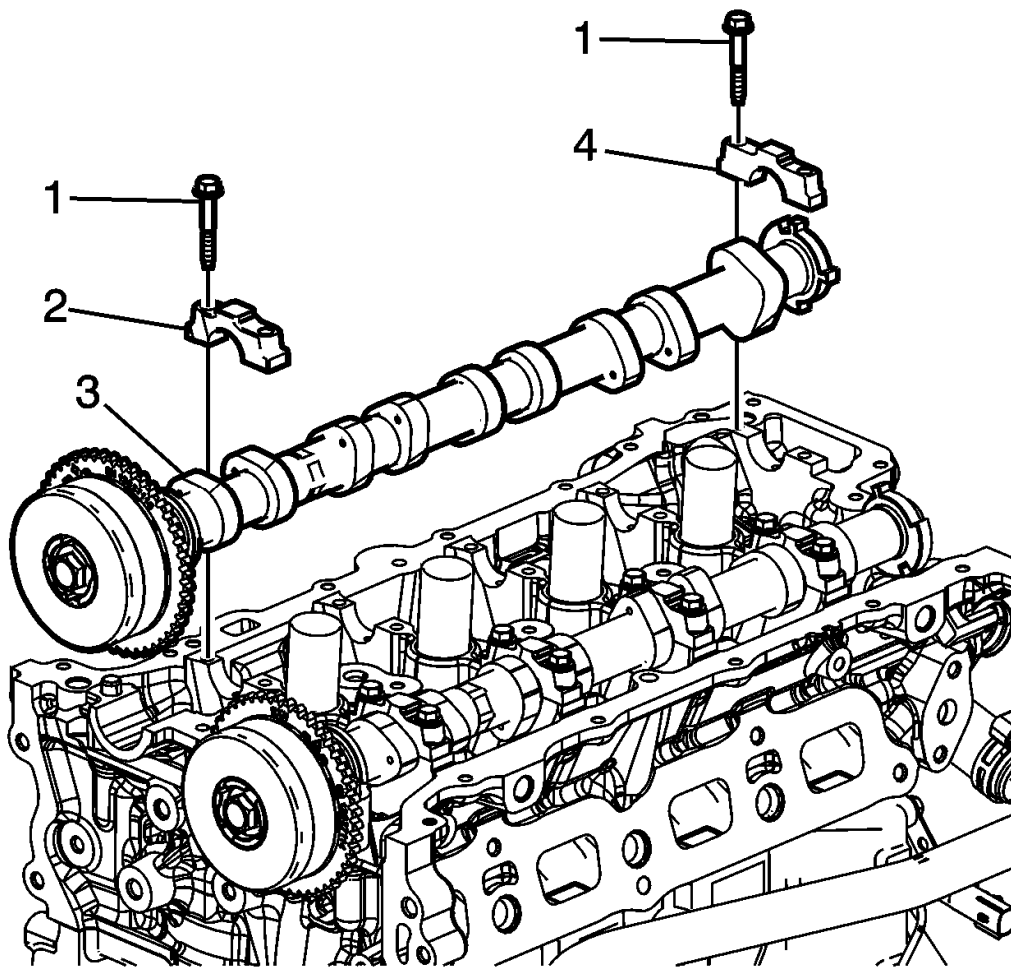


Fig. 230: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

5. Lubricate the intake camshaft lobes and journals with camshaft lubricant. Refer to Adhesives, Fluids, Lubricants, and Sealers .

Set the intake camshaft (3) on top of the roller followers in the camshaft bearing journals with the intake actuator timing mark at approximately the 11 O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

6. Install the camshaft cap bolts (1) into the camshaft caps (2, 4).
7. Install the camshaft caps (2) and hand start the camshaft cap bolts (1).
8. Install the camshaft rear cap (4) and hand start the camshaft cap bolts (1).

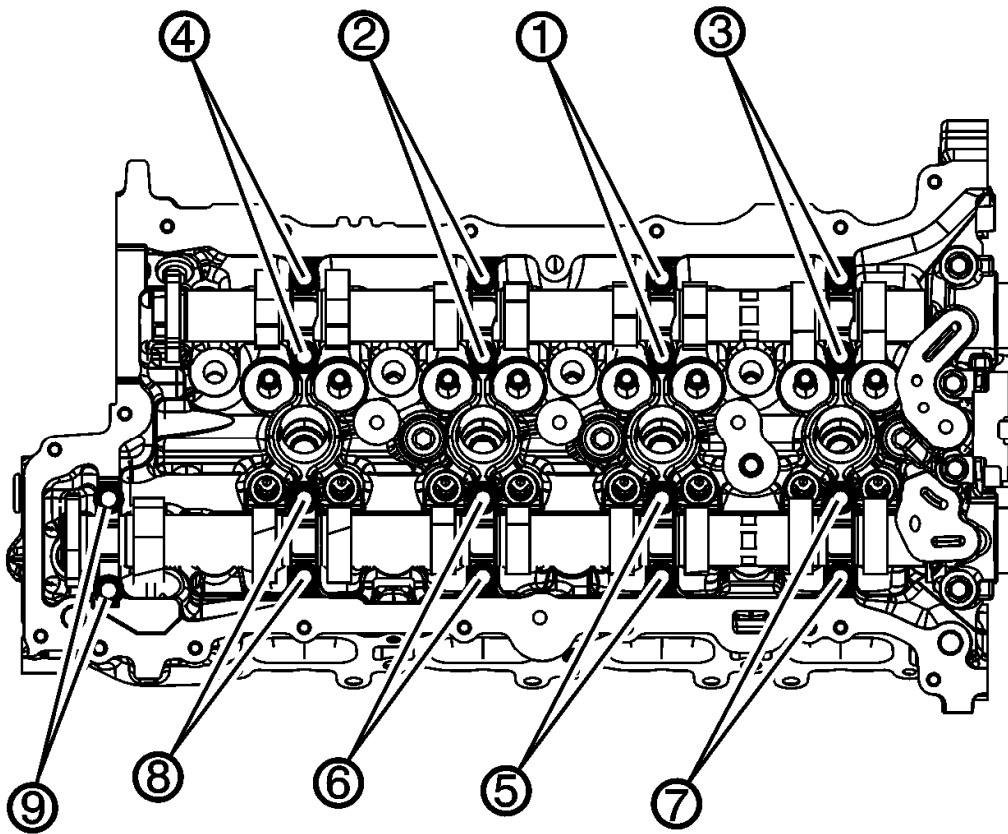


Fig. 231: Camshaft Cap Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.

9. Tighten the camshaft cap bolts in sequence using the following procedure:
 1. Tighten the camshaft cap bolts in sequence to 8 N.m (71 lb in).
 2. Loosen both bolts in each cap in sequence to 180 degrees.
 3. Tighten the camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

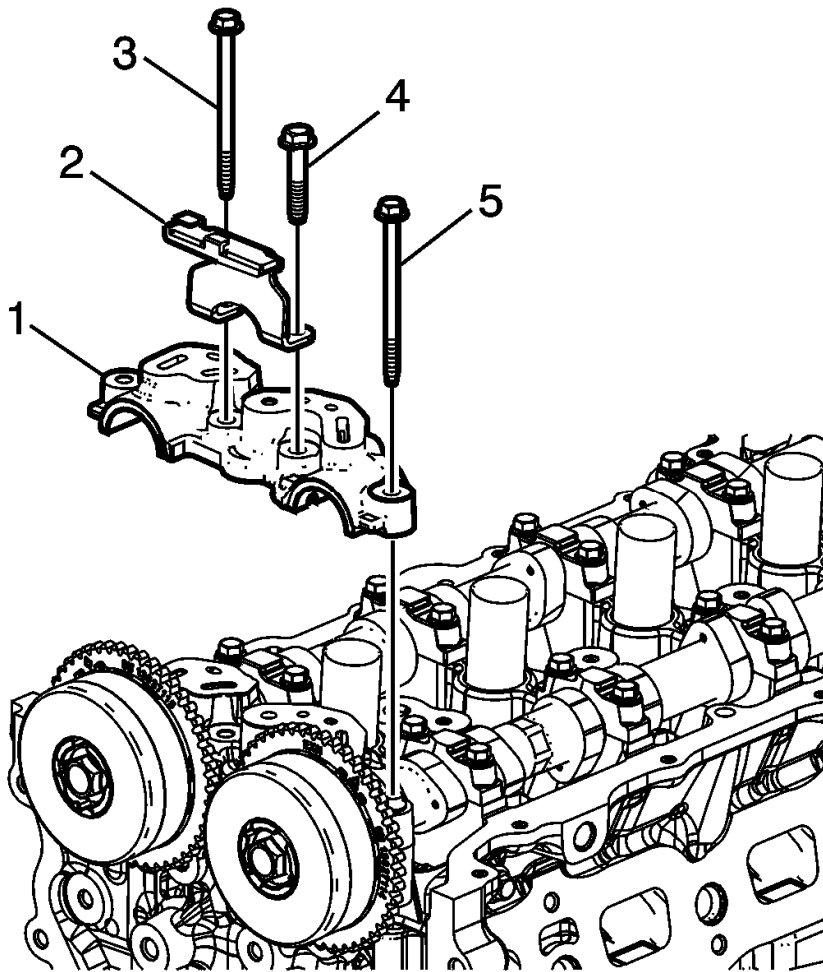


Fig. 232: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Installation of the timing chain guide (2) and bolts (3, 4), and final torque for the front bearing cap is performed after the timing chain is installed.

10. Install the front camshaft bearing cap (1). Install the 2 outer bolts (5) for the front camshaft bearing cap finger tight.

BALANCER CHAIN, SPROCKET, AND TENSIONER INSTALLATION

Special Tools

EN-50837 Timing Chain Tensioner Retraction Tool

For equivalent regional tools, refer to **Special Tools** .

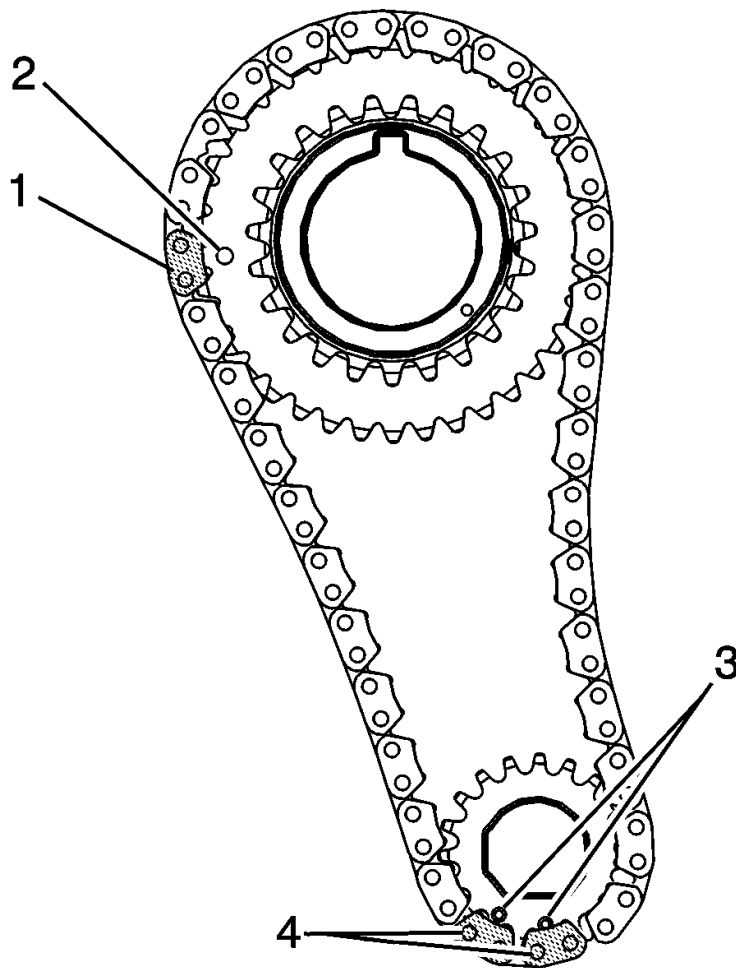


Fig. 233: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

NOTE: Proper setup is critical to ensure correct timing when installing the sprockets and chain simultaneously onto the shafts. The timing links are heat treated blued steel.

1. Assemble the crankshaft sprocket, balancer shaft driven sprocket, and balancer chain. Ensure the timing link (1) lines up with the timing mark (2) on the crankshaft sprocket. Ensure that both timing teeth (3) on the balancer shaft driven sprocket line up with the timing links (4).

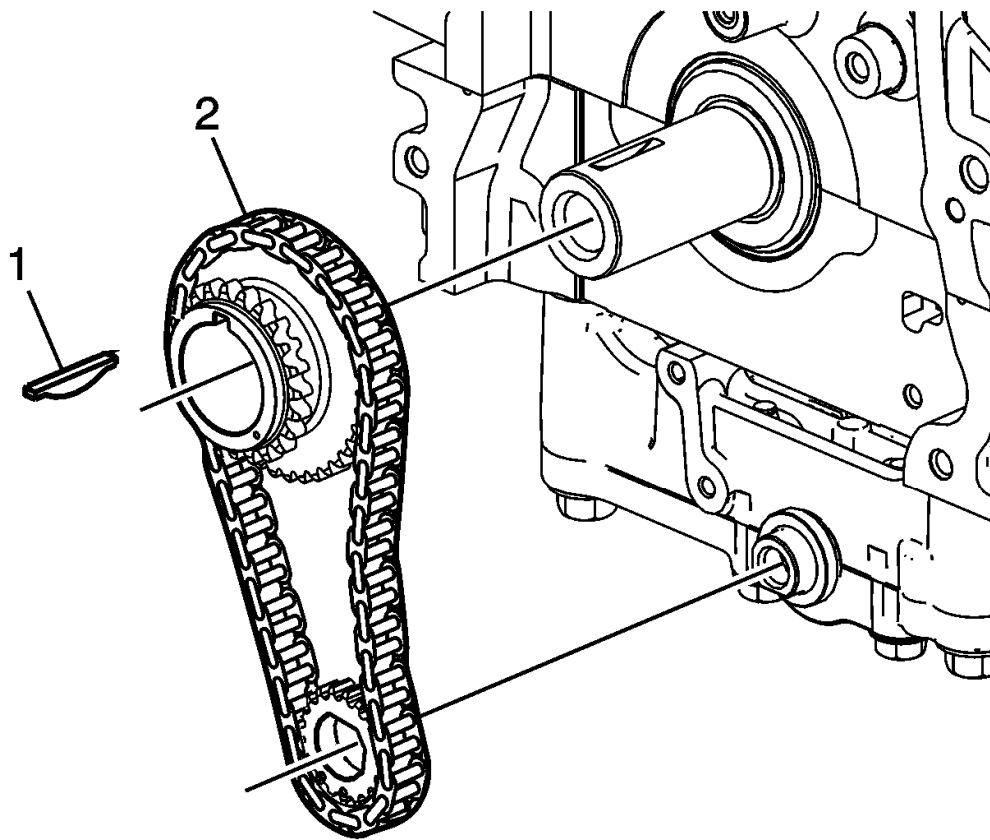


Fig. 234: Balancer Shaft Driven Sprocket And Balancer Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: The crankshaft keyway should be in the 12 O'clock position.

2. Install the sprockets and chain (2) as an assembly to the crankshaft and balancer shaft assembly.
3. Install the crankshaft key (1).

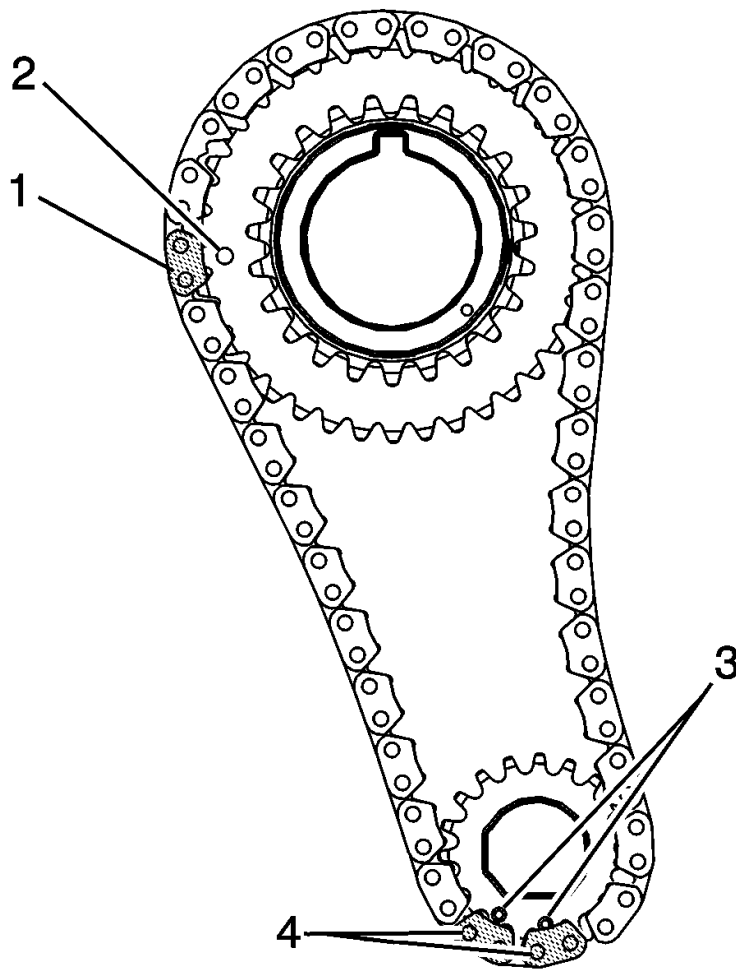


Fig. 235: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

4. Ensure the timing link (1) is aligned with the crankshaft sprocket timing mark (2).
5. Ensure the adjacent timing links (4) are aligned with both of the timing marks (3) on the balancer shaft driven sprocket.

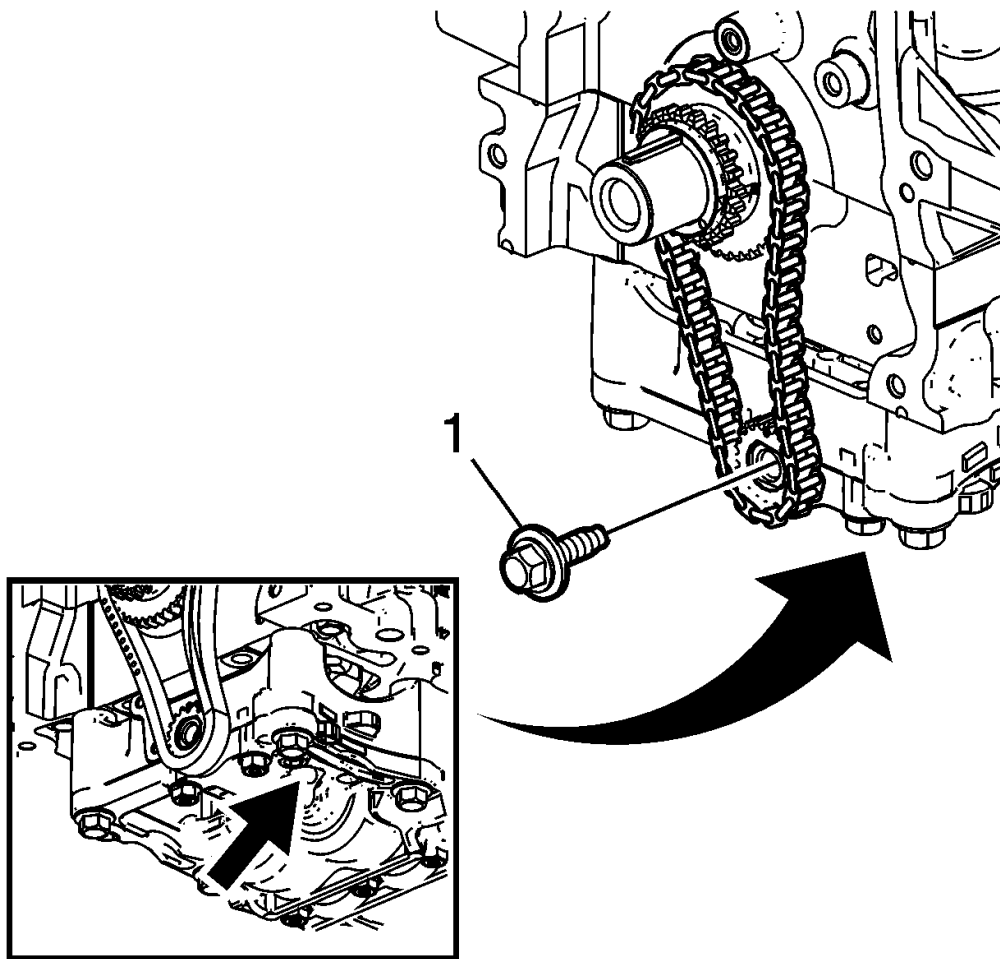


Fig. 236: Balancer Shaft Driven Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

6. Install the NEW balancer shaft driven sprocket bolt (1).

CAUTION: Refer to Fastener Caution .

7. Use an 18 mm open end wrench over flat on balance shaft while tightening the balancer shaft sprocket bolt to specification. Tighten the balancer shaft driven sprocket bolt to 40 N.m (30 lb ft) plus 50 degrees.

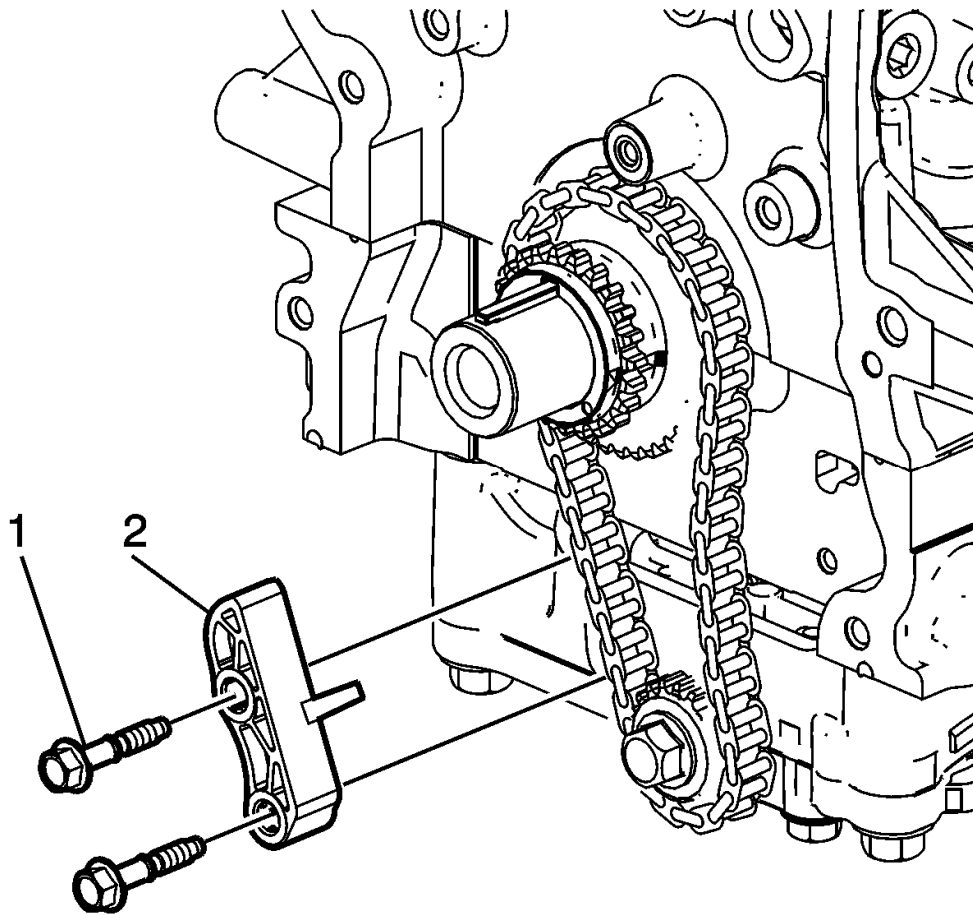


Fig. 237: Balancer Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the guide is installed in the correct orientation. The long end must point toward the crankshaft and the flat edge must be adjacent to the balancer chain.

8. Install the balancer chain guide (2).
9. Install the balancer chain guide bolts (1). Tighten the bolts to 10 N.m (89 lb in).

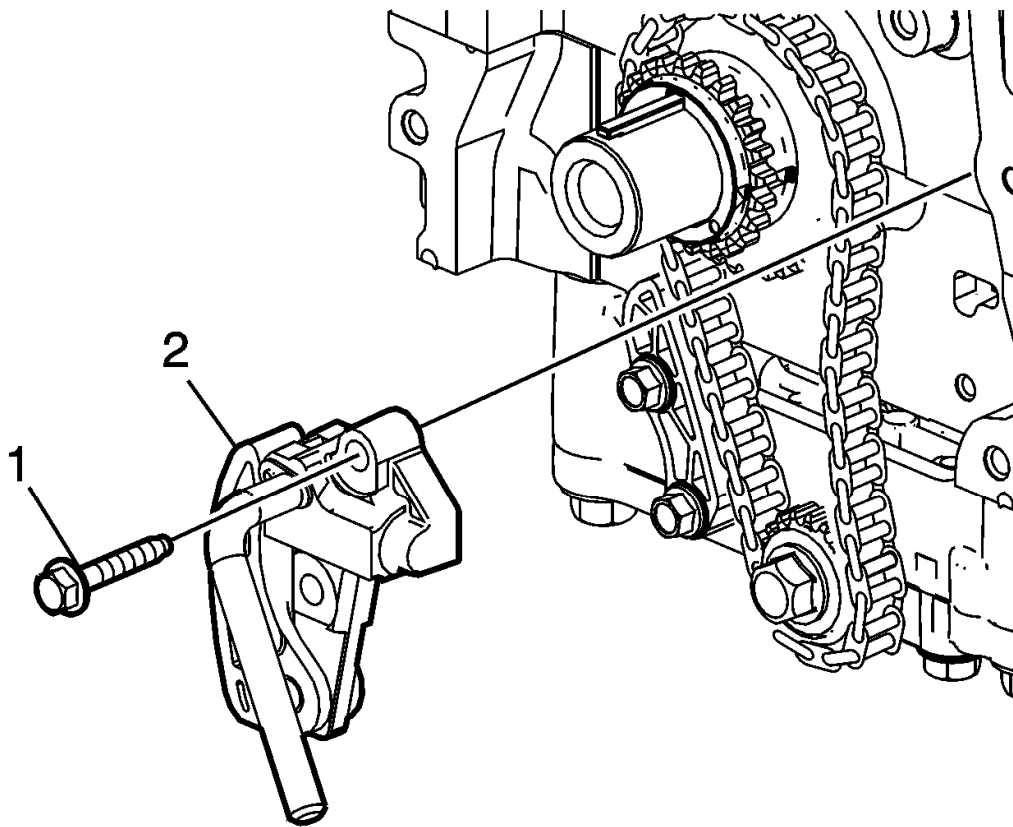


Fig. 238: Balancer Chain Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install the balancer chain tensioner (2).
11. Install the balancer chain tensioner bolts (1). Tighten the bolts to 10 N.m (89 lb in).
12. Remove **EN-50837** retention tool to restore the tension to the balancer chain.

OIL PAN INSTALLATION

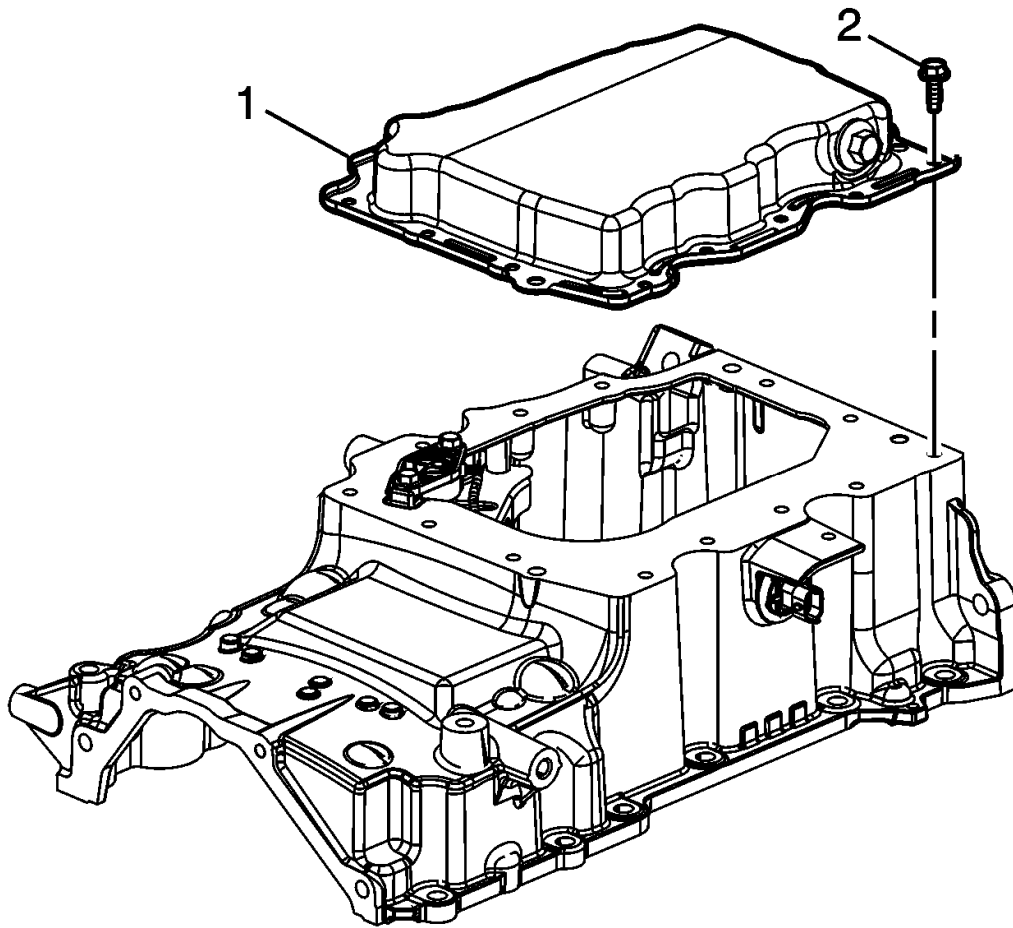


Fig. 239: Lower Oil Pan

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The oil pan sealing surfaces must be free of contamination prior to applying the sealer.
- Install and align the oil pans within 20 minutes of applying the sealer.
- The oil pans must be fastened to final torque specification within 60 minutes of applying the sealer.

1. Apply a bead of RTV sealant to the perimeter of the lower oil pan.
2. Install the lower oil pan (1) to the upper oil pan.

CAUTION: Refer to Fastener Caution .

NOTE:

Two long bolts secure the lower oil pan and upper oil pan together to the lower crankcase.

3. Install the short lower oil pan bolts (2) and tighten to 10 N.m (89 lb in).

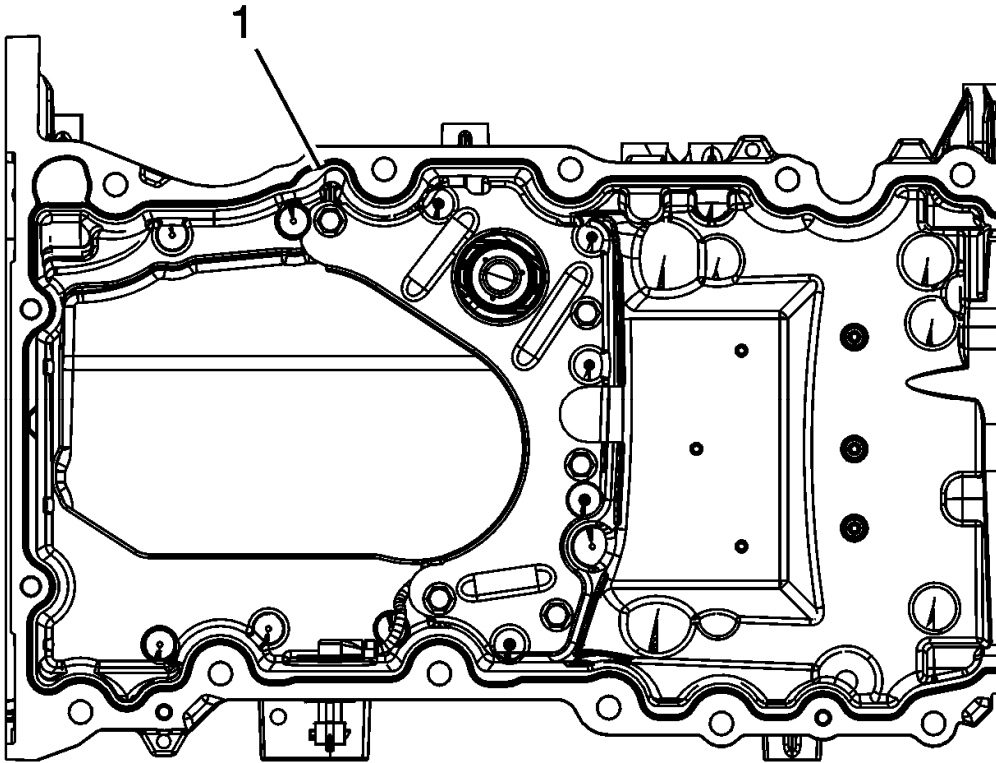


Fig. 240: Short Lower Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The lower crankcase surface must be free of contamination prior to applying the sealer.
- Install and align the oil pan to block within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

4. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

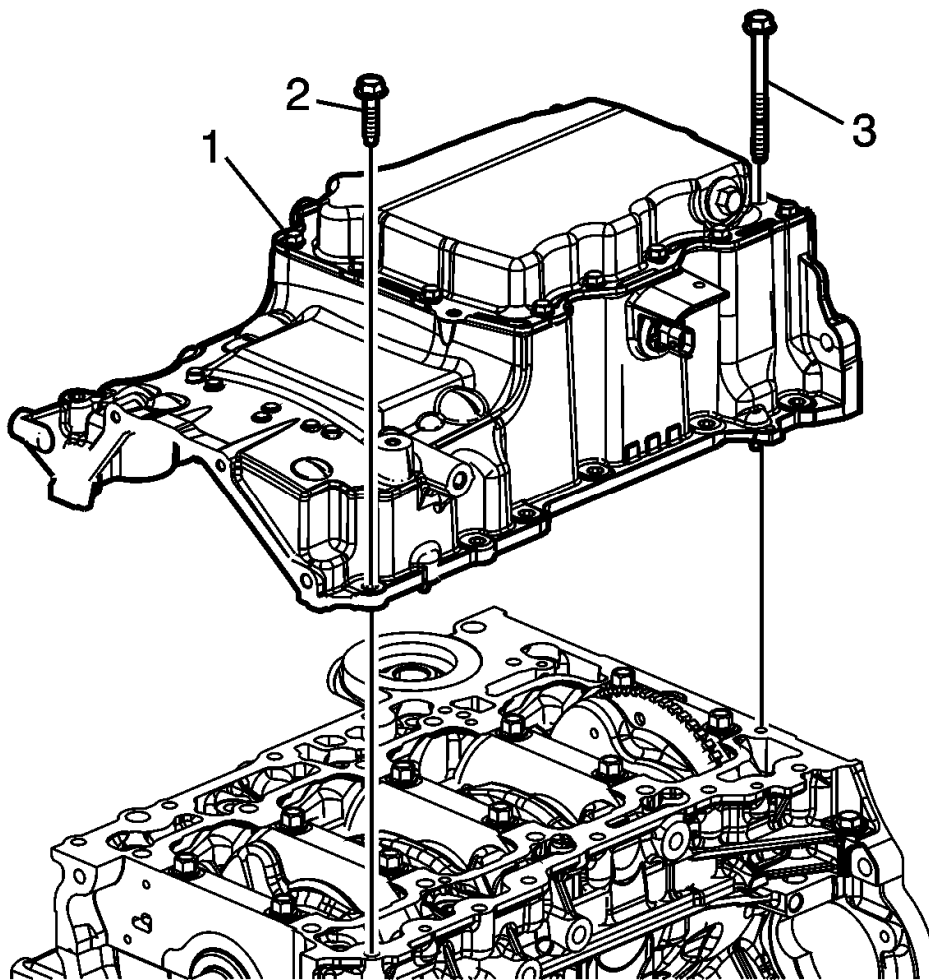


Fig. 241: Oil Pan And Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pan (1).
6. Install the oil pan bolts (2, 3) finger tight.

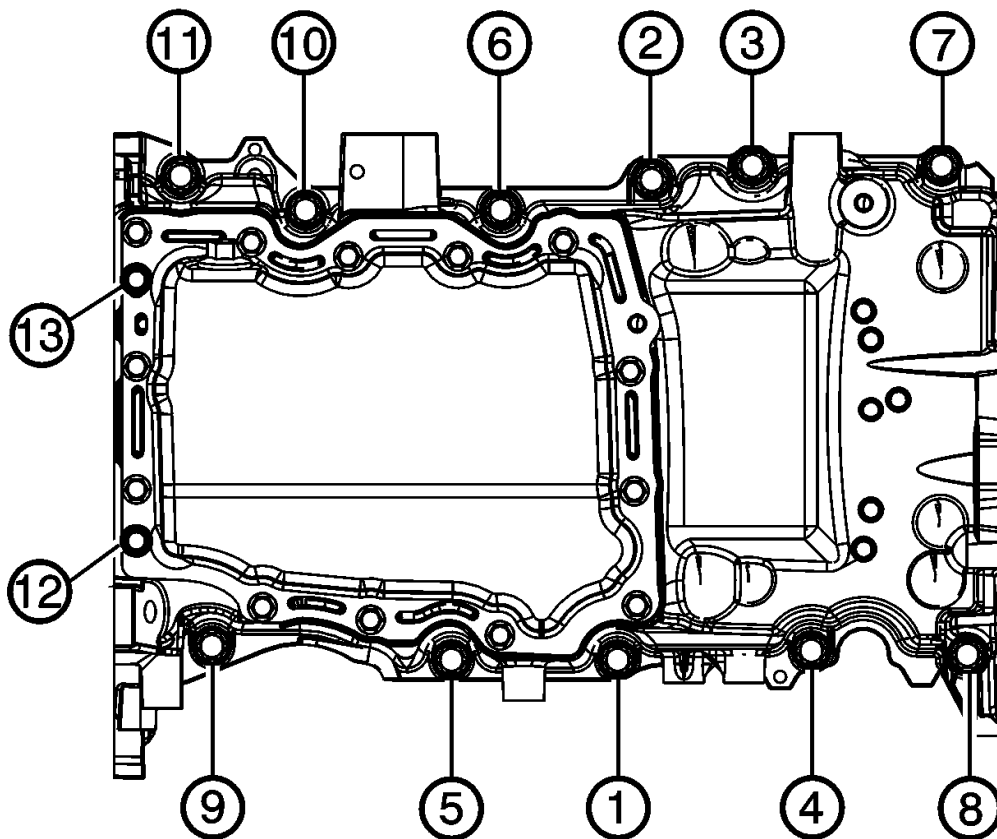


Fig. 242: Oil Pan Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the oil pan bolts in sequence to final torque twice using the following procedure:
 1. Tighten bolts in sequence 1-11 to 25 N.m (18 lb ft).
 2. Tighten bolts in sequence 12-13 to 10 N.m (89 lb in).

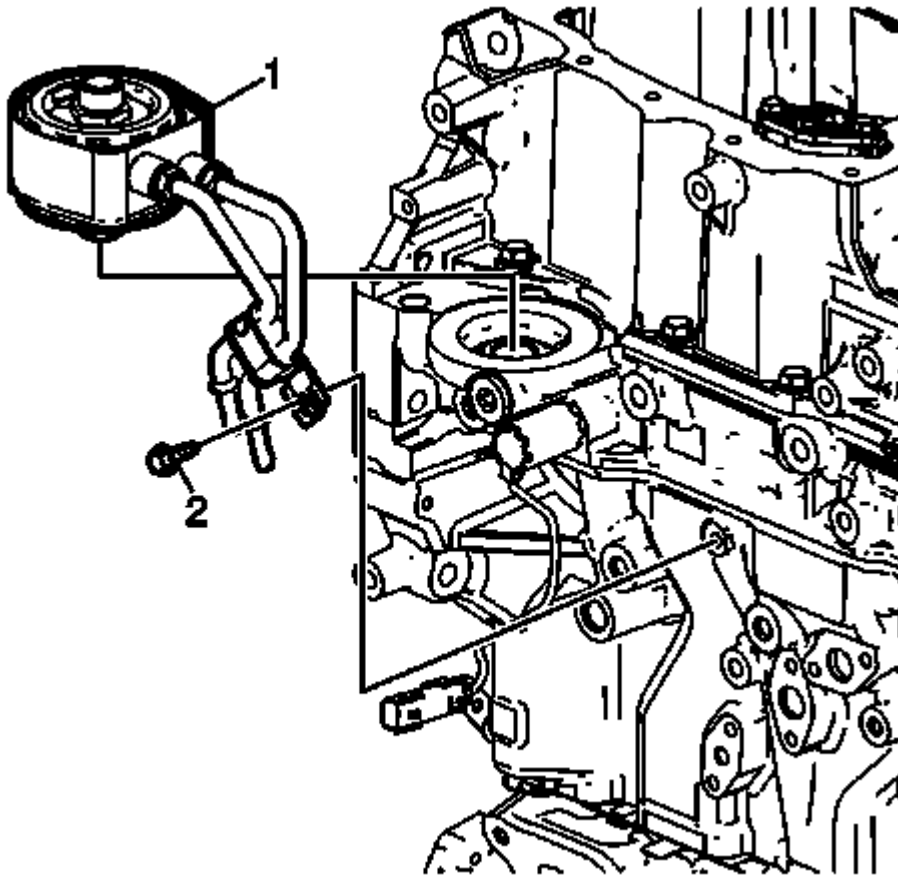


Fig. 243: Engine Oil Cooler And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the engine oil cooler (1).
9. Install the engine oil cooler bolt (2) and tighten to 10 N.m (89 lb in).

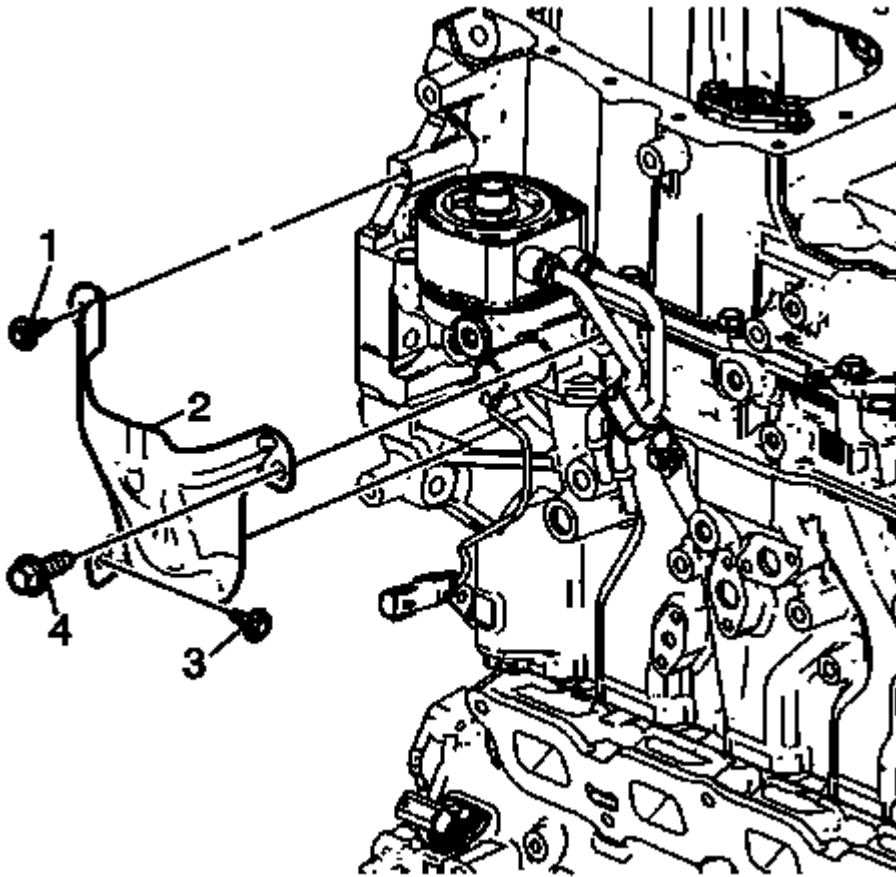


Fig. 244: Oil Pump Flow Control Valve Cover
Courtesy of GENERAL MOTORS COMPANY

10. Install the oil pump flow control valve cover (2).
11. Install the valve cover bolts (1, 3) and tighten to 9 N.m (80 lb in).
12. Install the valve cover bolt (4) and tighten to 58 N.m (43 lb ft).

CAMSHAFT TIMING CHAIN AND TENSIONER INSTALLATION

Special Tools

- **EN 45059** Angle Meter
- **EN 50837** Timing Chain Tensioner Retraction Tool

For equivalent regional tools, refer to **Special Tools** .

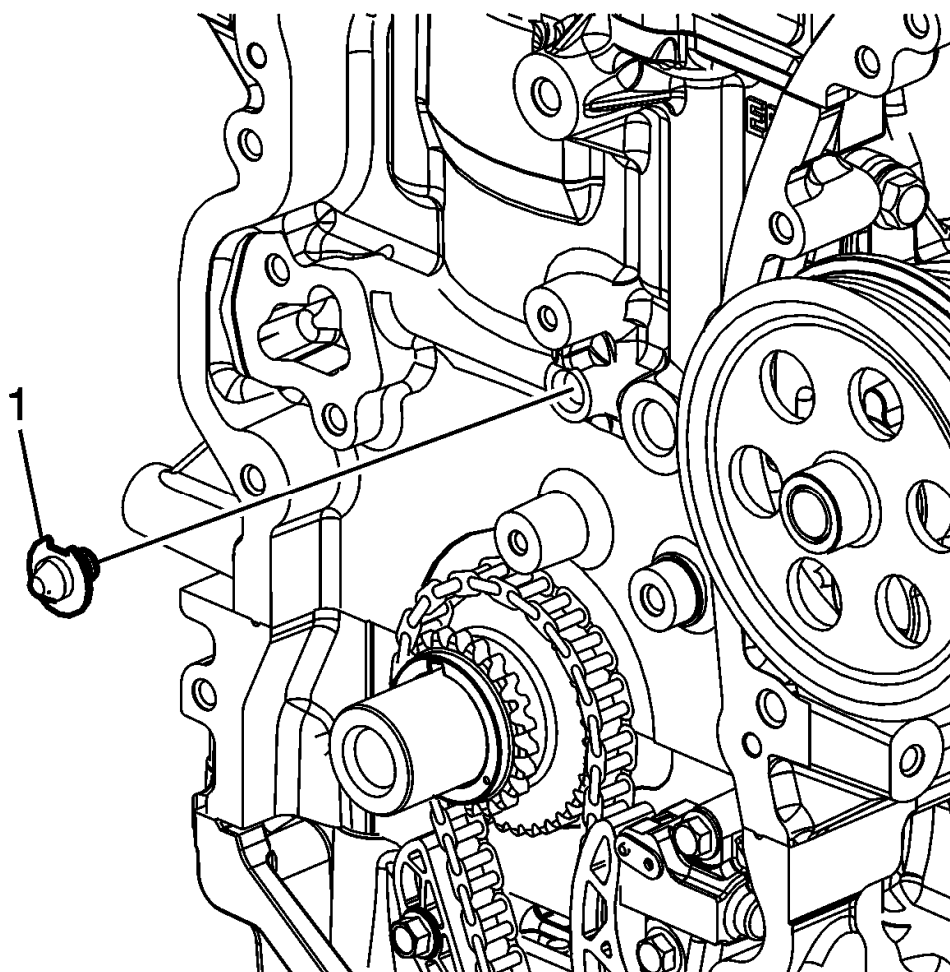


Fig. 245: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the timing chain oil nozzle is rotated with the notch facing upward, and aligned with the tab on the engine block.

1. Install the timing chain oil nozzle (1).

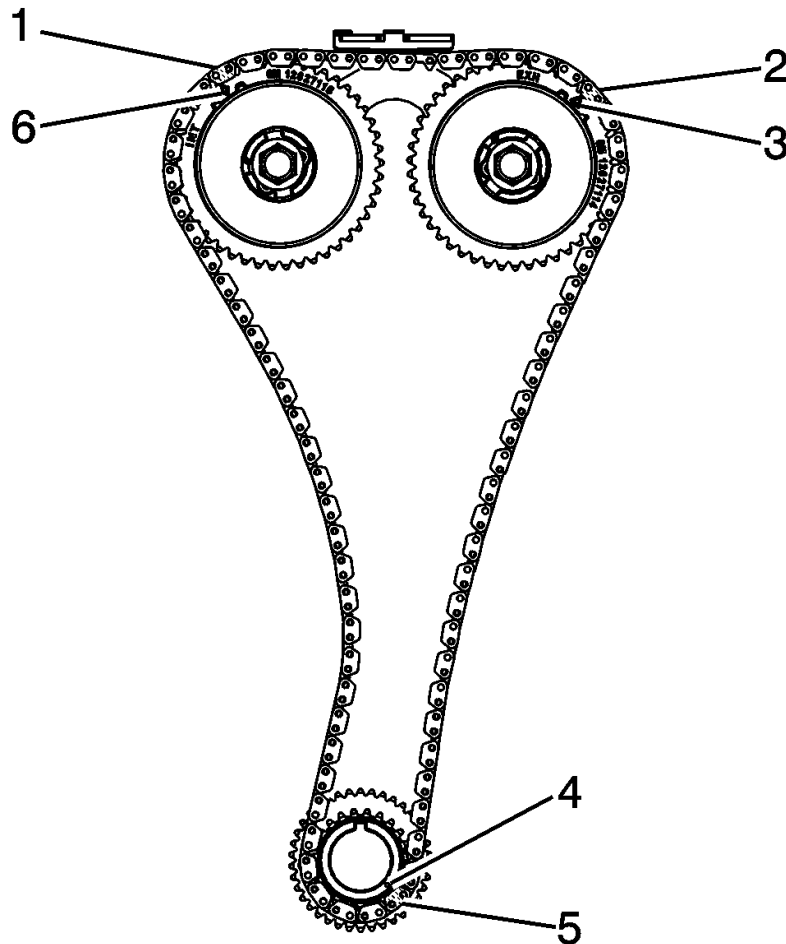


Fig. 246: Timing Chain Oil Nozzle
 Courtesy of GENERAL MOTORS COMPANY

NOTE: There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning the unique colored link (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: The unique colored links will not initially align with the intake actuator timing mark or the crankshaft sprocket timing mark.

3. Ensure the crankshaft key in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

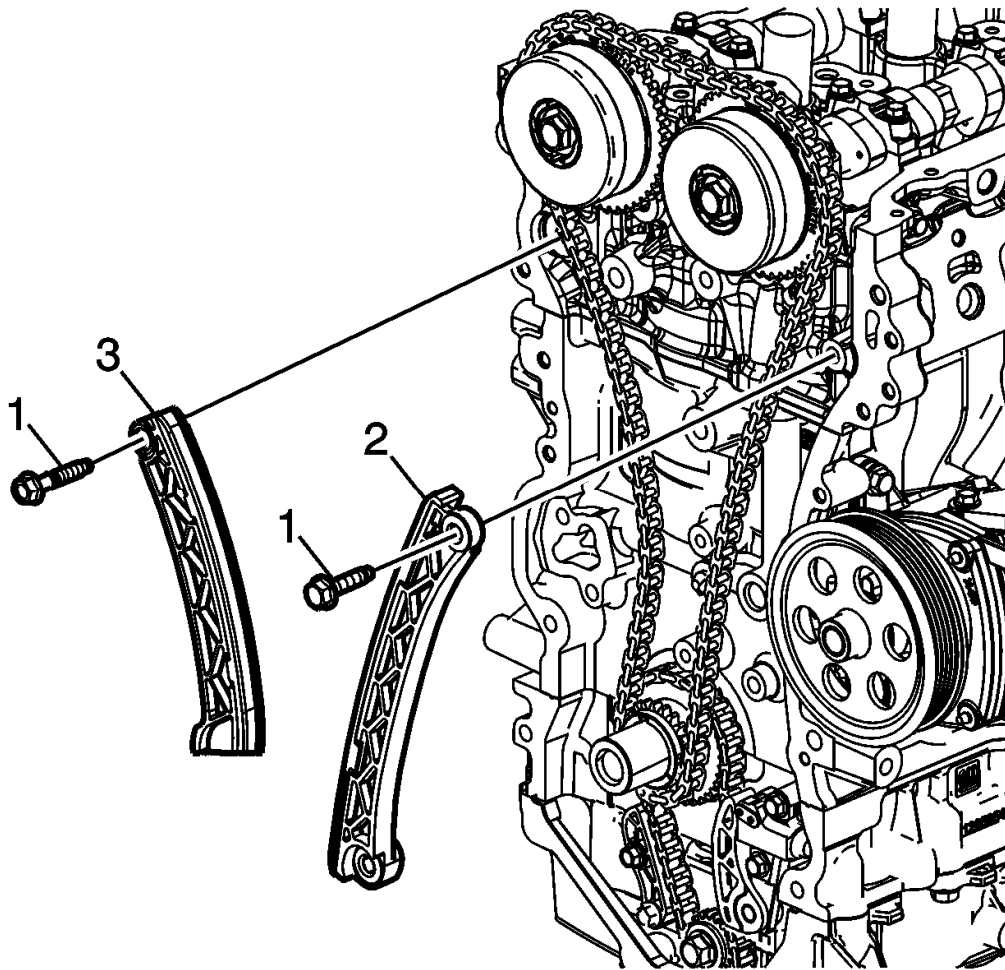


Fig. 247: Timing Chain Guide And Upper Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Timing will be established before the final install and torque of the guide bolts.

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

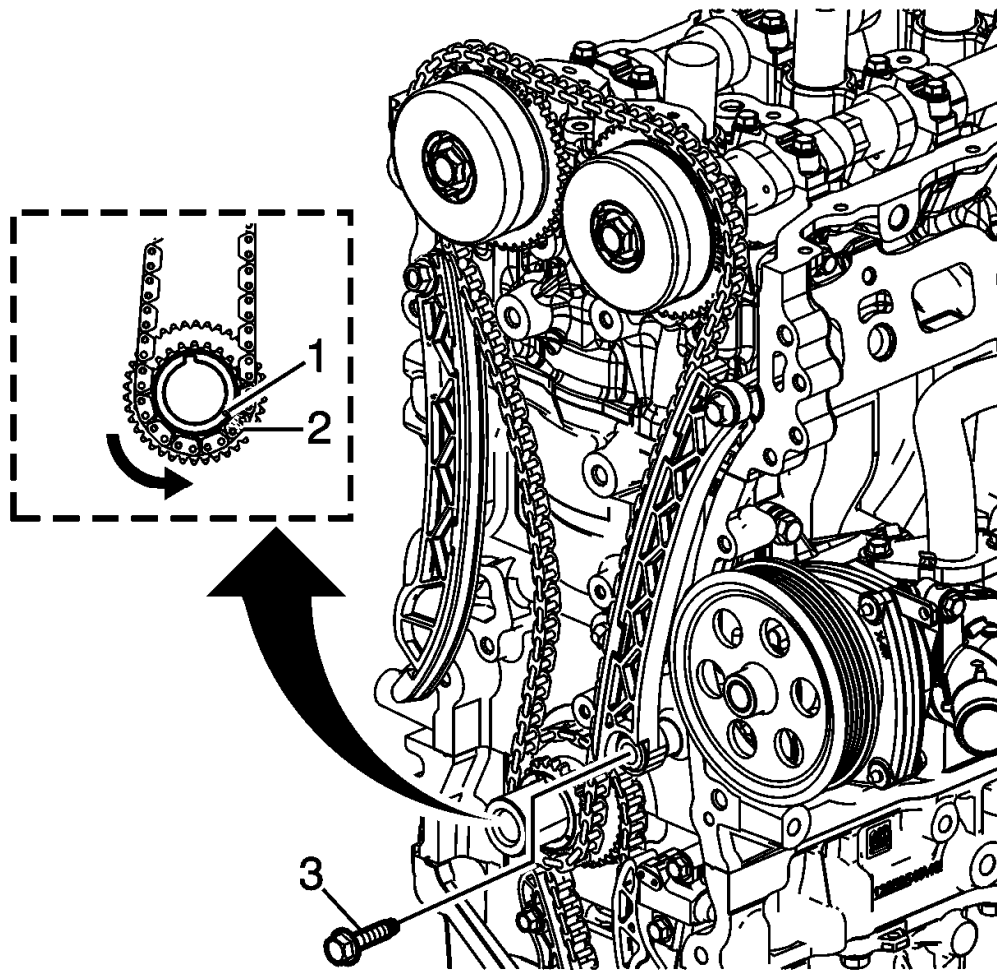


Fig. 248: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the timing link (2).

NOTE:

- Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.
- Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the timing link.

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: Refer to Fastener Caution .

9. Tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

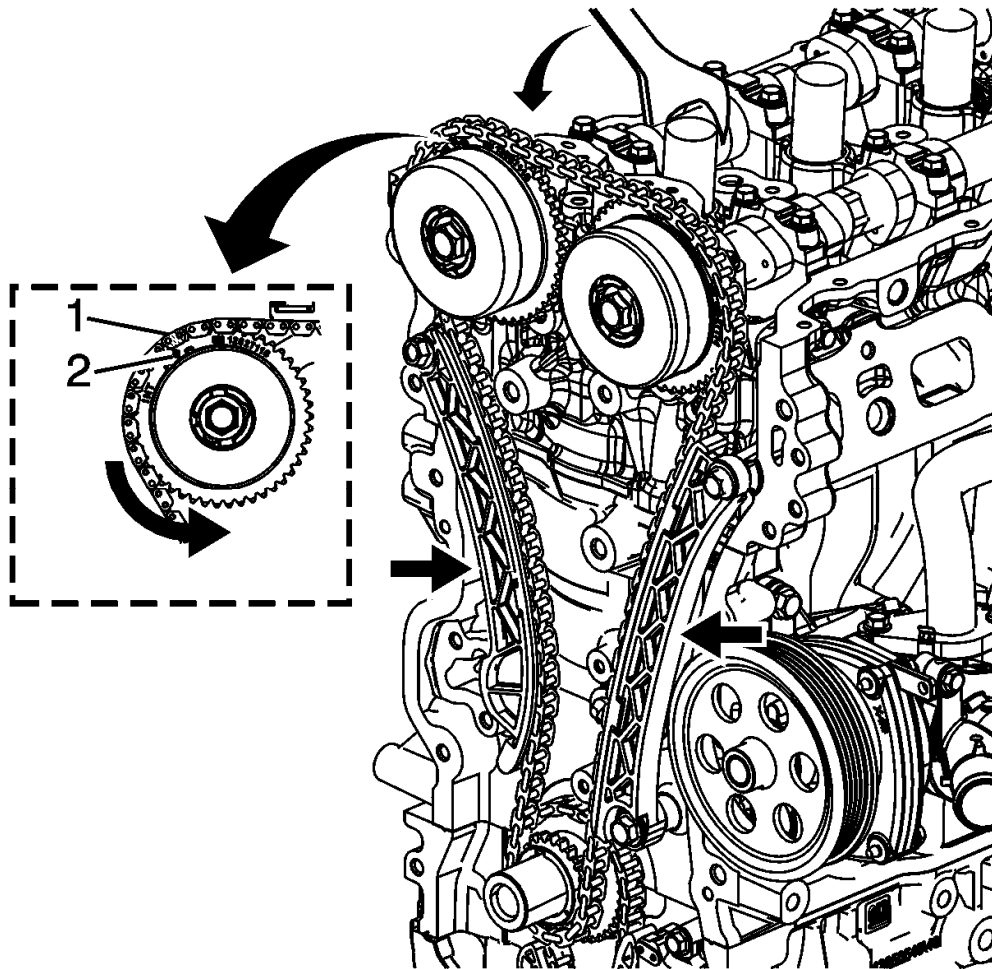


Fig. 249: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.
 - Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.
10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

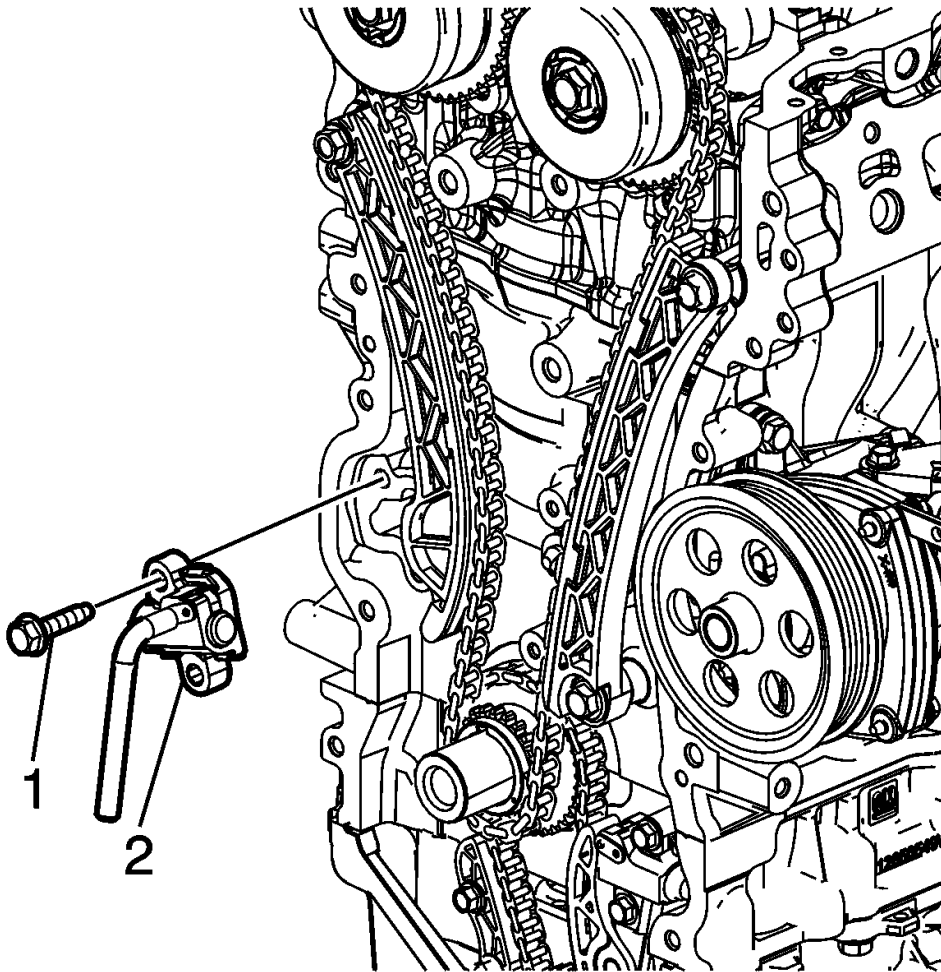


Fig. 250: Timing Chain Tensioner Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure EN-50837 retraction tool is installed and the tensioner is locked in a compressed state before installing.

11. While maintaining the intake camshaft actuator timing alignment, install the timing chain tensioner (2) and bolts (1) and tighten to 25 N.m (18 lb ft).
12. Tighten the pivot arm bolt to 25 N.m (18 lb ft).
13. Remove **EN-50837** retraction tool.

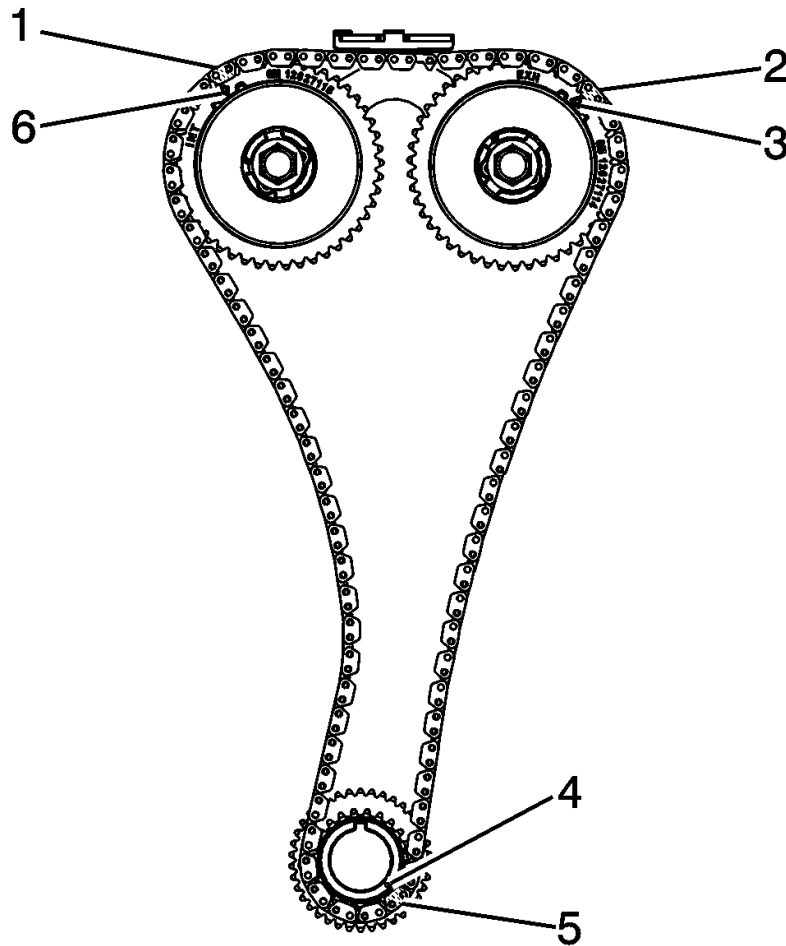


Fig. 251: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

14. Verify the timing links on the timing chain are properly aligned to the timing marks:
 1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
 2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
15. If they are not, repeat the portion of the procedure necessary to align the timing marks.

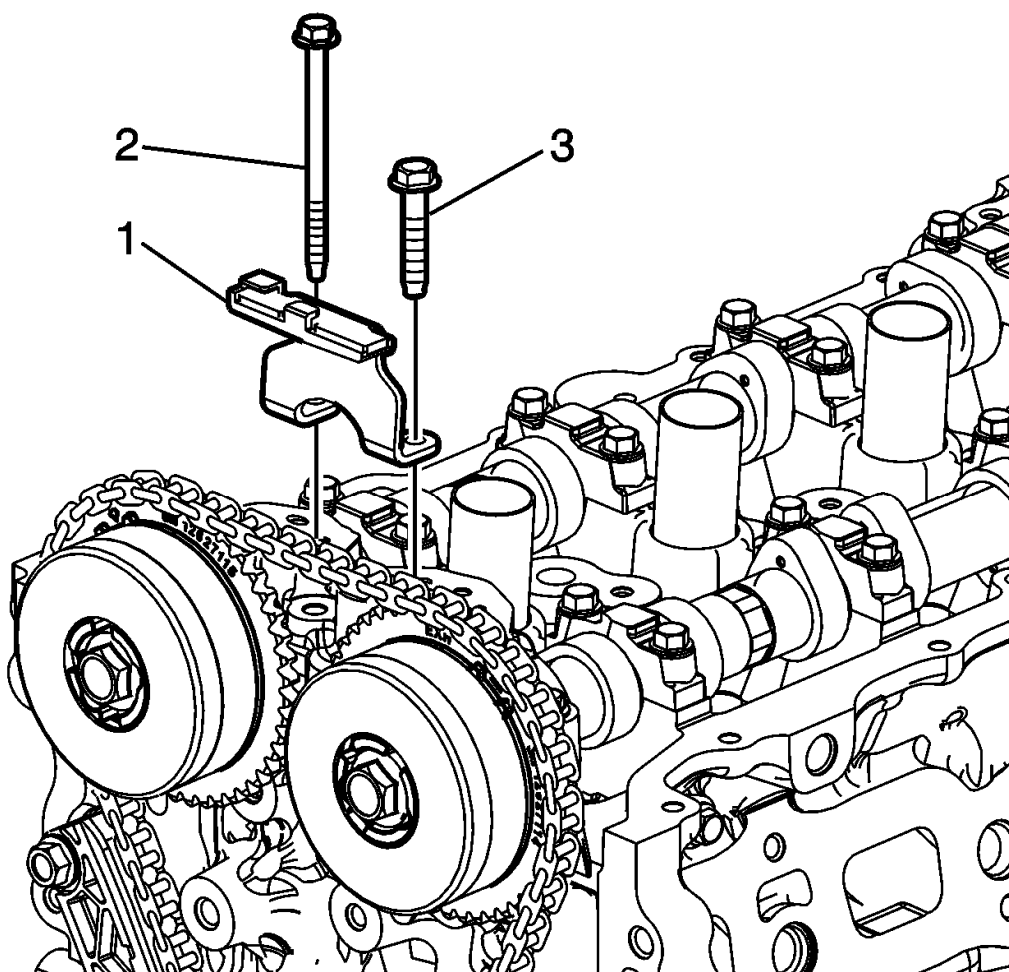


Fig. 252: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Install the timing chain guide (1) and bolts (2, 3) finger tight.

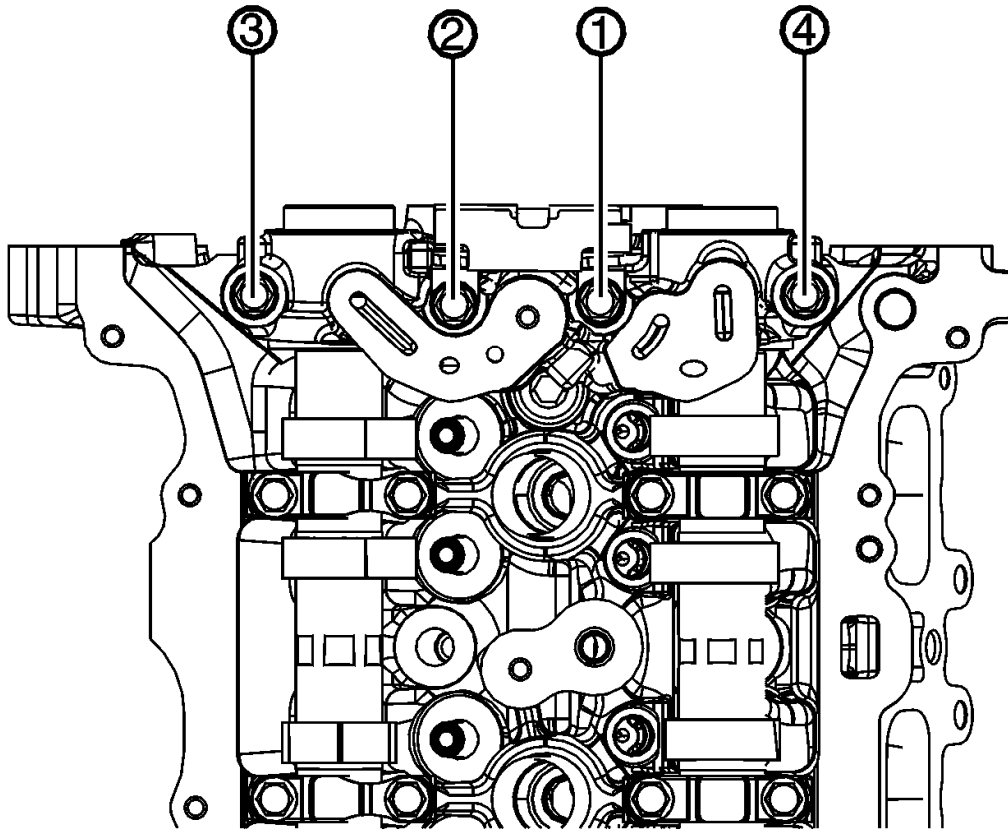


Fig. 253: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

17. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

NOTE: Rotating the crankshaft will engage the tensioner and remove slack from the timing chain.

18. Rotate the crankshaft slightly in a clockwise direction. If the timing chain jumps actuator teeth, repeat procedure to align the timing marks.

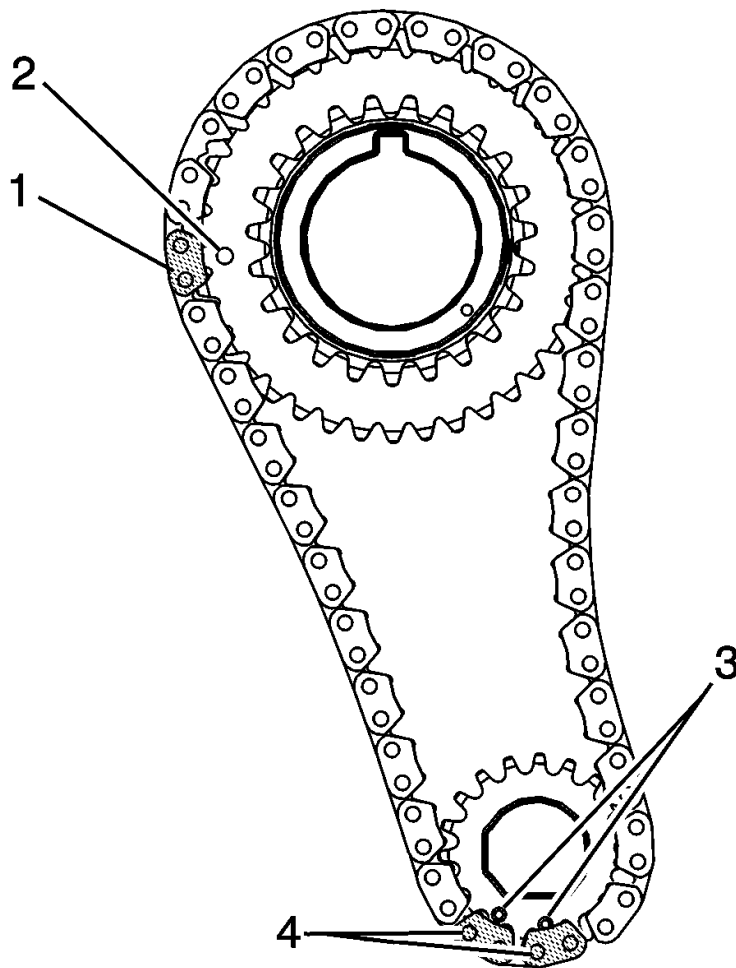


Fig. 254: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

NOTE: Because of slight clockwise rotation, all chain marks may be advanced slightly in relation to the actuator and sprocket marks, yet still aligned.

19. Verify the timing links on the balance chain are properly aligned to the timing marks:
 1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
 2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.

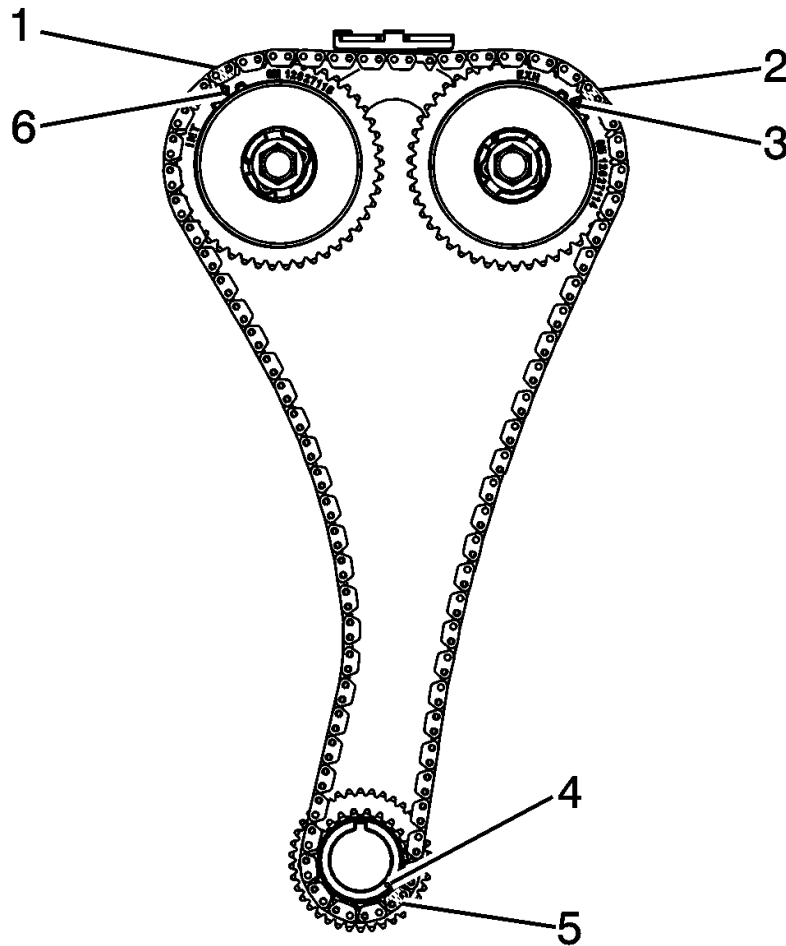


Fig. 255: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: Because of slight clockwise rotation, all chain marks may be advanced slightly in relation to the actuator and sprocket marks, yet still aligned.

20. Verify the timing links on the timing chain are properly aligned to the timing marks:
 1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
 2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
21. If they are not, repeat the portion of the procedure necessary to align the timing marks.

ENGINE FRONT COVER INSTALLATION (LTG)

Special Tools

EN-50820 Front Crankshaft Seal Installer

For equivalent regional tools, refer to **Special Tools** .

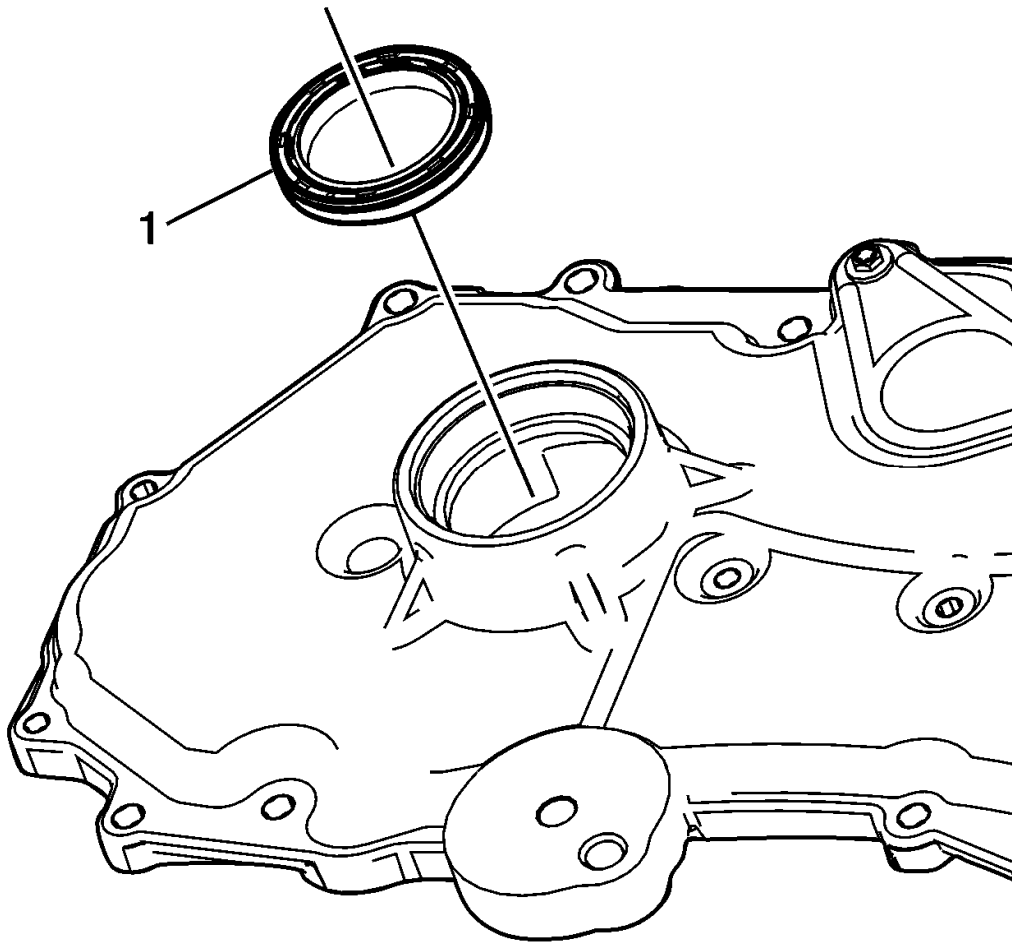


Fig. 256: Front Crankshaft Seal
Courtesy of GENERAL MOTORS COMPANY

1. Using **EN-50820** installer , install the front crankshaft seal (1) into the engine front cover.

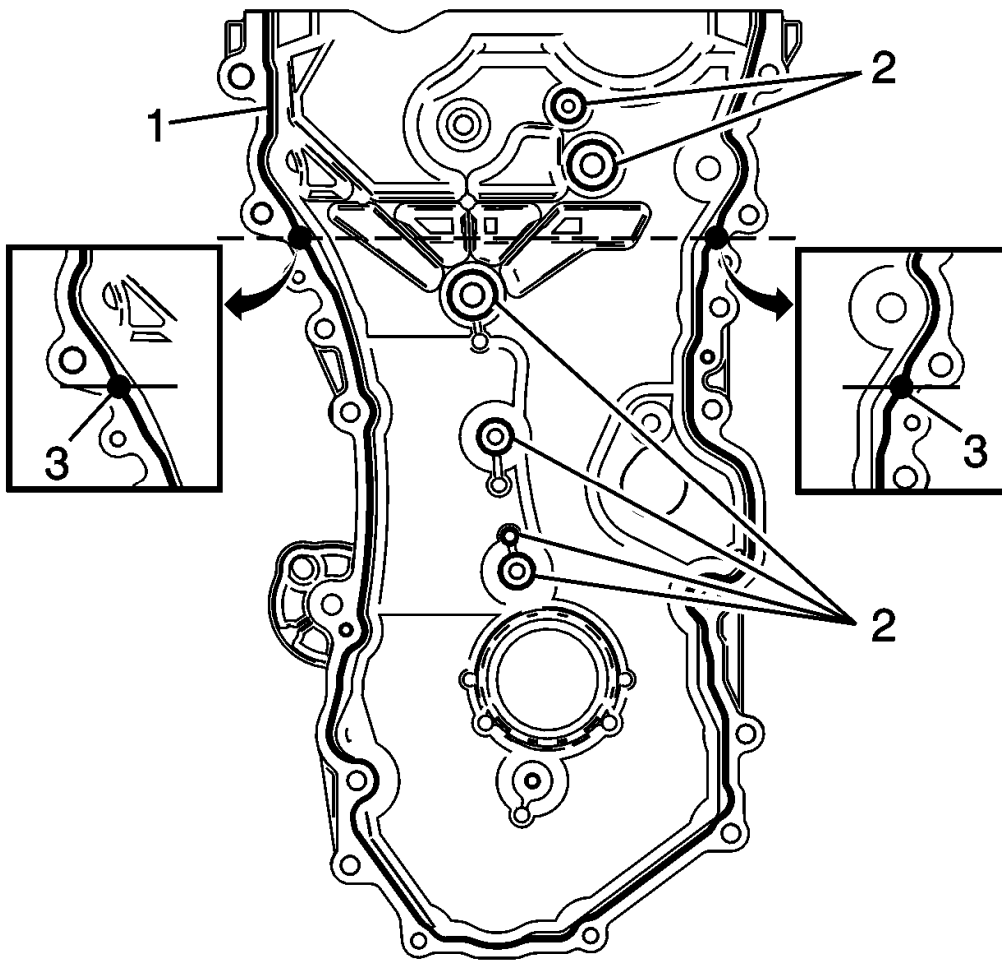


Fig. 257: Applying Bead Of Sealer Directly In Flange
 Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The engine front cover surface must be free of contamination prior to applying the sealer.
- Install and align the cover within 20 minutes of applying the sealer.
- The cover must be fastened to final torque specification within 60 minutes of applying the sealer.
- Additional sealant is necessary to reduce the possibility of leakage where the cylinder head to engine block interface along the bead path flange on the front cover.

2. Apply a 5 mm bead of sealer directly in the flange (1) of the engine front cover perimeter mating surface. Also apply a 5 mm bead of sealer directly to the locations indicated (2). Finally, apply a 14 mm dab of sealant at the locations indicated (3). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

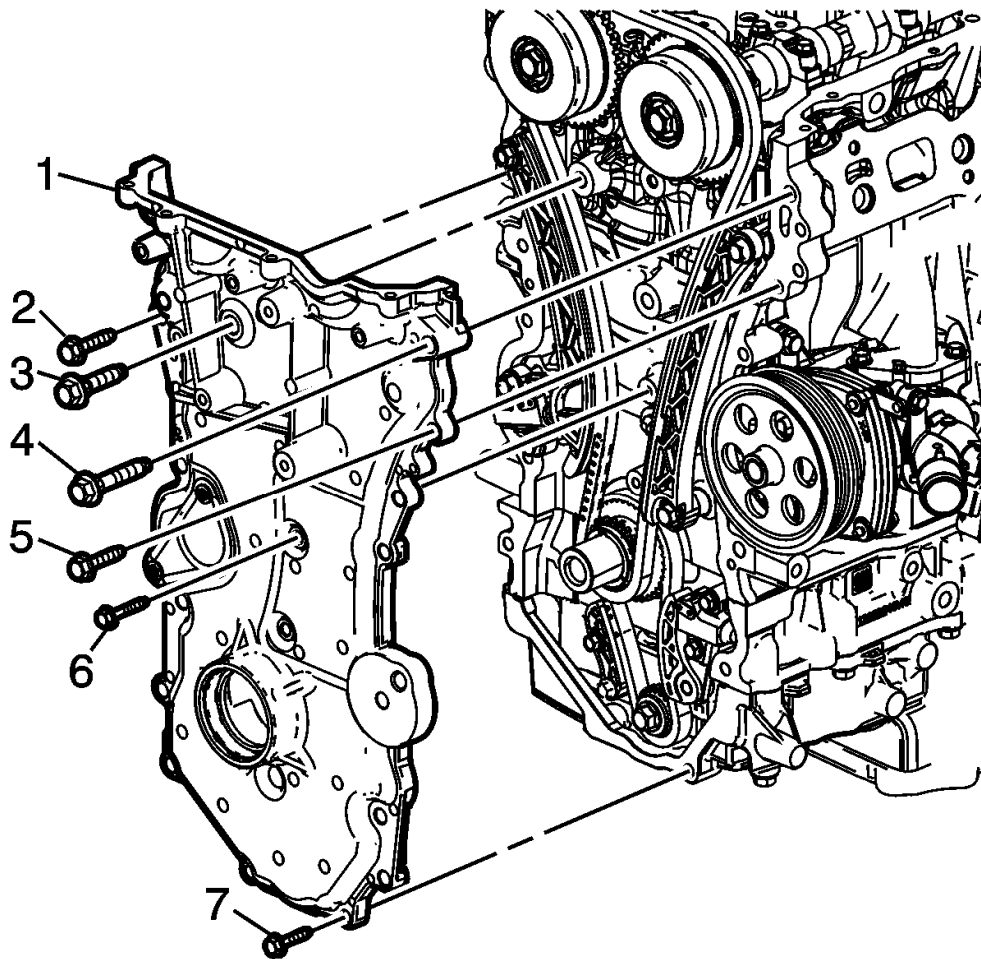


Fig. 258: Exploded View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine front cover (1).
4. Hand start the engine front cover bolts (2-6, 7).

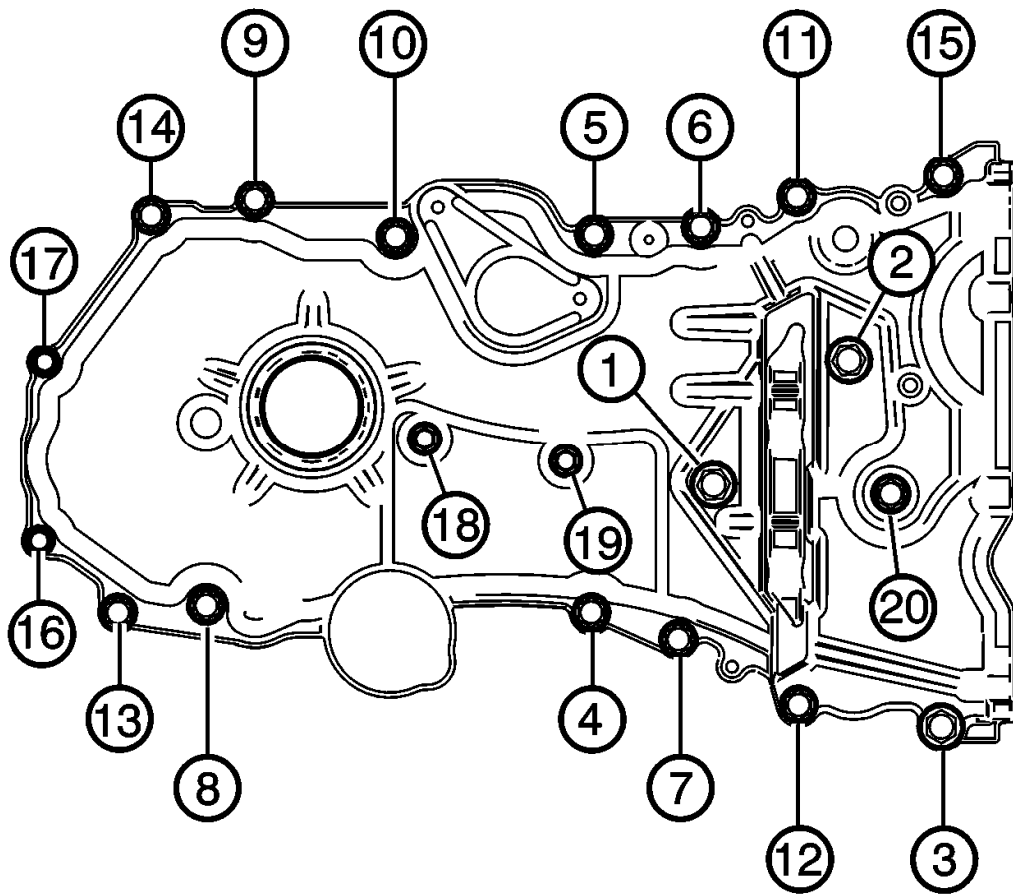


Fig. 259: Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the engine front cover bolts in sequence to final torque twice:
 1. Tighten sequence 1-3 bolts to 58 N.m (43 lb ft).
 2. Tighten sequence 4-11 bolts to 25 N.m (18 lb ft).
 3. Tighten sequence 12 bolt to 25 N.m (18 lb ft).
 4. Tighten sequence 13-15 bolts to 25 N.m (18 lb ft).
 5. Tighten sequence 16-17 bolts to 10 N.m (89 lb in).
 6. Tighten sequence 18-19 bolts to 10 N.m (89 lb in).
 7. Tighten sequence 20 bolt to 25 N.m (18 lb ft).

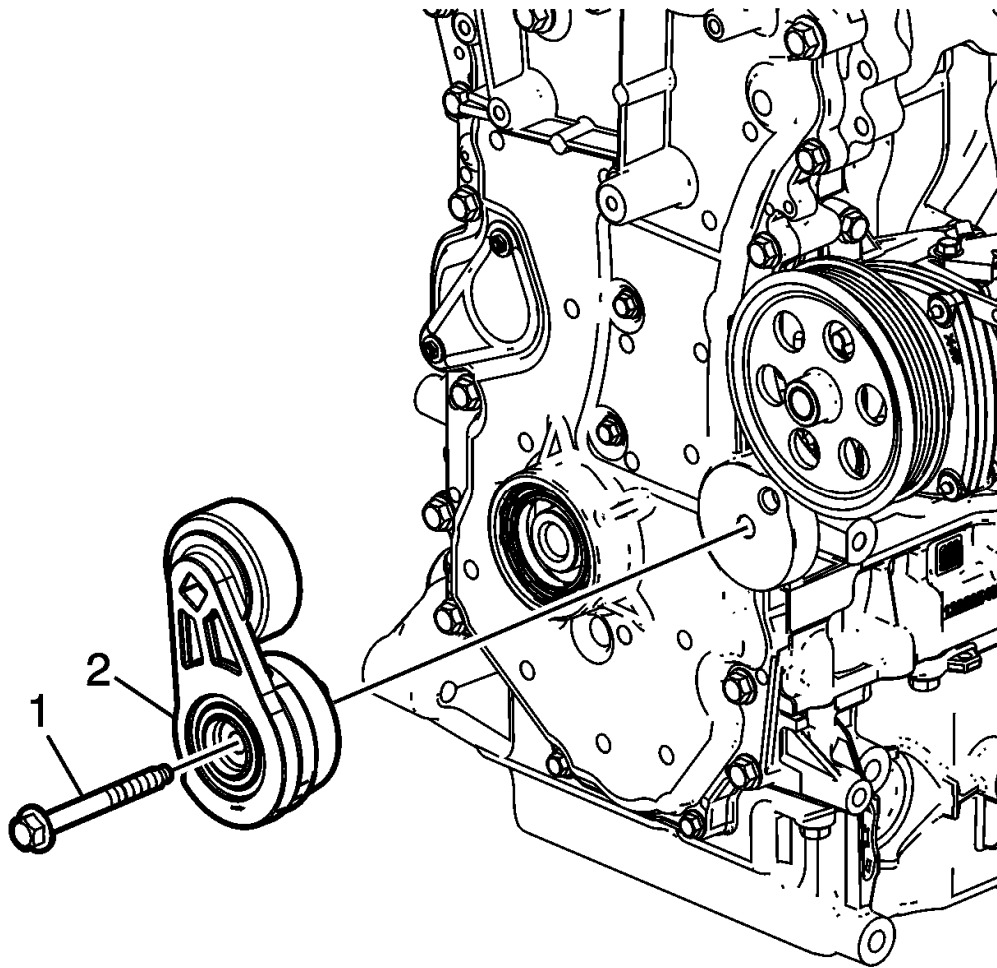


Fig. 260: Accessory Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

6. Install the accessory drive belt tensioner (2).
7. Install the accessory drive belt tensioner bolt (1) and tighten to 58 N.m (43 lb ft).

CAMSHAFT COVER INSTALLATION

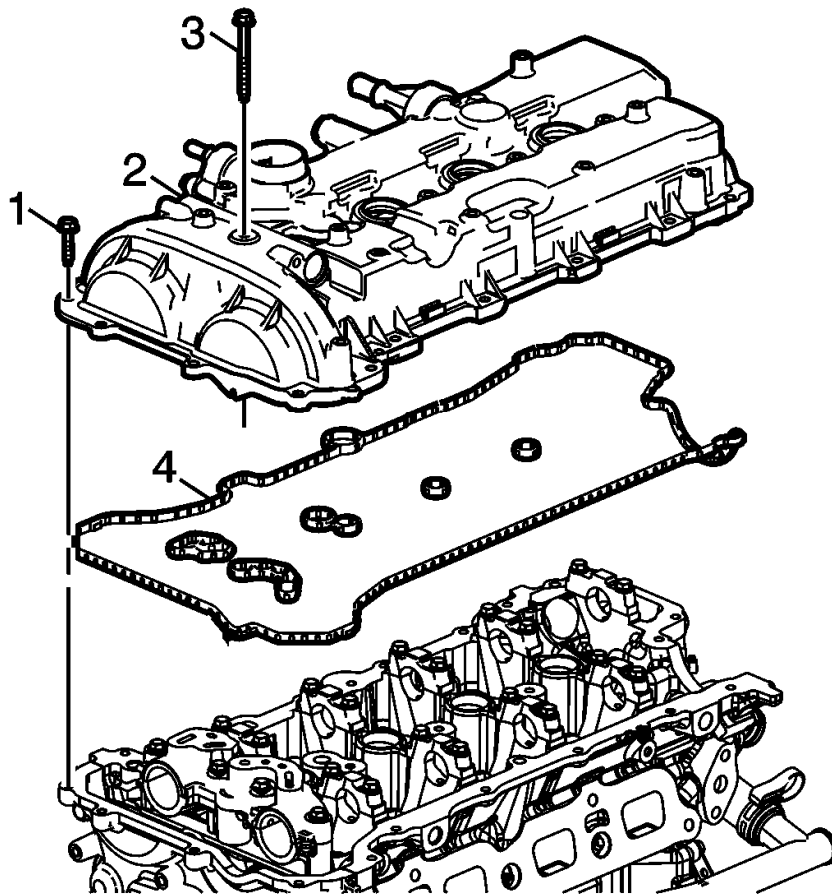


Fig. 261: Camshaft Cover Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Assemble the camshaft cover (2) and a NEW gasket (4). Ensure that the gasket is located in the retaining groove in the camshaft cover.
2. Install the cover on the cylinder head and hand start the bolts (1, 3).

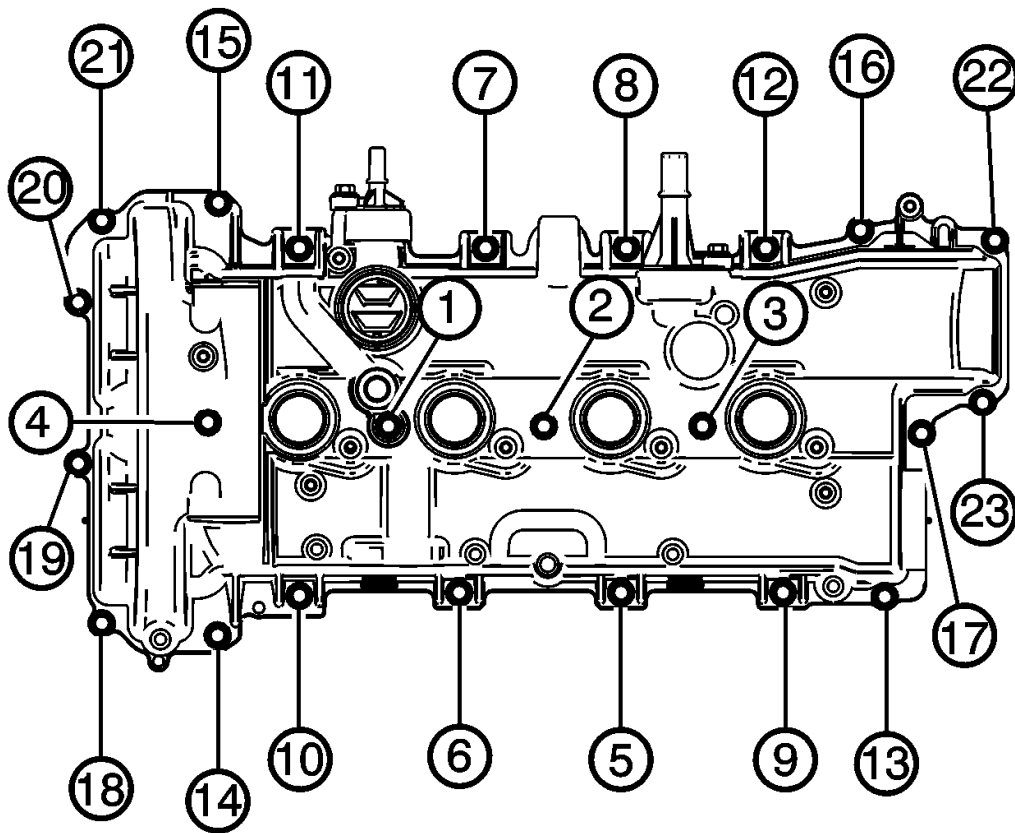


Fig. 262: Camshaft Cover Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the camshaft cover bolts in sequence to 10 N.m (89 lb in).

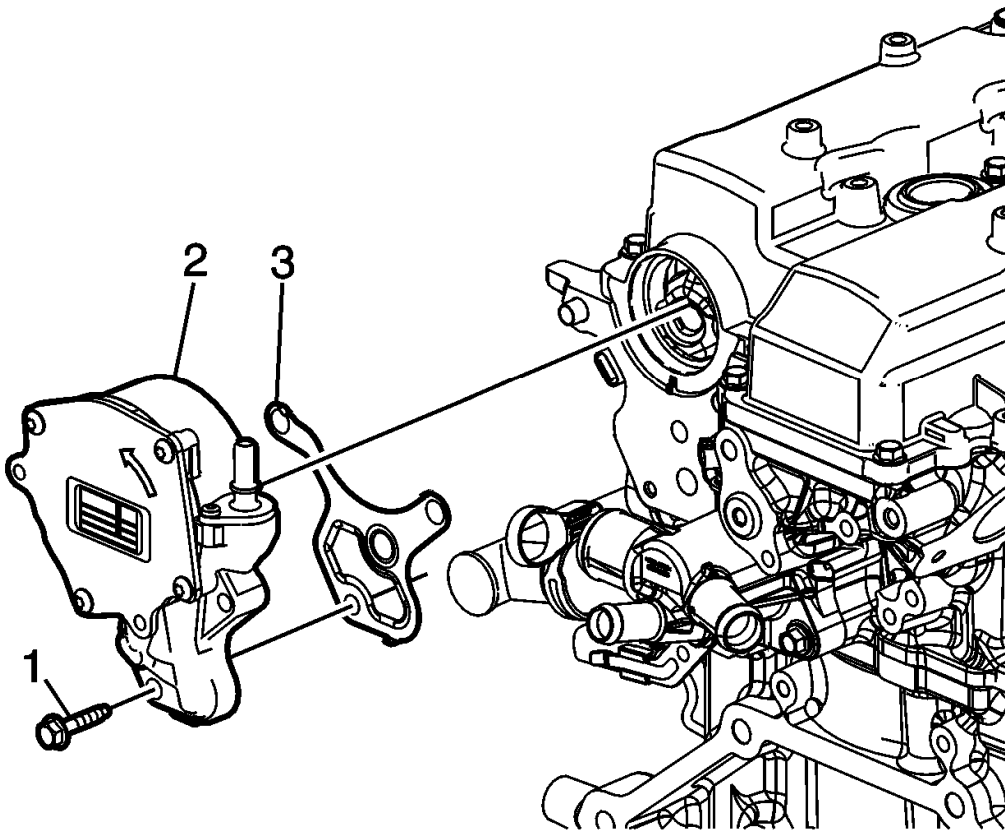


Fig. 263: Vacuum Assembly And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the vacuum pump seal does not need to be replaced, and the sealing surface is clean prior to installing the gasket and pump.

4. Inspect the vacuum pump seal. Refer to Camshaft Cover Cleaning and Inspection.
5. Install a NEW vacuum pump assembly gasket (3) on the vacuum pump assembly (2).
6. Install the vacuum pump assembly (2) and bolts (1). Tighten the bolts to 10 N.m (89 lb in).

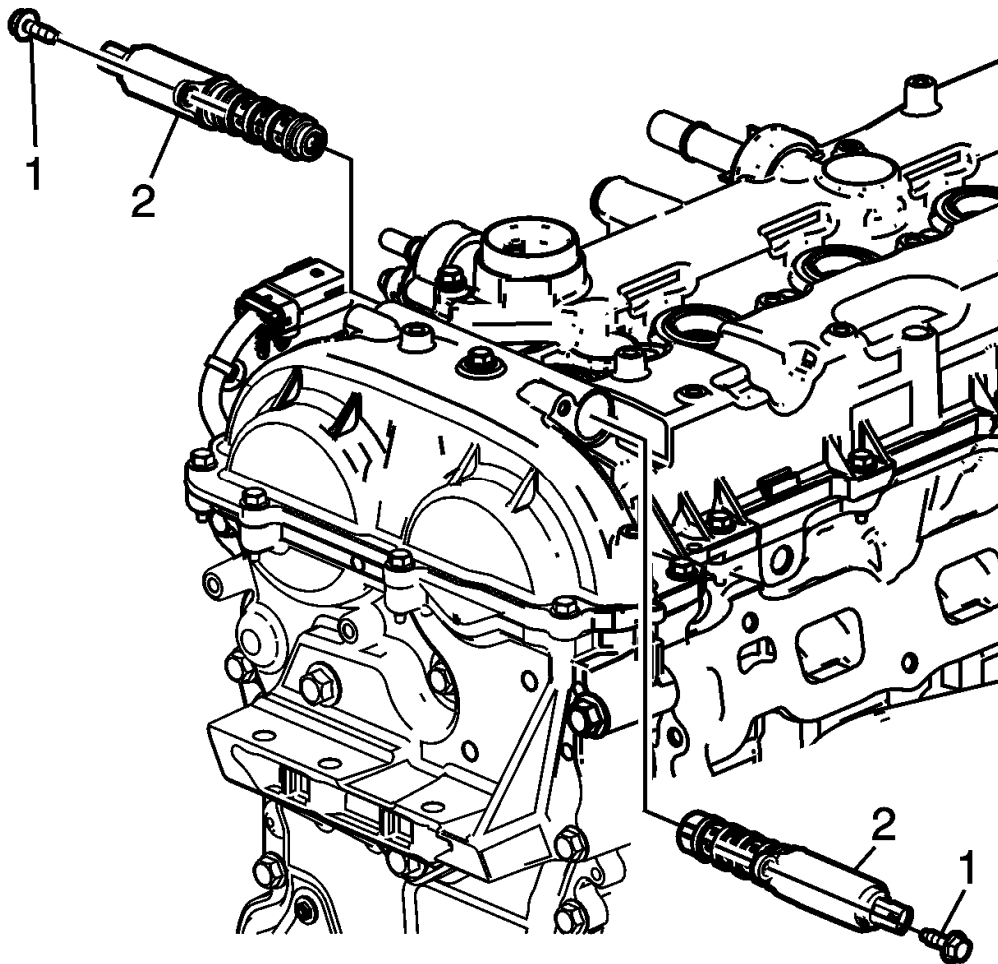


Fig. 264: Camshaft Position Actuator Control Solenoid Valves
Courtesy of GENERAL MOTORS COMPANY

7. Install the camshaft position actuator control solenoid valves (2) and bolts (1). Tighten the bolts to 10 N.m (89 lb in).

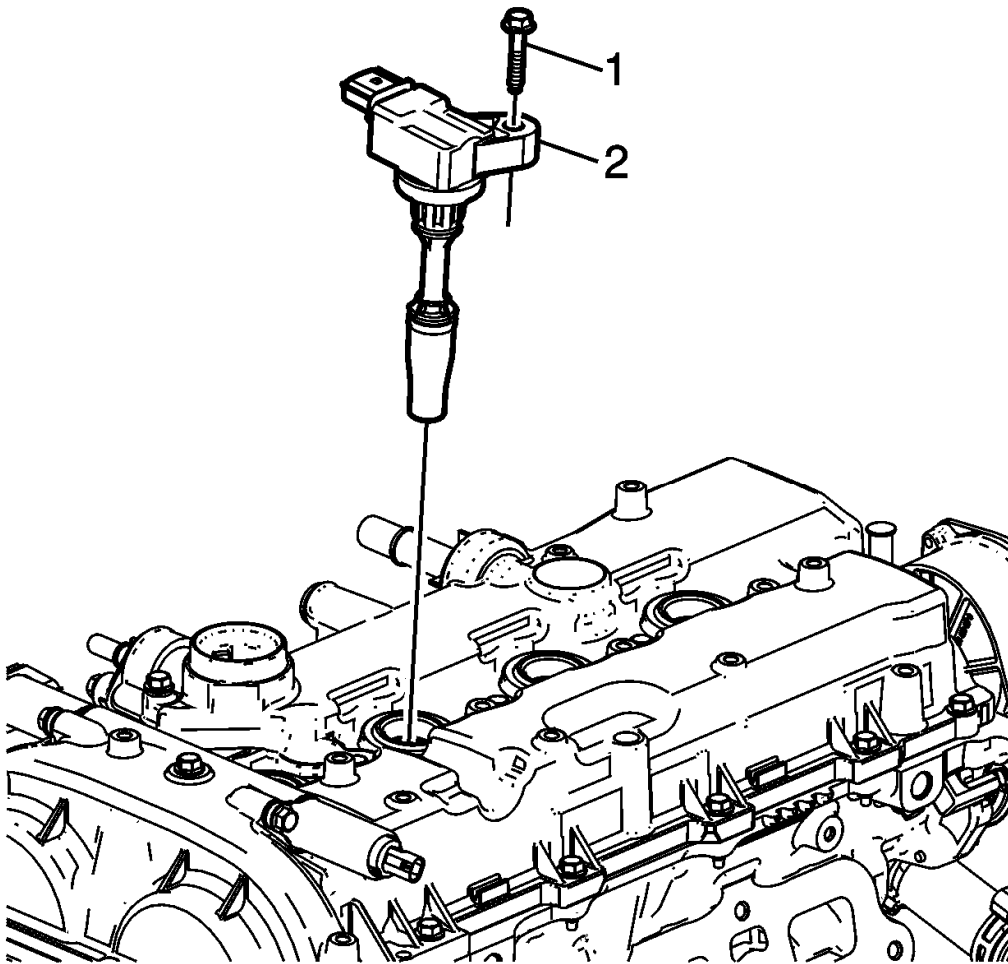


Fig. 265: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
 1. Apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
 2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
9. Install the ignition coils (2) and bolts (1). Tighten the bolt to 10 N.m (89 lb in).

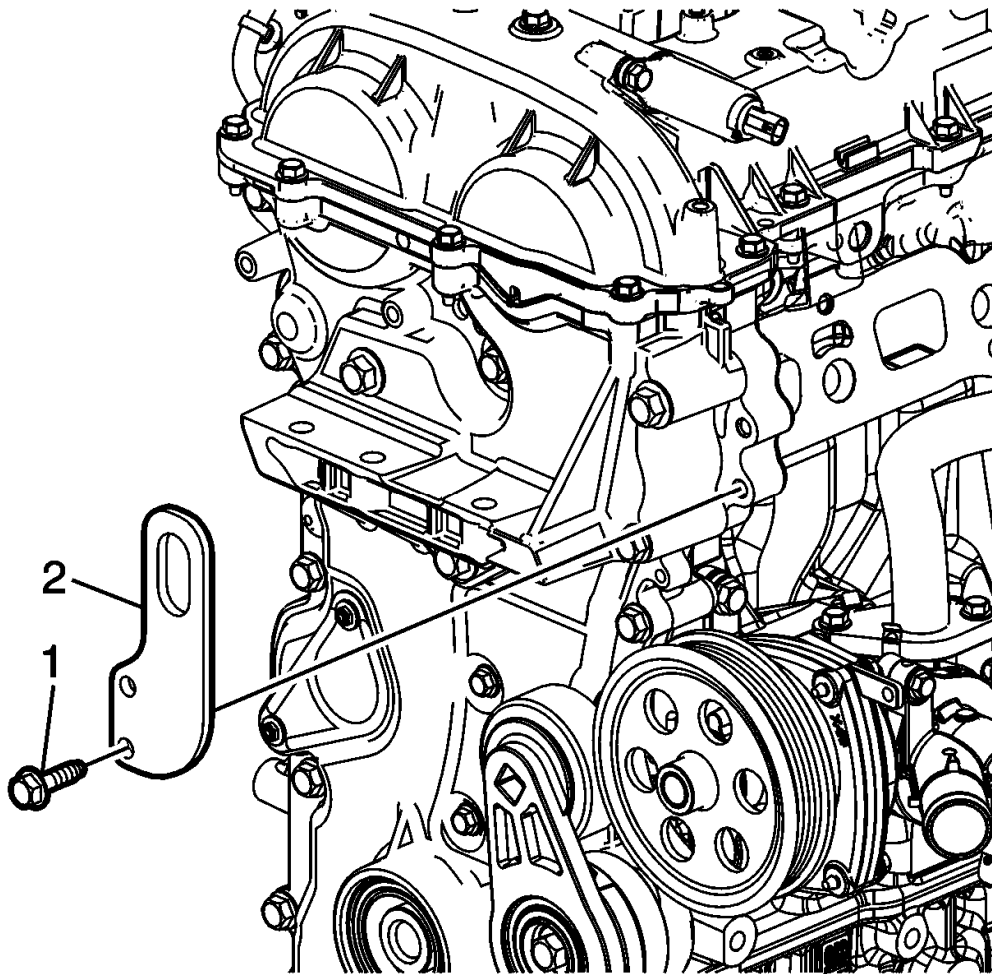


Fig. 266: Front Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

10. Install the front lift bracket (2).
11. Install the front lift bracket bolts (1) and tighten to 25 N.m (18 lb ft).

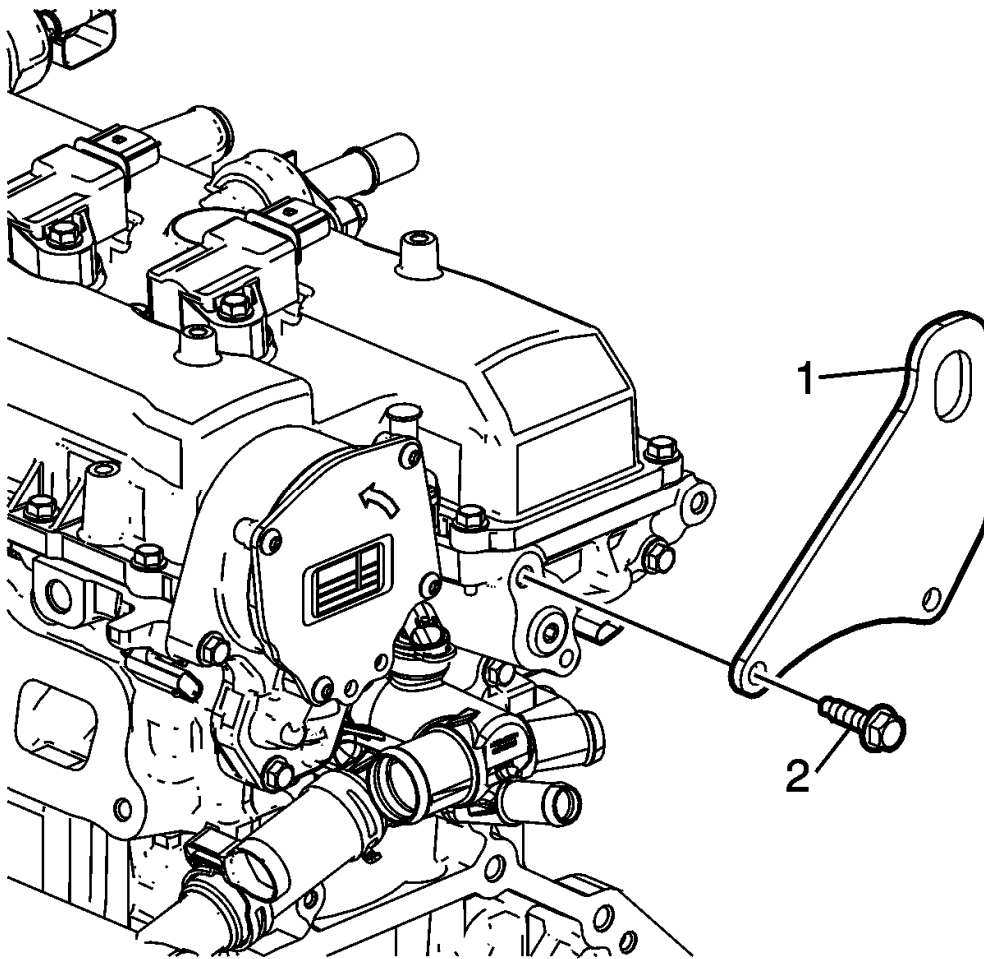


Fig. 267: Rear Lift Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Install the rear lift bracket (1).
13. Install the rear lift bracket bolts (2) and tighten to 25 N.m (18 lb ft).

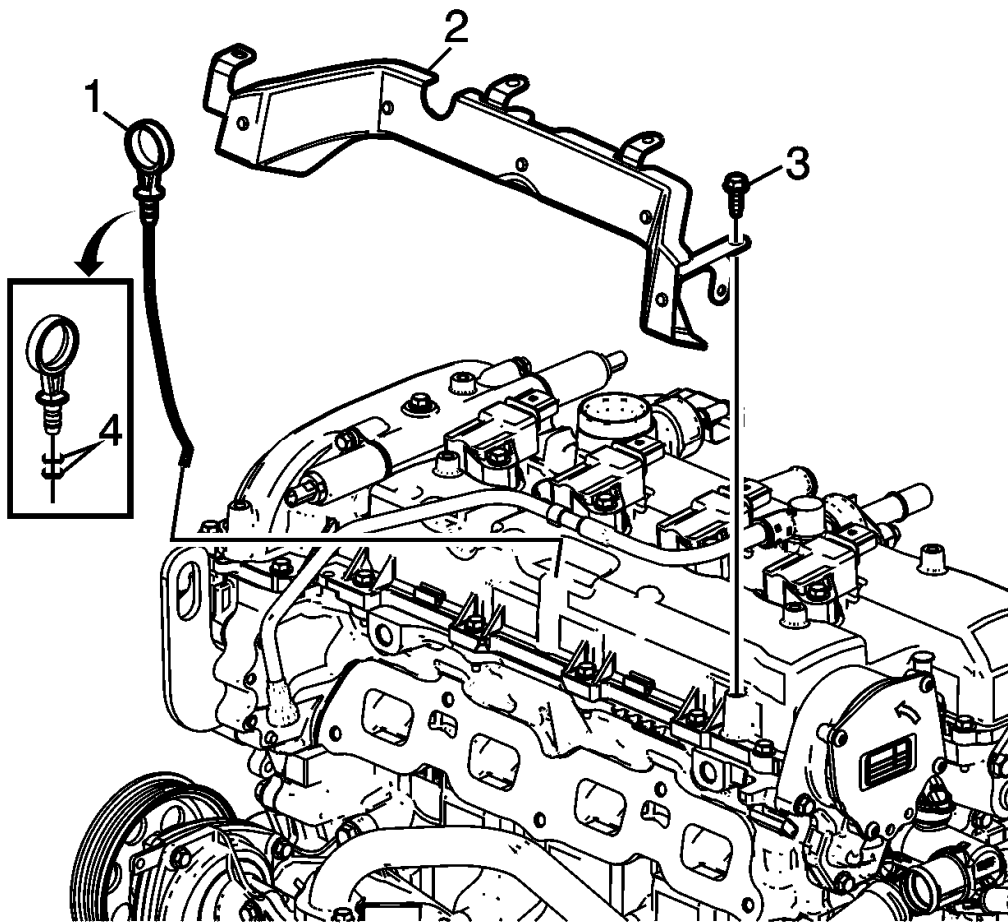


Fig. 268: Camshaft Cover Heat Shield
Courtesy of GENERAL MOTORS COMPANY

14. Install the camshaft cover heat shield (2) and bolts (3). Tighten the bolts to 10 N.m (89 lb in).
15. Inspect the oil level indicator O-ring seals (4) and replace if necessary. Install the oil level indicator (1).

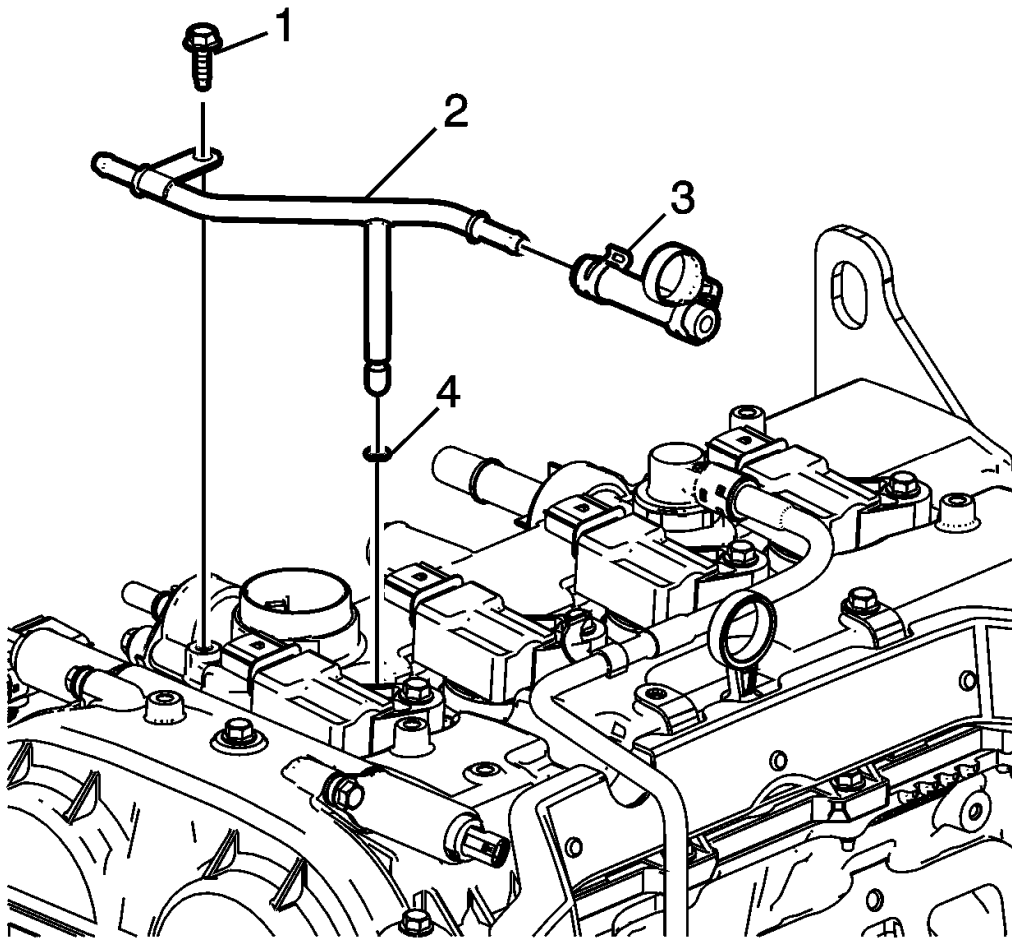


Fig. 269: Engine Coolant Air Bleed Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Inspect the O-ring (4) on the engine coolant air bleed pipe. Replace if necessary.
17. Install the engine coolant air bleed hose (3), if necessary.
18. Install the engine coolant air bleed pipe (2).
19. Install the pipe bolt (1) and tighten to 10 N.m (89 lb in).

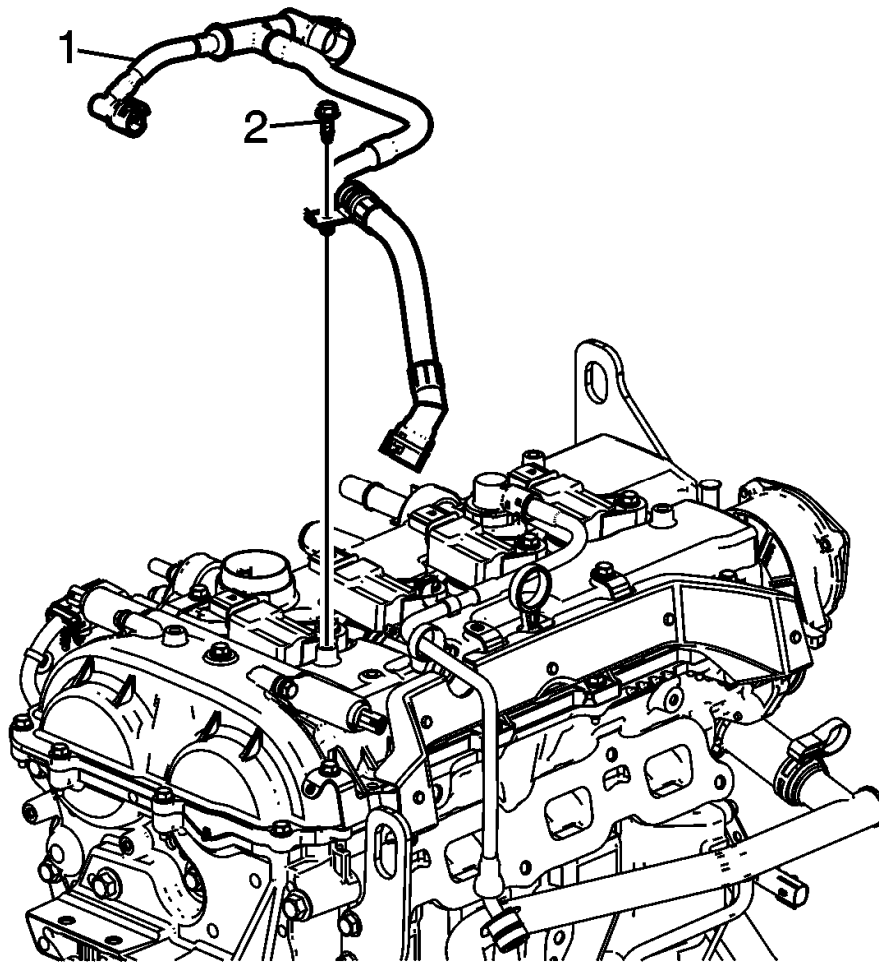


Fig. 270: PCV Hose Bolt
Courtesy of GENERAL MOTORS COMPANY

20. Install the PCV hose assembly (1) at the quick-connect fittings.
21. Install the PCV hose bolt (2) and tighten to 12 N.m (106 lb in).

FUEL RAIL AND INJECTORS INSTALLATION

Special Tools

EN-47909 Injector Bore and Sleeve Cleaning Kit

For equivalent regional tools, refer to **Special Tools** .

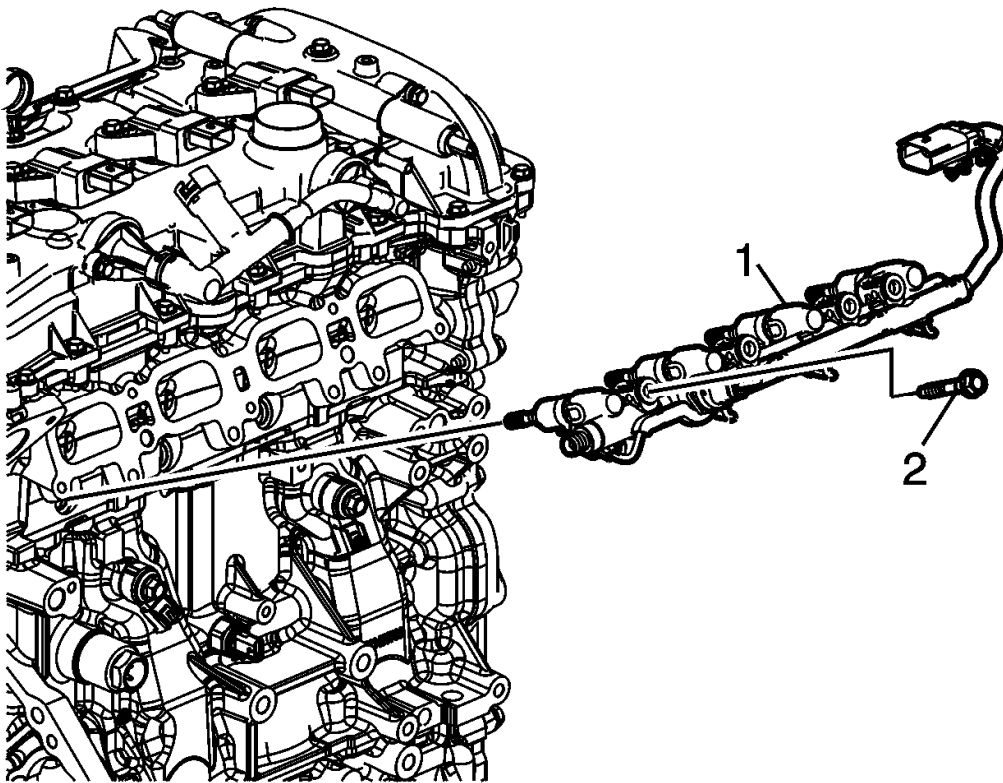


Fig. 271: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

1. Clean the fuel injector bore in the cylinder head using the **EN-47909** kit.
2. Replace the fuel rail insulators, if necessary. Refer to **Fuel Rail and Injectors Cleaning and Inspection**. Replace the fuel rail bolts, if necessary.
3. Install the fuel rail (1) with injectors into the cylinder head evenly.

NOTE: **Mount the bolts evenly to avoid cocking of the fuel injectors during installation.**

4. Hand start the 2 outer fuel rail bolts (2) to seat the injectors into the injector bores.
5. Hand start the remaining fuel rail bolts.

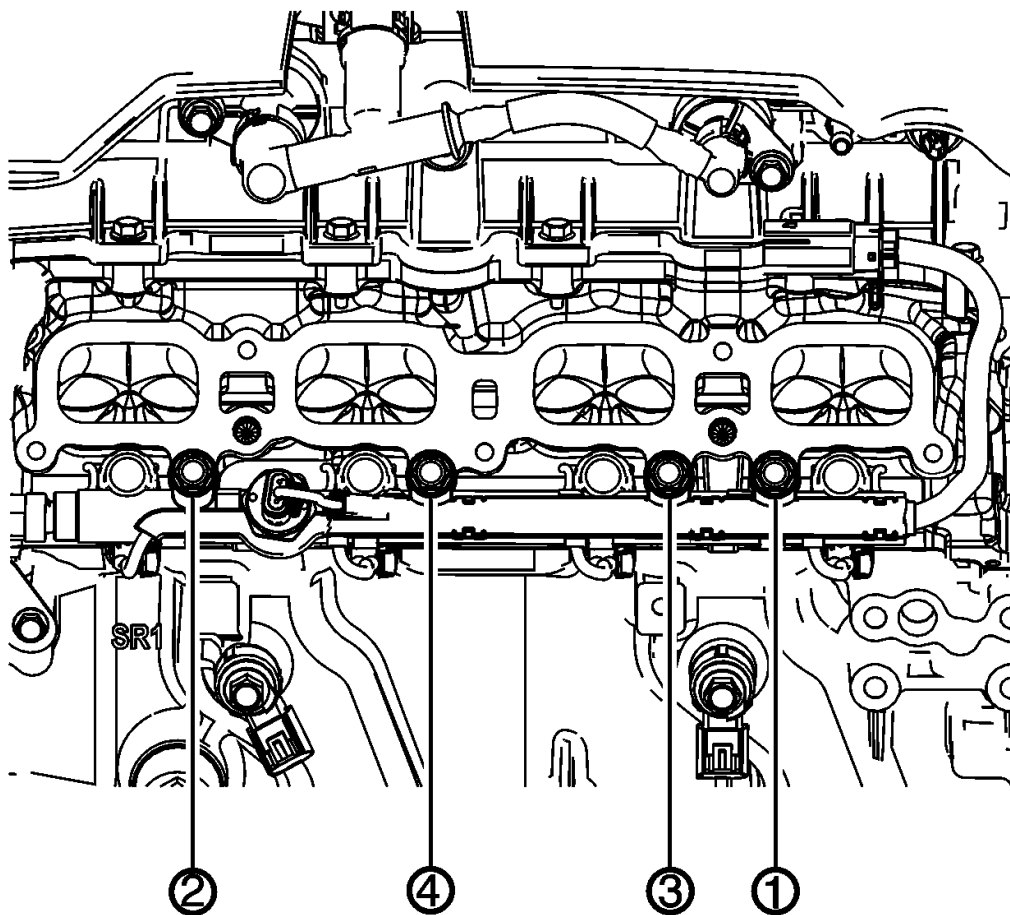


Fig. 272: Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the fuel rail bolts in sequence to 25 N.m (18 lb ft).
7. Connect the electrical harness to the fuel rail harness connections.

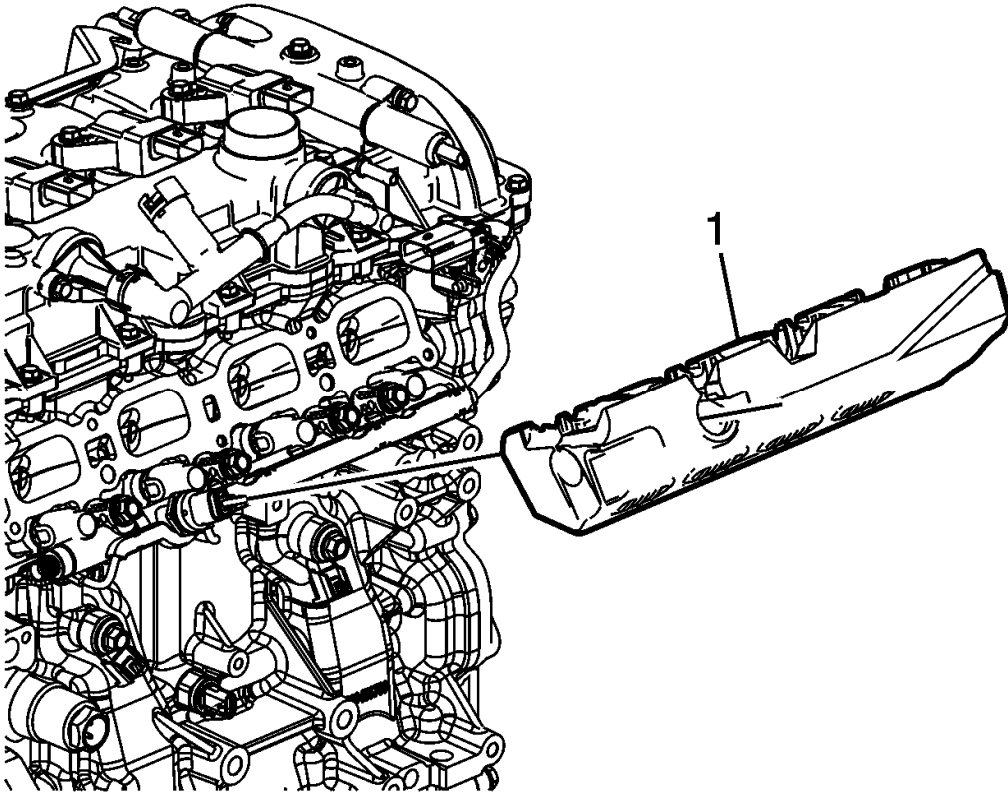


Fig. 273: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

8. Install the fuel injection fuel rail noise shield (1).

SECONDARY AIR INJECTION CHECK VALVE INSTALLATION

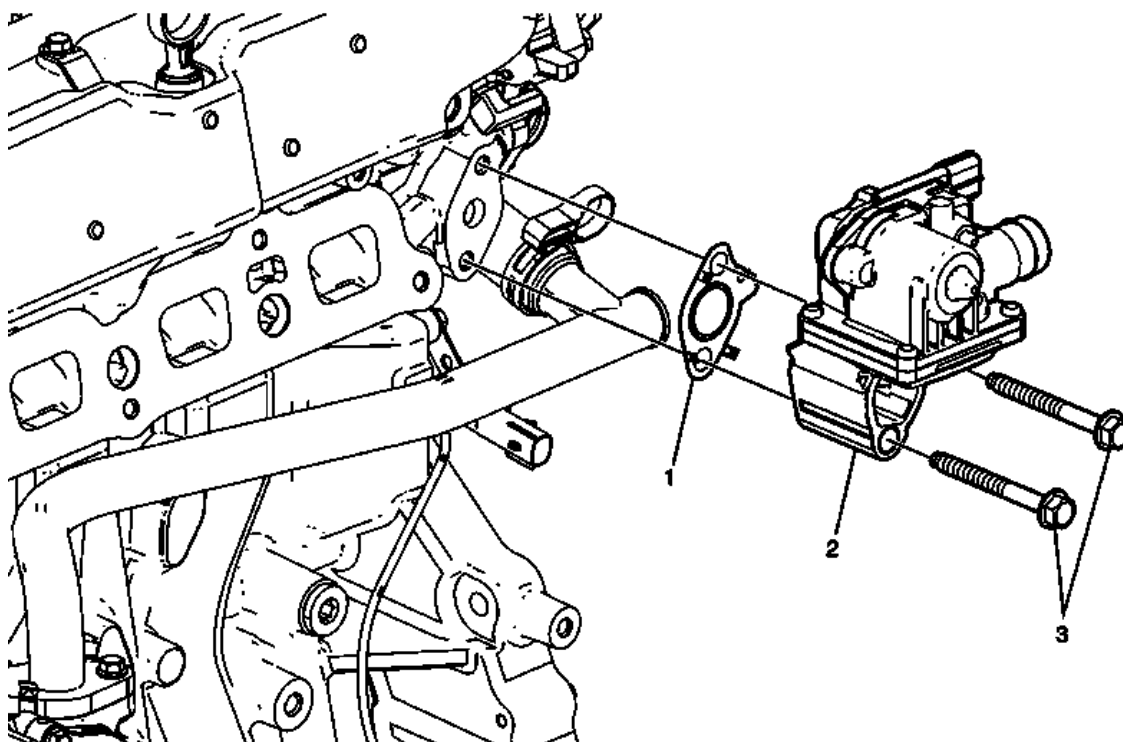


Fig. 274: Secondary Air Injection Check Valve
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Check Valve Installation

Callout	Component Name
1	Secondary Air Injection Check Valve Gasket
2	Secondary Air Injection Check Valve
3	Secondary Air Injection Check Valve Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)

EXHAUST MANIFOLD INSTALLATION

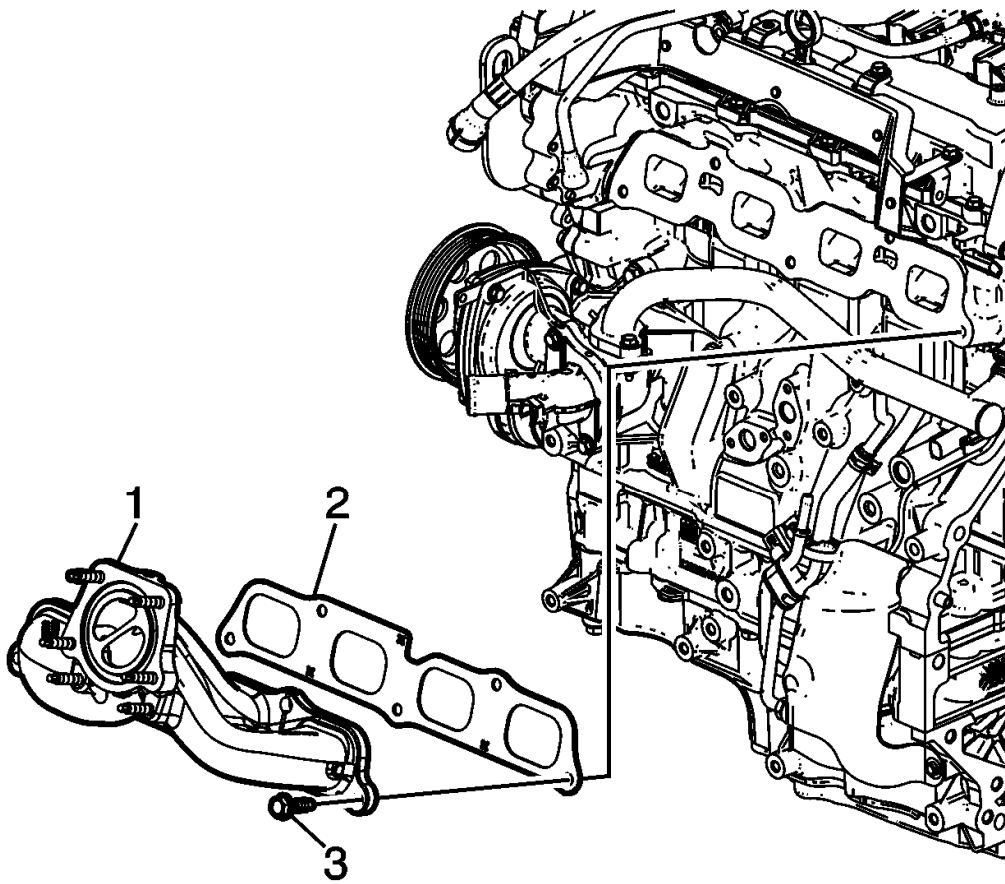


Fig. 275: Exhaust Manifold And Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW exhaust manifold gasket (2).
2. Install the exhaust manifold (1) to the cylinder head.
3. Hand start NEW exhaust manifold to cylinder head retaining bolts (3).

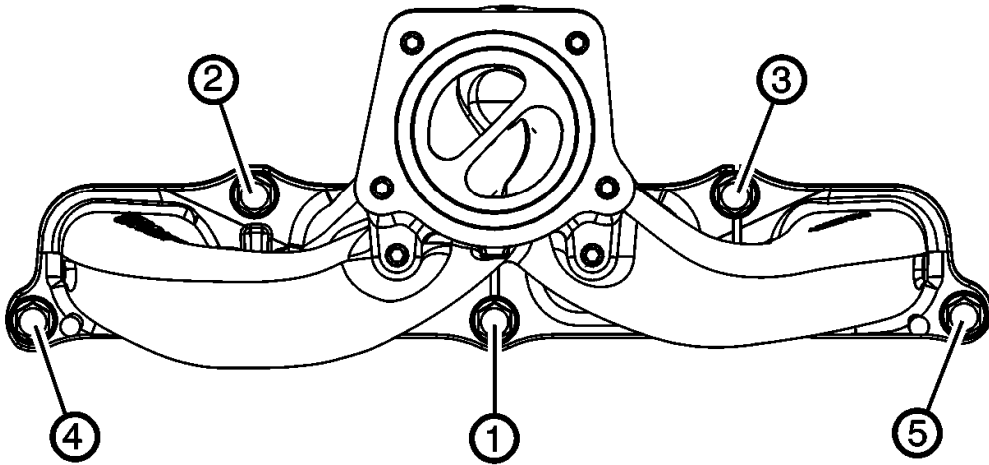


Fig. 276: Exhaust Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Fasteners have adhesive patch and must be tightened to final torque within 5 minutes.

4. Tighten the NEW exhaust manifold to cylinder head bolts three passes in sequence to 20 N.m (15 lb ft).

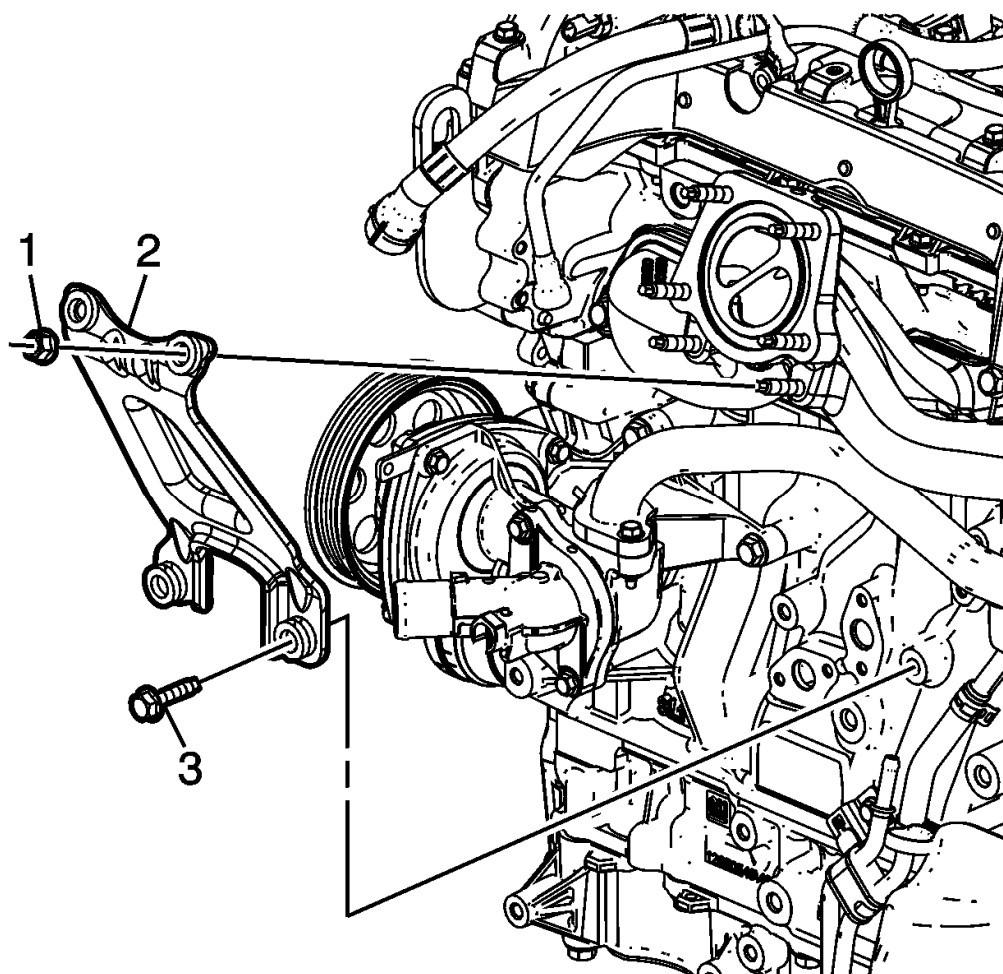


Fig. 277: Exhaust Manifold Brace Nuts
Courtesy of GENERAL MOTORS COMPANY

5. Install the exhaust manifold brace (2).
6. Install the exhaust manifold brace bolts (3) and tighten to 25 N.m (18 lb ft)
7. Install NEW exhaust manifold brace nuts (1) and tighten to 25 N.m (18 lb ft)

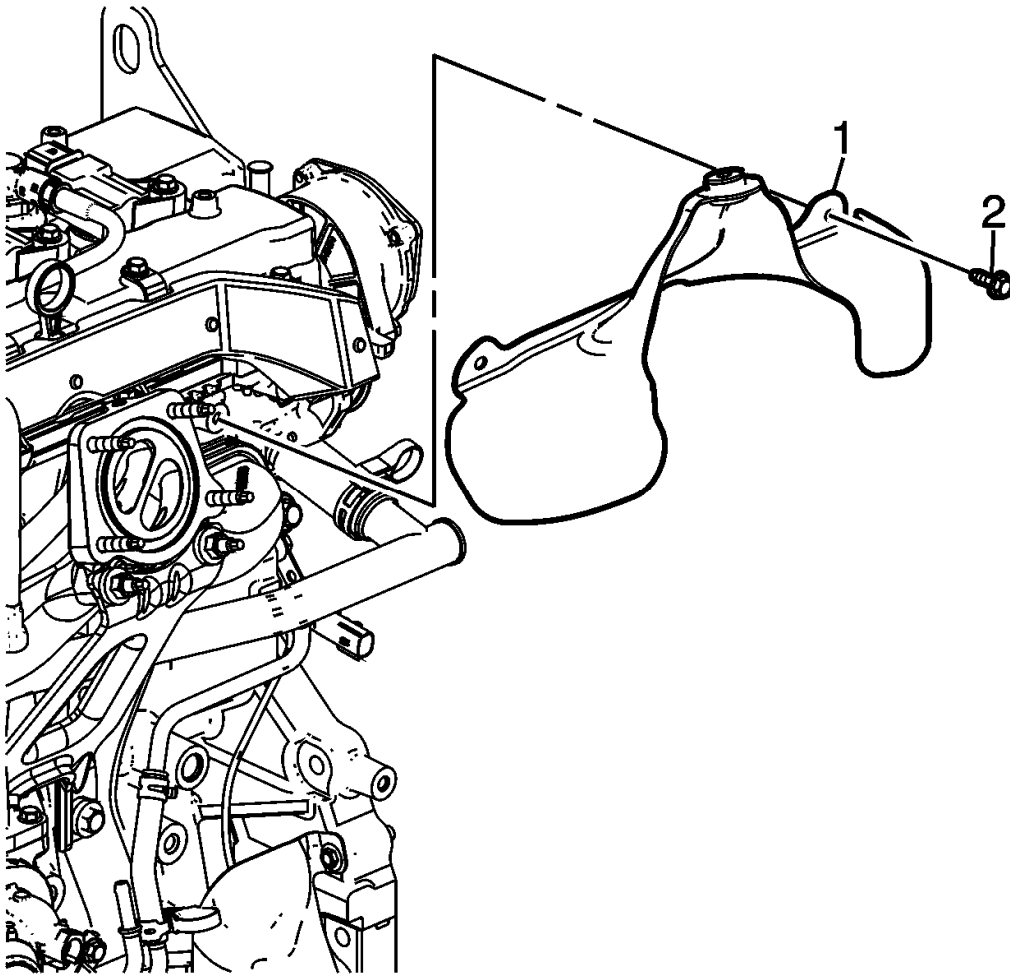


Fig. 278: Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust manifold heat shield (1).
9. Install the exhaust manifold heat shield bolts (2) and tighten to 14 N.m (124 lb in).

INTAKE MANIFOLD INSTALLATION

Special Tools

EN-50790 HP Fuel Pump Installation Alignment Gauge

For equivalent regional tools, refer to **Special Tools** .

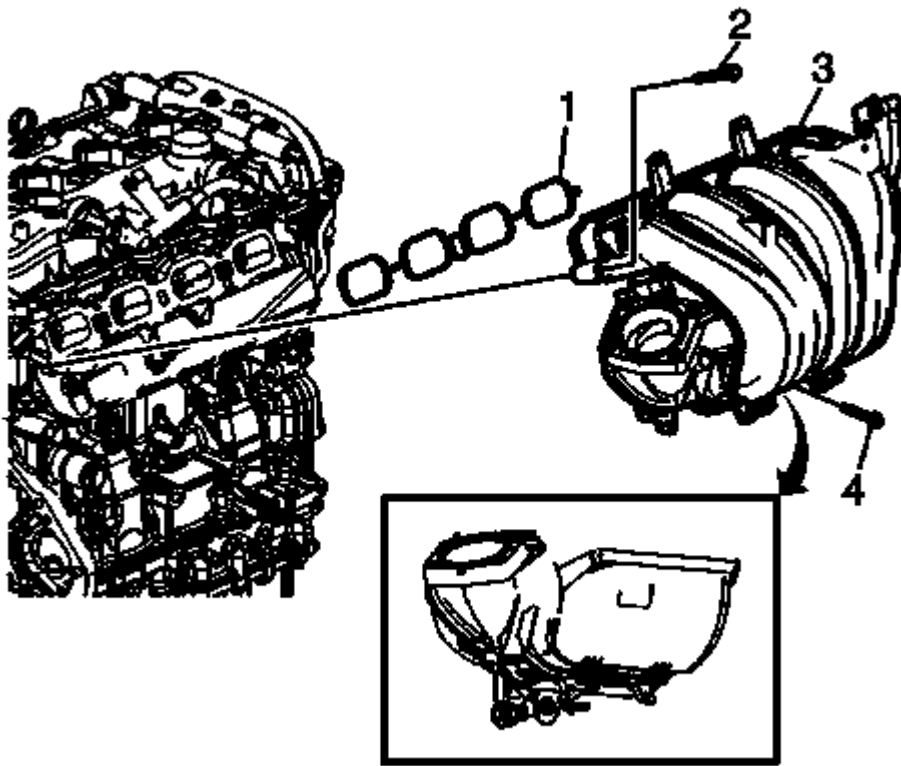


Fig. 279: Intake Manifold And Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket (1) on the intake manifold (3). Install the intake manifold and hand start the intake manifold bolts (2, 4).

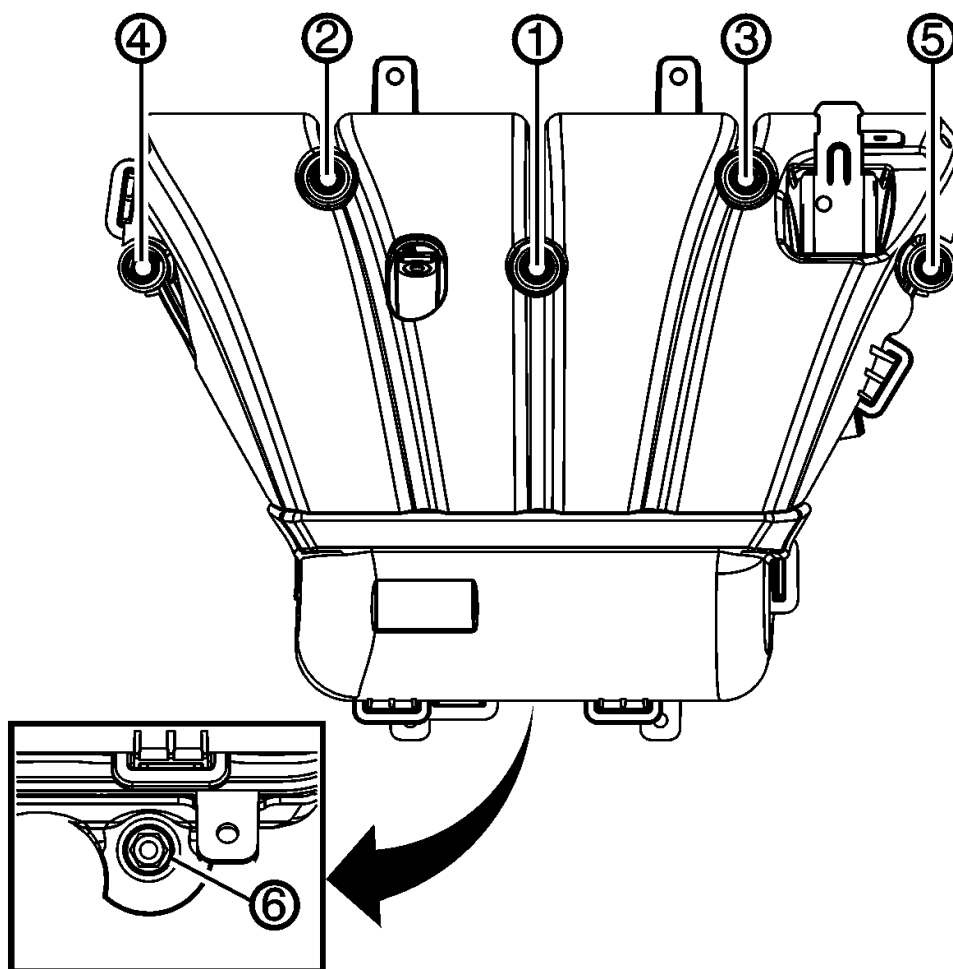


Fig. 280: Tightening Fastener In Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Tighten the bolts and nuts in sequence twice to 12 N.m (106 lb in).

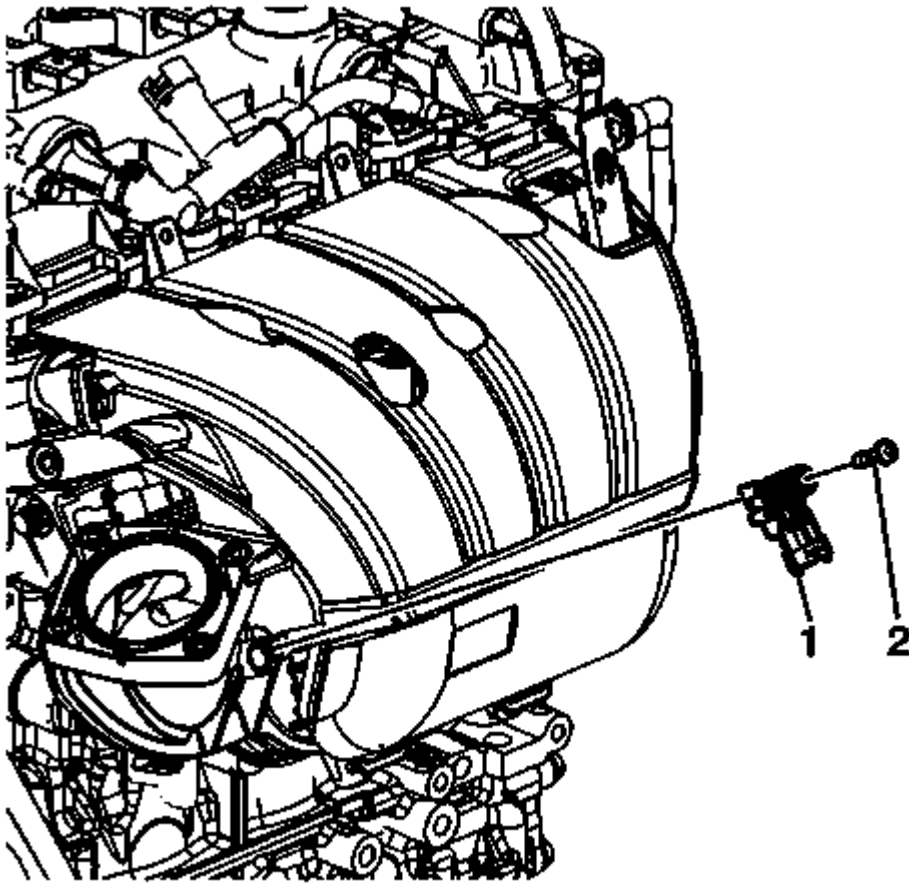


Fig. 281: MAP Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the MAP sensor (1) and bolt (2). Tighten the bolt to 5 N.m (44 lb in).

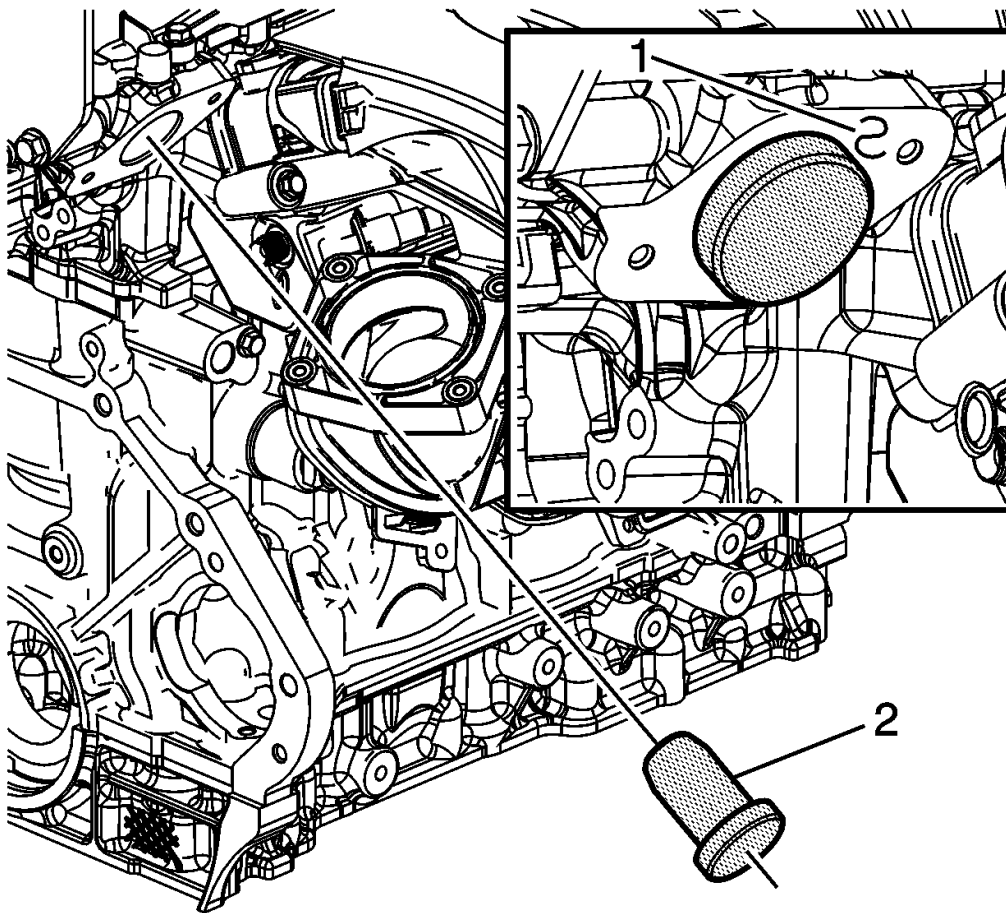


Fig. 282: View Of HP Fuel Pump Installation Alignment Gauge
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

4. Use the **EN-50790** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the head (1).

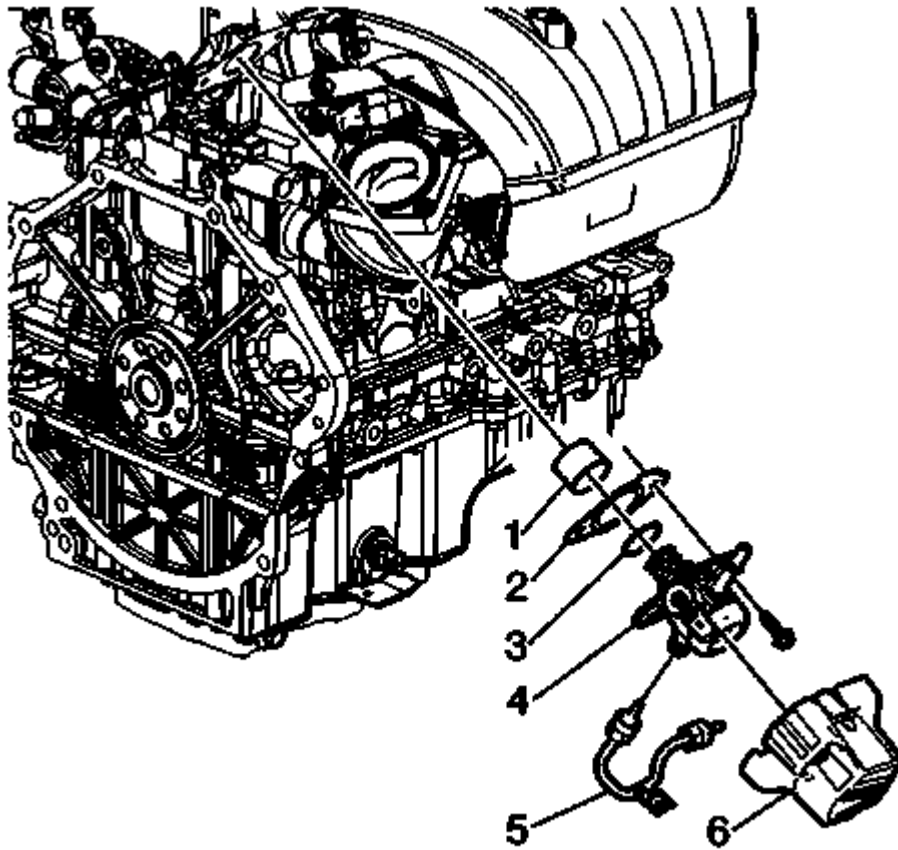


Fig. 283: Fuel Pump Insulator

Courtesy of GENERAL MOTORS COMPANY

5. Lubricate the high pressure fuel pump cylinder head bore with clean, silicone-free 5W30 engine oil.

NOTE: Ensure that the high pressure fuel pump roller lifter is oriented properly, and the camshaft is at base circle.

6. Lubricate the high pressure fuel pump roller lifter (1) with 5W30 engine oil and install into the cylinder head bore.

NOTE: Ensure the fuel pump housing gasket (2) is properly aligned with the tab upward at the 2 O'clock position.

7. Install a NEW fuel pump housing O-ring (3) and gasket (2).
8. Install the fuel pump assembly (4).
9. Hand start the fuel pump assembly bolts evenly. Tighten the fuel pump bolts evenly to 15 N.m (11 lb ft).
10. Hand start both ends of the NEW fuel feed intermediate pipe (5).
 1. Tighten the fitting nut to the fuel rail to 15 N.m (11 lb ft).
 2. Tighten the fitting nut to the fuel pump to 15 N.m (11 lb ft).

3. Tighten the fitting nut to the fuel rail a final pass to 30 N.m (22 lb ft).
4. Tighten the fitting nut to the fuel pump a final pass to 30 N.m (22 lb ft).
11. Install the fuel pump insulator (6).

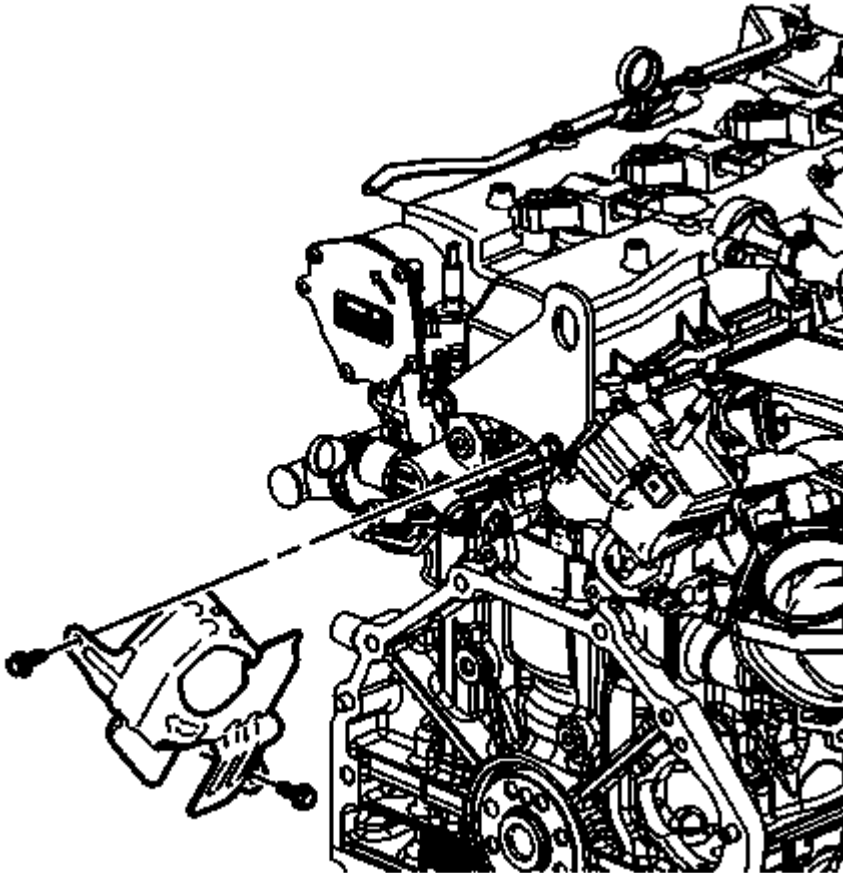


Fig. 284: Fuel Pump Cover Bolts And Cover
Courtesy of GENERAL MOTORS COMPANY

12. Install the fuel pump cover and bolts. Tighten the bolts to 10 N.m (89 lb in).

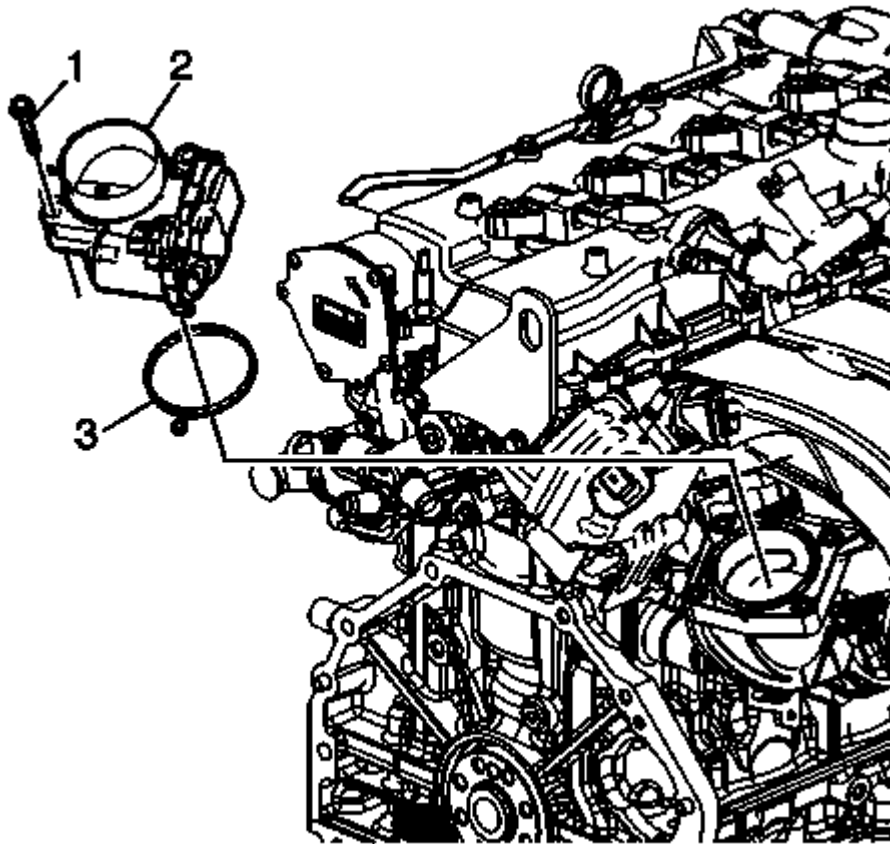


Fig. 285: Throttle Body Bolts

Courtesy of GENERAL MOTORS COMPANY

13. Install a new throttle body gasket (3).
14. Install the throttle body (2).
15. Install the throttle body bolts (1) and tighten to 10 N.m (89 lb in).

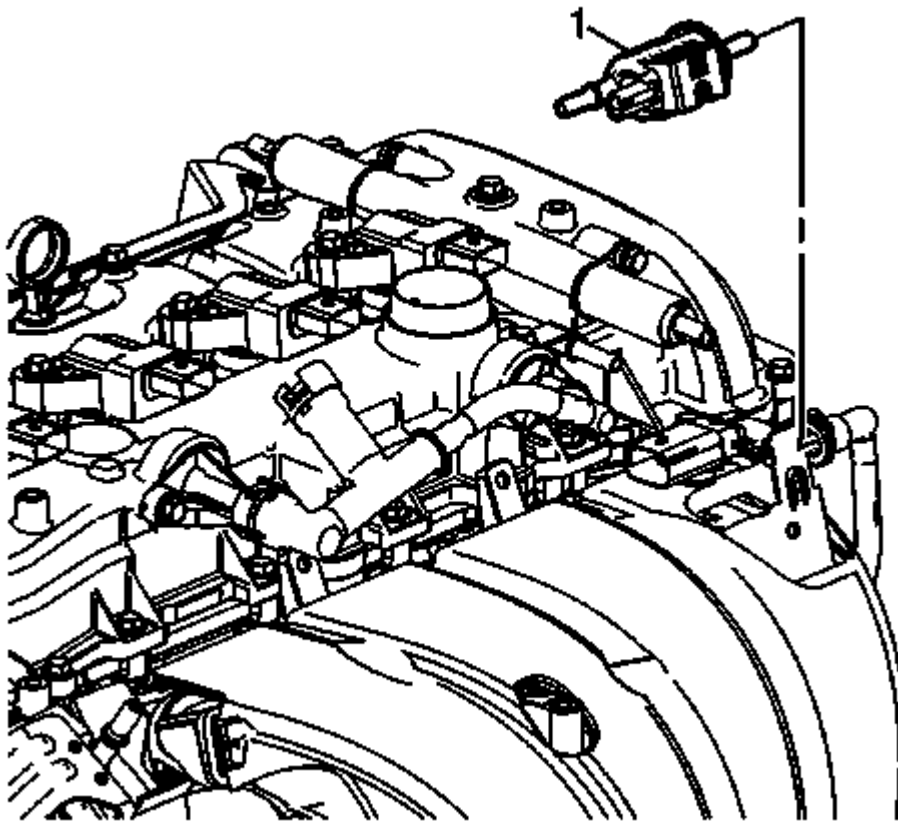


Fig. 286: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the quick-connect is clean and free of debris. The latch should move freely prior to installation.

16. Install the EVAP canister valve (1) and connect the EVAP canister valve tube.

TURBOCHARGER INSTALLATION

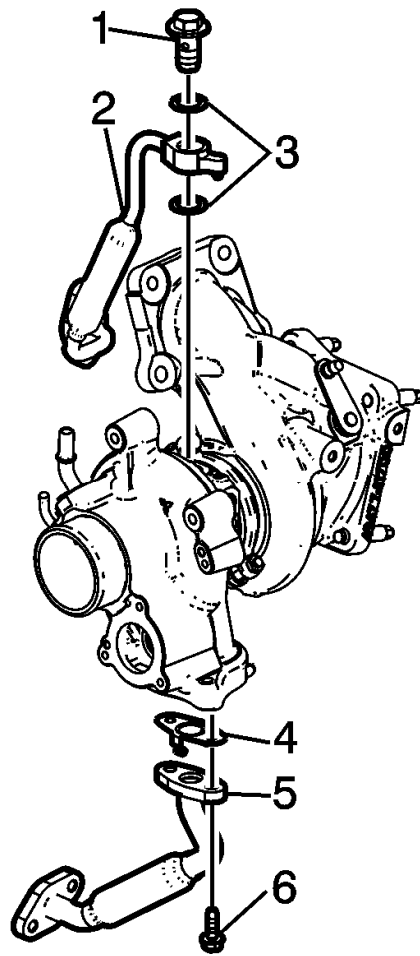


Fig. 287: Turbocharger Oil Feed Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust pipe studs do not come installed on new turbochargers. If the turbocharger is being replaced, new studs will need to be installed.

1. Install the turbocharger oil feed pipe (2) and NEW washers (3) onto the turbocharger.

CAUTION: Refer to Fastener Caution .

2. Install the turbocharger oil feed pipe bolt (1) and tighten to 35 N.m (26 lb ft).
3. Install a NEW turbocharger oil return pipe gasket (4).
4. Install the turbocharger oil return pipe (5) onto the turbocharger.
5. Install the turbocharger oil return pipe bolts (6) and tighten to 10 N.m (89 lb in).

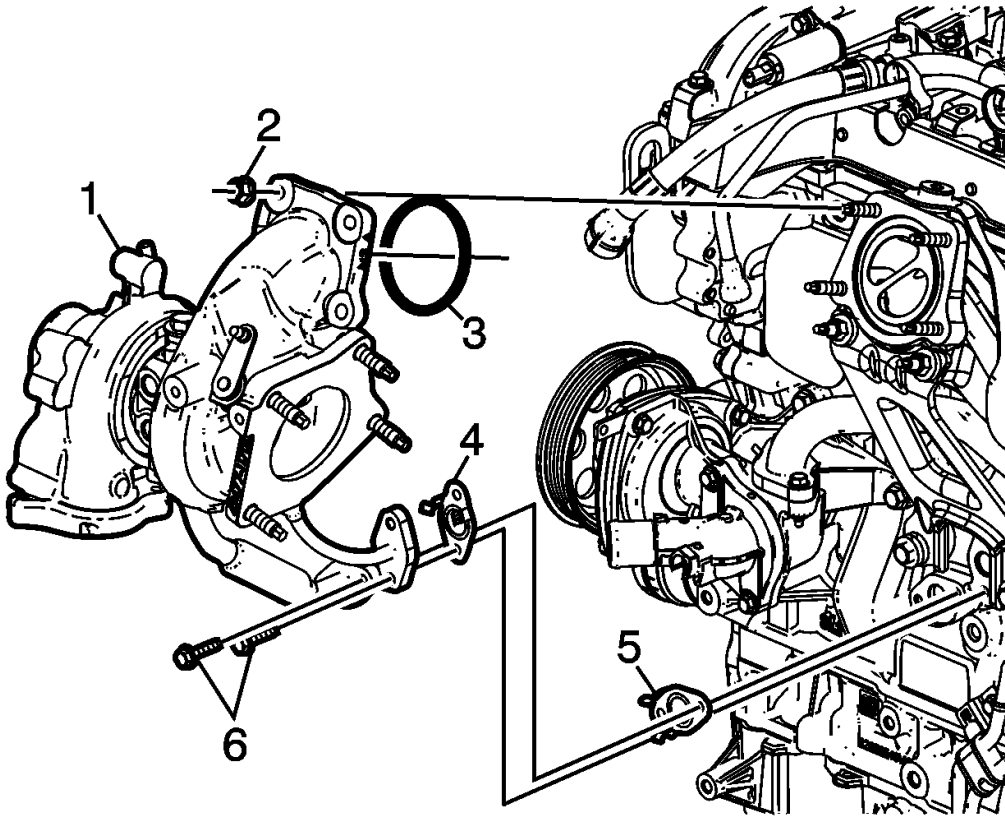


Fig. 288: Turbocharger Nuts

Courtesy of GENERAL MOTORS COMPANY

6. Install a NEW turbocharger gasket (3) on the turbocharger.
7. Install NEW turbocharger oil feed and oil return pipe gaskets (4, 5).
8. Install the turbocharger (1).

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

9. Install NEW turbocharger nuts (2) finger tight.
10. Install the turbocharger oil feed and return pipe bolts (6) at the engine block. tighten the bolts to 10 N.m (89 lb in).

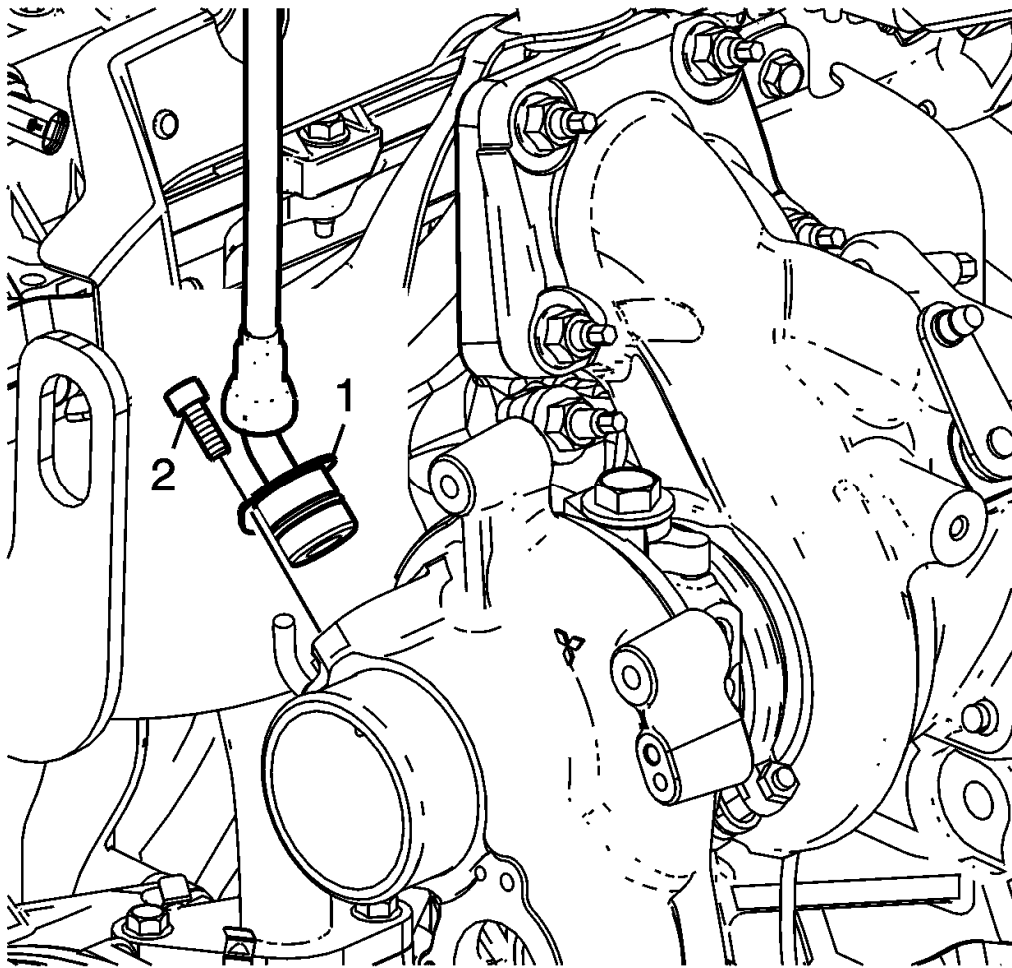


Fig. 289: PCV Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: The PCV hose and fitting assembly connection is permanent. Reinstall these components as an assembly unless new components are being used.

11. Install the PCV hose and fitting assembly (1) to the turbocharger. Install the PCV hose fitting assembly bolt (2) and tighten to 8 N.m (71 lb in).

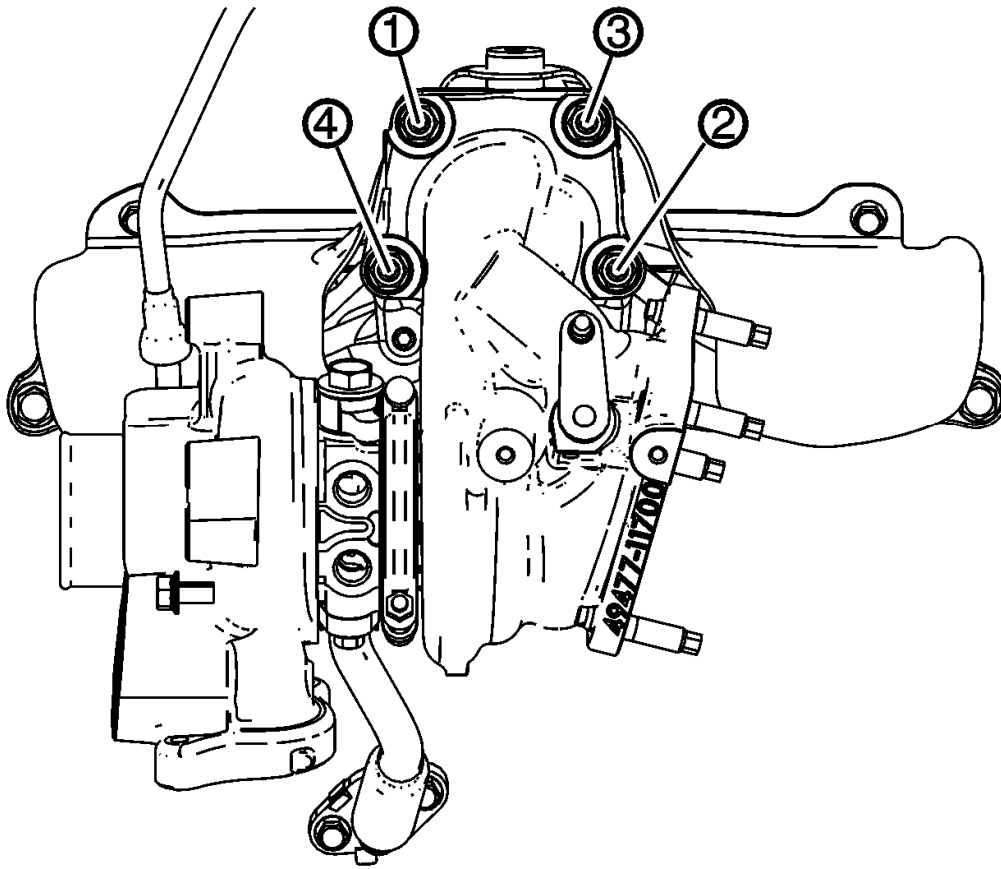


Fig. 290: Turbocharger Nut Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

12. Tighten the turbocharger nuts in sequence to 30 N.m (22 lb ft) plus 90 degrees.

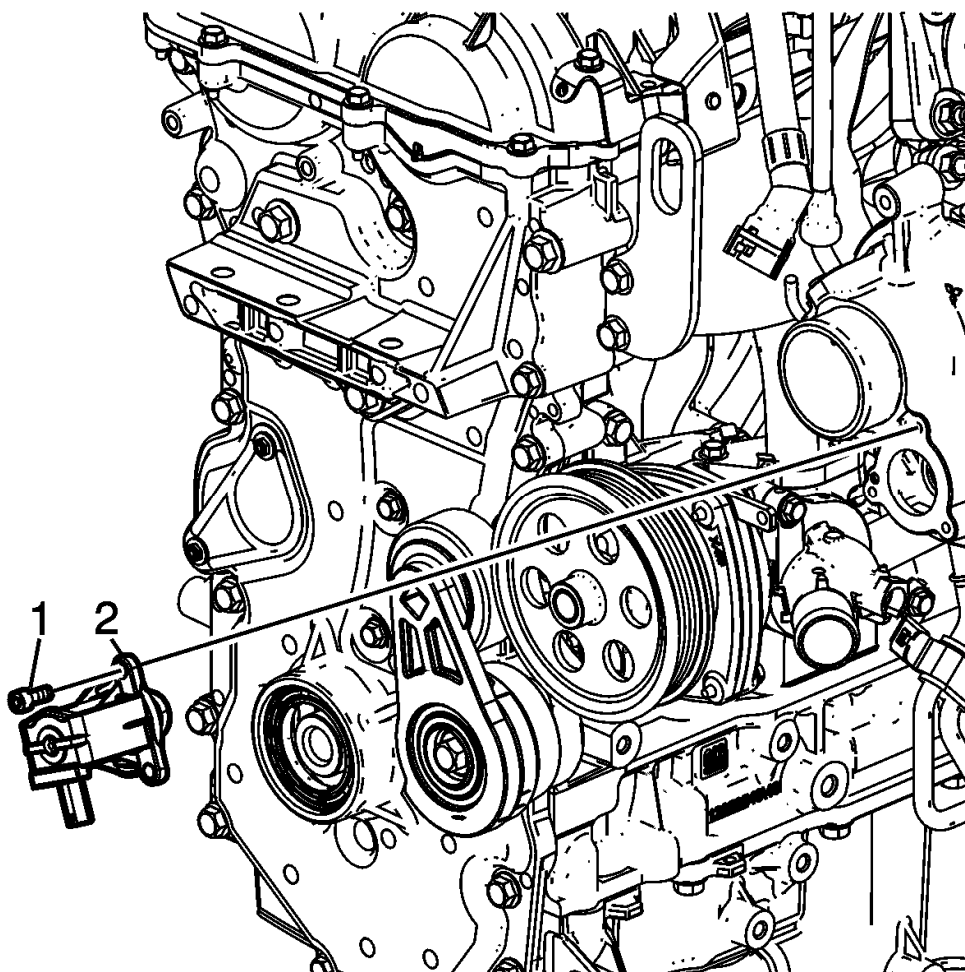


Fig. 291: Turbocharger Bypass Valve Solenoid Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the turbocharger bypass valve solenoid (2).
14. Install the turbocharger bypass valve solenoid bolts (1) and tighten to 8 N.m (71 lb in).

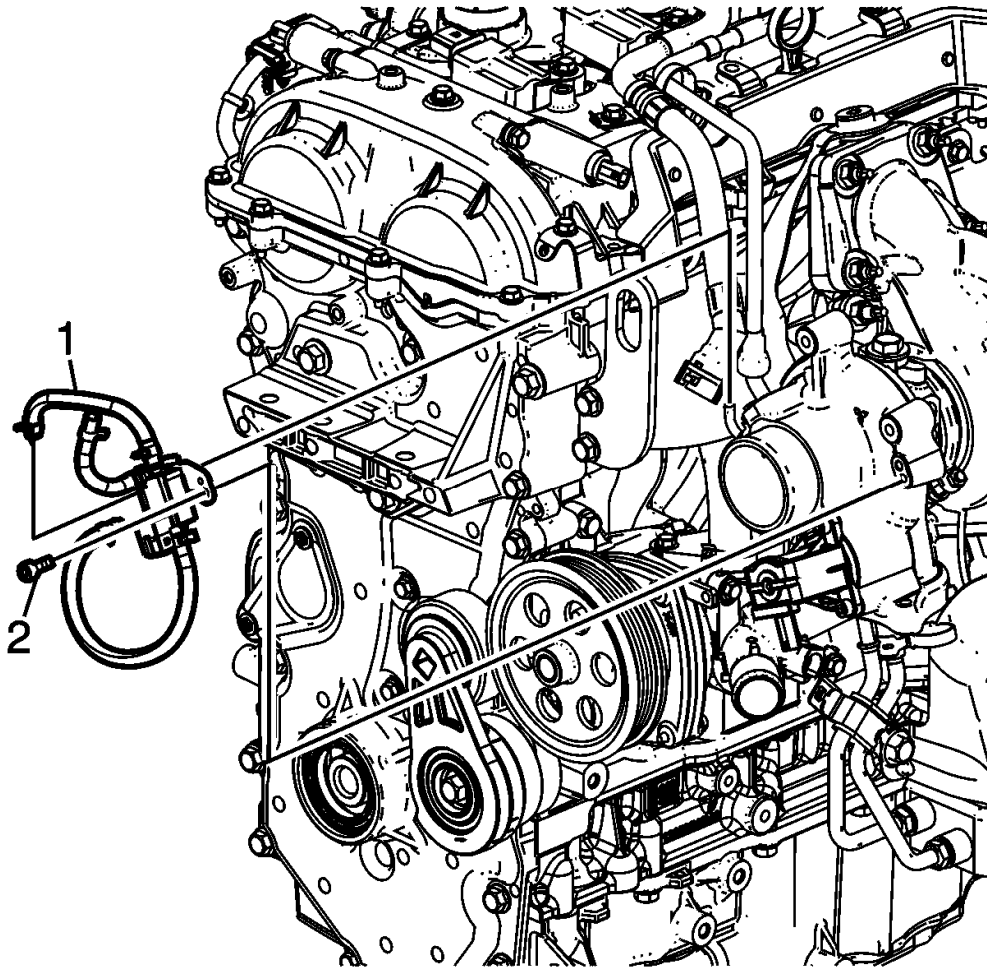


Fig. 292: Turbocharger Wastegate Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

15. Install the turbocharger wastegate regulator solenoid valve (1).
16. Install the turbocharger wastegate regulator solenoid valve bracket bolt (2) and tighten to 8 N.m (71 lb in).
17. Connect the turbocharger wastegate regulator solenoid valve hoses to the turbocharger.

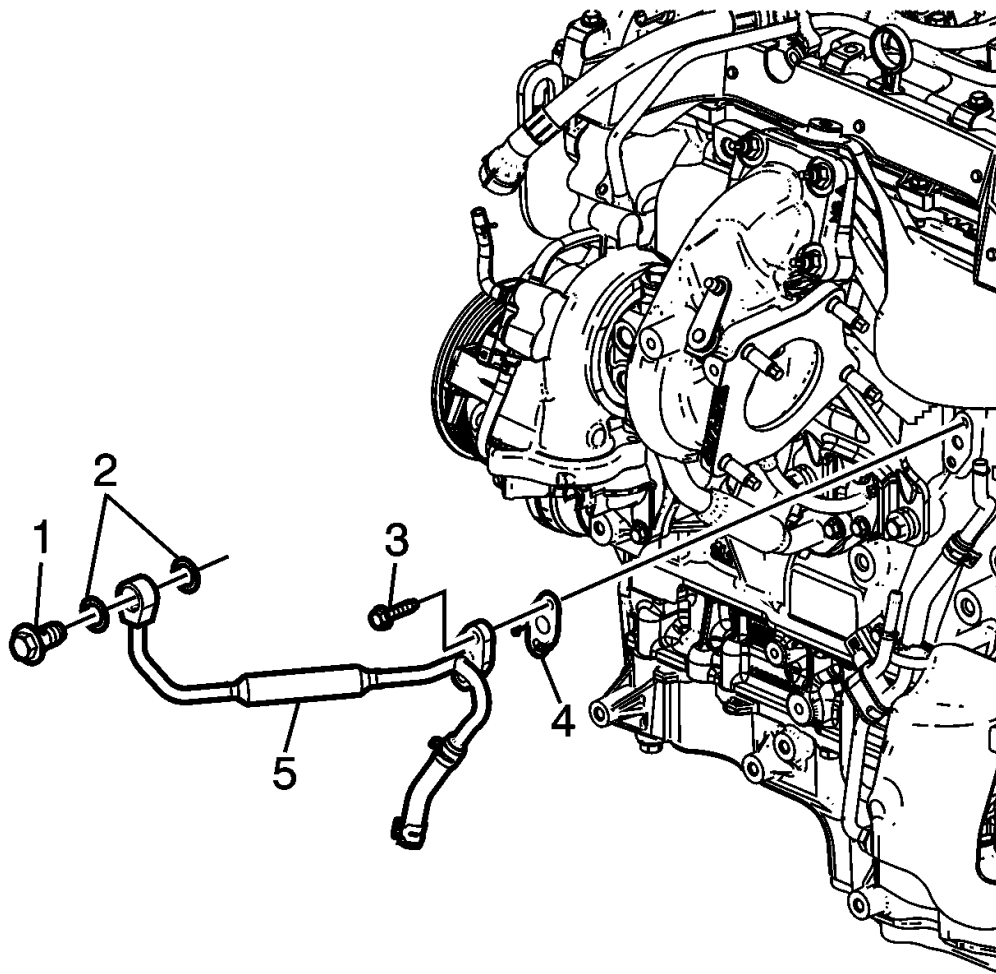


Fig. 293: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Install the turbocharger coolant feed pipe (5) and NEW washers (2) on the turbocharger.
19. Install the turbocharger coolant feed pipe bolt (1) and tighten to 35 N.m (26 lb ft).
20. Install a NEW turbocharger coolant feed pipe gasket (4).
21. Install the turbocharger coolant feed pipe bolts (3) and tighten to 10 N.m (89 lb in).
22. Connect the turbocharger coolant feed pipe hose to the engine oil cooler.

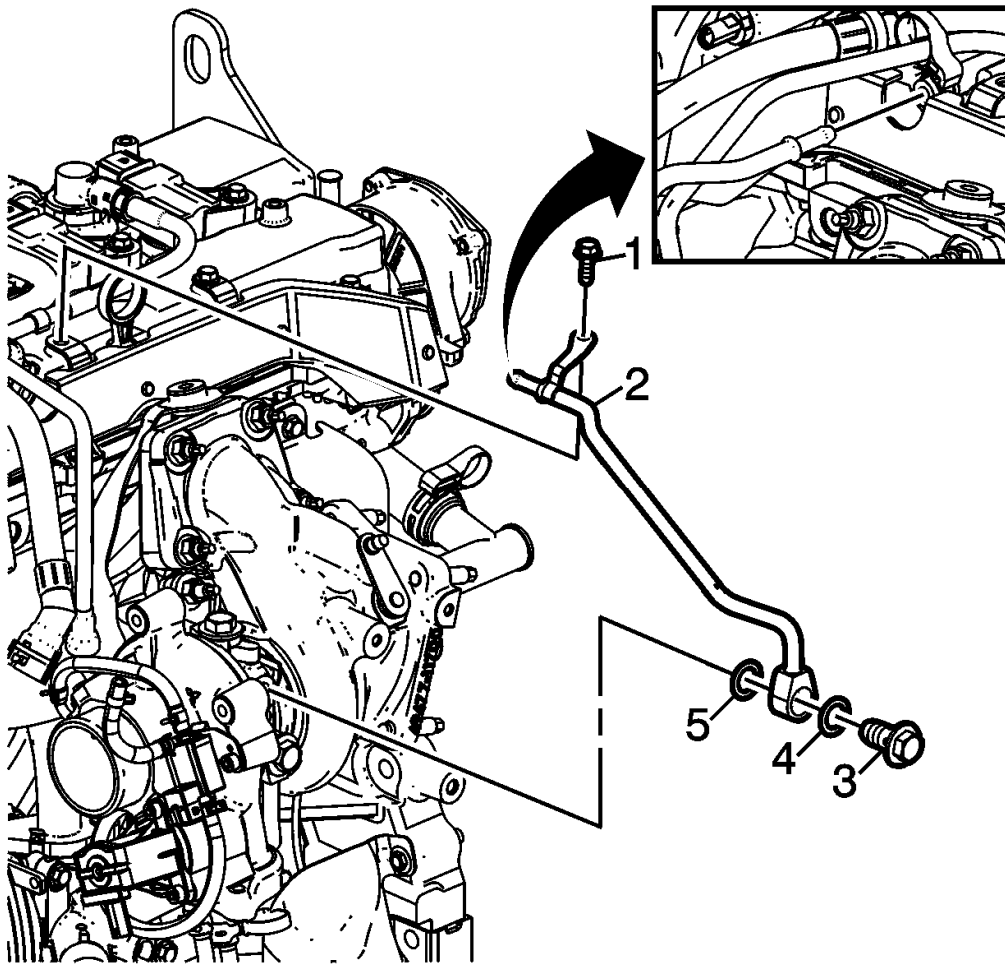


Fig. 294: Camshaft Cover Heat Shield Bolt
Courtesy of GENERAL MOTORS COMPANY

23. Install the turbocharger coolant return pipe (2) and NEW washers (4, 5) on the turbocharger.
24. Install the turbocharger coolant return pipe bolt (3) and tighten to 35 N.m (26 lb ft).
25. Connect the turbocharger coolant return pipe to the air bleed hose.
26. Install the camshaft cover heat shield bolt (1) that retains the turbocharger coolant return pipe (2) at the camshaft cover. Tighten the bolt to 10 N.m (89 lb in).

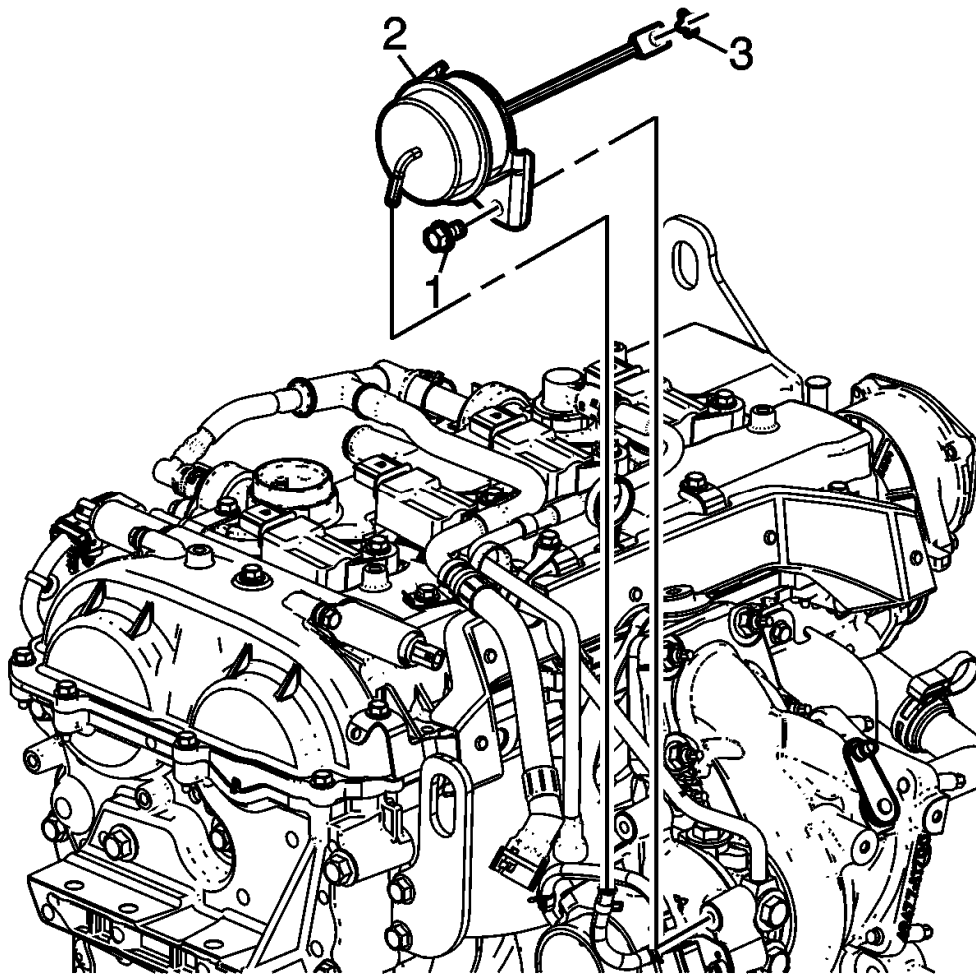


Fig. 295: Turbocharger Wastegate Actuator Arm Retainer
Courtesy of GENERAL MOTORS COMPANY

27. Install the turbocharger wastegate actuator (2) and actuator bolts (1) and tighten to 8 N.m (71 lb in).
28. Install the turbocharger wastegate actuator arm retainer (3).

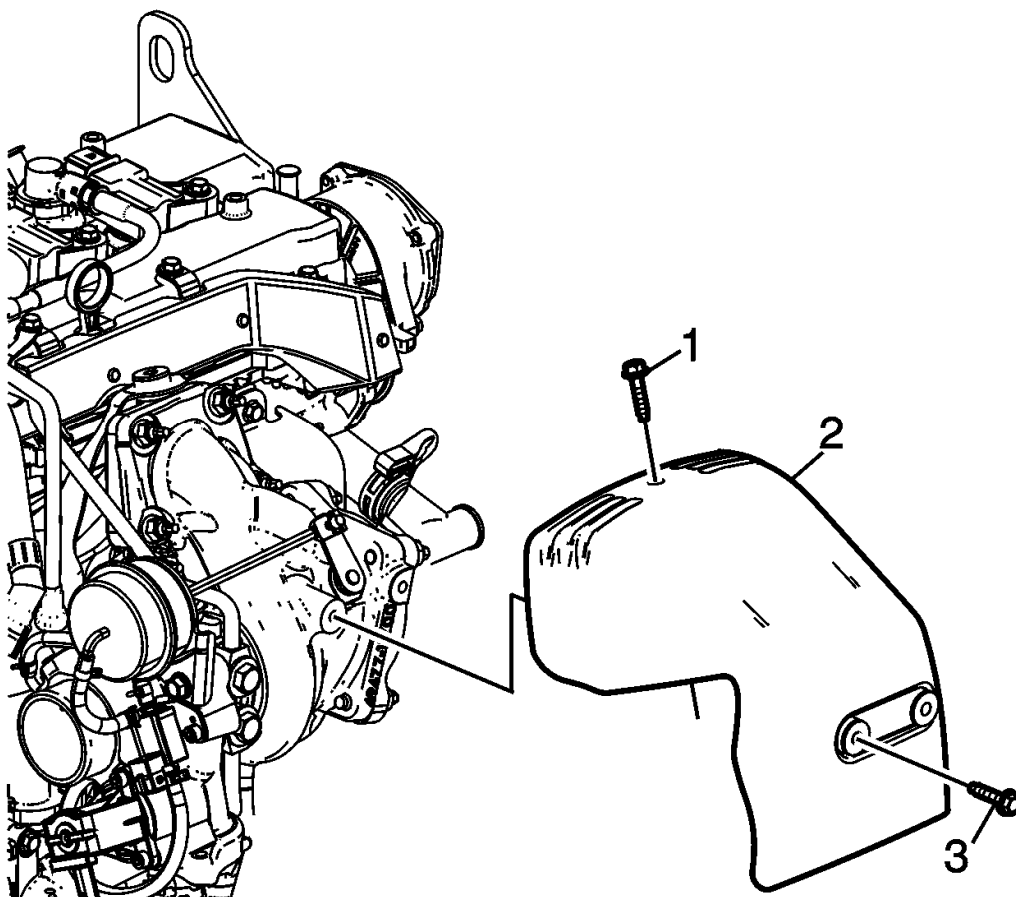


Fig. 296: Turbocharger Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

29. Install the turbocharger heat shield (2).
30. Install the turbocharger heat shield bolts (1, 3) and tighten to 14 N.m (124 lb in).

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

Special Tools

- **EN-50792** Flywheel Holding Tool
- **EN-45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

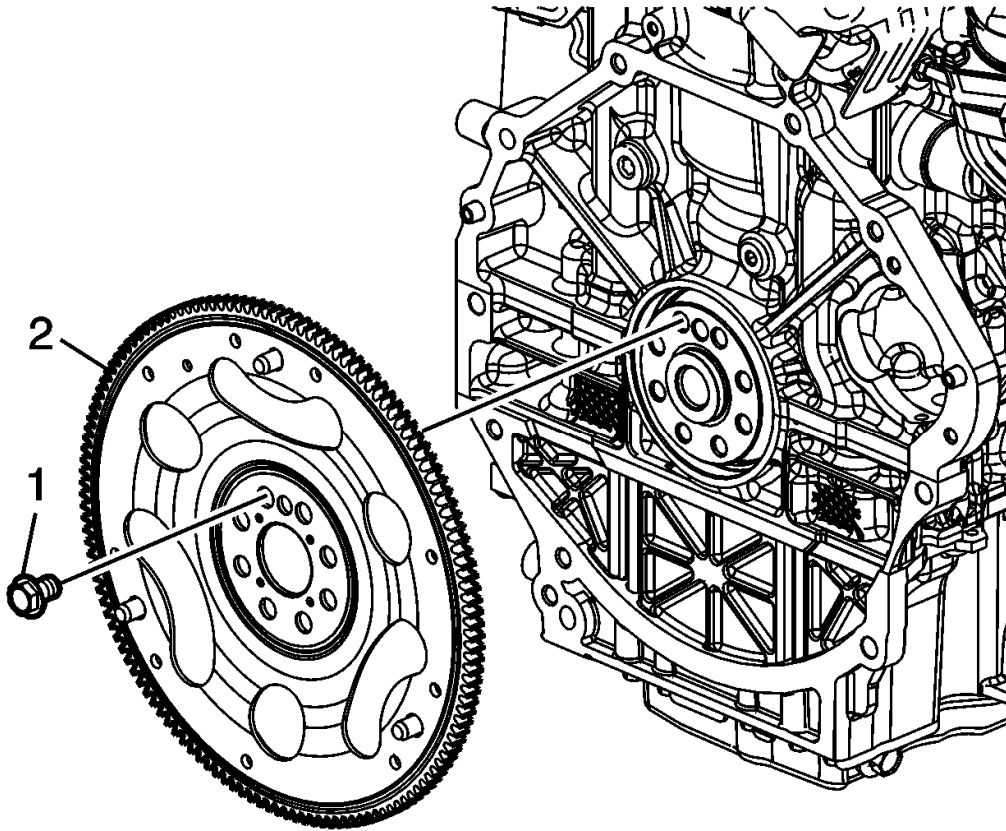


Fig. 297: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE: Fasteners have adhesive patch and must be tightened to final torque within 5 minutes.

1. Install the flywheel (2) and hand start NEW bolts (1).

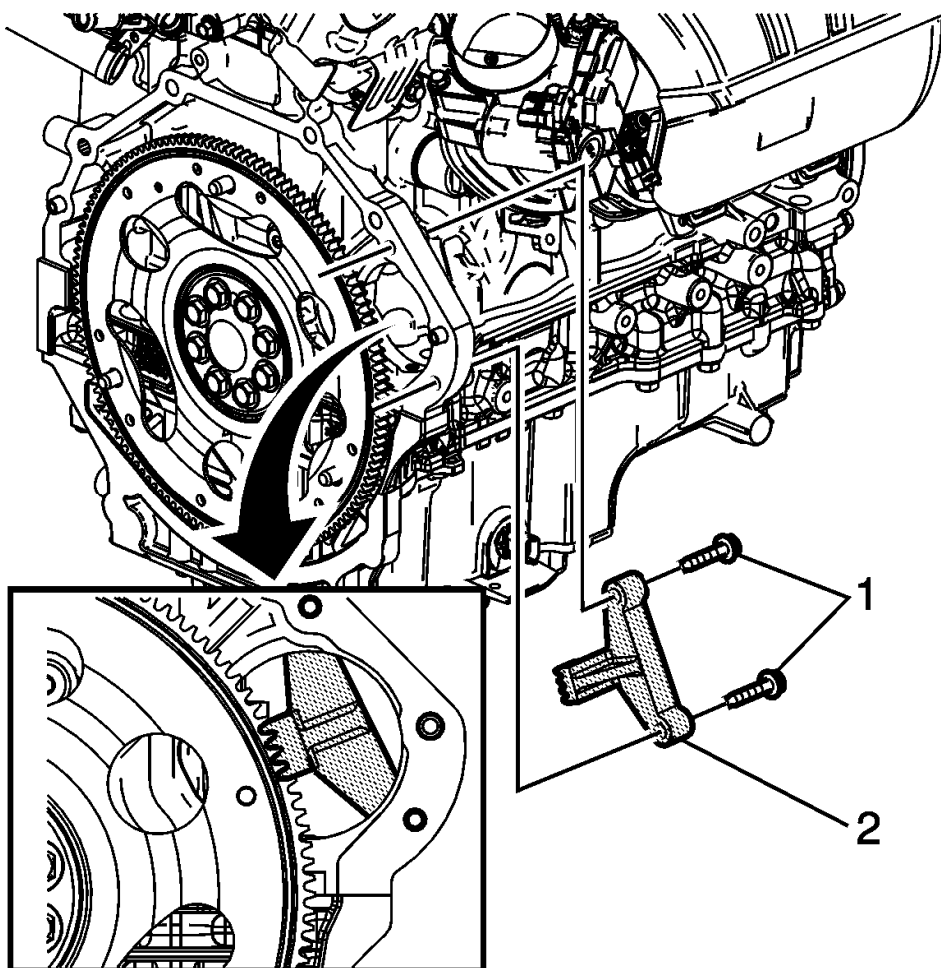


Fig. 298: Starter Motor Bolts

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN-50792** flywheel holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

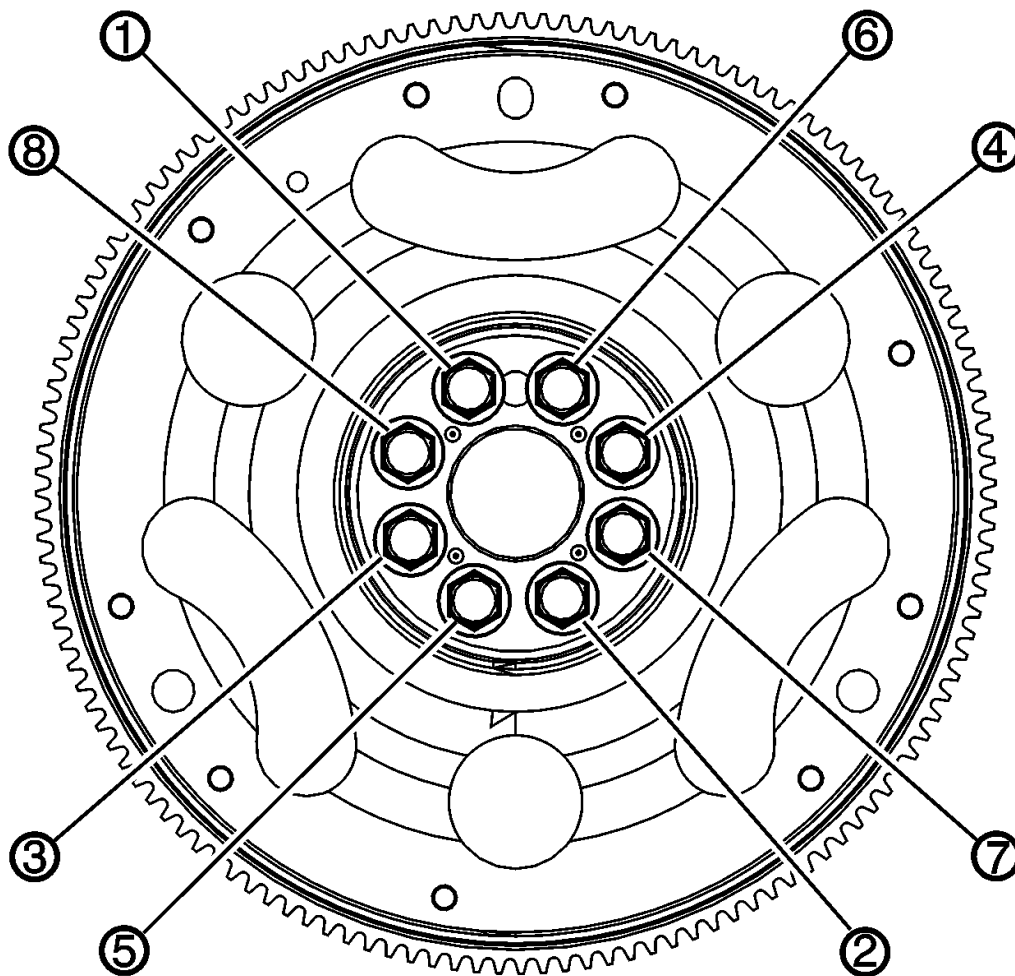


Fig. 299: Flywheel Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the bolts evenly using the following procedure:
 1. Tighten the bolts a first pass in sequence to 20 N.m (15 lb ft).
 2. Tighten the bolts a second pass in sequence to 30 N.m (22 lb ft).
 3. Tighten the bolts a final pass in sequence 40 degrees using the **EN-45059** meter.
4. Remove **EN-50792** flywheel holding tool.

CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **EN 45059** Angle Meter

- **EN 48034** Crankshaft Balancer Installer
- **EN-50792** Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

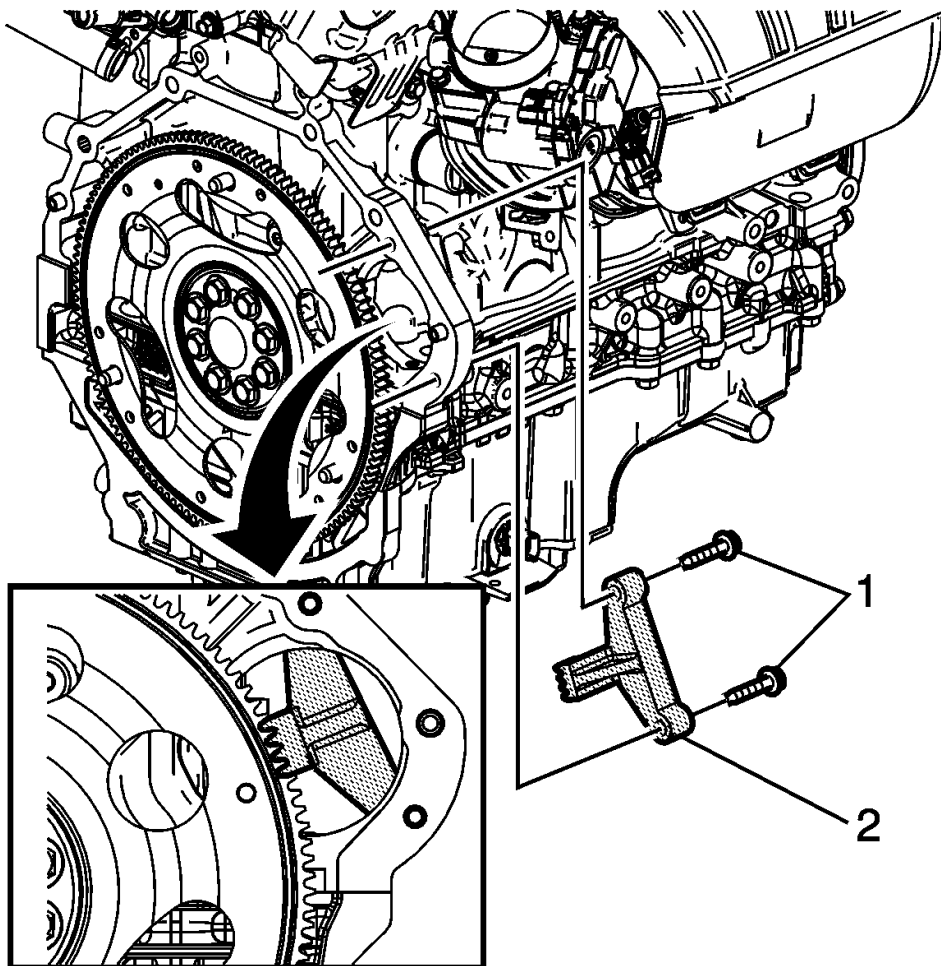


Fig. 300: Starter Motor Bolts

Courtesy of GENERAL MOTORS COMPANY

1. To prevent crankshaft rotation, install **EN-50792** flywheel holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

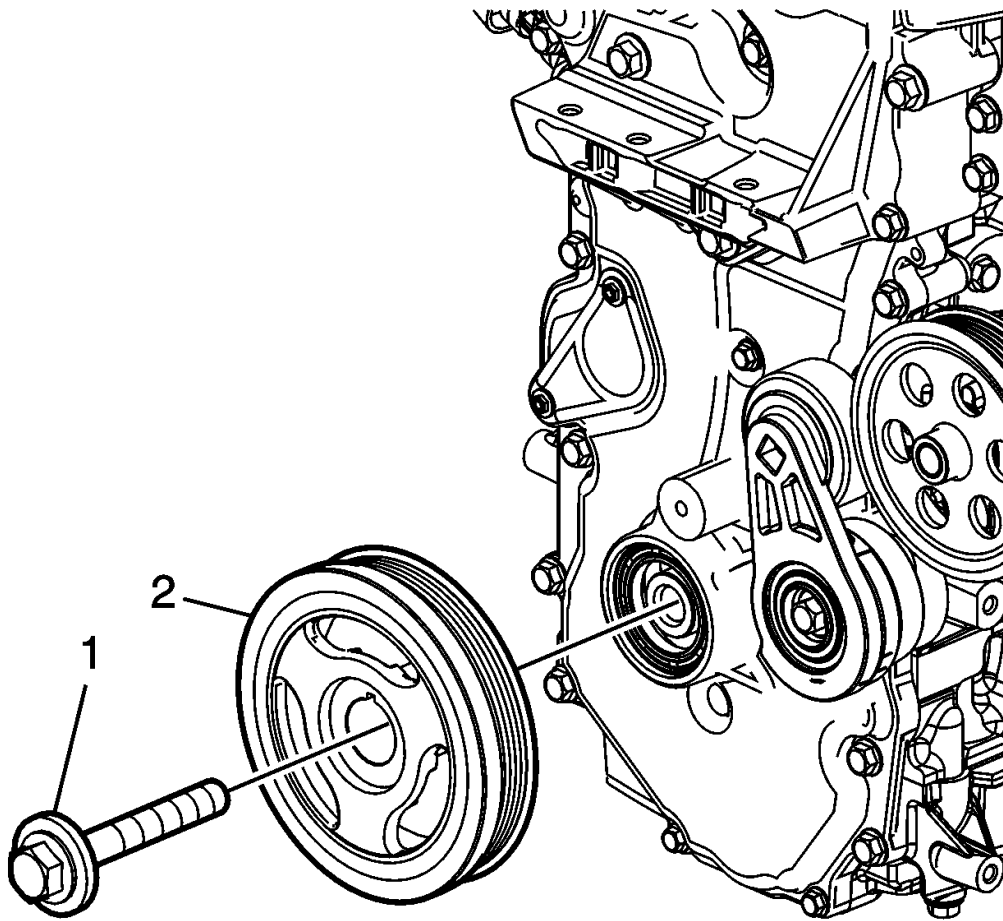


Fig. 301: Crankshaft Balancer

Courtesy of GENERAL MOTORS COMPANY

2. Using **EN-48034** installer , install the crankshaft balancer (2).

CAUTION: Refer to **Fastener Caution** .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

3. Install a NEW crankshaft balancer bolt and washer. Tighten the bolt to 150 N.m (111 lb ft) plus 180 degrees using the **EN 45059** meter.
4. Remove **EN-50792** flywheel holding tool.

OIL FILTER INSTALLATION

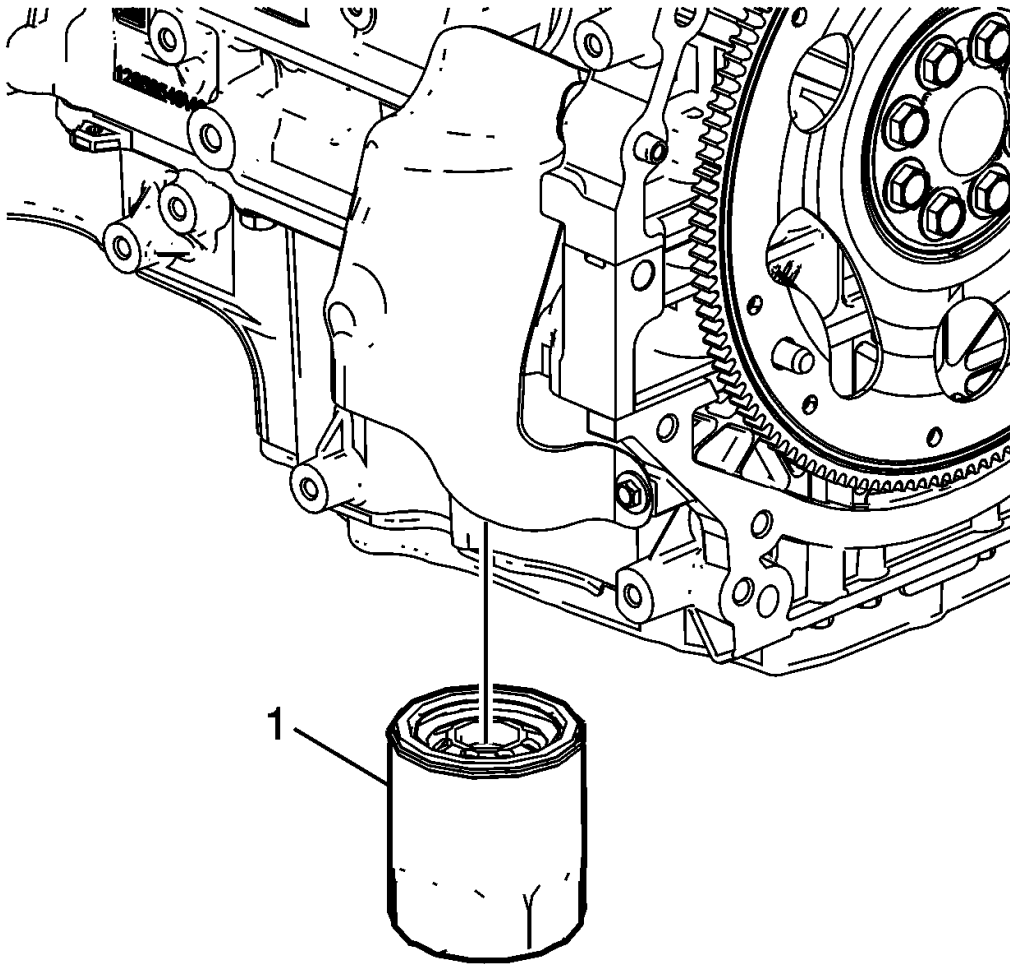


Fig. 302: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the O-ring on the oil filter with 5W30 engine oil.
2. Install a new oil filter (1).

CAUTION: Refer to Fastener Caution .

3. Tighten the oil filter to 30 N.m (22 lb ft).

ENGINE PRELUBING

NOTE: This procedure is not used in Europe.

Special Tools

EN-45299 Engine Preluber

For equivalent regional tools, refer to **Special Tools** .

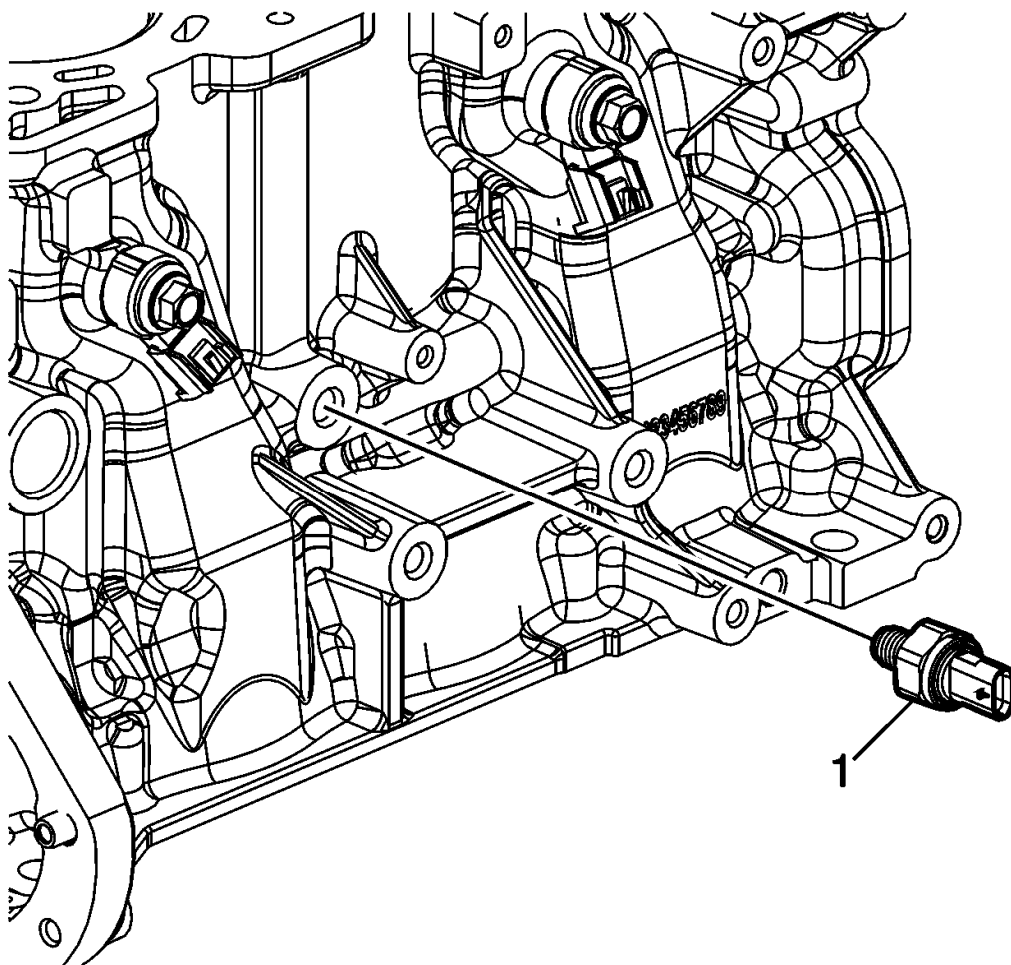


Fig. 303: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Ensure an approved engine oil is used, as specified in the owners manual.

1. Remove the engine oil pressure sensor (1).
2. Install the M12 x 1.75 adapter P/N 509376.

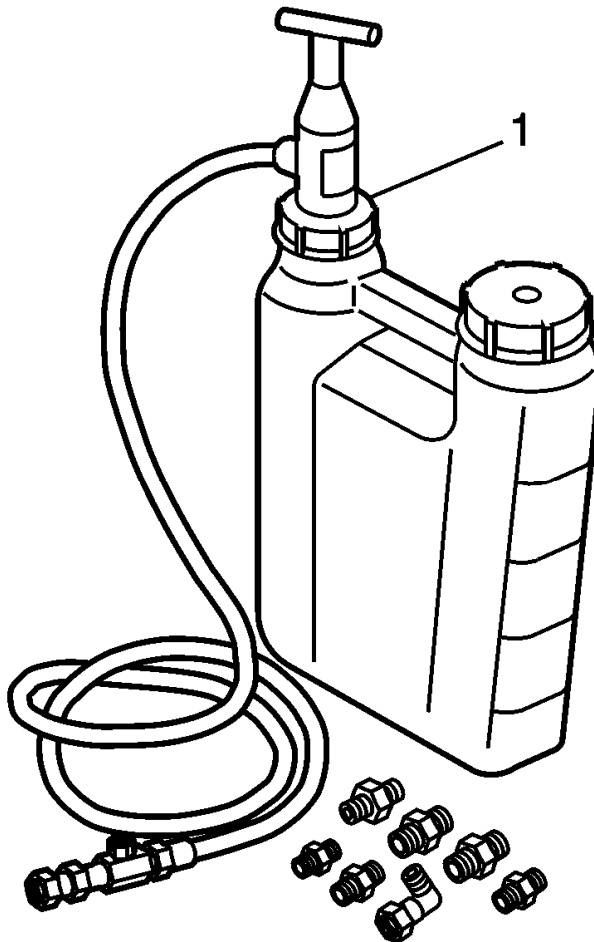


Fig. 304: View of Flexible Hose, Adapter and Preluber
Courtesy of GENERAL MOTORS COMPANY

3. Install the flexible hose to the adapter and open the valve.
4. Pump the handle on the **EN-45299** preluber (1) in order to flow a minimum of 1-1.9 liters (1-2 quarts) of engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
5. Close the valve and remove the flexible hose and adapter from the engine.

CAUTION: Refer to Fastener Caution .

6. Install the engine oil pressure sensor and tighten to 27 N.m (20 lb ft).
7. Top-off the engine oil to the proper level.

Engine

Engine Mechanical - 2.0L (LTG) - Repair Instructions - On Vehicle

REPAIR INSTRUCTIONS - ON VEHICLE

INTAKE MANIFOLD COVER REPLACEMENT

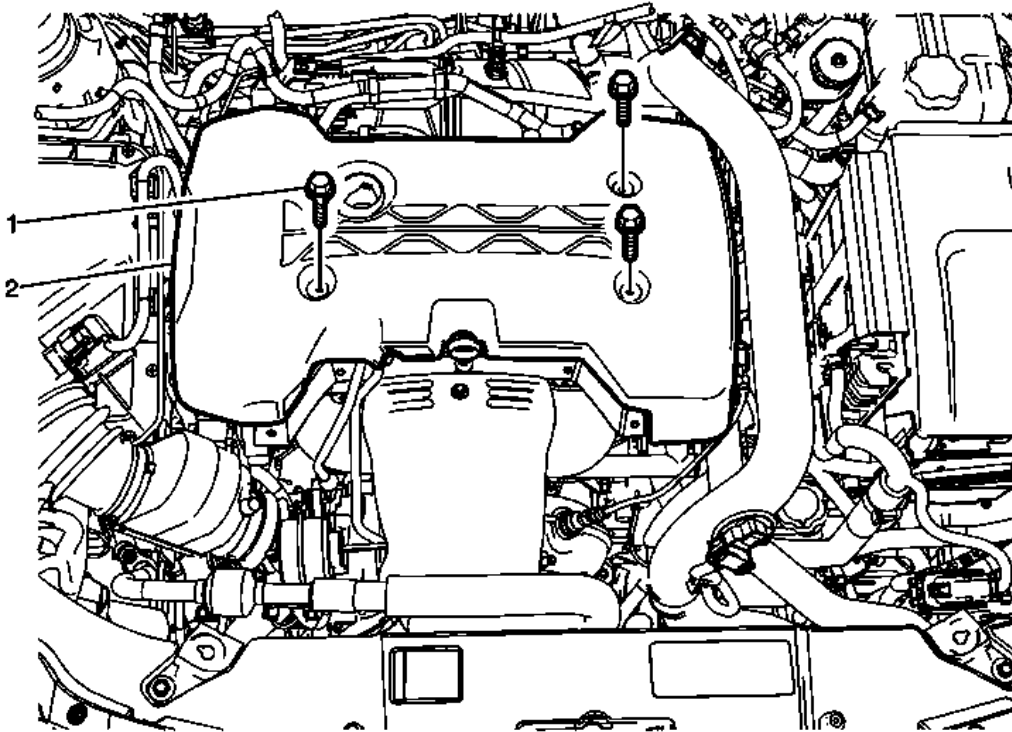


Fig. 1: Intake Manifold Cover (LTG)

Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement

Callout	Component Name
1	Intake Manifold Cover Fastener (Qty,3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Intake Manifold Cover Procedure Remove the oil cap before removing the intake manifold cover.

DRIVE BELT REPLACEMENT

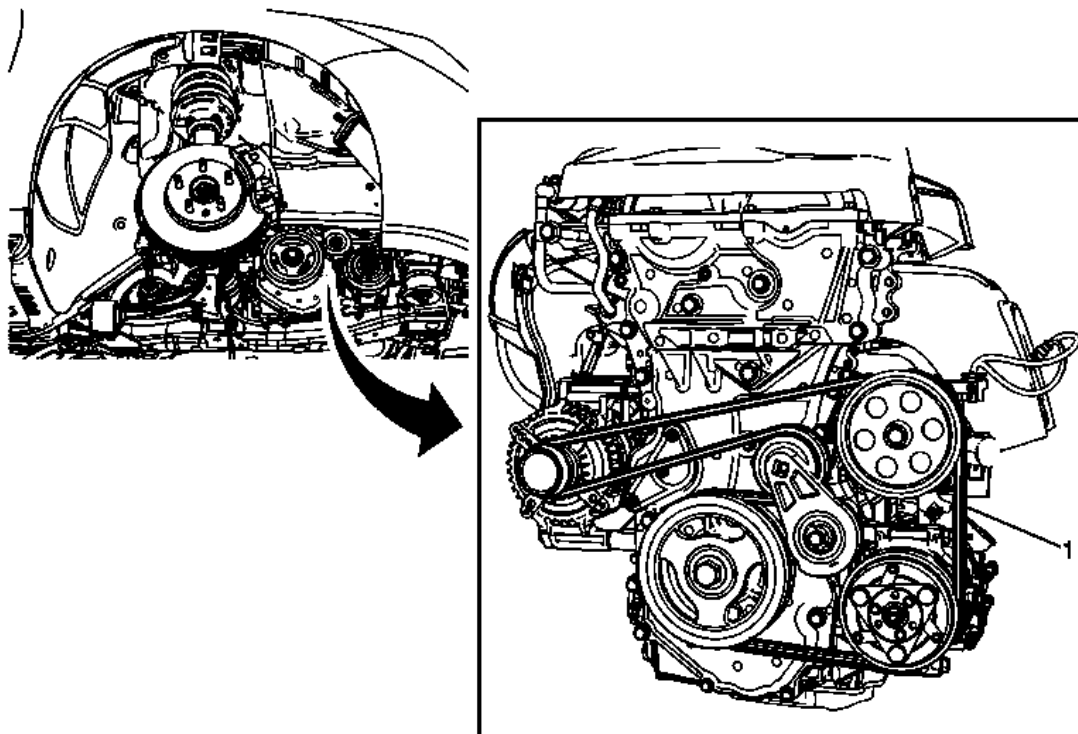


Fig. 2: Drive Belt Routing (LTG)
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement

Callout	Component Name
Preliminary Procedure Remove the front wheelhouse front liner. Refer to Front Wheelhouse Front Liner Replacement .	
1	Drive Belt Procedure <ol style="list-style-type: none">1. Use the proper tool to rotate the drive belt tensioner.2. Remove the drive belt from the pulleys and tensioner.

DRIVE BELT TENSIONER REPLACEMENT

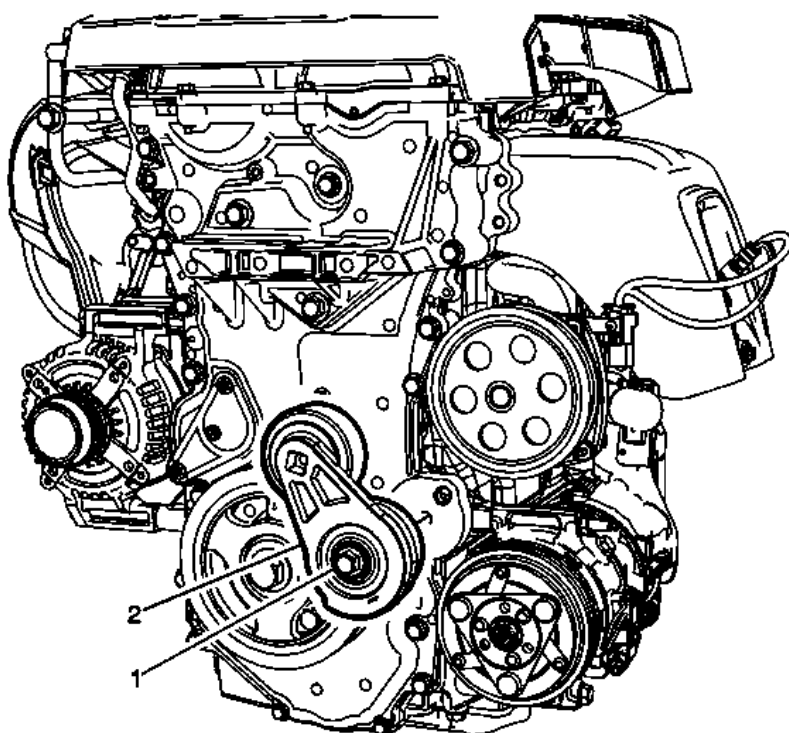


Fig. 3: Drive Belt Tensioner
 Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement

Callout	Component Name
Preliminary Procedures	
Remove the drive belt. Refer to <u>Drive Belt Replacement</u> .	
1	Drive belt tensioner fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 (43 lb ft)
2	Drive belt tensioner

ENGINE MOUNT INSPECTION

NOTE: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.

1. Install the engine support fixture. Refer to **Engine Support Fixture**. Raising the engine removes the weight from the engine mount and creates slight tension in the rubber.

2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber surface is covered with heat check cracks.
 - The rubber is split through the center of the engine mount.
 - The GLYCOL™ fluid is leaking from the engine mount.
3. Inspect the system for loose vacuum hose connections or vacuum leaks. Refer to Vacuum Operated Engine Mounts Description and Operation.
4. Inspect the engine mount valve assemblies for loose electrical connections. Inspect the electrical system connected to the engine mount valve assemblies. Refer to **Diagnostic System Check - Vehicle** .
5. Inspect for the presence of glycol fluid in the vacuum system. Remove the hose assembly connections at the engine mounts. If fluid is present in the engine mount vacuum system, the entire vacuum system should be replaced.

POWERTRAIN MOUNT BALANCING

NOTE: Follow the balance procedure steps listed below. Powertrain mounts must be tightened in sequence.

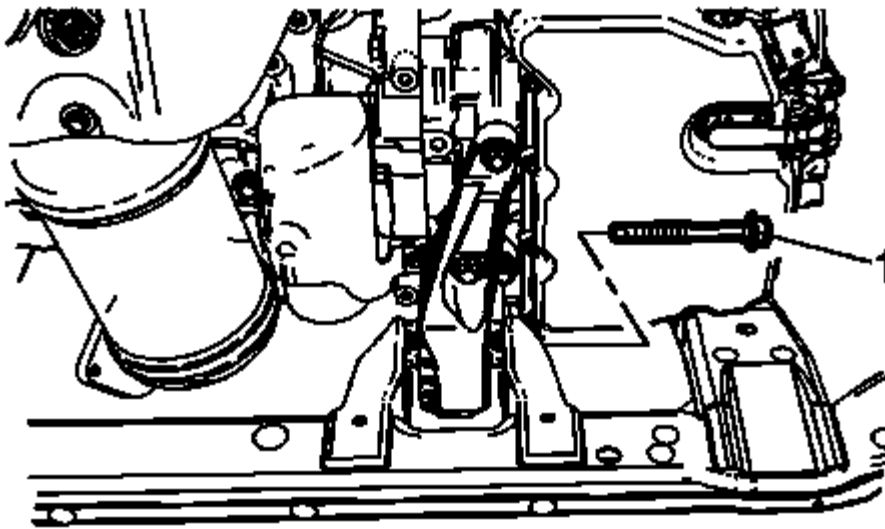


Fig. 4: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the battery tray. Refer to **Battery Tray Replacement** .
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Loosen the front transaxle mount through bolt (1).
5. Loosen the rear transaxle mount through bolt.
6. Lower the vehicle.
7. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.

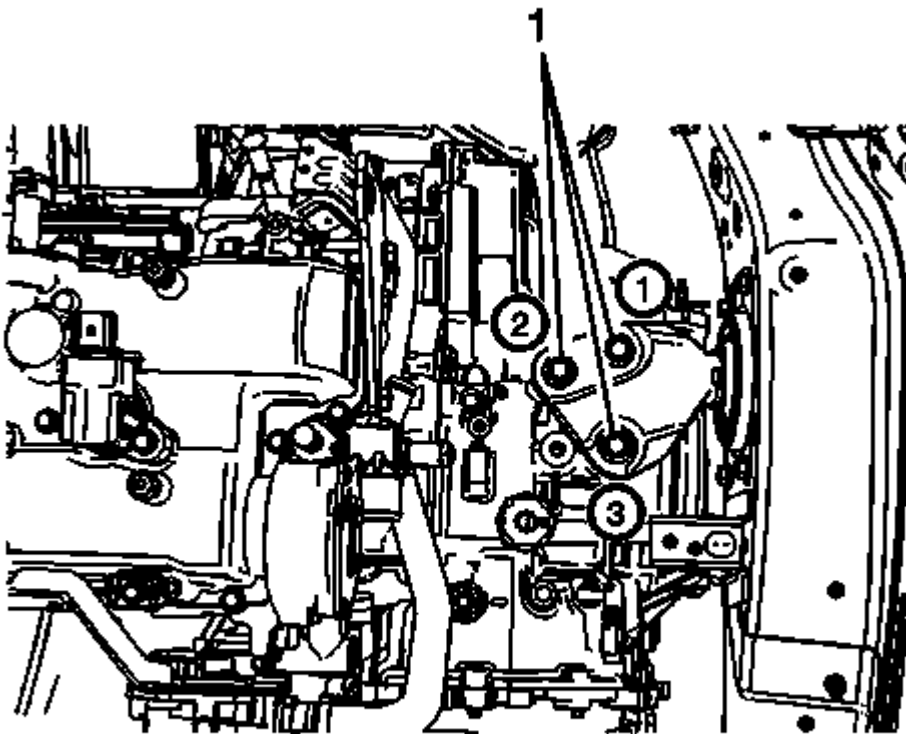


Fig. 5: Transaxle Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Loosen the transaxle mount bolts (1).

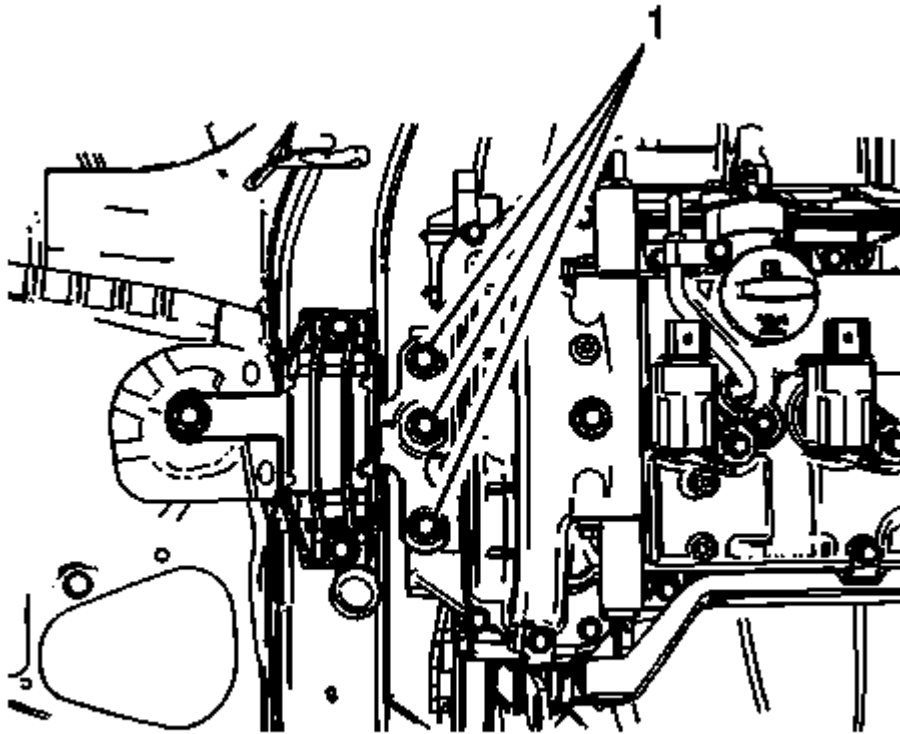


Fig. 6: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

9. Loosen the engine mount to bracket bolts (1).
10. Reposition both floor jacks in order to allow a 1/8 inch gap between the mount and bracket.

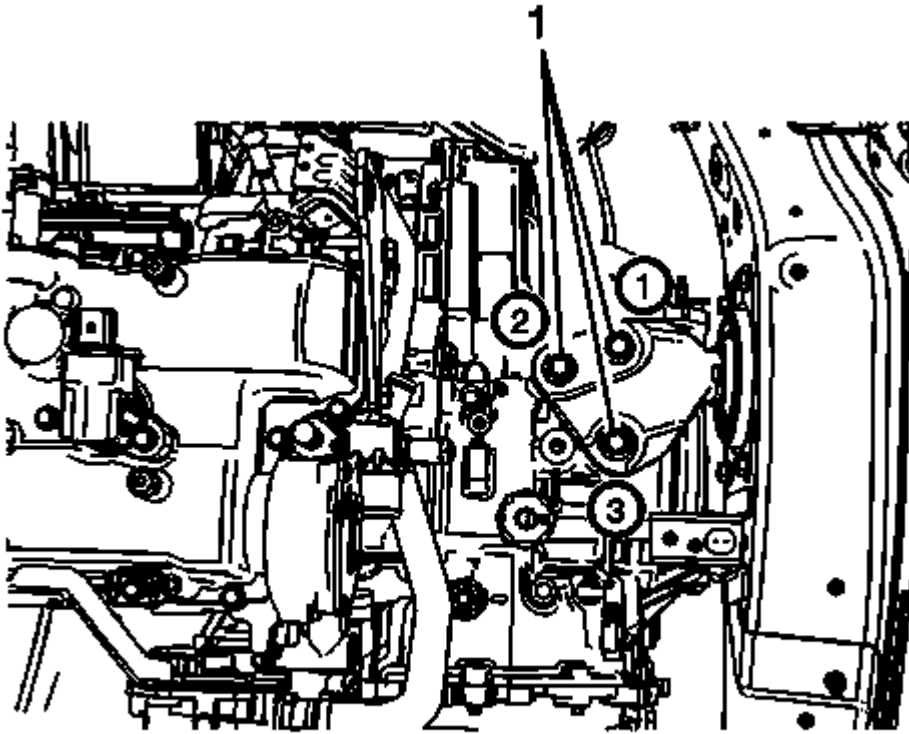


Fig. 7: Transaxle Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the transaxle mount bolts (1) to 50 (37 lb ft) in sequence.

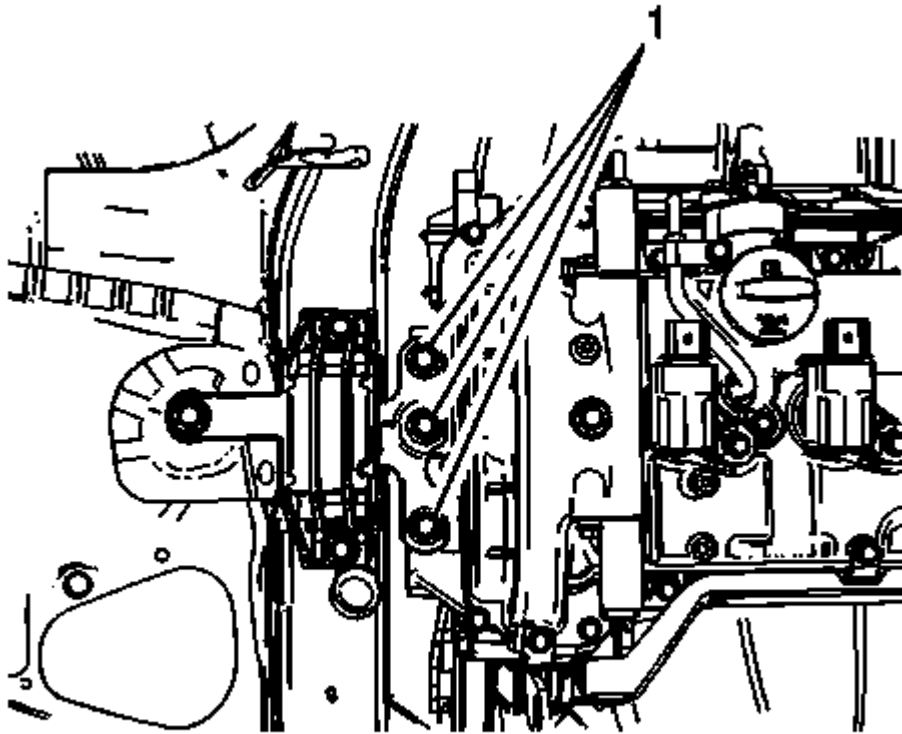


Fig. 8: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

12. Tighten the engine mount to bracket bolts (1) to 62 (46 lb ft) in the following sequence.
13. Remove the floor jacks from under the oil pan.
14. Shake the powertrain vigorously from front to rear and allow the powertrain to settle.
15. Raise the vehicle.
16. Tighten the rear transaxle mount through bolt to 100 (74 lb ft).

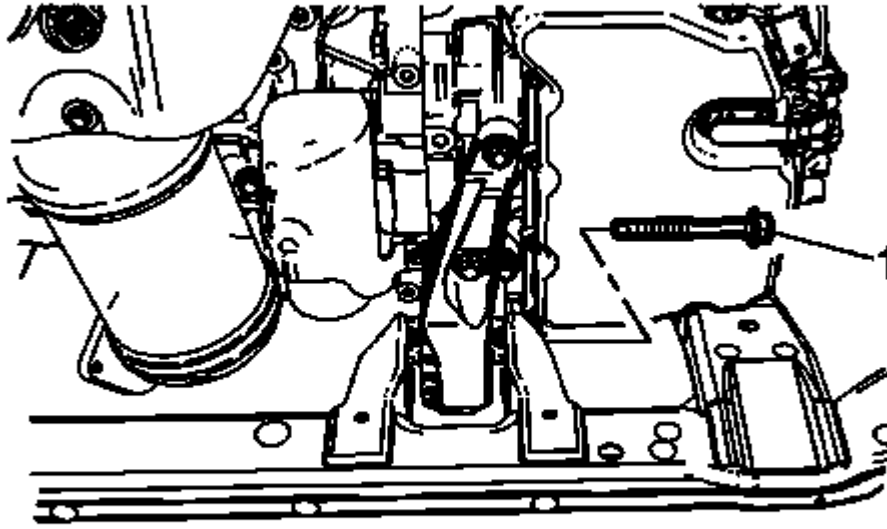


Fig. 9: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

17. Tighten the front transaxle mount through bolt (1) to 100 (74 lb ft).
18. Lower the vehicle.
19. Install the battery tray. Refer to **Battery Tray Replacement** .
20. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

POWERTRAIN MOUNT BALANCING - LOWER

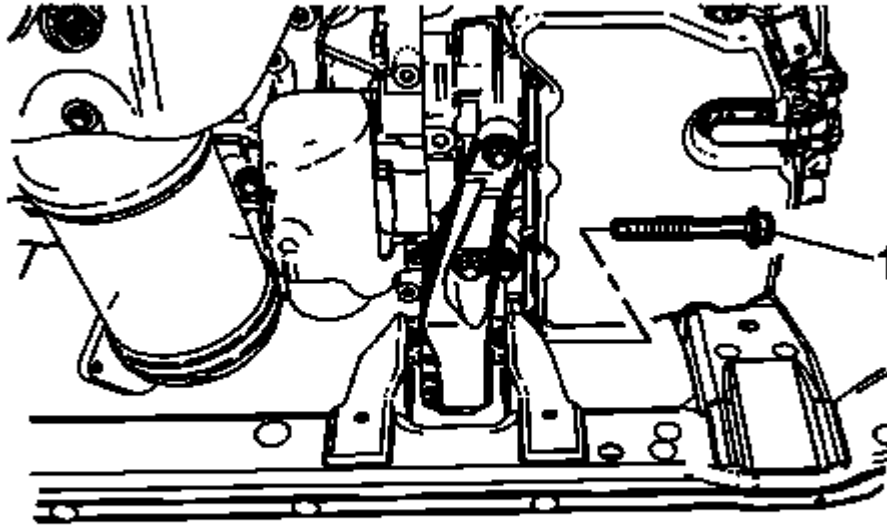


Fig. 10: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Follow the balance procedure steps listed below. Powertrain mounts must be tightened in sequence.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Loosen the front transaxle mount through bolt (1).
3. Loosen the rear transaxle mount through bolt.
4. Shake the powertrain vigorously from front to rear and allow the powertrain to settle.

CAUTION: Refer to Fastener Caution .

5. Tighten the rear transaxle mount through bolt to 100 (74 lb ft).
6. Tighten the front transaxle mount through bolt (1) to 100 (74 lb ft).
7. Lower the vehicle.

ENGINE MOUNT REPLACEMENT

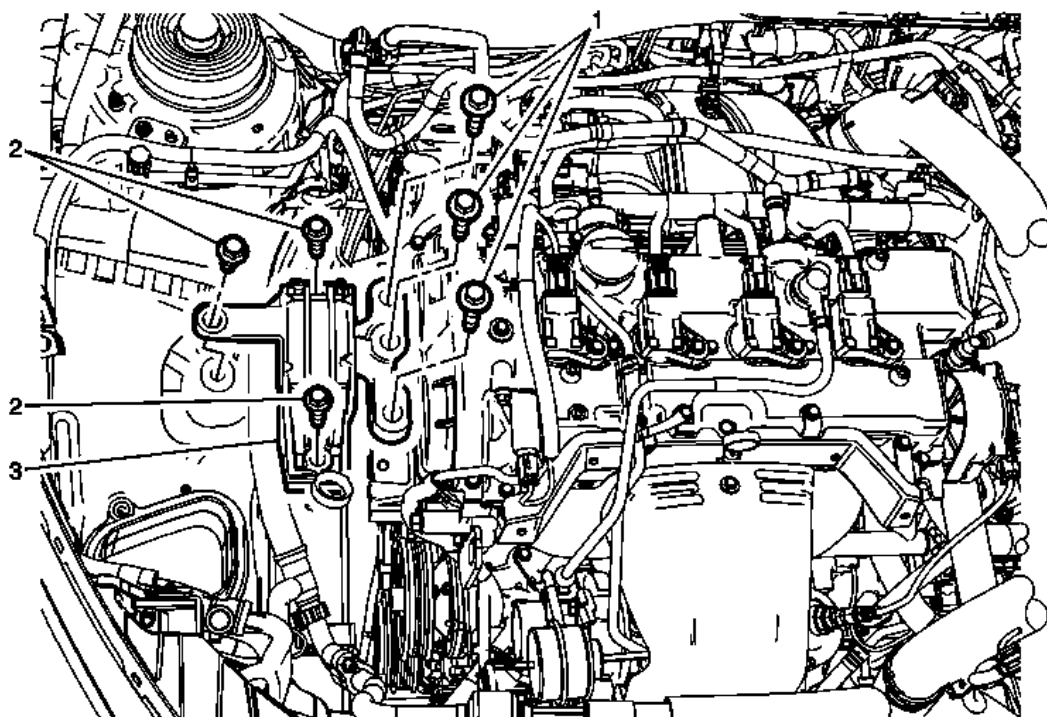


Fig. 11: Engine Mount (LTG)

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 2. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u>. 3. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 	
1	Engine Mount Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 62 N.m (46 lb ft)
2	Engine Mount Bolt (Qty: 3) Tighten 62 N.m (46 lb ft)
3	Engine Mount

ENGINE SUPPORT FIXTURE

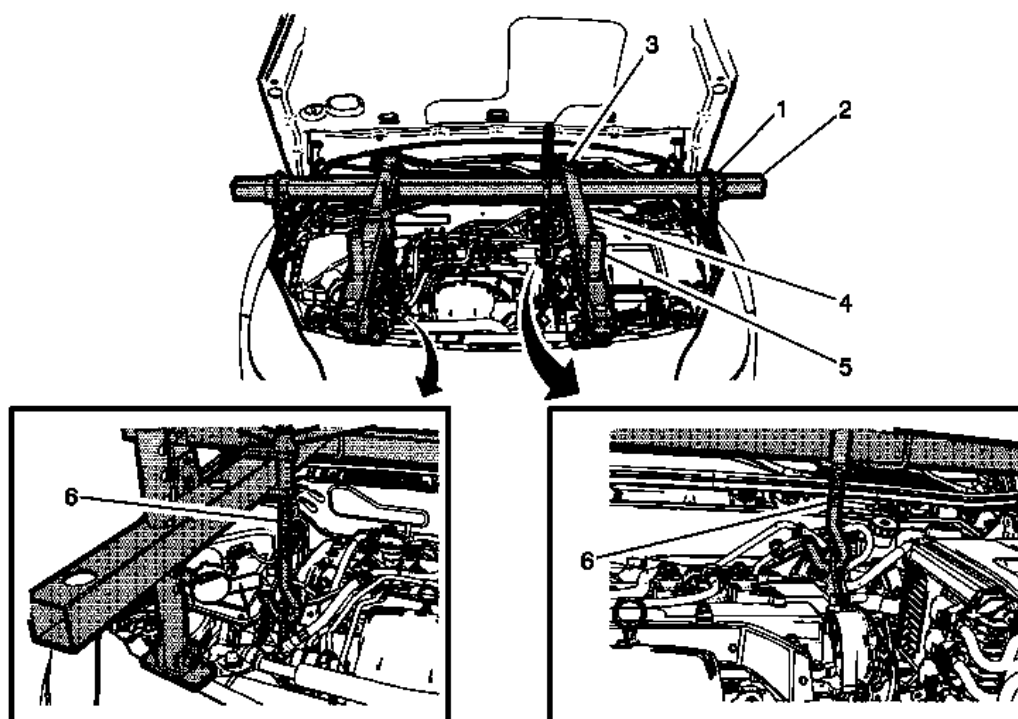


Fig. 12: Engine Support Fixture
 Courtesy of GENERAL MOTORS COMPANY

Engine Support Fixture

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Remove the hood strut. Refer to <u>Hood Strut Replacement</u> . 3. Remove the charge air cooler outlet air tube. Refer to <u>Charge Air Cooler Outlet Air Tube Replacement</u> .	
Special Tools EN-51007 Engine Support Fixture.For equivalent regional tools. Refer to <u>Special Tools</u> .	
1	Engine Support Fixture Adapter Leg (Qty: 2) Procedure Install the bracket to fender frame. Do not install on top of the fender lip.
2	Main Support Beam
3	Cross Bracket (Qty: 2)
4	Strut Tower Support Assembly (Qty: 2) Procedure Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly (Qty: 2)
	Hook Assembly (Qty: 2)

Procedure

- 6
 1. If the engine is not equipped with engine lift brackets, install **J-36857** engine lift bracket in place.
 2. Use a grade 10.9 bolt to install the engine lift bracket.

TURBOCHARGER HEAT SHIELD REPLACEMENT

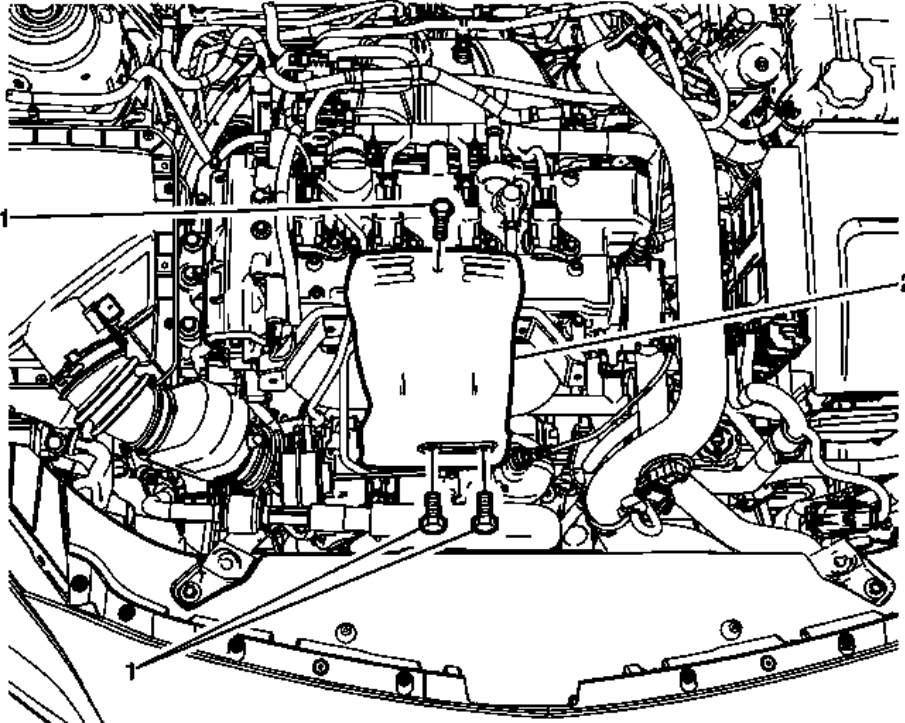


Fig. 13: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Heat Shield Replacement

Callout	Component Name
1	Turbocharger Heat Shield Fastener (Qty;3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 14 (10 lb ft)
2	Turbocharger Heat Shield

TURBOCHARGER REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

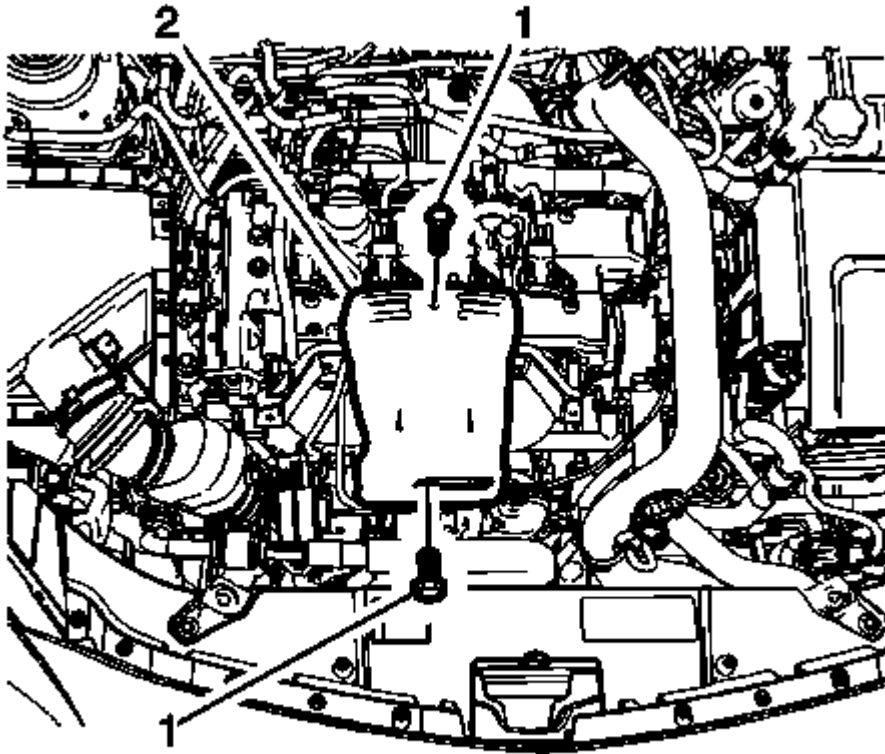


Fig. 14: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

3. Remove the turbocharger heat shield (2). Refer to **Turbocharger Heat Shield Replacement**.
4. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)**.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
6. Remove the PCV hose. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

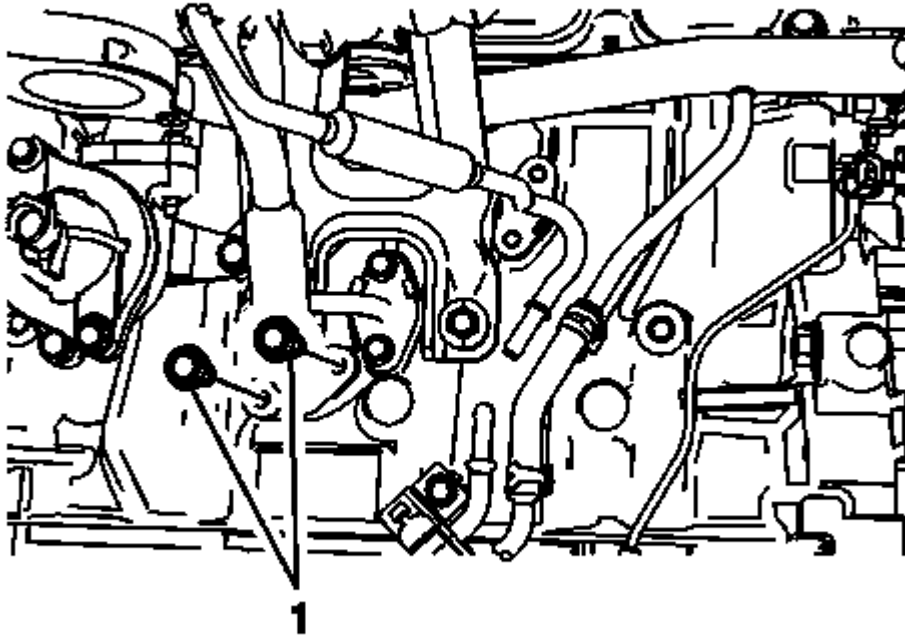


Fig. 15: Turbocharger Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the turbocharger oil return pipe bolts (1).

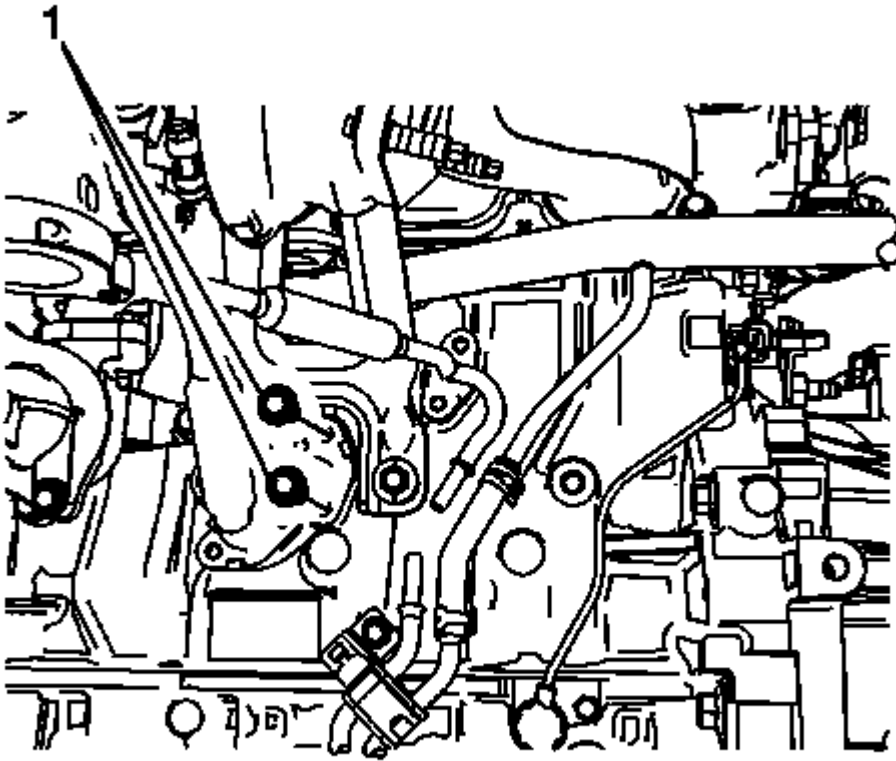


Fig. 16: Turbocharger Oil Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the turbocharger oil feed pipe bolts (1).

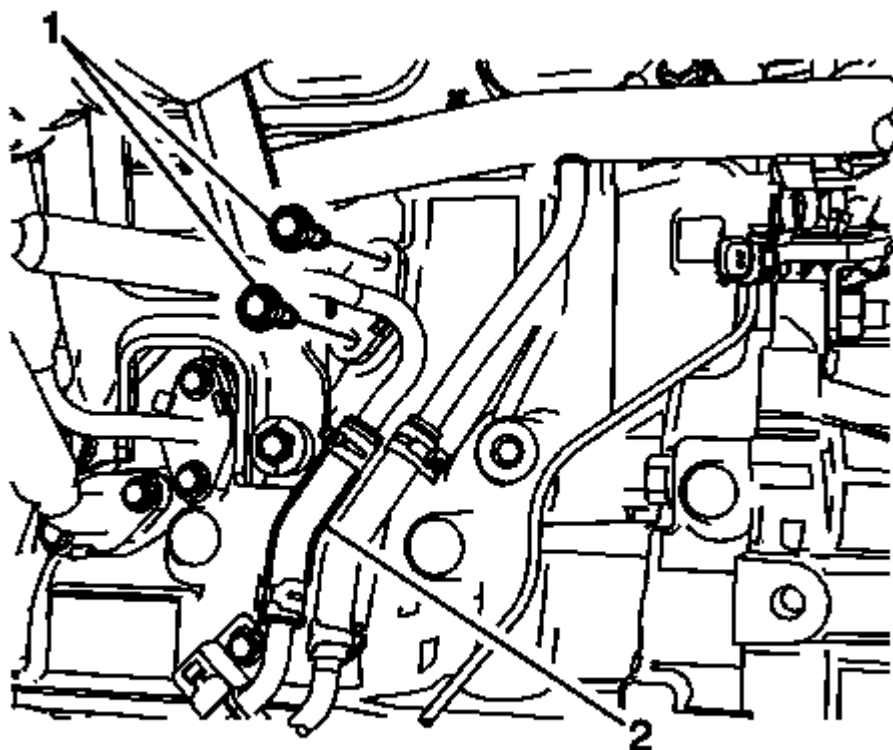


Fig. 17: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the turbocharger coolant feed pipe bolts (1). Refer to **Turbocharger Coolant Feed Pipe Replacement (LTG)** .
10. Remove the turbocharger coolant return pipe. Refer to **Turbocharger Coolant Return Pipe Replacement (LTG)** .

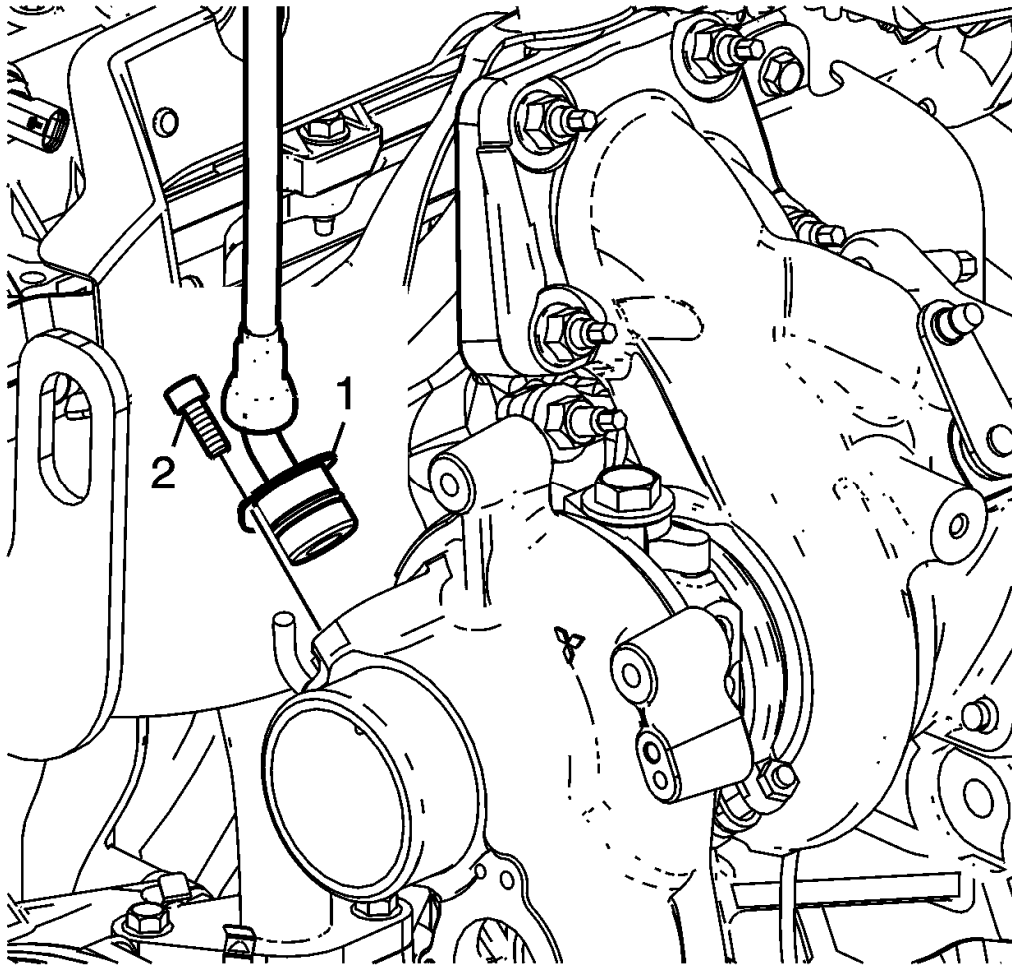


Fig. 18: PCV Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not disturb the joint between the PCV hose and PCV hose fitting at the turbocharger. This is a permanent connection.

11. Remove the PCV hose fitting bolt (2). Disconnect the PCV hose fitting (1) with the PCV hose attached from the turbocharger.

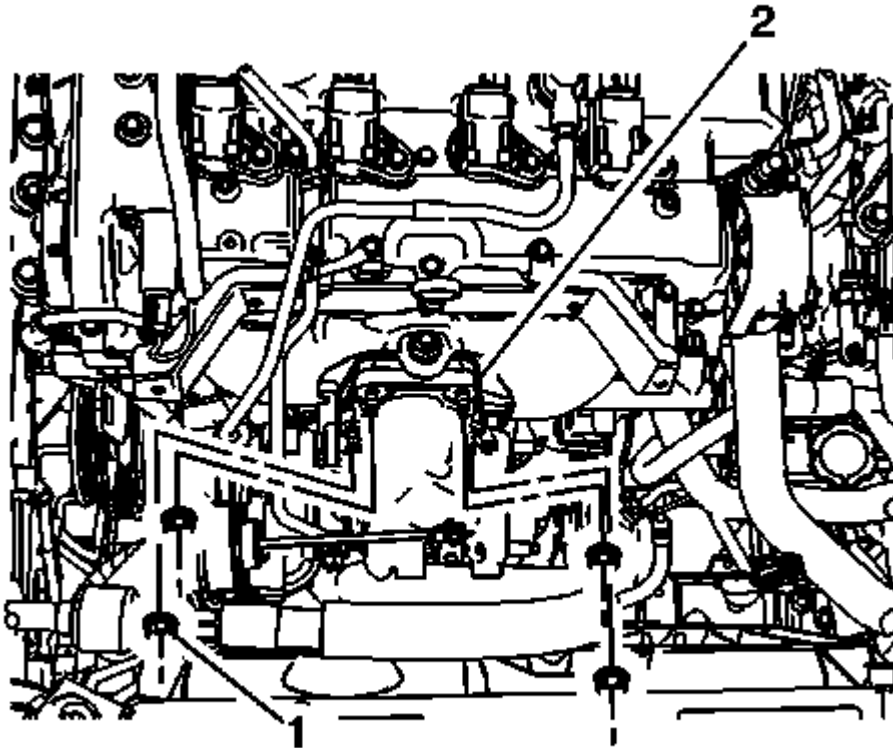


Fig. 19: Turbocharger Nuts And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

12. Remove the turbocharger nuts (1) and turbocharger (2).
13. For turbocharger cleaning and inspection, refer to **Turbocharger Cleaning and Inspection** .

Installation Procedure

NOTE: The exhaust pipe studs do not come installed on new turbochargers. If the turbocharger is being replaced, new studs will need to be installed.

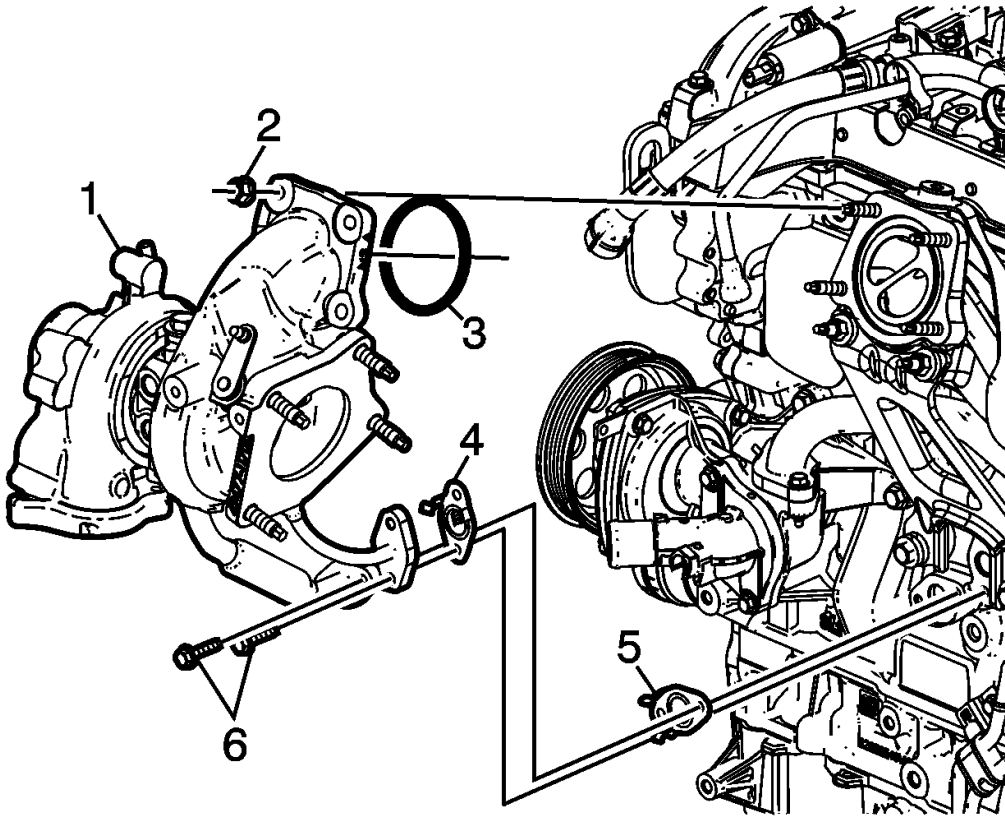


Fig. 20: Turbocharger Nuts

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW turbocharger gasket (3) on the turbocharger.
2. Install NEW turbocharger oil feed and oil return pipe gaskets (4, 5).
3. Install the turbocharger (1).
4. Install NEW turbocharger nuts (2) finger tighten.

CAUTION: Refer to Fastener Caution .

5. Install the turbocharger oil feed and return pipe bolts (6) at the engine block. Tighten the bolts to 10 (89 lb in).

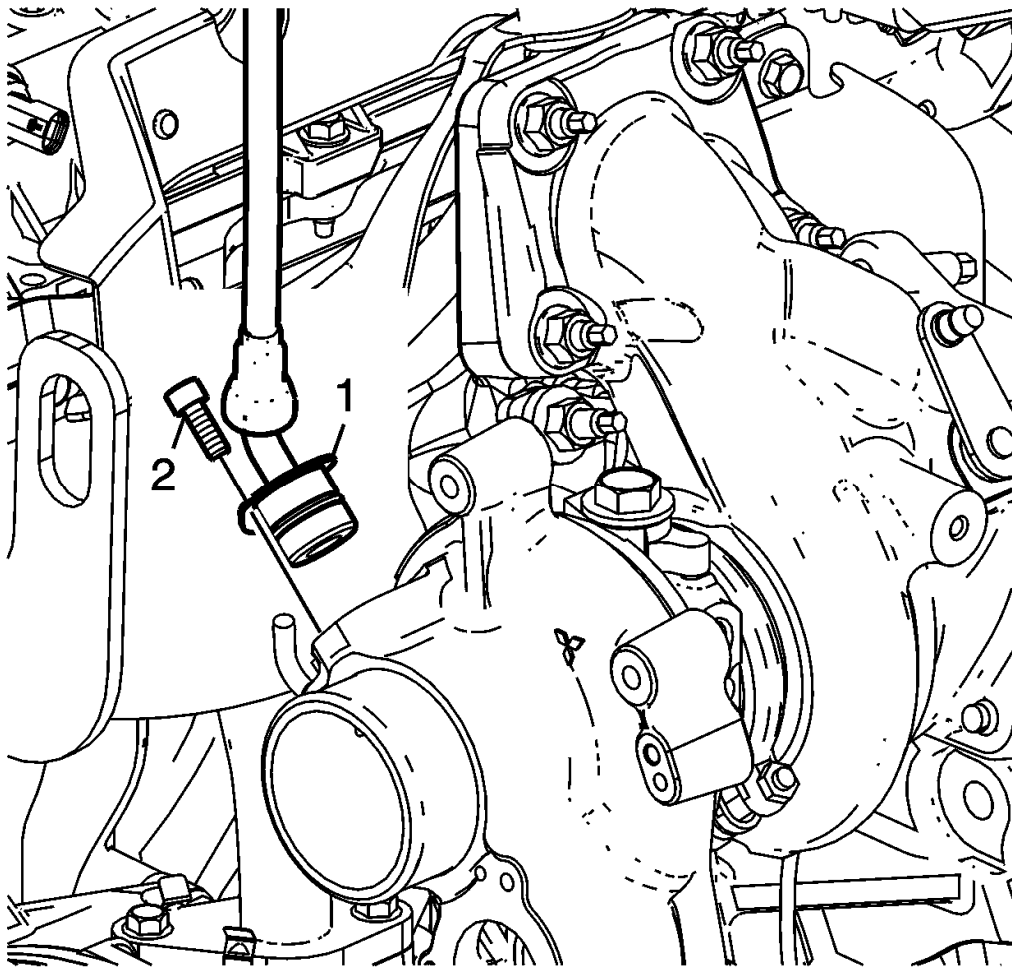


Fig. 21: PCV Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: The PCV hose and fitting assembly connection is permanent. Reinstall these components as an assembly unless new components are being used.

6. Install the PCV hose and fitting assembly (1) to the turbocharger. Install the PCV hose fitting assembly bolt (2) and tighten to 8 (6 lb ft)

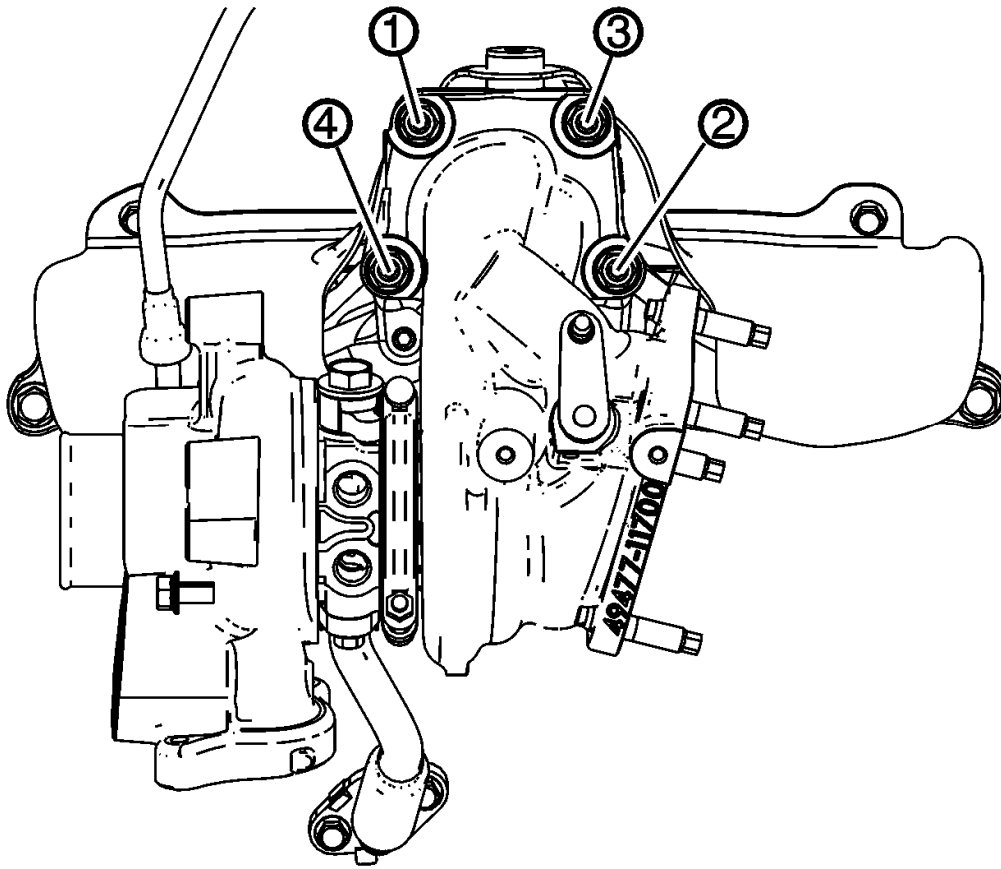


Fig. 22: Turbocharger Nut Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the turbocharger nuts in sequence:
 1. First pass 30 (22 lb ft).
 2. Final pass plus 90 degrees.

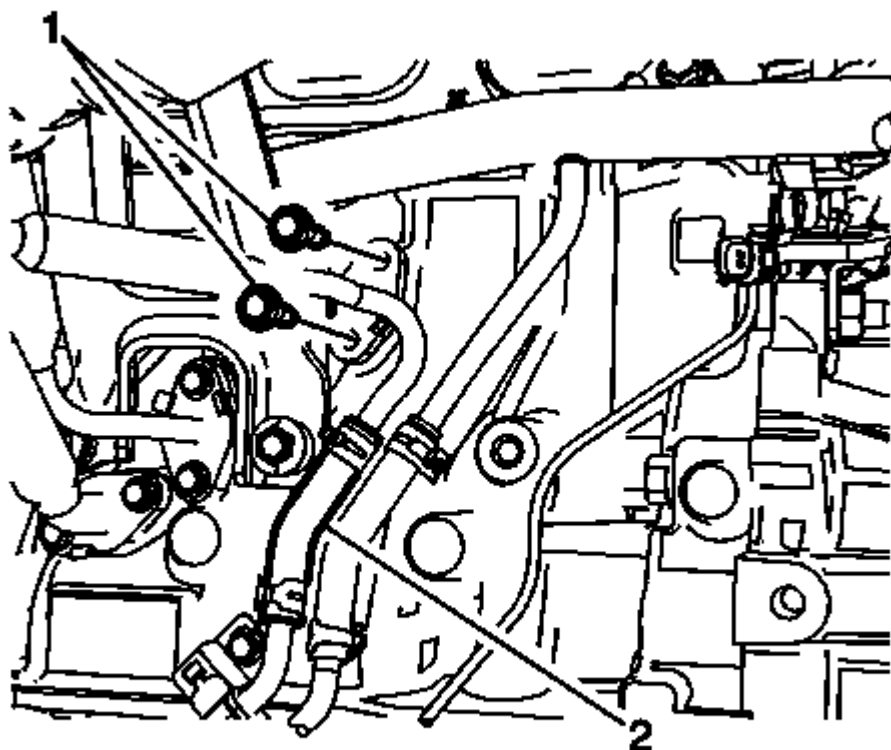


Fig. 23: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the turbocharger coolant feed pipe bolts (1) and tighten to 10 (89 lb in).
9. Install the turbocharger coolant return pipe. Refer to **Turbocharger Coolant Return Pipe Replacement (LTG)** .
10. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** .

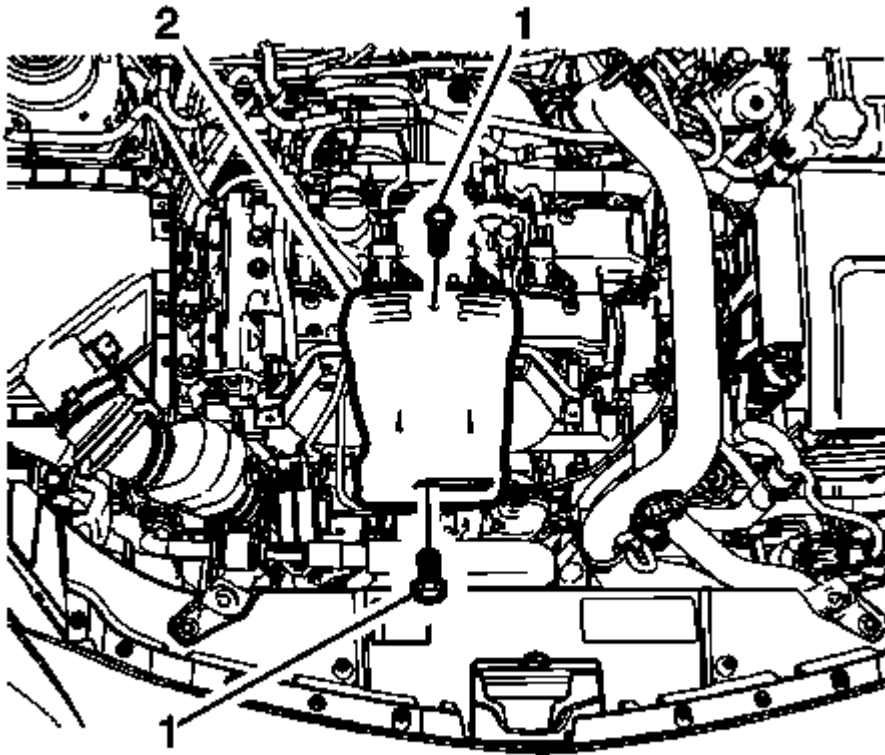


Fig. 24: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

11. Install the turbocharger heat shield (2). Refer to **Turbocharger Heat Shield Replacement**.
12. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
13. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

TURBOCHARGER OIL RETURN PIPE REPLACEMENT

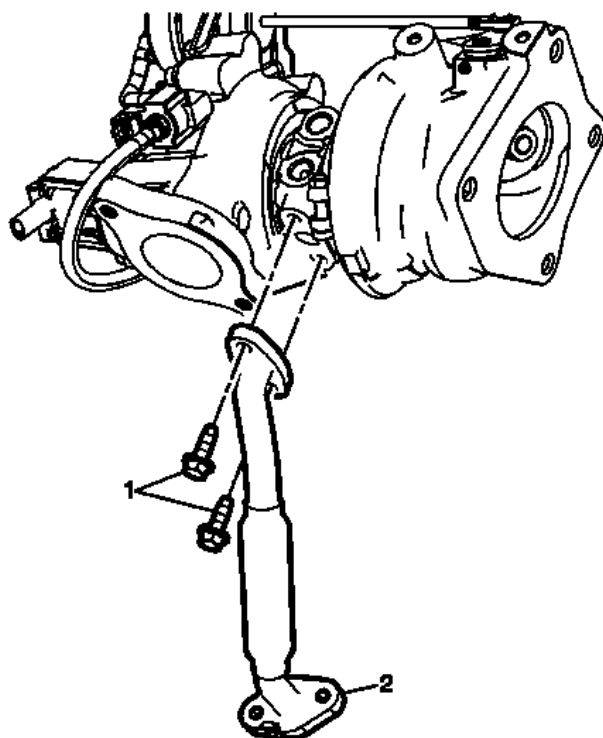


Fig. 25: Turbocharger Oil Return Pipe
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Return Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the turbocharger. Refer to <u>Turbocharger Replacement</u> .	
1	Turbocharger Oil Return Pipe Fastener (Qty; 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Turbocharger Oil Return Pipe Procedure A NEW turbocharger oil return gasket should be used whenever installing the pipe.

TURBOCHARGER OIL FEED PIPE REPLACEMENT

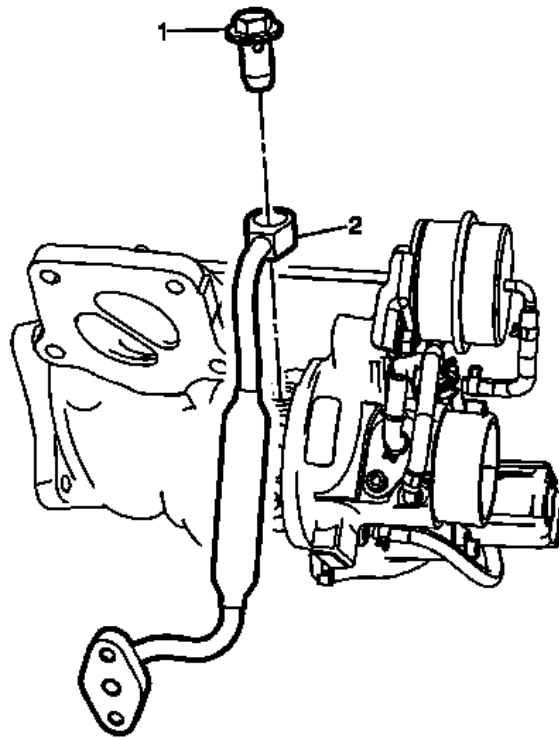


Fig. 26: Turbocharger Oil Feed Pipe
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Feed Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the turbocharge. Refer to <u>Turbocharger Replacement</u> .	
1	Turbocharger Oil Feed Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 (26 lb ft)
2	Turbocharger Oil Feed Pipe NOTE: A NEW turbocharger oil feed gasket should be used whenever the pipe is installed.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (CAMSHAFT COVER TO AIR CLEANER RESONATOR TO OUTLET DUCT)

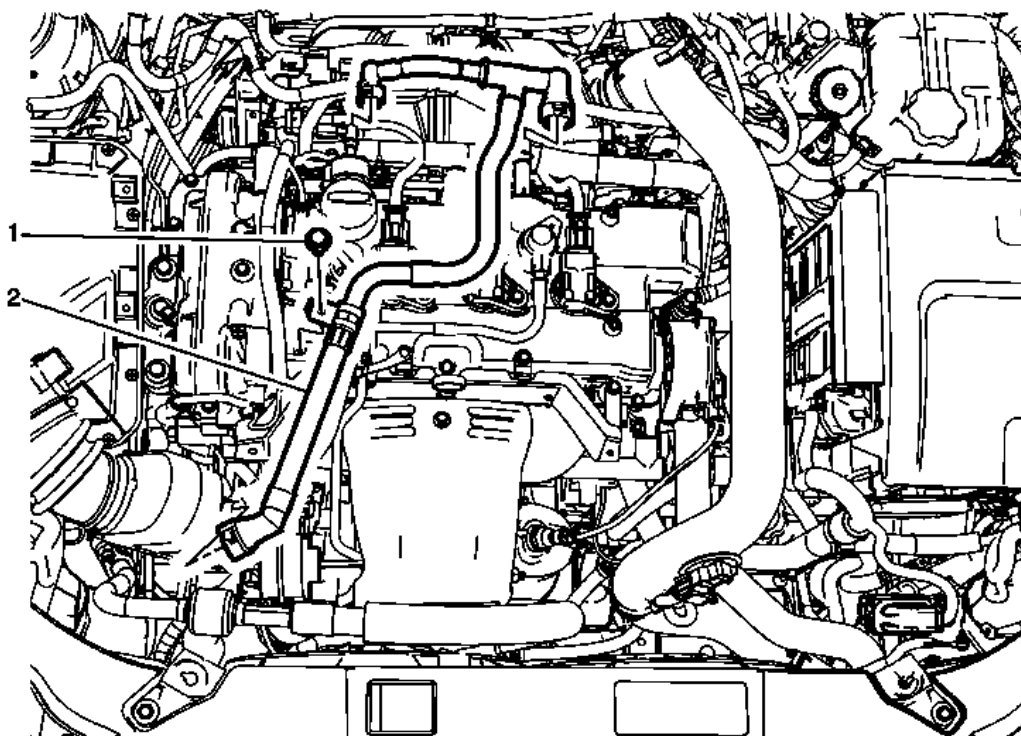


Fig. 27: Positive Crankcase Ventilation Hose/Pipe/Tube (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)

Callout	Component Name
Preliminary Procedures	
Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Positive Crankcase Ventilation Hose Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Positive Crankcase Ventilation Hose

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the charge air cooler outlet tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement** .

3. Disconnect the fuel feed pipe. Refer to **Fuel Feed Front Pipe Replacement** .

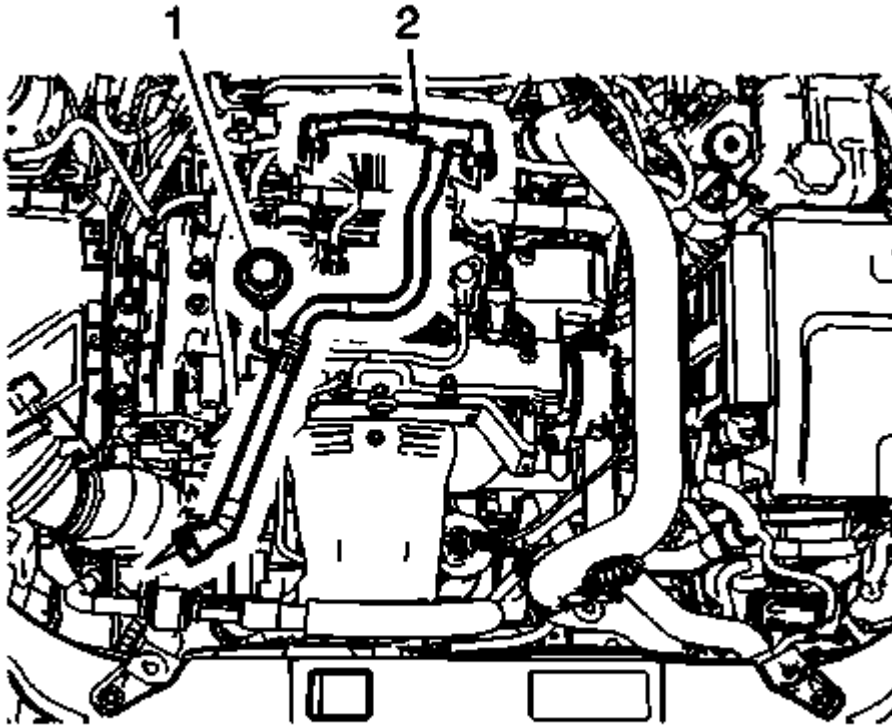


Fig. 28: PCV Pipe

Courtesy of GENERAL MOTORS COMPANY

4. Remove the PCV pipe (2). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

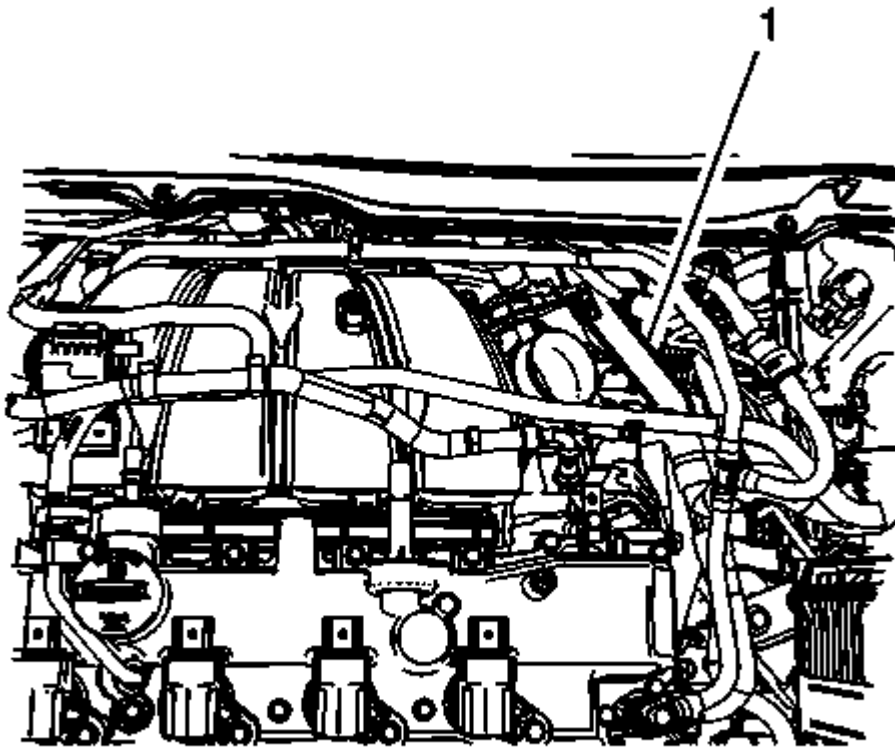


Fig. 29: Brake Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake vacuum pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (LTG)**.

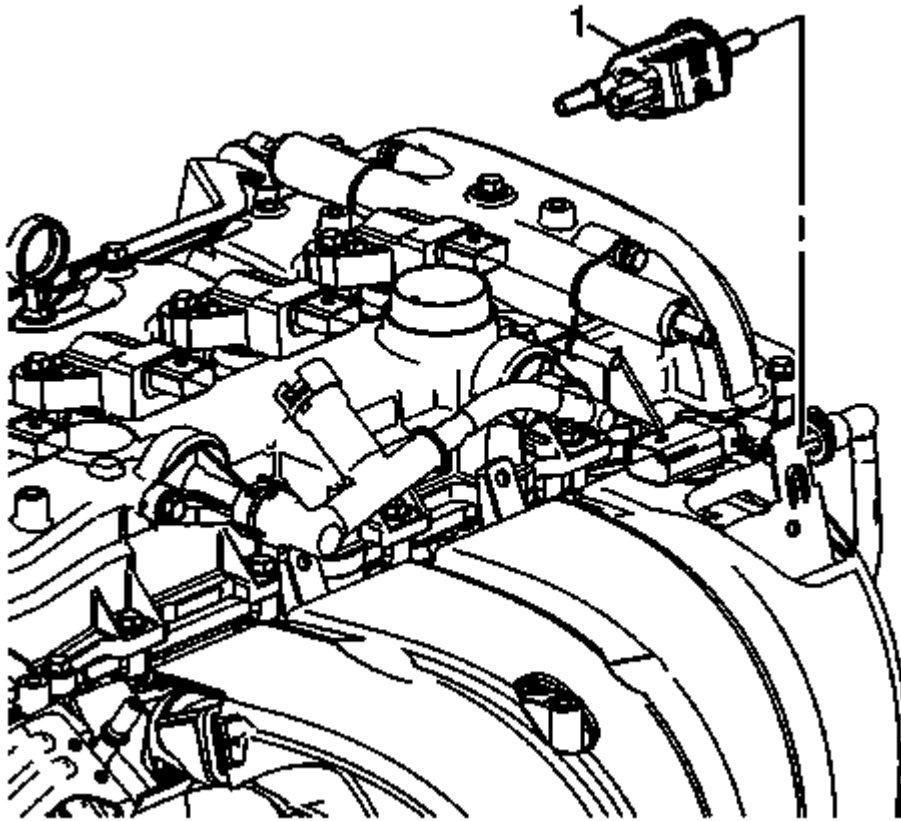


Fig. 30: EVAP Canister Valve
Courtesy of GENERAL MOTORS COMPANY

6. Remove the EVAP Canister Purge Solenoid Valve. (1).
7. Remove the throttle body. Refer to **Throttle Body Assembly Replacement** .
8. Remove the fuel pump. Refer to **Fuel Pump Replacement** .

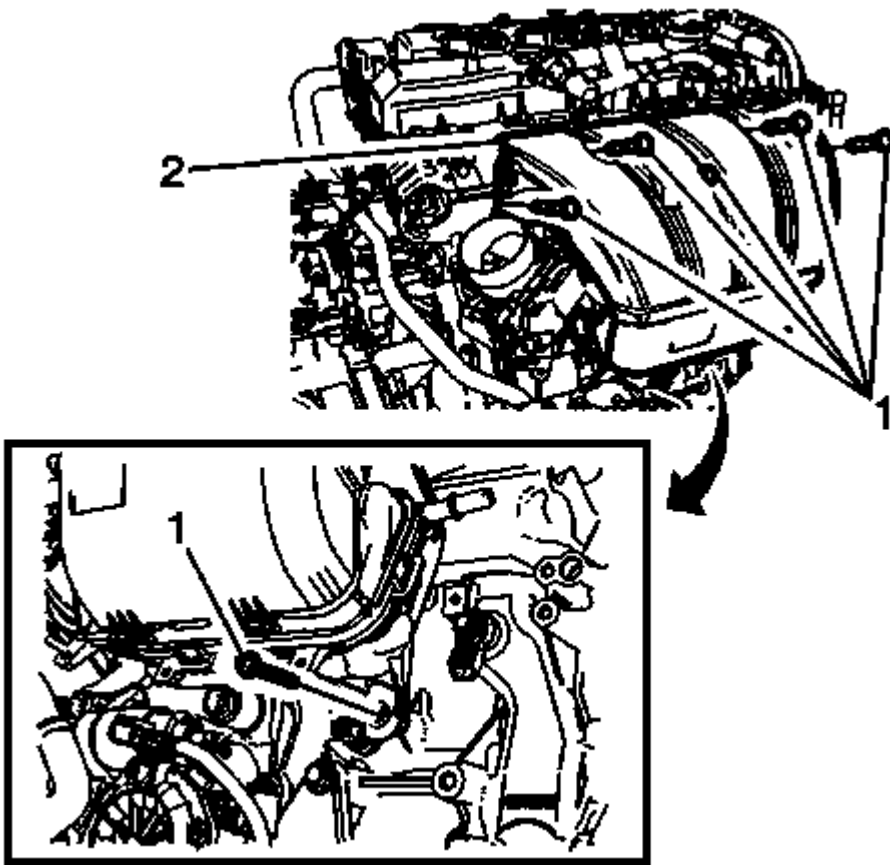


Fig. 31: Intake Bolts

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake bolts (1).
10. Remove the intake manifold (2) from the vehicle.

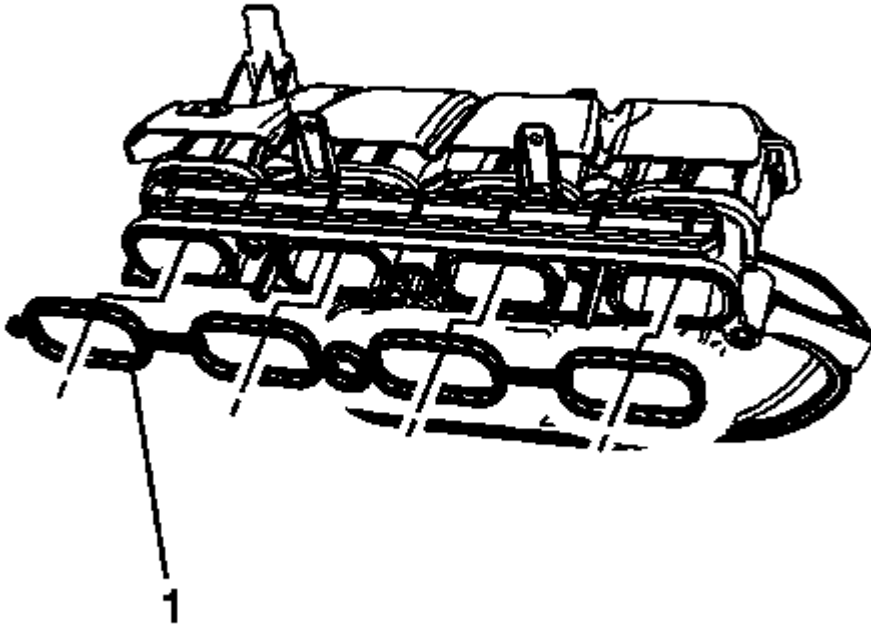


Fig. 32: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

11. Remove the intake manifold gasket (1) and DISCARD.
12. For intake manifold cleaning and inspection. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

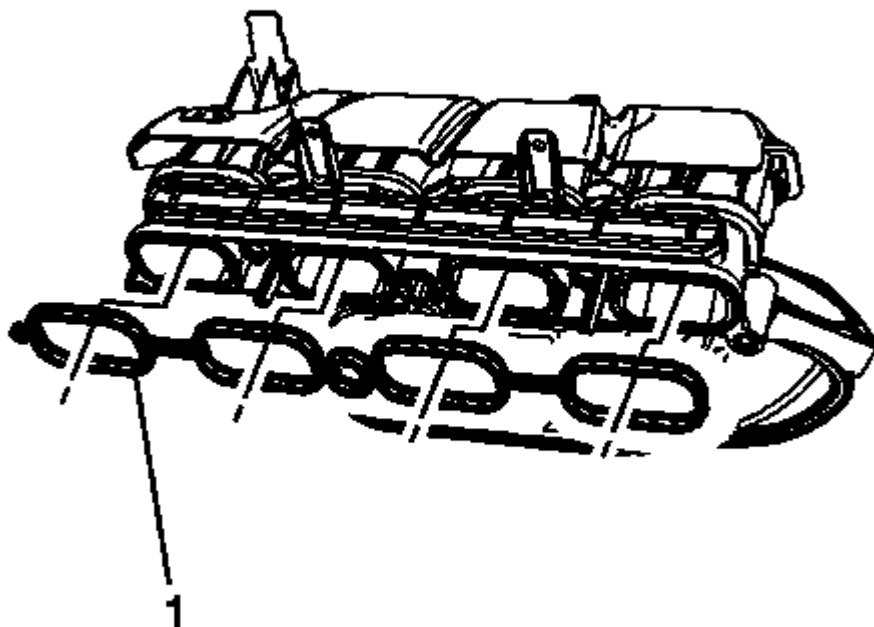


Fig. 33: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Install the intake manifold gasket (1).

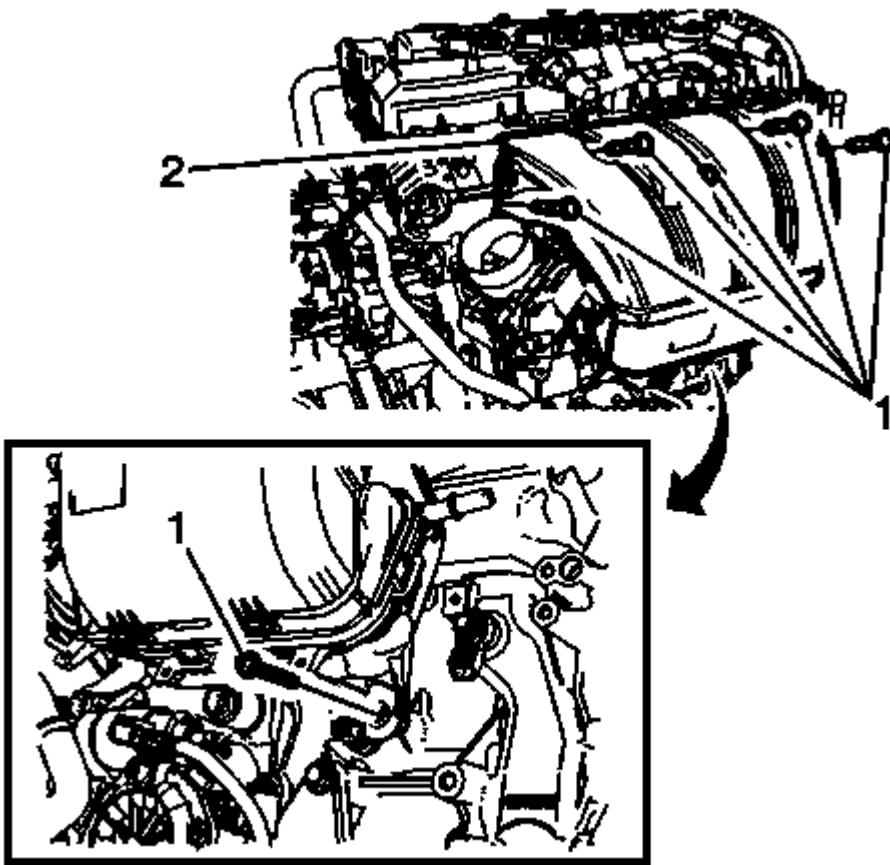


Fig. 34: Intake Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (2).
3. Hand start the intake manifold bolts (1).

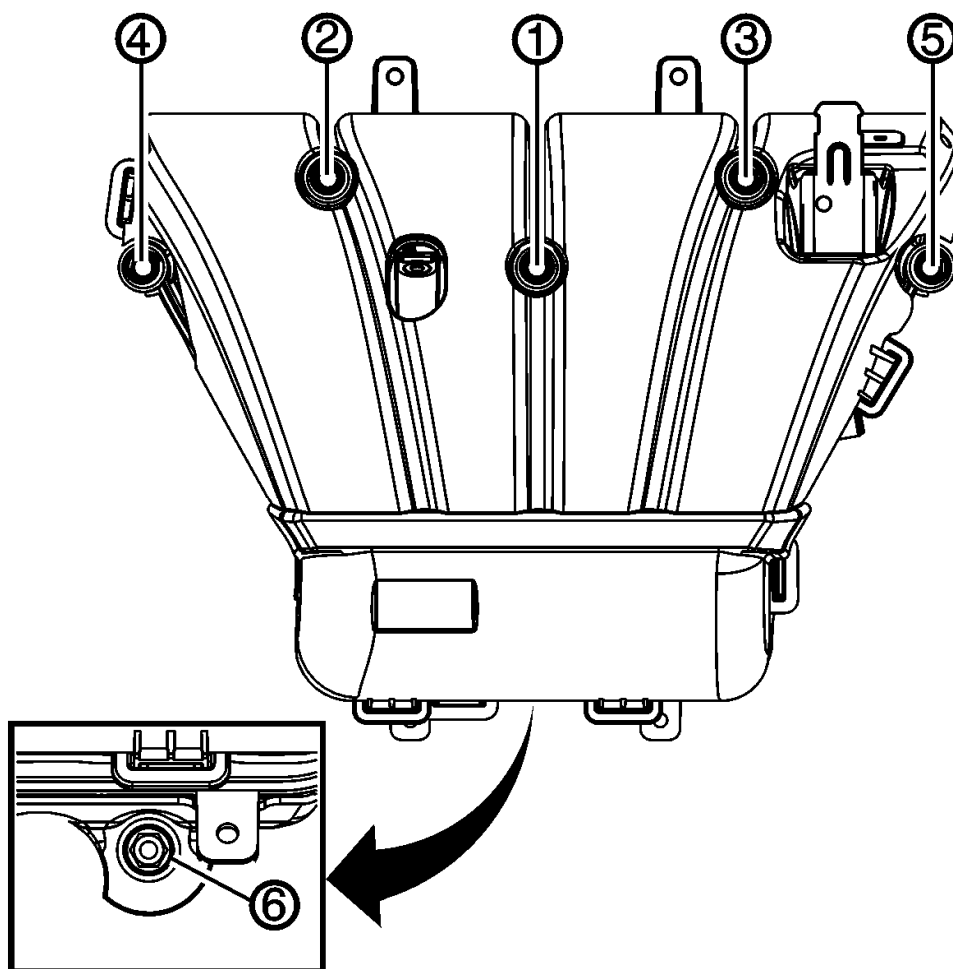


Fig. 35: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the fastener in sequence twice to 12 (106 lb in).
5. Install the fuel pump. Refer to Fuel Pump Replacement .
6. Install the throttle body. Refer to Throttle Body Assembly Replacement .

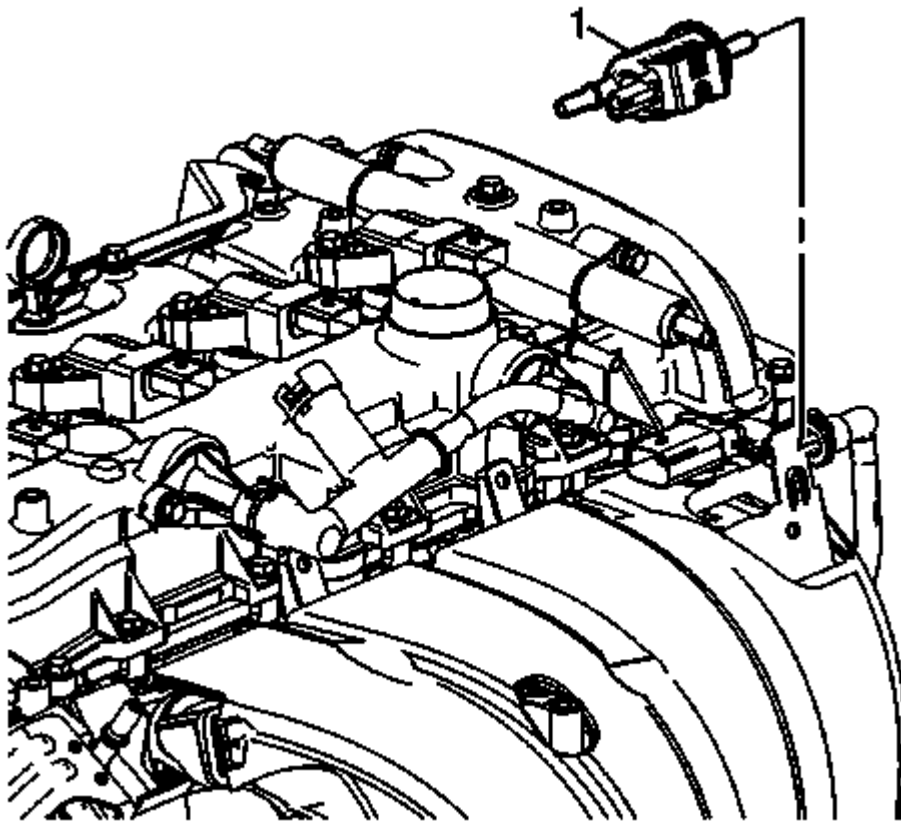


Fig. 36: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

7. Install the EVAP Canister Purge Solenoid Valve (1).

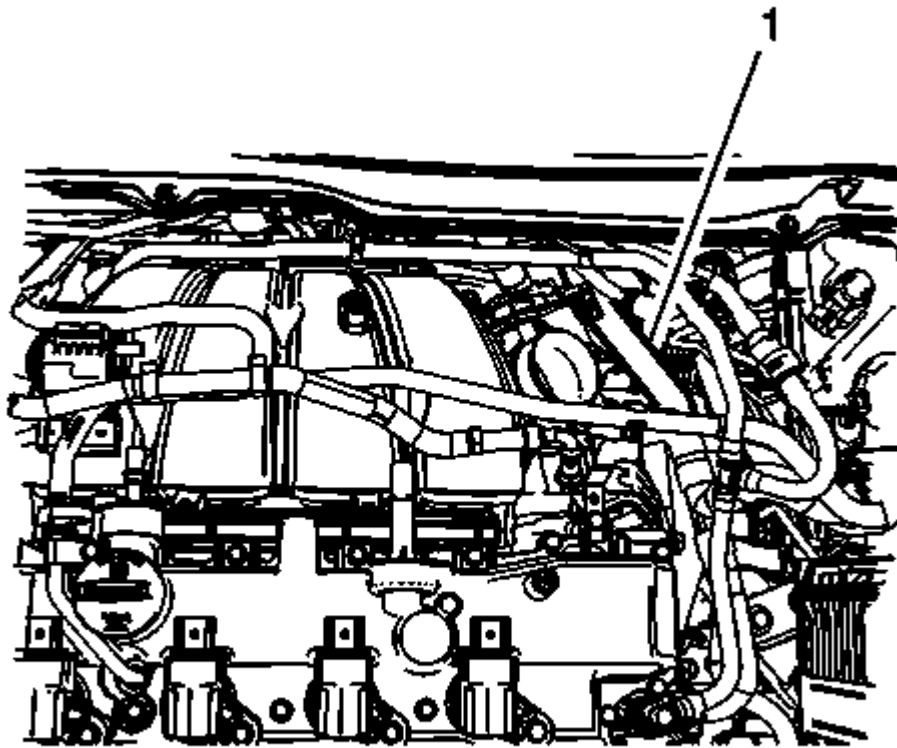


Fig. 37: Brake Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

8. Install the brake vacuum pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (LTG)** .

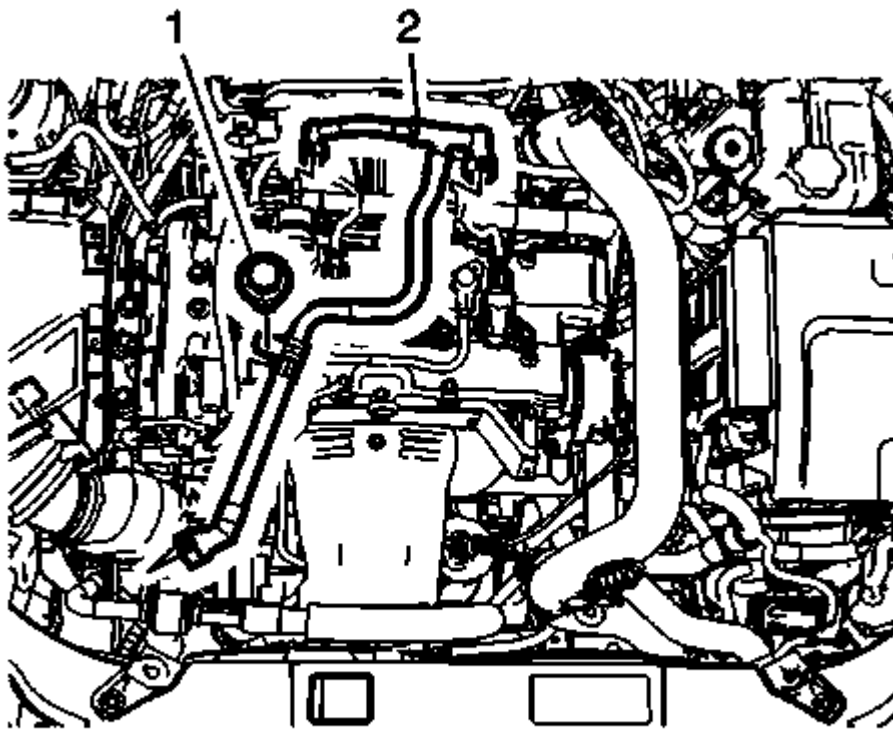


Fig. 38: PCV Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Install the PCV pipe (2). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.
10. Install the charge air cooler outlet tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement** .
11. Connect the fuel feed pipe. Refer to **Fuel Feed Front Pipe Replacement** .
12. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

CRANKSHAFT BALANCER REPLACEMENT

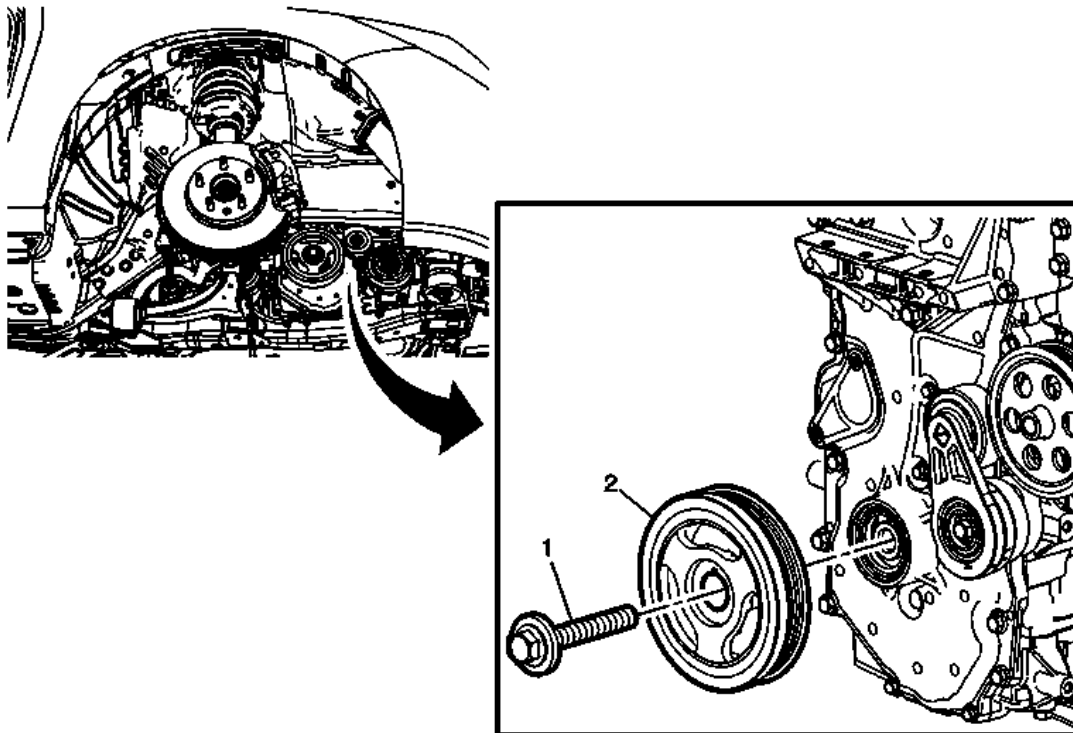


Fig. 39: Crankshaft Balancer
 Courtesy of GENERAL MOTORS COMPANY

Crankshaft Balancer Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the starter . Refer to <u>Starter Replacement (LTG)</u> . 2. Install the EN-46106 flywheel holder. 3. Remove the drive belt. Refer to <u>Drive Belt Replacement</u>. 	
Special Tools <ul style="list-style-type: none"> • EN-41816 Crankshaft Balancer Remover • EN-45059 Angle Meter • EN-46106 Flywheel Holder 	
For equivalent regional tools, refer to <u>Special Tools</u> .	
1	Crankshaft Balancer Bolt CAUTION: Refer to <u>Fastener Caution</u> .

Procedure Install a NEW crankshaft bolt and washer. Tighten 150 (111 lb ft) plus 180 degrees.	
2	Crankshaft Balancer

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

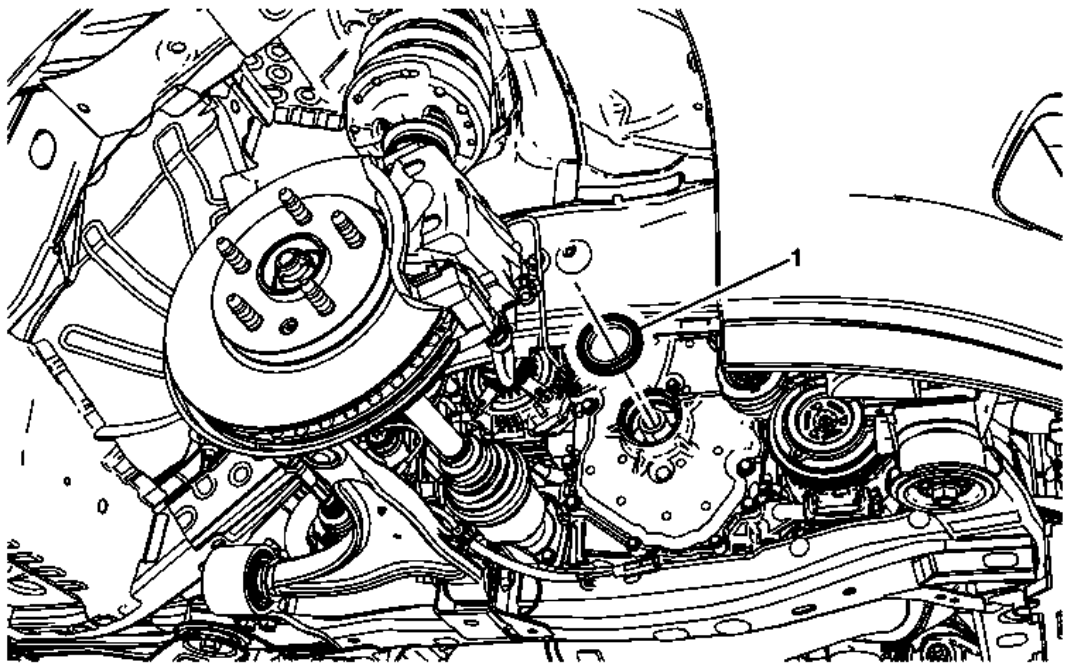


Fig. 40: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Front Oil Seal Replacement

Callout	Component Name
Preliminary Procedure Remove the crankshaft balancer. Refer to <u>Crankshaft Balancer Replacement</u> .	
1	Front Crankshaft Seal Procedure <ol style="list-style-type: none"> 1. Use a suitable tool to remove the front cover oil seal. 2. Use the EN 50820 Front Crankshaft Seal Installer to install the seal. Special Tools EN 50820 Front Crankshaft Seal Installer

For equivalent regional tools, refer to **Special Tools** .

ENGINE FRONT COVER REPLACEMENT

Removal Procedure

Special Tools

EN-50820 Front Crankshaft Seal Installer

KM-470-B Angular Torque Gauge

For equivalent regional tools, refer to **Special Tools** .

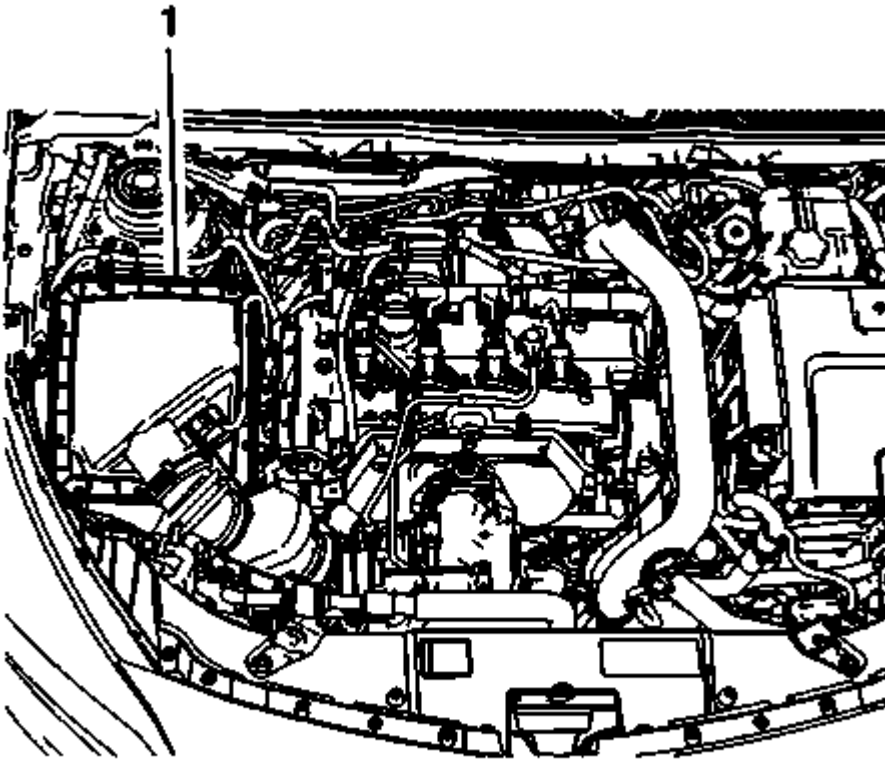


Fig. 41: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.

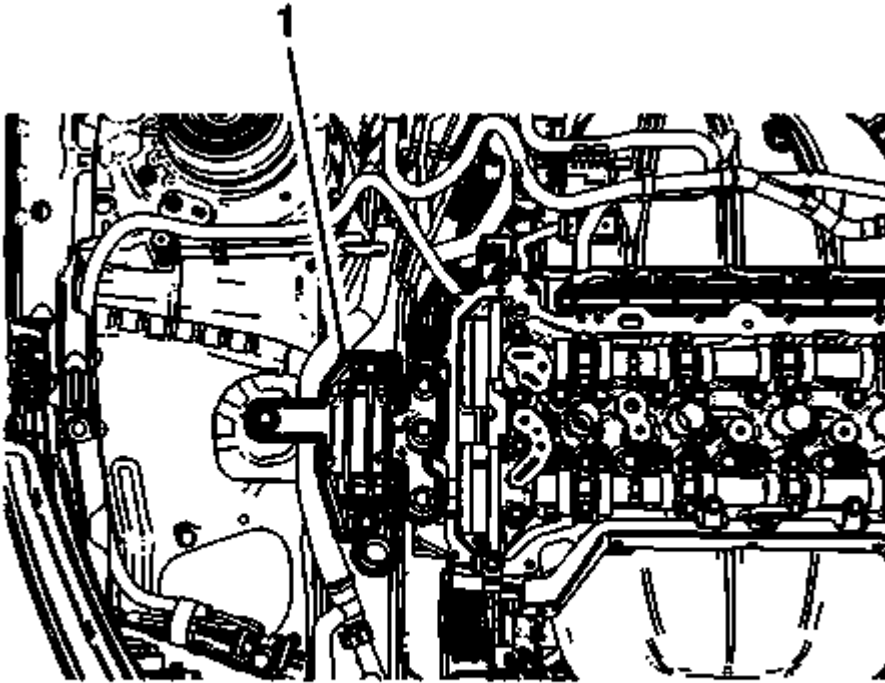


Fig. 42: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine mount (1). Refer to **Engine Mount Replacement**.
4. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
5. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

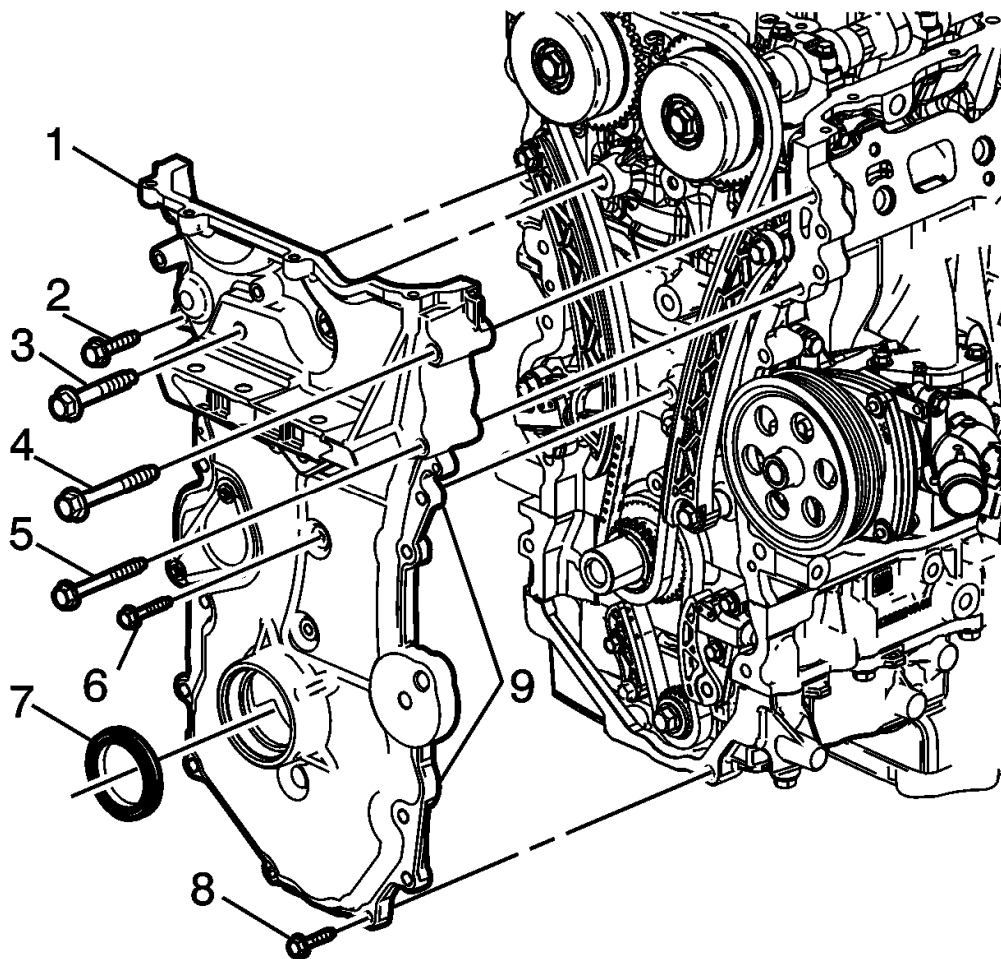


Fig. 43: Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine front cover bolts (2-6, 8).
7. Remove the engine front cover (1).
8. Remove the front oil seal (7) with an appropriate tool.

Installation Procedure

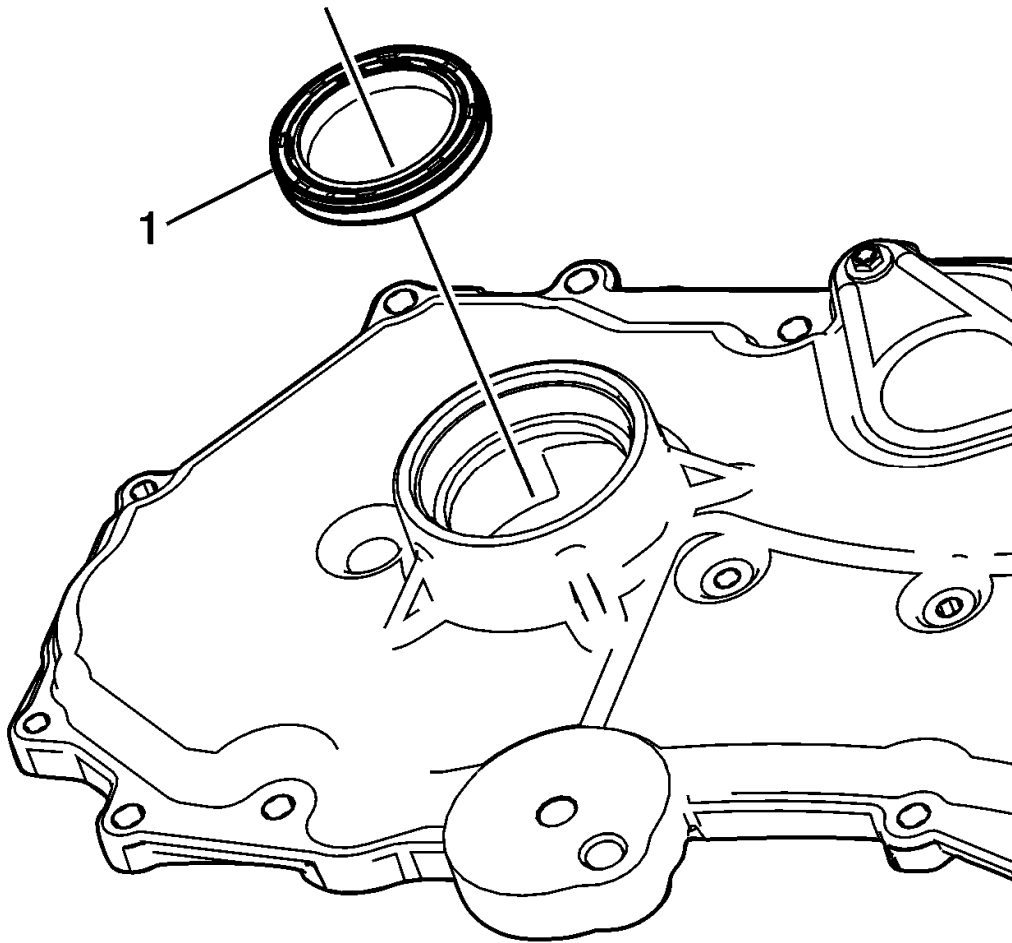


Fig. 44: Front Crankshaft Seal

Courtesy of GENERAL MOTORS COMPANY

1. Using **EN-50820** installer , install the front crankshaft seal (1) into the engine front cover.

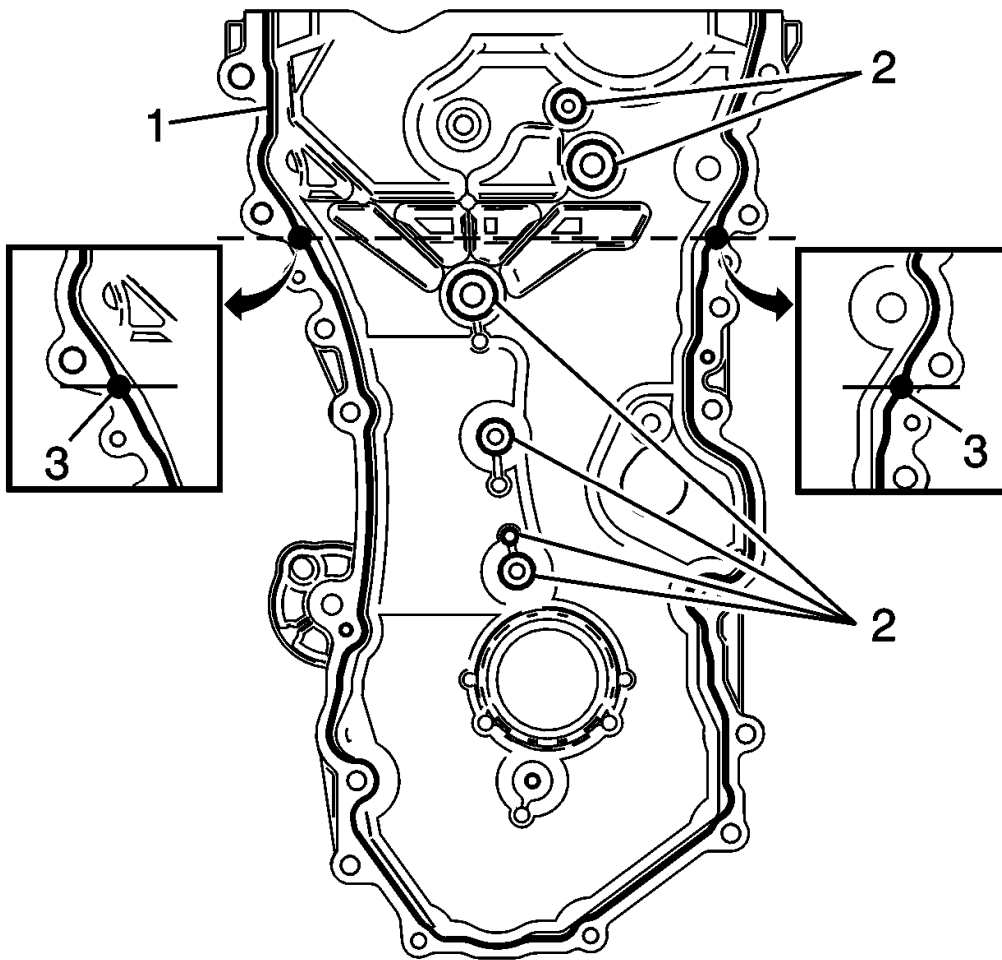


Fig. 45: Applying Bead Of Sealer Directly In Flange
 Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The engine front cover surface must be free of contamination prior to applying the sealer.
- Install and align the cover within 20 minutes of applying the sealer.
- The cover must be fastened to final torque specification within 60 minutes of applying the sealer.
- Additional sealant is necessary to reduce the possibility of leakage where the cylinder head to engine block interface along the bead path flange on the front cover.

2. Apply a 5 mm bead of sealer directly in the flange (1) of the engine front cover perimeter mating surface. Also apply a 5 mm bead of sealer directly to the locations indicated (2). Finally, apply a 14 mm dab of sealant at the locations indicated (3). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

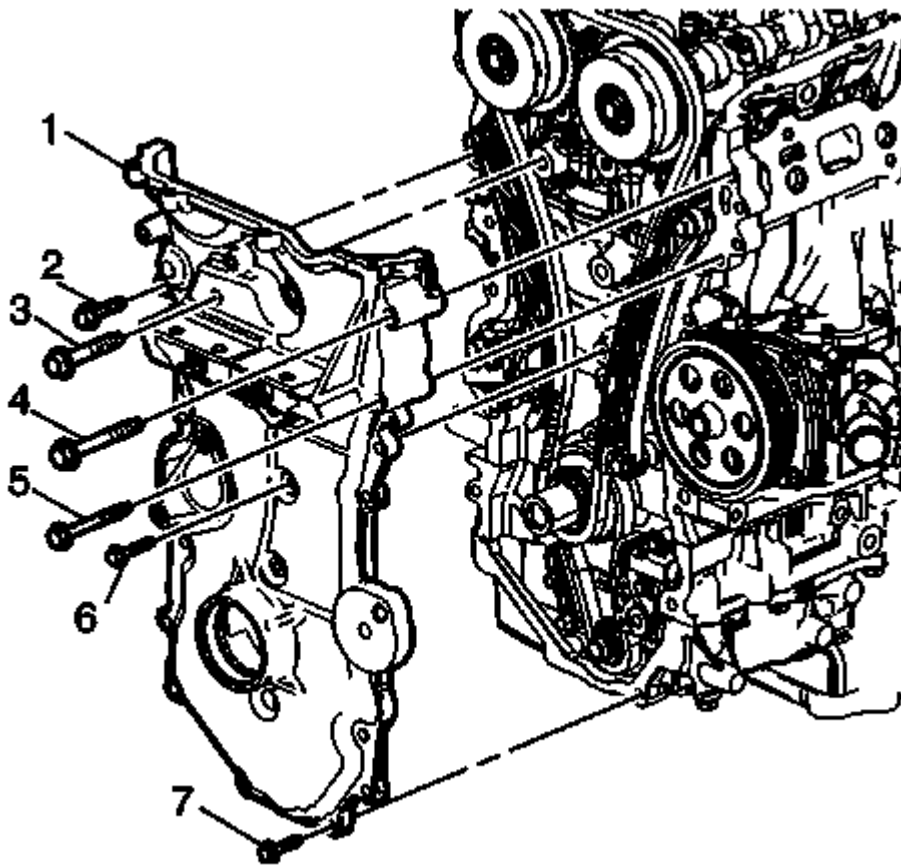


Fig. 46: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

3. Install the engine front cover (1).
4. Hand start the engine front cover bolts (2-6, 7).

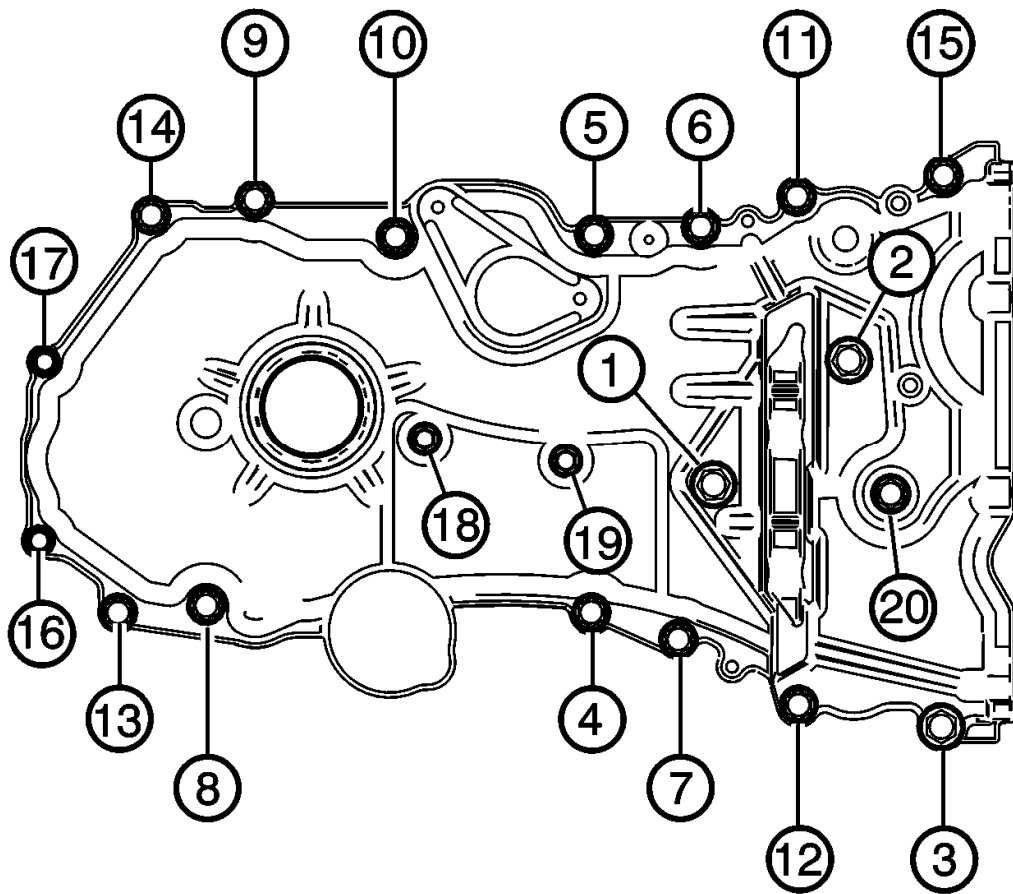


Fig. 47: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the engine front cover bolts in sequence to final torque twice:
 1. Using **KM-470-B** Angular Torque Gauge tighten sequence 1-2 bolts to 15 (11 lb ft) + 130 degrees.
 2. Tighten sequence 3 bolt to 58 (43 lb ft).
 3. Tighten sequence 4-11 bolts to 25 (18 lb ft).
 4. Tighten sequence 12 bolt to 25 (18 lb ft).
 5. Tighten sequence 13-15 bolts to 25 (18 lb ft).
 6. Tighten sequence 16-17 bolts to 10 (89 lb in).
 7. Tighten sequence 18-19 bolts to 10 (89 lb in).
 8. Using **KM-470-B** Angular Torque Gauge tighten sequence 20 bolt to 15 (11 lb ft) + 130 degrees.
6. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

7. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

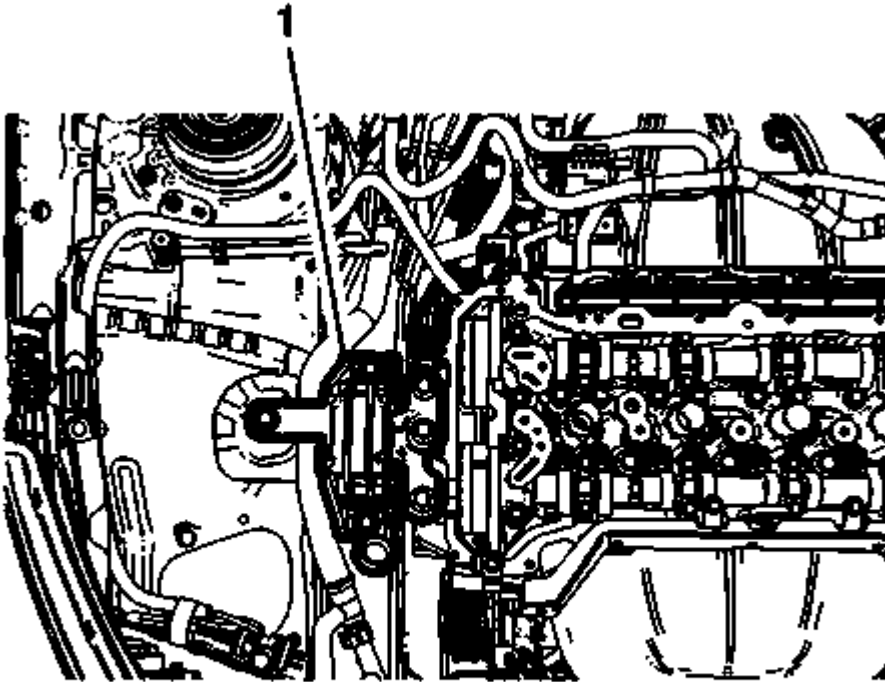


Fig. 48: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

8. Install the engine mount (1). Refer to **Engine Mount Replacement**.
9. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

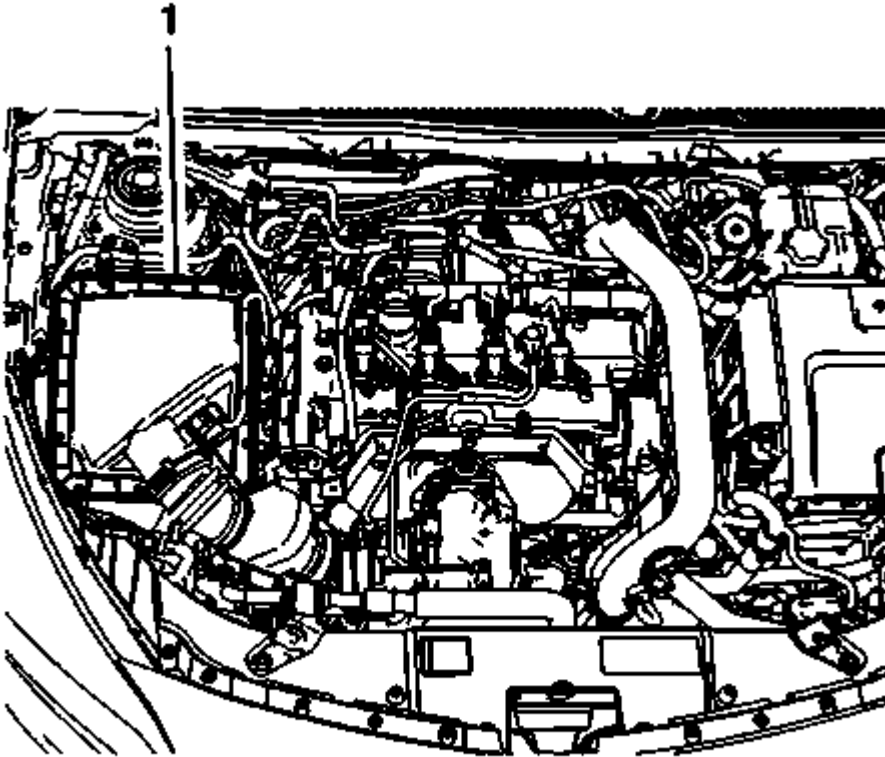


Fig. 49: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

10. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .

INTAKE VALVE ROCKER ARM REPLACEMENT

Removal Procedure

1. Remove the camshaft position actuator and camshaft - intake. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake.**

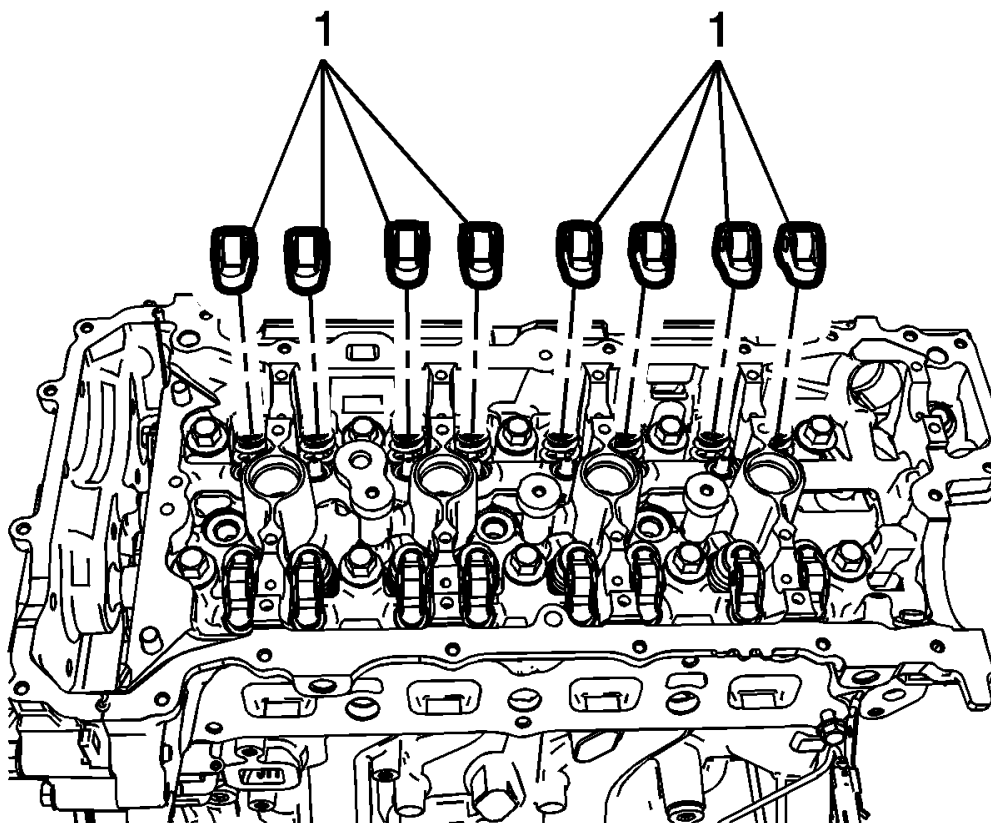


Fig. 50: Intake Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the valve rocker arms and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

2. Remove the intake rocker arm (1).

Installation Procedure

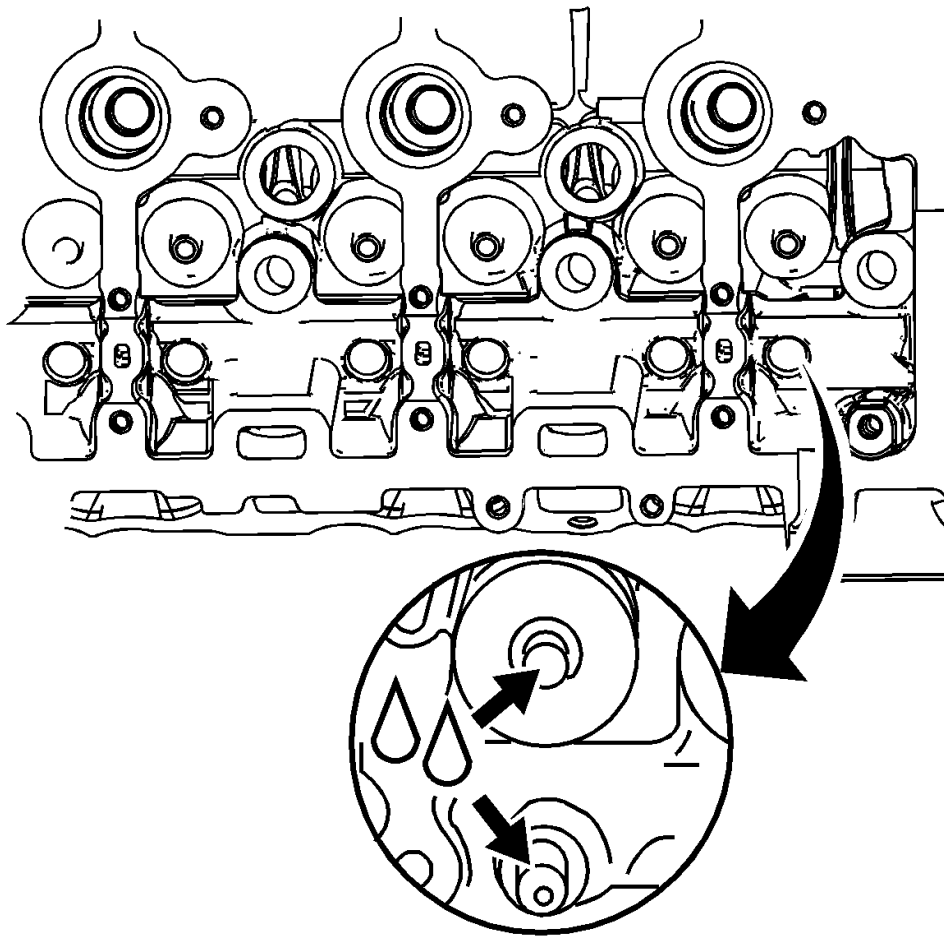


Fig. 51: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

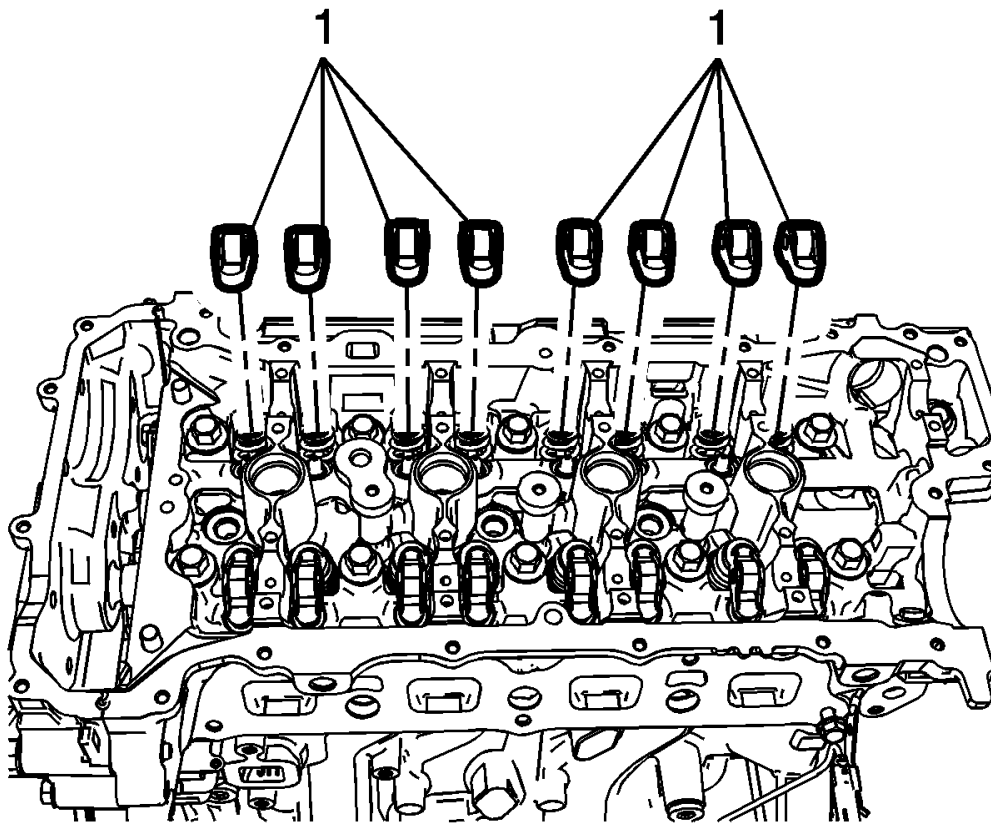


Fig. 52: Intake Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.
 - Pre-oil roller bearings before installation.
2. Lubricate the roller bearings with valve rocker arm lubricant. Refer to Adhesives, Fluids, Lubricants, and Sealers .
 3. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to Adhesives, Fluids, Lubricants, and Sealers .
 4. Install the camshaft position actuator and camshaft - intake. Refer to Camshaft Position Actuator and Camshaft Replacement - Intake.

EXHAUST VALVE ROCKER ARM REPLACEMENT

Removal Procedure

1. Remove the camshaft position actuator and camshaft - exhaust. Refer to **Camshaft Position Actuator and Camshaft Replacement - Exhaust.**

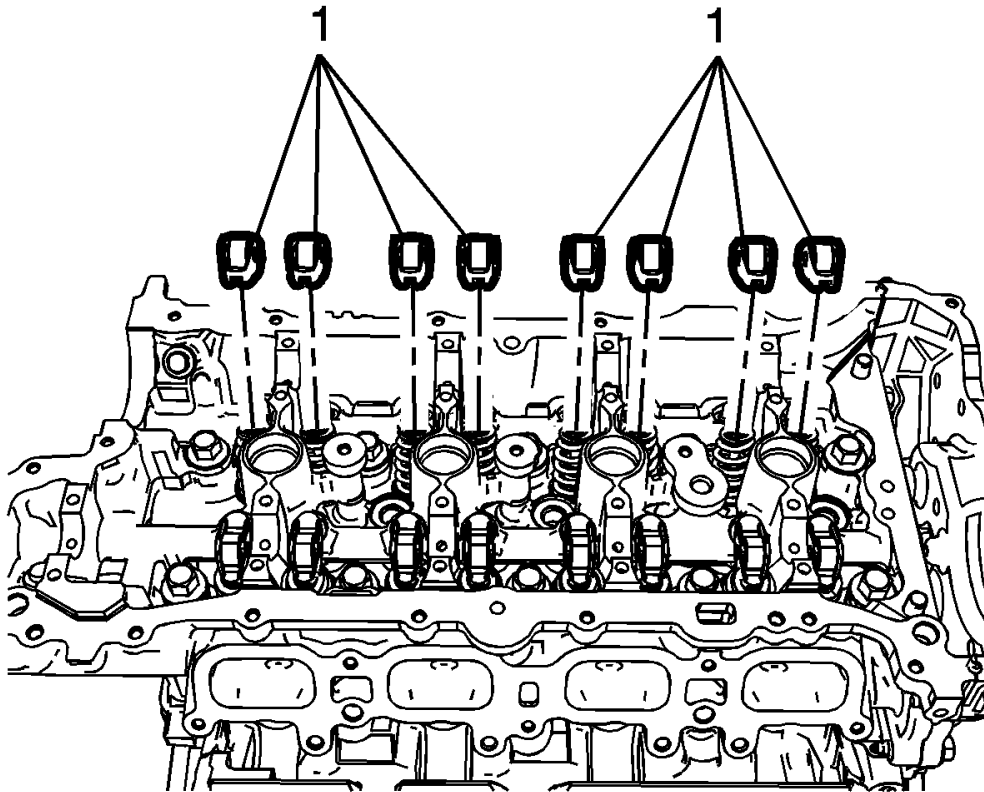


Fig. 53: Exhaust Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the Valve Rocker Arms and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

2. Remove the exhaust rocker arm (1).

Installation Procedure

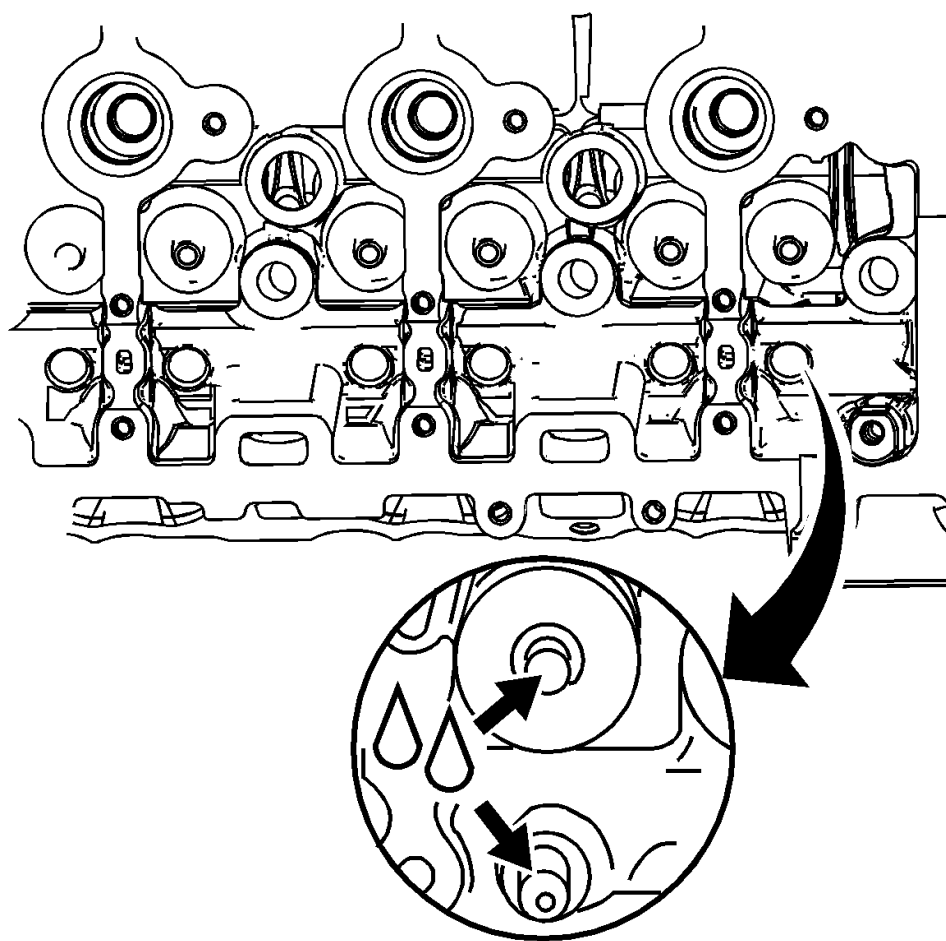


Fig. 54: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

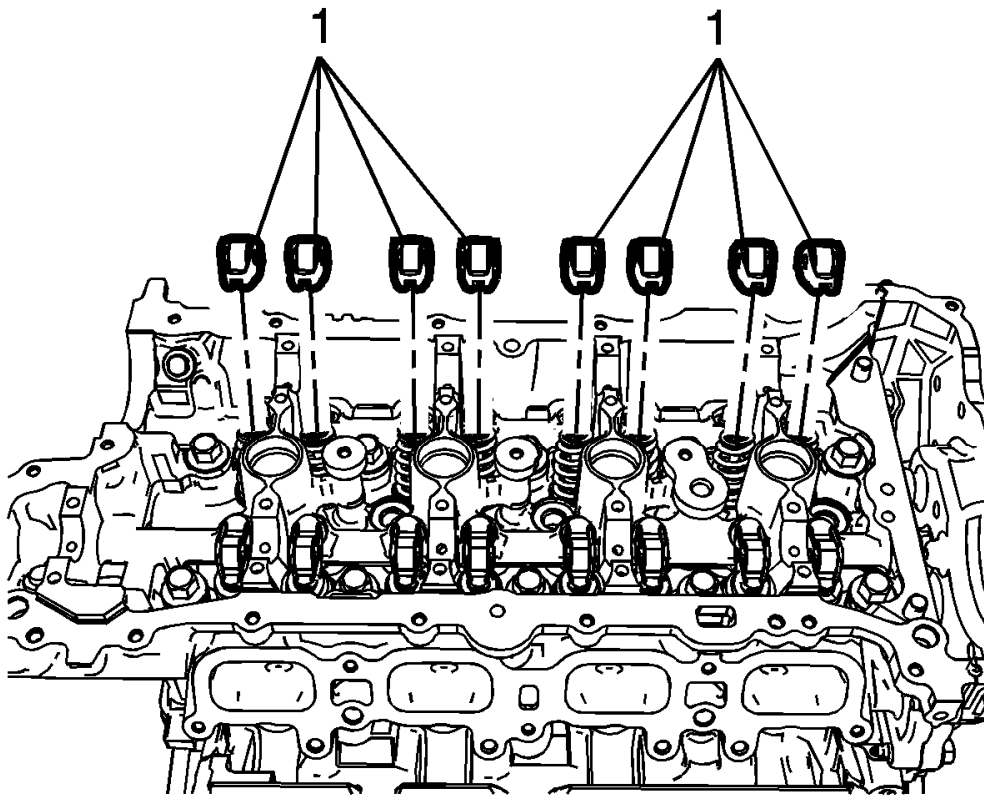


Fig. 55: Exhaust Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.
- Pre-oil roller bearings before installation.

2. Lubricate the roller bearings with valve rocker arm lubricant. Refer to Adhesives, Fluids, Lubricants, and Sealers .
3. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to Adhesives, Fluids, Lubricants, and Sealers .
4. Install the camshaft position actuator and camshaft - exhaust. Refer to Camshaft Position Actuator and Camshaft Replacement - Exhaust.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.

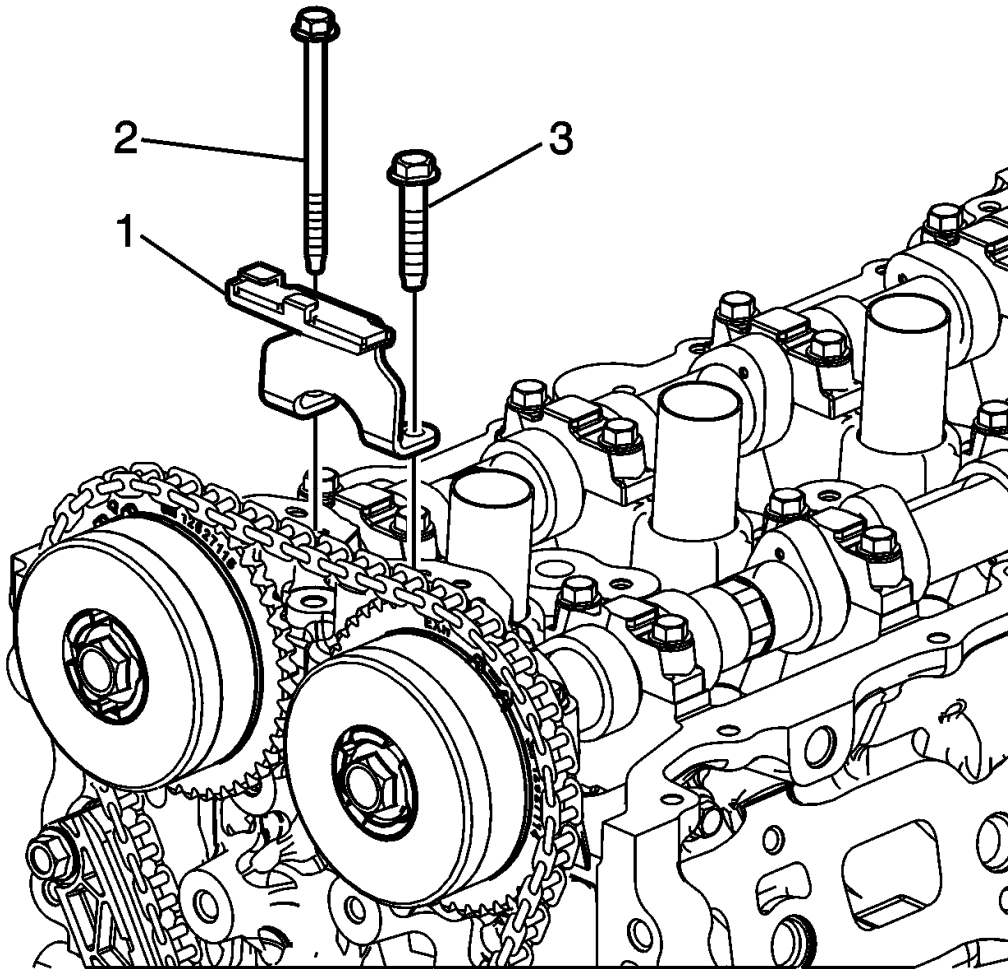


Fig. 56: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper timing chain guide bolts (2, 3).
3. Remove the upper timing chain guide (1).

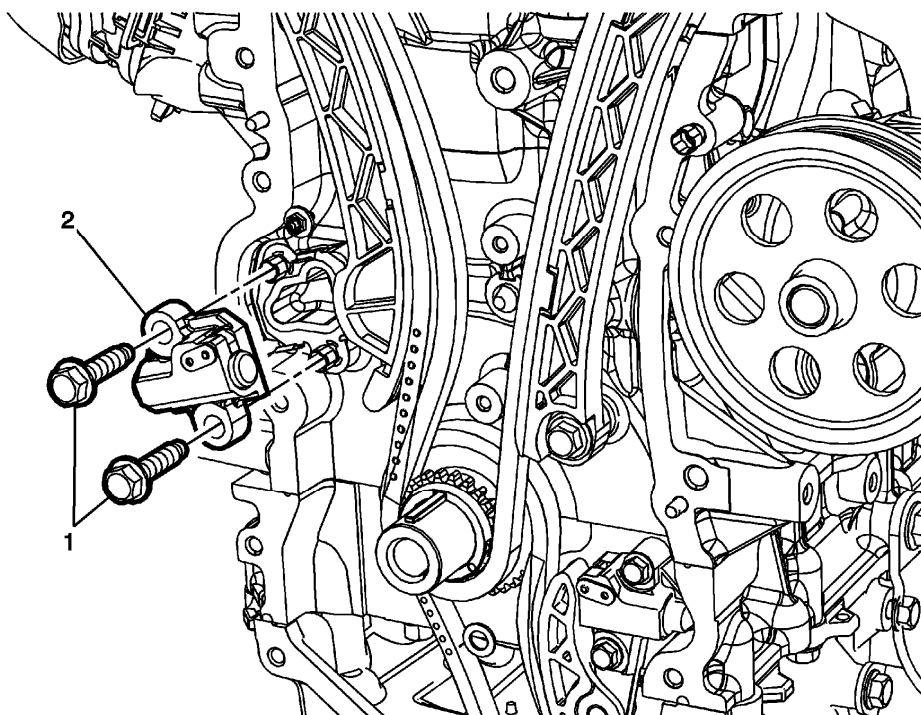


Fig. 57: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain tensioner bolts (1) and timing chain tensioner (2).

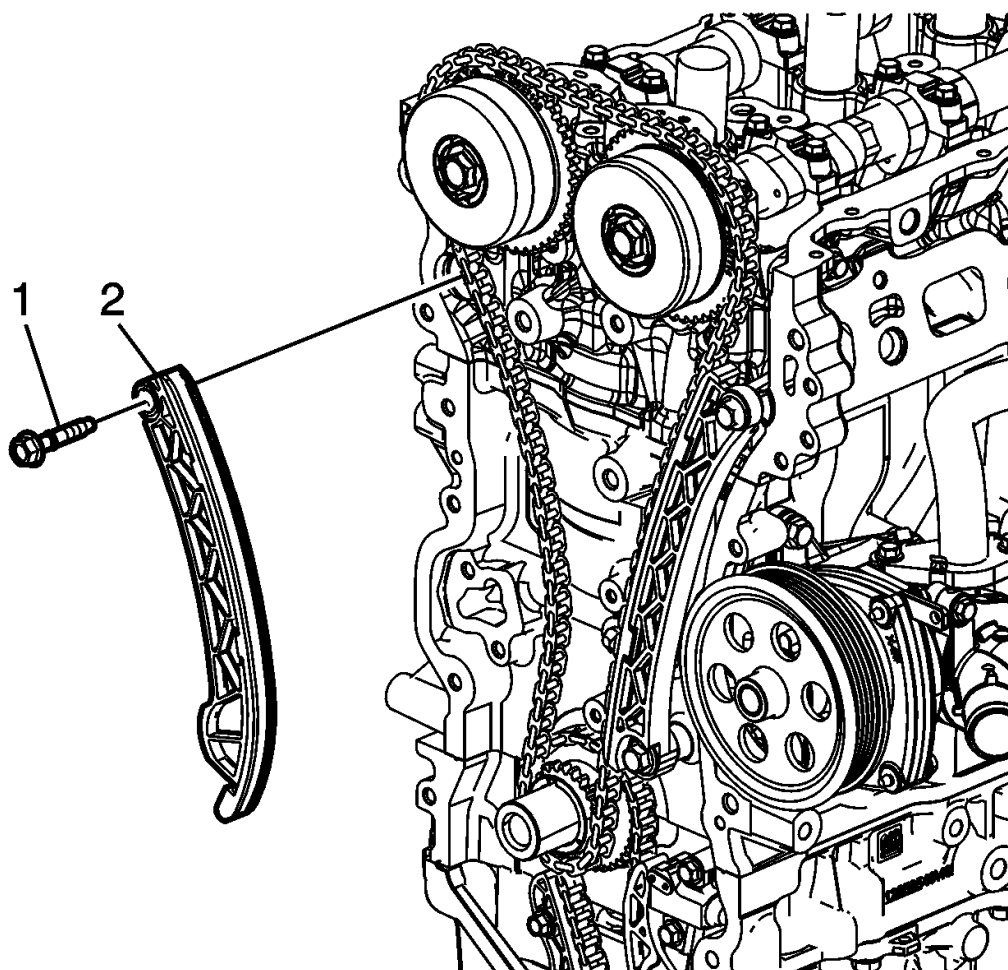


Fig. 58: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the timing chain tensioner pivot arm bolt (1).
6. Remove the timing chain tensioner pivot arm (2).

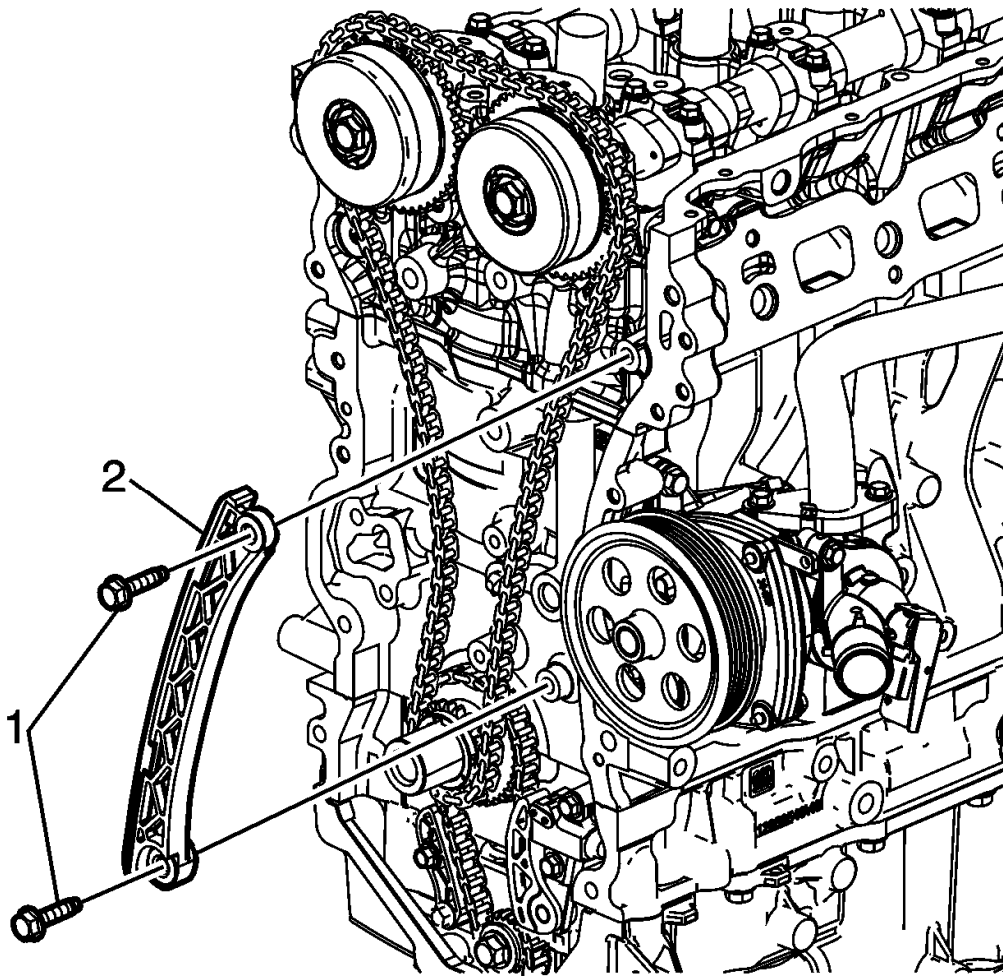


Fig. 59: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain guide bolts (1).
8. Remove the timing chain guide (2).

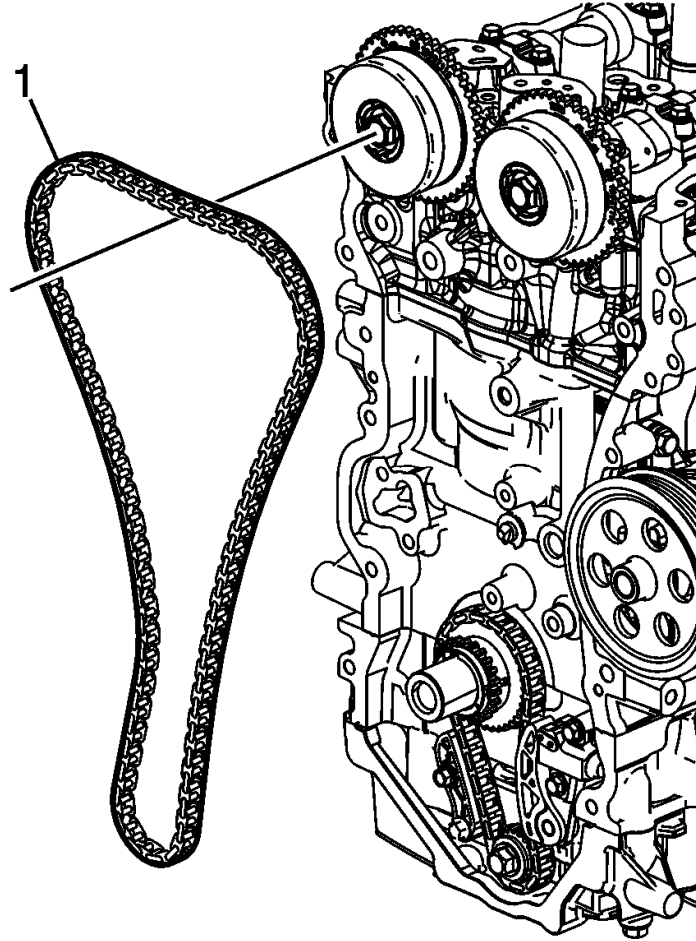


Fig. 60: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain (1).

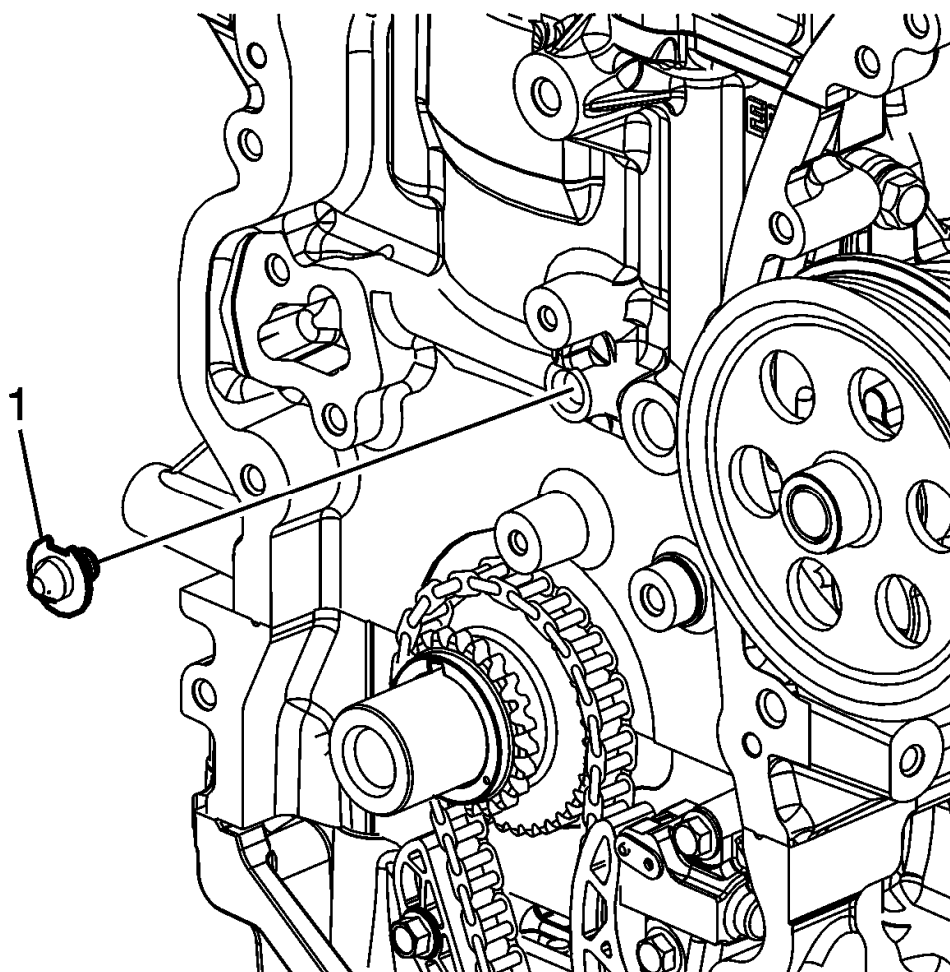


Fig. 61: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain oil nozzle (1).
11. For camshaft timing chain, sprocket, and tensioner cleaning and inspection. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Cleaning and Inspection** .

Installation Procedure

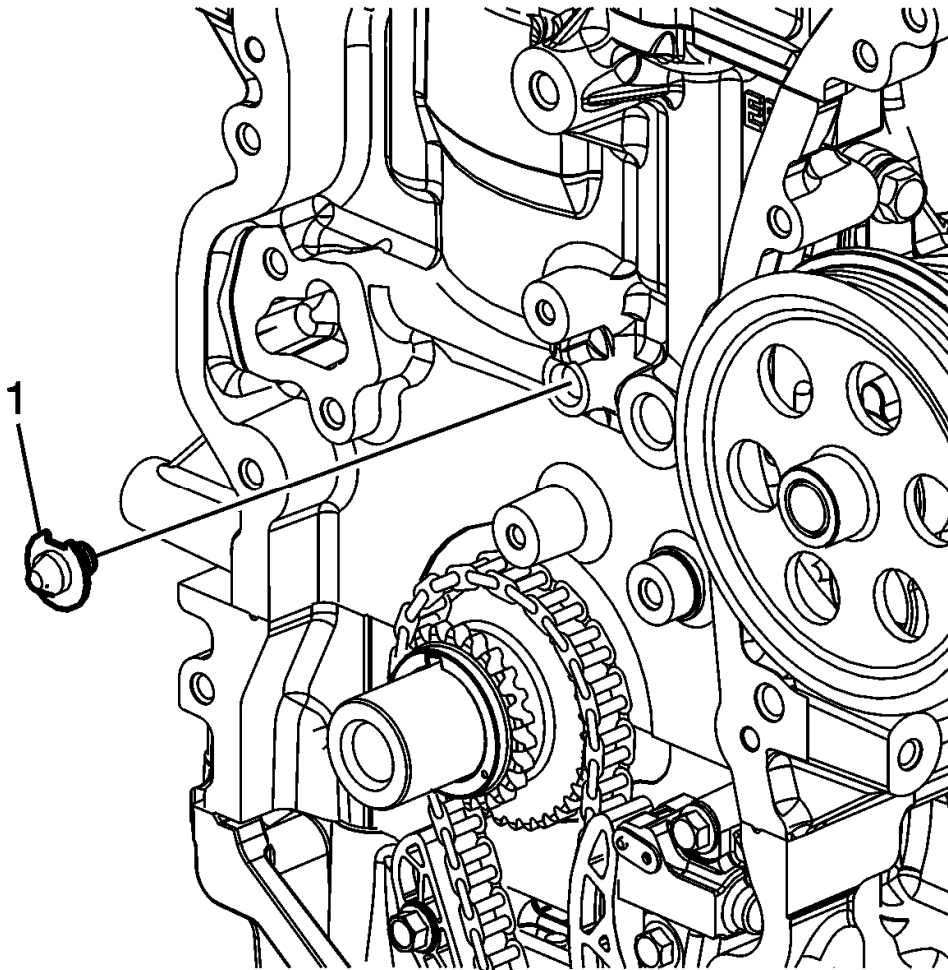


Fig. 62: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the timing chain oil nozzle is rotated with the notch facing upward, and aligned with the tab on the engine block.

1. Install the timing chain oil nozzle (1).

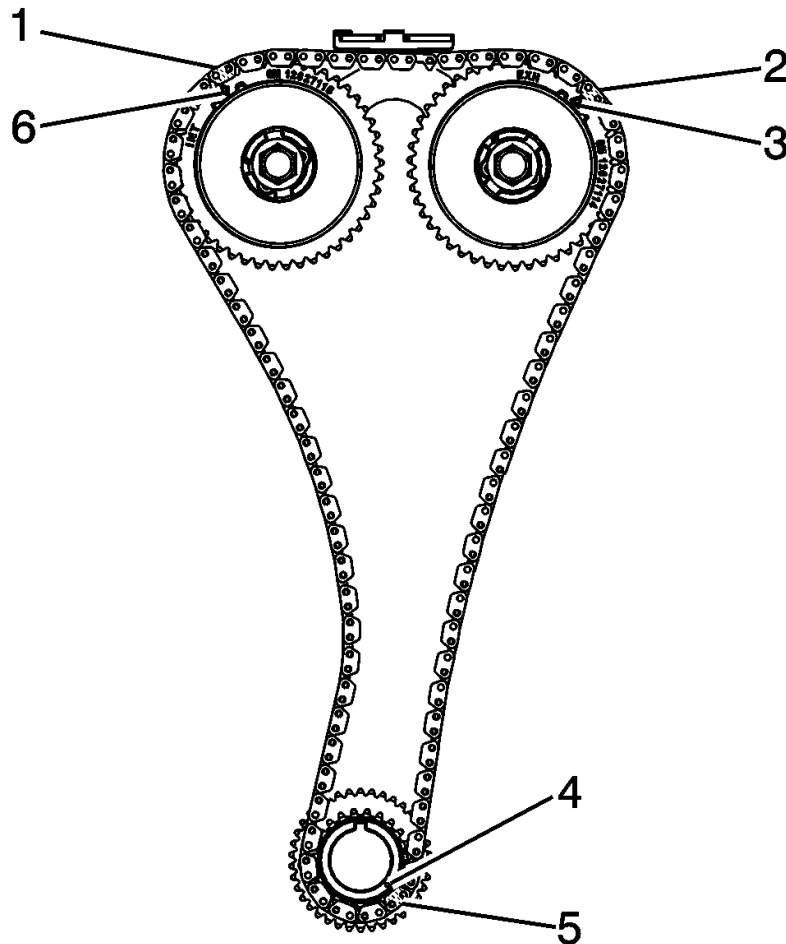


Fig. 63: Timing Chain Oil Nozzle
 Courtesy of GENERAL MOTORS COMPANY

NOTE: There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning the unique colored link (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: The unique colored links will not initially align with the intake actuator timing mark or the crankshaft sprocket timing mark.

3. Ensure the crankshaft key is in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

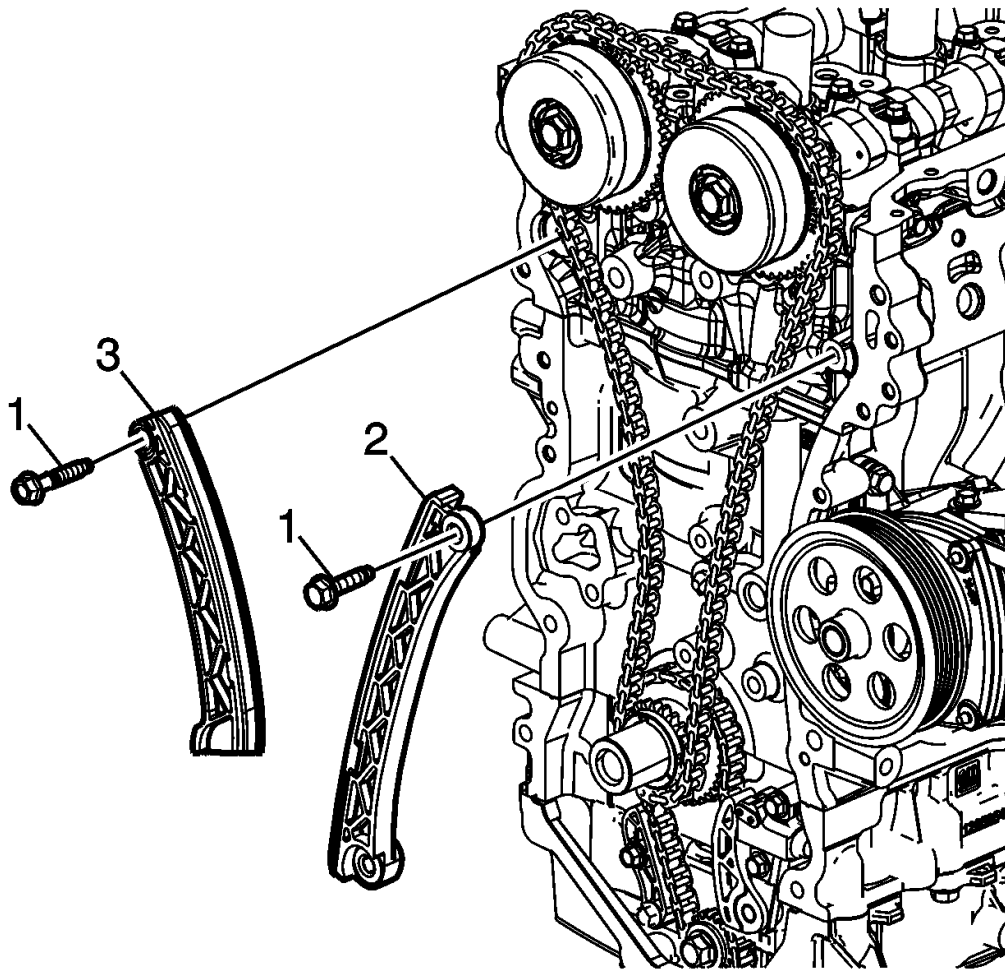


Fig. 64: Timing Chain Guide And Upper Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Timing will be established before the final install and torque of the guide bolts.

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

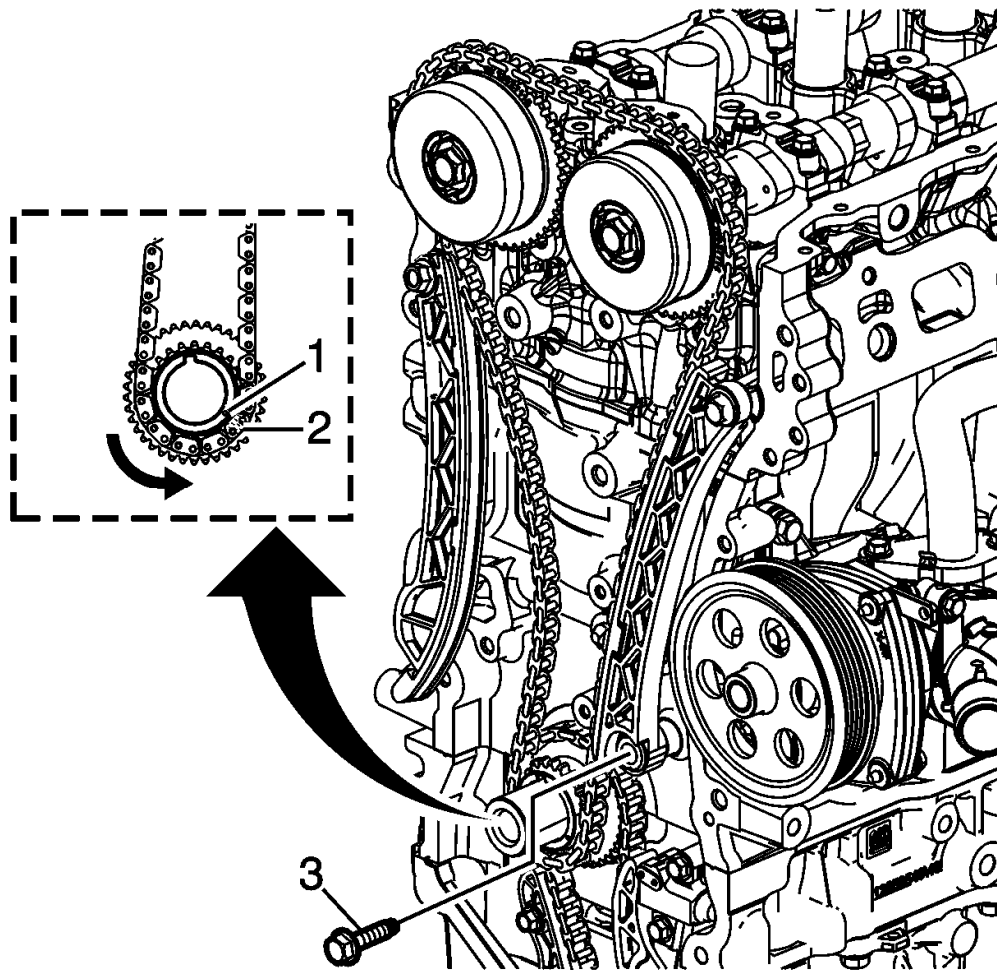


Fig. 65: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the timing link (2).

NOTE:

- Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.
- Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the timing link.

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: Refer to Fastener Caution .

9. Tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

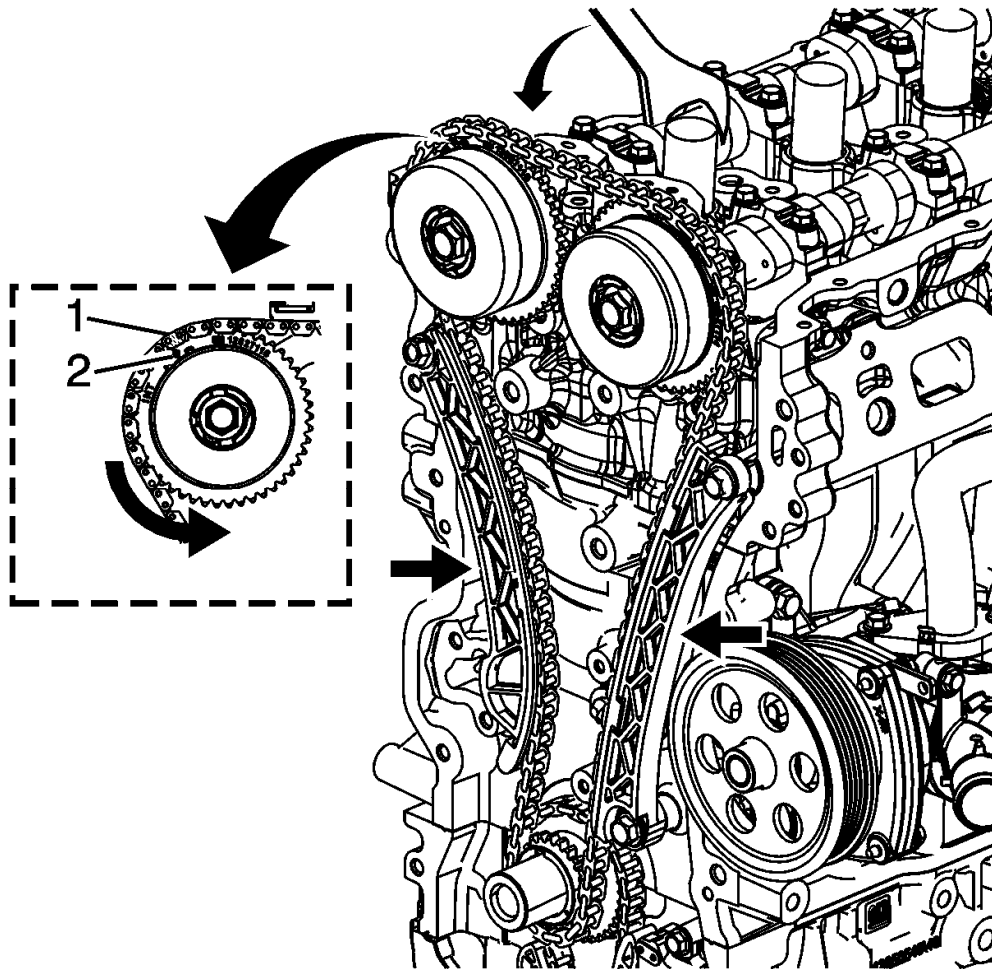


Fig. 66: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.
 - Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.
10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

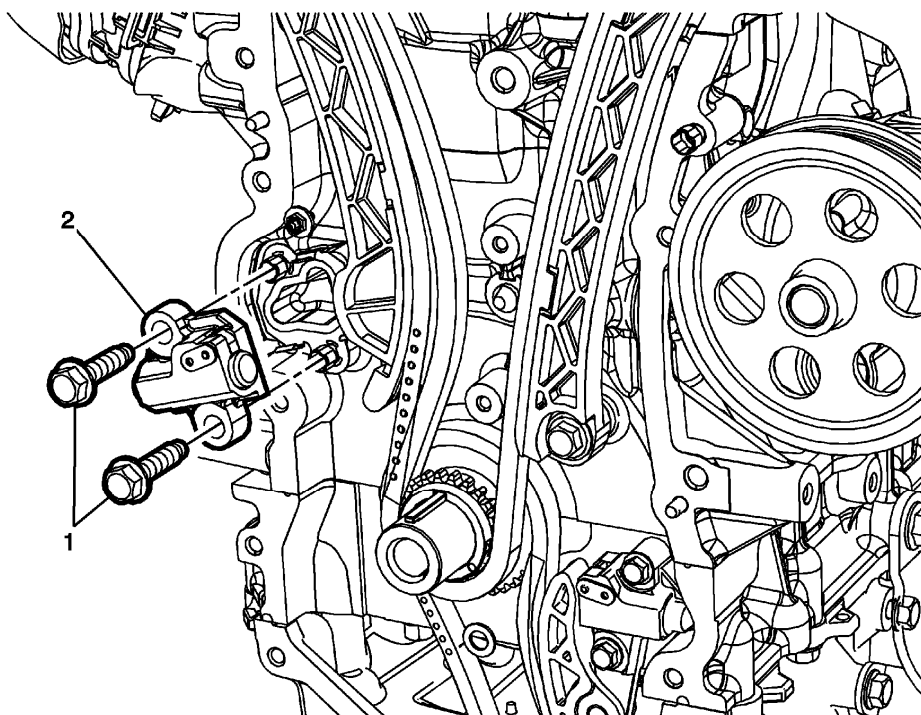


Fig. 67: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Install the timing chain tensioner (2) and tighten timing chain tensioner bolts (1) to 25 (18 lb ft)

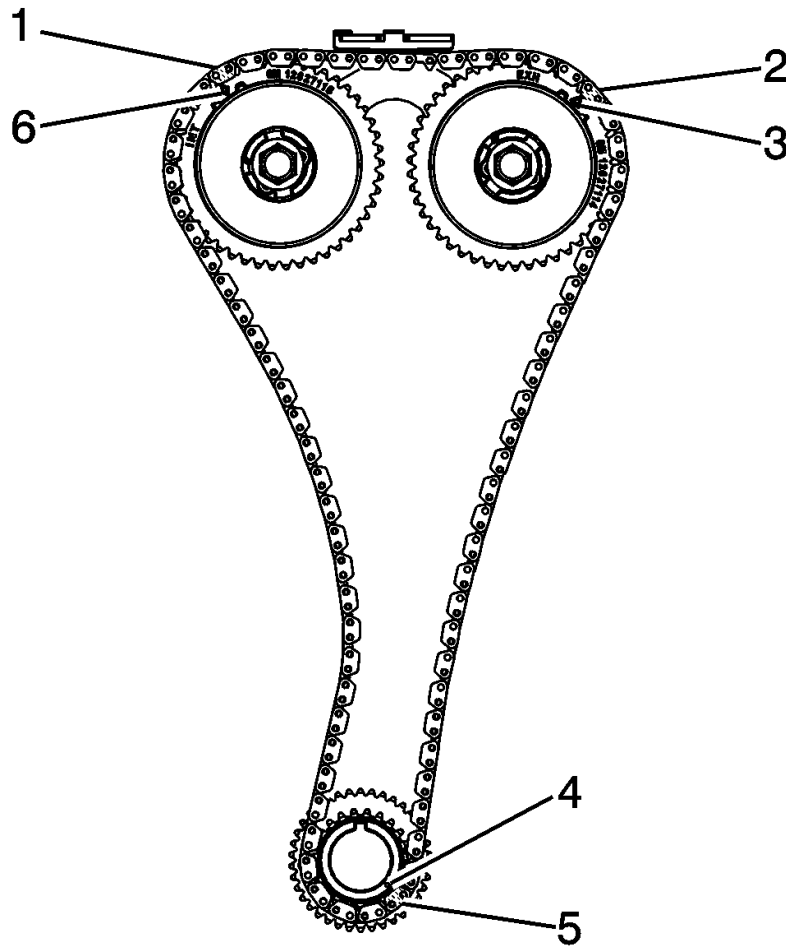


Fig. 68: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

12. Verify the timing links on the timing chain are properly aligned to the timing marks:
 1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
 2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
13. If they are not, repeat the portion of the procedure necessary to align the timing marks.

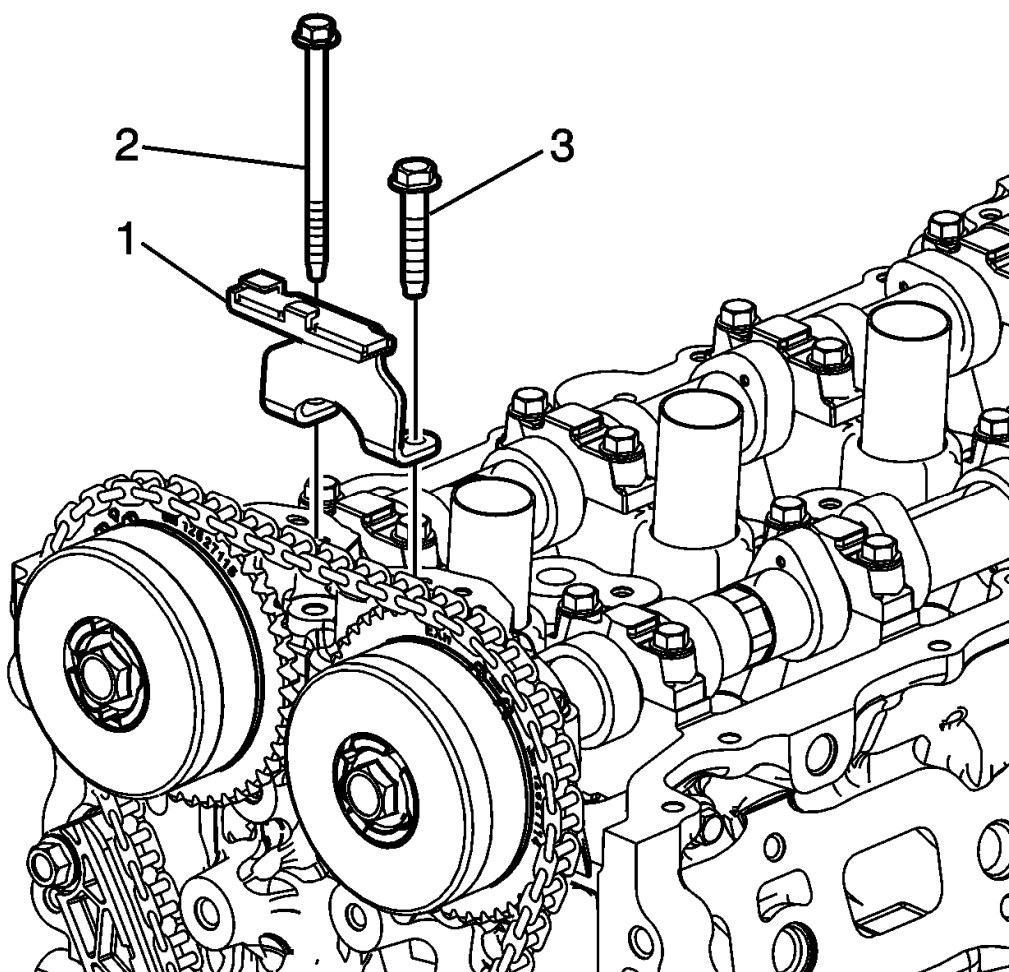


Fig. 69: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the timing chain guide (1) and bolts (2, 3) finger tight.

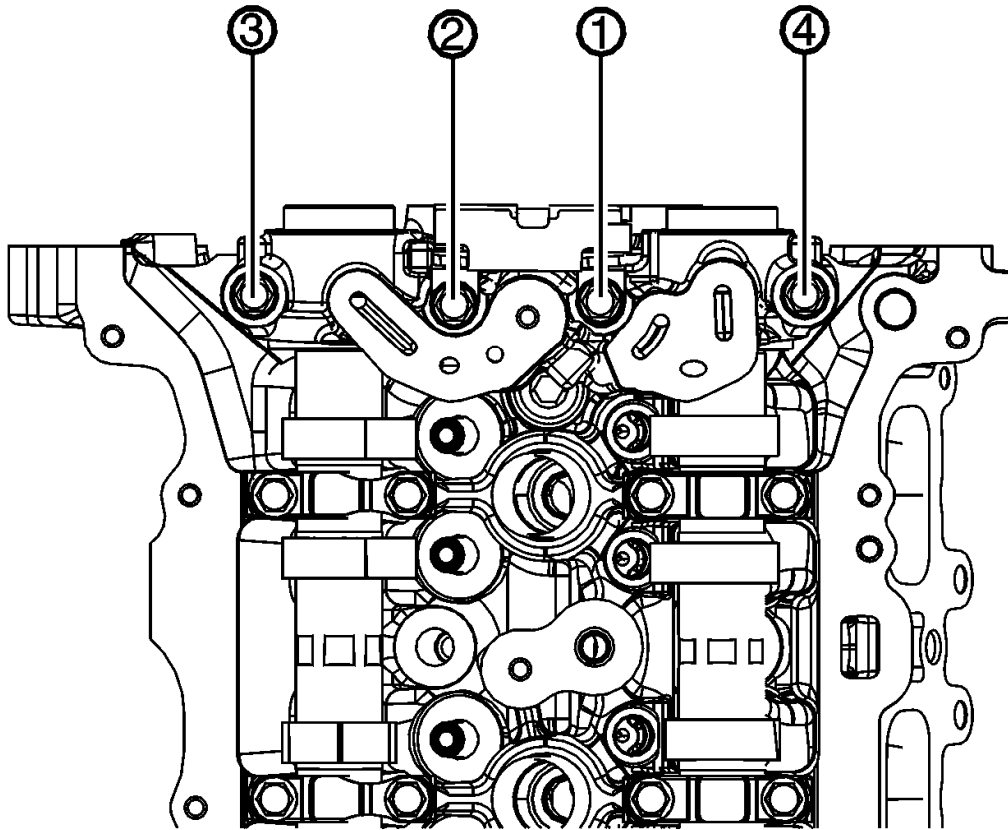


Fig. 70: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

15. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.
16. Rotate the crankshaft clockwise to see if either of the actuators or the crankshaft sprocket jump timing chain teeth. If this occurs, repeat procedure to align the timing marks.

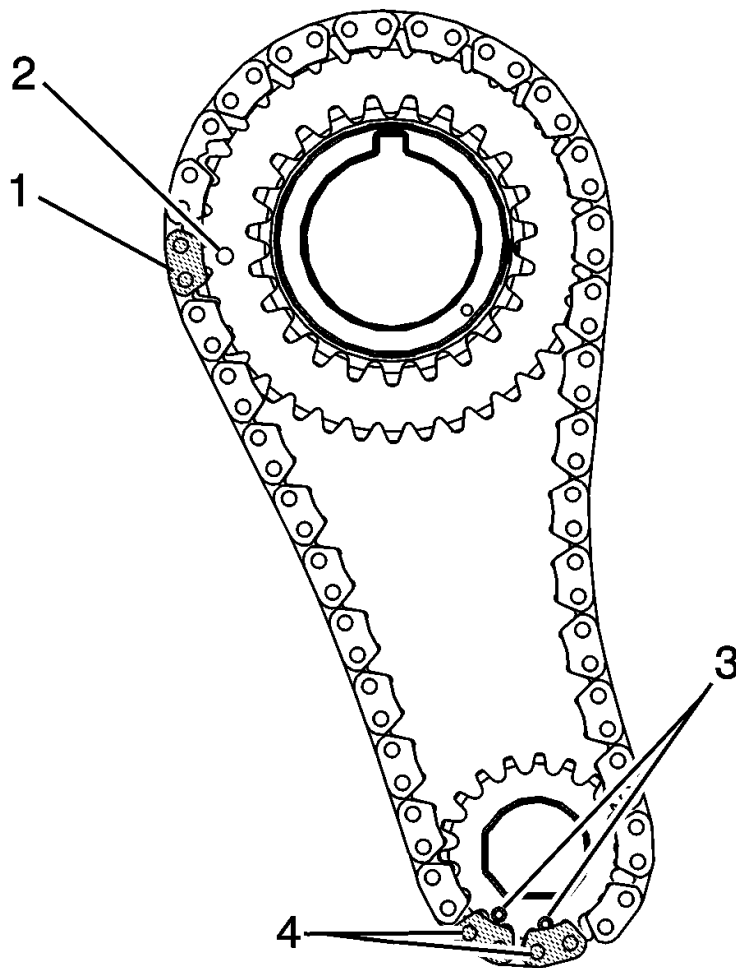


Fig. 71: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

17. Verify the timing links on the balance chain are properly aligned to the timing marks:
 1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
 2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.
18. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT TIMING CHAIN AND TENSIONER REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

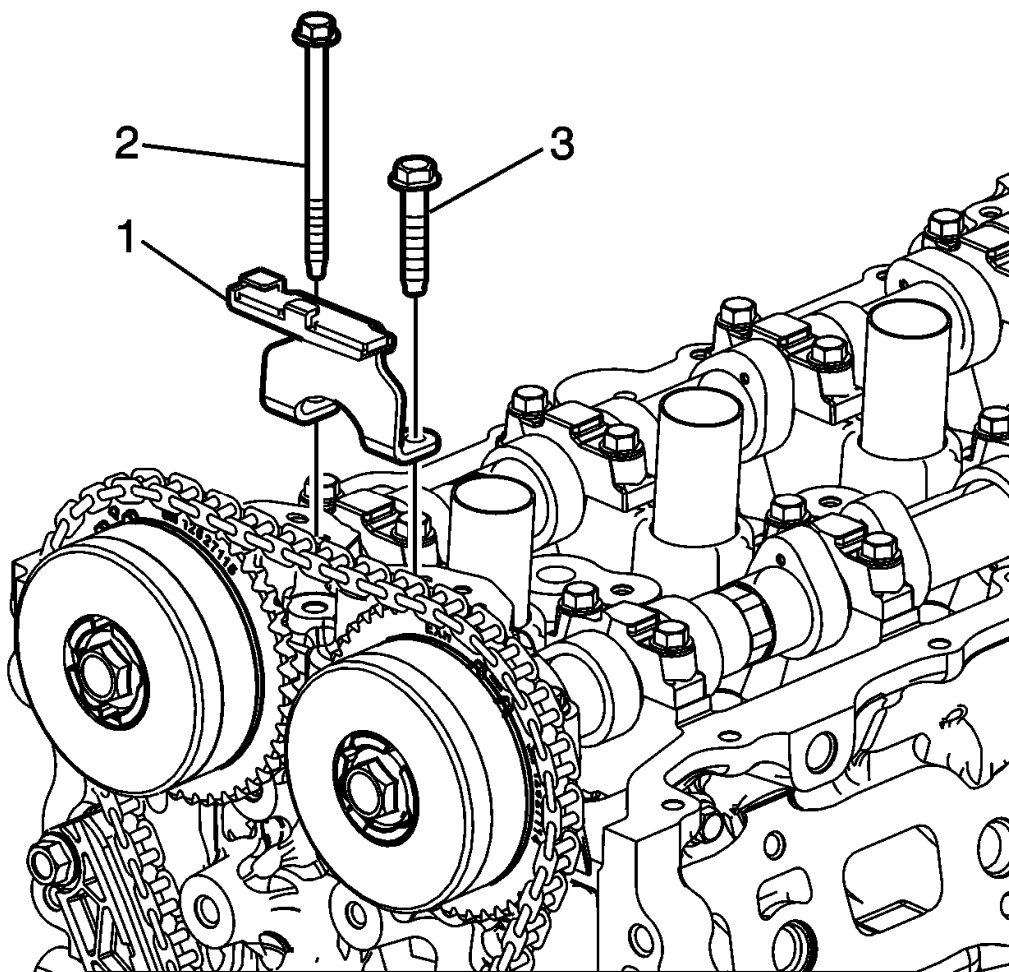


Fig. 72: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper timing chain guide bolts (2, 3).
3. Remove the upper timing chain guide (1).

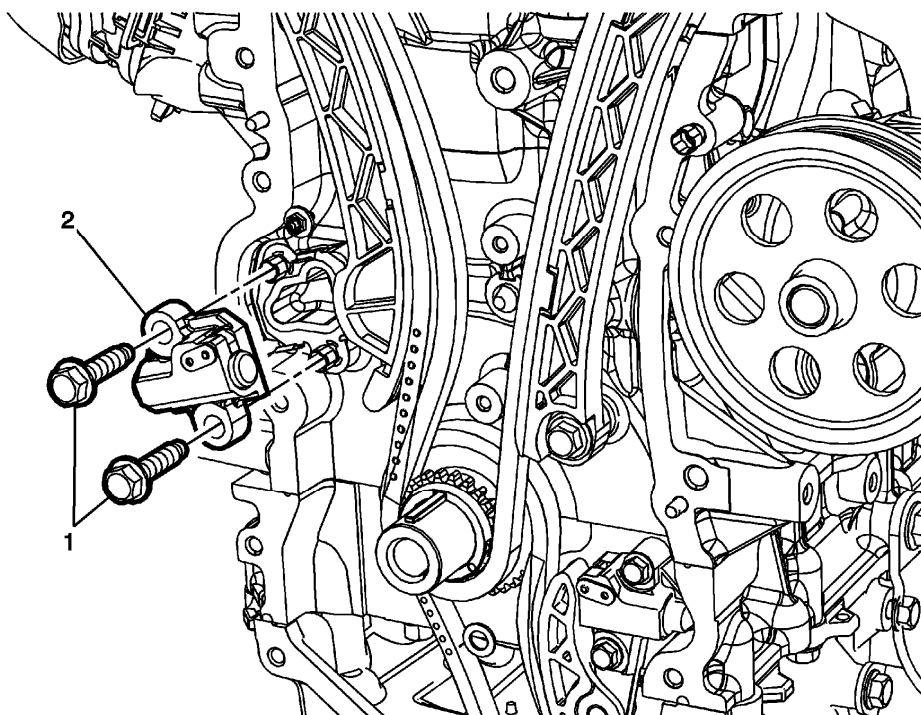


Fig. 73: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain tensioner bolts (1) and timing chain tensioner (2).

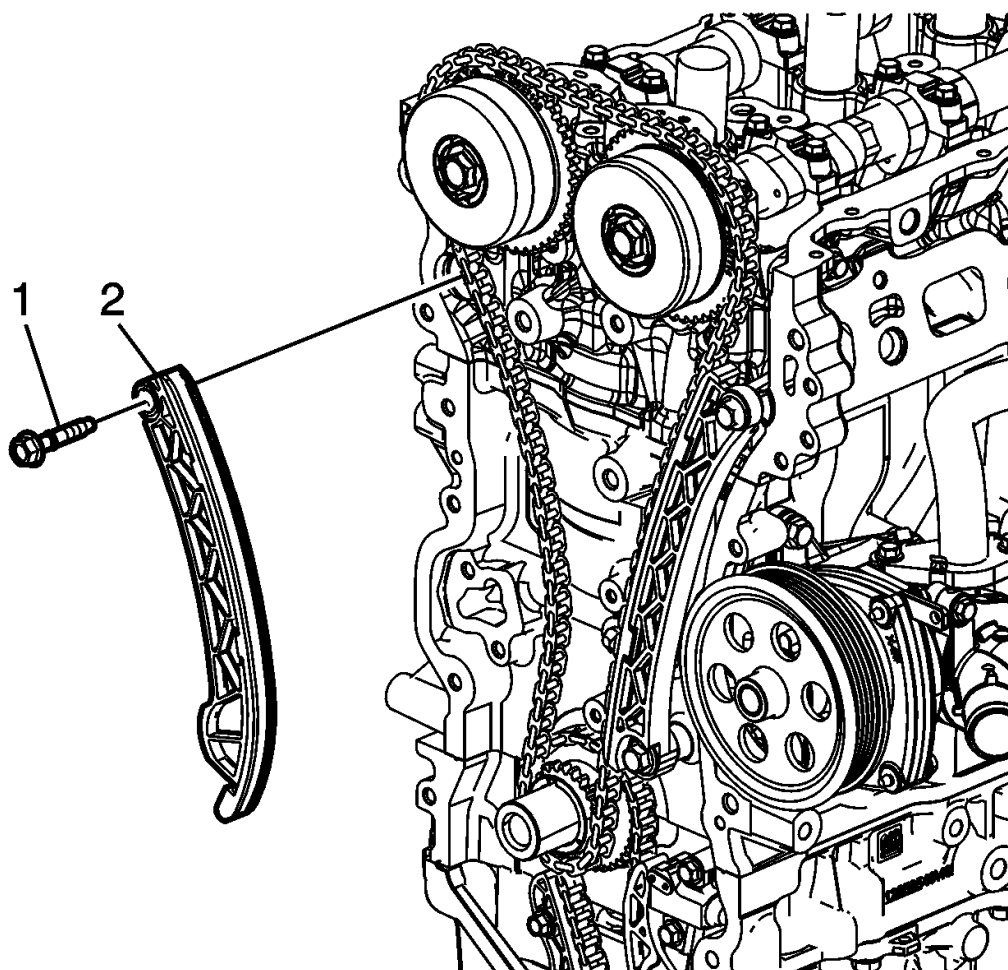


Fig. 74: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the timing chain tensioner pivot arm bolt (1).
6. Remove the timing chain tensioner pivot arm (2).

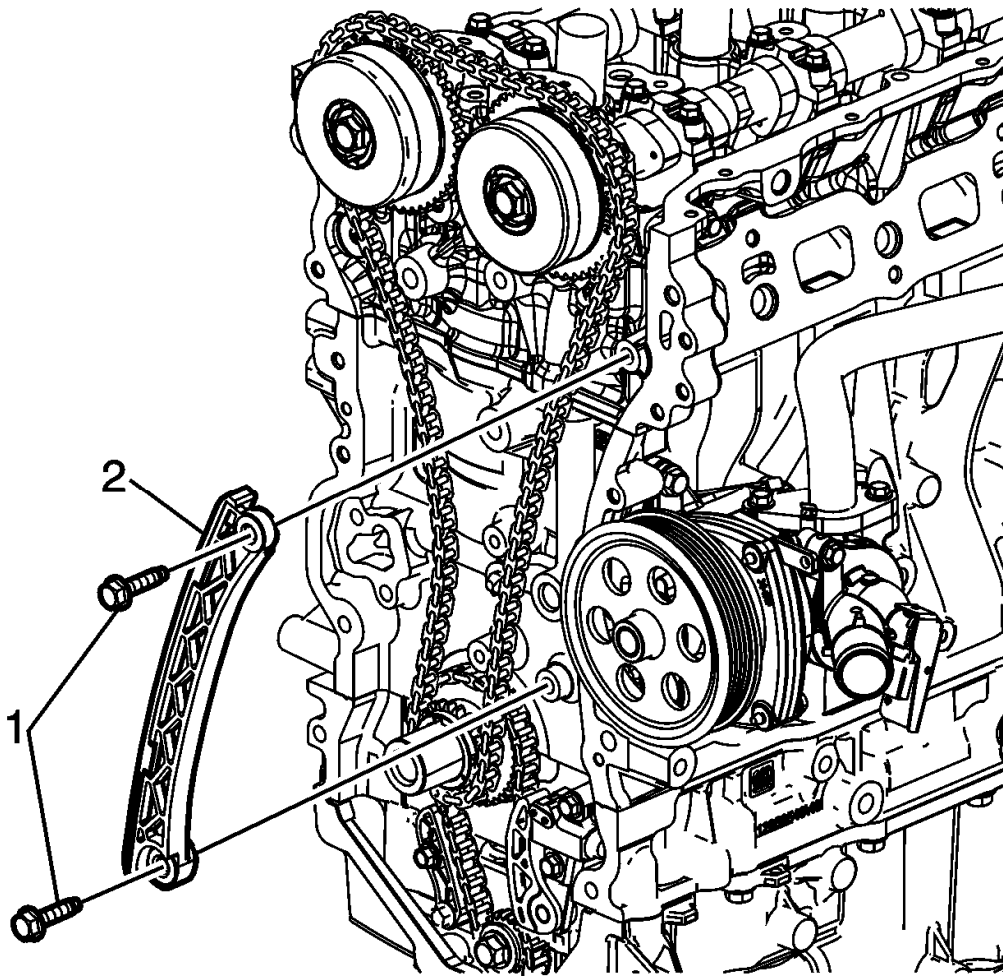


Fig. 75: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain guide bolts (1).
8. Remove the timing chain guide (2).

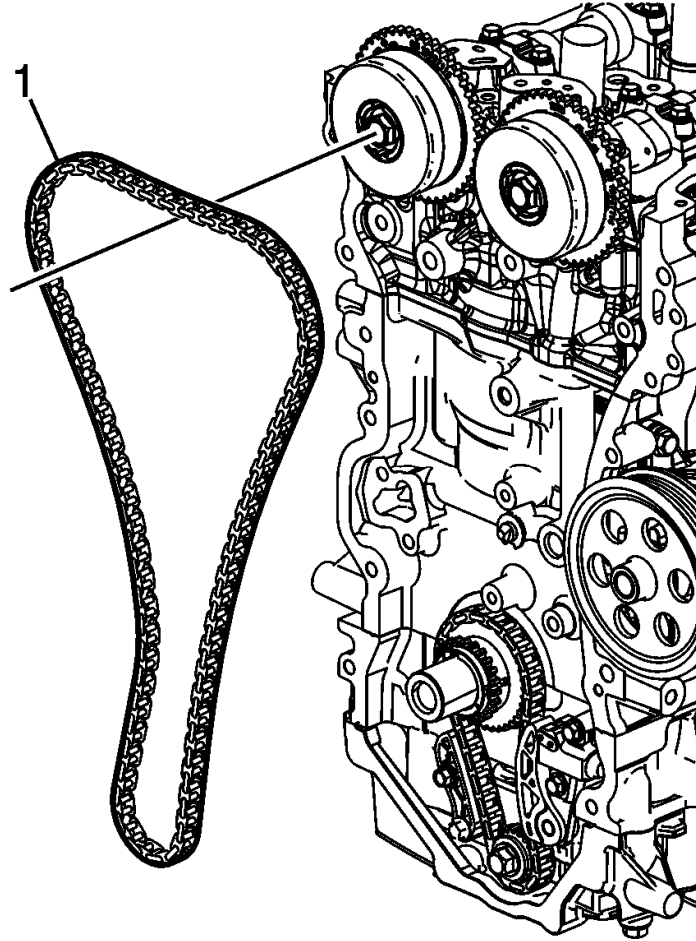


Fig. 76: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain (1).

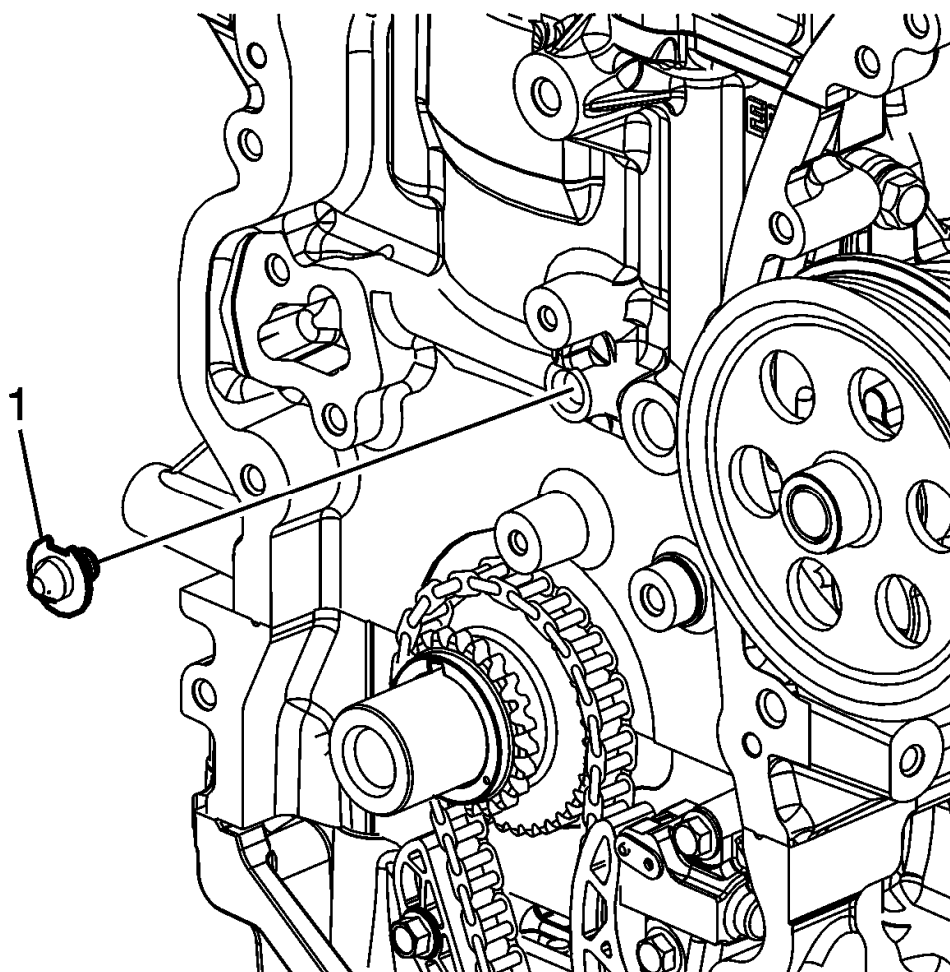


Fig. 77: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain oil nozzle (1).
11. For camshaft timing chain, sprocket, and tensioner cleaning and inspection. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Cleaning and Inspection** .

Installation Procedure

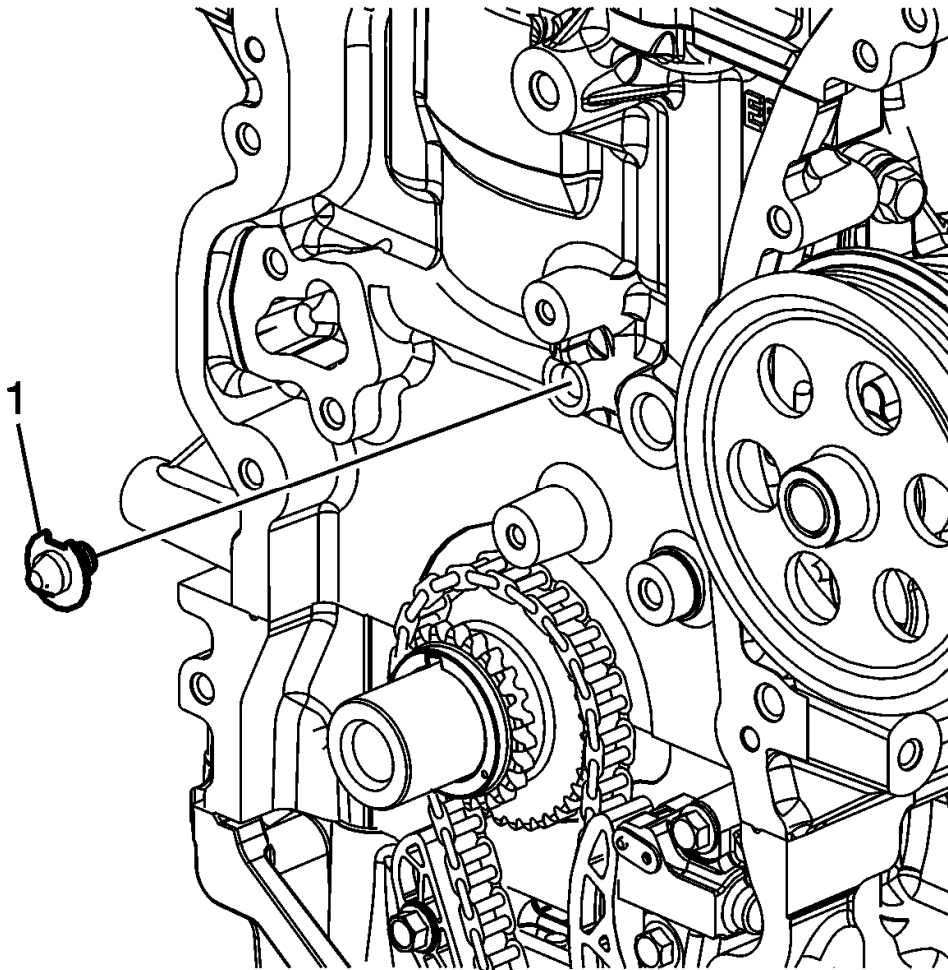


Fig. 78: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the timing chain oil nozzle is rotated with the notch facing upward, and aligned with the tab on the engine block.

1. Install the timing chain oil nozzle (1).

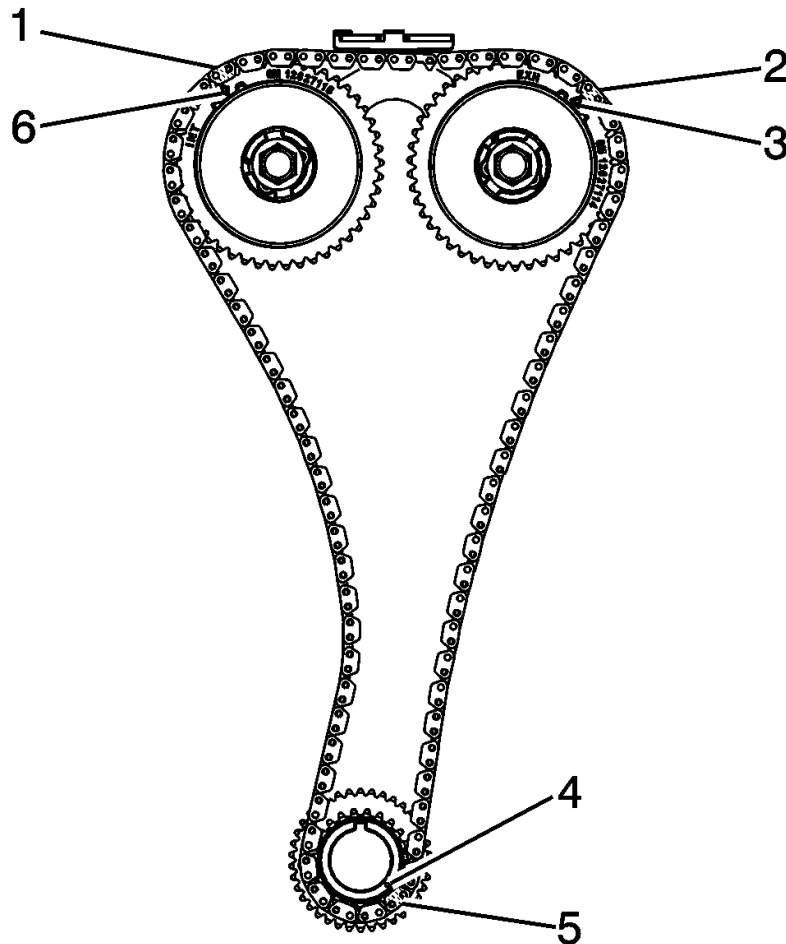


Fig. 79: Timing Chain Oil Nozzle
 Courtesy of GENERAL MOTORS COMPANY

NOTE: There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning the unique colored link (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: The unique colored links will not initially align with the intake actuator timing mark or the crankshaft sprocket timing mark.

3. Ensure the crankshaft key in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

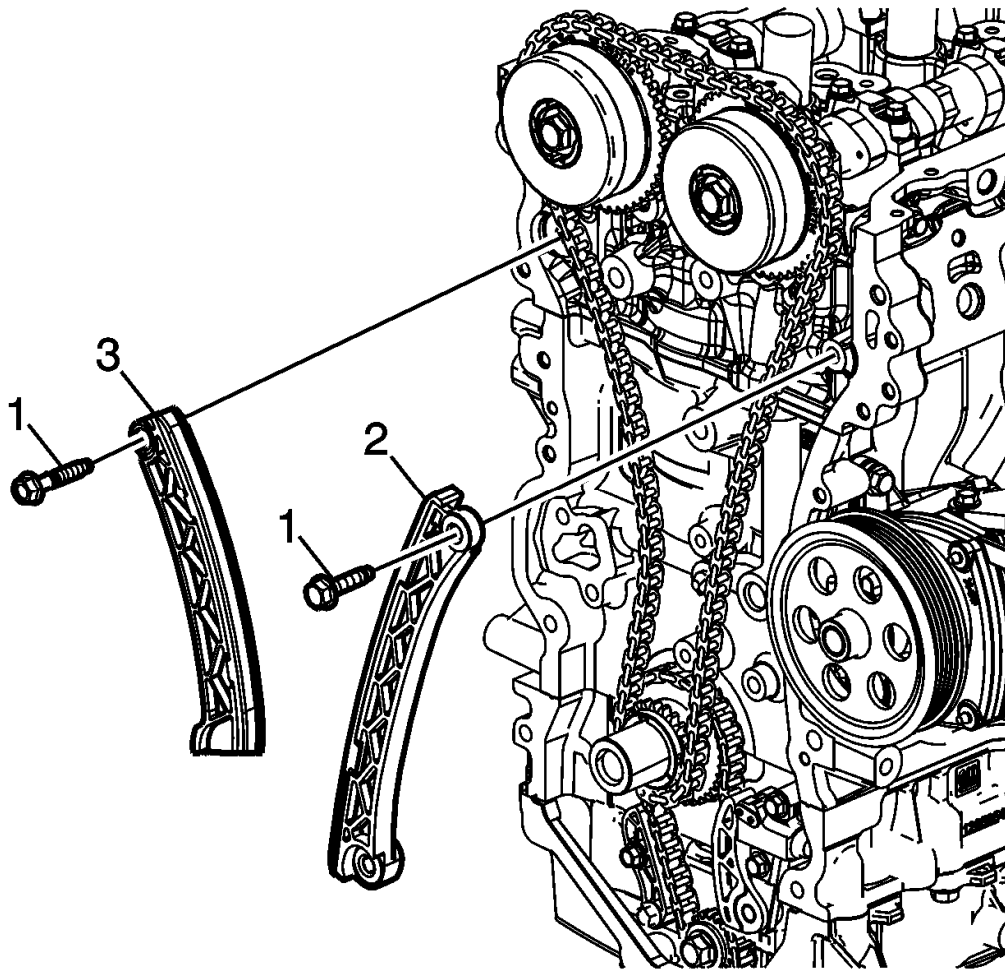


Fig. 80: Timing Chain Guide And Upper Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Timing will be established before the final install and torque of the guide bolts.

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

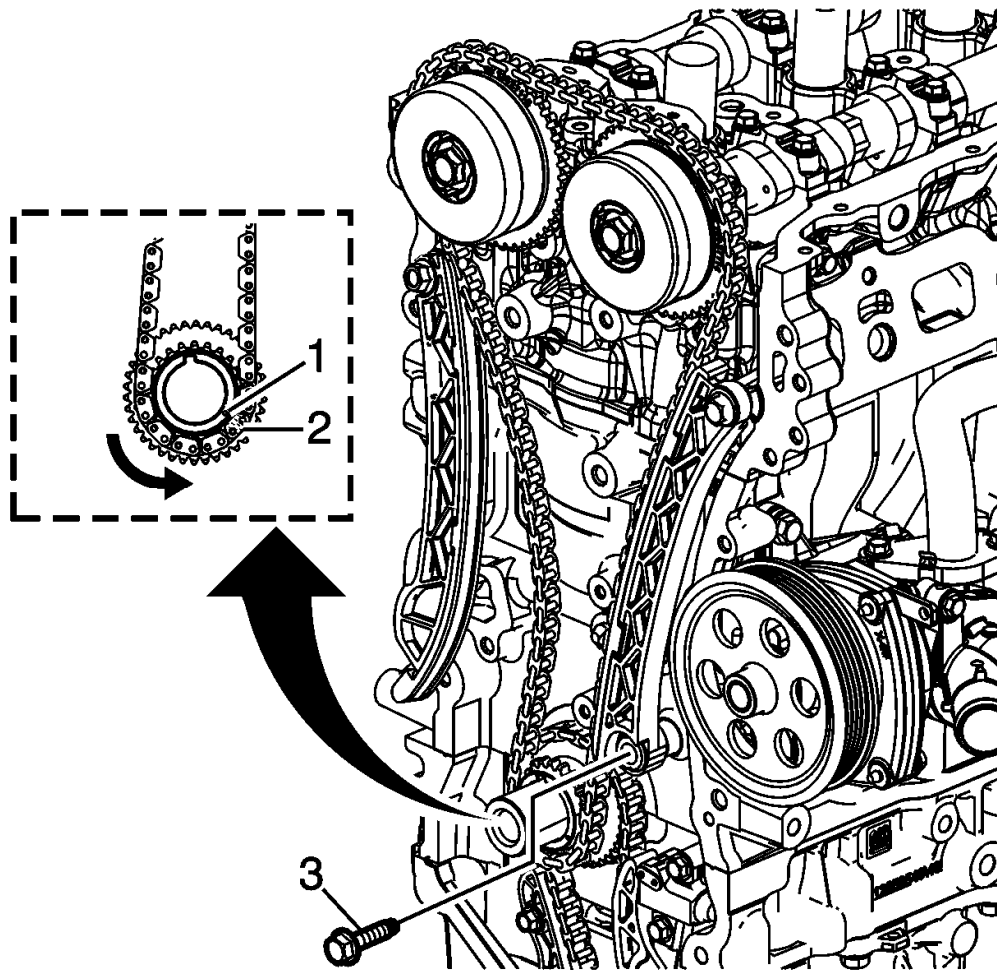


Fig. 81: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the timing link (2).

NOTE:

- Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.
- Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the timing link.

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: Refer to Fastener Caution .

9. Tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

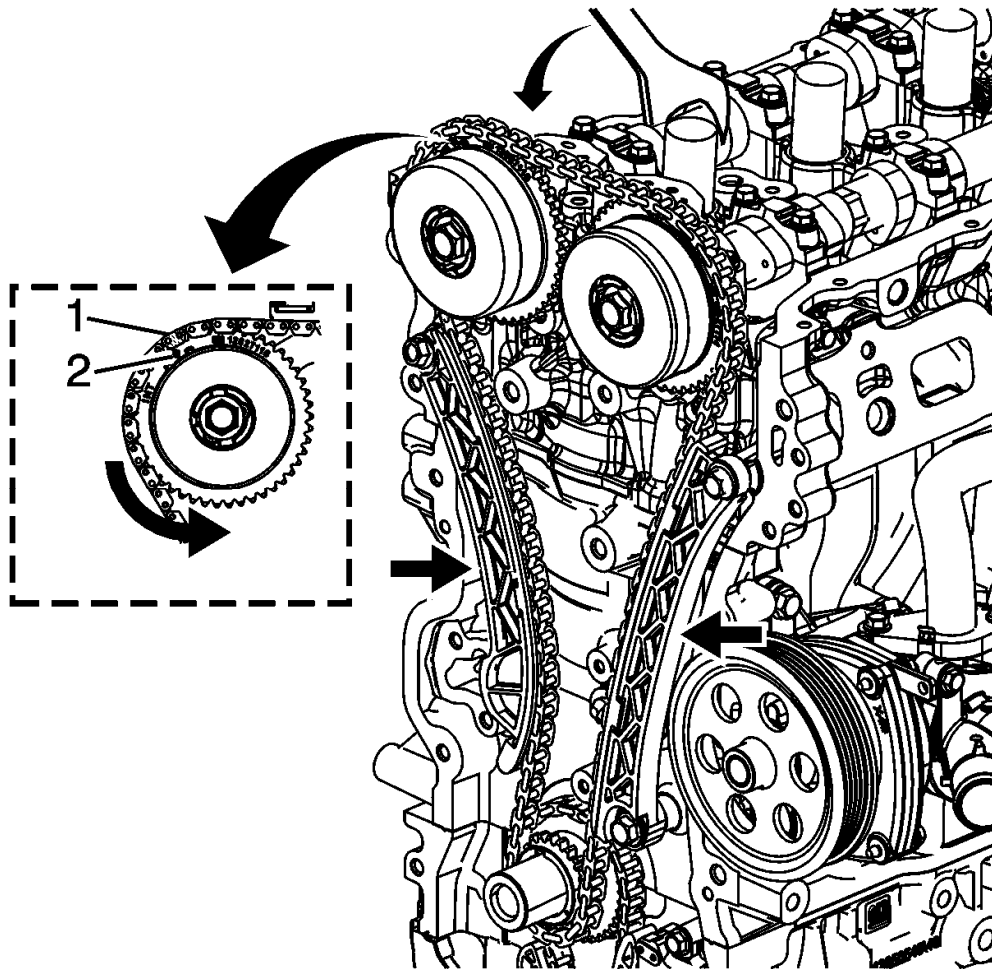


Fig. 82: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.
 - Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.
10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

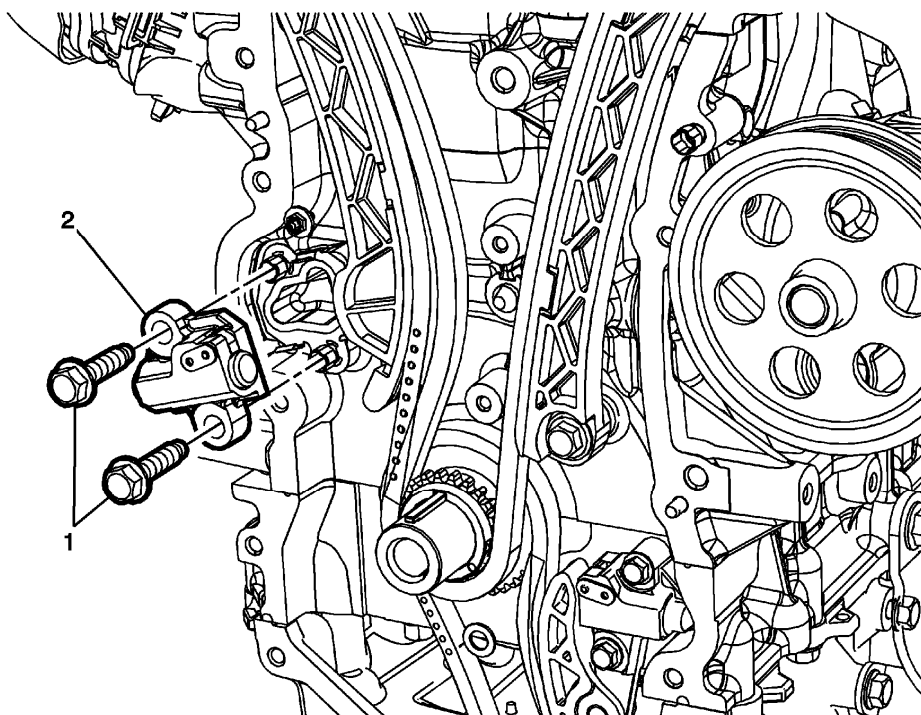


Fig. 83: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Install the timing chain tensioner (2) and tighten timing chain tensioner bolts (1) to 25 (18 lb ft)

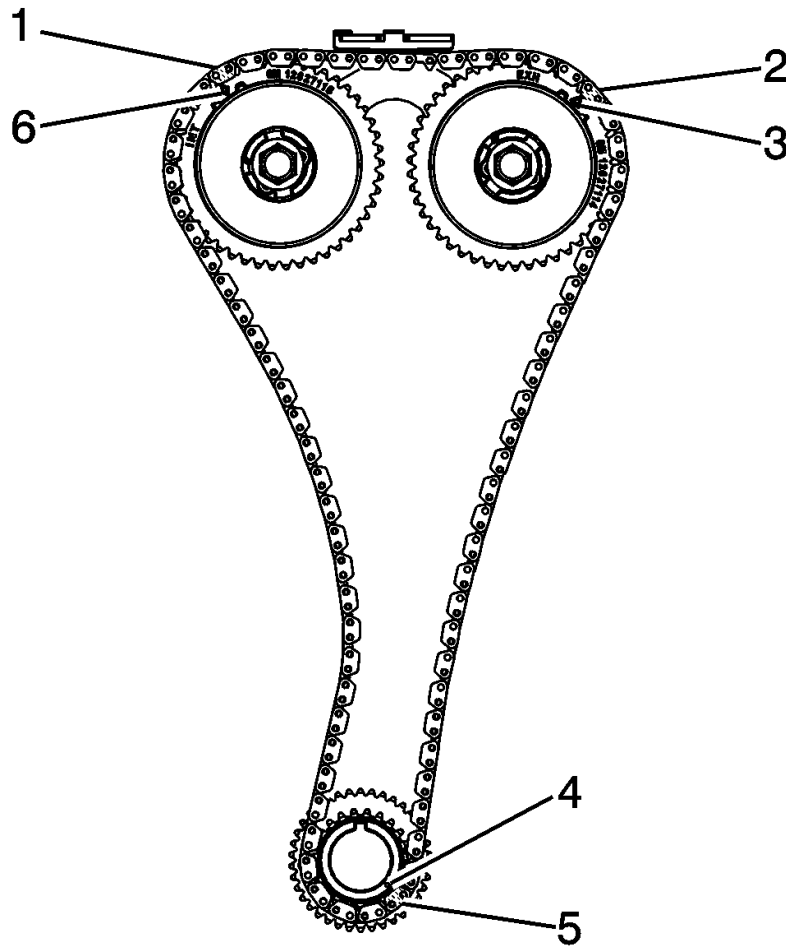


Fig. 84: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

12. Verify the timing links on the timing chain are properly aligned to the timing marks:
 1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
 2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
13. If they are not, repeat the portion of the procedure necessary to align the timing marks.

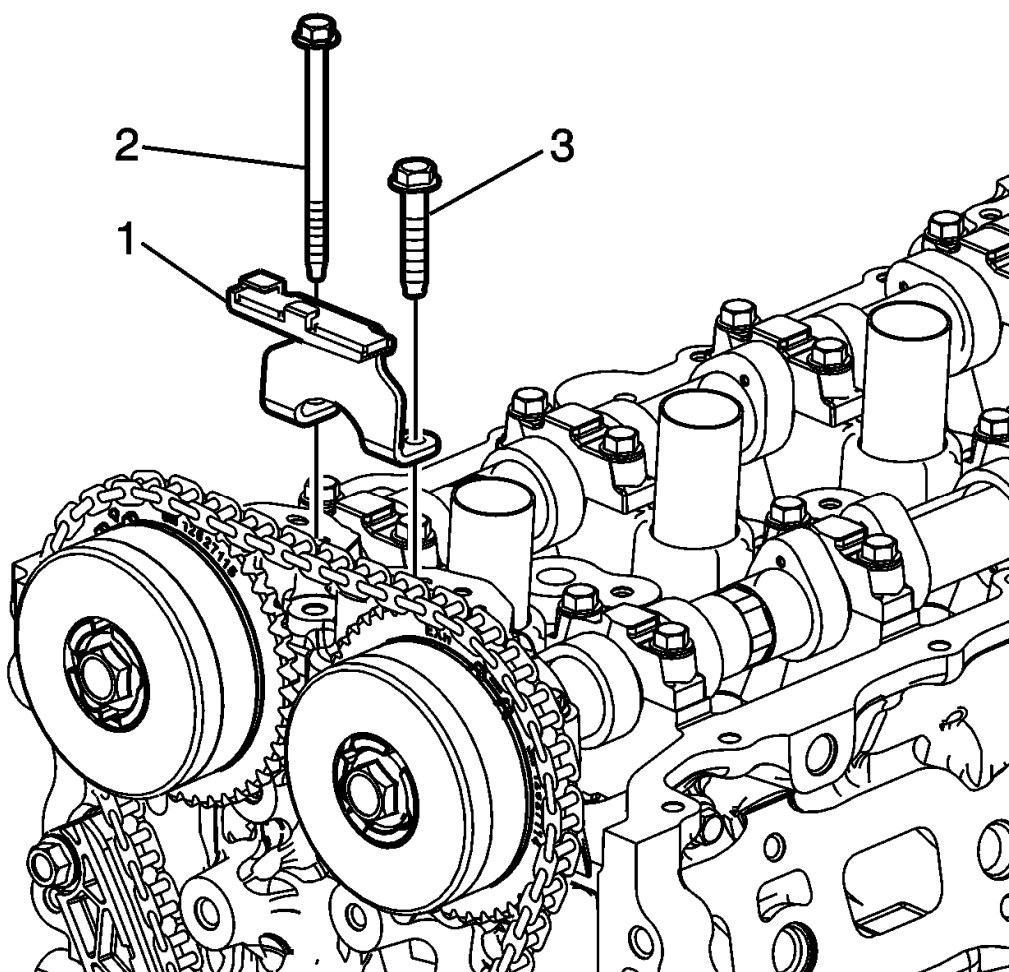


Fig. 85: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the timing chain guide (1) and bolts (2, 3) finger tight.

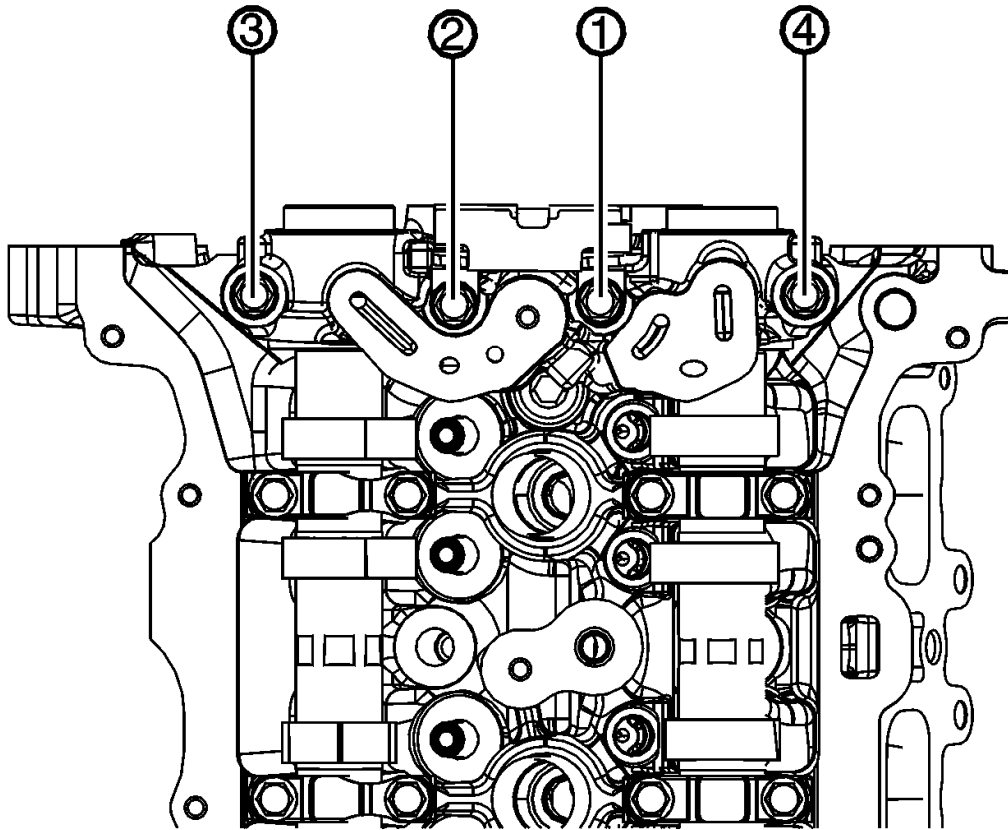


Fig. 86: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

15. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.
16. Rotate the crankshaft clockwise to see if either of the actuators or the crankshaft sprocket jump timing chain teeth. If this occurs, repeat procedure to align the timing marks.

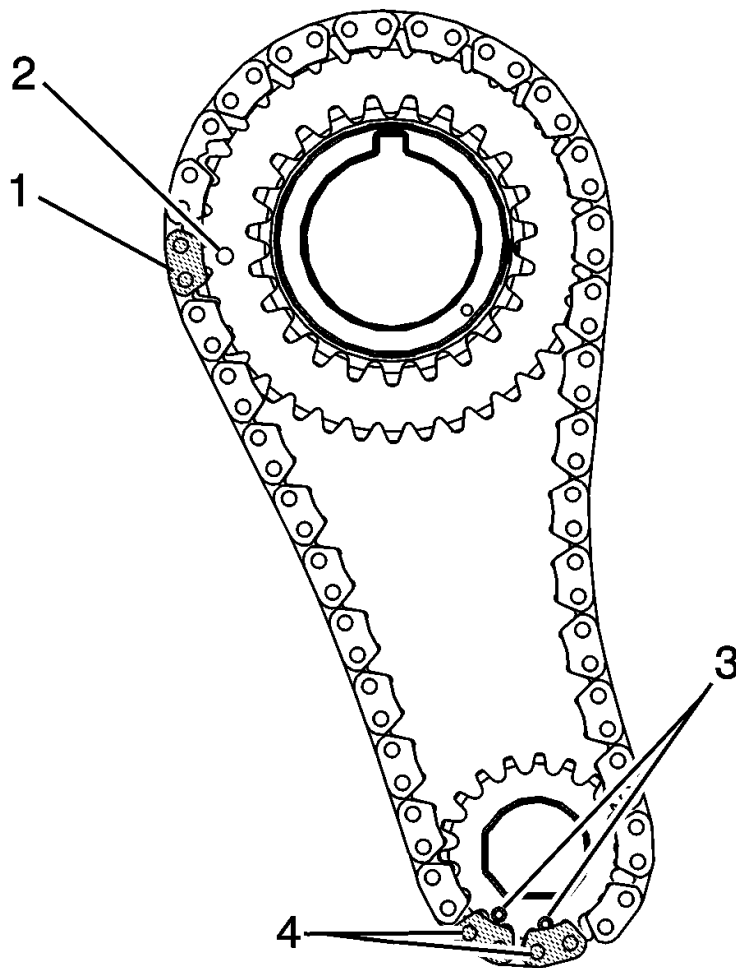


Fig. 87: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

17. Verify the timing links on the balance chain are properly aligned to the timing marks:
 1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
 2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.
18. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT COVER REPLACEMENT

Removal Procedure

1. Remove the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

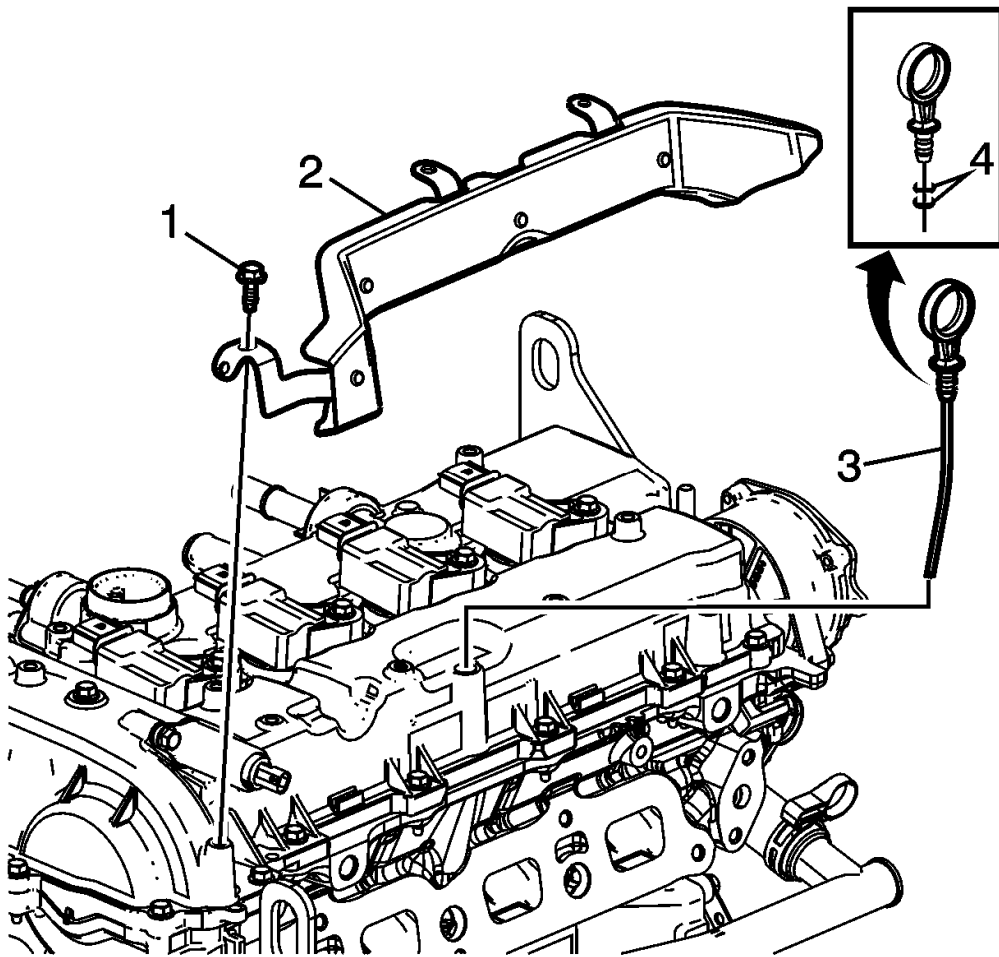


Fig. 88: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator (3). Inspect and replace the oil indicator O-ring seals (4), if necessary.
3. Remove the camshaft cover heat shield (2) and bolts (1).

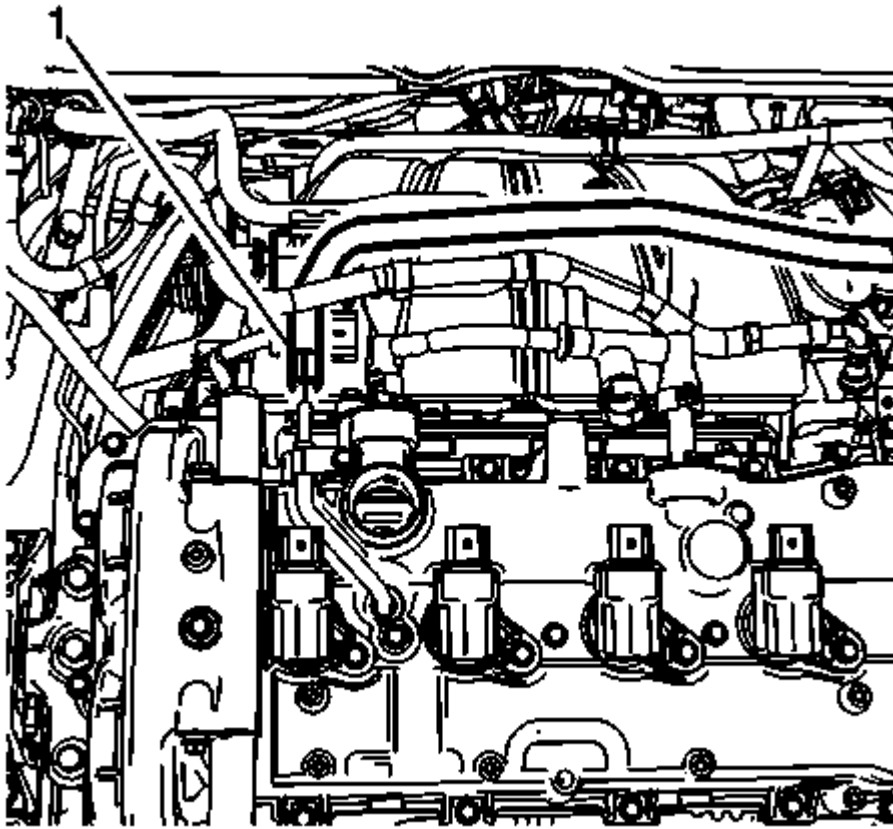


Fig. 89: Surge Tank Hose

Courtesy of GENERAL MOTORS COMPANY

4. Remove the surge tank hose (1).
5. Remove the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LTG)** .

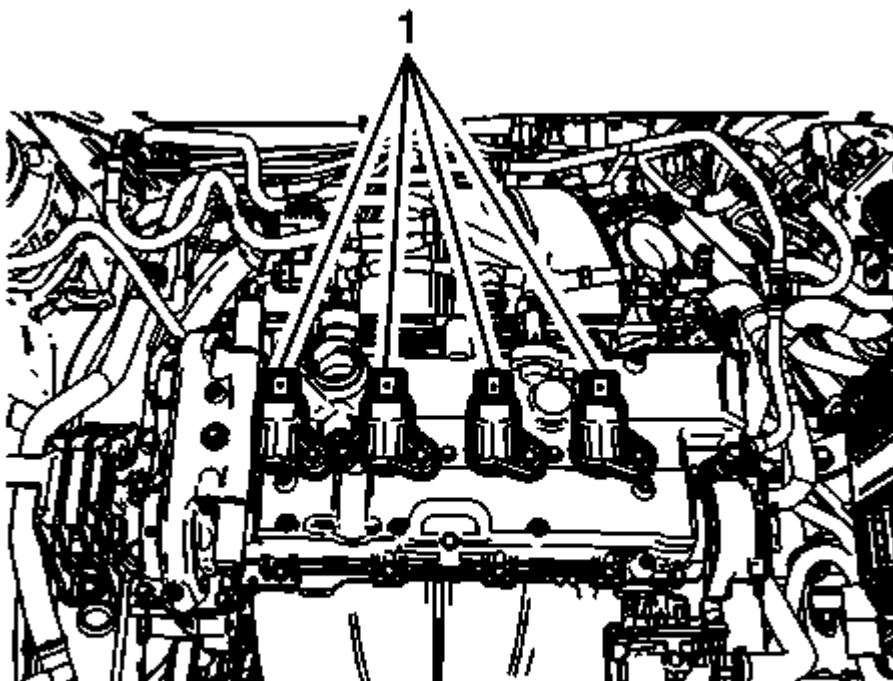


Fig. 90: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

6. Remove the ignition coils (1). Refer to **Ignition Coil Replacement** .

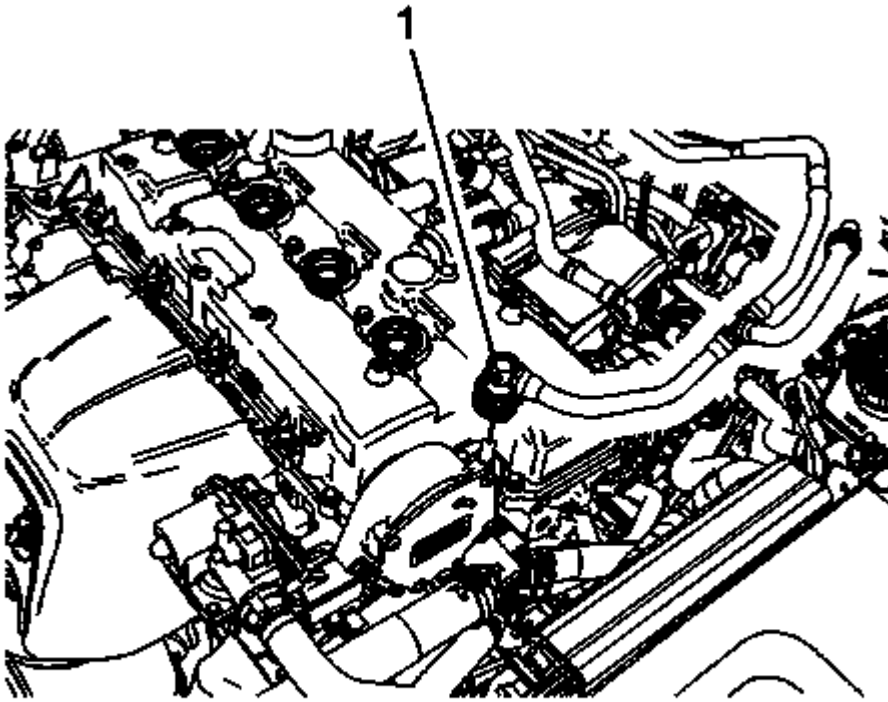


Fig. 91: Vacuum Booster Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect vacuum booster pipe (1).

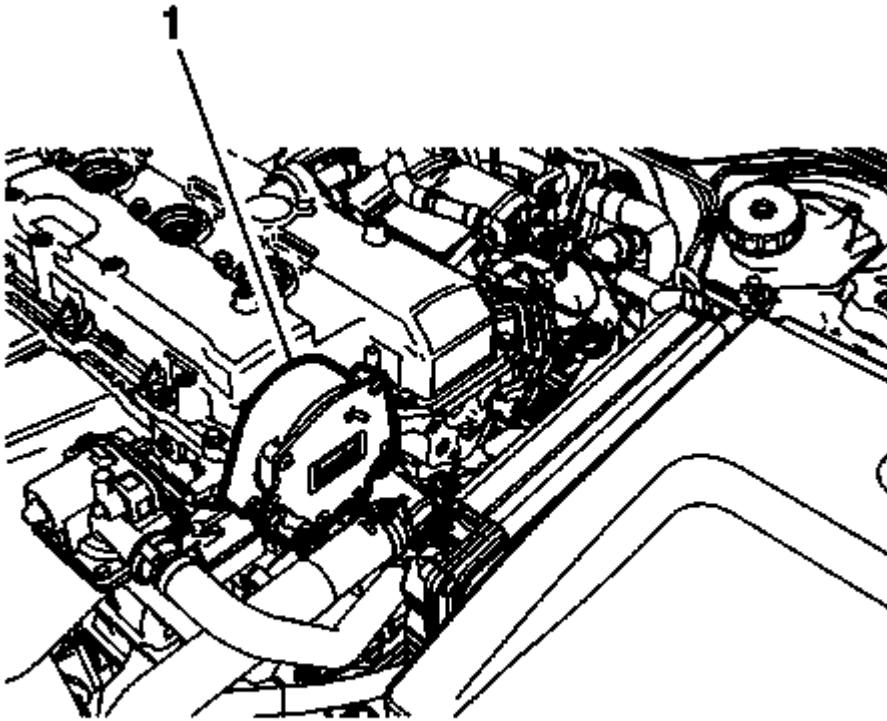


Fig. 92: Vacuum Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Remove the vacuum assembly (1). Refer to **Vacuum Pump Replacement** .

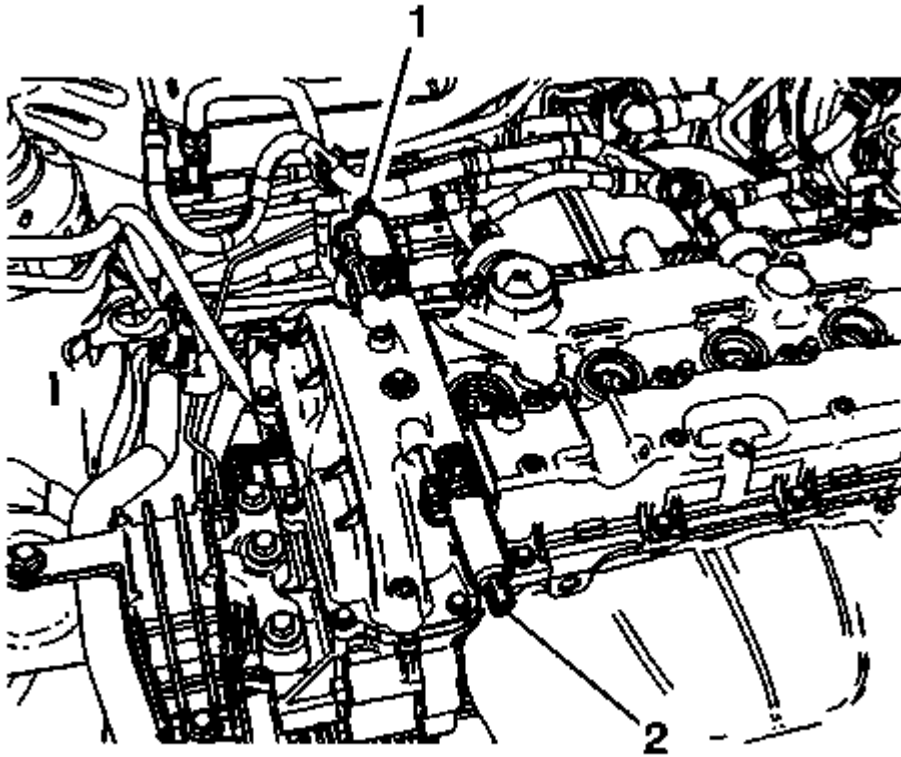


Fig. 93: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

9. Remove the camshaft position actuator intake (1) solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement**
10. Remove the camshaft position actuator exhaust (2) solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement**

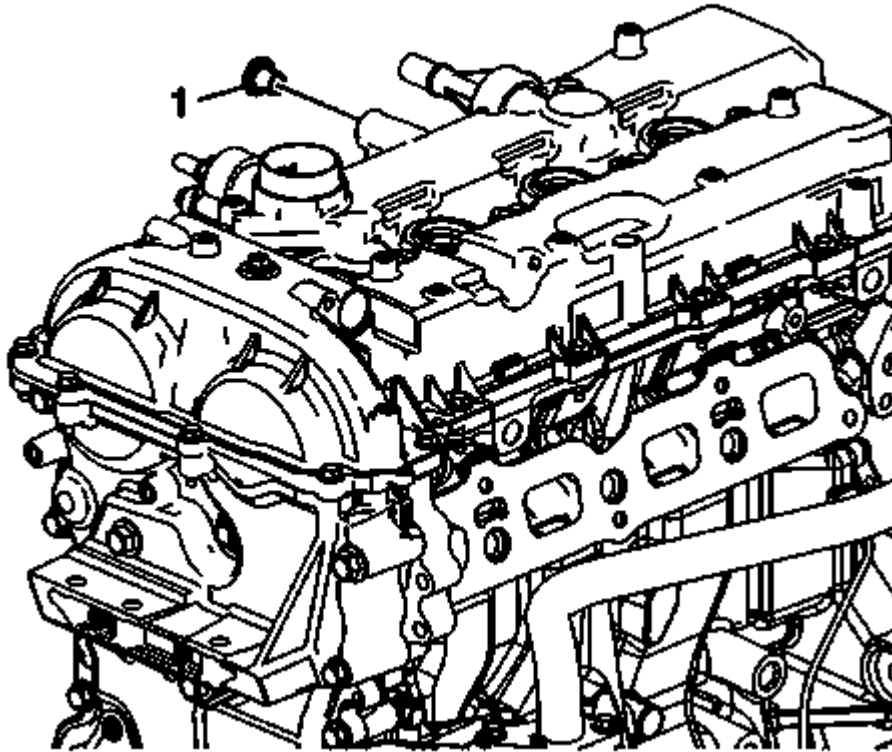


Fig. 94: Camshaft Cover Plug
Courtesy of GENERAL MOTORS COMPANY

11. Remove the camshaft cover plug (1).

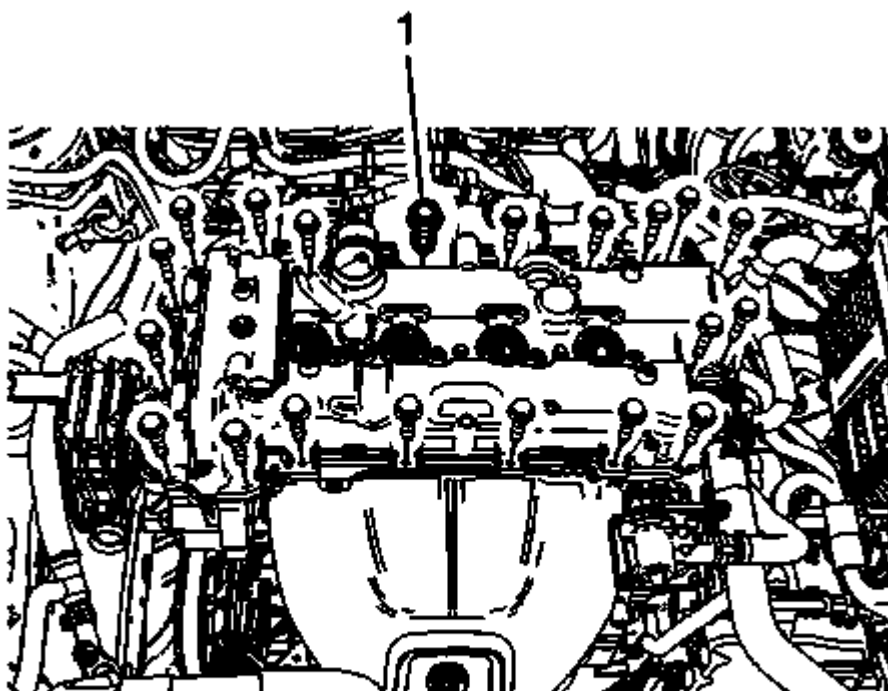


Fig. 95: Camshaft Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

12. Remove the camshaft cover fasteners (1).

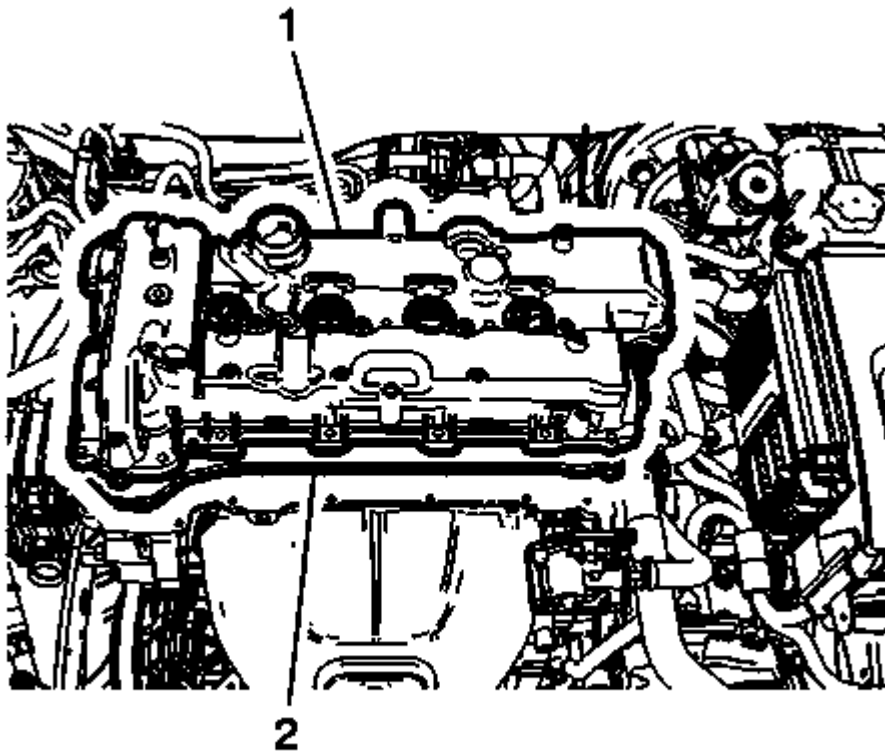


Fig. 96: Camshaft Cover And Gasket
Courtesy of GENERAL MOTORS COMPANY

13. Remove the camshaft cover (1) and gasket (2).
14. For cleaning and inspection. Refer to **Camshaft Cover Cleaning and Inspection** .

Installation Procedure

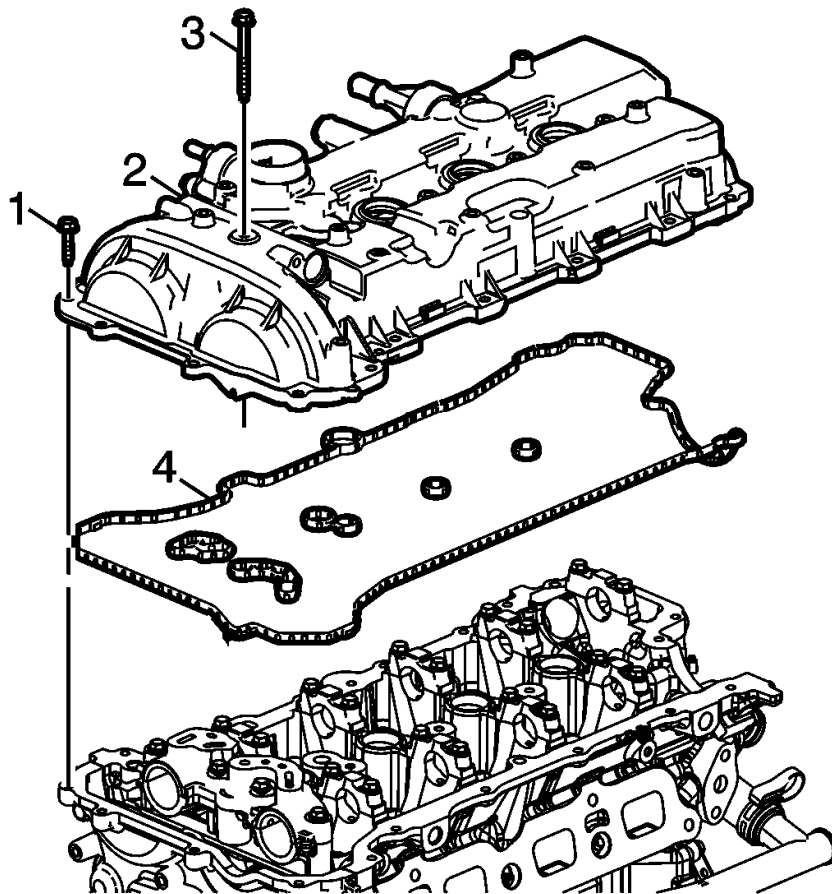


Fig. 97: Camshaft Cover Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: Add 14mm bead of sealant part # 12378521 at right and left T-Joint where front cover meets head and at rear of camshaft cover right and left T-Joint where vacuum pump bolts on.

1. Assemble the camshaft cover (2) and a NEW gasket (4). Ensure that the gasket is located in the retaining groove in the camshaft cover.
2. Install the cover on the cylinder head and hand start the bolts (1, 3).

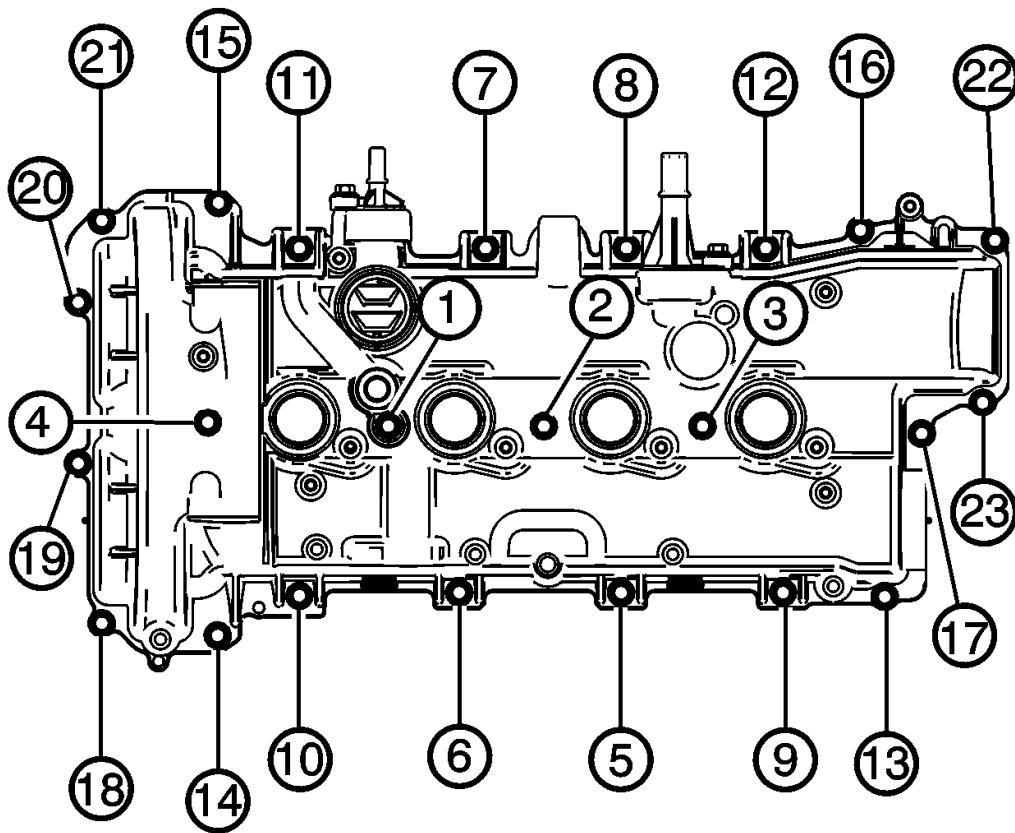


Fig. 98: Camshaft Cover Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the camshaft cover bolts in sequence to 10 (89 lb in).

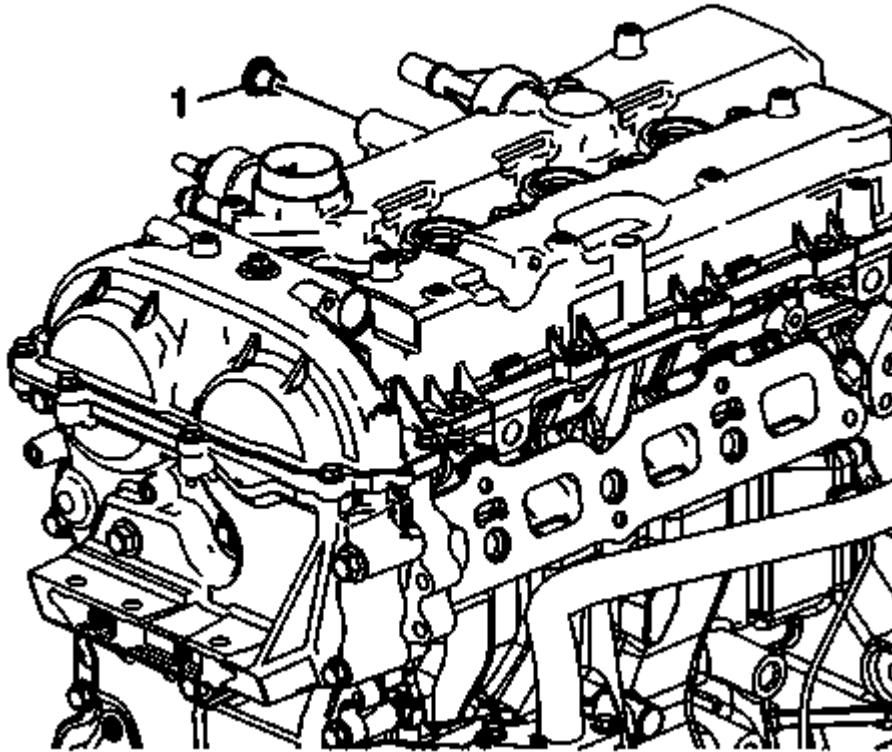


Fig. 99: Camshaft Cover Plug

Courtesy of GENERAL MOTORS COMPANY

4. Install the camshaft cover plug (1). Tighten the plug to 35 (26 lb ft).
5. Install the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LTG)** .

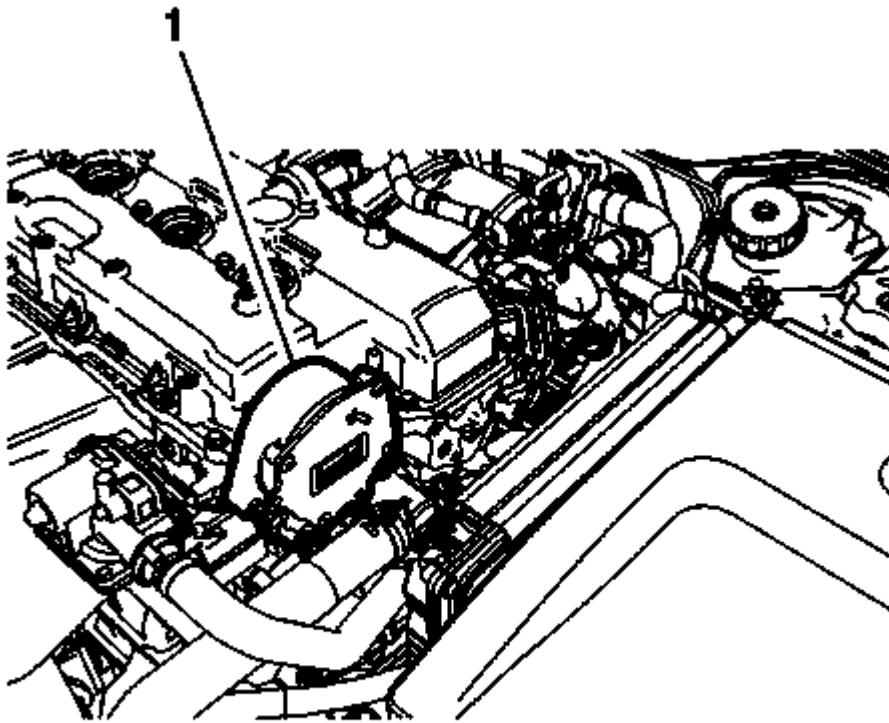


Fig. 100: Vacuum Assembly

Courtesy of GENERAL MOTORS COMPANY

6. Install the vacuum assembly (1). Refer to **Vacuum Pump Replacement** .

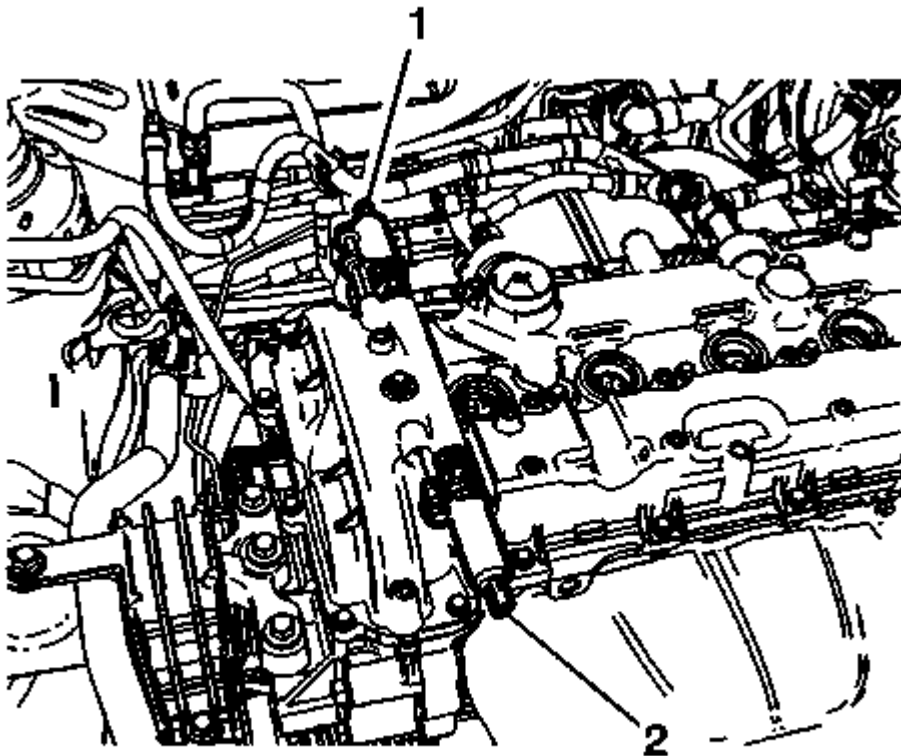


Fig. 101: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

7. Install the camshaft position actuator intake (1) solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement** .
8. Install the camshaft position actuator exhaust (2) solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** .

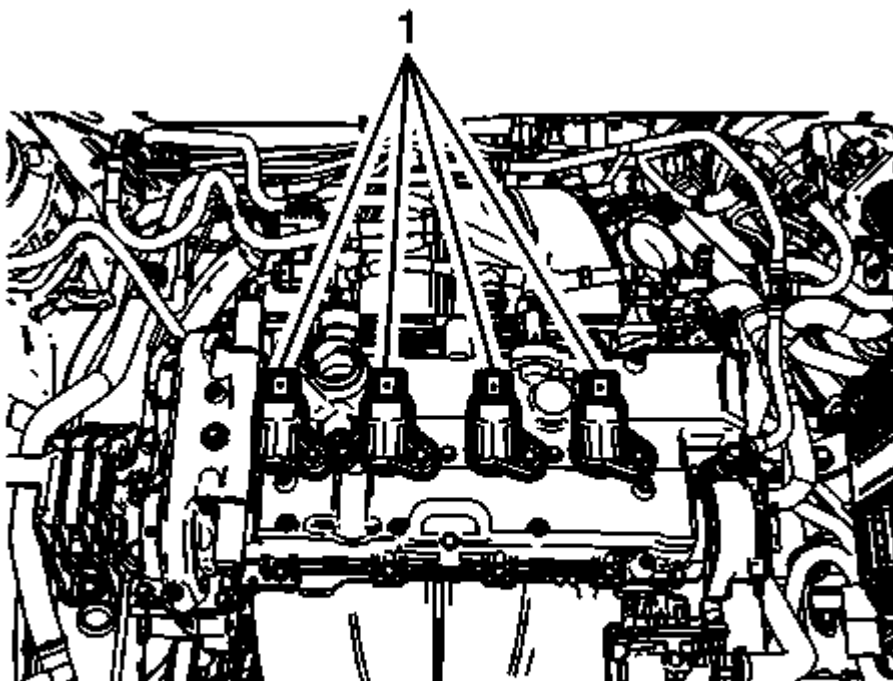


Fig. 102: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

9. Install the ignition coils (1). Refer to **Ignition Coil Replacement** .

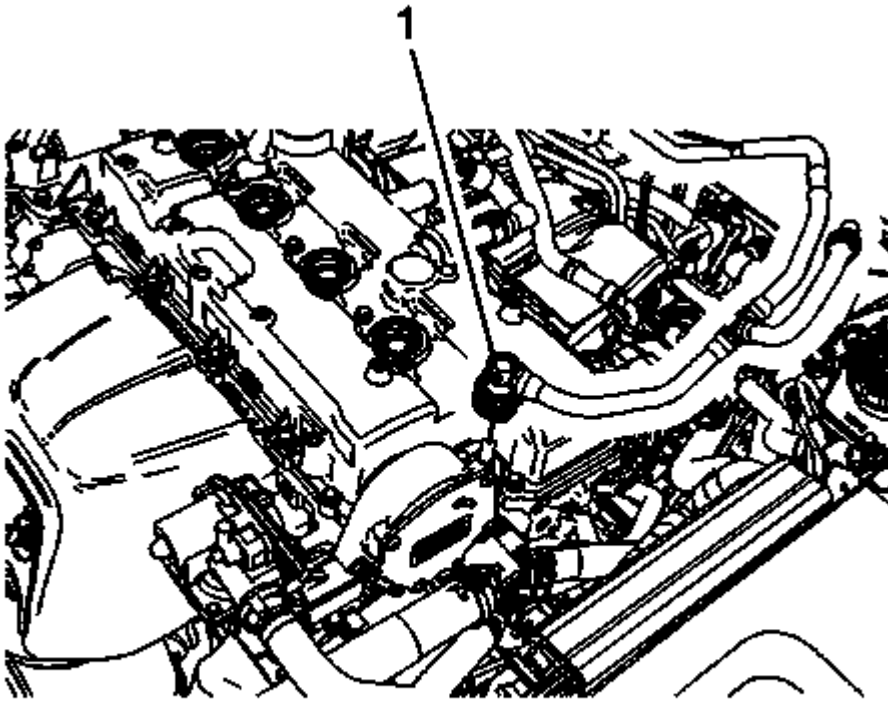


Fig. 103: Vacuum Booster Pipe

Courtesy of GENERAL MOTORS COMPANY

10. Connect vacuum booster pipe (1).

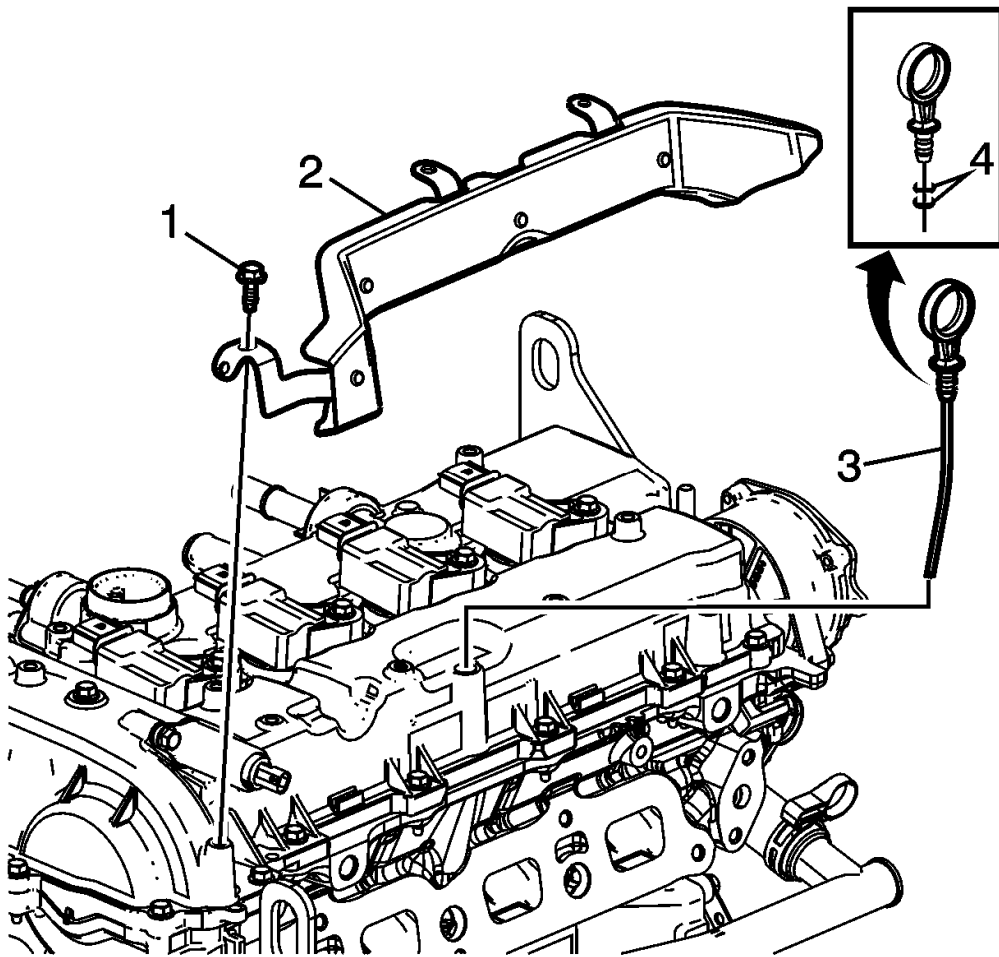


Fig. 104: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

11. Install the camshaft cover heat shield (2) and bolts (1). Tighten the bolts to 10 (89 lb in).
12. Inspect the oil level indicator O-ring seals (4) and replace if necessary. Install the oil level indicator (3).

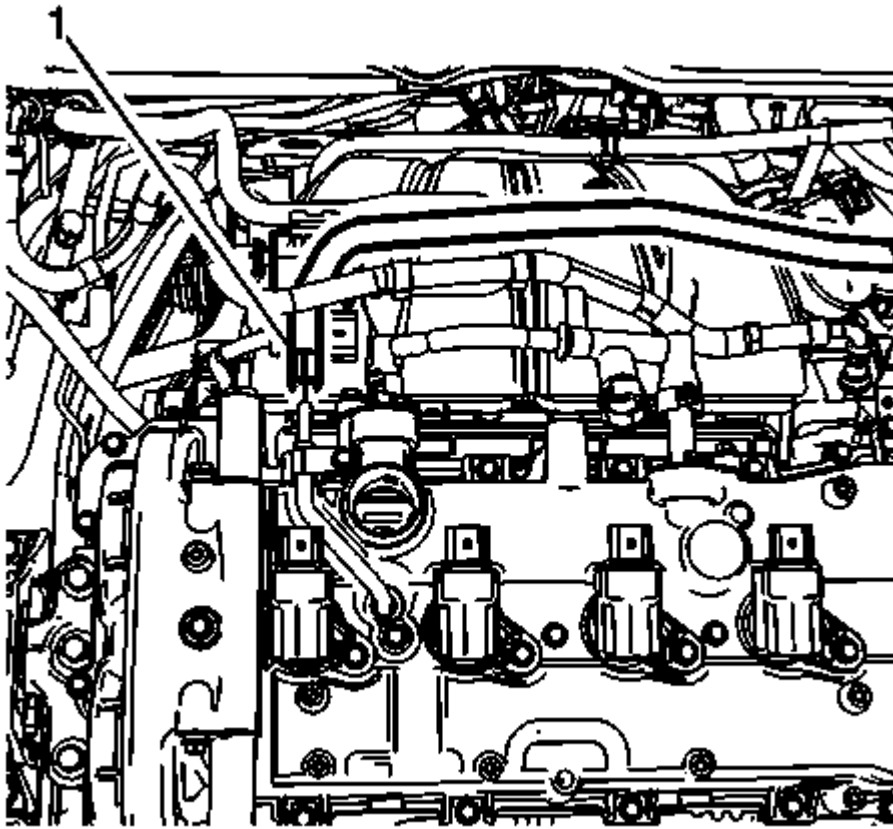


Fig. 105: Surge Tank Hose

Courtesy of GENERAL MOTORS COMPANY

13. Install the surge tank hose (1).
14. Install the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

TIMING CHAIN TENSIONER REPLACEMENT

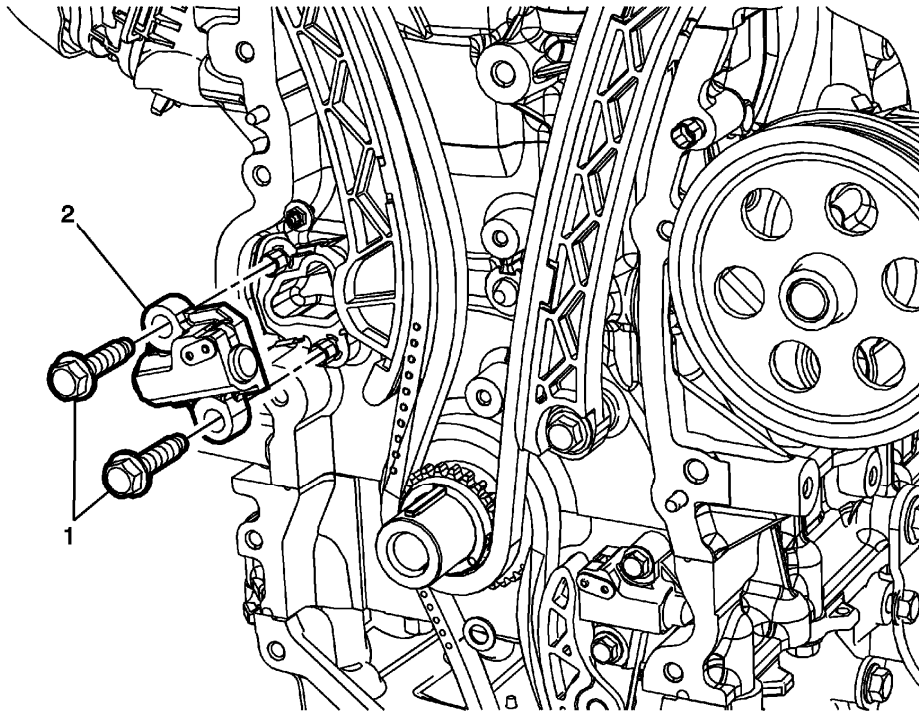


Fig. 106: Timing Chain Tensioner Bolts And Timing Chain Tensioner
 Courtesy of GENERAL MOTORS COMPANY

Timing Chain Tensioner Replacement

Callout	Component Name
Preliminary Procedure Remove the engine front cover. Refer to <u>Engine Front Cover Replacement</u> .	
1	Timing Chain Tensioner Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft) Special Tool EN-50837 Timing Chain Tensioner Retraction Tool . For equivalent regional tools, refer to <u>Special Tools</u> .
2	Timing Chain Tensioner

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - EXHAUST

Removal Procedure

1. Remove the exhaust valve rocker arm. Refer to **Exhaust Valve Rocker Arm Replacement**.

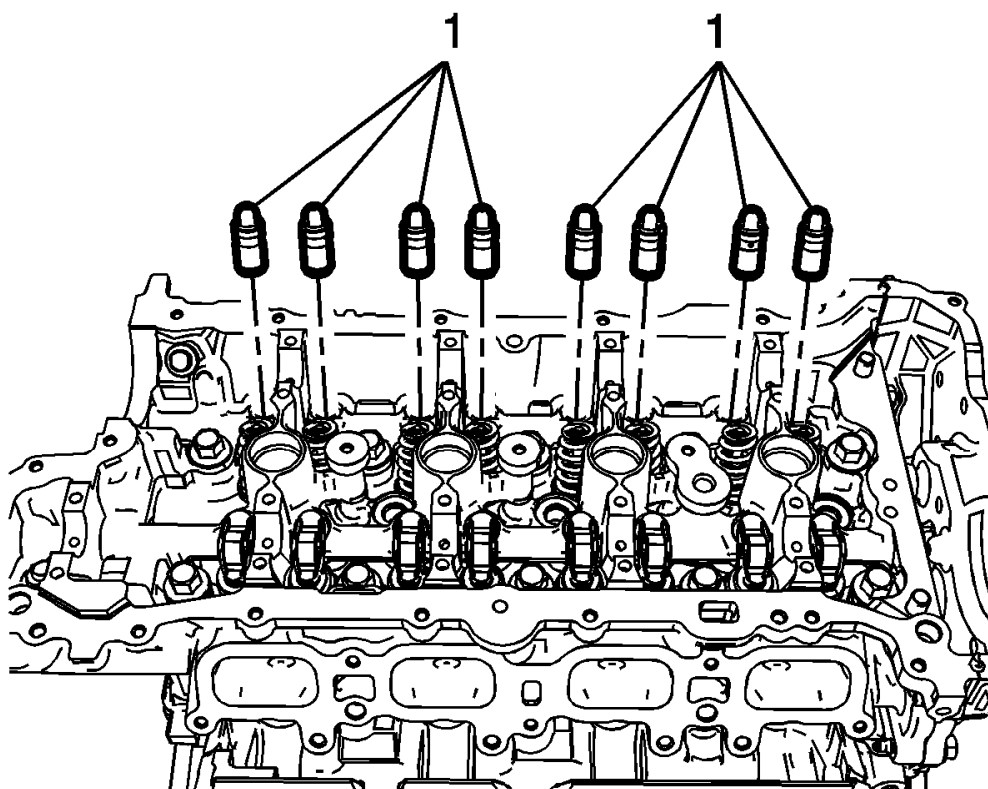


Fig. 107: Hydraulic Lash Adjusters - Exhaust
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

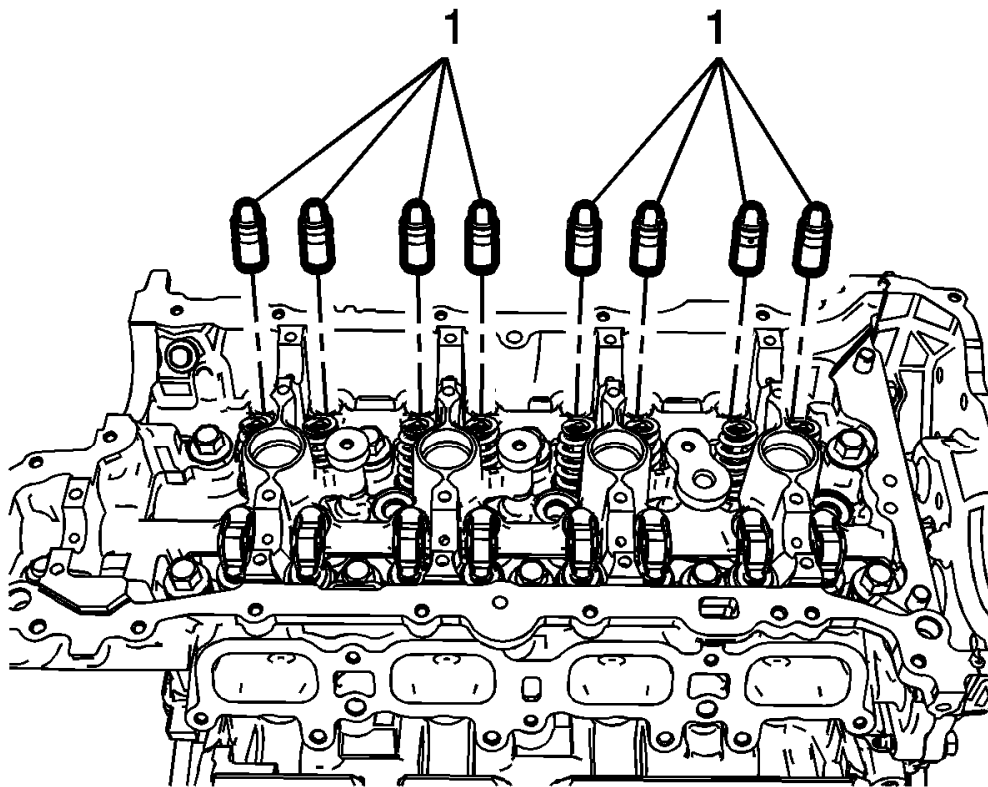


Fig. 108: Hydraulic Lash Adjusters - Exhaust
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the exhaust valve rocker arm. Refer to **Exhaust Valve Rocker Arm Replacement**.

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - INTAKE

Removal Procedure

1. Remove the intake valve rocker arm. Refer to **Intake Valve Rocker Arm Replacement**.

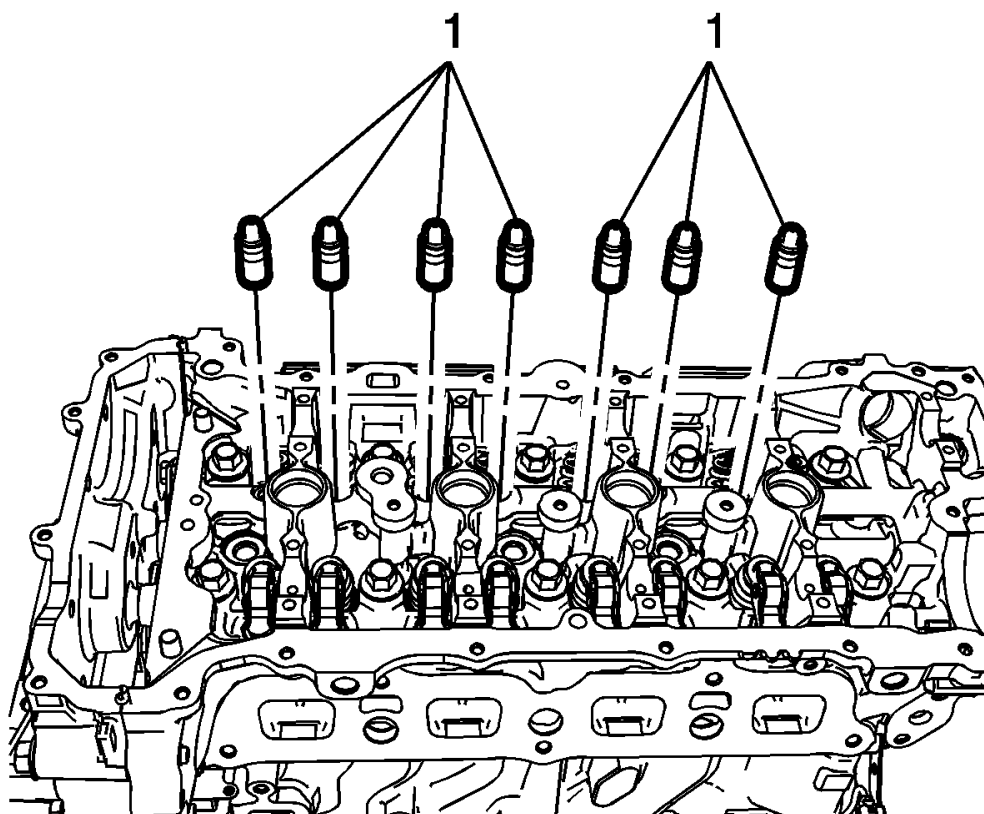


Fig. 109: Hydraulic Lash Adjusters - Intake
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

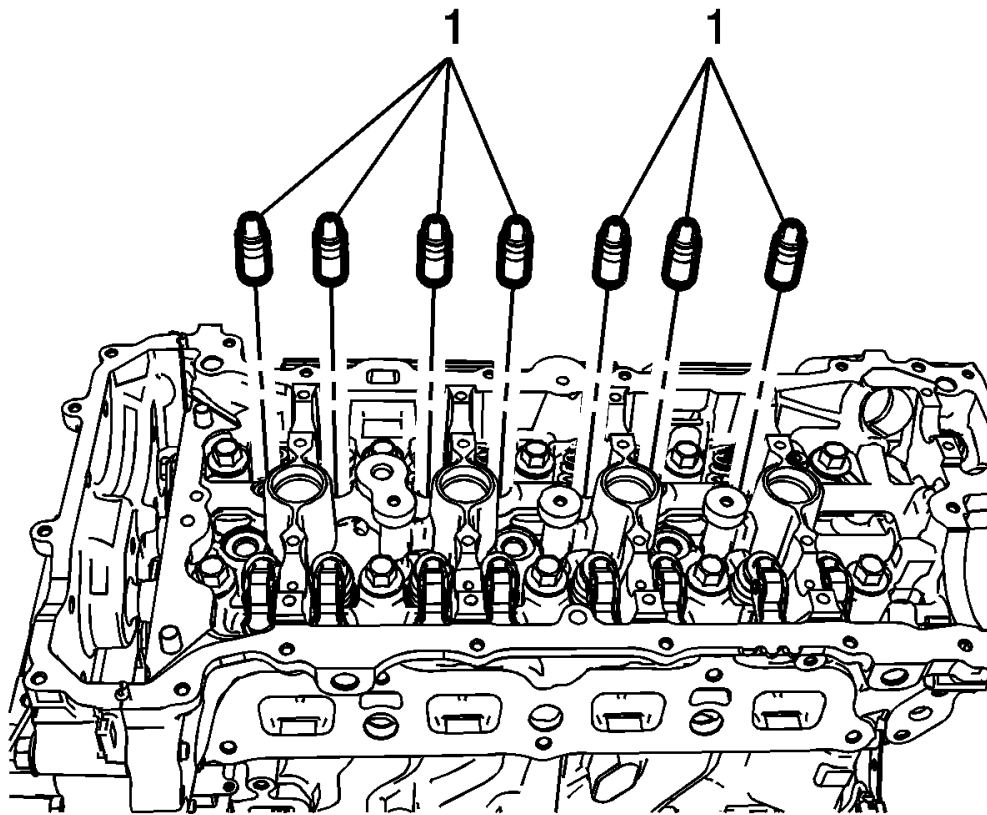


Fig. 110: Hydraulic Lash Adjusters - Intake
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the intake valve rocker arm. Refer to **Intake Valve Rocker Arm Replacement**.

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - INTAKE

Special Tools

- **EN-50656** Holding Tool

- **EN 50793** Locking Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

NOTE: **Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.**

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
2. Remove the high pressure fuel pump. Refer to **Fuel Pump Replacement** .

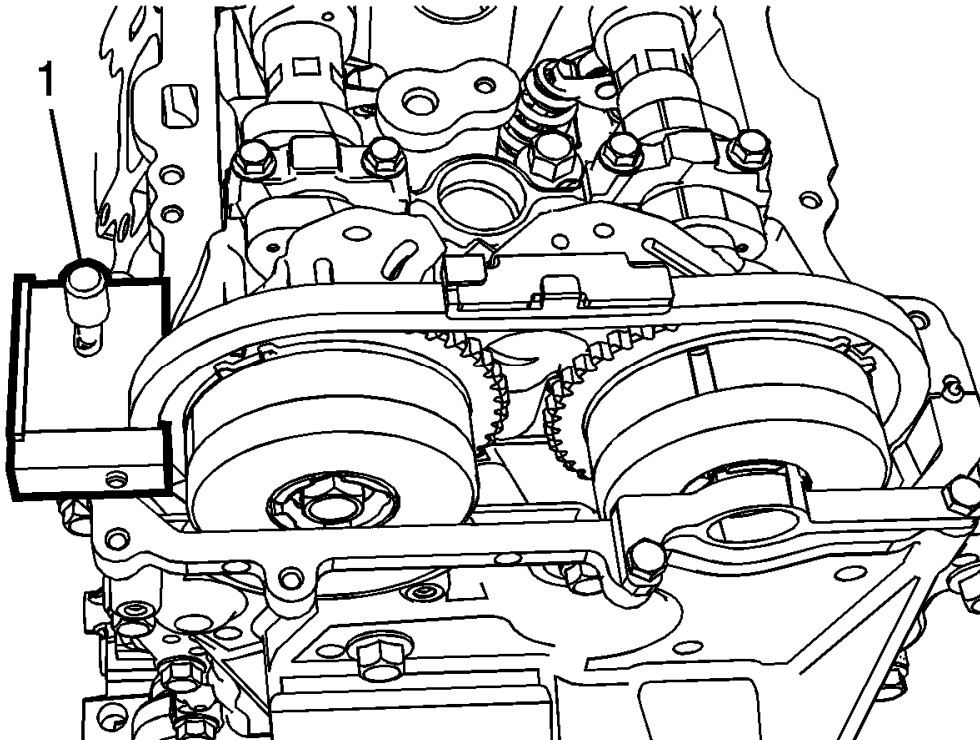


Fig. 111: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the EN-50656 holding tool is installed and securely tightened to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.**

3. Install **EN-50656** timing chain holding tool (1) and tighten to 8 (71 lb in).

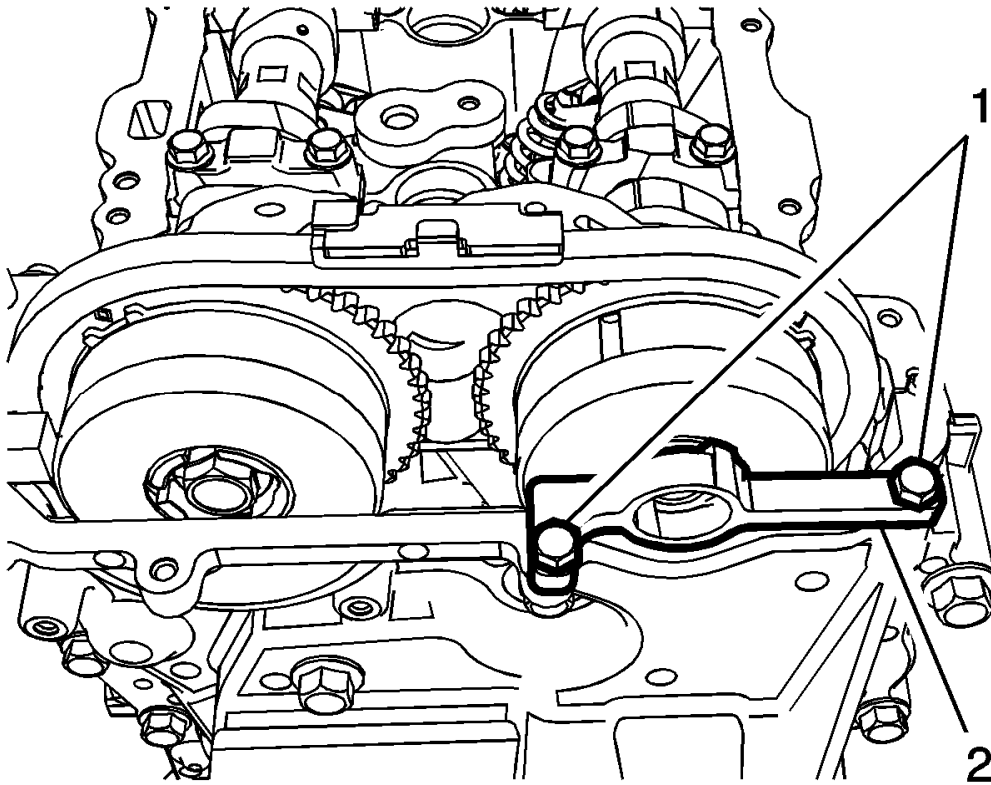


Fig. 112: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: **Ensure to mark actuator sprocket and chain before removal.**

4. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

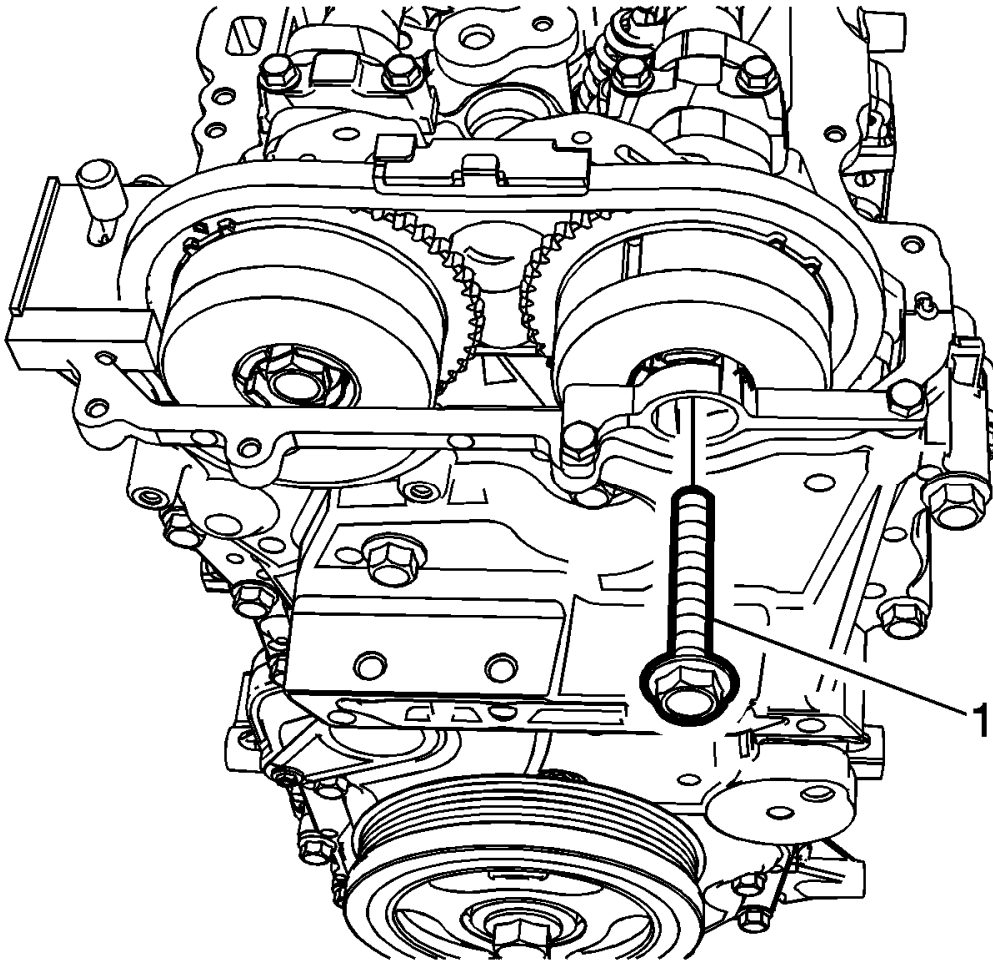


Fig. 113: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove and DISCARD the camshaft actuator bolt (1).

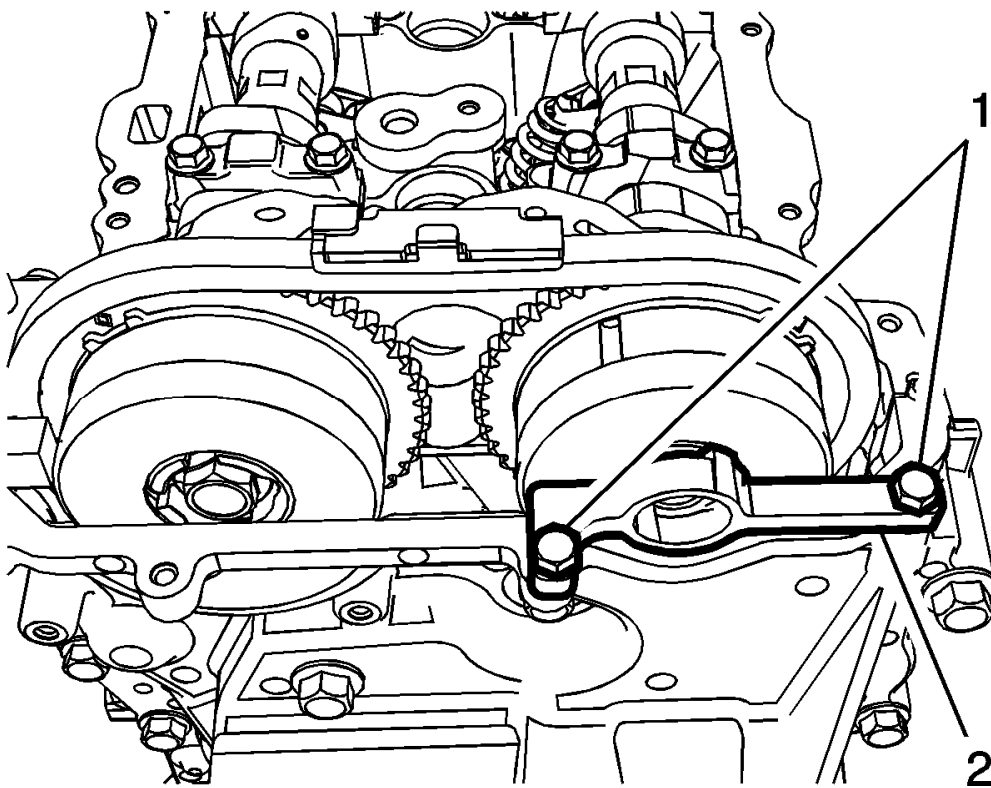


Fig. 114: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-50793** holding tool (2).

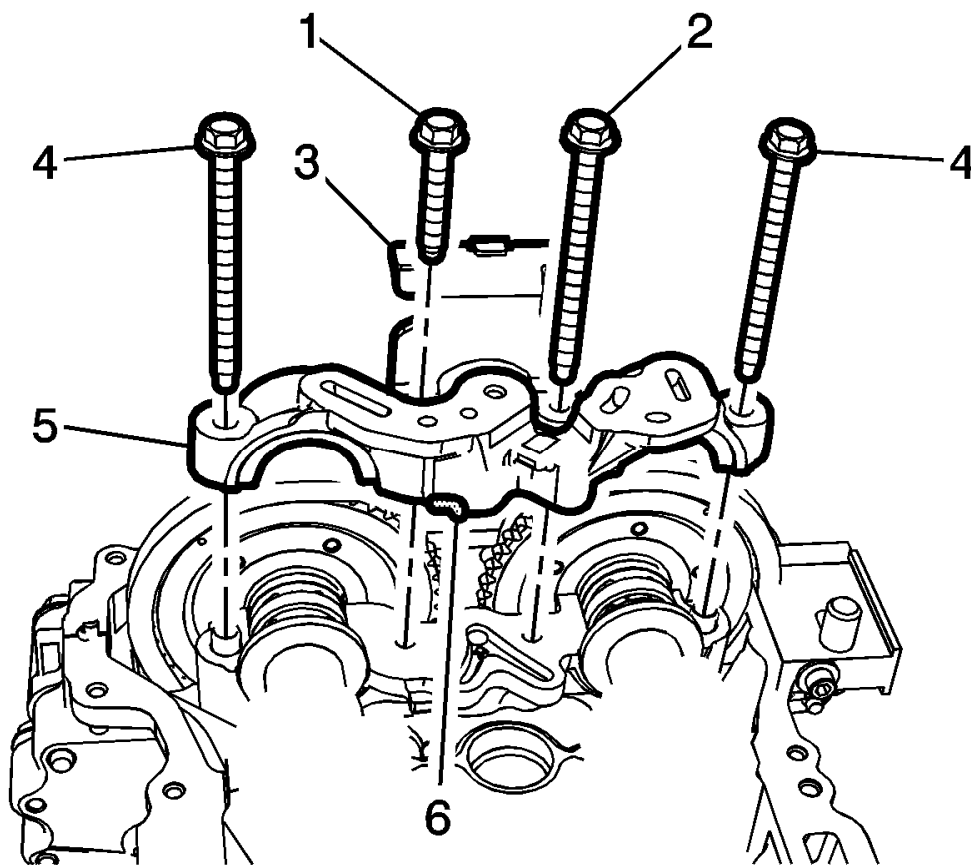


Fig. 115: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the upper timing chain guide bolts (1, 2).
8. Remove the upper timing chain guide (3).
9. Remove the camshaft front bearing cap bolts (4).

NOTE: Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.

10. Remove the camshaft front bearing cap (5).

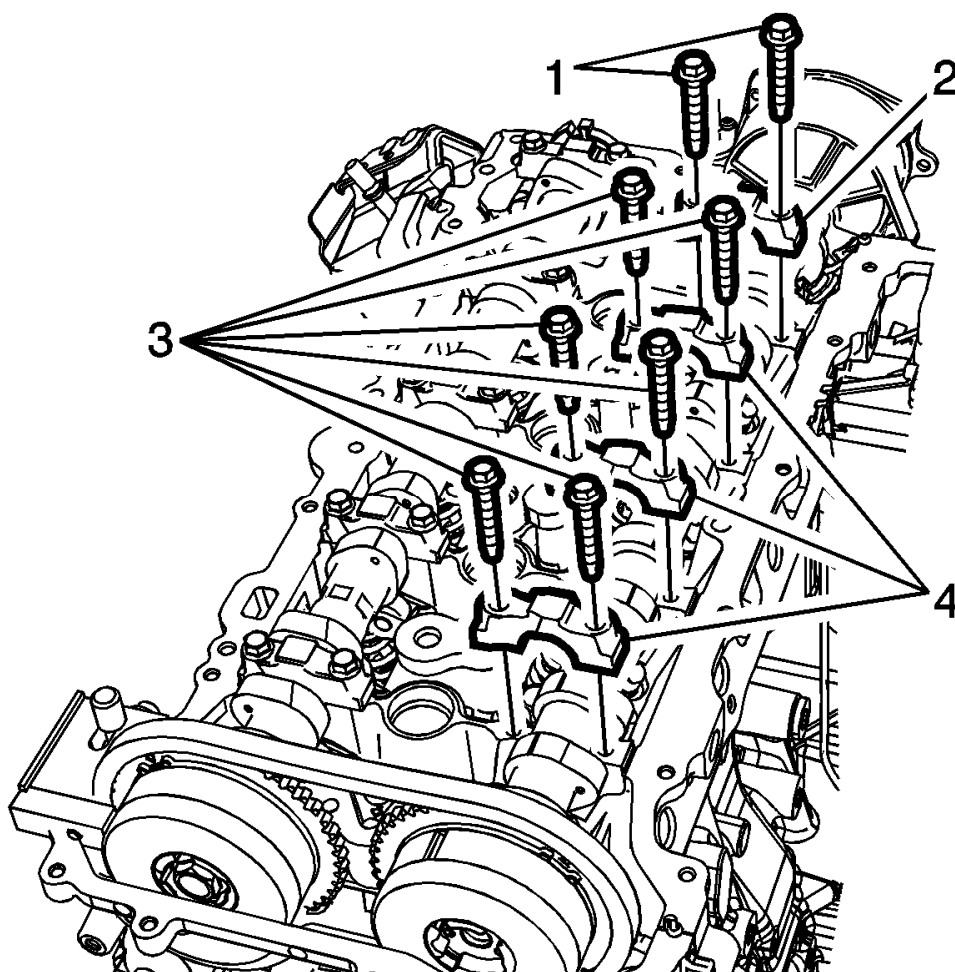


Fig. 116: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

11. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

NOTE: Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

12. Mark the camshaft caps (4) to ensure they are installed in the same position.
13. Remove the exhaust camshaft cap bolts (3).
14. Remove the camshaft caps (4).

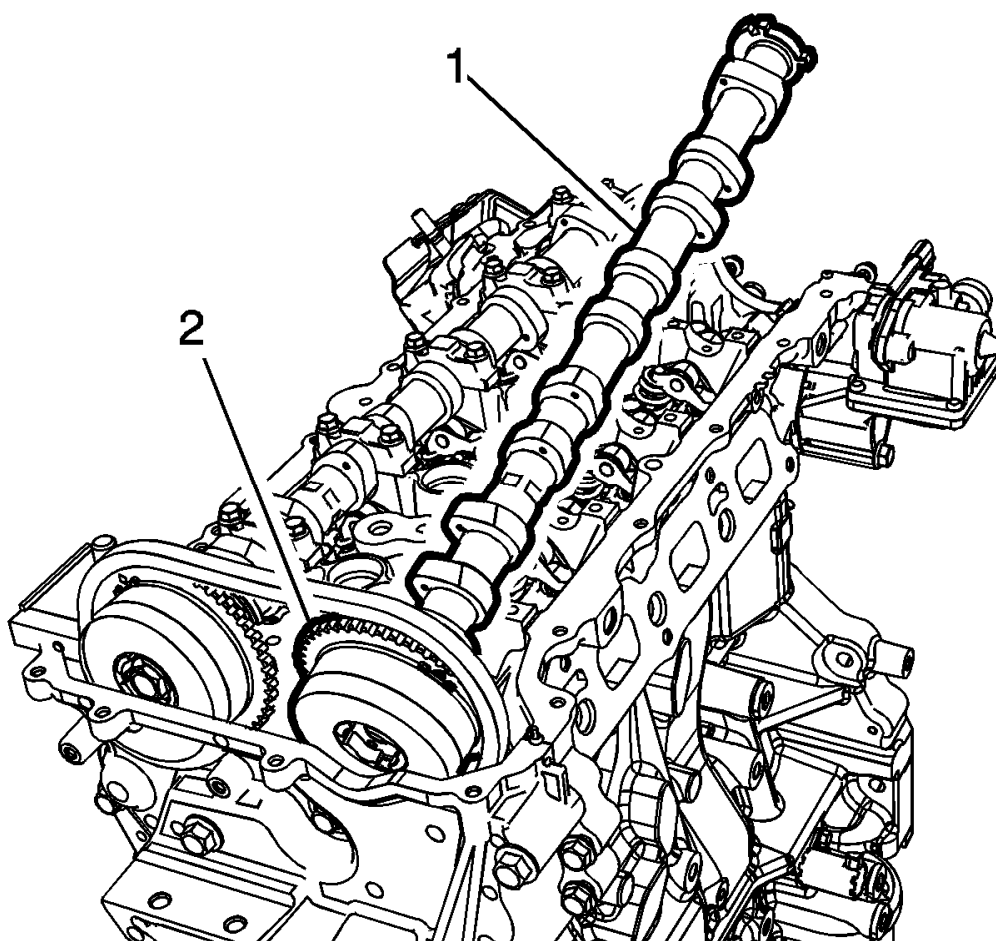


Fig. 117: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

15. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

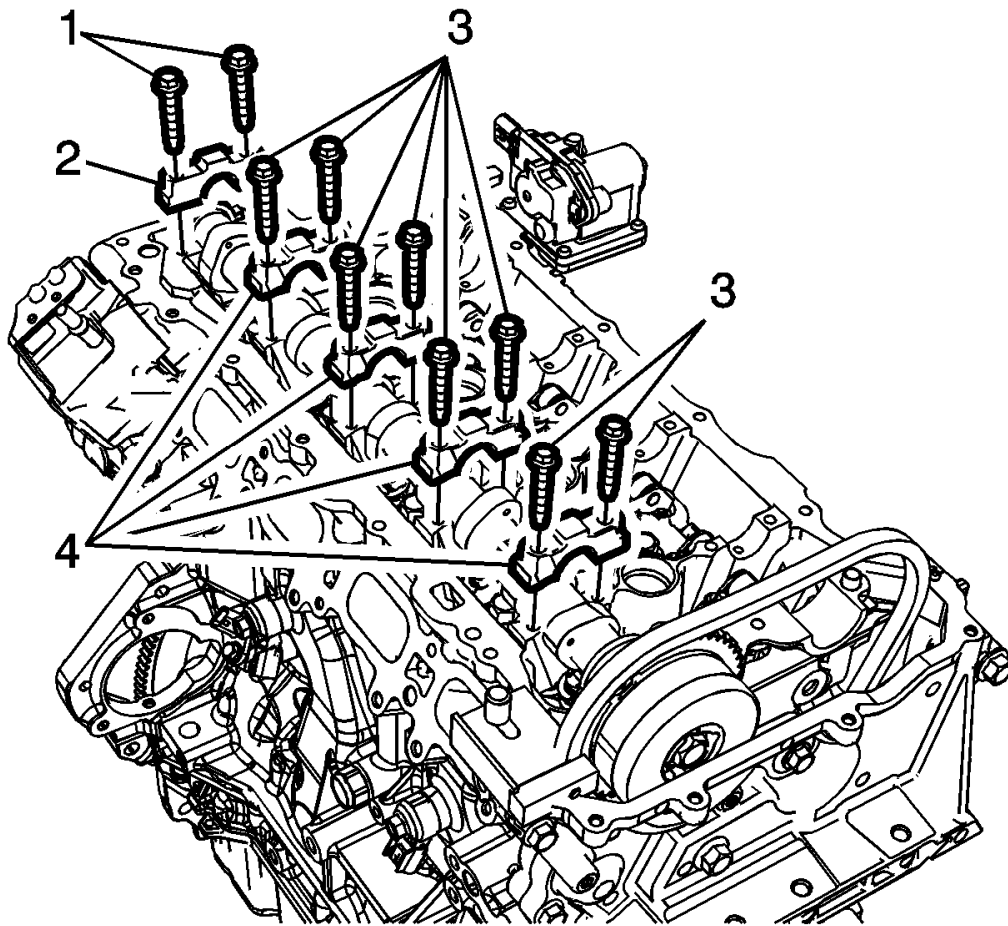


Fig. 118: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

16. Mark the intake camshaft rear cap to ensure it is installed in the same position. Remove the intake camshaft bearing rear cap bolts (1) and cap (2).

NOTE: Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

17. Mark the camshaft caps (4) to ensure they are installed in the same position.
18. Remove the intake camshaft cap bolts (3).
19. Remove the camshaft caps (4).
20. Lift and roll intake camshaft assembly from original position over into exhaust camshaft position within engine head assembly.

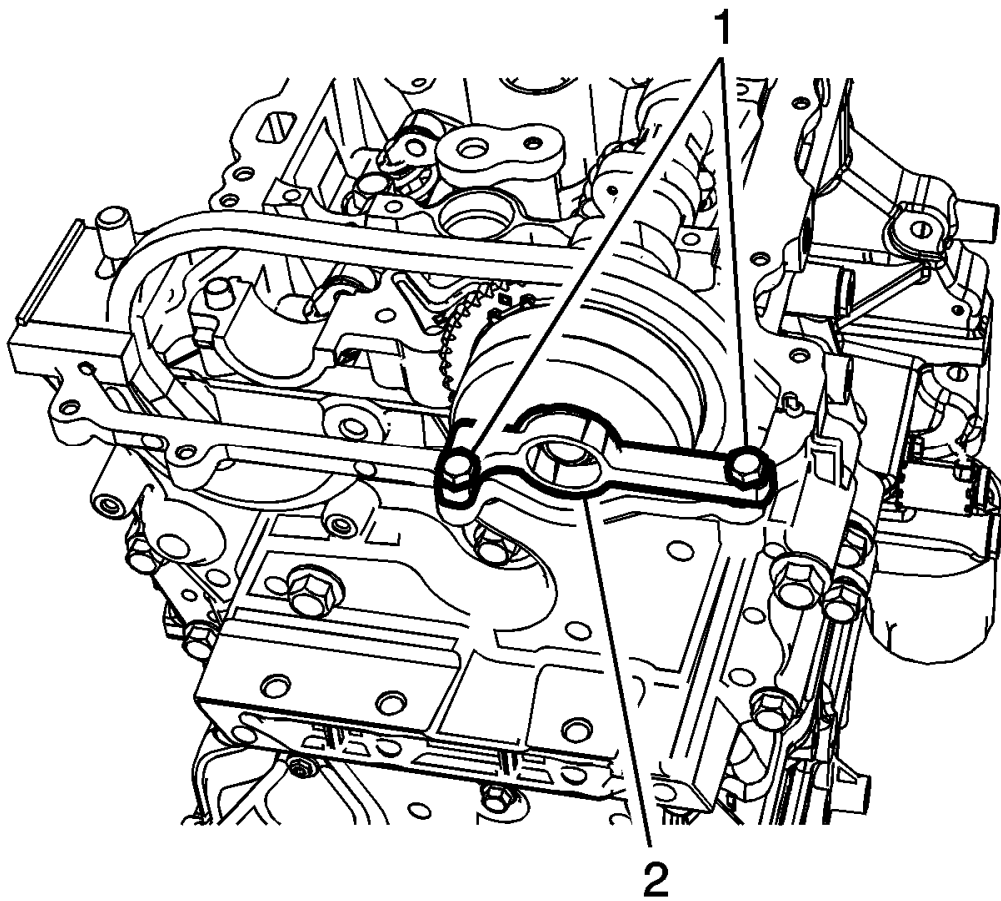


Fig. 119: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

21. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

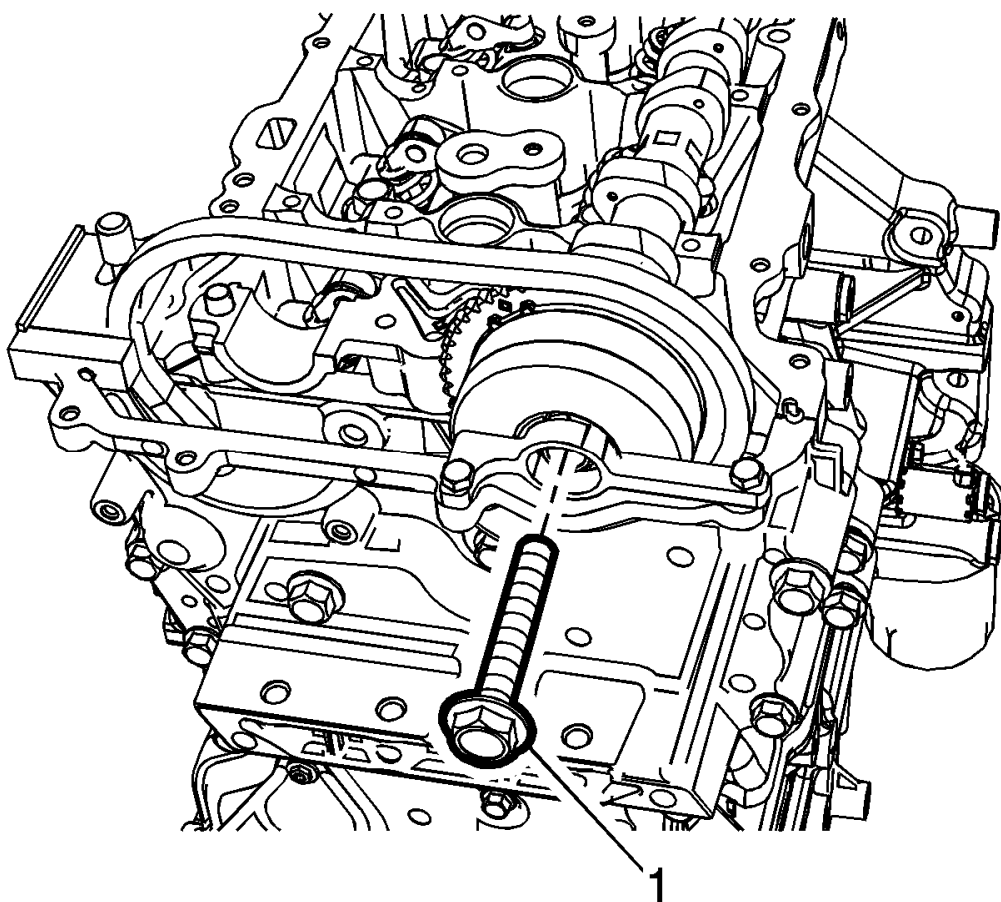


Fig. 120: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

22. Remove the camshaft actuator bolt (1).

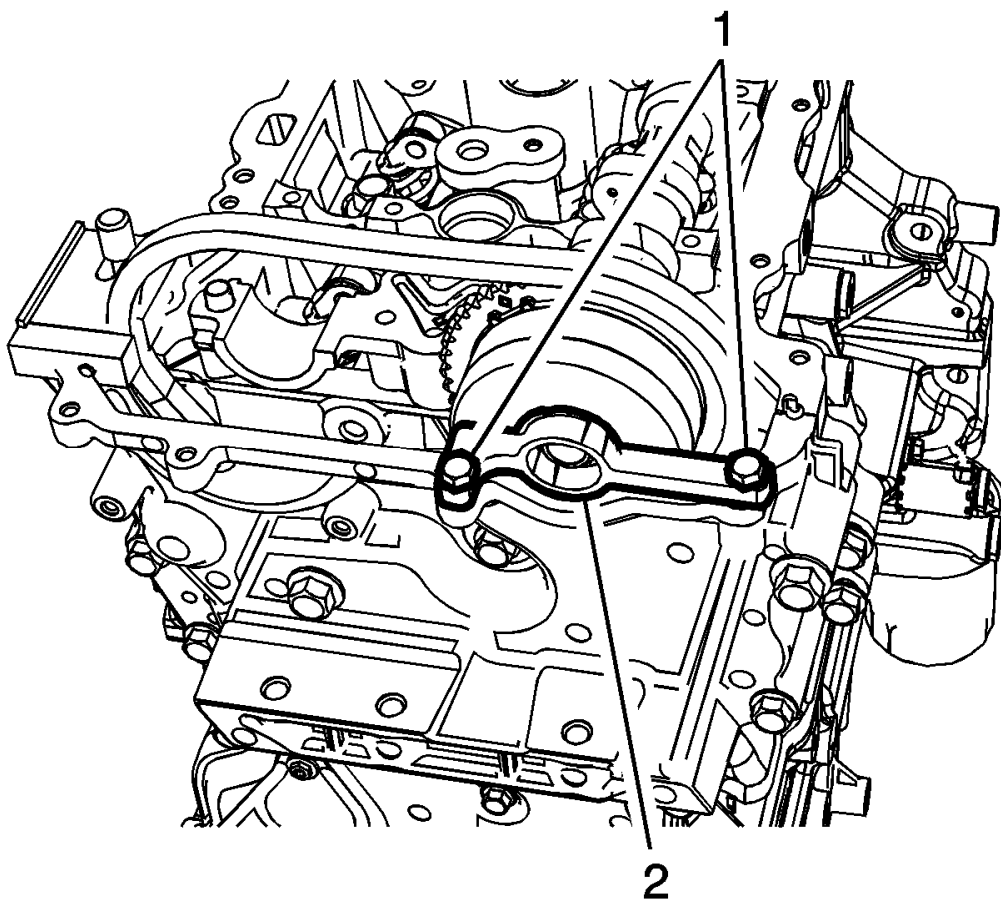


Fig. 121: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

23. Remove the **EN-50793** holding tool (2).

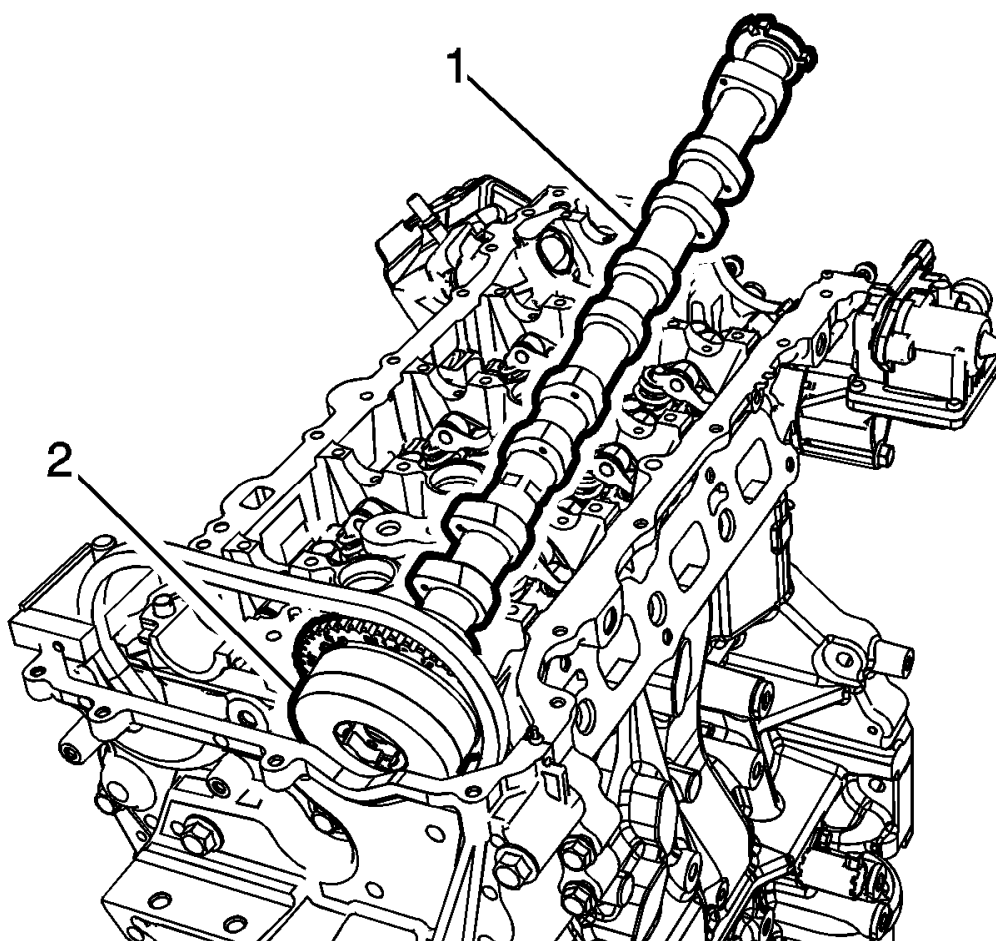


Fig. 122: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

24. Pull intake camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of intake camshaft assembly to a tilt and pull free from intake camshaft actuator assembly (2).

NOTE: **If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.**

25. Replace the camshaft if necessary.

Installation Procedure

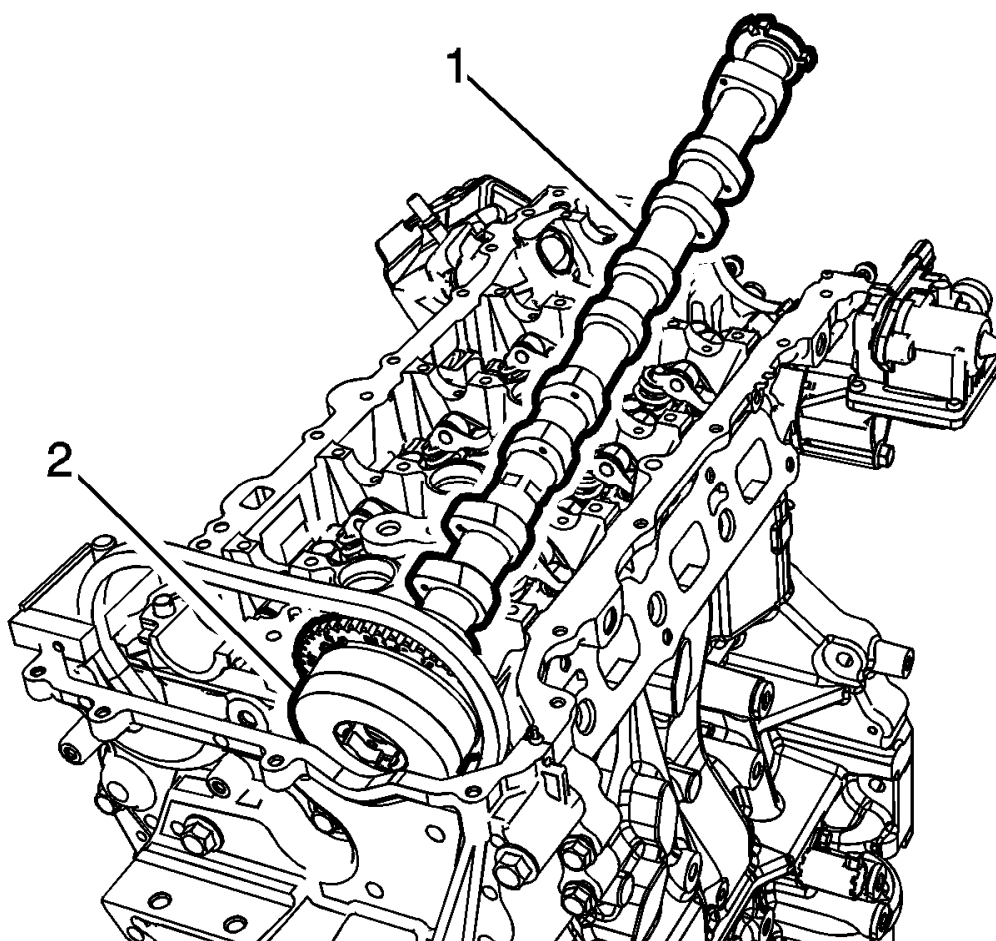


Fig. 123: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Install the intake camshaft (1) and camshaft actuator (2).

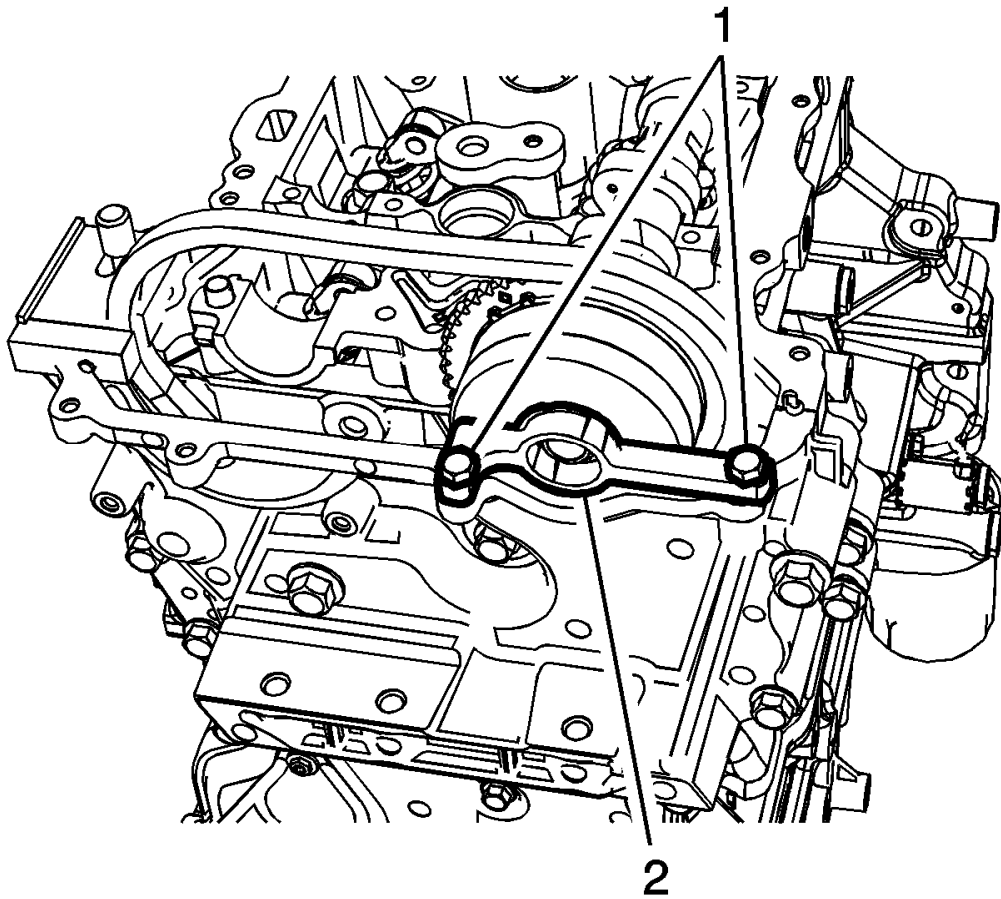


Fig. 124: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

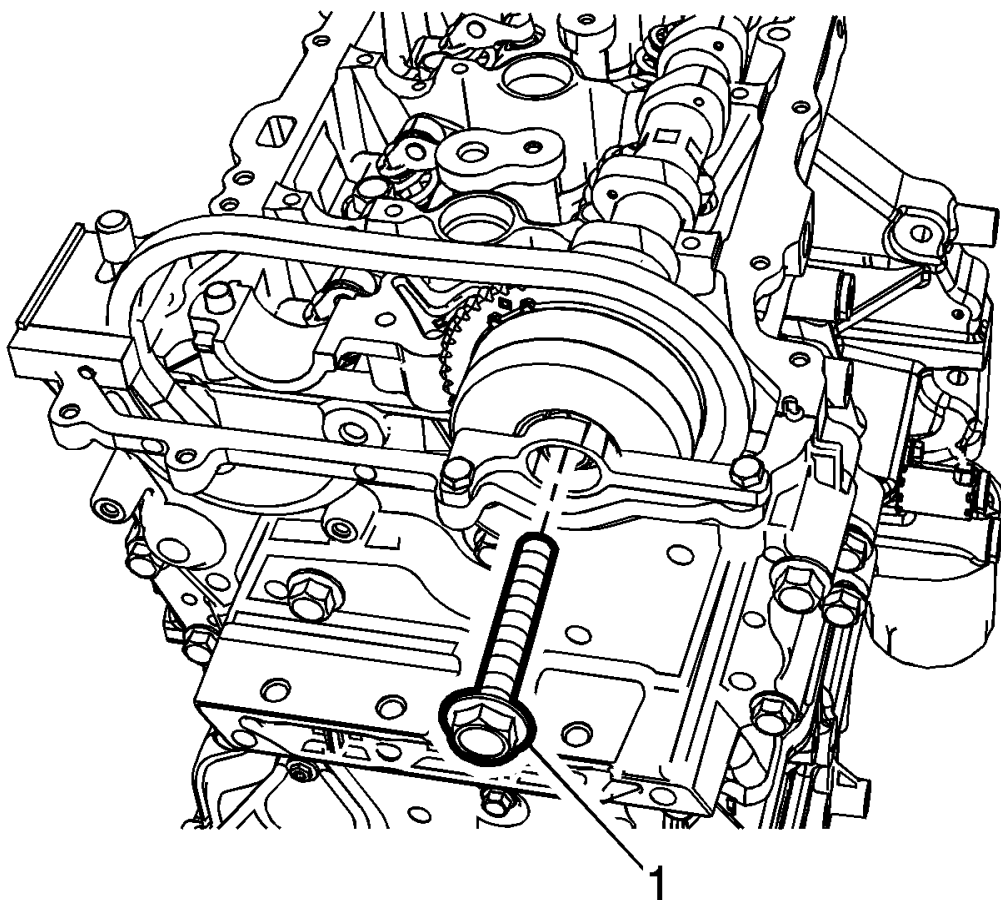


Fig. 125: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.
4. Lift and roll intake camshaft assembly from exhaust camshaft position over into original position.

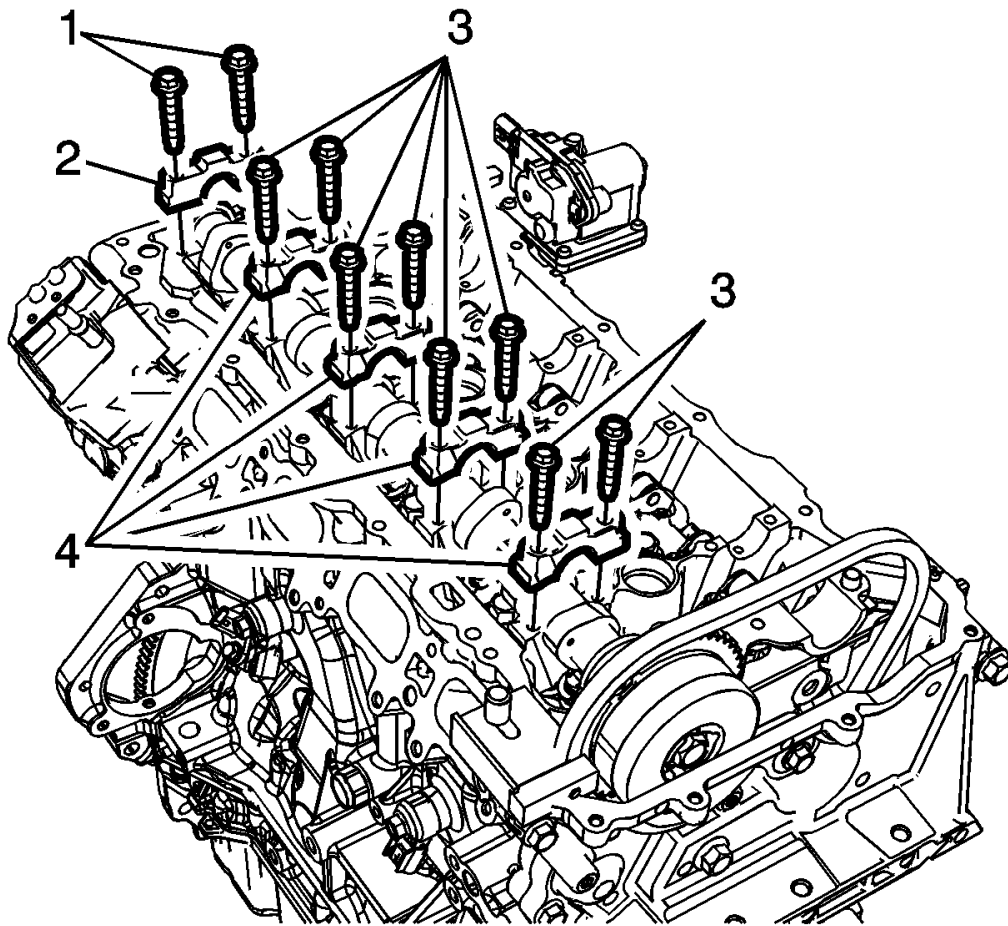


Fig. 126: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

5. Set the intake camshaft on top of the roller followers in the camshaft bearing journals with the intake actuator timing mark at approximately the 11 O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

6. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
7. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

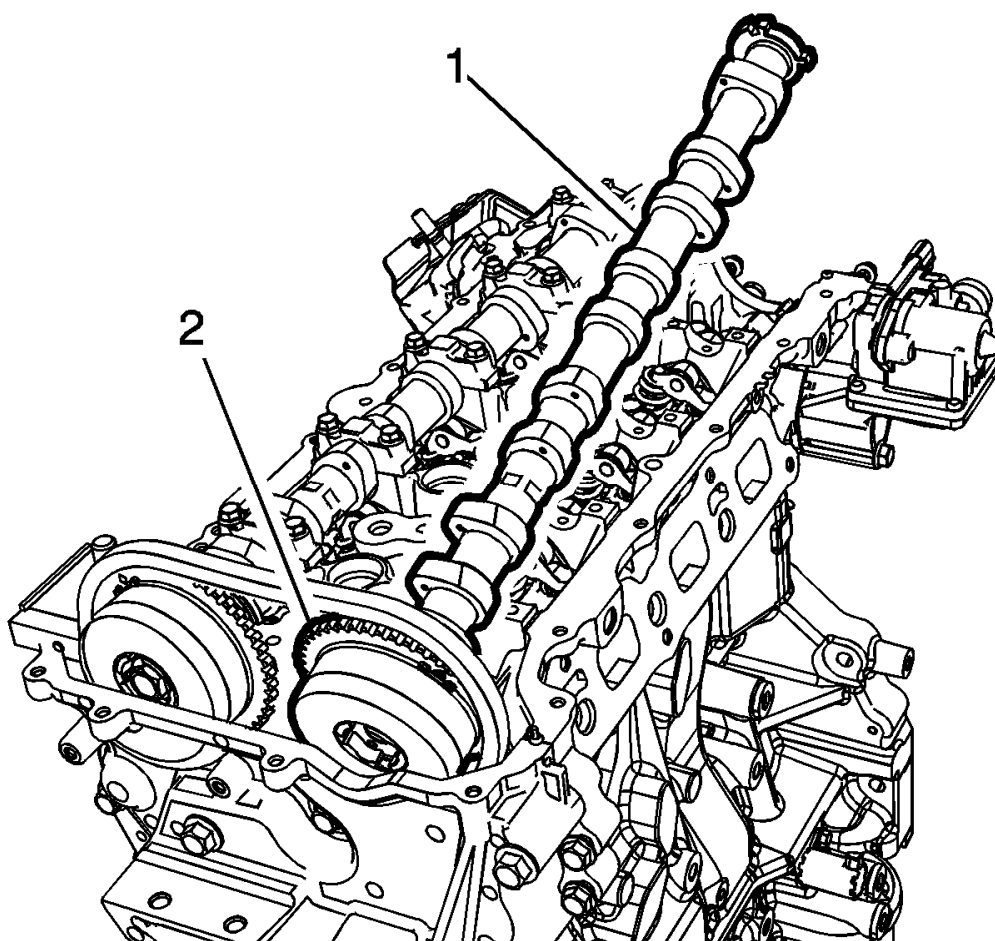


Fig. 127: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust camshaft (1) and camshaft actuator (2).

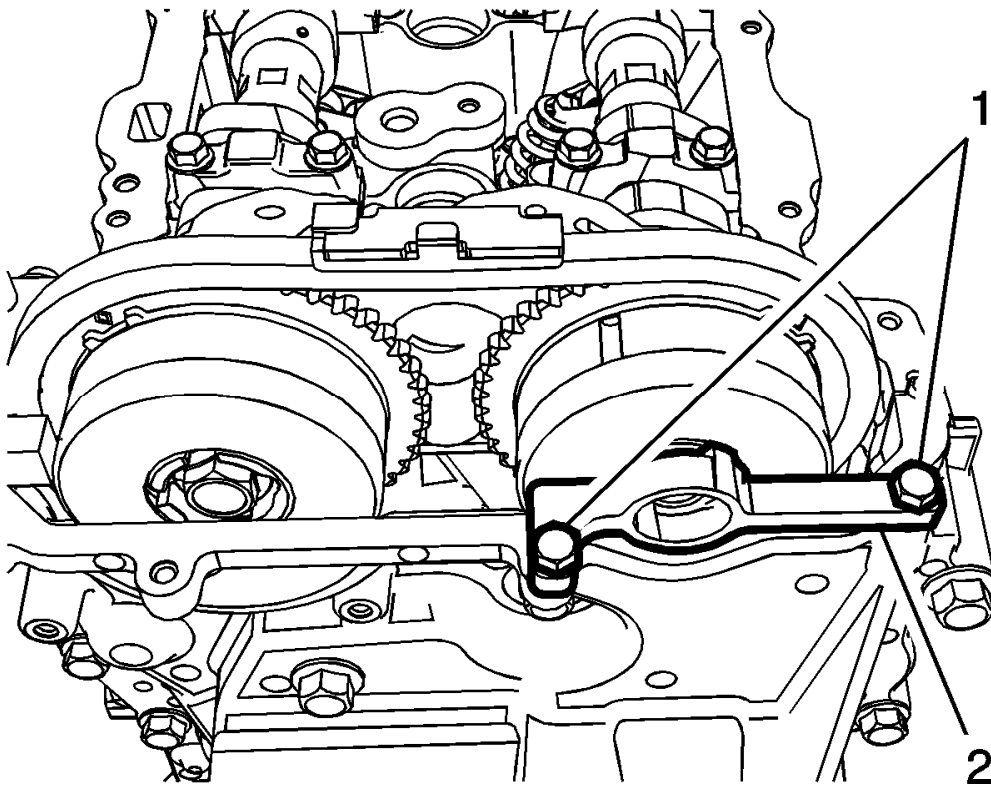


Fig. 128: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

9. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

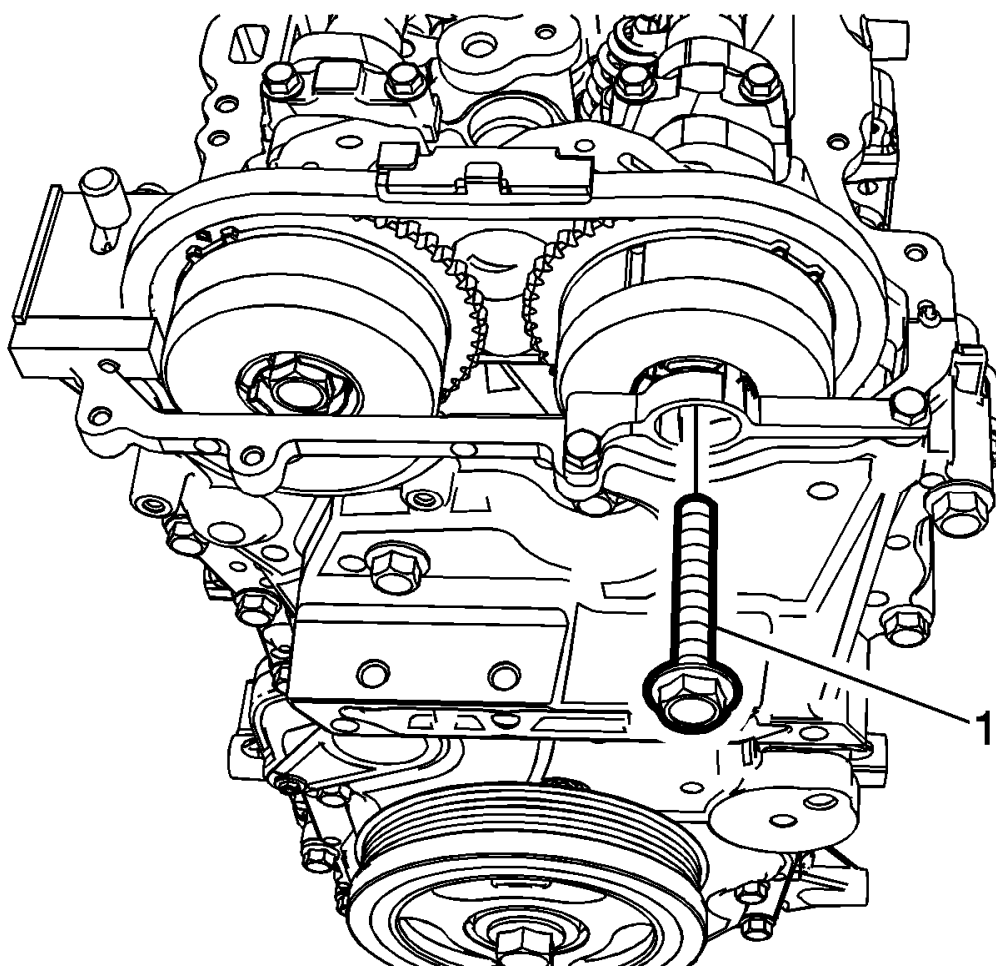


Fig. 129: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.

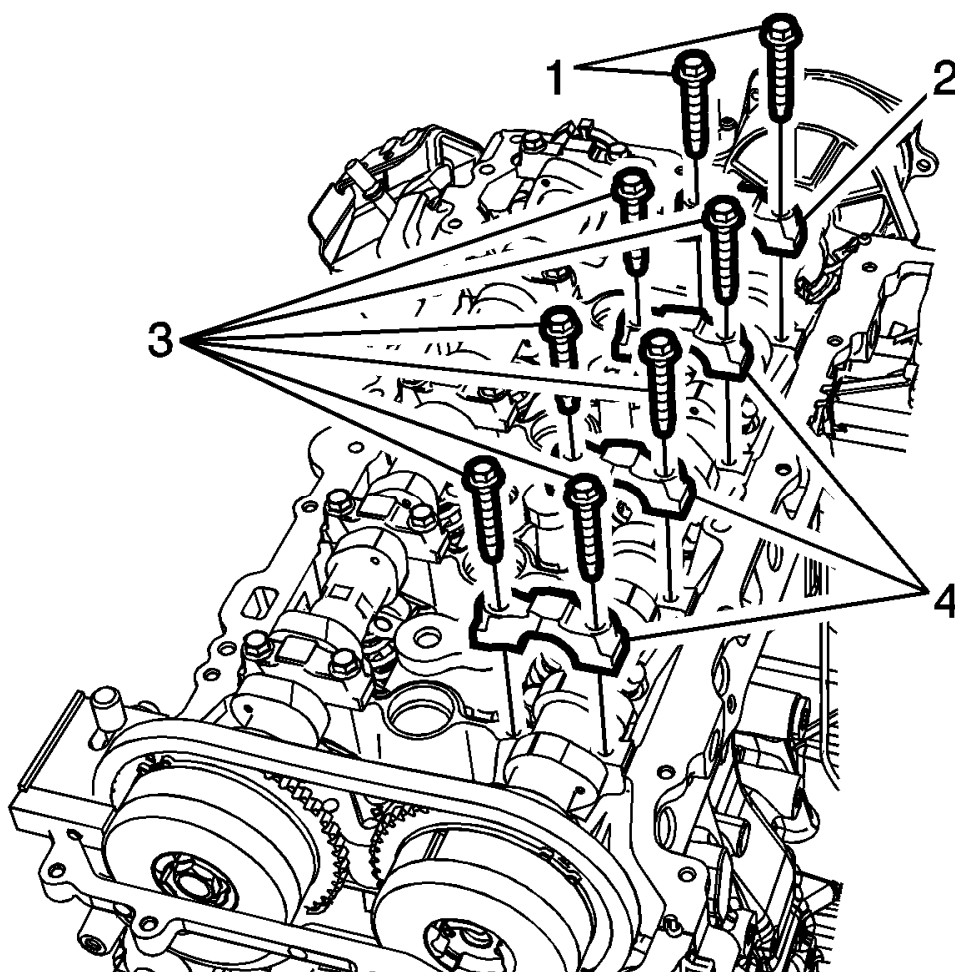


Fig. 130: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

11. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

12. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
13. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

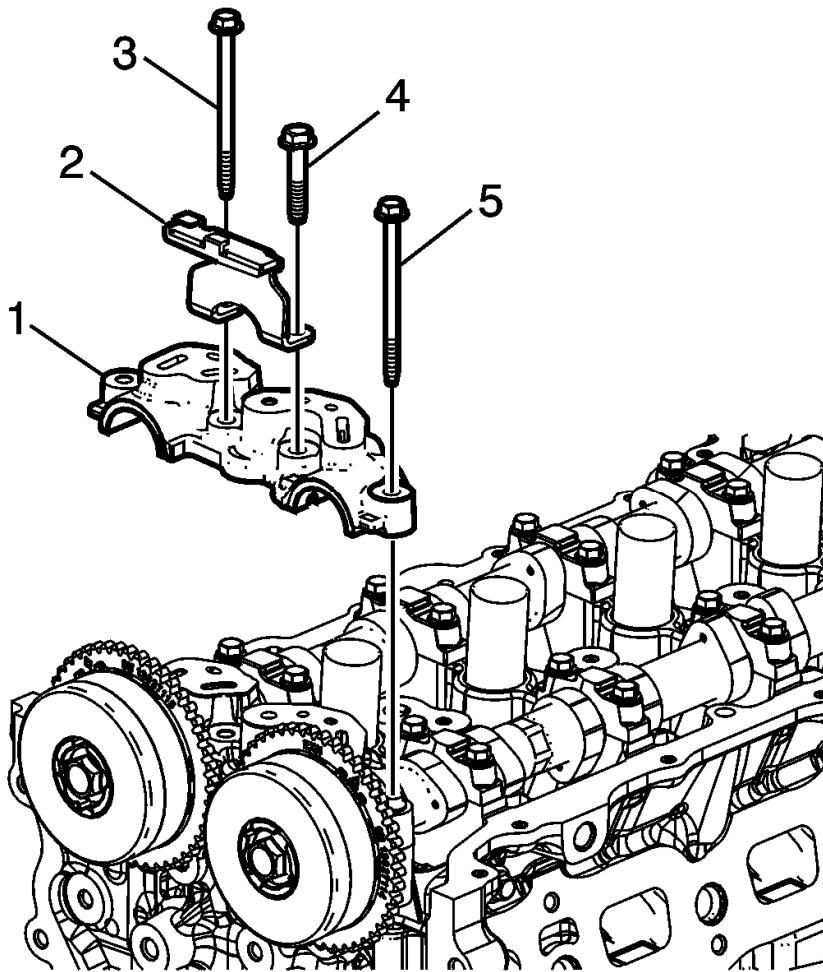


Fig. 131: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

14. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3-5).

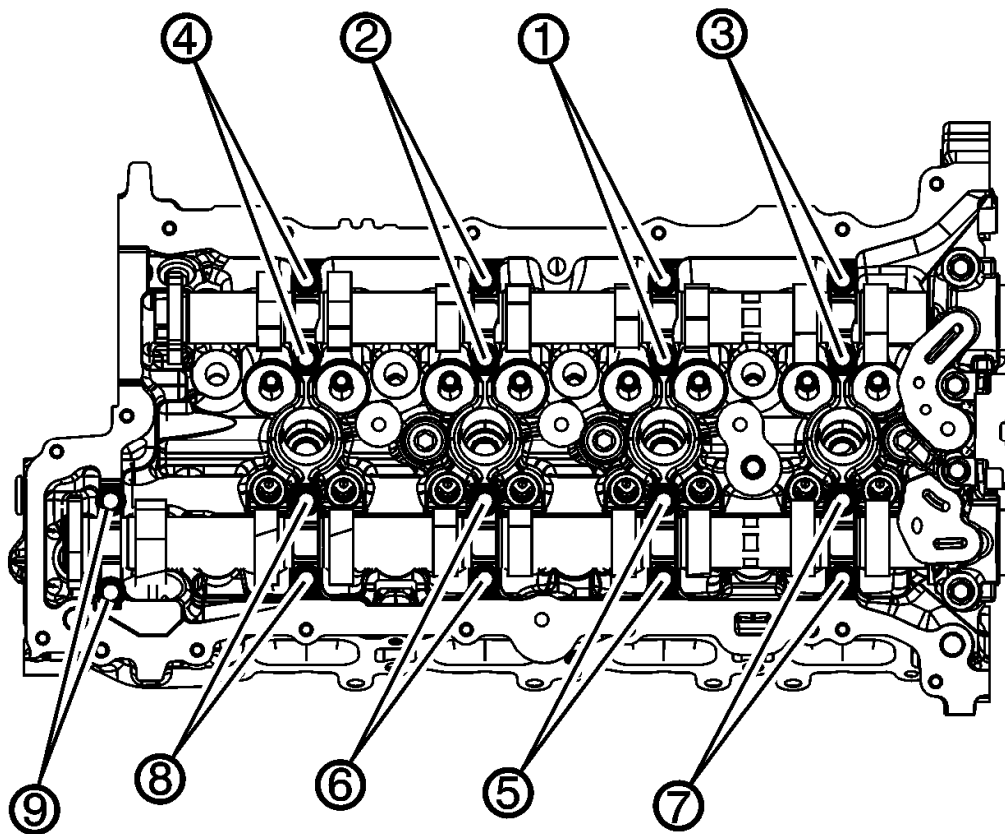


Fig. 132: Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.

15. Tighten the camshaft cap bolts in sequence using the following procedure:
 1. Tighten the camshaft cap bolts in sequence to 8 (71 lb in).
 2. Loosen both bolts in each cap in sequence to 180 degrees.
 3. Tighten the camshaft cap bolts in sequence to 10 (89 lb in) twice.

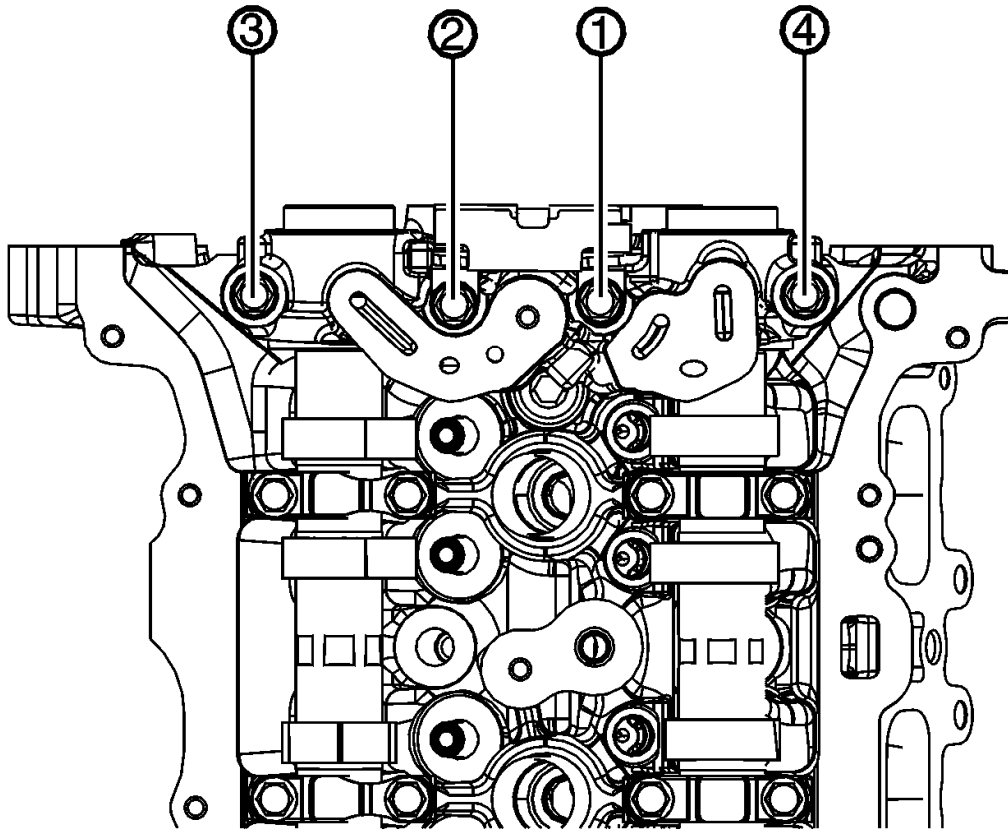


Fig. 133: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

16. Tighten the front camshaft cap bolts in sequence to 10 (89 lb in) twice.

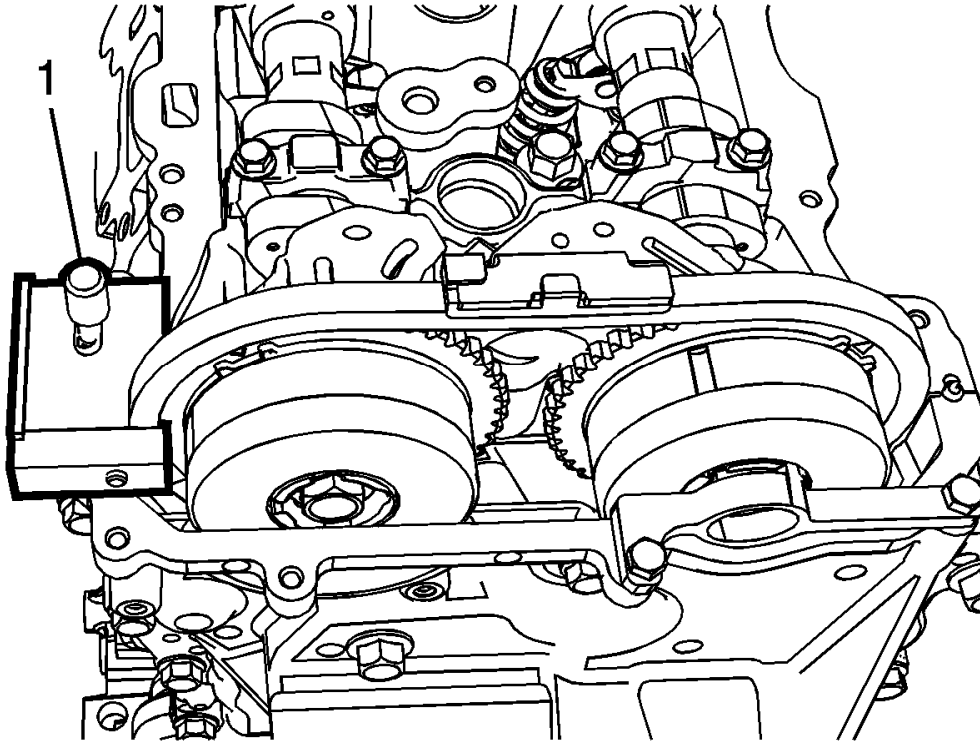


Fig. 134: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove **EN-50656** timing chain holding tool (1).
18. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
19. Install the high pressure fuel pump. Refer to **Fuel Pump Replacement** .

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - EXHAUST

Special Tools

- **EN-50656** Holding Tool
- **EN 50793** Locking Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

NOTE: Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.

1. Remove the camshaft cover. Refer to Camshaft Cover Replacement.

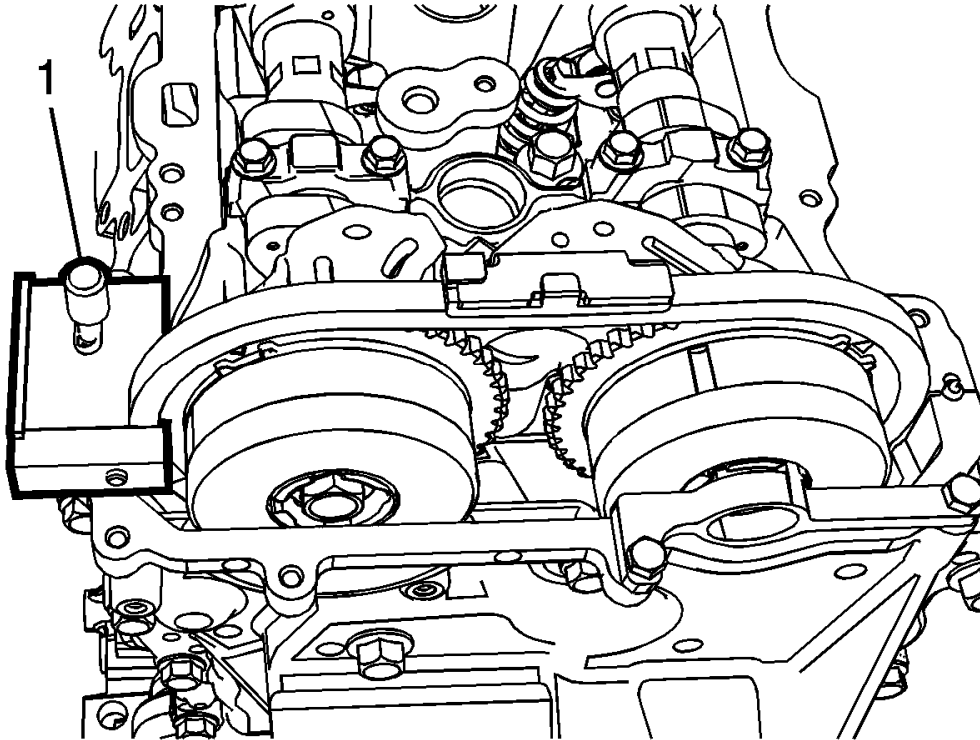


Fig. 135: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the EN-50656 Holding tool is installed and securely tightened to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.

2. Install **EN-50656** timing chain holding tool (1) and tighten to 8 (71 lb in).

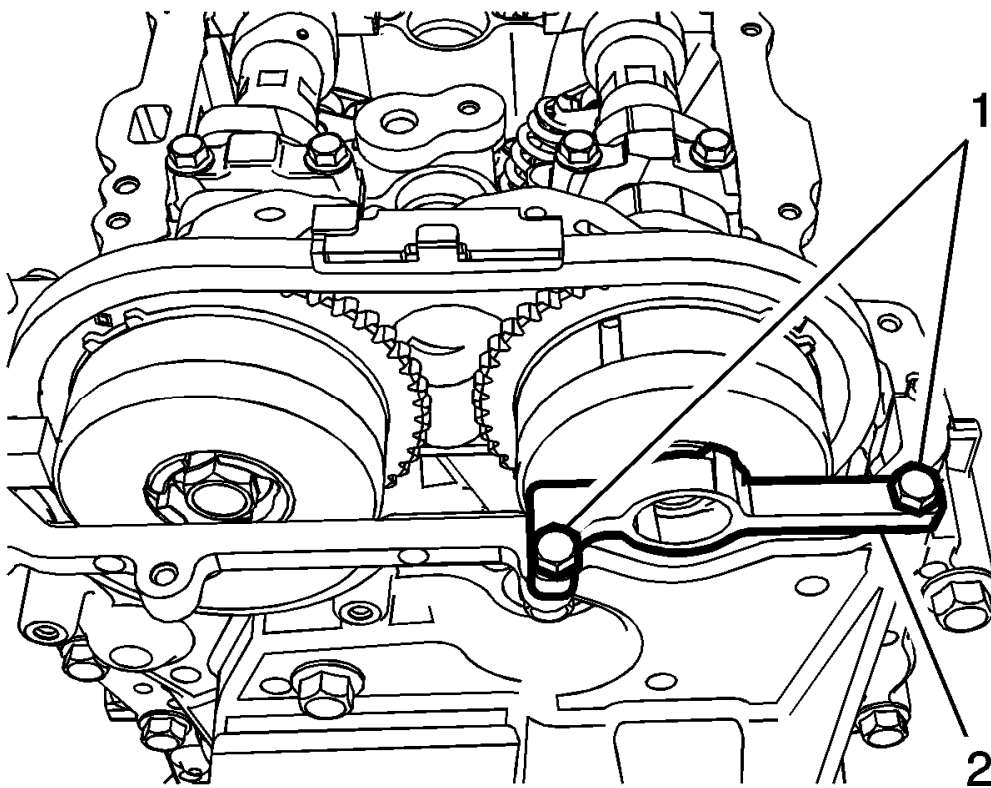


Fig. 136: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: **Ensure to mark actuator sprocket and chain before removal.**

3. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

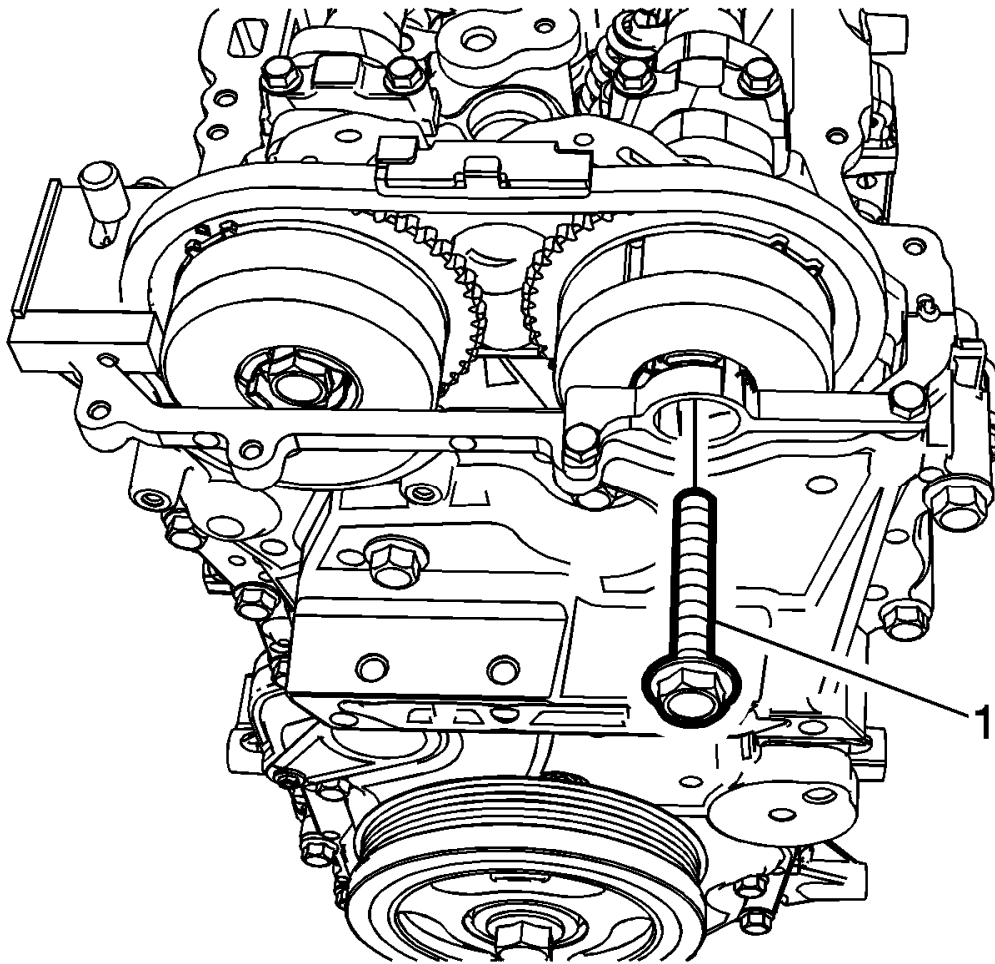


Fig. 137: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the camshaft actuator bolt (1).

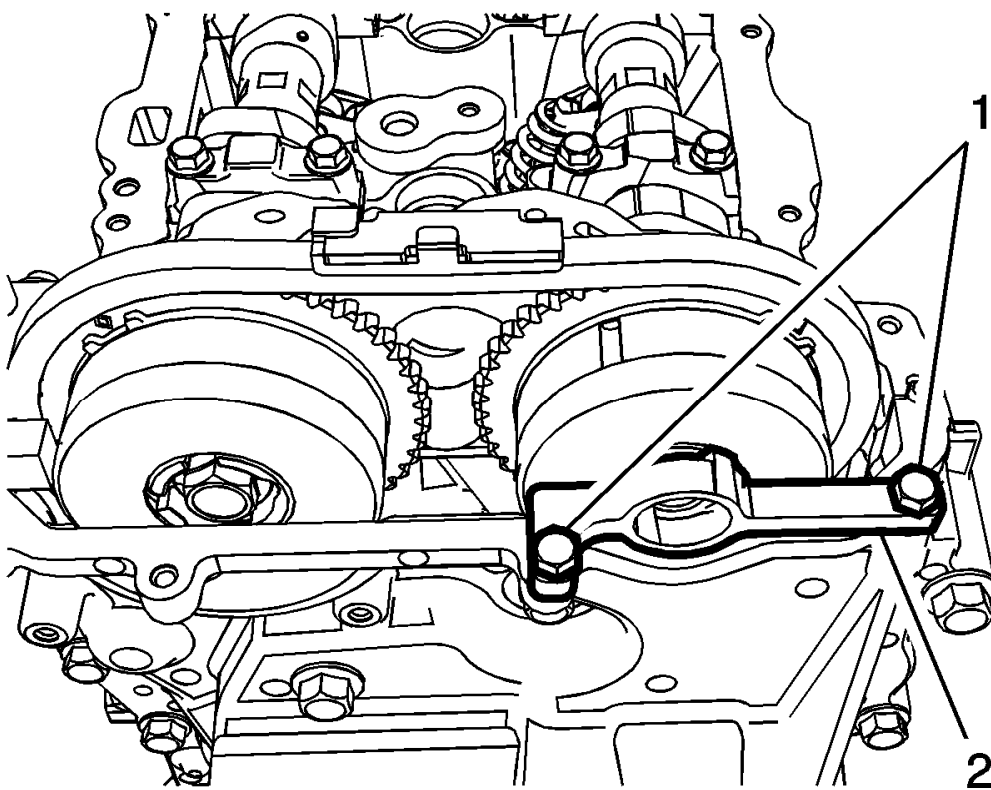


Fig. 138: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-50793** holding tool (2).

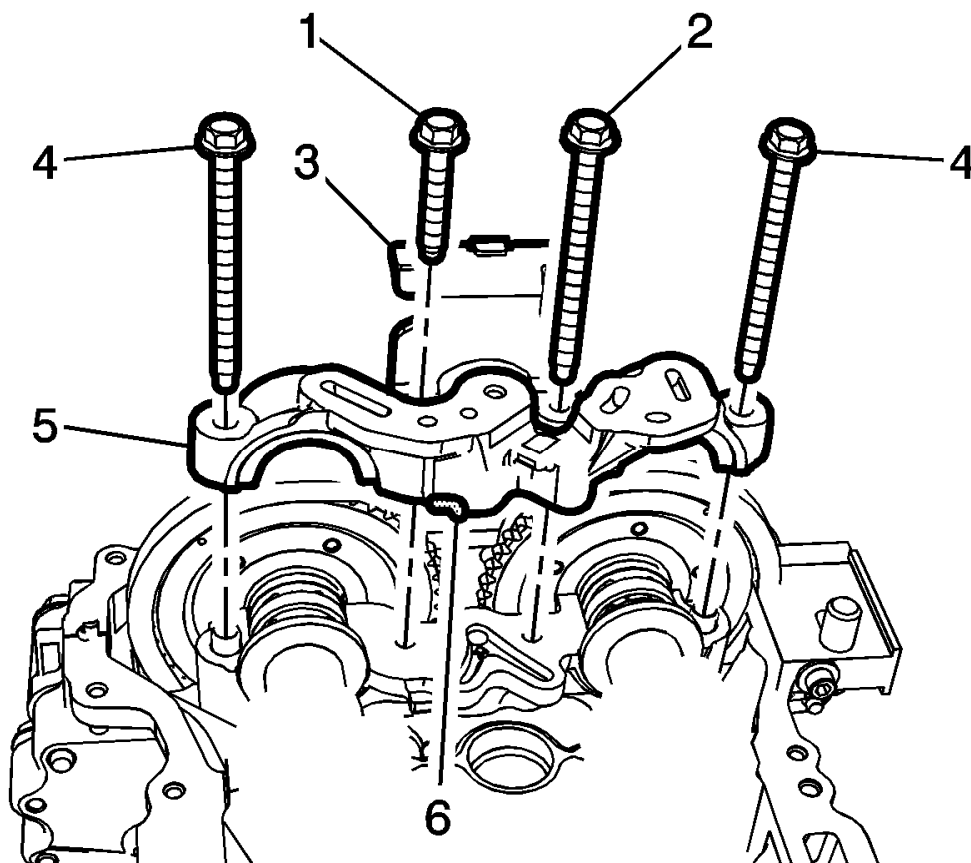


Fig. 139: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the upper timing chain guide bolts (1, 2).
7. Remove the upper timing chain guide (3).
8. Remove the camshaft front bearing cap bolts (4).

NOTE: Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.

9. Remove the camshaft front bearing cap (5).

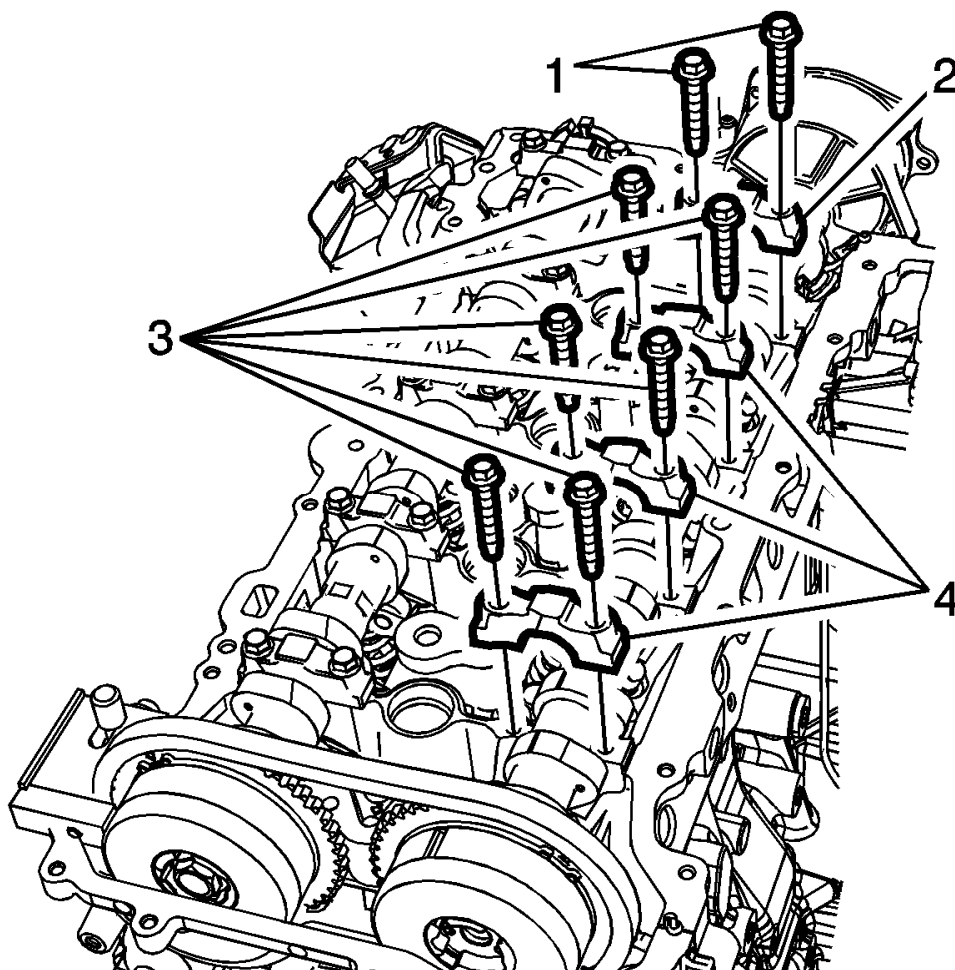


Fig. 140: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

10. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

NOTE: Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

11. Mark the camshaft caps (4) to ensure they are installed in the same position.
12. Remove the exhaust camshaft cap bolts (3).
13. Remove the camshaft caps (4).

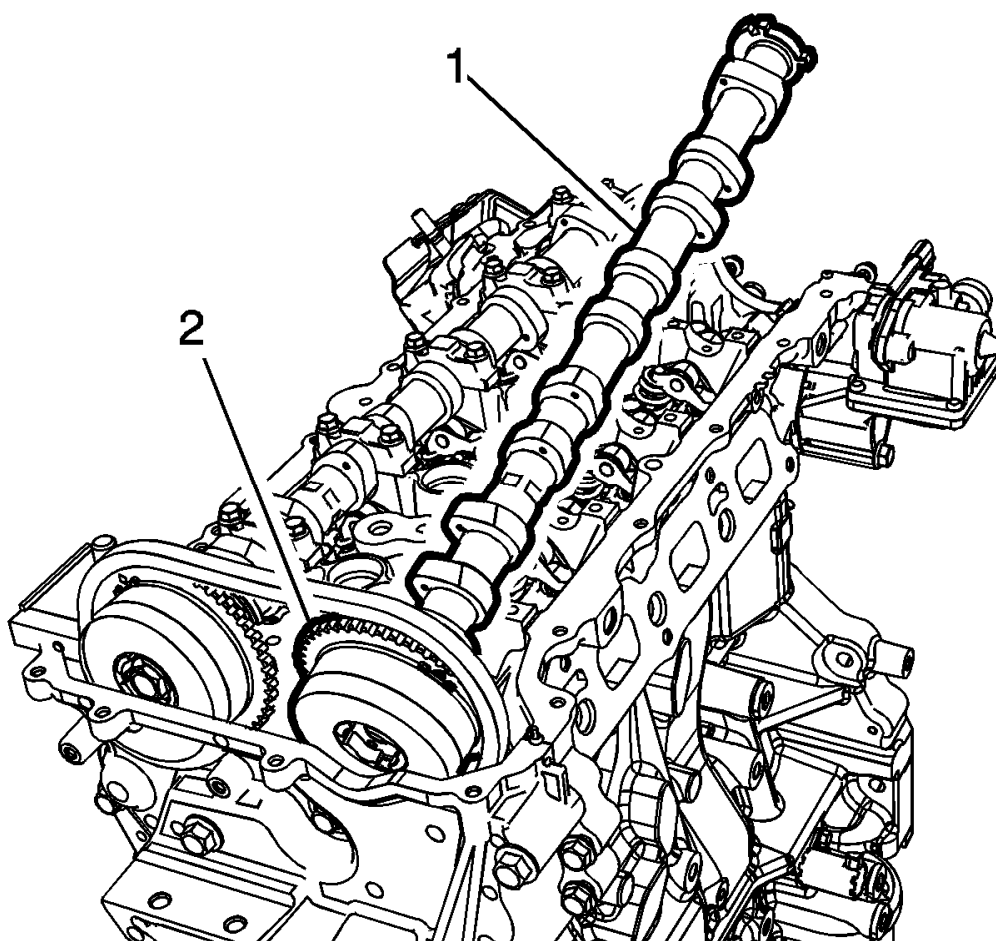


Fig. 141: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

14. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

NOTE: If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.

15. Replace the camshaft if necessary.

Installation Procedure

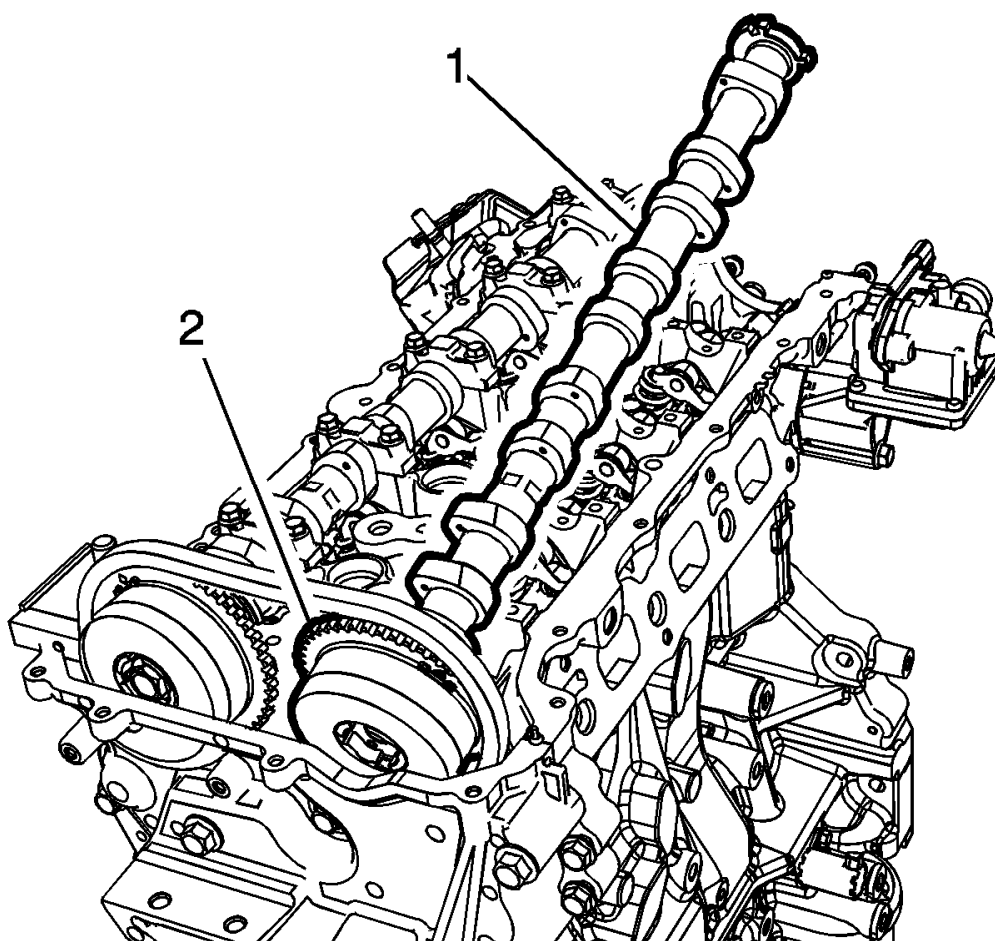


Fig. 142: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust camshaft (1) and camshaft actuator (2).

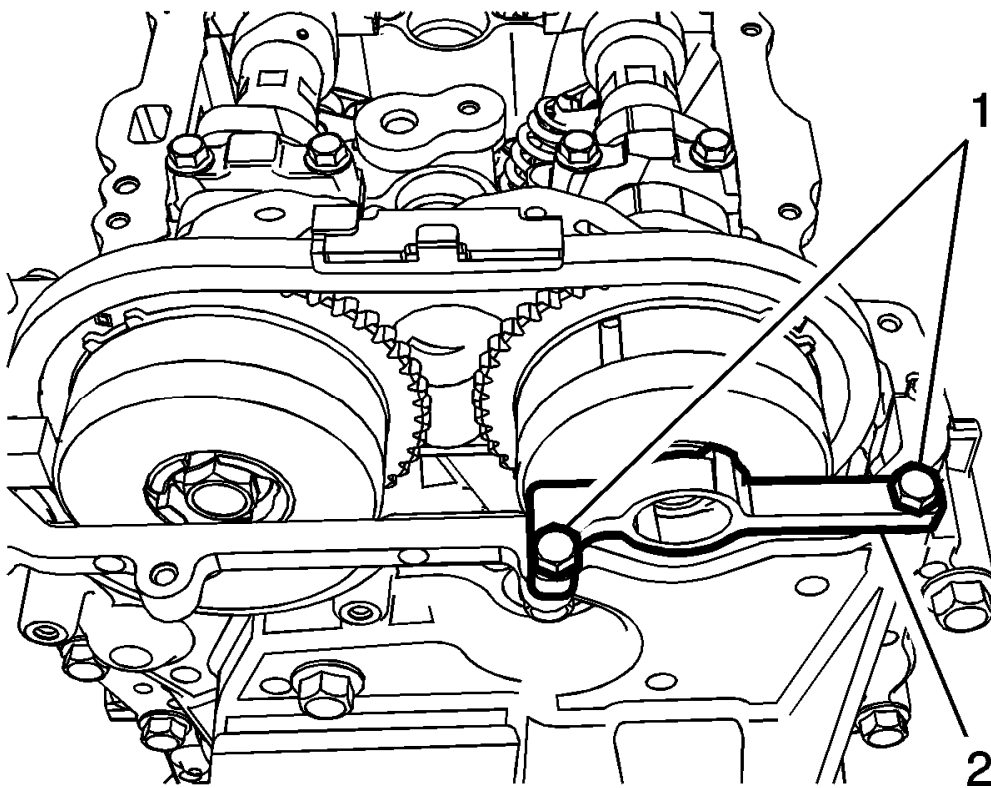


Fig. 143: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

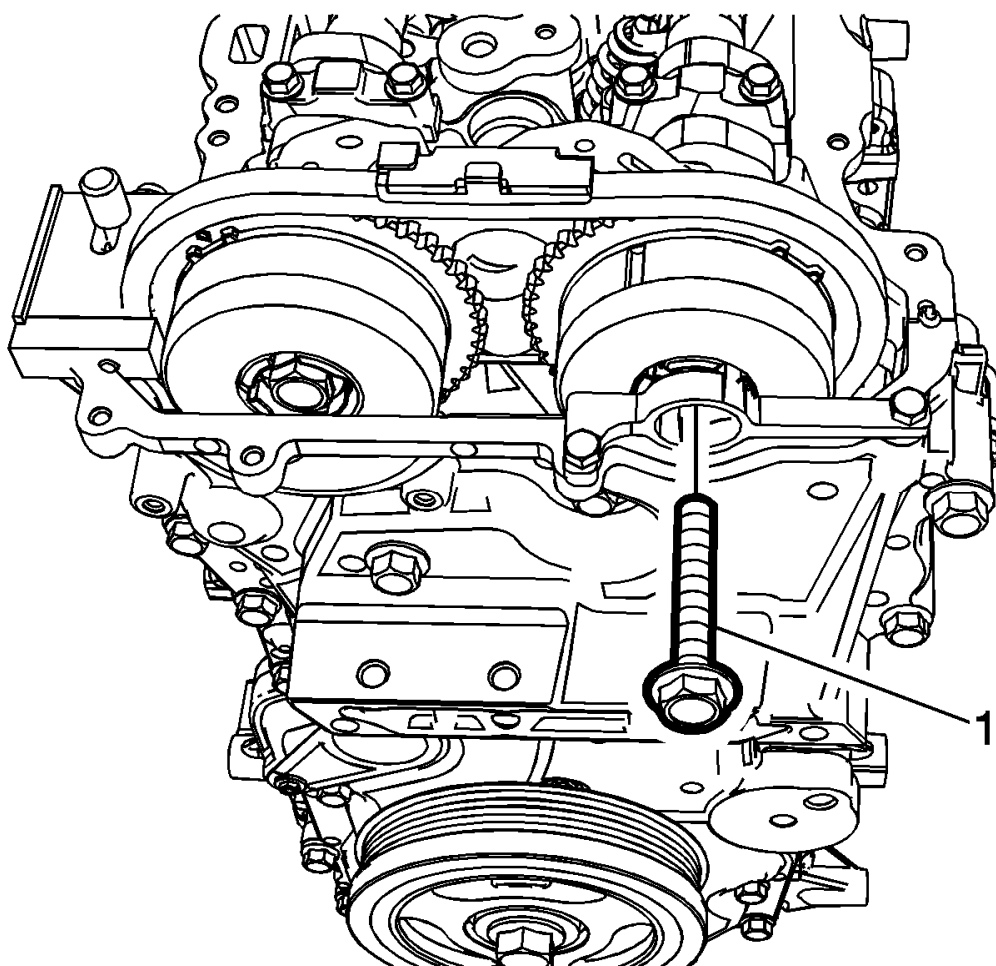


Fig. 144: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.

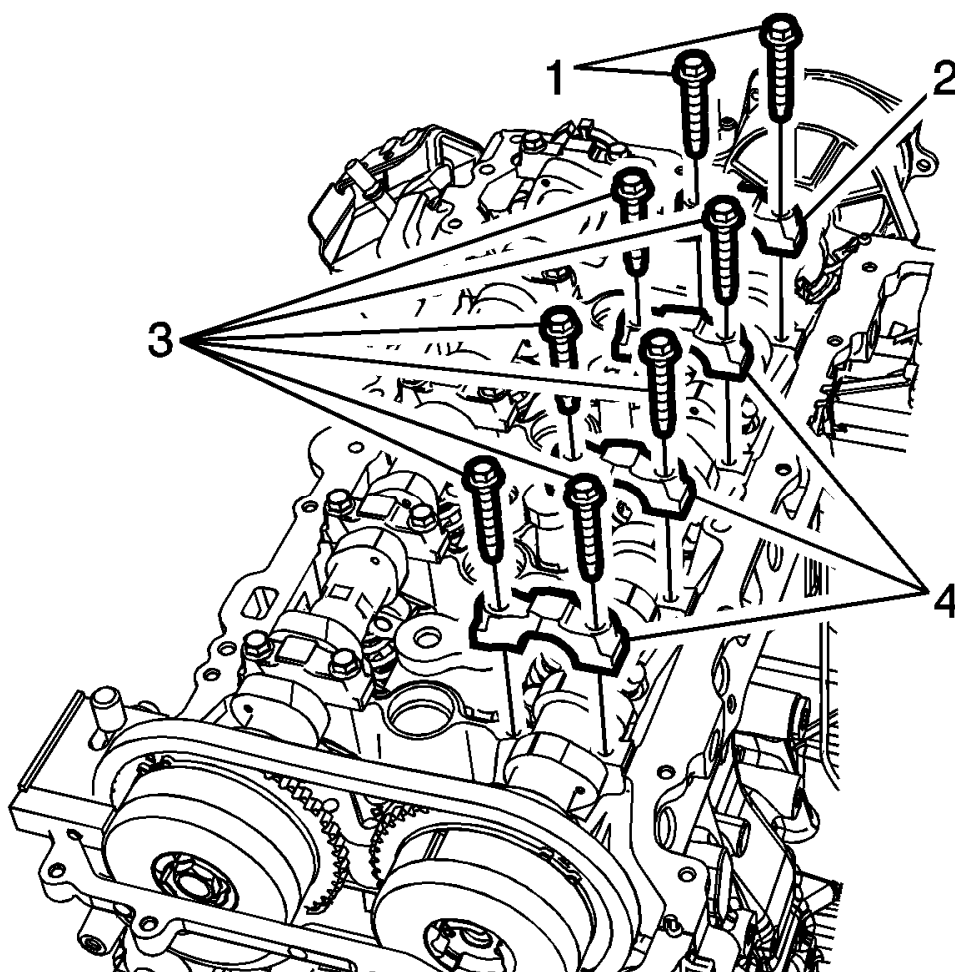


Fig. 145: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

4. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

5. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
6. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

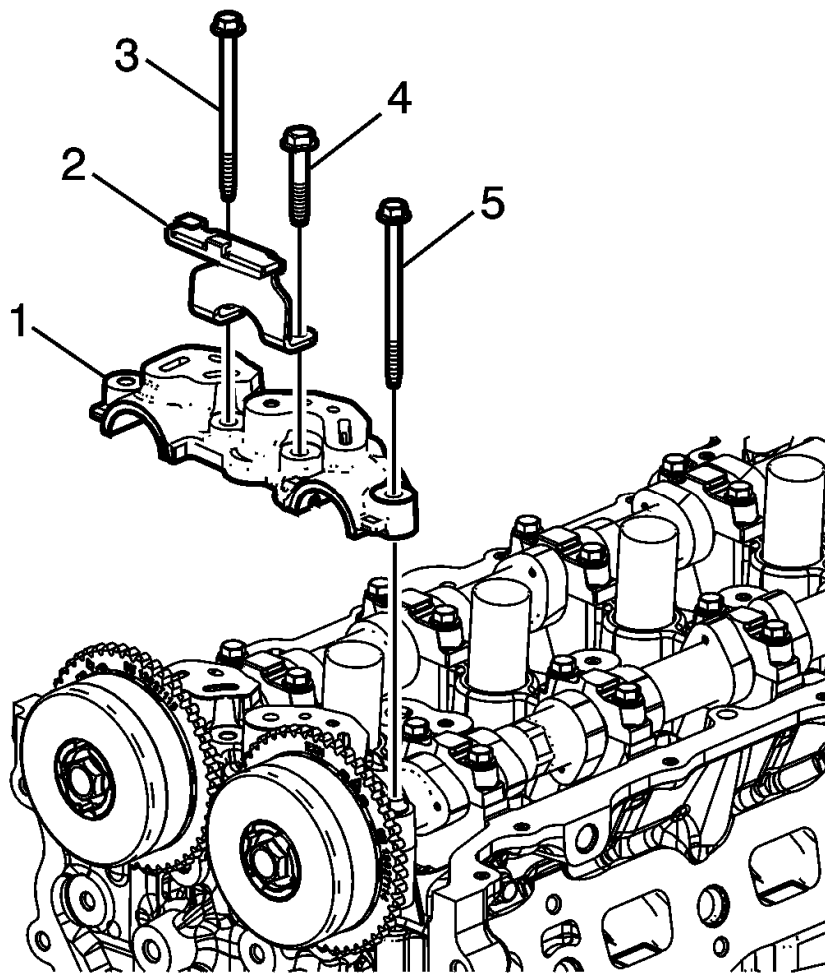


Fig. 146: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

7. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3-5).

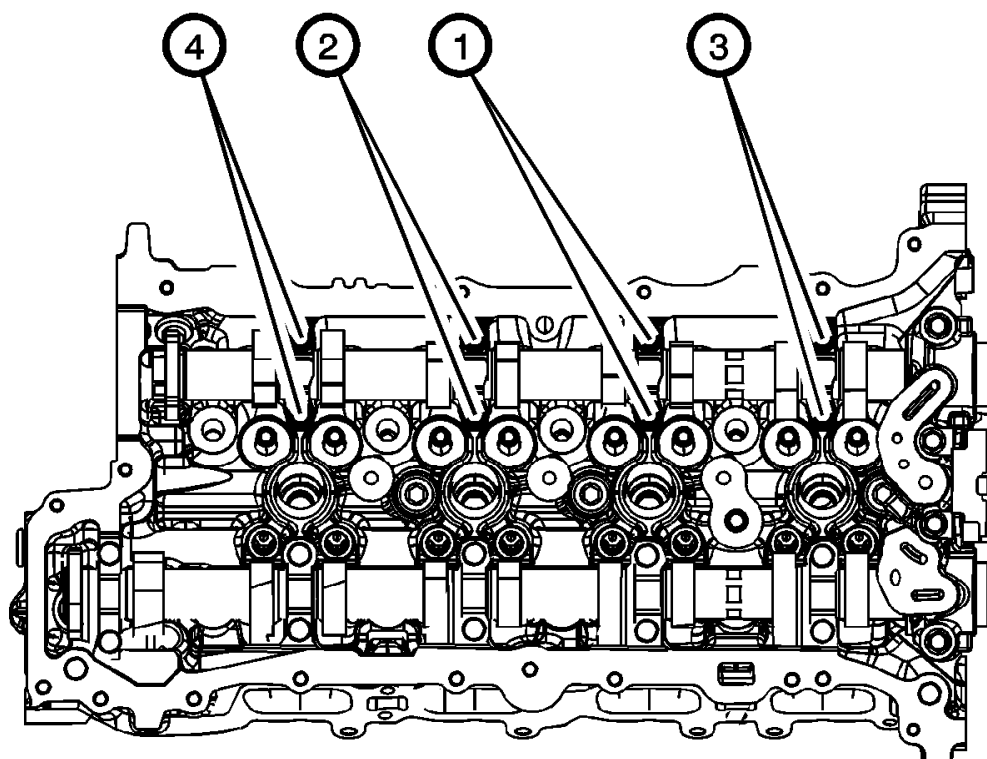


Fig. 147: Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.

8. Install the camshaft cap bolts in sequence using the following procedure:
 1. Tighten the camshaft cap bolts in sequence to 8 (71 lb in).
 2. Loosen both bolts in each cap in sequence to 180 degrees.
 3. Tighten the camshaft cap bolts in sequence to 10 (89 lb in) twice.

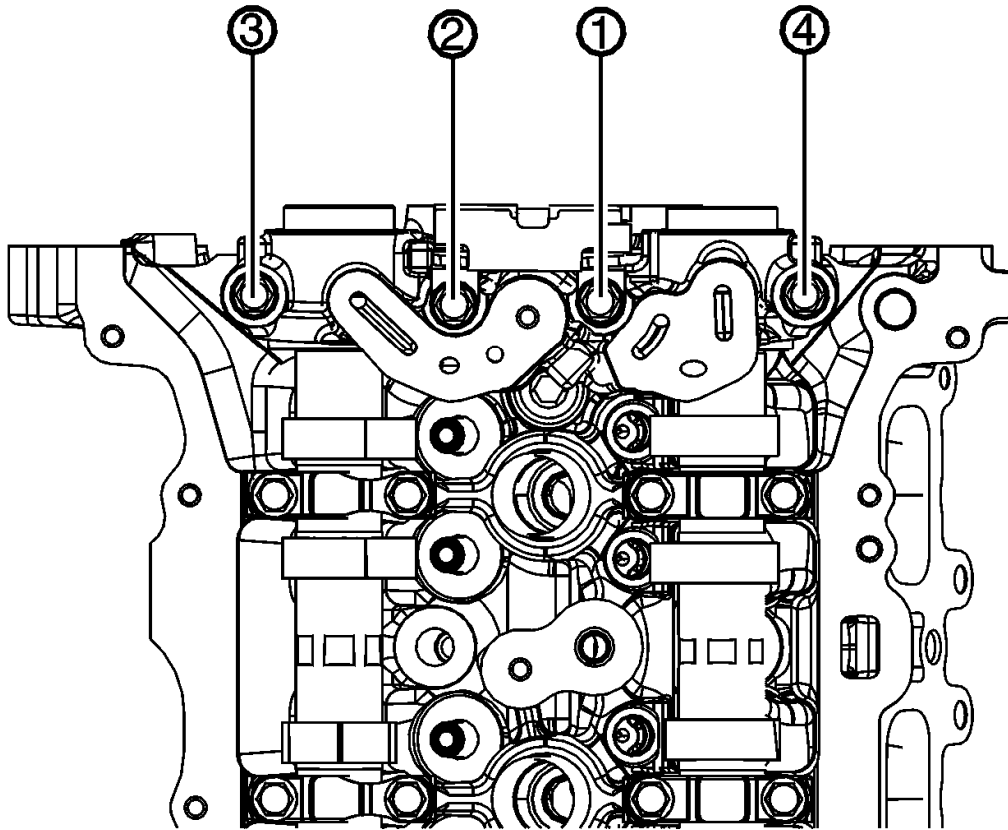


Fig. 148: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

9. Tighten the front camshaft cap bolts in sequence to 10 (89 lb in) twice.

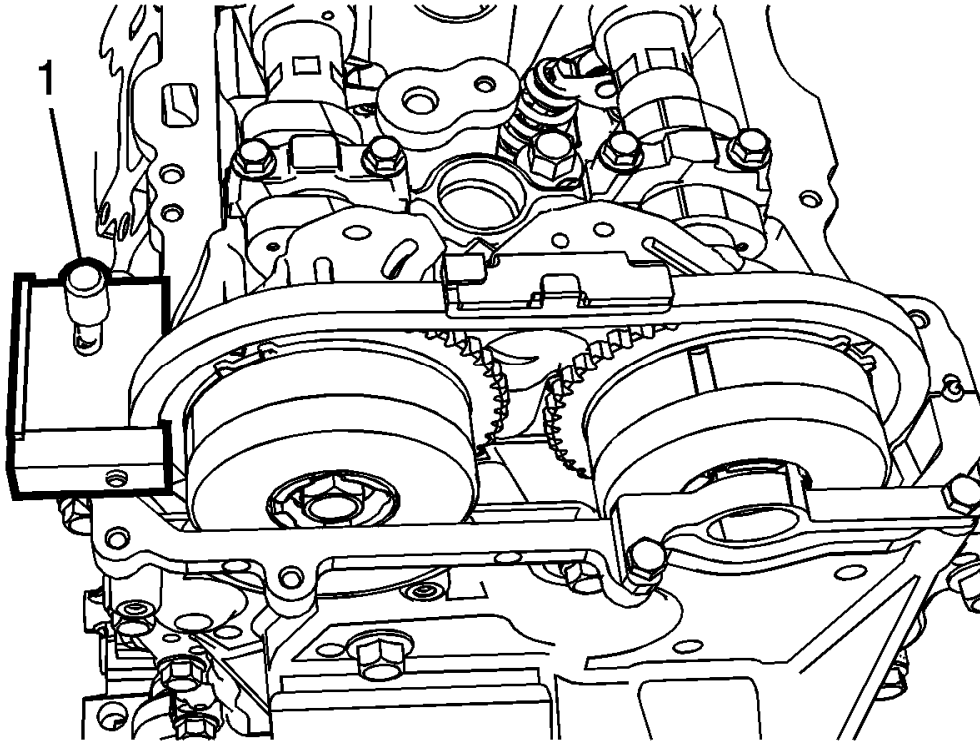


Fig. 149: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove **EN-50656** timing chain holding tool (1).
11. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

CAMSHAFT COVER HEAT SHIELD REPLACEMENT

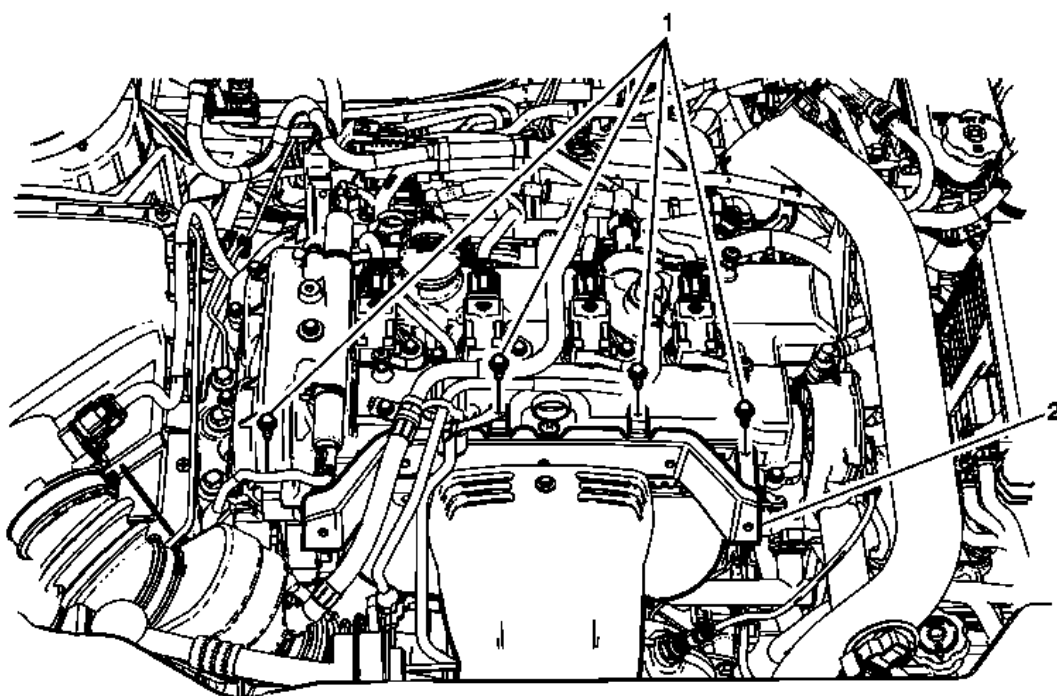


Fig. 150: Camshaft Cover Heat Shield
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Heat Shield Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Heat Shield Cover Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Camshaft Heat Shield Cover

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **EN-36017** Valve Guide Seal Remover
- **EN-43649** Valve Spring Compressor
- **EN-43649-10** Valve Spring Compressor Adaptor Set

- **EN-46106** Flywheel Holder

For equivalent regional tools refer to **Special Tools** .

Removal Procedure

NOTE: Prevent the crankshaft from rotating clockwise or counterclockwise before using compressed air in the cylinder. Rotation of the crankshaft may cause damage to EN-46106 flywheel holding.

1. If equipped with a manual transmission, leave the transmission in first gear with the vehicle on the ground and the parking brake set.
2. If equipped with an automatic transmission, remove the starter. Refer to **Starter Replacement (LTG)** .
3. Install **EN-46106** flywheel holding.
4. Remove the camshaft. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**, or **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.

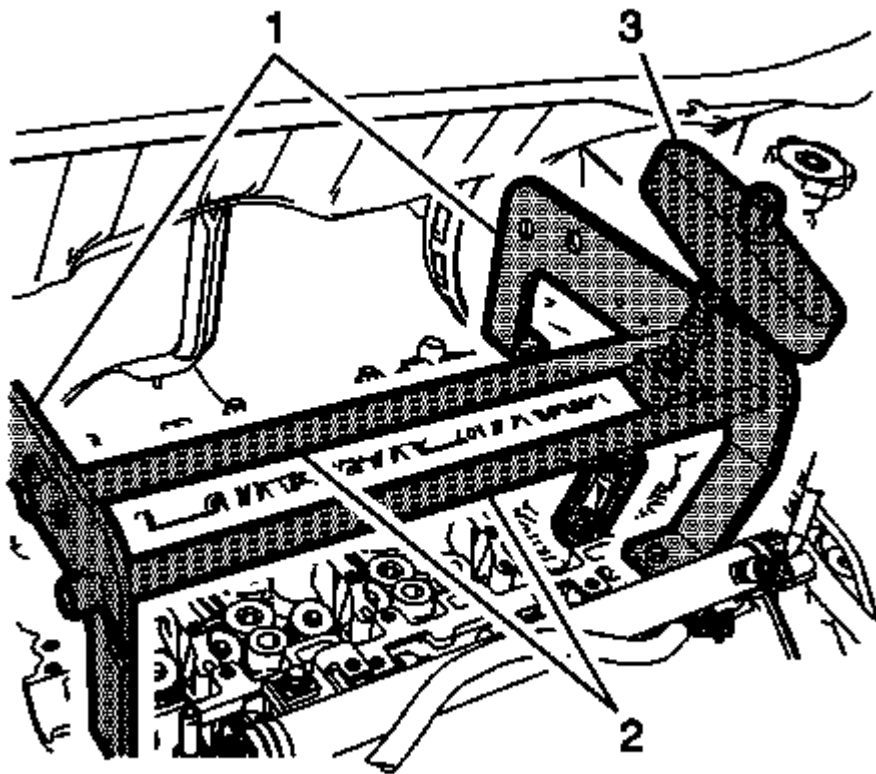


Fig. 151: View Of Valve Spring Compressor Adaptor Set
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-43649-10** adaptor set (1) to the front and rear of the cylinder head.

6. Install the cross bars and locks (2) of the **EN-43649** compressor to the valve spring compressor adaptors.
7. Remove the spark plugs. Refer to **Spark Plug Replacement** .
8. Install an air hose adapter into the spark plug hole.
9. Attach an air hose to the adapter and pressurize the cylinder to 690 kPa (100 psi).
10. Compress the valve spring using the valve spring compressor (3).

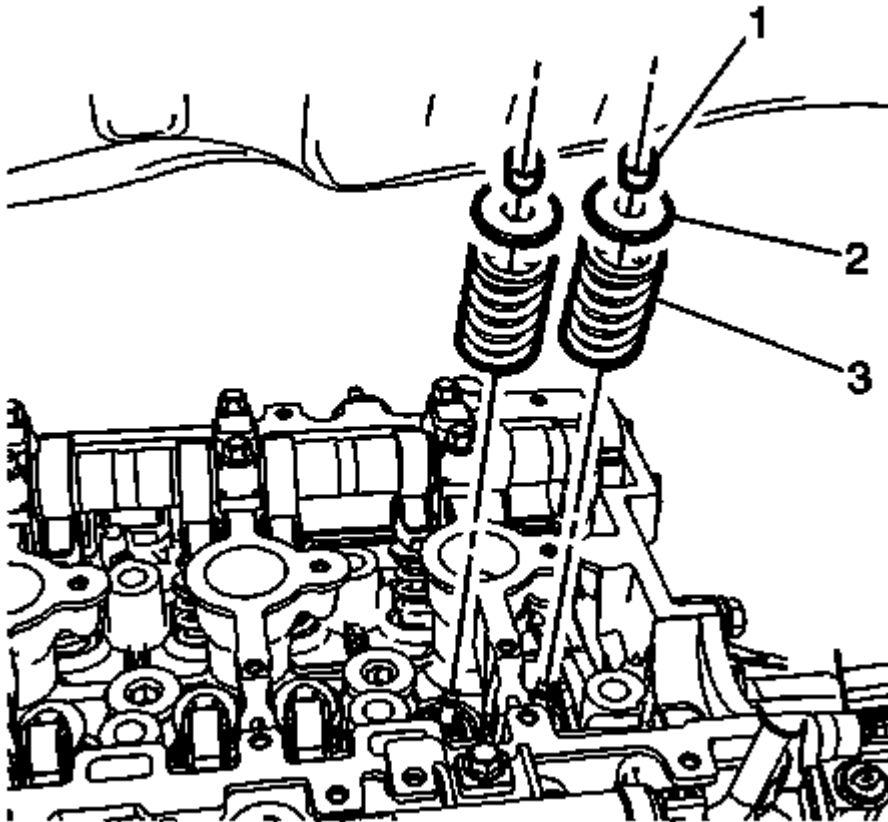


Fig. 152: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Remove the valve spring keepers (1).
12. Remove the valve spring (3) and retainer (2).

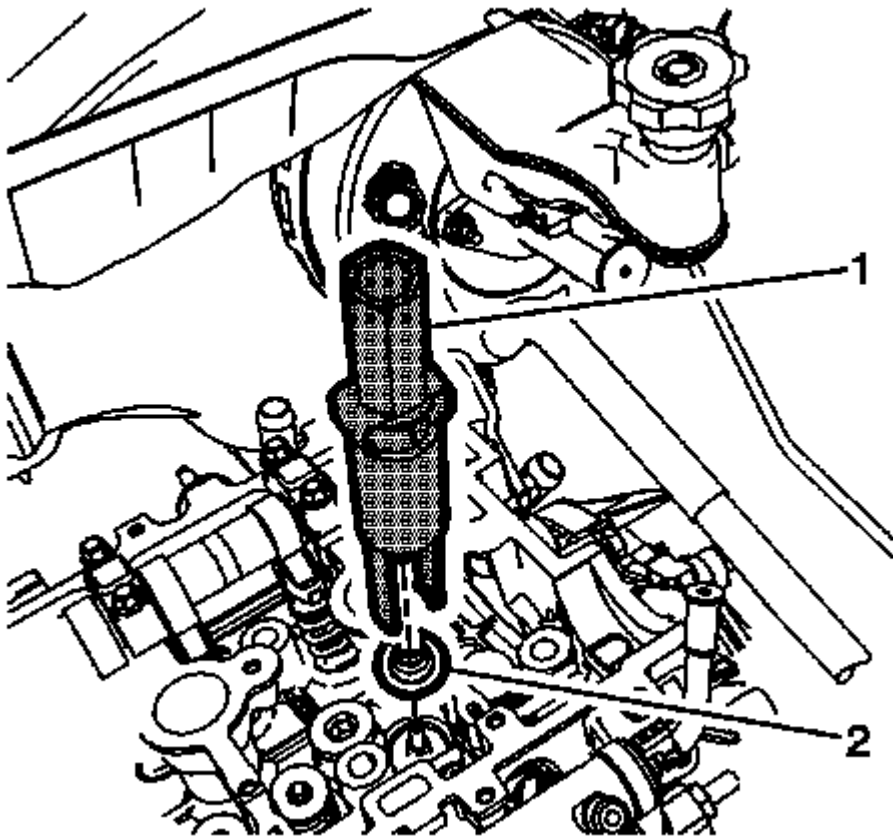


Fig. 153: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

13. Use the **EN-36017** seal remover (1) to remove the valve seal.

Installation Procedure

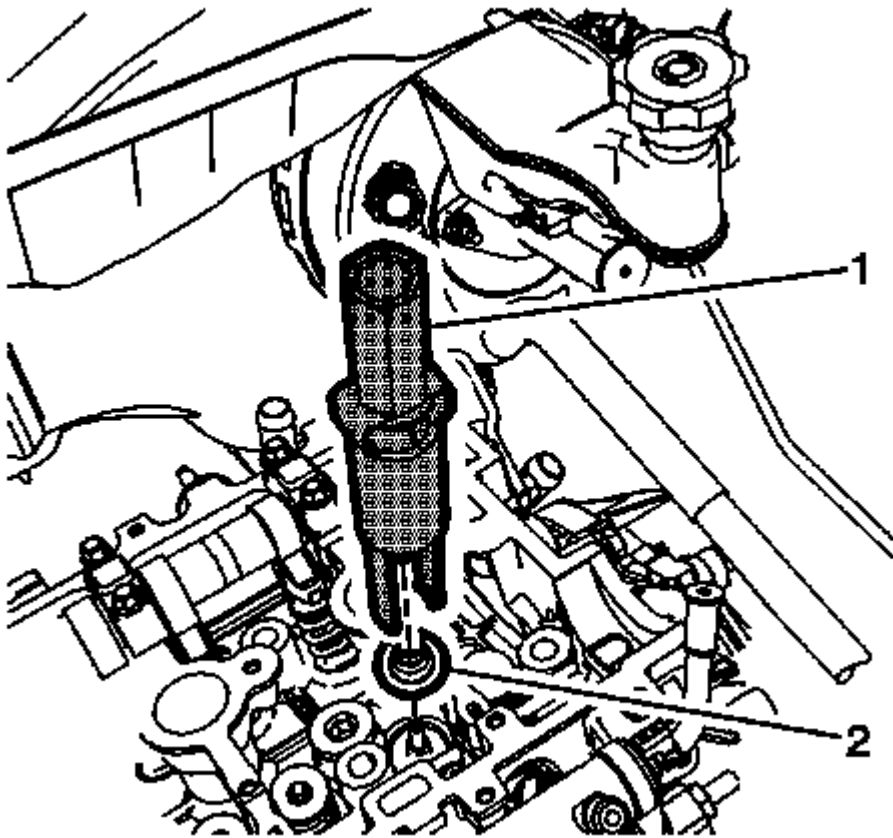


Fig. 154: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

1. Using the **EN-36017** seal remover (1) install the NEW valve seal. Fully seat the seal onto the valve guide.

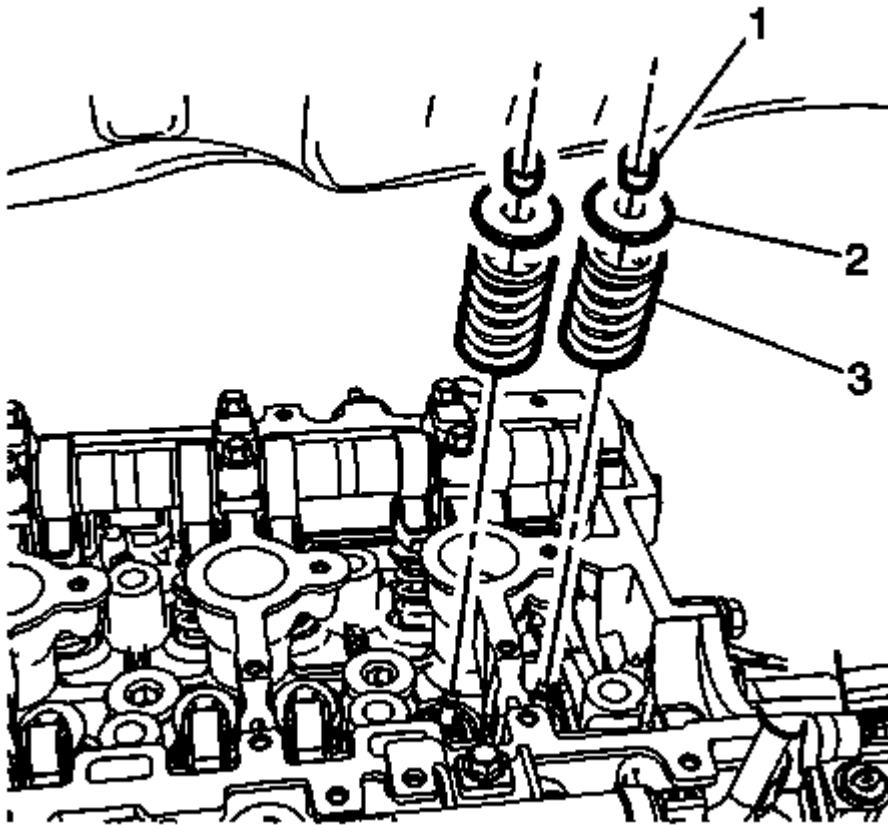


Fig. 155: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring (3) and retainer (2).
3. Compress the valve spring using the valve spring compressor.
4. Install the valve spring keepers (1).
5. Disconnect the air hose and air hose adapter.

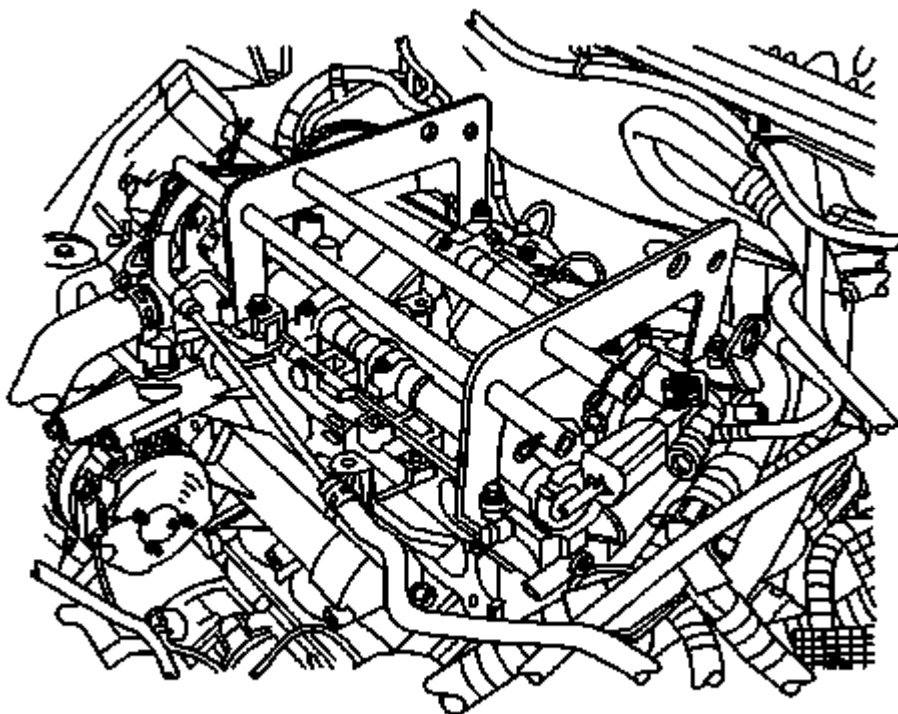


Fig. 156: Cylinder Head Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-43649** compressor and **EN-43649-10** adaptor set from the cylinder head.
7. Install the spark plugs. Refer to **Spark Plug Replacement** .
8. Install the camshaft. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**, or **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.
9. Remove the **EN-46106** flywheel holding.
10. If equipped with an automatic transmission, install the starter. Refer to **Spark Plug Replacement** .

CYLINDER HEAD REPLACEMENT

Removal Procedure

Special Tools

- **EN 38188** Cylinder Head Broken Bolt Extractor Kit
- **EN 45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

1. Drain the coolant system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .
2. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.
3. Remove the camshaft cover. Refer to Camshaft Cover Replacement.
4. Remove the intake manifold. Refer to Intake Manifold Replacement.
5. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LTG) .
6. Remove the engine front cover. Refer to Engine Front Cover Replacement.
7. Remove the camshaft position actuator and camshaft - Intake. Refer to Camshaft Position Actuator and Camshaft Replacement - Intake.

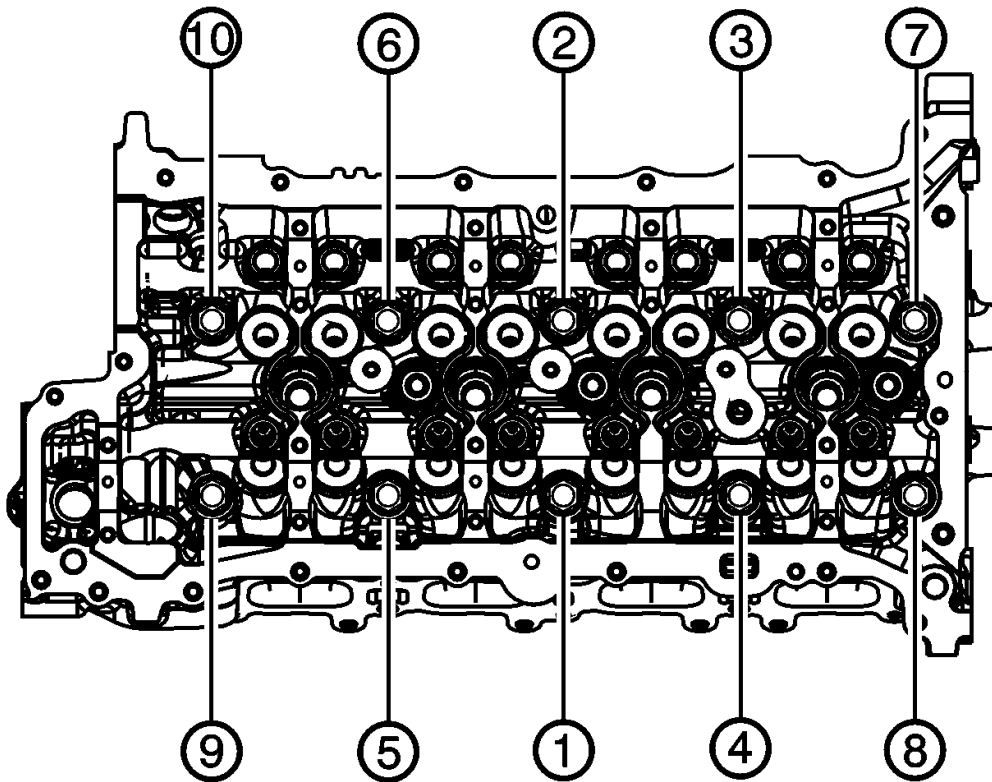


Fig. 157: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

8. Remove the cylinder head to the block bolts in sequence.

Discard the bolts.

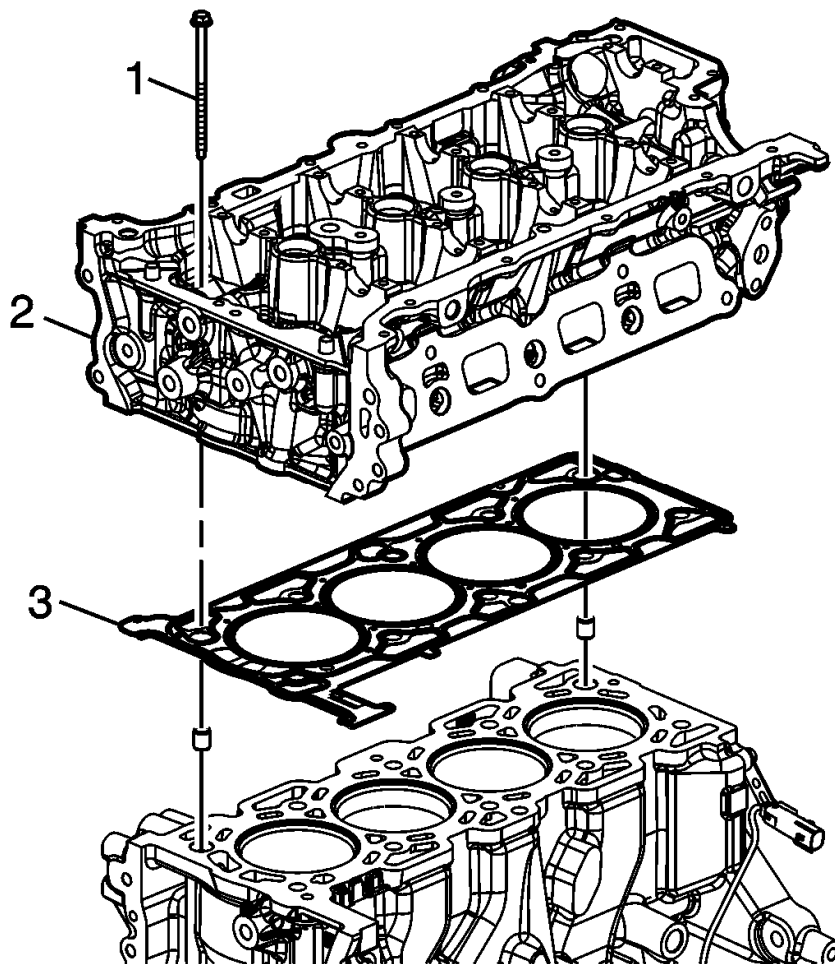


Fig. 158: Cylinder Head Gasket

Courtesy of GENERAL MOTORS COMPANY

CAUTION: In order to prevent damage to the valves and injectors during cylinder head removal, set the cylinder head on blocks.

9. Remove the cylinder head (2).
10. Remove the cylinder head gasket (3).
11. Clean all of the gasket surfaces.
12. Use the following procedures when cleaning the cylinder head and cylinder block surfaces:
 - Use a gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge any surface.

NOTE: Do not use any other method or technique to clean these gasket surfaces.

NOTE: Be careful not to gouge or scratch the gasket surfaces. Do not gouge

or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.

•

NOTE: Do not use a tap to clean the cylinder head bolt holes.

13. Clean the old sealer/lube and dirt from the bolt holes.
14. Clean the bolt holes with a nylon bristle brush.

WARNING: Wear safety glasses to avoid injury when using compressed air or any cleaning solvent. Bodily injury may occur if fumes are inhaled or if skin is exposed to chemicals.

15. When cleaning the cylinder head bolt holes use a suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun to reach the bottom of the holes.
16. Remove any broken long cylinder head bolts using the **EN 38188** kit.
17. For cylinder head disassemble. Refer to **Cylinder Head Disassemble** .
18. For cylinder head cleaning and inspection. Refer to **Cylinder Head Cleaning and Inspection**

Installation Procedure

1. For cylinder head assemble. Refer to **Cylinder Head Assemble** .

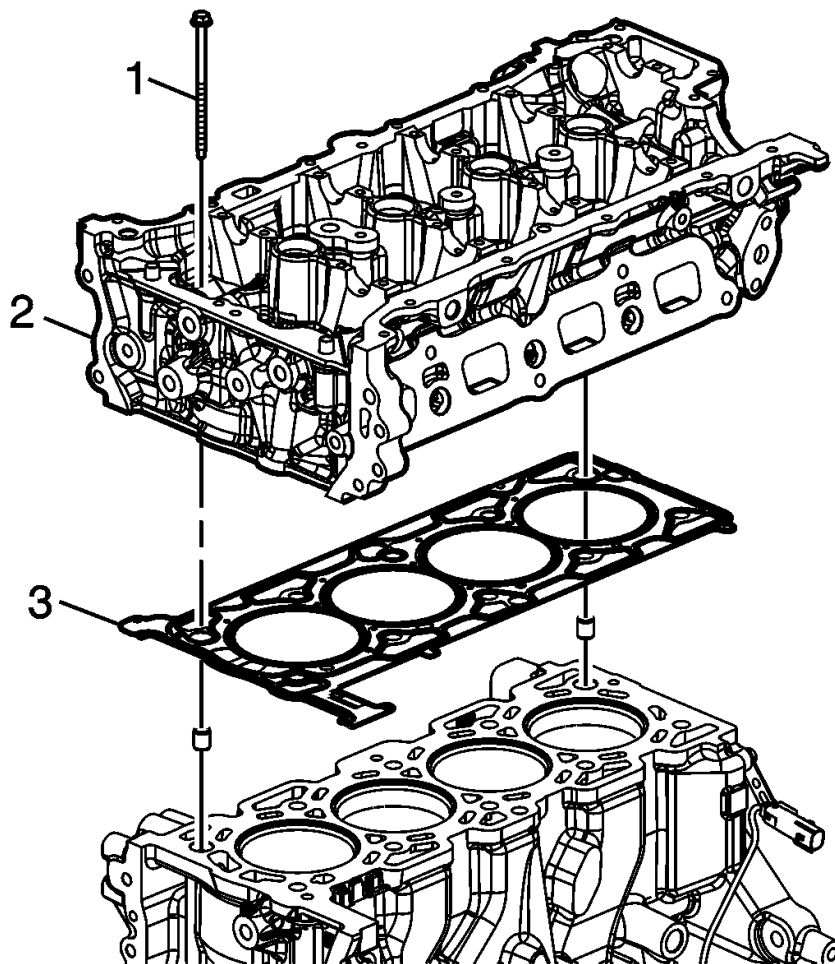


Fig. 159: Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use any sealing material.**

2. Install the cylinder head gasket (3) to the block.
3. Install the cylinder head (2). Ensure the number 1 cylinder is at top dead center (TDC). The key on the crankshaft should be on top in the 12 o'clock position.

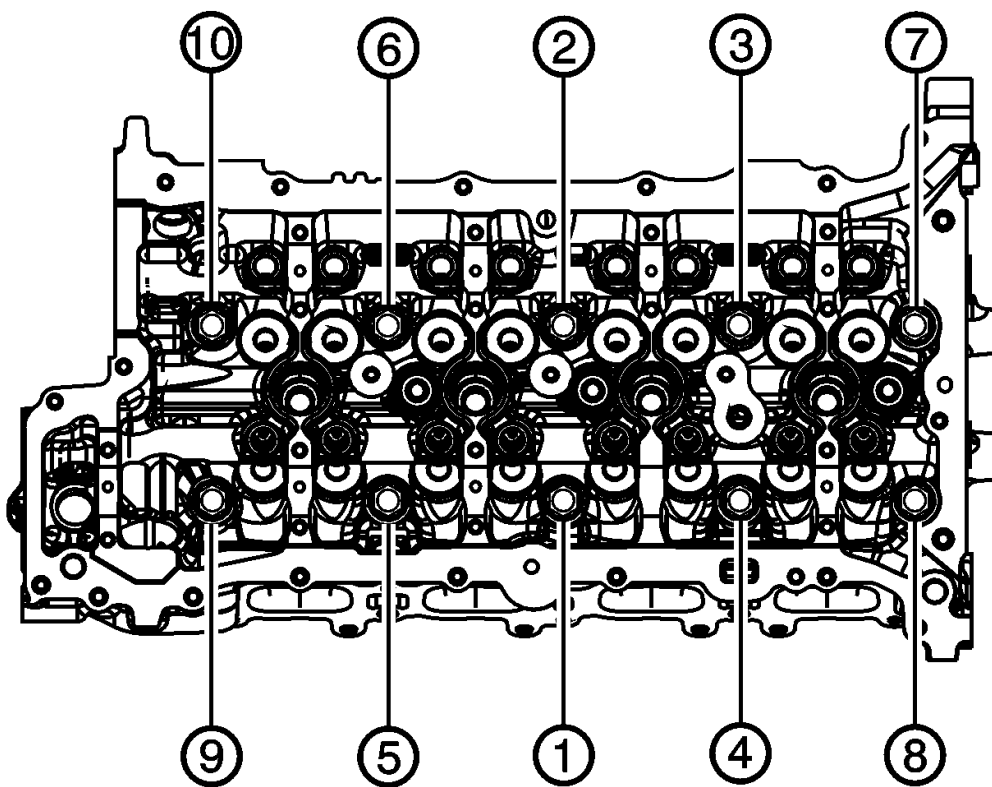


Fig. 160: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Always use NEW cylinder head bolts.

4. Install the cylinder head bolts.
 1. Tighten the bolts in sequence to 30 N.m (22 lb ft).
 2. Tighten the bolts an additional 190 degrees in sequence using the **EN 45059** meter.
5. Install the camshaft position actuator and camshaft - Intake. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake.**
6. Install the engine front cover. Refer to **Engine Front Cover Replacement.**
7. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LTG)** .
8. Install the intake manifold. Refer to **Intake Manifold Replacement.**

9. Install the camshaft cover. Refer to Camshaft Cover Replacement.
10. Refill the engine with NEW oil. Refer to Engine Oil and Oil Filter Replacement.
11. Refill the coolant system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .

ENGINE OIL COOLER REPLACEMENT (AWD)

Removal Procedure

1. Remove the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.

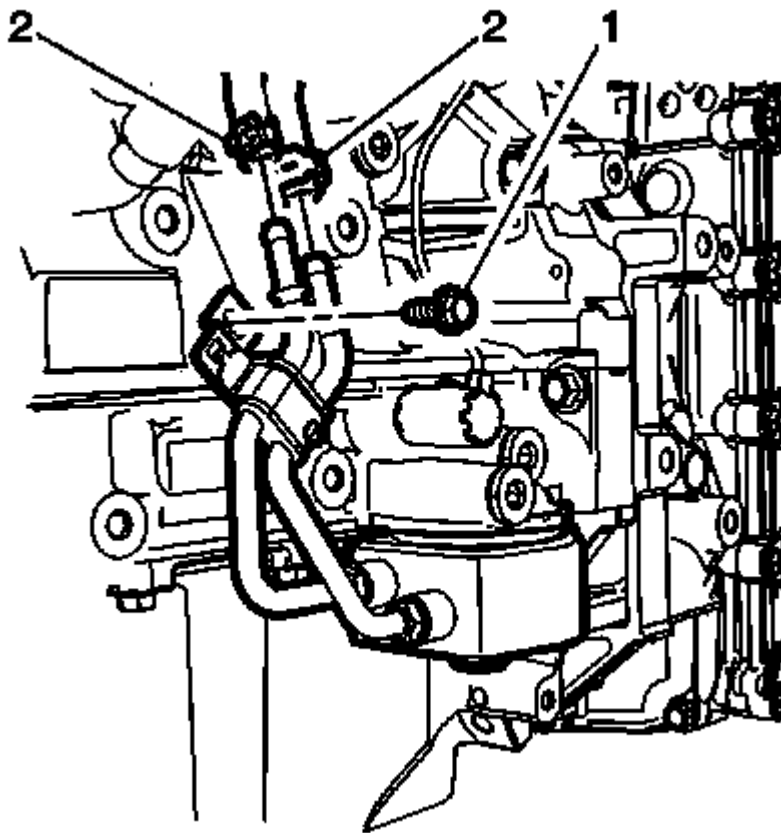


Fig. 161: Engine Oil Cooler Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil cooler fastener (1).
3. Remove the engine oil cooler hoses (2).

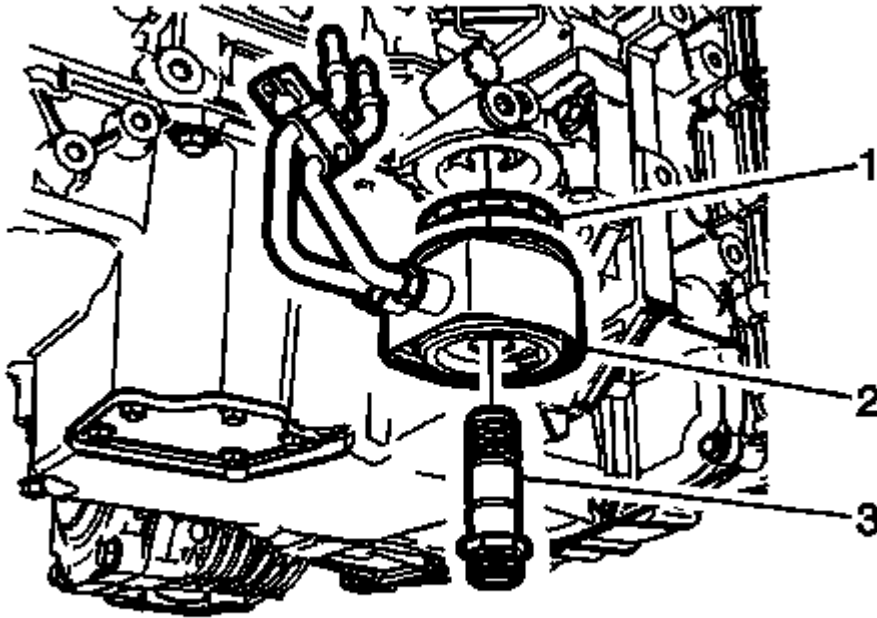


Fig. 162: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil cooler connector (3).

NOTE: **DISCARD** the old engine oil cooler seal (1).

5. Remove the engine oil cooler (2).

Installation Procedure

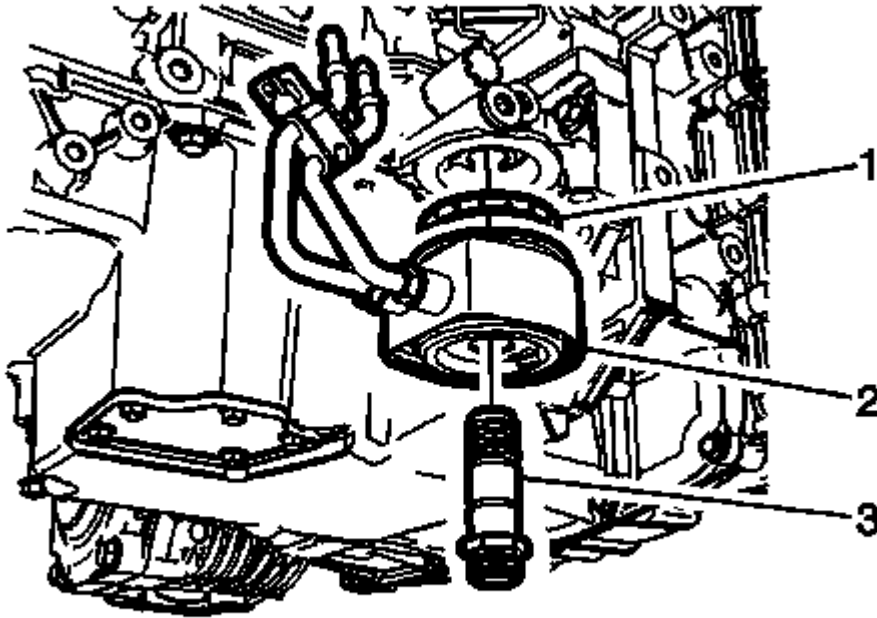


Fig. 163: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

NOTE: A NEW engine oil cooler seal must be used whenever reinstalling the engine oil cooler.

1. Install the engine oil cooler (2) with a NEW seal.

CAUTION: Refer to Component Fastener Tightening Caution .

2. Install the engine oil cooler connector (3) and tighten to 50 (37 lb ft).

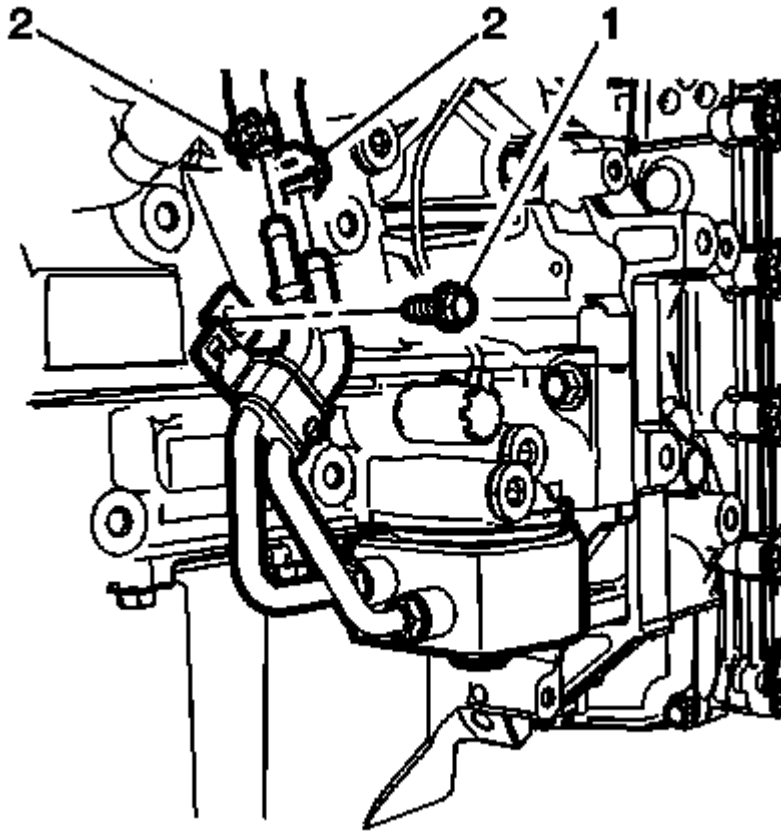


Fig. 164: Oil Cooler Hoses

Courtesy of GENERAL MOTORS COMPANY

3. Install the oil cooler hoses (2).

CAUTION: Refer to Fastener Caution .

4. Install the oil cooler fastener (1) and tighten to 10 (89 lb in)
5. Install the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.

ENGINE OIL COOLER REPLACEMENT (FWD)

Removal Procedure

1. Remove the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.

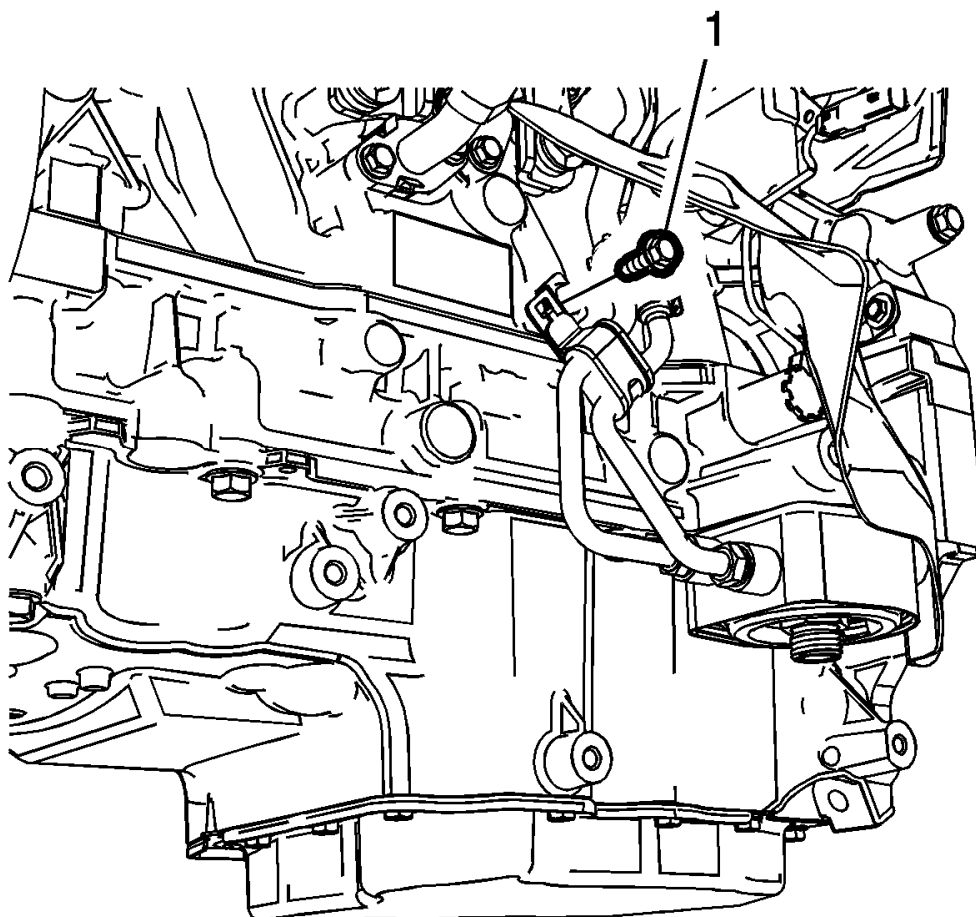


Fig. 165: Engine Oil Cooler Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil cooler fastener (1).

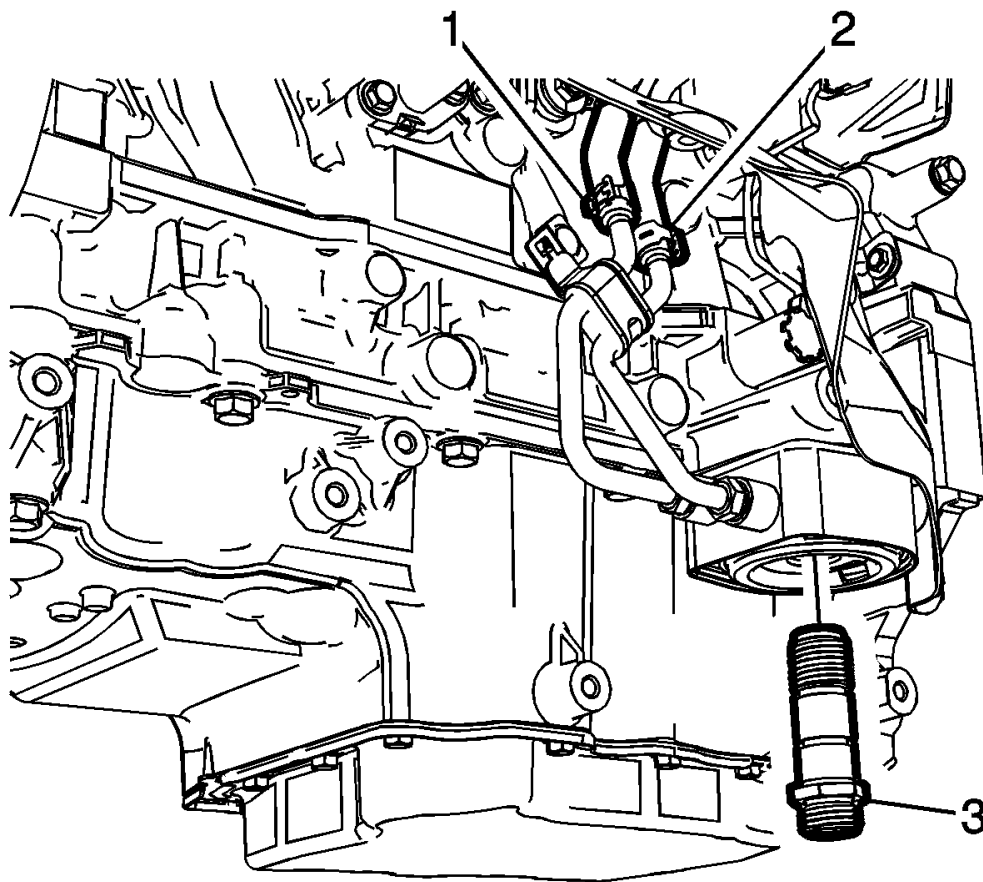


Fig. 166: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil cooler hose (1) and (2).
4. Remove the engine oil cooler connector (3).

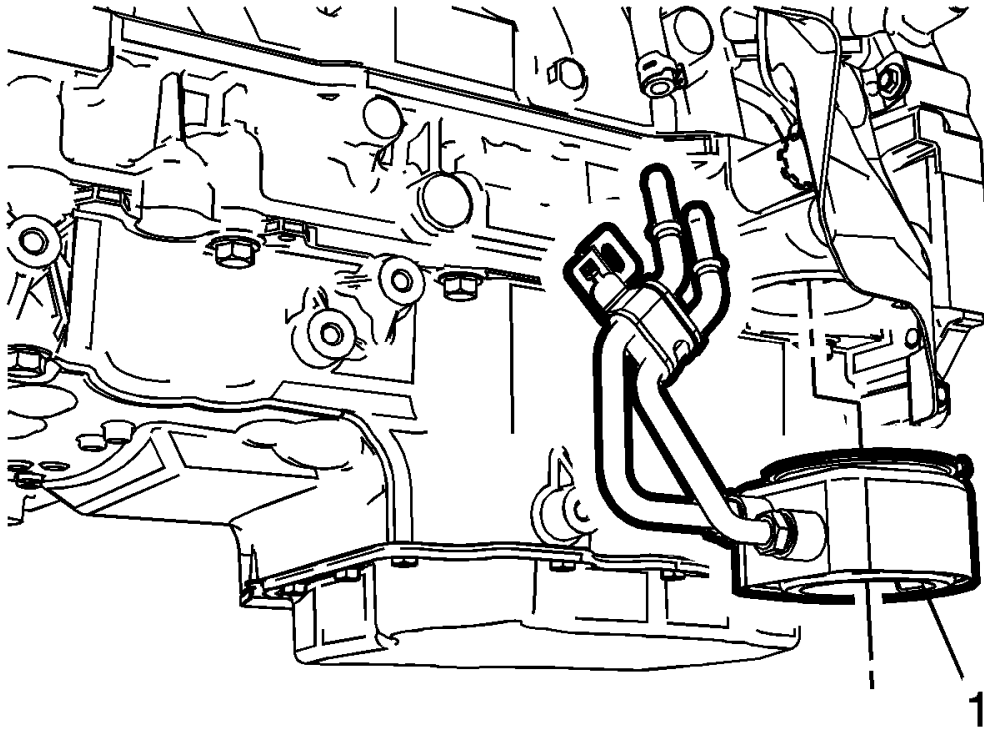


Fig. 167: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DISCARD** the old engine oil cooler seal.

5. Remove the engine oil cooler (1).

Installation Procedure

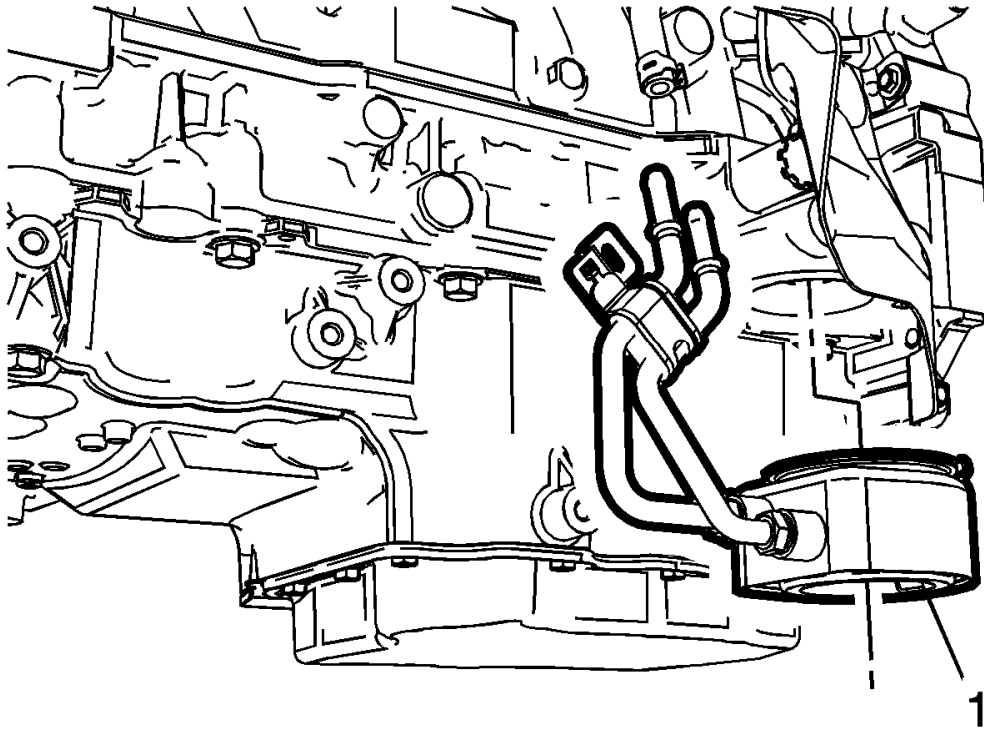


Fig. 168: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

NOTE: A NEW engine oil cooler seal must be used whenever reinstalling the engine oil cooler.

1. Install the engine oil cooler (1).

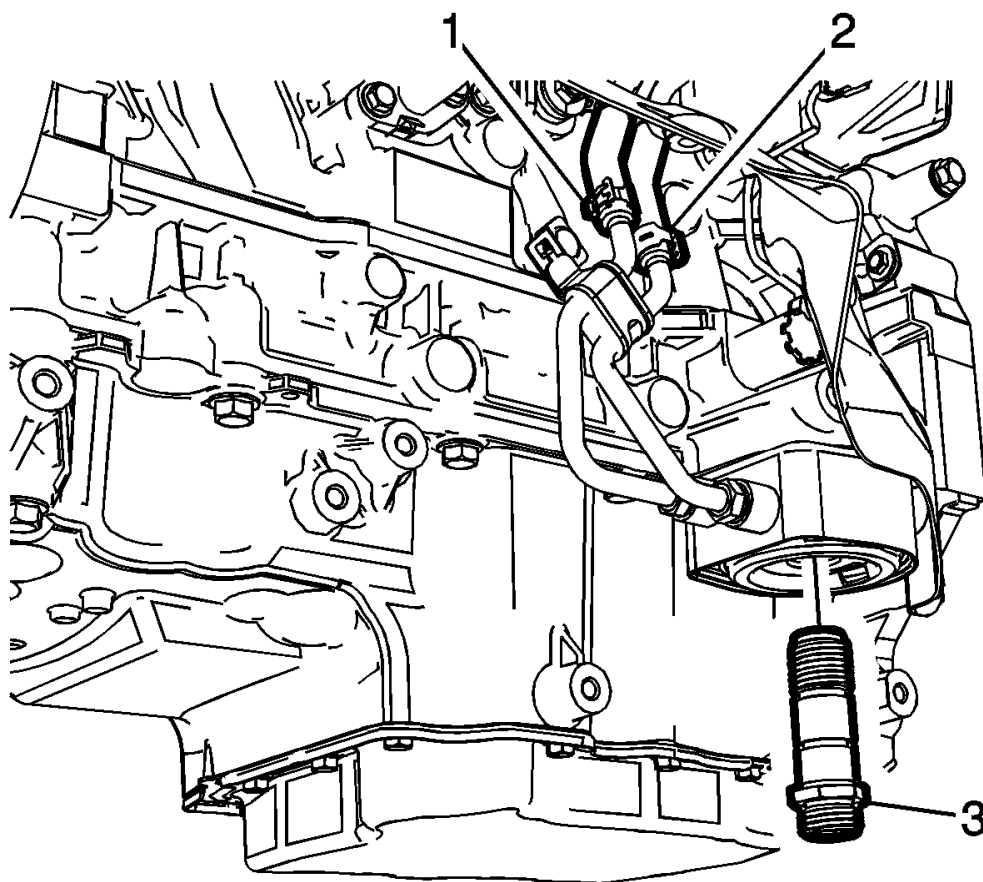


Fig. 169: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

2. Install the engine oil cooler connector (3) and tighten to 50 (37 lb ft).
3. Install the oil cooler hose (1) and (2).

CAUTION: Refer to Fastener Caution .

4. Install the oil cooler fastener (1) and tighten to 10 (89 lb in)
5. Install the engine oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

OIL PAN REPLACEMENT (AWD)

Removal Procedure

1. Drain the engine oil and remove the oil filter. Refer to Engine Oil and Oil Filter Replacement.
2. Support the engine using the engine support fixture. Refer to Engine Support Fixture.
3. Remove the drivetrain and front suspension frame front crossmember. Refer to Drivetrain and Front Suspension Frame Replacement.
4. Remove the transfer case. Refer Transfer Case Replacement.

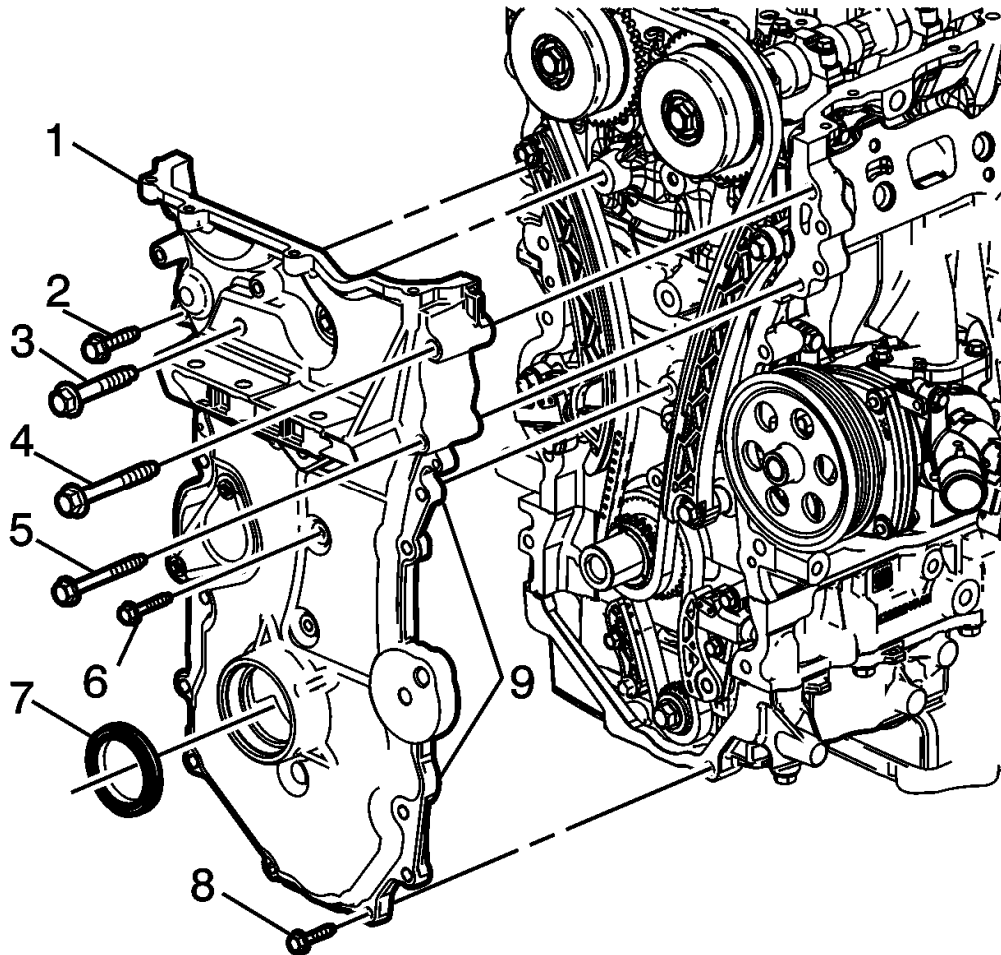


Fig. 170: Front Oil Seal

Courtesy of GENERAL MOTORS COMPANY

5. Remove the front engine cover. Refer to Engine Front Cover Replacement.
6. Remove the front exhaust pipe. Refer to Exhaust Front Pipe Replacement (LTG AWD).

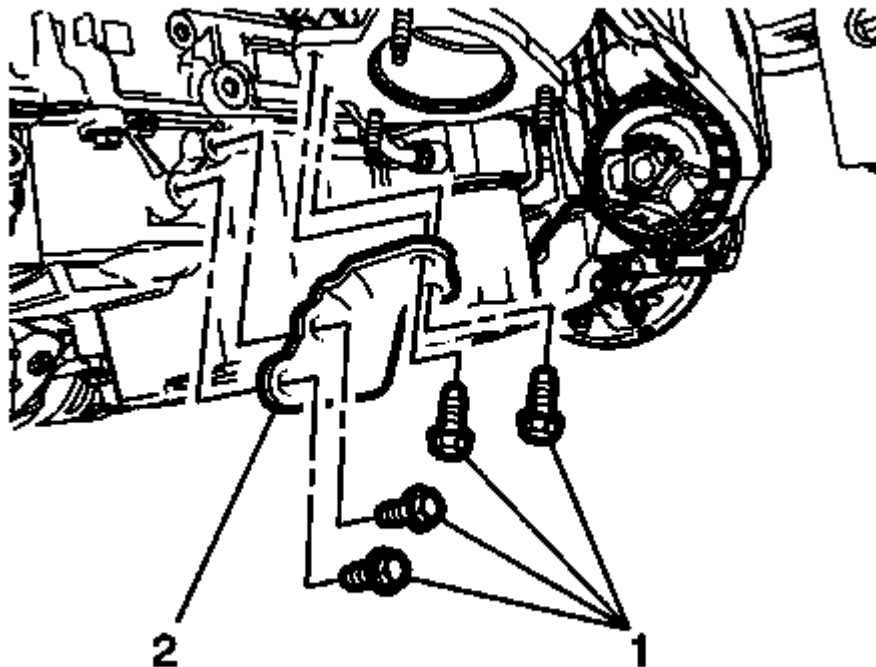


Fig. 171: Catalytic Converter Lower Brace & Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the catalytic converter to oil pan brace fasteners (1).
8. Remove the catalytic lower brace (2).
9. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** .

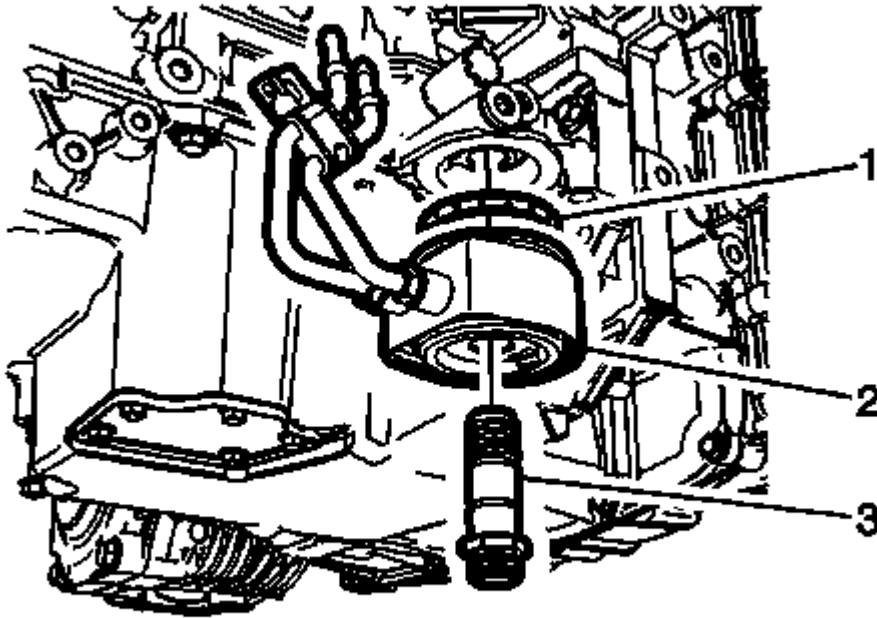


Fig. 172: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

10. Remove the engine oil cooler (2). Refer to **Engine Oil Cooler Replacement (AWD)**.

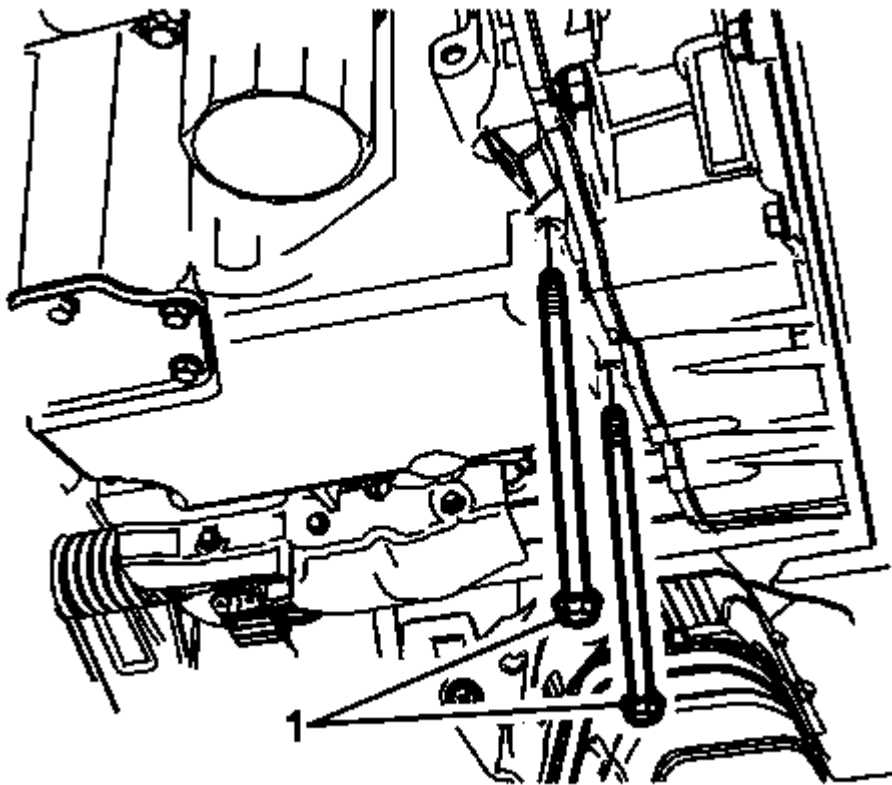


Fig. 173: Rear Oil Pan to Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

11. Remove the rear oil pan to engine block fasteners (1).

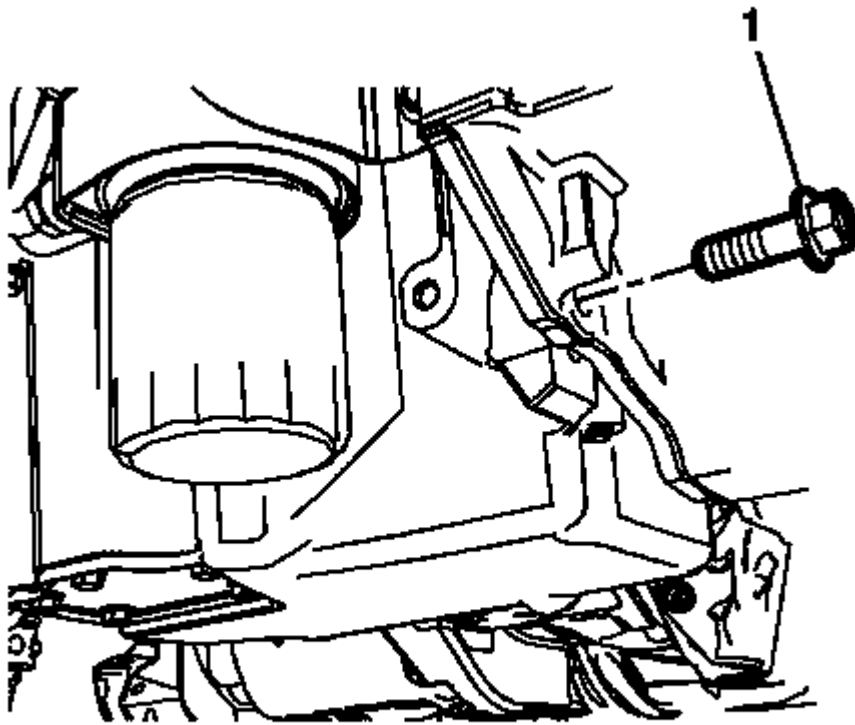


Fig. 174: Transmission To Oil Pan Fastener
Courtesy of GENERAL MOTORS COMPANY

12. Remove the transmission to oil pan fastener (1).

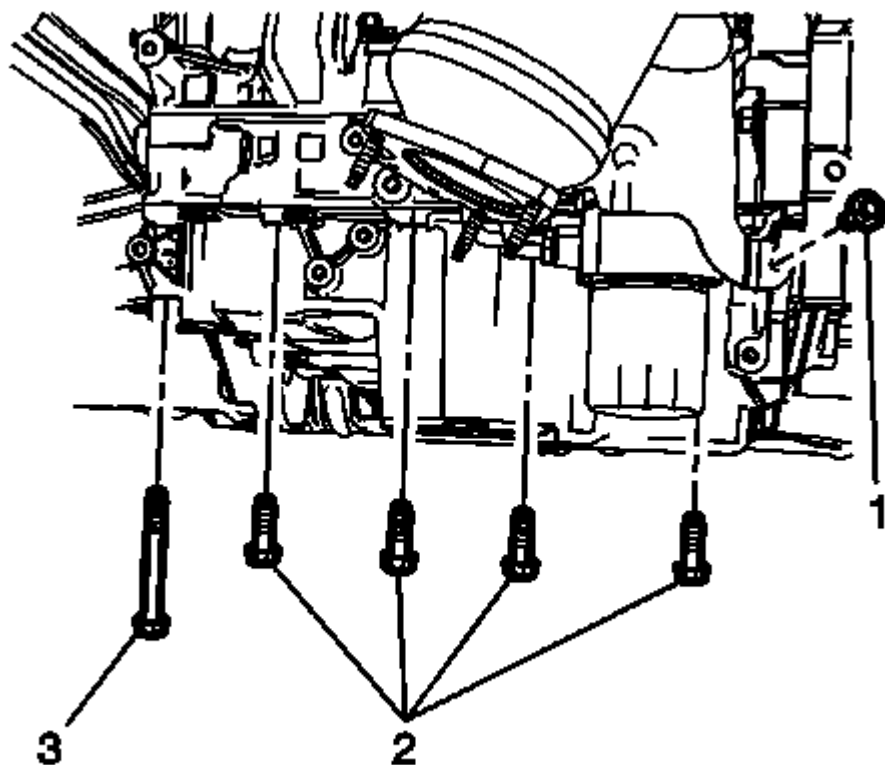


Fig. 175: Left Oil Pan To Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

13. Remove the left oil pan to engine block fasteners (2, 3).

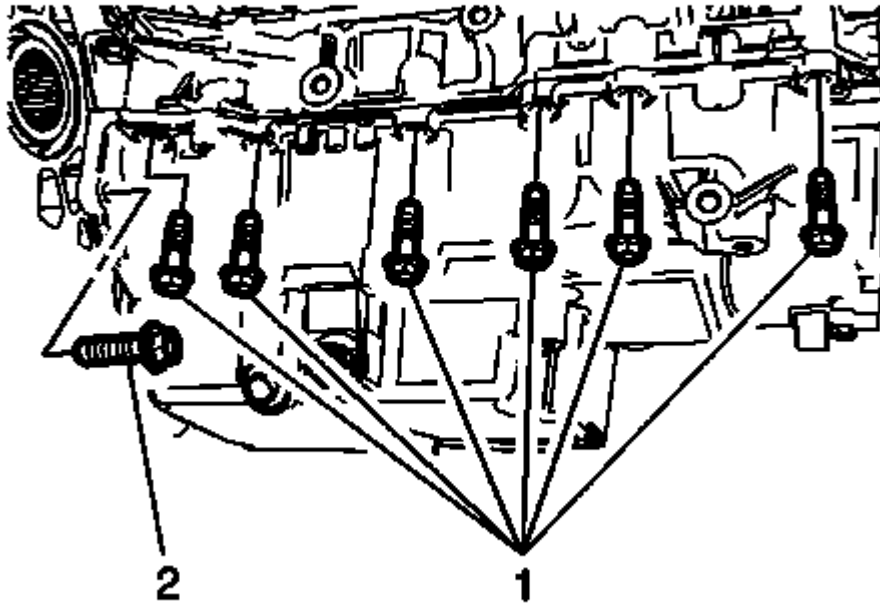


Fig. 176: Oil Pan To Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the oil level sensor harness connector.
15. Remove the oil pan to transmission fastener (2).
16. Remove the right oil pan to engine block fasteners (1).

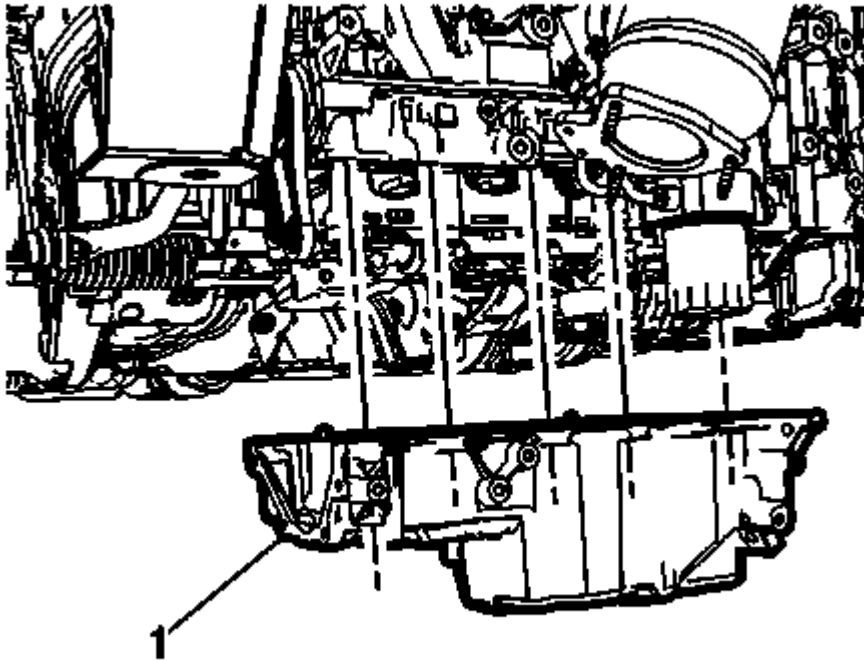


Fig. 177: Engine Oil Pan

Courtesy of GENERAL MOTORS COMPANY

17. Remove the oil pan (1) from the engine.

Installation Procedure

1. Clean and inspect the surfaces of the oil pan and engine block. Refer to **Oil Pan Cleaning and Inspection** .

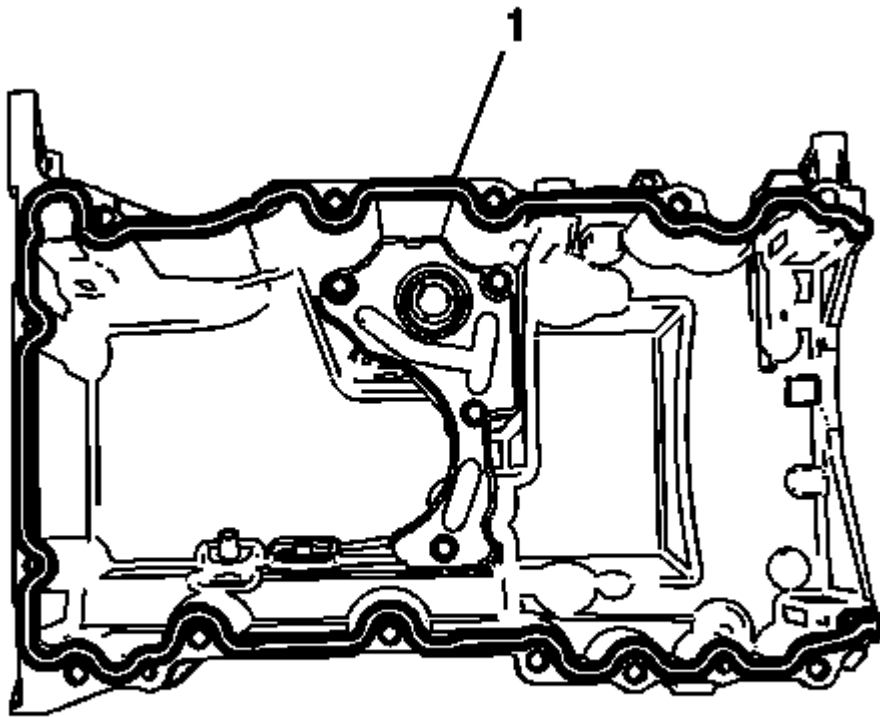


Fig. 178: Engine Oil Pan Sealing Surface
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The oil pan sealing surfaces must be free of contamination prior to applying the sealer.
- Install and align the oil pans within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

2. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
3. Place the oil pan to the engine and loosely installing fasteners at the four corners of the oil pan.

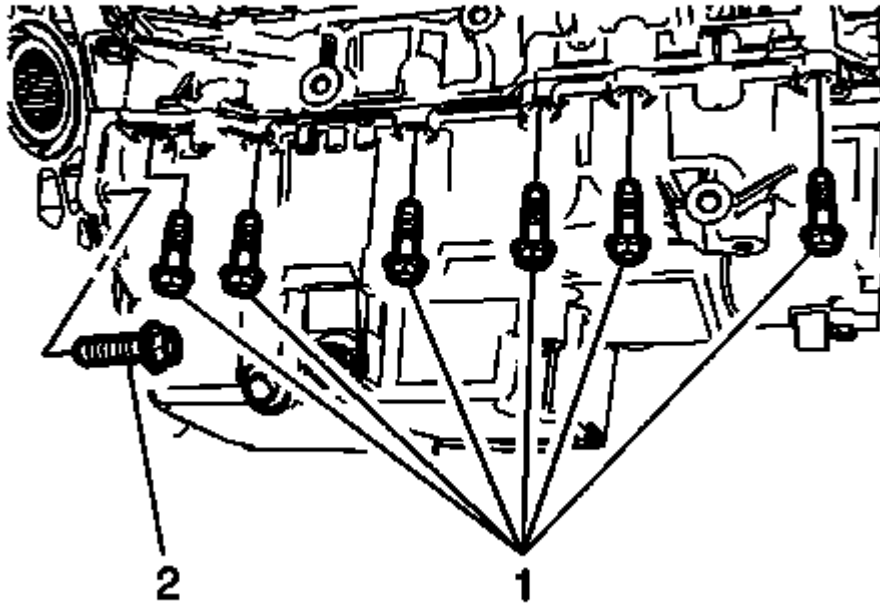


Fig. 179: Oil Pan To Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the right oil pan to engine block fasteners (1) hand tight.
5. Install the oil pan to transmission fastener (2) hand tight.
6. Connect the oil level sensor harness connector.

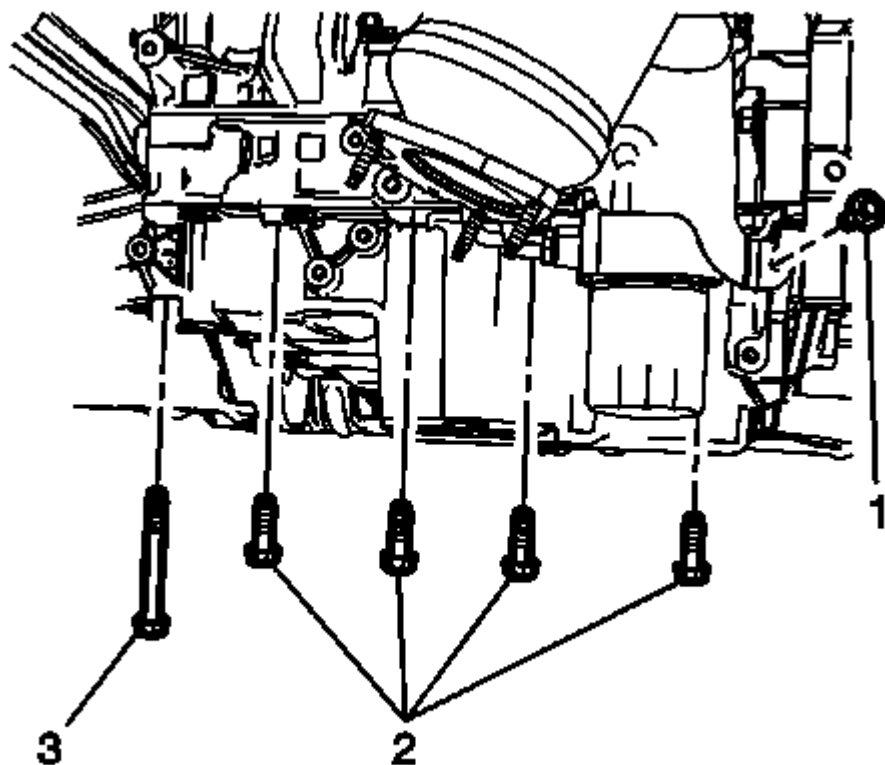


Fig. 180: Left Oil Pan To Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Install the left oil pan to engine block fasteners (2, 3) hand tight.

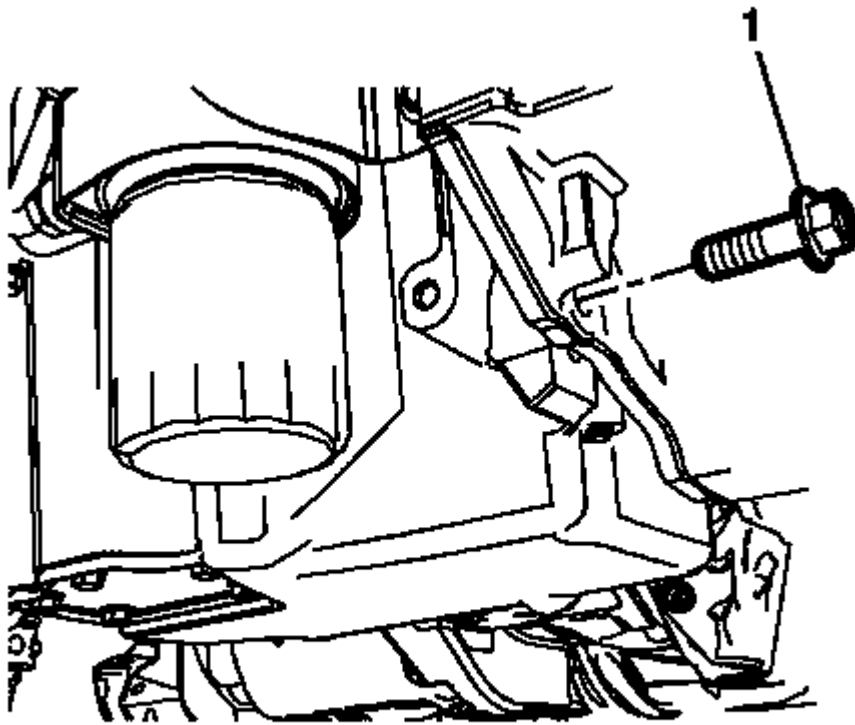


Fig. 181: Transmission To Oil Pan Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Install the transmission to oil pan fastener (1) hand tight.

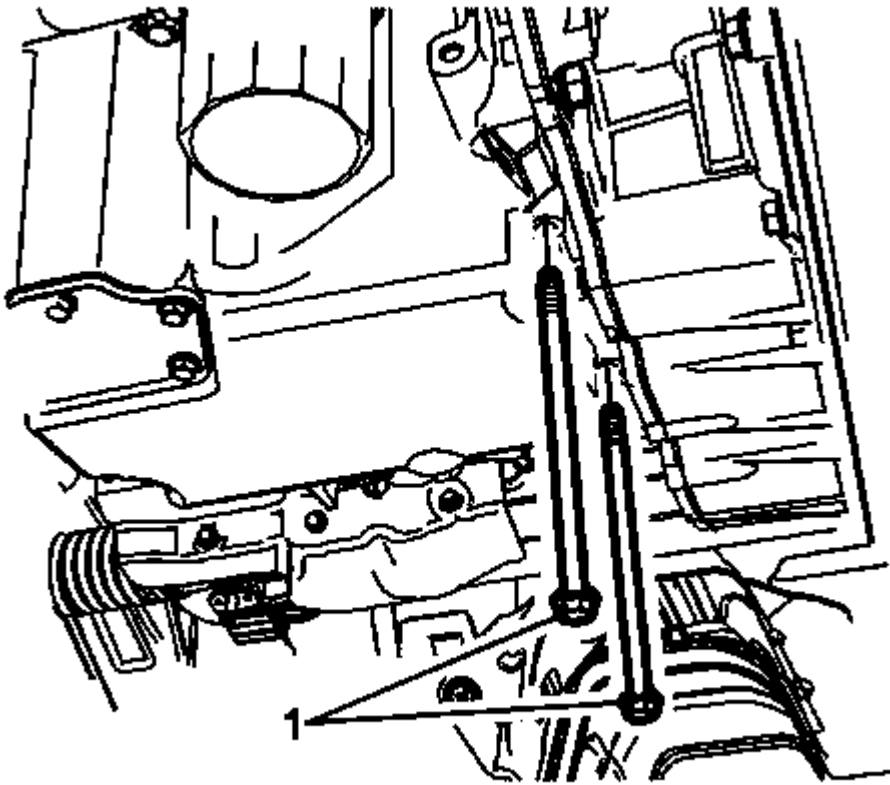


Fig. 182: Rear Oil Pan to Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Install the rear oil pan to engine block fasteners (1) hand tight.

CAUTION: Refer to Fastener Caution .

10. Tighten the oil pan bolts in sequence to final torque twice using the following procedure:
 1. Tighten the fasteners in sequence (1-11) to 25 (18 lb ft).
 2. Tighten the fasteners in sequence (12-13) to 10 (89 lb in).
11. Tighten the oil pan to engine bolts to 60 (44 lb ft).

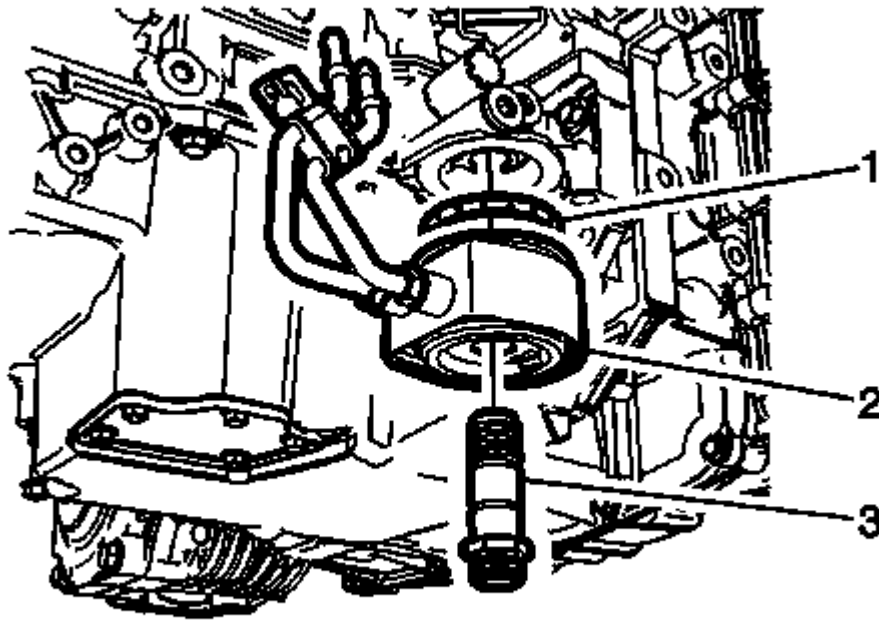


Fig. 183: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

12. Install the engine oil cooler (2). Refer to **Engine Oil Cooler Replacement (AWD)**.
13. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)**.

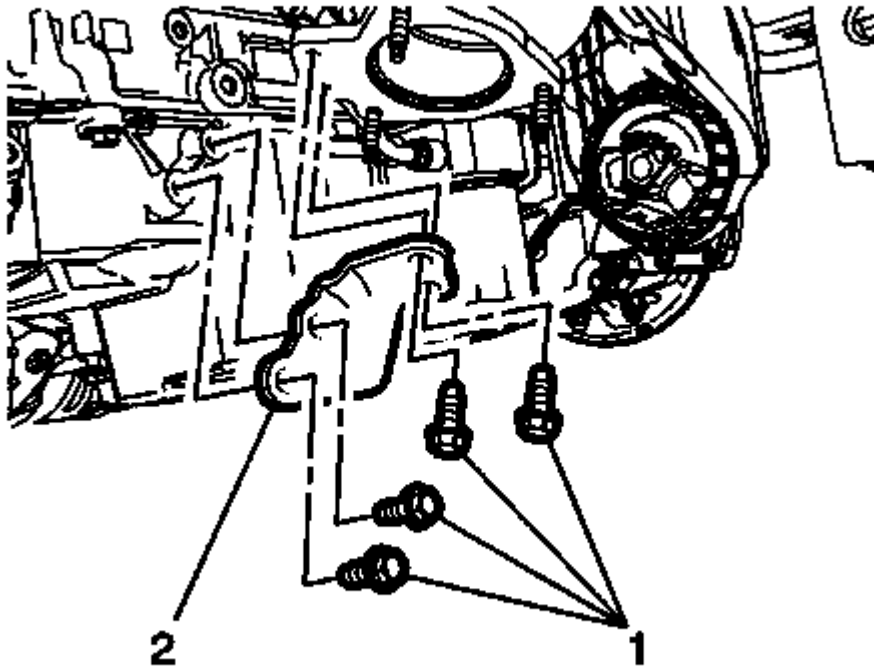


Fig. 184: Catalytic Converter Lower Brace & Fasteners
Courtesy of GENERAL MOTORS COMPANY

14. Position the catalytic lower brace (2).
15. Install the catalytic converter to oil pan brace fasteners (1) and tighten to 25 (18 lb ft).
16. Install the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG AWD)** .

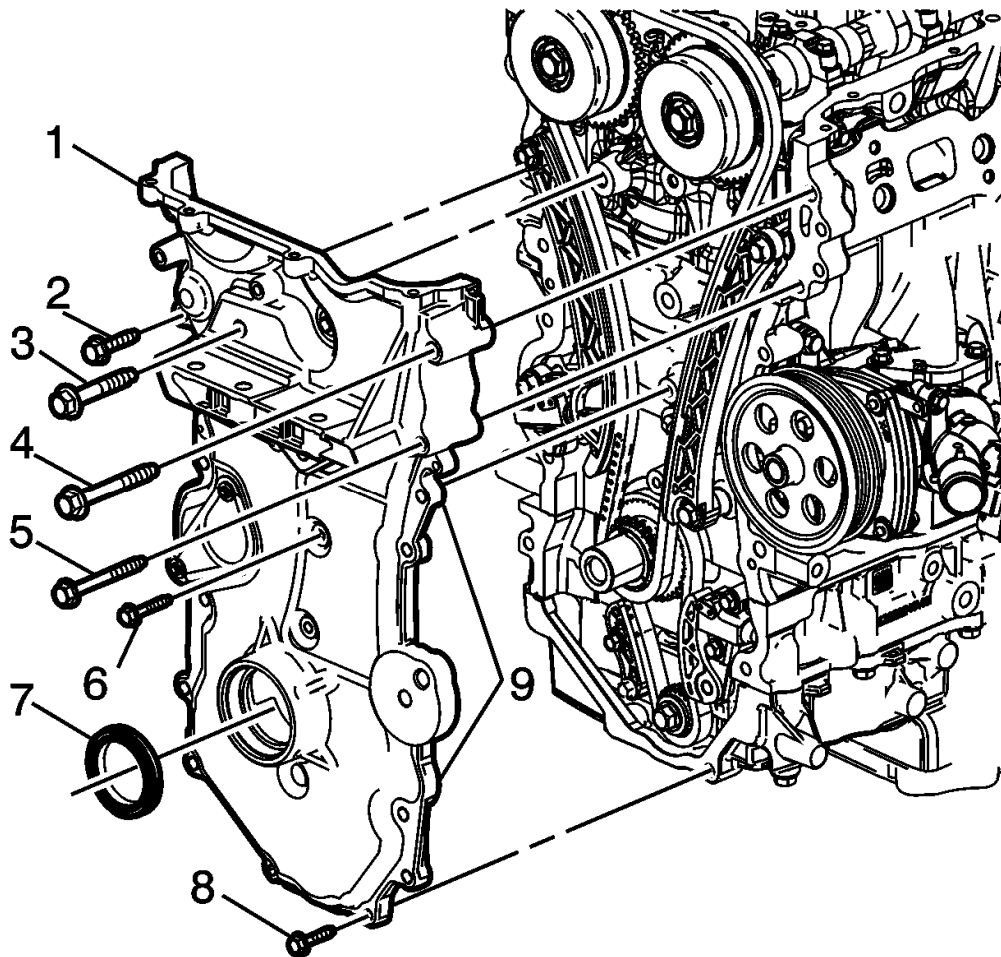


Fig. 185: Front Oil Seal

Courtesy of GENERAL MOTORS COMPANY

17. Install the front engine cover. Refer to **Engine Front Cover Replacement**.
18. Install the transfer case. Refer **Transfer Case Replacement** .
19. Install the drivetrain and front suspension frame front crossmember. Refer to **Drivetrain and Front Suspension Frame Replacement** .
20. Remove the engine support fixture. Refer to **Engine Support Fixture**.
21. Refill the engine oil and install a NEW oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

OIL PAN REPLACEMENT (FWD)

Removal Procedure

1. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
2. Support the engine. Refer to **Engine Support Fixture**.
3. Remove the drivetrain and front suspension frame front crossmember. Refer to **Drivetrain and Front Suspension Frame Replacement** .

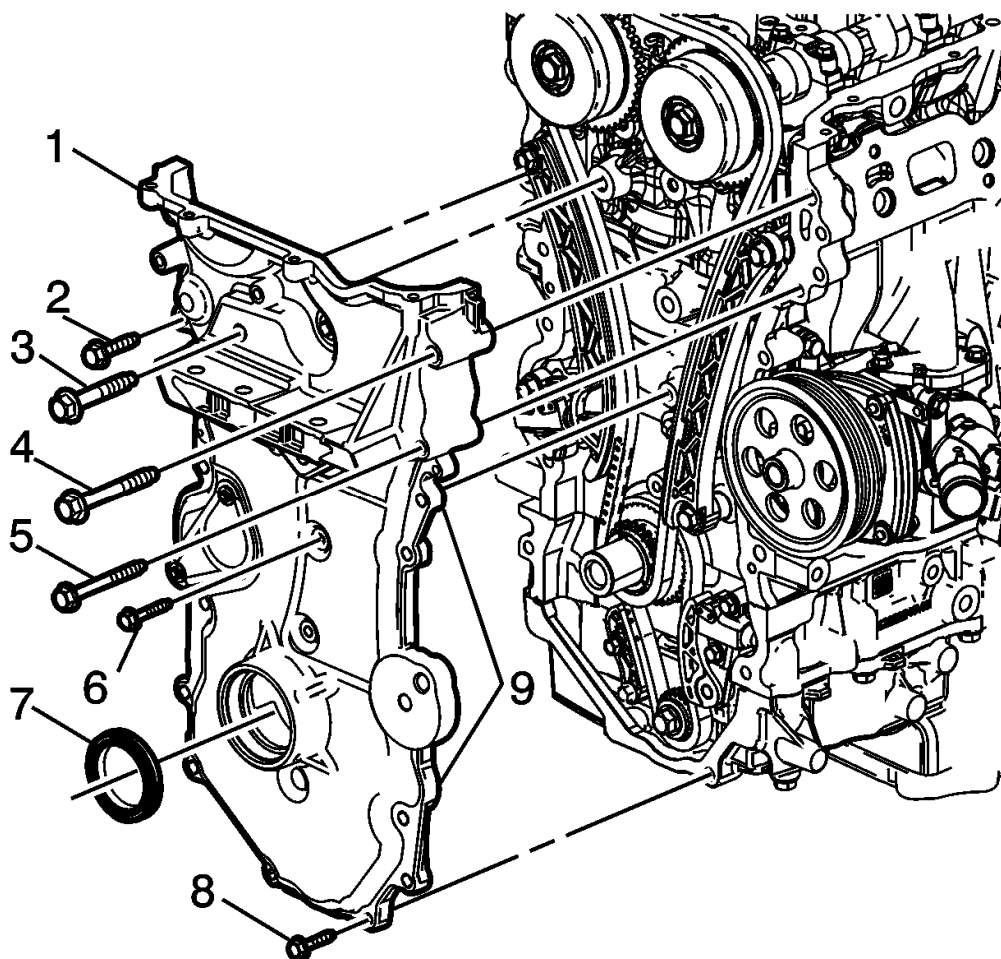


Fig. 186: Front Oil Seal

Courtesy of GENERAL MOTORS COMPANY

4. Remove the front engine cover (1). Refer to **Engine Front Cover Replacement**.
5. Remove the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG)**.

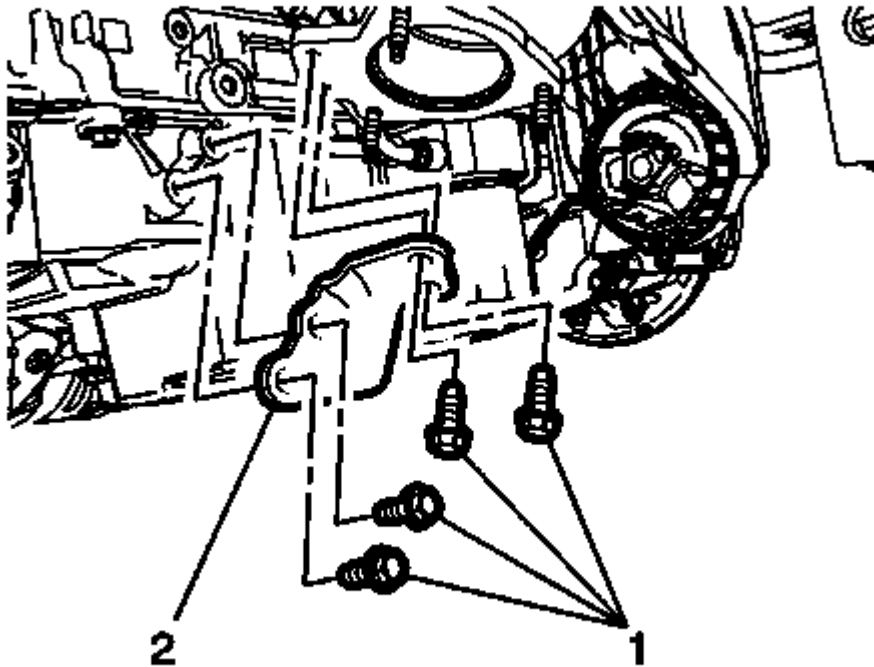


Fig. 187: Catalytic Converter Lower Brace & Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the catalytic converter to oil pan brace fasteners (1).
7. Remove the catalytic lower brace (2).
8. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** .

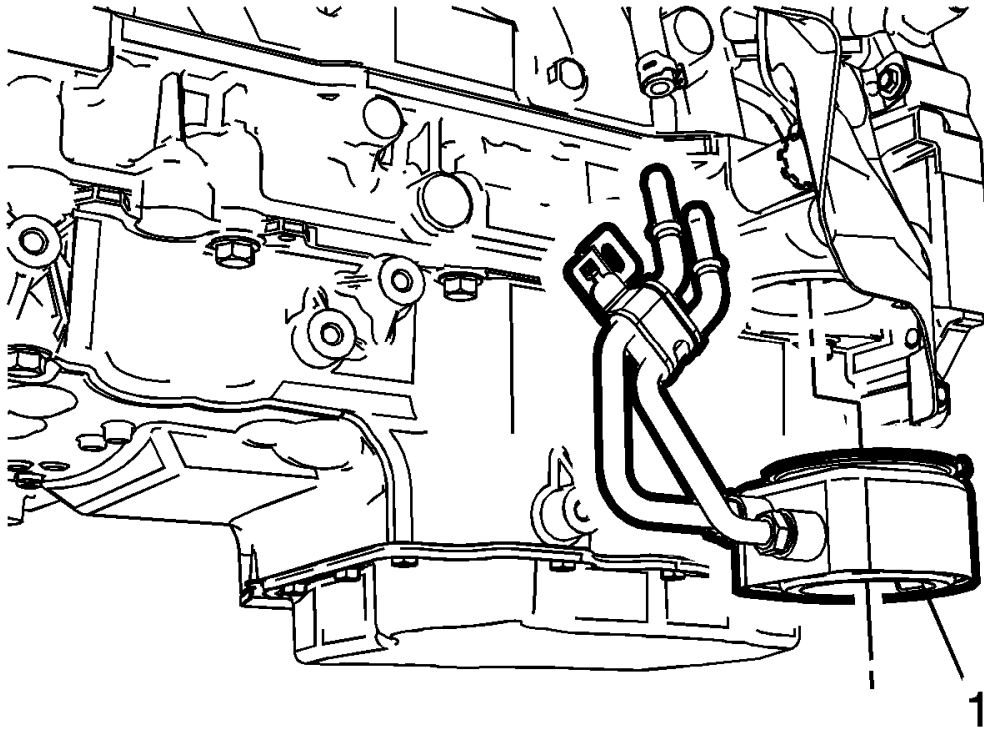


Fig. 188: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

9. Remove the engine oil cooler (1). Refer to **Engine Oil Cooler Replacement (FWD)**.

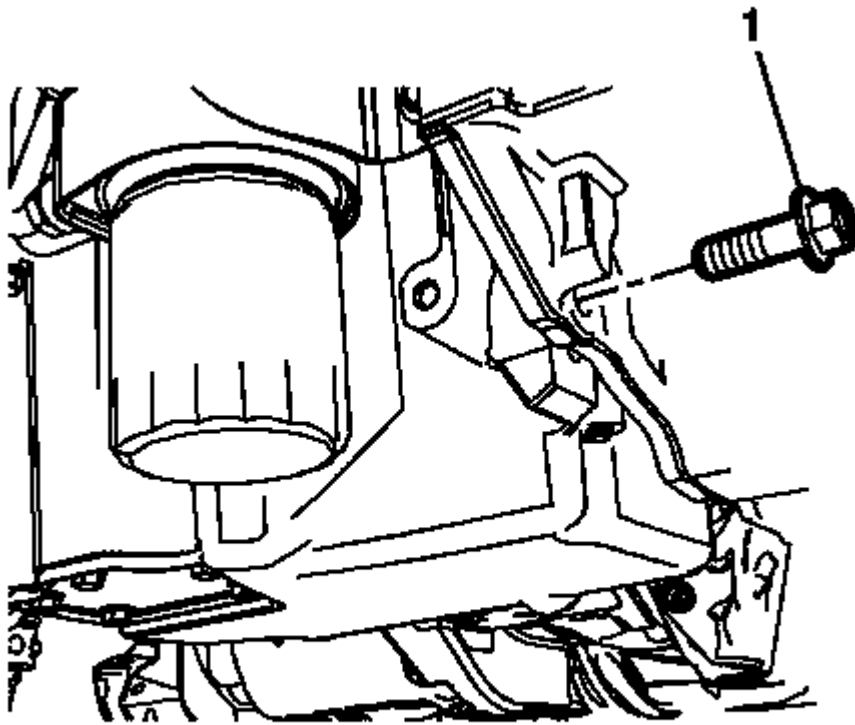


Fig. 189: Transmission To Oil Pan Fastener
Courtesy of GENERAL MOTORS COMPANY

10. Remove the transmission to oil pan fastener (1).

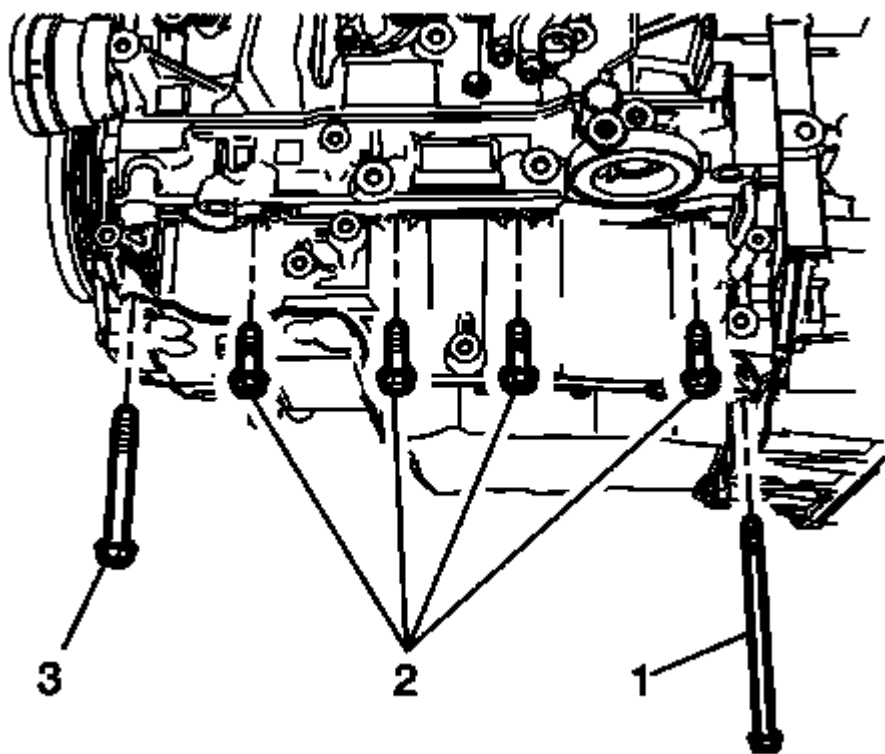


Fig. 190: Left Oil Pan to Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

11. Remove the left oil pan to engine block fasteners (1, 2, 3).

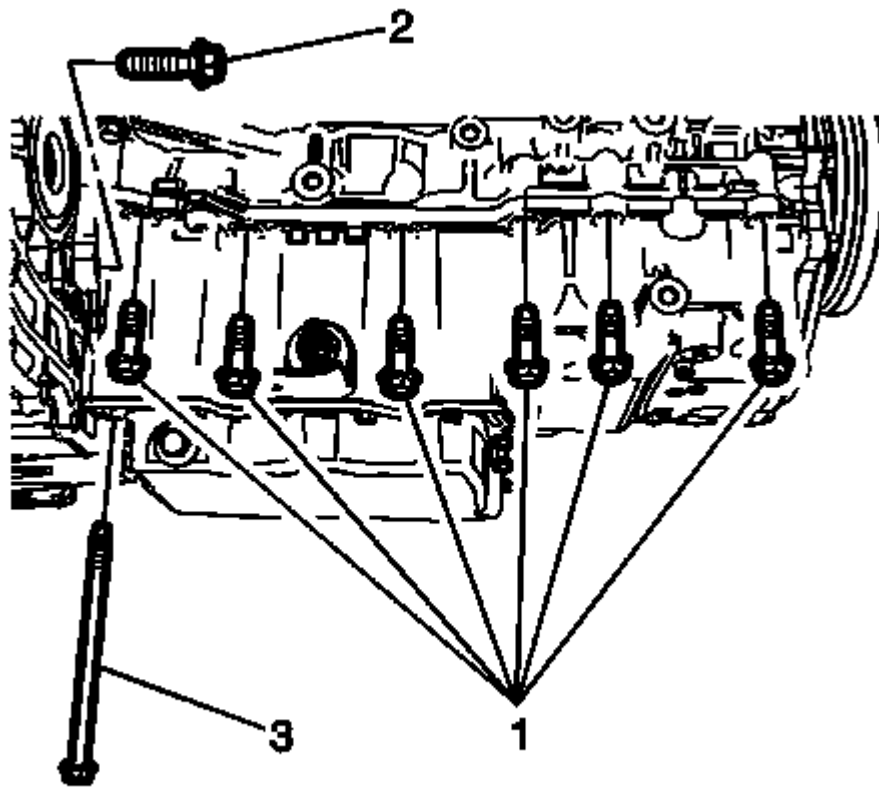


Fig. 191: Right Oil Pan to Transmission & Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the oil level sensor harness connector.
13. Remove the oil pan to transmission fastener (2).
14. Remove the right oil pan to engine block fasteners (1, 3).

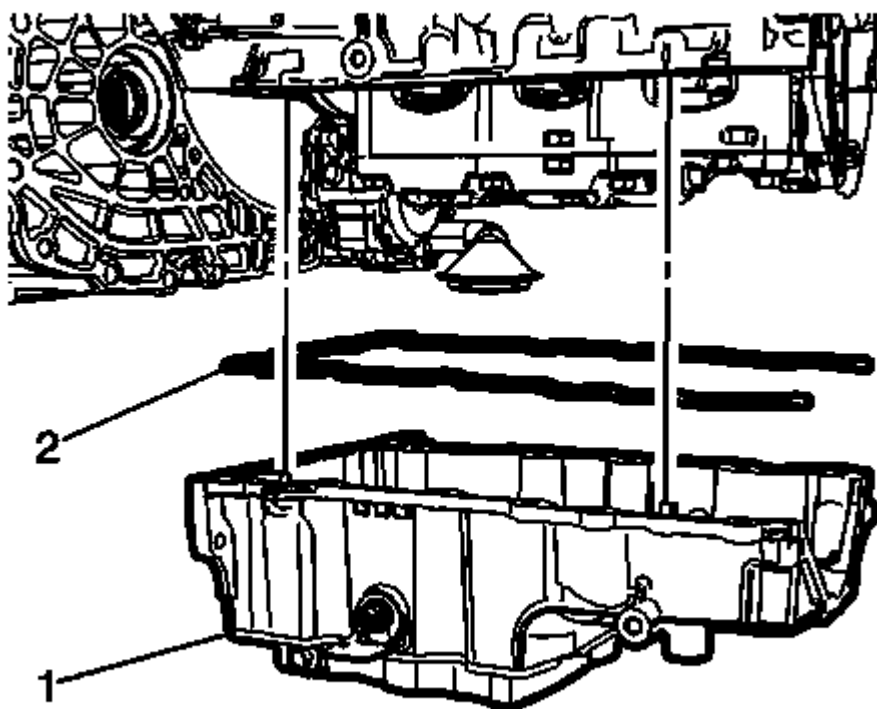


Fig. 192: Oil Pan & Gasket

Courtesy of GENERAL MOTORS COMPANY

15. Remove the oil pan (1) from the engine.

Installation Procedure

1. Clean and inspect the surfaces of the oil pan and engine block. Refer to **Oil Pan Cleaning and Inspection** .

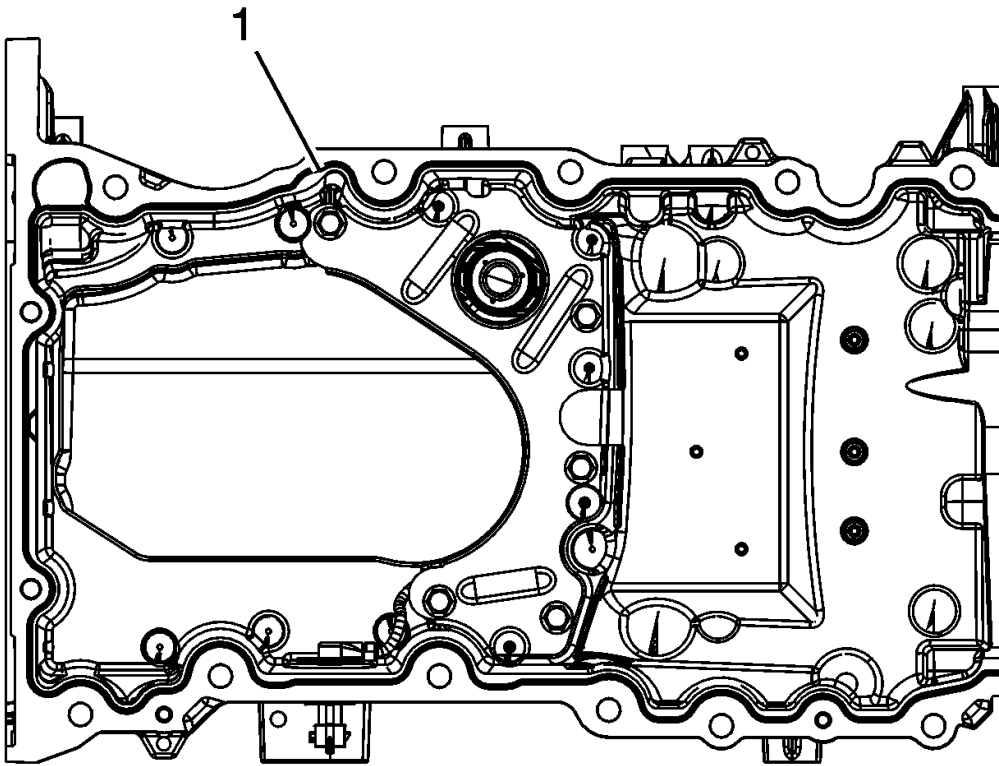


Fig. 193: Short Lower Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The oil pan sealing surfaces must be free of contamination prior to applying the sealer.
 - Install and align the oil pans within 20 minutes of applying the sealer.
 - The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.
2. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
 3. Place the oil pan to the engine and loosely installing fasteners at the four corners of the oil pan.

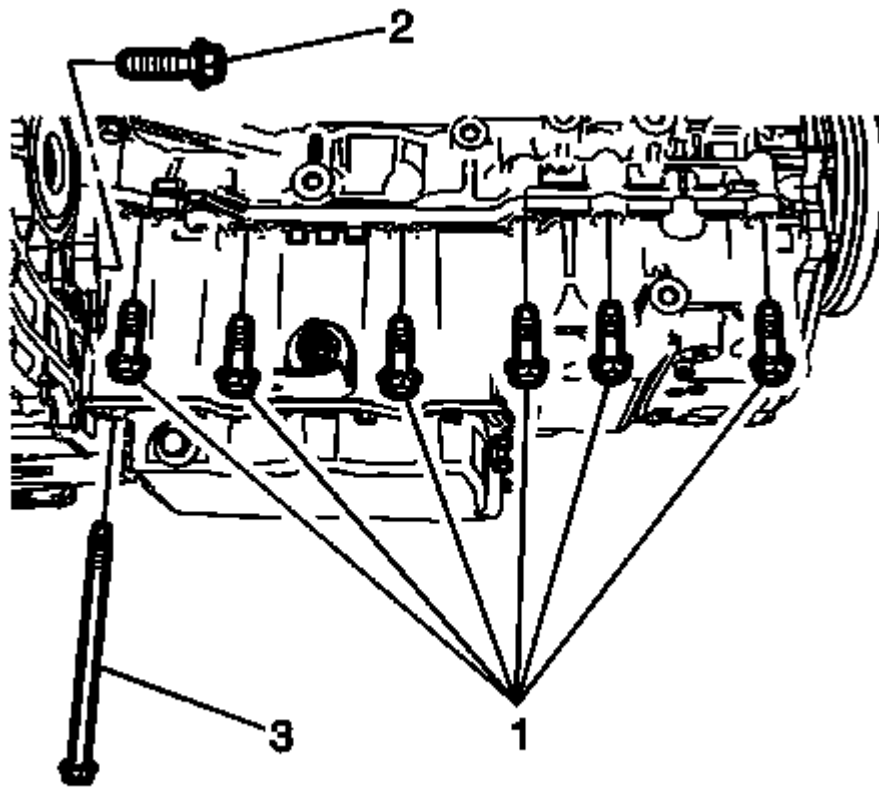


Fig. 194: Right Oil Pan to Transmission & Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the right oil pan to engine block fasteners (1, 3) hand tight.
5. Install the oil pan to transmission fastener (2) hand tight.
6. Connect the oil level sensor harness connector.

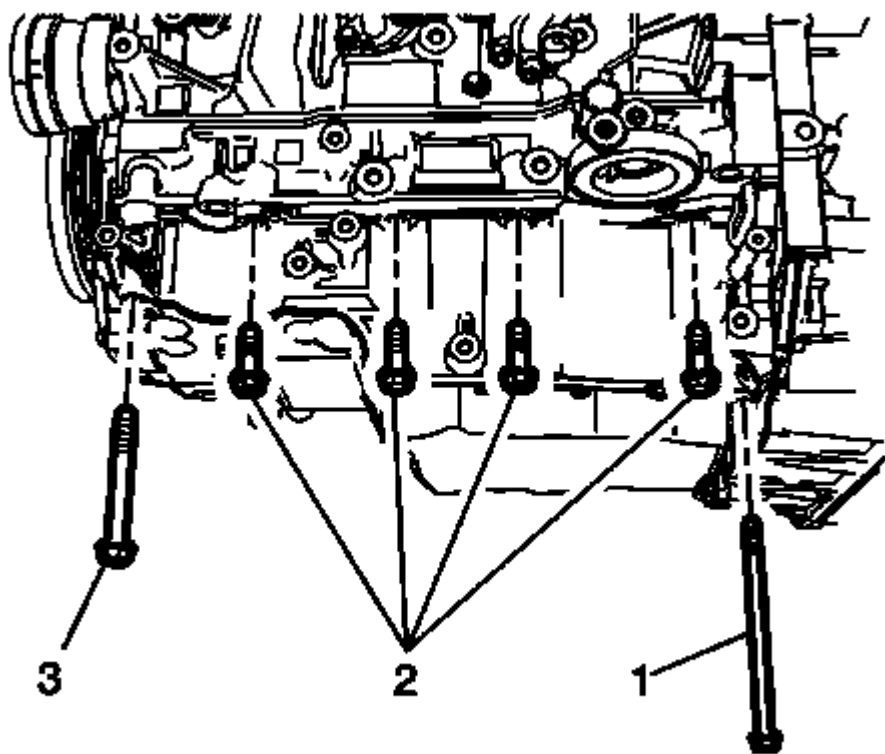


Fig. 195: Left Oil Pan to Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Install the left oil pan to engine block fasteners (1, 2, 3) hand tight.

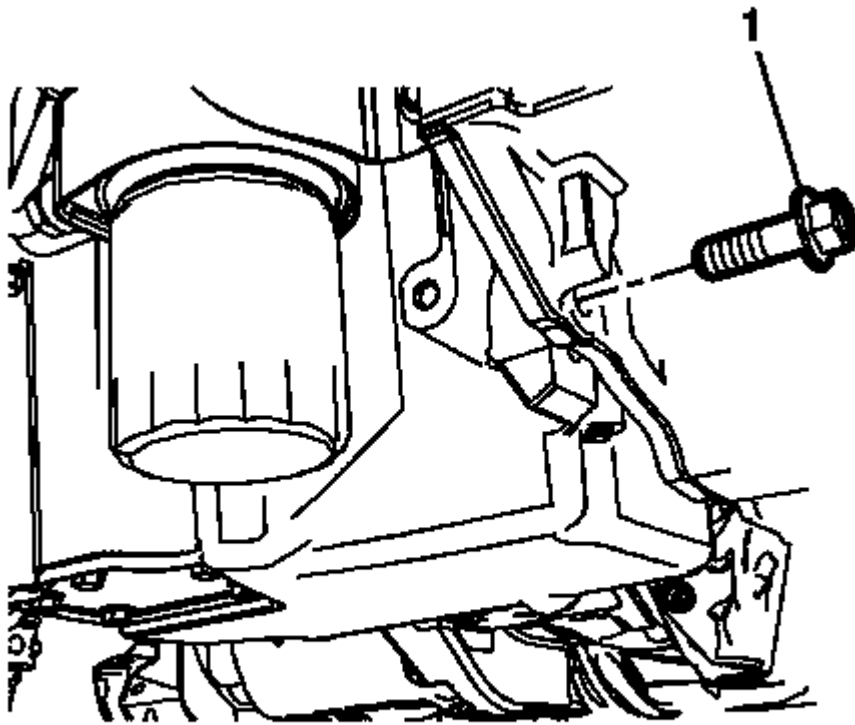


Fig. 196: Transmission To Oil Pan Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Install the transmission to oil pan fastener (1) hand tight.

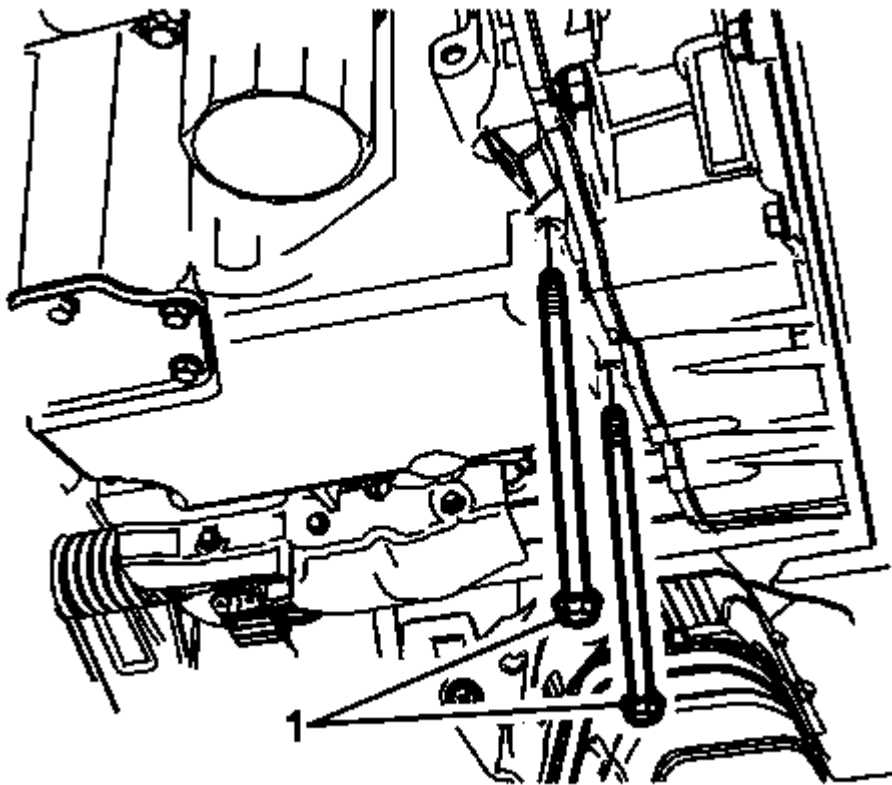


Fig. 197: Rear Oil Pan to Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Install the rear oil pan to engine block fasteners (1) hand tight.

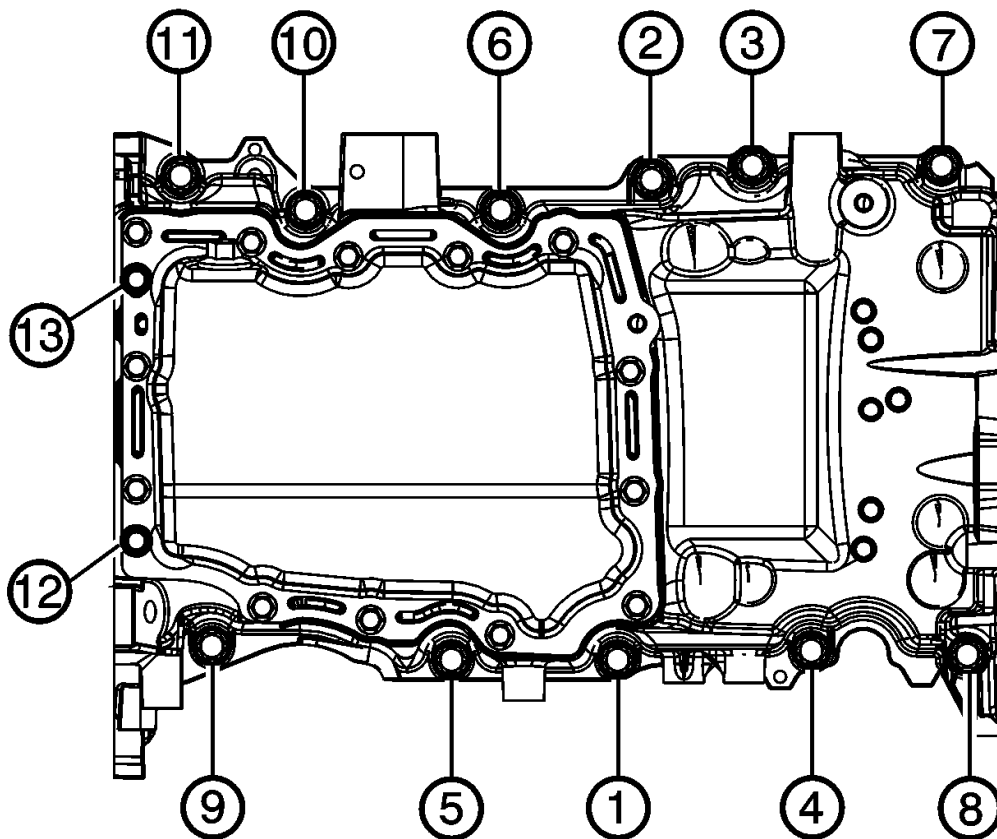


Fig. 198: Oil Pan Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

10. Tighten the oil pan bolts in sequence to final torque twice using the following procedure:
 1. Tighten the fasteners in sequence (1-11) to 25 (18 lb ft).
 2. Tighten the fasteners in sequence (12-13) to 10 (89 lb in).
11. Tighten the oil pan to transmission bolts to 60 (44 lb ft).

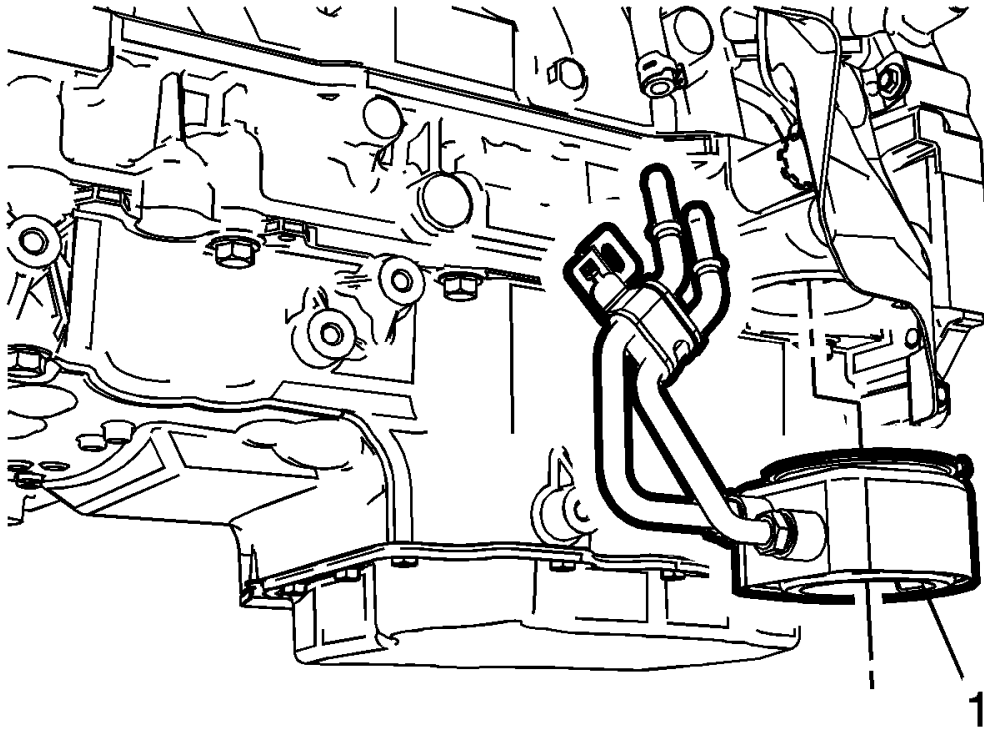


Fig. 199: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

12. Install the engine oil cooler (1). Refer to **Engine Oil Cooler Replacement (FWD)**.
13. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)**.

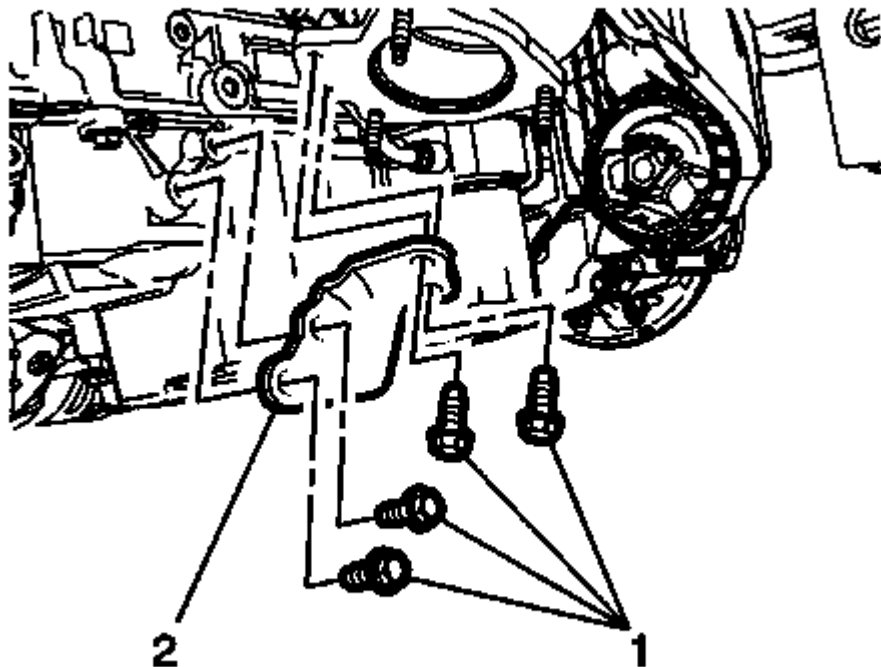


Fig. 200: Catalytic Converter Lower Brace & Fasteners
Courtesy of GENERAL MOTORS COMPANY

14. Position the catalytic lower brace (2).
15. Install the catalytic converter to oil pan brace fasteners (1) and tighten to 25 (18 lb ft).
16. Install the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** .

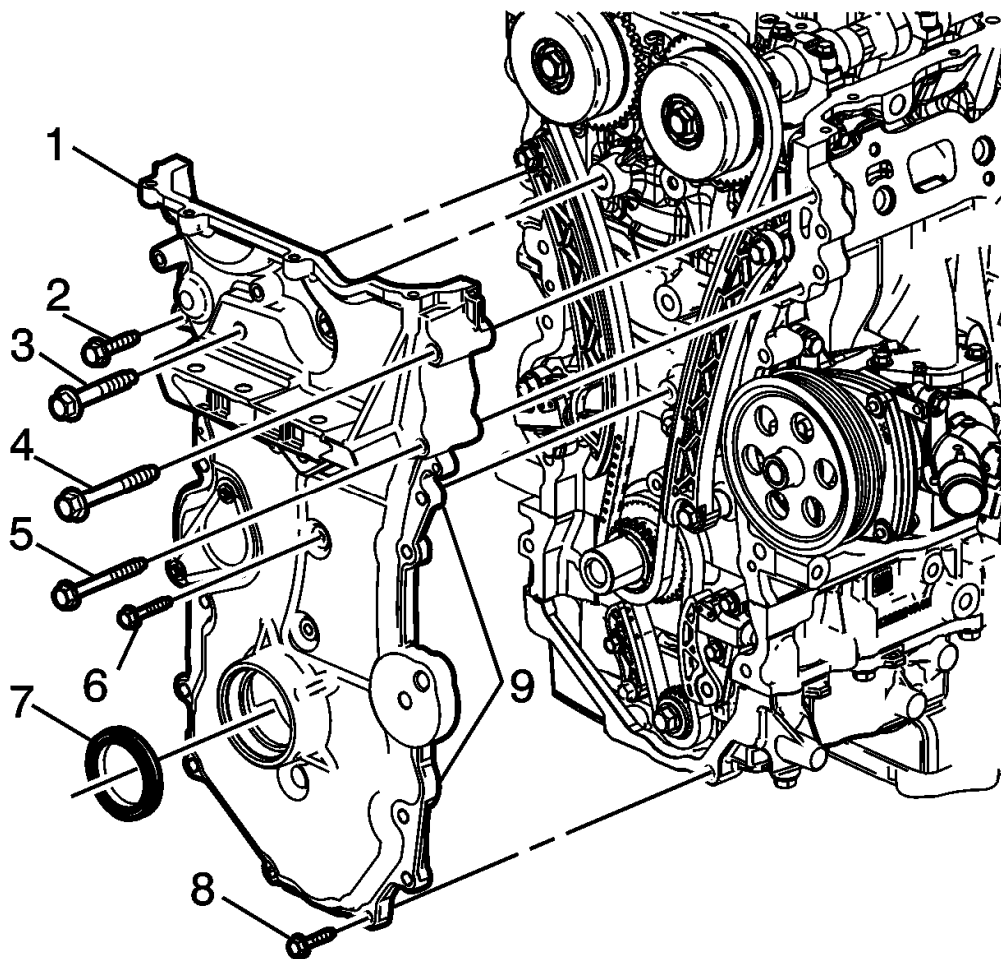


Fig. 201: Front Oil Seal

Courtesy of GENERAL MOTORS COMPANY

17. Install the front engine cover (1). Refer to **Engine Front Cover Replacement**.
18. Install the drivetrain and front suspension frame front crossmember. Refer to **Drivetrain and Front Suspension Frame Replacement**.
19. Remove the engine support fixture. Refer to **Engine Support Fixture**.
20. Refill the engine oil and install a NEW oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

LOWER OIL PAN REPLACEMENT

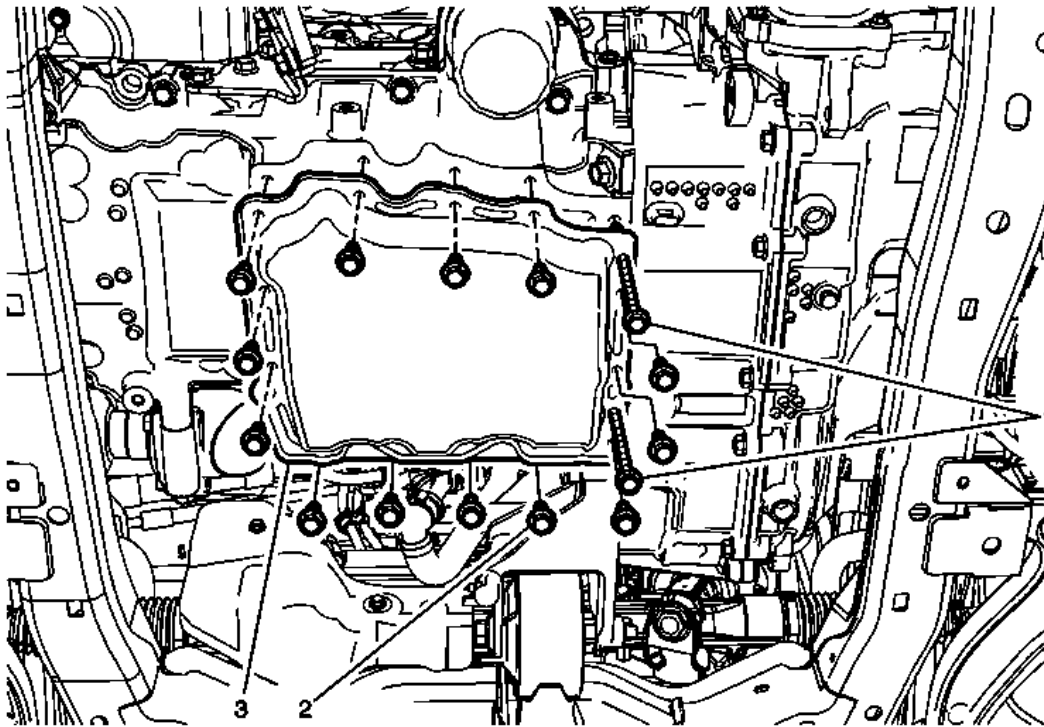


Fig. 202: Oil Pan & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Lower Oil Pan Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain engine oil. Refer to <u>Engine Oil and Oil Filter Replacement</u> 2. Remove the exhaust front pipe. Refer to <u>Exhaust Front Pipe Replacement (LTG)</u> , <u>Exhaust Front Pipe Replacement (LTG AWD)</u> .	
1	Oil Pan Bolts (Qty 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Oil Pan Bolts (Qty; 13) Tighten 10 (89 lb in)
	Oil Pan Procedure Apply a 2.25 mm bead of sealer on the level part of the flange around the perimeter of the oil pan. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .

3

NOTE:

- The lower crankcase surface must be free of contamination prior to applying the sealer.
- Install and align the oil pan to block within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT (FWD)

Removal Procedure

1. Remove the lower oil pan. Refer to . Lower Oil Pan Replacement.
2. Disconnect the oil level sensor electrical connector.

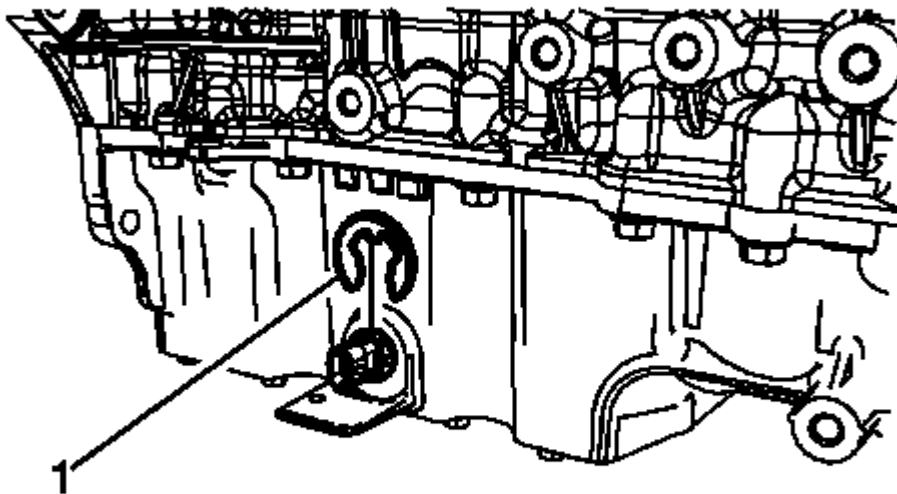


Fig. 203: Engine Oil Level Sensor C-clip
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil level sensor retainer (1).

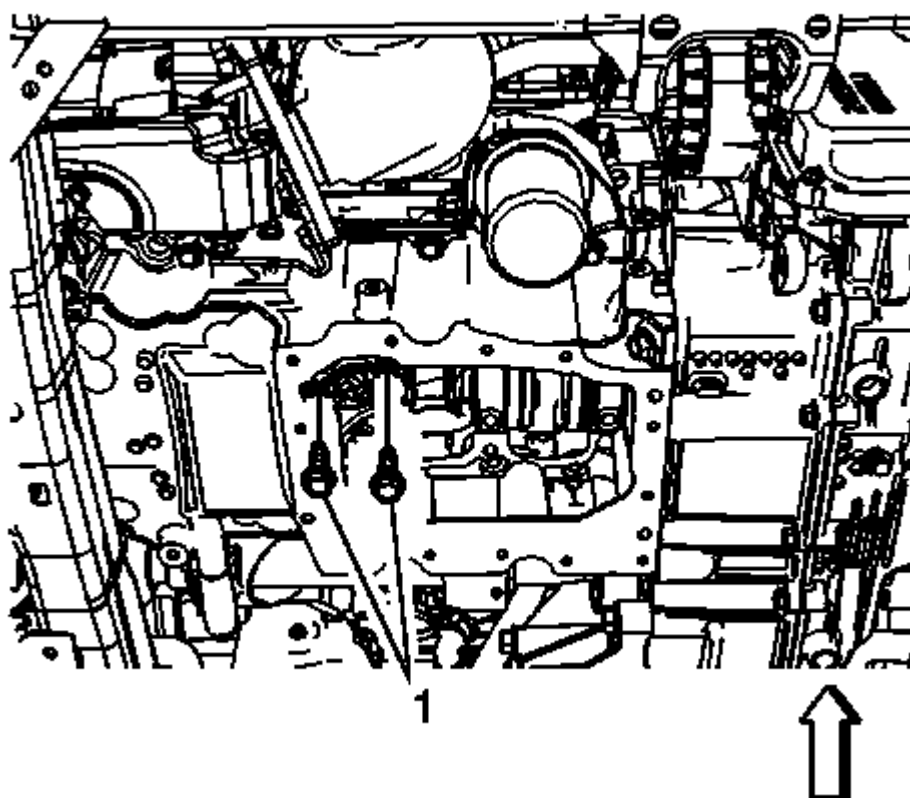


Fig. 204: Engine Oil Level Sensor Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil level sensor fasteners (1).

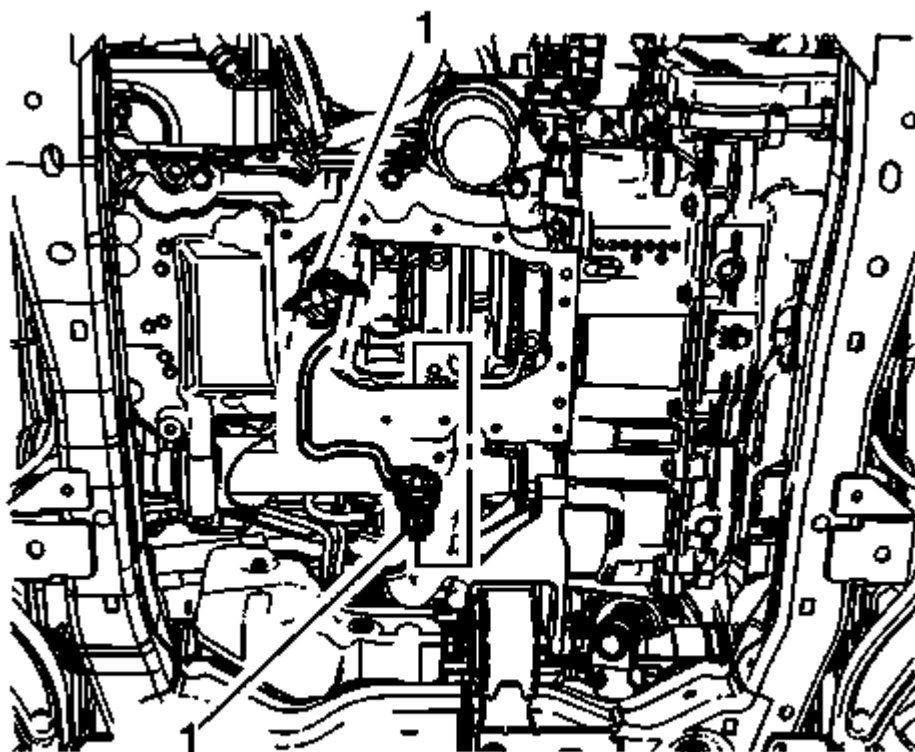


Fig. 205: O-ring Around Level Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: Replace the O-ring around the level sensor.

5. Remove the engine oil level sensor (1) from the oil pan.

Installation Procedure

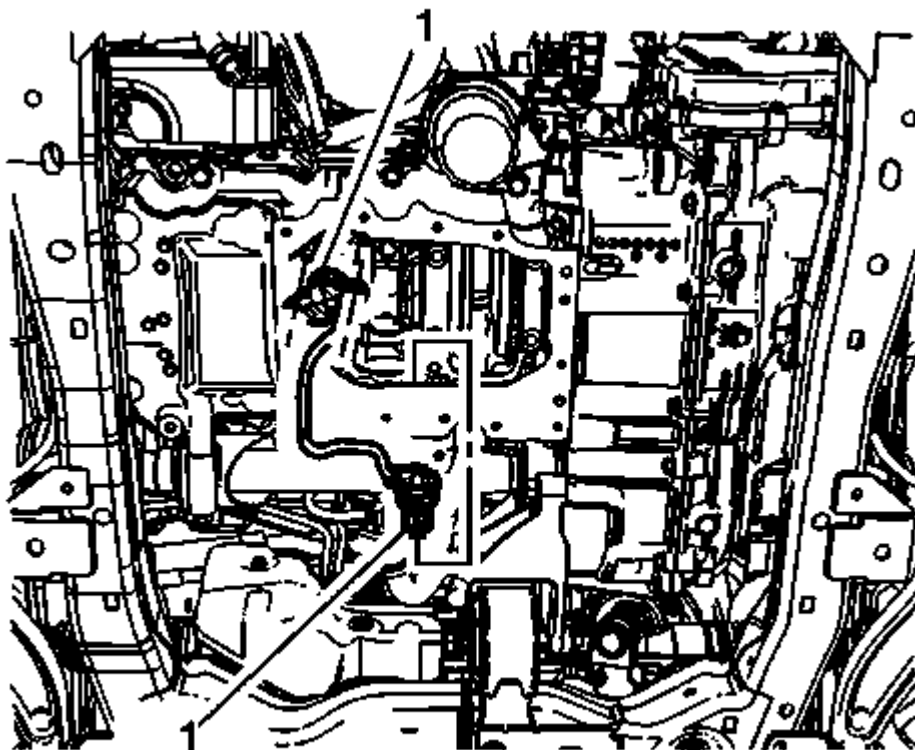


Fig. 206: O-ring Around Level Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil level sensor (1).

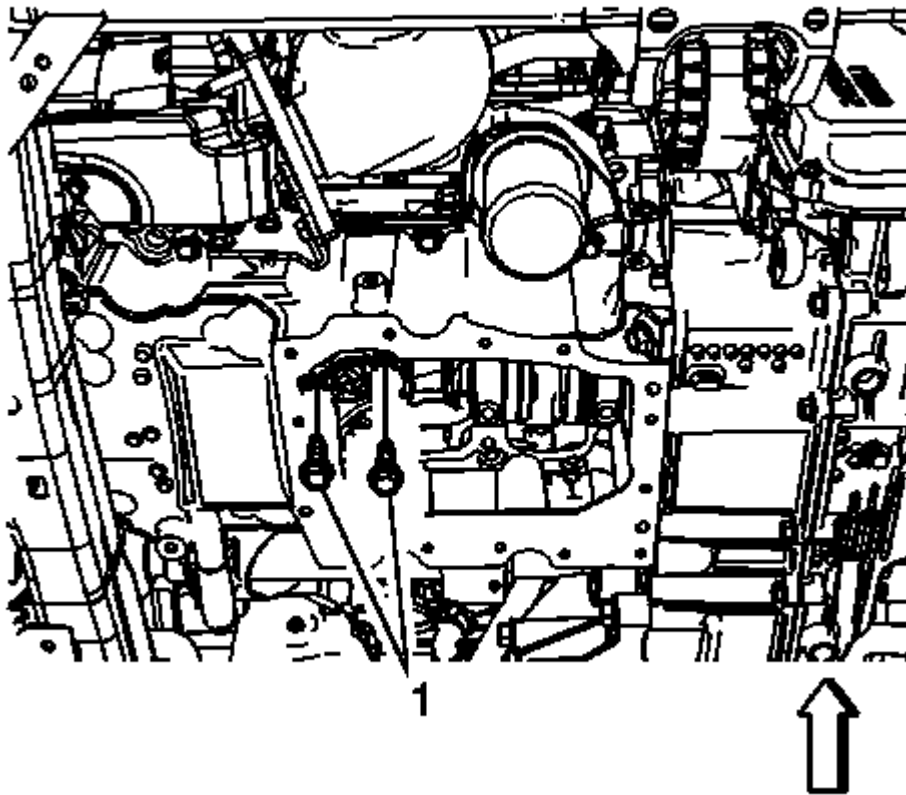


Fig. 207: Engine Oil Level Sensor Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the engine oil level sensor fastener (1) and tight to 10 (89 lb in).

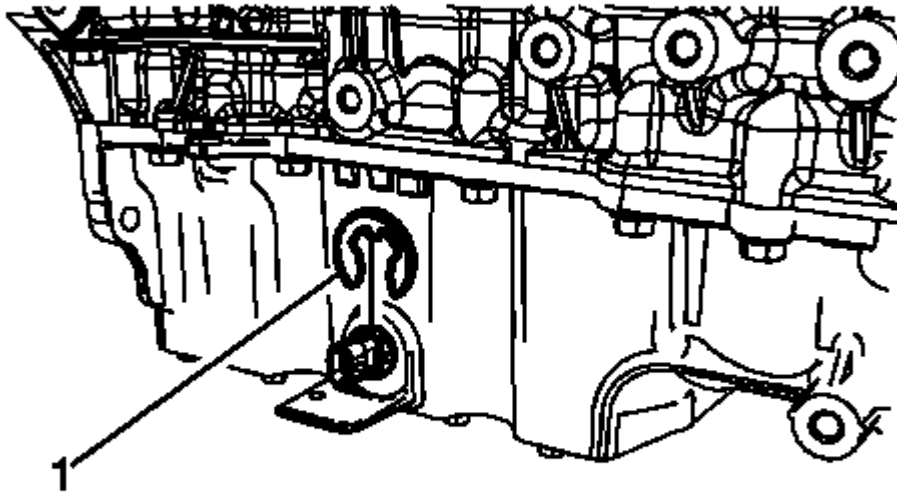


Fig. 208: Engine Oil Level Sensor C-clip
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine oil level sensor retainer (1).
4. Connect the oil level sensor electrical connector.
5. Install the lower oil pan. Refer to **Lower Oil Pan Replacement**.

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT (AWD)

Removal Procedure

1. Remove the oil pan. Refer to . **Oil Pan Replacement (AWD)**.

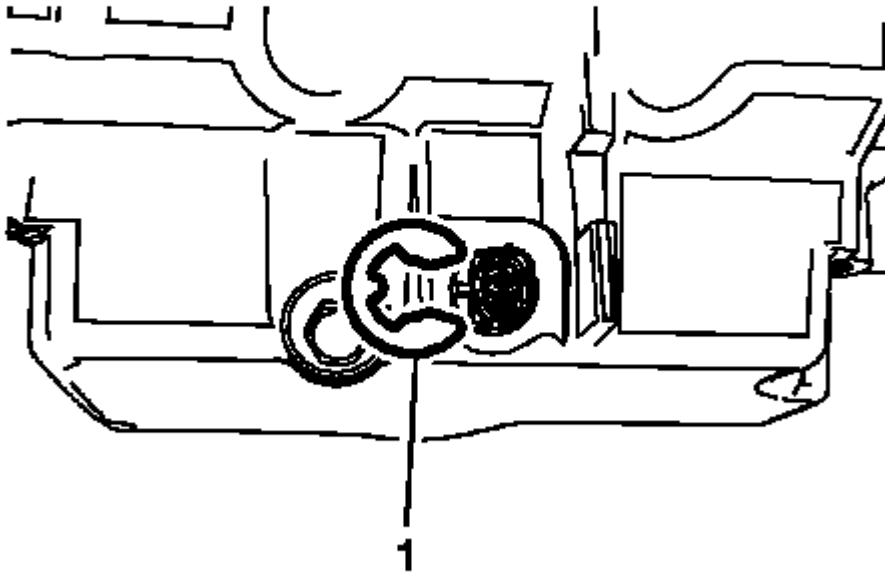


Fig. 209: Engine Oil Level Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil level sensor retainer (1).

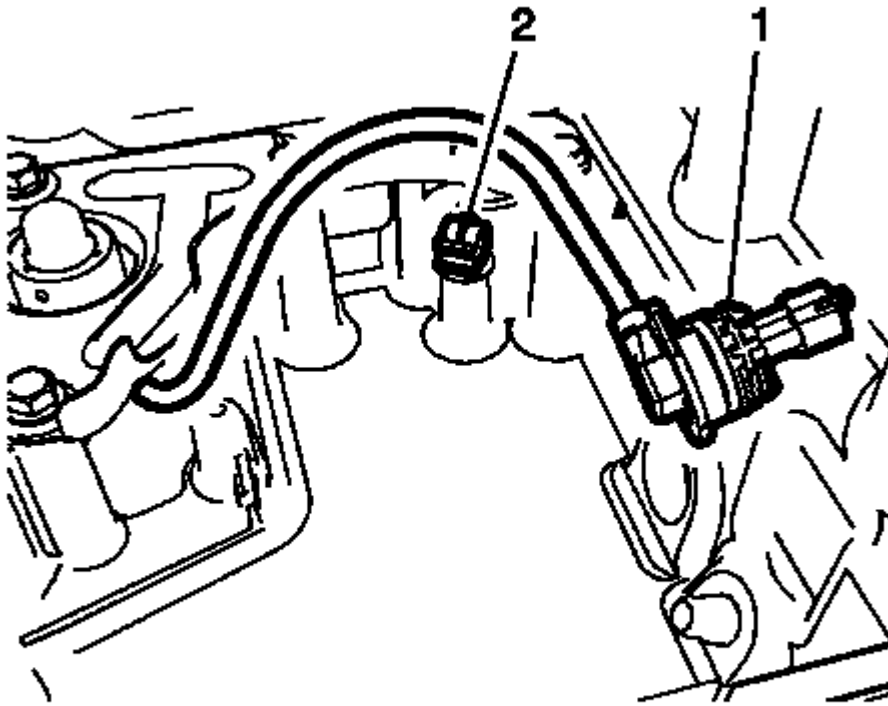


Fig. 210: Engine Oil Level Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the engine oil level sensor connector (1) from the oil pan and the retainer (2). Discard the O-ring.

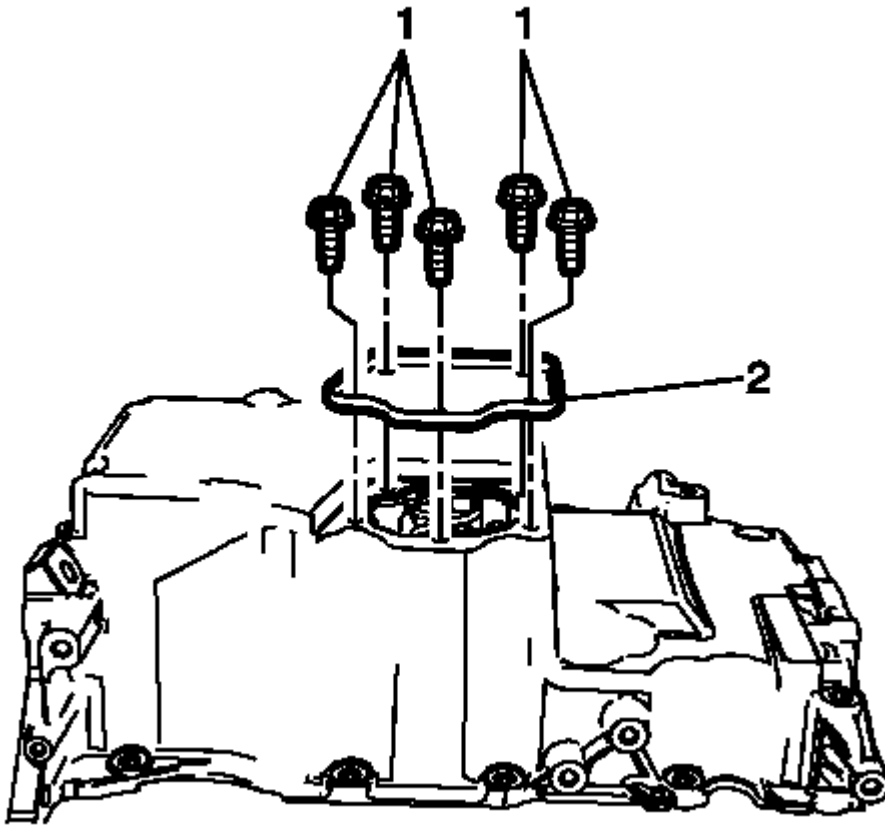


Fig. 211: Lower Oil Pan

Courtesy of GENERAL MOTORS COMPANY

4. Remove the lower oil pan (2) and fasteners (1).

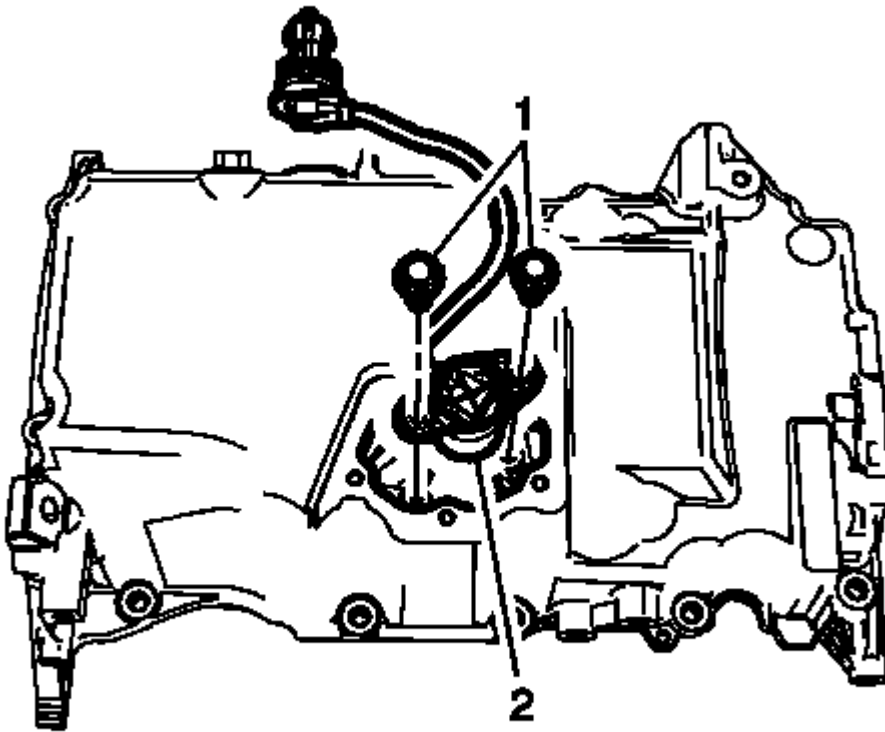


Fig. 212: Engine Oil Level Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine oil level sensor fasteners (1).
6. Remove the engine oil level sensor (2) from the oil pan.

Installation Procedure

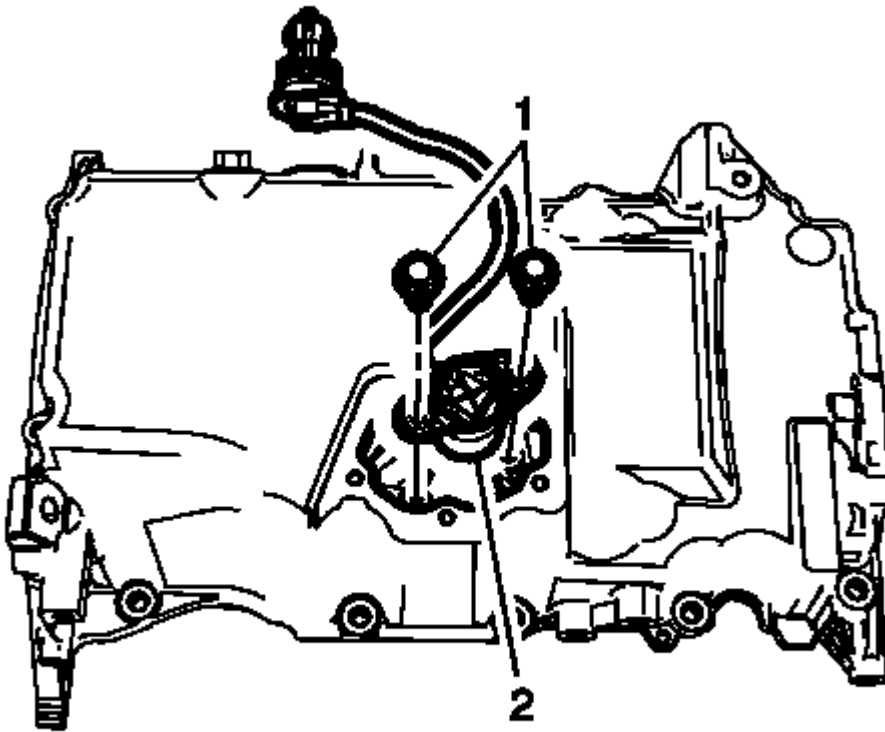


Fig. 213: Engine Oil Level Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil level sensor (1) into the oil pan

CAUTION: Refer to Fastener Caution .

2. Install the engine oil level sensor fastener (1) and tighten to 10 (89 lb in).

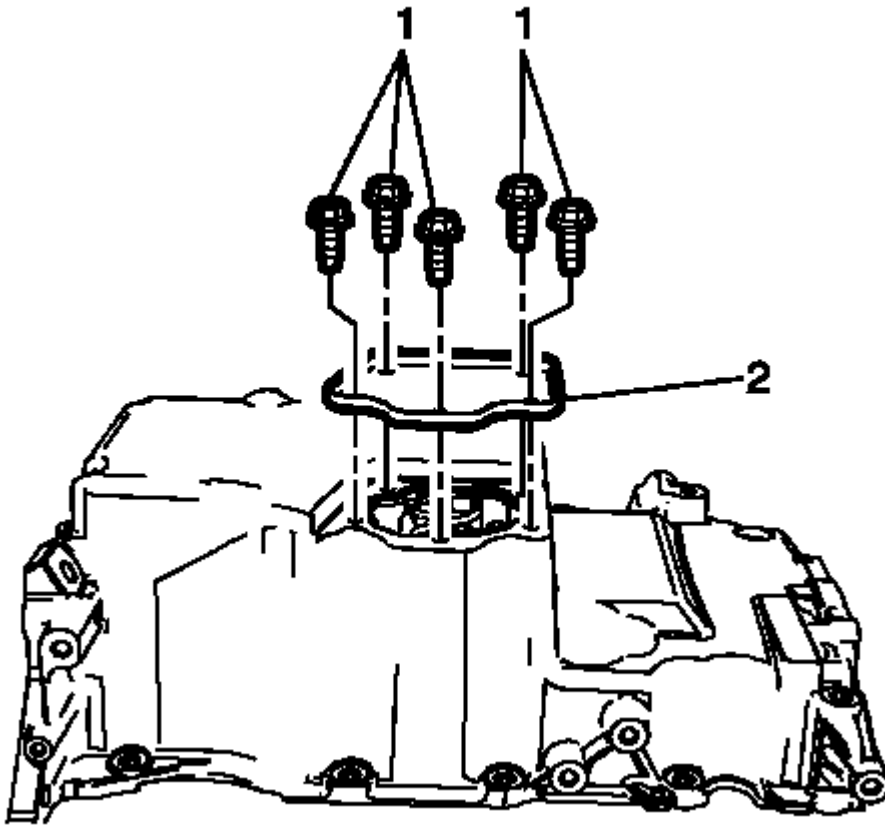


Fig. 214: Lower Oil Pan

Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the lower oil pan. Refer to Adhesives, Fluids, Lubricants, and Sealers .

3. Install the lower oil pan (2) and fasteners (1) and tighten to 10 (89 lb in).

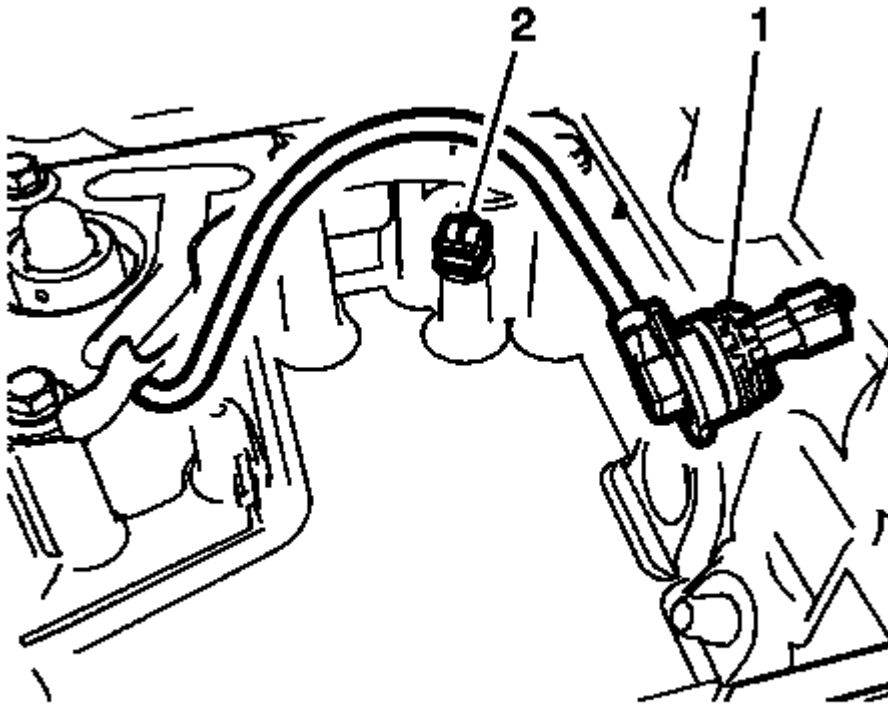


Fig. 215: Engine Oil Level Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Always install a NEW O-ring when installing the engine oil level sensor.

4. Connect the engine oil level sensor connector (1) to the oil pan with a NEW O-ring.
5. Connect the engine oil level sensor pigtail wire to the retainer (2).

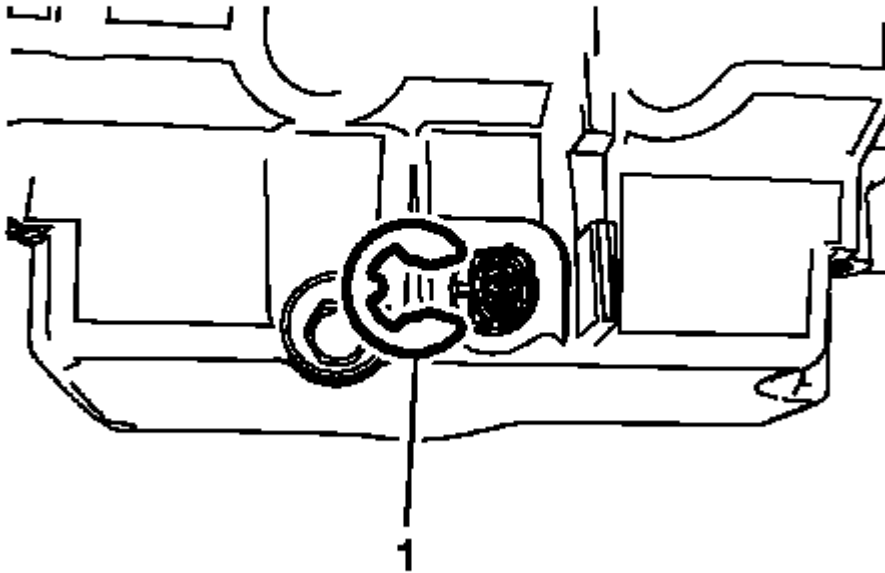


Fig. 216: Engine Oil Level Sensor
Courtesy of GENERAL MOTORS COMPANY

6. Install the engine oil level sensor retainer (1).
7. Install the oil pan. Refer to **Oil Pan Replacement (AWD)**, **Oil Pan Replacement (FWD)**.

ENGINE FLYWHEEL REPLACEMENT

Special Tools

- **EN 50792** Flywheel Holding Tool
- **EN-45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the clutch assembly. Refer to **Clutch Assembly Replacement (With DT-6263)** .

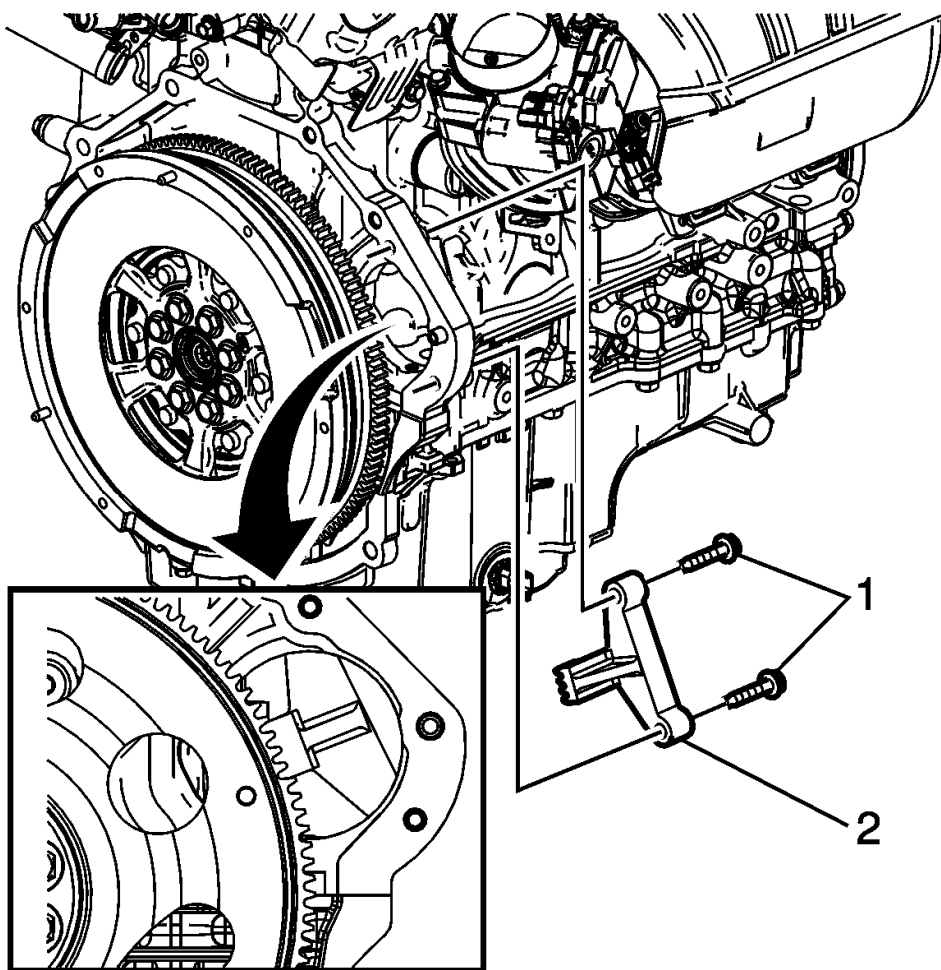


Fig. 217: Flywheel Holding Tool & Starter Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN-50792** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

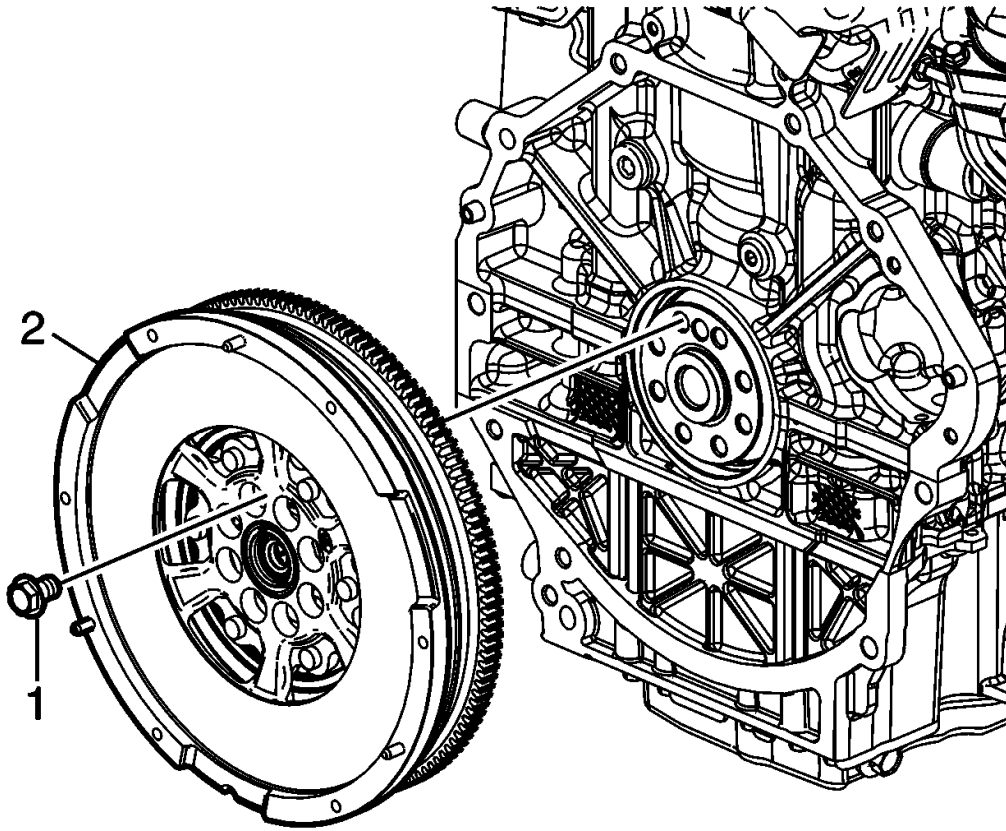


Fig. 218: Flywheel & Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the flywheel attaching bolts (1).
4. Remove the flywheel (2).
5. Remove **EN 50792** holding tool.

Installation Procedure

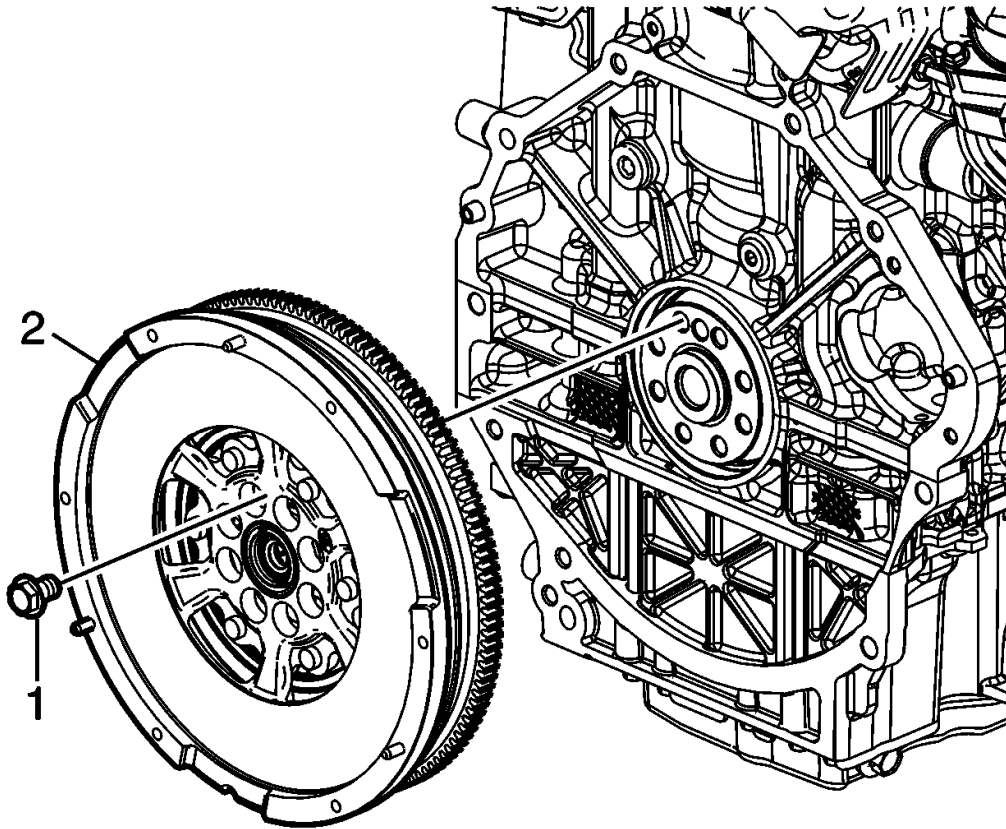


Fig. 219: Flywheel & Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Fasteners have adhesive patch and must be tightened to final torque within 5 minutes.

1. Install the flywheel (2) and hand start NEW bolts (1).

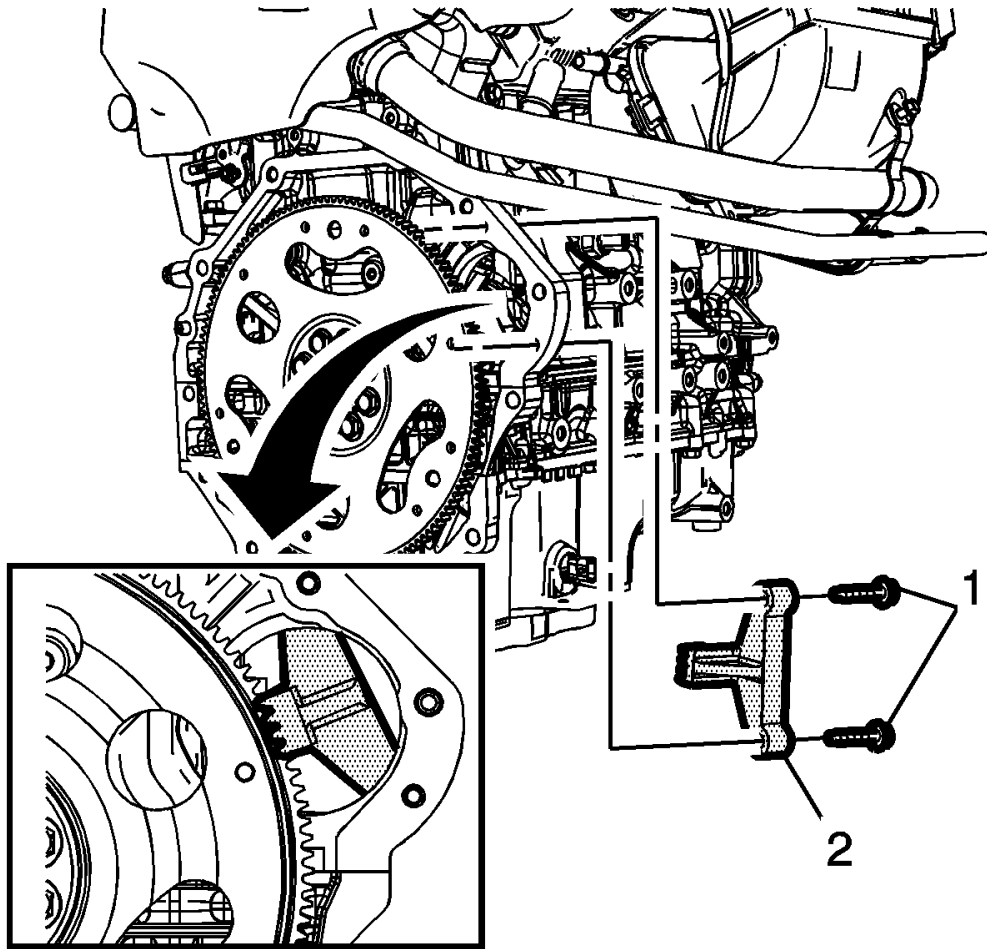


Fig. 220: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN-50792** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

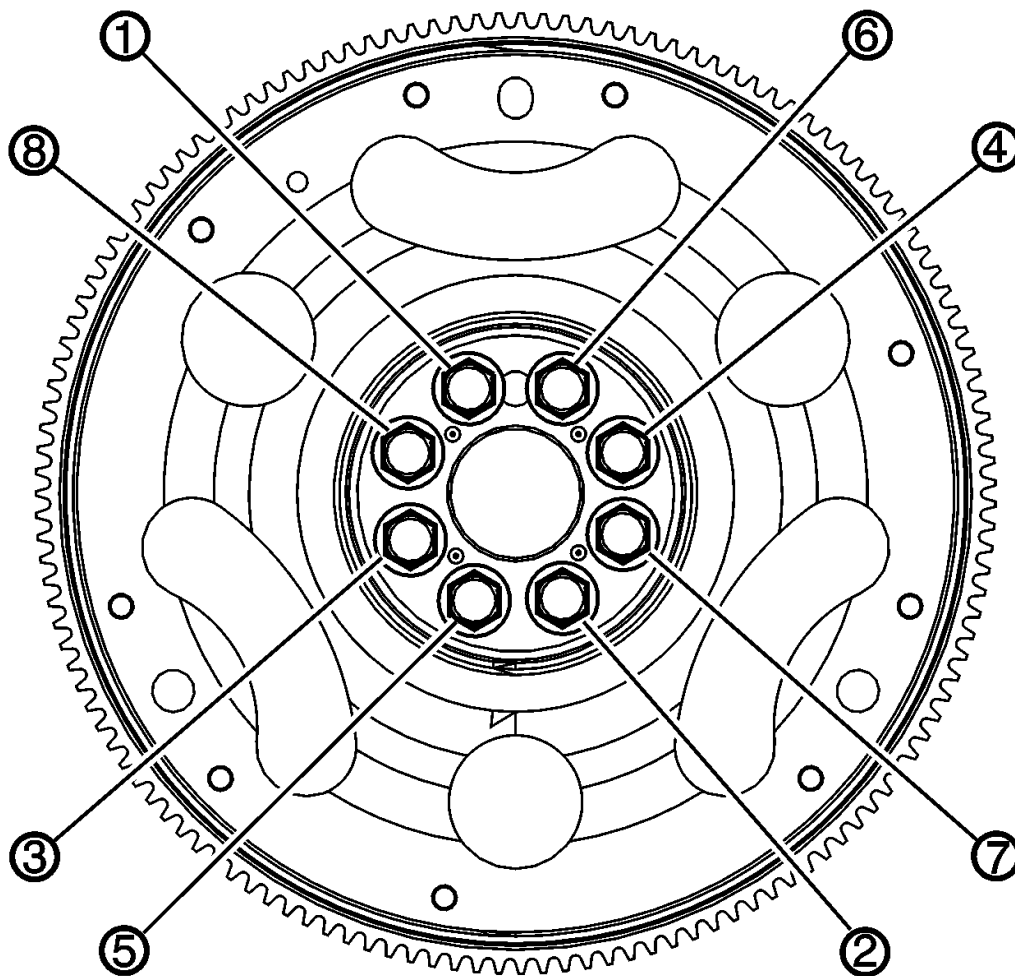


Fig. 221: Flywheel Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the bolts evenly using the following procedure:
 1. Tighten the bolts a first pass in sequence to 20 (15 lb ft).
 2. Tighten the bolts a second pass in sequence to 30 (22 lb ft).
 3. Tighten the bolts a final pass in sequence 40 degrees using the **EN-45059** angle meter.
4. Remove **EN-50792** holding tool.
5. Install the clutch assembly. Refer to **Clutch Assembly Replacement (With DT-6263)** .

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Removal Procedure

Special Tools

- **EN 45059** Angle Meter
- **EN 46106** Holding Tool

For equivalent regional tools, refer to **Special Tools** .

1. Remove the transmission. Refer to **Transmission Replacement** .

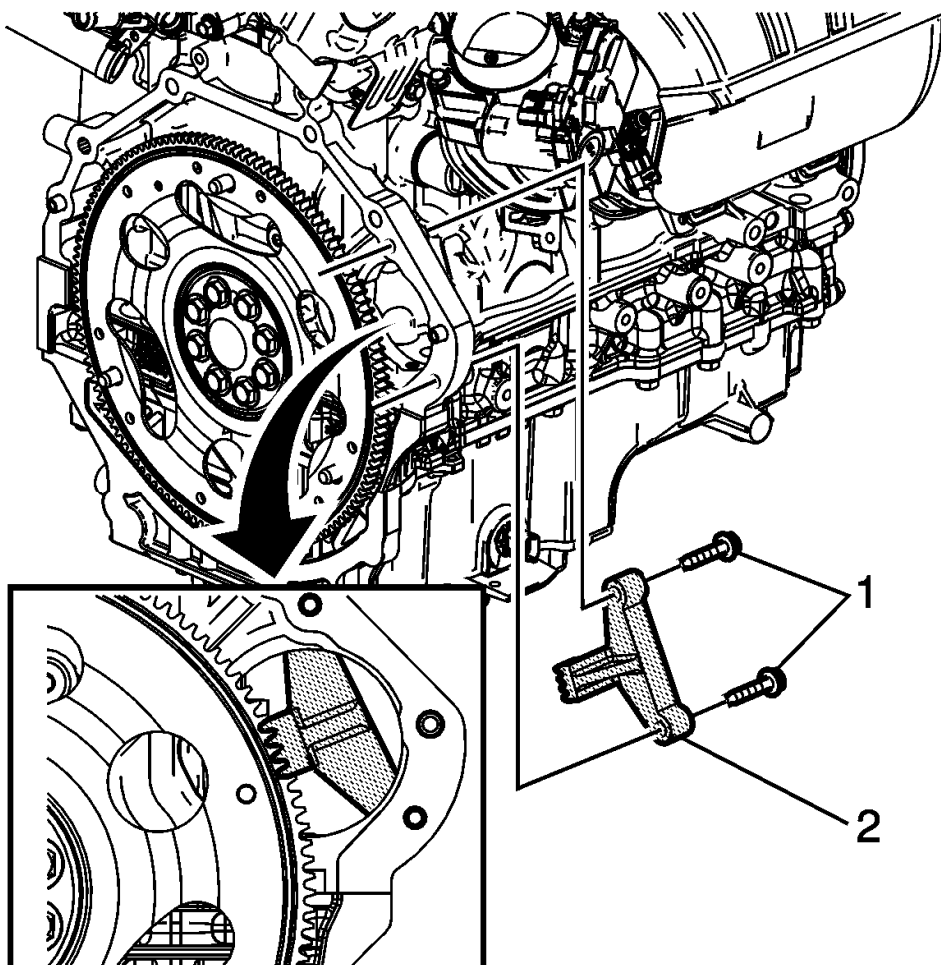


Fig. 222: Starter Motor Bolts

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN 46106** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the automatic flex plate.

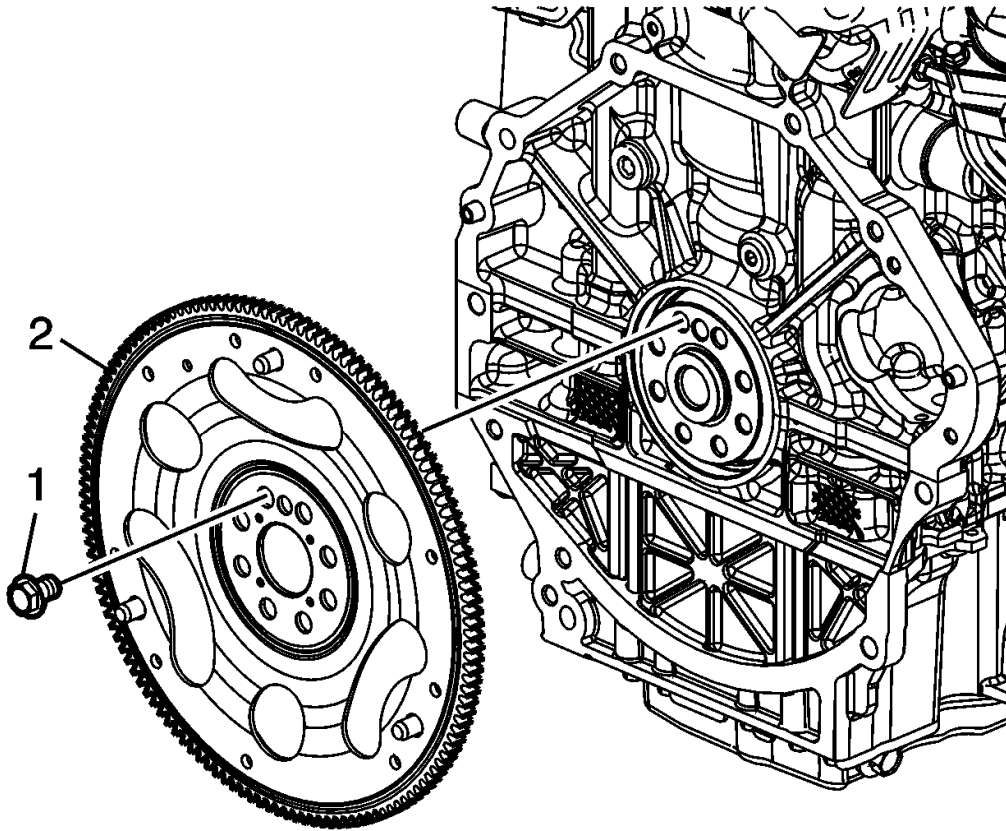


Fig. 223: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the automatic flex plate attaching bolts (1).
4. Remove the automatic flex plate (2).
5. Remove **EN 46106** holding tool.
6. For automatic flex plate cleaning and inspection, Refer to **Automatic Transmission Flex Plate Cleaning and Inspection** .

Installation Procedure

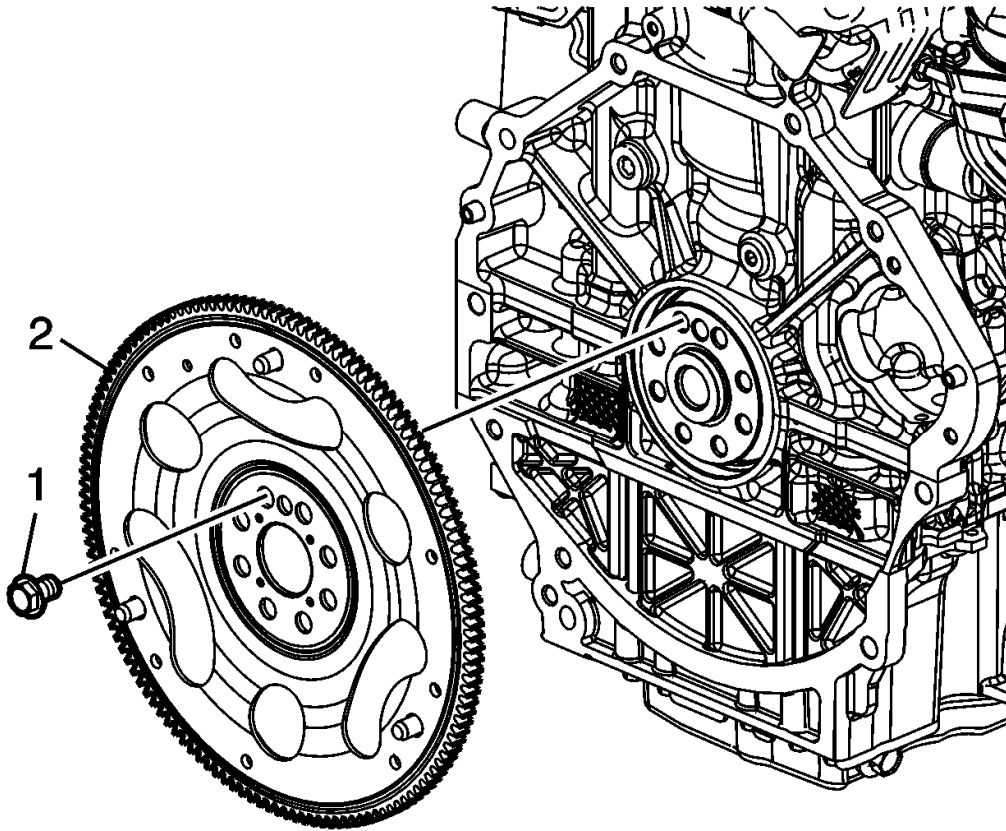


Fig. 224: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Fasteners have adhesive patch and must be tightened to final torque within 5 minutes.

1. Install the automatic flex plate (2) and hand start NEW bolts (1).

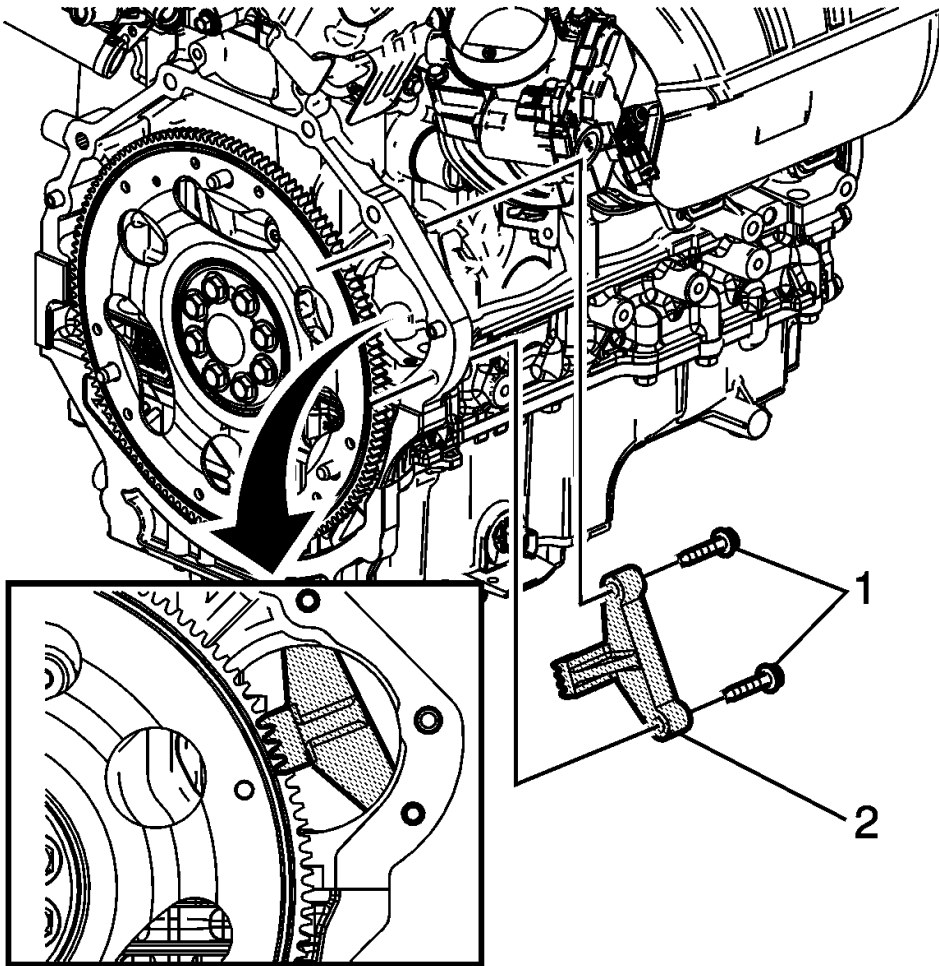


Fig. 225: Starter Motor Bolts

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN 46106** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flex plate.

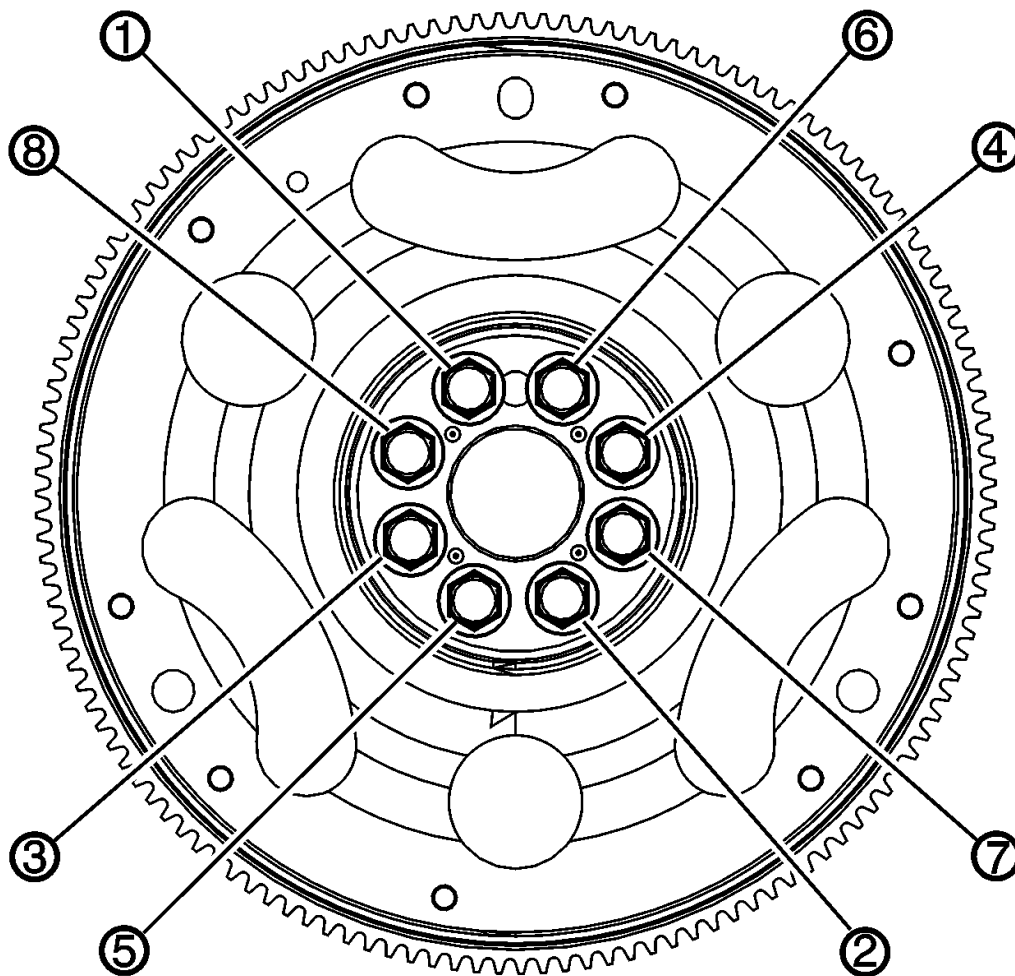


Fig. 226: Flywheel Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the bolts evenly using the following procedure:
 1. Tighten the bolts a first pass in sequence to 20 (15 lb ft).
 2. Tighten the bolts a second pass in sequence to 30 (22 lb ft).
 3. Tighten the bolts a final pass in sequence 40 degrees using the **EN 45059** meter.
4. Remove **EN 46106** holding tool.
5. Install the transmission. Refer to Transmission Replacement .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

EN-51380 Rear Main Seal Installer

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. If equipped with an automatic transmission, remove the flex plate. Refer to Automatic Transmission Flex Plate Replacement.
2. If equipped with a manual transmission, remove the flywheel. Refer to Engine Flywheel Replacement.

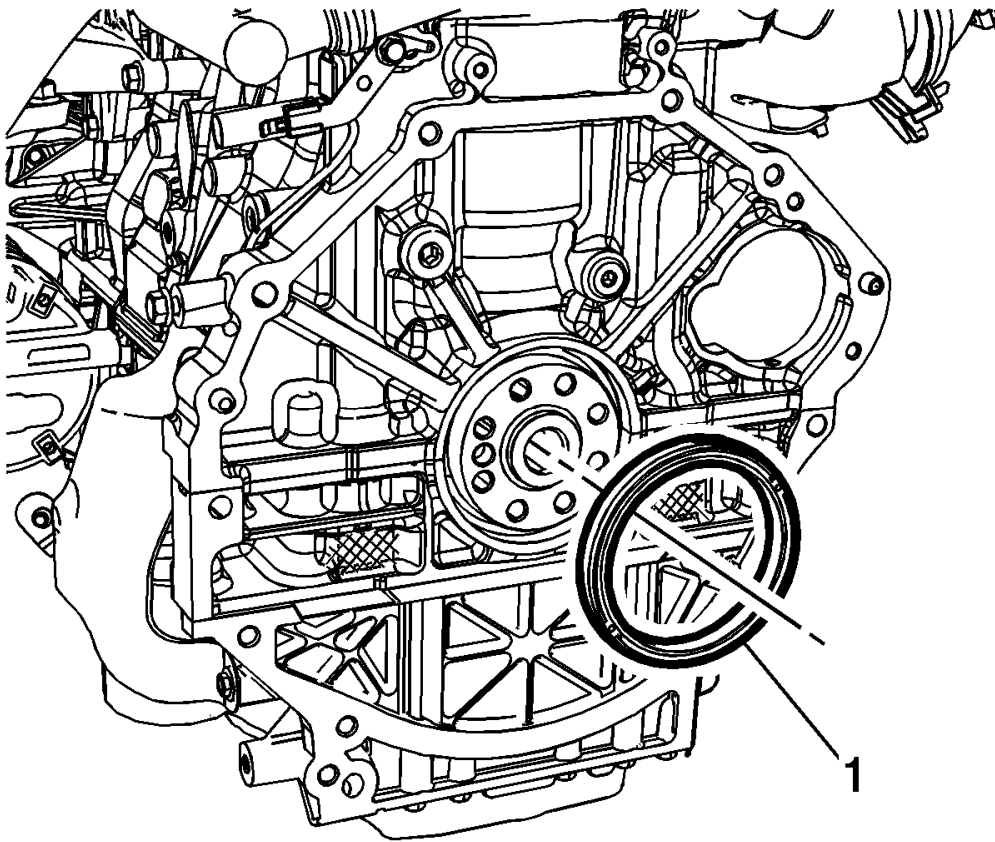


Fig. 227: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage the outside diameter of the crankshaft or chamber with any tool.

3. Use a suitable tool to remove the crankshaft rear oil seal (1).

Installation Procedure

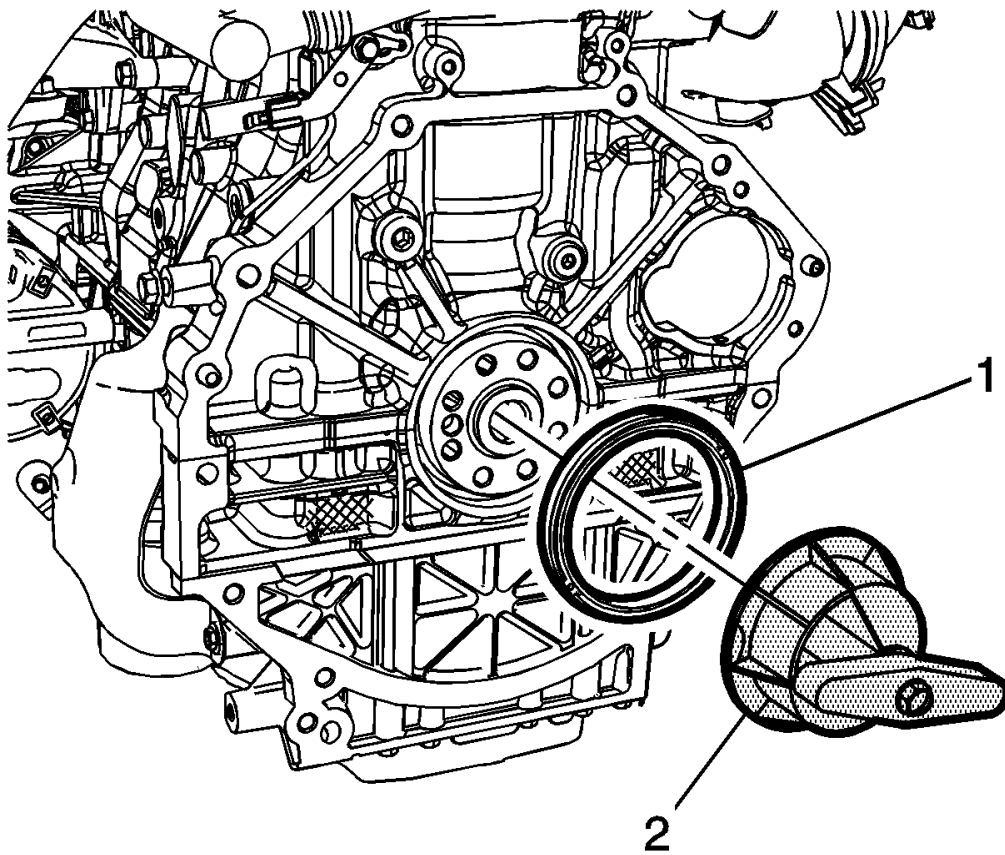


Fig. 228: Crankshaft Real Oil Seal
 Courtesy of GENERAL MOTORS COMPANY

1. Using the (2) **EN-51380** seal installer , install a NEW crankshaft real oil seal (1).
2. If equipped with a manual transmission, install the flywheel and transmission. Refer to **Engine Flywheel Replacement**.
3. If equipped with an automatic transmission, install the automatic transmission flex plate and transmission. Refer to **Automatic Transmission Flex Plate Replacement**.

ENGINE REPLACEMENT (FWD)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

4. Evacuate the A/C system. Refer to Refrigerant Recovery and Recharging .
5. Remove the battery tray. Refer to Battery Tray Replacement .
6. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .

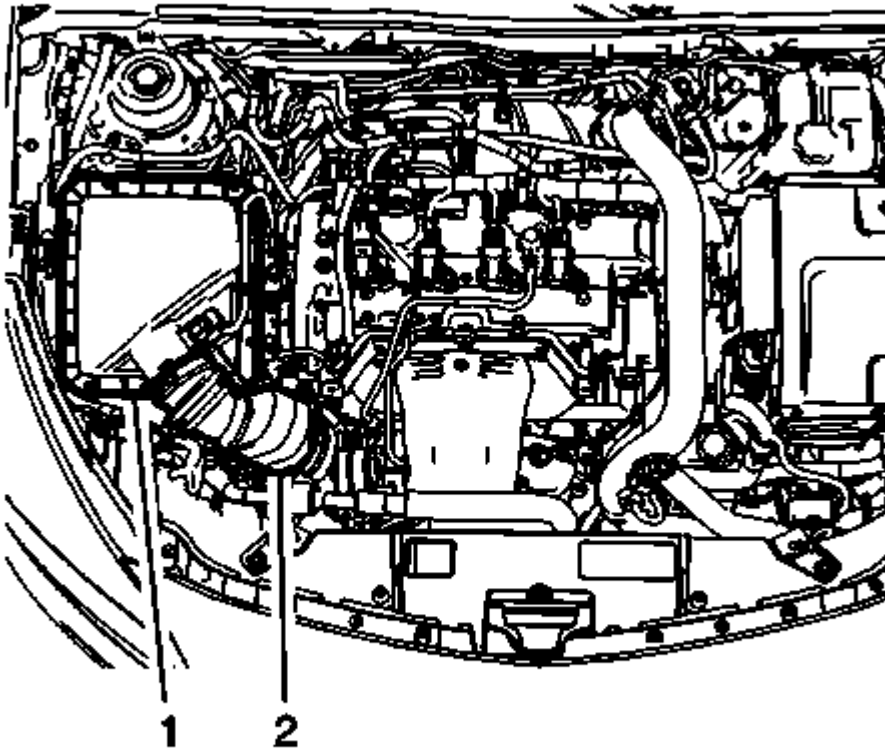


Fig. 229: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove the air cleaner assembly (1). Refer to Air Cleaner Assembly Replacement .
8. Remove the air cleaner outlet duct (2). Refer to Air Cleaner Outlet Duct Replacement .

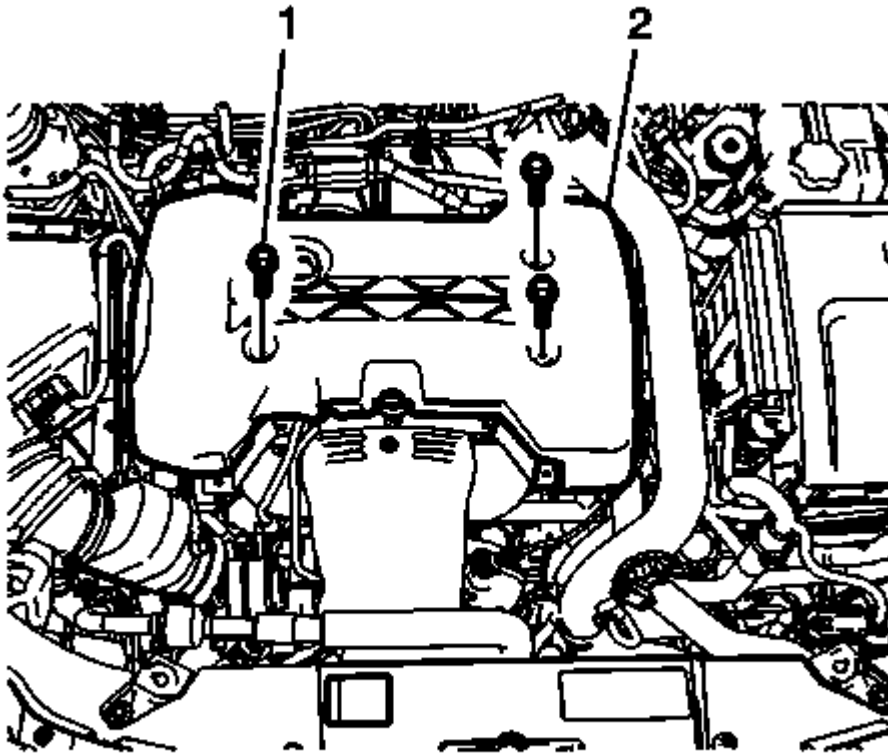


Fig. 230: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

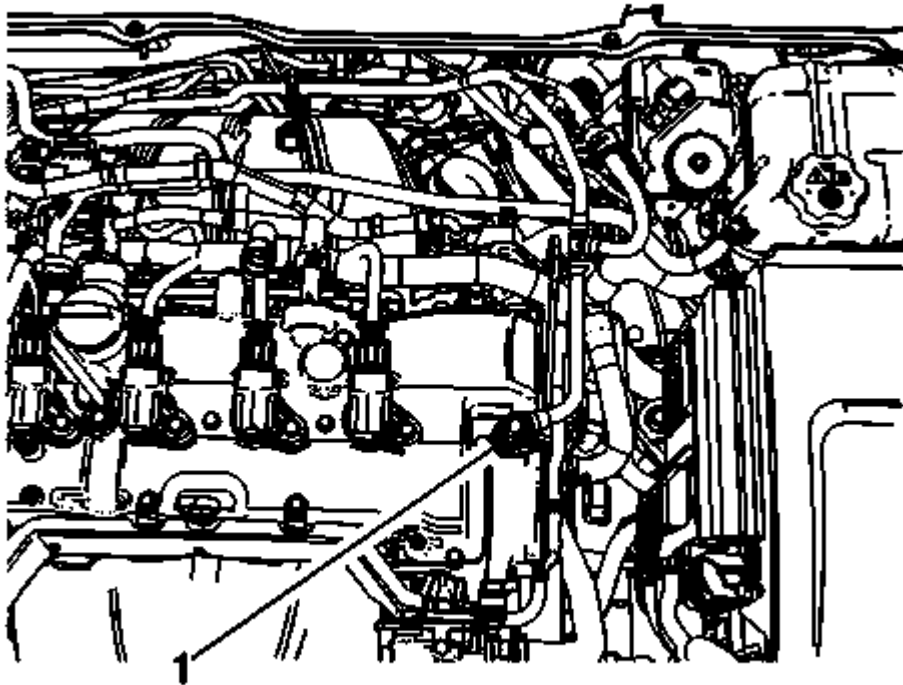


Fig. 231: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
11. Disconnect the fuel line (1). Refer to **Metal Collar Quick Connect Fitting Service** .

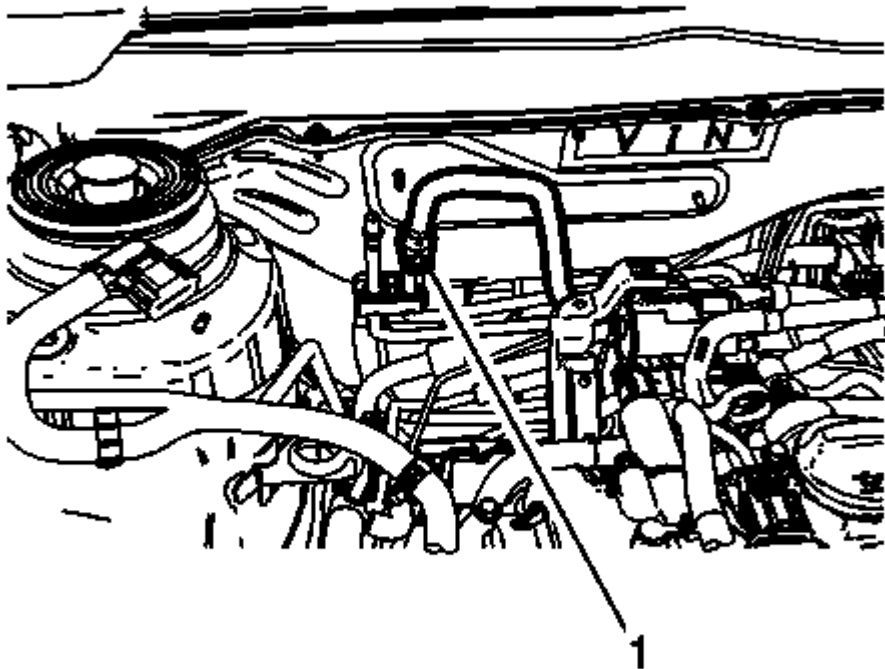


Fig. 232: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

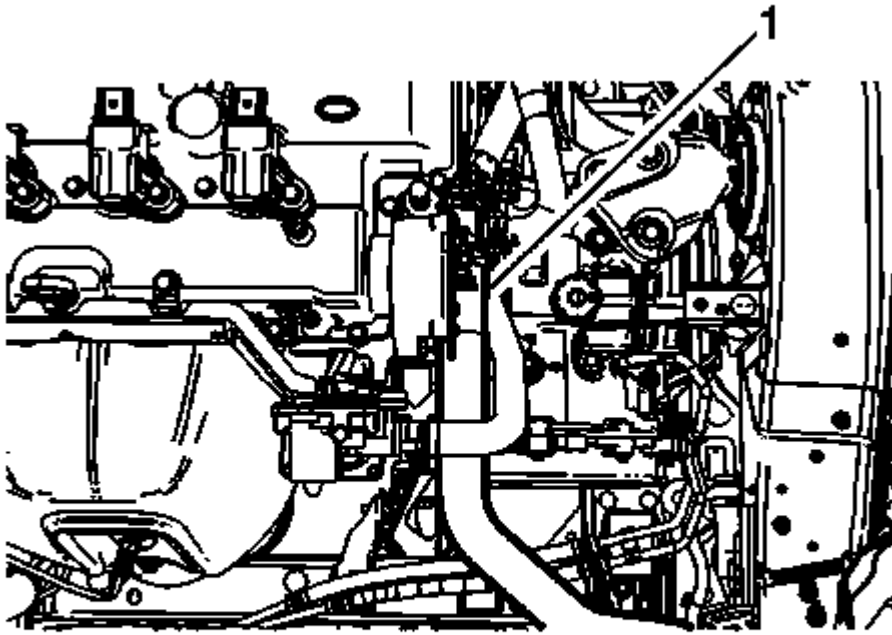


Fig. 233: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

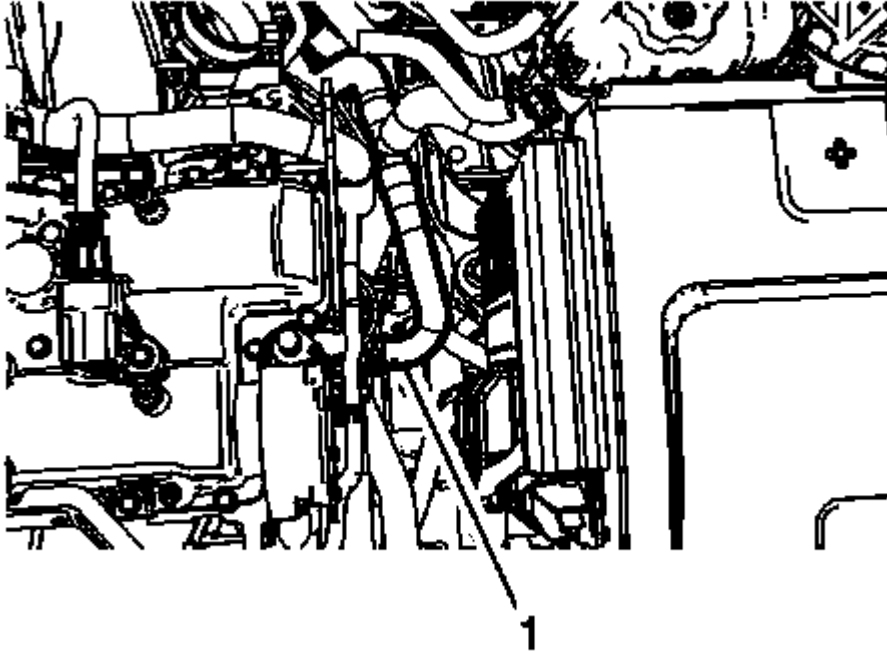


Fig. 234: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

14. Remove the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .
15. Remove the heater outlet hose (2). Refer to **Heater Outlet Hose Replacement (LTG)** .

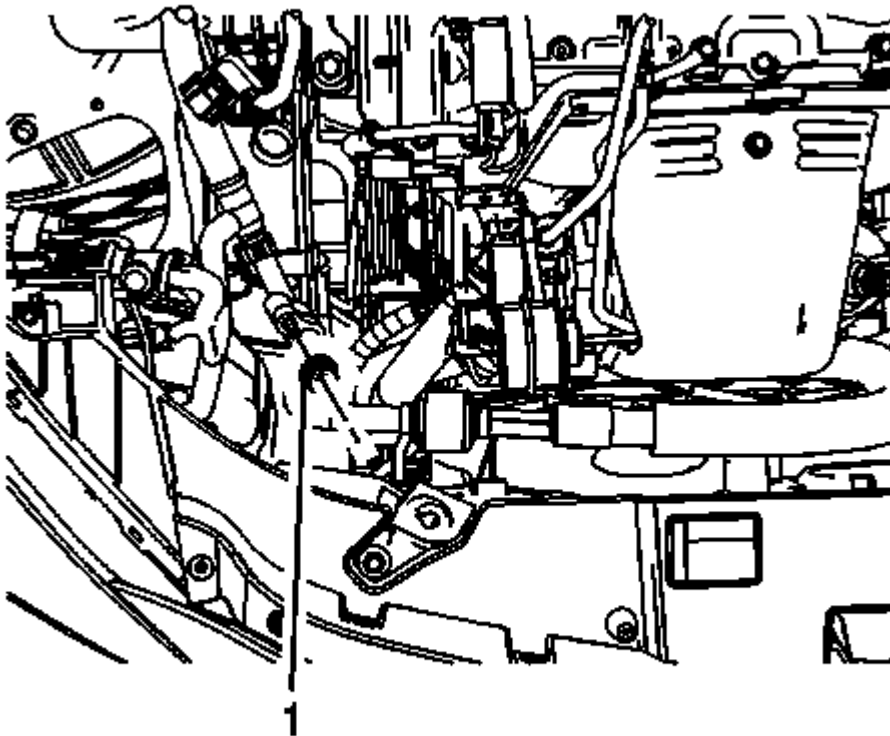


Fig. 235: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Remove the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LUK)** .

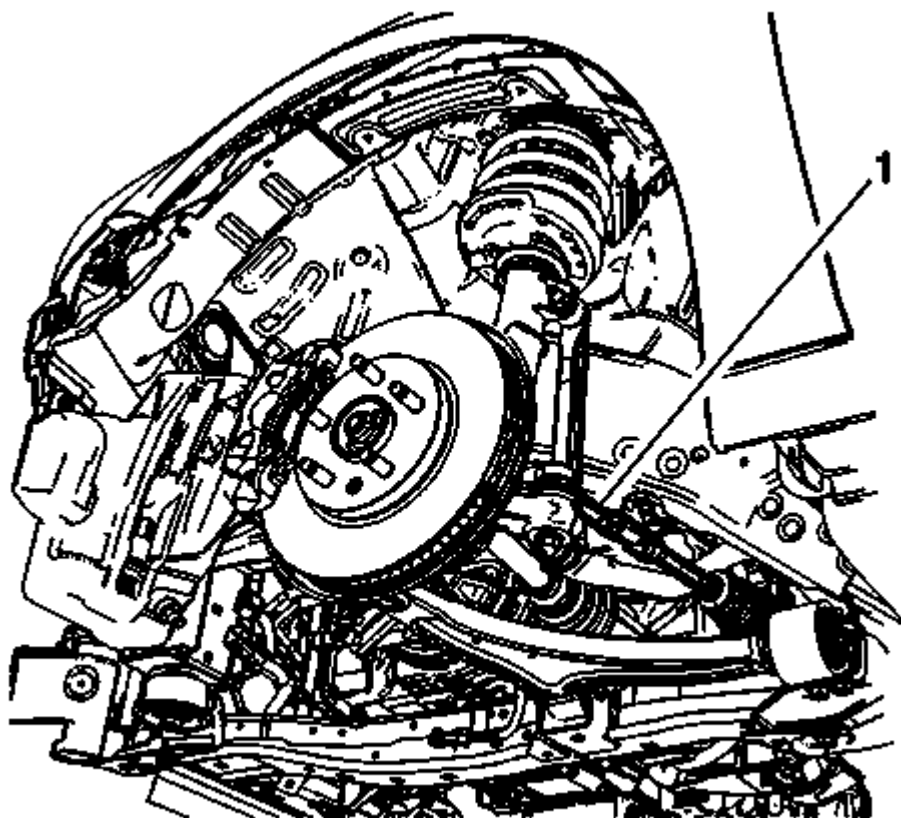


Fig. 236: Tie Rods And Steering Knuckles
Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

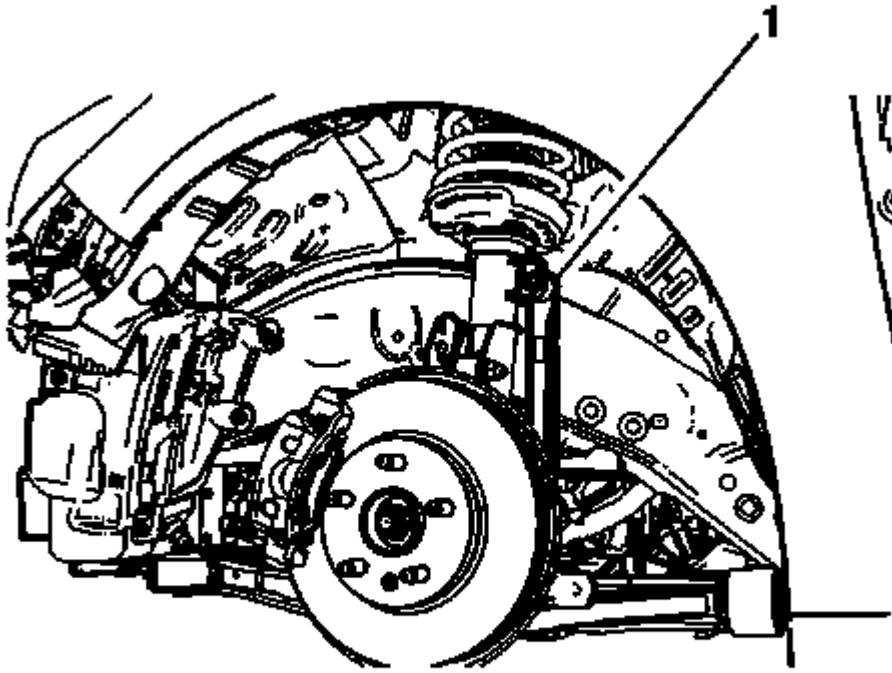


Fig. 237: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

18. Disconnect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .
19. Disconnect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
20. Remove the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG)** .
21. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
22. Remove the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
23. Remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)** , **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)** .

NOTE: During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.

24. Position an engine support table under the powertrain assembly.
25. Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.

26. With the table positioned, fully raise the table to contact with the powertrain assembly.

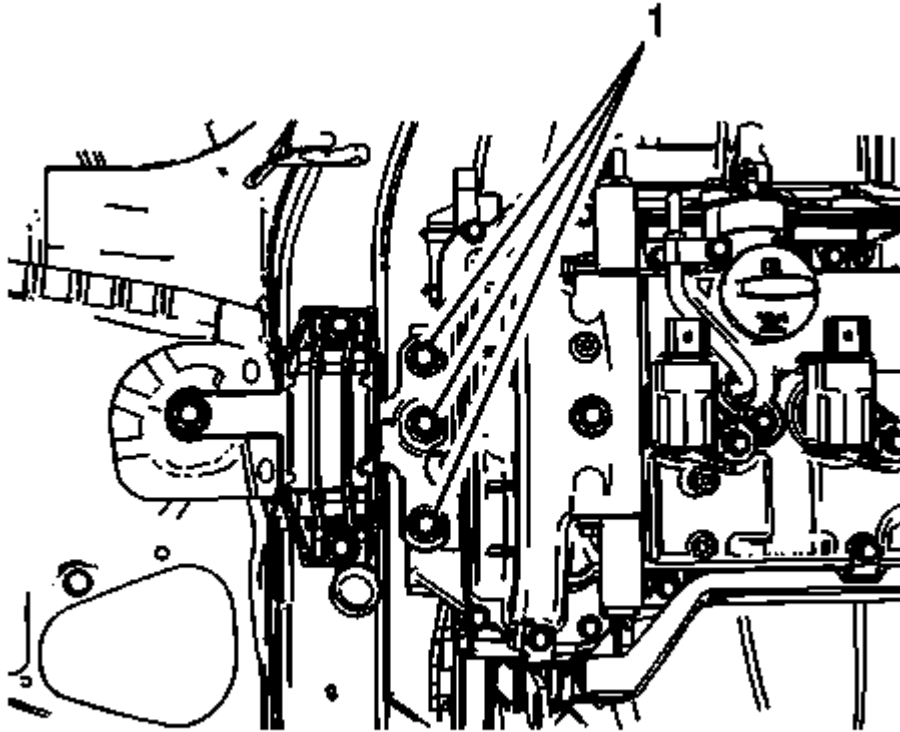


Fig. 238: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

27. Remove the engine mount (1). Refer to **Engine Mount Replacement**.
28. Remove the transmission mount . Refer to **Transmission Mount Replacement - Left Side** .
29. Remove the frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
30. Disconnect electrical connectors as necessary.
31. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
32. Separate the engine from the transaxle. Refer to **Transmission Replacement** .
33. Install the engine to a suitable engine stand.

Installation Procedure

1. Install the engine and transaxle back together. Refer to **Transmission Replacement** .
2. Position the powertrain support table under the vehicle.
3. Raise the powertrain into position under the vehicle.

4. With the table positioned, if required, lower the vehicle over the powertrain.
5. Install the NEW frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
6. Lower the vehicle.
7. Install the transmission mount. Refer to **Transmission Mount Replacement - Left Side** .

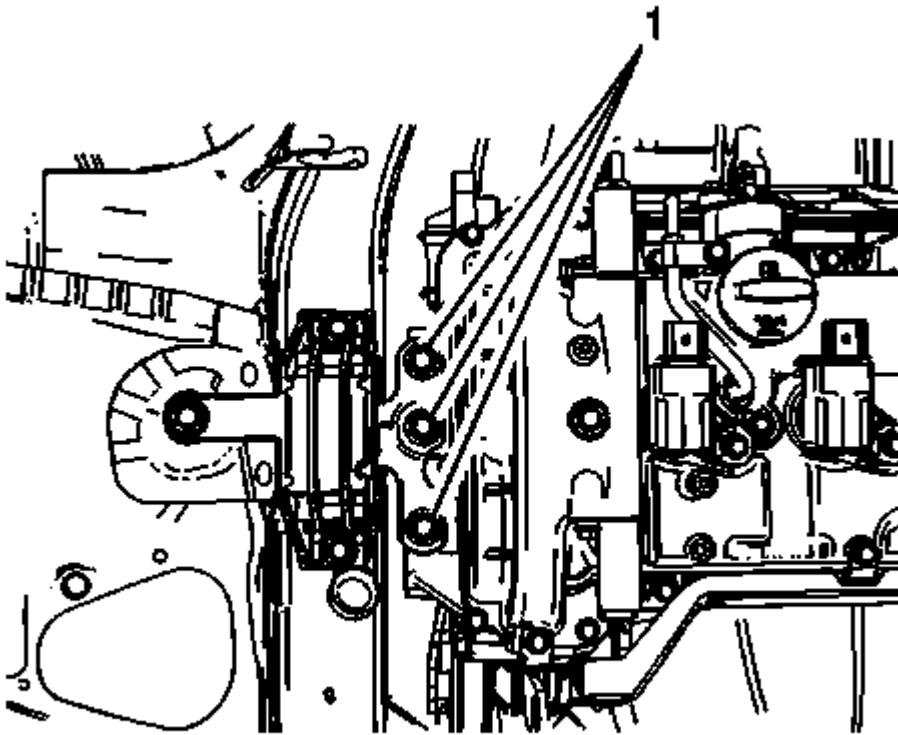


Fig. 239: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

8. Install the engine mount (1). Refer to **Engine Mount Replacement**.
9. Install the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)** , **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)** .
10. Install the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
11. Connect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
12. Install the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG)** .
13. Connect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .

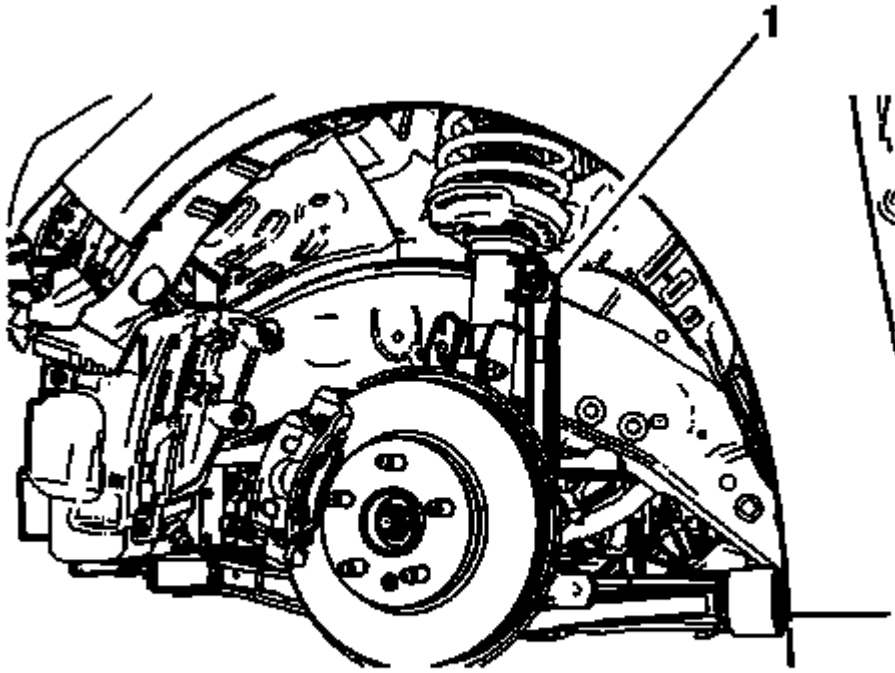


Fig. 240: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

14. Connect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .

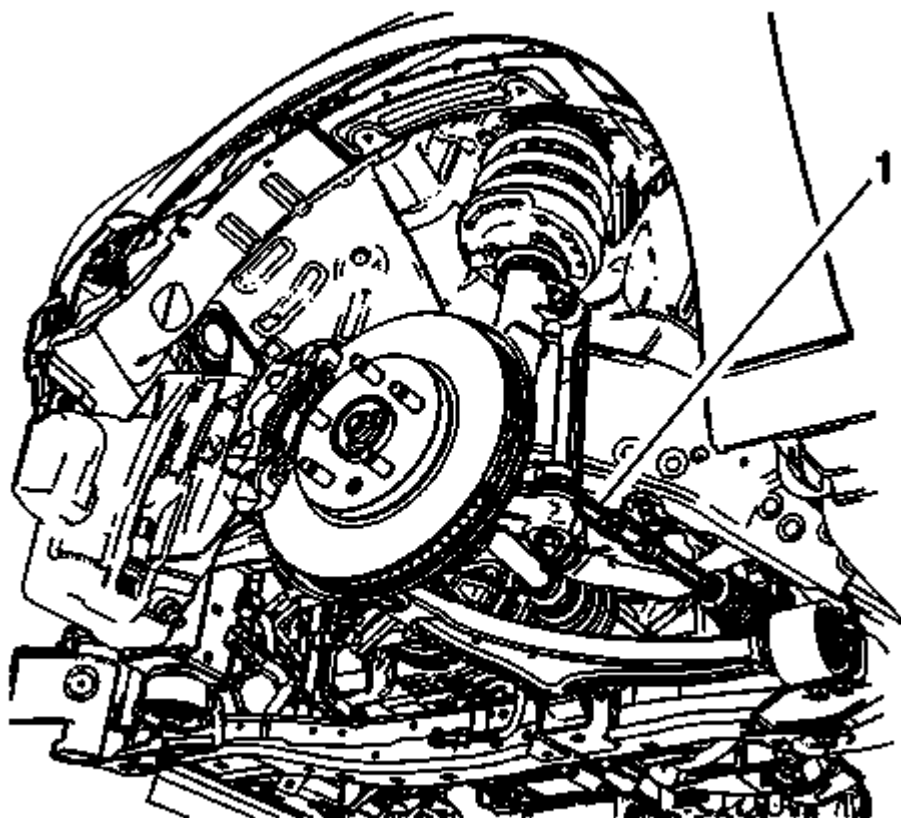


Fig. 241: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

15. Connect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

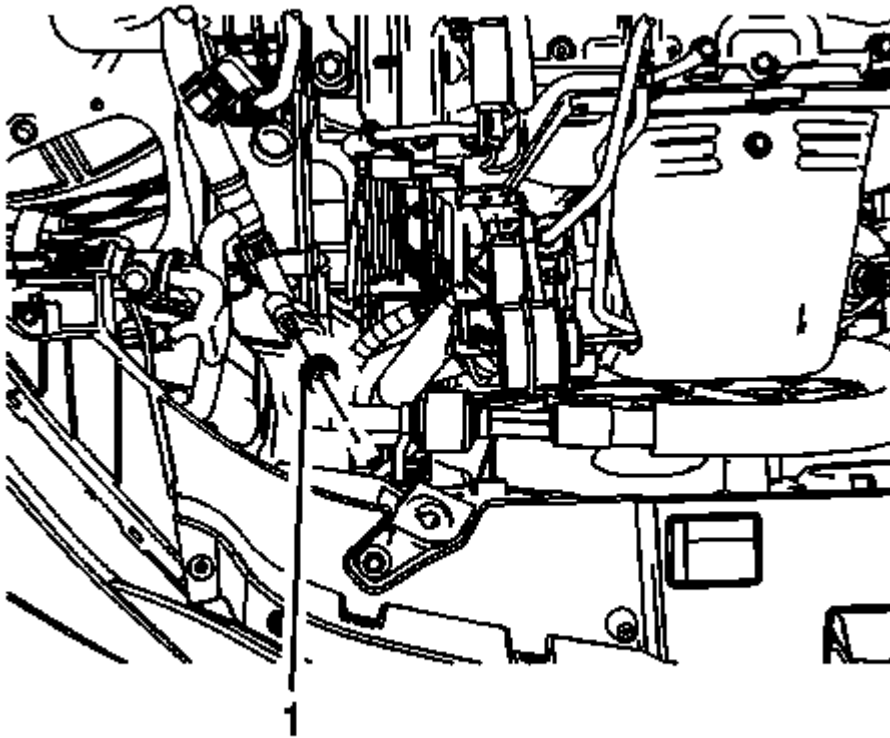


Fig. 242: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Install the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LUK)** .

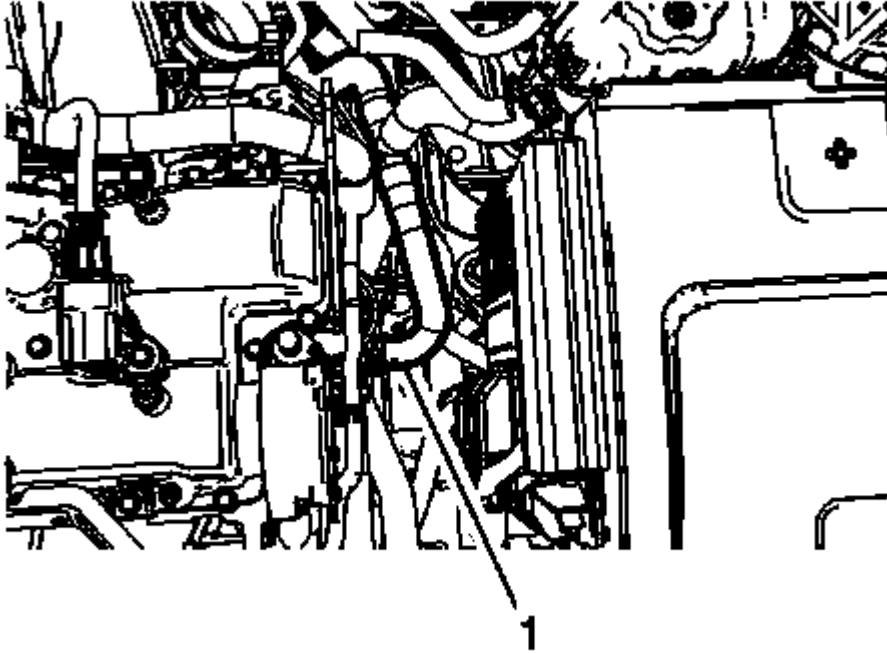


Fig. 243: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

17. Install the heater outlet hose (2). Refer to **Heater Outlet Hose Replacement (LTG)** .
18. Install the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .

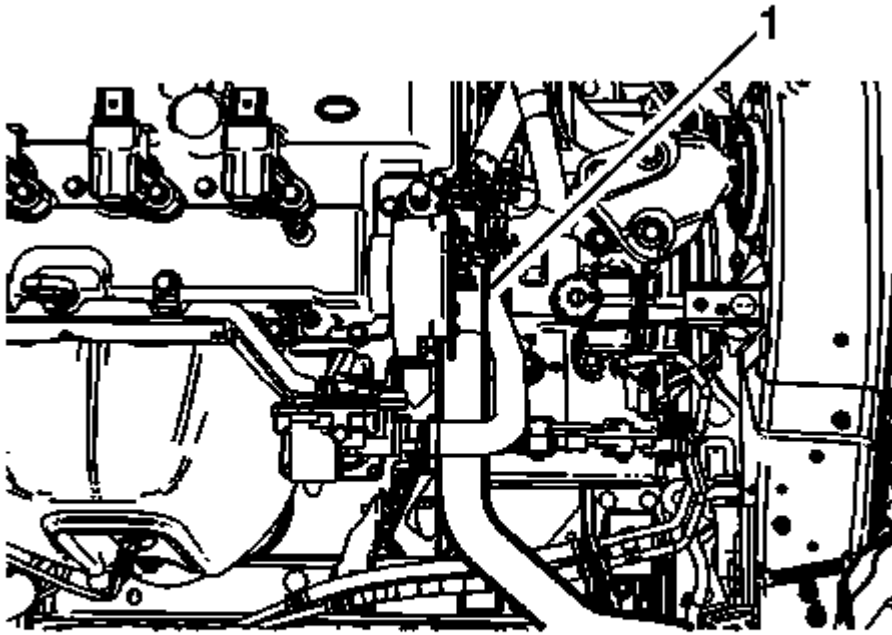


Fig. 244: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

19. Connect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

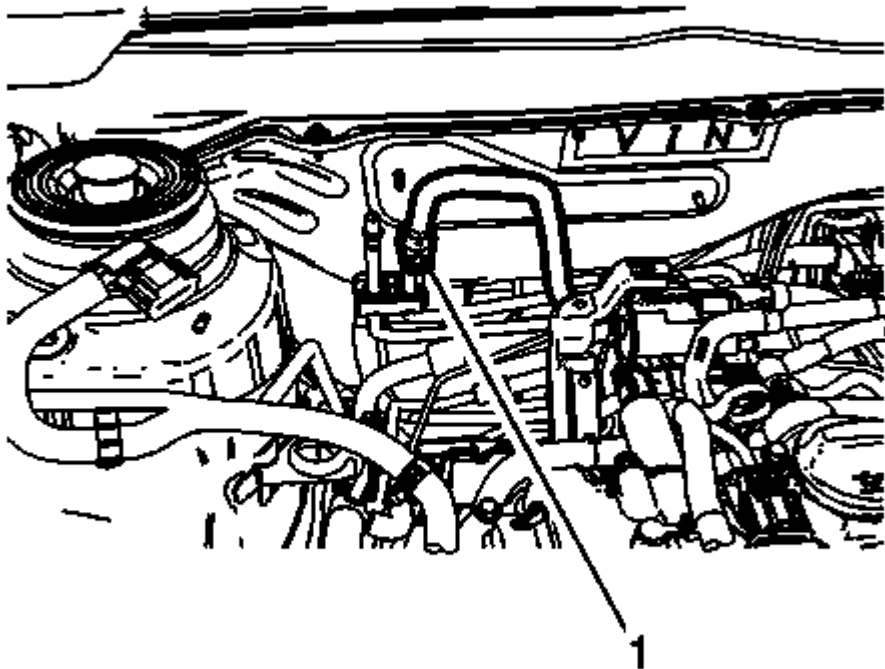


Fig. 245: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

20. Connect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
21. Connect the fuel line (1). Refer to **Metal Collar Quick Connect Fitting Service** .

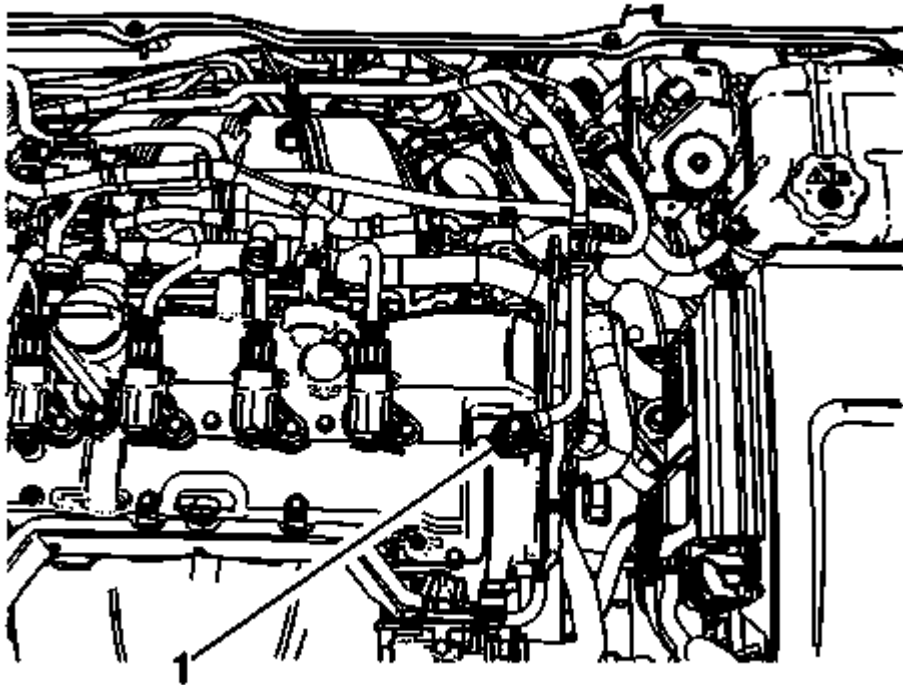


Fig. 246: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

22. Connect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

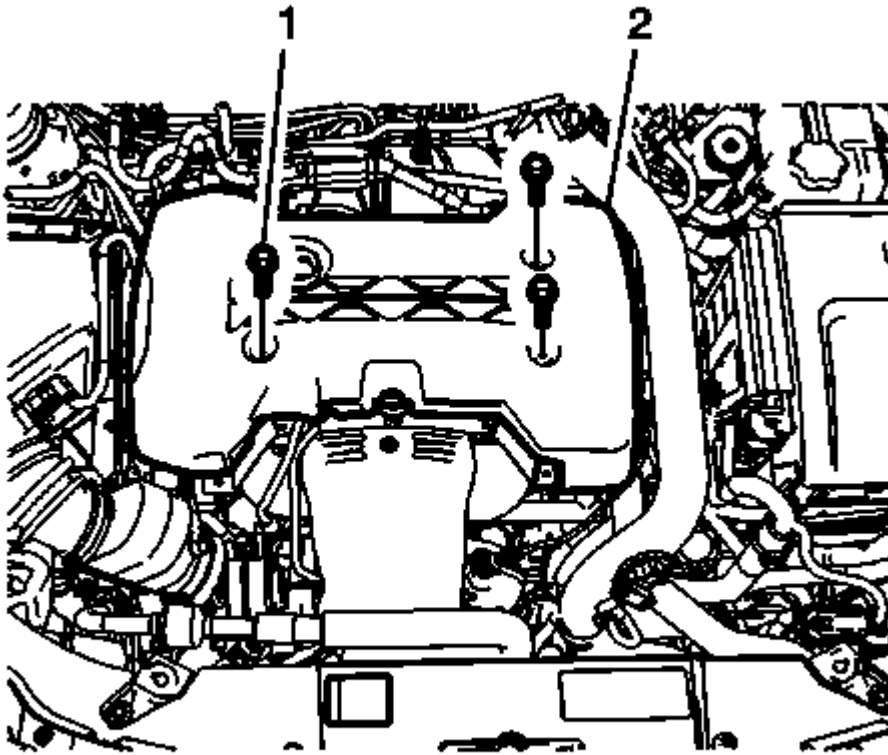


Fig. 247: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

23. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

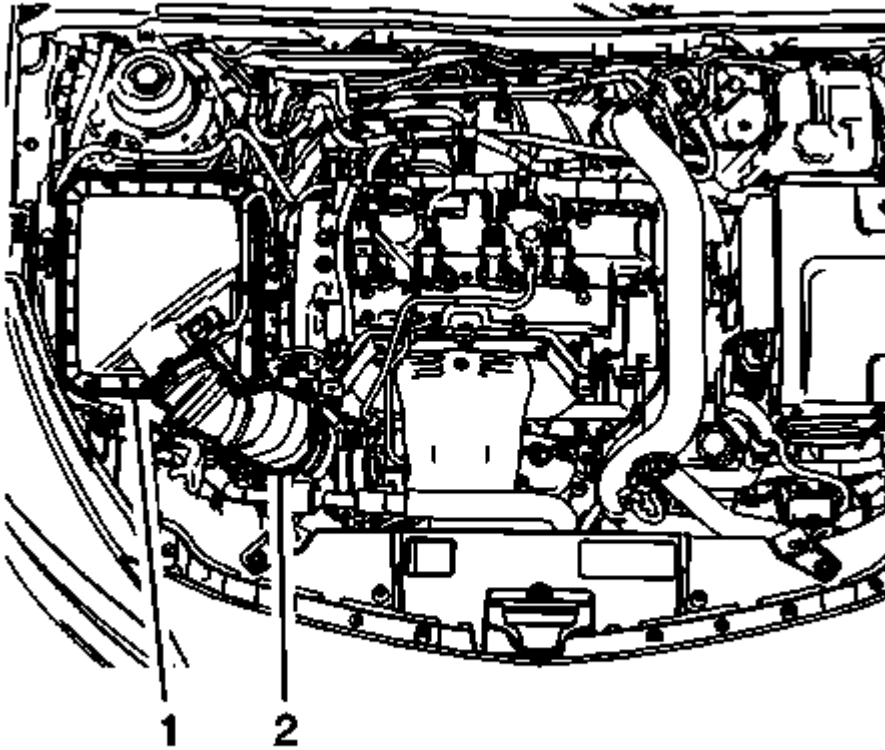


Fig. 248: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

24. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
25. Install the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .
26. Install the battery tray. Refer to **Battery Tray Replacement** .
27. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
28. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
29. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
30. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE REPLACEMENT (AWD)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
4. Evacuate the A/C system. Refer to **Refrigerant Recovery and Recharging** .
5. Remove the battery tray. Refer to **Battery Tray Replacement** .
6. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .

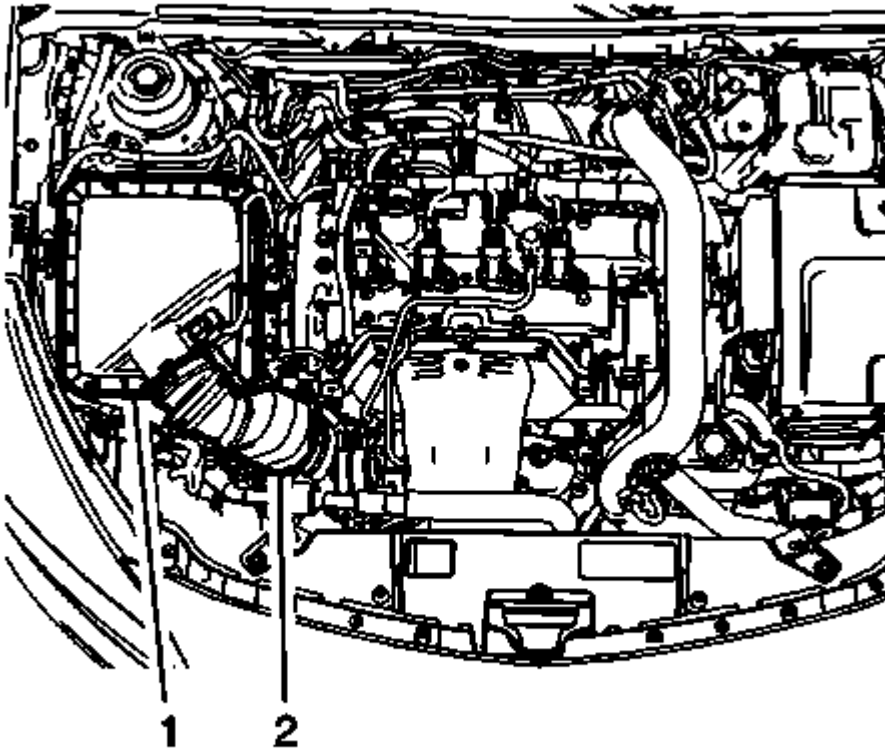


Fig. 249: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
8. Remove the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .

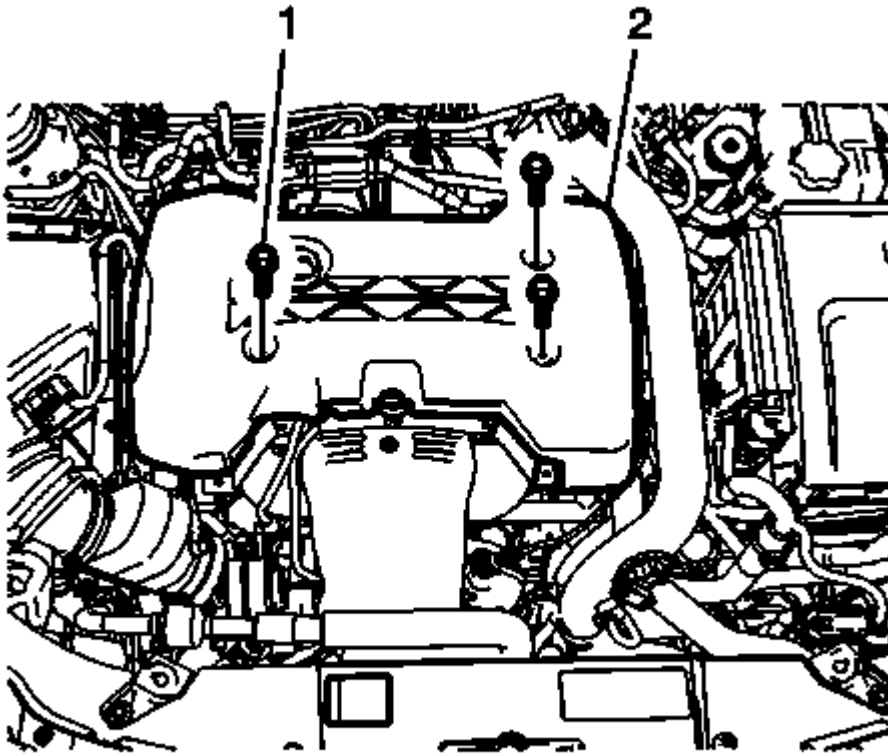


Fig. 250: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

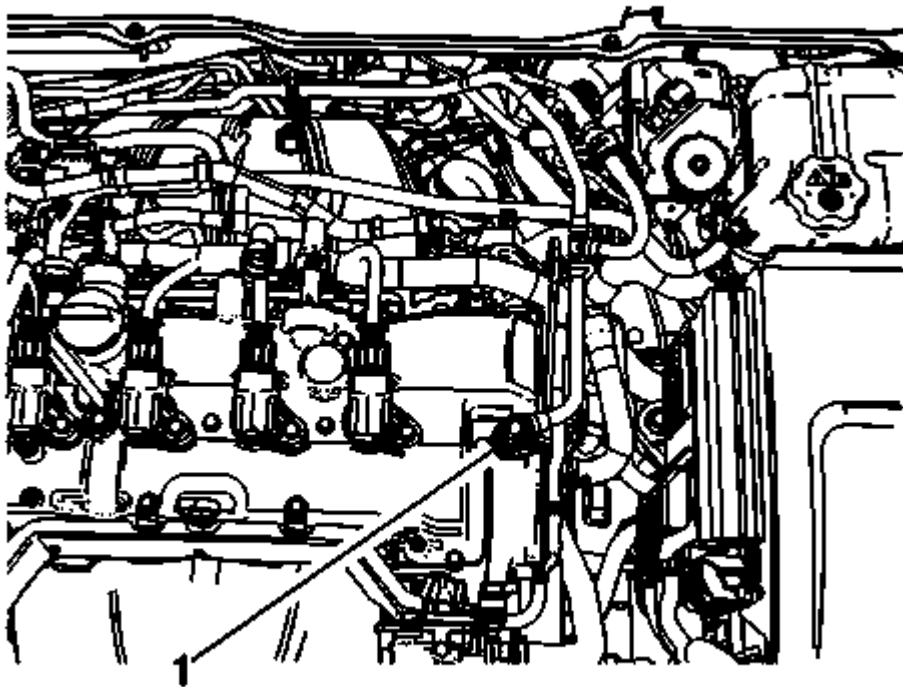


Fig. 251: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
11. Disconnect the fuel line. Refer to **Metal Collar Quick Connect Fitting Service** .

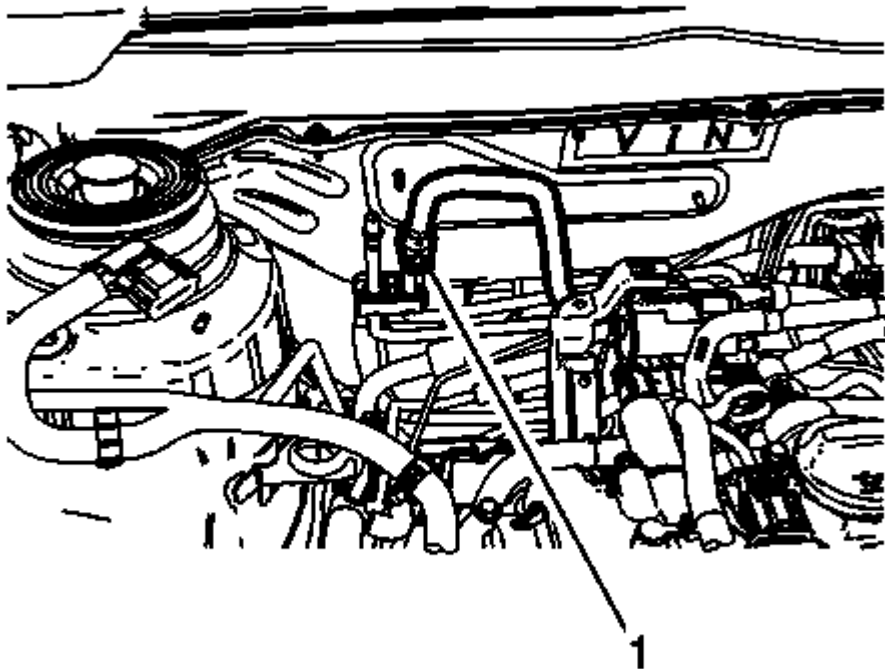


Fig. 252: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

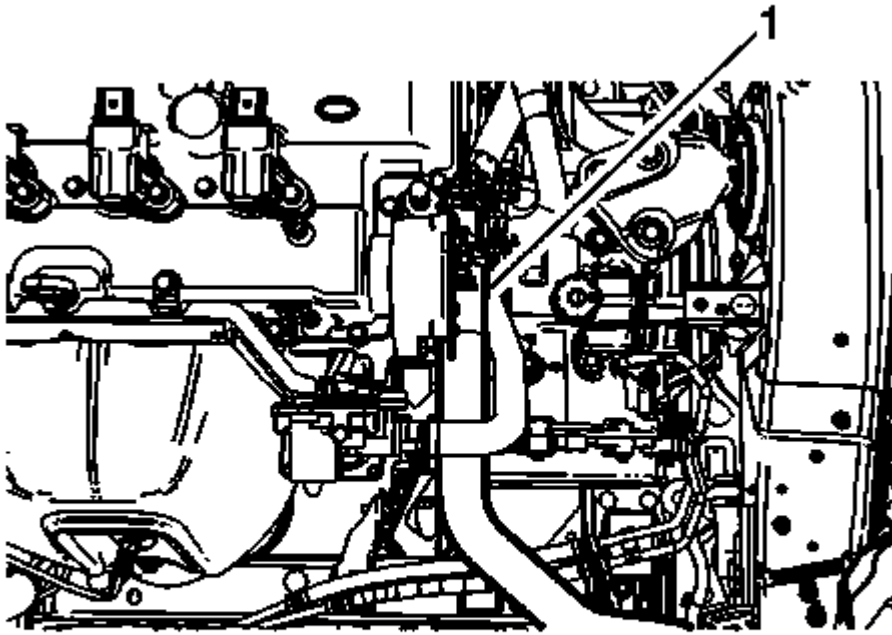


Fig. 253: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

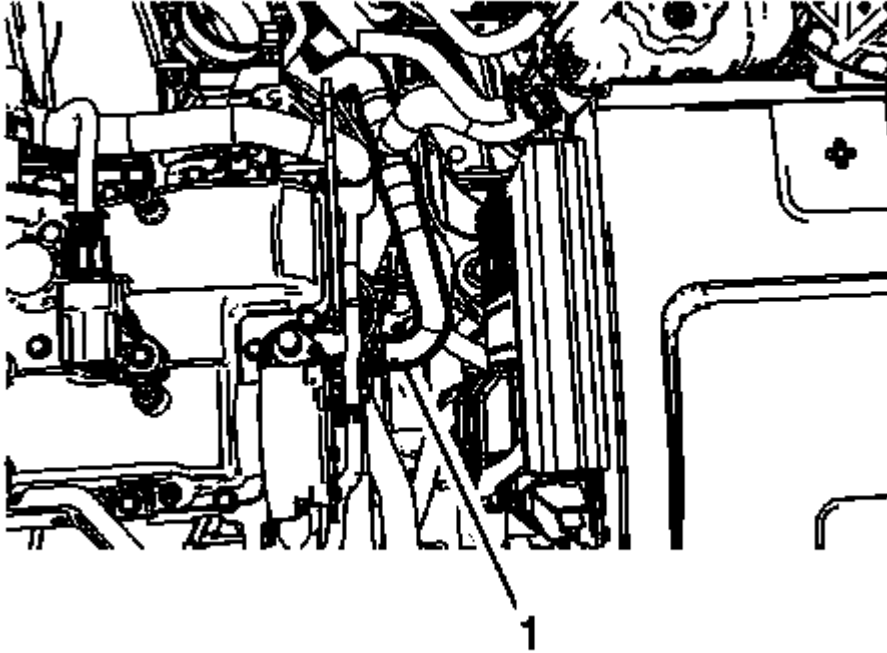


Fig. 254: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

14. Remove the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .
15. Remove the heater outlet hose. Refer to **Heater Outlet Hose Replacement (LTG)** .

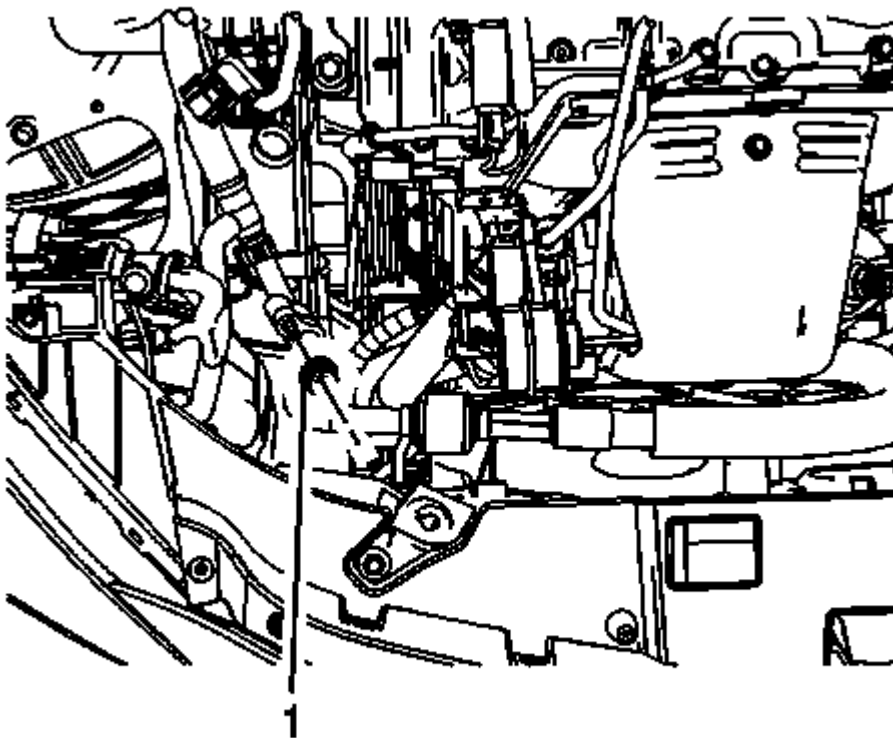


Fig. 255: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Remove the air conditioning compressor and condenser hose (1).

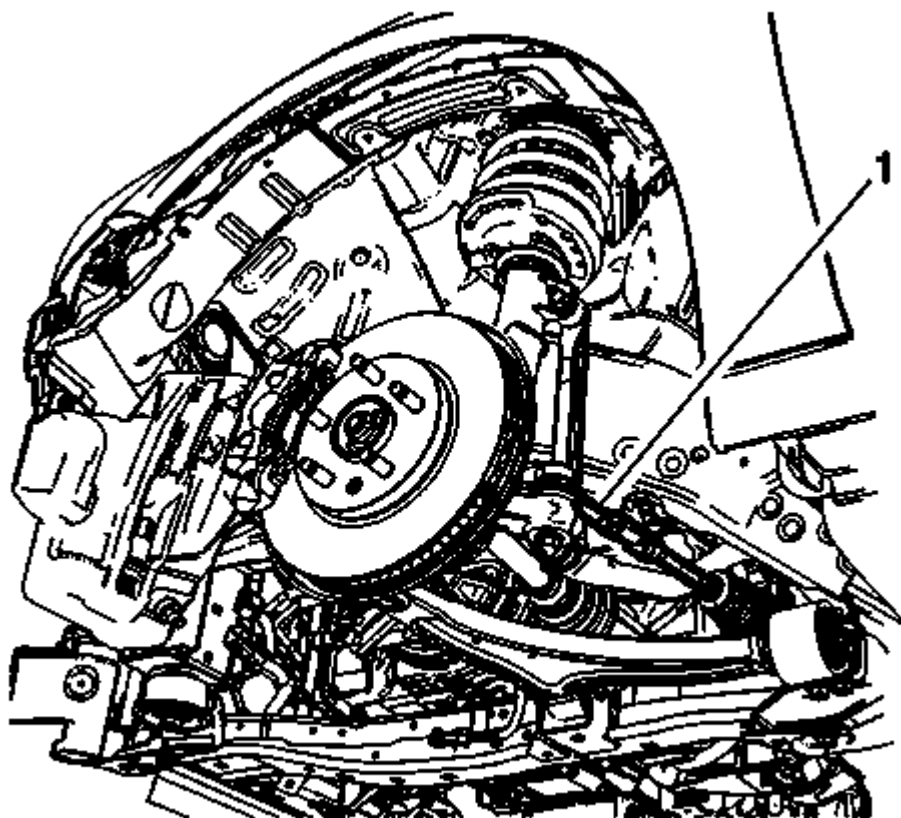


Fig. 256: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

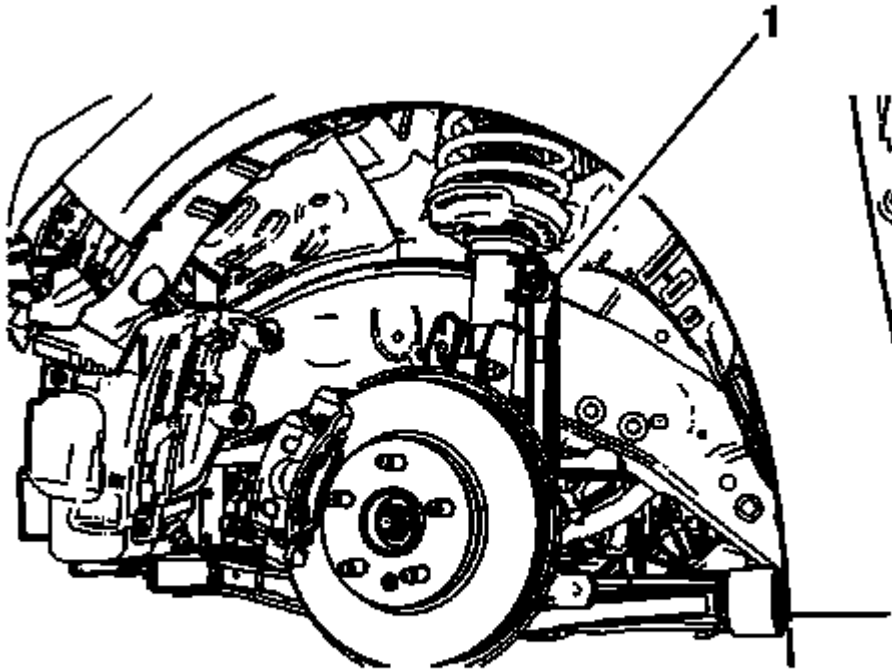


Fig. 257: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

18. Disconnect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .
19. Disconnect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
20. Remove the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG AWD)** .
21. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
22. Remove the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
23. Remove the transfer case. Refer to **Transfer Case Replacement** .

NOTE: **During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.**

24. Position an engine support table under the powertrain assembly.
25. Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.
26. With the table positioned, fully raise the table to contact with the powertrain assembly.

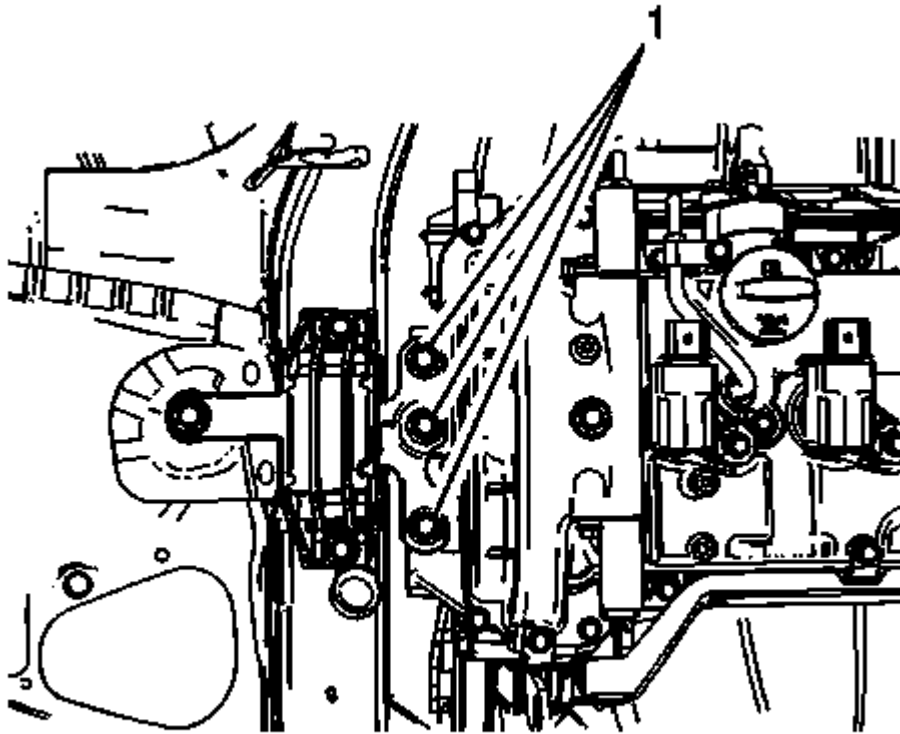


Fig. 258: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

27. Remove the engine mount (1). Refer to **Engine Mount Replacement**.
28. Remove the transmission mount . Refer to **Transmission Mount Replacement - Left Side** .
29. Remove the frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
30. Disconnect electrical connectors as necessary.
31. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
32. Separate the engine from the transaxle. Refer to **Transmission Replacement** .
33. Install the engine to a suitable engine stand.

Installation Procedure

1. Install the engine and transaxle back together. Refer to **Transmission Replacement** .
2. Position the powertrain support table under the vehicle.
3. Raise the powertrain into position under the vehicle.
4. With the table positioned, if required, lower the vehicle over the powertrain.
5. Install the NEW frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .

6. Lower the vehicle.
7. Install the transmission mount. Refer to **Transmission Mount Replacement - Left Side** .

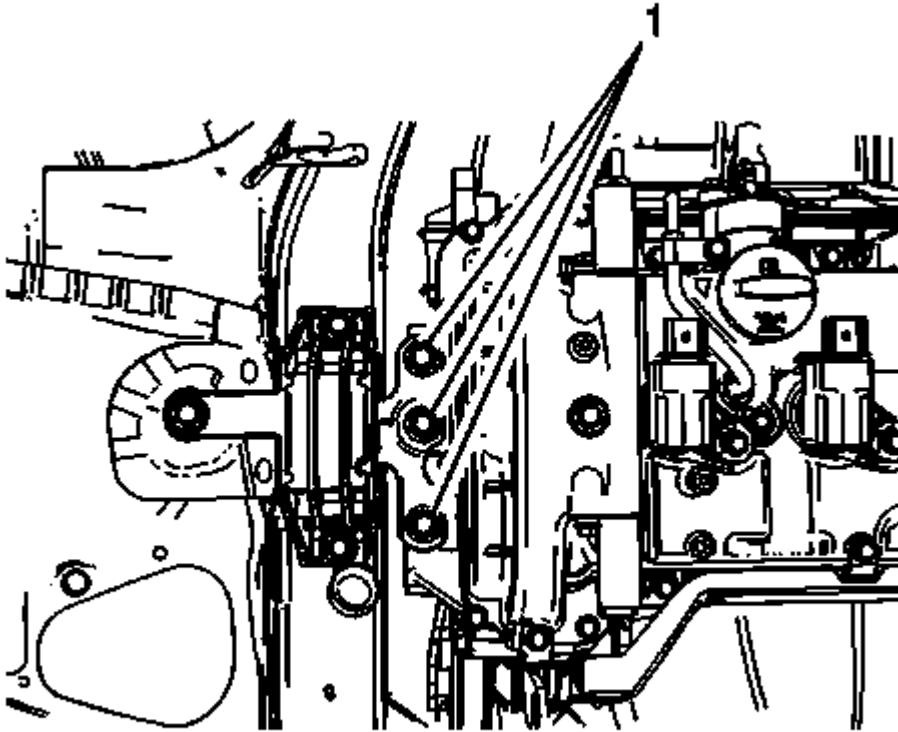


Fig. 259: Engine Mount
Courtesy of GENERAL MOTORS COMPANY

8. Install the engine mount (1). Refer to **Engine Mount Replacement**.
9. Install the transfer case. Refer to **Transfer Case Replacement** .
10. Install the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
11. Connect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
12. Install the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG AWD)** .
13. Connect the intermediate shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement** .

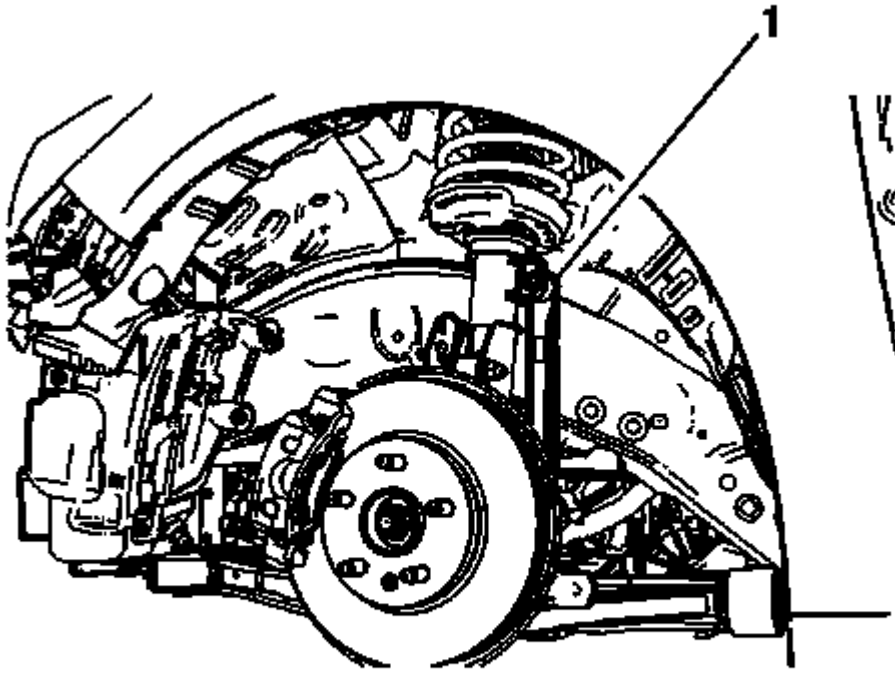


Fig. 260: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

14. Connect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .

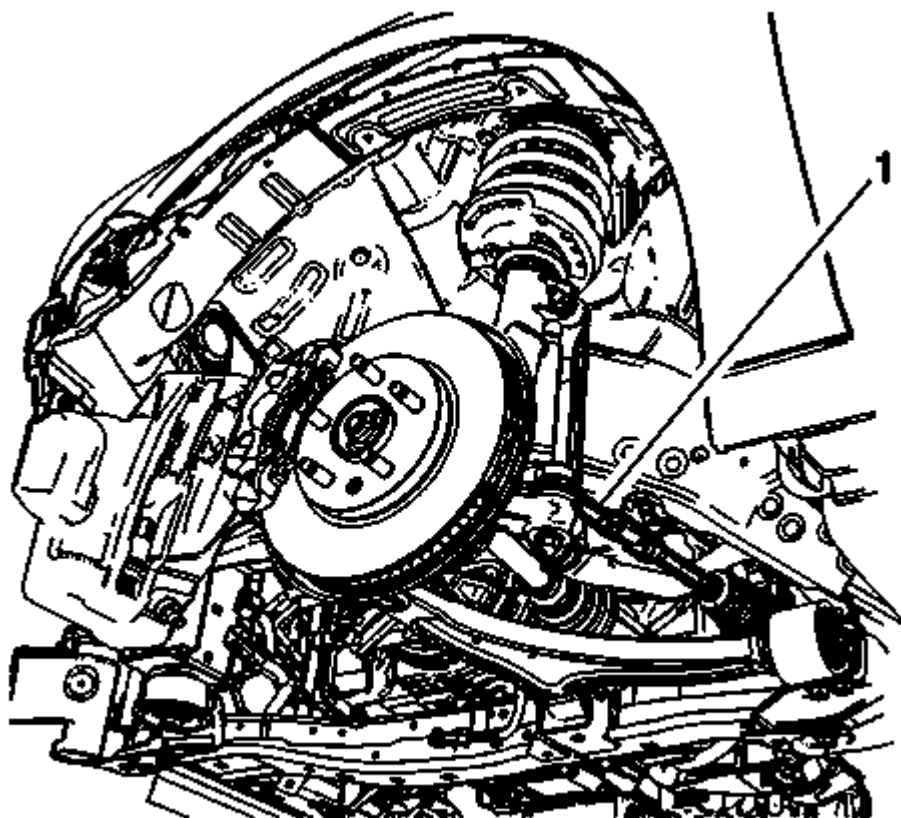


Fig. 261: Tie Rods And Steering Knuckles
Courtesy of GENERAL MOTORS COMPANY

15. Connect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

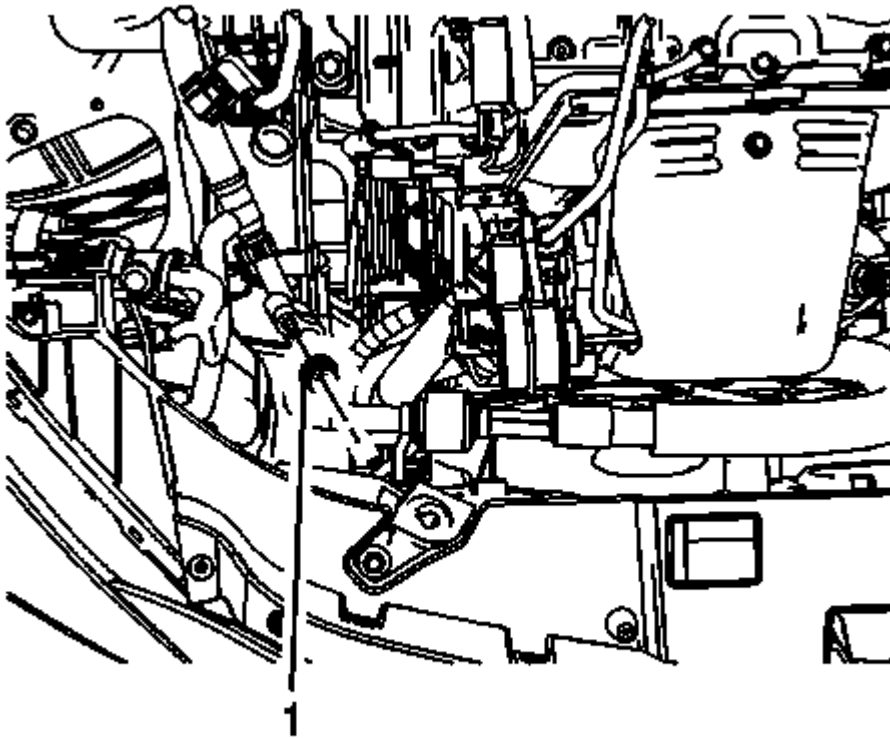


Fig. 262: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Install the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LUK)** .

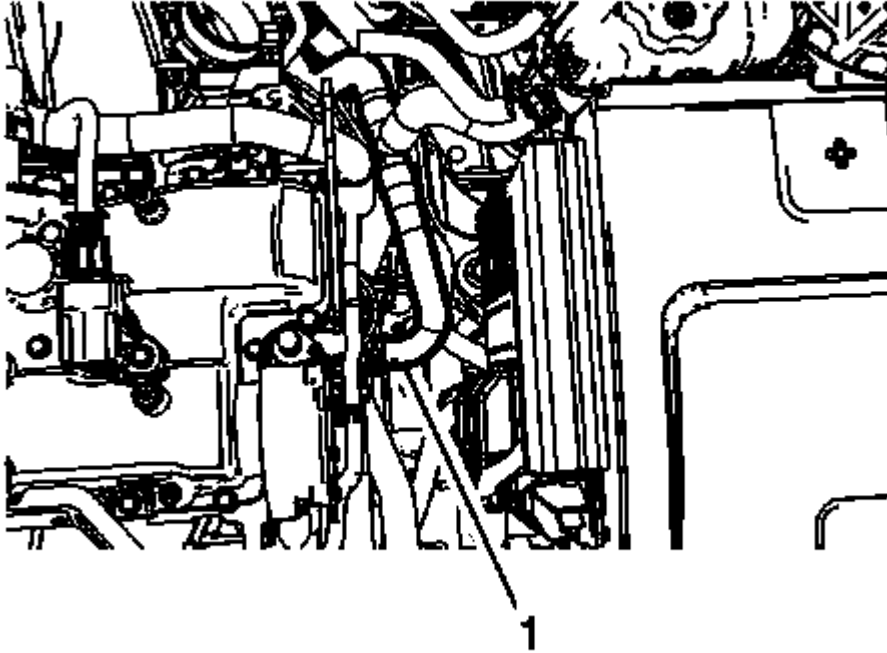


Fig. 263: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

17. Install the heater outlet hose. Refer to **Heater Outlet Hose Replacement (LTG)** .
18. Install the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .

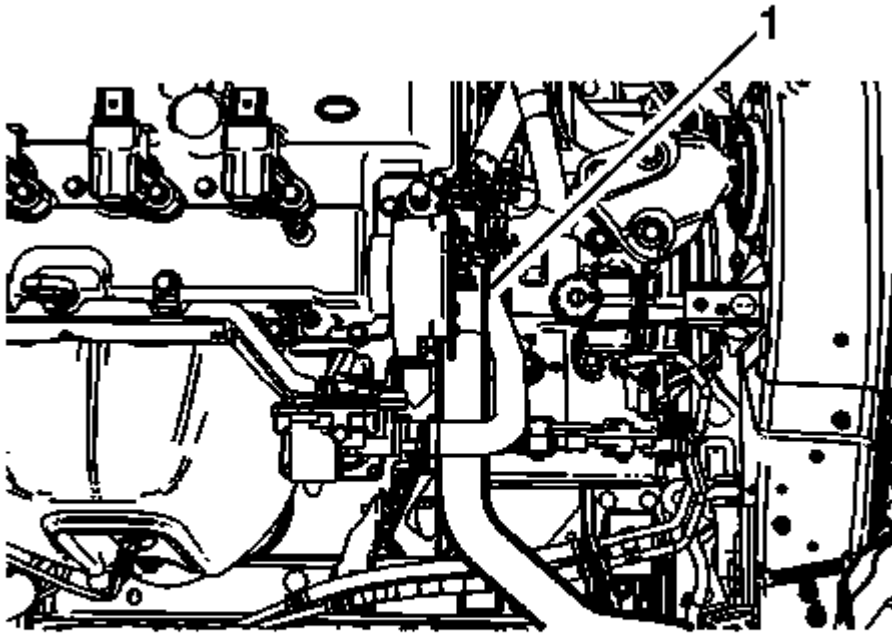


Fig. 264: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

19. Connect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

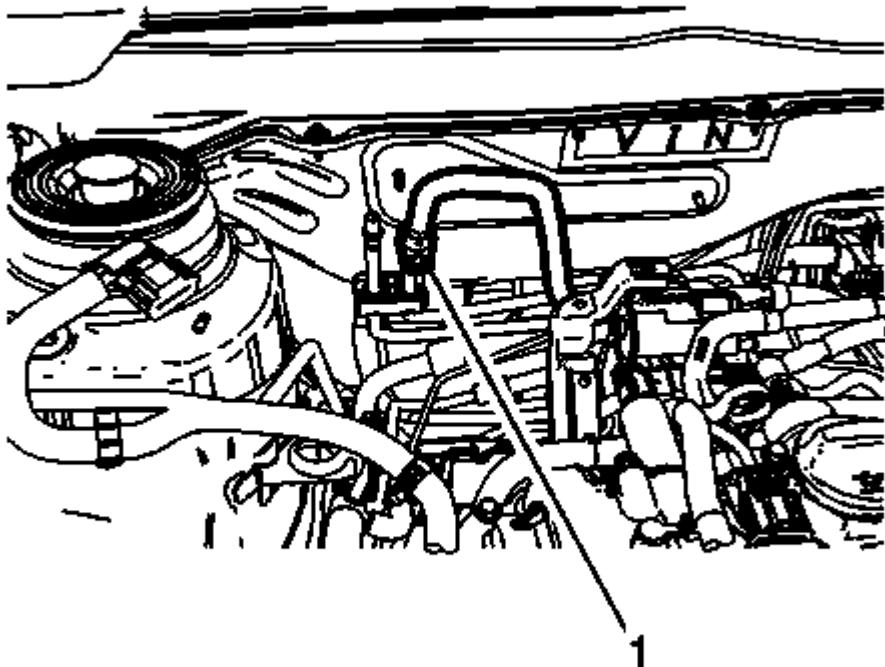


Fig. 265: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

20. Connect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
21. Connect the fuel line. Refer to **Metal Collar Quick Connect Fitting Service** .

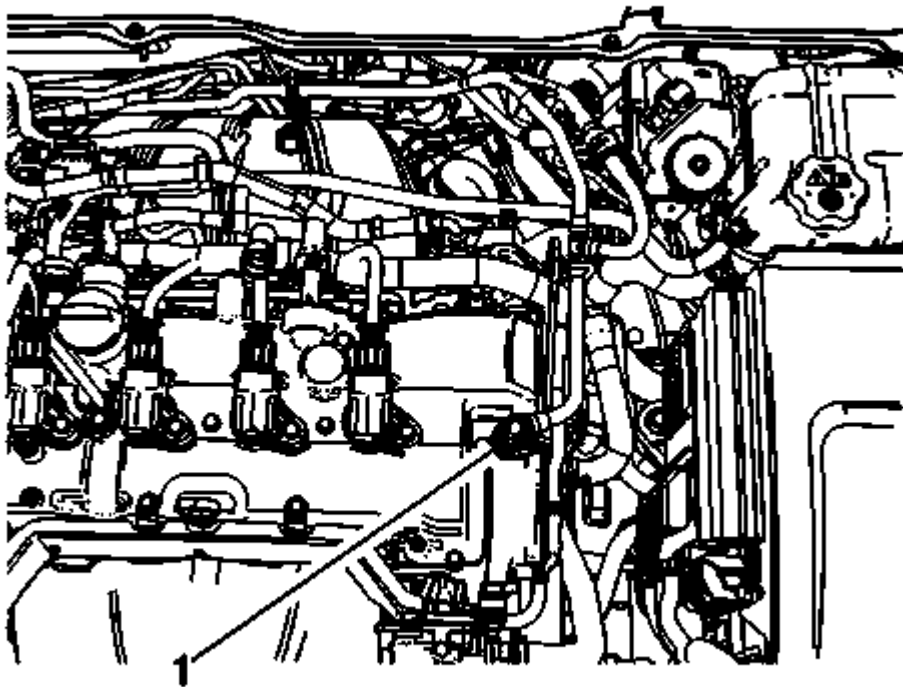


Fig. 266: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

22. Connect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

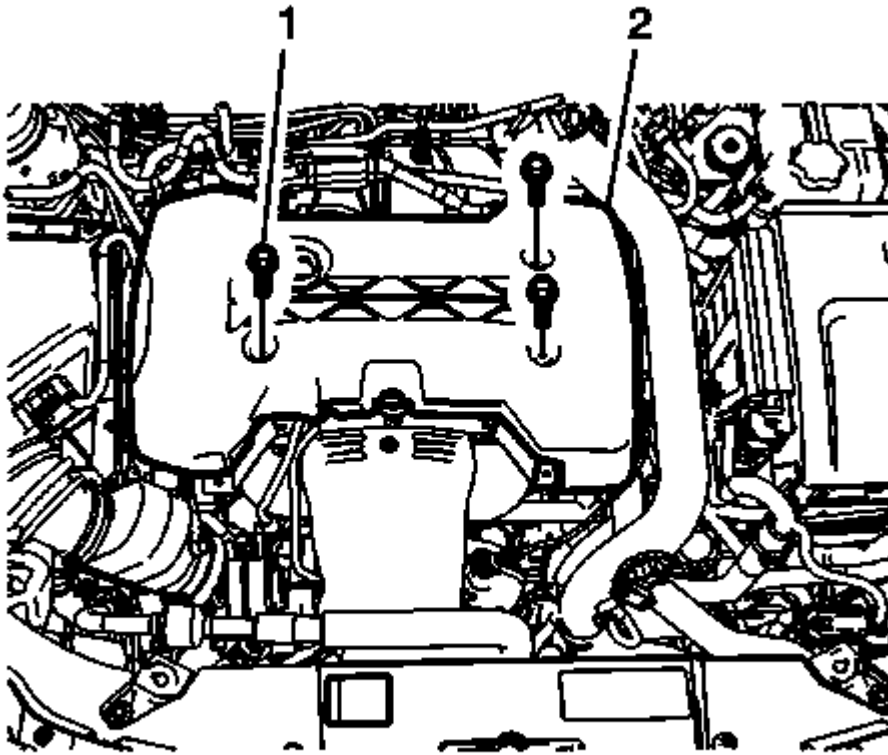


Fig. 267: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

23. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

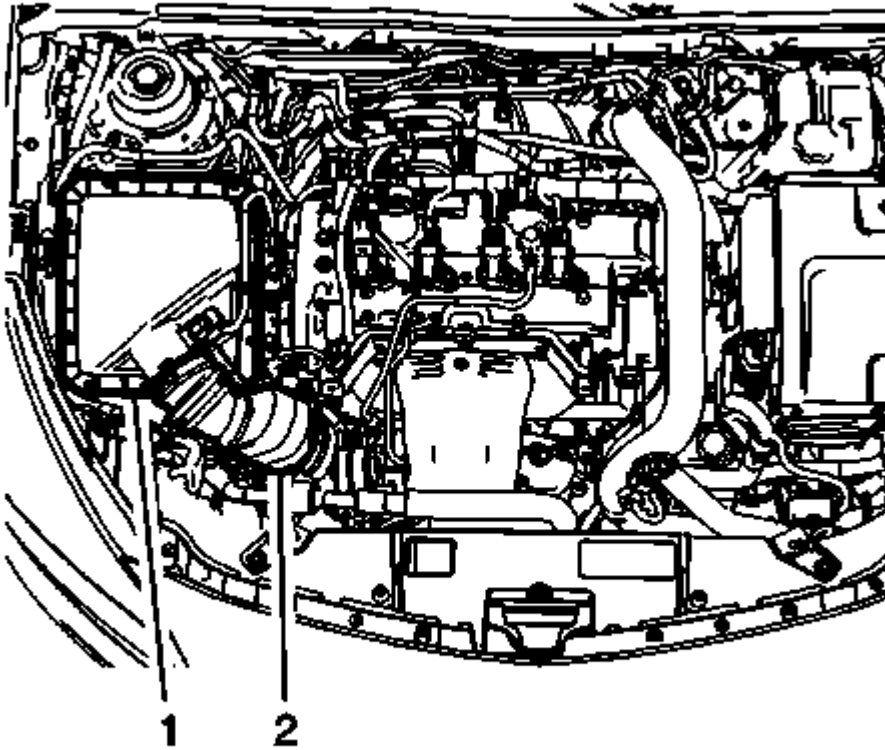


Fig. 268: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

24. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
25. Install the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .
26. Install the battery tray. Refer to **Battery Tray Replacement** .
27. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
28. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
29. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
30. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle**
2. Place a drain pan under the oil drain plug.

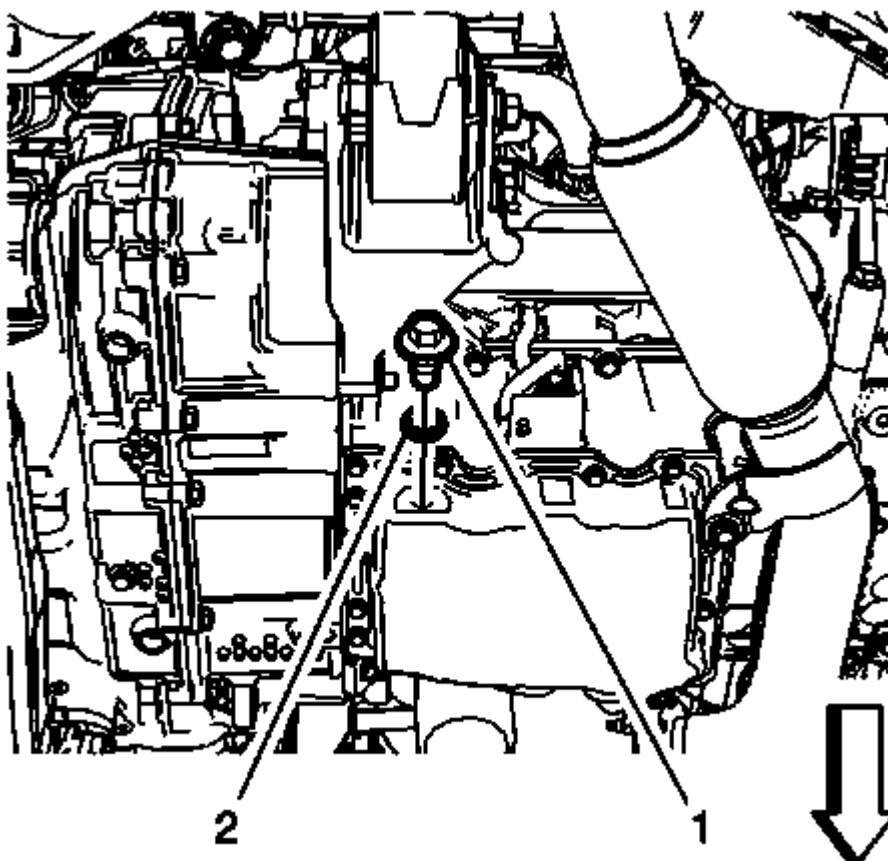


Fig. 269: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan drain plug (1).
4. Allow the oil to drain completely.
5. Clean and inspect the oil pan drain plug, replace if necessary.
6. Clean and inspect the oil pan drain plug sealing surface (2), replace the oil pan drain plug sealing surface if necessary.

CAUTION: Refer to Component Fastener Tightening Caution .

7. Reinstall oil pan drain plug (1) and tighten to 25 (18 lb ft).

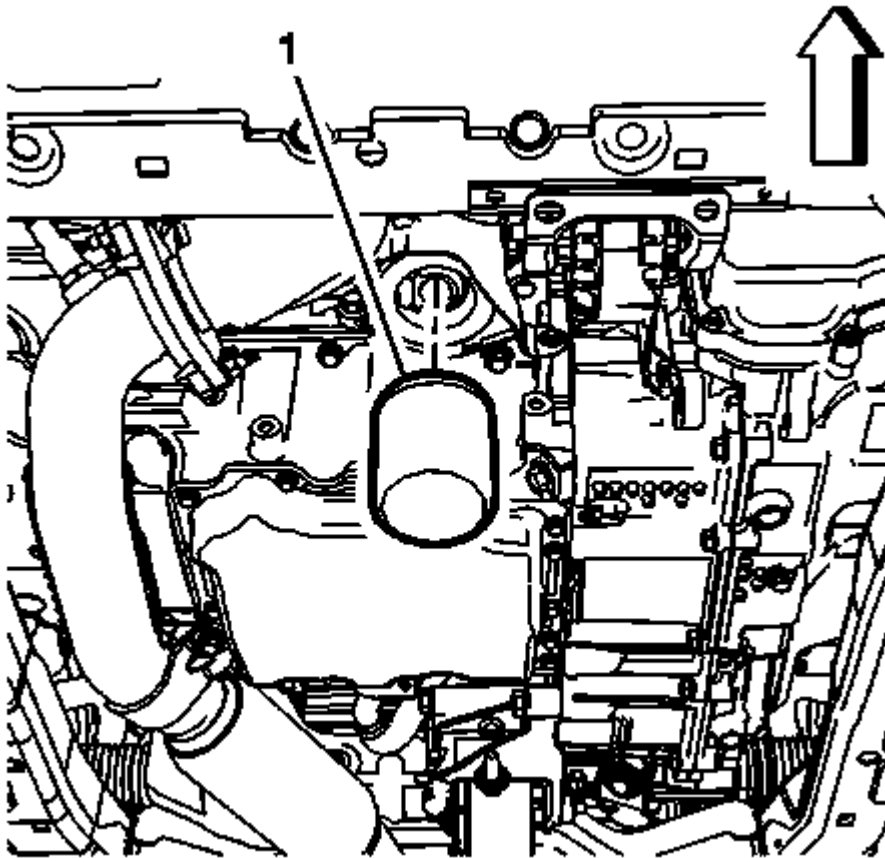


Fig. 270: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

8. Position a suitable drain pan under the oil filter.
9. Remove the oil filter (1).
10. Ensure that the oil filter gasket is still on the old oil filter, if not remove the oil filter gasket from the adapter.

Installation Procedure

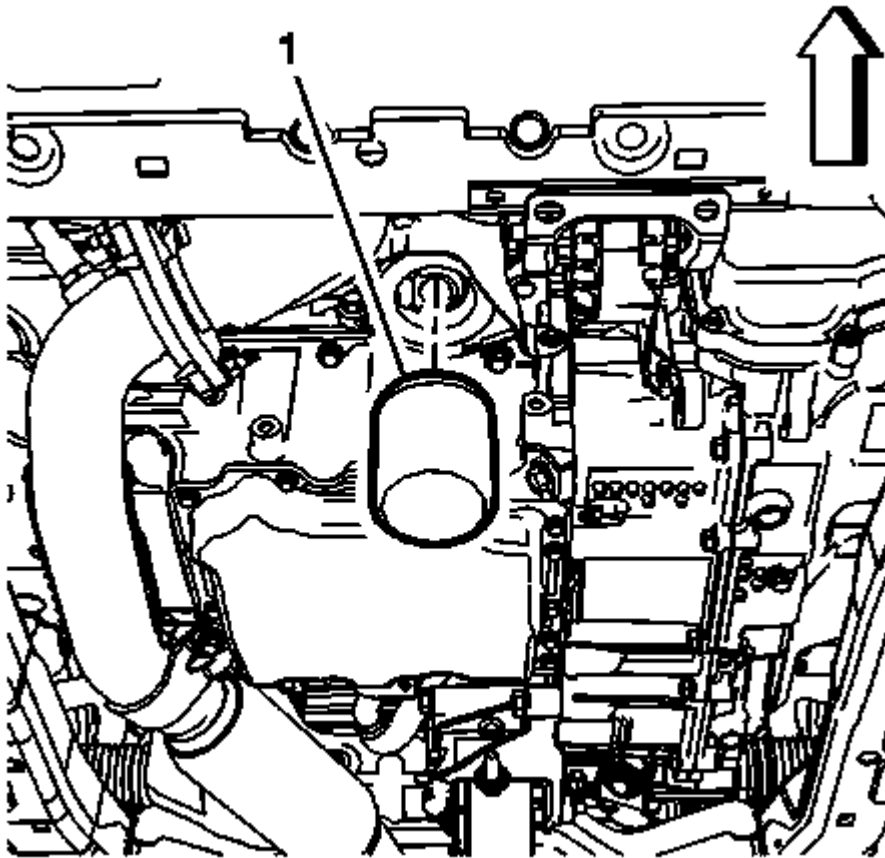


Fig. 271: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

1. Install the oil filter and tighten to 30 (22 lb ft)
2. Remove the oil drain pan from under the vehicle
3. Lower the vehicle.
4. Fill the engine with new engine oil.
5. Start the engine.
6. Inspect for oil leaks after engine start up.

Engine

Engine Mechanical - 2.0L (LTG) - Schematic and Routing Diagrams

SCHEMATIC WIRING DIAGRAMS

ENGINE MECHANICAL WIRING SCHEMATICS

Engine Oil Level (LTG)

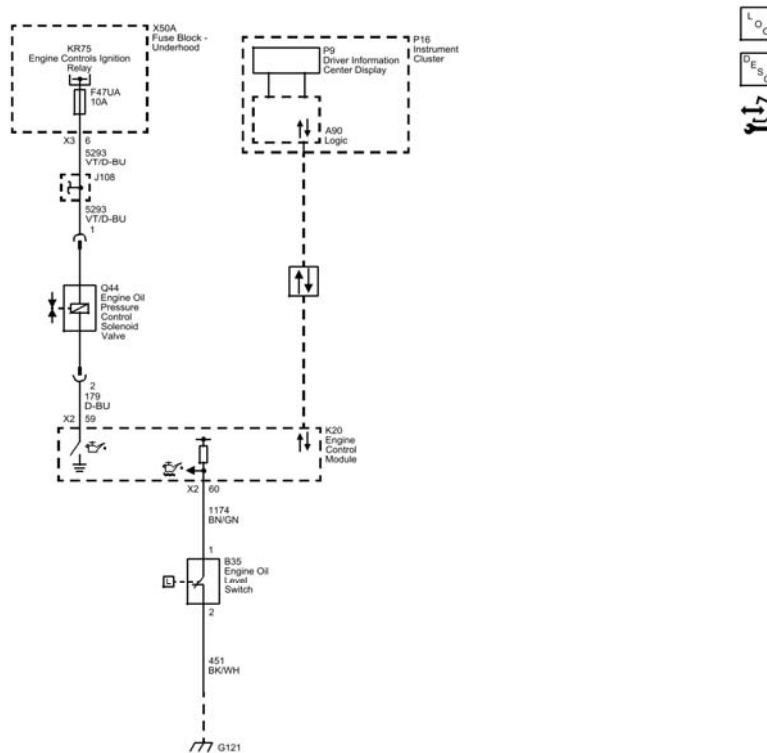


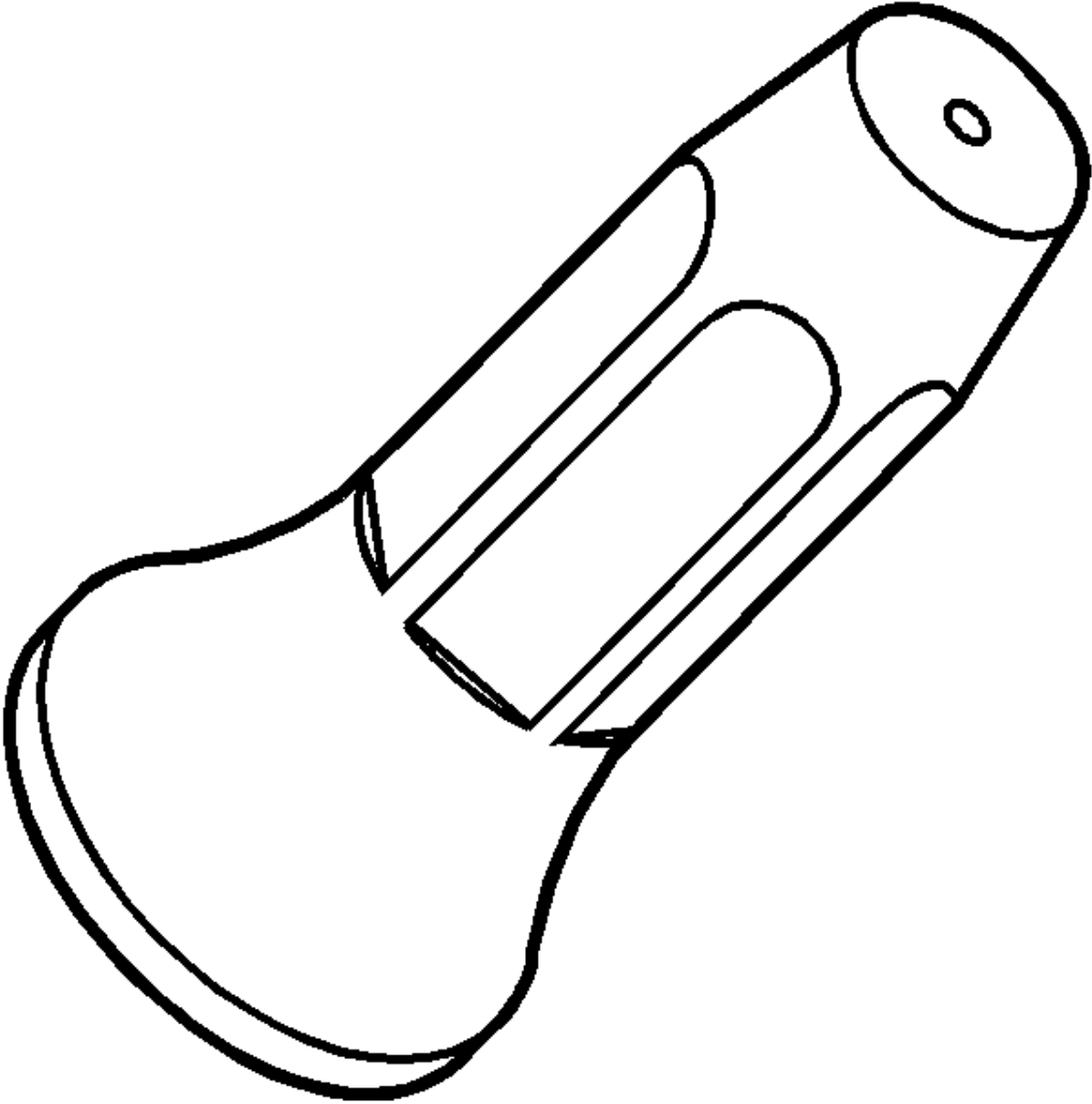
Fig. 1: Engine Oil Level (LTG)
Courtesy of GENERAL MOTORS COMPANY

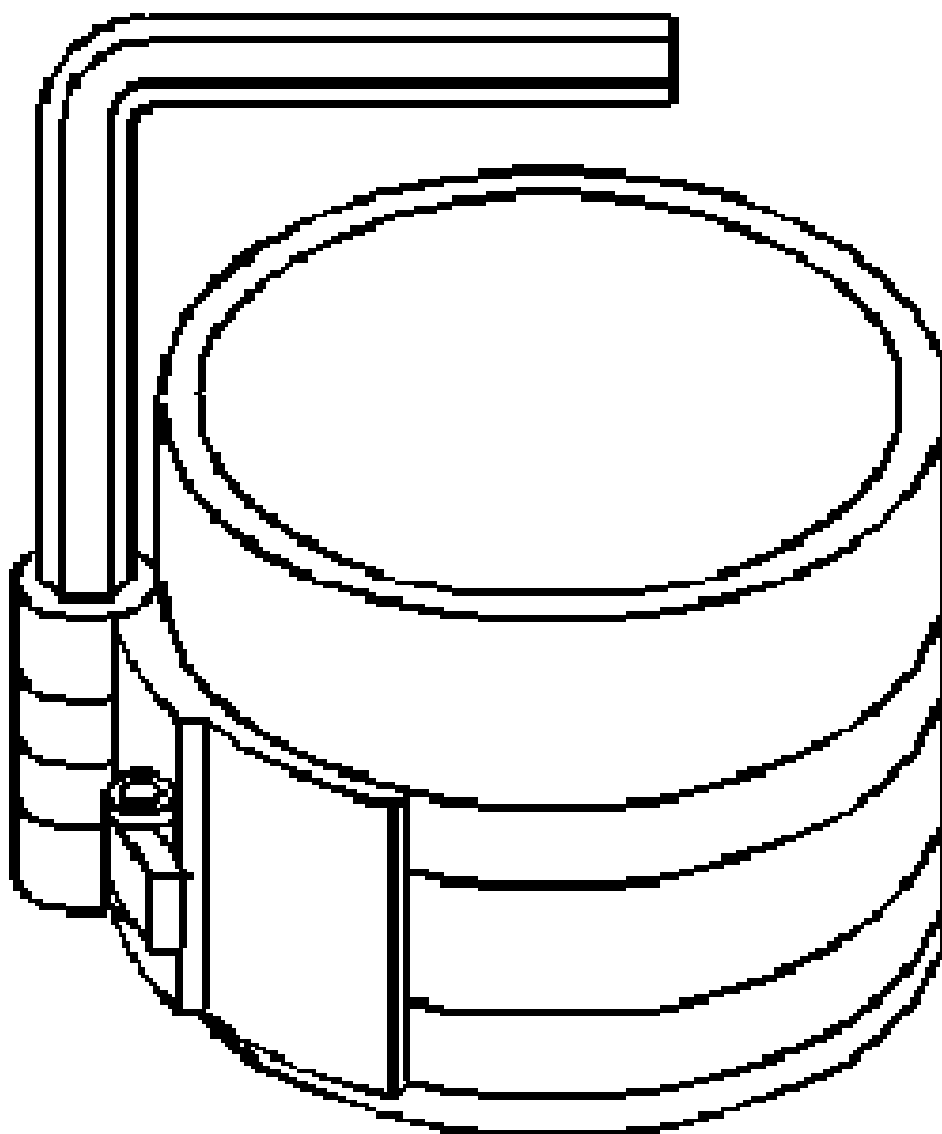
Engine

Engine Mechanical - 2.0L (LTG) - Special Tools and Equipment

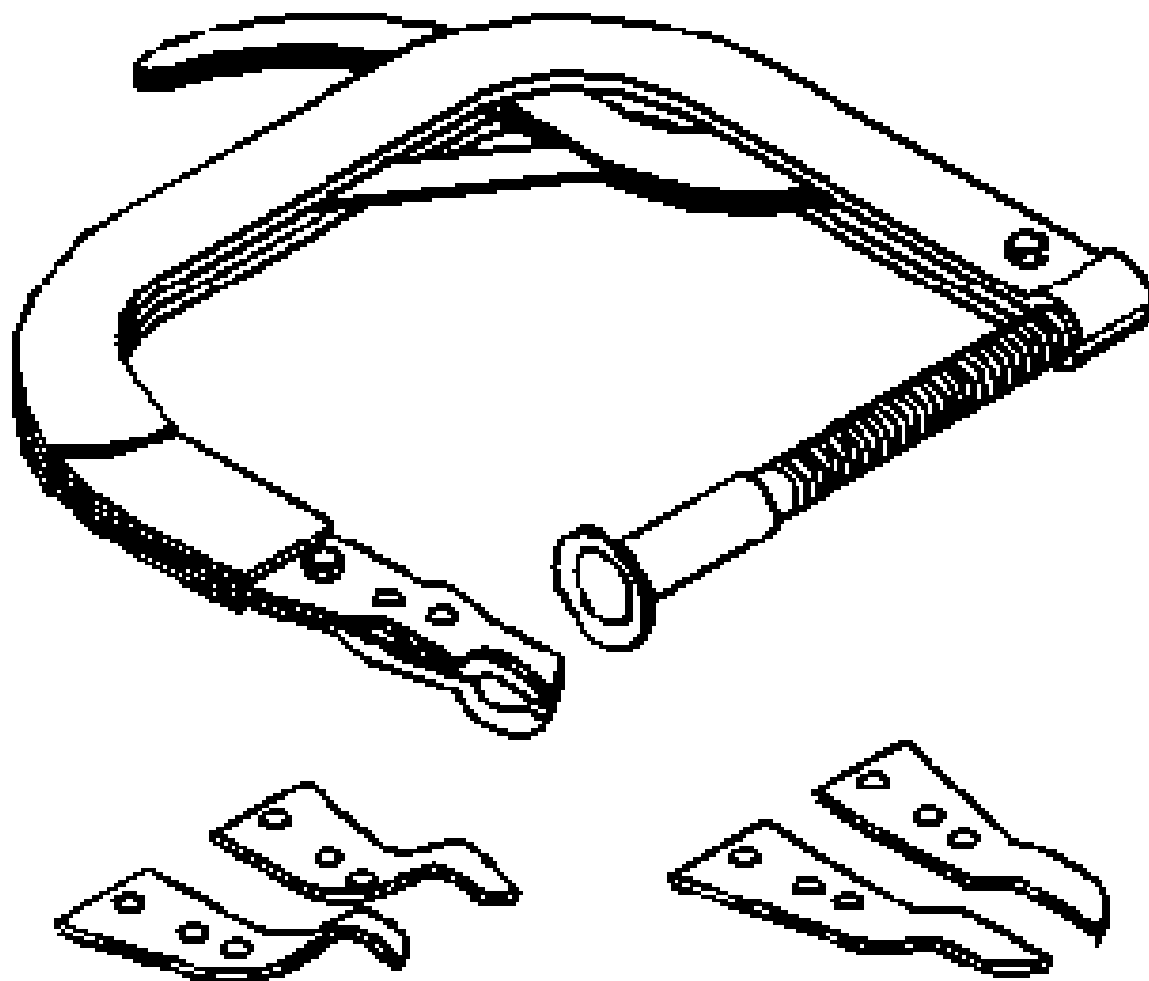
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

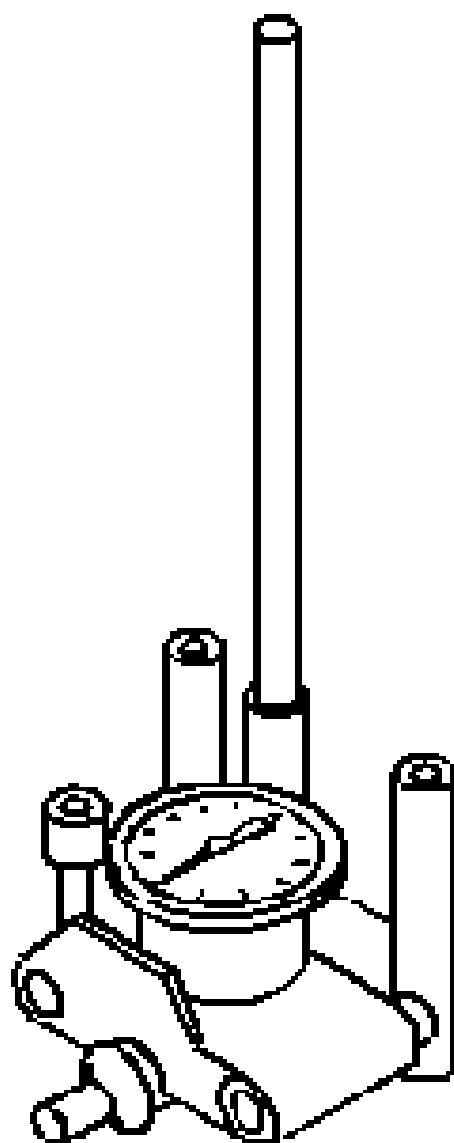
Illustration	Tool Number/Descrip
	DT-45866 J-45866 Input Shaft Seal Installer



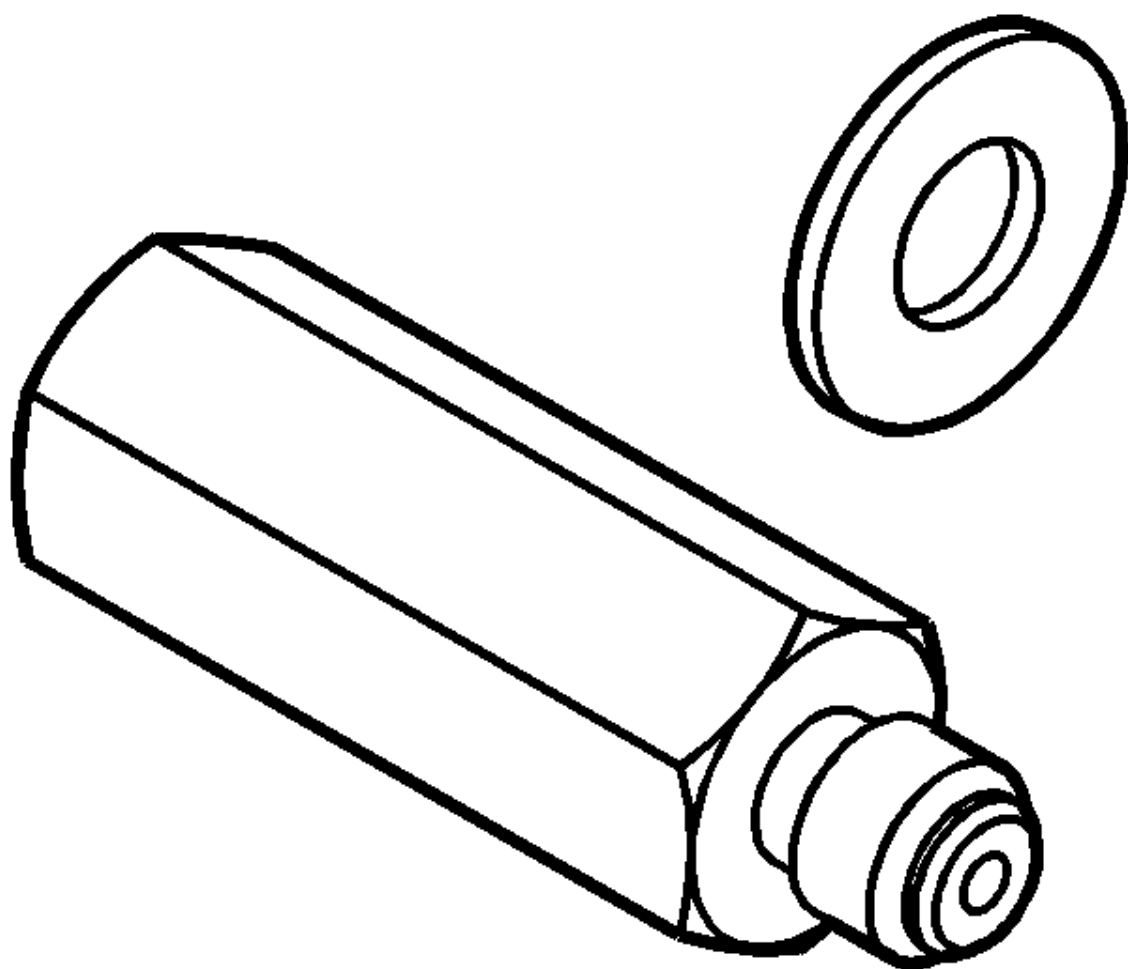
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J-8037
Ring Compressor



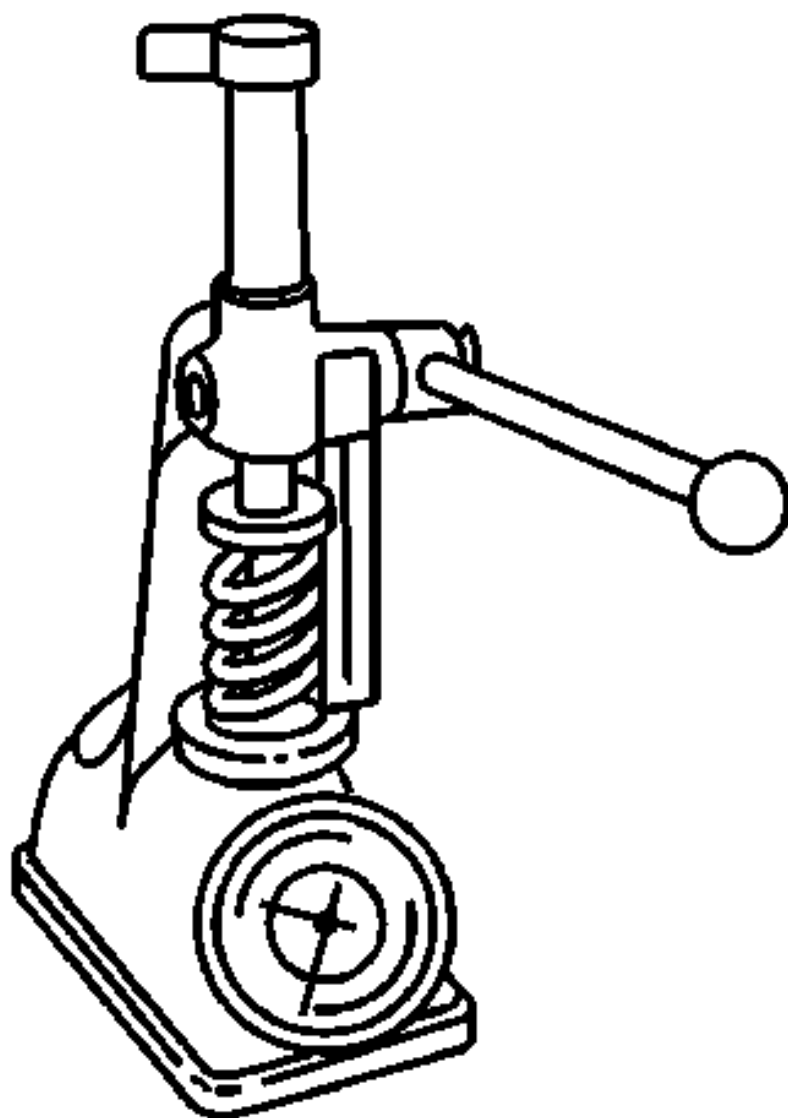
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J-8062
KM-348
Valve Spring
Compressor - Hc
Off



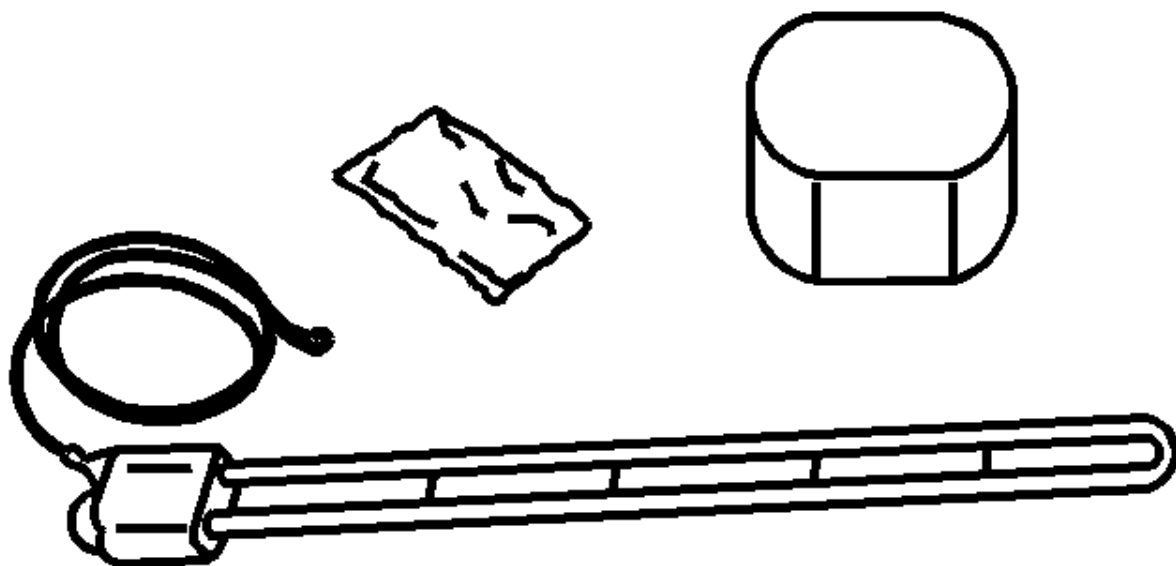
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J-8087
Cylinder Bore Ga



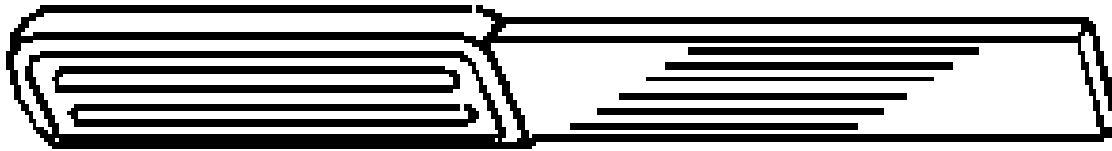
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KM-498-B
KM-6106
83 93 852
Oil Pressure Gau
Adapter



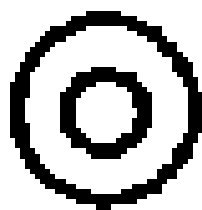
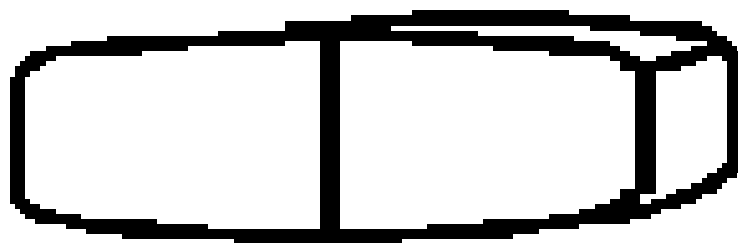
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GE-22738-B
J-22738-B
J-9666
Valve Spring Tes



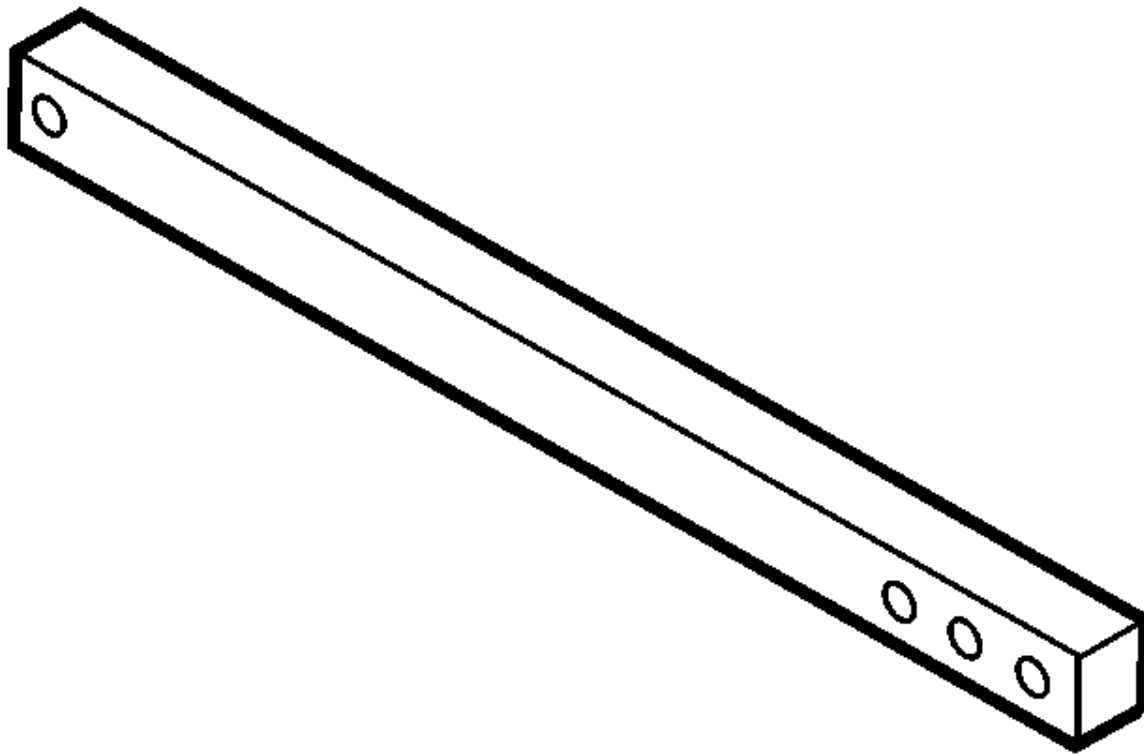
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Valve Manomet



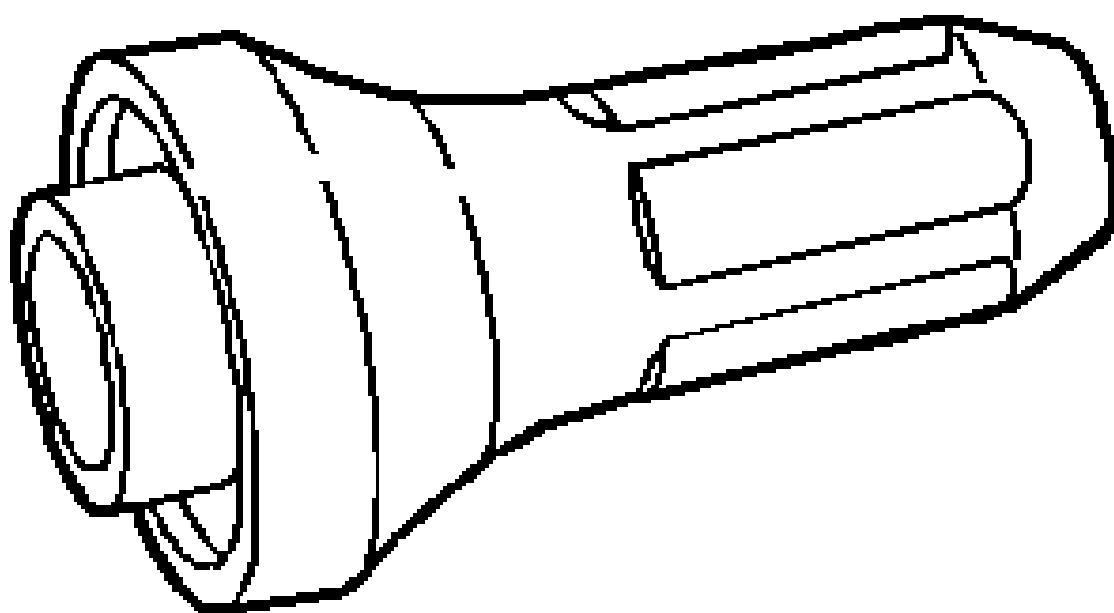
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J-28410
Gasket Removal



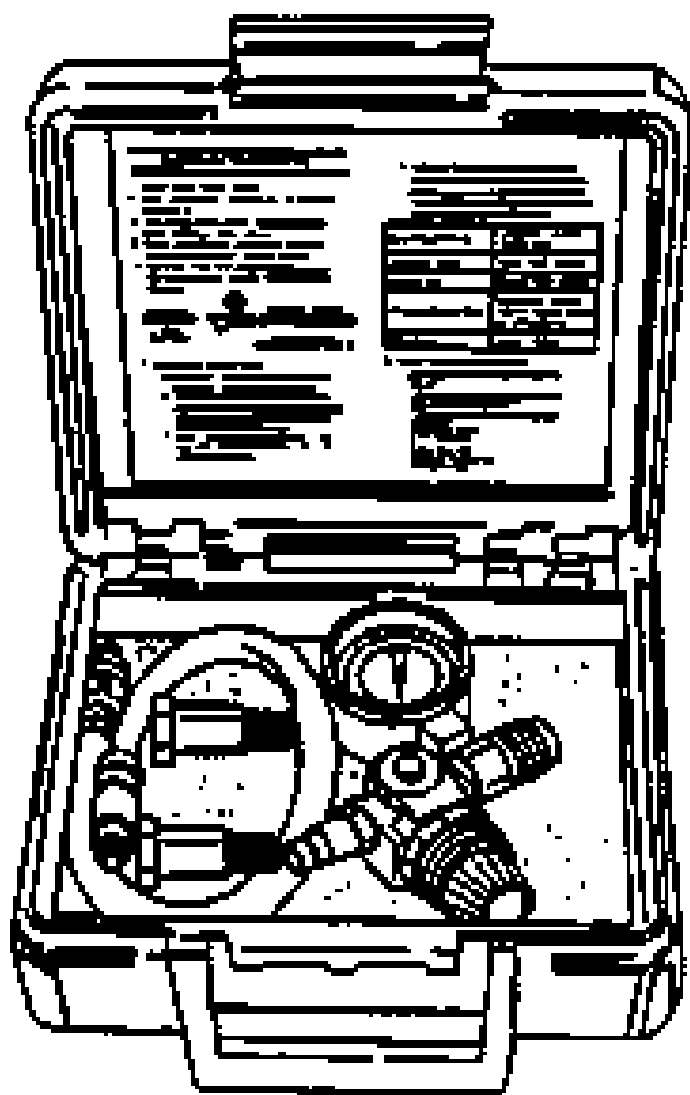
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J-28467-34
Lift Hook Wing]
and Washer



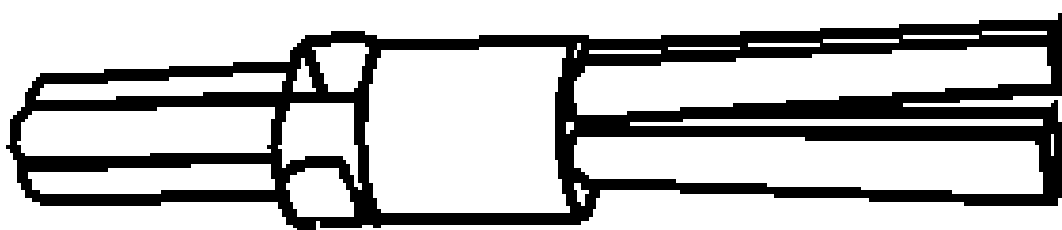
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J-28467-518
Engine Support
Adapter - Main
Support Beam



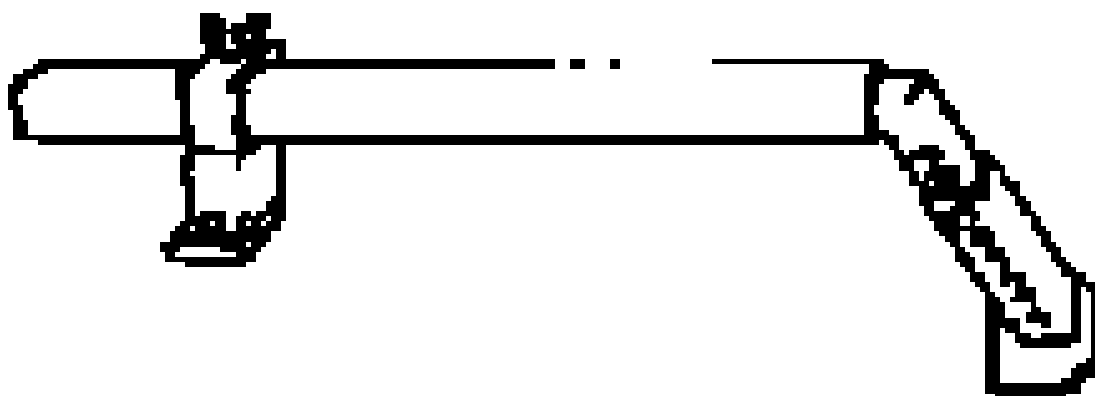
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J-34115
Sprocket Bearing
Installer



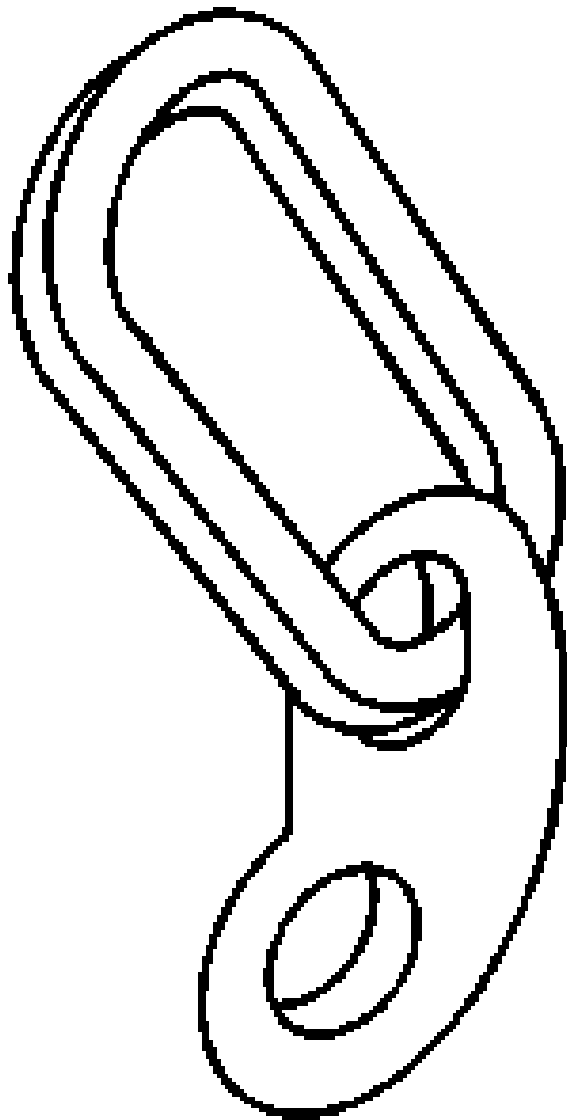
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J-35667-A
Cylinder Head
Leakdown Test



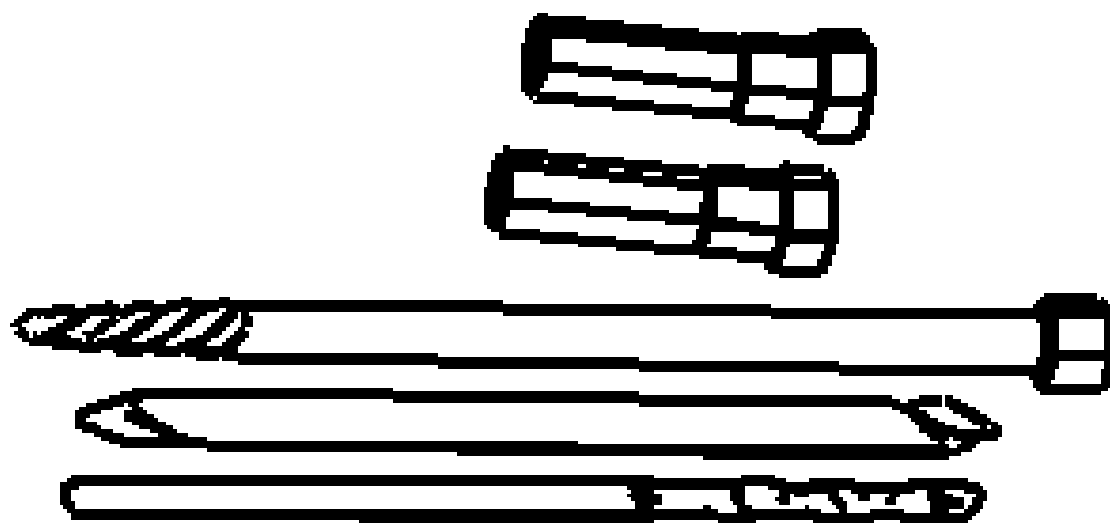
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J-36017
KM-840 - Remo
KM-6152 -
Installation
Valve Seal Remo



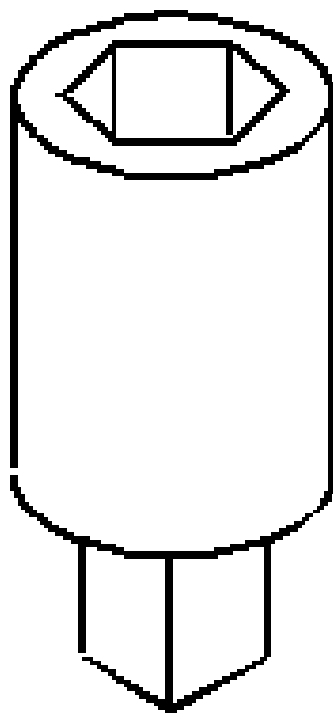
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J-36462-A
Engine Support
Adapter Leg Set



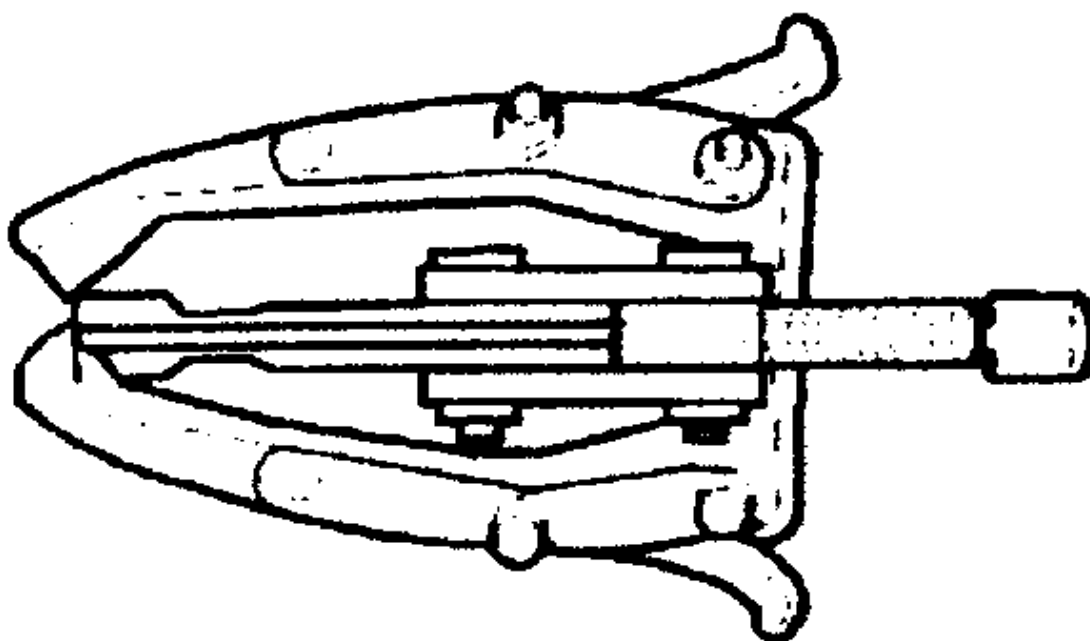
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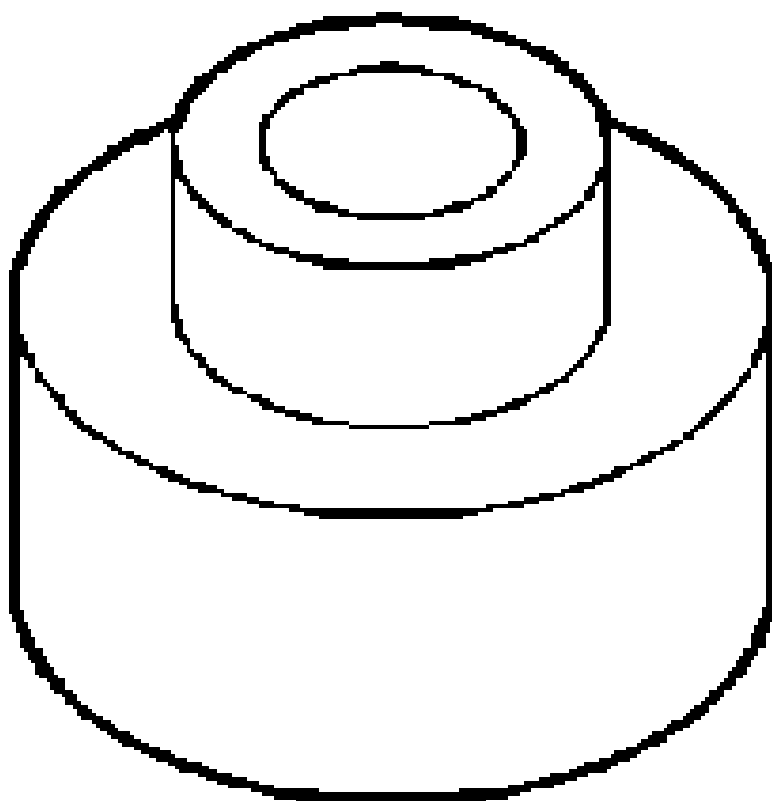
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J-38188
Cylinder Head
Broken Bolt
Extractor Kit



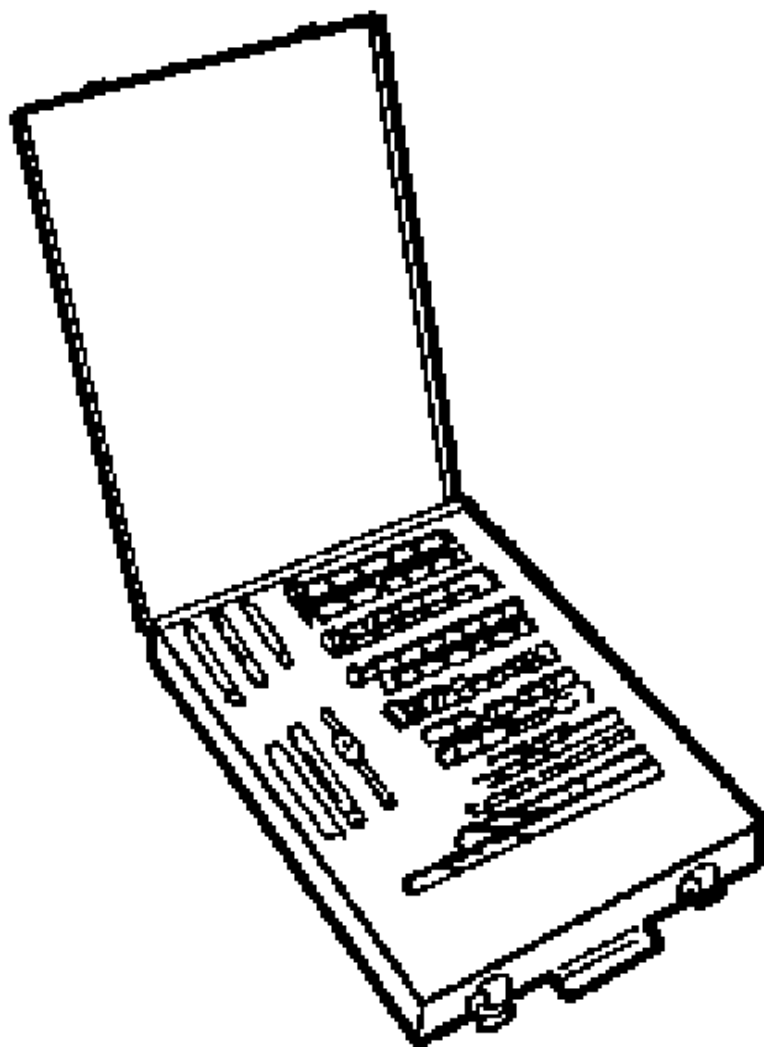
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J-39358
83 94 785
Spark Plug Socket



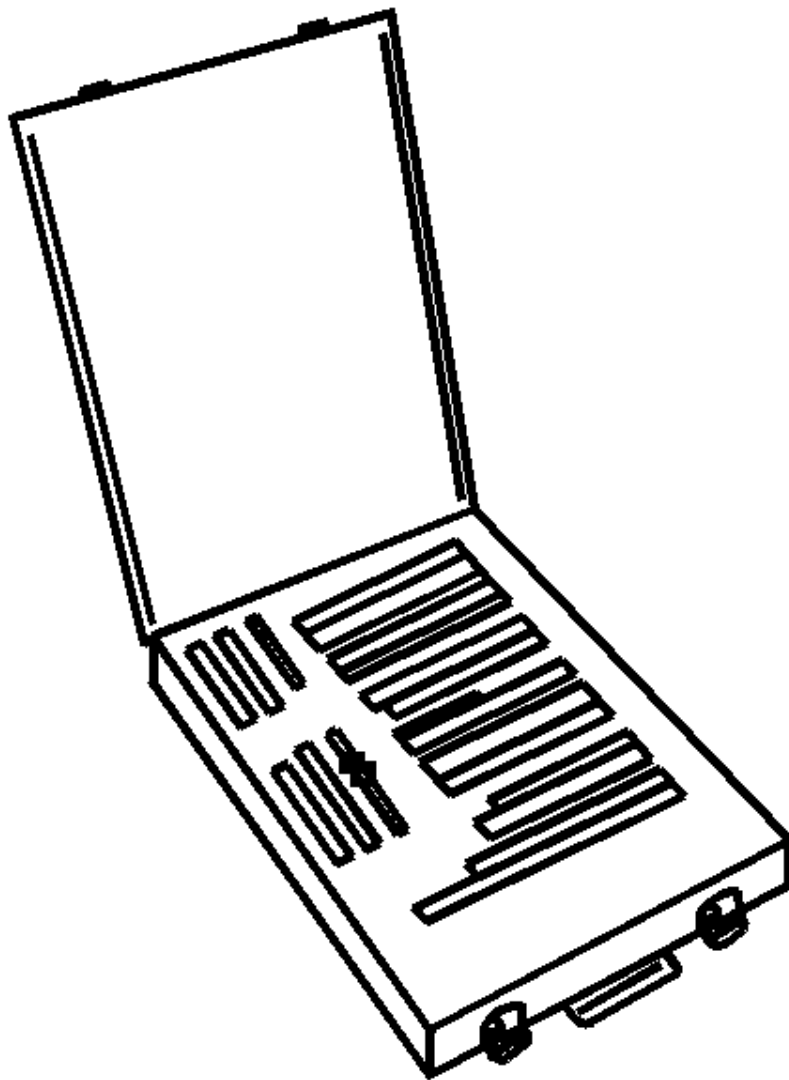
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J-41816
Crankshaft Balan
Remover



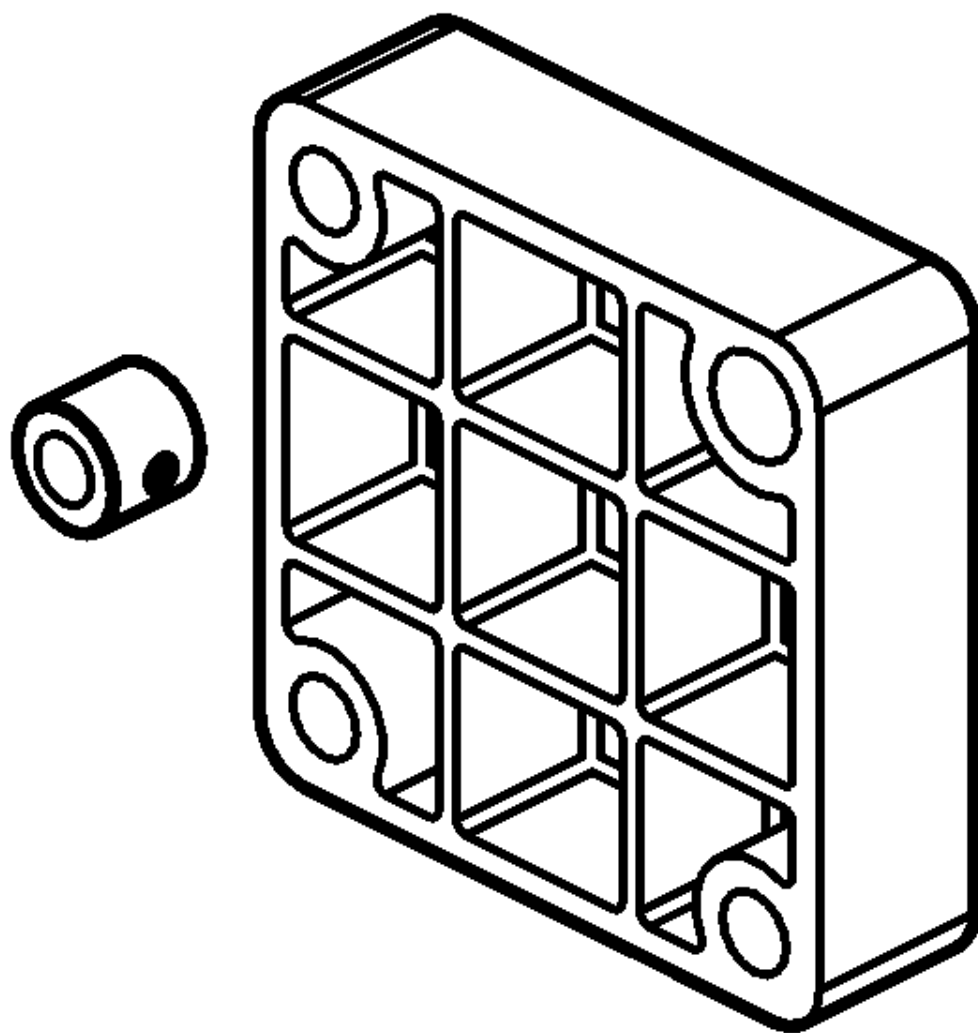
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J-41816-2
Crankshaft End
Protector



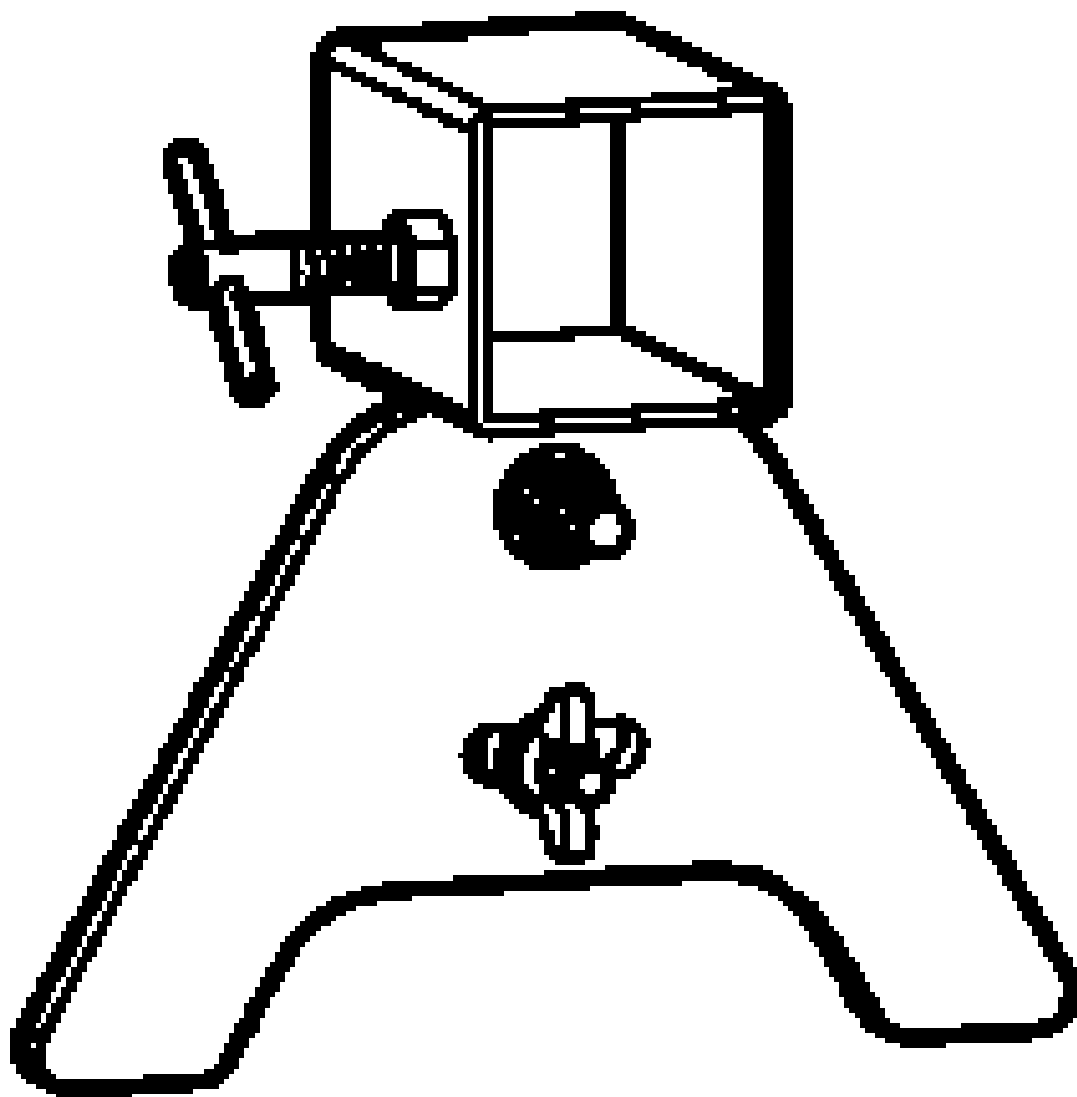
EN-42385-700
J-42385-700
High Feature Thr
Repair Kit



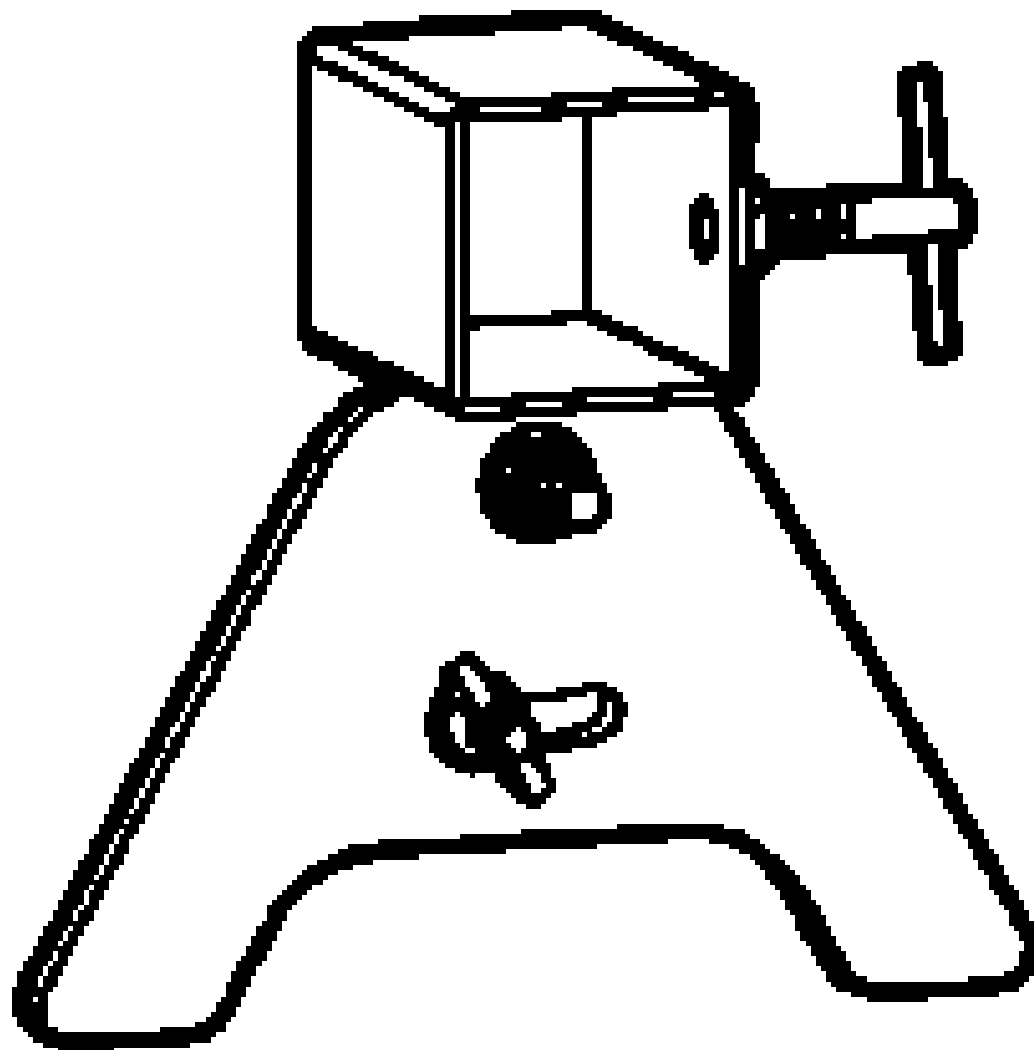
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J-42385-850
Thread Repair Kit



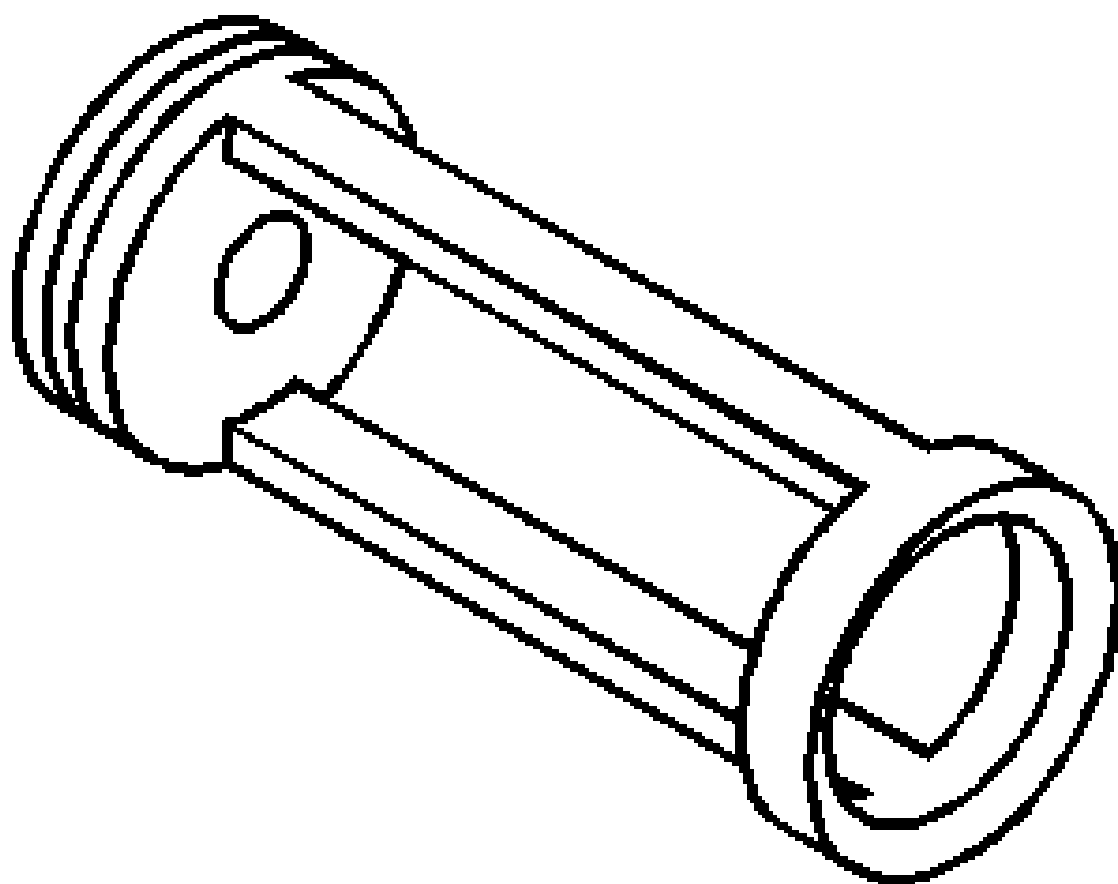
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Head Bolt Thre:
Repair Adapter I



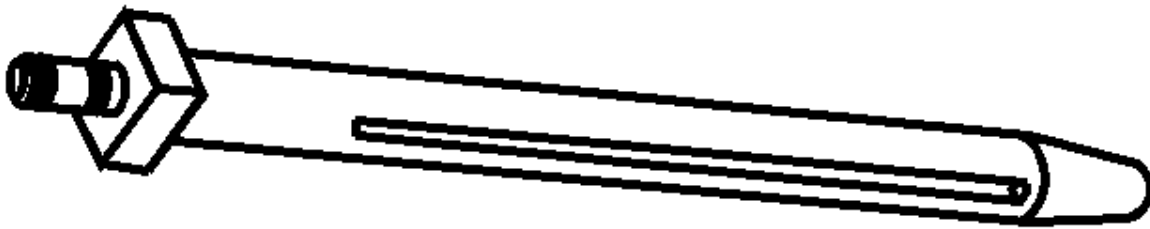
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J-43405-1
Engine Support
Fixture Adapter
Passenger Side



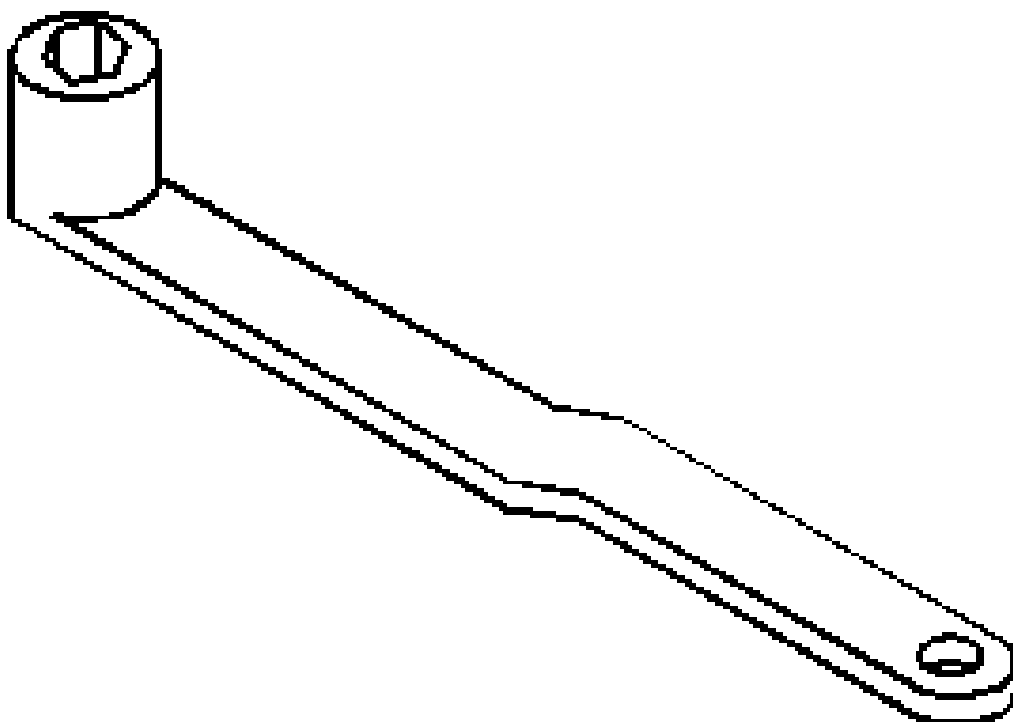
EN-43405-2
J-43405-2
Engine Support
Fixture Adapter
Driver Side



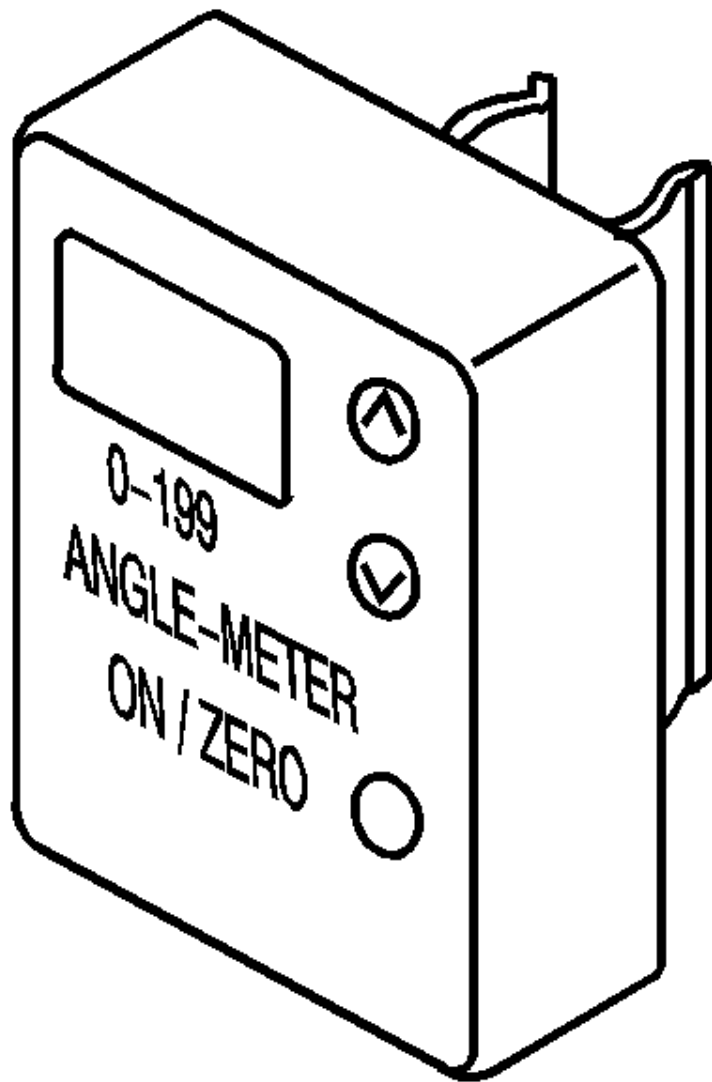
EN-43963
J-43963
KM-6149
Valve Spring
Compressor (off)



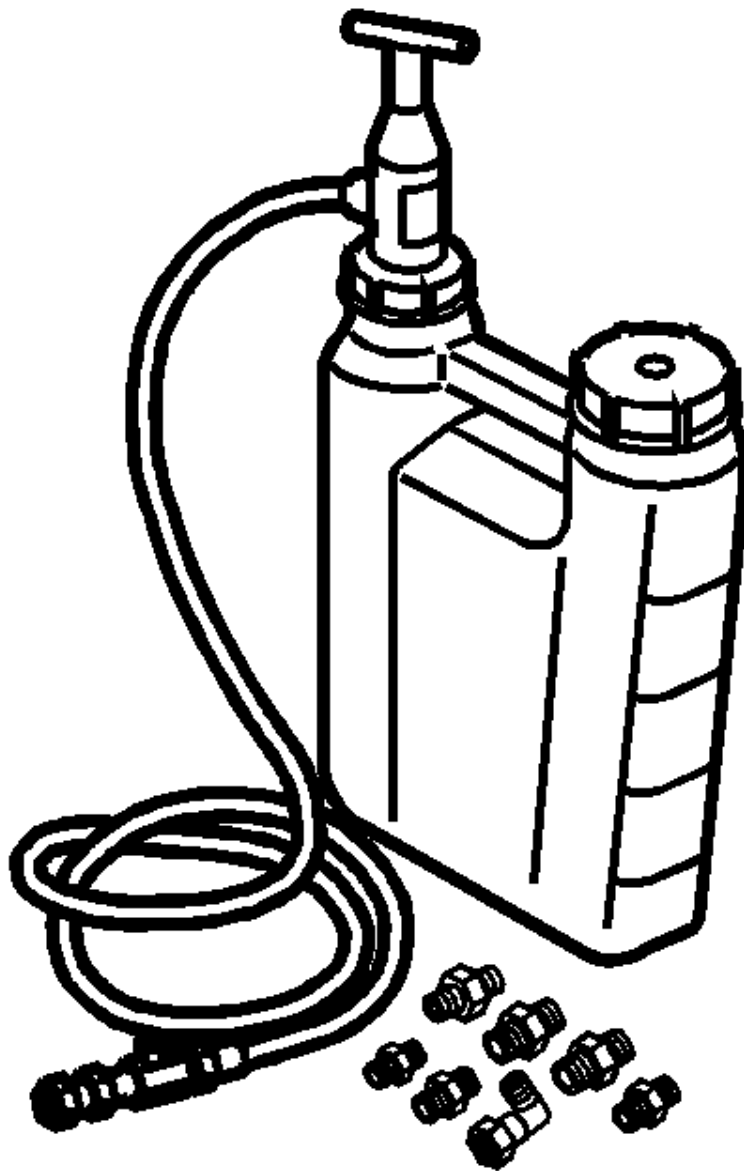
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J-43966-1
Connecting Ro
Guides



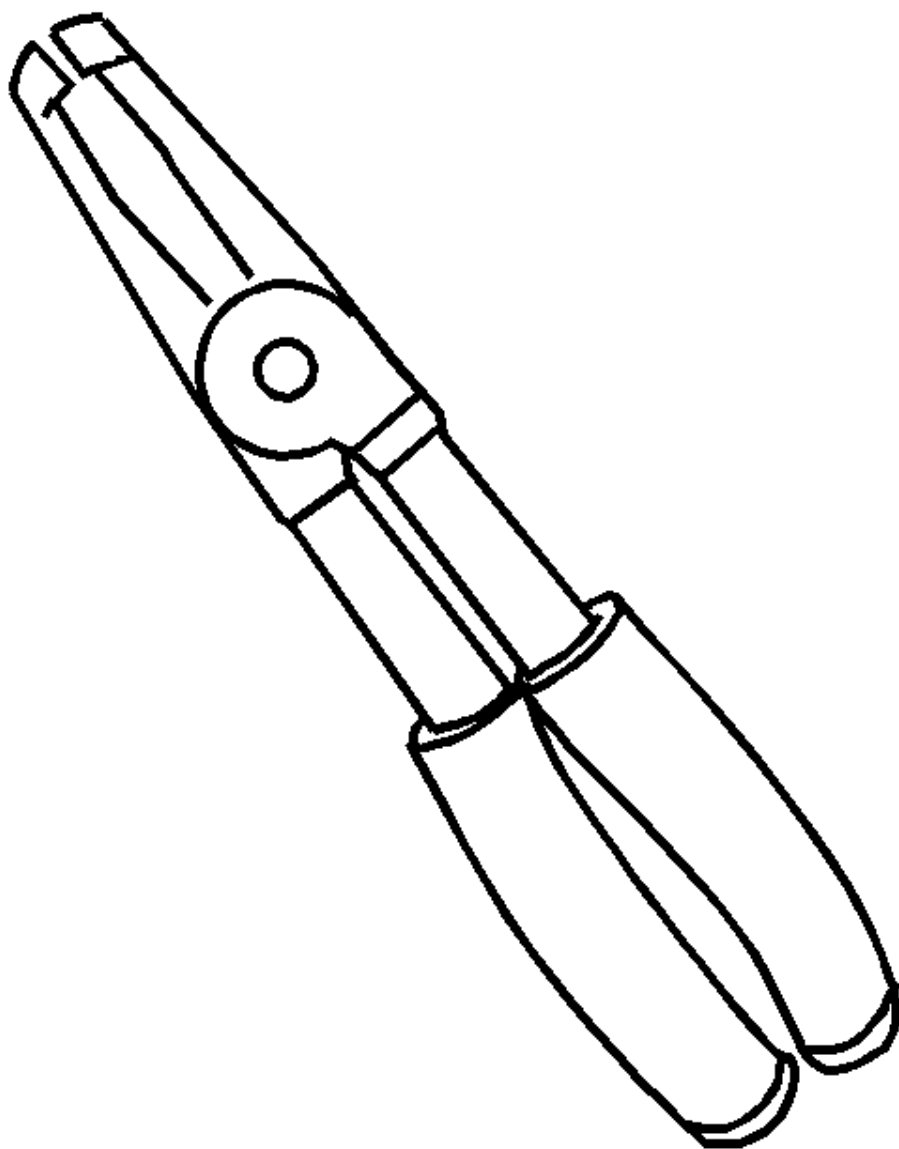
EN-45025
J-45025
Belt Tensioner
Wrench



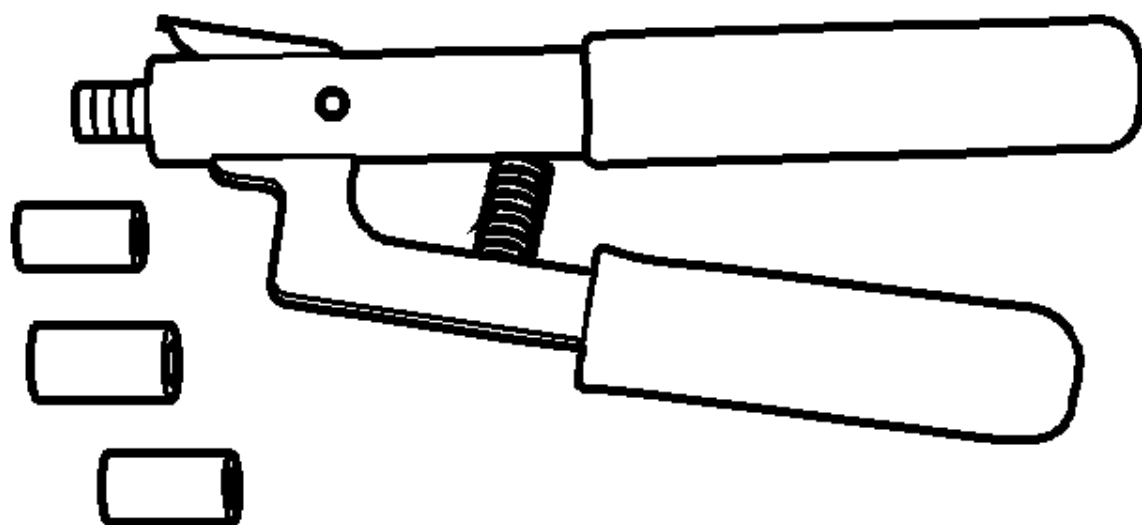
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J-45059
Angle Meter



EN-45299
J-45299
Engine Pre-Lub

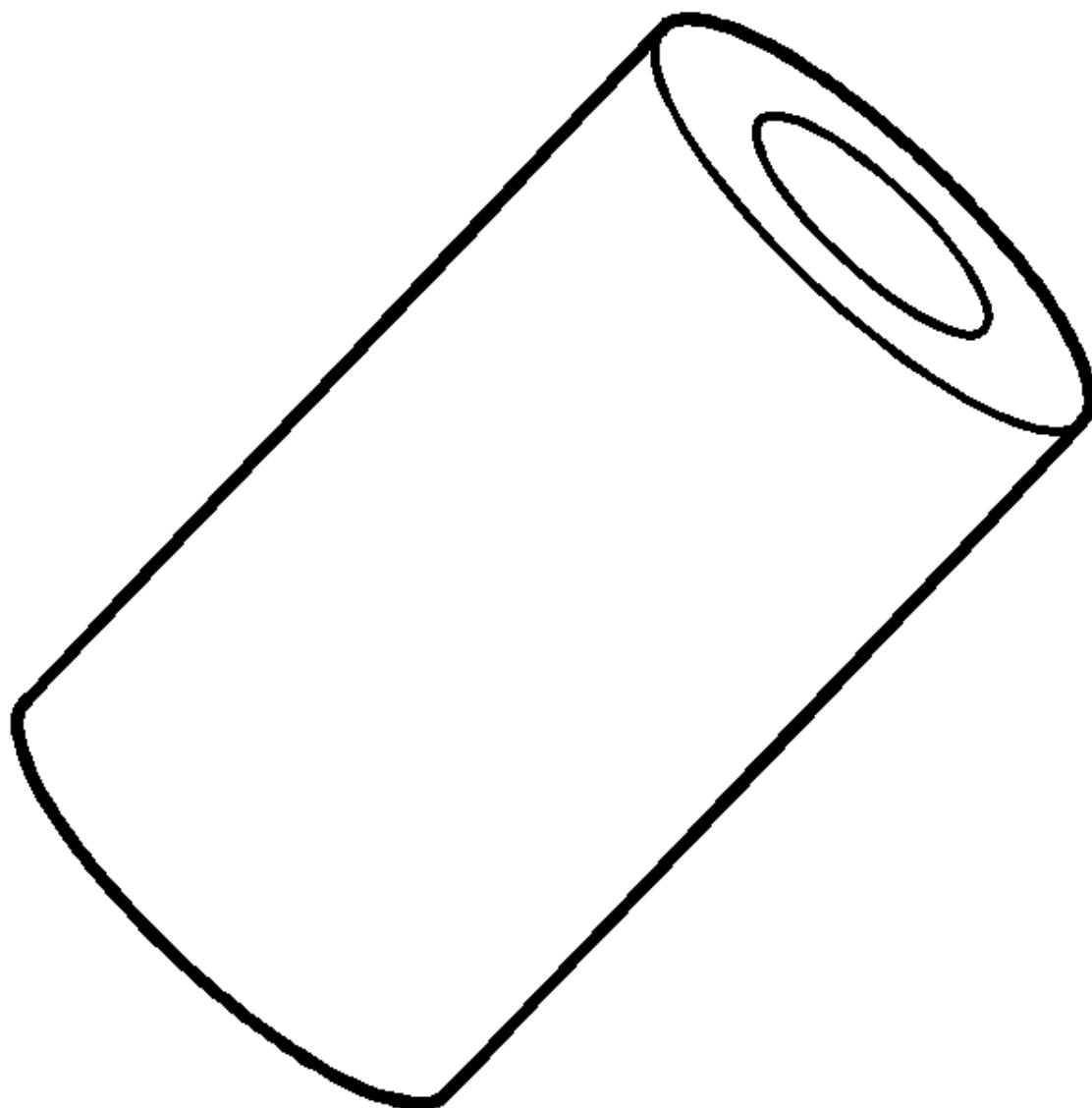


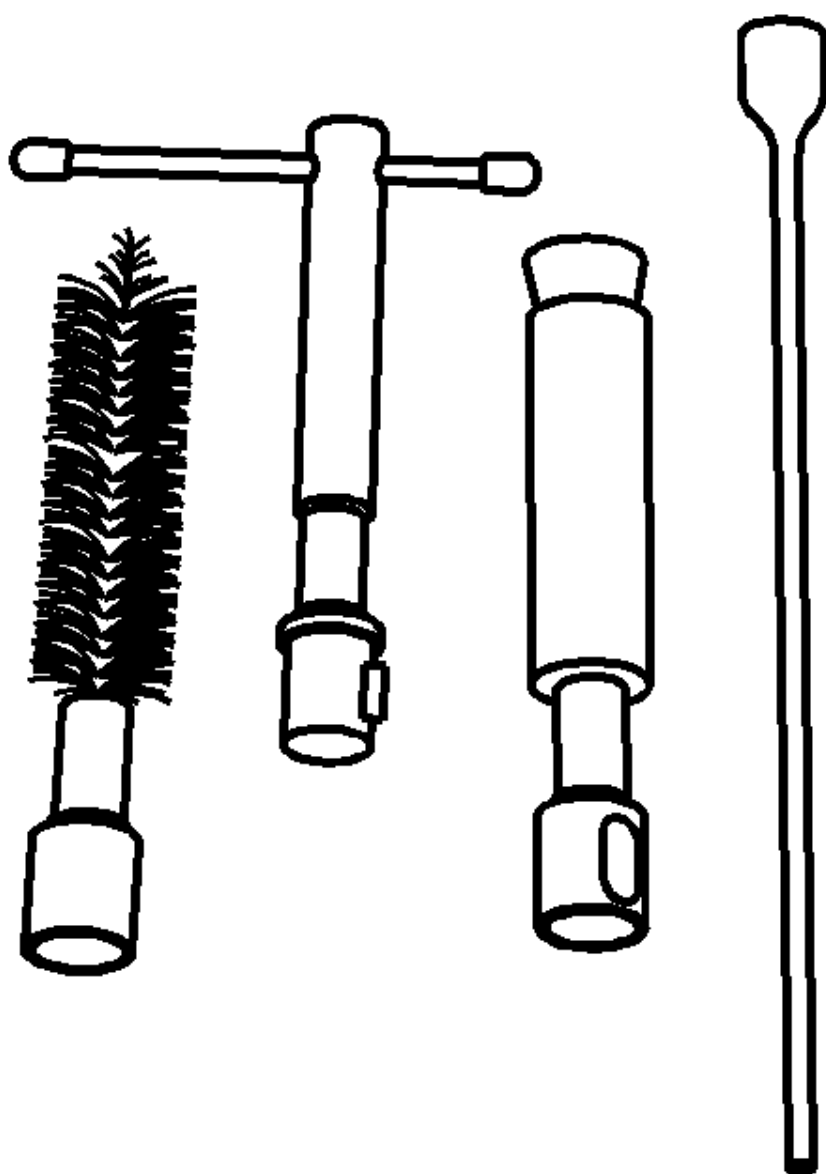
EN-46116
Valve Stem Seal
Remover



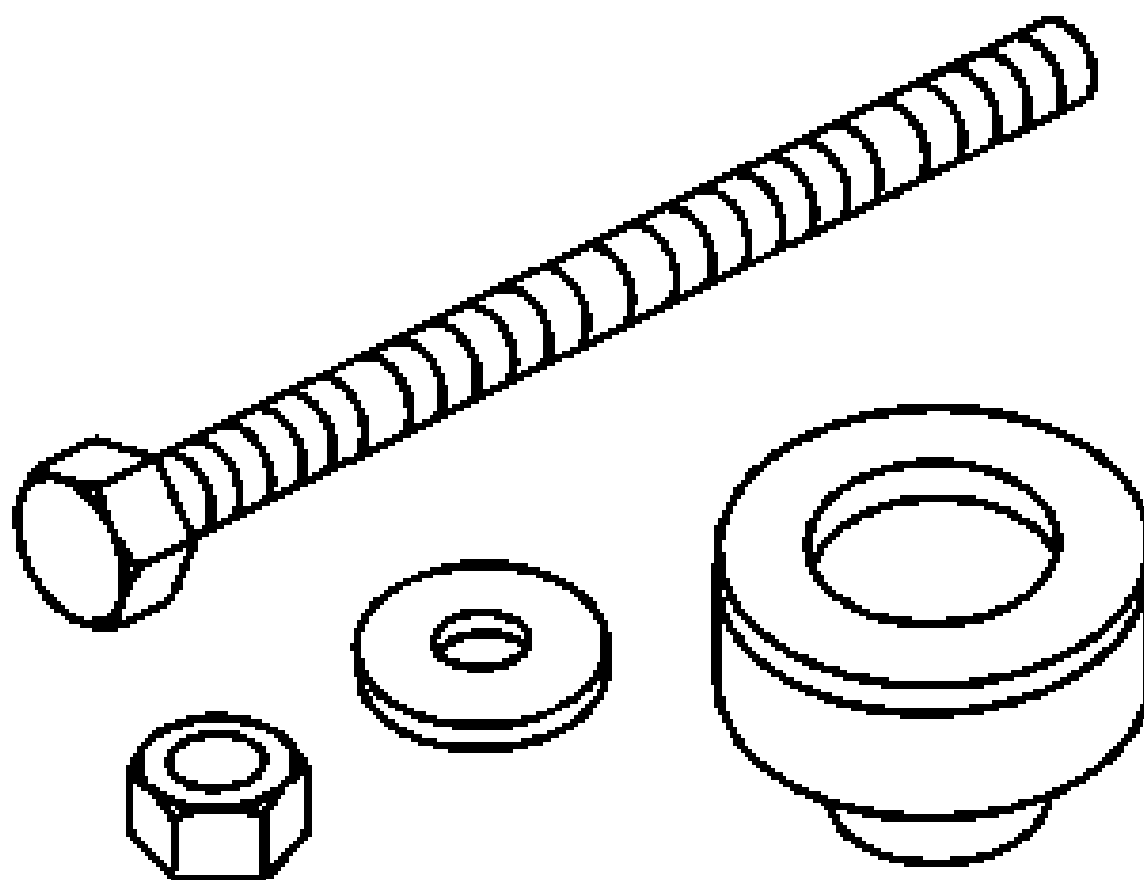
EN-46745
J-43654
Piston Pin Clip
Remover/Install

EN-46745-4
Piston Pin Clip
Remover/Install
Adapter

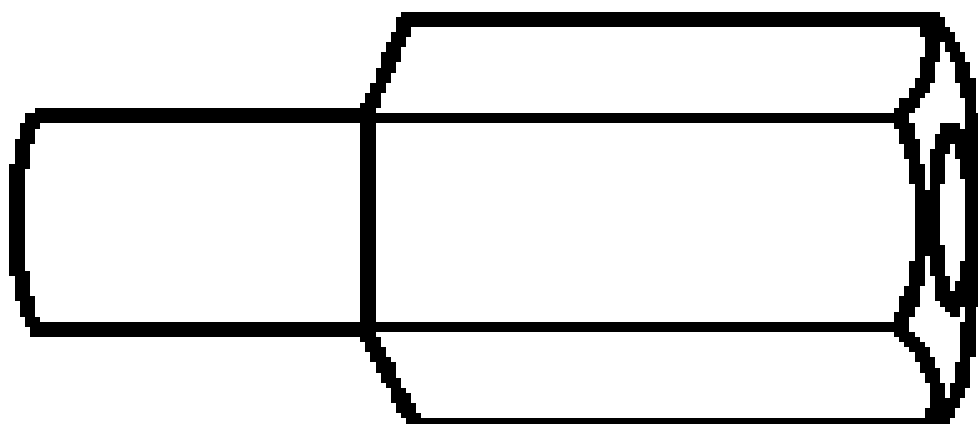
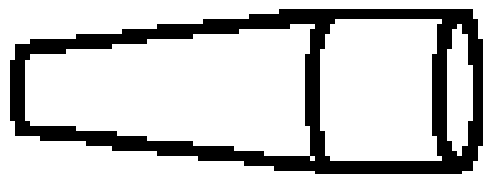




EN-47909
Injector Bore and
Sleeve Cleaning

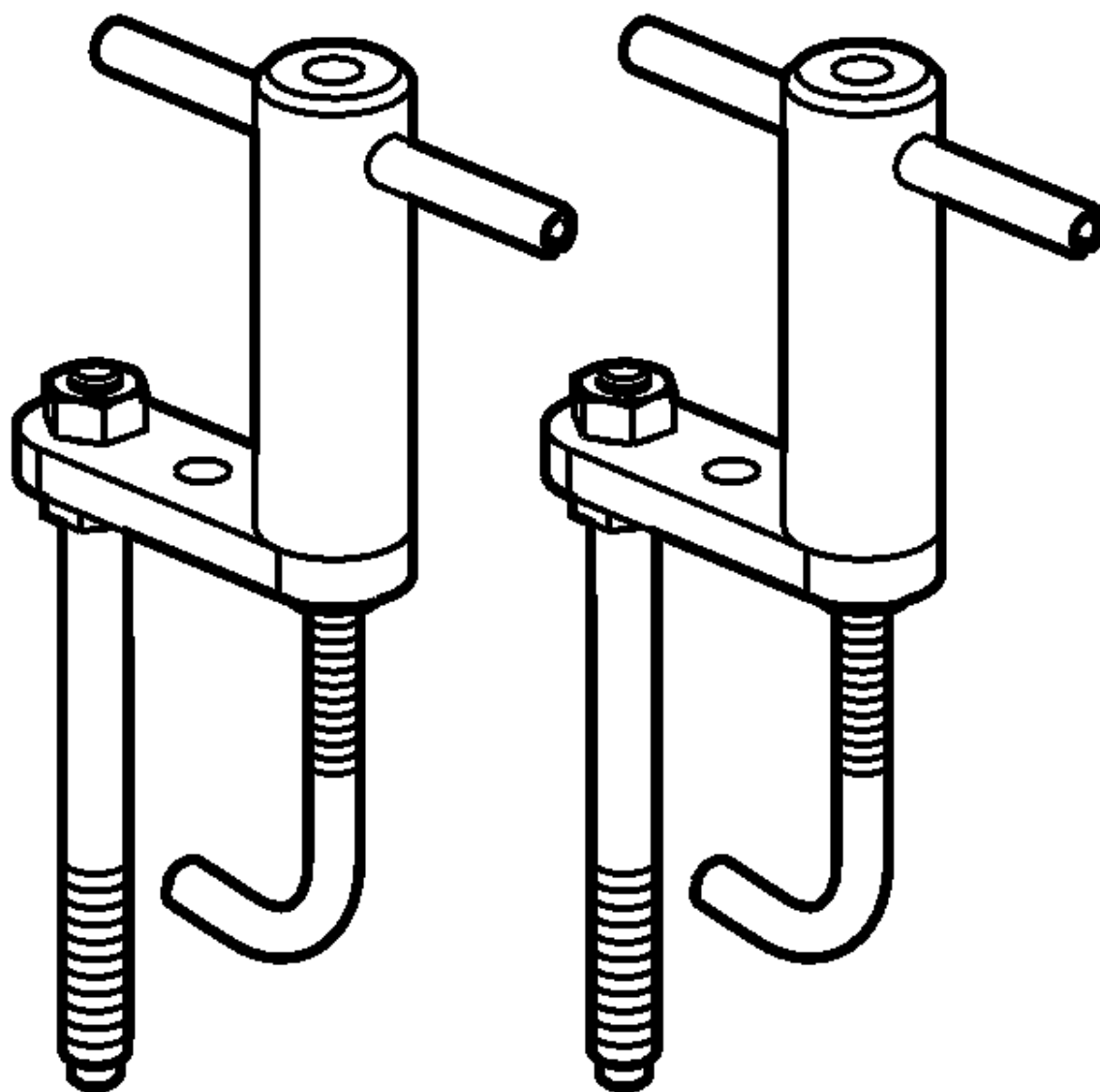


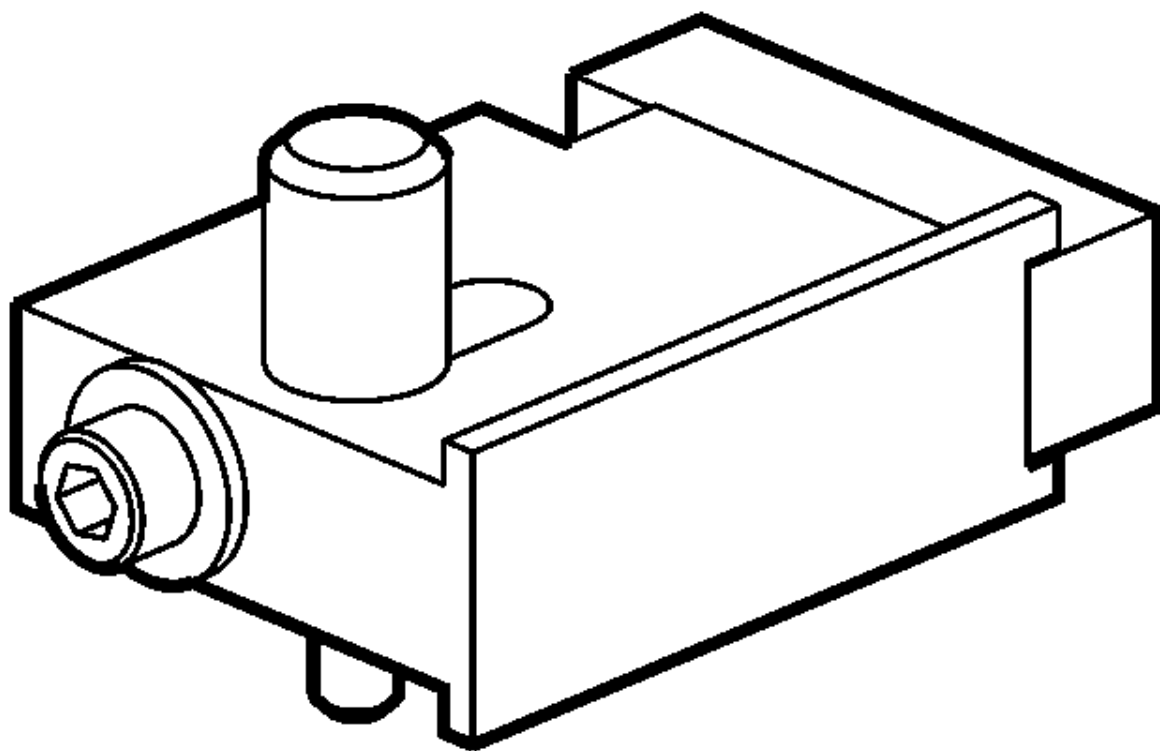
EN-48034
Crankshaft Balan
Installer



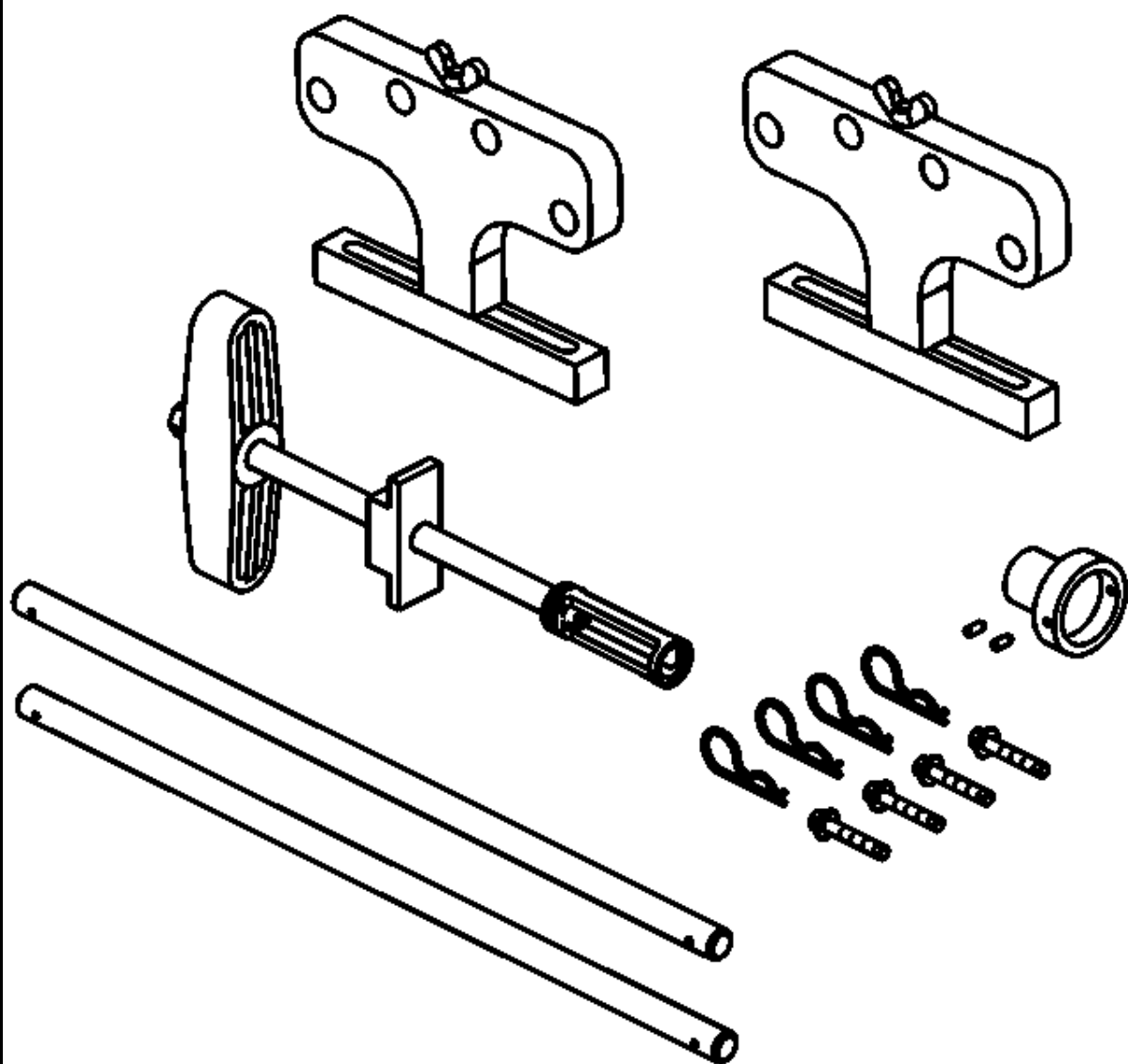
EN-48266
Injector Seal Inst:
and Sizer

EN-49248
Fuel Rail Assem
Remover





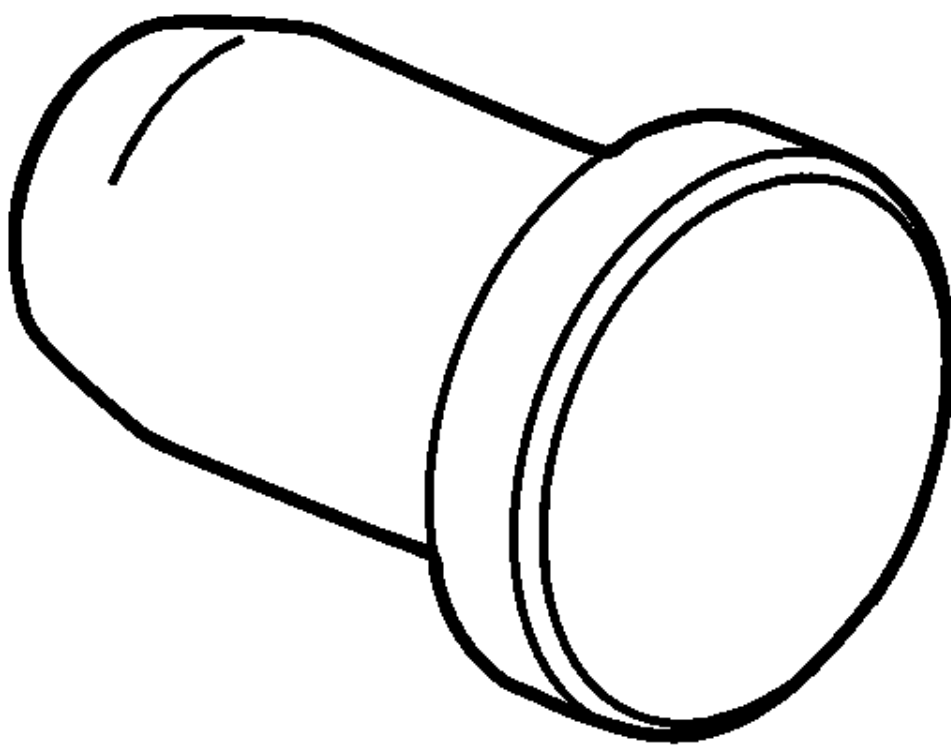
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Timing Chain
Retention Tool I



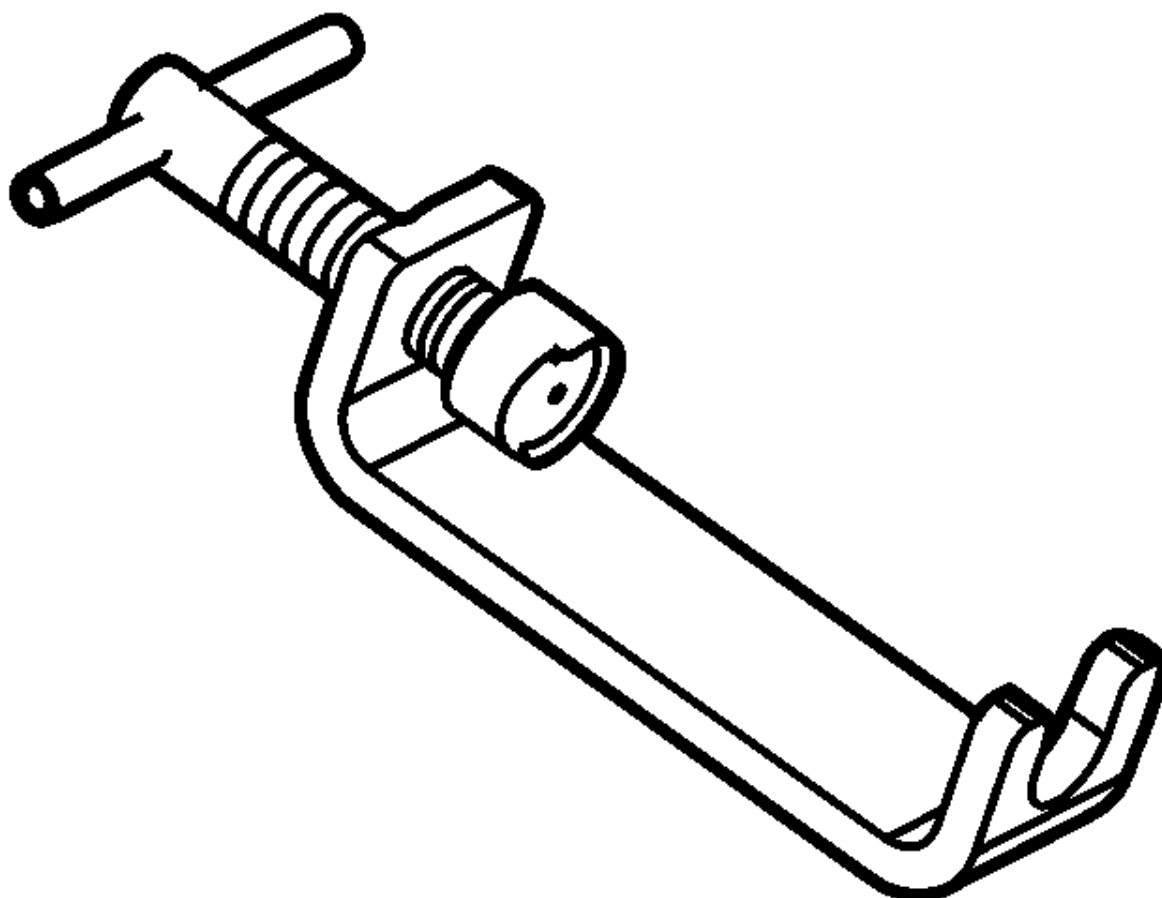
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Valve Spring
Compressor



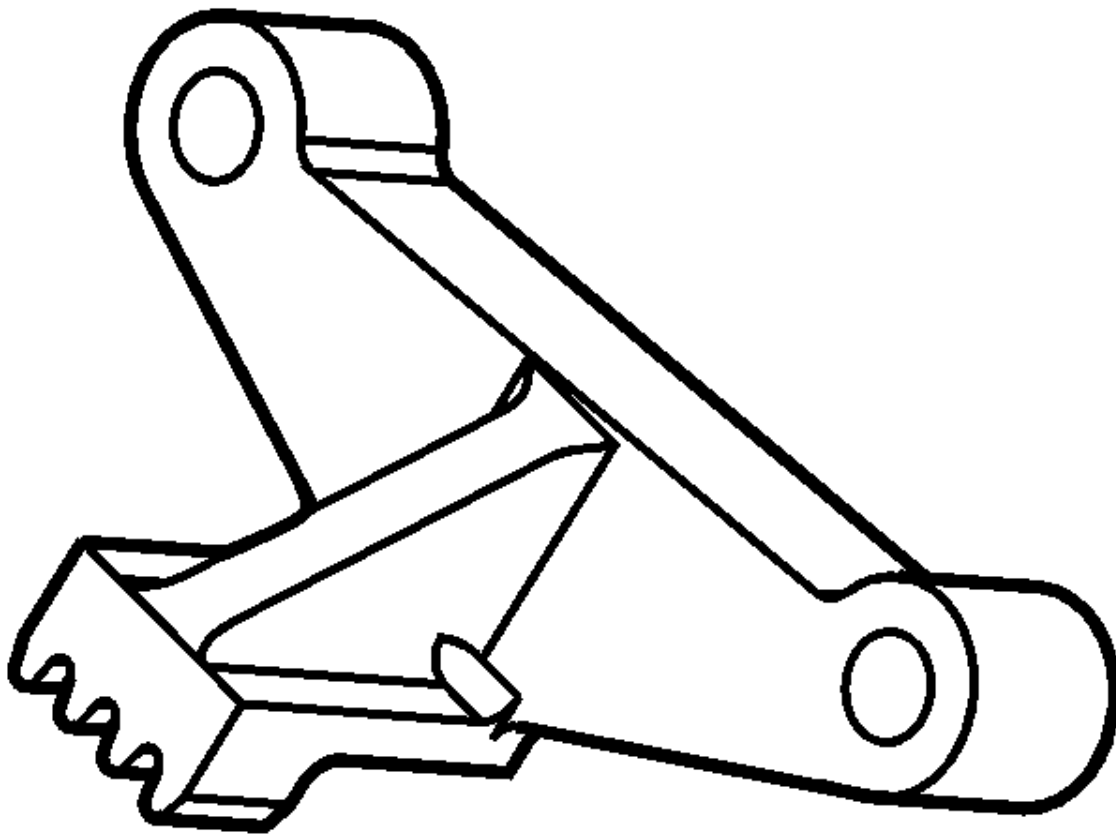
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Valve Spring
Compressor Adaj



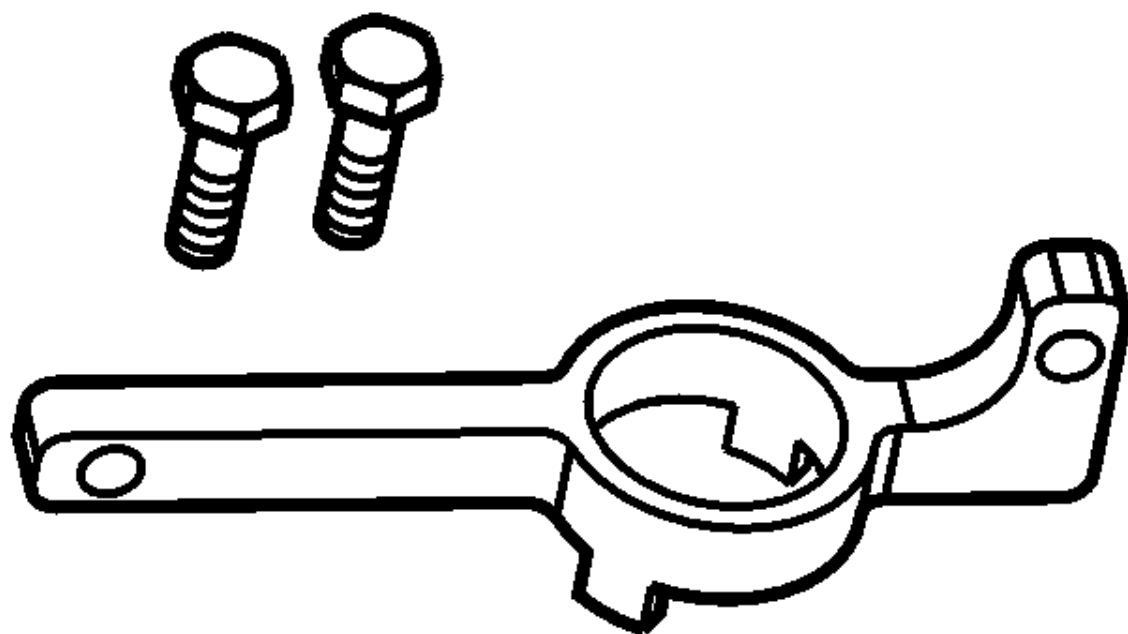
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High Pressure Fitting
Pump Installation
Alignment Gauge



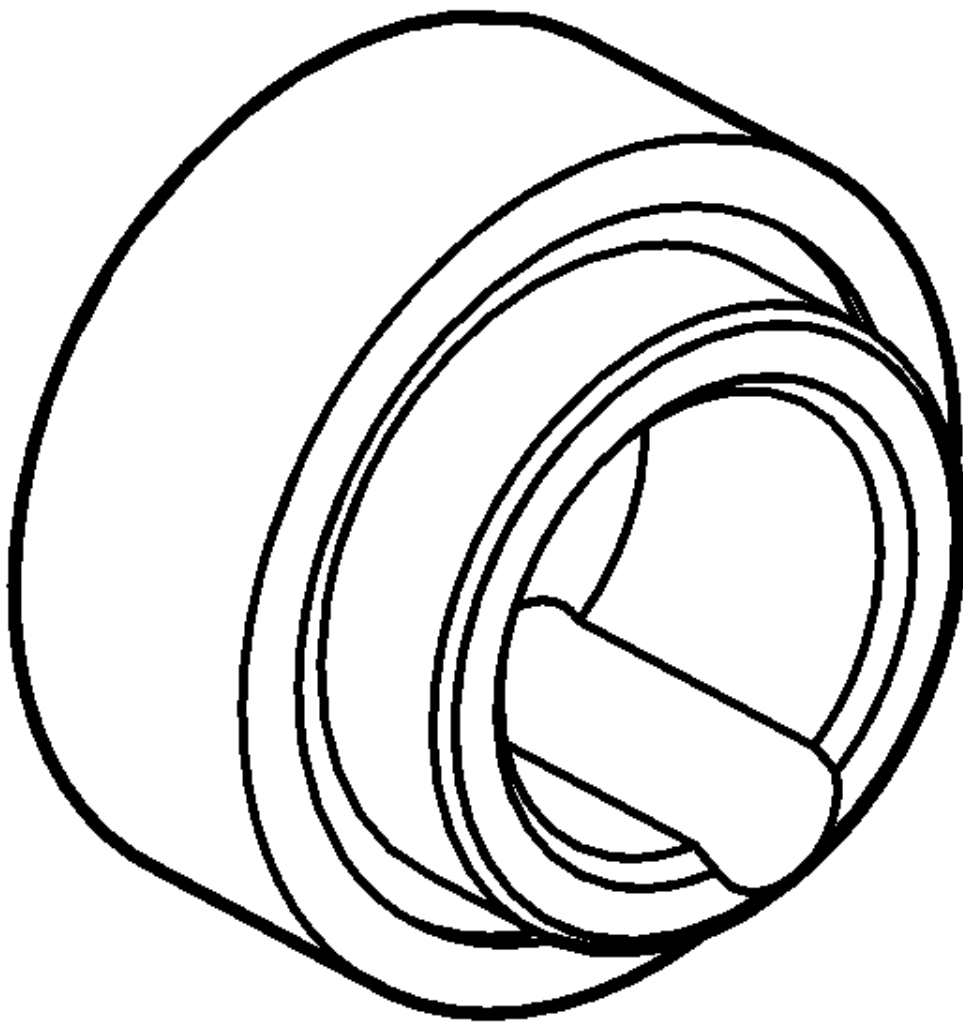
EN-50791
Fuel Injector Noz
Installer - to Ra



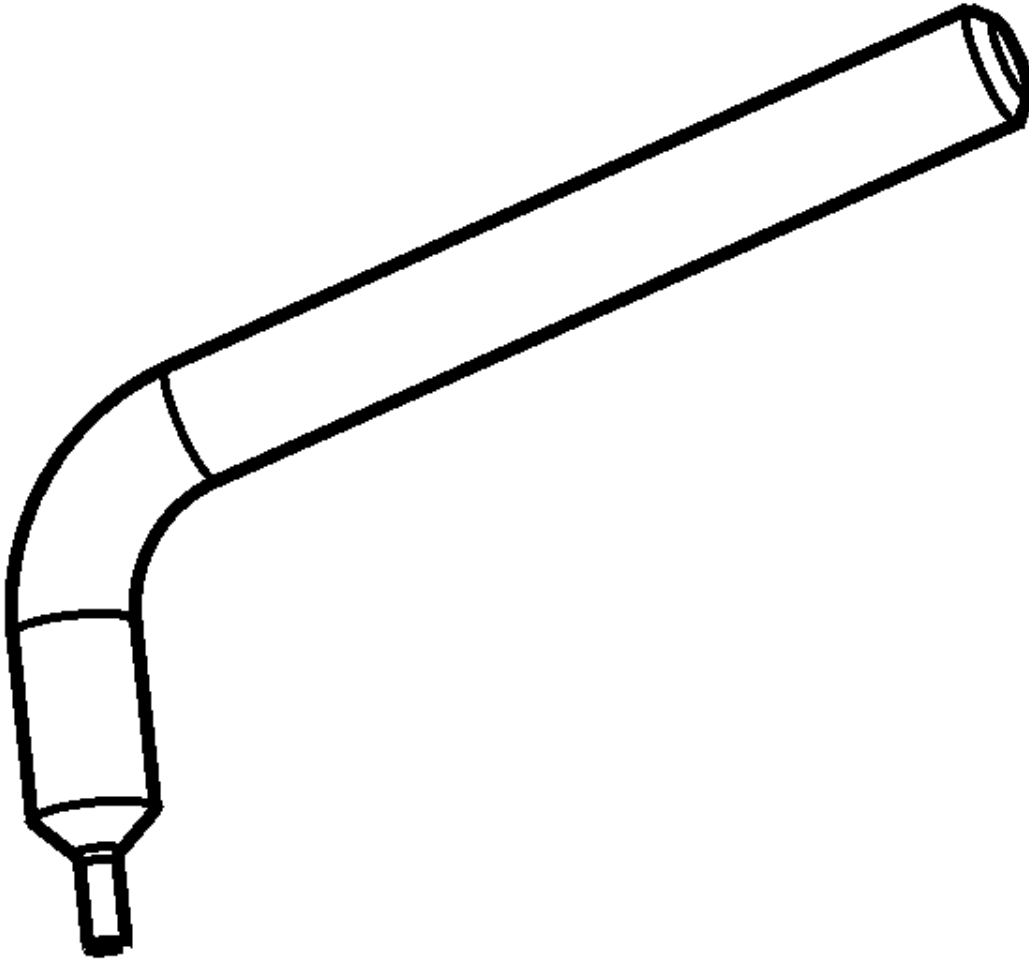
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Flywheel Holding
Tool



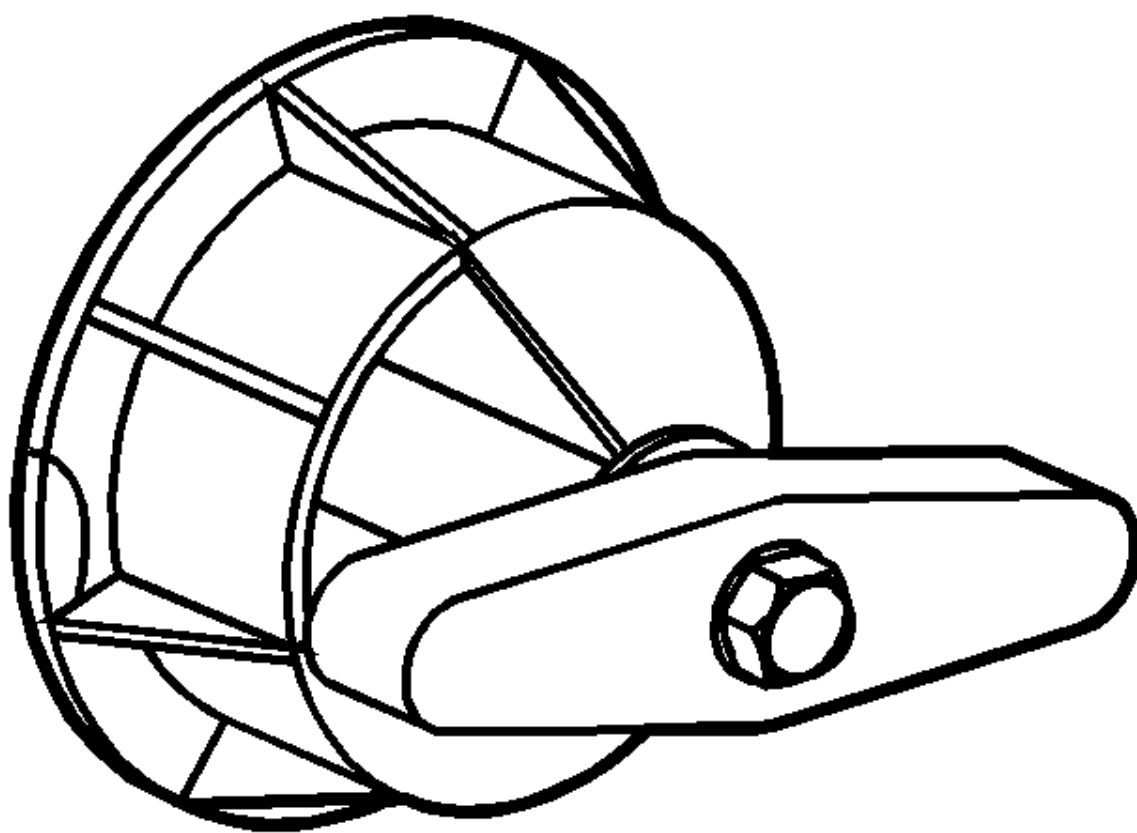
EN-50793
Camshaft Actuator
Locking Tool



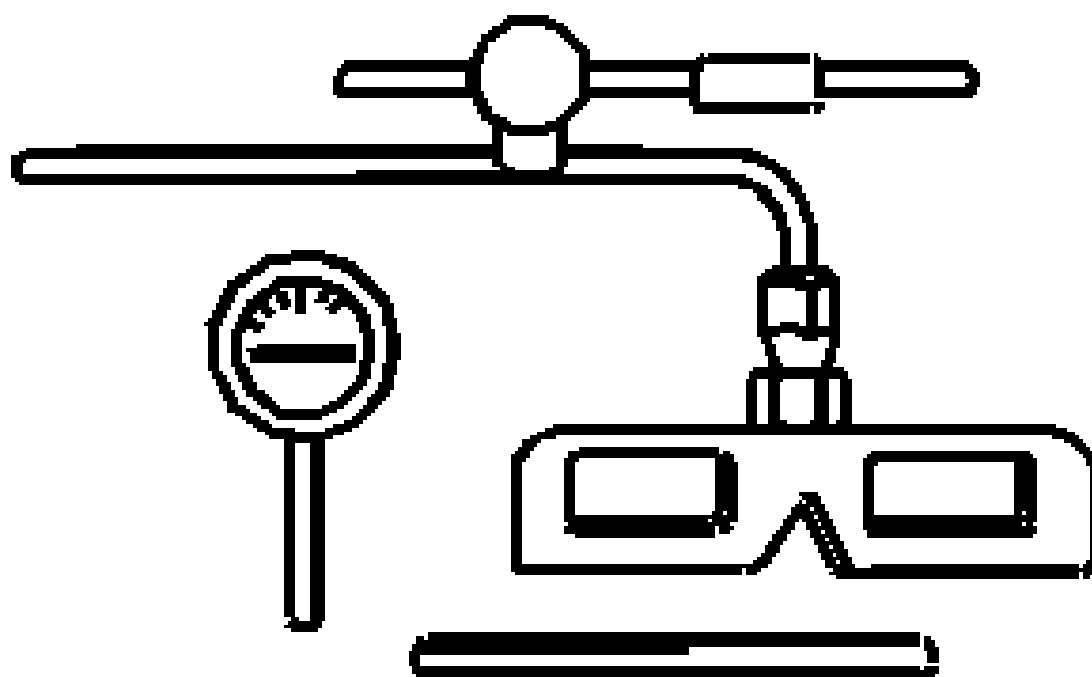
EN-50820
Front Crankshaft
Installer



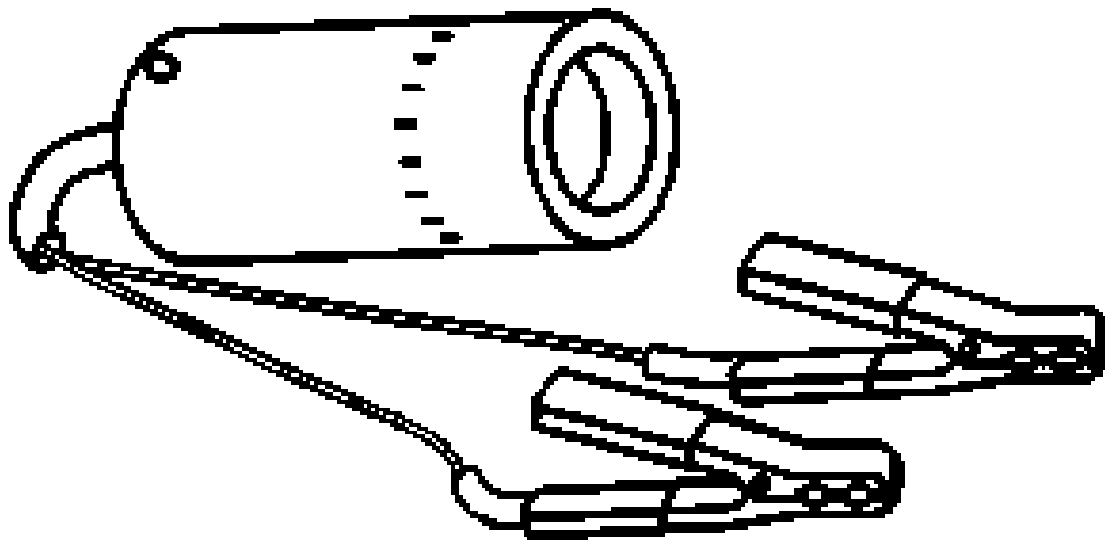
EN-50837
Timing Chain
Tensioner Retractor
Tool



EN-51380
Seal Installer



GE-7872
J-7872
Magnetic Base I
Indicator Set



GE-42220
J-28428-E
J-42220
Universal 12V L
Detection Lam

Engine

Engine Mechanical - 2.0L (LTG) - Specifications

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Automatic Transmission Flexplate Bolt ¹		
• First Pass	30 N.m ¹	22 lb ft ¹
• Final Pass	40 Degrees ¹	
Balancer Chain Guide Bolt	10 N.m	89 lb in
Balancer Chain Tensioner Bolt	10 N.m	89 lb in
Balancer Shaft Driven Sprocket Bolt ¹		
• First Pass	40 N.m ¹	30 lb ft ¹
• Final Pass	50 Degrees ¹	
Balancer Shaft Housing Bolt	58 N.m	43 lb ft
Camshaft Bearing Cap Bolt	10 N.m	89 lb in
Camshaft Cover Bolt	10 N.m	89 lb in
Camshaft Cover Heat Shield Bolt	10 N.m	89 lb in
Camshaft Cover Opening Plug	35 N.m	26 lb ft
Camshaft Position Actuator Bolt ¹		
• First Pass	30 N.m ¹	22 lb ft ¹
• Final Pass	100 Degrees ¹	
Camshaft Position Actuator Solenoid Valve Bolt	10 N.m	89 lb in
Camshaft Position Sensor Bolt	10 N.m	89 lb in
Catalytic Converter Brace Bolt	22 N.m	16 lb ft
Catalytic Converter Brace Bracket Bolt	22 N.m	16 lb ft
Catalytic Converter Nut - Exhaust Manifold ¹	50 N.m ¹	37 lb ft ¹
Connecting Rod Bolt ¹		
• First Pass	25 N.m ¹	18 lb ft ¹
• Final Pass	110 Degrees ¹	
Crankshaft Position Sensor Reluctor Ring Bolt	15 N.m	11 lb ft
Crankshaft Balancer Bolt ¹		
• First Pass	150 N.m ¹	111 lb ft ¹

• Final Pass	180 Degrees ¹	
Crankshaft Position Sensor Bolt	10 N.m	89 lb in
Cylinder Head Bolt ¹		
• First Pass	30 N.m ¹	22 lb ft ¹
• Final Pass	190 Degrees ¹	
Cylinder Head Core Hole Plug	50 N.m	37 lb ft
Cylinder Head Oil Gallery Plug	40 N.m	30 lb ft
Drive Belt Tensioner Bolt	58 N.m	43 lb ft
Engine Block Oil Gallery Plug - Large, Left Side and Rear Engine Block	65 N.m	48 lb ft
Engine Block Oil Gallery Plug - Large, Left Side Lower Crankcase	65 N.m	48 lb ft
Engine Block Oil Gallery Plug - Small, Rear Engine Block	40 N.m	30 lb ft
Engine Coolant Air Bleed Pipe Bolt	10 N.m	89 lb in
Engine Coolant Heater Hole Plug	60 N.m	44 lb ft
Engine Coolant Thermostat Housing Bolt	10 N.m	89 lb in
Engine Front Cover Bolt - M6	10 N.m	89 lb in
Engine Front Cover Bolt - M10	58 N.m	43 lb ft
Engine Front Cover Bolt - M8	25 N.m	18 lb ft
Engine Lift Bracket Bolt - Front	25 N.m	18 lb ft
Engine Lift Bracket Bolt - Rear	25 N.m	18 lb ft
Engine Oil Cooler Bolt	10 N.m	89 lb in
Engine Oil Cooler Connector	50 N.m	37 lb ft
Engine Oil Level Indicator Switch Bolt	10 N.m	89 lb in
Engine Oil Pressure Sensor	27 N.m	20 lb ft
Exhaust Manifold Bolt ¹	20 N.m ¹	21 lb ft ¹
Exhaust Manifold Brace Bolt	25 N.m	18 lb ft
Exhaust Manifold Brace Nut ¹	25 N.m ¹	18 lb ft ¹
Exhaust Manifold Heat Shield Bolt	14 N.m	124 lb in
Exhaust Manifold Stud	20 N.m	21 lb ft
Flywheel Bolt ¹		
• First Pass	30 N.m ¹	22 lb ft ¹
• Final Pass	80 Degrees ¹	
Fuel Feed Intermediate Pipe Nut		
• First Pass - Fuel Feed Intermediate Pipe Nut to Fuel Rail	15 N.m	11 lb ft
• Second Pass - Fuel Feed Intermediate Pipe Nut to Fuel Pump	15 N.m	11 lb ft
• Third Pass - Fuel Feed Intermediate Pipe Nut to Fuel	30 N.m	22 lb ft

Rail		
• Final Pass - Fuel Feed Intermediate Pipe Nut to Fuel Pump	30 N.m	22 lb ft
Fuel Feed Pipe	30 N.m	22 lb ft
Fuel Feed Pipe Clip Stud	10 N.m	89 lb in
Fuel Injection Fuel Rail Bolt	25 N.m	18 lb ft
Fuel Injection Fuel Rail Fuel Pressure Sensor	33 N.m	24 lb ft
Fuel Pump Bolt	15 N.m	11 lb ft
Fuel Pump Shield Bolt	10 N.m	89 lb in
Ignition Coil Bolt	10 N.m	89 lb in
Intake Manifold Bolt	12 N.m	106 lb in
Intake Manifold Cover Bolt	9 N.m	80 lb in
Knock Sensor Bolt	25 N.m	18 lb ft
Lower Crankcase Bolt - Crankshaft Bearing ¹		
• First Pass	20 N.m ¹	15 lb ft ¹
• Final Pass	140 Degrees ¹	
Lower Crankcase Bolt - Perimeter ¹	25 N.m ¹	18 lb ft ¹
Manifold Absolute Pressure (MAP) Sensor Bolt	5 N.m	44 lb in
Oil Pan Baffle Bolt	10 N.m	89 lb in
Oil Pan Bolt, Long	10 N.m	89 lb in
Oil Pan Bolt, Perimeter	25 N.m	18 lb ft
Oil Pan Bolt, Lower	10 N.m	89 lb in
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pump Suction Pipe Bolt	10 N.m	89 lb in
Oil Pump Flow Control Valve Bolt	10 N.m	89 lb in
Oil Filter	30 N.m	22 lb ft
Oxygen Sensor	42 N.m	31 lb ft
PCV Valve Bolt	10 N.m	89 lb in
Piston Oil Nozzle Bolt	10 N.m	89 lb in
Spark Plug	20 N.m	15 lb ft
Thermal Bypass Pipe Bolt	10 N.m	89 lb in
Throttle Body Bolt	10 N.m	89 lb in
Timing Chain Cover Bolt - Engine Front Cover	5 N.m	44 lb in
Timing Chain Guide Bolt	25 N.m	18 lb ft
Timing Chain Tensioner Pivot Arm Bolt	25 N.m	18 lb ft
Timing Chain Tensioner Shoe Bolt	25 N.m	18 lb ft
Turbocharger Coolant Feed and Return Pipe Bolt	35 N.m	26 lb ft
Turbocharger Coolant Feed Pipe Bolt	10 N.m	89 lb in
Turbocharger Coolant Return Pipe to Camshaft Cover Heat Shield Bolt	14 N.m	124 lb in

Turbocharger Exhaust Pipe Stud	25 N.m	18 lb ft
Turbocharger Nut ¹		
• First Pass	30 N.m ¹	22 lb ft ¹
• Final Pass	90 Degrees ¹	
Turbocharger Oil Feed Pipe Bolt	35 N.m	26 lb ft
Turbocharger Oil Feed and Return Pipe Bolt	10 N.m	89 lb in
Vacuum Pump Bolt	10 N.m	89 lb in
Water Outlet Bolt	10 N.m	89 lb in
Water Pump Bolt	25 N.m	18 lb ft
Water Pump Housing Bolt	10 N.m	89 lb in
¹ Use NEW fastener.		

ENGINE MECHANICAL SPECIFICATIONS

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		
• Engine Type	Inline 4 Cylinder	
• Displacement	2.0 L	122 CID
• RPO	LTG	
• Liter (VIN)	-	
• Bore	85.992-86.008 mm	3.3855-3.3861 in
• Stroke	86 mm	3.386 in
• Compression Ratio	9.50	
• Spark Plug Gap	0.95-1.10 mm	0.037-0.043 in
Block		
• Crankshaft Main Bearing Bore Diameter	60.862-60.876 mm	2.3961-2.3967 in
• Cylinder Bore Diameter	85.992-86.008 mm	3.3855-3.3861 in
• Cylinder Bore Out-of-Round - Maximum	0.013 mm	0.0005 in
• Cylinder Head Deck Surface Flatness - over 25 mm length	0.025 mm	0.001 in
• Cylinder Head Deck Surface Flatness - over 150 mm length	0.050 mm	0.002 in
Engine Block to Bedplate Flatness - overall	0.1 mm	0.0039 in
Engine Block to Bedplate Flatness - straightness	0.050 mm in 100 mm	0.002 in in 3.937 in
Piston Deck Height - Below Deck	1.155-1.725 mm	0.0455-0.0679 in
Camshaft		

• Camshaft End Play	0.040-0.307 mm	0.0016-0.0121 in
• Camshaft Journal Diameter - Journal 1	34.935-34.960 mm	1.3754-1.3764 in
• Camshaft Journal Diameter - Journal 2 thru 5	26.935-26.960 mm	1.0604-1.0614 in
• Camshaft Thrust Width - Camshaft with Phaser installed	30.025-30.175 mm	1.1821-1.1880 in
• Camshaft Thrust Width - Cylinder Head	29.868-29.890 mm	1.1759-1.1768 in
Connecting Rod		
• Connecting Rod Bearing to Crankpin Clearance	0.030-0.073 mm	0.0012-0.0029 in
• Connecting Rod Bore Diameter - Bearing End	52.118-52.134 mm	2.0519-2.05252 in
• Connecting Rod Bore Diameter - Pin End	24.007-24.017 mm	0.9452-0.9455 in
• Connecting Rod Side Clearance	0.070-0.370 mm	0.0028-0.0146 in
• Connecting Rod Straightness - Bend - Maximum	0.017 mm	0.0007 in
• Connecting Rod Straightness - Twist - Maximum	0.040 mm	0.0016 in
Crankshaft		
• Connecting Rod Pin Diameter	48.999-49.015 mm	1.9291-1.9297 in
• Crankshaft End Play	0.040-0.270 mm	0.0016-0.0106 in
• Crankshaft Main Bearing Clearance	0.020-0.048 mm	0.0008-0.0019 in
• Crankshaft Main Journal Diameter	55.993-56.009 mm	2.2044-2.2051 in
Cylinder Head		
• Surface Flatness - Block Deck - in 25 mm	0.025 mm	0.0001 in
• Surface Flatness - Block Deck - in 150 mm	0.050 mm	0.0019 in
• Surface Flatness - Block Deck - between bolts	0.030 mm	0.0012 in
• Surface Flatness - Block Deck - Overall	0.100 mm	0.0039 in
• Valve Guide Bore - Exhaust	6.000-6.020 mm	0.2362-0.2370 in
• Valve Guide Bore - Intake	6.000-6.020 mm	0.2362-0.2370 in
• Valve Lifter Bore Diameter - Stationary Lash Adjusters	12.008-12.030 mm	0.4728-0.4736 in
• Valve Seat Angle - Relief Surface	30 Degrees	
• Valve Seat Angle - Seating Surface	45 Degrees	
• Valve Seat Angle - Undercut Surface	60 Degrees	
• Valve Seat Runout - Maximum	0.080 mm	0.0031 in
Lubrication System		
• Oil Pressure - @700 RPM 100°C	140-200 kPa	20-29 psi
• Oil Capacity - 2WD	4.7L	5.0 quarts

• Oil Capacity - 4WD/AWD	5.7L	6.0 quarts
Piston Rings		
• Piston Ring End Gap - Top	0.20-0.35 mm	0.008-0.014 in
• Piston Ring End Gap - Second	0.35-0.55 mm	0.014-0.022 in
• Piston Ring End Gap - Oil Control	0.25-0.75 mm	0.010-0.030 in
• Piston Ring to Groove Clearance - Top	0.04-0.08 mm	0.0015-0.0031 in
• Piston Ring to Groove Clearance - Second	0.030-0.070 mm	0.0012-0.0030 in
• Piston Ring to Groove Clearance - Oil Control	0.024-0.176 mm	0.0009-0.0069 in
• Piston Ring Thickness - Top	1.170-1.190 mm	0.0461-0.0469 in
• Piston Ring Thickness - Second	1.470-1.490 mm	0.0579-0.0587 in
• Piston Ring Thickness - Oil Control - Rail	0.447-0.473 mm	0.0176-0.0186 in
• Piston Ring Thickness - Oil Control - Spacer	0.960-1.040 mm	0.0378-0.0409 in
Pistons and Pins		
• Pin - Piston Pin Clearance to Connecting Rod Bore	0.007-0.020 mm	0.0003-0.0008 in
• Pin - Piston Pin Clearance to Piston Pin Bore	0.005-0.013 mm	0.0002-0.0005 in
• Pin - Piston Pin Diameter	23.997-24.000 mm	0.9448-0.9449 in
• Pin - Piston Pin End Play	0.263-1.164 mm	0.0104-0.0458 in
• Piston - Piston Diameter - @14.8 mm up	85.968-85.982 mm	3.3846-3.3851 in
• Piston - Piston Pin Bore Diameter	24.005-24.010 mm	0.9451-0.9453 in
• Piston - Piston Ring Groove Width - Top	1.23-1.25 mm	0.0484-0.0492 in
• Piston - Piston Ring Groove Width - Second	1.52-1.54 mm	0.0598-0.0606 in
• Piston - Piston Ring Groove Width - Oil Control	2.01-2.03 mm	0.0791-0.0799 in
• Piston - Piston to Bore Clearance - w/polymer	-0.022 to +0.024 mm	-0.0009 to +0.0009 in
Valve System		
• Valves - Valve Face Angle	45 Degrees	
• Valves - Valve Face Runout - Maximum	0.040 mm	0.0016 in
• Valves - Valve Seat Runout - Maximum	0.080 mm	0.0031 in
• Valves - Valve Seat Gauge Ball Height - Exhaust	12.746-12.976 mm	0.4912-0.5038 in
• Valves - Valve Seat Gauge Ball Height - Intake	12.425-12.653 mm	0.4892-0.4981 in
• Valves - Valve Stem Diameter - Exhaust	5.945-5.965 mm	0.2341-0.2348 in
• Valves - Valve Stem Diameter - Intake	5.955-5.975 mm	0.2344-0.2352 in
• Valves - Valve Stem Installed Height	Check and Record	
• Valves - Valve Stem to Guide Clearance - Exhaust	0.038-0.082 mm	0.0015-0.0032 in
• Valves - Valve Stem to Guide Clearance - Intake	0.030-0.057 mm	0.0012-0.0022 in

• Valve Lash Adjusters - Valve Lash Adjuster Diameter - Stationary Lash Adjuster	11.986-12.000 mm	0.0005-0.0020 in
• Valve Lash Adjusters - Valve Lash-Adjuster-to-Bore Clearance - Stationary Lash Adjuster	0.013-0.051 mm	3.2210-3.2299 in
• Valve Springs - Valve Spring Installed Height	35.0 mm	1.3779 in
• Valve Springs - Valve Spring Load - Closed - @35 mm	247-273 N	56-61 lb
• Valve Springs - Valve Spring Load - Open - @24 mm	598-662 N	134-149 lb

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Balance Shaft Bearings	5W-30	19293000	19286321
Cam Lobes	5W-30	19293000	19286321
Camshaft Cover	Sealant	12378521	88901148
Crank Sensor O-ring	5W-30	19293000	19286321
Cylinder Bores	5W-30	19293000	19286321
Cylinder Head Plugs	Threadlocker	12345382	10953489
Engine Block Threaded Plugs	Sealant	12346004	10953480
Engine Block to Bedplate	Sealant	12378521	88901148
Engine Front Cover	Sealant	12378521	88901148
Engine Oil	5W-30	19293000	19286321
Fuel Injector O-rings	5W-30	19293000	19286321
Fuel Injector Tip Insulators, for Multiple Port Injection Only	5W-30	19293000	19286321
Hydraulic Lash Adjusters	5W-30	19293000	19286321
Ignition Coils	Lubricant	19260901	19260902
Intake and Exhaust Valve Stems	5W-30	19293000	19286321
Lower Oil Pan	Sealant	12378521	88901148
Main Bearings	5W-30	19293000	19286321
Oil Filter - Threads and O-ring Lead-in Chamfers	5W-30	19293000	19286321
Oil Level Indicator Tube O-ring	Lubricant	88862586	88862827
Oil Pan to Bedplate Joint	Sealant	12378521	88901148
Oil Pump- Pump Elements	5W-30	19293000	19286321
Oxygen Sensor Threads	Anti-seize	88862477	88862478
Piston Pin to Piston/Rod- Pin Bores of Piston and Rod	5W-30	19293000	19286321
Rod Bearings- Rod Pins of Crankshaft	5W-30	19293000	19286321

Thread Repair Cutting Oil	Lubricant	1052864	992881
Thread Repair	Cleaner	88862650	88901247
Timing Chain Tensioner Cover	Sealant	12378521	88901148
Valves	Parts Immersion Solvent	12345368	10953514
Valve Rocker Arm/Valve Tip	5W-30	19293000	19286321
Water Feed Tube O-rings	Lubricant	19260901	19260902

THREAD REPAIR SPECIFICATIONS

Engine Block - Front View

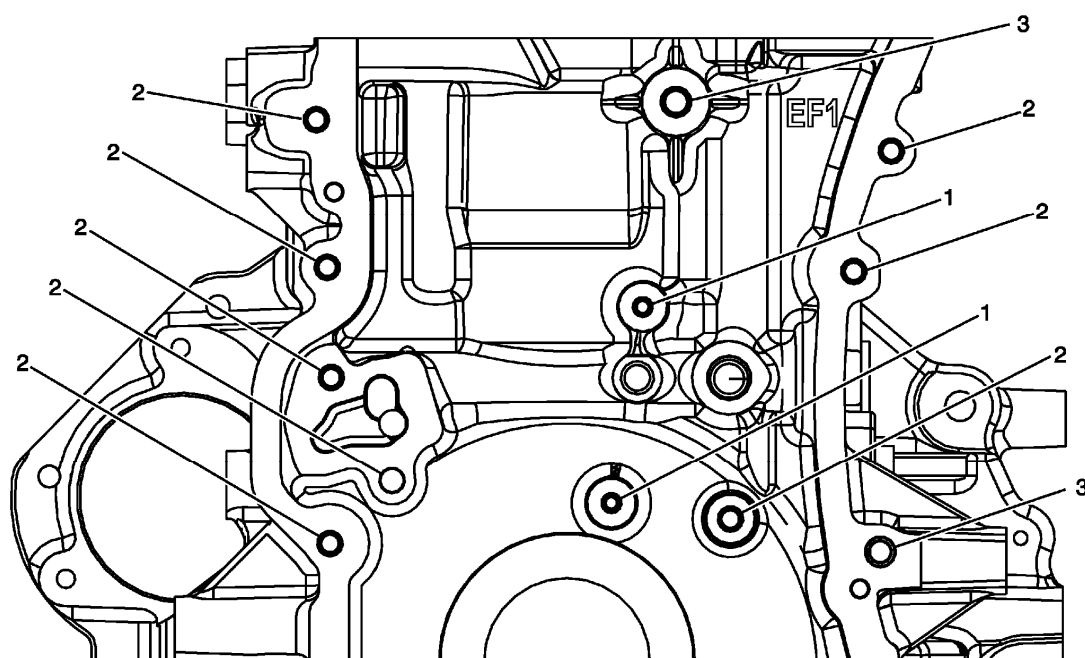


Fig. 1: Engine Block -- Front View

Courtesy of GENERAL MOTORS COMPANY

Engine Block - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Engine Block - Back View

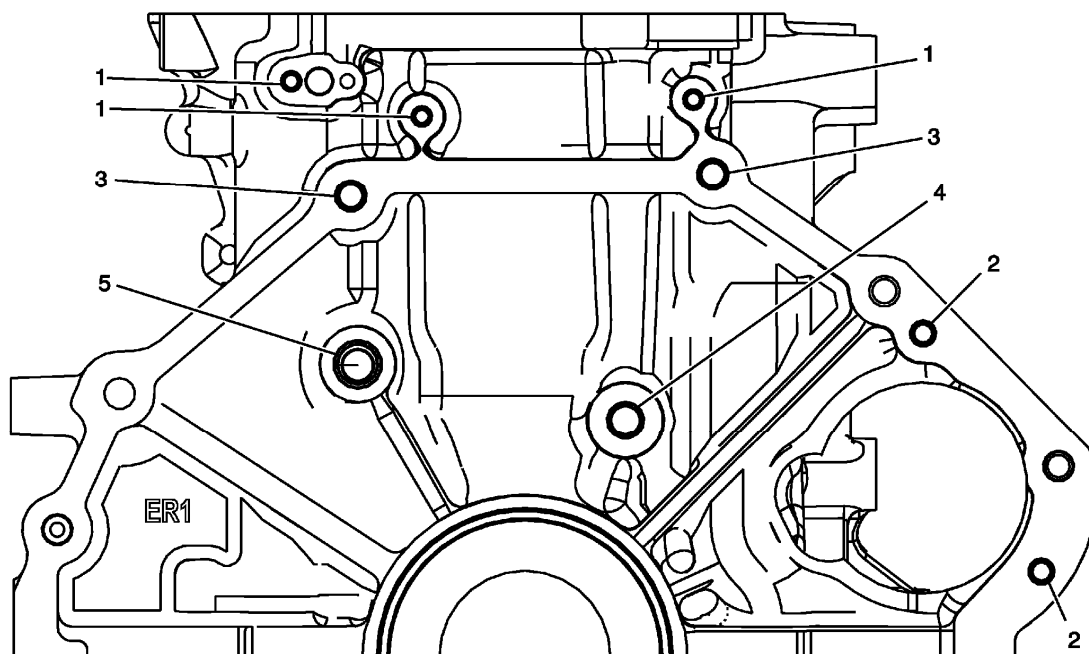


Fig. 2: Engine Block -- Back View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block - Back View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M10x1.5	420	211	212	213	214	34.0	1.35	24.0	1.35
4	M12x1.75	865	856	857	858	859	27.5	1.08	27.5	1.08
5	M16x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Engine Block - Right Side View

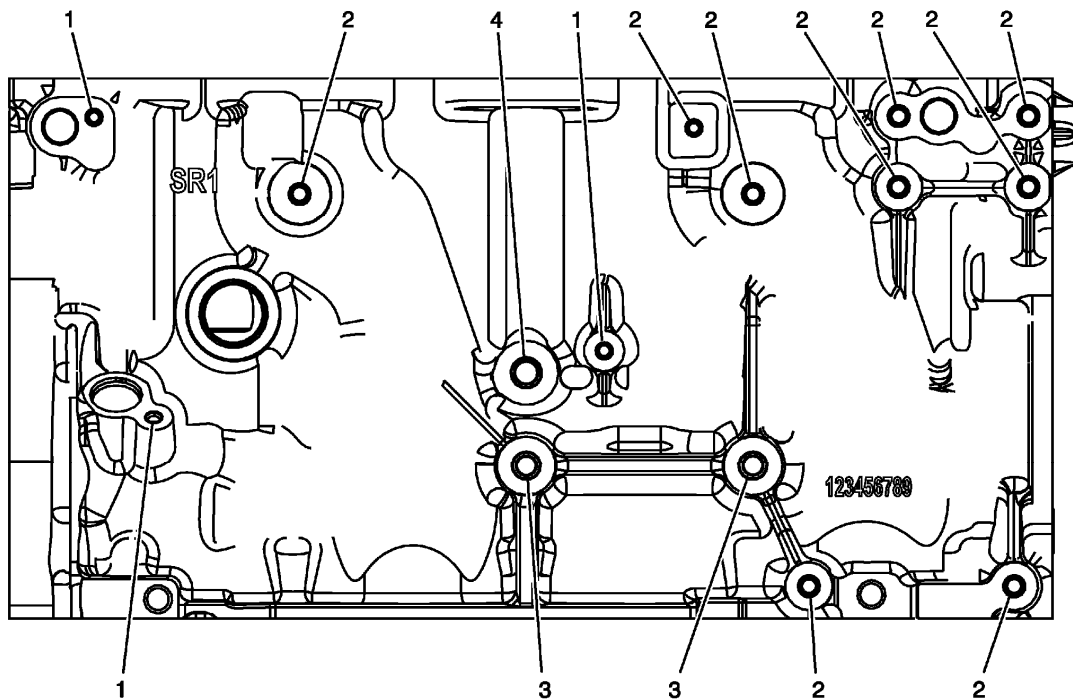


Fig. 3: Engine Block -- Right Side View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block - Right Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	m10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35
4	M12x1.75	865	856	857	858	859	27.5	1.08	27.5	1.08

Engine Block - Bottom View

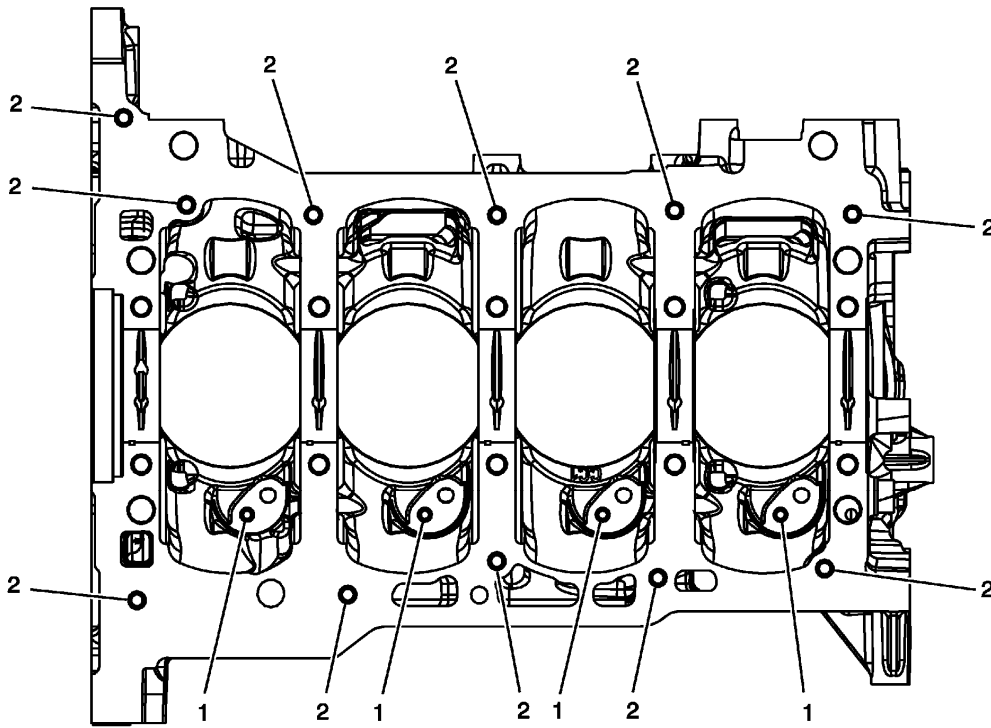


Fig. 4: Engine Block -- Bottom View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block - Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
							MM	(IN)	MM	(IN)
EN 42385										
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14

Engine Block - Left Side View

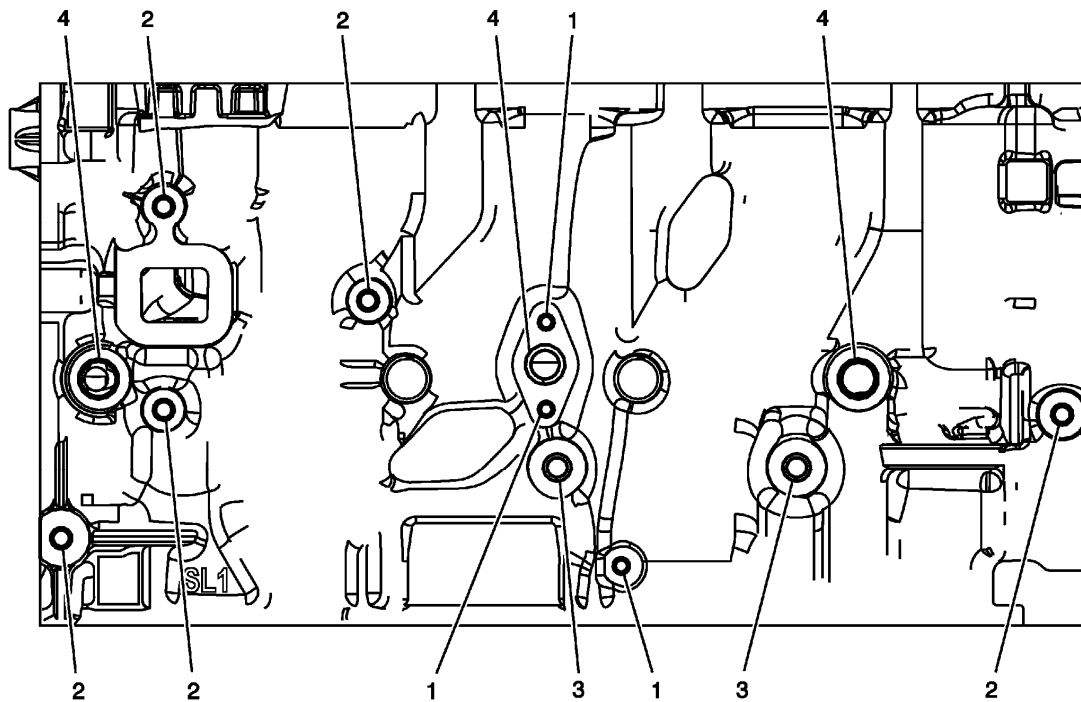


Fig. 5: Engine Block -- Left Side View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block - Left Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
							MM	(IN)	MM	(IN)
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35
4	M16x1.5	420	211	212	213	214	22.0	0.866	22.0	0.866

Engine Block - Top View

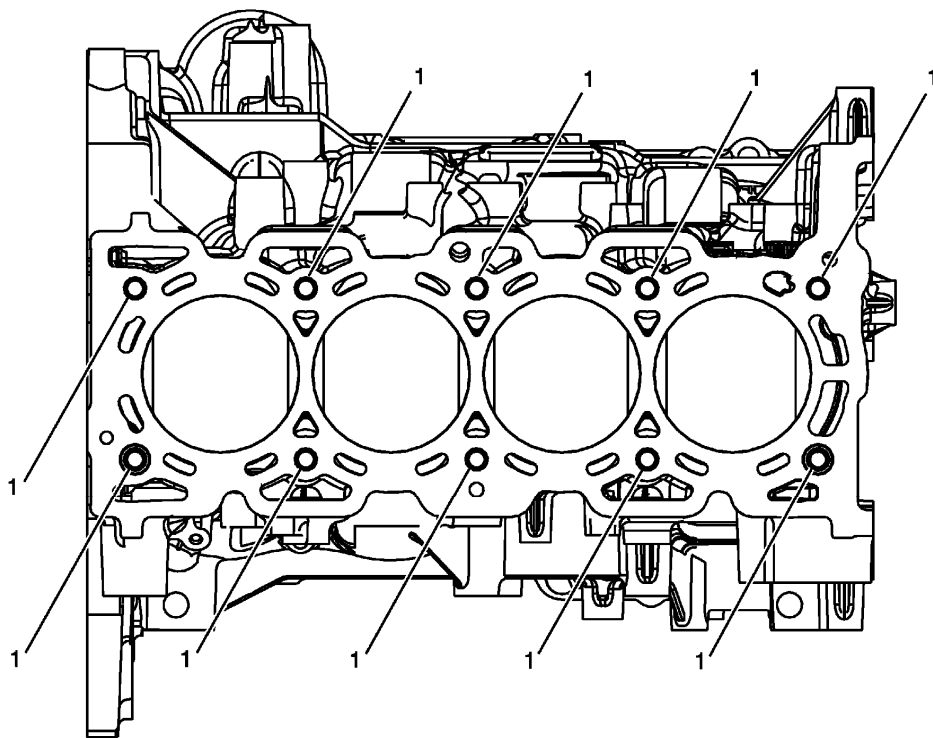


Fig. 6: Engine Block -- Top View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M11x2.0	108	723	none	724	725	88.0	3.46	80.0	3.15

Lower Crankcase - Bottom View

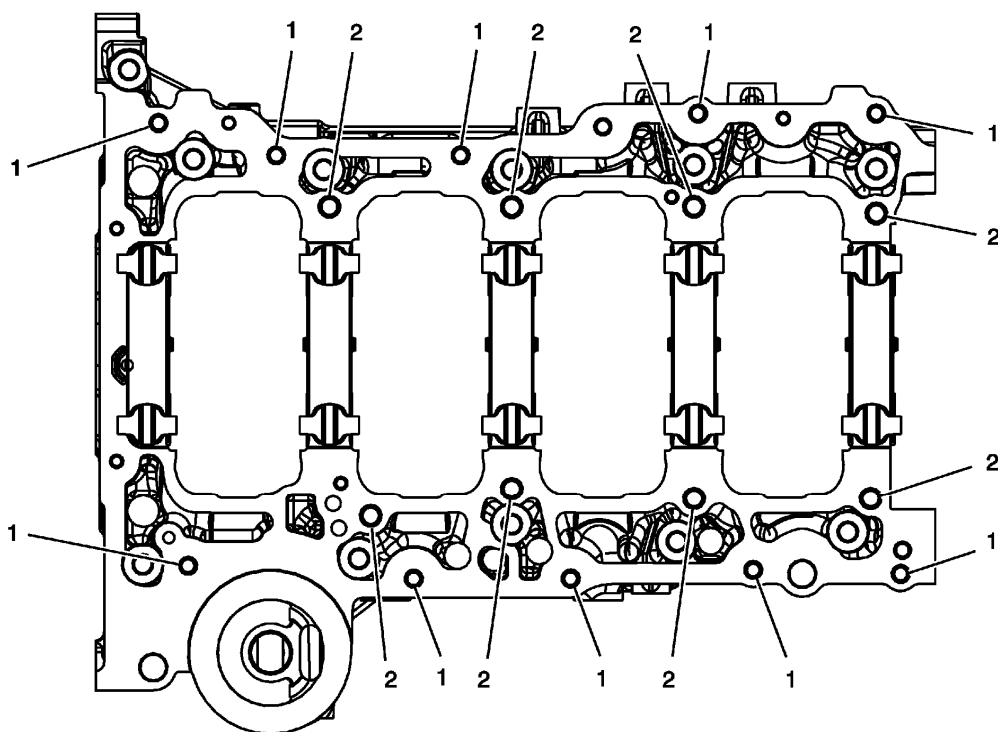


Fig. 7: Lower Crankcase -- Bottom View
 Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
2	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Lower Crankcase - Right Side View

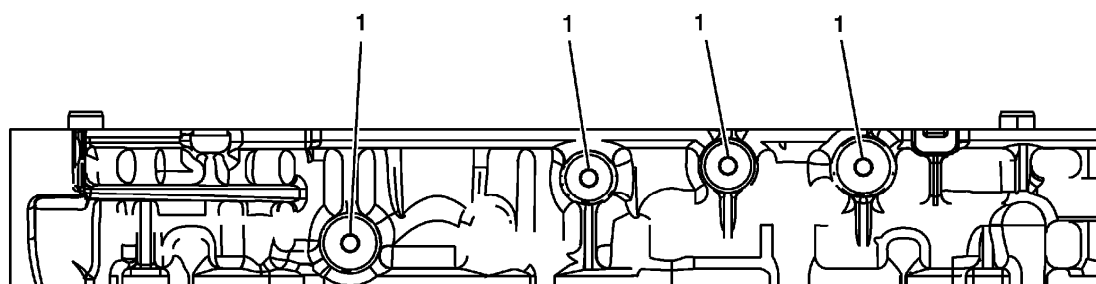


Fig. 8: Lower Crankcase -- Right Side View

Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Right Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Lower Crankcase - Left Side View

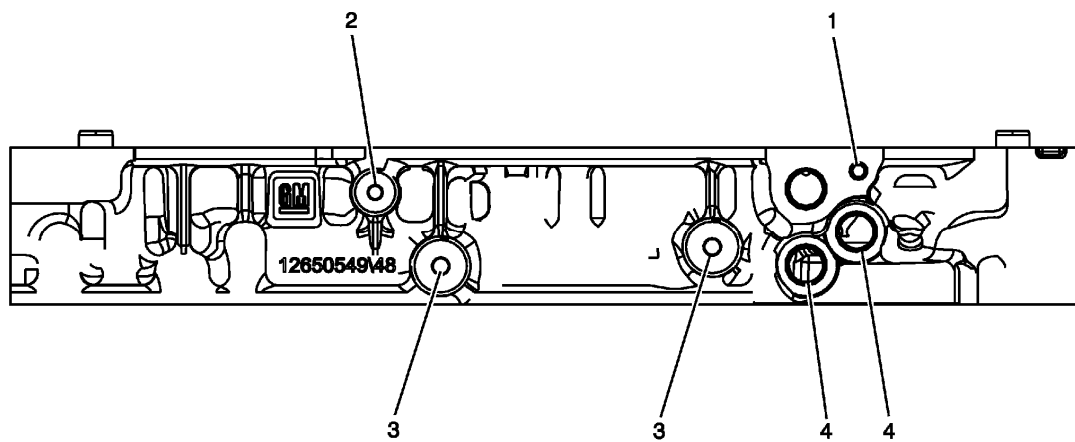


Fig. 9: Lower Crankcase -- Left Side View

Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Left Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35
4	M16x1.5	420	211	212	213	214	22.0	0.866	22.0	0.866

Cylinder Head - Top View

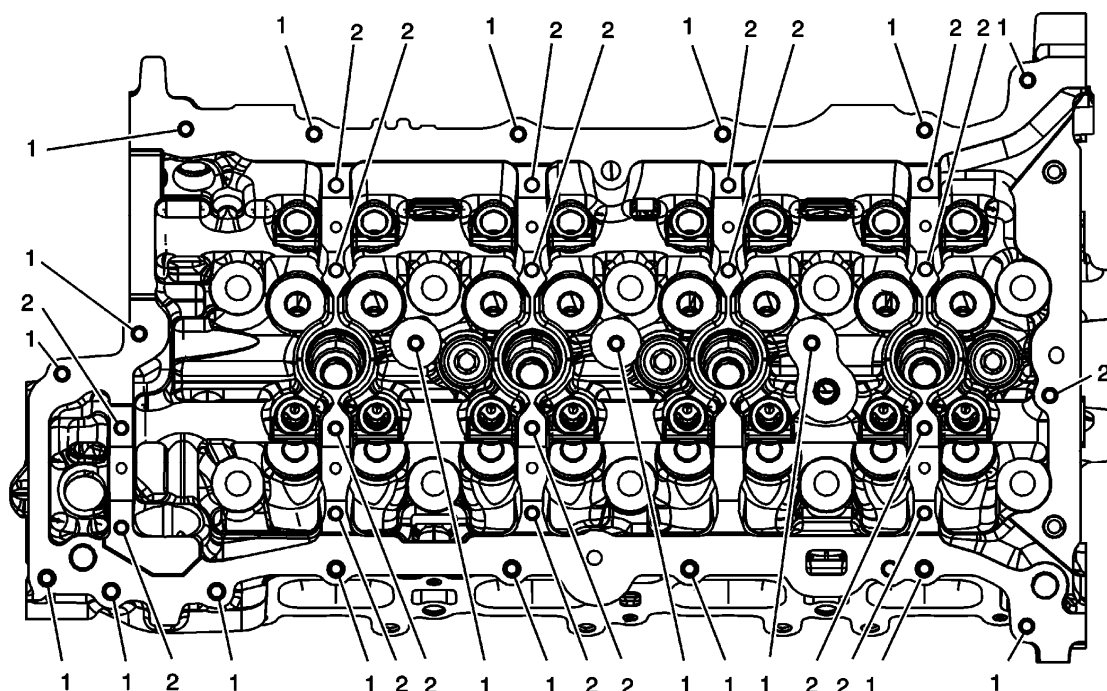


Fig. 10: Cylinder Head -- Top View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	205	201	202	203	204	23.0	0.907	23.0	0.907
2	M6x1.0	205	701	none	203	204	23.0	0.907	23.0	0.907

Cylinder Head Right Side View - Intake Manifold Deck Face

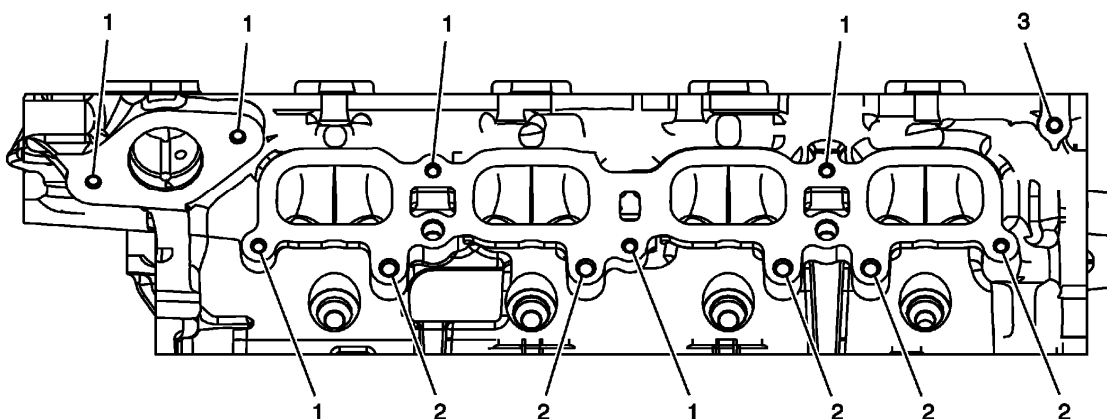


Fig. 11: Cylinder Head Right Side View -- Intake Manifold Deck Face

Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Right Side View - Intake Manifold Deck Face

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth Maximum		Tap Depth Maximum	
EN 42385							MM	IN	MM	IN
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M6x1.0	205	201	202	203	204	23.0	0.907	23.0	0.907
3	M6x1.0	205	701	none	203	204	23.0	0.907	23.0	0.907

Cylinder Head Left Side View - Exhaust Manifold Deck Face

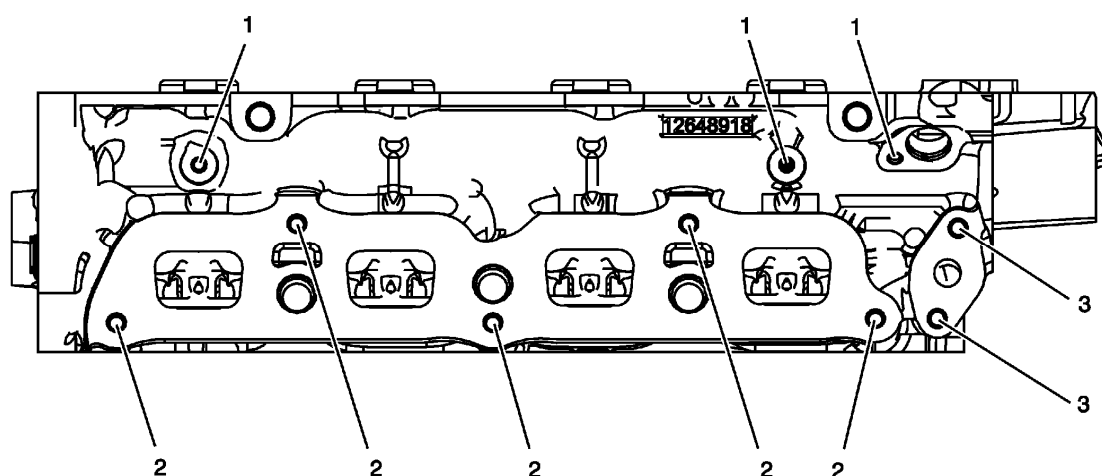


Fig. 12: Cylinder Head Left Side View -- Exhaust Manifold Deck Face
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Left Side View - Exhaust Manifold Deck Face

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M6x1.0	205	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M8x1.25	210	206	207	208	209	29.0	1.14	29.0	1.14

Cylinder Head - Front View

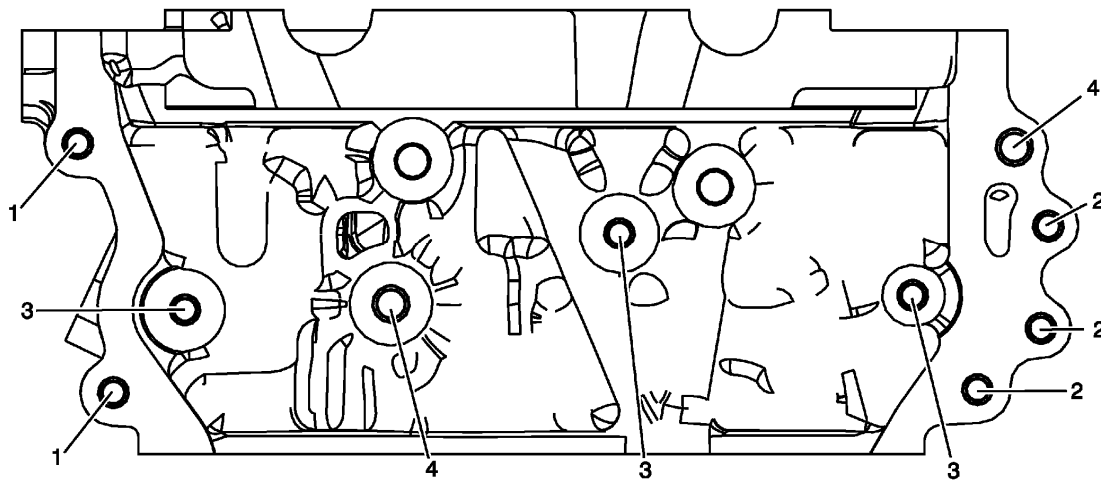


Fig. 13: Cylinder Head -- Front View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M8x1.25	18129	206	207	208	209	29.0	1.14	29.0	1.14
2	M8x1.25	18127	206	207	208	209	29.0	1.14	29.0	1.14
3	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
4	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Cylinder Head - Back View

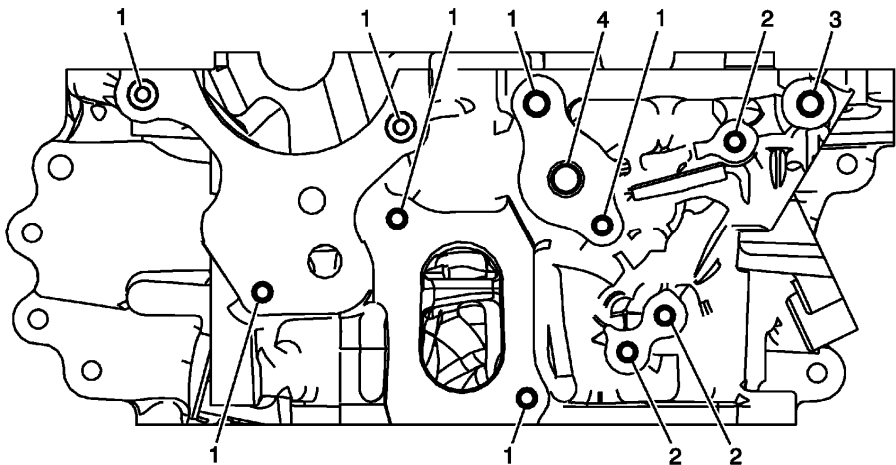


Fig. 14: Cylinder Head -- Back View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Back View

Service				Counterbore			Drill Depth	Tap Depth
---------	--	--	--	-------------	--	--	-------------	-----------

Call Out	Thread Size	Insert	Drill	Tool	Tap	Driver	Maximum		Maximum	
EN 42385							MM	IN	MM	IN
1	M6X1	205	201	202	203	204	20	0.787	16	0.63
2	M6X1	205	701	none	203	204	20	0.787	16	0.63
3	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
4	M12x1.75	865	856	857	858	859	18	0.709	14	0.551

Upper Oil Pan - Top View

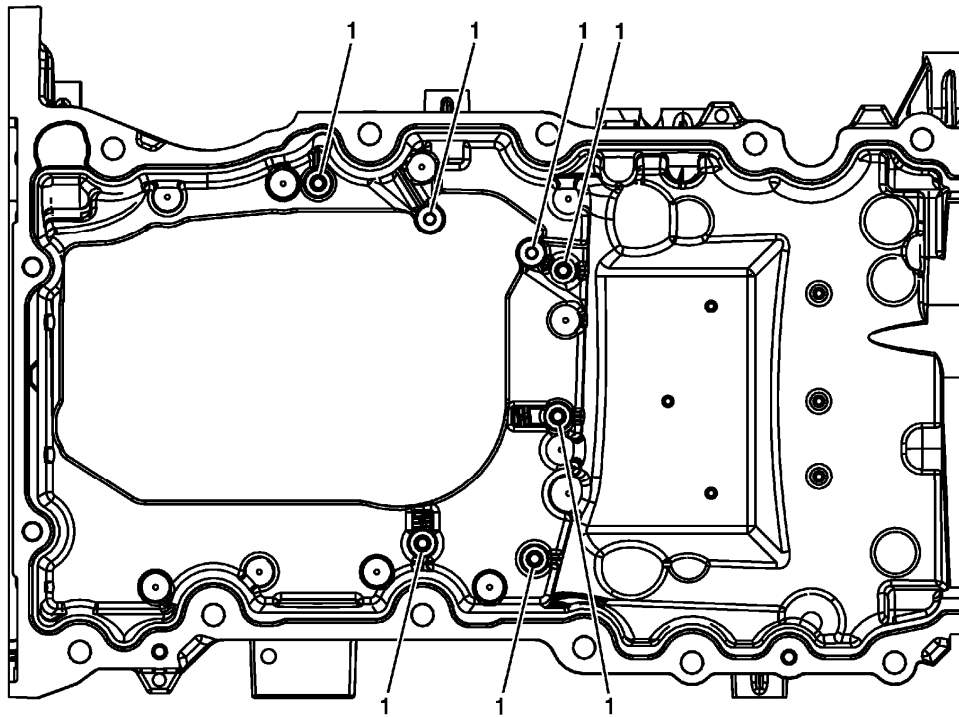


Fig. 15: Upper Oil Pan -- Top View
 Courtesy of GENERAL MOTORS COMPANY

Upper Oil Pan - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907

Upper Oil Pan - Bottom View

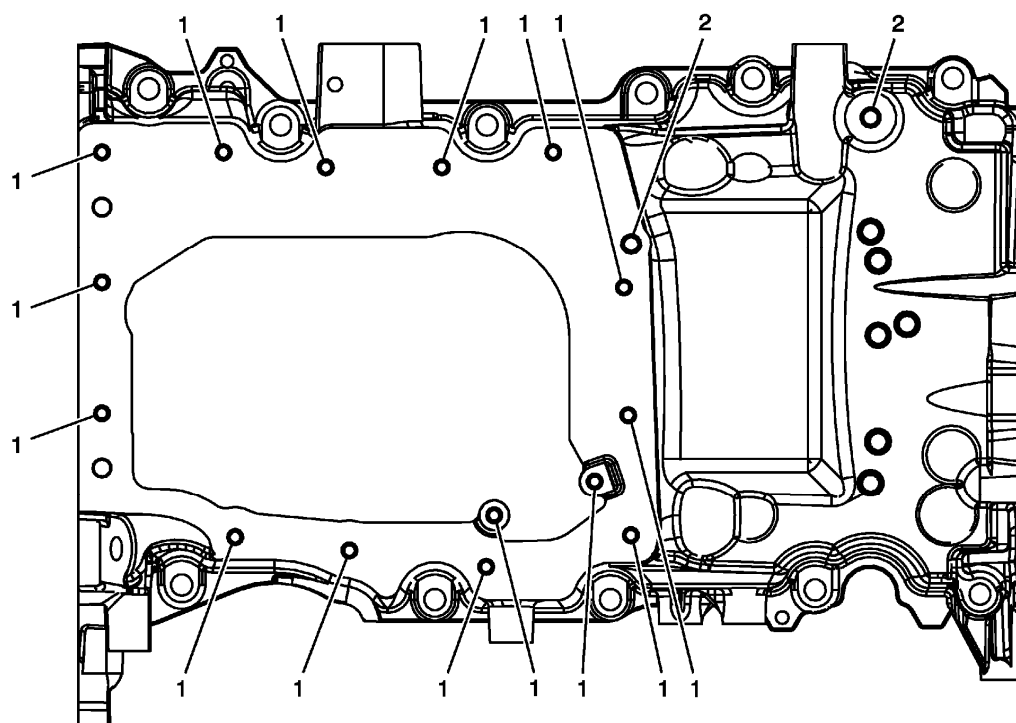


Fig. 16: Upper Oil Pan -- Bottom View
 Courtesy of GENERAL MOTORS COMPANY

Upper Oil Pan - Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14

Upper Oil Pan - Front View

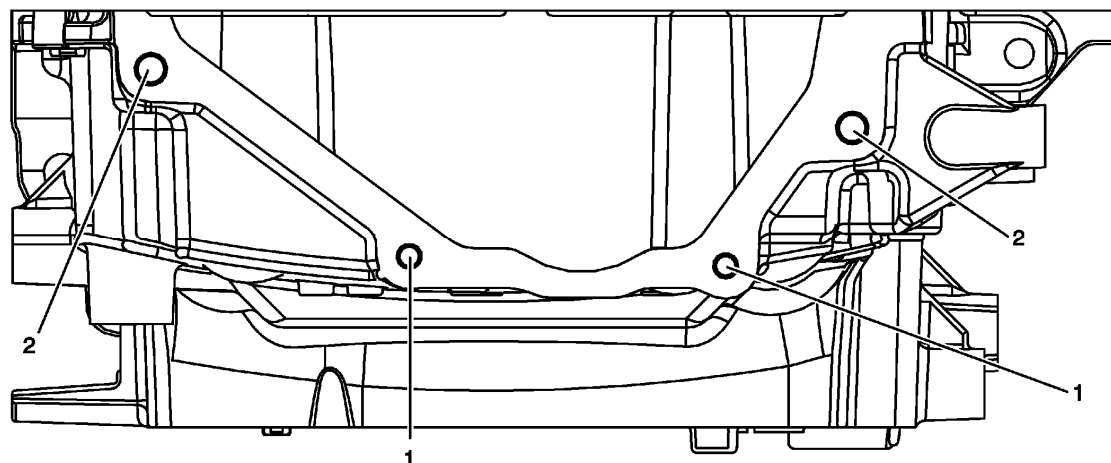


Fig. 17: Upper Oil Pan -- Front View

Courtesy of GENERAL MOTORS COMPANY

Upper Oil Pan - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M10x1.5	216	211	212	213	214	34.0	1.35	34.0	1.35
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14

Upper Oil Pan - Back View

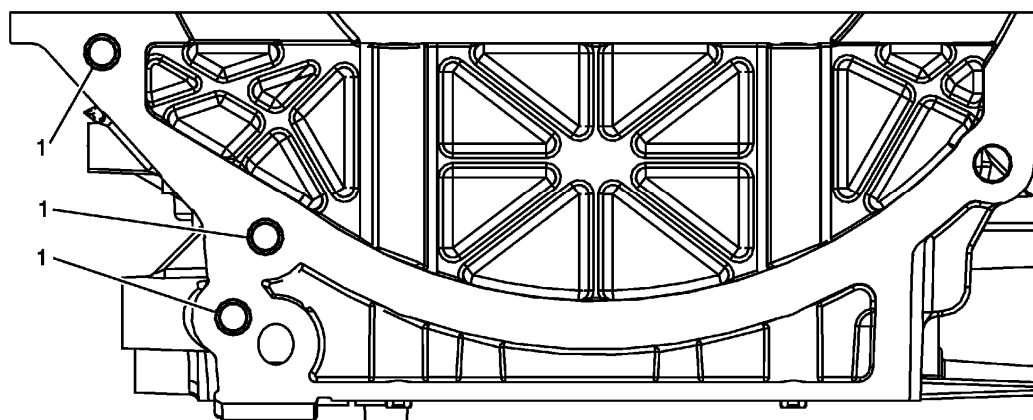


Fig. 18: Upper Oil Pan -- Back View

Courtesy of GENERAL MOTORS COMPANY

Upper Oil Pan - Back View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907

Engine Front Cover - Top View

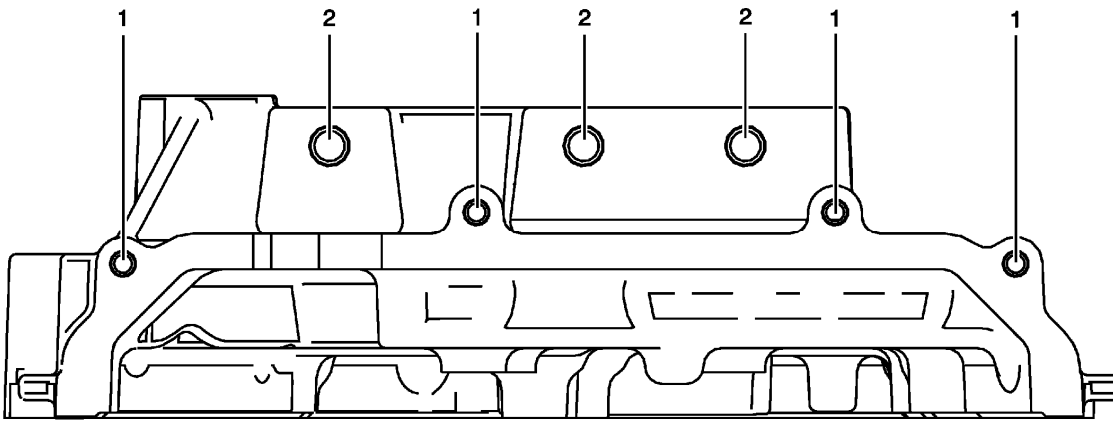


Fig. 19: Engine Front Cover -- Top View
 Courtesy of GENERAL MOTORS COMPANY

Engine Front Cover - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M5x0.8	3005	3001	3002	3003	3004	23.0	0.907	23.0	0.907
2	M6x1.0	205	201	202	203	204	23.0	0.907	23.0	0.907

Engine Front Cover - Front View

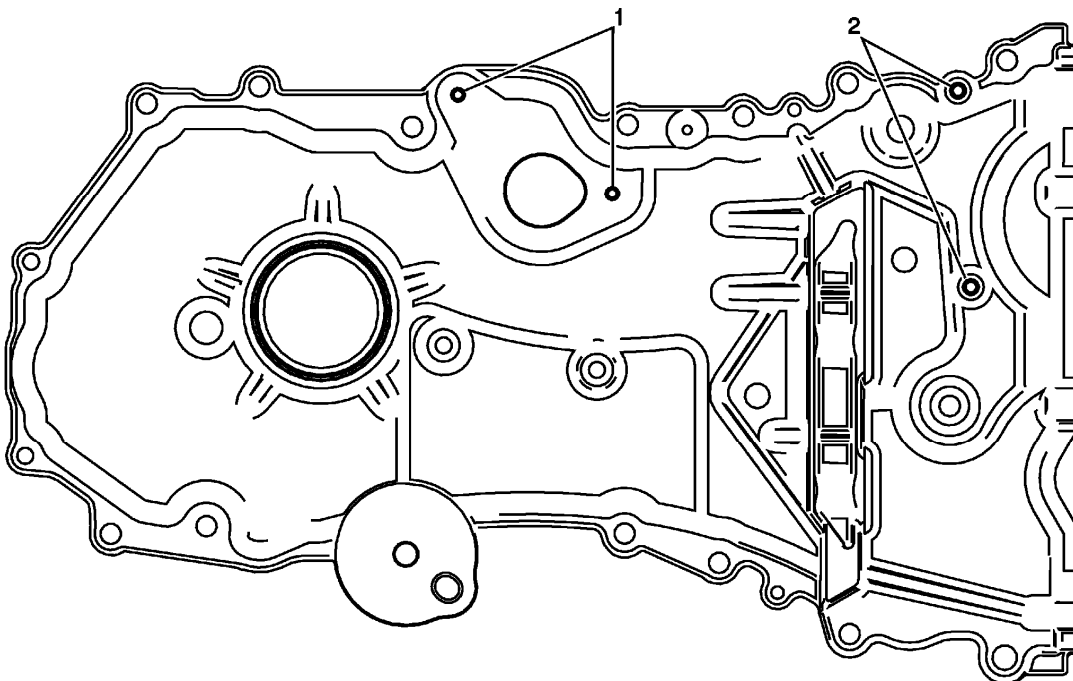


Fig. 20: Engine Front Cover -- Front View

Courtesy of GENERAL MOTORS COMPANY

Engine Front Cover - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M6x1.0	16105	201	202	203	204	23.0	0.907	23.0	0.907
2	M6x1.0	420	201	202	203	204	23.0	0.907	23.0	0.907

Engine

Engine Mechanical - 2.4L (LEA LUK) - Component Locator

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Cylinder Head and Components

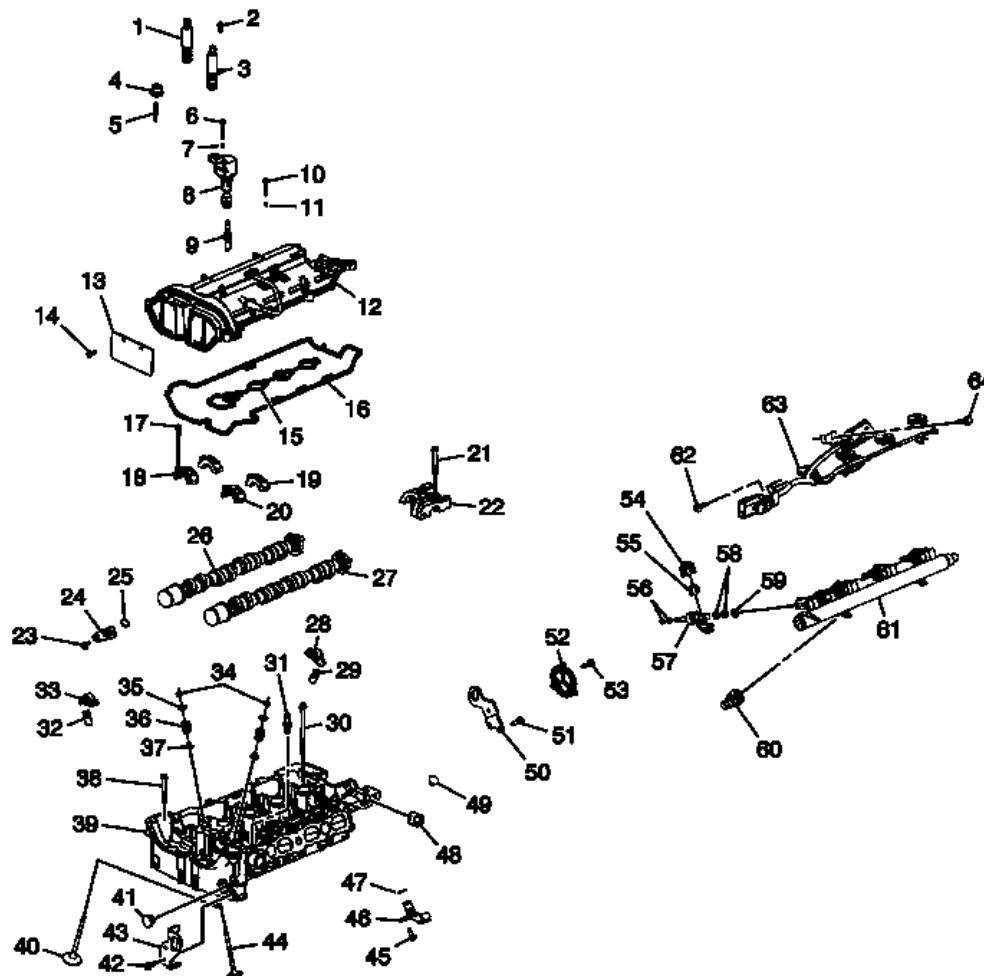


Fig. 1: View Of Cylinder Head And Components

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve - Exhaust
2	Camshaft Position Actuator Solenoid Valve Bolt
3	Camshaft Position Actuator Solenoid Valve - Intake
4	Upper Intake Manifold Sight Shield Grommet

5	Ball Stud
6	Ignition Coil Bolt
7	Ignition Coil Bolt Retainer
8	Ignition Coil
9	Spark Plug
10	Camshaft Cover Bolt
11	Camshaft Cover Bolt Retainer
12	Camshaft Cover
13	Camshaft Housing Cover Insulator
14	Camshaft Housing Cover Insulator Bolt
15	Camshaft Cover Seal
16	Camshaft Cover Seal
17	Camshaft Bearing Cap Bolt
18	Camshaft Bearing Front Cap
19	Camshaft Bearing Cap
20	Camshaft Bearing Front Cap
21	Camshaft Rear Cap Bolt
22	Intake Camshaft Rear Cap
23	Camshaft Position Sensor Bolt
24	Camshaft Position Sensor
25	Camshaft Position Sensor O-Ring
26	Exhaust Camshaft
27	Intake Camshaft
28	Roller Finger Follower
29	Hydraulic Lash Adjuster
30	Cylinder Head Bolt
31	Engine Coolant Air Bleed Fitting
32	Hydraulic Lash Adjuster
33	Roller Finger Follower
34	Valve Keys
35	Valve Spring Retainer
36	Valve Spring
37	Valve Stem Seal
38	Small Cylinder Head Bolt
39	Cylinder Head
40	Valve
41	Timing Chain Guide Bolt Access Hole Plug
42	Front Lift Bracket Bolt
43	Front Lift Bracket
44	Valve
45	Camshaft Position Sensor Bolt

	Camshaft Position Sensor
47	Camshaft Position Sensor O-Ring
48	High Pressure Fuel Pump Roller Lifter
49	Cylinder Head Gallery Plug
50	Rear Lift Bracket
51	Rear Lift Bracket Bolt
52	Cylinder Head Cover Plate
53	Cylinder Head Cover Plate Bolt
54	Fuel Injector Retainer
55	Fuel Injector Bushing
56	Fuel Injector Seal
57	Multiport Fuel Injector
58	Fuel Injector Spacer
59	Fuel Injector O-Ring
60	Fuel Injection Fuel Pressure Sensor Assembly
61	Multiport Fuel Injection Fuel Rail
62	Fuel Injector Wiring Harness Bolt
63	Fuel Injector Wiring Harness
64	Fuel Injector Wiring Harness Bolt

Intake Manifold and Components

14	Low Pressure Fuel Pipe Assembly Bolt
15	Manifold Absolute Pressure (MAP) Sensor Bolt
16	MAP Sensor
17	MAP Sensor O-Ring
18	Intake Manifold Nut
19	Throttle Body
20	Intake Manifold Stud
21	Intake Manifold Insulator Bolt
22	Intake Manifold Insulator
23	Oil Indicator Tube
24	Oil Indicator Tube Bolt
25	Oil Indicator Tube O-Ring
26	Oil Indicator
27	Oil Indicator O-Ring
28	Intake Manifold
29	Fuel Injection Fuel Rail Noise Insulator
30	Evaporative (EVAP) Emission Canister Purge Tube Assembly
31	EVAP Emission Canister Purge Solenoid Valve

Exhaust Manifold and Components

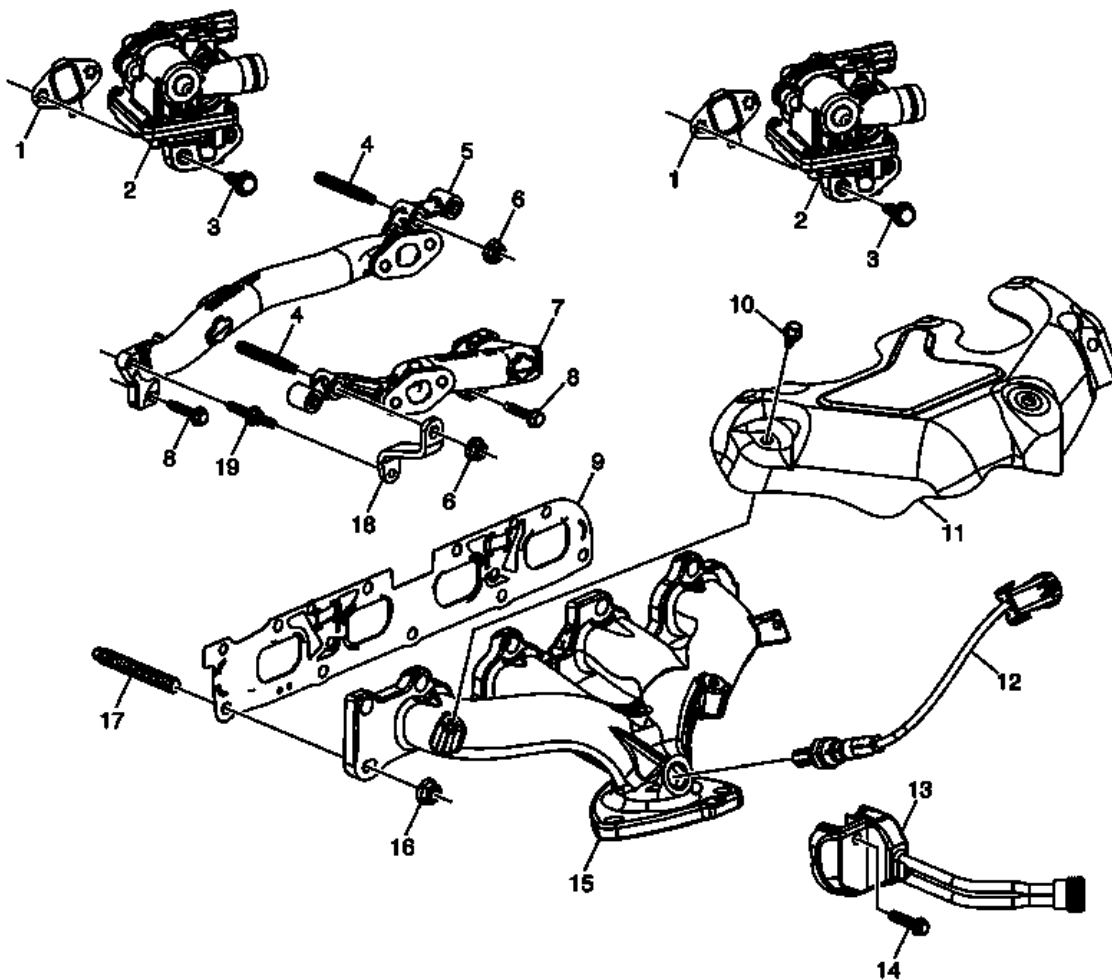


Fig. 3: Exhaust Manifold and Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Secondary Air Injection Check Valve Gasket
2	Secondary Air Injection Check Valve Assembly
3	Secondary Air Injection Check Valve Bolt
4	Secondary Air Injection Assembly Stud
5	Secondary Air Injection Check Valve Pipe Adapter
6	Secondary Air Injection Check Valve Nut
7	Secondary Air Injection Check Valve Pipe Adapter
8	Secondary Air Injection Check Valve Pipe Adapter Bolt
9	Exhaust Manifold Gasket
10	Exhaust Manifold Heat Shield Bolt
11	Exhaust Manifold Heat Shield
12	Oxygen Sensor
13	Block Heater

14	Block Heater Bolt
15	Exhaust Manifold
16	Exhaust Manifold Nut
17	Exhaust Manifold Stud
18	Secondary Air Injection Check Valve Pipe Adapter Bracket
19	Secondary Air Injection Check Valve Pipe Adapter Bolt/Stud

Engine Block and Components

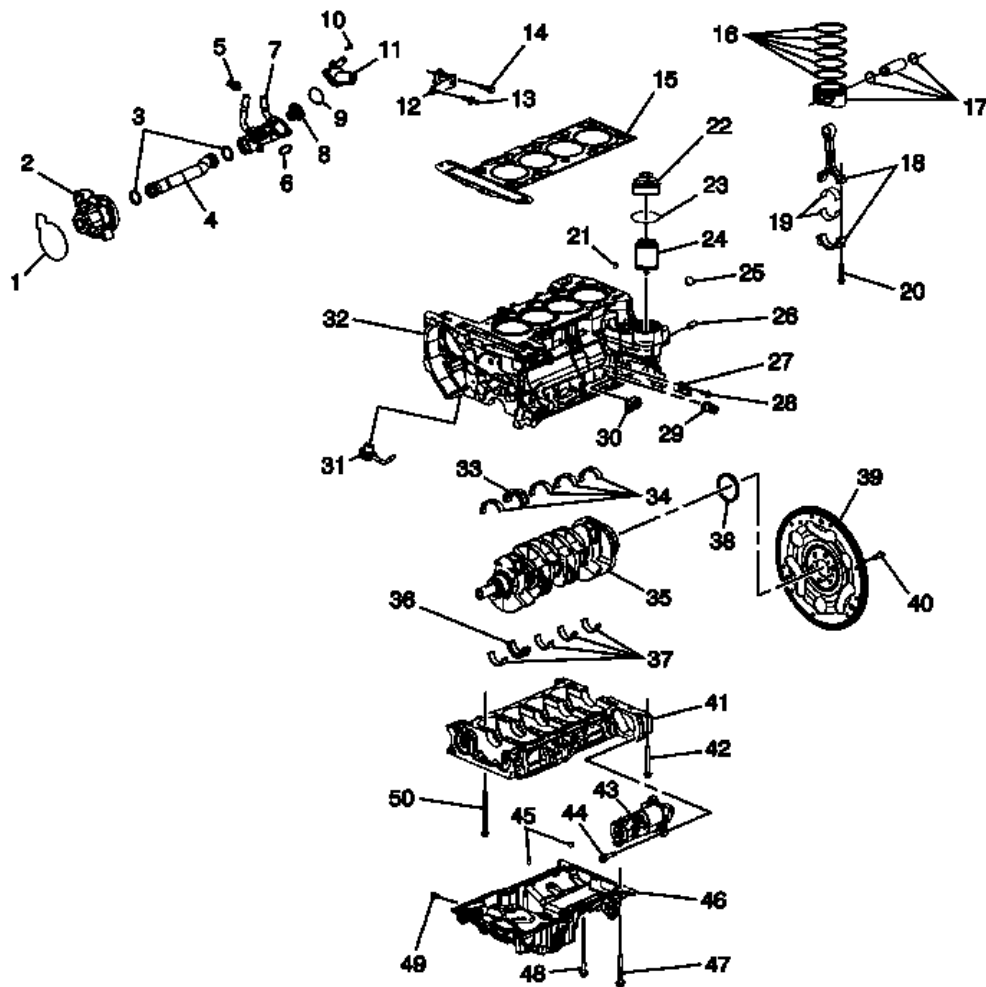


Fig. 4: View Of Engine Block And Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Water Pump to Engine Block Seal
2	Water Pump
3	Water Transfer Pipe O-ring Seals
4	Water Transfer Pipe

5	Coolant Temperature Sensor
6	Thermostat Housing to Block Gasket
7	Thermostat Housing
8	Thermostat
9	Thermostat Gasket
10	Thermostat Housing Cap Bolt
11	Thermostat Housing Cap
12	Water Pipe Support Bracket
13	Water Pipe Support Bracket Bolt Stud
14	Water Pipe Support Bracket Bolt
15	Cylinder Head Gasket
16	Piston Ring Assembly
17	Piston Assembly
18	Connecting Rod
19	Connecting Rod Bearing
20	Connecting Rod Cap Bolt
21	Cylinder Head Alignment Pin
22	Oil Filter Cap
23	Oil Filter Cap O-Ring
24	Oil Filter
25	Engine Block Gallery Plug
26	Engine Block to Transaxle Alignment Pin
27	Crankshaft Position Sensor
28	Crankshaft Position Sensor Bolt
29	Oil Pressure Switch
30	Knock Sensor
31	Piston Oil Nozzle
32	Engine Block
33	Crankshaft Thrust Bearing - Upper
34	Crankshaft Bearing - Upper
35	Crankshaft
36	Crankshaft Thrust Bearing - Lower
37	Crankshaft Bearing - Lower
38	Crankshaft Rear Seal
39	Flywheel
40	Flywheel to Crankshaft Bolt
41	Lower Crankcase
42	Lower Crankcase Perimeter Bolt
43	Starter
44	Starter Bolt
45	Engine Oil Pan Alignment Pins

	Engine Oil Pan
47	Engine Oil Pan Long Bolt
48	Engine Oil Pan Bolt
49	Engine Oil Pan Drain Plug
50	Lower Crankcase Main Bearing Bolt

Timing Chain and Components

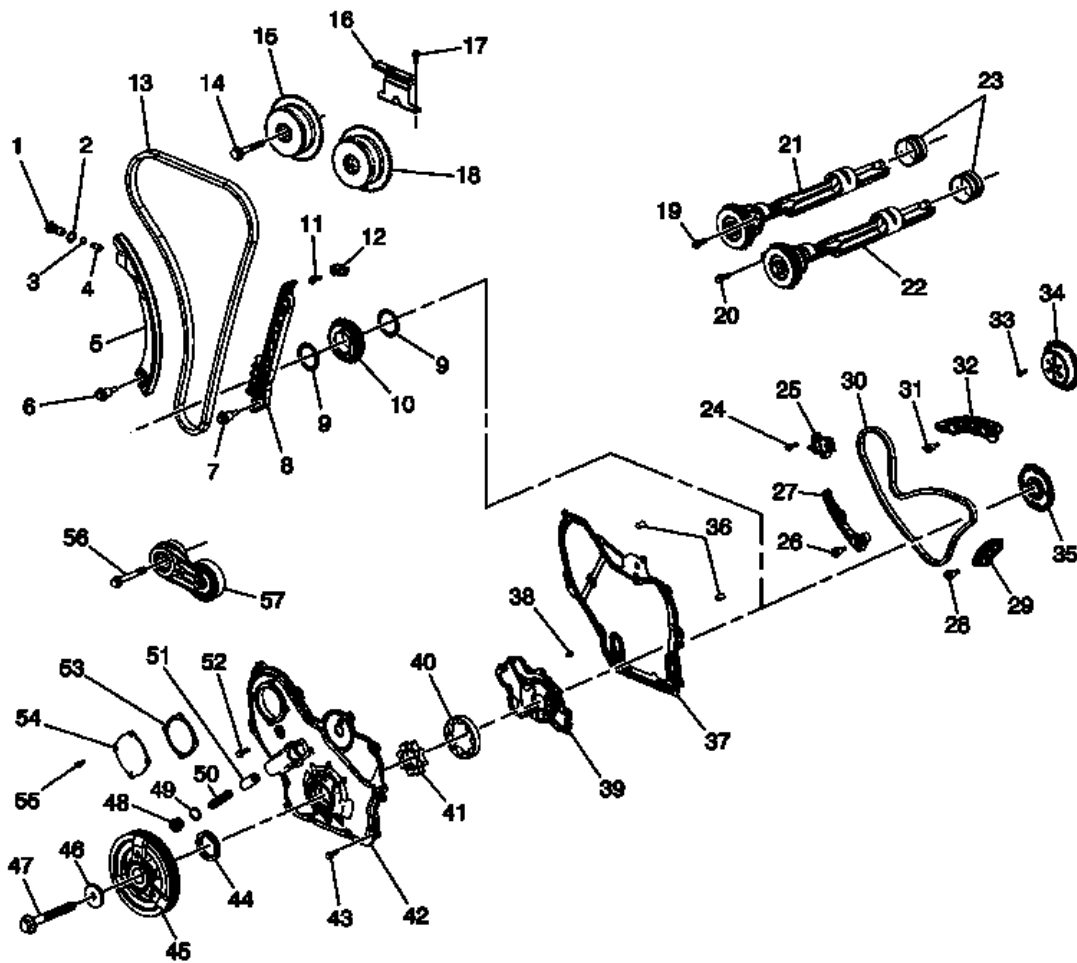


Fig. 5: Timing Chain and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Timing Chain Tensioner Body
2	Timing Chain Tensioner Washer
3	Timing Chain Tensioner O-Ring Seal
4	Timing Chain Tensioner Plunger
5	Adjustable Timing Chain Guide

6	Adjustable Timing Chain Guide Bolt
7	Fixed Timing Chain Guide Bolt
8	Fixed Timing Chain Guide
9	Friction Washer
10	Timing Chain Drive Sprocket
11	Timing Chain Oil Nozzle Bolt
12	Timing Chain Oil Nozzle
13	Timing Chain
14	Camshaft Position Actuator Bolt
15	Exhaust Camshaft Position Actuator
16	Upper Timing Chain Guide
17	Upper Timing Chain Guide Bolt
18	Intake Camshaft Position Actuator
19	Exhaust Balance Shaft Assembly Bolt
20	Intake Balance Shaft Assembly Bolt
21	Exhaust Balance Shaft Assembly
22	Intake Balance Shaft Assembly
23	Balance Shaft Rear Bearing
24	Balance Shaft Drive Chain Tensioner Assembly Bolt
25	Balance Shaft Drive Chain Tensioner Assembly
26	Adjustable Balance Shaft Drive Chain Guide Bolt
27	Adjustable Balance Shaft Drive Chain Guide
28	Balance Shaft Drive Chain Guide Bolt
29	Balance Shaft Drive Chain Guide
30	Balance Shaft Drive Chain
31	Balance Shaft Drive Chain Guide Bolt
32	Balance Shaft Drive Chain Guide
33	Water Pump Drive Sprocket Bolt
34	Water Pump Drive Sprocket
35	Balance Shaft Drive Sprocket
36	Engine Front Cover Alignment Pins
37	Engine Front Cover Gasket
38	Oil Pump Cover Bolt
39	Oil Pump Cover
40	Oil Pump Outer Gerotor
41	Oil Pump Inner Gerotor
42	Engine Front Cover
43	Engine Front Cover Bolt
44	Crankshaft Front Seal
45	Crankshaft Balancer
46	Crankshaft Balancer Washer

	Crankshaft Balancer Bolt
48	Oil Pressure Relief Valve Plug
49	Oil Pressure Relief Valve O-Ring Seal
50	Oil Pressure Relief Valve Spring
51	Oil Pressure Relief Valve Plunger
52	Water Pump Bolt
53	Engine Front Cover Access Plate Gasket
54	Engine Front Cover Access Plate
55	Engine Front Cover Access Plate Bolt
56	Belt Tensioner Bolt
57	Belt Tensioner

ENGINE IDENTIFICATION (LEA, OR LUK)

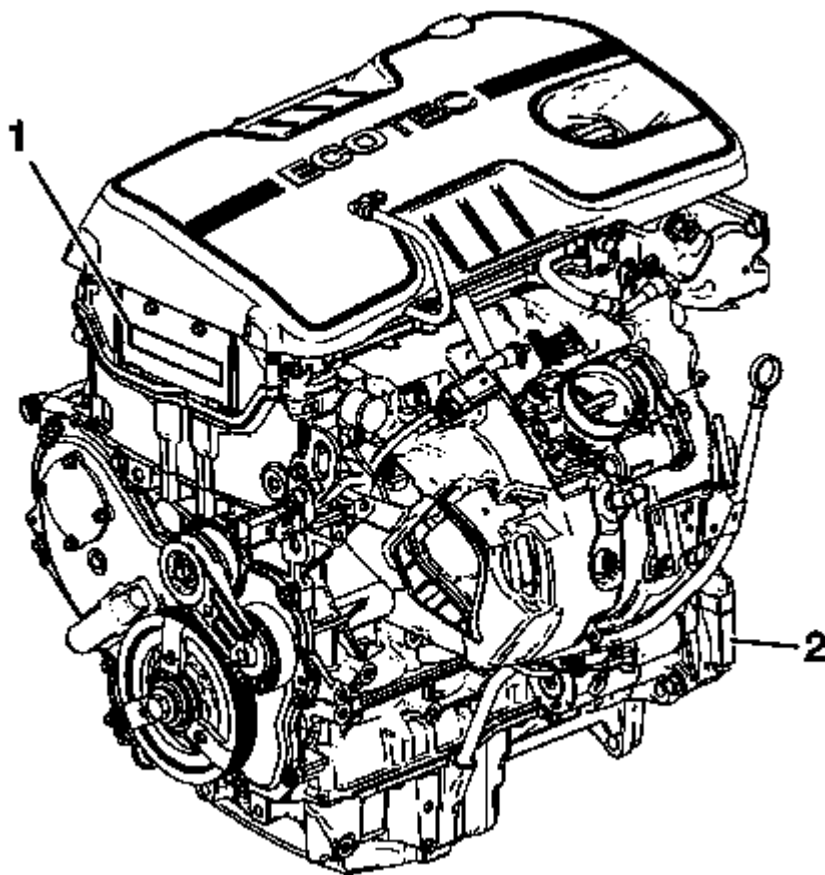


Fig. 6: Engine Identification Points

Courtesy of GENERAL MOTORS COMPANY

Identification can be made through the use of the Broadcast Code label on the engine (1) and the use of the partial VIN etched in one of two places - the primary location is on the starter motor flange (2). The secondary location is the oil filter bowl.

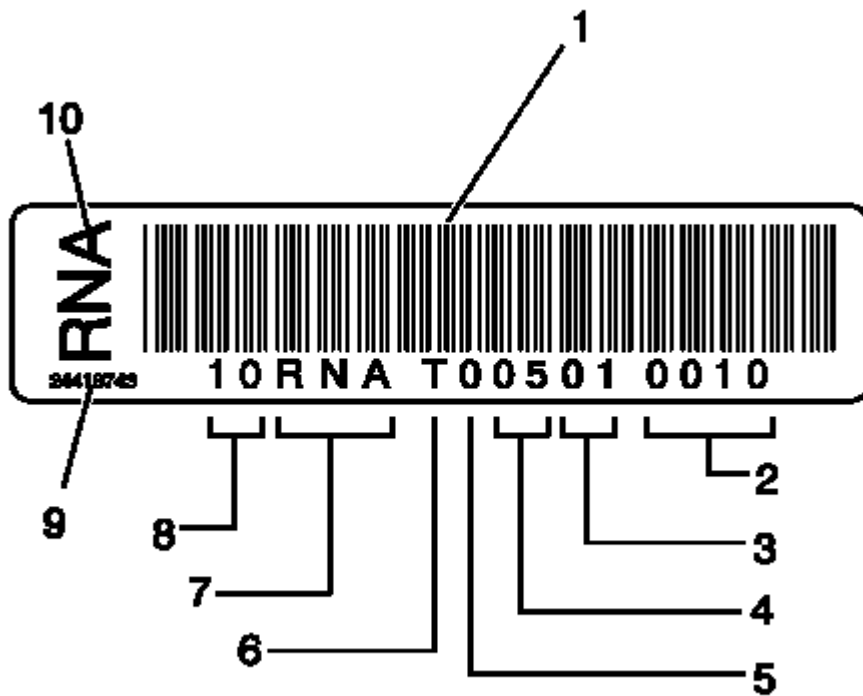


Fig. 7: View Of Broadcast Code Label
Courtesy of GENERAL MOTORS COMPANY

- Barcode (1)
- Sequence Number (2)
- Day (3)
- Month (4)
- Year (5)
- Engine Assembly Plant (6)
- Broadcast Code (7)
- Part Designation (8)
- Engine Assembly Number (9)
- Broadcast Code (10)

The partial VIN identifies the specific vehicle by sequence number.

Engine

Engine Mechanical - 2.4L (LEA LUK) - Description and Operation

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

General Description

A crankcase ventilation system is used to consume crankcase vapors in the combustion process instead of venting them to atmosphere. Fresh air from the intake system is supplied to the crankcase, mixed with blow by gases and then passed through a calibrated orifice into the intake manifold.

Operation

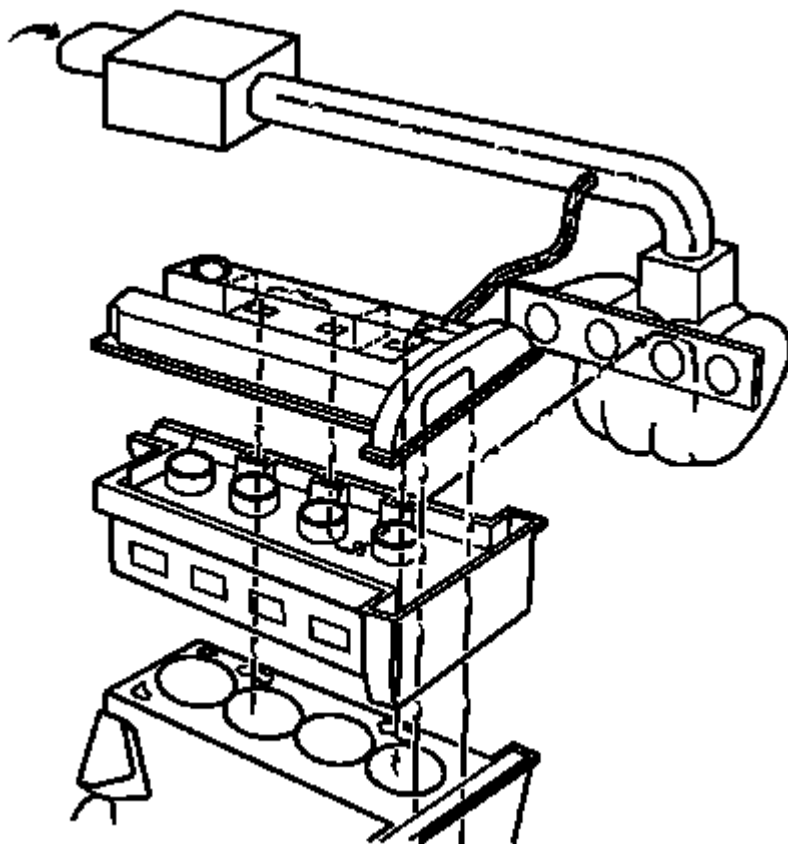


Fig. 1: Identifying Crankcase Ventilation System
Courtesy of GENERAL MOTORS COMPANY

The primary control is through the positive crankcase ventilation (PCV) orifice which meters the flow at a rate depending on inlet vacuum. The PCV orifice is an integral part of the camshaft cover. If abnormal operating conditions occur, the system is designed to allow excessive amounts of blow by gases to back flow through the

crankcase vent into the intake system to be consumed by normal combustion.

Results of Incorrect Operation

A plugged orifice may cause the following conditions:

- Rough idle
- Stalling or slow idle speed
- Oil leaks
- Sludge in engine

A leaking orifice may cause the following conditions:

- Rough idle
- Stalling
- High idle speed

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
 - The power steering pump, if belt driven
 - The generator
 - The A/C compressor, if equipped
 - The engine cooling fan, if belt driven
 - The water pump, if belt driven
 - The vacuum pump, if equipped
 - The air compressor, if equipped

The drive belt system may use one belt or two belts. The drive belt is thin so that it can bend backward and has several ribs to match the grooves in the pulleys. There also may be a V-belt style belt used to drive certain accessory drive components. The drive belts are made of different types of rubber (chloroprene or EPDM) and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

ENGINE COMPONENT DESCRIPTION (LEA, OR LUK)

Engine Description

Cylinder Block

The cylinder block is constructed of aluminum alloy by precision sand-casting with 4 cast-in-place iron cylinder liners arranged in-line. The block has 5 crankshaft bearings with the thrust bearing located on the second bearing from the front of the engine. The cylinder block incorporates a bedplate design that forms an upper and lower crankcase. This design promotes cylinder block rigidity and reduced noise and vibration.

Crankshaft

The crankshaft is cast nodular iron with 8 counterweights. The number 8 counterweight is also the ignition system reluctor wheel. The main bearing journals are cross-drilled, and the upper bearings are grooved. The crankshaft has a slip fit balance shaft drive sprocket. Number 2 main bearing is the thrust bearing. The crankshaft balancer is used to control torsional vibration.

Connecting Rod and Piston

The connecting rods are powdered metal. The connecting rod incorporates the floating piston pin. The pistons are cast aluminum. The piston rings are of a low tension type to reduce friction. The top compression ring is ductile iron with a molybdenum facing and phosphate coated sides. The second compression ring is gray iron. The oil ring is a 3-piece spring construction with chromium plating.

Oil Pan

The oil pan is die cast aluminum. The oil pan includes an attachment to the transmission to provide additional structural support.

Balance Shaft Assembly

There are 2 block mounted balance shafts located on each side of the crankcase at the bottom of the cylinder bores. The balance shafts are driven by a single roller chain that also drives the water pump. The chain is tensioned by a hydraulic tensioner that is supplied pressure by the engine oil pump. This design promotes the maximum effectiveness of the balance shaft system and reduces noise and vibration.

Cylinder Head

The cylinder head is a semi-permanent mold. Pressed-in powdered metal valve guides and valve seat insets are used. The fuel injection nozzle is located in the intake port. The cylinder head incorporates camshaft journals and camshaft caps.

Valves

There are 2 intake and 2 exhaust valves per cylinder. Rotators are used on all of the intake valves. The rotators are located at the bottom of the valve spring to reduce valve train reciprocating mass. Positive valve stem seals are used on all valves.

Camshaft

Two camshafts are used, one for all intake valves, the other for all exhaust valves. The camshafts are cast iron.

Valve Lash Adjusters

The valve train uses a roller finger follower acted on by a hydraulic lash adjuster. The roller finger follower reduces friction and noise.

Camshaft Cover

The camshaft cover has a steel crankcase ventilation baffling incorporated. The camshaft cover has mounting locations for the ignition system.

Camshaft Drive

A roller chain is used for camshaft drive. There is a tensioner and active guide used on the slack side of the chain to control chain motion and noise. The chain drive promotes long valve train life and low maintenance.

Intake and Exhaust Manifold

The intake manifold is made of composite plastic. The exhaust manifold is cast iron. The intake manifold incorporates a distribution and control system for positive crankcase ventilation (PCV) gases. The exhaust manifold is a dual plane design that promotes good low end torque and performance.

LUBRICATION DESCRIPTION

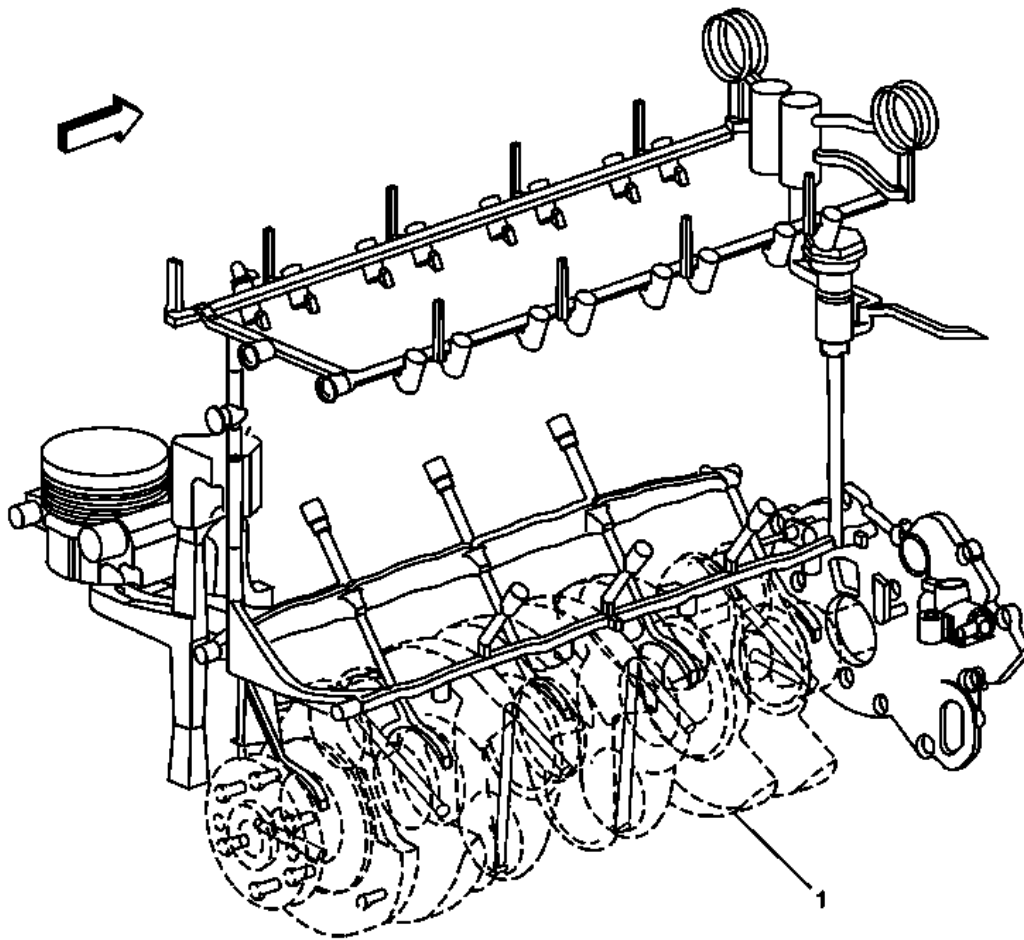


Fig. 2: Lubrication System

Courtesy of GENERAL MOTORS COMPANY

Oil is applied under pressure to the crankshaft (1), connecting rods, balance shaft assembly, camshaft bearing surfaces, valve lash adjusters and timing chain hydraulic tensioner. All other moving parts are lubricated by gravity flow or splash. Oil enters the gerotor type oil pump through a fixed inlet screen. The oil pump is driven by the crankshaft. The oil pump body is within the engine front cover. The pressurized oil from the pump passes through the oil filter. The oil filter is located on the left rear side of the engine block. The oil filter is housed in a casting that is integrated with the engine block. The oil filter is a disposable cartridge type. A by-pass valve in the filter cap allows continuous oil flow in case the oil filter should become restricted. Oil then enters the gallery where it is distributed to the balance shafts, crankshaft, camshafts and camshaft timing chain oiler nozzle. The connecting rod bearings are oiled by constant oil flow passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. The pressurized oil passes through the cylinder head restrictor orifice into the cylinder head and then into each camshaft feed gallery. Cast passages feed each hydraulic element adjuster and drilled passages feed each camshaft bearing surface. An engine oil pressure switch or sensor is installed at the end. Oil returns to the oil pan through passages cast into the cylinder head. The timing chain lubrication drains directly into the oil pan.

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished, and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces during initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

SEPARATING PARTS

NOTE:

- **Disassembly of the piston, press fit design piston pin, and connecting rod may create scoring or damage to the piston pin and piston pin bore. If the piston, pin, and connecting rod have been disassembled, replace the components as an assembly.**
- **Many internal engine components will develop specific wear patterns on their friction surfaces.**
- **When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.**

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod to the crankshaft journal
- Connecting rod to the bearing cap

A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.

- Crankshaft main and connecting rod bearings
- Camshaft and valve lash adjusters
- Valve lash adjusters, lash adjuster guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

REPLACING ENGINE GASKETS

Special Tools

EN-28410 Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

Gasket Reuse and Applying Sealants

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the **EN-28410** remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.
 - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
 - This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tightened.
- Tighten bolts to specifications. Do not overtighten.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

Three types of sealer are commonly used in engines. These are RTV sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil

leaks. DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

Room Temperature Vulcanizing (RTV) Sealer

- RTV sealant hardens when exposed to air. This type sealer is used where 2 rigid parts, such as the lower crankcase and the engine block, are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

- Apply RTV to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause damage when the bolt is tightened.
- Assemble components while RTV is still wet, within 3 minutes. Do not wait for RTV to skin over.
- Tighten bolts to specifications. Do not overtighten.

Anaerobic Sealer

- Anaerobic gasket eliminator hardens in the absence of air. This type sealer is used where two rigid parts (such as castings) are assembled together. When two rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

- Apply a continuous bead of gasket eliminator to one flange. Surfaces to be resealed must be clean and dry.
- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.
- Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause damage when tightened.

NOTE: **Anaerobic sealed joints that are partially torqued and allowed to cure more than five minutes may result in incorrect shimming and sealing of the joint.**

- Tighten bolts to specifications. Do not overtighten.
- After properly tightening the fasteners, remove the excess sealer from the outside of the joint.

Pipe Joint Compound

- Pipe joint compound is a pliable sealer that does not completely harden.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include:

exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.

- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when the bolt is tightened.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.

TOOLS AND EQUIPMENT

Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

Engine

Engine Mechanical - 2.4L (LEA/LUK) - Diagnostic Information and Procedures

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **Disassembled Views** , **Engine Component Description (LEA, or LUK)** , and **Lubrication Description** .

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**

- Upper Engine Noise, Regardless of Engine Speed
- Lower Engine Noise, Regardless of Engine Speed
- Engine Noise Under Load
- Engine Will Not Crank - Crankshaft Will Not Rotate
- Engine Compression Test
- Oil Consumption Diagnosis
- Oil Pressure Diagnosis and Testing
- Oil Leak Diagnosis
- Drive Belt Chirping, Squeal, and Whine Diagnosis
- Drive Belt Rumbling and Vibration Diagnosis
- Drive Belt Falls Off and Excessive Wear Diagnosis
- Drive Belt Tensioner Diagnosis

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Base Engine Misfire without Internal Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, and repair or replace as required.
A loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Improperly installed or damaged MAP sensor The sealing grommet of the MAP sensor should not	Repair or replace the MAP sensor as required.

be torn or damaged.	
Damage to the MAP sensor housing	Replace the intake manifold.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lash adjusters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression.	<ul style="list-style-type: none"> • Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	<ul style="list-style-type: none"> • Inspect for spark plugs saturated by coolant. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> • Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
<p>A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage.</p> <ul style="list-style-type: none"> • Systems with electronic communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of 	Replace the sensor and/or crankshaft as required.

generating a P0300 DTC or P0336.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine, and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none">• Inspect the spark plugs for oil deposits.• Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>.• Perform cylinder leak down and compression testing to determine the cause.• Repair or replace as required.
Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft, and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should intact within the rocker arm assembly.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.

Worn camshaft lobes	Replace the camshaft and valve lash adjusters.
Sticking lifters	Replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	<ol style="list-style-type: none"> 1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to <u>Camshaft Position Intake Actuator Replacement</u> , or <u>Camshaft Position Exhaust Actuator Replacement</u> .

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Base Engine Misfire with Coolant Consumption

Cause	Correction
Faulty cylinder head gasket and/or cracking, or other damage to the cylinder head and engine block cooling system passages. Coolant consumption may or may not cause the engine to overheat.	<ul style="list-style-type: none"> • Inspect for spark plugs saturated by coolant. • Perform a cylinder leak down test. • Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Base Engine Misfire with Excessive Oil Consumption

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	<ul style="list-style-type: none"> • Inspect the spark plugs for oil deposits. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> • Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.

ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

Engine Noise on Start-Up, but Only Lasting a Few Seconds

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Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	<ol style="list-style-type: none"> 1. Drain the oil. 2. Install the correct viscosity oil.
High valve lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	<ol style="list-style-type: none"> 1. Inspect the thrust bearing and crankshaft. 2. Repair or replace as required.
Damaged or faulty oil filter by-pass valve	<ol style="list-style-type: none"> 1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	<ol style="list-style-type: none"> 1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to <u>Camshaft Position Intake Actuator Replacement</u> , or <u>Camshaft Position Exhaust Actuator Replacement</u> .

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> • Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace as required.
Loose and/or worn valve rocker arm attachments	<ul style="list-style-type: none"> • Inspect the valve rocker arm stud, nut or bolt. • Repair or replace as required.
Worn valve rocker arm	Replace the valve rocker arm.
Improper lubrication to the valve rocker arms	<p>Inspect the following components, and repair or replace as required:</p> <ul style="list-style-type: none"> • The valve rocker arm • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries

Broken valve spring	Replace the valve spring.
Worn or dirty valve lash adjusters	Replace the valve lash adjusters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn, damaged, or faulty timing chain tensioners	Replace tensioners
Worn engine camshaft lobes	<ul style="list-style-type: none"> Inspect the engine camshaft lobes. Replace the camshaft and valve lash adjusters as required.
Worn valve guides or valve stems	<p>Inspect the following components, and repair as required:</p> <ul style="list-style-type: none"> The valves The valve guides
<p>Stuck valves</p> <p>Carbon on the valve stem or valve seat may cause the valve to stay open.</p>	<p>Inspect the following components, and repair as required:</p> <ul style="list-style-type: none"> The valves The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. Repair or replace damaged components as required.
Worn accessory drive components - abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt and/or misalignment of system components	<ol style="list-style-type: none"> Inspect the accessory drive system. Repair or replace as required.
Loose or damaged crankshaft balancer	<ol style="list-style-type: none"> Inspect the crankshaft balancer. Repair or replace as required.
Detonation or spark knock	<p>Verify the correct operation of the ignition system. Refer to <u>Symptoms - Engine Controls (LUK)</u> , <u>Symptoms - Engine Controls (LEA)</u> .</p>
Loose torque converter bolts	<ol style="list-style-type: none"> Inspect the torque converter bolts and flywheel. Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen - an oil pan that has been damaged, may improperly	<ol style="list-style-type: none"> Inspect the oil pan. Inspect the oil pump screen.

position the oil pump screen, preventing proper oil flow to the oil pump.	3. Repair or replace as required.
Oil pump screen loose, damaged or restricted	1. Inspect the oil pump screen. 2. Repair or replace as required.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston and cylinder bore. 2. Repair as required.
Excessive piston pin-to-bore clearance	1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: <ul style="list-style-type: none"> • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: <ul style="list-style-type: none"> • The crankshaft bearings • The crankshaft journals
Incorrect piston, piston pin, and connecting rod installation - pistons must be installed with the mark or dimple on the top of the piston, facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	1. Verify the pistons, piston pins and connecting rods are installed correctly. 2. Repair as required.

ENGINE NOISE UNDER LOAD

Engine Noise Under Load

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u> . 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition. Refer to <u>Symptoms - Engine Controls (LUK)</u> , <u>Symptoms - Engine Controls (LEA)</u> .
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair as required.
Cracked flywheel, automatic transmission	1. Inspect the flywheel bolts and flywheel. 2. Repair as required.

Excessive connecting rod bearing clearance	<p>Inspect the following components, and repair as required:</p> <ul style="list-style-type: none"> • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	<p>Inspect the following components, and repair as required:</p> <ul style="list-style-type: none"> • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	<ol style="list-style-type: none"> 1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to <u>Camshaft Position Intake Actuator Replacement</u> , or <u>Camshaft Position Exhaust Actuator Replacement</u> .

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component	<ol style="list-style-type: none"> 1. Remove accessory drive belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder <ul style="list-style-type: none"> • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder 	<ol style="list-style-type: none"> 1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Inspect for cracked cylinder wall.
Seized automatic transmission torque converter	<ol style="list-style-type: none"> 1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	<ol style="list-style-type: none"> 1. Disengage the clutch.

	2. Rotate crankshaft by hand at the balancer or flywheel location.
Broken timing chain and/or gears	1. Inspect timing chain and gears. 2. Repair as required.
Seized balance shaft	1. Inspect balance shaft. 2. Repair as required.
Material in cylinder <ul style="list-style-type: none"> • Broken valve • Piston material • Foreign material • Cracked cylinder wall 	1. Inspect cylinder for damaged components and/or foreign materials. 2. Inspect for fallen cylinder wall. 3. Repair or replace as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings. 2. Inspect for fallen cylinder wall. 3. Repair as required.
Bent or broken connecting rod	1. Inspect connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

COOLANT IN COMBUSTION CHAMBER

Coolant in Combustion Chamber

Cause	Correction
<p>DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage.</p> <ol style="list-style-type: none"> 1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u>. 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. 3. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. 4. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>. 	
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection (LEA, or LUK)</u> , and <u>Cylinder Head Replacement</u> .

Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Cleaning and Inspection (LEA, or LUK)</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner	Replace the components as required.
Cylinder head or block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Coolant in Engine Oil

Cause	Correction
<p>DEFINITION: Foamy or discolored oil or an engine oil "overfill" condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.</p> <ol style="list-style-type: none"> 1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u>. 2. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block with low compression may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>. 	
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection (LEA, or LUK)</u> , and <u>Cylinder Head Replacement</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Cleaning and Inspection (LEA, or LUK)</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner	Replace the components as required.
Cylinder head or block porosity	Replace the components as required.

ENGINE COMPRESSION TEST

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.
4. Remove all spark plugs.
5. Turn the ignition to the ON position.
6. Depress the accelerator pedal to position the throttle plate wide open.
7. Start with the compression gauge at zero and crank the engine through 4 compression strokes, 4 puffs.

8. Measure the compression for each cylinder. Record the readings.
9. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.
10. The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any 1 cylinder is 1 035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). ($1\ 035 \times 70\% = 725$) ($150 \times 70\% = 105$).
 - Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
 - Piston Rings Leaking - Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.
 - Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
 - If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

CYLINDER LEAKAGE TEST

Special Tools

EN 35667-A Cylinder Head Leakdown Tester

For equivalent regional tools, refer to **Special Tools** .

NOTE: **A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High leakage may indicate one or more of the following:**

- Worn or burnt valves
- Broken valve springs
- Stuck valve lash adjusters
- Incorrect valve lash/adjustment
- Damaged piston
- Worn piston rings
- Worn or scored cylinder bore
- Damaged cylinder head gasket
- Cracked or damaged cylinder head
- Cracked or damaged engine block

WARNING: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal.

Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** .
3. Rotate the crankshaft to place the piston in the cylinder being tested at Top Dead Center (TDC) of the compression stroke.
4. Install the **EN 35667-A** tester or equivalent.

NOTE: It may be necessary to hold the crankshaft balancer bolt to prevent the engine from rotating.

5. Apply shop air pressure to the **EN 35667-A** tester and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
 - Air leakage sounds at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
 - Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
 - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
 - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

Excessive oil consumption, not due to leaks, is the use of 0.9 L (1 qt) or greater of engine oil within 3 200 kilometers (2,000 miles). The causes of excessive oil consumption include the following conditions:

- External oil leaks

Tighten bolts and/or replace gaskets and oil seals as necessary.

- Incorrect oil level or improper reading of oil level indicator

With the vehicle on a level surface, allow adequate drain down time and inspect for the correct oil level.

- Improper oil viscosity

Use recommended SAE viscosity for the prevailing temperatures.

- Continuous high speed driving and/or severe usage
- Crankcase ventilation system restrictions or malfunctioning components
- Valve guides and/or valve stem oil seals worn, or the seal omitted

Ream guides and install oversize service valves and/or new valve stem oil seals.

- Piston rings broken, improperly installed, worn, or not seated properly

Allow adequate time for rings to seat. Replace broken or worn rings, as necessary.

- Piston improperly installed or mis-fitted

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **CH-48027** Digital Pressure Gauge
- **EN-21867-850** Oil Pressure Gauge Adapter

For equivalent regional tools, refer to **Special Tools** .

1. With the vehicle on a level surface, allow adequate drain down time of 2-3 minutes and measure for a low oil level.

Add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.

2. Run the engine, and verify low, or no oil pressure on the vehicle gauge or light.

Listen for a noisy valve train or a knocking noise.

3. Inspect for the following:
 - Correct oil filter with anti-drain back feature and O-ring on the cylinder block side of the filter
 - Oil diluted by moisture or unburned fuel mixtures
 - Improper oil viscosity for the expected temperature
 - Incorrect or malfunctioning oil pressure sender
 - Incorrect or malfunctioning oil pressure gauge
 - Plugged oil filter
 - Malfunctioning oil bypass valve
4. Remove the oil pressure sender or another engine block oil gallery plug.
5. Install **EN-21867-850** adapter and **CH-48027** gauge and measure the engine oil pressure.
6. Compare the readings to specifications. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .
7. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
 - Correct oil filter with anti-drain back feature and O-ring on the cylinder block side of the filter
 - Oil pump worn or dirty

Refer to **Oil Pump Disassemble** .

- Oil pump-to-engine front cover bolts loose

Refer to **Engine Front Cover and Oil Pump Installation (LUK)** , **Engine Front Cover and Oil Pump Installation (LEA)** .

- Oil pump screen loose, plugged, or damaged
- Oil pump screen O-ring seal missing or damaged
- Malfunctioning oil pump pressure regulator valve
- Excessive bearing clearance

Refer to **Crankshaft and Bearing Cleaning and Inspection** .

- Cracked, porous or restricted oil galleries
- Oil gallery plugs missing or incorrectly installed

Refer to **Engine Block Assemble** .

- Broken lash adjusters

OIL LEAK DIAGNOSIS

Oil Leak Diagnosis

Step	Action	Yes	No
DEFINITION: You can repair most fluid leaks by first, visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the			

leak. Repair the cause of the leak as well as the leak itself.

1	<ol style="list-style-type: none"> 1. Operate the vehicle until it reaches normal operating temperature. Refer to <u>Engine Mechanical Specifications (LEA, or LUK)</u> . 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Check for drippings. <p>Are drippings present?</p>	Go to Step 2	System OK
2	<p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 3
3	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 4
4	<ol style="list-style-type: none"> 1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 5
5	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 6

6	<ol style="list-style-type: none"> 1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 7
7	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 8
8	<p>Use EN 28428-E Dye and Light Kit , in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool.</p> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 9
9	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	System OK
	<ol style="list-style-type: none"> 1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas: <ul style="list-style-type: none"> • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves 		

10	<ul style="list-style-type: none"> • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces <p>2. Inspect the engine for customer modifications.</p> <p>Is there mechanical damage, or customer modifications to the engine?</p>	Go to Step 11	System OK
11	<p>Repair or replace all damaged or modified components.</p> <p>Did you complete the repair?</p>	Go to Step 1	-

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS (WITHOUT TURBOCHARGER)

Special Tools

EN 23951 Valve Manometer

1. Remove the oil level indicator. Install a **EN 23951** valve manometer or equivalent.
2. Start the engine.
3. Check for slight vacuum. The vacuum level should be less than 3.377 kPa (1 in Hg).
4. If vacuum is higher, inspect and verify that the clean air hose from cam cover to air intake is not blocked or kinked.
5. If vacuum is in the normal range, block or pinch off the clean air hose. The clean air hose is the hose between the cam cover and air intake system. Vacuum should increase on the manometer. If held too long, vacuum will be drawn through the crankshaft seals creating a sucking sound.
6. If vacuum does not increase, the orifice in the intake manifold could be plugged.
7. If there is zero vacuum or pressure, verify compression of the engine.
8. If compression is normal, check for a blocked orifice at the intake manifold. Clean the orifice.

DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they

are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.

- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.

3

The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4

Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.

6

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

10

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.

12

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

14

This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.

15

This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.

16

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

17

This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.

19

Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

Drive Belt Chirping, Squeal, and Whine Diagnosis

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The following items are indications of chirping: <ul style="list-style-type: none"> • A high pitched noise that is heard once per revolution of the drive belt or a pulley • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp. 			
DEFINITION: The following items are indications of drive belt squeal: <ul style="list-style-type: none"> • A loud screeching noise that is caused by a slipping drive belt-This is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component. 			

DEFINITION: The following items are indications of drive belt whine:

- A high pitched continuous noise
- The noise may be caused by an accessory drive component failed bearing.

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a chirping, squeal, or whine noise. Does the engine make the chirping, squeal, or whine noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belts. Does the chirping, squeal, or whine noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13. Do the belt grooves have pilling?	Go to Step 5	Go to Step 6
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to Step 20	Go to Step 6
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to Step 7	Go to Step 8
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to Step 20	Go to Step 8
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to Step 9	Go to Step 10
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to Step 20	Go to Step 10
10	Inspect for improper, loose, or missing fasteners. Did you find the condition?	Go to Step 11	Go to Step 12
	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to		

11	<u>Fastener Tightening Specifications (LEA, or LUK)</u> . 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to Step 20	Go to Step 12
12	Inspect for a bent pulley. Did you find the condition?	Go to Step 18	Go to Step 19
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to Step 20	Go to Step 14
14	Test the drive belt tensioner for proper operation. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Did you find and correct the condition?	Go to Step 20	Go to Step 15
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to Step 20	Go to Step 16
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 20	Go to Step 17
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 20	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to Step 20	Go to Step 19
19	Replace the drive belt. Refer to <u>Drive Belt Replacement (LEA)</u> , <u>Drive Belt Replacement (LUK)</u> . Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

The drive belt may have a rumbling condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belts are installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

3

This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4

Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt or felt as a lump in the belt.

5

Small amounts of pilling is normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.

9

Inspecting of the fasteners can eliminate the possibility that the wrong bolt, nut, spacer, or washer was installed.

11

This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.

12

Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

Drive Belt Rumbling and Vibration Diagnosis

Step	Action	Yes	No
CAUTION:			

Refer to **Belt Dressing Caution** .

DEFINITION: The following items are indications of drive belt rumbling:

- A low pitch tapping, knocking, or thumping noise heard at or just above idle.
- Heard once per revolution of the drive belt or a pulley.
- Rumbling may be caused from:
 - Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove
 - The separation of the drive belt
 - A damaged drive belt

DEFINITION: The following items are indications of drive belt vibration:

- The vibration is engine-speed related.
- The vibration may be sensitive to accessory load.

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	Go to <u>Symptoms - Engine Mechanical</u> or Vibration Analysis - Engine	Go to Step 4
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to <u>Drive Belt</u>		

	<u>Replacement (LEA) , Drive Belt Replacement (LUK) .</u>		
	Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <u>Drive Belt Replacement (LEA) , Drive Belt Replacement (LUK) .</u> Did you complete the replacement?	Go to Step 8	Go to Step 9
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 9
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 10	Go to Step 11
10	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications (LEA, or LUK) .</u> 2. Replace improper or missing fasteners. Did you complete the repair?	Go to Step 13	Go to Step 11
11	Inspect for a bent water pump shaft. Did you find and correct the condition?	Go to Step 13	Go to Step 12
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 13	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

If the drive belt repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.

An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate properly.

If the drive belt is the incorrect length, the drive belt tensioner may not keep the proper tension on the drive belt.

Excessive wear on a drive belt is usually caused by an incorrect installation or the wrong drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.

Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall

off.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

This inspection is to verify the condition of the drive belt. Damage may have occurred to the drive belt when the drive belt fell off. The drive belt may have been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plies.

4

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.

5

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

6

Accessory drive component brackets that are bent or cracked will let the drive belt fall off.

7

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed. Missing, loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

13

The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.

14

The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

15

This inspection is to verify the drive belt is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

Drive Belt Falls Off and Excessive Wear Diagnosis

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to <u>Drive Belt Replacement (LEA)</u> , <u>Drive Belt Replacement (LUK)</u> . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications (LEA, or LUK)</u> . 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to <u>Drive Belt Replacement (LEA)</u> , <u>Drive Belt Replacement (LUK)</u> . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <u>Drive Belt Replacement (LEA)</u> , <u>Drive Belt Replacement (LUK)</u> .		

	Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2
13	Inspect the drive belt for the proper installation. Refer to <u>Drive Belt Replacement (LEA)</u> , <u>Drive Belt Replacement (LUK)</u> . Did you find this condition?	Go to Step 16	Go to Step 14
14	Inspect for the proper drive belt. Did you find this condition?	Go to Step 16	Go to Step 15
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 17	Go to Diagnostic Aids
16	Replace the drive belt. Refer to <u>Drive Belt Replacement (LEA)</u> , <u>Drive Belt Replacement (LUK)</u> . Did you complete the replacement?	Go to Step 17	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

Drive Belt Tensioner Diagnosis

Step	Action	Yes	No
1	1. Remove the drive belt. Refer to <u>Drive Belt Replacement (LEA)</u> , <u>Drive Belt Replacement (LUK)</u> . 2. Inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to Step 4	Go to Step 2
2	Rotate the drive belt tensioner Does the tensioner rotate without any unusual resistance or binding?	Go to Step 3	Go to Step 4
3	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10 percent of the second torque reading?	System OK	Go to Step 4

4	Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement (LUK)</u> , <u>Drive Belt Tensioner Replacement (LEA)</u> . Is the repair complete?	System OK	-
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Engine

Engine Mechanical - 2.4L (LEA LUK) - Repair Instructions - Off Vehicle

REPAIR INSTRUCTIONS - OFF VEHICLE

DRAINING FLUIDS AND OIL FILTER REMOVAL

Special Tools

EN-44887 Oil Filter Wrench

For equivalent regional tools, refer to Special Tools .

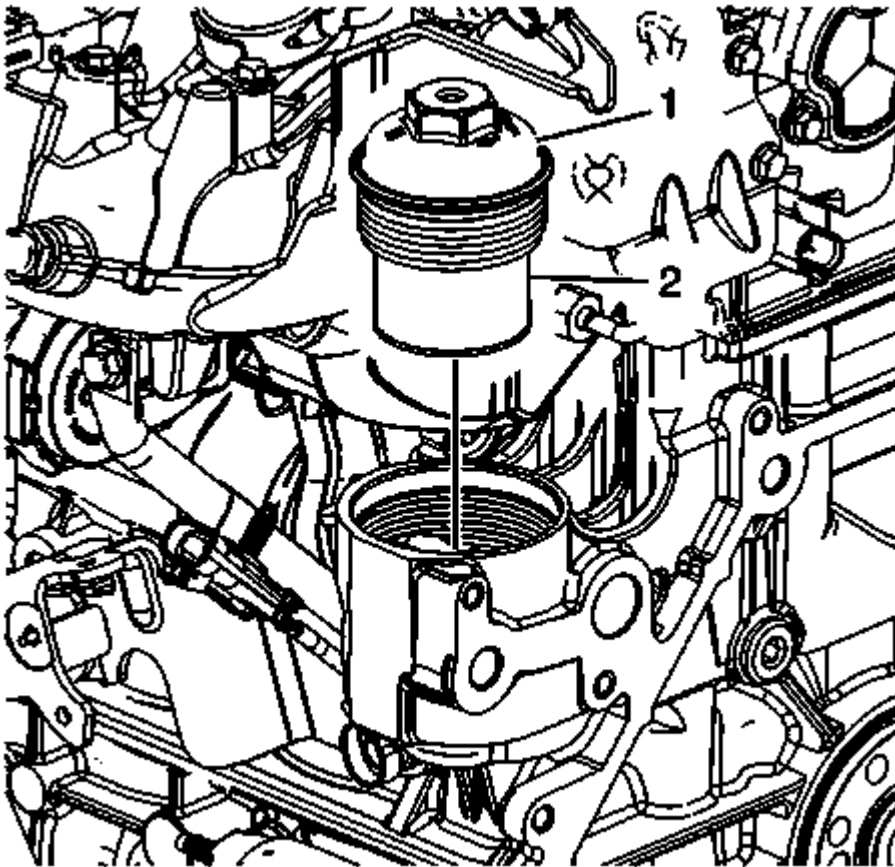


Fig. 1: View of Draining Fluids and Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Use EN-44887 wrench to remove the oil filter cap (1). Remove the oil pan drain plug and allow the oil to drain out.
2. Remove the oil filter (2) from the cap and discard.
3. Clean the oil filter housing in the engine block.

CAUTION: Refer to Fastener Caution .

4. Install the oil pan drain plug and tighten to 25 N.m (18 lb ft).
5. Remove the water pump drain plug from the water pump and allow the coolant to drain from the water jacket.
6. Apply sealant to the water pump drain plug. Refer to Adhesives, Fluids, Lubricants, and Sealers .
7. Install the water pump drain plug and tighten to 20 N.m (15 lb ft).
8. If cleaning or repairing the engine block, it is not necessary to reinstall the plugs.

CRANKSHAFT BALANCER REMOVAL

Special Tools

EN 43653 Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools

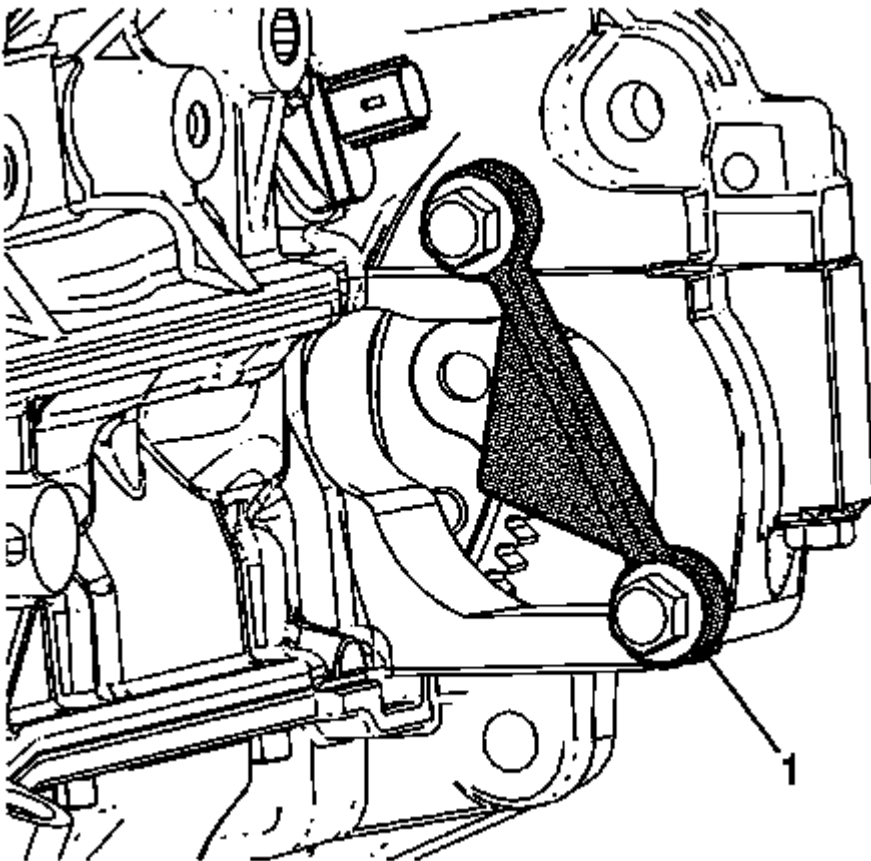


Fig. 2: View of Engine Flywheel
Courtesy of GENERAL MOTORS COMPANY

1. Install **EN 43653** holding tool (1) in the starter assembly location, engaging the flywheel, in order to prevent crankshaft rotation.

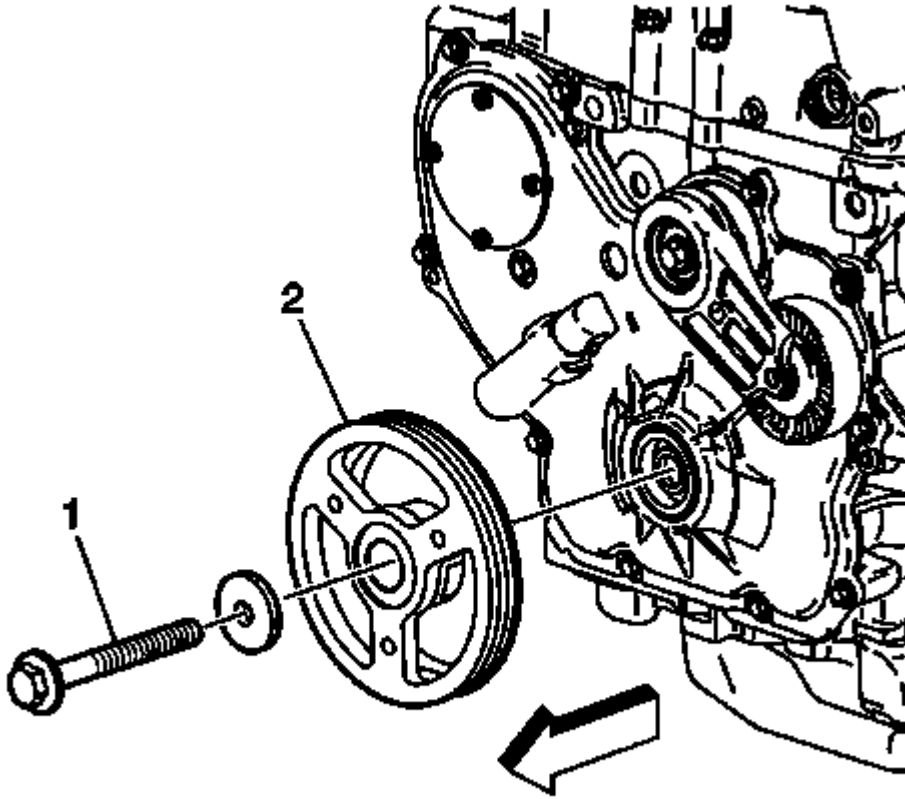


Fig. 3: Balancer And Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the balancer retaining bolt (1) and washer. Discard the bolt.
3. Remove the balancer (2) using a universal removal tool.

ENGINE FLYWHEEL REMOVAL

Special Tools

EN 43653 Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools**

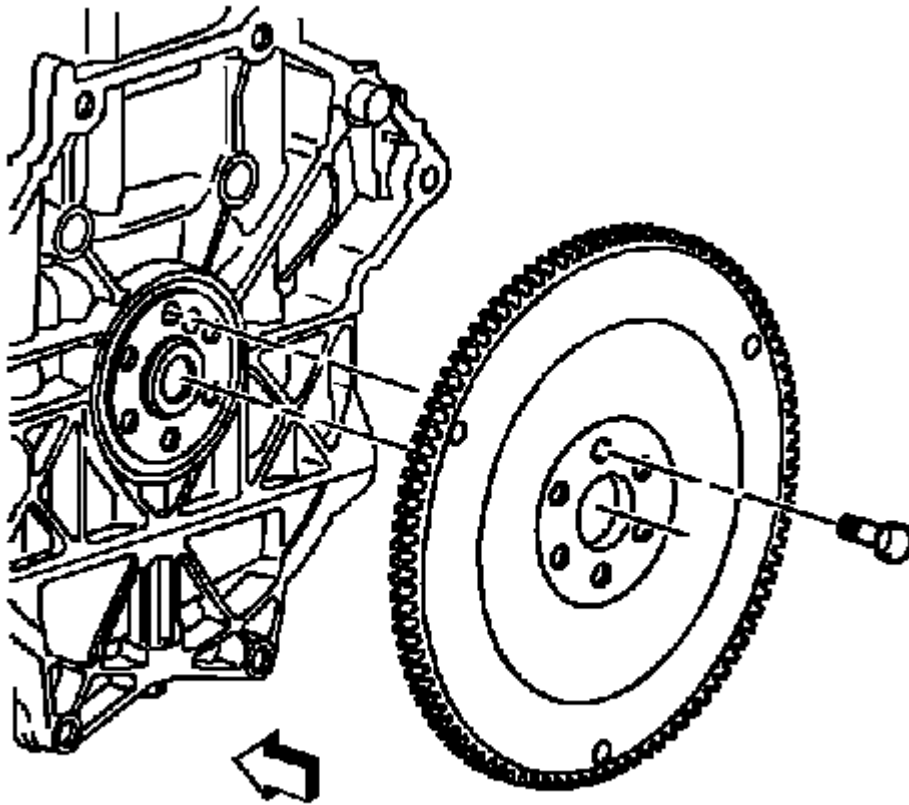


Fig. 4: View Of Flywheel

Courtesy of GENERAL MOTORS COMPANY

1. Ensure that **EN 43653** tool is installed and engaging the flywheel to prevent crankshaft rotation.
2. Remove the flywheel attaching bolts.
3. Remove the flywheel.
4. Remove **EN 43653** tool.

OIL LEVEL INDICATOR AND TUBE REMOVAL (LEA, OR LUK)

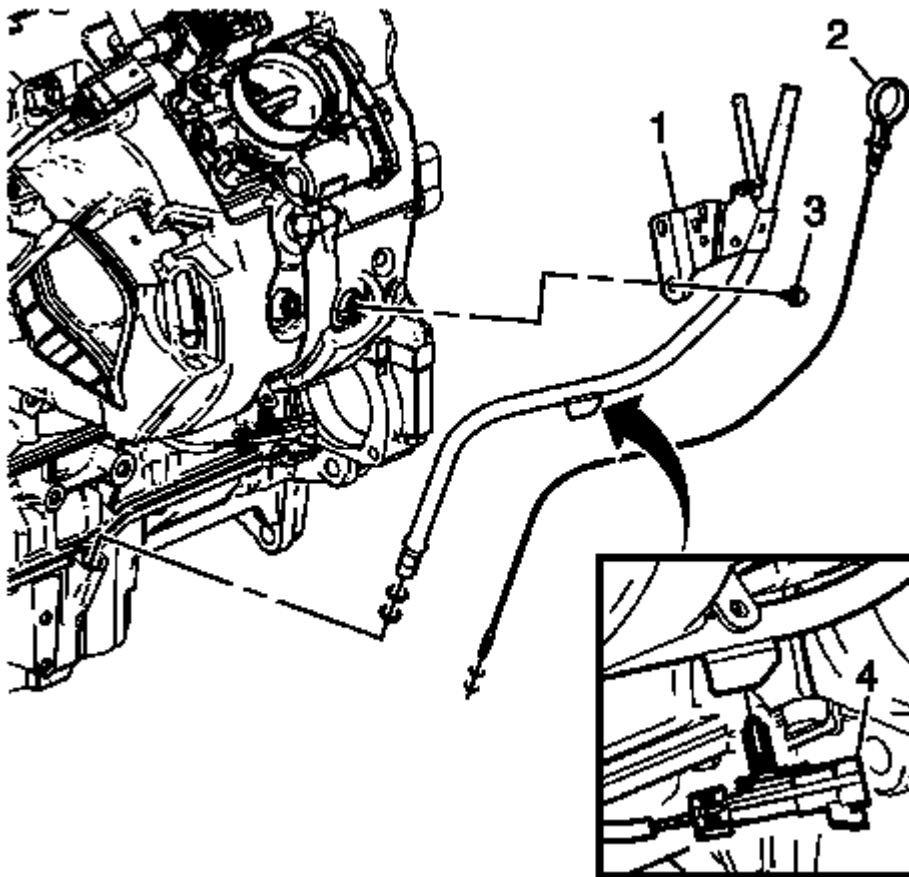


Fig. 5: Oil Level Indicator Tube Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove knock sensor connector (4) from the oil level indicator tube.
2. Remove the electrical wiring harness from the oil level indicator tube.
3. Remove the oil level indicator tube bracket bolt (3).
4. Remove the oil level indicator (2) and the oil level indicator tube (1) from the oil pan.
5. Inspect the O-ring and replace if necessary.

EXHAUST MANIFOLD REMOVAL

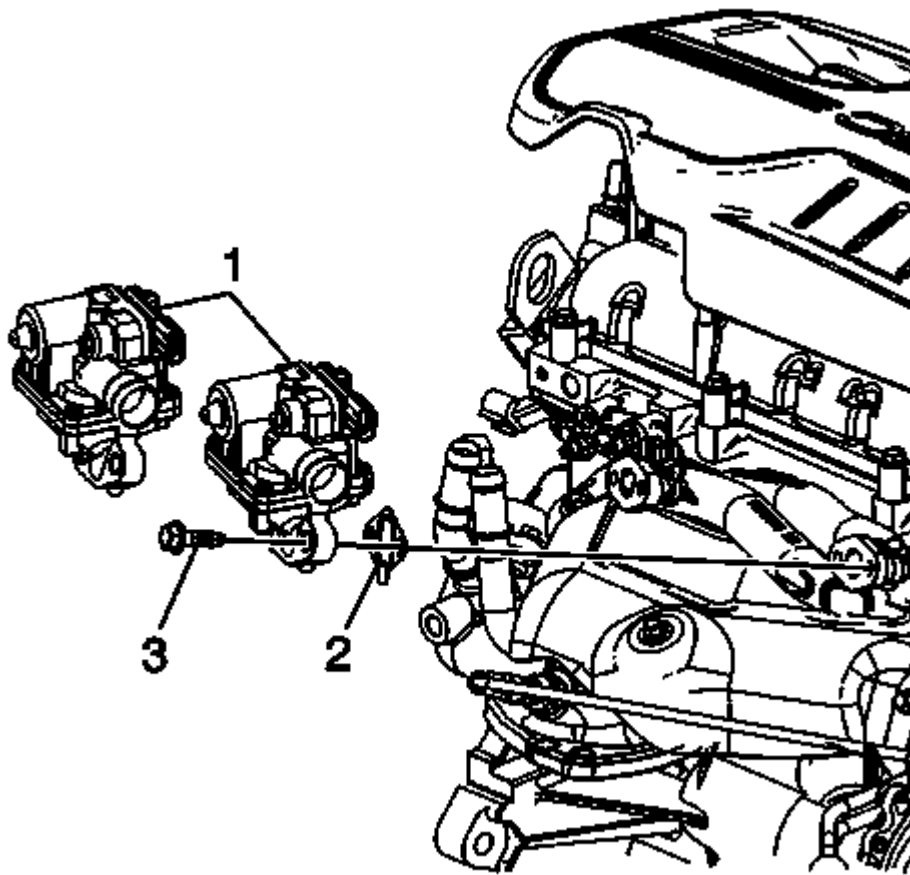


Fig. 6: Secondary Air Injection Check Valves, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Remove the secondary air injection check valves (1) bolts (3), and gaskets (2).

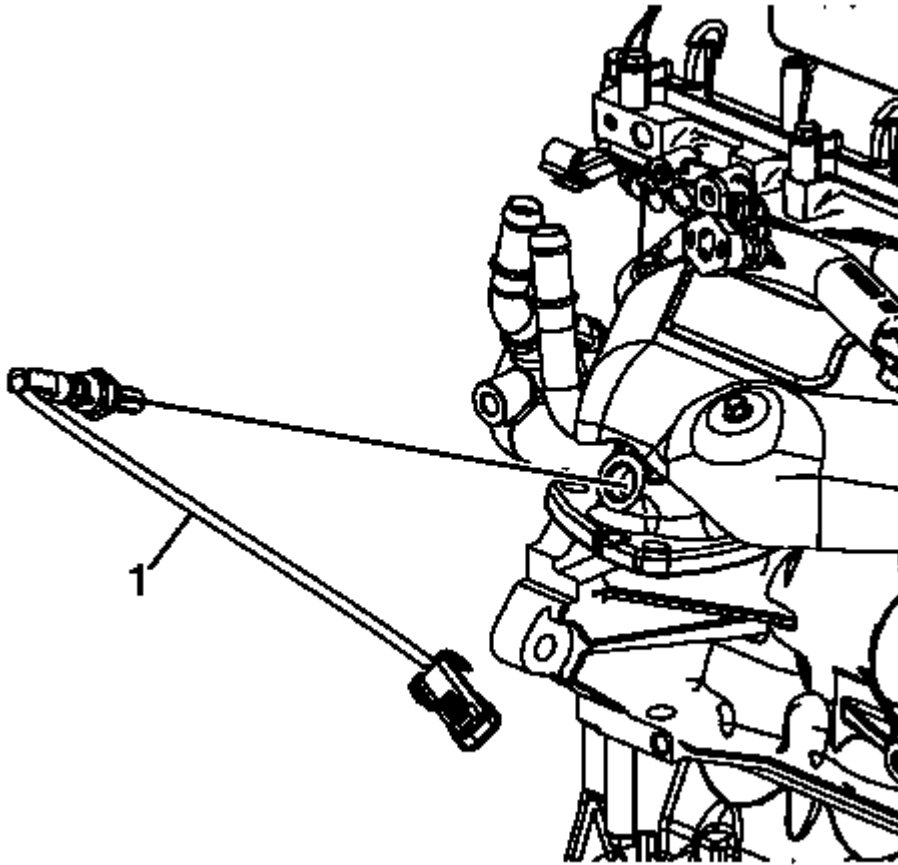


Fig. 7: Oxygen Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oxygen sensor (1).

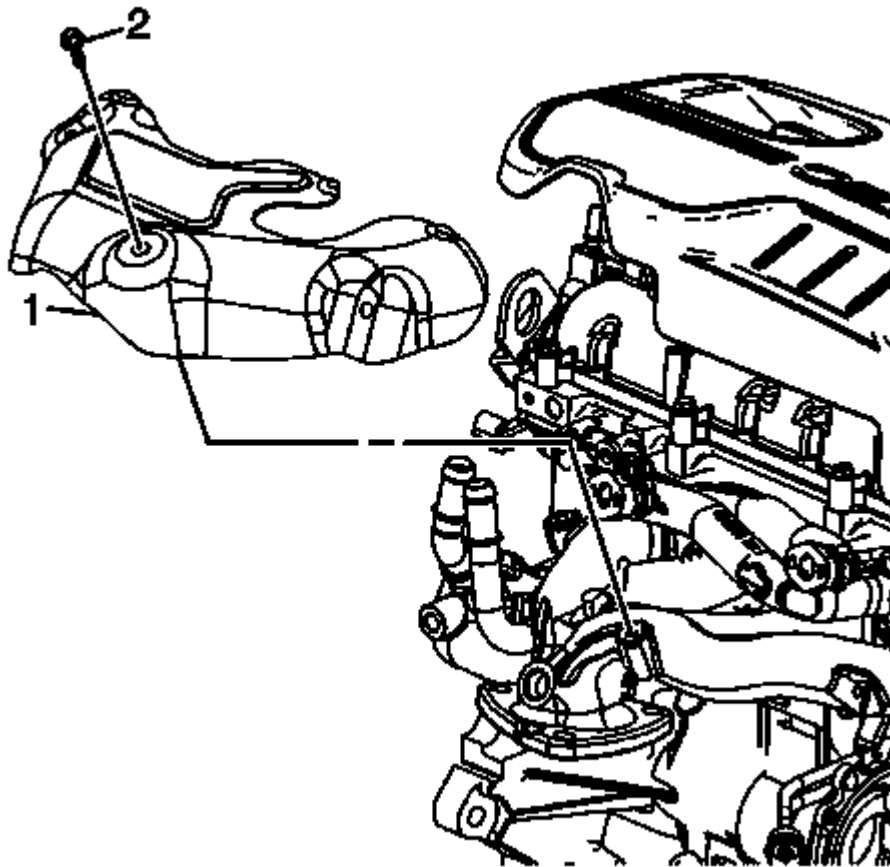


Fig. 8: Exhaust Manifold Heat Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the exhaust manifold heat shield (1) and bolts (2).

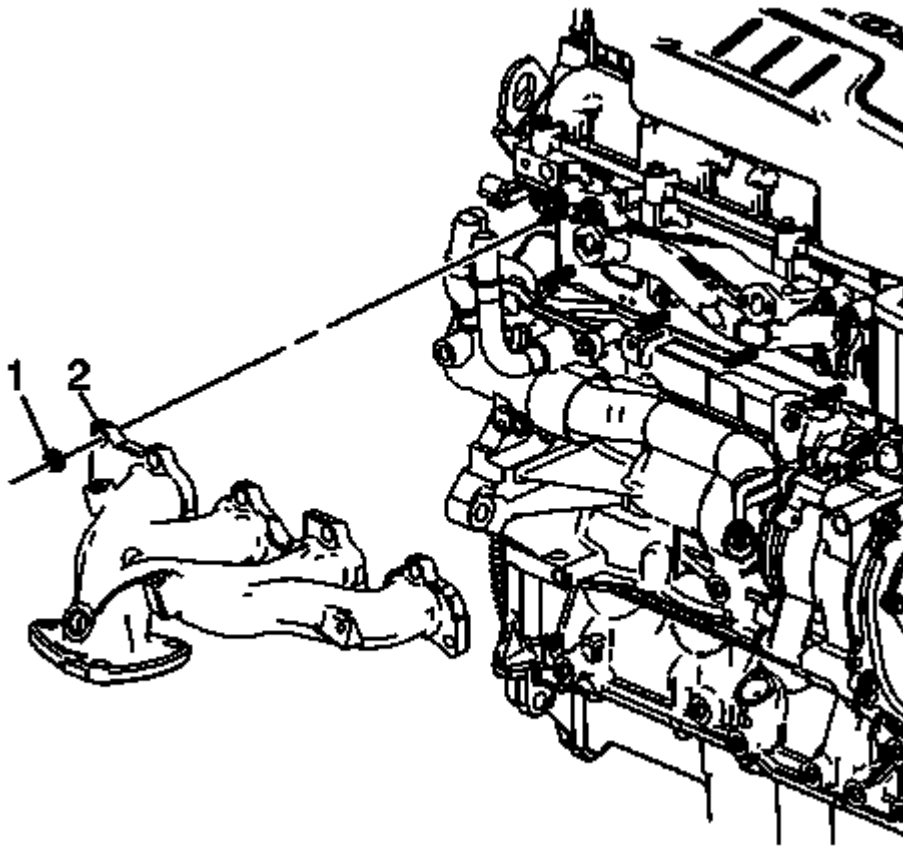


Fig. 9: Exhaust Manifold & Retaining Nuts
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the exhaust manifold to cylinder head retaining nuts (1).
5. Remove the exhaust manifold (2).
6. Clean all of the sealing surfaces.
7. If the exhaust manifold is being replaced, transfer the following parts:
 - The exhaust manifold heat shield
 - The oxygen sensor

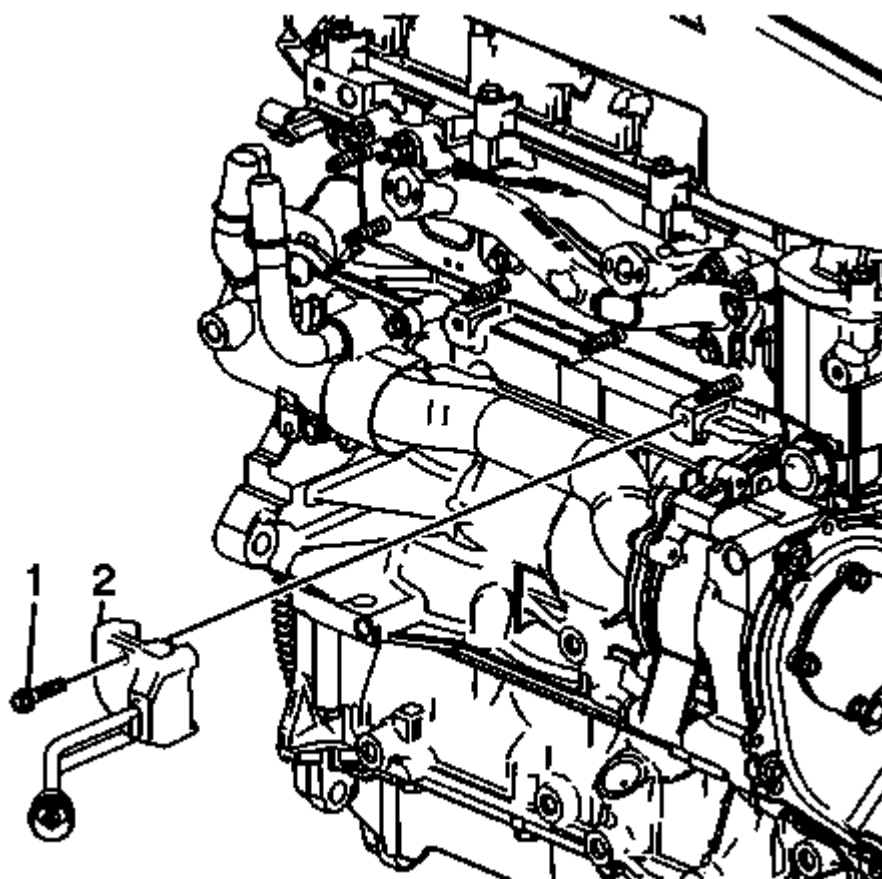


Fig. 10: Block Heater & Bolt

Courtesy of GENERAL MOTORS COMPANY

8. Remove the block heater (1), if equipped.

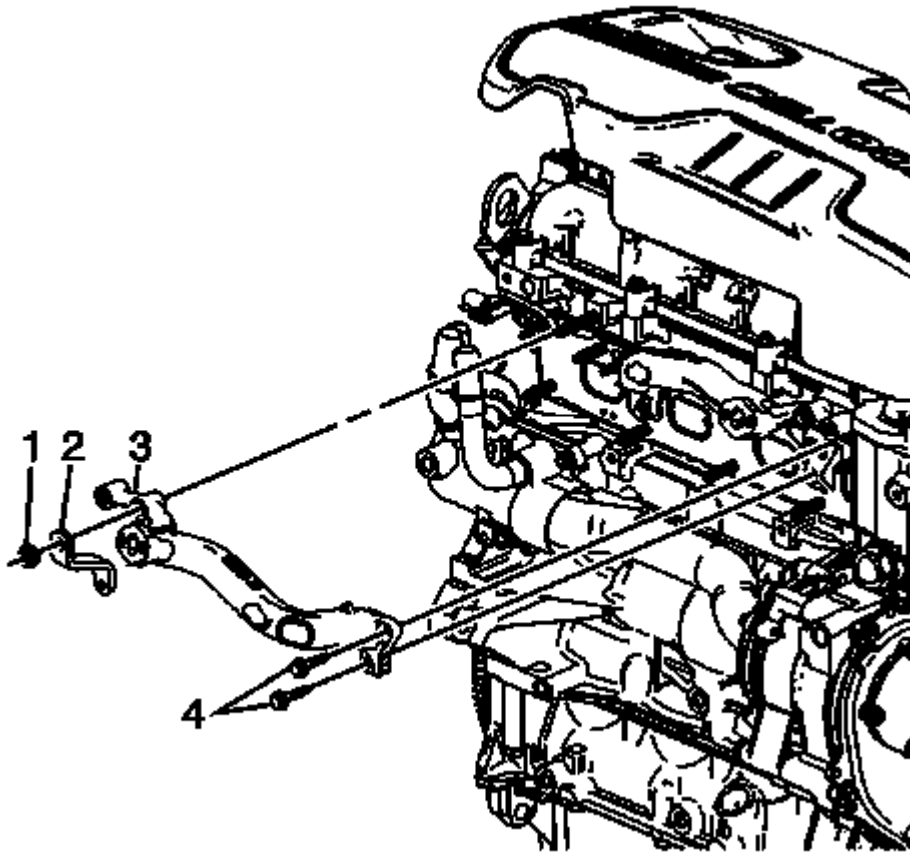


Fig. 11: Secondary Air Injection Check Valve Pipe Adapter And Mounting Components
Courtesy of GENERAL MOTORS COMPANY

9. Remove the nut (1), bracket (2), bolts (4), and secondary air injection check valve pipe adapter (3).

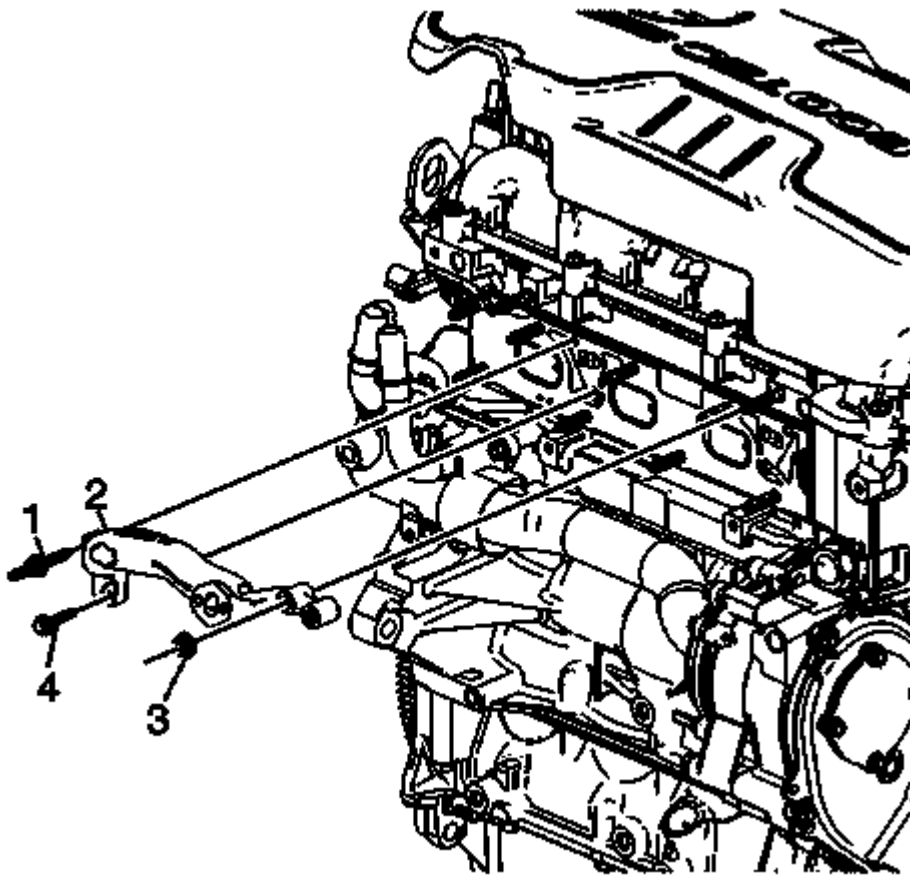


Fig. 12: Secondary Air Injection Check Valve Pipe Adapter & Mounting Components
Courtesy of GENERAL MOTORS COMPANY

10. Remove the stud-bolt (1), bolt (4), nut (3), and secondary air injection check valve pipe adapter (2).

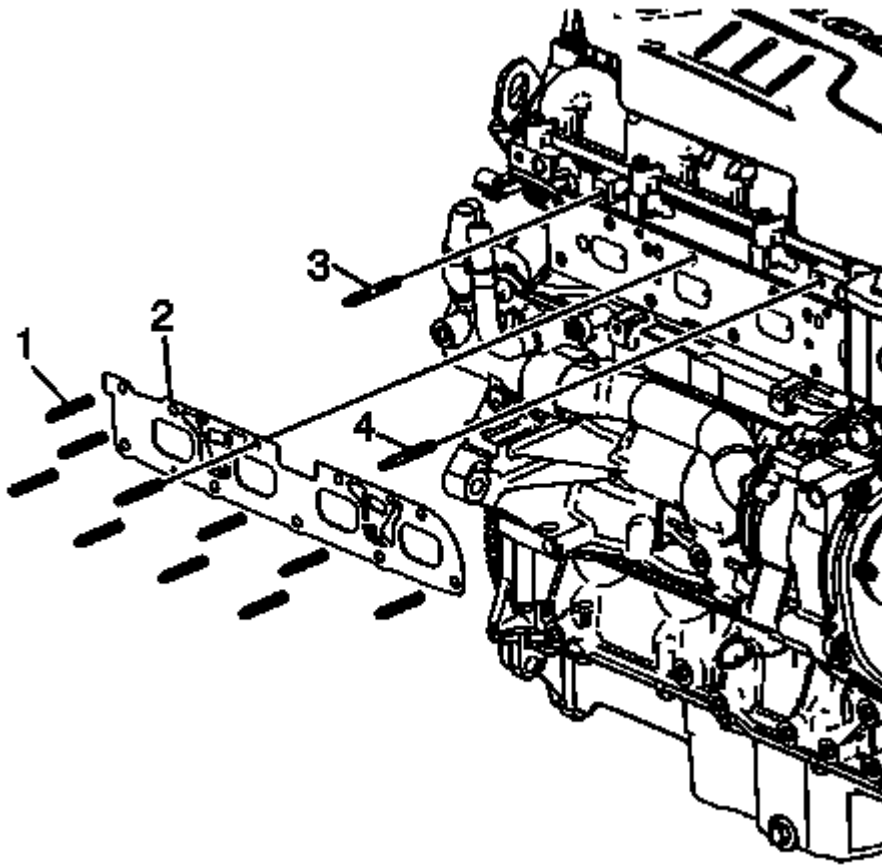


Fig. 13: Upper Secondary Air Injection Assembly Studs, Exhaust Manifold Gasket & Studs
Courtesy of GENERAL MOTORS COMPANY

11. Remove and discard the exhaust manifold studs (1).
12. Remove and discard the upper secondary air injection assembly studs (3, 4), if necessary.
13. Remove and discard the exhaust manifold gasket (2).
14. Clean all of the sealing surfaces.

INTAKE MANIFOLD REMOVAL

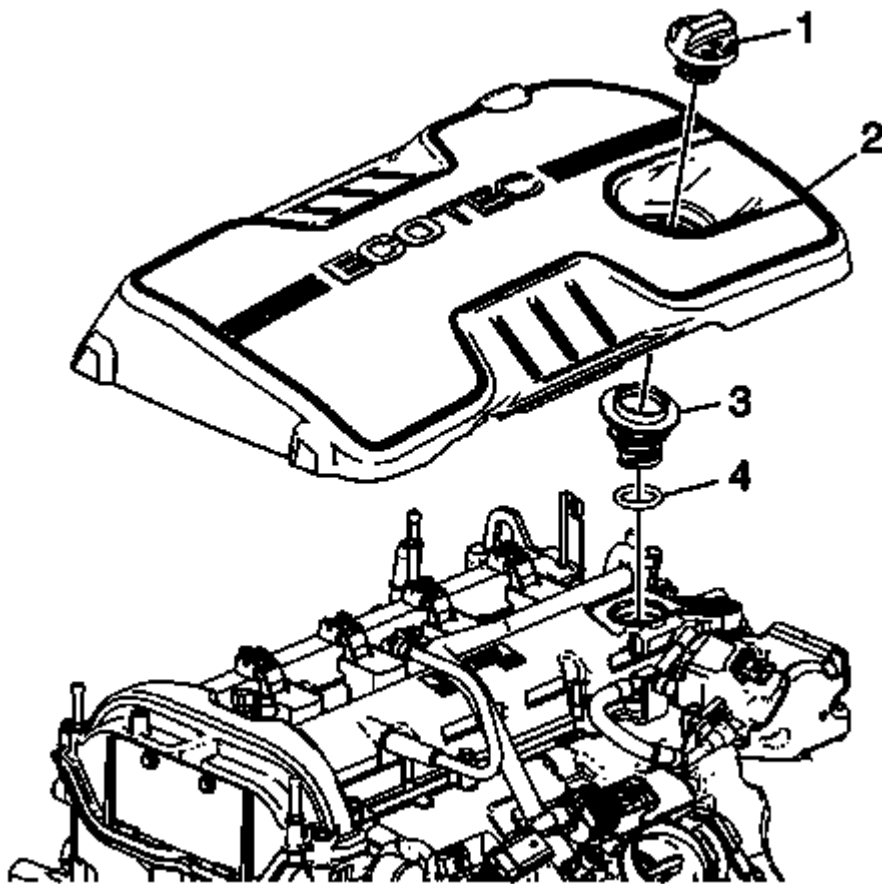


Fig. 14: Oil Fill Cap Components

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Never attempt to remove the intake manifold from a hot engine, allow the engine to cool to ambient temperature. The intake manifold can be damaged if it is removed when the engine is hot.

1. Remove the oil fill cap (1).
2. Remove the intake manifold cover (2).
3. Remove the oil fill tube assembly (3) and O-ring (4).

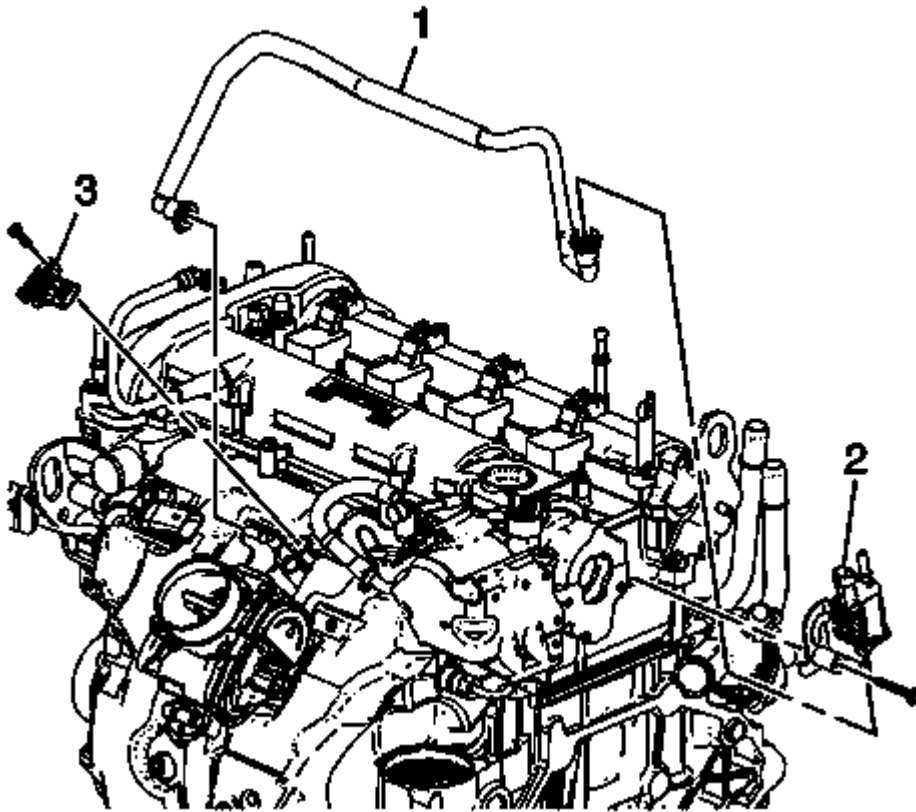


Fig. 15: EVAP Canister Valve, Tube & MAP Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove the evaporative (EVAP) emission canister valve tube (1).
5. Remove the EVAP canister valve (2).
6. Remove the MAP sensor (3).

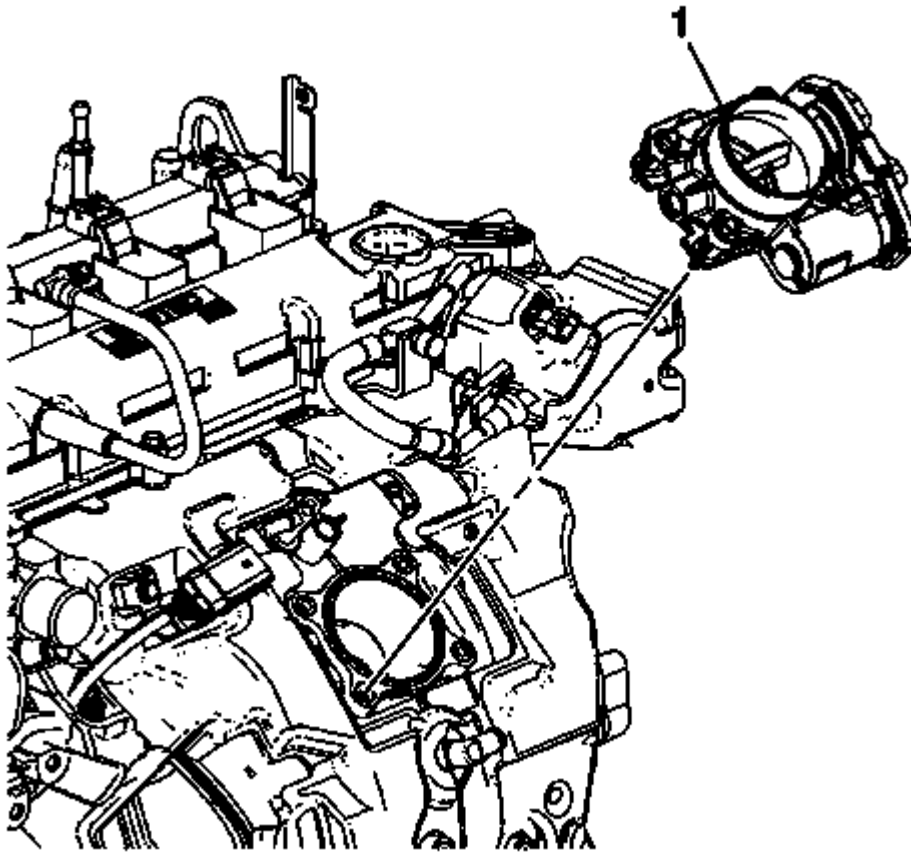


Fig. 16: Throttle Body
Courtesy of GENERAL MOTORS COMPANY

7. Remove the throttle body (1).

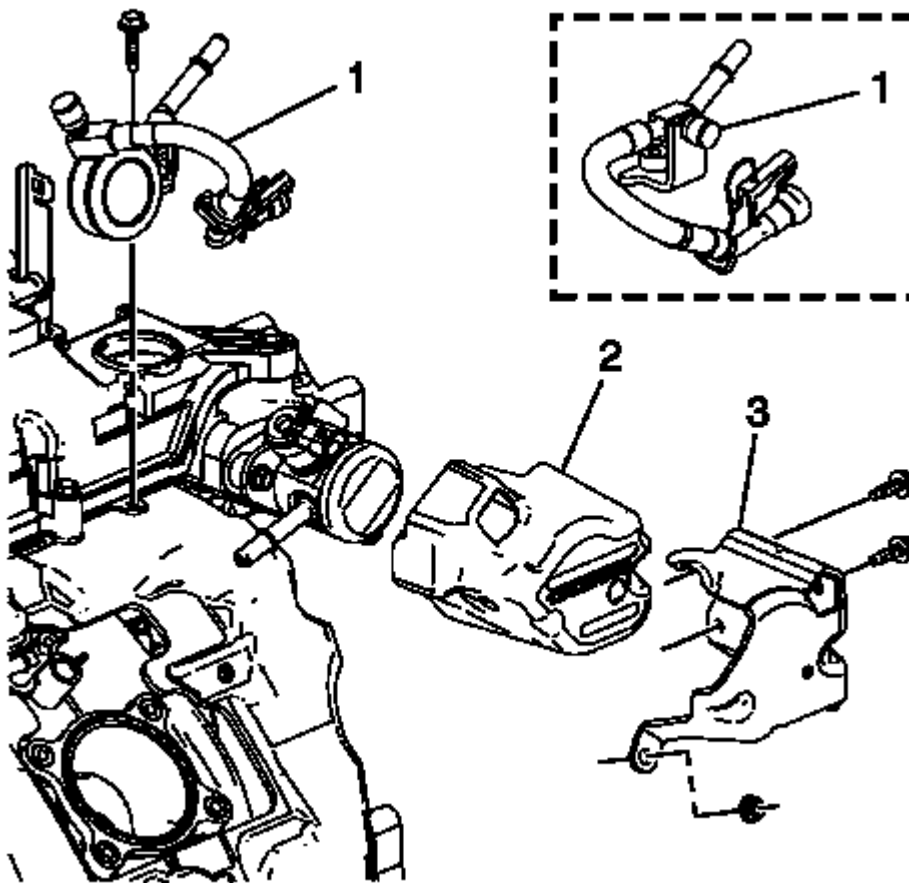


Fig. 17: Fuel Pump Components

Courtesy of GENERAL MOTORS COMPANY

8. Remove the fuel pump cover nut, bolts, and cover (3).

NOTE: The low pressure fuel pipe used is model dependent.

9. Remove the bracket bolt and low pressure fuel pipe assembly (1).
10. Remove the fuel pump insulator (2).

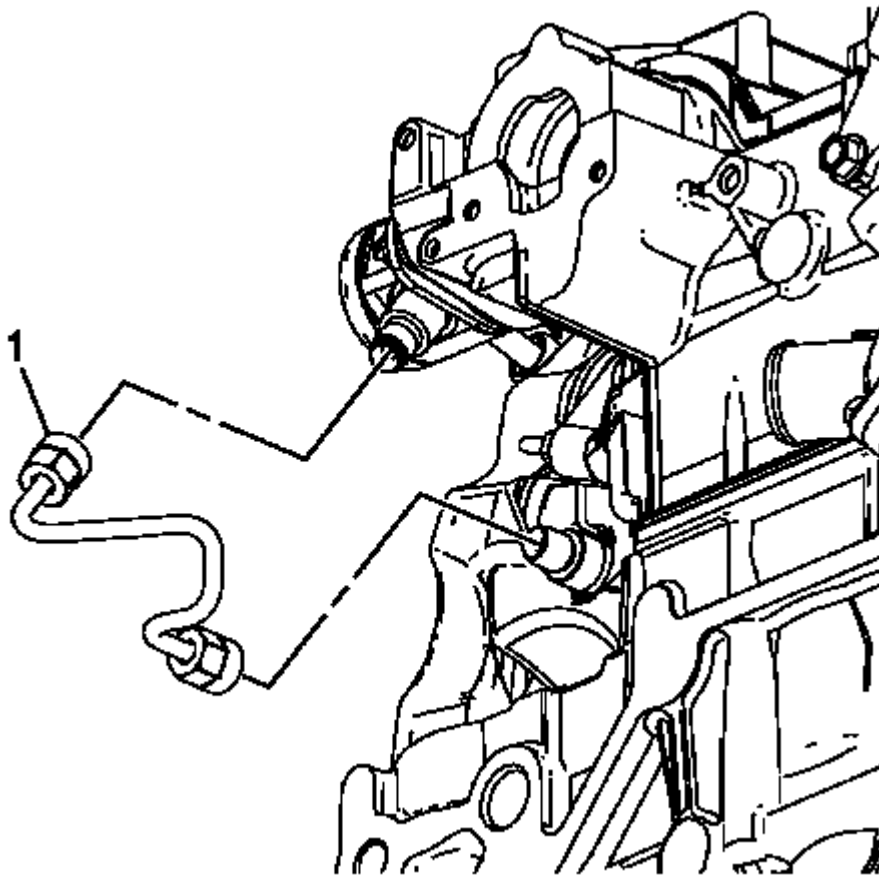


Fig. 18: High Pressure Fuel Line
Courtesy of GENERAL MOTORS COMPANY

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

11. Remove and discard the fuel feed intermediate pipe (1).

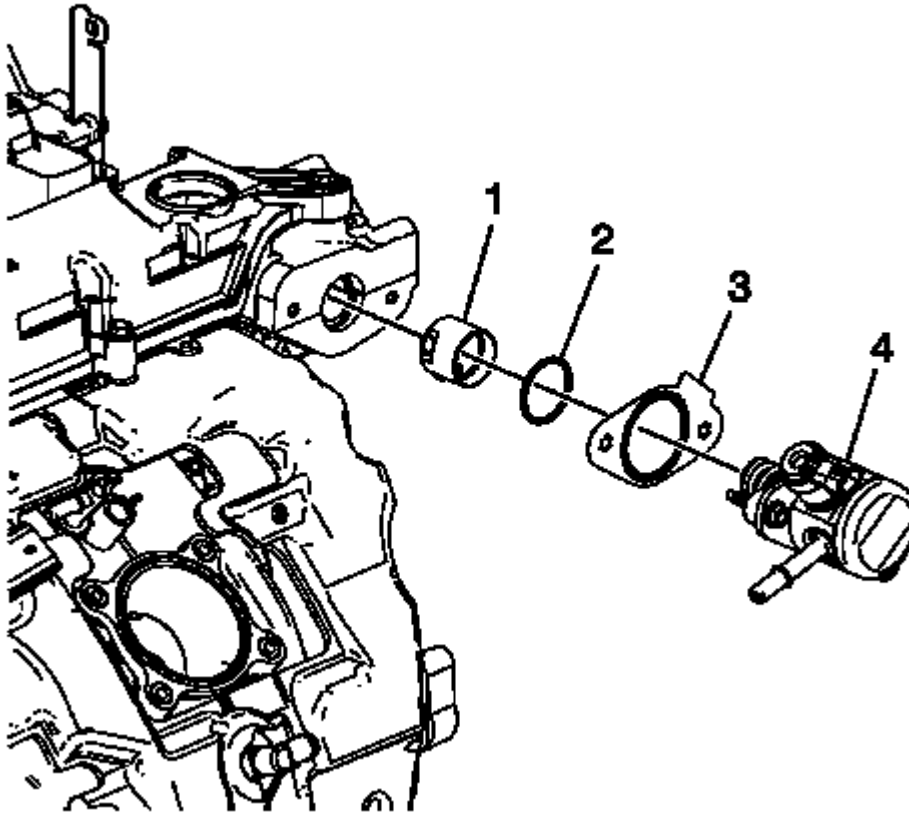


Fig. 19: Fuel Pump Assembly Components
Courtesy of GENERAL MOTORS COMPANY

12. Remove the fuel pump assembly (4).
13. Remove and discard the fuel pump housing O-ring (2) and gasket (3).
14. Remove the fuel pump roller lifter (1).

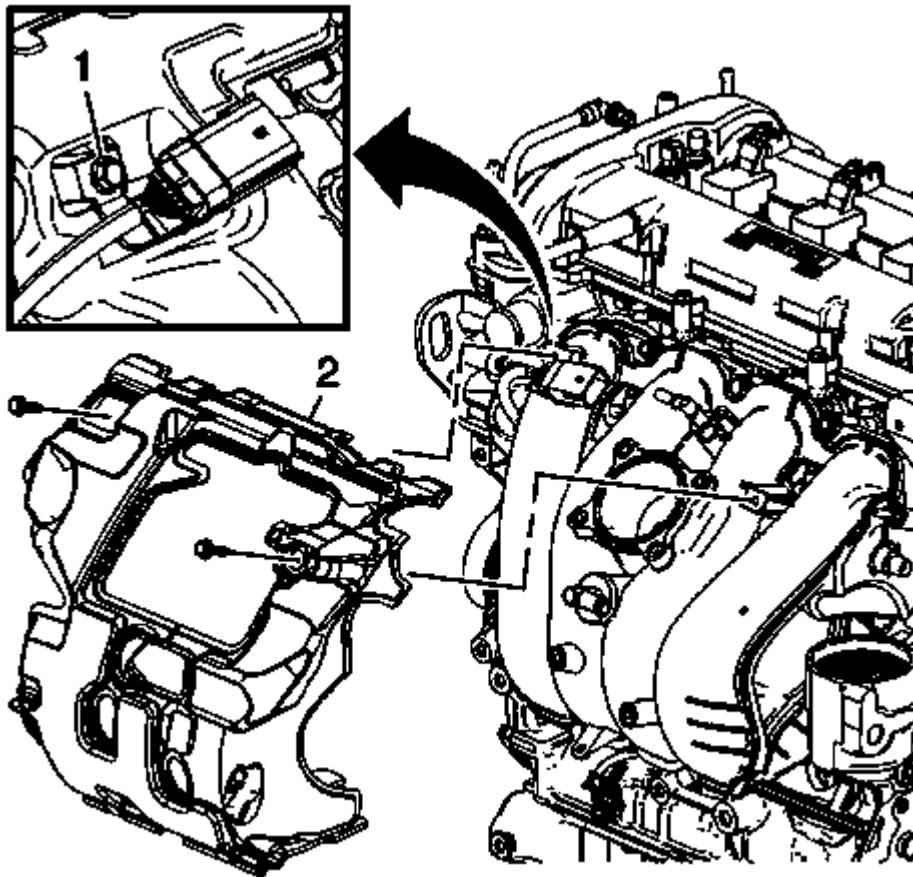


Fig. 20: Fuel Rail Harness Connector Bracket And Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

15. Remove the fuel rail harness connector bracket bolt (1) and intake manifold insulator bolt.
16. Remove the intake manifold insulator (2).

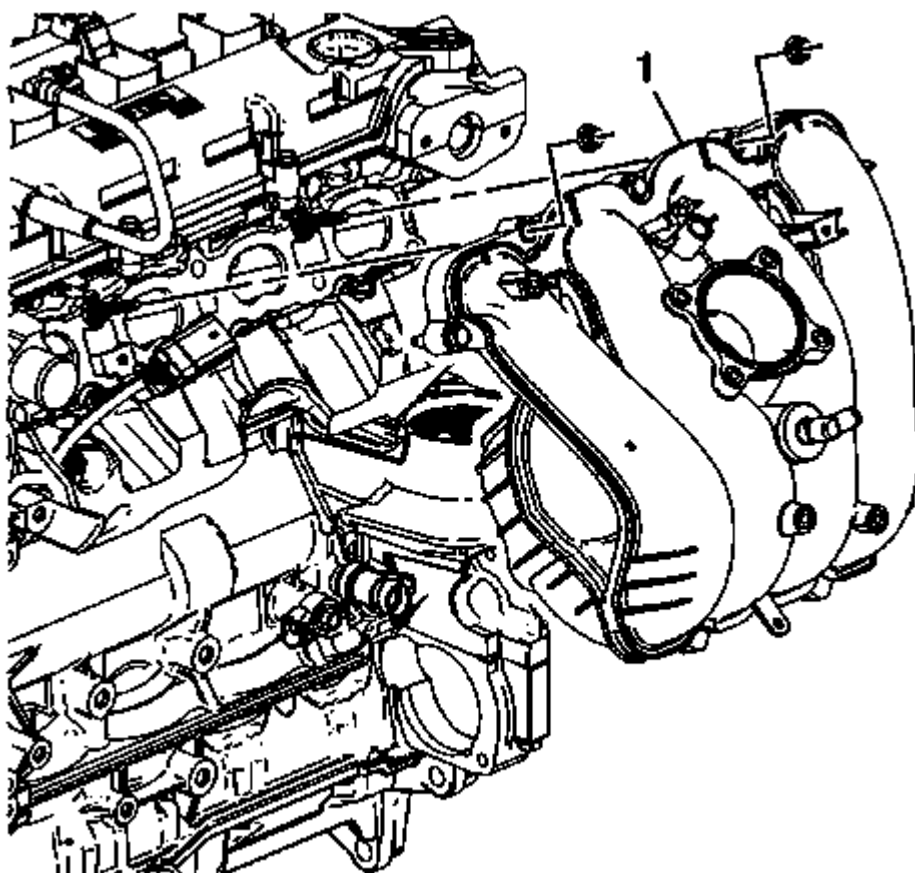


Fig. 21: Intake Manifold Retaining Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Remove the intake manifold retaining nuts and bolts.
18. Remove the intake manifold (1).
19. If the intake manifold needs to be replaced, transfer the throttle body to the new intake manifold.

FUEL RAIL AND INJECTORS REMOVAL

Special Tools

EN-49248 Fuel Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools**

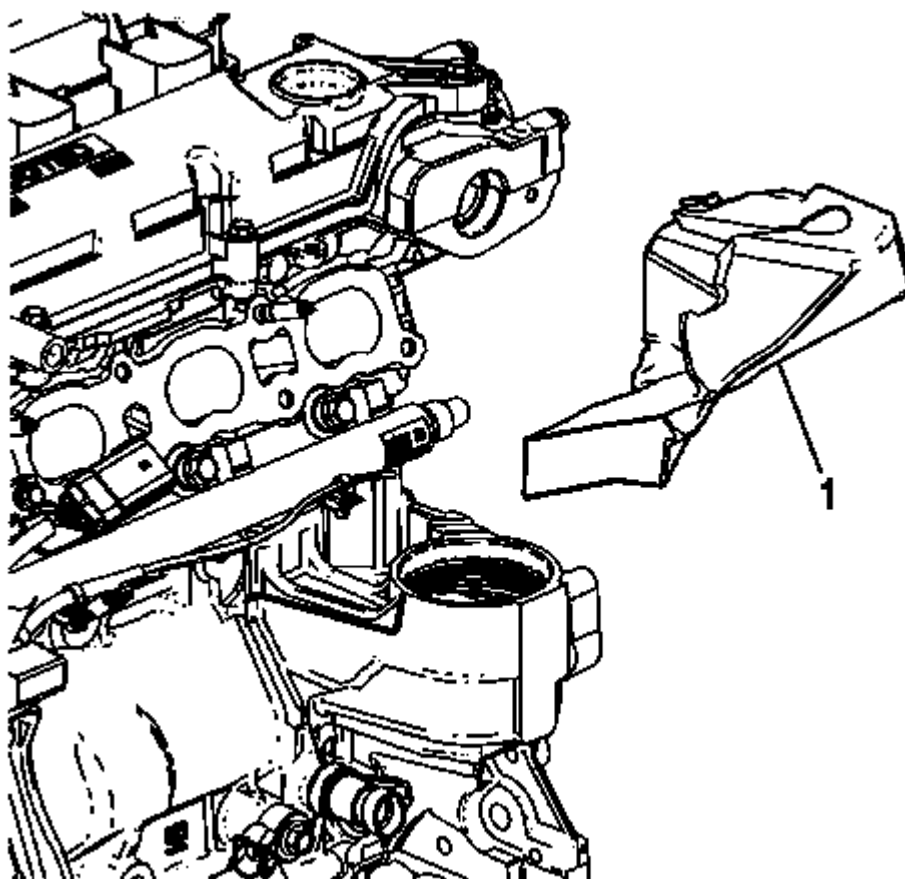


Fig. 22: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injection fuel rail noise shield (1).

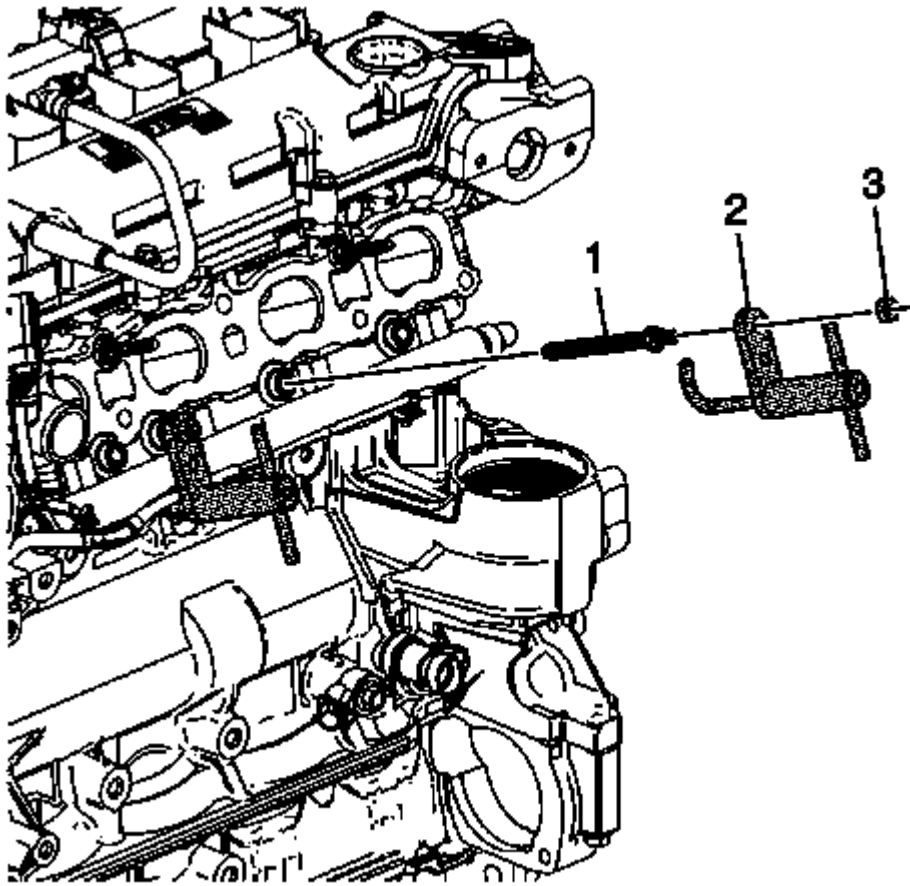


Fig. 23: Electrical Harness And Fuel Rail Harness
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical harness from the fuel rail harness connection.
3. Disconnect all 4 fuel injector electrical connections.
4. Remove the fuel rail assembly retaining bolts.

NOTE: Use care to avoid contact with the fuel rail harness during special tool installation and fuel rail removal.

5. Install **EN-49248** studs (1) into the 2 center fuel rail assembly retaining bolt locations. Tighten the studs to 22 N.m (16 lb ft).
6. Install **EN-49248** remover (2) onto each stud, and engage the hooks to the fuel rail. Install the nuts (3) retaining the remover onto the studs and tighten until snug.

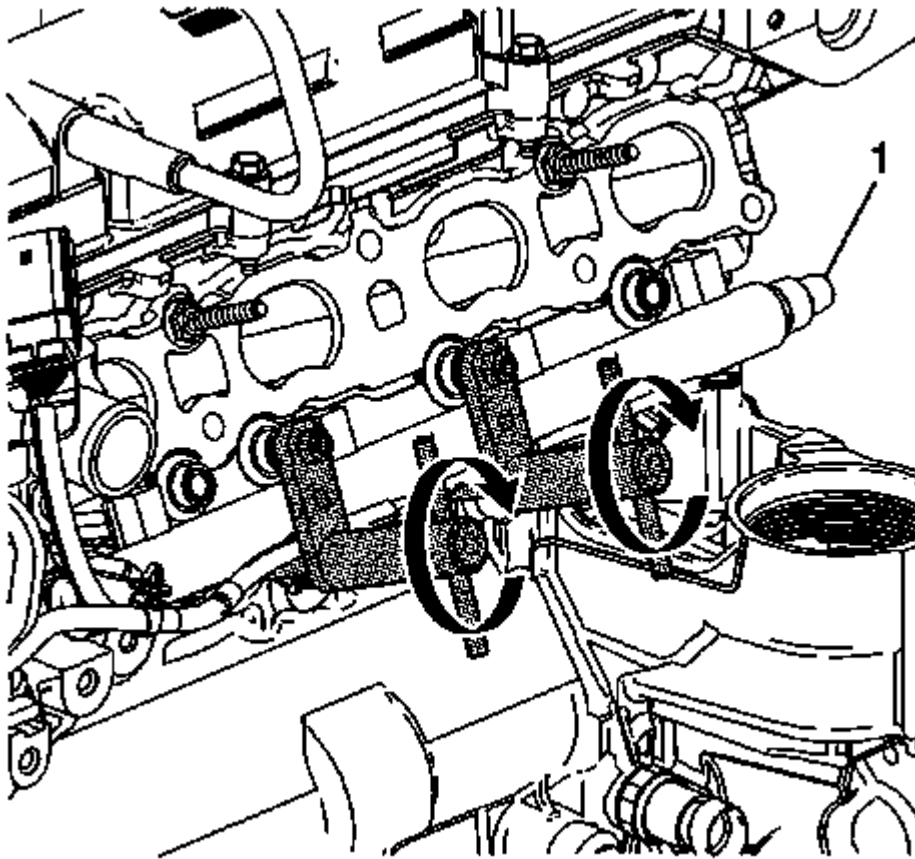


Fig. 24: Removing Fuel Rail Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: EN-49248 will assist in the proper removal of the fuel rail assembly. Ensure that the following conditions are met:

- Turn the handles simultaneously in order to pull the fuel rail straight out along the fuel injector axis.
- DO NOT twist when pulling out on the fuel rail and injector assembly.

7. Using **EN-49248** remover , remove the fuel rail assembly (1).

CAMSHAFT COVER REMOVAL (LEA, OR LUK)

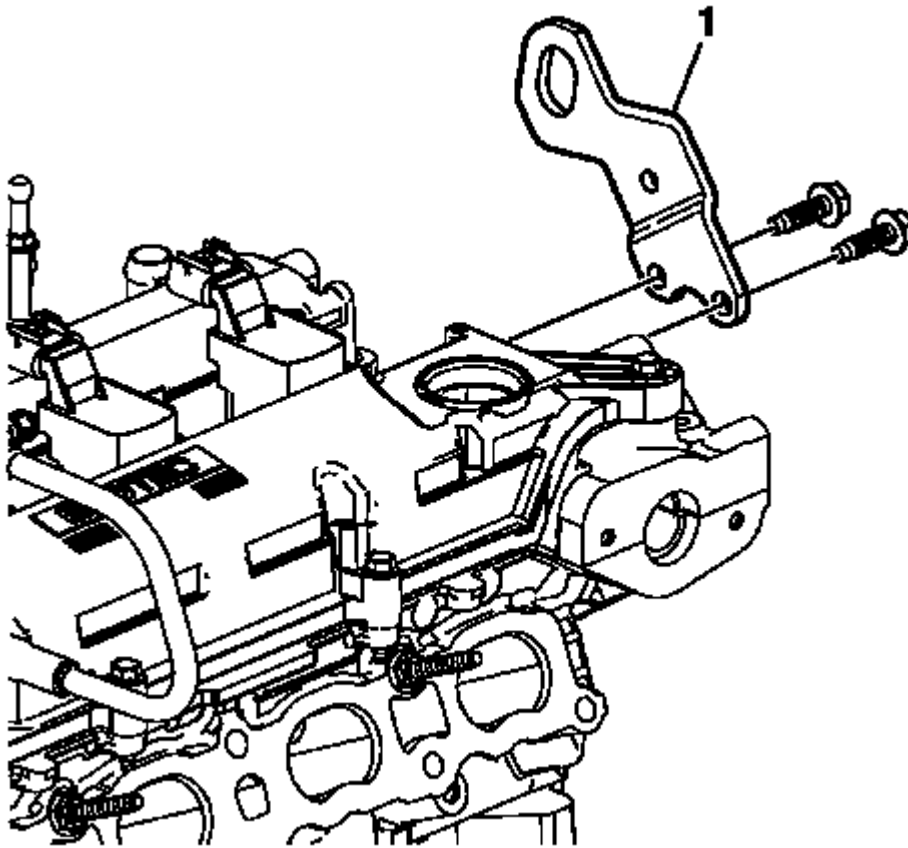


Fig. 25: Rear Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

1. Remove the rear lift bracket (1).

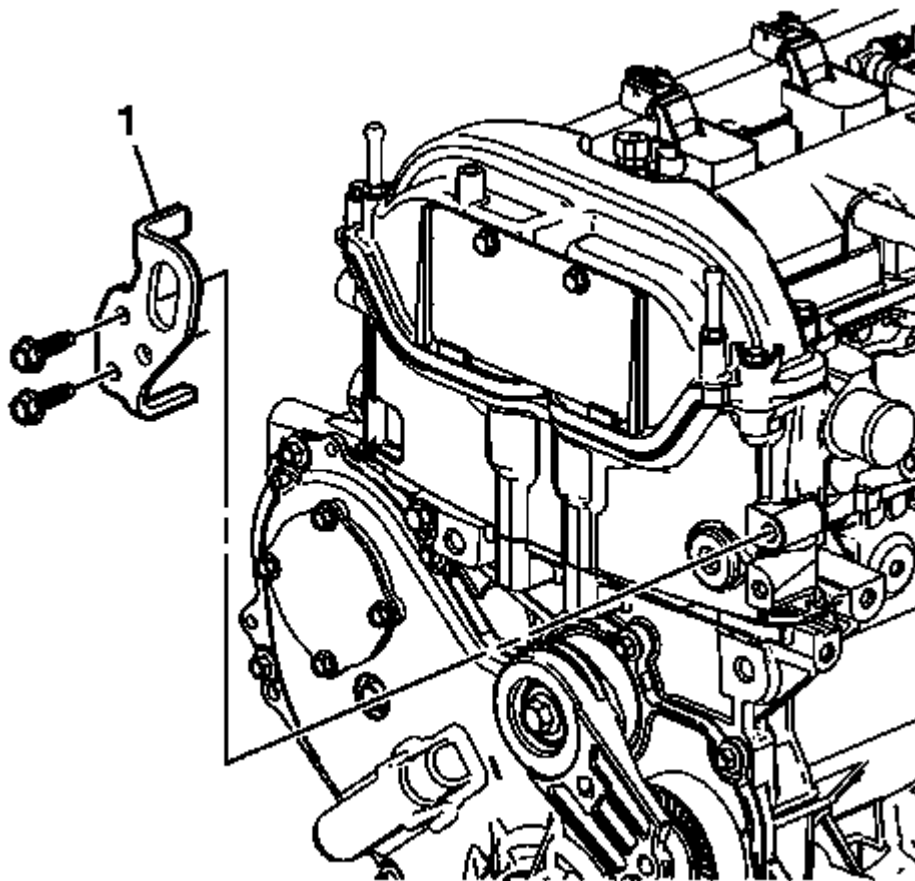


Fig. 26: Front Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

2. Remove the front lift bracket (1).

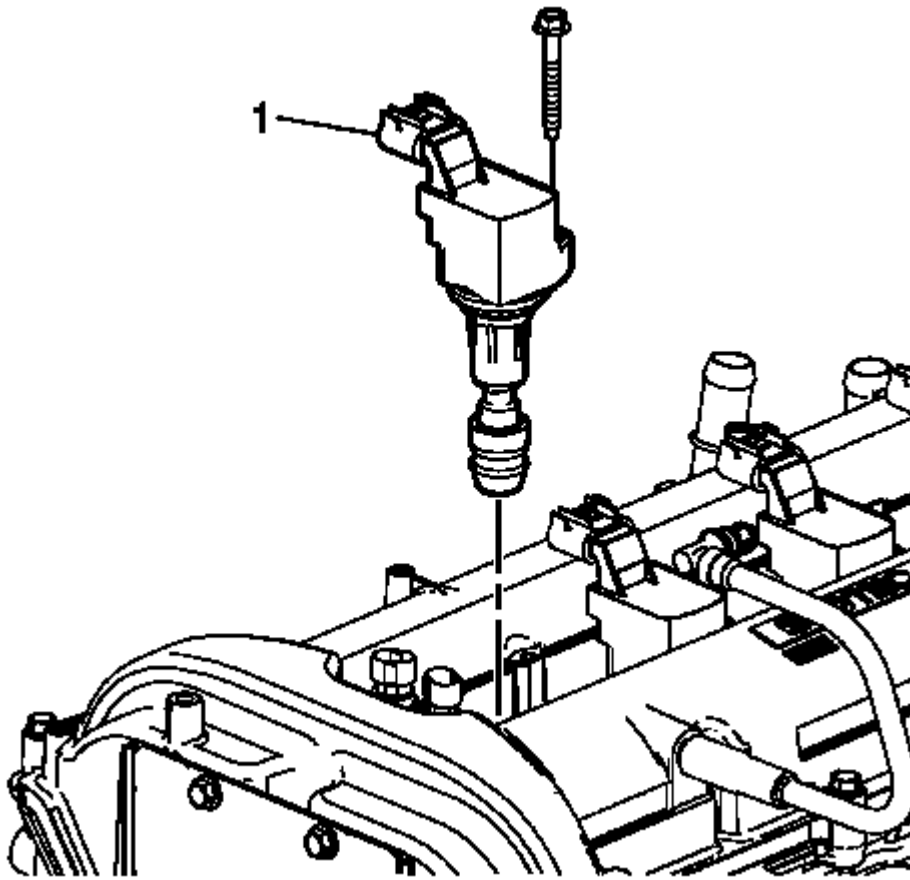


Fig. 27: Ignition Coil
Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil (1).

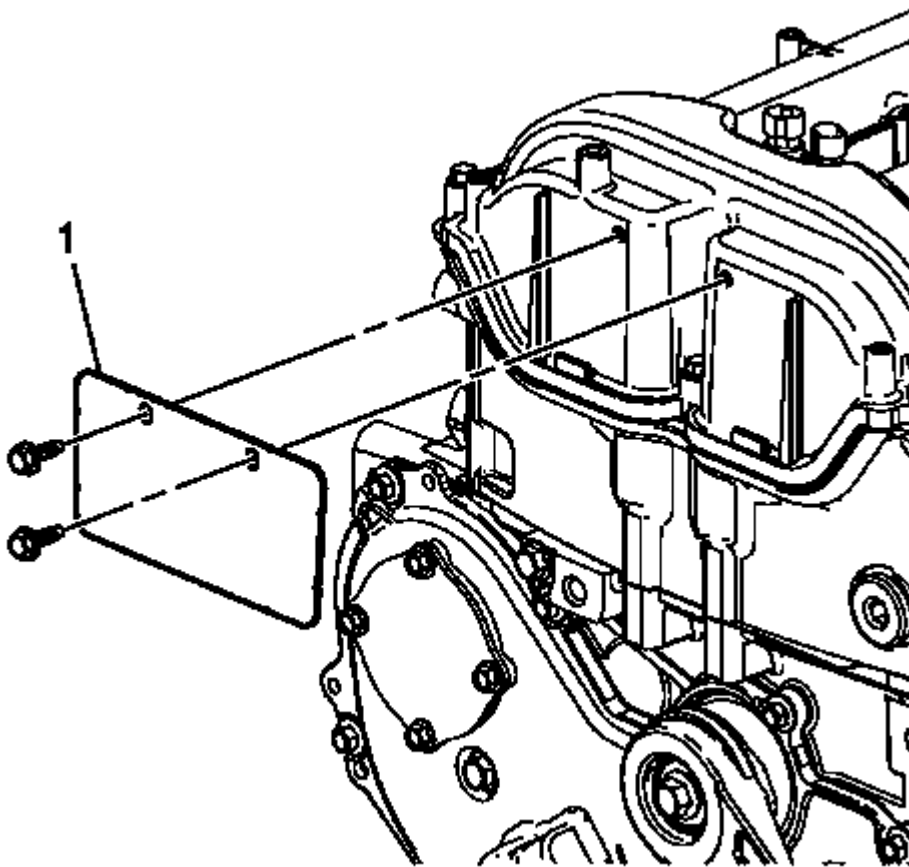


Fig. 28: Camshaft Housing Cover Insulator
Courtesy of GENERAL MOTORS COMPANY

4. Remove the camshaft housing cover insulator (1).

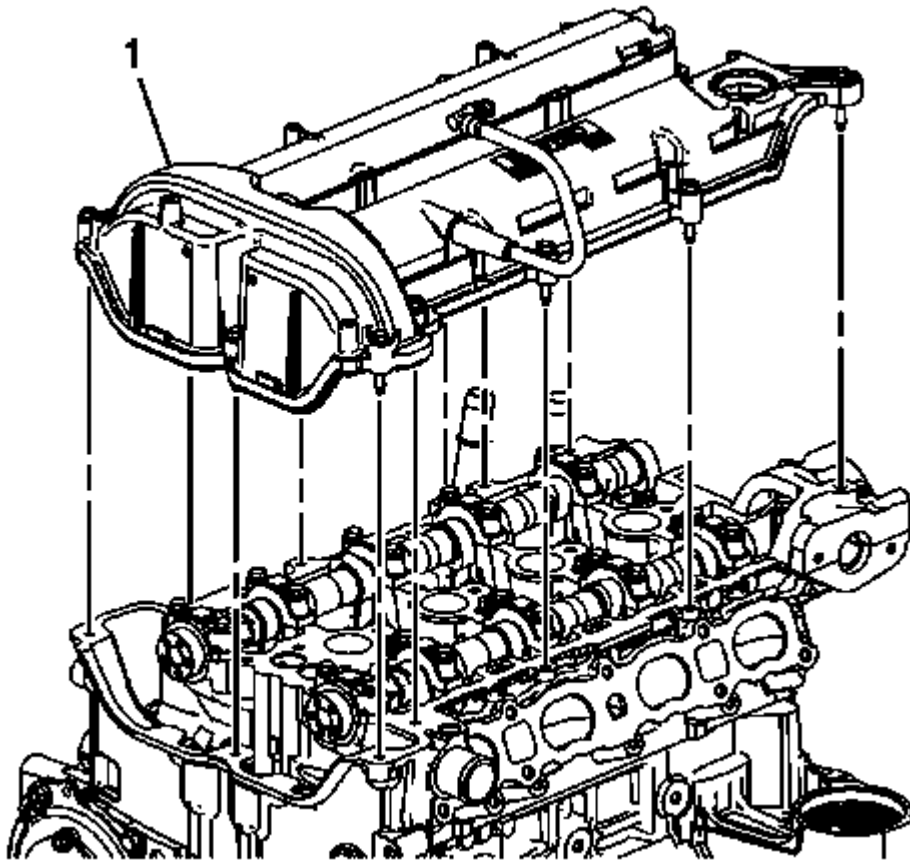


Fig. 29: Camshaft Cover Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT** remove the PCV hose from the camshaft cover. If damage to the hose or connectors is present, the cover must be replaced.

5. Remove the camshaft cover assembly (1).
6. Remove and discard the camshaft cover gasket, camshaft cover grommets, and camshaft cover bolts if they are serviced with the grommet.

ENGINE FRONT COVER AND OIL PUMP REMOVAL (LUK)

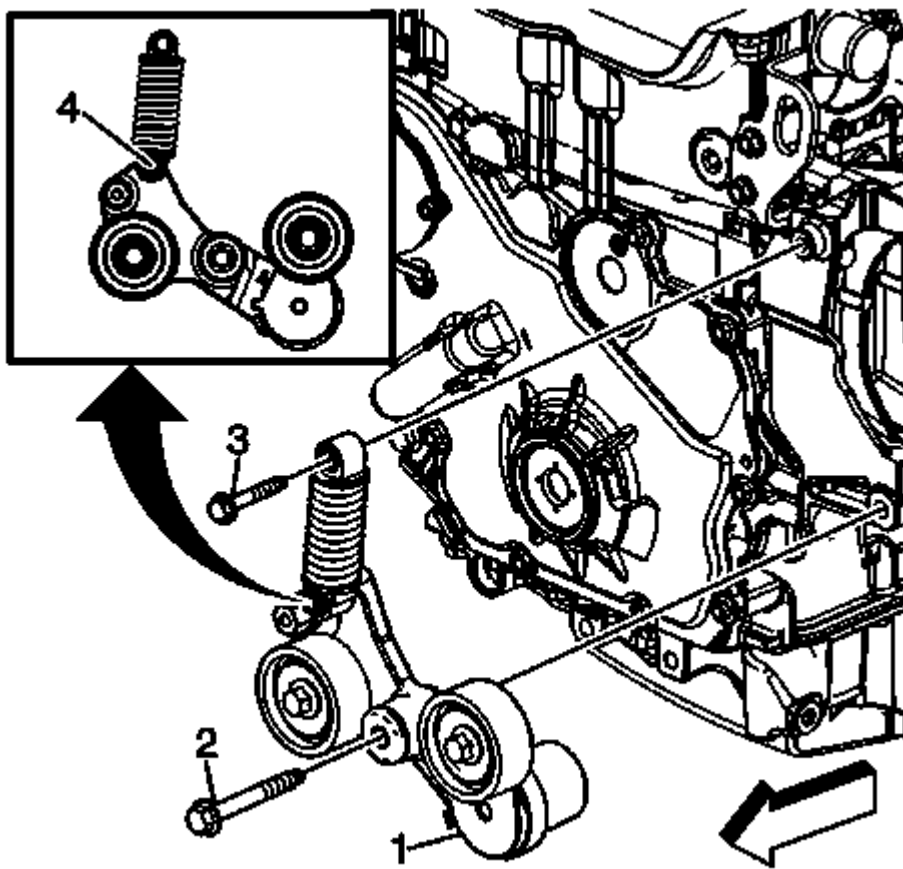


Fig. 30: Accessory Drive Belt Tensioner And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT remove bolts from the drive belt tensioner assembly except for the two bolts (2, 3) that retain the assembly to the bracket. If the tensioner spring lower shoulder bolt is disturbed, the drive belt tensioner must be replaced as an assembly.

1. Remove only the upper drive belt tensioner bolt (3).
2. Remove the drive belt tensioner pivot bolt (2).
3. Remove the accessory drive belt tensioner (1).
4. Inspect the drive belt tensioner assembly (1). Replace the assembly if necessary, or if any of the following conditions exist:
 - The tensioner spring lower shoulder bolt (4) shows wear or signs it has been removed or tampered with. This bolt should NEVER be removed when servicing.
 - The drive belt tensioner pivot bolt (2) has thread or hex head wear and requires replacement. The drive belt tensioner assembly and bolts are always replaced at the same time.

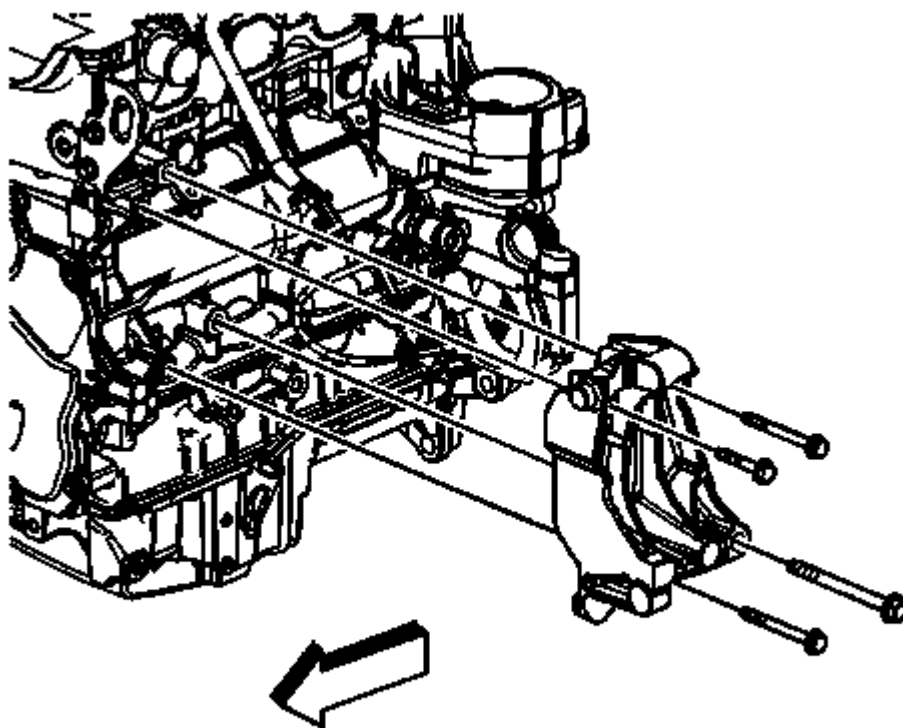


Fig. 31: Drive Belt Tensioner Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the drive belt tensioner bracket bolts.
6. Remove the drive belt tensioner bracket.

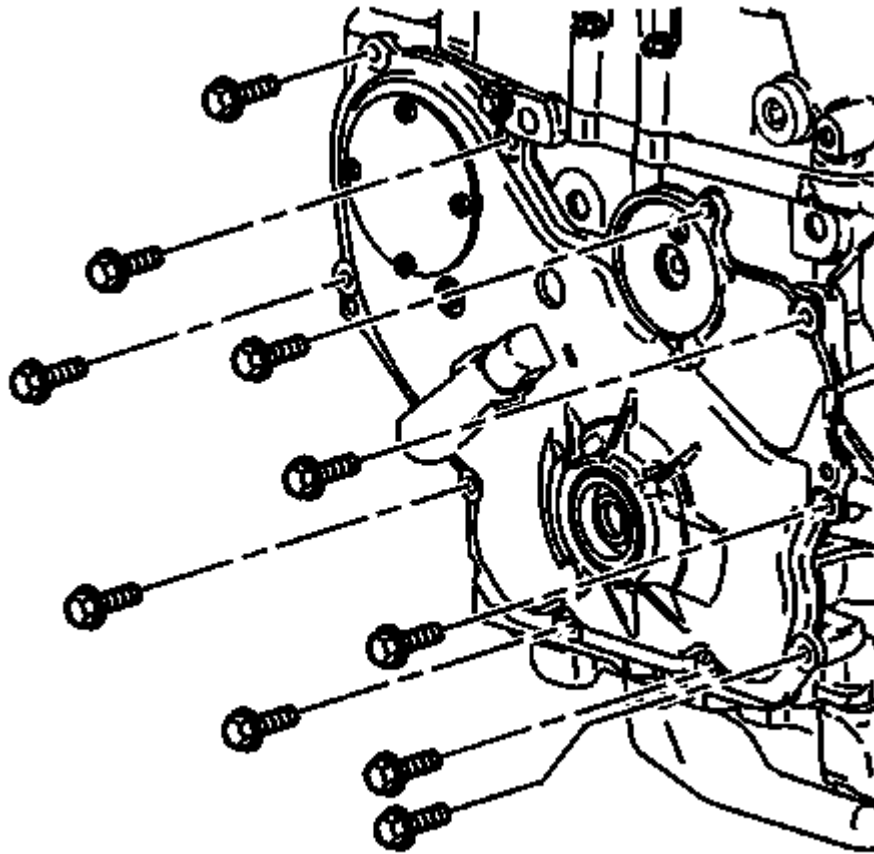


Fig. 32: View Of Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine front cover bolts.

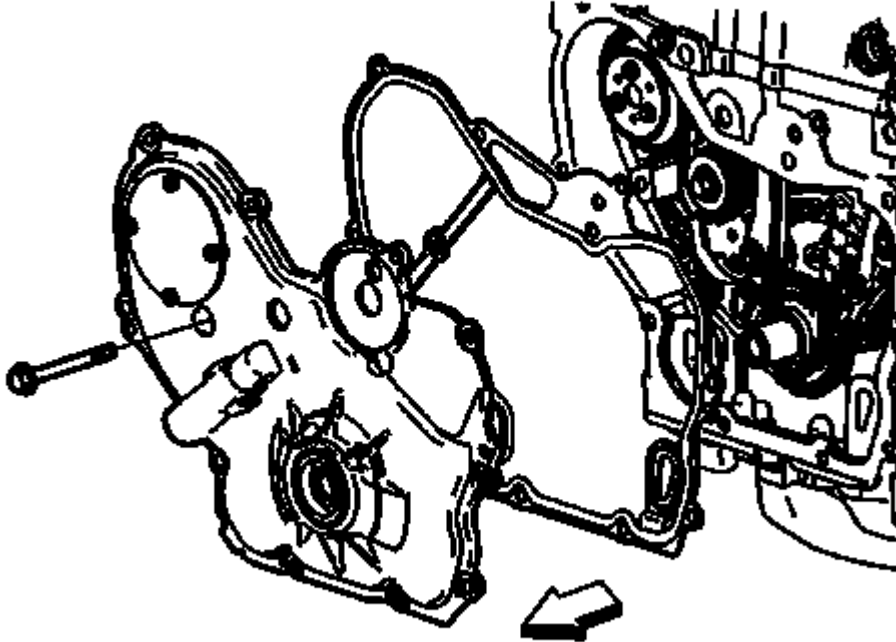


Fig. 33: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

8. Remove the long water pump bolt.
9. Remove the engine front cover and gaskets.
10. Remove the crankshaft front cover oil seal with an appropriate tool.

ENGINE FRONT COVER AND OIL PUMP REMOVAL (LEA)

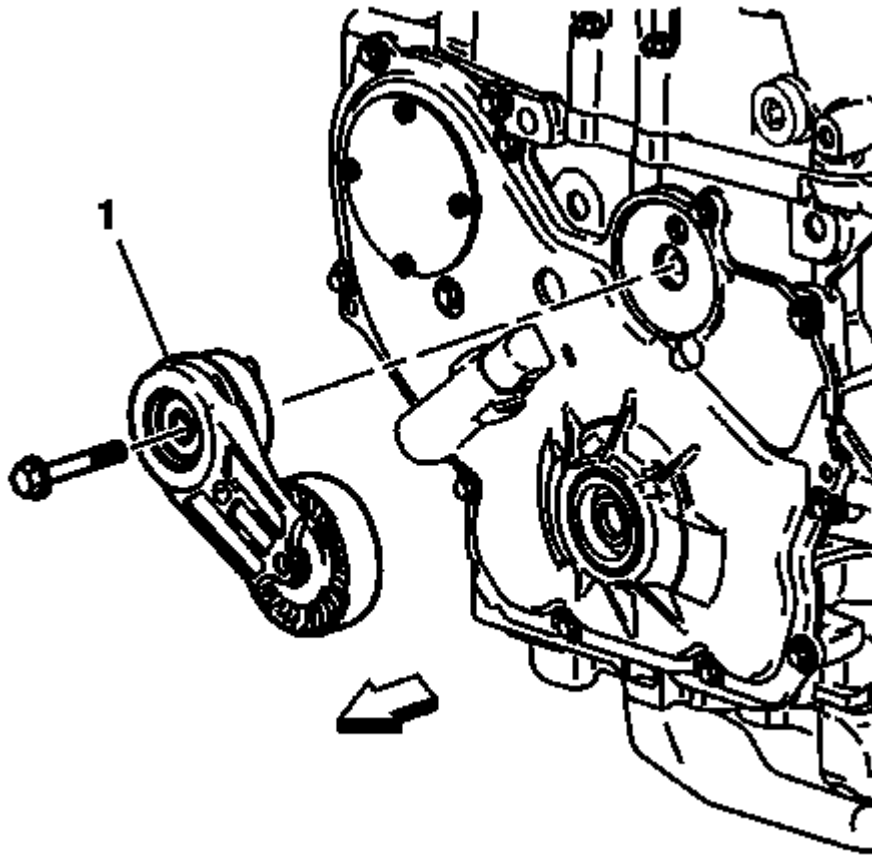


Fig. 34: Accessory Drive Belt Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the accessory drive belt tensioner bolt.
2. Remove the accessory drive belt tensioner (1).

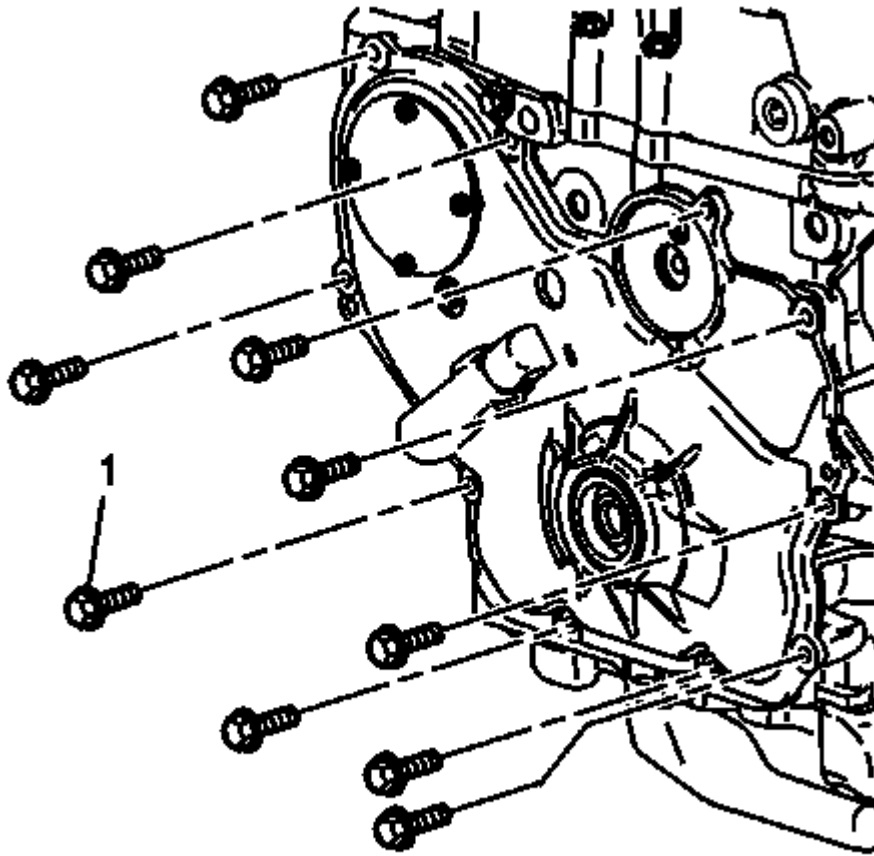


Fig. 35: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine front cover bolts (1).

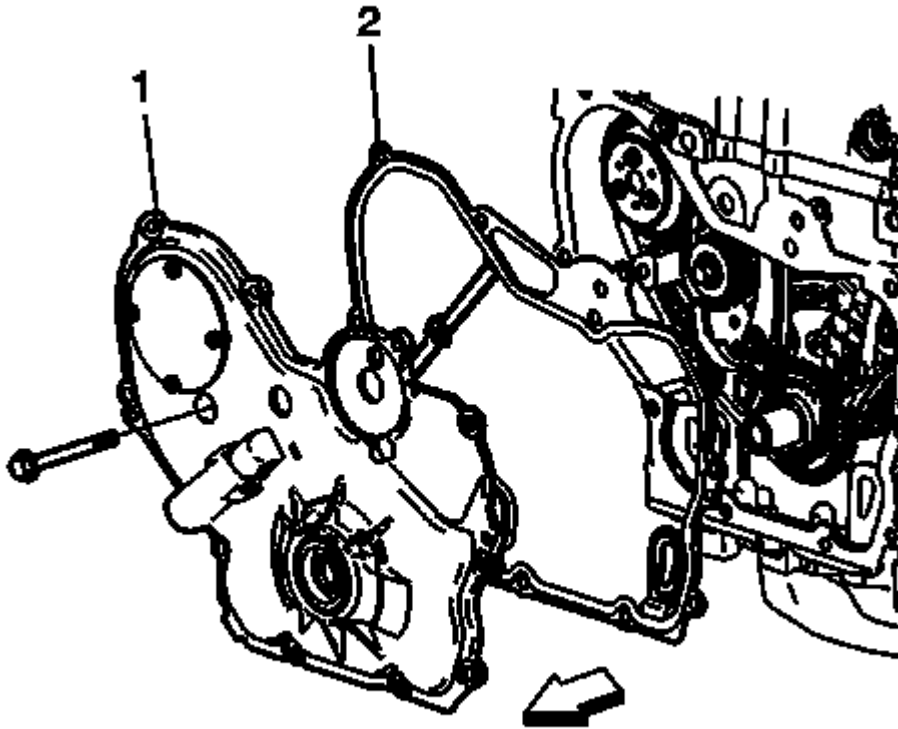


Fig. 36: Long Water Pump Bolt And Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

4. Remove the long water pump bolt.
5. Remove the engine front cover (1) and gaskets (2).
6. Remove the crankshaft front cover oil seal with an appropriate tool.

CAMSHAFT TIMING CHAIN AND TENSIONER REMOVAL (LEA, OR LUK)

Special Tools

EN-48953 Camshaft Actuator Locking Tool

For equivalent regional tools, refer to **Special Tools** .

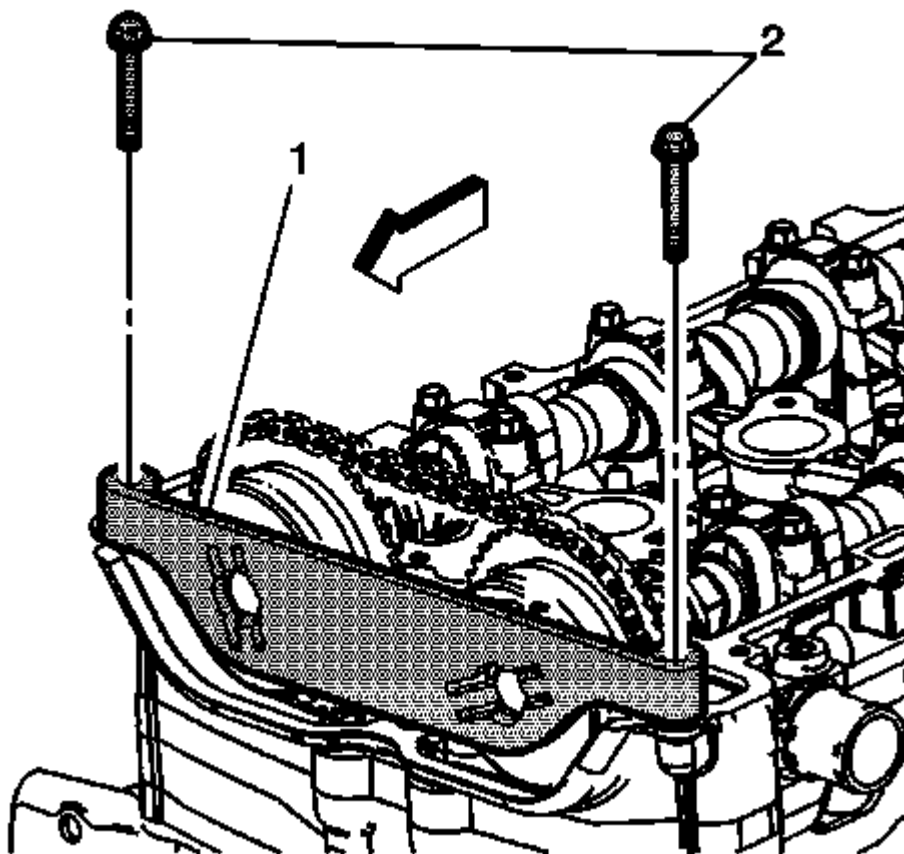


Fig. 37: View Locking Tool

Courtesy of GENERAL MOTORS COMPANY

1. Rotate the crankshaft to install **EN-48953** locking tool (1).

NOTE: Marking the chain and actuators is crucial to procedures operation. The camshaft actuator and timing chain must have oil removed from the surface prior to marking both actuators and chain.

2. Install **EN-48953** locking tool onto the cylinder head and tighten to 10 N.m (89 lb in). If the intake camshaft actuator is moving independent of cam and is not locked, rotate the intake camshaft counterclockwise and the tool will hold the actuator, locking the actuator to the cam.
3. Loosen the intake camshaft actuator bolt.
4. Loosen the exhaust camshaft actuator bolt.
5. Remove **EN-48953** locking tool.

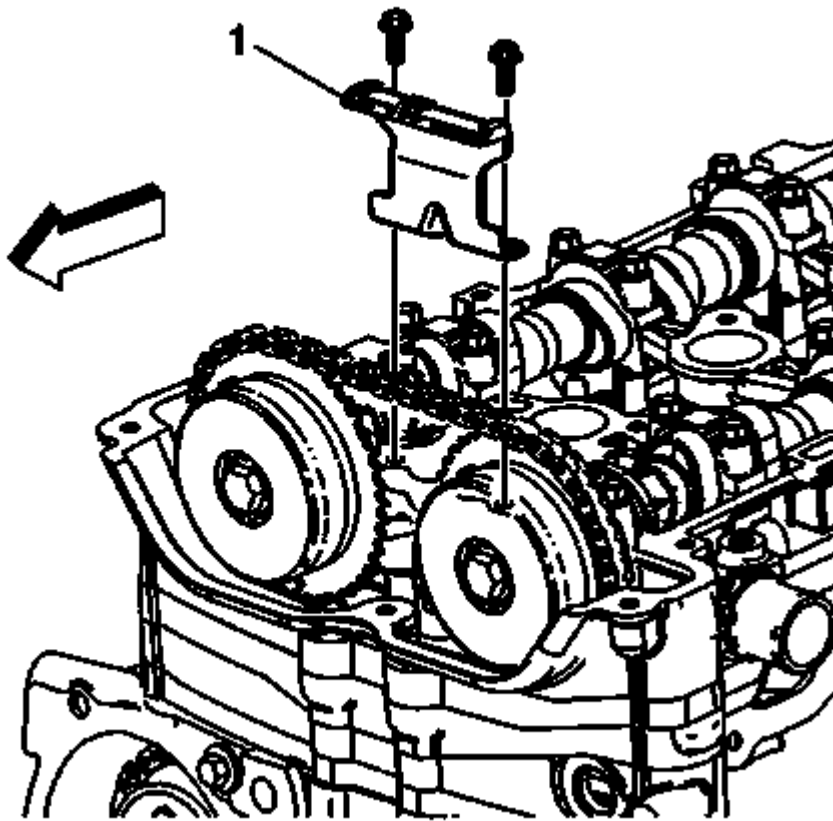


Fig. 38: View of Timing Chain and Tensioner
Courtesy of GENERAL MOTORS COMPANY

6. Remove the upper timing chain guide bolts.
7. Remove the upper timing chain guide (1).

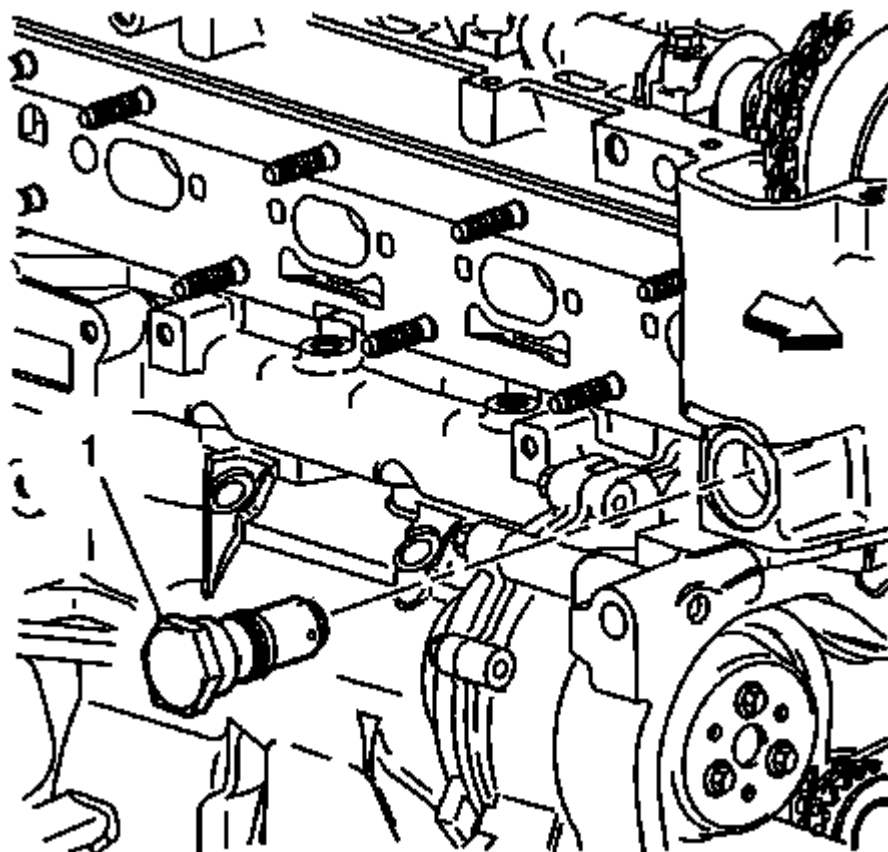


Fig. 39: Identifying Timing Chain Tensioner Plunger
Courtesy of GENERAL MOTORS COMPANY

NOTE: The timing chain tensioner must be removed to unload chain tension before the timing chain is removed.

8. Remove the timing chain tensioner plunger (1).

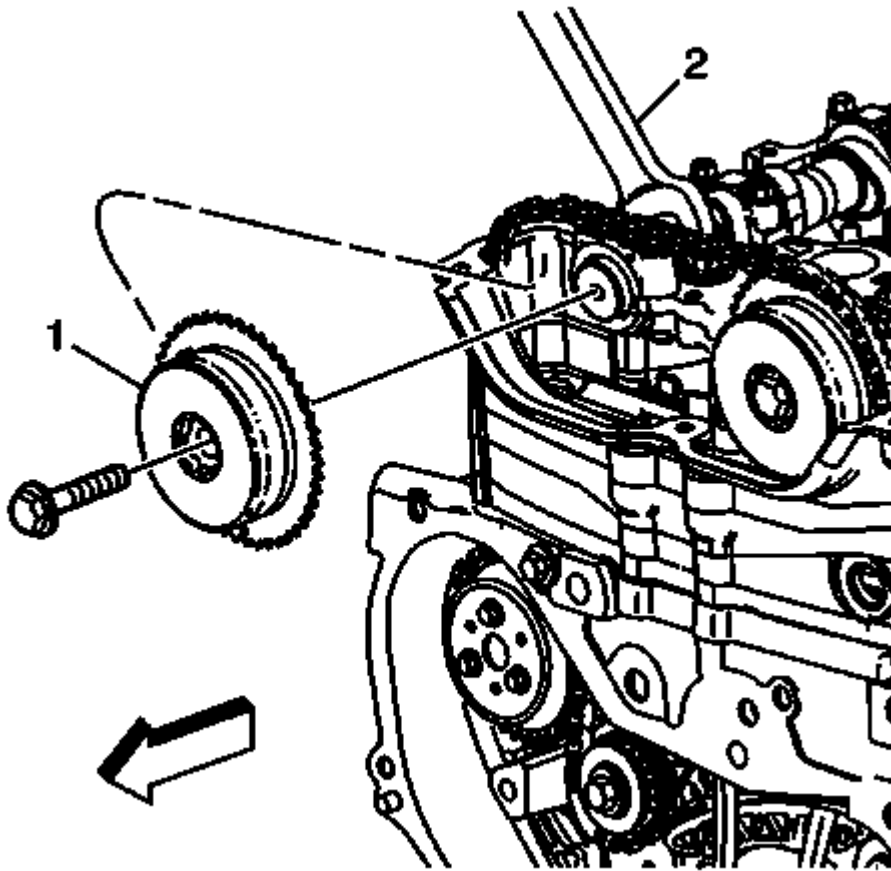


Fig. 40: Identifying Exhaust Camshaft Actuator
Courtesy of GENERAL MOTORS COMPANY

9. Locate hex on the exhaust camshaft and hold with a wrench (2).
10. Remove the exhaust camshaft bolt and the exhaust camshaft actuator (1). Discard the bolt.

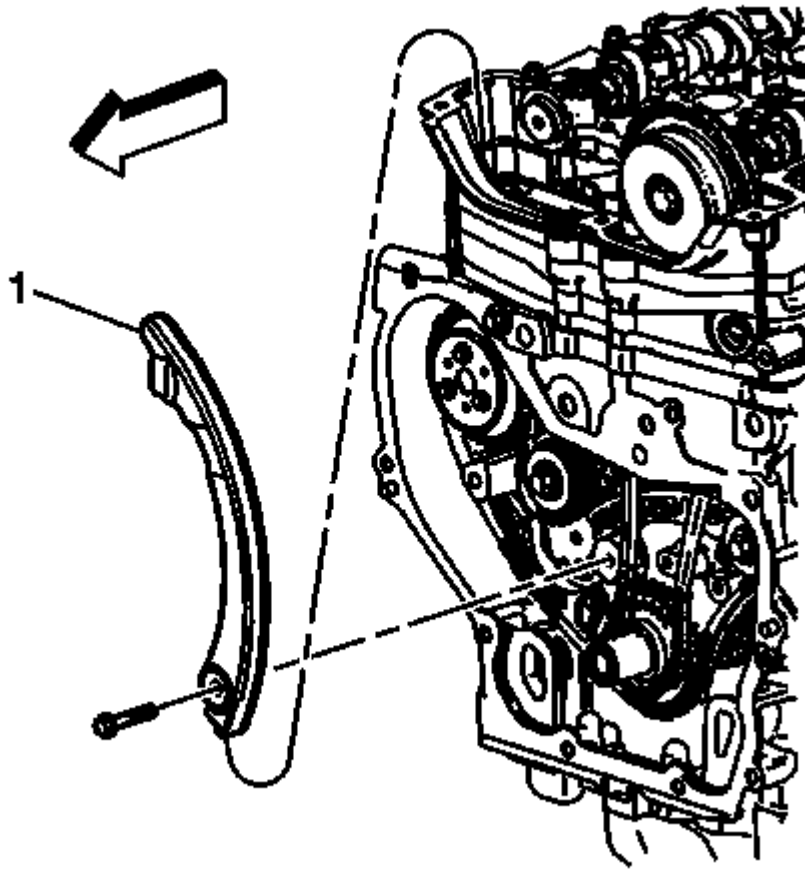


Fig. 41: View of Adjustable Timing Chain Guide Bolt.
Courtesy of GENERAL MOTORS COMPANY

11. Remove the adjustable timing chain guide bolt.
12. Remove the adjustable timing chain guide (1).

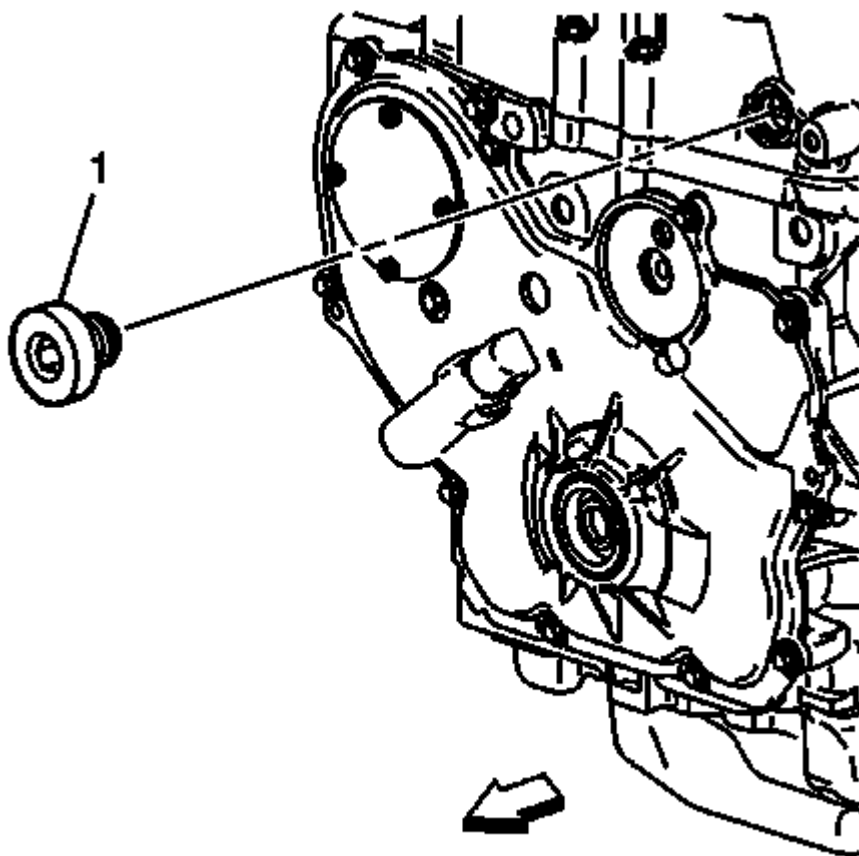


Fig. 42: Identifying Fixed Timing Chain Guide Bolt Plug
Courtesy of GENERAL MOTORS COMPANY

13. Remove the plug (1) to gain access to the fixed timing chain guide bolt.

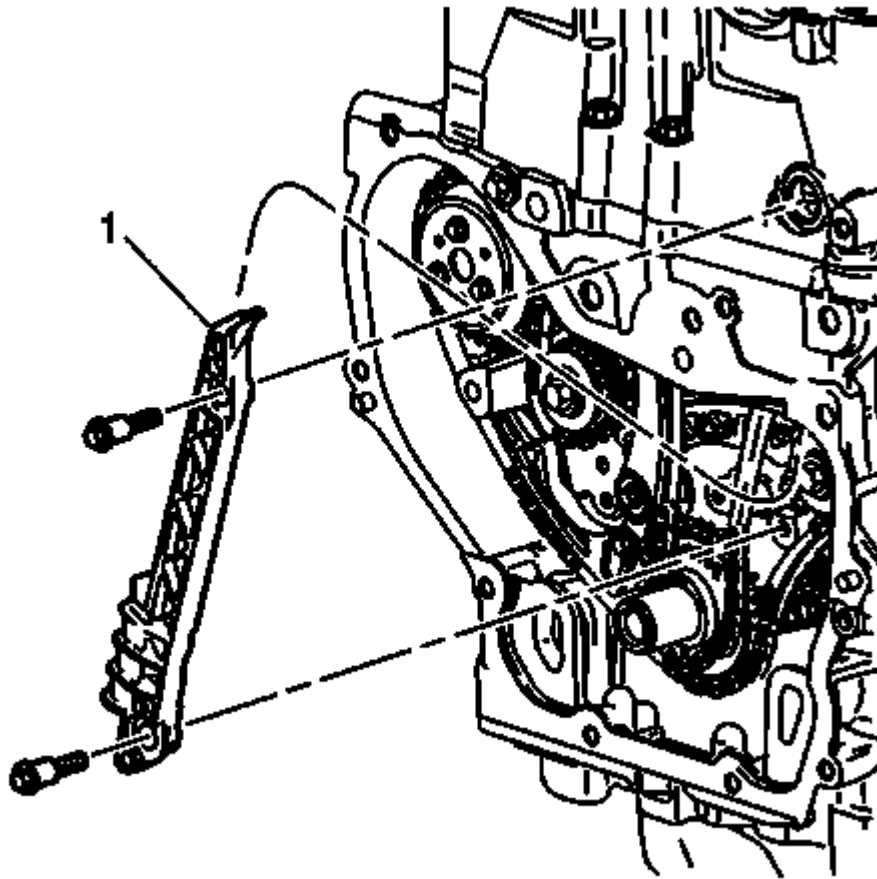


Fig. 43: View of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

14. Remove the fixed timing chain guide bolts.
15. Remove the fixed timing chain guide (1).

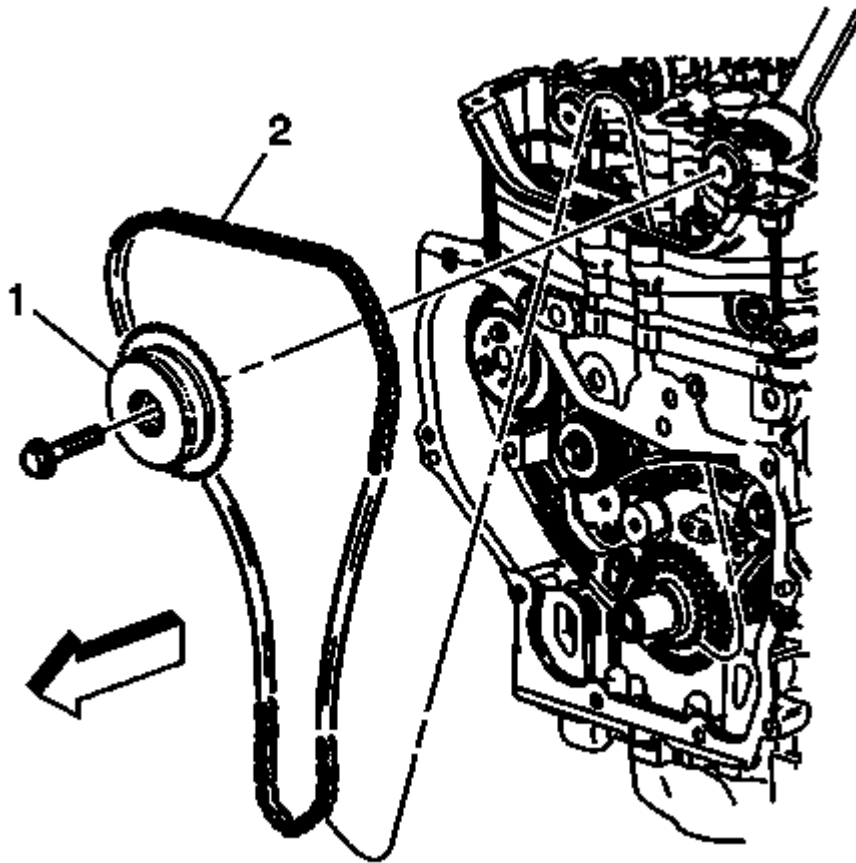


Fig. 44: Identifying Intake Camshaft Actuator & Timing Chain
Courtesy of GENERAL MOTORS COMPANY

16. Locate hex on the intake camshaft and hold with a wrench.
17. Remove the intake camshaft actuator bolt, the intake camshaft actuator (1) and the timing chain (2) through the top of the cylinder head. Discard the bolt.

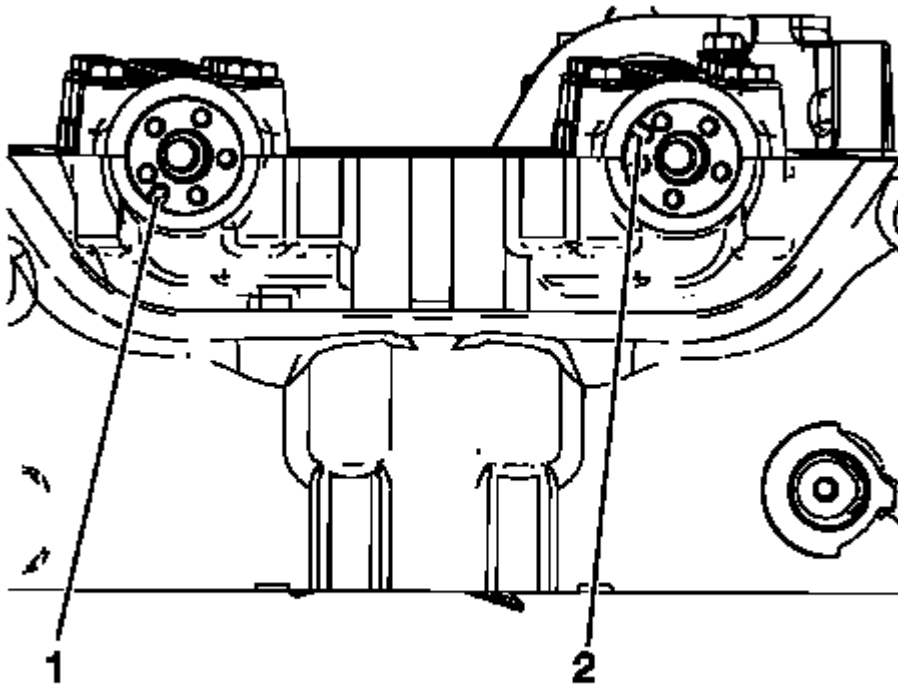


Fig. 45: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The number 3 exhaust valves are open.
- Note the position and direction of the camshafts before removal. Mark the cylinder head in relation to the locking notches before component removal.

18. Mark the cylinder head where the exhaust camshaft actuator locking notch (1) and intake camshaft locking notch (2) are lined up with the cylinder head.

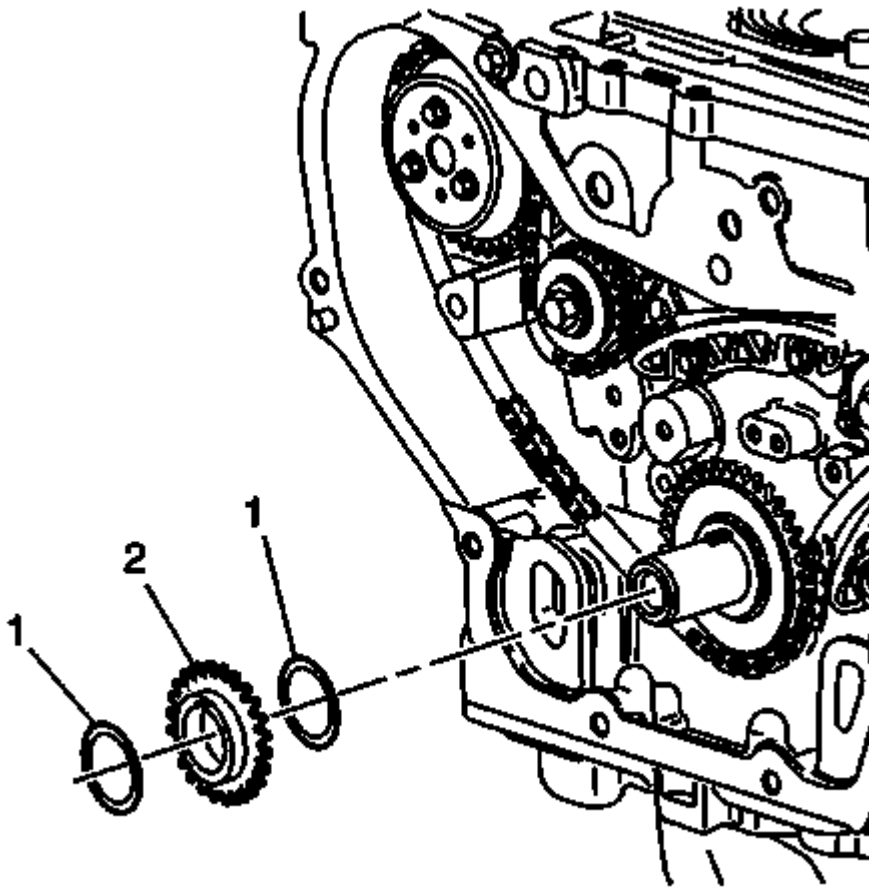


Fig. 46: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

19. Remove the crankshaft sprocket (2) and friction washers (1), if equipped.

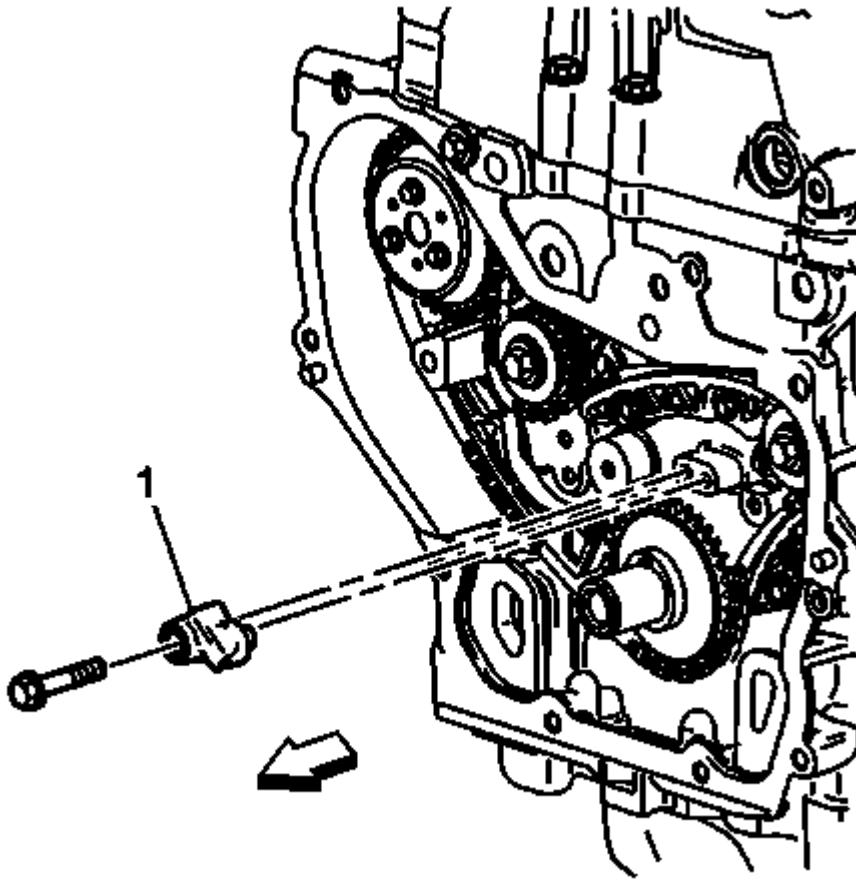


Fig. 47: View of Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

20. Remove the timing chain oil nozzle bolt.
21. Remove the timing chain oil nozzle (1).

INTAKE AND EXHAUST CAMSHAFT, BEARING CAP, AND LASH ADJUSTER REMOVAL (LEA, OR LUK)

Intake Camshaft and Components Removal

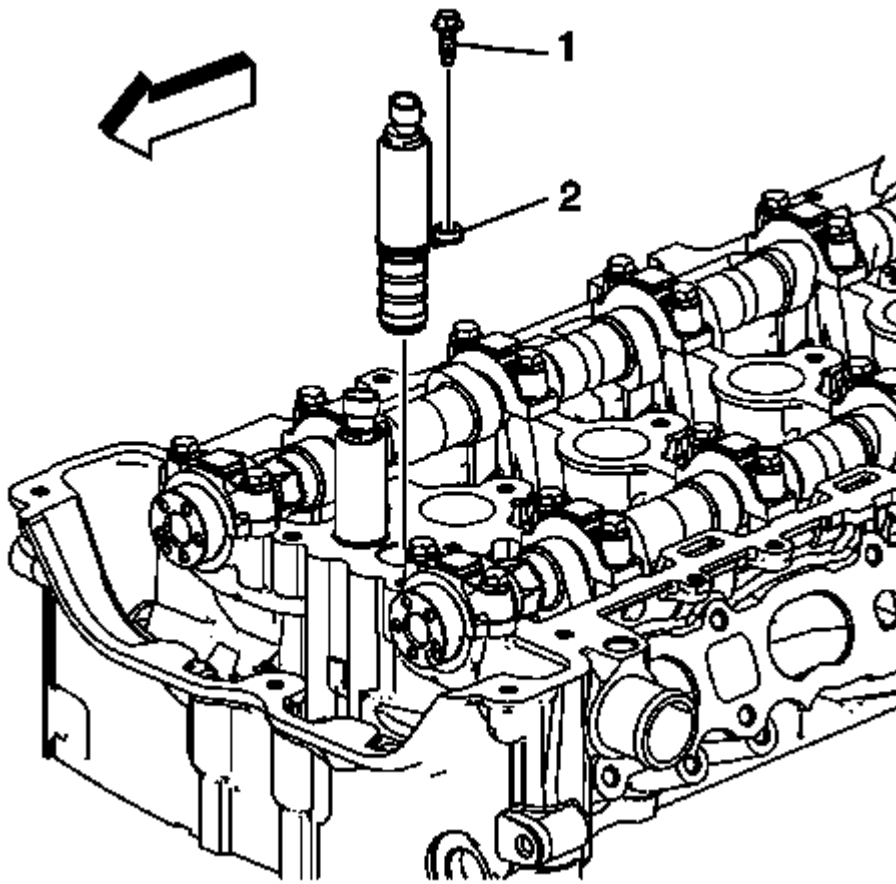


Fig. 48: Intake Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake camshaft position actuator solenoid valve bolt (1) and valve (2).

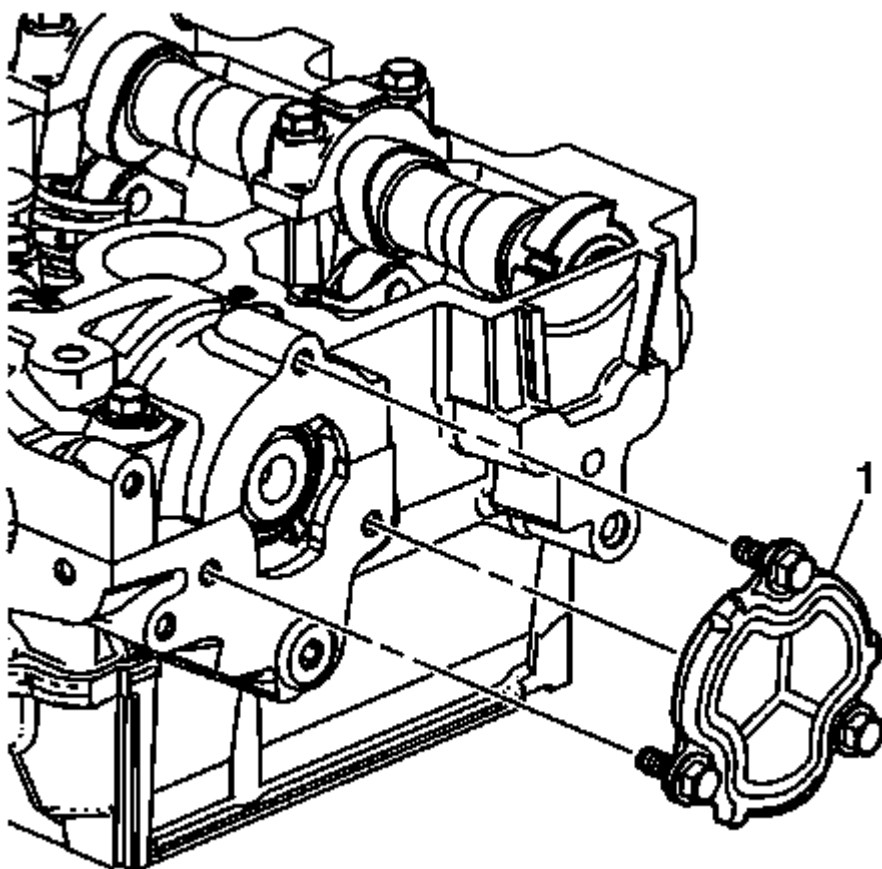


Fig. 49: Rear Cylinder Head Cover Plate
Courtesy of GENERAL MOTORS COMPANY

2. Remove the rear cylinder head cover plate (1).

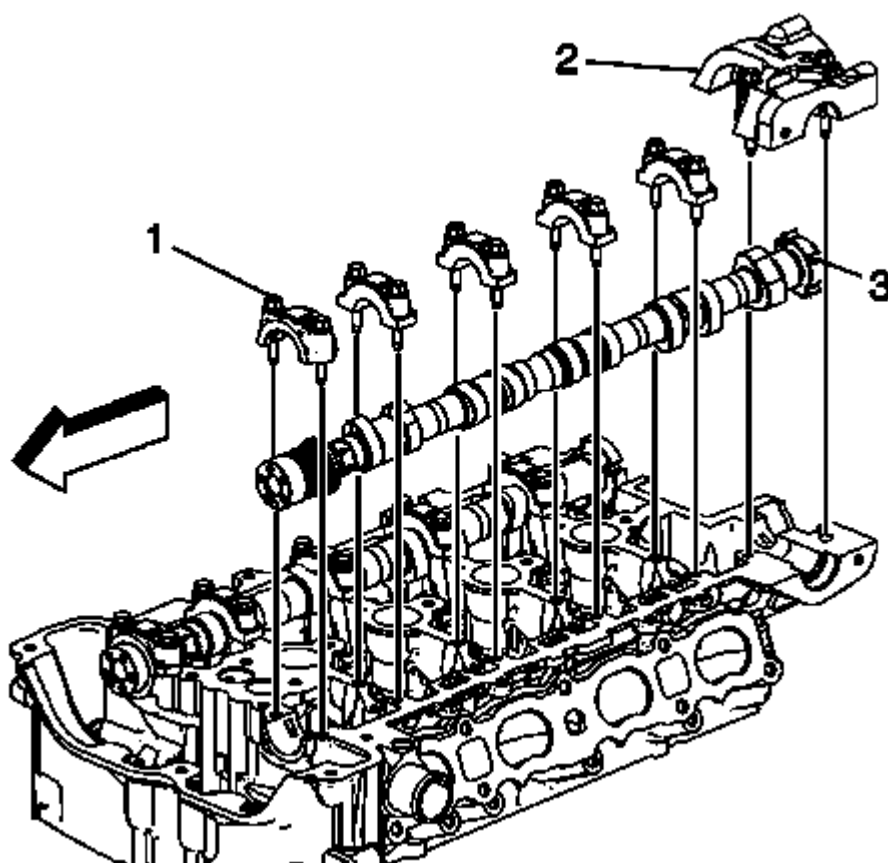


Fig. 50: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

3. Remove the intake camshaft bearing rear cap bolts and cap (2).

NOTE: Remove each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

4. Mark camshaft caps to ensure they are installed in the same position.
5. Remove the intake camshaft cap bolts.
6. Remove the camshaft caps (1).
7. Remove the intake camshaft (3).

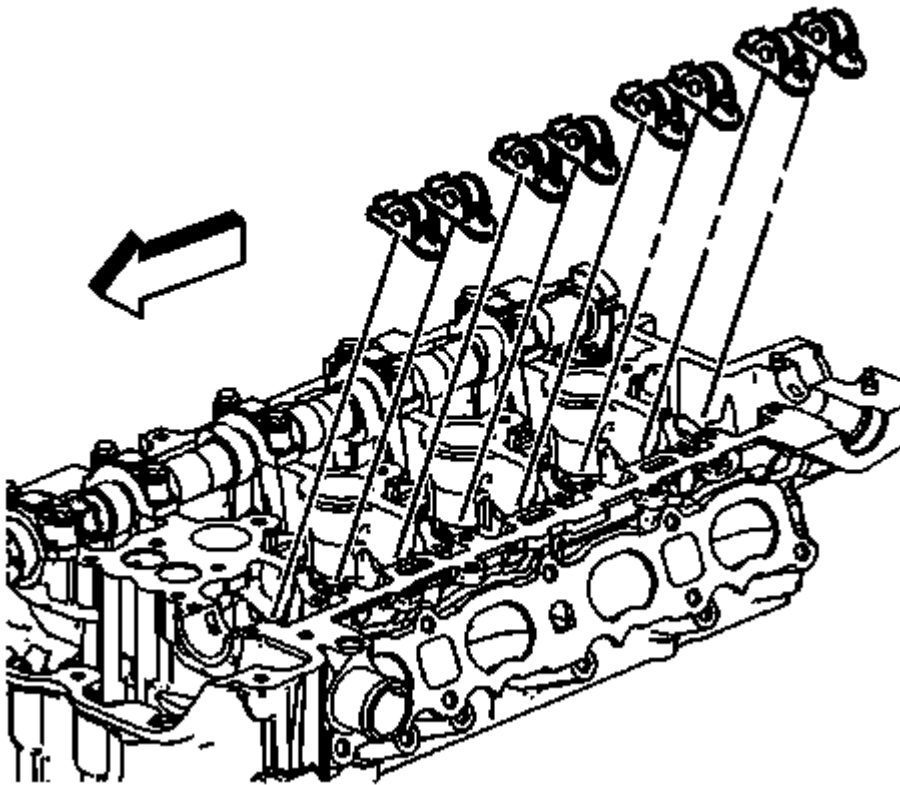


Fig. 51: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the roller finger followers and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

8. Remove the intake camshaft roller finger followers.

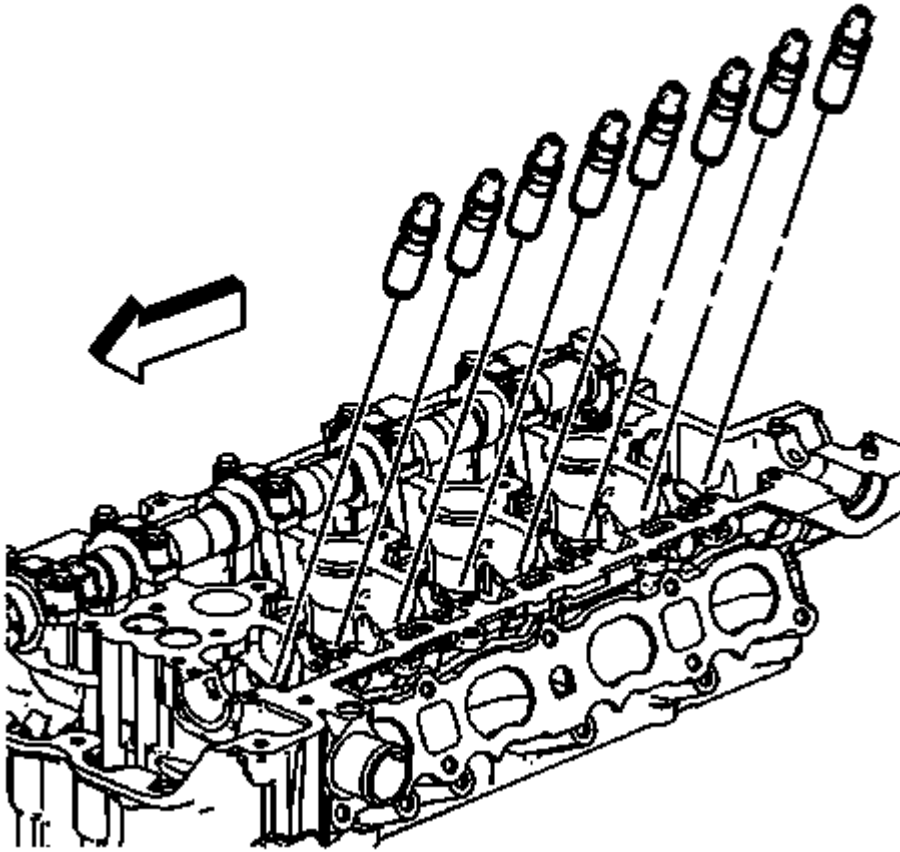


Fig. 52: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

9. Remove the hydraulic lash adjusters.

Exhaust Camshaft and Components Removal

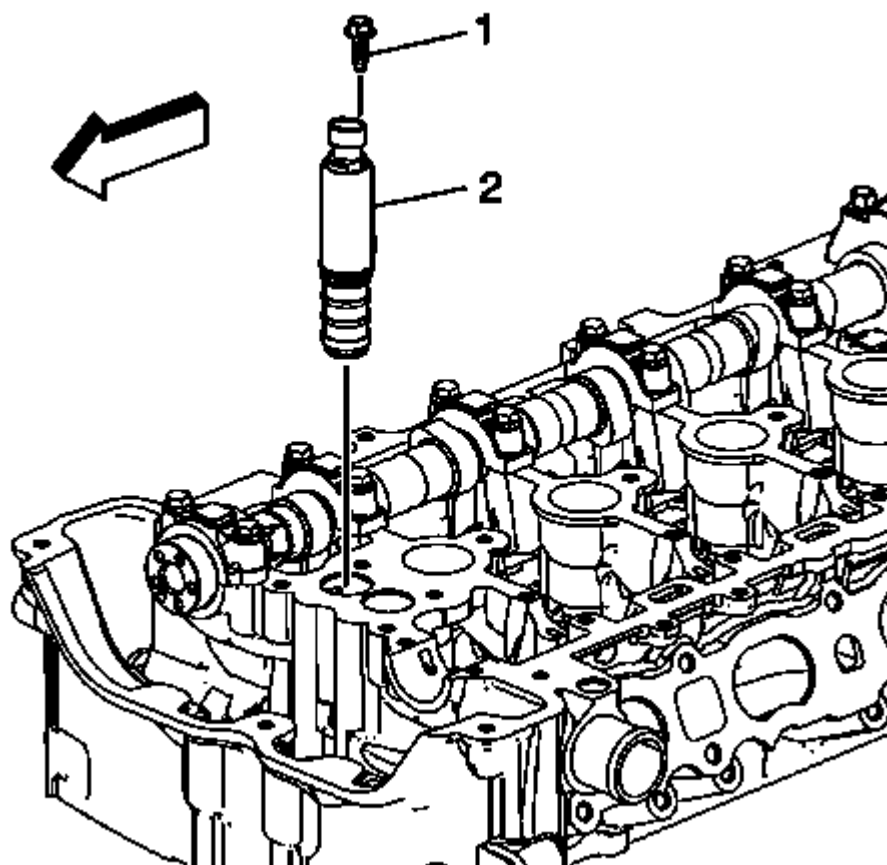


Fig. 53: Exhaust Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the exhaust camshaft position actuator solenoid valve bolt (1) and valve (2).

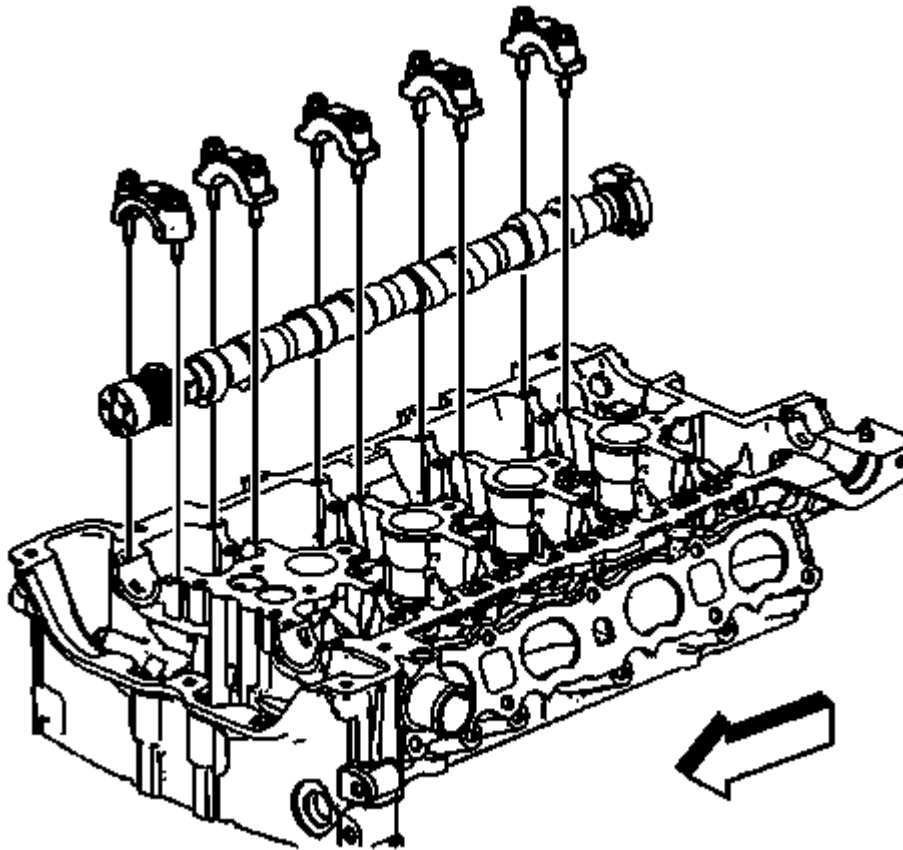


Fig. 54: Exhaust Camshaft & Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: Remove each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

2. Mark camshaft caps to ensure they are installed in the same position.
3. Remove the exhaust camshaft cap bolts.
4. Remove the camshaft caps ensuring they are marked and refitted in same position on assembly.
5. Remove the exhaust camshaft.

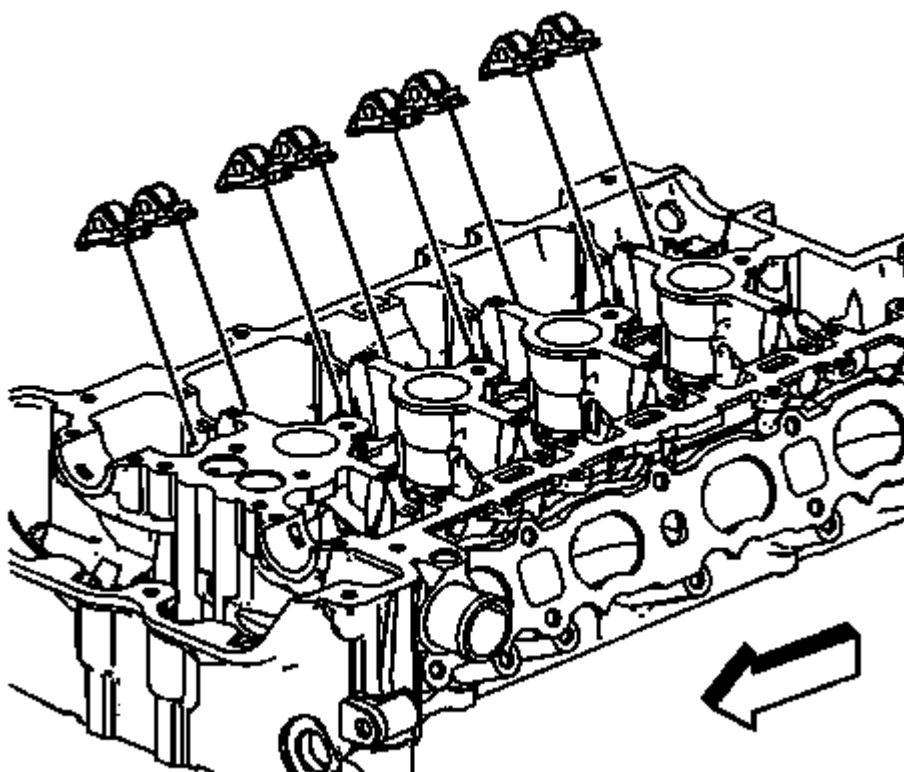


Fig. 55: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the roller finger followers and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

6. Remove the exhaust camshaft roller finger followers.

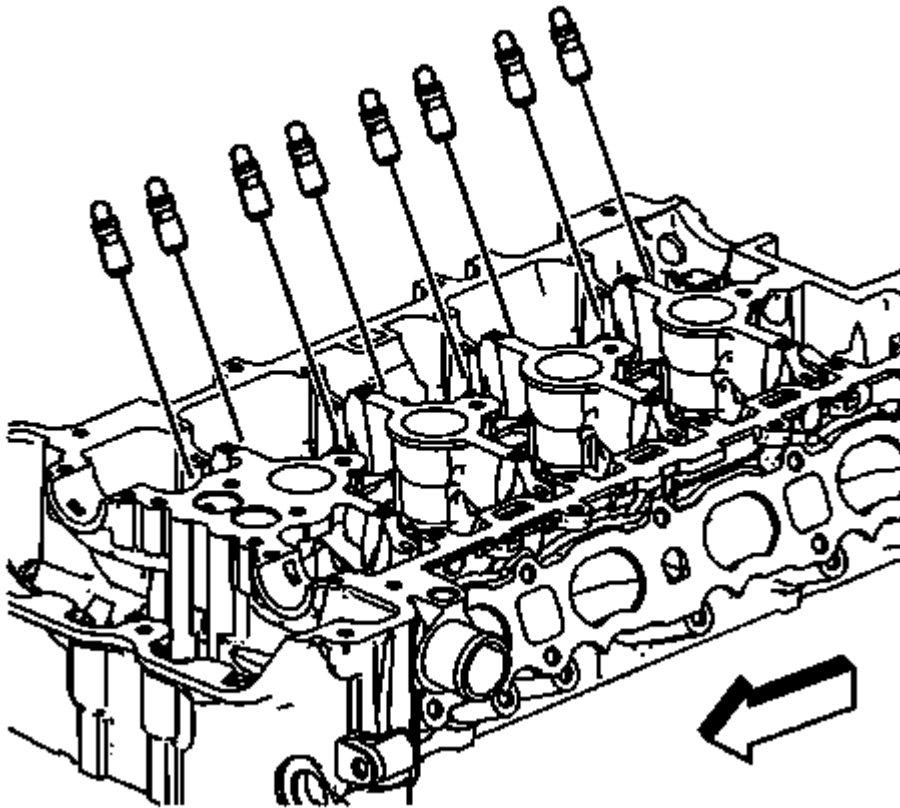


Fig. 56: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

7. Remove the hydraulic lash adjusters.

WATER PUMP AND BALANCE SHAFT CHAIN AND TENSIONER REMOVAL

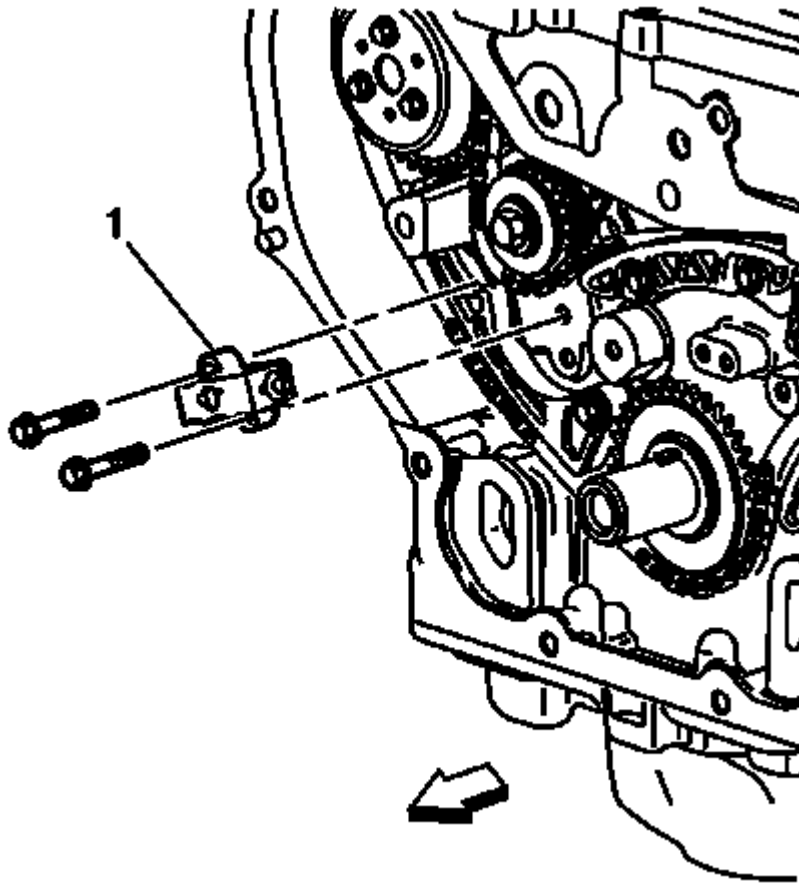


Fig. 57: Balance Shaft Drive Chain Tensioner And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the balance shaft drive chain tensioner bolts.
2. Remove the balance shaft drive chain tensioner (1).

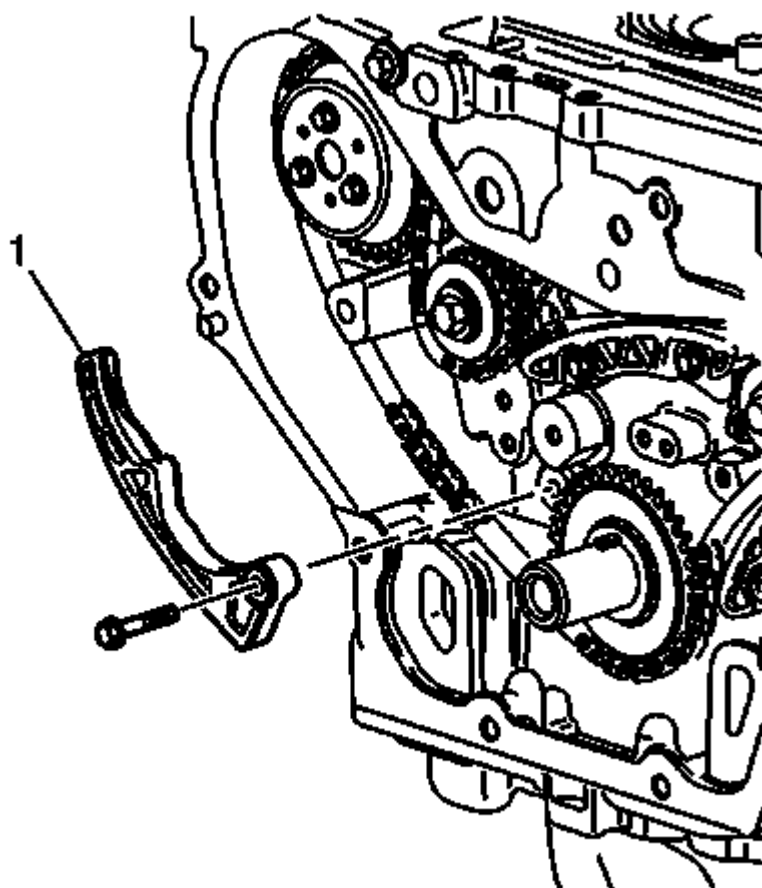


Fig. 58: Adjustable Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

3. Remove the adjustable balance shaft chain guide bolt.
4. Remove the adjustable balance shaft chain guide (1).

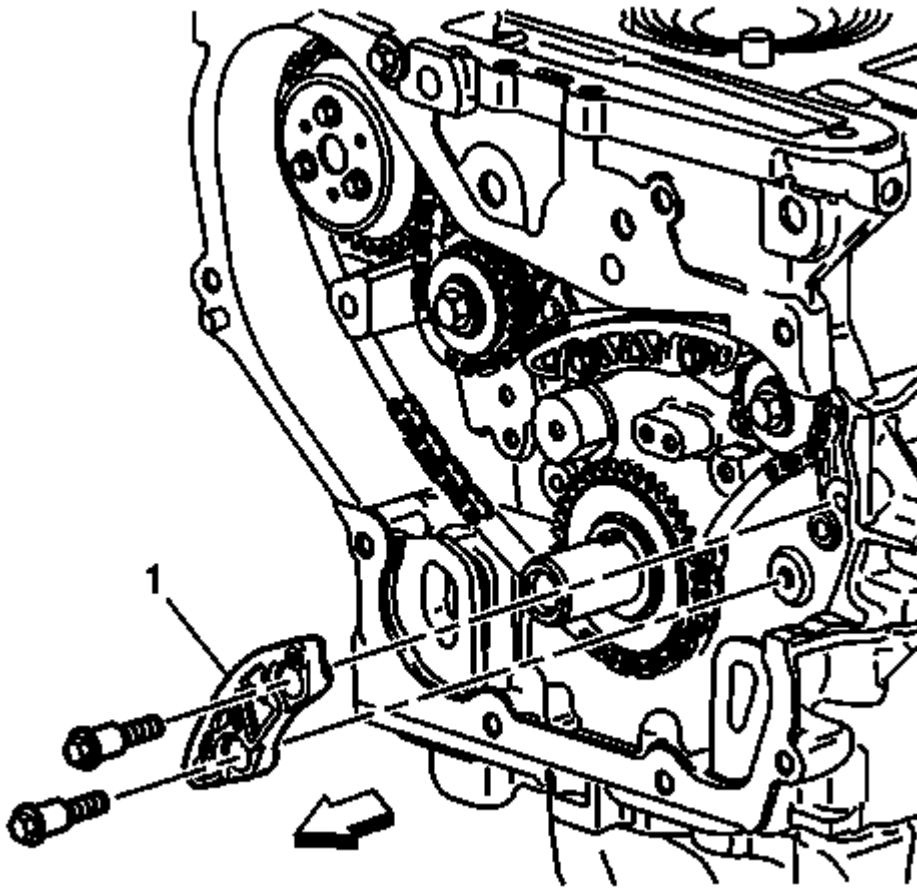


Fig. 59: Small Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS COMPANY

5. Remove the small balance shaft drive chain guide bolts.
6. Remove the small balance shaft drive chain guide (1).

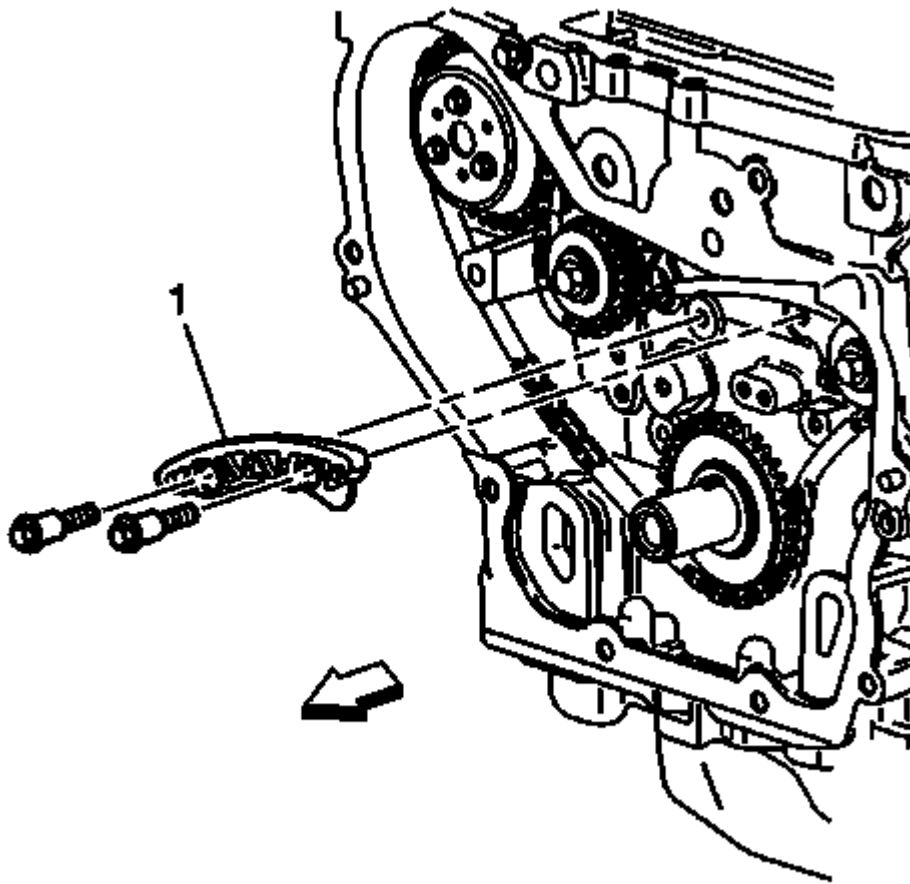


Fig. 60: Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

7. Remove the upper balance shaft drive chain guide bolts.
8. Remove the upper balance shaft drive chain guide (1).

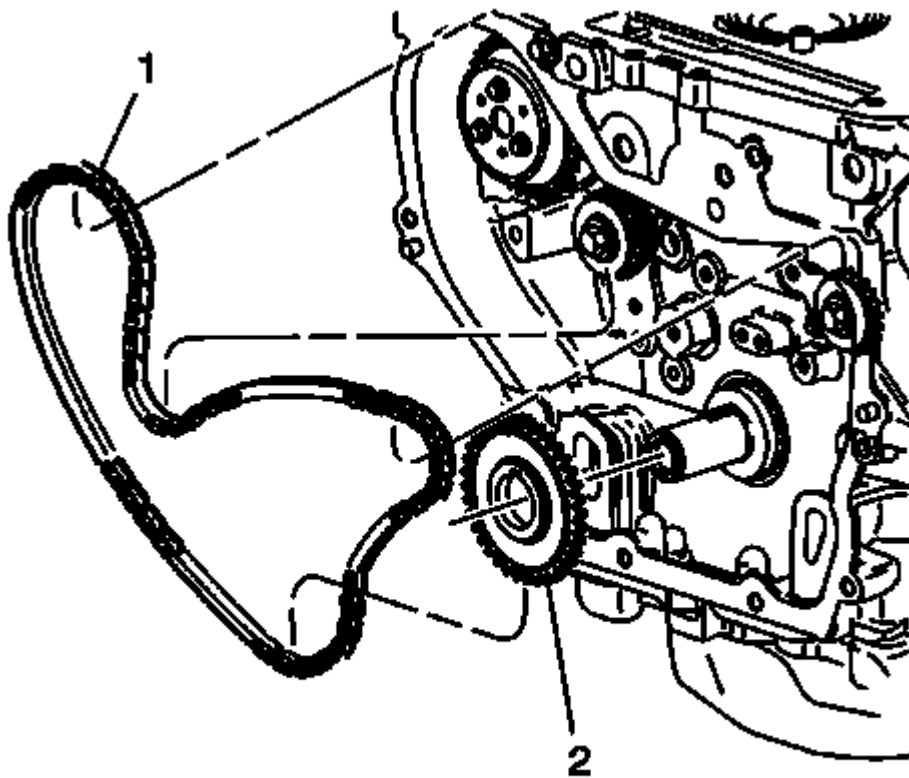


Fig. 61: Balance Shaft Drive Chain And Sprocket
Courtesy of GENERAL MOTORS COMPANY

NOTE: It may ease removal of the balance shaft drive chain to get all of the slack in the chain between the crankshaft and water pump sprockets.

9. Remove the balance shaft drive chain (1).
10. Remove the balance shaft drive sprocket (2).

BALANCE SHAFT REMOVAL

NOTE: This procedure is not used in Europe.

Special Tools

EN-43650 Balancer Shaft Bearing Remover and Installer

For equivalent regional tools, refer to **Special Tools** .

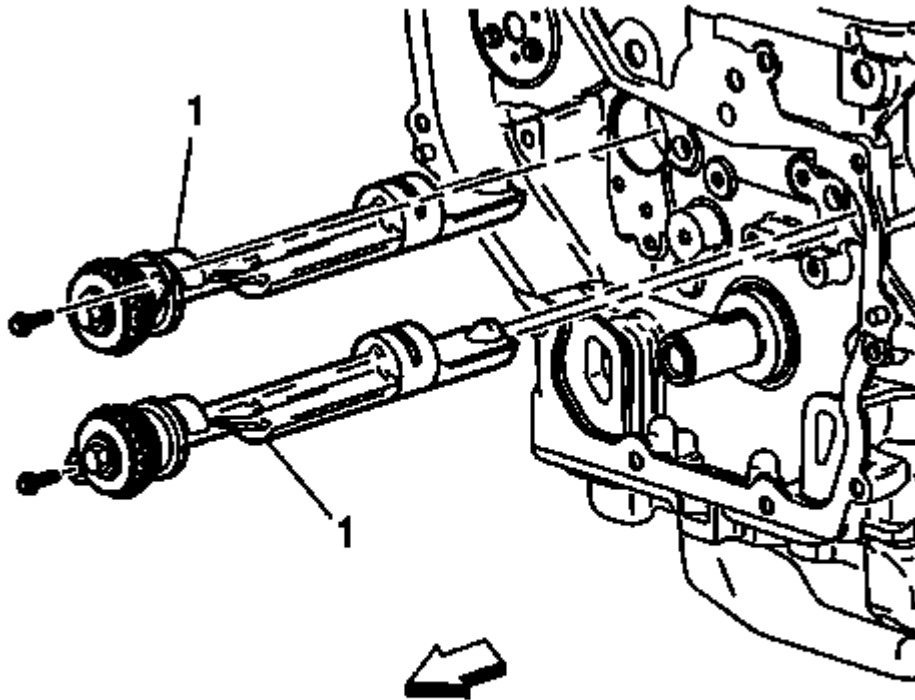


Fig. 62: View of Balance Shaft Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the balance shaft bearing carrier bolts.

NOTE:

- It is possible to install the intake side balance shaft into the exhaust side and vice versa. Please use care not to install the balance shafts into the wrong bores. Engine vibration will result.
- Do not remove the bolt holding the sprocket.

2. Remove the balance shaft assemblies (1).

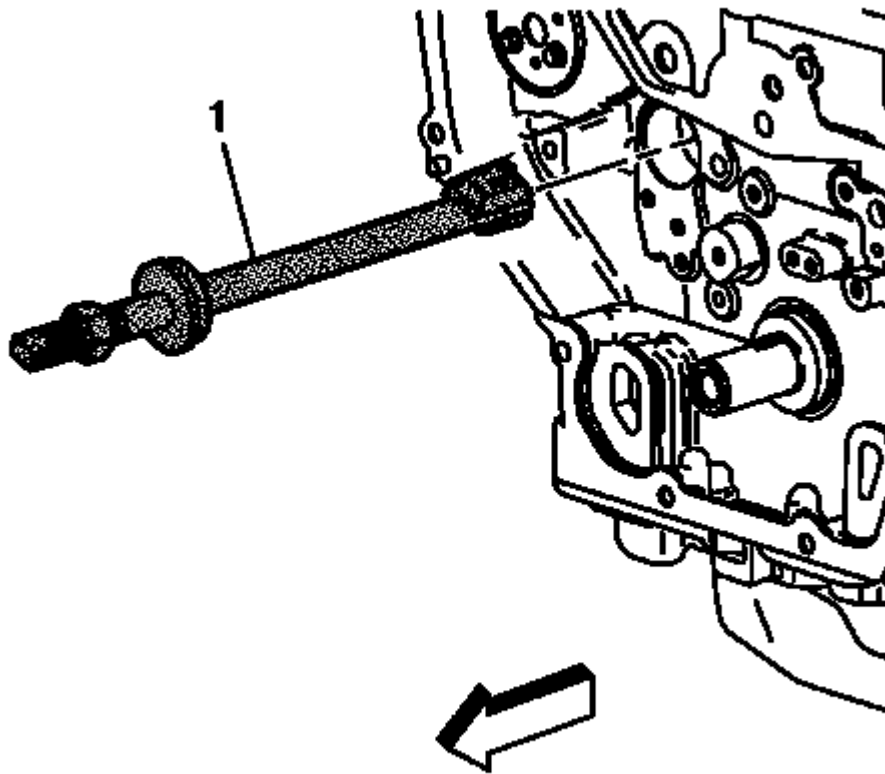


Fig. 63: View of Special Tool EN-43650 on the Balance Shaft Bushing
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Proper centering of the tool is required on the balance shaft bushing. If the tool is not properly centered then damage to the bearing bore and block will occur.

3. Install the **EN-43650** remover (1) into the balance shaft hole. Insert the tool with the foot parallel to the shaft.

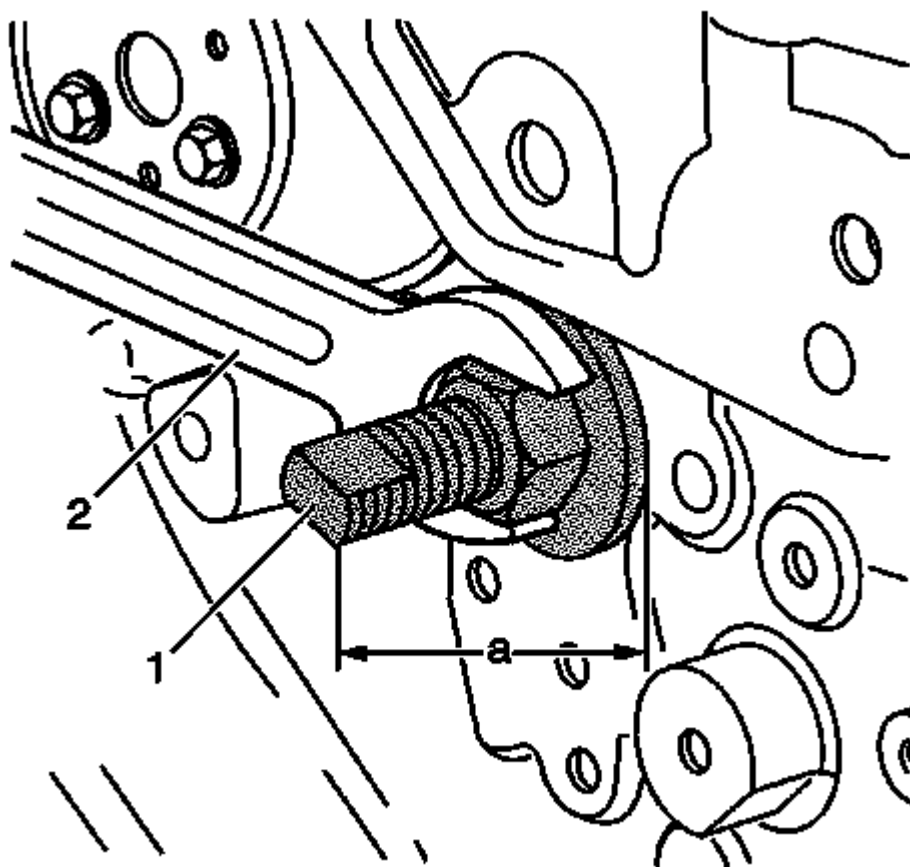


Fig. 64: Balancer Shaft Bearing Remover and Installer
Courtesy of GENERAL MOTORS COMPANY

4. When the **EN-43650** remover (1) is inserted in the block turn the **EN-43650** remover so that the foot becomes perpendicular to the shaft.
5. Center the foot of the **EN-43650** remover on the balance shaft bushing.
6. Once the **EN-43650** remover is centered on the balance shaft bushing, then insert the centering guide into the front balance shaft bore and tighten the nut with an appropriate wrench (2).

When the **EN-43650** remover is properly installed, before removing the bushing, the end of the tool should be 116 mm (4.6 in) (a) from the block face.

If the **EN-43650** remover is less than approximately 114 mm (4.5 in) (a), recheck the tool alignment.

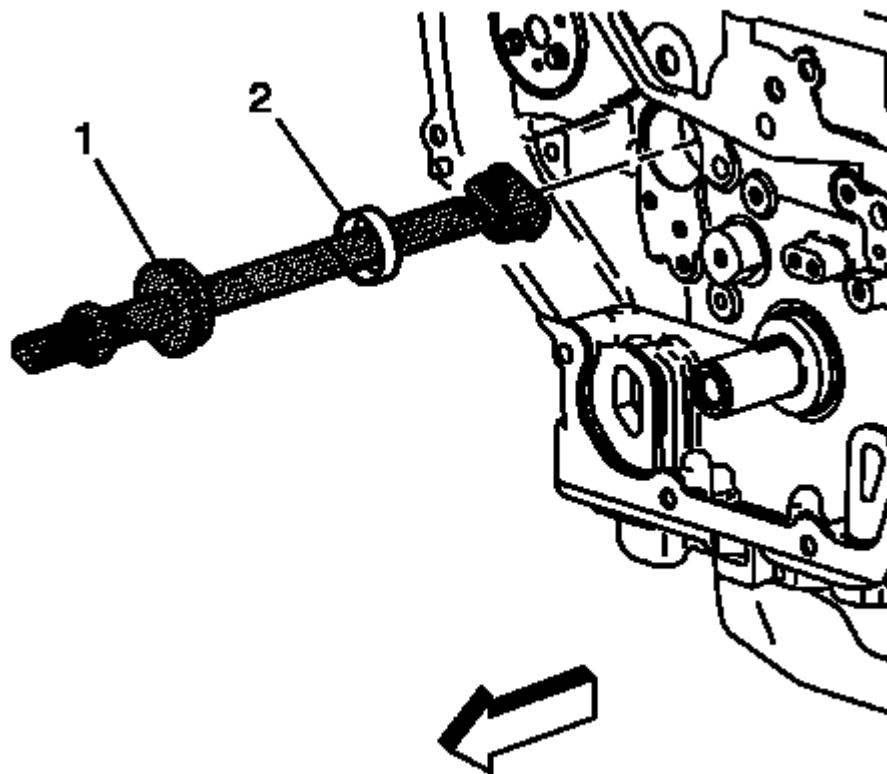


Fig. 65: Balancer Shaft Bearing Remover and Installer
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the nut on the **EN-43650** remover (1) until the tension releases. When the tension releases, remove the **EN-43650** remover and the balance shaft bushing (2).

WATER PUMP REMOVAL

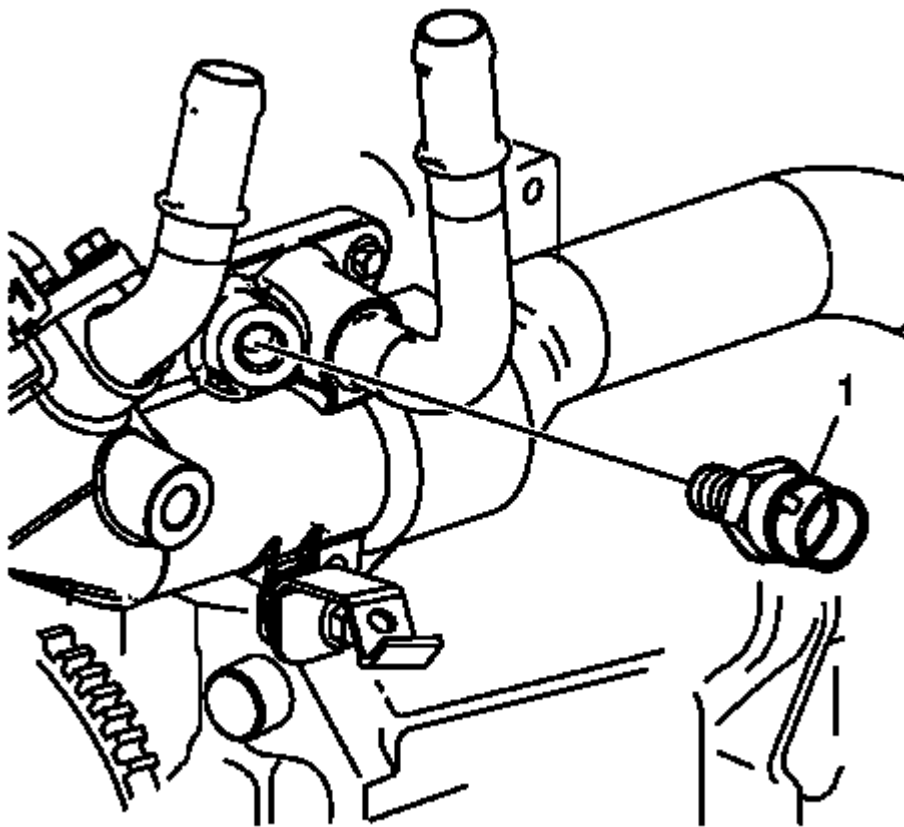


Fig. 66: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine coolant temperature sensor (1).

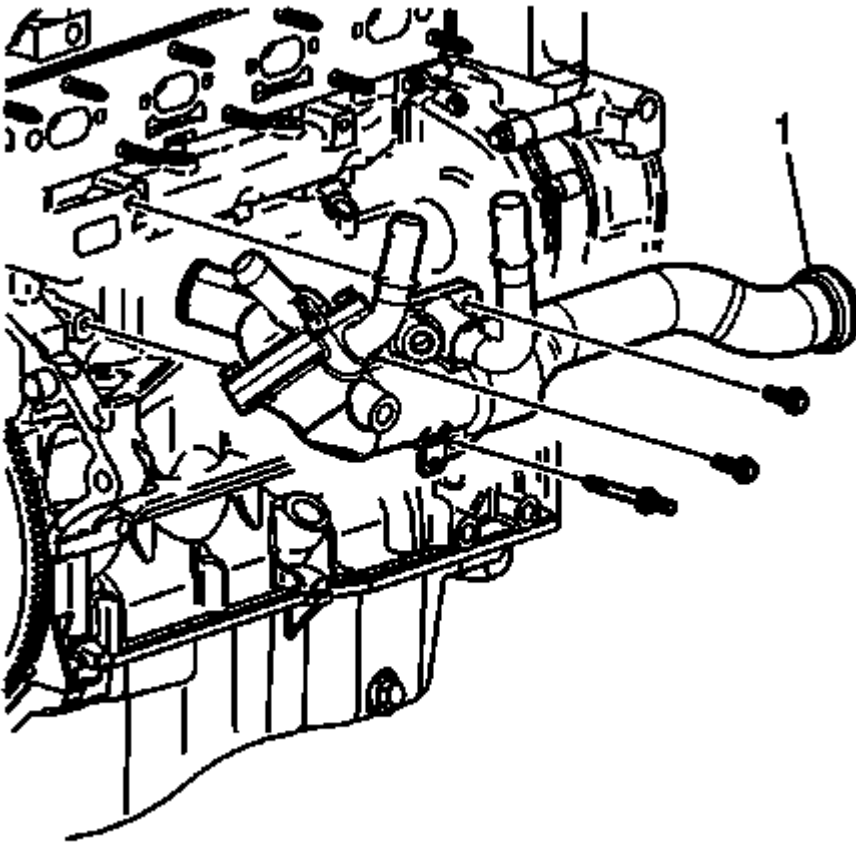


Fig. 67: Thermostat Housing, Water Feed Pipe & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the thermostat and water feed pipe retaining bolts.

NOTE: **Twist the water feed pipe while pulling to remove it from the water pump cover.**

3. Remove the thermostat housing and water feed pipe (1) from the water pump cover.

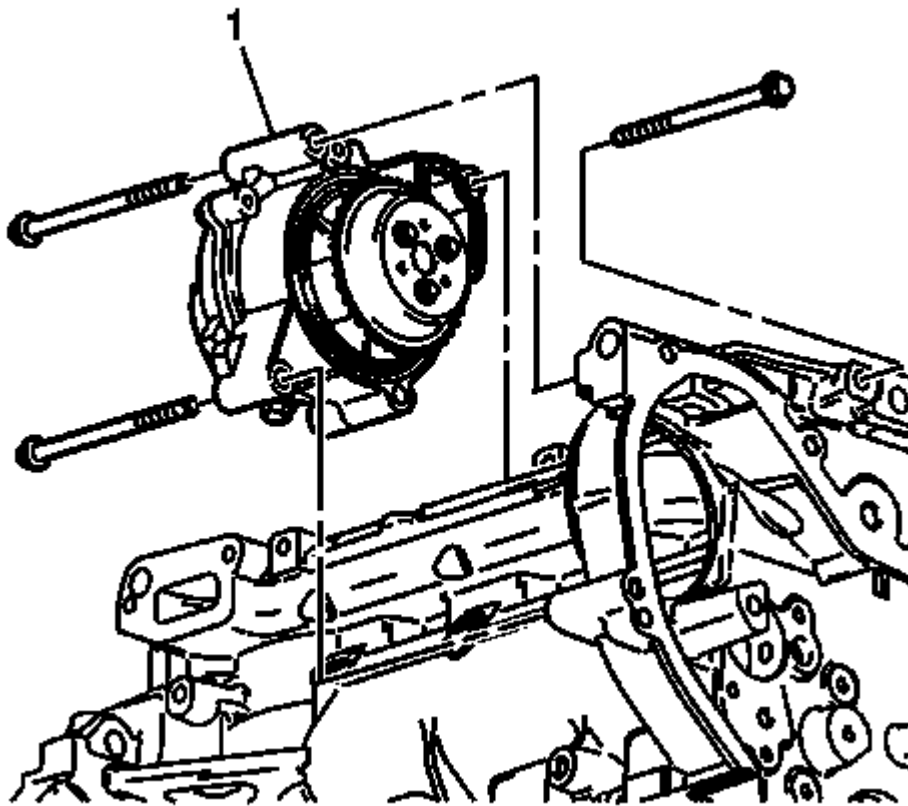


Fig. 68: Water Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Remove the water pump retaining bolts. Be sure to remove the bolt that goes through the front of the engine block.
5. Remove the water pump assembly (1).

CYLINDER HEAD REMOVAL (LEA, OR LUK)

Special Tools

EN 38188 Cylinder Head Broken Bolt Extractor Kit

For equivalent regional tools, refer to **Special Tools**

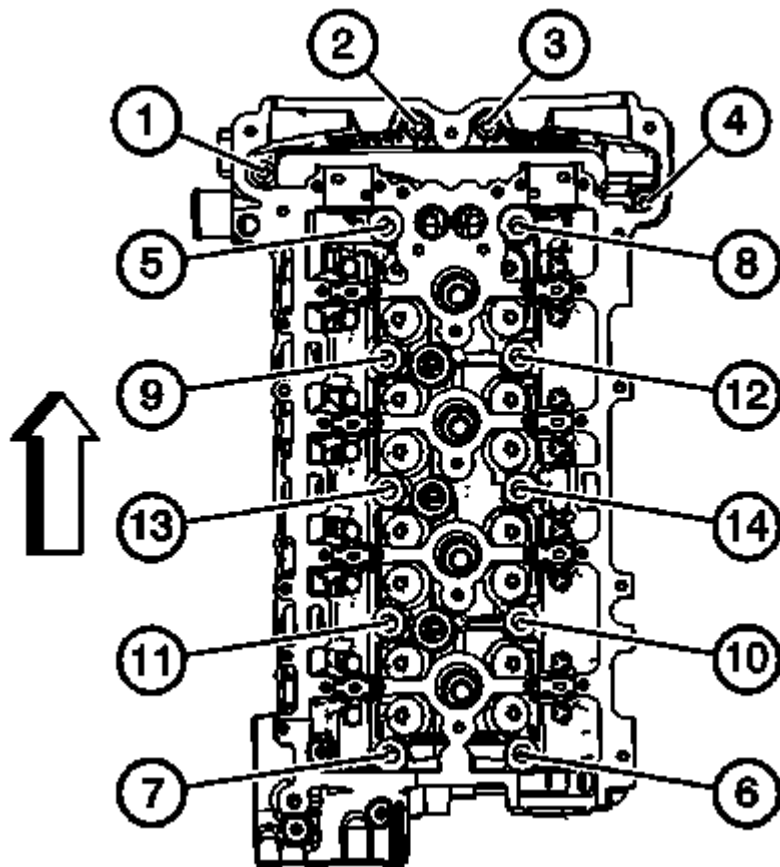


Fig. 69: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS COMPANY

1. Remove the cylinder head to the block bolts in sequence.

Discard the bolts.

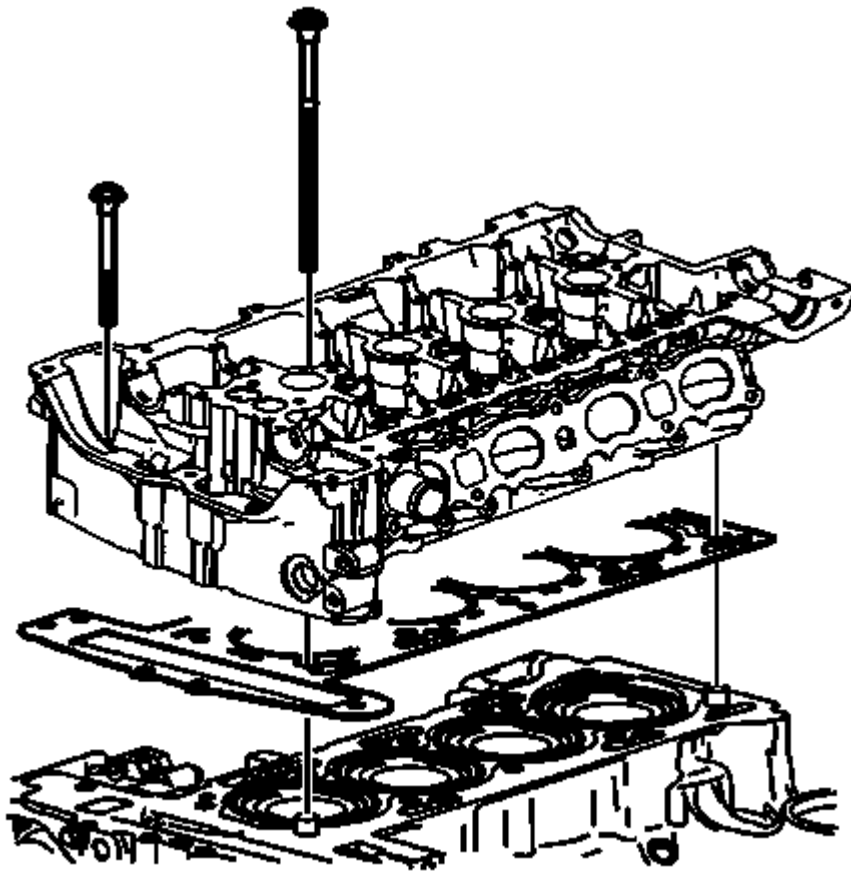


Fig. 70: Cylinder Head

Courtesy of GENERAL MOTORS COMPANY

CAUTION: In order to prevent damage to the valves and injectors during cylinder head removal, set the cylinder head on blocks.

2. Remove the cylinder head.
3. Remove the cylinder head gasket.
4. Clean all of the gasket surfaces.
5. Use the following procedures when cleaning the cylinder head and cylinder block surfaces:
 - Use a razor blade gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge any surface.

NOTE: Do not use any other method or technique to clean these gasket surfaces.

- Use a new razor blade for each cylinder head and cylinder block.

NOTE: Be careful not to gouge or scratch the gasket surfaces. Do not gouge

or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.

- Hold the razor blade as parallel to the gasket surface as possible.

NOTE: Do not use a tap to clean the cylinder head bolt holes.

6. Clean the old sealer/lube and dirt from the bolt holes.
7. Clean the bolt holes with a nylon bristle brush.

WARNING: Wear safety glasses to avoid injury when using compressed air or any cleaning solvent. Bodily injury may occur if fumes are inhaled or if skin is exposed to chemicals.

8. When cleaning the cylinder head bolt holes use a suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun to reach the bottom of the holes.
9. Remove any broken long cylinder head bolts using the **EN 38188** kit.

OIL PAN REMOVAL

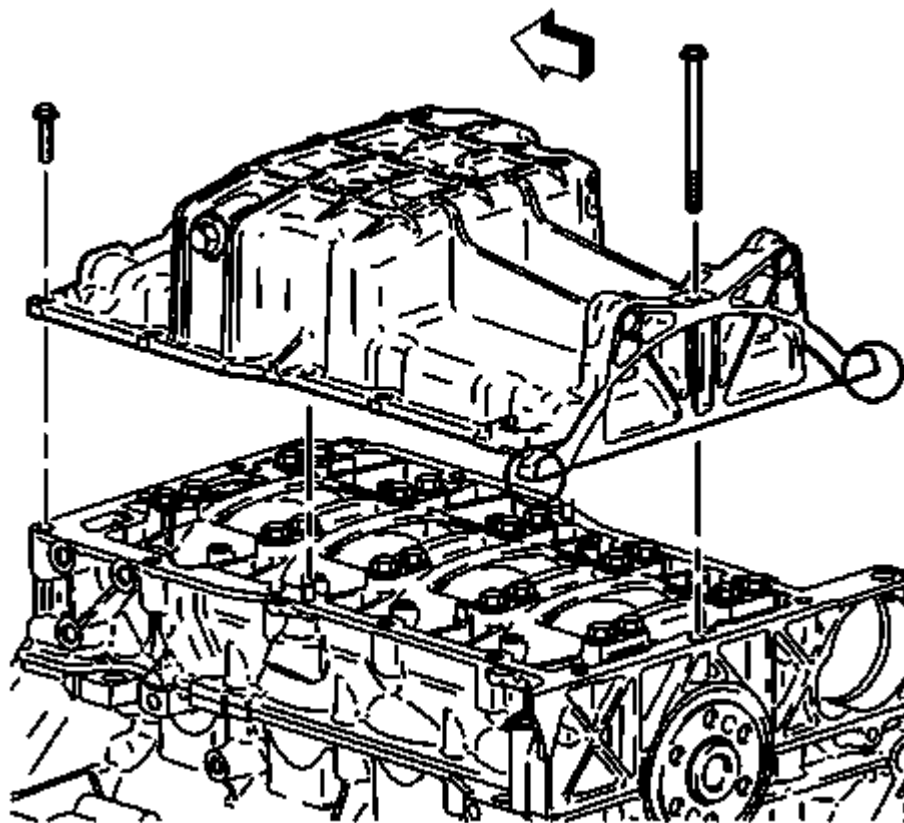


Fig. 71: View Of Oil Pan

Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan bolts.
2. Remove the oil pan at pry points.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Special Tools

EN-43966-1 Connecting Rod Guides

For equivalent regional tools, refer to **Special Tools** .

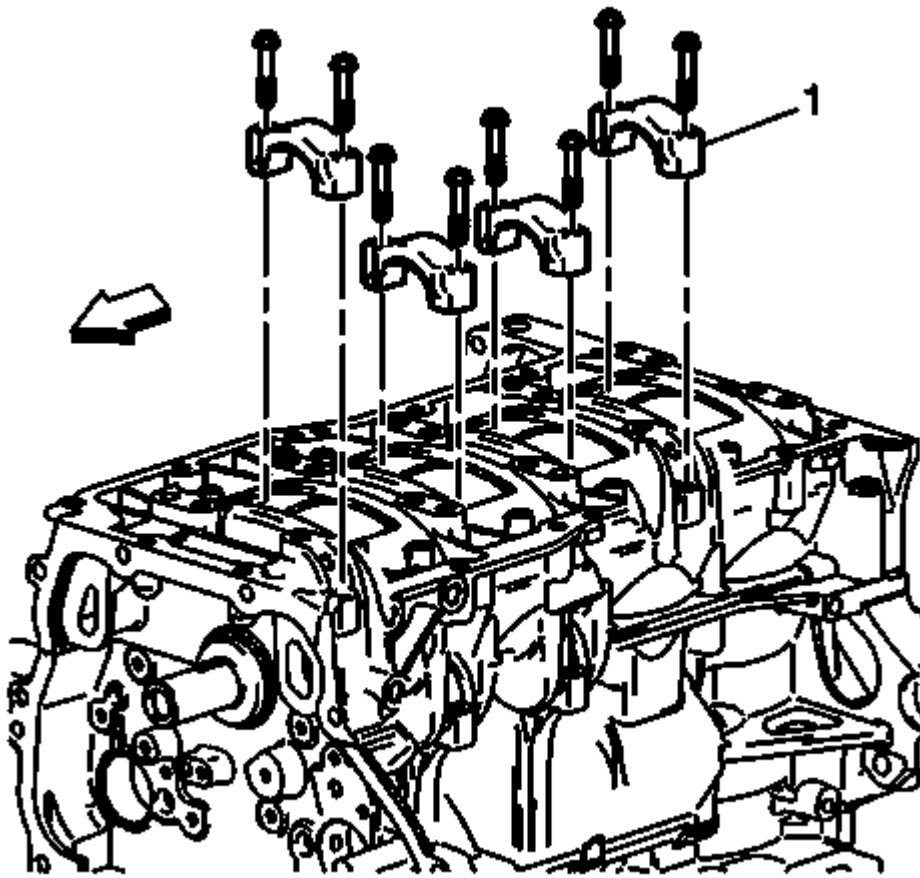


Fig. 72: View of Connecting Rod Cap
Courtesy of GENERAL MOTORS COMPANY

1. Rotate the crankshaft to a position where the connecting rod bolts are the most accessible.
2. Mark the connecting rod and cap with the cylinder position. Also mark their orientation. This will ensure the caps and connecting rods are re-assembled properly.
3. Remove any ridge at the top of the cylinder bore to avoid damage to the piston ring lands.
4. Remove the connecting rod bolts.
5. Remove the connecting rod cap (1).

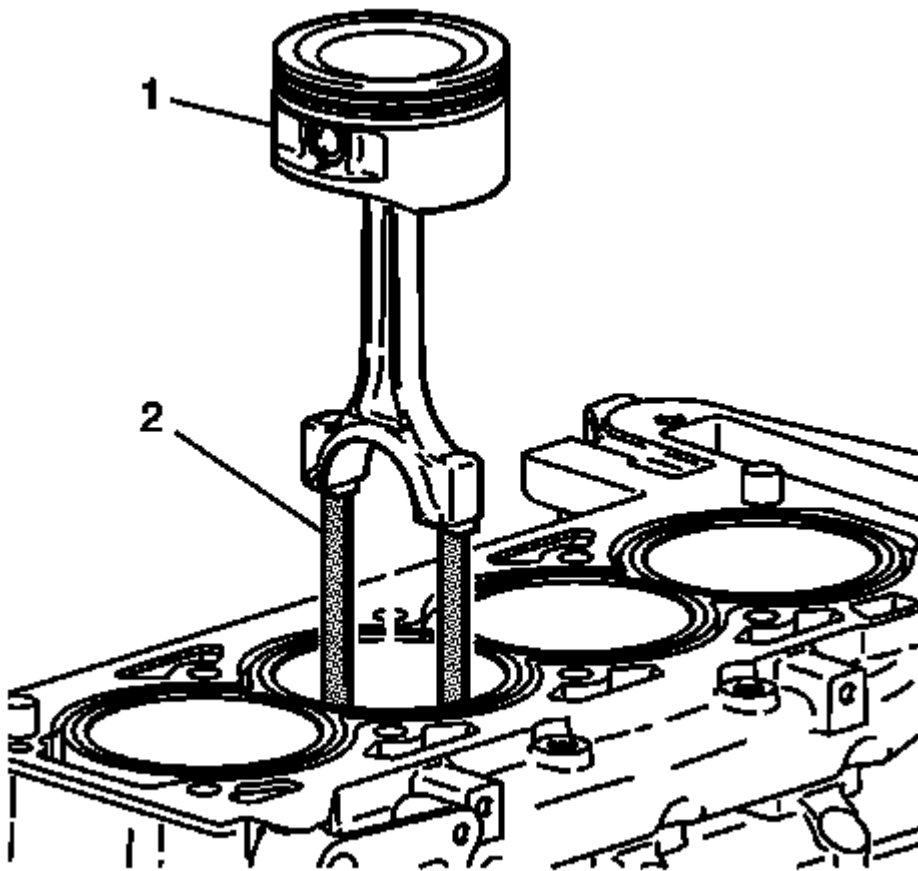


Fig. 73: View Of Connecting Rod Guides
Courtesy of GENERAL MOTORS COMPANY

6. Install **EN-43966-1** guides (2) on the connecting rod bolts before removing the piston and connecting rod assembly.
7. Remove the piston and connecting rod assembly (1).

LOWER CRANKCASE REMOVAL

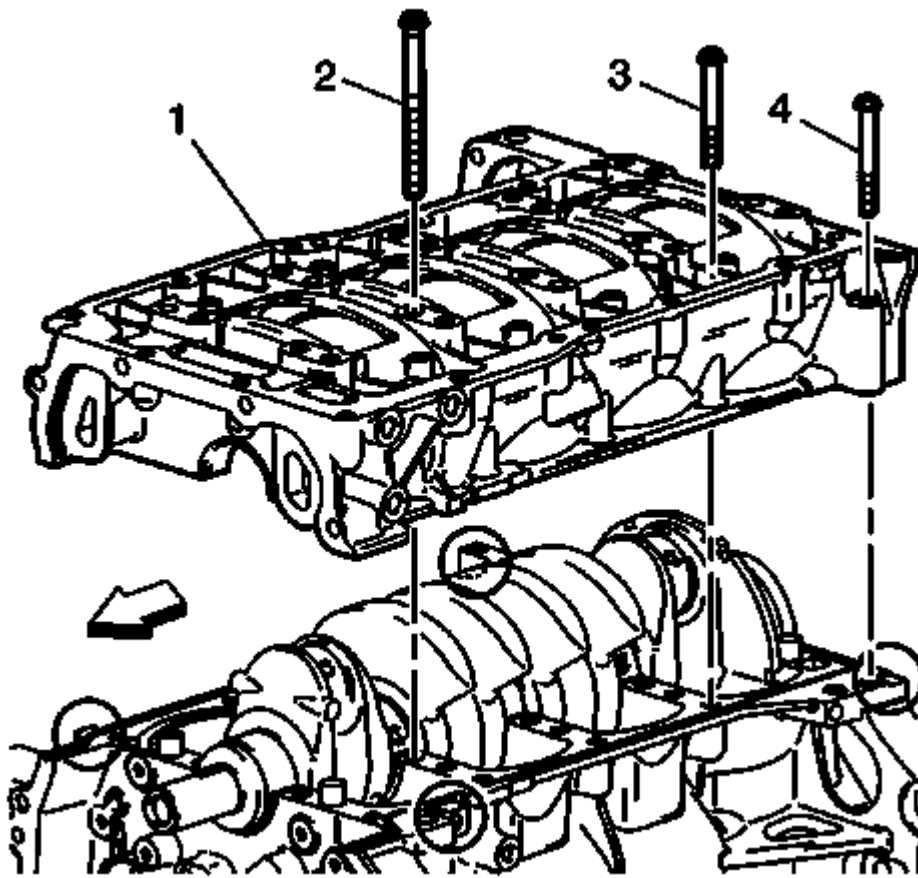


Fig. 74: Upper And Lower Crankcase With Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the bedplate perimeter bolts (3).

NOTE: Do not forget the 2 outside rear bolts (4).

2. Remove and discard the crankshaft bearing bolts (2).
3. Using the pry-points and an appropriate prying tool, gently separate the upper and lower crankcase (1).

CRANKSHAFT AND BEARING REMOVAL

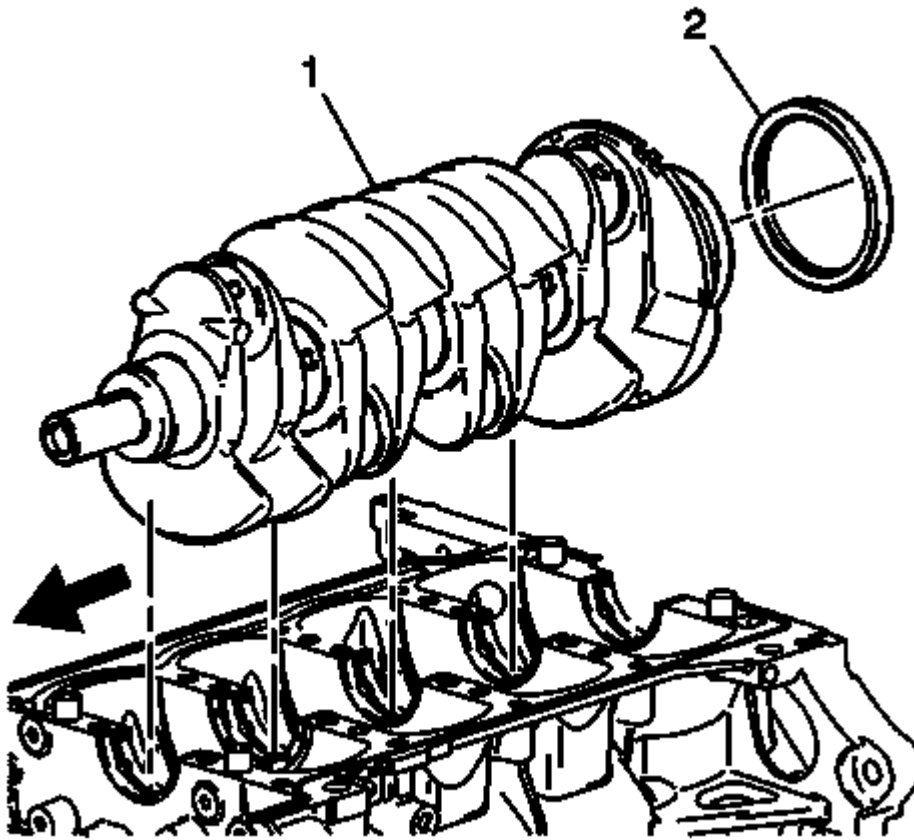


Fig. 75: Crankshaft And Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft (1) from the block.
2. Remove the crankshaft rear oil seal (2) from the block.

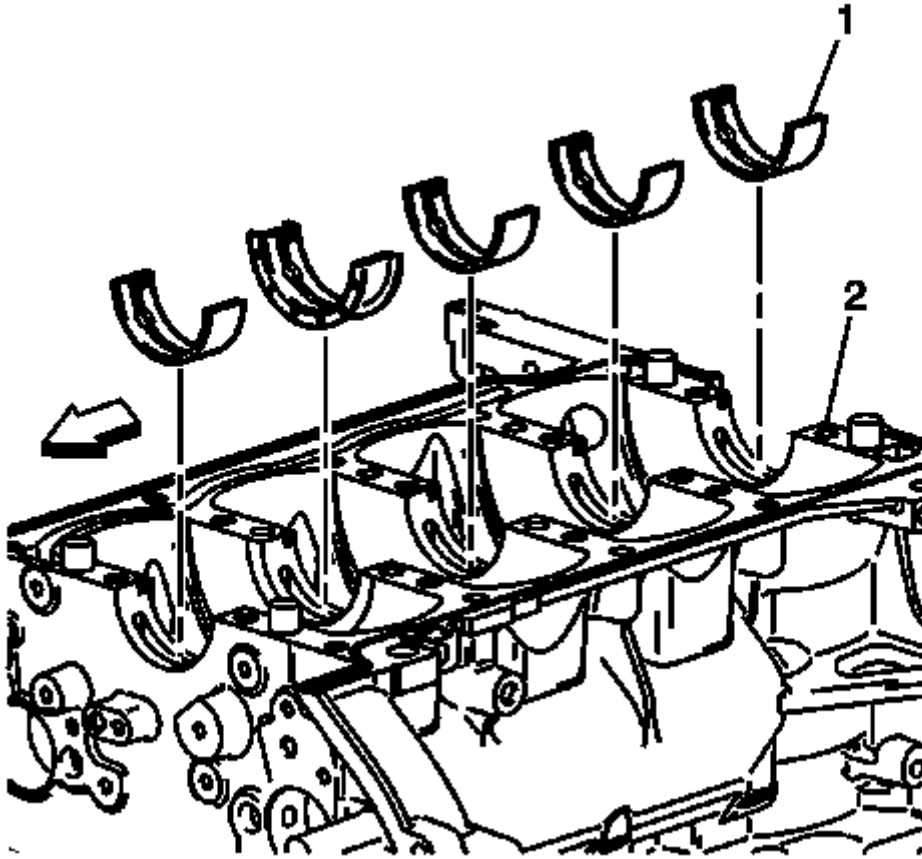


Fig. 76: View of Upper Crankshaft Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.

3. Remove the bearing inserts (1) from the block (2).

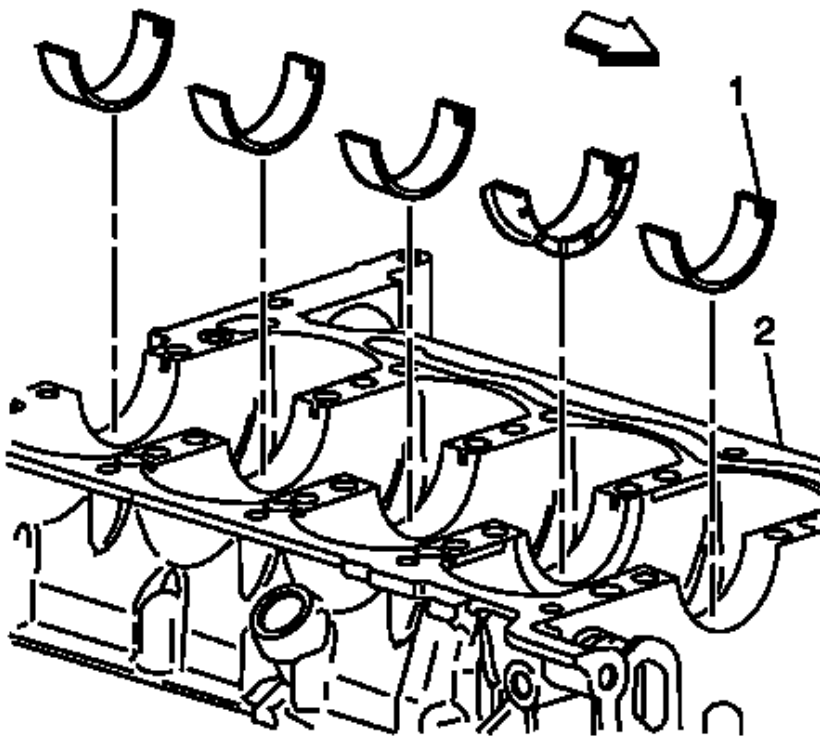


Fig. 77: View of Lower Bearing Halves
Courtesy of GENERAL MOTORS COMPANY

4. Remove the bearing inserts (1) from the bed plate (2).
5. Clean the oil, sludge, and carbon.
6. Inspect the oil passages for obstructions.
7. Inspect the threads.
8. Inspect the bearing journals and the thrust surfaces for the following conditions:
 - Cracks
 - Chips
 - Gouges
 - Roughness
 - Grooves
 - Overheating (discoloration)
9. Inspect the corresponding bearing inserts for imbedded foreign material. If foreign material exists find the cause and repair it.

NOTE: Replace the crankshaft if cracks, severe gouges or burned spots are found. Slight roughness may be removed with a fine polishing cloth soaked in clean engine oil. Burrs may be removed with a fine oil stone.

10. Measure the crankshaft journals. Use a micrometer or dial indicator to measure the taper and runout. Note the result for the later selection of bearing inserts. If not within limits the crankshaft must be replaced.

Note the location of the main bearing high spots. If they are not in line, the crankshaft is bent and must be replaced.

ENGINE BLOCK DISASSEMBLE

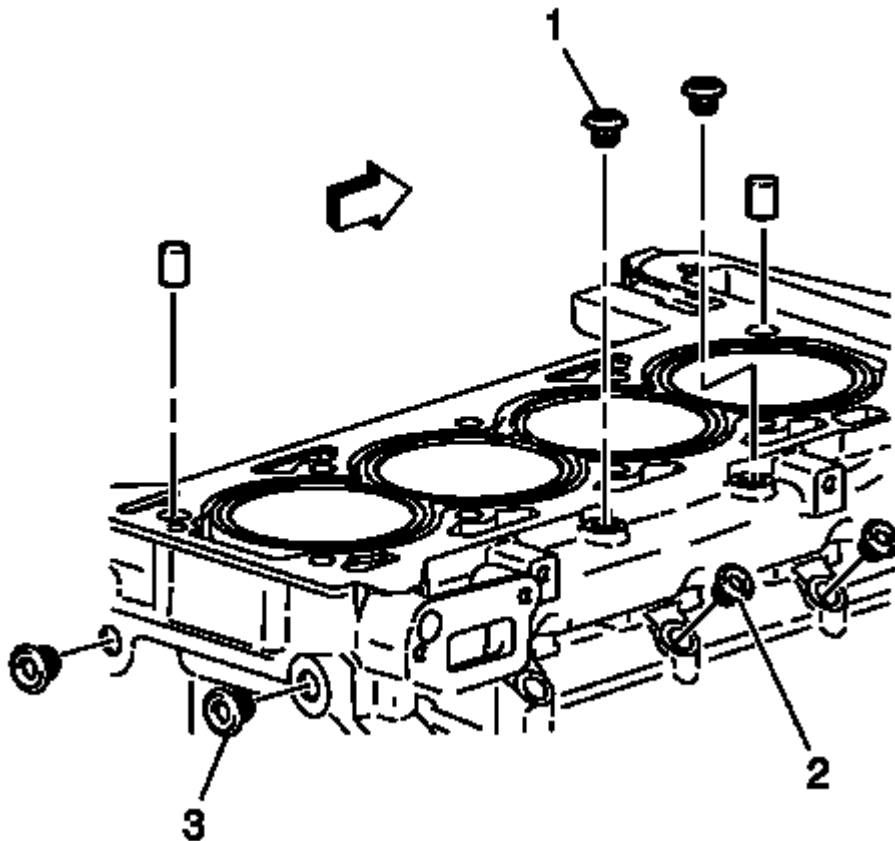


Fig. 78: Locating Block Plugs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine block coolant drain plug.
2. Remove the oil flow check valve.
3. Remove the rear oil passage plugs (3).
4. Remove the 3 oil passage plugs on each side of the block (2).
5. Remove the 2 water passage plugs on the top of the block (1).
6. Remove the 2 front oil passage plugs.

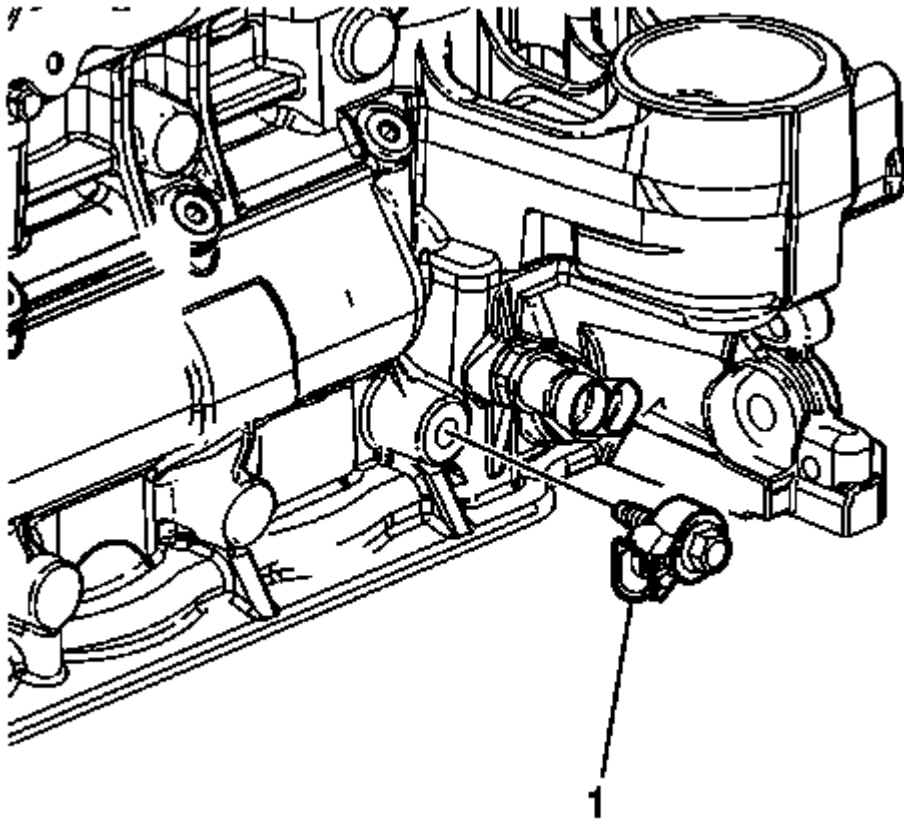


Fig. 79: Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Remove the knock sensor (1) and bolt.

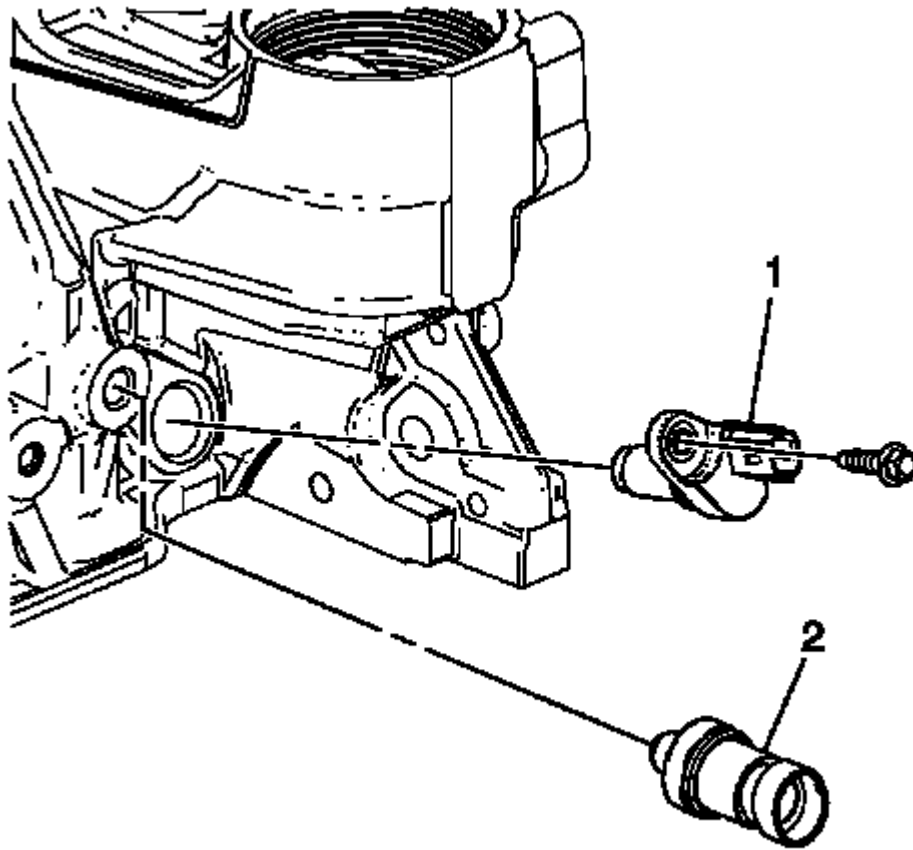


Fig. 80: Oil Pressure Switch

Courtesy of GENERAL MOTORS COMPANY

8. Remove the oil pressure switch (2).
9. Remove the crankshaft position (CKP) sensor (1) and bolt.

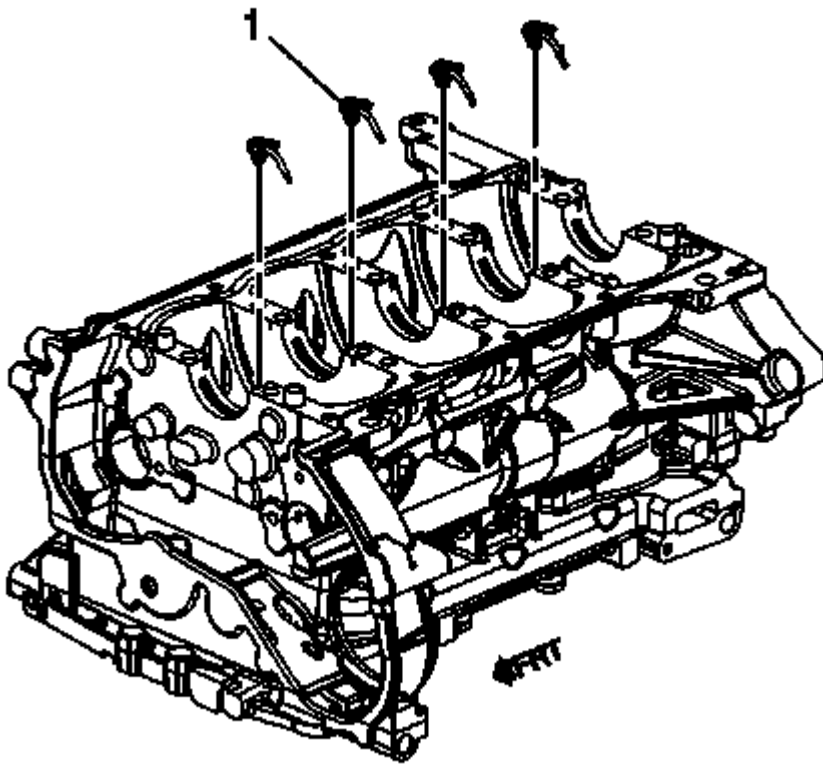


Fig. 81: Piston Oil Nozzle Assembly
Courtesy of GENERAL MOTORS COMPANY

10. If equipped, loosen the piston oil nozzle assembly (1) bolt and remove the piston oil nozzle assembly.

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **EN-8087** Cylinder Bore Gauge
- **GE-7872** Magnetic Base Dial Indicator

For equivalent regional tools, refer to **Special Tools** .

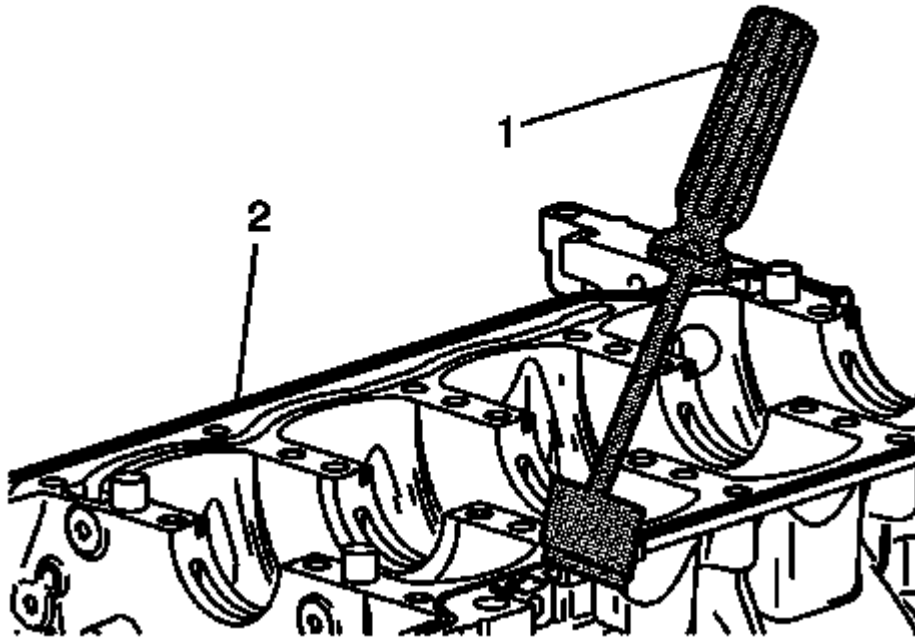


Fig. 82: Clean Sealing Material From Gasket Mating Surfaces With A Suitable Tool
Courtesy of GENERAL MOTORS COMPANY

1. Clean the sealing material from the gasket mating surfaces (2) with a suitable tool (1).
2. Clean the engine block and lower crankcase in a cleaning tank with solvent appropriate for aluminum.
3. Flush the engine block with clean water or steam.
4. Clean the oil passages.
5. Clean the blind holes.
6. Inspect the cylinder bores for glazing. If the bore is glazed but otherwise serviceable, refer to Deglazing Procedure in **Cylinder Boring and Honing (LEA, or LUK)**.
7. Spray the cylinder bores and the machined surfaces with engine oil.
8. Inspect the threaded holes. Clean the threaded holes with a rifle brush. If necessary, drill out the holes and install thread inserts. Refer to **Thread Repair**.

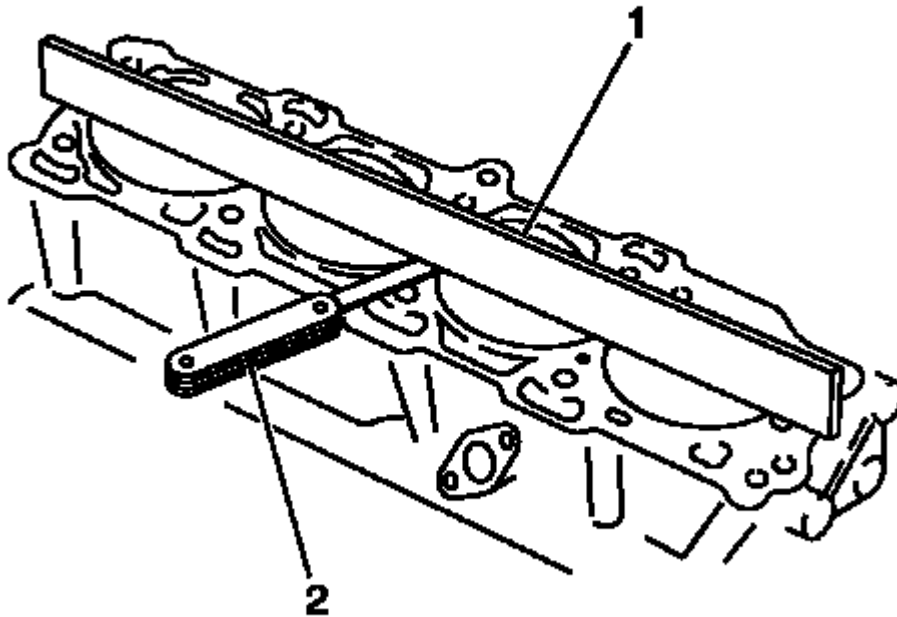


Fig. 83: Use A Straight Edge And Feeler Gage To Check Deck Surface For Flatness
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not attempt to machine the lower crankcase to engine block surfaces.

9. Use a straight edge (1) and a feeler gauge (2) to check the deck surface for flatness. Carefully machine minor irregularities. Replace the block if more than 0.254 mm (0.010 in) must be removed.
10. Inspect the oil pan rail for nicks. Inspect the front cover attaching area for nicks. Use a flat mill file to remove any nicks.

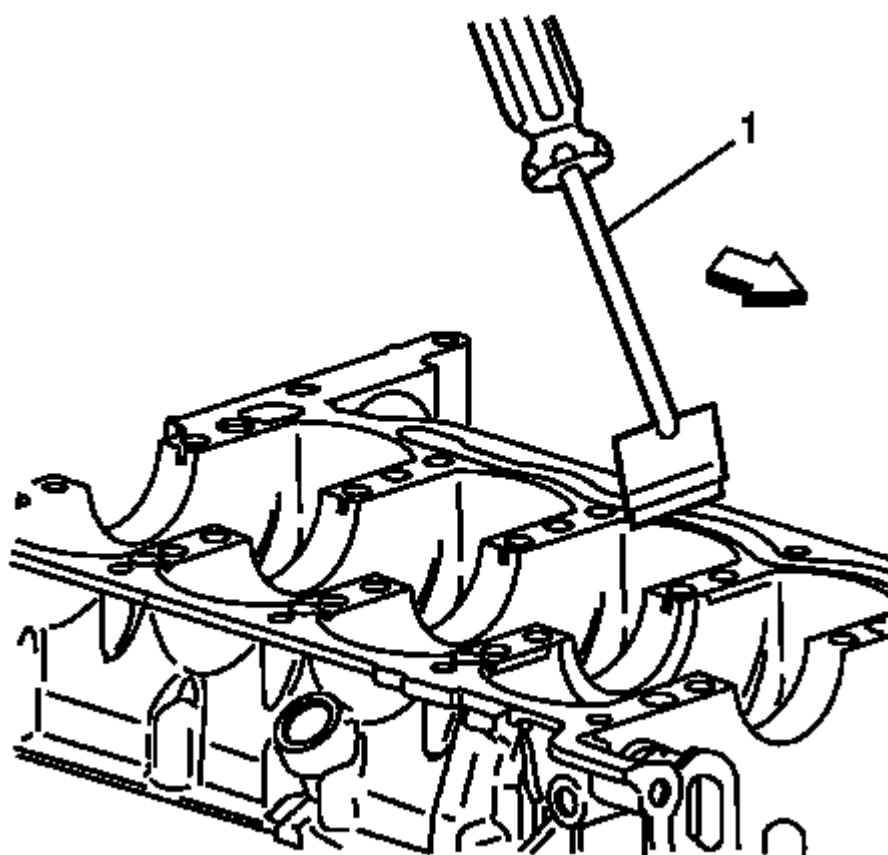


Fig. 84: Clean Sealing Material From Gasket Mating Surfaces On Lower Crankcase Engine Block Side With Suitable Tool

Courtesy of GENERAL MOTORS COMPANY

11. Clean the sealing material from the gasket mating surfaces on the lower crankcase engine block side with a suitable tool (1).

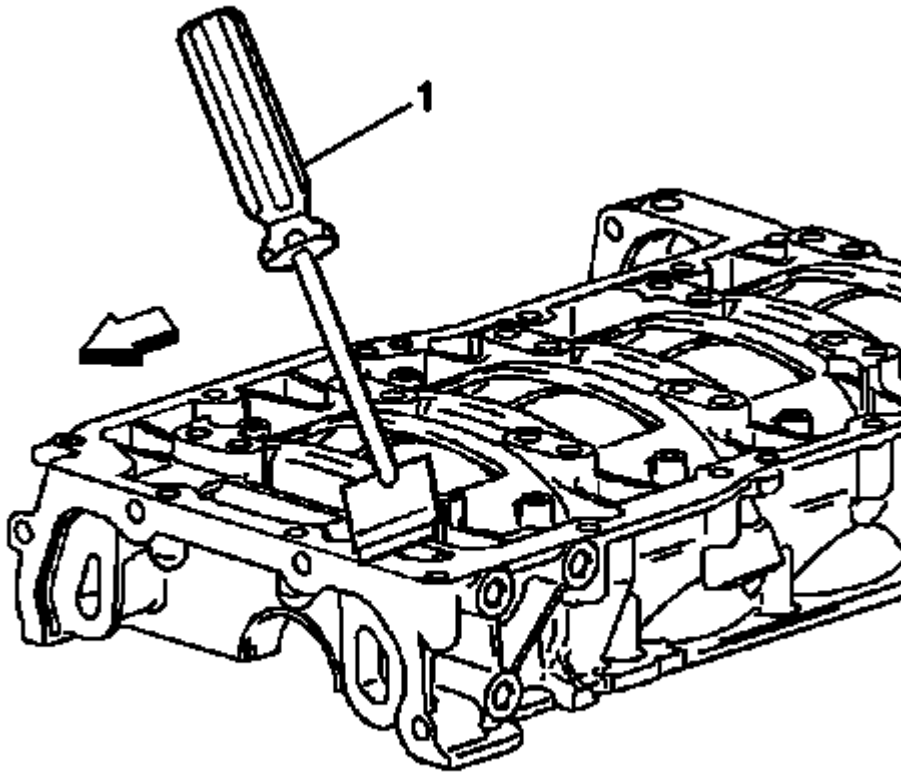


Fig. 85: Clean Sealing Material From Gasket Mating Surfaces On Lower Crankcase Oil Pan Side With Suitable Tool

Courtesy of GENERAL MOTORS COMPANY

12. Clean the sealing material from the gasket mating surfaces on the lower crankcase oil pan side with a suitable tool (1).

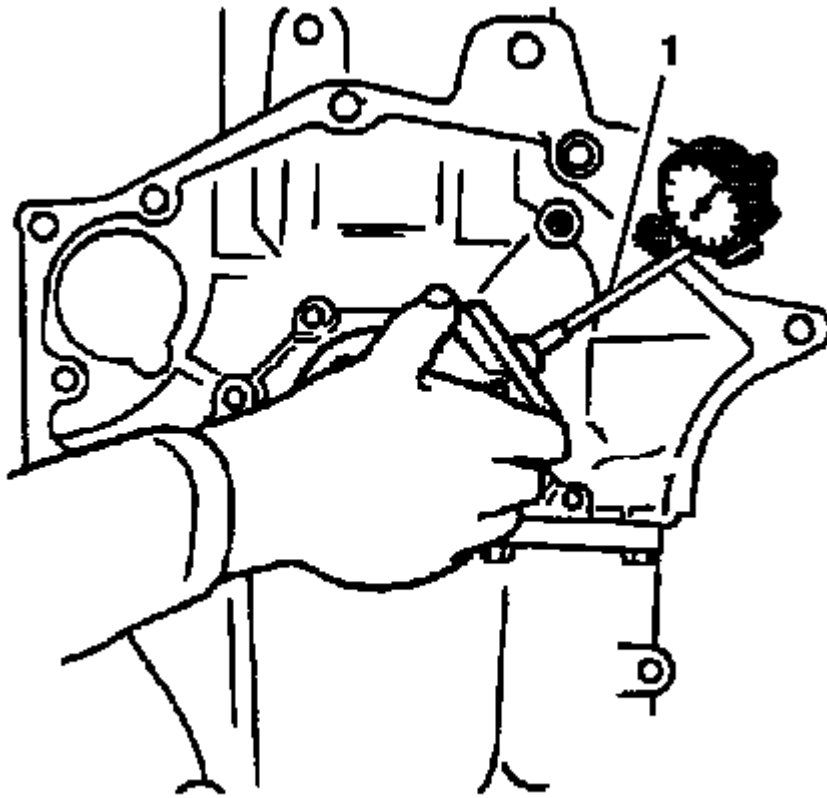


Fig. 86: Inspect The Mating Surfaces Of The Transmission Face
Courtesy of GENERAL MOTORS COMPANY

13. Inspect the mating surfaces of the transmission face.

CAUTION: A broken flywheel may result if the transmission case mating surface is not flat.

14. Use the following procedure in order to measure the engine block flange runout at the mounting bolt hole bosses:
 1. Temporarily install the crankshaft and upper bearings. Measure the crankshaft flange runout using the **GE-7872** dial indicator (1)
 2. Hold the gauge plate flat against the crankshaft flange.
 3. Place the dial indicator stem on the transmission mounting bolt hole boss. Set the indicator to 0.
 4. Record the readings obtained from all of the bolt hole bosses. The measurements should not vary more than 0.203 mm (0.008 in).
 5. Recheck the crankshaft flange runout if the readings vary more than 0.203 mm (0.008 in).
 6. Remove the crankshaft and bearings.

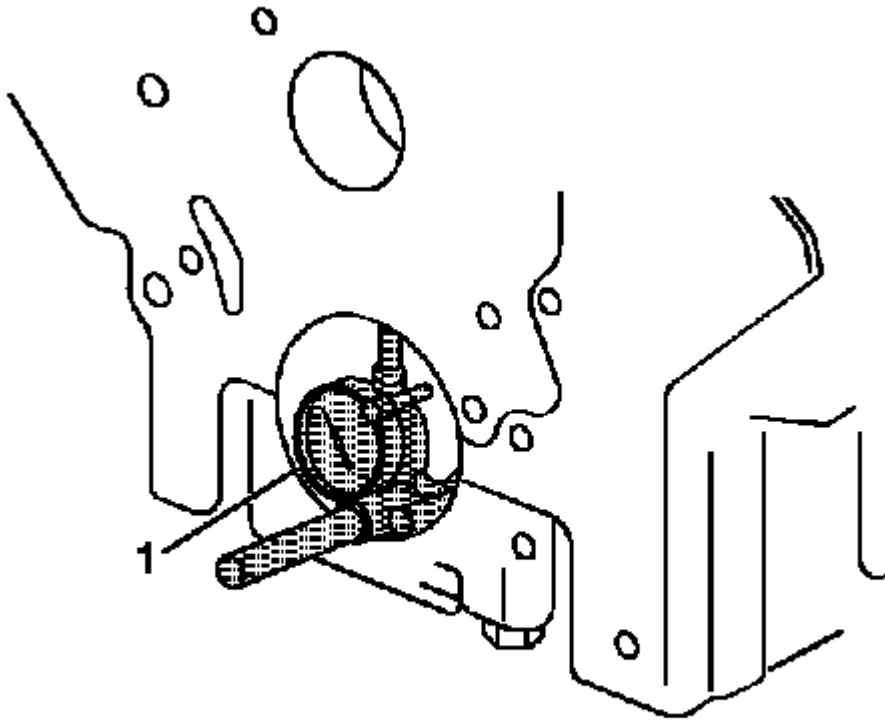


Fig. 87: Measuring Bearing Bore
Courtesy of GENERAL MOTORS COMPANY

15. Install the bed plate and bolts. Tighten the bed plate bolts to specification.
16. Inspect the crankshaft main bearing bores. Use the **EN-8087** gauge (1) to measure the bearing bore concentricity and alignment. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .
17. Replace the engine block and bed plate if the crankshaft bearing bores are out of specification.
18. Remove the bed plate.

Measuring Cylinder Bore Diameter

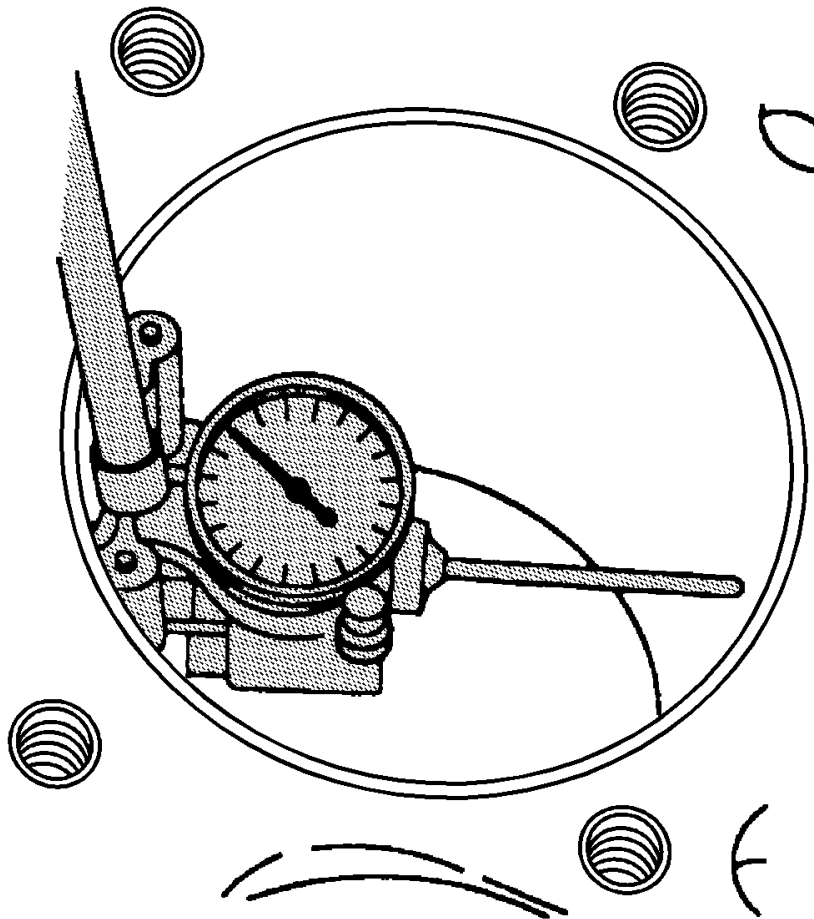


Fig. 88: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

1. Measure the cylinder bore diameter 37 mm (1.457 in) from the deck face using the **EN-8087** gauge.
2. Compare your results with the **Engine Mechanical Specifications (LEA, or LUK)** , . If the cylinder diameter exceeds the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service. Refer to **Cylinder Boring and Honing (LEA, or LUK)**.

Measuring Cylinder Bore Taper

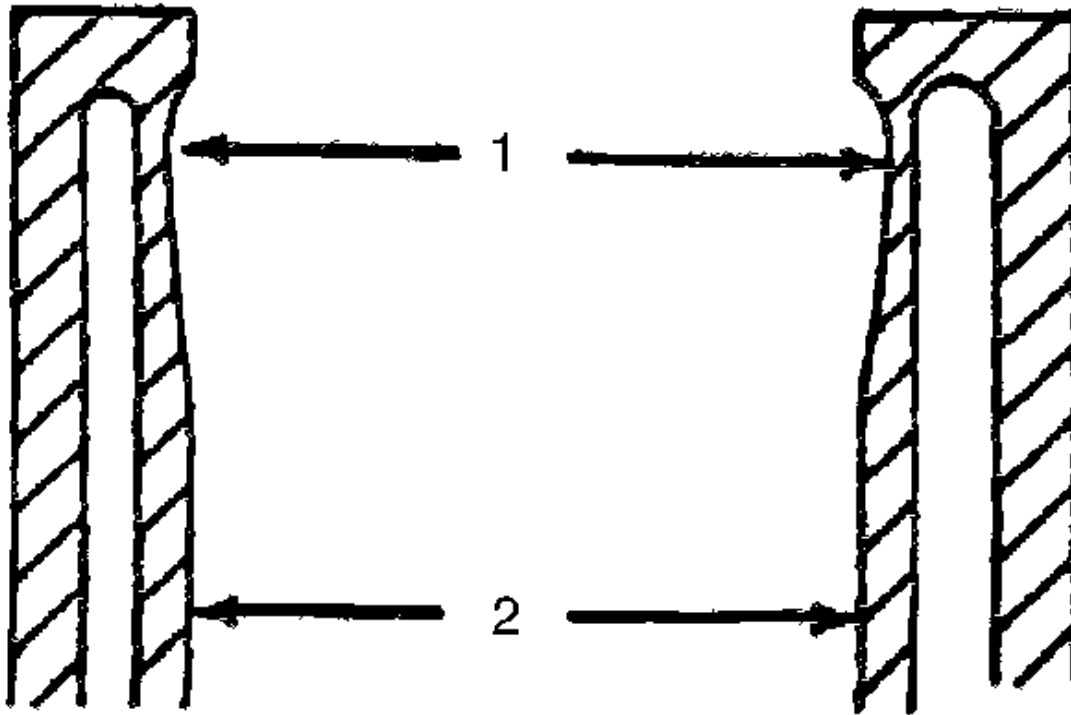


Fig. 89: Measuring Head Gasket Dimensions
Courtesy of GENERAL MOTORS COMPANY

1. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 13 mm (0.510 in) below the deck surface (1) and record your measurement.
2. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 100 mm (3.938 in) below the deck surface (2) and record your measurement.
3. Calculate the difference between the 2 measurements. The result will be the cylinder taper.
4. Compare your results with the **Engine Mechanical Specifications (LEA, or LUK)** . If the cylinders exceed the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service. Refer to **Cylinder Boring and Honing (LEA, or LUK)**.

Measuring Cylinder Bore Out-of-Round

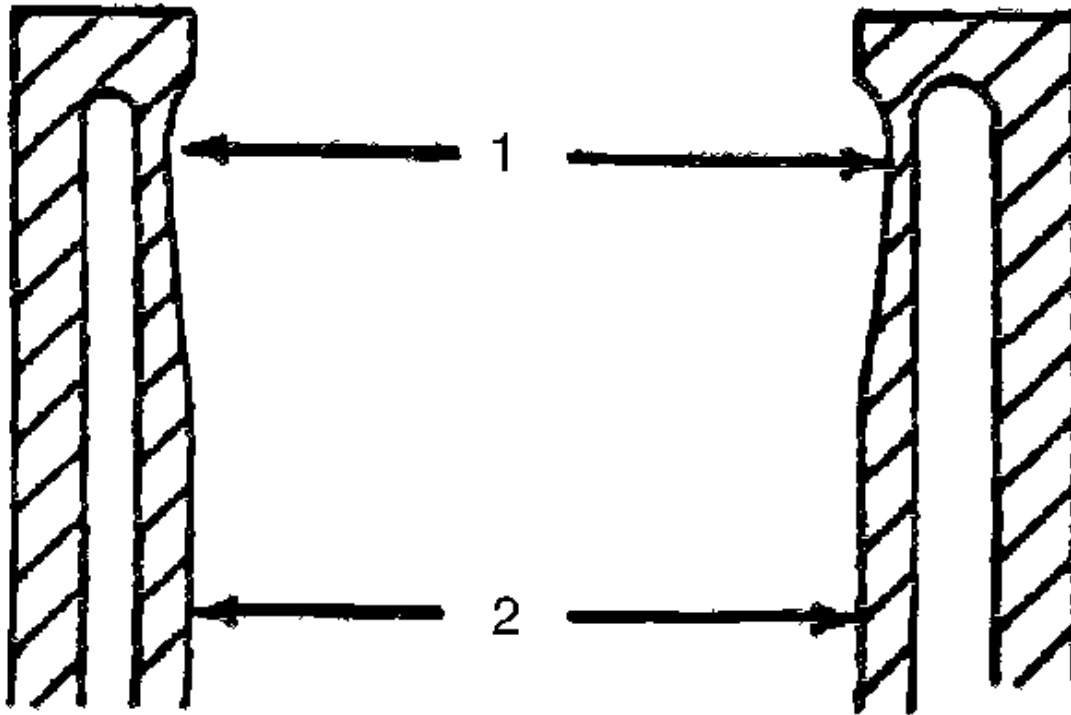


Fig. 90: Measuring Head Gasket Dimensions
Courtesy of GENERAL MOTORS COMPANY

1. Measure both the thrust and non-thrust cylinder diameter at 13 mm (0.510 in) below the deck surface (1). Record your measurements.
2. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the upper end of the cylinder.
3. Measure both the thrust and non-thrust cylinder diameter at 100 mm (3.938 in) below the deck surface (2). Record your measurements.
4. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the lower end of the cylinder.
5. Compare your results with the **Engine Mechanical Specifications (LEA, or LUK)** . If the cylinders exceed these specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service. Refer to **Cylinder Boring and Honing (LEA, or LUK)**.

CYLINDER BORING AND HONING (LEA, OR LUK)

Boring Procedure

1. Measure all pistons with a micrometer to determine the cylinder bore diameter. Refer to **Engine Block Cleaning and Inspection**.
2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block, removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned or tilted and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.
4. When you bore the cylinders, ensure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.
5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for the finish honing and fit of the piston.

Honing Procedure

NOTE: **Fine vertical scratches made by the ring ends do not, by themselves, cause excessive oil consumption. Do not hone the cylinder in order to remove these scratches.**

1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.

NOTE: **All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.**

2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.
3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100-grit stone.

NOTE: **A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.**

4. Perform final cylinder honing with a 240-grit stone and obtain a 45 degree cross hatch pattern.
5. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
6. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.
7. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not

allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.

8. Perform final measurements of the piston and the cylinder bore.
9. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
10. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure

1. If the bore is glazed but otherwise serviceable, lightly break the glaze with a hone. Replace the piston rings. Refer to **Piston, Connecting Rod, and Bearing Installation (LEA, or LUK)**.

NOTE: **A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.**

2. Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240-grit stone of silicone carbide, or equivalent, material when performing the deglazing procedure.
 1. The honing stones must be clean, sharp, and straight.
 2. Move the hone slowly up and down to produce a 45 degree cross-hatch pattern.
 3. Clean the bore thoroughly with soap and water.
 4. Dry the bore.
 5. Rub clean engine oil in the bore.
 6. Re-measure the bore.
3. If the cylinder bore is out of specification, the cylinder bore may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.
4. If honing is not required, clean the cylinder bores with hot water and detergent. Apply clean engine oil to the bore after washing and drying the bore.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

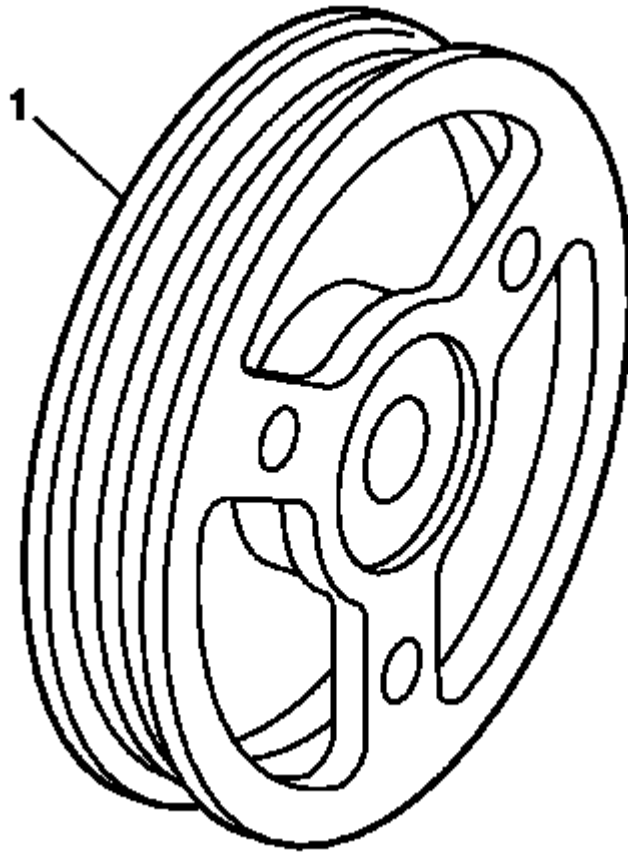


Fig. 91: Crankshaft Balancer

Courtesy of GENERAL MOTORS COMPANY

1. Clean the crankshaft balancer (1).
2. Clean the belt grooves of all dirt or debris with a wire brush.

WARNING: Refer to Safety Glasses Warning .

3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following:
 - Worn, grooved, or damaged hub seal surface
 - A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

NOTE: In order for the belt to track properly, the belt grooves should be free of all dirt or debris.

- Dirty or damaged belt grooves

The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.

- Minor imperfections may be removed with a fine file.
- Worn, chunking or deteriorated rubber between the hub and pulley

ENGINE FLYWHEEL CLEANING AND INSPECTION

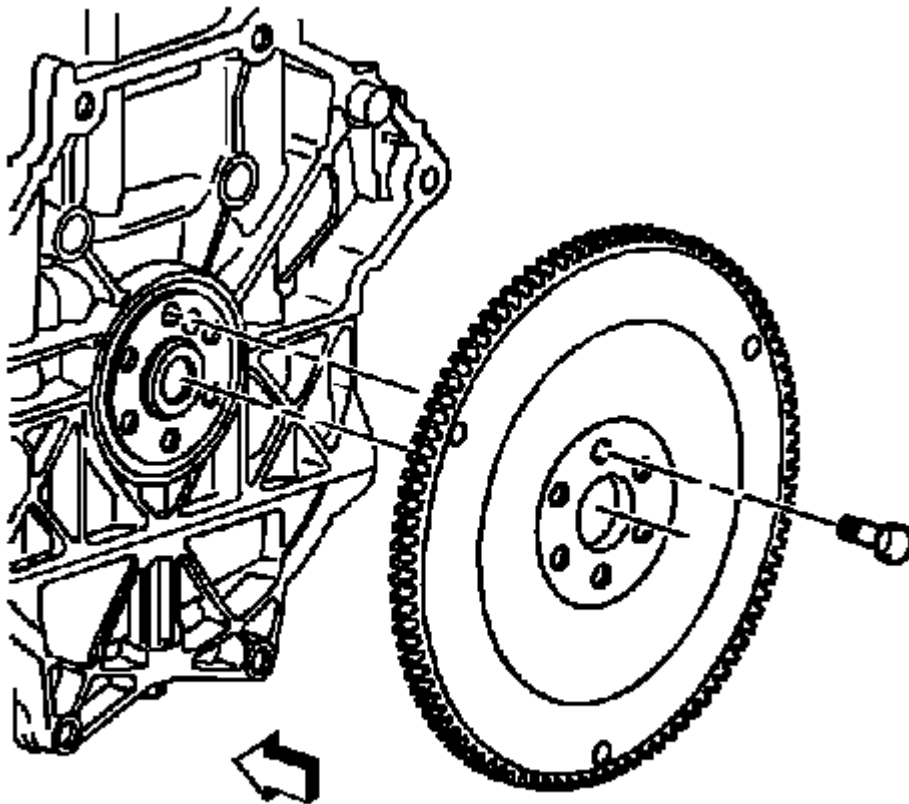


Fig. 92: View Of Flywheel

Courtesy of GENERAL MOTORS COMPANY

1. Clean the flywheel in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the flywheel with compressed air.
3. Inspect the flywheel for the following:
 - Damaged ring gear teeth
 - Stress cracks around the flywheel-to-crankshaft bolt hole locations
 - Weight saving holes

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

GE-7872 Magnetic Base Dial Indicator Set

For equivalent regional tools, refer to **Special Tools** .

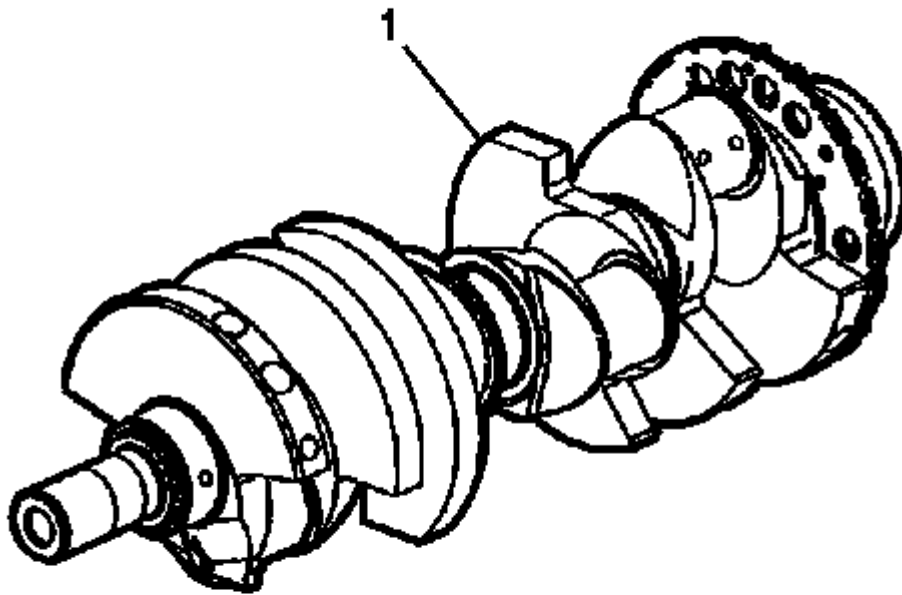


Fig. 93: Clean Crankshaft With Solvent
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position reluctor ring. Damage to the teeth of the crankshaft position reluctor ring may affect on-board diagnostic (OBD) II system performance.

1. Clean the crankshaft (1) with solvent.
2. Thoroughly clean all oil passages and inspect for restrictions or burrs.

WARNING: Refer to Safety Glasses Warning .

3. Dry the crankshaft with compressed air.

NOTE: Reluctor ring teeth should not have imperfections on the rising or falling edges.

Imperfections of the reluctor ring teeth may effect OBD II system performance.

4. Perform a visual inspection of the crankshaft for damage.

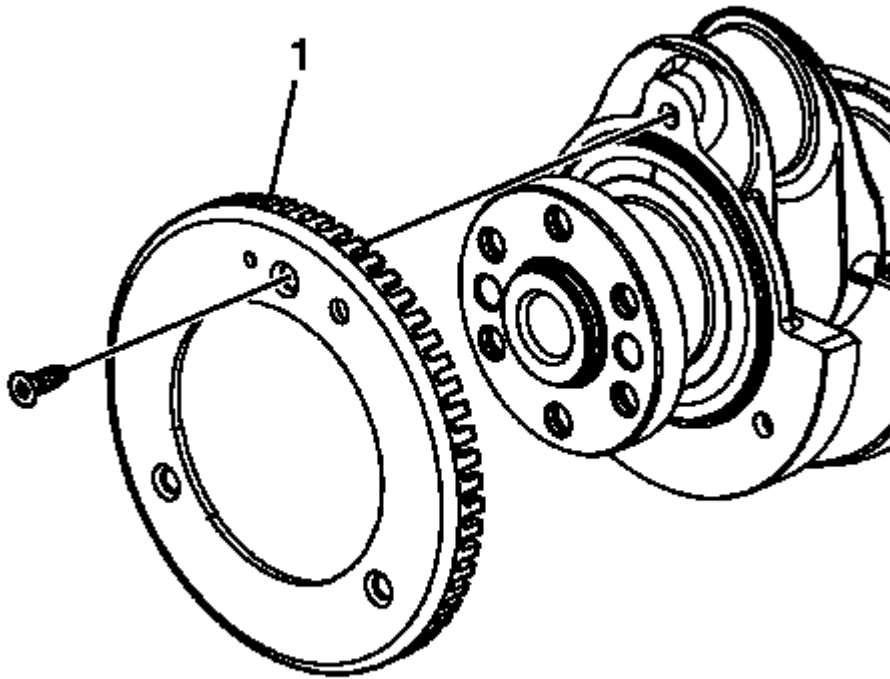


Fig. 94: View of Crankshaft Position Reluctor Ring
Courtesy of GENERAL MOTORS COMPANY

5. The crankshaft position reluctor ring (1) may be replaced if damaged. Tighten the crankshaft position reluctor ring bolts to 15 N.m (11 lb ft).

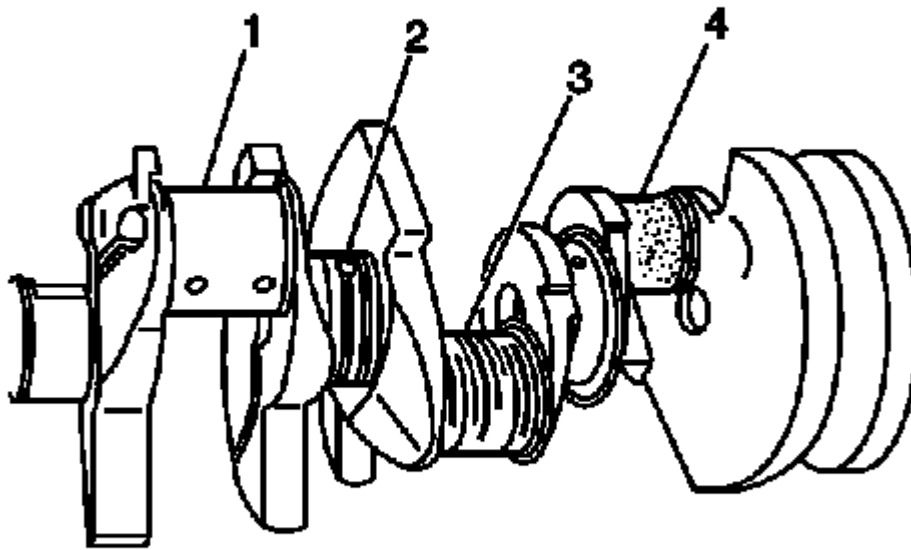


Fig. 95: Identifying Different Crankshaft Journal Wear Patterns
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the crankshaft journals for wear (1). The journals should be smooth, with no signs of scoring, wear, or damage.
7. Inspect the crankshaft journals for grooves or scoring (2).
8. Inspect the crankshaft journals for scratches or wear (3).
9. Inspect the crankshaft journals for pitting or imbedded bearing material (4).

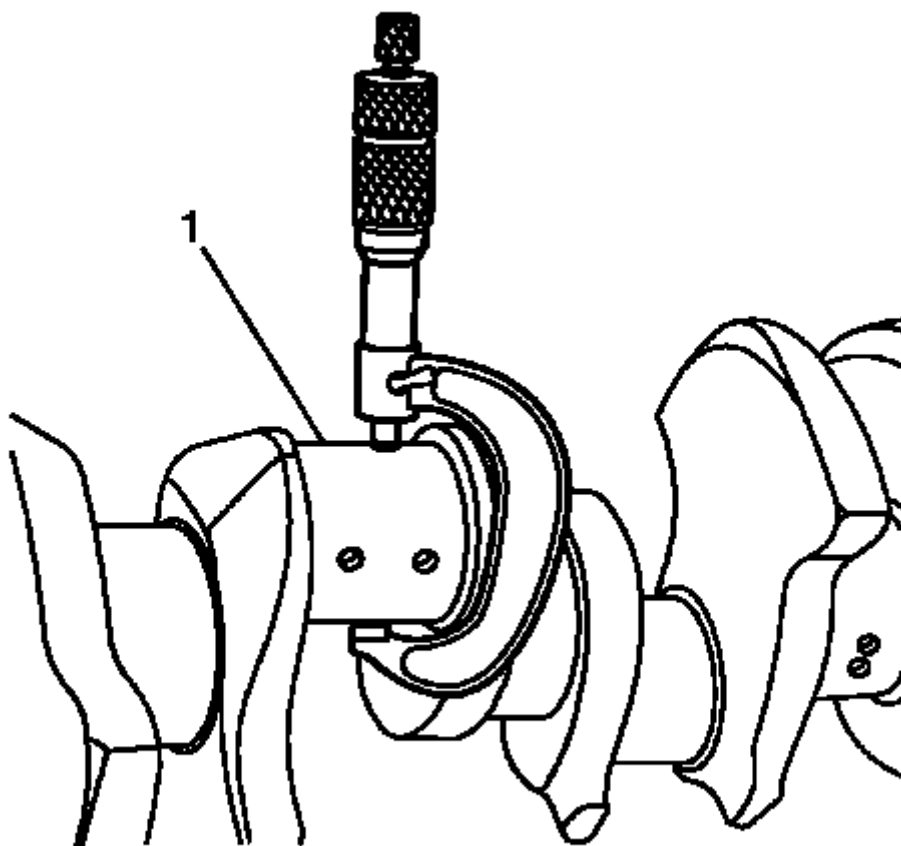


Fig. 96: Measure Crankshaft Journals For Out-Of-Round
Courtesy of GENERAL MOTORS COMPANY

10. Measure the crankshaft journals (1) for out-of-round.
11. Measure the crankshaft journals for taper.

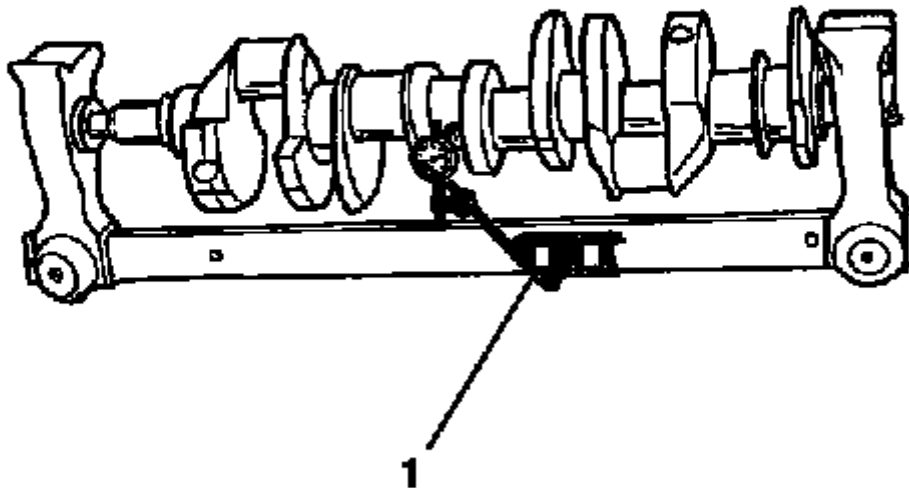


Fig. 97: Measuring The Crankshaft Runout
Courtesy of GENERAL MOTORS COMPANY

12. Measure the crankshaft runout.

Using wooden V-blocks, support the crankshaft on the front and rear journals.

13. Use the **GE-7872** indicator (1) in order to measure the crankshaft runout at the front and rear intermediate journals.
14. Use the **GE-7872** indicator in order to measure the runout of the crankshaft rear flange.
15. Replace the crankshaft if the measurements are not within specifications.

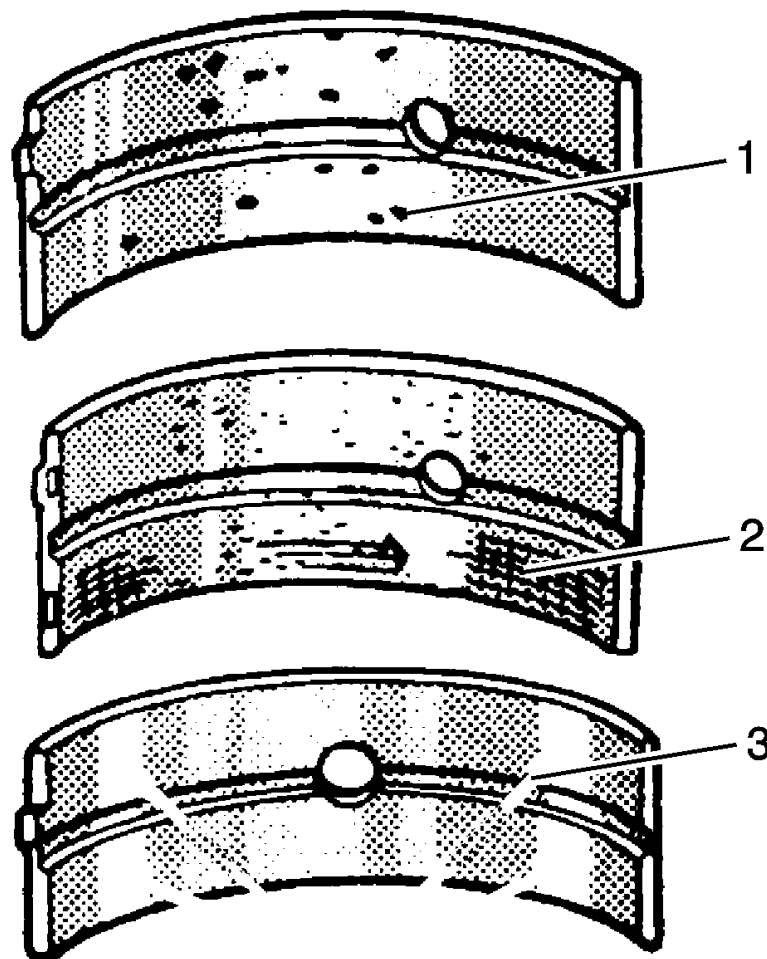


Fig. 98: Identifying Crankshaft Bearings For Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

NOTE: Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.

16. Inspect crankshaft bearings for craters or pockets (1). Flattened sections on the bearing halves also indicate fatigue.
17. Inspect the crankshaft bearings for excessive scoring or discoloration (2).
18. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.
19. Inspect the crankshaft bearings for improper seating indicated by bright, polished sections of the bearing (3).

If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

PISTON AND CONNECTING ROD DISASSEMBLE

Special Tools

EN-46745 Piston Pin Retainer Remover and Installer

For equivalent regional tools, refer to **Special Tools** .

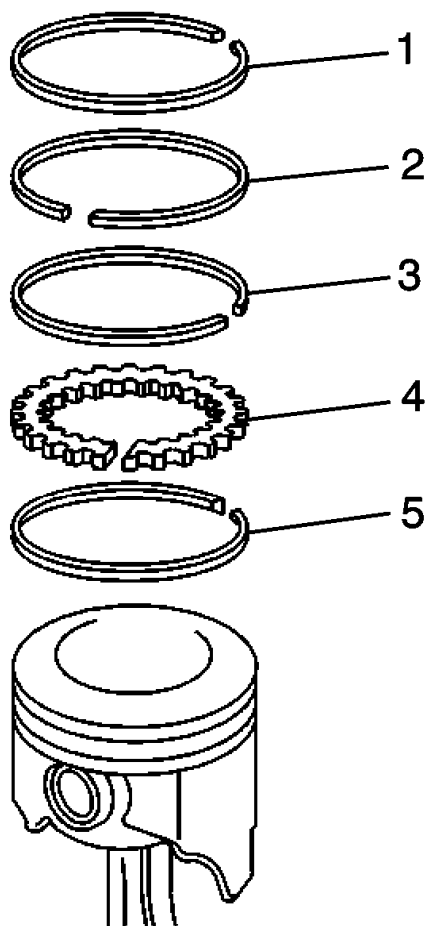


Fig. 99: Identifying Piston Rings

Courtesy of GENERAL MOTORS COMPANY

WARNING: Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.

1. Disassemble the piston rings (1, 2, 3, 4, 5). Use a suitable tool to expand the rings. The piston rings must not be reused.

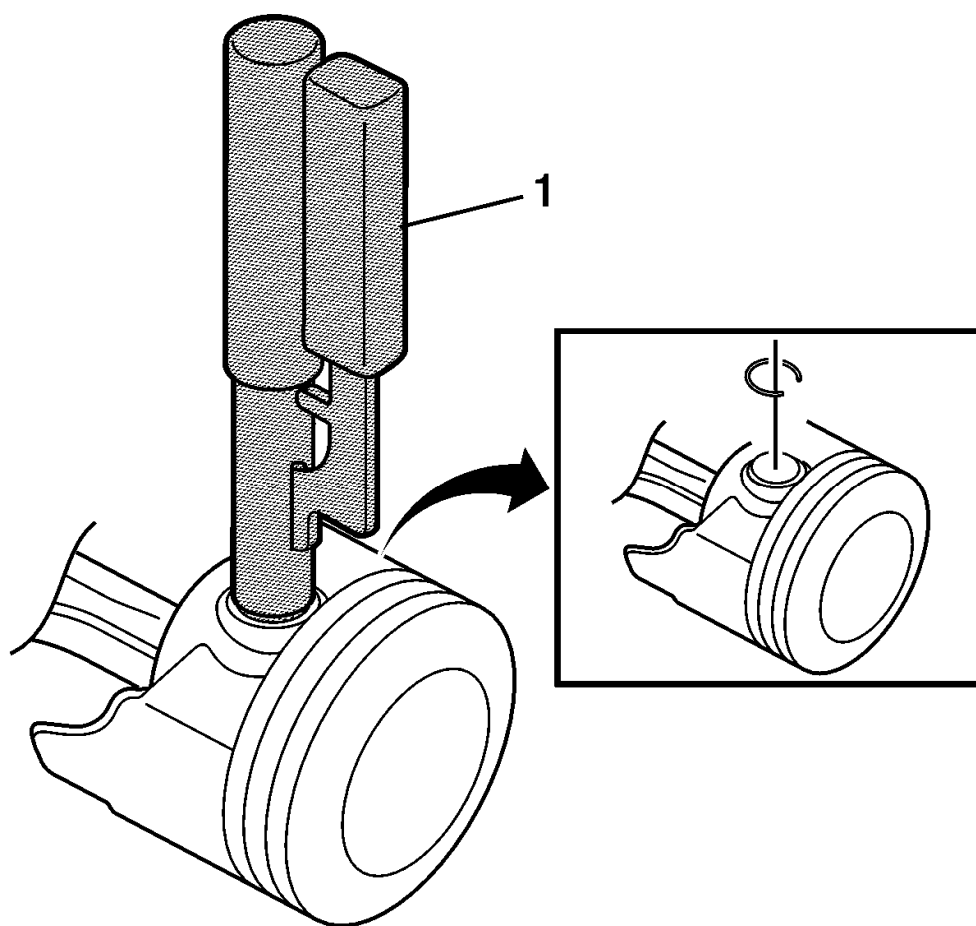


Fig. 100: View of Piston Pin Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Two retainers hold the piston pins in place. No special tools are required to remove the piston pins. Ensure that the piston pin is not damaged. Do not reuse the retainers.

2. Remove the piston pin retainers using the **EN-46745** remover (1).

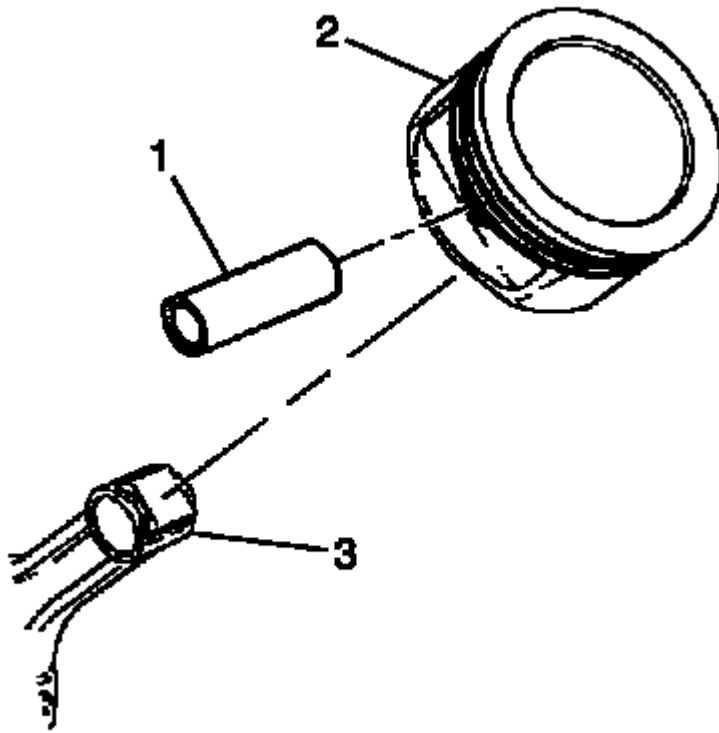


Fig. 101: Identifying Piston Pin And Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

3. Remove the piston pin (1) and the connecting rod (3) from the piston (2).

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

Connecting Rod Measurement

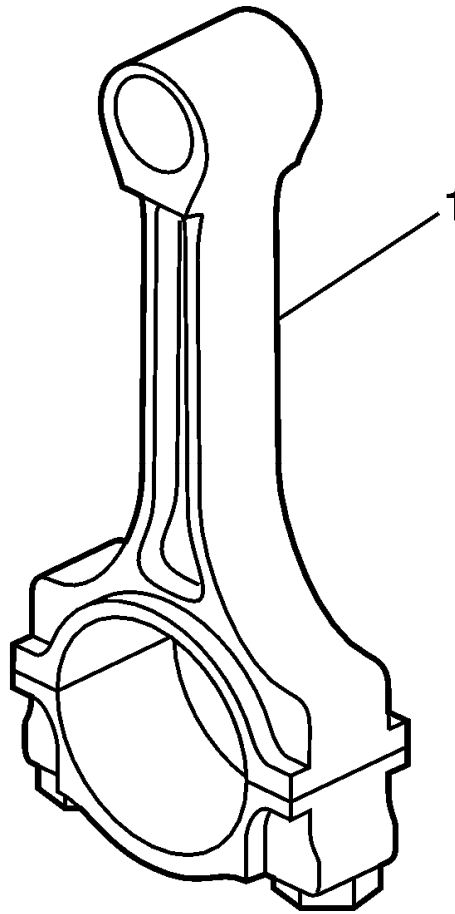


Fig. 102: Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

1. Clean the connecting rods (1) in solvent and dry with compressed air.
2. Inspect the connecting rods for the following:
 - Signs of being twisted, bent, nicked, or cracked
 - Scratches or abrasion on the rod bearing seating surface
3. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper. DO NOT scrape the rod or rod cap.
4. If the beam of the rod is scratched or has other damage replace the connecting rod.
5. Measure the piston pin to connecting rod bore using the following procedure:
 1. Using an outside micrometer, take two measurements of the piston pin in the area of the connecting rod contact.
 2. Using an inside micrometer, measure the connecting rod piston pin bore.
 3. Subtract the piston pin diameter from the piston pin bore diameter.
 4. The clearance should not be more than 0.021 mm (0.0008 in).

6. If there is excessive clearance, replace the piston pin.
7. If there is still excessive clearance, replace the connecting rod.

Piston Measurement

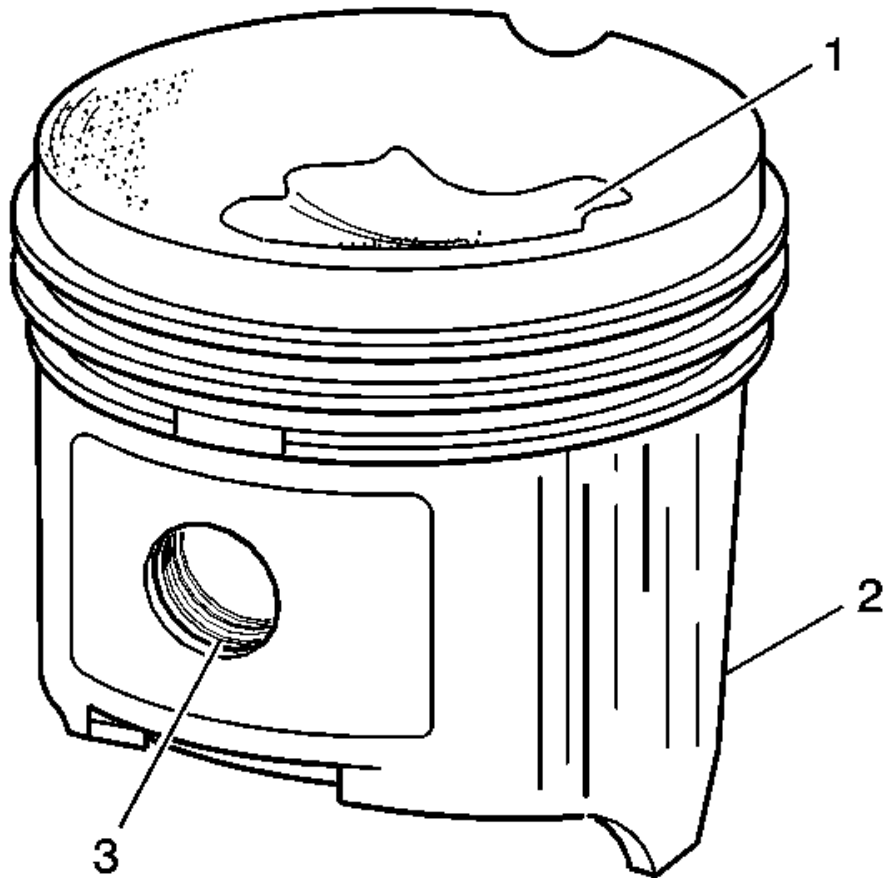


Fig. 103: Identifying Piston Damage Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Clean the piston skirts and the pins with a cleaning solvent. DO NOT wire brush any part of the piston.
2. Clean the piston ring grooves with a groove cleaner. Make sure oil ring holes and slots are clean.
3. Inspect the pistons for the following conditions:
 - Cracked ring lands, skirts, or pin bosses
 - Ring grooves for nicks, burrs that may cause binding
 - Warped or worn ring lands
 - Eroded areas at the top of the piston (1)
 - Scuffed or damaged skirts (2)

- Worn piston pin bores (3)
4. Replace pistons that show any signs or damage or excessive wear.
 5. Measure the piston pin bore to piston pin clearances using the following procedure:
 1. Piston pin bores and pins must be free of varnish or scuffing.
 2. Use an outside micrometer to measure the piston pin in the piston contact areas.
 3. Using an inside micrometer, measure the piston pin bore.
 4. Subtract the measurement of the piston pin bore from the piston pin. The clearance should be within 0.002-0.012 mm (0.00007-0.00047 in).
 5. If the clearance is excessive, determine which component is out of specification.

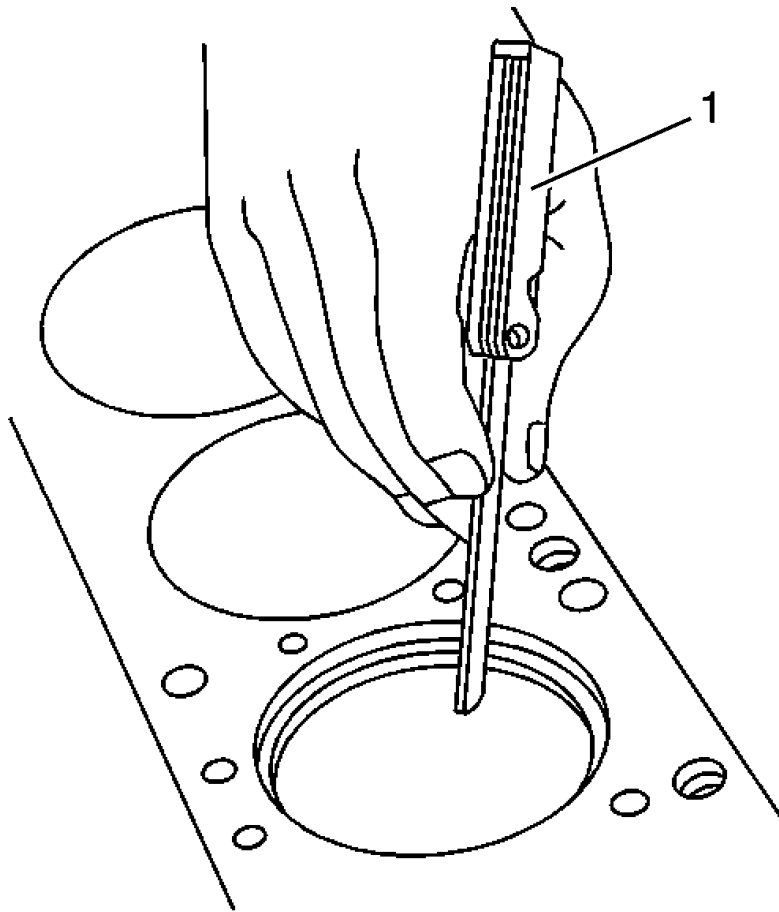


Fig. 104: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS COMPANY

6. Measure the piston ring end gap using the following procedure:
 1. Place the piston ring in the area of the bore where the piston ring will travel (approximately 25 mm or 1 inch down from the deck surface). Be sure the ring is square with the cylinder bore by

positioning the ring with the piston head.

2. Measure the end gap of the piston ring with feeler gauges (1). Compare the measurements with those provided below:
 - The top compression ring end gap should be 0.20-0.40 mm (0.0060-0.015 in).
 - The second compression ring end gap should be 0.35-0.55 mm (0.0137-0.0216 in).
 - The oil ring end gap should be 0.25-0.76 mm (0.0098-0.029 in).
3. If the clearance exceeds the provided specifications, the piston rings must be replaced.
4. Repeat the procedure for all the piston rings.

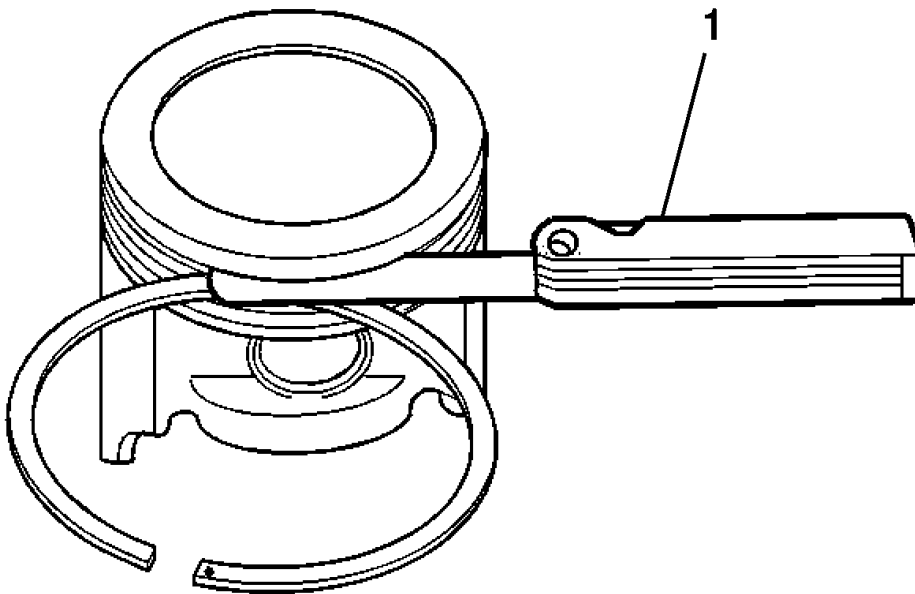


Fig. 105: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS COMPANY

7. Measure the piston ring side clearance using the following procedure:
 1. Roll the piston ring entirely around the piston ring groove. If any binding is caused by a distorted piston ring, replace the ring.
 2. With the piston ring on the piston, use feeler gauges (1) to check clearance at multiple locations.

3. The clearance between the surface of the top piston ring and the ring land should be no greater than 0.075 mm (0.0030 in).
4. If the clearance is greater than specifications, replace the piston ring.
5. If the new ring does not reduce the top ring side clearance to 0.075 mm (0.0030 in) or less, install a new piston.
8. The top compression ring may be installed with either side up. There is a locating dimple on the 2nd compression ring near the end for identification of the top side. Install the 2nd compression ring with the dimple facing up.
9. The clearance between the surface of the second piston ring and the ring land should be no greater than 0.069 mm (0.0026 in).
10. If the new ring does not reduce the clearance to 0.069 mm (0.0026 in) or less, install a new piston.

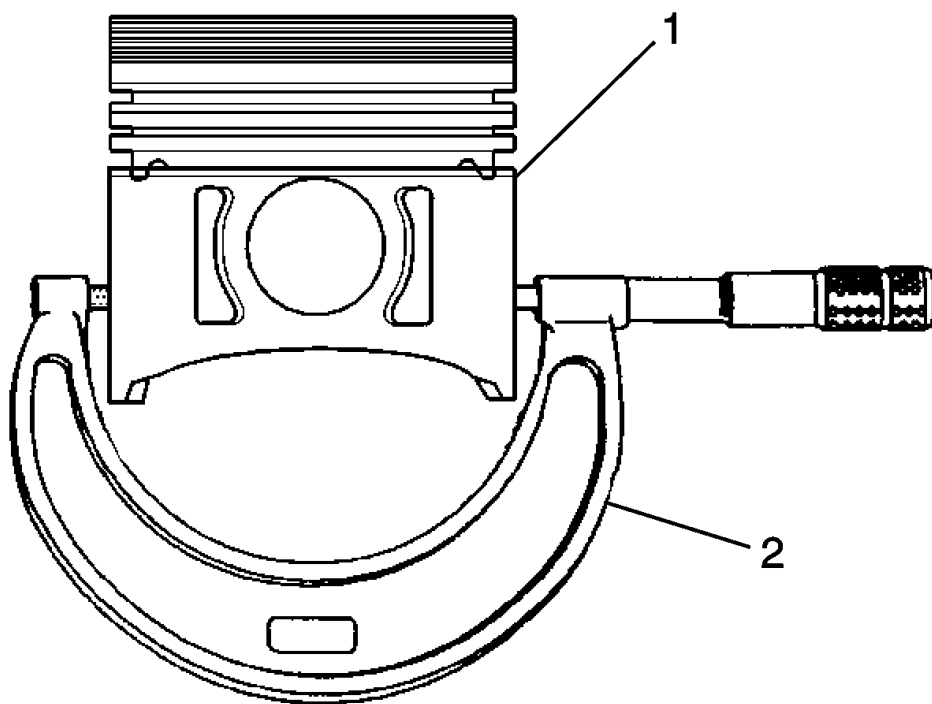


Fig. 106: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

11. Measure piston width using the following procedure:

1. Using an outside micrometer (2), measure the width of the piston 14.5 mm (0.570 in) above the bottom of the piston skirt at the thrust surface perpendicular to the centerline of the piston pin.
 2. Compare the measurement of the piston to its original cylinder by subtracting the piston width from the cylinder diameter.
 3. The proper clearance specification for the piston is 0.010-0.041 mm (0.0006-0.0016 in).
12. If the clearance obtained through measurement is greater than these specifications and the cylinder bores are within specification, replace the piston (1).

Piston Selection

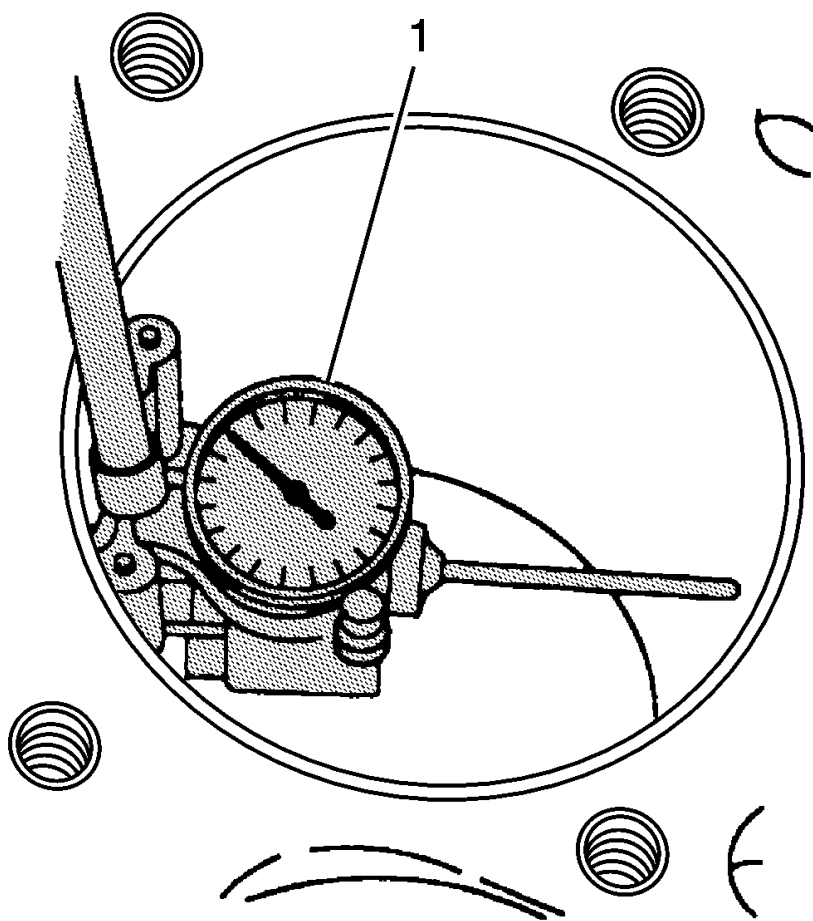


Fig. 107: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

NOTE: Measurements of all components should be taken with the components at normal room temperature.

For proper piston fit, the engine block cylinder bores must not have excessive wear or taper.

A used piston and pin set may be reinstalled if, after cleaning and inspection, they are within specifications.

1. Inspect the engine block cylinder bore. Refer to **Engine Block Cleaning and Inspection**.
2. Inspect the piston and the piston pin.
3. Use a bore gauge (1) and measure the cylinder bore diameter. Measure at a point 64 mm (2.5 in) from the top of the cylinder bore.

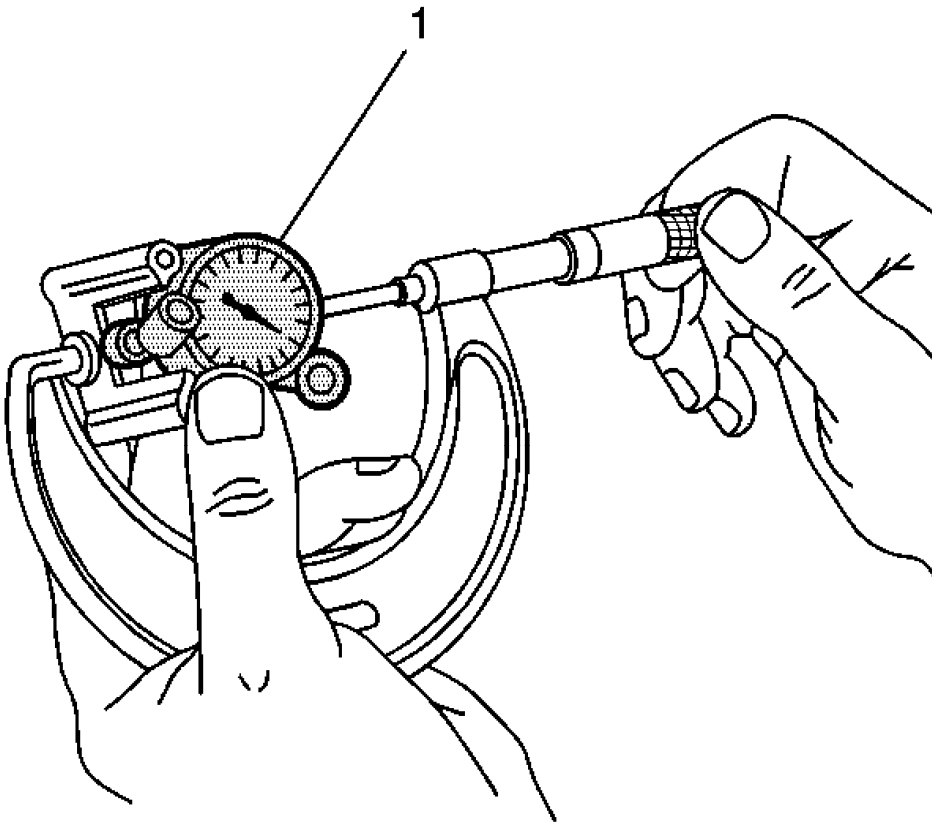


Fig. 108: Measuring Bore Gauge
Courtesy of GENERAL MOTORS COMPANY

4. Measure the bore gauge with a micrometer (1) and record the reading.

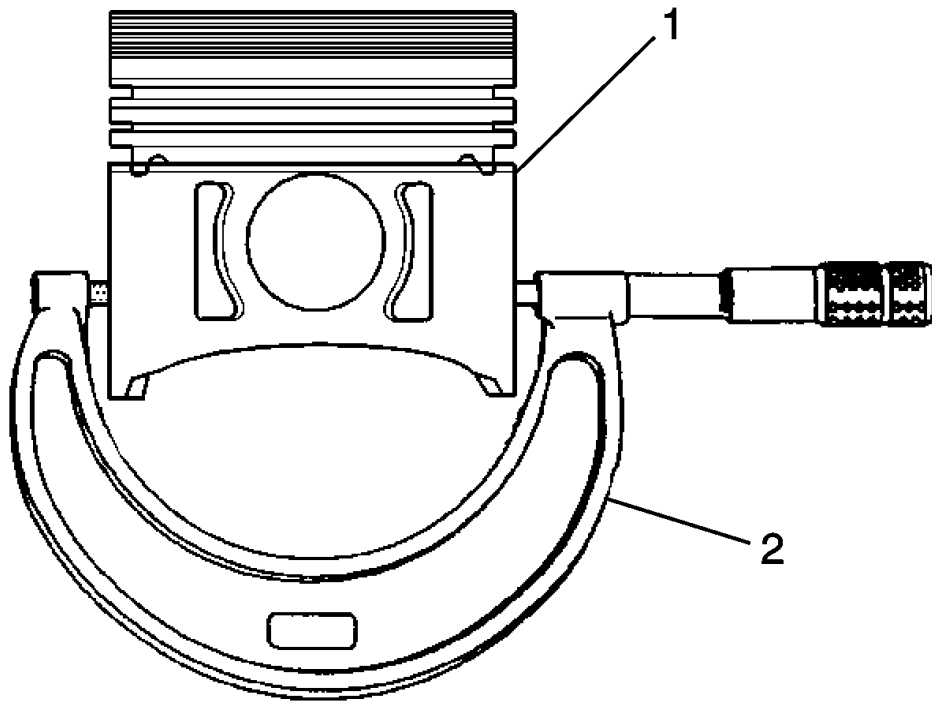


Fig. 109: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

5. With a micrometer (2) or caliper at a right angle to the piston (1), measure the piston 14 mm (0.570 in) from the bottom of the skirt.
6. Subtract the piston diameter from the cylinder bore diameter in order to determine piston-to-bore clearance.
7. For proper piston-to-bore clearance. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .
8. If the proper clearance cannot be obtained, select another piston and measure for the clearances.
9. If the proper fit cannot be obtained, hone the cylinder bore or replace the cylinder block.
10. When the piston-to-cylinder bore clearance is within specifications, mark the top of the piston using a permanent marker for installation to the proper cylinder. Refer to **Separating Parts** .

PISTON AND CONNECTING ROD ASSEMBLE

Special Tools

EN-46745 Piston Pin Retainer Remover and Installer

For equivalent regional tools, refer to **Special Tools** .

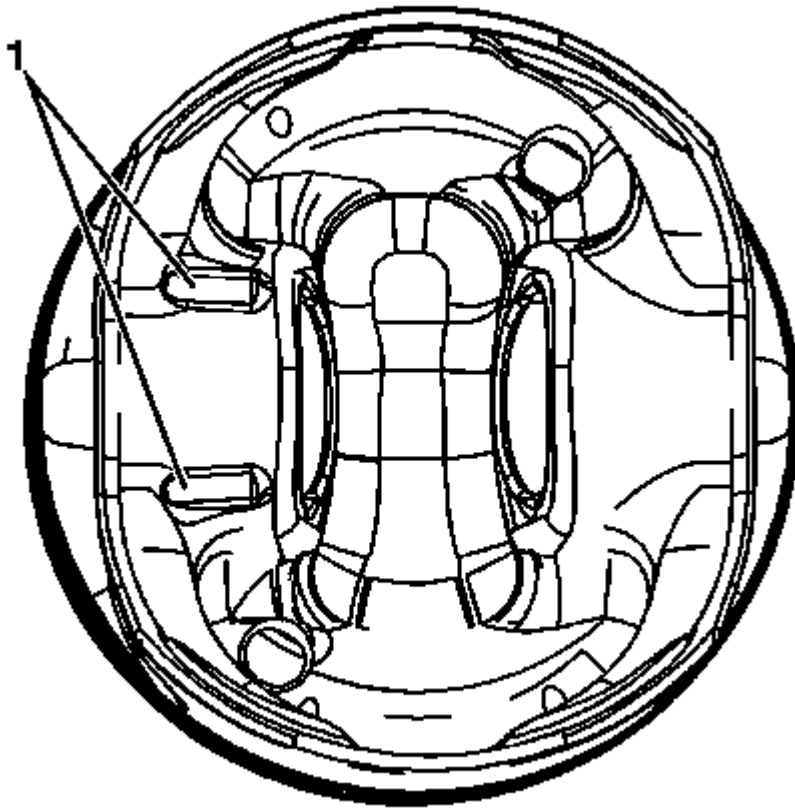


Fig. 110: Locating "Cast Boss" On Underside of Piston
Courtesy of GENERAL MOTORS COMPANY

- NOTE:** Install the piston onto the connecting rod with the arrow on top of the piston toward the front oriented toward the front of the engine.
- NOTE:** The cast boss (1) can be in either or both locations depending on displacement.

1. The cast boss (1), on the underside of the piston, must go to the rear of the block.

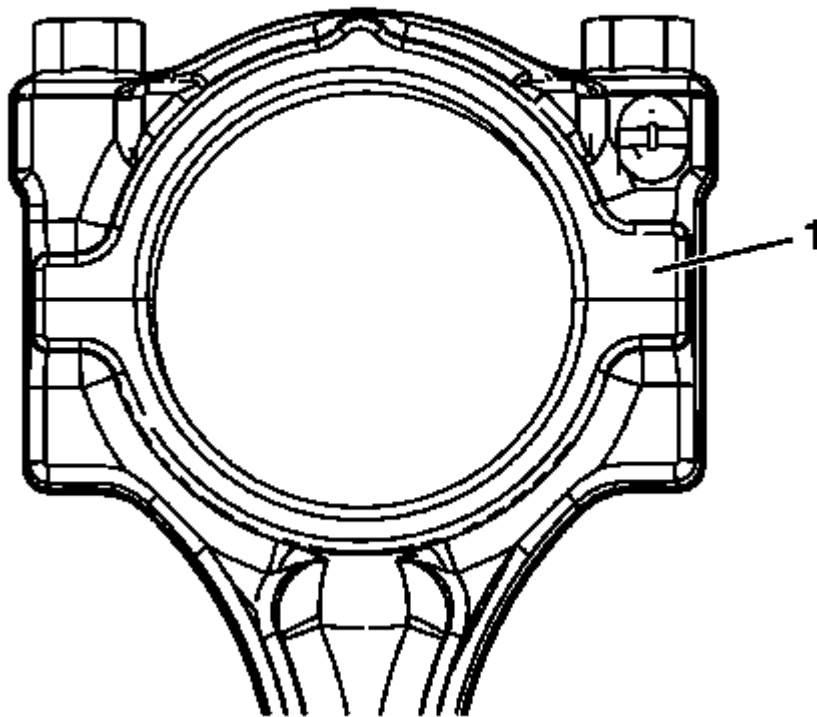


Fig. 111: Identifying Cast Mark

Courtesy of GENERAL MOTORS COMPANY

2. The larger feature (1), at the split line located on one side of the connecting rod, must go to the front of the block.

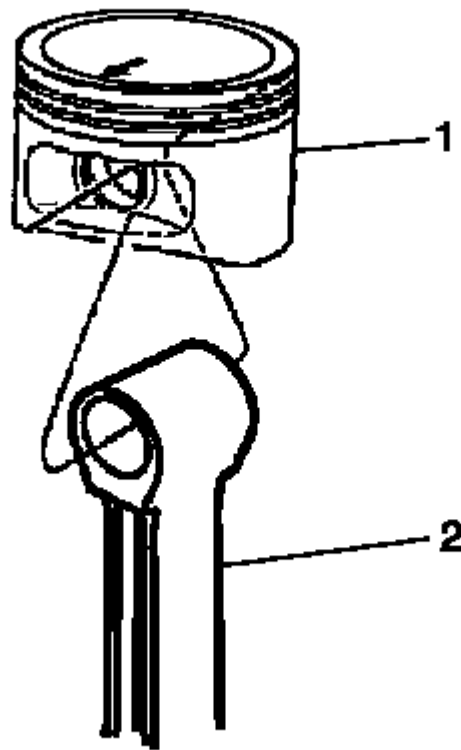


Fig. 112: View of Connecting Rod and Piston
Courtesy of GENERAL MOTORS COMPANY

3. Assemble the connecting rod (2) and the piston (1).

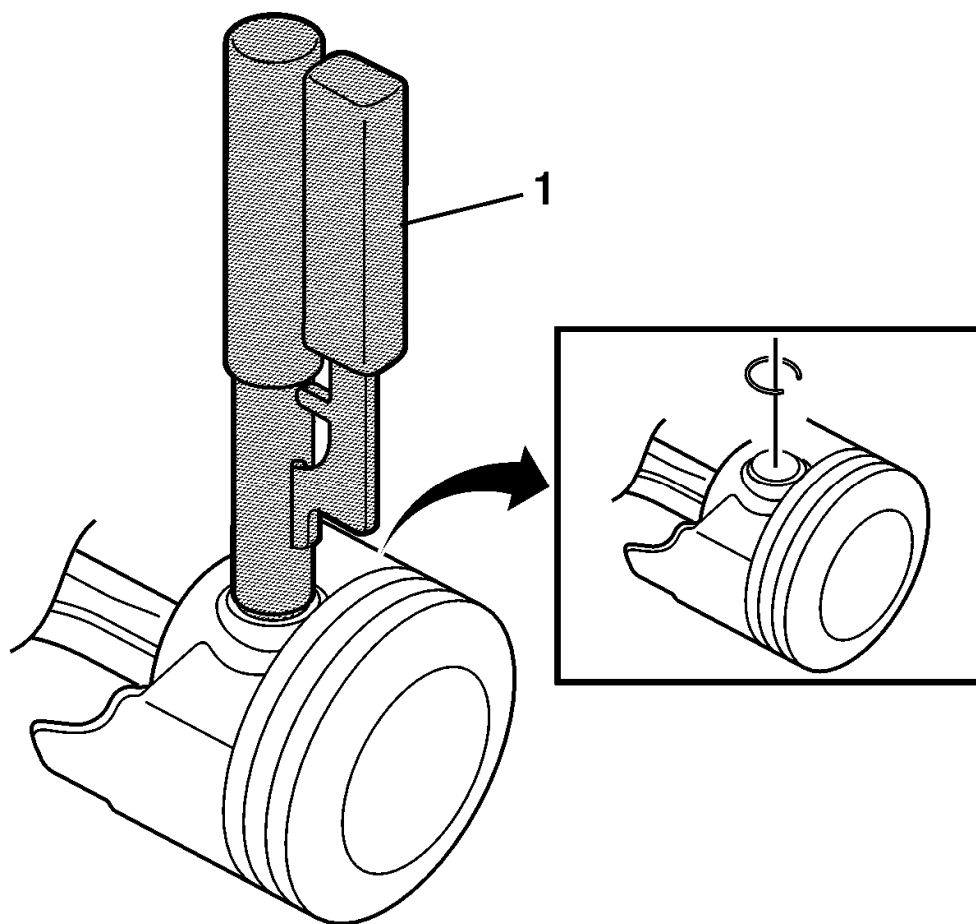


Fig. 113: View of Piston Pin Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Install the piston pin retainers correctly in the retaining groove during assembly in order to avoid engine damage.

4. Use the following procedure to assemble the piston pin and the retainer:
 1. Coat the piston pin with oil.
 2. Install one side of one piston pin retainer into the retaining groove using **EN-46745** installer. Rotate the retainer until it is fully seated in the groove.
 3. Install the connecting rod and the piston pin.

Push the piston pin until it bottoms in the previously installed retainer.

4. Install the second piston pin retainer, using **EN-46745** installer (1) .
5. Ensure that the piston moves freely.

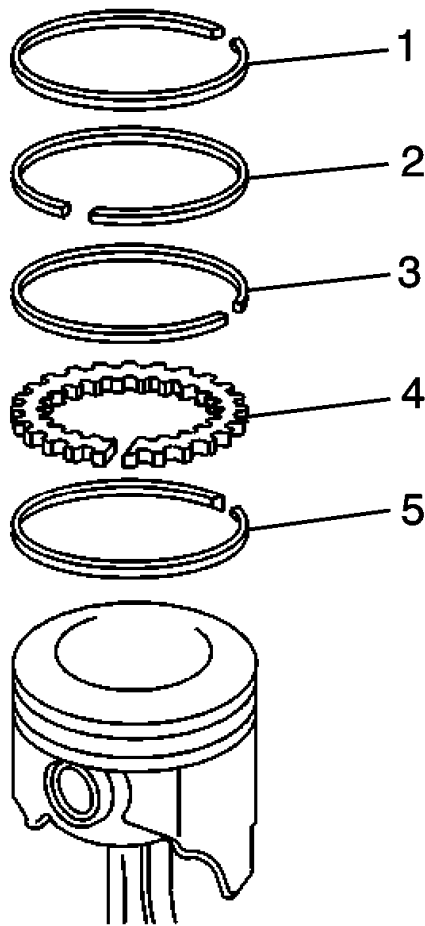


Fig. 114: Identifying Piston Rings

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

5. Install the following components of the oil control ring assembly (bottom ring):
 1. The expander (5)
 2. The lower oil control ring (4)
 3. The upper control ring (3)
6. Install the lower compression ring (2). Place the manufacturer's mark facing up.
7. Install the upper compression ring (1).

CAMSHAFT CLEANING AND INSPECTION (LEA, OR LUK)

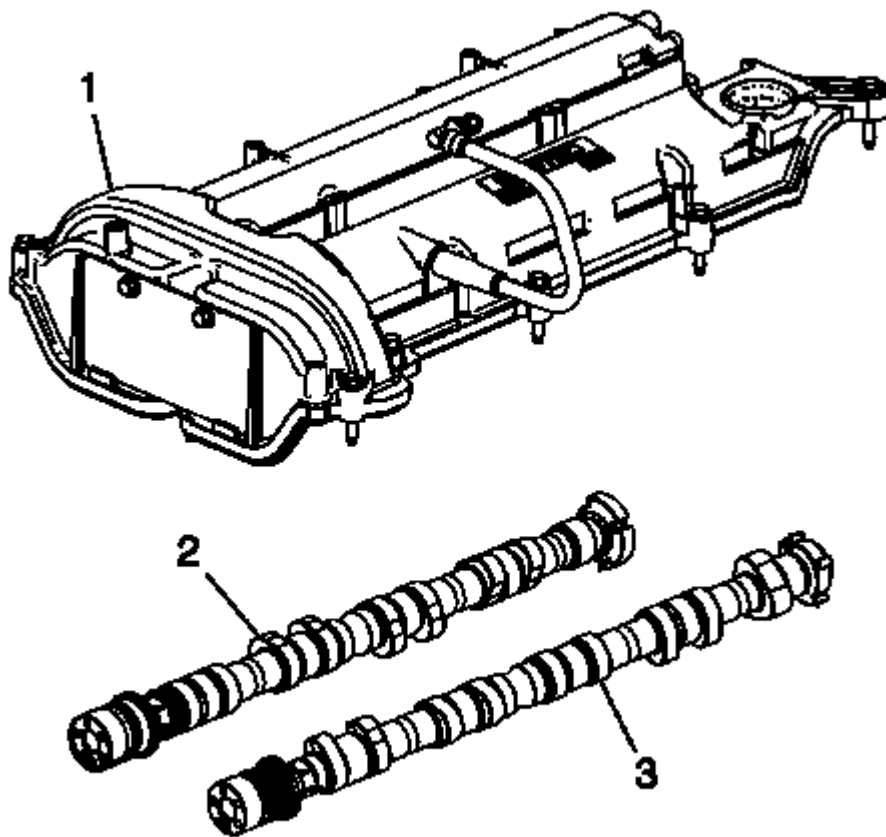


Fig. 115: Camshaft Cover And Camshafts
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft journals and lobes for wear or scoring.
2. Inspect the camshaft sprocket alignment notch for damage.
3. Inspect the camshaft cover (1) for damage or loose oil control baffles.
4. Clean the camshaft cover.
5. Wash the camshafts (2, 3) in solvent.
6. Oil the camshafts.
7. Inspect the camshaft cover for cracks or other signs of damage.

CAMSHAFT TIMING CHAIN AND SPROCKET CLEANING AND INSPECTION

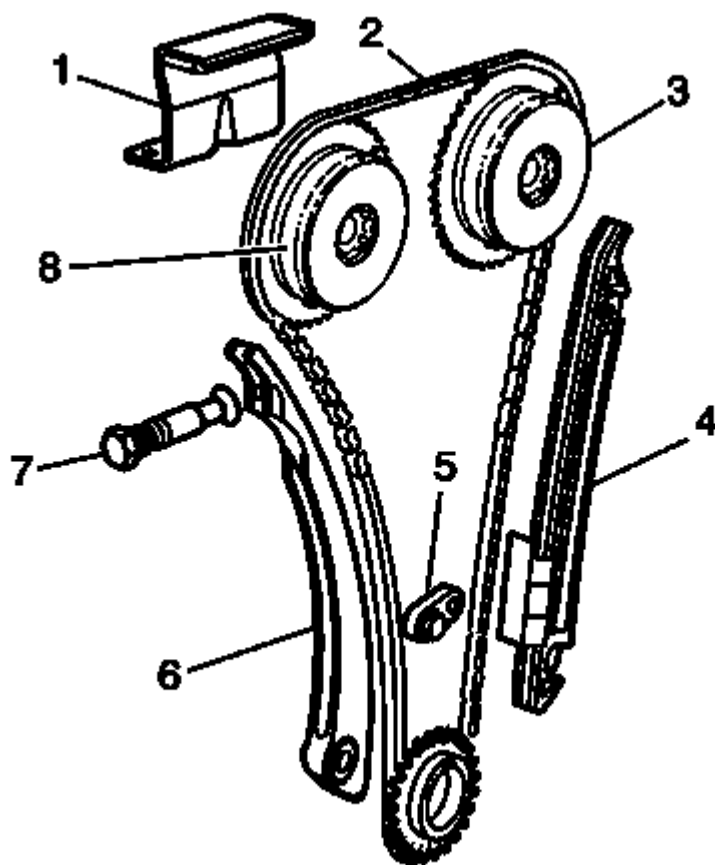


Fig. 116: Timing Chain Guides

Courtesy of GENERAL MOTORS COMPANY

1. Inspect the timing chain guides (1, 4, 6) for cracking or wear.
2. Replace the timing chain guides if wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface.
3. Inspect the timing chain tensioner shoe for wear.
4. Replace the timing chain tensioner shoe if wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface.
5. Inspect the timing chain (2) and actuators (3, 8) for wear.
6. Inspect the camshaft actuator faces for signs of movement.
7. Inspect the camshaft actuator teeth and chain for signs of excessive wear, chipping, or seizure of the timing chain links.
8. Inspect the oil nozzle body (5) for collapse or cracks at the bolt boss. Discard and replace the oil nozzle body if it is damaged.
9. Verify oil nozzle oil flow with compressed air.
10. Inspect the timing chain tensioner (7) for the scoring or free movement.
11. Inspect the timing chain tensioner washer and O-ring for damage. If damaged, replace the timing chain tensioner.

BALANCE SHAFT CLEANING AND INSPECTION

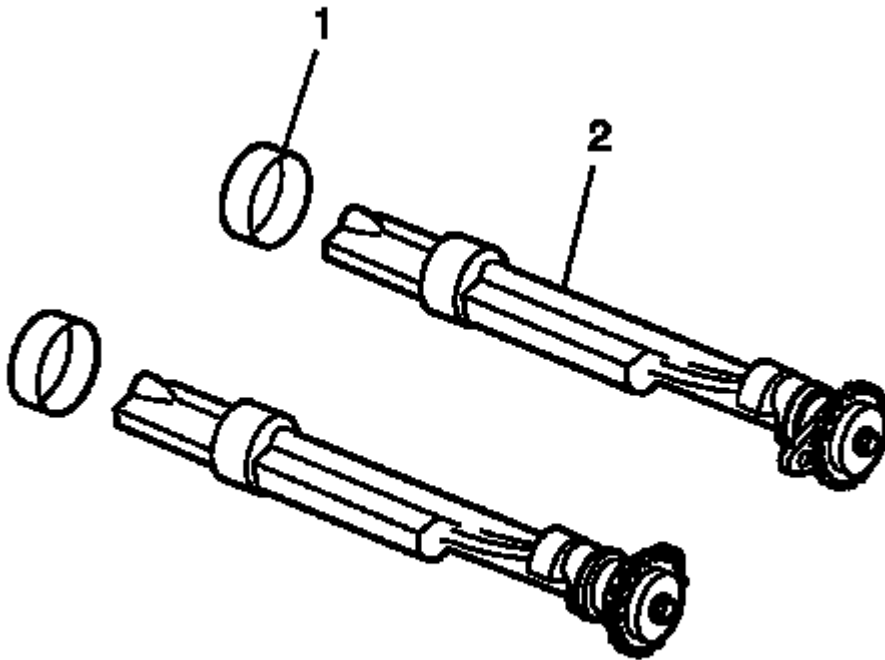


Fig. 117: Balance Shafts

Courtesy of GENERAL MOTORS COMPANY

1. Clean the balance shafts (1) in solvent.
2. Inspect the bearing surfaces on the balance shafts for scoring or unusual wear.

NOTE: Do not remove the balance shaft drive sprockets.

3. Inspect the balance shaft drive sprockets for wear, damage, or missing teeth.
4. Measure the rear bearing journals on the balance shafts, the journals should be 36.723-36.743 mm (1.4458-1.4466 in) in diameter.
5. Measure the front bearing journals on the balance shafts, the front bearing journals should be 20.020-20.000 mm (0.7881-0.7874 in) in diameter.
6. When the balance shafts have been installed in the engine block, check for smooth rotation, sticking, binding, or roughness.

WATER PUMP AND BALANCE SHAFT CHAIN AND SPROCKET CLEANING AND INSPECTION

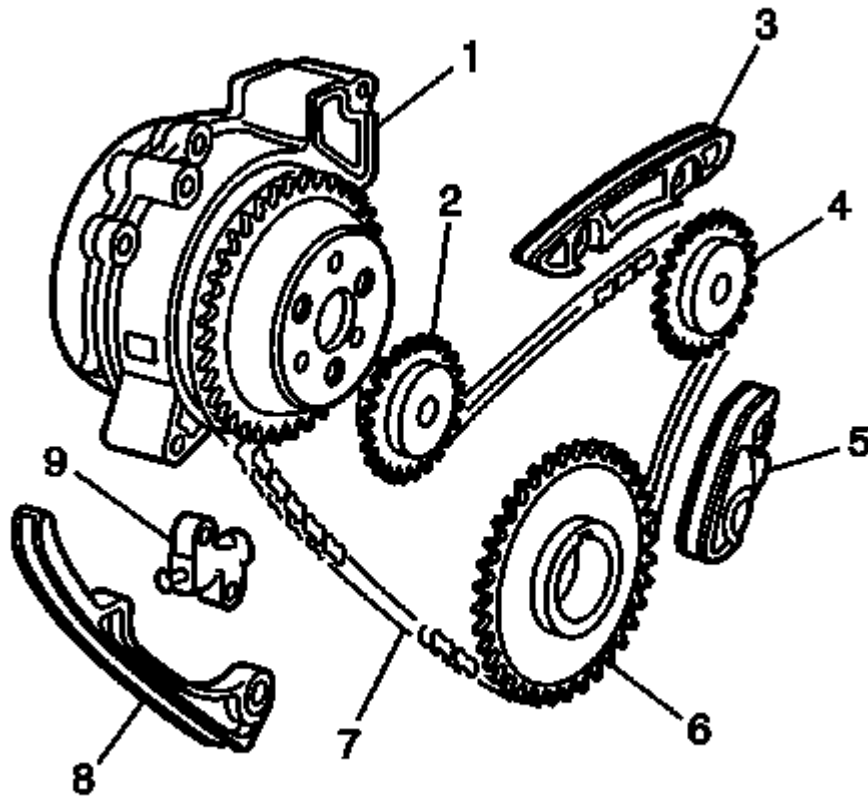


Fig. 118: Water Pump, Balance Shaft Chain And Sprocket
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the balance shaft drive chain guides (3, 5, 8) for cracking or wear.
2. Replace the balance shaft drive chain guides if wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface.
3. Inspect the balance shaft drive chain tensioner guide shoe for wear.

Replace the balance shaft drive chain tensioner guide shoe if wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface.

4. Inspect the balance shaft drive chain (7) and sprockets (2, 4) for wear.
5. Inspect the crankshaft sprocket (6) faces for signs of movement.
6. Inspect the alignment notch in the balance shaft for cracking or damage.
7. Inspect the water pump (1), crankshaft, and balance shaft sprocket teeth and chain for signs of excessive wear, chipping, or seizure of the balance shaft drive chain links.
8. Inspect the timing chain tensioner (9) for damage or wear.

CYLINDER HEAD DISASSEMBLE (LEA, OR LUK)

Special Tools

- **EN-8062** Valve Spring Compressor
- **EN-36017** Valve Seal Remover
- **EN-43963** Valve Spring Compressor (off car)

For equivalent regional tools, refer to **Special Tools** .

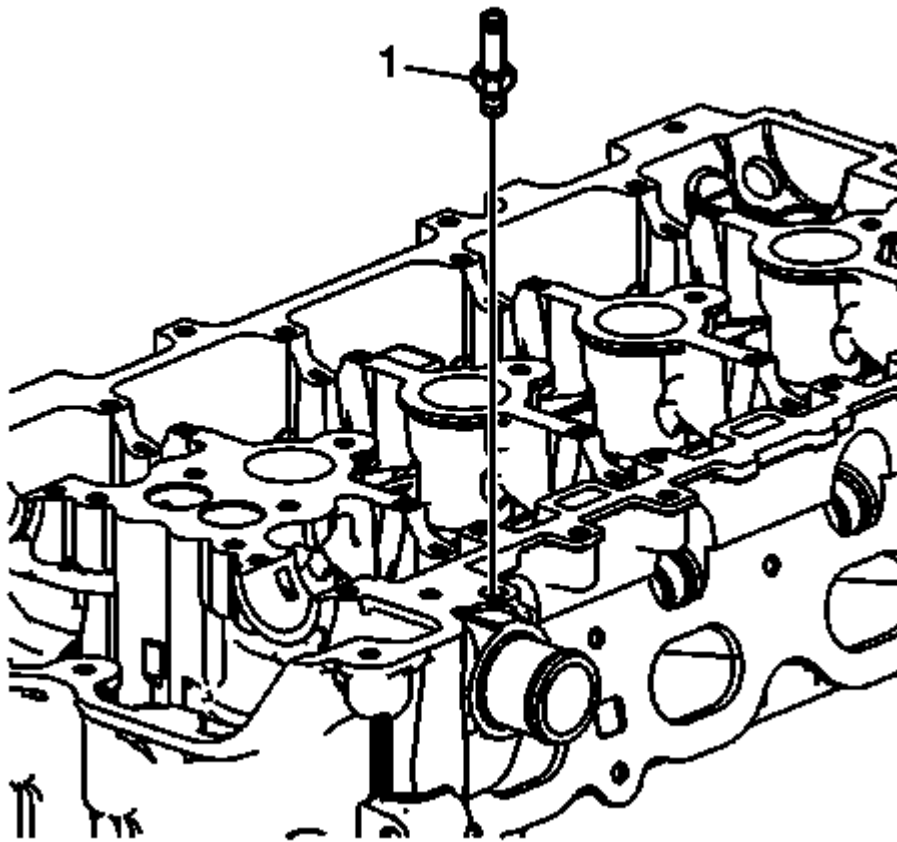


Fig. 119: Identifying the Coolant Air Bleed Hose Fitting
Courtesy of GENERAL MOTORS COMPANY

1. Remove the coolant air bleed hose fitting (1).

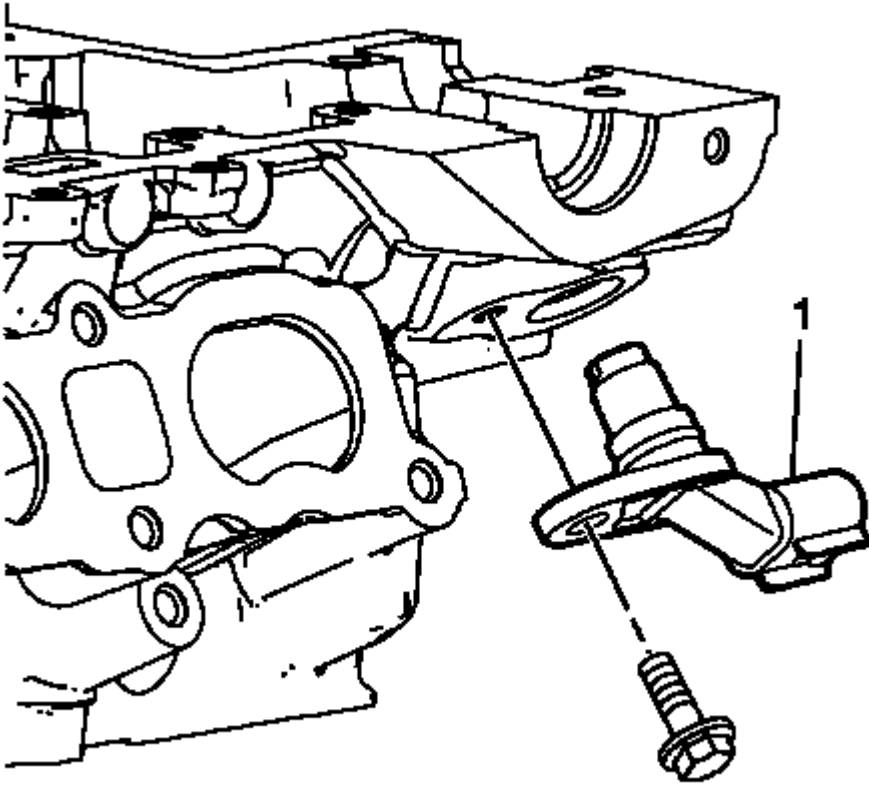


Fig. 120: Intake Camshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake camshaft position sensor (1) and bolt.

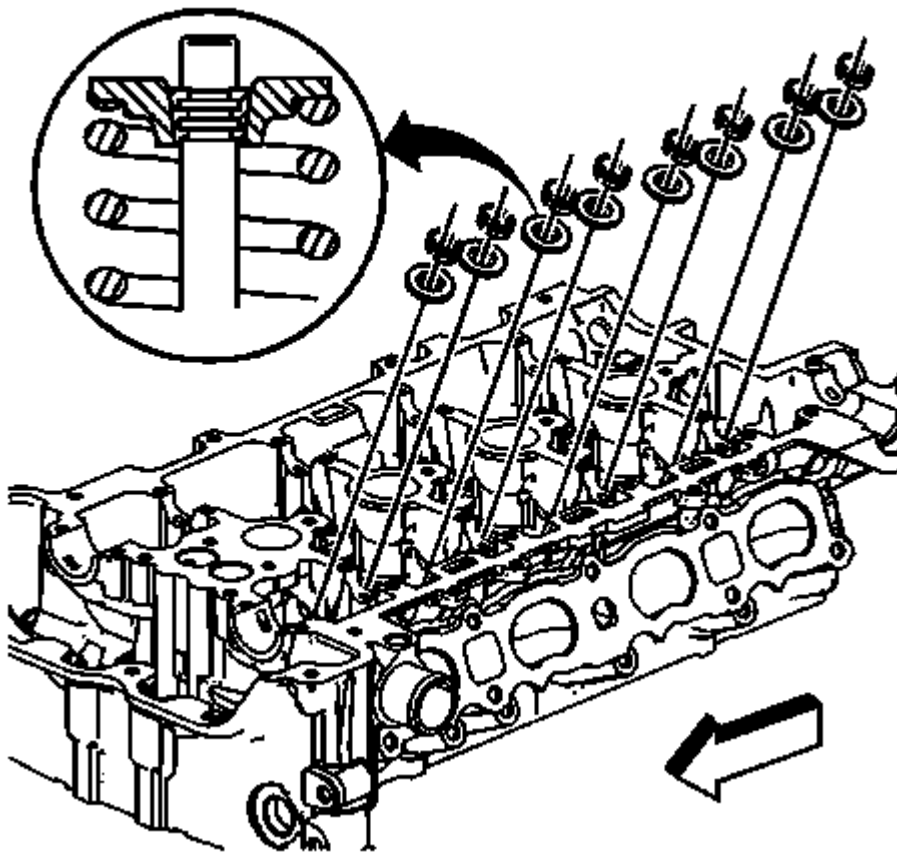


Fig. 121: Valve Train Components
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

NOTE: Ensure that the valve train components are kept together and identified in order for proper installation in their original position.

3. Perform the following procedure to remove the valve keys, springs, and retainers:
 1. Using the **EN-8062** compressor and the **EN-43963** compressor , compress the valve spring.

2. Remove the valve keys.
3. Slowly release the **EN-8062** compressor and the **EN-43963** compressor from the valve spring assembly.
4. Remove the retainer.

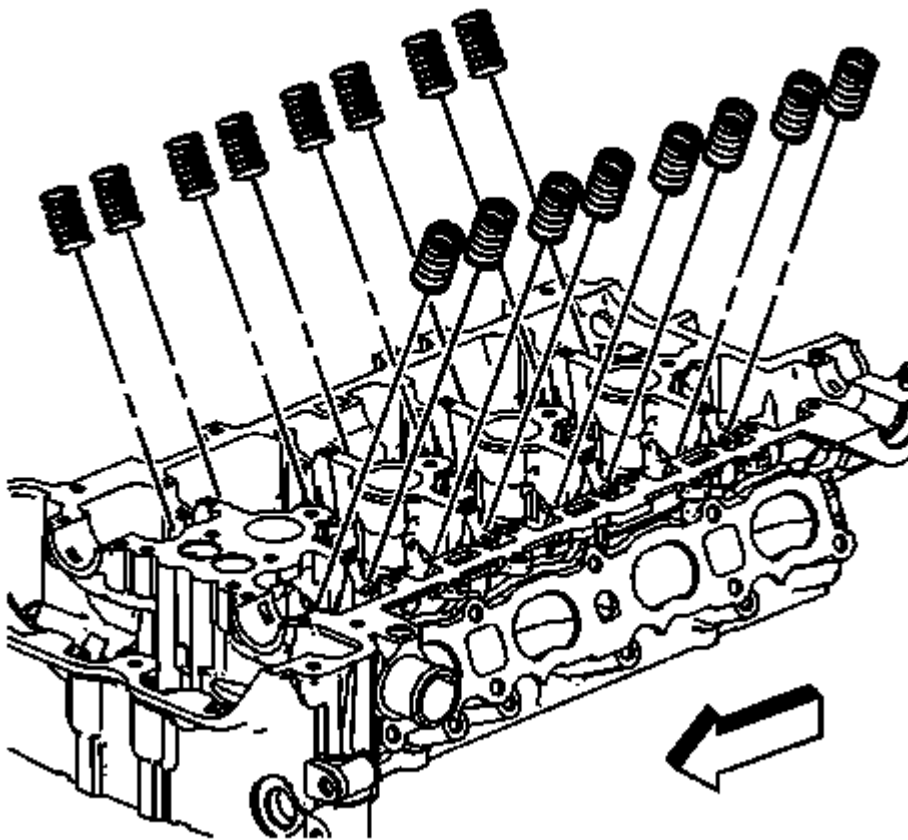


Fig. 122: Valve Springs
Courtesy of GENERAL MOTORS COMPANY

4. Remove the springs.

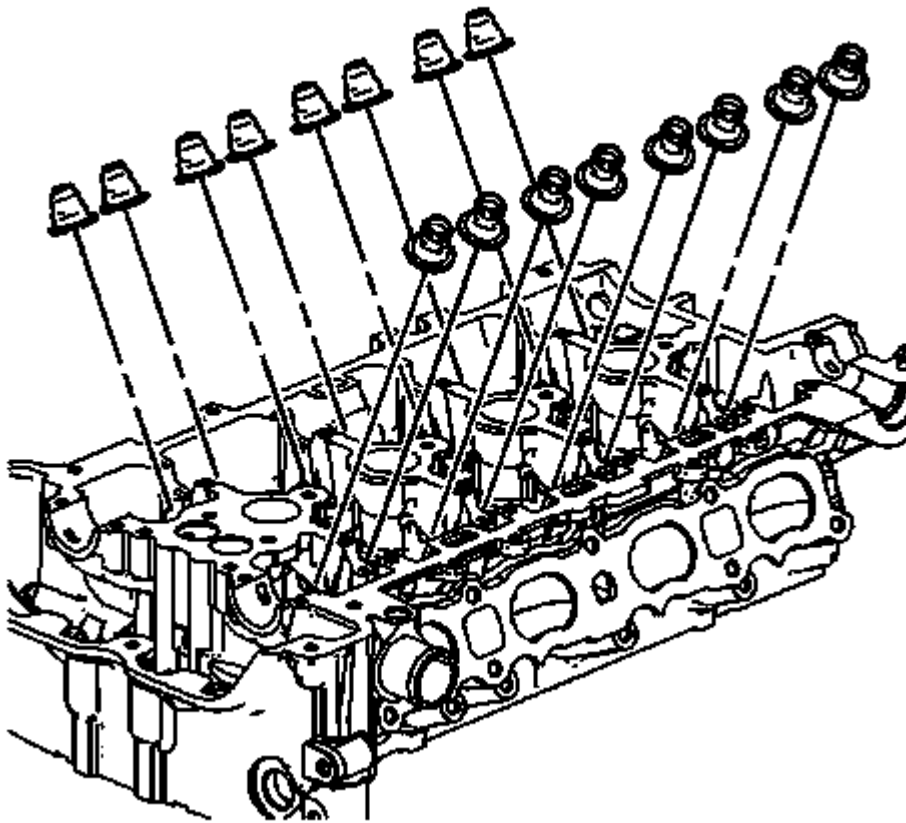


Fig. 123: Valve Guides

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not damage the valve guide. Remove any burrs that have formed at the key groove by chamfering the valve stem with an oil stone or a file.

5. Using **EN-36017** remover , remove the valve seals. Discard the seals, do not reuse.

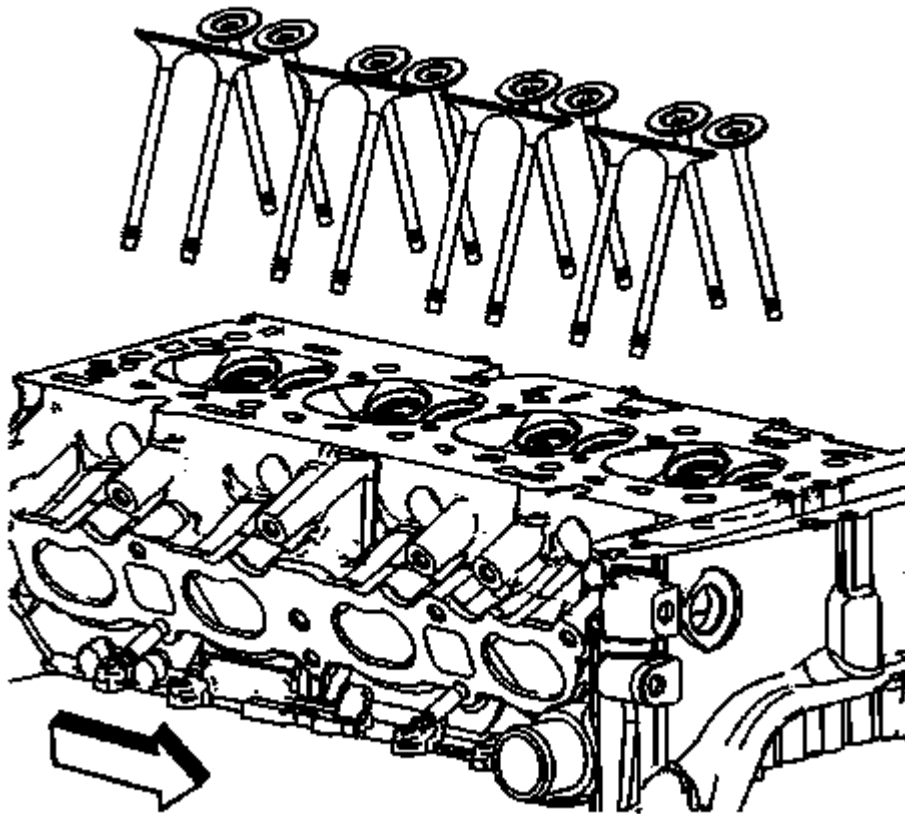


Fig. 124: Valves

Courtesy of GENERAL MOTORS COMPANY

6. Remove the valves.

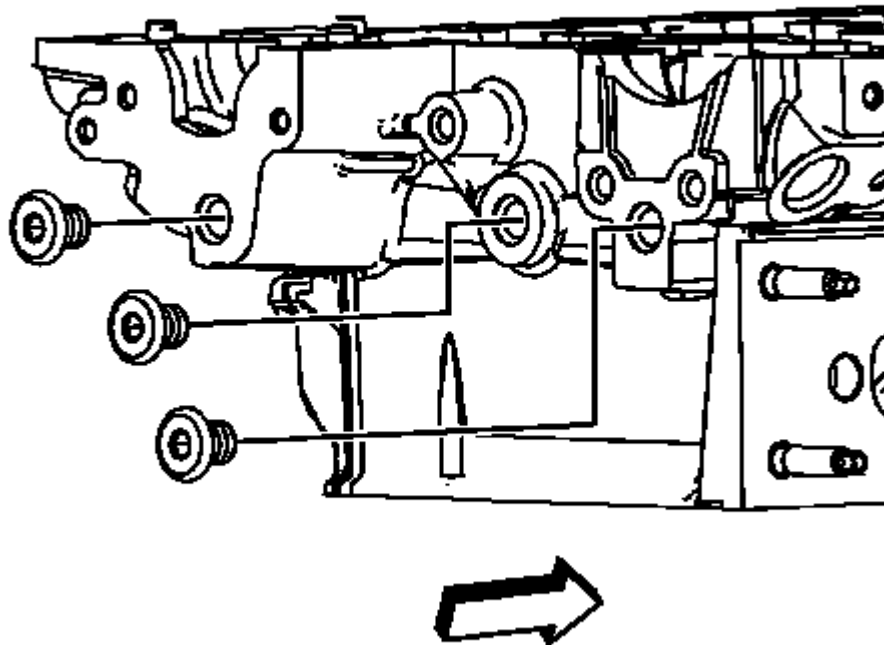


Fig. 125: Cylinder Head Plugs
Courtesy of GENERAL MOTORS COMPANY

7. Remove the cylinder head plugs.

CYLINDER HEAD CLEANING AND INSPECTION (LEA, OR LUK)

Special Tools

- **EN 22738-B** Valve Spring Tester
- **EN-28410** Gasket Remover
- **GE 7872** Magnetic Base Dial Indicator

For equivalent regional tools, refer to **Special Tools** .

Valve Cleaning and Inspection

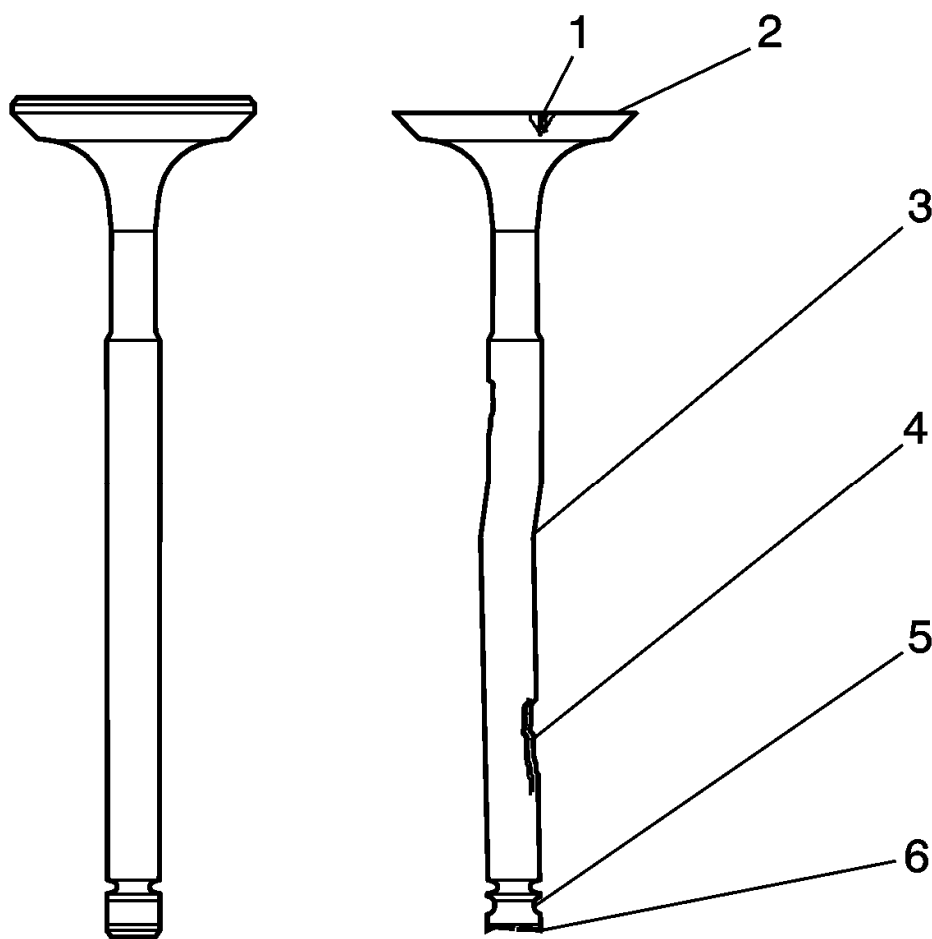


Fig. 126: Valve Inspection Areas

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use a wire brush on any part of the valve stem.

NOTE: Do not grind or condition the intake valve. If the intake valve is out of specification, replace the valve.

1. Clean the valves of carbon, oil and varnish. Use a soft bristle wire brush to clean any carbon build-up from the valve head. Varnish can be removed by soaking in Parts Immersion Solvent. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Clean the valve guides.
3. Inspect the valve stem for pitting or wear (4).
4. Inspect the valve key groove for chipping or wear (5). Replace the valve if chipped or worn.
5. Inspect the valve face for burning or cracking (1). If pieces are broken off, inspect the corresponding piston and cylinder head area for damage.
6. Inspect the valve stem for burrs and scratches. Burrs and minor scratches may be removed with an oil

stone.

7. Inspect the valve stem for straightness (3) and the valve head for bending or distortion using V blocks. Bent or distorted valves must be replaced.
8. Clean the deposits from the valve face. Inspect the valve face for grooving.
9. Replace the valve if the face is grooved. Valve faces cannot be machined. If worn, or damaged, the valves must be replaced.
10. Replace the valve if the valve head O.D. and chamfer (2) is worn or out of specification. Refer to **Valve and Seat Grinding**.
11. The valves may be lightly lapped to the valve seats.
12. Replace the valve if the valve tip (6) is worn.
13. If no apparent wear, pitting, grooving, or distortion is present, perform the valve measurement and reconditioning procedure to verify valve specification. Refer to **Valve and Seat Grinding**.

Valve Guide Measurement

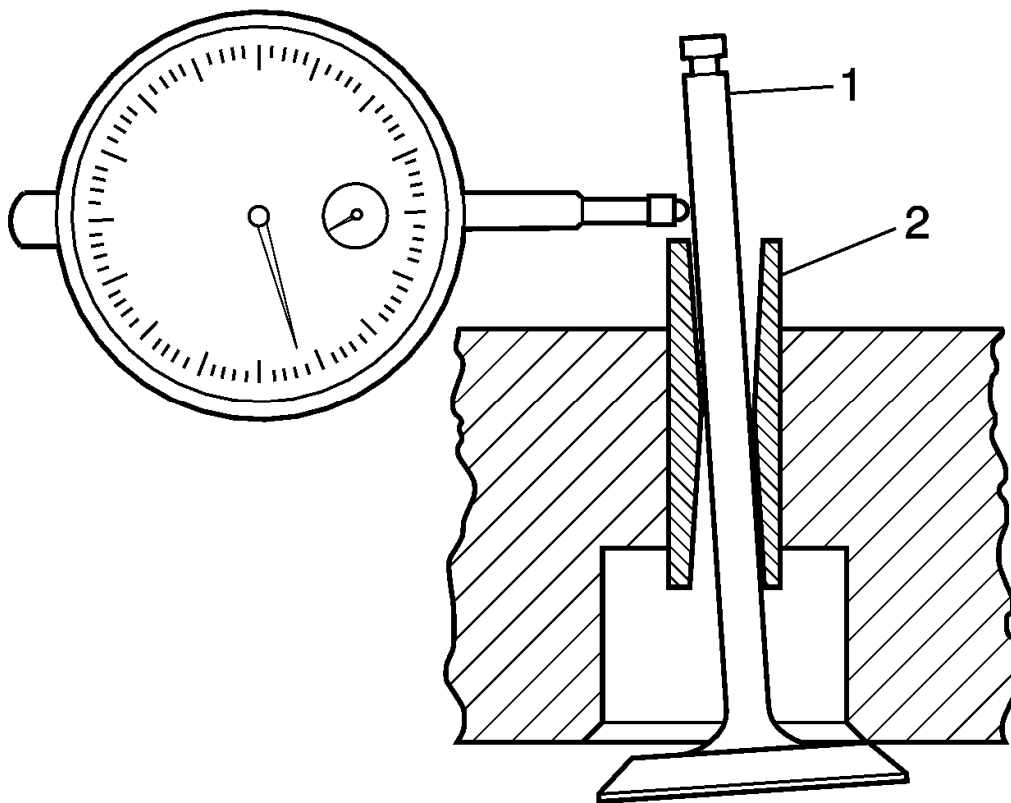


Fig. 127: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve stem (1)-to-guide (2) clearance. Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.
2. Clamp the **GE 7872** dial indicator to the cylinder head at the camshaft cover rail.
3. Locate the dial indicator so that the movement of the valve stem from side to side, crossways to the cylinder head, will cause a direct movement of the indicator stem. The dial indicator stem must contact the side of the valve stem just above the valve guide.
4. Drop the valve head about 0.064 mm (0.0025 in) off the valve seat.
5. Use light pressure when moving the valve stem from side to side in order to obtain a clearance reading. Refer to **Engine Mechanical Specifications (LEA, or LUK)** for proper clearance.

NOTE: **Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.**

6. If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, replace the cylinder head.

Valve Spring Cleaning and Inspection

1. Clean the valve springs in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the valve springs with compressed air.
3. Inspect the valve springs for broken coils or coil ends.

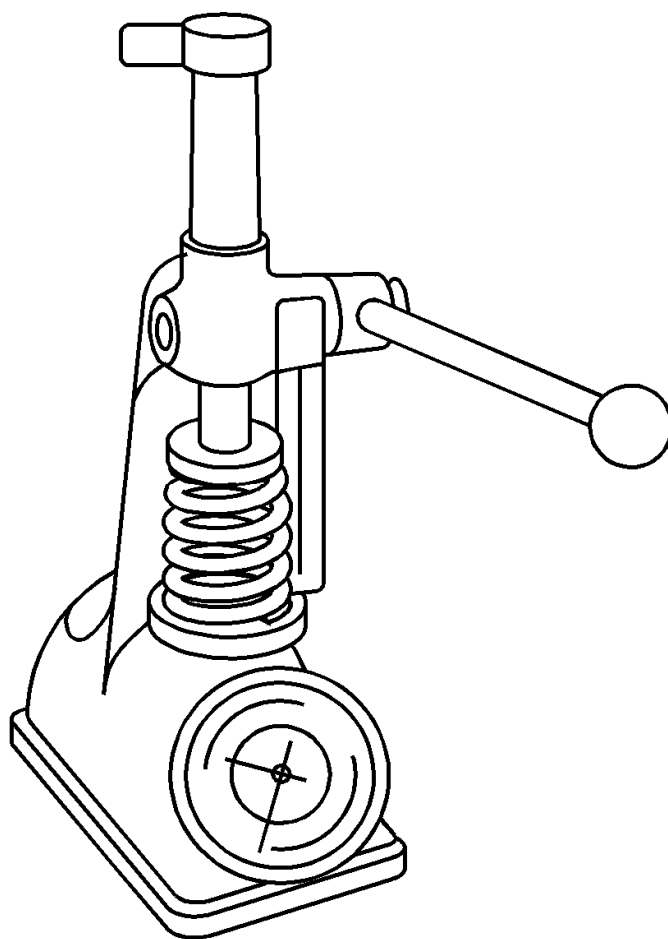


Fig. 128: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS COMPANY

4. Measure the valve spring tension using the **EN 22738-B** tester. Refer to **Engine Mechanical Specifications (LEA, or LUK)**
5. If low valve spring load is found, replace the valve springs. **DO NOT** use shims to increase spring load. The use of shims can cause the valve spring to bottom out before the camshaft lobe is at peak lift.

Valve Rocker Arm Cleaning and Inspection

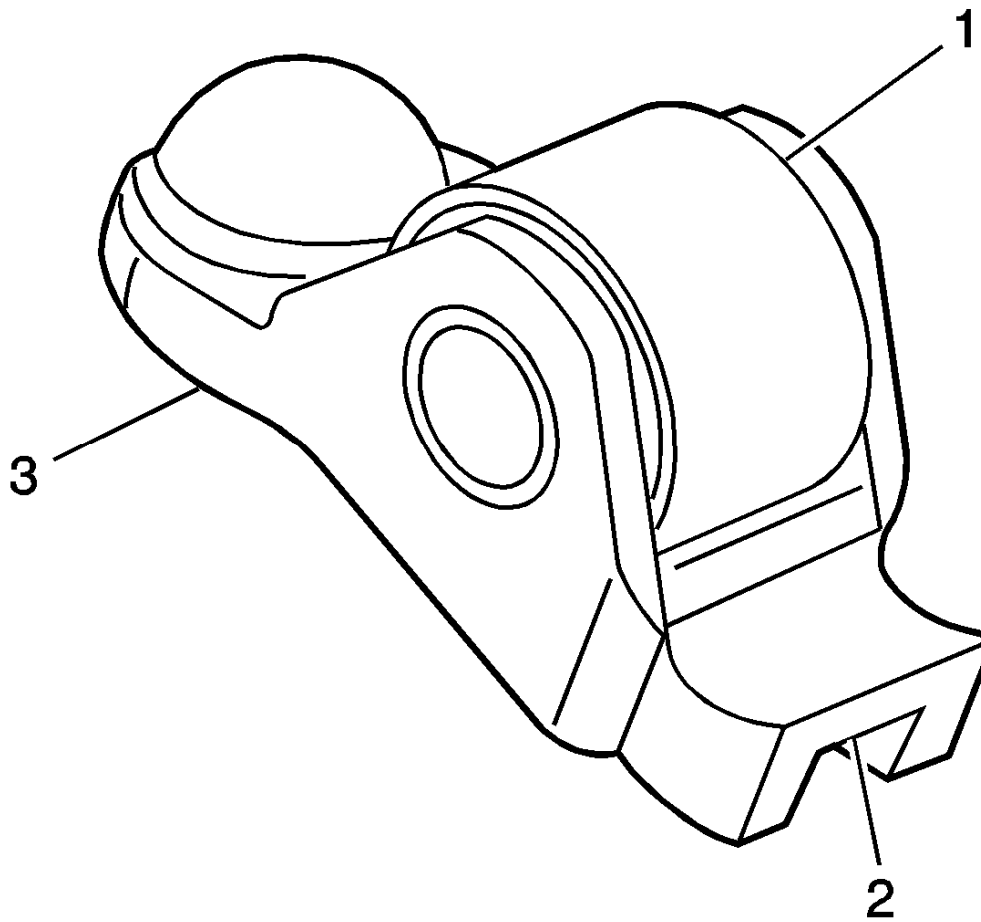


Fig. 129: Inspecting Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft follower roller (1) for the following:
 - Flat spots
 - Excessive scoring and pitting
 - Ensure the roller spins freely
2. Inspect the camshaft follower valve tip area (2).
3. Inspect the camshaft follower stationary hydraulic lash adjuster (SHLA) pivot area (3).
4. Replace the camshaft follower or followers as necessary.

Cylinder Head and Gasket Surface Cleaning and Inspection

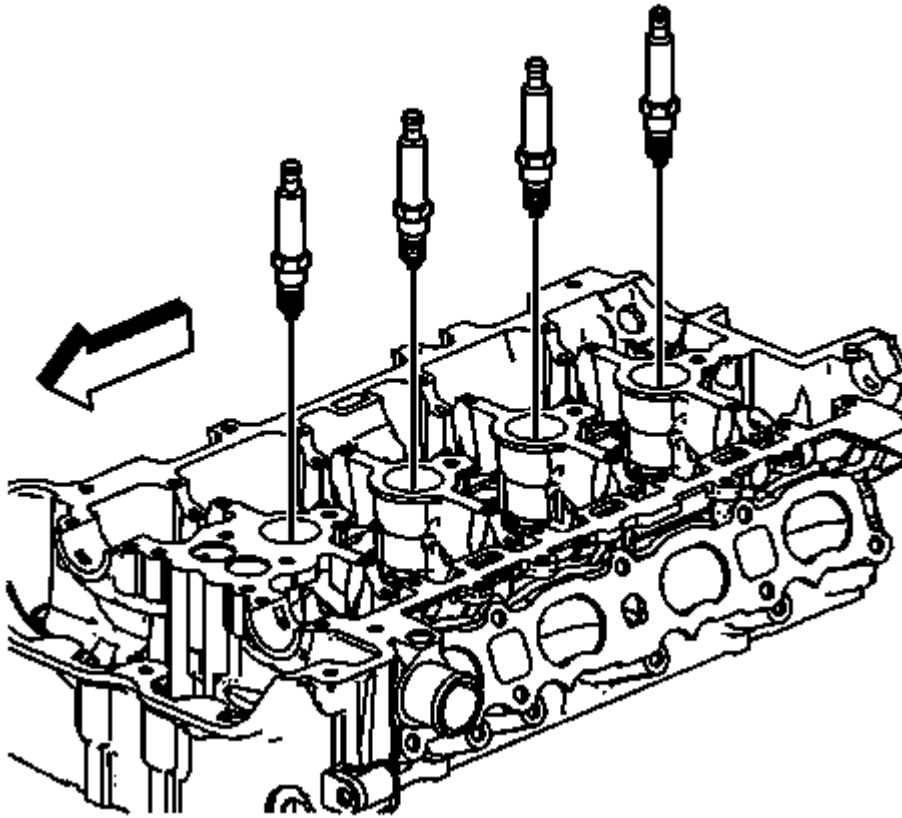


Fig. 130: Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

1. Remove the spark plugs.
2. Inspect the cylinder head gasket and mating surfaces for leaks, corrosion and blow-by. If the gasket has failed, use the following faults to determine the cause:
 1. Improper installation
 2. Loose or warped cylinder head
 3. Missing, off location or not fully seated dowel pins
 4. Corrosion in the seal area around the coolant passages
 5. Chips or debris in the cylinder head bolt holes
 6. Bolt holes in the cylinder block not drilled or tapped deep enough

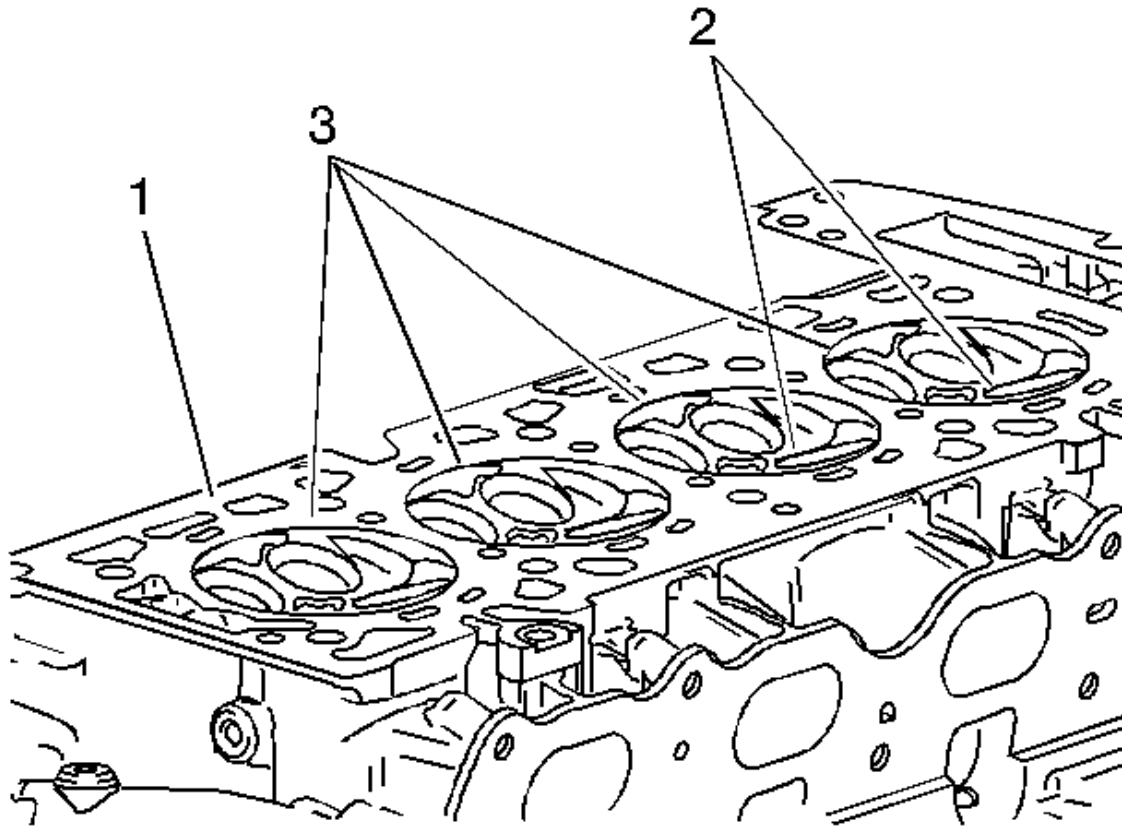


Fig. 131: Locating Combustion Chambers
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the cylinder head gasket surface.
 - Cylinder head may be reused if corrosion is found only outside a 4 mm (0.375 in) band around each combustion chamber (1).
 - Replace the cylinder head if the area between the valve seats is cracked (2).
 - Replace the cylinder head if corrosion has been found inside a 4 mm (0.375 in) band around each combustion chamber (3).
4. Clean the cylinder head bolts.

NOTE: **Do not use a wire brush on any gasket sealing surface.**

5. Remove the sealant from the rear cap mating surface with **EN-28410** remover. Care must be used to avoid gouging or scraping the sealing surfaces.

6. Clean the cylinder head. Remove all varnish, soot and carbon to the bare metal.
7. Clean the valve guides.
8. Clean the threaded holes. Use a nylon bristle brush.
9. Clean the remains of the sealer from the plug holes.
10. Inspect the cylinder head bolts for damaged threads or stretching and damaged heads caused by improper use of tools.
11. Replace all suspect bolts.
12. Inspect the cylinder head for cracks. Check between the valve seats and in the exhaust ports.

NOTE: Do not attempt to weld the cylinder head, replace it.

13. Inspect the cylinder head deck for corrosion, sand inclusions and blow holes.

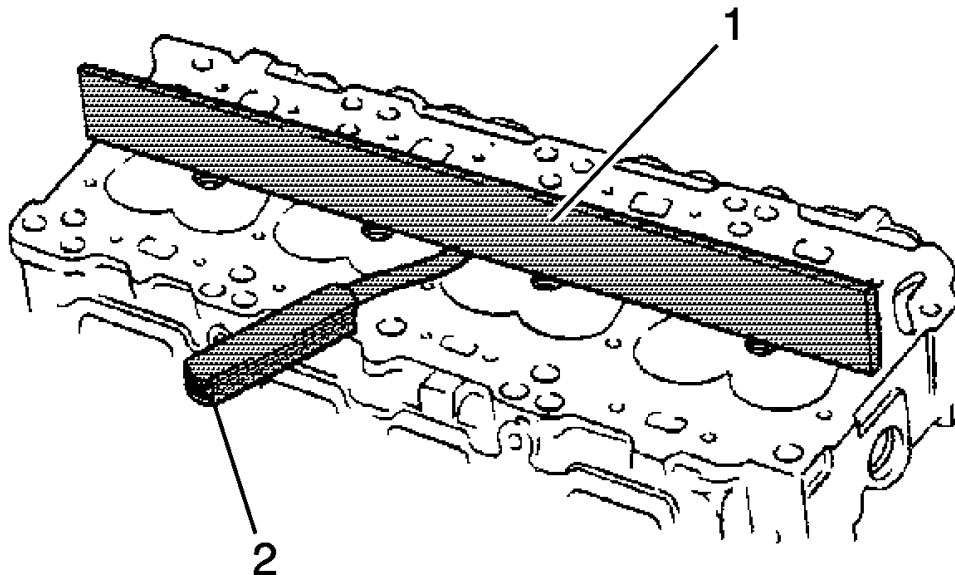


Fig. 132: Checking Cylinder Head Deck Surface For Flatness
Courtesy of GENERAL MOTORS COMPANY

14. Using a straight edge (1) and feeler gauge (2), inspect the cylinder head deck surface for flatness. Refer to **Engine Mechanical Specifications (LEA, or LUK)** . If the cylinder head is out of specification, replace the cylinder head. Do not machine the cylinder head.
15. Inspect all the threaded holes for damage. Threads may be reconditioned with thread inserts.
16. Inspect the sealing surfaces.

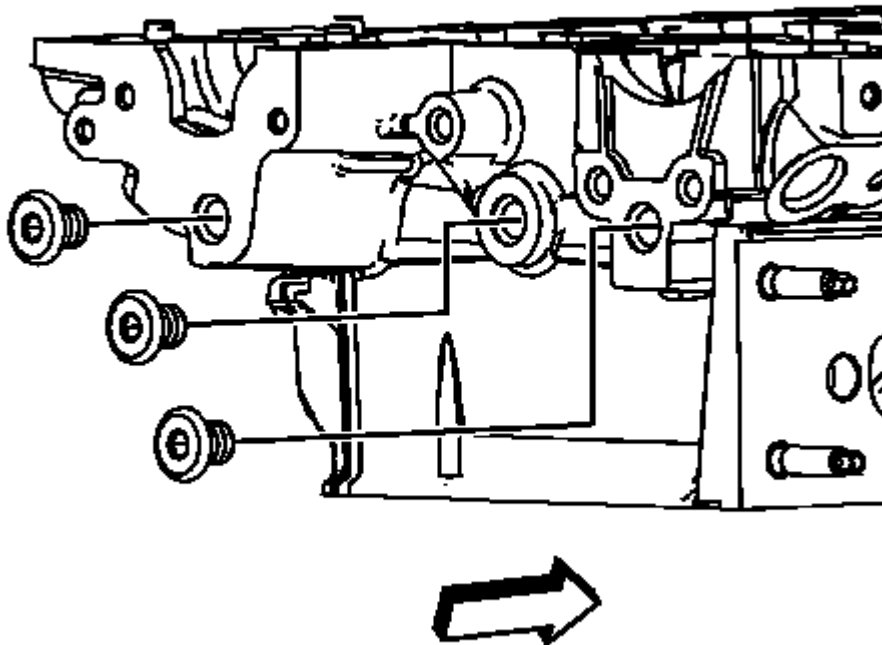


Fig. 133: Cylinder Head Plugs

Courtesy of GENERAL MOTORS COMPANY

17. Inspect the cylinder head plugs and verify the oil orifice is clear and free of debris.

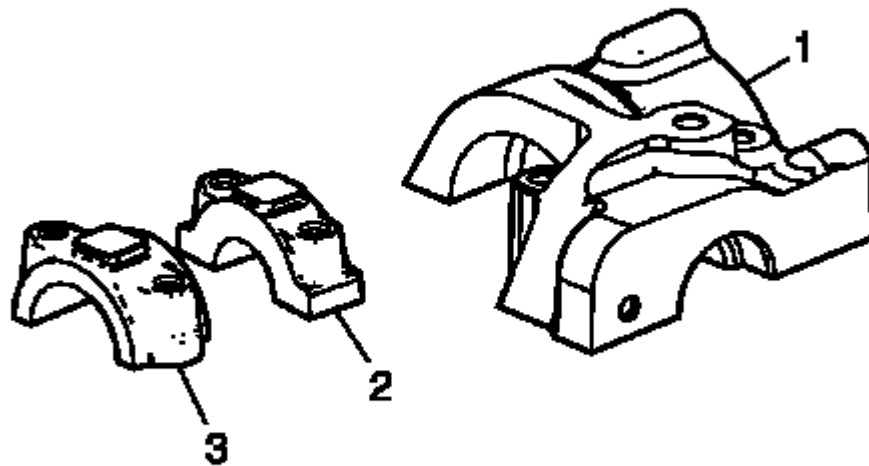


Fig. 134: Bearing Caps

Courtesy of GENERAL MOTORS COMPANY

18. Clean the sealant from the rear cap mating surface with **EN-28410** remover. Care must be used to avoid gouging or scraping the sealing surfaces.
19. Inspect the intake camshaft bearing rear cap (1) for damage.
20. Inspect the rear bearing mating surfaces for damage.
21. Inspect the camshaft bearing caps (2) for damage.
22. Inspect the camshaft front bearing caps (3) for damage.

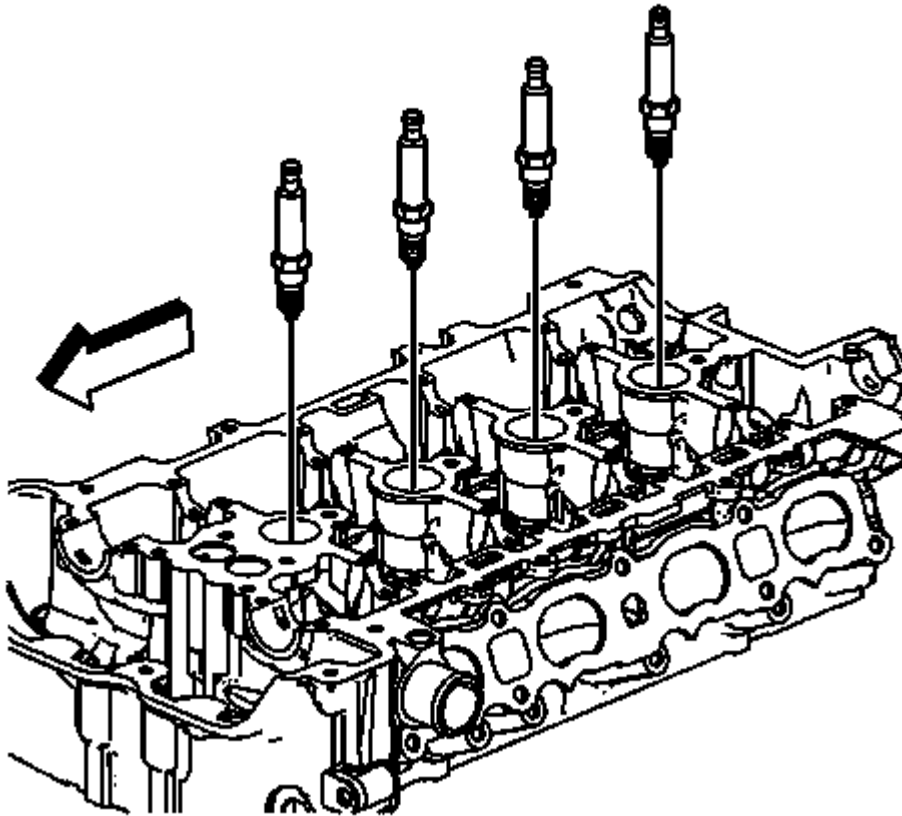


Fig. 135: Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

23. Install the spark plugs. Tighten the plugs to 20 N.m (15 lb ft).

VALVE AND SEAT GRINDING

Valve Measurement and Reconditioning Overview

- Proper valve service is critical to engine performance. Therefore, all detailed measurement procedures must be followed to identify components that are out of specification.
- If the measurement procedures reveal that the valve or valve seat must be reconditioned, it is critical to perform the measurement procedures after reconditioning.

Valve Seat Width Measurement Procedure

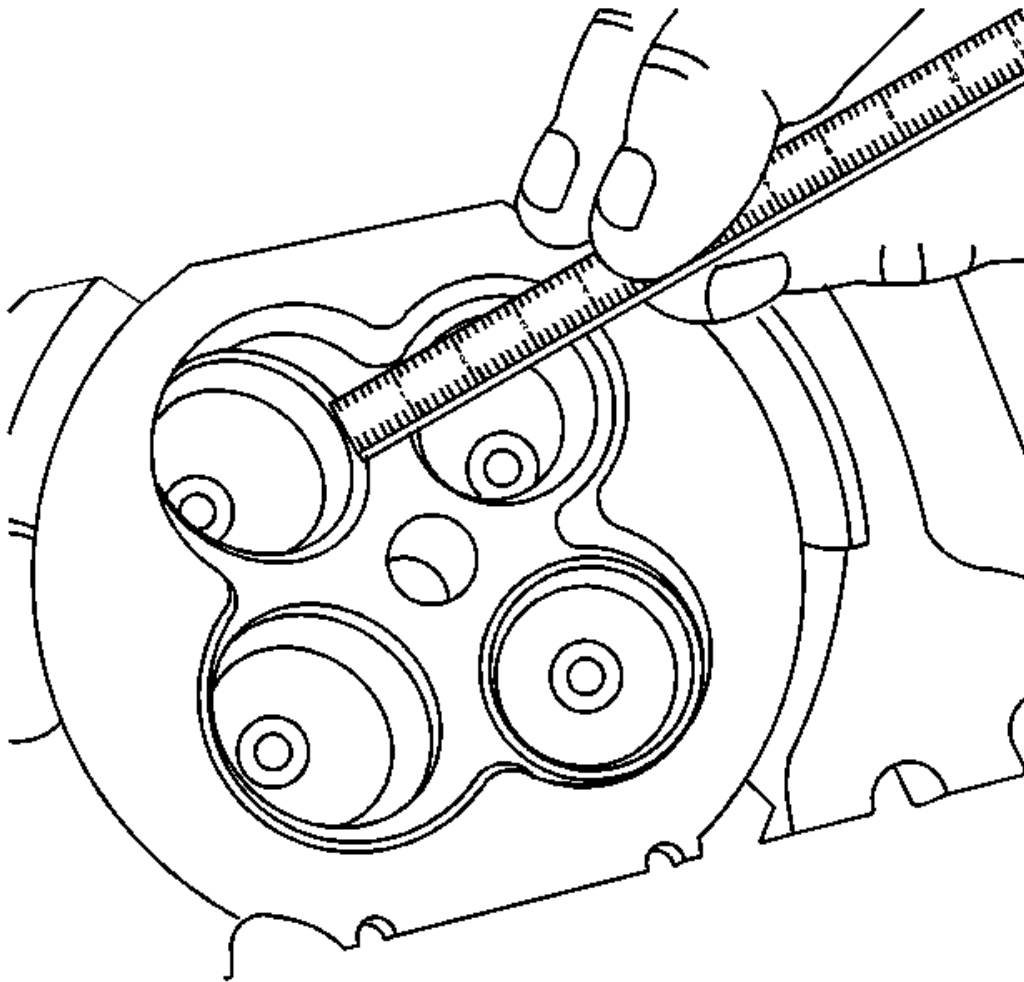


Fig. 136: Checking Valve Seat Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve seat width in the cylinder head using a proper scale.

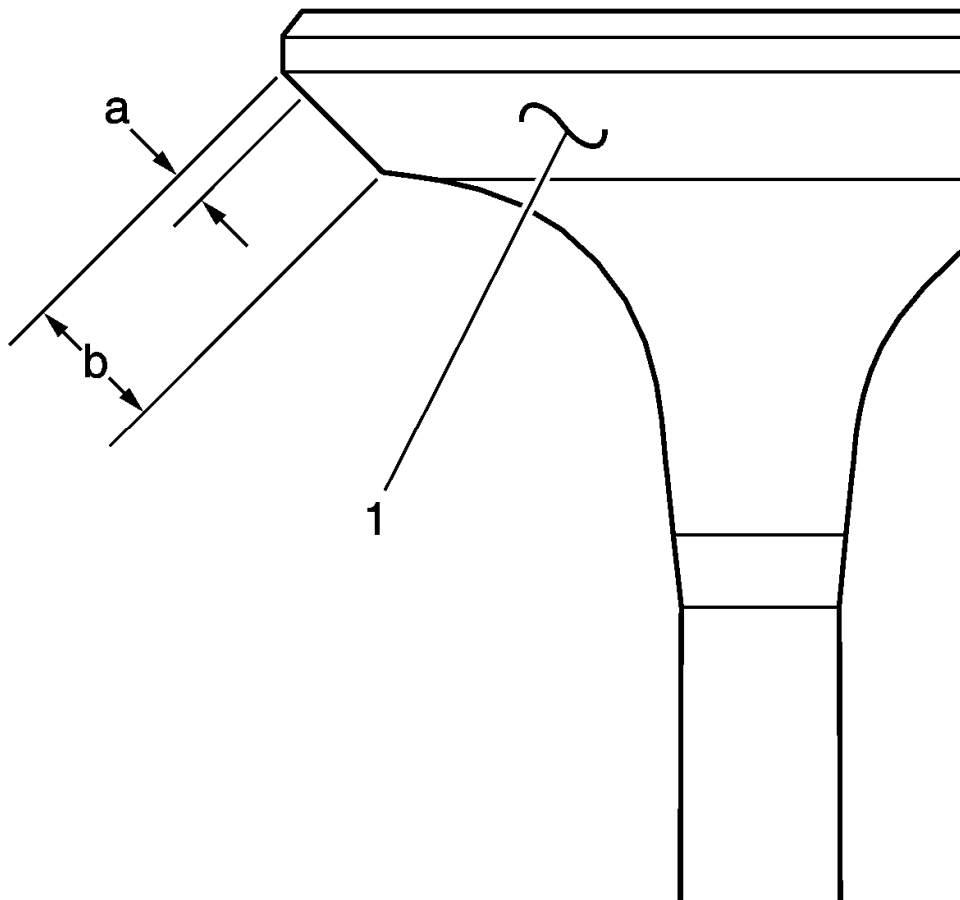


Fig. 137: Valve Face Seat width

Courtesy of GENERAL MOTORS COMPANY

2. Measure the seat width (b) on the valve face (1) using a proper scale.

NOTE: The seat contact area must be at least 0.5 mm (0.020 in) from the outer diameter, margin (a), of the valve. If the contact area is too close to the margins, the seat must be reconditioned to move the contact area away from the margin.

3. Compare your measurements with the specifications listed in Engine Mechanical Specifications (LEA, or LUK).
4. If the seat widths are acceptable, check the valve seat roundness using the Valve Seat Roundness Measurement Procedure.
5. If the seat width is not acceptable, you must grind the valve seat using the Valve and Seat Reconditioning Procedure to bring the width back into specification. Proper valve seat width is critical to providing the correct amount of valve heat dissipation.

Valve Seat Roundness Measurement Procedure

1. Measure the valve seat roundness using a dial indicator attached to a tapered pilot installed in the guide. The pilot should have a slight bind when installed in the guide.

CAUTION: The correct size pilot must be used. Do not use adjustable diameter pilots. Adjustable pilots may damage the valve guides.

2. Compare your measurements with the specifications listed in Engine Mechanical Specifications (LEA, or LUK).
3. If the valve seat exceeds the roundness specification, you must grind the valve and valve seat using the Valve and Seat Reconditioning Procedure.
4. If new valves are being used, the valve seat roundness must be within 0.05 mm (0.002 in).

Valve Head O.D. and Chamfer Measurement Procedure

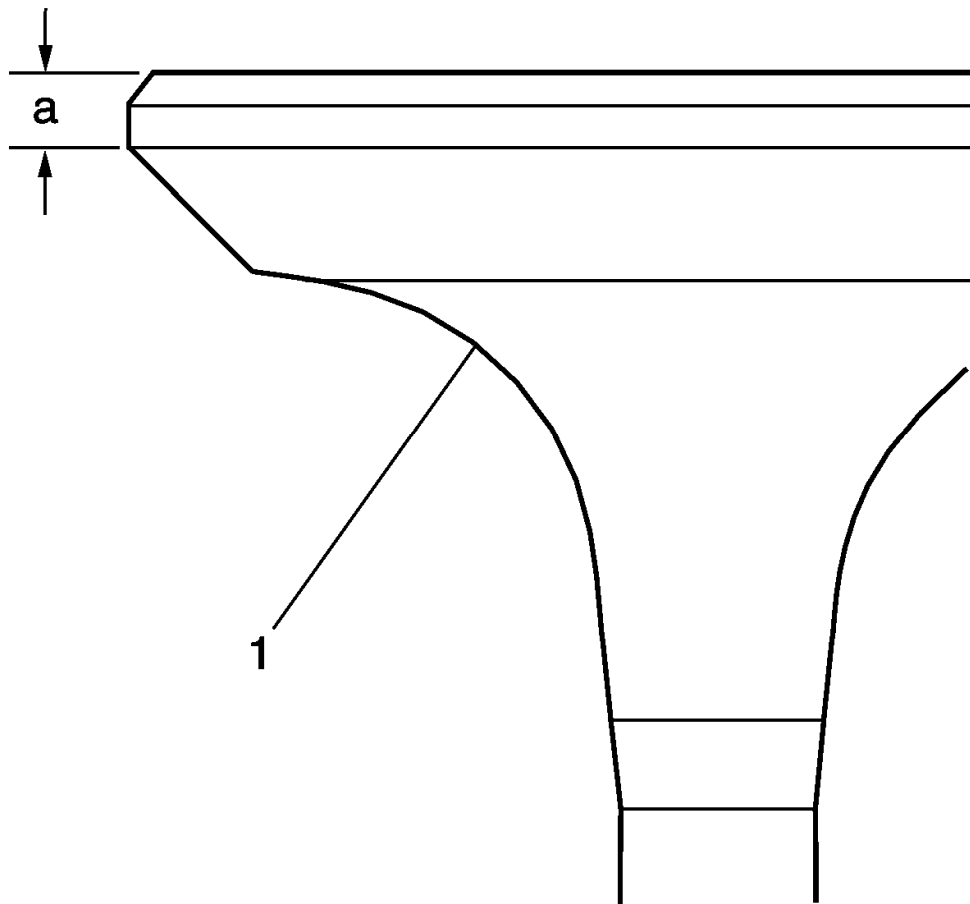


Fig. 138: View Of Valve Head O.D. & Chamfer
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve head O.D. and chamfer (a) using an appropriate scale. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .
2. If the valve head O.D. and chamfer is within specification, test the valve (1) for seat concentricity using the Valve-to-Seat Concentricity Measurement Procedure. Reinspect the valve head O.D. and chamfer after completing the concentricity measurement if valve seat reconditioning is performed.

Valve-to-Seat Concentricity Measurement Procedure

NOTE:

- Checking the valve-to-seat concentricity determines whether the valve and seat are sealing properly.
- You must measure the valve face and the valve seat to ensure proper valve sealing.

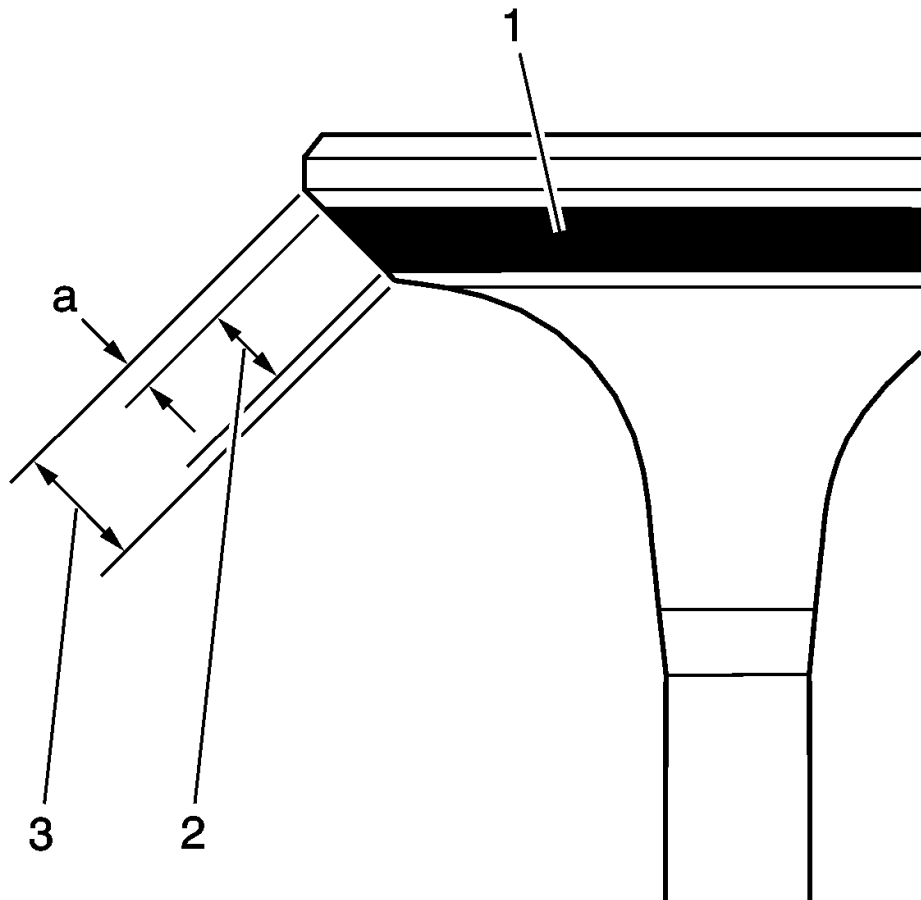


Fig. 139: Inspecting Valve Face
Courtesy of GENERAL MOTORS COMPANY

1. Coat the valve face (3) lightly with blue dye (1).
2. Install the valve in the cylinder head.

3. Turn the valve against the seat with enough pressure to wear off the dye.
4. Remove the valve from the cylinder head.
5. Inspect the valve face.
 - If the valve face is concentric, providing a proper seal, with the valve stem, a continuous mark (2) will be made around the entire face.

NOTE: **The wear mark MUST be at least 0.5 mm (0.020 in) from the outer diameter, the margin (a), of the valve. If the wear mark is too close to the margin, the seat must be reconditioned to move the contact area away from the margin.**

NOTE: **Do not grind or condition the intake valve. If the intake valve is out of specification, replace the valve.**

- If the face is not concentric with the stem, the mark will NOT be continuous around the valve face. The valve should be refaced or replaced and the seat must be reconditioned using the Valve and Seat Reconditioning Procedure.

Valve and Seat Reconditioning Procedure

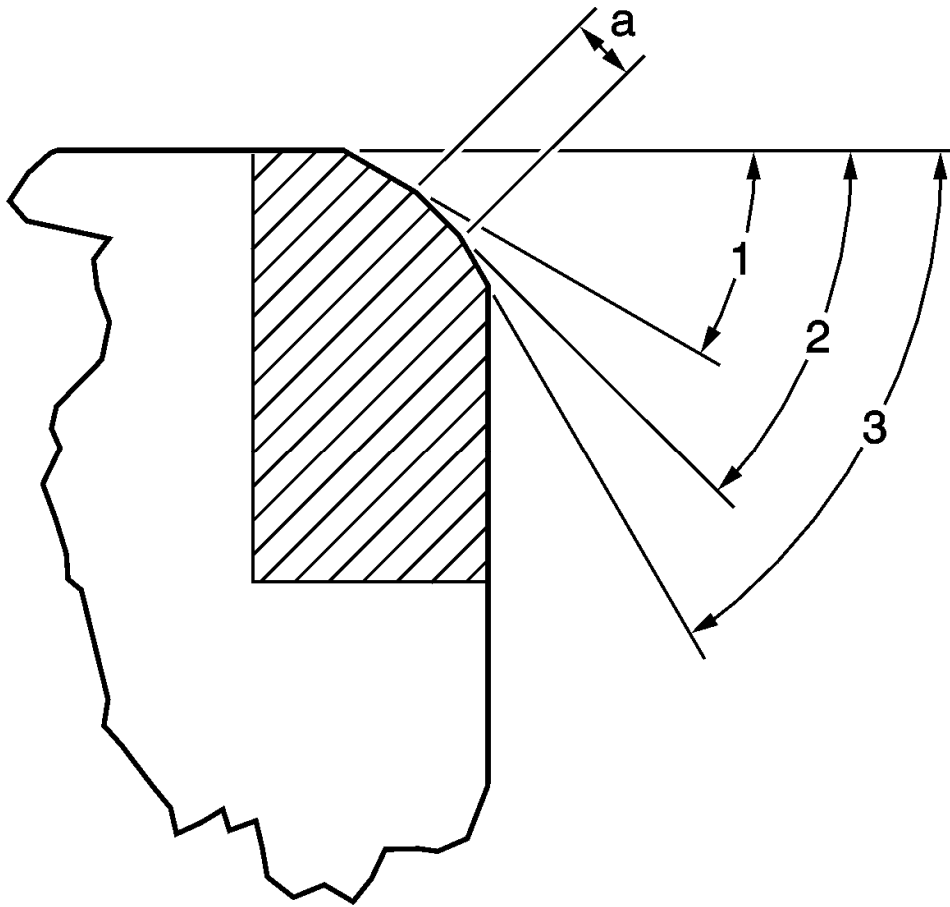


Fig. 140: Valve Seating Surface Angle
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- If the valve seat width, roundness or concentricity is beyond specifications, you must grind the seats in order to ensure proper heat dissipation and prevent the build up of carbon on the seats.
- It is necessary to reface the valve if seat reconditioning is required unless a new valve is used.

1. Grind the valve seating surface (a) to the proper angle specification (2) listed in **Engine Mechanical Specifications (LEA, or LUK)** .
2. Grind the valve relief surface to the proper angle specification (1) listed in **Engine Mechanical Specifications (LEA, or LUK)** , to correctly position the valve seating surface (a) to the valve.
3. Grind the valve undercut surface to the proper angle specification (3) listed in **Engine Mechanical Specifications (LEA, or LUK)** , to narrow the valve seating surface width (a) to the specifications listed in **Engine Mechanical Specifications (LEA, or LUK)** .

NOTE: **Do not grind or condition the intake valve. If the intake valve seat has been reconditioned, replace the corresponding intake valve.**

4. Replace the intake valve if it is out of specification. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .
5. If the original exhaust valve is being used, grind the valve to the specifications listed in **Engine Mechanical Specifications (LEA, or LUK)** . Measure the valve head O.D. and chamfer again after grinding using the Valve Head O.D. and Chamfer Measurement Procedure. Replace the exhaust valve if it is out of specification. New valves do not require grinding.
6. When grinding the valves and seats, grind off as little material as possible. Cutting valve seat results in lowering the valve spring pressure.
7. Install the valve in the cylinder head.
 - If you are using refaced exhaust valves, lap the valves into the seats with a fine grinding compound. The refacing and reseating operations should leave the refinished surfaces smooth and true so that minimal lapping is required. Excessive lapping will groove the valve face and prevent a good seat when hot.
 - Be sure to clean any remaining lapping compound from the valve and seat with solvent and compressed air prior to final assembly.
8. After obtaining the proper valve seat width in the cylinder head, you must re-measure the valve stem height using the Valve Stem Height Measurement Procedure.
9. If the valve stem height is acceptable, test the seats for concentricity using the Valve-to-Seat Concentricity Measurement Procedure.

Valve Stem Height Measurement Procedure

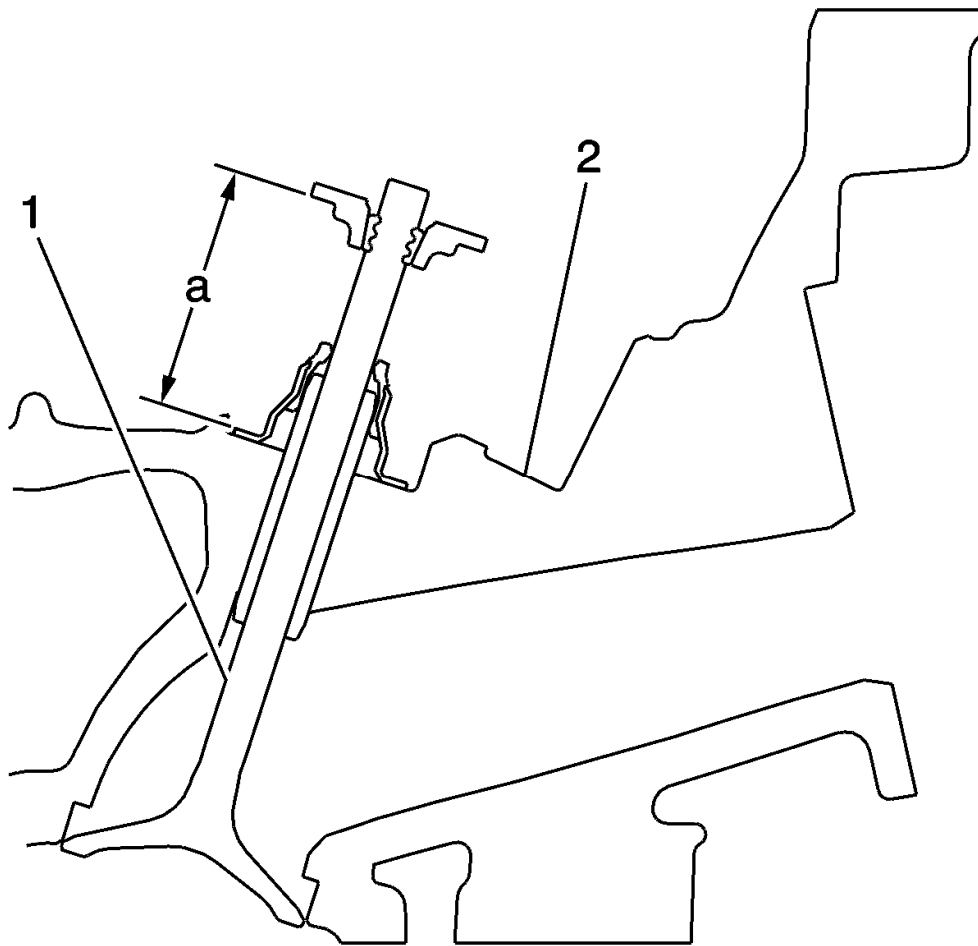


Fig. 141: Valve Stem Height Measurement
Courtesy of GENERAL MOTORS COMPANY

NOTE: To determine the valve stem height measurement, measure from the valve spring seat to the valve spring retainer.

1. Install the valve (1) into the valve guide in the cylinder head (2).
2. Ensure the valve is seated to the cylinder head valve seat.
3. Install the valve stem oil seal.
4. Install the valve spring retainer and valve stem locks.
5. Measure the distance (a) between the valve seal lip to the bottom of the valve spring retainer. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .
6. If the maximum height specification is exceeded, a new valve should be installed and the valve stem height re-measured.

CAUTION: DO NOT grind the valve stem tip. The tip of the valve is hardened and grinding the tip will eliminate the hardened surface causing

premature wear and possible engine damage.

CAUTION: DO NOT use shims in order to adjust valve stem height. The use of shims will cause the valve spring to bottom out before the camshaft lobe is at peak lift and engine damage could result.

7. If the valve stem height still exceeds the maximum height specification, the cylinder head must be replaced.

CYLINDER HEAD ASSEMBLY (LEA, OR LUK)

Special Tools

- **EN-8062** Valve Spring Compressor
- **EN-9666** Valve Spring Tester
- **EN-43963** Valve Spring Compressor (off car)

For equivalent regional tools, refer to **Special Tools** .

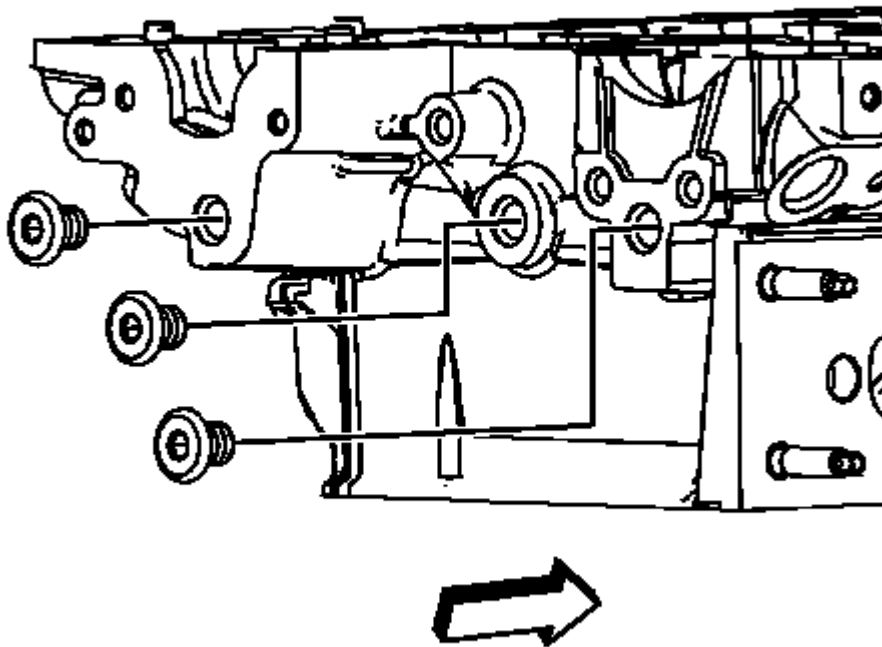


Fig. 142: Cylinder Head Plugs
Courtesy of GENERAL MOTORS COMPANY

CAUTION: In order to avoid damage, install the spark plugs after the cylinder head has been installed on the engine.

CAUTION: Refer to Component Fastener Tightening Caution .

1. Install NEW cylinder head plugs. Coat the plugs with sealer. Refer to Adhesives, Fluids, Lubricants, and Sealers .
2. Inspect the valve springs for the following conditions:
 - Expanded height
 - Unparallel spring ends
 - Spring tension using **EN-9666** tester
 - Any distorted springs should be replaced

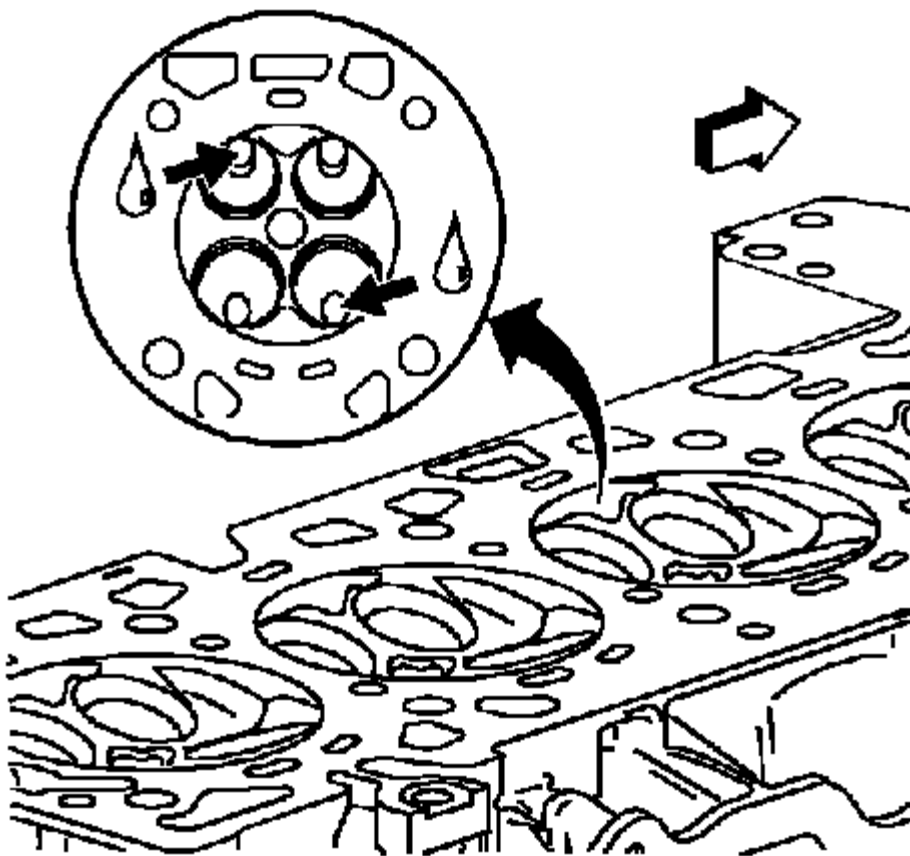


Fig. 143: Applying Prussian Blue
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the valves and the valve seats. Refer to Valve and Seat Grinding.

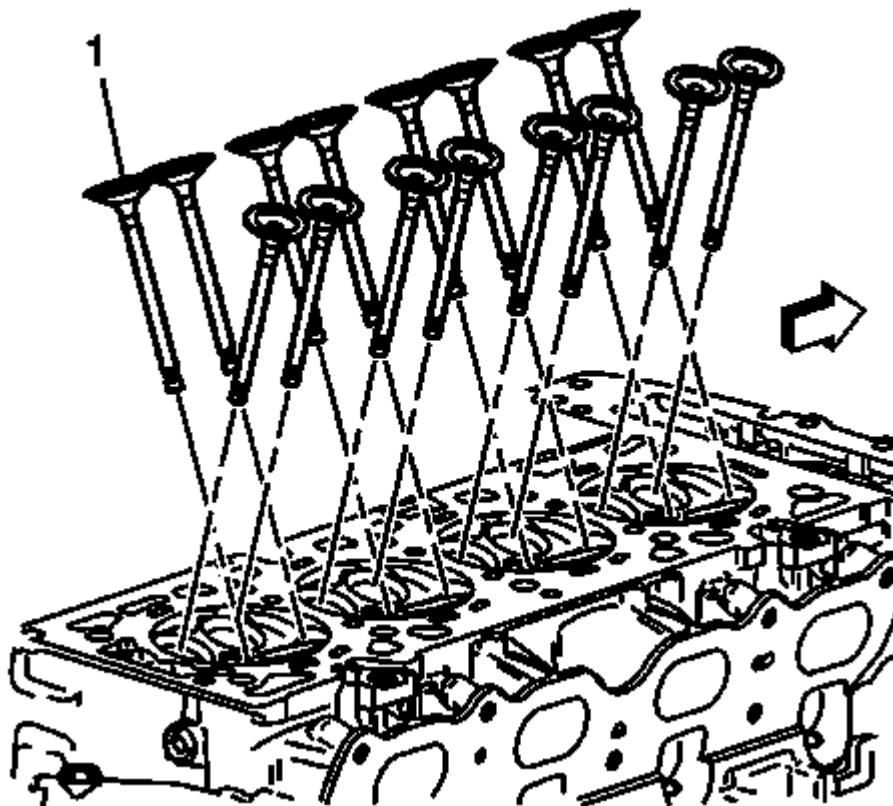


Fig. 144: View of Valves

Courtesy of GENERAL MOTORS COMPANY

4. Install the valves (1). Replace the valves, if required.

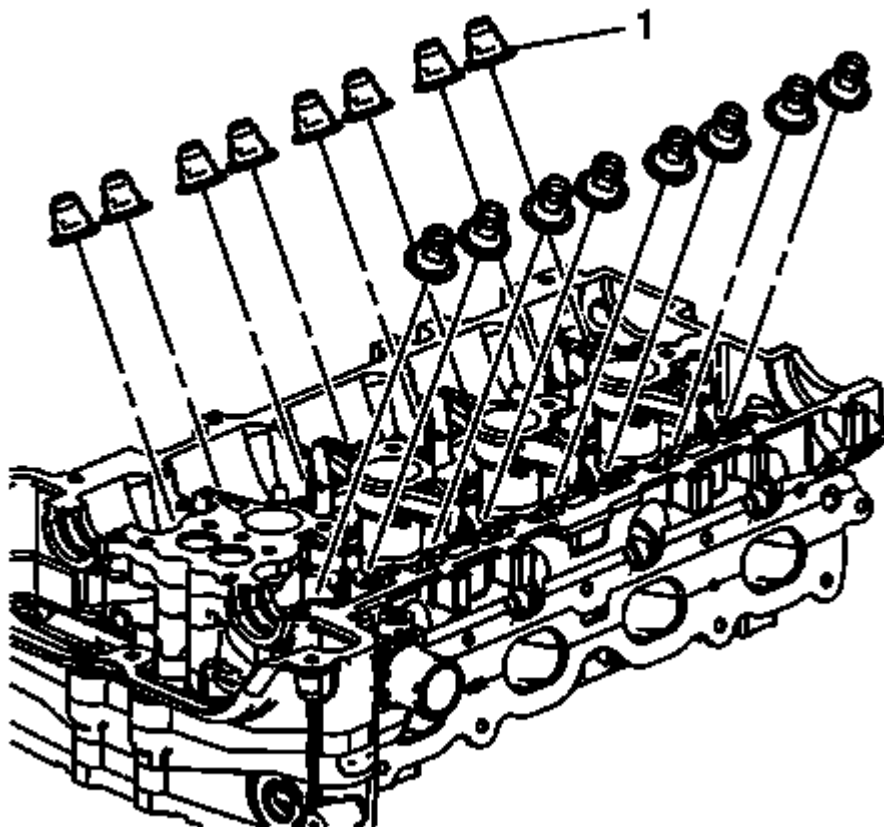


Fig. 145: View of Valve Seals

Courtesy of GENERAL MOTORS COMPANY

NOTE: Always use NEW valve stem oil seals when assembling the cylinder head.

5. Install the NEW valve seals (1). Fully seat the seals on the valve guides.

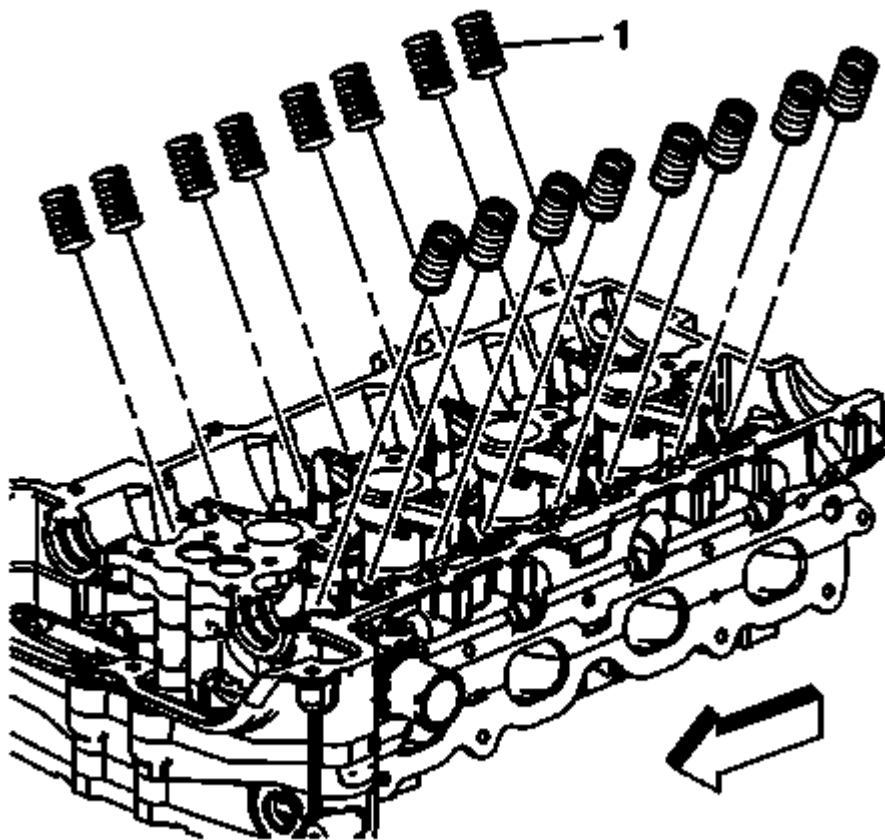


Fig. 146: View of Valve Springs
Courtesy of GENERAL MOTORS COMPANY

6. Install the springs (1).

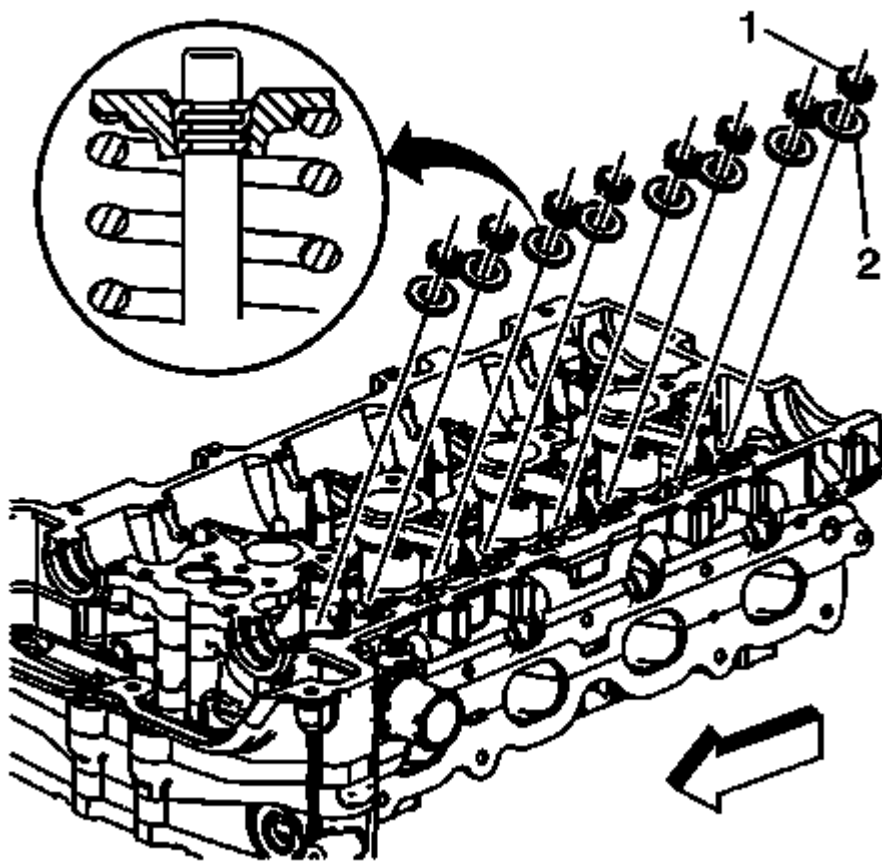


Fig. 147: View of Valve Keys and Retainer
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

7. Install the retainers and keys using the following procedure:
 1. Install the retainer (2).
 2. Using the **EN-8062** compressor and the **EN-43963** compressor , compress the valve spring.
 3. Install the valve keys (1).

4. Slowly release the **EN-8062** compressor and the **EN-43963** compressor (off car) from the valve/spring assembly.
5. Inspect for proper valve key seating.

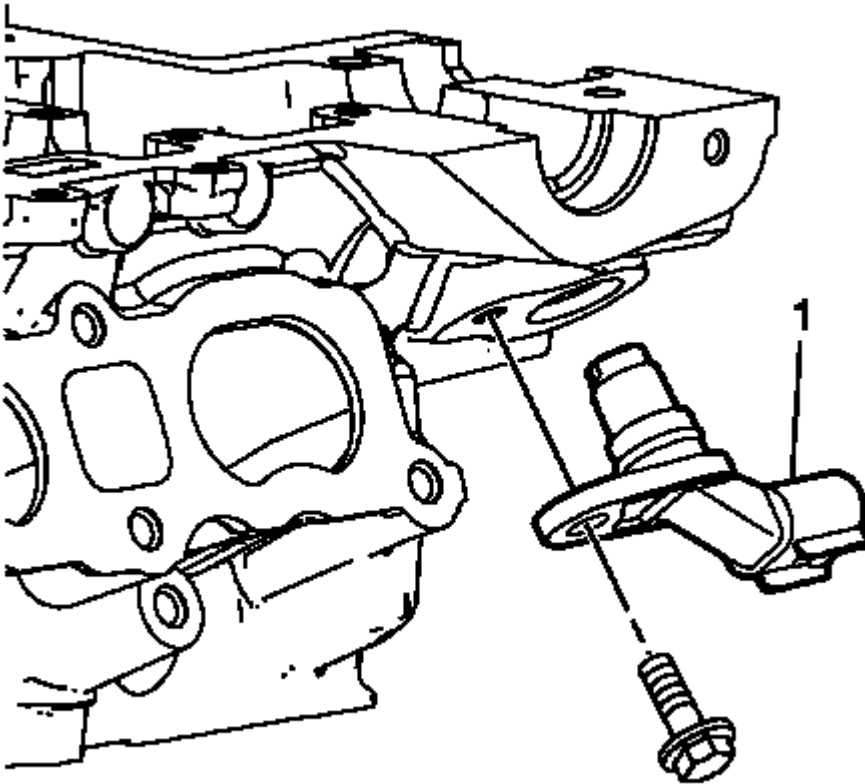


Fig. 148: Intake Camshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

8. Lubricate the camshaft position sensor O-ring with clean engine oil.

CAUTION: Refer to Fastener Caution .

9. Install the intake camshaft position sensor (1) and bolt. Tighten the bolt to 10 N.m (89 lb in).

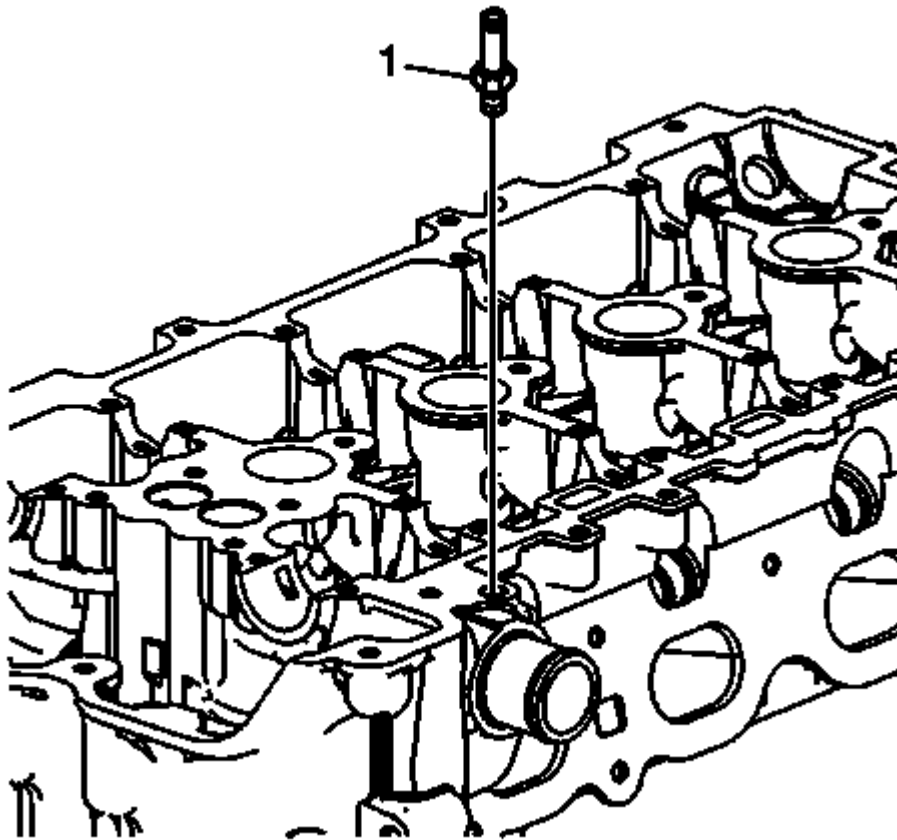


Fig. 149: Identifying the Coolant Air Bleed Hose Fitting
Courtesy of GENERAL MOTORS COMPANY

10. Install the cylinder head air bleed tube (1) and tighten the tube to 15 N.m (11 lb ft).

OIL PUMP DISASSEMBLE

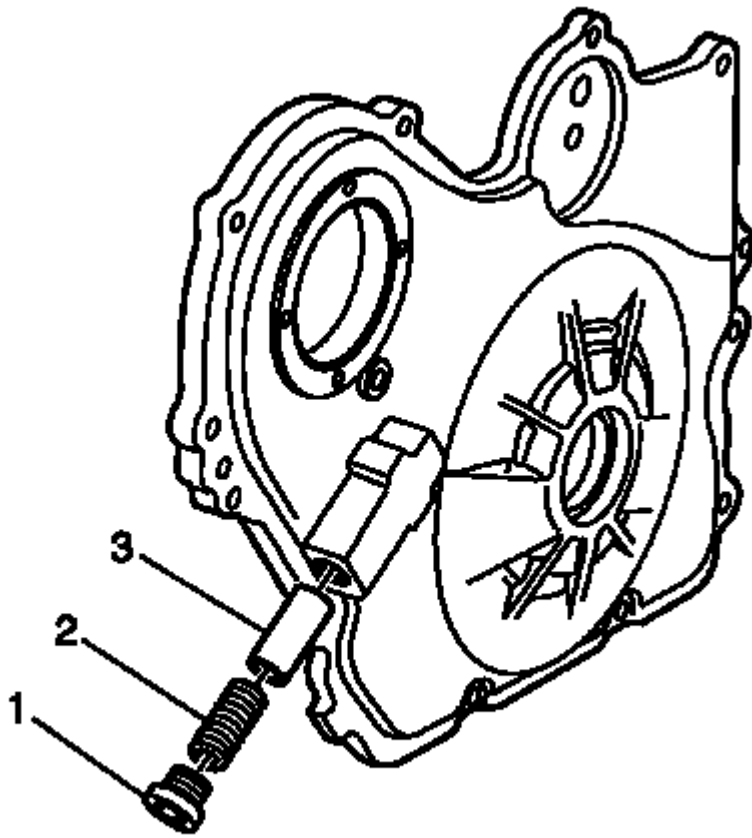


Fig. 150: Pressure Relief Valve
Courtesy of GENERAL MOTORS COMPANY

1. Remove the pressure relief plug (1), spring (2), and plunger (3).

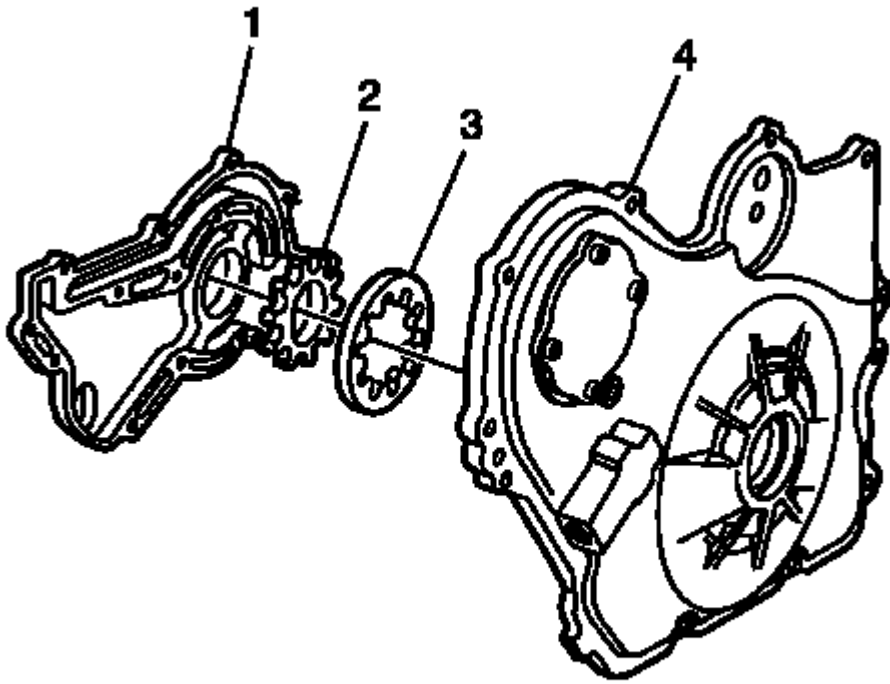


Fig. 151: Oil Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pump gerotor cover (1) and bolts.
3. Clean all of the parts in cleaning solvent. Remove varnish, sludge and dirt.
4. Inspect the oil pump (2, 3) for wear and scoring. Ensure that all components are within specifications. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .

Replace the front cover (4) and oil pump assembly if it is out of specification or damaged.

OIL PUMP ASSEMBLE

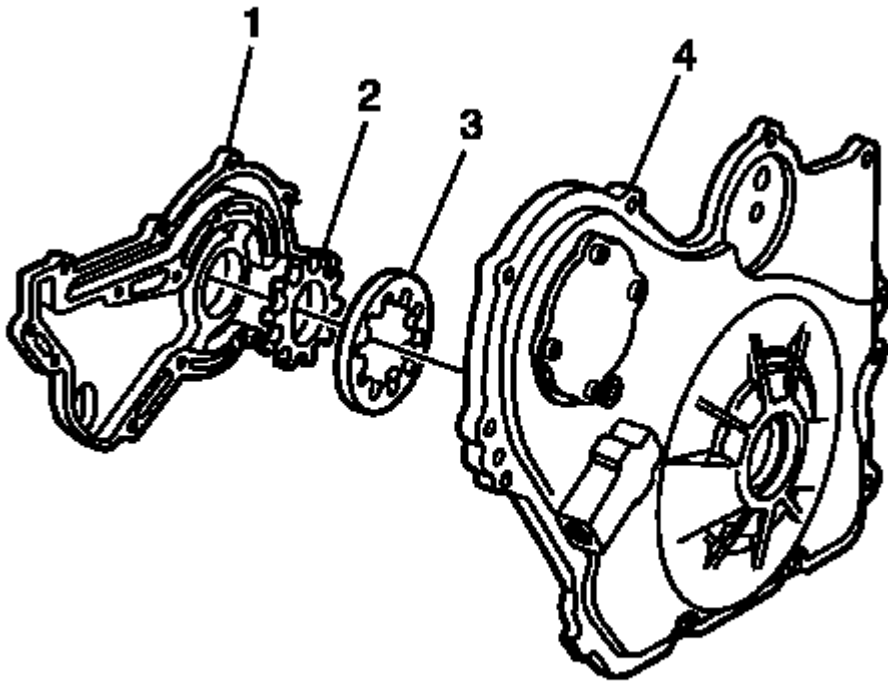


Fig. 152: Oil Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate all oil pump parts with engine oil.
2. Install the inner gear (2) into the outer gear (3).

NOTE: If gears are improperly installed in the front cover, the gerotor cover will not bolt on.

3. Install the gears together into the front cover (4) with the hub of the center gear facing the front cover.

CAUTION: Refer to Fastener Caution .

4. Install the oil pump gerotor cover (1) and bolts and tighten to 6 N.m (53 lb in).

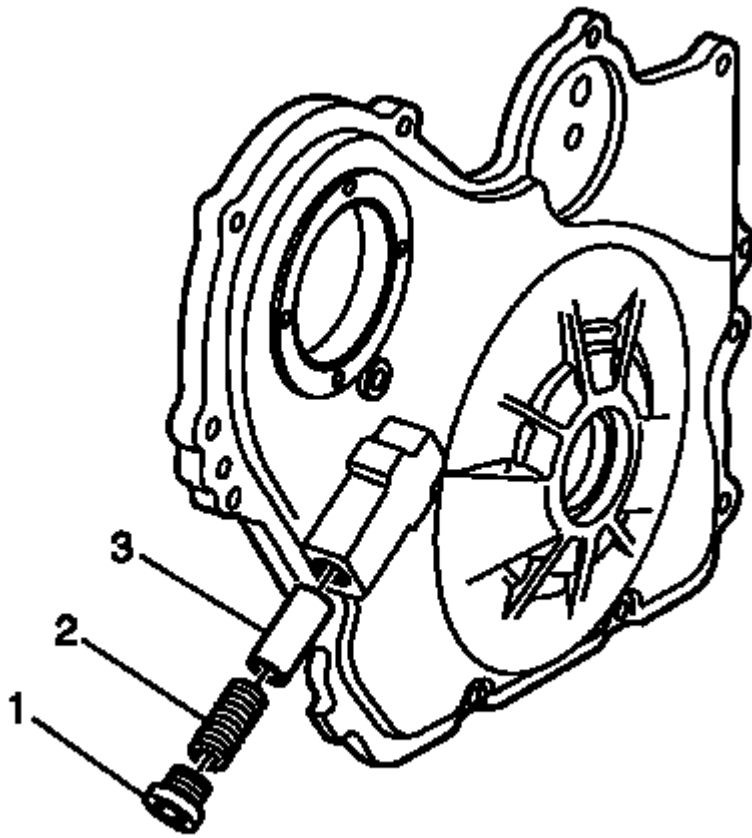


Fig. 153: Pressure Relief Valve
Courtesy of GENERAL MOTORS COMPANY

5. Install the pressure relief valve plunger (3).
6. Install the pressure relief valve spring (2).
7. Install and tighten the pressure relief valve plug (1) to 40 N.m (30 lb ft).

FUEL RAIL AND INJECTORS CLEANING AND INSPECTION (LEA, OR LUK)

Special Tools

- **EN-49245** Fuel Injector Seal Installer and Sizer
- **EN-49247** Injector Retaining Clip Installer

For equivalent regional tools, refer to **Special Tools** .

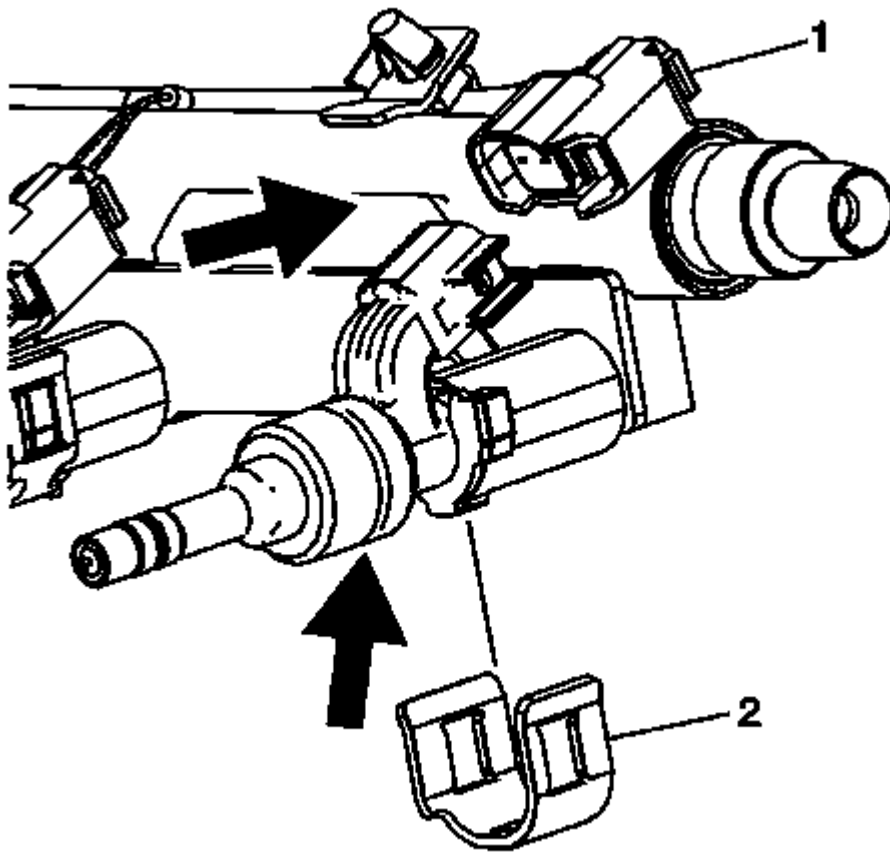


Fig. 154: Fuel Injectors And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the electrical connections from the fuel injectors (1).

NOTE: Support the fuel rail along the bottom, indicated by the arrow. Support the fuel injector at the widest point, indicated by the arrow. DO NOT support or hold the fuel injector by the tip or connector when removing the fuel injector retainer.

2. Remove and discard the fuel injector retainer (2).

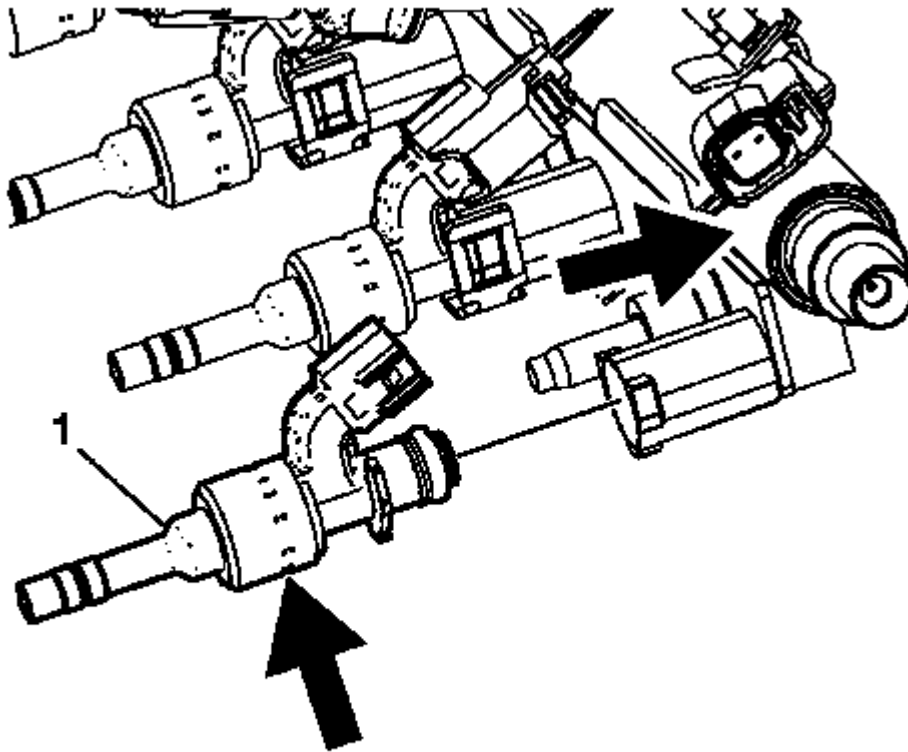


Fig. 155: Supporting Fuel Injector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Support the fuel injector at the widest point, indicated by the arrow.
 Support the fuel rail at the point indicated by the arrow.

- DO NOT support or hold the fuel injector by the tip or connector
- DO NOT tilt or excessively twist the injector during removal

3. Remove the injectors (1) from the fuel rail by pulling straight out along the fuel injector axis. Slight rotation of the fuel injector is acceptable.

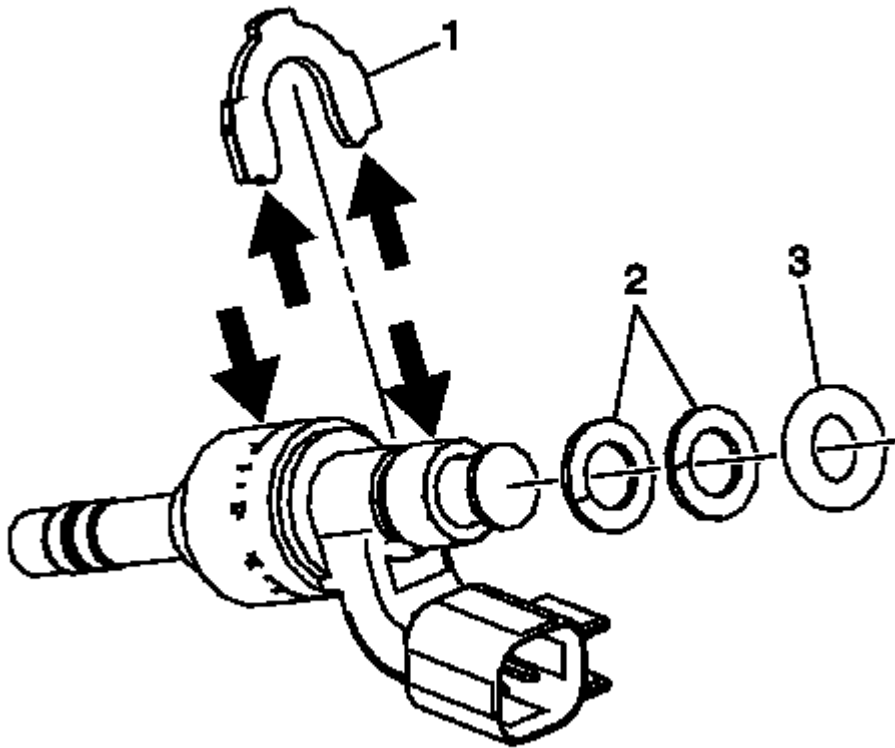


Fig. 156: Fuel Injector Bushing, O-Ring And Spacers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Support the fuel injector at the widest point, and directly behind the bushing location, indicated by the arrows. DO NOT support or hold the fuel injector by the tip or connector when removing the fuel injector bushing.

4. Using a suitable tool, remove the fuel injector bushing (1) by pushing straight off at the bushing tabs, indicated by the arrows. Discard the bushing.
5. Remove and discard the fuel injector O-ring (3) and plastic spacers (2).

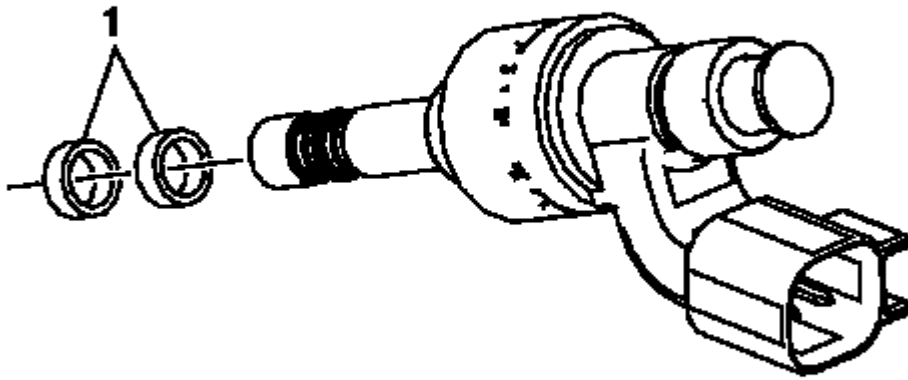


Fig. 157: Fuel Injector Seals

Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the fuel injector seals (1).

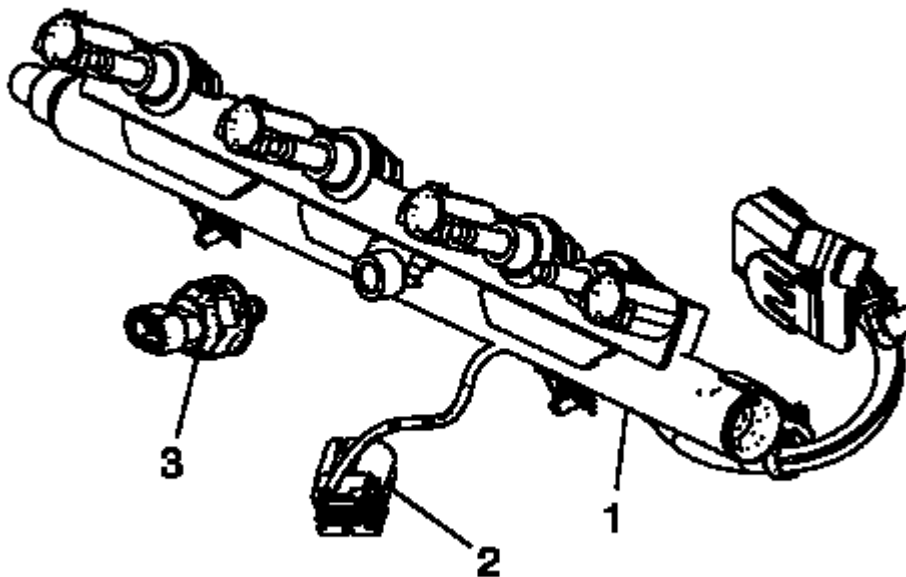


Fig. 158: Fuel Rail, Connector And Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not soak or submerge the fuel rail or injectors in solvent.

7. Clean the exterior of the fuel rail (1) and injectors in solvent.
8. Inspect the fuel rail and components for the following conditions:
 - Damage, debris, or restrictions to the fuel rail
 - Damage, debris, or restrictions to the fuel ports in the fuel rail
 - Damage to the mounting area for the fuel rail
 - Damage to the fuel rail mounting bolts
 - Damage to the threads on the fuel rail fuel feed fitting
9. Replace the fuel rail if any damage is found. Do not attempt to repair a fuel rail.

CAUTION: Refer to **Fastener Caution** .

10. Inspect the fuel pressure sensor (3) for damage.
 1. Disconnect the harness connector (2) from the fuel pressure sensor.

2. Remove the fuel pressure sensor. Dry the fuel pressure sensor bore in the fuel rail with a lint free cloth. The bore should be free of fuel, debris, and burrs.
3. Lubricate the fuel rail fuel pressure sensor bore with clean engine oil.
4. Lubricate the threads and sealing area on the fuel pressure sensor with clean engine oil.
5. Install the fuel pressure sensor hand tight.
6. Remove the fuel pressure sensor and re-lubricate the bore, threads, and sealing area.
7. Install the fuel pressure sensor and tighten to 33 N.m (25 lb ft).
8. Connect the harness connector to the fuel pressure sensor.

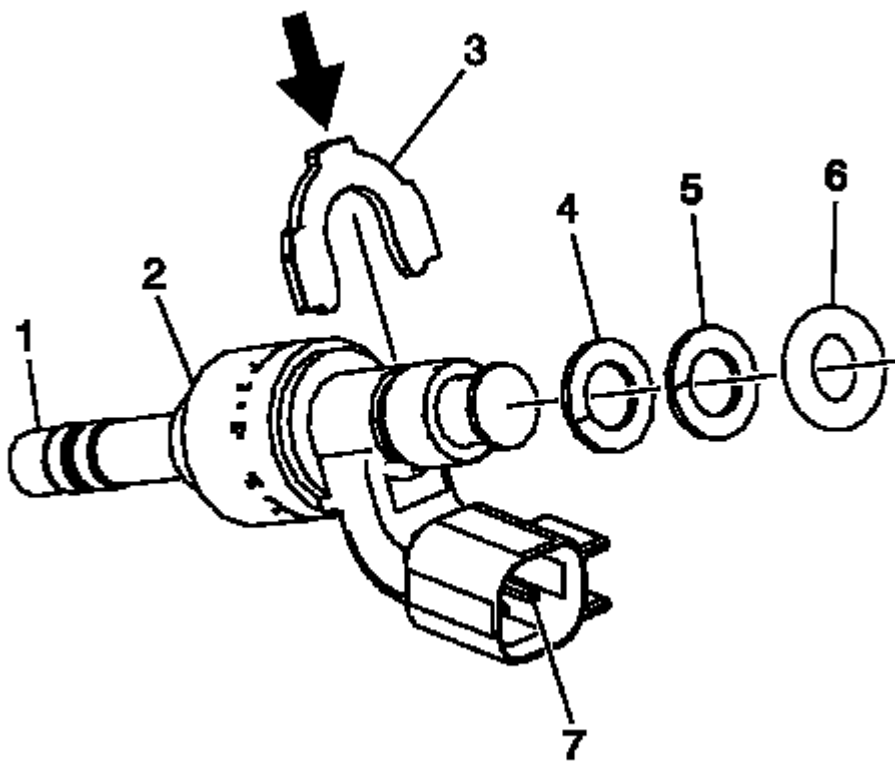


Fig. 159: Fuel Injector Components

Courtesy of GENERAL MOTORS COMPANY

11. Inspect the fuel injectors for the following conditions:
 - Damage to the fuel injector connector (7)
 - Damage to the fuel injector harness connector
 - Damage to the fuel injector tip (1)
 - Damage to the tolerance ring (2)
12. Replace the fuel injector if any damage is found. Do not attempt to repair a fuel injector.

13. Install a new fuel injector bushing (3) onto the fuel injector. The bushing should seat with a distinct "snap" sound and feel.

NOTE: **DO NOT** reverse the order of the plastic spacers. Identify the correct order in which the new plastic spacers are installed by the color of the spacer.

14. Install the new white plastic spacer (4) on the fuel injector first.
15. Install the new brown plastic spacer (5) second.
16. Lubricate the new O-ring (6) with 5W30 engine oil.
17. Install the O-ring on the injector.

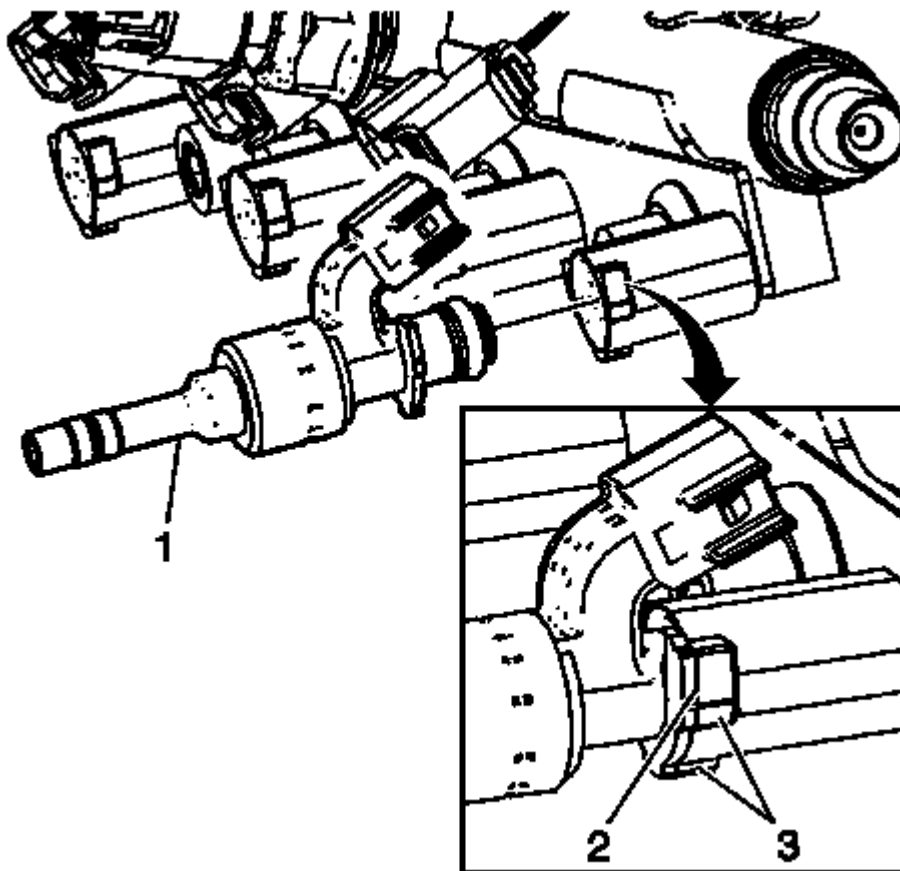


Fig. 160: Fuel Injectors

Courtesy of GENERAL MOTORS COMPANY

NOTE: **The injector must be fully installed and properly aligned with the fuel rail in order to install the retainer.**

18. Install the fuel injectors (1) into the fuel rail.
 - Ensure the fuel injector is fully seated in the fuel rail, and no gaps are present (2).
 - Ensure the injector and fuel rail flanges are aligned (3)

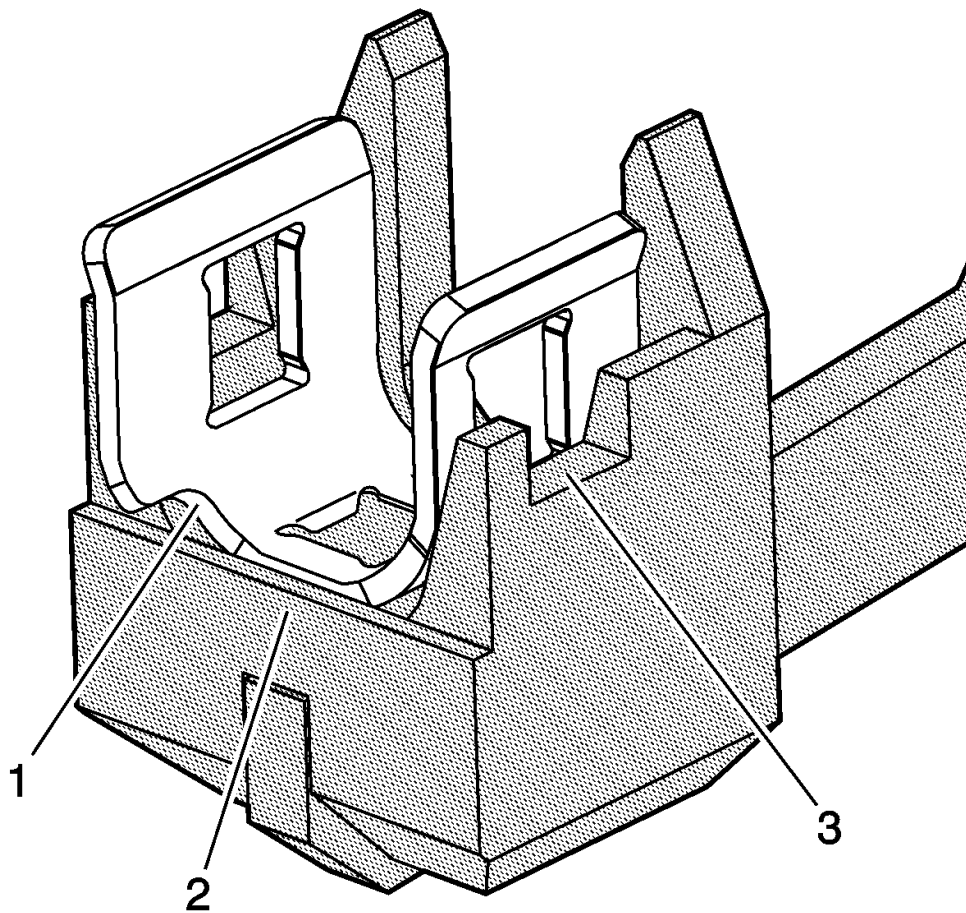


Fig. 161: Retainer Installer

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the retainer is set properly into EN-49247 installer.

- The notch should always face forward (1)
- The retainer should be behind the plate (2)
- The tool windows allow for visual alignment (3)

19. Install the fuel injector retainer onto the **EN-49247** installer.

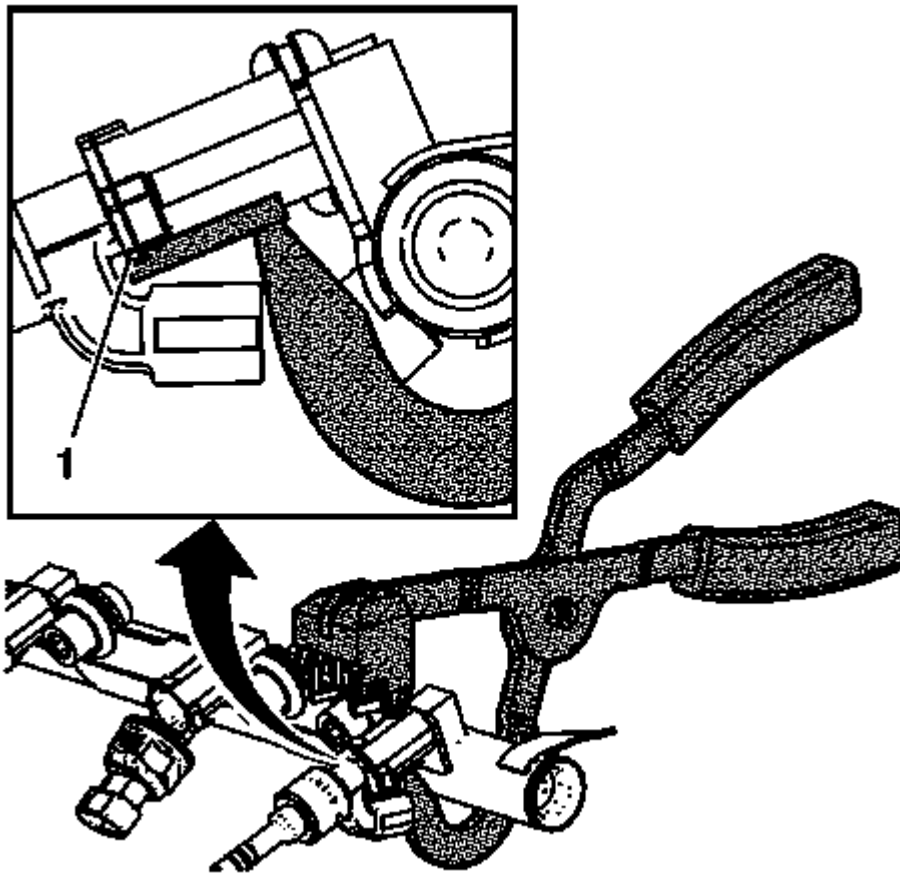


Fig. 162: Installing Fuel Injector Retainer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the tool is resting on the flange of the injector bushing (1).

20. Using **EN-49247** installer , install the fuel injector retainer.

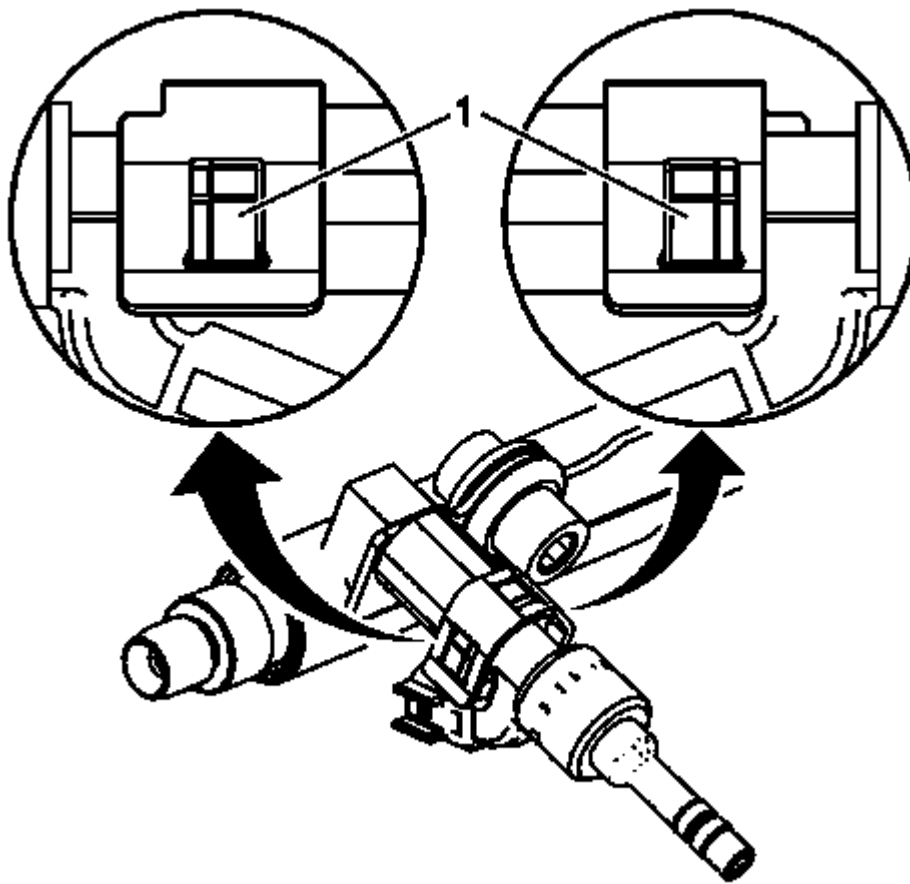


Fig. 163: Proper Injector Retainer Installation
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure the fuel injector retainer is properly installed. Failure to completely install the retainers may degrade fuel injection system performance or cause system malfunction.

21. Inspect each installed fuel injector retainer, and ensure the retainer is fully seated on the fuel rail and fuel injector bushing flanges (1). The flanges on each side and at the top of the fuel injector should seat completely into the window on the retainer.

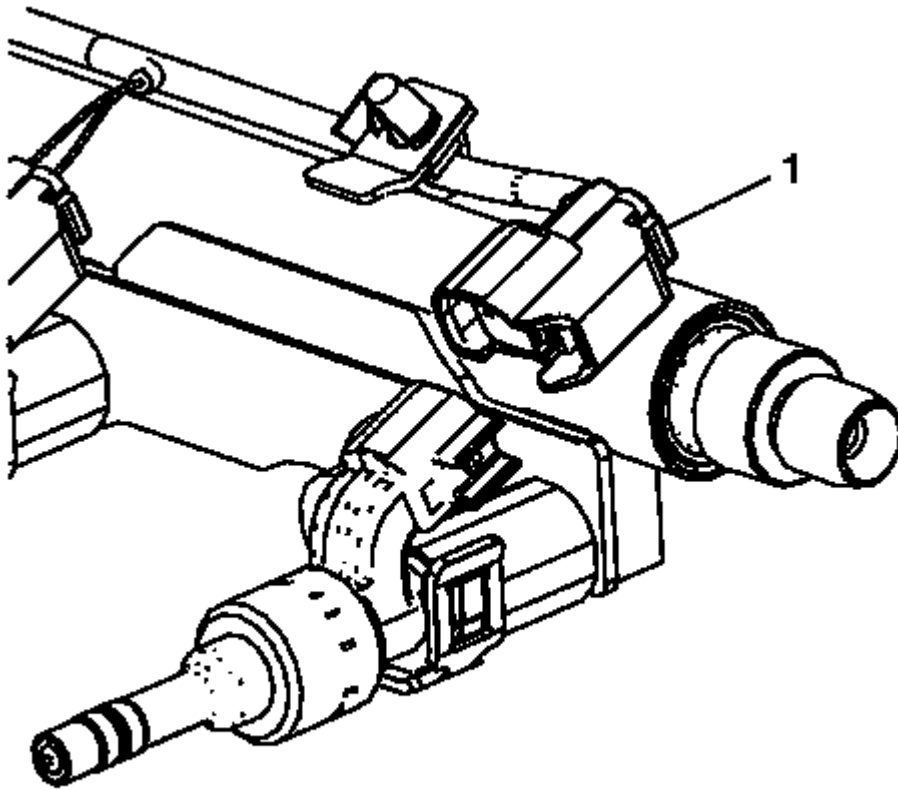


Fig. 164: Fuel Rail Harness Connector
Courtesy of GENERAL MOTORS COMPANY

22. Connect the electrical connection to the fuel rail.
23. Connect the fuel rail harness connectors (1) to the fuel injectors.

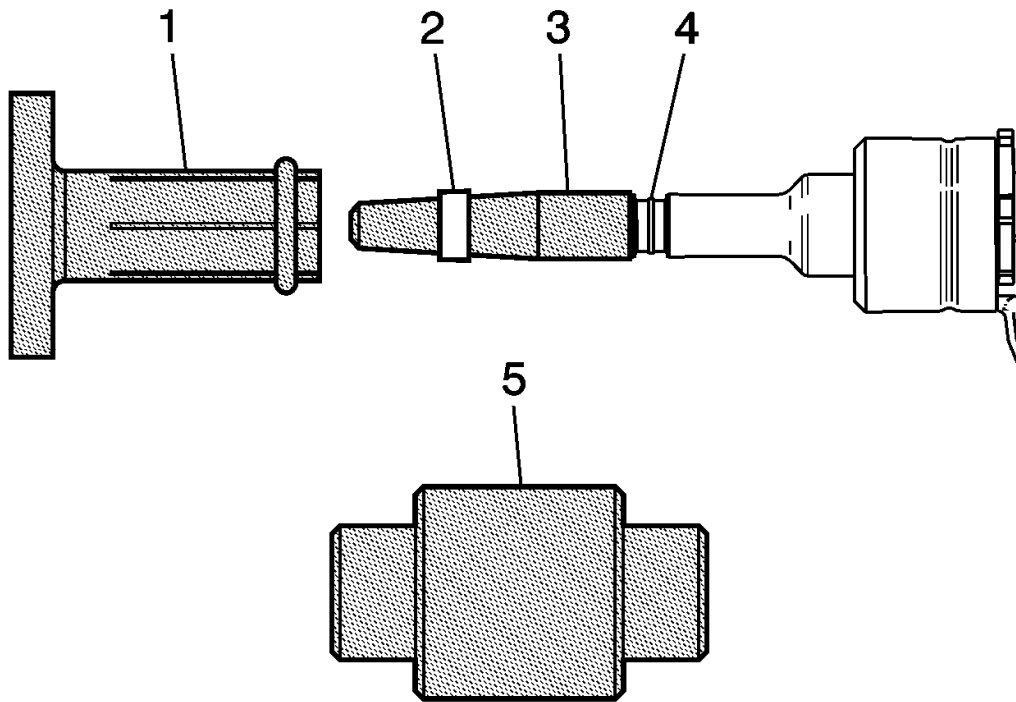


Fig. 165: Installing Seals With Long Protector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any type of lubricant when installing the NEW seals (2) on the fuel injector tip.

24. Install **EN-49245-1** long protector (3) onto the fuel injector tip, covering the first recessed area closest to the tip. Place a NEW seal (2) on **EN-49245-1** long protector.
25. Using **EN-49245-3** pusher (1), install the seal into the second recessed area (4) of the fuel injector.

NOTE: The **EN-49245-4** sizer is two sided, and either direction will size the seal correctly.

26. Compress the seal with your fingers, then resize the seal using the **EN-49245-4** sizer (5).

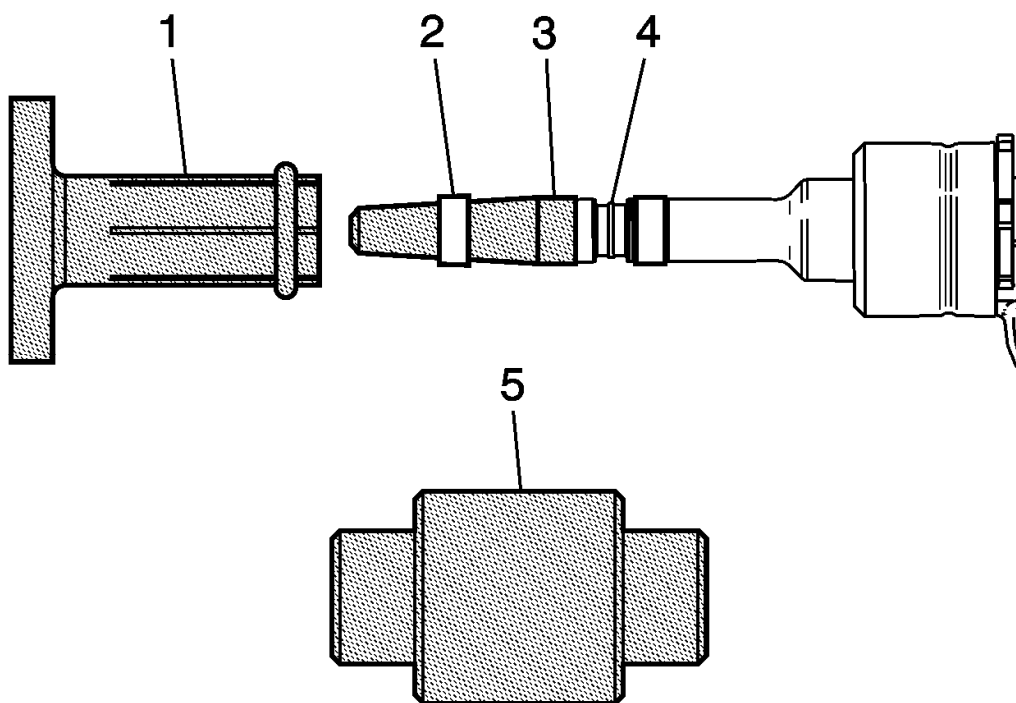


Fig. 166: Installing Seals With Short Protector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any type of lubricant when installing the NEW seals (2) on the fuel injector tip.

27. Install **EN-49245-2** short protector (3) onto the fuel injector tip. Place a NEW seal (2) on **EN-49245-2** short protector.
28. Using **EN-49245-3** pusher (1), install the seal into the first recessed area (4) of the fuel injector.

NOTE: The **EN-49245-4** sizer is two sided, and either direction will size the seal correctly.

29. Compress the seal with your fingers, then resize the seal using the **EN-49245-4** sizer (5).

INTAKE MANIFOLD CLEANING AND INSPECTION (LEA, OR LUK)

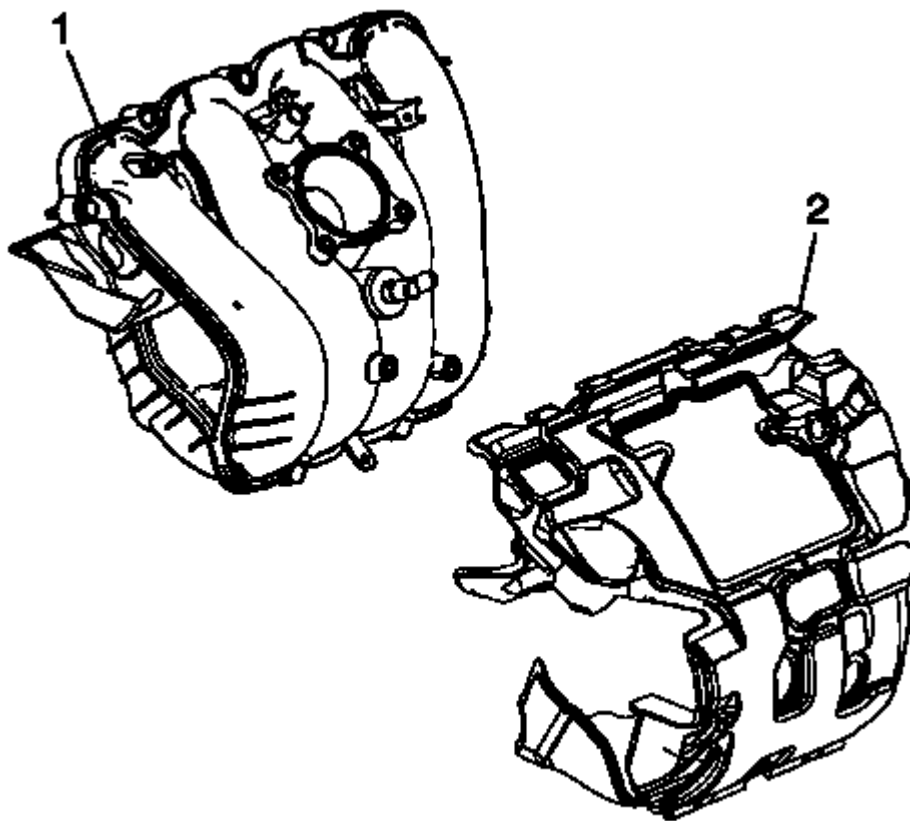


Fig. 167: Intake Manifold And Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

1. Clean the intake manifold (1) mating surfaces.
2. Inspect the intake manifold for damage.
3. Inspect the intake manifold for cracks near metallic inserts.
4. Clean and inspect the intake manifold insulator (2) for damage.

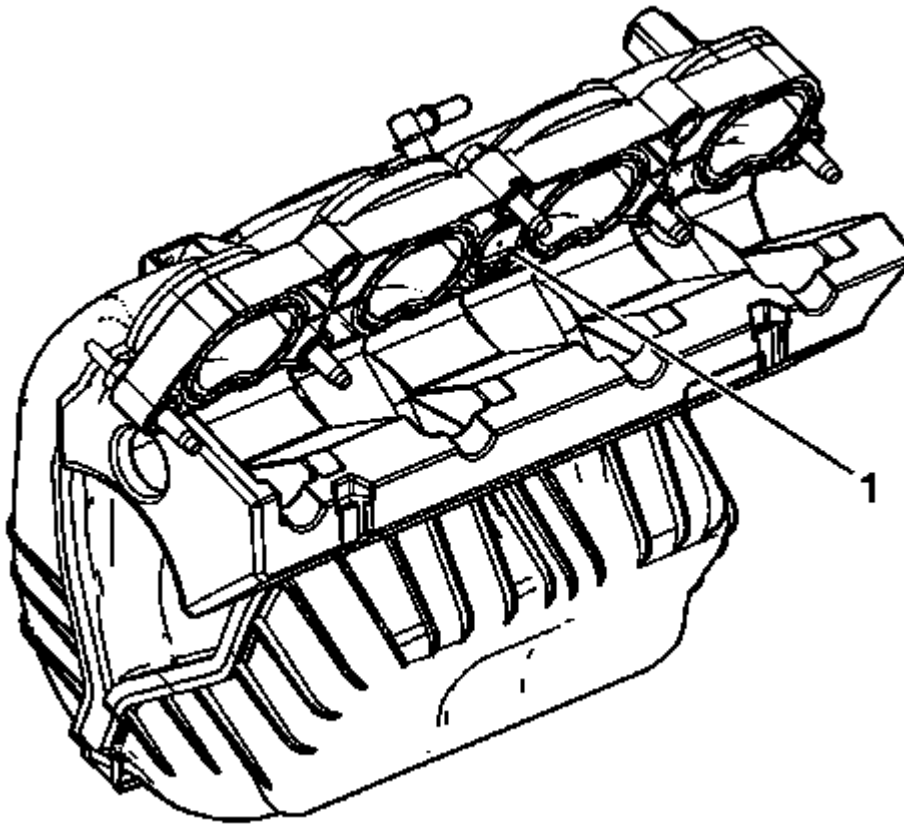


Fig. 168: Crankcase Ventilation Passages
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the crankcase ventilation passages (1) in the intake manifold face for blockage.

WARNING: Refer to Safety Glasses Warning .

6. Clean the crankcase ventilation passages with compressed air if necessary. Use a maximum of 172 kPa (25 psi) of air pressure.
7. Replace the intake manifold as necessary.

EXHAUST MANIFOLD CLEANING AND INSPECTION (LEA, OR LUK)

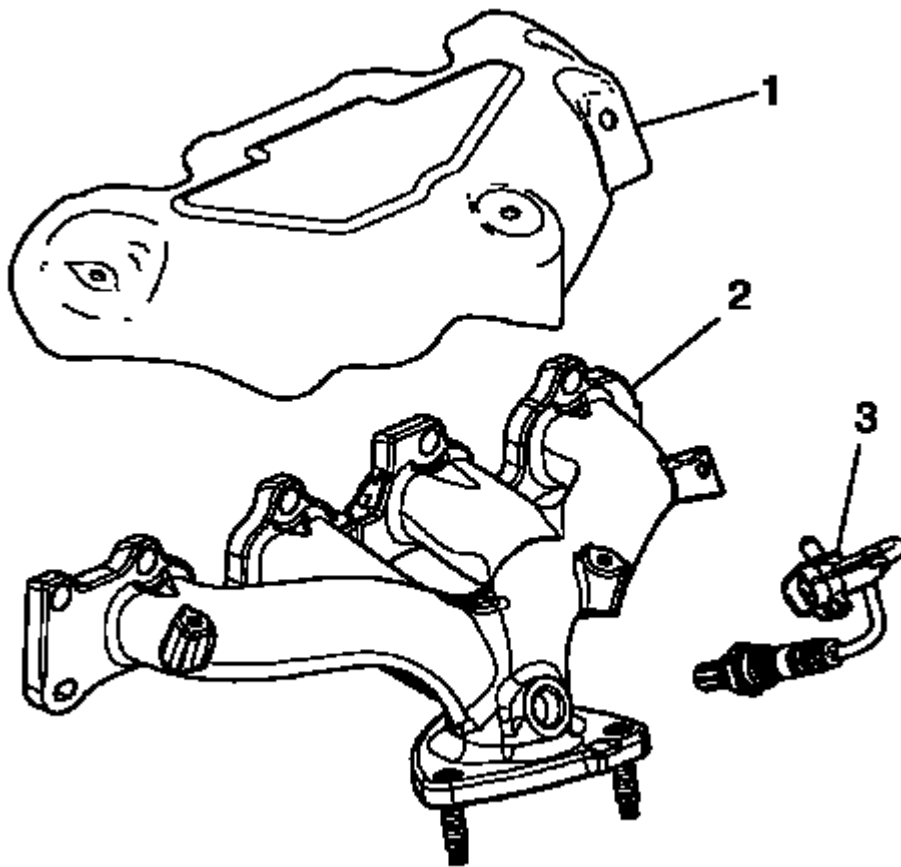


Fig. 169: Exhaust Manifold, Oxygen Sensor And Heat Shield
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Do not reuse the exhaust manifold-to-cylinder head gaskets. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may effect On-Board Diagnostics (OBD) II system performance.
- Remove the oxygen sensor prior to cleaning the manifold. Do not submerge the oxygen sensor in cleaning solvent.

1. Remove the oxygen sensor (3) from the manifold.
2. Clean the exhaust manifold (2) in solvent.

WARNING: Refer to Safety Glasses Warning .

3. Dry the exhaust manifold with compressed air.
4. Inspect the heat shield (1) for damage.

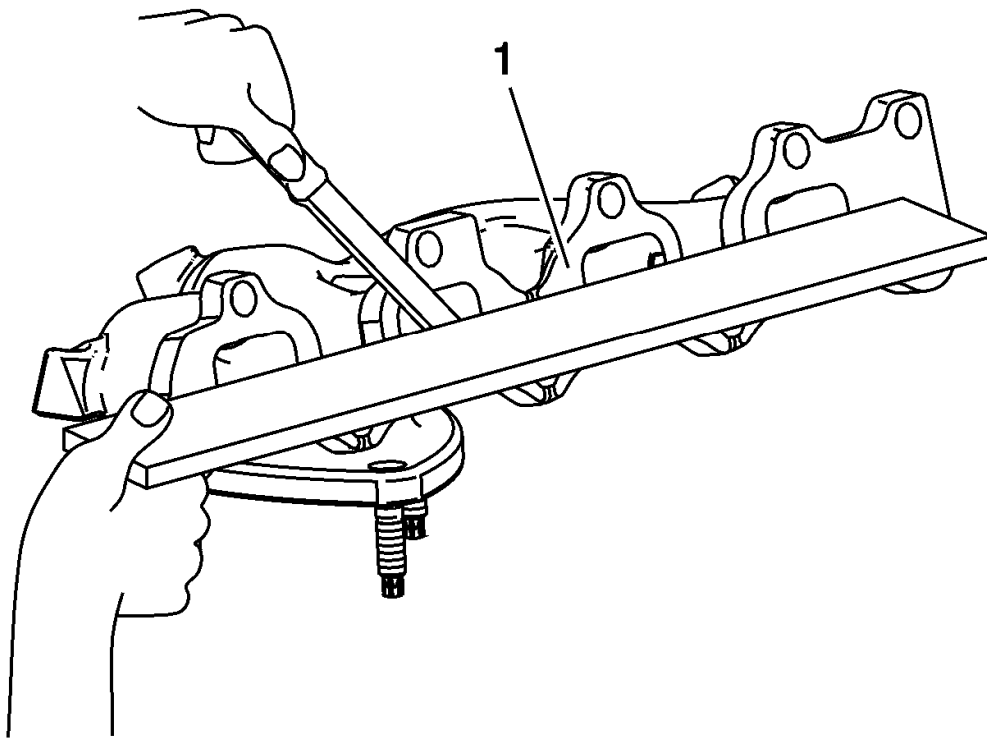


Fig. 170: Measuring Exhaust Manifold Mounting Face
Courtesy of GENERAL MOTORS COMPANY

5. Use a straight edge and a feeler gauge and measure the exhaust manifold mounting face (1) for warpage.

An exhaust manifold face with warpage in excess of 0.25 mm (0.0100 in) may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

OIL PAN CLEANING AND INSPECTION

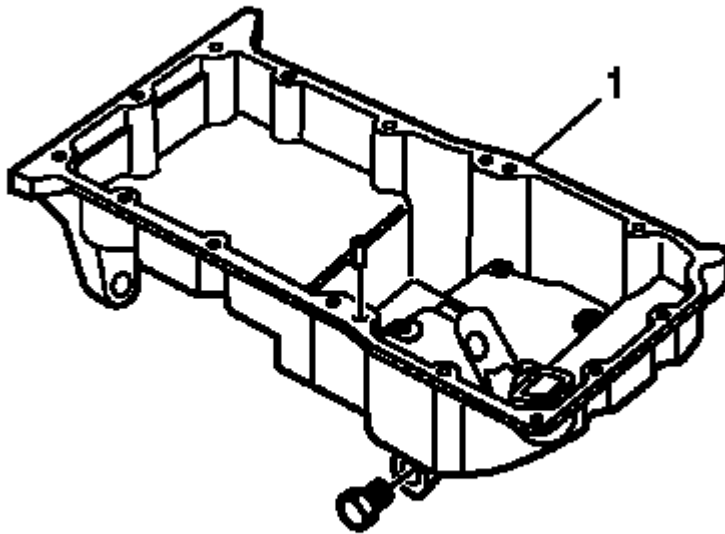


Fig. 171: Oil Pan

Courtesy of GENERAL MOTORS COMPANY

1. Clean the oil pan mating surface.
2. Clean the oil pan (1). Remove all the sludge and the oil deposits.
3. Inspect the threads for the engine oil drain plug.
4. Inspect the oil pan for cracking near the pan rail and the transmission mounting points.
5. Inspect the oil pan for cracking resulting from impact or flying road debris.

NOTE: **The oil pan baffle and pickup screen are not removable from the oil pan.**

6. Inspect the oil pan baffle and pickup screen.
7. Repair or replace the oil pan as necessary.

THREAD REPAIR

Special Tools

EN 42385-850 Thread Repair Kit

For equivalent regional tools, refer to **Special Tools** .

General Thread Repair

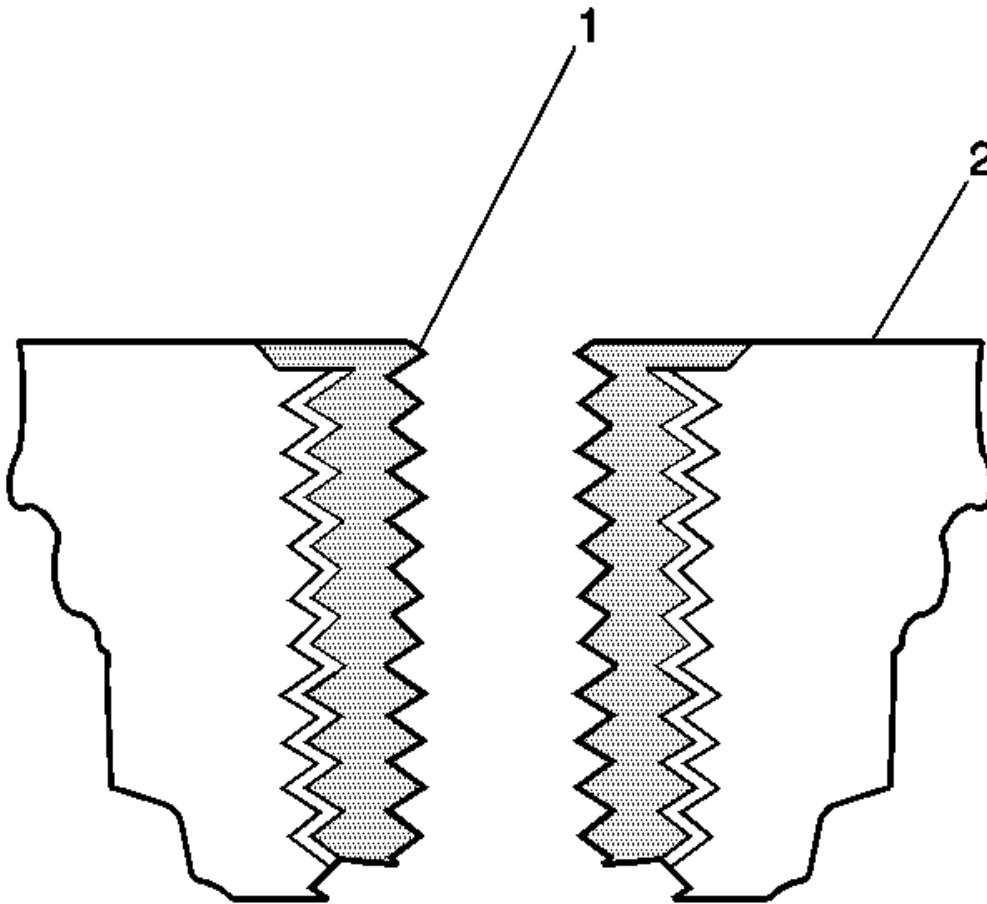


Fig. 172: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.

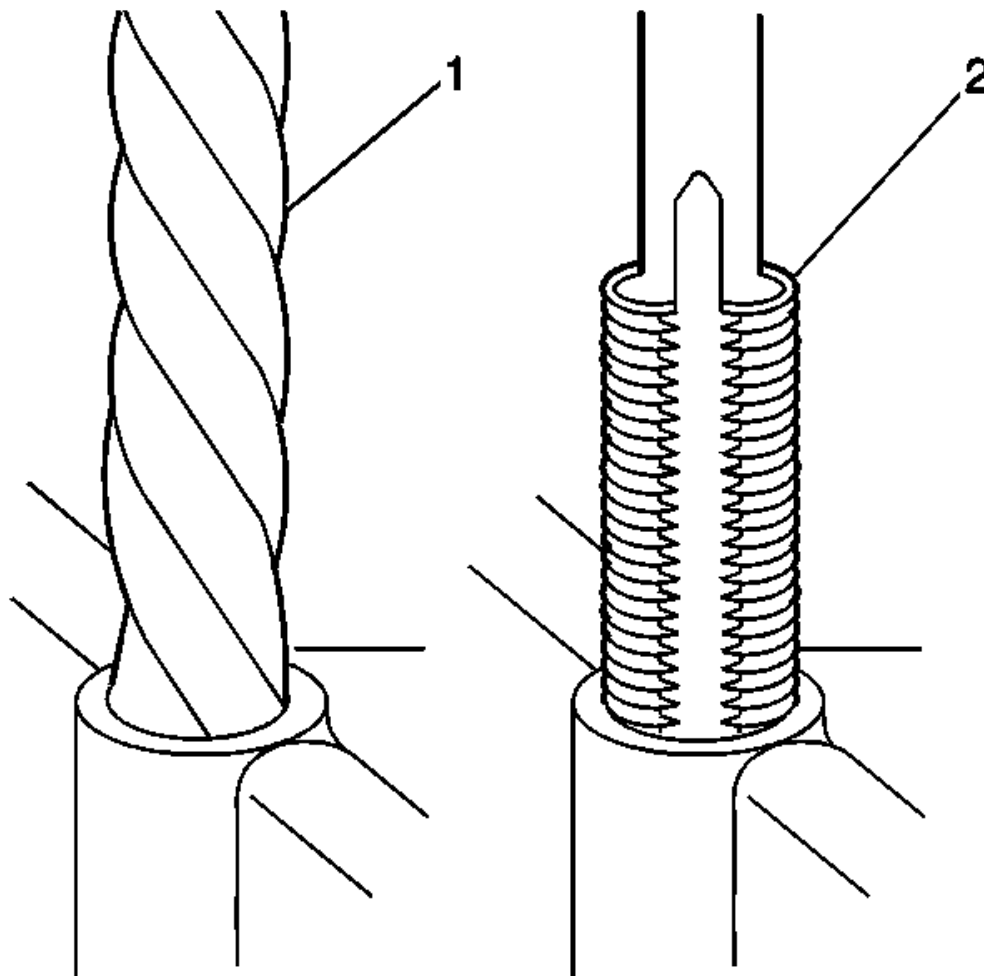


Fig. 173: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

NOTE: The use of a cutting fluid, WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers .

Driver oil MUST be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

1. Drill out the threads of the damaged hole (1).
 - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
 - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
 - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Using compressed air, clean out any chips.

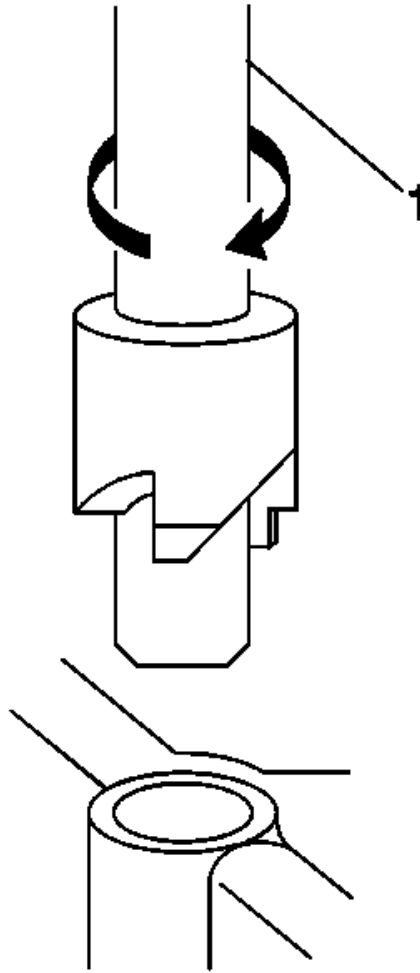


Fig. 174: Identifying Tool Used To Counterbore The Hole
Courtesy of GENERAL MOTORS COMPANY

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

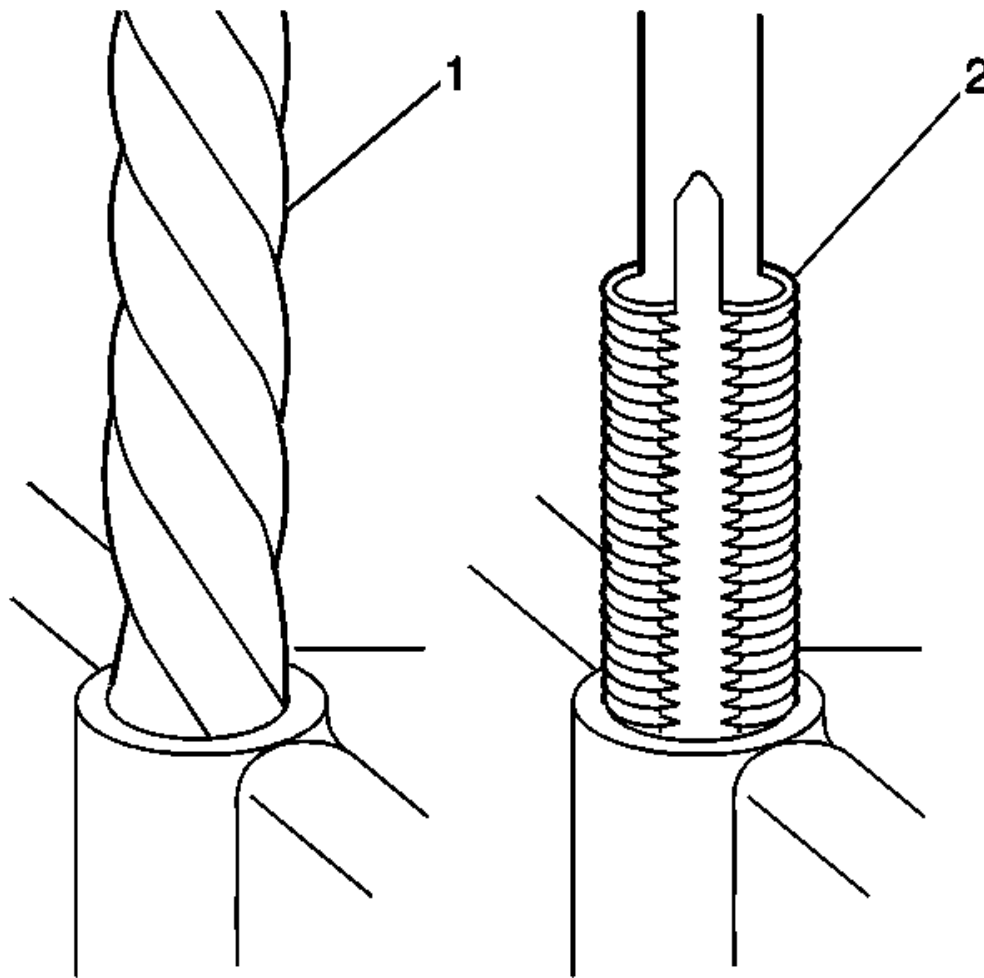


Fig. 175: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

5. Using a tap wrench (2), tap the threads of the drilled hole.
 - M6 inserts require a minimum tap depth of 15 mm (0.59 in).
 - M8 inserts require a minimum tap depth of 20 mm (0.79 in).
 - M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).

WARNING: Refer to Safety Glasses and Compressed Air Warning .

WARNING: Refer to Cleaning Solvent Warning .

6. Using compressed air, clean out any chips.

7. Spray cleaner into the hole. Refer to Adhesives, Fluids, Lubricants, and Sealers .
8. Using compressed air, clean any cutting oil and chips out of the hole.

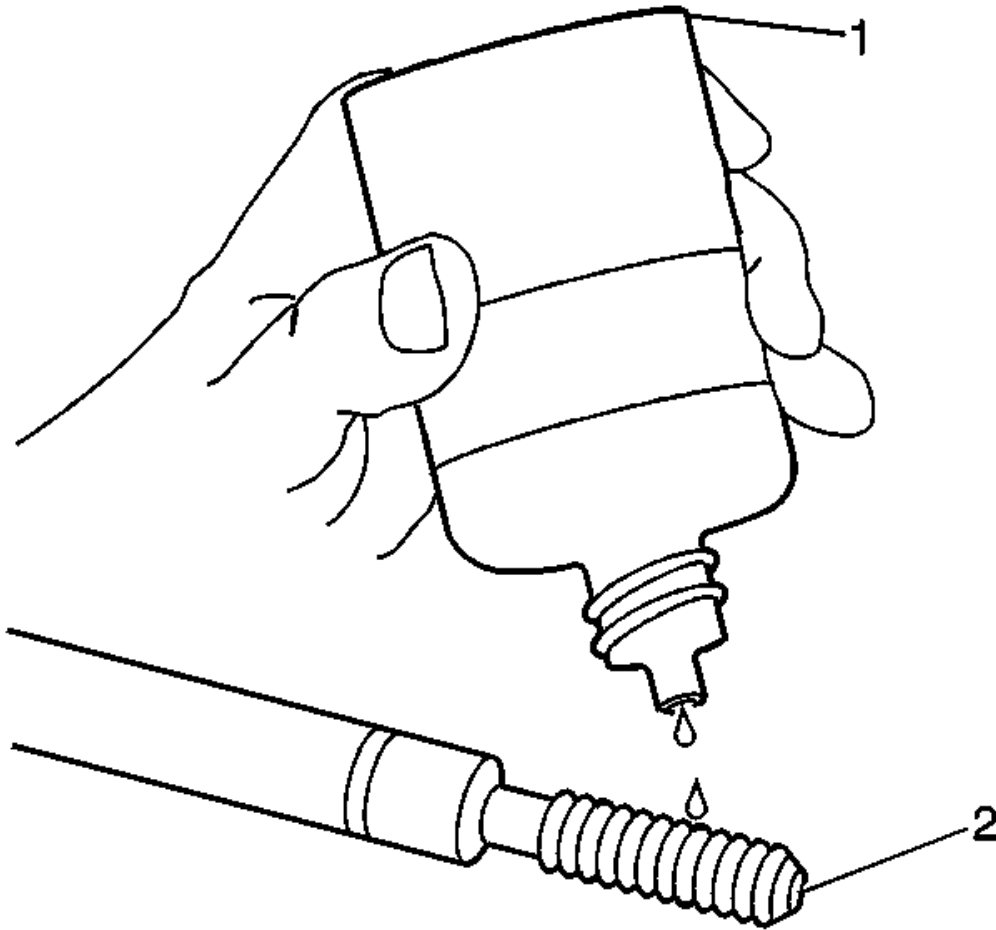


Fig. 176: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).

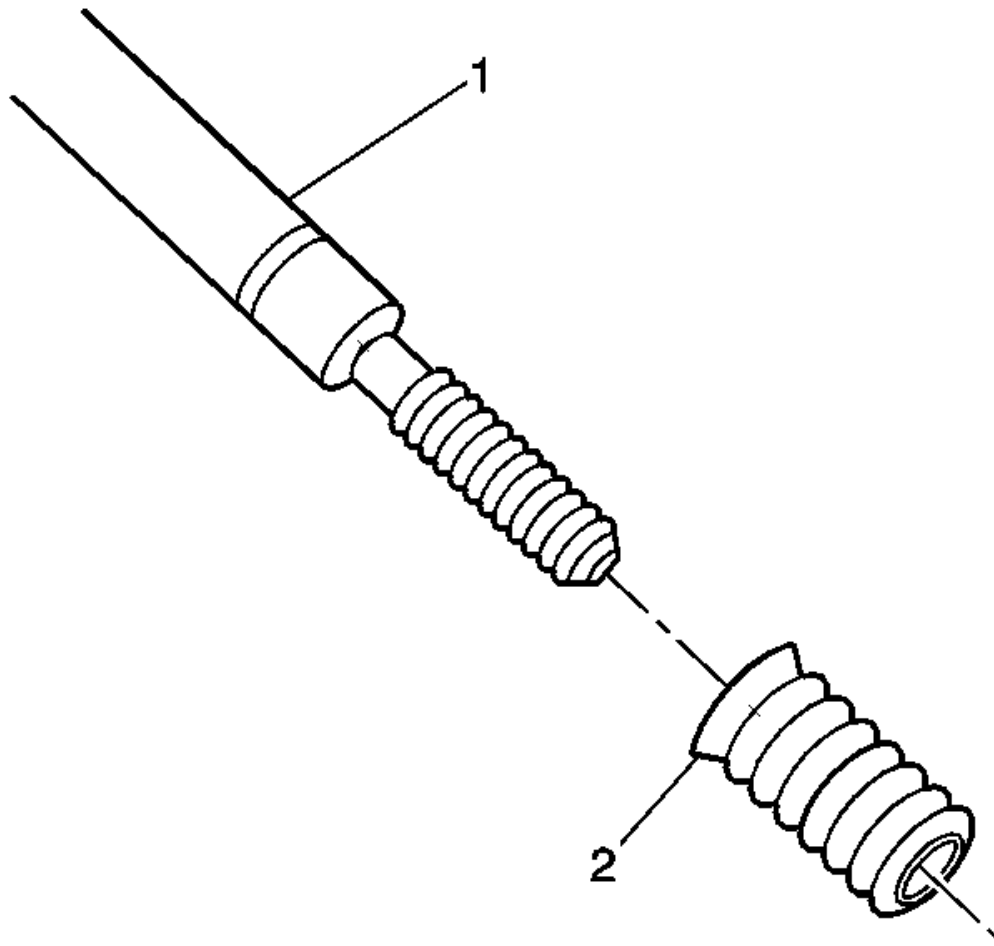


Fig. 177: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

10. Install the insert (2) onto the driver tool (1).

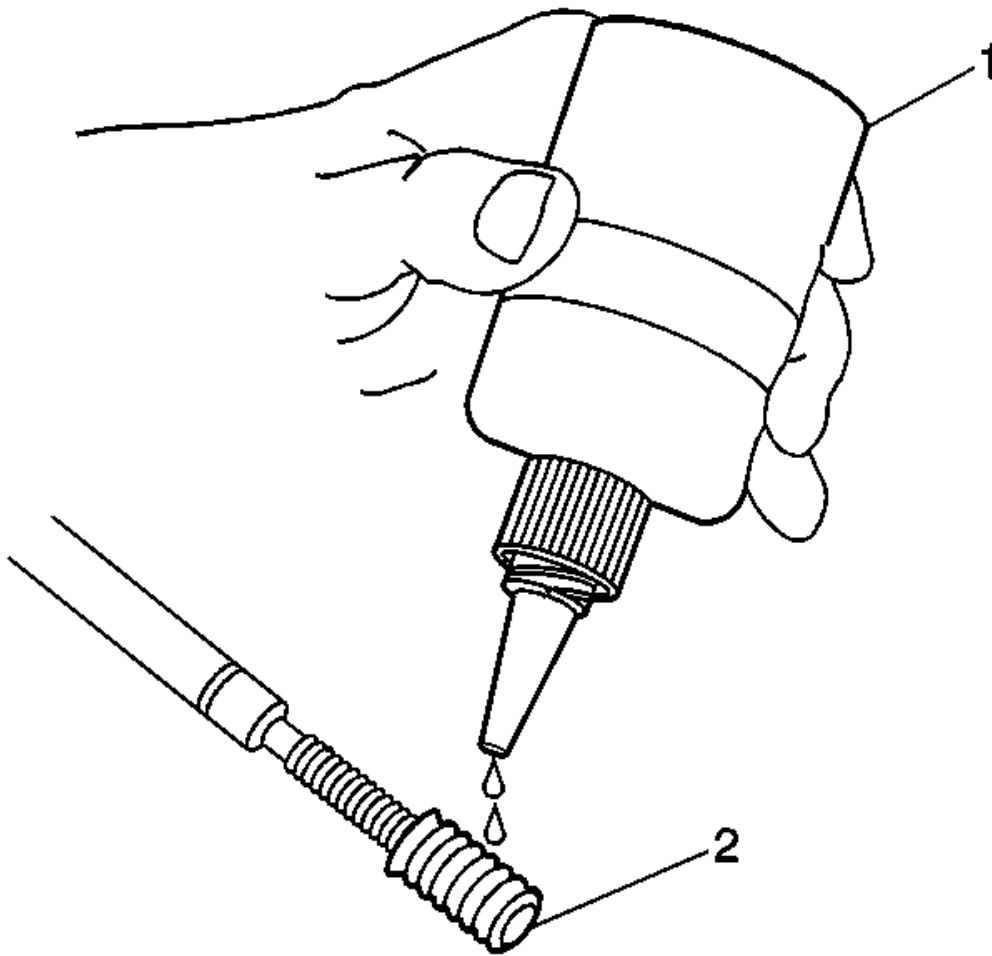


Fig. 178: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

11. Apply threadlock LOCTITE™ 277, EN 42385-109 (1) loctite , or equivalent to the insert OD threads (2).

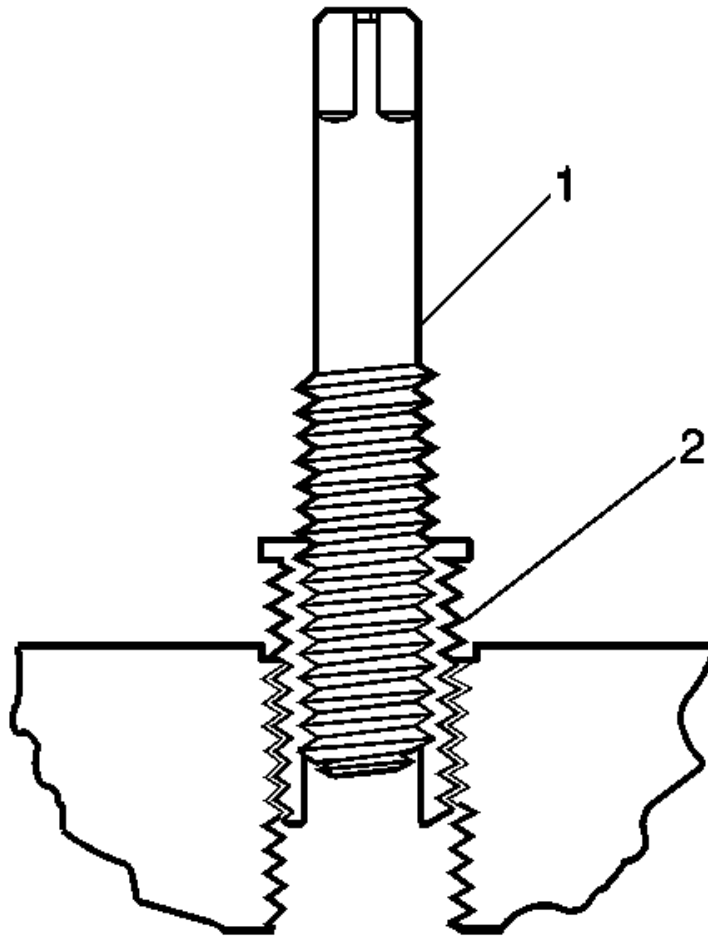


Fig. 179: View Of Insert In Tapped Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

12. Install the insert (2) into the hole.

Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

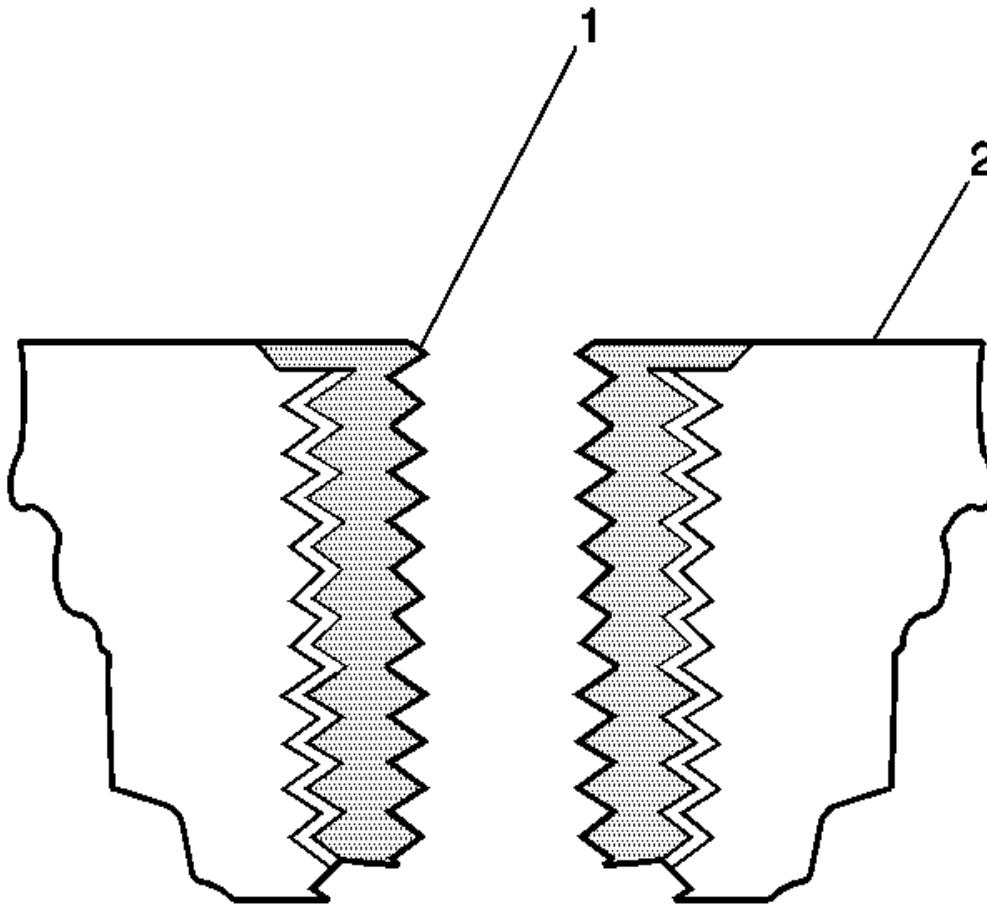


Fig. 180: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

13. Inspect the insert for proper installation into the hole.

A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

Cylinder Head Bolt Hole Thread Repair

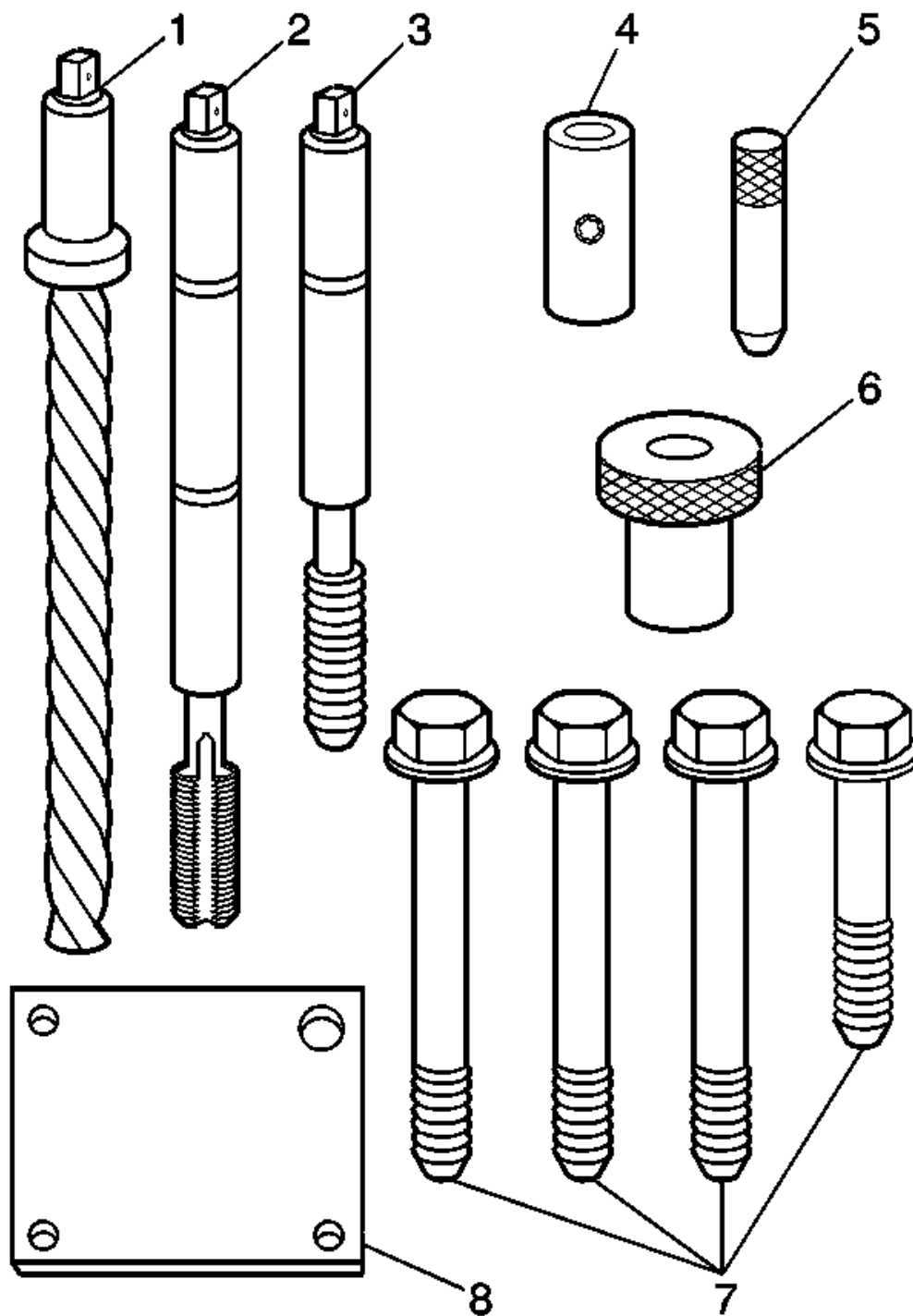


Fig. 181: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS COMPANY

1. The cylinder head bolt hole thread repair kit consists of the following items:

- Drill (1)
- Tap (2)
- Installer (3)
- Sleeve (4)
- Alignment Pin (5)
- Bushing (6)
- Bolts (7)
- Fixture Plate (8)

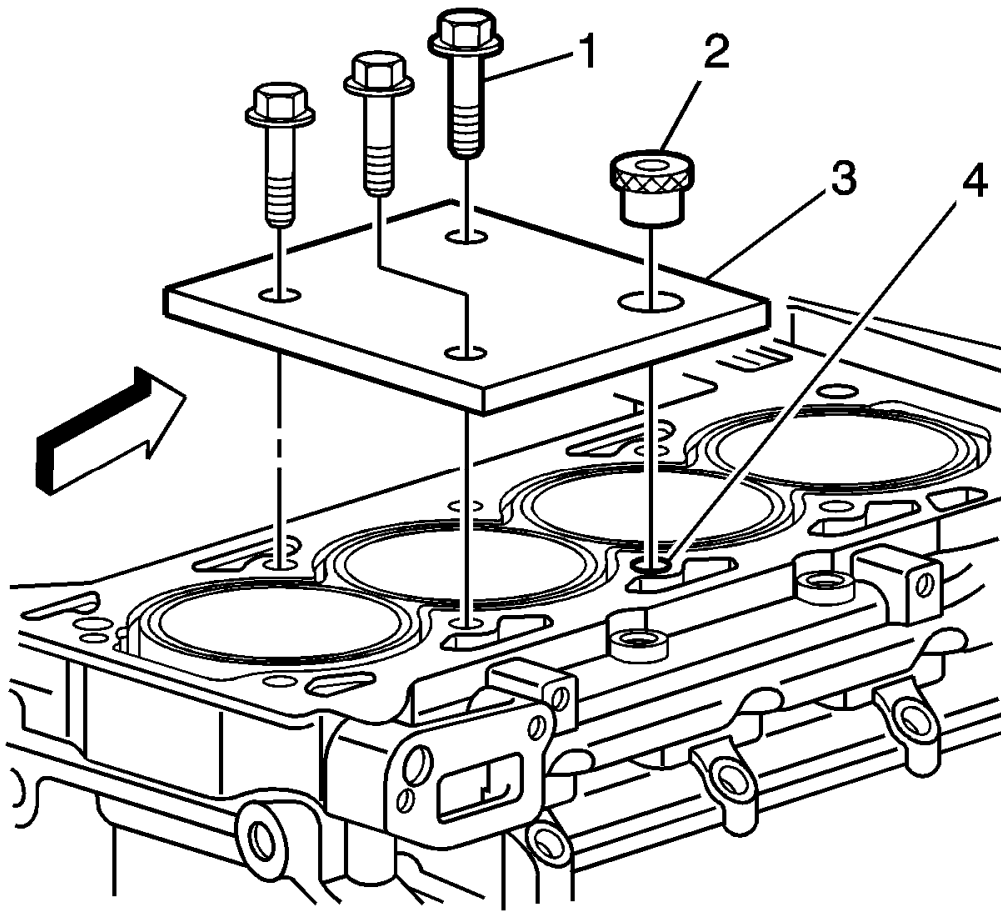


Fig. 182: Identifying Fixture Plate, Bolts, & Bushing
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses and Compressed Air Warning .

NOTE: The use of a cutting fluid, WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers .

Driver oil **MUST** be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

Position the fixture plate and bushing over the hole that is to be repaired (4).

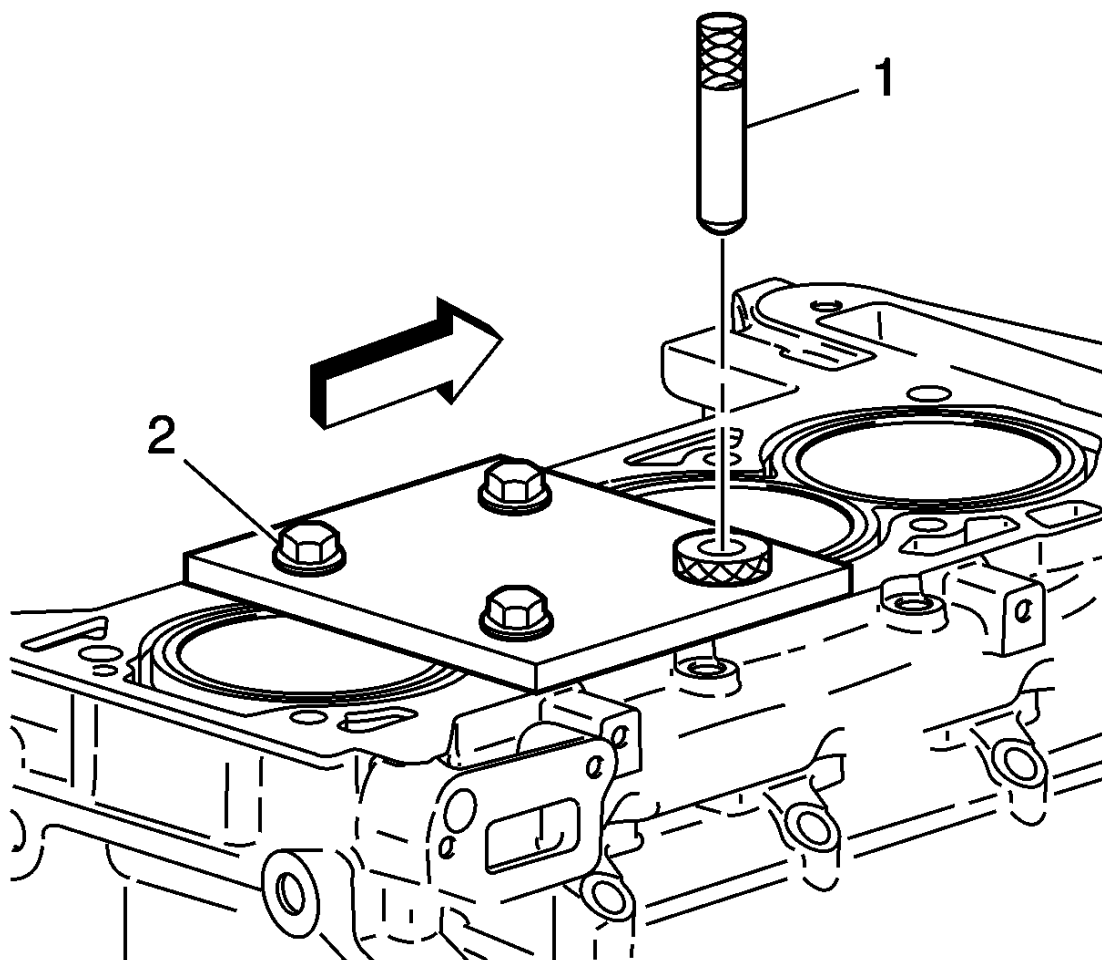


Fig. 183: Identifying Alignment Pin
Courtesy of GENERAL MOTORS COMPANY

3. Position the alignment pin (1) through the bushing and into the hole.

4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.

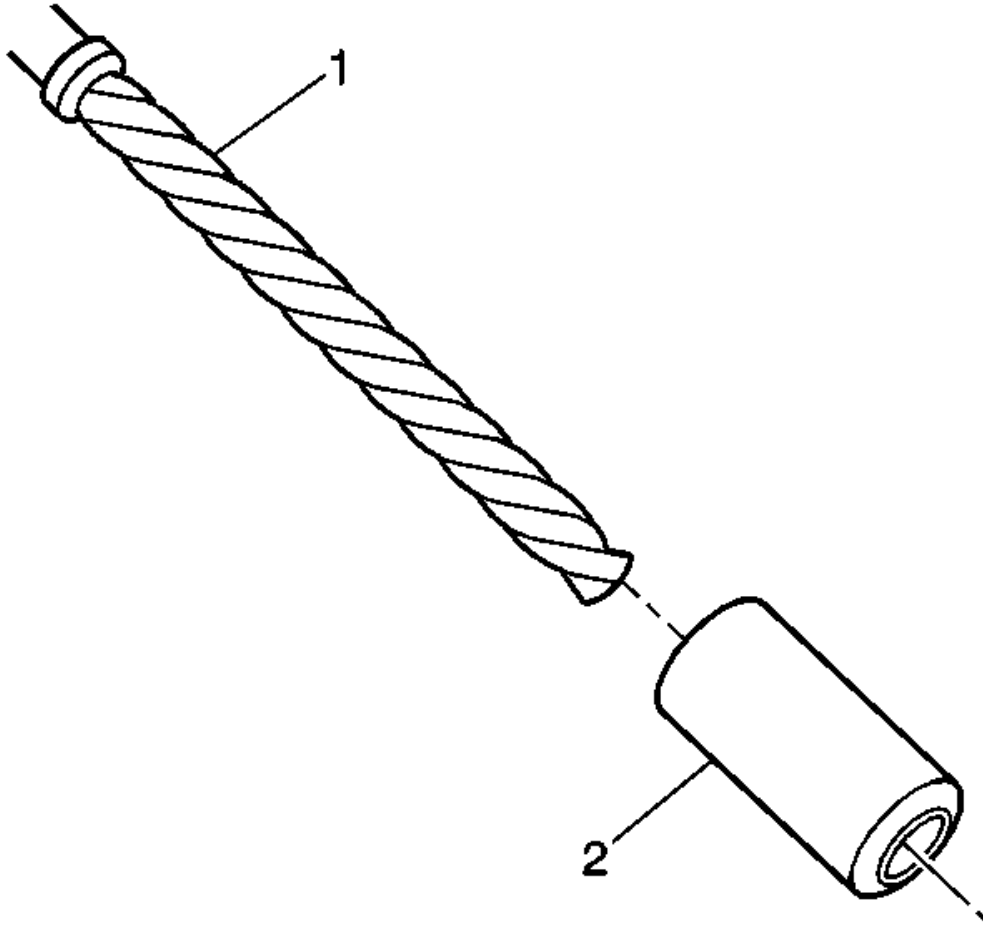


Fig. 184: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS COMPANY

6. Install the sleeve (2) onto the drill (1), if required.

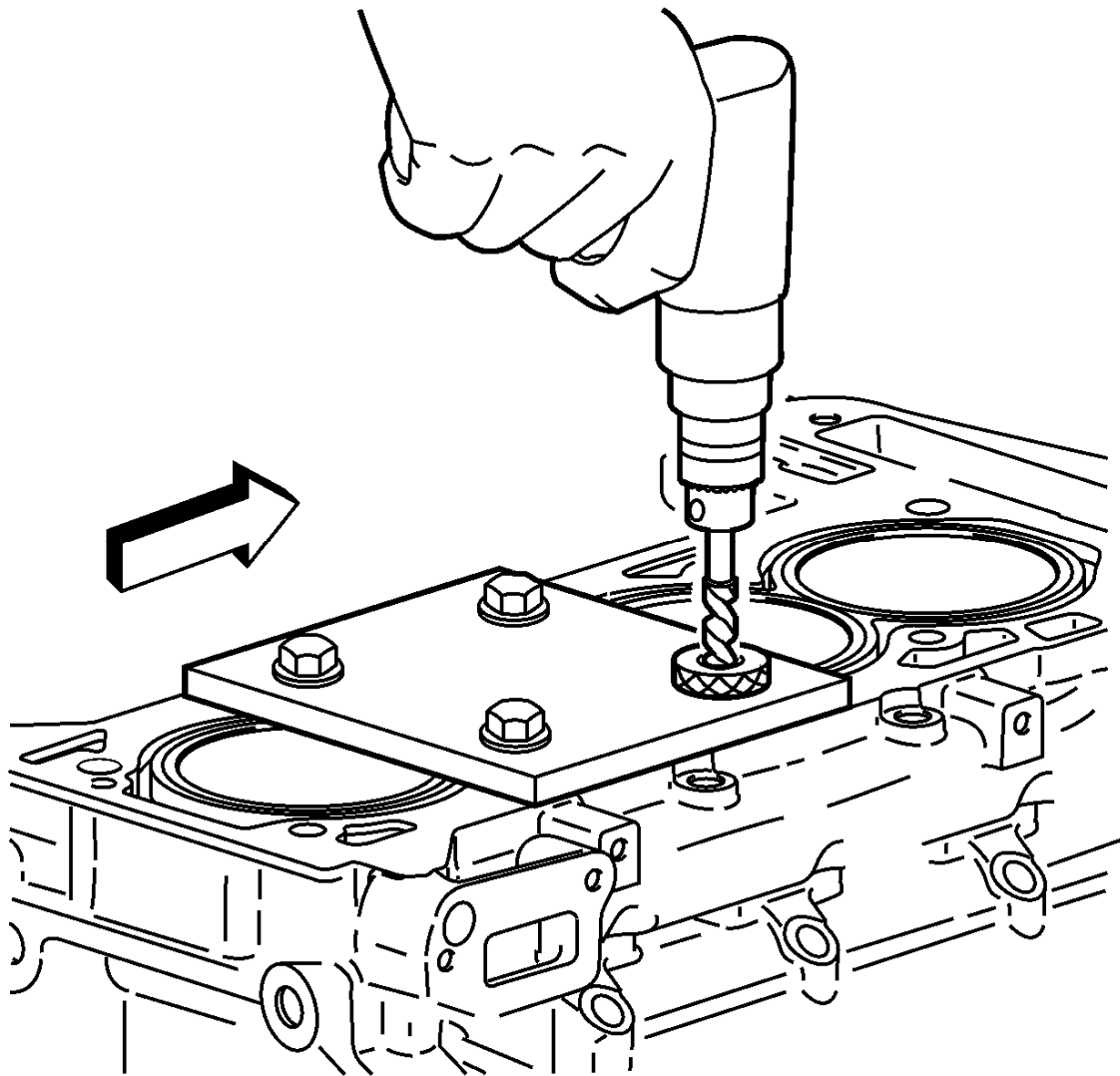


Fig. 185: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

7. Drill out the threads of the damaged hole.

Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

8. Using compressed air, clean out any chips.

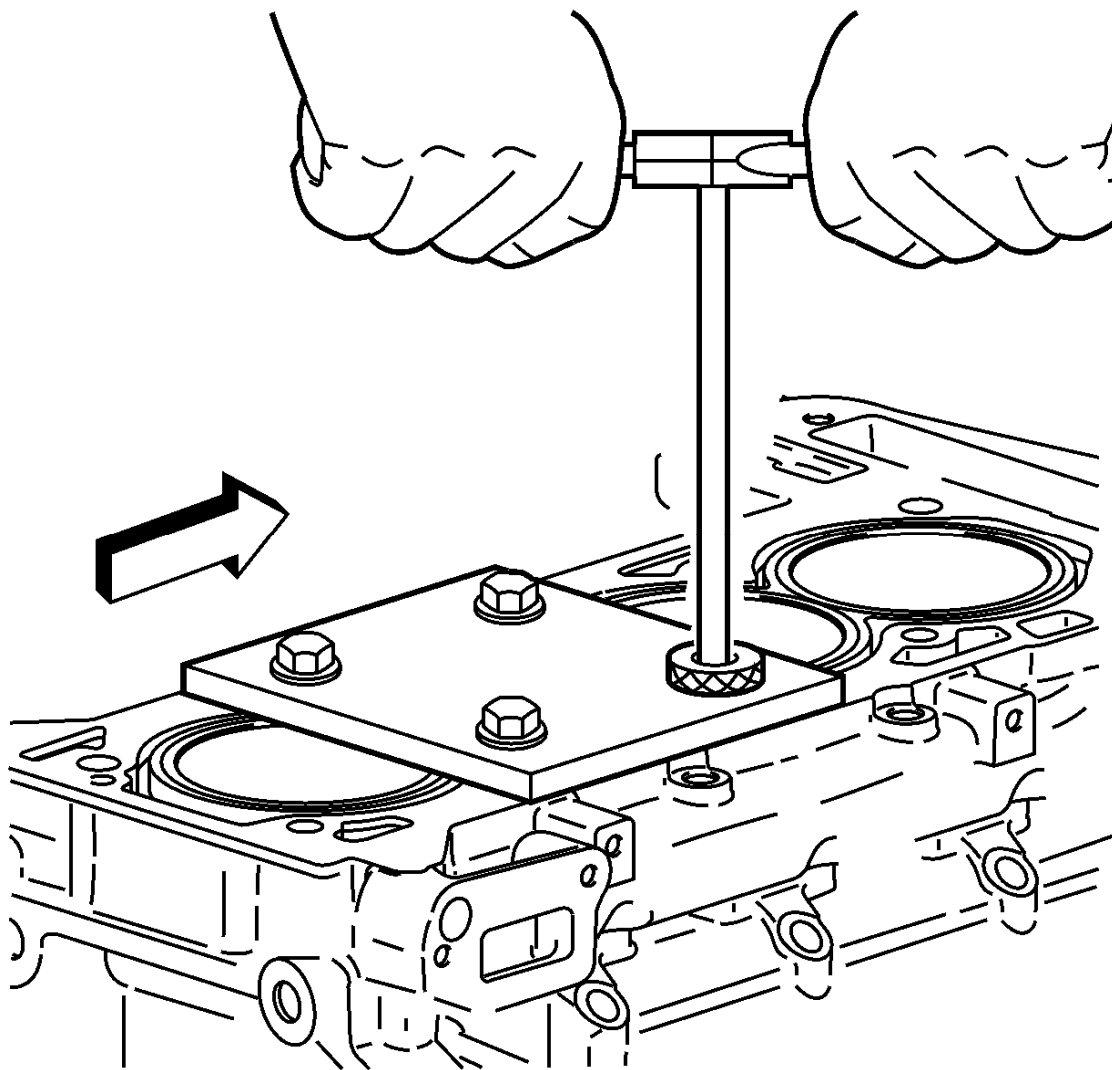


Fig. 186: Tapping Threads Of Drilled Hole With Tap Wrench
Courtesy of GENERAL MOTORS COMPANY

9. Using a tap wrench, tap the threads of the drilled hole.

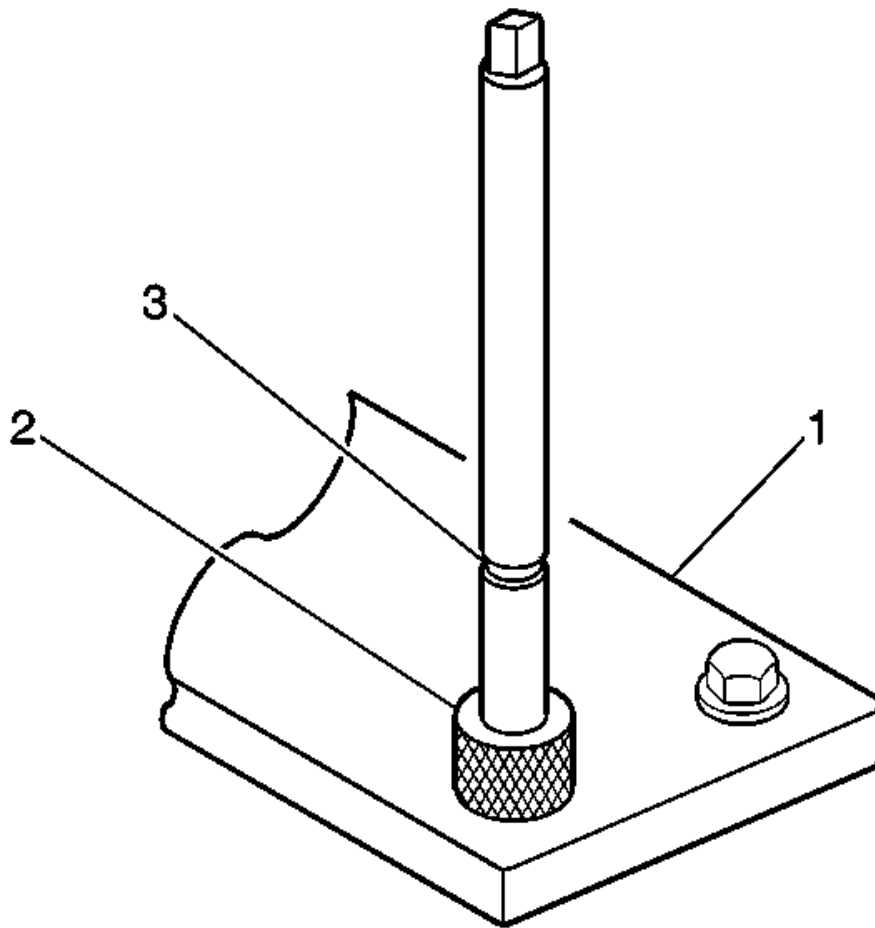


Fig. 187: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

10. Using a TAP wrench, tap the threads of the drilled hole.

In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (3) on the tap align with the top of the drill bushing (2).

11. Remove the fixture plate (1), bushing (2), and bolts.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

WARNING: Refer to Cleaning Solvent Warning .

12. Using compressed air, clean out any chips.
13. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
14. Using compressed air, clean any cutting oil and chips out of the hole.

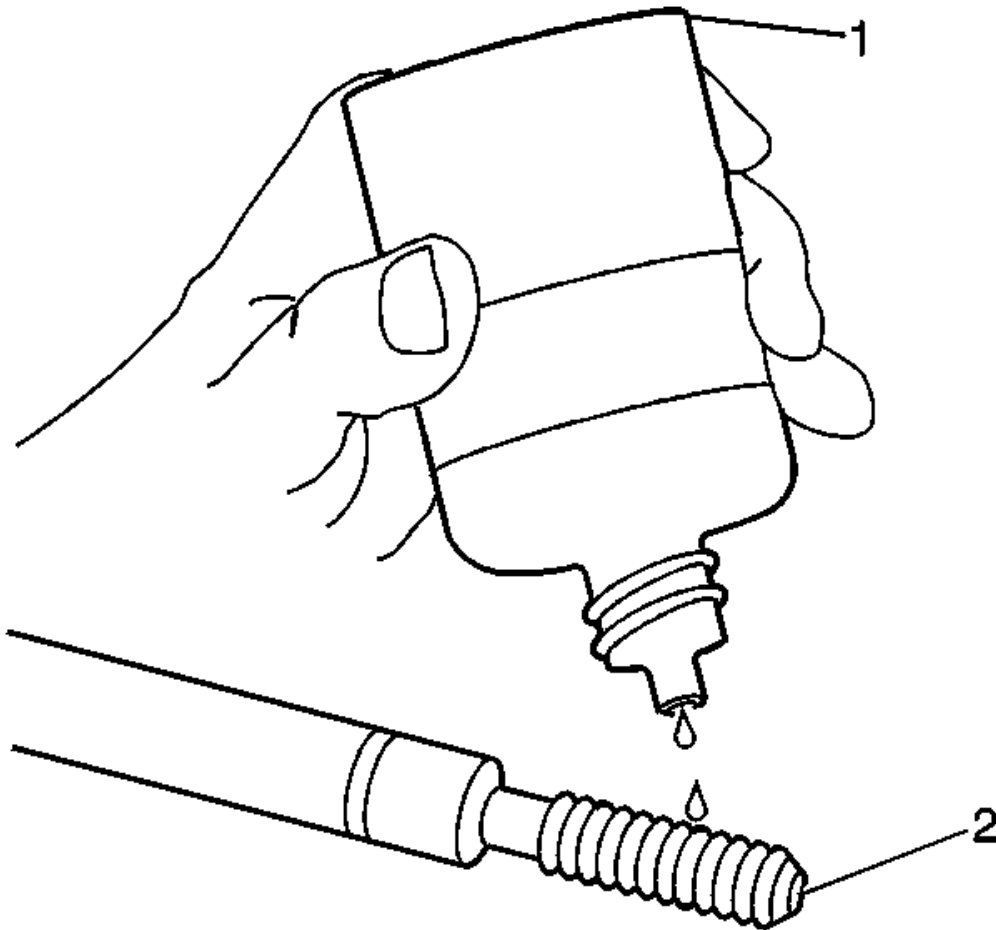


Fig. 188: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

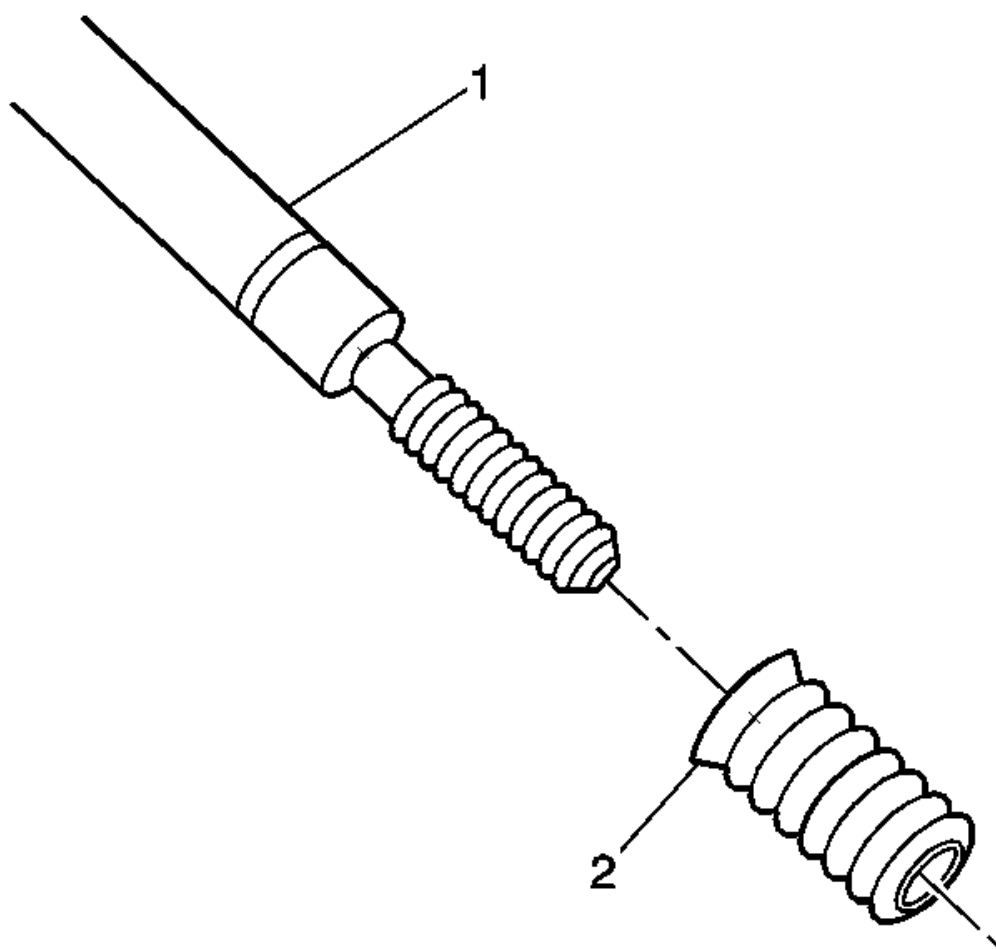


Fig. 189: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert (2) onto the driver tool (1).

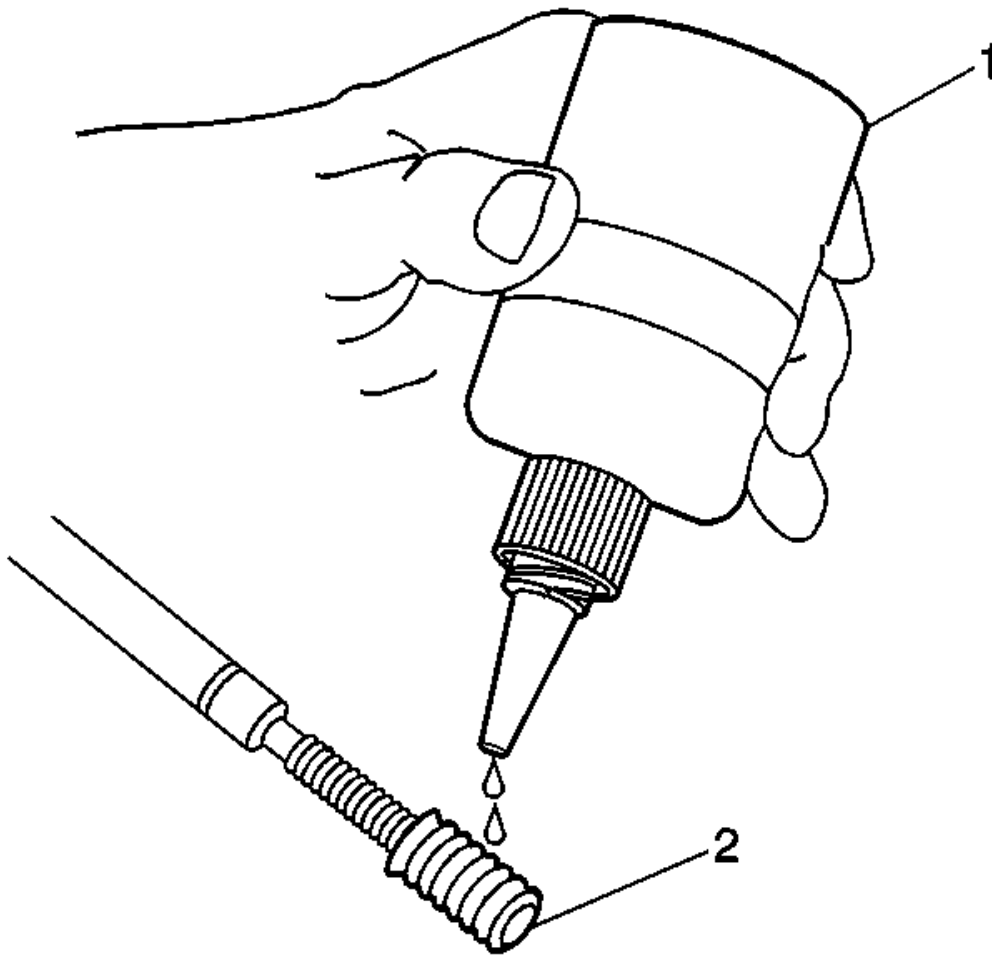


Fig. 190: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

17. Apply threadlock LOCTITE™ 277, EN 42385-109 loctite (1), or equivalent to the insert OD threads (2).

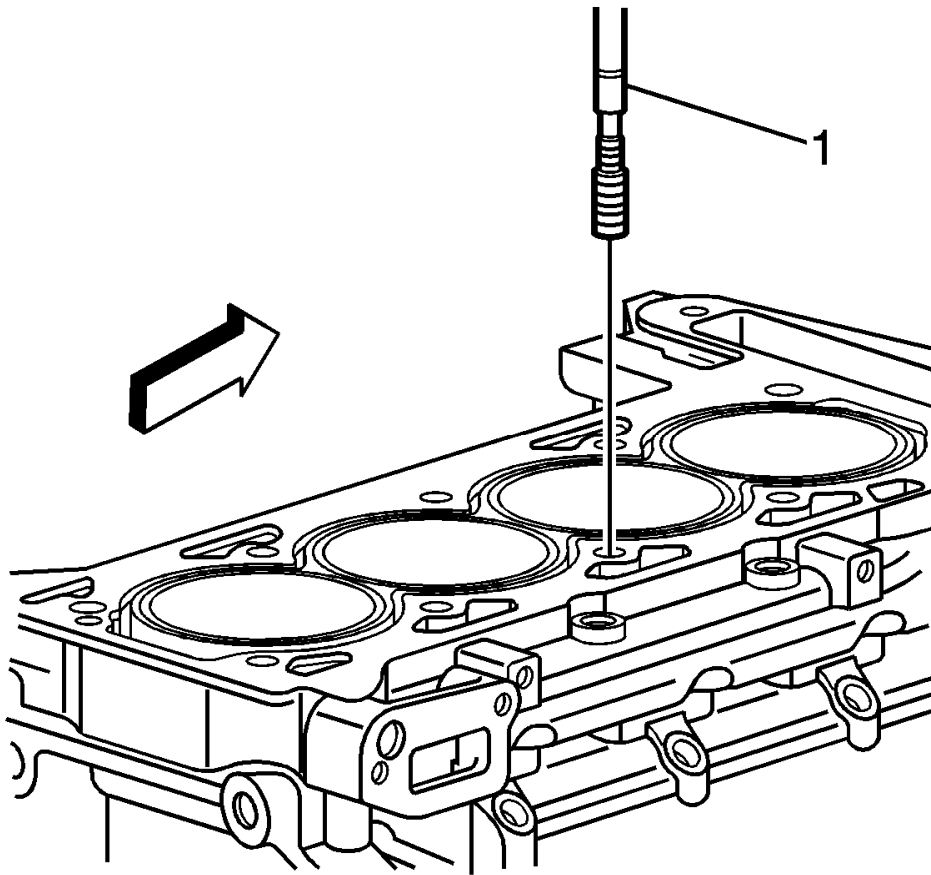


Fig. 191: Installing & Inserting Driver Into Hole
Courtesy of GENERAL MOTORS COMPANY

18. Install the insert and driver (1) into the hole.

Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

Main Cap Bolt Hole Thread Repair

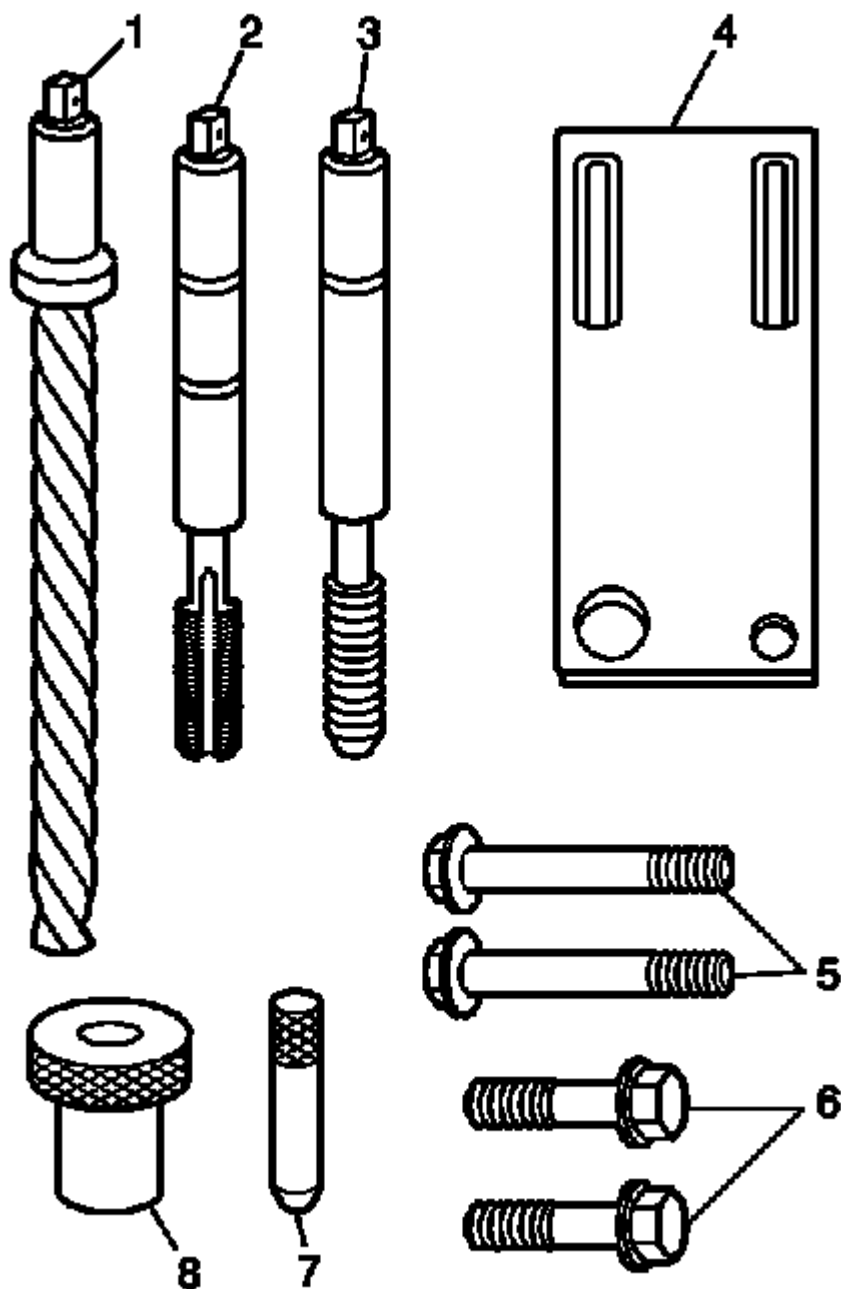


Fig. 192: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS COMPANY

1. The main cap bolt hole thread repair kit consists of the following items:
 - Drill (1)
 - Tap (2)
 - Installer (3)

- Fixture Plate (4)
- Long Bolts (5)
- Short Bolts (6)
- Alignment Pin (7)
- Bushing (8)

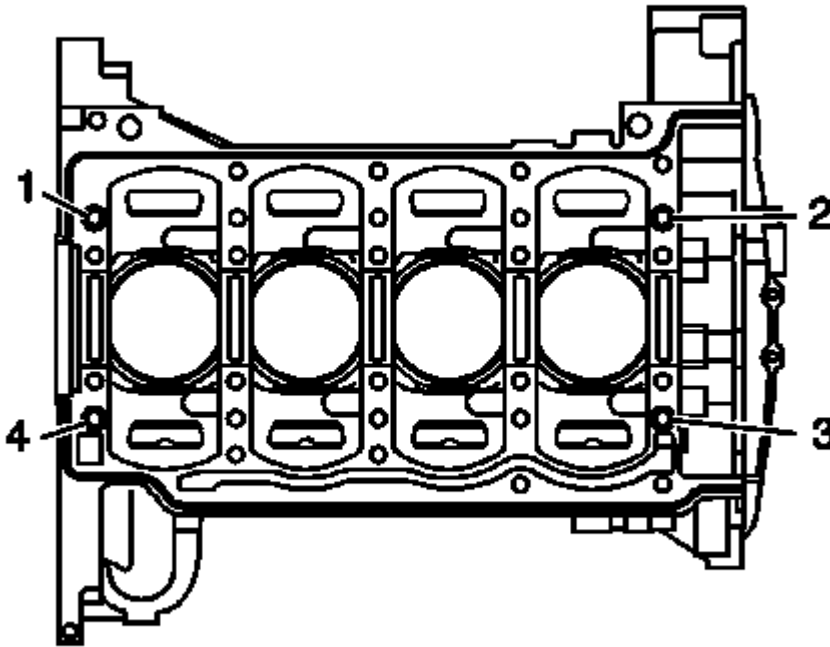


Fig. 193: Identifying Alignment Dowel Pins
Courtesy of GENERAL MOTORS COMPANY

2. Remove the alignment dowel pins from the holes (1-4), if necessary.

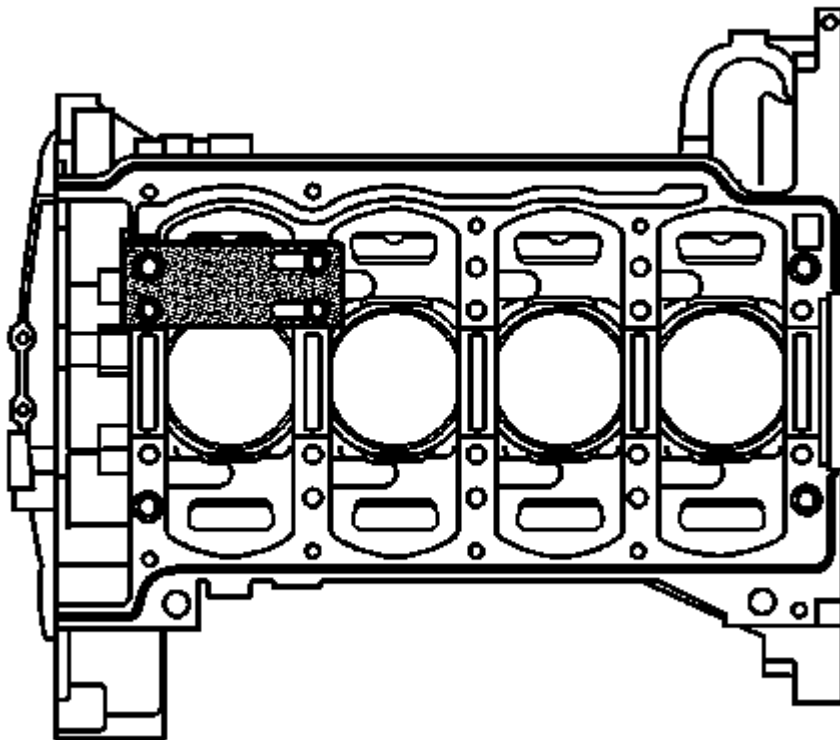


Fig. 194: Installing Fixture Plate, Bolt, & Bushing Onto Engine Block
Courtesy of GENERAL MOTORS COMPANY

3. Install the fixture plate, bolt, and bushing, onto the engine block.

Position the fixture plate and bushing over the hole that is to be repaired.

4. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.
5. Drill out the damaged hole.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

6. Using compressed air, clean out any chips.

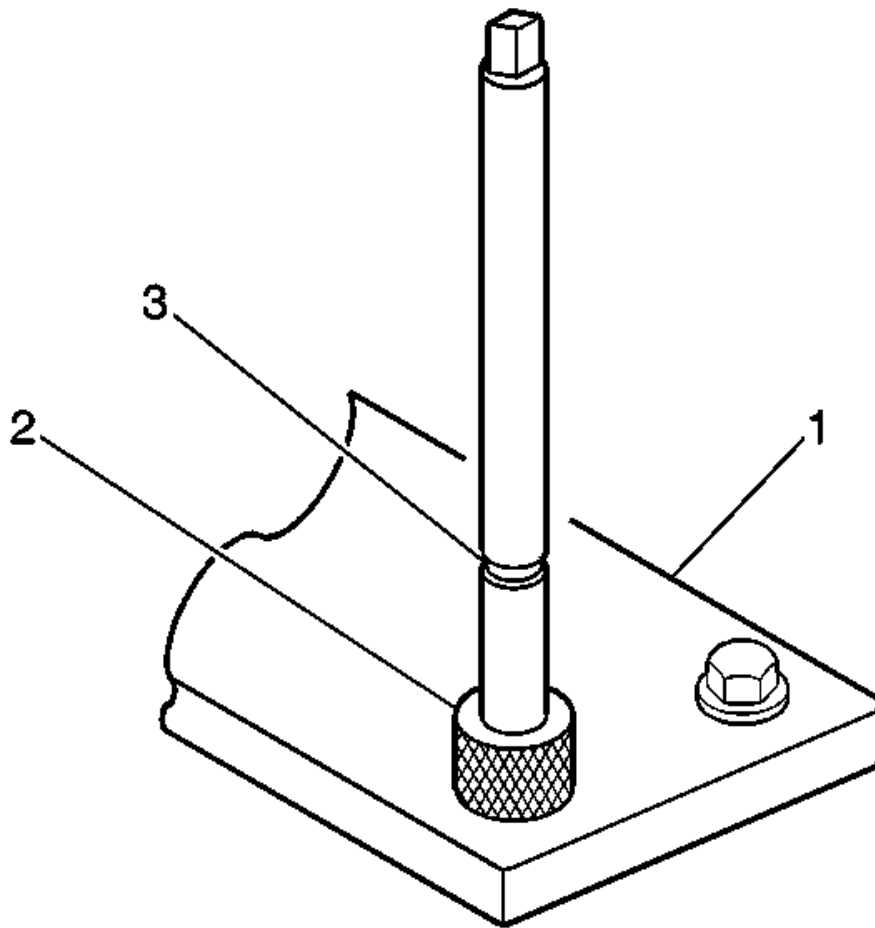


Fig. 195: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

7. Using a tap wrench, tap the threads of the drilled hole.

In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (3) on the tap aligns with the top of the bushing (2).

WARNING: Refer to Safety Glasses and Compressed Air Warning .

WARNING: Refer to Cleaning Solvent Warning .

8. Using compressed air, clean out any chips.
9. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

10. Using compressed air, clean any cutting oil and chips out of the hole.

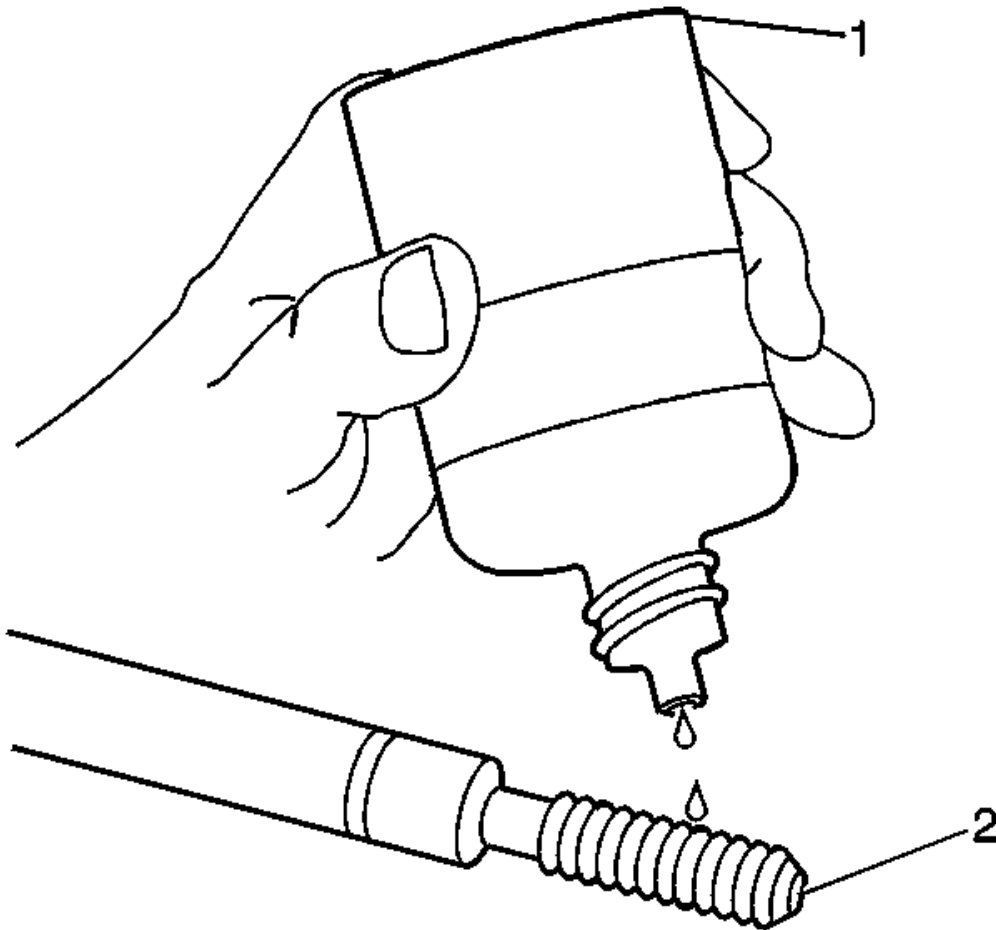


Fig. 196: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

11. Lubricate the threads of the installer tool (2) with the driver oil (1).

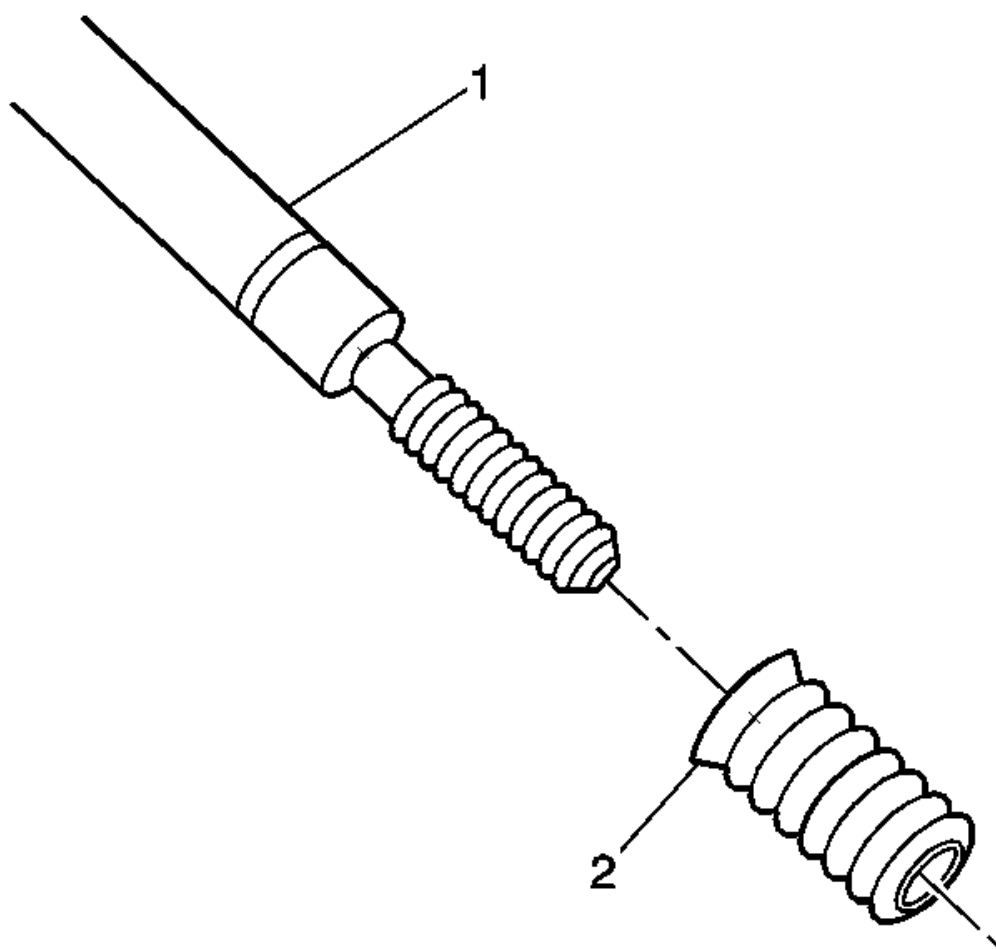


Fig. 197: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

12. Install the insert (2) onto the driver tool (1).

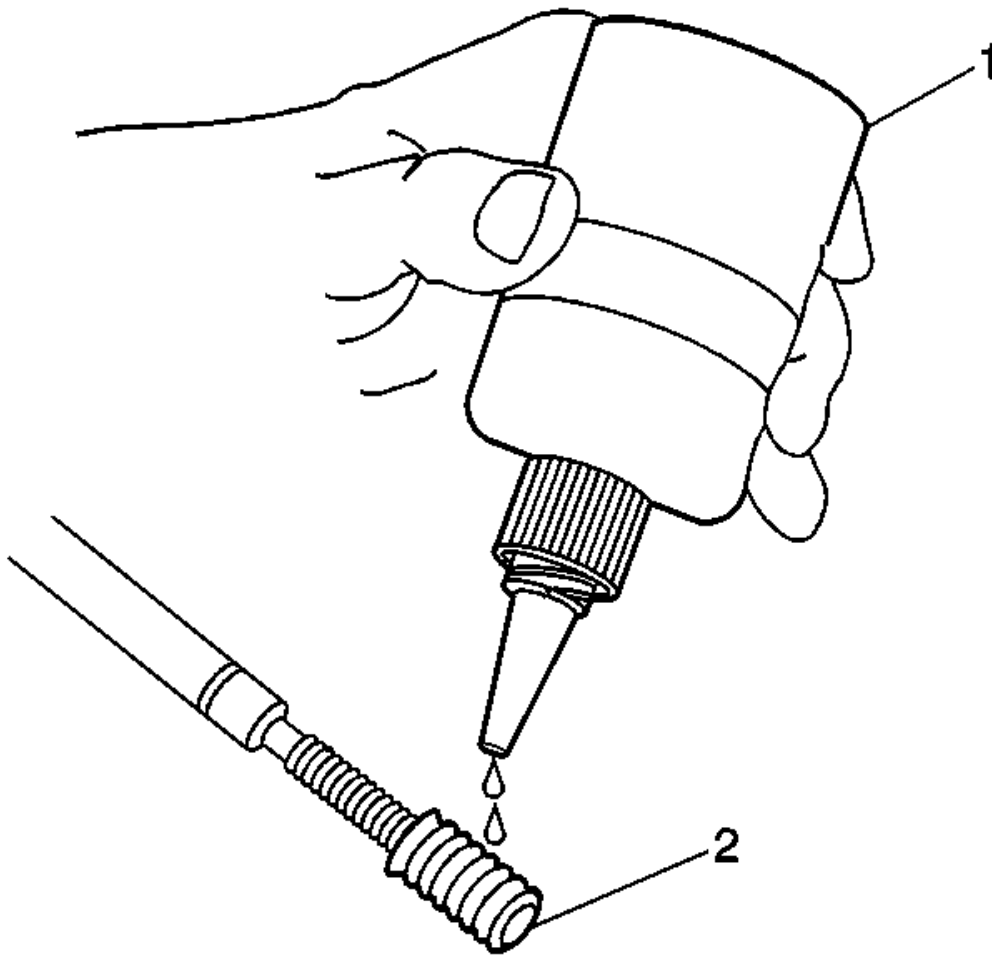


Fig. 198: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

13. Apply threadlock LOCTITE™ 277, EN 42385-109 (1), or equivalent to the insert OD threads (2).

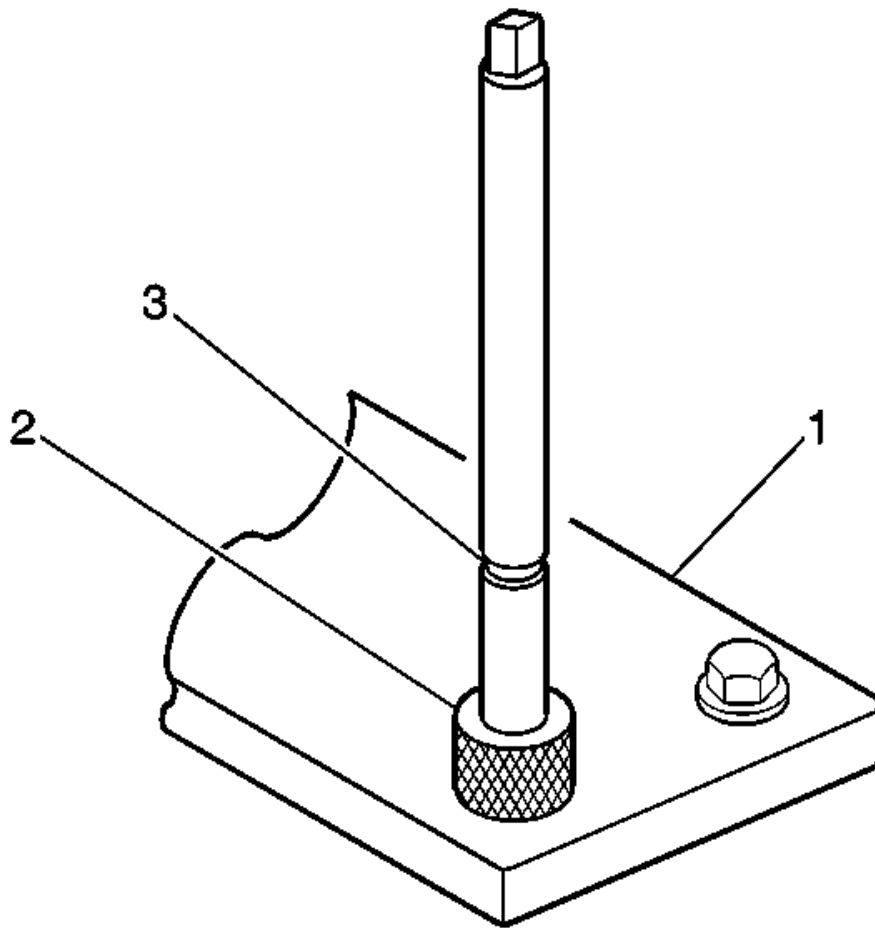


Fig. 199: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.**

14. Install the insert and driver through the bushing (2), fixture plate (1) and into the hole.

Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2).

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

15. Remove the driver, bushing (2), fixture plate (1), and bolts.

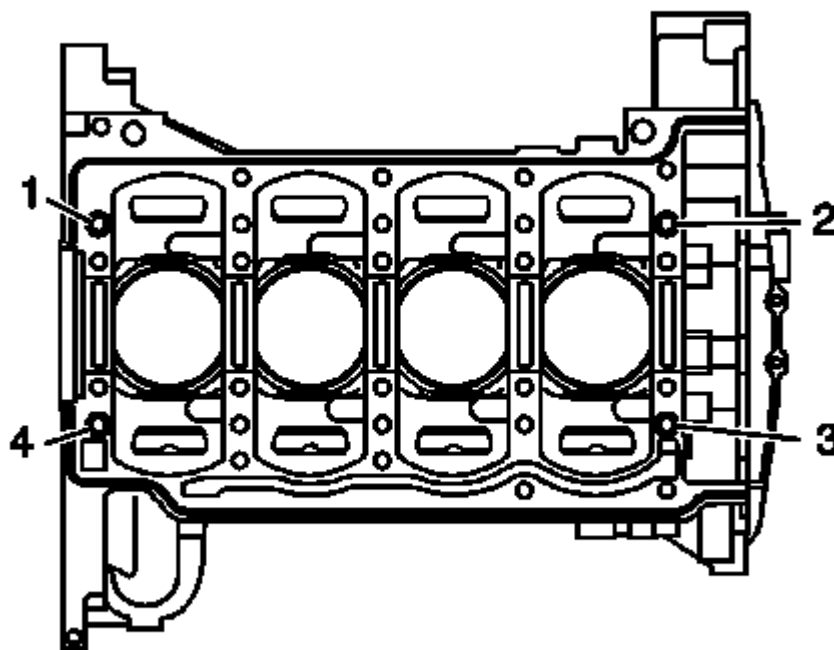


Fig. 200: Identifying Alignment Dowel Pins
Courtesy of GENERAL MOTORS COMPANY

16. Install the alignment dowel pins in holes (1-4), if necessary.

SERVICE PRIOR TO ASSEMBLY

The importance of cleanliness during assembly cannot be overstated. Dirt or debris will cause engine damage. An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Lubricate all moving parts with engine oil or a specified assembly lubricant. This will provide lubrication for initial start up.

ENGINE BLOCK ASSEMBLE

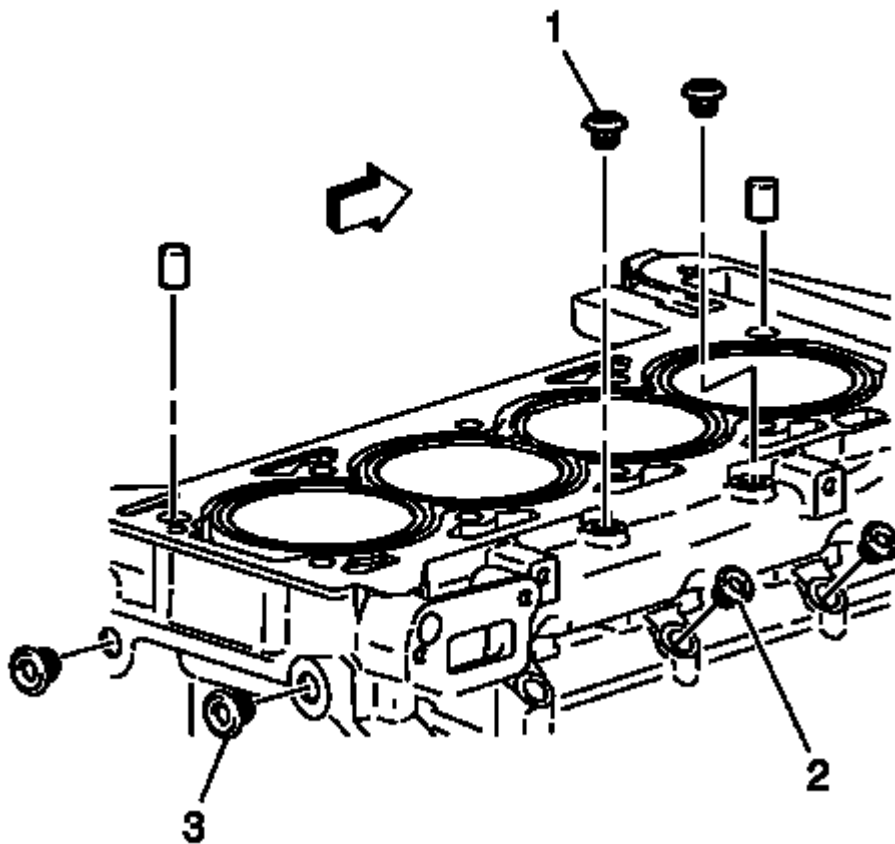


Fig. 201: Locating Block Plugs

Courtesy of GENERAL MOTORS COMPANY

1. Apply sealant to all plugs (1, 2, 3) prior to installation. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the drain plug, with sealant, in the water pump.

CAUTION: Refer to Fastener Caution .

3. Install the coolant jacket plugs, with sealant, and tighten to 35 N.m (26 lb ft).
4. Install the rear oil passage plugs, with sealant, and tighten to 60 N.m (44 lb ft).
5. Install the other oil passage plugs, with sealant, and tighten to 35 N.m (26 lb ft).

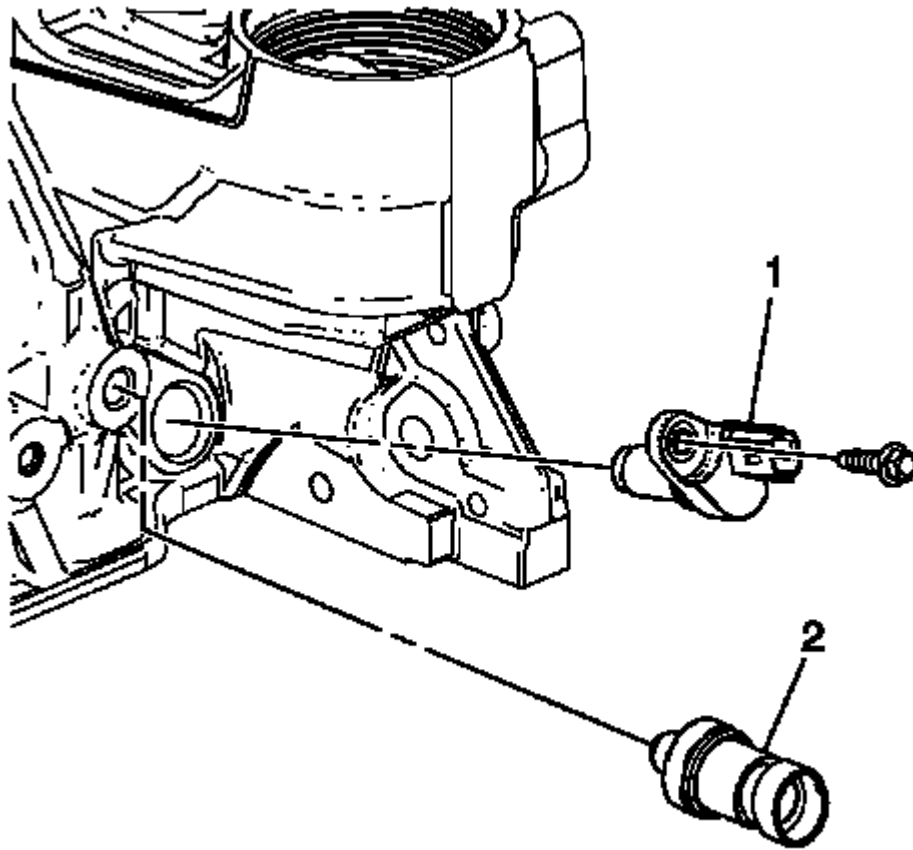


Fig. 202: Oil Pressure Switch

Courtesy of GENERAL MOTORS COMPANY

6. Lubricate the crankshaft position sensor O-ring with engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
7. Install the crankshaft position sensor (1) and bolt and tighten to 10 N.m (89 lb in).
8. Install the oil pressure switch (2) and tighten to 26 N.m (19 lb ft).

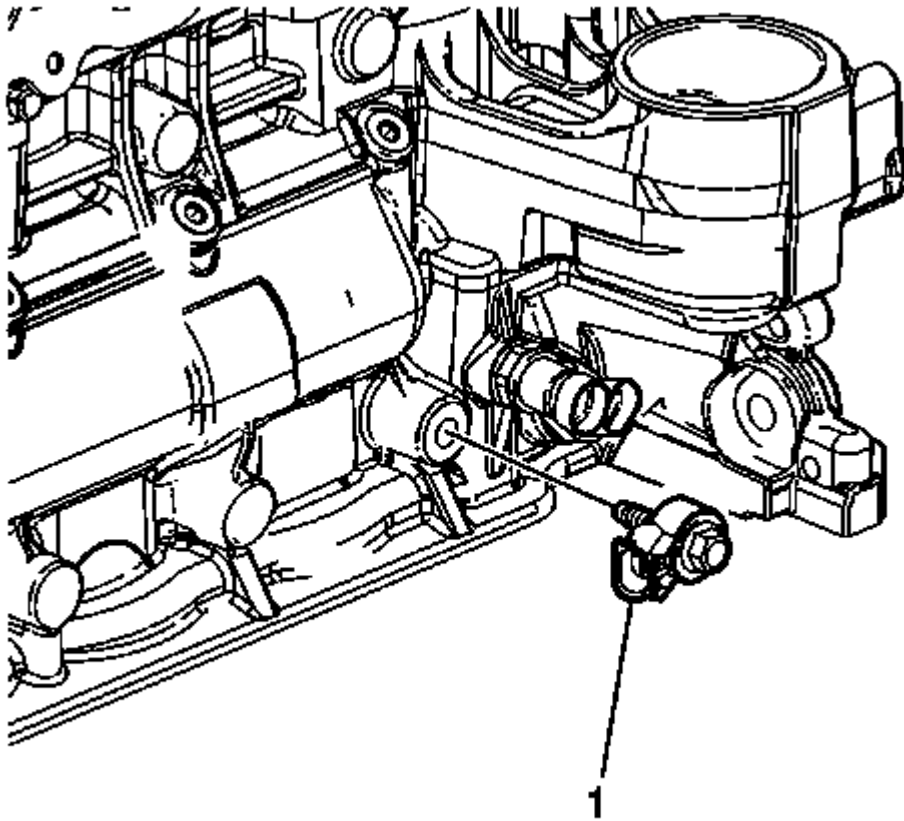


Fig. 203: Knock Sensor

Courtesy of GENERAL MOTORS COMPANY

9. Install the knock sensor (1) and bolt and tighten to 25 N.m (18 lb ft).

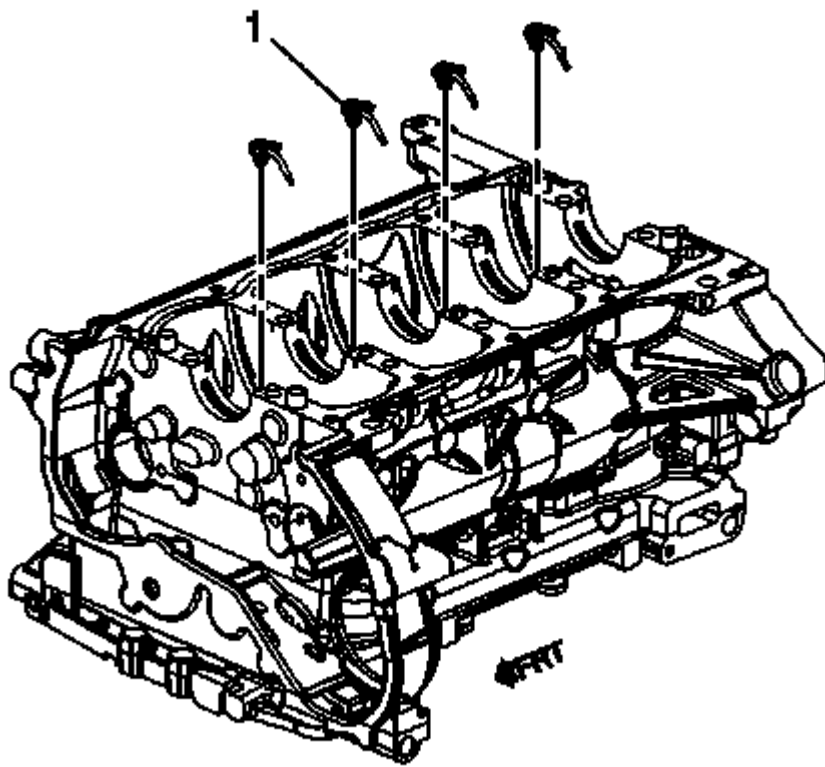


Fig. 204: Piston Oil Nozzle Assembly
Courtesy of GENERAL MOTORS COMPANY

10. Install the piston oil nozzle assemblies (1), if equipped.
11. Install the piston oil nozzle assembly bolts and tighten to 15 N.m (11 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

- **EN-8087** Cylinder Bore Checking Gauge
- **EN 45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

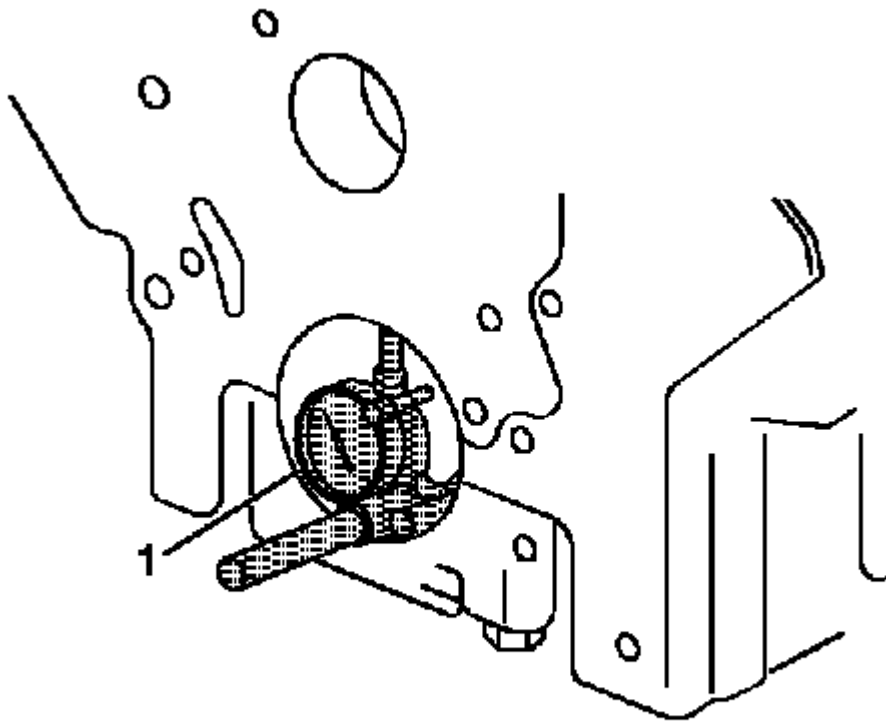


Fig. 205: Measuring Bearing Bore

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.
- If crankshaft bearing failure is due to other than normal wear, investigate the cause. Inspect the crankshaft or connecting rod bearing bores.

Inspect the connecting rod bearing bores or crankshaft main bearing bores using the following procedure:

- Tighten the bedplate to specification using the **EN 45059** meter.
- Measure the bearing bore for taper and out-of-round using the **EN-8087** gauge (1).
- No taper or out-of-round should exist.

Bearing Selection

1. Measure the bearing clearance to determine the correct replacement bearing insert size. There are 2 methods to measure bearing clearance. Method A gives more reliable results and is preferred.

- Method A yields measurement from which the bearing clearance can be computed.
- Method B yields the bearing clearance directly. Method B does not give any indication of bearing run-out.

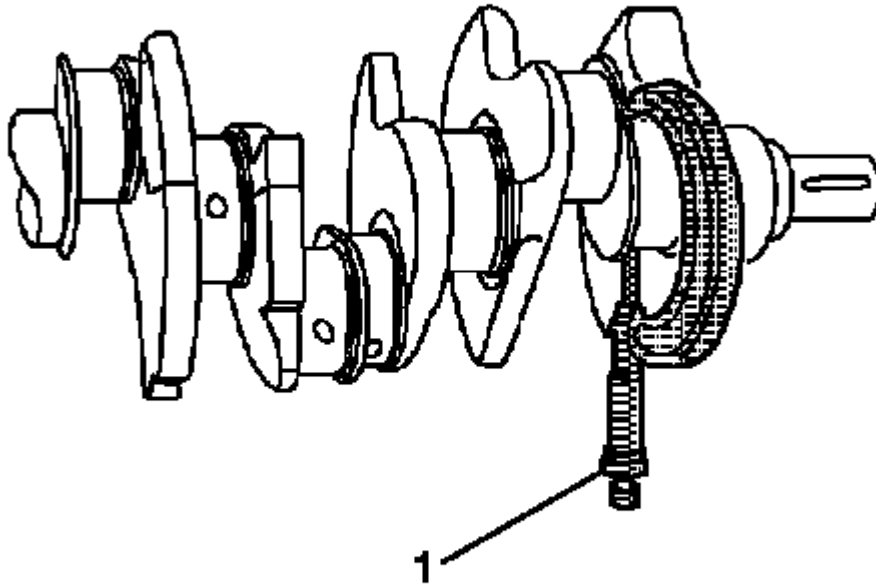


Fig. 206: View of Measuring Crankshaft Bearing Journal Using Method A
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not mix inserts of different nominal size in the same bearing bore.

2. To measure bearing clearance using Method A, use the following procedure:
 1. Measure the crankshaft bearing journal diameter with a micrometer (1) in several places, 90 degrees apart. Average the measurements.
 2. Measure the crankshaft bearing journal taper and runout.
 3. Install the lower crankcase and tighten the bearing cap bolts to specification.
 4. Measure bearing inside diameter (ID) in several places 90 degrees apart, average measurements.
 5. Subtract journal measurement from bearing ID measurement to determine clearance.
 6. Determine whether clearance is within specification.
 7. If out of specification, choose different inserts.

8. Measure the connecting rod inside diameter in the same direction as the length of the rod with an inside micrometer.
9. Measure the crankshaft main bearing inside diameter with an inside micrometer.

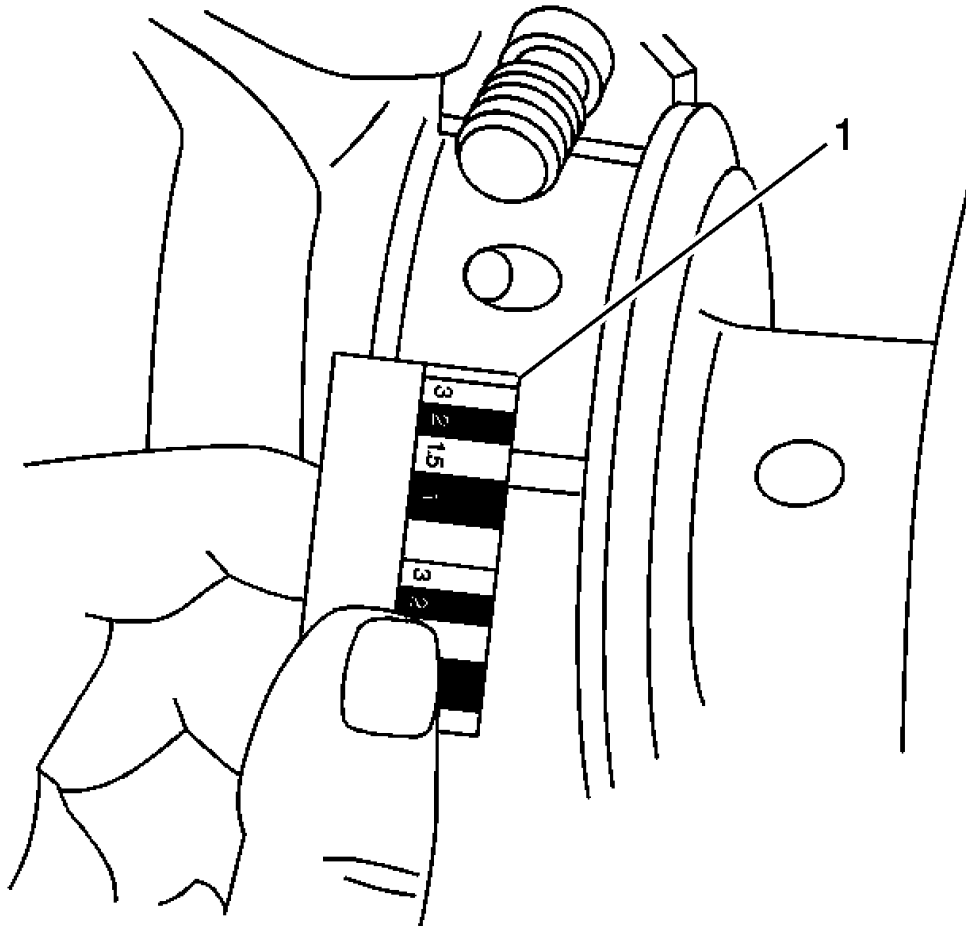


Fig. 207: Measuring Bearing Clearance Using Method B
Courtesy of GENERAL MOTORS COMPANY

3. To measure bearing clearance using Method B, use the following procedure:
 1. Clean the used bearing inserts.
 2. Install the used bearing inserts.
 3. Place a piece of gaging plastic across the entire bearing width.
 4. Install the bearing caps.

CAUTION: In order to prevent the possibility of cylinder block or crankshaft bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead, or a leather mallet before the attaching bolts are installed. Do not

use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.

5. Install the bearing cap bolts to specification.

NOTE: Do not rotate the crankshaft.

6. Remove the bearing cap, leaving the gauging plastic in place. It does not matter whether the gauging plastic adheres to the journal or to the bearing cap.
7. Measure the gauging plastic at its widest point with the scale (1) printed on the gauging plastic package.
8. Remove the gauging plastic.

LOWER CRANKCASE INSTALLATION

Special Tools

EN 45059 Angle Meter

For equivalent regional tools, refer to **Special Tools** .

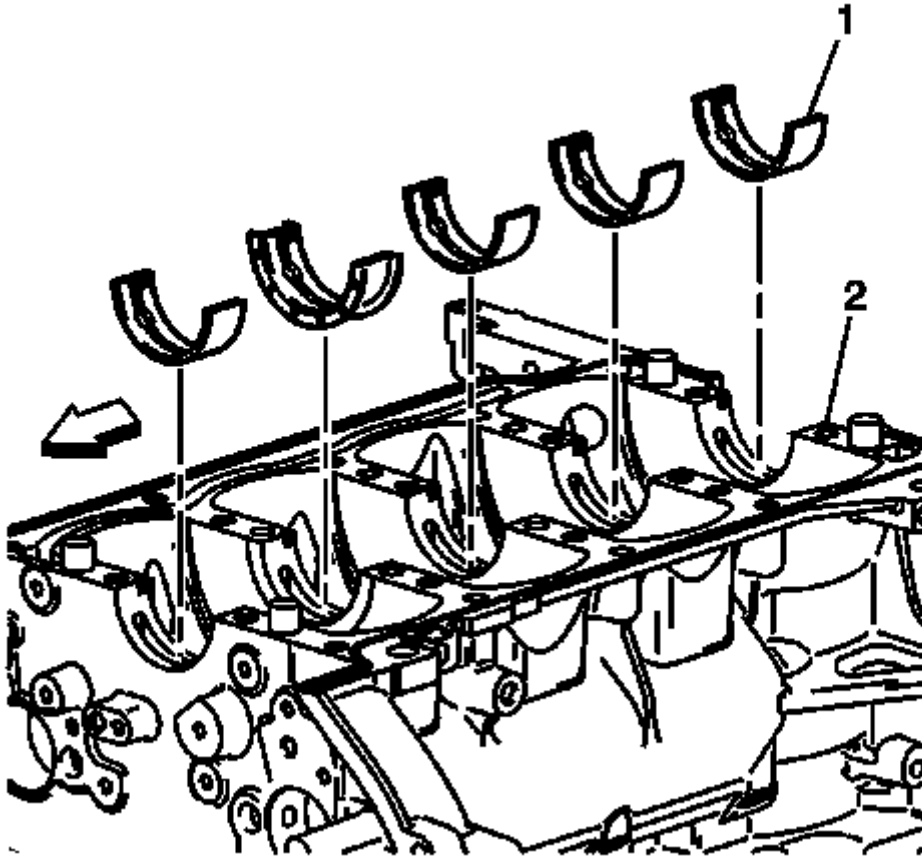


Fig. 208: View of Upper Crankshaft Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: Crankshaft bearings **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.

1. Install the upper crankshaft bearings (1) and lubricate bearing surfaces with engine oil.

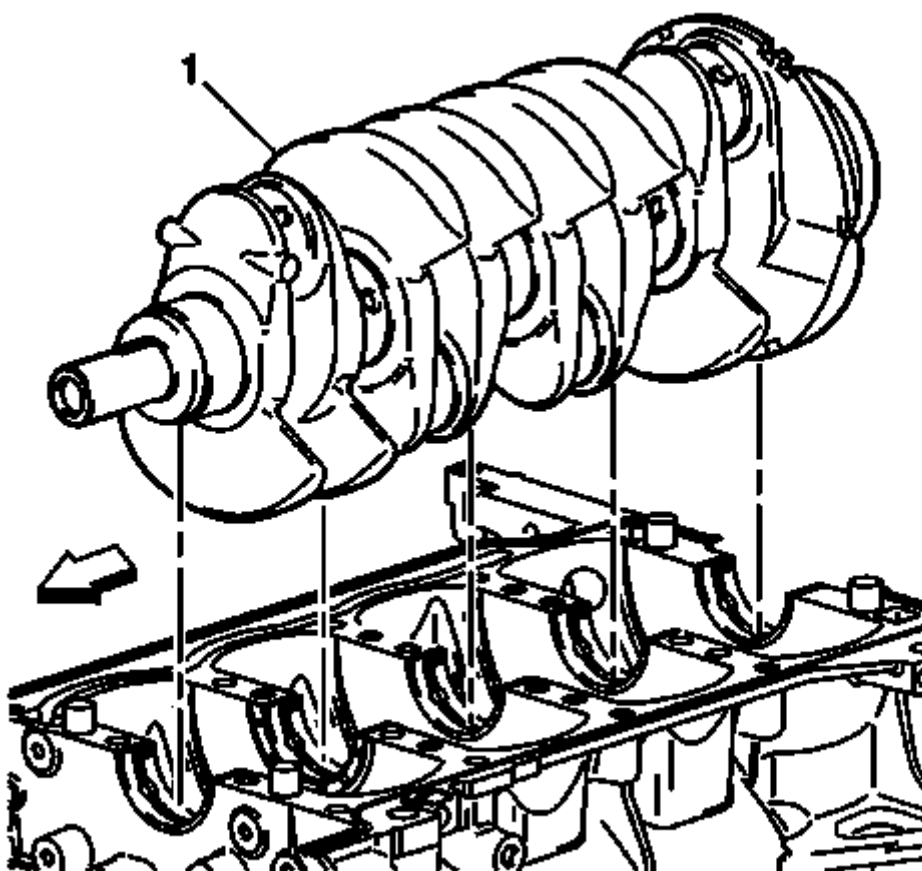


Fig. 209: View of Crankshaft
Courtesy of GENERAL MOTORS COMPANY

2. Install the crankshaft (1) on the journals.

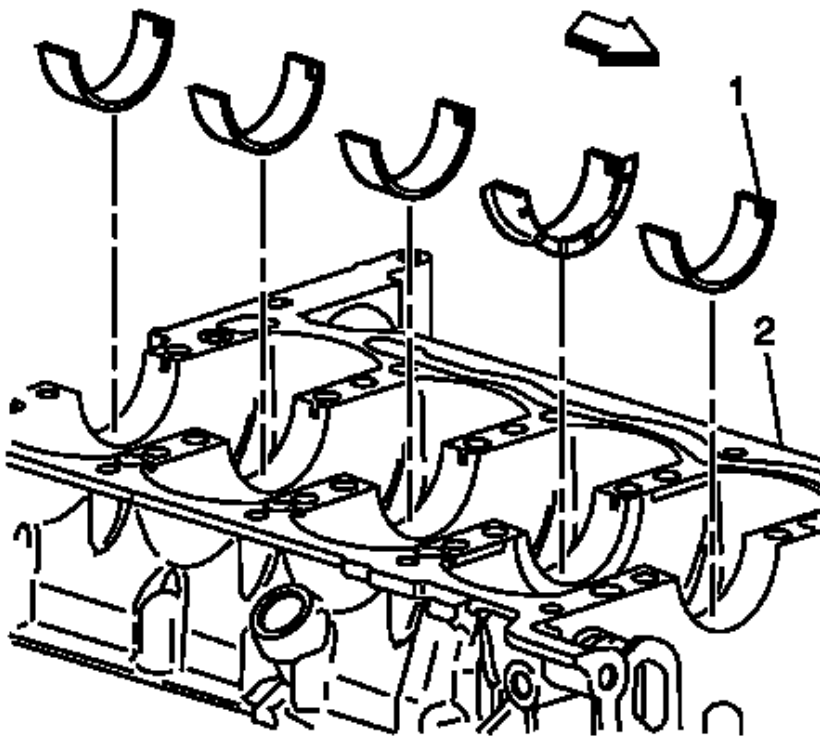


Fig. 210: View of Lower Bearing Halves
Courtesy of GENERAL MOTORS COMPANY

3. Install the lower bearing halves (1), without grooves, into the lower crankcase. Apply oil to bearing surfaces.

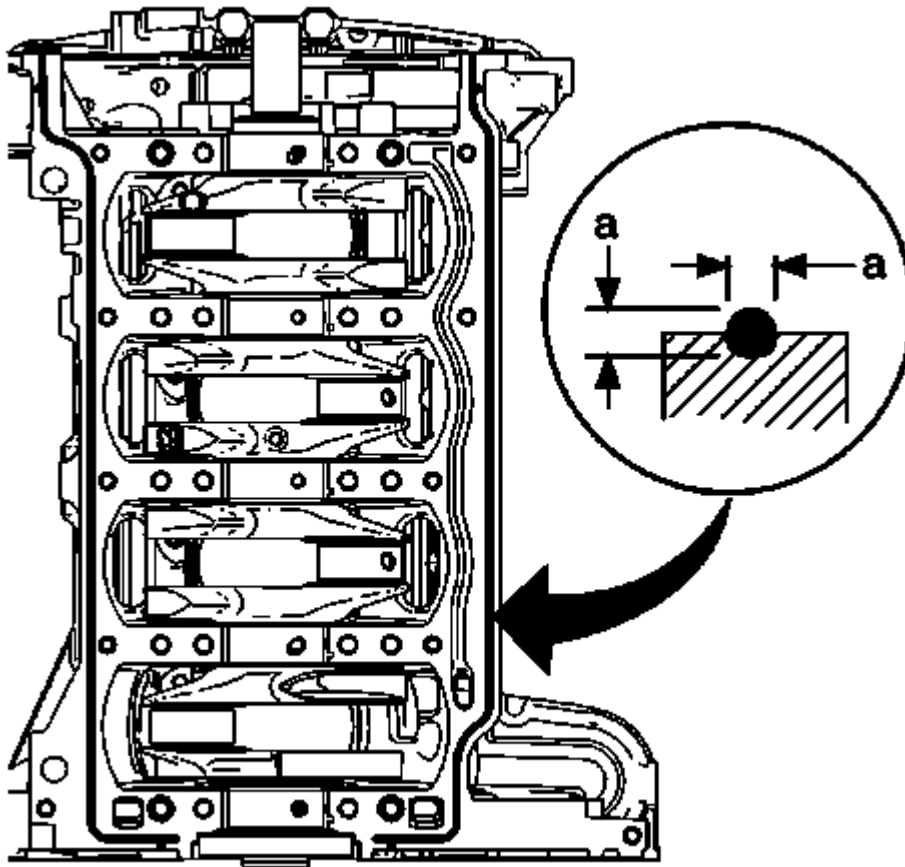


Fig. 211: View of Bead of Sealer on Bedplate Mating Surface
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The block assembly surface must be free of contamination prior to applying the sealer.
- Install and align the bedplate to block within 20 minutes of applying the sealer.
- The bedplate must be fastened to final torque specification within 60 minutes of applying the sealer.

4. Apply a 4.25 mm bead of sealer, dimension (a), directly in the groove of the block to bedplate mating surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

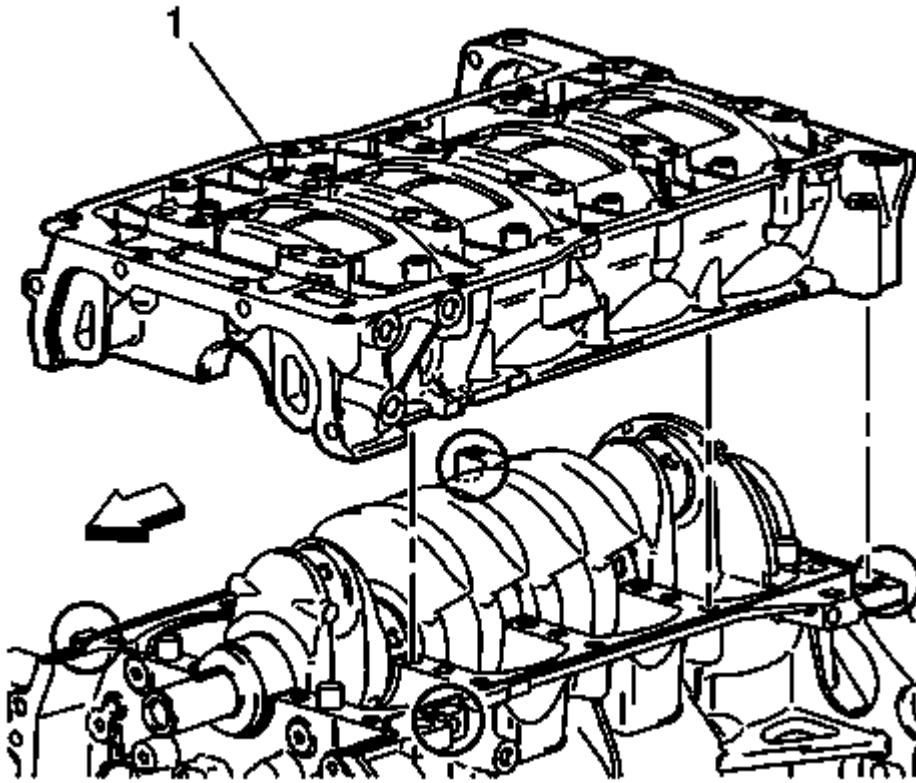


Fig. 212: View of Lower Crankcase
Courtesy of GENERAL MOTORS COMPANY

5. Install the lower crankcase (1). Tap gently into place with a suitable tool if necessary. Ensure it is aligned properly on the dowels.

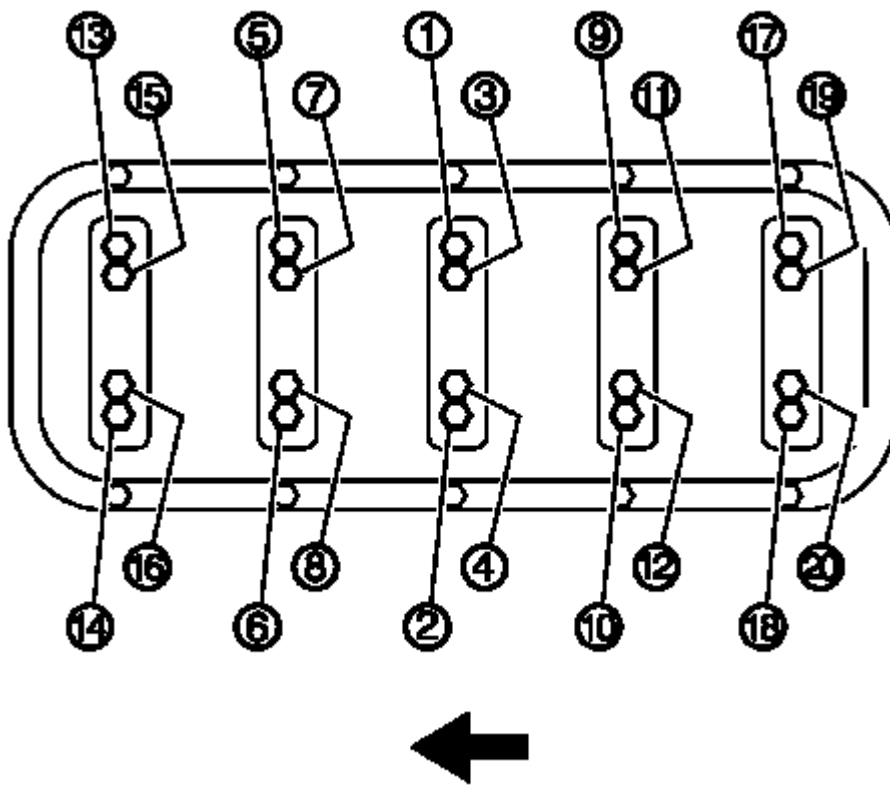


Fig. 213: Identifying Crankshaft Bearing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Install the NEW crankshaft bearing bolts in sequence finger tight.
 1. Tighten the crankshaft bearing bolts in sequence to 20 N.m (15 lb ft).
 2. Tighten the crankshaft bearing bolts in sequence using the **EN 45059** meter an additional 70 degrees.

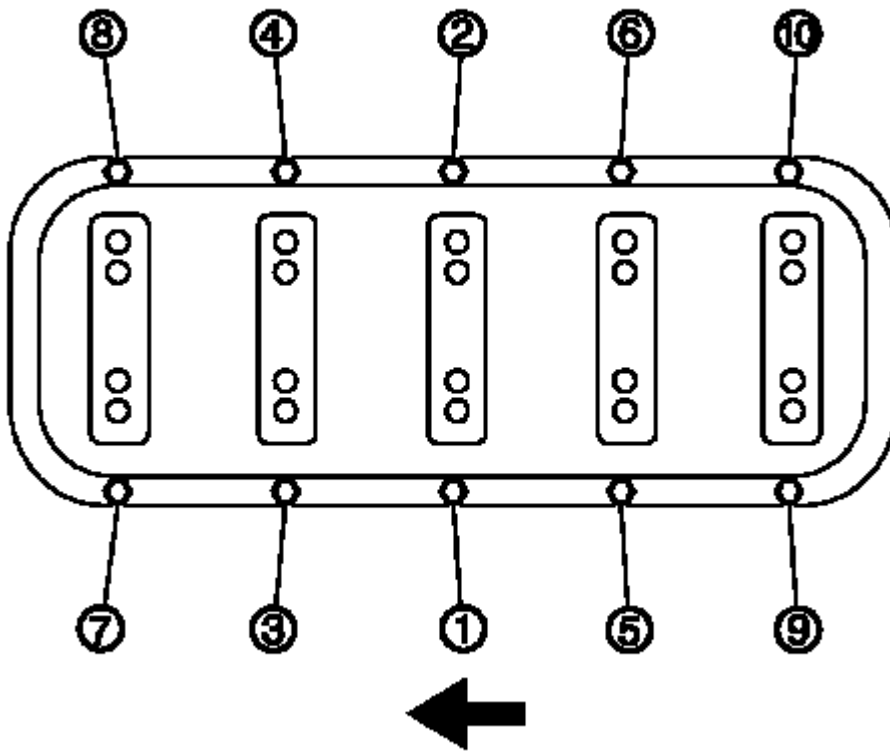


Fig. 214: Lower Crankcase Perimeter Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the lower crankcase perimeter bolts in sequence to 25 N.m (18 lb ft).

CRANKSHAFT REAR OIL SEAL INSTALLATION

Special Tools

EN-42067 Rear Main Seal Installer

For equivalent regional tools, refer to **Special Tools** .

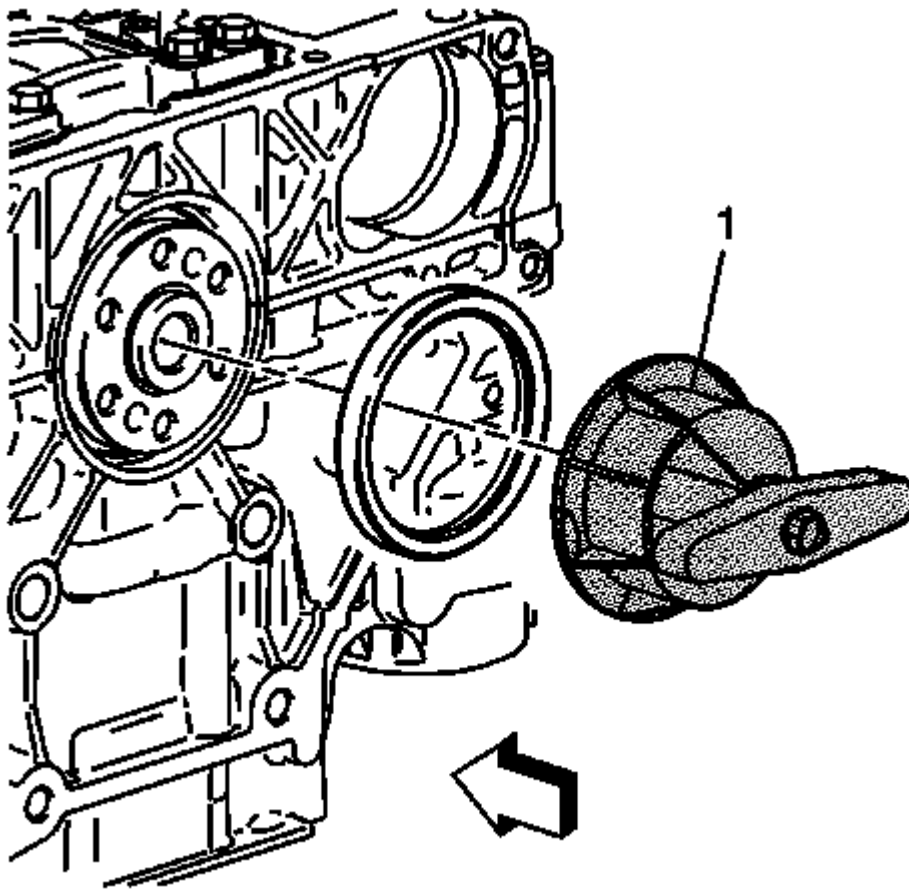


Fig. 215: Rear Crankshaft Seal And Installer
 Courtesy of GENERAL MOTORS COMPANY

1. Remove excess sealer from seal recess.
2. Lubricate the outside diameter of the new crankshaft seal with clean engine oil.
3. Using the **EN-42067** installer (1), press the new crankshaft seal into the housing. The **EN-42067** installer also establishes the depth of the seal in the crankshaft seal bore.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION (LEA, OR LUK)

NOTE: This procedure is not used in Europe.

Special Tools

- **EN-43966** Connecting Rod Guides
- **EN 45059** Angle Meter
- **EN-47836** Piston Ring Compressor

For equivalent regional tools, refer to **Special Tools** .

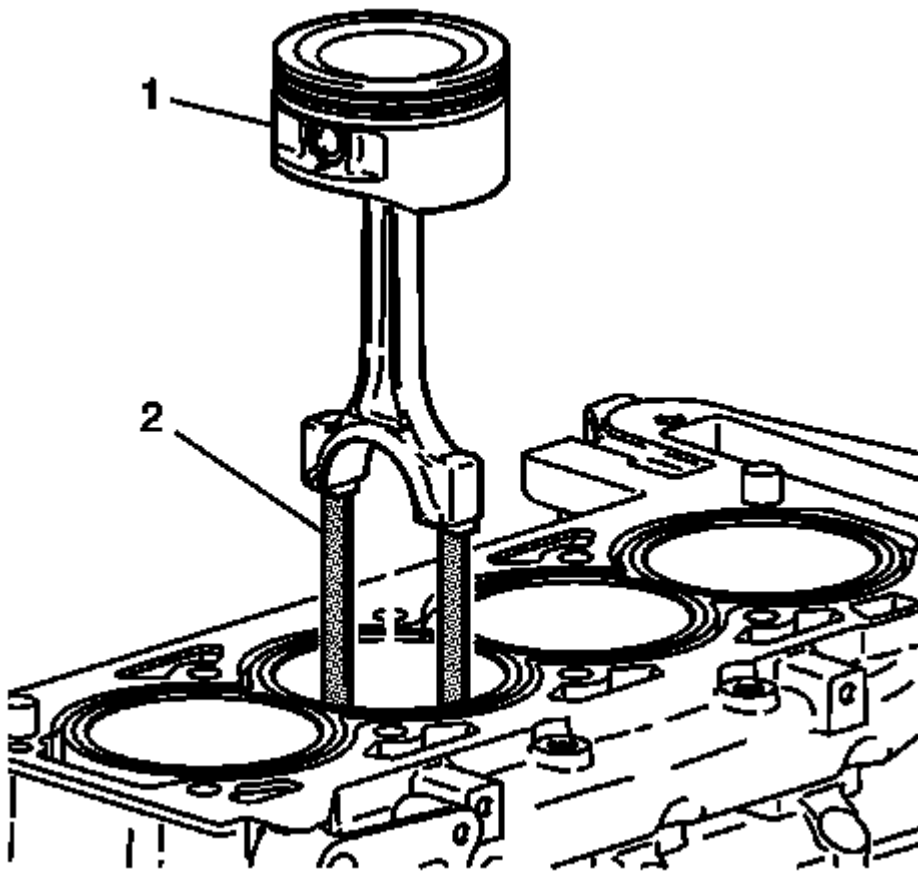


Fig. 216: View Of Connecting Rod Guides
Courtesy of GENERAL MOTORS COMPANY

1. Install the connecting rod bearings. Use NEW bearings.
 1. Install the bearing inserts into the connecting rod and the connecting rod cap.
 2. Lubricate the connecting rod bearings with engine oil.
2. Install the **EN-43966** guides (1) into the connecting rod bolt holes. This protects the crankshaft journal during piston and connecting rod installation.
3. Install **EN-47836** compressor , piston, and the connecting rod to the correct bore.
 1. Stagger each piston ring end gap equally around the piston.
 2. Lubricate the piston and the piston rings with engine oil.
 3. Do not disturb the piston ring end gap location.
 4. The piston must be installed so that the mark on the top of the piston faces the front of the engine.
 5. Place the piston in its matching bore.
 6. Tap the piston into its bore with a hammer handle. Guide the connecting rod to the connecting rod journal while tapping the piston into place.
 7. Hold the **EN-47836** compressor against the engine block until all the rings have entered the cylinder bore.

8. Remove the connecting rod guides from the connecting rod bolt holes.

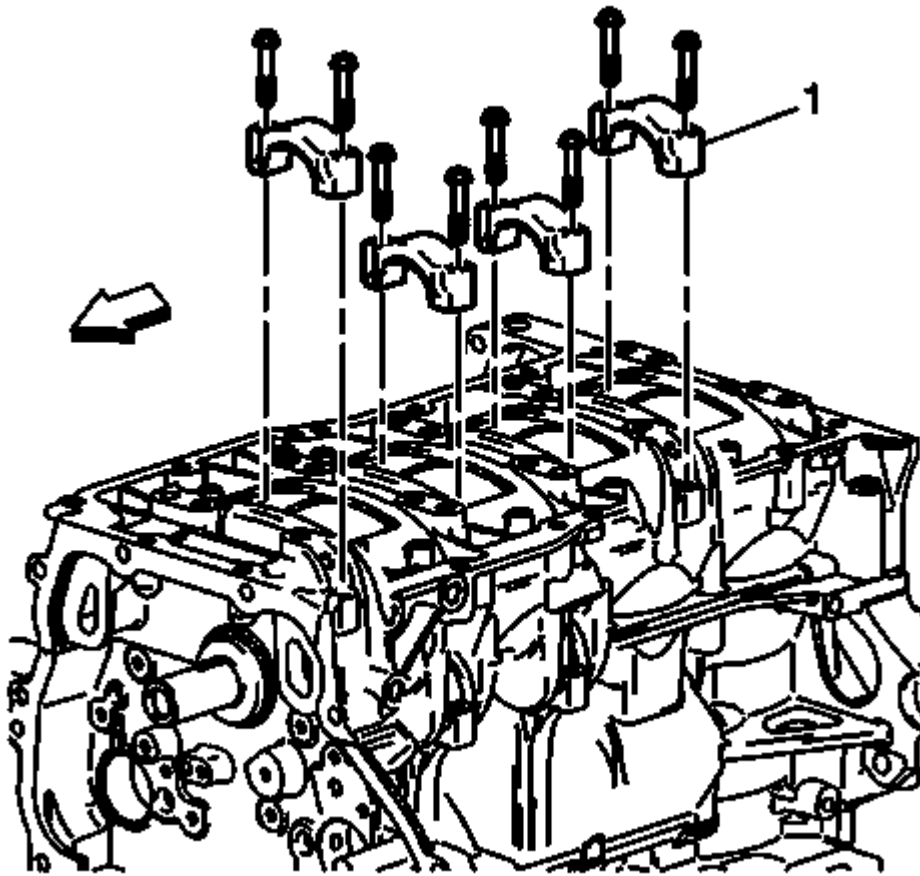


Fig. 217: View of Connecting Rod Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the connecting rod cap is properly oriented on the connecting rod.

4. Install the connecting rod cap (1).

CAUTION: Refer to Fastener Caution .

5. Install the connecting rod bolts. Always use new bolts. Tighten the connecting rod bolts to 25 N.m (18 lb ft), plus 100 degrees using the **EN 45059** meter.
6. Install the remaining connecting rods and piston assemblies.

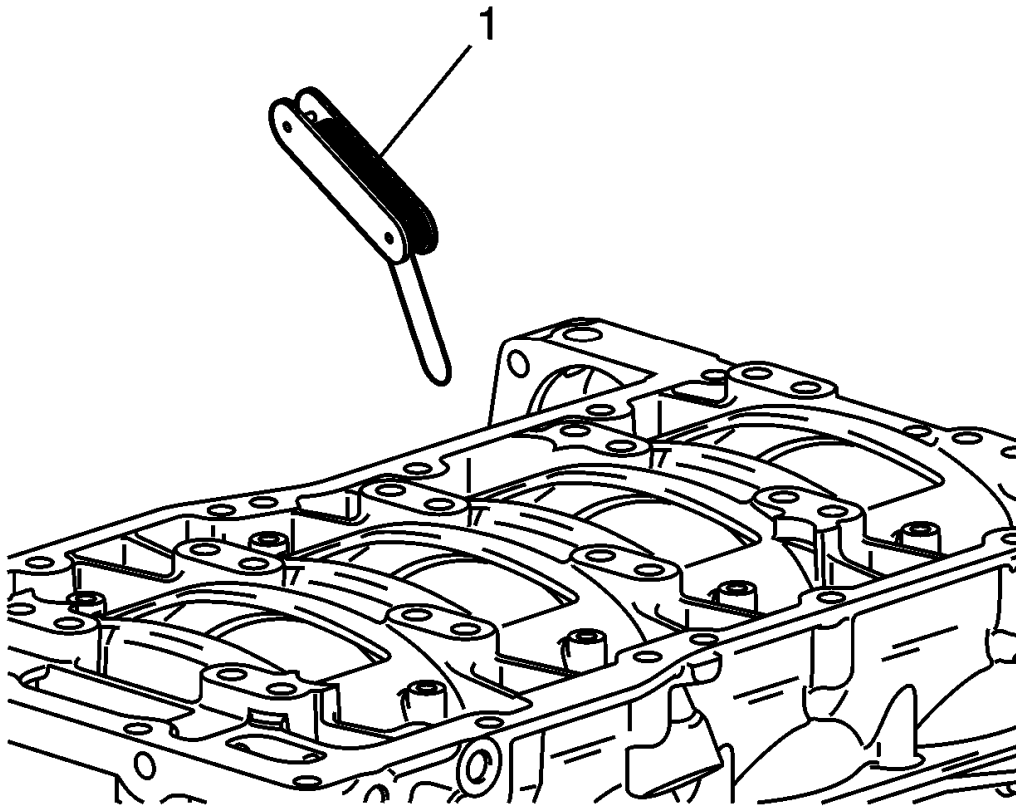


Fig. 218: View of Checking Rod Side Clearance With Feeler Gauge
Courtesy of GENERAL MOTORS COMPANY

7. Measure the connecting rod side clearance with a feeler gauge (1).

The correct clearance is 0.07-0.37 mm (0.0027-0.0145 in).

CYLINDER HEAD INSTALLATION (LEA, OR LUK)

Special Tools

EN 45059 Angle Meter

For equivalent regional tools, refer to **Special Tools**

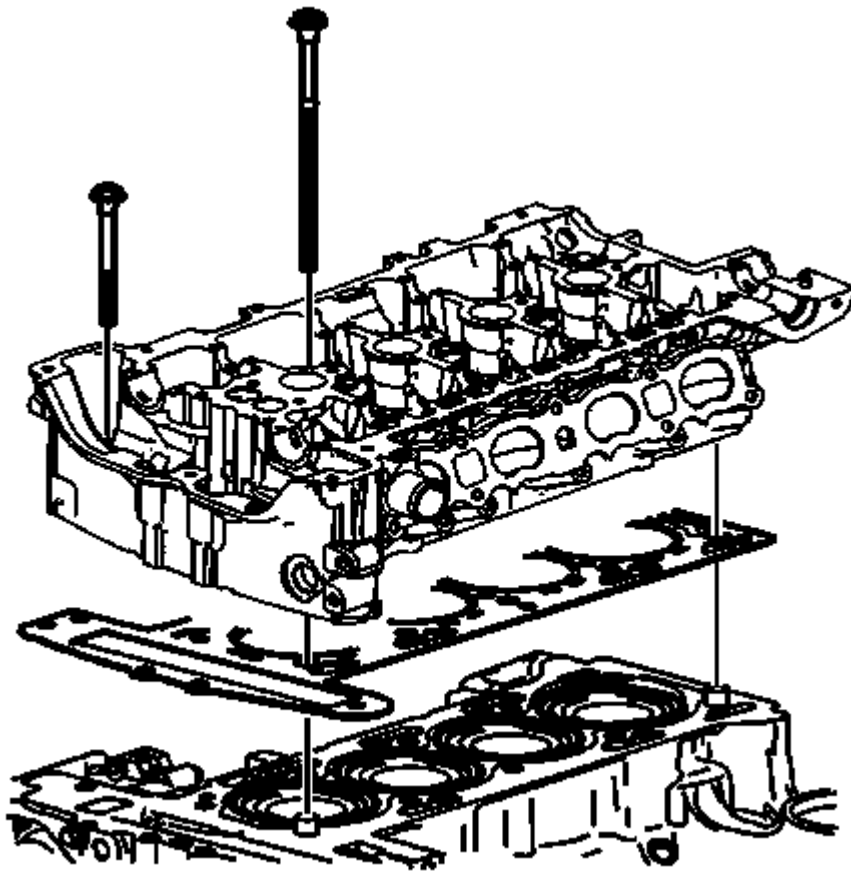


Fig. 219: Cylinder Head

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any sealing material.

1. Install the cylinder head gasket to the block.
2. Install the cylinder head. Ensure the number 1 cylinder is at top dead center (TDC). The key on the crankshaft should be on top in the 12 o'clock position.

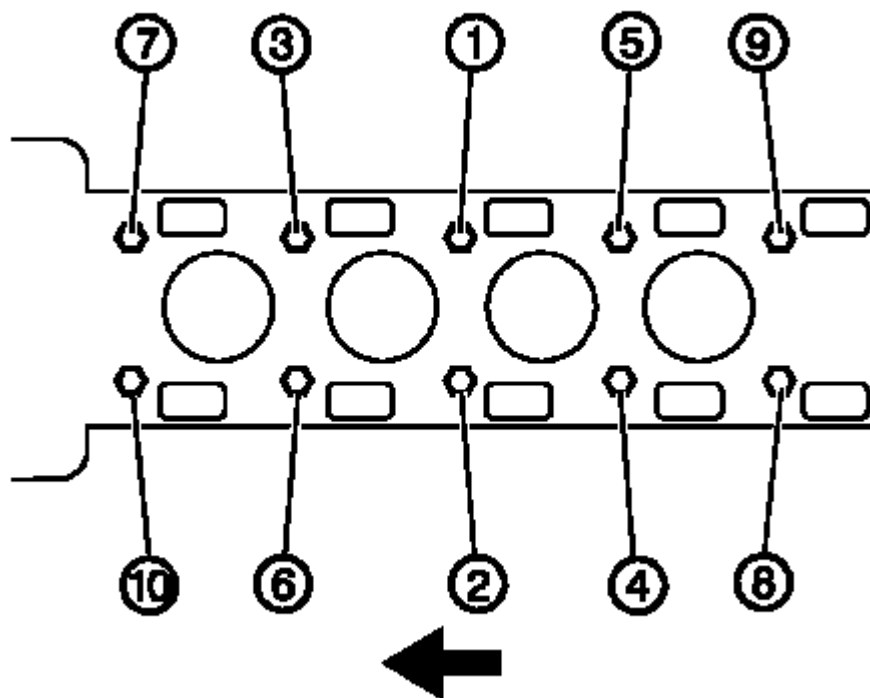


Fig. 220: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Always use **NEW** cylinder head bolts.

3. Install the cylinder head bolts.
 1. Tighten the bolts in sequence to 30 N.m (22 lb ft).
 2. Tighten the bolts an additional 155 degrees in sequence using the **EN 45059** meter.

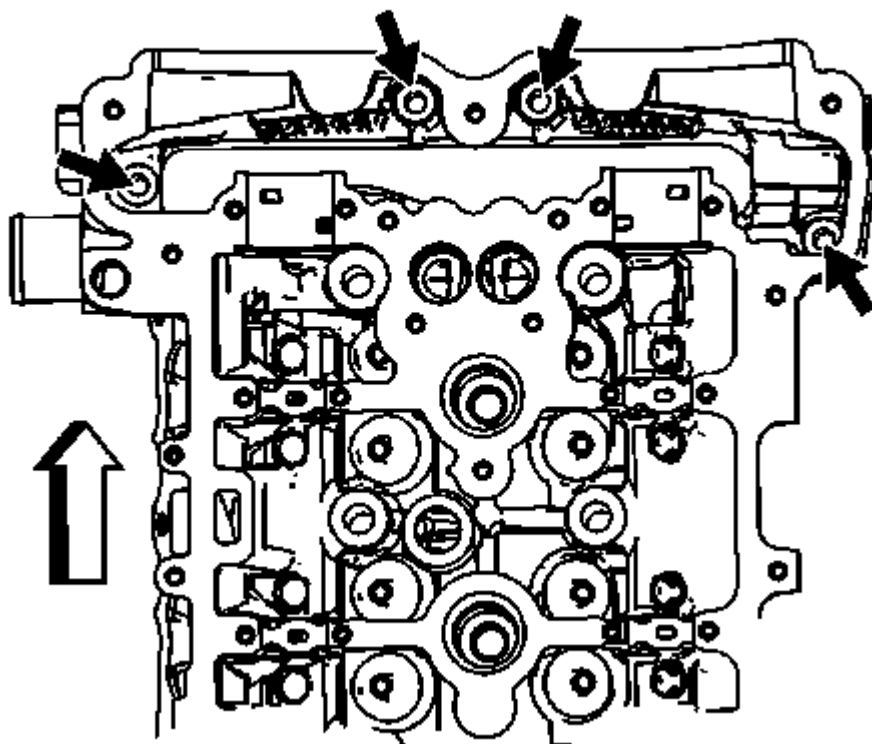


Fig. 221: Locating Front Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the front cylinder head bolts and tighten to 30 N.m (22 lb ft).

INTAKE AND EXHAUST CAMSHAFT, BEARING CAP, AND LASH ADJUSTER INSTALLATION (LEA, OR LUK)

Exhaust Camshaft Installation

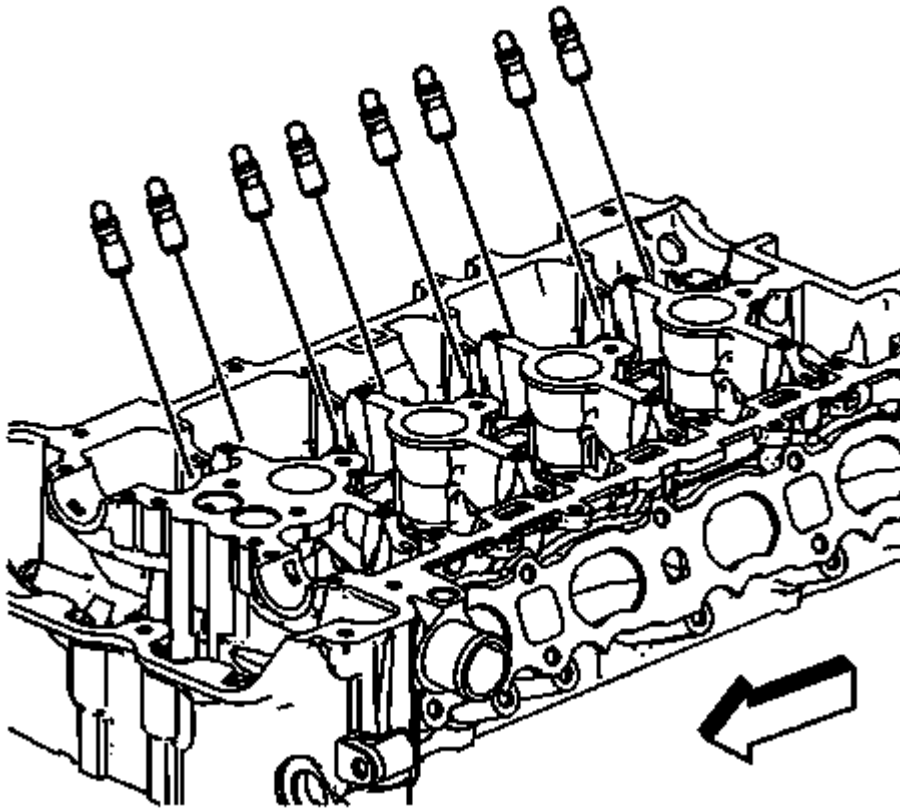


Fig. 222: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

1. Install the hydraulic lash adjusters into their bores in the cylinder head and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

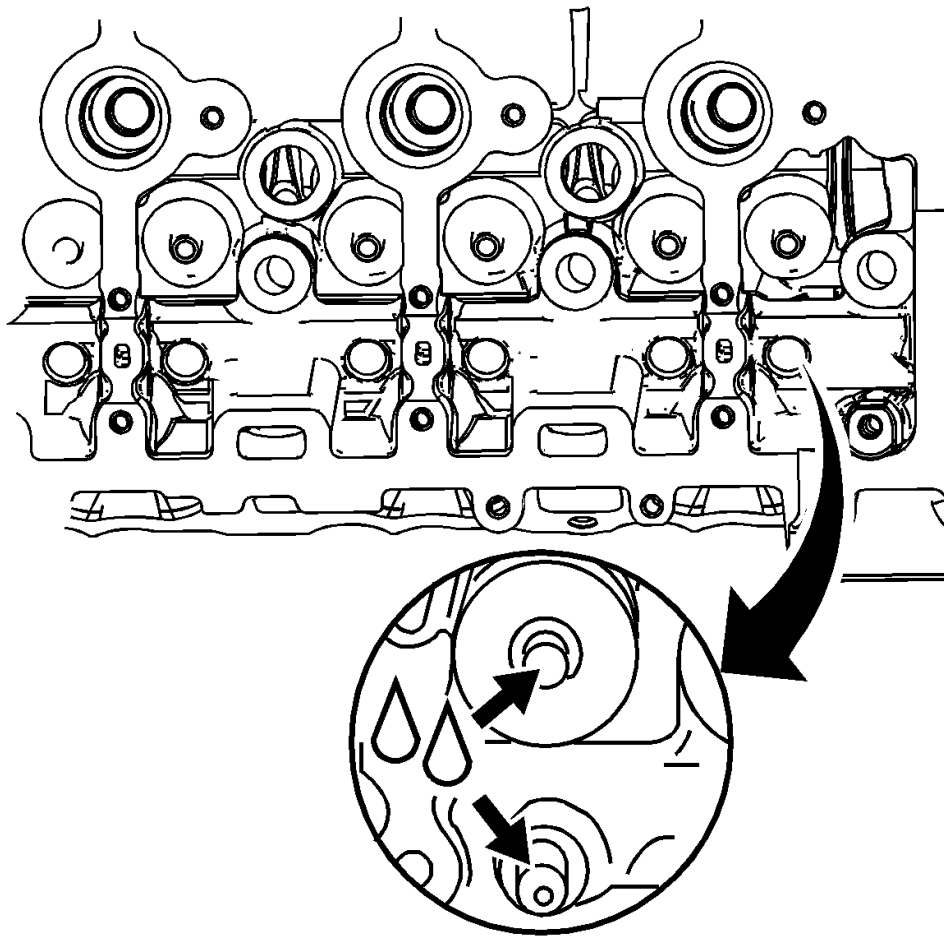


Fig. 223: Valve Tips
Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the valve tips. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

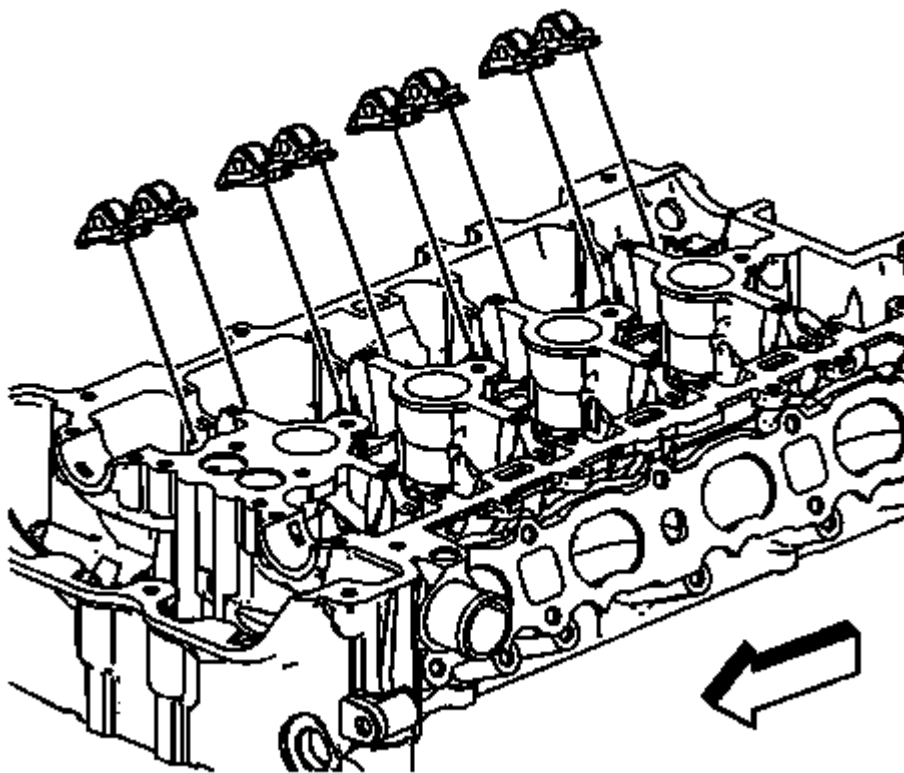


Fig. 224: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Used roller followers must be returned to the original position on the camshaft. If the camshaft is being replaced, the roller followers actuated by the camshaft must also be replaced.

3. Position the roller followers on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

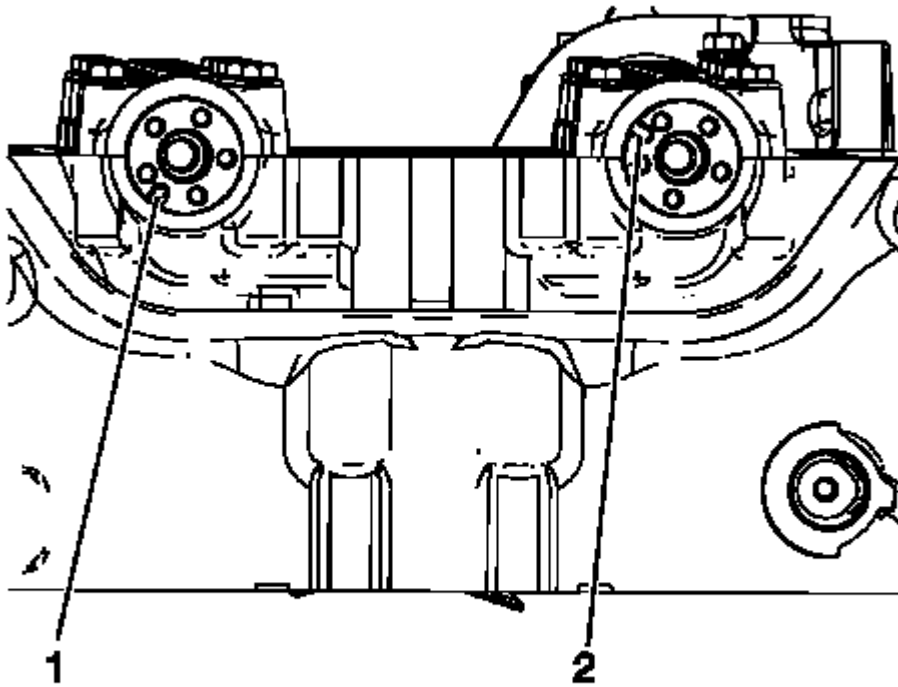


Fig. 225: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: The engine is timed top-dead center exhaust stroke.

4. When installing the camshafts, ensure the intake camshaft notch is in the 10 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

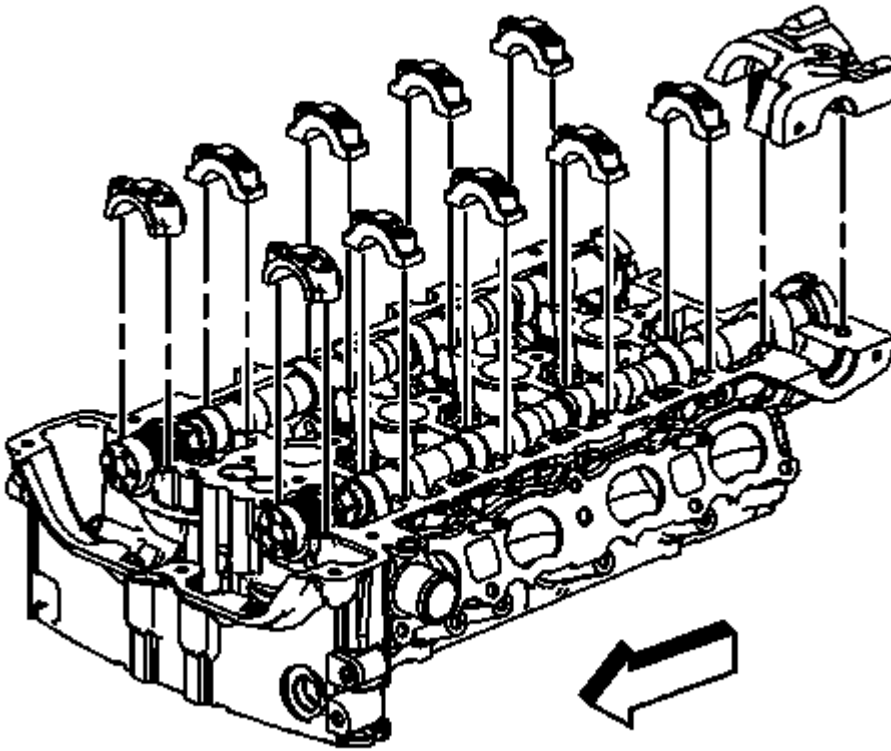


Fig. 226: Intake Camshaft & Caps
Courtesy of GENERAL MOTORS COMPANY

5. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

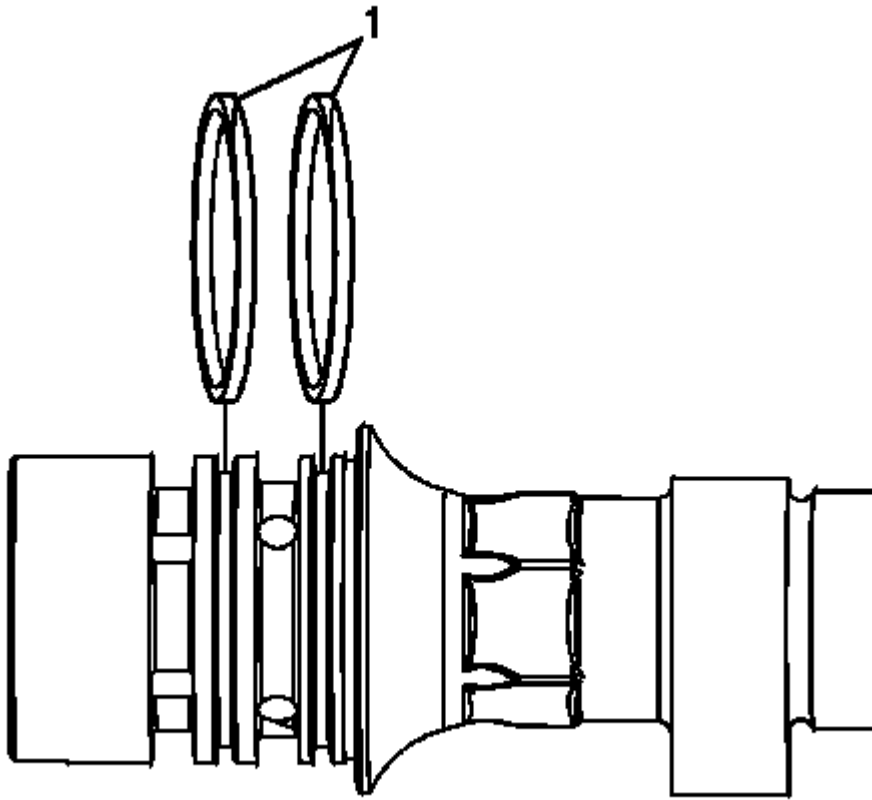


Fig. 227: Oil Seals

Courtesy of GENERAL MOTORS COMPANY

6. Rotate the oil seal in the groove of the number one camshaft journal so the split line (1) is at approximately the 12:00 position before installing the camshaft caps.

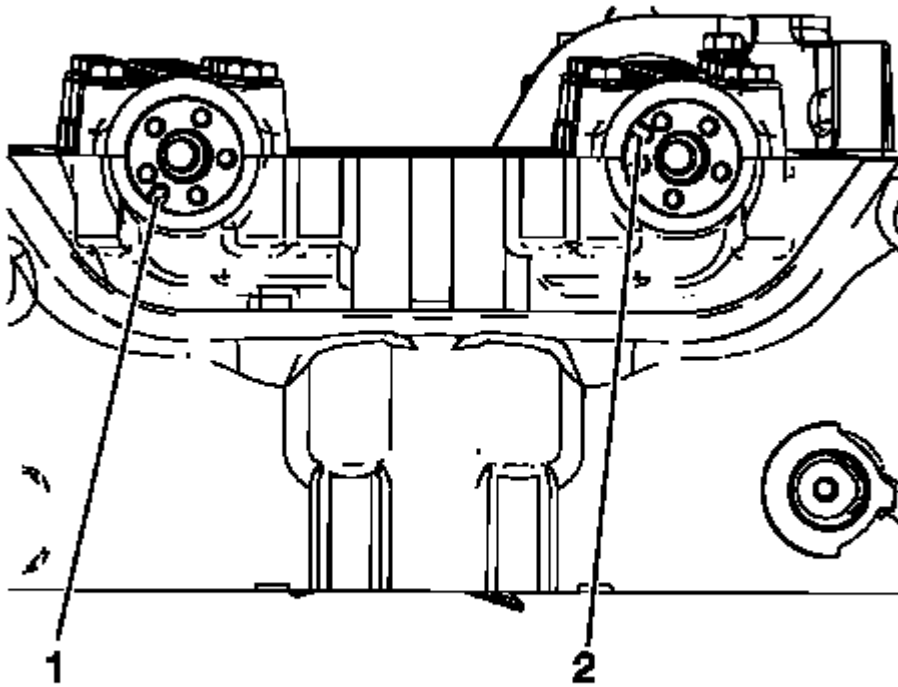


Fig. 228: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

7. Install the exhaust camshaft with the notch on the front (1) at approximately the 7 o'clock position.
8. Install the camshaft caps and hand start the camshaft cap bolts.

CAUTION: Refer to Fastener Caution .

9. Tighten the camshaft cap bolts in increments of 3 turns until they are seated. Tighten the camshaft caps to 10 N.m (89 lb in).

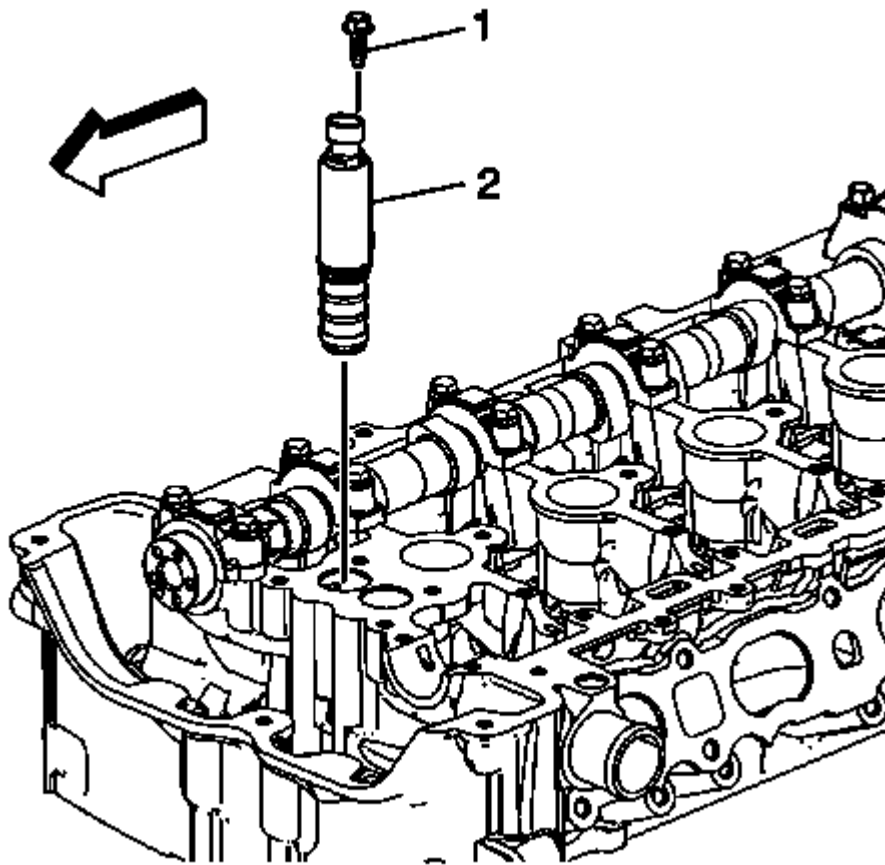


Fig. 229: Exhaust Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install the exhaust camshaft position actuator solenoid valve (2). Tighten the solenoid valve bolt (1) to 10 N.m (89 lb in).

Intake Camshaft Installation

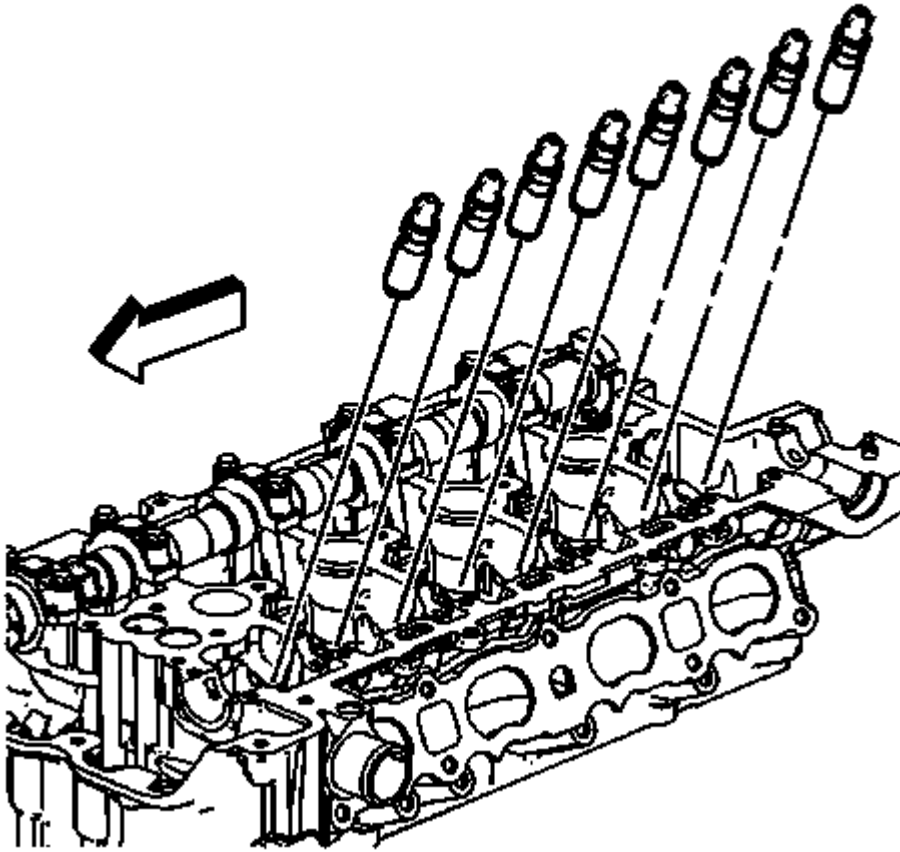


Fig. 230: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

1. Install the hydraulic lash adjusters into their bores in the cylinder head.
2. Lubricate the hydraulic lash adjusters. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

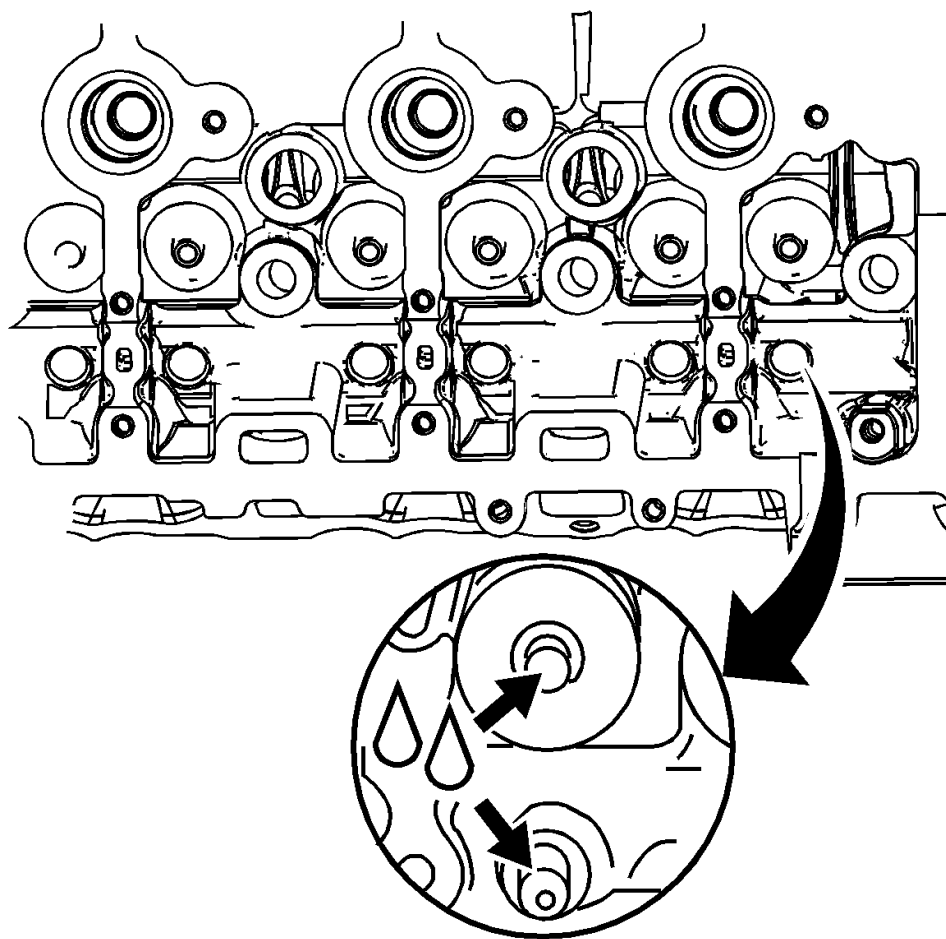


Fig. 231: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

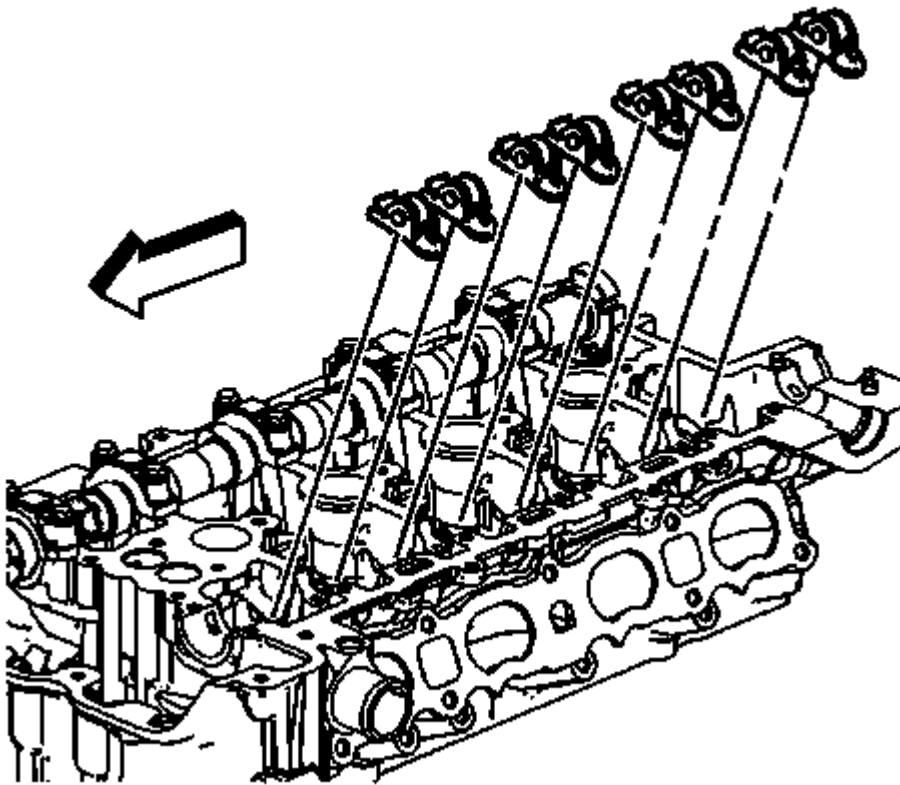


Fig. 232: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Used roller followers must be returned to the original position on the camshaft. If the camshaft is being replaced, the roller followers actuated by the camshaft must also be replaced.

4. Position the roller followers on the tip of the valve stem and on the lash adjuster. Lubricate roller followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

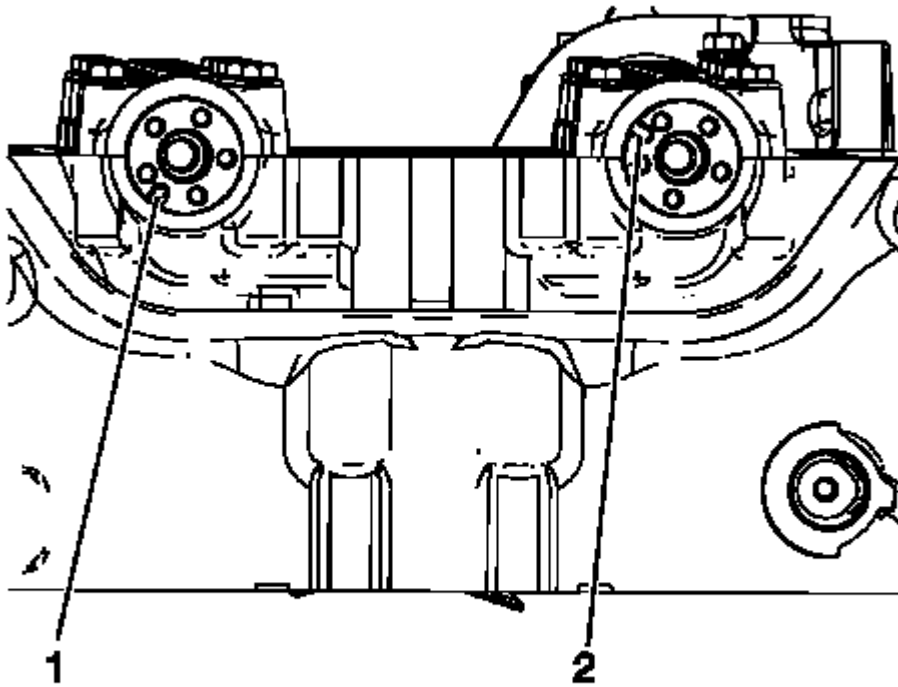


Fig. 233: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: The engine is timed top-dead center exhaust stroke.

5. When installing the camshafts, ensure the intake camshaft notch is in the 10 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

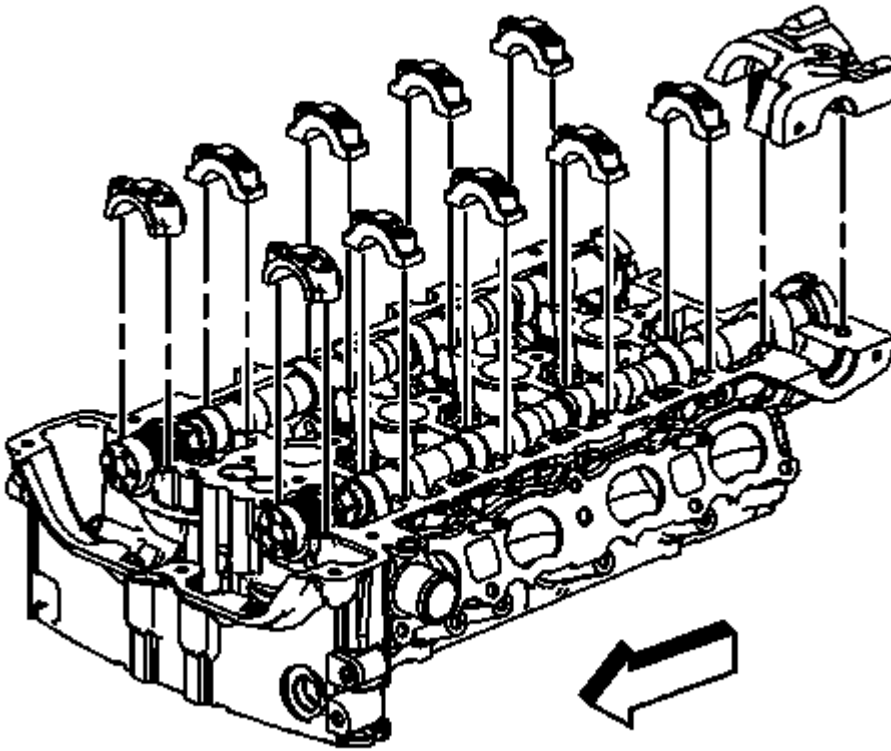


Fig. 234: Intake Camshaft & Caps
Courtesy of GENERAL MOTORS COMPANY

6. Set the intake camshaft on top of the roller followers in the camshaft bearing journals and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

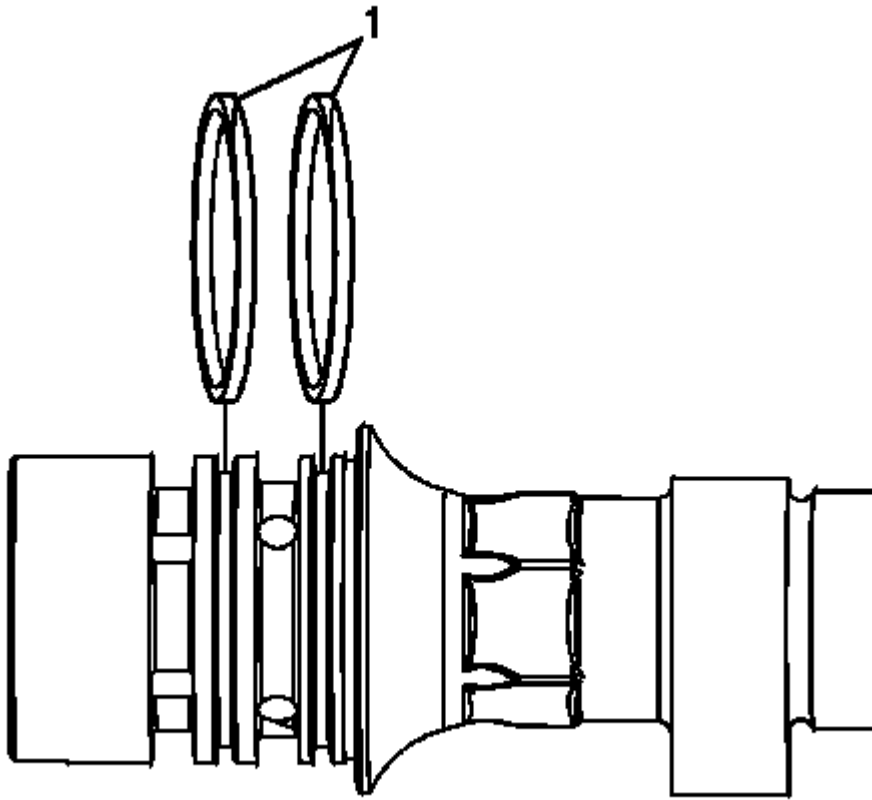


Fig. 235: Oil Seals

Courtesy of GENERAL MOTORS COMPANY

7. Rotate the oil seal in the groove of the number one camshaft journal so the split line (1) is at approximately the 12:00 position before installing the camshaft caps.

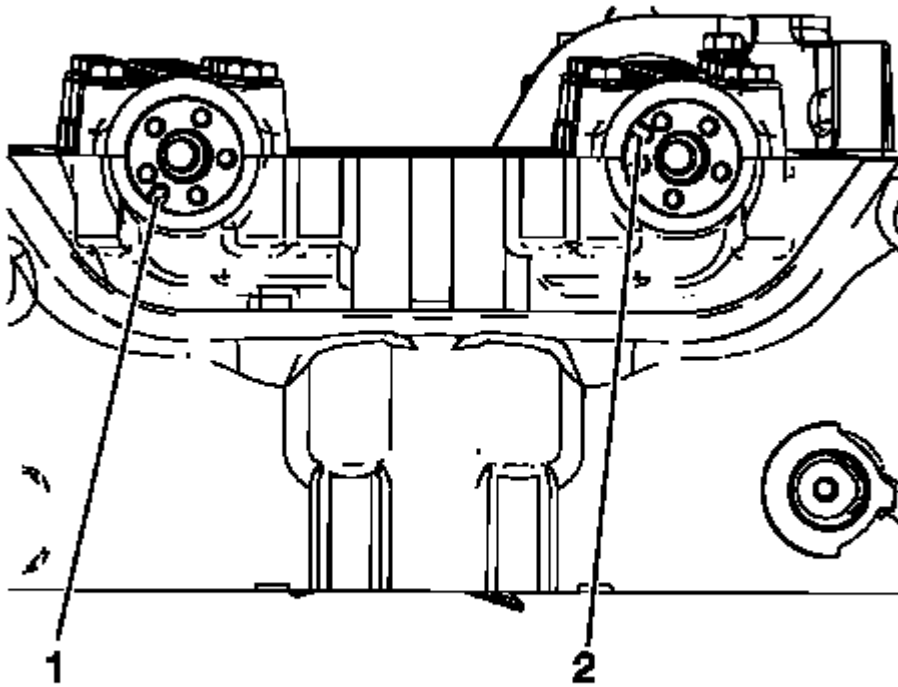


Fig. 236: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: The number 1 cylinder must be at top dead center (TDC), crankshaft keyway at the 12 o'clock position.

8. Install the intake camshaft with the notch on the front at approximately the 10 o'clock position (2).
9. Install the camshaft caps and hand start the camshaft cap bolts.
10. Tighten the camshaft cap bolts in increments of 3 turns until they are seated. Tighten the camshaft caps to 10 N.m (89 lb in).

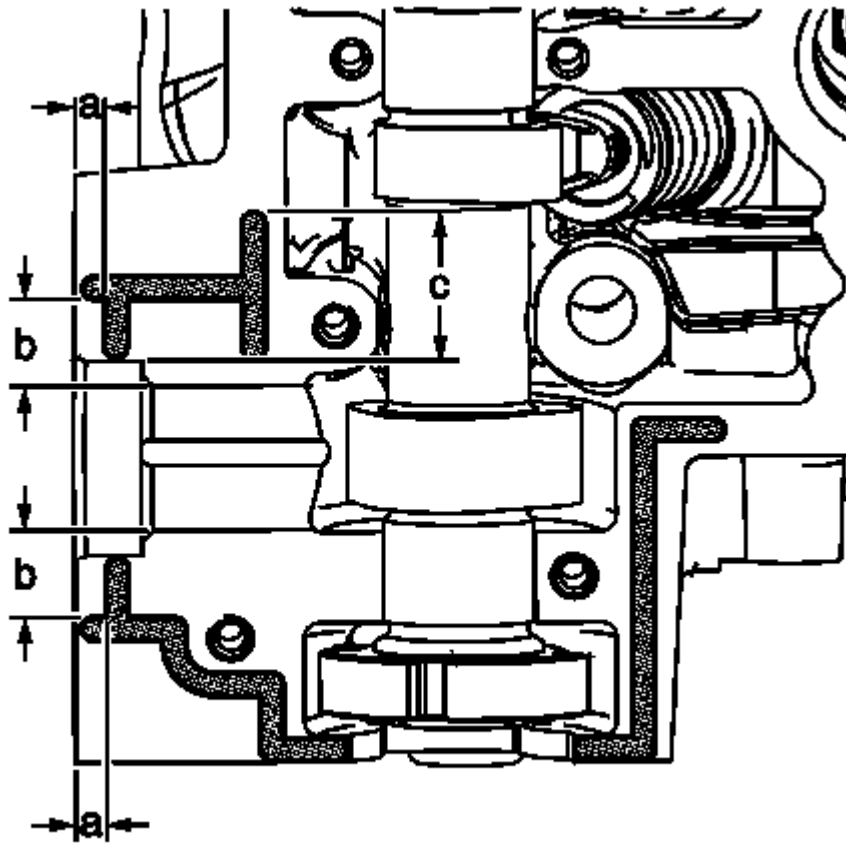


Fig. 237: Sealer Application Areas
 Courtesy of GENERAL MOTORS COMPANY

- NOTE:** It is critical during installation to ensure the bearing rear cap and cylinder head alignment is correct and the mating surfaces are flush.
- Ensure that all sealing material has been removed from the components, and the sealing surfaces are clean and free of contamination prior to applying the sealer.
 - Install and align the rear cap within 20 minutes of applying the sealer.

- NOTE:** Apply the sealer to all locations centrally locating the bead on the rail.
- Run bead to 5.0 mm, dimension a, as shown.
 - Where the cap ends on the perimeter rail, extend bead approximately 4.0 mm beyond edge of cap.
 - Run bead, dimension c, 32 mm from the edge of the cylinder head as shown.
 - Run beads, dimension b, 20 mm from edge of cylinder head as shown.

11. Apply a 2.5 mm bead of sealer to the cylinder head at the number 6 intake camshaft rear cap mating surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
12. Install the number 6 intake camshaft rear cap.
 1. Tighten the cap bolts evenly to 5 N.m (44 lb in).
 2. Tighten the cap bolts evenly to 10 N.m (89 lb in).
 3. Back the cap bolts out 120 degrees.
 4. Tighten the cap bolts evenly a final pass to 10 N.m (89 lb in).

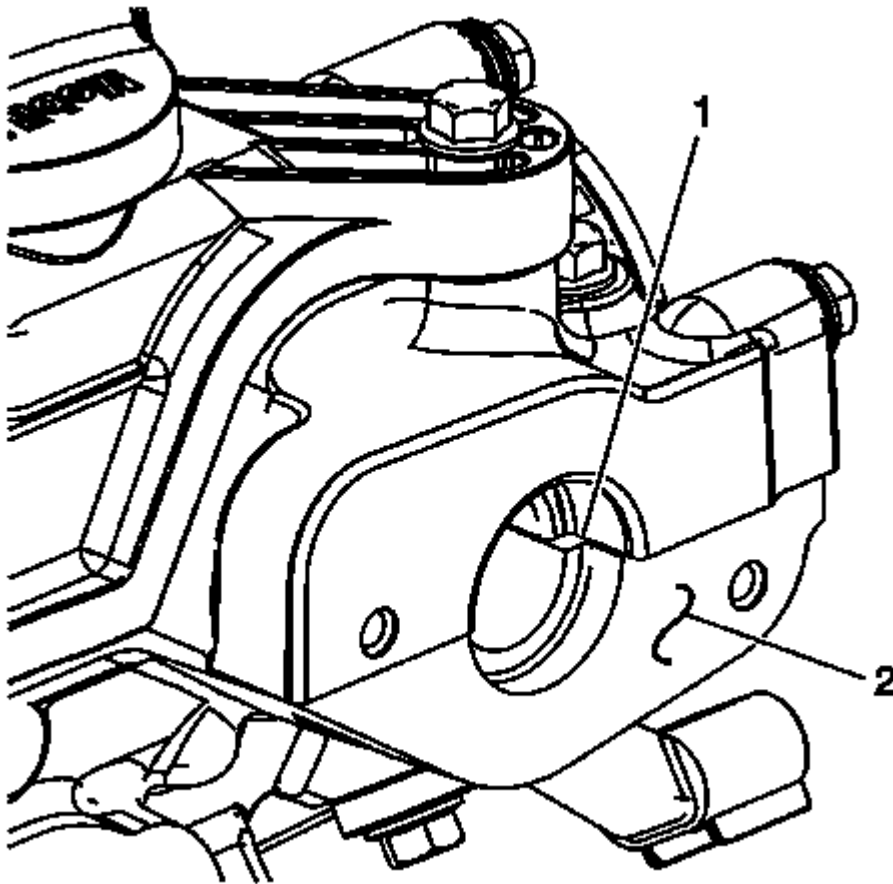


Fig. 238: Identifying Fuel Pump Roller Lifter Orifice
Courtesy of GENERAL MOTORS COMPANY

13. Remove all excess sealing material from the fuel pump roller lifter bore (1), and ensure the bore is free of debris. Do not allow any excess sealing material to remain within the cylinder head or on any sealing surface.
14. Remove all excess sealing material from the fuel pump assembly sealing surface (2).

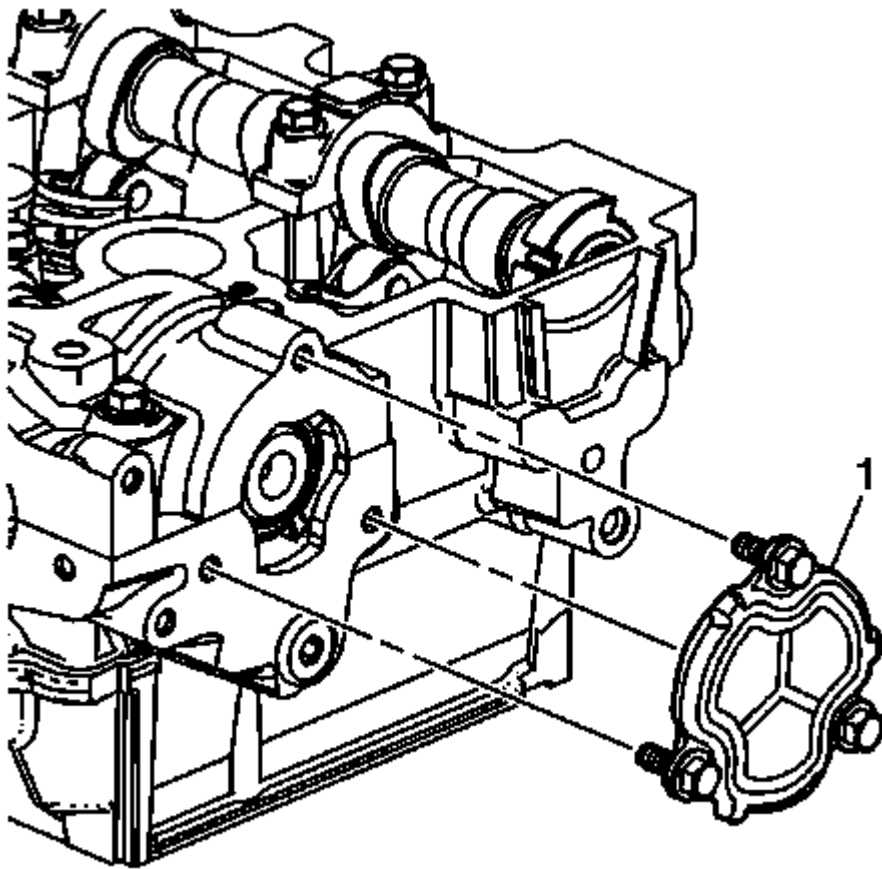


Fig. 239: Rear Cylinder Head Cover Plate
Courtesy of GENERAL MOTORS COMPANY

15. Verify the seal on the cylinder head cover plate (1) is intact and in good condition.
16. Ensure that the opening plate sealing surface is clean and free of excess sealing material. Install the rear cylinder head opening plate (1) and tighten the bolts to 10 N.m (89 lb in).

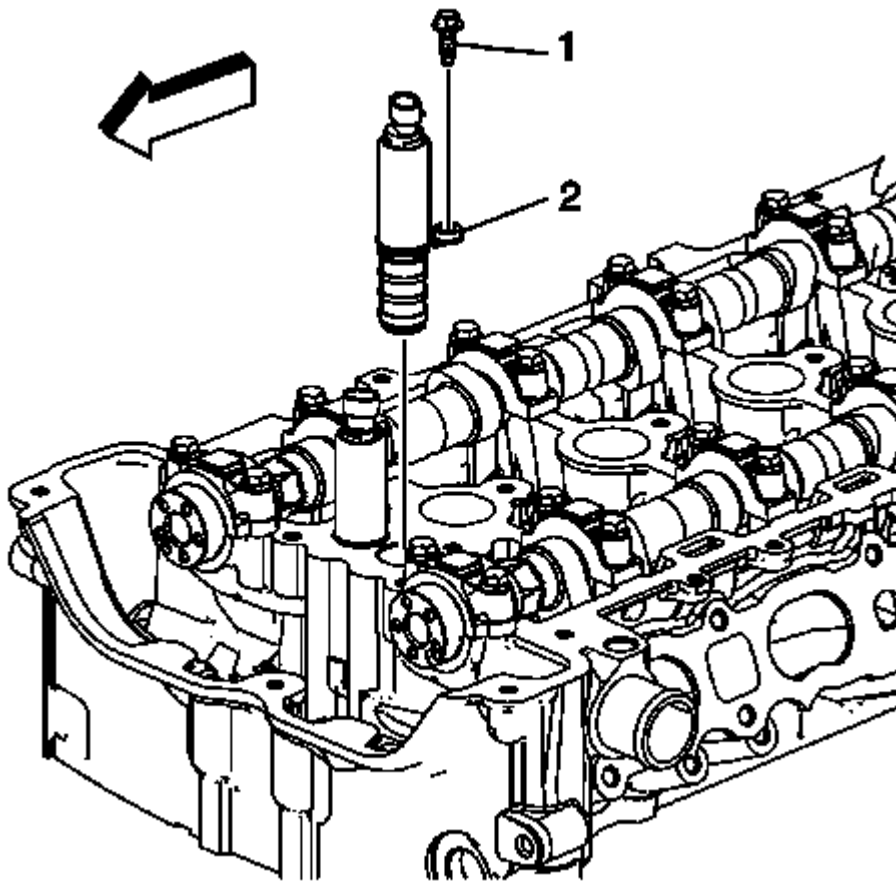


Fig. 240: Intake Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

17. Install the intake camshaft position actuator solenoid valve (2). Tighten the solenoid valve bolt (1) to 10 N.m (89 lb in).

BALANCE SHAFT INSTALLATION

NOTE: This procedure is not used in Europe.

Special Tools

EN-43650 Balance Shaft Bushing Remover/Installer

For equivalent regional tools, refer to **Special Tools** .

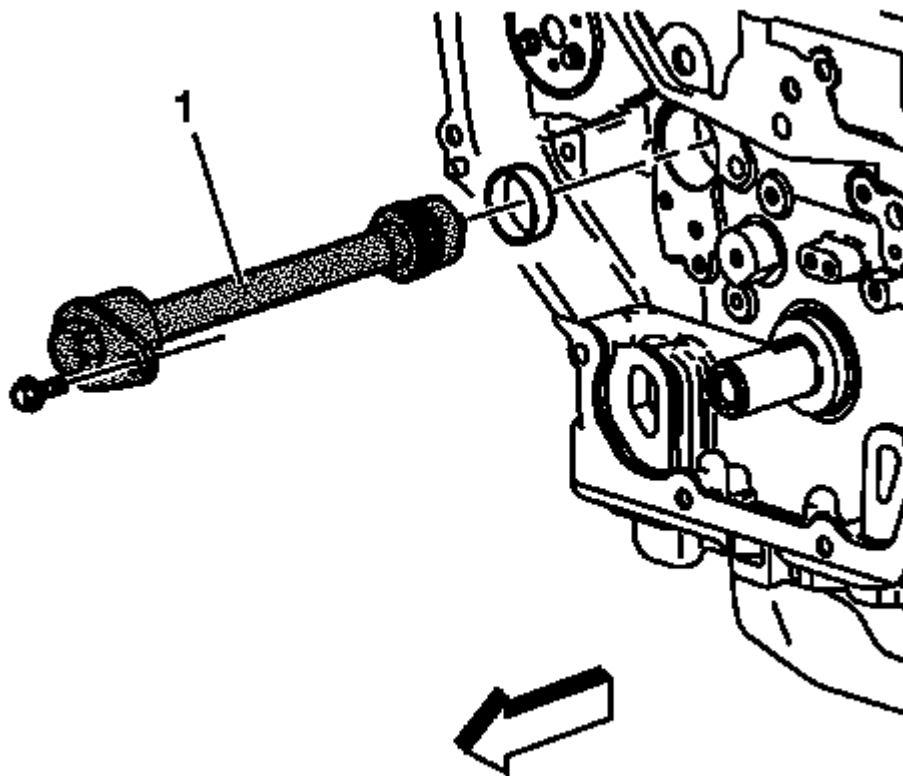


Fig. 241: Balance Shaft Bushing Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

1. Install the balance shaft bushing using the **EN-43650** installer (1).

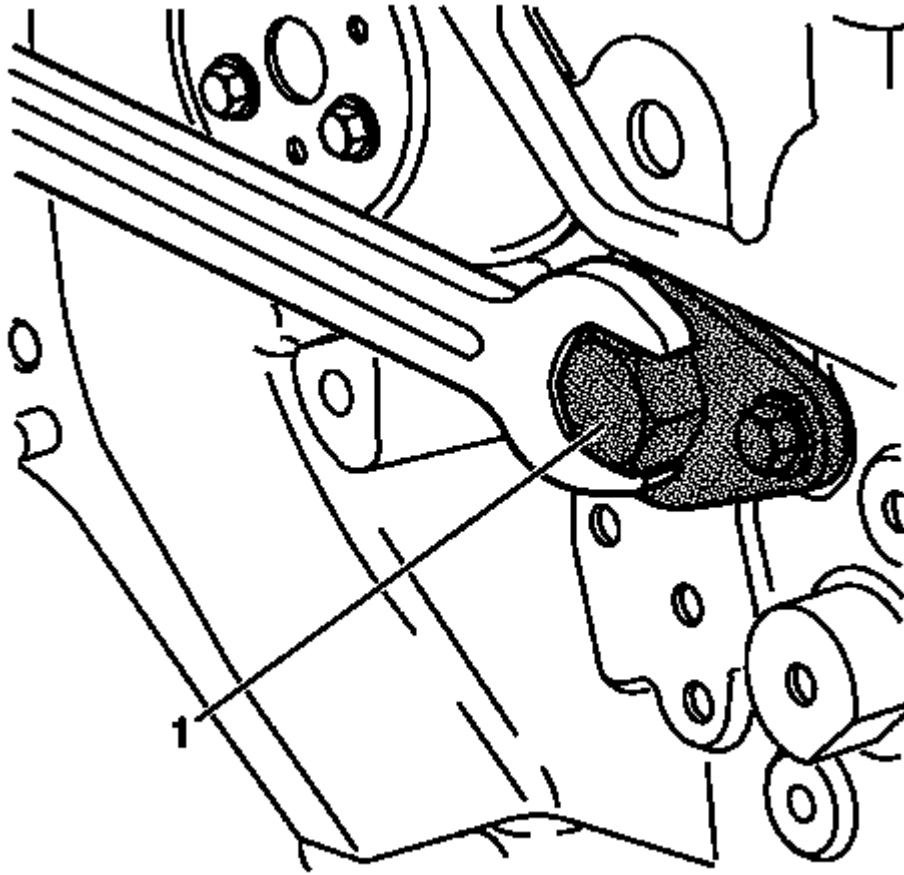


Fig. 242: Seat Balance Shaft Bushing Into Bore Using Balance Shaft Bushing Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

2. Seat the balance shaft bushing into the bore using the **EN-43650** installer (1) and a wrench.
3. When the **EN-43650** installer is fully seated in the engine block, remove it with a wrench.

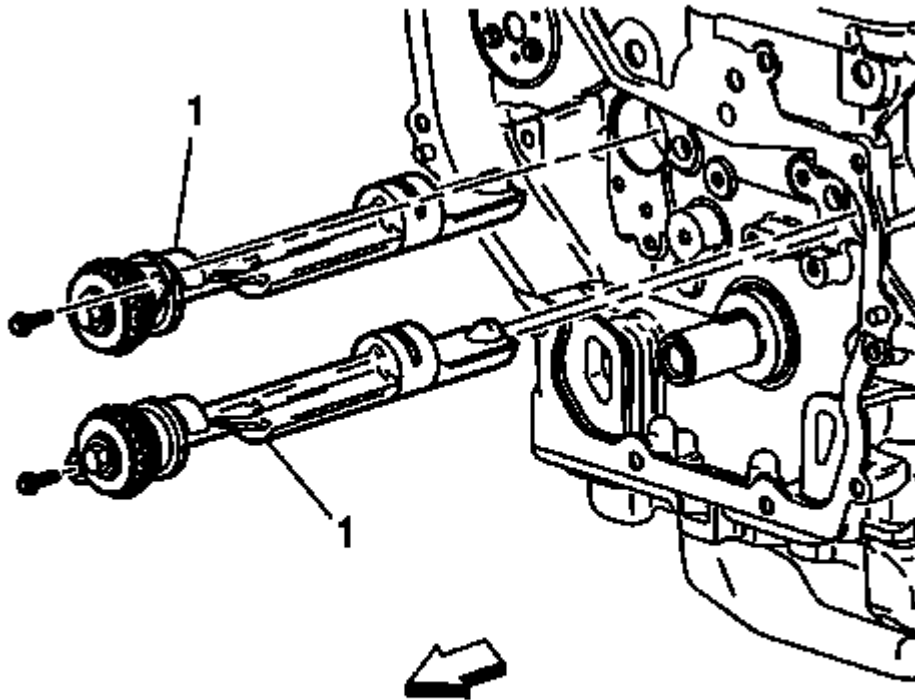


Fig. 243: View of Balance Shaft Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.

4. Place the number one piston at top dead center (TDC).
5. Lubricate the balance shaft lobes with engine oil.
6. Install the balance shafts (1) into their bores.

CAUTION: Refer to Fastener Caution .

7. Install the balance shaft retaining bolts and tighten to 10 N.m (89 lb in).

WATER PUMP INSTALLATION

Prior to installing the water pump, read the entire procedure. Pay special attention to avoid part damage and to ensure proper sealing.

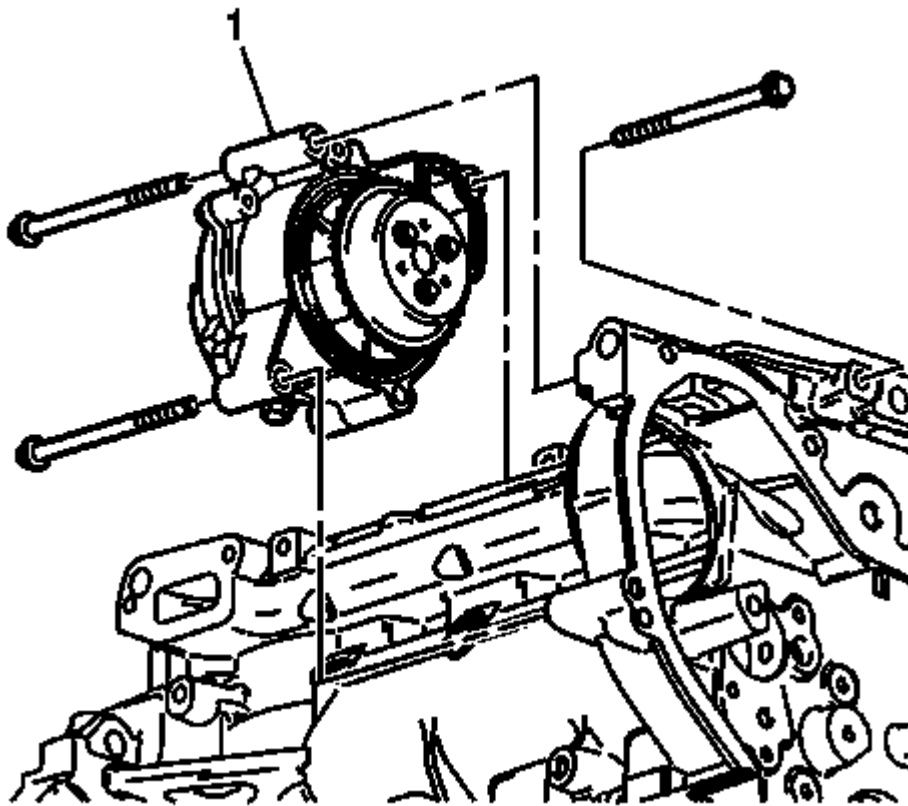


Fig. 244: Water Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the water pump assembly (1).
2. Install the water pump bolts. Finger tighten the bolts.

CAUTION: Refer to Fastener Caution .

3. Tighten the water pump bolts to 25 N.m (18 lb ft).
4. Apply sealant to the water pump drain plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
5. Install the water pump drain plug, if necessary. Tighten to 20 N.m (15 lb ft).

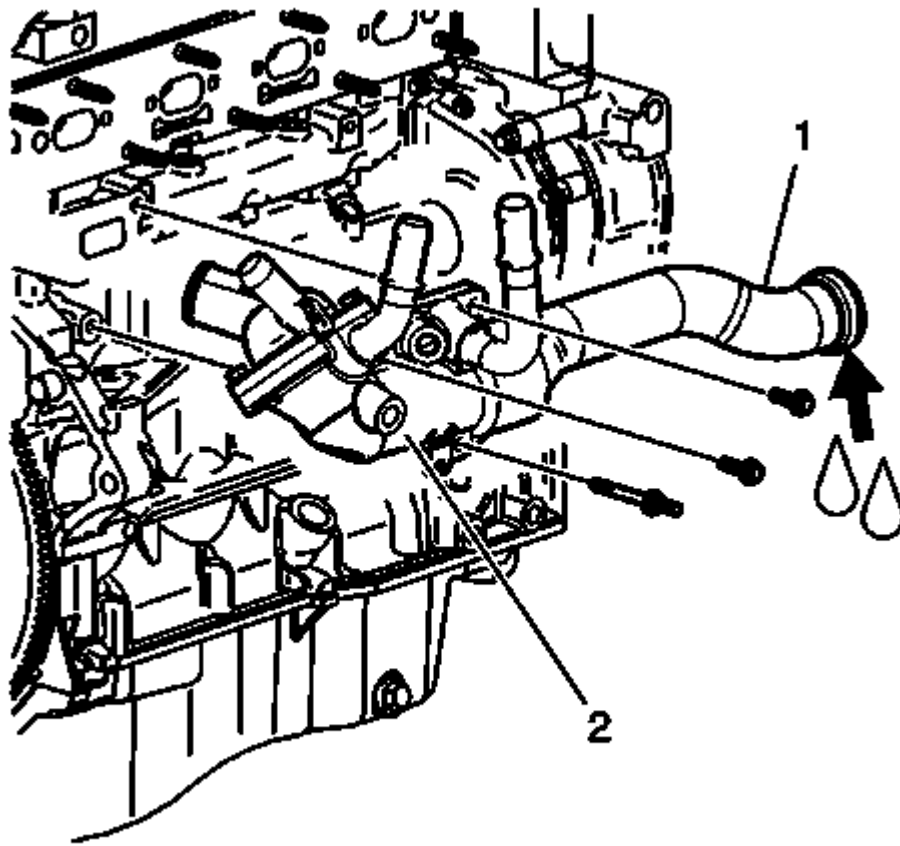


Fig. 245: Water Feed Tube And Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

6. Install the water feed tube (1).
7. Lubricate the feed tube O-ring with antifreeze.
8. Install the water feed tube by twisting and pushing toward the water pump. Take care not to tear or damage the O-ring.
9. Install the thermostat housing (2) to block bolts and stud and tighten to 10 N.m (89 lb in).

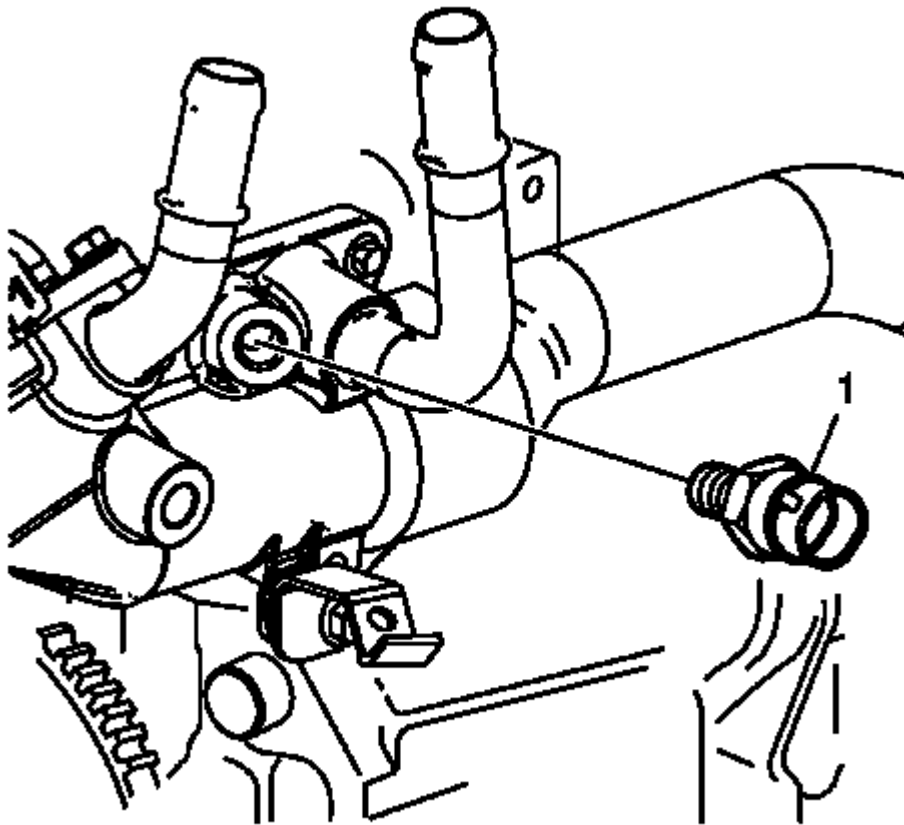


Fig. 246: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

10. Install the engine coolant temperature sensor (1) by hand.
11. Tighten the engine coolant temperature sensor and tighten to 20 N.m (15 lb ft).

BALANCE SHAFT TO ENGINE TIMING (LEA, OR LUK)

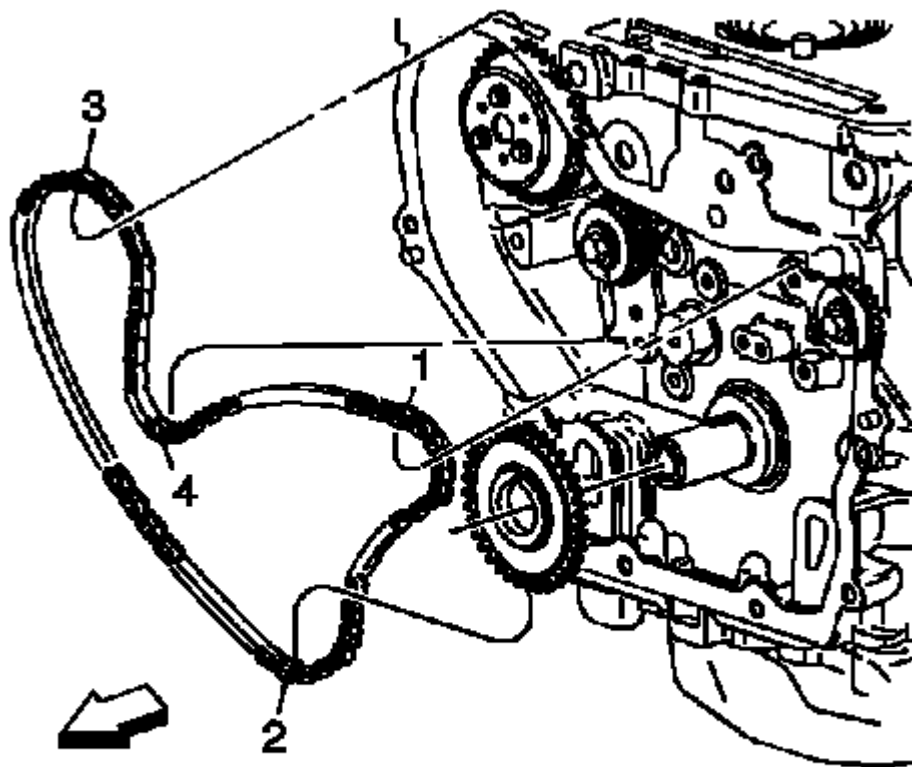


Fig. 247: Aligning Balance Shaft Drive Chain
 Courtesy of GENERAL MOTORS COMPANY

1. Install the balance shaft drive sprocket.

NOTE: **If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.**

2. Install the balance shaft drive chain with the colored links lined up on with the marks on the balance shaft drive sprockets and the crankshaft sprocket. There are three colored links on the chain. Two links are of matching colors, and one link is of a unique color. Use the following procedure to line up the links with the sprockets:

Orient the chain so that the colored links are visible.

3. Place the uniquely colored link (1) so that it lines up with the timing mark on the intake side balance shaft sprocket.
4. Working clockwise around the chain, place the first matching colored link (2) in line with the timing mark on the crankshaft drive sprocket, approximately 6 o'clock position on the crank sprocket.
5. Place the chain (3) on the water pump drive sprocket. The alignment is not critical.
6. Align the last matching colored link (4) with the timing mark on the exhaust side balance shaft drive

sprocket.

WATER PUMP AND BALANCE SHAFT CHAIN AND TENSIONER INSTALLATION

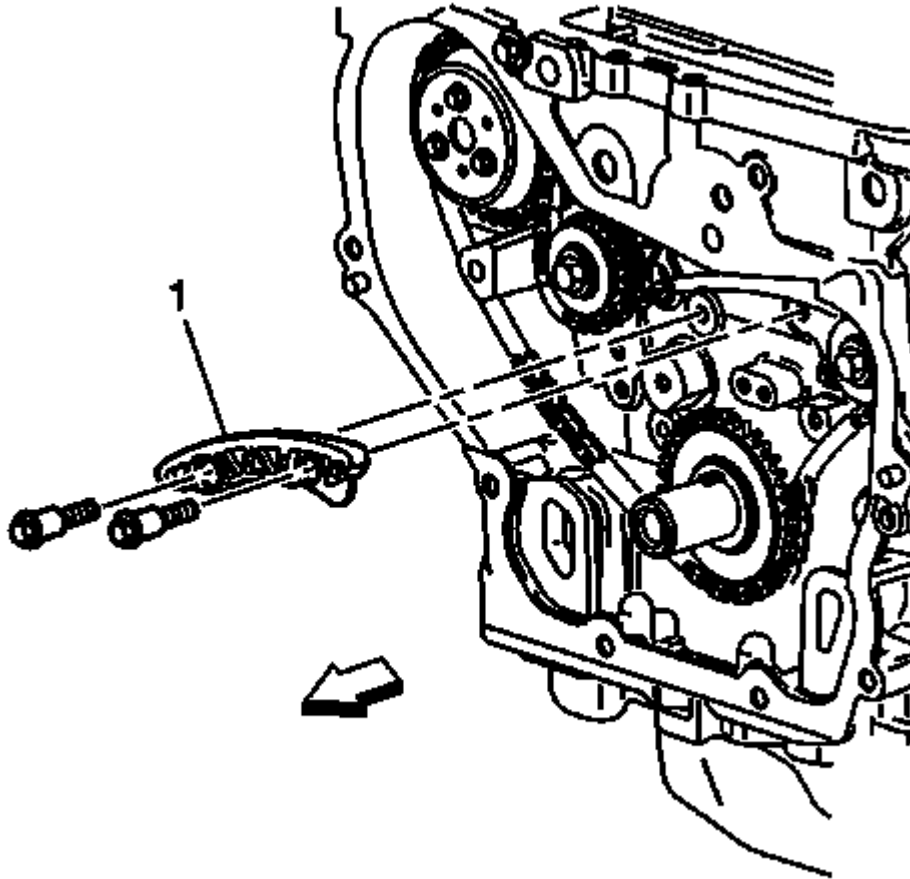


Fig. 248: Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: If the balance shafts are not properly timed to the engine, the engine may vibrate and make noise.

1. Install the upper balance shaft chain guide (1) and bolts and tighten to 12 N.m (106 lb in).

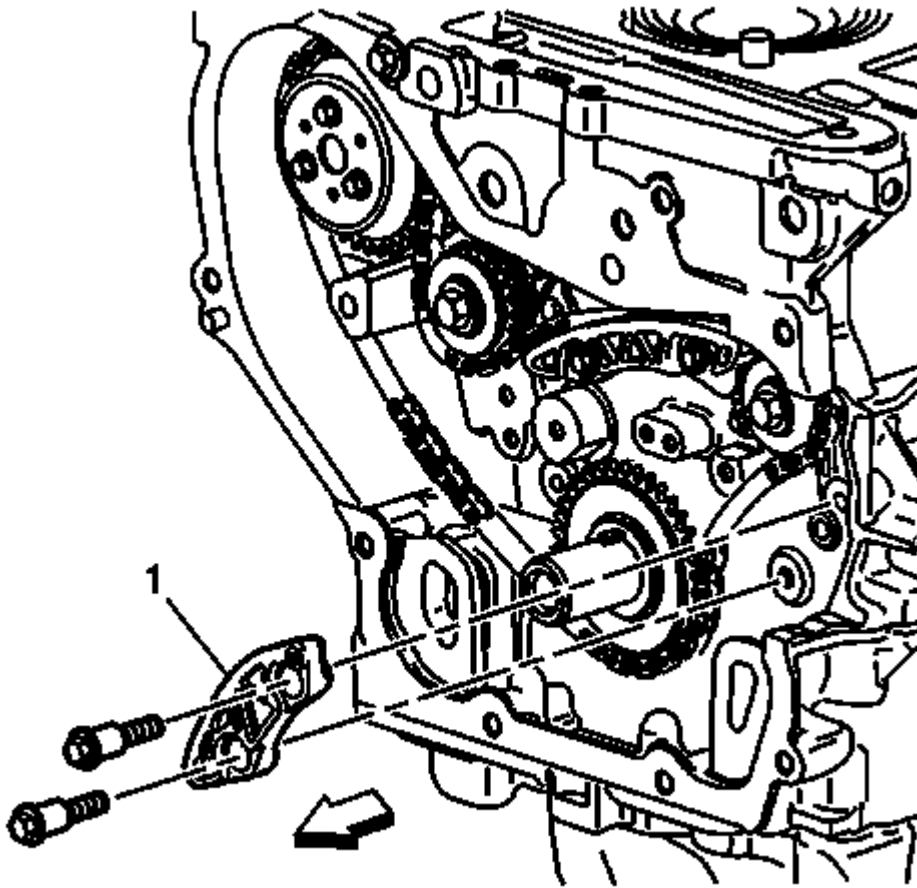


Fig. 249: Small Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS COMPANY

2. Install the small balance shaft chain guide (1).
3. Install the balance shaft chain guide bolts and tighten to 12 N.m (106 lb in).

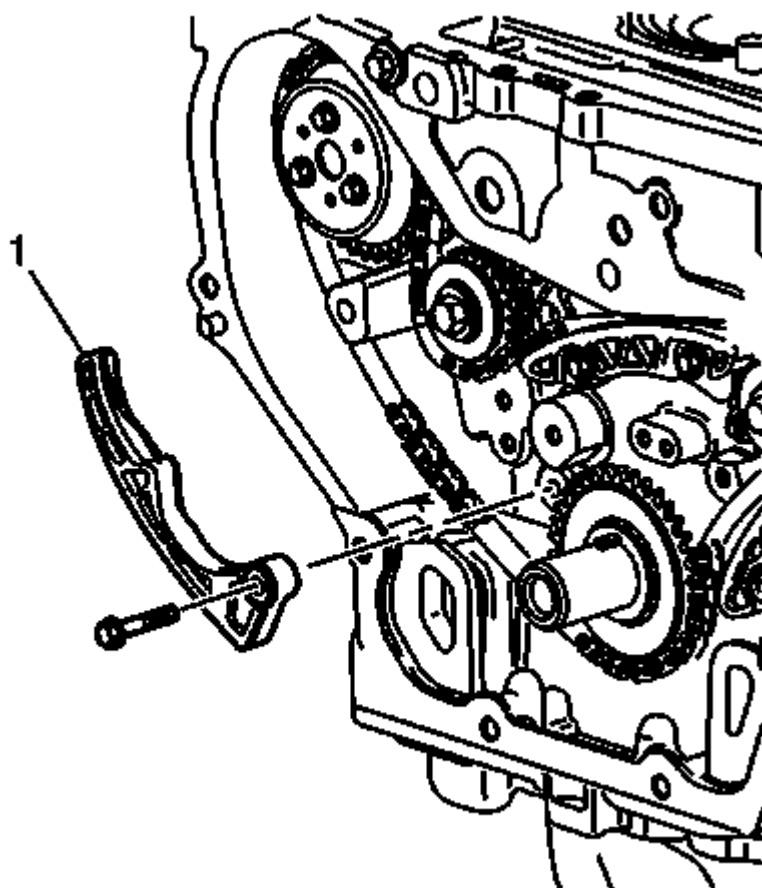


Fig. 250: Adjustable Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

4. Install the adjustable balance shaft drive chain guide (1).
5. Install the adjustable balance shaft drive chain guide bolts and tighten to 10 N.m (89 lb in).

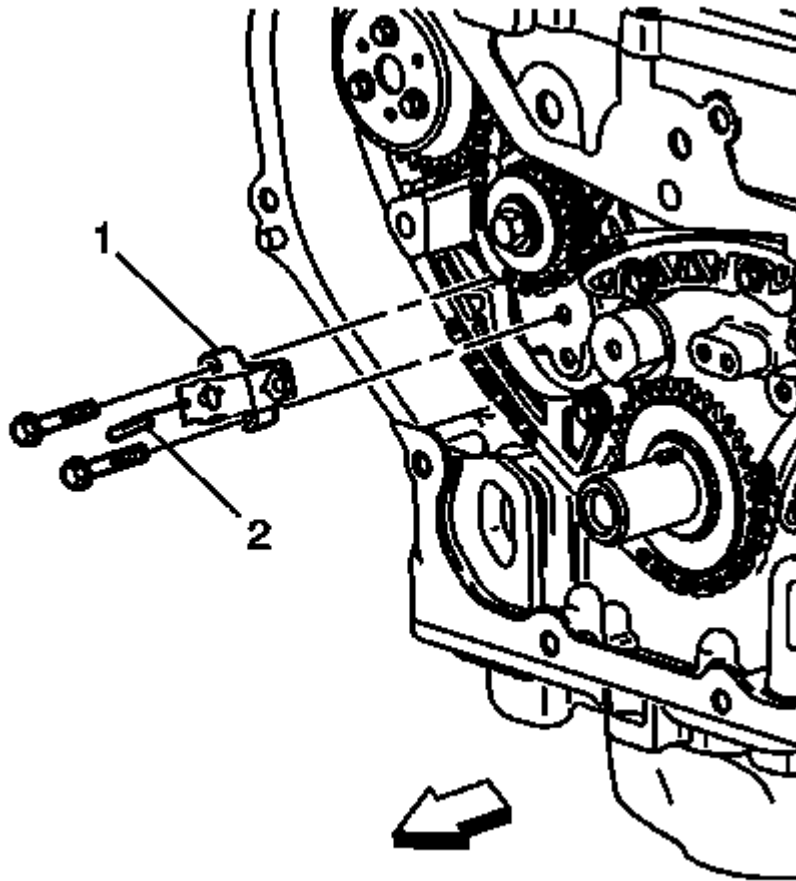


Fig. 251: Timing Chain Tensioner

Courtesy of GENERAL MOTORS COMPANY

6. Reset the timing chain tensioner (1) by performing the following steps:
 1. Turn the tensioner plunger 90 degrees in its bore and compress the plunger.
 2. Turn the tensioner back to the original 12 o'clock position and insert a paper clip through the hole in the plunger body and into the hole in the tensioner plunger.
7. Install the timing chain tensioner.
8. Install the chain tensioner bolts and tighten to 10 N.m (89 lb in).
9. Remove the paper clip from the balance shaft drive chain tensioner.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER INSTALLATION (LEA, OR LUK)

Special Tools

- **EN-45027** Tensioner Tool
- **EN 45059** Angle Meter
- **EN-48953** Camshaft Actuator Locking Tool

For equivalent regional tools, refer to **Special Tools** .

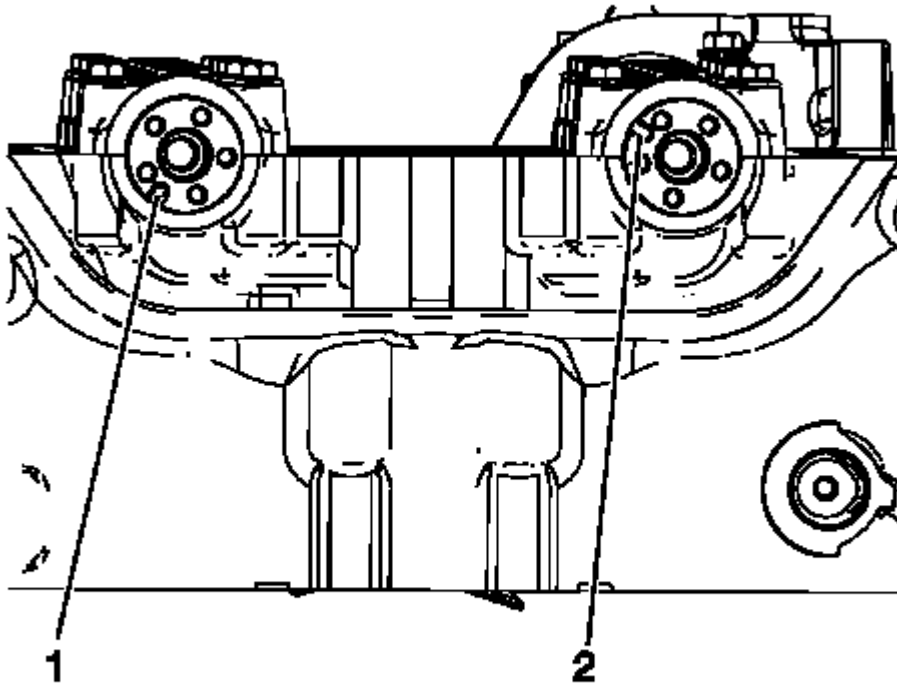


Fig. 252: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: The engine is timed top-dead center exhaust stroke.

1. Ensure the intake camshaft notch is in the 10 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

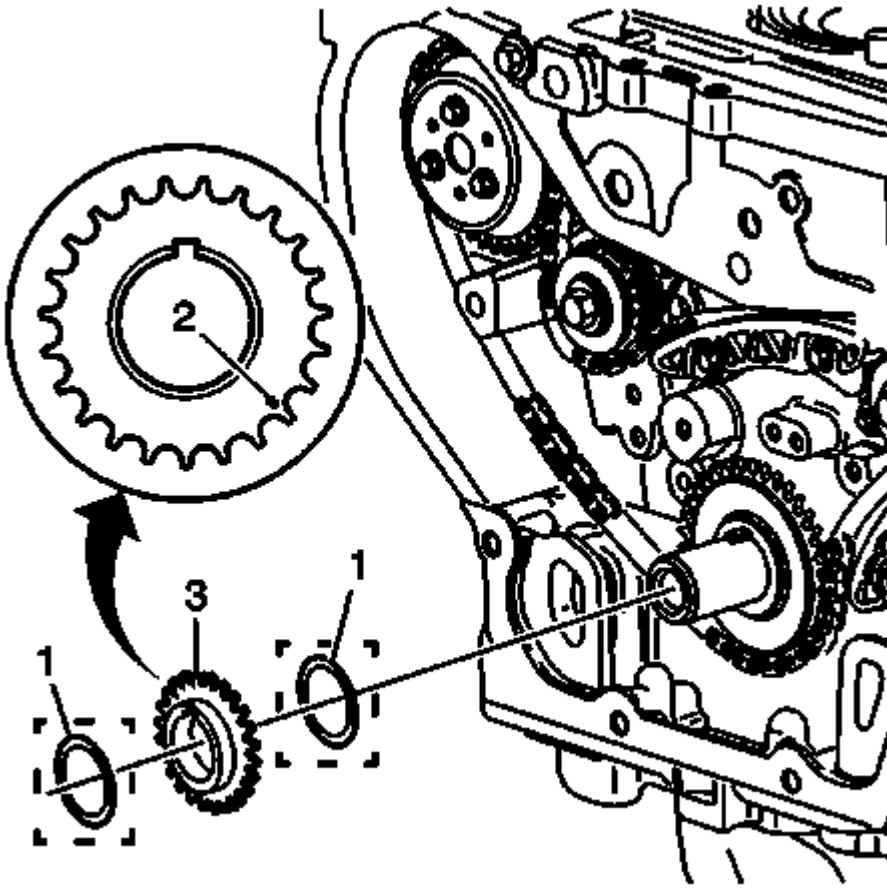


Fig. 253: View of Friction Washer and Timing Chain Drive Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Install a friction washer (1), if equipped.
3. Install the timing chain drive sprocket (3) to the crankshaft with the timing mark (2) in the 5 o'clock position and the front of the sprocket facing out.

NOTE: The outer spacer/washer (1) is in between the crank/balancer pulley and the lower timing gear and may remain in place when the pulley is removed. The spacer/washer (1) has a dot/mark on its surface that may be mistaken for the lower timing mark, and blocks the proper timing mark on the gear from view. The outer spacer/washer (1) must be removed when timing the engine in order to view the correct timing mark on the lower crank gear.

4. Install a second friction washer (1), if equipped.

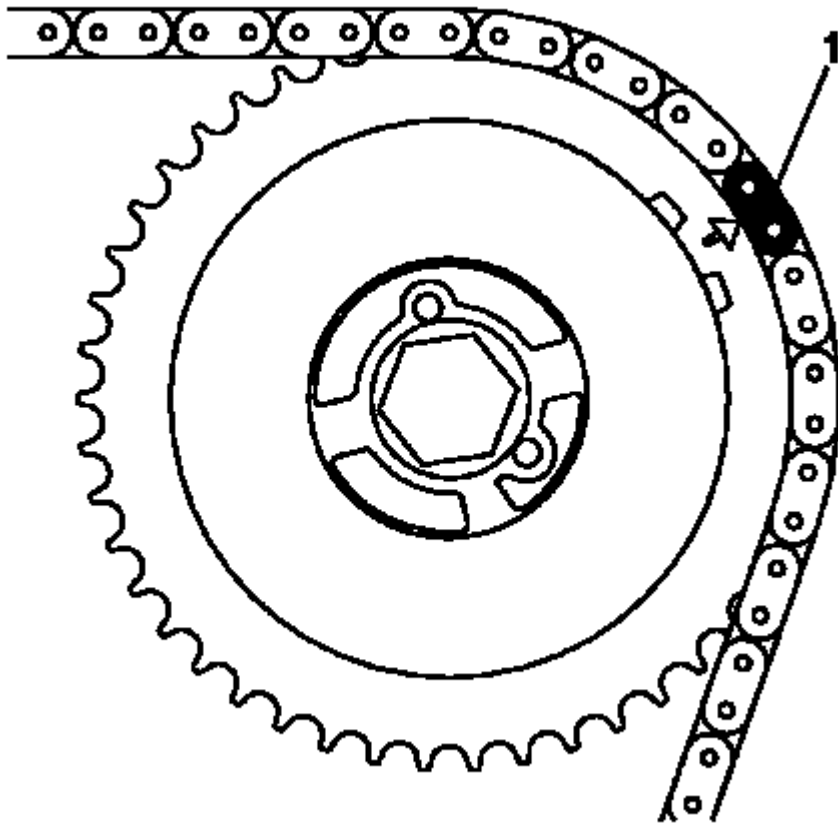


Fig. 254: Identifying Colored Links On Timing Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are three colored links on the timing chain. Two links are of matching color, and one link is of a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.

5. Assemble the intake camshaft actuator into the timing chain with the timing mark lined up with the uniquely colored link (1).

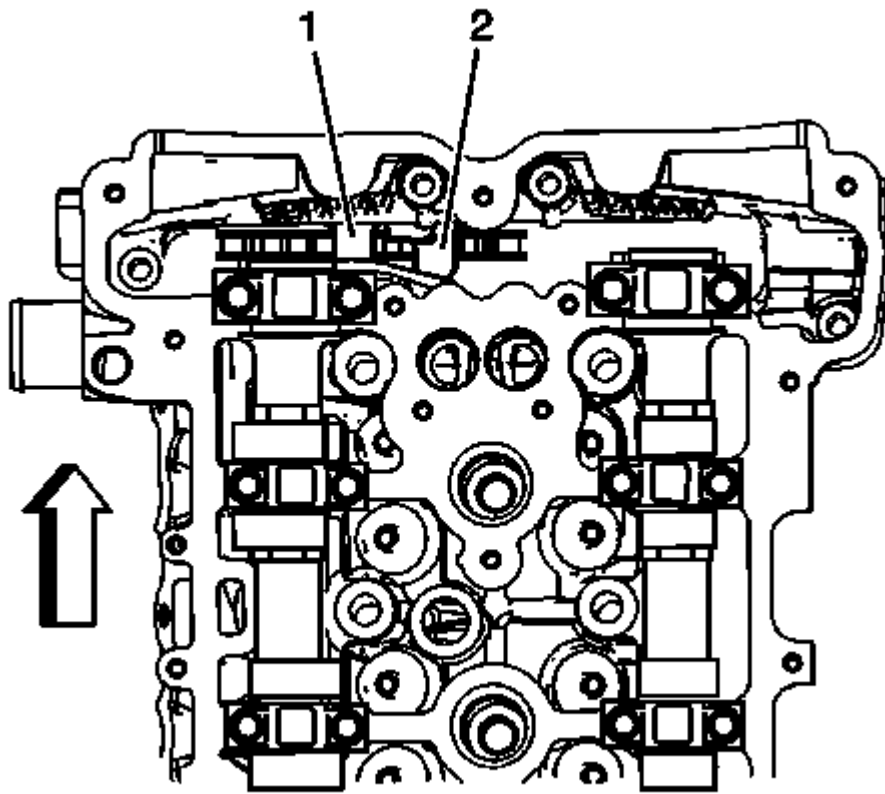


Fig. 255: Identifying Cylinder Head Opening
Courtesy of GENERAL MOTORS COMPANY

6. Lower the timing chain through the opening in the cylinder head. Use care to ensure that the chain goes around both sides of the cylinder block bosses (1, 2).
7. Install the intake camshaft actuator onto the intake camshaft while aligning the dowel pin into the camshaft slot.

NOTE: Always use NEW actuator bolts.

8. Hand tighten the new intake camshaft actuator bolt.

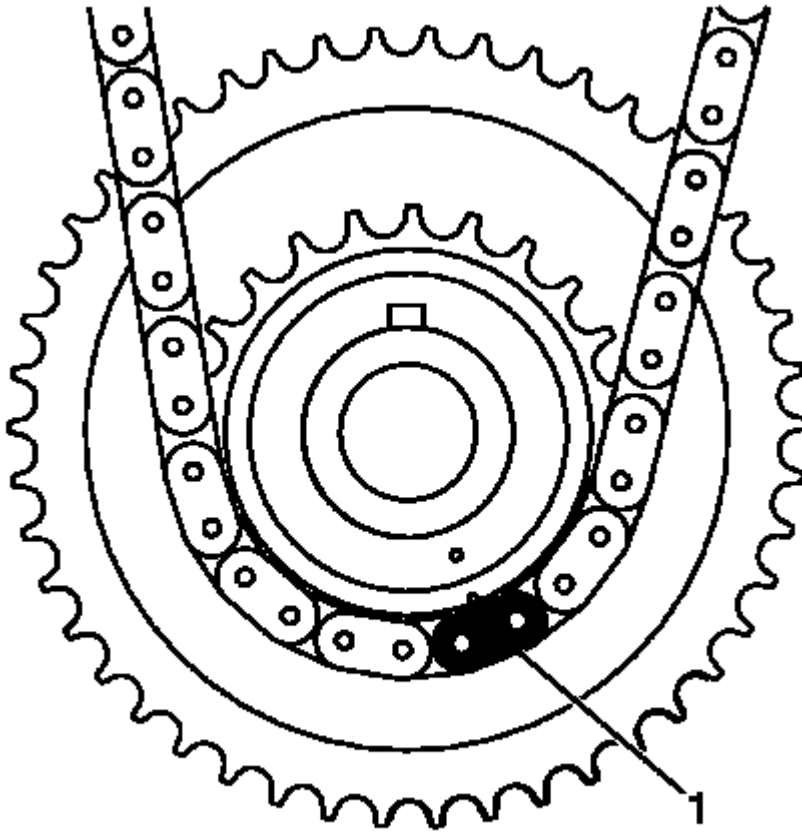


Fig. 256: Identifying Timing Mark on Crankshaft Sprocket and Lining Up With First Matching Colored Link

Courtesy of GENERAL MOTORS COMPANY

9. Route the timing chain around the crankshaft sprocket and line up the first matching colored link (1) with the timing mark on the crankshaft sprocket, in approximately the 5 o'clock position.

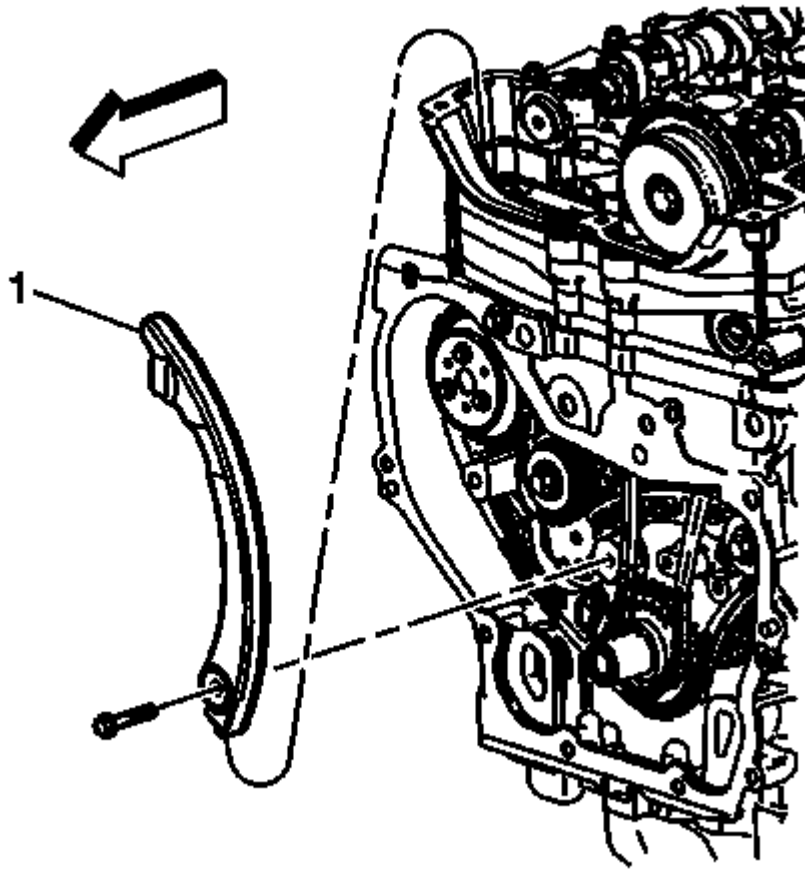


Fig. 257: View of Adjustable Timing Chain Guide Bolt.
Courtesy of GENERAL MOTORS COMPANY

10. Rotate the crankshaft clockwise to remove all chain slack. Do not rotate the intake camshaft.

CAUTION: Refer to Fastener Caution .

11. Install the adjustable timing chain guide (1) down through the opening in the cylinder head and install the adjustable timing chain bolt and tighten to 10 N.m (89 lb in).

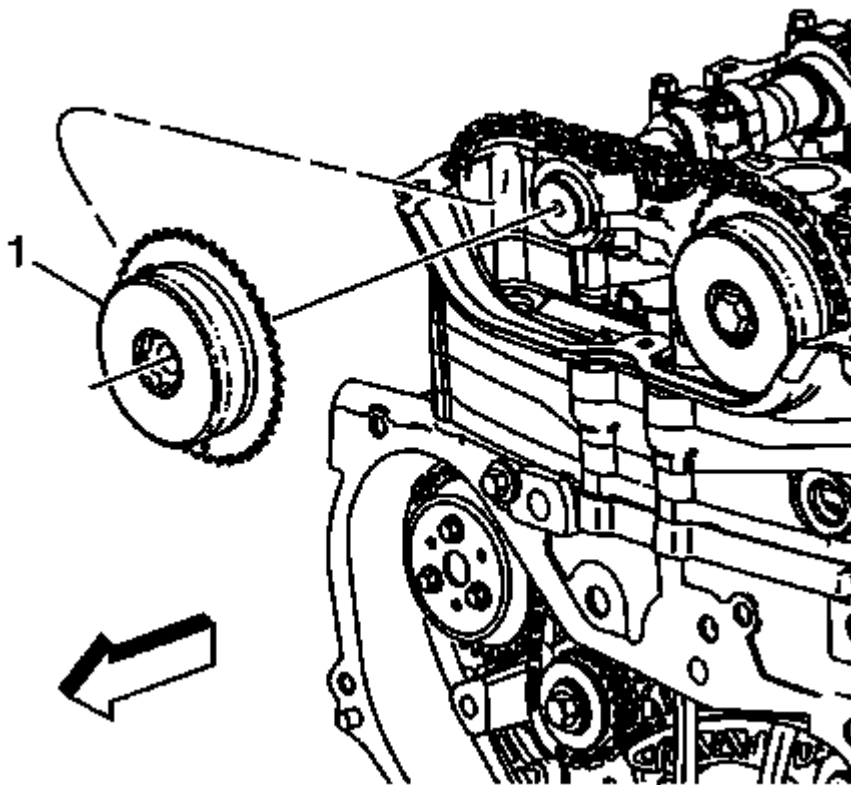


Fig. 258: View of Exhaust Camshaft Actuator
Courtesy of GENERAL MOTORS COMPANY

12. Install the exhaust camshaft actuator (1) into the timing chain with the timing mark lined up with the second matching colored link.

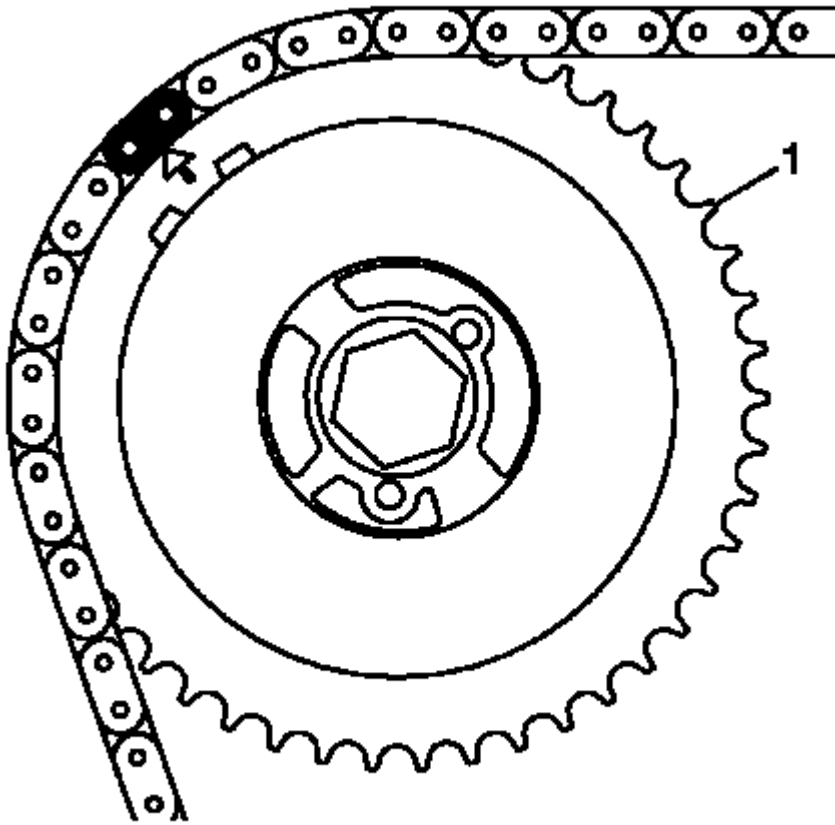


Fig. 259: Exploded View of Exhaust Camshaft Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE: Always install NEW actuator bolts.

13. Install the exhaust camshaft actuator (1) onto the exhaust camshaft, aligning the dowel pin into the camshaft slot.
14. Using a 23-24 mm open end wrench, rotate the exhaust camshaft clockwise until the dowel pin in the camshaft actuator goes into the camshaft slot.

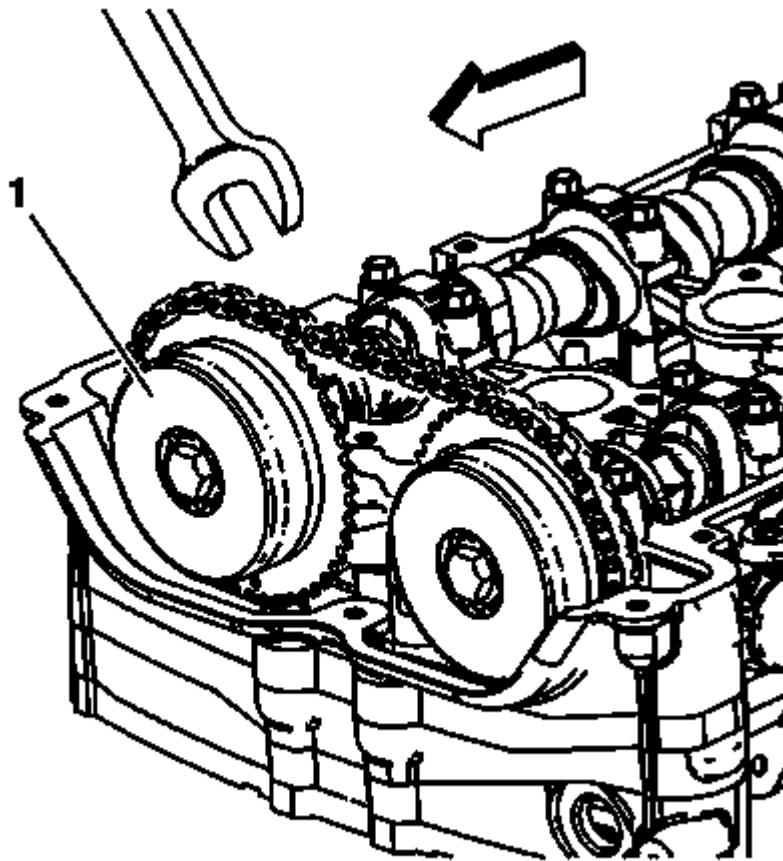


Fig. 260: View of Actuator

Courtesy of GENERAL MOTORS COMPANY

15. When the actuator (1) seats on the cam, tighten the new exhaust camshaft actuator bolt hand tight.
16. Verify that all of the colored links and the appropriate timing marks are still aligned. If they are not, repeat the portion of the procedure necessary to align the timing marks.

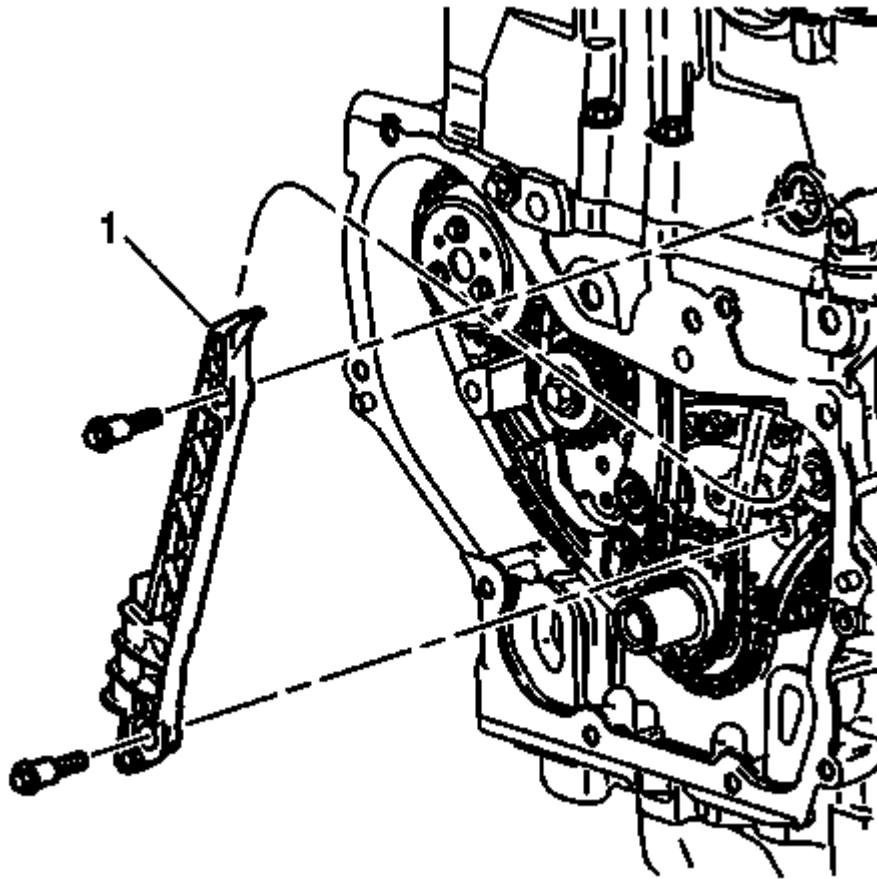


Fig. 261: View of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

17. Install the fixed timing chain guide (1) and bolts and tighten to 12 N.m (106 lb in).

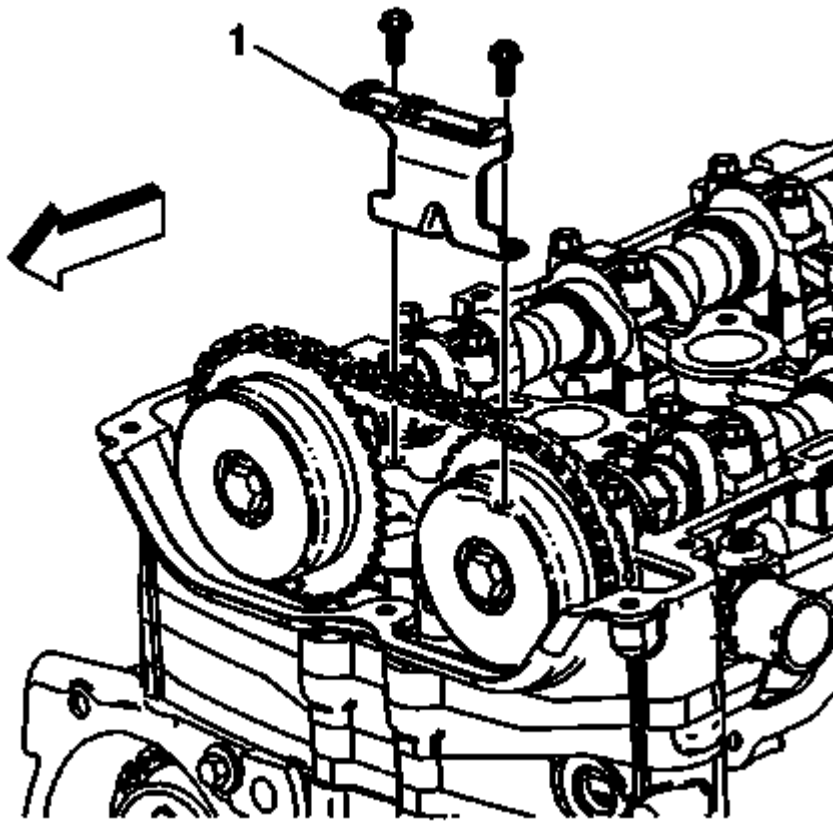


Fig. 262: View of Timing Chain and Tensioner
Courtesy of GENERAL MOTORS COMPANY

18. Install the upper timing chain guide (1) and bolts and tighten to 10 N.m (89 lb in).

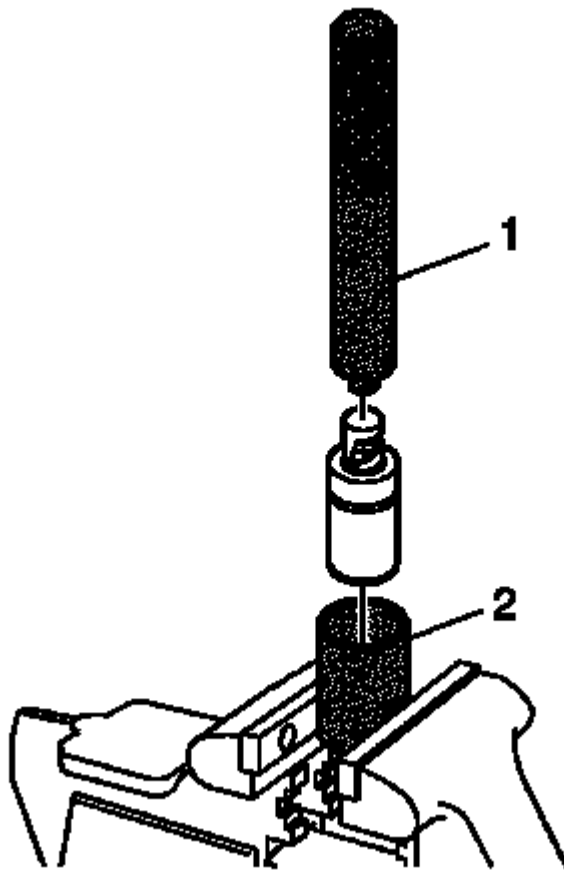


Fig. 263: Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

19. Reset the timing chain tensioner by performing the following steps:
 1. Remove the snap ring.
 2. Remove the piston assembly from the body of the timing chain tensioner.
 3. Install the **EN-45027-2 (2)** tensioner into a vise.
 4. Install the notch end of the piston assembly into the **EN-45027-2 (2)** tensioner.
 5. Using the **EN-45027-1 (1)** tensioner , turn the ratchet cylinder into the piston.
 6. Reinstall the piston assembly into the body of the tensioner.
 7. Install the snap ring.

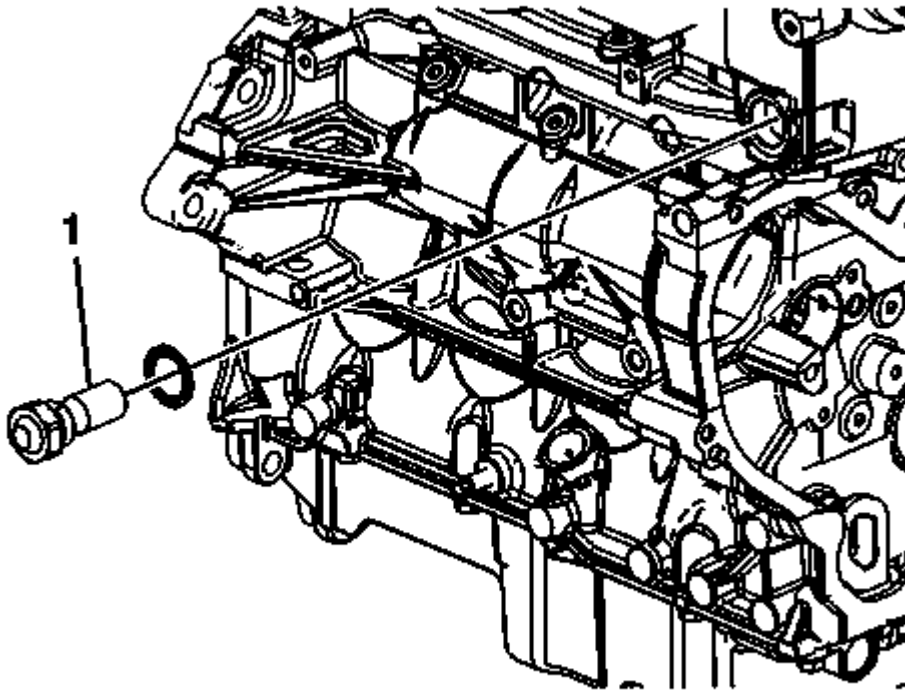


Fig. 264: View of Timing Chain Tensioner Seal
Courtesy of GENERAL MOTORS COMPANY

20. Inspect the timing chain tensioner seal for damage. If damaged, replace the seal.
21. Inspect to ensure all dirt and debris is removed from the timing chain tensioner threaded hole in the cylinder head.

NOTE: Ensure the timing chain tensioner seal is centered throughout the torque procedure to eliminate the possibility of an oil leak.

22. Install the timing chain tensioner assembly (1) and tighten to 75 N.m (55 lb ft).

NOTE: The timing chain tensioner is released by compressing it 2 mm (0.079 in), which will release the locking mechanism in the ratchet.

23. The crankshaft balancer must be installed in order to release the tensioner. Refer to **Crankshaft Balancer Installation**.

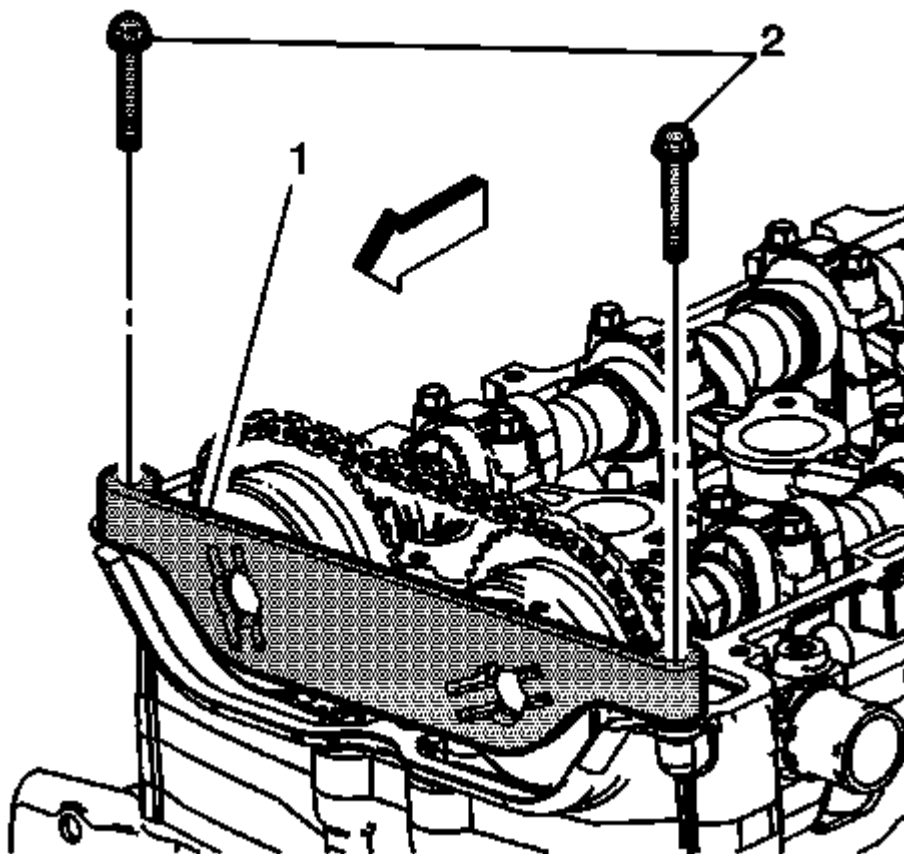


Fig. 265: View Locking Tool

Courtesy of GENERAL MOTORS COMPANY

24. Install **EN-48953** locking tool (1) and tighten the bolts into the cylinder head to 10 N.m (89 lb in).
25. Using a torque wrench, tighten the intake camshaft actuator bolt to 30 N.m (22 lb ft), plus 100 degrees using the **EN 45059** meter.
26. Using a torque wrench, tighten the exhaust camshaft actuator bolt to 30 N.m (22 lb ft), plus 100 degrees using the **EN 45059** meter.
27. Remove **EN-48953** locking tool.

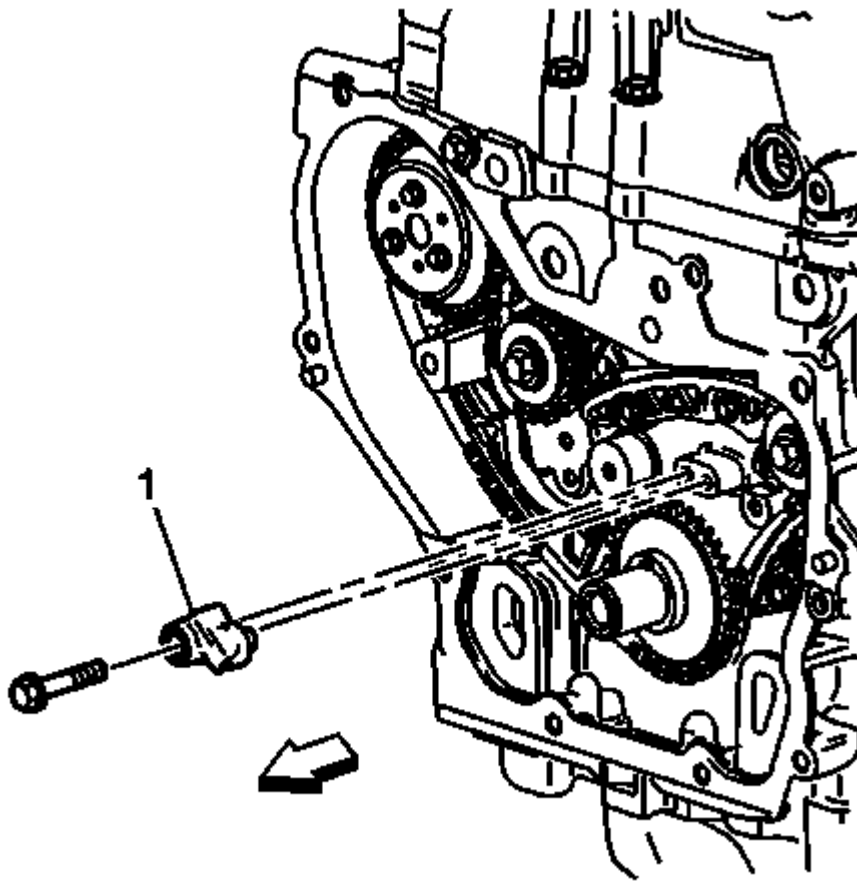


Fig. 266: View of Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

28. Install the timing chain oiling nozzle (1) and tighten the bolt to 10 N.m (89 lb in).

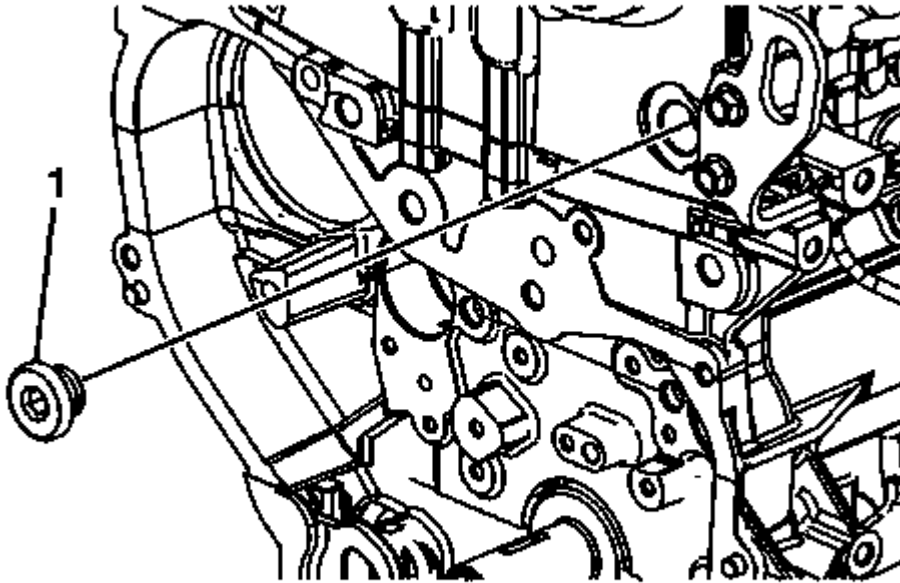


Fig. 267: View of timing Chain Guide Bolt Access Hole Plug
Courtesy of GENERAL MOTORS COMPANY

29. Apply sealant to the thread of the timing chain guide bolt access hole plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
30. Install the timing chain guide bolt access hole plug (1) and tighten to 75 N.m (55 lb ft).

CRANKSHAFT FRONT OIL SEAL INSTALLATION

Special Tools

EN-35268-A Camshaft/Front Main Seal Installer

For equivalent regional tools, refer to **Special Tools** .

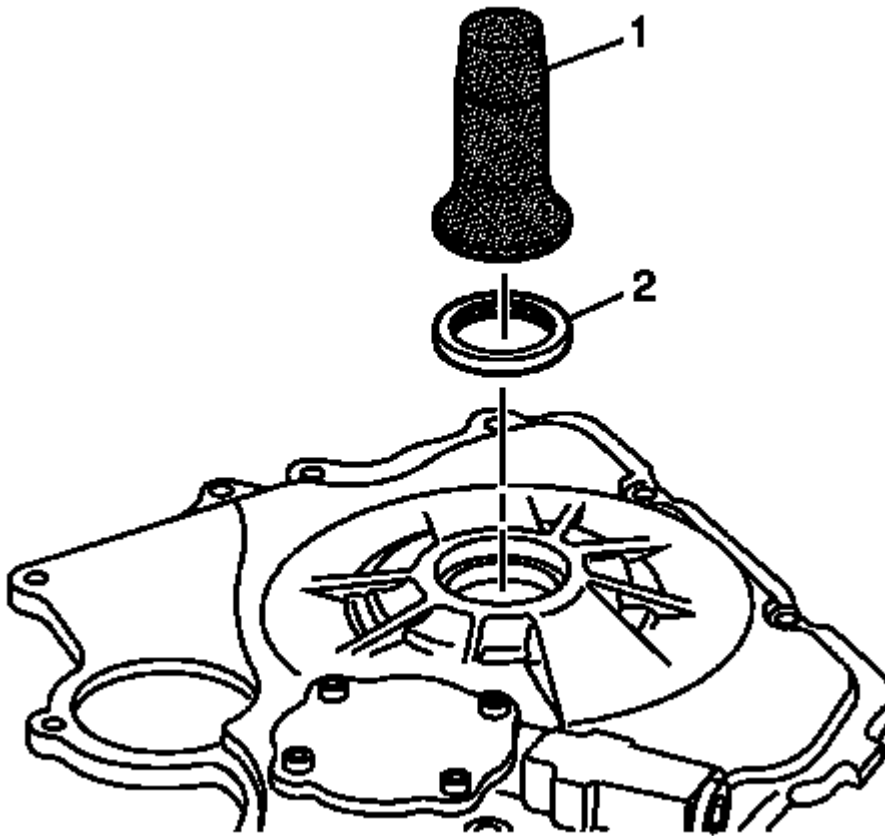


Fig. 268: Istalling Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install the seal (2) into the front cover using the **EN-35268-A** installer (1).
2. Ensure that the engine front cover is properly supported when installing the seal.

ENGINE FRONT COVER AND OIL PUMP INSTALLATION (LUK)

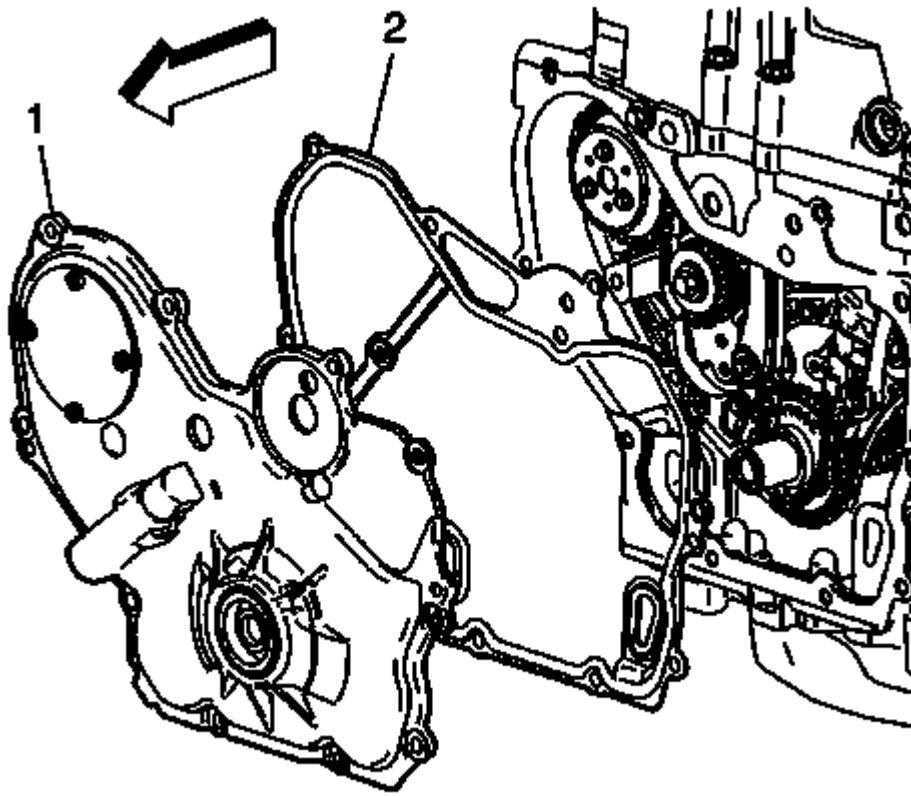


Fig. 269: View Of Engine Front Cover & Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine front cover (1) with a new gasket (2).

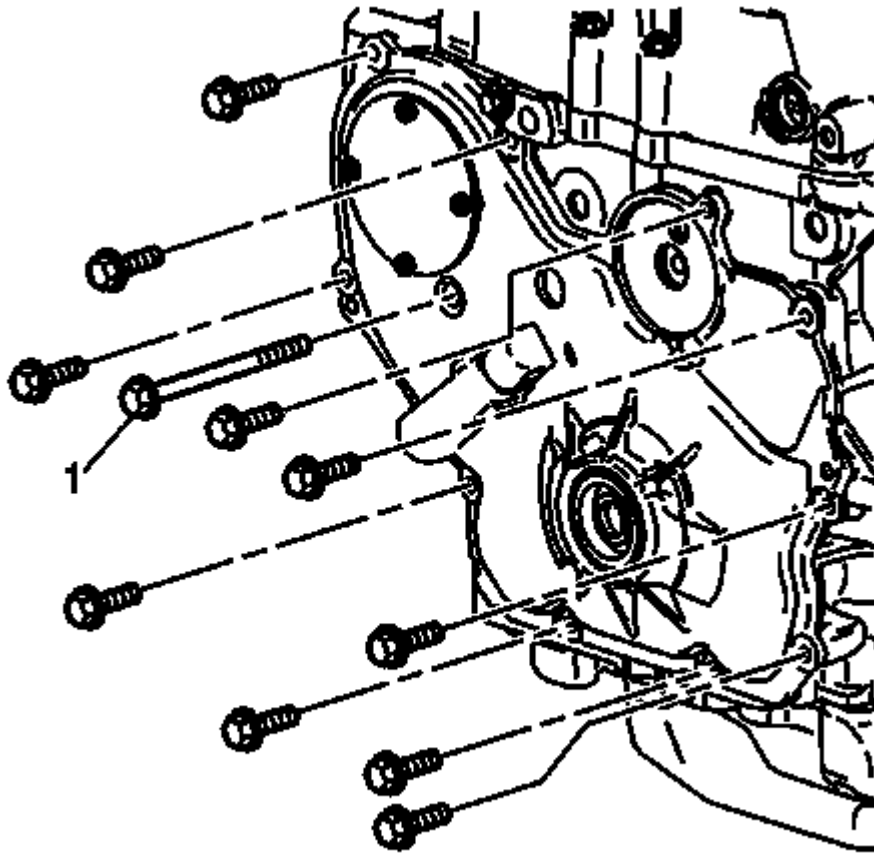


Fig. 270: Engine Front Cover Bolts & Long Water Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: The center bolt (1) should be tightened last.

2. Install the engine front cover bolts and tighten to 25 N.m (18 lb ft).
3. Install the long water pump bolt (1) and tighten to 25 N.m (18 lb ft).

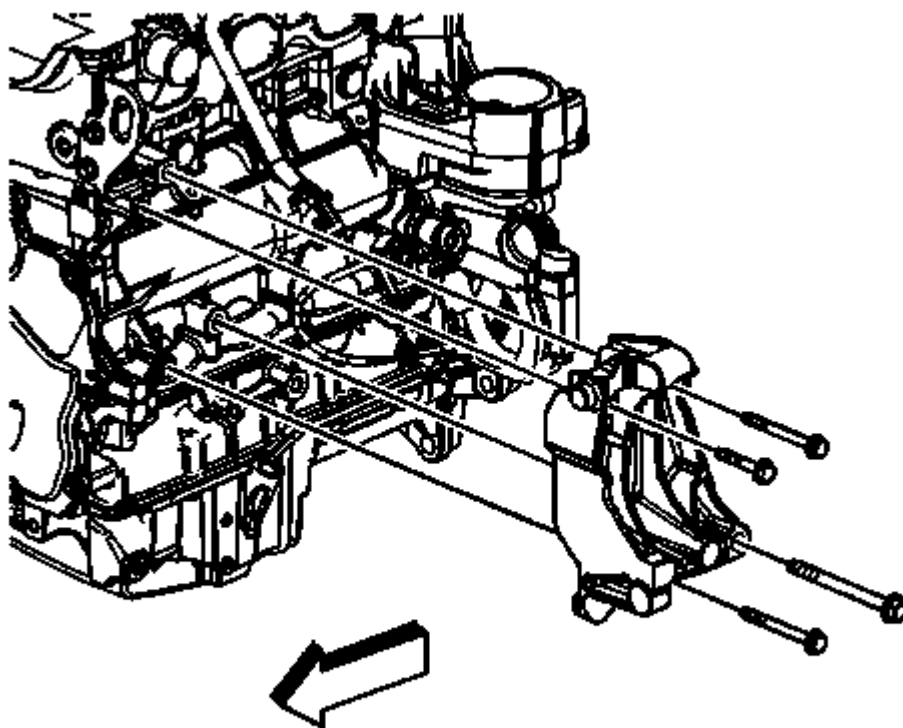


Fig. 271: Drive Belt Tensioner Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the drive belt tensioner bracket.
5. Install the drive belt tensioner bracket bolts and tighten to 45 N.m (33 lb ft).

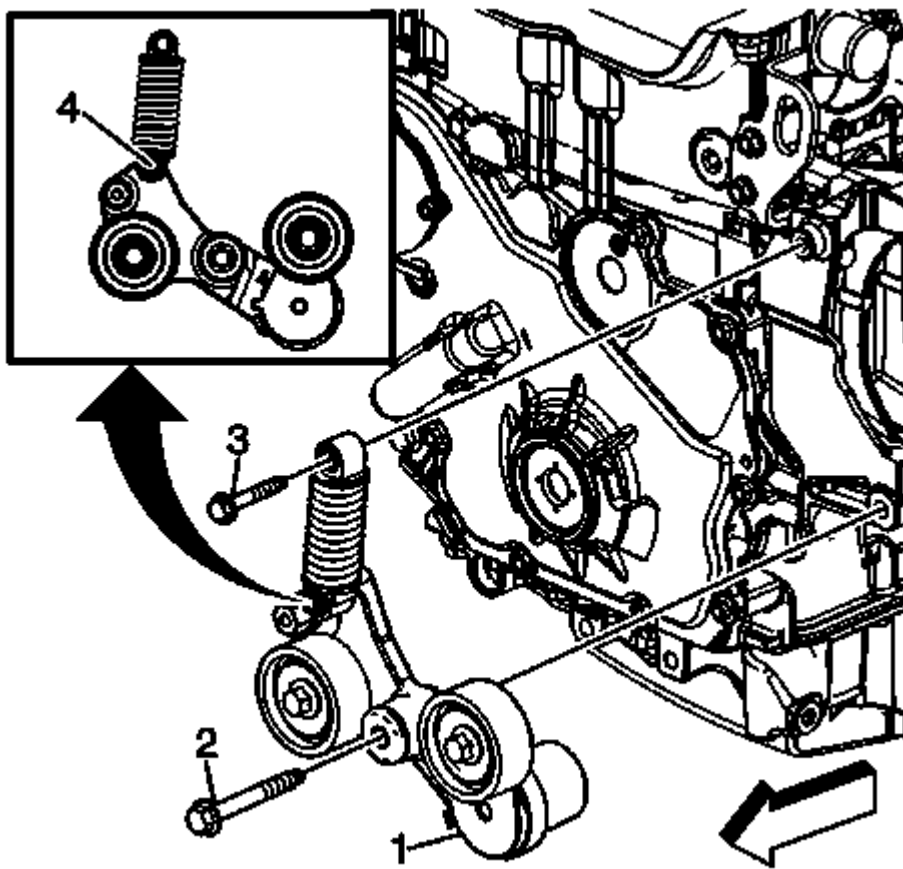


Fig. 272: Accessory Drive Belt Tensioner And Bolts
Courtesy of GENERAL MOTORS COMPANY

- NOTE:** The tensioner spring lower shoulder bolt (4) should NEVER be removed when servicing. If the bolt head shows signs of tampering or removal, replace the drive belt tensioner assembly. If the pivot bolt has thread or hex head damage, the drive belt tensioner assembly MUST be replaced with a new assembly, which includes new bolts.
- NOTE:** A new drive belt tensioner assembly will include a shipping clip retaining the tensioner spring. Do NOT remove the shipping clip until the tensioner is properly mounted to the engine and the accessory drive belt is properly routed.
6. Install the drive belt tensioner pivot bolt (2) into the tensioner (1).
 7. Position the accessory drive belt tensioner in place. Install the drive belt tensioner bolts (2, 3).
 8. Tighten the drive belt tensioner bolt (3) to 22 N.m (16 lb ft).

CAUTION: Refer to Drive Belt Tensioner Pivot Bolt Caution .

9. Tighten the drive belt tensioner pivot bolt (2) to 50 N.m (37 lb ft).
10. Tighten the drive belt tensioner pivot bolt a final pass 90 degrees.

ENGINE FRONT COVER AND OIL PUMP INSTALLATION (LEA)

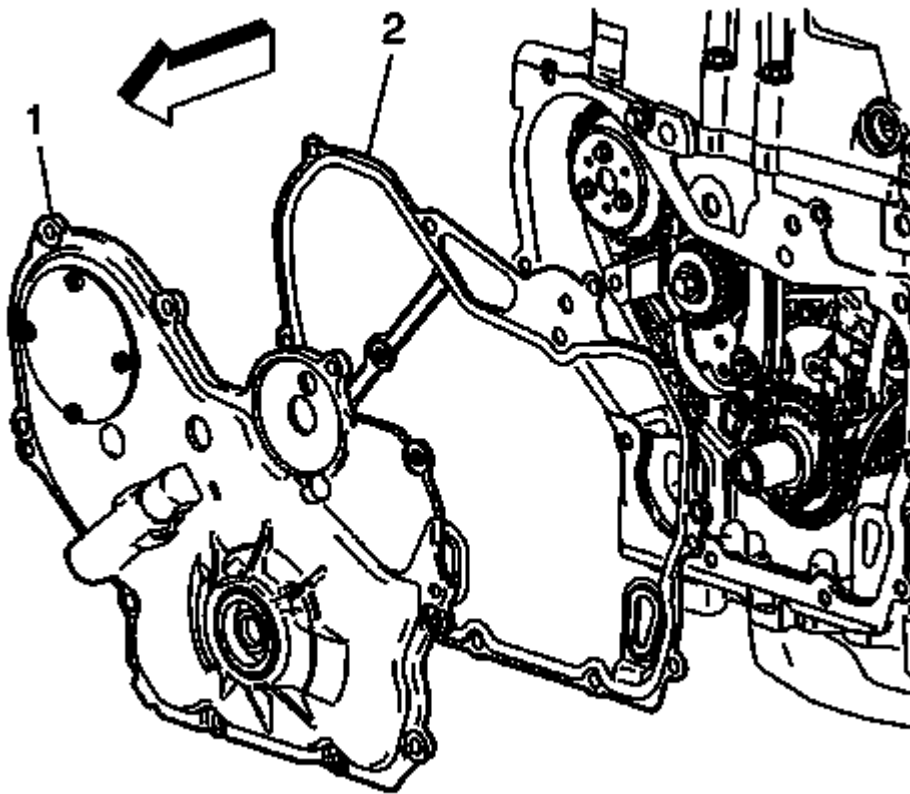


Fig. 273: View Of Engine Front Cover & Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine front cover (1) with a new gasket (2).

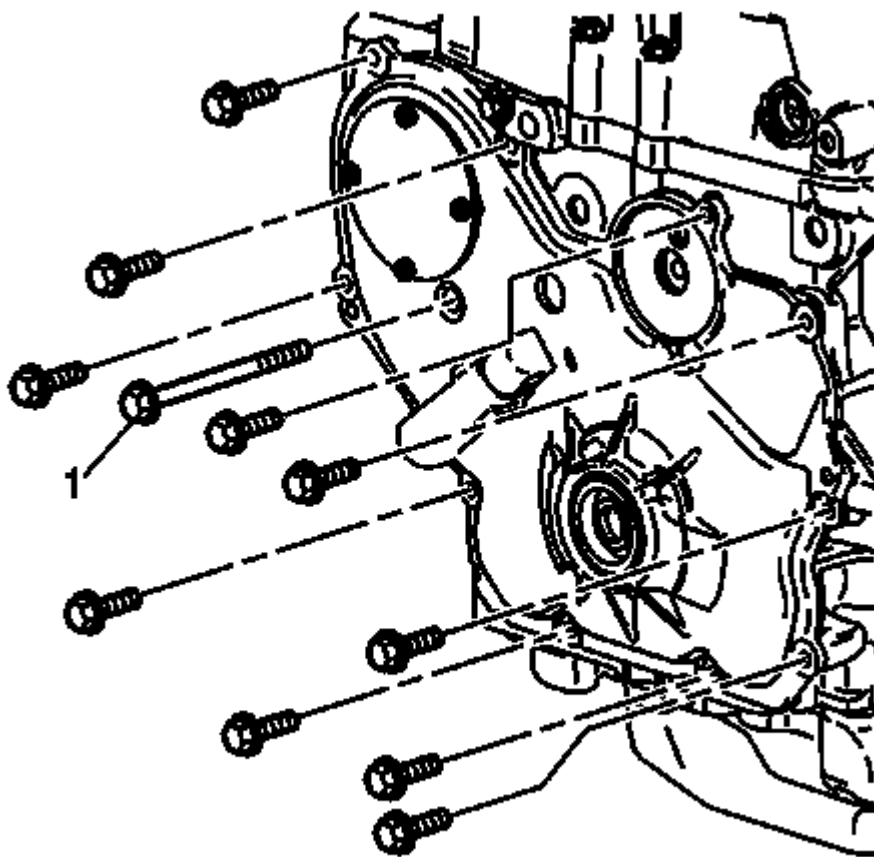


Fig. 274: Engine Front Cover Bolts & Long Water Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: The center bolt (1) should be tightened last.

2. Install the engine front cover bolts and tighten to 25 N.m (18 lb ft).
3. Install the long water pump bolt (1) and tighten to 25 N.m (18 lb ft).

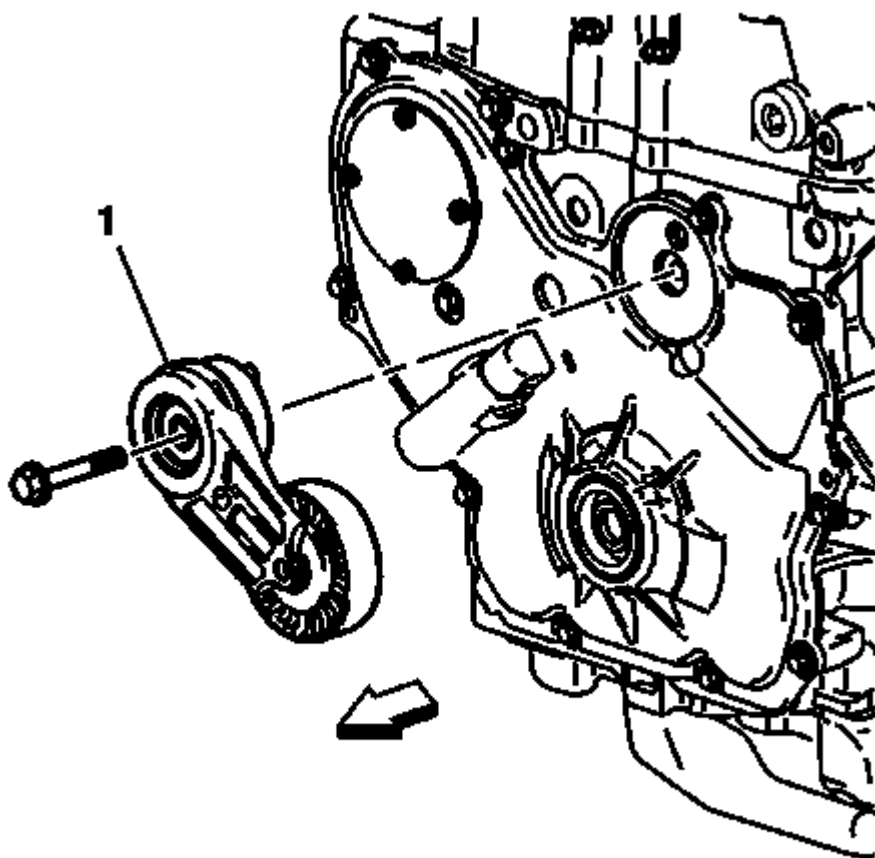


Fig. 275: Accessory Drive Belt Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the accessory drive belt tensioner (1).
5. Install the accessory drive belt tensioner bolt and tighten to 45 N.m (33 lb ft).

OIL PAN INSTALLATION

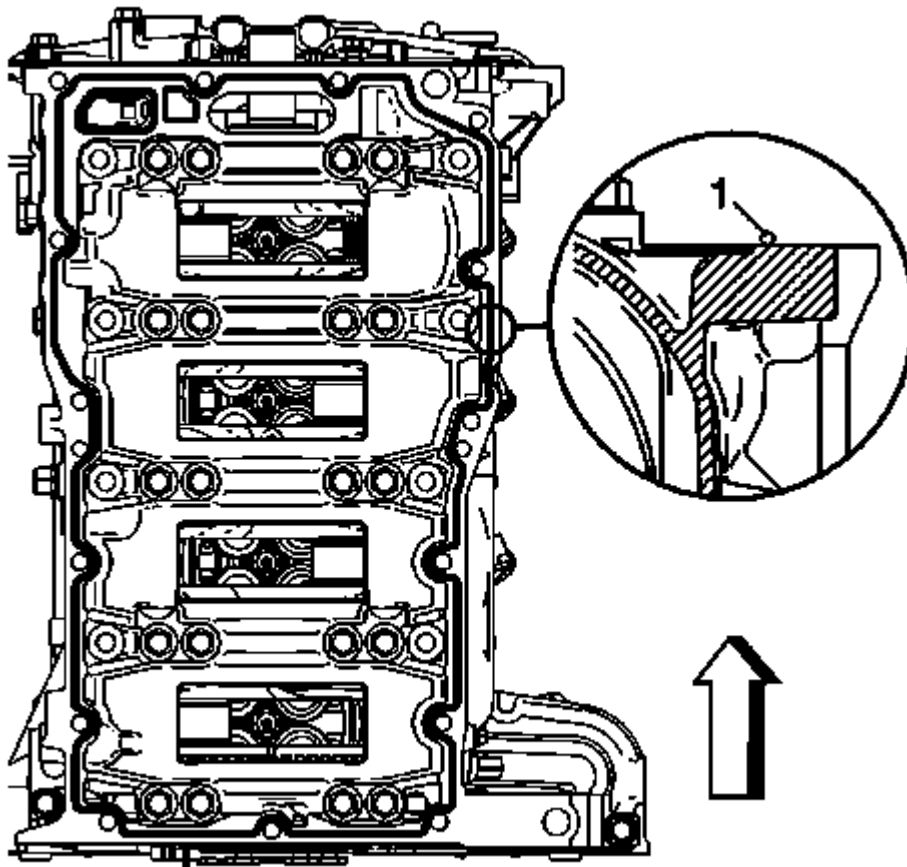


Fig. 276: Identifying Bead of Sealer on Oil Pan
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The lower crankcase surface must be free of contamination prior to applying the sealer.
- Install and align the oil pan to block within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

1. Apply a 2.25 mm bead of sealer (1) on the level part of the flange next to the chamfer around the perimeter of the oil pan and the oil suction port opening. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

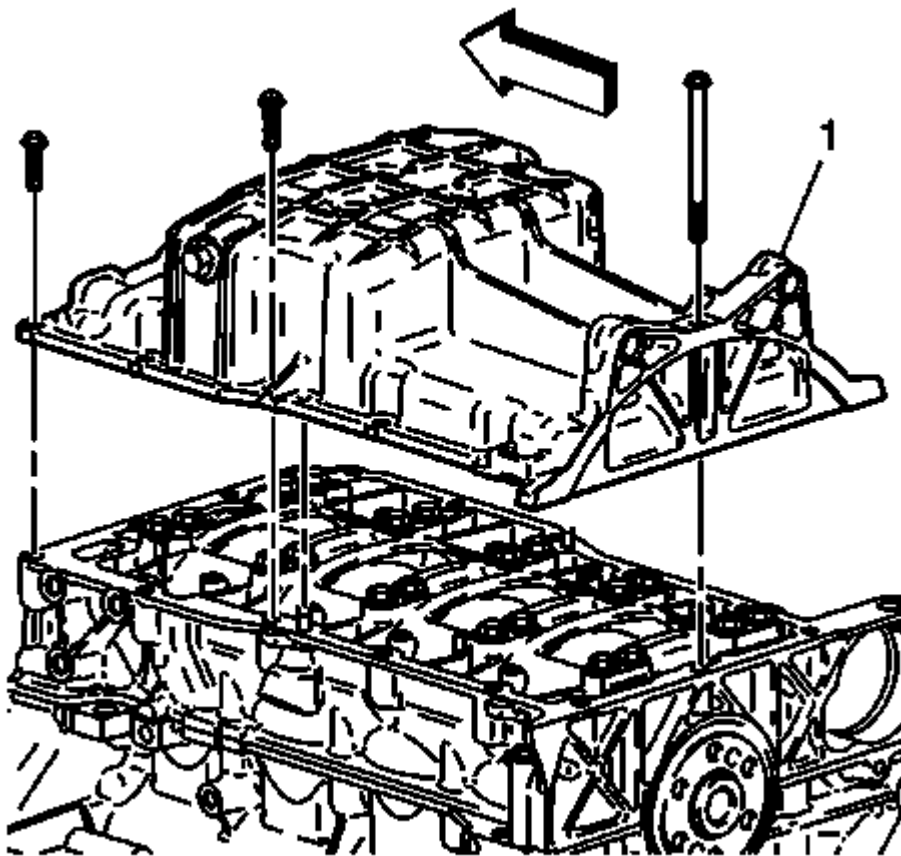


Fig. 277: Oil Pan (1)

Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pan (1).

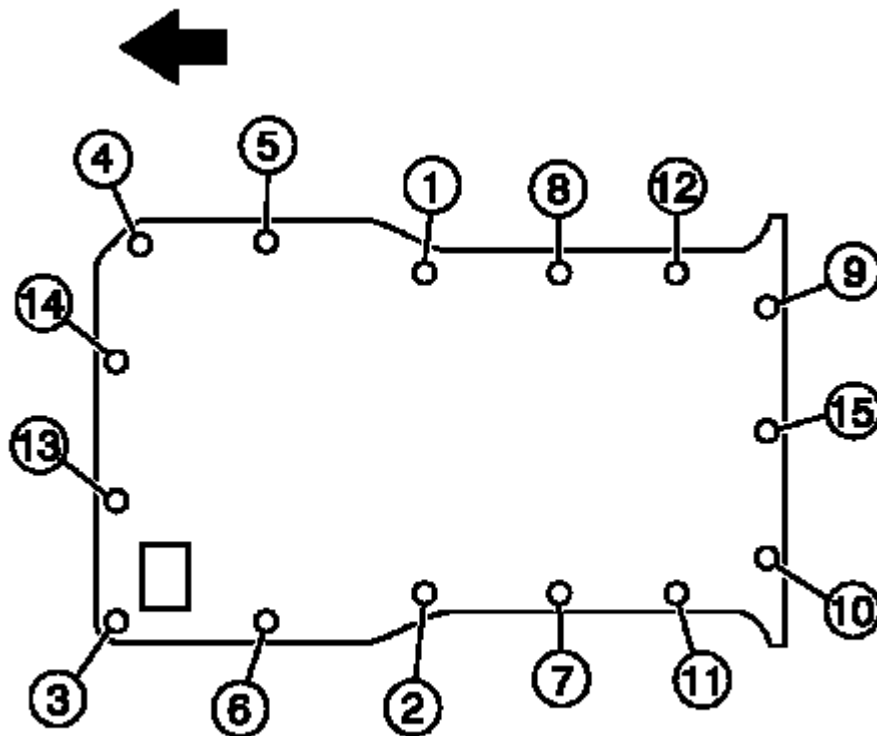


Fig. 278: Identifying Oil Pan Bolts Removal & Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the oil pan bolts and tighten to 25 N.m (18 lb ft) in sequence.

CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **EN-48585** Crankshaft Balancer Guide
- **EN-48953** Camshaft Actuator Locking Tool
- **EN 38122-A** Crankshaft Balancer Holder
- **EN 43653** Flywheel Holding Tool
- **EN 45059** Angle Meter

For equivalent regional tools, refer to Special Tools .

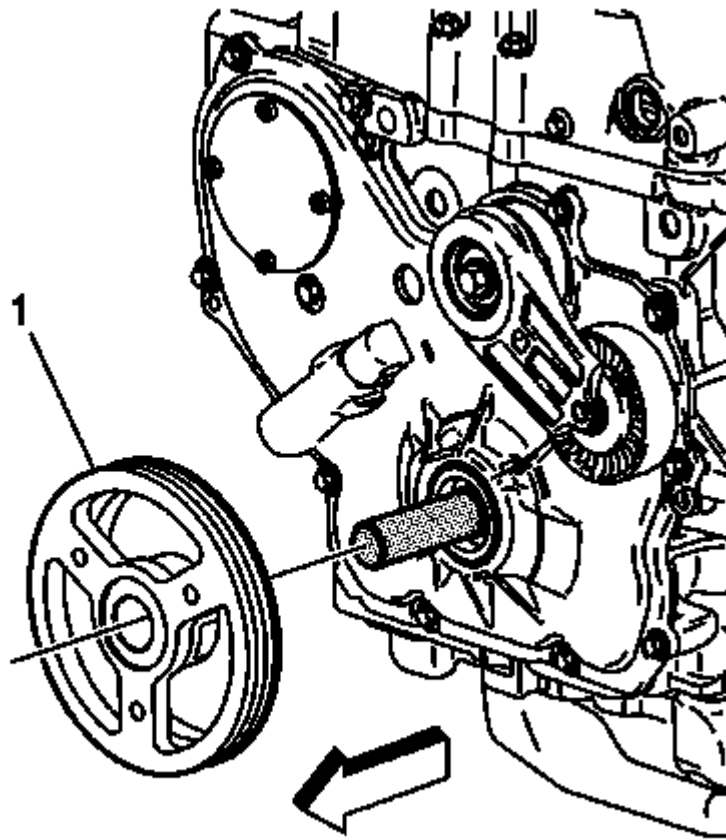


Fig. 279: Identifying Balancer

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure both components are aligned correctly or serious engine damage will occur.

1. Install the **EN 38122-A** holder into the end of the crankshaft.
2. Install the balancer (1) onto the **EN-48585** guide. Use care to properly align the keyway and flats on the balancer with the oil pump drive.

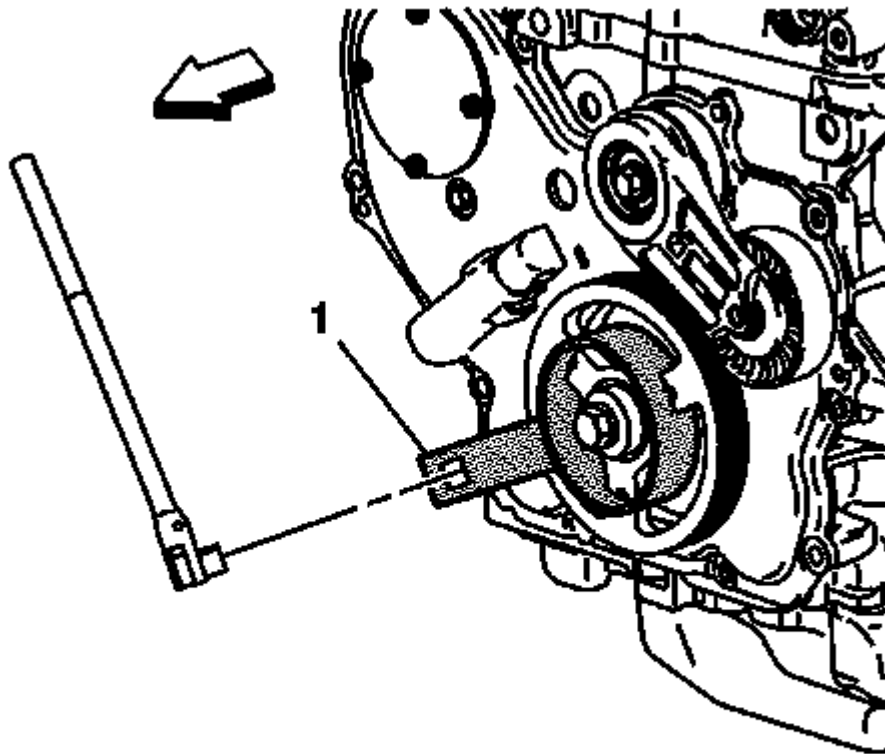


Fig. 280: Crankshaft Balancer Holder
Courtesy of GENERAL MOTORS COMPANY

NOTE: EN 43653 locking tool may be used instead of EN 38122-A holder to prevent crankshaft rotation.

3. Install the EN 38122-A holder (1).

CAUTION: Refer to Fastener Caution .

NOTE: Always install a new crankshaft balancer retaining bolt and washer.

4. Install a new retaining bolt and washer. Use the EN 38122-A holder and a breaker bar to prevent the crankshaft from rotating when tightening the bolt. Tighten the bolt to 150 N.m (111 lb ft) plus 100 degrees using the EN 45059 meter.

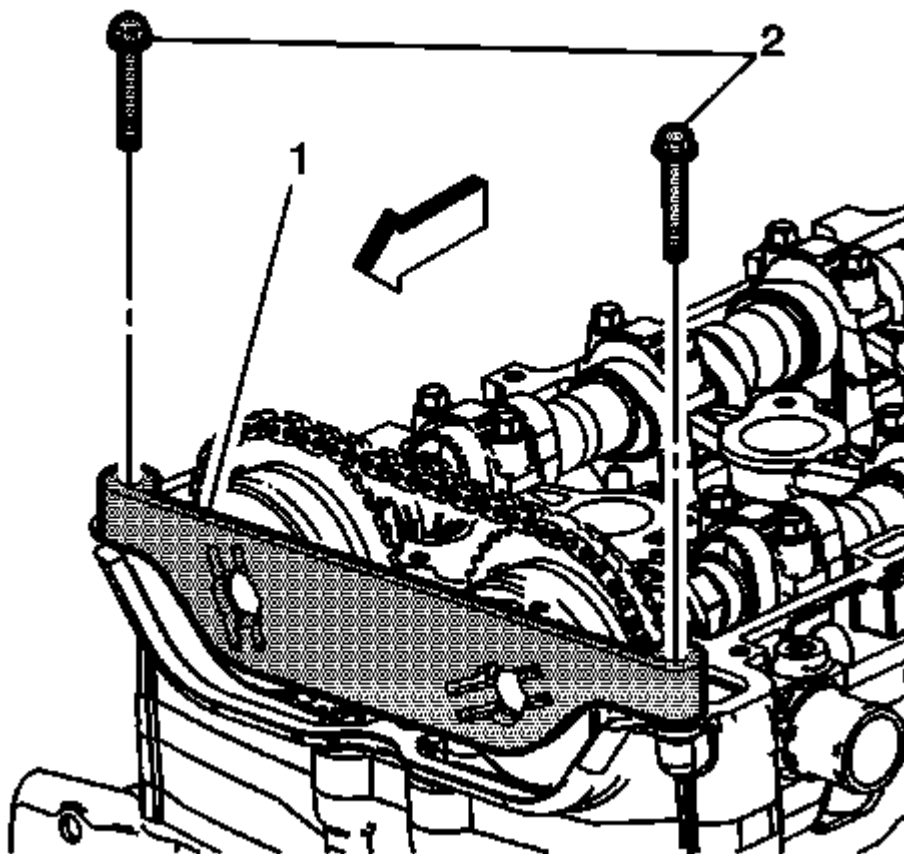


Fig. 281: View Locking Tool

Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-48953** locking tool (1) and tighten the bolts into the cylinder head. Tighten the **EN-48953** locking tool retaining bolts to 10 N.m (89 lb in).
6. Release the timing chain tensioner by applying 45 N.m (33 lb ft) counterclockwise torque to the crankshaft balancer bolt.
7. Remove the **EN-48953** locking tool.

CAMSHAFT COVER INSTALLATION (LEA, OR LUK)

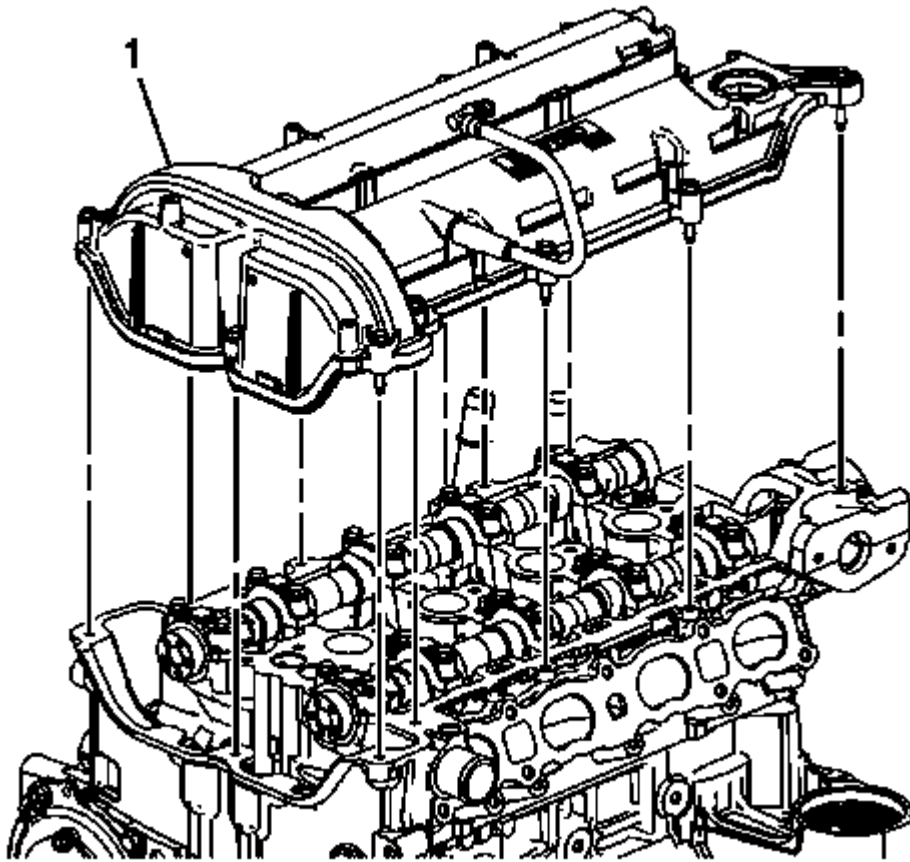


Fig. 282: Camshaft Cover Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW camshaft cover grommets and camshaft cover bolts if they are serviced with the grommet.
2. Assemble the camshaft cover (1) and a NEW gasket. Ensure that the gasket is located in the retaining groove in the camshaft cover.

CAUTION: Refer to Fastener Caution .

3. Install the cover on the cylinder head and hand start the bolts. Tighten the bolts to 10 N.m (89 lb in).

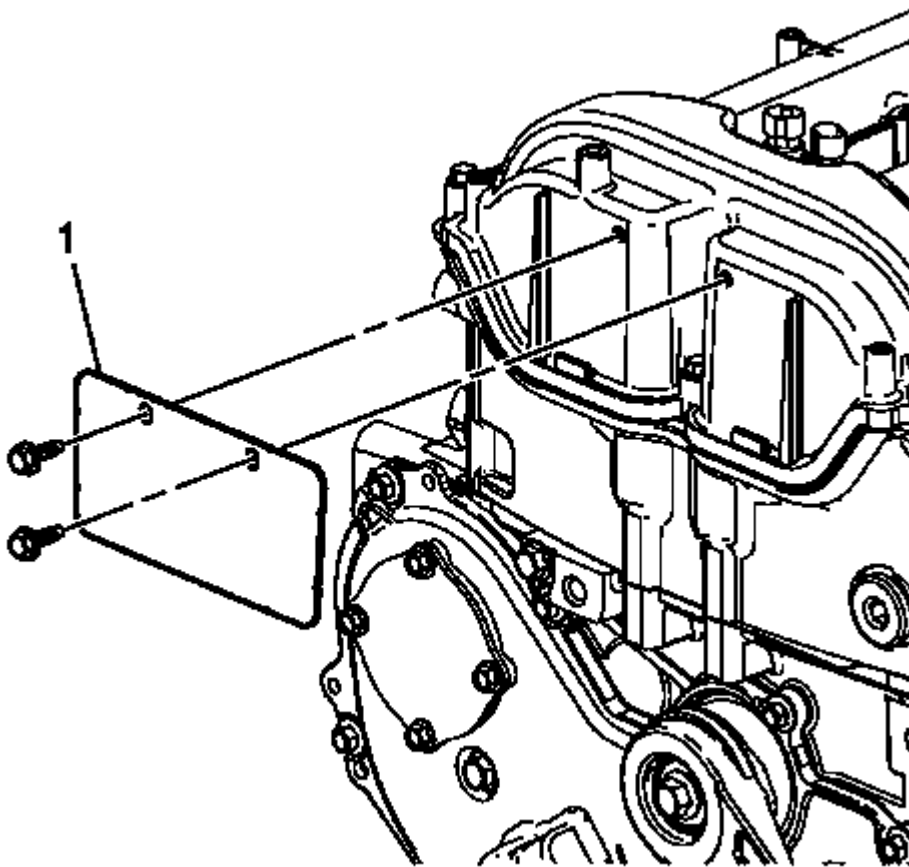


Fig. 283: Camshaft Housing Cover Insulator
Courtesy of GENERAL MOTORS COMPANY

4. Install the camshaft housing cover insulator (1). Tighten the bolts to 10 N.m (89 lb in).

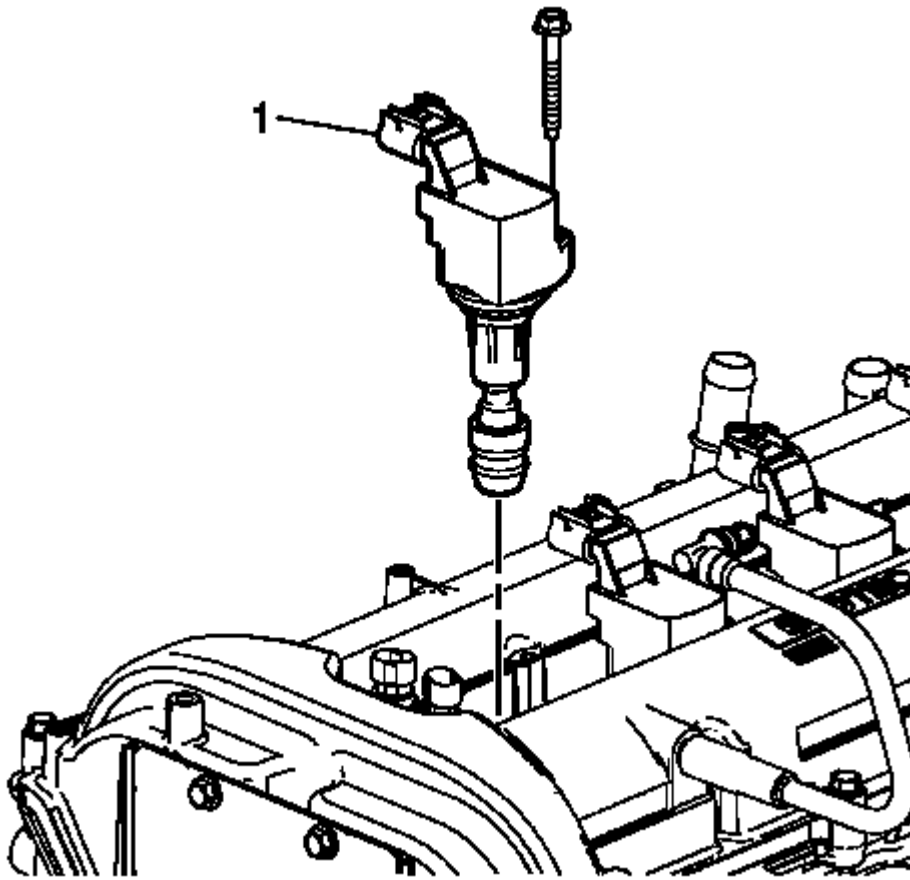


Fig. 284: Ignition Coil
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
 1. Apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
 2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
6. Install the ignition coil (1). Tighten the bolt to 10 N.m (89 lb in).

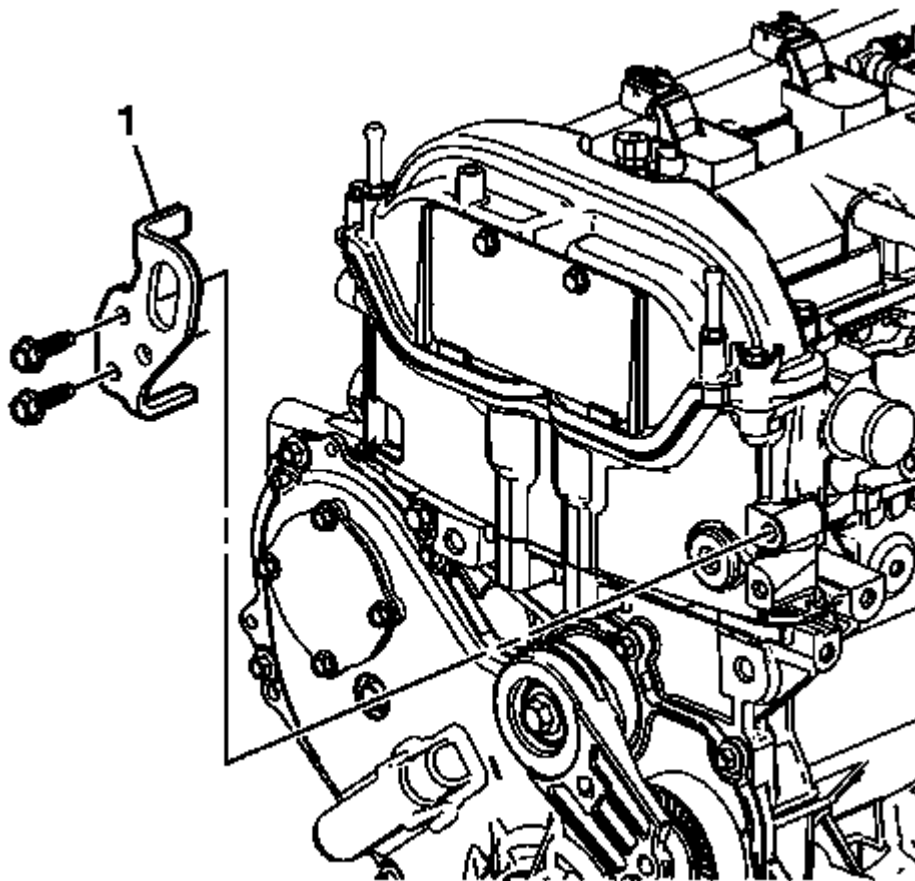


Fig. 285: Front Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

7. Install the front lift bracket (1).
8. Install the front lift bracket bolts and tighten to 25 N.m (18 lb ft).

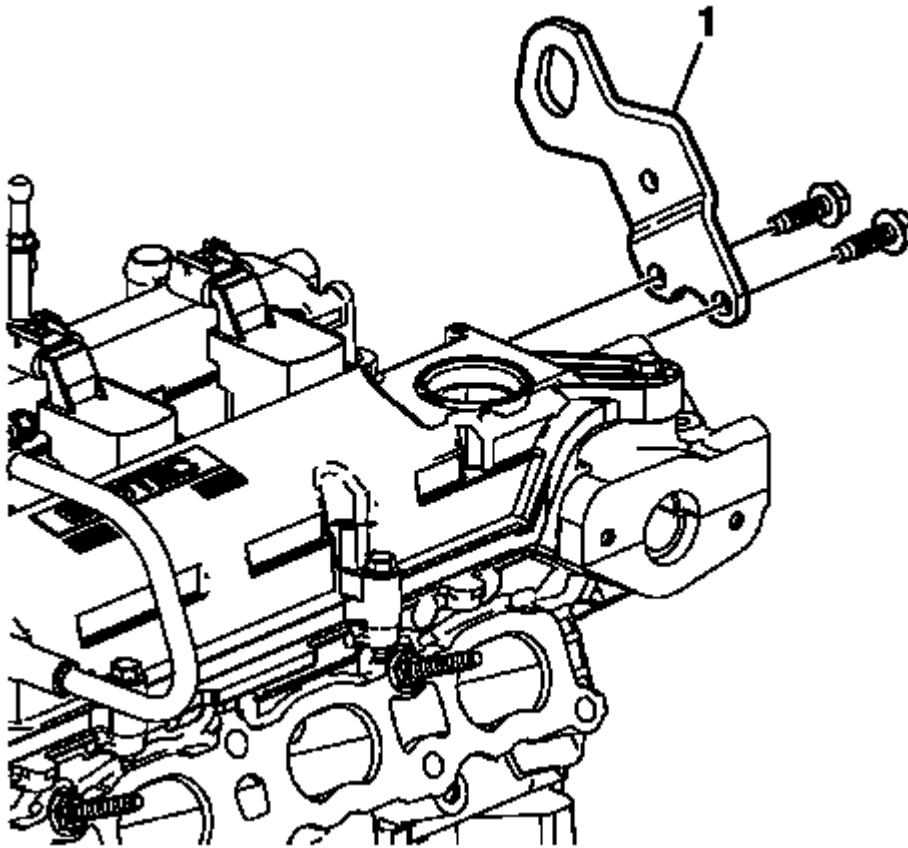


Fig. 286: Rear Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

9. Install the rear lift bracket (1).
10. Install the rear lift bracket bolts and tighten to 25 N.m (18 lb ft).

OIL FILTER WITH CAP AND SEAL INSTALLATION

Special Tools

EN-44887 Oil Filter Wrench

For equivalent regional tools, refer to **Special Tools** .

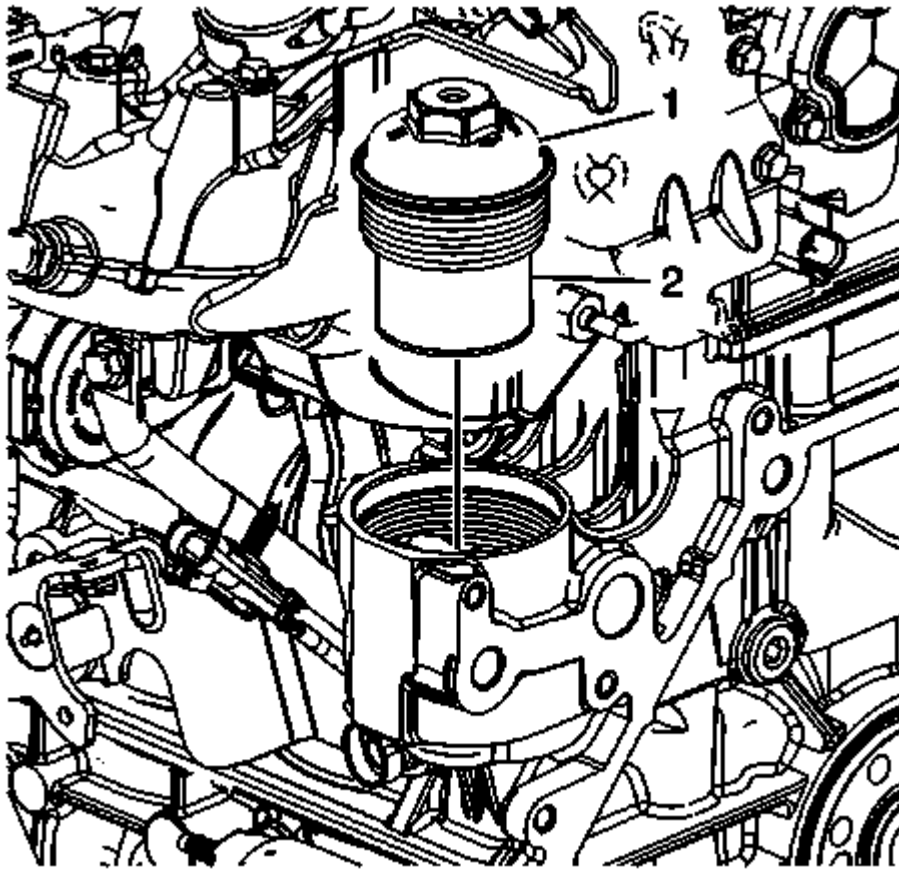


Fig. 287: View of Draining Fluids and Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Install a new oil filter (2) on the oil filter cap (1).
2. Lubricate the O-ring on the oil filter cap with 5W30 engine oil.

CAUTION: Refer to Fastener Caution .

3. Use **EN-44887** wrench to install the oil filter cap. Tighten the oil filter cap to 25 N.m (18 lb ft).

FUEL RAIL AND INJECTORS INSTALLATION

Special Tools

EN-47909 Injector Bore and Sleeve Cleaning Kit

For equivalent regional tools, refer to **Special Tools** .

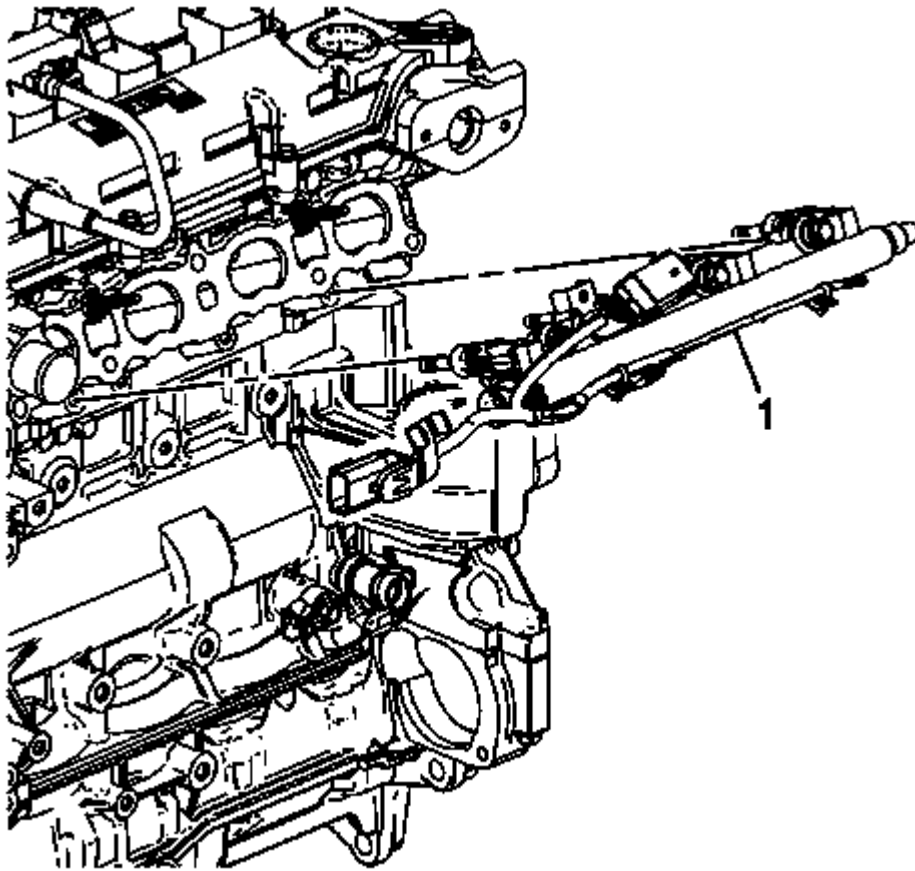


Fig. 288: Fuel Rail

Courtesy of GENERAL MOTORS COMPANY

1. Clean the fuel injector bore in the cylinder head using the **EN-47909** kit.
2. Install the fuel rail (1) with injectors into the cylinder head evenly.
3. Hand tighten the 2 outer fuel rail bolts to seat the injector into the injector bores.

CAUTION: Refer to Fastener Caution .

4. Start and hand tighten the remaining fuel rail bolts. Tighten the bolts in sequence to final torque using the following procedure:
 1. Tighten first pass in sequence to 25 N.m (18 lb ft).
 2. Tighten final pass in sequence to 25 N.m (18 lb ft).
5. Connect the electrical harness to the fuel rail harness connections.

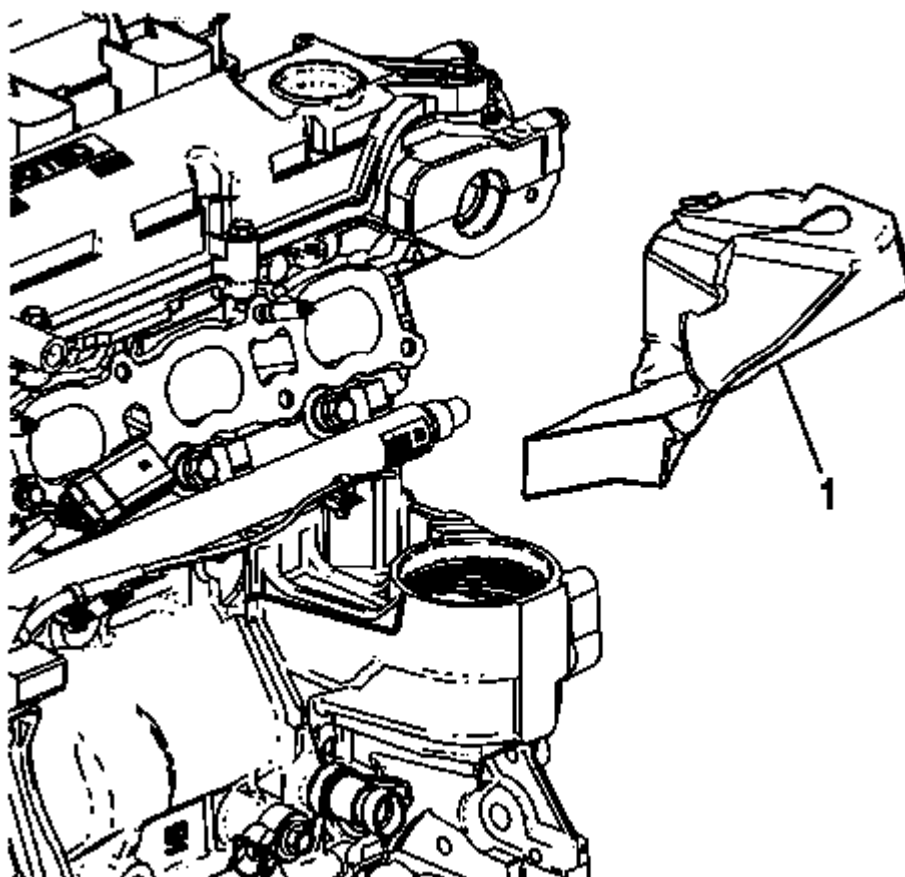


Fig. 289: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

6. Install the fuel injection fuel rail noise shield (1).

INTAKE MANIFOLD INSTALLATION

Special Tools

EN-48896 HP Fuel Pump Installation Alignment Gauge

For equivalent regional tools, refer to **Special Tools** .

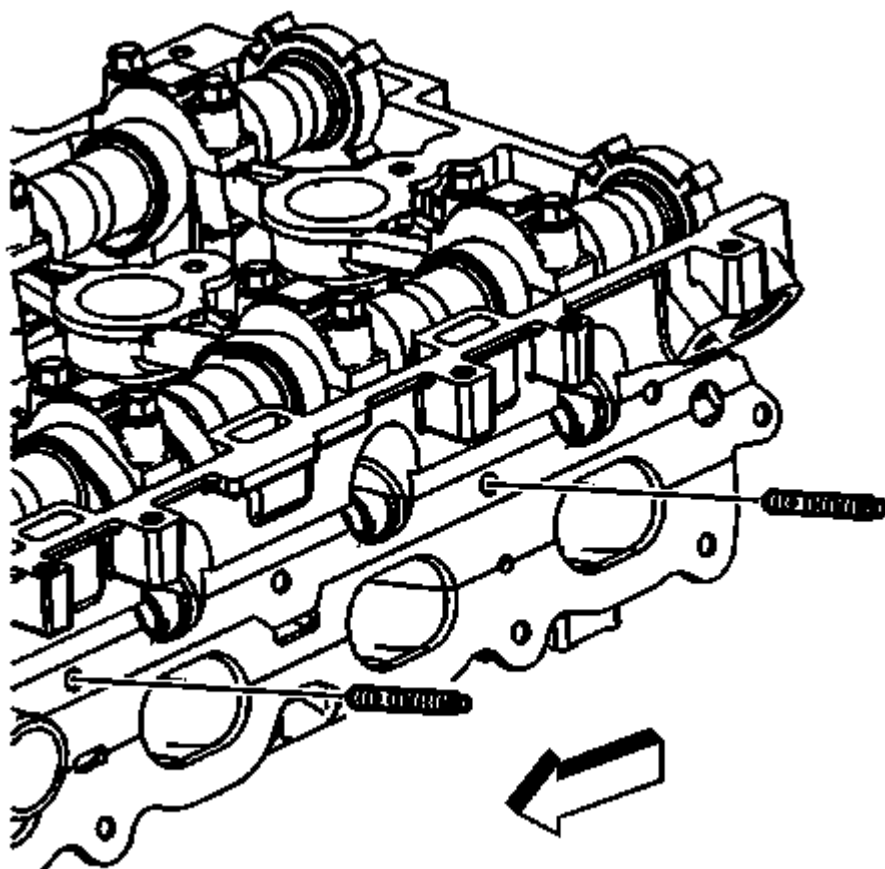


Fig. 290: Intake Manifold Studs

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the intake manifold studs in the manifold face and tighten to 15 N.m (11 lb ft).

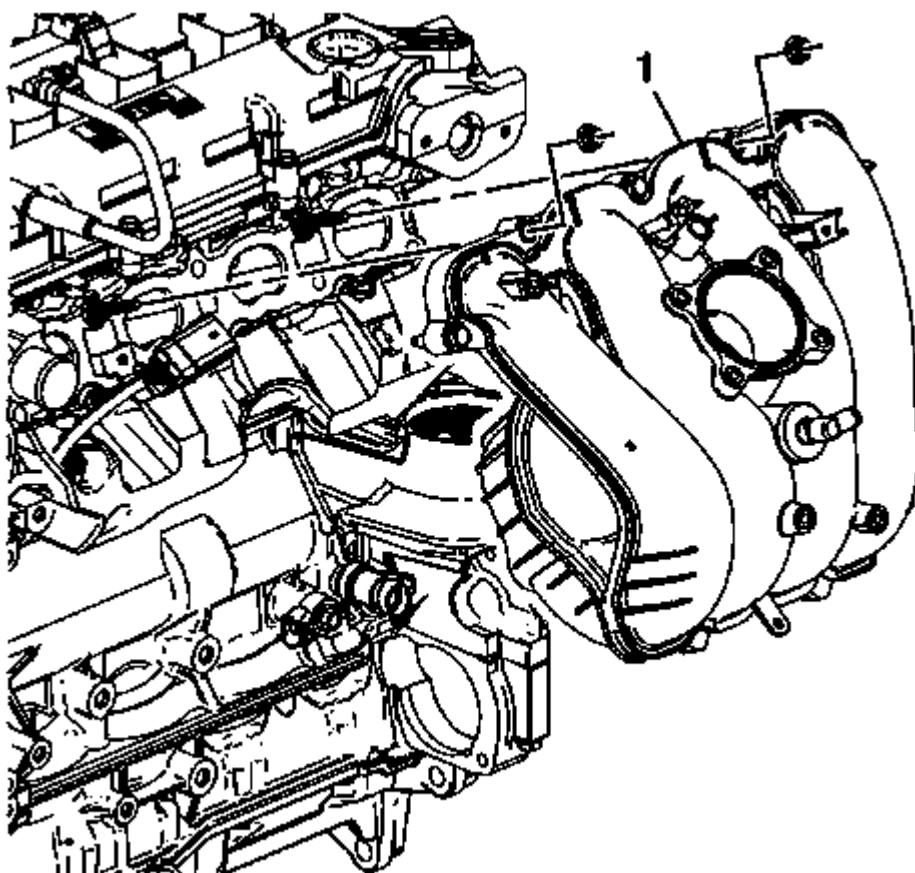


Fig. 291: Intake Manifold Retaining Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (1). Start and hand tighten the intake manifold bolts and nuts.

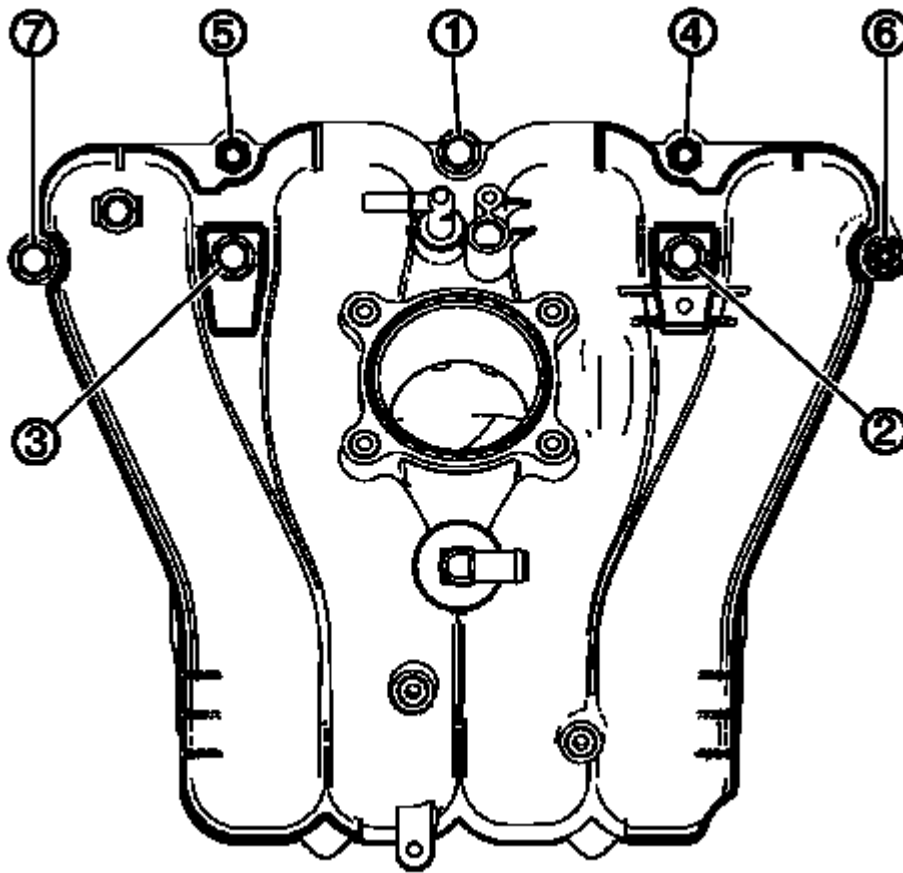


Fig. 292: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

3. Tighten the bolts and nuts in sequence to 25 N.m (18 lb ft).

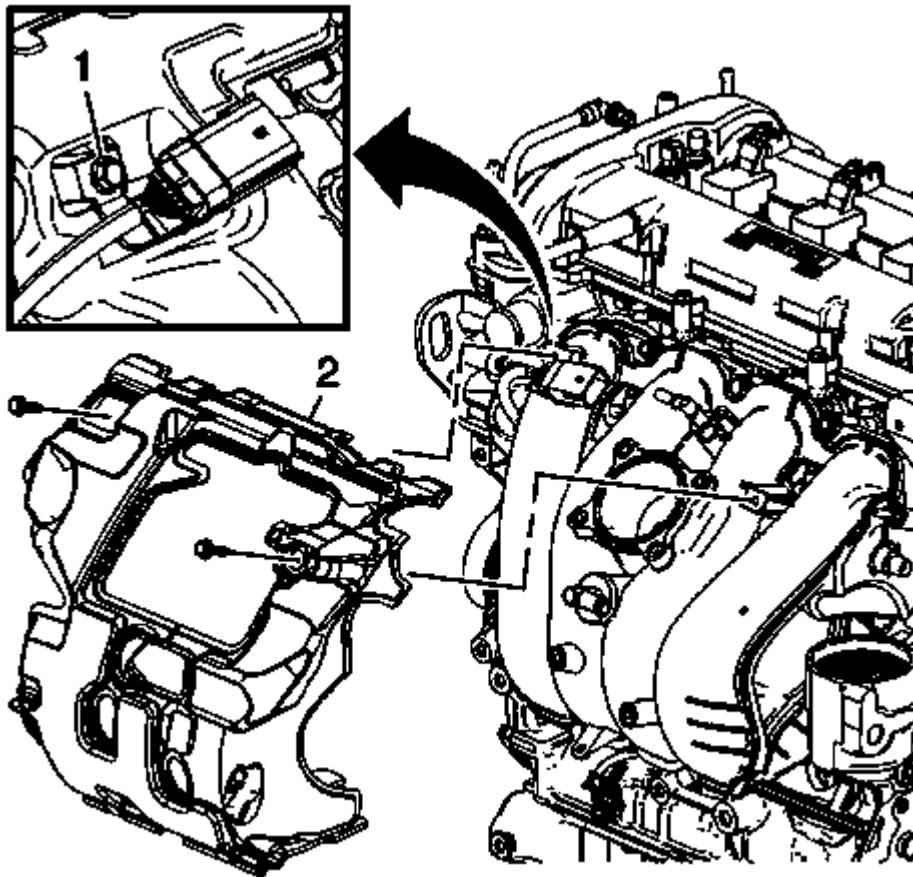


Fig. 293: Fuel Rail Harness Connector Bracket And Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

4. Install the intake manifold insulator (2).
5. Install the insulator bolt and tighten to 10 N.m (89 lb in).
6. Install the fuel rail harness connector bracket (1) to the intake manifold. Tighten the bracket bolt to 10 N.m (89 lb in).

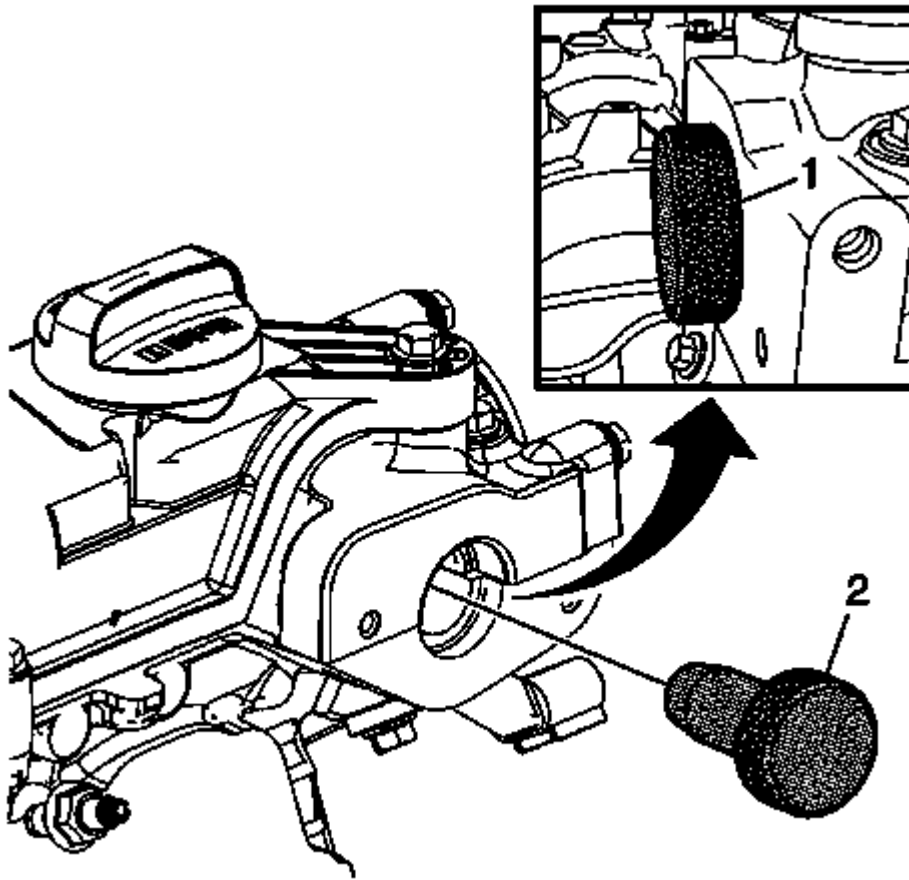


Fig. 294: Using Alignment Gage
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

7. Use the **EN-48896** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the head (1).

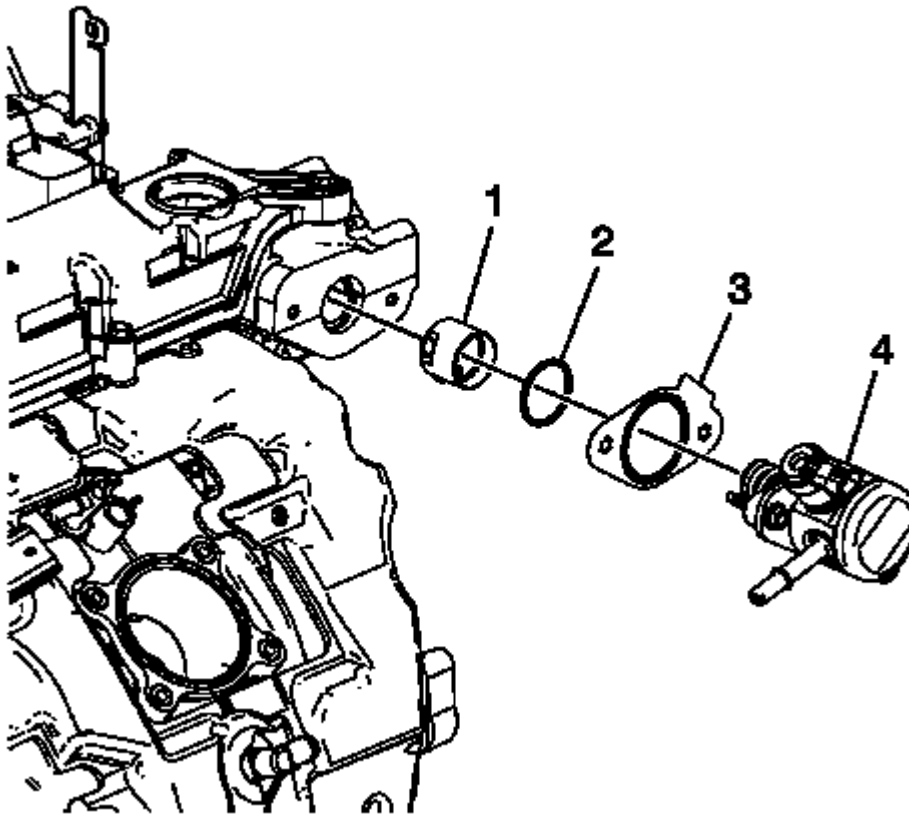


Fig. 295: Fuel Pump Assembly Components
Courtesy of GENERAL MOTORS COMPANY

8. Lubricate the high pressure fuel pump cylinder head bore with 5W30 engine oil.

NOTE: Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle, and the number 1 piston is at top dead center (TDC) on the exhaust stroke. The distance from the mounting flange surface to the camshaft at base circle should be 52 mm (2.05 in).

9. Lubricate the high pressure fuel pump roller lifter (1) with 5W30 engine oil and install into the cylinder head bore.
10. Install a NEW fuel pump housing O-ring (2) and gasket (3).

NOTE: Ensure the plastic bolt retainers are installed in the high pressure fuel pump mounting holes before installing.

11. Install the fuel pump assembly (4).
12. Start and hand-tighten the fuel pump assembly bolts evenly. Tighten the fuel pump bolts evenly to 15 N.m (11 lb ft).

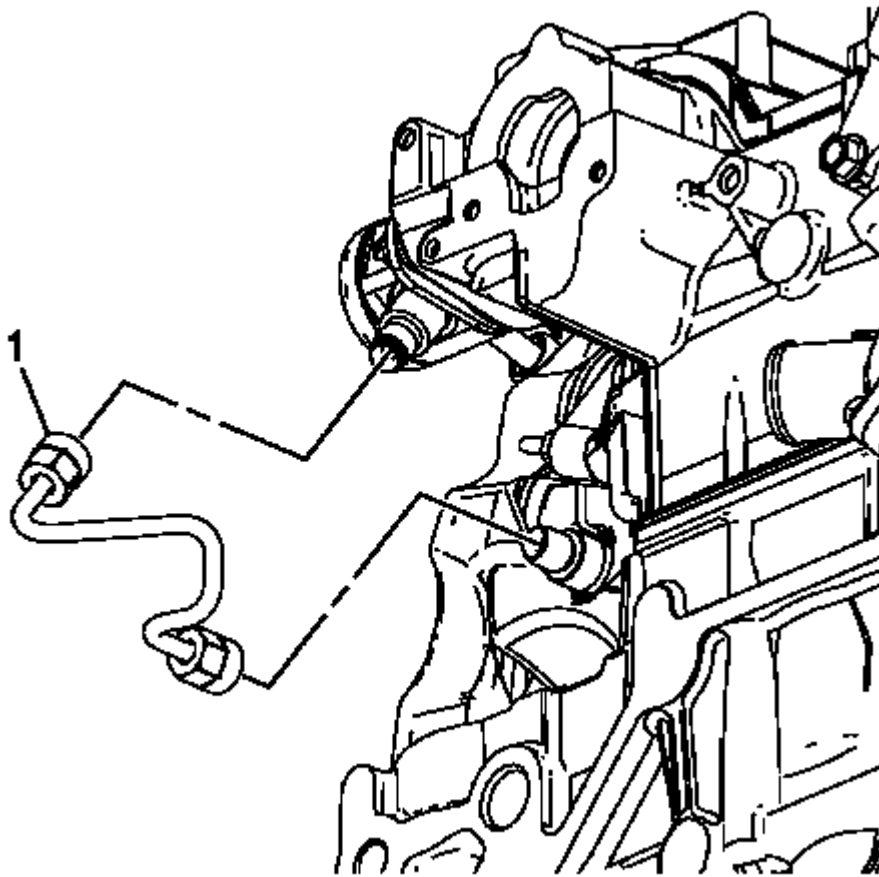


Fig. 296: High Pressure Fuel Line

Courtesy of GENERAL MOTORS COMPANY

13. Install and hand-tighten both ends of the NEW high pressure fuel line (1). Tighten the high pressure fuel line fitting nuts to 30 N.m (22 lb ft).

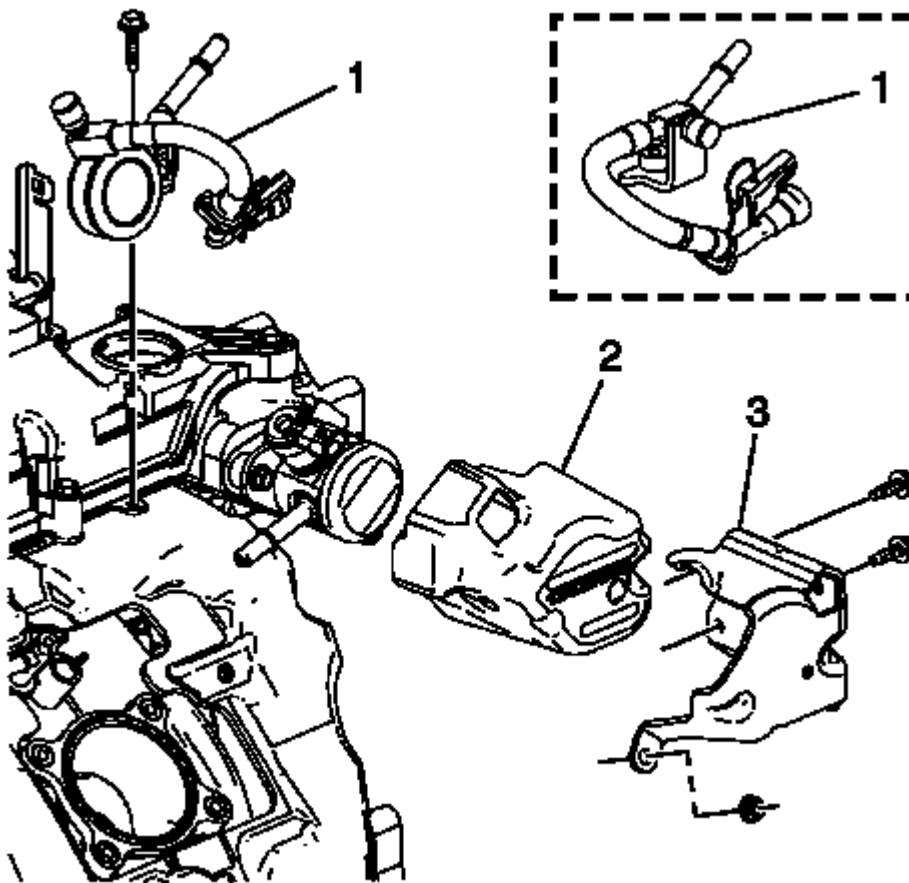


Fig. 297: Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

14. Install the fuel pump insulator (2).

NOTE: The low pressure fuel pipe used is model dependent.

15. Install the low pressure fuel pipe assembly (1).

16. Install the fuel pump cover (3) and nut. Tighten the nut to 10 N.m (89 lb in).

17. Install the fuel pump cover bolts. Tighten the bolts to 10 N.m (89 lb in).

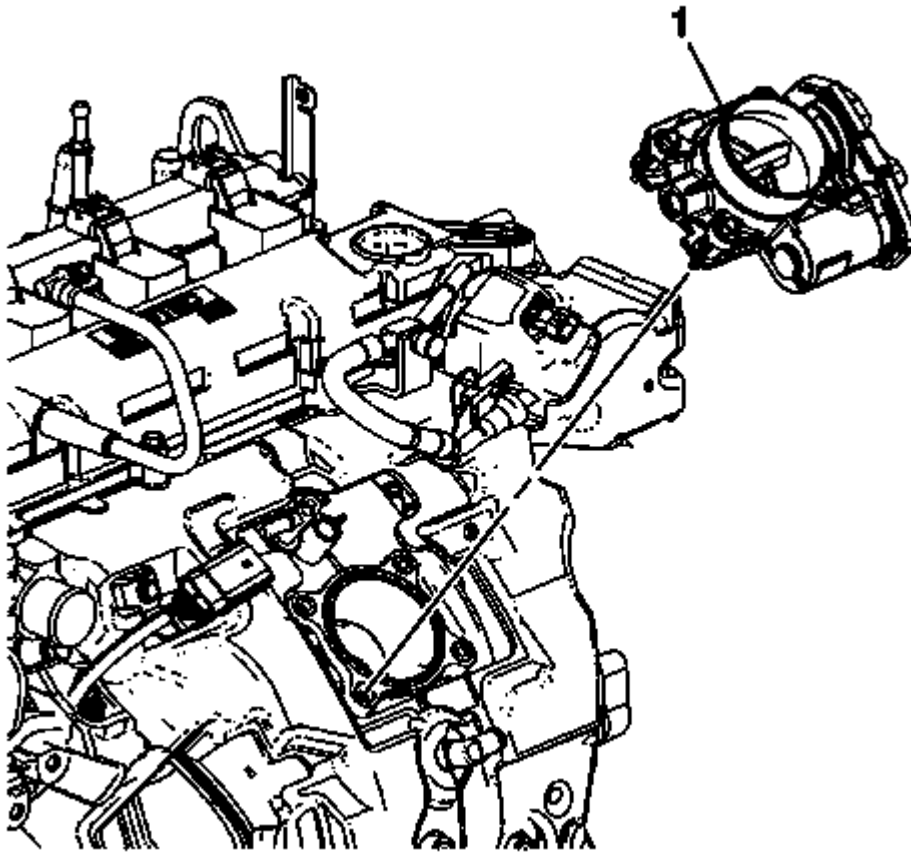


Fig. 298: Throttle Body

Courtesy of GENERAL MOTORS COMPANY

18. Install a new throttle body gasket.
19. Install the throttle body (1).
20. Install the throttle body bolts and tighten to 10 N.m (89 lb in).

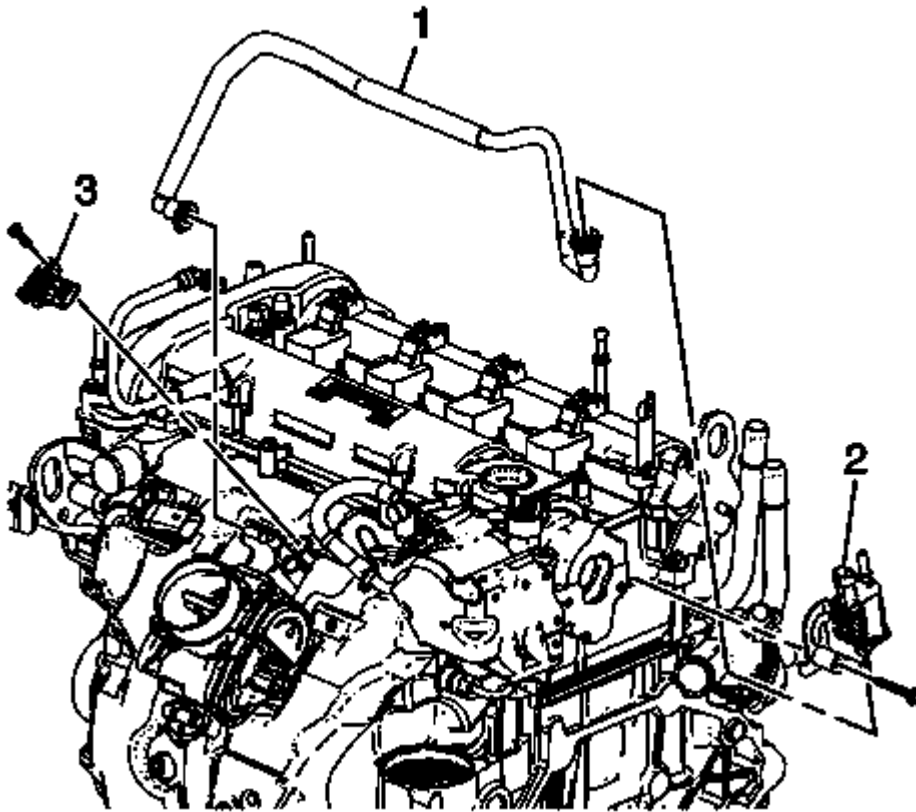


Fig. 299: EVAP Canister Valve, Tube & MAP Sensor
Courtesy of GENERAL MOTORS COMPANY

21. Install the MAP sensor (3). Tighten the sensor bolt to 4 N.m (35 lb in).
22. Install the EVAP canister valve (2) and tighten to 25 N.m (18 lb ft).
23. Install the EVAP canister valve tube (1).

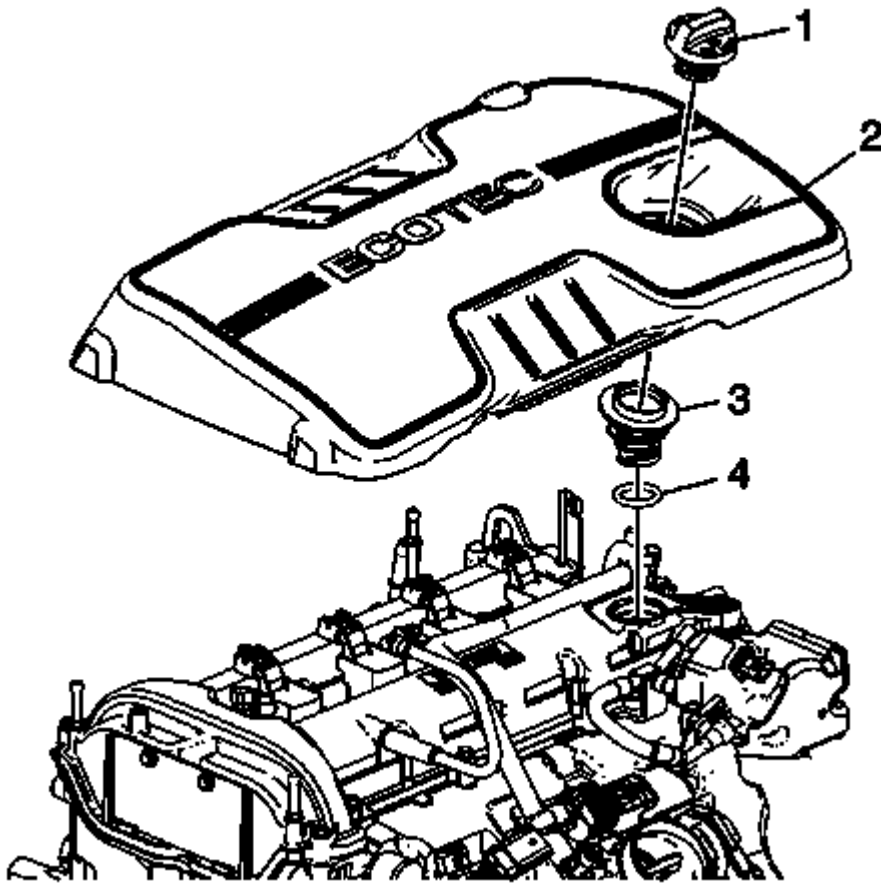


Fig. 300: Oil Fill Cap Components
Courtesy of GENERAL MOTORS COMPANY

24. Install the O-ring and oil fill tube assembly (3).
25. Install the intake manifold cover (2) onto the camshaft cover ball studs.
26. Install the oil fill cap (1).

EXHAUST MANIFOLD INSTALLATION

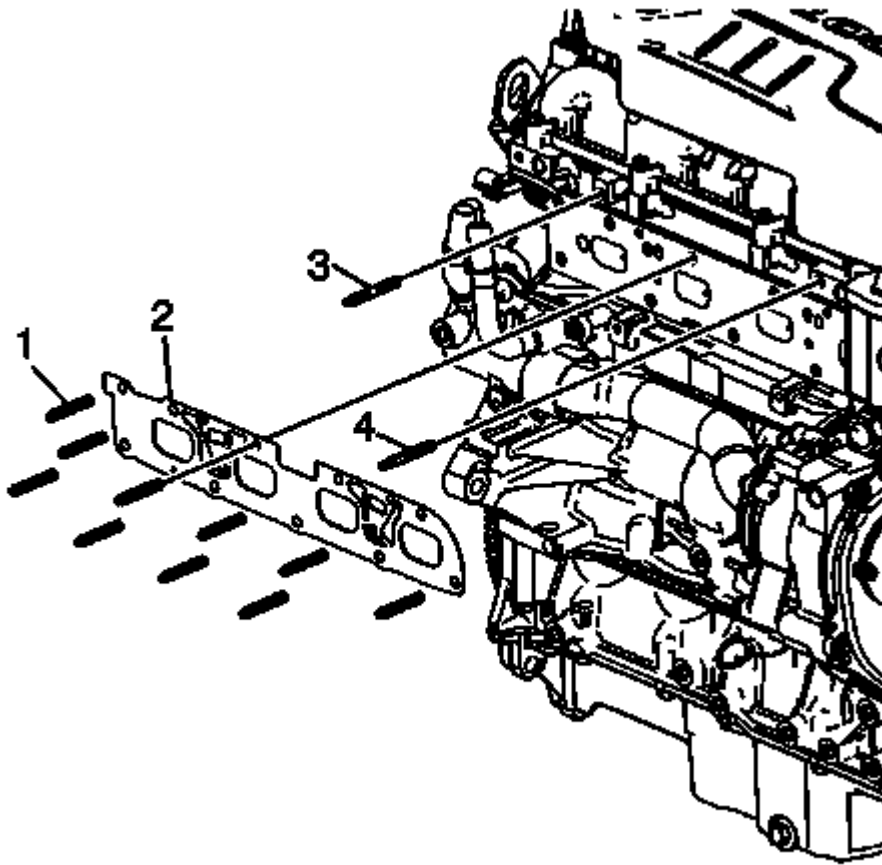


Fig. 301: Upper Secondary Air Injection Assembly Studs, Exhaust Manifold Gasket & Studs
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install NEW exhaust manifold studs (1) and tighten to 10 N.m (89 lb in).
2. Install secondary air injection assembly studs (3, 4) and tighten to 10 N.m (89 lb in), if necessary.
3. Install a NEW exhaust manifold gasket (2).

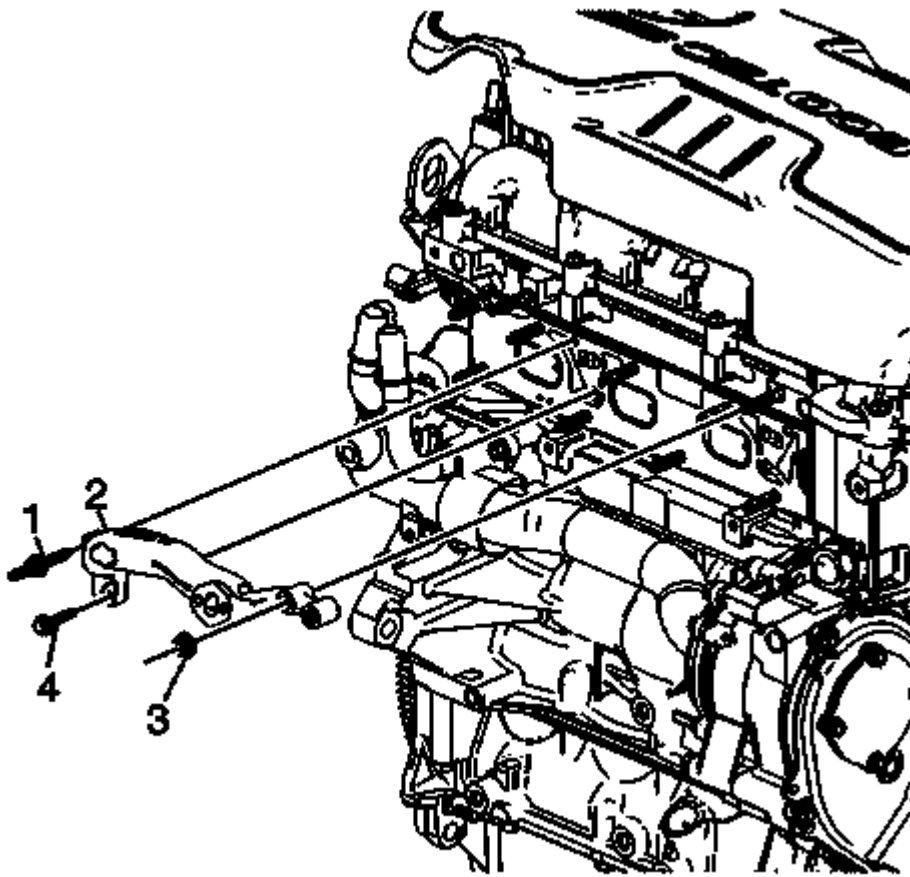


Fig. 302: Secondary Air Injection Check Valve Pipe Adapter & Mounting Components
Courtesy of GENERAL MOTORS COMPANY

4. Install the secondary air injection check valve pipe adapter (2). Install the nut (3) and tighten to 25 N.m (18 lb ft).
5. Install the stud-bolt (1) and bolt (4). Tighten the stud-bolt and bolt to 10 N.m (89 lb in).

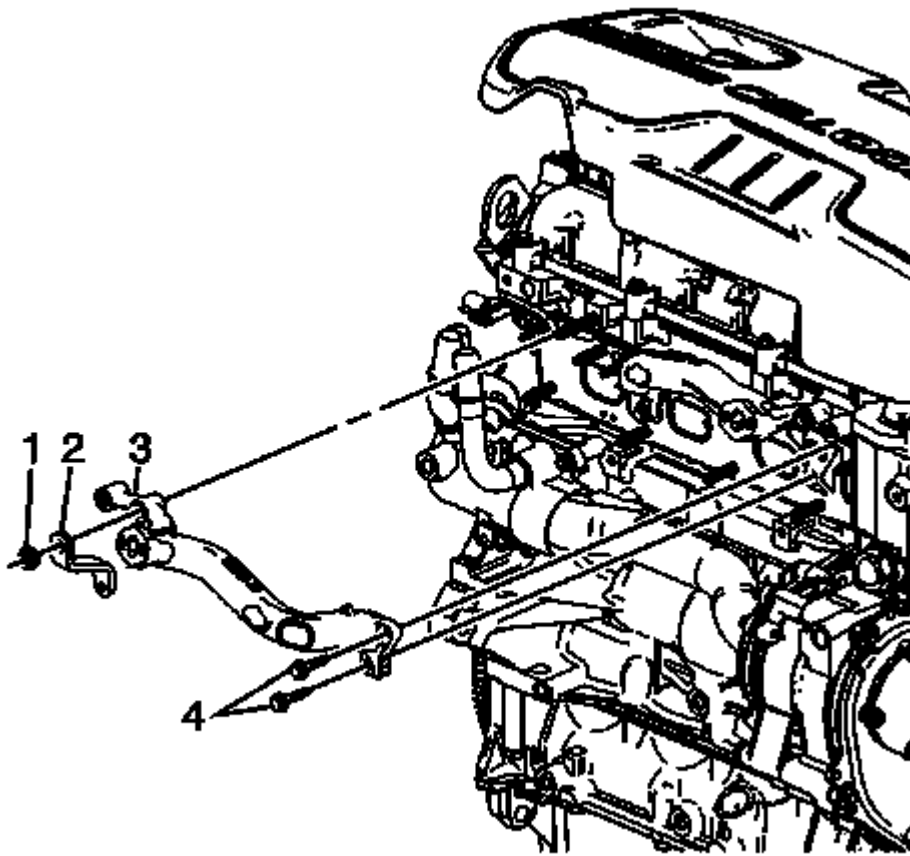


Fig. 303: Secondary Air Injection Check Valve Pipe Adapter And Mounting Components
Courtesy of GENERAL MOTORS COMPANY

6. Install the second secondary air injection check valve pipe adapter (3). Install the bolts (4) and tighten to 10 N.m (89 lb in).
7. Install the secondary air injection check valve bracket (2) and the upper nut (1). Tighten the nut (1) to 25 N.m (18 lb ft).

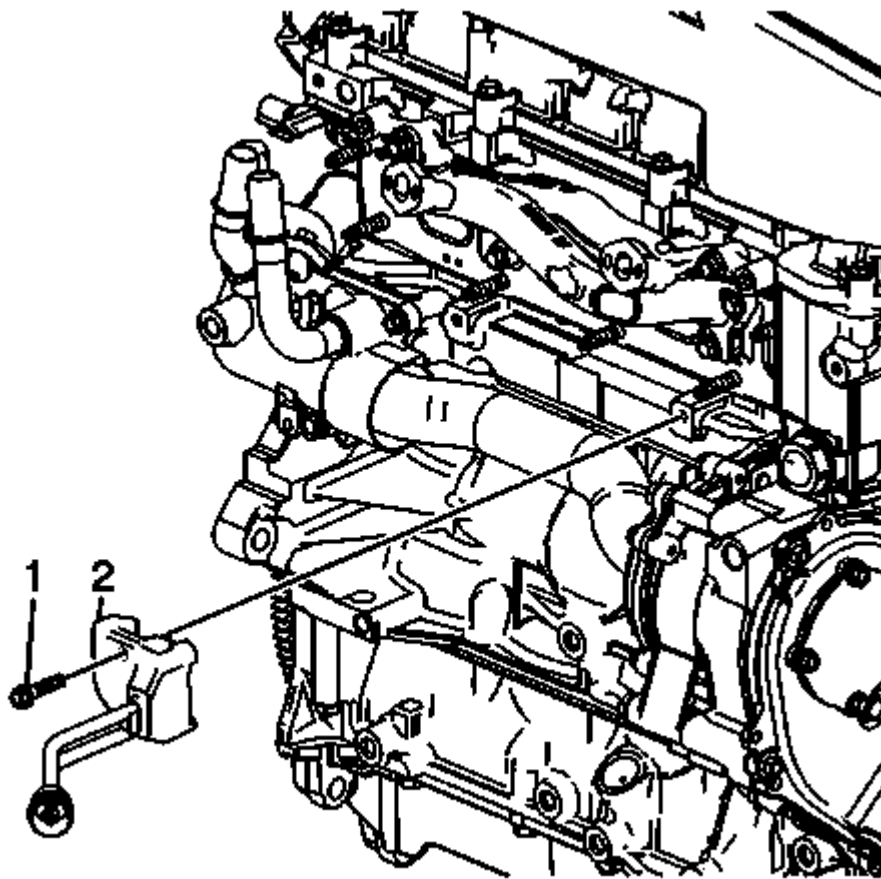


Fig. 304: Block Heater & Bolt

Courtesy of GENERAL MOTORS COMPANY

8. Install the block heater (1). Tighten the bolt to 10 N.m (89 lb in).

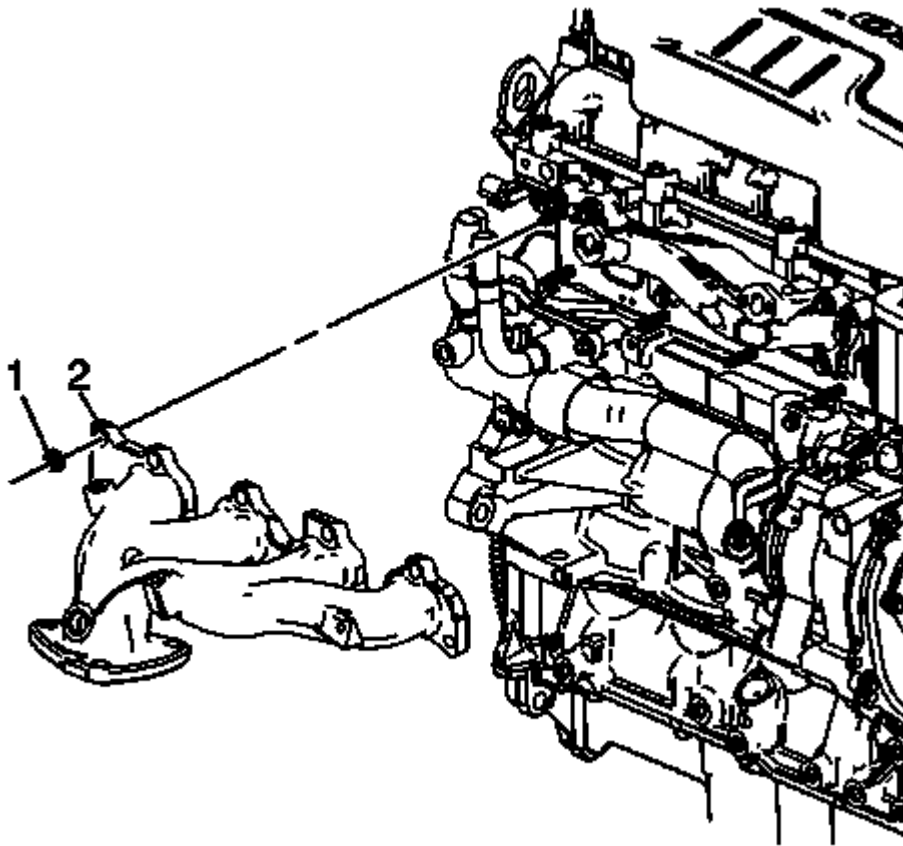


Fig. 305: Exhaust Manifold & Retaining Nuts
Courtesy of GENERAL MOTORS COMPANY

9. Install the exhaust manifold (2) to the cylinder head.
10. Install NEW exhaust manifold to cylinder head retaining nuts (1) finger tight.

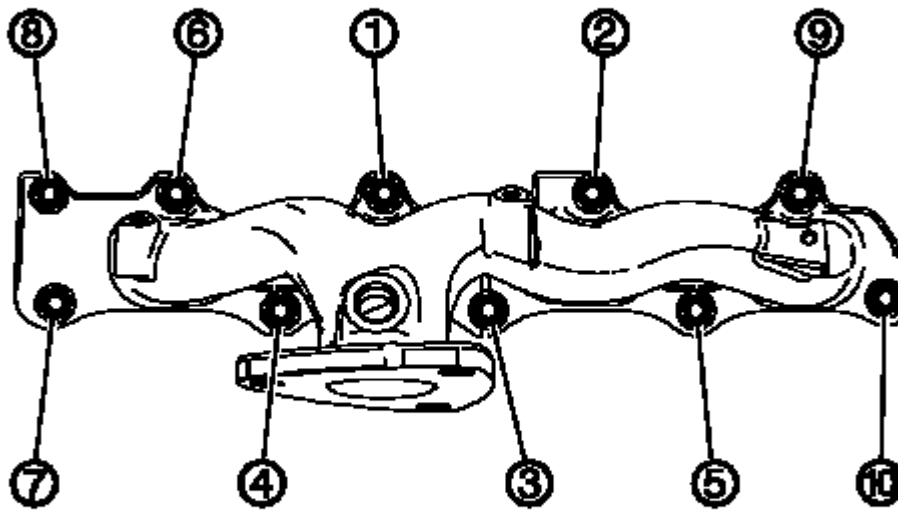


Fig. 306: Exhaust Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

11. Tighten the NEW exhaust manifold to cylinder head retaining nuts two passes in sequence:
 1. Tighten first pass in sequence to 14 N.m (124 lb in).
 2. Tighten final pass in sequence to 14 N.m (124 lb in).

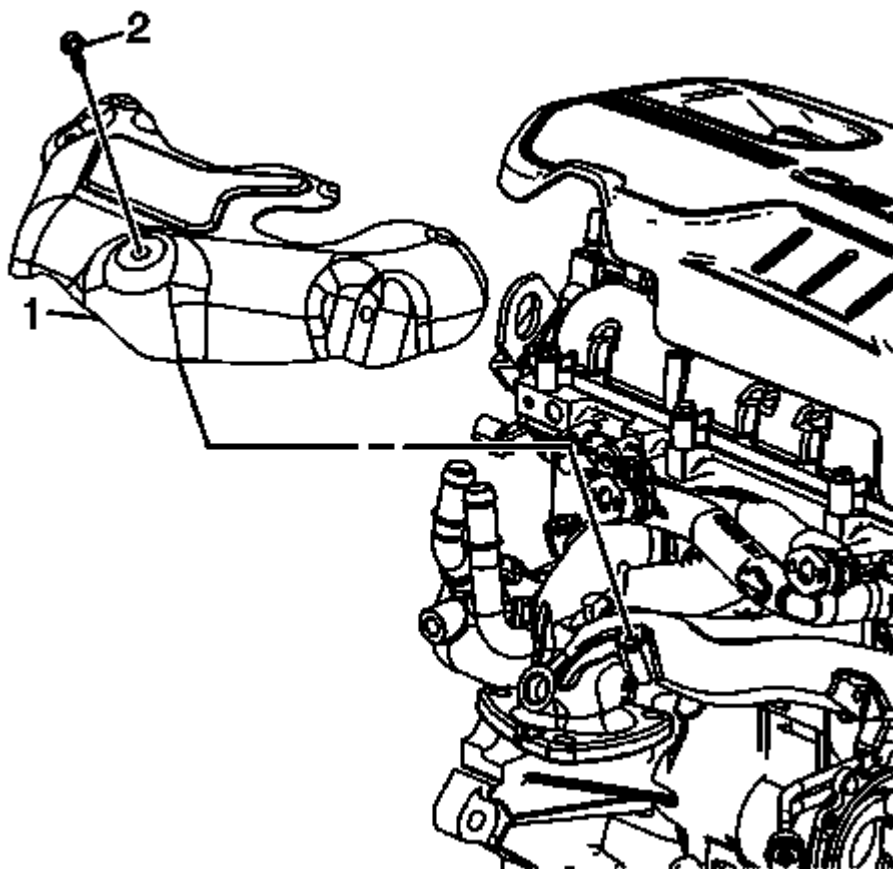


Fig. 307: Exhaust Manifold Heat Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Install the exhaust manifold heat shield (1) and bolts (2). Tighten the bolts to 14 N.m (124 lb in).

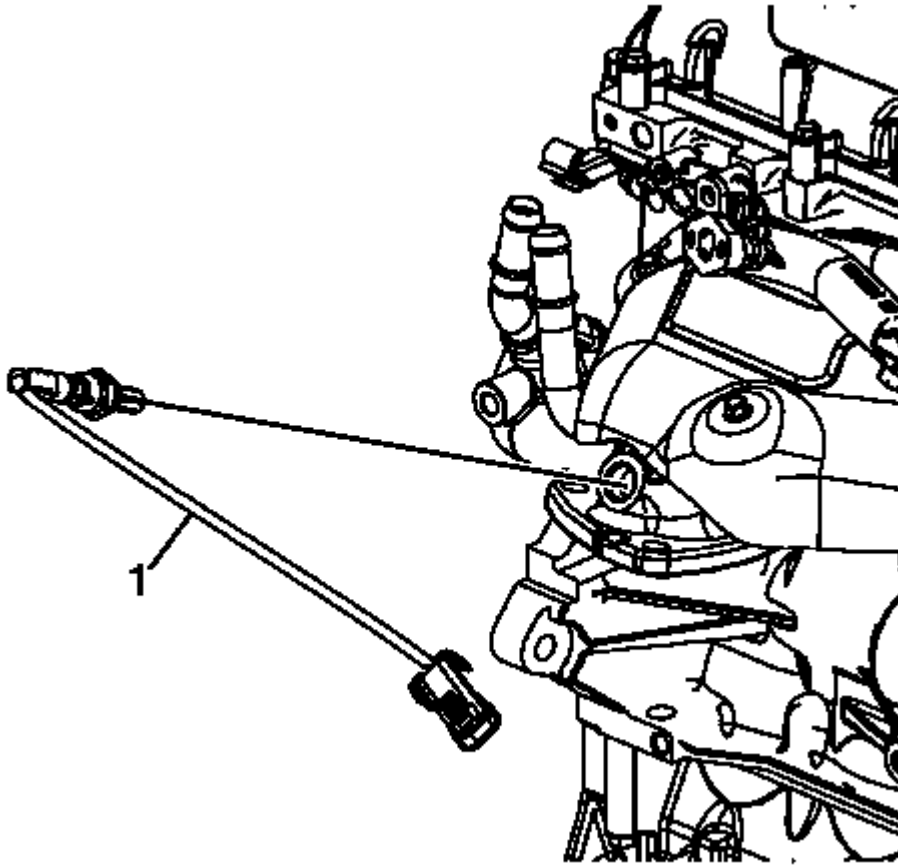


Fig. 308: Oxygen Sensor

Courtesy of GENERAL MOTORS COMPANY

13. Coat the threads of the oxygen sensor (1) with antiseize. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
14. Install the oxygen sensor and tighten to 42 N.m (31 lb ft).

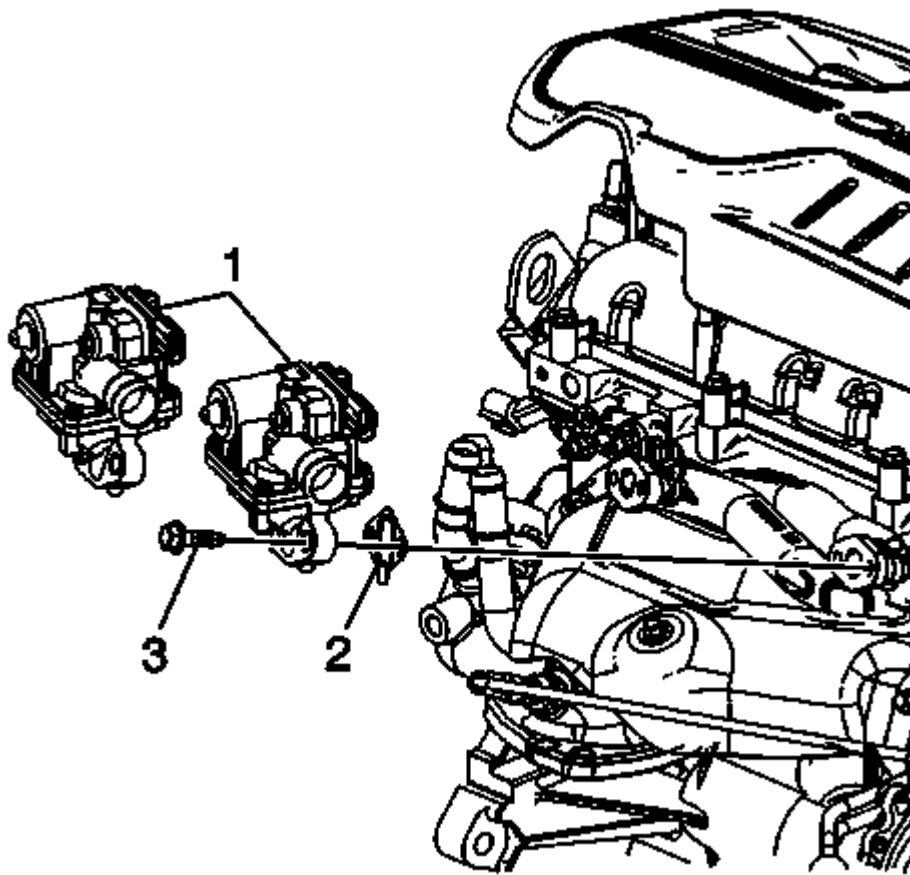


Fig. 309: Secondary Air Injection Check Valves, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

15. Install a NEW gasket (2) on each of the secondary air injection check valve assemblies (1).
16. Install the secondary air injection check valve assemblies (1) and bolts (3). Tighten the bolts to 25 N.m (18 lb ft).

OIL LEVEL INDICATOR AND TUBE INSTALLATION (LEA, OR LUK)

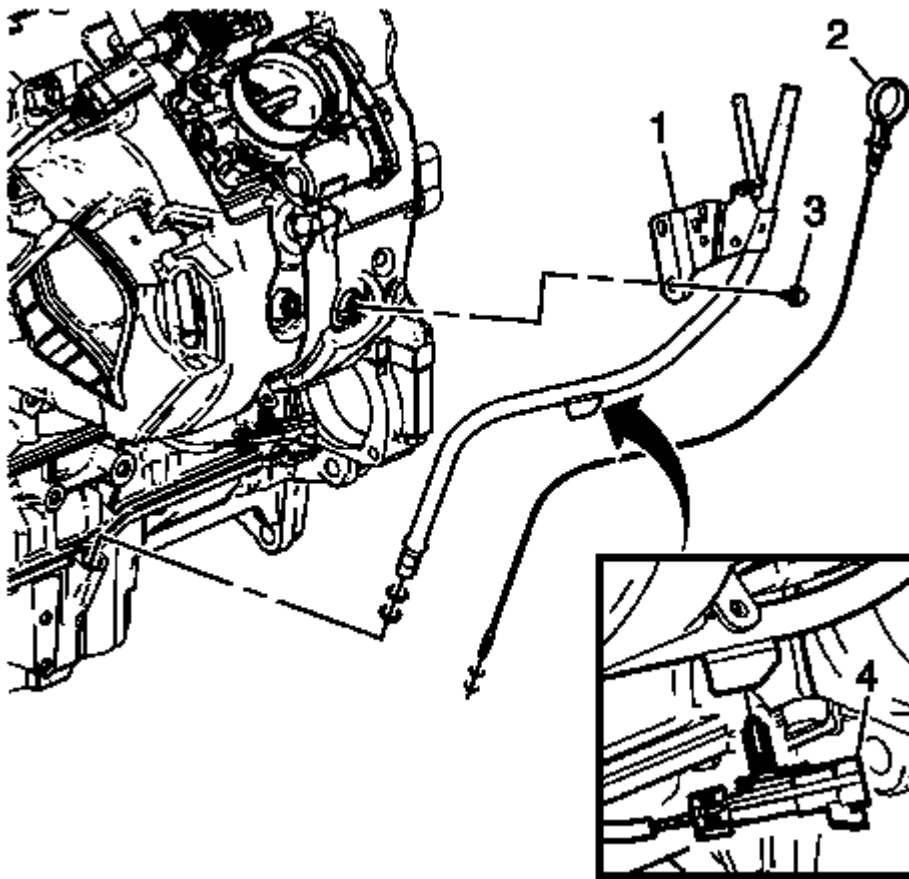


Fig. 310: Oil Level Indicator Tube Components
 Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the oil level indicator tube O-ring. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the oil level indicator (2) and the oil level indicator tube (1) into the oil pan.

CAUTION: Refer to Fastener Caution .

3. Install the oil level indicator tube bracket bolt (3) to the intake manifold and tighten to 10 N.m (89 lb in).
4. Install the electrical wiring harness to the oil level indicator tube.
5. Install the knock sensor wiring clip (4) into the oil level indicator tube.

ENGINE FLYWHEEL INSTALLATION

Special Tools

- **EN-38122-A** Crankshaft Balancer Holder
- **EN-43653** Flywheel Holding Tool
- **EN-45059** Angle Meter

For equivalent regional tools, refer to Special Tools .

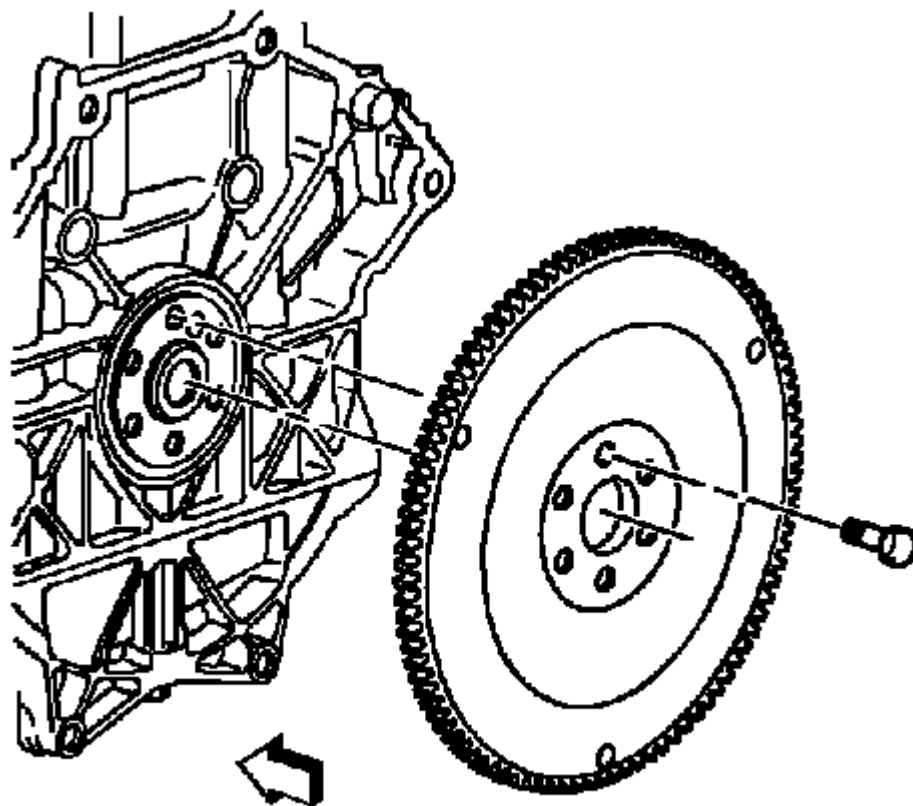


Fig. 311: View Of Flywheel

Courtesy of GENERAL MOTORS COMPANY

1. Install the flywheel.
2. Install NEW bolts.

CAUTION: Refer to Fastener Caution .

NOTE: EN-43653 flywheel holding tool may be used instead of EN-38122-A holder in order to prevent crankshaft rotation.

3. Holding the crankshaft balancer with **EN-38122-A** holder , tighten the bolts evenly. Tighten the bolts to 53 N.m (39 lb ft), plus 25 degrees using the **EN-45059** meter

ENGINE PRELUBING

NOTE: This procedure is not used in Europe.

Special Tools

EN-45299 Engine Preluber

For equivalent regional tools, refer to Special Tools .

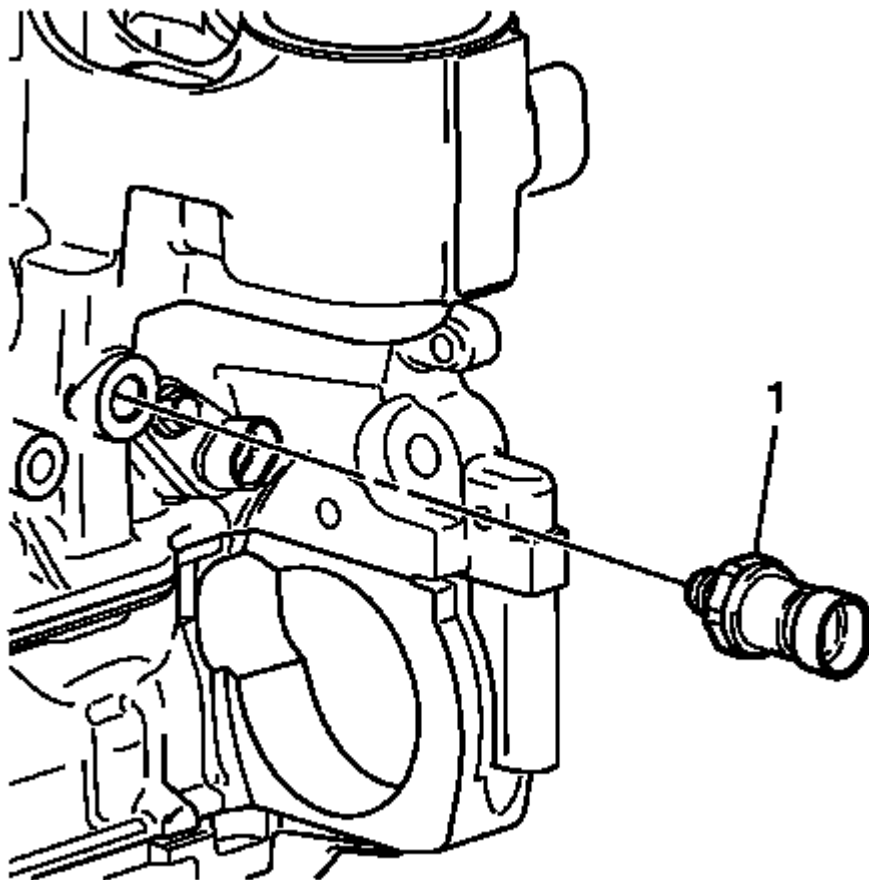


Fig. 312: Identifying the M12 x 1.75 Adapter
Courtesy of GENERAL MOTORS COMPANY

NOTE: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Ensure an approved engine oil is used, as specified in the owners manual.

1. Remove the oil pressure switch.
2. Install the M12 x 1.75 adapter (1) P/N 509376.

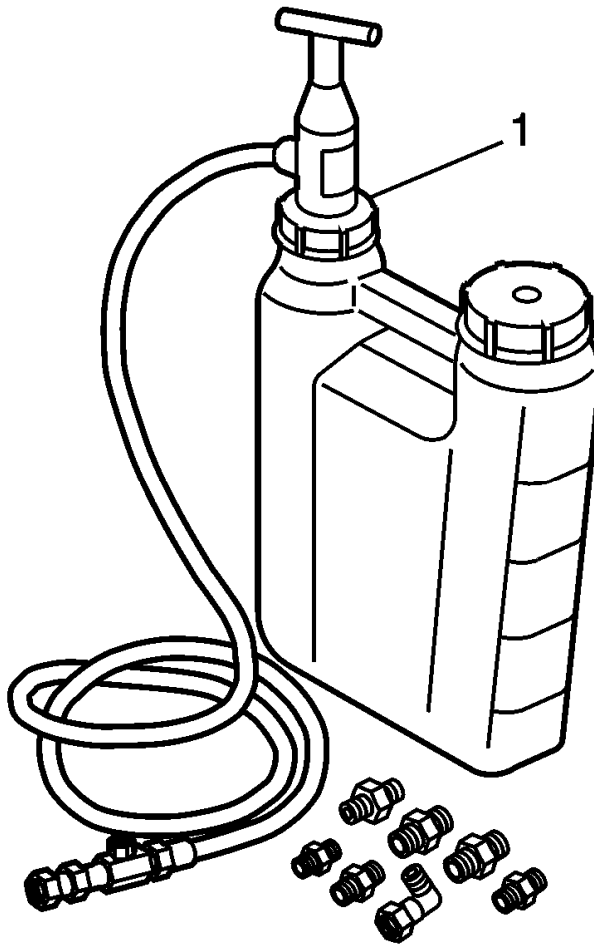


Fig. 313: View of Flexible Hose, Adapter and Preluber
Courtesy of GENERAL MOTORS COMPANY

3. Install the flexible hose to the adapter and open the valve.
4. Pump the handle on the **EN-45299** preluber (1) in order to flow a minimum of 1-1.9 liters (1-2 quarts) of engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
5. Close the valve and remove the flexible hose and adapter from the engine.

CAUTION: Refer to Fastener Caution .

6. Install the oil pressure switch to the engine and tighten to 22 N.m (16 lb ft).
7. Top-off the engine oil to the proper level.

ENGINE

Engine Mechanical - 2.4L (LEA LUK) - Repair Instructions - On Vehicle

REPAIR INSTRUCTIONS - ON VEHICLE

INTAKE MANIFOLD COVER REPLACEMENT

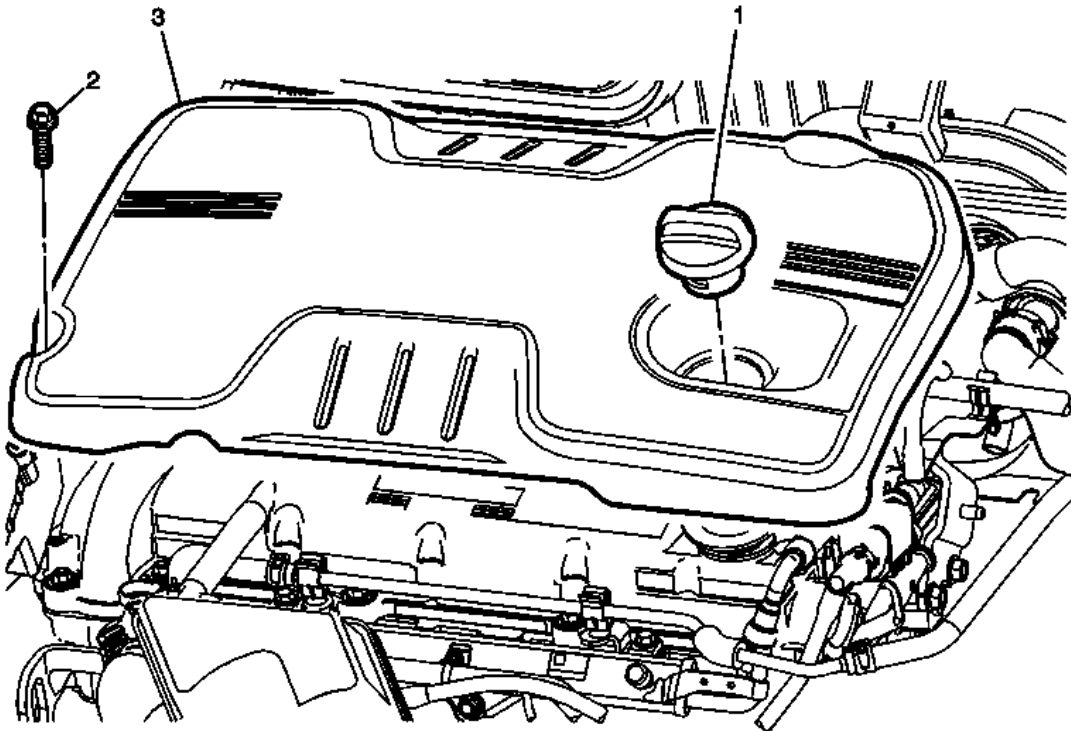


Fig. 1: Intake Manifold Cover, Fastener & Oil Cap
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement

Callout	Component Name
1	Oil Cap
2	Intake Manifold Cover Fastener CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
3	Intake Manifold Cover Procedure Transfer components as necessary.

DRIVE BELT REPLACEMENT (LEA)

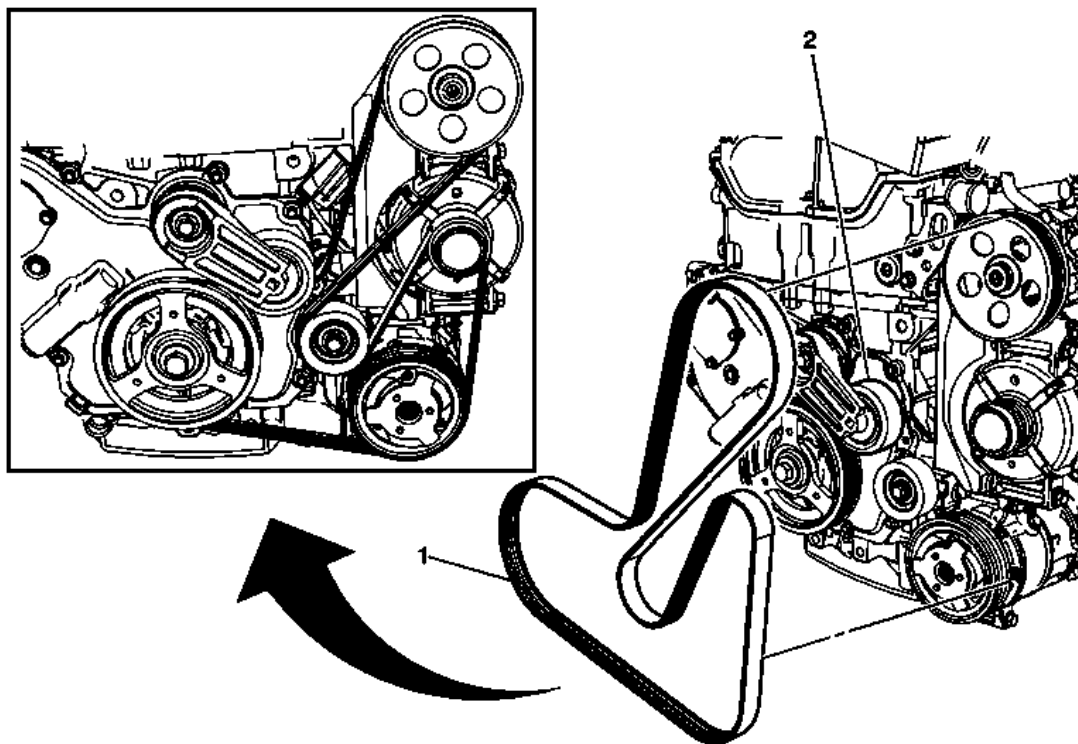


Fig. 2: Drive Belt Routing (LEA)

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement (LEA)

Callout	Component Name
Preliminary Procedure	
Remove the Engine Mount. Refer to <u>Engine Mount Replacement</u>	
1	<p>Drive Belt</p> <p>Procedure</p> <ol style="list-style-type: none">1. Use the proper tool to rotate the drive belt tensioner.2. Remove the drive belt from the pulleys and tensioner.
2	<p>Drive Belt Tensioner</p> <p>Procedure</p> <ol style="list-style-type: none">1. Clean and inspect the drive belt surfaces of all the pulleys.2. Inspect the drive belt for correct alignment.

DRIVE BELT REPLACEMENT (LUK)

Special Tools

EN-48932 Hydraulic Belt Tensioner Compressor

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .

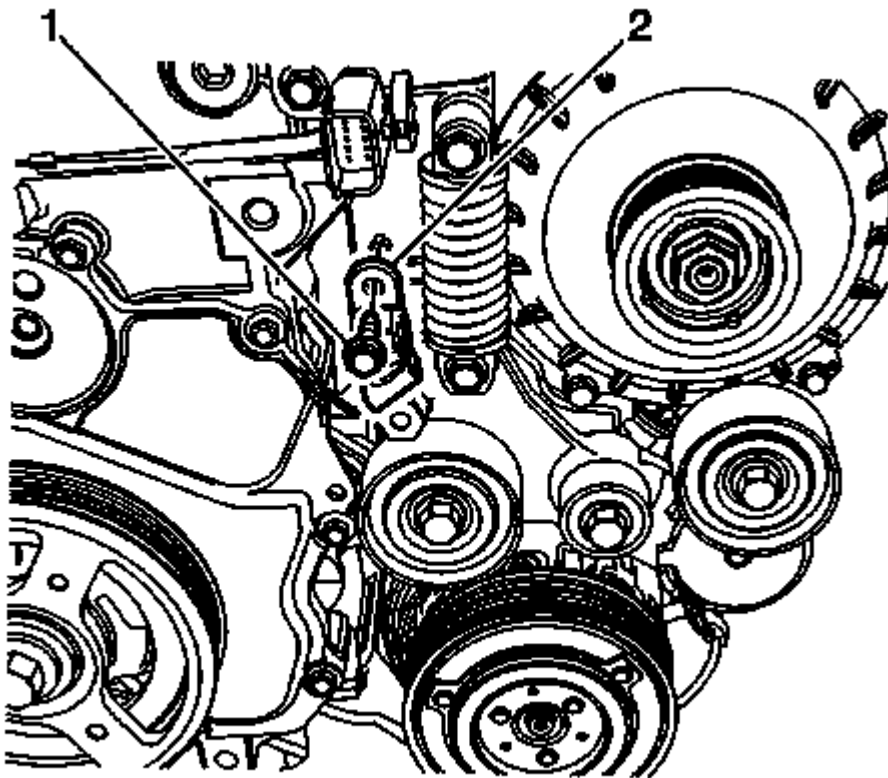


Fig. 3: View Of Tensioner Stop Fastener And Stop
Courtesy of GENERAL MOTORS COMPANY

NOTE: The tensioner stop is critical and must be removed prior to compressing the drive belt tensioner spring.

2. Remove the tensioner stop fastener (1) and stop (2).

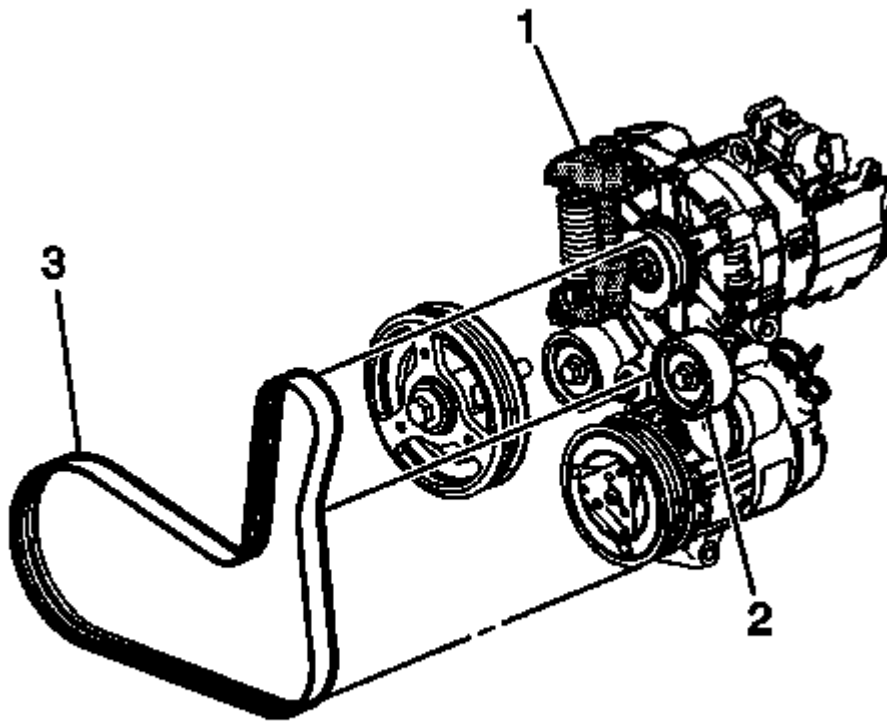


Fig. 4: Drive Belt Routing (LUK)

Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the EN- 48932 compressor tool is not on the generator bracket and A/C compressor bracket.

3. Install the **EN-48932** compressor (1) to the drive belt tensioner spring.
4. Compress the drive belt tensioner spring fully using the **EN-48932** compressor.
5. Reposition the idler pulley (2) to release tension off the drive belt.
6. Remove the drive belt from under the middle idler pulley.
7. Remove the drive belt (3) from the vehicle.

Installation Procedure

1. With the **EN-48932** compressor still compressing the tensioner spring Install and position the drive belt around all of the pulleys except for the middle idler pulley.

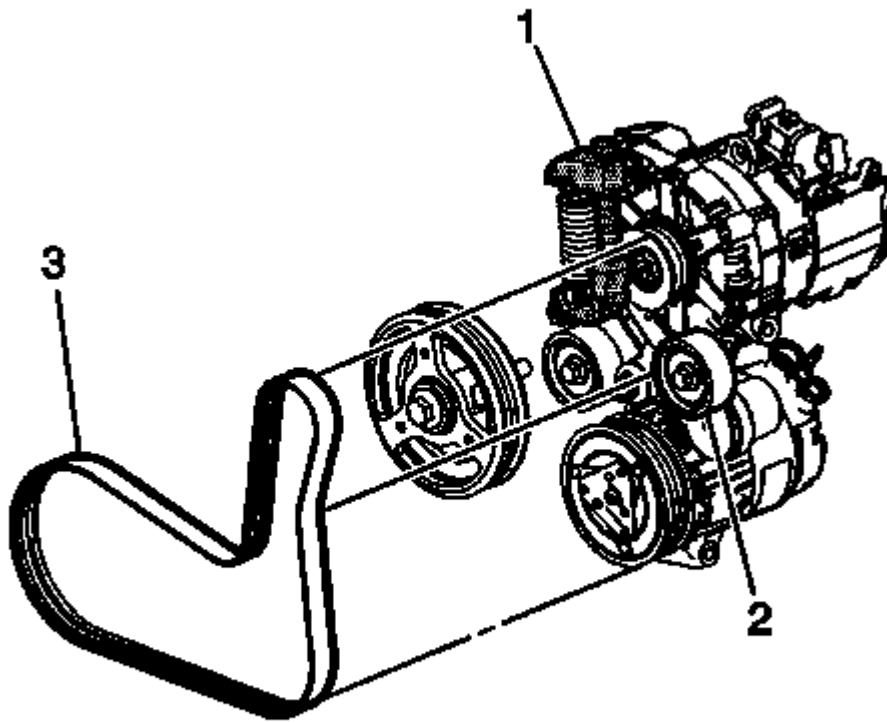


Fig. 5: Drive Belt Routing (LUK)

Courtesy of GENERAL MOTORS COMPANY

2. Rotate pulley (2) clockwise and install the drive belt under the middle idler pulley.
3. Ensure the drive belt tensioner idler pulley is fully seated against the drive belt (3).
4. Loosen the forcing bolt on the **EN-48932** compressor (1) and remove from the drive belt tensioner spring.

NOTE: If tensioner assembly is new, use a 6 point socket on the drive belt tensioner hex boss (1) and rotate hex boss clockwise to release the tension and remove the shipping retainer by hand. Discard the shipping retainer.

5. Ensure that the drive belt tensioner idler is fully seated against the drive belt.

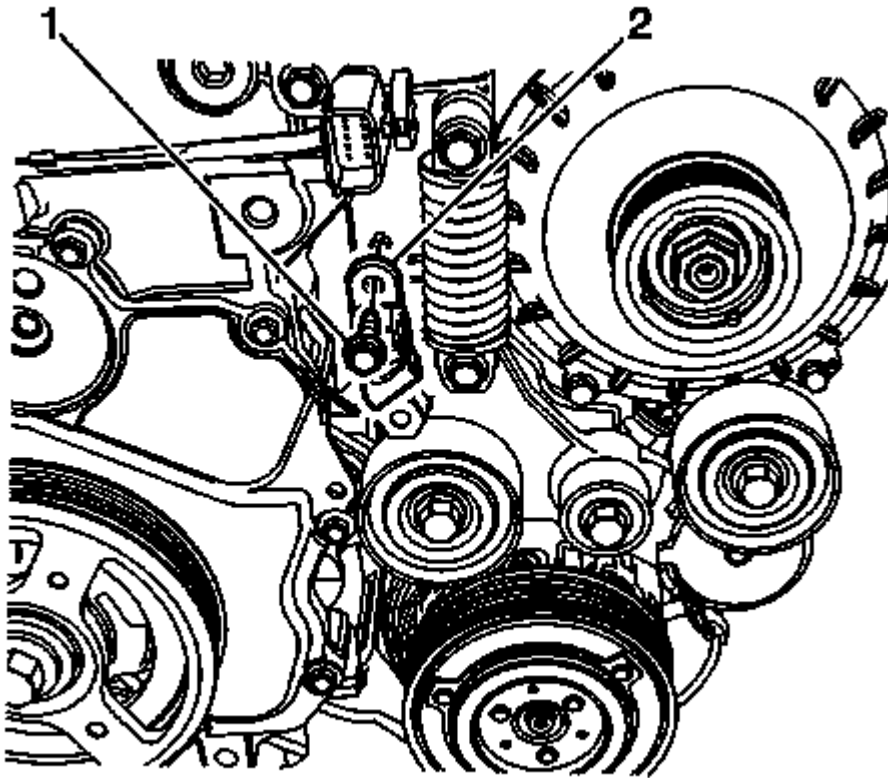


Fig. 6: View Of Tensioner Stop Fastener And Stop
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Make sure the Tensioner Stop locator pin is in the guide hole of the bracket.

6. Install the tension stop (2) and fastener (1), then tighten to 10 (89 lb in).
7. Install the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .

DRIVE BELT TENSIONER REPLACEMENT (LUK)

Special Tools

J-45025 Torque Wrench Adapter

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Remove the drive belt. Refer to Drive Belt Replacement (LUK).
2. Remove the right side engine mount. Refer to Engine Mount Replacement.

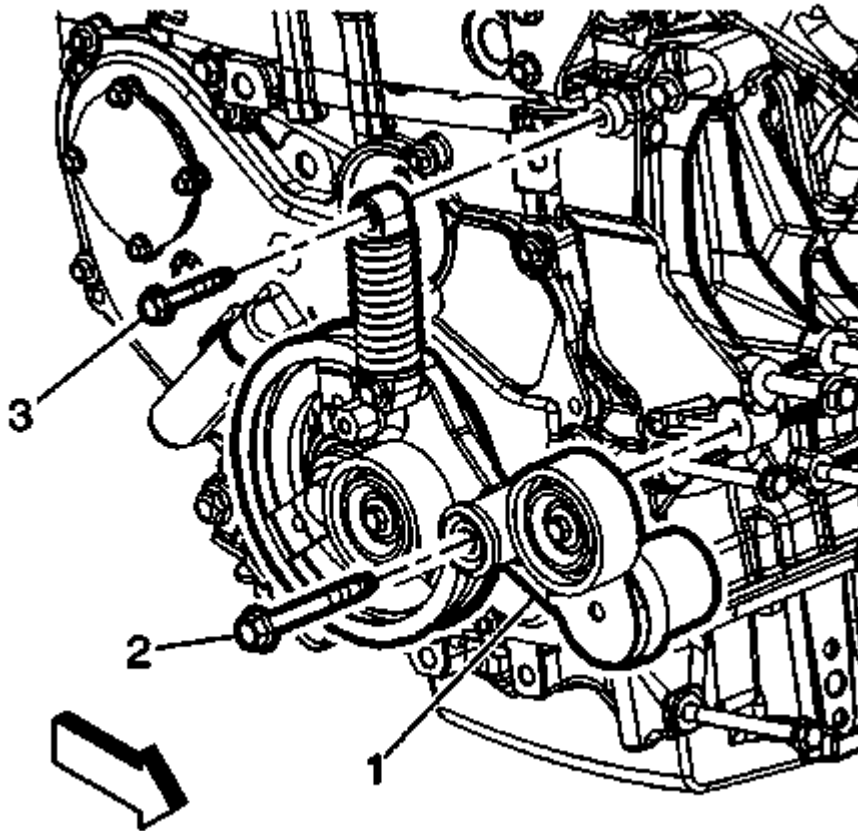


Fig. 7: Drive Belt Tensioner, Drive Belt Tensioner Spring And Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the drive belt tensioner bolts (2, 3).
4. Remove the drive belt tensioner (1) with drive belt tensioner bolt (3) from top of vehicle.

Installation Procedure

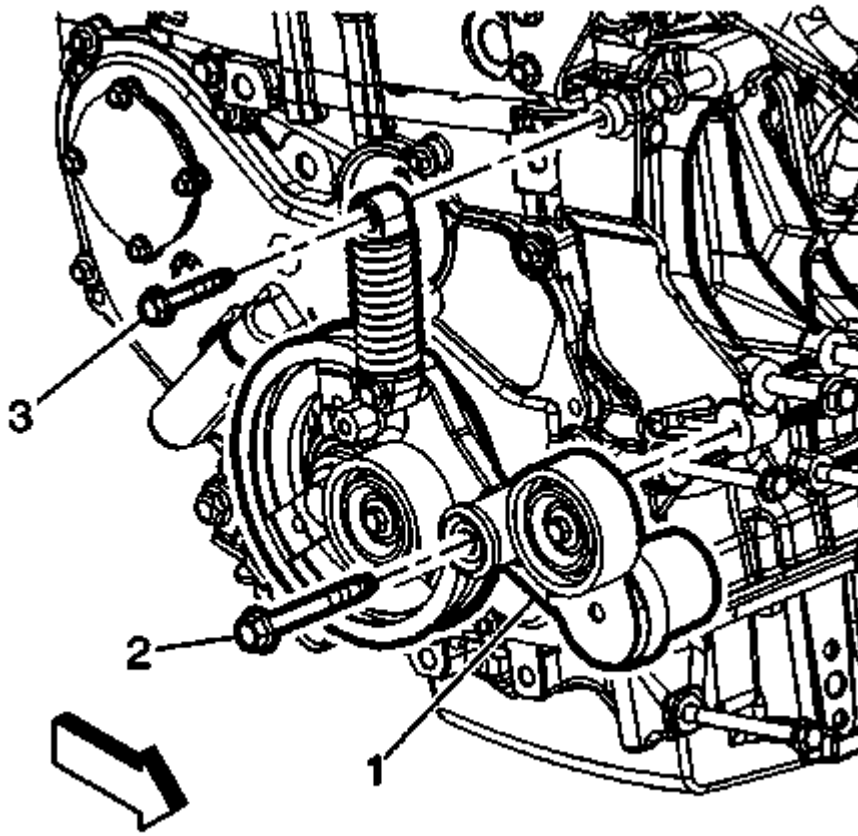


Fig. 8: Drive Belt Tensioner, Drive Belt Tensioner Spring And Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the accessory drive belt tensioner and bolt as an assembly.

1. Install the lower tensioner pivot bolt (2) into the tensioner (1).
2. Position the tensioner assembly in place.

WARNING: To avoid personal injury, only remove the tensioner shipping clip when the tensioner is properly mounted to the engine and the accessory drive belt is in place and properly routed.

CAUTION: Refer to Fastener Caution .

3. Install the drive belt tensioner bolts (2, 3).

CAUTION: Refer to Drive Belt Tensioner Pivot Bolt Caution .

NOTE: Use J-45025 adapter in combination with a 3/8 drive torque wrench to reach & achieve proper torque on tensioner pivot bolt. Make sure that the torque wrench and the J-45025 adapter are in a straight line to ensure proper torque at the bolt.

4. Tighten the bolts (2, 3) in sequence. Make sure that the torque wrench and J-45025 are in a straight line to ensure proper torque at the bolt.
 1. Tighten the top bolt to 22 N.m (16 lb ft).
 2. Use the **J-45025** adapter , to tighten the tensioner pivot bolt to 42 N.m (31 lb ft).
5. Install the drive belt. Refer to **Drive Belt Replacement (LUK)**.
6. Install the right side engine mount. Refer to **Engine Mount Replacement**.

DRIVE BELT TENSIONER REPLACEMENT (LEA)

Removal Procedure

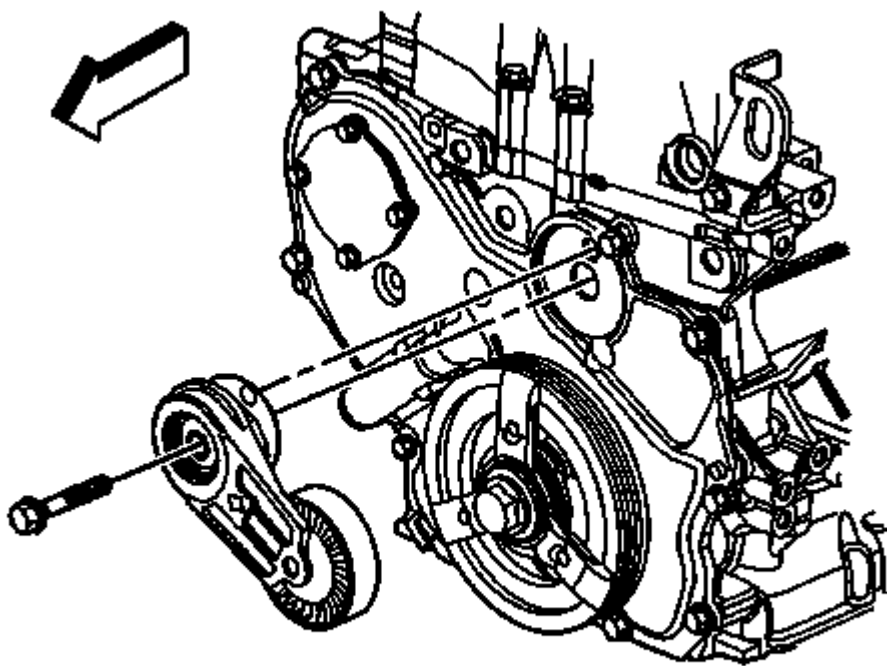


Fig. 9: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt. Refer to **Drive Belt Replacement (LEA)**

2. Remove the drive belt tensioner bolt.
3. Remove the drive belt tensioner.

Installation Procedure

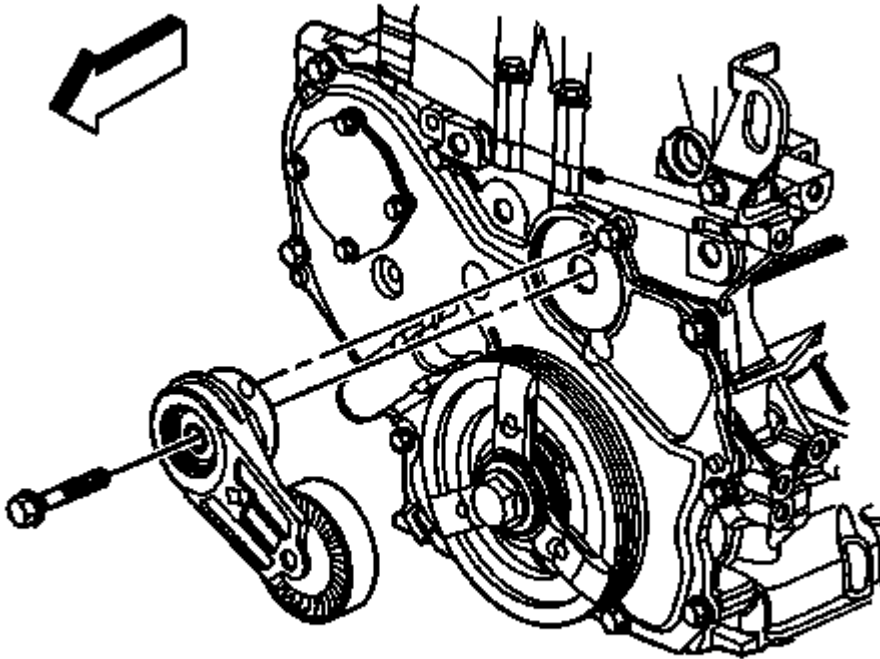


Fig. 10: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Position the drive belt tensioner.

CAUTION: Refer to Fastener Caution .

2. Install the drive belt tensioner bolt and tighten to 45 N.m (33 lb ft).
3. Install the drive belt. Refer to Drive Belt Replacement (LEA).

ENGINE OIL PRESSURE SWITCH REPLACEMENT

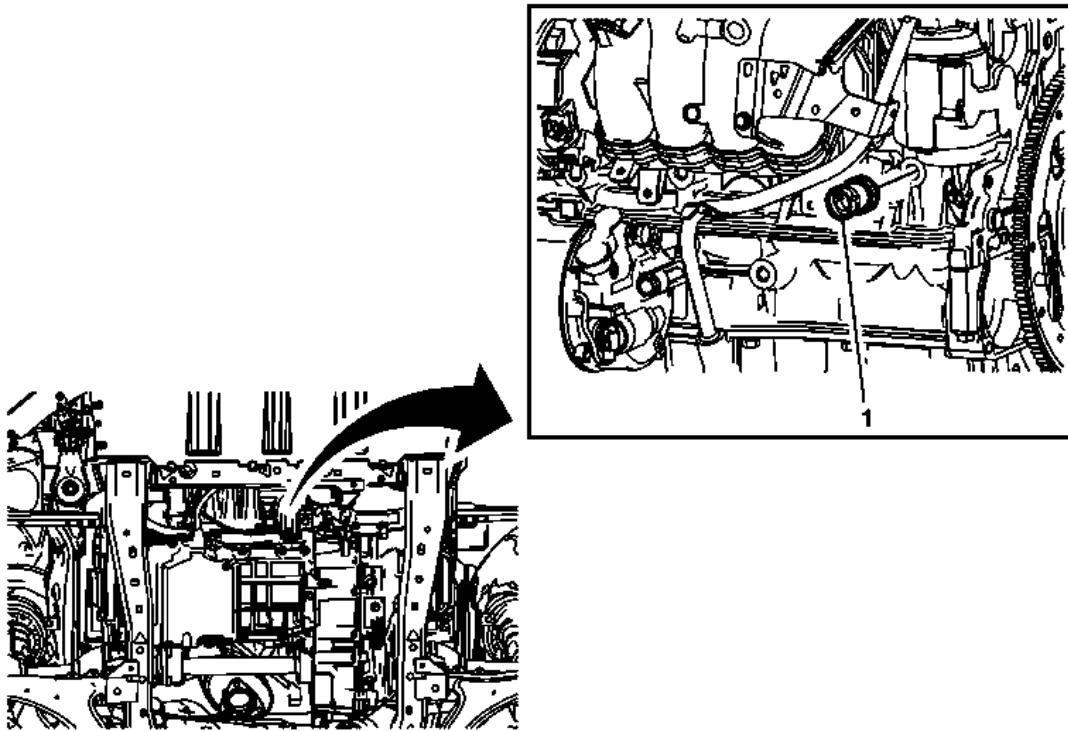


Fig. 11: Engine Oil Pressure Switch
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the starter. Refer to <u>Starter Replacement (LUK)</u> .	
1	Oil Pressure Switch CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the engine wiring harness electrical connector as necessary. Tighten 22 N.m (16 lb ft)

ENGINE MOUNT INSPECTION

NOTE: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.

1. Install the engine support fixture. Refer to **Engine Support Fixture**.
2. Raise the engine slightly and observe the engine mount. Raising the engine removes the weight from the

engine mount and creates a slight tension on the rubber portion.

3. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
 - The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to **Engine Mount Replacement**.

ENGINE MOUNT BRACKET REPLACEMENT (LEA)

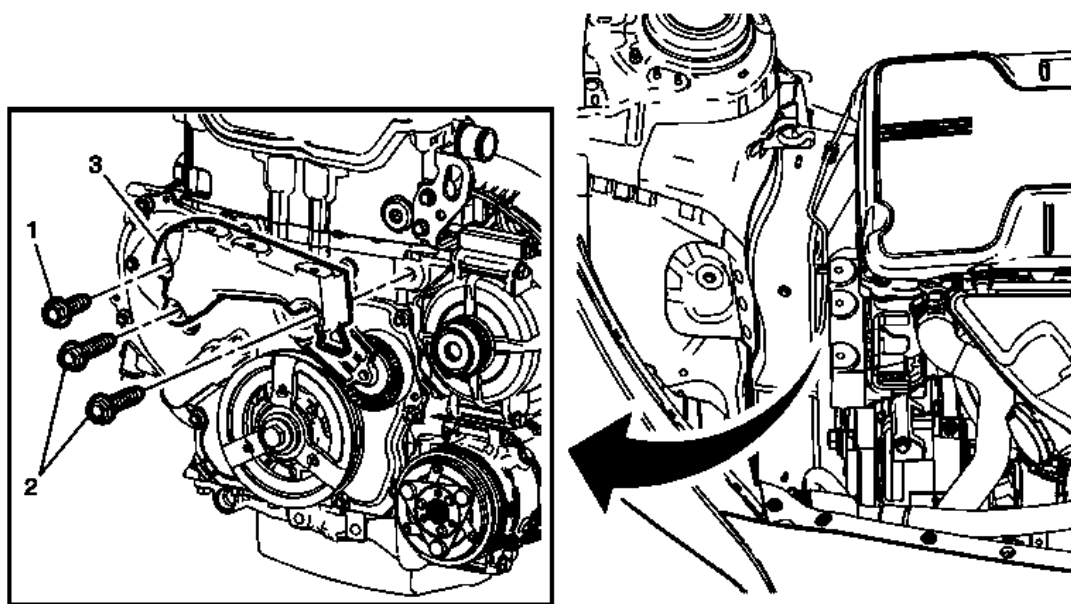


Fig. 12: Engine Mount Bracket (LEA)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement (LEA)

Callout	Component Name
Preliminary Procedure	
Remove the engine mount. Refer to <u>Engine Mount Replacement</u> .	
1	Engine Mount Bracket Fastener
	CAUTION: Refer to <u>Fastener Caution</u> .
	Tighten

	100 N.m (74 lb ft)
2	Engine Mount Bracket Fastener (Qty,2) Tighten 100 N.m (74 lb ft)
3	Engine Mount Bracket

ENGINE MOUNT BRACKET REPLACEMENT (LUK)

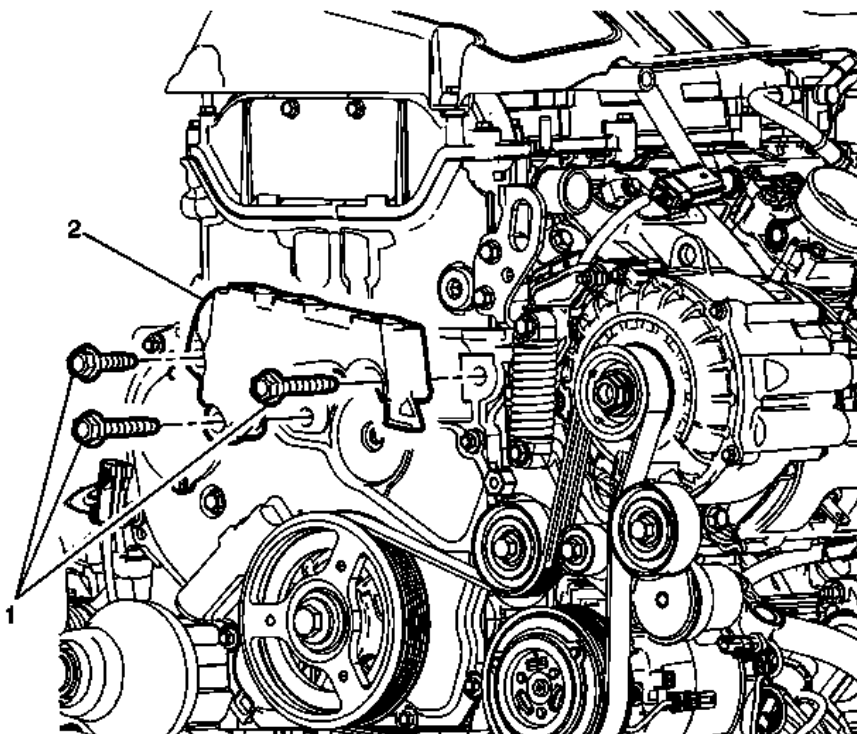


Fig. 13: Engine Mount Bracket (LUK)

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement (LUK)

Callout	Component Name
Preliminary Procedure	
Remove the engine mount. Refer to <u>Engine Mount Replacement</u> .	
1	Engine Mount Bracket Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 100 N.m (73 lb ft)
2	Engine Mount Bracket

POWERTRAIN MOUNT BALANCING

NOTE: Follow the balance procedure steps listed below when no starting point has been established such as in a collision repair.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

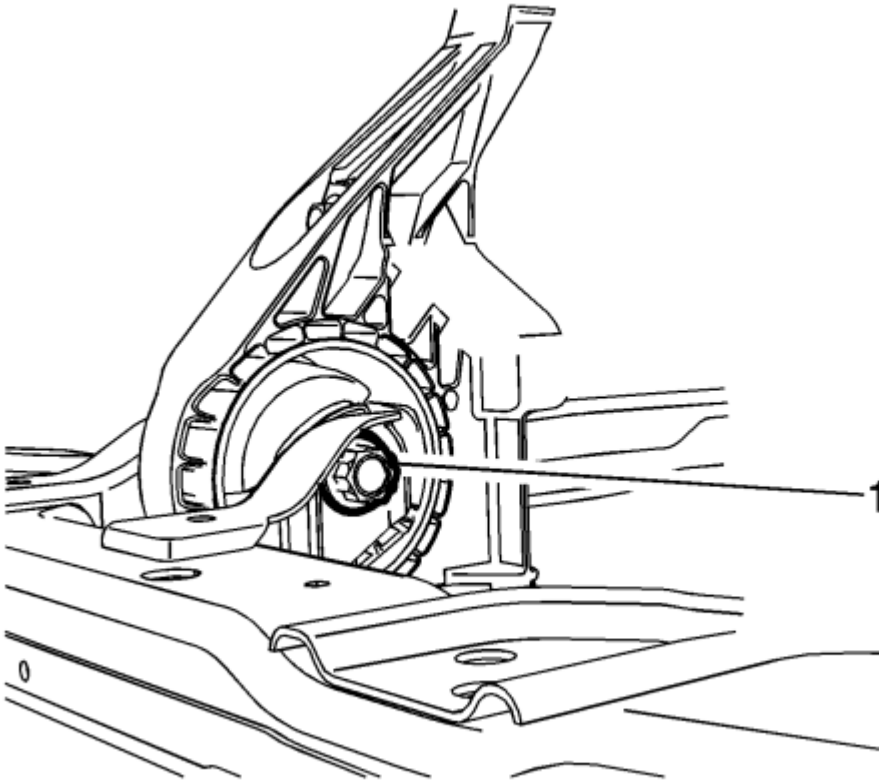


Fig. 14: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the front transaxle mount through bolt (1) until it is finger tight.

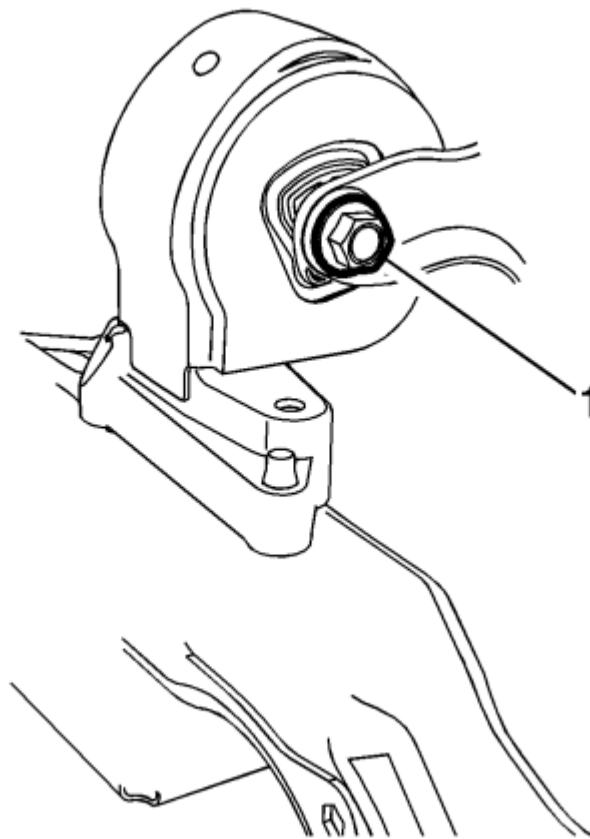


Fig. 15: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the rear transaxle mount (1) through bolt until it is finger tight.
4. Lower the vehicle.

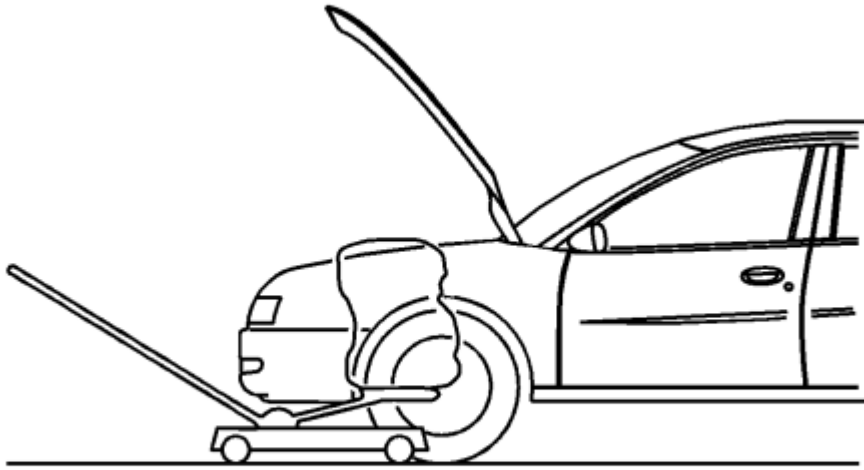


Fig. 16: Supporting Engine/Transmission With Hydraulic Floor Jack
Courtesy of GENERAL MOTORS COMPANY

5. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.

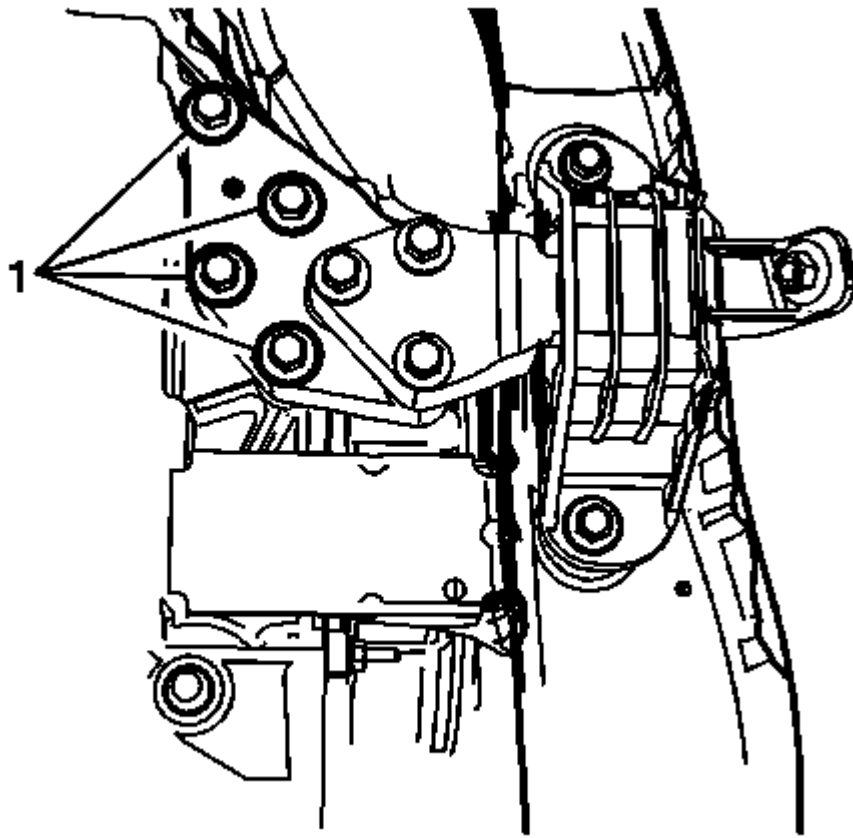


Fig. 17: Transaxle Bolts

Courtesy of GENERAL MOTORS COMPANY

6. Loosen the transaxle adapter to transaxle bolts (1).

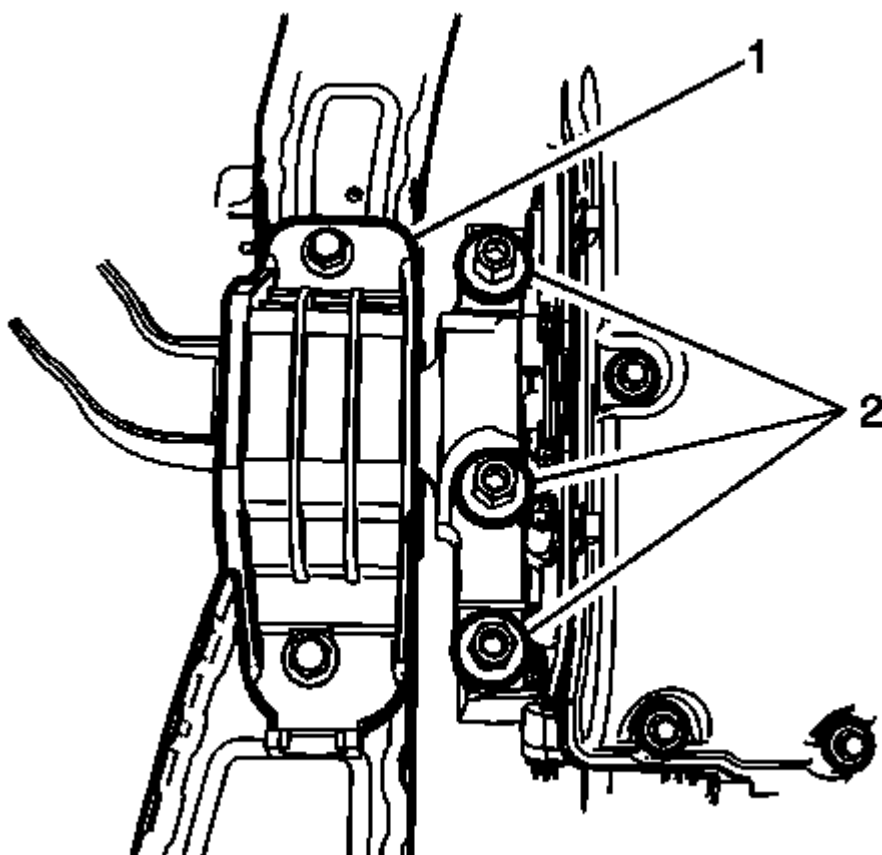


Fig. 18: Engine Mount And Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the engine mount (1) to bracket bolts (2).
8. Lower the floor jacks in order to allow a 1/4 inch (6 mm) gap between the upper engine mount and engine mount bracket, and also between the transmission and left transmission mount.

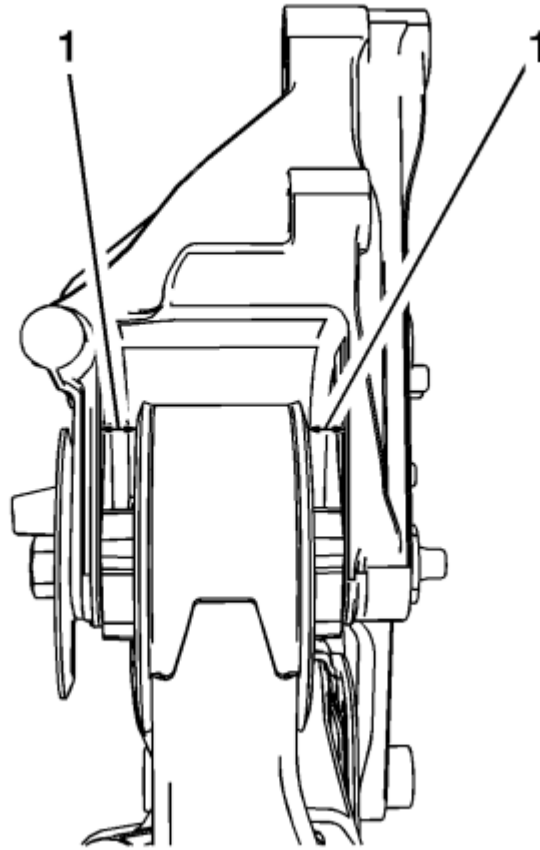


Fig. 19: Front And Rear Powertrain Mounts
Courtesy of GENERAL MOTORS COMPANY

9. Check that the front and rear mounts are centered (1) in the mount brackets, adjust if necessary.
10. Tighten the left hand (transaxle side) mount bolts, starting with the bolt nearest to the center of the mount. See the appropriate transmission mount replacement procedure for the fastener tightening specifications.

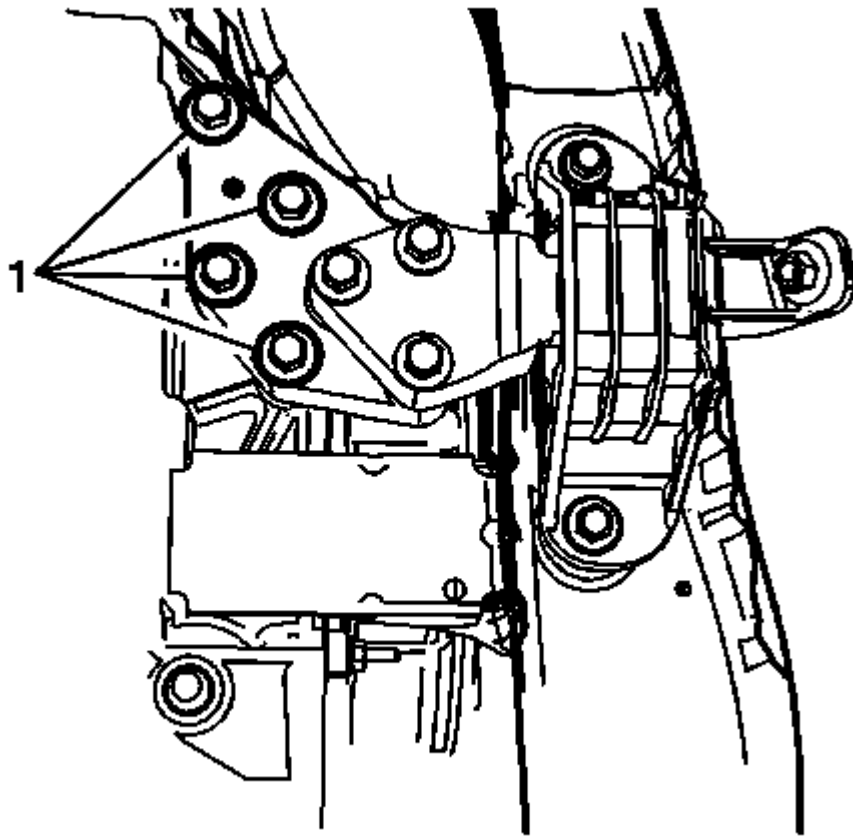


Fig. 20: Transaxle Bolts

Courtesy of GENERAL MOTORS COMPANY

11. Tighten the right hand (engine side) mount bolts (1), starting with the bolt nearest to the center of the mount. See the appropriate engine mount replacement procedure for the fastener tightening specifications.
12. Remove the floor jacks from under the oil pan and transmission.
13. Raise the vehicle.
14. Shake the powertrain from front to rear and allow the powertrain to settle.

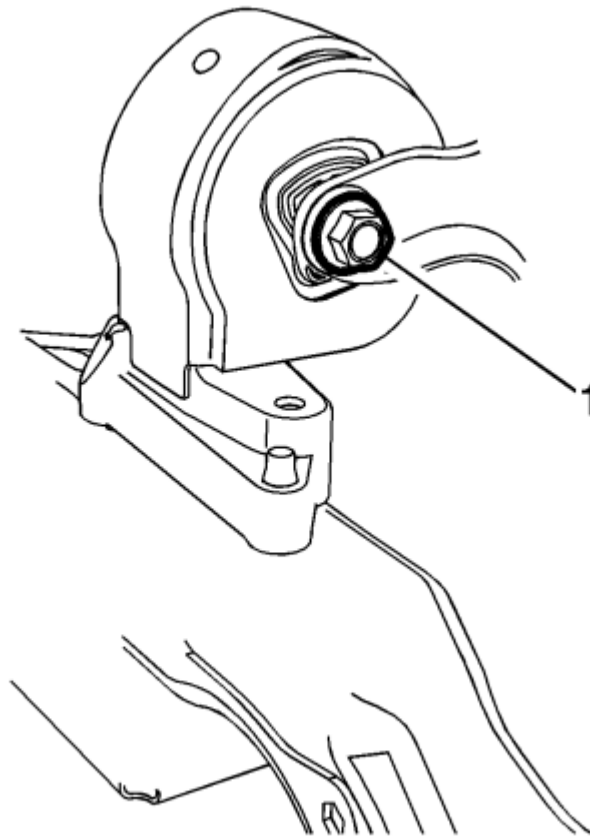


Fig. 21: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: It is essential that the lower mount through bolts should be as close to centered as possible in the oversized mount insert holes before tightening to specification.

15. Tighten the rear transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.

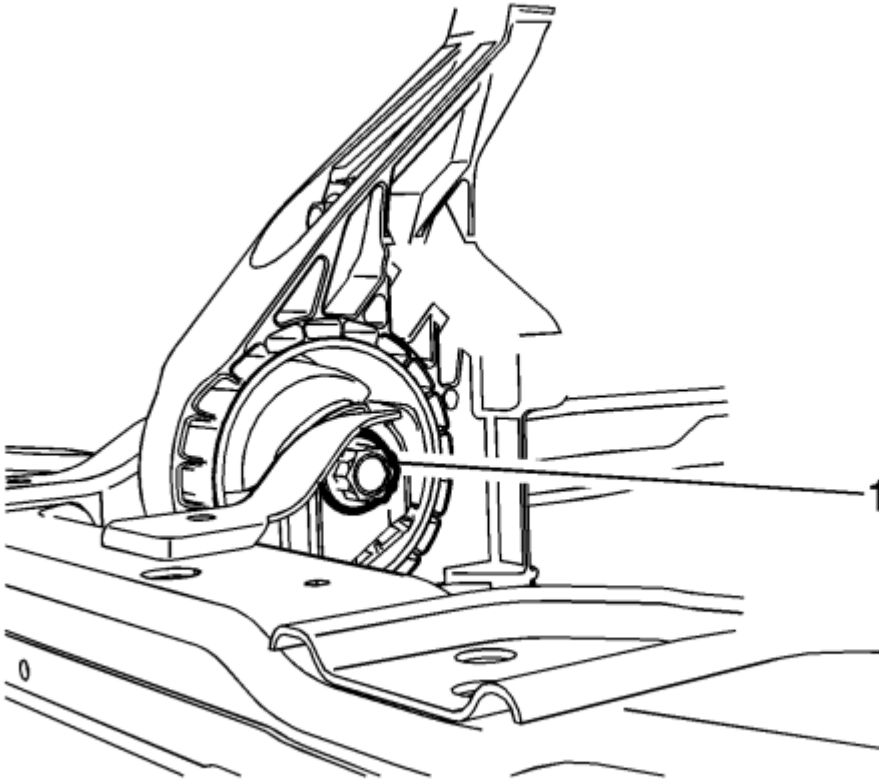


Fig. 22: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Tighten the front transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.
17. Lower the vehicle.

POWERTRAIN MOUNT BALANCING - LOWER

NOTE: Follow the balance procedure steps listed below when front or rear mounts through bolts are loosened or removed during a repair procedure.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

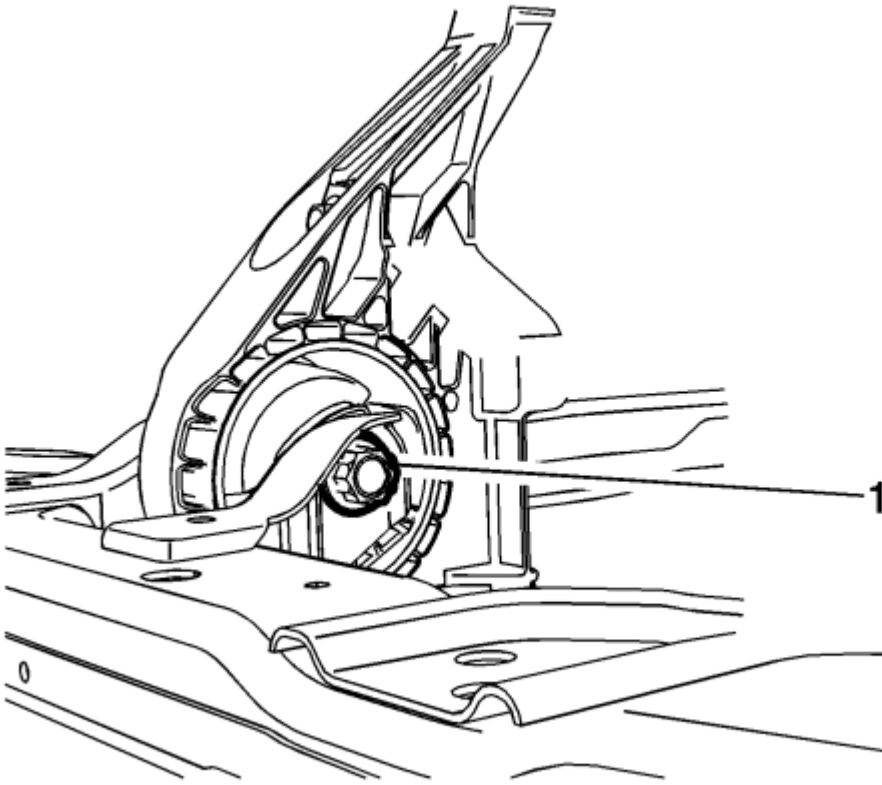


Fig. 23: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the front transaxle mount through bolt (1).

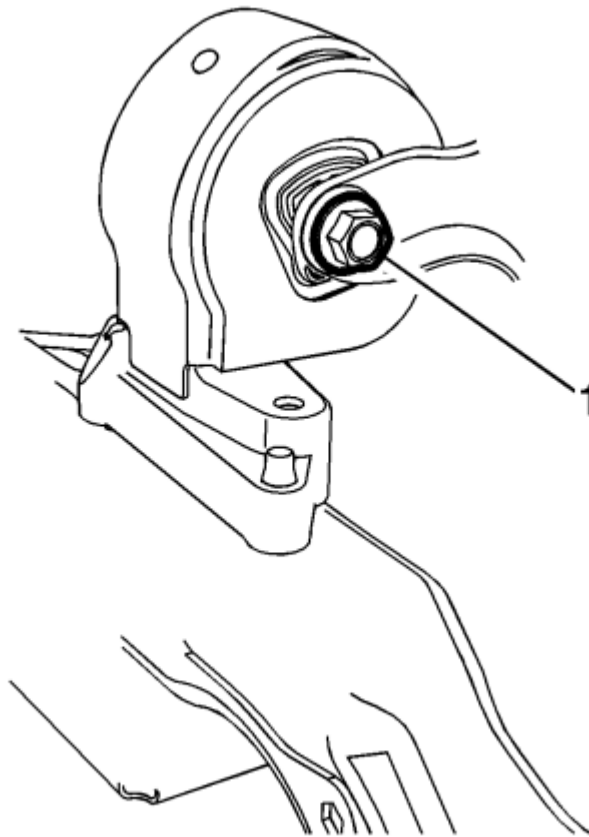


Fig. 24: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the rear transaxle mount through bolt (1).
4. Shake the powertrain from front to rear and allow the powertrain to settle.

NOTE: It is essential that the through bolts are as close to centered as possible in the oversized mount insert holes before tightening to specification.

5. Tighten the rear transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.

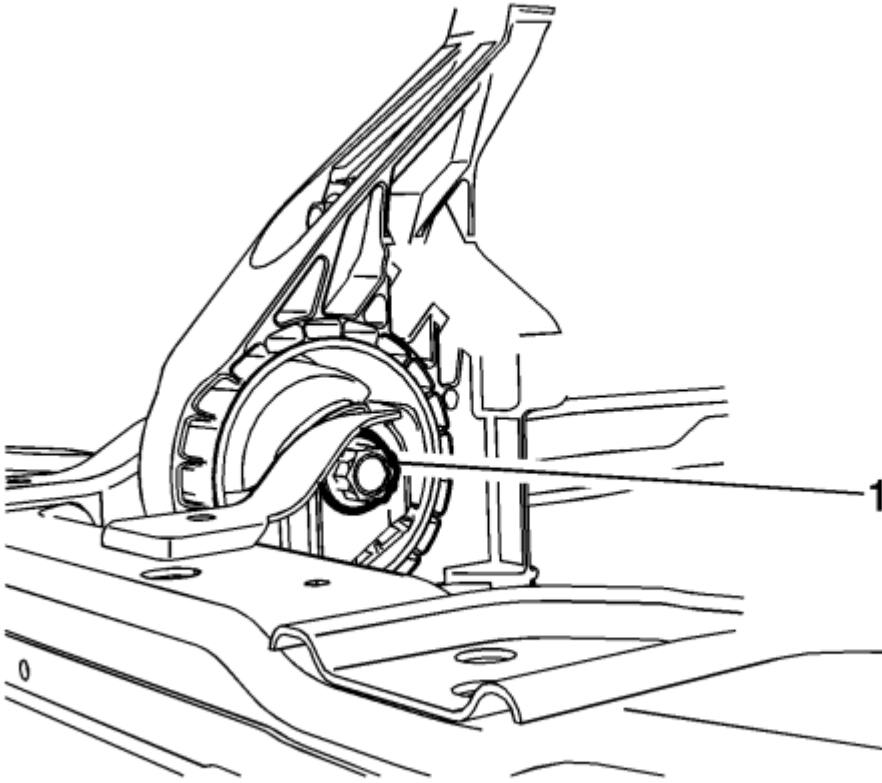


Fig. 25: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the front transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.
7. Lower the vehicle.

ENGINE MOUNT REPLACEMENT

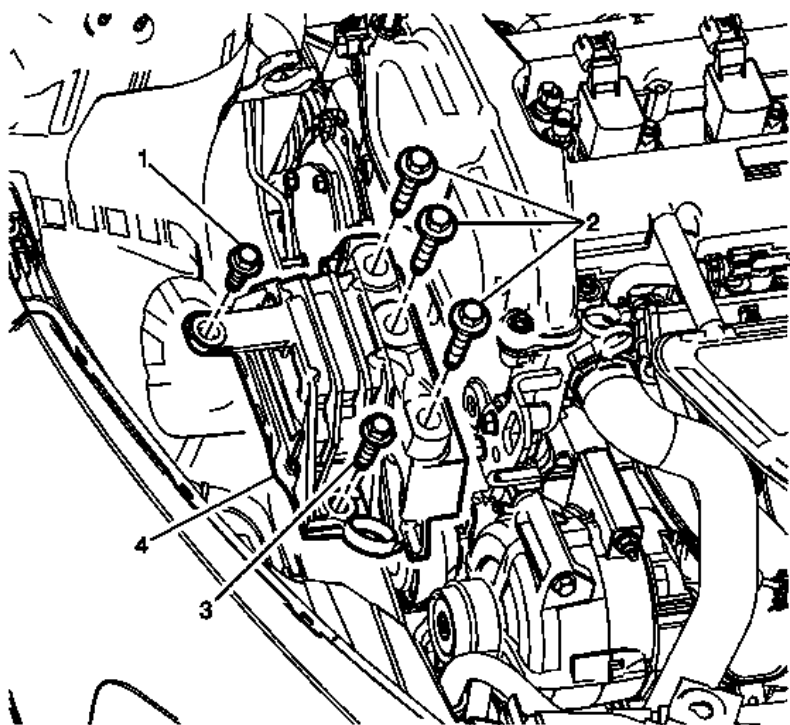


Fig. 26: Engine Mount And Engine Mount Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> . 2. Install engine support fixture. Refer to <u>Engine Support Fixture</u>. 3. Prior to removing the mount, mark mount to bracket, mount to body interfaces and fasteners to mount interfaces using a marker for correct positioning during installation. 	
1	Engine Mount Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 62 N.m (46 lb ft)
2	Engine Mount Fastener (Qty: 3) Tighten 62 N.m (46 lb ft)
3	Engine Mount Fastener (Qty: 2) Tighten

	62 N.m (46 lb ft)
4	Engine Mount Procedure Transfer components as necessary.

ENGINE SUPPORT FIXTURE

Special Tools

- **EN-28467-B** Universal Engine Support Fixture
- **EN-28467-500B** Engine Support Fixture
- **EN-43405-10** Engine Support Fixture Adaptor

For equivalent regional tools, refer to **Special Tools** .

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

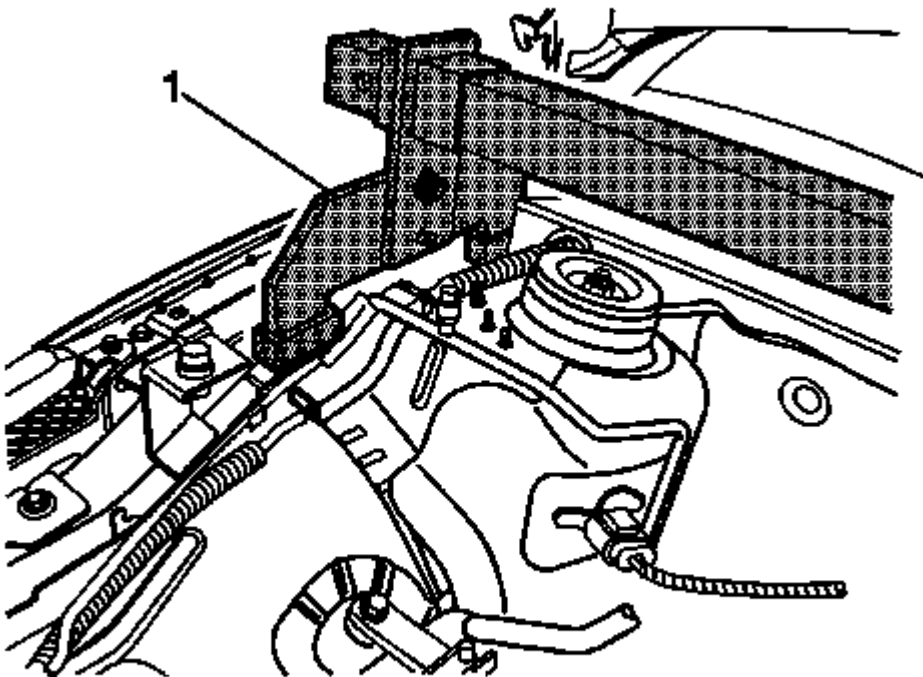


Fig. 27: Universal Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

2. Assemble the **EN-28467-B** universal engine support fixture to the **EN-43405-1** engine support feet

(passenger side) and **EN-43405-2** engine support feet (drivers side) (1) and place across the engine compartment.

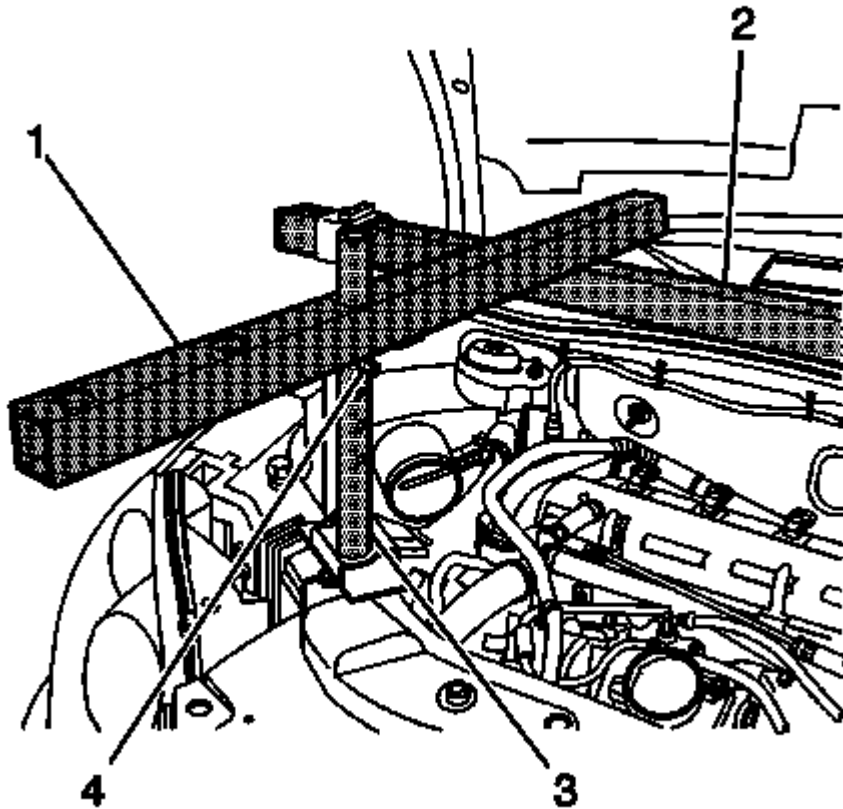


Fig. 28: View Of Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

3. From the **EN-28467-500B** universal engine support fixture , install the radiator shelf tube J-28467-2A (1) on top of the strut tower tube J-28467-3 (2) above the engine front (right back) lift hook bracket.
4. Install the round tube of the front support assembly J-28467-4A (3) through the large hole in the radiator shelf tube J-28467-2A.
5. Locate the J-28467-4A front support assembly to the upper tie bar.
6. Install the J-28467-9 7/16 inch x 2.0 inch quick-release pin (4) through the top hole in the J-28467-4A front support assembly.

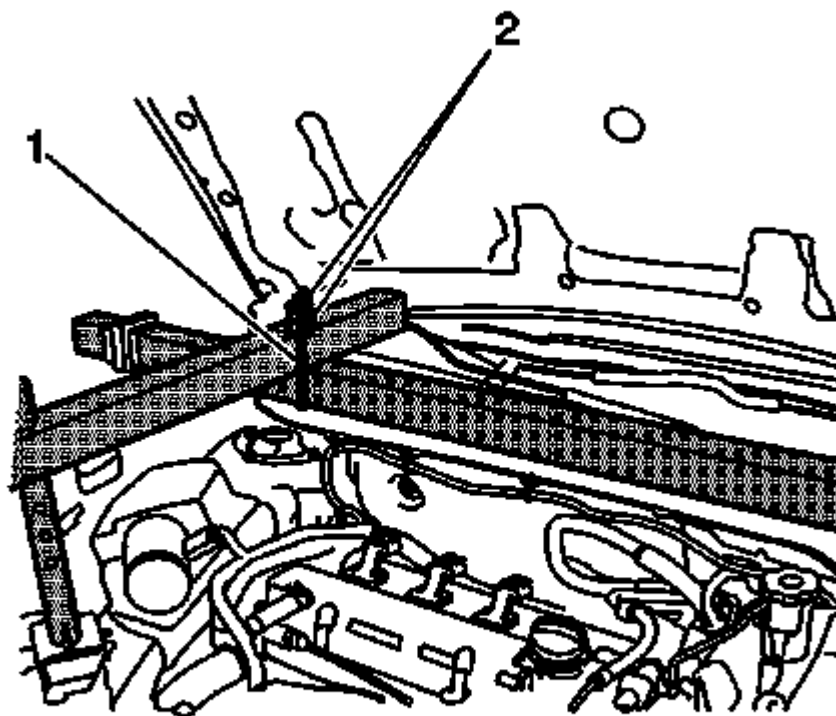


Fig. 29: View Of Engine Support Fixture & Cross Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Install the J-28467-1A cross bracket assembly (1).
8. Hand tighten the J-28467-1A cross bracket wing nuts (2).

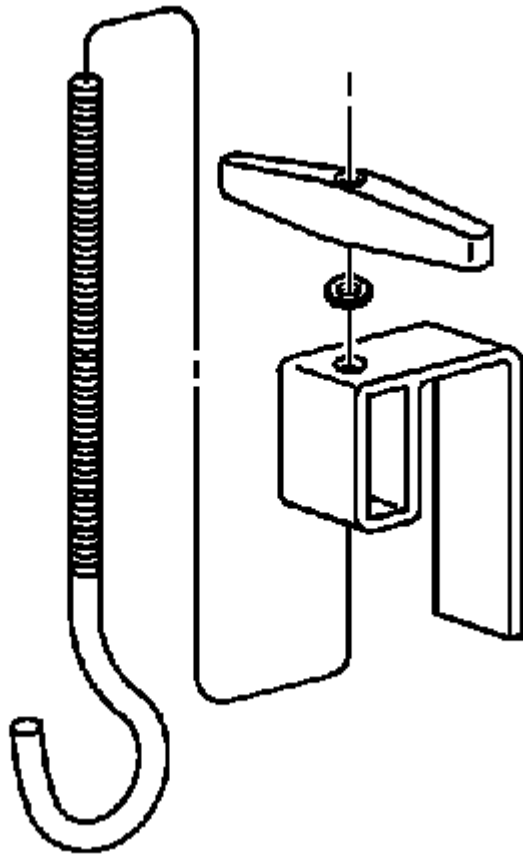


Fig. 30: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Install the J-28467-7A bolt hook through the J-28467-6A bracket.
10. Install the J-28467-34 lift hook wing nut and washer to the J-28467-7A lift hook.
11. Repeat the previous 2 steps in order to assemble 2 lift hooks and brackets.

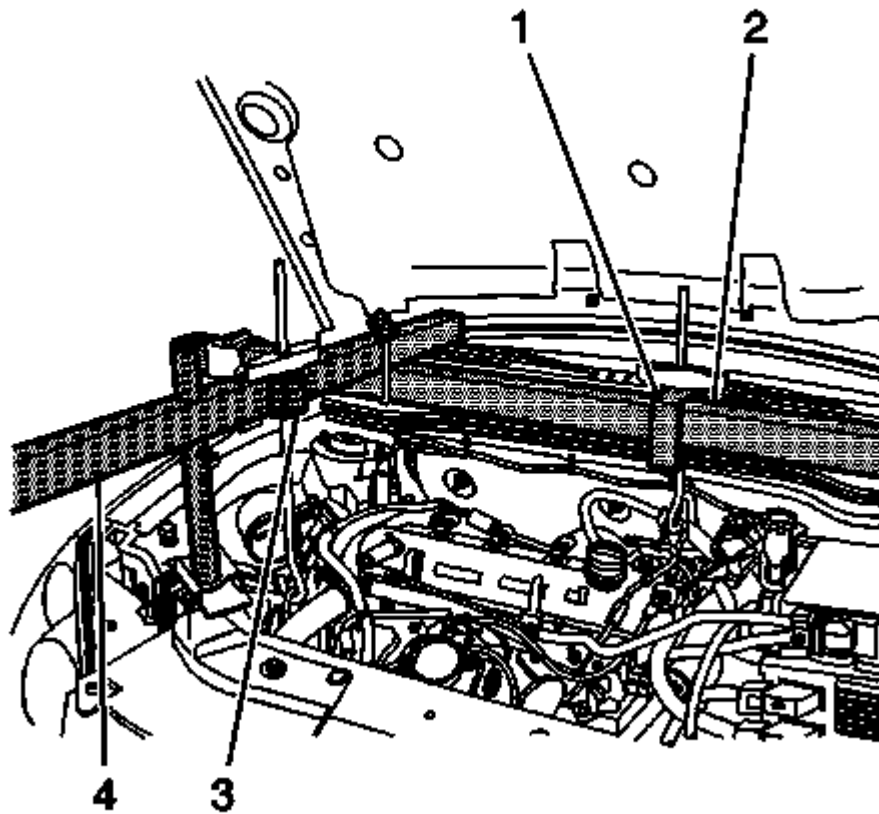


Fig. 31: Identifying Engine Support Fixture & Cross Bracket
Courtesy of GENERAL MOTORS COMPANY

12. Install one of the lift hook and bracket assemblies (1) to the engine support fixture long bar (2).
13. Install the other lift hook and bracket assembly (3) to the J-28467-2A radiator shelf tube (4) above the engine front lift bracket.

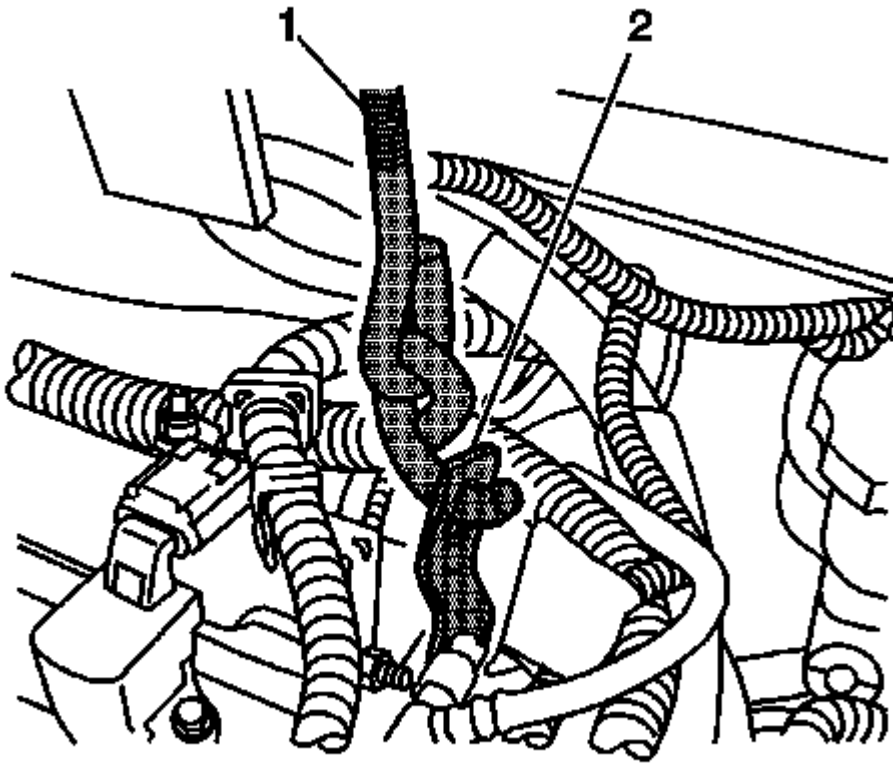


Fig. 32: Inserting Lift Hook Through Engine Rear Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

14. Install the lift hook J-28467-7A through the engine rear lift bracket (2).

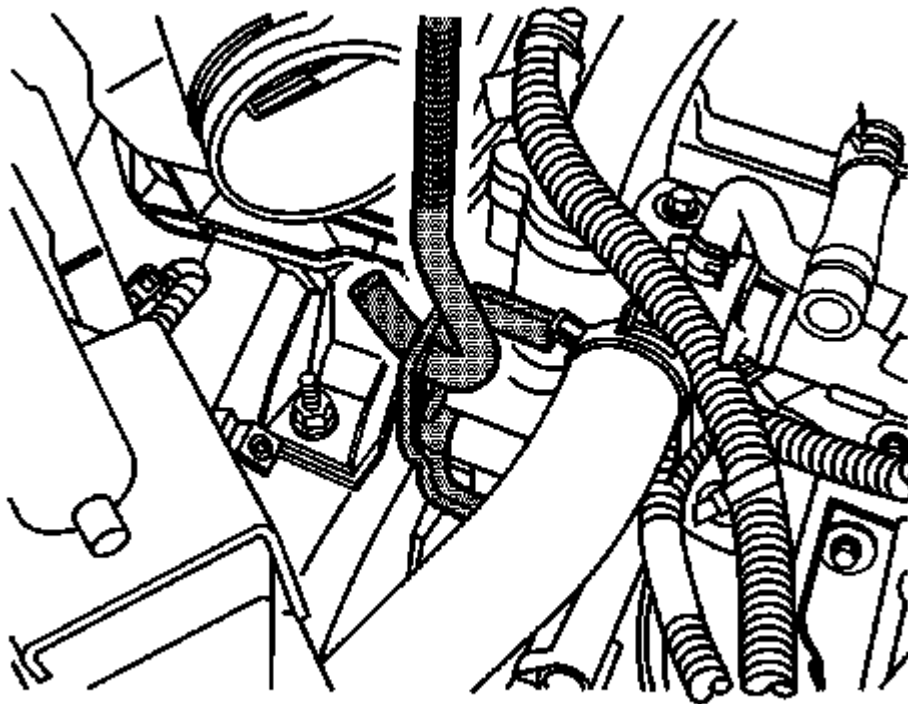


Fig. 33: Inserting Lift Hook Through Engine Front Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

15. Install the lift hook J-28467-7A through the engine front lift bracket.
16. Hand tighten the lift hook wing nuts J-28467-34 in order to remove all slack from the engine support fixture assembly.

OIL LEVEL INDICATOR TUBE REPLACEMENT

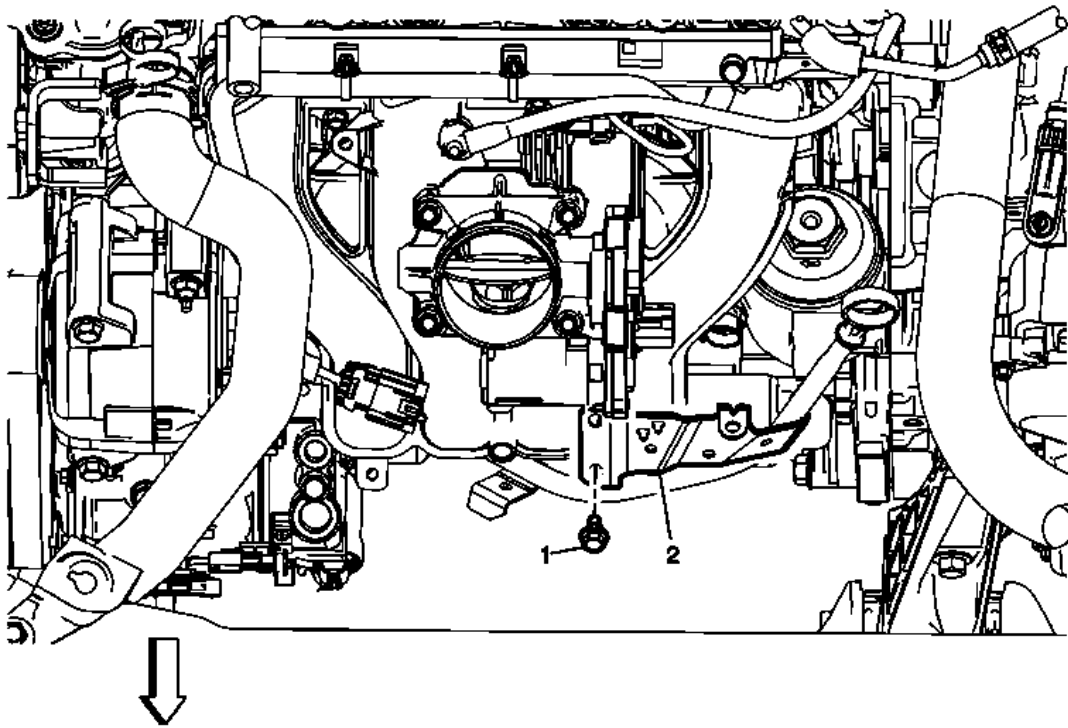


Fig. 34: Oil Level Indicator Tube & Bolt
 Courtesy of GENERAL MOTORS COMPANY

Oil Level Indicator Tube Replacement

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
1	<p>Oil Level Indicator Tube Bolt</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 10 N.m (89 lb in)</p>
2	<p>Oil Level Indicator Tube</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Transfer over the oil level indicator. 2. Install NEW oil level indicator tube O-ring seals. 3. Disconnect electrical connector

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

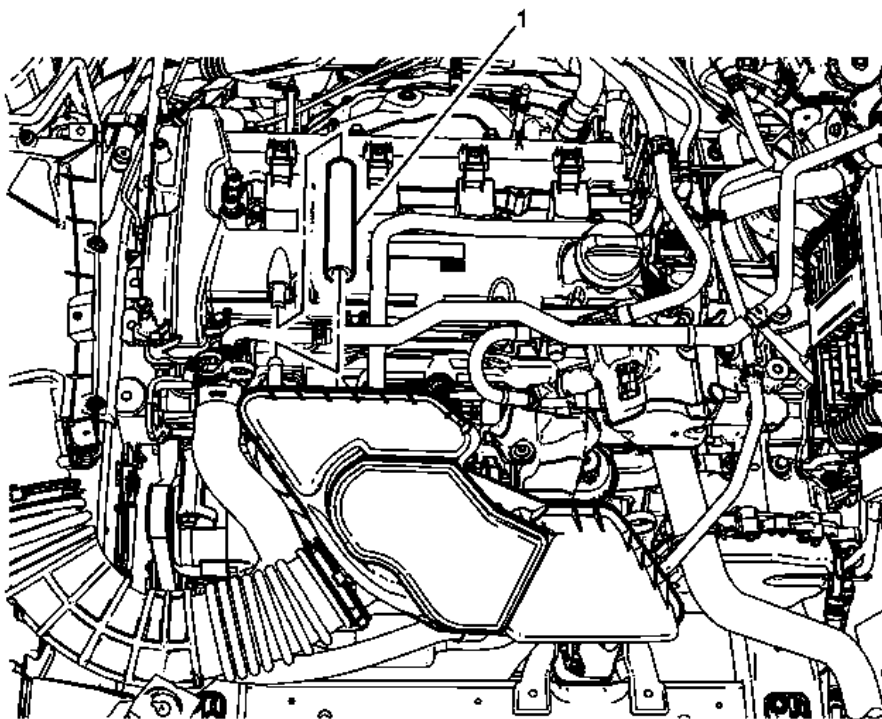


Fig. 35: Positive Crankcase Ventilation Hose/Pipe/Tube
 Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement

Callout	Component Name
Preliminary Procedure	
Remove intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>	
1	Positive Crankcase Ventilation Hose/Pipe/Tube

INTAKE MANIFOLD REPLACEMENT (LEA)

Removal Procedure

1. Recover the A/C system. Refer to **Refrigerant Recovery and Recharging** .
2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Assembly Replacement** .

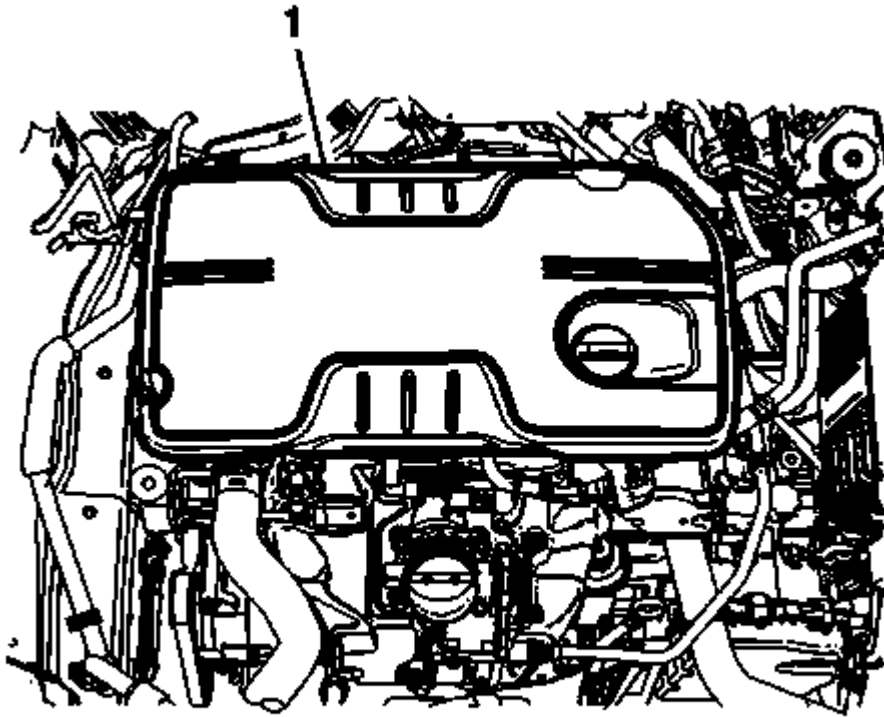


Fig. 36: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Never attempt to remove the intake manifold from a hot engine, allow the engine to cool to ambient temperature. The intake manifold can be damaged if it is removed when the engine is hot.

4. Remove the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement**

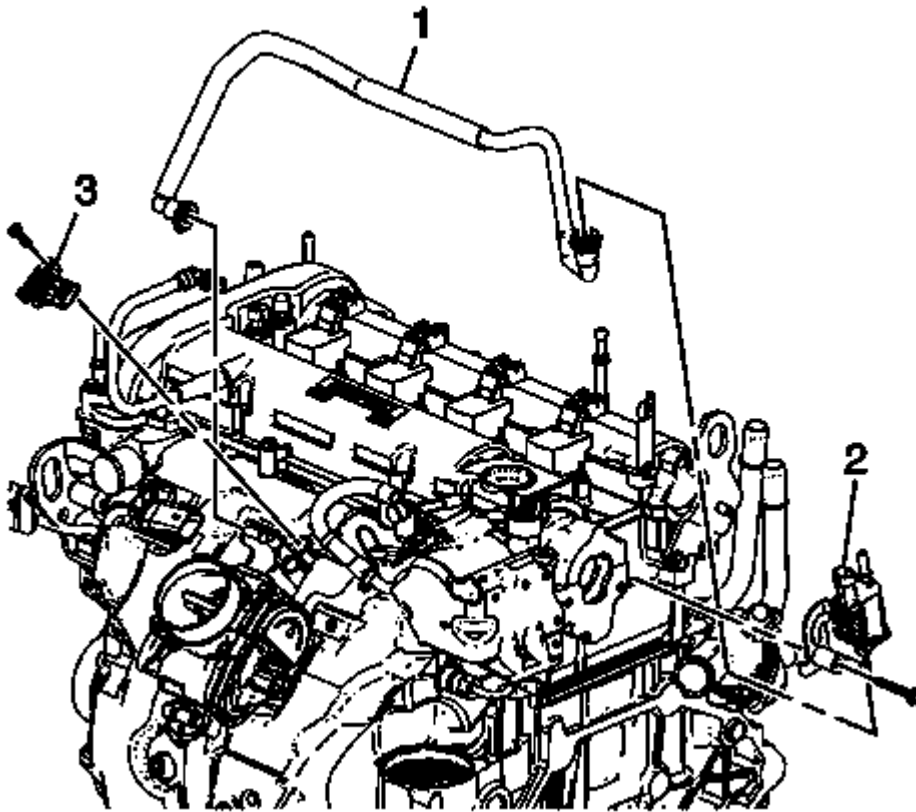


Fig. 37: EVAP Canister Valve, Tube & MAP Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the evaporative (EVAP) emission canister valve tube (1) from the intake manifold and reposition.
6. Remove the MAP sensor (3) electrical connector.

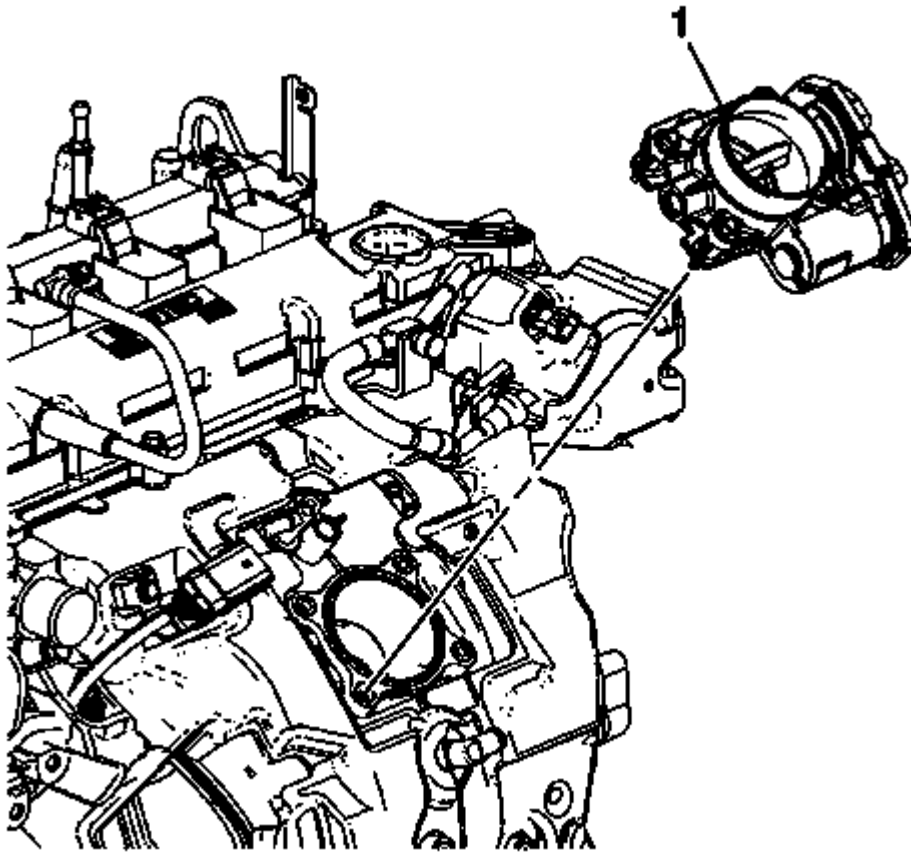


Fig. 38: Throttle Body
Courtesy of GENERAL MOTORS COMPANY

7. Remove the throttle body (1). Refer to **Throttle Body Assembly Replacement** .

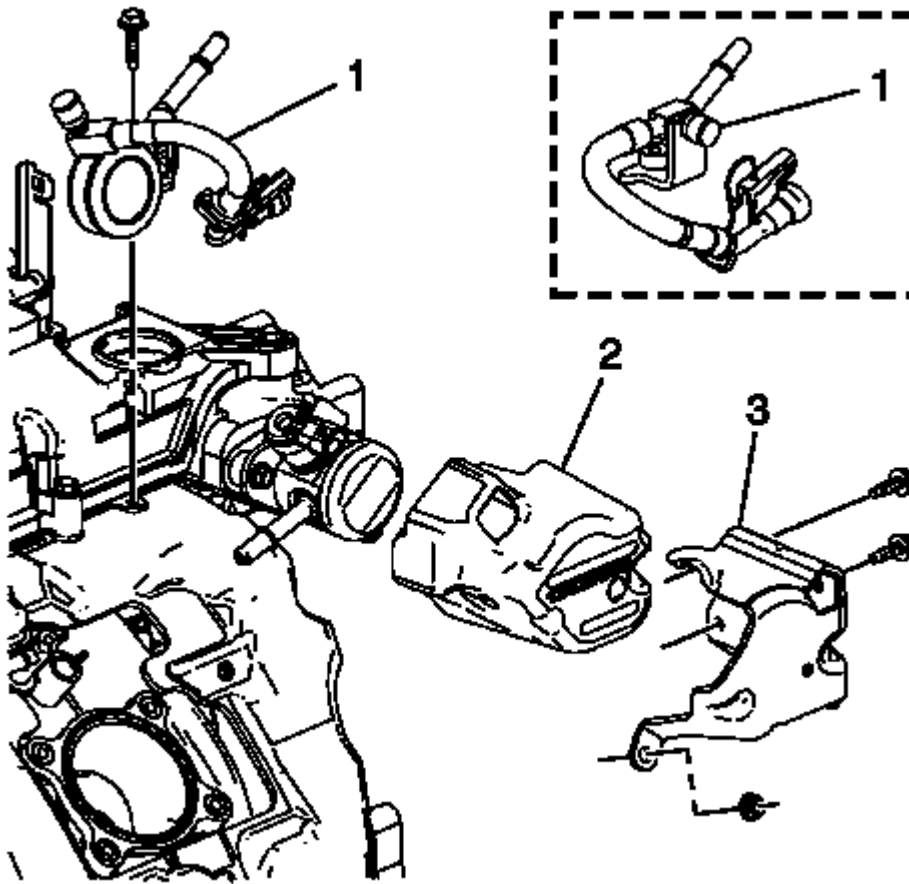


Fig. 39: Fuel Pump Components

Courtesy of GENERAL MOTORS COMPANY

8. Remove the fuel pump cover (3) and insulator (2). Refer to **Fuel Pump Cover Replacement** .

NOTE: The low pressure fuel pipe used is model dependent.

9. Disconnect and reposition the low pressure fuel feed pipe from the fuel pump. Refer to **Metal Collar Quick Connect Fitting Service** .

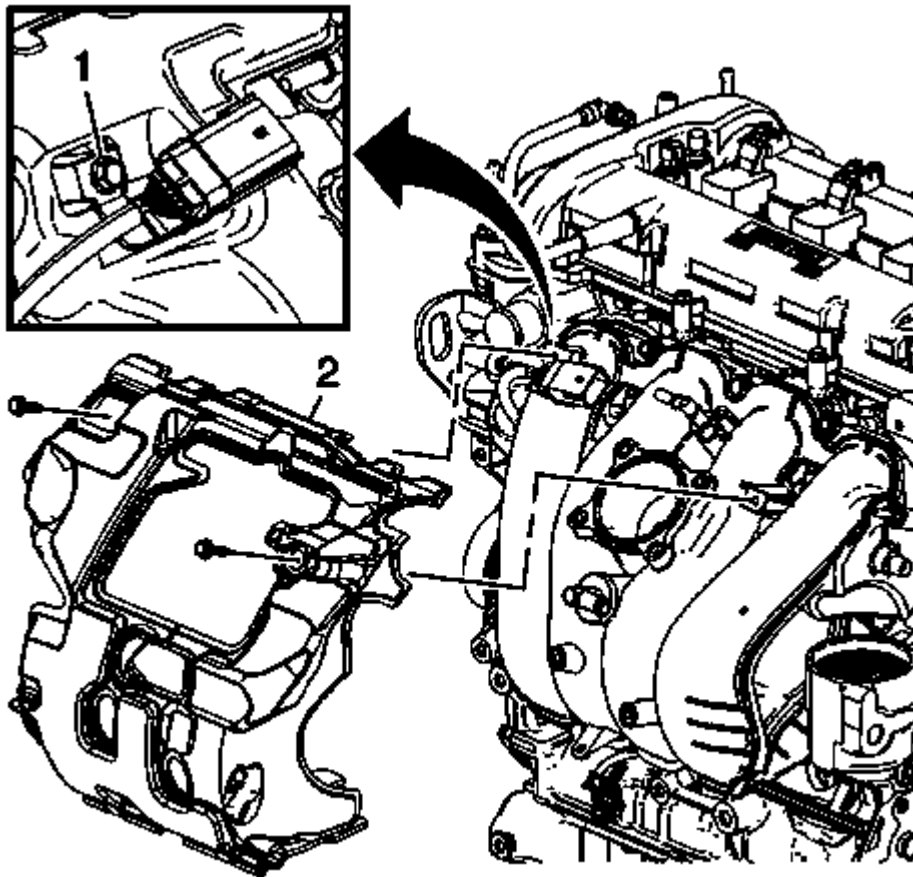


Fig. 40: Fuel Rail Harness Connector Bracket And Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

10. Remove the fuel rail harness connector bracket bolt (1) and intake manifold insulator bolt.
11. Remove the intake manifold insulator (2).

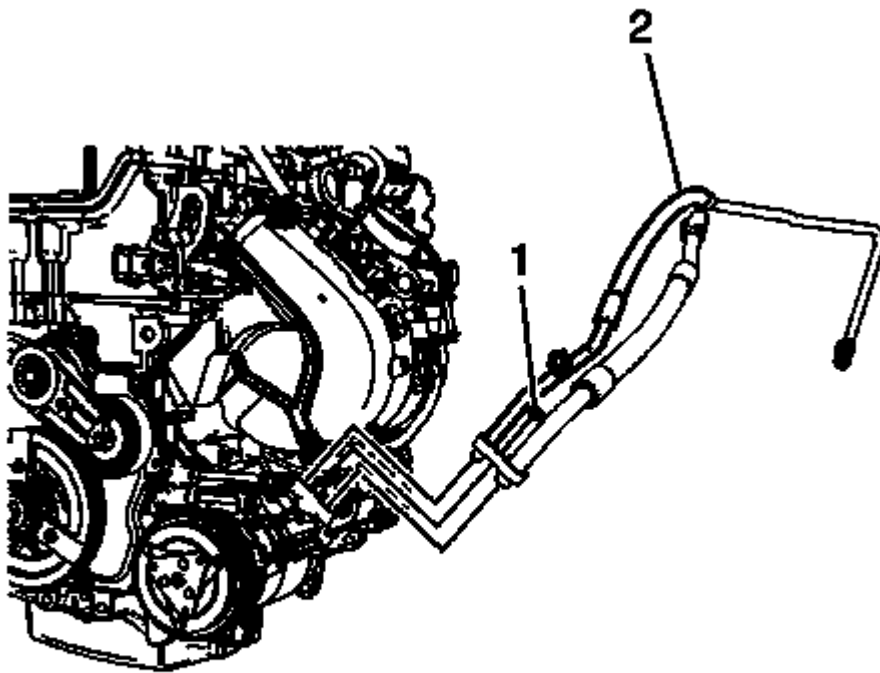


Fig. 41: Compressor Hose At Compressor
Courtesy of GENERAL MOTORS COMPANY

12. Remove the A/C line nut (1) and line (2) from the compressor and reposition the line to the side.

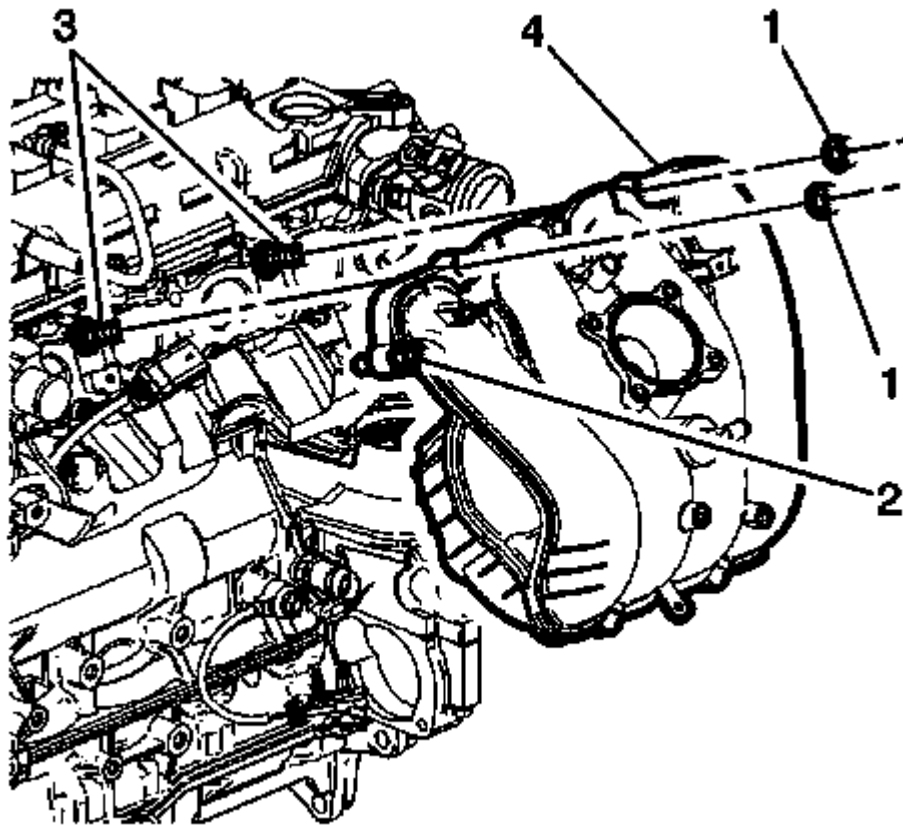


Fig. 42: Intake Manifold Retaining Nuts And Studs
Courtesy of GENERAL MOTORS COMPANY

NOTE: Removing studs allows the intake manifold to be removed without removing the fuel pump.

13. Remove the intake manifold retaining nuts (1), studs (3), and bolts (2).
14. Remove the intake manifold (1).
15. Disconnect electrical connectors as necessary.
16. Transfer parts as necessary.
17. If reusing the intake manifold, clean and inspect as necessary. Refer to **Intake Manifold Cleaning and Inspection (LEA, or LUK)**.

Installation Procedure

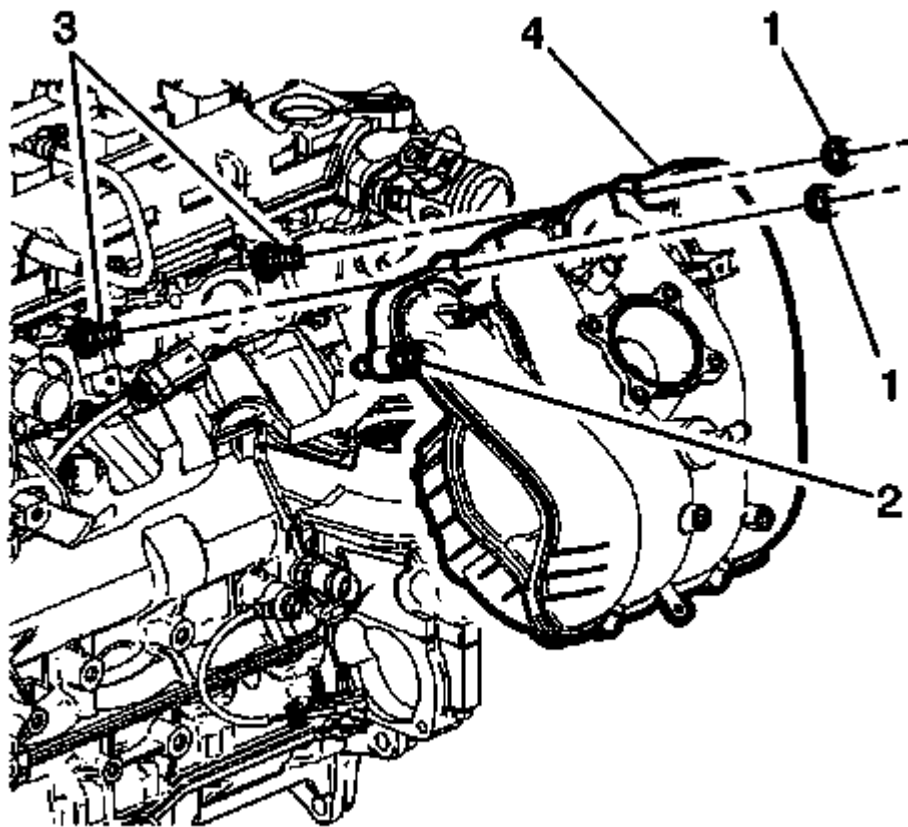


Fig. 43: Intake Manifold Retaining Nuts And Studs
Courtesy of GENERAL MOTORS COMPANY

1. Position the intake manifold (4) and hand start the bolts (2).

CAUTION: Refer to Fastener Caution .

2. Install the intake manifold studs (3) and tighten to 6 N.m (53 lb in).

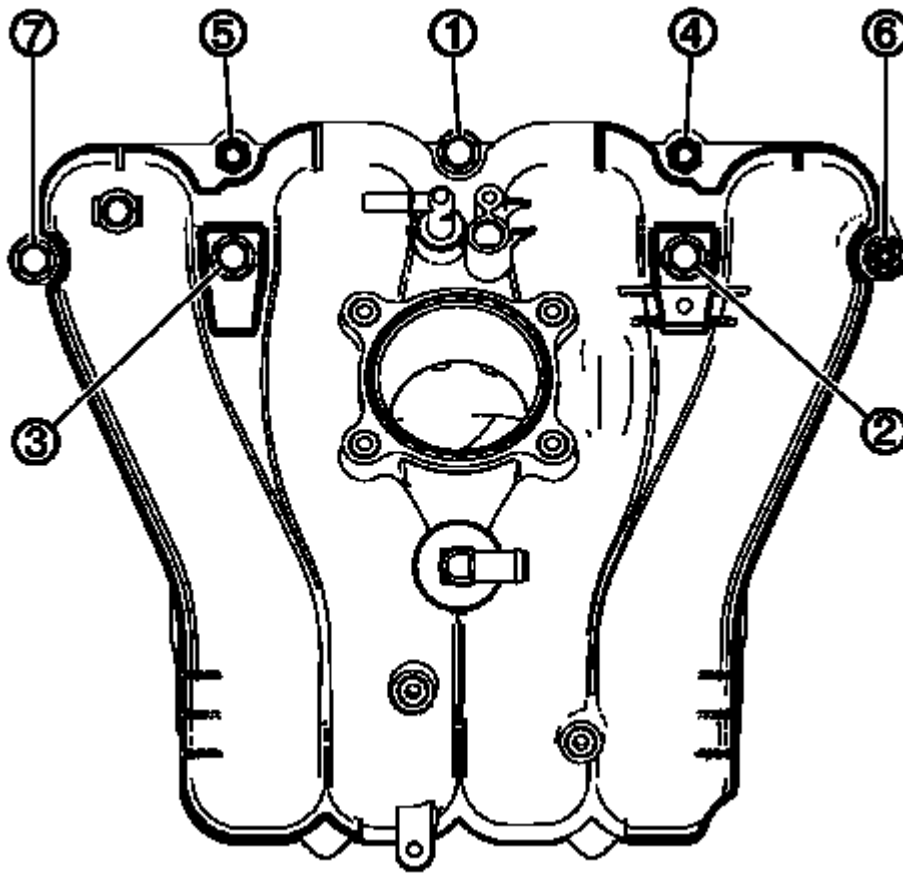


Fig. 44: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

3. Tighten the bolts (2) and nuts (1) in sequence to 10 N.m (89 lb in).

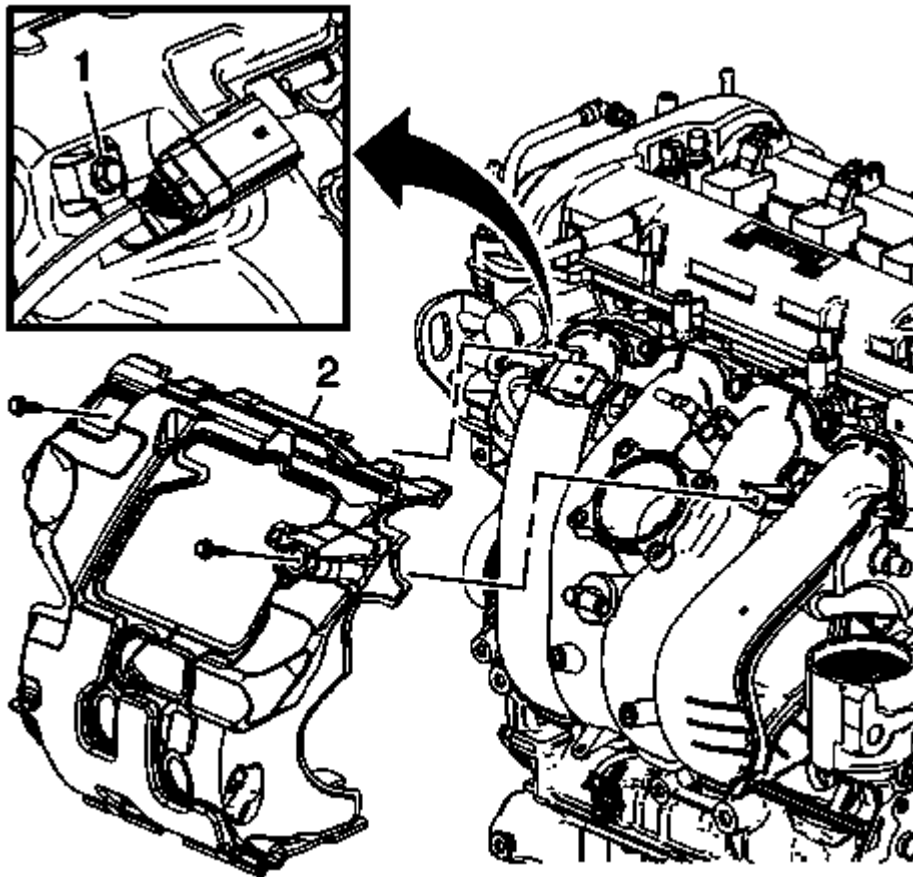


Fig. 45: Fuel Rail Harness Connector Bracket And Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

4. Install the intake manifold insulator (2).
5. Install the insulator bolt and tighten to 10 N.m (89 lb in).
6. Install the fuel rail harness connector bracket (1) to the intake manifold. Tighten the bracket bolt to 10 N.m (89 lb in).

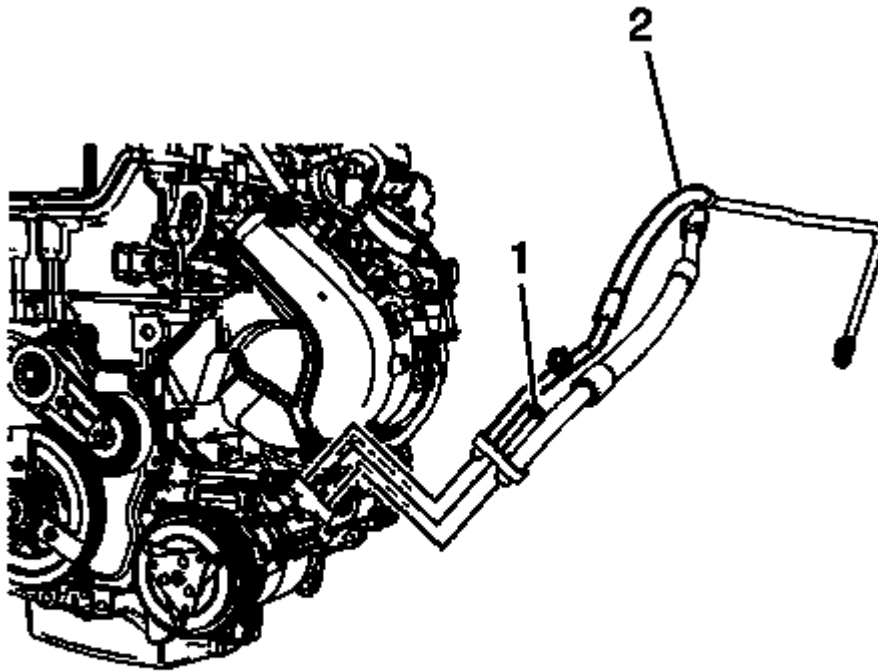


Fig. 46: Compressor Hose At Compressor
Courtesy of GENERAL MOTORS COMPANY

7. Install new seal washers to the compressor hose. Refer to **Air Conditioning System Seal Replacement** .
8. Install the compressor hose (2) to the compressor.
9. Install the compressor hose nut (1) to the compressor and tighten the nut to 22 N.m (16 lb ft).
10. Connect the engine harness electrical connector as necessary.

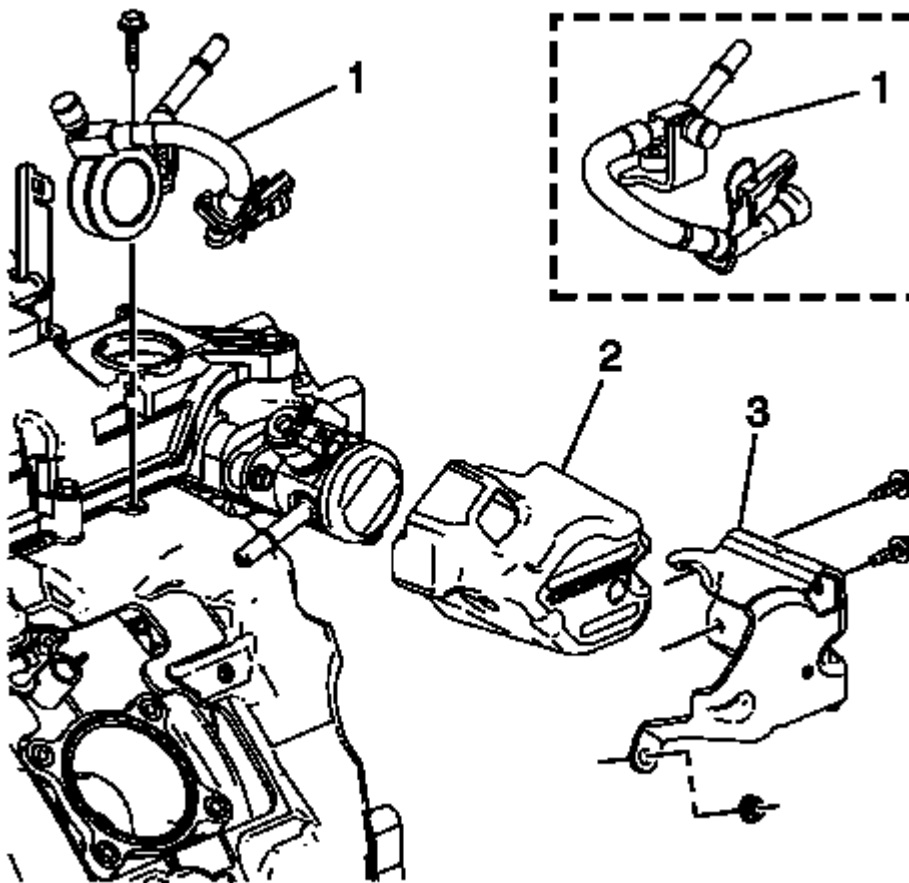


Fig. 47: Fuel Pump Components

Courtesy of GENERAL MOTORS COMPANY

11. Install the fuel pump insulator (2) and cover (3). Refer to **Fuel Pump Cover Replacement** .

NOTE: The low pressure fuel pipe used is model dependent.

12. Install the low pressure fuel pipe assembly (1).

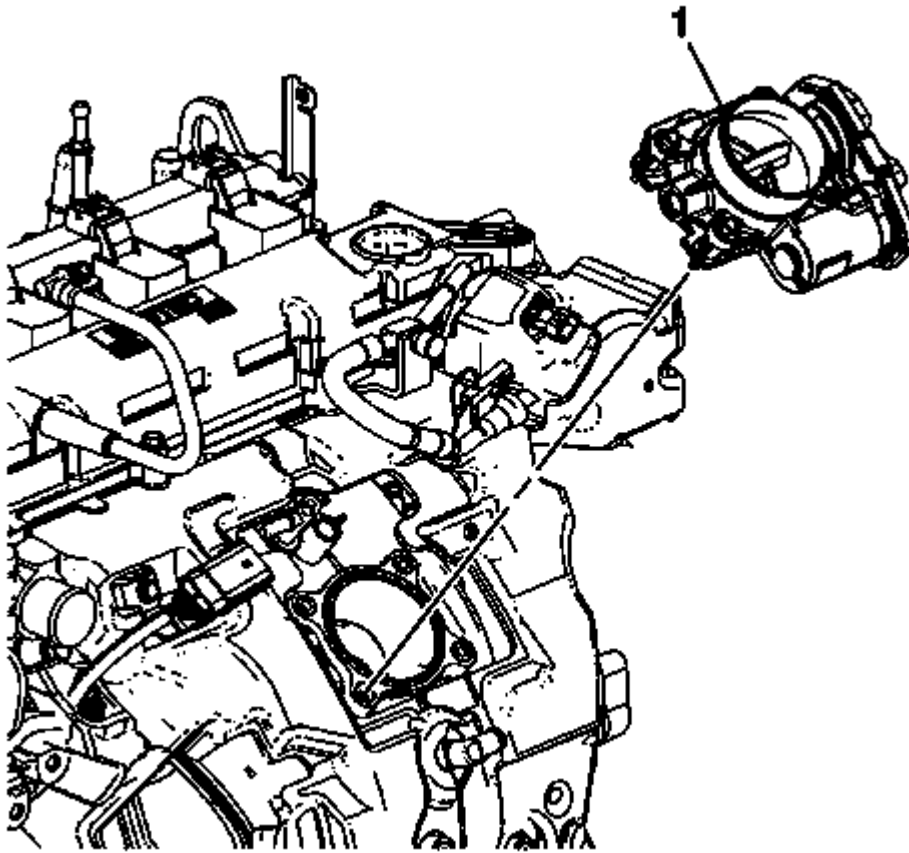


Fig. 48: Throttle Body
Courtesy of GENERAL MOTORS COMPANY

13. Install a new throttle body gasket.
14. Install the throttle body (1). Refer to **Throttle Body Assembly Replacement** .

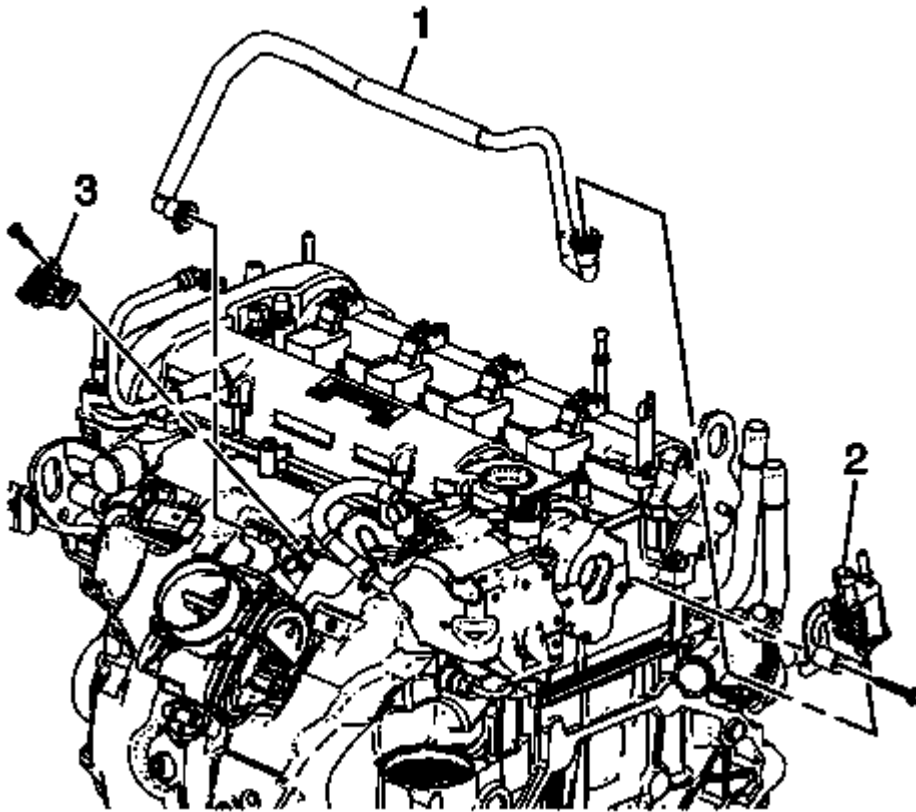


Fig. 49: EVAP Canister Valve, Tube & MAP Sensor
Courtesy of GENERAL MOTORS COMPANY

15. Install the EVAP canister valve tube (1).
16. Connect the MAP sensor electrical connector.

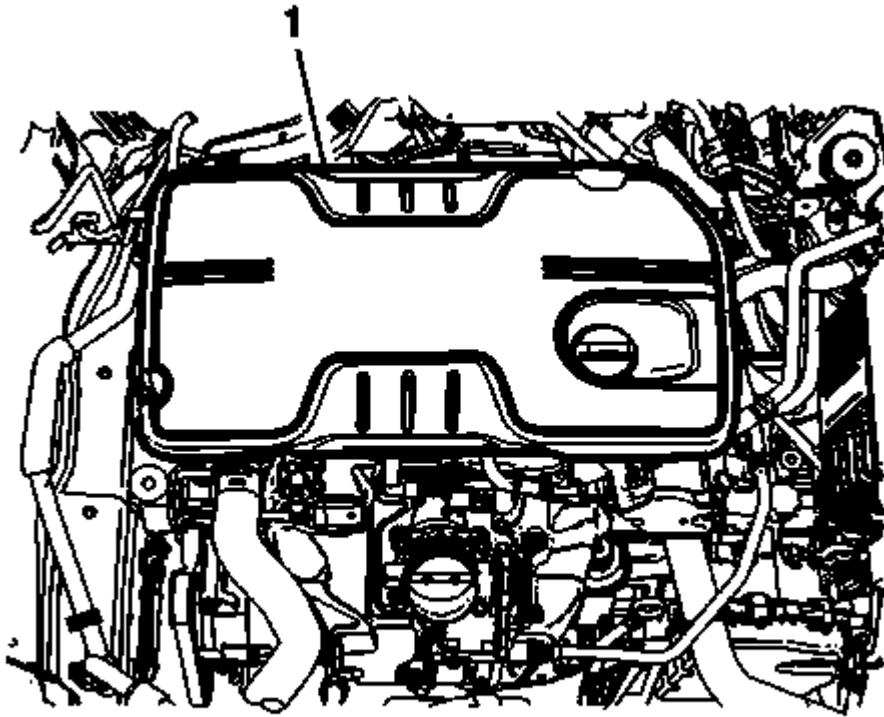


Fig. 50: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Never attempt to remove the intake manifold from a hot engine, allow the engine to cool to ambient temperature. The intake manifold can be damaged if it is removed when the engine is hot.

17. Install the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement**
18. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
19. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

INTAKE MANIFOLD REPLACEMENT (LUK)

Removal Procedure

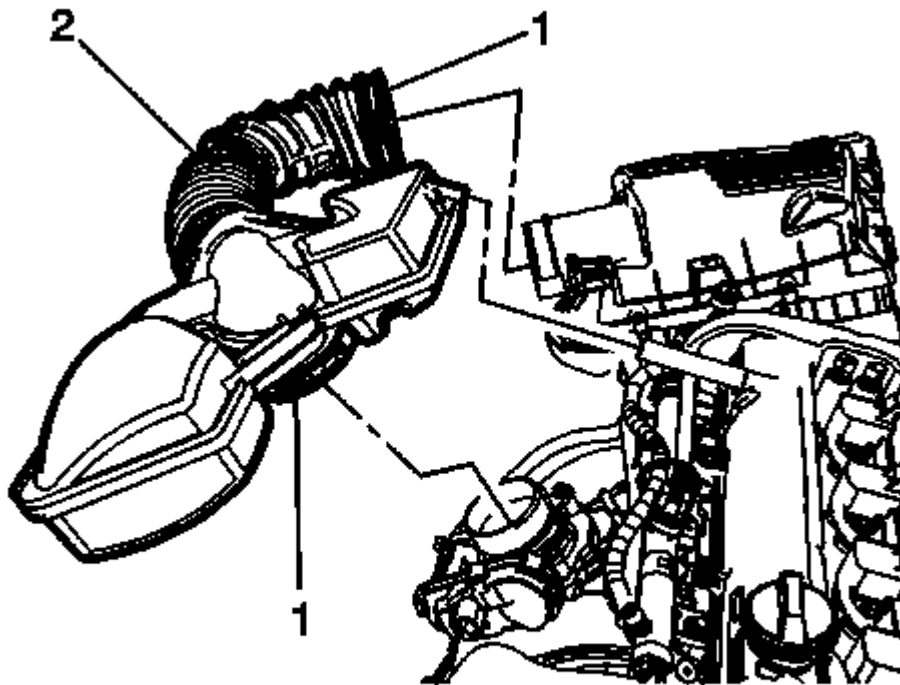


Fig. 51: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .

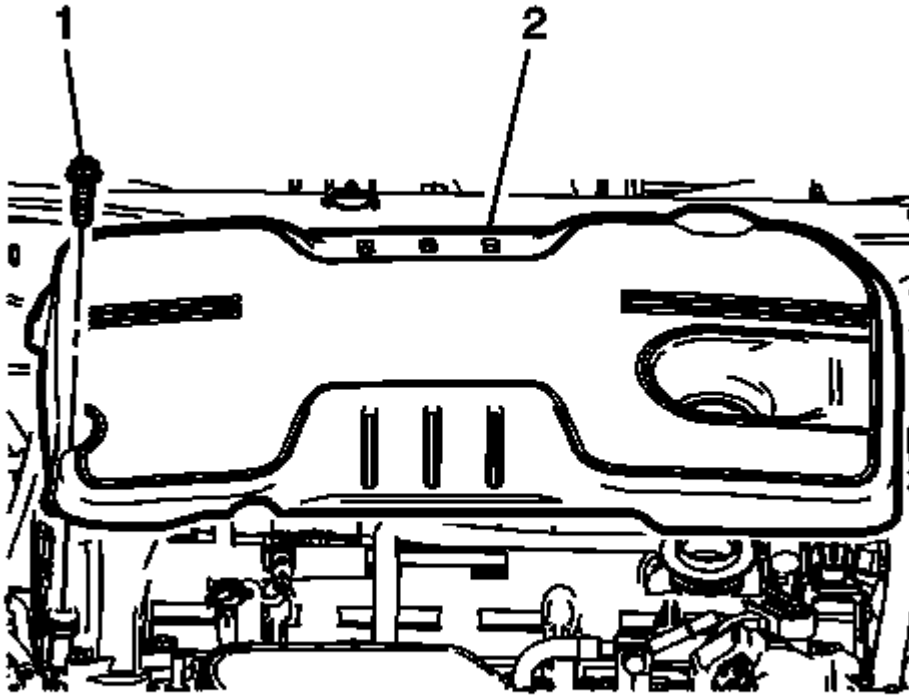


Fig. 52: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**

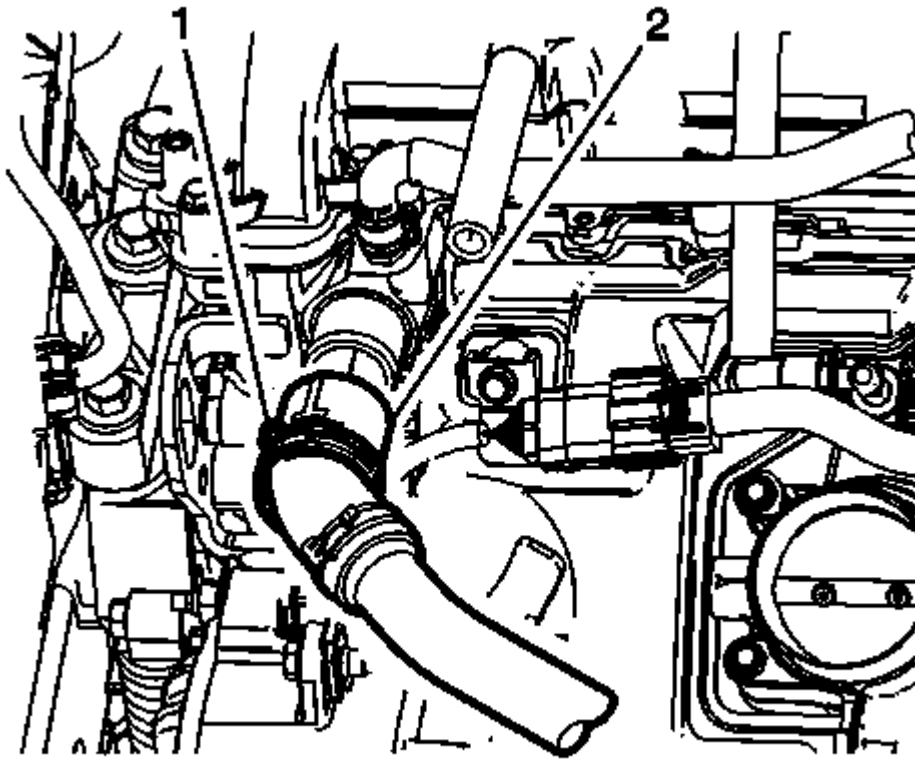


Fig. 53: Hose Clamp And Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

3. Reposition the hose clamp (1) and disconnect the radiator inlet hose (2). Refer to **Radiator Inlet Hose Replacement (LUK)** .

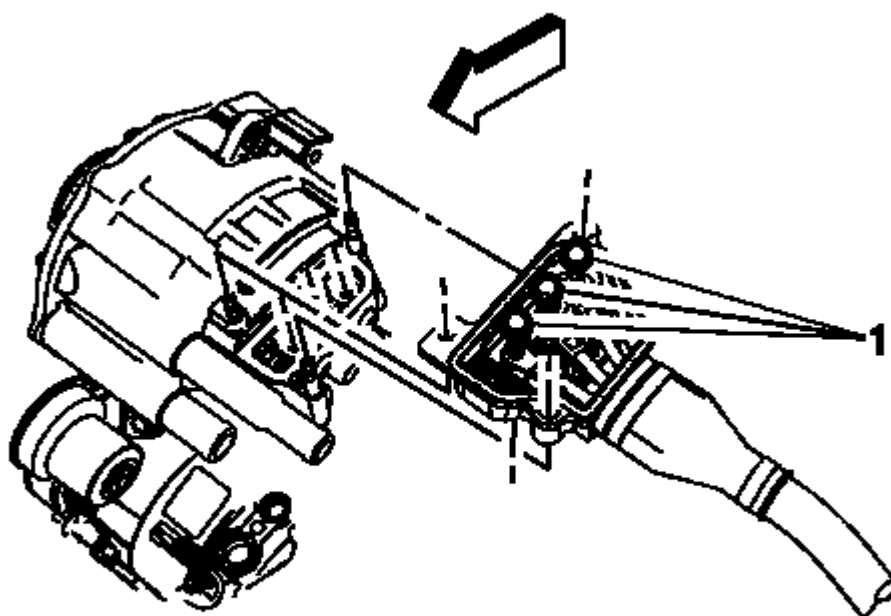


Fig. 54: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

4. Remove the starter generator. Refer to **Starter Generator Replacement**

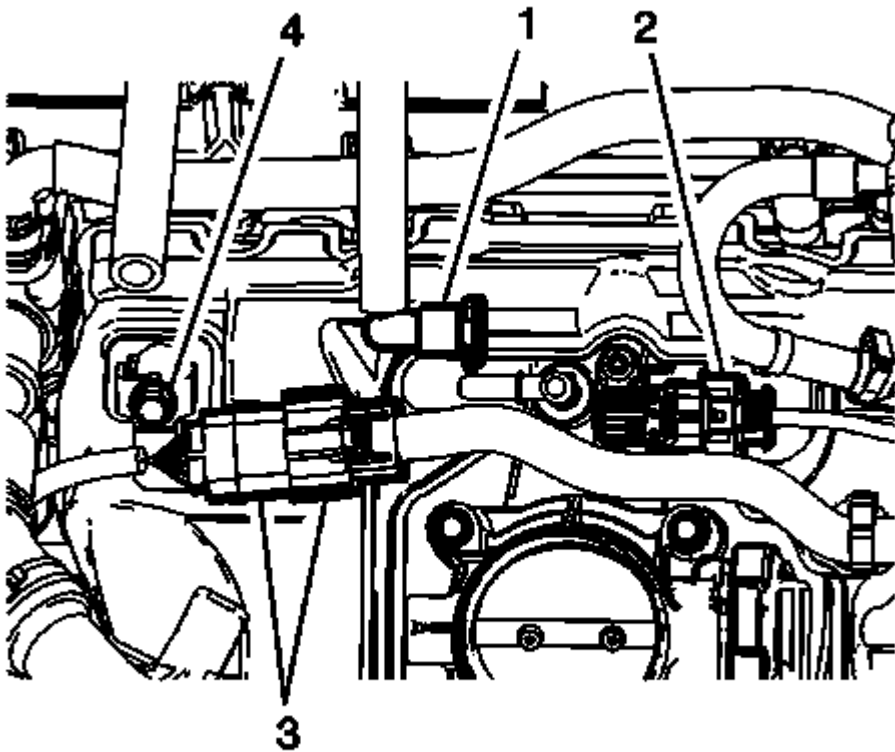


Fig. 55: Fuel Injector Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the fuel injector wiring harness electrical connector (3) from the engine wiring harness electrical connector.
6. Remove the fuel injector wiring harness fastener (4) from the intake manifold.
7. Disconnect the evaporative emission (EVAP) canister purge tube (1) from the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
8. Disconnect the MAP sensor connector (2).

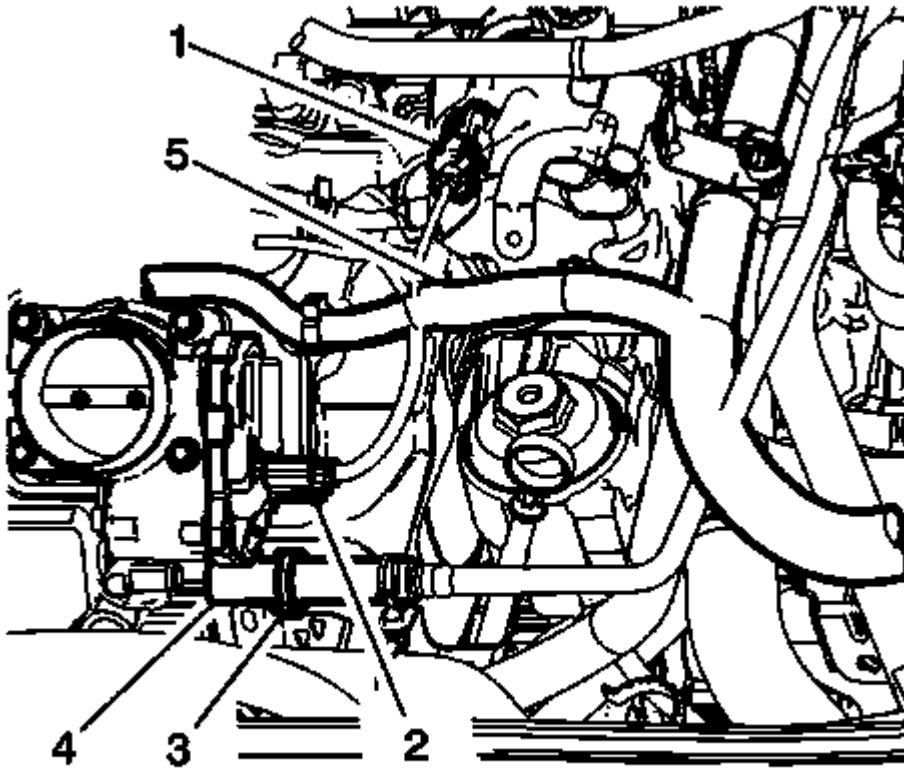


Fig. 56: Engine Harness And Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the fuel pump electrical connector (1).
10. Disconnect the engine wiring harness electrical connector (2) from the throttle actuator control (TAC).
11. Reposition the vacuum brake booster hose clamp (3) at the intake manifold.
12. Remove the vacuum brake booster hose (4) from the intake manifold.
13. Reposition the engine harness (5) away from the intake manifold.

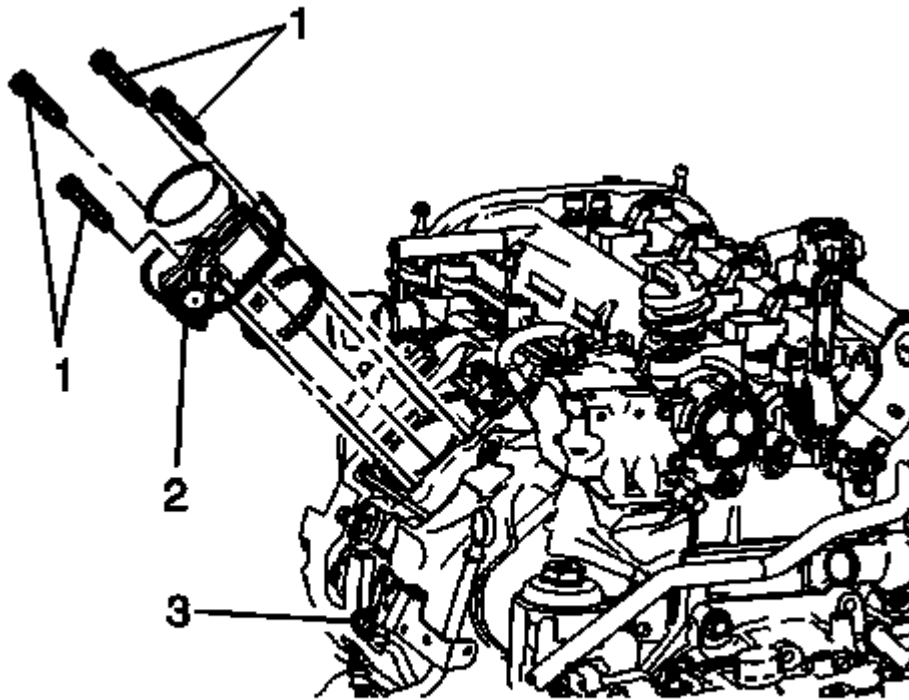


Fig. 57: Throttle Body

Courtesy of GENERAL MOTORS COMPANY

14. Remove the throttle body (2). Refer to **Throttle Body Assembly Replacement** .
15. Remove the fastener (3) from the oil level indicator tube and remove the tube. Refer to **Oil Level Indicator Tube Replacement**.

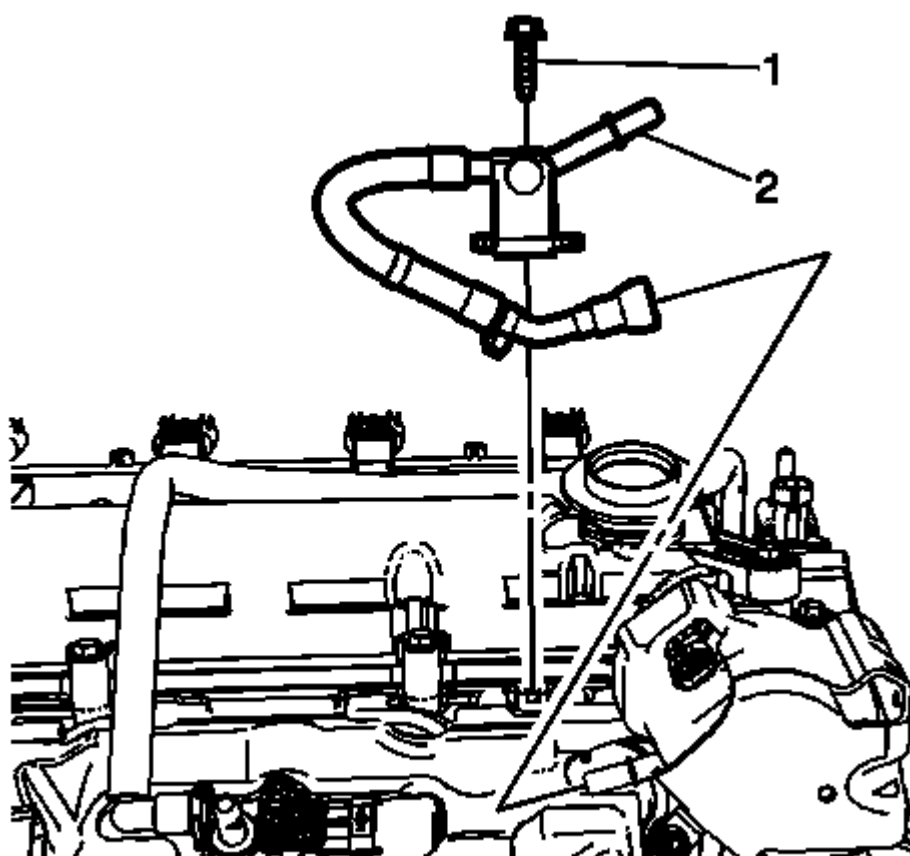


Fig. 58: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

16. Remove the fuel feed pipe (2). Refer to **Fuel Feed Pipe Replacement (Engine)** , **Fuel Feed Pipe Replacement (Chassis)** .

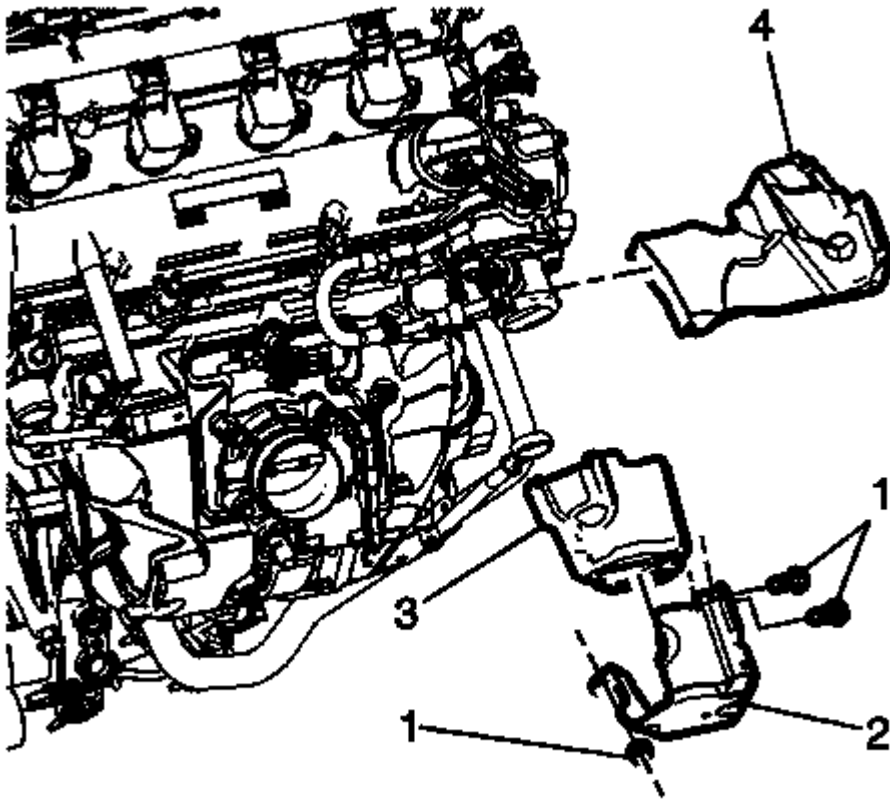


Fig. 59: Fuel Pump Cover

Courtesy of GENERAL MOTORS COMPANY

17. Remove the fuel pump cover (1-4). Refer to **Fuel Pump Cover Replacement** .

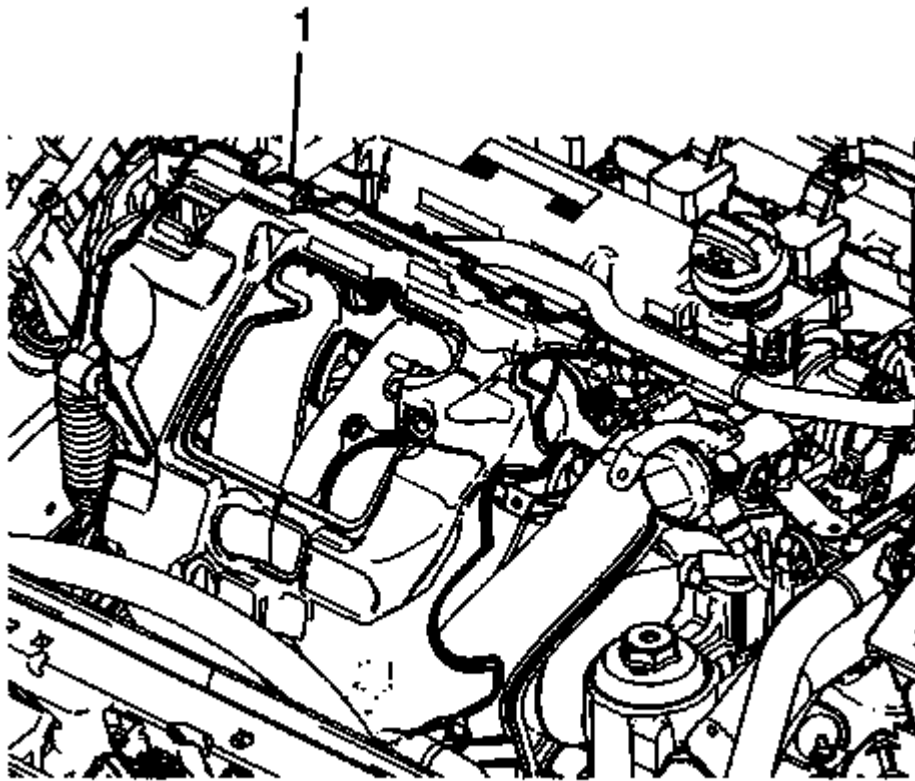


Fig. 60: Intake Manifold Heat Shield
Courtesy of GENERAL MOTORS COMPANY

18. Remove the intake manifold heat shield (1).

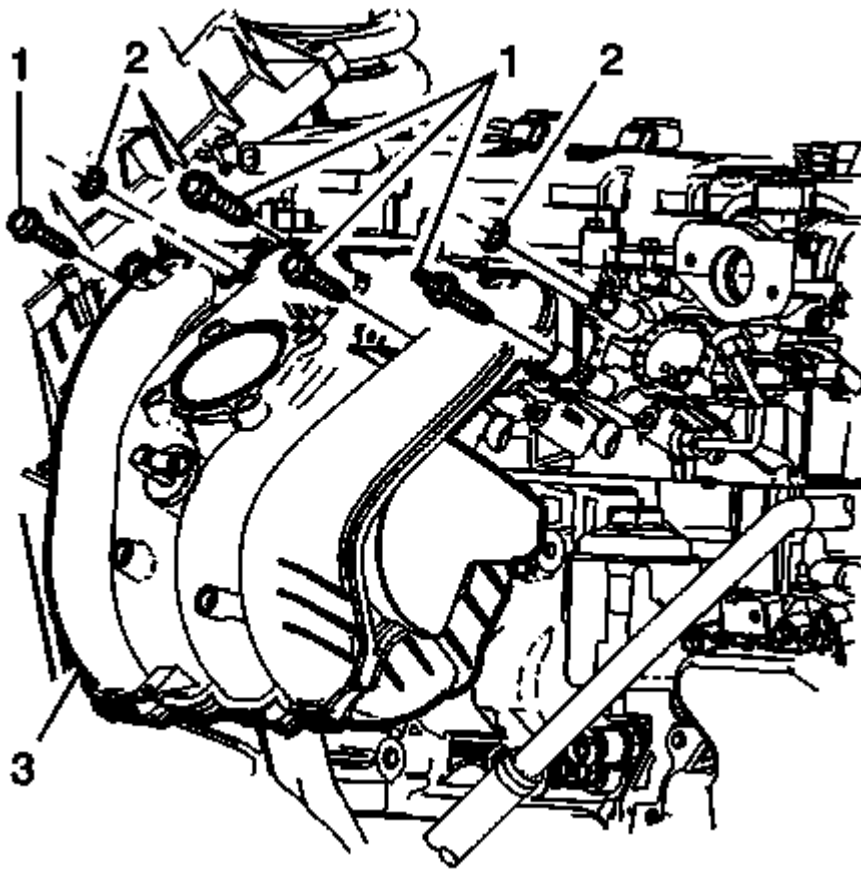


Fig. 61: Intake Manifold Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

19. Remove the intake manifold lower bolts (1).
20. Remove the intake manifold upper nuts (2).
21. Remove the intake manifold (3).

NOTE: **The intake manifold gasket is reusable, only replace the gasket if damage has occurred.**

22. Remove and inspect the intake manifold gasket.

Installation Procedure

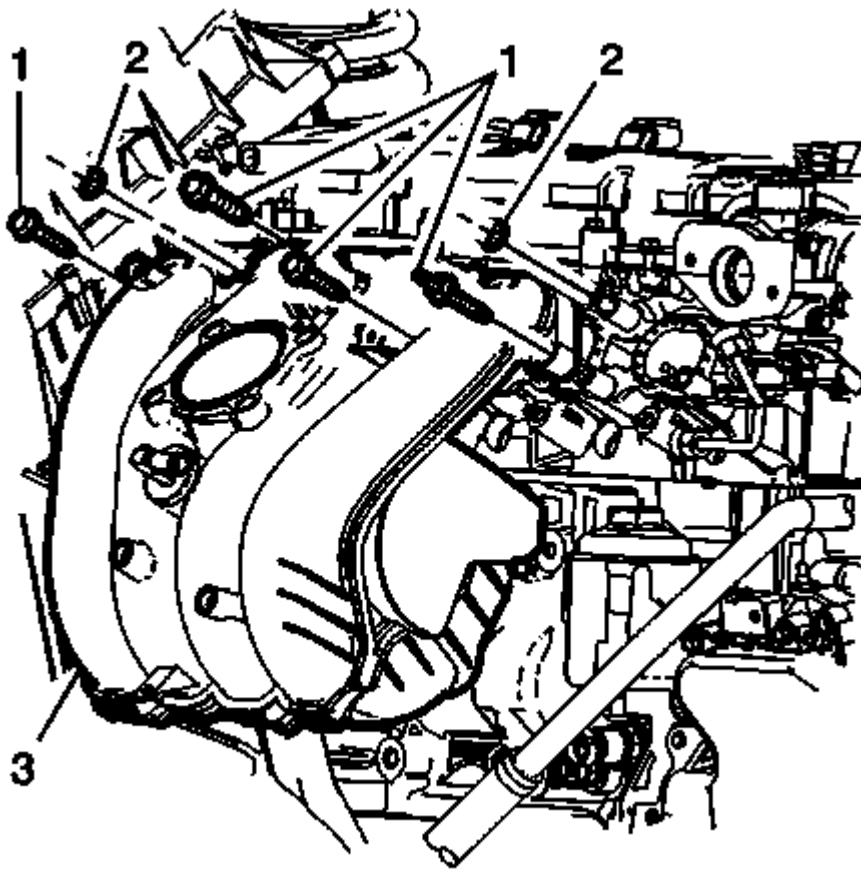


Fig. 62: Intake Manifold Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW intake manifold gasket if necessary, otherwise install the old gasket.
2. Install the intake manifold (3).
3. Install the intake manifold upper nuts (2).

CAUTION: Refer to Fastener Caution .

4. Install the intake manifold lower bolts (1). Tighten the bolts/nuts (1 and 2) to 10 N.m (89 lb in).

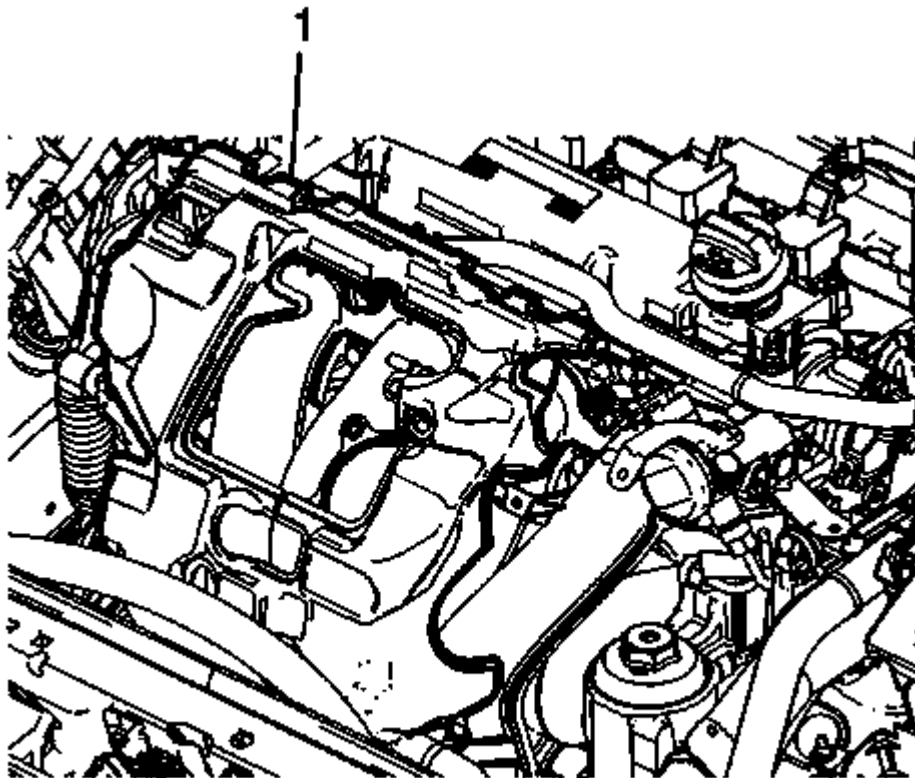


Fig. 63: Intake Manifold Heat Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install the intake manifold heat shield (1).

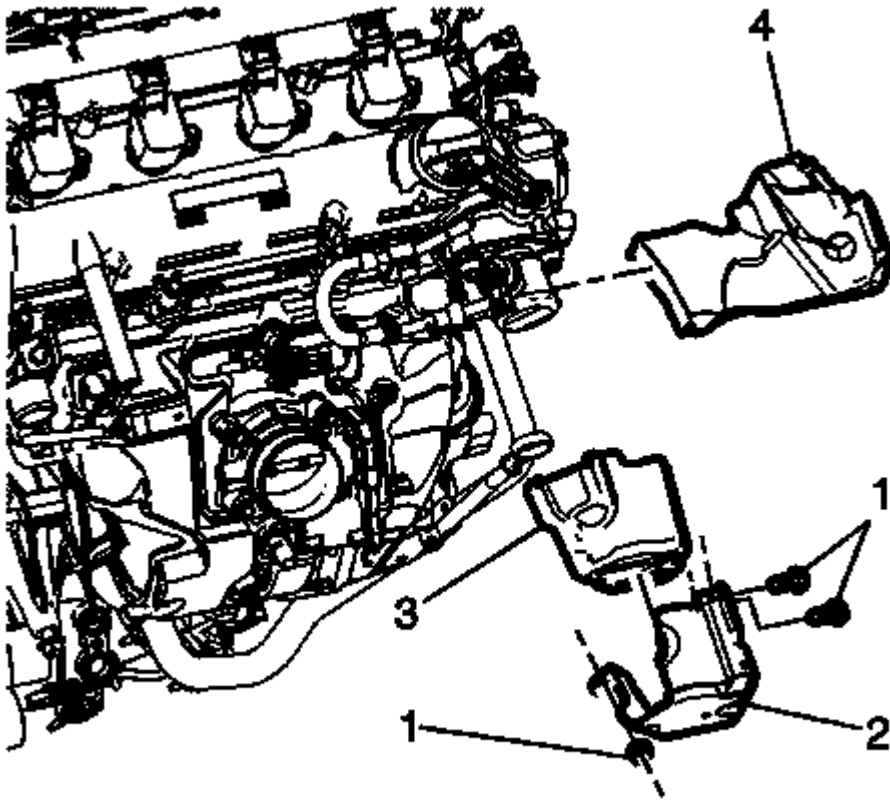


Fig. 64: Fuel Pump Cover

Courtesy of GENERAL MOTORS COMPANY

6. Install the fuel pump cover (1-4). Refer to **Fuel Pump Cover Replacement** .

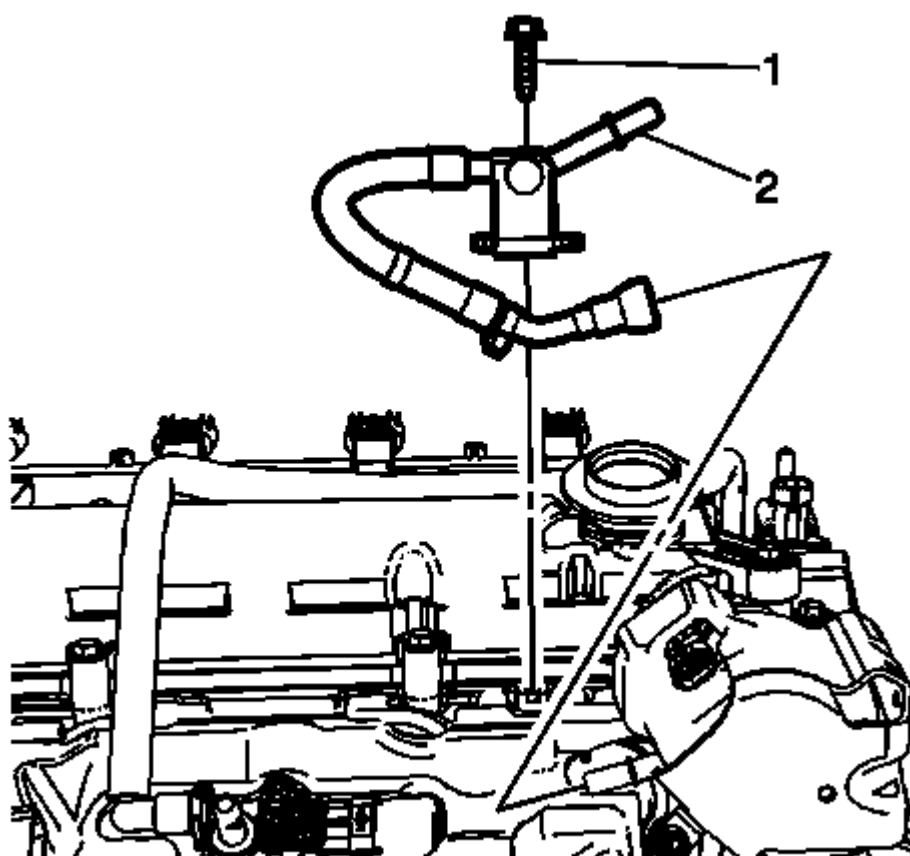


Fig. 65: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

7. Install the fuel feed pipe (2). Refer to **Fuel Feed Pipe Replacement (Engine)** , **Fuel Feed Pipe Replacement (Chassis)** .

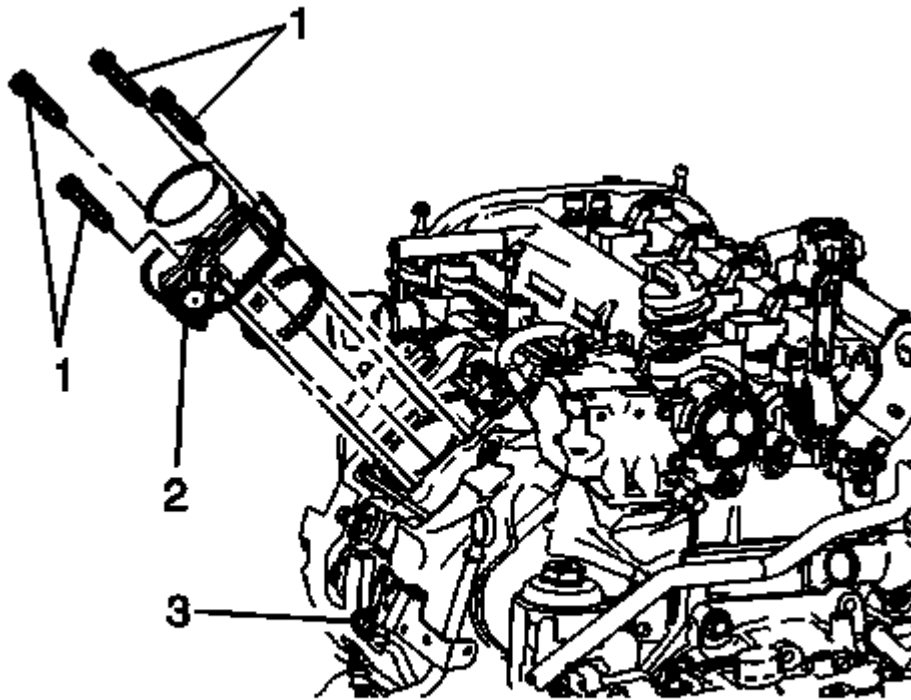


Fig. 66: Throttle Body
Courtesy of GENERAL MOTORS COMPANY

8. Install the throttle body (2). Refer to **Throttle Body Assembly Replacement** .
9. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

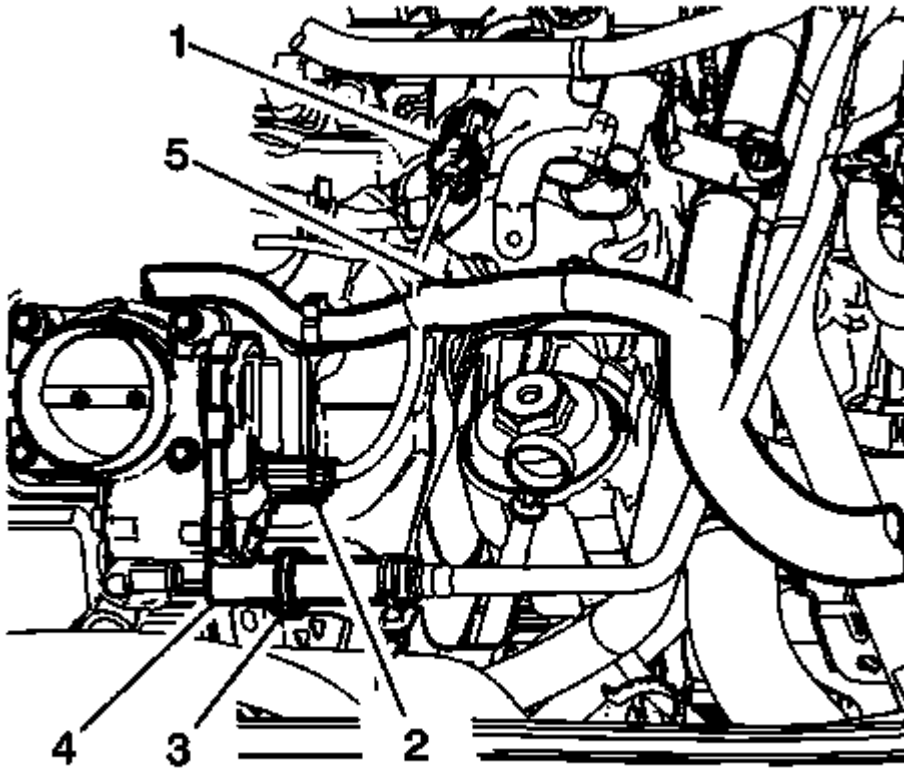


Fig. 67: Engine Harness And Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS COMPANY

10. Reposition the engine harness (5) across the intake manifold.
11. Connect the engine wiring harness electrical connector (2) to the throttle actuator control (TAC).
12. Connect the vacuum brake booster hose (4) at the intake manifold.
13. Install the brake booster hose clamp (3).
14. Connect the fuel pump electrical connector (1).

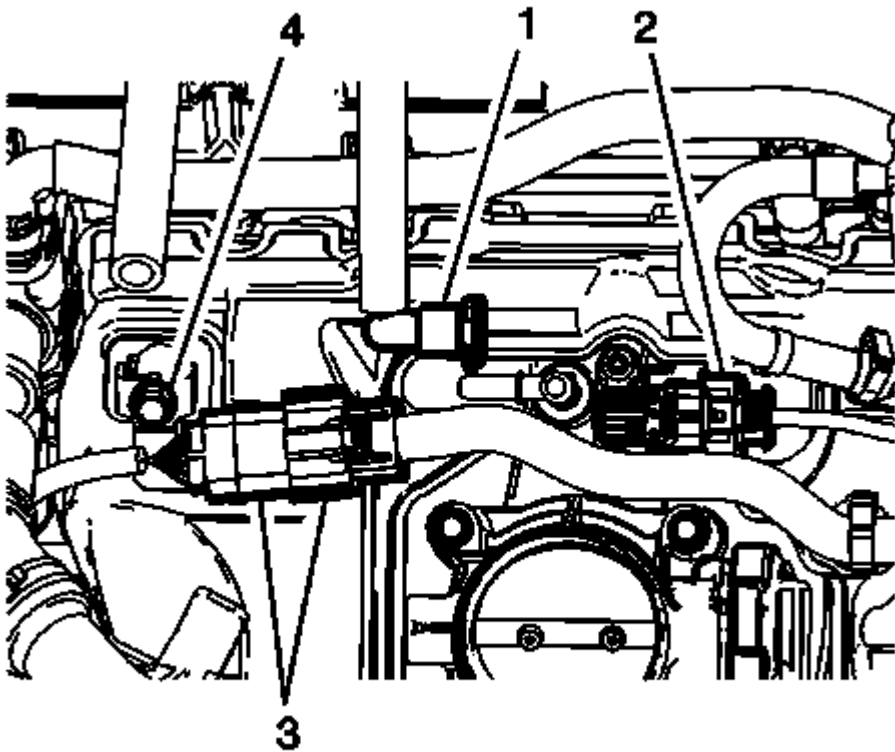


Fig. 68: Fuel Injector Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

15. Connect the fuel injector wiring harness electrical connector (3) to the engine wiring harness electrical connector.
16. Install the fuel injector wiring harness fastener (4) to the intake manifold.
17. Connect the evaporative emission (EVAP) canister purge tube (1) to the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
18. Connect the MAP sensor connector (2).

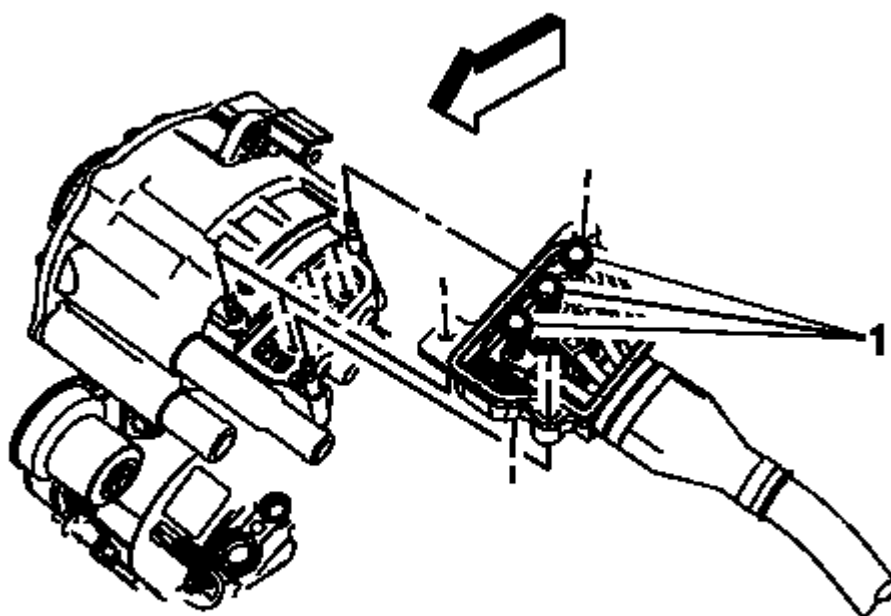


Fig. 69: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

19. Install the starter generator. Refer to **Starter Generator Replacement**

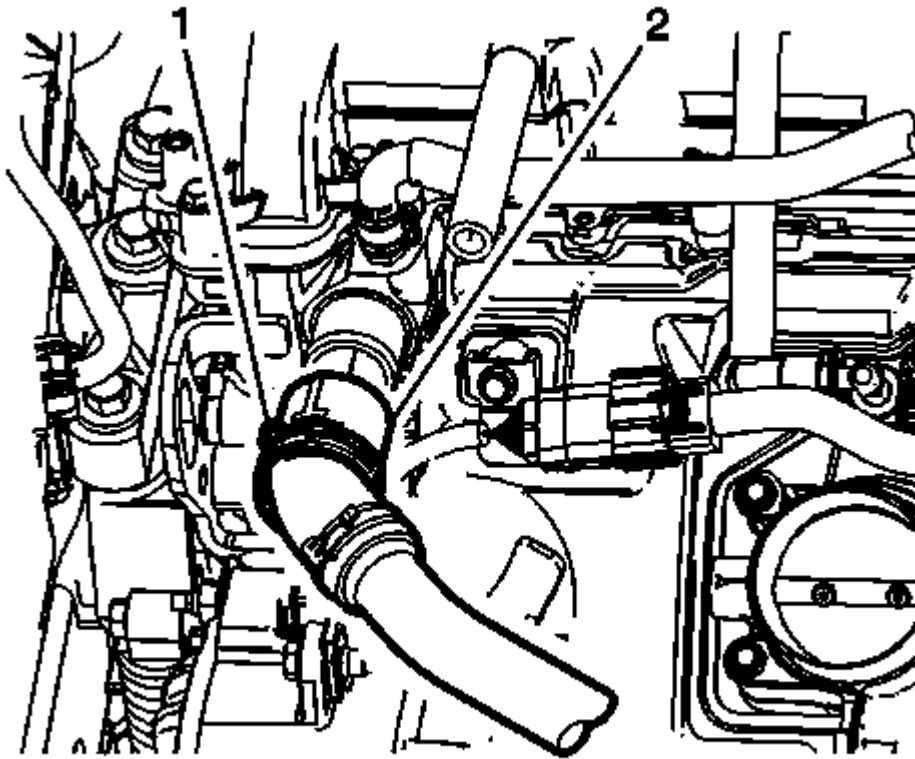


Fig. 70: Hose Clamp And Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

20. Connect the radiator inlet hose (2), reposition the hose clamp (1). Refer to **Radiator Inlet Hose Replacement (LUK)** .

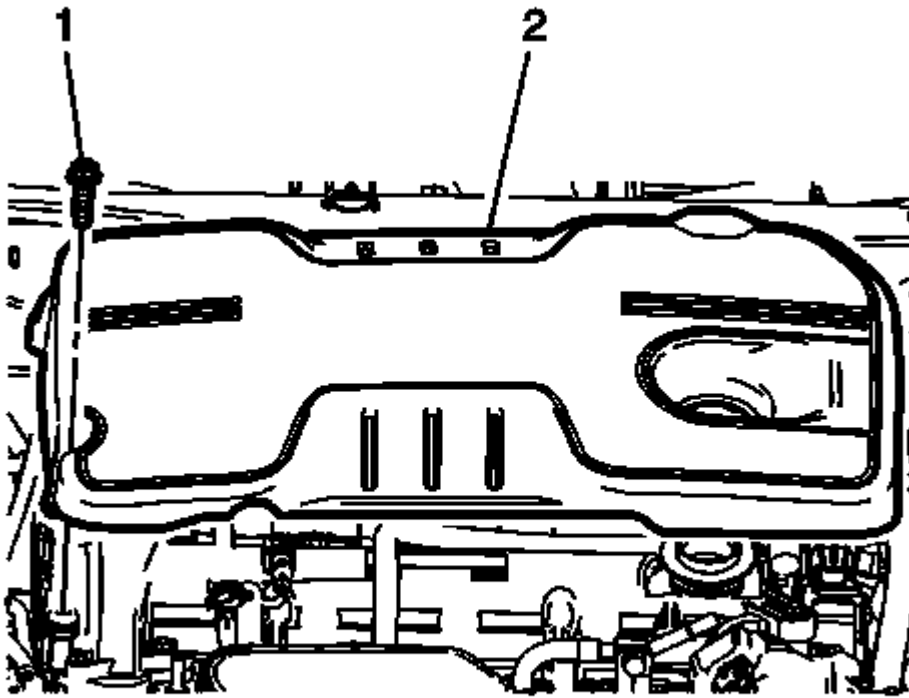


Fig. 71: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

21. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**

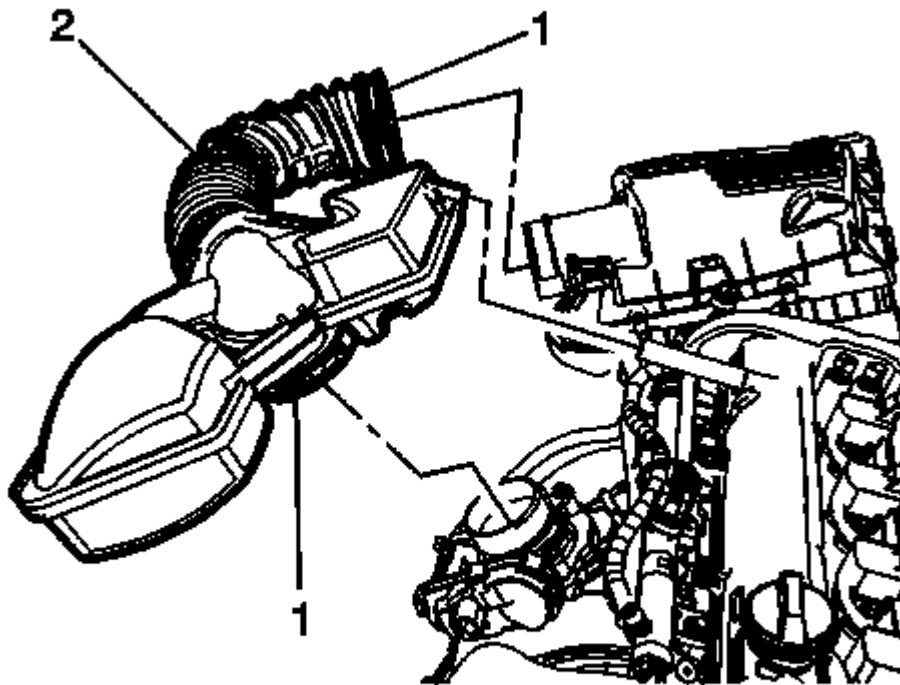


Fig. 72: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

22. Install the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **EN-45059** Angle Meter.
- **J-43653** Flywheel Holding Tool.

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the wheelhouse front liner. Refer to **Front Wheelhouse Front Liner Replacement** .
2. Remove the drive belt. Refer to **Drive Belt Replacement (LEA)**, **Drive Belt Replacement (LUK)**.
3. Remove the starter. Refer to **Starter Replacement (LUK)** .
4. Install the **J-43653** flywheel holding tool in the starter opening.

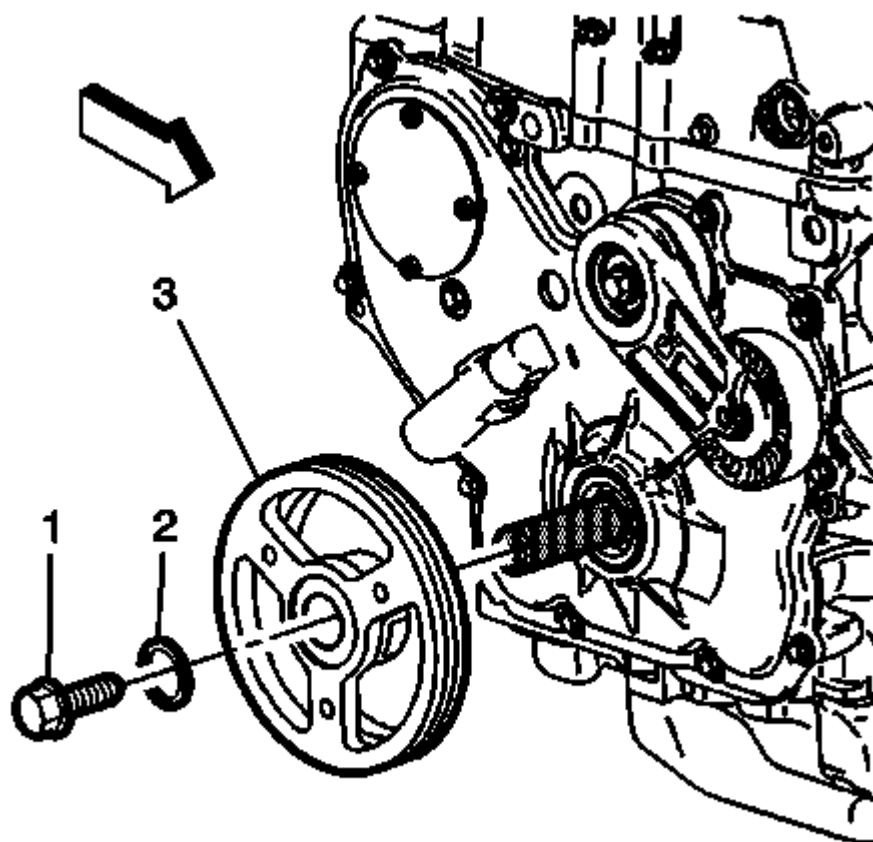


Fig. 73: Bolt, Washer And Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the crankshaft balancer bolt (1), washer (2), and crankshaft balancer (3). Discard the crankshaft balancer bolt.

Installation Procedure

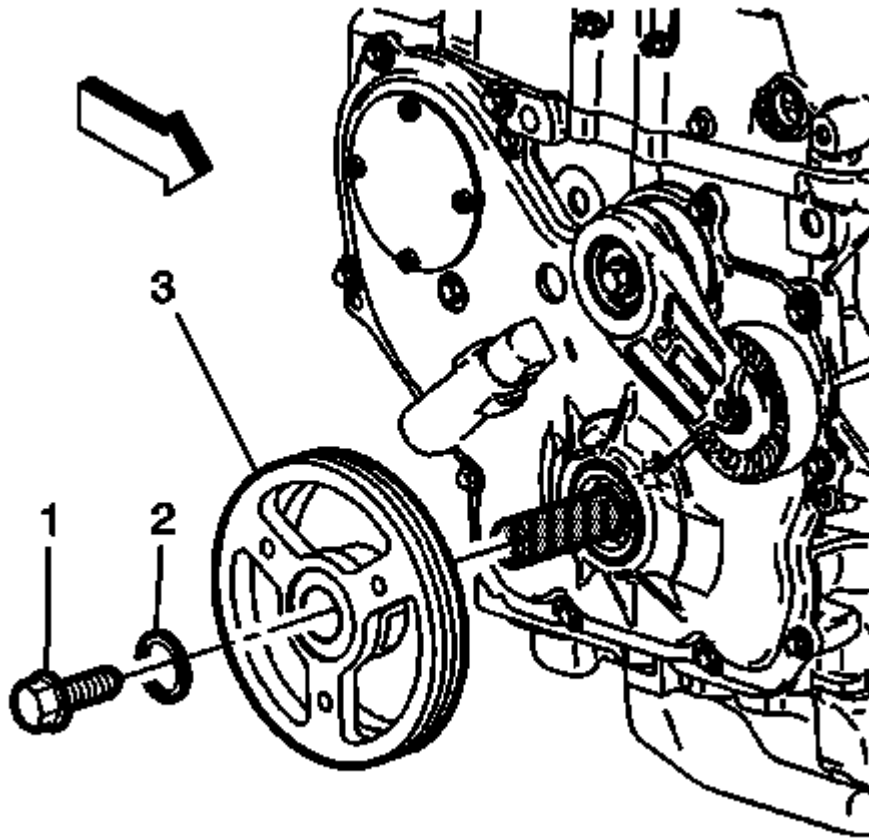


Fig. 74: Bolt, Washer And Crankshaft Balancer
 Courtesy of GENERAL MOTORS COMPANY

1. Position the crankshaft balancer (3) .

CAUTION: Refer to Fastener Caution .

2. Install a NEW crankshaft balancer bolt (1) and washer (2).

Tighten

1. First Pass 100 (74 lb ft).
2. Final Pass 125 degrees using the **EN-45059** meter.
3. Remove the **J-43653** flywheel holding tool.
4. Install the starter. Refer to **Starter Replacement (LUK)** .
5. Install the drive belt. Refer to **Drive Belt Replacement (LEA)**, **Drive Belt Replacement (LUK)**.
6. Install the wheelhouse front liner. Refer to **Front Wheelhouse Front Liner Replacement** .

WATER PUMP AND BALANCE SHAFT CHAIN CRANKSHAFT SPROCKET REPLACEMENT

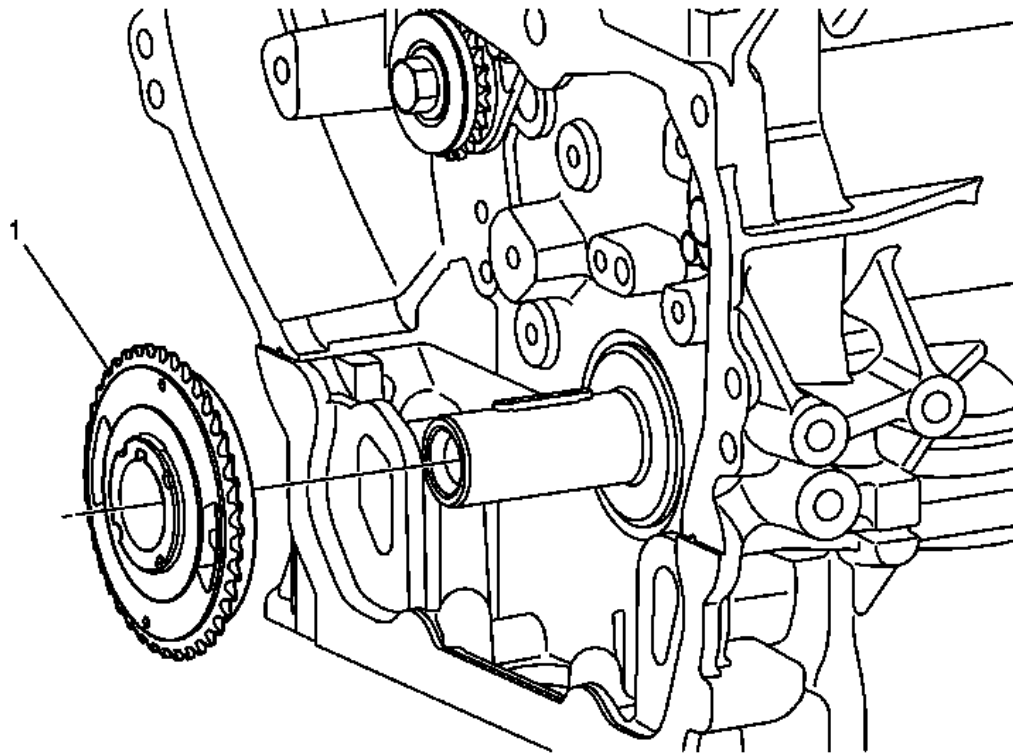


Fig. 75: Water Pump and Balance Shaft Chain Crankshaft Sprocket
 Courtesy of GENERAL MOTORS COMPANY

Water Pump and Balance Shaft Chain Crankshaft Sprocket Replacement

Callout	Component Name
Preliminary Procedure Remove the water pump and balancer shaft chain. Refer to <u>Water Pump and Balance Shaft Chain Replacement</u> .	
1	Water Pump and Balance Shaft Chain Crankshaft Sprocket Procedure <ul style="list-style-type: none"> • Pull the water pump and balance shaft chain crankshaft sprocket from the crankshaft. • For installation align the crankshaft sprocket key with the slot in the water pump and balance shaft chain crankshaft sprocket. Slide the gear into place. <p>NOTE: The crankshaft sprocket key is only placed in the recess of the crankshaft. Take care that it does not fall into the oil pan.</p>

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

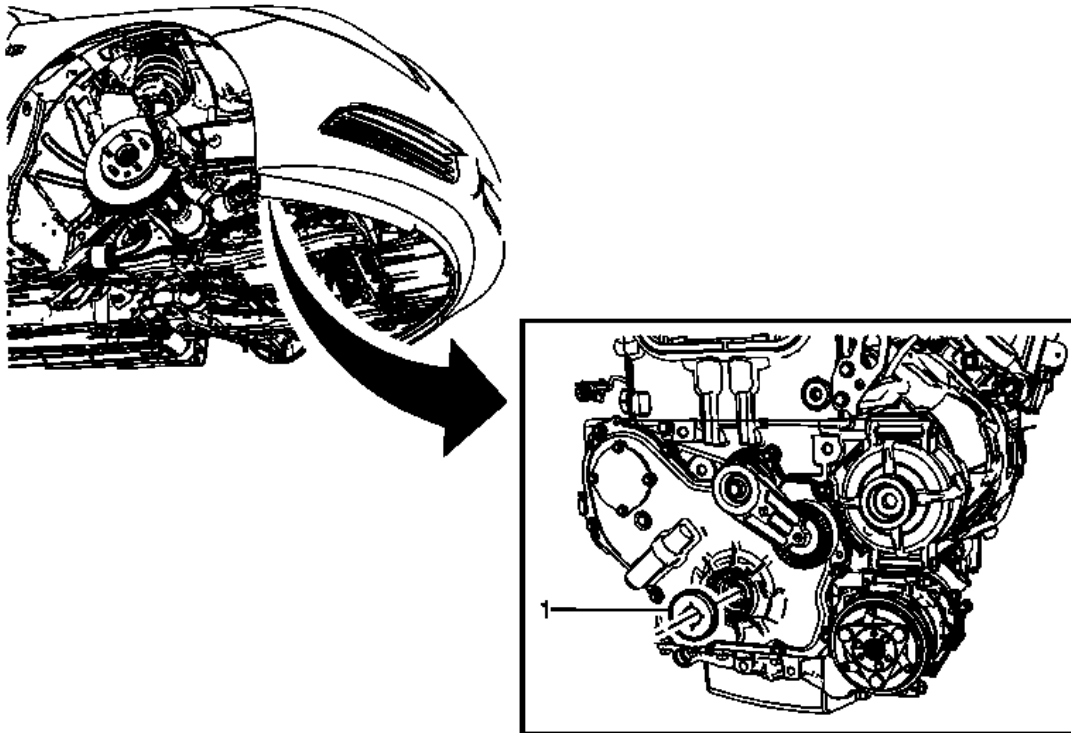


Fig. 76: Crankshaft Front Oil Seal
 Courtesy of GENERAL MOTORS COMPANY

Crankshaft Front Oil Seal Replacement

Callout	Component Name
Preliminary Procedure	
Remove the crankshaft balancer. Refer to <u>Crankshaft Balancer Replacement</u> .	
1	Crankshaft Front Oil Seal NOTE: Use a flat-bladed tool to remove the seal from the front cover. Special Tools Use EN-35268-A Camshaft/Front Main Seal Installer to install the front crankshaft front oil seal.

ENGINE FRONT COVER REPLACEMENT (LEA)

Removal Procedure

1. Remove the engine mount bracket Refer to **Engine Mount Bracket Replacement (LEA)**.
2. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement (LEA)**.
3. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

4. Disconnect the oxygen sensor harness from the front cover and reposition.

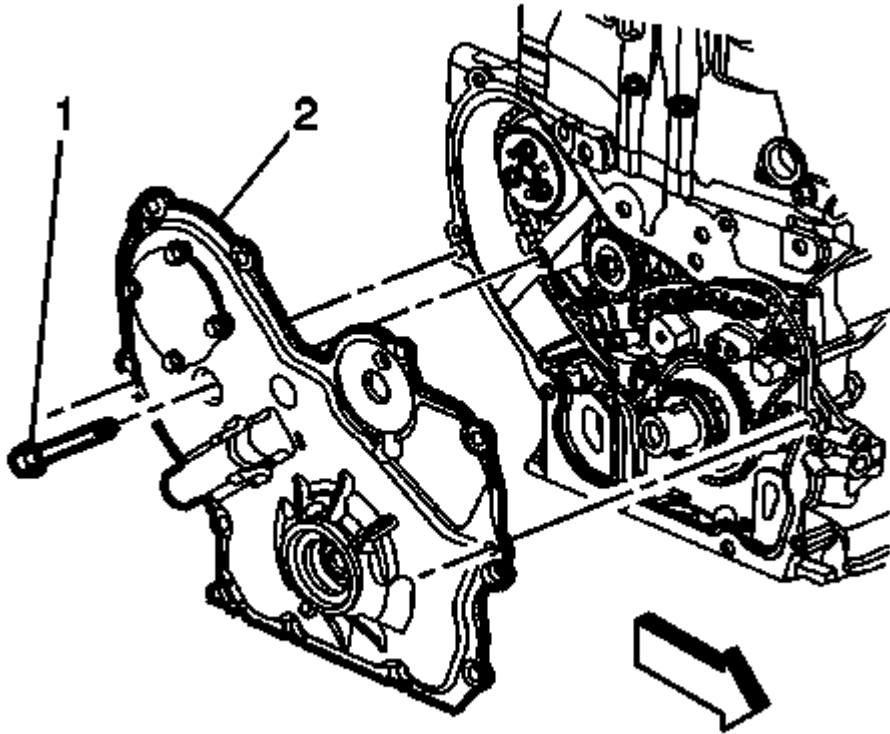


Fig. 77: Water Pump Bolt

Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine front cover to water pump bolt (1).

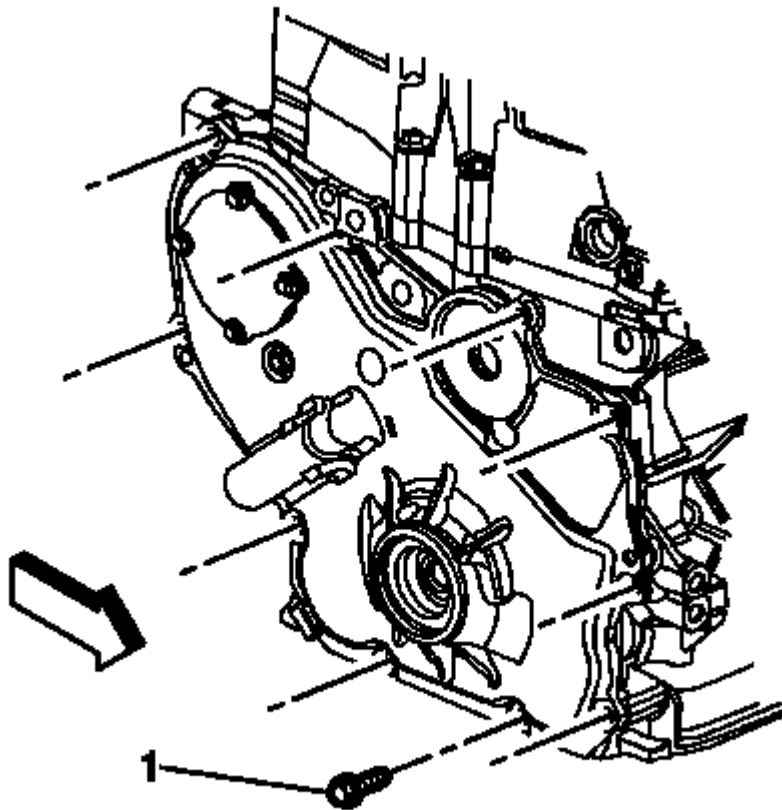


Fig. 78: Engine Front Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

6. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
7. Remove the engine front cover bolts (1).
8. Remove the engine front cover.

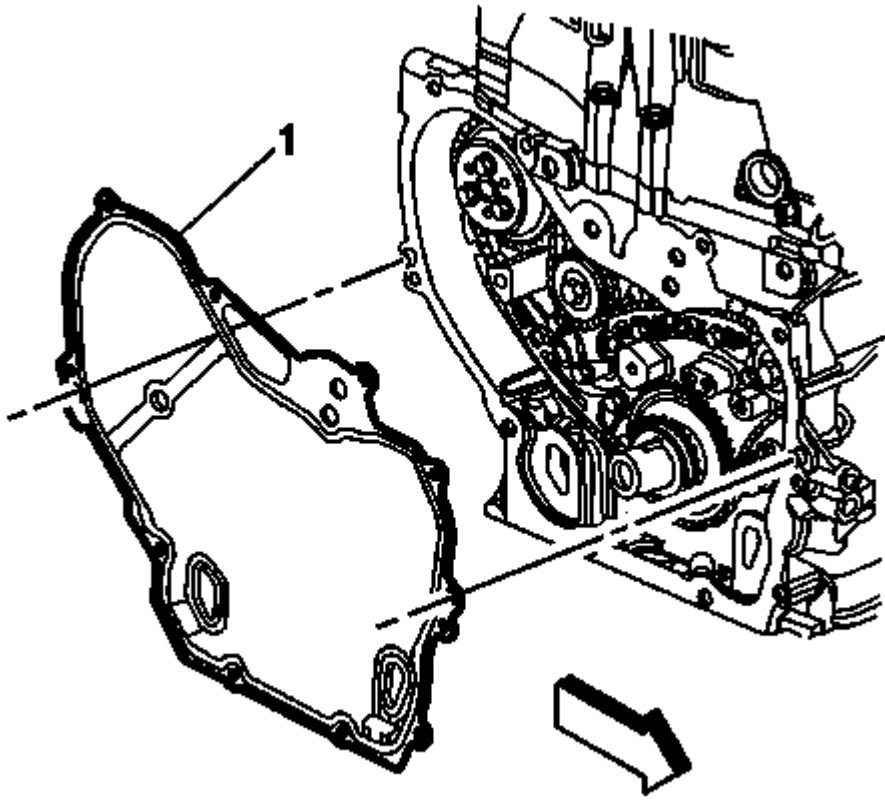


Fig. 79: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

9. Remove and discard the engine front cover gasket (1).

Installation Procedure

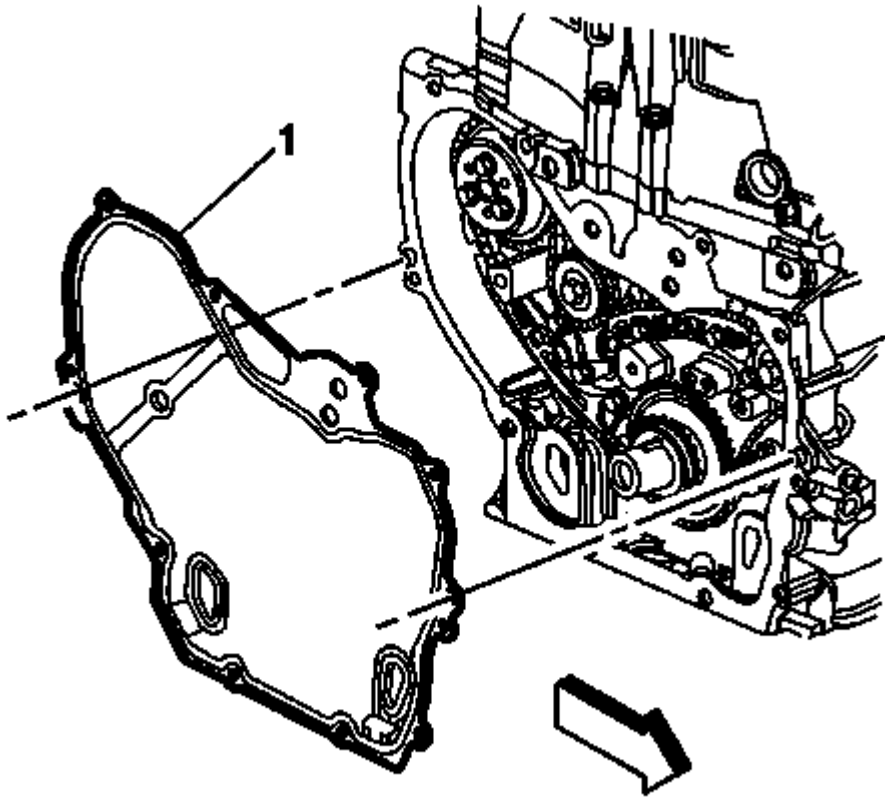


Fig. 80: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW engine front cover gasket (1) to the dowel pins.
2. Install the engine front cover.

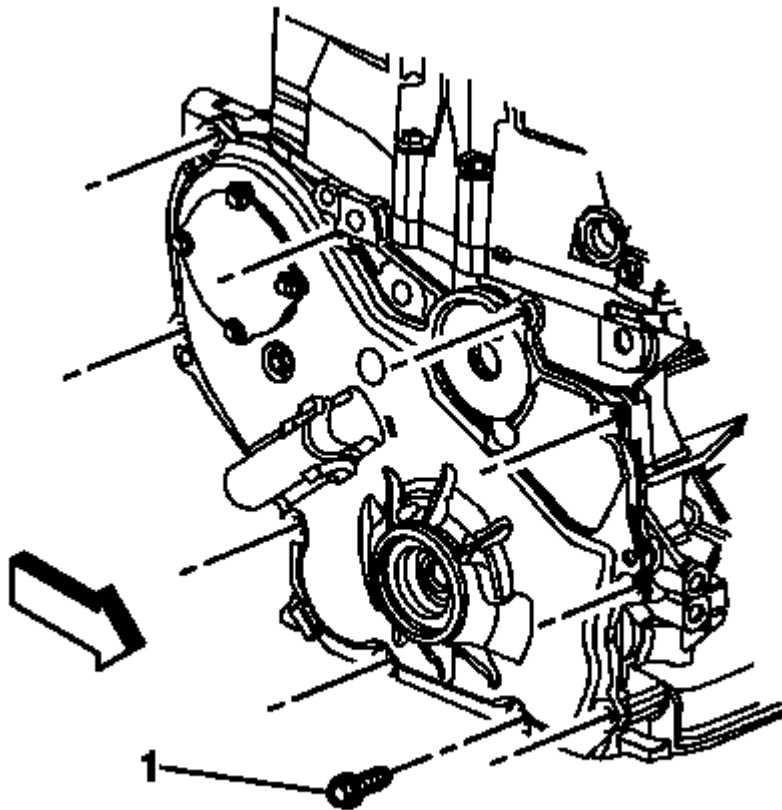


Fig. 81: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the engine front cover bolts (1) and tighten to 25 N.m (18 lb ft).
4. Lower the vehicle.

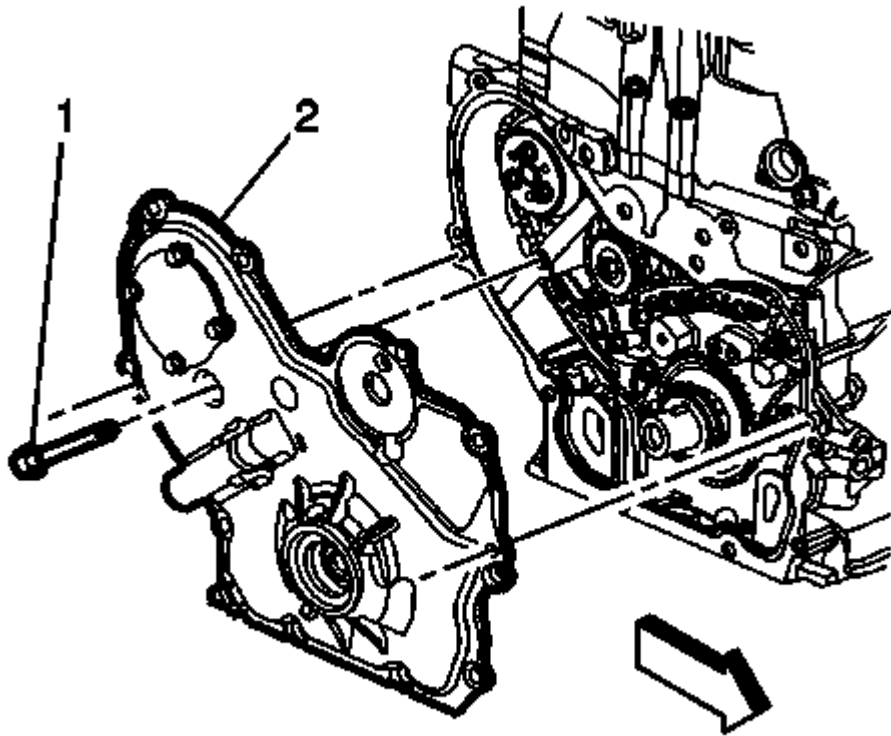


Fig. 82: Water Pump Bolt

Courtesy of GENERAL MOTORS COMPANY

5. Install the engine front cover to water pump bolt (1) and tighten to 25 N.m (18 lb ft).
6. Reposition the oxygen sensor harness to the front cover.
7. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
8. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement (LEA)**.
9. Install the engine mount bracket. Refer to **Engine Mount Bracket Replacement (LEA)**.

ENGINE FRONT COVER REPLACEMENT (LUK)

Special Tools

- **J 38122-A** Harmonic Balancer Holder
- **J 45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

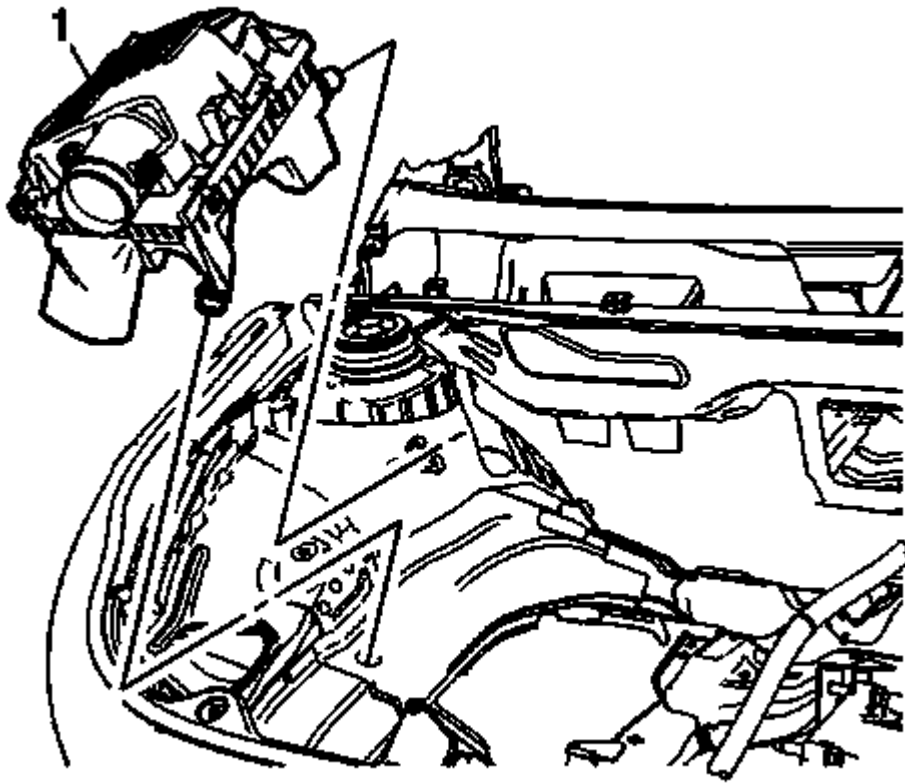


Fig. 83: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .

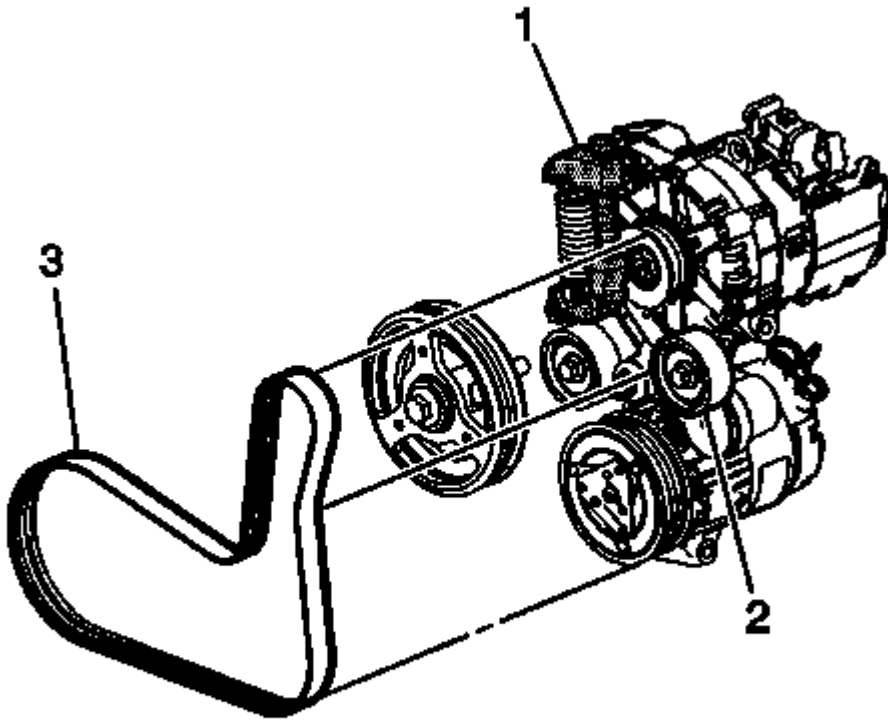


Fig. 84: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive belt (1). Refer to **Drive Belt Replacement (LUK)**.
3. Remove the wheelhouse splash shield. Refer to **Front Compartment Splash Shield Replacement** .

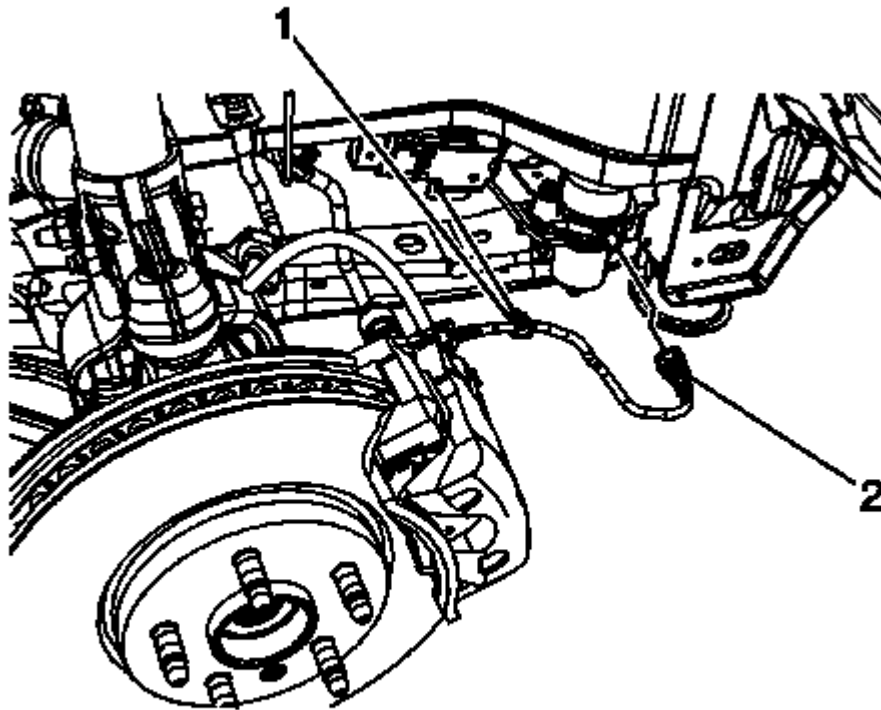


Fig. 85: Power Brake Booster Vacuum Rear Pipe Quick Connect And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect and reposition the vacuum booster rear pipe (2). Refer to **Power Brake Booster Vacuum Rear Pipe Replacement (LUK)**

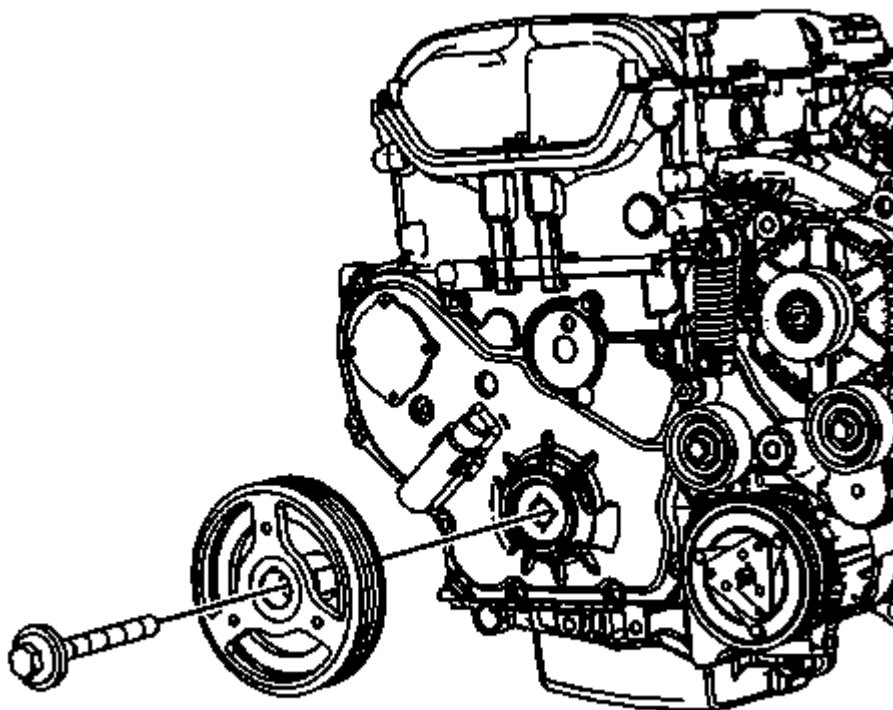


Fig. 86: Crankshaft Balancer And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

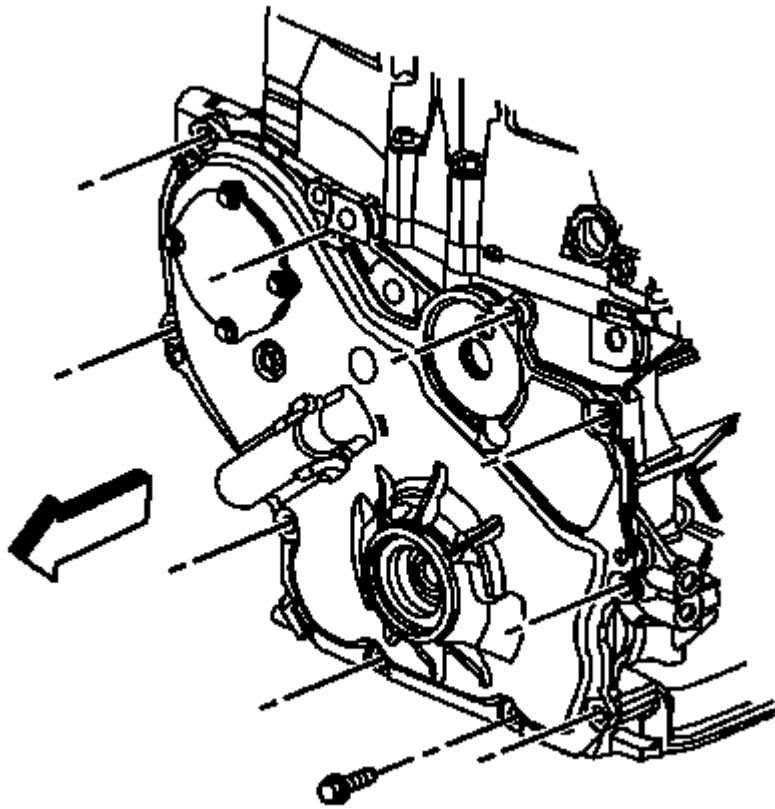


Fig. 87: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine front cover bolts.

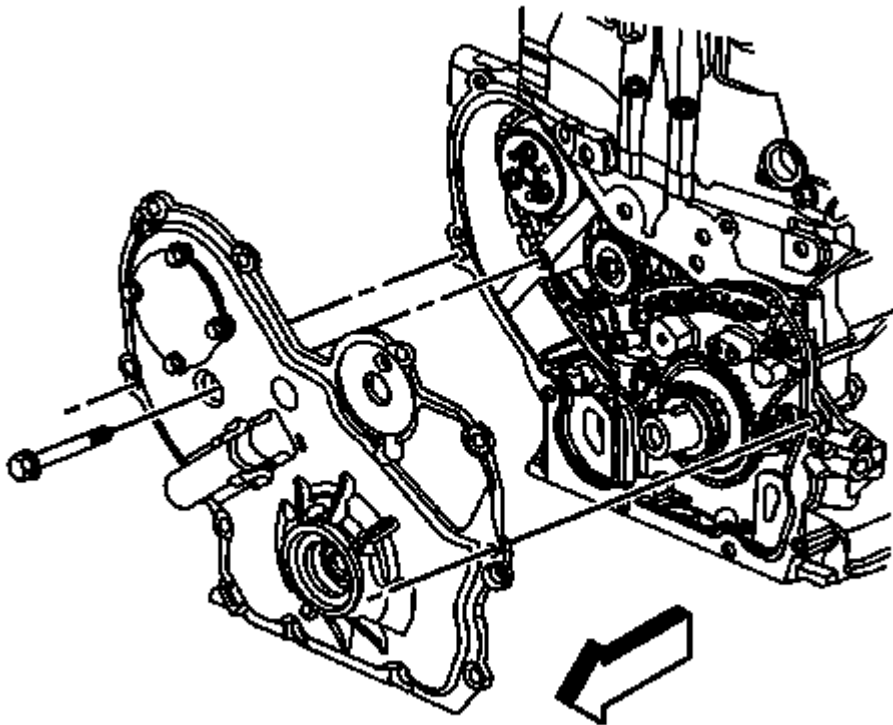


Fig. 88: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine front cover to water pump bolt.
8. Remove the engine front cover.

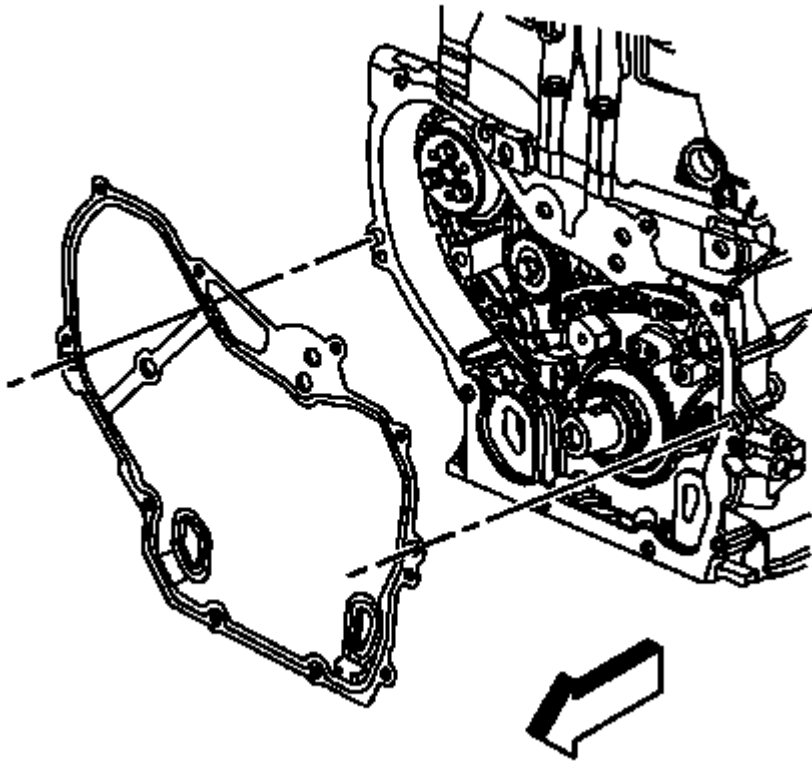


Fig. 89: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

9. Remove and discard the engine front cover gasket.

Installation Procedure

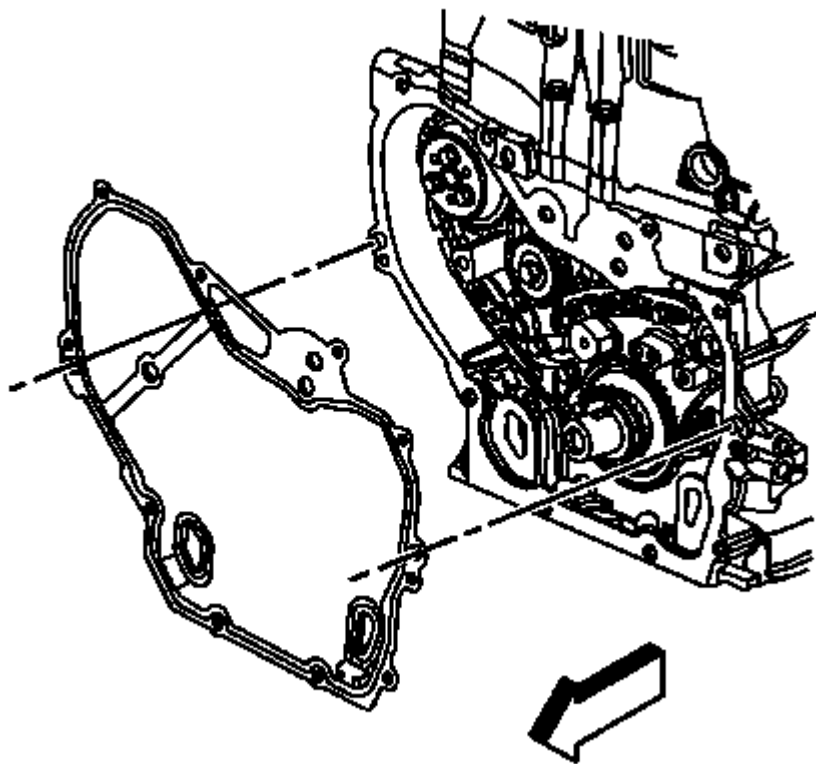


Fig. 90: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW engine front cover gasket to the dowel pins.

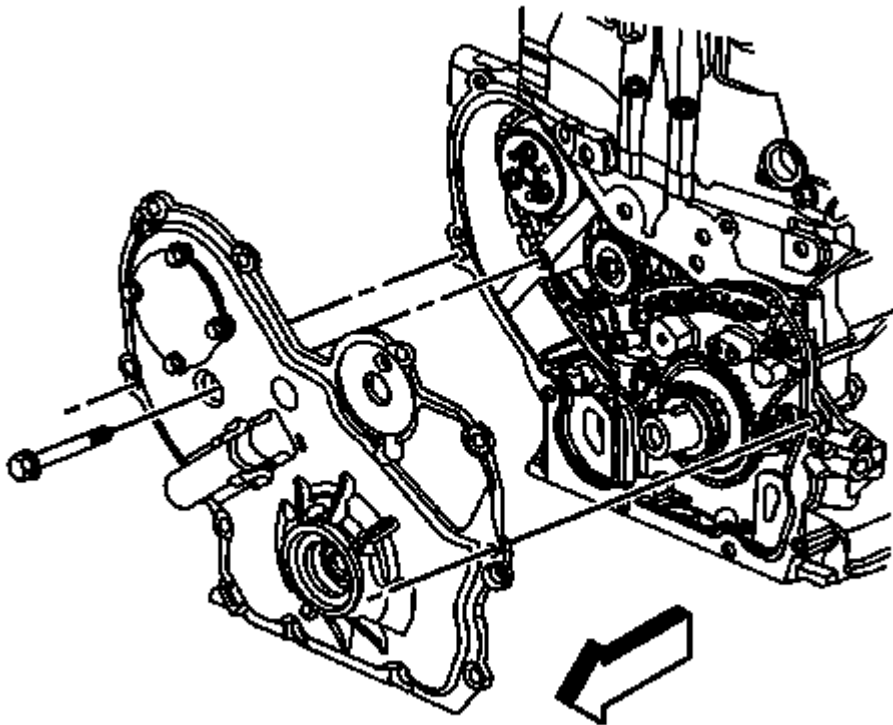


Fig. 91: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the engine front cover and install the water pump bolt and tighten to 25 N.m (18 lb ft).

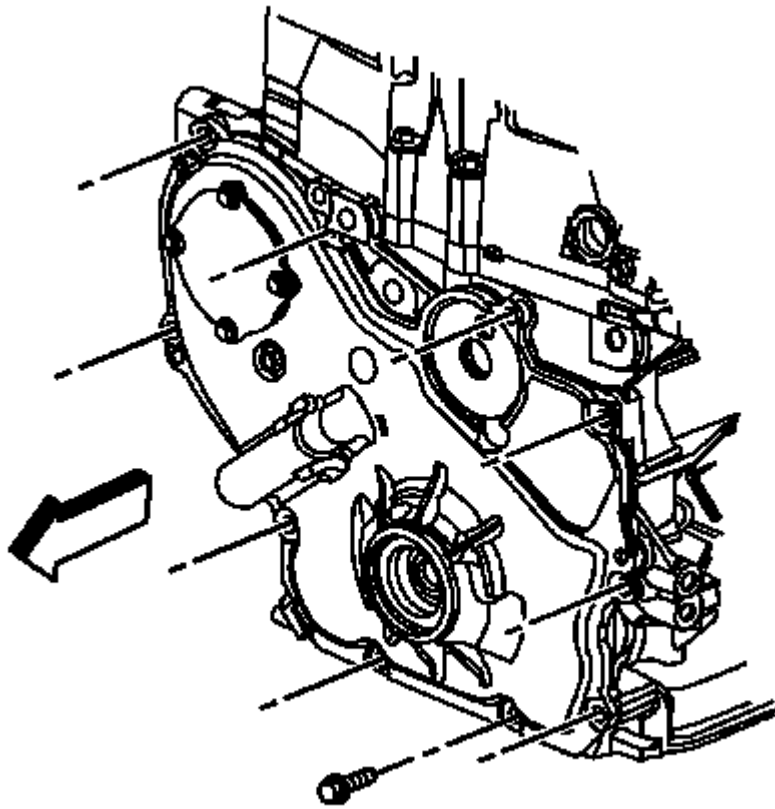


Fig. 92: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine front cover bolts and tighten to 25 N.m (18 lb ft).

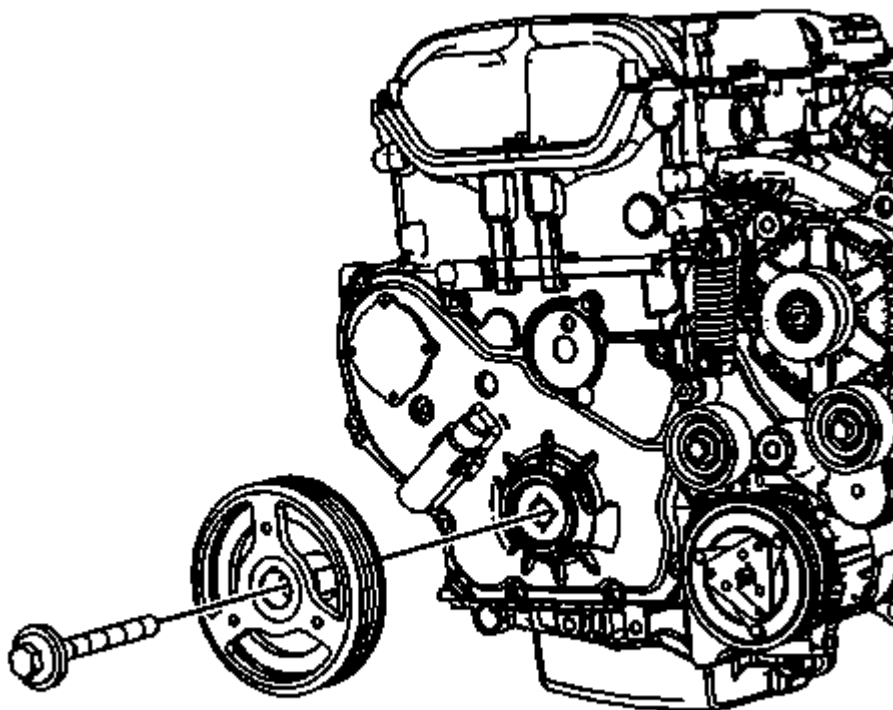


Fig. 93: Crankshaft Balancer And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

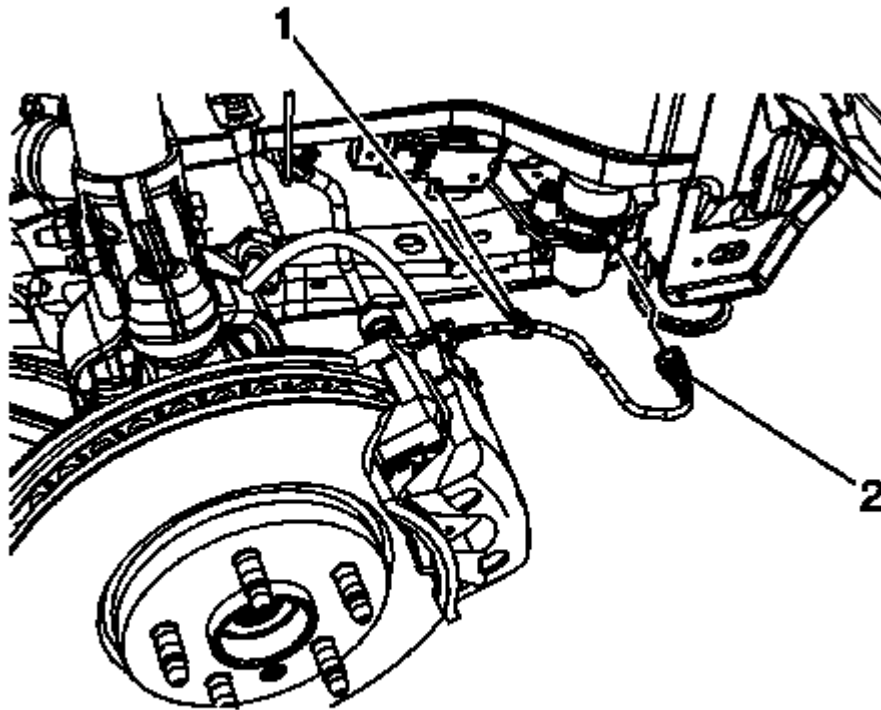


Fig. 94: Power Brake Booster Vacuum Rear Pipe Quick Connect And Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Reposition and connect the vacuum booster rear pipe (2). Refer to **Power Brake Booster Vacuum Rear Pipe Replacement (LUK)** .
6. Install the wheelhouse splash shield. Refer to **Front Compartment Splash Shield Replacement** .

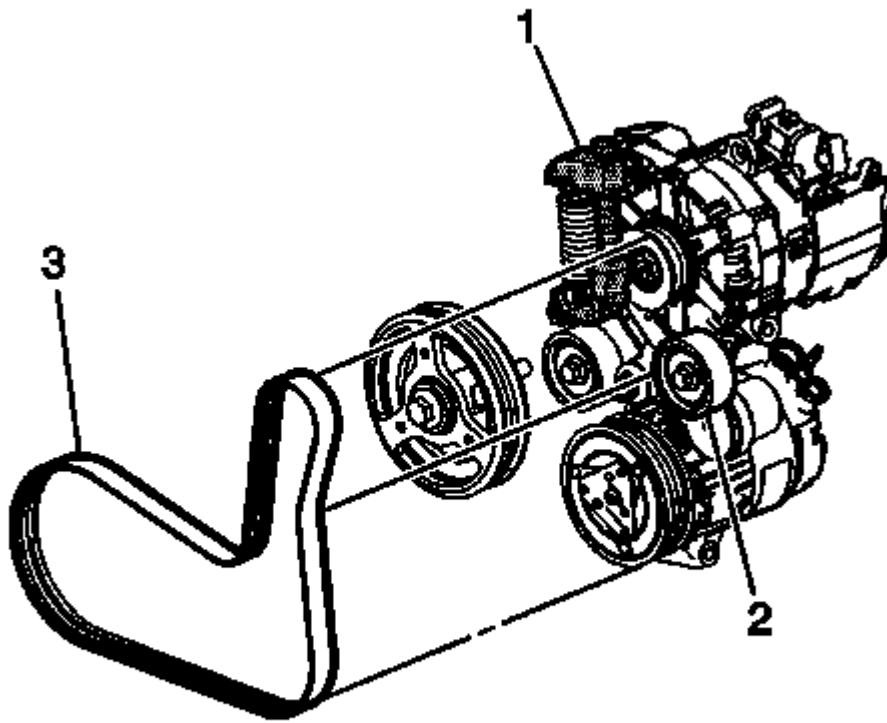


Fig. 95: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

7. Install the drive belt (1). Refer to **Drive Belt Replacement (LUK)**.

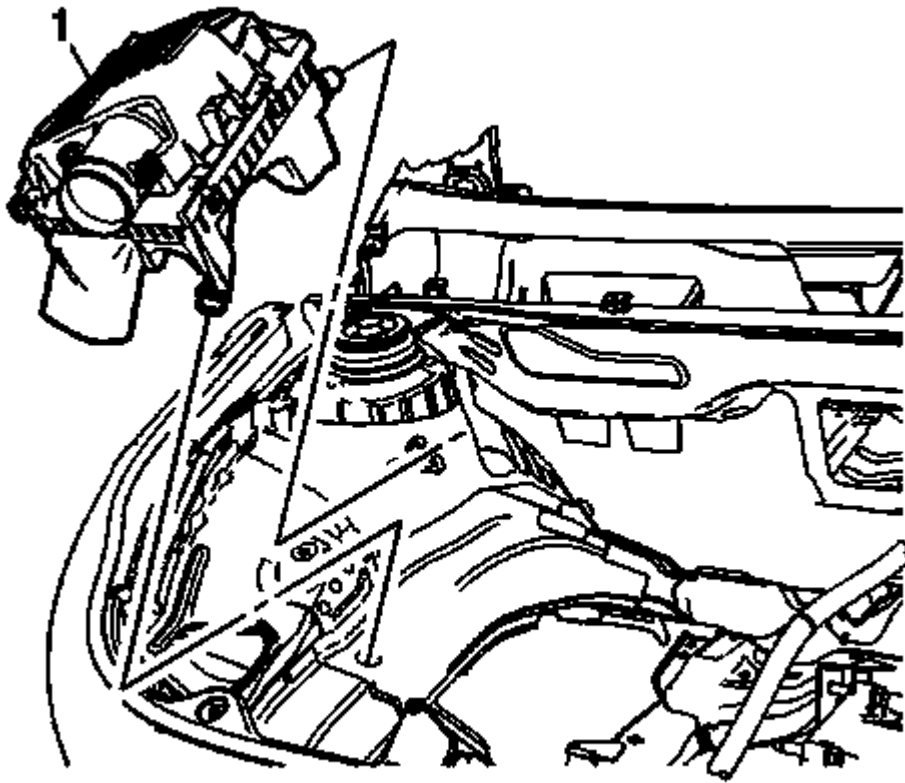


Fig. 96: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

Special Tools

- **EN-45027** Tensioner Tool
- **EN-45059** Angle Meter
- **EN-48953** Camshaft Actuator Locking Tool

For equivalent regional tools, refer to **Special Tools**

Removal Procedure

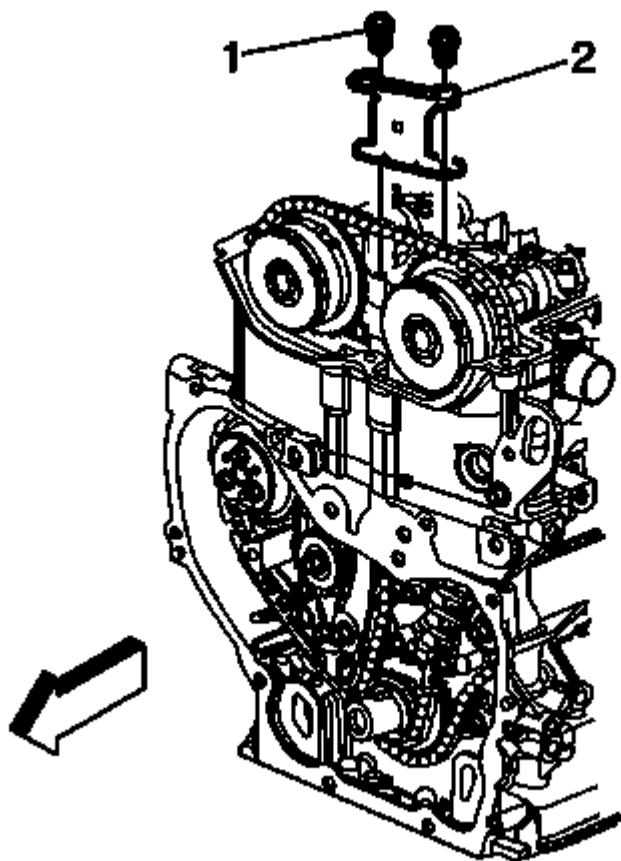


Fig. 97: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**, **Camshaft Cover Replacement (LEA)**.
2. Remove the number 1 cylinder spark plug. Refer to **Spark Plug Replacement**.
3. Rotate the crankshaft in the engine rotational direction clockwise, until the number 1 piston is at top dead center (TDC) on the exhaust stroke.
4. Remove the engine front cover. Refer to **Engine Front Cover Replacement (LEA)**, **Engine Front Cover Replacement (LUK)**.
5. Remove the upper timing chain guide bolts (1) and guide (2).

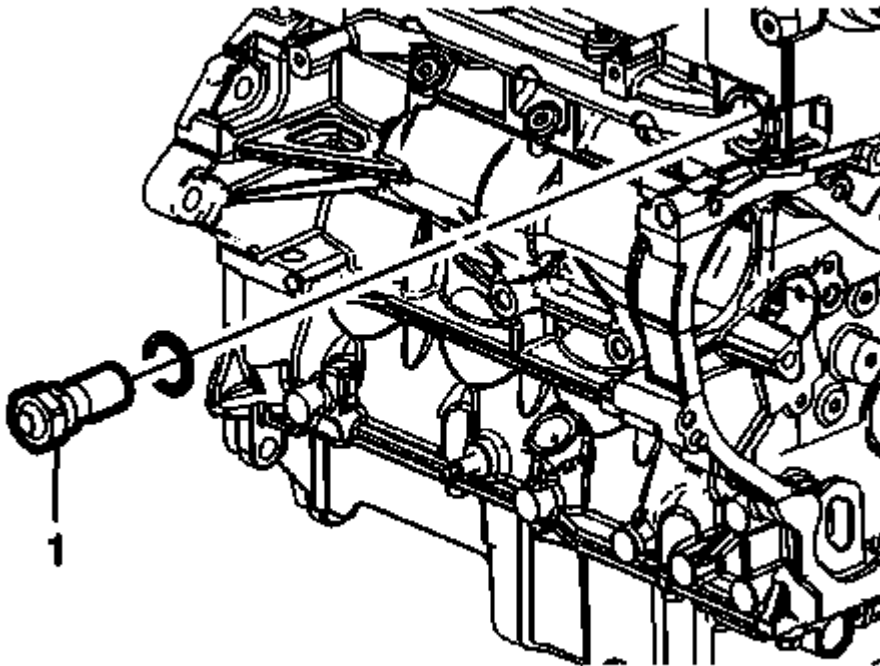


Fig. 98: Timing Chain Tensioner

Courtesy of GENERAL MOTORS COMPANY

NOTE: The timing chain tensioner must be removed to unload chain tension before the timing chain is removed. If it is not, the timing chain will become cocked and it will be difficult to remove.

6. Remove the timing chain tensioner (1).

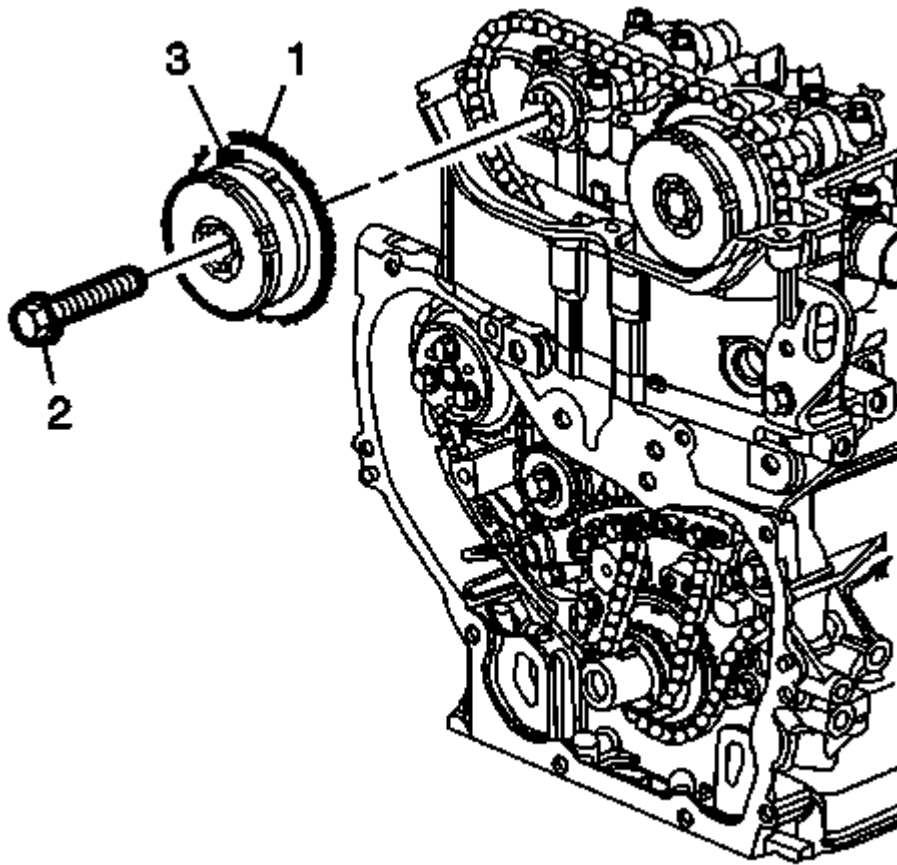


Fig. 99: Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

7. Install a 24 mm wrench on the hex on the exhaust camshaft in order to hold the camshaft.
8. Remove and discard the exhaust camshaft actuator bolt (2).
9. Remove the exhaust camshaft actuator (1, 3) from the camshaft and timing chain.

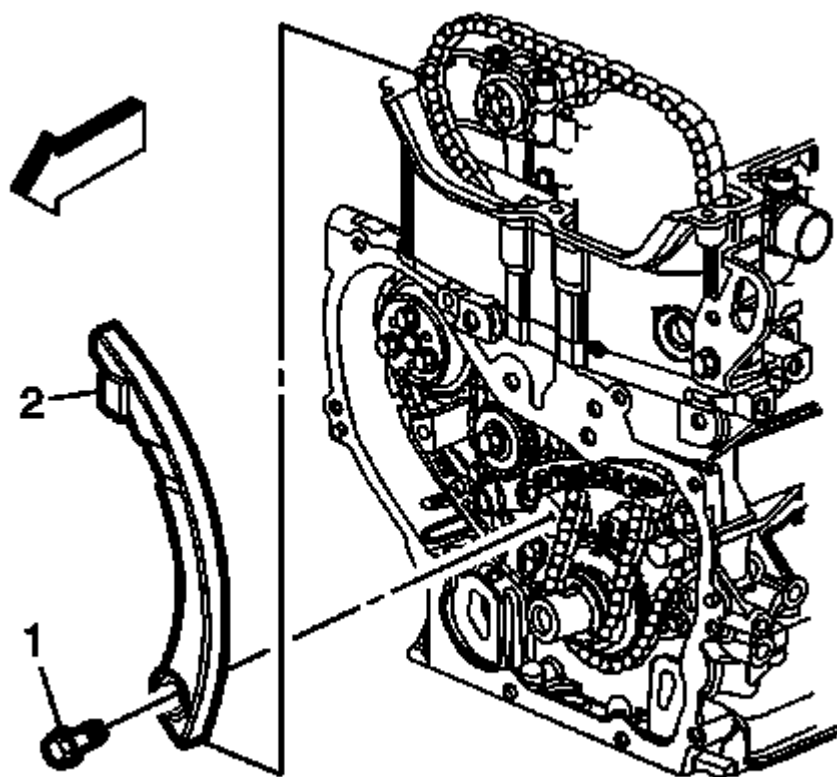


Fig. 100: Timing Chain Tensioner Guide Bolt And Guide
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain tensioner guide bolt (1) and guide (2).

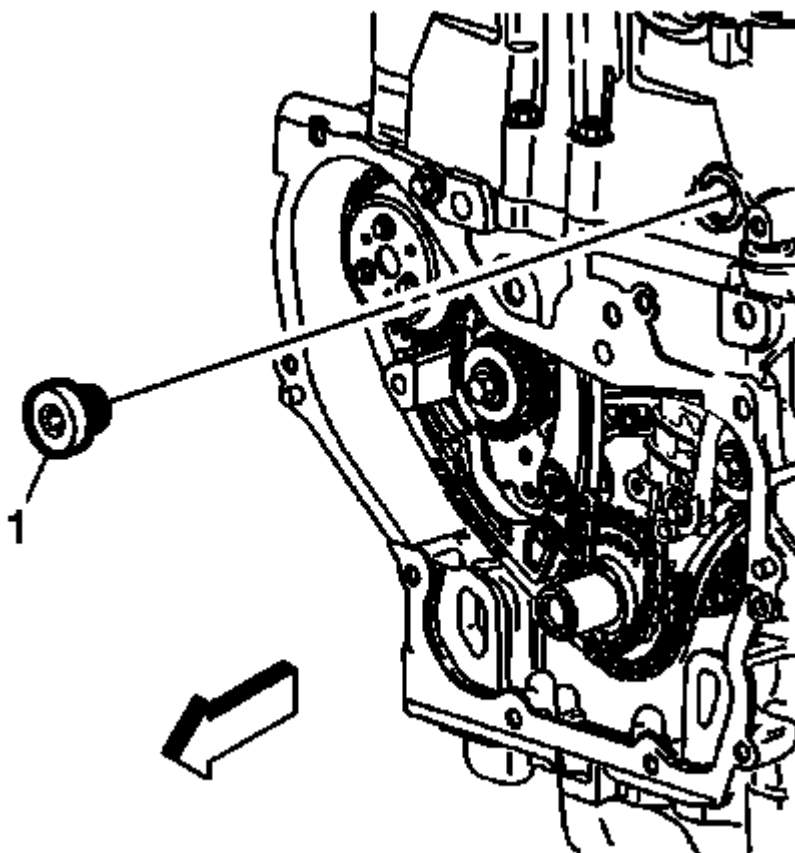


Fig. 101: Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

11. Remove the fixed timing chain guide access plug (1).

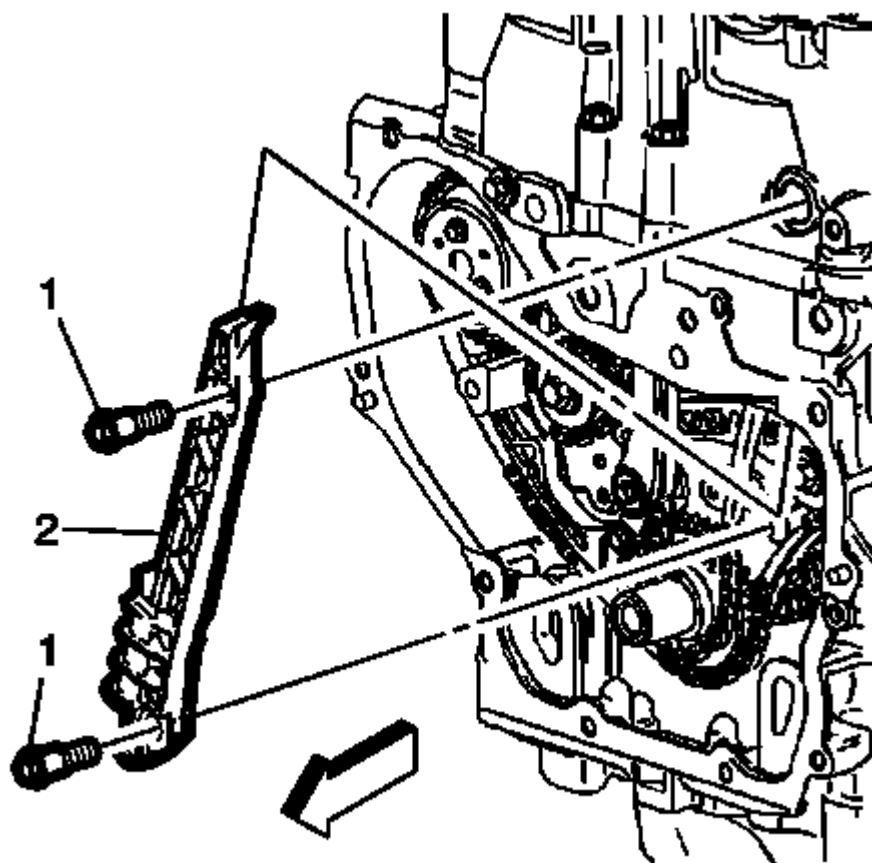


Fig. 102: Fixed Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

12. Remove the fixed timing chain guide bolts (1) and guide (2).

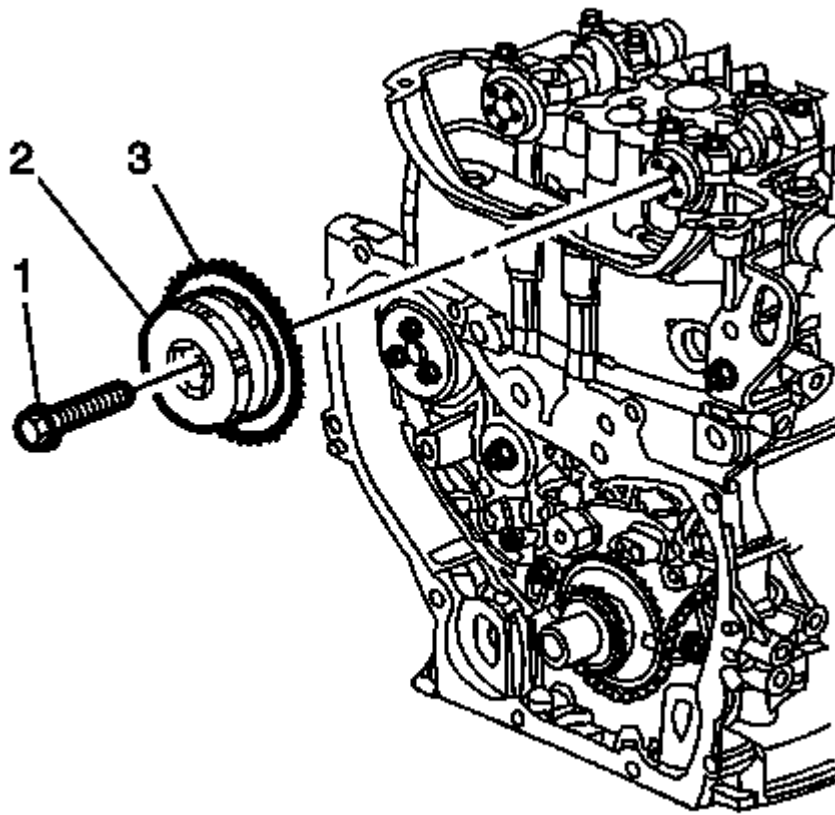


Fig. 103: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

13. Install a 24 mm wrench on the hex on the intake camshaft in order to hold the camshaft.
14. Remove and discard the intake camshaft actuator bolt (1).
15. Remove the intake camshaft actuator (3), and the timing chain through the top of the cylinder head.

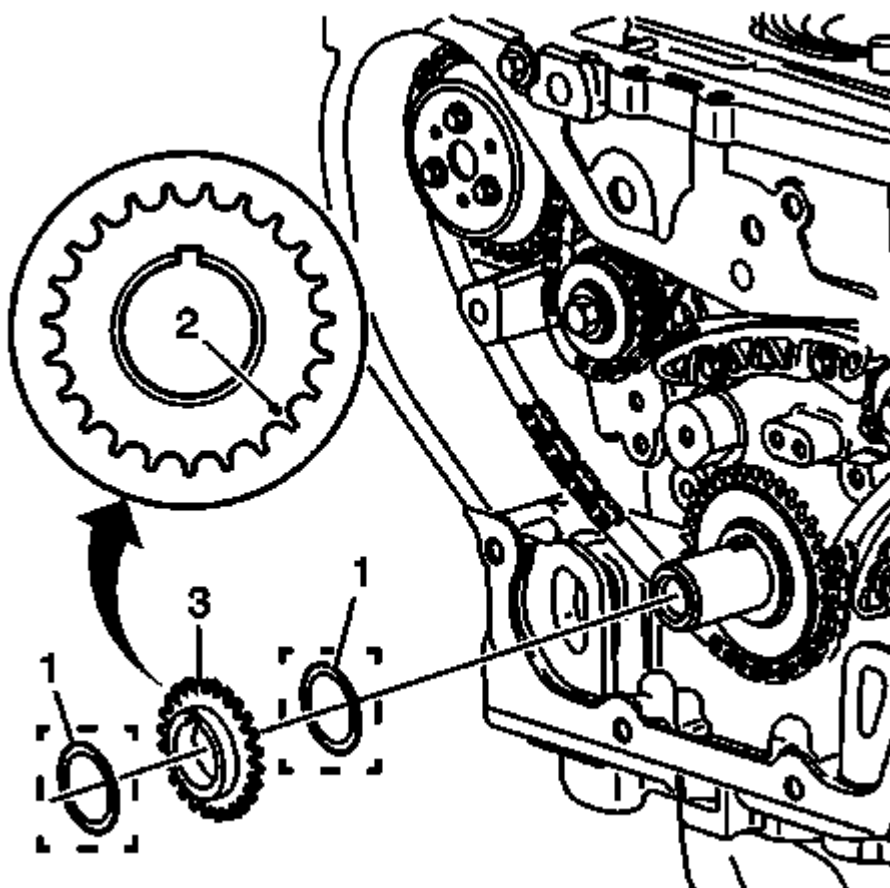


Fig. 104: View of Friction Washer and Timing Chain Drive Sprocket
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ecotec 4 cylinder engines with SIDI-Direct Injection, the lower timing chain crank gear may be equipped with a second spacing washer installed in front of the lower timing chain crank gear. The outer spacer/washer is in between the crank/balancer pulley and the lower timing gear and may remain in place when the pulley is removed. The spacer/washer has a dot/mark on its surface that may be mistaken for the lower timing mark. If applicable, the washer must be removed in order to view the correct timing mark on the lower crank gear.

16. Remove the outer friction washer (1) if equipped.
17. Ensure the crankshaft gear timing mark (2) is in the 5 o'clock position and crankshaft key is in the 12 o'clock position.
18. Remove the crankshaft sprocket (3).
19. Remove the inner friction washer (1).

Installation Procedure

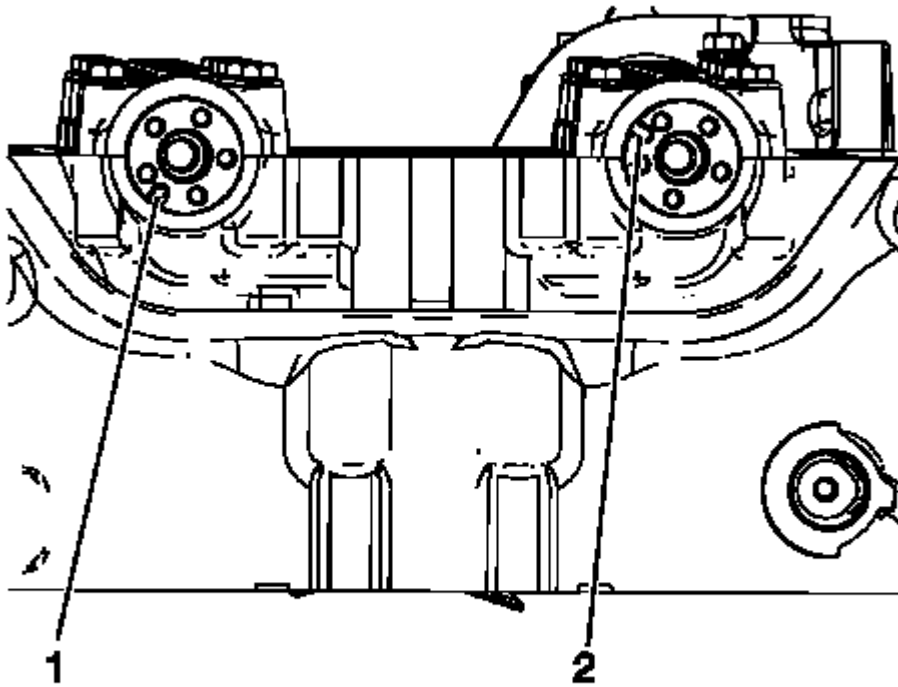


Fig. 105: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

1. When installing the camshafts, ensure the intake camshaft notch is in the 10 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

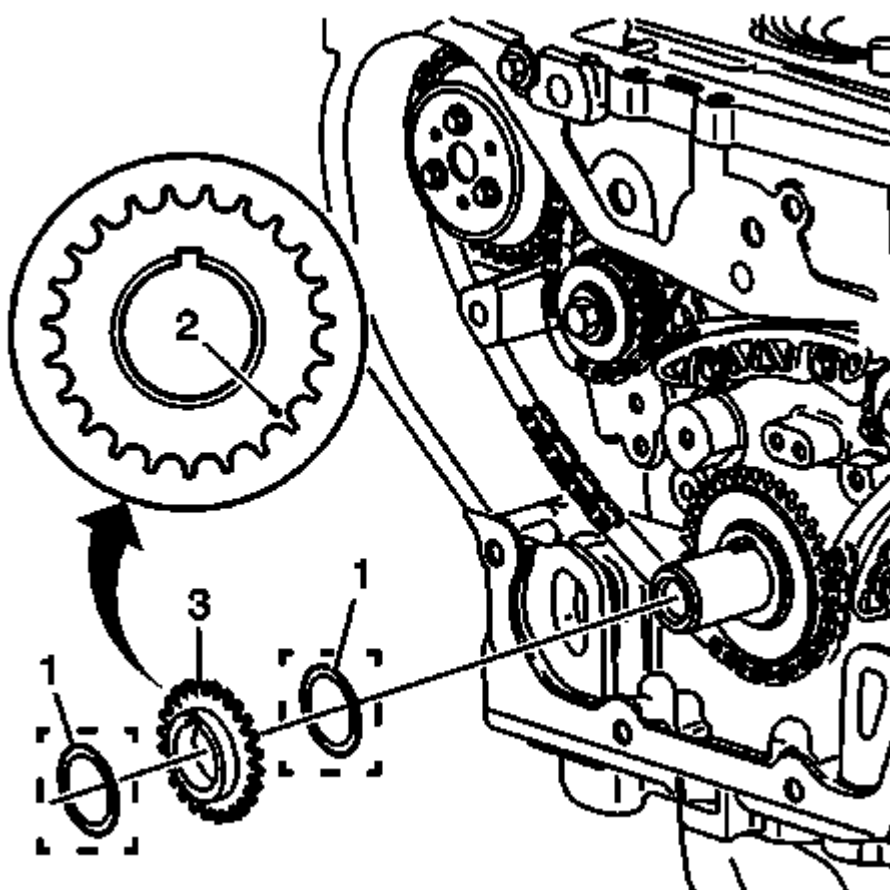


Fig. 106: View of Friction Washer and Timing Chain Drive Sprocket
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ecotec 4 cylinder engines with SIDI-Direct Injection, the lower timing chain crank gear may be equipped with a second spacing washer installed in front of the lower timing chain crank gear. The outer spacer/washer is in between the crank/balancer pulley and the lower timing gear and may remain in place when the pulley is removed. The spacer/washer has a dot/mark on its surface that may be mistaken for the lower timing mark. If applicable, the washer must be removed in order to view the correct timing mark on the lower crank gear.

2. Install the inner friction washer (1).
3. Install the crankshaft sprocket with the timing mark (2) is in the 5 o'clock position and facing outward.
4. Install the outer friction washer (1) if equipped.

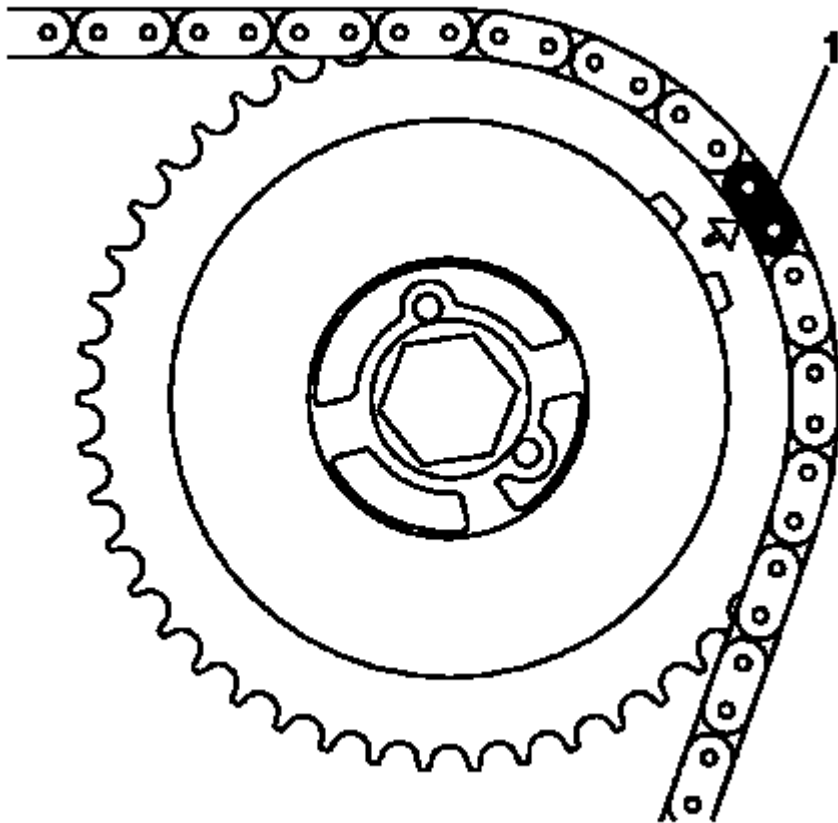


Fig. 107: Identifying Colored Links On Timing Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- There are 3 colored links on the timing chain. Two links are of matching color, and 1 link is of a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.
 - Always use new actuator bolts.
5. Assemble the intake camshaft actuator into the timing chain with the timing mark lined up with the uniquely colored link (1).

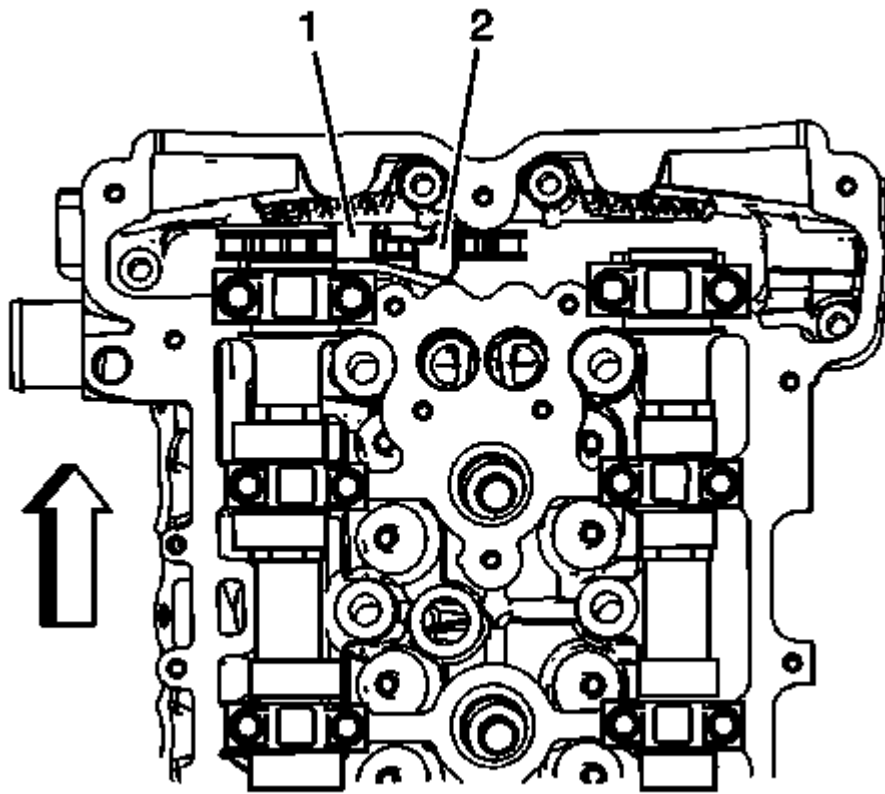


Fig. 108: Identifying Cylinder Head Opening
Courtesy of GENERAL MOTORS COMPANY

6. Lower the timing chain through the opening in the cylinder head. Use care to ensure that the chain goes around both sides of the cylinder block bosses (1, 2).
7. Install the intake camshaft actuator onto the intake camshaft while aligning the dowel pin into the camshaft slot.
8. Hand tighten the new intake camshaft actuator bolt.

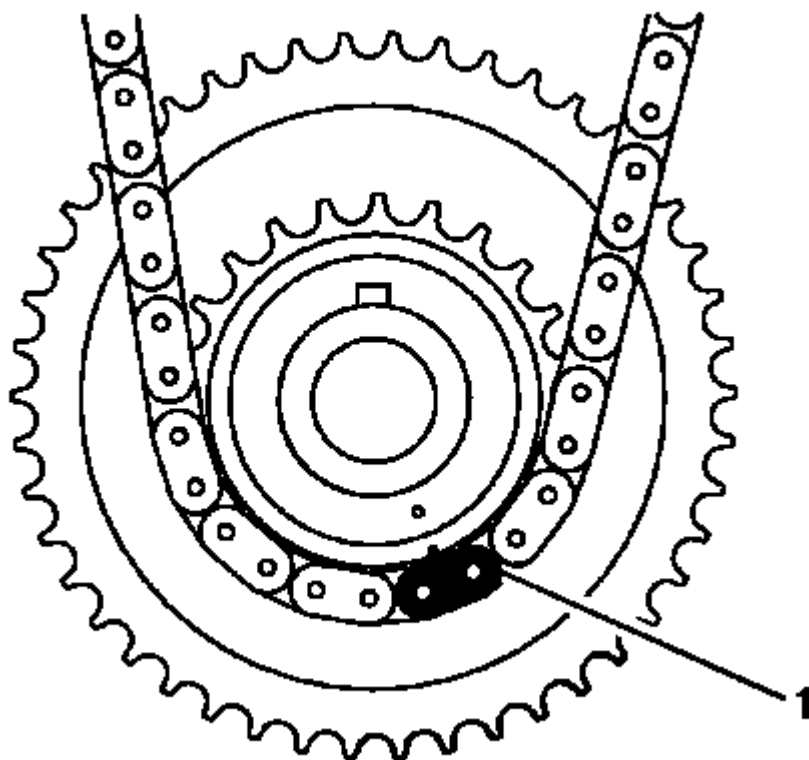


Fig. 109: Lining Up First Pink Link With Timing Mark On Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

9. Route the timing chain around the crankshaft sprocket and line up the first matching colored (1) link with the timing mark on the crankshaft sprocket, in approximately the 5 o'clock position.
10. Install the friction washer, if applicable.

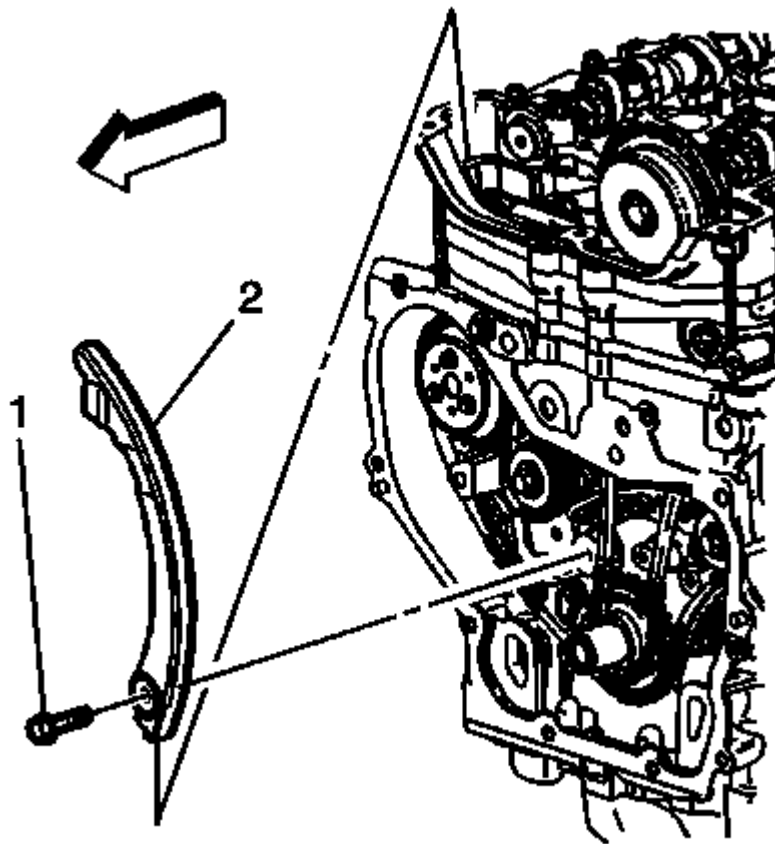


Fig. 110: Adjustable Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

11. Rotate the crankshaft clockwise to remove all chain slack. Do not rotate the intake camshaft.

CAUTION: Refer to Fastener Caution .

12. Install the adjustable timing chain guide (2) down through the opening in the cylinder head and install the adjustable timing chain bolt. Tighten the adjustable timing chain guide bolt (1) to 10 N.m (89 lb in).

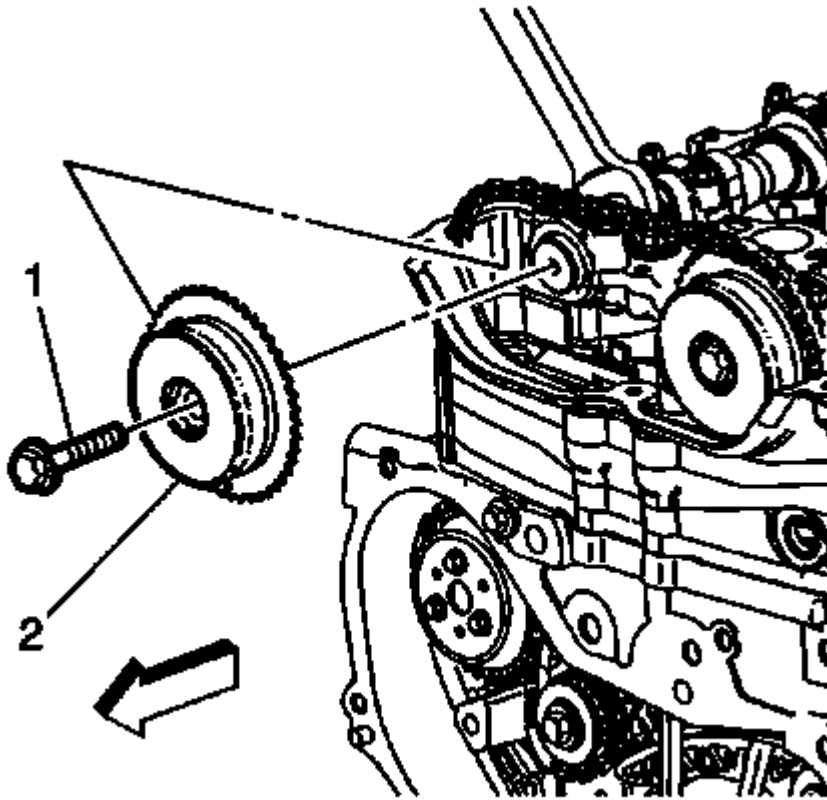


Fig. 111: Camshaft Actuator

Courtesy of GENERAL MOTORS COMPANY

NOTE: Always install NEW actuator bolts.

13. Install the exhaust camshaft actuator (2) into the timing chain with the timing mark lined up with the second matching colored link.

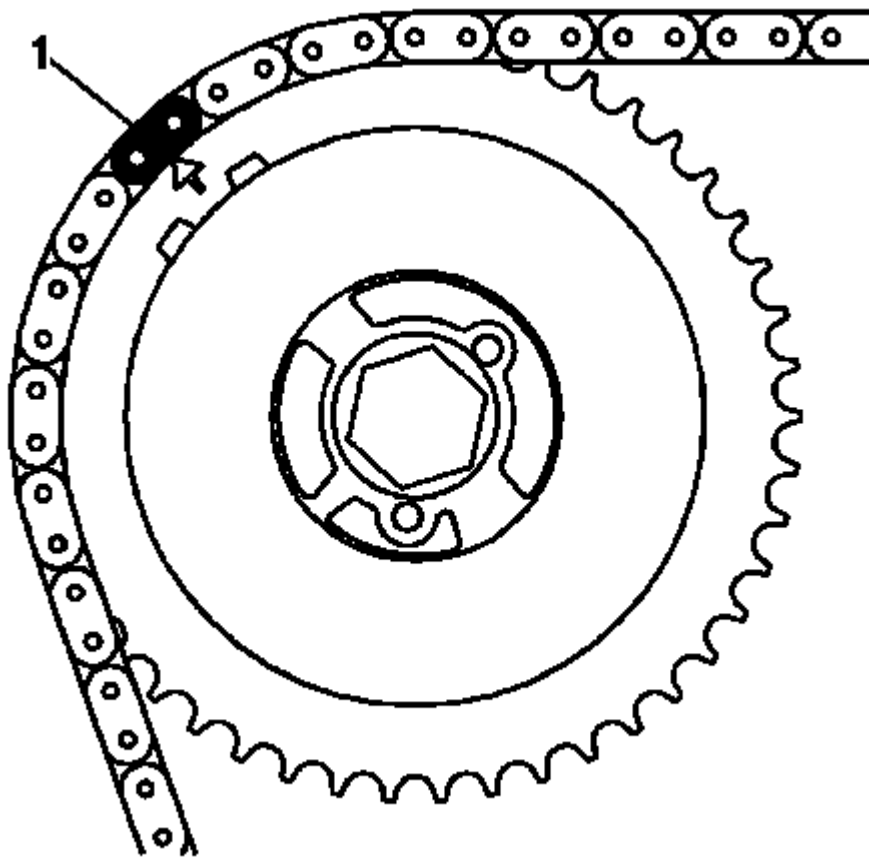


Fig. 112: Camshaft Slot

Courtesy of GENERAL MOTORS COMPANY

14. Install the exhaust camshaft actuator onto the exhaust camshaft, aligning the dowel pin into the camshaft slot (1).
15. Use 24 mm open ended wrench, rotate the exhaust camshaft approximately 45 degrees until the dowel pin in the camshaft actuator goes into the camshaft slot.
16. When the actuator seats on the cam, tighten the new exhaust camshaft actuator bolt hand tight.

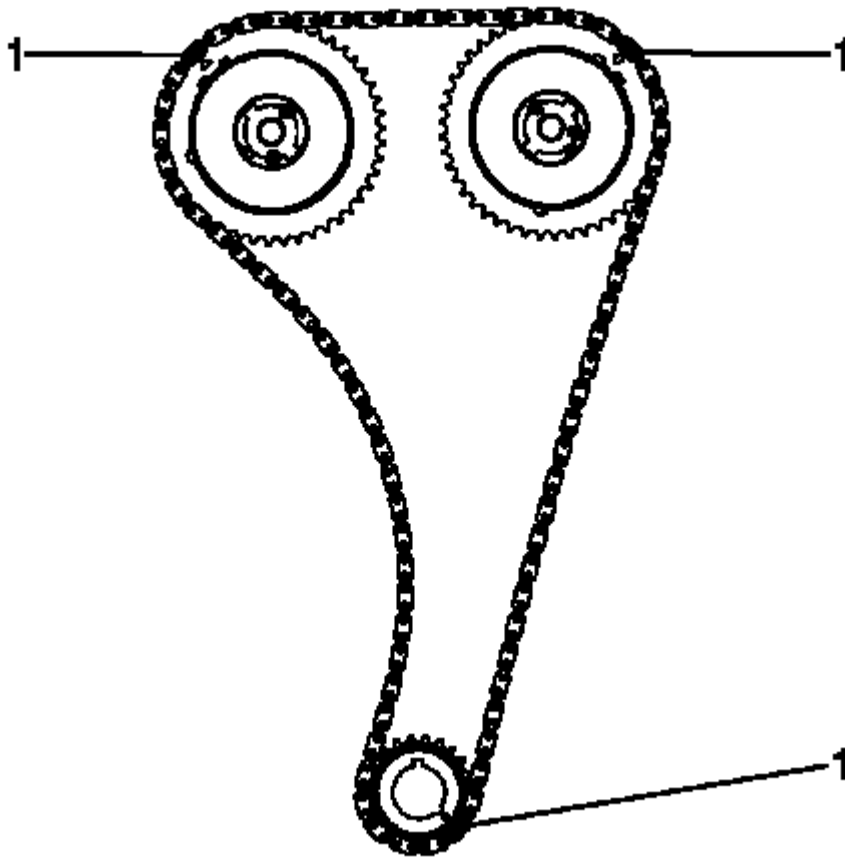


Fig. 113: Colored Links

Courtesy of GENERAL MOTORS COMPANY

17. Verify that all of the colored links (1) and the appropriate timing marks are still aligned. If they are not aligned, repeat the portion of the procedure necessary to align the timing marks.

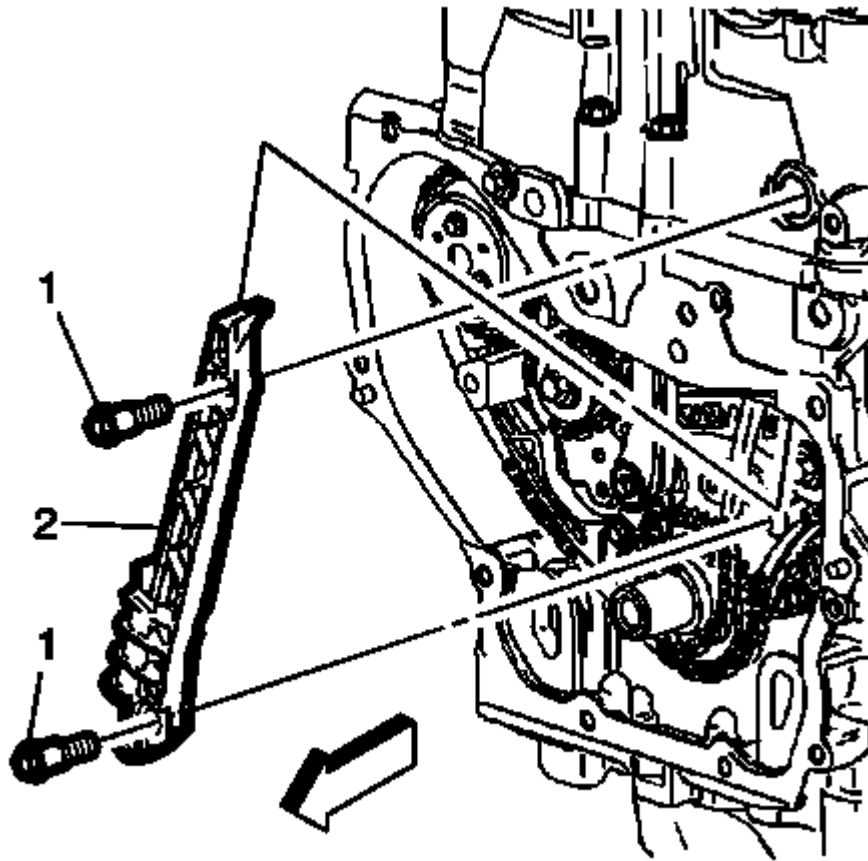


Fig. 114: Fixed Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

18. Install the fixed timing chain guide (2) and bolts (1). Tighten the fixed timing chain guide bolts to 12 N.m (106 lb in).

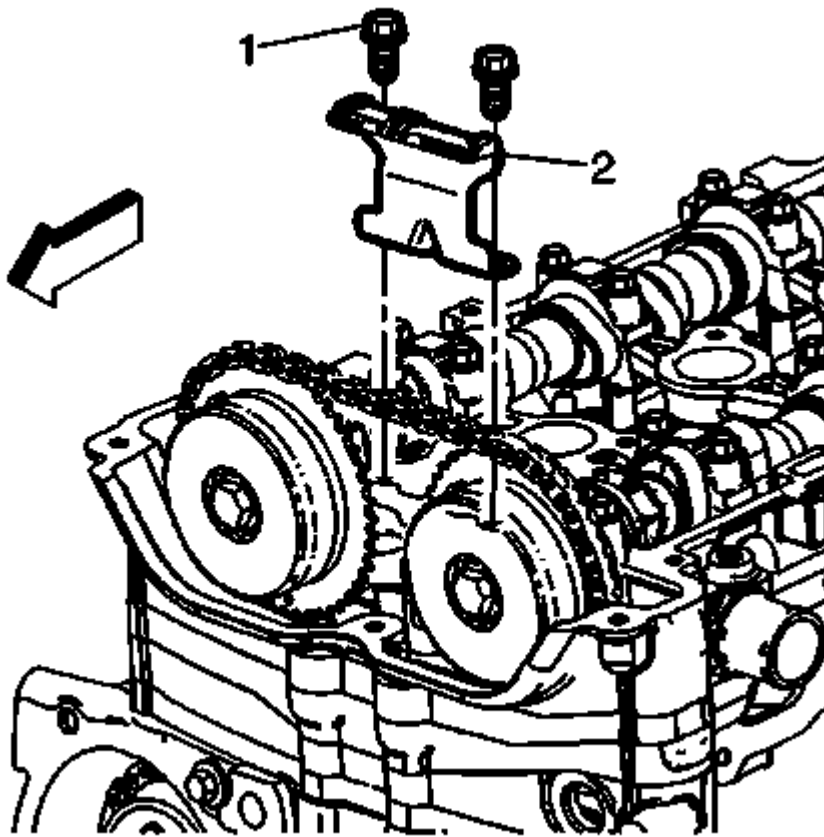


Fig. 115: Upper Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

19. Install the upper timing chain guide (2) and bolts (1). Tighten the upper timing chain guide bolts to 10 N.m (89 lb in).

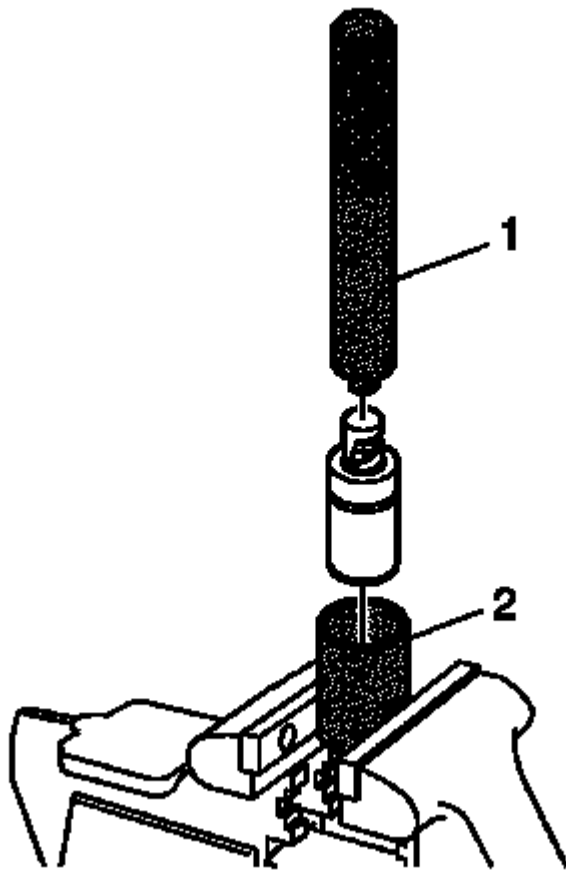


Fig. 116: Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

20. Reset the timing chain tensioner by performing the following steps:
 1. Remove the snap ring.
 2. Remove the piston assembly from the body of the timing chain tensioner.
 3. Install the **EN-45027-2** tool (2) into a vise.
 4. Install the notch end of the piston assembly into the **EN-45027-2** tool (2).
 5. Using the **EN-45027-1** tool (1), turn the ratchet cylinder into the piston.
 6. Reinstall the piston assembly into the body of the tensioner.
 7. Install the snap ring.

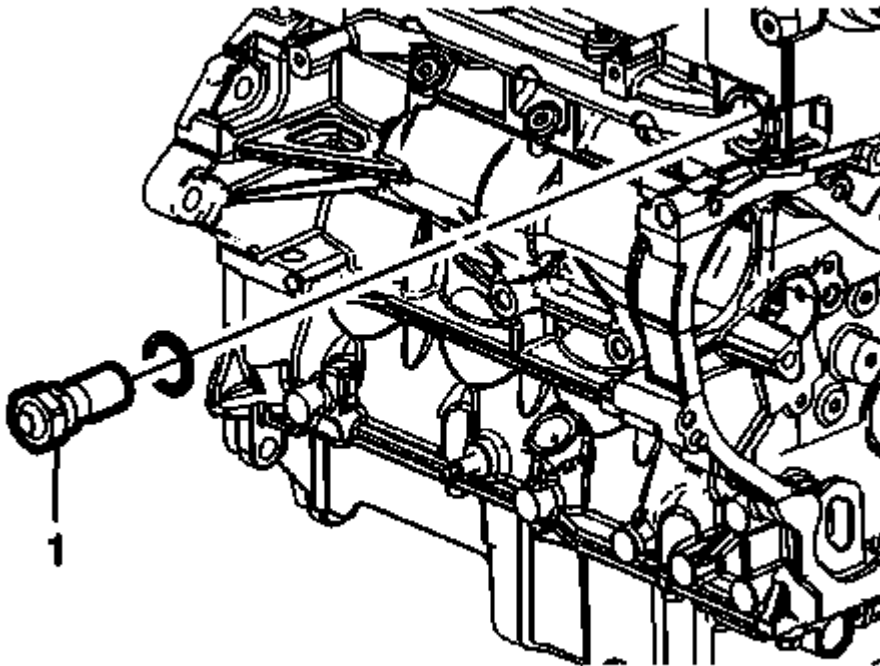


Fig. 117: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

21. Inspect the timing chain tensioner seal for damage. If damaged, replace the seal.
22. Inspect to ensure all dirt and debris is removed from the timing chain tensioner threaded hole in the cylinder head.

NOTE: **Ensure the timing chain tensioner seal is centered throughout the torque procedure to eliminate the possibility of an oil leak.**

23. Install the timing chain tensioner assembly. Tighten the timing chain tensioner (1) to 75 N.m (55 lb ft).
24. The timing chain tensioner is released by compressing it 2 mm (0.079 in), which will release the locking mechanism in the ratchet. To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.

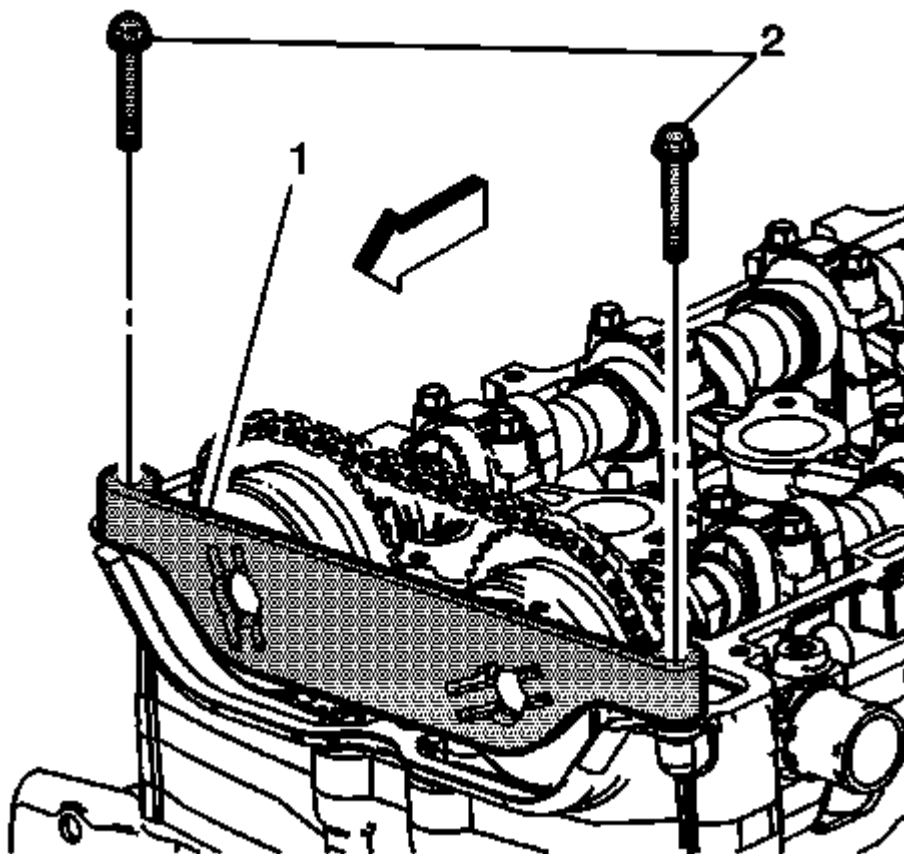


Fig. 118: View Locking Tool

Courtesy of GENERAL MOTORS COMPANY

25. Install **EN-48953** locking tool (1) and tighten the bolts into the cylinder head to 10 N.m (89 lb in).
26. Using a torque wrench, tighten the camshaft actuator bolt (2) to 30 N.m (22 lb ft) plus 100 degrees using the **EN-45059** meter.
27. Remove the **EN-48953** locking tool.

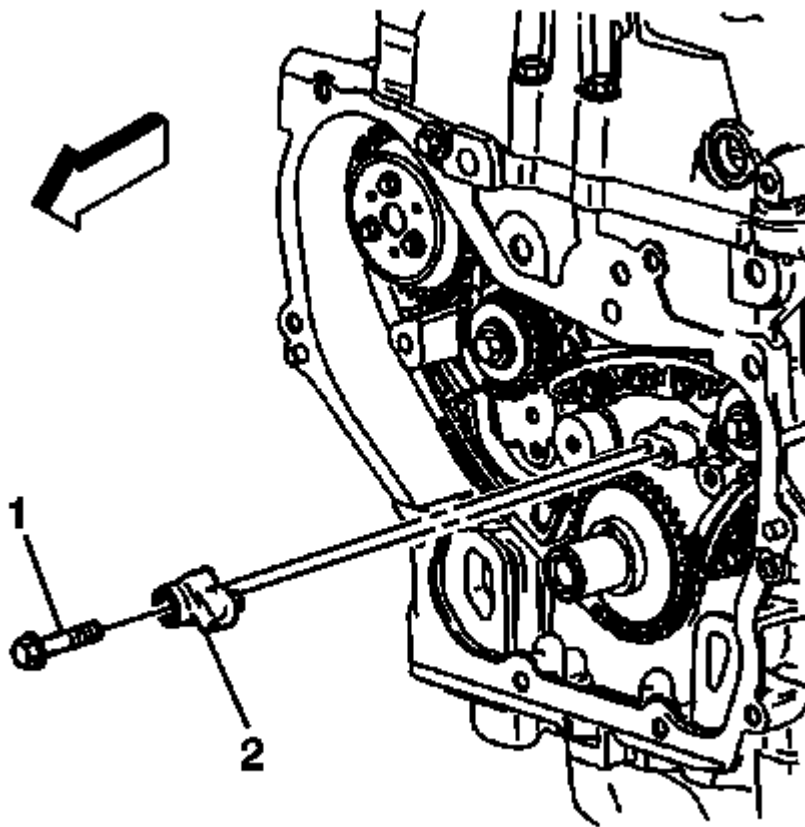


Fig. 119: View Of Oil Nozzle & Bolt
Courtesy of GENERAL MOTORS COMPANY

28. Install the timing chain oiling nozzle (2). Tighten the timing chain oiling nozzle bolt (1) to 10 N.m (89 lb in).

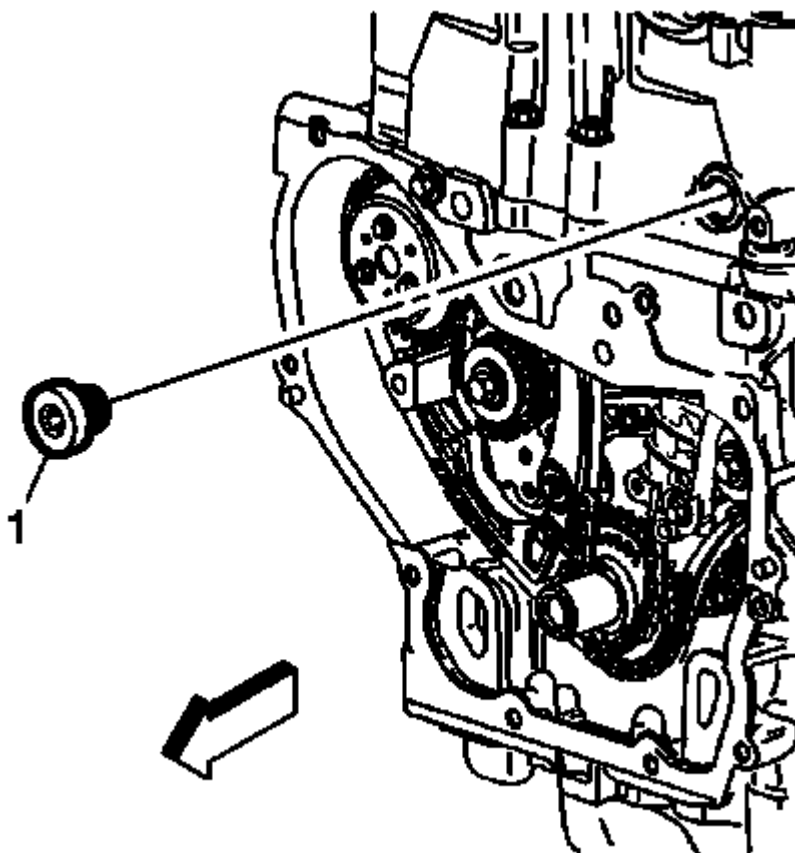


Fig. 120: Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

29. Apply sealant compound to the thread of the timing chain guide bolt access hole plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
30. Install the timing chain guide bolt access hole plug (1) . Tighten the access hole plug to 90 N.m (66 lb ft).
31. Install the engine front cover. Refer to **Engine Front Cover Replacement (LEA)**, **Engine Front Cover Replacement (LUK)**.
32. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**, **Camshaft Cover Replacement (LEA)**.
33. Install the number 1 cylinder spark plug. Refer to **Spark Plug Replacement** .

WATER PUMP AND BALANCE SHAFT CHAIN REPLACEMENT

Removal Procedure

1. Remove the camshaft timing chain, sprocket, and tensioner. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.

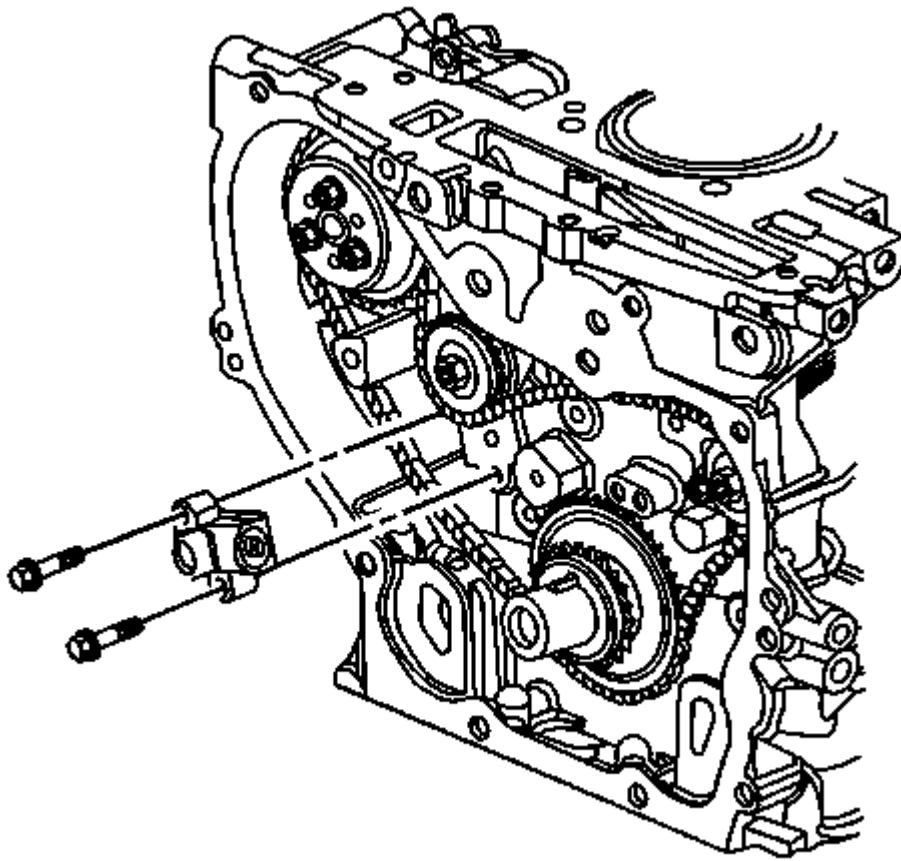


Fig. 121: Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

2. Remove the adjustable balance shaft chain guide bolt and guide

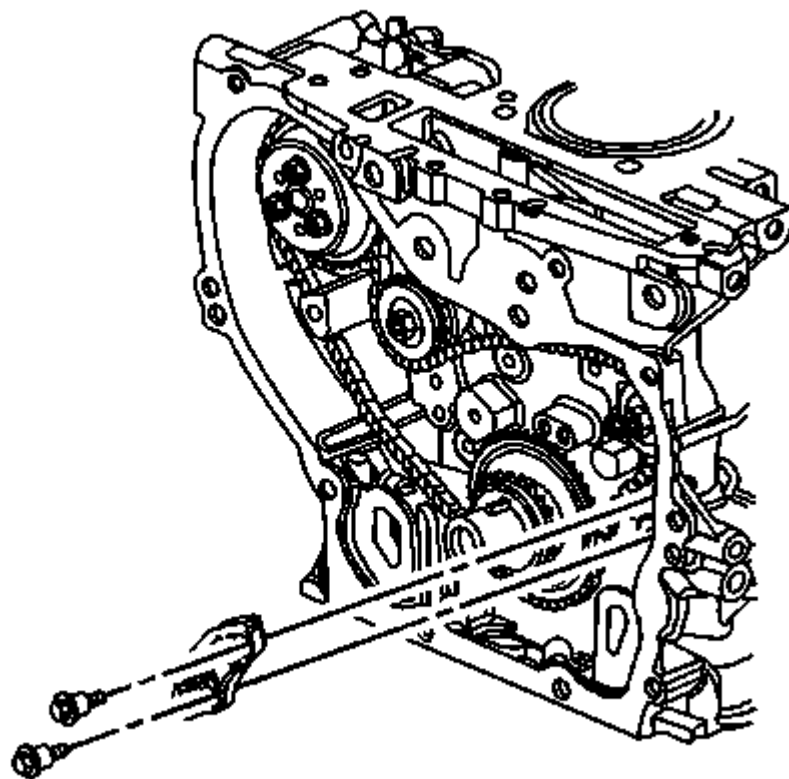


Fig. 122: Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

3. Remove the small balance shaft drive chain guide bolts and guide.

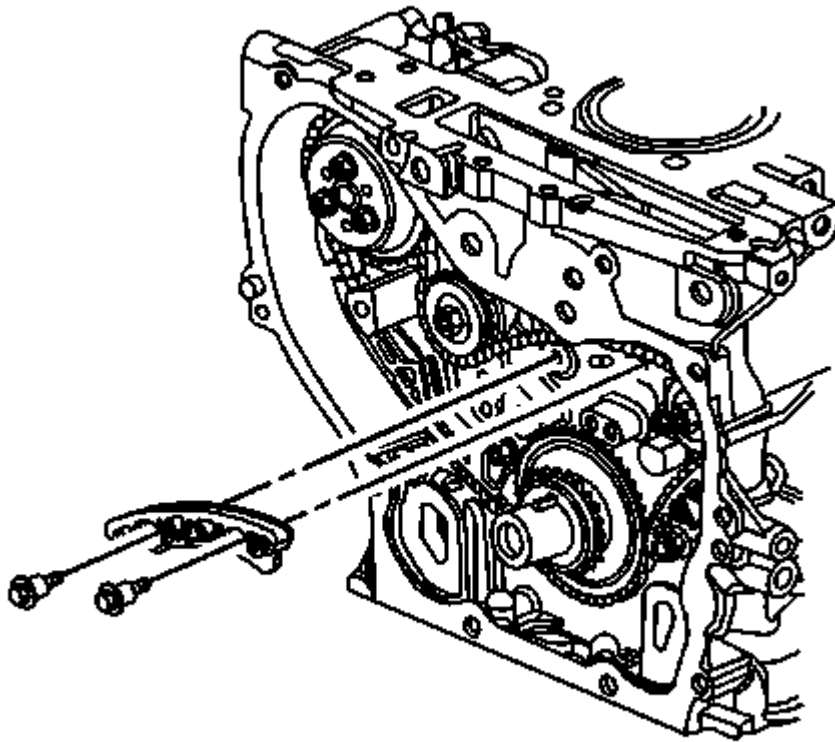


Fig. 123: Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

4. Remove the upper balance shaft drive chain guide bolts and guide.

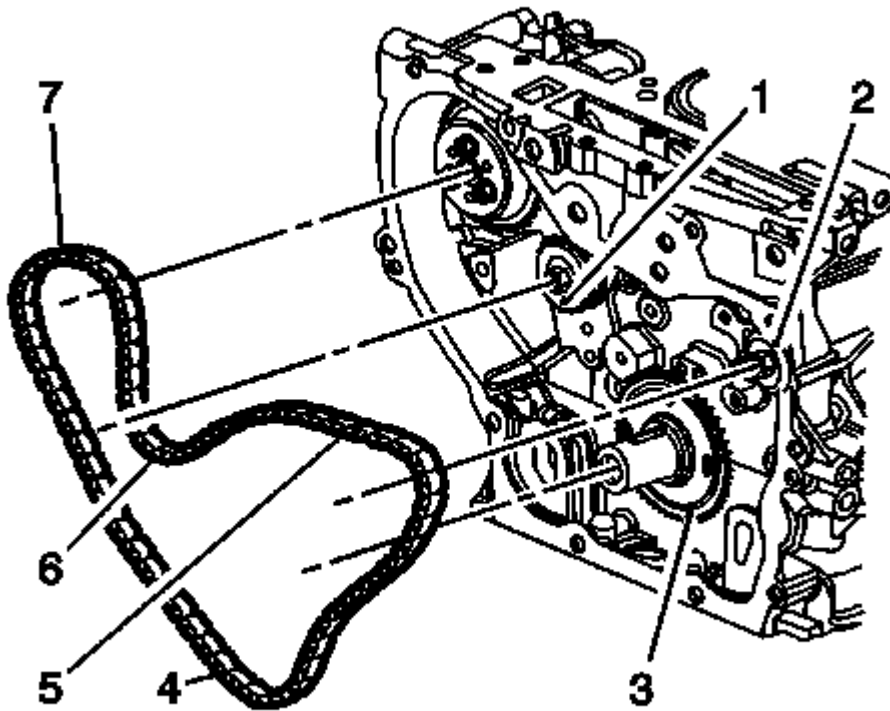


Fig. 124: Balance Shaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: It may ease removal of the balance shaft drive chain to get all the slack in the chain between the crankshaft and water pump sprockets.

5. Remove the balance shaft drive chain (7).
6. Remove the balance shaft drive sprocket.

Installation Procedure

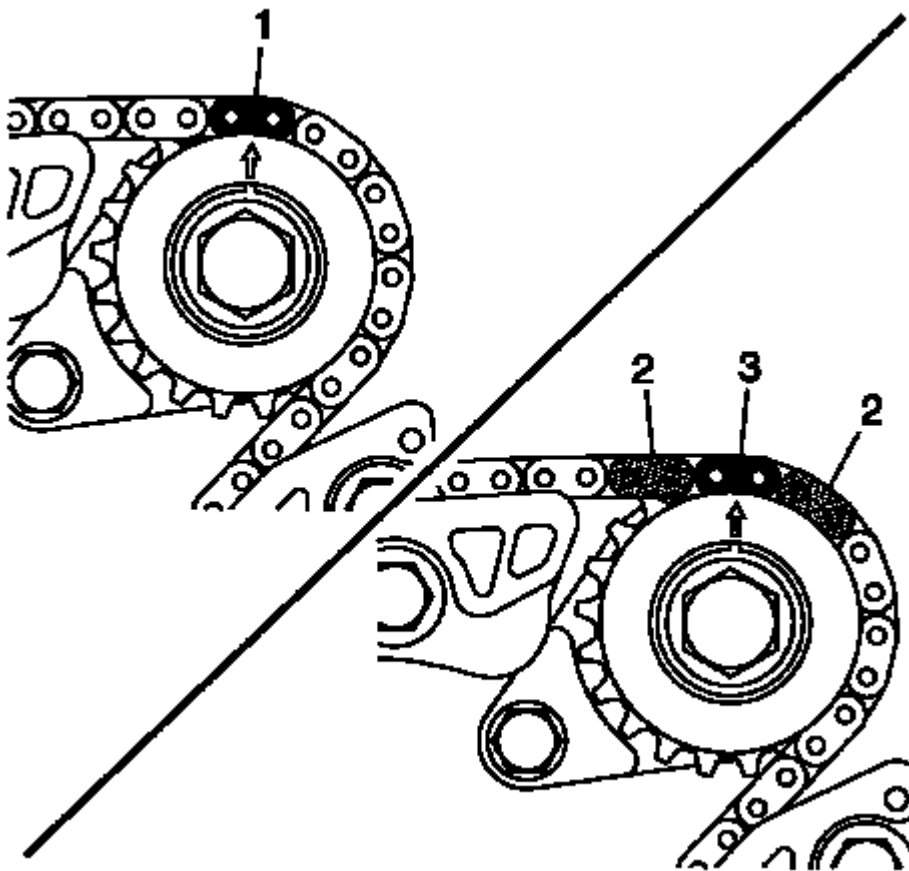


Fig. 125: View Of Intake Side Balance Shaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are two possible chain configurations for the engine. Both configurations use a unique chain link to line up with the intake side balance shaft sprocket timing mark. The first design uses a unique link color (1). The second design uses a black anodized link (3) with uniquely colored links on either side (2).

1. Determine the configuration of the balance chain.

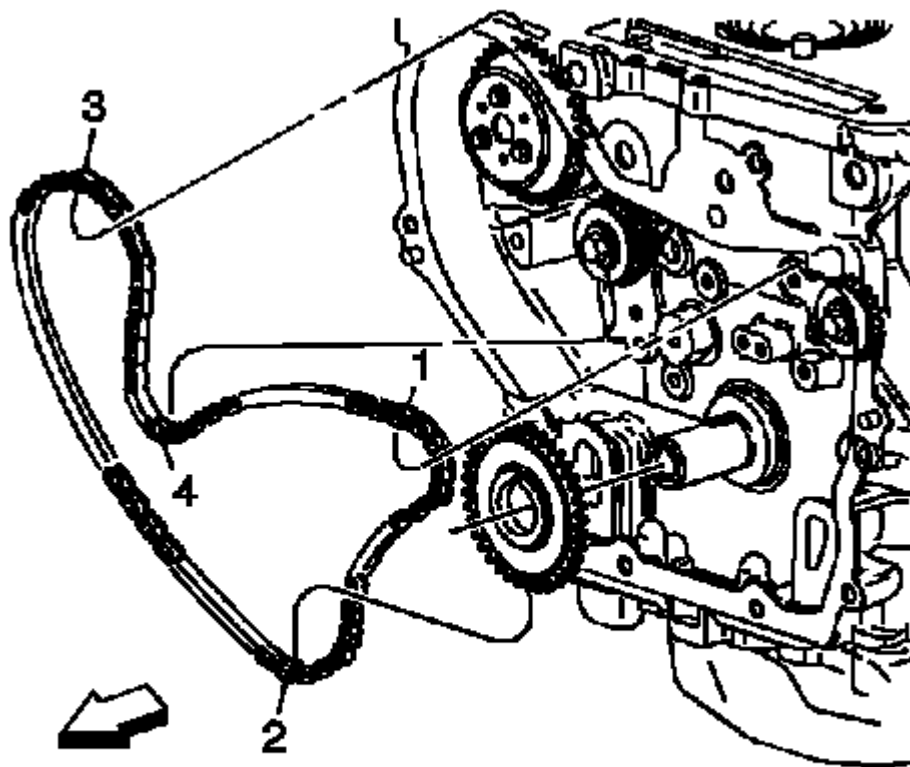


Fig. 126: Aligning Balance Shaft Drive Chain
 Courtesy of GENERAL MOTORS COMPANY

NOTE: If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.

2. Install the balance shaft drive sprocket.
3. For the 1st design balance chain, install the balance shaft drive chain with the colored links lined up with the marks on the balance shaft drive sprockets and the crankshaft sprocket. There are three colored links on the chain. Two links are of matching colors, and one link is of a unique color. Use the following procedure to line up the links with the sprockets:
 1. Orient the chain so that the colored links are visible.
 2. Place the uniquely colored link (1) so that it lines up with the timing mark on the intake side balance shaft sprocket.
 3. Working clockwise around the chain, place the first matching colored link (2) in line with the timing mark on the crankshaft drive sprocket, approximately 6 o'clock position on the crank sprocket.
 4. Place the chain (3) on the water pump drive sprocket. The alignment is not critical.
 5. Align the last matching colored link (4) with the timing mark on the exhaust side balance shaft drive sprocket.

4. For the 2nd design balance chain, install the balance shaft drive chain with the black anodized links lined up with the marks on the balance shaft drive sprockets and the crankshaft sprocket. There are three timing links with a black anodized finish on the chain. One black anodized link has uniquely colored links on either side. Use the following procedure to line up the links with the sprockets:
 1. Orient the chain so that the colored links are visible.
 2. Place the black anodized link (1), with uniquely colored links on either side, so that it lines up with the timing mark on the intake side balance shaft sprocket.
 3. Working clockwise around the chain, place the next black anodized link (2) in line with the timing mark on the crankshaft drive sprocket, approximately 6 o'clock position on the crank sprocket.
 4. Place the chain (3) on the water pump drive sprocket. The alignment is not critical.
 5. Align the last black anodized link (4) with the timing mark on the exhaust side balance shaft drive sprocket.

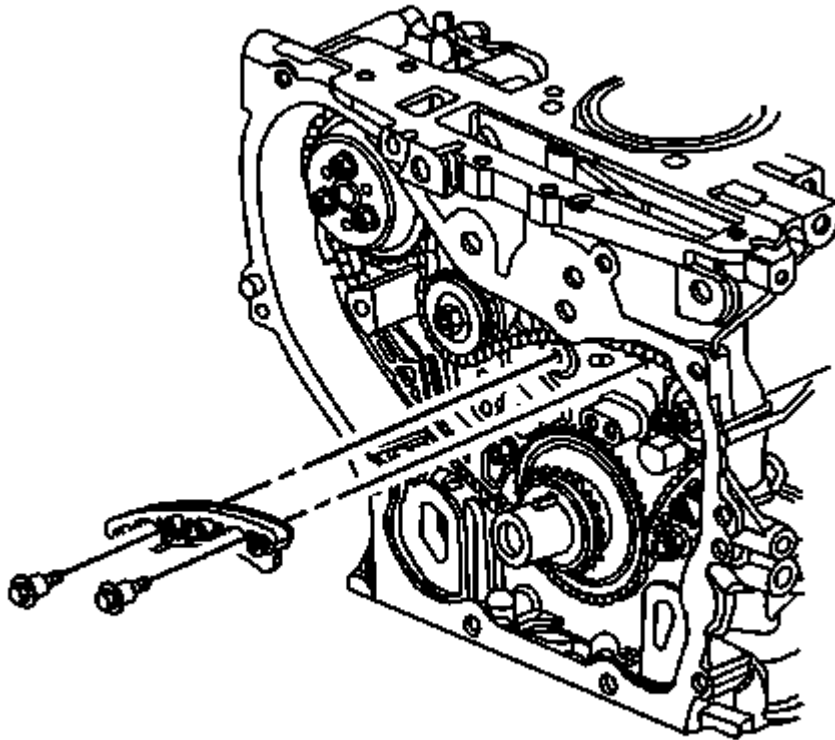


Fig. 127: Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the upper balance shaft drive chain guide and bolts and tighten to 12 (106 lb in).

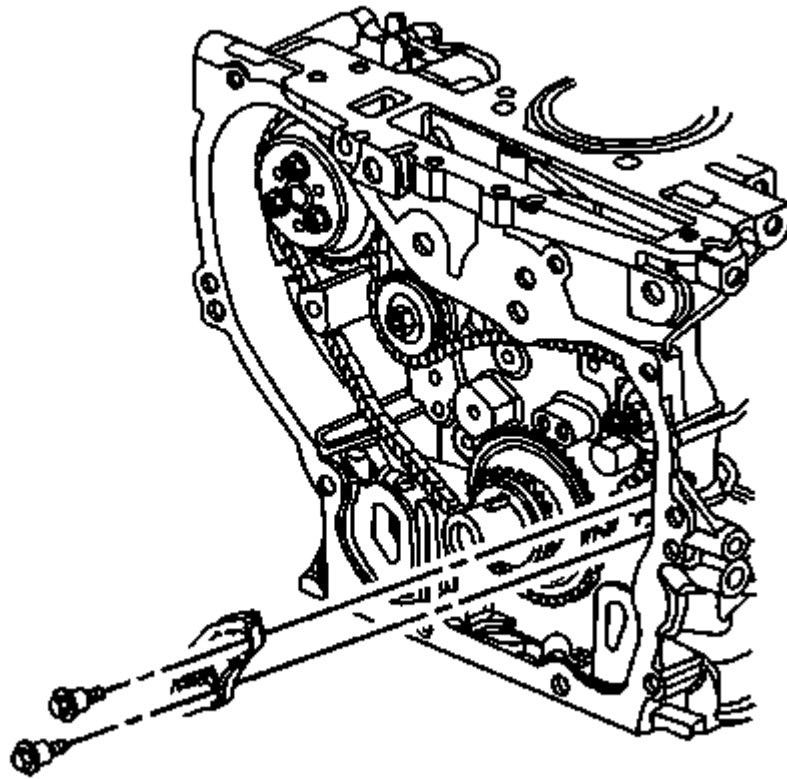


Fig. 128: Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

6. Install the small balance shaft drive chain guide and bolts and tighten to 12 (106 lb in).

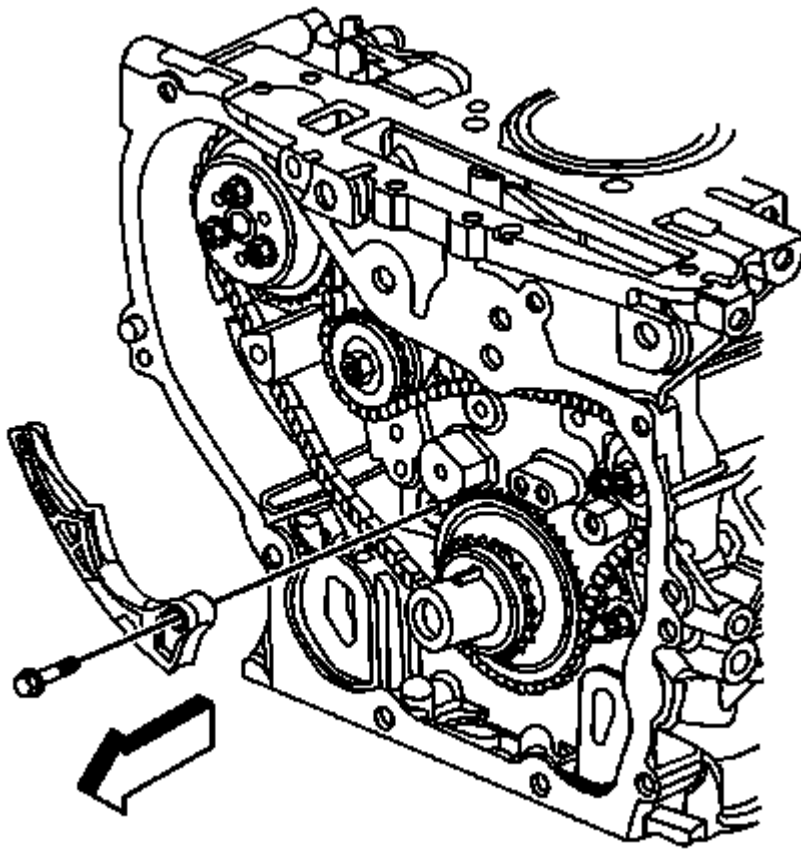


Fig. 129: Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS COMPANY

7. Install the adjustable balance shaft chain guide and bolt and tighten to 10 (89 lb in).

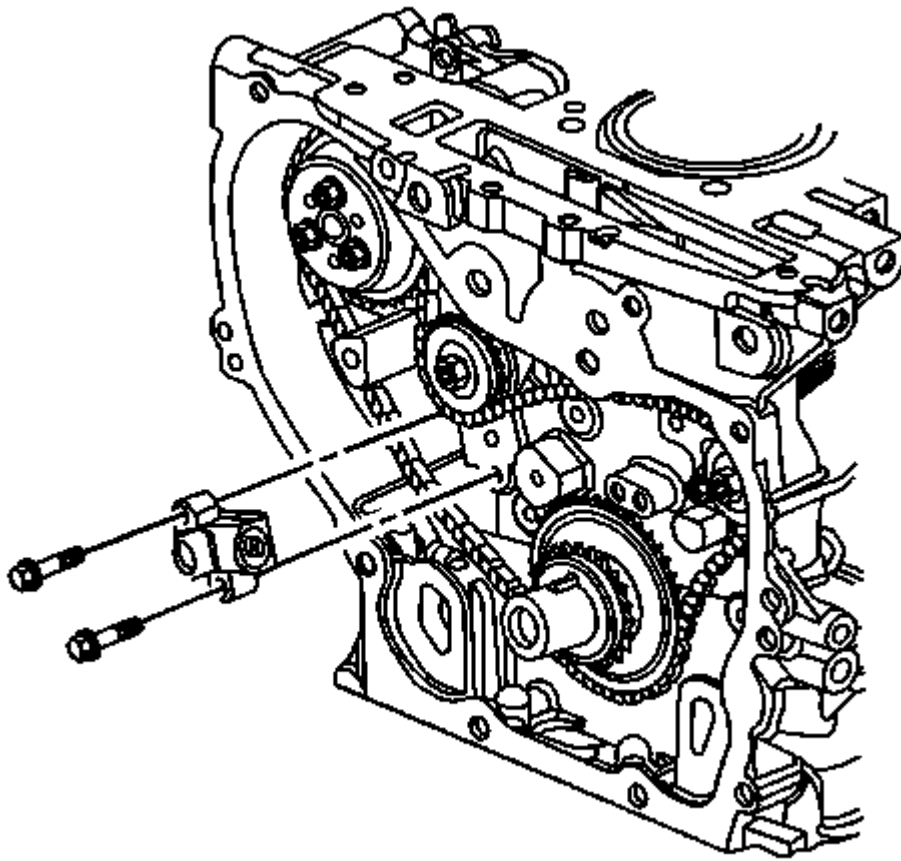


Fig. 130: Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

8. Reset the timing chain tensioner by performing the following steps:
 - Rotate the tensioner plunger 90 degrees in its bore and compress the plunger.
 - Rotate the tensioner back to the original 12 o'clock position and insert a paper clip through the hole in the plunger body and into the hole in the tensioner plunger.
9. Install the balance shaft drive chain tensioner and bolts and tighten to 10 N•m (89 lb in).
10. Remove the paper clip from the balance shaft drive chain tensioner.
11. Install the camshaft timing chain, sprocket, and tensioner. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.

WATER PUMP AND BALANCE SHAFT CHAIN TENSIONER REPLACEMENT

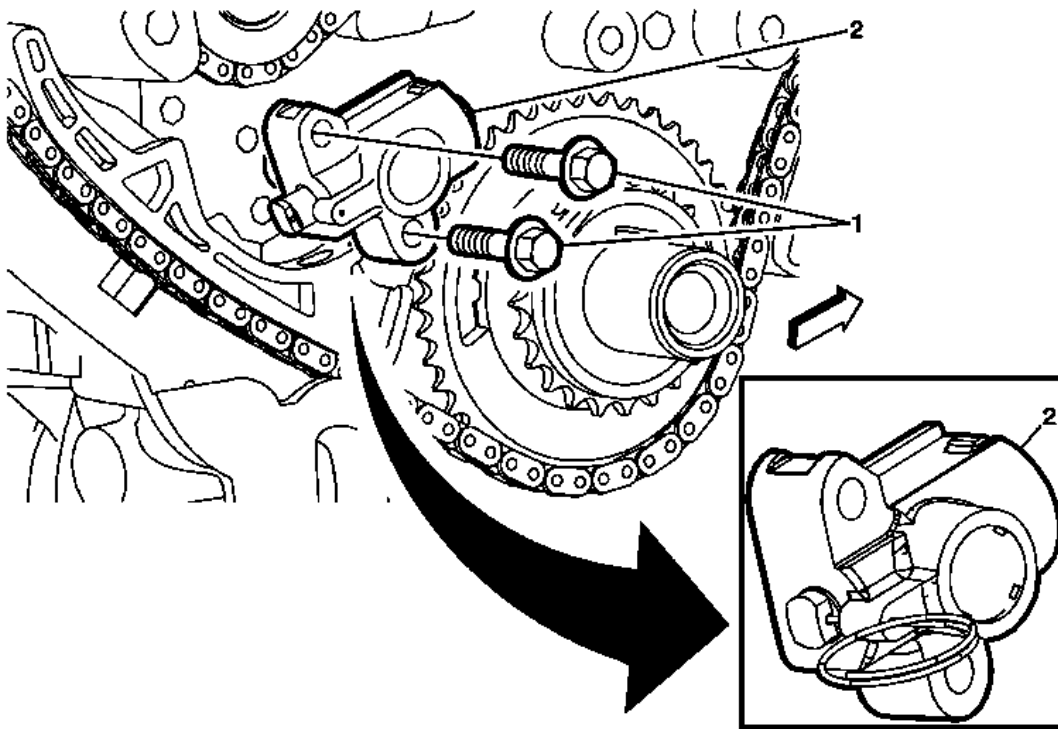


Fig. 131: Water Pump and Balance Shaft Chain Tensioner
 Courtesy of GENERAL MOTORS COMPANY

Water Pump and Balance Shaft Chain Tensioner Replacement

Callout	Component Name
Preliminary Procedure Remove the engine front cover. Refer to <u>Engine Front Cover Replacement (LEA)</u> , <u>Engine Front Cover Replacement (LUK)</u> .	
1	Water Pump and Balancer Shaft Chain Tensioner Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Procedure <ol style="list-style-type: none"> 1. Rotate the tensioner plunger counterclockwise and push the tensioner pin in the tensioner body. 2. Rotate the tensioner plunger clockwise and secure the tensioner plunger with a positioning pin. Install the tensioner. 3. Remove the positioning pin. Tighten 10 (89 lb in)

CAMSHAFT COVER REPLACEMENT (LUK)

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) Air Cleaner Outlet Duct Replacement
2. Remove the ignition coils. Refer to [Ignition Coil Replacement](#) Ignition Coil Replacement

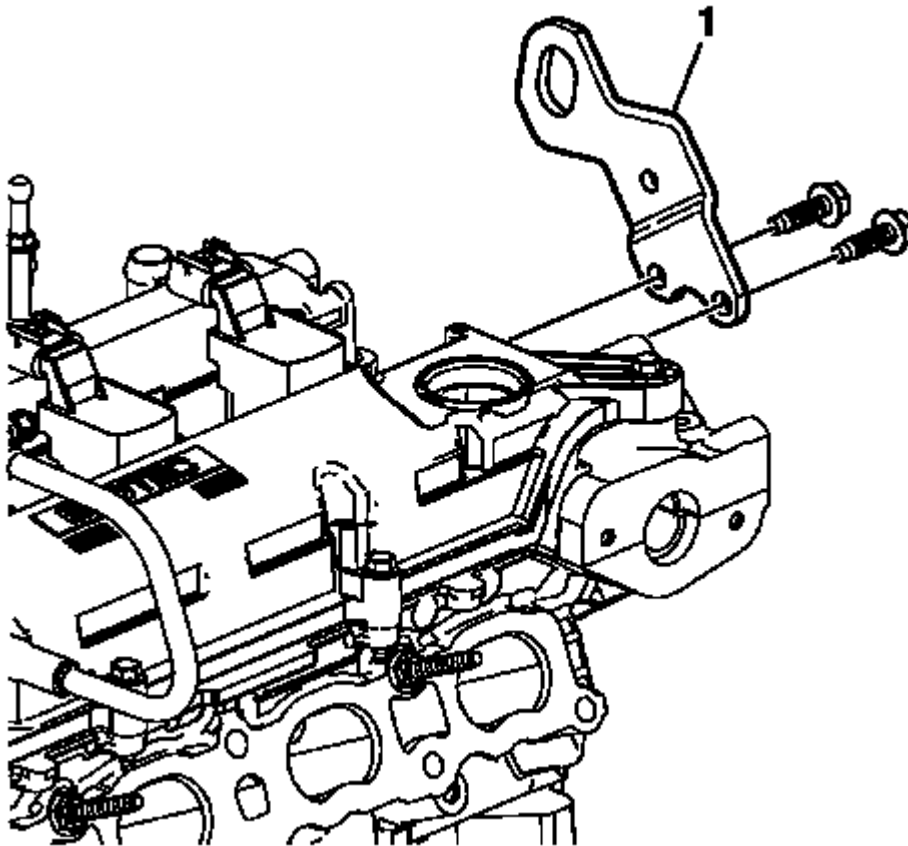


Fig. 132: Rear Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

3. Remove the rear lift bracket (1).

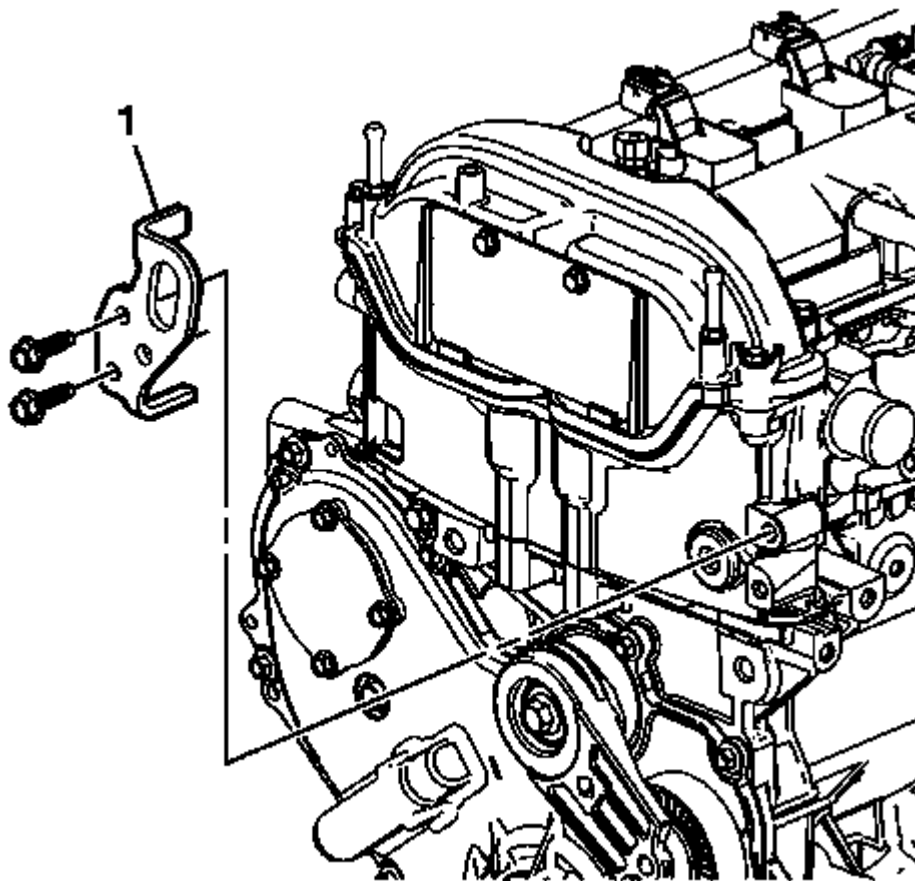


Fig. 133: Front Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front lift bracket (1).

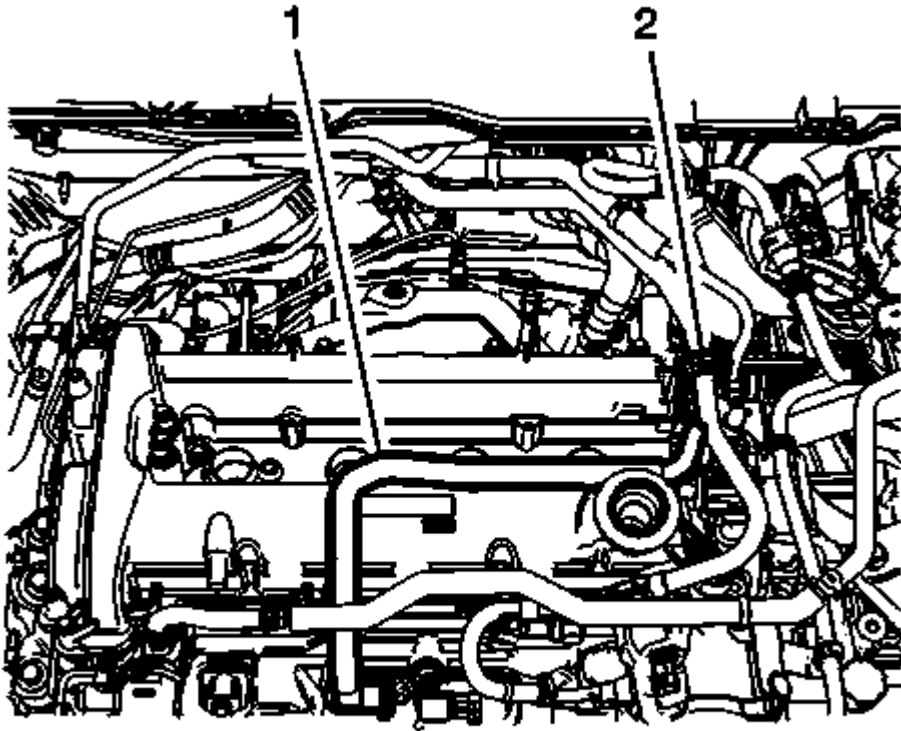


Fig. 134: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

5. Remove the evaporative emission canister purge tube (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
6. Disconnect fuel line clip (2).

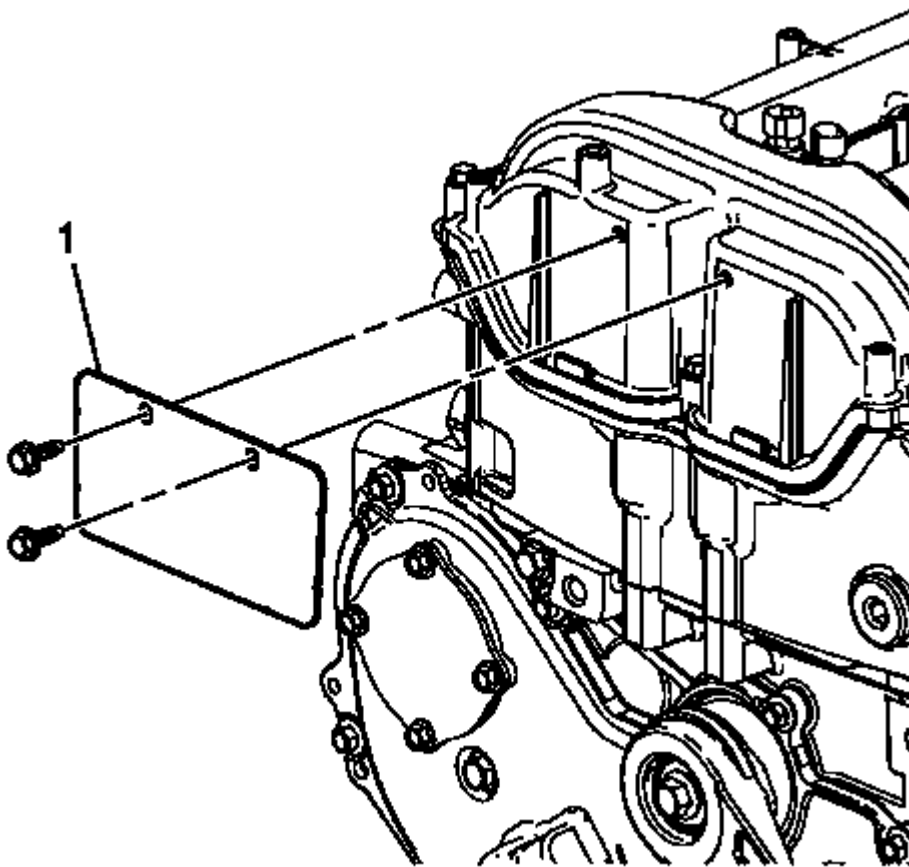


Fig. 135: Camshaft Housing Cover Insulator
Courtesy of GENERAL MOTORS COMPANY

7. Remove the camshaft housing cover insulator (1).

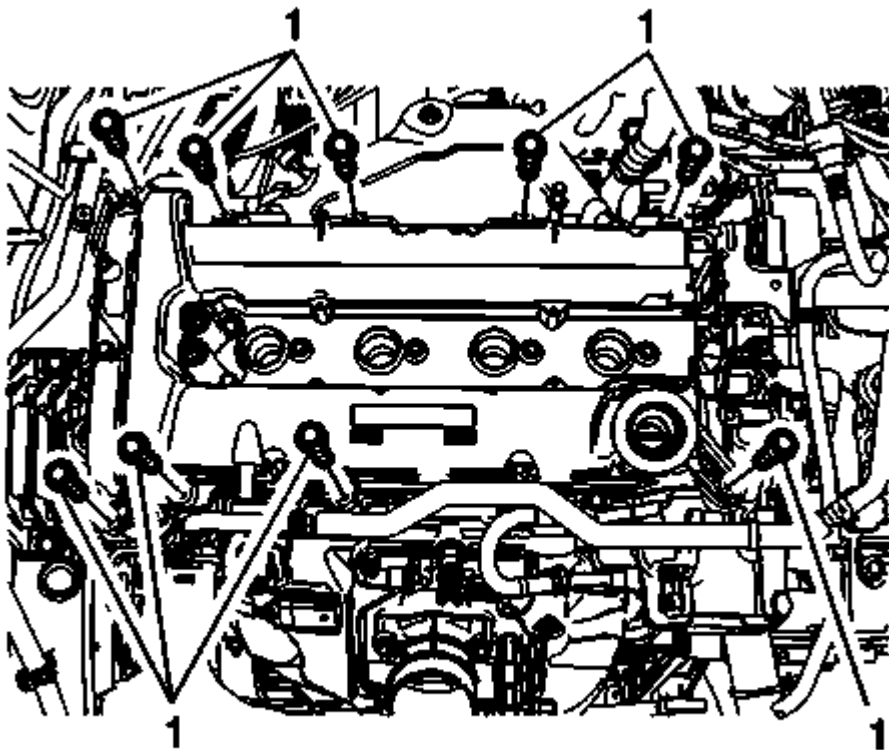


Fig. 136: Camshaft Cover Bolt

Courtesy of GENERAL MOTORS COMPANY

8. Remove the camshaft cover bolts (1).

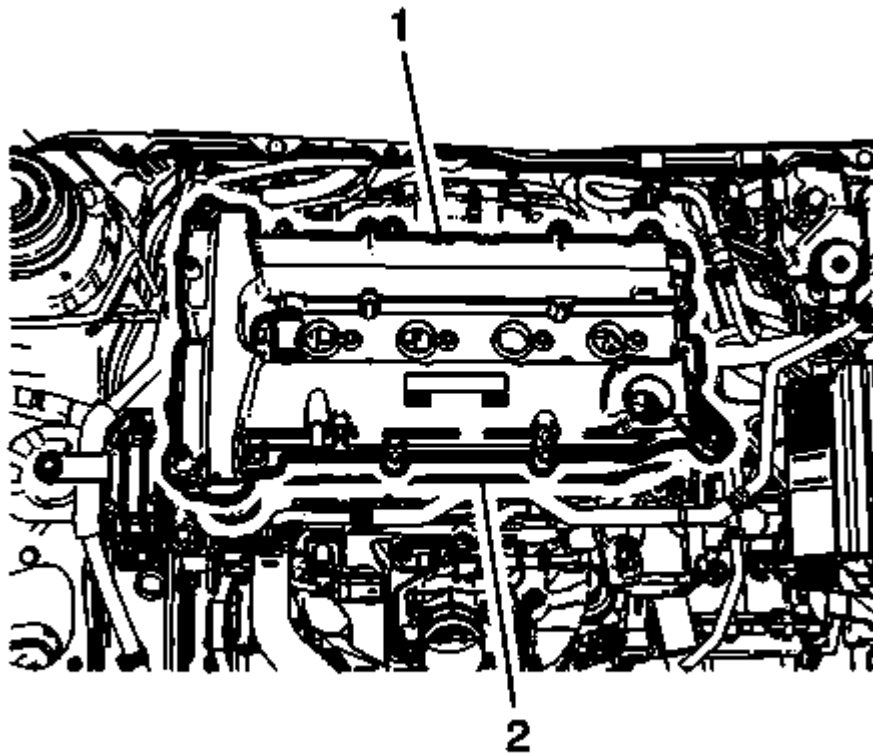


Fig. 137: Camshaft Cover And Gasket
Courtesy of GENERAL MOTORS COMPANY

9. Remove the camshaft cover (1) and gasket (2).

Installation Procedure

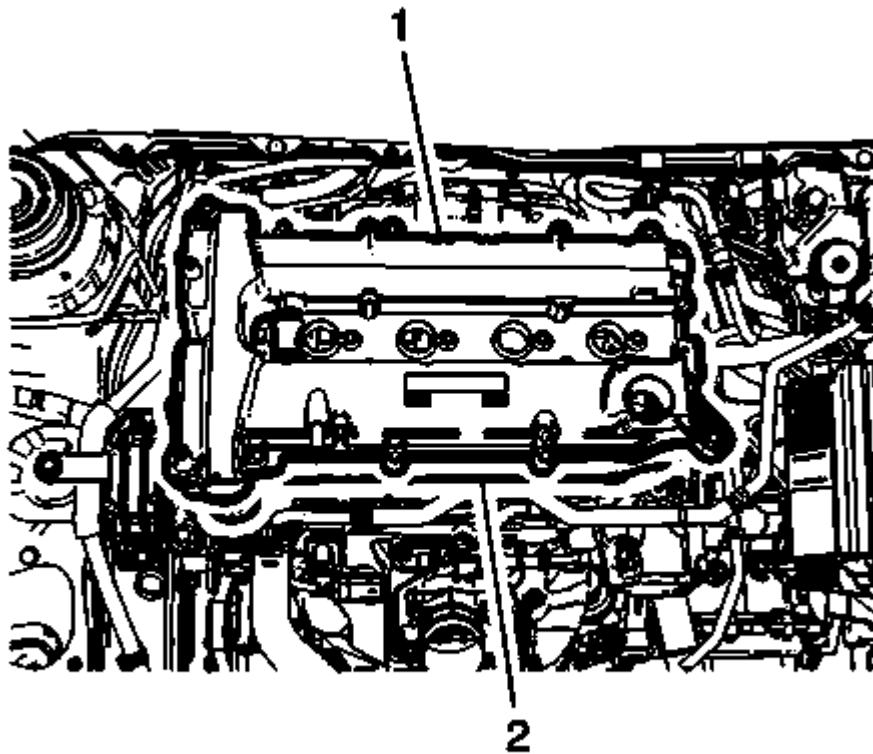


Fig. 138: Camshaft Cover And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Assemble the camshaft cover (1) and a NEW gasket (2). Ensure that the gasket is located in the retaining groove in the camshaft cover.

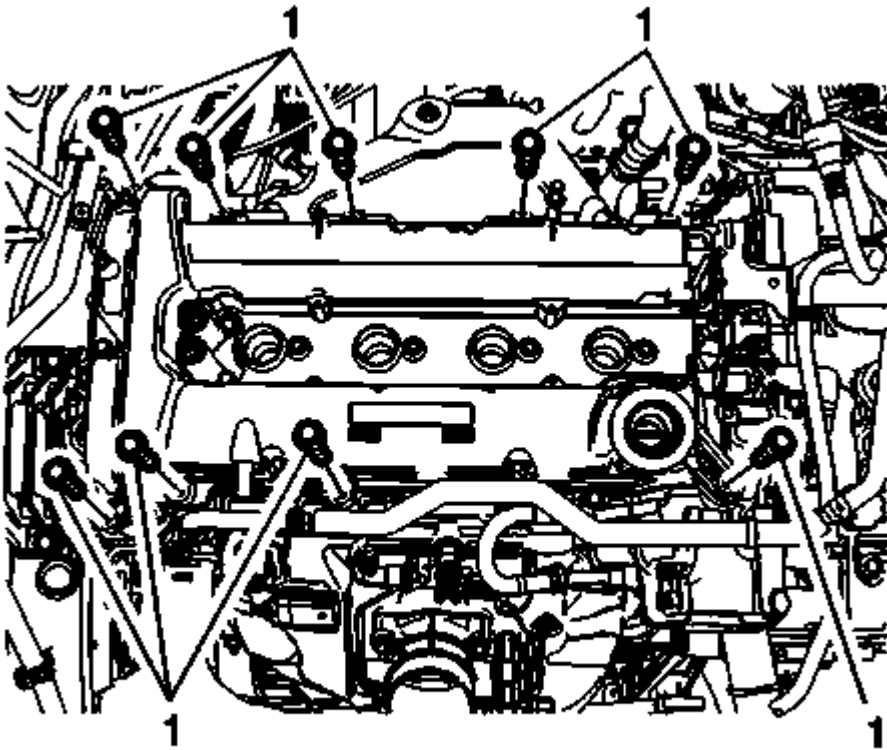


Fig. 139: Camshaft Cover Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Install NEW camshaft cover grommets and camshaft cover bolts (1).
3. Install the cover on the cylinder head and hand start the bolts. Tighten the bolts to 10 N.m (89 lb in).

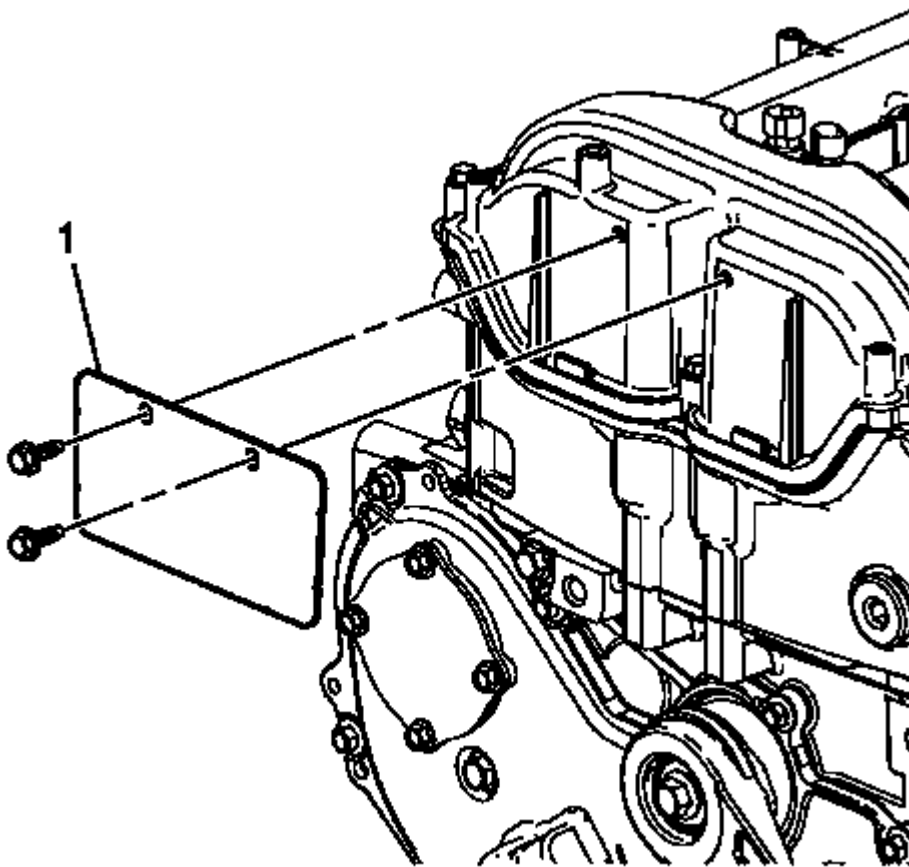


Fig. 140: Camshaft Housing Cover Insulator
Courtesy of GENERAL MOTORS COMPANY

4. Install the camshaft housing cover insulator (1). Tighten the bolts to 10 N.m (89 lb in).

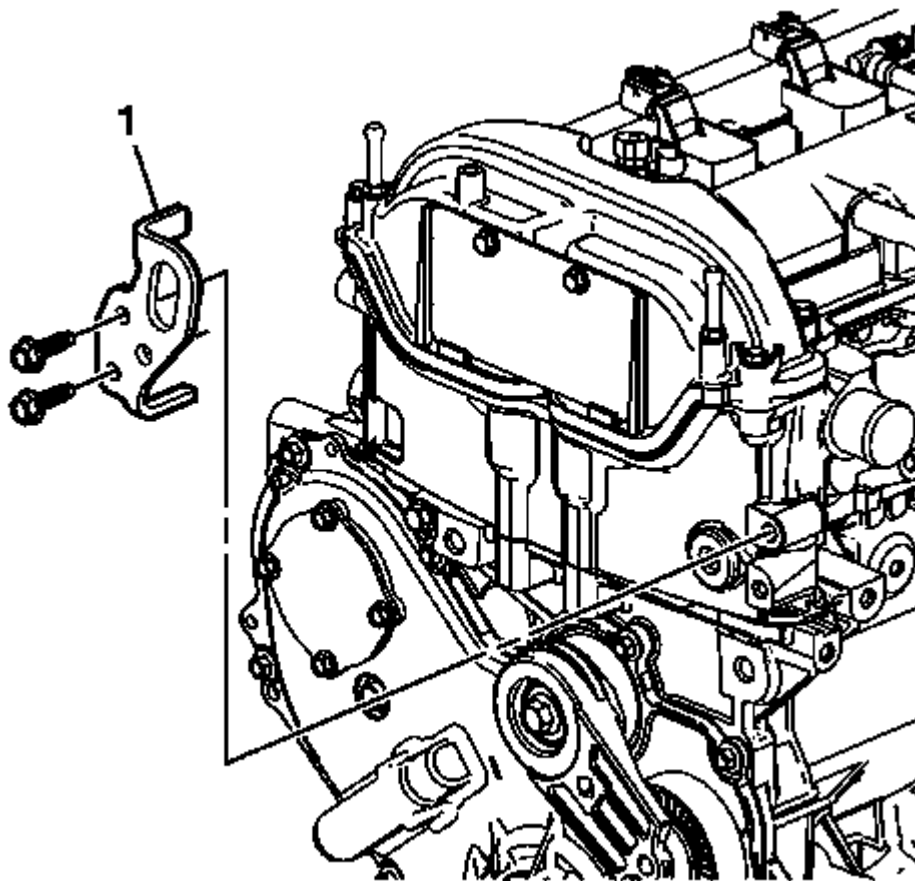


Fig. 141: Front Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

5. Install the front lift bracket (1).
6. Install the front lift bracket bolts and tighten to 25 N.m (18 lb ft).

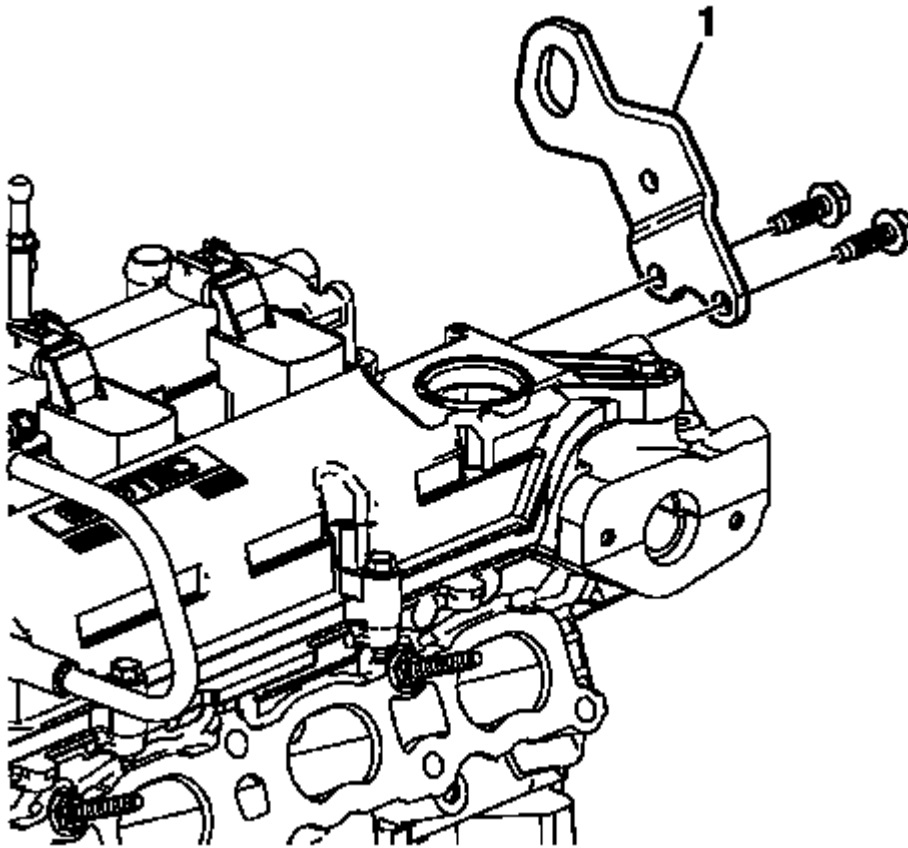


Fig. 142: Rear Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Install the rear lift bracket (1).
8. Install the rear lift bracket bolts and tighten to 25 N.m (18 lb ft).

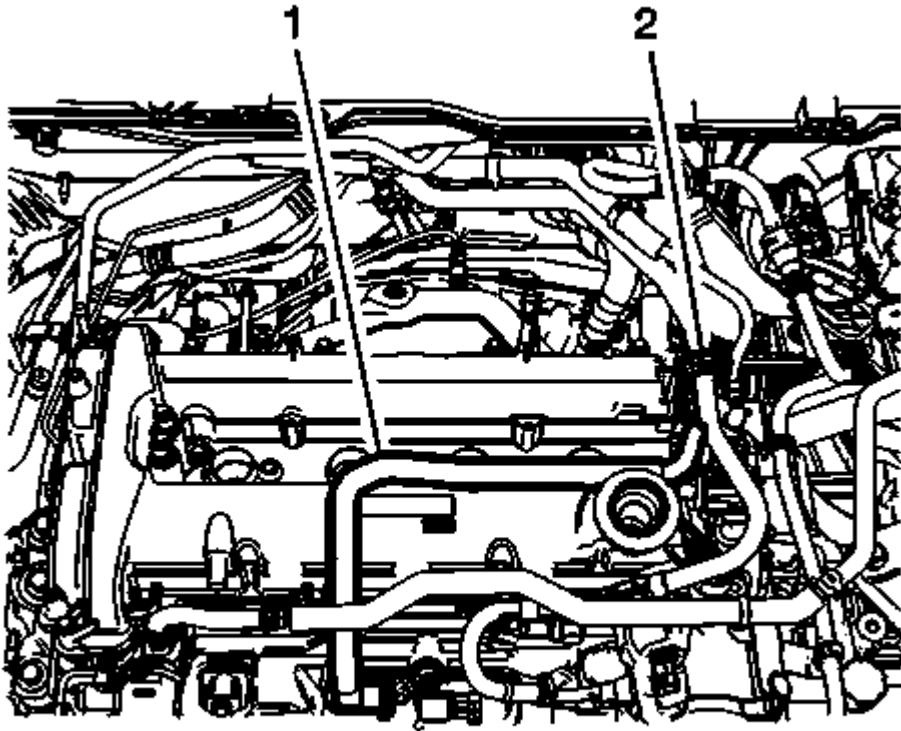


Fig. 143: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

9. Install the evaporative emission canister purge tube (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
10. connect the fuel like clip.
11. install the ignition coils. Refer to **Ignition Coil Replacement** Ignition Coil Replacement.
12. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** Air Cleaner Outlet Duct Replacement.

CAMSHAFT COVER REPLACEMENT (LEA)

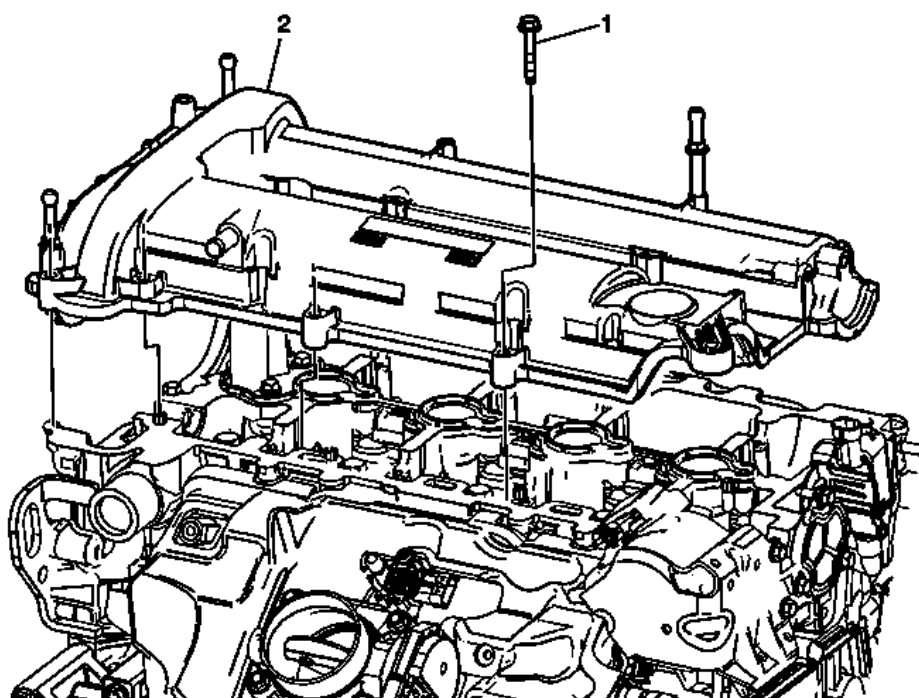


Fig. 144: Camshaft Cover (LEA)

Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Replacement (LEA)

Callouts	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 2. Remove the ignition coils. Refer to <u>Ignition Coil Replacement</u> . 3. Remove the Camshaft Position Sensor intake. Refer to <u>Camshaft Position Sensor Replacement - Intake</u> 4. Remove the Camshaft Position Sensor Exhaust . Refer to <u>Camshaft Position Sensor Replacement - Exhaust</u> 	
1	Camshaft Cover Fastener (Qty: 11) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
	Camshaft Cover Procedure

2	<ol style="list-style-type: none"> 1. Do not reuse camshaft gasket. Also use a new gasket when removing or replacing camshaft cover. 2. Remove ignition coil wiring harness clips from the camshaft cover. 3. Remove the fuel line bracket from the camshaft cover. 4. Transfer components as necessary.
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TIMING CHAIN TENSIONER REPLACEMENT

Special Tools

EN-45027 Tensioner Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**, **Camshaft Cover Replacement (LEA)**.

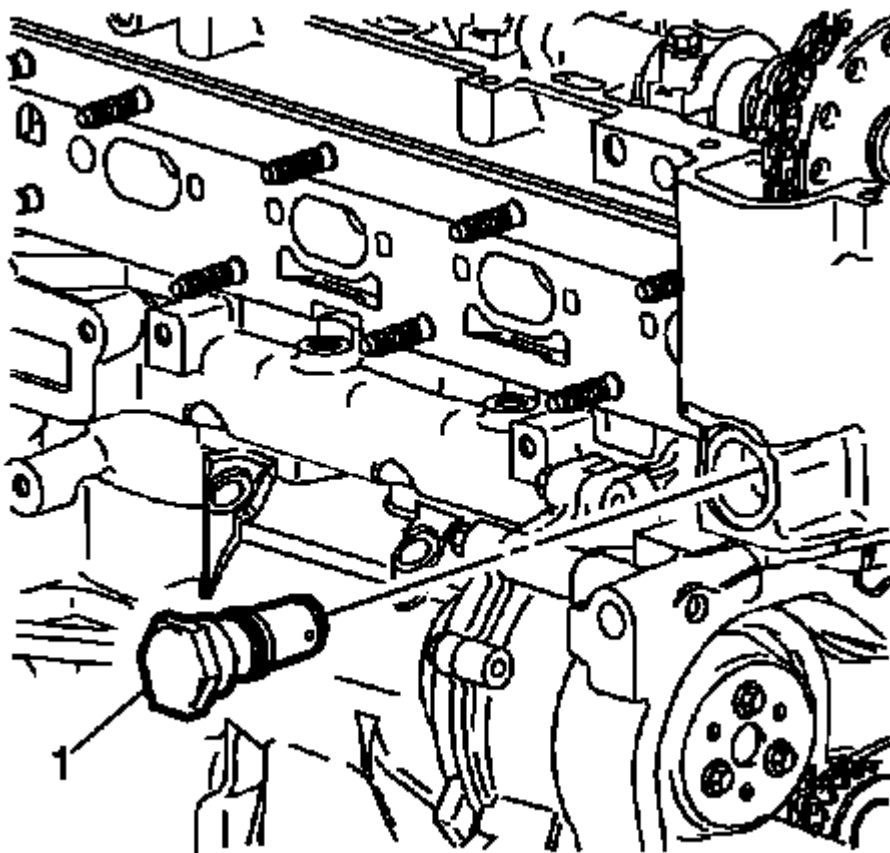


Fig. 145: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

3. Remove the timing chain tensioner (1).
4. Remove the seal from the tensioner and DISCARD.

Installation Procedure

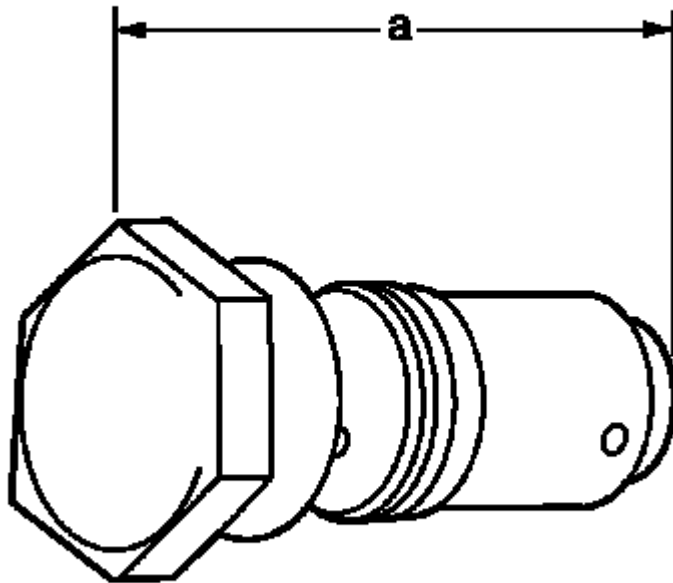


Fig. 146: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the timing chain tensioner. If the timing chain tensioner, O-ring seal, or washer is damaged, replace the timing chain tensioner or O-ring seal as applicable.
2. Measure the timing chain tensioner assembly from end to end. If the timing chain tensioner is to be replaced, a new tensioner should be supplied in the fully compressed non-active state.

A tensioner in the compressed state will measure 72 mm (2.83 in) (a) from end to end. A tensioner in the active state will measure 85 mm (3.35 in) (a) from end to end.

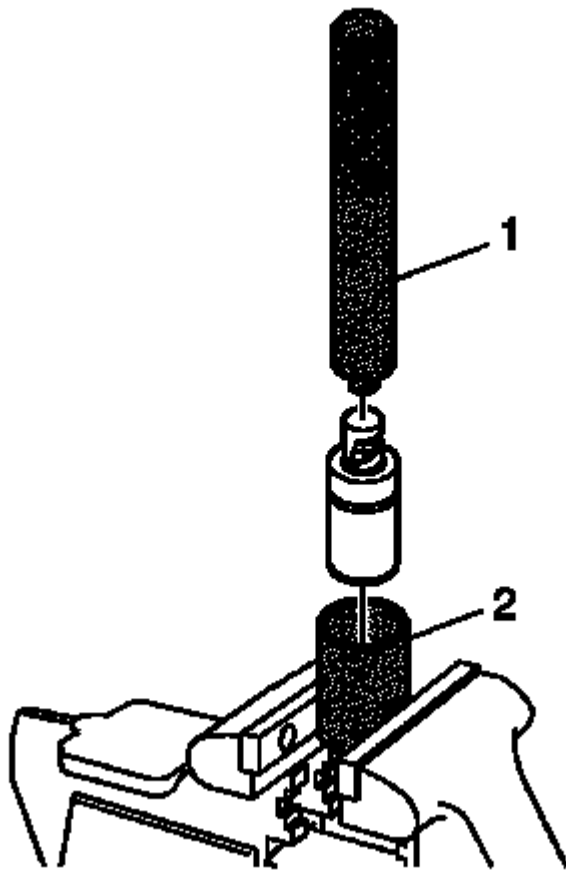


Fig. 147: Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

3. If the timing chain tensioner is not in the compressed state, perform the following steps:
 1. Remove the piston assembly from the body of the timing chain tensioner by pulling it out.
 2. Install the **EN-45027-2** retainer (2) into a vise.
 3. Install the notch end of the piston assembly into the **EN-45027-2** retainer (2).
 4. Using the **EN-45027-1** compressor (1), turn the ratchet cylinder into the piston.

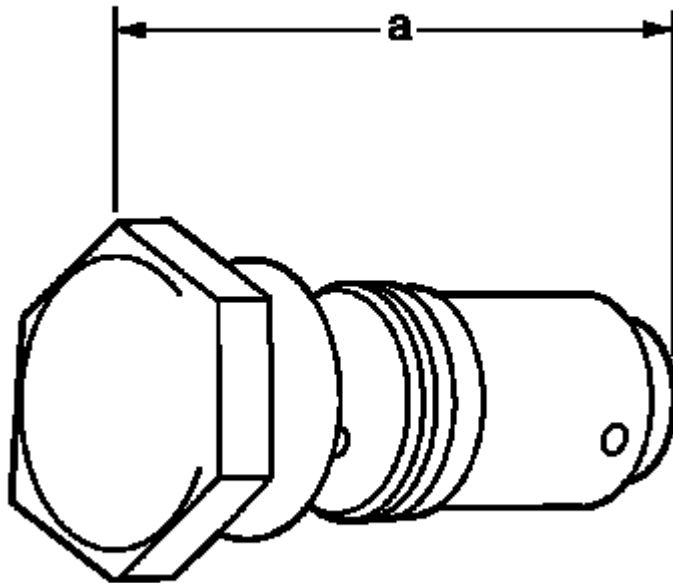


Fig. 148: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the bore of the tensioner body for dirt, debris, and damage. If any damage appears, replace the tensioner. Clean dirt or debris out with a lint-free cloth.
5. Install the compressed piston assembly back into the timing chain tensioner body until it stops at the bottom of the bore.

Do not compress the piston assembly against the bottom of the bore. If the piston assembly is compressed against the bottom of the bore, it will activate the tensioner, which will then need to be reset again.

6. At this point the tensioner should measure approximately 72 mm (2.83 in) (a) from end to end. If the tensioner does not read 72 mm (2.83 in) (a) from end to end, repeat steps 3-5.

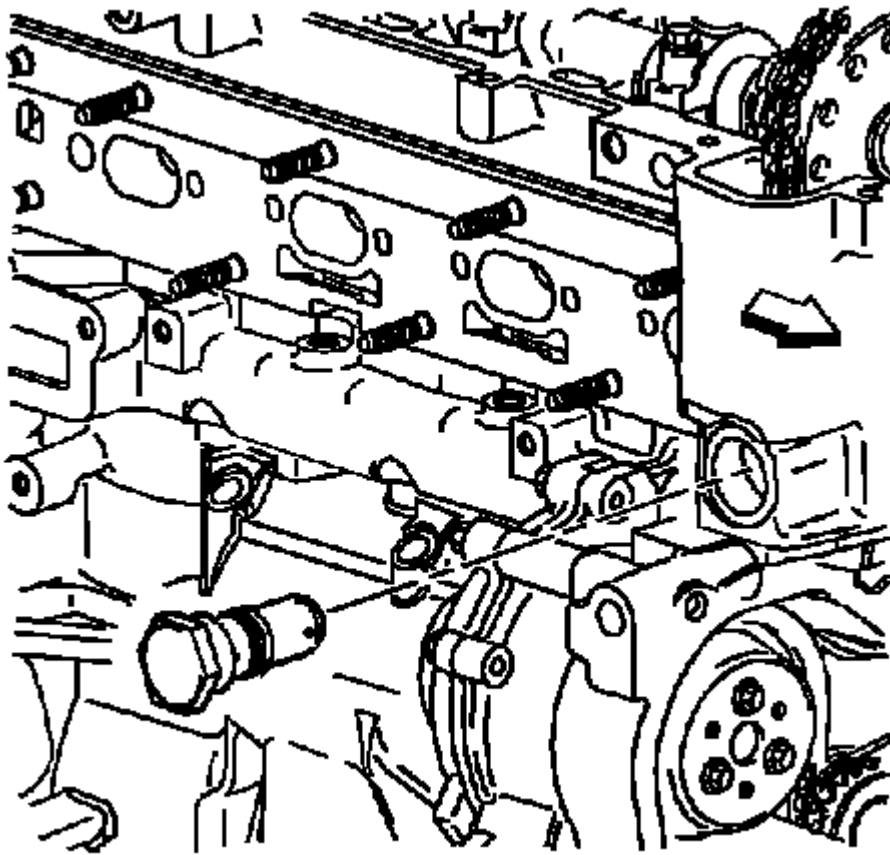


Fig. 149: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

7. Inspect to ensure all dirt and debris is removed from the timing chain tensioner threaded hole in the cylinder head.

CAUTION: Refer to Fastener Caution .

NOTE: **Ensure the timing chain tensioner seal is centered throughout the torque procedure to eliminate the possibility of an oil leak.**

8. Install the timing chain tensioner assembly (1) and tighten the tensioner to 75 N.m (55 lb ft).
9. The timing chain tensioner is released by compressing the tensioner 2 mm (0.079 in) which will release the locking mechanism in the ratchet.

To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.

10. Install the camshaft cover. Refer to Camshaft Cover Replacement (LUK), Camshaft Cover Replacement (LEA).
11. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

INTAKE CAMSHAFT AND VALVE LIFTER REPLACEMENT

Removal Procedure

1. Remove the intake camshaft position actuator. Refer Camshaft Position Intake Actuator Replacement.

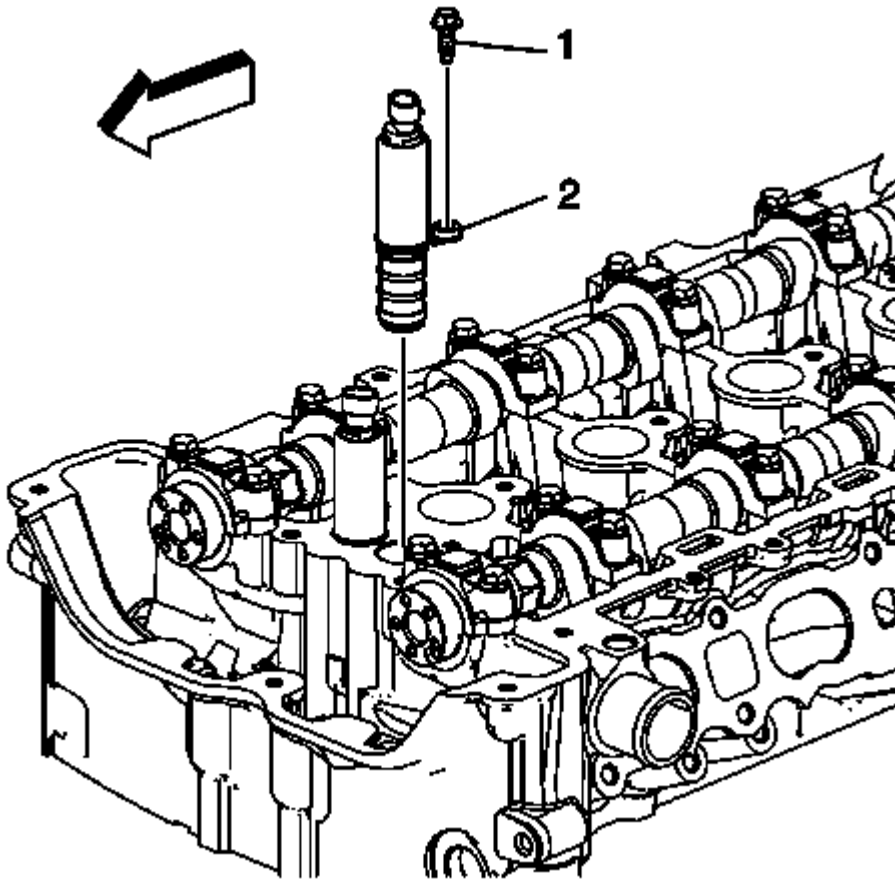


Fig. 150: Intake Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake camshaft position actuator solenoid valve bolt (1) and valve (2).

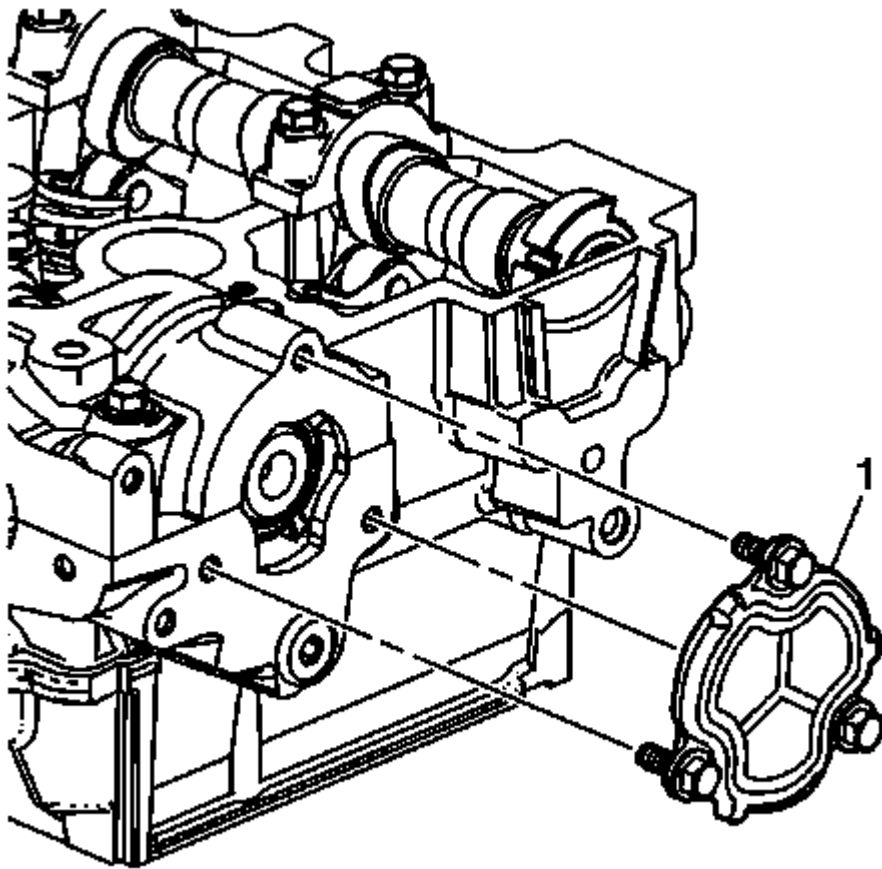


Fig. 151: Rear Cylinder Head Cover Plate
Courtesy of GENERAL MOTORS COMPANY

3. Remove the rear cylinder head cover plate (1).
4. Remove the fuel pump. Refer to **Fuel Pump Replacement** .

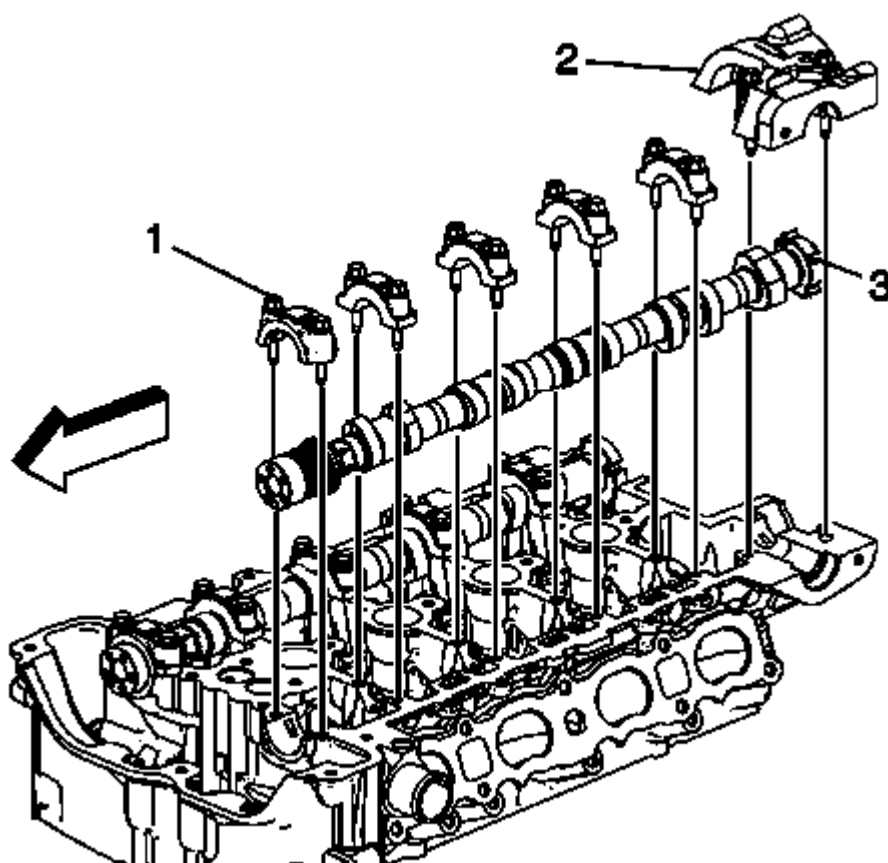


Fig. 152: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intake camshaft bearing rear cap bolts and cap (2).

NOTE: Remove each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

6. Mark camshaft caps to ensure they are installed in the same position.
7. Remove the intake camshaft cap bolts.
8. Remove the camshaft caps (1).
9. Remove the intake camshaft (3).

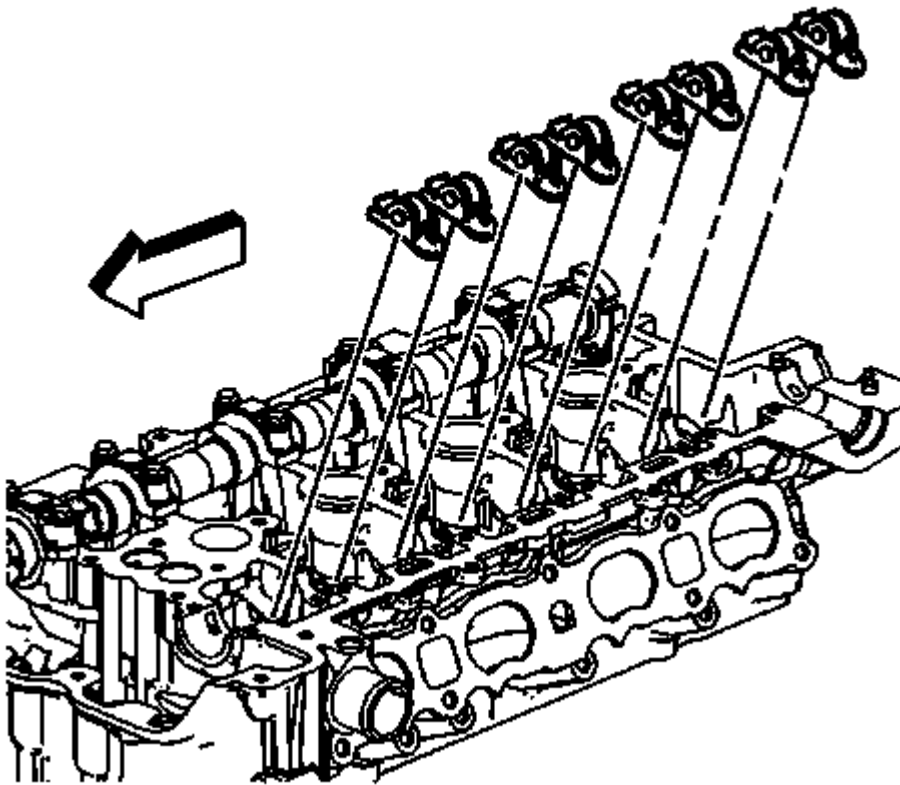


Fig. 153: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the roller finger followers and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

10. Remove the intake camshaft roller finger followers.

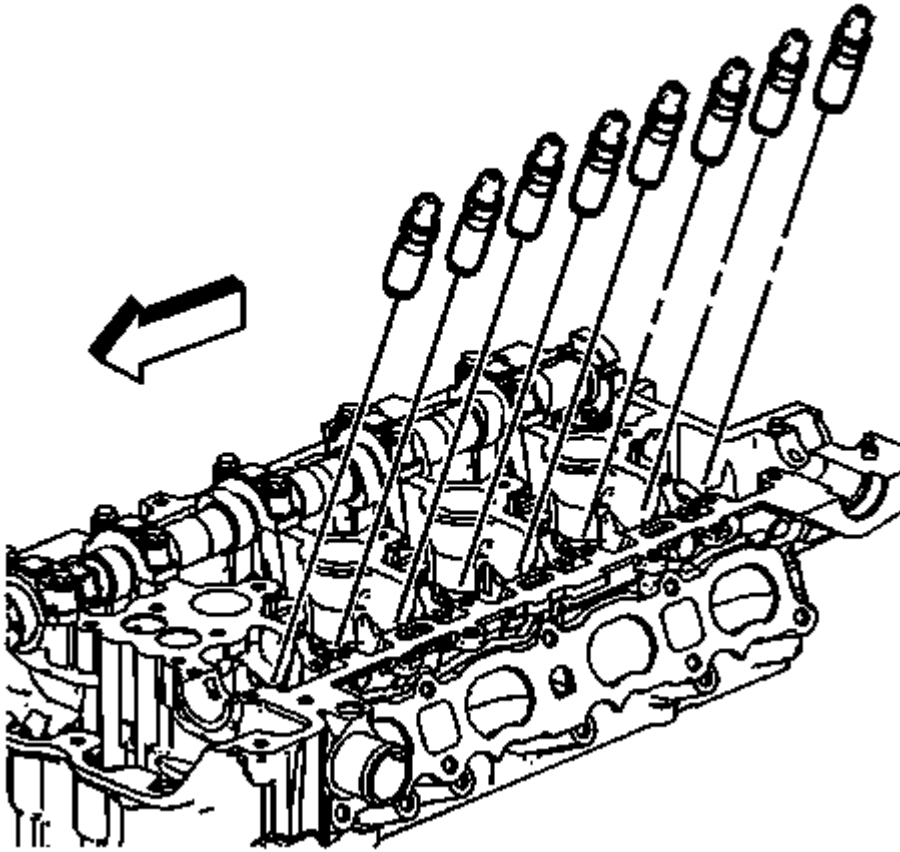


Fig. 154: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

11. Remove the hydraulic lash adjusters.

Installation Procedure

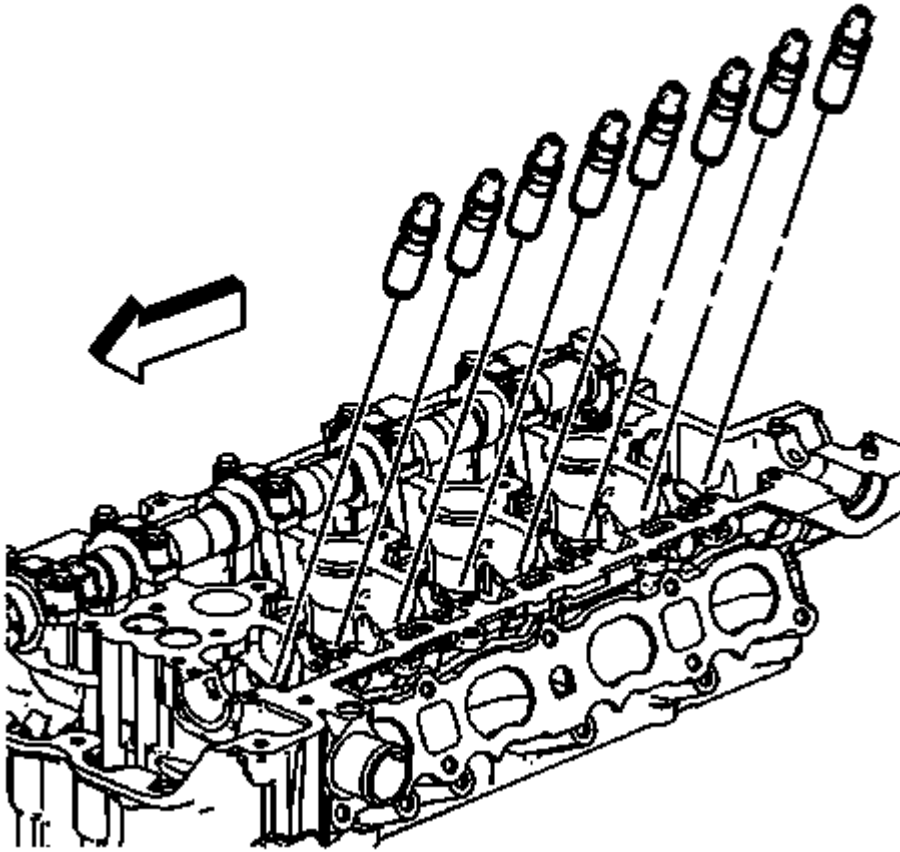


Fig. 155: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

1. Install the hydraulic lash adjusters into their bores in the cylinder head.
2. Lubricate the hydraulic lash adjusters. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

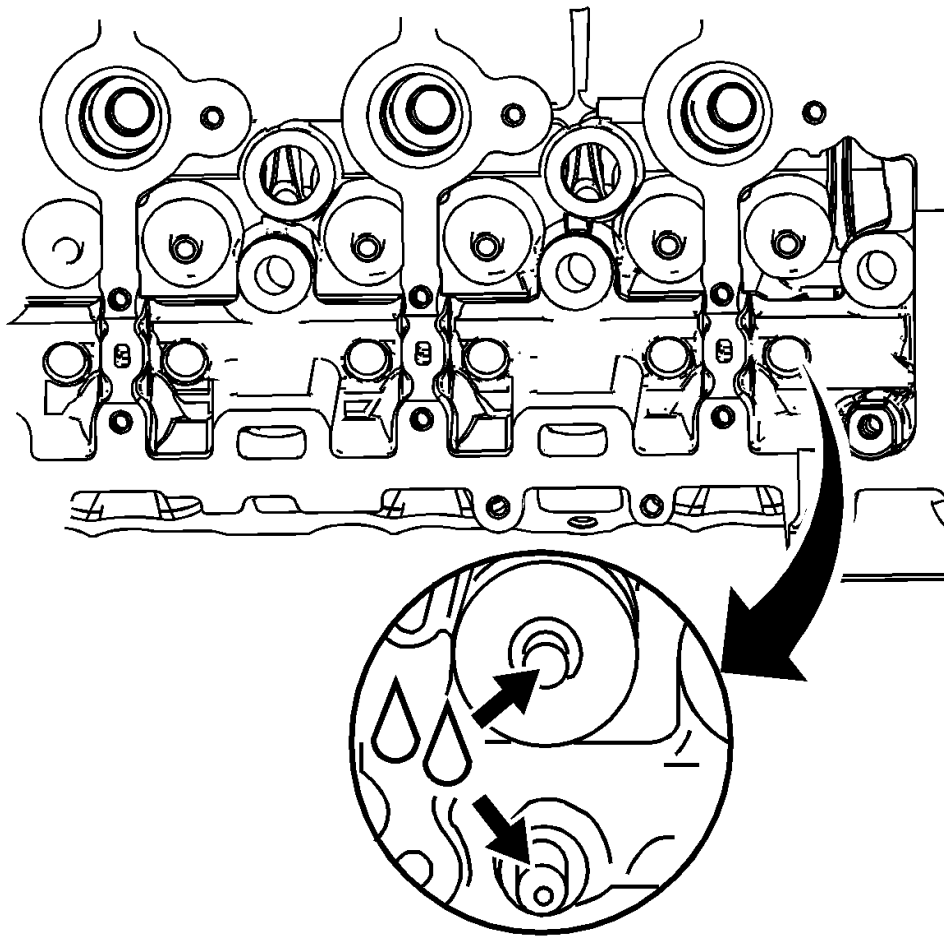


Fig. 156: Valve Tips
Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

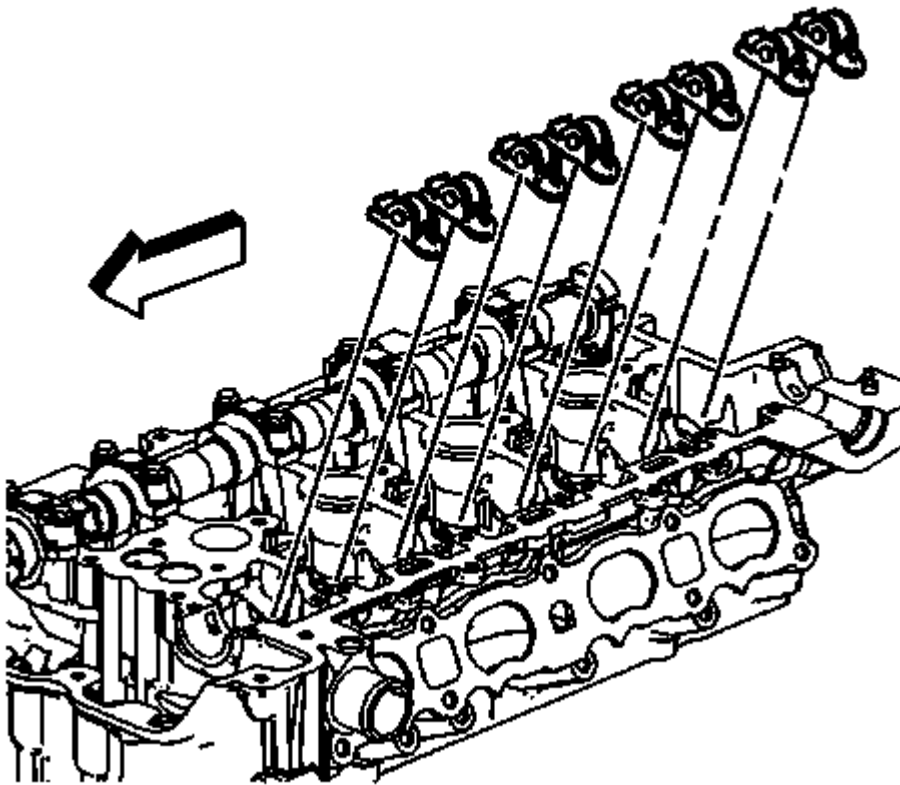


Fig. 157: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Used roller followers must be returned to the original position on the camshaft. If the camshaft is being replaced, the roller followers actuated by the camshaft must also be replaced.

4. Position the roller followers on the tip of the valve stem and on the lash adjuster. Lubricate roller followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

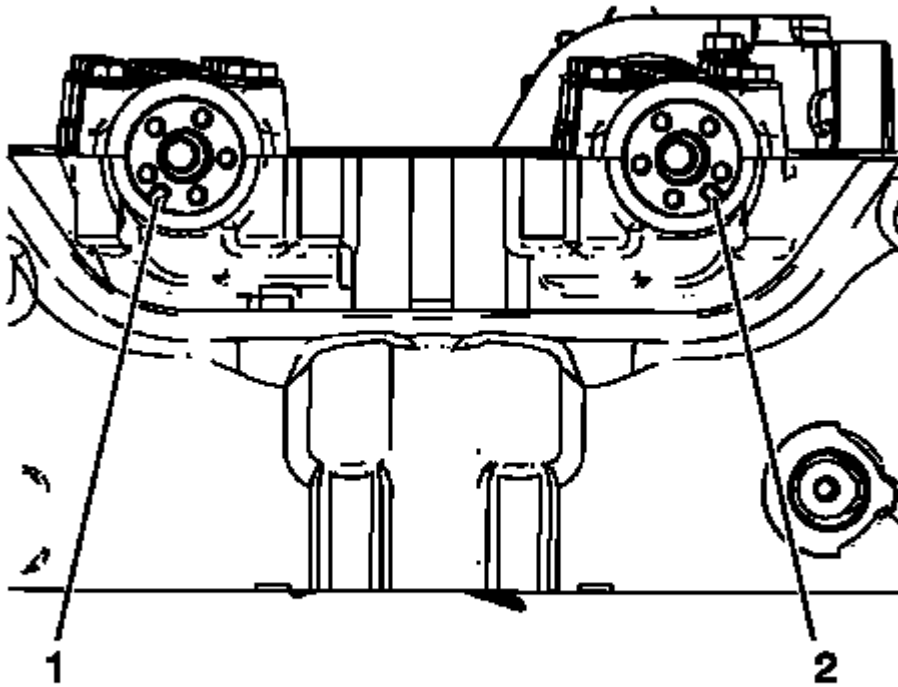


Fig. 158: Identifying Proper Exhaust/Intake Camshaft Alignment positions
Courtesy of GENERAL MOTORS COMPANY

NOTE: If equipped with the following engine; LE5, LE9, LAT, LNF, LDK, LHU, LTD, LBN, ensure the intake camshaft notch is in the 5 o'clock position and the exhaust camshaft notch is in the 7 o'clock position.

5. Ensure the intake camshaft notch is in the 5 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

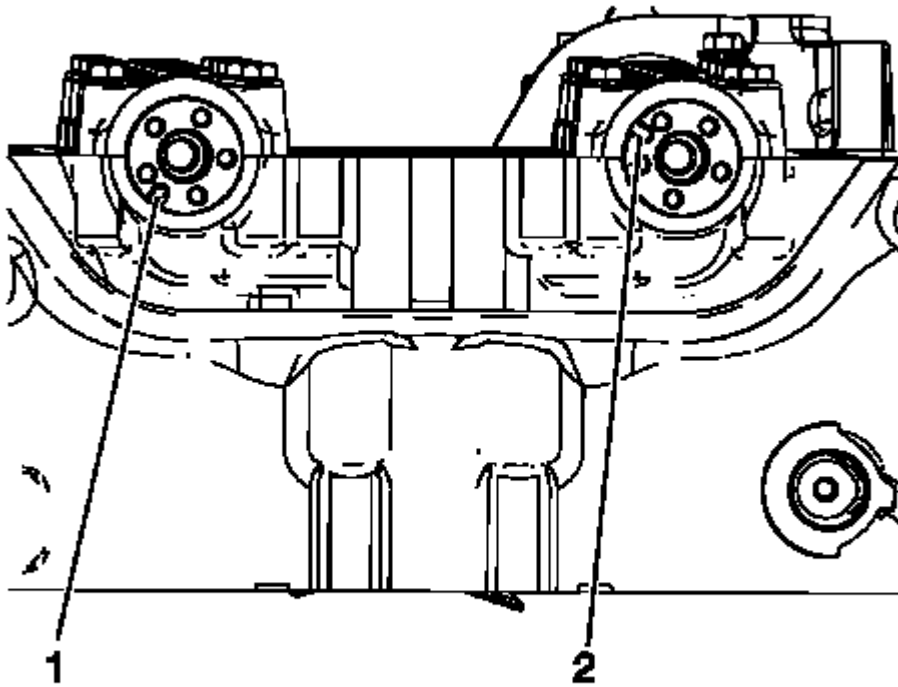


Fig. 159: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: If equipped with following engine; LEA, LUK, ensure the intake camshaft notch is in the 10 o'clock position and the exhaust camshaft notch is in the 7 o'clock position.

6. Ensure the intake camshaft notch is in the 10 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

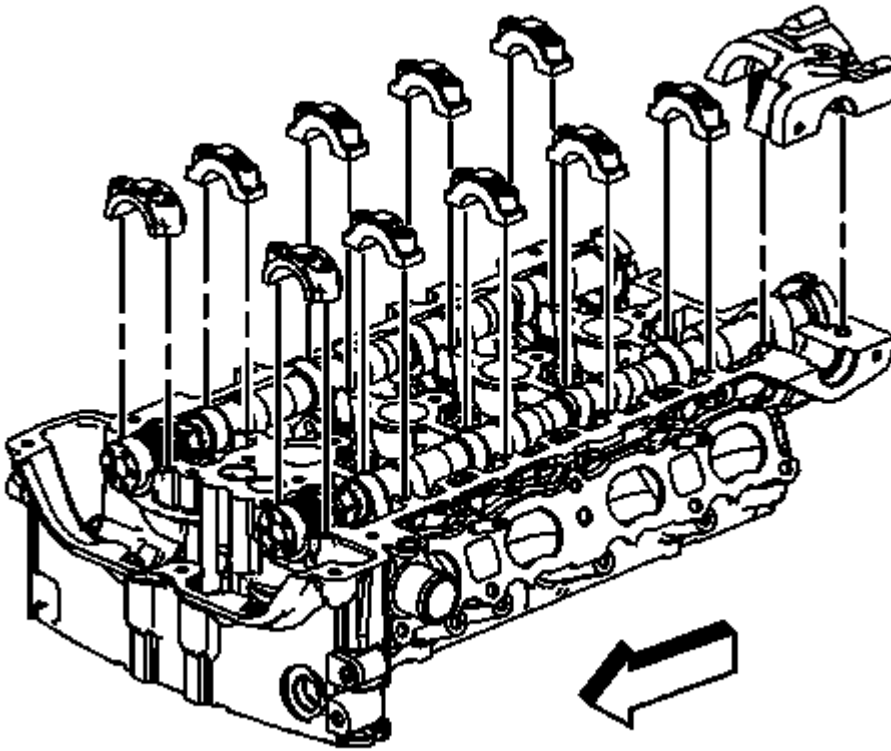


Fig. 160: Intake Camshaft & Caps
Courtesy of GENERAL MOTORS COMPANY

7. Set the intake camshaft on top of the roller followers in the camshaft bearing journals and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

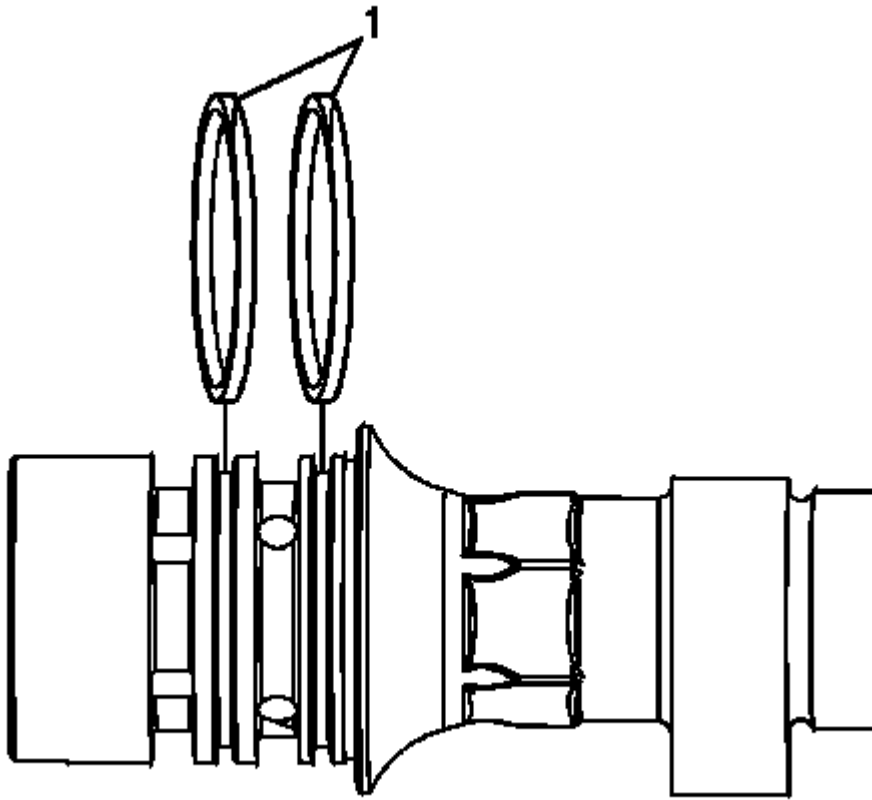


Fig. 161: Oil Seals

Courtesy of GENERAL MOTORS COMPANY

8. Rotate the oil seal in the groove of the number one camshaft journal so the split line (1) is at approximately the 12:00 position before installing the camshaft caps.

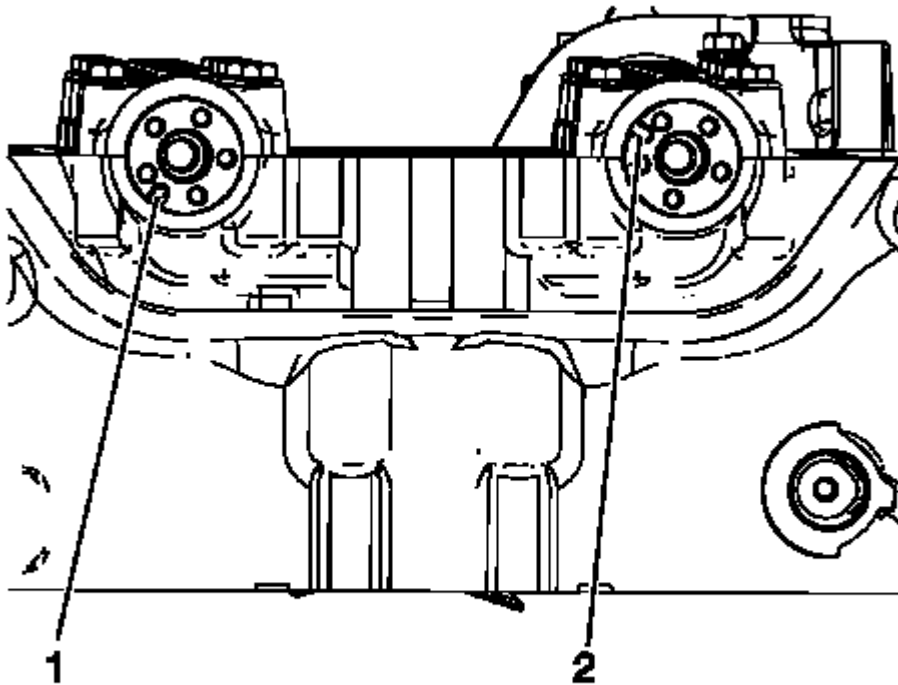


Fig. 162: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: The number 1 cylinder must be at top dead center (TDC), crankshaft keyway at the 12 o'clock position.

9. Install the intake camshaft with the notch on the front at approximately the 10 o'clock position (2).
10. Install the camshaft caps and hand start the camshaft cap bolts.

CAUTION: Refer to Fastener Caution .

11. Tighten the camshaft cap bolts in increments of 3 turns until they are seated. Tighten the camshaft caps to 10 N.m (89 lb in).

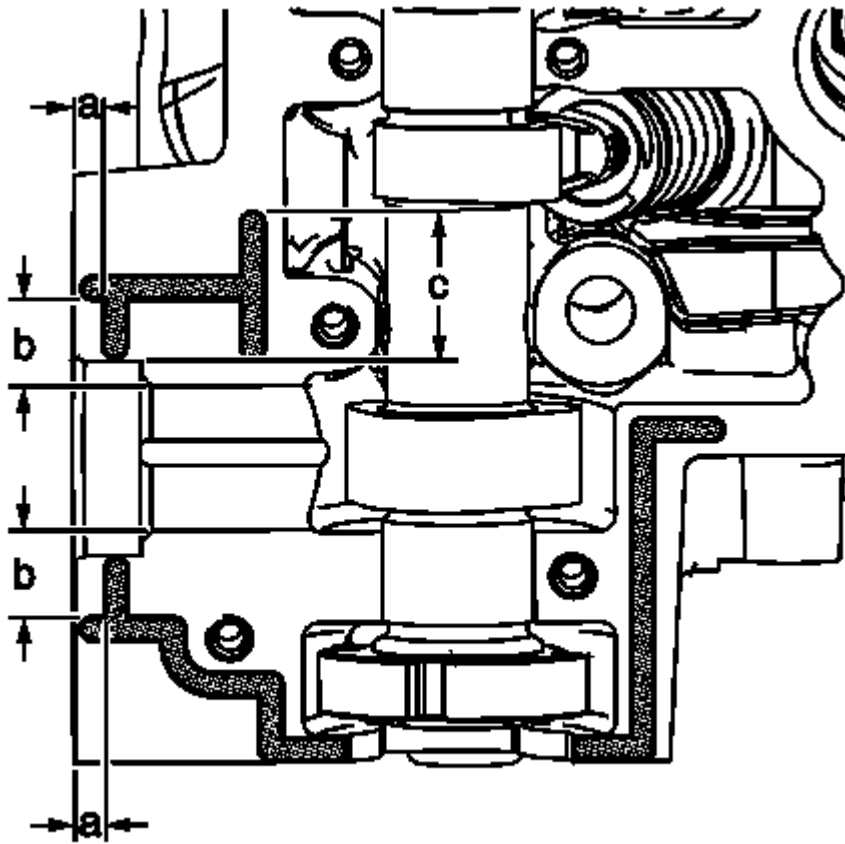


Fig. 163: Sealer Application Areas
 Courtesy of GENERAL MOTORS COMPANY

- NOTE:** It is critical during installation to ensure the bearing rear cap and cylinder head alignment is correct and the mating surfaces are flush.
- Ensure that all sealing material has been removed from the components, and the sealing surfaces are clean and free of contamination prior to applying the sealer.
 - Install and align the rear cap within 20 minutes of applying the sealer.

- NOTE:** Apply the sealer to all locations centrally locating the bead on the rail.
- Run bead to 5.0 mm, dimension a, as shown.
 - Where the cap ends on the perimeter rail, extend bead approximately 4.0 mm beyond edge of cap.
 - Run bead, dimension c, 32 mm from the edge of the cylinder head as shown.
 - Run beads, dimension b, 20 mm from edge of cylinder head as shown.

12. Apply a 2.5 mm bead of sealer to the cylinder head at the number 6 intake camshaft rear cap mating surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
13. Install the number 6 intake camshaft rear cap.
 1. Tighten the cap bolts evenly to 5 N.m (44 lb in).
 2. Tighten the cap bolts evenly to 10 N.m (89 lb in).
 3. Back the cap bolts out 120 degrees.
 4. Tighten the cap bolts evenly a final pass to 10 N.m (89 lb in).

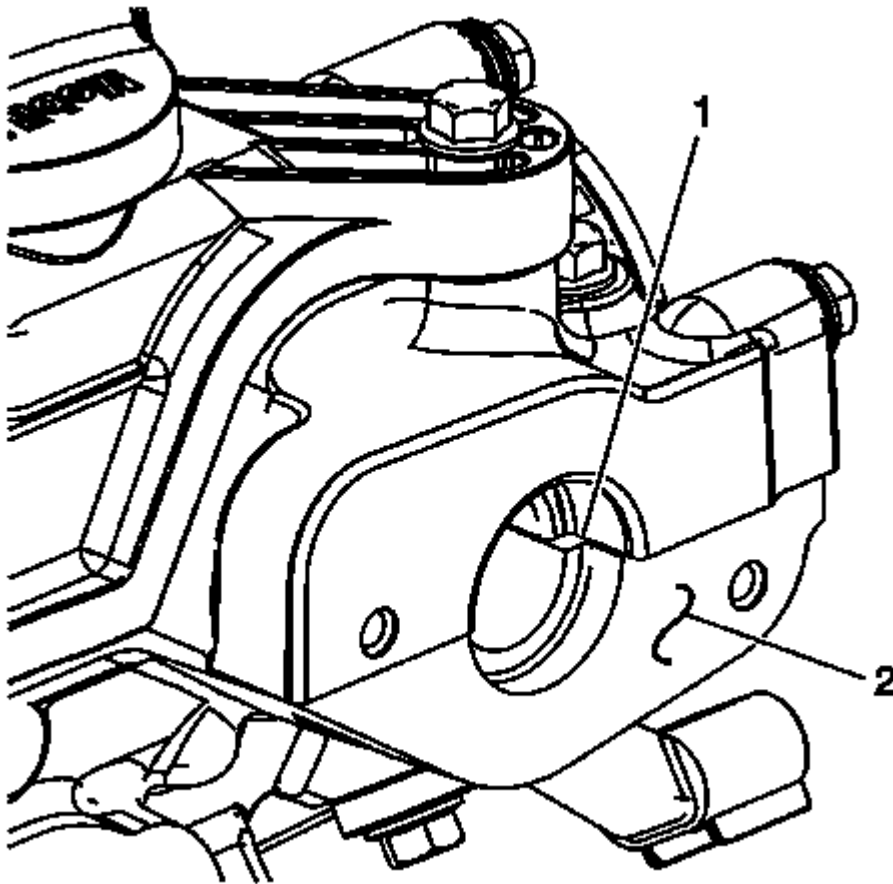


Fig. 164: Identifying Fuel Pump Roller Lifter Orifice
Courtesy of GENERAL MOTORS COMPANY

14. Remove all excess sealing material from the fuel pump roller lifter bore (1), and ensure the bore is free of debris. Do not allow any excess sealing material to remain within the cylinder head or on any sealing surface.
15. Remove all excess sealing material from the fuel pump assembly sealing surface (2).
16. Install the fuel pump. Refer to **Fuel Pump Replacement** .

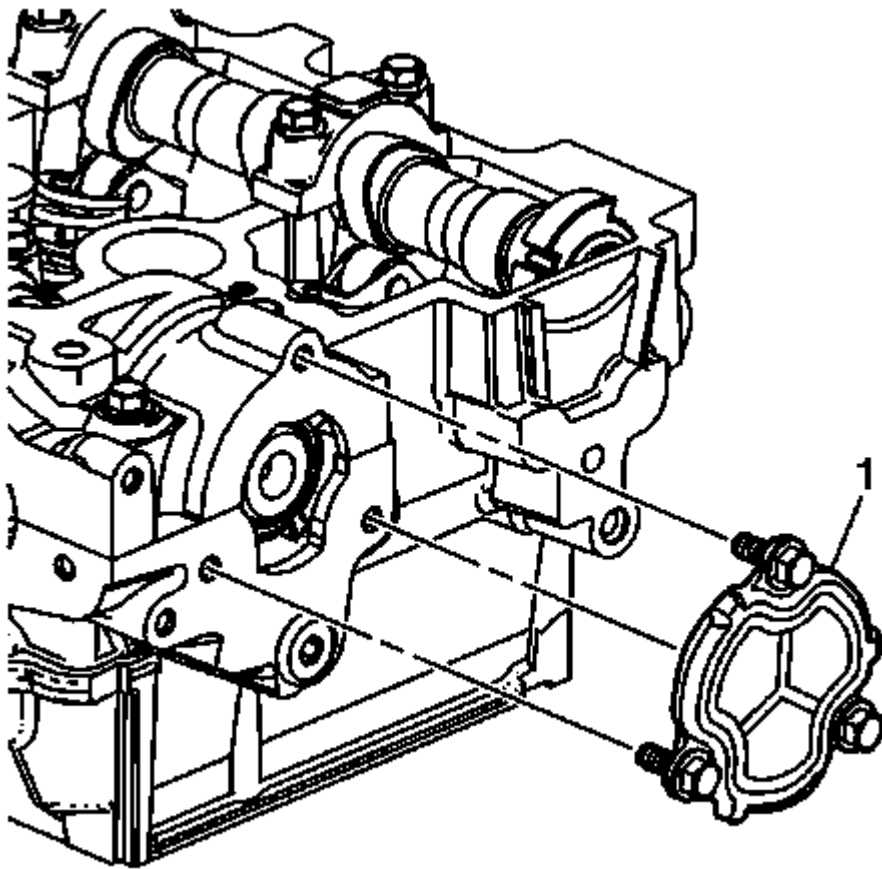


Fig. 165: Rear Cylinder Head Cover Plate
Courtesy of GENERAL MOTORS COMPANY

17. Verify the seal on the cylinder head cover plate (1) is intact and in good condition.
18. Ensure that the opening plate sealing surface is clean and free of excess sealing material. Install the rear cylinder head opening plate (1) and tighten the bolts to 10 N.m (89 lb in).

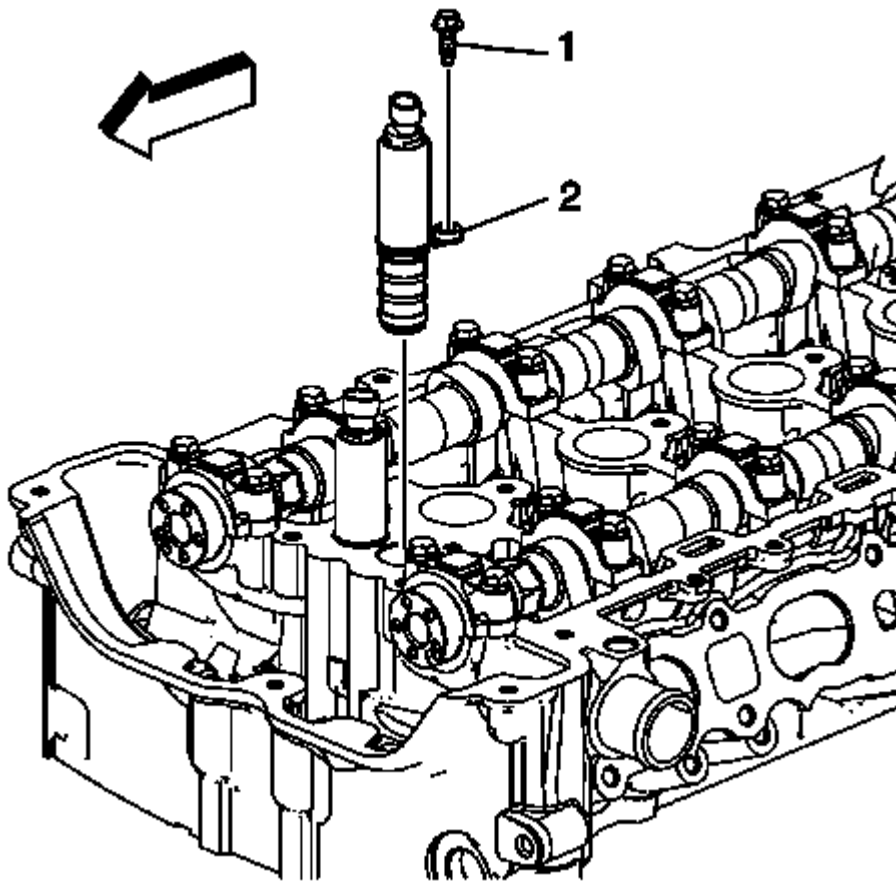


Fig. 166: Intake Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

19. Install the intake camshaft position actuator solenoid valve (2). Tighten the solenoid valve bolt (1) to 10 N.m (89 lb in).
20. Install the intake camshaft position actuator. Refer **Camshaft Position Intake Actuator Replacement**.

EXHAUST CAMSHAFT AND VALVE LIFTER REPLACEMENT

Removal Procedure

1. Remove the exhaust camshaft position actuator. Refer to **Camshaft Position Exhaust Actuator Replacement**.

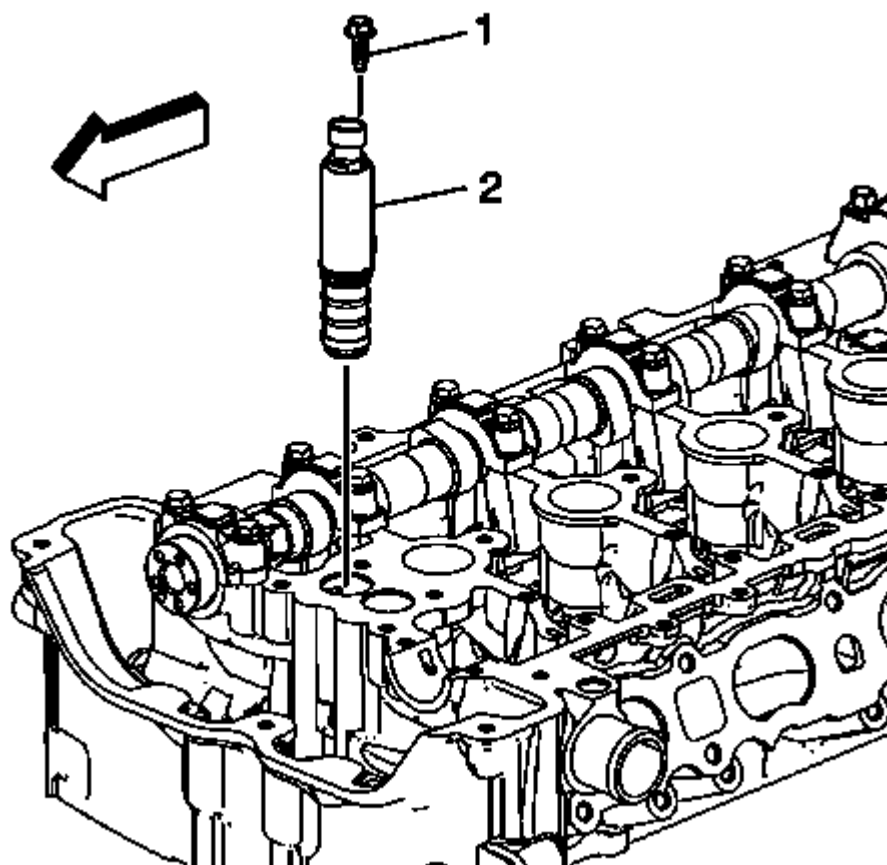


Fig. 167: Exhaust Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the exhaust camshaft position actuator solenoid valve bolt (1) and valve (2).

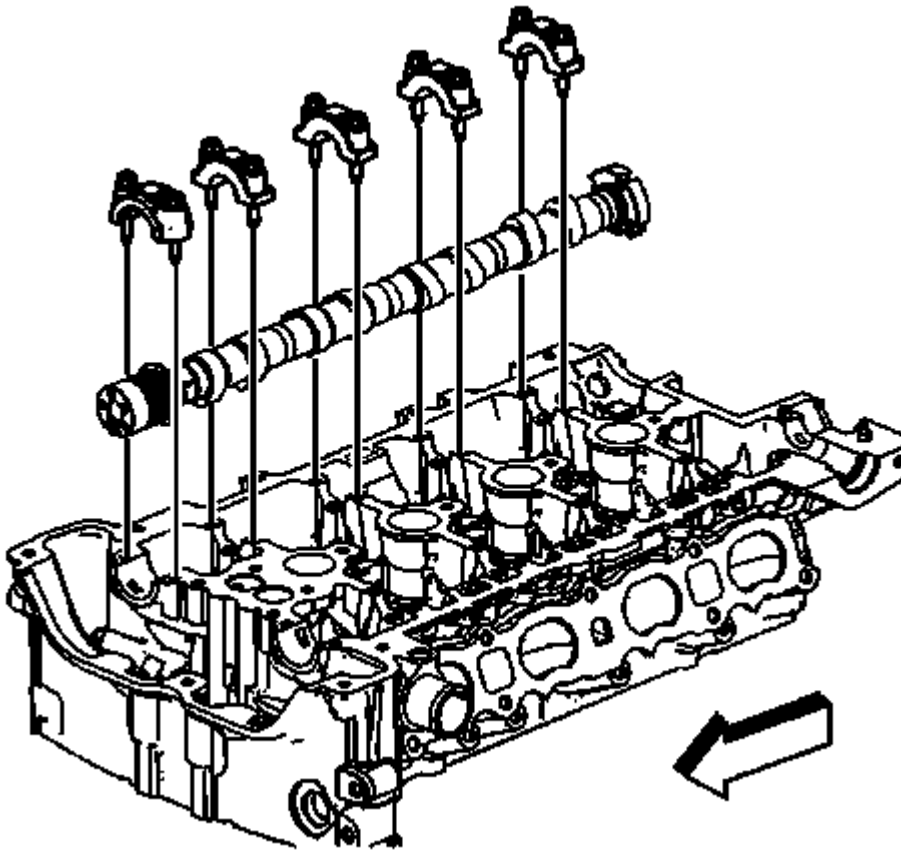


Fig. 168: Exhaust Camshaft & Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: Remove each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

3. Mark camshaft caps to ensure they are installed in the same position.
4. Remove the exhaust camshaft cap bolts.
5. Remove the camshaft caps ensuring they are marked and refitted in same position on assembly.
6. Remove the exhaust camshaft.

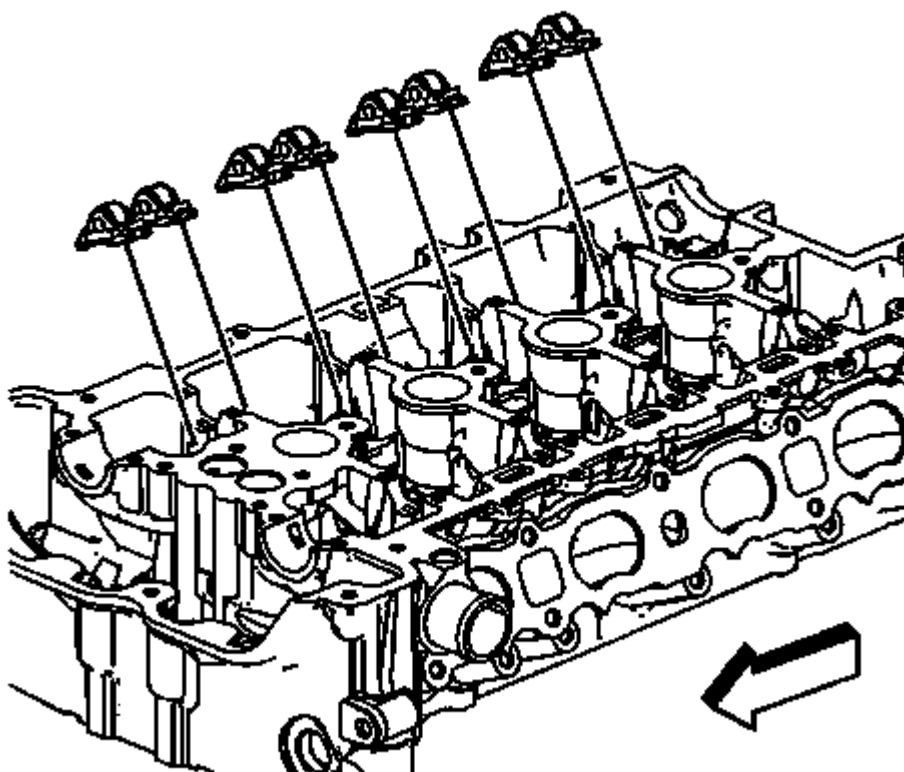


Fig. 169: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the roller finger followers and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

7. Remove the exhaust camshaft roller finger followers.

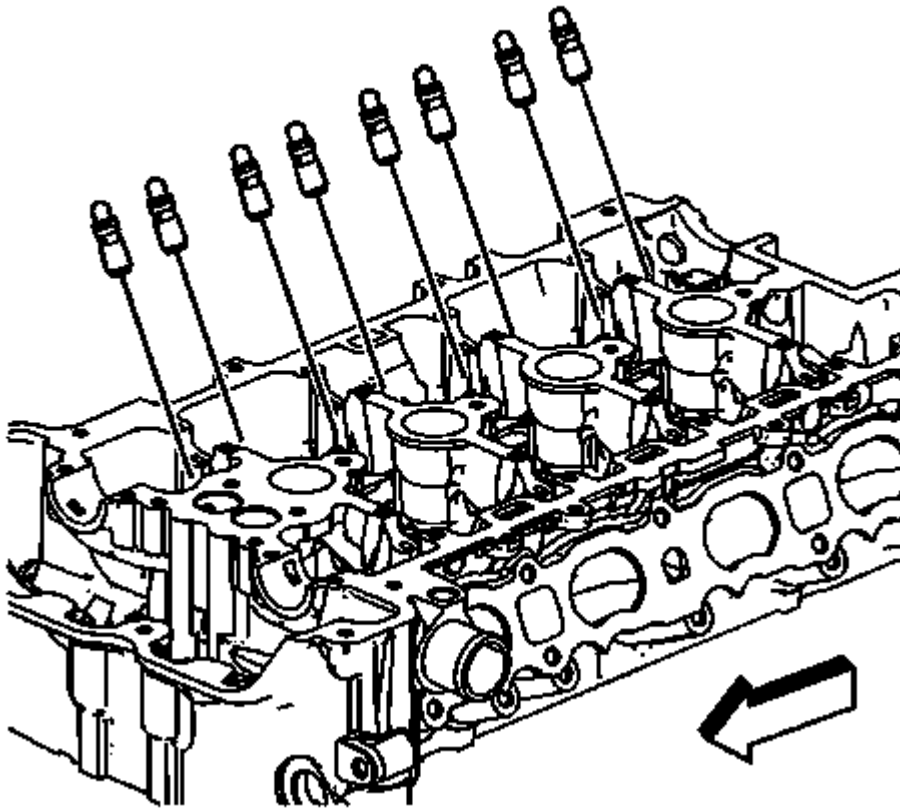


Fig. 170: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

8. Remove the hydraulic lash adjusters.

Installation Procedure

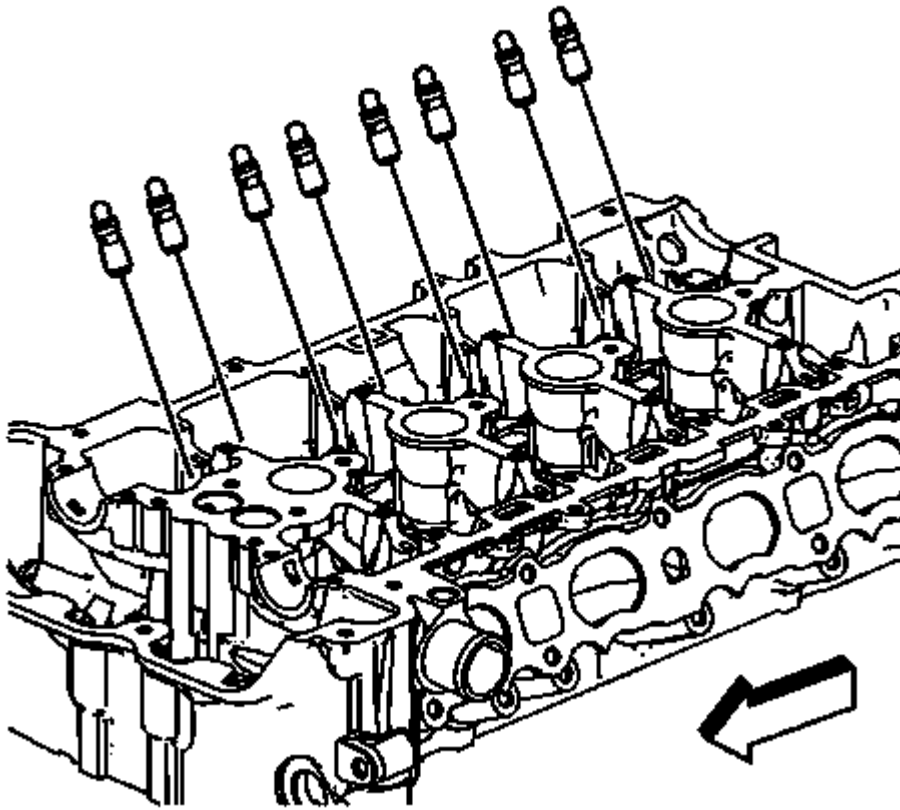


Fig. 171: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

1. Install the hydraulic lash adjusters into their bores in the cylinder head and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

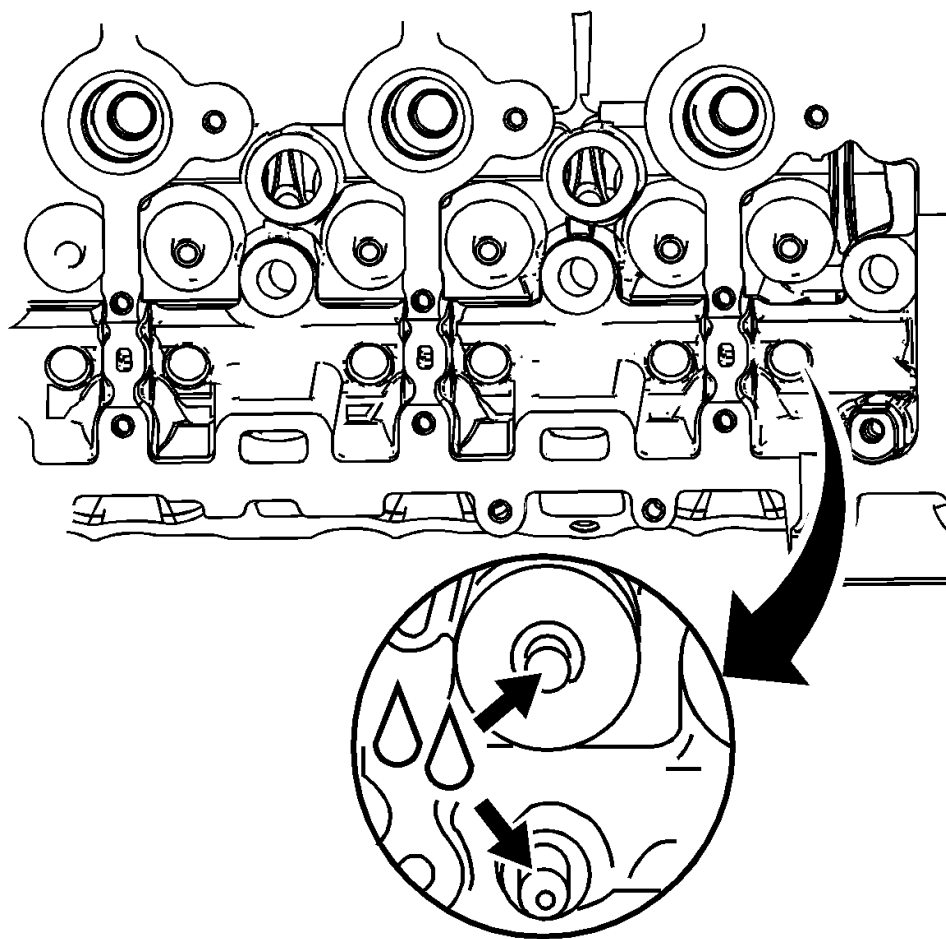


Fig. 172: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

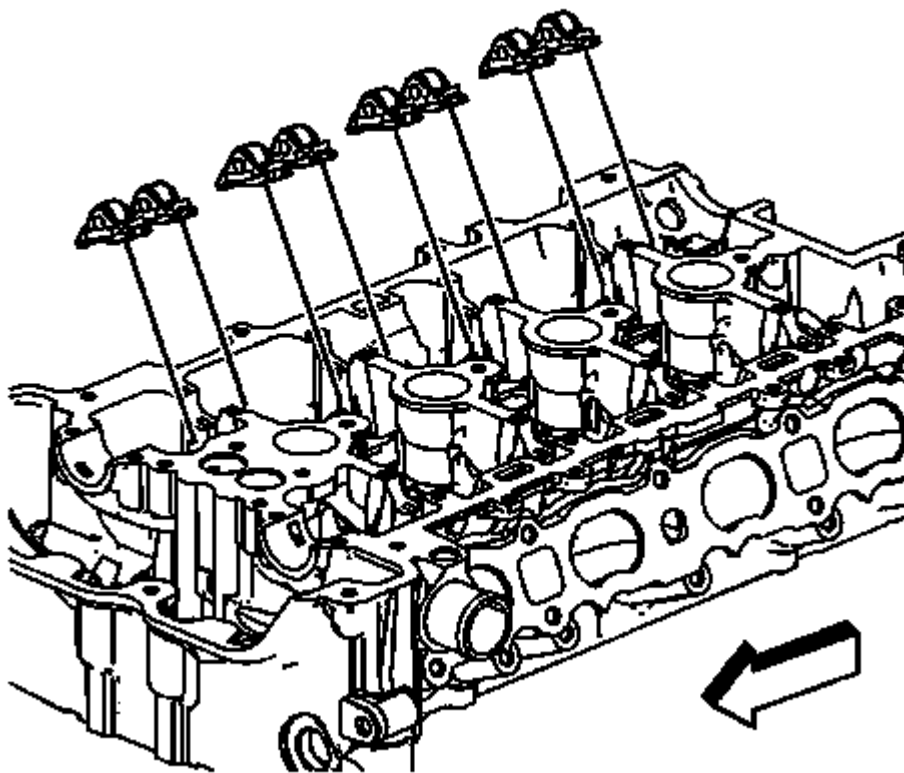


Fig. 173: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Used roller followers must be returned to the original position on the camshaft. If the camshaft is being replaced, the roller followers actuated by the camshaft must also be replaced.

3. Position the roller followers on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

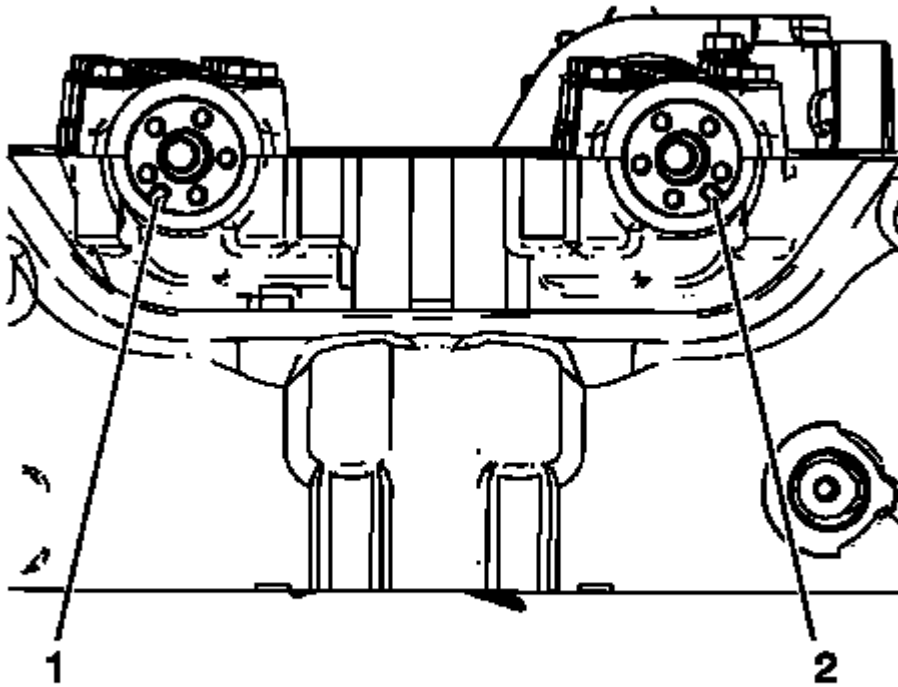


Fig. 174: Identifying Proper Exhaust/Intake Camshaft Alignment positions
Courtesy of GENERAL MOTORS COMPANY

NOTE: If equipped with the following engine; LE5, LE9, LAT, LNF, LDK, LHU, LTD, LBN, ensure the intake camshaft notch is in the 5 o'clock position and the exhaust camshaft notch is in the 7 o'clock position.

4. Ensure the intake camshaft notch is in the 5 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

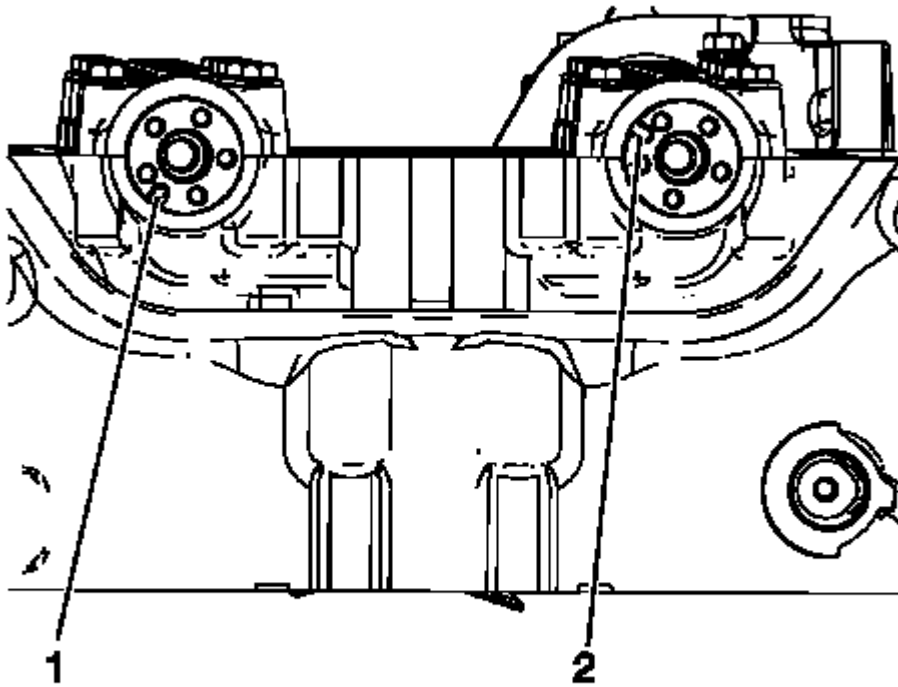


Fig. 175: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: If equipped with following engine; LEA, LUK, ensure the intake camshaft notch is in the 10 o'clock position and the exhaust camshaft notch is in the 7 o'clock position.

5. Ensure the intake camshaft notch is in the 10 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

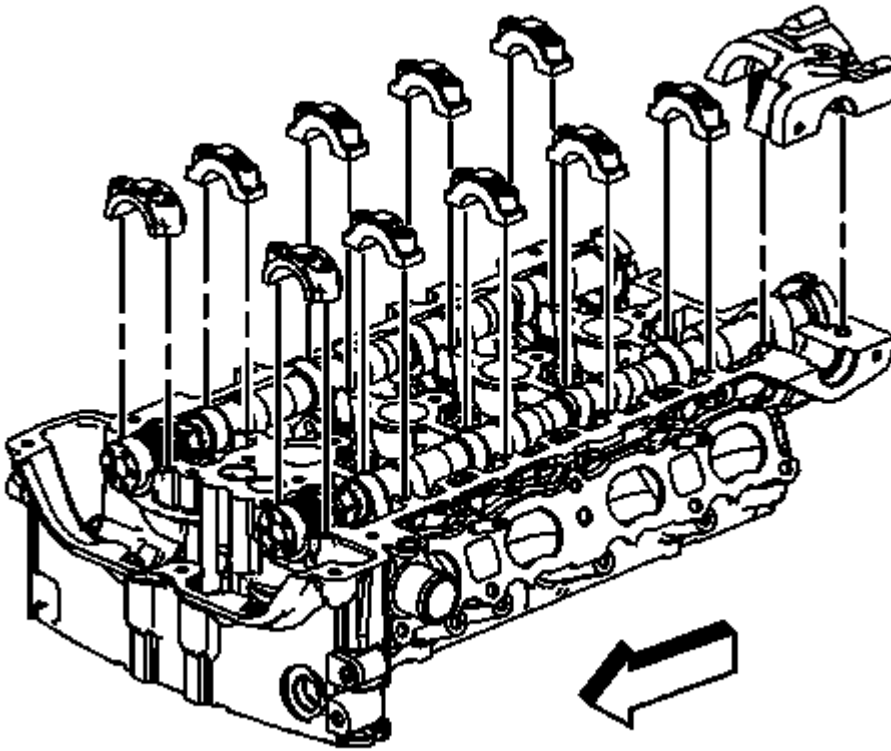


Fig. 176: Intake Camshaft & Caps
Courtesy of GENERAL MOTORS COMPANY

6. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

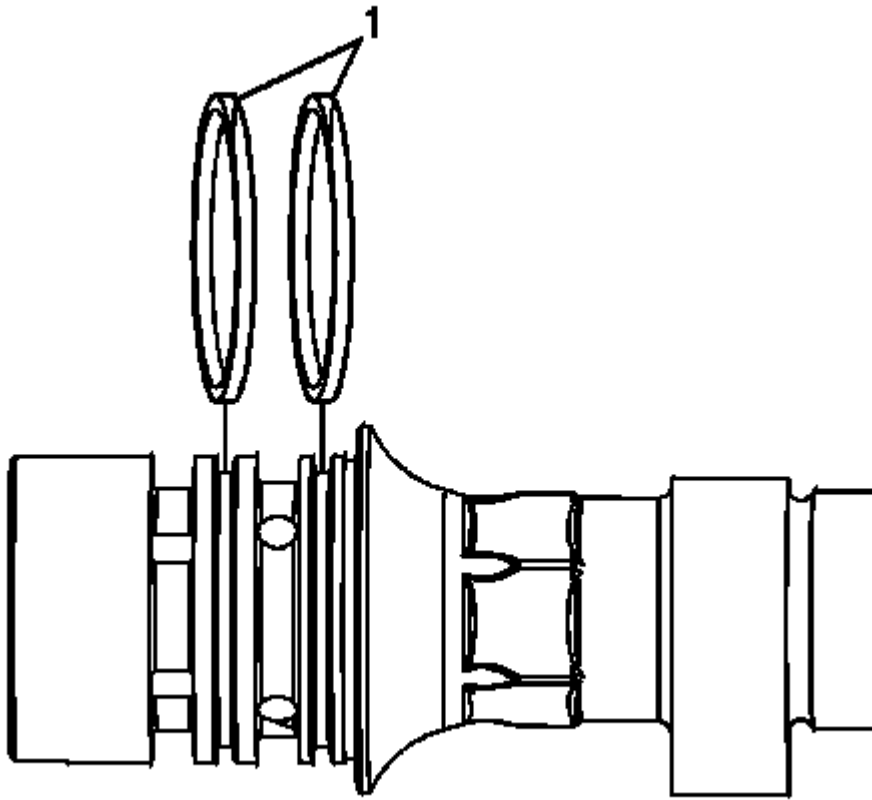


Fig. 177: Oil Seals

Courtesy of GENERAL MOTORS COMPANY

7. Rotate the oil seal in the groove of the number one camshaft journal so the split line (1) is at approximately the 12:00 position before installing the camshaft caps.

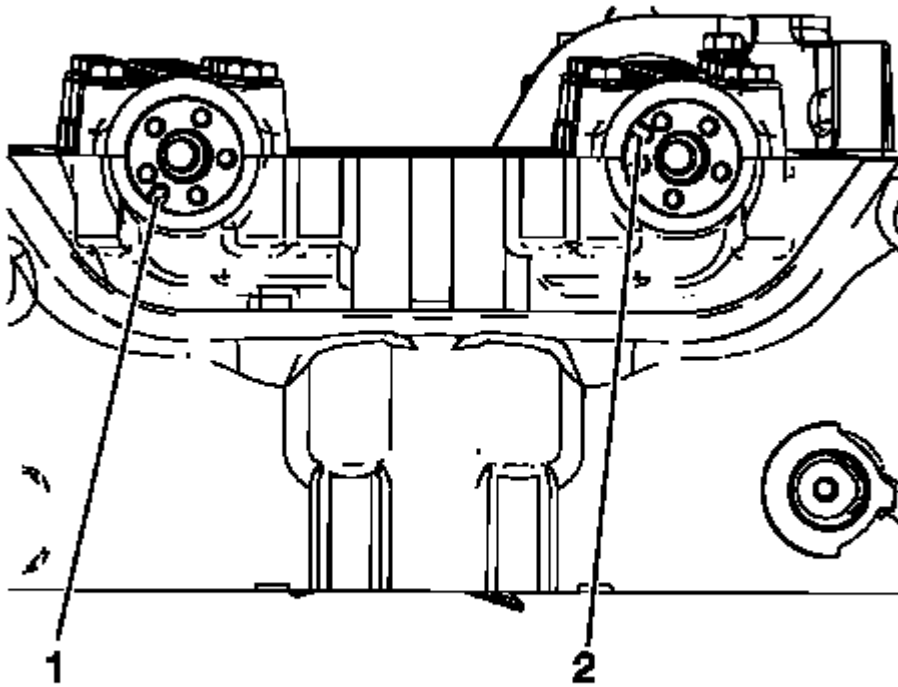


Fig. 178: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust camshaft with the notch on the front (1) at approximately the 7 o'clock position.
9. Install the camshaft caps and hand start the camshaft cap bolts.

CAUTION: Refer to Fastener Caution .

10. Tighten the camshaft cap bolts in increments of 3 turns until they are seated. Tighten the camshaft caps to 10 N.m (89 lb in).

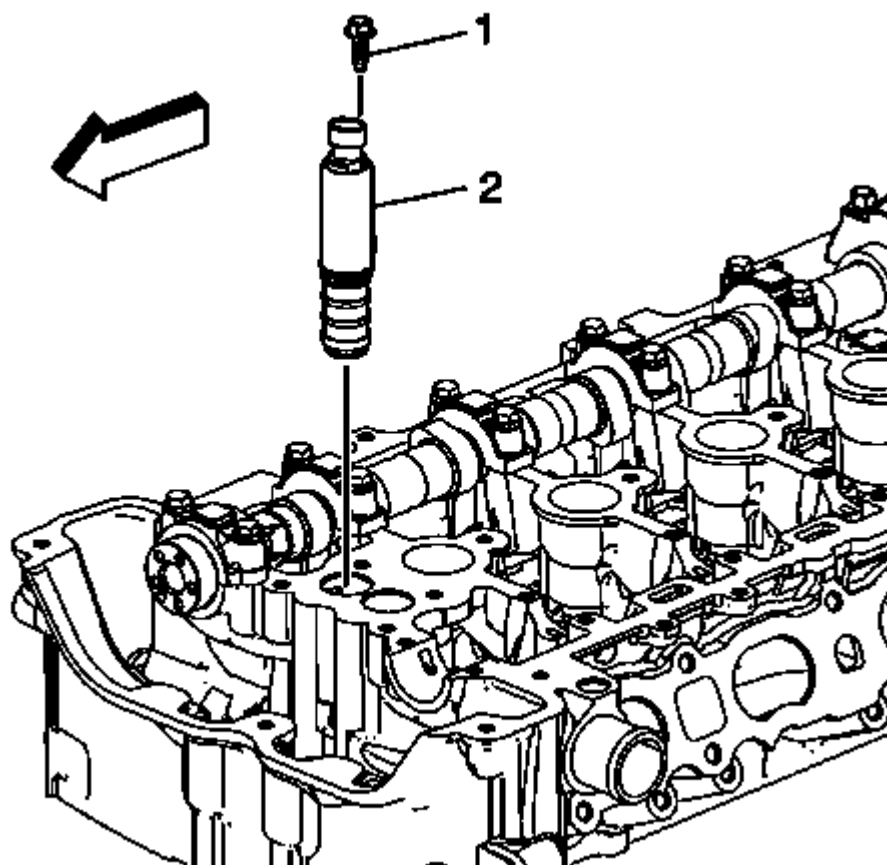


Fig. 179: Exhaust Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Install the exhaust camshaft position actuator solenoid valve (2). Tighten the solenoid valve bolt (1) to 10 N.m (89 lb in).
12. Install the exhaust camshaft position actuator. Refer to **Camshaft Position Exhaust Actuator Replacement**.

CAMSHAFT POSITION INTAKE ACTUATOR REPLACEMENT

Special Tools

- **EN-45059** Angle Meter
- **EN-48749** Timing Chain Retention Tool Kit
- **EN-48953** Camshaft Actuator Locking Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**, **Camshaft Cover**

Replacement (LEA).

2. Remove the spark plugs. Refer to **Spark Plug Replacement** .

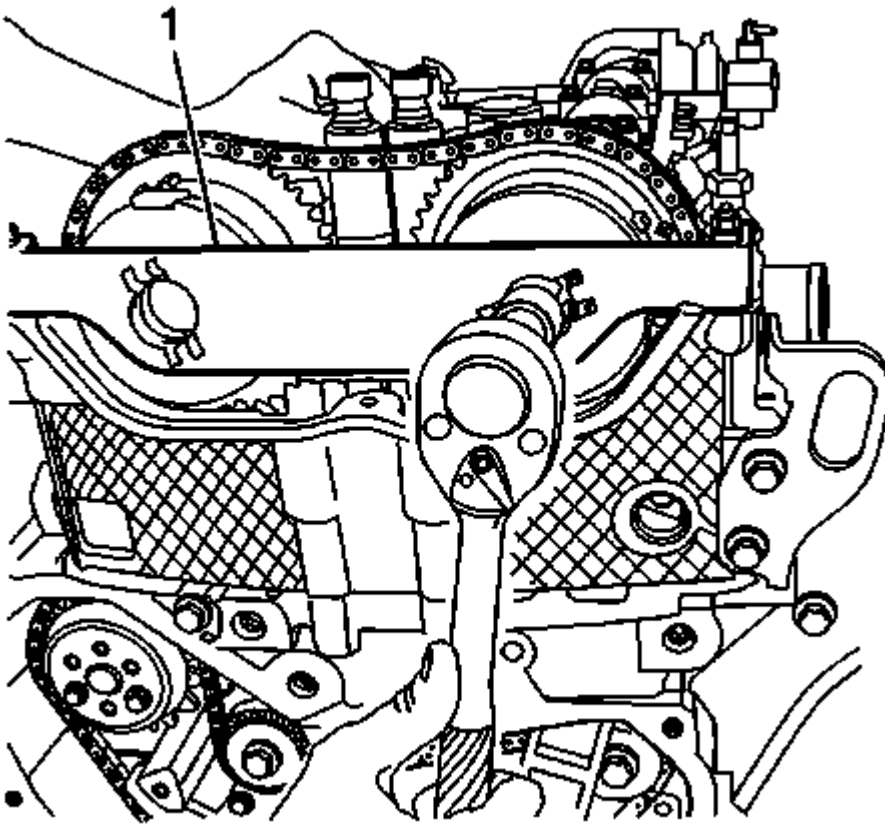


Fig. 180: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Rotate the crankshaft clockwise and install the **EN-48953** retention tool (1).

CAUTION: Refer to **Fastener Caution** .

4. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
5. Loosen, but DO NOT remove the intake camshaft actuator bolt.
6. Remove the **EN-48953** locking tool (1).
7. Clean the timing chain and gears with solvent.

NOTE: **Ensure the timing chain and the camshaft position actuators are marked for proper assembly.**

8. Mark the intake and exhaust camshaft actuators and the respective locations on the timing chain.

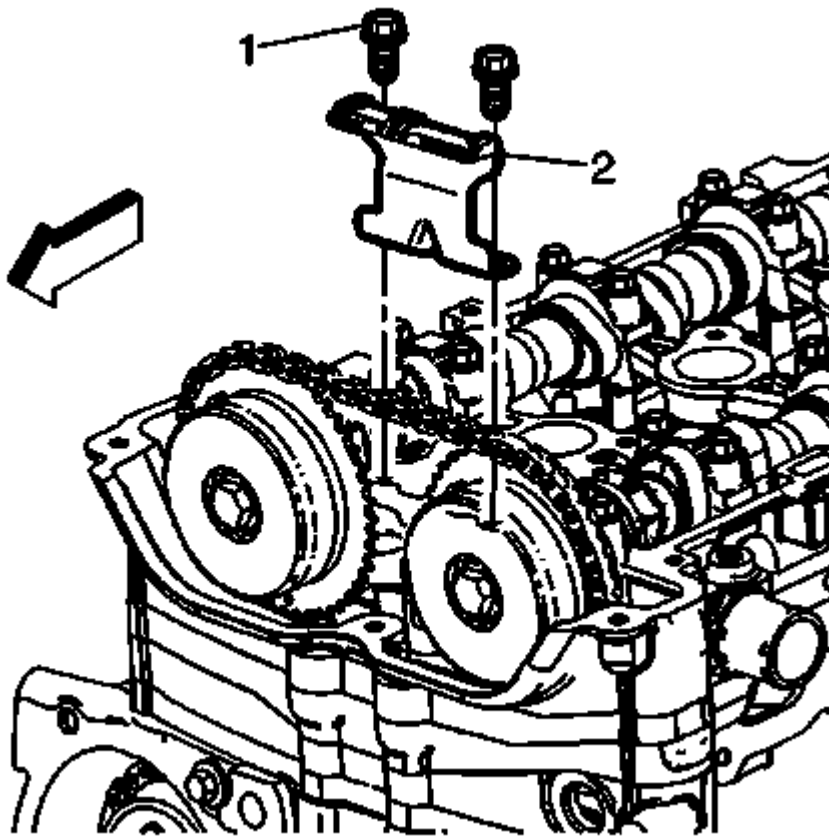


Fig. 181: Upper Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

9. Remove the upper timing chain guide bolts (1) and guide (2).

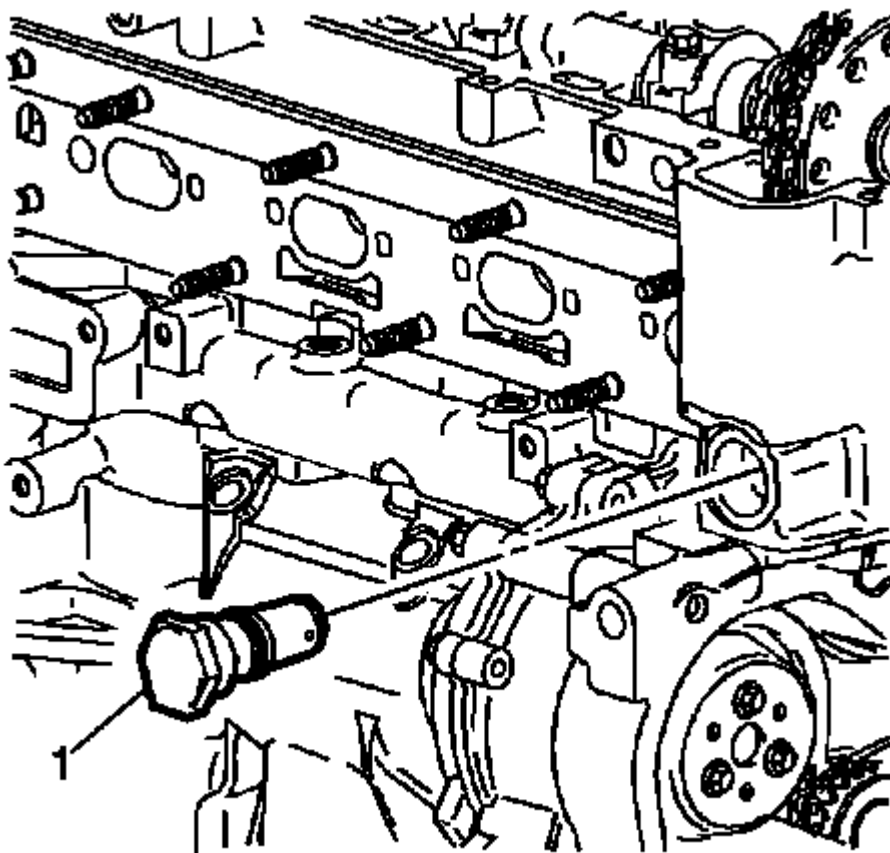


Fig. 182: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain tensioner (1).

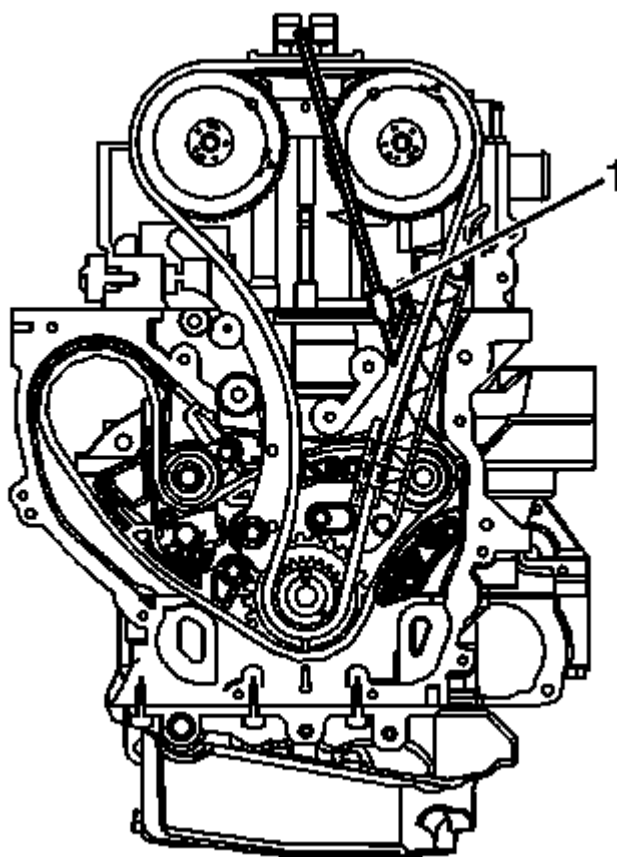


Fig. 183: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The intake camshaft actuator should not rotate during the removal or installation.
- Ensure the tips of the tool are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

11. Install the **EN-48749** retention tool (1) to the intake side of the timing chain.

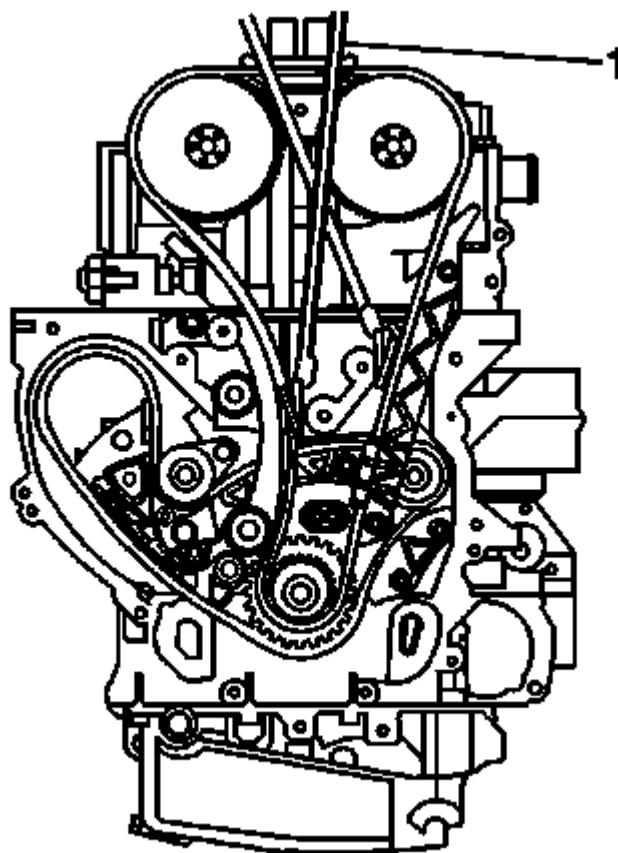


Fig. 184: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

12. Install the **EN-48749** retention tool (1) to the exhaust side of the timing chain.

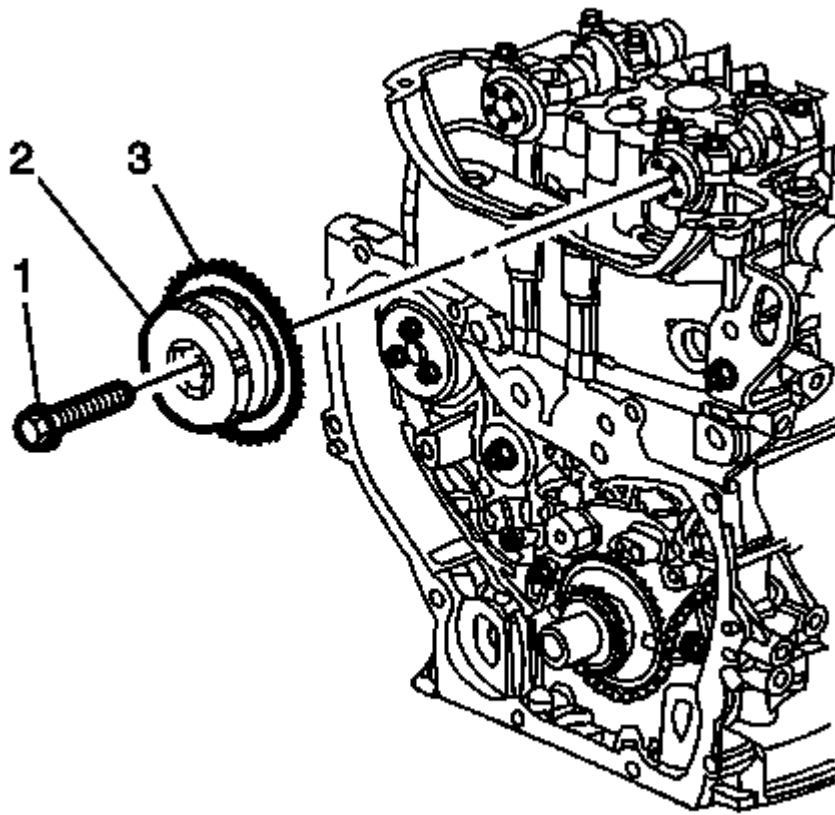


Fig. 185: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

13. Remove and discard the intake camshaft actuator bolt (1).
14. Rotate the exhaust camshaft clockwise slightly to take the tension off of the timing chain on the intake actuator.
15. Remove the intake camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

Installation Procedure

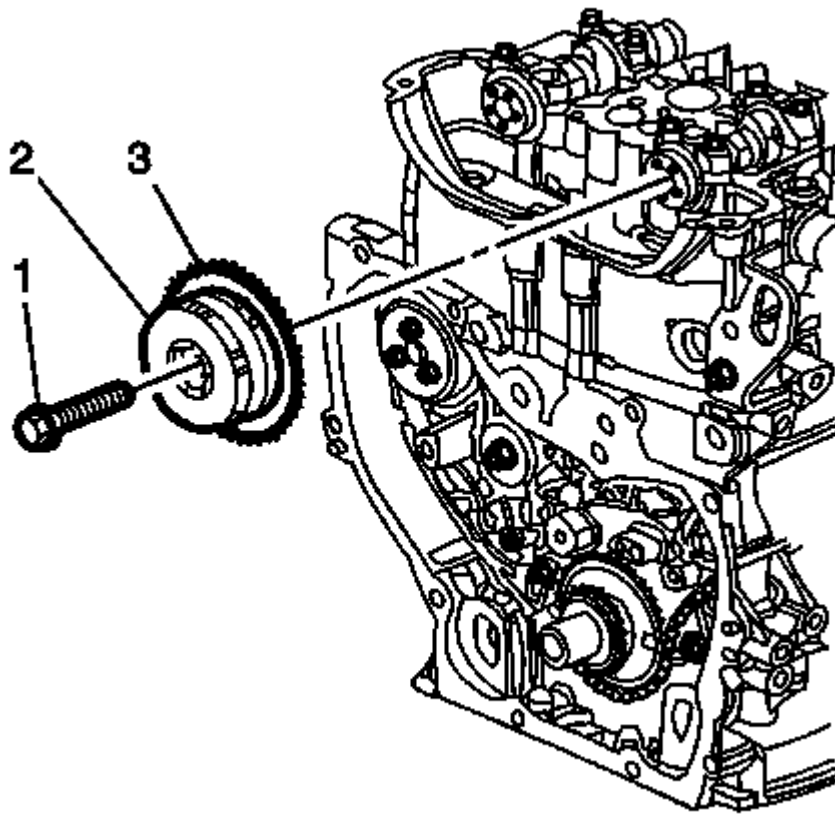


Fig. 186: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain.

1. Install the timing chain onto the intake camshaft actuator.
2. Align the intake camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft rotating the exhaust camshaft clockwise, if required.
3. Install a NEW intake camshaft actuator bolt (1) until snug.

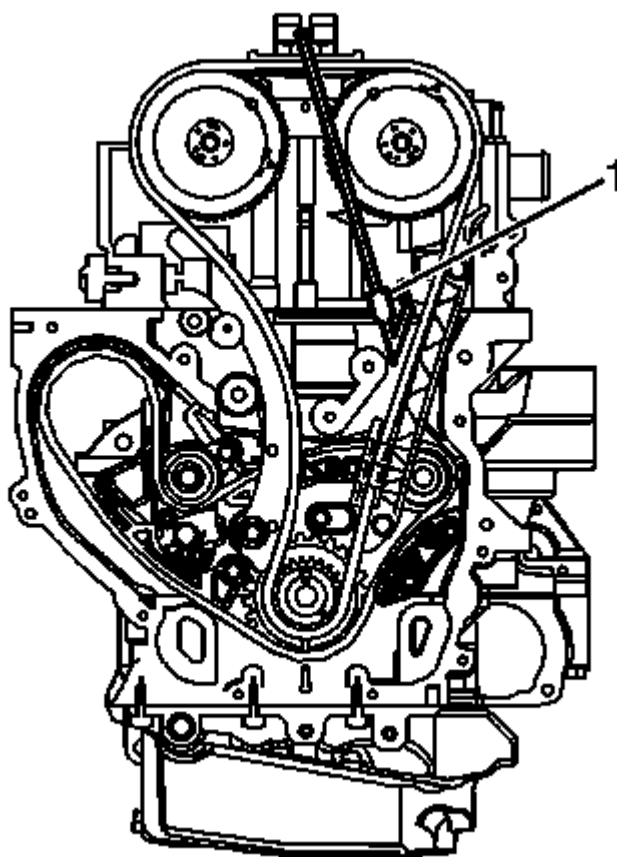


Fig. 187: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain retention tool (1) from the intake side of the timing chain.

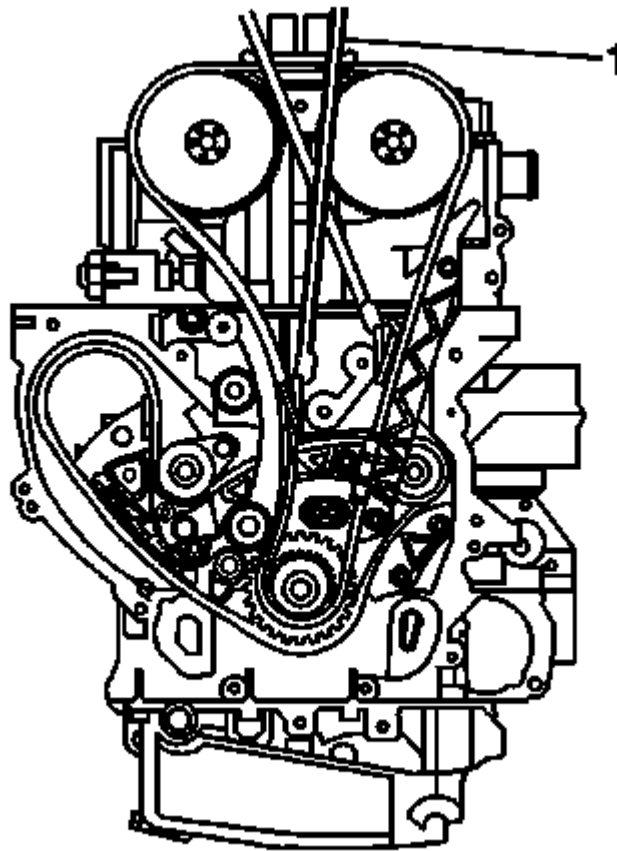


Fig. 188: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the alignment mark previously on the intake camshaft actuator is still aligned properly with the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

5. Remove the timing chain retention tool (1) from the exhaust side of the timing chain.

NOTE: Failure to reset the tensioner will allow the tensioner to over extend, limiting the timing chain life.

6. Reset and install the timing chain tensioner. Refer to Timing Chain Tensioner Replacement.

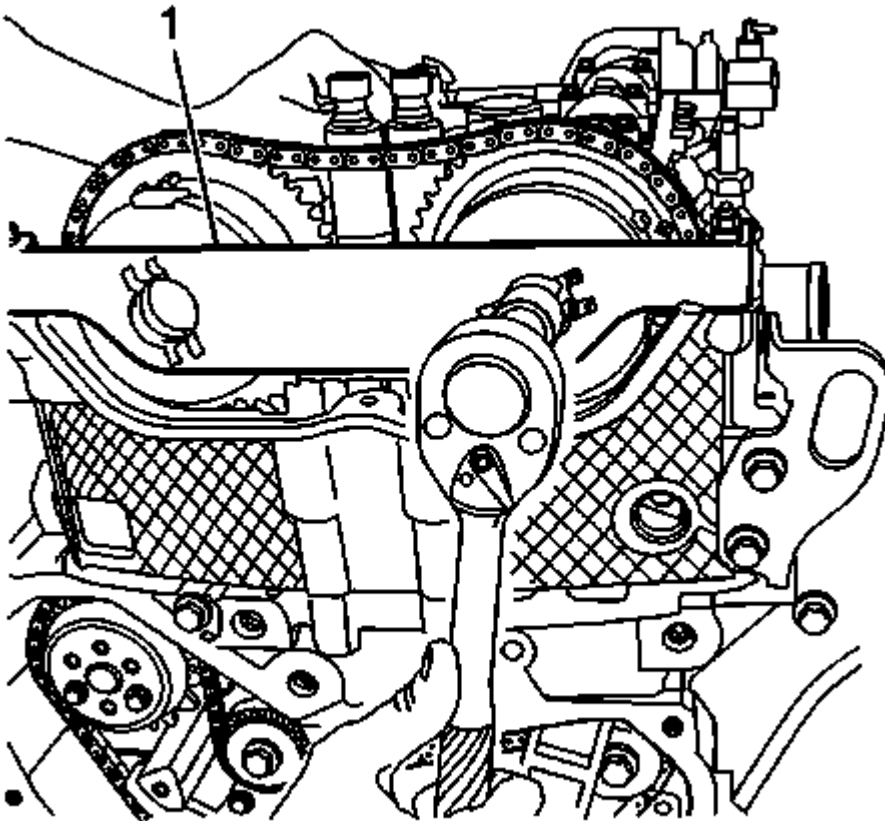


Fig. 189: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-48953** retention tool (1) .
8. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
9. Tighten the NEW camshaft actuator bolt to 30 N.m (22 lb ft) plus an additional 100 degrees using the **EN-45059** meter.

NOTE: **You must have the EN-48953 retention tool installed to perform this procedure.**

10. To release the tensioner apply a counterclockwise rotational torque to the crankshaft balancer bolt of 45 N.m (33 lb ft).
11. Remove the **EN-48953** retention tool (1).

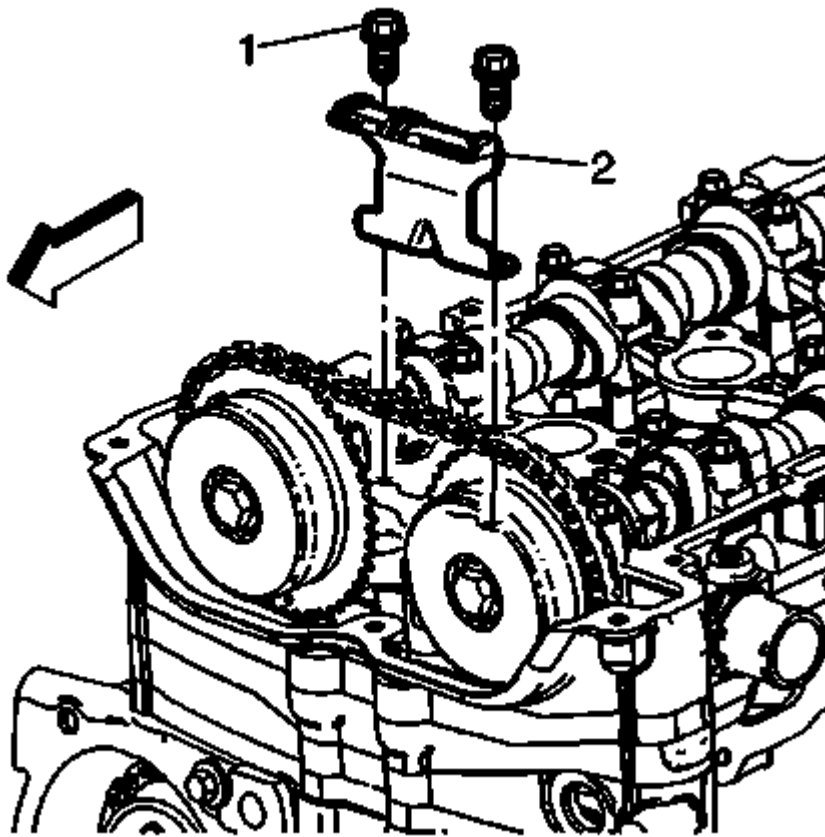


Fig. 190: Upper Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

12. Install the upper timing chain guide (2) and bolts (1) and tighten to 10 N.m (89 lb in).
13. Install the spark plugs. Refer to **Spark Plug Replacement** .
14. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**, **Camshaft Cover Replacement (LEA)**.

CAMSHAFT POSITION EXHAUST ACTUATOR REPLACEMENT

Special Tools

- **EN-45059** Angle Meter
- **EN-48749** Timing Chain Retention Tool Kit
- **EN-48953** Camshaft Actuator Locking Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**, **Camshaft Cover**

Replacement (LEA).

2. Remove the spark plugs. Refer to **Spark Plug Replacement** .

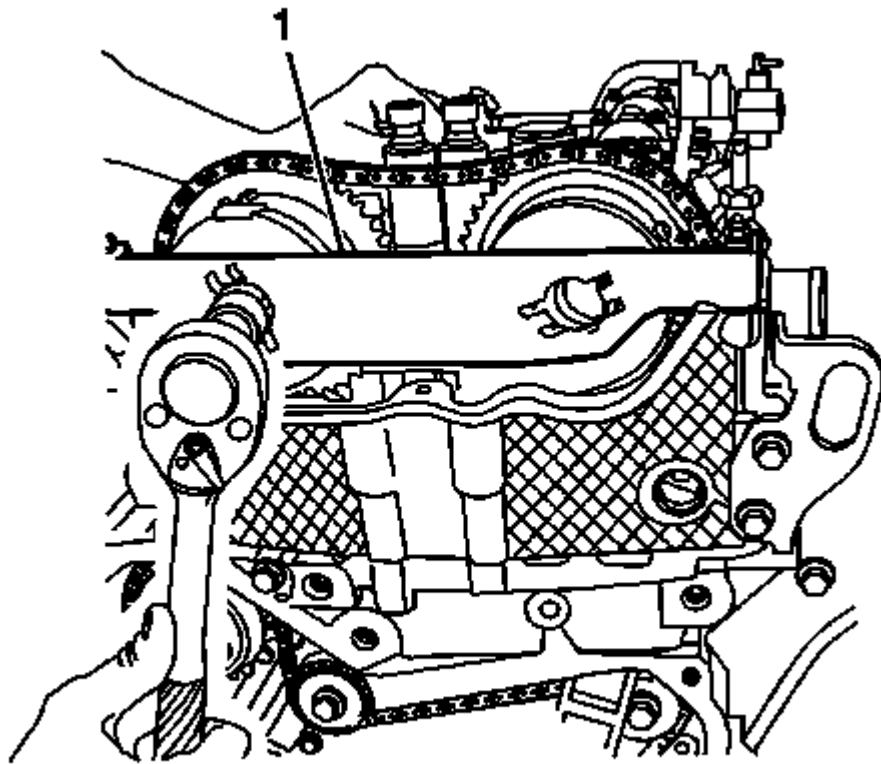


Fig. 191: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Rotate the crankshaft clockwise and install the **EN-48953** locking tool (1).

CAUTION: Refer to **Fastener Caution** .

4. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
5. Loosen, but do not remove the exhaust camshaft actuator bolt.
6. Remove the **EN-48953** locking tool (1).
7. Clean the timing chain and gears with solvent.

NOTE: **Ensure the timing chain and the camshaft position actuators are marked for proper assembly.**

8. Mark the intake and exhaust camshaft actuators and the respective locations on the timing chain.

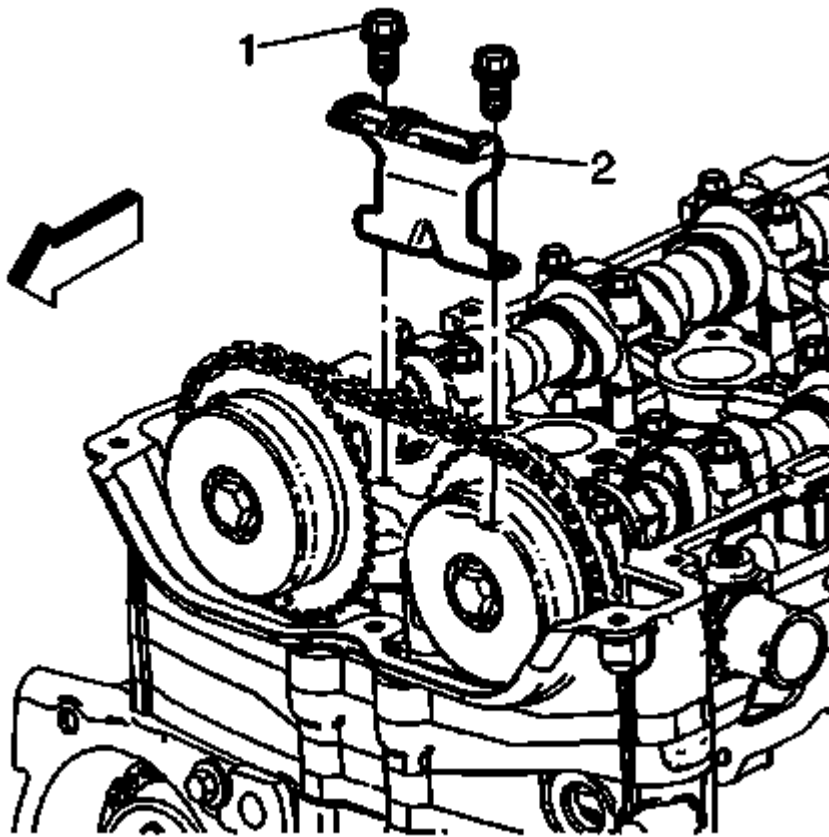


Fig. 192: Upper Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

9. Remove the upper timing chain guide bolts (1) and guide (2).

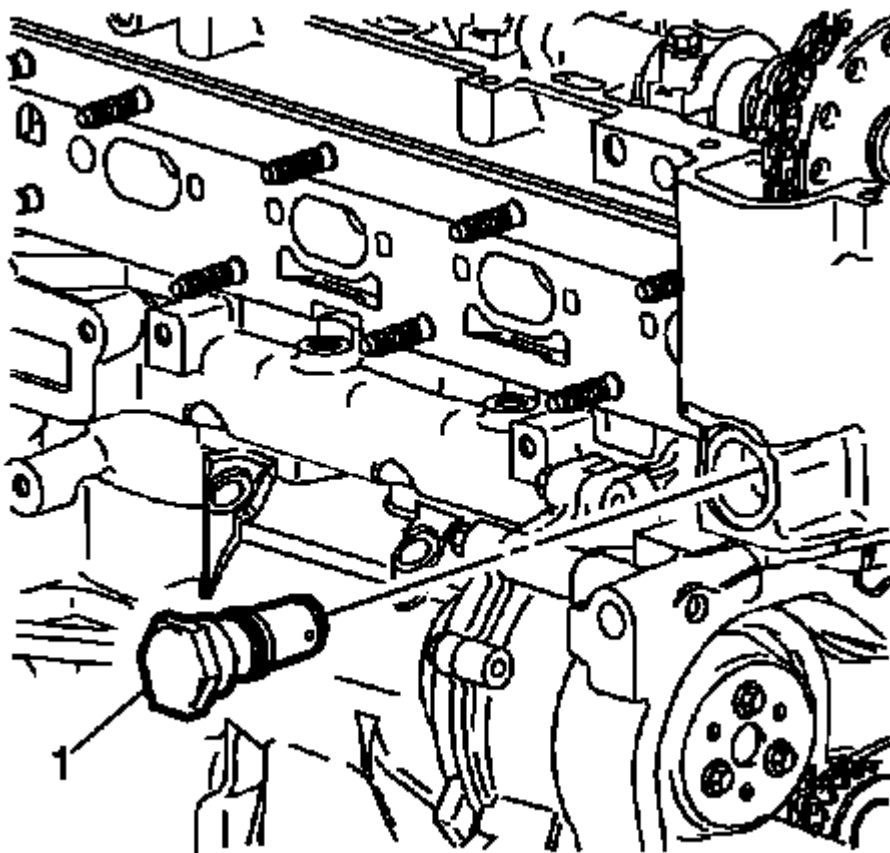


Fig. 193: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain tensioner (1).

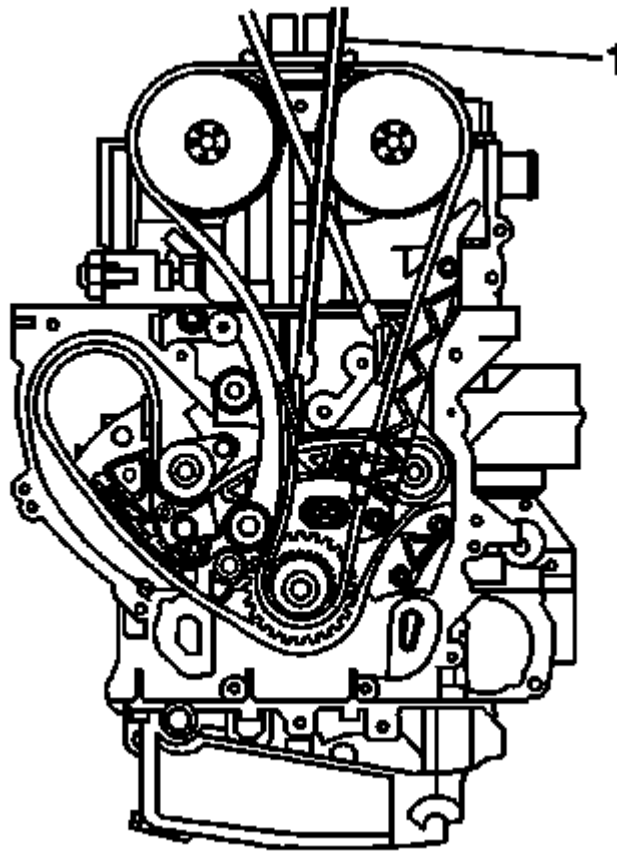


Fig. 194: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The camshaft actuators should not rotate during the removal or installation.
- Ensure the tips of the EN-48749 retention tool are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

11. Install the **EN-48749** retention tool (1) to the exhaust side of the timing chain.

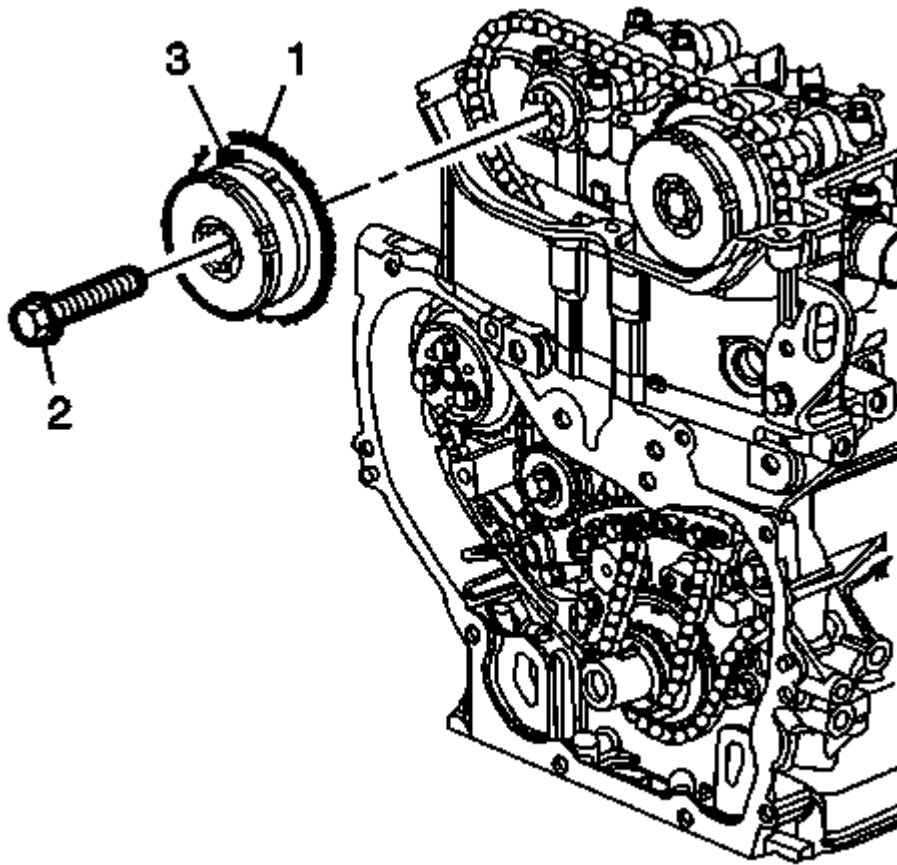


Fig. 195: Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

12. Remove and discard the exhaust camshaft actuator bolt (2).
13. Remove the exhaust camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

Installation Procedure

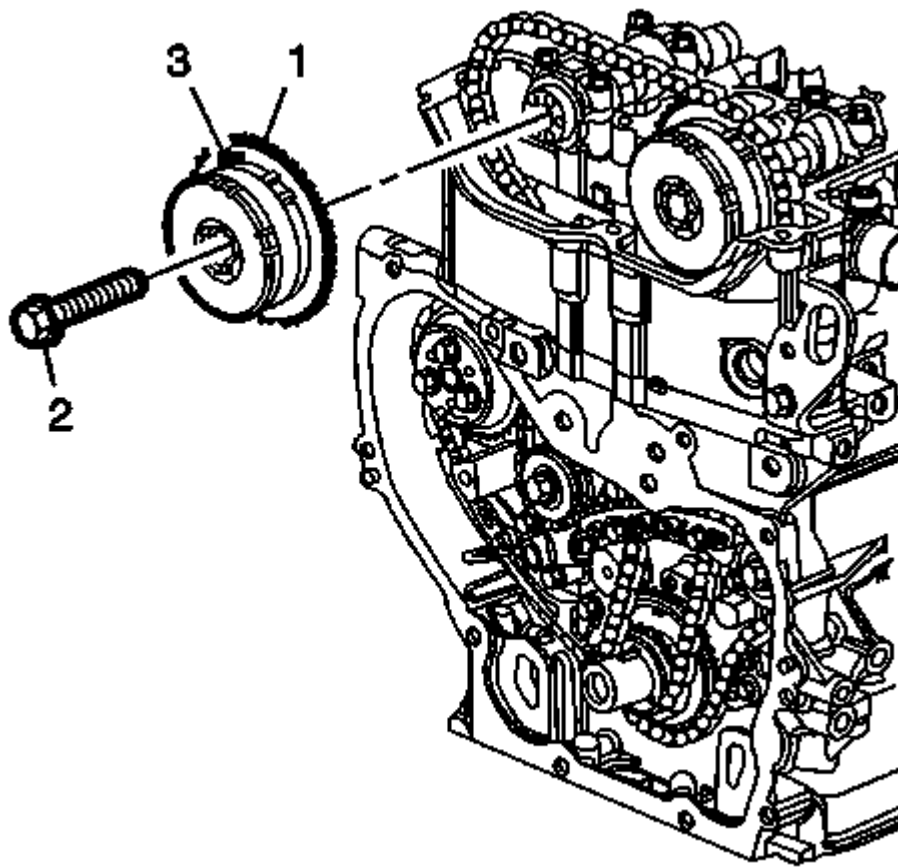


Fig. 196: Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain.
- The exhaust camshaft may need to be rotated clockwise to fully set the camshaft actuator.

1. Install the timing chain onto the exhaust camshaft actuator.
2. Align the exhaust camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
3. Install a NEW exhaust camshaft actuator bolt (2) until snug.

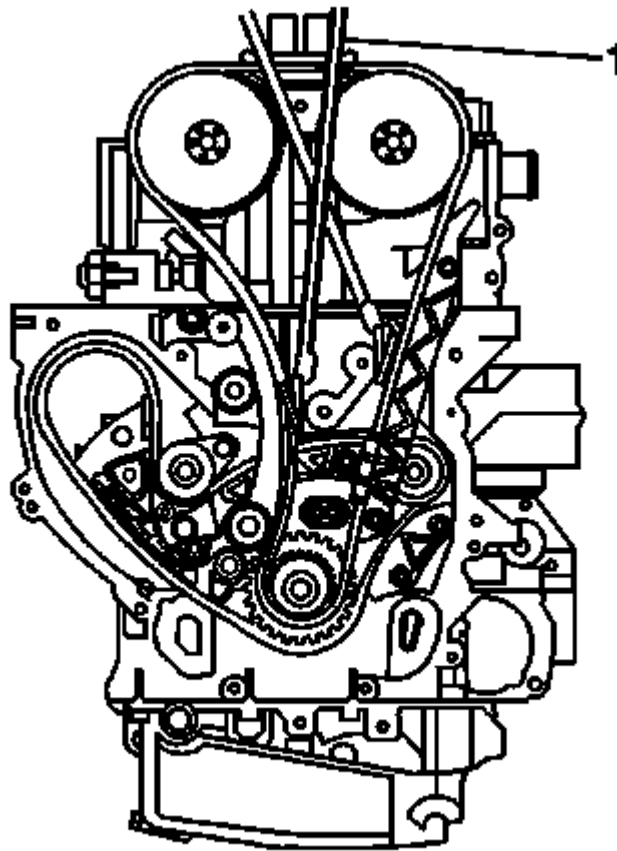


Fig. 197: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the alignment mark previously on the exhaust camshaft actuator is still aligned properly with the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

4. Remove the **EN-48749** retention tool (1) from the exhaust side of the timing chain.

NOTE: Failure to reset the tensioner will allow the tensioner to over extend, limiting the timing chain life.

5. Reset and install the timing chain tensioner. Refer to Timing Chain Tensioner Replacement.

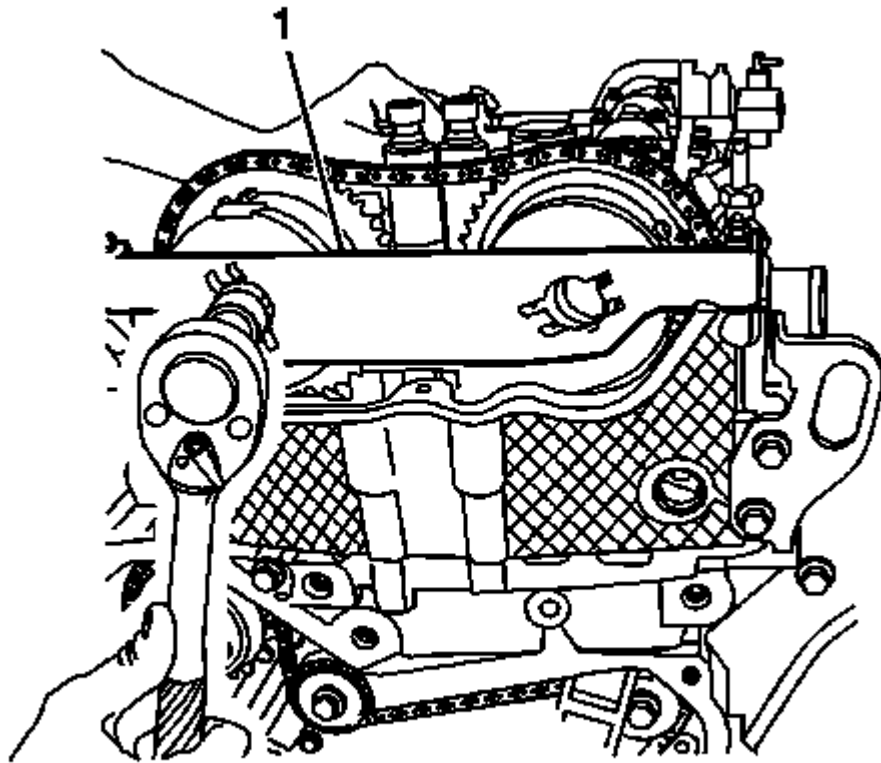


Fig. 198: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN-48953** locking tool (1).
7. Install the camshaft actuator retainer bolts and tighten 10 N.m (89 lb in).
8. Tighten the NEW camshaft actuator bolt to 30 N.m (22 lb ft) plus an additional 100 degrees using the **EN-45059** meter.

NOTE: **You must have the EN-48953 locking tool installed to perform this procedure.**

9. To release the tensioner apply a counterclockwise rotational torque to the crankshaft balancer bolt of 45 N.m (33 lb ft).

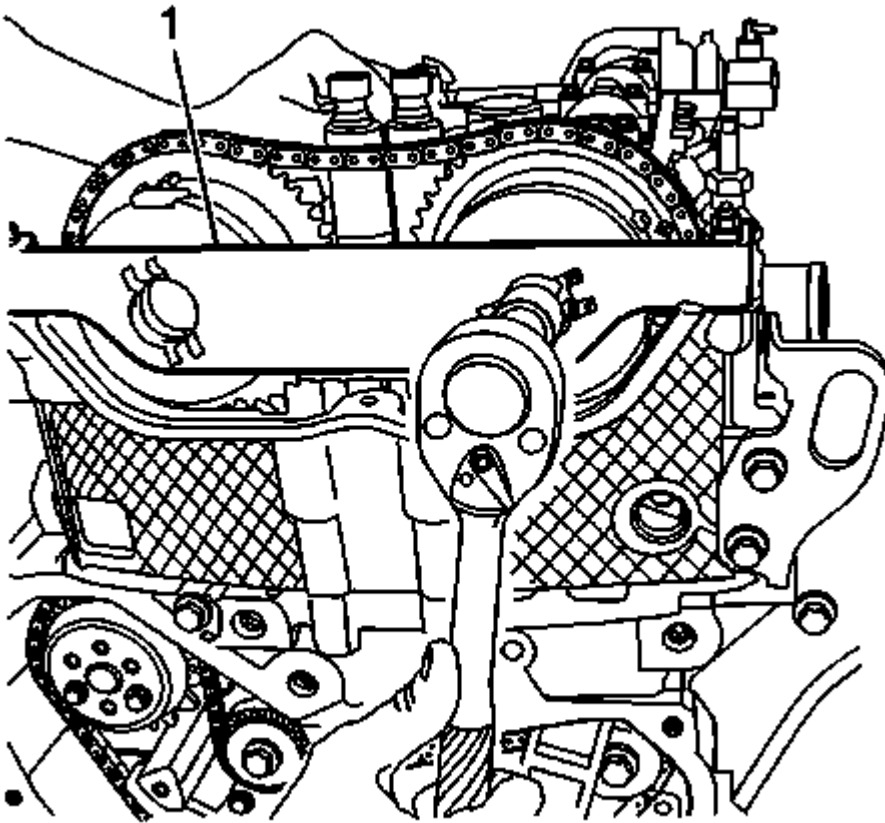


Fig. 199: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the camshaft actuator retainer **EN-48953** locking tool (1).

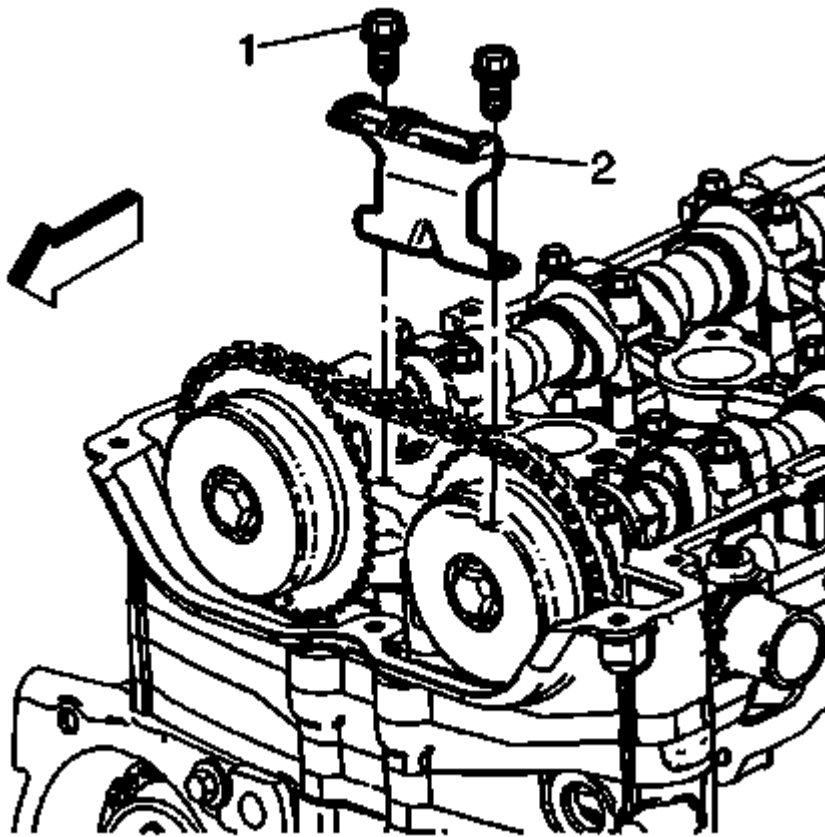


Fig. 200: Upper Timing Chain Guide
 Courtesy of GENERAL MOTORS COMPANY

11. Install the upper timing chain guide (2) and bolts (1) and tighten to 10 N.m (89 lb in).
12. Install the camshaft cover. Refer to Camshaft Cover Replacement (LUK), Camshaft Cover Replacement (LEA).
13. Install the spark plugs. Refer to Spark Plug Replacement .

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **EN-36017** Valve Guide Seal Remover
- **EN-43649** Valve Spring Compressor
- **EN-43649-10** Valve Spring Compressor Adaptor Set
- **EN-43653** Flywheel Holding Tool

For equivalent regional tools refer to Special Tools .

Removal Procedure

NOTE: This procedure is not used in Brazil.

NOTE: Prevent the crankshaft from rotating clockwise or counterclockwise before using compressed air in the cylinder. Rotation of the crankshaft may cause damage to EN-43653 holding tool.

1. If equipped, with a manual transmission leave the transmission in first gear with the vehicle on the ground and the parking brake set.
2. If equipped, with an automatic transmission, remove the starter. Refer to **Starter Replacement (LUK)** .
3. Install **EN-43653** holding tool.
4. Remove the camshaft. Refer to **Intake Camshaft and Valve Lifter Replacement**, or **Exhaust Camshaft and Valve Lifter Replacement**.

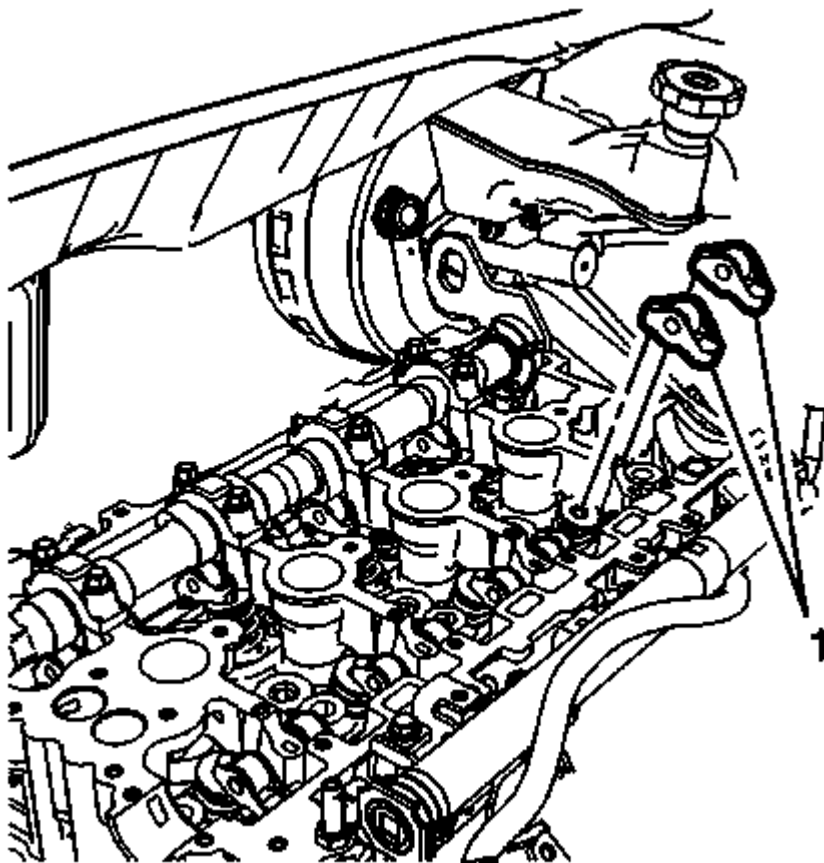


Fig. 201: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft roller followers (1).

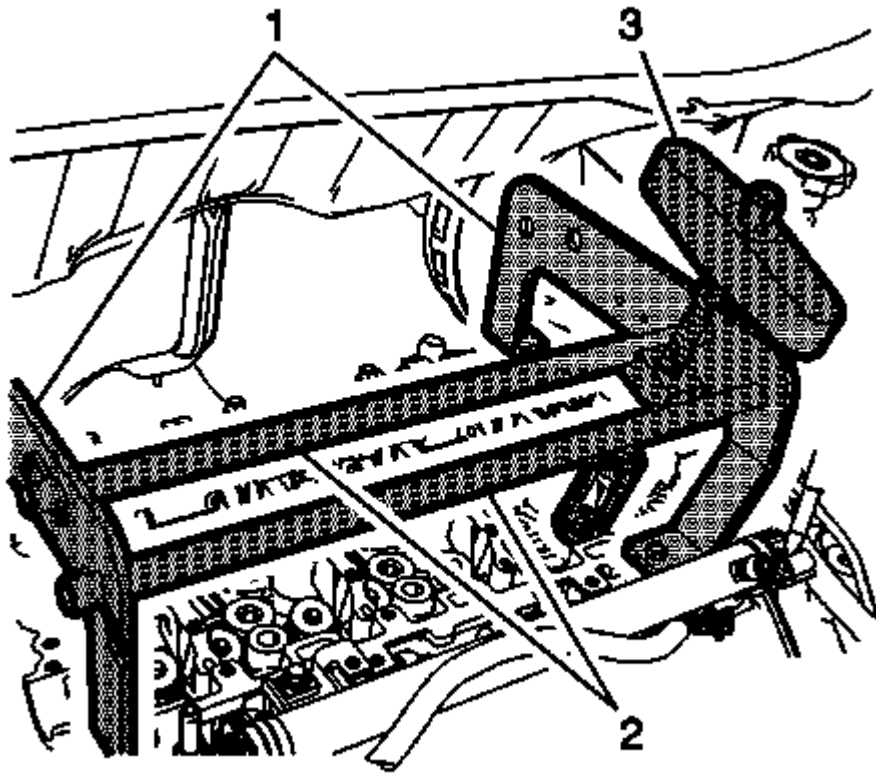


Fig. 202: View Of Valve Spring Compressor Adaptor Set
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN-43649-10** adaptor set (1) to the front and rear of the cylinder head.
7. Install the cross bars and locks (2) of the **EN-43649** compressor to the valve spring compressor adaptors.
8. Remove the spark plugs. Refer to **Spark Plug Replacement** .
9. Install an air hose adapter into the spark plug hole.
10. Attach an air hose to the adapter and pressurize the cylinder to 690 kPa (100 psi).
11. Compress the valve spring using the valve spring compressor (3).

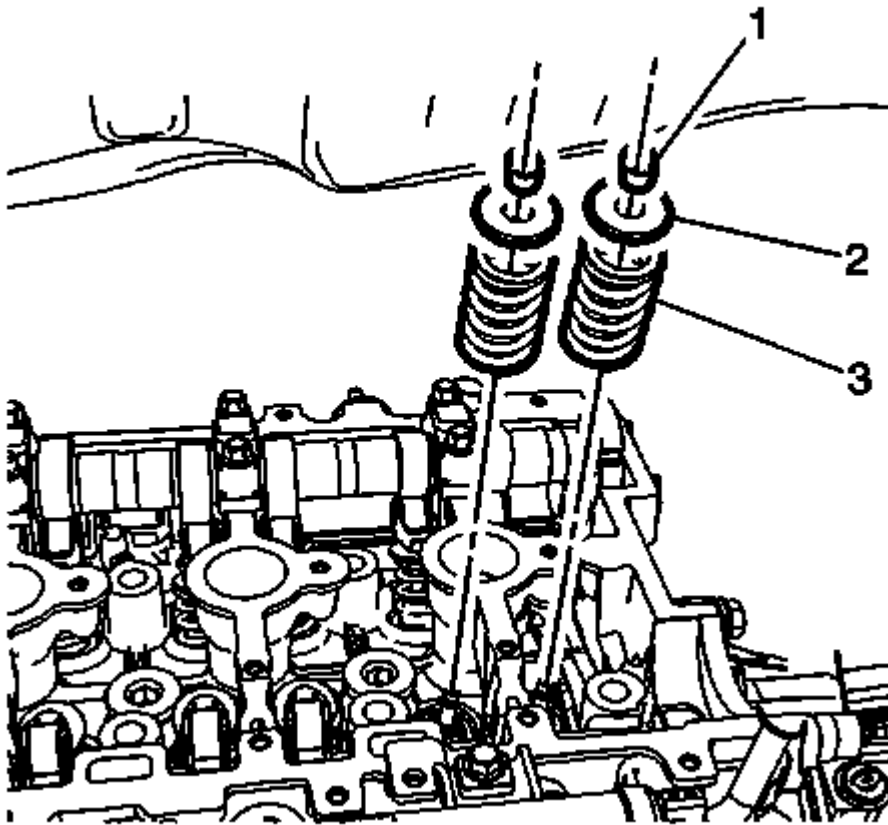


Fig. 203: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring keepers (1).
13. Remove the valve spring (3) and retainer (2).

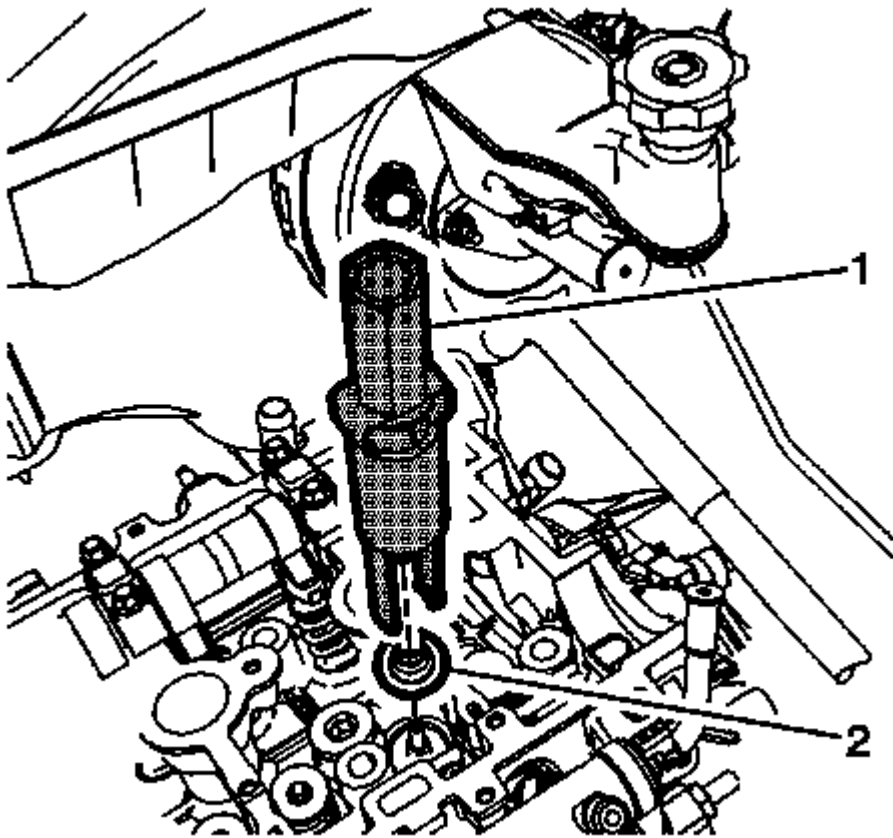


Fig. 204: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

14. Use the **EN-36017** seal remover (1) to remove the valve seal.

Installation Procedure

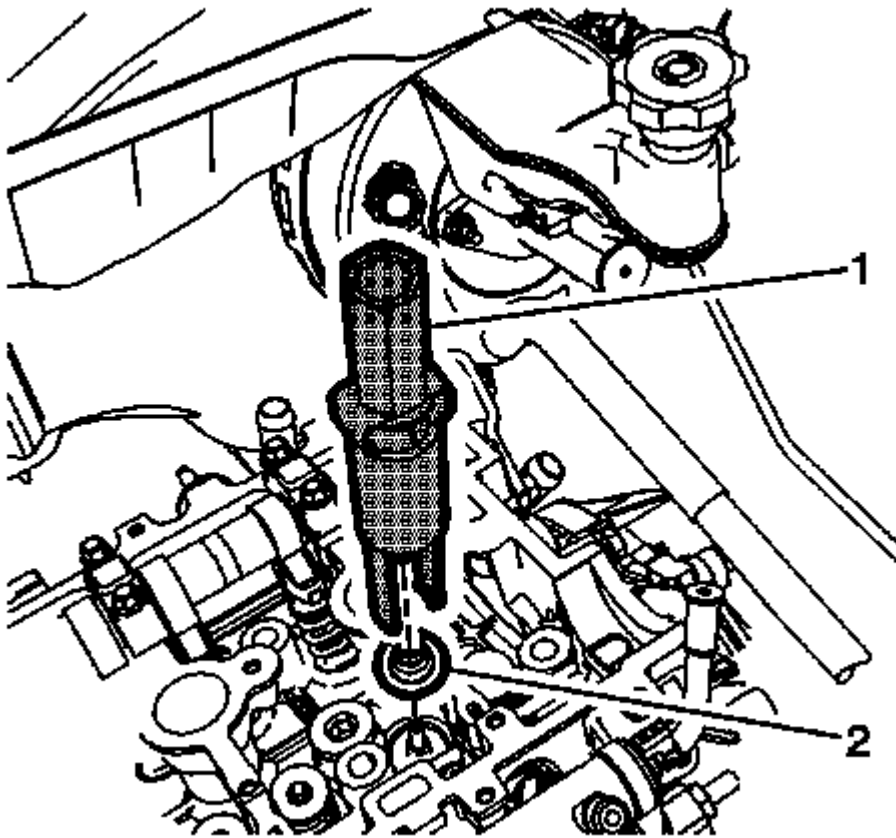


Fig. 205: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

1. Using the **EN-36017** seal remover (1) install the NEW valve seal. Fully seat the seal onto the valve guide.

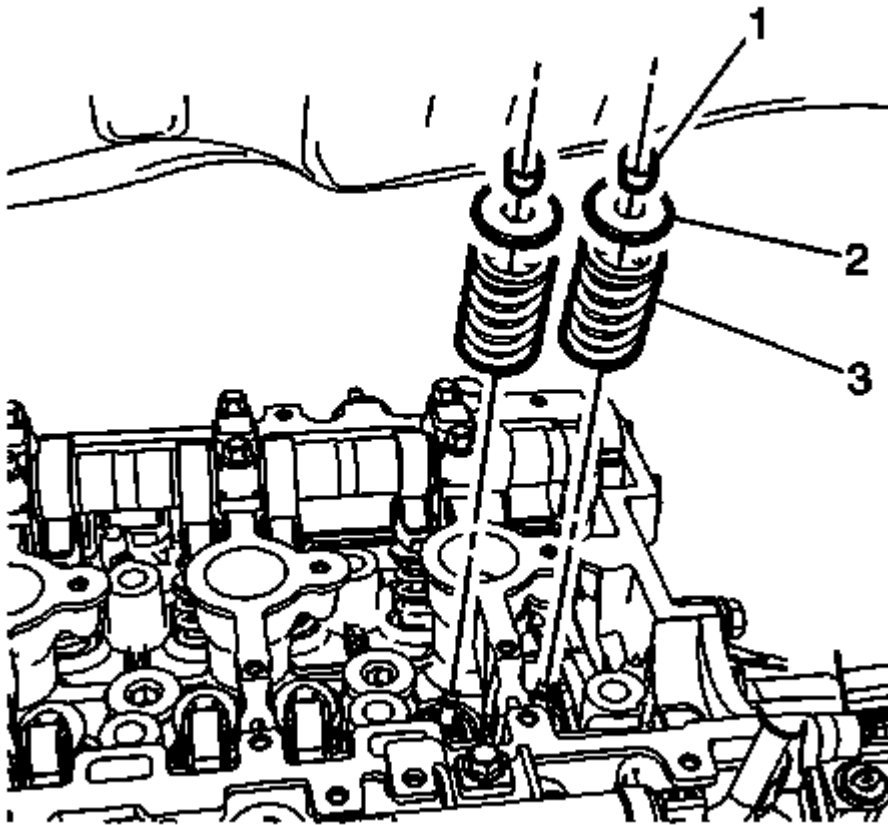


Fig. 206: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring (3) and retainer (2).
3. Compress the valve spring using the valve spring compressor.
4. Install the valve spring keepers (1).
5. Disconnect the air hose and air hose adapter.

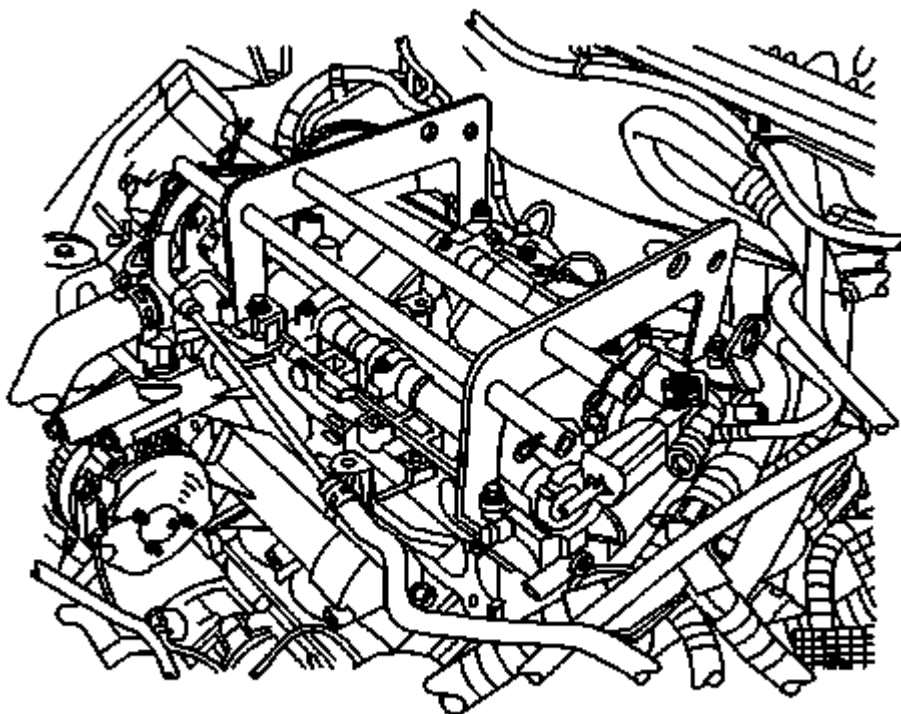


Fig. 207: Cylinder Head Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-43649** compressor and **EN-43649-10** adaptor set from the cylinder head.
7. Install the spark plugs. Refer to **Spark Plug Replacement** .

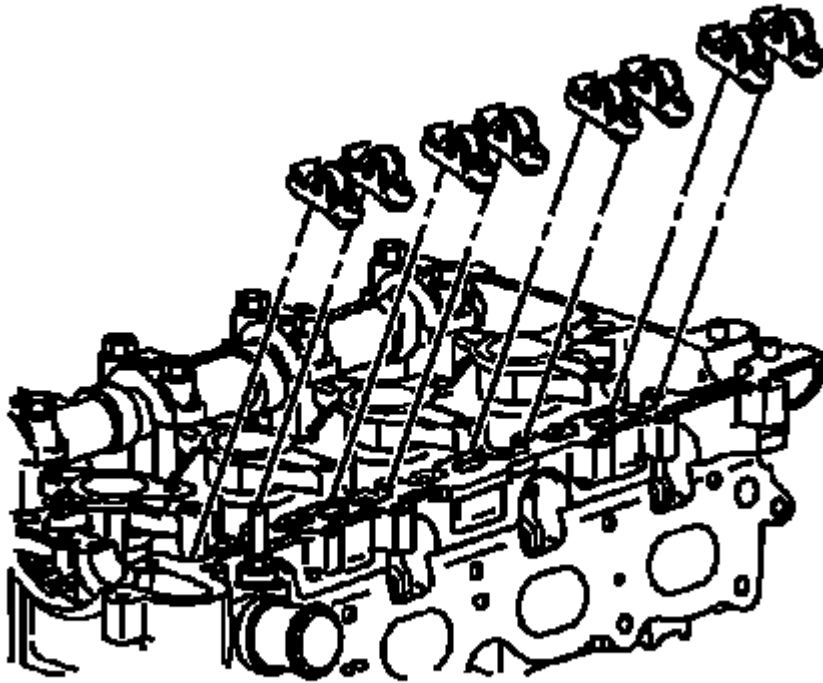


Fig. 208: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft roller followers.
9. Install the camshaft. Refer to **Intake Camshaft and Valve Lifter Replacement**, or **Exhaust Camshaft and Valve Lifter Replacement**.
10. If used, remove the **EN-43653** holding tool.
11. If removed, install the starter. Refer to **Starter Replacement (LUK)** .

CYLINDER HEAD REPLACEMENT

Special Tools

- **EN-45059** Angle Meter
- **EN-48749** Timing Chain Retention Tool Kit
- **EN-48953** Camshaft Actuator Locking Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .

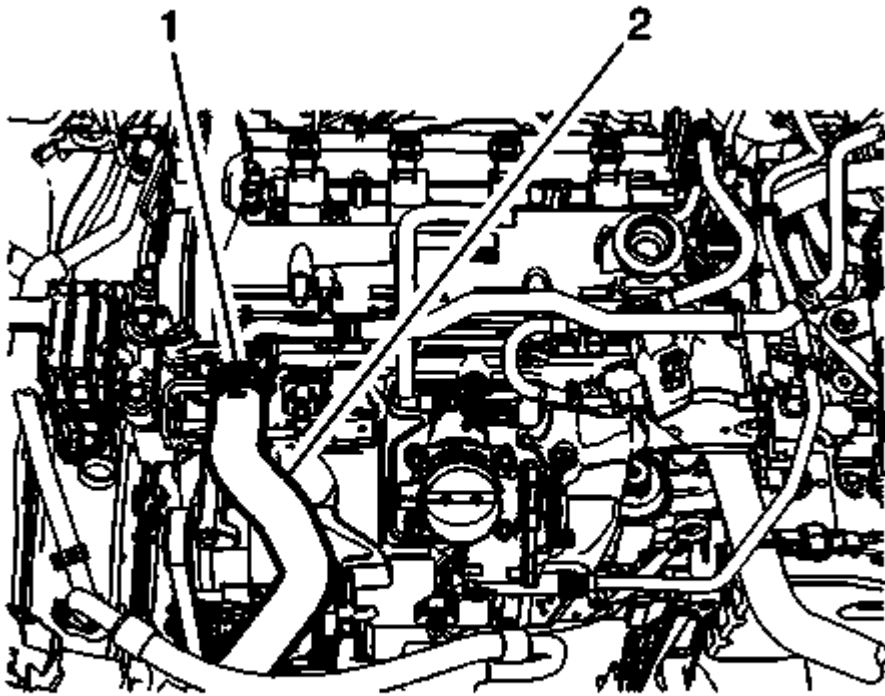


Fig. 209: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

2. Reposition the radiator inlet hose clamp (1) .
3. Remove the radiator inlet hose from the cylinder head (2).
4. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LUK) , Exhaust Manifold Replacement (LTG) .
5. Remove the intake manifold. Refer to Intake Manifold Replacement (LEA), Intake Manifold Replacement (LUK).
6. Remove the fuel pump. Refer to Fuel Pump Replacement .
7. Remove the radiator surge tank air bleed hose from the cylinder head.
8. Disconnect all electrical connectors as necessary.
9. Remove the camshaft cover. Refer to Camshaft Cover Replacement (LUK), Camshaft Cover Replacement (LEA).
10. Remove the purge solenoid and bracket. Refer to Evaporative Emission Canister Purge Solenoid Valve Replacement .

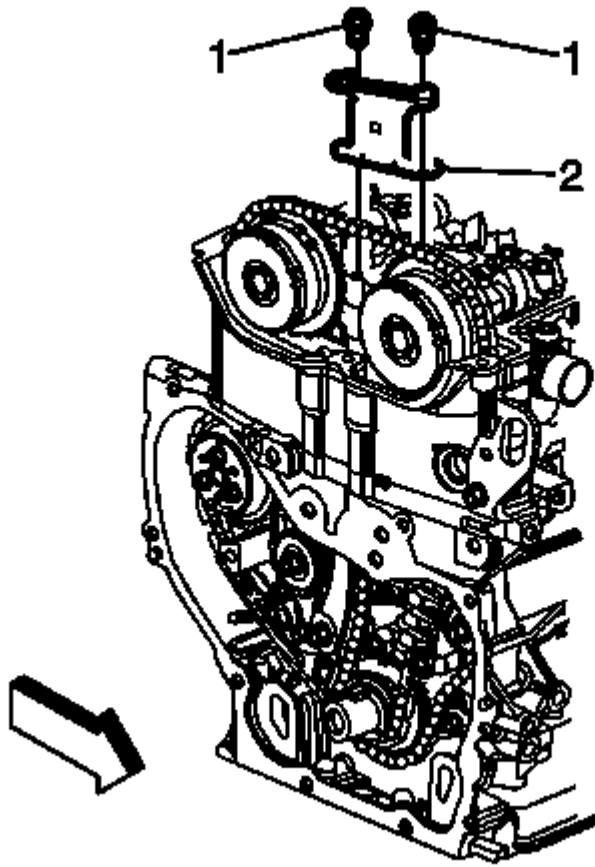


Fig. 210: Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

11. Remove the upper timing chain guide bolts (1) and guide (2).

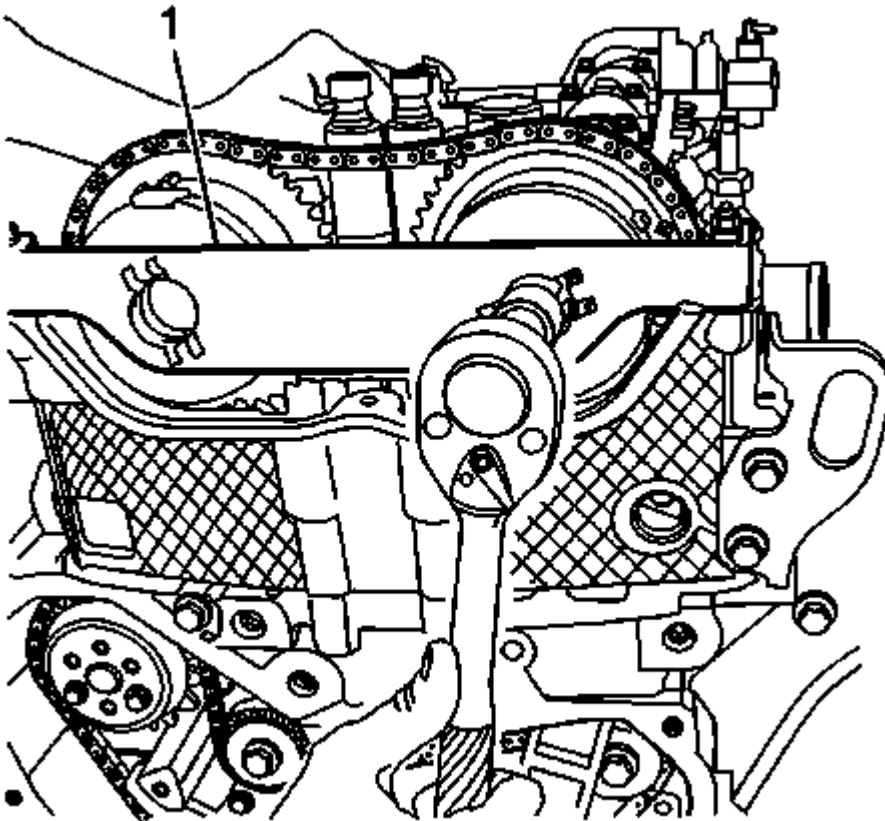


Fig. 211: Loosening/Tightening Camshaft Actuator Retainer Bolts
 Courtesy of GENERAL MOTORS COMPANY

NOTE:

- If the intake camshaft actuator is moving independently of the camshaft, this means the camshaft is not locked to the actuator. Rotate the camshaft counterclockwise while the holding tool is installed and this will lock the camshaft to the actuator.
- Ensure the timing chain and the camshaft position actuators are marked for proper assembly.

12. Rotate the intake camshaft clockwise and install the **EN-48953** locking tool (1) to the actuators.

CAUTION: Refer to Fastener Caution .

13. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
14. Clean the timing chain and gears with solvent.
15. Mark the timing gear sprockets and the timing chain. It is recommended that the paint marks are located in the 12 o'clock position.

16. Use a 24 mm wrench on the hex flats of the camshaft to prevent camshaft rotation.
17. Loosen, but do not remove the intake and exhaust camshaft actuator bolts.
18. Remove the **EN-48953** locking tool.

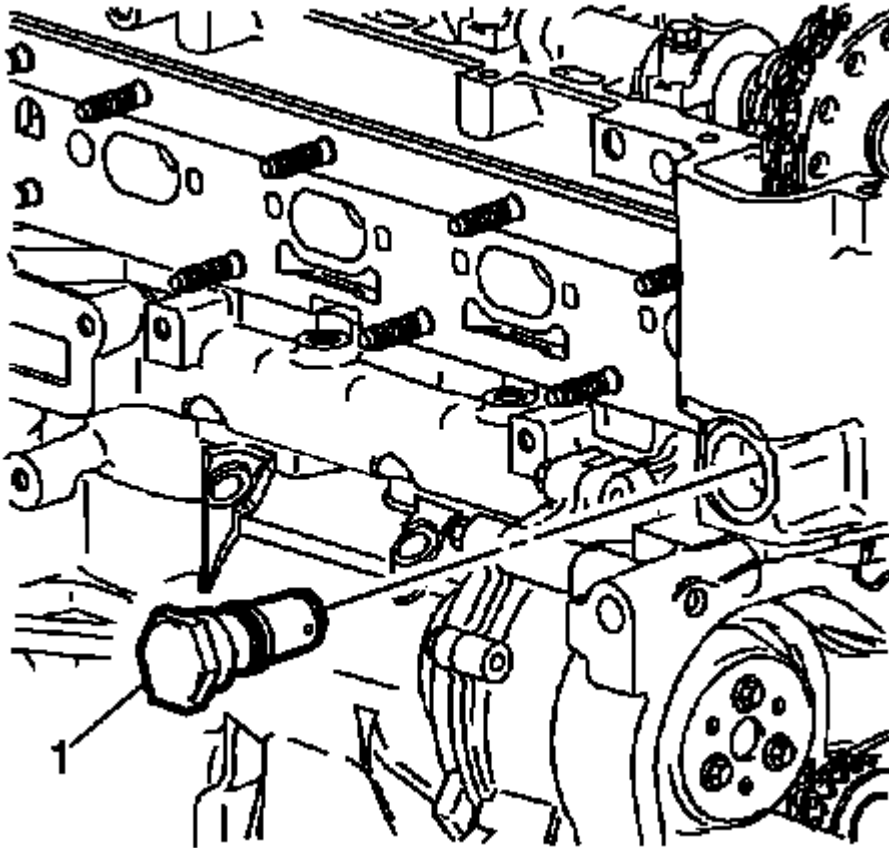


Fig. 212: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

19. Remove the timing chain tensioner (1).

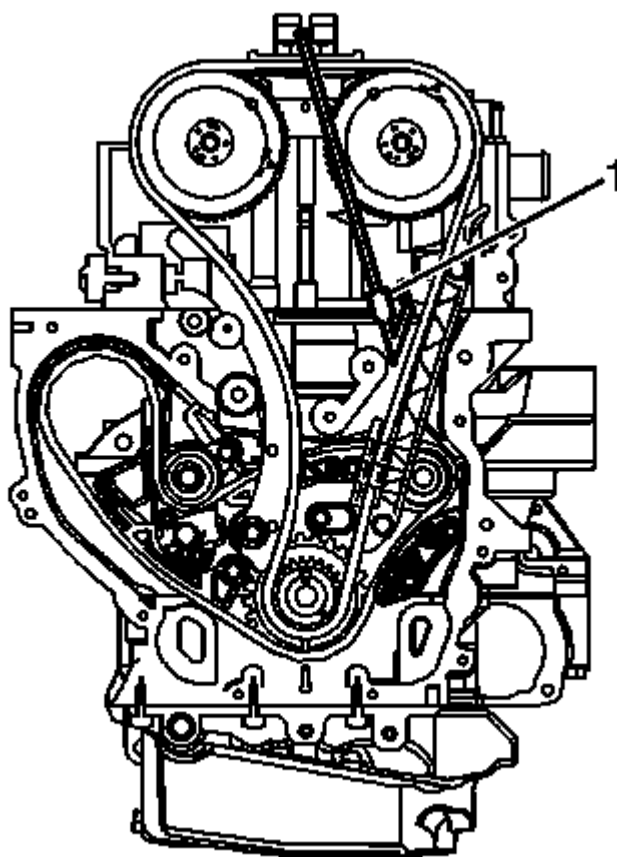


Fig. 213: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the tips of the EN-48749 retention tool are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

20. Install the **EN-48749** retention tool (1) to the intake side of the timing chain.

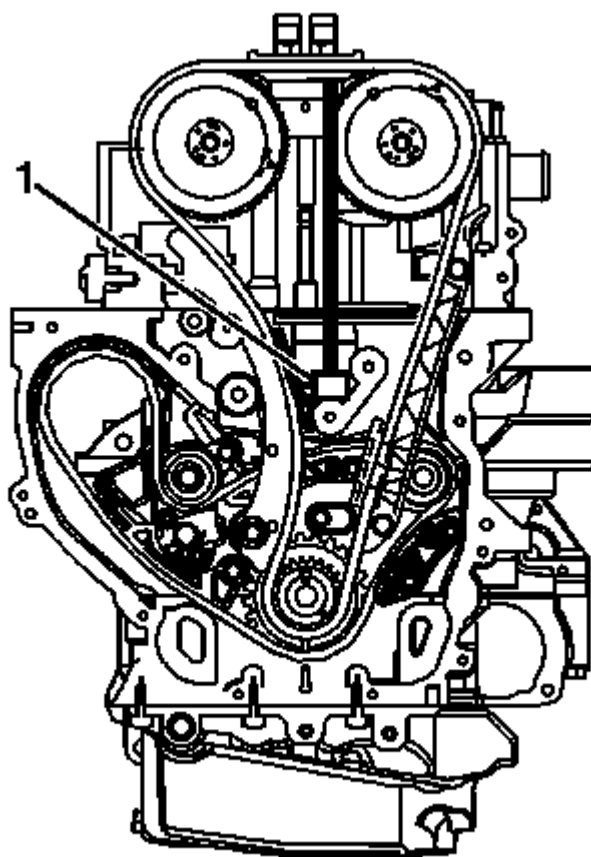


Fig. 214: View Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft actuators should not rotate during the removal of installation.

21. Install the **EN-48749** retention tool (1) to the exhaust side of the timing chain.

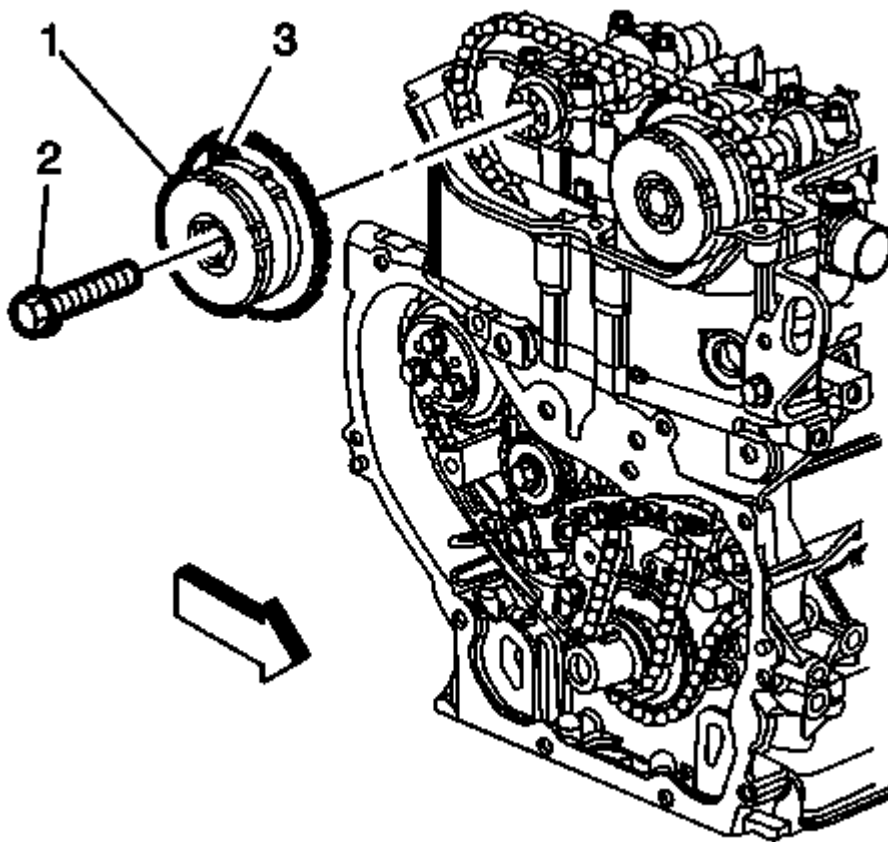


Fig. 215: Exhaust Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

22. Remove and discard the exhaust camshaft actuator bolt (2).
23. Remove the exhaust camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

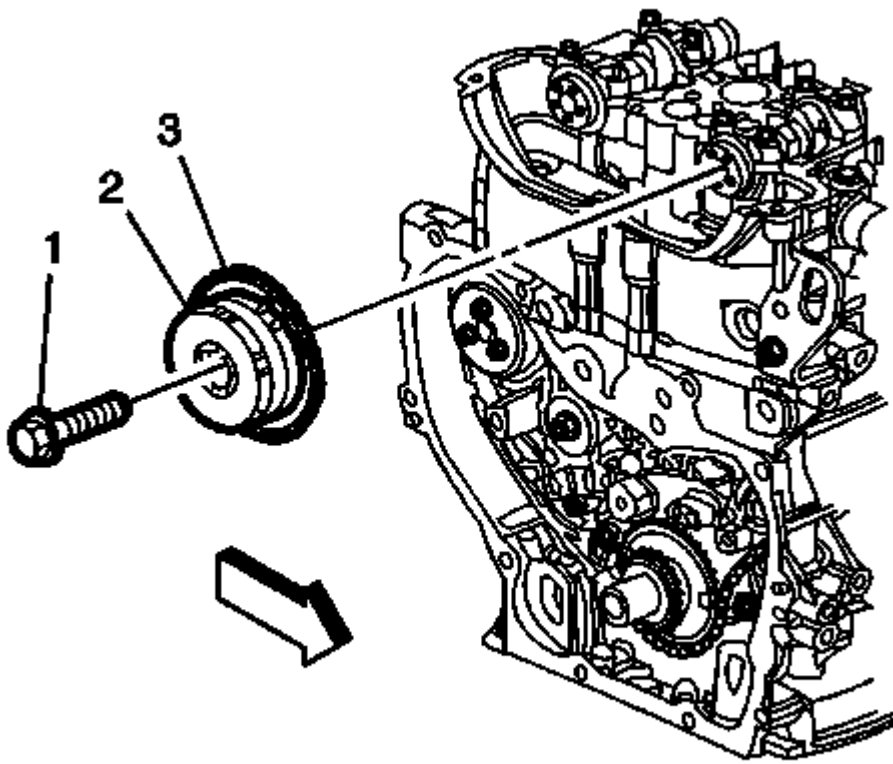


Fig. 216: Intake Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

24. Remove and discard the intake camshaft actuator bolt (1).
25. Remove the intake camshaft actuator (2) from the camshaft while also removing the actuator from the timing chain.

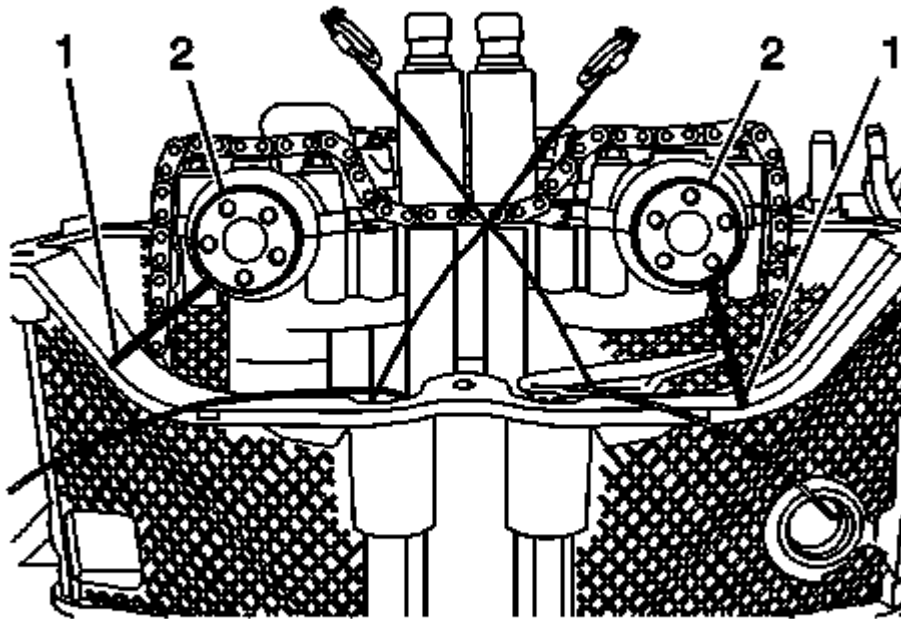


Fig. 217: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS COMPANY

26. Mark the cylinder head (1) in relationship to the camshaft actuator notch is on the camshaft (2).

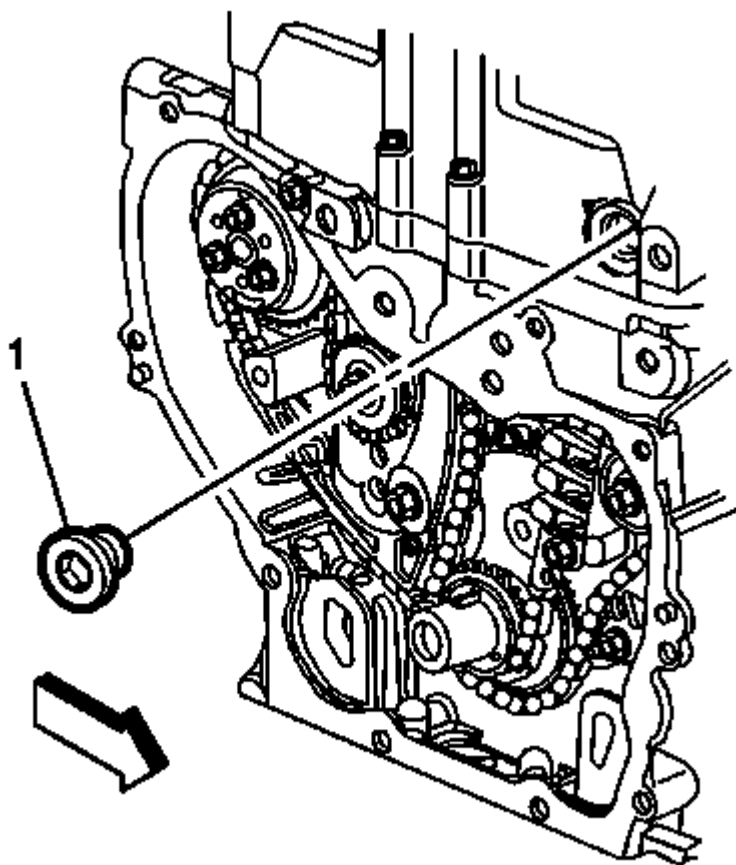


Fig. 218: Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

27. Remove the fixed timing chain guide access plug (1).
28. Remove the fixed guide upper bolt.

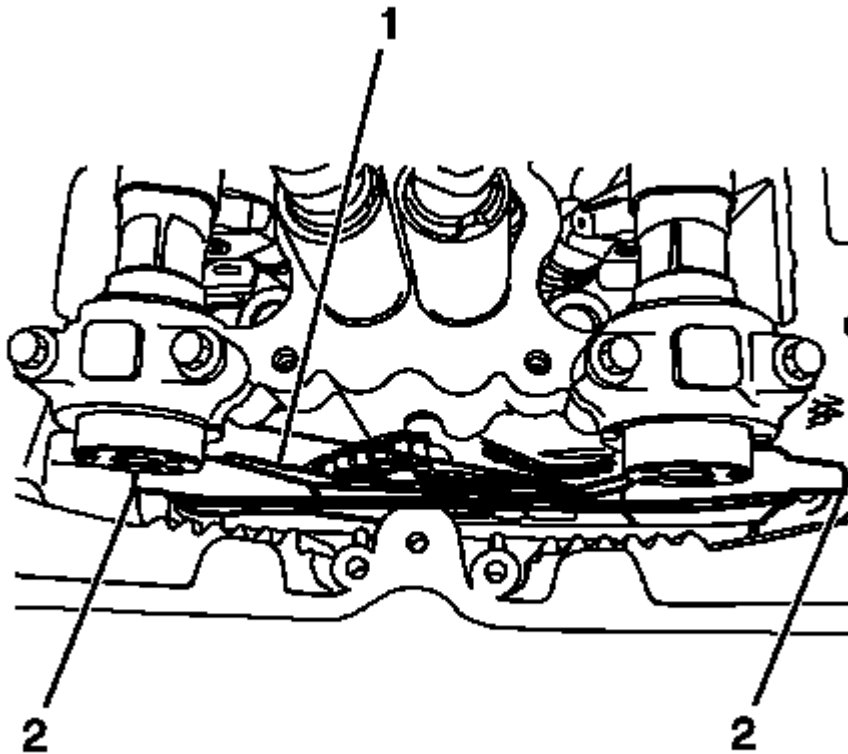


Fig. 219: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS COMPANY

NOTE: The threaded rod from the timing chain retention tool can be used to help feed the rubber band around the chain guides.

29. Install a rubber band (1) around the top of the upper timing chain guides (2) in order to pull the guides together.

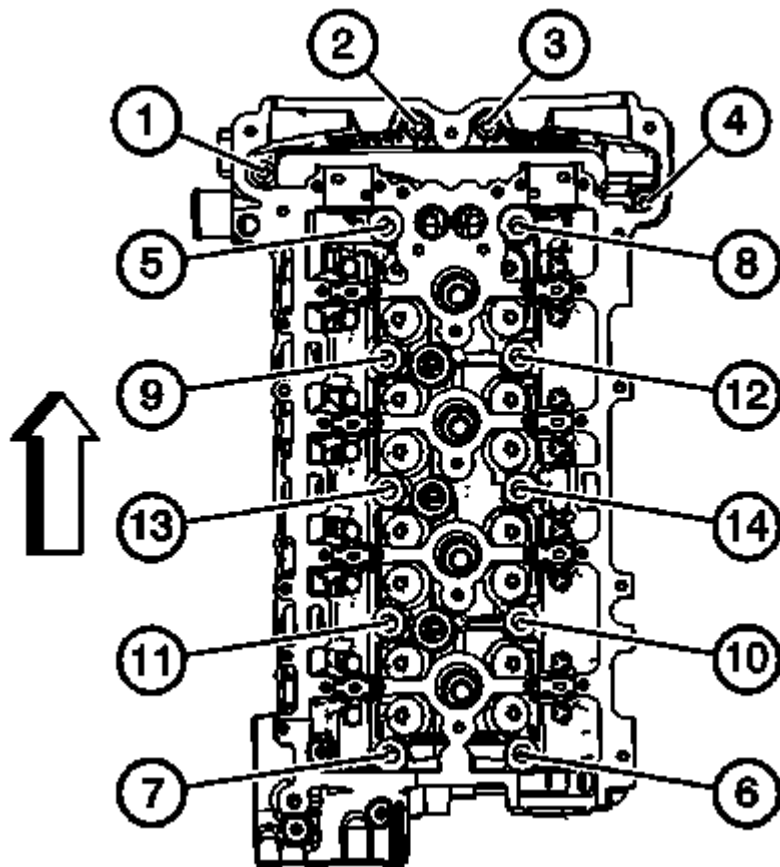


Fig. 220: Cylinder Head-To-Block Bolt Removal Sequence
Courtesy of GENERAL MOTORS COMPANY

30. Remove the cylinder head bolts in the sequence shown. Discard the bolts.

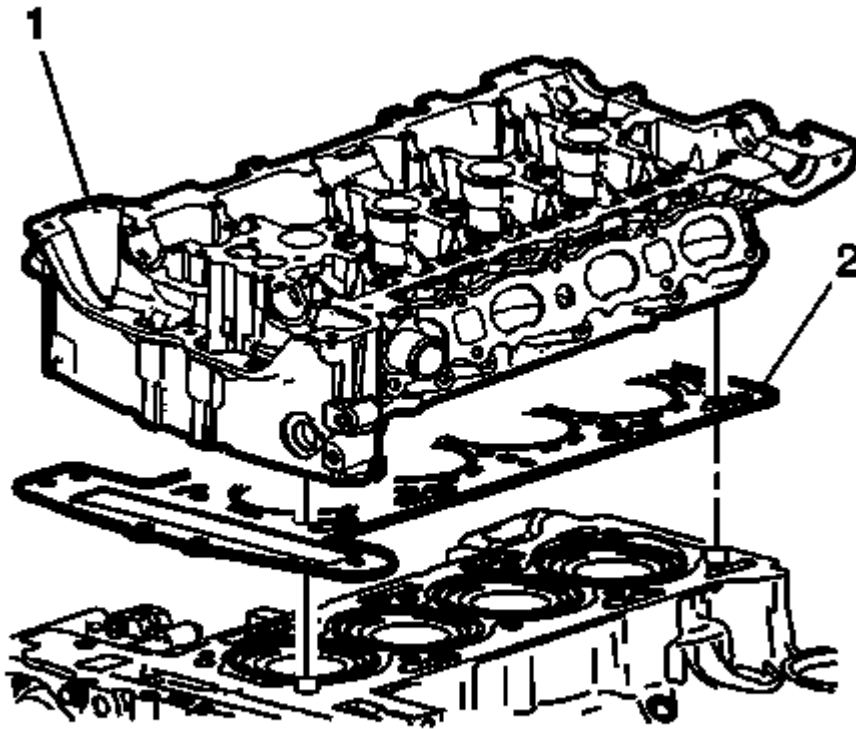


Fig. 221: Cylinder Head

Courtesy of GENERAL MOTORS COMPANY

31. Remove the cylinder head (1).
32. Remove the cylinder head gasket (2).
33. Clean all of the gasket surfaces.
34. Use the following steps when cleaning the cylinder head and cylinder block surfaces:
 - Use a razor blade gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge either surface.

NOTE: **DO NOT use any other method or technique to clean these gasket surfaces.**

- Use a NEW razor blade on the cylinder head and a NEW blade on the cylinder block.

NOTE: **Be careful not to gouge or scratch the gasket surfaces. DO NOT gouge or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in**

by the NEW gasket.

- Hold the razor blade as parallel to the gasket surface as possible.
35. Clean the old sealer/lube and any dirt from around the bolt holes.

NOTE: DO NOT use a tap to clean the cylinder head bolt holes.

36. Clean the bolts holes with a nylon bristle brush.
37. When cleaning the cylinder head bolt holes use suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun in order to reach the bottom of the holes.
38. If replacing the cylinder head, transfer all parts as necessary.

Installation Procedure

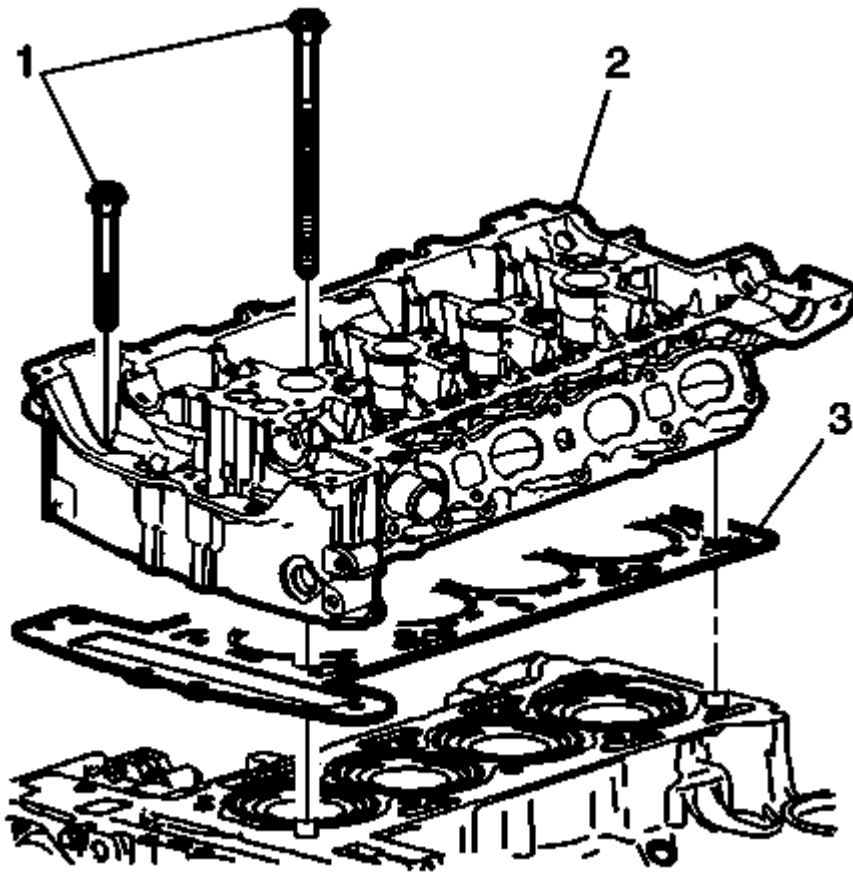


Fig. 222: Cylinder Head Gasket

Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT use any sealing material.

1. Install the cylinder head gasket (3).

2. Install the cylinder head (2).
3. Install NEW cylinder head bolts (1).

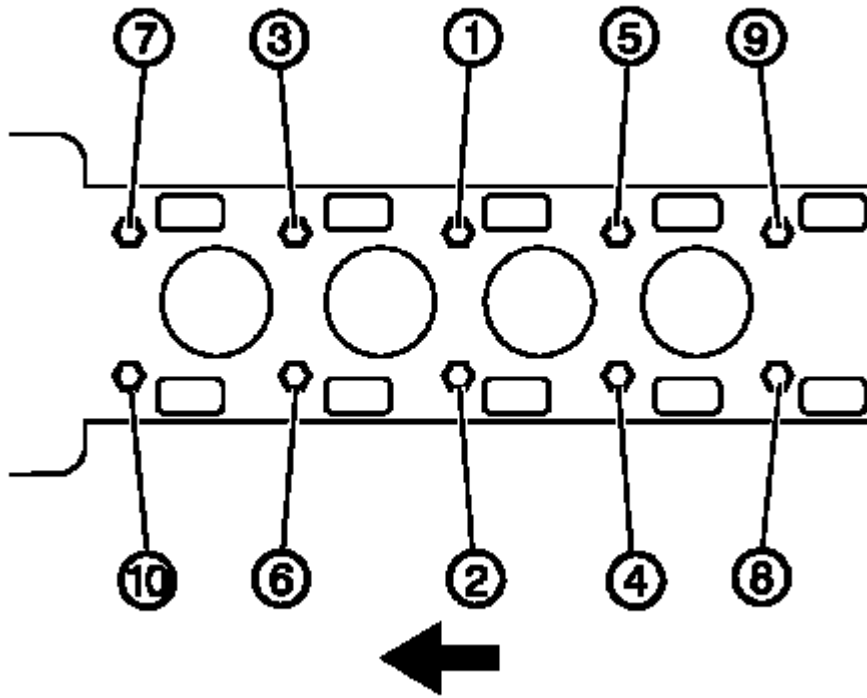


Fig. 223: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

4. Install and tighten the cylinder head bolts in the sequence shown. Tighten the bolts to 30 N.m (22 lb ft) plus an additional 155 degrees using the **EN-45059** meter.

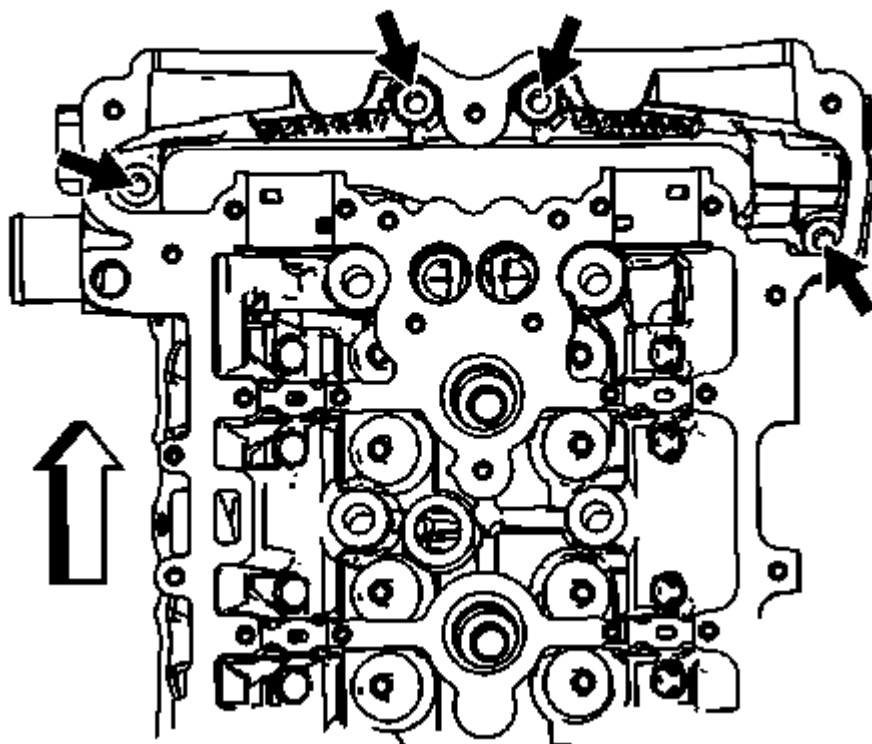


Fig. 224: Locating Front Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the NEW front cylinder head bolts and tighten to 35 N.m (26 lb ft).

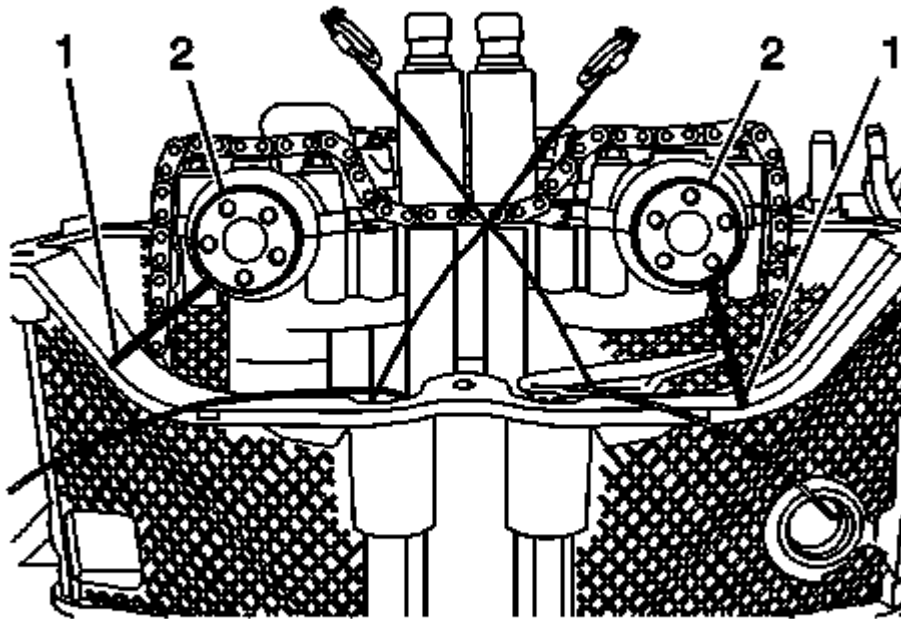


Fig. 225: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS COMPANY

6. Ensure the cylinder head (1) and the camshaft (2) are correctly aligned.

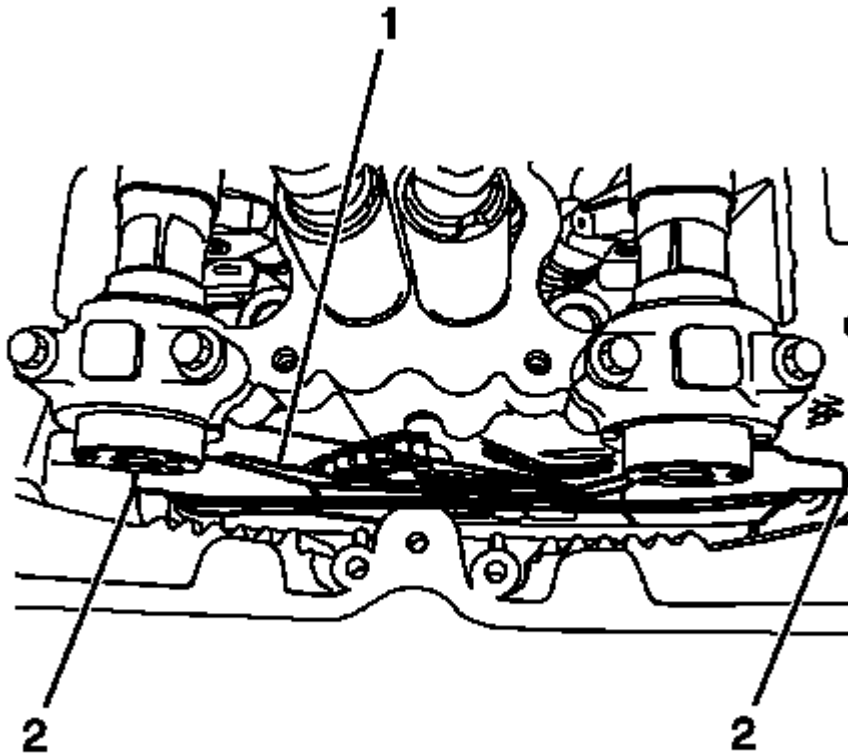


Fig. 226: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS COMPANY

7. Remove the rubber band (1) from around the top of the upper timing chain guides (2).
8. Install the fixed guide bolt into the cylinder bolt and tighten to 12 N.m (106 lb in).

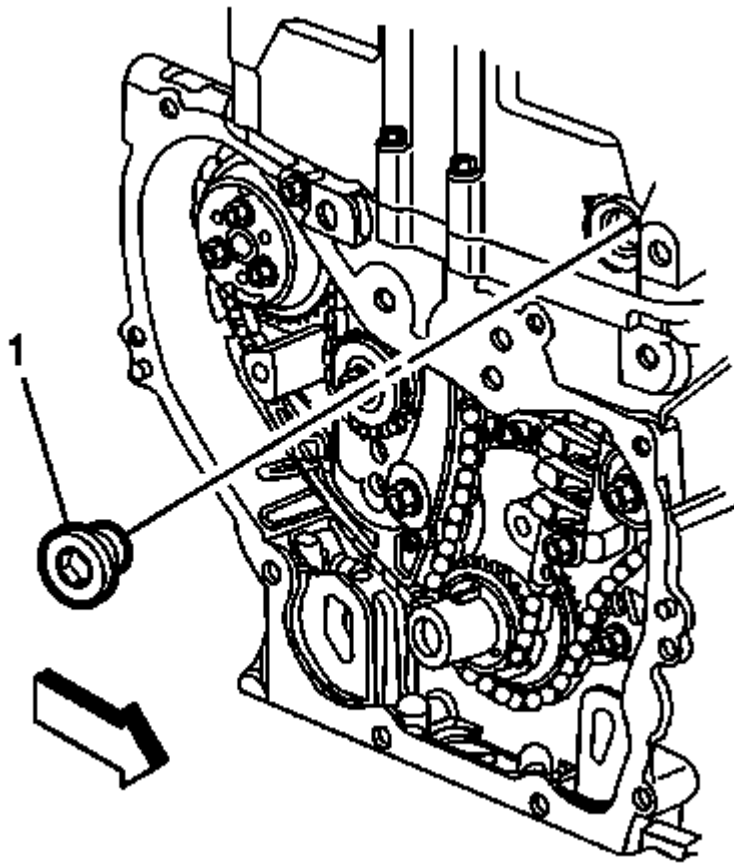


Fig. 227: Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

9. Apply sealant compound to thread and install the timing chain guide bolt access hole plug (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers**
10. Install the fixed timing chain guide access plug. Tighten the chain guide plug to 90 N.m (59 lb ft).

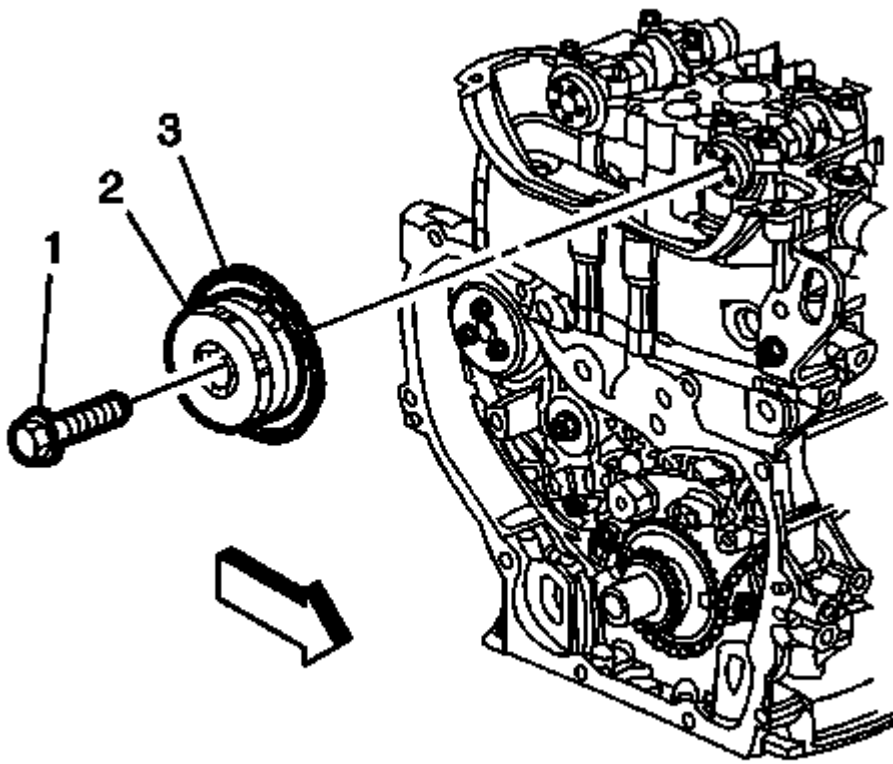


Fig. 228: Intake Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the alignment mark made previously on the exhaust camshaft actuator is still aligned properly with the mark on the timing chain.

11. Install the timing chain onto the intake camshaft actuator (2).
12. Align the intake camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
13. Install a NEW intake camshaft actuator bolt (1) until snug.

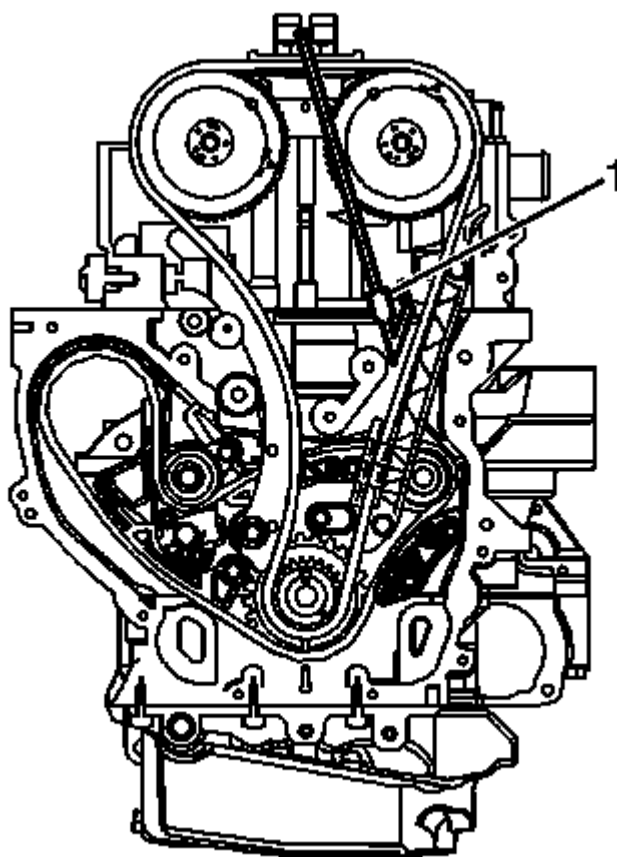


Fig. 229: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

14. Remove the **EN-48749** retention tool (1) from the intake side of the timing chain.

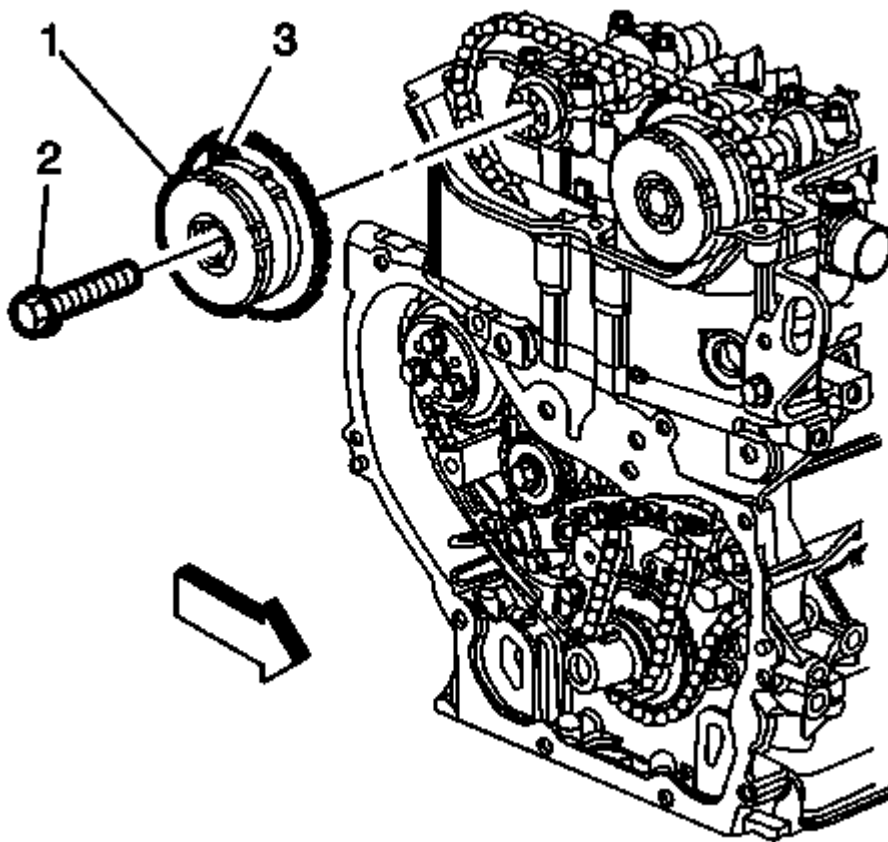


Fig. 230: Exhaust Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain.

15. Install the timing chain onto the exhaust camshaft actuator (3).
16. Align the exhaust camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
17. Install a NEW exhaust camshaft actuator bolt (2) until snug.

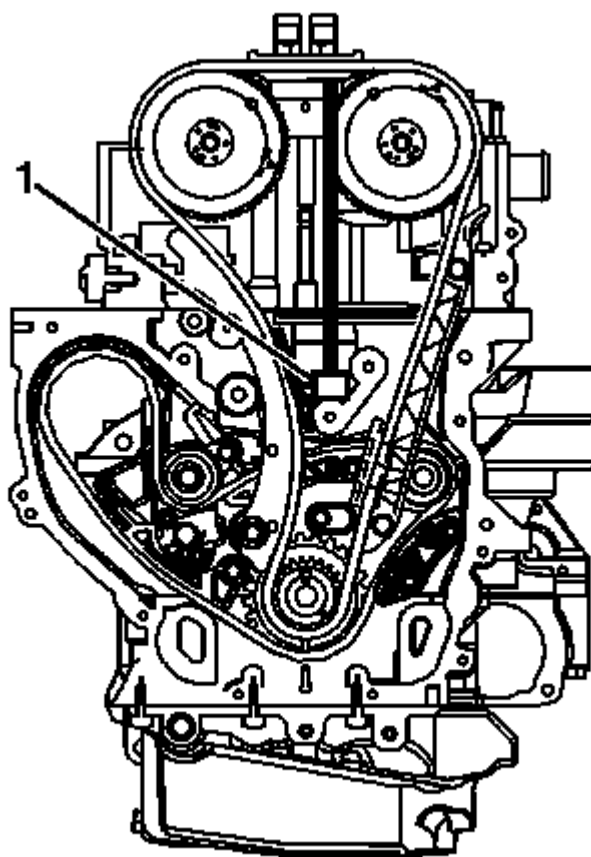


Fig. 231: View Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

18. Remove the **EN-48749** retention tool (1) from the exhaust side of the timing chain.
19. Reset and install the timing chain tensioner. Refer to **Timing Chain Tensioner Replacement**

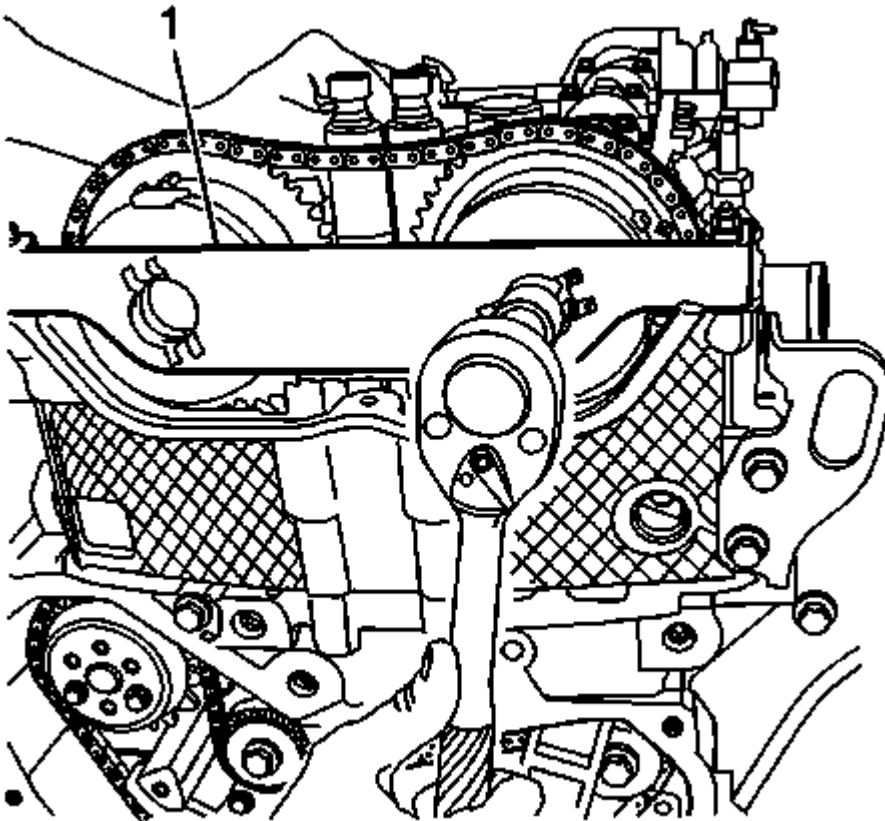


Fig. 232: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

20. Install the **EN-48953** locking tool (1) to the actuators.
21. Install the camshaft actuator locking tool bolts and tighten to 10 N.m (89 lb in).
22. Release the tensioner by applying a counterclockwise torque on the harmonic balancer bolt and tighten the bolt to 45 N.m (33 lb ft).
23. Tighten the NEW camshaft actuator bolt to 85 N.m (63 lb ft), plus an additional 30 degrees using the **EN-45059** meter.
24. Remove the camshaft actuator locking tool, **EN-48953** locking tool.

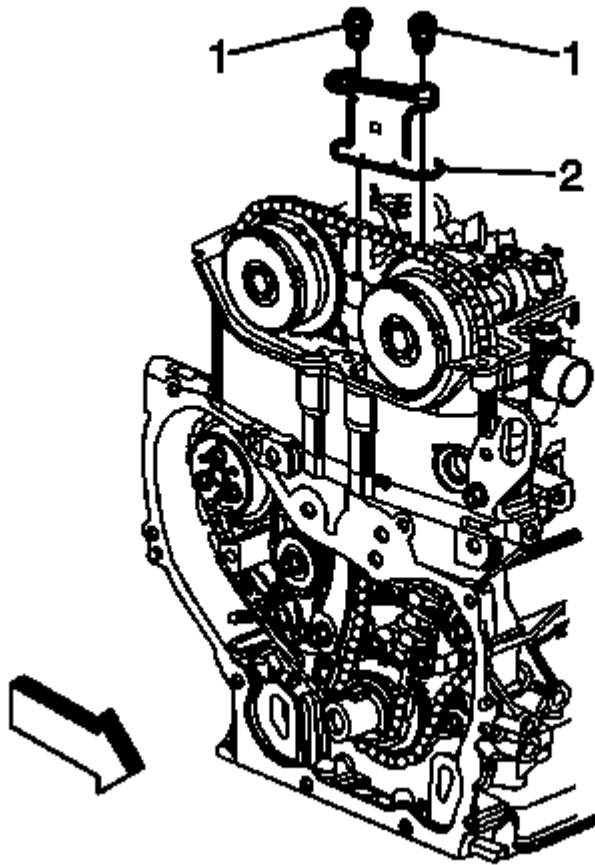


Fig. 233: Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

25. Install the upper timing chain guide bolts (1) and guide (2). Tighten the bolts to 10 N.m (89 lb in).
26. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**, **Camshaft Cover Replacement (LEA)**
27. Install the fuel pump. Refer to **Fuel Pump Replacement** .
28. Install the purge solenoid and bracket. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .
29. Connect all electrical connectors as necessary.
30. Install the radiator surge tank air bleed hose to the cylinder head.
31. Position the radiator surge tank air bleed hose clamp.
32. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LUK)** .
33. Install the intake manifold. Refer to **Intake Manifold Replacement (LEA)**, **Intake Manifold Replacement (LUK)**.

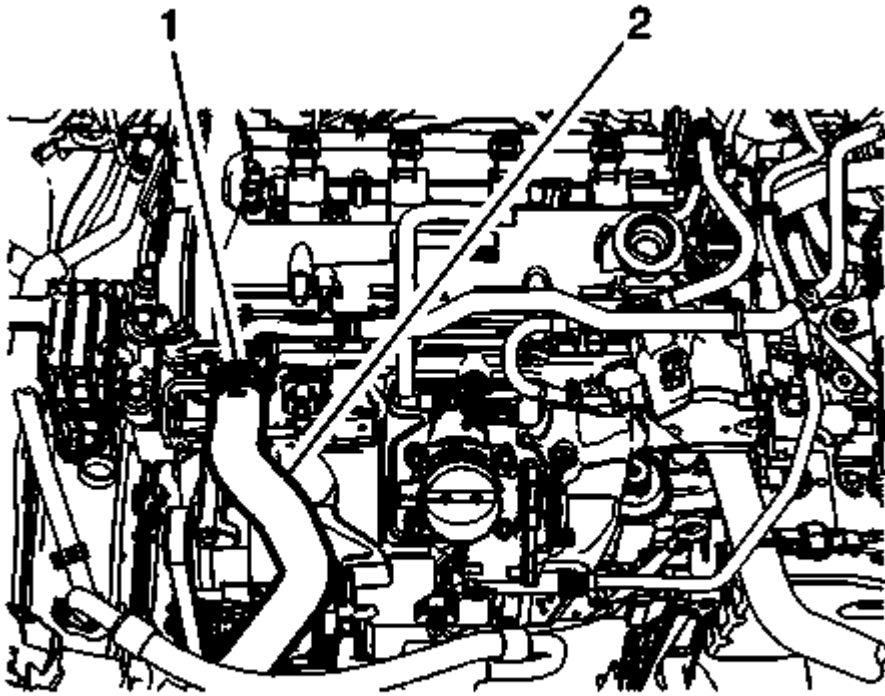


Fig. 234: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

34. Install the radiator inlet hose to the cylinder head (2).
35. Position the radiator inlet hose clamp (1) .
36. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

OIL PAN REPLACEMENT (LEA)

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement (LEA)**.
2. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.
3. Remove the drivetrain and front suspension frame . Refer to **Drivetrain and Front Suspension Frame Replacement** .

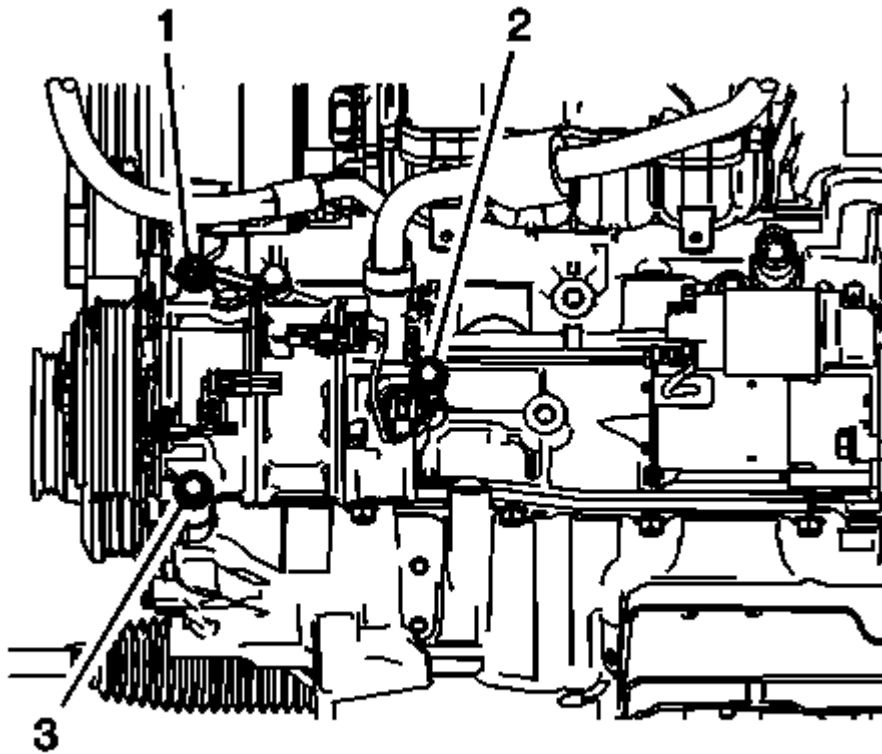


Fig. 235: A/C Compressor Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the (A/C) compressor nut (1).
5. Loosen the (A/C) compressor bolt (2).
6. Remove the lower A/C compressor bolt (3).

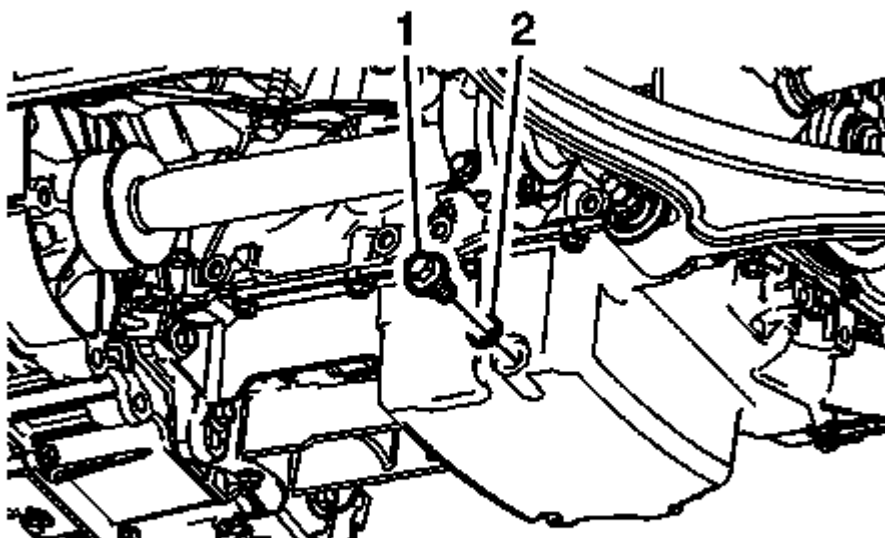


Fig. 236: Engine Oil Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

7. Place a suitable drain pan under the oil pan drain plug.
8. Remove the oil pan drain plug (1).
9. Drain the engine oil.
10. Install a new oil pan plug gasket (2).

CAUTION: Refer to Fastener Caution .

11. Install the oil pan drain plug (1) and tighten to 25 N.m (18 lb ft)

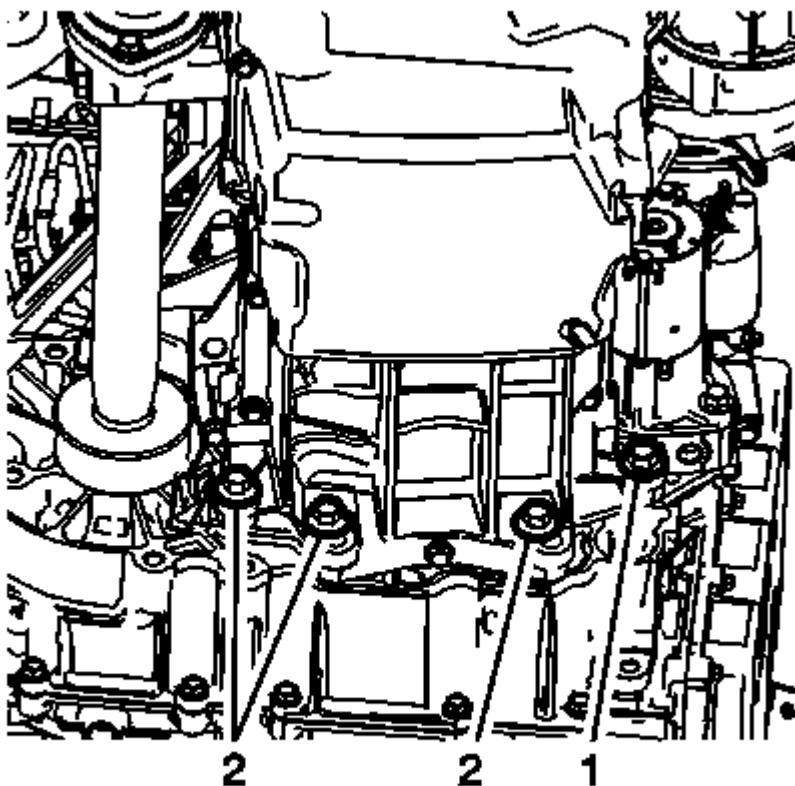


Fig. 237: Oil Pan To Transaxle Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the oil pan to transaxle bolts (1).

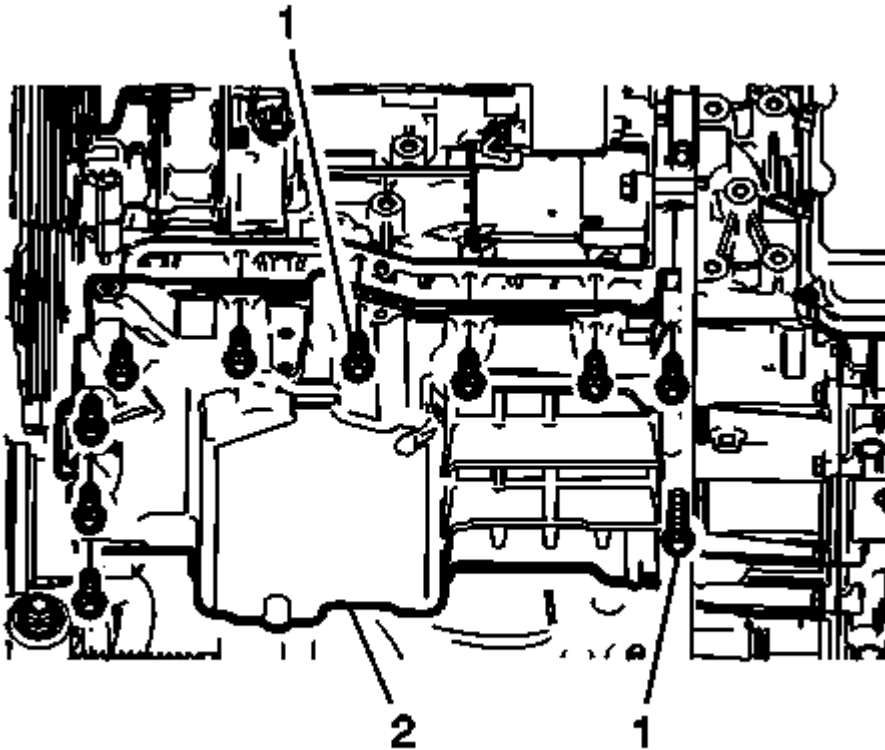


Fig. 238: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the oil pan bolts (1).
14. Remove the oil pan. (2).
15. Remove any old oil pan sealant

Installation Procedure

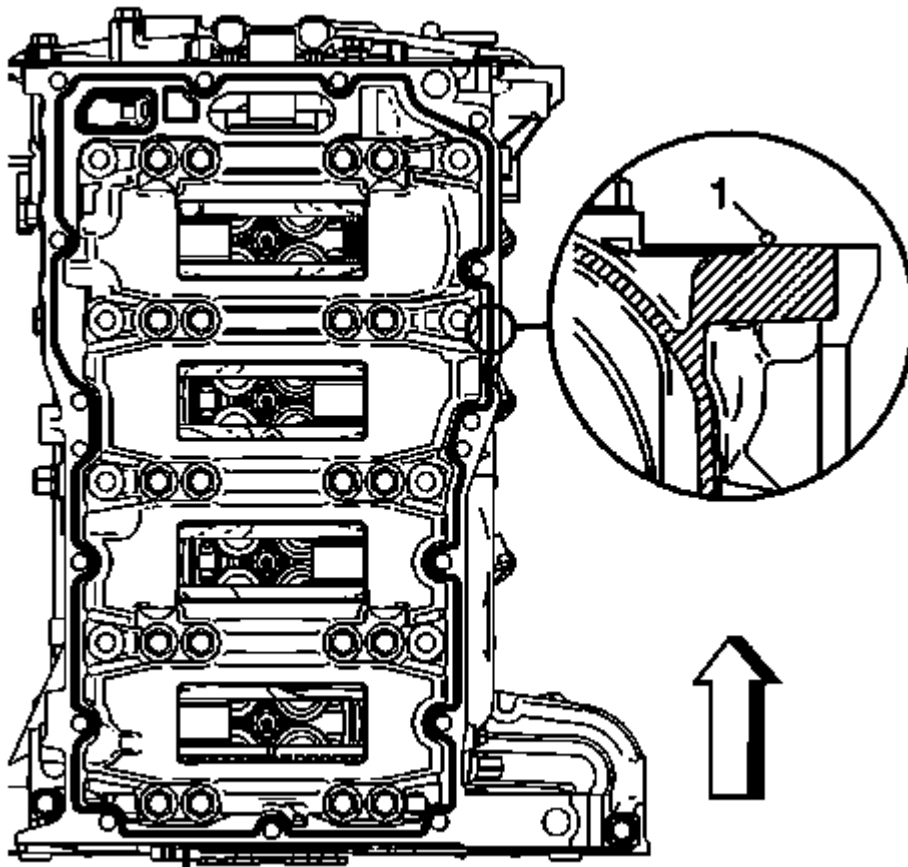


Fig. 239: Identifying Bead of Sealer on Oil Pan
Courtesy of GENERAL MOTORS COMPANY

NOTE: The lower crankcase surface must be free of contamination prior to applying the sealer.

NOTE: Install and align the oil pan to block within 20 minutes of applying the sealer.

NOTE: The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

1. Apply a 2.3 mm bead of sealer (1) on the level part of the flange next to the chamfer around the perimeter of the oil pan and the oil suction port opening. Refer to Adhesives, Fluids, Lubricants, and Sealers .

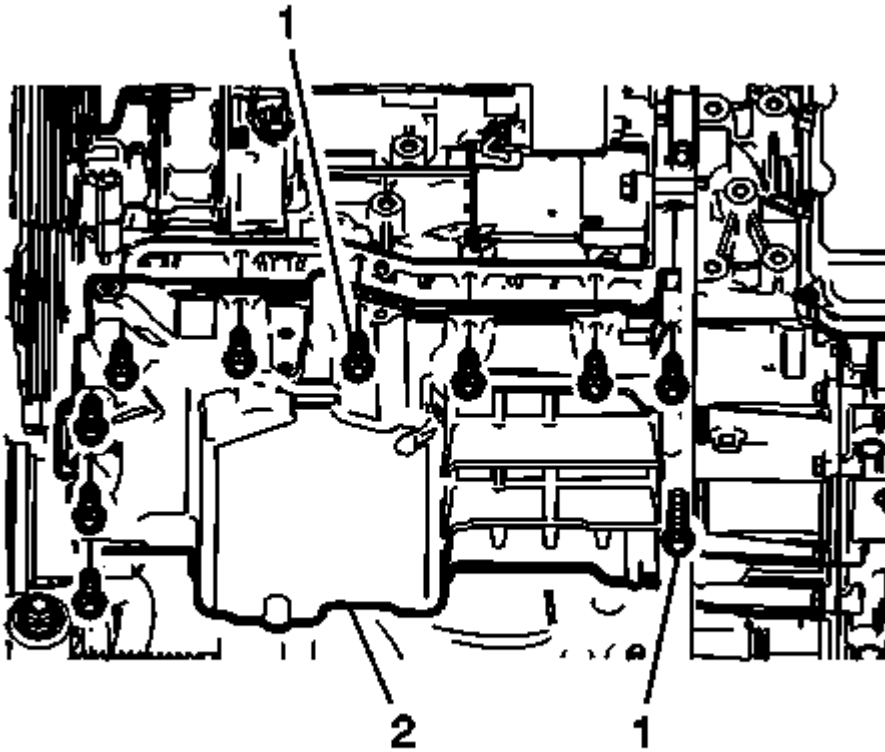


Fig. 240: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pan (2).
3. Install the oil pan bolts (1).

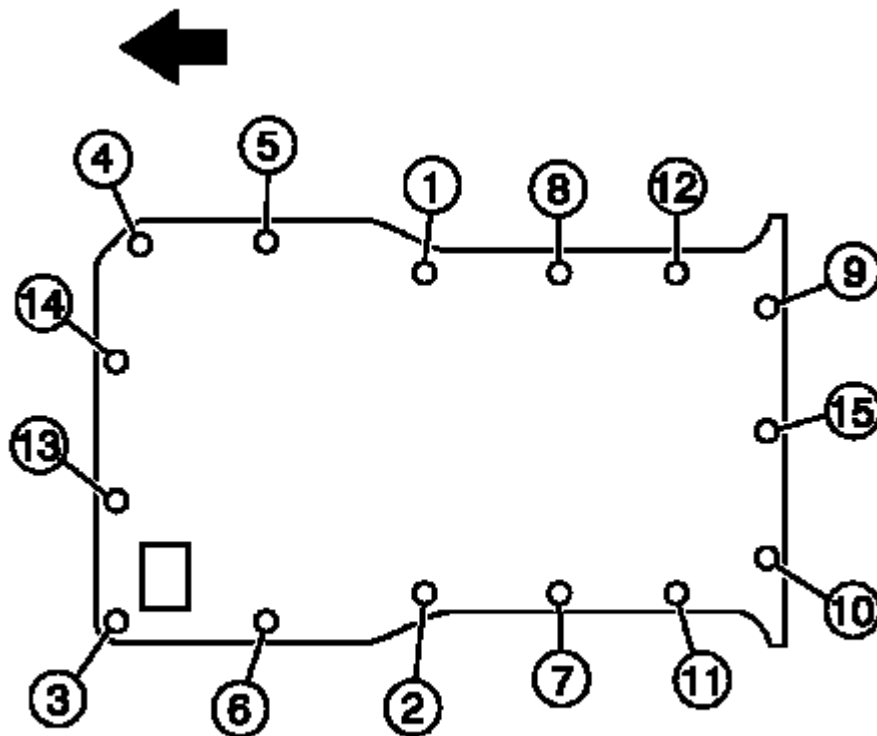


Fig. 241: Identifying Oil Pan Bolts Removal & Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the oil pan bolts in the sequence shown to 25 N.m (18 lb ft).

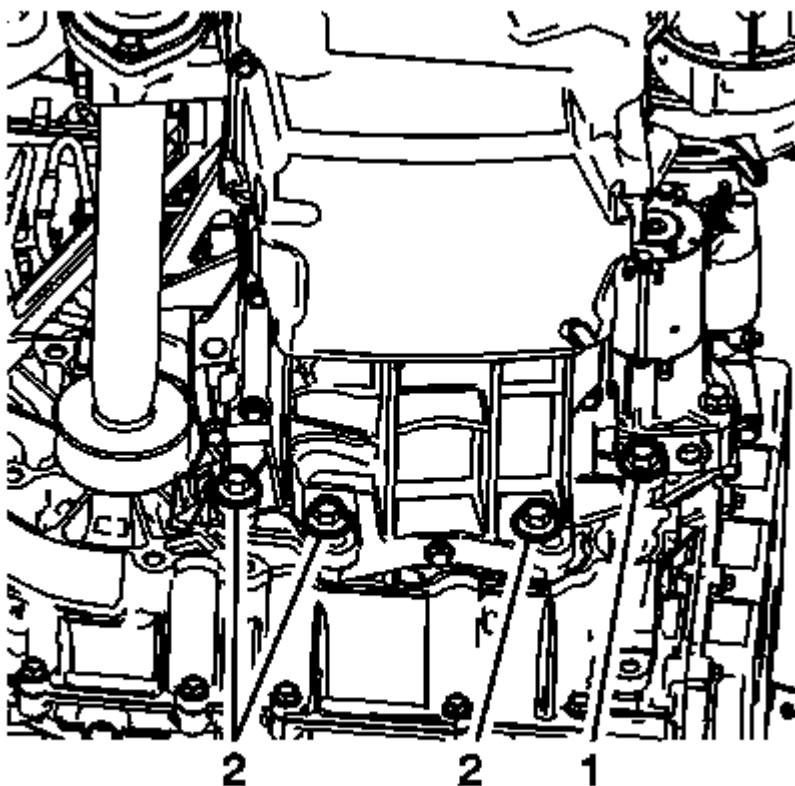


Fig. 242: Oil Pan To Transaxle Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pan to transaxle bolts (1) and tighten to 75 N.m (55 lb ft).

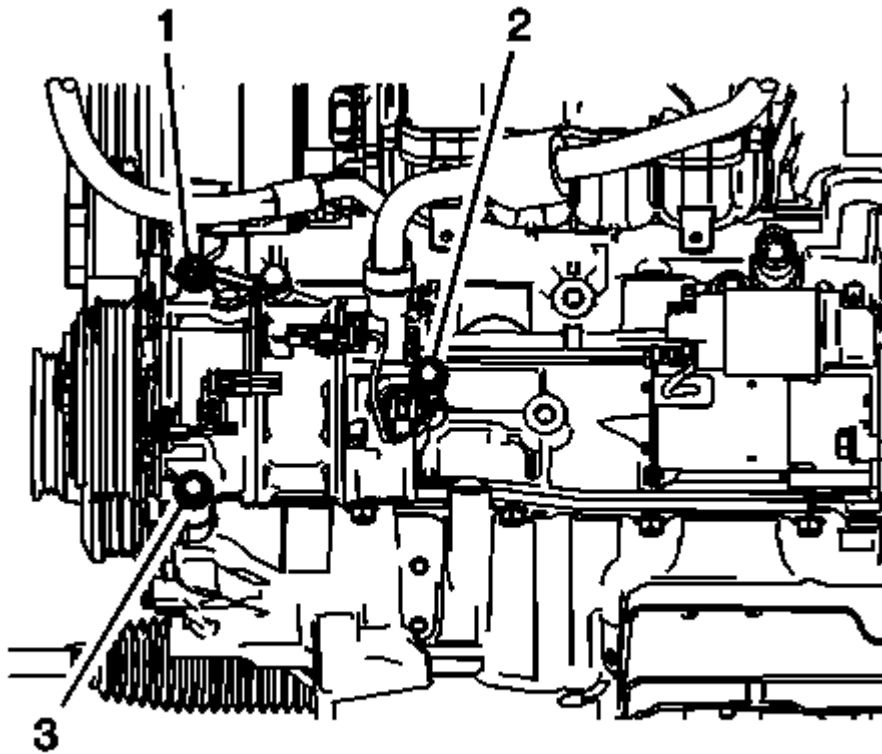


Fig. 243: A/C Compressor Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

6. Install the A/C Compressor bolts (2) and (3) and nut (1) and tighten bolt to 20 N.m (15 lb ft)
7. Install the drivetrain and front suspension frame . Refer to **Drivetrain and Front Suspension Frame Replacement** .
8. Install the oil level indicator tube. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .
9. Install the drive belt. Refer to **Drive Belt Replacement (LEA)**.
10. Fill the engine oil to the proper level. Refer to **Engine Oil and Oil Filter Replacement**

OIL PAN REPLACEMENT (LUK)

Removal Procedure

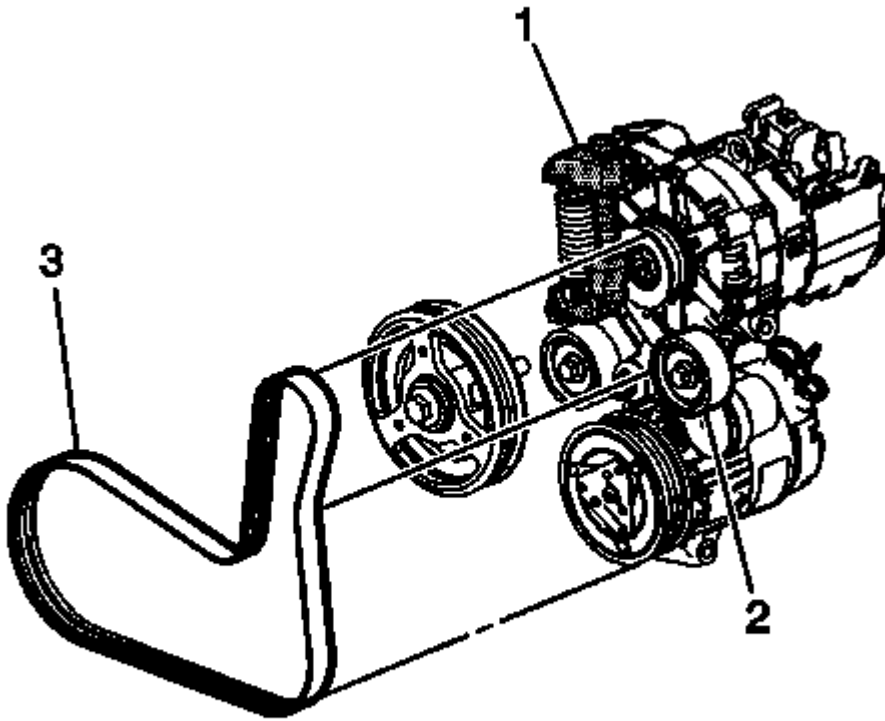


Fig. 244: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt. Refer to **Drive Belt Replacement (LUK)**.
2. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

NOTE: The support fixture bar must be installed to provide enough access to remove and properly tighten the oil pan bolts.

3. Install the engine support fixture. Refer to **Engine Support Fixture**.

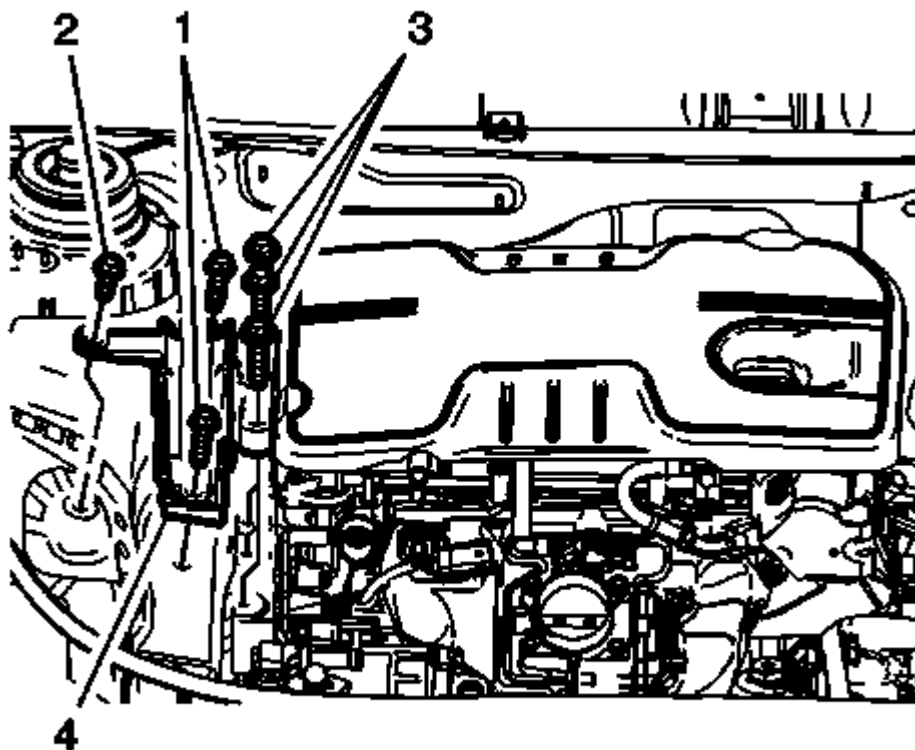


Fig. 245: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

4. Remove engine mount (4). Refer to **Engine Mount Replacement**.
5. Using the engine support fixture, raise the engine approximately 76 mm (3 in).
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

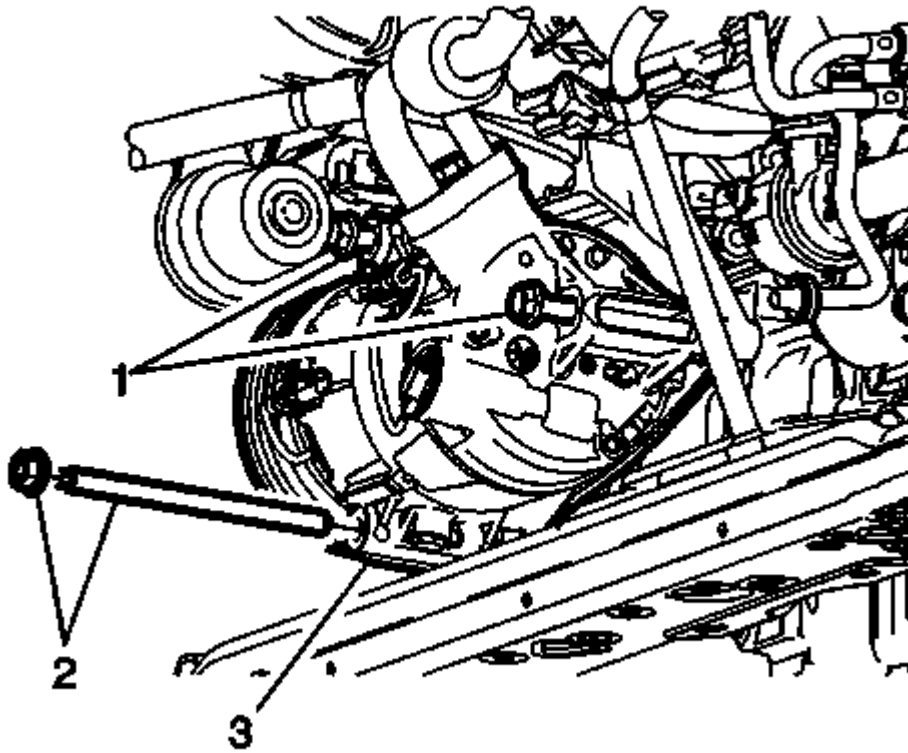


Fig. 246: Air Conditioning (A/C) Compressor Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the upper air conditioning (A/C) compressor bolts (1).
8. Remove the lower A/C compressor nut and stud (2).

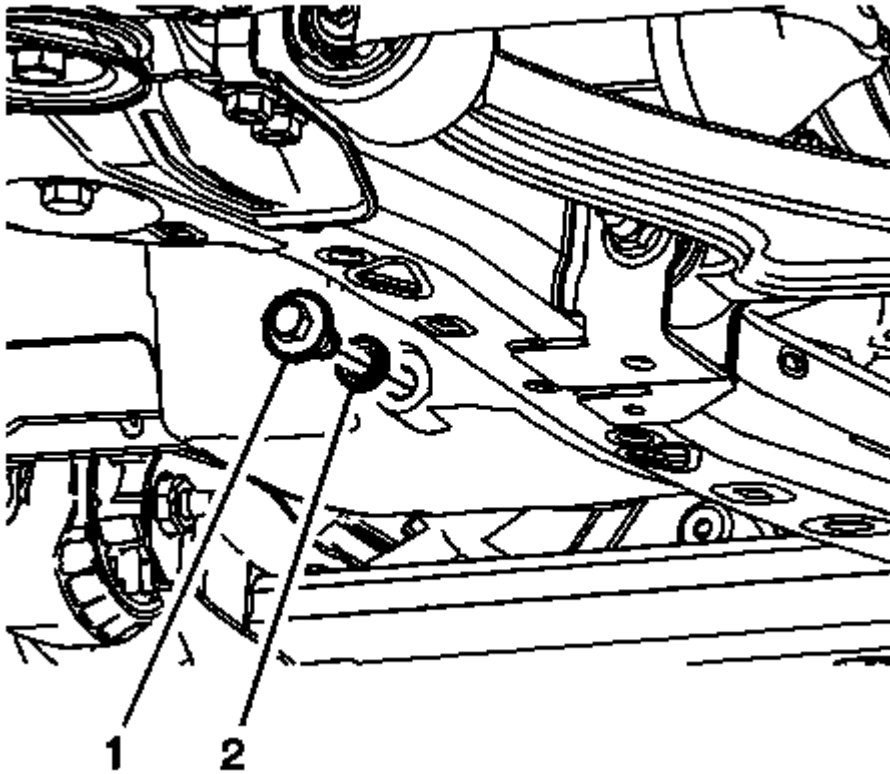


Fig. 247: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS COMPANY

9. Place a suitable drain pan under the oil pan drain plug (1).
10. Remove the oil pan drain plug.
11. Drain the engine oil.
12. Reinstall the oil pan drain plug until snug.

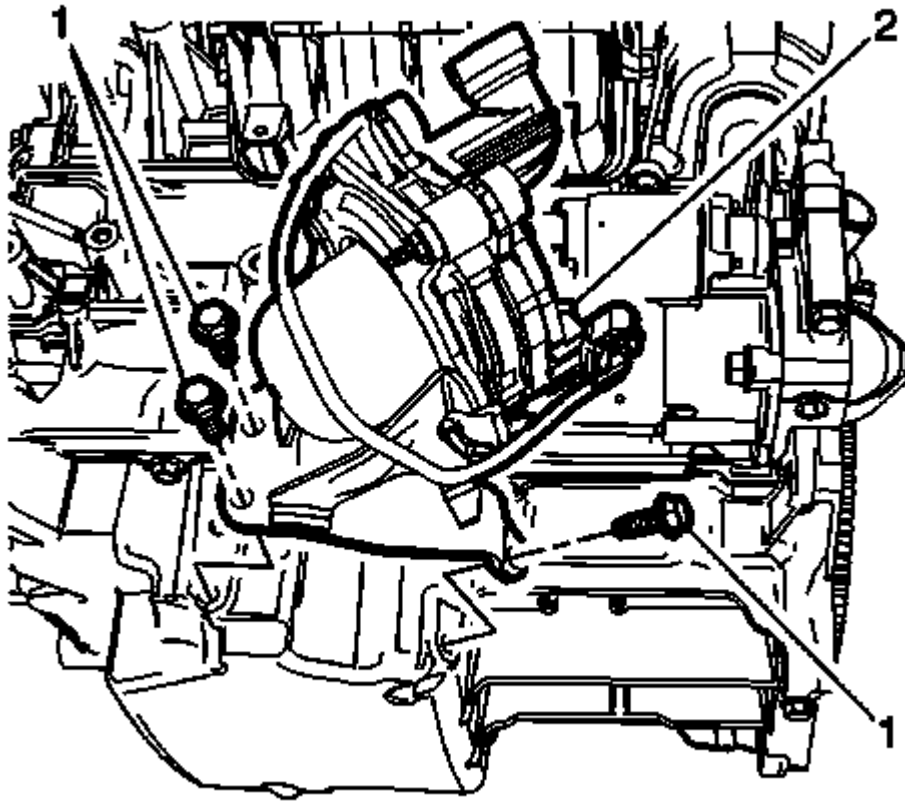


Fig. 248: Bolts And Secondary Air Injection Pump
Courtesy of GENERAL MOTORS COMPANY

13. Remove the bolts (1) retaining the secondary air injection pump (2) to the oil pan.
14. Tie the secondary air injection pump out of the way of the oil pan.

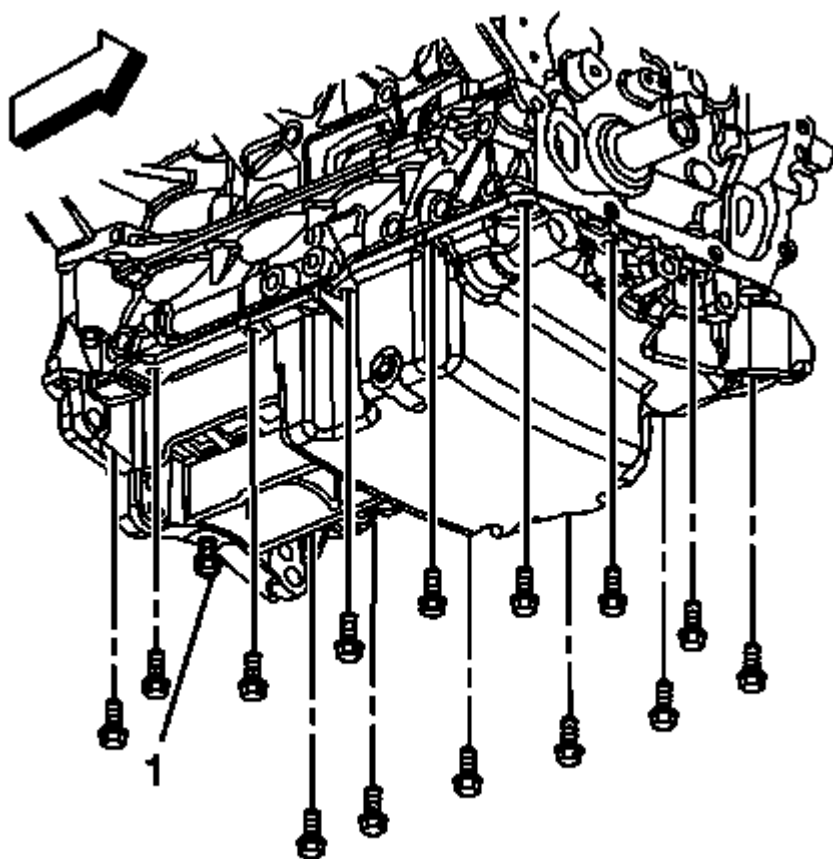


Fig. 249: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the 4 oil pan to transaxle bolts.
16. Remove the oil pan bolts.

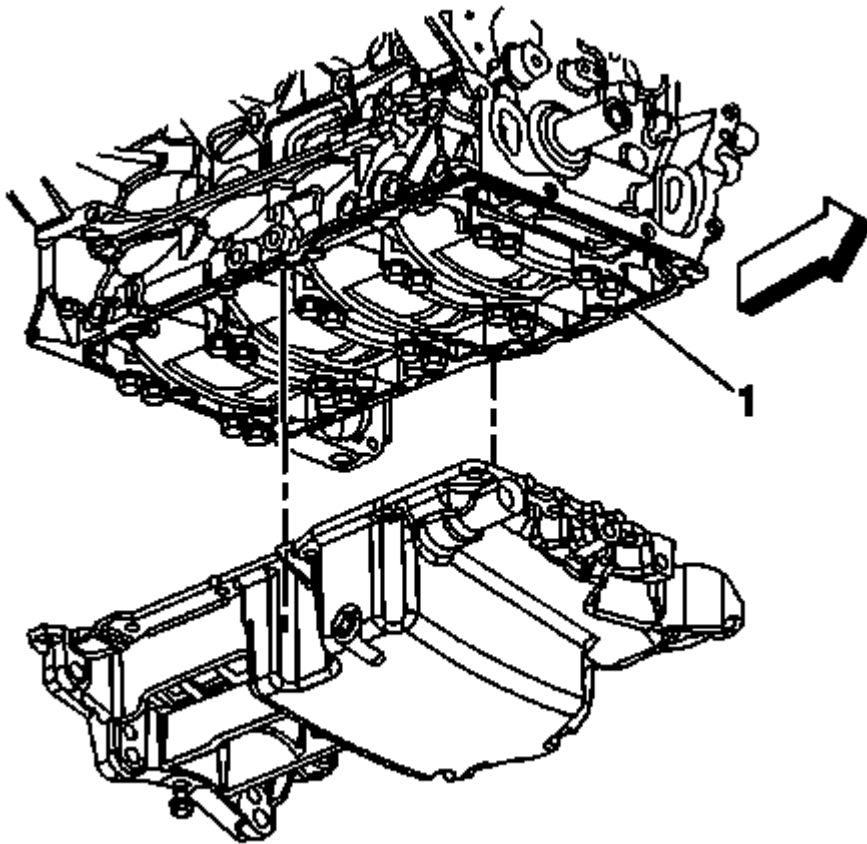


Fig. 250: Identifying Oil Pan

Courtesy of GENERAL MOTORS COMPANY

17. Remove the oil pan
18. Remove any old oil pan sealant (1).

Installation Procedure

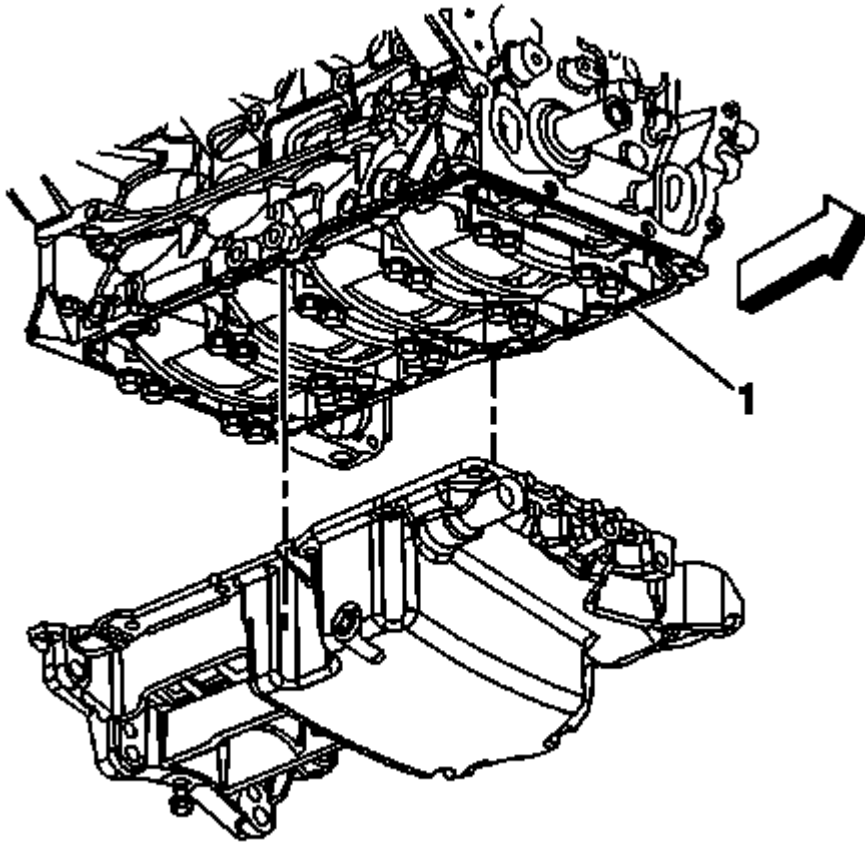


Fig. 251: Identifying Oil Pan

Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the oil pan and the sealing surface on the lower crankcase are free of all oil and debris.
2. Apply a 2 mm bead of sealant (1) around the perimeter of the oil pan and the oil suction port opening. DO NOT over apply the sealant. More than a 2 mm bead is not required. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Install the oil pan.

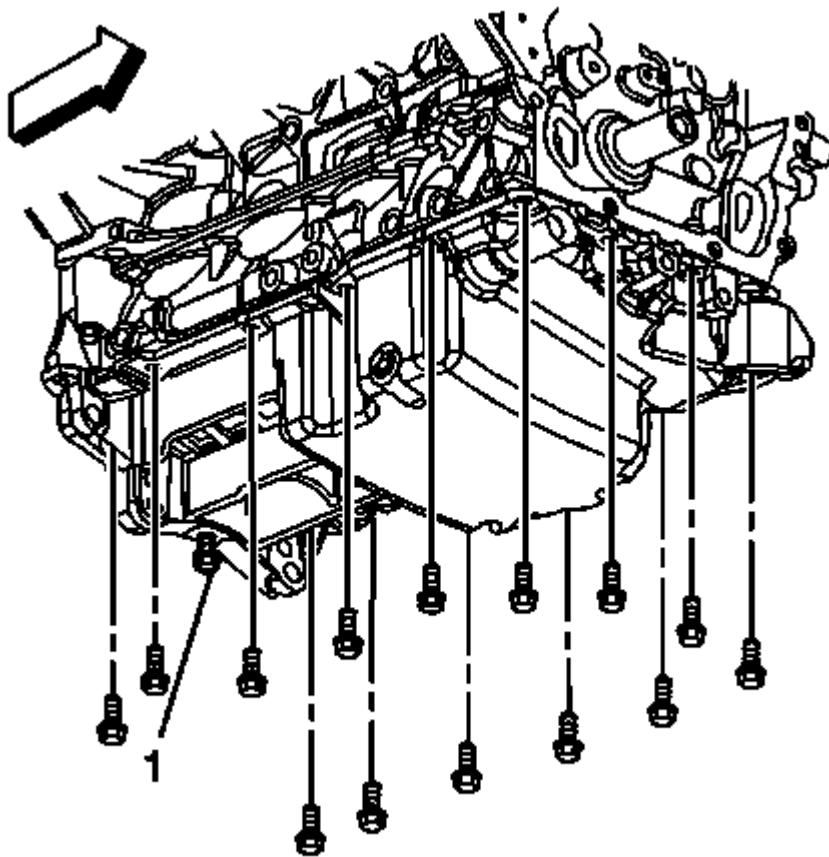


Fig. 252: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the oil pan bolts.

CAUTION: Refer to Fastener Caution .

5. Install the 4 oil pan to transaxle bolts and tighten to 75 N.m (55 lb ft).

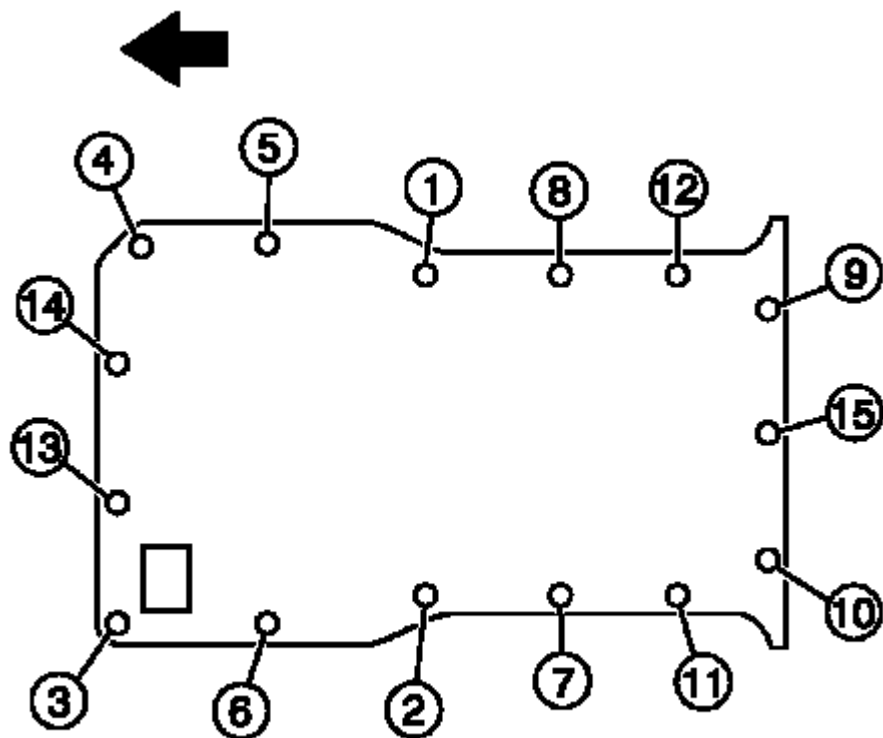


Fig. 253: Identifying Oil Pan Bolts Removal & Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the oil pan bolts in the sequence shown to 25 N.m (18 lb ft).

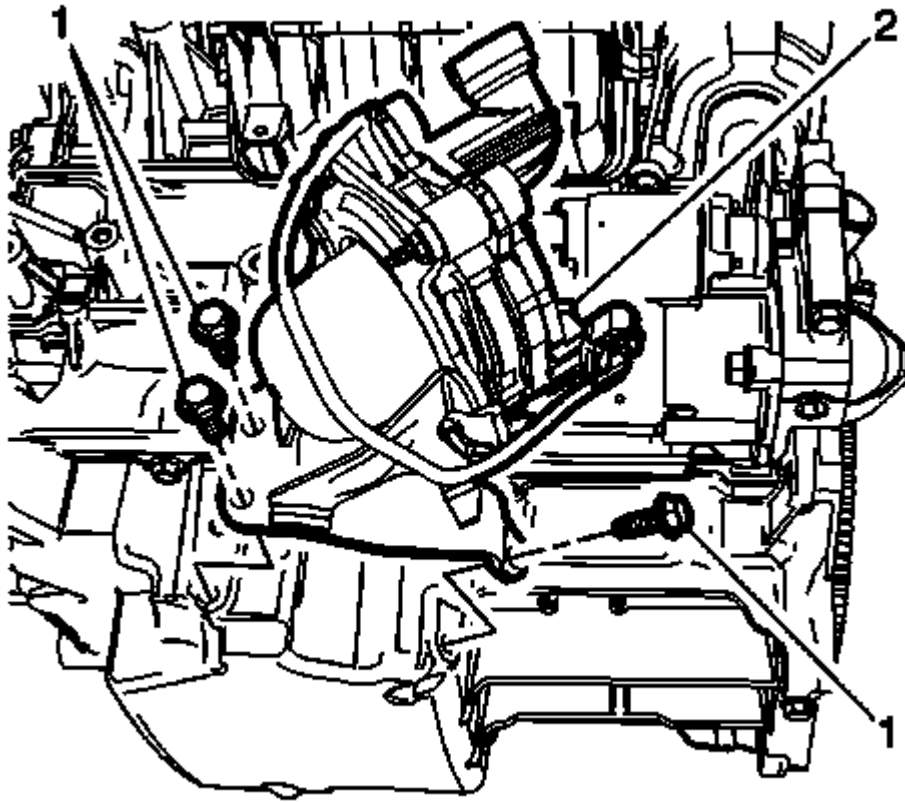


Fig. 254: Bolts And Secondary Air Injection Pump
Courtesy of GENERAL MOTORS COMPANY

7. Position the secondary air injection pump (2) to the oil pan.
8. Install the injection pump bolts (1) and tighten to 25 N.m (18 lb ft).
9. Lower the vehicle.
10. Using the engine support fixture, lower the engine.

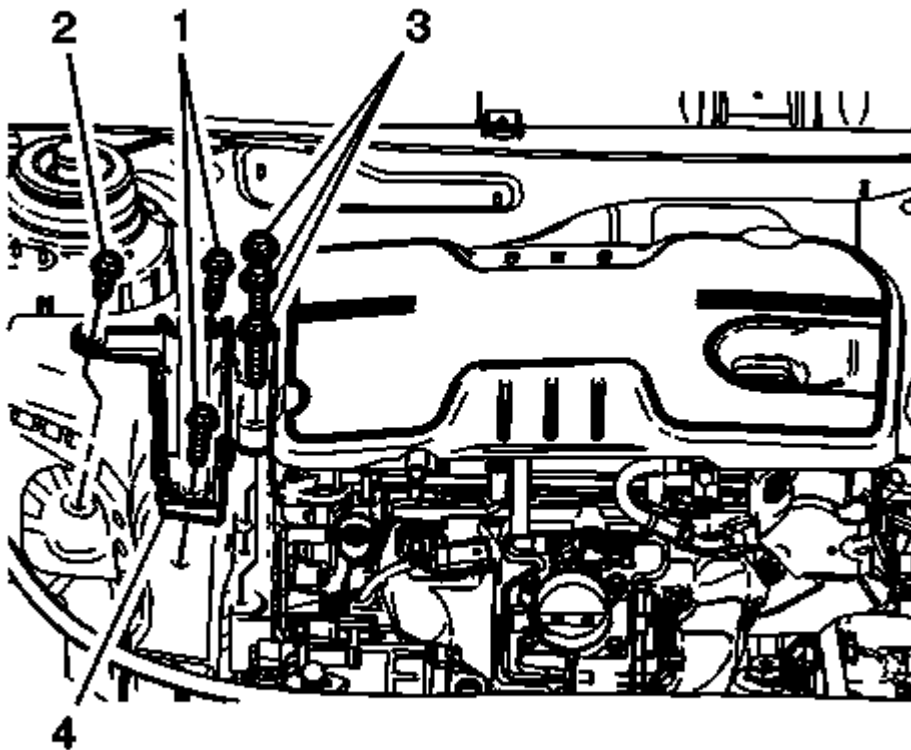


Fig. 255: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

11. Install the engine mount. Refer to **Engine Mount Replacement**.
12. Remove the engine support fixture.
13. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

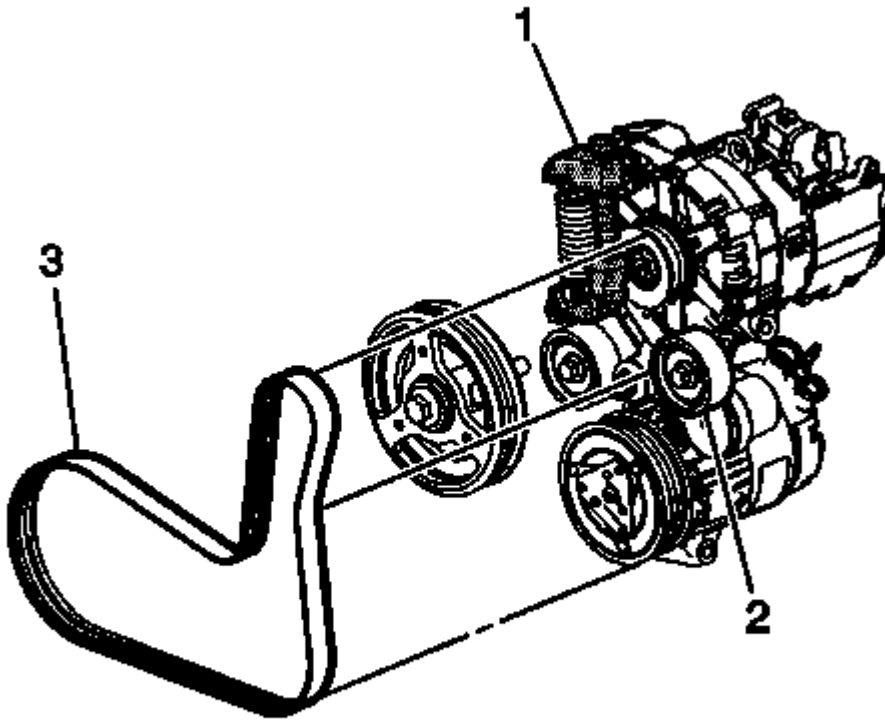


Fig. 256: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

14. Install the drive belt. Refer to **Drive Belt Replacement (LUK)**.
15. Fill the engine oil to the proper level.

ENGINE FLYWHEEL REPLACEMENT

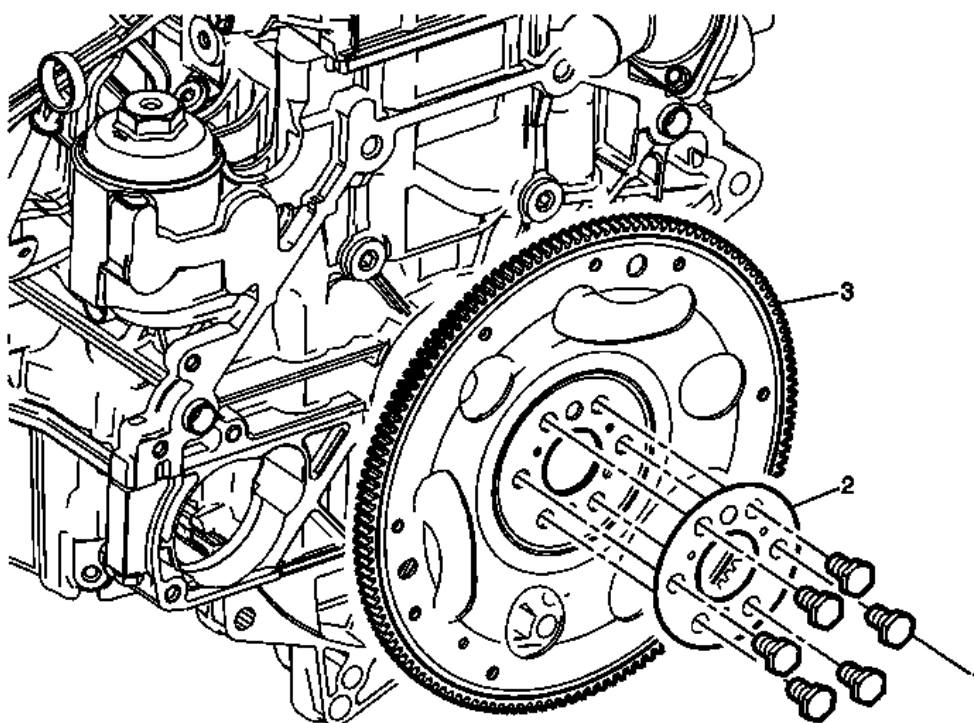


Fig. 257: Engine Flywheel Components
 Courtesy of GENERAL MOTORS COMPANY

Engine Flywheel Replacement

Callout	Component Name
Preliminary Procedure Remove the transmission. Refer to Transmission Replacement .	
Special Tools J-38122-A Crankshaft Balancer Holder. For equivalent regional tools. Refer to Special Tools .	
1	Engine Flywheel Fastener (Qty: 6) CAUTION: Refer to Fastener Caution . Tighten <ul style="list-style-type: none"> • 53 N.m (39 lb ft) • Tighten the bolt an additional 2 degrees.
2	Engine Flywheel Plate
	Engine Flywheel Procedure Inspect the engine flywheel for the following:

3

1. Stress cracks around the engine flywheel .
2. Cracks at welded areas that retain the ring gear onto the engine flywheel.
3. Damaged or missing ring gear teeth.
4. Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

EN-42067 Rear Main Seal Installer

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the flywheel. Refer to **Engine Flywheel Replacement**

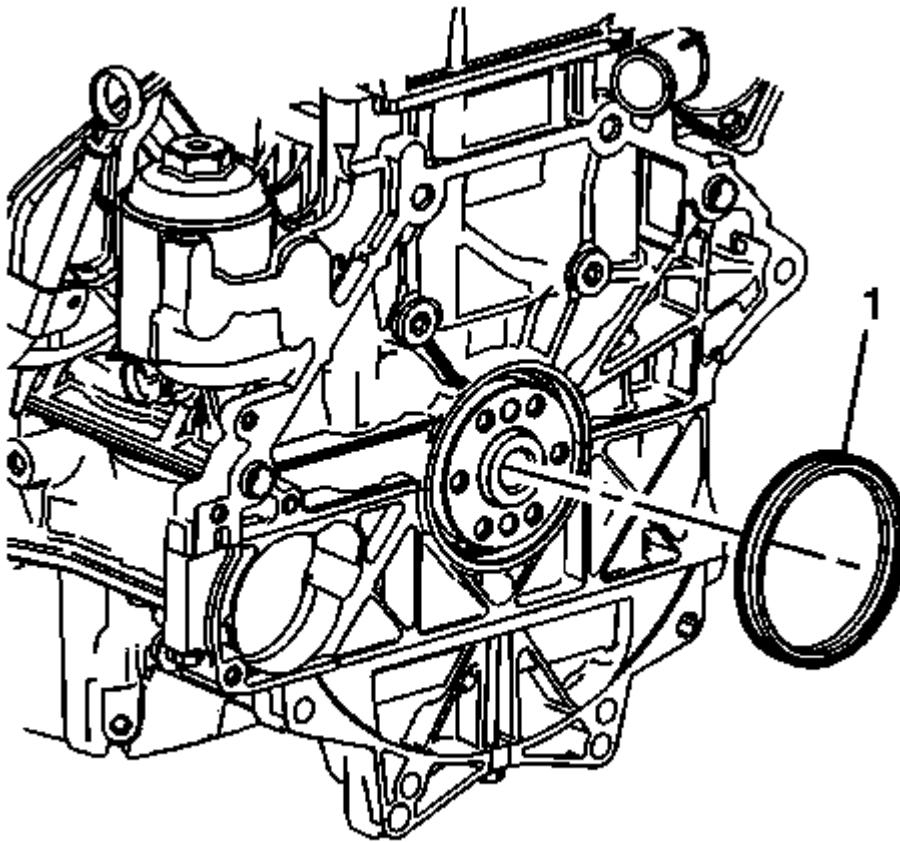


Fig. 258: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage the outside diameter of the crankshaft or chamber with any tool.

2. Use a suitable tool to remove the crankshaft rear oil seal (1).

Installation Procedure

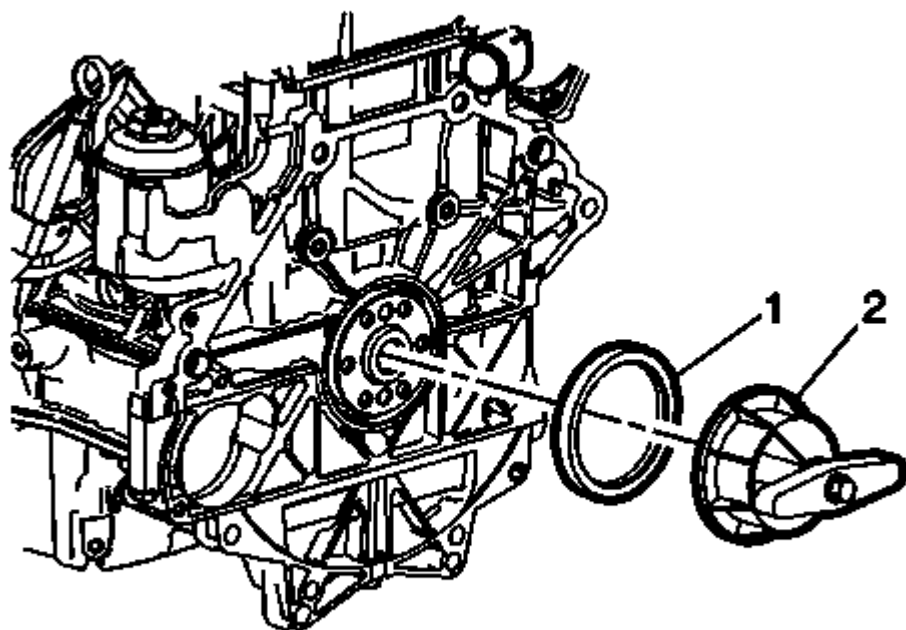


Fig. 259: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Using the (2) **EN-42067** installer , install a NEW crankshaft real oil seal (1).
2. Install the flywheel. Refer to **Engine Flywheel Replacement**.

ENGINE REPLACEMENT (LUK)

Special Tools

- **BO-38185** Hose Clamp Pliers.
- **J-39580** Engine Support Table.

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Recover the refrigerant system. Refer to Refrigerant Recovery and Recharging .
3. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .
4. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.
5. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .

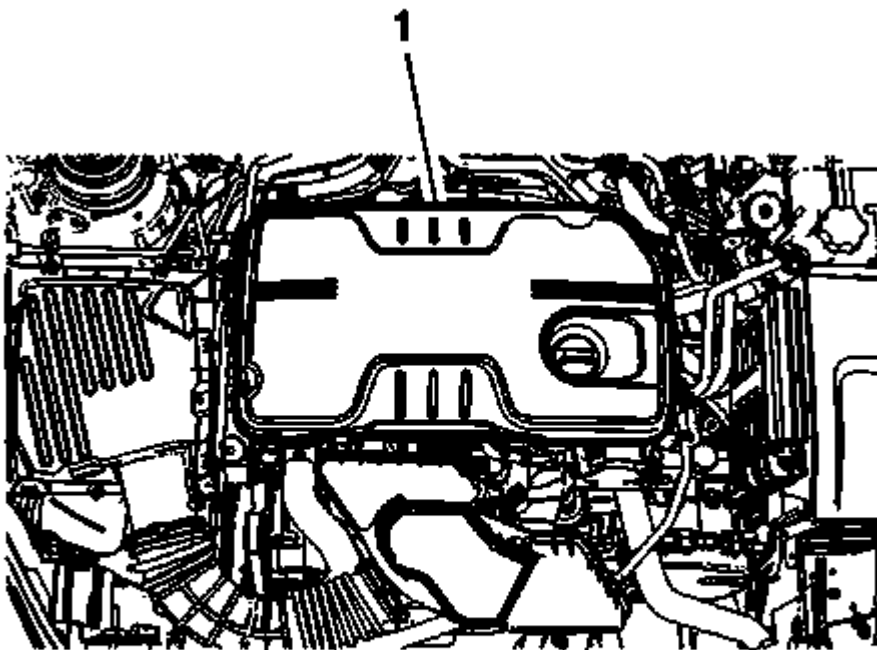


Fig. 260: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

6. Remove the intake manifold cover (1). Refer to Intake Manifold Cover Replacement.

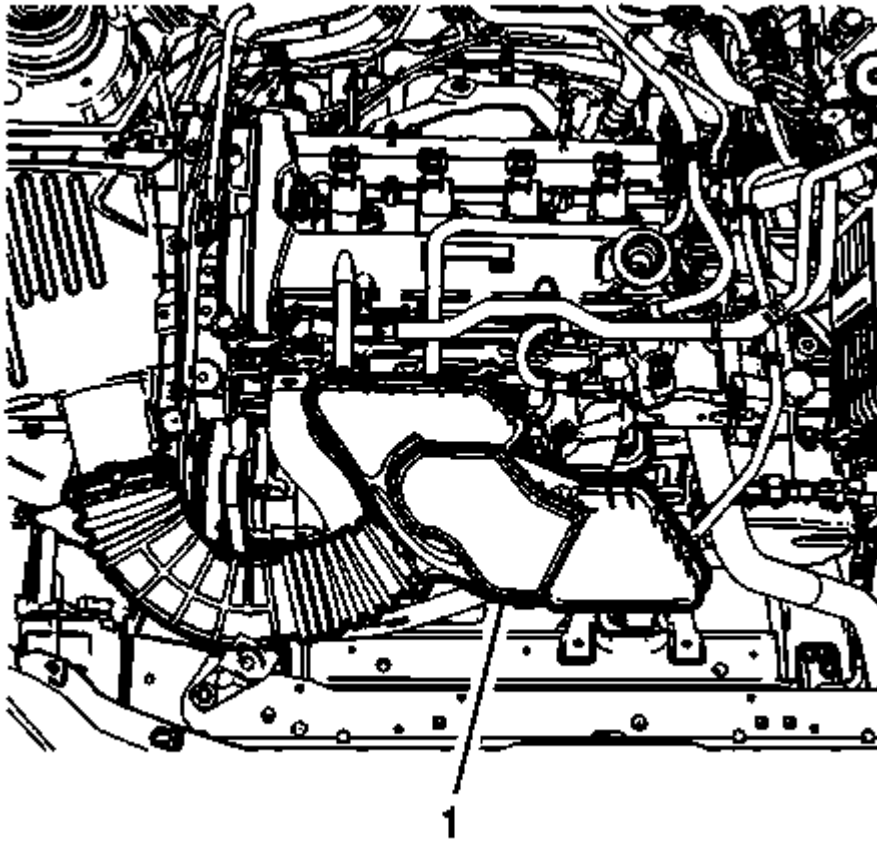


Fig. 261: Air Cleaner Outlet Duct Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove the air cleaner outlet duct assembly (1). Refer to **Air Cleaner Outlet Duct Replacement** .

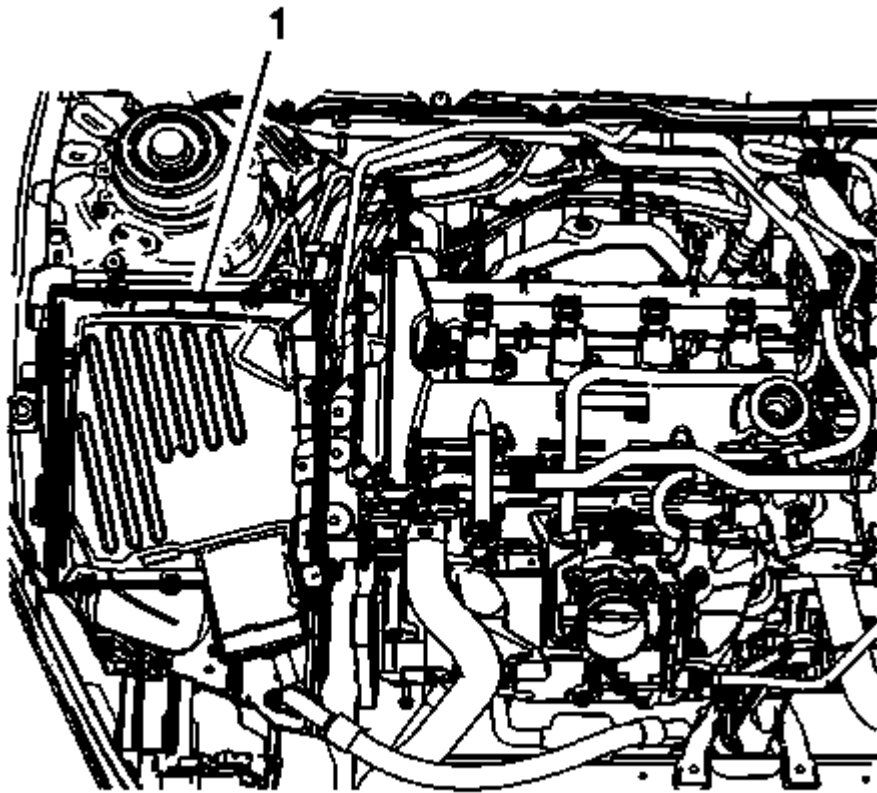


Fig. 262: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .

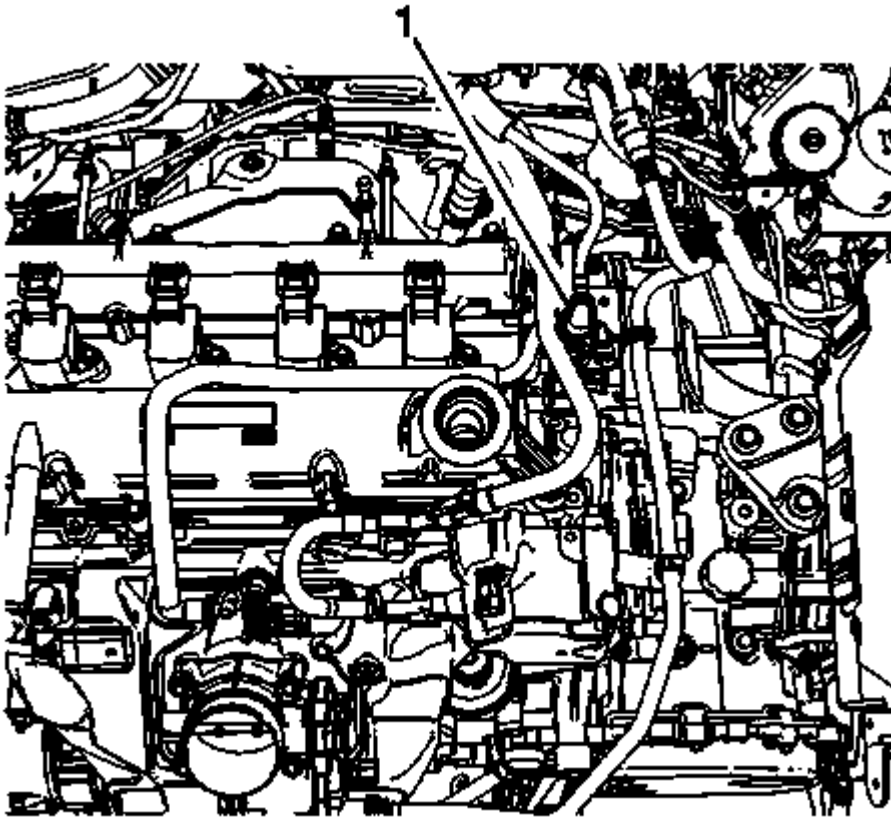


Fig. 263: Evaporative Emission (EVAP) Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the evaporative emission (EVAP) line quick connect fitting (1) from the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .

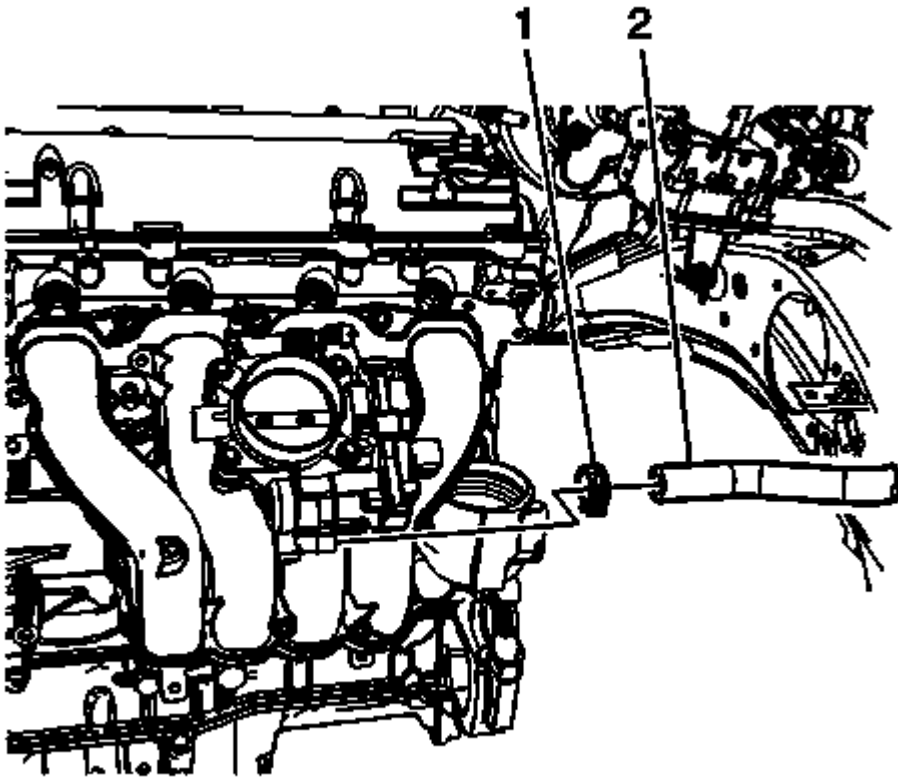


Fig. 264: Clamp And Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Release the clamp (1) and remove the power brake booster vacuum pipe (2) from the intake manifold vacuum port.
11. Release the power brake booster vacuum pipe from the routing clips and remove the vacuum pipe.

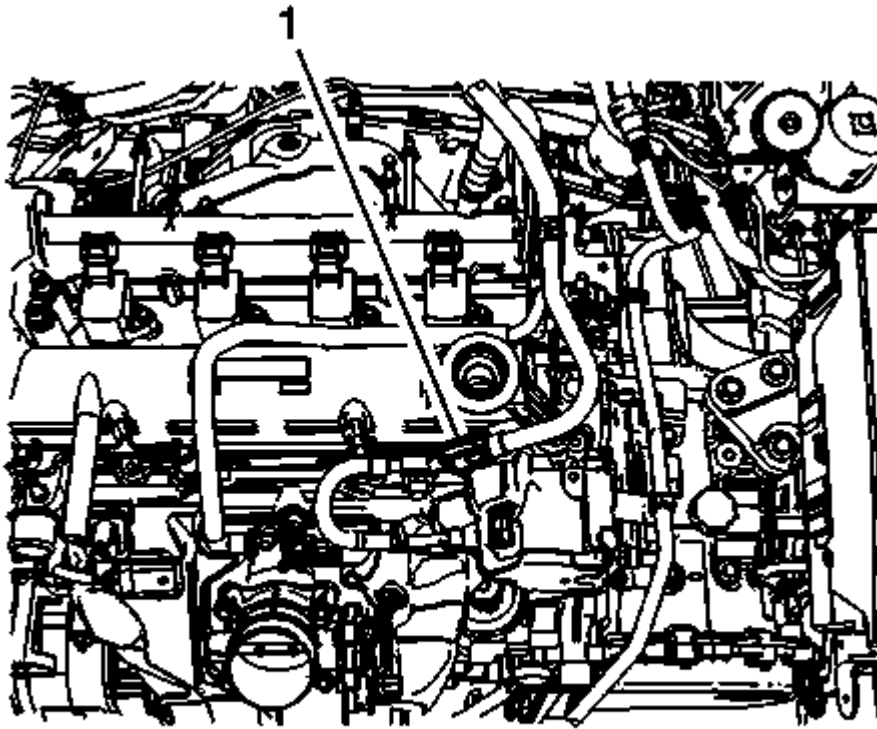


Fig. 265: Fuel Feed Line

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the fuel feed line (1). Refer to **Metal Collar Quick Connect Fitting Service** .

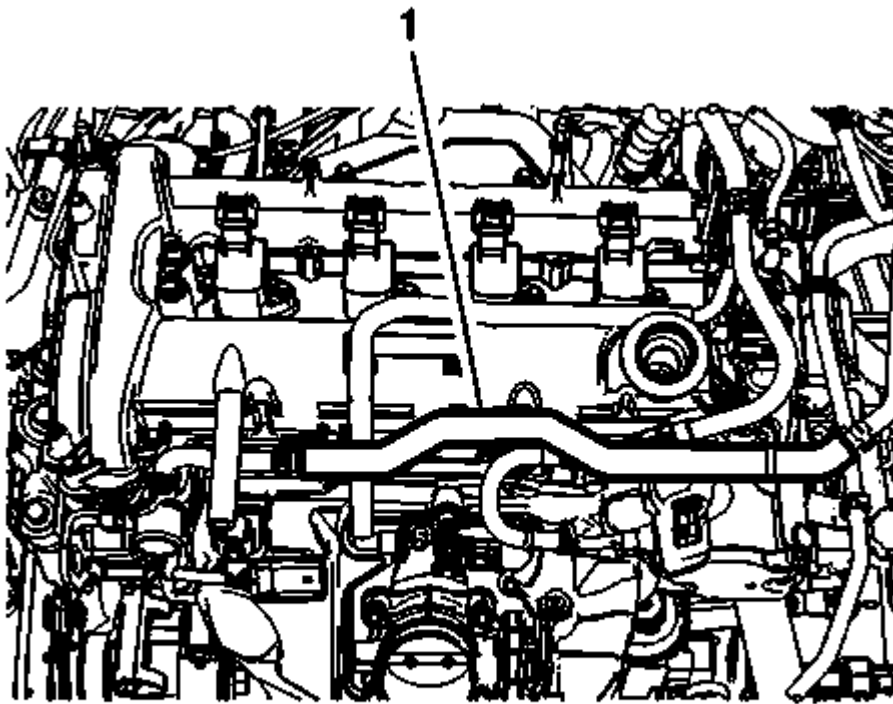


Fig. 266: Radiator Surge Tank Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

13. Remove the radiator surge tank inlet hose (1). Refer to **Radiator Surge Tank Inlet Hose Replacement (LEA)**.

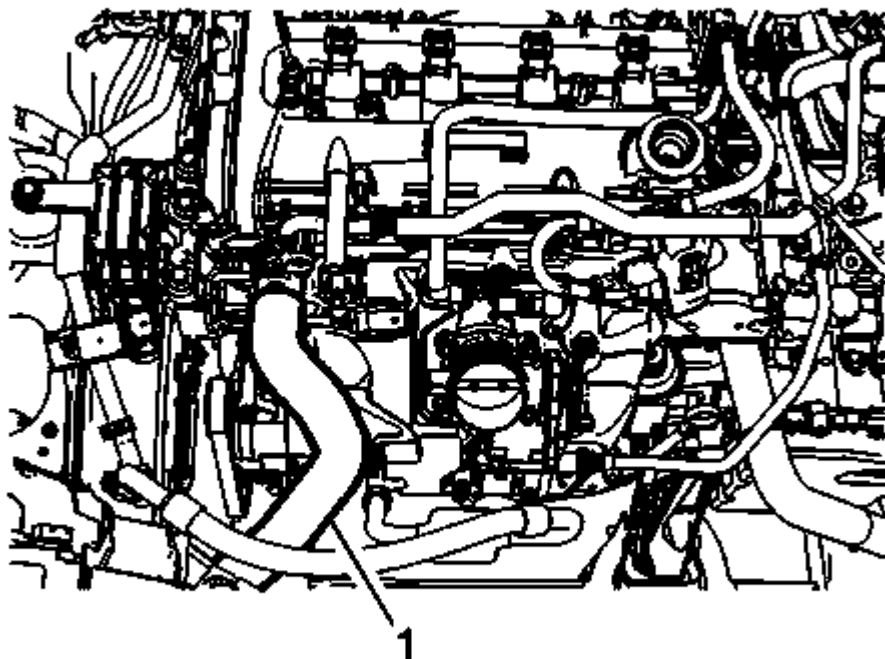


Fig. 267: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

14. Remove the radiator inlet hose (1). Refer to **Radiator Inlet Hose Replacement (LUK)** .
15. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LUK)** .

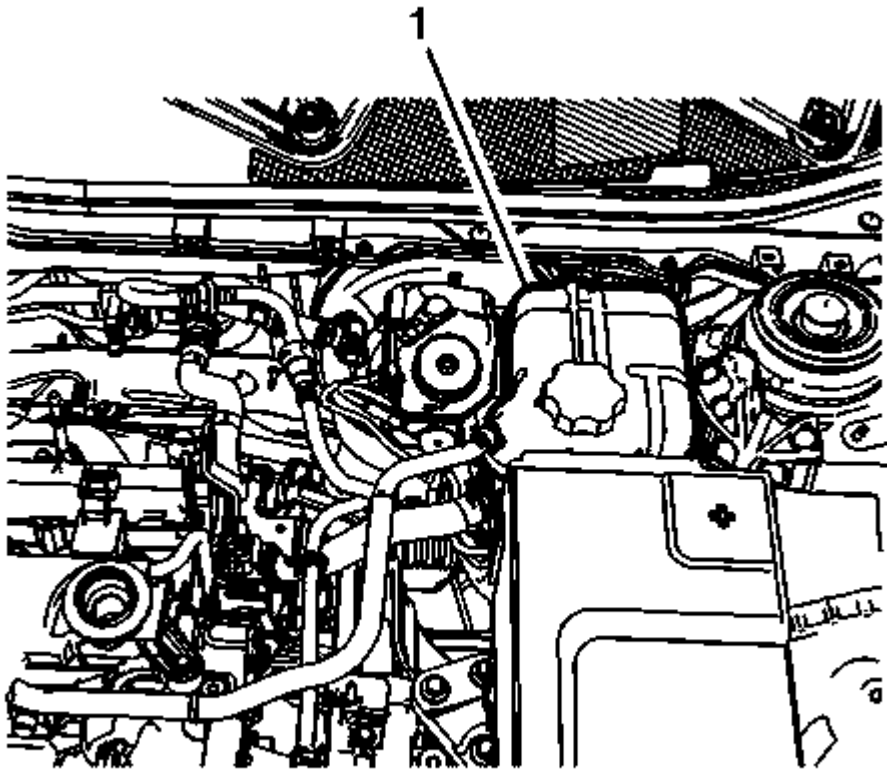


Fig. 268: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

16. Remove the radiator surge tank (1). Refer to **Radiator Surge Tank Replacement (LUK)** .

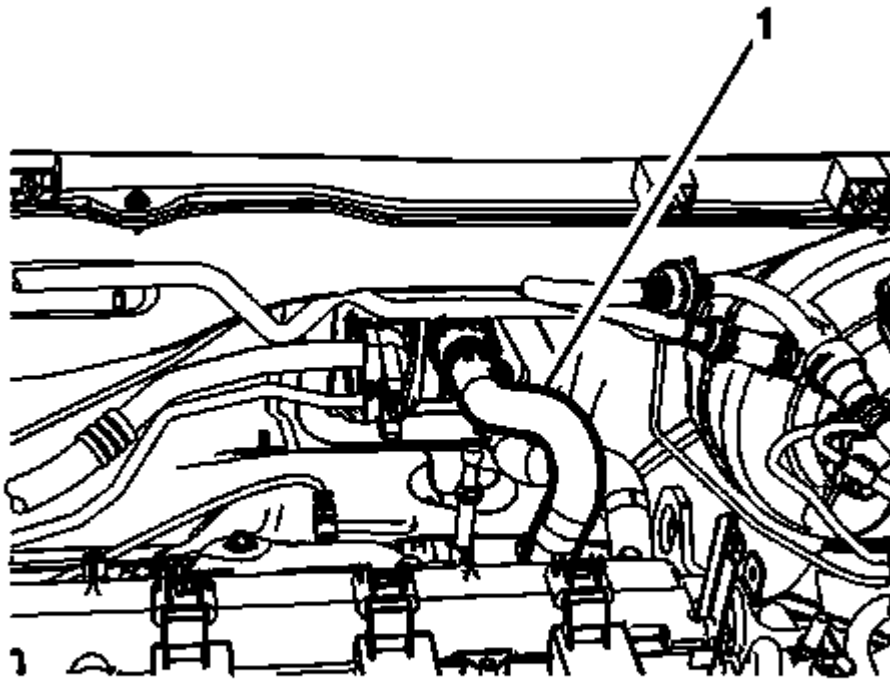


Fig. 269: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LUK)** .

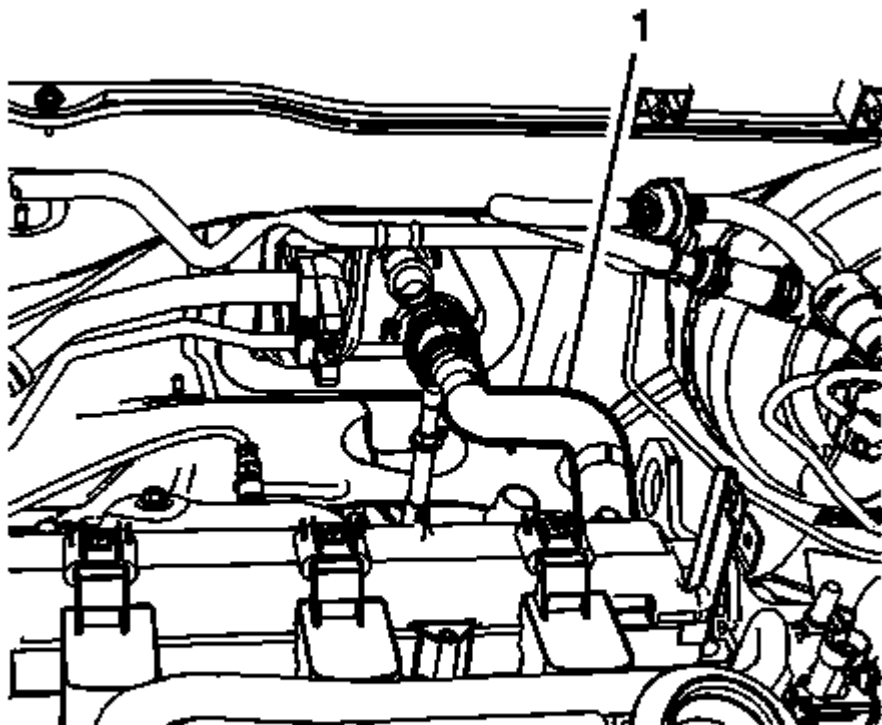


Fig. 270: Heater Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

18. Disconnect the heater outlet hose (1). Refer to **Heater Outlet Hose Replacement (LUK)** .

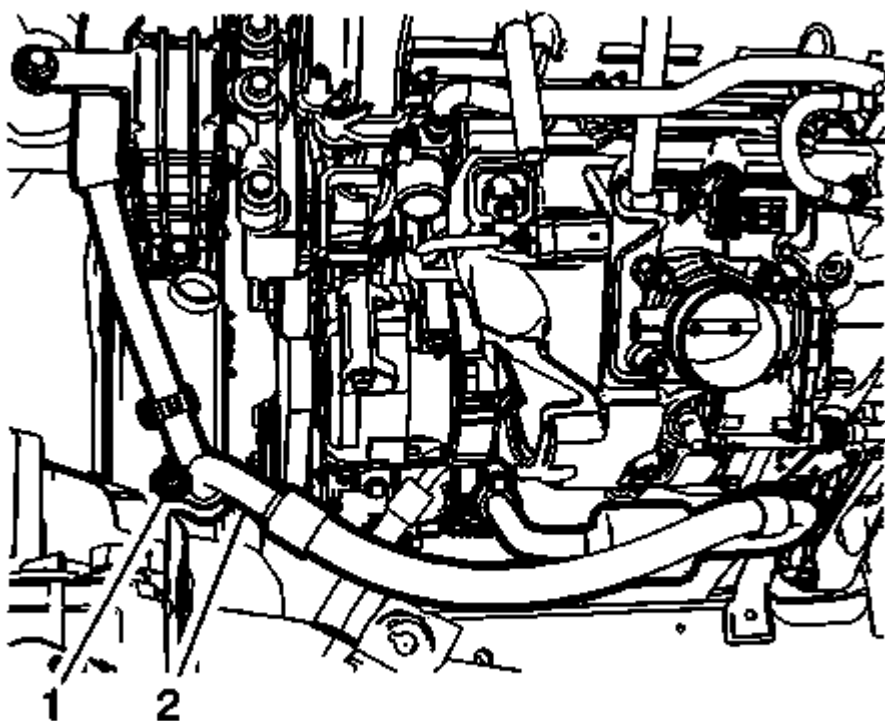


Fig. 271: Evaporator Outlet Hose And Nut
Courtesy of GENERAL MOTORS COMPANY

19. Remove the A/C compressor hose to evaporator outlet hose nut (1).
20. Disconnect the A/C compressor hose to evaporator outlet hose (2).

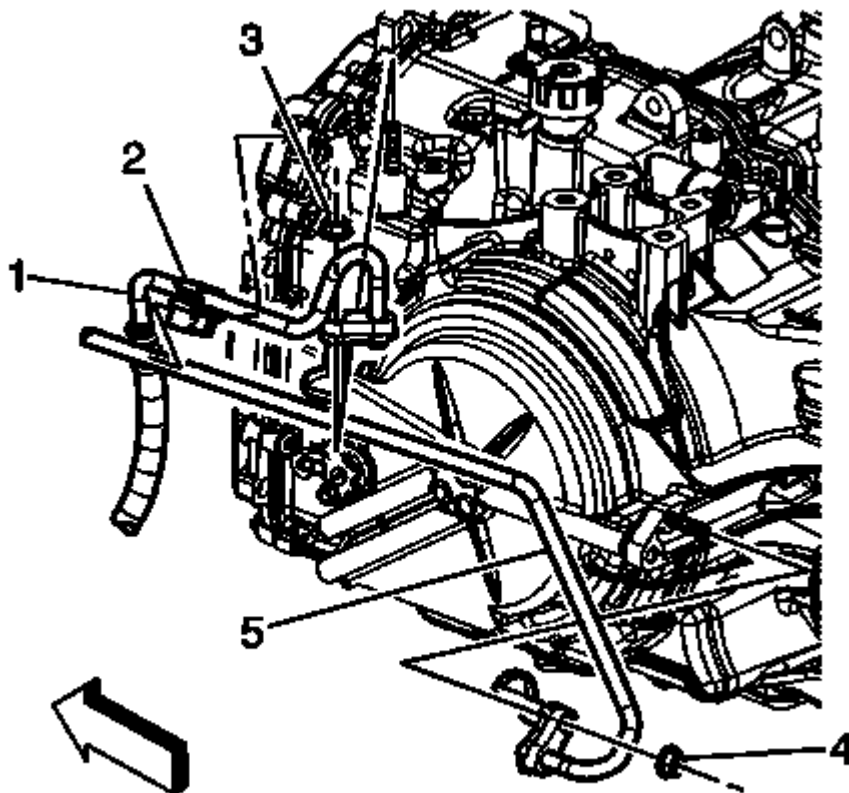


Fig. 272: Identifying Cooler Inlet & Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

21. Remove the transmission fluid cooler inlet (1) and outlet (5) hoses from the retainer (2) on the control valve body cover.
22. Remove the transmission fluid cooler inlet hose nut (3) from the transmission.
23. Remove the transmission fluid cooler inlet hose (1) from the transmission.
24. Remove the transmission fluid cooler outlet hose nut (4) from the transmission.
25. Remove the transmission fluid cooler outlet hose (5) from the transmission.
26. Plug and/or cap the hose and transmission to prevent contamination.
27. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
28. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .
29. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LUK)** .

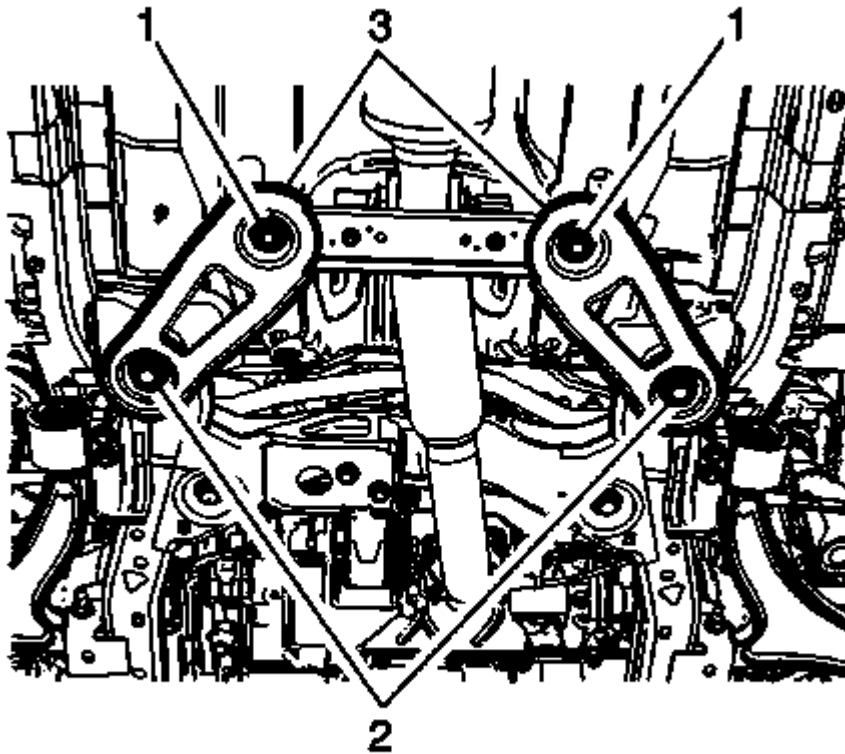


Fig. 273: Frame Reinforcements Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

30. Remove the frame reinforcements bracket bolts (1) and (2).
31. Remove the frame reinforcements bracket (3).
32. Remove the starter. Refer to **Starter Replacement (LUK)** .

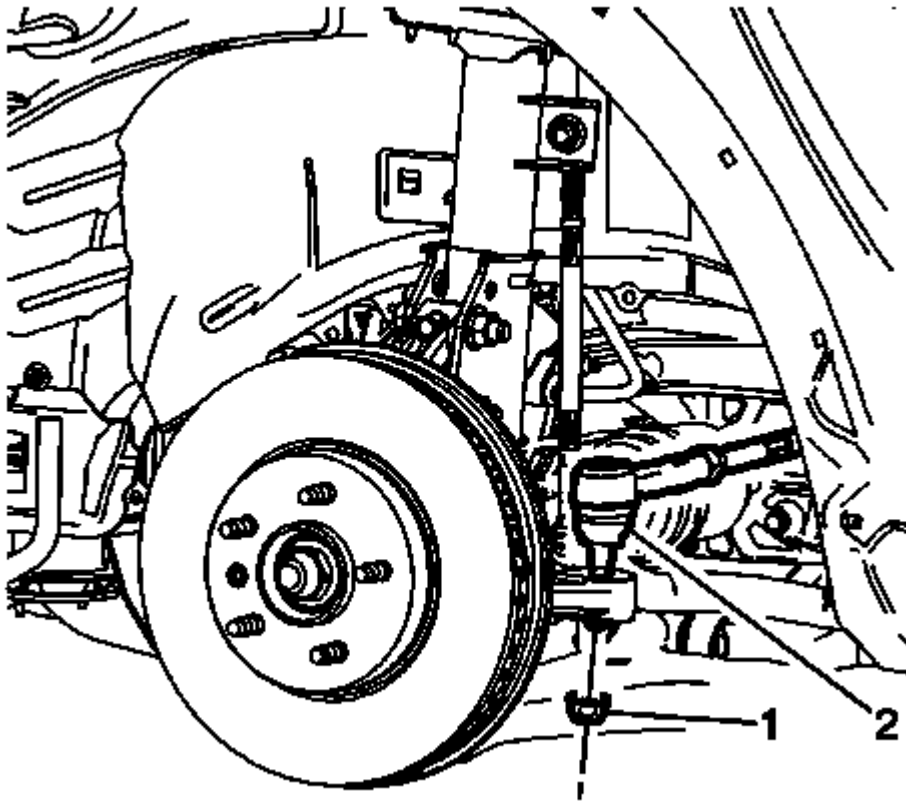


Fig. 274: Steering Linkage Outer Tie Rod Nut And Tie Rod
Courtesy of GENERAL MOTORS COMPANY

33. Remove the steering linkage outer tie rod nut (1) and tie rod (2). Refer to **Steering Linkage Outer Tie Rod Replacement** .

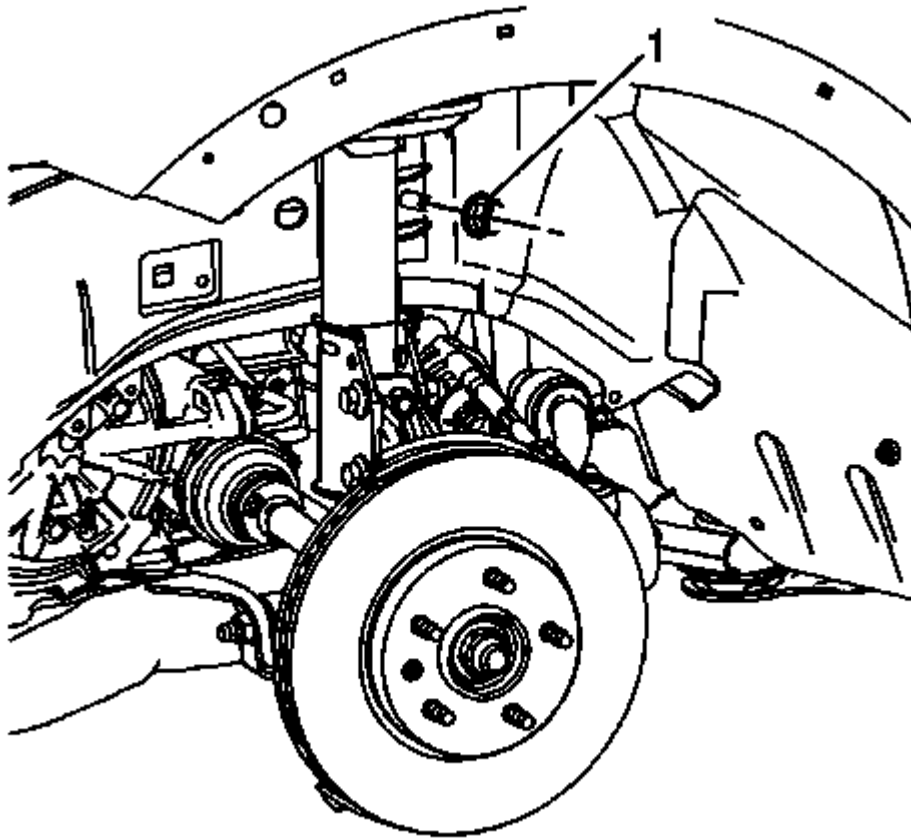


Fig. 275: Stabilizer Link And Strut Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow the stabilizer link ball stud to rotate while removing the link nut.

34. Remove the nut (1) and separate the stabilizer link from the strut assembly. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .

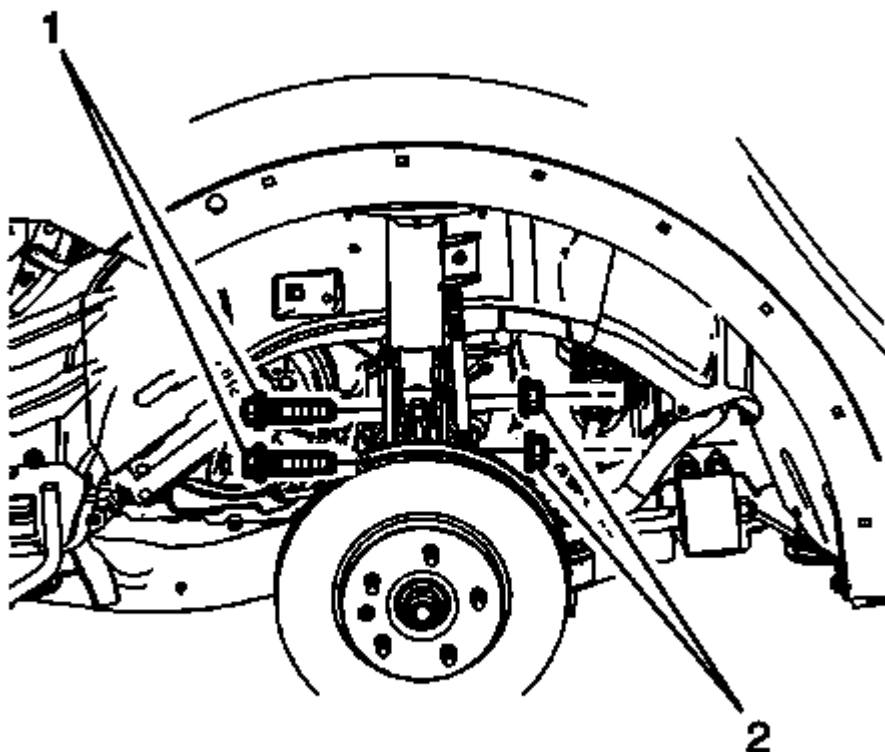


Fig. 276: Steering Knuckle To Strut Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

35. Remove the steering knuckle to strut bolts (1) and nuts (2). Refer to **Strut Assembly Removal and Installation (GNB)** , **Strut Assembly Removal and Installation (GNA)** .

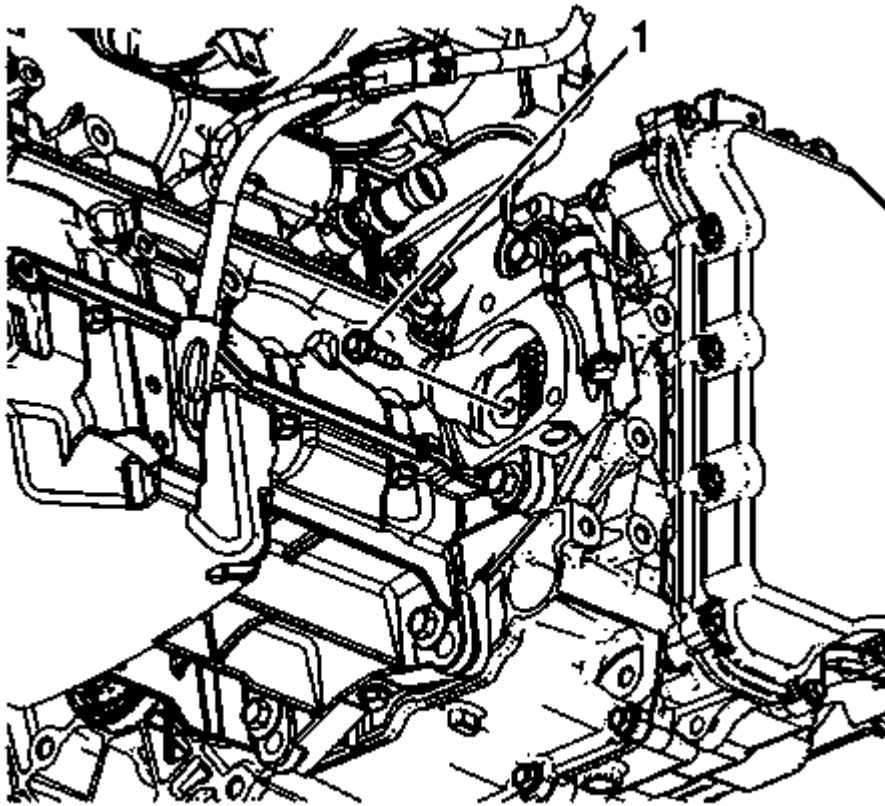


Fig. 277: Identifying Starter Bolts
Courtesy of GENERAL MOTORS COMPANY

36. Mark the relationship of the flywheel to the torque converter for reassembly.
37. Remove the torque converter to flywheel bolt (1).

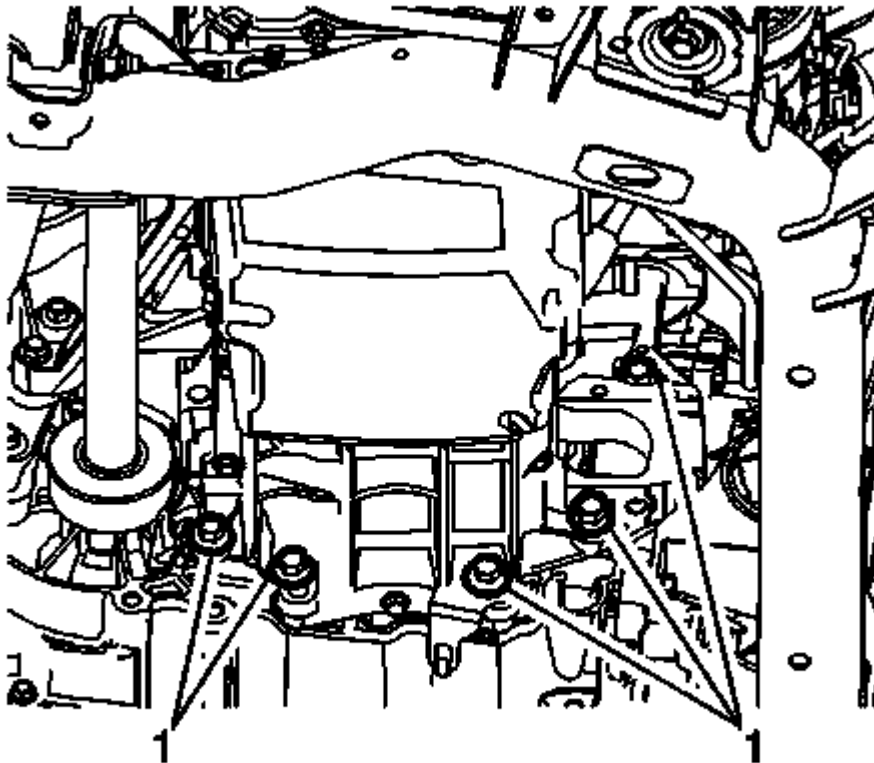


Fig. 278: Lower Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

38. Remove the lower transmission bolts (1).

NOTE: Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.

39. Position a engine support table under the powertrain assembly.

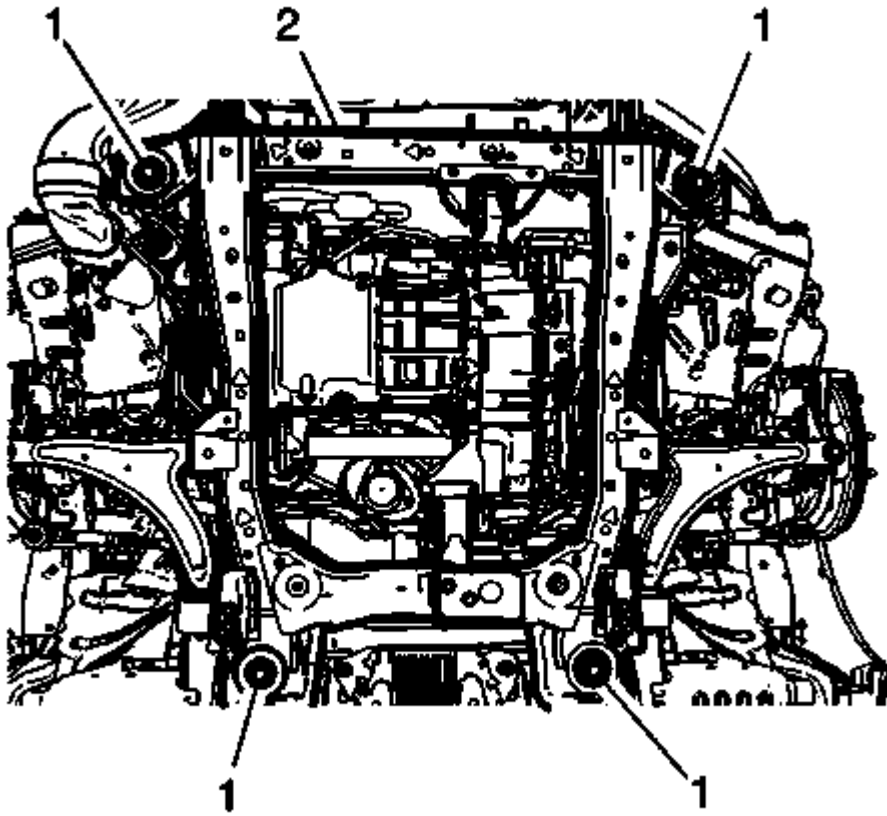


Fig. 279: Frame Bolts
Courtesy of GENERAL MOTORS COMPANY

40. Remove the frame bolts (1).
41. Lower the vehicle on the engine support table.

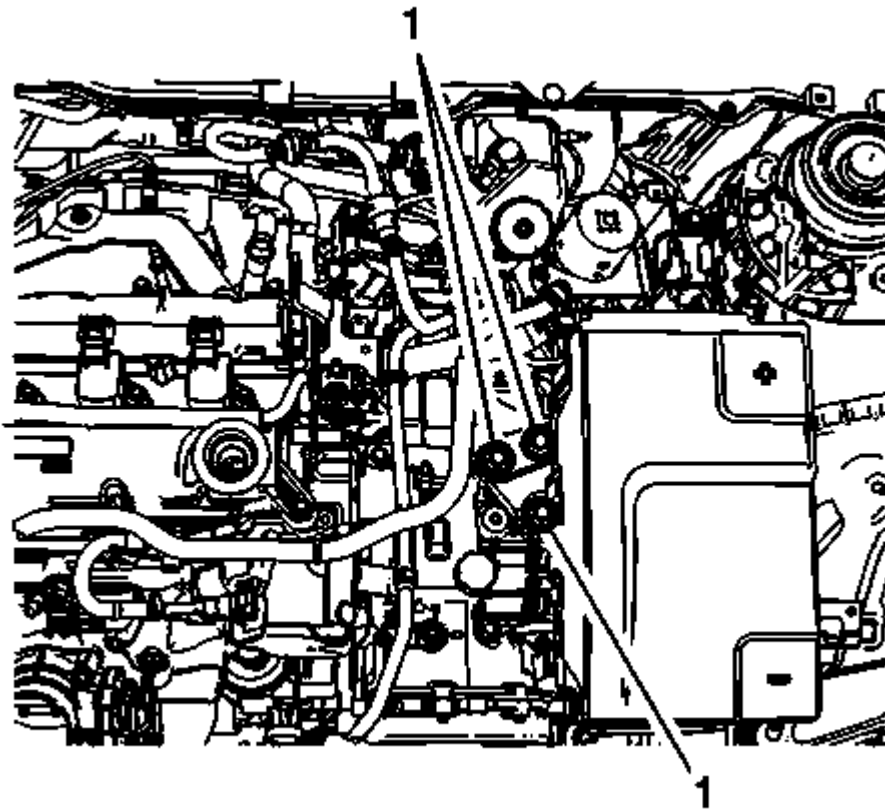


Fig. 280: Transmission Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

42. Remove the transmission mount bolts (1).

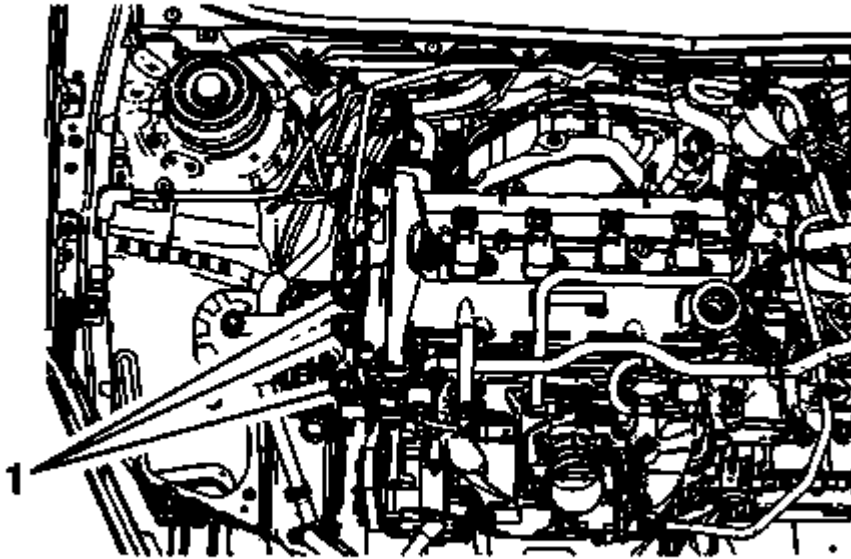


Fig. 281: Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

43. Remove the engine mount bolts (1).
44. Disconnect electrical connector as necessary.
45. Disconnect coolant hoses as necessary.

NOTE: **When lowering the engine/transaxle assembly, verify all brake lines, shiftier cables and other components are free during removal**

46. Lower the engine table and raise the body on the hoist until the engine/transaxle and cradle are free from the vehicle.

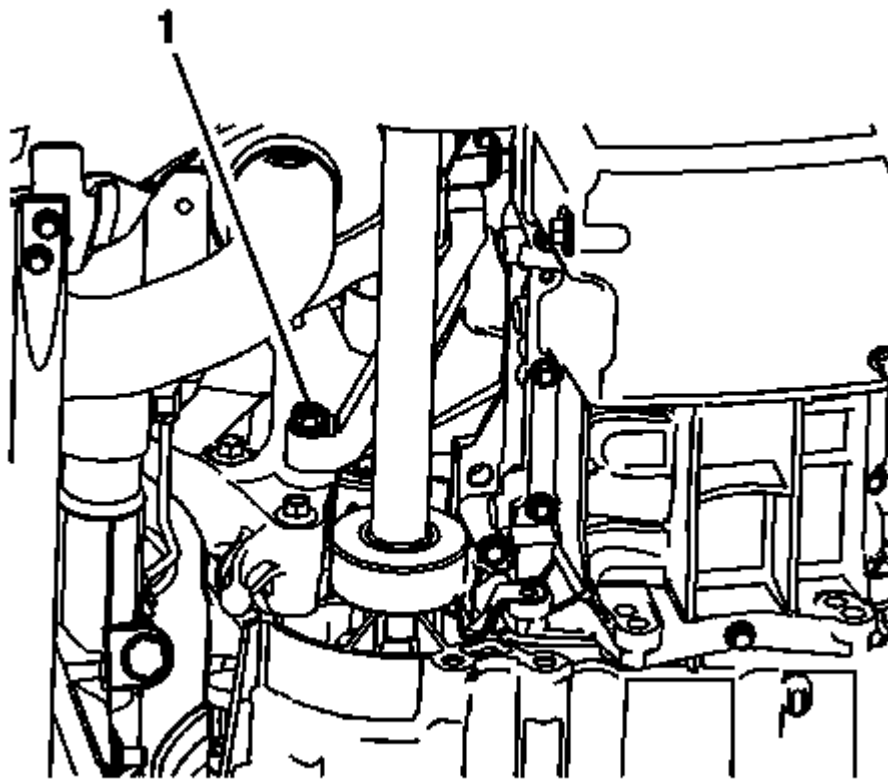


Fig. 282: Transmission Brace

Courtesy of GENERAL MOTORS COMPANY

47. Remove the transmission brace (1).

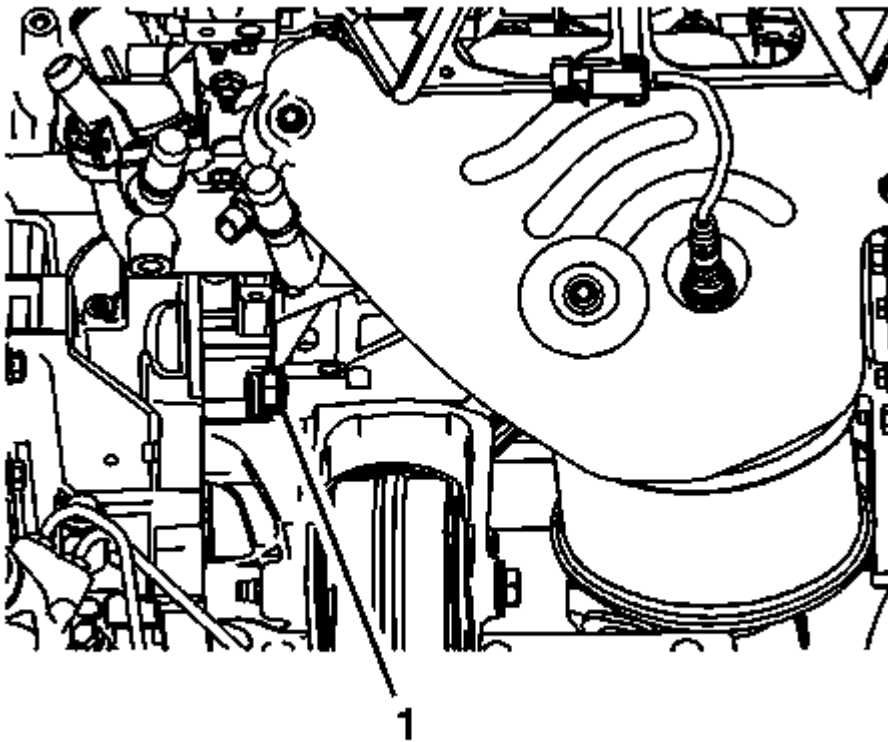


Fig. 283: Lower Trans Bolts

Courtesy of GENERAL MOTORS COMPANY

48. Remove the lower trans bolts (1).

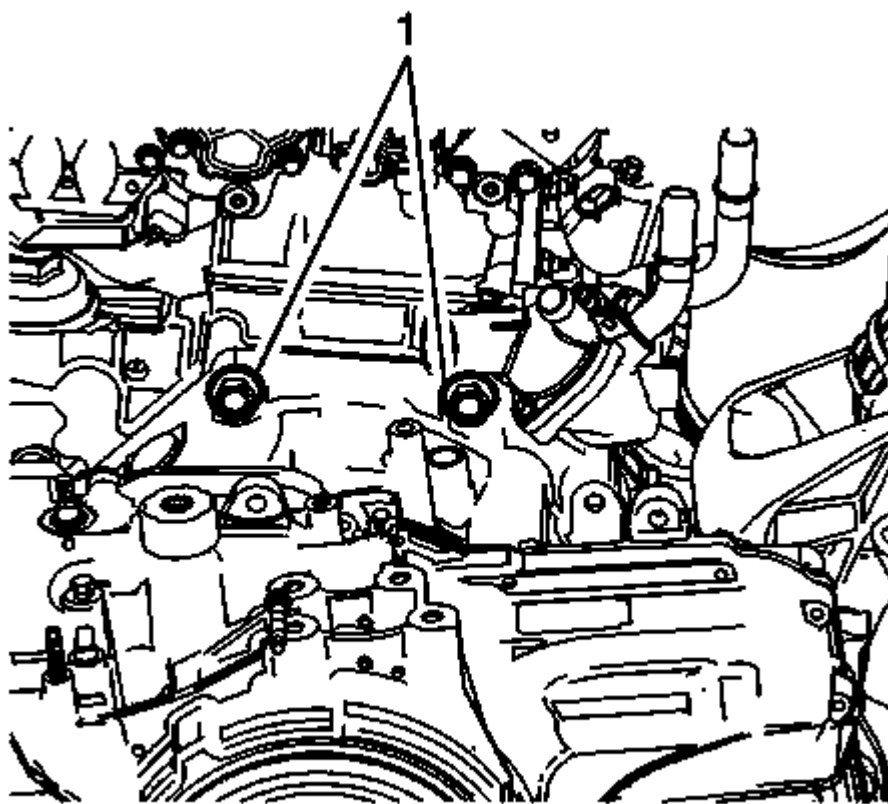


Fig. 284: Upper Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

49. Remove the upper transmission bolts (1).
50. Separate the engine from the transmission.
51. Install the engine to a suitable engine stand.

Installation Procedure

1. Remove the engine from the engine stand.
2. Install the transmission to the engine.

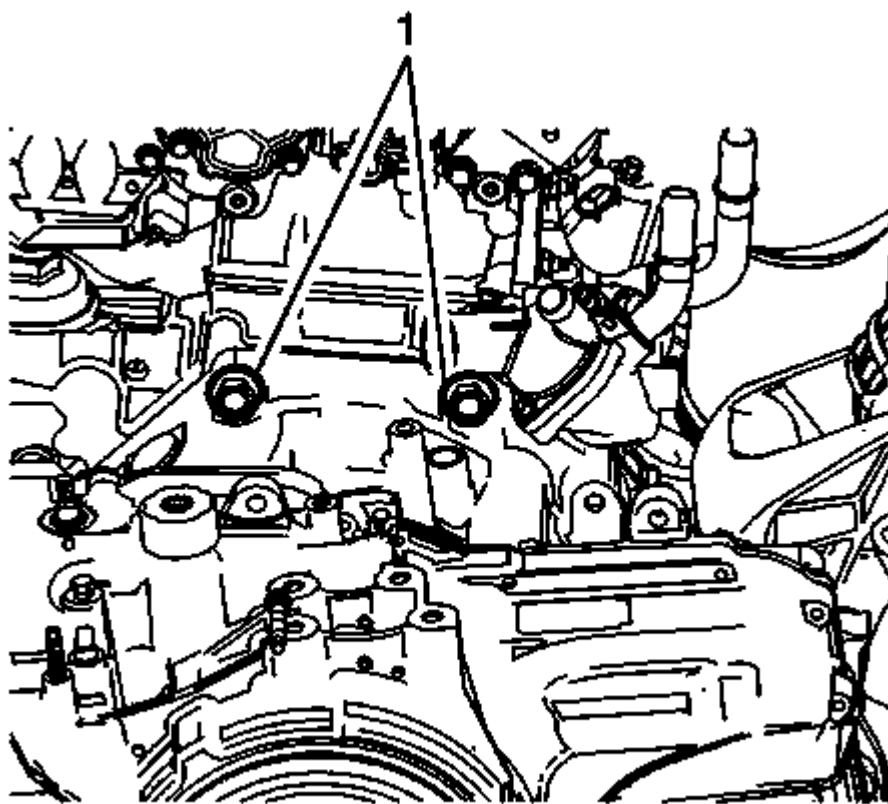


Fig. 285: Upper Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the upper transmission bolts (1) and tighten to 75 (55 lb ft).

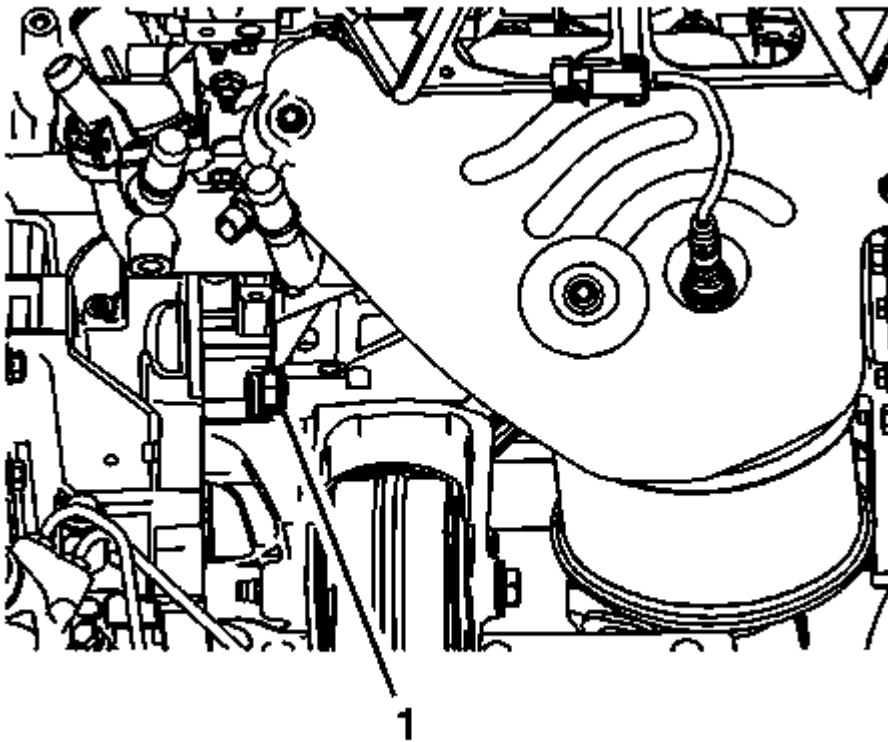


Fig. 286: Lower Trans Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Install the upper transmission bolts (1) and tighten to 75 (55 lb ft).

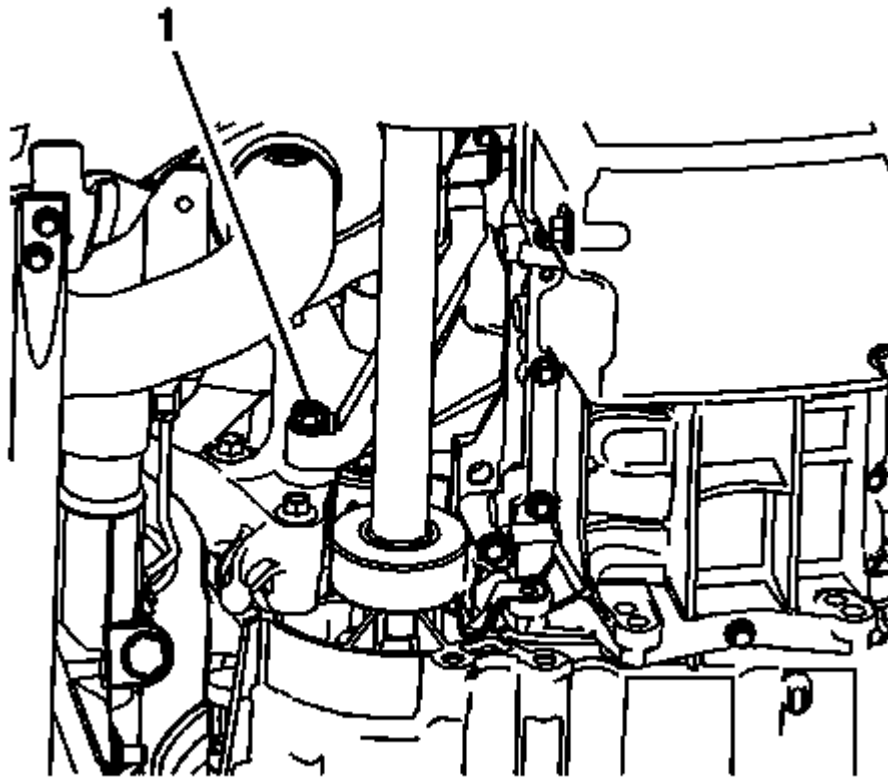


Fig. 287: Transmission Brace

Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission brace (1) and tighten to 58 (43 lb ft).
6. Slowly lower the body onto the powertrain.

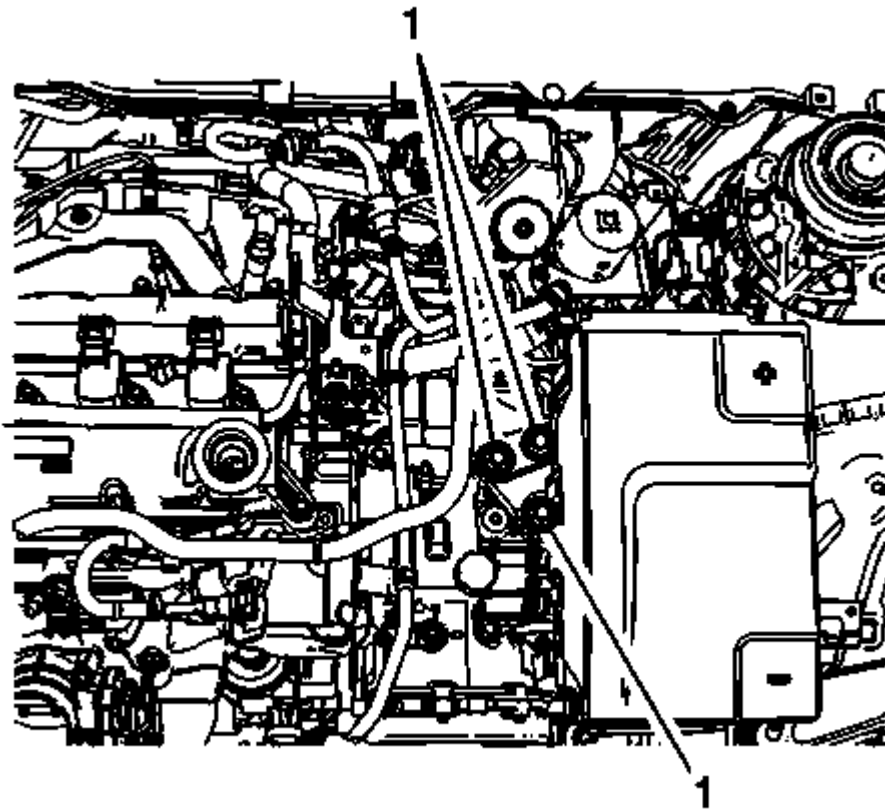


Fig. 288: Transmission Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the NEW left transmission mount to transmission bolts (1) and tighten to 50 (37 lb ft).

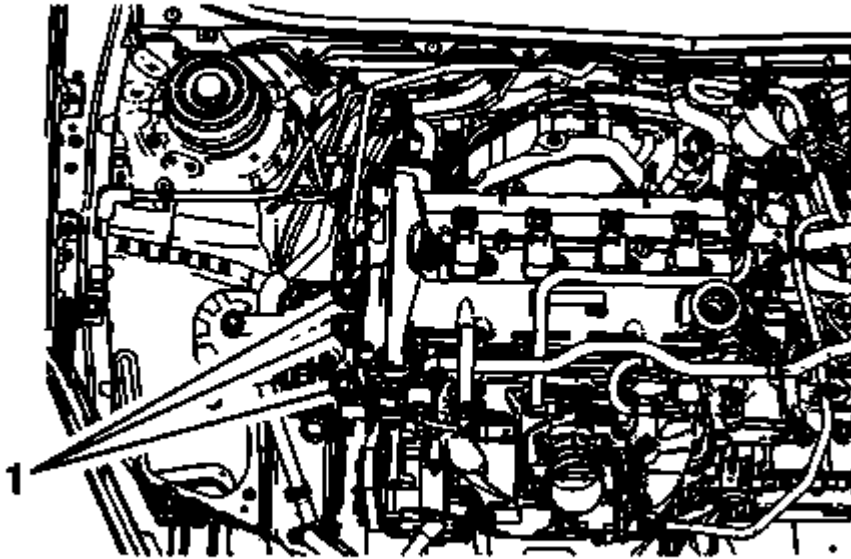


Fig. 289: Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Install the NEW right side engine mount bolts (1) and tighten to 62 (46 lb ft).

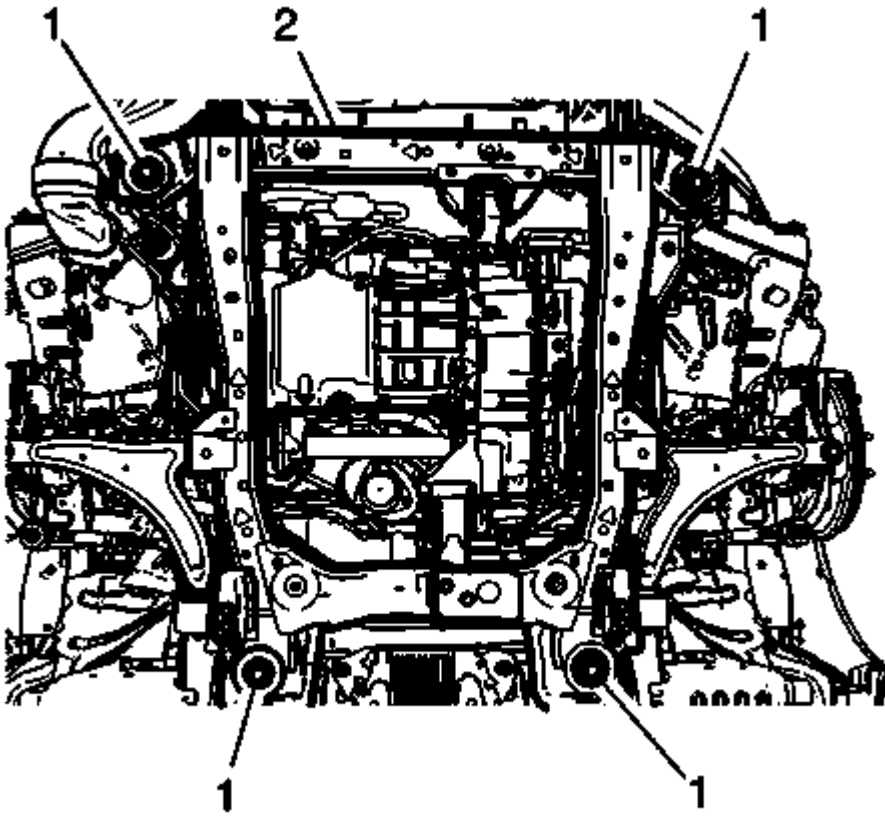


Fig. 290: Frame Bolts

Courtesy of GENERAL MOTORS COMPANY

9. Install the frame retaining bolts (1) then tighten the bolts to 160 (118 lb ft)

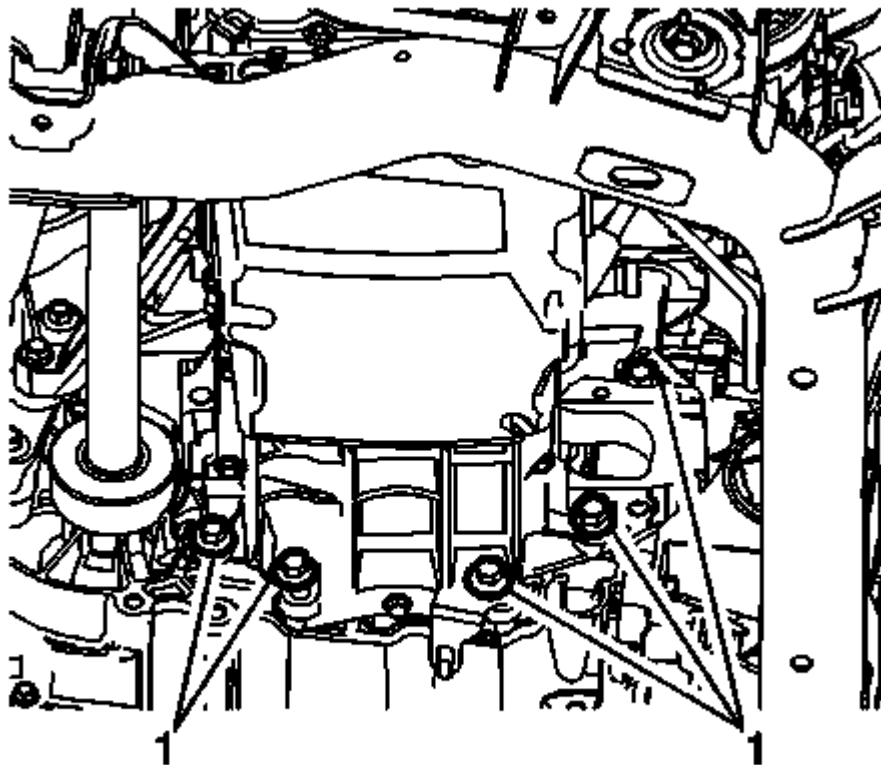


Fig. 291: Lower Transmission Bolts

Courtesy of GENERAL MOTORS COMPANY

10. Install the lower transmission bolts (1) and tighten to 75 (55 lb ft).

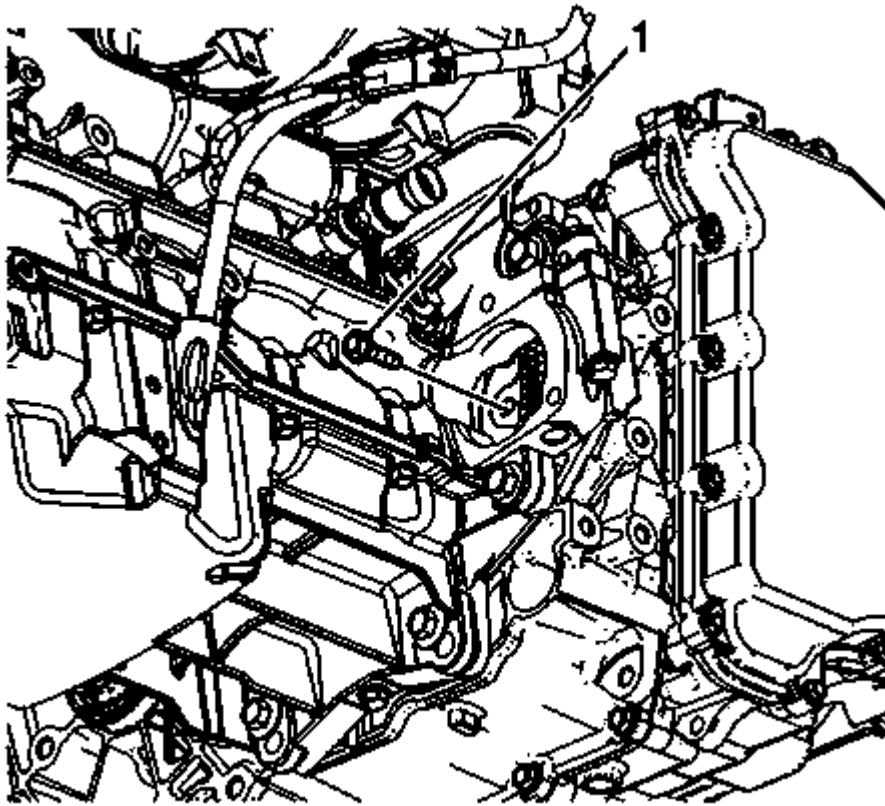


Fig. 292: Identifying Starter Bolts

Courtesy of GENERAL MOTORS COMPANY

11. Install the torque converter to flywheel bolts (1) and tighten to 62 (46 lb ft)
12. Install the starter. Refer to **Starter Replacement (LUK)** .
13. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LUK)** .

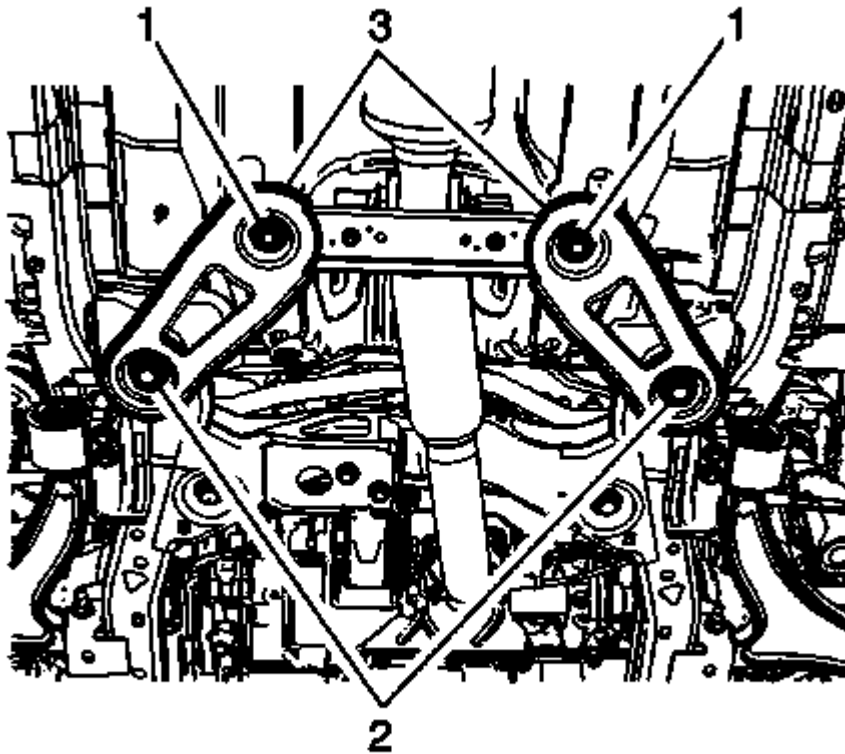


Fig. 293: Frame Reinforcements Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the frame reinforcements bracket (3) then tighten the bolts (1) and (2) to 42 (31 lb ft).

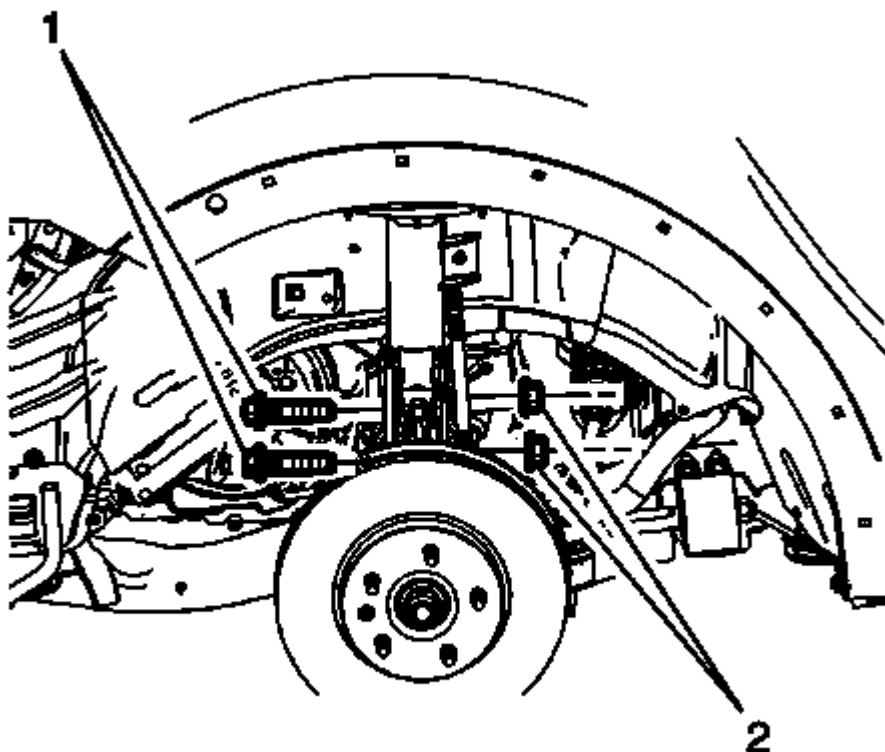


Fig. 294: Steering Knuckle To Strut Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Install the NEW strut to the steering knuckle using new bolts (1) and nuts (2) and tighten to 185 (136 lb ft).
16. Inspect the stabilizer link seals for damage and replace the link as necessary.

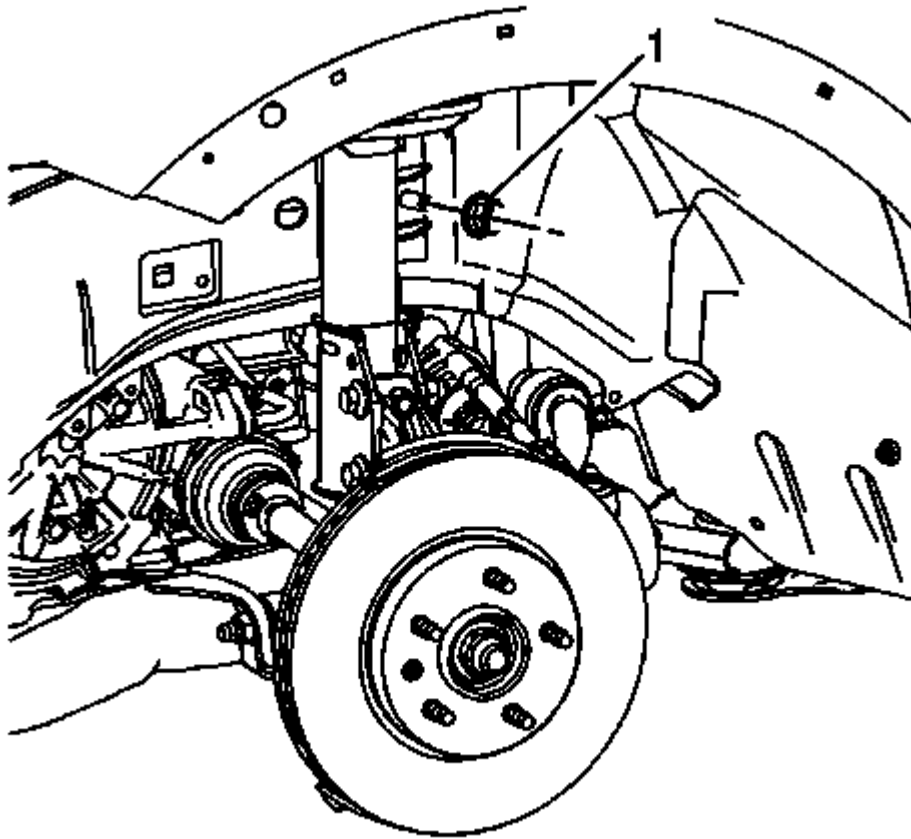


Fig. 295: Stabilizer Link And Strut Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use the proper size allen wrench to keep the stabilizer link ball stud from rotate while installing the nut.

17. Install the stabilizer link to the strut nut (1) and tighten to 65 (48 lb ft)

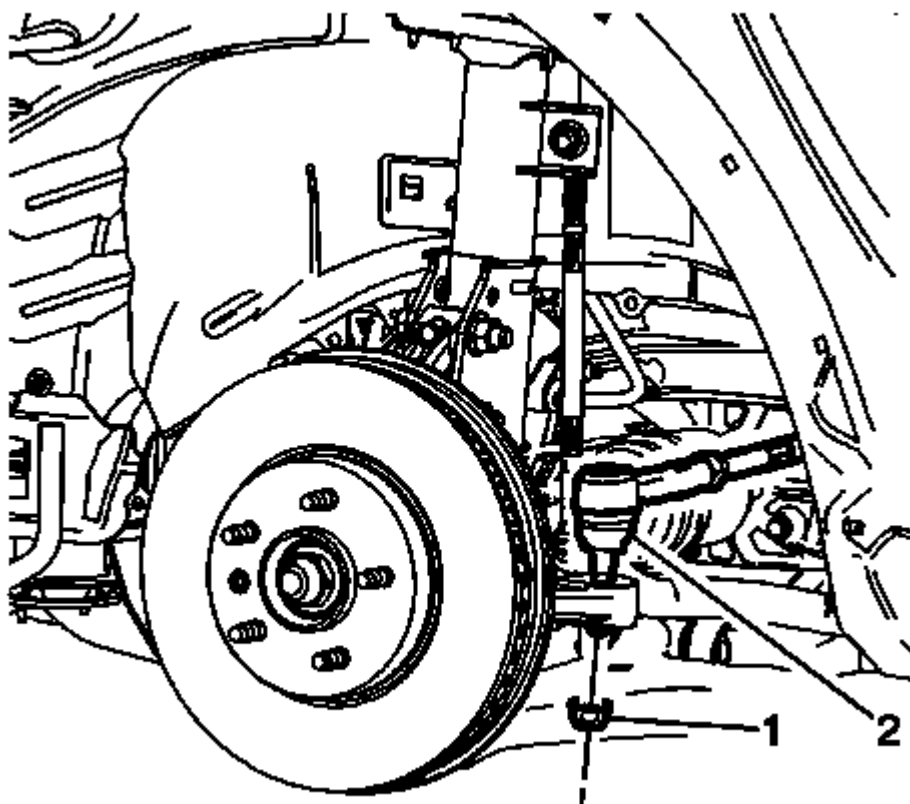


Fig. 296: Steering Linkage Outer Tie Rod Nut And Tie Rod
Courtesy of GENERAL MOTORS COMPANY

18. Install the steering linkage outer tie rod (2). Refer to **Steering Linkage Outer Tie Rod Replacement**
19. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

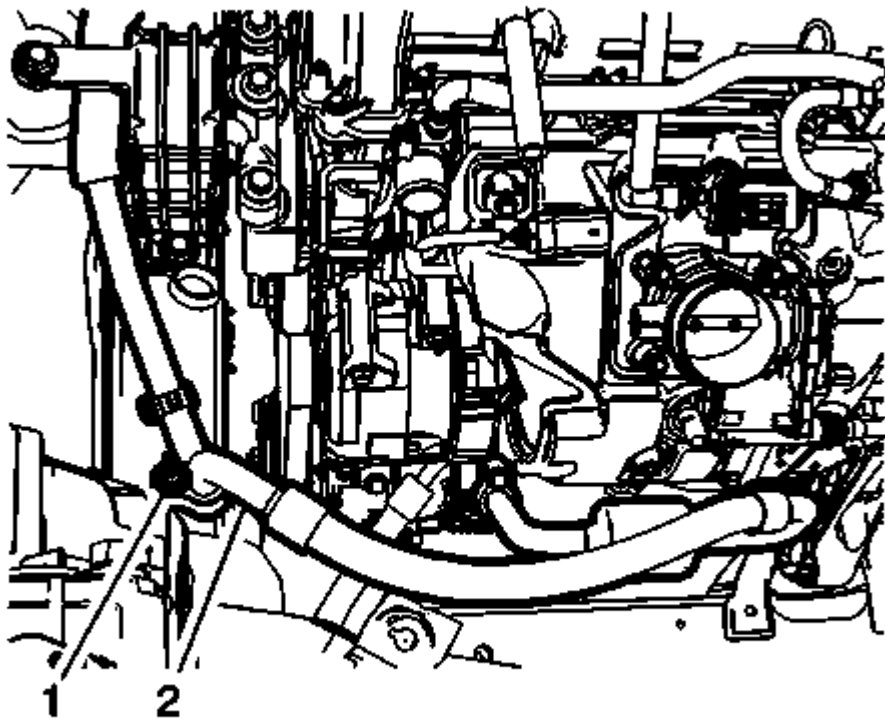


Fig. 297: Evaporator Outlet Hose And Nut
Courtesy of GENERAL MOTORS COMPANY

20. Install the air conditioning compressor and condenser hose (2). Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LUK)** .

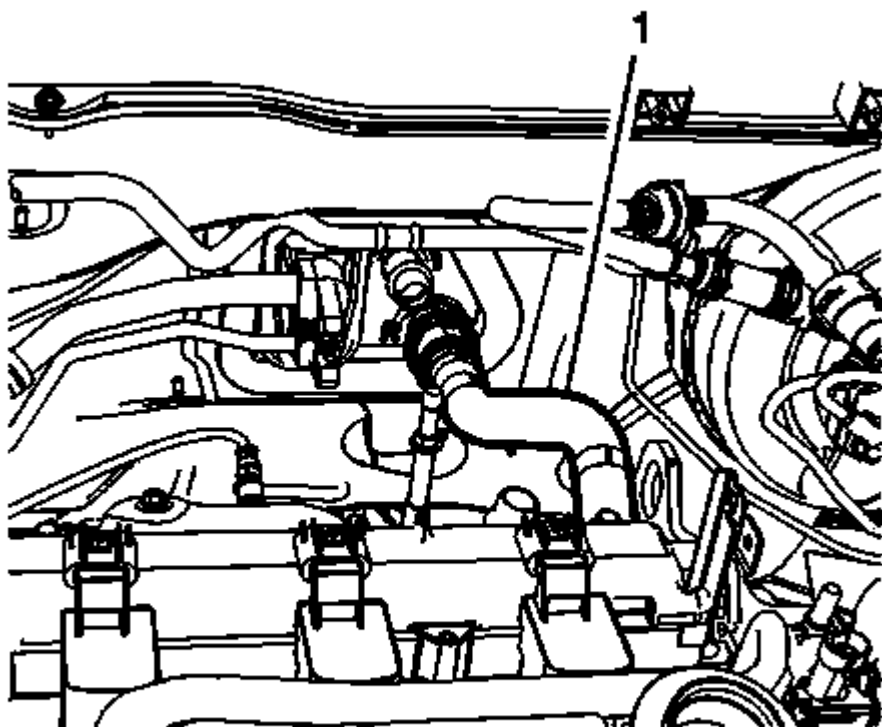


Fig. 298: Heater Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

21. Connect the heater outlet hose (1). Refer to **Heater Outlet Hose Replacement (LUK)** .

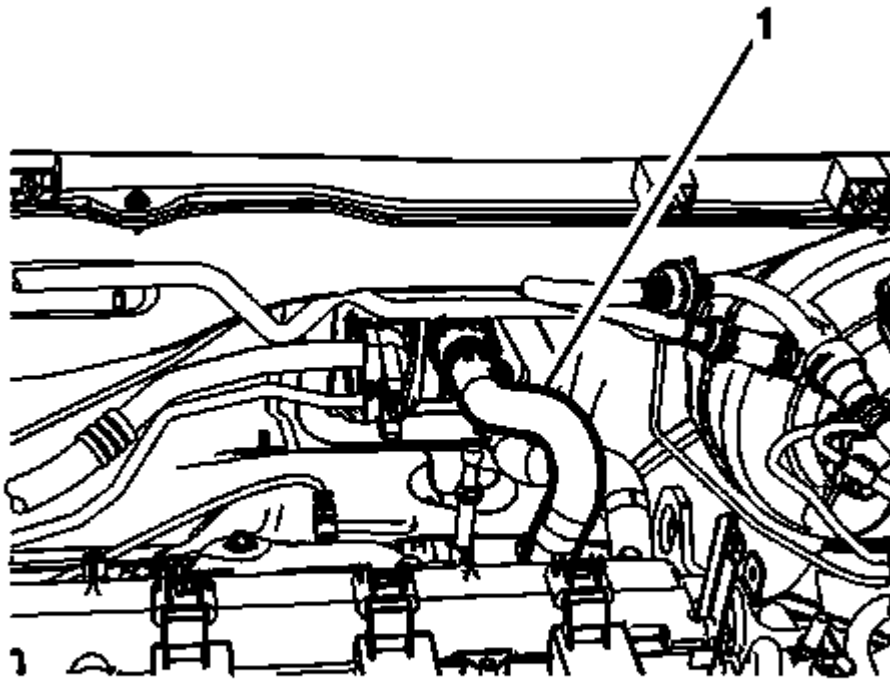


Fig. 299: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

22. Connect the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LUK)** .

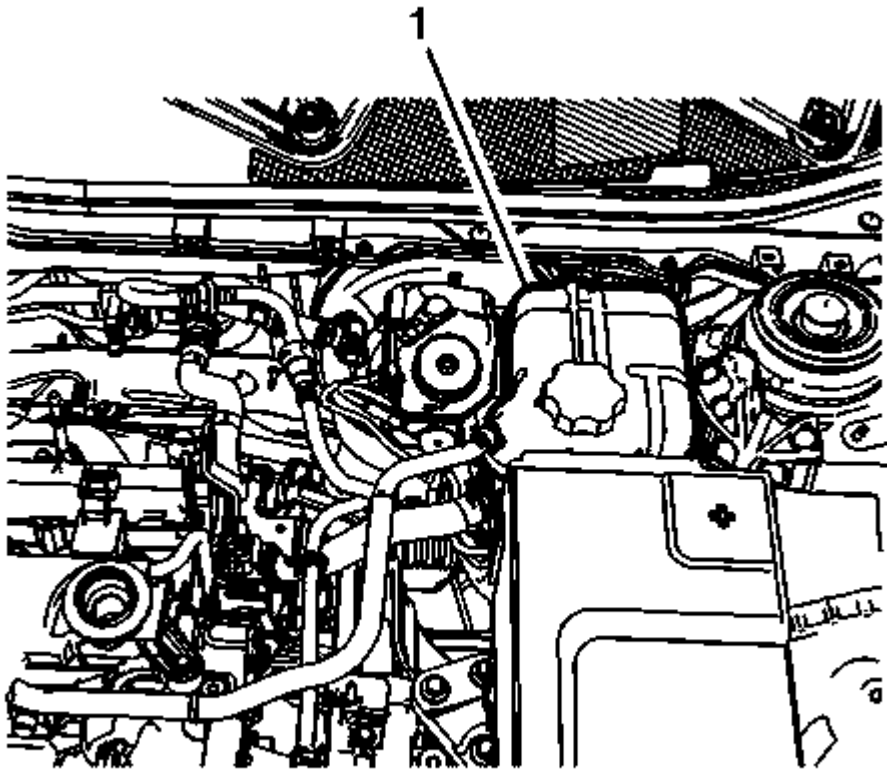


Fig. 300: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

23. Install the radiator surge tank (1). Refer to **Radiator Surge Tank Replacement (LUK)** .

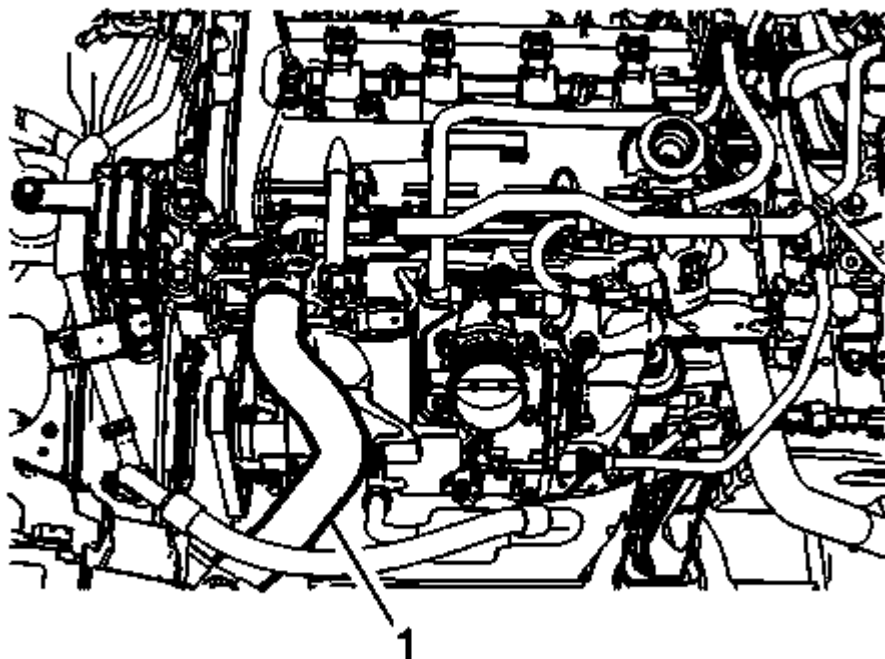


Fig. 301: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

24. Install the radiator inlet hose (1). Refer to **Radiator Inlet Hose Replacement (LUK)** .
25. Install radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LUK)** .

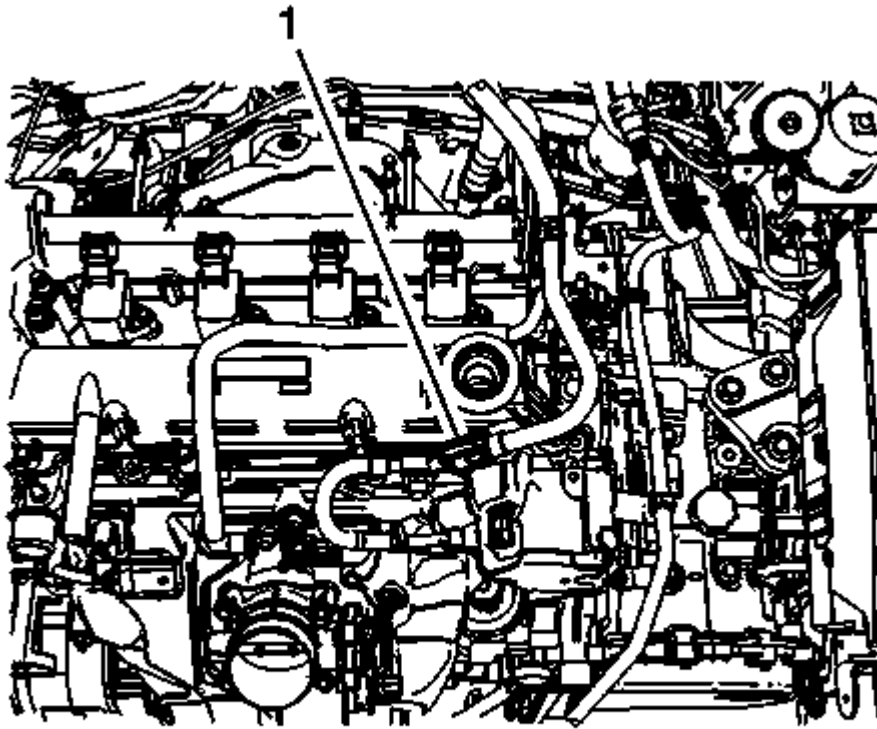


Fig. 302: Fuel Feed Line

Courtesy of GENERAL MOTORS COMPANY

26. Install the fuel feed line (1).

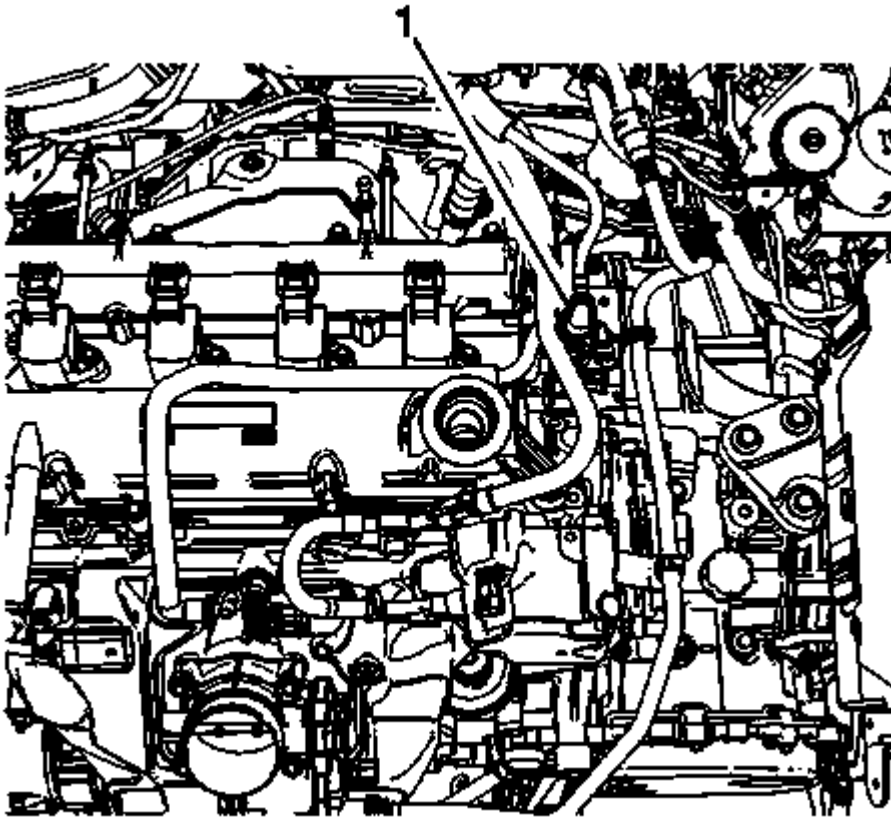


Fig. 303: Evaporative Emission (EVAP) Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

27. Connect the EVAP pipe (1).

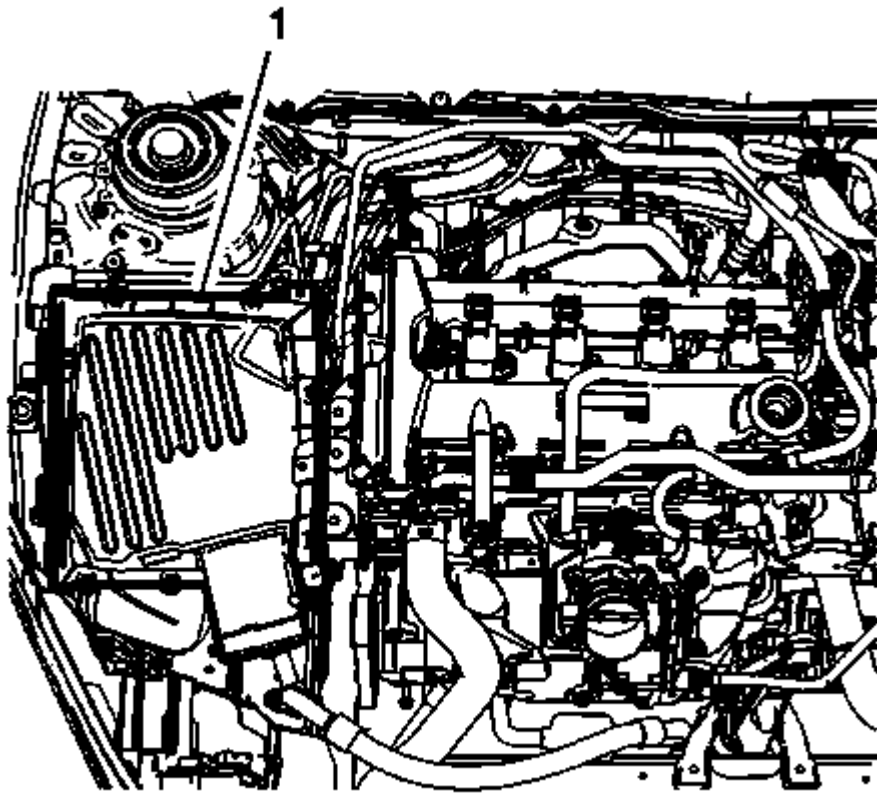


Fig. 304: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

28. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement**

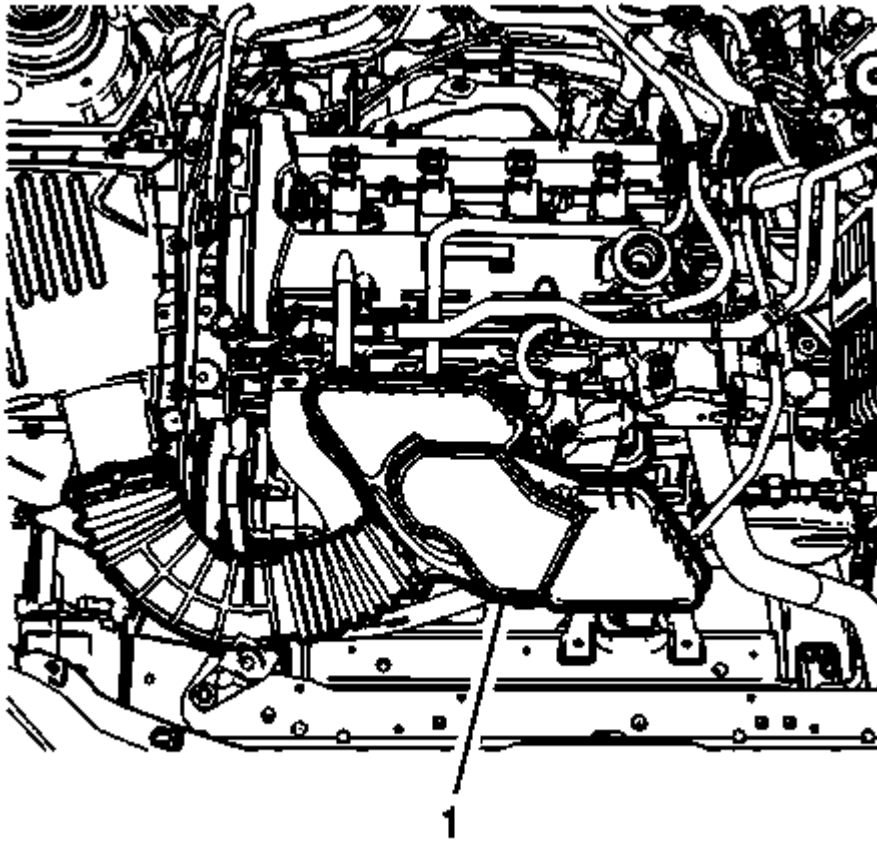


Fig. 305: Air Cleaner Outlet Duct Assembly
Courtesy of GENERAL MOTORS COMPANY

29. Install the air cleaner outlet duct assembly (1). Refer to **Air Cleaner Outlet Duct Replacement** .

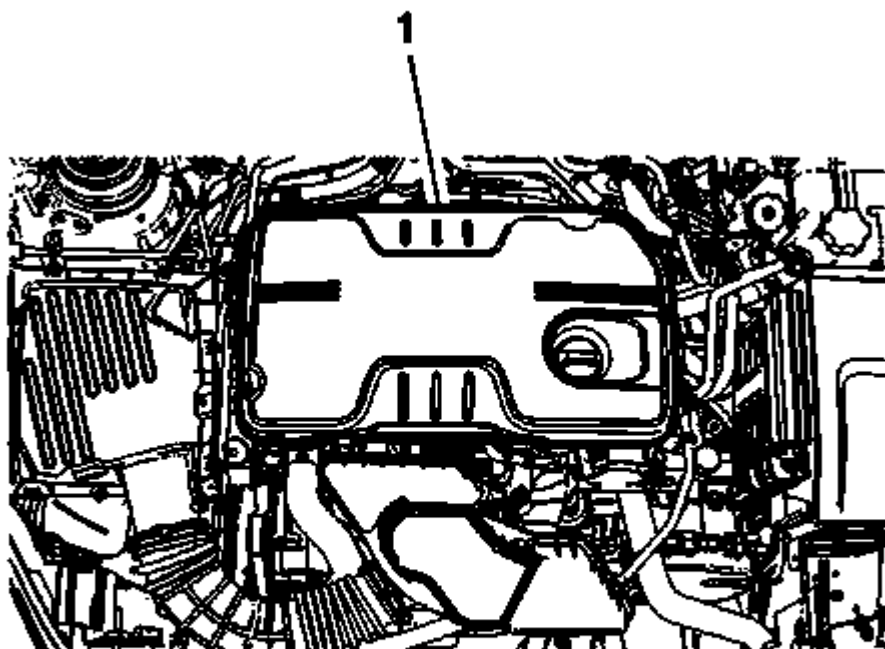


Fig. 306: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

30. Install the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement**.
31. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
32. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
33. Refill the refrigerant system. Refer to **Refrigerant Recovery and Recharging** .
34. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE REPLACEMENT (LEA)

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
3. Disconnect the fuel feed pipe quick connect fitting at the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
4. Disconnect the evaporative emission (EVAP) line quick connect fitting from the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .

5. Remove the fuel feed pipe clip from the fuel line bracket.
6. Remove the transaxle shift cable clip from the fuel line bracket.
7. Remove the battery tray. Refer to **Battery Tray Replacement** .
8. Remove the vacuum brake booster hose from the intake manifold.
9. Remove the coolant recovery inlet pipe clip from the fuel rail.
10. Remove the coolant recovery inlet hose from the cylinder head.
11. Remove the radiator inlet hose from the cylinder head.
12. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LEA)** .

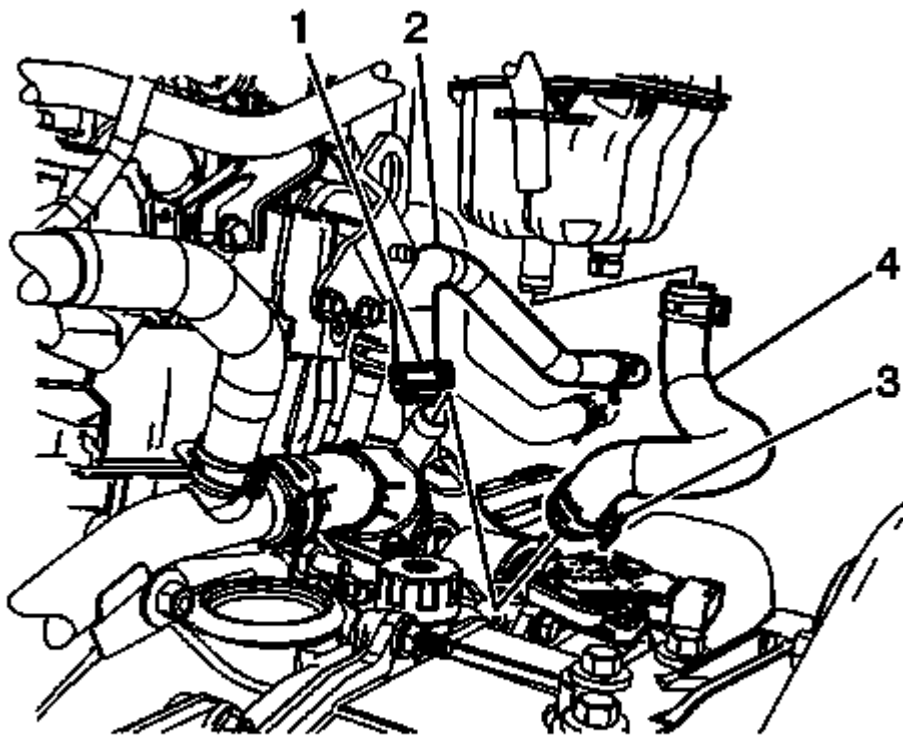


Fig. 307: Inlet Hoses

Courtesy of GENERAL MOTORS COMPANY

13. Remove the heater inlet hose (2) from the thermostat housing.
14. Remove the coolant recovery reservoir/heater inlet hose (4) from the thermostat housing.
15. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
16. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
17. Disconnect the engine wiring harness electrical connector from the air conditioning (A/C) compressor.

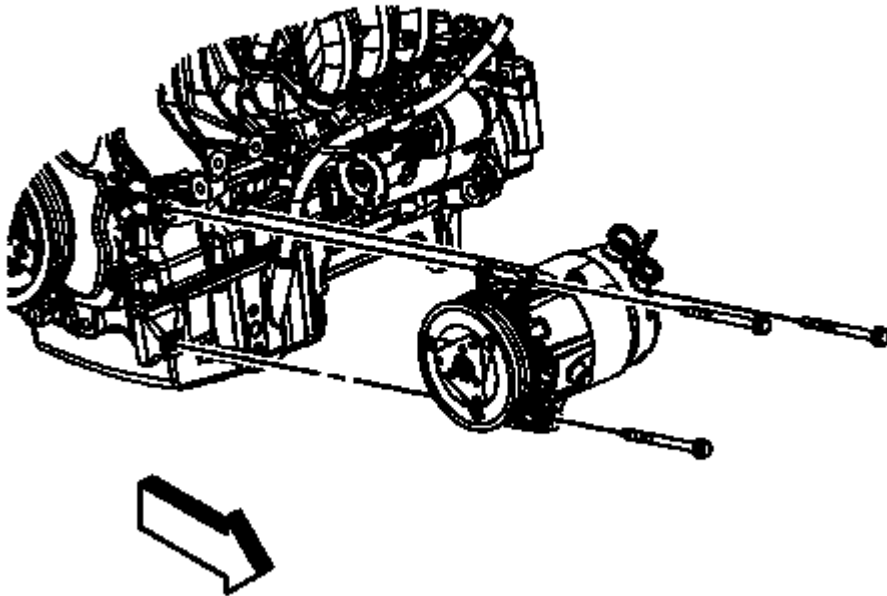


Fig. 308: Compressor Bolts

Courtesy of GENERAL MOTORS COMPANY

18. Unbolt the A/C compressor and reposition out of the way.
19. Remove the positive battery cable from the starter motor.
20. Disconnect the generator electrical connectors.
21. Lower the vehicle.

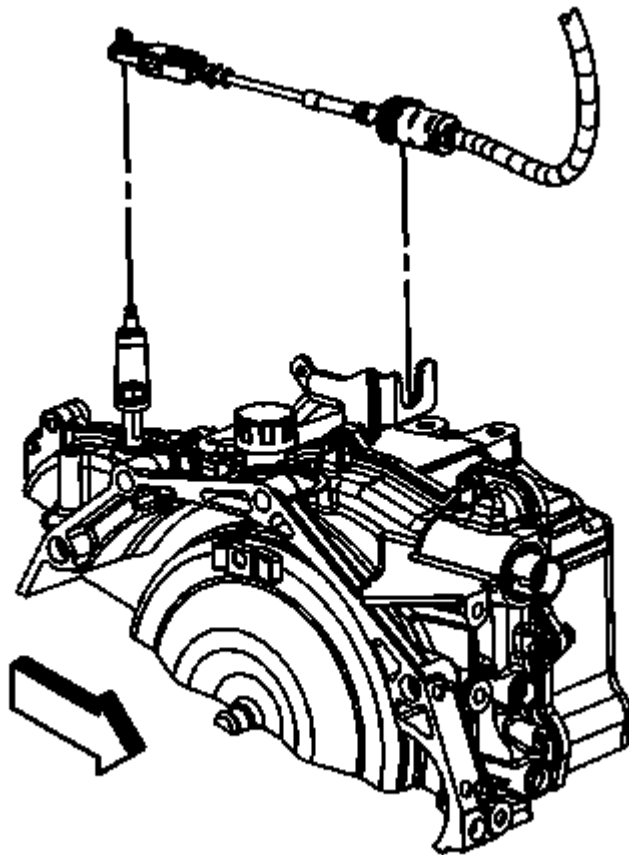


Fig. 309: Transaxle Shift Cable And Range Select Lever
Courtesy of GENERAL MOTORS COMPANY

22. Remove the transaxle shift cable from the range select lever.
23. Release the shift control cable retaining clip and remove the cable from the shift control cable bracket.

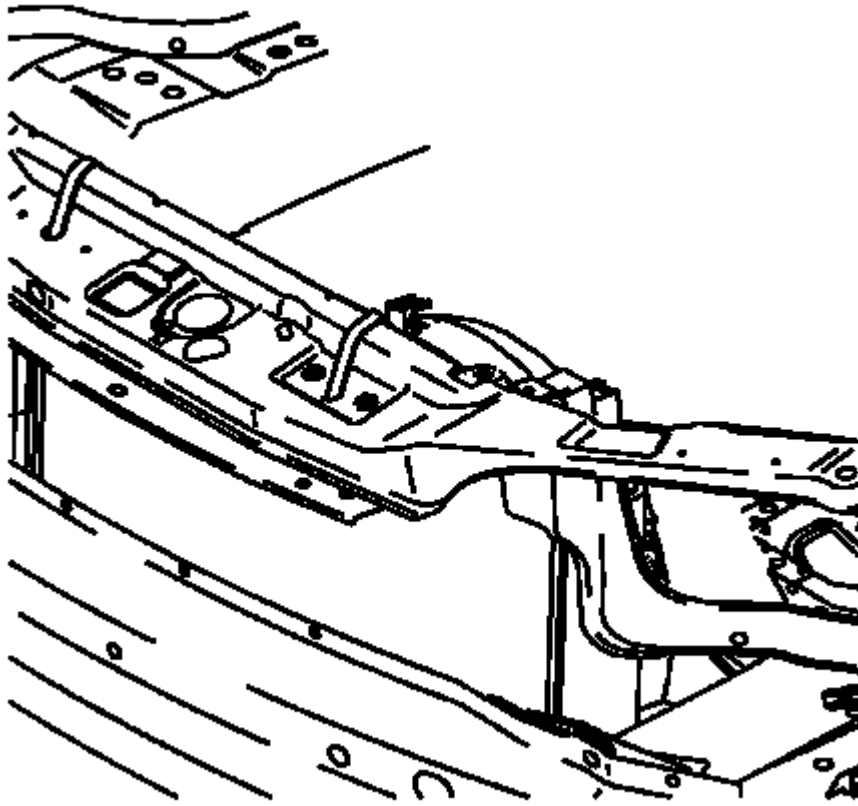


Fig. 310: View Of Cooling Module Secured To Upper Body Structure
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The radiator/condenser/fan assembly will stay in the vehicle during engine removal.**

24. Using long tie straps, secure the radiator/condenser/fan assembly to the radiator support.
25. Raise the vehicle.
26. Remove the front wheels and tires. Refer to **Tire and Wheel Removal and Installation** .
27. Remove the front wheelhouse panel. .
28. Drain the transaxle fluid.
29. Remove the catalytic converter. .

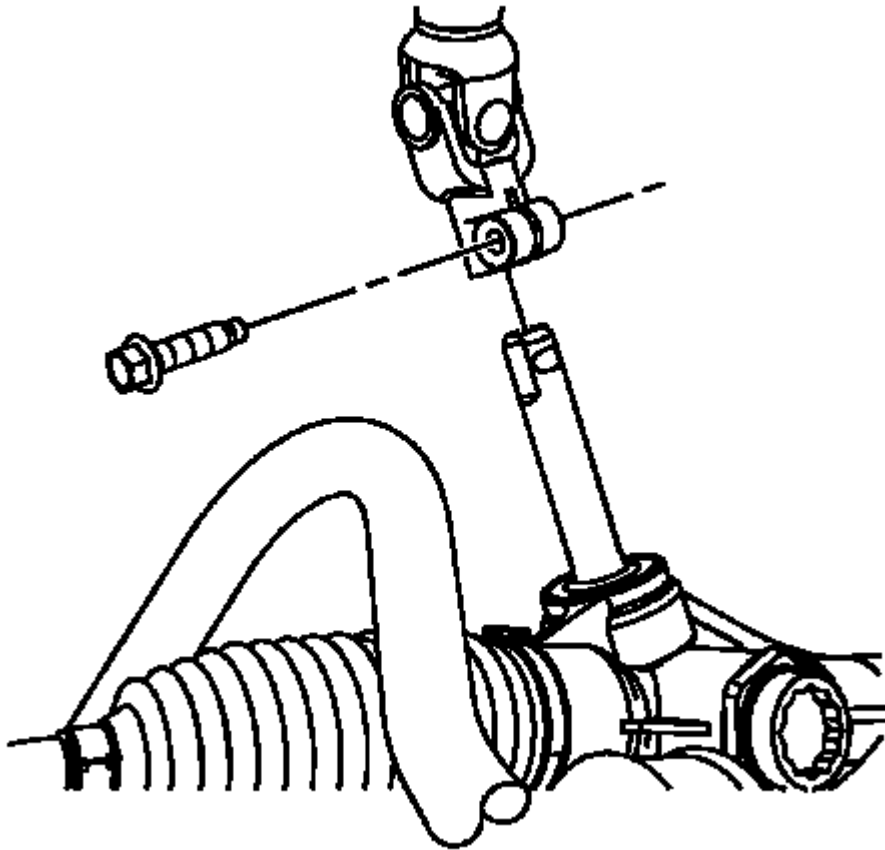


Fig. 311: View Of Intermediate Shaft To Steering Gear Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Secure the steering wheel in the straight forward position before separating the intermediate shaft from the steering gear, or damage to the SIR coil will occur.**

30. Remove the intermediate to steering gear pinch bolt and disconnect the intermediate shaft from the steering gear. Discard the pinch bolt.
31. Separate the tie rods from the steering knuckles. .
32. Remove the wheel drive shafts. .
33. Lower the vehicle.

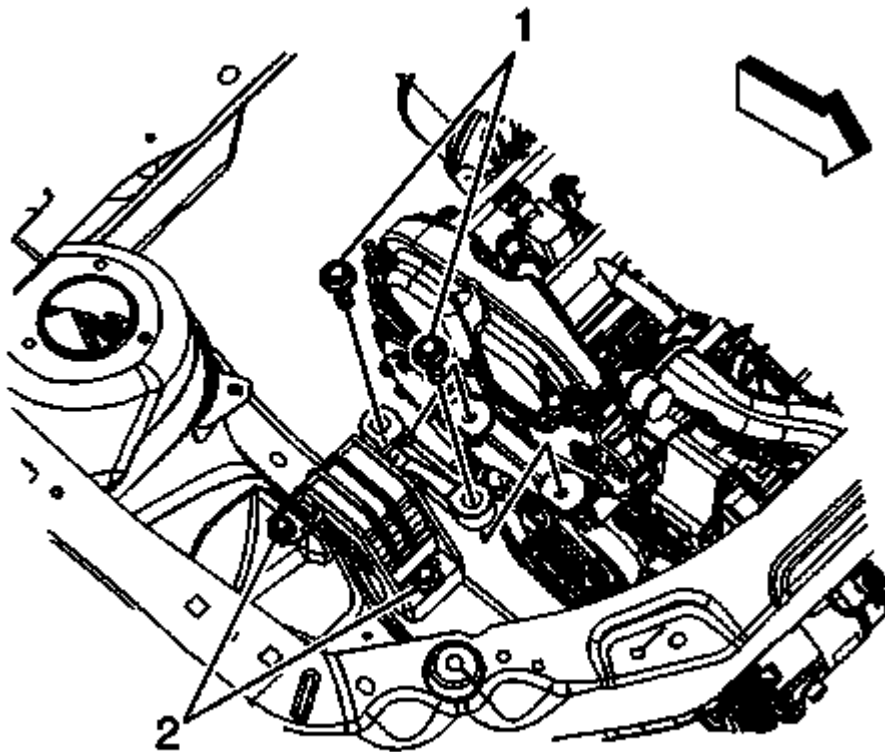


Fig. 312: Engine Mount To Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

34. Remove the engine mount to bracket bolts (1).

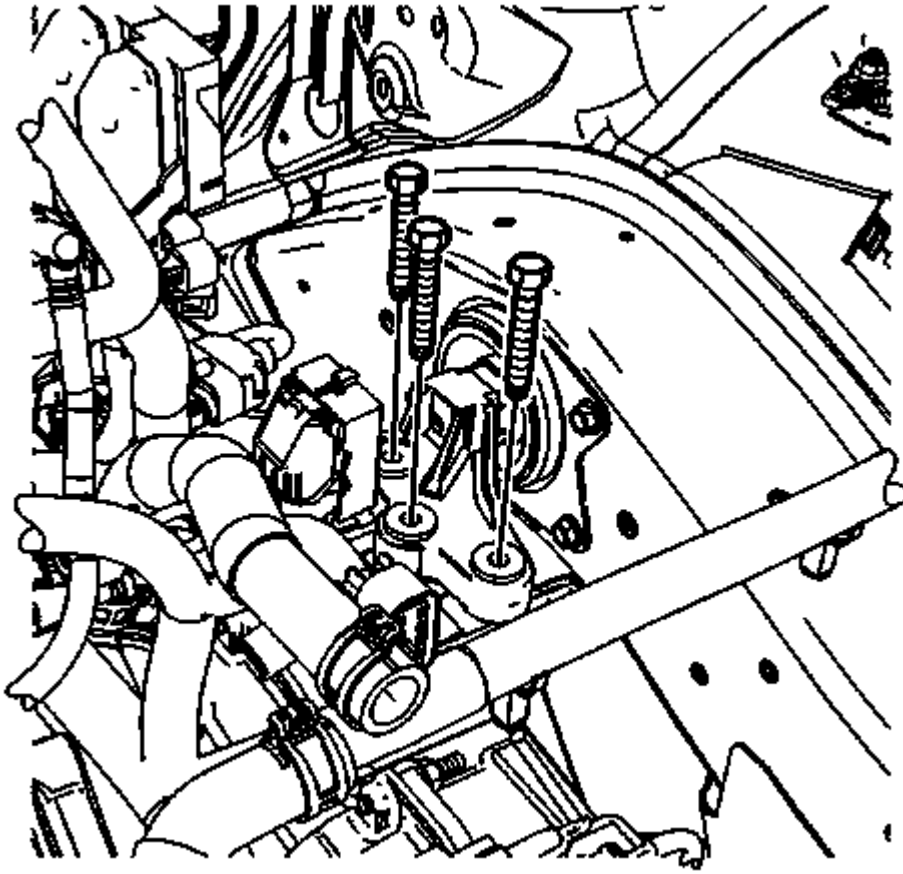


Fig. 313: Transaxle Mount To Transaxle Bolts
Courtesy of GENERAL MOTORS COMPANY

35. Remove the transaxle mount to transaxle bolts.
36. Raise the vehicle.

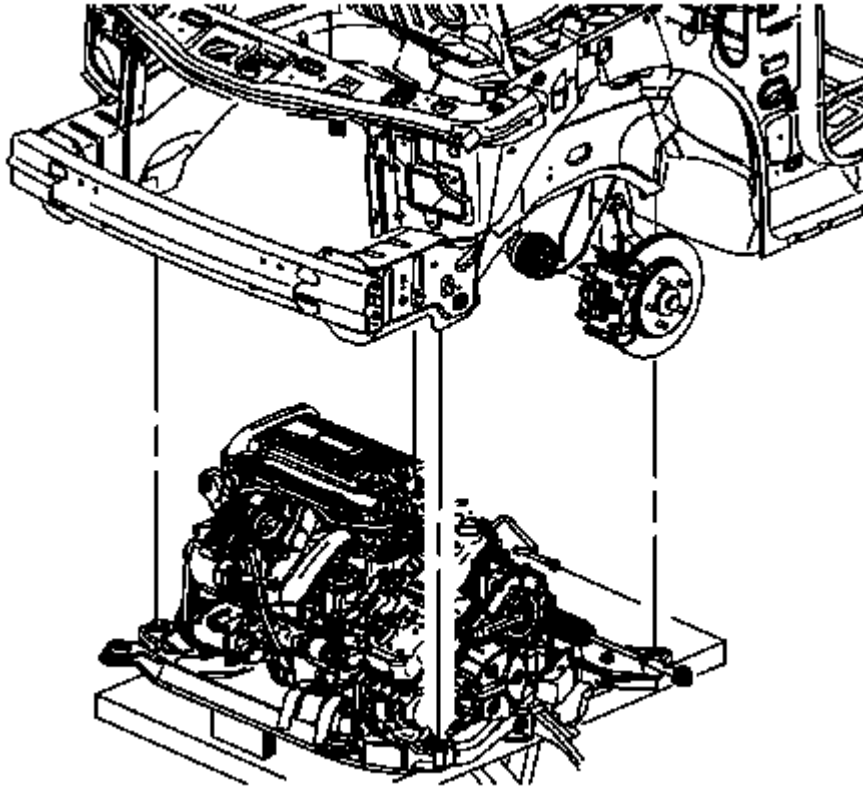


Fig. 314: Raising Powertrain Assembly Into Position
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.

37. Position a engine support table under the powertrain assembly.

NOTE: Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.

38. With the table positioned, fully raise the table to contact the powertrain assembly.
39. Remove the frame to body bolts. Discard the bolts.

NOTE: When lowering the engine/transaxle assembly, verify all brake lines, shiftier cables and other components are free during removal.

40. Lower the engine table and raise the body on the hoist until the engine/transaxle and frame are free from the vehicle.
41. Disconnect the engine wiring harness electrical connectors as necessary.

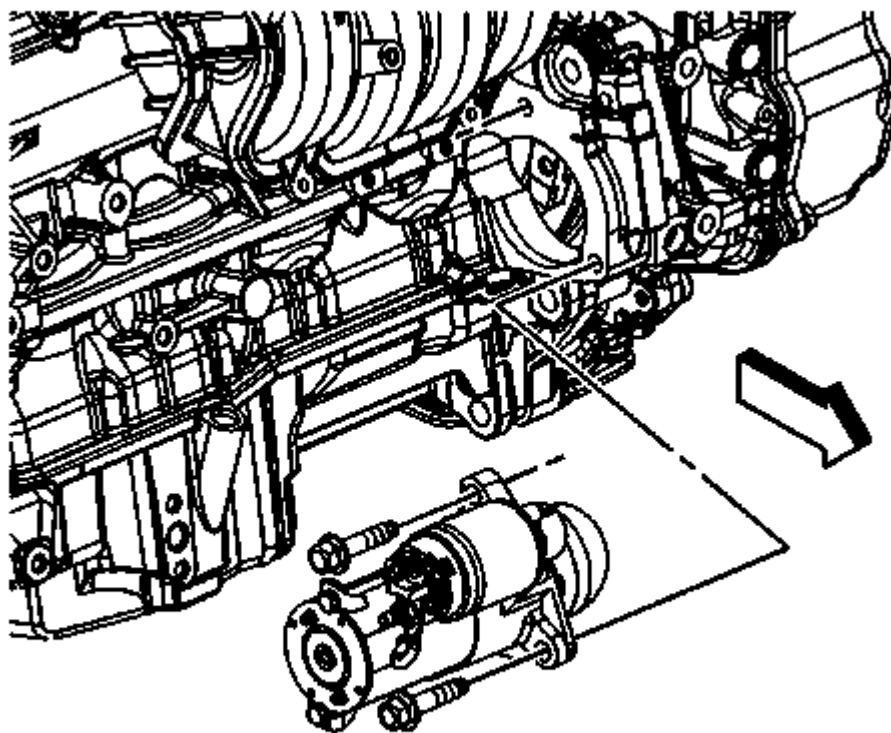


Fig. 315: Identifying Starter Motor Bolts & Starter
Courtesy of GENERAL MOTORS COMPANY

42. Remove the starter motor bolts and starter.

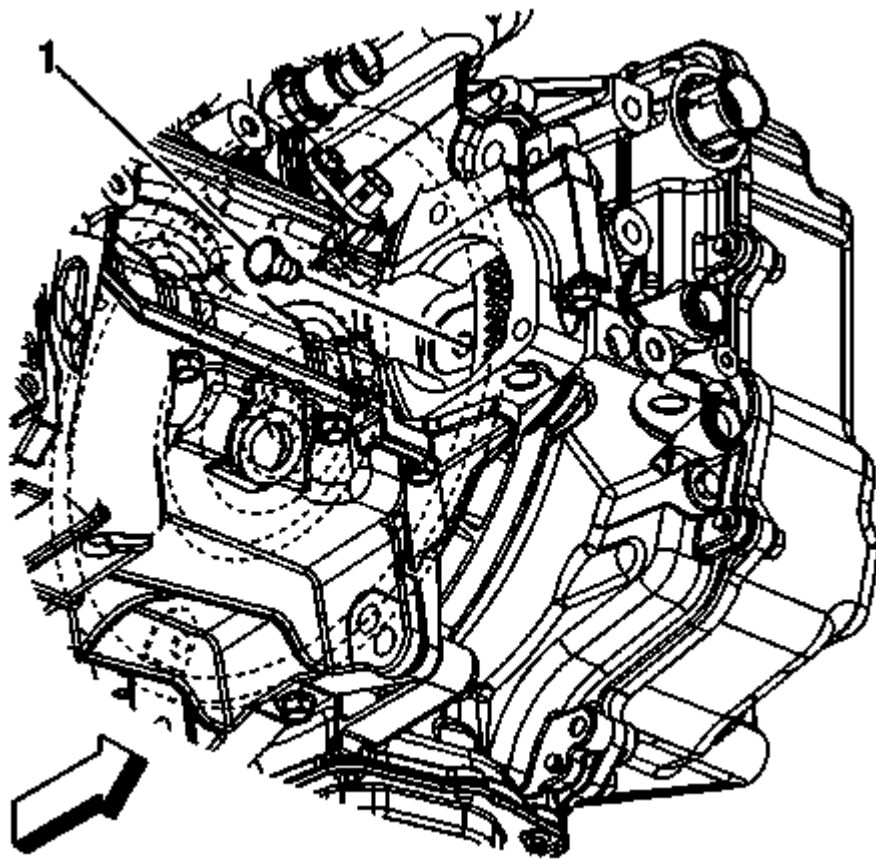


Fig. 316: Torque Converter To Flexplate Bolts
Courtesy of GENERAL MOTORS COMPANY

43. Remove the torque converter to flexplate bolts (1).
44. Install a suitable lifting device to the engine.

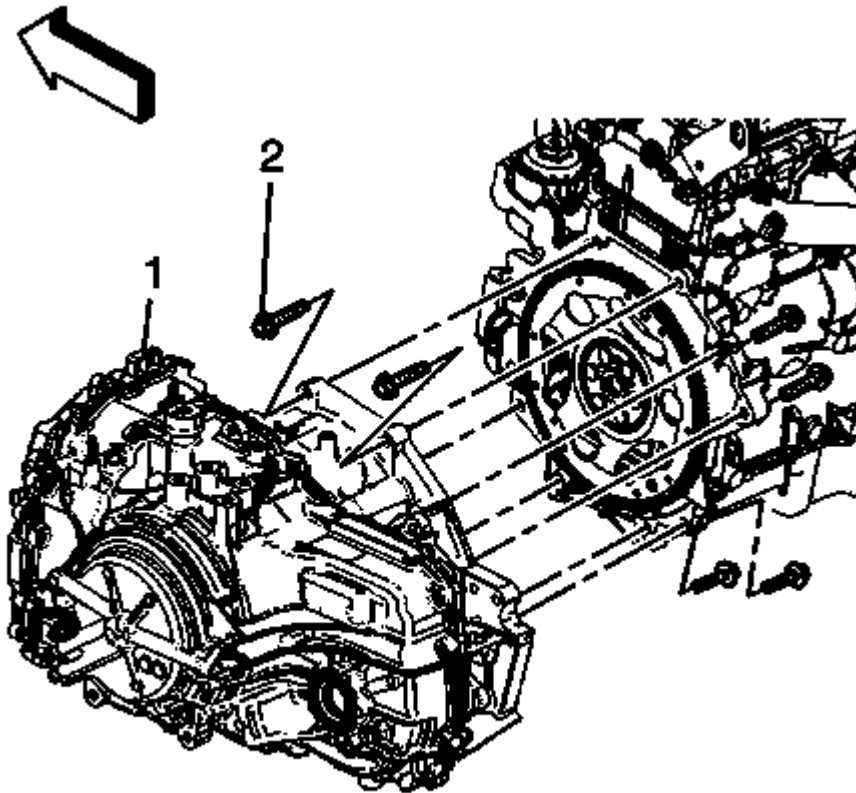


Fig. 317: Transaxle And Transaxle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

45. Remove the transaxle bolts (2) from the engine.
46. Separate the engine from the transaxle (1).
47. Install the engine to a suitable engine stand.

Installation Procedure

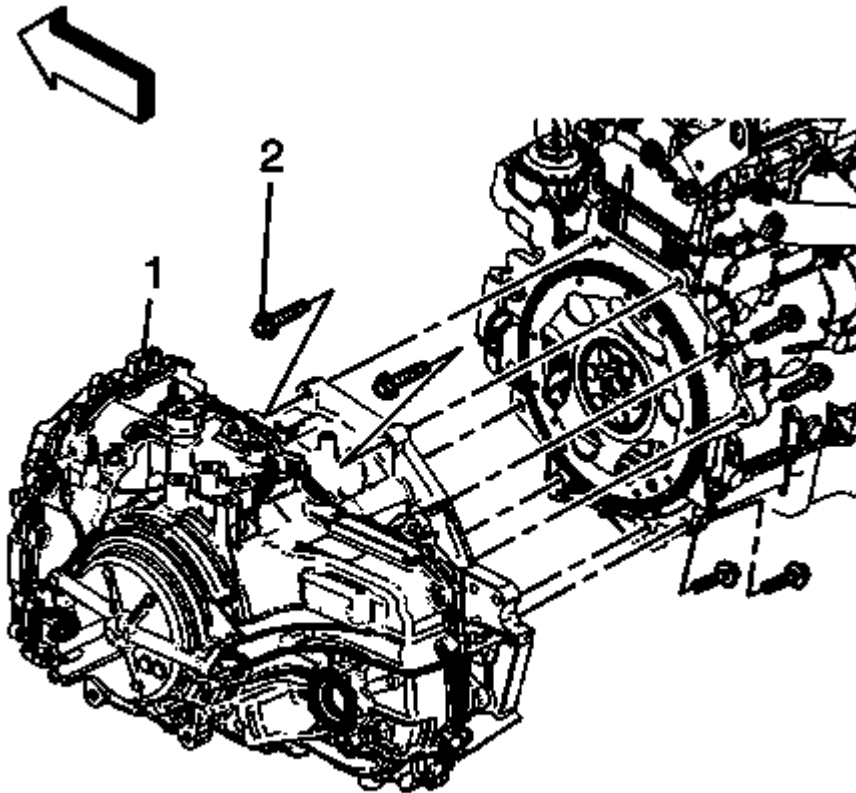


Fig. 318: Transaxle And Transaxle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a suitable lifting device to the engine.
2. Using the lifting device, position and install the engine to the transaxle (1).

CAUTION: Refer to Fastener Caution .

3. Install the transaxle bolts (2) to the engine and tighten to 75 N.m (55 lb ft).

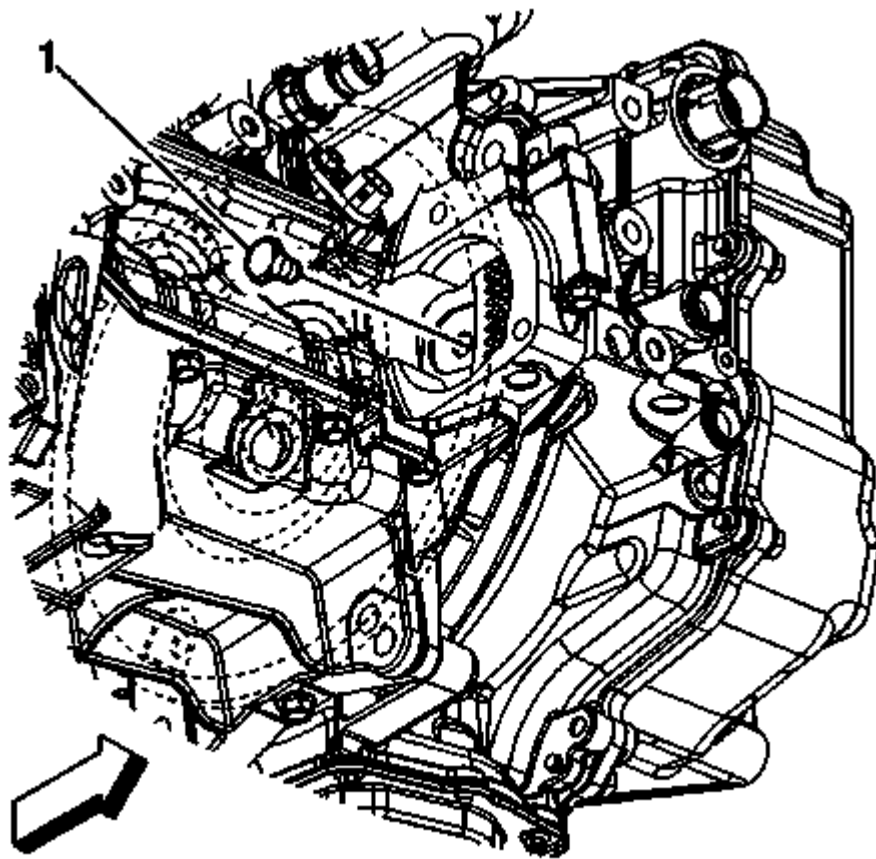


Fig. 319: Torque Converter To Flexplate Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the torque converter to flexplate bolts (1) and tighten to 60 N.m (44 lb ft).
5. Remove the engine lifting device.

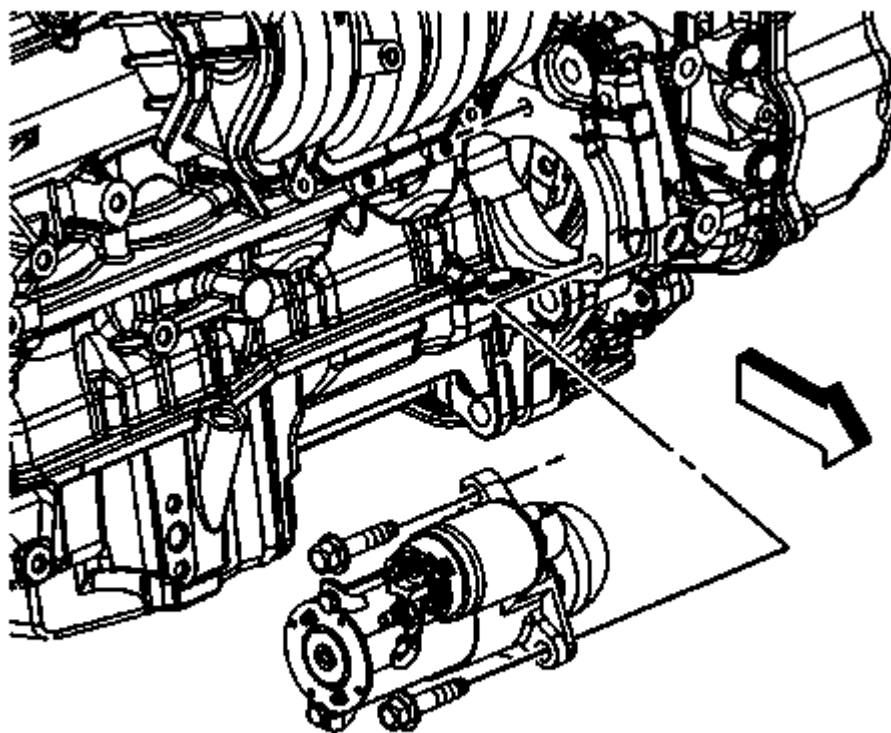


Fig. 320: Identifying Starter Motor Bolts & Starter
Courtesy of GENERAL MOTORS COMPANY

6. Install the starter motor and bolts and tighten to 53 N.m (39 lb ft).
7. Connect the engine wiring harness electrical connectors as necessary.

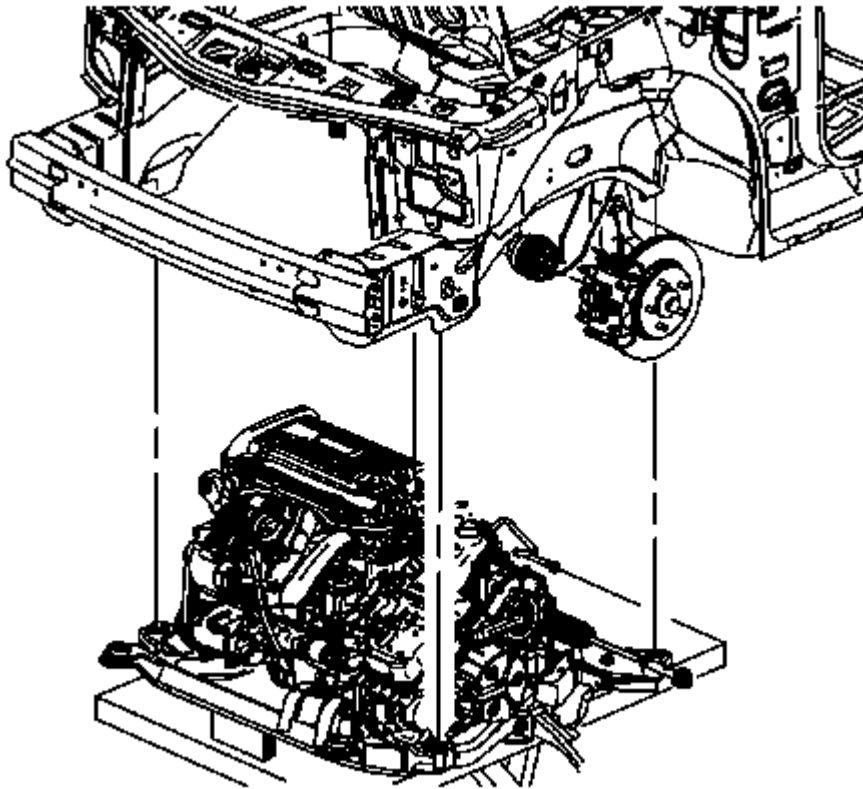


Fig. 321: Raising Powertrain Assembly Into Position
Courtesy of GENERAL MOTORS COMPANY

8. Position the powertrain and support table under the vehicle.
9. Raise the powertrain into position under the vehicle.
10. With the table positioned, if required, lower the vehicle over the powertrain.
11. Align the lower radiator pins with the frame. Ensure all hoses and electrical harnesses are correctly routed and free from the loading path of the powertrain.
12. Install the NEW frame to body bolts and tighten to 155 N.m (114 lb ft).
13. Lower the vehicle.

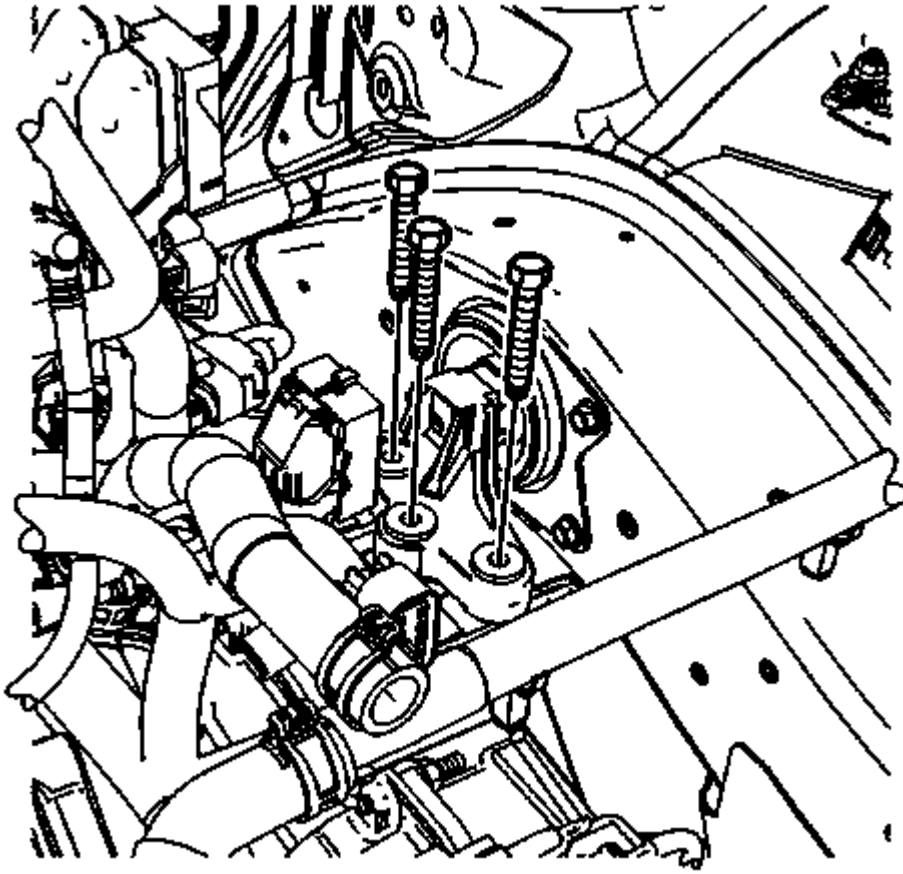


Fig. 322: Transaxle Mount To Transaxle Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the transaxle mount to transaxle bolts and tighten to 55 N.m (41 lb ft).

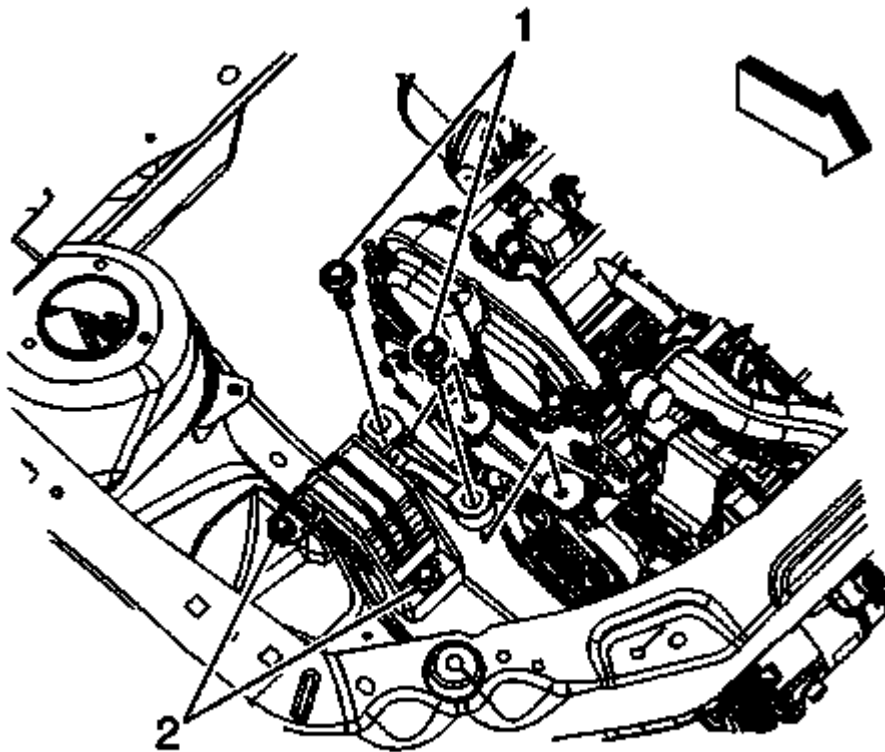


Fig. 323: Engine Mount To Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: The engine mount to bracket bolts must be hand started. Do not pry the engine mount to align the holes.

15. Install the engine mount to bracket bolts (1) and tighten to 50 N.m (37 lb ft).
16. Raise and support the vehicle.
17. Install the wheel drive shafts.

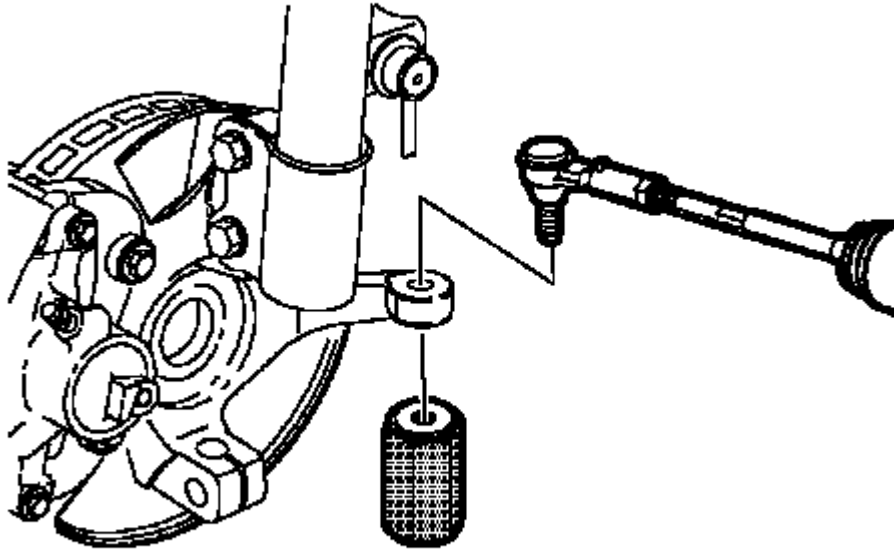


Fig. 324: View Of Tie Rod, Knuckle & Tapered Ball Stud
Courtesy of GENERAL MOTORS COMPANY

18. Connect the outer tie rods to the steering knuckles.

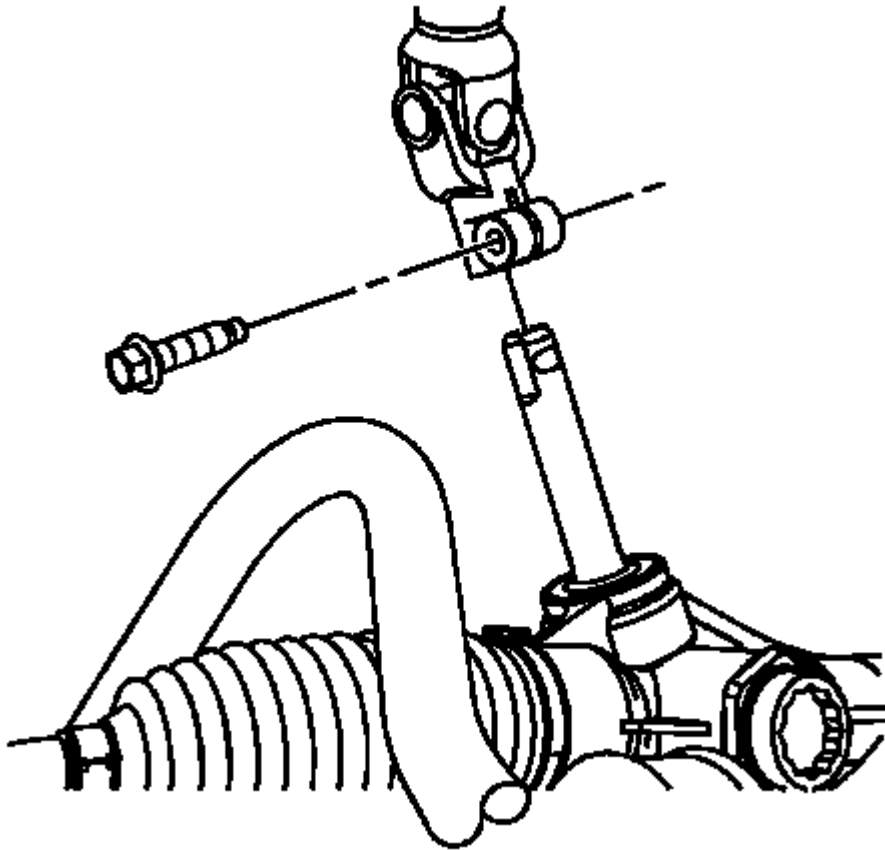


Fig. 325: View Of Intermediate Shaft To Steering Gear Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

19. Position the intermediate shaft to the steering gear and install a NEW pinch bolt and tighten to 34 N.m (25 lb ft).
20. Install the catalytic converter. .
21. Install the front wheelhouse panel. .
22. Install the front wheels and tires. Refer to **Tire and Wheel Removal and Installation** .
23. Lower the vehicle.

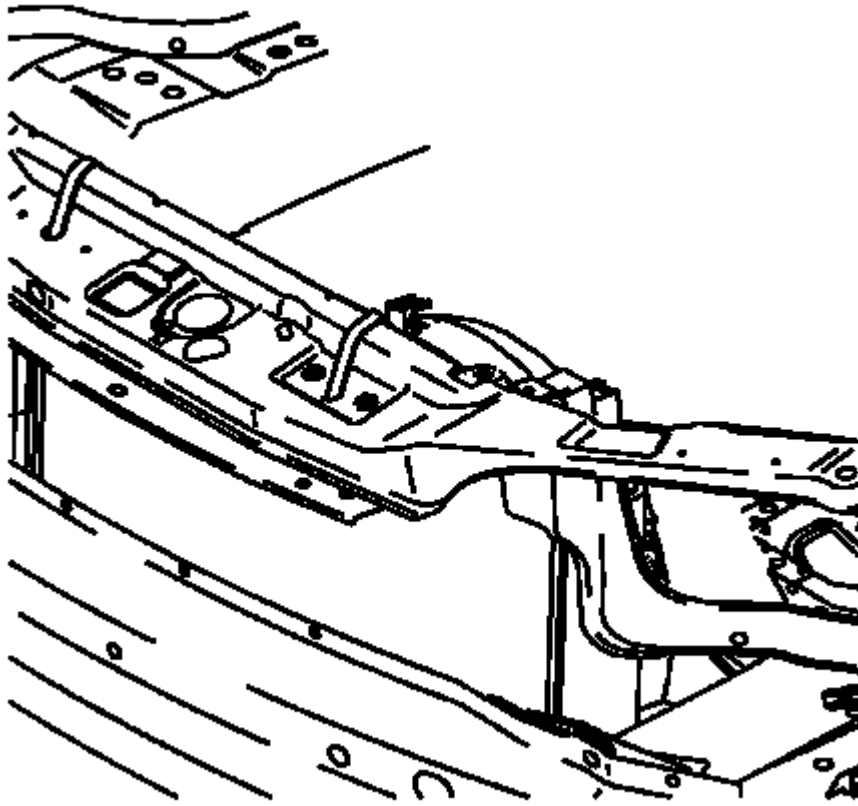


Fig. 326: View Of Cooling Module Secured To Upper Body Structure
Courtesy of GENERAL MOTORS COMPANY

24. Unsecure and position the radiator/condenser/fan assembly.

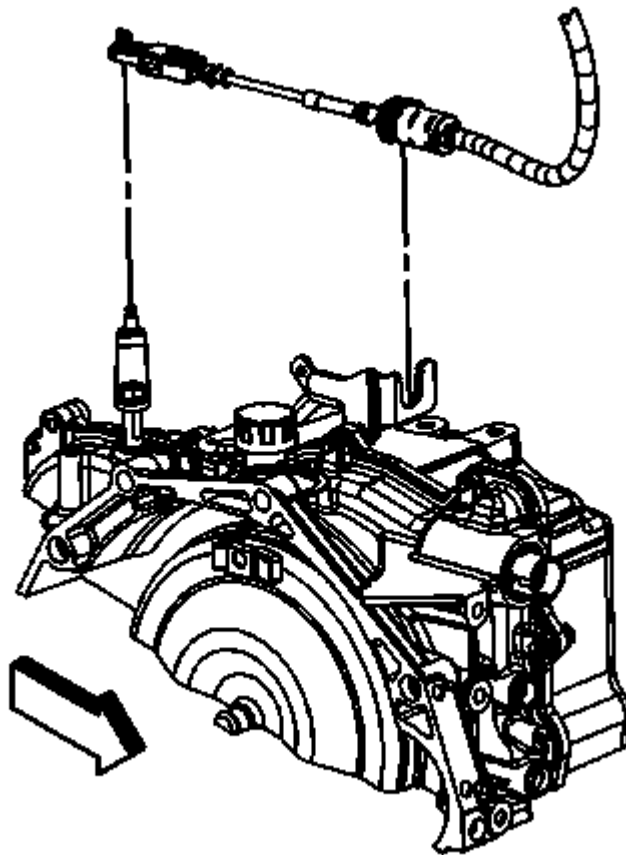


Fig. 327: Transaxle Shift Cable And Range Select Lever
Courtesy of GENERAL MOTORS COMPANY

25. Install the shift control cable to the shift control cable bracket and engage the shift control cable retaining clip.
26. Install the transaxle shift cable to the range select lever.
27. Raise and support the vehicle.
28. Connect the generator electrical connectors.
29. Install the positive battery cable to the starter motor, tighten to 9 N.m (80 lb in)

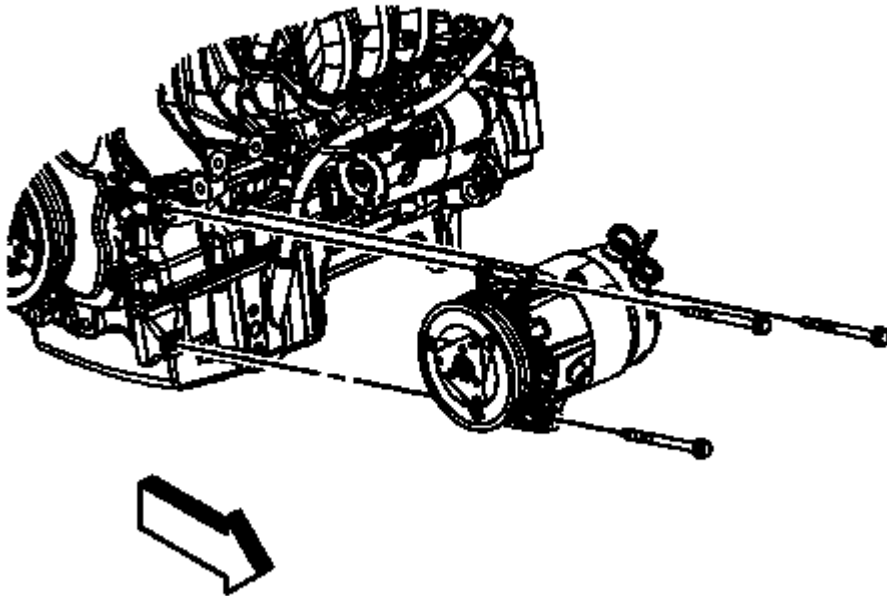


Fig. 328: Compressor Bolts

Courtesy of GENERAL MOTORS COMPANY

30. Position the A/C compressor and install the bolts and tighten to 50 N.m (37 lb ft).
31. Connect the engine wiring harness electrical connector to the A/C compressor.
32. Lower the vehicle.
33. Install the coolant recovery reservoir/heater inlet hose to the thermostat housing.
34. Install the heater inlet hose to the thermostat housing.
35. Install the radiator inlet hose from the cylinder head.
36. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LEA)** .
37. Position and install the coolant recovery inlet hose to the cylinder head.
38. Install the coolant recovery inlet pipe clip to the fuel rail.
39. Position and install the vacuum brake booster hose to the intake manifold.
40. Install the battery tray. Refer to **Battery Tray Replacement** .
41. Install the transaxle shift cable clip to the fuel line bracket.
42. Install the fuel feed pipe clip to the fuel line bracket.
43. Connect the EVAP line quick connect fitting to the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .

44. Connect the fuel feed pipe quick connect fitting at the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
45. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
46. Fill the transaxle with fluid. Refer to **Transmission Fluid Level and Condition Check** .
47. Refill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.
48. Perform the CKP system variation learn procedure. Refer to **Control Module References** .
49. Start the engine and allow the engine to run, inspect for leaks. Correct as necessary.

ENGINE OIL AND OIL FILTER REPLACEMENT

Special Tools

EN-44887 Oil Filter Wrench

For equivalent regional tools, refer to **Special Tools**

Removal Procedure

1. Place a collecting pan underneath the oil filter.

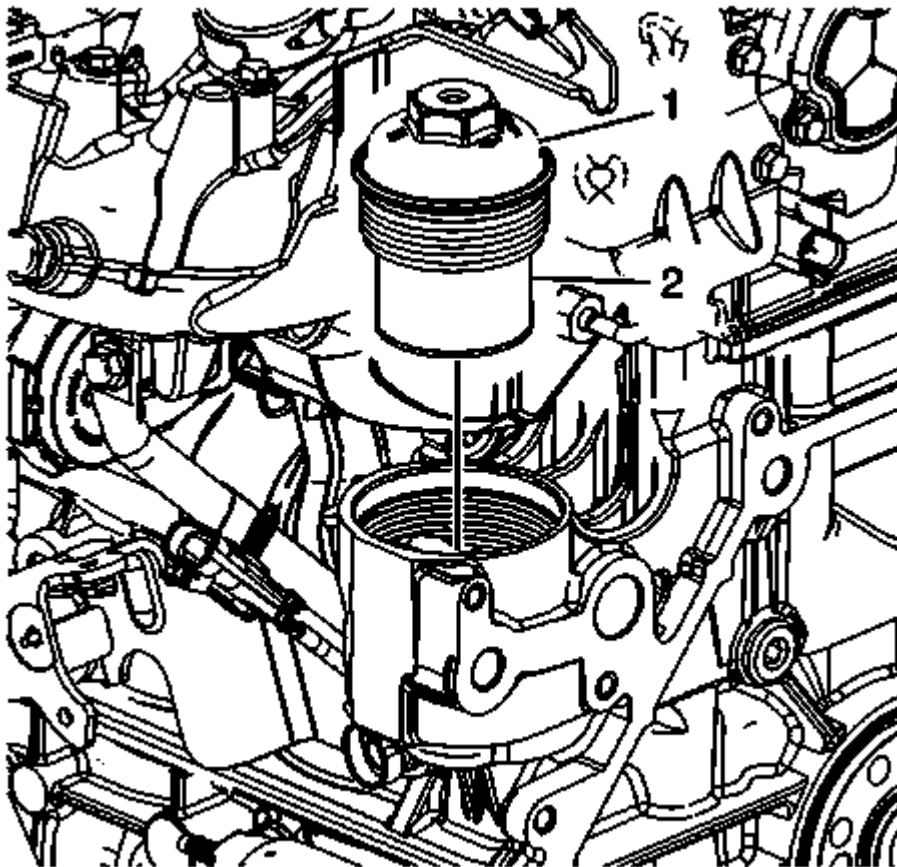


Fig. 329: View of Draining Fluids and Oil Filter
Courtesy of GENERAL MOTORS COMPANY

2. Use EN-44887 wrench to remove the oil filter cap (1) and seal .

CAUTION: This engine uses a special high performance oil filter. Use of any other filter may lead to filter failure and/or severe engine damage.

3. Remove and properly dispose of the oil filter insert (2).
4. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Place a collecting pan underneath the oil drain plug .

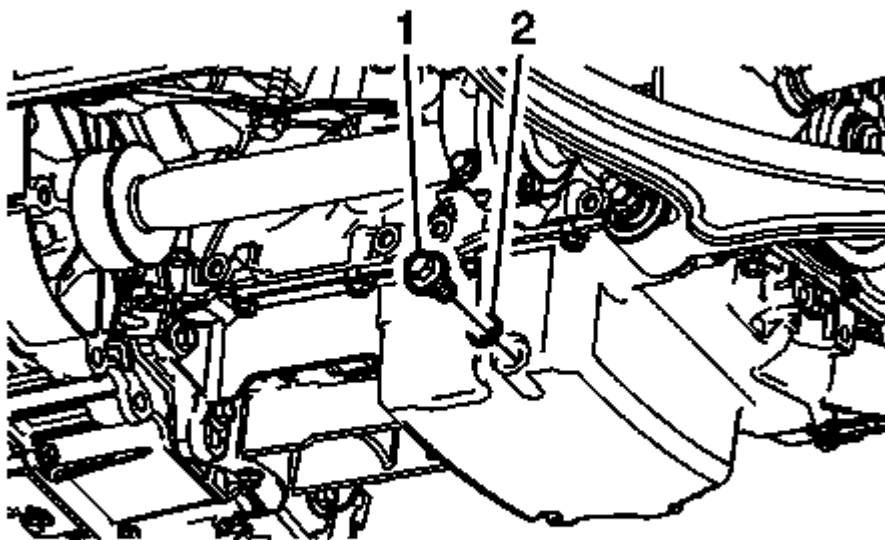


Fig. 330: Engine Oil Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil drain plug (1) and seal (2).

Installation Procedure

1. Clean the oil drain plug thread and the thread in the oil pan.

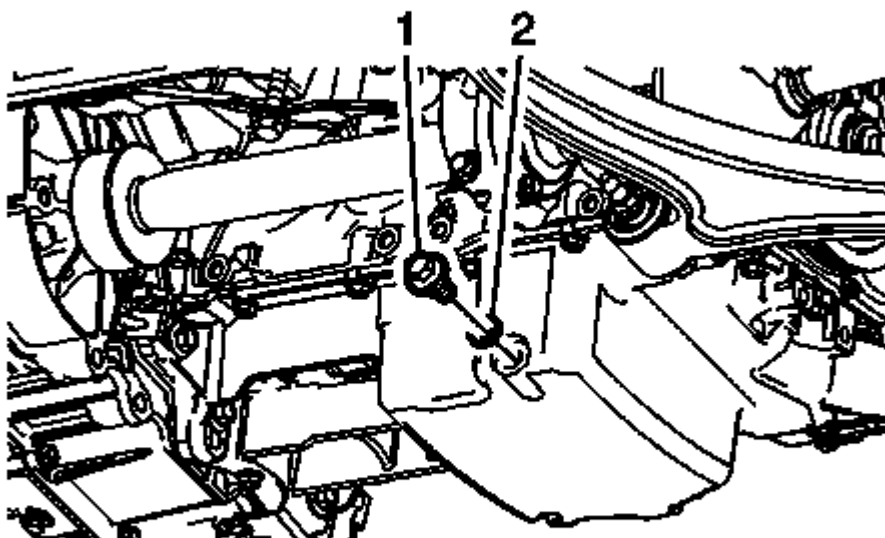


Fig. 331: Engine Oil Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install a seal (2) to the oil drain plug (1).

CAUTION: Refer to Fastener Caution .

3. Install the oil drain plug to the oil pan and tighten to 25 N.m (18 lb ft).
4. Lower the vehicle.

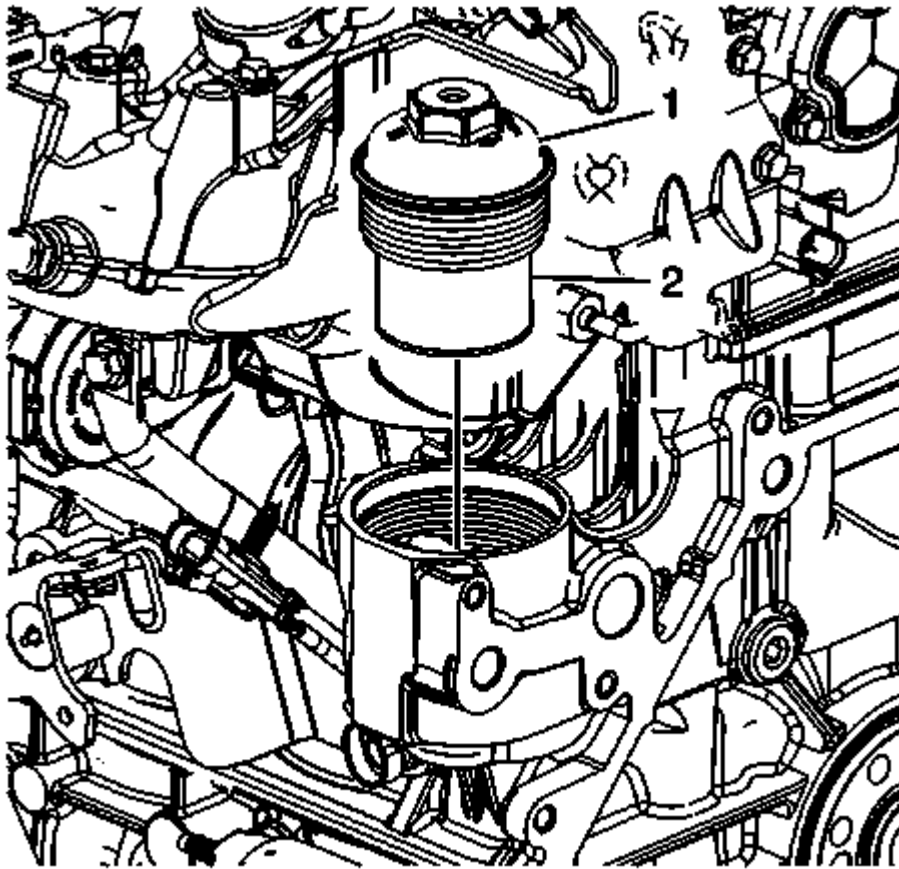


Fig. 332: View of Draining Fluids and Oil Filter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.

NOTE: Coat the oil filter seal with NEW engine oil.

5. Use **EN-44887** wrench to Install a NEW oil filter (2) and a NEW seal and tighten the oil filter cap (1) to 22 N.m (16 lb ft).

CAUTION: Using engine oils of any viscosity other than those viscosities recommended could result in engine damage.

NOTE:

- Use specified volume of engine oil with the specified viscosity class.
- Start the engine and allow it to run until the oil pressure control indicator goes off.
- Inspect the engine oil level.

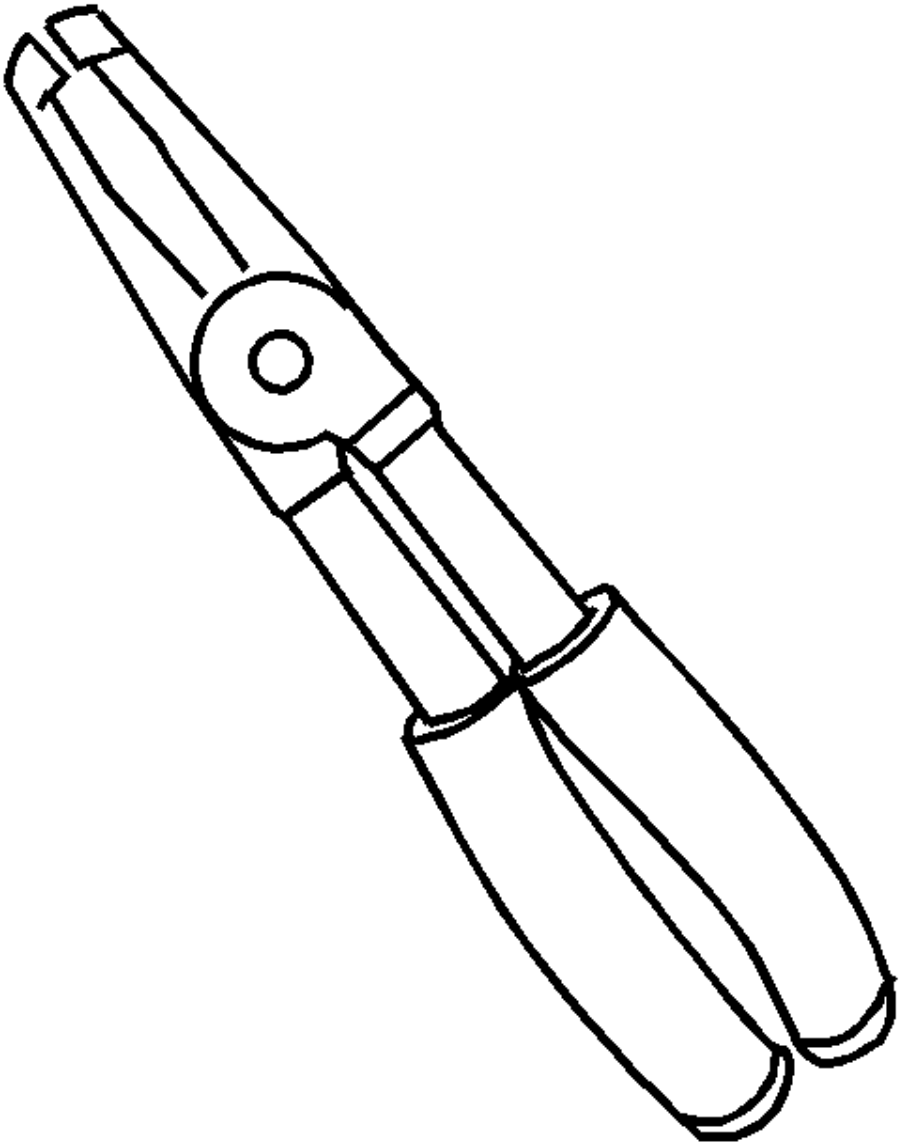
6. Fill in NEW engine oil. Refer to **Engine Mechanical Specifications (LEA, or LUK)** .
7. Reset the service interval indicator.

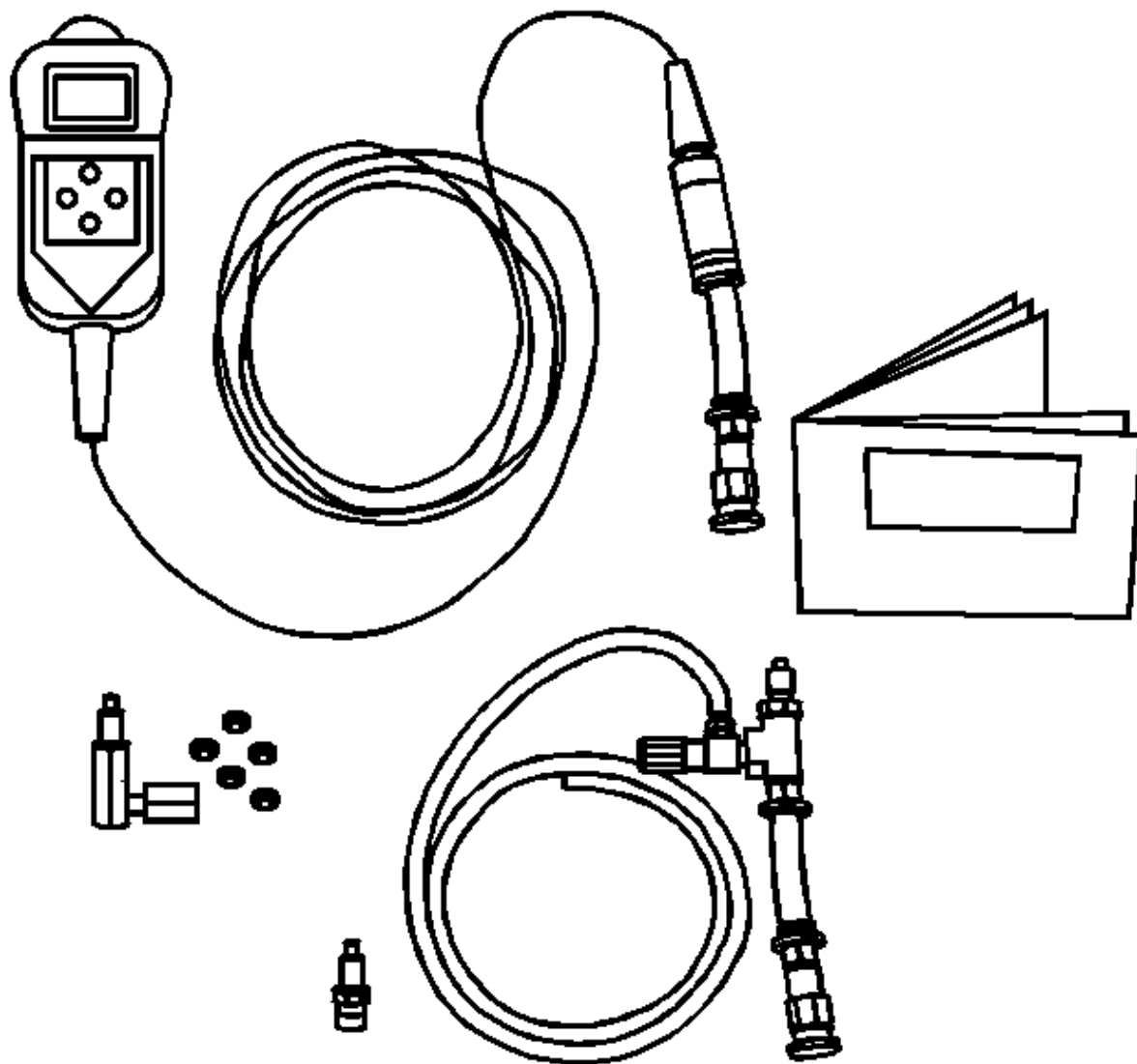
Engine

Engine Mechanical - 2.4L (LEA LUK) - Special Tools and Equipment

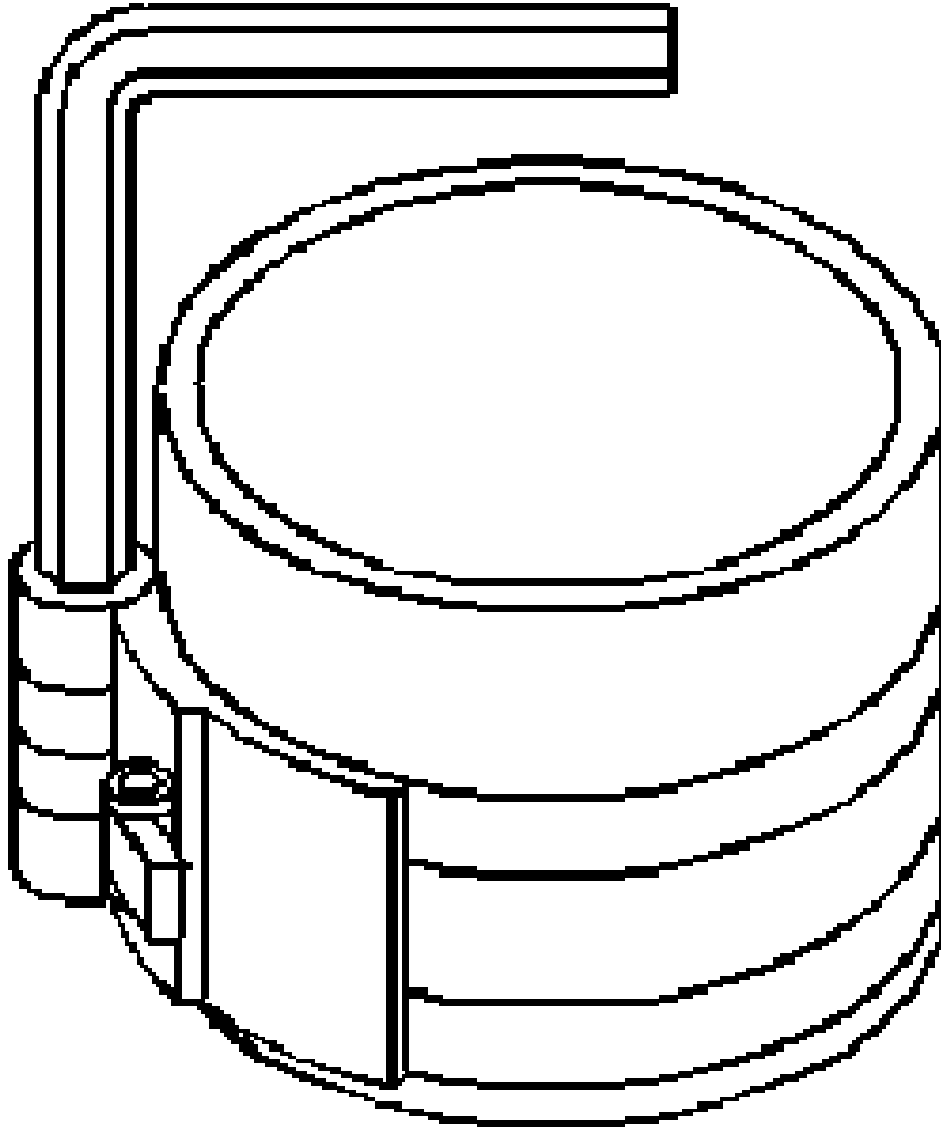
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

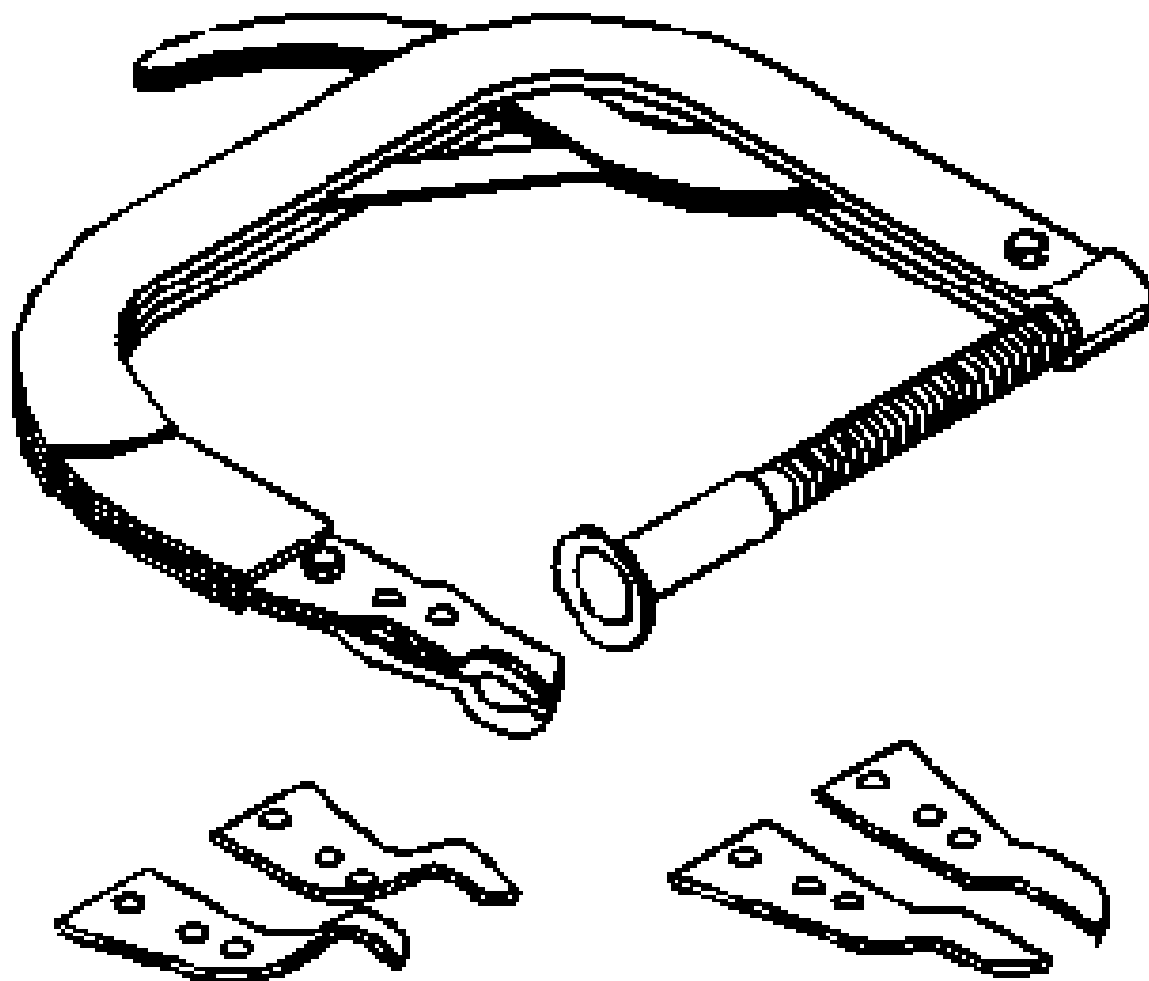
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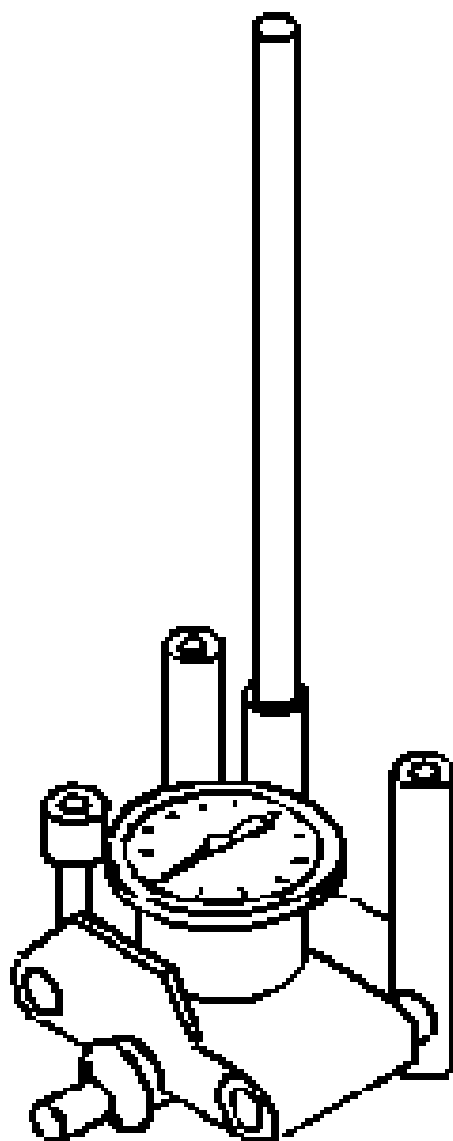
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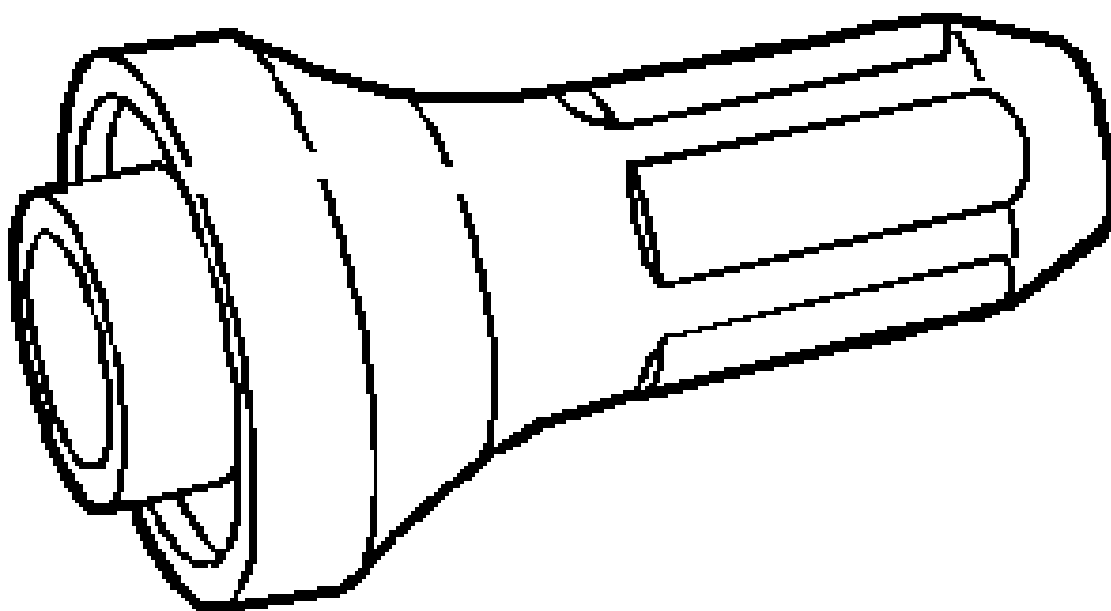
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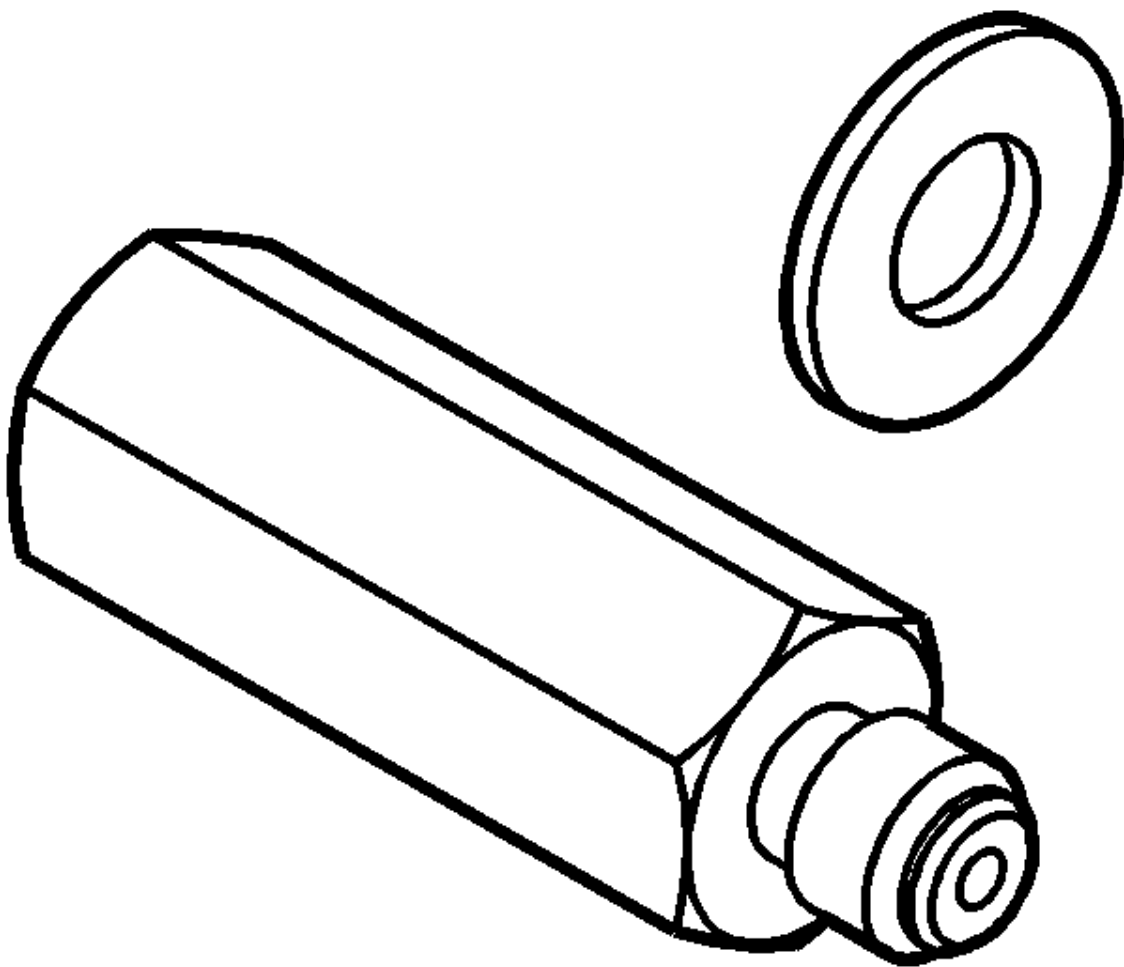
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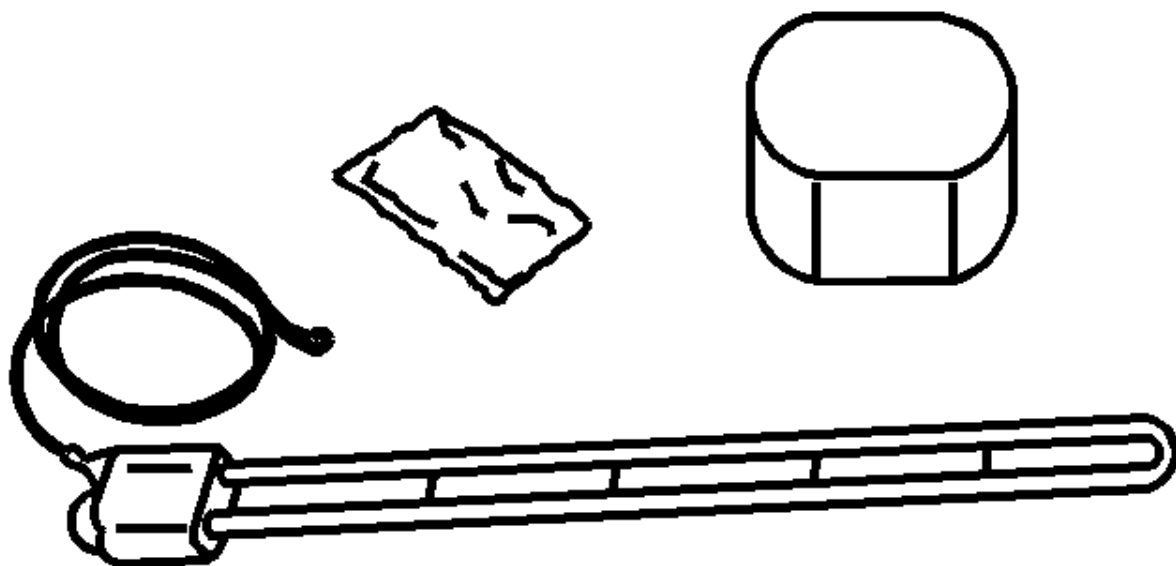
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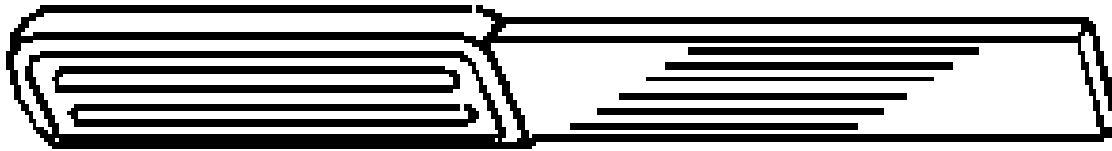
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Oil Pressure Gauge
Adapter



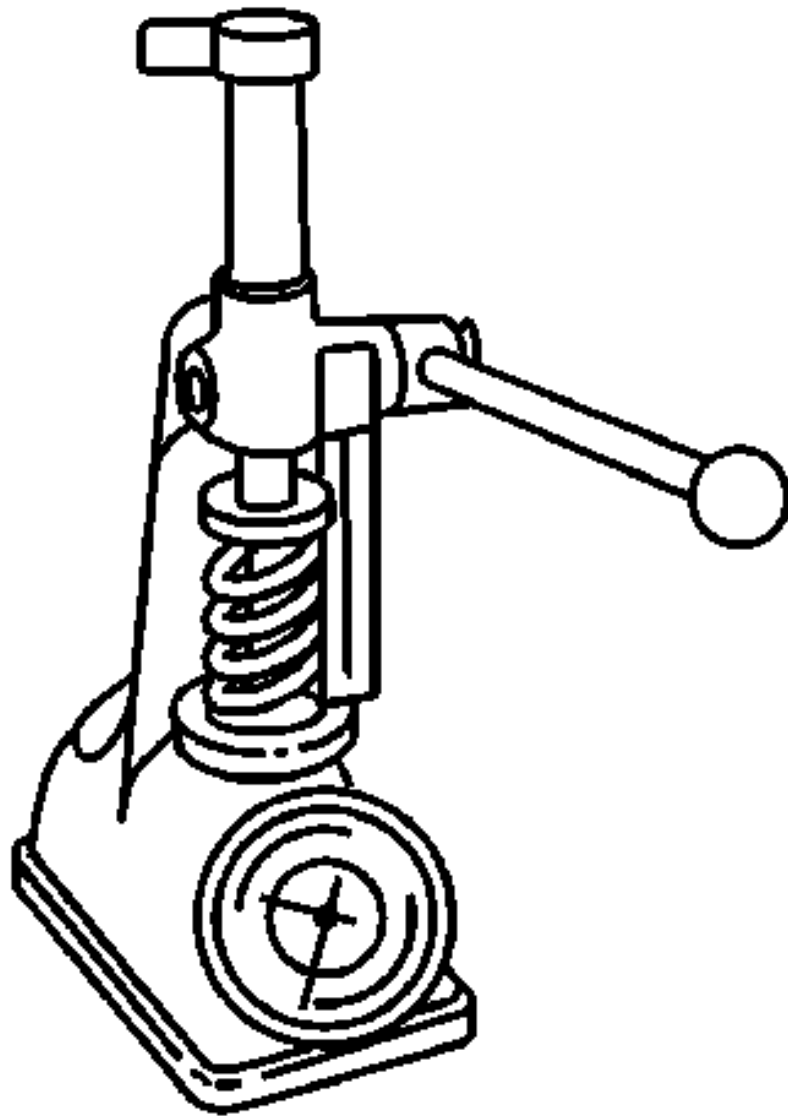
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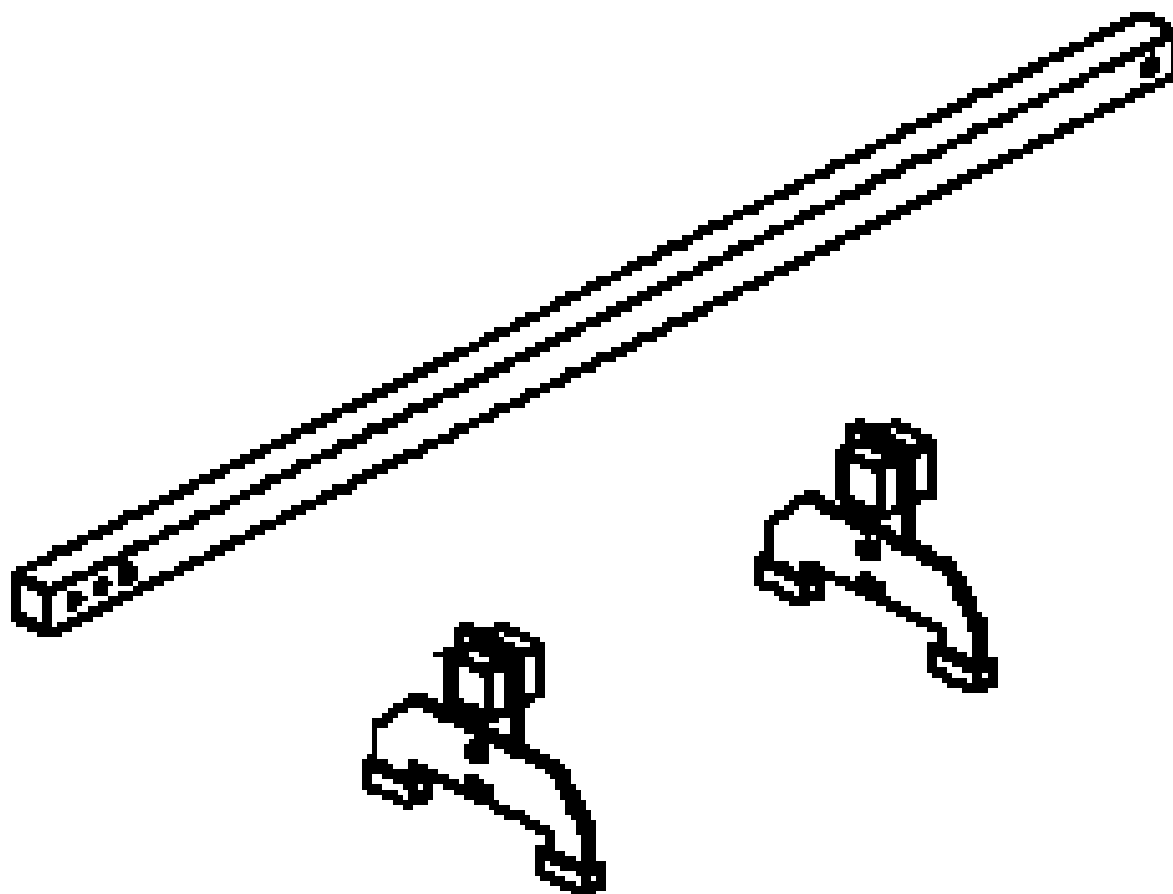
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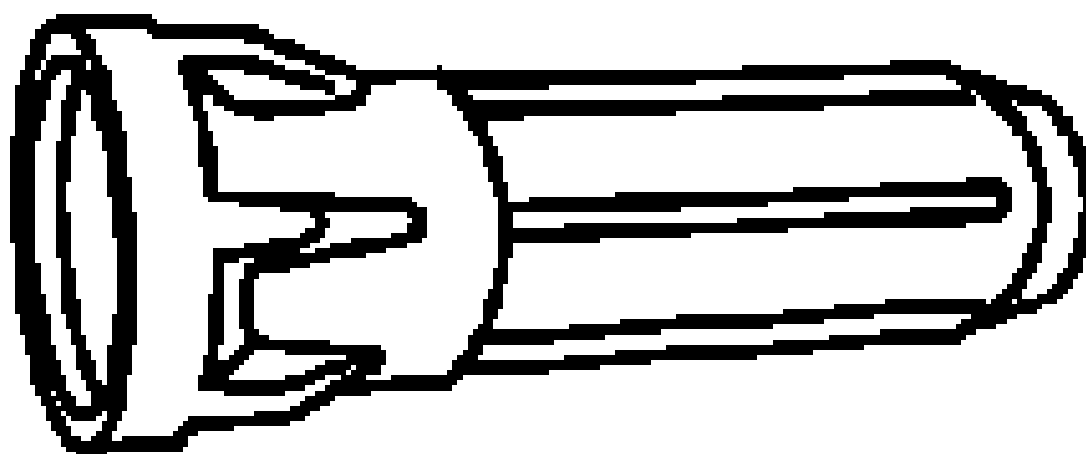
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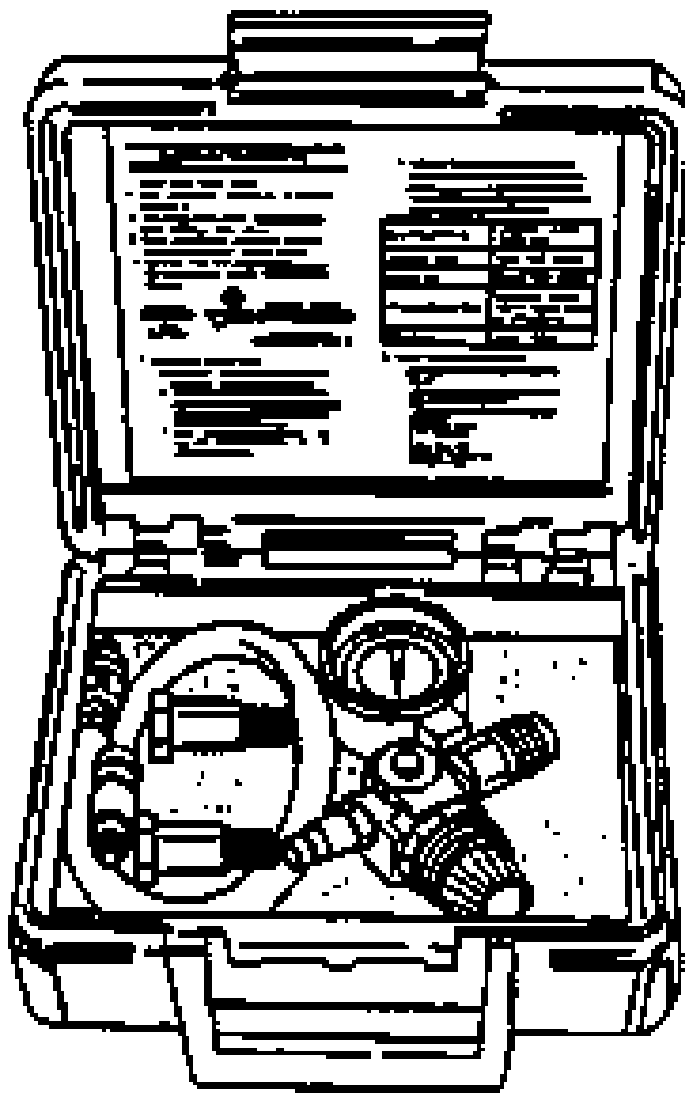
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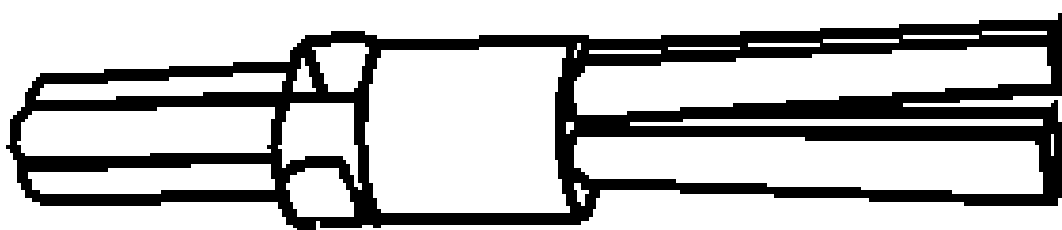
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Engine Support
Fixture



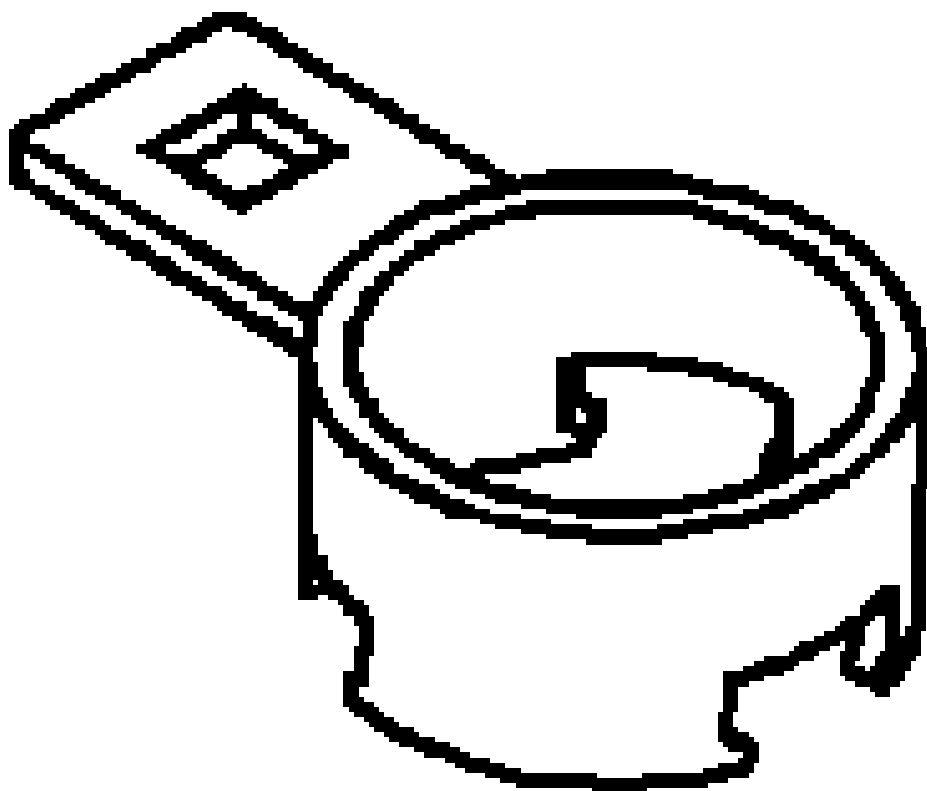
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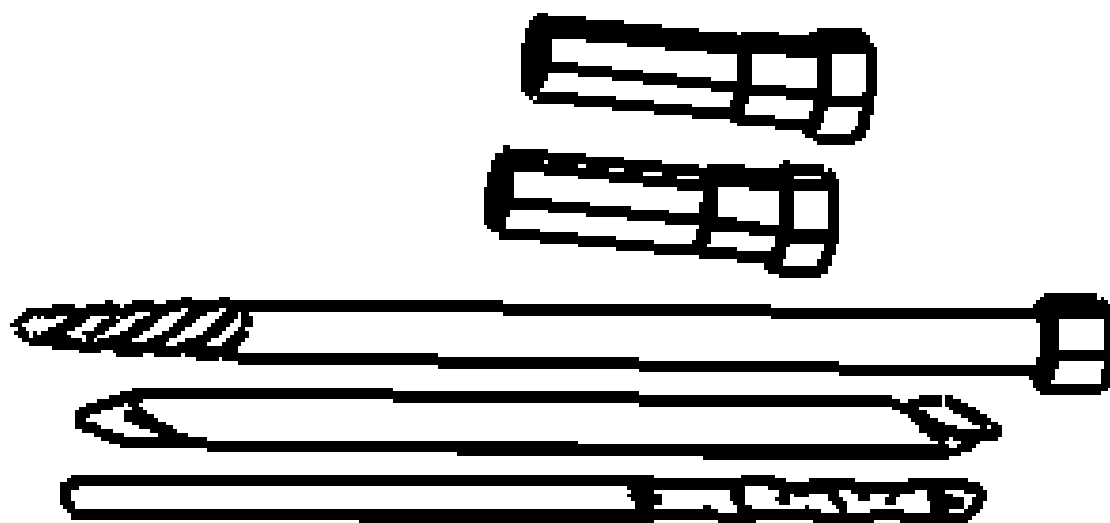
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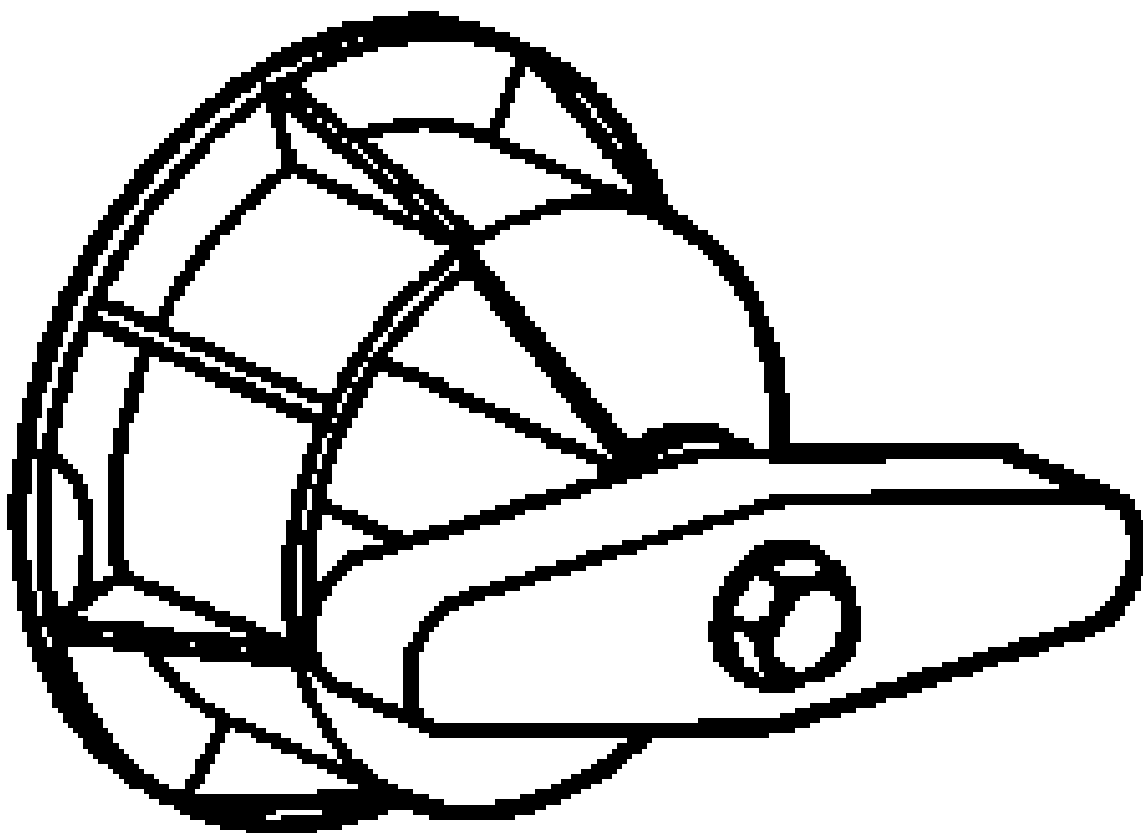
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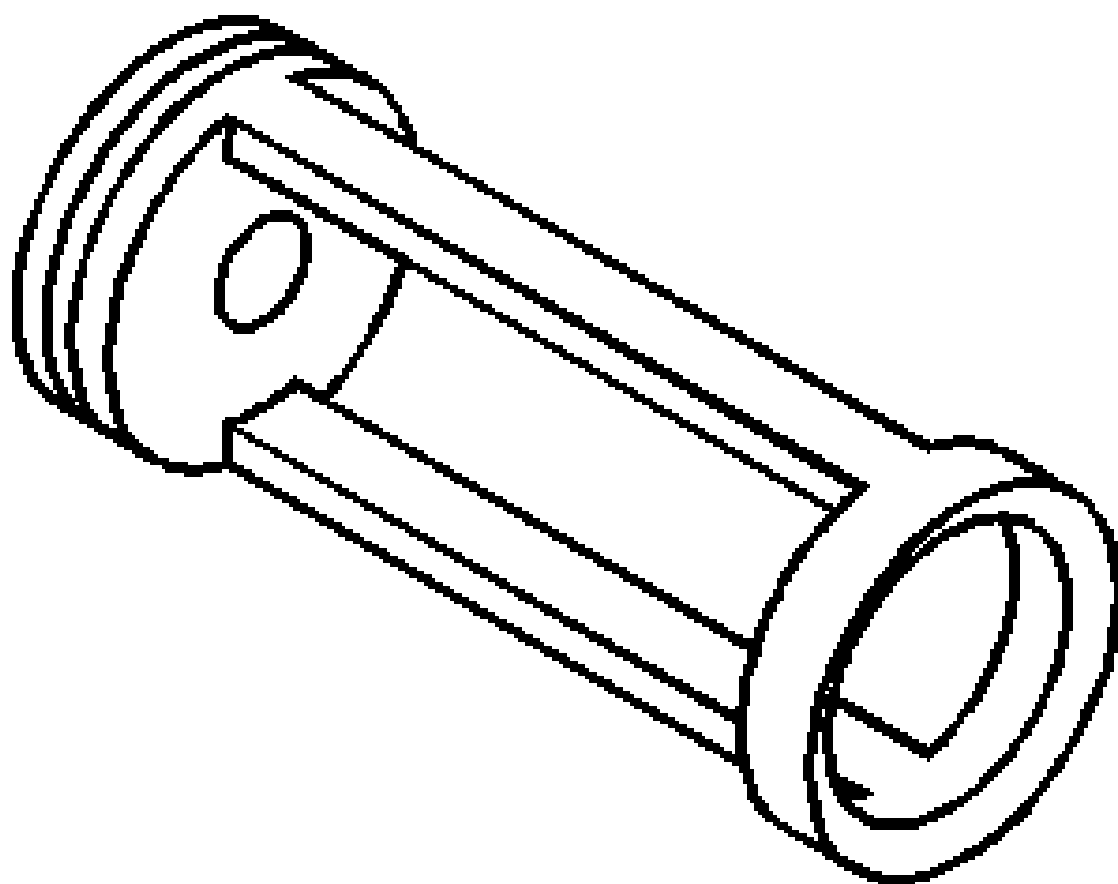
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Crankshaft Balan
Holder



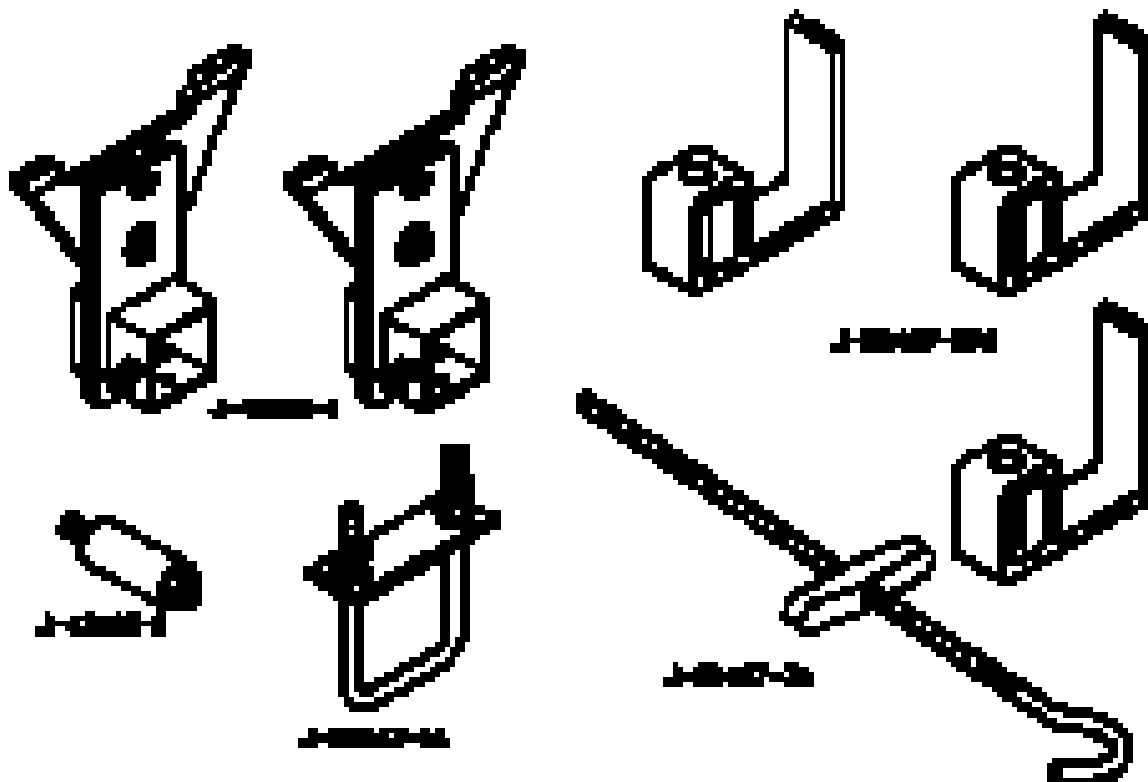
EN-38188
J 38188
Cylinder Head
Broken Bolt
Extractor Kit
South America U
Local Equivale



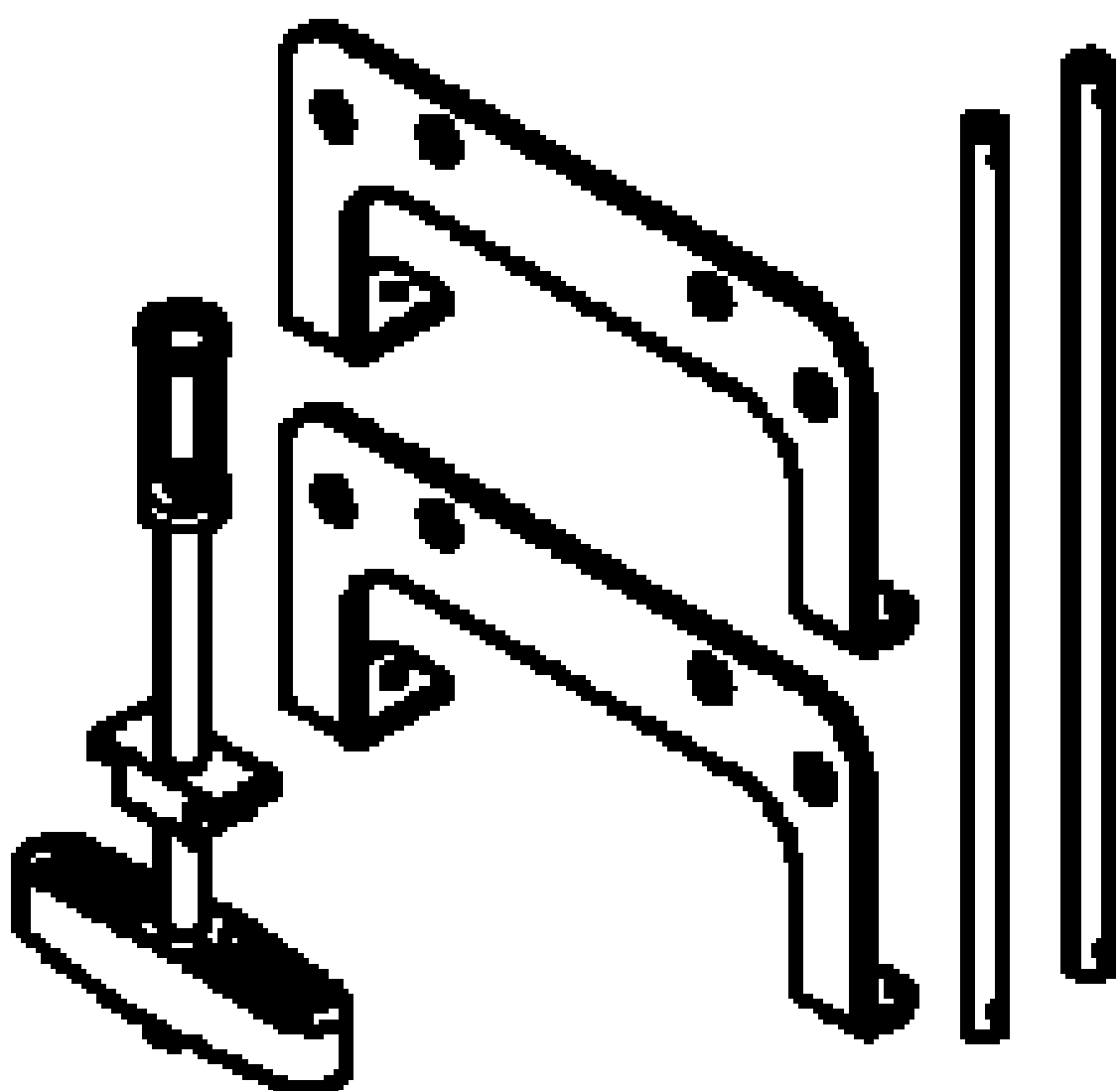
EN-42067
J 42067
KM-J-42067
Rear Main Sea
Installer



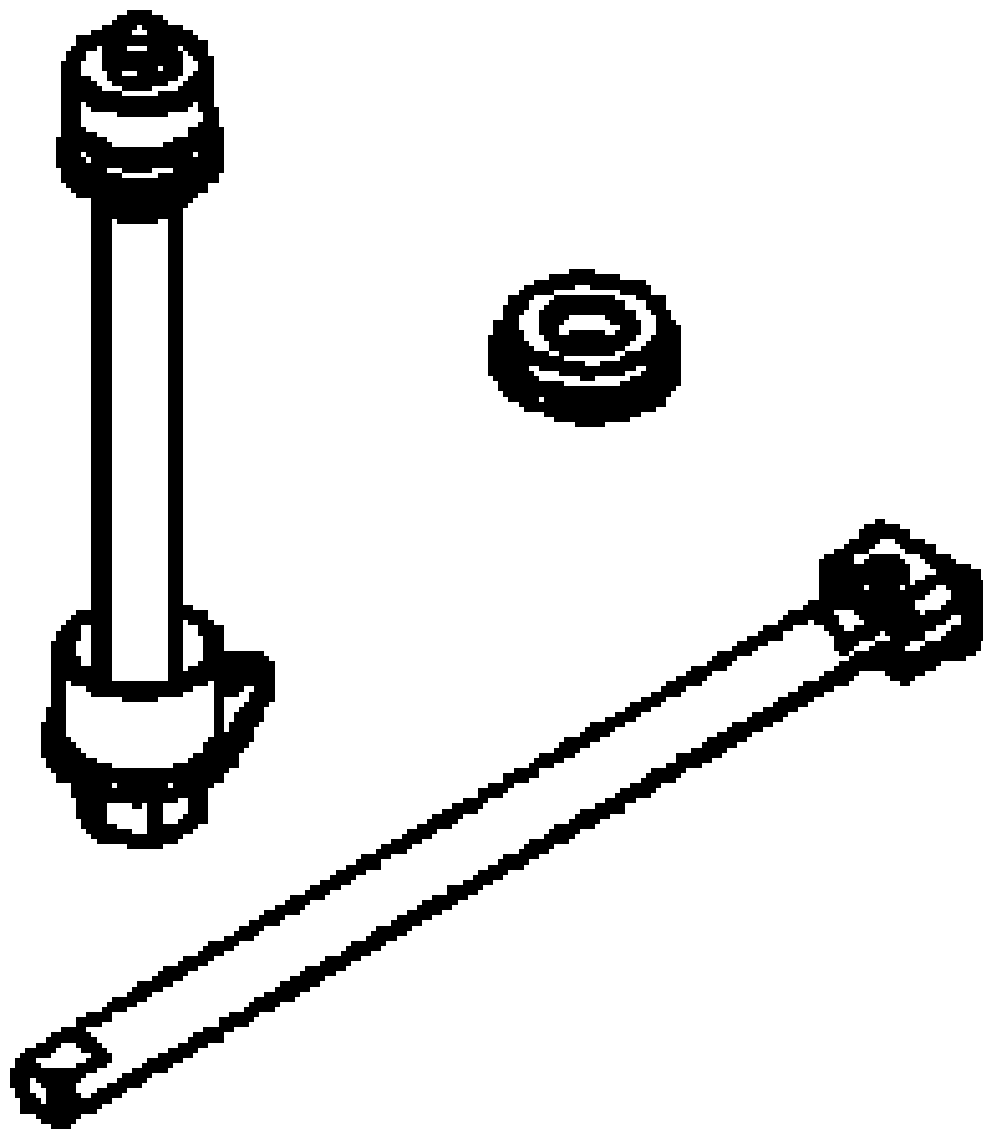
EN-42385-850
J 42385-850
Thread Repair F
South America U
Local Equivale



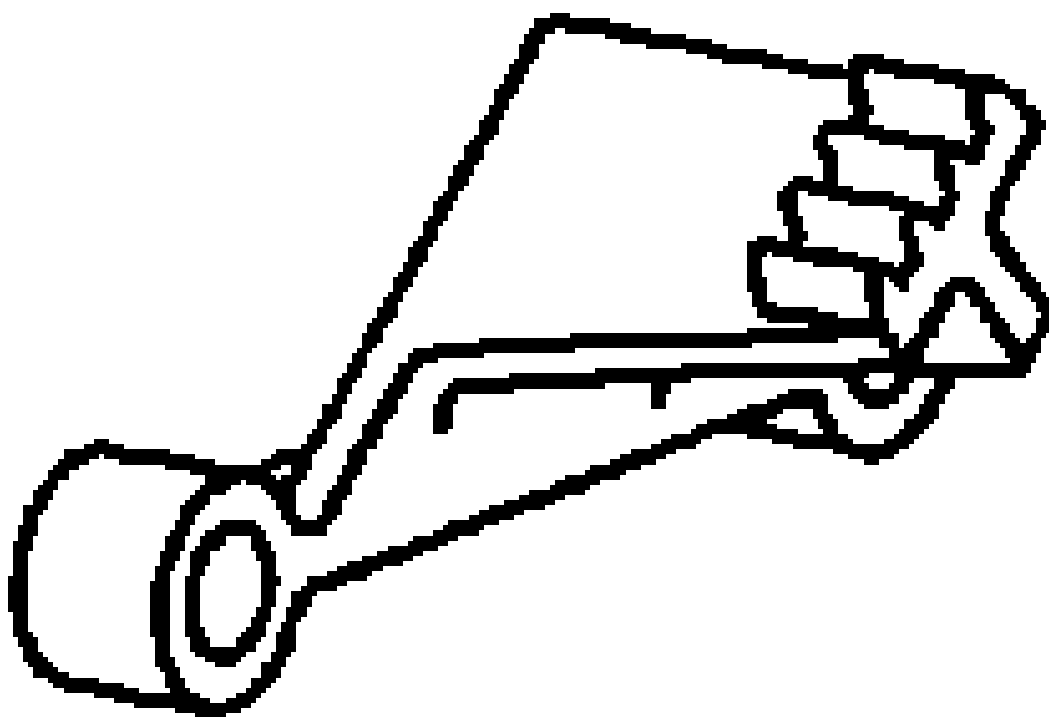
EN 43405
J 43405
Engine Support
Fixture Adapter



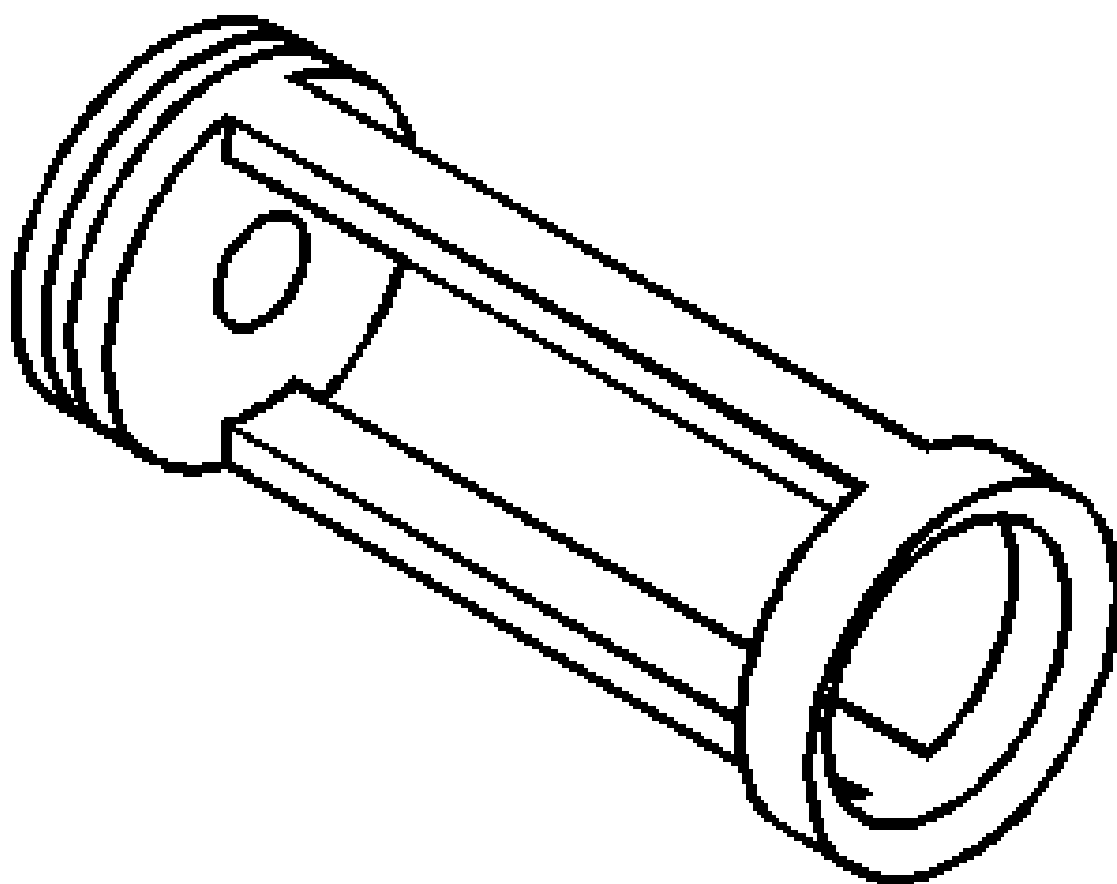
EN-43649
J 43649
Valve Spring
Compressor
South America U
Local Equivale



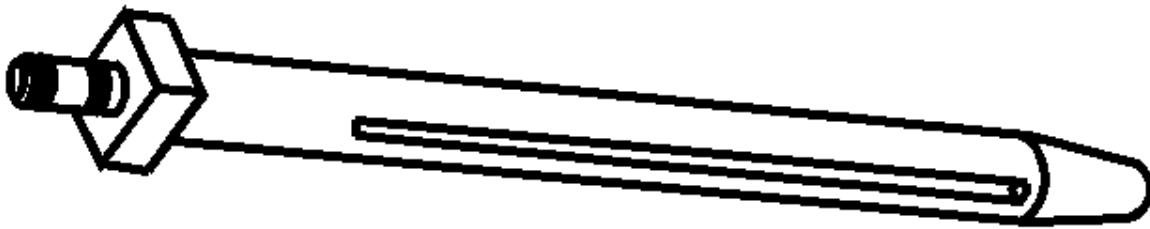
EN-43650
J 43650
Balance Shaft
Bearing Remover
Installer



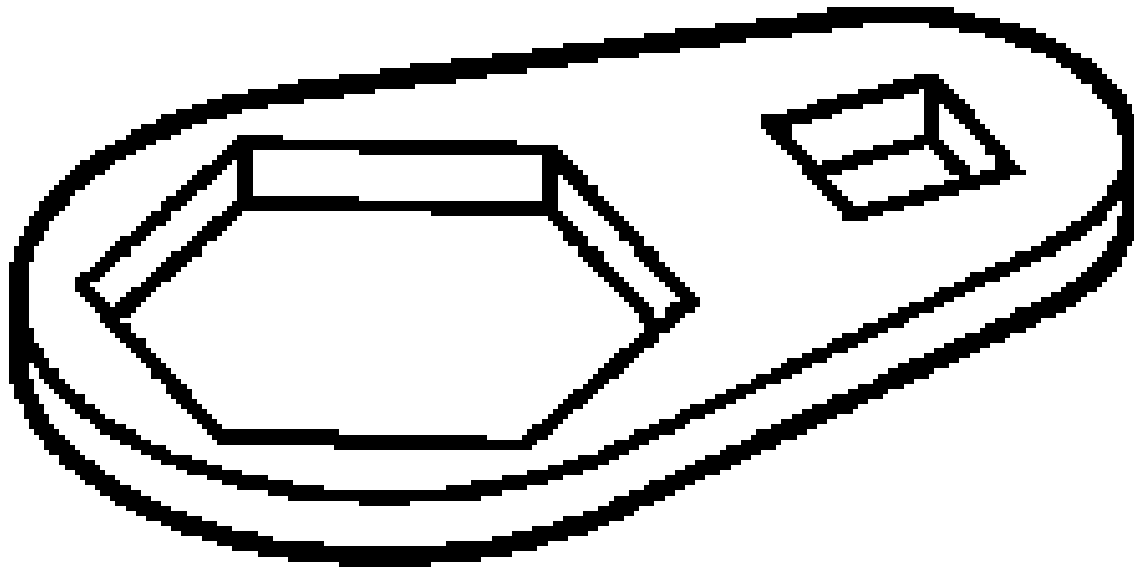
EN 43653
J 43653
KM-652
Flywheel Holding
Tool
South America U
Local Equivalent



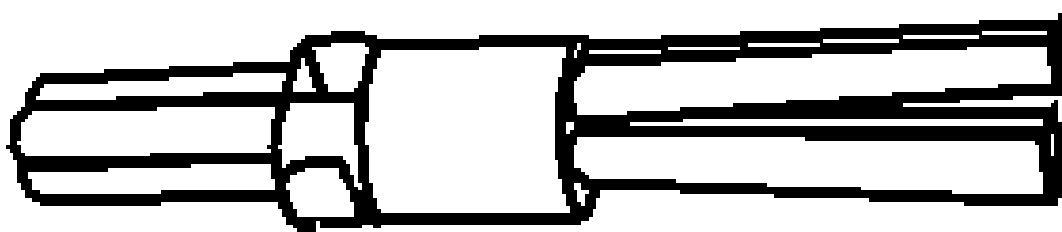
EN-43963
J 43963
KM-6149
V-0306983
Valve Spring
Compressor (off)



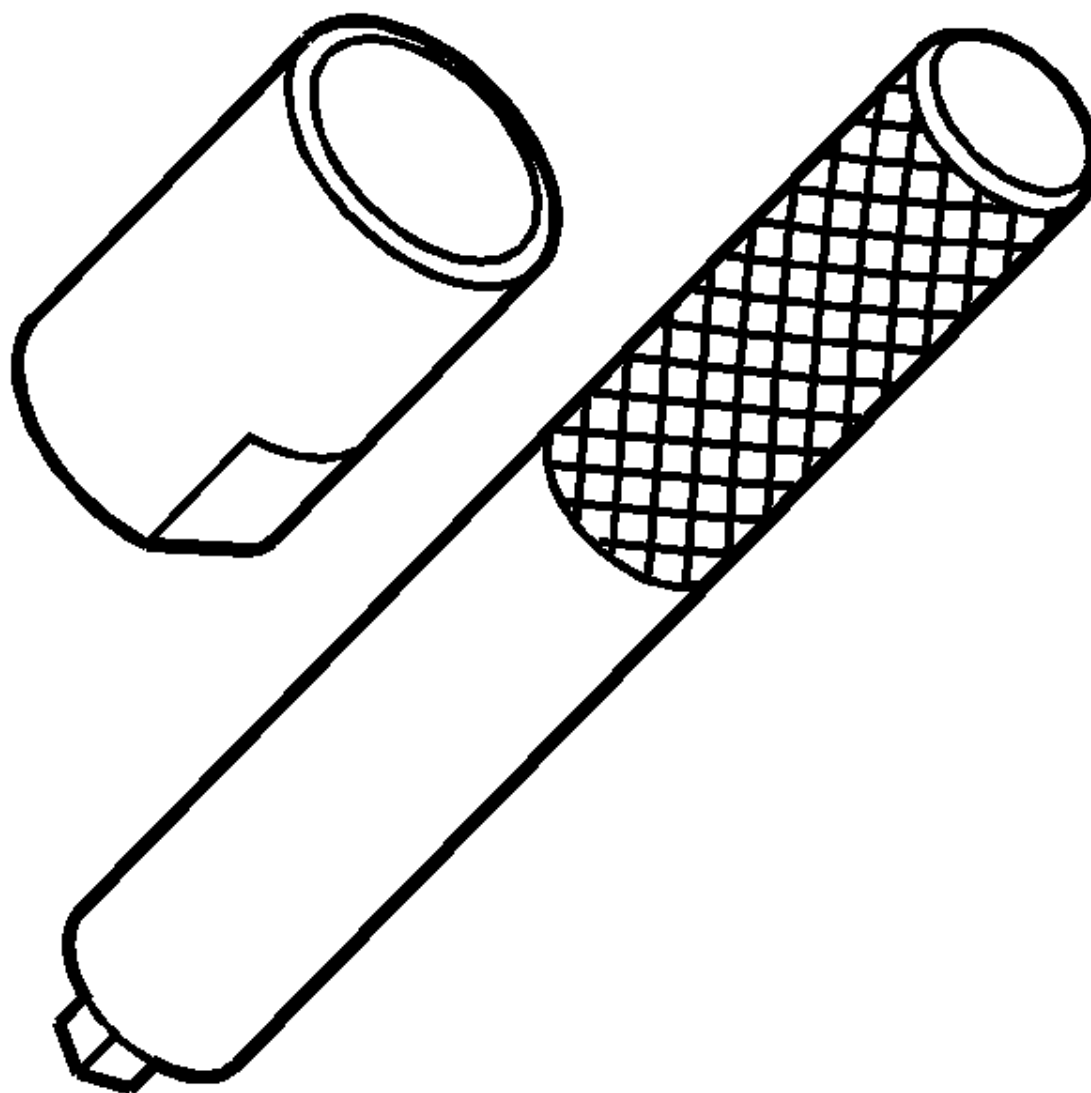
EN-43966
J 43966
V-0506030
Connecting Ro
Guides



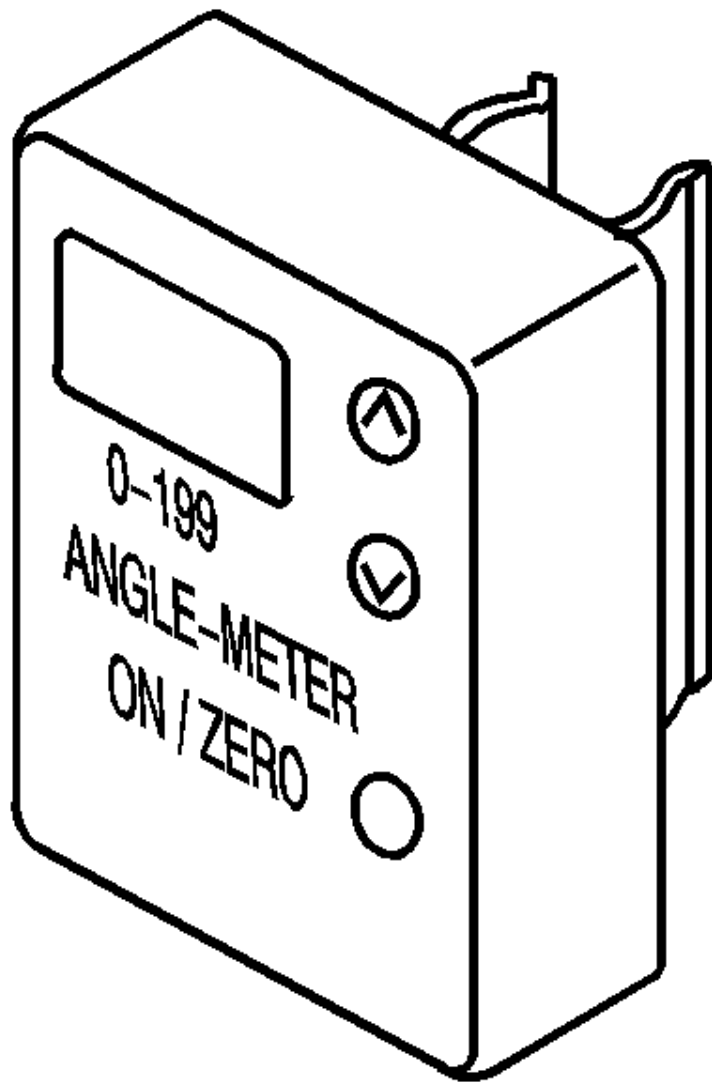
EN-44887
J 44887
KM-6150
Oil Filter Wrench



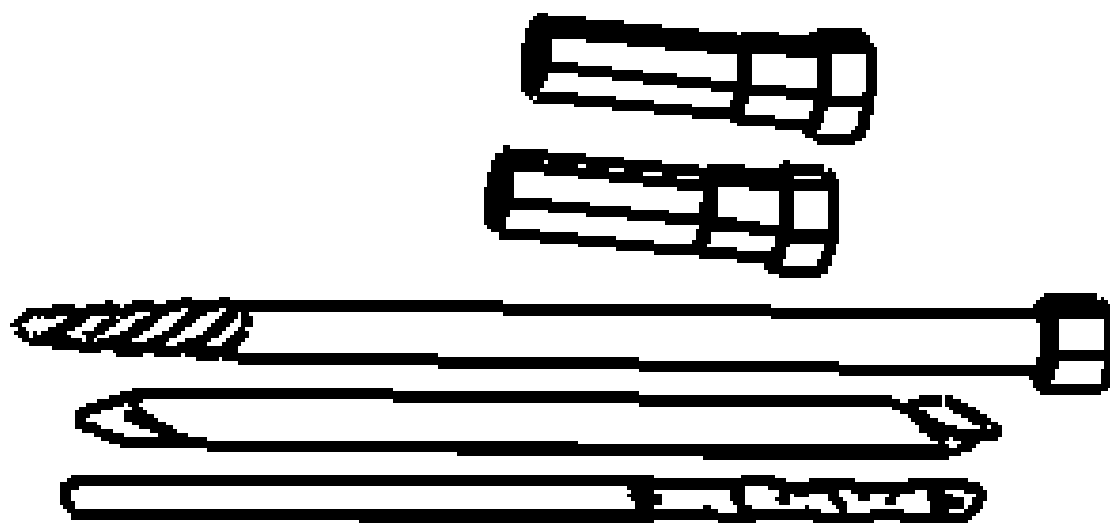
EN 45025
J 45025
Belt Tensioner
Wrench



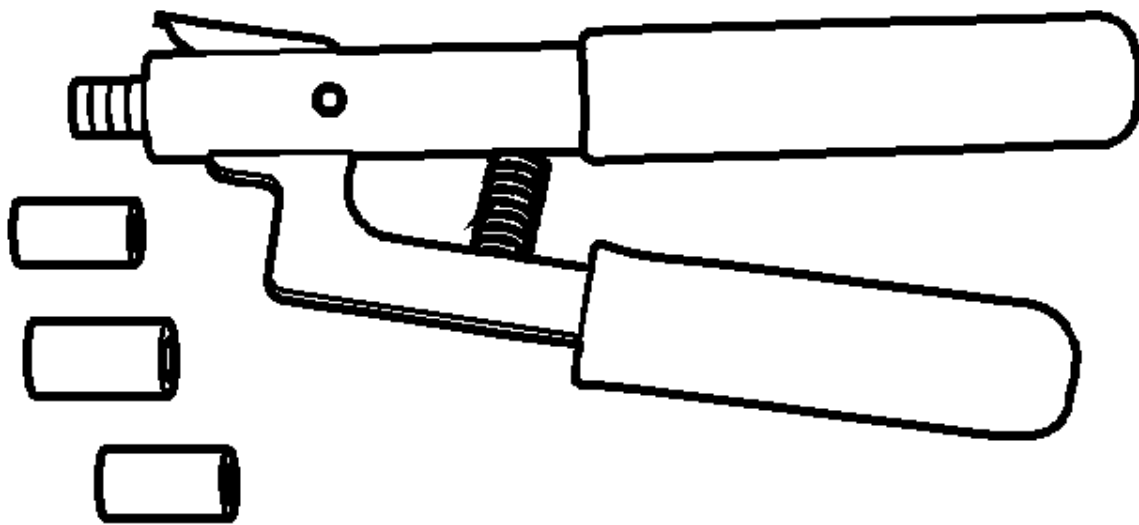
EN-45027
J 45027
Tensioner Too
South America U
Local Equivale



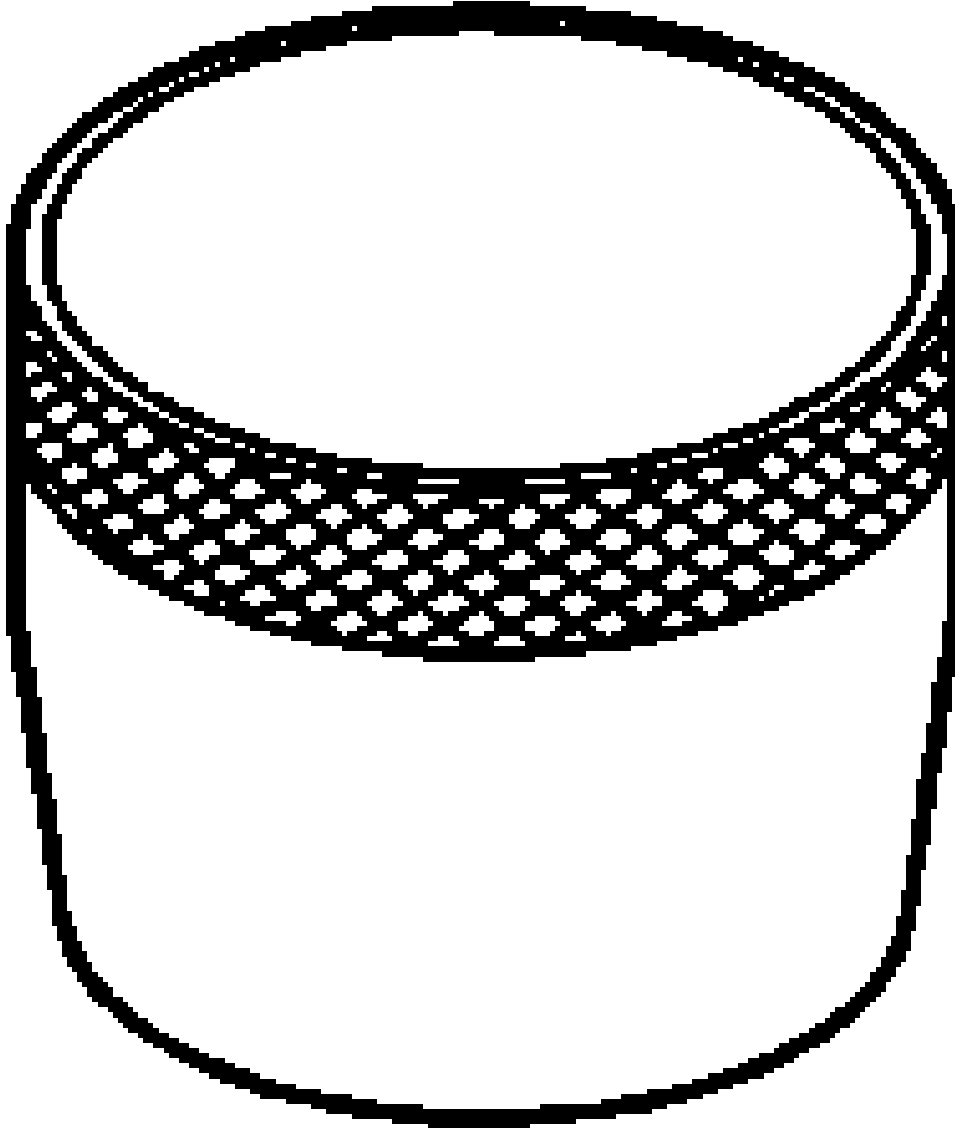
EN-45059
J 45059
KM-470-B
Angle Meter
South America U
Local Equivale



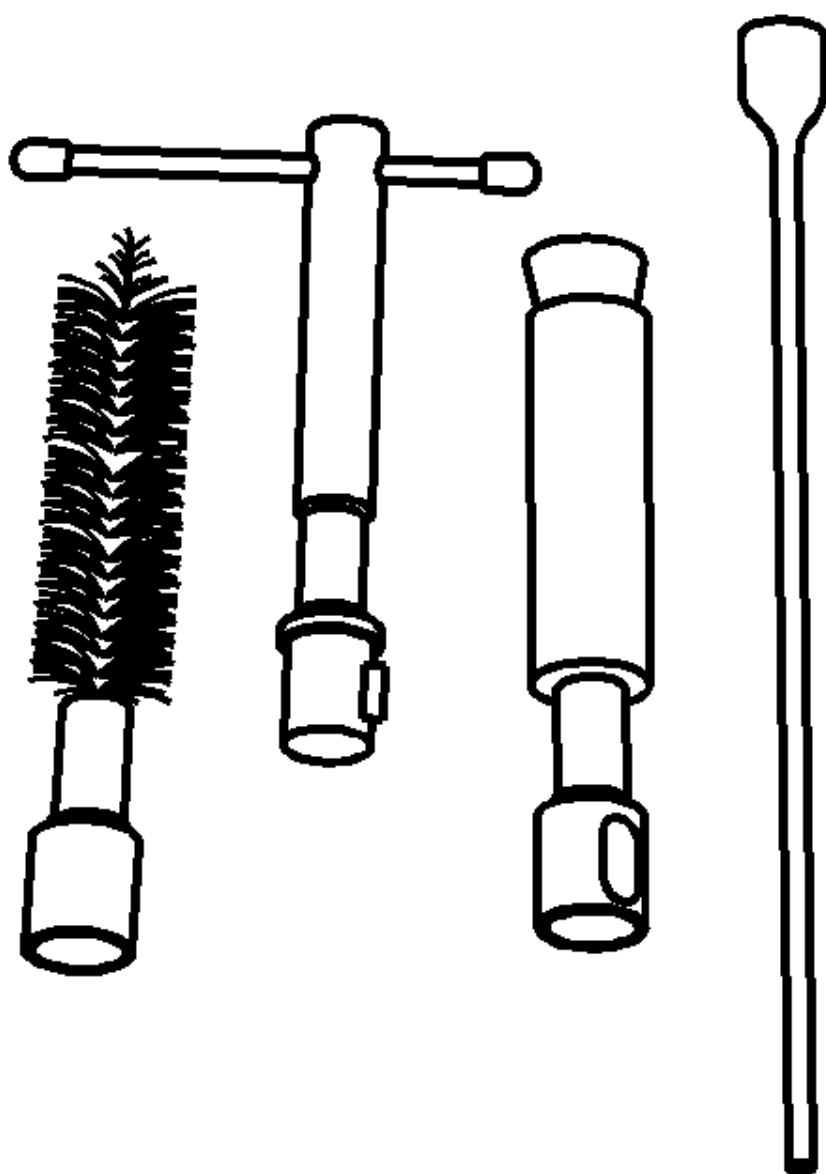
EN-45299
J 45299
Engine Pre-Lub
South America U
Local Equivale



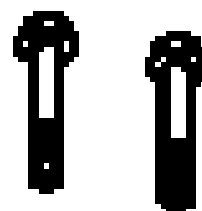
EN 46745
J 43654
Piston Pin Clip
Remover/Install
South America U
Local Equivale



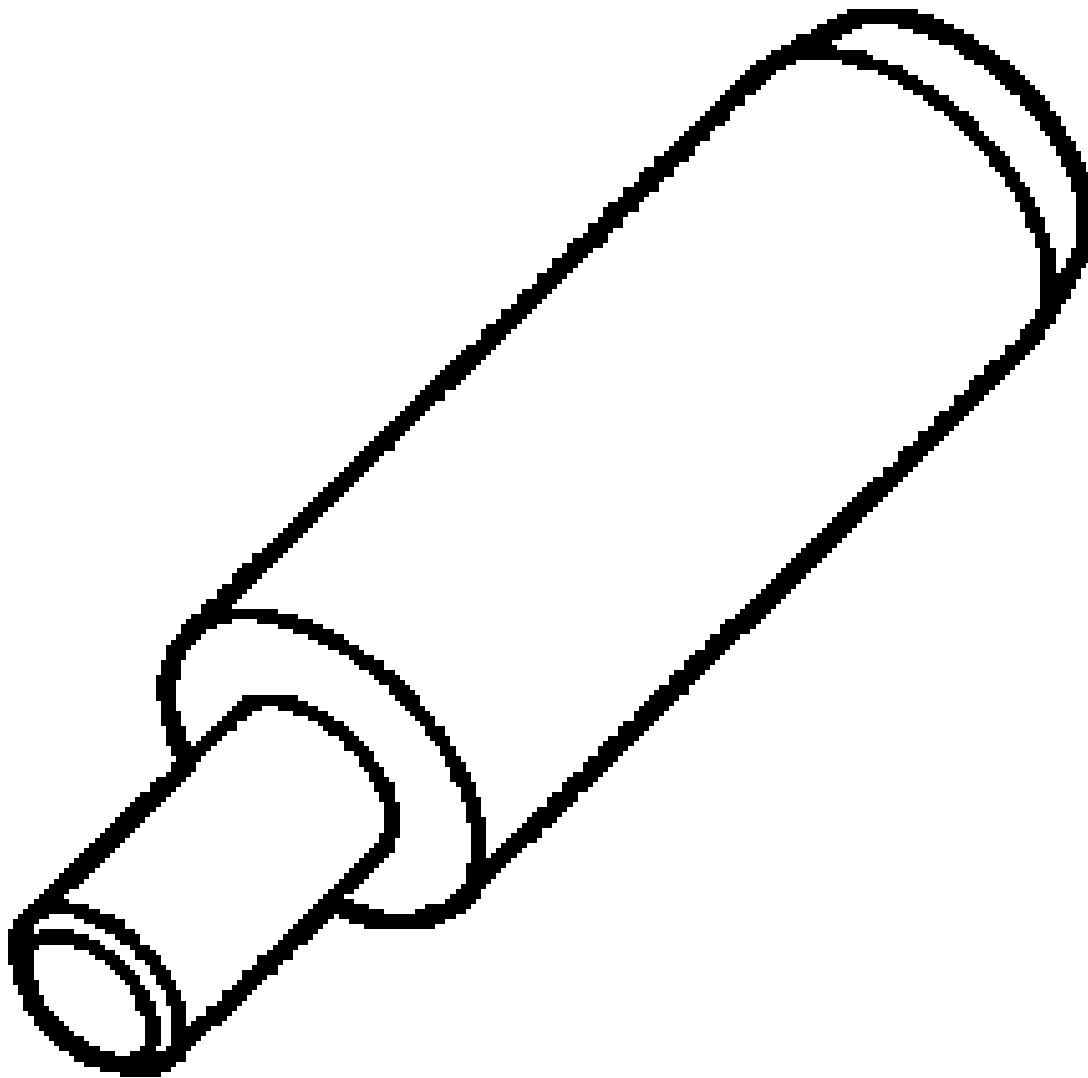
EN 47836
Piston Ring
Compressor
South America U
Local Equivale



EN-47909
Injector Bore and
Sleeve Cleaning

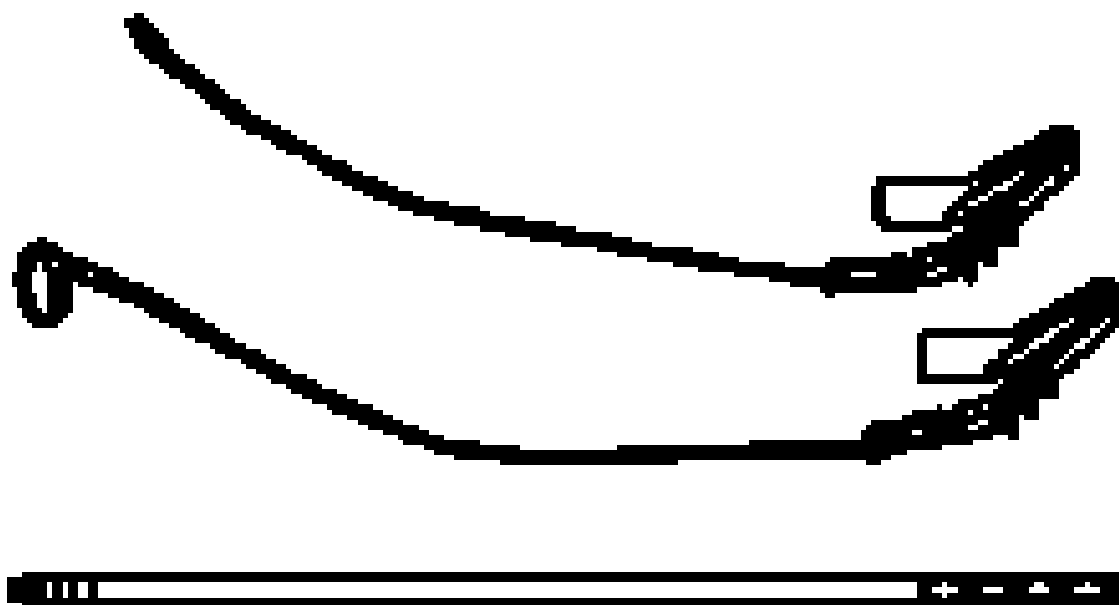


EN 48366
EN 48368
EN 48953
Camshaft Actuator
Locking Tool
South America U
Local Equivalent

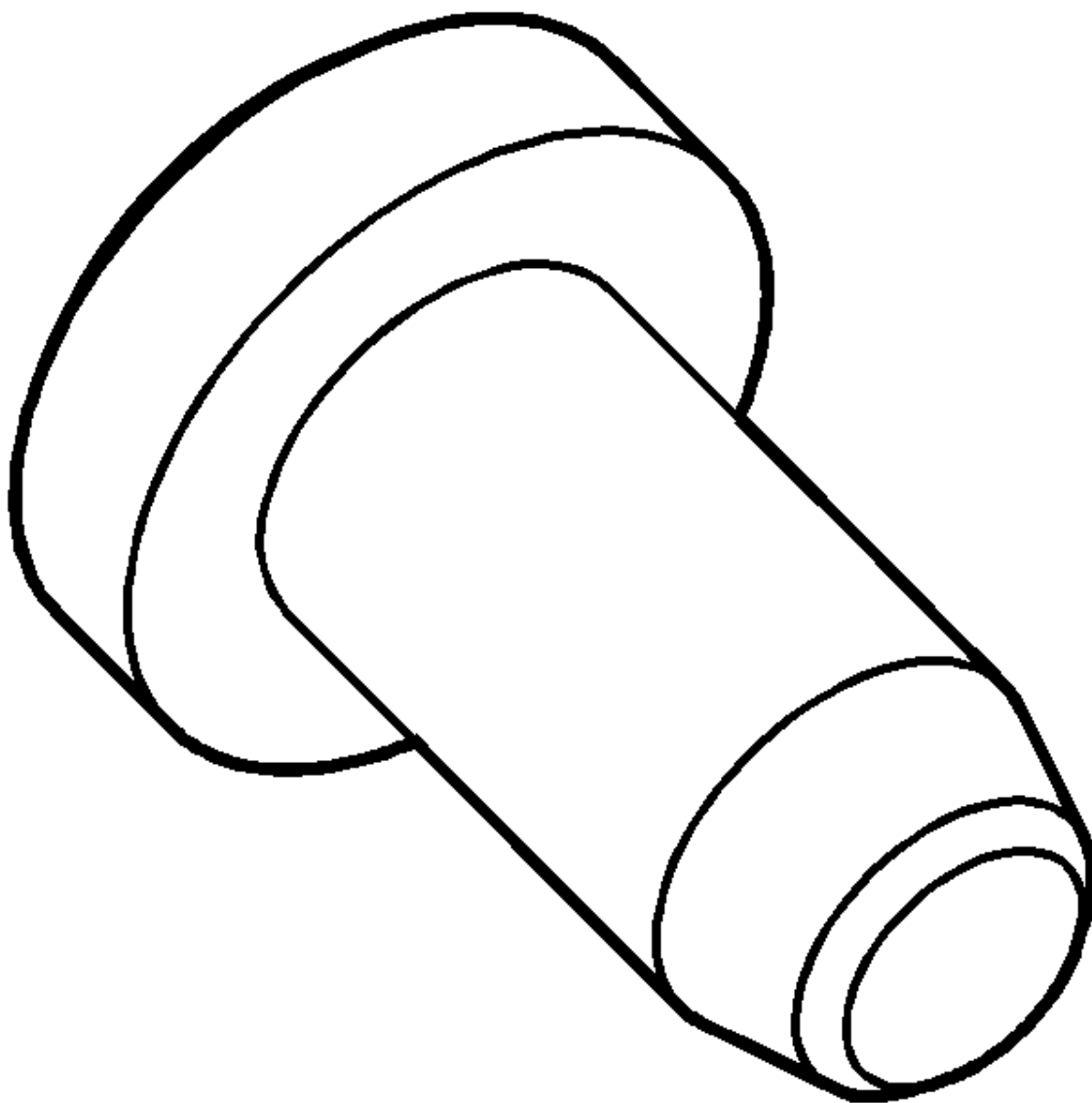


EN 48585
Crankshaft Balan
Guide
South America U
Local Equivale

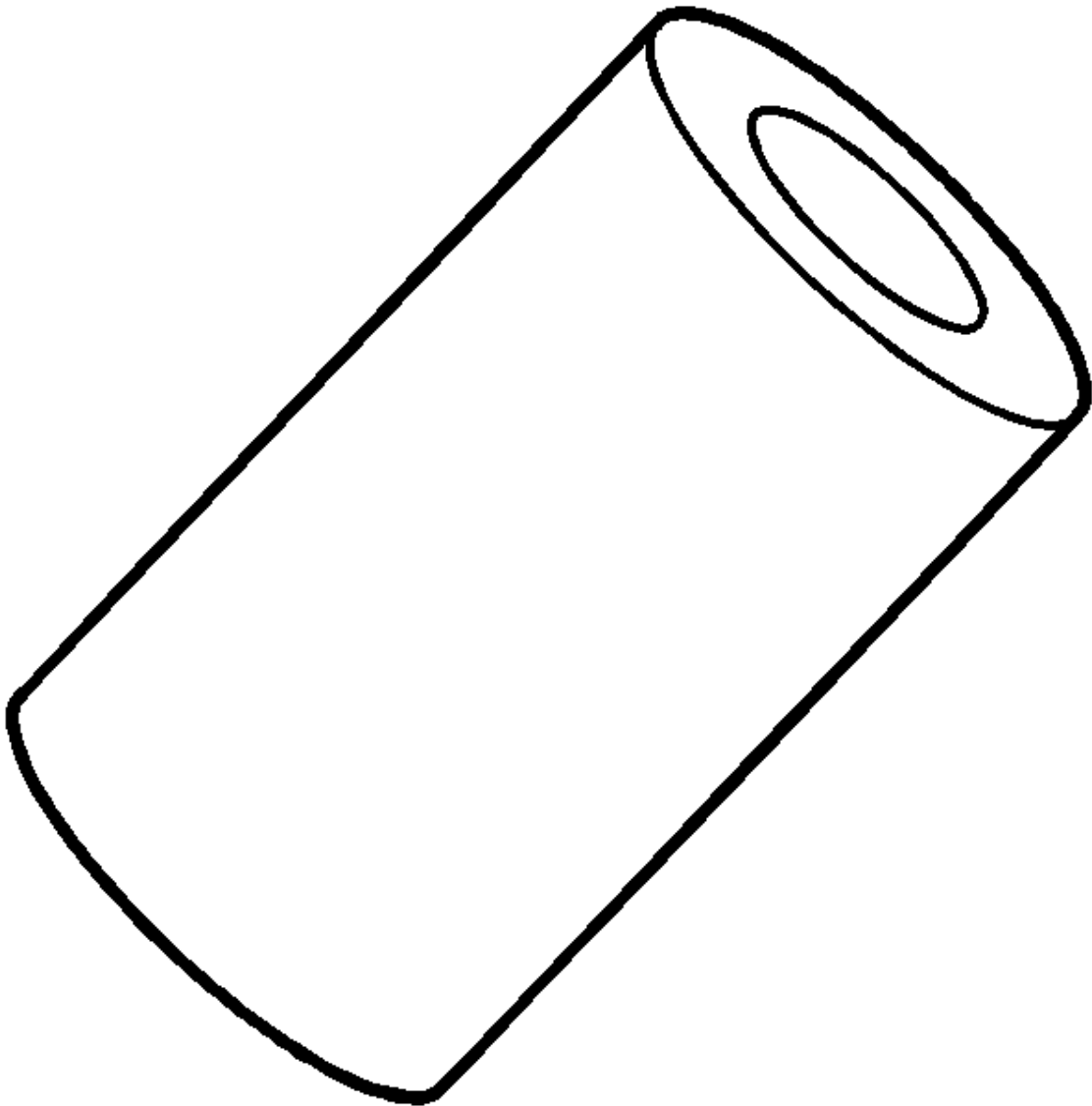
EN 48749
J 44217
Timing Chain
Retention Tool I
South America U
Local Equivale

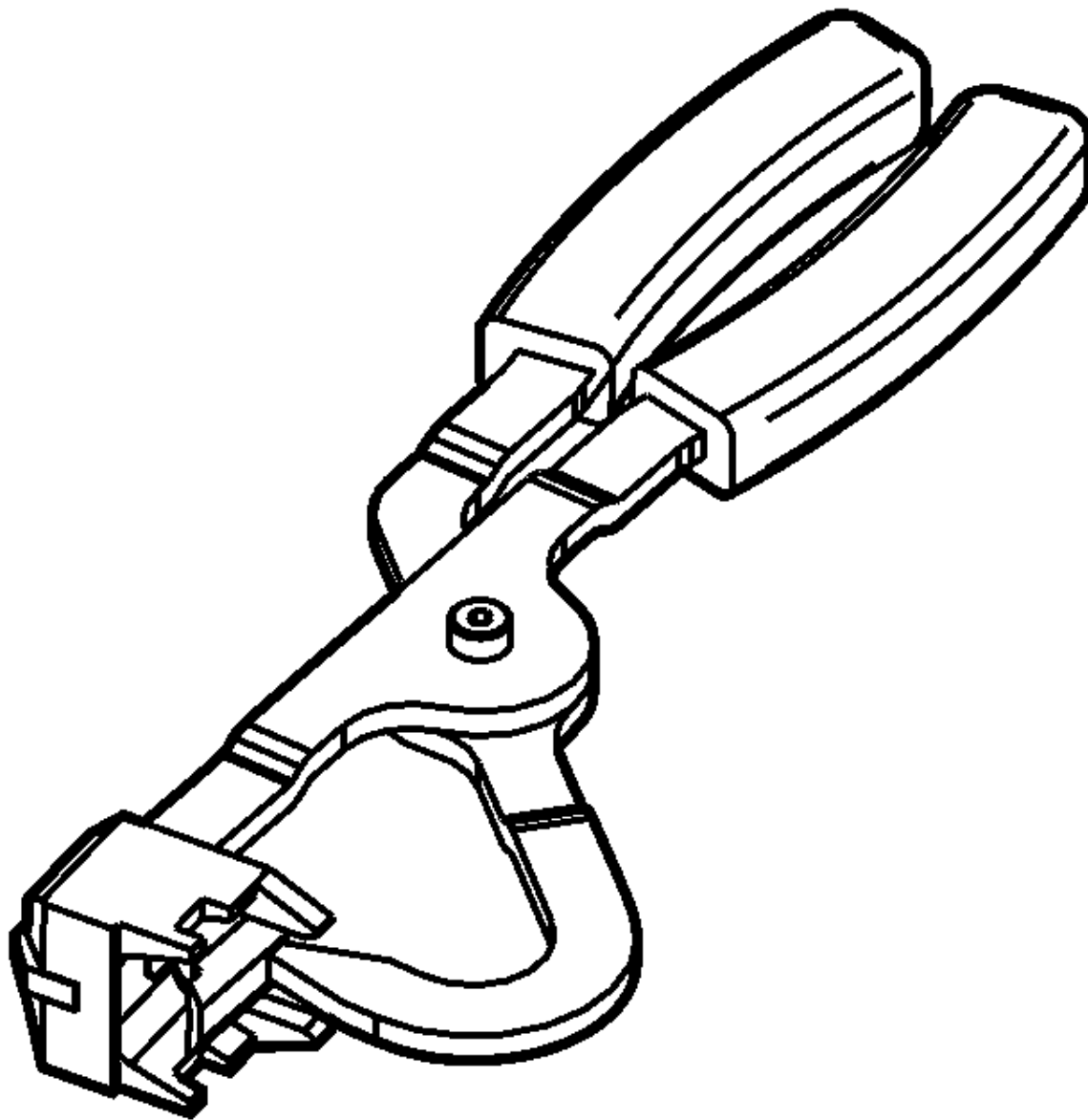


EN 48896
HP Fuel Pump
Installation
Alignment Gau;



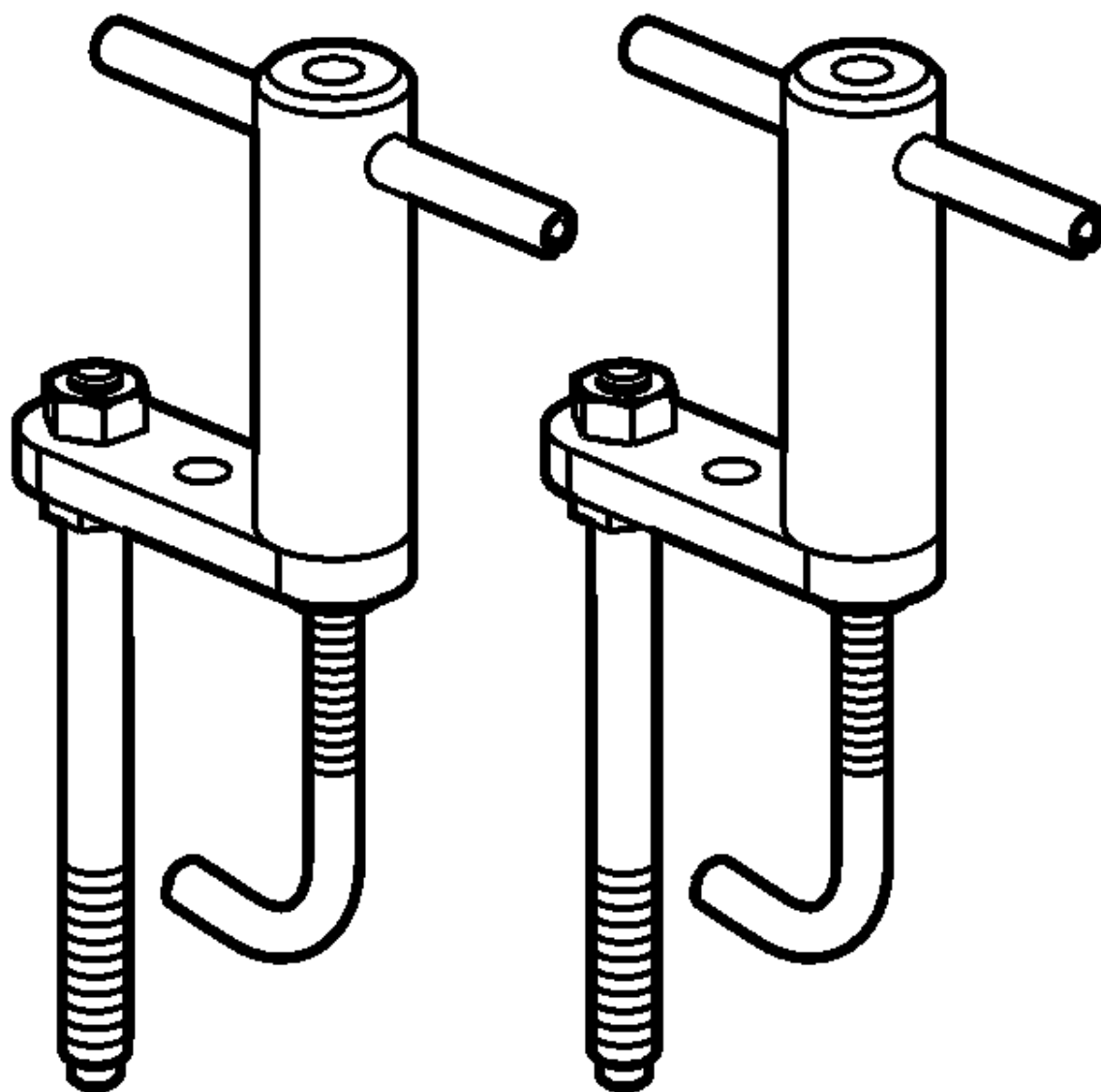
EN 49245
EN-48266 and E
49245-1
Fuel Injector Se
Installer/Sizer

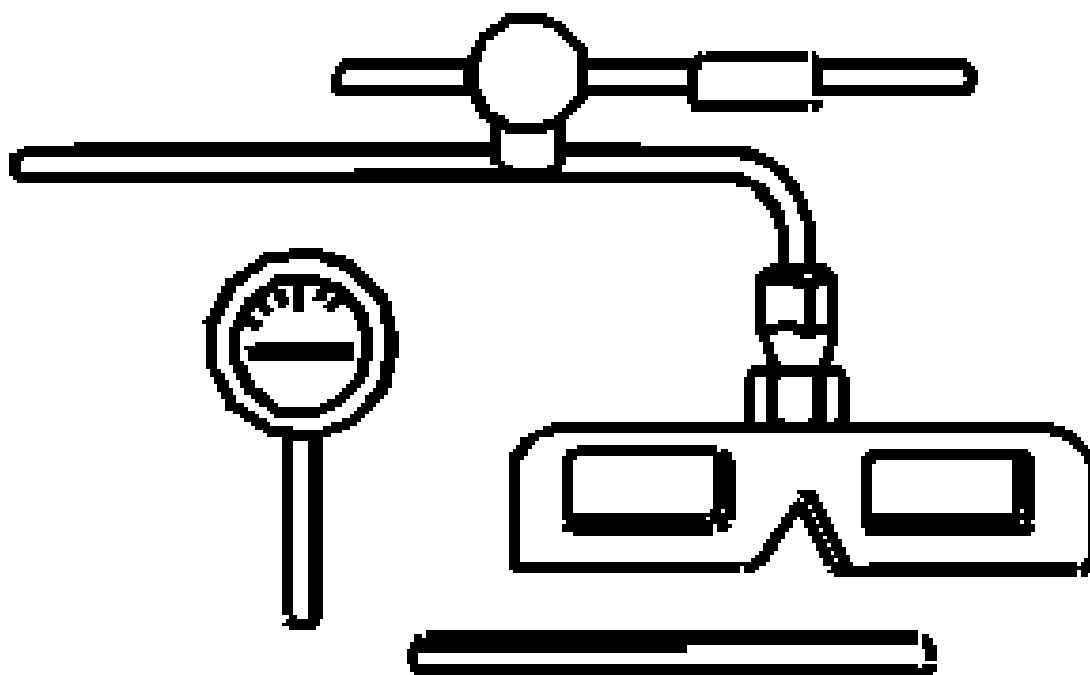




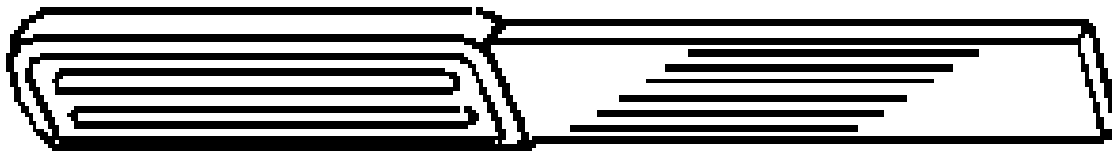
EN 49247
Injector Retainer
Clip Installer

EN 49248
Fuel Rail Assem
Remover

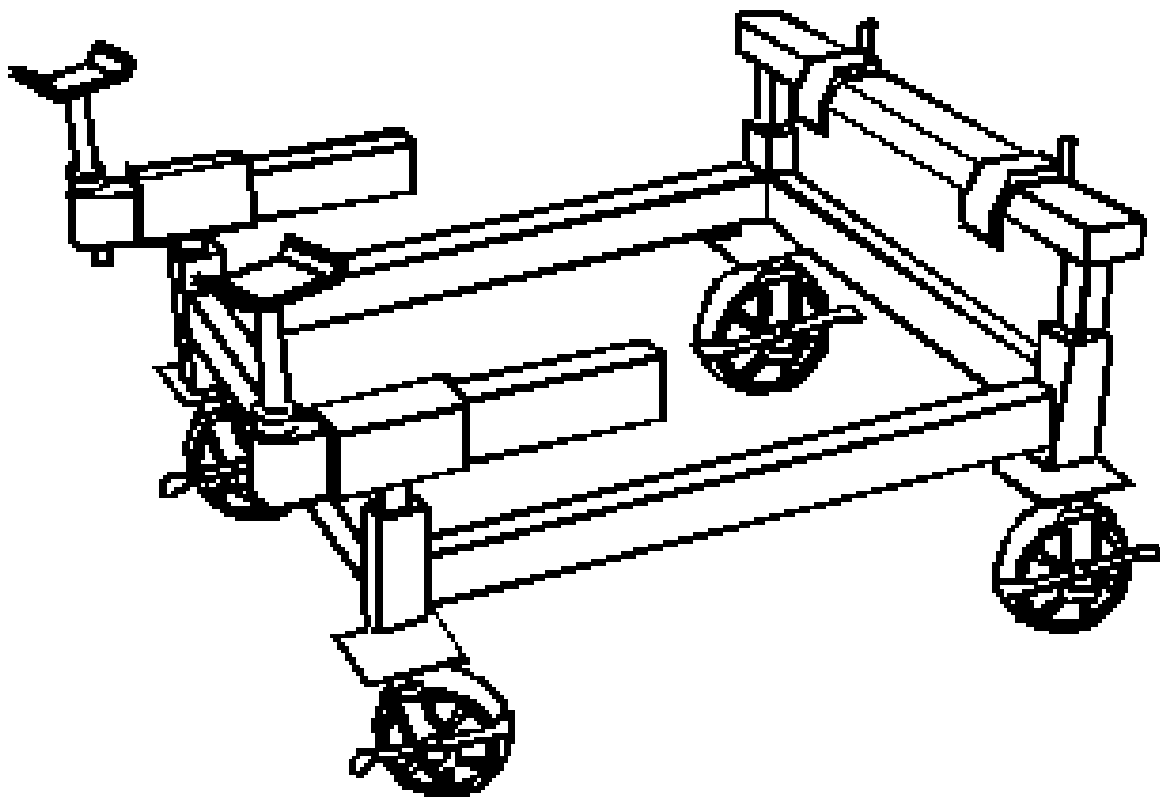




GE-7872
J 7872
Magnetic Base Indicator Set
South America U
Local Equivale



GE-42220
J 28428-E
J 42220
Universal 12V L
Detection Lam
South America U
Local Equivale



J-39580
J-9703386
J-9703392
L-0806003
L-0906001
L-0906002
L-0906003
L-0906004
Engine Support T

Engine

Engine Mechanical - 2.4L (LEA, LUK) - Specifications

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS (LEA, OR LUK)

Fastener Tightening Specifications (LAF, LEA, or LUK)

Application	Specification	
	Metric	English
A/C Compressor to Block Bolt	22 N.m	16 lb ft
Air Pump Assembly Bolt	22 N.m	16 lb ft
Balance Shaft Bearing Carrier to Block Bolt	10 N.m	89 lb in
Balance Shaft Chain Guide Bolt, Adjustable	10 N.m	89 lb in
Balance Shaft Chain Guide Bolt, Fixed	12 N.m	106 lb in
Balance Shaft Chain Tensioner	10 N.m	89 lb in
Block Core Plug	35 N.m	26 lb ft
Block Heater Bolt	10 N.m	89 lb in
Cam Cover to Cylinder Head Bolt	10 N.m	89 lb in
Cam Cover to Ground Cable Bolt	10 N.m	89 lb in
Cam Cover to Ground Cable Stud	10 N.m	89 lb in
Camshaft		
• Camshaft Bearing Cap Bolt	10 N.m	89 lb in
• Camshaft Position Actuator Solenoid Valve Bolt	10 N.m	89 lb in
• Camshaft Position Sensor Bolt	10 N.m	89 lb in
• Exhaust Camshaft Position Actuator - First Pass	30 N.m	22 lb ft
• Exhaust Camshaft Position Actuator - Final Pass	100 degrees	
• Intake Camshaft Position Actuator - First Pass	30 N.m	22 lb ft
• Intake Camshaft Position Actuator - Final Pass	100 degrees	
• Intake Camshaft Rear Cap Bolt	10 N.m	89 lb in
Connecting Rod Bolt		
• First Pass	25 N.m	18 lb ft
• Final Pass	100 degrees	
Crankshaft Balancer Bolt		
• First Pass	150 N.m	111 lb ft
• Final Pass	100 degrees	
Crankshaft Position Reluctor Ring	15 N.m	11 lb ft
Crankshaft Position Sensor Bolt	10 N.m	89 lb in

Cylinder Head Bolt		
• First Pass	30 N.m	22 lb ft
• Final Pass	155 degrees	
Cylinder Head Front Chaincase Bolt	35 N.m	26 lb ft
Cylinder Head Oil Gallery Plug	35 N.m	26 lb ft
Drive Belt Tensioner Bolt (LAF, LEA)	45 N.m	33 lb ft
Drive Belt Tensioner Bolt (LUK) - OFF Vehicle		
• First Pass	50 N.m	37 lb ft
• Final Pass	90 degrees	
Drive Belt Tensioner Bolt (LUK) - ON Vehicle - Use J 45025 Belt Tensioner Wrench in combination with a 3/8 drive torque wrench	42 N.m	31 lb ft
Engine Block Oil Gallery Plug	60 N.m	44 lb ft
Engine Coolant Air Bleed Fitting	15 N.m	11 lb ft
Engine Coolant Temperature Sensor	20 N.m	15 lb ft
Engine Lift Bracket Bolt, Front	25 N.m	18 lb ft
Engine Lift Bracket Bolt, Rear	25 N.m	18 lb ft
Engine Lift Bracket Stud	25 N.m	18 lb ft
Engine Mount Bracket to Body Bolts	62 N.m	46 lb ft
Engine Mount Bracket to Engine Bolts	100 N.m	74 lb ft
Engine to Transmission Bolts	75 N.m	55 lb ft
EVAP Canister Valve Bolt	25 N.m	18 lb ft
Exhaust Manifold Heat Shield Bolt	9 N.m	80 lb in
Exhaust Manifold to Cylinder Head Nut - 2 passes	14 N.m	124 lb in
Exhaust Manifold to Cylinder Head Stud	15 N.m	11 lb ft
Flywheel Bolt - Automatic Transmission		
• First Pass	53 N.m	39 lb ft
• Final Pass	25 degrees	
Front Cover to Block Bolt	25 N.m	18 lb ft
Front Lift Bracket Bolt	25 N.m	18 lb ft
Fuel Feed Intermediate Pipe	30 N.m	22 lb ft
Fuel Pipe Bracket Bolt	10 N.m	89 lb in
Fuel Pump Cover Bolt	10 N.m	89 lb in
Fuel Pump Cover Nut	10 N.m	89 lb in
Fuel Rail Assembly Bolt	25 N.m	18 lb ft
Fuel Rail Harness Connector Bracket Bolt	10 N.m	89 lb in
Generator to Block Bolt	23 N.m	17 lb ft
Generator Wiring Harness Nut	20 N.m	15 lb ft
Ignition Coil Bolt	10 N.m	89 lb in
Intake Manifold Insulator Bolt	10 N.m	89 lb in

Intake Manifold to Cylinder Head Bolt	25 N.m	18 lb ft
Intake Manifold to Cylinder Head Nut	25 N.m	18 lb ft
Intake Manifold to Cylinder Head Stud	15 N.m	11 lb ft
Knock Sensor Bolt	25 N.m	18 lb ft
Lower Crankcase Bolts		
• Crankshaft Bearings - Lower Crankcase to Block - Bedplate		
• First Pass	20 N.m	15 lb ft
• Final Pass	70 Degrees	
• Lower Crankcase Perimeter Bolt	25 N.m	18 lb ft
Manifold Absolute Pressure (MAP) Sensor Bolt	4 N.m	35 lb in
Oil Filter Cap	25 N.m	18 lb ft
Oil Gallery Gerotor Cover - Rear Bolt	6 N.m	53 lb in
Oil Level Indicator Tube to Intake Manifold Bolt	10 N.m	89 lb in
Oil Pan Baffle	14 N.m	124 lb in
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pan to Block Bolts	25 N.m	18 lb ft
Oil Pressure Switch	26 N.m	19 lb ft
Oil Pump Cover Bolt	6 N.m	53 lb in
Oil Pump Pressure Relief Valve Plug	40 N.m	30 lb ft
Oxygen Sensor	42 N.m	31 lb ft
Piston Oil Nozzle Assembly	15 N.m	11 lb ft
Secondary Air Injection Assembly to Secondary Air Injection Pipe Assembly Bolt	10 N.m	89 lb in
Secondary Air Injection Pipe Assembly to Cylinder Head Bolt	10 N.m	89 lb in
Secondary Air Injection Assembly to Cylinder Head Bolt	22Y	16 lb ft
Secondary Air Injection Assembly Stud	10 N.m	89 lb in
Secondary Air Injection Assembly Nut	22Y	16 lb ft
Spark Plug	20 N.m	15 lb ft
Thermostat Housing to Block Bolts	10 N.m	89 lb in
Throttle Body Bolt	10 N.m	89 lb in
Throttle Body Nut	10 N.m	89 lb in
Throttle Body Stud	6 N.m	53 lb in
Timing Chain Guide Bolt, Adjustable	10 N.m	89 lb in
Timing Chain Guide Bolt, Fixed	12 N.m	106 lb in
Timing Chain Guide Bolt, Upper	10 N.m	89 lb in
Timing Chain Guide Bolt Access Hole Plug	75 N.m	55 lb ft
Timing Chain Oil Nozzle Bolt	10 N.m	89 lb in
Timing Chain Tensioner	75 N.m	55 lb ft
Transmission to Engine Brace Bolts	50 N.m	37 lb ft

Transmission Torque Converter to Flywheel Bolt	62 N.m	46 lb ft
Vent Tube to Cylinder Head	15 N.m	11 lb ft
Water Jacket Drain Plug	20 N.m	15 lb ft
Water Pipe Support Bracket Bolt	10 N.m	89 lb in
Water Pump Access Cover Bolt	10 N.m	89 lb in
Water Pump/Balance Shaft Chain Tensioner Bolt	10 N.m	89 lb in
Water Pump Bolts	25 N.m	18 lb ft
Water Pump Cover Stud	10 N.m	89 lb in
Water Pump Sprocket Bolt	10 N.m	89 lb in

ENGINE MECHANICAL SPECIFICATIONS (LEA, OR LUK)

Engine Mechanical Specifications (LEA, or LUK)

Application	Specification	
	Metric	English
General Data		
• Engine Type	Inline 4 Cylinder	
• Displacement	2.4 L	146 CID
• RPO	LAF LEA LUK	
• Liter (VIN)	Passenger Car: C Truck: W	
• Bore	87.992-88.008 mm	3.4642-3.4649 in
• Stroke	98 mm	3.861 in
• Compression Ratio	11.16:1	
• Spark Plug Gap	0.75-0.90 mm	0.030-0.035 in
Balance Shaft		
• Bearing Clearance	0.030-0.060 mm	0.0012-0.0024 in
• Bearing Diameter - Inside - Carrier	20.050-20.063 mm	0.7894-0.7899 in
• Bearing Diameter - Outside - Carrier	41.975-41.995 mm	1.6526-1.6534 in
• Bearing Journal Diameter	20.000-20.020 mm	0.7874-0.7882 in
• Bushing Clearance	0.033-0.102 mm	0.0013-0.0040 in
• Bushing Diameter - Inside	36.776-36.825 mm	1.4479-1.4498 in
• Bushing Journal Diameter	36.723-36.743 mm	1.4458-1.4466 in
• End Play	0.050-0.300 mm	0.0020-0.0118 in
Block		
• Balance Shaft Bearing Bore Diameter - Carrier	42.000-42.016 mm	1.6535-1.6542 in

• Balance Shaft Bushing Bore Diameter	40.763-40.776 mm	1.6048-1.6054 in
• Crankshaft Main Bearing Bore Diameter	64.068-64.082 mm	2.5224-2.5229 in
• Cylinder Bore Diameter	87.992-88.008 mm	3.4642-3.4649 in
• Cylinder Bore Out-of-Round - Maximum	0.010 mm	0.0004 in
• Cylinder Bore Taper - Maximum	0.010 mm	0.0004 in
• Cylinder Head Deck Surface Flatness - Longitude	0.050 mm	0.002 in
• Cylinder Head Deck Surface Flatness - Overall	0.08 mm	0.0031 in
• Cylinder Head Deck Surface Flatness - Transverse	0.030 mm	0.0012 in
Camshaft		
• Camshaft End Play	0.040-0.144 mm	0.0016-0.0057 in
• Camshaft Journal Diameter	26.935-26.960 mm	1.0604-1.0614 in
• Camshaft Thrust Surface	21.000-21.052 mm	0.8268-0.8252 in
Connecting Rod		
• Connecting Rod Bearing Clearance	0.029-0.073 mm	0.0011-0.0029 in
• Connecting Rod Bore Diameter - Bearing End	52.118-52.134 mm	2.0519-2.05252 in
• Connecting Rod Bore Diameter - Pin End	20.007-20.017 mm	0.7877-0.7881 in
• Connecting Rod Side Clearance	0.070-0.370 mm	0.0028-0.0146 in
• Connecting Rod Straightness - Bend - Maximum	0.021 mm	0.0083 in
• Connecting Rod Straightness - Twist - Maximum	0.04 mm	0.0157 in
Crankshaft		
• Connecting Rod Journal Diameter	48.999-49.015 mm	1.9291-1.9297 in
• Crankshaft End Play	0.050-0.380 mm	0.0012-0.0150 in
• Crankshaft Main Bearing Clearance	0.031-0.067 mm	0.0012-0.0026 in
• Crankshaft Main Journal Diameter	55.993-56.009 mm	2.2044-2.2051 in
Cylinder Head		
• Overall Height - Minimum	128.9 mm	5.07 in
• Surface Flatness - Block Deck - Longitude	0.050 mm	0.002 in
• Surface Flatness - Block Deck - Overall	0.1 mm	0.004 in
• Surface Flatness - Block Deck - Transverse	0.030 mm	0.0012 in
• Valve Guide Bore - Exhaust	6.000-6.012 mm	0.2362-0.2367 in
• Valve Guide Bore - Intake	6.000-6.012 mm	0.2362-0.2367 in
• Valve Lifter Bore Diameter - Stationary Lash Adjusters	12.013-12.037 mm	0.4730-0.4739 in
• Valve Seat Angle - Relief Surface	30 Degrees	

• Valve Seat Angle - Seating Surface	45 Degrees	
• Valve Seat Angle - Undercut Surface	60 Degrees	
• Valve Seat Roundness - Maximum	0.025 mm	0.0010 in
• Valve Seat Runout - Maximum	0.080 mm	0.0031 in
• Valve Seat Width - Exhaust Seating Surface	1.600 mm	0.0630 in
• Valve Seat Width - Intake Seating Surface	1.200 mm	0.0472 in
Lubrication System		
• Oil Pressure - Minimum - @1000 RPM @ 90°C (194°F)	206.84-482.63 kPa	30-70 psi
• Oil Capacity	4.7L	5.0 quarts
Piston Rings		
• Piston Ring End Gap - First Compression Ring	0.15-0.25 mm	0.006-0.010 in
• Piston Ring End Gap - Second Compression Ring	0.20-0.45 mm	0.008-0.018 in
• Piston Ring End Gap - Oil Control Ring - Rails	0.15-0.65 mm	0.006-0.026 in
• Piston Ring to Groove Clearance - First Compression Ring	0.04-0.08 mm	0.0015-0.0031 in
• Piston Ring to Groove Clearance - Second Compression Ring	0.030-0.070 mm	0.0012-0.0030 in
• Piston Ring to Groove Clearance - Oil Control Ring	0.058-0.207 mm	0.0023-0.0081 in
• Piston Ring Thickness - First Compression Ring	1.170-1.190 mm	0.0461-0.0469 in
• Piston Ring Thickness - Second Compression Ring	1.471-1.490 mm	0.0579-0.0587 in
• Piston Ring Thickness - Oil Control Ring - Rail - Maximum	0.473 mm	0.0186 in
• Piston Ring Thickness - Oil Control Ring - Spacer - Rail	0.929-1.006 mm	0.0366-0.0396 in
Pistons and Pins		
• Pin - Piston Pin Clearance to Connecting Rod Bore	0.007-0.020 mm	0.0003-0.0008 in
• Pin - Piston Pin Clearance to Piston Pin Bore	0.004-0.012 mm	0.0002-0.0005 in
• Pin - Piston Pin Diameter	19.997-20.000 mm	0.7873-0.7874 in
• Pin - Piston Pin End Play	0.410-1.266 mm	0.0161-0.0498 in
• Piston - Piston Diameter - @14.5 mm up	87.967-87.982 mm	3.4633-3.4638 in
• Piston - Piston Pin Bore Diameter	20.004-20.009 mm	0.7876-0.7878 in
• Piston - Piston Ring Groove Width - Oil Control	2.01-2.03 mm	0.0791-0.0799 in
• Piston - Piston Ring Groove Width - Second	1.52-1.54 mm	0.0598-0.0606 in
• Piston - Piston Ring Groove Width - Top	1.23-1.25 mm	0.0484-0.0492 in

• Piston - Piston to Bore Clearance	0.010-0.041 mm	0.0004-0.0016 in
Valve System		
• Valves - Valve Face Angle	45 Degrees	
• Valves - Valve Face Runout - Maximum	0.040 mm	0.0016 in
• Valves - Valve Seat Runout - Maximum	0.080 mm	0.0031 in
• Valves - Valve Face Seat Width - Exhaust	1.6000 mm	0.06299 in
• Valves - Valve Face Seat Width - Intake	1.2000 mm	0.04724 in
• Valves - Valve Head Diameter - Exhaust	29.950-30.250 mm	1.1791-1.1909 in
• Valves - Valve Head Diameter - Intake	34.950-35.250 mm	1.3760-1.4154 in
• Valves - Valve Head O.D. and Chamfer Height - Exhaust	1.1174 mm	0.04399 in
• Valves - Valve Head O.D. and Chamfer Height - Intake	1.0526 mm	0.04144 in
• Valves - Valve Stem Diameter - Exhaust	5.935-5.950 mm	0.2337-0.2343 in
• Valves - Valve Stem Diameter - Intake	5.955-5.970 mm	0.2344-0.2355 in
• Valves - Valve Stem Height - Closed	32.500 mm	1.2795 in
• Valves - Valve Stem to Guide Clearance - Exhaust	0.050-0.077 mm	0.0020-0.0026 in
• Valves - Valve Stem to Guide Clearance - Intake	0.030-0.057 mm	0.0012-0.0022 in
• Valve Lash Adjusters - Valve Lash Adjuster Diameter - Stationary Lash Adjuster	11.986-12.000 mm	0.0005-0.0020 in
• Valve Lash Adjusters - Valve Lash-Adjuster-to-Bore Clearance - Stationary Lash Adjuster	0.013-0.051 mm	3.2210-3.2299 in
• Valve Rocker Arms - Rocker Arm Ratio	1.68 to 1	
• Valve Rocker Arms - Rocker Arm Roller Diameter	17.740-17.800 mm	0.6987-0.7008 in
• Valve Springs - Valve Spring Free Length	41.400-44.200 mm	1.6299-1.7402 in
• Valve Springs - Valve Spring Installed Height - Closed	32.500 mm	1.2795 in
• Valve Springs - Valve Spring Installed Height - Open	22.500 mm	0.8858 in
• Valve Springs - Valve Spring Load - Closed - @32.5 mm	245.0-271.0 N	55-61 lb
• Valve Springs - Valve Spring Load - Open - @22.5 mm	525.0-575.0 N	118-129 lb

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

		GM Part Number
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Application	Type of Material	United States	Canada
# 6 Intake Rear Camshaft Cap	Sealant	12378521	88901148
Balance Shaft Bearings	5W-30	19293000	19286321
Cam Lobes	5W-30	19293000	19286321
Crank Sensor O-ring	5W-30	19293000	19286321
Cylinder Bores	5W-30	19293000	19286321
Cylinder Head Plugs	Threadlocker	12345382	10953489
Engine Block Threaded Plugs	Sealant	12346004	10953480
Engine Block to Bedplate	Sealant	12378521	88901148
Engine Oil	5W-30	19293000	19386321
Fuel Injector O-rings	5W-30	19293000	19386321
Fuel Injector Tip Insulators, for Multiple Port Injection Only	5W-30	19293000	19386321
Hydraulic Lash Adjusters	Lubricant	88862586	88862827
Ignition Coils	Lubricant	19260901	19260902
Intake and Exhaust Valve Stems	Lubricant	88862586	88862827
Main Bearings	Lubricant	88862586	88862827
Oil Filter Cap- Threads and O-ring Lead-in Chamfers	5W-30	19293000	19286321
Oil Level Indicator Tube O-ring	Lubricant	88862586	88862827
Oil Pan to Bedplate Joint	Sealant	12378521	88901148
Oil Pump- Pump Elements	5W-30	19293000	19286321
Oxygen Sensor Threads	Anti-seize	88862477	88862478
Piston Pin to Piston/Rod- Pin Bores of Piston and Rod	5W-30	19293000	19286321
Rod Bearings- Rod Pins of Crankshaft	5W-30	19293000	19286321
Thread Repair Cutting Oil	Lubricant	1052864	992881
Thread Repair	Cleaner	88862650	88901247
Timing Chain Guide Bolt Access Hole Plug	Threadlocker	12345382	10953489
Valves	Parts Immersion Solvent	12345368	10953514
Valve Rocker Arm/Valve Tip	Lubricant	12345501	992704
Water Feed Tube O-rings	Lubricant	19260901	19260902
Water Pump Drain Plug	Sealant	12346004	10953480

THREAD REPAIR SPECIFICATIONS (LEA, OR LUK)

Engine Block- Front View

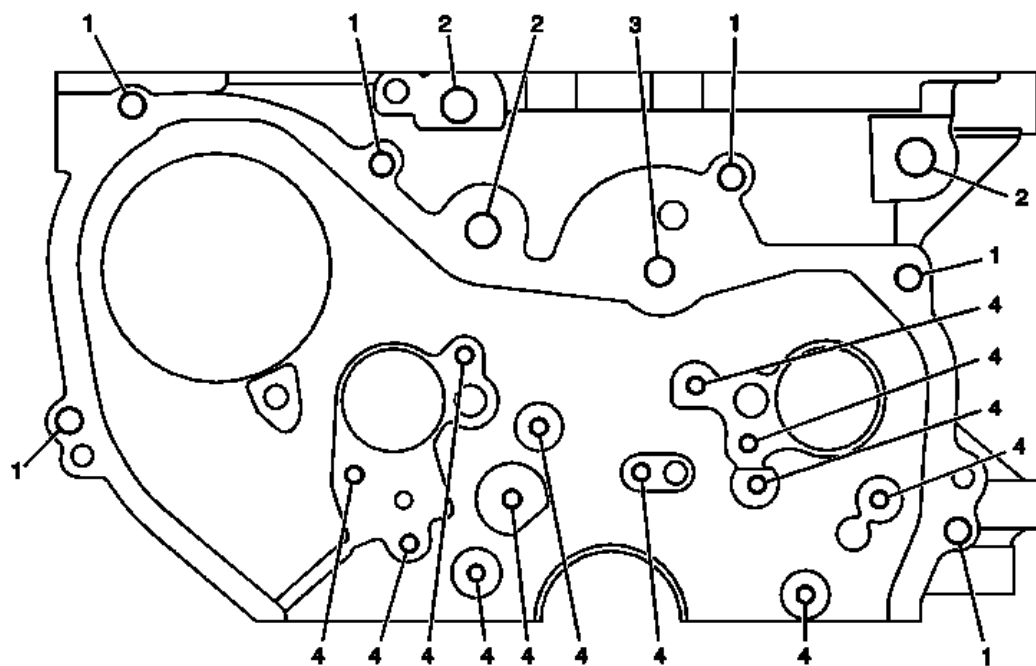


Fig. 1: Identifying Bolt Size & Locations On Engine Block - Front View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block- Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M8 x 1.25	210	206	207	208	209	23.5	0.93	18.5	0.73
2	M12 x 1.75	855	856	857	858	859	33.5	1.32	26.5	1.04
3	M10 x 1.5	215	211	212	213	214	24.5	0.96	19.5	0.77
4	M6 x 1	205	201	202	203	204	20	0.787	16	0.63

Engine Block- Back View

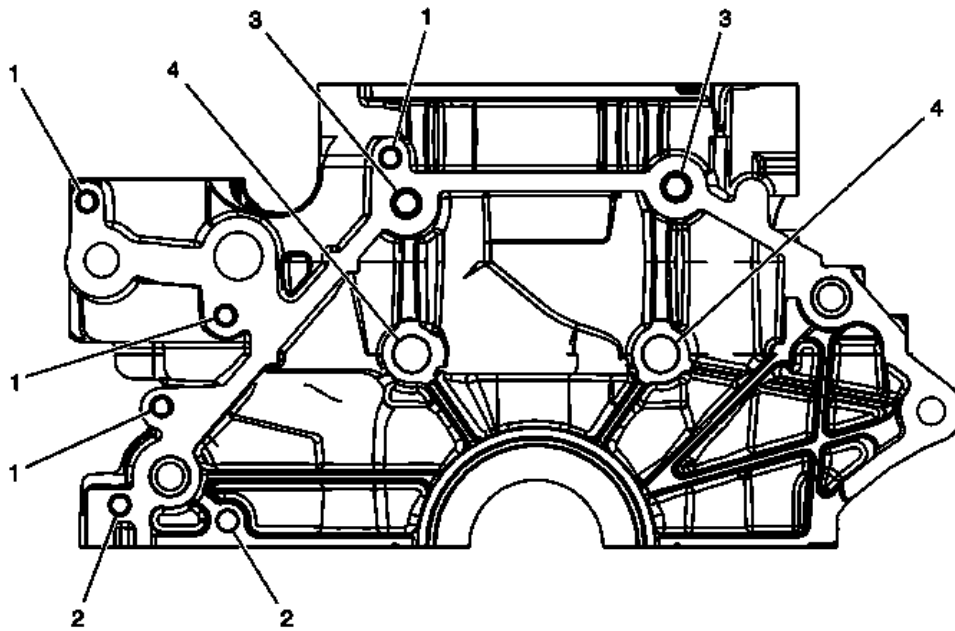


Fig. 2: Identifying Bolt Size & Locations On Engine Block - Back View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block- Back View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M8 x 1.25	210	206	207	208	209	18	0.709	THRU	
2	M10 x 1.5	215	211	212	213	214	29	1.161	THRU	
3	M12 x 1.75	855	856	857	858	859	39	1.535	33.5	1.32
4	M16 x 1.5	860	861	862	863	864	21	0.827	15	0.59

Engine Block- Right Side View

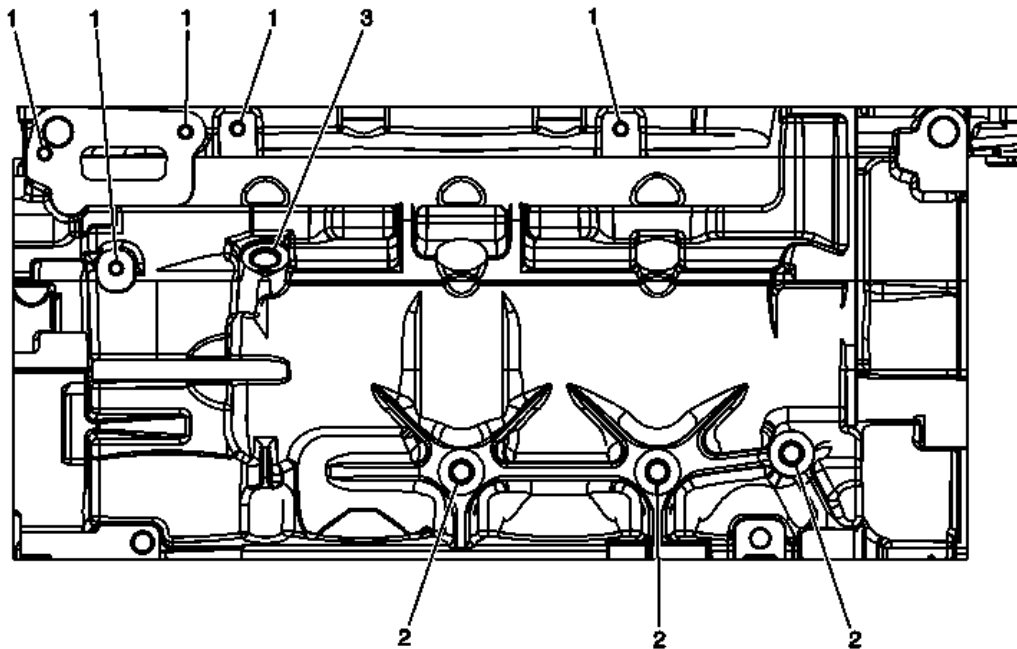


Fig. 3: Locating Bolts On Engine Block - Right Side View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block- Right Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M6 x 1	205	201	202	203	204	20.5	0.807	16	0.63
2	M10 x 1.5	215	211	212	213	214	23.5	0.925	18.5	0.73
3	M12 x 1.75	865	856	857	858	859	19.5	0.768	12.5	0.49

Engine Block- Left Side View

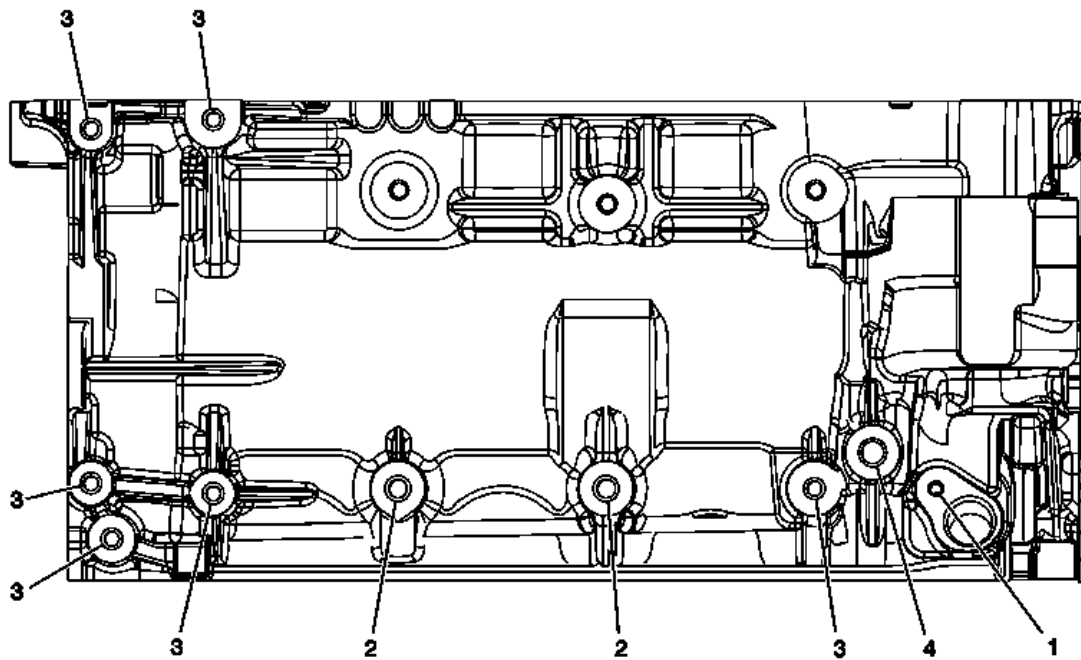


Fig. 4: Locating Bolts On Engine Block - Left Side View
 Courtesy of GENERAL MOTORS COMPANY

Engine Block- Left Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M6 x 1	205	201	202	203	204	20.5	0.807	16.5	0.65
2	M10 x 1.5	215	211	212	213	214	23.5	0.925	18	0.71
3	M8 x 1.25	210	206	2047	208	209	30.5	1.201	22.5	0.89
4	M12 x 1.75	865	856	857	858	859	15.5	.061	12.5	0.49

Engine Block- Bottom View

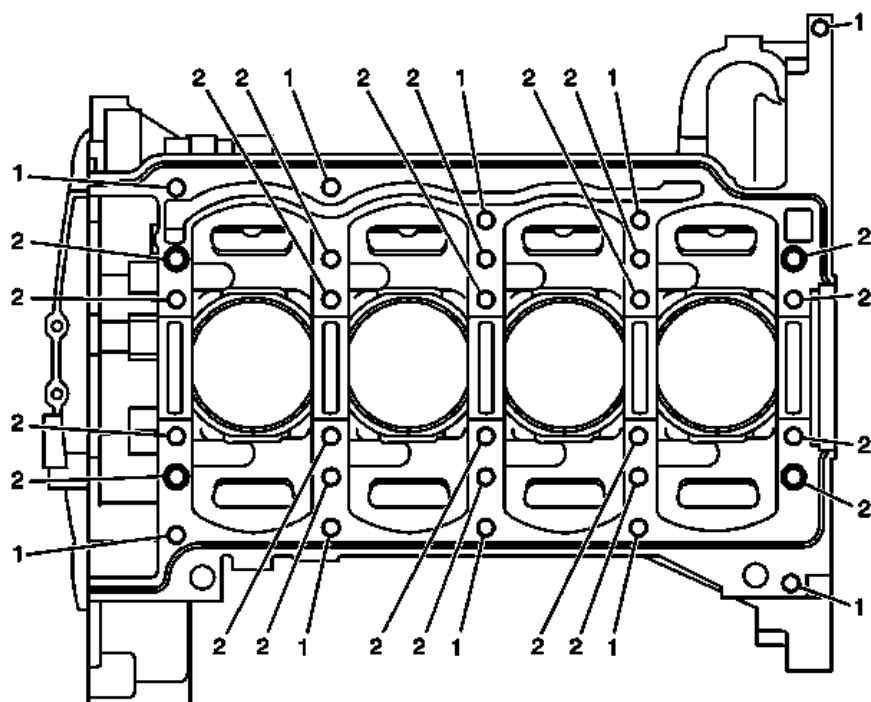


Fig. 5: Identifying Bolt Size & Locations On Engine Block - Bottom
 Courtesy of GENERAL MOTORS COMPANY

Engine Block- Bottom View

Engine Block Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M8 x 1.25	210	206	207	208	209	28	1.102	22	0.87
2	M10 x 1.5	514	511	N/A	512	513	60	2.362	53.5	2.11

Engine Block- Top View

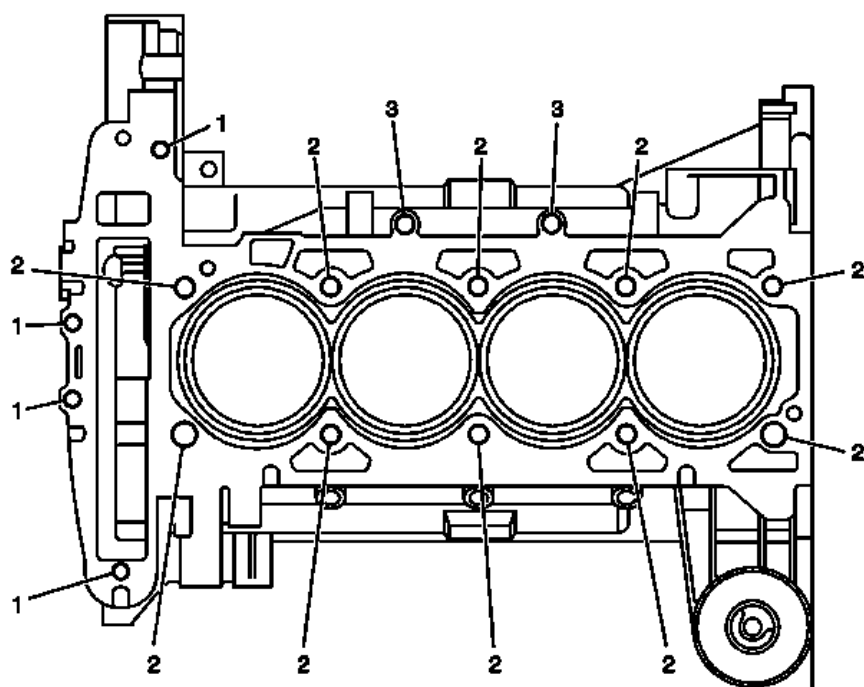


Fig. 6: Identifying Bolt Size & Locations On Engine Block - Top
 Courtesy of GENERAL MOTORS COMPANY

Engine Block- Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M8 x 1.25	210	206	207	208	209	23.5	0.925	18.5	0.73
2	M11 x 1.5	507	504	N/A	505	506	113.3	4.461	107.3	4.22
3	M12 x 1.75	865	856	857	858	859	13.5	0.531	12.5	0.49

Lower Crankcase- Front View

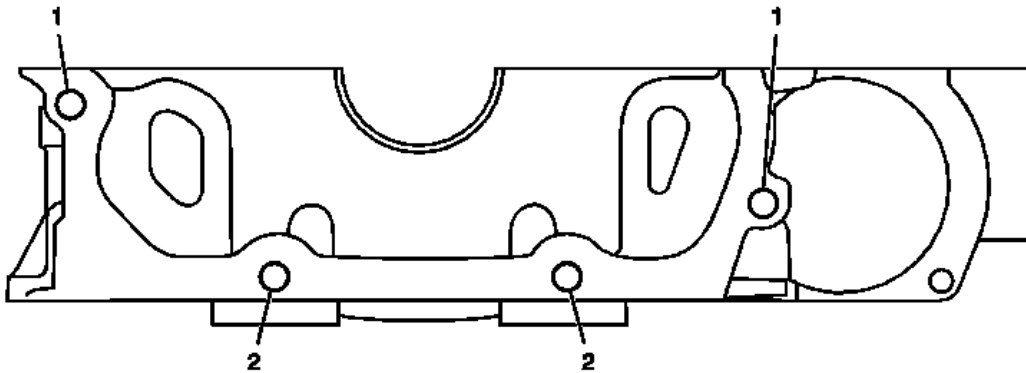


Fig. 7: Identifying Bolt Size & Locations On Engine Block - Top
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase- Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M8 x 1.25	210	206	207	208	209	23.5	0.925	18.5	0.73
2	M8 x 1.25	210	206	207	208	209	30.5	1.201	25.5	1.00

Lower Crankcase- Back View

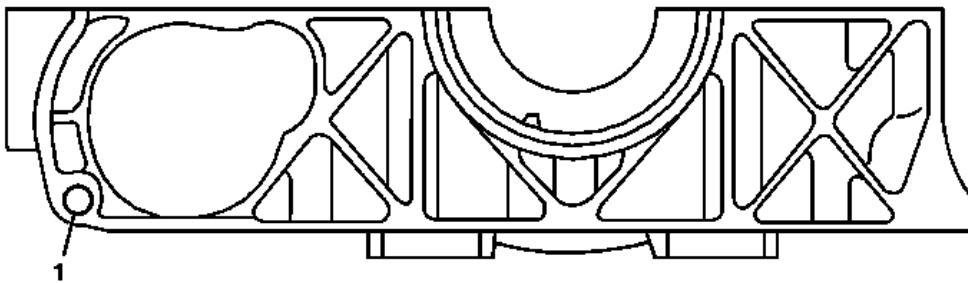


Fig. 8: Identifying Bolt Size & Locations On Lower Crankcase - Back
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase- Back View

[illegible]

1	M10 x 1.5	215	211	212	213	214	29.5	1.161	THRU
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Lower Crankcase- Bottom View

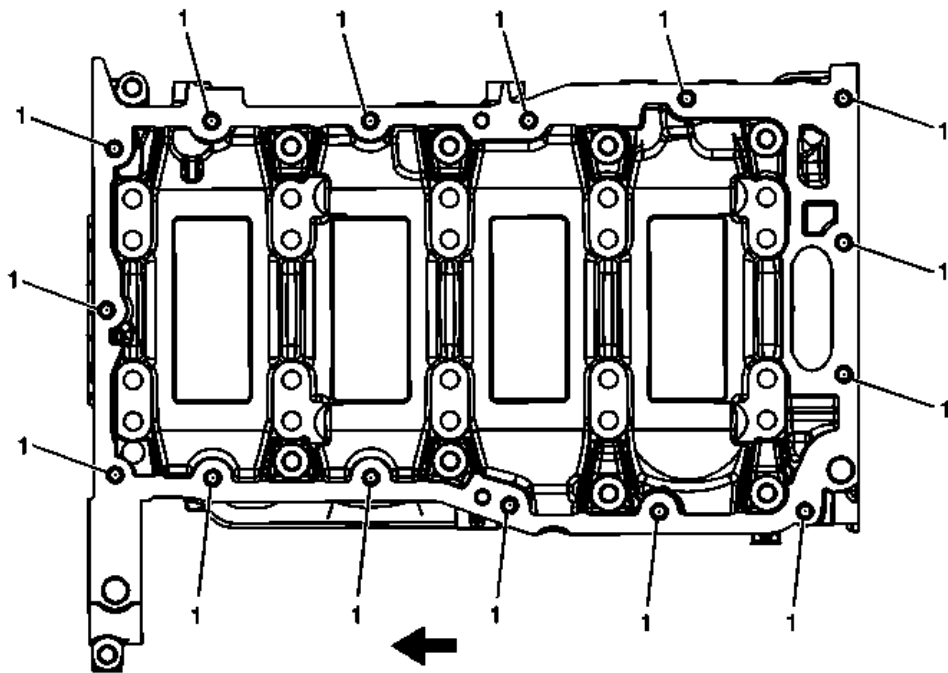


Fig. 9: Locating Bolts On Lower Crankcase - Bottom View
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase- Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M8 x 1.25	210	206	207	208	209	23.5	0.925	18.5	0.73

Lower Crankcase- Right View

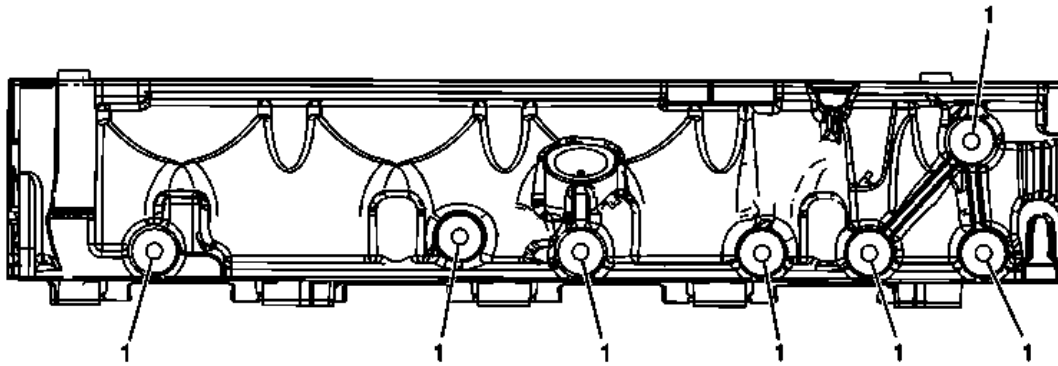


Fig. 10: Identifying Bolt Size & Locations On Lower Crankcase - Right
 Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase- Right View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M10 x 1.5	215	211	212	213	214	34	1.339	27	1.063

Lower Crankcase- Left View

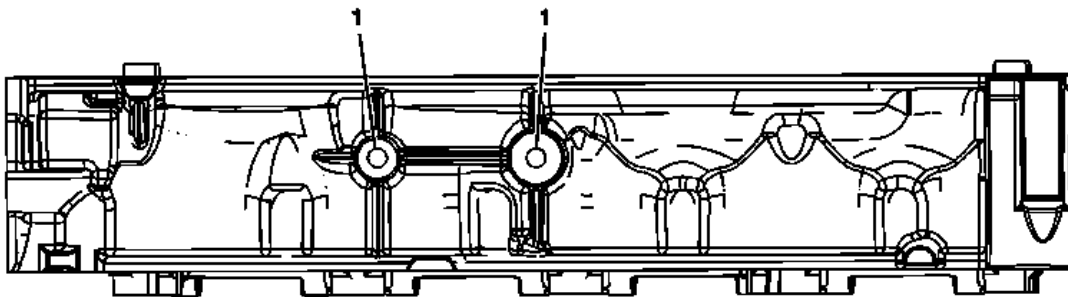


Fig. 11: Identifying Bolt Size & Locations On Lower Crankcase - Left
 Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase- Left View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M8 x 1.25	210	211	212	213	214	34	1.339	27	1.063

Cylinder Head- Top View

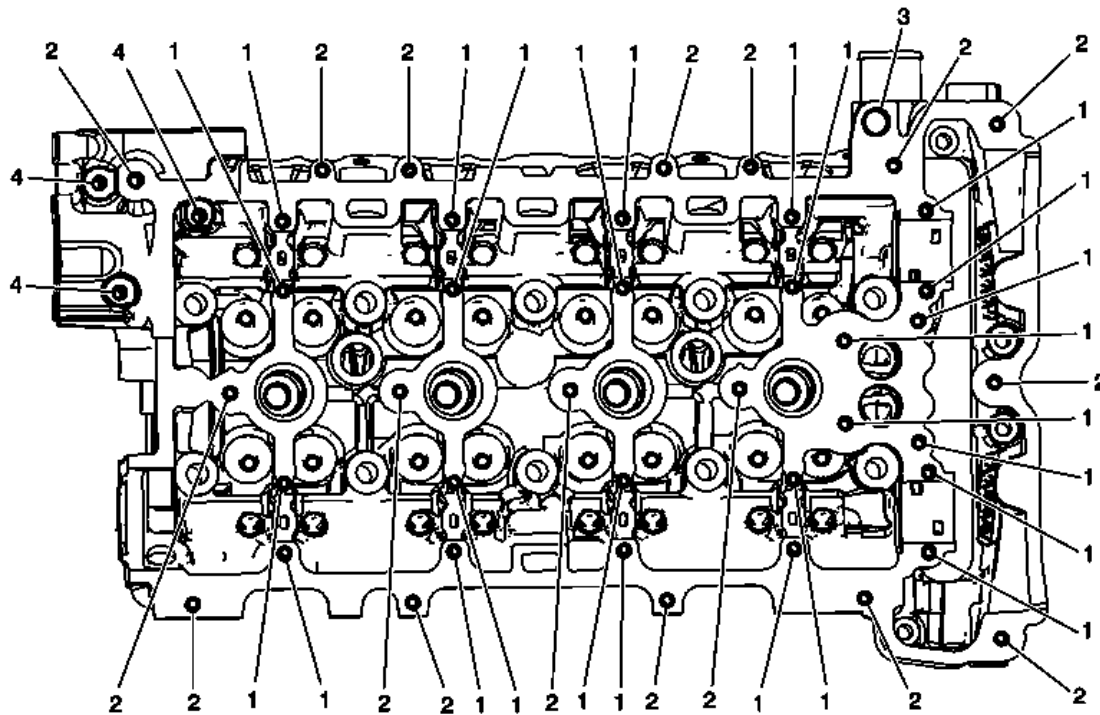


Fig. 12: Locating Bolts On Cylinder Head - Top View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head- Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M6 x 1	205	852	N/A	203	204	24	0.945	20	0.787
2	M6 x 1	205	201	202	203	204	20	0.787	16	0.63
3	M14 x 1.75	854	857	N/A	858	859	THRU		THRU	
4	M8 x 1.25	854	853	N/A	208	209	30	1.182	27	1.063

Cylinder Head- Intake Manifold Deck View

EN 42385-850							MM	(IN)	MM	(IN)
1	M6 x 1	205	201	202	203	204	20	0.78	16	0.63
2	M8 x 1.25	210	206	207	208	209	25	0.984	20	0.78

Cylinder Head- Front View

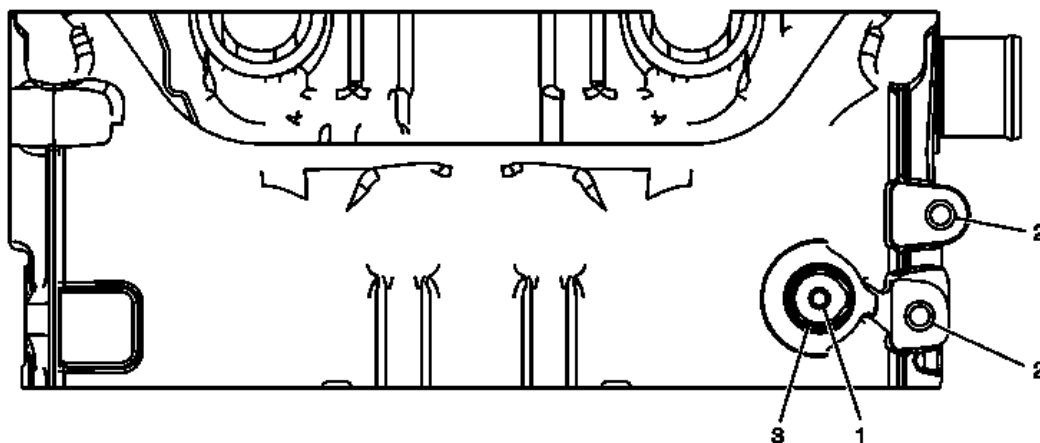


Fig. 15: Locating Bolts On Cylinder Head - Front View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head- Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-850							MM	(IN)	MM	(IN)
1	M6 x 1	205	201	202	203	204	20	0.787	16	0.63
2	M8 x 1.25	210	206	207	208	209	25	0.984	20	0.787
3	M22 x 1.5	No Service Tools Available					THRU		THRU	

Cylinder Head- Back View

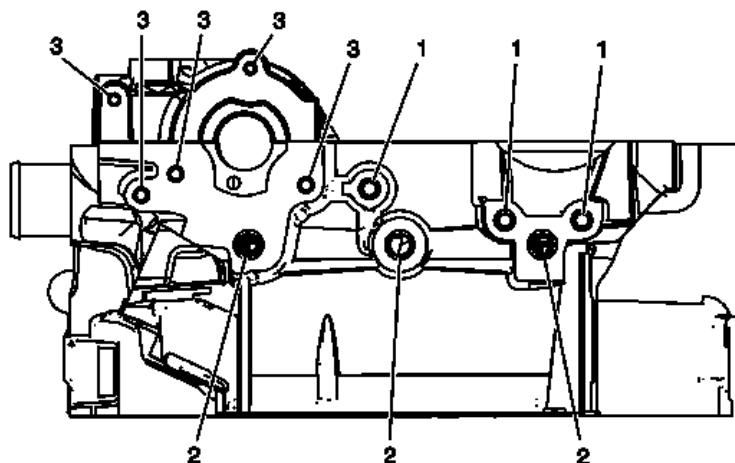


Fig. 16: Locating Bolts On Cylinder Head - Back View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head- Back View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth Maximum		Tap Depth Maximum	
EN 42385-850							MM	IN	MM	IN
1	M8 x 1.25	210	206	207	208	209	25	0.984	20	0.787
2	M12 x 1.75	865	856	857	858	859	18	0.709	14	0.551
3	M6 x 1	205	201	202	203	204	20	0.787	16	0.63

GENERAL INFORMATION

Engine Overhaul Procedures

*** PLEASE READ THIS FIRST ***

NOTE: Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the **ENGINES** section for complete overhaul procedures and specifications for the vehicle being repaired.

DESCRIPTION

Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of cleaning, inspection, and assembly processes are included.

ENGINE IDENTIFICATION

Engine may be identified from Vehicle Identification Number (VIN) stamped on a metal tab. Metal tab may be located in different locations depending on manufacturer. Engine identification number or serial number is located on cylinder block. Location varies with each manufacturer.

INSPECTION PROCEDURES

*** PLEASE READ THIS FIRST ***

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Engine components must be inspected to meet manufacturer's specifications and tolerances during overhaul. Proper dimensions and tolerances must be met to obtain proper performance and maximum engine life.

Micrometers, depth gauges and dial indicator are used for checking tolerances during engine overhaul. Magnaflux, Magnaglo, dye-check, ultrasonic and x-ray inspection procedures are used for parts inspection.

MAGNETIC PARTICLE INSPECTION

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Magnaflux & Magnaglo

Magnaflux is an inspection technique used to locate material flaws and stress cracks. Component is subjected to a strong magnetic field. Entire component or a localized area can be magnetized. Component is coated with either a wet or dry material that contains fine magnetic particles.

Cracks which are outlined by the particles cause an interruption of magnetic field. Dry powder method of Magnaflux can be used in normal lighting and crack appears as a bright line.

Fluorescent liquid is used along with a Black light in the Magnaglo Magnaflux system. Darkened room is required for this procedure. The crack will appear as a glowing line. Complete demagnetizing of component upon completion is required on both procedures. Magnetic particle inspection applies to ferrous materials only.

PENETRANT INSPECTION

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Zyglo

The Zyglo process coats material with a fluorescent dye penetrant. Component is often warmed to expand cracks that will be penetrated by the dye. Using darkened room and Black light, component is inspected for cracks. Crack will glow brightly.

Developing solution is often used to enhance results. Parts made of any material, such as aluminum cylinder heads or plastics, may be tested using this process.

Dye Check

Penetrating dye is sprayed on the previously cleaned component. Dye is left on component for 5-45 minutes, depending upon material density. Component is then wiped clean and sprayed with a developing solution. Surface cracks will show up as a bright line.

ULTRASONIC INSPECTION

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If an expensive part is suspected of internal cracking, ultrasonic testing is used. Sound waves are used for component inspection.

X-RAY INSPECTION

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This form of inspection is used on highly stressed components. X-ray inspection may be used to detect internal and external flaws in any material.

PRESSURE TESTING

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to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

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Cylinder heads can be tested for cracks using a pressure tester. Pressure testing is performed by plugging all but one of the holes of cylinder head and injecting air or water into the open passage.

Leaks are indicated by the appearance of wet or damp areas when using water. When air is used, it is necessary to spray the head surface with a soap solution. Bubbles will indicate a leak. Cylinder head may also be submerged in water heated to specified temperature to check for cracks created during heat expansion.

CLEANING PROCEDURES

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GENERAL

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

All components of an engine do not have the same cleaning requirements. Physical methods include bead blasting and manual removal. Chemical methods include solvent blast, solvent tank, hot tank, cold tank and steam cleaning of components.

BEAD BLASTING

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to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

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Manual removal of deposits may be required prior to bead blasting, followed by some other cleaning method. Carbon, paint and rust may be removed using bead blasting method. Components must be free of oil and grease prior to bead blasting. Beads will stick to grease or oil soaked areas causing area not to be cleaned.

Use air pressure to remove all trapped residual beads from component after cleaning. After cleaning internal engine parts made of aluminum, wash thoroughly with hot soapy water. Component must be thoroughly cleaned as glass beads will enter engine oil resulting in bearing damage.

CHEMICAL CLEANING

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Solvent tank is used for cleaning oily residue from components. Solvent blasting sprays solvent through a siphon gun using compressed air.

The hot tank, using heated caustic solvents, is used for cleaning ferrous materials only. DO NOT clean aluminum parts such as cylinder heads, bearings or other soft metals using the hot tank. After cleaning, flush parts with hot water.

A non-ferrous part will be ruined and caustic solution will be diluted if placed in the hot tank. Always use eye protection and gloves when using the hot tank.

Use of a cold tank is for cleaning aluminum cylinder heads, carburetors and other soft metals. A less caustic and unheated solution is used. Parts may be left in the tank for several hours without damage. After cleaning, flush parts with hot water.

Steam cleaning, with boiling hot water sprayed at high pressure, is recommended as the final cleaning process when using either hot or cold tank cleaning.

COMPONENT CLEANING

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SHEET METAL PARTS

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Examples of sheet metal parts are rocker covers, front and side covers, oil pan and bellhousing dust cover. Glass bead blasting or hot tank may be used for cleaning.

Ensure all mating surfaces are flat. Deformed surfaces should be straightened. Check all sheet metal parts for cracks and dents.

INTAKE & EXHAUST MANIFOLDS

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Using solvent cleaning or bead blasting, clean manifolds for inspection. If intake manifold has an exhaust crossover, all carbon deposits must be removed. Inspect manifolds for cracks, burned or eroded areas, corrosion and damage to fasteners.

Exhaust heat and products of combustion cause threads of fasteners to corrode. Replace studs and bolts as necessary. On "V" type intake manifolds, sheet metal oil shield must be removed for proper cleaning and inspection. Ensure all manifold parting surfaces are flat and free of burrs.

CYLINDER HEAD REPLACEMENT

*** PLEASE READ THIS FIRST ***

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REMOVAL

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Remove intake and exhaust manifolds and valve cover. Cylinder head and camshaft carrier bolts (if equipped) should be removed only when engine is cold. On many aluminum cylinder heads, removal while hot will cause cylinder head warpage. Mark rocker arm or overhead cam components for location.

Remove rocker arm components or overhead cam components. Components must be installed in original location. Individual design rocker arms may utilize shafts, ball-type pedestal mounts or no rocker arms. For all design types, wire components together and identify according to corresponding valve. Remove cylinder head bolts. Note length and location. Some applications require cylinder head bolts be removed in proper sequence to prevent cylinder head damage. See **Fig. 1**. Remove cylinder head.

INSTALLATION

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Ensure all surfaces and head bolts are clean. Check that head bolt holes of cylinder block are clean and dry to prevent block damage when bolts are tightened. Clean threads with tap to ensure accurate bolt torque.

Install head gasket on cylinder block. Some manufacturers may recommend sealant be applied to head gasket prior to installation. Note that all holes are aligned. Some gasket applications may be marked so that certain area faces upward. Install cylinder head using care not to damage head gasket. Ensure cylinder head is fully seated on cylinder block.

Some applications require head bolts be coated with sealant prior to installation. This is done if head bolts are exposed to coolant passages. Some applications require head bolts be coated with light coat of engine oil.

Install head bolts. Head bolts should be tightened in proper steps and sequence to specification. See **Fig. 1**. Install remaining components. Tighten all bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT.

NOTE: Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

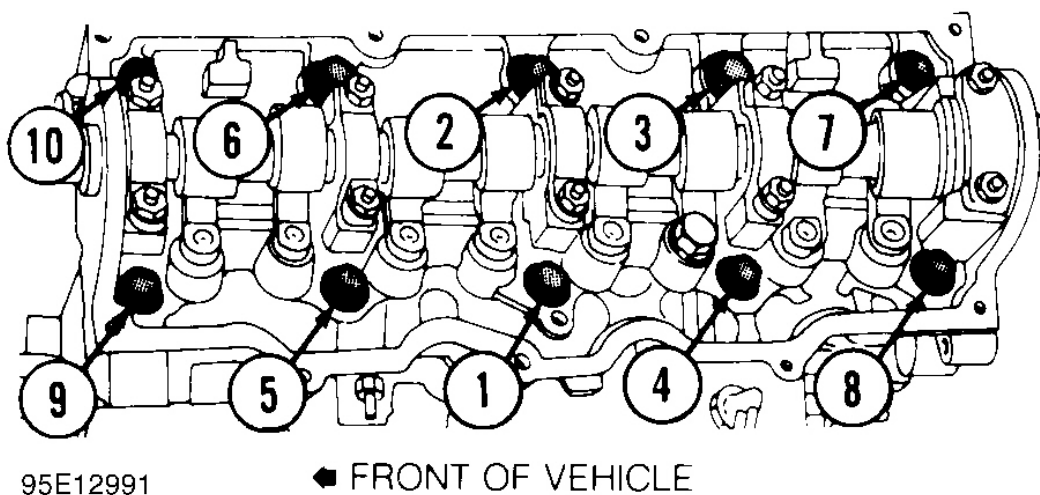


Fig. 1: Typical Cylinder Head Tightening or Loosening Sequence

VALVE ADJUSTMENT

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Engine specifications will indicate valve train clearance and temperature at which adjustment is to be made on most models. In most cases, adjustment will be made with a cold engine. In some cases, both a cold and a hot clearance will be given for maintenance convenience.

On some models, adjustment is not required. Rocker arms are tightened to specification and valve lash is automatically set. On some models with push rod actuated valve train, adjustment is made at push rod end of rocker arm while other models do not require adjustment.

Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

Some models require hydraulic lifter to be bled down and clearance measured. Push rods of different length can be used to obtain proper clearance. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge.

Overhead cam engines designed without rocker arms actuate valves directly on a cam follower. A hardened, removable disc is installed between the cam lobe and lifter. Clearance will be checked between cam heel and adjusting disc in proper sequence using a feeler gauge. Engine will be rotated to obtain all valve adjustments.

On overhead cam engines designed with rocker arms, adjustment is made at valve end of rocker arm. Ensure valve to be adjusted is riding on heel of cam on all engines. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

CYLINDER HEAD OVERHAUL

*** PLEASE READ THIS FIRST ***

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

CYLINDER HEAD DISASSEMBLY

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section for complete overhaul procedures and specifications for the vehicle being repaired.

Mark valves for location. Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator, valve spring, spring seat and valve. See **Fig. 2**.

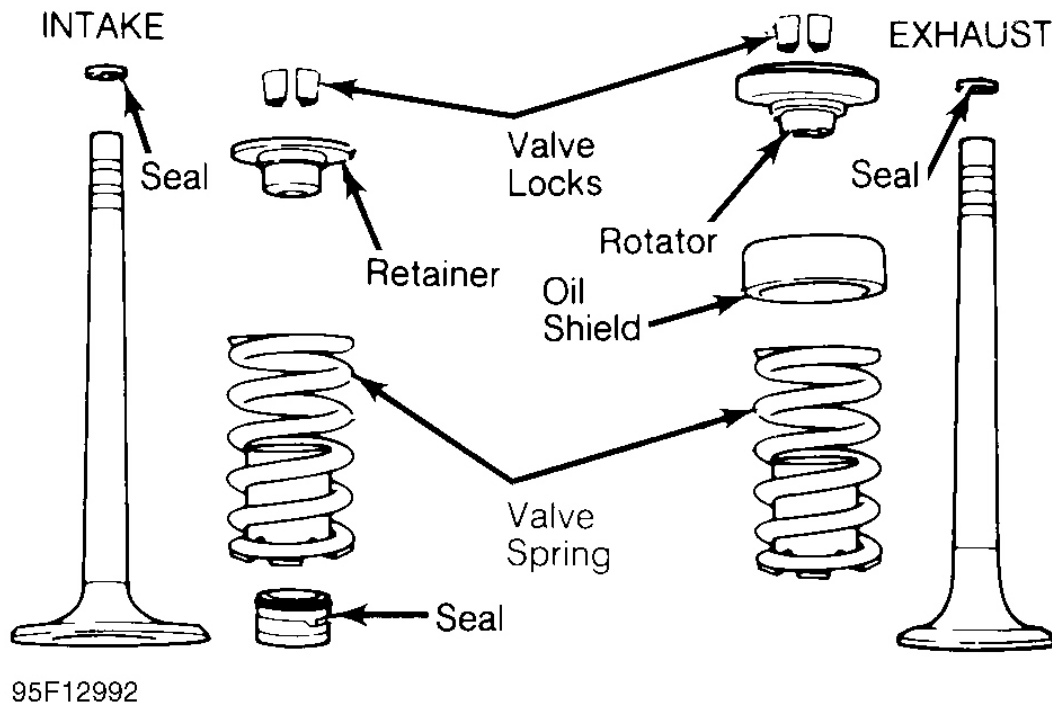


Fig. 2: Exploded View of Valve Assemblies

CYLINDER HEAD CLEANING & INSPECTION

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Clean cylinder head and valve components using approved cleaning methods. Inspect cylinder head for cracks, damage or warped gasket surface. Place straightedge across gasket surface. Determine clearance at center of straightedge. Measure across both diagonals, longitudinal center line and across cylinder head at several points. See **Fig. 3**.

On cast iron cylinder heads, if warpage exceeds .003" (.08 mm) in a 6" span, or .006" (.15 mm) over total length, cylinder head must be resurfaced. On most aluminum cylinder heads, if warpage exceeds .002" (.05 mm) in any area, cylinder head must be resurfaced. Warpage specification may vary by manufacturer. If warpage exceeds specification on some cylinder heads, cylinder head must be replaced.

Cylinder head thickness should be measured to determine amount of material which can be removed before replacement is required. Cylinder head thickness must not be less than the manufacturer's specification.

If cylinder head required resurfacing, it may not align properly with intake manifold. On "V" type engines, misalignment is corrected by machining intake manifold surface that contacts cylinder head. Cylinder head may be machined on surface that contacts intake manifold. Using oil stone, remove burrs or scratches from all sealing surfaces.

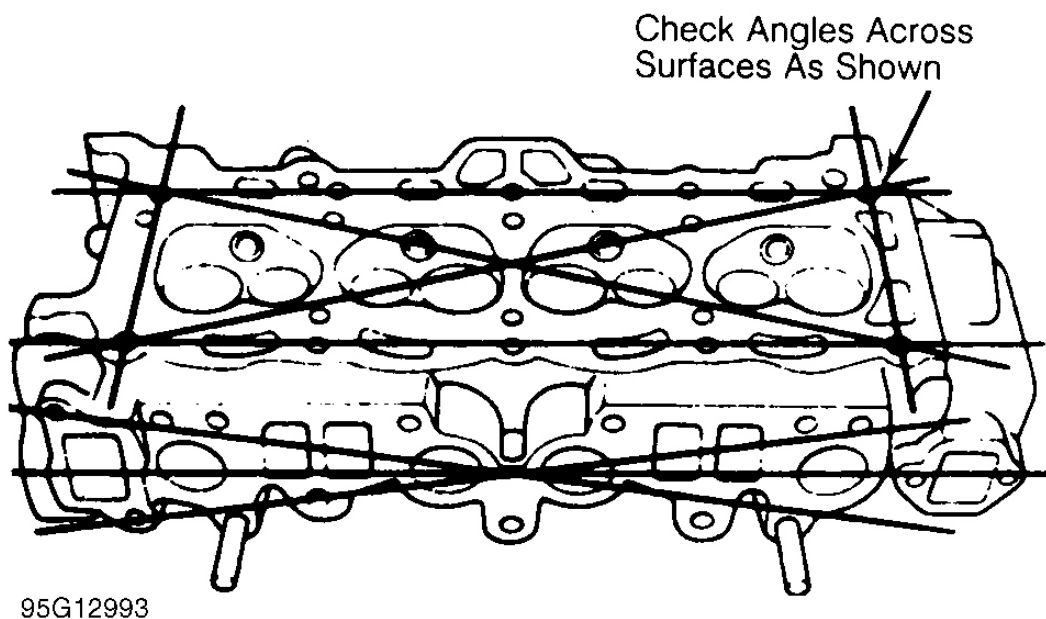


Fig. 3: Checking Cylinder Head for Warpage

VALVE SPRINGS

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Inspect valve springs for corroded or pitted valve spring surfaces which may lead to breakage. Polished spring ends caused by a rotating spring indicate that spring surge has occurred. Replace springs showing evidence of these conditions.

Inspect valve springs for squareness using a 90-degree straightedge. See **Fig. 4**. Replace valve spring if out-of-square exceeds manufacturer's specification.

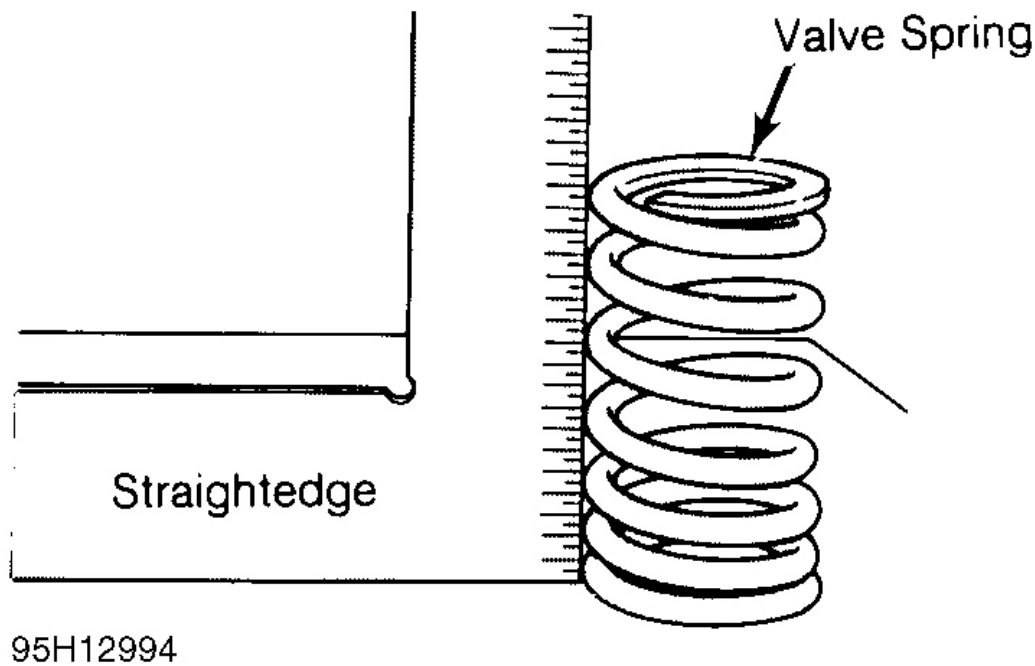


Fig. 4: Checking Valve Spring Squareness

Using vernier caliper, measure free length of all valve springs. Replace springs if not within specification. Using valve spring tester, test valve spring pressure at installed and compressed heights. See **Fig. 5**.

Usually compressed height is installed height minus valve lift. Replace valve spring if not within specification. It is recommended to replace all valve springs when overhauling cylinder head. Valve springs may need to be installed with color coded end or small coils at specified area according to manufacturer.

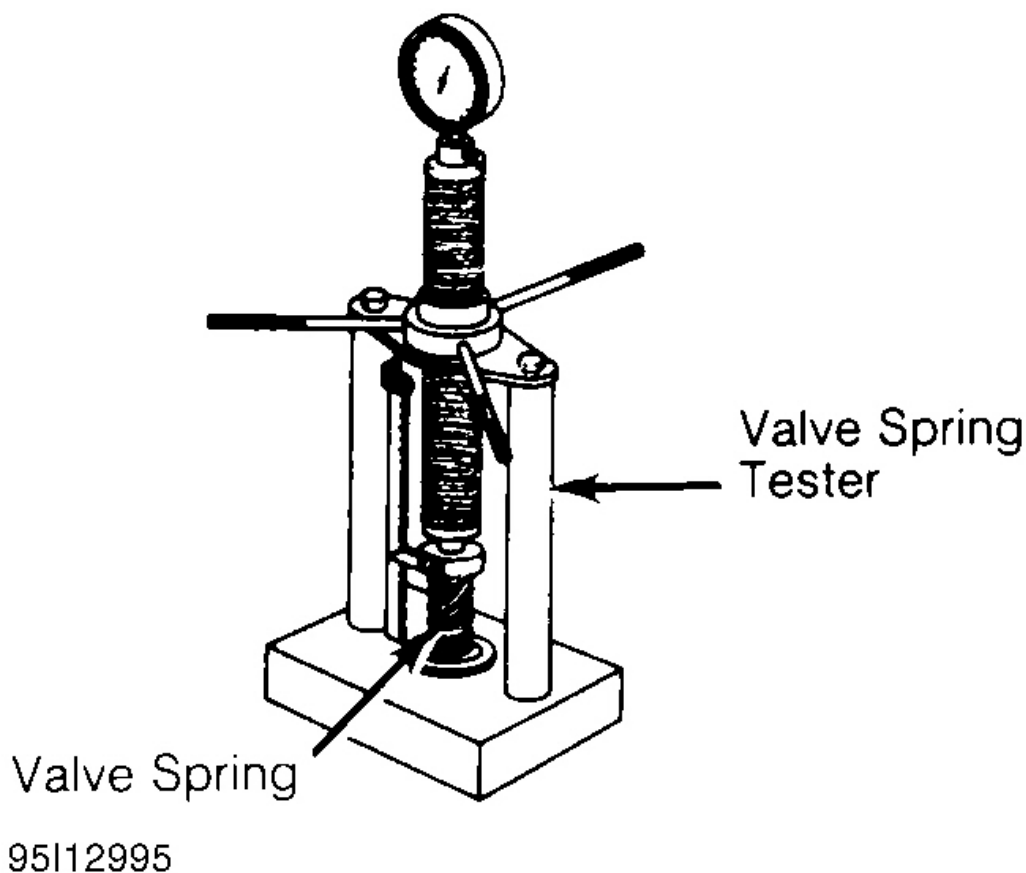


Fig. 5: Checking Valve Spring Pressure

VALVE GUIDE

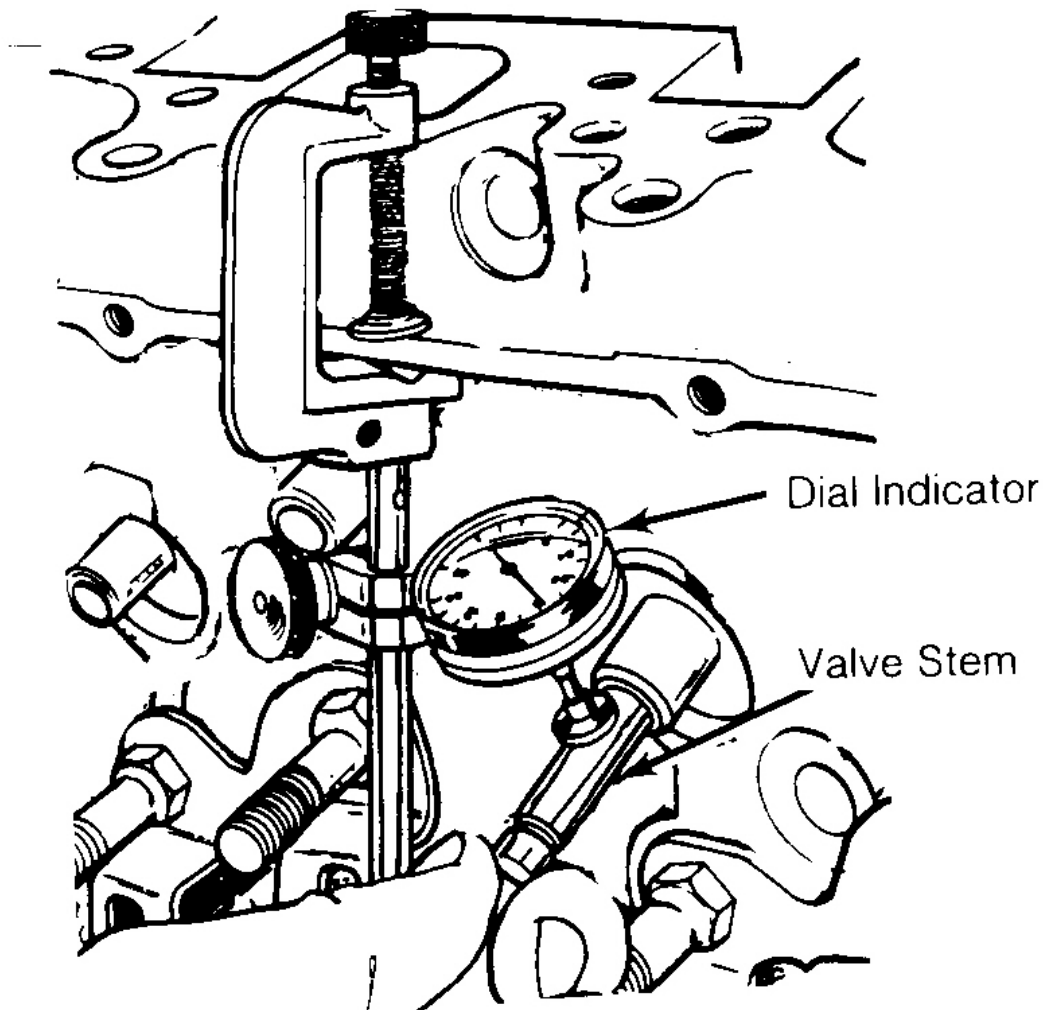
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Measuring Valve Guide Clearance

Check valve stem-to-guide clearance. Ensure valve stem diameter is within specification. Install valve in valve guide. Install dial indicator assembly on cylinder head with tip resting against valve stem just above valve

guide. See **Fig. 6**.



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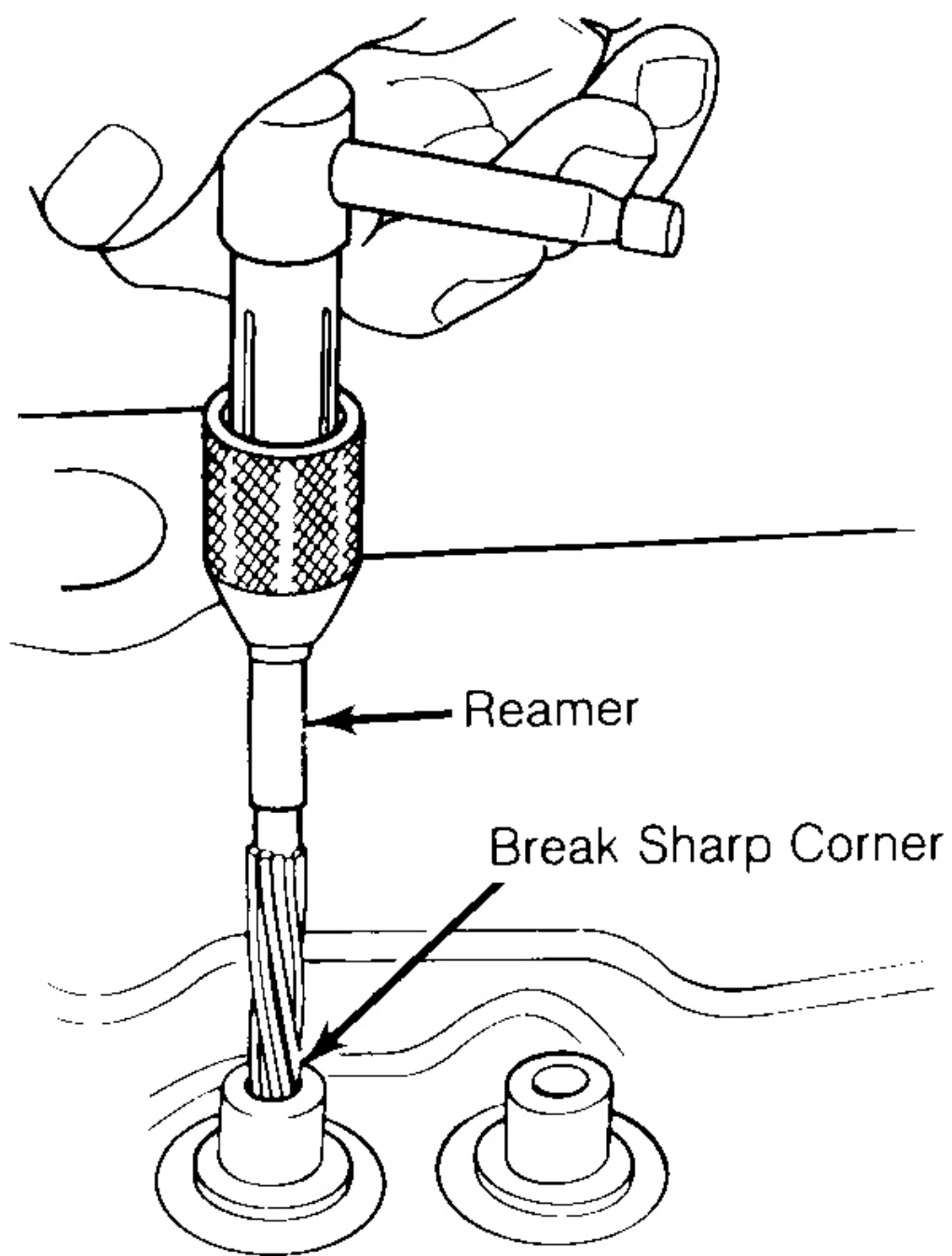
Fig. 6: Measuring Valve Stem-to-Guide Clearance

Lower valve approximately 1/16" below valve seat. Push valve stem against valve guide as far as possible. Adjust dial indicator to zero. Push valve stem in opposite direction and note reading. Clearance must be within specification.

If valve guide clearance exceeds specification, valves with oversize stems may be used and valve guides are reamed to larger size or valve guide must be replaced. On some applications, a false guide is installed, then reamed to proper specification. Valve guide reamer set is used to ream valve guide to obtain proper clearance for new valve.

Reaming Valve Guide

Select proper reamer for size of valve stem. Reamer must be of proper length to provide clean cut through entire length of valve guide. Install reamer in valve guide and rotate to cut valve guide. See **Fig. 7**.



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Fig. 7: Reaming Valve Guides

Replacing Valve Guide

Replace valve guide if clearance exceeds specification. Valve guides are either pressed, hammered or shrunk in place, depending upon cylinder head design and type of metal used.

Remove valve guide from cylinder head by pressing or tapping on a stepped drift. See **Fig. 8**. Once valve guide is installed, distance from cylinder head to top of valve guide must be checked. This distance must be within specification.

Aluminum heads are often heated before installing valve guide. Valve guide is sometimes cooled in dry ice prior to installation. Combination of a heated cylinder head and cooled valve guide ensures a tight guide fit upon assembly. The new guide must be reamed to specification.

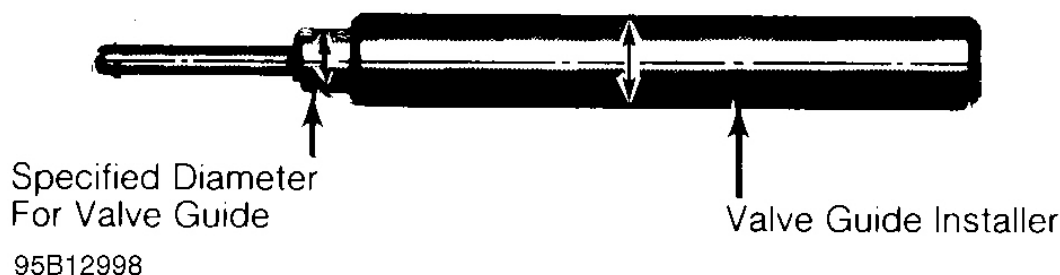


Fig. 8: Typical Valve Guide Remover & Installer

VALVES & VALVE SEATS

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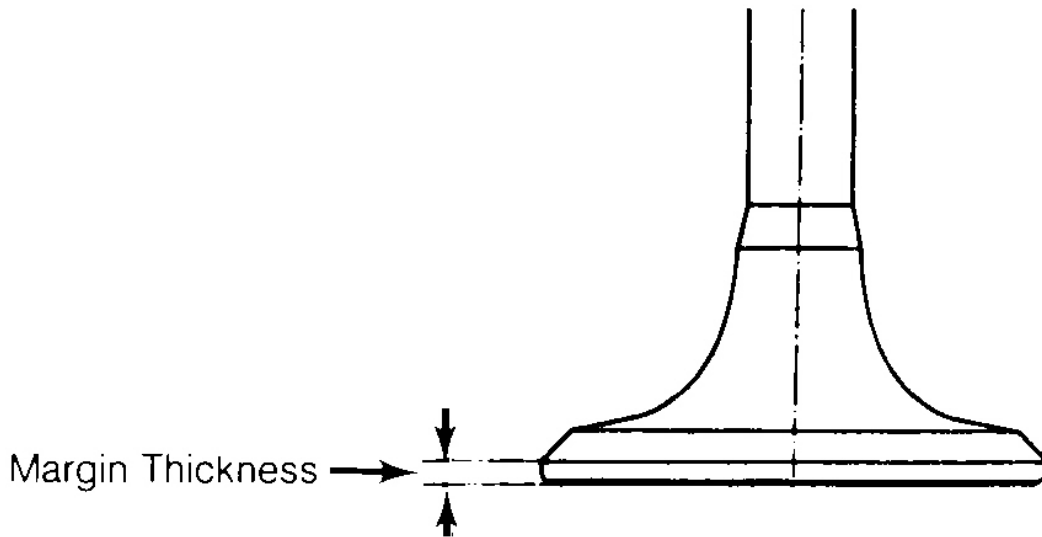
Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Valve Grinding

Valve stem O.D. should be measured in several areas to indicate amount of wear. Replace valve if not within specification. Valve margin area should be measured to ensure that valve can be ground. See **Fig. 9**.

If valve margin is less than specification, the valves will be burned. Valve must be replaced. Due to minimum margin dimensions during manufacture, some new type valves cannot be reground. Some manufacturers use stellite coated valves that must NOT be machined. Valves can only be lapped into valve seat.

CAUTION: Some valves are sodium filled. Extreme care must be used when disposing of damaged or worn sodium-filled valves.



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Fig. 9: Measuring Valve Head Margin

Resurface valve to proper angle specification using valve grinding machine. Follow manufacturer's instructions for valve grinding machine. Specifications may indicate a different valve face angle than seat angle. Measure valve margin after grinding. Replace valve if not within specification. Valve stem tip can be refinished using valve grinding machine.

Valve Lapping

During valve lapping of recently designed valves, be sure to follow manufacturer's recommendations. Surface hardening and materials used with some valves do not permit lapping. Lapping process will remove excessive amounts of the hardened surface.

Valve lapping is done to ensure adequate sealing between valve face and seat. Use either a hand drill or lapping stick with suction cup attached.

Moisten and attach suction cup to valve. Lubricate valve stem and guide. Apply a thin coat of fine valve grinding compound between valve and seat. Rotate lapping tool between the palms or with hand drill.

Lift valve upward off the seat and change position often. This is done to prevent grooving of valve seat. Lap valve until a smooth polished seat is obtained. Thoroughly clean grinding compound from components. Valve-to-valve seat concentricity should be checked. See **VALVE SEAT CONCENTRICITY**.

CAUTION: Valve guides must be in good condition and free of carbon deposits prior to valve seat grinding. Some engines contain an induction hardened valve seat. Excessive material removal will damage valve seats.

Valve Seat Grinding

Select coarse stone of correct size and angle for seat to be ground. Ensure stone is true and has a smooth surface. Select correct size pilot for valve guide dimension. Install pilot in valve guide. Lightly lubricate pilot shaft. Install stone on pilot. Move stone off and on the seat approximately 2 times per second during grinding operation.

Select a fine stone to finish grinding operation. Various angle grinding stones are used to center and narrow the valve seat as required. See **Fig. 10**.

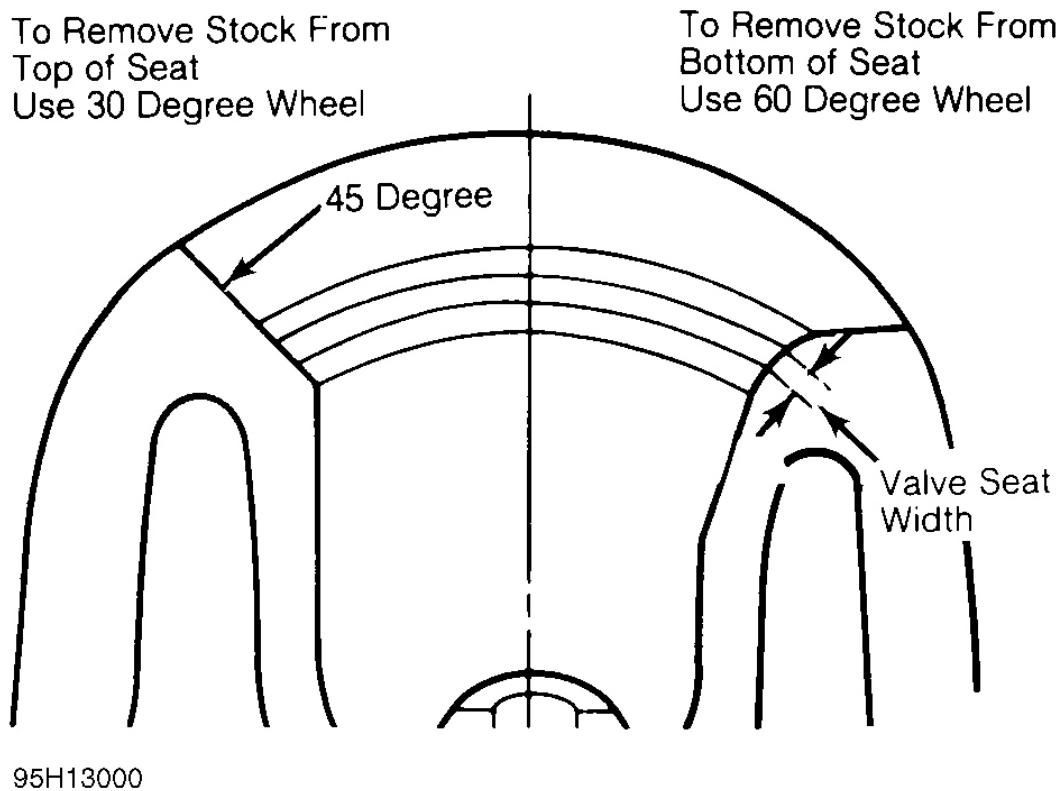


Fig. 10: Adjusting Valve Seat Width

Valve Seat Replacement

Replacement of valve seat inserts is done by cutting out the old insert and machining an oversize insert bore. Replacement oversize insert is usually cooled and the cylinder head is sometimes warmed. Valve seat is pressed into the head. This operation requires specialized machine shop equipment.

Valve Seat Concentricity

Using dial gauge, install gauge pilot in valve guide. Position gauge arm on the valve seat. Adjust dial indicator to zero. Rotate arm 360 degrees and note reading. Runout should not exceed specification.

To check valve-to-valve seat concentricity, coat valve face lightly with Prussian Blue dye. Install valve and rotate it on valve seat. If pattern is even and entire seat is coated at valve contact point, valve is concentric with the valve seat.

CYLINDER HEAD REASSEMBLY

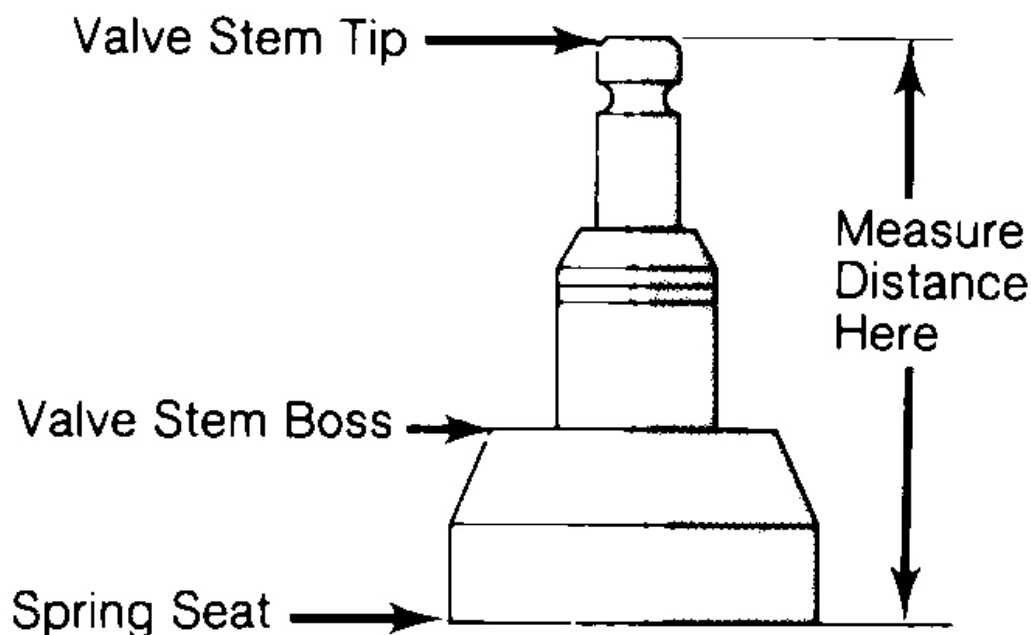
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Valve Stem Installed Height

Valve stem installed height must be checked when new valves are installed or when valves or valve seats have been ground. Install valve in valve guide. Measure distance from tip of valve stem to spring seat. See **Fig. 11**. Distance must be within specification to allow sufficient clearance for valve operation.

Remove valve and grind valve stem tip if height exceeds specification. Valve tips are surface hardened. DO NOT remove more than .010" (.25 mm) from tip. Chamfer sharp edge of reground valve tip. Recheck valve stem installed height.



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Fig. 11: Measuring Valve Stem Installed Height

VALVE STEM OIL SEALS

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Valve stem oil seals must be installed on valve stem. See **Fig. 2**. Seals are needed due to pressure differential at the ends of valve guides. Atmospheric pressure above intake guide, combined with manifold vacuum below guide, causes oil to be drawn into the cylinder.

Exhaust guides also have pressure differential created by exhaust gas flowing past the guide, creating a low pressure area. This low pressure area draws oil into the exhaust system.

Some manufacturers require that special color code or specified height valve stem oil seal be installed in

designated area.

Replacement (On-Vehicle)

Mark rocker arm or overhead cam components for location. Remove rocker arm components or overhead cam components. Components must be installed in original location. Remove spark plugs. Valve stem oil seals may be replaced by holding valves against seats using air pressure.

Air pressure must be installed in cylinder using an adapter for spark plug hole. An adapter can be constructed by welding air hose connection to spark plug body with porcelain removed.

Rotate engine until piston is at top of stroke. Install adapter in spark plug hole. Apply a minimum of 140 psi (9.8 kg/cm²) line pressure to adapter. Air pressure should hold valve closed. If air pressure does not hold valve closed, check for damaged or bent valve. Cylinder head must be removed for service.

Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator and valve spring. Remove valve stem oil seal.

If oversize valves have been installed, oversize oil seals must be used. Coat valve stem with engine oil. Install protective sleeve over end of valve stem. Install new oil seal over valve stem and seat on valve guide. Remove protective sleeve. Install spring seat, valve spring and retainer or rotator. Compress spring and install valve locks. Remove spring compressor. Ensure valve locks are fully seated.

Install rocker arms or overhead cam components. Tighten all bolts to specification. Adjust valves if required. Remove adapter. Install spark plugs, valve cover and gasket.

VALVE SPRING INSTALLED HEIGHT

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Valve spring installed height should be checked during reassembly. Measure height from lower edge of valve spring to the upper edge. DO NOT include valve spring seat or retainer. Distance must be within specification. If valves and/or seats have been ground, a valve spring shim may be required to correct spring height. See **Fig. 12**.

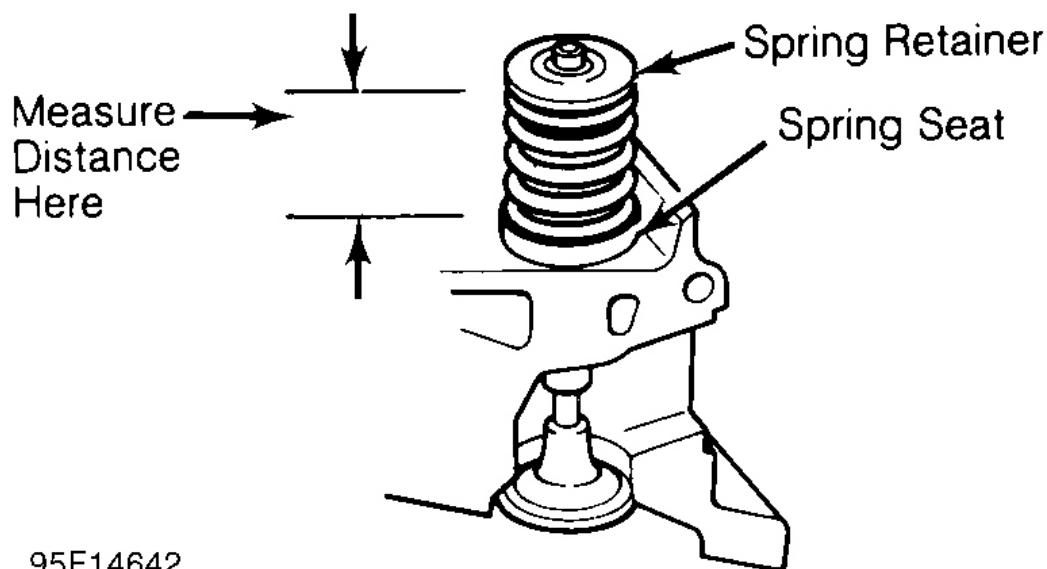


Fig. 12: Measuring Valve Spring Installed Height

ROCKER ARMS & ASSEMBLIES

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Rocker Studs

Rocker studs are either threaded or pressed in place. Threaded studs are removed by locking 2 nuts on the stud. Unscrew the stud by turning the jam nut. Coat new stud threads with Loctite and install. Tighten to specification.

Pressed-in stud can be removed using a stud puller. Ream stud bore to proper specification and press in a new oversize stud. Pressed-in studs are often replaced by cutting threads in the stud bore to accept a threaded stud.

Rocker Arms & Shafts

Mark rocker arms for location. Remove rocker arm retaining bolts. Remove rocker arms. Inspect rocker arms, shafts, bushings and pivot balls (if equipped) for excessive wear. Inspect rocker arms for wear in valve stem

contact area. Measure rocker arm bushing I.D. Replace bushings if excessively worn.

The rocker arm valve stem contact point may be reground, using special fixture for valve grinding machine. Remove minimum amount of material as possible. Ensure all oil passages are clear. Install rocker arm components in original location. Ensure rocker arm is properly seated in push rod. Tighten bolts to specification. Adjust valves if required. See **VALVE ADJUSTMENT**.

PUSH RODS

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Remove rocker arms. Mark push rods for location. Remove push rods. Push rods can be steel or aluminum, solid or hollow. Hollow push rods must be internally cleaned to ensure oil passage to rocker arms is cleaned. Check push rods for damage, such as loose ends on steel tipped aluminum types.

Check push rod for straightness. Roll push rod on a flat surface. Using feeler gauge, check clearance at center. Replace push rod if bent. The push rod can also be supported at each end and rotated. A dial indicator is used to detect a bent area in the push rod.

Lubricate ends of push rod and install push rod in original location. Ensure push rod is properly seated in lifter. Install rocker arm. Tighten bolts to specification. Adjust valves if required. See **VALVE ADJUSTMENT**.

LIFTERS

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Hydraulic Lifters

Before replacing a hydraulic lifter for noisy operation, ensure noise is not caused by worn rocker arms or valve tips. Also ensure sufficient oil pressure exists. Hydraulic lifters must be installed in original location. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold, cylinder head or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use a hydraulic lifter remover or magnet. Different type lifters are used. See **Fig. 13**.

On sticking lifters, disassemble and clean lifter. DO NOT mix lifter components or positions. Parts are select-fitted and are not interchangeable. Inspect all components for wear. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. On roller type lifters, inspect roller for flaking, pitting, loss of needle bearings and roughness during rotation.

Measure lifter body O.D. in several areas. Measure lifter bore I.D. Ensure components or oil clearance is within specification. Some models offer oversize lifters. Replace lifter if damaged.

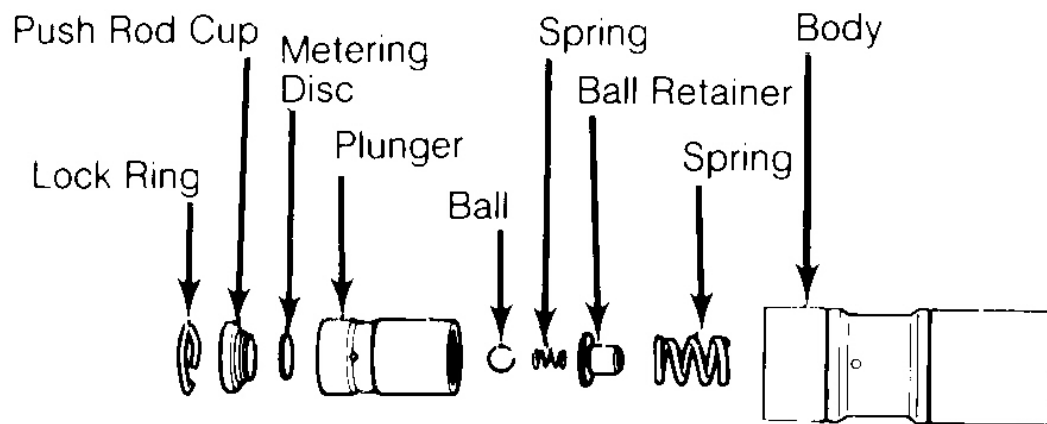
If lifter check valve is not operating, obstructions may be preventing it from closing or valve spring may be broken. Clean or replace components as necessary.

Check plunger operation. Plunger should drop to bottom of the body by its own weight when assembled dry. If plunger is not free, soak lifter in solvent to dissolve deposits.

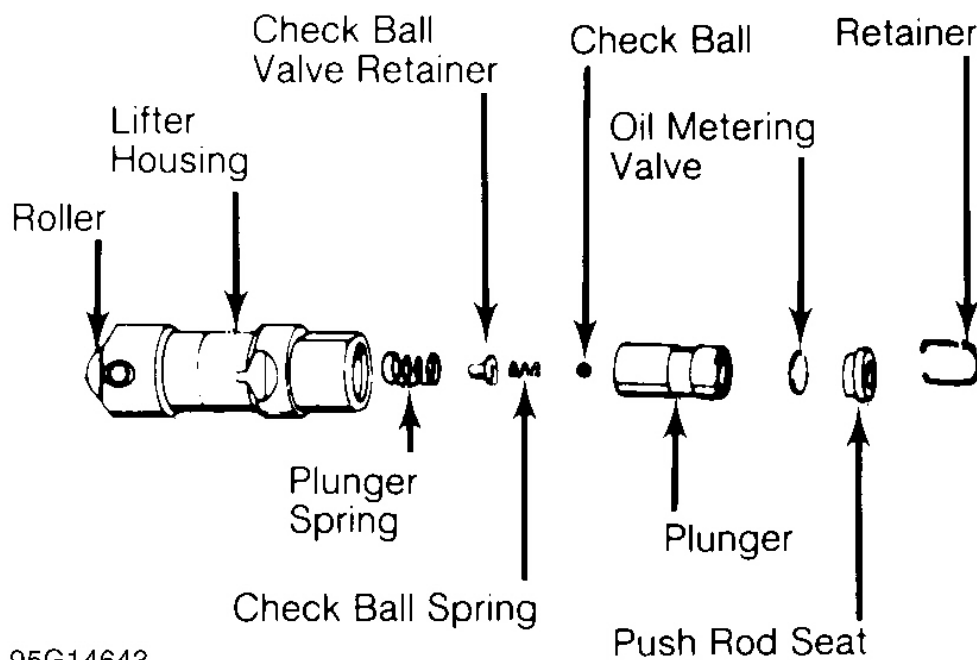
Lifter leak-down test can be performed on lifter. Lifter must be filled with special test oil. New lifters contain special test oil. Using lifter leak-down tester, perform leak-down test following manufacturer's instructions. If leak-down time is not within specifications, replace lifter assembly.

Lifters should be soaked in clean engine oil several hours prior to installation. Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. See **Fig. 13**. Install lifter in original location. Install remaining components. Valve lash adjustment is not required on most hydraulic lifters. Preload of hydraulic lifter is automatic. Some models may require adjustment.

NOTE: **Some manufacturers require that a crankcase conditioner be added to engine oil and engine operated for specified amount of time to aid in lifter break-in procedure if new lifters or camshaft are installed.**



FLAT LIFTER



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ROLLER LIFTER

Fig. 13: Typical Hydraulic Valve Lifter Assemblies

Mechanical Lifters

Lifter assemblies must be installed in original locations. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use lifter remover or magnet.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. Install lifter in original location. Install remaining components. Tighten bolts to specification. Adjust valves. See [VALVE ADJUSTMENT](#).

PISTONS, CONNECTING RODS & BEARINGS

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RIDGE REMOVAL

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Ridge in cylinder wall must be removed prior to piston removal. Failure to remove ridge prior to removing pistons will cause piston damage in piston ring lands or grooves.

With piston at bottom dead center, place rag in bore to trap metal chips. Install ridge reamer in cylinder bore. Adjust ridge reamer using manufacturer's instructions. Remove ridge using ridge reamer. DO NOT remove an excessive amount of material. Ensure ridge is completely removed.

PISTON & CONNECTING ROD REMOVAL

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Note top of piston. Some pistons may contain a notch, arrow or be marked FRONT. Piston must be installed in proper direction to prevent damage with valve operation.

Check that connecting rod and cap are numbered for cylinder location and which side of cylinder block the number faces. Proper cap and connecting rod must be installed together. Connecting rod cap must be installed on connecting rod in proper direction to ensure bearing lock procedure. Mark connecting rod and cap if necessary. Pistons must be installed in original location.

Remove cap retaining nuts or bolts. Remove bearing cap. Install tubing protectors on connecting rod bolts. This protects cylinder walls from scoring during removal. Ensure proper removal of ridge. Push piston and connecting rod from cylinder. Connecting rod boss can be tapped with a wooden dowel or hammer handle to aid in removal.

PISTON & CONNECTING ROD

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Disassembly

Using ring expander, remove piston rings. Remove piston pin retaining rings (if equipped). Note direction of piston installation on connecting rod. On pressed type piston pins, special fixtures and procedures according to manufacturer must be used to remove piston pins. Follow manufacturer's recommendations to avoid piston distortion or breakage.

Cleaning

Remove all carbon and varnish from piston. Pistons and connecting rods may be cleaned in cold type chemical tank. Using ring groove cleaner, clean all deposits from ring grooves. Ensure all deposits are cleaned from ring grooves to prevent ring breakage or sticking. DO NOT attempt to clean pistons with wire brush.

Inspection

Inspect pistons for nicks, scoring, cracks or damage in ring areas. Connecting rod should be checked for cracks using Magnaflux procedure. Piston diameter must be measured in manufacturer's specified area.

Using telescopic gauge and micrometer, measure piston pin bore of piston in 2 areas, 90 degrees apart. This is

done to check diameter and out-of-round.

Install proper bearing cap on connecting rod. Ensure bearing cap is installed in proper location. Tighten bolts or nuts to specification. Using inside micrometer, measure inside diameter in 2 areas, 90 degrees apart.

Connecting rod I.D. and out-of-round must be within specification. Measure piston pin bore I.D. and piston pin O.D. All components must be within specification. Subtract piston pin diameter from piston pin bore in piston and connecting rod to determine proper fit.

Connecting rod length must be measured from center of crankshaft journal inside diameter to center of piston pin bushing using proper caliper. Connecting rods must be the same length. Connecting rods should be checked on an alignment fixture for bent or twisted condition. Replace all components which are damaged or not within specification.

PISTON & CYLINDER BORE FIT

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Ensure cylinder is checked for taper, out-of-round and properly honed prior to checking piston and cylinder bore fit. See **CYLINDER BLOCK**. Using dial bore gauge, measure cylinder bore.

Measure piston skirt diameter at 90 degree angle to piston pin at specified area by manufacturer. Subtract piston diameter from cylinder bore diameter to determine piston-to-cylinder clearance. Clearance must be within specification. Mark piston for proper cylinder location.

ASSEMBLING PISTON & CONNECTING ROD

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Install piston on connecting rod for corresponding cylinder. Ensure reference marking on top of piston corresponds with connecting rod and cap number. See **Fig. 14**.

Lubricate piston pin and install in connecting rod. Ensure piston pin retainers are fully seated (if equipped). On

pressed type piston pins, follow manufacturer's recommended procedure to avoid distortion or breakage.

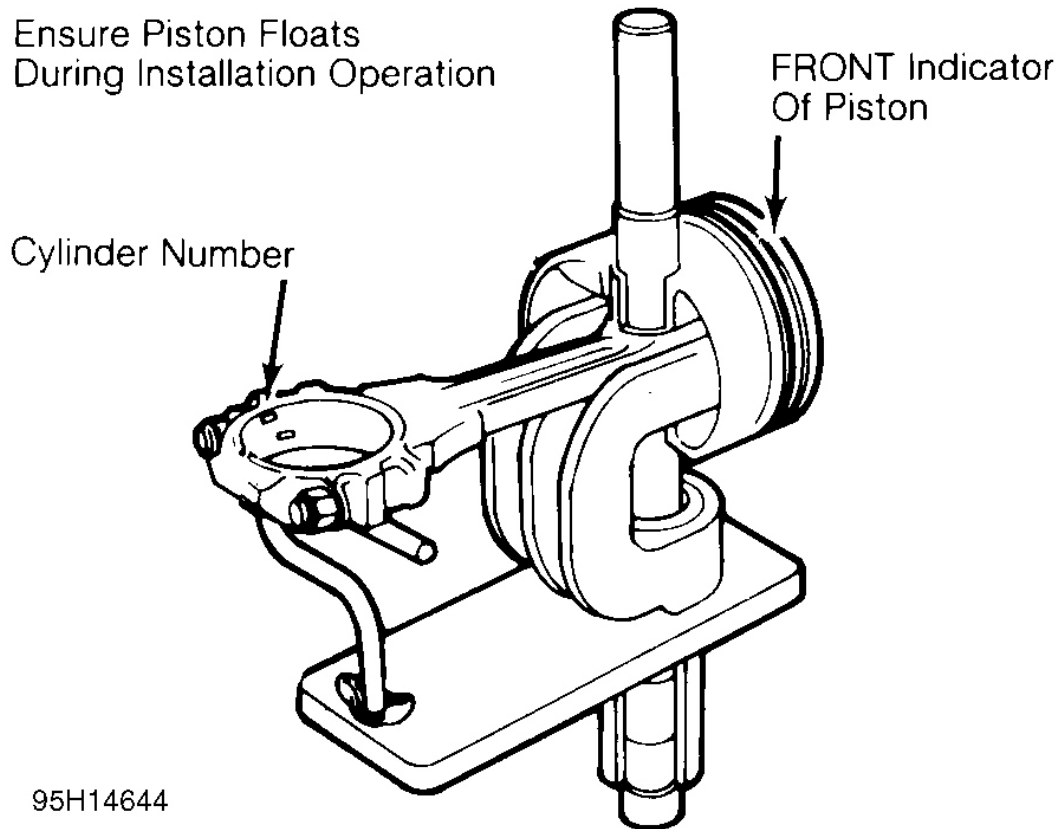


Fig. 14: Installing Typical Piston Pin

CHECKING PISTON RING CLEARANCES

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Piston rings must be checked for side clearance and end gap. To check end gap, install piston ring in cylinder in which it is to be installed. Using an inverted piston, push ring to bottom of cylinder in smallest cylinder diameter.

Using feeler gauge, check ring end gap. See **Fig. 15**. Piston ring end gap must be within specification. Ring breakage will occur if insufficient ring end gap exists.

Some manufacturers permit correcting insufficient ring end gap by using a fine file while other manufacturers recommend using another ring set. Mark rings for proper cylinder installation after checking end gap.

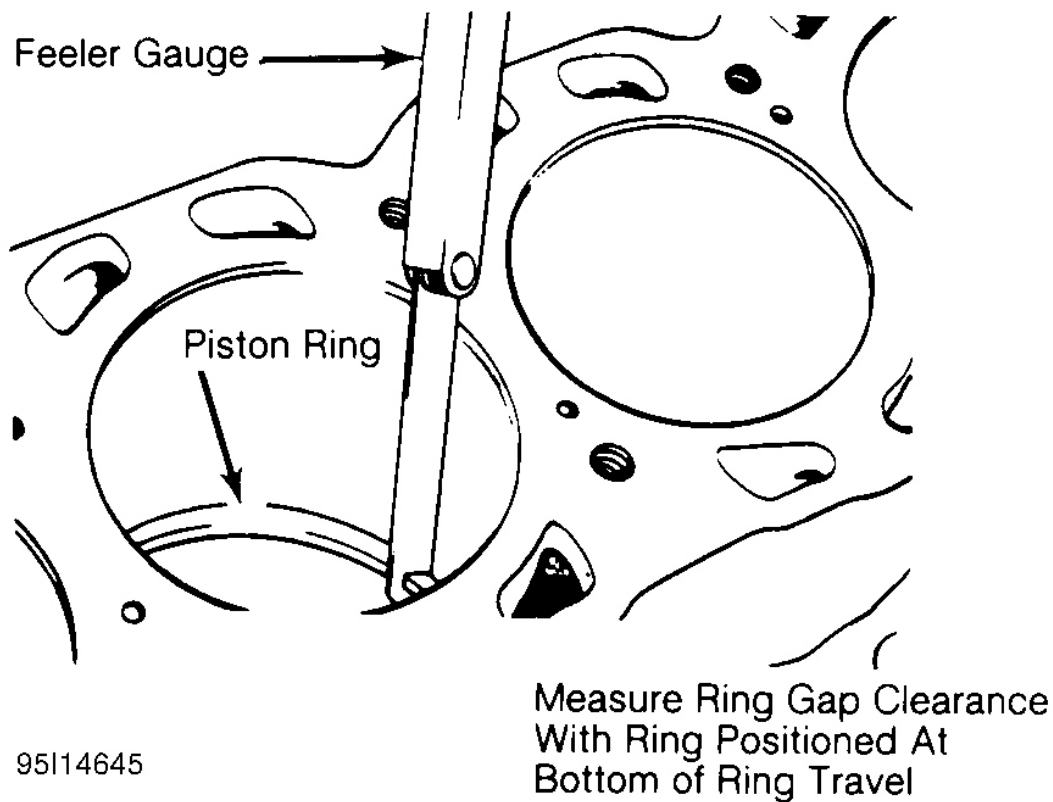


Fig. 15: Checking Piston Ring End Gap

For checking side clearance, install rings on piston. Using feeler gauge, measure clearance between piston ring and piston ring land. Check side clearance in several areas around piston. Side clearance must be within specification.

If side clearance is excessive, piston ring grooves can be machined to accept oversize piston rings (if available). Normal practice is to replace piston.

PISTON & CONNECTING ROD INSTALLATION

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of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the **ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.**

Cylinders must be honed prior to piston installation. See **CYLINDER HONING** under **CYLINDER BLOCK**.

Install upper connecting rod bearings. Lubricate upper bearings with engine oil. Install lower bearings in rod caps. Ensure bearing tabs are properly seated. Position piston ring gaps according to manufacturer's recommendations. See **Fig. 16**. Lubricate pistons, rings and cylinder walls.

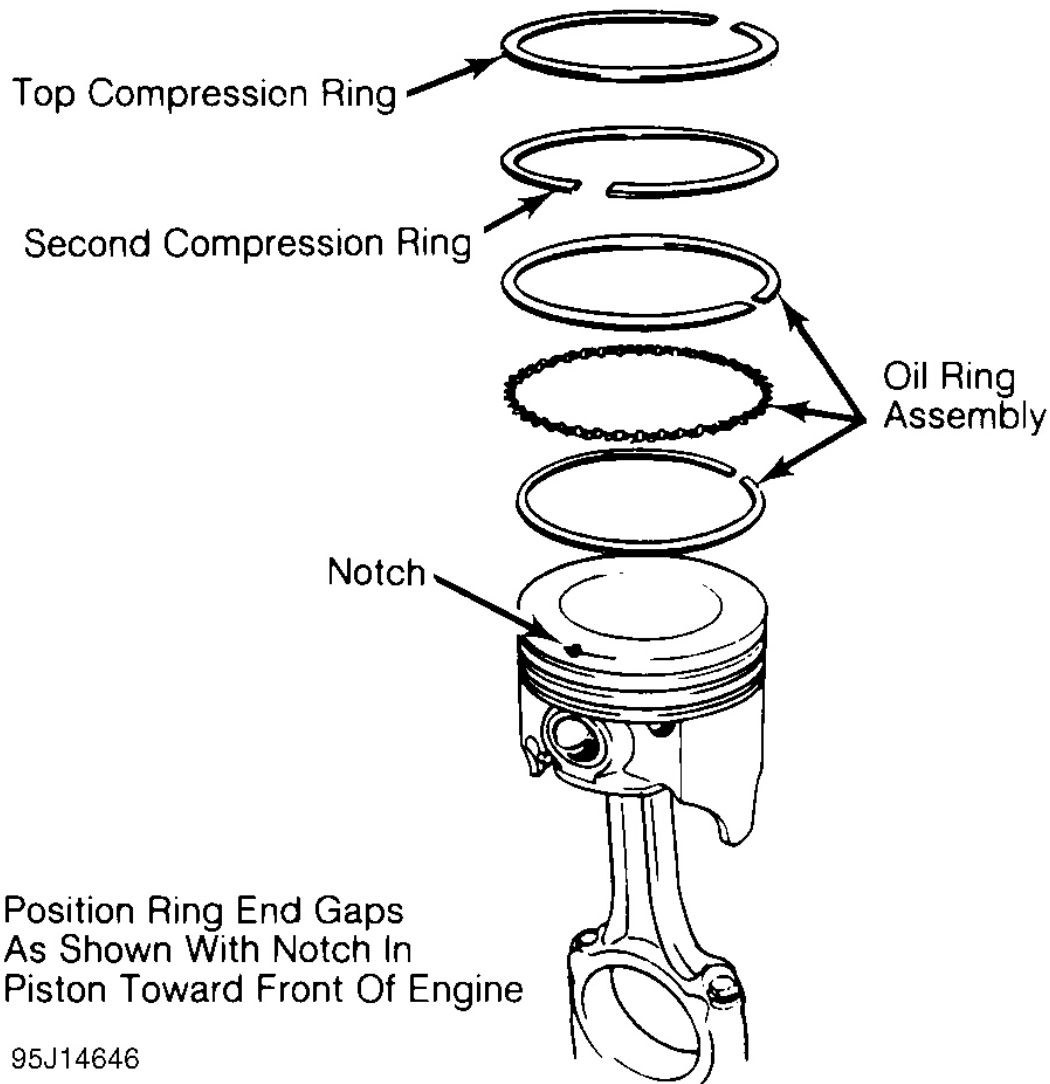


Fig. 16: Positioning Typical Piston Ring End Gap

Install ring compressor. Use care not to rotate piston rings. Compress rings with ring compressor. Install plastic tubing protectors over connecting rod bolts. Install piston and connecting rod assembly. Ensure piston notch, arrow or FRONT mark is toward front of engine. See **Fig. 17**.

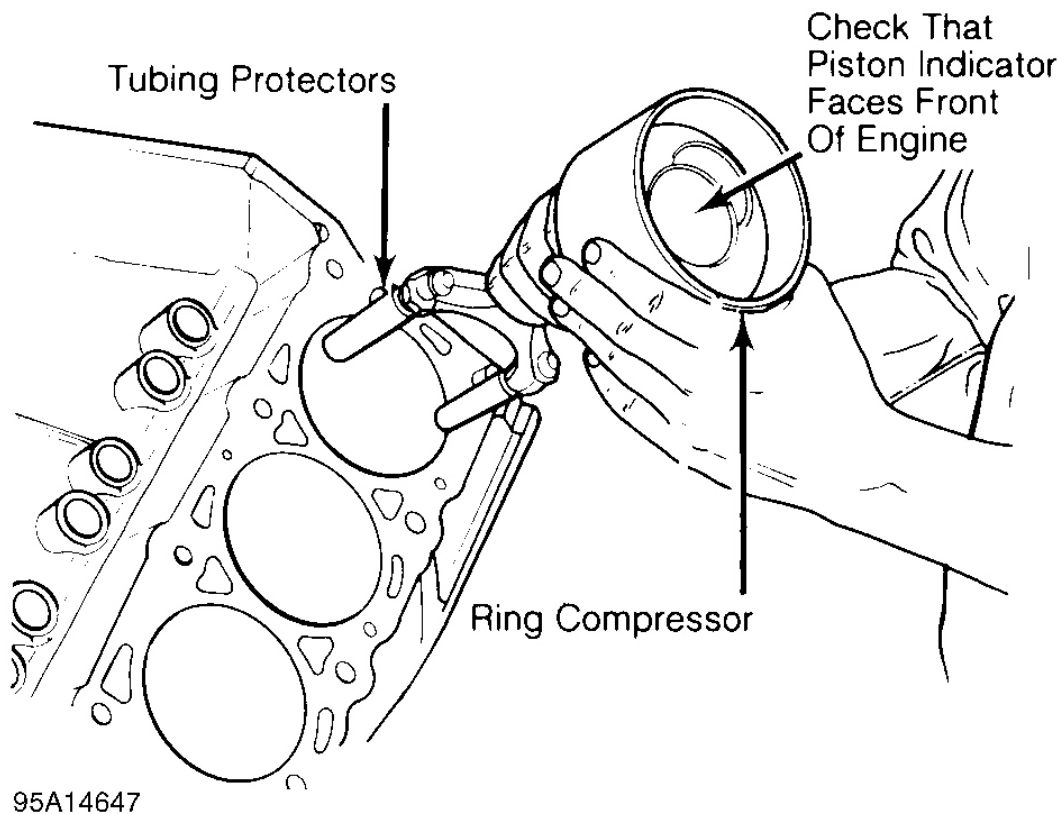


Fig. 17: Installing Piston & Connecting Rod Assembly

Carefully tap piston into cylinder until rod bearing is seated on crankshaft journal. Remove protectors. Install rod cap and bearing. Lightly tighten connecting rod bolts. Repeat procedure for remaining cylinders. Check bearing clearance. See **MAIN & CONNECTING ROD BEARING CLEARANCE**.

Once clearance is checked, lubricate journals and bearings. Install bearing caps. Ensure marks are aligned on connecting rod and cap. Tighten rod nuts or bolts to specification. Ensure rod moves freely on crankshaft. Check connecting rod side clearance. See **CONNECTING ROD SIDE CLEARANCE**.

CONNECTING ROD SIDE CLEARANCE

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Position connecting rod toward one side of crankshaft as far as possible. Using feeler gauge, measure clearance between side of connecting rod and crankshaft. See **Fig. 18**. Clearance must be within specification.

Check for improper bearing installation, wrong bearing cap or insufficient bearing clearance if side clearance is insufficient. Connecting rod may require machining to obtain proper clearance. Excessive clearance usually indicates excessive wear at crankshaft. Crankshaft must be repaired or replaced.

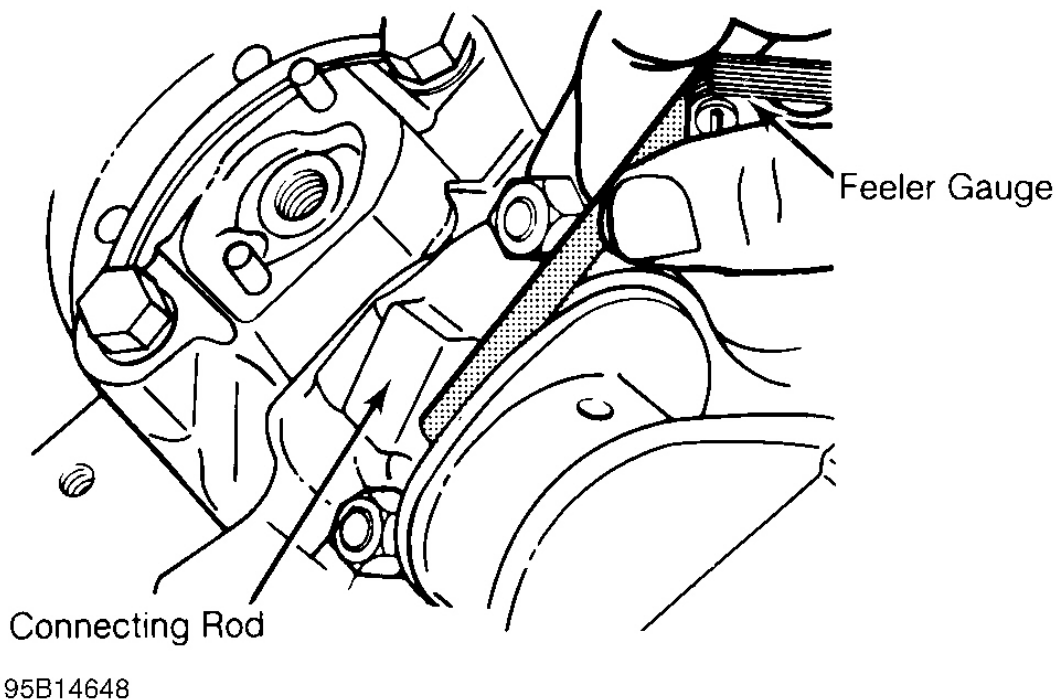


Fig. 18: Measuring Connecting Rod Side Clearance

MAIN & CONNECTING ROD BEARING CLEARANCE

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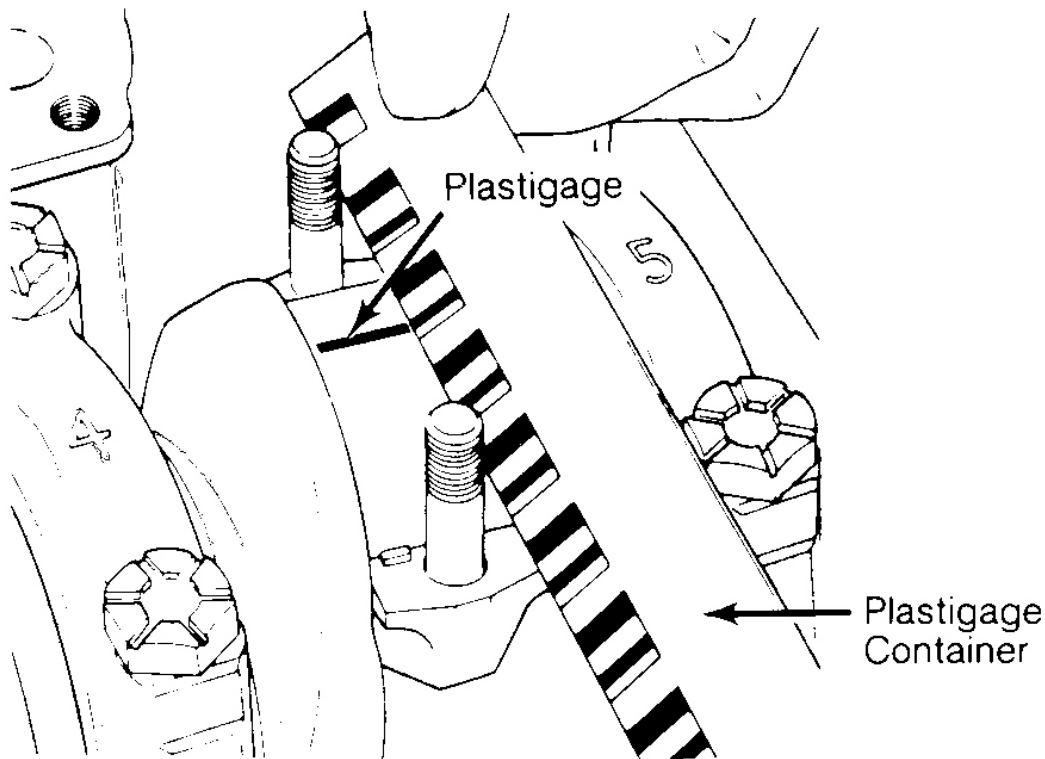
Plastigage Method

Plastigage method may be used to determine bearing clearance. Plastigage can be used with an engine in service or during reassembly. Plastigage material is oil soluble.

Ensure journals and bearings are free of oil or solvent. Oil or solvent will dissolve material and false reading will be obtained. Install small piece of Plastigage along full length of bearing journal. Install bearing cap in original location. Tighten bolts to specification.

CAUTION: DO NOT rotate crankshaft while Plastigage is installed. Bearing clearance will not be obtained if crankshaft is rotated.

Remove bearing cap. Compare Plastigage width with scale on Plastigage container to determine bearing clearance. See **Fig. 19**. Rotate crankshaft 90 degrees. Repeat procedure. This is done to check journal eccentricity. This procedure can be used to check oil clearance on both connecting rod and main bearings.



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Fig. 19: Measuring Bearing Clearance

Micrometer & Telescopic Gauge Method

A micrometer is used to determine journal diameter, taper and out-of-round dimensions of the crankshaft. See **CLEANING & INSPECTION** under CRANKSHAFT & MAIN BEARINGS in this article.

With crankshaft removed, install bearings and caps in original location on cylinder block. Tighten bolts to specification. On connecting rods, install bearings and caps on connecting rods. Install proper connecting rod cap on corresponding rod. Ensure bearing cap is installed in original location. Tighten bolts to specification.

Using a telescopic gauge and micrometer or inside micrometer, measure inside diameter of connecting rod and main bearings bores. Subtract each crankshaft journal diameter from the corresponding inside bearing bore diameter. This is the bearing clearance.

CRANKSHAFT & MAIN BEARINGS

*** PLEASE READ THIS FIRST ***

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REMOVAL

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Ensure all main bearing caps are marked for location on cylinder block. Some main bearing caps have an arrow stamped on them. The arrow must face timing belt or timing chain end of engine. Remove main bearing cap bolts. Remove main bearing caps. Carefully remove crankshaft. Use care not to bind crankshaft in cylinder block during removal.

CLEANING & INSPECTION

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

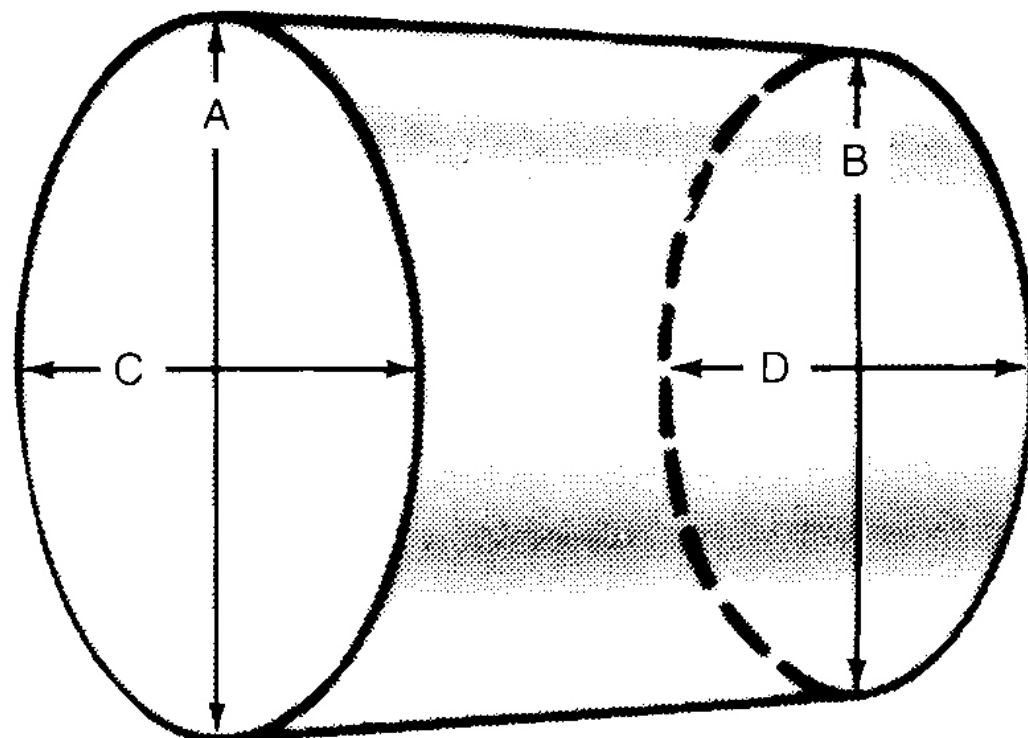
Thoroughly clean crankshaft using solvent. Dry with compressed air. Ensure all oil passages are clear and free of sludge, rust, dirt and metal chips.

Inspect crankshaft for scoring and nicks. Inspect crankshaft for cracks using Magnaflux procedure. Inspect rear seal area for grooving or damage. Inspect bolt hole threads for damage. If pilot bearing or bushing is used, check pilot bearing or bushing fit in crankshaft. Inspect crankshaft gear for damaged or cracked teeth. Replace gear if damaged. Ensure oil passage plugs are tight (if equipped).

Using micrometer, measure all journals in 4 areas to determine journal taper, out-of-round and undersize. See **Fig. 20**. Some crankshafts can be reground to the next largest undersize, depending on the amount of wear or damage. Crankshafts with rolled fillet cannot be reground and must be replaced.

A - B = Vertical Taper
C - D = Horizontal Taper
A - C & B - D = Out-Of-Round

Check For Out-Of-Round At Each End Of Journal



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Fig. 20: Measuring Crankshaft Journals

Crankshaft journal runout should be checked. Install crankshaft in "V" blocks or bench center. Position dial indicator with tip resting on the main bearing journal area. See **Fig. 21**. Rotate crankshaft and note reading. Journal runout must not exceed specification. Repeat procedure on all main bearing journals. Crankshaft must be replaced if runout exceeds specification.

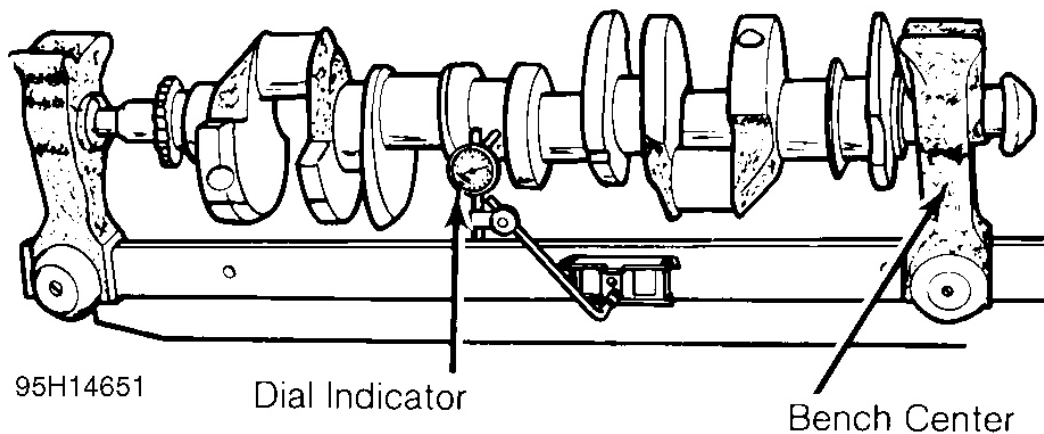


Fig. 21: Measuring Crankshaft Main Bearing Journal Runout

INSTALLATION

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Install upper main bearing in cylinder block. Ensure lock tab is properly located in cylinder block. Install bearings in main bearing caps. Ensure all oil passages are aligned. Install rear seal (if removed).

Ensure crankshaft journals are clean. Lubricate upper main bearings with clean engine oil. Carefully install crankshaft. Check each main bearing clearance using Plastigage method. See **MAIN & CONNECTING ROD BEARING CLEARANCE**.

Once clearance is checked, lubricate lower main bearing and journals. Install main bearing caps in original location. Install rear seal in rear main bearing cap (if removed). Some rear main bearing caps require sealant to be applied in corners to prevent oil leakage.

Install and tighten all bolts except thrust bearing cap to specification. Tighten thrust bearing cap bolts finger tight only. Some models require that thrust bearing be aligned. On most applications, crankshaft must be moved rearward then forward. Procedure may vary with manufacturer. Thrust bearing cap is then tightened to specification. Ensure crankshaft rotates freely. Crankshaft end play should be checked. See **CRANKSHAFT END PLAY**.

CRANKSHAFT END PLAY

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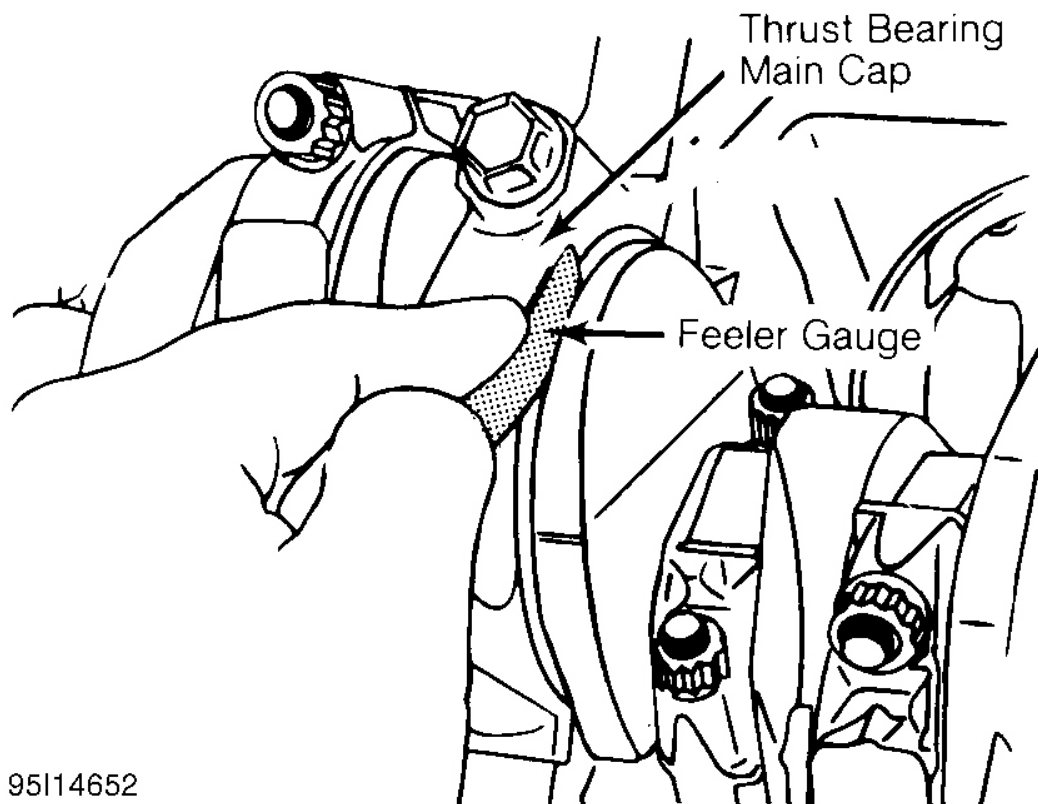
Dial Indicator Method

Crankshaft end play can be checked using dial indicator. Mount dial indicator on rear of cylinder block. Position dial indicator tip against rear of crankshaft. Ensure tip is resting against flat surface.

Pry crankshaft rearward. Adjust dial indicator to zero. Pry crankshaft forward and note reading. Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversize thrust bearings.

Feeler Gauge Method

Crankshaft end play can be checked using feeler gauge. Pry crankshaft rearward. Pry crankshaft forward. Using feeler gauge, measure clearance between crankshaft and thrust bearing surface. See **Fig. 22**.



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Fig. 22: Checking Crankshaft End Play

Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversize thrust bearings.

CYLINDER BLOCK

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Block Cleaning

Only cast cylinder blocks should be hot tank cleaned. Aluminum cylinder blocks should be cleaned using cold tank method. Cylinder block is cleaned in order to remove carbon deposits, gasket residue and water jacket

scale. Remove oil gallery plugs, freeze plugs and cam bearings before cleaning block.

Block Inspection

Visually inspect the block. Check suspected areas for cracks using the Dye Penetrant inspection method. Block may be checked for cracks using the Magnaflux method.

Cracks are most commonly found at the bottom of cylinders, main bearing saddles, near expansion plugs and between cylinders and water jackets. Inspect lifter bores for damage. Inspect all head bolt holes for damaged threads. Threads should be cleaned using tap to ensure proper head bolt torque. Consult machine shop concerning possible welding and machining (if required).

Cylinder Bore Inspection

Inspect bore for scoring or roughness. Cylinder bore is dimensionally checked for out-of-round and taper using dial bore gauge. For determining out-of-round, measure cylinder parallel and perpendicular to the block center line. Difference in the 2 readings is the bore out-of-round. Cylinder bore must be checked at top, middle and bottom of piston travel area.

Bore taper is obtained by measuring bore at the top and bottom. If wear has exceeded allowable limits, block must be honed or bored to next available oversize piston dimension.

Cylinder Honing

Cylinder must be properly honed to allow new piston rings to properly seat. Cross-hatching at correct angle and depth is critical to lubrication of cylinder walls and pistons.

A flexible drive hone and power drill are commonly used. Drive hone must be lubricated during operation. Mix equal parts of kerosene and SAE 20W engine oil for lubrication.

Apply lubrication to cylinder wall. Operate cylinder hone from top to bottom of cylinder using even strokes to produce 45 degree cross-hatch pattern on the cylinder wall. DO NOT allow cylinder hone to extend below cylinder during operation.

Recheck bore dimension after final honing. Wash cylinder wall with hot soapy water to remove abrasive particles. Blow dry with compressed air. Coat cleaned cylinder walls with lubricating oil.

Deck Warpage

Check deck for damage or warped gasket surface. Place a straightedge across gasket surface of the deck. Using feeler gauge, measure clearance at center of straightedge. Measure across width and length of cylinder block at several points.

If warpage exceeds specifications, deck must be resurfaced. If warpage exceeds manufacturer's maximum tolerance for material removal, replace block.

NOTE: **Some manufacturers recommend that a total amount of material (cylinder head and cylinder block) can only be removed before components must be replaced.**

Deck Height

Distance from crankshaft center line to block deck is called the deck height. Measure and record front and rear main journals of crankshaft. To compute this distance, install crankshaft and retain with center main bearing and cap only. Measure distance from crankshaft journal to block deck, parallel to cylinder center line.

Add one half of main bearing journal diameter to distance from crankshaft journal to block deck. This dimension should be checked at front and rear of cylinder block. Both readings should be the same.

If difference exceeds specification, cylinder block must be repaired or replaced. Deck height and warpage should be corrected at the same time.

Main Bearing Bore & Alignment

For checking main bearing bore, remove all bearings from cylinder block and main bearing caps. Install main bearing caps in original location. Tighten bolts to specification. Using inside micrometer, measure main bearing bore in 2 areas 90 degrees apart. Determine bore size and out-of-round. If diameter is not within specification, block must be align-bored.

For checking alignment, place a straightedge along center line of main bearing saddles. Check for clearance between straightedge and main bearing saddles. Block must be align-bored if clearance exists.

Expansion Plug Removal

Drill hole in center of expansion plug. Remove with screwdriver or punch. Use care not to damage sealing surface.

Expansion Plug Installation

Ensure sealing surface is free of burrs. Coat expansion plug with sealer. Using wooden dowel or pipe of slightly smaller diameter, install expansion plug. Ensure expansion plug is evenly located.

Oil Gallery Plug Removal

Remove threaded oil gallery plugs using appropriate wrench. Soft press-in plugs are removed by drilling into plug and installing a sheet metal screw. Remove plug with slide hammer or pliers.

Oil Gallery Plug Installation

Ensure threads or sealing surface is clean. Coat threaded oil gallery plugs with sealer and install. Replacement soft press-in plugs are installed with a hammer and drift.

CAMSHAFT

*** PLEASE READ THIS FIRST ***

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CLEANING & INSPECTION

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Clean camshaft with solvent. Ensure all oil passages are clear. Inspect cam lobes and bearing journals for pitting, flaking or scoring. Using micrometer, measure bearing journal O.D.

Support camshaft at each end with "V" blocks. Position dial indicator with tip resting on center bearing journal. Rotate camshaft and note camshaft runout reading. If reading exceeds specification, replace camshaft.

Check cam lobe lift by measuring base circle of camshaft using micrometer. Measure again at 90-degree angle to tip of cam lobe. Cam lift can be determined by subtracting base circle diameter from tip of cam lobe measurement.

Different lift dimensions are given for intake and exhaust cam lobes. Reading must be within specification. Replace camshaft if cam lobes or bearing journals are not within specification.

Inspect camshaft gear for chipped, eroded or damaged teeth. Replace gear if damaged. On camshafts using thrust plate, measure distance between thrust plate and camshaft shoulder. Replace thrust plate if not within specification.

CAMSHAFT BEARINGS

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Removal & Installation

Remove camshaft rear plug. Camshaft bearing remover is assembled with shoulder resting against bearing to be removed according to manufacturer's instructions. Tighten puller nut until bearing is removed. Remove remaining bearings, leaving front and rear bearings until last. These bearings act as a guide for camshaft bearing remover.

To install new bearings, puller is rearranged to pull bearings toward the center of block. Ensure all lubrication passages of bearing are aligned with cylinder block. Coat new camshaft rear plug with sealant. Install camshaft rear plug. Ensure plug is even in cylinder block.

CAMSHAFT INSTALLATION

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Lubricate bearing surfaces and cam lobes with ample amount of Molykote or camshaft lubricant. Carefully install camshaft. Use care not to damage bearing journals during installation. Install thrust plate retaining bolts (if equipped). Tighten bolts to specification. On overhead camshafts, install bearing caps in original location. Tighten bolts to specification. On all applications, check camshaft end play.

CAMSHAFT END PLAY

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Using dial indicator, check camshaft end play. Position dial indicator on front of engine block or cylinder head. Position indicator tip against camshaft. Push camshaft toward rear of cylinder head or engine and adjust indicator to zero.

Move camshaft forward and note reading. Camshaft end play must be within specification. End play may be adjusted by relocating gear, shimming thrust plate or replacing thrust plate depending on each manufacturer.

TIMING CHAINS & BELTS

*** PLEASE READ THIS FIRST ***

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TIMING CHAINS

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Timing chains will stretch during operation. Limits are placed upon amount of stretch before replacement is required. Timing chain stretch will alter ignition timing and valve timing.

To check timing chain stretch, rotate crankshaft to eliminate slack from one side of timing chain. Mark reference point on cylinder block. Rotate crankshaft in opposite direction to eliminate slack from remaining side of timing chain. Force other side of chain outward and measure distance between reference point and timing chain. See **Fig. 23**. Replace timing chain and gears if not within specification.

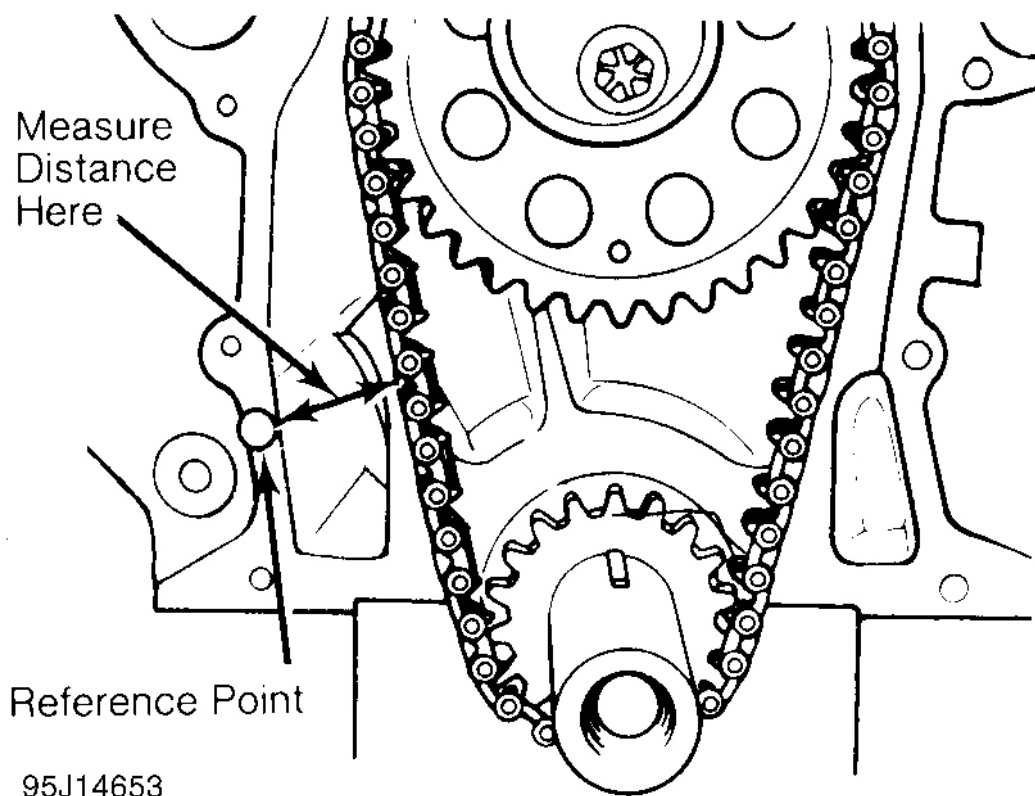


Fig. 23: Measuring Timing Chain Stretch

Timing chains must be installed so timing marks on camshaft gear and crankshaft gear are aligned according to manufacturer. See **Fig. 24**.

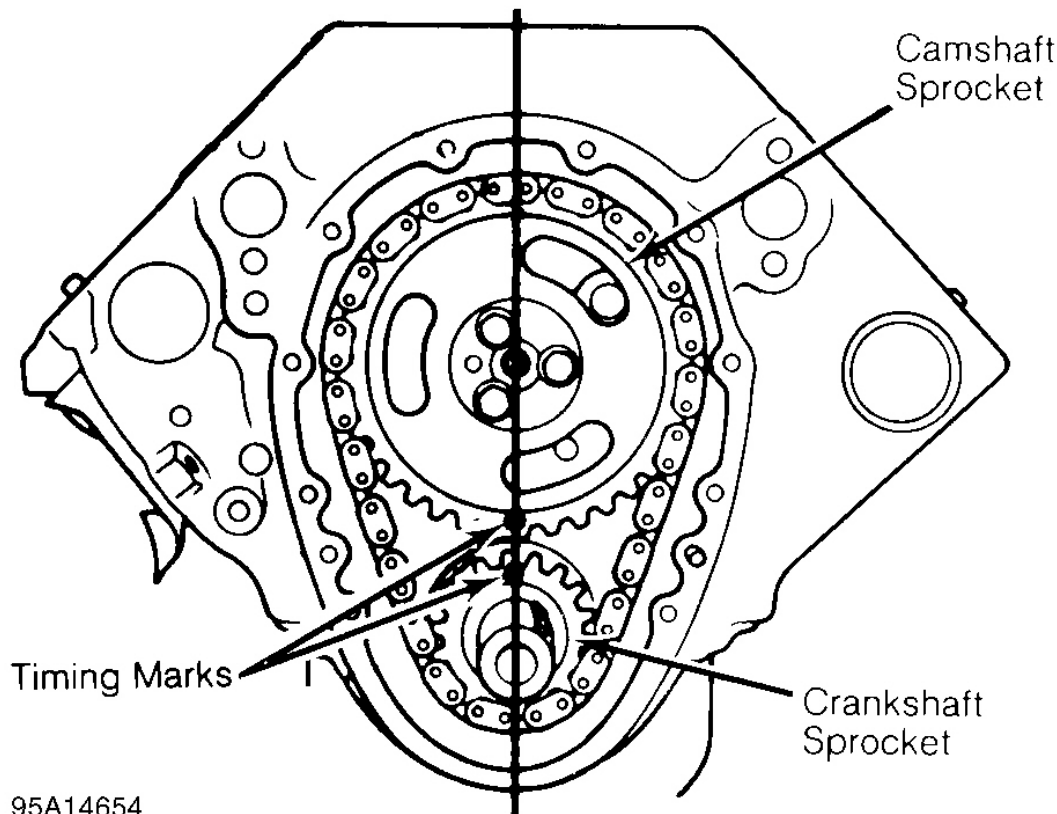


Fig. 24: Typical Gear Timing Mark Alignment

TIMING BELTS

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Cogged tooth belts are commonly used on overhead cam engines. Inspect belt teeth for rounded corners or cracking. Replace belt if it is cracked, damaged, missing teeth or oil soaked.

Used timing belt must be installed in original direction of rotation. Inspect all sprocket teeth for wear. Replace all worn sprockets. Sprockets are marked for timing purposes. Engine is positioned so that crankshaft sprocket mark will be upward. Camshaft sprocket is aligned with reference mark on cylinder head or timing belt cover and then timing belt can be installed. See **Fig. 25**.

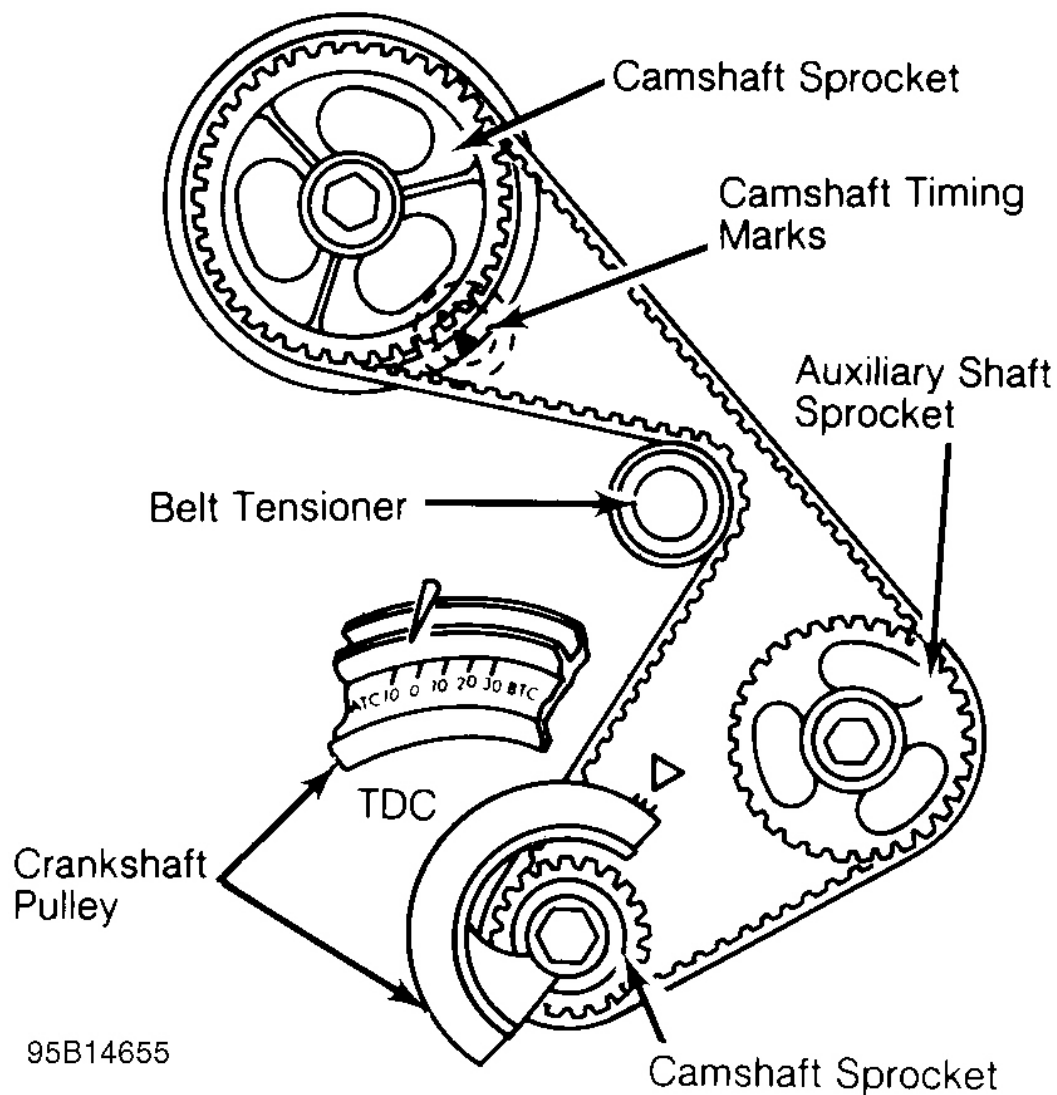


Fig. 25: Typical Camshaft Belt Sprocket Alignment

TENSION ADJUSTMENT

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If guide rails are used with spring loaded tensioners, ensure at least half of original rail thickness remains. Spring loaded tensioner should be inspected for damage.

Ensure all timing marks are aligned. Adjust belt tension using manufacturer's recommendations. Belt tension may require checking using tension gauge. See **Fig. 26**.

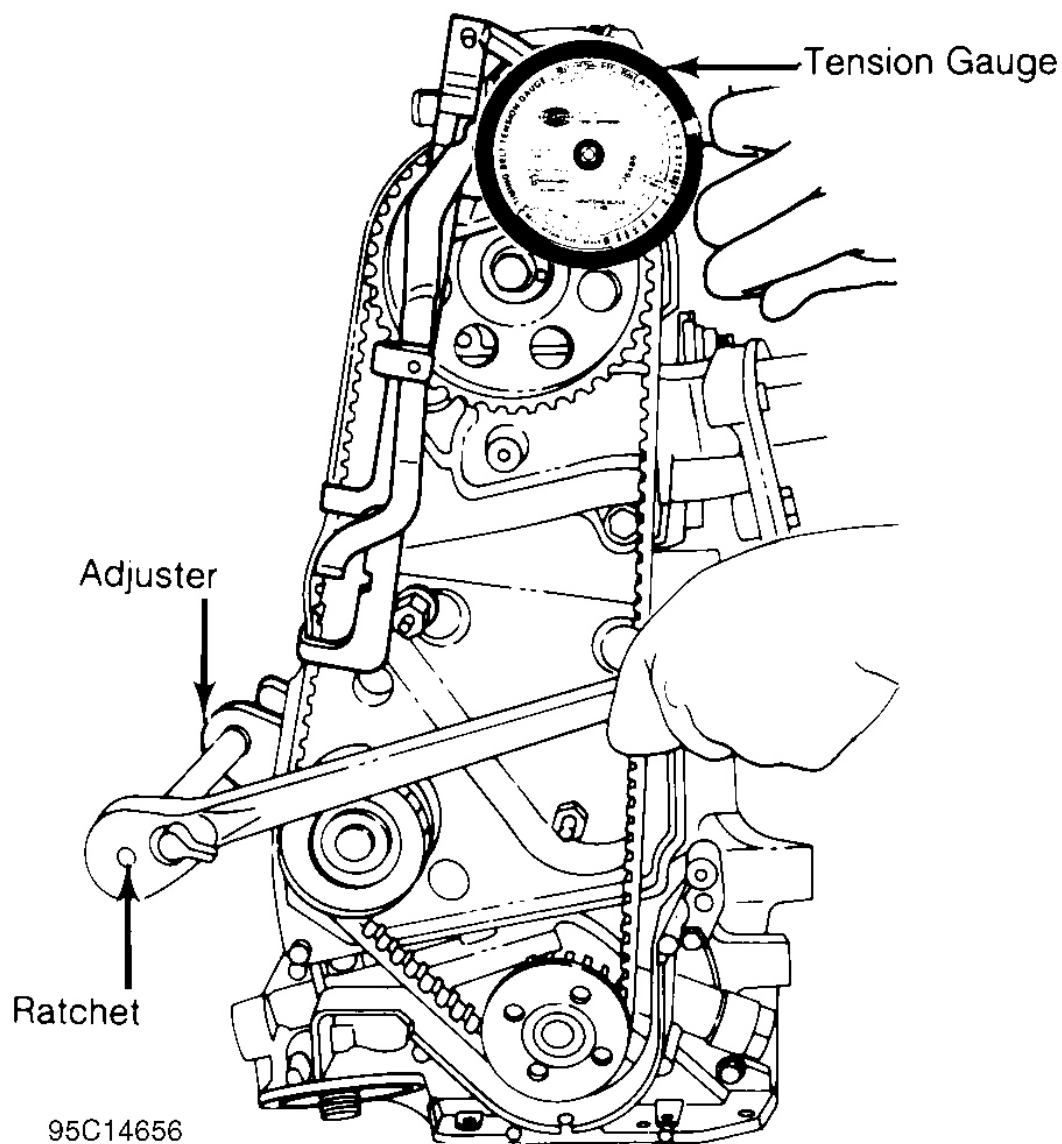


Fig. 26: Adjusting Typical Timing Belt Tension

TIMING GEARS

*** PLEASE READ THIS FIRST ***

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TIMING GEAR BACKLASH & RUNOUT

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On engines where camshaft gear operates directly on crankshaft gear, gear backlash and runout must be checked. To check backlash, install dial indicator with tip resting on tooth of camshaft gear. Rotate camshaft gear as far as possible. Adjust indicator to zero. Rotate camshaft gear in opposite direction as far as possible and note reading.

To determine timing gear runout, mount dial indicator with tip resting on face edge of camshaft gear. Adjust indicator to zero. Rotate camshaft gear 360 degrees and note reading. If backlash or runout exceeds specification, replace camshaft and/or crankshaft gear.

REAR MAIN OIL SEAL INSTALLATION

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One-Piece Type Seal

For one-piece type oil seal installation, coat block contact surface of seal with sealer if seal is not factory coated. Ensure seal surface is free of burrs. Lubricate seal lip with engine oil and press seal into place using proper oil seal installer. See **Fig. 27**.

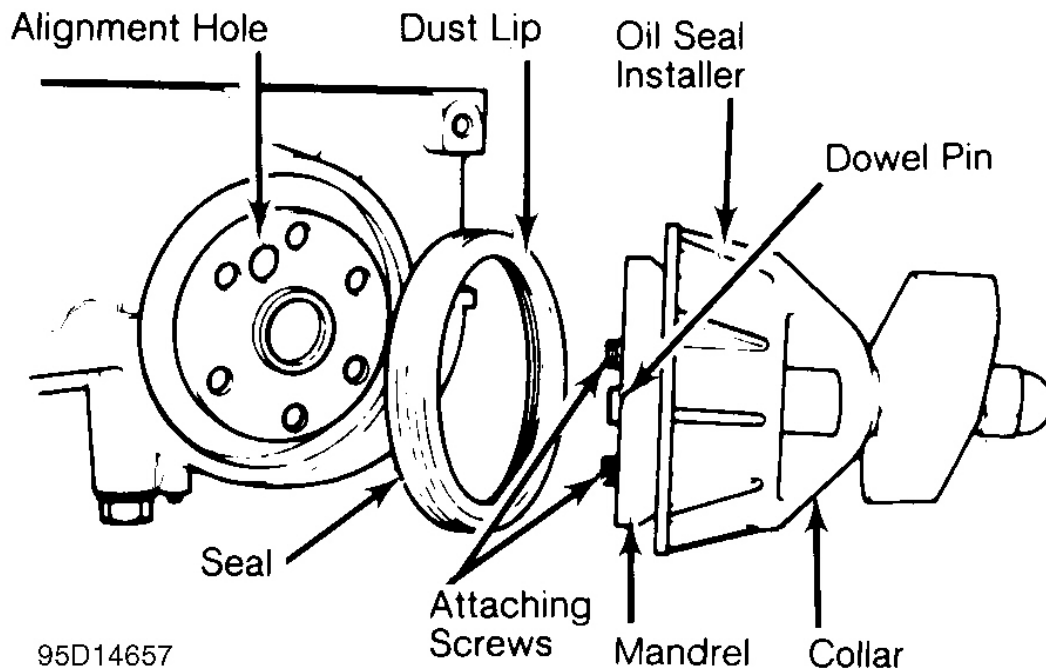


Fig. 27: Installing Typical One-Piece Oil Seal

Rope Type Seal

For rope type rear main oil seal installation, press seal lightly into seat area. Using seal installer, fully seat seal in bearing cap or cylinder block.

Trim seal ends even with cylinder block parting surface. Some applications require sealer to be applied on main bearing cap before installing. See **Fig. 28**.

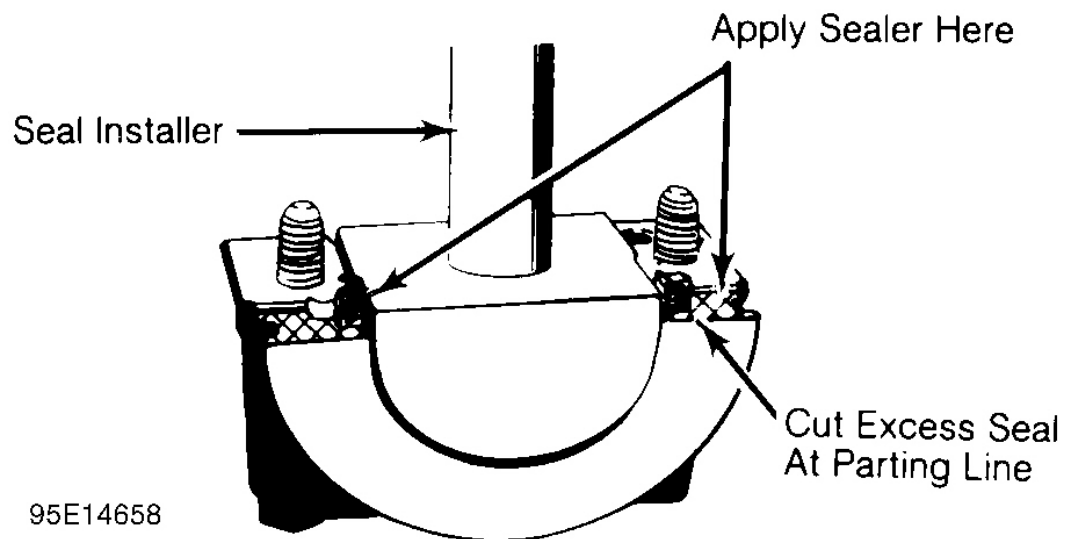


Fig. 28: Installing Typical Rope Seal

Split-Rubber Type Seal

Follow manufacturer's procedures when installing split-rubber type rear main oil seals. Installation procedures vary with manufacturer and engine type. See **Fig. 29**.

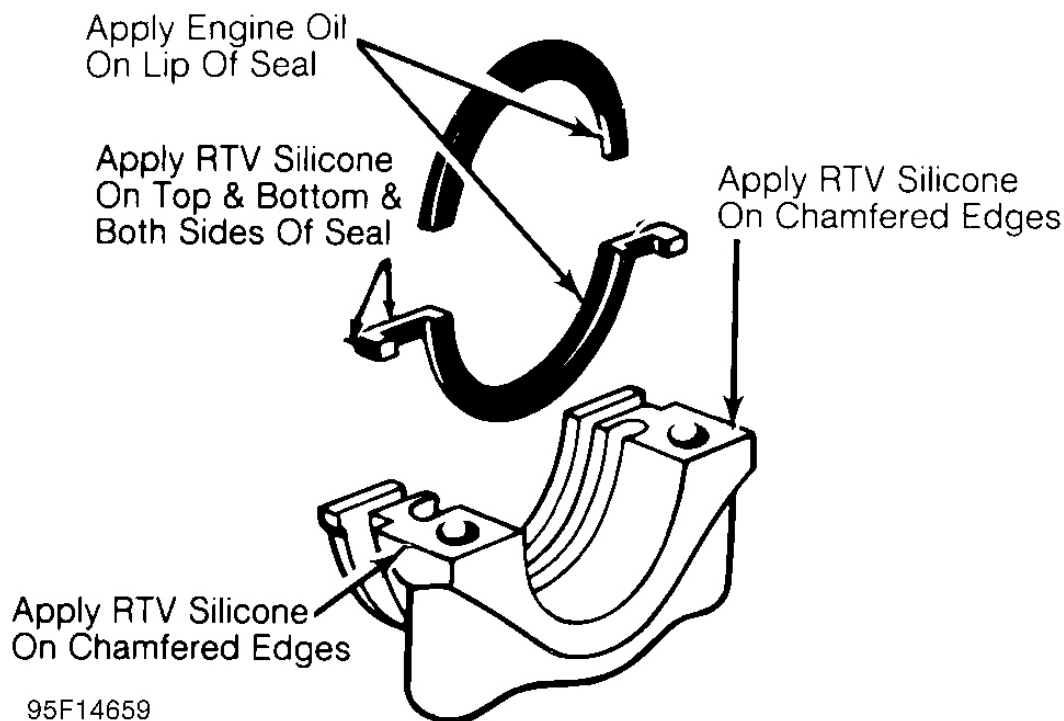


Fig. 29: Installing Typical Split-Rubber Seal

OIL PUMP

*** PLEASE READ THIS FIRST ***

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ROTOR TYPE

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Mark oil pump rotor locations before removing. See **Fig. 30**. Remove outer rotor and measure thickness and diameter. Measure inner rotor thickness. Inspect shaft for scoring or wear. Inspect rotors for pitting or damage. Inspect cover for grooving or wear. Replace worn or damaged components.

Measure outer rotor-to-body clearance. Replace pump assembly if clearance exceeds specification. Measure clearance between rotors. See **Fig. 31**. Replace shaft and both rotors if clearance exceeds specification.

Install rotors in pump body. Position straightedge across pump body. Using feeler gauge, measure clearance between rotors and straightedge. Pump cover wear is measured using a straightedge and feeler gauge. Replace pump if clearance exceeds specification.

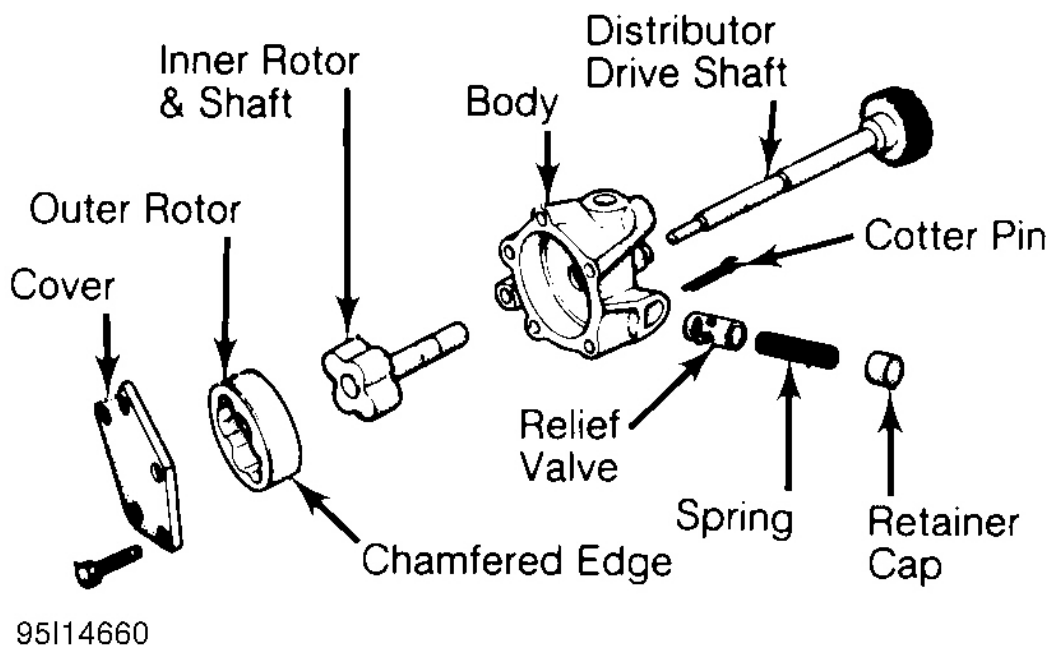


Fig. 30: Typical Rotor Type Oil Pump

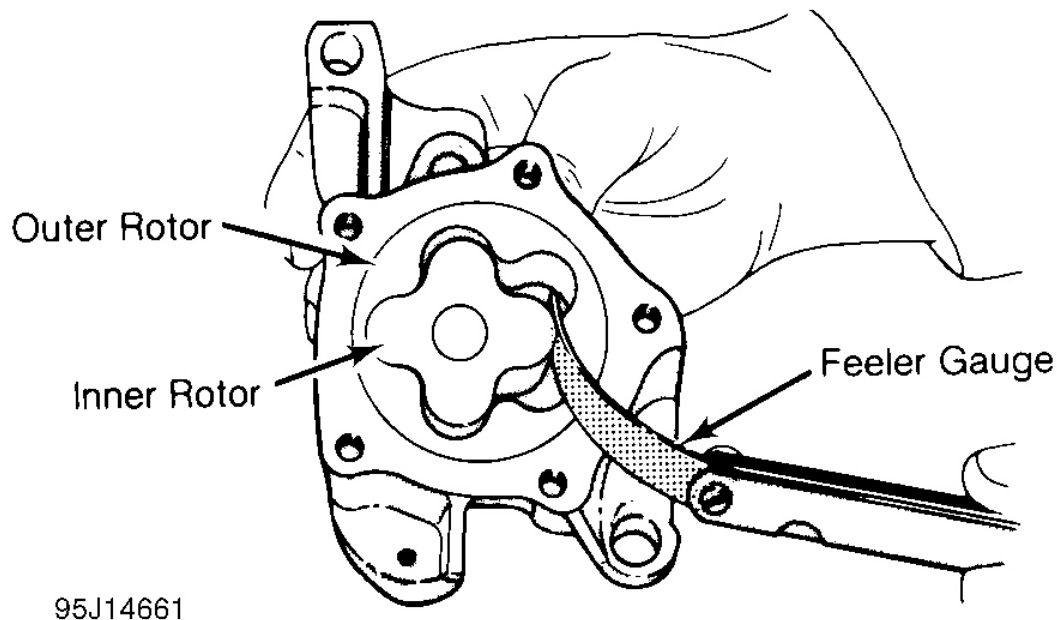


Fig. 31: Measuring Rotor Clearance

GEAR TYPE

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Mark oil pump gear location before removing. See **Fig. 32**. Remove gears from pump body. Inspect gears for pitting or damage. Inspect cover for grooving or wear. Measure gear diameter and length. Measure gear housing cavity depth and diameter. See **Fig. 33**. Replace worn or damaged components.

Pump cover wear is measured using a straightedge and feeler gauge. Replace pump or components if warpage or wear exceeds specification, or mating surface of pump cover is scratched or grooved.

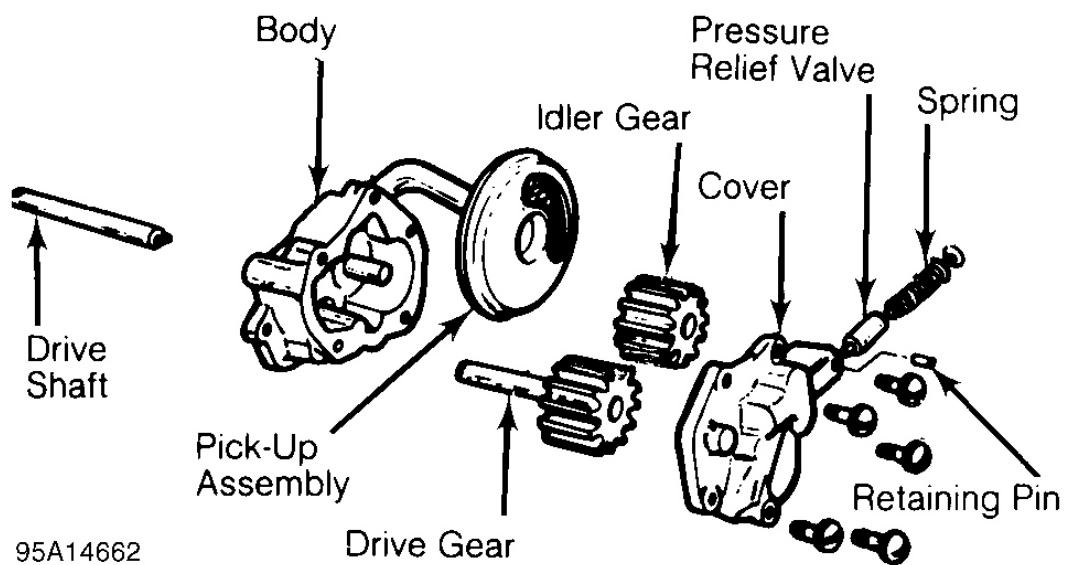
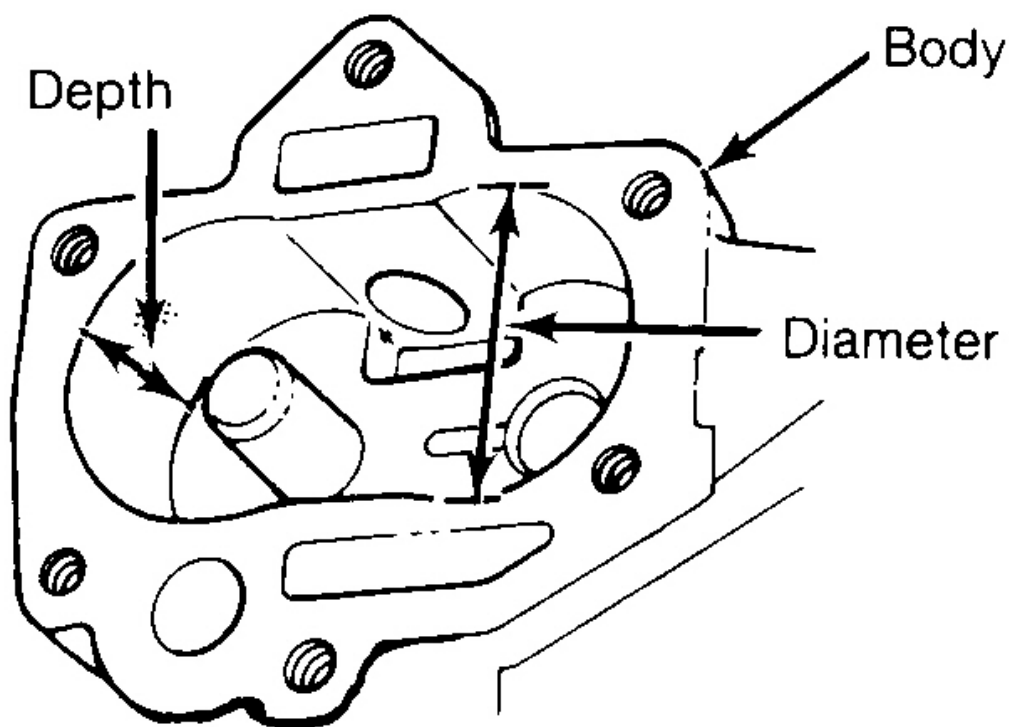


Fig. 32: Typical Gear Type Oil Pump



95B14663

Fig. 33: Measuring Oil Pump Gear Cavity

BREAK-IN PROCEDURE

*** PLEASE READ THIS FIRST ***

NOTE: Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the **ENGINES** section for complete overhaul procedures and specifications for the vehicle being repaired.

ENGINE PRE-OILING

NOTE: Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Pre-oil engine prior to operation to prevent engine damage. Lightly oiled oil pump will cavitate unless oil pump cavities are filled with engine oil or petroleum jelly.

Engine pre-oiling can be done using pressure oiler (if available). Connect pressure oiler to cylinder block oil passage such as oil pressure sending unit. Operate pressure oiler long enough to ensure correct amount of oil has filled crankcase. Check oil level while pre-oiling.

If pressure oiler is not available, disconnect ignition system. Remove oil pressure sending unit and replace with oil pressure test gauge. Using starter motor, rotate engine starter until gauge shows normal oil pressure for several seconds. DO NOT crank engine for more than 30 seconds to avoid starter motor damage. Ensure oil pressure has reached the most distant point from the oil pump.

NOTE: If new lifters or camshaft are installed, some manufacturers require that a crankcase conditioner be added to engine oil. The engine should be operated for specified amount of time to aid in lifter break-in procedure.

INITIAL START-UP

NOTE: Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Start engine and operate engine at low speed while checking for coolant, fuel and oil leaks. Stop engine. Recheck coolant and oil level. Adjust if necessary.

CAMSHAFT

NOTE: Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Break-in procedure is required when new or reground camshaft has been installed. Operate and maintain engine speed between 1500-2500 RPM for approximately 30 minutes. Procedure may vary due to manufacturer's recommendations.

PISTON RINGS

NOTE: Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Piston rings require a break-in procedure to ensure seating of rings to cylinder walls. Serious damage may occur to rings if correct procedures are not followed.

Extremely high piston ring temperatures are obtained during break-in process. If rings are exposed to excessively high RPM or high cylinder pressures, ring damage can occur. Follow piston ring manufacturer's recommended break-in procedure.

FINAL ADJUSTMENTS

NOTE: Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Check or adjust ignition timing and dwell (if applicable). Adjust valves (if necessary). Adjust idle speed and mixture. Retighten cylinder heads (if required). If cylinder head or block is aluminum, retighten bolts when engine is cold. Follow the engine manufacturer's recommended break-in procedure and maintenance schedule for new engines.

NOTE: Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

GENERAL INFORMATION

Engine Performance Diagnostic Routine Outline

*** PLEASE READ THIS FIRST ***

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

WHERE DOES DRIVEABILITY DIAGNOSIS START?

PERFORM BASIC INSPECTION

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

1. Verify Customer Complaint
2. Check for Relevant Technical Service Bulletins (TSBs)
3. Perform Visual Inspection (**See Basic Diagnostic Procedures**)
4. Test Engine Sub-Systems (**See Basic Diagnostic Procedures**)
 - Mechanical Condition (Compression)
 - Ignition Output
 - Fuel Delivery
5. Check Air Induction System For Leaks
6. Check & Adjust Basic Engine Settings(**See On-Vehicle Adjustments**)
 - Ignition Timing
 - Idle Speed

CHECK FOR TROUBLE CODES

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

1. Check for Diagnostic Trouble Codes (DTCs).(See **Self-Diagnostics**)
2. Repair cause of DTCs.
3. Clear PCM memory and repeat self-test.

DIAGNOSE SYMPTOM

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

1. If no self-diagnostics available, or no trouble codes present, identify symptom.
2. See trouble shooting procedure to identify problem. (See **Trouble Shooting - No Codes**)

TEST SYSTEM

NOTE: This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the **ENGINE PERFORMANCE** category.

1. Perform required tests. (See **Systems & Component Testing**)
2. Verify complaint is repaired.

ACCESSORIES & EQUIPMENT

Exterior Trim

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Front Side Door Window Frame Rear Cover Fastener	2	18 lb ft
Rear Side Door Window Frame Front Cover Fastener	2	18 lb ft

REPAIR INSTRUCTIONS

BODY PANEL PAINT PROTECTOR REPLACEMENT (VGC)

1. The paint protective film and vehicle surface temperature should be 13-32°C (55-90°F) for best results.
2. Automatic car washes should be avoided for at least 24 hours after the paint protective film application.
3. Wipe the vehicle surface with isopropyl alcohol or flash naptha at the application area.
4. Dry the surface with a clean lint-free cloth.
5. Create a mixture of 25 percent isopropyl alcohol and 75 percent water and two drops of baby shampoo per 16 oz of fluid mixture.
6. Remove the backing liner from the protective film patch.
7. Use the solution to liberally spray the adhesive side of the protective patch, the mounting location along with your hands.
8. Position the paint protective film patch to the desired location on the vehicle.
9. Spray the surface of the film with the alcohol, water and soap solution.
10. Using a dampened squeegee, start at the center of the protective patch, working outward in order to remove the air and solution from under the protective patch.
11. Release any air bubbles with a pin.
12. Dry the surface with a clean, lint-free cotton cloth.

REAR CLOSURE CENTER APPLIQUE REPLACEMENT

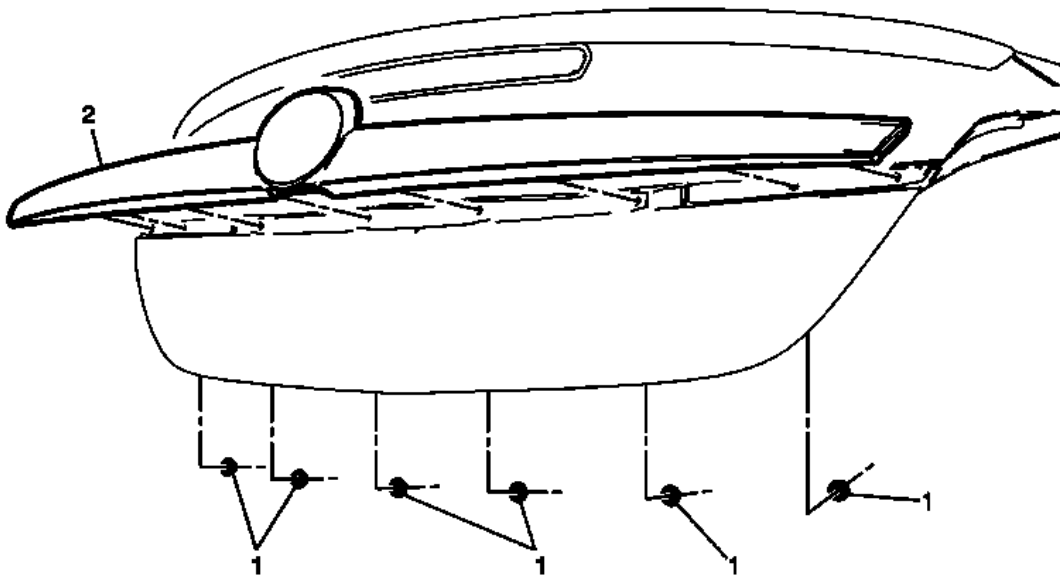


Fig. 1: Rear Closure Center Applique
 Courtesy of GENERAL MOTORS COMPANY

Rear Closure Center Applique Replacement

Callout	Component Name
Preliminary Procedure Remove rear compartment lid inner panel trim. Refer to <u>Rear Compartment Lid Inner Panel Trim Replacement</u> .	
1	Rear Closure Center Applique Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 6 (53 lb in)
2	Rear Closure Center Applique Procedure <ol style="list-style-type: none"> 1. Release the two retainers at each end of the rear closure center applique. 2. Disconnect the electrical connector. 3. Transfer components as necessary.

FRONT BUMPER FASCIA TOW EYE ACCESS HOLE COVER REPLACEMENT

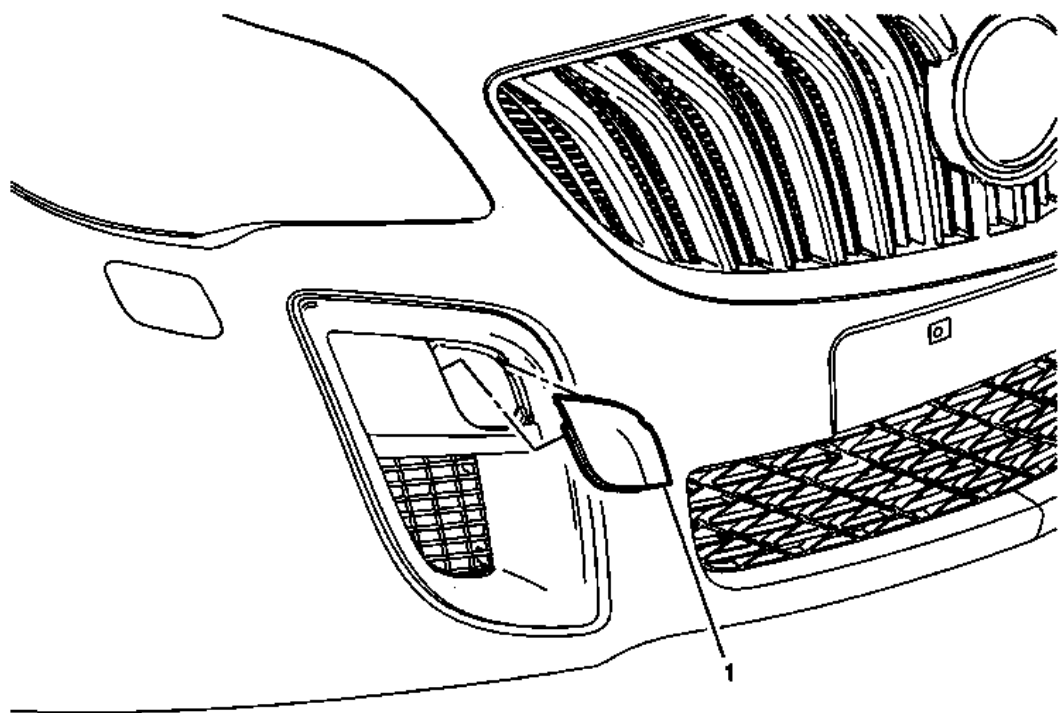


Fig. 2: Front Bumper Fascia Tow Eye Access Hole Cover
Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Tow Eye Access Hole Cover Replacement

Callout	Component Name
1	Rear Bumper Fascia Tow Eye Access Hole Cover Procedure Using a small plastic flat-bladed tool release the upper right locking tab and pull up and out from the rear bumper fascia.

REAR BUMPER FASCIA TOW EYE ACCESS HOLE COVER REPLACEMENT

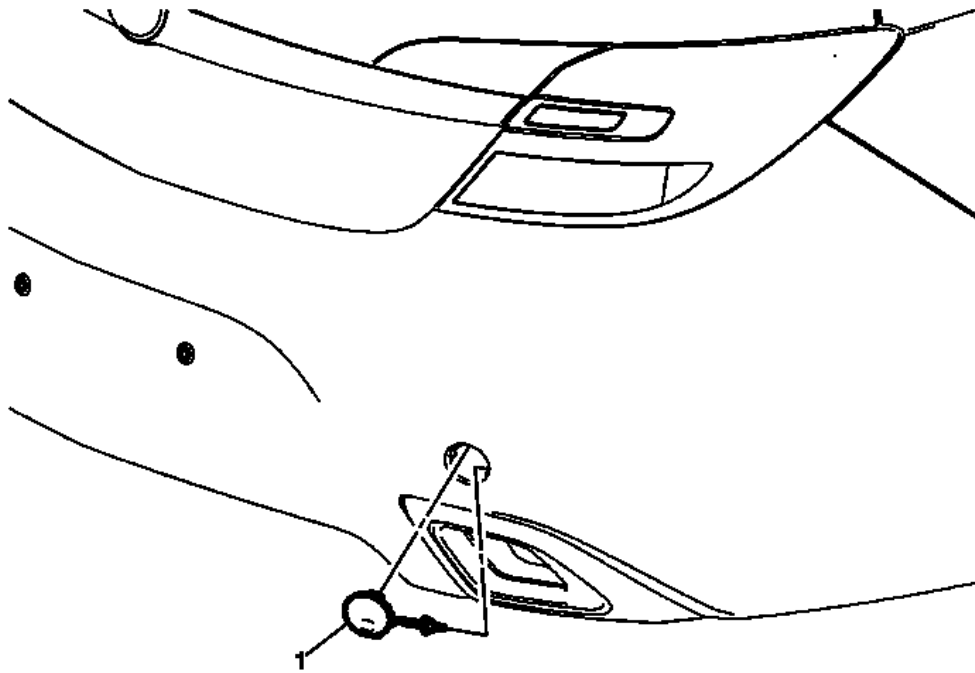


Fig. 3: Rear Bumper Fascia Tow Eye Access Hole Cover
Courtesy of GENERAL MOTORS COMPANY

Rear Bumper Fascia Tow Eye Access Hole Cover Replacement

Callout	Component Name
1	Rear Bumper Fascia Tow Eye Access Hole Cover Procedure <ol style="list-style-type: none"> 1. Using a small plastic flat-bladed tool release the bottom locking tab and pull down from the rear bumper fascia. 2. Using needle nose pliers release the v-notch hook from the retainer hole in the rear bumper fascia and remove.

FRONT SIDE DOOR WINDOW FRAME REAR COVER REPLACEMENT

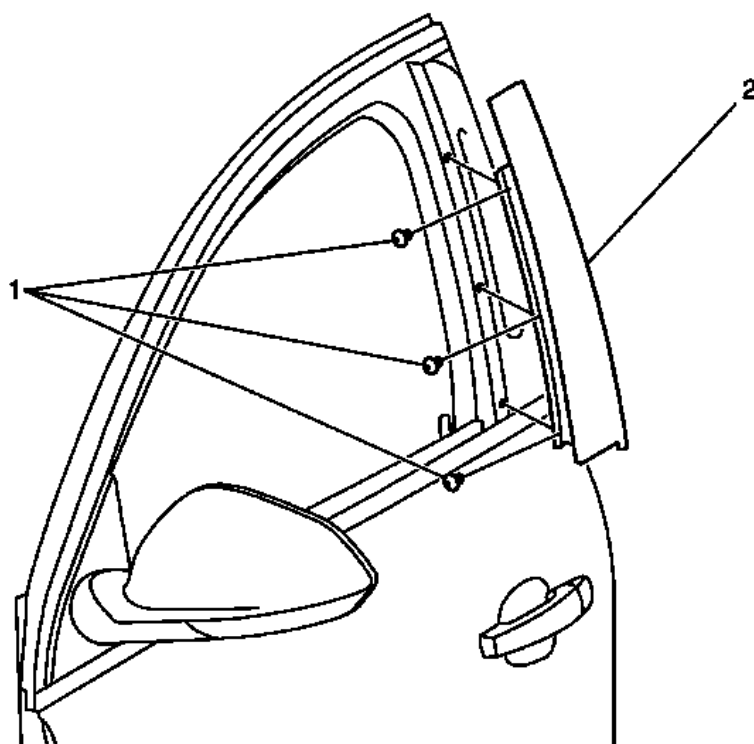


Fig. 4: Front Door Frame Rear Cover & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Frame Rear Cover Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Place the front door window in the full down position. 2. Remove the front side door window outer sealing strip. Refer to <u>Front Side Door Window Outer Sealing Strip Replacement</u> . 	
1	Front Side Door Window Frame Rear Cover Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Pull the front side door window weatherstrip from the applique to expose the fasteners. Tighten 2 N.m (18 lb in)
2	Front Side Door Window Frame Rear Cover

REAR SIDE DOOR WINDOW FRAME FRONT COVER REPLACEMENT

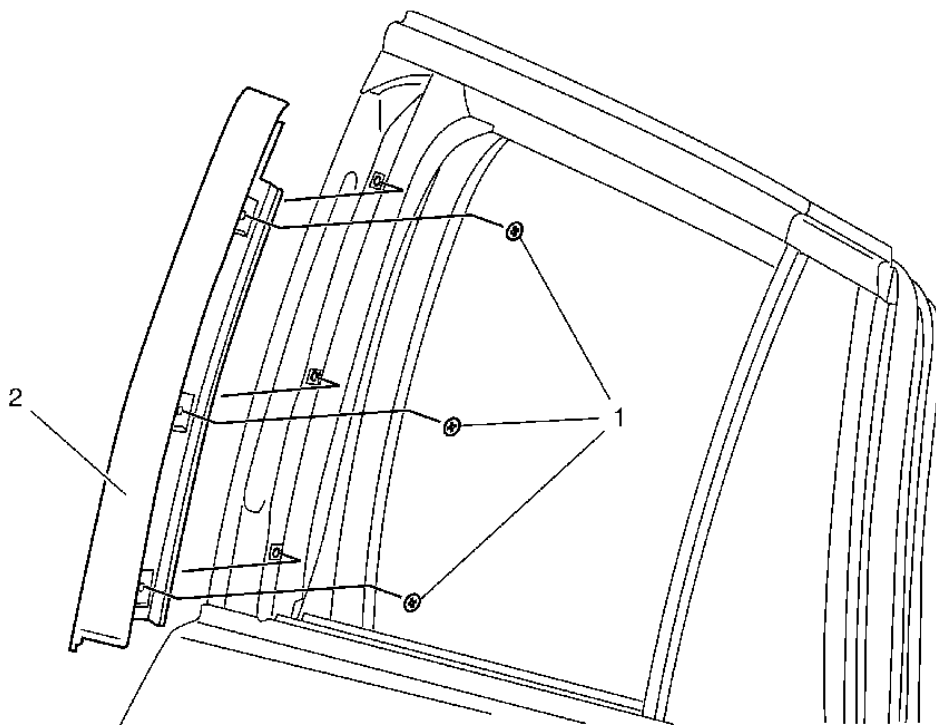


Fig. 5: Rear Side Door Window Frame Front Cover
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Window Frame Front Cover Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Place the rear door window in the full down position. 2. Remove the rear side door window outer sealing strip. Refer to <u>Rear Side Door Window Outer Sealing Strip Replacement</u> . 	
1	Rear Side Door Window Frame Front Cover Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Pull the rear side door window weatherstrip from the applique to expose the fasteners. Tighten 2 N.m (18 lb in)
2	Rear Side Door Window Frame Front Cover

FRONT BUMPER FASCIA OUTER INSERT REPLACEMENT

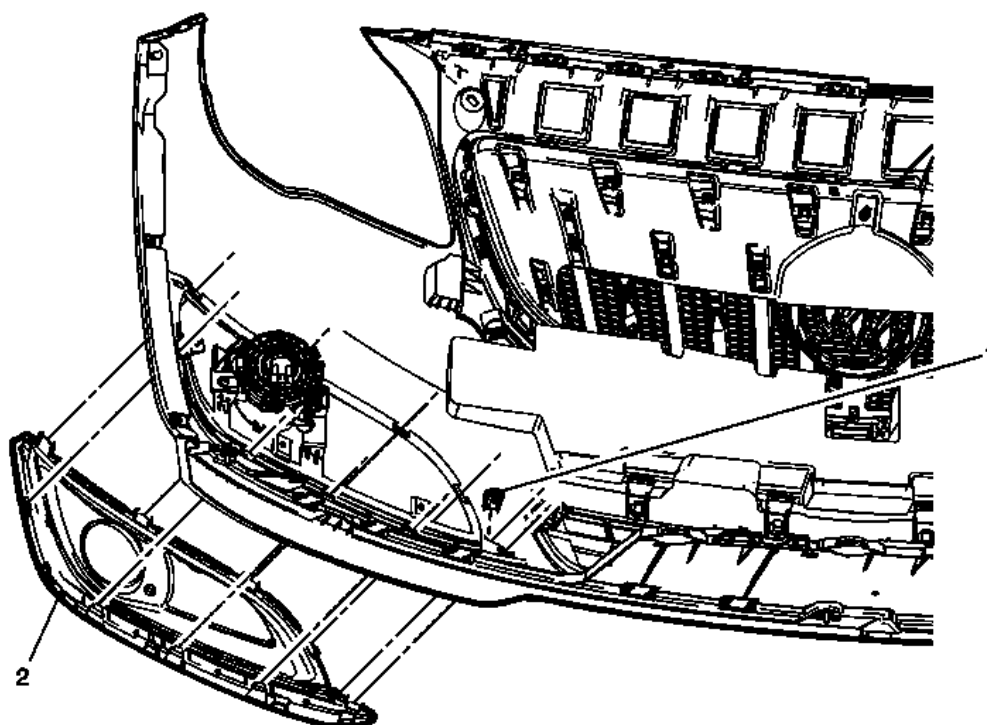


Fig. 6: Front Bumper Fascia Outer Insert
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Outer Insert Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Front Bumper Fascia Outer Insert Molding Retainer
2	Front Bumper Fascia Outer Insert CAUTION: Refer to <u>Exterior Trim Emblem Removal Caution</u> . Procedure Release the 9 locking tabs on the front bumper fascia outer insert and pull from the front bumper fascia.

FRONT GRILLE EMBLEM/NAMEPLATE REPLACEMENT

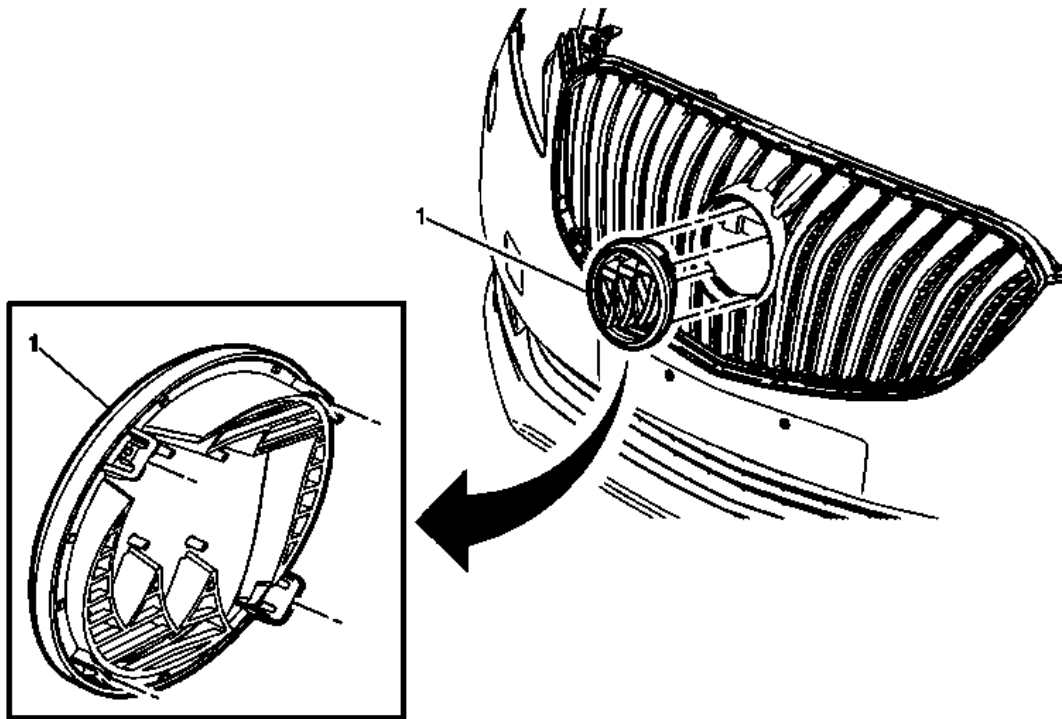


Fig. 7: Front Grille Emblem/Nameplate
 Courtesy of GENERAL MOTORS COMPANY

Front Grille Emblem/Nameplate Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Front Grille Emblem Procedure Using a suitable flat bladed tool release the 4 locking tabs and pull the front grille emblem forward.

FRONT GRILLE REPLACEMENT

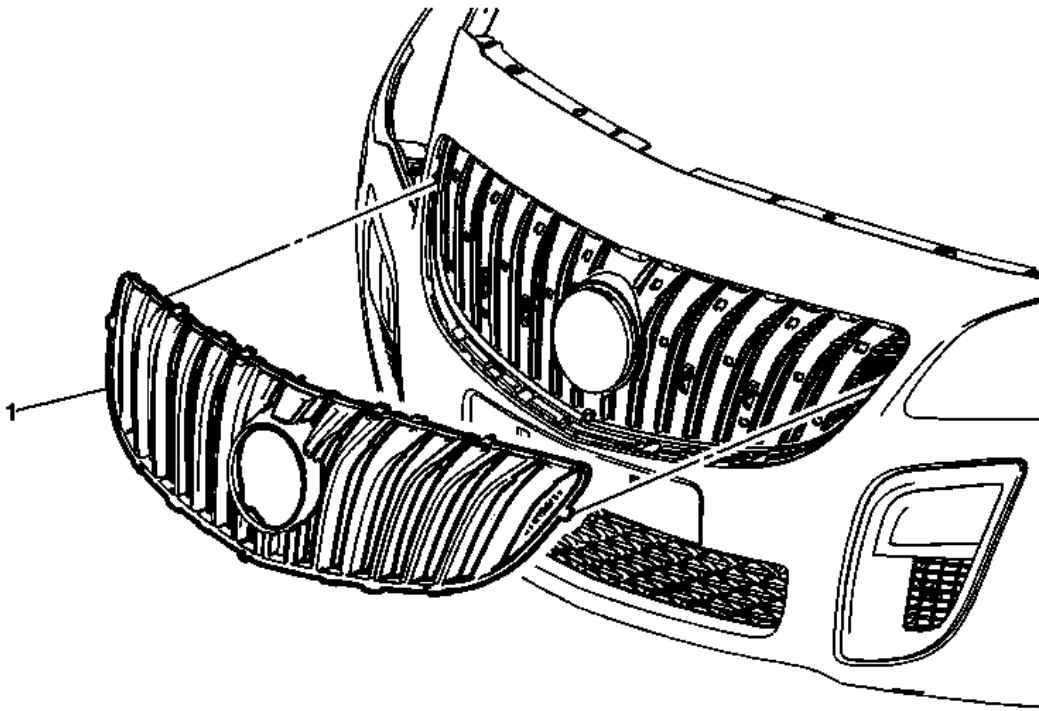


Fig. 8: Front Grille
Courtesy of GENERAL MOTORS COMPANY

Front Grille Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Radiator Upper Grille Procedure Release the locking tabs from the front grille and pull from the front bumper fascia.

FRONT LOWER GRILLE REPLACEMENT

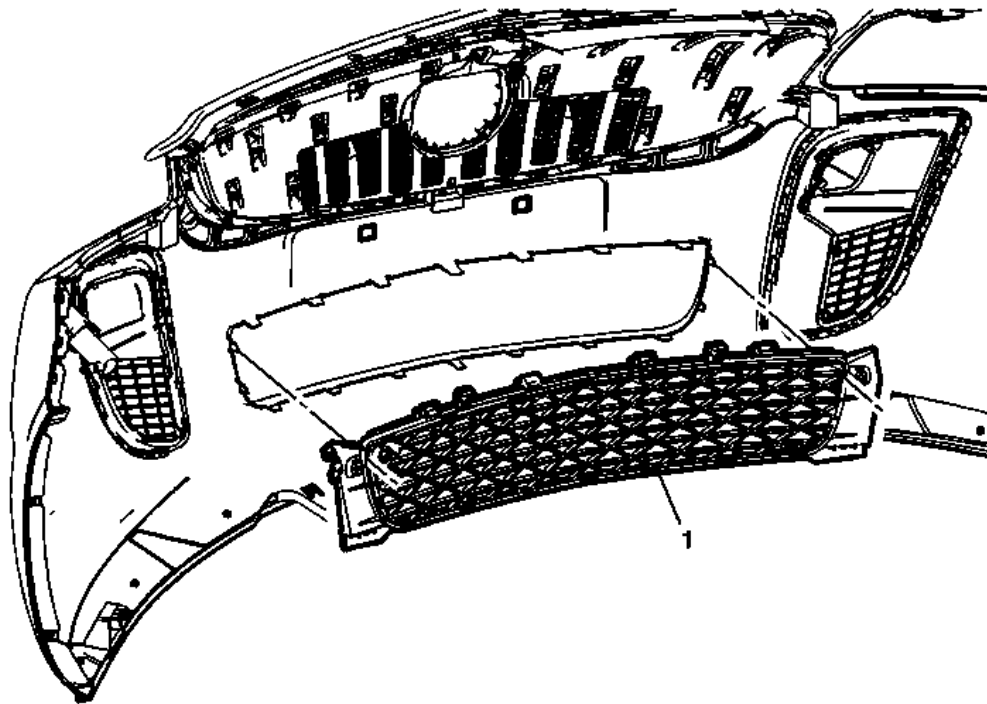


Fig. 9: Front Lower Grille

Courtesy of GENERAL MOTORS COMPANY

Front Lower Grille Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Front Lower Grille Procedure Release the locking tabs on the front lower grille and pull from the front bumper fascia.

FRONT BUMPER FASCIA OUTER INSERT MOLDING REPLACEMENT (GS)

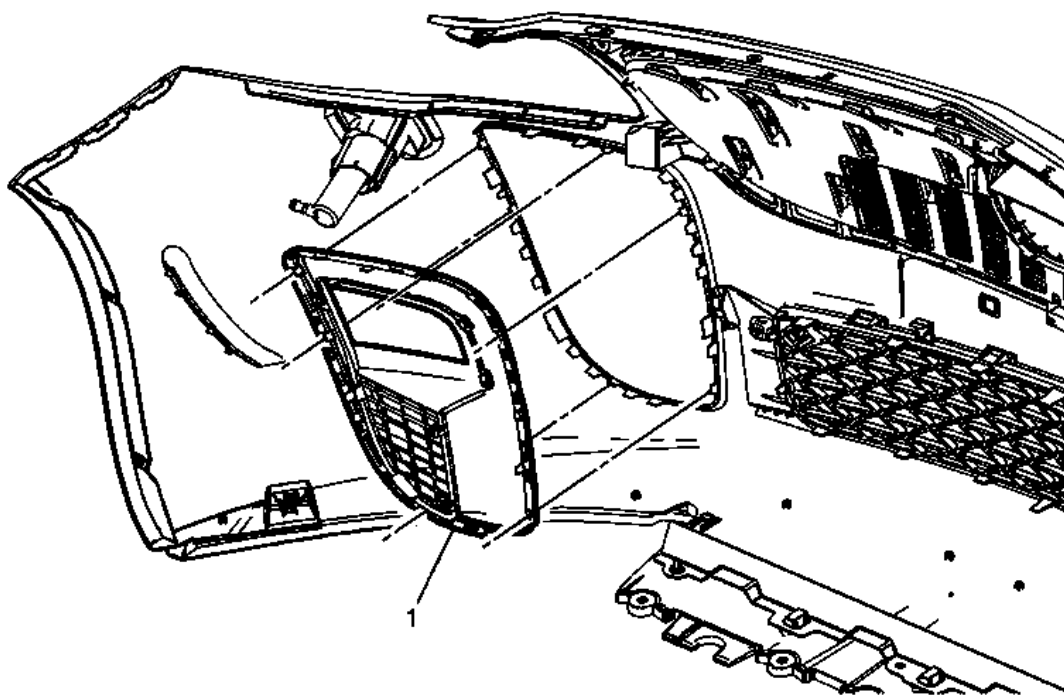


Fig. 10: Front Bumper Fascia Outer Insert Molding (GS)

Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Outer Insert Molding Replacement (GS)

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Front Bumper Fascia Outer Insert Molding Procedure Release the locking tabs on the front bumper fascia outer insert molding and pull from the front bumper fascia.

FRONT BUMPER FASCIA OUTER INSERT MOLDING REPLACEMENT

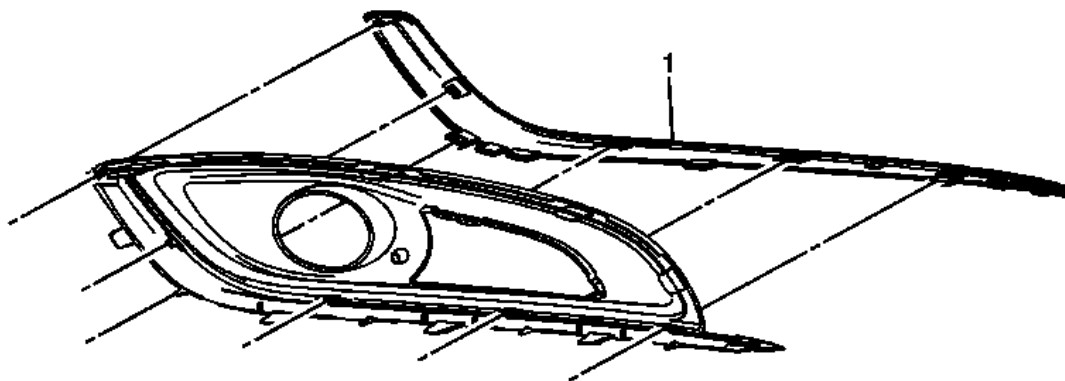


Fig. 11: Front Bumper Fascia Outer Insert Molding
Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Outer Insert Molding Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia outer insert. Refer to <u>Front Bumper Fascia Outer Insert Replacement.</u>	
1	Front Bumper Fascia Outer Insert Molding CAUTION: Refer to <u>Exterior Trim Emblem Removal Caution .</u> Procedure Release the 6 locking tabs on the front bumper fascia outer insert molding and pull from the front bumper fascia outer insert.

FRONT BUMPER FASCIA UPPER MOLDING REPLACEMENT

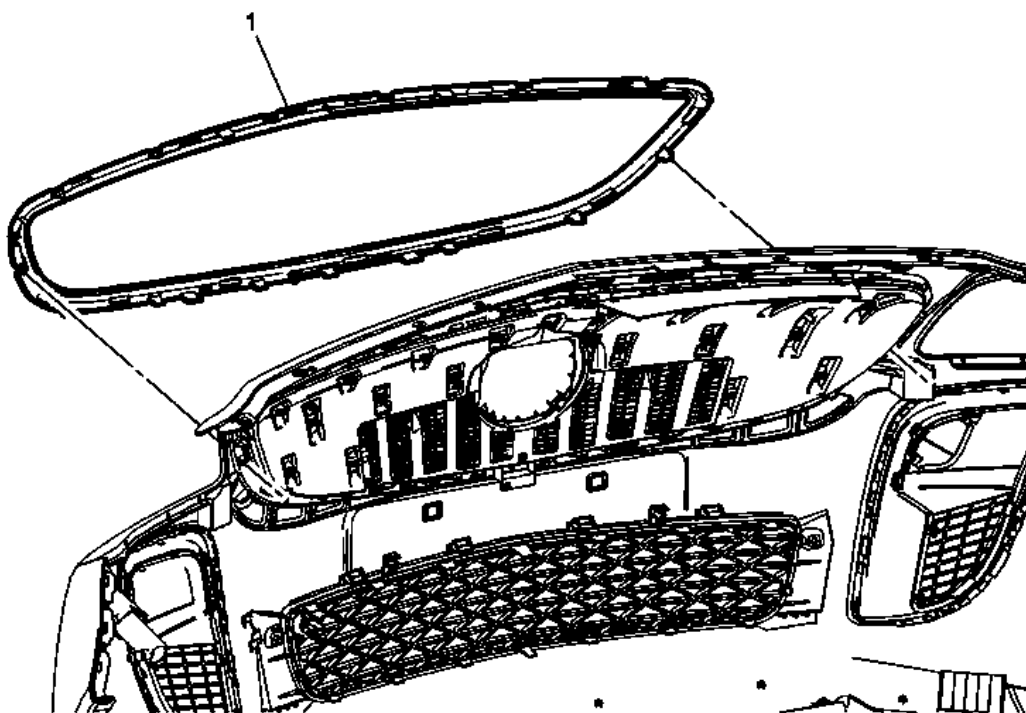


Fig. 12: Front Bumper Fascia Upper Molding
 Courtesy of GENERAL MOTORS COMPANY

Front Bumper Fascia Upper Molding Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Front Bumper Fascia Upper Molding Procedure Release the locking tabs on the front bumper fascia upper molding and pull from the front bumper fascia.

ROCKER PANEL MOLDING REPLACEMENT

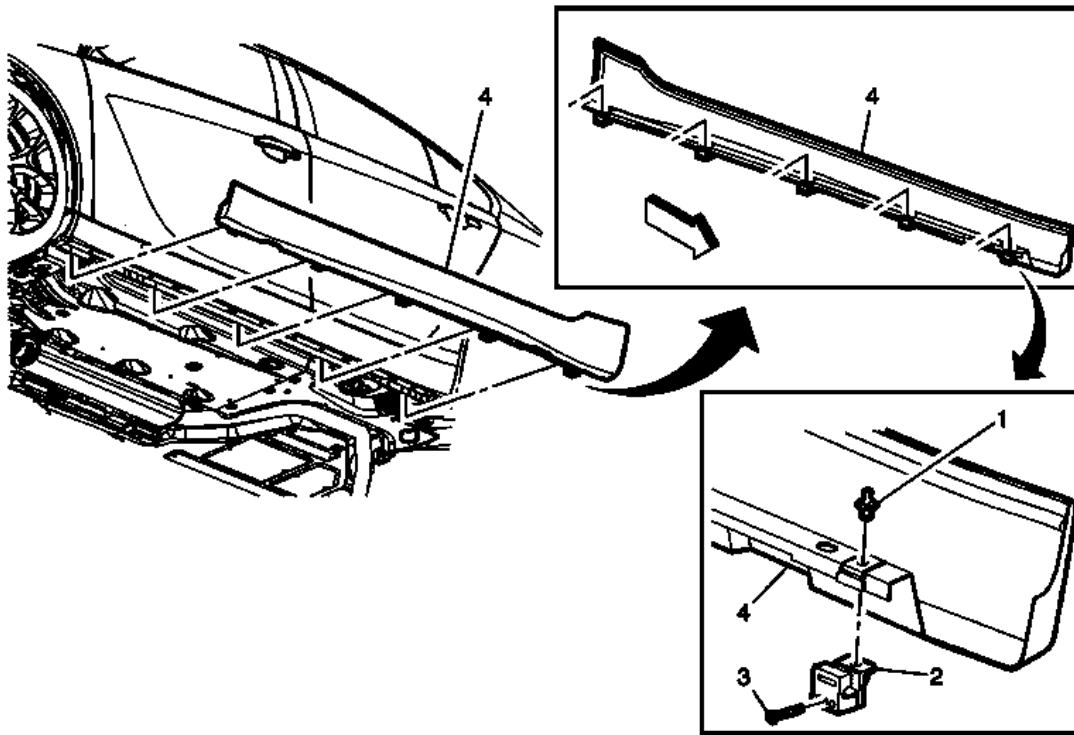


Fig. 13: Rocker Panel Molding & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Rocker Panel Molding Replacement

Callout	Component Name
1	Rocker Panel Finish Panel Rivet (Qty: 5) CAUTION: Refer to <u>Eye Protection Warning</u> . CAUTION: Refer to <u>Fastener Caution</u> .
2	Rocker Panel Molding Bracket (Qty: 5)
3	Rocker Panel Molding Bolt (Qty: 5) CAUTION: Refer to <u>Fastener Caution</u> .
	Rocker Panel Molding Procedure 1. The part and surface should be 21°C (70°F) prior to installation. The vehicle should remain 21°C (70°F) for one hour after assembly to allow adhesive to develop sufficient bond strength.

4

2. Using a heat gun in a circular motion, warm the rocker panel molding in order to help remove the adhesive.
3. From the bottom edge firmly pull out and up to remove the rocker panel molding from the rocker panel. Use a flat bladed plastic tool to assist in removal.
4. Clean and prime the rocker panel and the new rocker panel molding with a suitable cleaner and primer before installing.
5. Use an appropriate tape to hold rocker panel molding in position while adhesive cures.

REAR END SPOILER REPLACEMENT

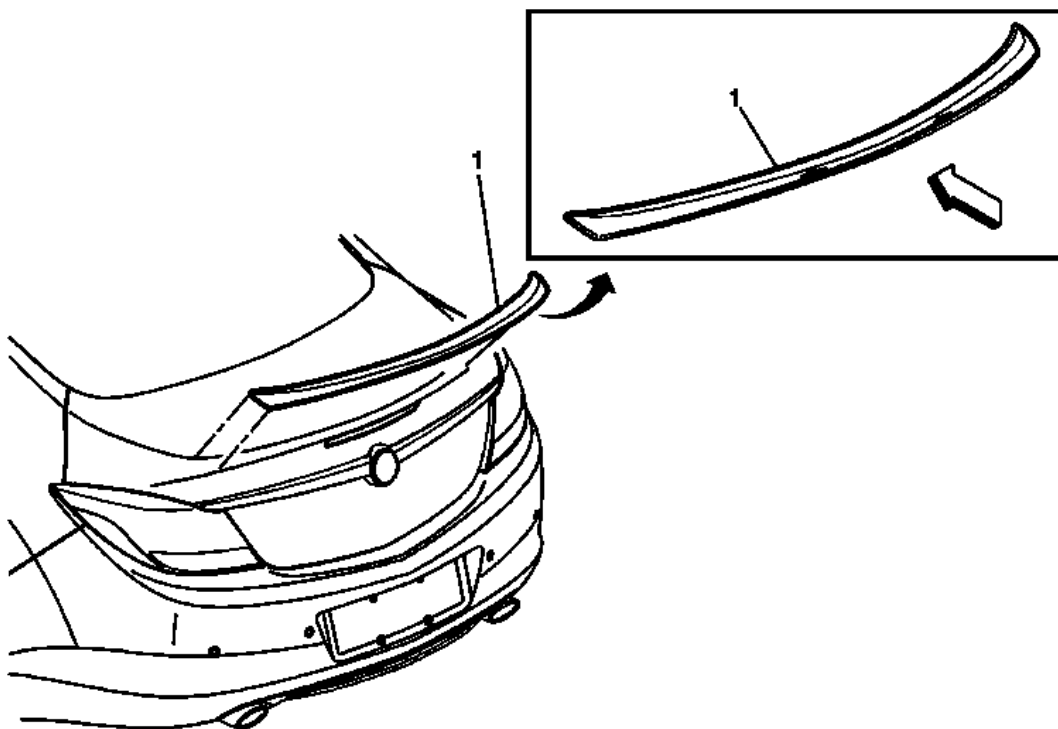


Fig. 14: Rear End Spoiler

Courtesy of GENERAL MOTORS COMPANY

Rear End Spoiler Replacement

Callout	Component Name
	Rear End Spoiler
	Procedure <ol style="list-style-type: none"> 1. The part and surface should be 21°C (70°F) prior to installation. The vehicle should remain 21°C (70°F) for one hour after assembly to allow adhesive to develop sufficient bond strength. 2. Outline the rear end spoiler with masking tape for alignment when reinstalling.

1	<ol style="list-style-type: none"> 3. Use a heat gun in a circular motion to remove the rear end spoiler. Use a flat bladed plastic tool to assist in removal. 4. Clean any left over adhesive residue with a 50/50 mixture by volume of isopropyl alcohol and clean drinkable water. Wipe the surface dry with a clean lint-free towel. 5. When removing protective liners from the adhesive tape, be careful not to touch tape with hands and do not allow tape to come in contact with dirt or any foreign matter prior to adhesion. 6. Using the palm of the hand apply equal pressure to the rear end spoiler to ensure full adhesion to the rear compartment lid.
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DESCRIPTION AND OPERATION

ADHESIVE RETAINED MOLDING AND EMBLEM DESCRIPTION

CAUTION: Use of harsh chemicals when cleaning can damage exterior lamps. Suggested cleaners are a mild soap and water, or Varnish Makers and Painters (VM&P) Naptha. VM&P Naptha is a specific type of naptha and should not be substituted by any other naptha.

The following components are attached to the body panels with adhesive tape.

The name plates.

In order to ensure a good replacement of new or old moldings, emblems and name plates, take the following precautions:

- Warm the panel surface to between 21-32°C (70-90°F).
- Clean the panels.
- Remove any wax or oily film.

The following methods for attachment are listed:

Replacement nameplates.

WATER MANAGEMENT DESCRIPTION AND OPERATION

Plenum Water Flow Direction and Cleaning

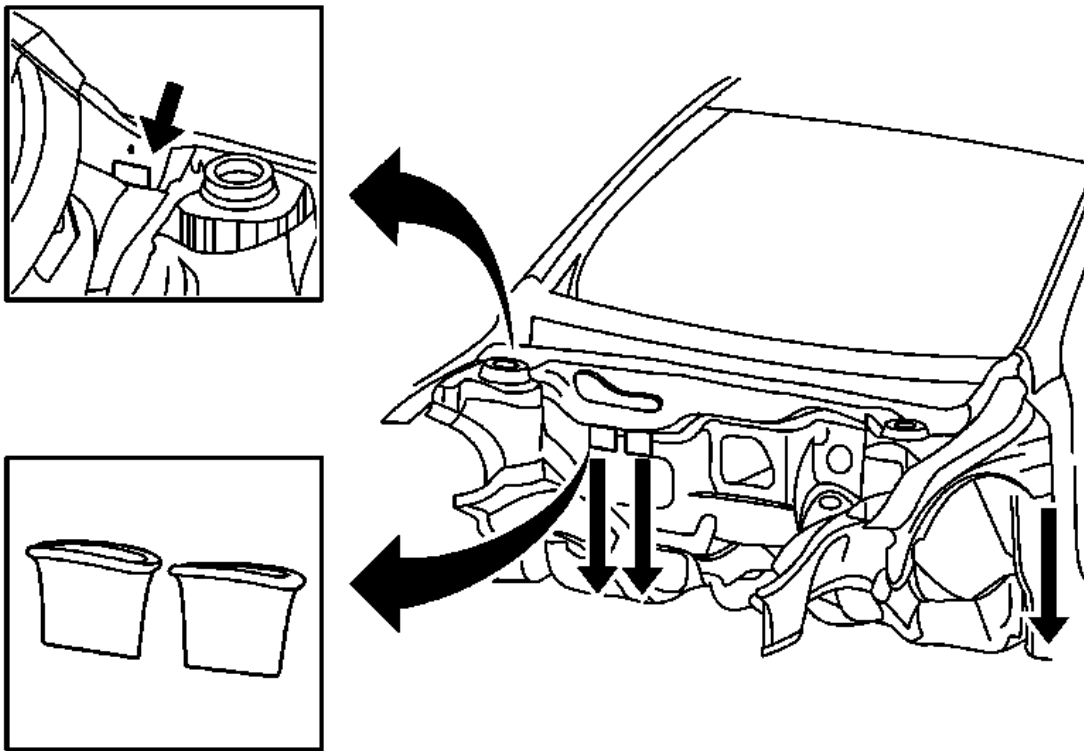


Fig. 15: Plenum Water Flow Direction
 Courtesy of GENERAL MOTORS COMPANY

A large percentage of water will flow off the windshield area into the plenum chamber drain system and then down the outside on the plenum to the underside of the vehicle. To ensure that the plenum chamber water management system performs properly, the plenum water deflector, plenum chamber, and drains must not be blocked with debris.

In the graphic the arrows show the water flow direction in the plenum chamber and drains system.

Plenum Chamber and Drain Valve-Cleaning

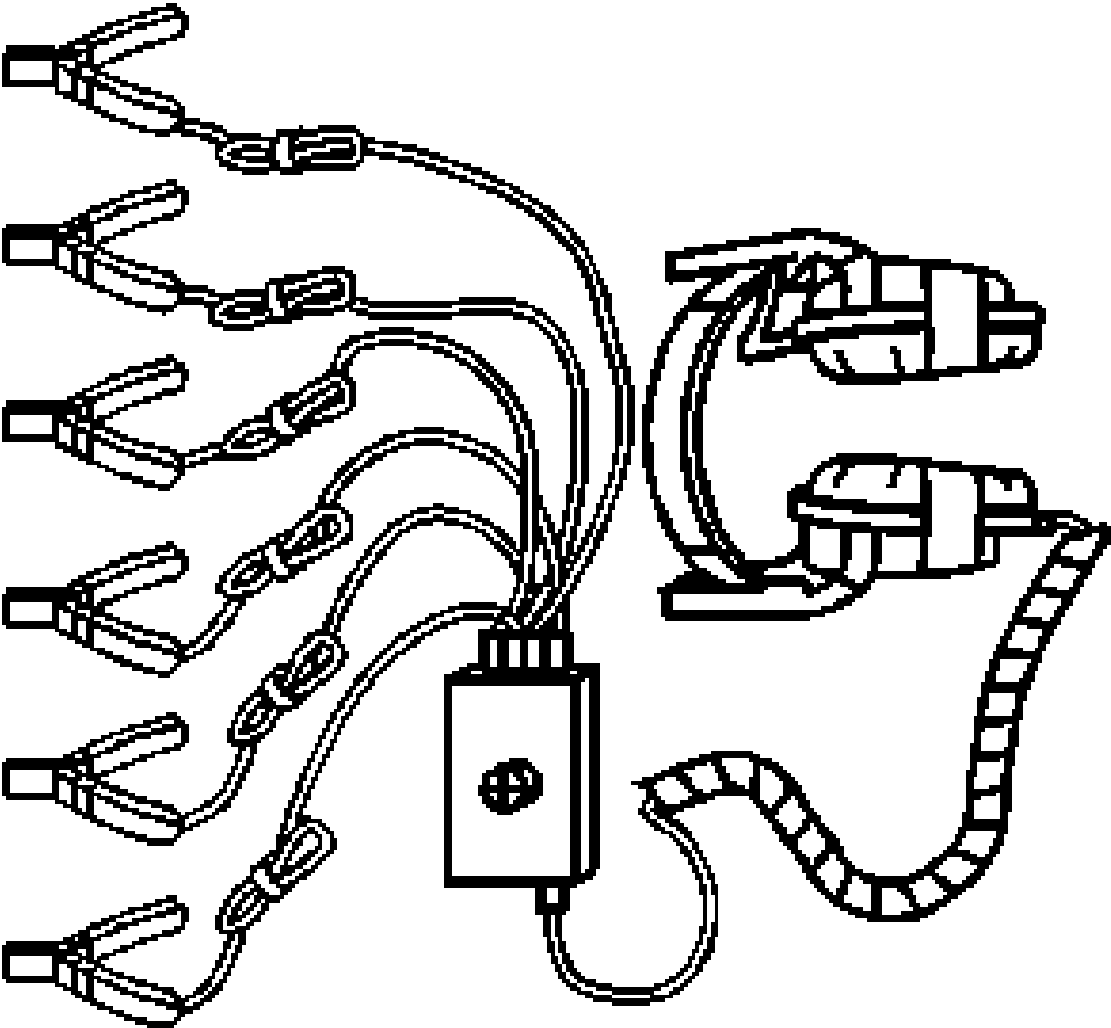
The plenum chamber is located in front of the windshield and below the plenum water deflector.

1. Remove the air inlet panel. Refer to [**Air Inlet Grille Panel Replacement**](#) .
2. Clean the plenum chamber, drains and the plenum water deflector of debris blockage.
3. Flush the plenum chamber, drains and the plenum water deflector with clean water.
4. Install the air inlet panel. Refer to [**Air Inlet Grille Panel Replacement**](#) .

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

	Tool Number/
--	-------------------------

Illustration	Description
	<p>J 25070 Heat Gun- 500-700°F</p>

ENGINE PERFORMANCE

Firing Order & Cylinder Identification - GM, & Saturn - All Models

FIRING ORDER & CYLINDER IDENTIFICATION

NOTE: This information is intended as a quick reference for firing order and cylinder identification only. The information provided covers many vehicles and may include some information that does not apply to the vehicle you have currently selected.

3 CYLINDER ENGINE

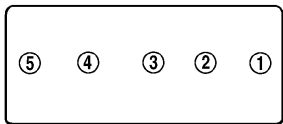
Engine Configuration	Firing Order	Cylinder Identification
In-Line 3	1-3-2	<div><div>FRONT</div><div><div>①</div><div>②</div><div>③</div></div><div>G00016189</div></div>

4 CYLINDER ENGINE

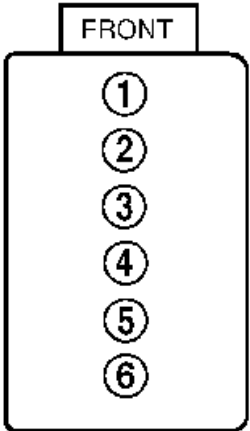
Engine Configuration	Firing Order	Cylinder Identification
In-Line 4	1-3-4-2	<div><div>FRONT</div><div><div>①</div><div>②</div><div>③</div><div>④</div></div><div>G00016200</div></div>

5 CYLINDER ENGINE

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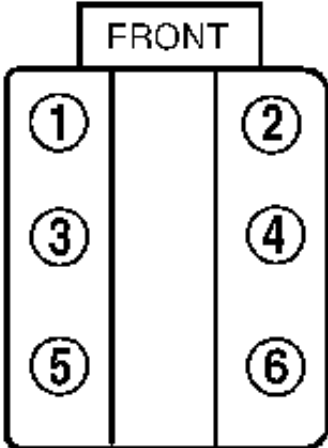
Engine Configuration	Firing Order	Cylinder Identification
In-Line 5	1-3-5-4-2	<p>FRONT OF ENGINE →</p>  <p>G00016208</p>

IN-LINE 6 ENGINE

Engine Configuration	Firing Order	Cylinder Identification
In-Line 6	1-5-3-6-2-4	<p>FRONT</p>  <p>G00016201</p>

V6 ENGINE

2.5L V6 Engine - Tracker

Engine Configuration	Firing Order	Cylinder Identification
2.5L Tracker	1-2-3-4-5-6	<p>FRONT</p>  <p>G00016202</p>

3.5L VIN 4 V6 Engine

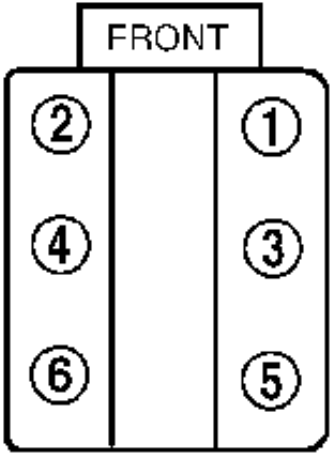
Engine Configuration	Firing Order	Cylinder Identification
3.5L VIN 4	1-4-2-5-3-6	<div><div>FRONT</div><div><div>④</div><div>⑤</div><div>⑥</div></div><div><div>①</div><div>②</div><div>③</div></div></div> <div>G00016204</div>

3.8L & 4.3L V6 Engines

Engine Configuration	Firing Order	Cylinder Identification
3.8L & 4.3L	1-6-5-4-3-2	<div><div>FRONT</div><div><div>①</div><div>③</div><div>⑤</div></div><div><div>②</div><div>④</div><div>⑥</div></div></div> <div>G00016202</div>

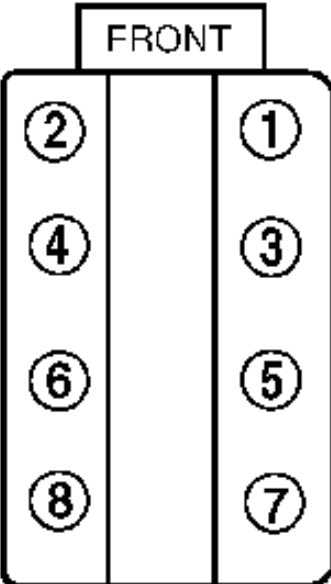
All Other V6 Engines

Engine Configuration	Firing Order	Cylinder Identification

All Others	1-2-3-4-5-6	 <p>G00016203</p>
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8 CYLINDER ENGINE

4.0L, 4.4L & 4.6L V8 Engines

Engine Configuration	Firing Order	Cylinder Identification
4.0L, 4.4L, 4.6L	1-2-7-3-4-5-6-8	 <p>G00016206</p>

5.0L, 5.7L (VIN R & VIN K) & 7.4L V8 Engines

Engine Configuration	Firing Order	Cylinder Identification

5.0L, 5.7L (VIN R & K), 7.4L	1-8-4-3-6-5-7-2	<div style="text-align: center;"> <div>FRONT</div> </div> <p>G00016205</p>
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6.6L Diesel V8 Engine

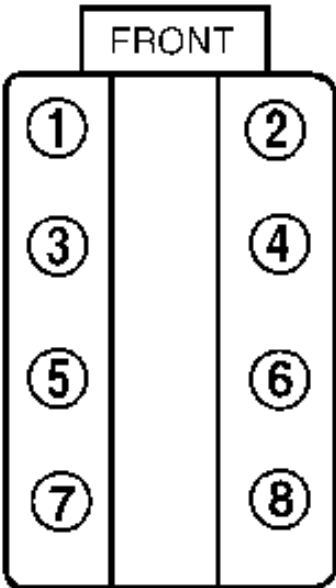
Engine Configuration	Firing Order	Cylinder Identification
6.6L Diesel	1-2-7-8-4-5-6-3	<div style="text-align: center;"> <div>FRONT</div> </div> <p>G00016206</p>

All Other V8 Engines

Engine Configuration	Firing Order	Cylinder Identification

All Others

1-8-7-2-6-5-4-3



G00016205

ACCESSORIES & EQUIPMENT

Fixed and Moveable Windows

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Side Door Window Rear Channel Fasteners	10 N.m	89 lb in
Front Side Door Window Regulator Fastener	10 N.m	89 lb in
Front Side Door Window Regulator Motor Fastener	10 N.m	89 lb in
Rear Side Door Window Rear Channel Fasteners	10 N.m	89 lb in
Rear Side Door Stationary Window Rear Channel Fasteners	10 N.m	89 lb in
Rear Side Door Window Regulator Fastener	10 N.m	89 lb in
Rear Side Door Window Regulator Motor Fastener	10 N.m	89 lb in

SCHEMATIC WIRING DIAGRAMS

MOVEABLE WINDOW WIRING SCHEMATICS

Driver Door (Except CZ2)

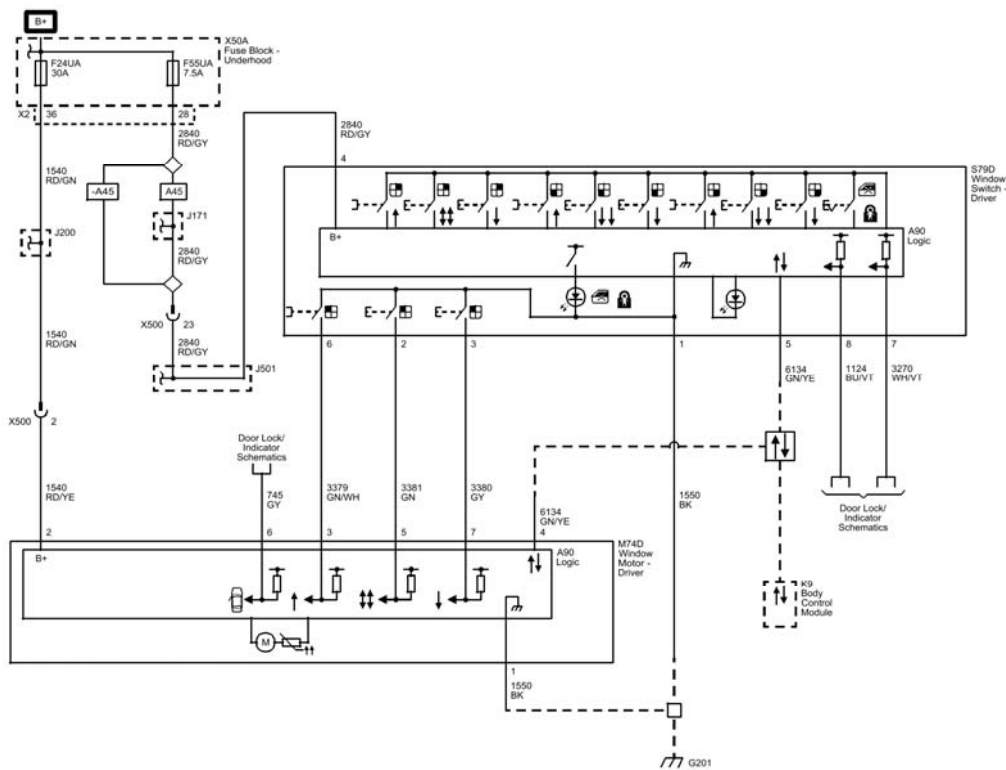


Fig. 1: Driver Door (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Driver Door (CZ2)

Passenger Door (AEF)

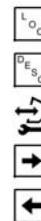
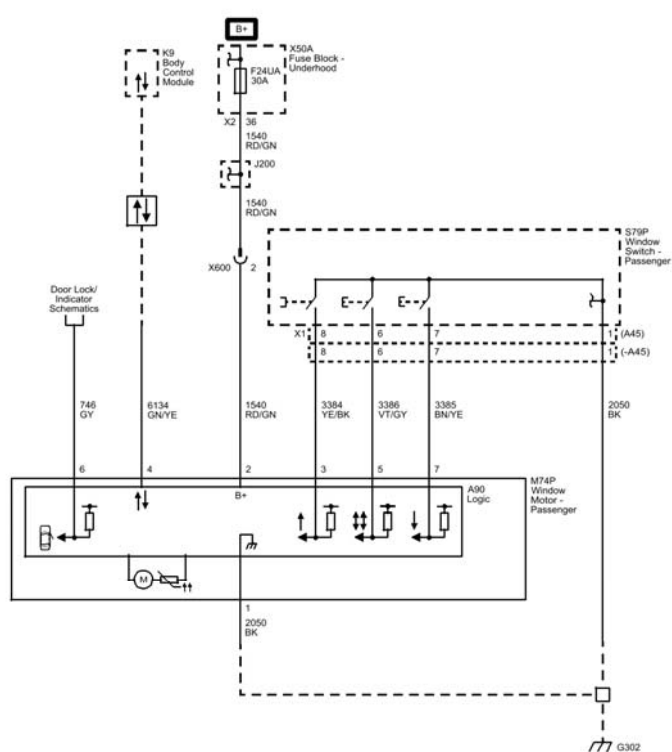


Fig. 3: Passenger Door (AEF)
 Courtesy of GENERAL MOTORS COMPANY

Passenger Door (AED)

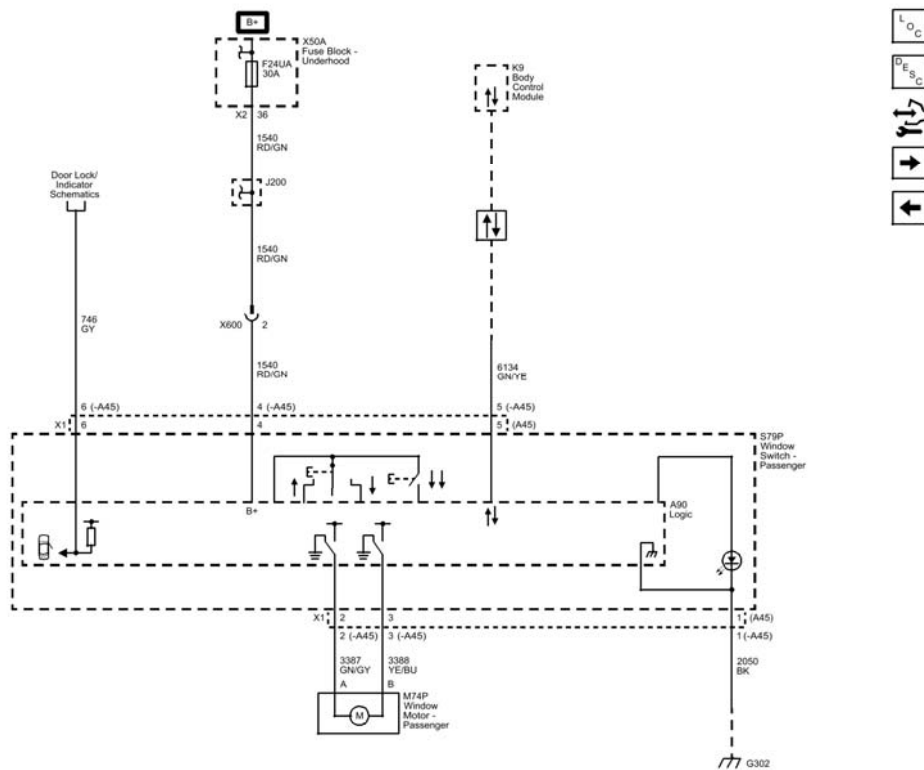


Fig. 4: Passenger Door (AED)
Courtesy of GENERAL MOTORS COMPANY

Rear Doors (AEQ)

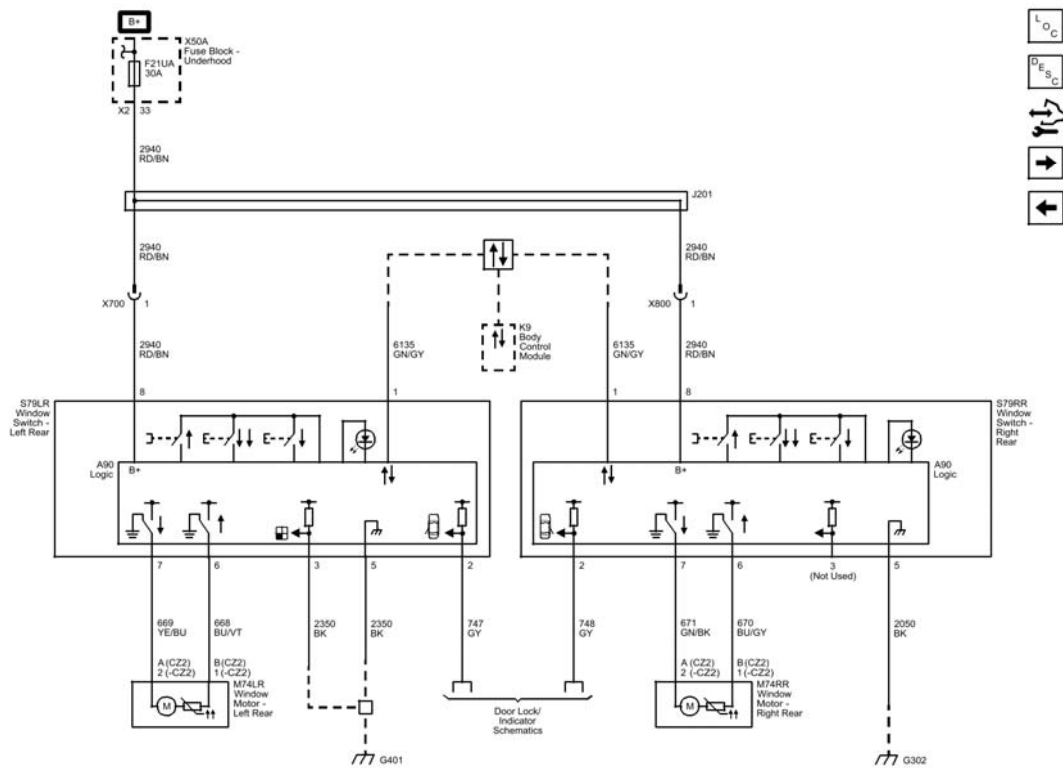


Fig. 5: Rear Doors (AEQ)
Courtesy of GENERAL MOTORS COMPANY

Rear Doors (AER)

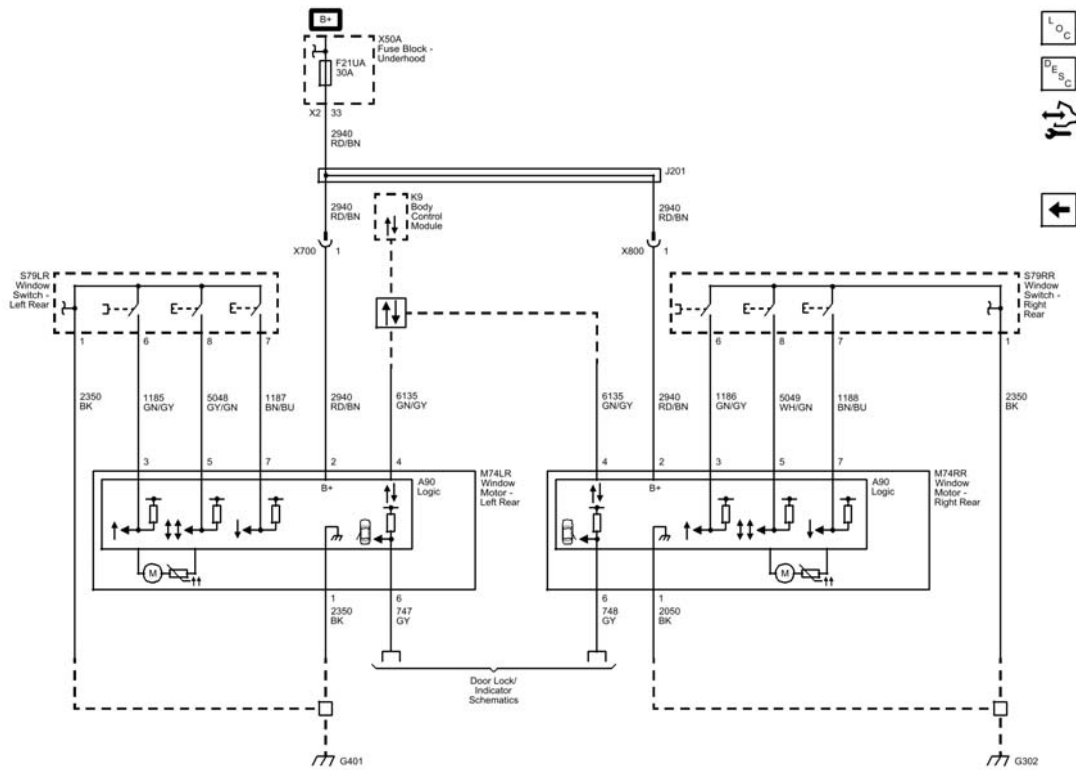


Fig. 6: Rear Doors (AER)
 Courtesy of GENERAL MOTORS COMPANY

DEFOGGER WIRING SCHEMATICS

Defogger

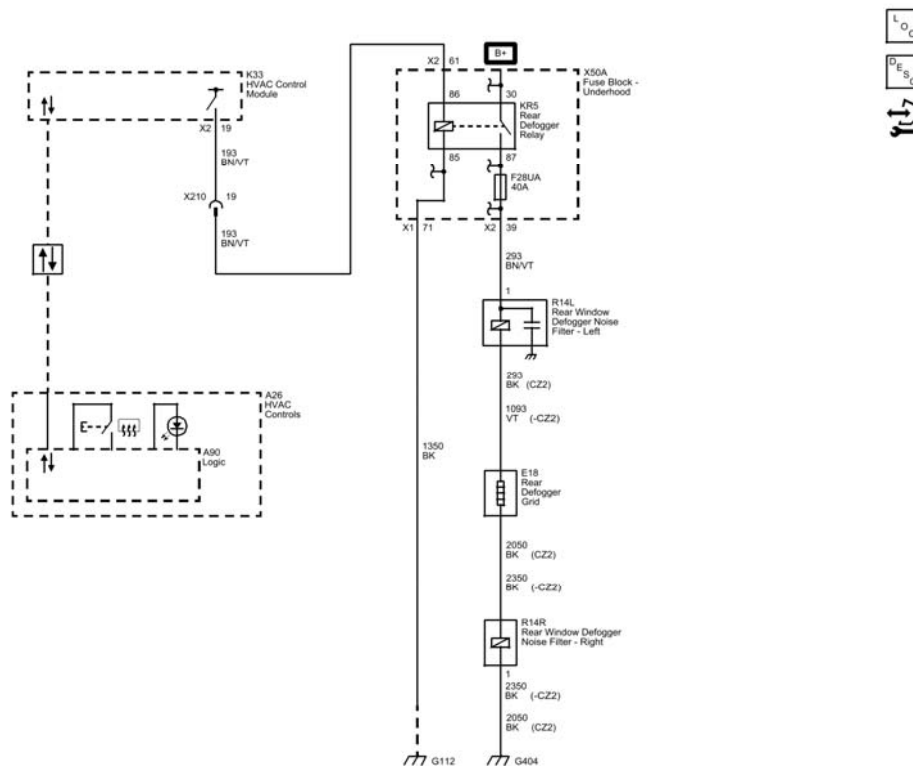


Fig. 7: Defogger

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B0283</u>	DTC B0283 Rear Defrost Circuit
<u>DTC B316B, B317A, B318A, or B319A</u>	DTC B316B Driver Window Switch DTC B317A Passenger Window Switch DTC B318A Left Rear Window Switch DTC B319A Right Rear Window Switch
<u>DTC B3205 or B3210</u>	DTC B3205 Driver Window Motor DTC B3210 Passenger Window Motor

DTC B0283: REAR DEFROST CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0283

Rear Defrost Circuit

For symptom byte information refer to: **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	B0283 02	B0283 05	B0283 05	-
Ground	-	B0283 05	-	-

Circuit/System Description

When the rear defogger switch is pressed, the HVAC control module will supply voltage to the relay coil. Battery positive voltage is supplied at all times to the relay switched input and the relay coil is always grounded. This allows battery positive voltage from the relay switched input to flow through the switch contacts and out the relay switched output to the rear window defogger grid.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B0283 02

The HVAC control module detects a short to ground in the relay coil control circuit.

B0283 05

The HVAC control module detects a short to voltage or an open/high resistance in the relay coil control circuit or an open/high resistance in the relay coil ground circuit

Action Taken When the DTC Sets

B0283 02

The rear window defogger will be inoperative.

B0283 05

The rear window defogger will be inoperative or continuously active depending upon the fault.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Defogger Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Rear Window Defogger Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine Running.
2. Verify the E18 Rear Defogger Grid turns ON and OFF when commanding the Rear Defogger On and Off with a scan tool.
 - **If the E18 Rear Defogger Grid does not turn ON or OFF**

Refer to Circuit/System Testing

- **If the E18 Rear Defogger Grid turns ON and OFF**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR5 Rear Defogger Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 85 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85, Engine Running.
4. Verify the test lamp turns ON and OFF when commanding the Rear Defogger On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K33 HVAC Control Module, Engine Running.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K33 HVAC Control Module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the KR5 Rear Defogger Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR5 Rear Defogger Relay.
2. Test for 60-180 ohms between terminals 85 and 86.
 - **If less than 60 ohms or greater than 180 ohms**

Replace the KR5 Rear Defogger Relay.

- **If between 60-180 ohms**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

- **If less than infinite resistance**

Replace the KR5 Rear Defogger Relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.

5. Test for less than 2 ohms between terminals 30 and 87.

- **If 2 ohms or greater**

Replace the KR5 Rear Defogger Relay.

- **If less than 2 ohms**

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for HVAC control module replacement, setup and programming

DTC B316B, B317A, B318A, OR B319A: REAR DEFROST CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B316B

Driver Window Switch

DTC B317A

Passenger Window Switch

DTC B318A

Left Rear Window Switch

DTC B319A

Right Rear Window Switch

For symptom byte information refer to: **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Window Motor Control	B316B 02	1	1	-
Passenger Window Motor Control	B317A 02	2	2	-
1. Driver Window Malfunction 2. Passenger Window Malfunction				

Circuit/System Description

The driver and passenger window motors supply 12V signal circuits to their respective window switches, when a window switch has been activated, a switch closes providing a ground to the appropriate signal circuit causing the voltage to drop to 0V. The window motor will detect the voltage drop in the signal circuit and will command the window to move in the desired direction.

The driver window master control switch also contains control switches for the passenger, left rear and right rear window functions. When a window switch is pressed, a serial data message is sent to the body control module (BCM). The BCM examines the request and checks for messages from other power window motors that may prohibit window movement. If no prohibitive messages have been received, the BCM will send a serial data message to the passenger window motor or to the appropriate rear window switch which will perform the command as requested.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B316B 00

The BCM has detected a control switch on the driver window master switch has been active for greater than 60 seconds.

B316B 02

The driver window motor has detected the driver window master switch is active for greater than 60 seconds.

B317A 02

The passenger window motor has detected the passenger window switch is active for greater than 60 seconds.

B318A 02

The BCM has detected the left rear window switch is active for greater than 60 seconds

B319A 02

The BCM has detected the right rear window switch is active for greater than 60 seconds

B316B 39

The driver window motor has detected an internal failure within the driver window switch

B317A 39

The passenger window motor has detected an internal failure within the passenger window switch

B318A 39

The BCM has detected an internal failure within the left rear window switch

B319A 39

The BCM has detected an internal failure within the right rear window switch

Action Taken When the DTC Sets

The affected power window will malfunction.

Conditions for Clearing the DTC**B316B 00, B316B 02, B317A 02, B318A 02, B319A 02**

- The DTC will be current for as long as the fault is present.
- The DTC will change from current to history when the fault is no longer present.
- A history DTC will clear after 100 consecutive ignition cycles if the condition for the malfunction is no longer present.

B316B 39, B317A 39, B318A 39, B319A 39

If the DTC is current, the affected window switch must be replaced before the DTC can be cleared.

Reference Information

Schematic Reference

Moveable Window Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Windows Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool parameters listed below change when pressing and pulling the switches for the passenger, left rear and right rear window on the driver window master control;
 - Left Rear Main Control Down Switch - Inactive and Active
 - Left Rear Main Control Express Switch - Inactive and Active
 - Left Rear Main Control Up Switch - Inactive and Active
 - Right Rear Main Control Down Switch - Inactive and Active
 - Right Rear Main Control Express Switch - Inactive and Active
 - Right Rear Main Control Up Switch - Inactive and Active
 - Front Passenger Main Control Down Switch - Inactive and Active
 - Front Passenger Main Control Express Switch - Inactive and Active
 - Front Passenger Main Control Up Switch - Inactive and Active
 - **If any parameter does not change**

Replace the S79D Window Switch-Driver.

- **If the parameters change**

3. Verify the scan tool parameters listed below change when pressing and pulling the driver window control switch on the driver window master control:

- Driver Window Main Control Down Switch - Inactive and Active
- Driver Window Main Control Up Switch - Inactive and Active
- Driver Window Main Control Express Down Switch - Inactive and Active
- Driver Window Main Control Express Up Switch - Inactive and Active

- **If any parameter does not change**

Refer to Circuit/System Testing - Driver Window Switch Malfunction.

- **If all the parameters change**

4. Verify the scan tool Passenger Window Switch at Door parameters change to Inactive, Up, Express Up, Down, Express Down when pressing and pulling the S79P Window Switch-Passenger.

- **If any parameter does not change**

Refer to Circuit/System Testing - Passenger Window Switch Malfunction.

- **If all the parameters change**

5. Verify the scan tool parameters listed below change when pressing and pulling the S79LR Window Switch-Left Rear and the S79RR Window Switch-Right Rear.

- Left Rear Window Switch at Door - Inactive, Up, Express Up, Down, Express Down
- Right Rear Window Switch at Door - Inactive, Up, Express Up, Down, Express Down

- **If any parameter does not change**

Test or replace the appropriate S79 Window Switch-Rear.

- **If all the parameters change**

6. All OK.

Circuit/System Testing

Driver Window Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the S79D Window Switch-Driver, ignition ON
2. Verify the scan tool Driver Window Main Control Down Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the M74D Window Motor-Driver.
2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74D Window Motor-Driver.

- **If Inactive**

3. Install a 3 A fused jumper wire between the signal circuit terminal 3 and ground.
4. Verify the scan tool Driver Window Main Control Down Switch parameter is Active
 - **If not Active**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the M74D Window Motor-Driver, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF, test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74D Window Motor-Driver.
 - **If Active**
5. Verify the scan tool Driver Window Main Control Up Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the M74D Window Motor-Driver.
 2. Test for infinite resistance between the signal circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74D Window Motor-Driver.
 - **If Inactive**
6. Install a 3 A fused jumper wire between the signal circuit terminal 6 and ground.
7. Verify the scan tool Driver Window Main Control Up Switch parameter is Active
 - **If not Active**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the M74D Window Motor-Driver, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF, test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74D Window Motor-Driver.
 - **If Active**
8. Verify the scan tool Driver Window Main Control Express Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the M74D Window Motor-Driver.
 2. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74D Window Motor-Driver.
 - **If Inactive**

9. Install a 3 A fused jumper wire between the signal circuit terminal 2 and ground.
10. Verify the scan tool Driver Window Main Control Express Switch parameter is Active
 - **If not Active**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the M74D Window Motor-Driver, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF, test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74D Window Motor-Driver.
 - **If Active**
11. Test or replace the S79D Window Switch-Driver.

Passenger Window Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the S79P Window Switch-Passenger, ignition ON
2. Verify the appropriate scan tool Passenger Window Switch at Door parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the M74P Window Motor-Passenger.
 2. Test for infinite resistance between the signal circuit terminal listed below and ground:
 - S79P Window Switch-Passenger - signal circuit terminal 7
 - S79P Window Switch-Passenger - signal circuit terminal 8
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74P Window Motor-Passenger.
 - **If Inactive**
3. Install a 3 A fused jumper wire between the signal circuit terminal 8 and ground:
4. Verify the scan tool Passenger Window Switch at Door parameter is Up
 - **If Inactive**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the M74P Window Motor-Passenger, ignition ON.
 2. Test for less than 1 V between the circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF, test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74P Window Motor-Passenger.
 - **If Up**
5. Install a 3 A fused jumper wire between the signal circuit terminal 7 and ground.

6. Verify the scan tool Passenger Window Switch at Door parameter is Down
 - **If Inactive**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the M74P Window Motor-Passenger, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF, test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74P Window Motor-Passenger.
 - **If Down**
7. Test for greater than 10 V between the signal circuit terminal 6 and ground
 - **If less than 10 V**
 1. Ignition OFF, disconnect the harness connector at the M74P Window Motor-Passenger.
 2. Test for infinite resistance between the signal circuit 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the M74P Window Motor-Passenger.
 - **If greater than 10 V**
8. Test or replace the S79P Window Switch-Passenger.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Window Switch Replacement**
- **Rear Side Door Window Switch Replacement**
- **Front Side Door Window Regulator Motor Replacement**

DTC B3205 OR B3210: WINDOW MOTOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3205

Driver Window Motor

DTC B3210

Passenger Window Motor

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The body control module (BCM) monitors, receives and transmits serial data messages to the driver and passenger window motors. When a window switch has been activated on the driver window switch, a signal is sent to the BCM which sends a signal to the appropriate window motor and the window motor will move in the direction commanded.

Conditions for Running the DTC

- The ignition switch is in the ON position.
- Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B3205 00, B3210 00

The BCM has detected that the compatibility code stored in the affected window motor does not match the compatibility code stored in the BCM.

B3205 39, B3210 39

An internal malfunction has been detected by the BCM in the power window motor while commanding the window UP or DOWN.

B3205 42, B3210 42

The BCM will automatically attempt to download the calibration program into the appropriate window motor (As will occur when the window motor has been replaced), if the first calibration program fails to load, the BCM will attempt to download the calibration program a second time. If this download fails, the BCM will set appropriate DTC.

B3205 4B, B3210 4B

The BCM detects that a window motor is "not normalized" which will occur under the following conditions:

- When the battery has been disconnected
- When the battery has been replaced

- When the door wiring harness has been disconnected
- When the window motor has been disconnected.

Action Taken When the DTC Sets

B3205 00, B3205 39, B3205 42, B3210 00, B3210 39, B3210 42

The affected motor will be inoperative.

B3205 4B, B3210 4B

The affected motor will not perform the express up or express down functions and the driver information center will display Open, then Close Driver Window or will display Open, then Close Passenger Window.

Conditions for Clearing the DTC

B3205 00, B3210 00

Installing a compatible window motor for that specific make and model vehicle.

B3205 39, B3210 39

The appropriate window motor must be replaced before the DTC can be cleared.

B3205 42, B3210 42

The appropriate window motor must be replaced before the DTC can be cleared.

B3205 4B, B3210 4B

The appropriate window motor must be normalized before the DTC can be cleared.

Reference Information

Schematic Reference

Moveable Window Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Windows Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the driver and passenger functions while commanding the Driver Window Motor or Passenger Window Motor Up and Down with a scan tool.
 - **If the Up and Down does not work**

Replace the appropriate M74 Window Motor .
 - **If the Up and Down works**
3. Verify the driver and passenger window performs the Express Up and Express Down functions with the driver window switch.
 - **If a window does not Express Up and Express Down**

Normalize the window motor, refer to **Window Motor Programming - Express Function**.
 - **If the window performs the Express Up and Express Down functions**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Front Side Door Window Regulator Replacement

SYMPTOMS - FIXED AND MOVEABLE WINDOWS

Important Preliminary Checks Before Starting:

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the power window system operation or rear window defogger system operation in order to familiarize yourself with the system functions. Refer to the following:

- **Rear Window Defogger Description and Operation**
- **Power Windows Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the rear window defogger. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

NOTE:

- **Inspect for proper installation of electrical components if an intermittent condition exists. Inspect for aftermarket theft deterrent devices, lights, and cellular phones. Ensure that no aftermarket equipment is connected to the class 2 circuit. If you can not locate an intermittent condition, a cellular phone signal may cause the condition. Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .**
- **The problem may or may not turn ON the SERVICE VEHICLE SOON indicator or store a DTC. Do not use the symptom tables to diagnose intermittent conditions. The malfunction must be present in order to locate the problem.**

Poor electrical connections or wiring cause most intermittent conditions. Perform a careful visual/physical check for the following conditions:

- Poor mating of the connector halves or a terminal not fully seated in the connector body
- An improperly formed or damaged terminal
- Reform or replace connector terminals in the problem circuit in order to ensure proper contact tension.
- Poor terminal to wire connection requires removing the terminal from the connector body in order to perform the check.

Use a scan tool in order to help detect intermittent conditions. The scan tool has several features that can be used to locate an intermittent condition. The snapshot feature can capture and store data parameters within the scan tool when the malfunction occurs. This information can then be reviewed in order to see what caused the malfunction.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Rear Window Defogger Malfunction**
- **Power Windows Malfunction**

DEFOGGER GRID LINES DIAGNOSIS

NOTE: If it has been observed during use that a grid line is inoperative, the following procedure can be used to find the break. If none of the grid lines is operating, a full system diagnosis should be completed before attempting to test the grid lines

NOTE: Lightly touch the grid lines when testing with the test lamp. If the test lamp point is scraped through the grid line it can cause an open in the circuit

1. Engine running, command the Rear Defogger ON with a scan tool.
2. Verify that a test lamp illuminates between each rear window defogger grid line and ground. The test lamp should be off when testing at the ground side of the grid and get brighter as the test lamp moves closer to the voltage supply side of the grid. The test lamp should be dim when testing each grid line in the middle

- **If the test lamp remains bright at the middle of the grid line.**

The grid line is open between the test point and the ground side of the grid.

Replace the rear window

- **If the test lamp remains off at the middle of the grid line.**

The grid line is open between the test point and the voltage supply side of the grid.

Replace the rear window

- **If the test lamp remains dim at the middle of each grid line.**

3. All OK

REAR WINDOW DEFOGGER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay B+	1	1	-	-
Relay Control	B0283 02	B0283 05	B0283 05	-
Rear Defogger Grid Control	1	1	2	-

Relay Ground	-	B0283 05	-	-
Rear Defogger Grid Ground	-	1	-	-
1. Rear Defogger Inoperative 2. Rear Defogger Always ON				

Circuit/System Description

When the HVAC control module receives a rear window defog request from the HVAC controls, the HVAC control module will supply voltage to the relay coil. Battery positive voltage is supplied at all times to the relay switched input and the relay coil is always grounded. This allows battery positive voltage from the relay switched input through the switch contacts and out the relay switched output to the rear window defogger grid.

Diagnostic Aids

The rear window defogger indicator will still function when the rear defogger switch is pressed, but any of the following conditions may cause the rear window defogger grid not to function:

- The battery state of charge is out of range causing the HVAC control module to suspend the rear window defogger operation.
- The Remote Start Enable ambient temperature is greater than 5°C (40°F).

Reference Information

Schematic Reference

Defogger Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Rear Window Defogger Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Rear Defogger Switch parameter changes between On and Off when pressing the rear window defogger switch.
 - **If the parameter does not change between On and Off**

Replace the A26 HVAC Controls.
 - **If the parameter changes between On and Off**
3. Verify the E18 Rear Defogger Grid turns ON and OFF when commanding the Rear Defogger On and Off with a scan tool.
 - **If the E18 Rear Defogger Grid does not turn ON and OFF**

Refer to Circuit/System Testing
 - **If the E18 Rear Defogger Grid turns ON and OFF**
4. Verify the rear defogger indicator turns ON and OFF when pressing the rear window defogger switch.
 - **If the rear defogger indicator does not turn ON and OFF**

Replace the A26 HVAC Controls.
 - **If the rear defogger indicator turns ON and OFF**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR5 Rear Defogger Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 85 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Engine Running.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate**
 - Replace the X50A Fuse Block-Underhood
 - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.

6. Verify the test lamp turns ON and OFF when commanding the Rear Defogger On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K33 HVAC Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K33 HVAC Control Module.
 - **If the test lamp turns ON and OFF**
7. Verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.
 - **If the test lamp illuminates**

Repair the short to voltage on the control circuit

- **If the test lamp does not illuminate**
8. Ignition OFF and all vehicle systems OFF, disconnect the X2 harness connector at the E18 Rear Defogger Grid. It may take up to 2 minutes for all vehicle systems to power down.
 9. Test for less than 10 ohms between the ground circuit terminal A and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
 10. Connect the X2 harness connector at the E18 Rear Defogger Grid.
 11. Ignition ON, connect a 40 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
 12. Verify the E18 Rear Defogger Grid is activated.
 - **If the E18 Rear Defogger Grid does not activate**
 1. Ignition OFF, remove the fused jumper wire, disconnect the X1 harness connector at the E18 Rear Defogger Grid.

2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the E18 Rear Defogger Grid.
 - **If the E18 Rear Defogger Grid activates**
13. Test or replace the KR5 Rear Defogger Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR5 Rear Defogger Relay.
2. Test for 60-180 ohms between terminals 85 and 86.
 - **If less than 60 ohms or greater than 180 ohms**

Replace the KR5 Rear Defogger Relay.
 - **If between 60-180 ohms**
3. Test for infinite resistance between the terminals listed below:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - **If less than infinite resistance**

Replace the KR5 Rear Defogger Relay.
 - **If infinite resistance**
4. Install a 3 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 ohms between terminals 30 and 87.
 - **If 2 ohms or greater**

Replace the KR5 Rear Defogger Relay.
 - **If less than 2 ohms**
6. All OK

Rear Defogger Grid Test

NOTE: **Lightly touch the grid lines when testing with the test lamp. If the test lamp point is scraped through the grid line it can cause an open in the circuit**

1. Engine running, command the Rear Defogger ON with a scan tool.
2. Verify that a test lamp illuminates between each rear window defogger grid line and ground. The test lamp should be off when testing at the ground side of the grid and get brighter as the test lamp moves closer to the voltage supply side of the grid. The test lamp should be dim when testing each grid line in the middle

- **If the test lamp remains bright at the middle of the grid line.**

The grid line is open between the test point and the ground side of the grid.

Replace the rear window

- **If the test lamp remains off at the middle of the grid line.**

The grid line is open between the test point and the voltage supply side of the grid.

Replace the rear window

- **If the test lamp remains dim at the middle of each grid line.**

3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Window Replacement**
- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for HVAC control module and HVAC controls replacement, setup, and programming

POWER WINDOWS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Window Switch B+	U1538 00	U1538 00	-	-

Driver Window Switch Serial Data	U1534 00, U1538 00, U153A 00	U1538 00	U1538 00	-
Driver Window Switch Ground	-	1	-	-
Driver Window Motor B+	U1534 00	U1534 00	-	-
Driver Window Motor Serial Data	U1530 00, U1534 00	U1534 00	U1534 00	-
Driver Window Motor Control	B316B 02	1	1	-
Driver Window Motor Ground	-	U1534 00	-	-
Passenger Window Motor B+	U1530 00, U1534 00	U1534 00	-	-
Passenger Window Motor Serial Data	U1530 00, U1534 00	U1534 00	U1534 00	-
Passenger Window Motor Control	B317A 02	2	2	-
Passenger Window Motor Ground	-	U1534 00	-	-
Passenger Window Switch Ground	-	U153A 00	-	-
Left Rear Window Switch B+	U1534 00	U1534 00	-	-
Left Rear Window Switch Serial Data	U1534 00, U154A 00	U1534 00	U1534 00	-
Left Rear Window Switch Ground	-	U1534 00	-	-
Left Rear Window Motor Control	3	3	3	-
Right Rear Window Switch B+	U154A 00	U154A 00	-	-
Right Rear Window Switch Serial Data	U154A 00, U1548 00	U154A 00	U154A 00	-
Right Rear Window Switch Ground	-	U154A 00	-	-
Right Rear Window Motor Control	4	4	4	-
1. Driver Window Motor Inoperative 2. Passenger Window Motor Inoperative 3. Left Rear Window Inoperative 4. Right Rear Window Inoperative				

Circuit/System Description

The driver and passenger window motors supply 12V signal circuits to their respective window switches, when a window switch has been activated, a switch closes providing a ground to the appropriate signal circuit causing the voltage to drop to 0V. The window motor will detect the voltage drop in the signal circuit and will command the window to move in the desired direction.

The driver window master control switch also contains control switches for the passenger, left rear and right rear window functions. When a window switch is pressed, a serial data message is sent to the body control module (BCM). The BCM examines the request and checks for messages from other power window motors that may prohibit window movement. If no prohibitive messages have been received, the BCM will send a serial data message to the passenger window motor or to the appropriate rear window switch which will perform the command as requested.

Diagnostic Aids

The loss of the express up and express down functions for the driver and passenger windows may have occurred for the following reasons:

- The battery was disconnected
- The battery was replaced
- A door wiring harness was disconnected
- A window motor was disconnected or replaced

The window motors will need to be normalized in order to restore the express functions, refer to **Window Motor Programming - Express Function** for the proper procedure.

Reference Information

Schematic Reference

Moveable Window Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Windows Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the driver window moves while commanding the window UP and DOWN with a scan tool.
 - **If the window does not move UP and DOWN as commanded**

Refer to Circuit/System Testing - Driver/Passenger Window Motor Malfunction.

- **If the window moves UP and DOWN as commanded**
3. Verify the driver window moves while commanding the window UP, express UP, DOWN and express DOWN with the S79D Window Switch-Driver.

- **If the driver window does not move UP or DOWN as commanded**

Refer to Circuit/System Testing - Driver Window Switch Malfunction.

- **If the driver window does not express UP or express DOWN**

Normalize the driver window motor, refer to **Window Motor Programming - Express Function.**

- **If after normalization, the driver window does not express UP or express DOWN**

Refer to Circuit/System Testing - Driver Window Switch Malfunction.

- **If the driver window moves UP, express UP, DOWN and express DOWN as commanded**
4. Verify the scan tool parameters listed below change when pressing and pulling the switches for the passenger, left rear and right rear window on the driver window master control;

- Left Rear Main Control Down Switch - Inactive and Active
- Left Rear Main Control Express Switch - Inactive and Active
- Left Rear Main Control Up Switch - Inactive and Active
- Right Rear Main Control Down Switch - Inactive and Active
- Right Rear Main Control Express Switch - Inactive and Active
- Right Rear Main Control Up Switch - Inactive and Active
- Front Passenger Main Control Down Switch - Inactive and Active
- Front Passenger Main Control Express Switch - Inactive and Active
- Front Passenger Main Control Up Switch - Inactive and Active
- **If the parameters do not change**

Refer to Circuit/System Testing - Driver Window Switch Malfunction.

- **If the parameters changes**

5. Verify the scan tool Child Security Lockout Switch parameter changes between Inactive and Active when pressing the window lockout switch on the S79D Window Switch-Driver.

- **If the parameters do not change**

Refer to **Power Door Child Lock Malfunction**

- **If the parameters changes**

6. Verify the lockout indicator turns ON and OFF when commanding the Child Security Lock Indicator ON and OFF with a scan tool.

- **If the indicator does not turn ON and OFF**

Replace the S79D Window Switch-Driver.

- **If the indicator turns ON and OFF**

7. Verify the passenger window moves while commanding the Passenger Window Motor Up and Down with a scan tool.

- **If the passenger window does not move UP and DOWN as commanded**

Refer to Circuit/System Testing - Driver/Passenger Window Motor Malfunction.

- **If the window moves UP and DOWN as commanded**

8. Verify the passenger window moves while commanding the window UP, express UP, DOWN and express DOWN with the S79P Window Switch-Passenger.

- **If the passenger window does not move UP or DOWN as commanded**

Refer to Circuit/System Testing - Passenger Window Switch Malfunction.

- **If the passenger window does not express UP or express DOWN**

Normalize the passenger window motor, refer to **Window Motor Programming - Express Function.**

- **If after normalization, the passenger window does not express UP or express DOWN**

Refer to Circuit/System Testing - Passenger Window Switch Malfunction.

- **If the passenger window moves UP, express UP, DOWN and express DOWN as commanded**

9. Verify the left rear and right rear window moves while commanding the window UP and DOWN with a scan tool.

- **If a rear window does not move UP and DOWN as commanded**

Refer to Circuit/System Testing - Rear Power Window Inoperative.

- **If the rear window moves UP and DOWN as commanded**

10. Command the rear window lockout by pressing the window lockout switch on the S79D Window Switch-Driver.

11. Verify the left rear and right rear window does not move while commanding the window UP and DOWN with the S79LR Window Switch-Left Rear and S79RR Window Switch-Right Rear.

- **If a rear window moves UP and DOWN as commanded**

Refer to **Power Door Child Lock Malfunction** .

- **If the rear windows do not move UP and DOWN**

12. All OK.

Circuit/System Testing

Driver/Passenger Window Motor Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate driver or passenger M74 Window Motor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74 Window Motor.
 - **If the test lamp illuminates**
5. Test or replace the M74 Window Motor.

Driver Window Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S79D Window Switch-Driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S79D Window Switch-Driver.
 - **If the test lamp illuminates**
- 5. Verify the scan tool Driver Window Main Control Down Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the M74D Window Motor-Driver.
 2. Test for infinite resistance between the S79D Window Switch-Driver signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74D Window Motor-Driver.
 - **If Inactive**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 1.
- 7. Verify the scan tool Driver Window Main Control Down Switch parameter is Active
 - **If not Active**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the M74D Window Motor-Driver, ignition ON.
 2. Test for less than 1 V between the S79D Window Switch-Driver signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74D Window Motor-Driver.
 - **If Active**
- 8. Verify the scan tool Driver Window Main Control Up Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the M74D Window Motor-Driver.
2. Test for infinite resistance between the S79D Window Switch-Driver signal circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74D Window Motor-Driver.

- **If Inactive**

9. Install a 3 A fused jumper wire between the signal circuit terminal 6 and the ground circuit terminal 1.
10. Verify the scan tool Driver Window Main Control Up Switch parameter is Active

- **If not Active**

1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the M74D Window Motor-Driver, ignition ON.
2. Test for less than 1 V between the S79D Window Switch-Driver signal circuit 6 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74D Window Motor-Driver.

- **If Active**

11. Verify the scan tool Driver Window Main Control Express Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the M74D Window Motor-Driver.
2. Test for infinite resistance between the S79D Window Switch-Driver signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74D Window Motor-Driver.

- **If Inactive**

12. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 1.

13. Verify the scan tool Driver Window Main Control Express Switch parameter is Active

- **If not Active**

1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the M74D Window Motor-Driver, ignition ON.
2. Test for less than 1 V between the S79D Window Switch-Driver signal circuit 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74D Window Motor-Driver.

- **If Active**

14. Test or replace the S79D Window Switch-Driver.

Passenger Window Switch Malfunction

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the S79P Window Switch-Passenger. It may take up to 2 minutes for all vehicle systems to power down
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Passenger Window Switch at Door parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the M74P Window Motor-Passenger
 2. Test for infinite resistance between the signal circuit terminal listed below and ground:
 - S79P Window Switch-Passenger - signal circuit terminal 7
 - S79P Window Switch-Passenger - signal circuit terminal 8
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74P Window Motor-Passenger.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 8 and ground.
6. Verify the scan tool Passenger Window Switch at Door parameter is Up
 - **If not Up**
 1. Ignition OFF, remove the fused jumper wire, disconnect the harness connector at the M74P Window Motor-Passenger, ignition ON.
 2. Test for less than 1 V between the S79P Window Switch-Passenger signal circuit terminal 8 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF, test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74P Window Motor-Passenger.
 - **If Up**
7. Install a 3 A fused jumper wire between the signal circuit terminal 7 and ground.
8. Verify the scan tool Passenger Window Switch at Door parameter is Down

- **If not Down**

1. Ignition OFF, remove the fused jumper wire, disconnect the harness connector at the M74P Window Motor-Passenger, ignition ON.
2. Test for less than 1 V between the S79P Window Switch-Passenger signal circuit terminal 7 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Ignition OFF, test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74P Window Motor-Passenger.

- **If Down**

9. Test for greater than 10 V between the signal circuit terminal 6 and ground

- **If less than 10 V**

1. Ignition OFF, disconnect the harness connector at the M74P Window Motor-Passenger.
2. Test for infinite resistance between the S79P Window Switch-Passenger signal circuit 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the M74P Window Motor-Passenger.

- **If greater than 10 V**

10. Test or replace the S79P Window Switch-Passenger.

Rear Power Window Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate S79 Window Switch-Rear. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 8.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.

2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S79 Window Switch-Rear
 - **If the test lamp illuminates**
5. Ignition OFF, connect the harness connector at the S79 Window Switch-Rear and disconnect the harness connector at the M74 Window Motor-Rear.
6. Test for less than 5 ohms between the control circuit terminal 1 and ground.
 - **If 5 ohms or greater**
 - 1. Ignition OFF, disconnect the harness connector at the S79 Window Switch-Rear.
 - 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79 Window Switch-Rear.
 - **If less than 5 ohms**
7. Test for less than 5 ohms between the control circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 - 1. Ignition OFF, disconnect the harness connector at the S79 Window Switch-Rear.
 - 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79 Window Switch-Rear.
 - **If less than 5 ohms**
8. Connect a test lamp between the control circuit terminal 1 and control circuit terminal 2, ignition ON.
9. Verify the test lamp turns ON when commanding the UP and DOWN states with the S79 Window Switch-Rear.
 - **If the test lamp is always OFF**
 - 1. Ignition OFF, disconnect the harness connector at the S79 Window Switch-Rear.
 - 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79 Window Switch-Rear.
 - **If the test lamp is always ON**
 - 1. Ignition OFF, disconnect the harness connector at the S79 Window Switch-Rear, ignition ON.

2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S79 Window Switch-Rear.

- **If the test lamp turns ON and OFF**

10. Test or replace the M74 Window Motor-Rear.

Component Testing

Rear Window Motor

1. Ignition OFF, disconnect the harness connector at the appropriate M74 Window Motor-Rear.
2. Install a 25 A fused jumper wire between one of the control terminals and 12 V. Momentarily install a jumper wire between the other control terminal and ground. Reverse the jumper wires at least two times, the M74 Window Motor-Rear should perform the UP and DOWN functions.

- **If the M74 Window Motor-Rear does not perform the UP and DOWN functions**

Replace the M74 Window Motor-Rear.

- **If the M74 Window Motor-Rear performs the UP and DOWN functions**

3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Front Side Door Window Switch Replacement**
- **Rear Side Door Window Switch Replacement**
- **Front Side Door Window Regulator Motor Replacement**
- **Rear Side Door Window Regulator Motor Replacement**

SIDE DOOR WINDOW MECHANICAL DIAGNOSIS

Side Door Window Mechanical Diagnosis

Cause	Correction
DEFINITION: A mechanical condition that requires a correction for proper operation of the side door window.	
Refer to <u>Symptoms - Fixed and Moveable Windows</u> prior to beginning this table.	
Intermittent Operation	Check proper glass alignment/attachment and door seal installation.
	Check switch and switch bezel to see if sticking.
	Check wire harness for pinched/shorted wire.
	THIS STEP APPLIES TO ALL TWO PIN MOTOR CONNECTORS ONLY. Perform electrical diagnostics, by first applying 12 volt power supply to the regulator motor to verify motor function.
	Check proper glass alignment/attachment.

Glass Binds	Check for defective seal and/or proper seal installation.
	Check for debris in glass run channel.
	Check for glass run channel position.
Regulator/Glass Rattles	Check for loose fasteners and retorque if required.
	Check that the glass is in the channel and reinstall if not positioned correctly.
Noisy Operation	Check for other components in the glass path such as wire harness, impact foam, lock rods, or cables.
	Check for proper glass alignment/attachment and door seal installation.
Windnoise	Check seals, mirror patch, and glass alignment.
False glass reversal, the glass goes down unexpectedly.	Check seals, reinitialize the glass and/or realign the glass.
	Check for debris in the glass run channel.

REPAIR INSTRUCTIONS

WINDSHIELD REPLACEMENT

Special Tools

- **BO-24402-A** Glass Sealant Remover (Cold Knife)
- **BO-39032** Stationary Glass Removal Tool
- Use an adhesive that is approved by GM

For equivalent regional tools, refer to **Special Tools**.

NOTE: Before cutting out a stationary window, apply a double layer of masking tape around the perimeter of the painted surfaces and the interior trim.

1. Open the hood.
2. Remove the windshield wiper arms and blades. Refer to **Windshield Wiper Arm Replacement** .
3. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement** .
4. Remove the windshield garnish moldings. Refer to **Windshield Side Garnish Molding Replacement** .
5. Remove the inside rearview mirror. Refer to **Inside Rearview Mirror Replacement** .
6. Remove the inside moisture and temperature sensor. Refer to **Inside Air Moisture and Windshield Temperature Sensor Replacement (ASV)** , **Inside Air Moisture and Windshield Temperature Sensor Replacement (ASV UFL)** .
7. Remove the remote control door lock receiver. Refer to **Remote Control Door Lock Receiver Replacement** .

WARNING: If broken glass falls into the defroster outlets, it can be blown into the passenger compartment and cause personal injury.

8. Cover to protect the following parts from broken glass:

- Upper dash pad
- Defroster outlets and A/C outlets
- Seats and carpeting

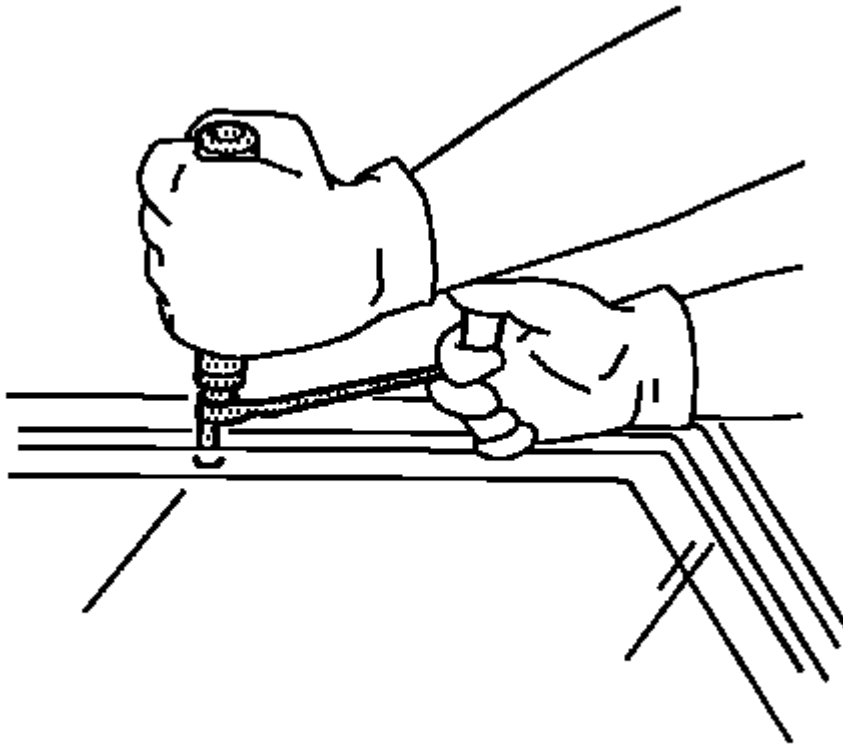


Fig. 8: Separating Urethane Adhesive From Window

Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Glass and Sheet Metal Handling Warning .

NOTE: Keep the cutting edge of the tool against the window. Use care Not to damage the window corner retainers. If the window retainers get cut off when removing the window it will be necessary to tape the window in place when installing.

9. This will allow the urethane adhesive to be separated from the window.

- Leave a base of urethane on the pinchweld flange.
- The only suitable lubrication is clear water.

- **BO-24402-A** Glass Sealant Remover (Cold Knife)
- **BO-39032** Stationary Glass Removal Tool

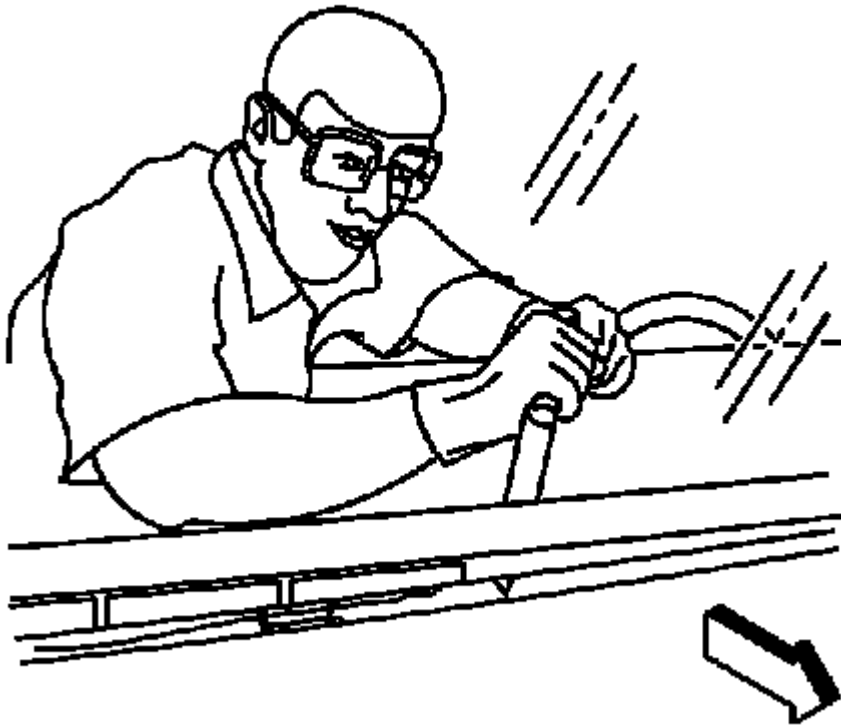


Fig. 9: Separating Bottom Of Window
Courtesy of GENERAL MOTORS COMPANY

10. Remove the bottom of the windshield from the urethane adhesive using a long utility knife or similar tool. Keep the cutting edge of the utility knife against the glass. Do this from inside the vehicle.

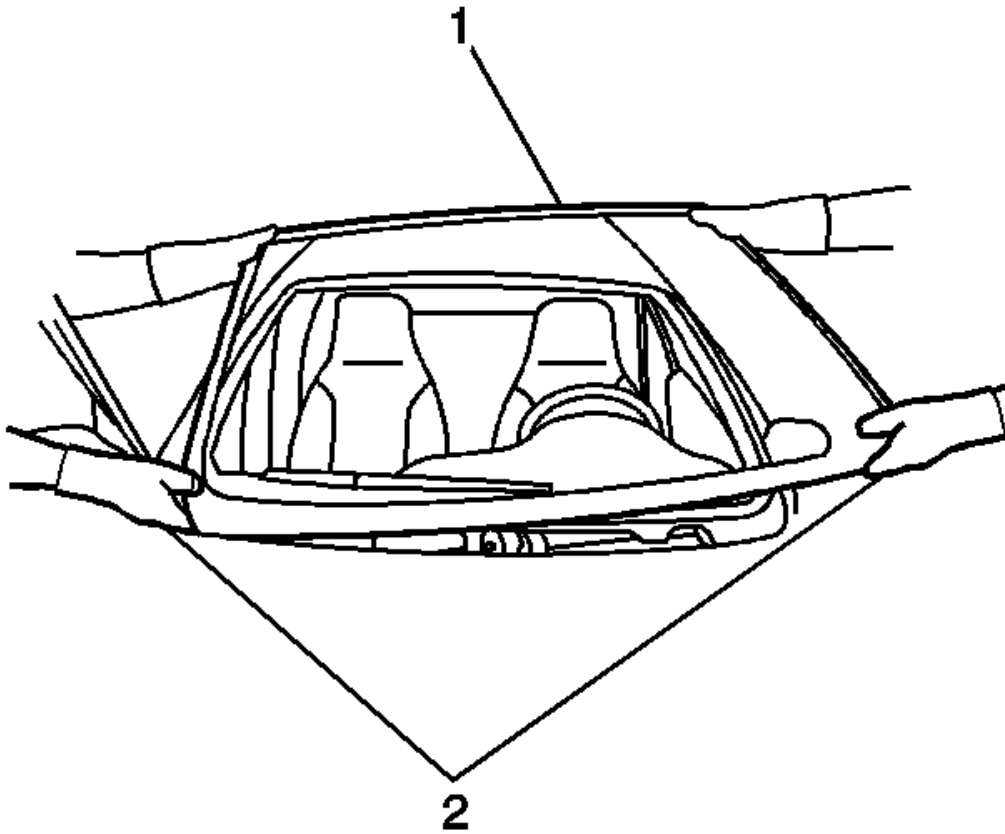


Fig. 10: Removing/Installing Windshield
Courtesy of GENERAL MOTORS COMPANY

11. Remove the windshield (1) from the vehicle with the aid of an assistant (2).

Installation Procedure

1. Install the windshield into the opening. Refer to **Adhesive Installation of Windshields**.
2. Install the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement**
3. Install the windshield wipers arms and blades. Refer to **Windshield Wiper Arm Replacement**
4. Install the windshield garnish molding. Refer to **Windshield Side Garnish Molding Replacement** .
5. Install the inside rearview mirror. Refer to **Inside Rearview Mirror Replacement** .
6. Install the remote control door lock receiver. Refer to **Remote Control Door Lock Receiver Replacement** .
7. Install the inside ambient air temperature and moisture sensor. Refer to **Inside Air Moisture and Windshield Temperature Sensor Replacement (ASV)** , **Inside Air Moisture and Windshield Temperature Sensor Replacement (ASV UFL)** .

8. Remove the double layer of masking tape around the perimeter of the painted surfaces and the interior trim.
9. Close the hood.

FRONT SIDE DOOR WINDOW ADJUSTMENT

Causes of Slow Moving Window

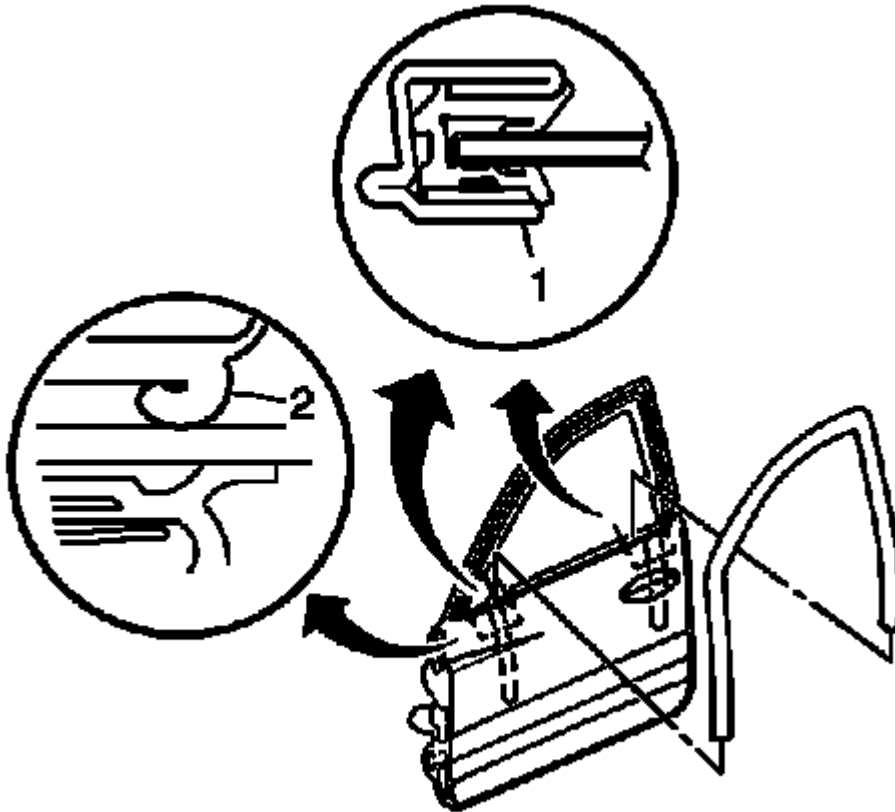


Fig. 11: Internal Detail For Front Door Window Adjustment
Courtesy of GENERAL MOTORS COMPANY

WARNING: Disconnect the power window switch when working inside the driver door. When operated, the Express Up/Down Feature allows the door window to move very quickly, without stopping, which could cause personal injury.

NOTE: Owners may comment that the windows operate slowly when going up or down.

1. Listed below are conditions that may cause a slow moving window.

- The window run channel outboard lip at the rearview mirror is rolled over or the window run channel outboard lip at the rear of door frame (2).
 - The window is not seated in the run channel.
 - The window is misaligned in the opening.
 - The regulator is misaligned causing misalignment of the window .
 - Inspect the power window motor for being loose.
2. After inspecting the conditions above, do the following:

Remove the front door trim panel.

3. Remove the water deflector.
4. Ensure that the window guide is fully seated and clipped.
5. Ensure that the window is fully seated into the window guide run channel.
6. Inspect the window for equal distance between the front and rear run channels.

Adjustment Procedure

1. Inspect for the following conditions before making adjustments.
 - Using a flat-bladed tool, straighten the run channel lip by pulling it out to its correct position.
 - Use a flat-bladed tool to push the run channel rearward to seat it in the door frame.
 - Inspect the window guide retainer to window for the proper alignment to the slots in the window.
 - Inspect the window to be straight up and down position.

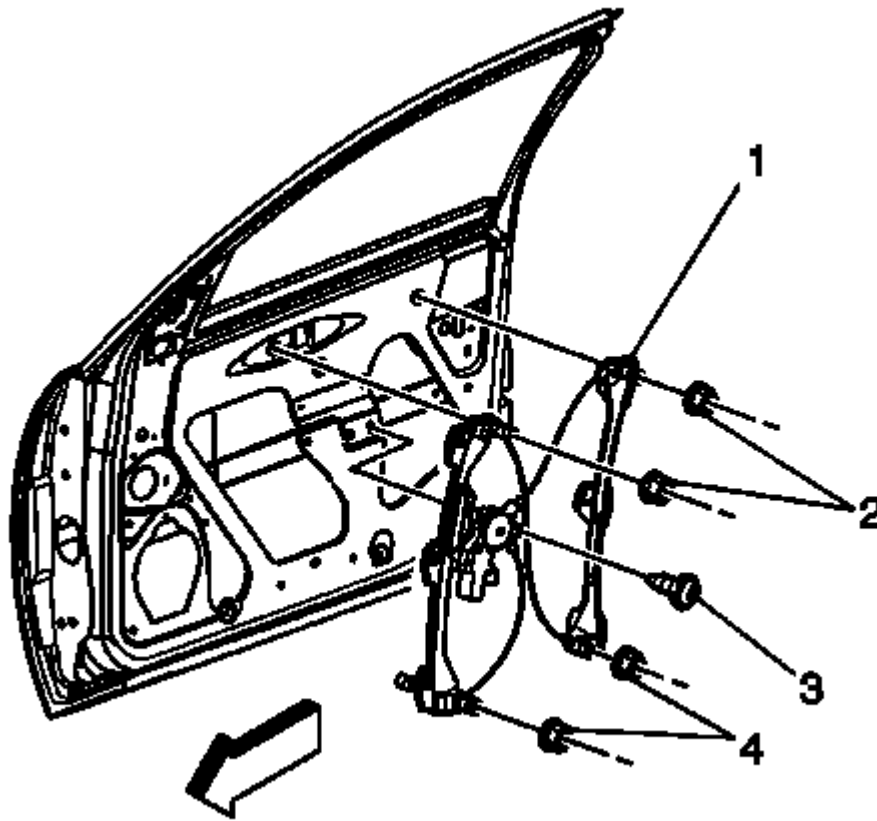


Fig. 12: Window Regulator
Courtesy of GENERAL MOTORS COMPANY

- Loosen the fasteners that attach the window regulator (1) to the inner door panel, in the specified sequence (2, 3, 4).

CAUTION: Refer to Fastener Caution .

2. Tighten the fasteners that attach the front side door window regulator (1) to the inner door panel in the specified sequence (2, 3, 4) to 10 N.m (89 lb in).
3. Inspect the window for proper operation.
4. Install the water deflector.
5. Install the front door trim panel.

FRONT SIDE DOOR WINDOW REPLACEMENT

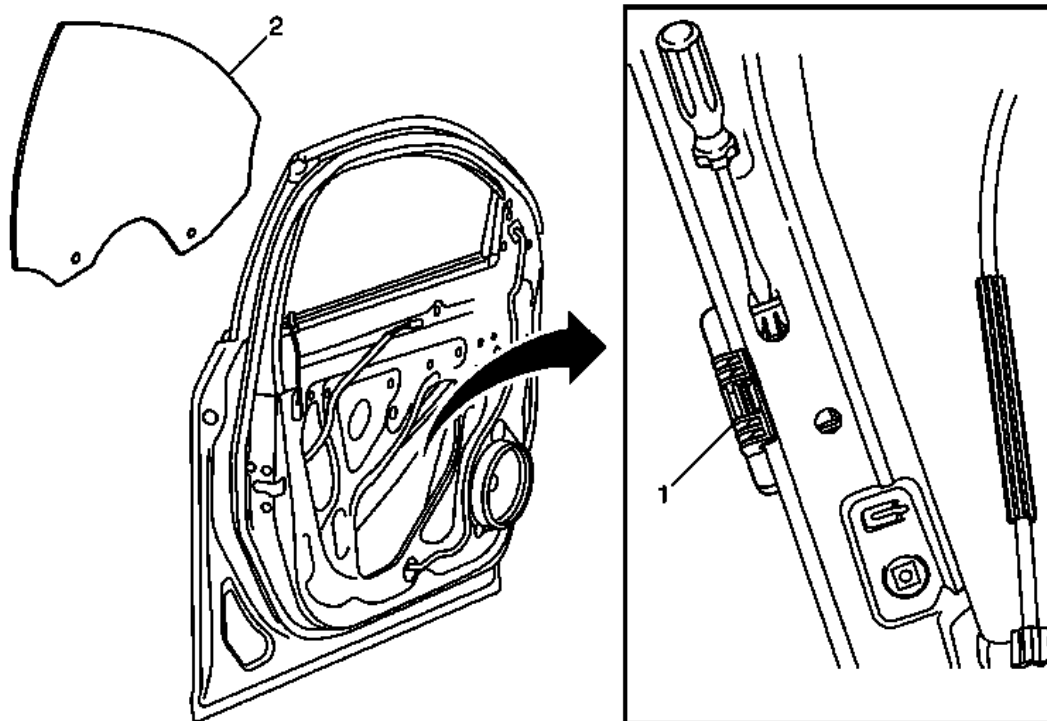


Fig. 13: Front Side Door Window & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Replacement

Callout	Component Name
WARNING: Disconnect the power window switch when working inside the driver door. When operated, the Express Up/Down Feature allows the door window to move very quickly, without stopping, which could cause personal injury.	
CAUTION: Refer to <u>Paint Damage Caution</u> .	
Preliminary Procedure <ol style="list-style-type: none"> 1. Remove the front side door trim panel. Refer to <u>Front Side Door Trim Panel Replacement</u> . 2. Remove the front side door inner sealing strip. Refer to <u>Front Side Door Window Inner Sealing Strip Replacement</u>. 3. Remove the front side door window weatherstrip. Refer to <u>Front Side Door Window Weatherstrip Replacement</u>. 	
	Front Side Door Window Guide Retainer Clip (Qty: 2)
	Procedures <ol style="list-style-type: none"> 1. Apply masking tape to the outer applique and frame.

1	<ol style="list-style-type: none"> Position the window approximately half way down in the door. Remove the front door water deflector. Push inward on the window guide retainer clip, lift upward on the window until it releases from the retaining clip on the left and right side. Tilt the window downward in the front, pull up on the back of the window and pull it out from the frame.
2	<p>Front Side Door Window</p> <p>Procedures</p> <ol style="list-style-type: none"> Window motor relearn procedure. Window regulator motor programming and set-up. Refer to <u>Window Motor Programming - Express Function</u> <p>NOTE: Inspect the window for proper operation before installing the trim panel.</p>

REAR SIDE DOOR WINDOW ADJUSTMENT

Causes of Slow Moving Window

NOTE: Owners may comment that the windows operate slowly when going up or down.

- Listed below are conditions that may cause a slow moving window:
 - The window run channel outboard lip at the rear of door frame.
 - The window is not seated in the run channel.
 - The window is misaligned in the opening.
 - The regulator is misaligned causing misalignment of the window .
- After inspecting the conditions above, do the following:
 - Remove the rear door trim panel.
 - Remove the water deflector.
 - Ensure that the window guide is fully seated and clipped.

Ensure that the window is fully seated in the window guide run channel.

- Inspect the window for equal distance between the front and rear run channels.
- Inspect the power window motor for being loose.
- Inspect the window for alignment.

Adjustment Procedure

- Remove the rear side door trim panel.

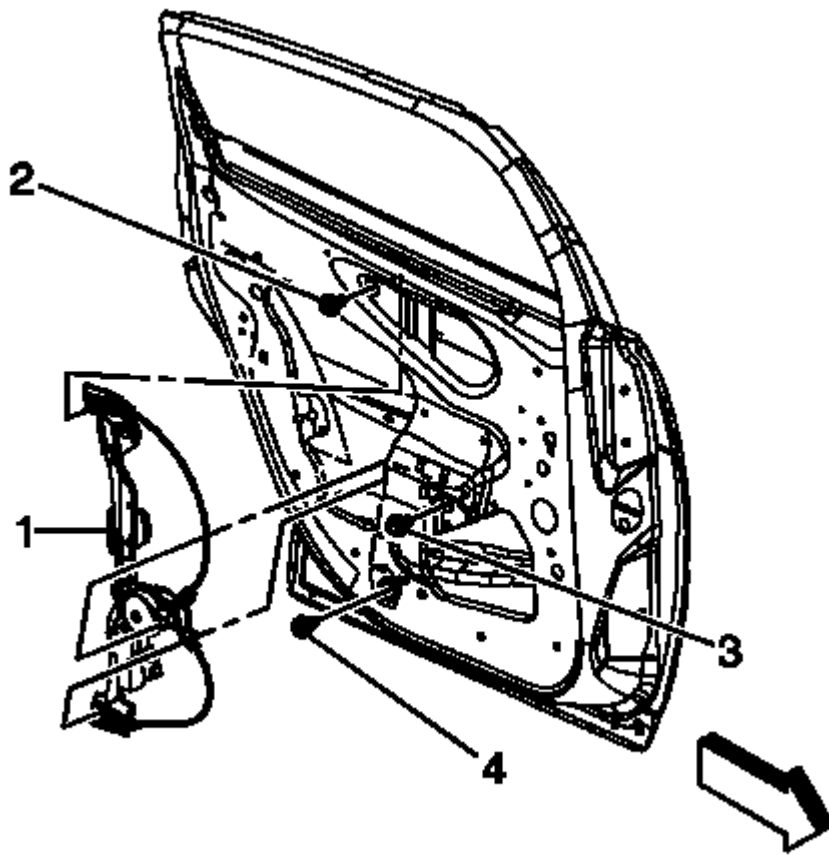


Fig. 14: Window Regulator

Courtesy of GENERAL MOTORS COMPANY

2. Inspect for the following conditions before making adjustments:
 - Using a flat-bladed tool, straighten the run channel lip by pulling it out to its correct position.
 - Use a flat-bladed tool to push the run channel rearward to seat it in the door frame.
 - Inspect the window guide channel to window fasteners to ensure that they are in the proper slots and the window is not tilted forward.
 - Inspect the window to be straight up and down position.
 - Loosen the fasteners that attach the window regulator (1) to the inner door panel, in the specified sequence (2, 3, 4).

CAUTION: Refer to Fastener Caution .

3. Loosen the fasteners that attach the rear side door window regulator (1) to the inner door panel in the specified sequence (2, 3, 4).

Tighten the fasteners to 10 N.m (89 lb in).

4. Inspect the window for proper operation.
5. Install the water deflector.
6. Install the rear door trim panel.

REAR SIDE DOOR WINDOW REPLACEMENT

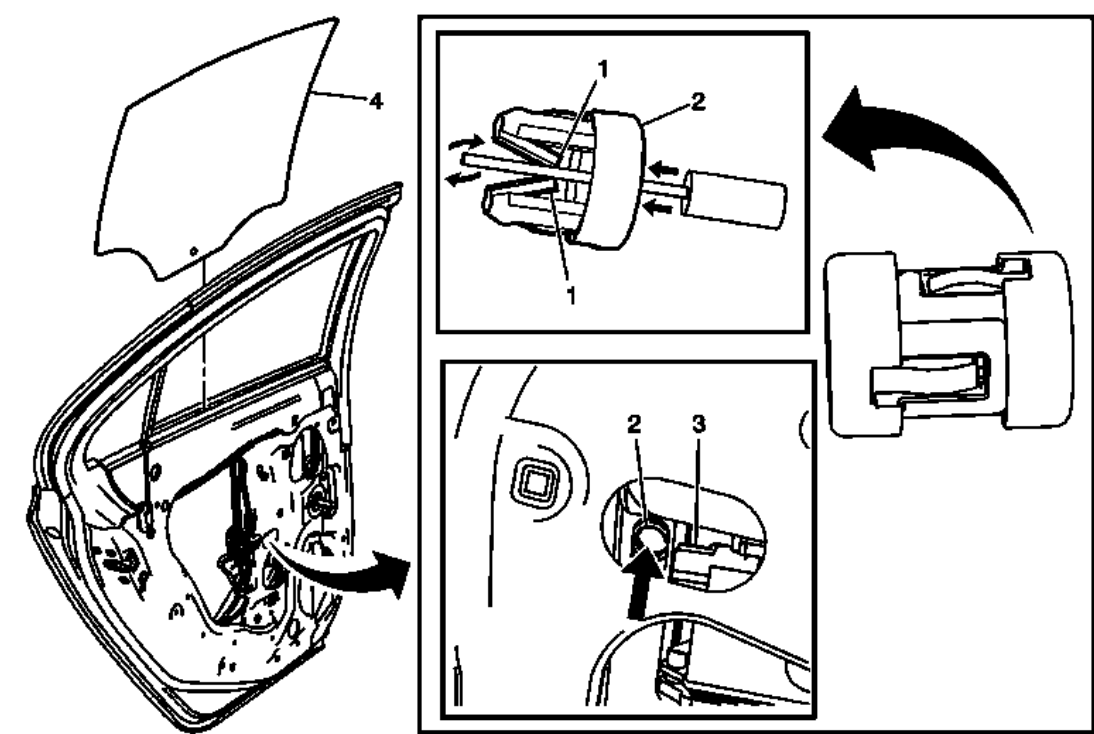


Fig. 15: Rear Side Door Window, Retainer & Tabs
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Window Replacement

Callout	Component Name
CAUTION: Refer to <u>Paint Damage Caution</u> .	
Preliminary Procedure <ol style="list-style-type: none"> 1. Remove the rear side door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u> . 2. Remove the rear side door stationary window. Refer to <u>Rear Side Door Stationary Window Replacement</u>. 	
	Rear Side Door Window Guide Retainer Tabs
	Procedures <ol style="list-style-type: none"> 1. Apply masking tape to the outer applique and frame.

1	<ol style="list-style-type: none"> 2. Raise the window. 3. Remove the rear side door water deflector. 4. Remove the energy absorber retainers and energy absorber from the door. 5. Loosen the rear side door window run channel guide fastener. 6. Position the window half way down or enough in order to gain access through the inner panel. 7. Install a suitable tool in the center of the center guide retainer, push inward to release the tabs.
2	Rear Side Door Window Guide Retainer Procedures Separate the window guide retainer in half.
3	Rear Side Door Window Guide Procedures Lift upward on the window until it released from the guide.
4	Rear Side Door Window Procedures After replacing the window it will be necessary to reprogram. Refer to <u>Control Module References</u> . NOTE: Inspect the window for proper operation before install the trim panel.

REAR SIDE DOOR STATIONARY WINDOW REPLACEMENT

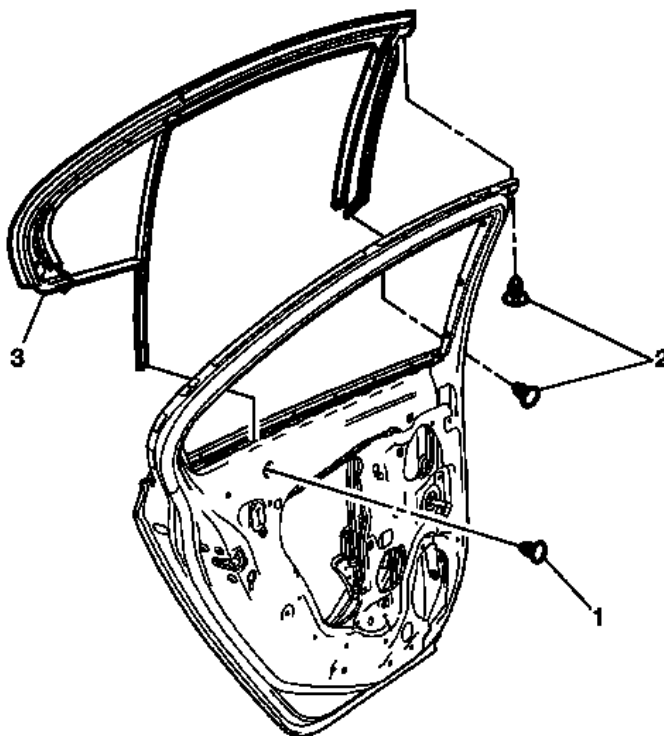


Fig. 16: Rear Side Door Window Weatherstrip & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Stationary Window Replacement

Callout	Component Name
CAUTION: Refer to <u>Paint Damage Caution</u> .	
Preliminary Procedure Remove the rear side door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u> .	
1	Rear Side Door Stationary Window Rear Channel Fastener (Qty: 2)
2	Rear Side Door Stationary Window Rear Channel Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedures 1. Apply masking tape to the outer applique and frame. 2. Lower the window. 3. Remove the rear side door water deflector. Tighten 10 N.m (89 lb in)
3	Rear Side Door Stationary Window NOTE: When replacing the rear side door window weatherstrip it is necessary to transfer the rear side door stationary window.

REAR WINDOW REPLACEMENT

Special Tools

- **BO-24402-A** Glass Sealant Remover (Cold Knife)
- **BO-39032** Stationary Glass Removal Tool
- Use an adhesive that is approved by GM

For equivalent regional tools, refer to **Special Tools**

Removal Procedure

WARNING: If a window is cracked but still intact, crisscross the window with

masking tape in order to reduce the risk of damage or personal injury.

NOTE: Before cutting out a stationary window, apply a double layer of masking tape around the perimeter of the painted surfaces and inner trim.

1. Open the rear compartment lid.

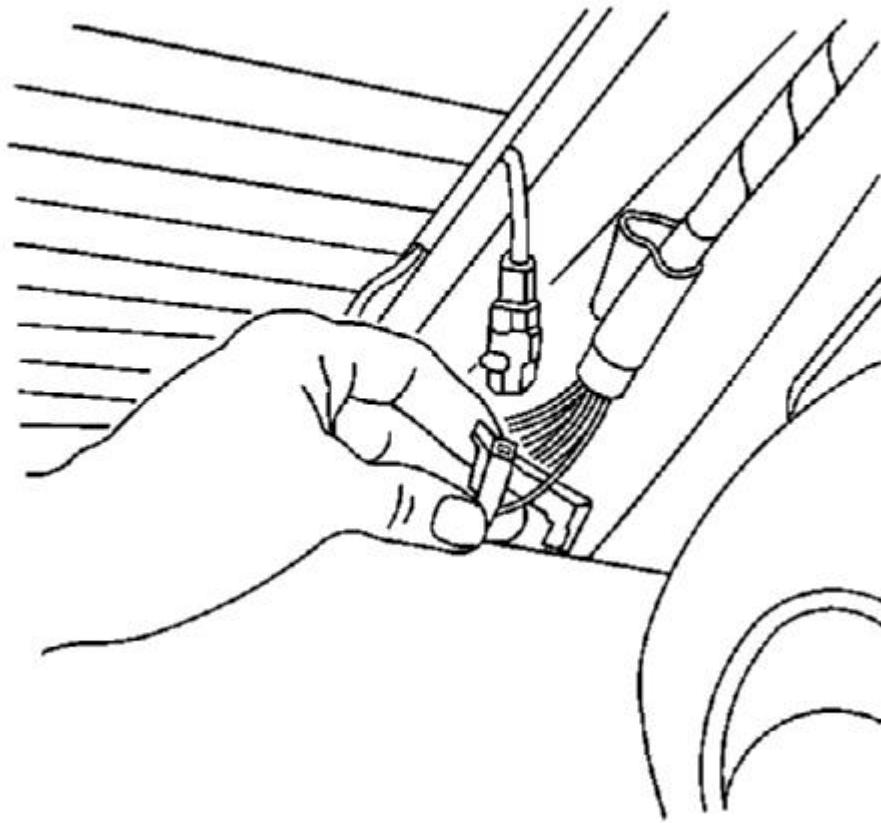


Fig. 17: Locating Rear Window Defogger Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the rear window defogger electrical connectors.
3. Disconnect the OnStar® antenna, if equipped.
4. Disconnect the rear window radio antenna connector.

WARNING: If broken glass falls into the defroster outlets, it can be blown into the passenger compartment and cause personal injury.

5. Cover to protect the following parts from broken glass:
 - Upper dash pad

- Defroster outlets and A/C outlets
- Seats and carpeting

WARNING: Refer to Glass and Sheet Metal Handling Warning .

NOTE: Keep the cutting edge of the tool against the window. Use care Not to damage the window corner retainers. If the window retainers get cut off when removing the window it will be necessary to tape the window in place when installing.

6. This will allow the urethane adhesive to be separated from the window.
 - Leave a base of urethane on the pinchweld flange.
 - The only suitable lubrication is clear water.
 - **BO-24402-A** Glass Sealant Remover (Cold Knife).
 - **BO-39032** Stationary Glass Removal Tool.

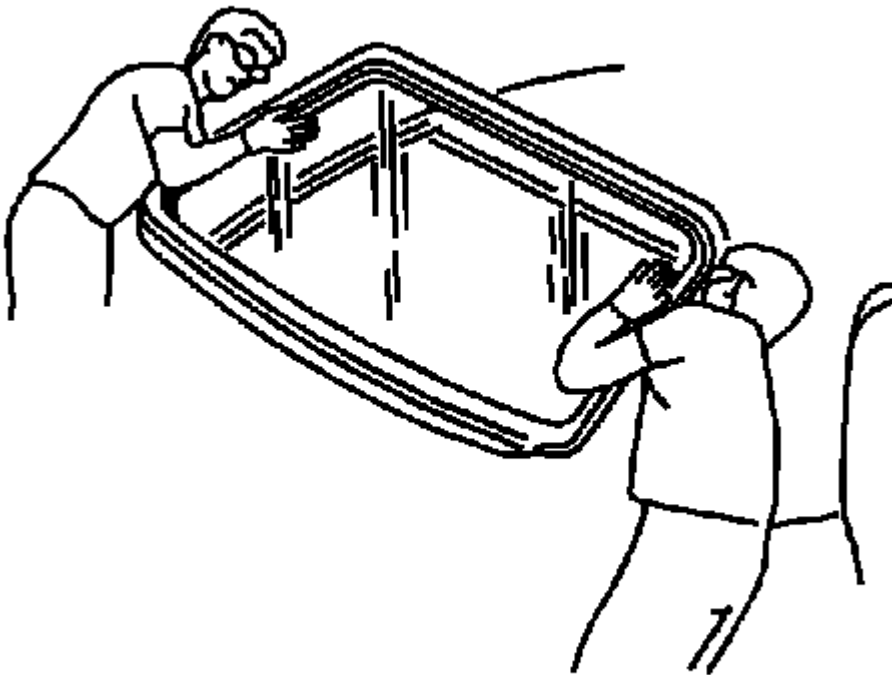


Fig. 18: Removing/Installing Rear Window
Courtesy of GENERAL MOTORS COMPANY

7. With the aid of an assistant lift the rear window from the opening.

Installation Procedure

1. Install the rear window into the opening. Refer to **Adhesive Installation of Rear Windows**.
2. Connect the rear window defogger electrical connectors.
3. Install the rear window radio antenna connector.
4. Connect the OnStar® antenna, if equipped.

Check the radio and OnStar® system to verify reception.

5. Close the rear compartment lid.
6. Remove the double layer of masking tape around the perimeter of the painted surfaces and the interior trim.

FRONT SIDE DOOR WINDOW SWITCH REPLACEMENT

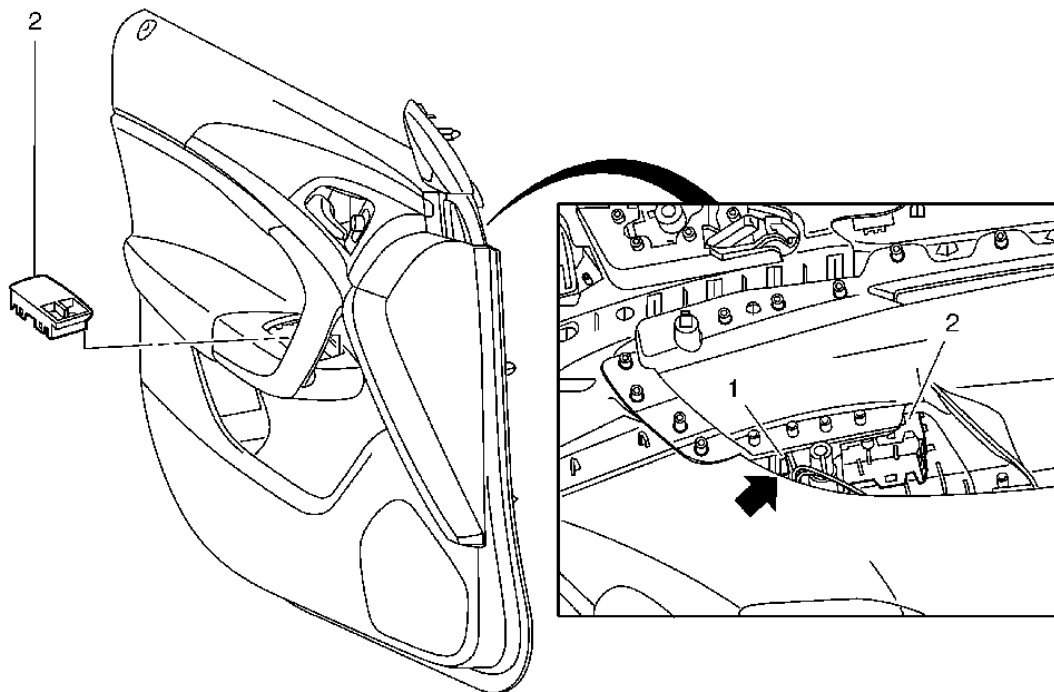


Fig. 19: Front Side Door Window Switch Bezel & Retainer
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Switch Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front side door trim panel. Refer to <u>Front Side Door Trim Panel Replacement</u> .	

1	Front Side Door Window Switch Retainer Procedure Use a small flat-bladed tool to release the retainer from the rear side of the front side door trim panel.
2	Front Side Door Window Switch Procedure Separate the switch and bezel, if necessary.

REAR SIDE DOOR WINDOW SWITCH REPLACEMENT

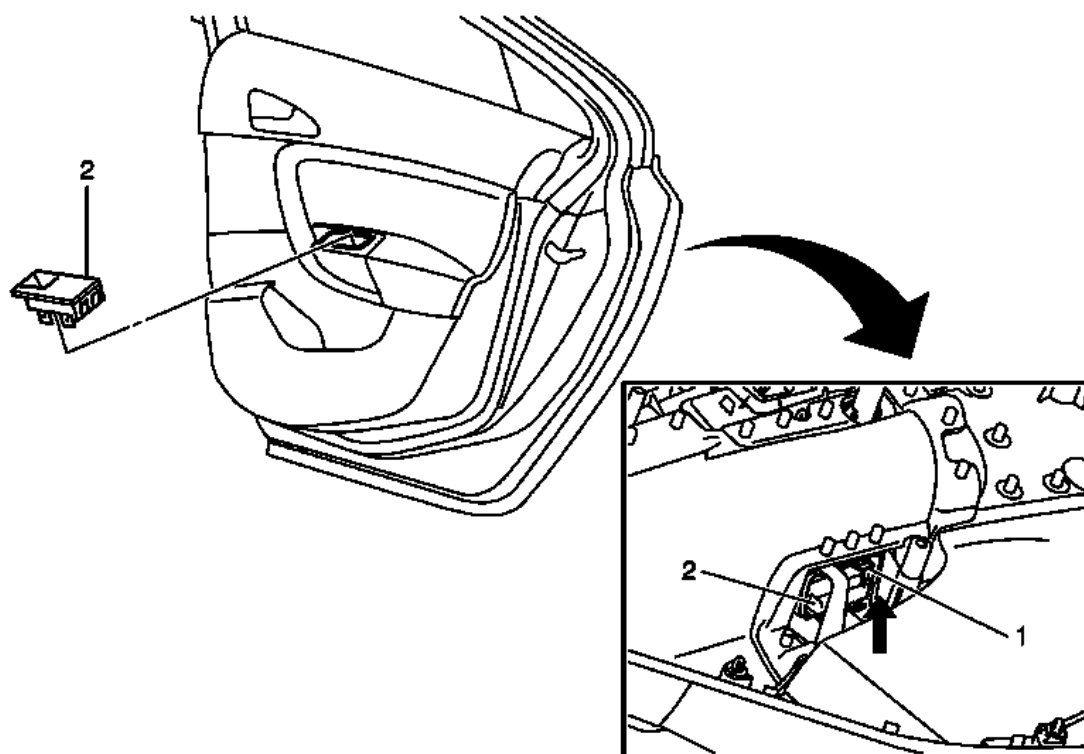


Fig. 20: Rear Side Door Window Switch
Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Window Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the rear side door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u> .	
1	Rear Side Door Switch Retainer TIP: Use a small flat-bladed tool to release the retainer from the rear side door switch.
2	Rear Side Door Switch Procedure Disconnect the electrical connector.

FRONT SIDE DOOR WINDOW REGULATOR REPLACEMENT

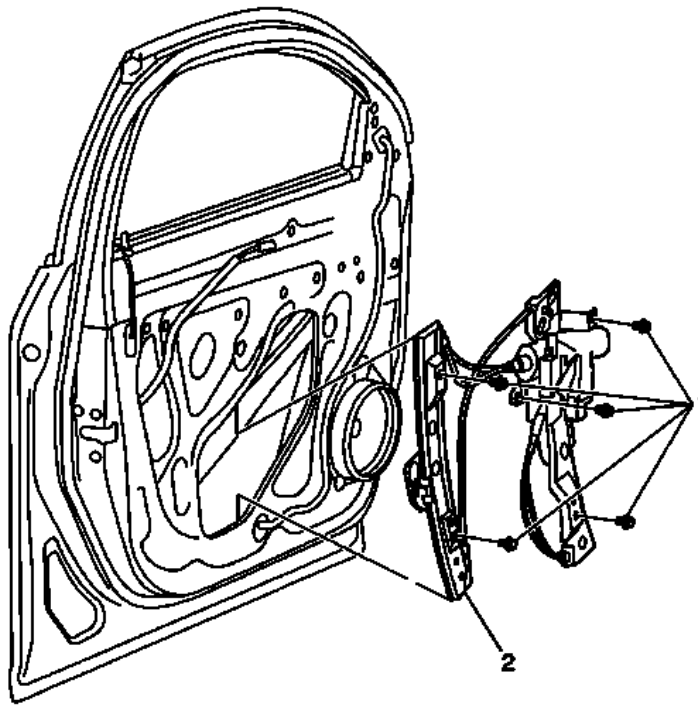


Fig. 21: Front Side Door Window Regulator & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Regulator Replacement

Callout	Component Name
WARNING: Disconnect the power window switch when working inside the driver door. When operated, the Express Up/Down Feature allows the door window to move very quickly, without stopping, which could cause personal injury.	
Preliminary Procedure Remove the water deflector. Refer to <u>Front Side Door Water Deflector Replacement</u>	
1	Front Side Door Window Regulator Fasteners (Qty: 5) CAUTION: Refer to <u>Fastener Caution</u> . Procedures <ol style="list-style-type: none"> 1. Release the 2 window fasteners. 2. After detaching window from regulator, manually move window to the full up position and tape to frame. Tighten

	10 N.m (89 lb in)
2	Front Side Door Window Regulator Procedures 1. Disconnect the front side door window regulator electrical connector. 2. Window regulator motor programming and set-up. Refer to <u>Control Module References</u> . 3. Inspect the door window for proper operation before installing the door trim panel.

WINDOW MOTOR PROGRAMMING - EXPRESS FUNCTION

Window Motor Normalized Procedure

A window motor that has not been normalized will no longer perform the express up and express down functions, this may occur during the following conditions:

- When a window motor has been disconnected or replaced
- When a door harness has been disconnected
- When the battery has been disconnected or replaced

NOTE: When DTC B3205 4B & 3210 4B are set, the following warnings will be displayed on the driver information center:

Open, then Close Driver Window

Open, then Close Passenger Window

These warnings will clear once the windows have been "Normalized" and the respective DTC will clear.

To normalize the window motor, follow these steps:

NOTE: The doors must be completely closed prior to normalizing the windows, a door that is open or ajar may cause the power window to function abnormally or to become inoperative while performing the normalizing procedure. If this occurs, verify that the door is completely closed then repeat the normalizing procedure.

NOTE: For vehicles equipped with a folding convertible top, the top must be closed and firmly latched prior to normalizing the windows.

1. Ignition ON.
2. Starting with the window completely UP, press and hold the power window switch until the window is fully open and continue holding the switch down for approximately 5 seconds after the window is

completely open.

3. Pull the power window switch up until the window is fully closed and continue holding the switch up for approximately 5 seconds after the window is completely closed.

The window should now be normalized and the window should perform the express up and express down functions.

Window Motor Relearn Procedure

A relearn procedure may need to be performed for any Local Interconnect Network (LIN) window motor for the following conditions:

- When the window glass is out of alignment
- When the window glass has been replaced
- When the door has been replaced
- When the window regulator has been replaced

NOTE: Prior to performing the relearn procedure the vehicle must have all 4 wheels properly inflated and mounted, the vehicle must be sitting on a level surface and all doors must be completely closed and for vehicles equipped with a folding convertible top, the top must be closed and firmly latched..

To relearn the window motor, follow these steps:

1. Ignition ON.
2. With a scan tool, select Module Diagnosis, Body Control Module, Configuration/Reset Functions and then select the appropriate Clear Window Learn Values for the window motor requiring the relearn procedure.
3. After the learn procedure, exit the scan tool learn procedure completely, the power window cannot be normalized and will not function until you exit the program.
4. Starting with the window completely UP, press and hold the power window switch until the window is fully open and continue holding the switch down for approximately 5 seconds after the window is completely open.
5. Pull the power window switch up until the window is fully closed and continue holding the switch up for approximately 5 seconds after the window is completely closed.

The window is now reprogrammed.

FRONT SIDE DOOR WINDOW REGULATOR MOTOR REPLACEMENT

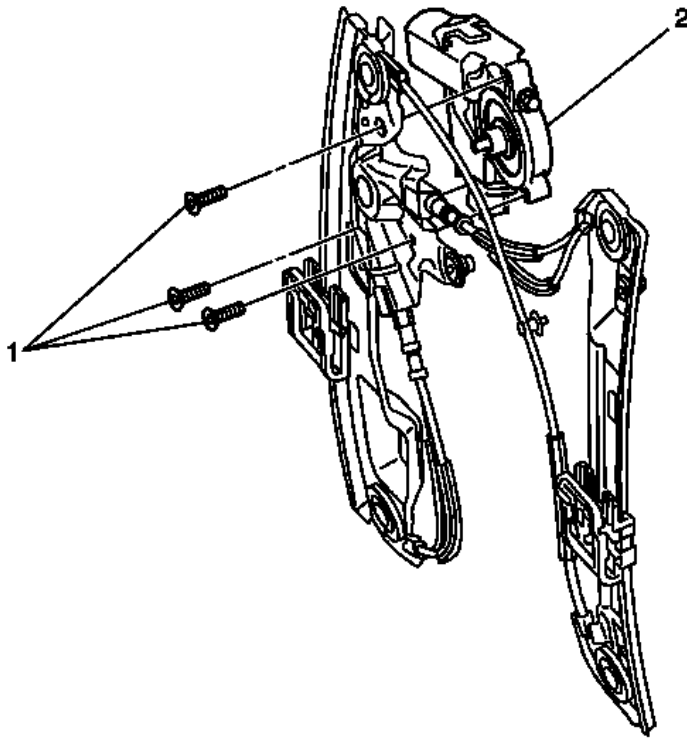


Fig. 22: Front Side Door Window Regulator Motor & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Regulator Motor Replacement

Callout	Component Name
Preliminary Procedure Remove the front side door window regulator. Refer to Front Side Door Window Regulator Replacement .	
1	Front Side Door Window Regulator Motor Fasteners (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Front Side Door Window Regulator Motor Procedure Inspect the door window for proper operation before installing the door trim panel.

REAR SIDE DOOR WINDOW REGULATOR REPLACEMENT

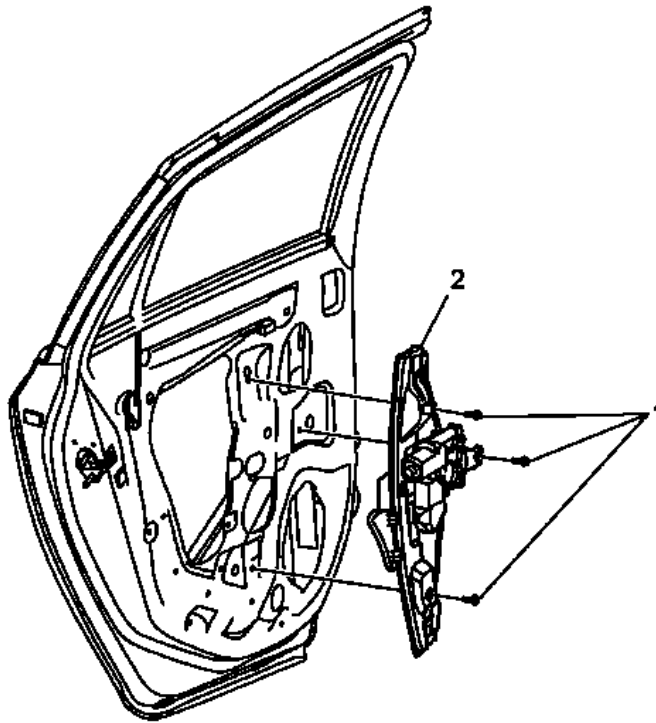


Fig. 23: Rear Side Door Window Regulator & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Window Regulator Replacement

Callout	Component Name
WARNING: Disconnect the power window switch when working inside the driver door. When operated, the Express Up/Down Feature allows the door window to move very quickly, without stopping, which could cause personal injury.	
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the rear side door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u> . 2. Release the door window from the guide retaining clips. Refer to <u>Rear Side Door Window Replacement</u> 	
1	Rear Side Door Window Regulator Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure After detaching window from regulator, manually move window to full up position and securely tape the window to the door frame. Tighten

	10 N.m (89 lb in)
	Rear Side Door Window Regulator
2	Procedures <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Transfer all parts as necessary. TIP: Inspect the window for proper operation, adjust if necessary.

REAR SIDE DOOR WINDOW REGULATOR MOTOR REPLACEMENT

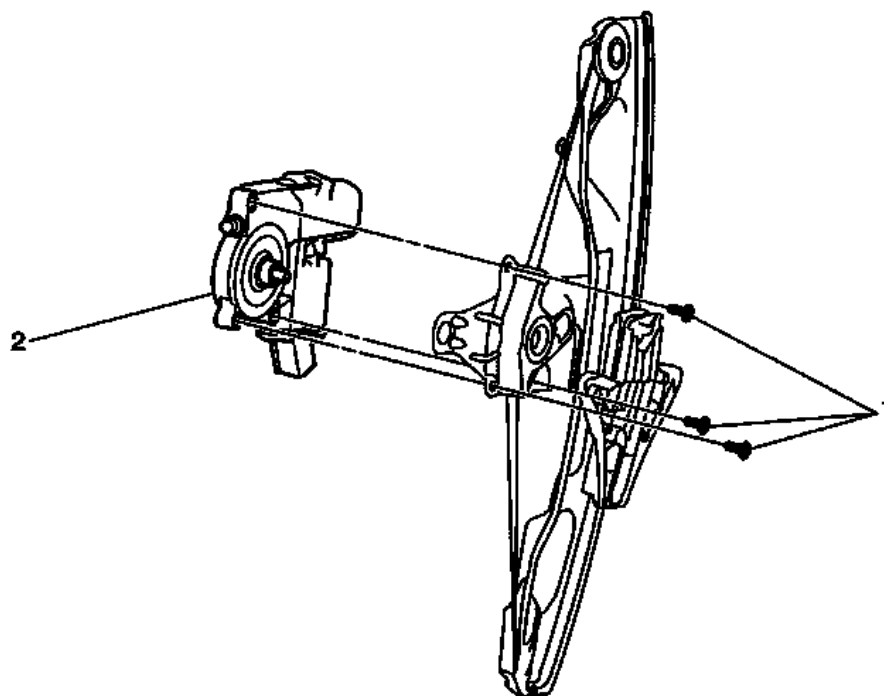


Fig. 24: View Of Rear Side Door Window Regulator Motor & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Window Regulator Motor Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the rear side door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u> . 2. Remove the rear side door window regulator. Refer to <u>Rear Side Door Window Regulator Replacement</u>. 	
	Rear Side Door Window Regulator Motor Fasteners (Qty: 3)

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Rear Side Door Window Regulator Motor Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Transfer all parts as necessary. TIP: Inspect the window for proper operation.

FRONT SIDE DOOR WINDOW OUTER SEALING STRIP REPLACEMENT

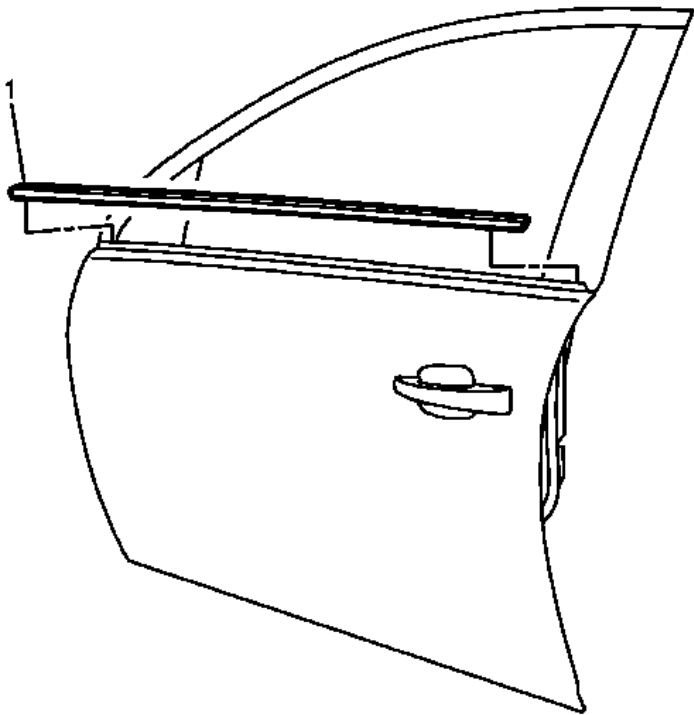


Fig. 25: Front Side Door Window Belt Reveal Molding
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Outer Sealing Strip Replacement

Callout	Component Name
Preliminary Procedure	

Remove the outside rearview mirror. Refer to **Outside Rearview Mirror Replacement** .

1	Front Side Door Window Outer Sealing Strip TIP: Use a small flat-bladed tool to lift the front side door window outer sealing strip up to remove it from the door flange.
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FRONT SIDE DOOR WINDOW INNER SEALING STRIP REPLACEMENT

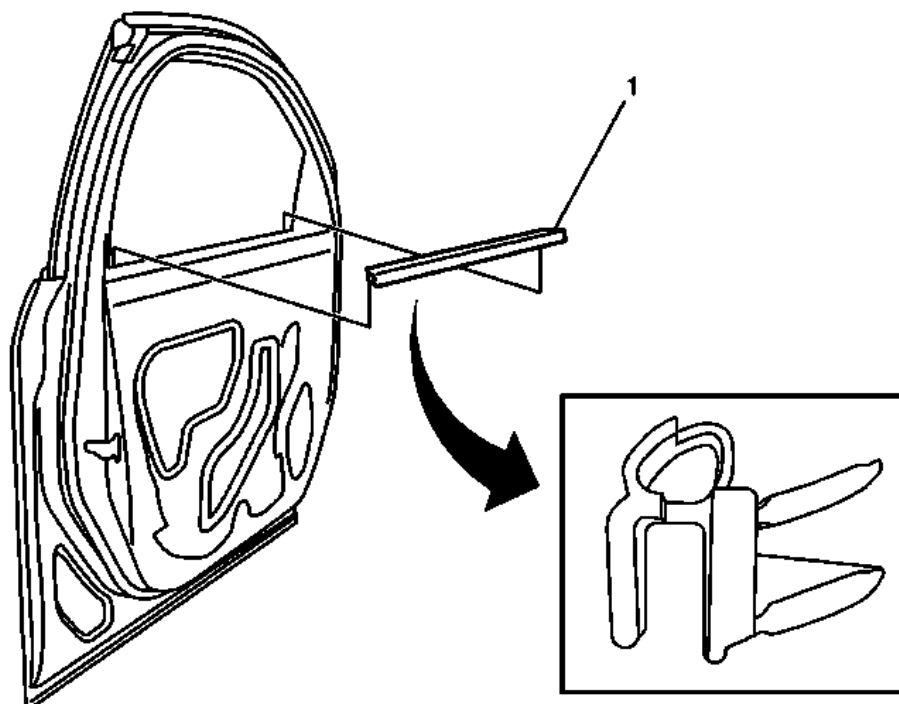


Fig. 26: Front Side Door Window Inner Sealing Strip

Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Inner Sealing Strip Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the front side door trim panel. Refer to <u>Front Side Door Trim Panel Replacement</u>	
2. Remove the front side door window frame garnish molding. Refer to <u>Front Side Door Window Frame Garnish Molding Replacement</u>	
1	Front Side Door Window Inner Sealing Strip Procedure Pull the sealing strip up and away from the door flange to remove.

REAR SIDE DOOR WINDOW INNER SEALING STRIP REPLACEMENT

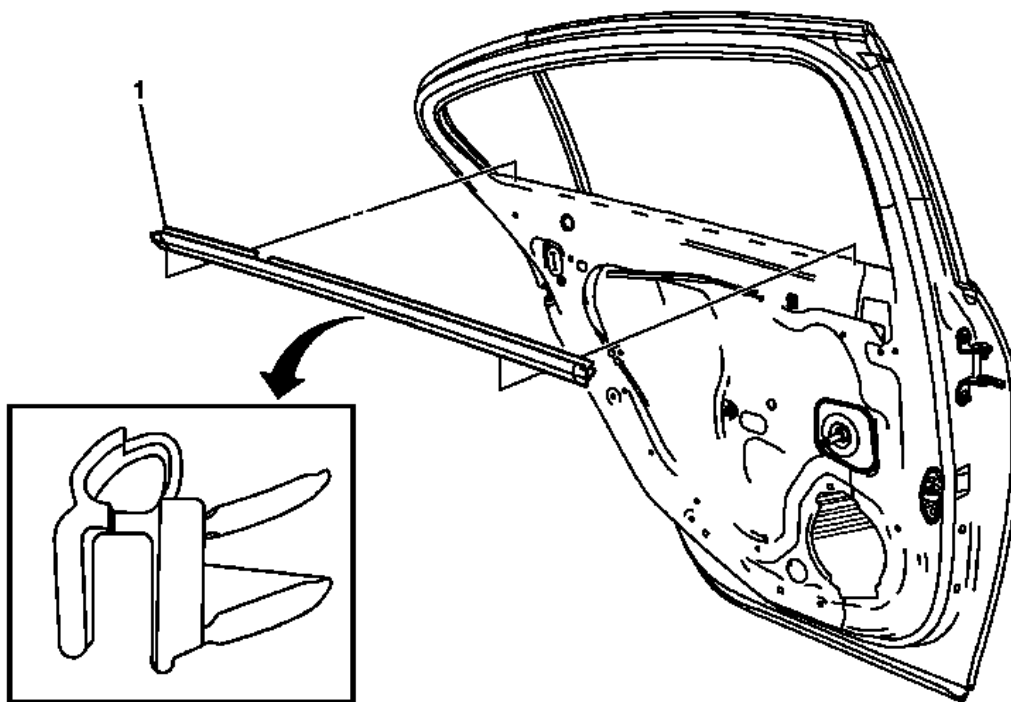


Fig. 27: Rear Side Door Window Inner Sealing Strip
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Window Inner Sealing Strip Replacement

Callout	Component Name
Preliminary Procedures	
Remove the rear side door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u> .	
1	Rear Side Door Window Inner Strip
	Procedures
	<ol style="list-style-type: none"> 1. Lift the rear side door window inner strip off the pinch-weld flange. 2. Press firmly to insert the rear side door window inner strip back on the door flange.
TIP: Inspect the window for proper operation.	

REAR SIDE DOOR WINDOW OUTER SEALING STRIP REPLACEMENT

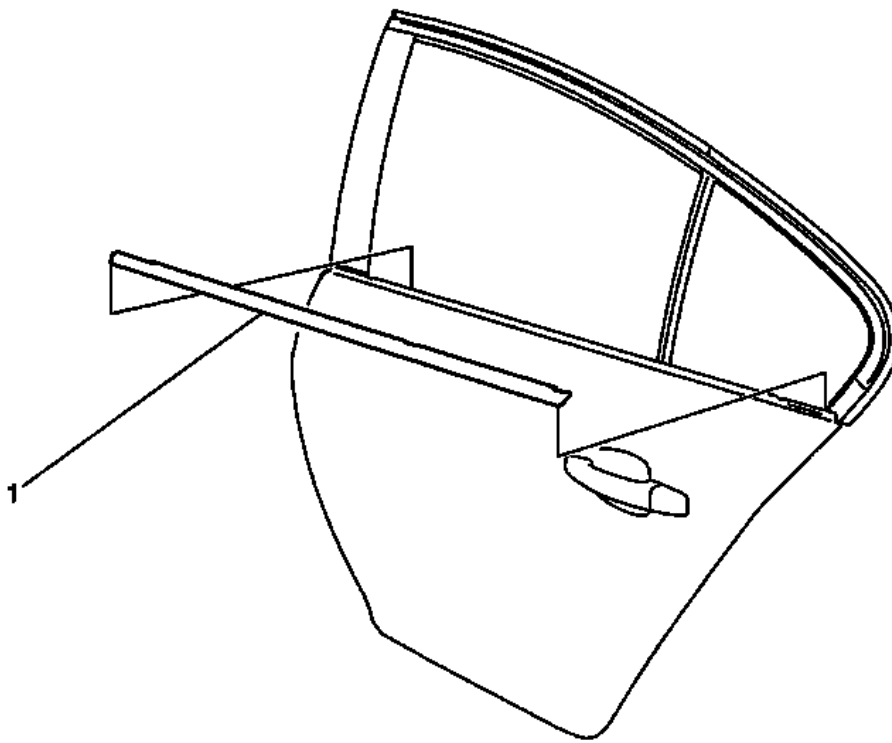


Fig. 28: Rear Side Door Window Belt Reveal Molding
Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Window Outer Sealing Strip Replacement

Callout	Component Name
1	Rear Side Door Window Outer Sealing Strip TIP: Using a small flat-bladed tool, lift the sealing strip up to remove it from the door flange.

FRONT SIDE DOOR WINDOW WEATHERSTRIP REPLACEMENT

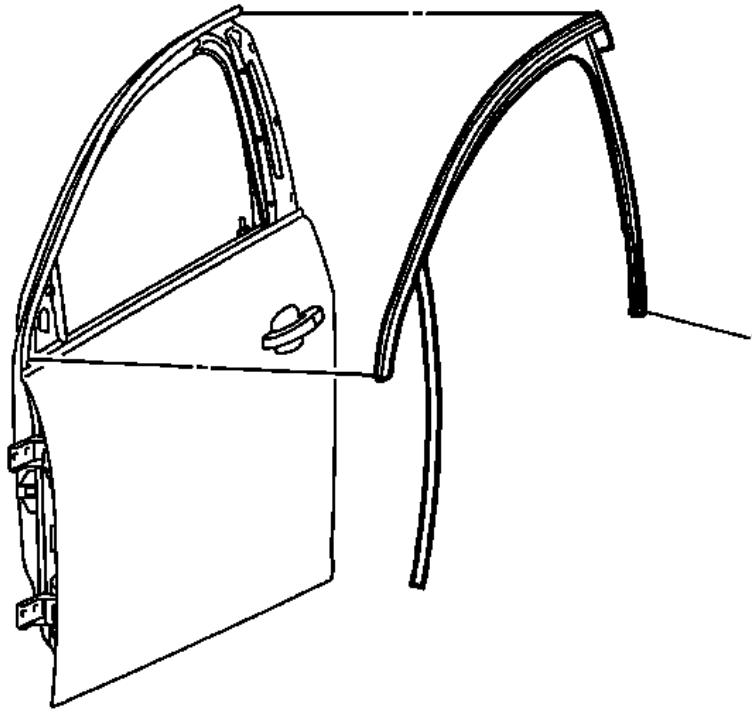


Fig. 29: Front Side Door Window Weatherstrip
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Weatherstrip Replacement

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Remove the front side door trim panel. Refer to <u>Front Side Door Trim Panel Replacement</u> . 2. Remove the front side door window outer sealing strip. Refer to <u>Front Side Door Window Outer Sealing Strip Replacement</u>. 3. Remove the front side door window frame garnish molding. Refer to <u>Front Side Door Window Frame Garnish Molding Replacement</u> . 4. Remove the front side door window frame rear cover. Refer to <u>Front Side Door Window Frame Rear Cover Replacement</u> . 	
1	Front Side Door Window Weatherstrip Procedure <ol style="list-style-type: none"> 1. Refit corner retainers. 2. Pull the front side door window weatherstrip from the window frame to remove.

ADHESIVE INSTALLATION OF WINDSHIELDS

WARNING: Refer to **Glass and Sheet Metal Handling Warning** .

1. Use a urethane adhesive systems which meet GM Specification GM 3651G.

NOTE: Remove all but approximately 2 mm (3/64 in) of the existing bead of urethane adhesive from the pinch-weld flange.

2. Remove all mounds or loose pieces of urethane adhesive from the pinch-weld area.
3. If the original window is being reused, remove all but a thin film of the existing urethane adhesive from the window surface by using a clean utility knife or razor blade scraper.
4. Inspect for any of the following problems in order to help prevent future breakage of the window:
 - High weld
 - Solder spots
 - Hardened sealer
 - Any other obstruction or irregularity in the pinch-weld flange

NOTE: If corrosion of the pinch-weld flange is present or if sheet metal repairs or replacements are required, the pinch-weld flange must be refinished in order to restore the bonding area strength. If paint repairs are required, mask the flange bonding area prior to applying the color coat in order to provide a clean primer only surface. Materials such as BASF DE15®, DuPont 2610®, Sherwin-Williams PSE 4600 and NP70® and Martin-Semour 5120 and 5130® PPG DP90LF SPIES/HECKER 3688/8590 - 3688/5150 - 4070/5090 STANDOX 11158/13320 - 14653/14980 products are approved for this application.

5. After repairing the opening as indicated, perform the following steps:
 1. Remove all traces of broken glass from the outer cowl panel, seats, floor, and defroster ducts.
 2. Clean around the edge of the inside surface of the window with a 50/50 mixture of isopropyl alcohol and water by volume on a dampened lint free cloth.

WARNING: Refer to Window Retention Warning .

6. Verify all primers and urethane adhesive are within expiration dates.

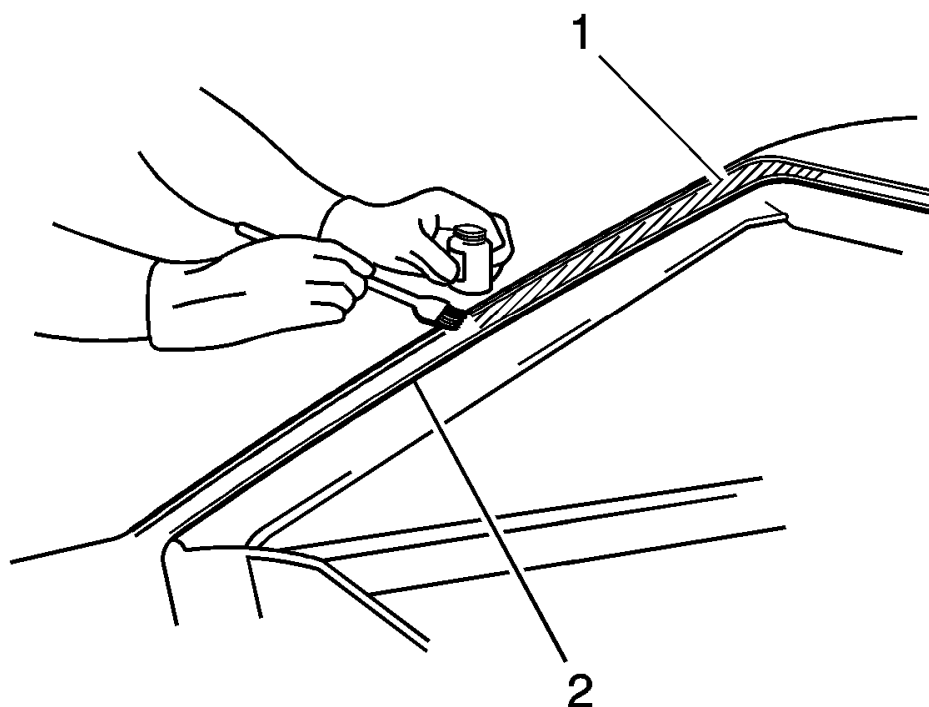


Fig. 30: Applying Pinch-Weld Primer
Courtesy of GENERAL MOTORS COMPANY

WARNING: Failure to prep the area prior to the application of primer may cause insufficient bonding of urethane adhesive. Insufficient bonding of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.

NOTE: Do not apply the black #3 primer to the existing bead (1) of the urethane adhesive on the pinch-weld flange. Apply the primer only to nicks, scratches, or the primed surfaces.

7. Shake the pinch-weld primer black #3 for at least 1 minute.
8. Use a new dauber in order to apply the primer to the surface of the pinch-weld flange (1).
9. Allow the pinch-weld primer to dry for approximately 10 minutes.

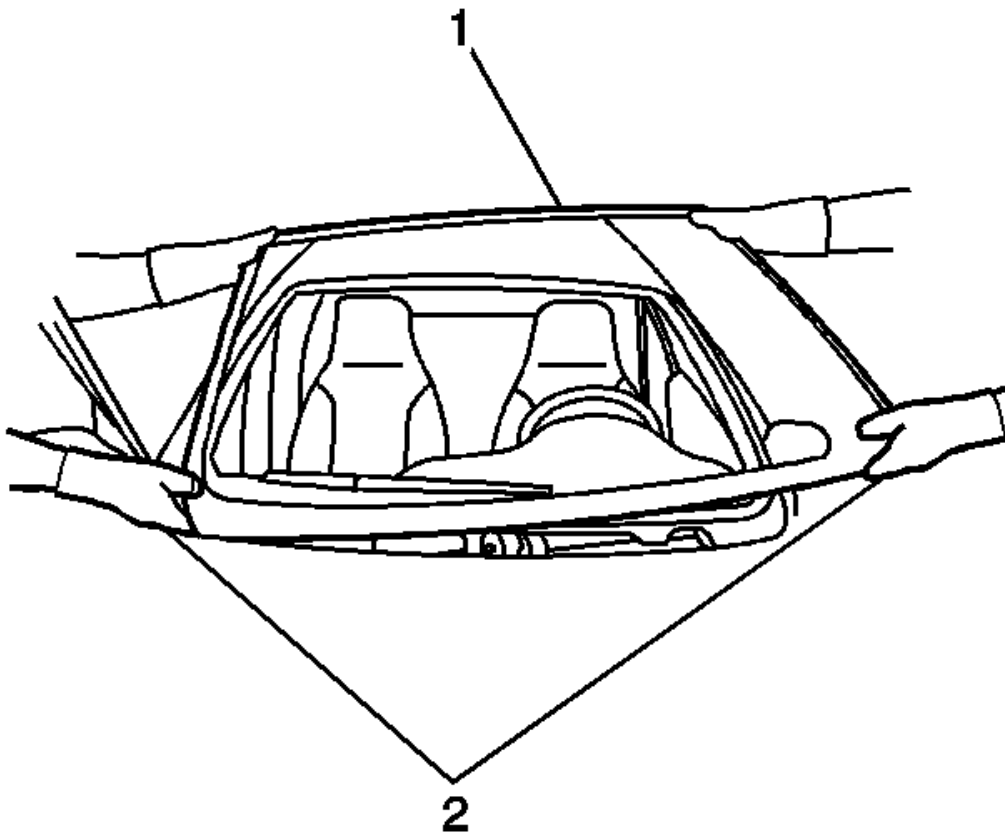


Fig. 31: Removing/Installing Windshield
Courtesy of GENERAL MOTORS COMPANY

10. With the aid of an assistant, dry fit the window (1) to the opening in order to determine the correct position.

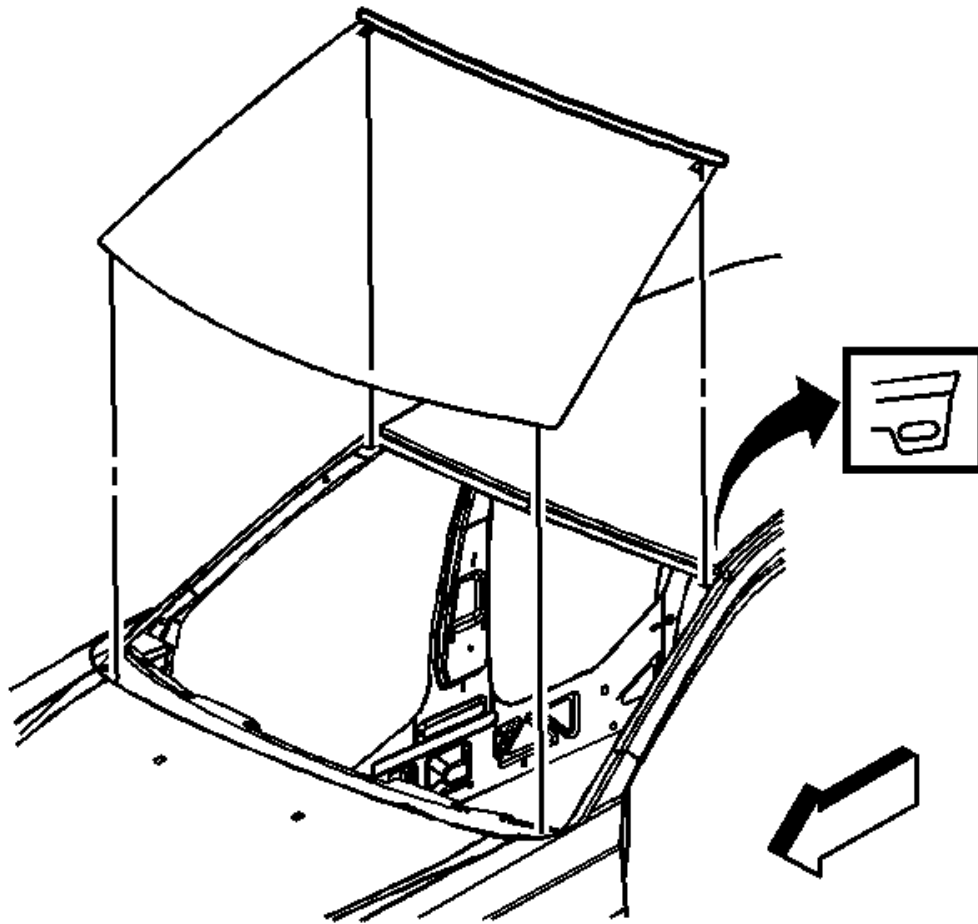


Fig. 32: Identifying Locator Slots On Upper Pinch-Weld Flange
Courtesy of GENERAL MOTORS COMPANY

11. If equipped, ensure that the windshield locator pins are positioned into the locator slots on the upper pinch-weld flange.

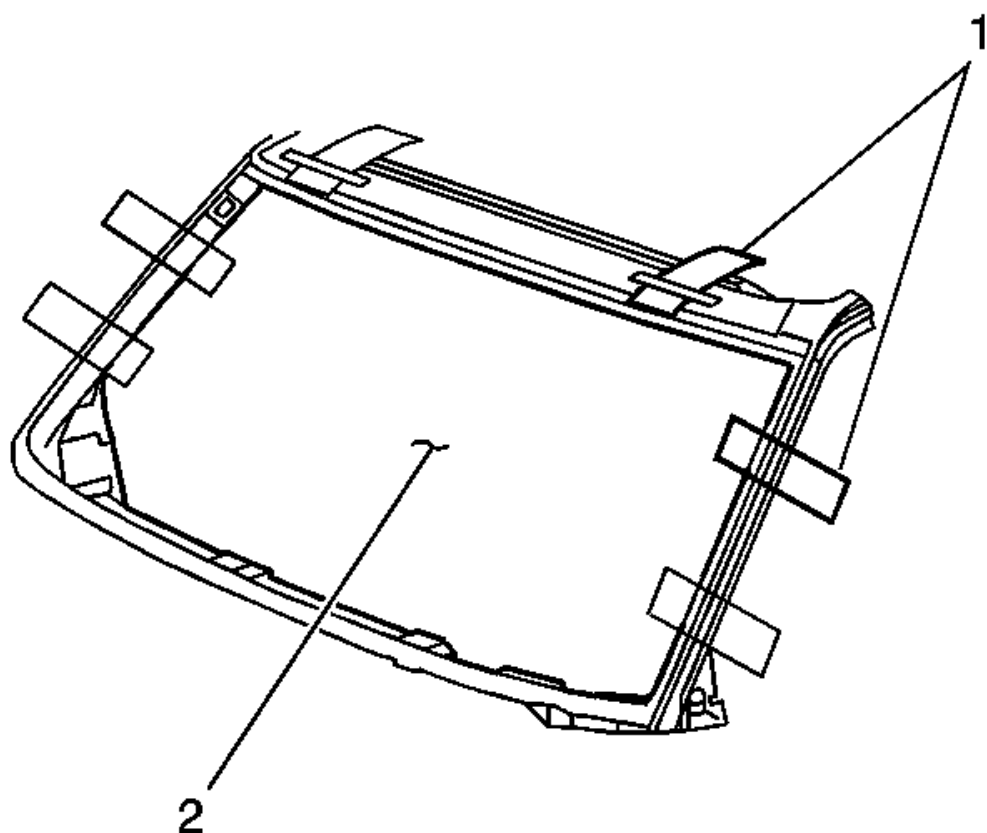


Fig. 33: Aligning Tape Lines On Window To Body
Courtesy of GENERAL MOTORS COMPANY

12. Use masking tape in order to mark the locations (1) of the window (2) in the opening.
13. Cut the masking tape in the center and remove the window from the opening.

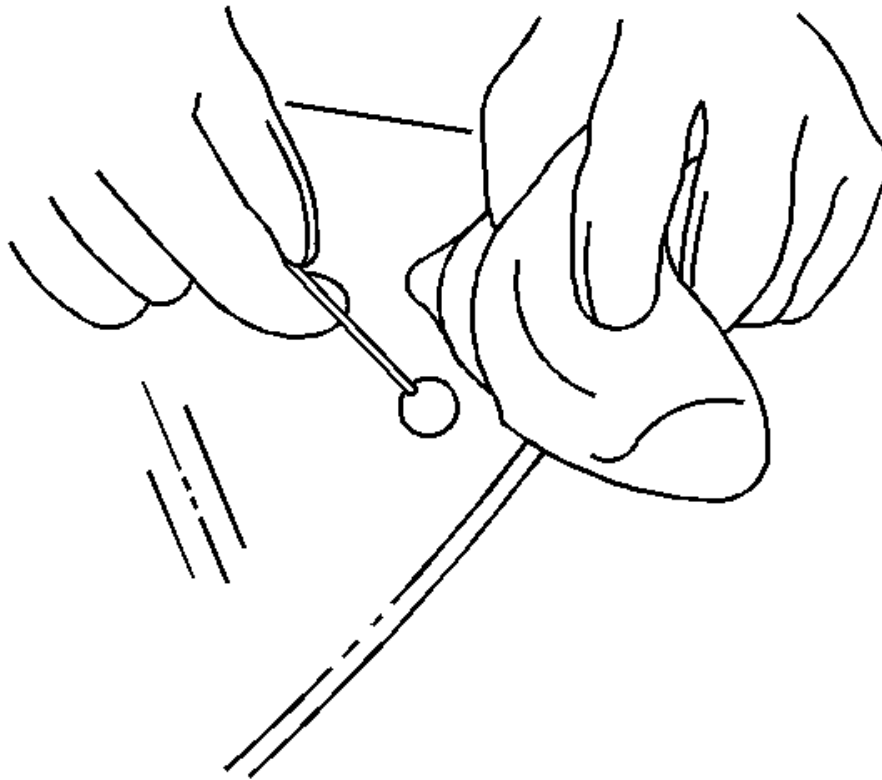


Fig. 34: Applying Glass Prep
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use care when applying glass prep clear #1 on the window. This primer dries almost instantly, and may stain the viewing area of the window if not applied evenly.

14. Use a new dauber in order to apply glass prep clear #1 to the area approximately 18 mm (0.71 in) around the entire perimeter of the window inner surface.

Immediately wipe the glass primed area using a clean, lint-free cloth.

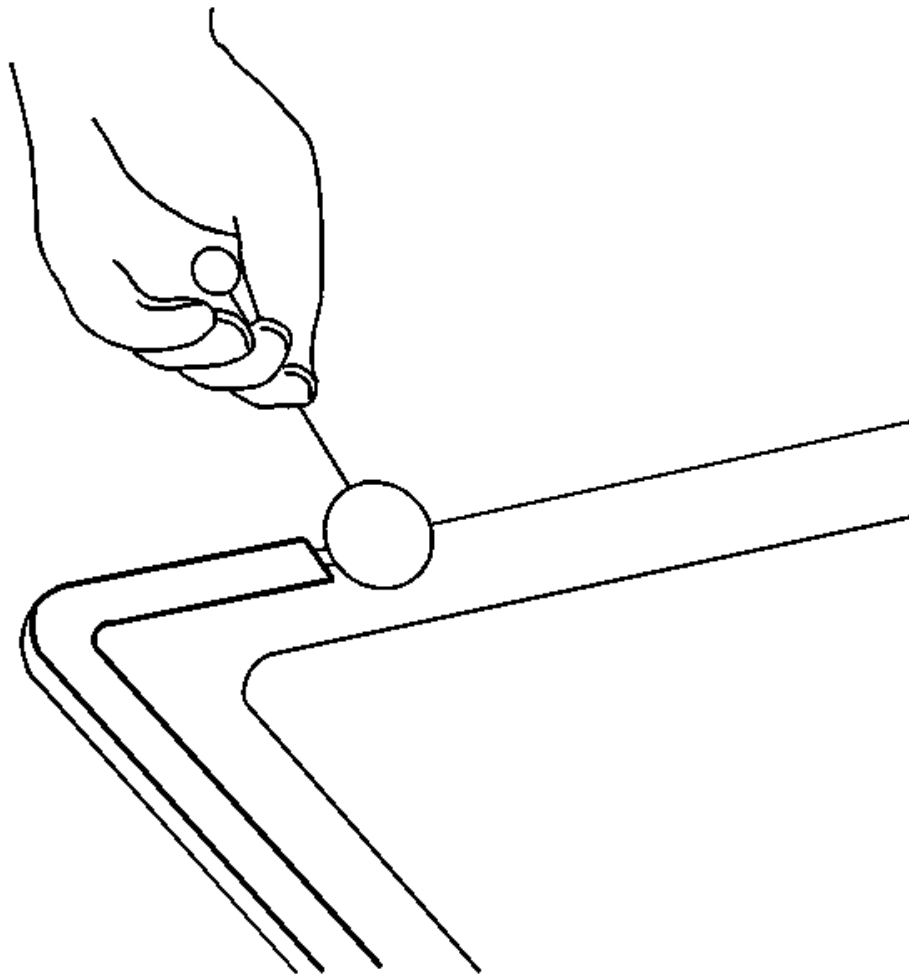


Fig. 35: Applying Glass Prep
Courtesy of GENERAL MOTORS COMPANY

15. Apply a second coat of the glass prep clear #1 to the same area of the glass.

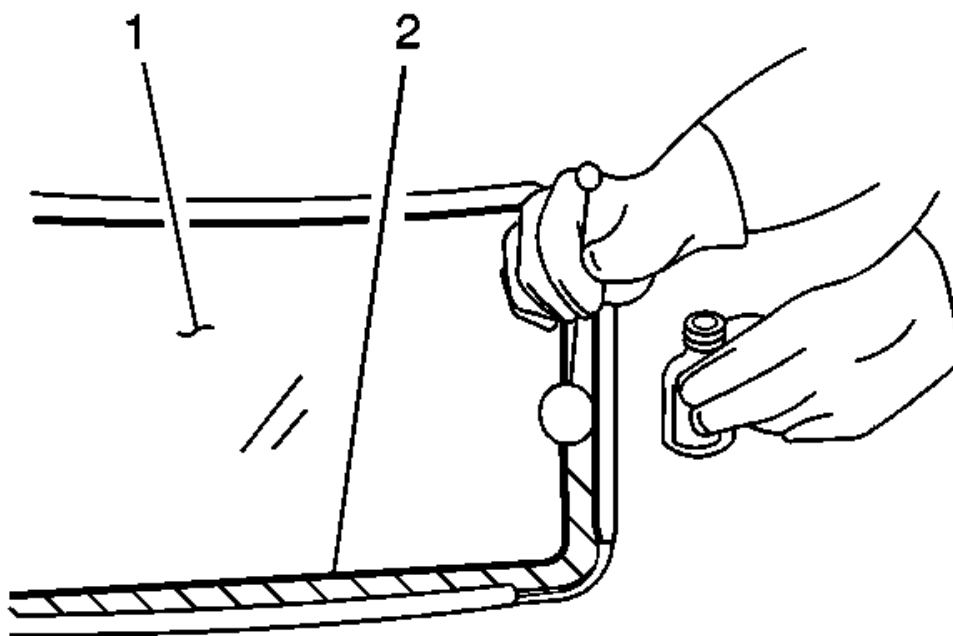


Fig. 36: Applying Glass Primer
Courtesy of GENERAL MOTORS COMPANY

NOTE: The glass primer black #2 is effective up to 8 hours after applying it to the glass. The primed surface of the glass must be kept clean.

16. Shake the glass primer black #2 for at least 1 minute.
17. Use a new dauber in order to apply the glass primer black #2 to the same areas (2) that glass prep clear #1 was applied.
18. Allow the glass primer to dry for approximately 10 minutes.

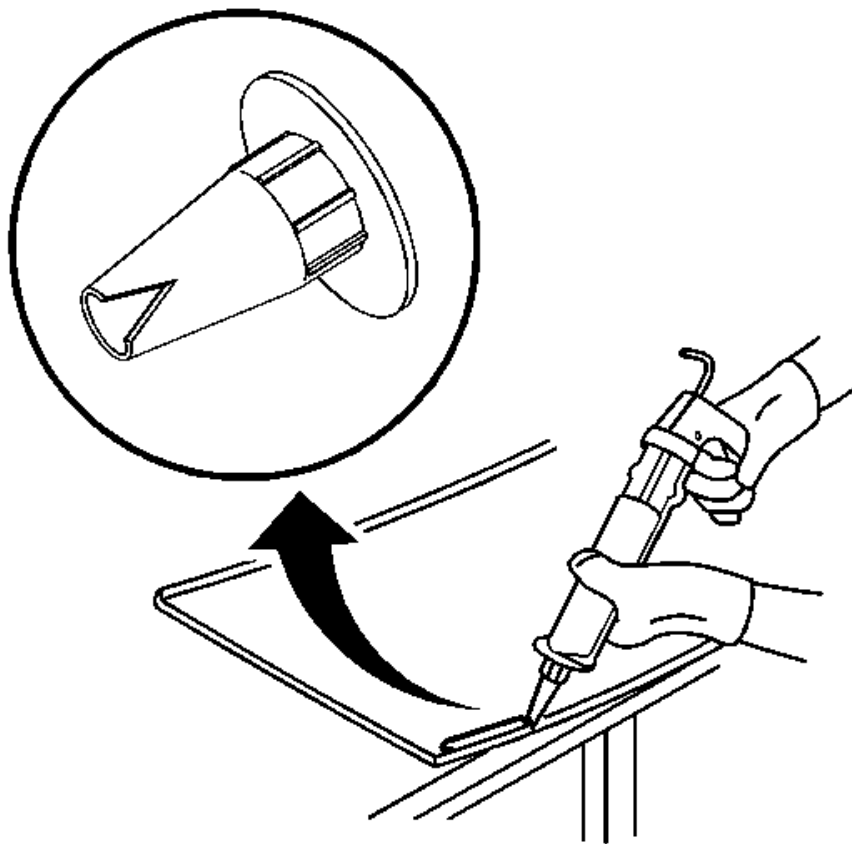


Fig. 37: View Of Modified Applicator Nozzle
Courtesy of GENERAL MOTORS COMPANY

19. Cut the applicator nozzle in order to provide a minimum urethane bead of 8 mm (0.31 in) wide and 16 mm (0.63 in) high.

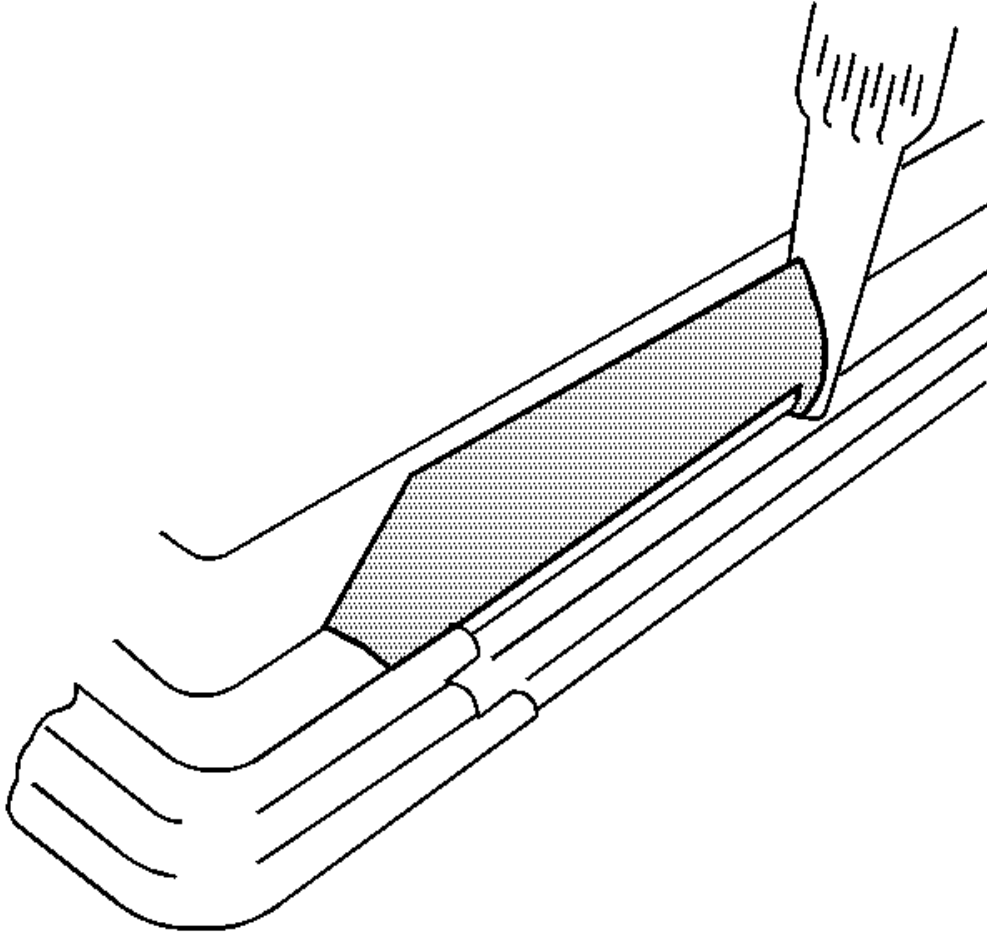


Fig. 38: Applying Continuous Bead Of Urethane Adhesive
Courtesy of GENERAL MOTORS COMPANY

20. Use a cartridge-type caulking gun in order to apply a smooth, continuous bead of urethane adhesive.

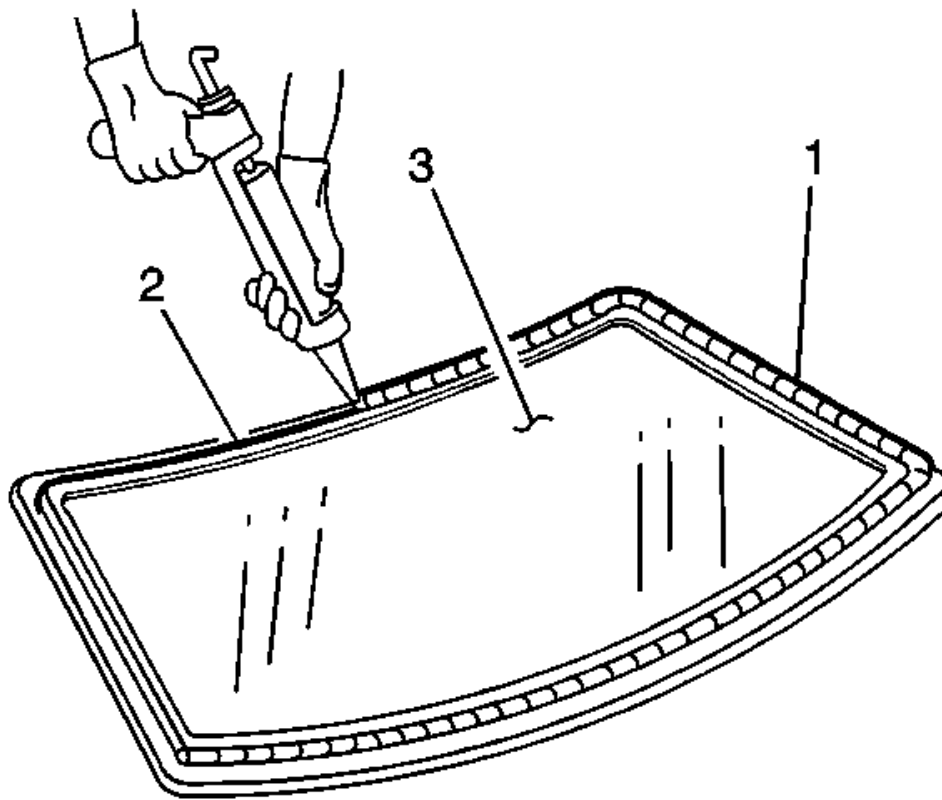


Fig. 39: Applying Urethane Adhesive To Inner Surface Of Window
Courtesy of GENERAL MOTORS COMPANY

21. Use the edge of the window as a guide for the nozzle in order to apply the urethane adhesive (1) to the inner surface of the window (3).

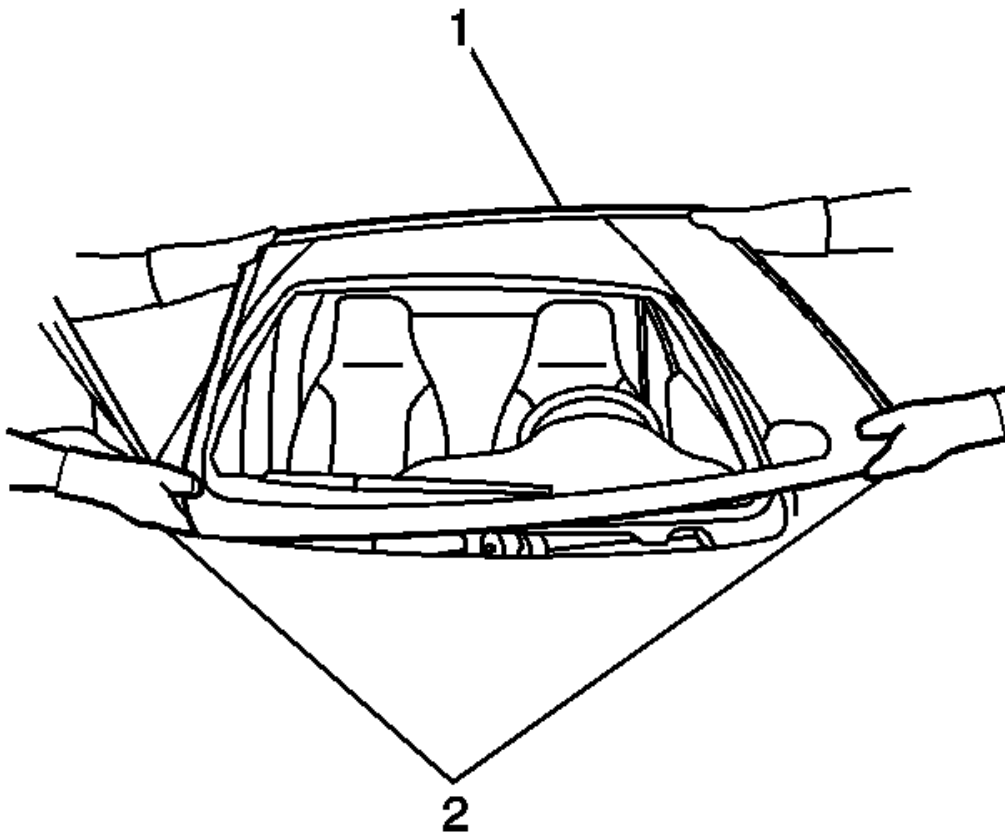


Fig. 40: Removing/Installing Windshield
Courtesy of GENERAL MOTORS COMPANY

22. With the aid of an assistant, place the window (1) in the opening.

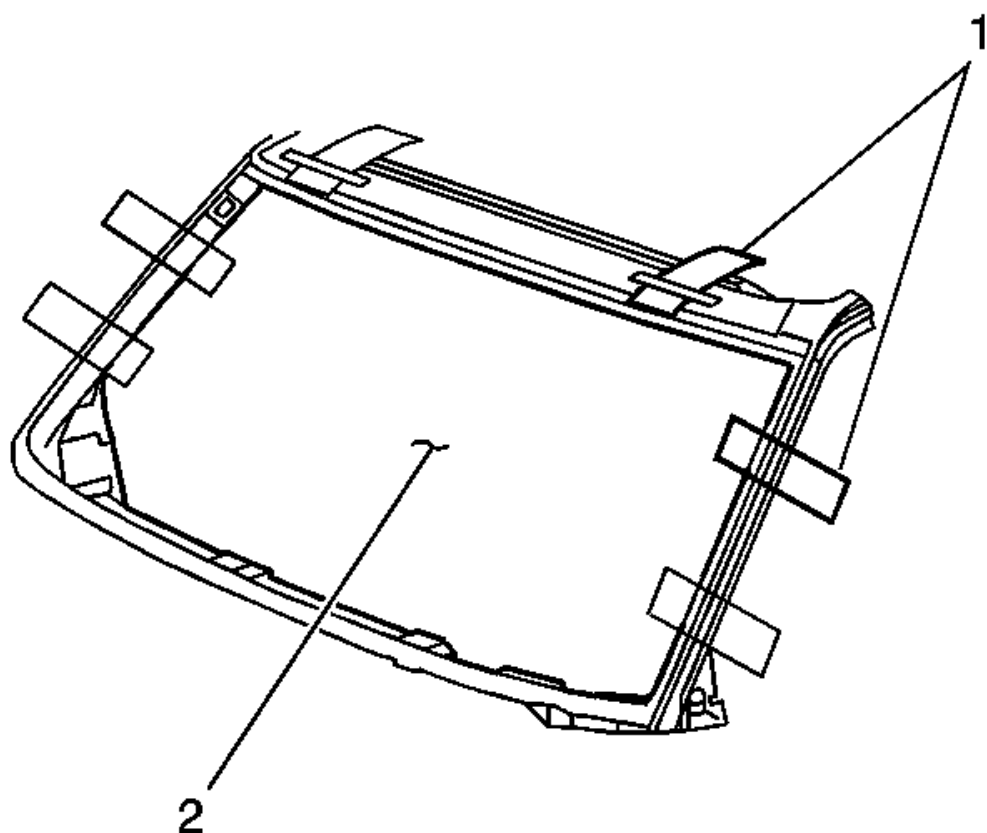


Fig. 41: Aligning Tape Lines On Window To Body
Courtesy of GENERAL MOTORS COMPANY

23. Align the masking tape (1) lines on the window (2) and the body.

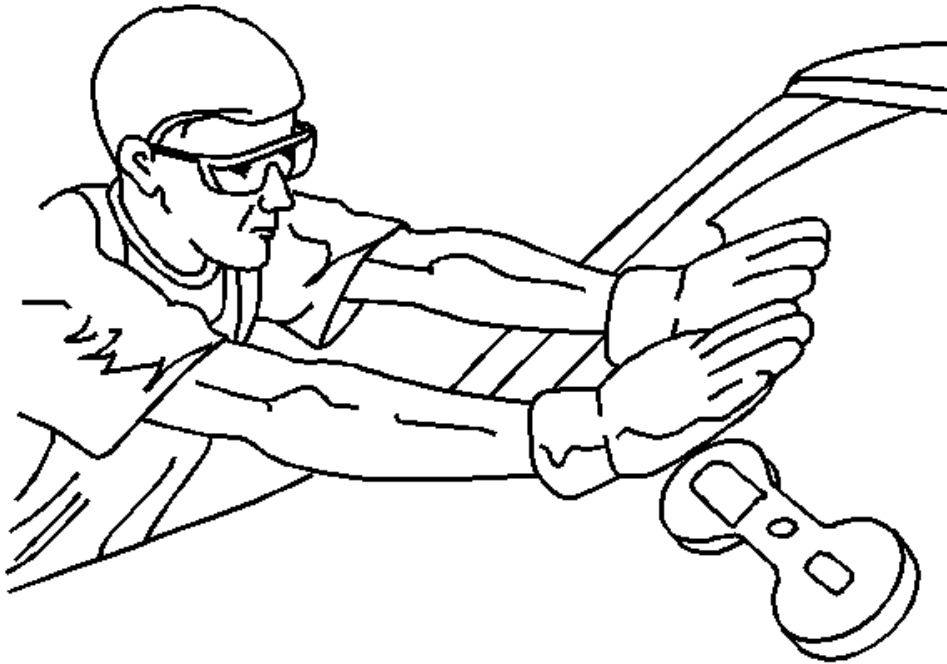


Fig. 42: Pressing Window Into Place
Courtesy of GENERAL MOTORS COMPANY

NOTE: To prevent damage to the window due to objects impacting an exposed edge, upon installation, the window must rest 1 mm (0.04 in) below the surface of the sheet metal.

24. Press firmly around the entire periphery of the windshield in order to wet-out the urethane bead.
25. Tape the window to the body in order to minimize movement until the urethane adhesive cures.

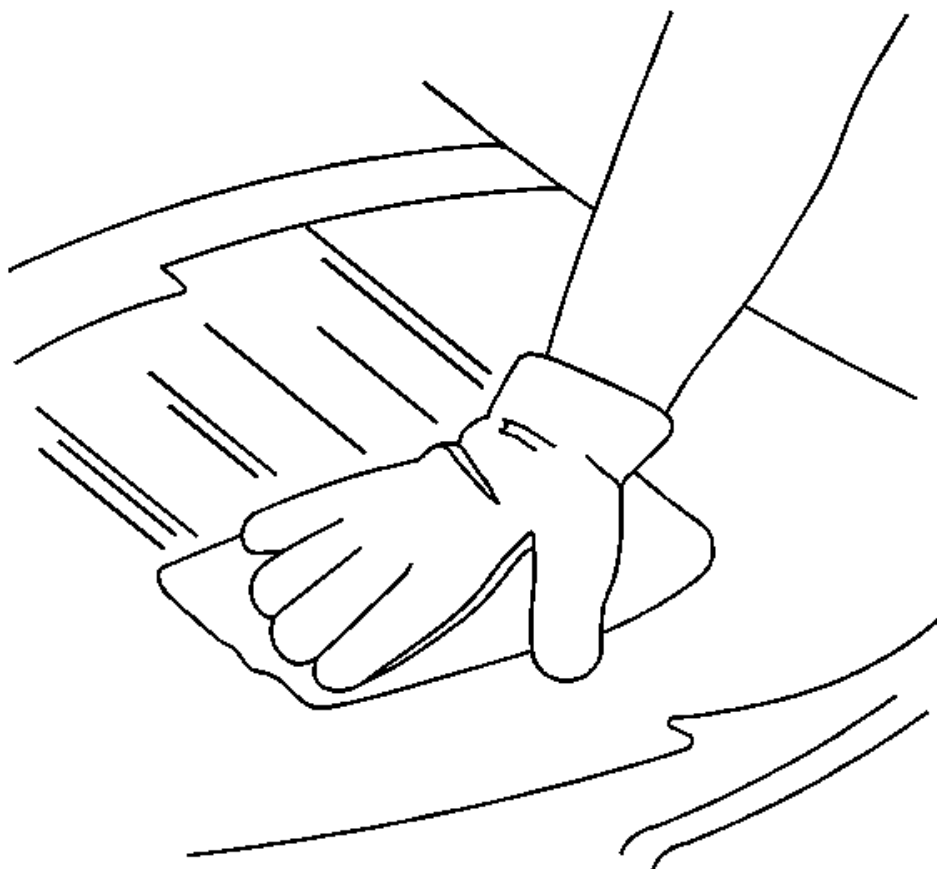


Fig. 43: Cleaning Excess Urethane Adhesive From Body
Courtesy of GENERAL MOTORS COMPANY

26. Clean any excess urethane adhesive from the body.

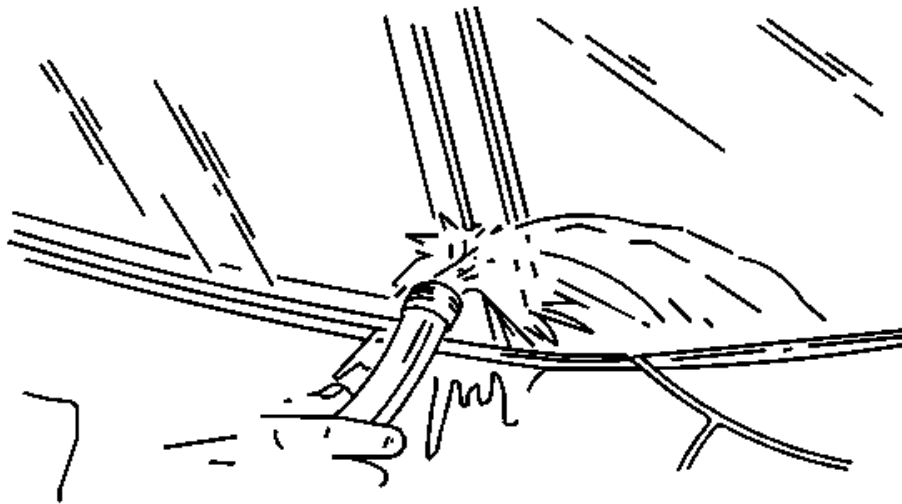


Fig. 44: Performing Water Hose Test
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not direct a hard stream of high pressure water to the freshly applied urethane adhesive.

27. Use a soft spray of warm water in order to immediately water test the window.
28. Inspect the window for leaks.
29. If any leaks are found, use a plastic paddle in order to apply extra urethane adhesive at the leak point.
30. Retest the window for leaks.

WARNING: Insufficient curing of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.

- For the moisture-curing type of urethane adhesive, allow a minimum of 6 hours at 21°C (70°F) or greater and with at least

30 percent relative humidity. Allow at least 24 hours for the complete curing of the urethane adhesive.

- **For the chemical-curing type of urethane adhesive, allow a minimum of 1 hour .**

Do NOT physically disturb the repair area until after these minimum times have elapsed.

31. Maintain the following conditions in order to properly cure the urethane adhesive:
 - Partially lower a door window in order to prevent pressure buildups when closing doors before the urethane adhesive cures.
 - Do not drive the vehicle until the urethane adhesive is cured. Refer to the above curing times.
 - Do not use compressed air in order to dry the urethane adhesive.
32. Complete the window installation.

ADHESIVE INSTALLATION OF REAR WINDOWS

WARNING: Refer to Glass and Sheet Metal Handling Warning .

1. Use a urethane adhesive systems which meet GM Specification GM 3651G.

NOTE: Remove all but approximately 2 mm (3/64 in) of the existing bead of urethane adhesive from the pinch-weld flange.

2. Remove all mounds or loose pieces of urethane adhesive from the pinch-weld area.
3. If the original window is being reused, remove all but a thin film of the existing urethane adhesive from the window surface by using a clean utility knife or razor blade scraper.
4. Inspect for any of the following problems in order to help prevent future breakage of the window:
 - High weld
 - Solder spots
 - Hardened sealer
 - Any other obstruction or irregularity in the pinch-weld flange

NOTE: If corrosion of the pinch-weld flange is present or if sheet metal repairs or replacements are required, the pinch-weld flange must be refinished in order to restore the bonding area strength. If paint repairs are required, mask the flange bonding area prior to applying the color coat in order to provide a clean primer only surface. Materials such as BASF DE15®, DuPont 2610®, Sherwin-Williams PSE 4600 and NP70® and Martin-Semour 5120 and 5130® PPG DP90LF SPIES/HECKER 3688/8590 - 3688/5150 - 4070/5090 STANDOX 11158/13320 - 14653/14980 products are approved for this application.

5. After repairing the opening as indicated, perform the following steps:
 1. Remove all traces of broken glass from the outer cowl panel, seats, floor and defroster ducts.
 2. Clean around the edge of the inside surface of the window with a 50/50 mixture of isopropyl alcohol and water by volume on a dampened lint free cloth.

WARNING: Refer to Window Retention Warning .

6. Verify all primers and urethane adhesive are within expiration dates.

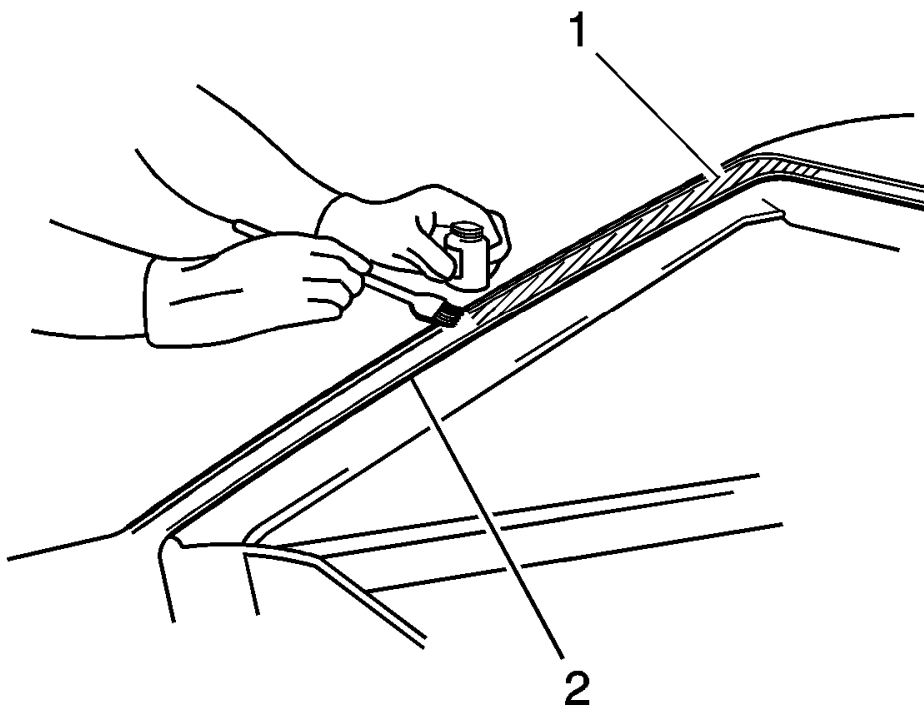


Fig. 45: Applying Pinch-Weld Primer
Courtesy of GENERAL MOTORS COMPANY

WARNING: Failure to prep the area prior to the application of primer may cause insufficient bonding of urethane adhesive. Insufficient bonding of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.

NOTE: Do not apply the black #3 primer to the existing bead (1) of the urethane adhesive on the pinch-weld flange. Apply the primer only to nicks, scratches or the primed surfaces.

7. Shake the pinch-weld primer black #3 for at least 1 minute.
8. Use a new dauber in order to apply the primer to the surface of the pinch-weld flange (2).
9. Allow the pinch-weld primer to dry for approximately 10 minutes.

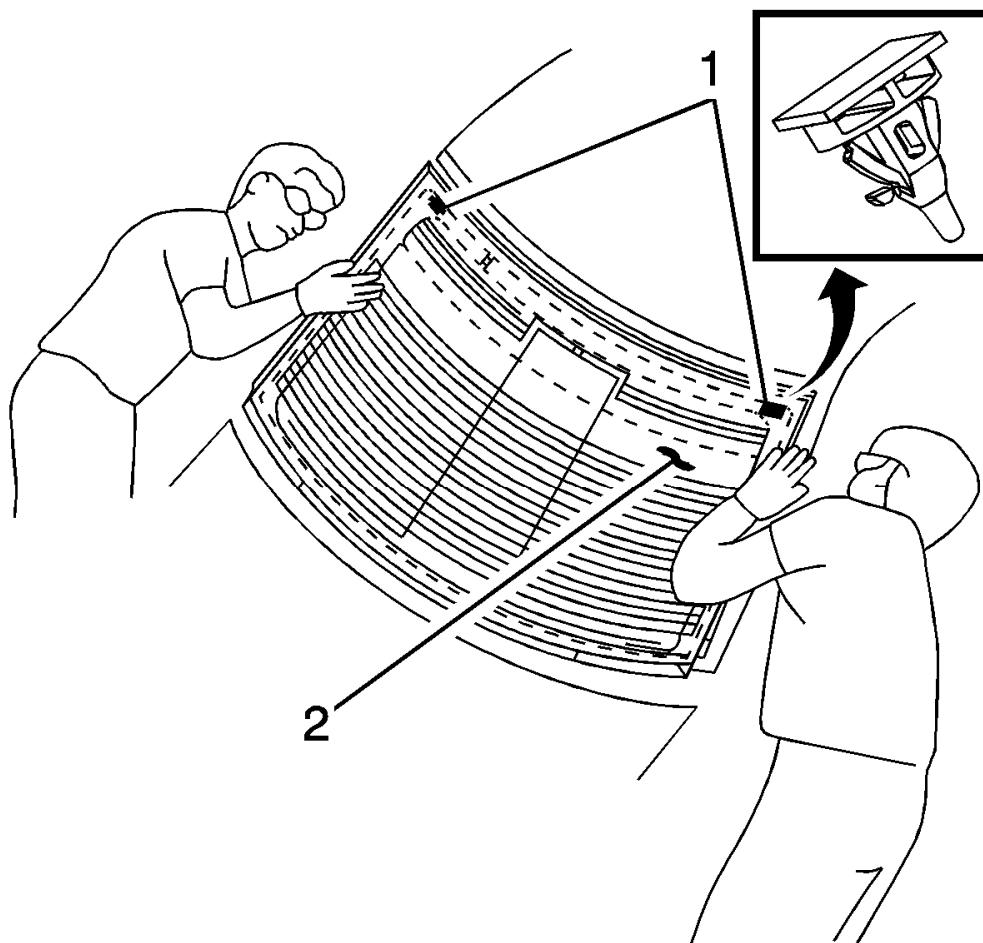


Fig. 46: Installing Rear Window
Courtesy of GENERAL MOTORS COMPANY

10. With the aid of an assistant, dry fit the window (2) to the opening in order to determine the correct position.
11. Ensure that the locator pins (1) are positioned into the locator slots on the upper pinch-weld flange.

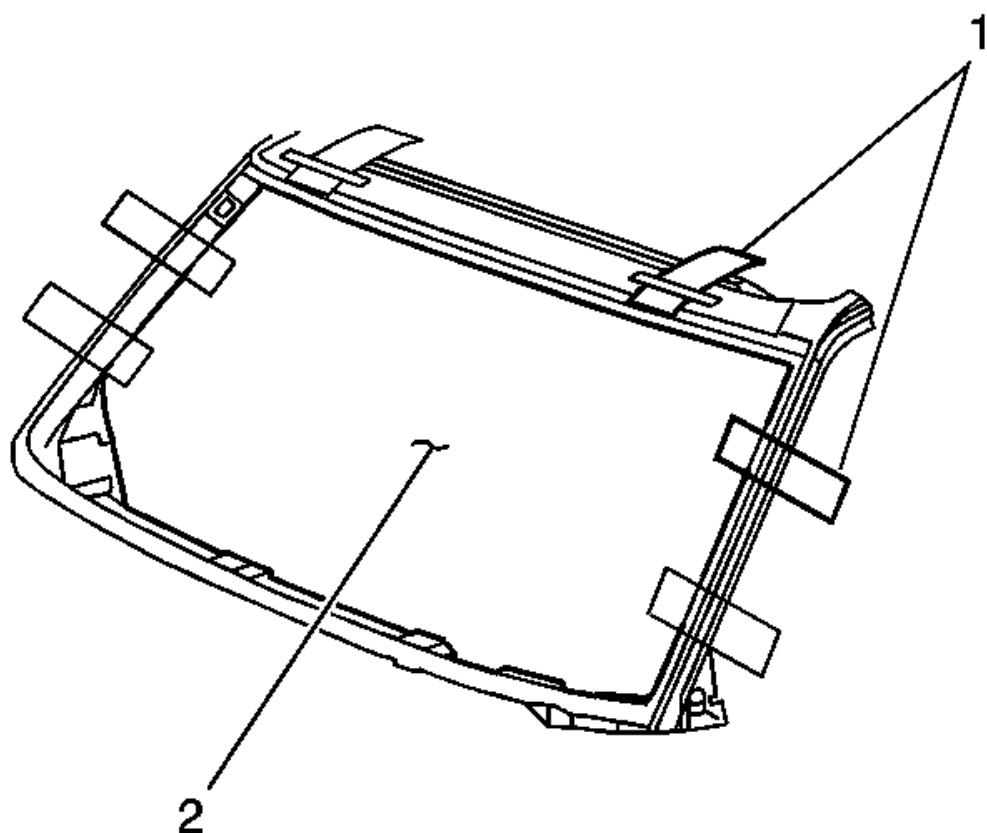


Fig. 47: Aligning Tape Lines On Window To Body
Courtesy of GENERAL MOTORS COMPANY

12. Use masking tape (1) to mark the locations of the window (2) in the opening.
13. Cut the masking in the center and remove the window from the opening.

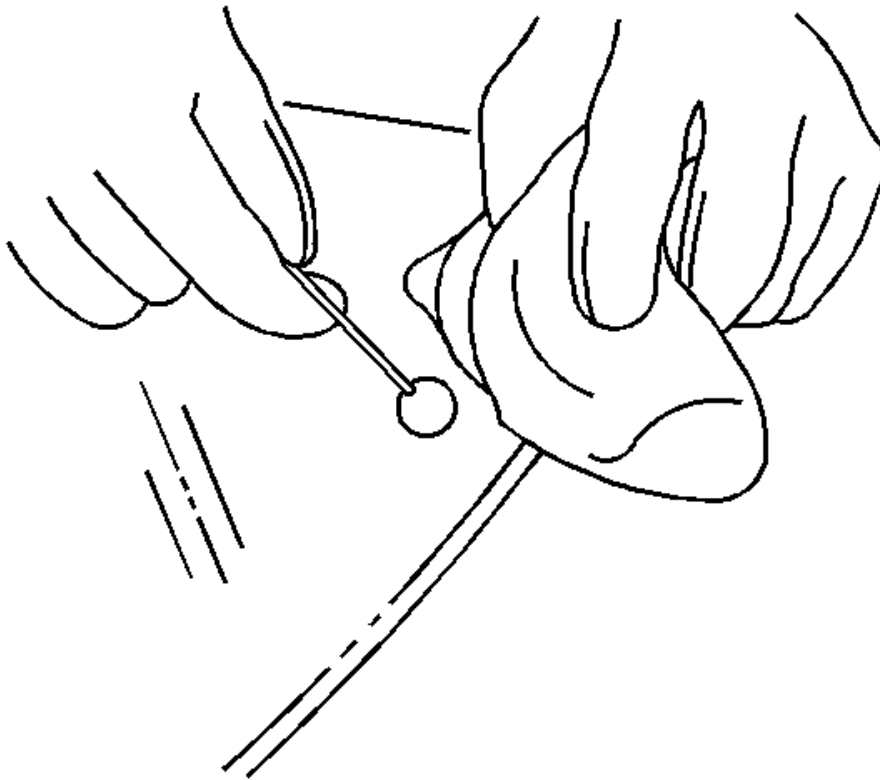


Fig. 48: Applying Glass Prep
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use care when applying glass prep clear #1 on the window. This primer dries almost instantly, and may stain the viewing area of the window if not applied evenly.

14. Use a new dauber in order to apply glass prep clear #1 to the area approximately 18 mm (0.71 in) around the entire perimeter of the window inner surface.

Immediately wipe the glass primed area using a clean, lint-free cloth.

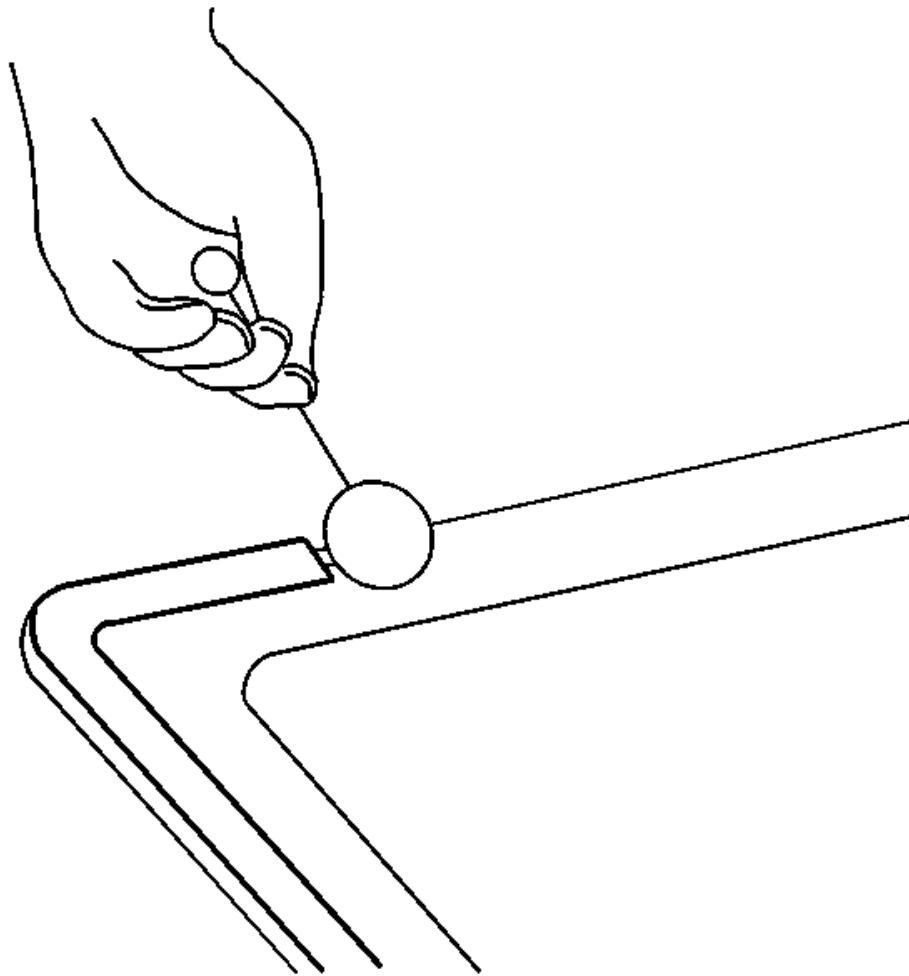


Fig. 49: Applying Glass Prep
Courtesy of GENERAL MOTORS COMPANY

15. Apply a second coat of the glass prep clear #1 to the same area of the glass.

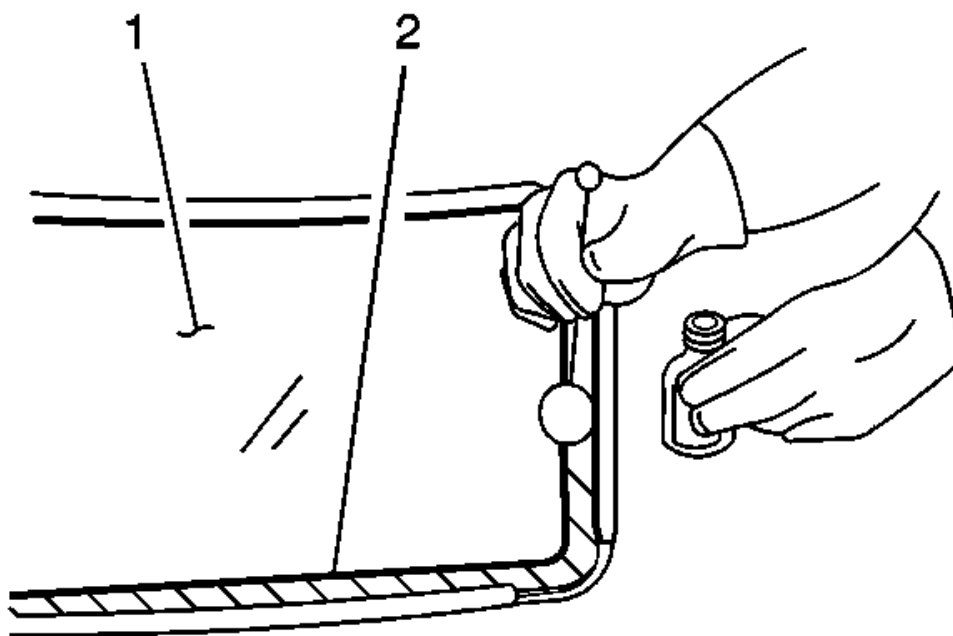


Fig. 50: Applying Glass Primer
Courtesy of GENERAL MOTORS COMPANY

NOTE: The glass primer black #2 is effective up to 8 hours after applying it to the glass. The primed surface of the glass must be kept clean.

16. Shake the glass primer black #2 for at least 1 minute.
17. Use a new dauber in order to apply the glass primer black #2 to the same areas (2) that glass prep clear #1 was applied.
18. Allow the glass primer to dry for approximately 10 minutes.

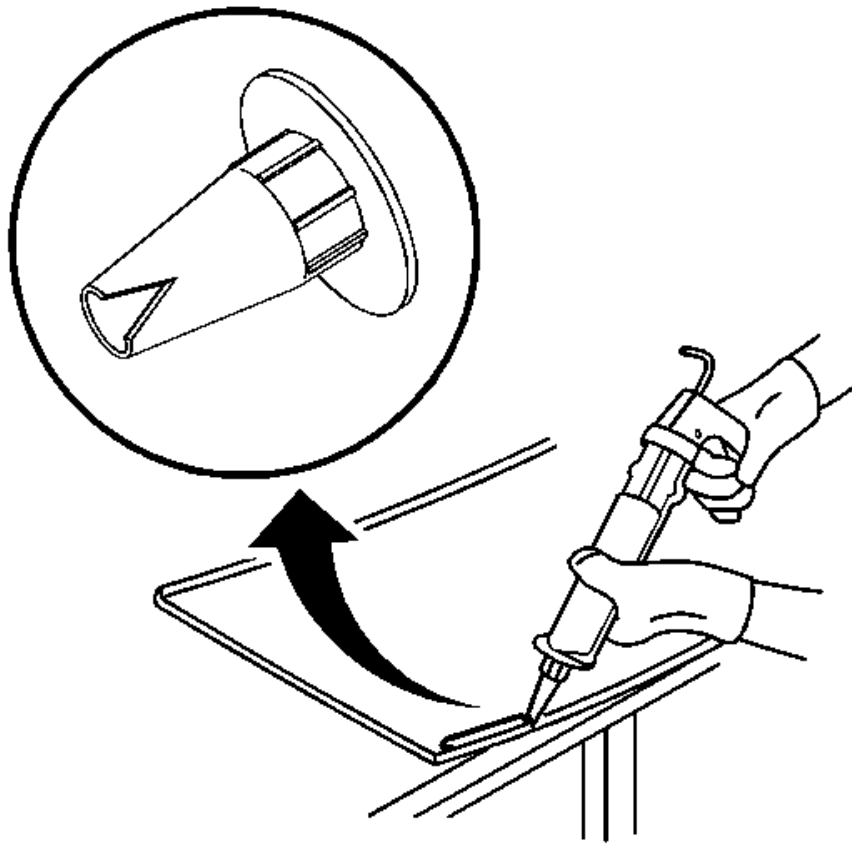


Fig. 51: View Of Modified Applicator Nozzle
Courtesy of GENERAL MOTORS COMPANY

19. Cut the applicator nozzle in order to provide a minimum urethane bead of 8 mm (0.31 in) wide and 16 mm (0.63 in) high.

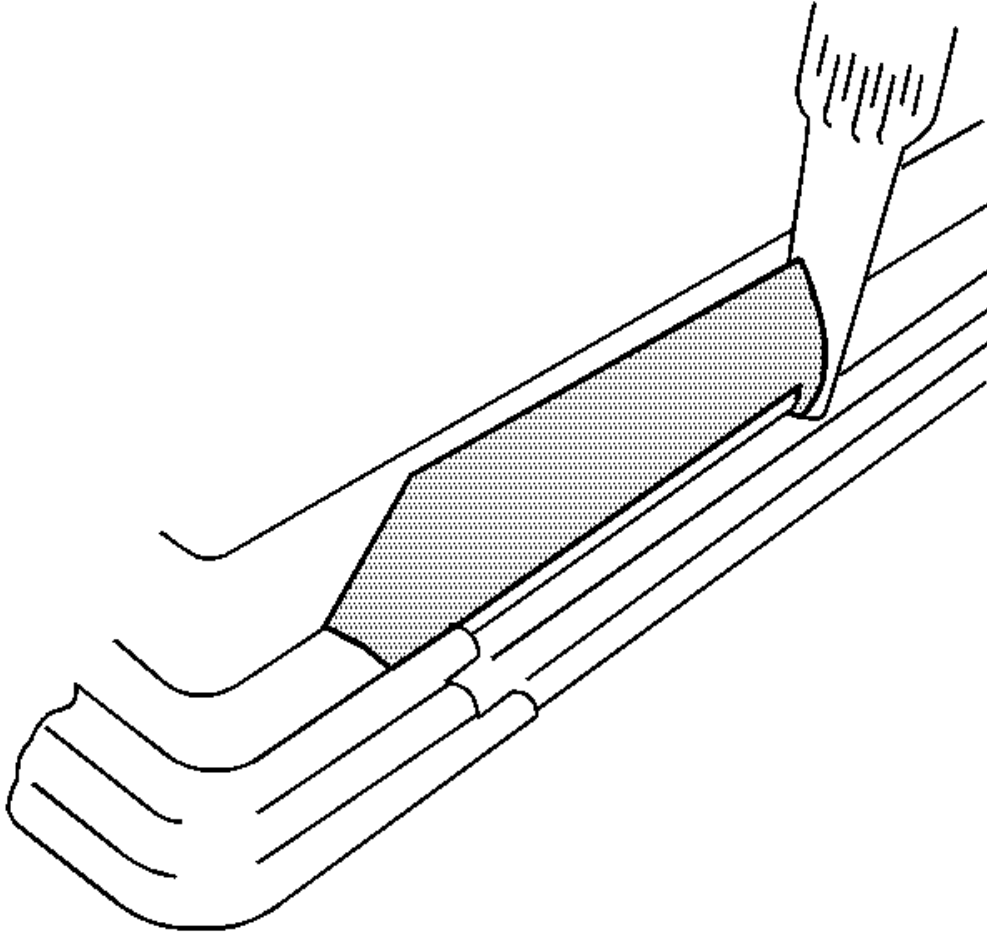


Fig. 52: Applying Continuous Bead Of Urethane Adhesive
Courtesy of GENERAL MOTORS COMPANY

20. Use a cartridge-type caulking gun in order to apply a smooth, continuous bead of urethane adhesive.

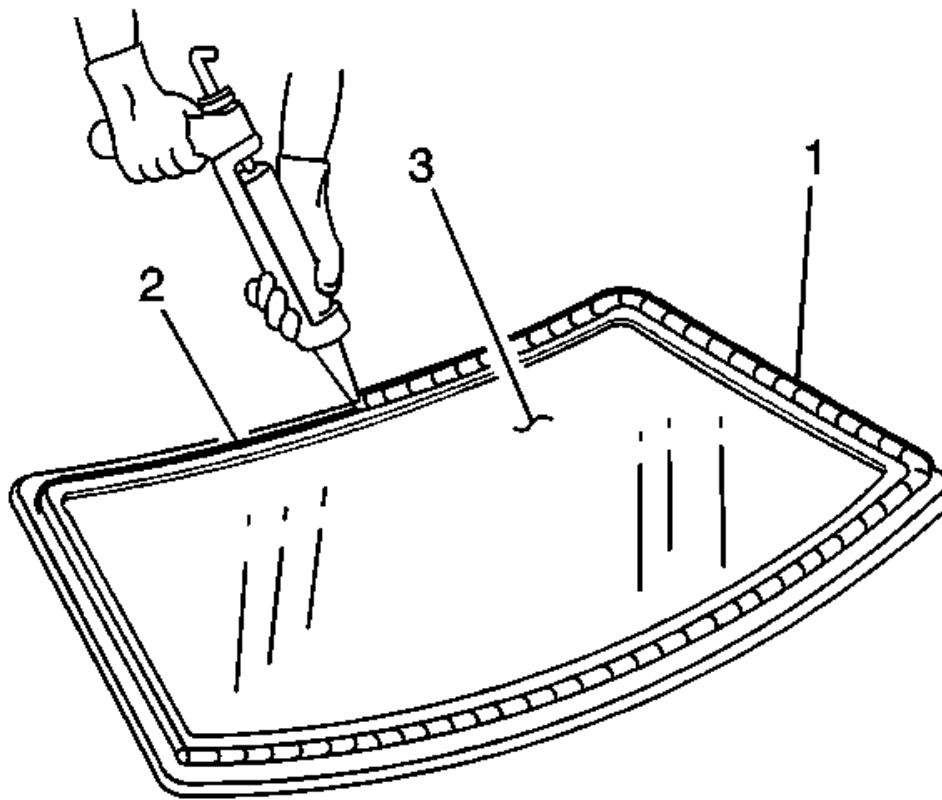


Fig. 53: Applying Urethane Adhesive To Inner Surface Of Window
Courtesy of GENERAL MOTORS COMPANY

21. Use the edge of the window as a guide for the nozzle in order to apply the urethane adhesive (1) to the inner surface of the window (3).

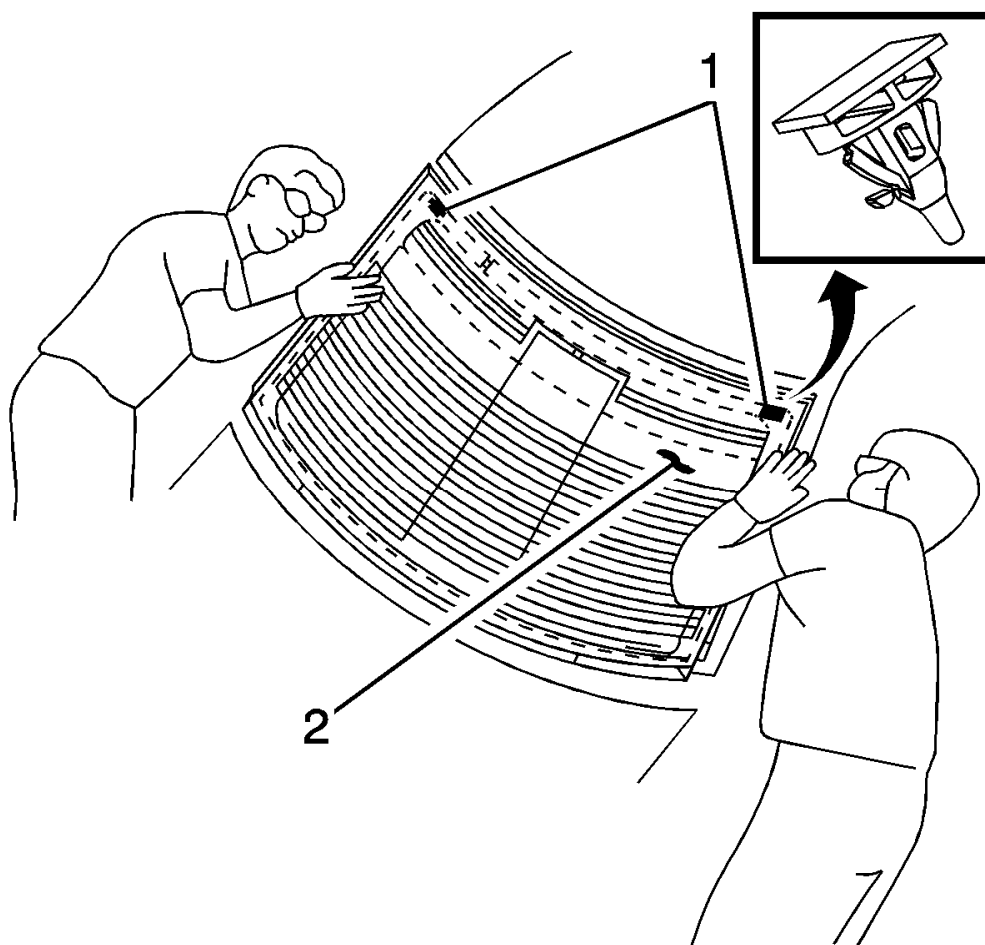


Fig. 54: Installing Rear Window
Courtesy of GENERAL MOTORS COMPANY

22. With the aid of an assistant, place the window (2) and locator (1) in the opening.

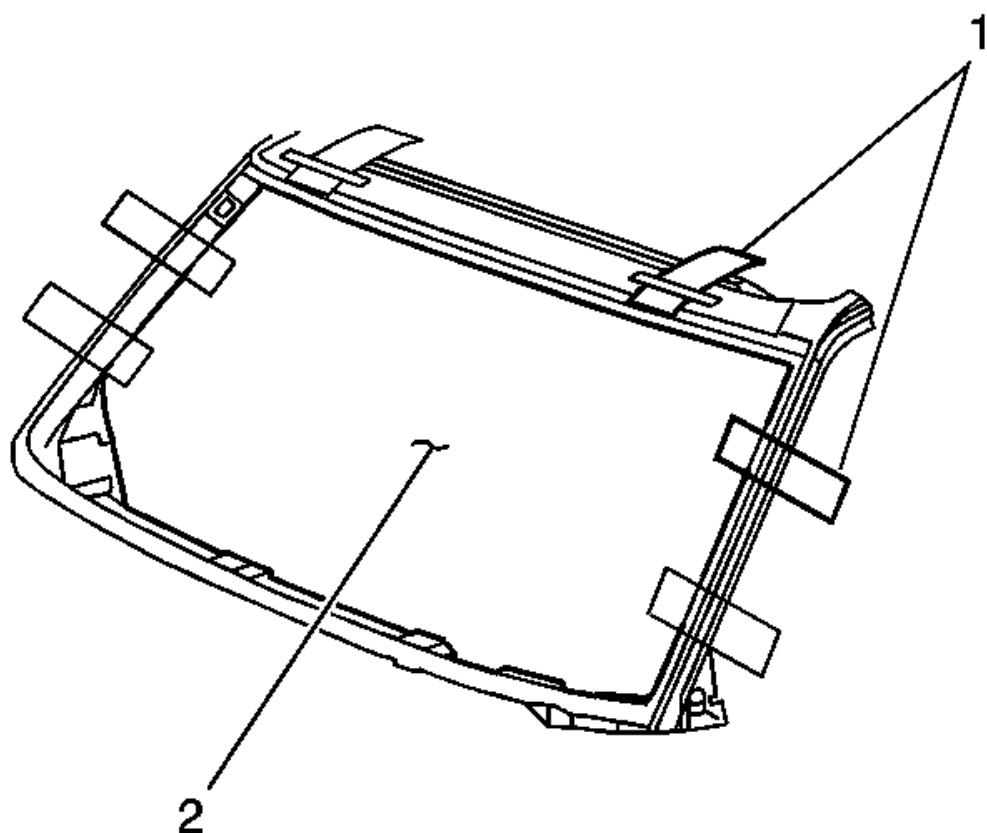


Fig. 55: Aligning Tape Lines On Window To Body
Courtesy of GENERAL MOTORS COMPANY

23. Align the masking tape (1) lines on the window (2) and the body.

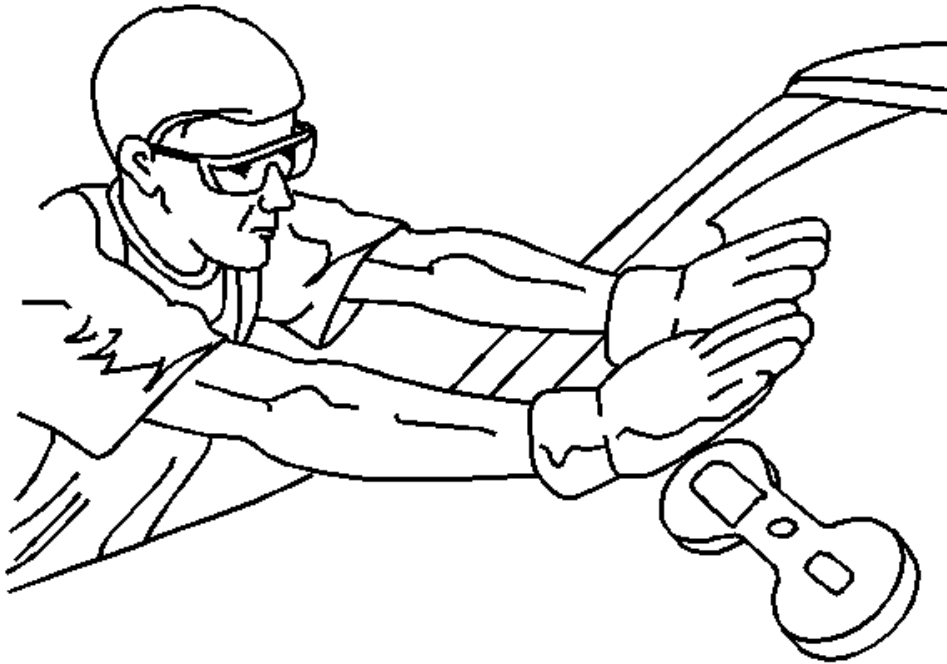


Fig. 56: Pressing Window Into Place
Courtesy of GENERAL MOTORS COMPANY

NOTE: To prevent damage to the window due to objects impacting an exposed edge, upon installation, the window must rest 1 mm (0.040 in) below the surface of the sheet metal.

24. Press firmly around the entire periphery of the window in order to wet-out the urethane bead.
25. Tape the window to the body in order to minimize movement until the urethane adhesive cures.

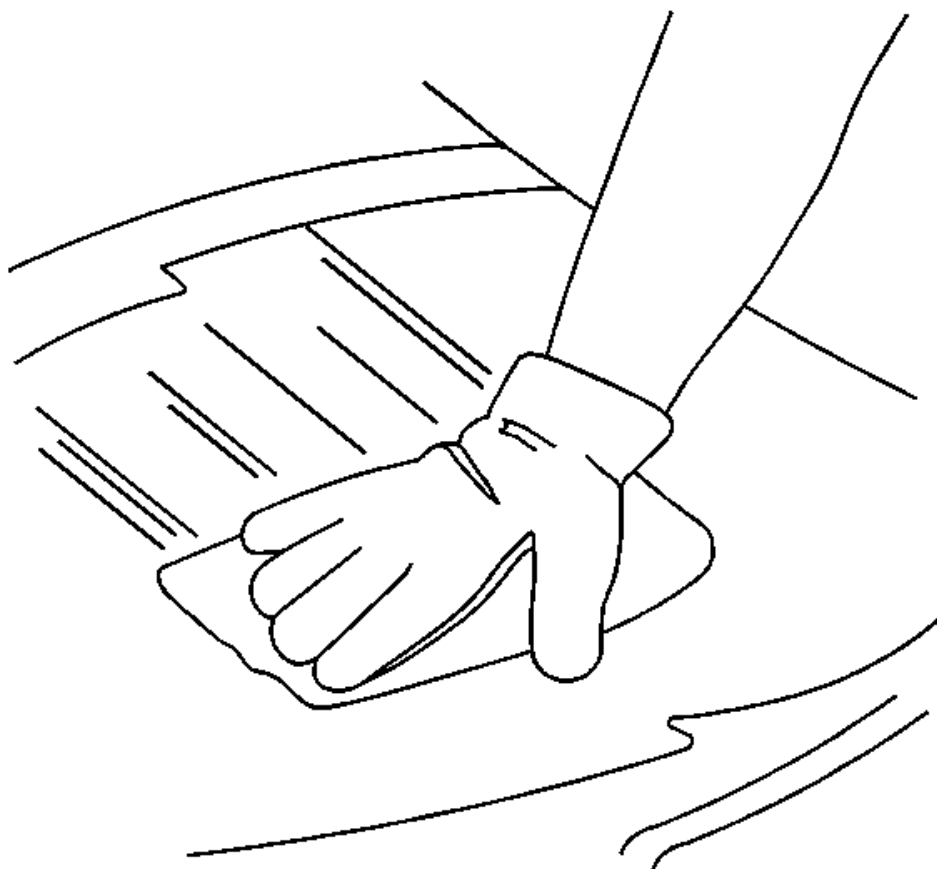


Fig. 57: Cleaning Excess Urethane Adhesive From Body
Courtesy of GENERAL MOTORS COMPANY

26. Clean any excess urethane adhesive from the body.

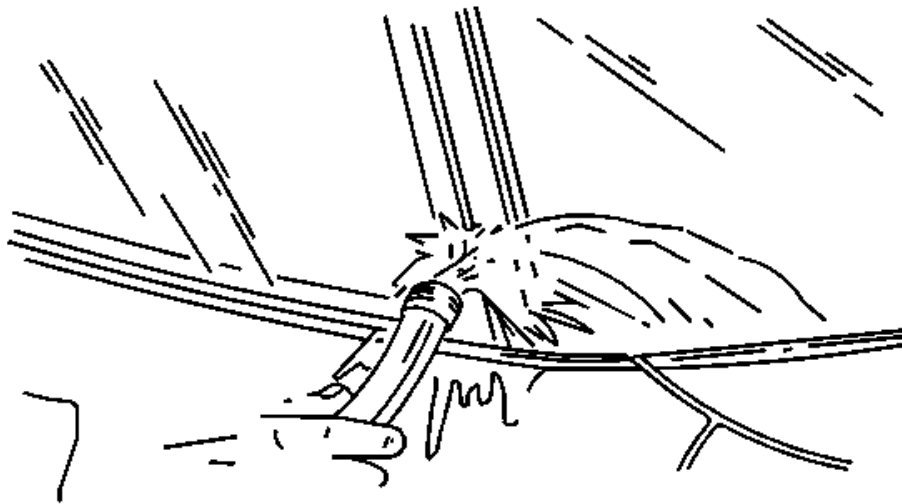


Fig. 58: Performing Water Hose Test
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not direct a hard stream of high pressure water to the freshly applied urethane adhesive.

27. Use a soft spray of warm water in order to immediately water test the window.
28. Inspect the window for leaks.
29. If any leaks are found, use a plastic paddle in order to apply extra urethane adhesive at the leak point.
30. Retest the window for leaks.

WARNING: Insufficient curing of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.

- For the moisture-curing type of urethane adhesive, allow a minimum of 6 hours at 21°C (70°F) or greater and with at least

30 percent relative humidity. Allow at least 24 hours for the complete curing of the urethane adhesive.

- **For the chemical-curing type of urethane adhesive, allow a minimum of 1 hour .**

Do NOT physically disturb the repair area until after these minimum times have elapsed.

31. Maintain the following conditions in order to properly cure the urethane adhesive:

- Partially lower a door window in order to prevent pressure buildups when closing doors before the urethane adhesive cures.
- Do not drive the vehicle until the urethane adhesive is cured. Refer to the above curing times.
- Do not use compressed air in order to dry the urethane adhesive.

32. Complete the window installation.

DESCRIPTION AND OPERATION

FULL-CUT METHOD DESCRIPTION

NOTE:

- **If corrosion of the pinch-weld flange is present, or if sheet metal repairs or replacements are required, refinish the pinch-weld flange in order to present a clean, primer-only surface.**
- **If paint repairs are required, mask the flange bonding area, prior to applying the color coat, in order to provide a clean, primer-only surface.**
- **Appropriate materials for these primer applications are typically 2 component catalyzed products. Use materials such as BASF DE15®, DuPont 2610®, Sherwin-Williams PSE 4600 and NP70® and Martin-Semour 5120 ,5130® , PPG DP90LF SPIES/HECKER 3688/8590 - 3688/5150 - 4070/5090 STANDOX 11158/13320 - 14653/14980 products are approved for this application. Follow the manufacturer's directions for the mix, the application, and the drying times.**
- **After repairing the opening as indicated, shake the pinch-weld primer black #3 well. Using a new dauber, apply the primer to the primed surface of the flange in the bonding area. Allow the primer to dry for 10 minutes.**

Use only the full cut method, also known in the field as full strip method, when installing windows.

This method includes the following:

- The replacement of a majority of the urethane adhesive bead. Remove all but approximately 2 mm (3/64 in) of the existing bead of urethane adhesive from the pinch-weld flange.
- Apply pinch-weld primer to any exposed painted areas on the pinch-weld flange.

No mounds or loose pieces of urethane adhesive should remain on the pinch-weld flange. Do not remove all

traces of urethane adhesive.

POWER WINDOWS DESCRIPTION AND OPERATION

Power Windows System Components

The power window system consists of the following components:

- Driver window switch
- Passenger window switch
- Left rear window switch
- Right rear window switch
- Window motors in each of the doors
- 30A Fuse
- Body control module (BCM)

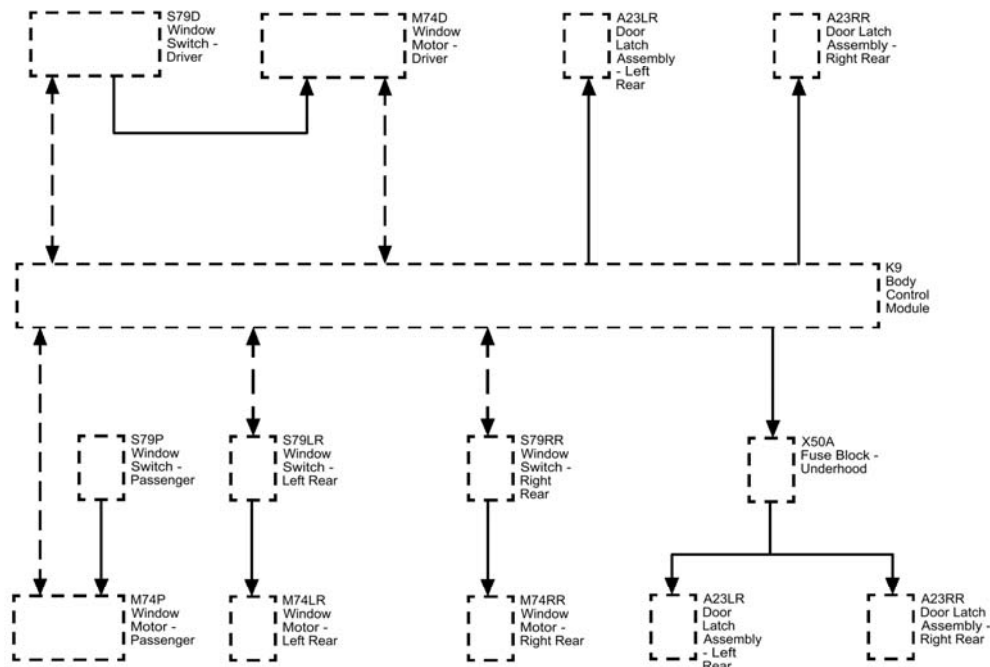


Fig. 59: Power Windows System Block Diagram

Courtesy of GENERAL MOTORS COMPANY

Driver and Passenger Express Up and Express Down Window Motors

The driver and passenger doors contains a window motor is smart motor that will detect excessive resistance while performing the express up function and automatically reverse direction to prevent injury to any occupants that may become trapped between the closing window and the door frame. The automatic reverse safety feature can be overridden by pulling and holding the window switch.

The logic circuit within the window motor monitors the up, down and express signal circuits which are normally equal to B+ voltage. When a switch is used on the window switch, the contacts close causing a voltage drop within the appropriate signal circuit. The window motor will detect the voltage drop and will command the window to move in the direction requested.

The driver window switch communicates to the BCM by a serial data circuit. When the driver wishes to control the passenger window, the driver will use the appropriate switch on the driver window switch. When this switch is used, a serial data message is sent to the BCM requesting the passenger window motor command, the BCM will then send a serial data message to the passenger window motor which will then move in the direction requested.

Left Rear, Right Rear Express Down Only Power Window Motors

For the right rear and left rear doors, when their window switch is pressed in the down position, battery positive voltage is applied to their respective window motor control circuit and ground to the other window motor control circuit causing that window to open. When the individual window switch is pulled in the up position, voltage and ground is applied to the window motor in the opposite direction causing that window to close. The return path to ground is supplied through the inactive control circuit being normally grounded through the window switch.

Each rear window switch communicates to the BCM by a serial data circuit. When the driver wishes to control the left rear or right rear window, the driver will use the appropriate switch on the driver window switch. When this switch is used, a serial data message is sent to the BCM requesting a window motor command, the BCM will then send a serial data message to the appropriate rear door window switch which will then command that window to move in the direction requested.

Rear Window and Rear Door Lockout Operation

The operator has the option to disable the rear window switches and the interior rear door handles to prevent the unauthorized opening of the rear door doors and windows while still retaining normal driver and passenger door window and handle functions. The driver door window switch has a lockout switch that will disable the interior rear door handles and the local rear window switches. The rear door latches contain switches that are open when the rear doors are unlocked and closed when the rear doors are locked. The operator will first lock all the doors by pressing the central door lock switch. When the lockout switch is pressed, the BCM will confirm that the rear doors have been locked, if the rear doors are locked the BCM will then command the child lockout latches and will also send a disable command to the local rear window switches. The driver and passenger doors will still function normally by pressing the central door lock switch which will unlock the doors but the child lockout latches will continue to disable the interior rear door handles. Pressing the lockout switch again will signal a command to the BCM to unlatch the rear doors, restore normal interior rear door handle functions and

restore normal function of the rear window switches.

If the lockout indicator flashes while commanding the lockout system, indicates that the BCM has detected a fault in the system and that one or both interior rear door handles are not locked out and/or the local rear window switches are not locked out.

REAR WINDOW DEFOGGER DESCRIPTION AND OPERATION

Rear Window Defogger System Components

The rear window defogger system consists of the following components:

- HVAC Control Module
- HVAC Controls
- Rear Defogger Relay
- Rear Defogger Grid
- Driver Outside Rearview Mirror
- Passenger Outside Rearview Mirror
- 40A Fuse

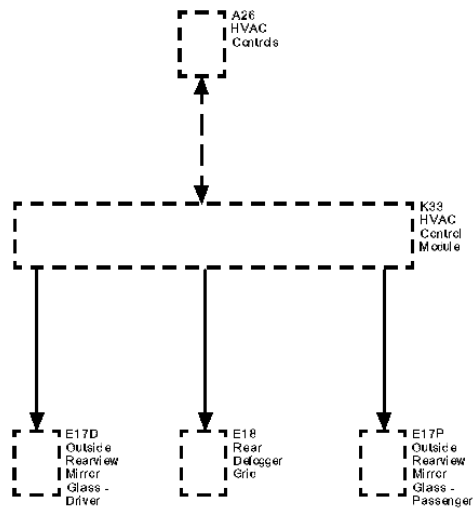


Fig. 60: Rear Window Defogger System Diagram
 Courtesy of GENERAL MOTORS COMPANY

Rear Window Defogger Operation

The rear defog control system utilizes a single zone backlight design, driven with a single relay configuration. Additionally, up to two outside rear view mirrors can be heated if required. A switch for the customer to control the system is provided within the HVAC controls. Also included in the HVAC controls is an indicator to inform the customer with the current state of the system. The system is only operational when engine is running or during remote start.

Pressing the heated rear window switch causes the HVAC controls to send a serial data message to the HVAC control module requesting rear window defog operation. The HVAC control module upon receipt of the serial data message will provide voltage to the coil side of the rear defogger relay, this will energize the relay causing the relay switch contacts to close allowing B+ voltage to flow through the rear defogger grid control circuit to the rear defogger grid.

When the rear heated window switch is pressed and the engine is running, the rear defog control system will remain active for 10 minutes. After the initial cycle has lapsed, pressing the switch again will continue rear

window defogger operation, but the cycle will only last 5 minutes. The rear defog control system will function continuously if the vehicle speed is greater than 70 kilometers per hour (45 mph).

Heated Mirrors

The heated mirrors are also controlled through the rear defogger relay. Whenever the rear window defogger is turned on battery voltage is supplied to the mirror heater elements through the left and right mirror heater element control circuits.

STATIONARY WINDOW DESCRIPTION

Most stationary windows, specifically windshields, are retained to the body with adhesive which adheres the window to the body, increasing structural integrity. The reinstallation of the windows with adhesive requires complete replacement of the adhesive bead, and is known as the full cut method. All stationary windows must use a adhesive systems which meet GM Specification GMW-15672.

URETHANE ADHESIVE DESCRIPTION

For replacement of any adhesive-installed window, use the full cut method only.

Use an adhesive that is approved by GM, Specification GMW-15672.

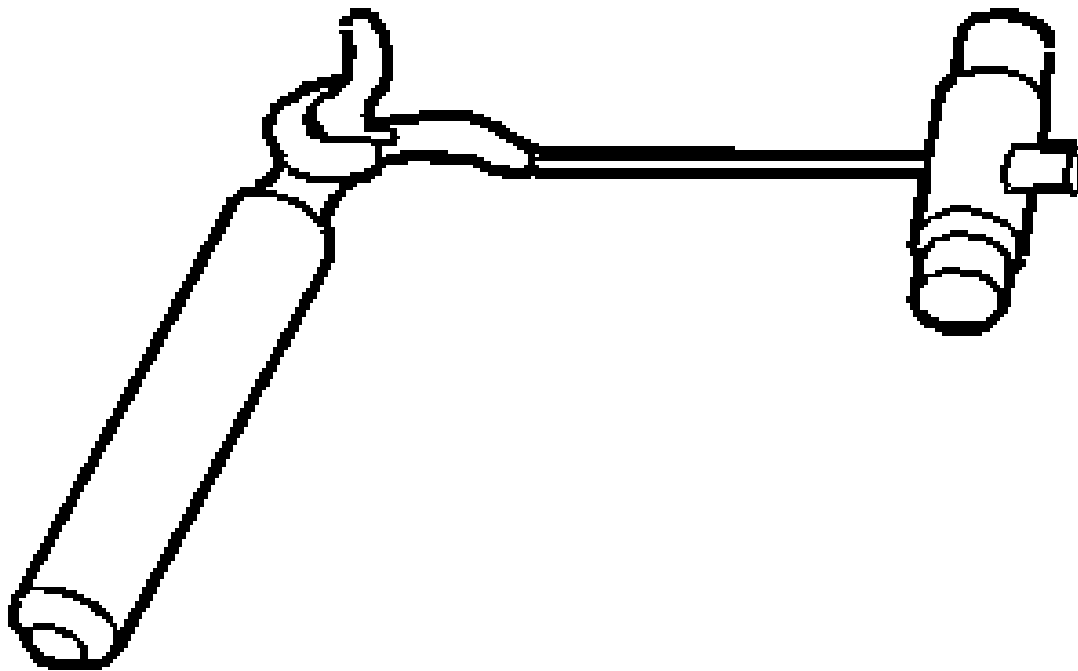
Use these materials based on specific manufacturer. Do NOT intermix primers or adhesives from one manufacturer to another.

Always follow the system manufacturers instructions for application, handling, and curing.

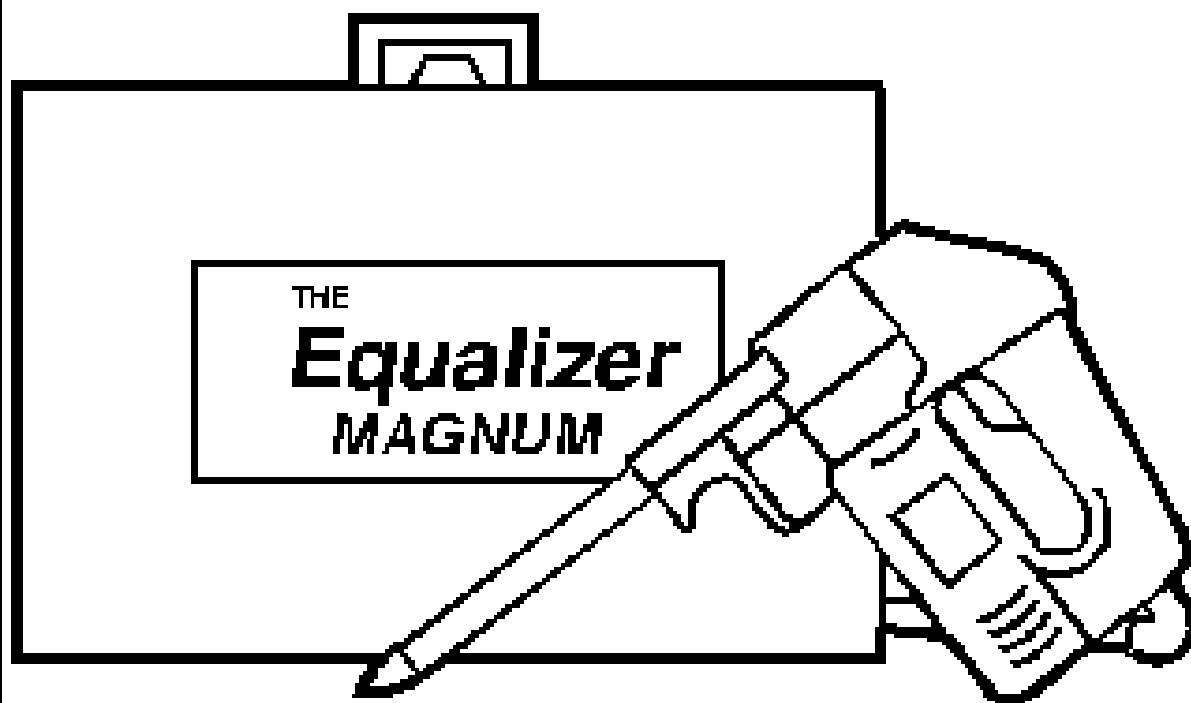
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

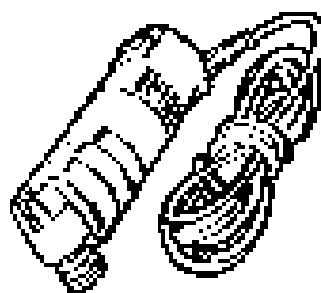
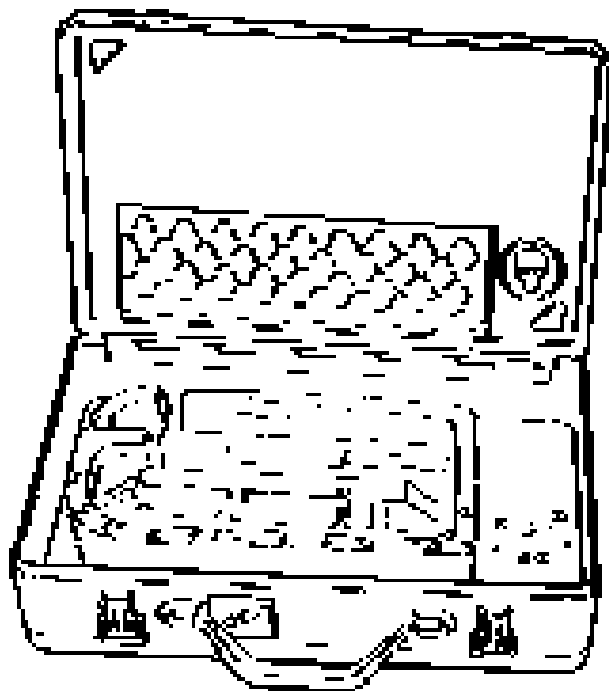
Illustration	Tool Number/ Description



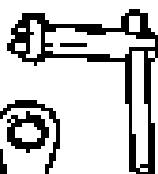
BO-24402-
A
J-24402-A
Glass
Sealant
Cold Knife
Remover



BO-39032
J-39032
Stationary
Glass
Removal
Tool



BO-39040
J-39040
Quarter
Window
Remover



ACCESSORIES & EQUIPMENT Floor

Coverings and Headlinings

SPECIFICATIONS

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
GM Vehicle Care Odor Eliminator	Fluids	88861431	88861436

REPAIR INSTRUCTIONS

ELIMINATING UNWANTED ODORS IN VEHICLES

GM Vehicle Care Odor Eliminator, Refer to **Adhesives, Fluids, Lubricants, and Sealers** , may control or eliminate odors in the interior and luggage compartment areas of GM vehicles. This non-toxic, biodegradable, odorless product has been shown to greatly reduce or remove the following types of odor:

- Objectionable smells of mold and mildew resulting from vehicle water leaks
- Customer created odors, such as smoke

You may safely use GM Vehicle Care Odor Eliminator on fabrics, vinyl, leather, carpet, and sound deadening materials. You may also induce this product into HVAC modules and instrument panel ducts for the control of non-bacterial related odors.

NOTE: **This product leaves no residual scent and should not be used as an air freshener.**

This product may result in the permanent elimination of an odor and may be preferable to customers whose allergies make them sensitive to perfumes. This product may effectively remove odors when directly contacting the odor source. In cases such as water leaks, use this product with diagnostic procedures to first eliminate the primary cause of the odor. Then use further applications on the residual odor to permanently correct the vehicle condition.

How to Use this Product

- Spray GM Vehicle Care Odor Eliminator directly or as an additive with carpet shampoo in steam cleaners.
- Do not use on any interior surface that plain water would deteriorate, because this product will have the same effect. Also avoid letting this product come into contact with vinegar or any acidic substance. Acid-based products will hamper the effectiveness of GM Vehicle Care Odor Eliminator.
- Complete 8 page treatment sheets are enclosed within each case of GM Vehicle Care Odor Eliminator.

These treatment instructions range from simple vehicle odor elimination to full step by step procedures for odor removal from water leaks. If lost, contact your dealership to get a replacement set.

- Instructions and cautions are printed on the bottle, but additional help is available. If you encounter a persistent or recurring odor, you may call the dealership to obtain additional information and usage suggestions.

FLOOR CARPET DRYING

If the carpet or the pad or insulator is wet, use the following criteria for drying or for replacing the components:

- For a 1-piece carpet assembly bonded to a cotton or a fiber padding, replace the entire assembly.
- For a 2-piece carpet assembly with a cotton or a fiber padding, replace the padding only. While the carpet is out of the vehicle, dry the carpet using the method described below.
- For a 1-piece carpet assembly bonded to a foam padding or attached to a synthetic padding, dry the carpet using the method described below.
- For a 2-piece carpet assembly with a synthetic padding, dry the assembly using the method described below.

Drying Method

1. If you observe puddles of liquid on the carpet face, use a wet vacuum to remove the excess moisture.
2. Blot the face of the carpet with a towel in order to absorb as much moisture as possible.
3. Point a fan at the affected area and air dry the carpet.

FRONT FLOOR PANEL CARPET REPLACEMENT

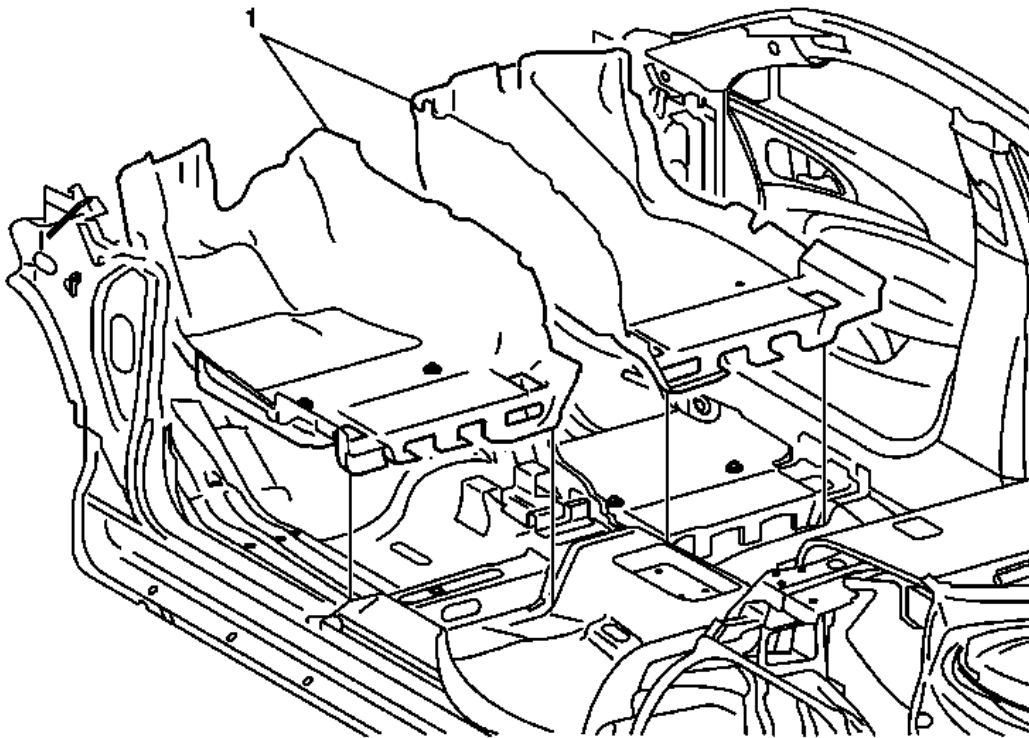


Fig. 1: Front Floor Panel Carpet
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Panel Carpet Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)</u> . 2. Remove the front floor console extension panel. Refer to <u>Front Floor Console Extension Panel Replacement</u> . 3. Remove the front and rear side door sill trim plate. Refer to <u>Front and Rear Side Door Sill Trim Plate Replacement</u> . 	
1	Front Floor Panel Carpet Assembly NOTE: Insert carpet panel behind instrument panel trim as required.

REAR FLOOR PANEL CARPET REPLACEMENT

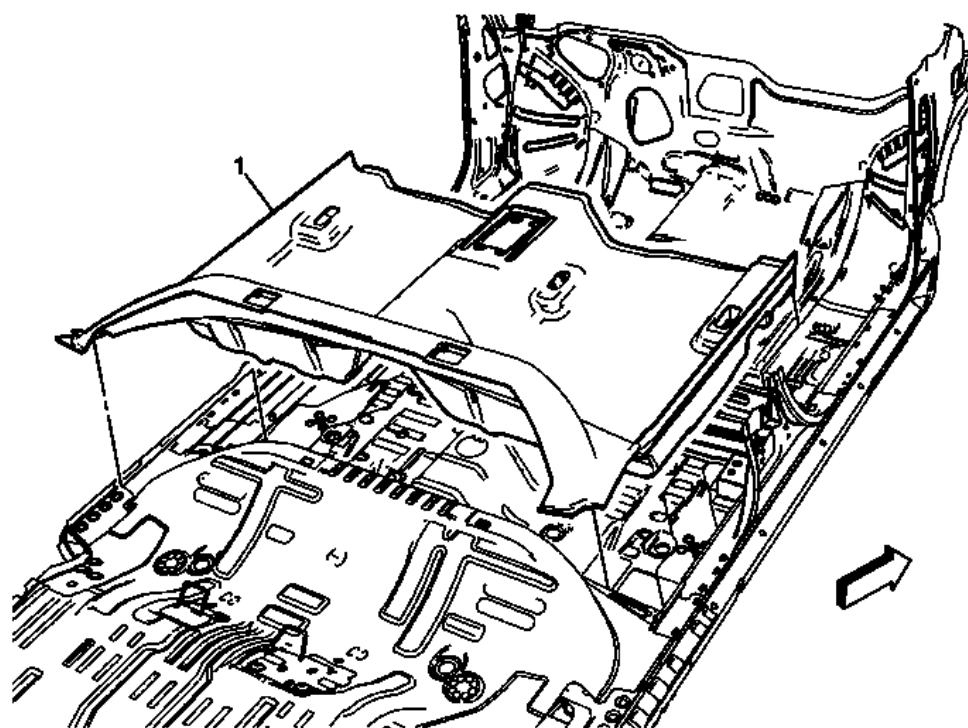


Fig. 2: Rear Floor Panel Carpet
 Courtesy of GENERAL MOTORS COMPANY

Rear Floor Panel Carpet Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the driver and passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)</u> . 2. Remove the rear seat cushion. Refer to <u>Rear Seat Cushion Removal and Installation</u> . 3. Remove the front floor console. Refer to <u>Front Floor Console Replacement</u> . 4. Remove the front and rear side door sill trim plate. Refer to <u>Front and Rear Side Door Sill Trim Plate Replacement</u> .	
1	Rear Floor Panel Carpet Assembly

HEADLINING TRIM PANEL REPLACEMENT (WITH SUNROOF)

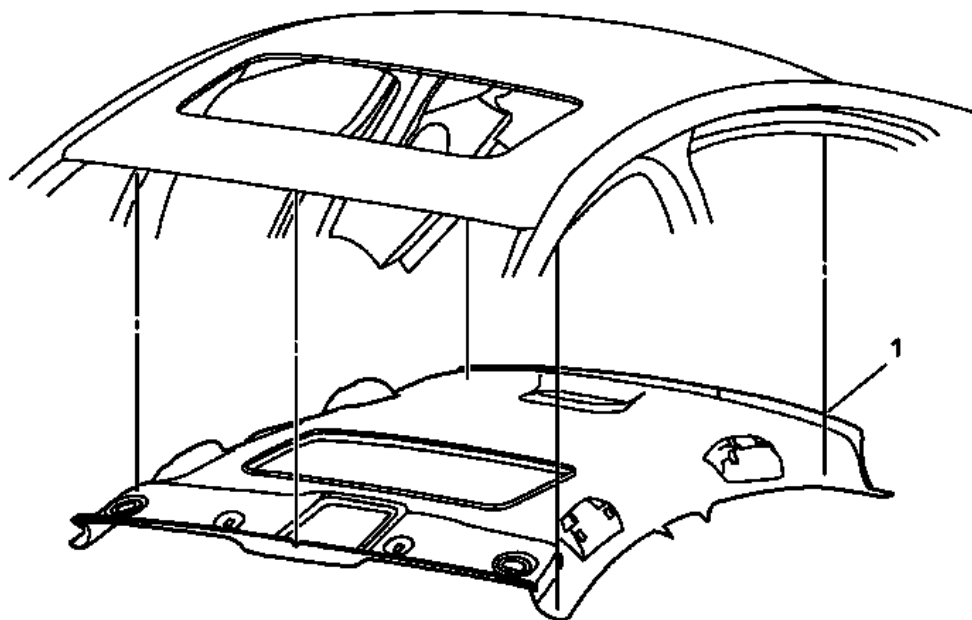


Fig. 3: Headlining Trim Panel (With Sunroof)
 Courtesy of GENERAL MOTORS COMPANY

Headlining Trim Panel Replacement (With Sunroof)

Callout	Component Name
<p>WARNING: Do not attempt to repair or alter the head impact energy-absorbing material glued to the headliner or to the garnish trims. If the material is damaged, replace the headliner and/or the garnish trim. Failure to do so could result in personal injury.</p> <p>CAUTION: If a vehicle is equipped with a head curtain inflator module ensure that the inflator module and tether are undamaged. If tether or curtain airbag are damaged in any way, they must be replaced.</p> <p>CAUTION: Use care when working around the head curtain inflator module. Sharp tools may puncture the curtain airbag. If the head curtain inflator module is damaged in any way, it must be replaced.</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none"> 1. Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u> . 2. Remove the sunshade. Refer to <u>Sunshade Replacement</u> . 3. Remove the sunshade supports. Refer to <u>Sunshade Support Replacement</u> . 4. Remove the roof rail front assist handles. Refer to <u>Roof Rail Front Assist Handle Replacement</u> . 	

5. Remove the windshield side garnish moldings. Refer to **Windshield Side Garnish Molding Replacement** .
6. Remove the center pillar upper garnish moldings. Refer to **Center Pillar Upper Garnish Molding Replacement** .
7. Remove the body lock pillar upper trim panel. Refer to **Body Lock Pillar Upper Trim Panel Replacement (Sedan)** .
8. Remove the roof console. Refer to **Roof Console Replacement** .
9. Remove the reading lamp assembly. Refer to **Reading Lamp Replacement** .
10. Move the passenger seat fully forward and recline.
11. Remove the driver seat. Refer to **Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)** .

Headlining Trim Panel

Procedure

1

1. Disconnect the electrical connectors.
2. Remove the headliner trim through the left rear door.

TIP: When installing a new headliner, tape any unused connector to the headliner with a high adhesive tape.

HEADLINING TRIM PANEL REPLACEMENT (WITHOUT SUNROOF)

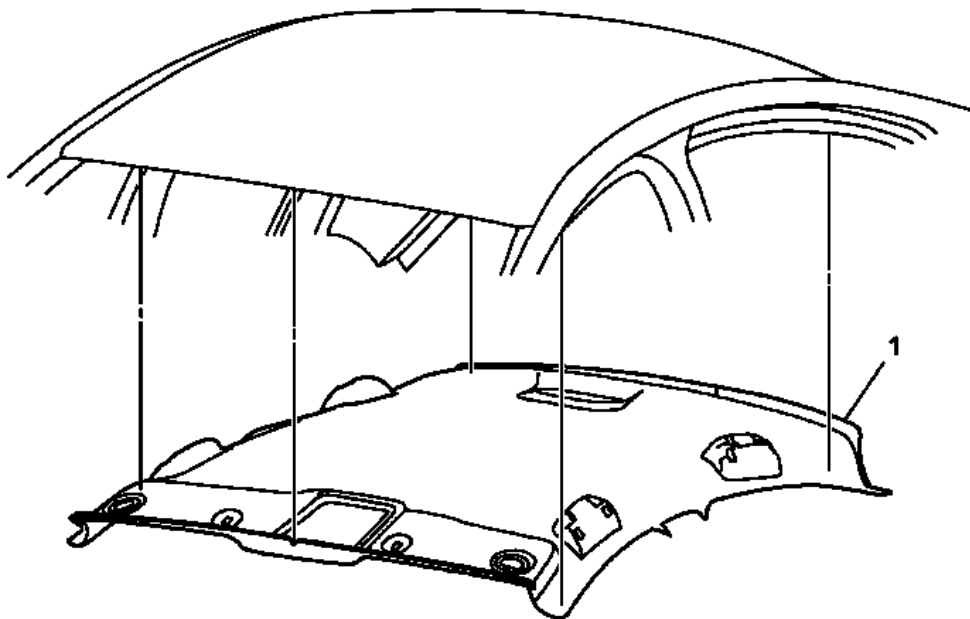


Fig. 4: Headlining Trim Panel (Without Sunroof)
 Courtesy of GENERAL MOTORS COMPANY

Headlining Trim Panel Replacement (Without Sunroof)

Callout	Component Name
<p>WARNING:</p> <p>Do not attempt to repair or alter the head impact energy-absorbing material glued to the headliner or to the garnish trims. If the material is damaged, replace the headliner and/or the garnish trim. Failure to do so could result in personal injury.</p> <p>CAUTION:</p> <p>If a vehicle is equipped with a head curtain inflator module ensure that the inflator module and tether are undamaged. If tether or curtain airbag are damaged in any way, they must be replaced.</p> <p>CAUTION:</p> <p>Use care when working around the head curtain inflator module. Sharp tools may puncture the curtain airbag. If the head curtain inflator module is damaged in any way, it must be replaced.</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none"> 1. Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u> . 2. Remove the sunshade. Refer to <u>Sunshade Replacement</u> . 3. Remove the sunshade supports. Refer to <u>Sunshade Support Replacement</u> . 4. Remove the roof rail front assist handles. Refer to <u>Roof Rail Front Assist Handle Replacement</u> . 5. Remove the windshield side garnish moldings. Refer to <u>Windshield Side Garnish Molding Replacement</u> . 6. Remove the center pillar upper garnish moldings. Refer to <u>Center Pillar Upper Garnish Molding Replacement</u> . 7. Remove the body lock pillar upper trim panel. Refer to <u>Body Lock Pillar Upper Trim Panel Replacement (Sedan)</u> . 8. Remove the reading lamp assembly. Refer to <u>Reading Lamp Replacement</u> . 9. Move the passenger seat fully forward and recline. 10. Remove the driver seat. Refer to <u>Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)</u> . 	
1	<p>Headlining Trim Panel</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connectors. 2. Remove the headliner trim through the left rear door. <p>TIP: When installing a new headliner, tape any unused connector to the headliner with a high adhesive tape.</p>

ACCESSORIES & EQUIPMENT

Frame and Underbody

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Drivetrain and Front Suspension Frame Transmission Protector Fasteners (AWD)	35	26 lb ft
Frame-to-Body Fasteners	160	118 lb ft
Frame-to-Body Reinforcement Fasteners (1)		
• First Pass	60	44 lb ft
• Final Pass	+ 30 degrees	
Front Transmission Mount Through Bolt	100	74 lb ft
Rear Support Reinforcement Arm Bolts (GNE)		
• First Pass	150	111 lb ft
• Second Pass	+ 30 degrees	
• Final Pass	+ 15 degrees	
Rear Support-to-Body Fasteners (GNE) (1)		
• First Pass	90	66 lb ft
• Second Pass	+ 180 degrees	
• Final Pass	+ 15 degrees	
Rear Support-to-Body Fasteners (GNC) (1)		
• First Pass	90	66 lb ft
• Second Pass	+ 120 degrees	
• Final Pass	+ 15 degrees	
Rear Transmission Mount Through Bolt	100	74 lb ft
Steering Gear Fasteners		
• First Pass	110	81 lb ft
• Second Pass	+ 150 degrees	
• Final Pass	+ 15 degrees	
Underbody Front Air Deflector Fastener	2.5	19 lb in
Underbody Rear Air Deflector Fastener	3	27 lb in
(1) Replace fastener with NEW fastener		

REPAIR INSTRUCTIONS

FRONT COMPARTMENT SPLASH SHIELD REPLACEMENT

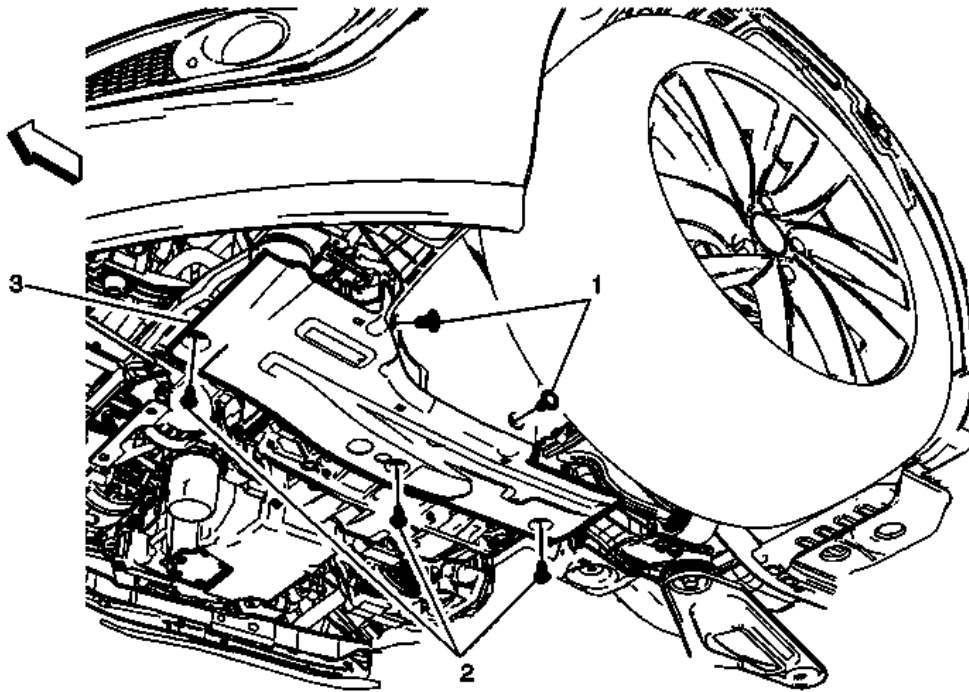


Fig. 1: Front Compartment Splash Shield
Courtesy of GENERAL MOTORS COMPANY

Front Compartment Splash Shield Replacement

Callout	Component Name
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>	
2. If equipped with AWD, remove the drivetrain and front suspension frame transmission protector. Refer to <u>Drivetrain and Front Suspension Frame Transmission Protector Replacement (AWD)</u> .	
1	Front Compartment Splash Shield Retainer (Qty 2)
2	CAUTION: Refer to <u>Fastener Caution</u> .
	Front Compartment Splash Shield Fastener (Qty 3) Tighten: 3 (27 lb in)
3	Front Compartment Splash Shield

DRIVETRAIN AND FRONT SUSPENSION FRAME TRANSMISSION PROTECTOR REPLACEMENT (AWD)

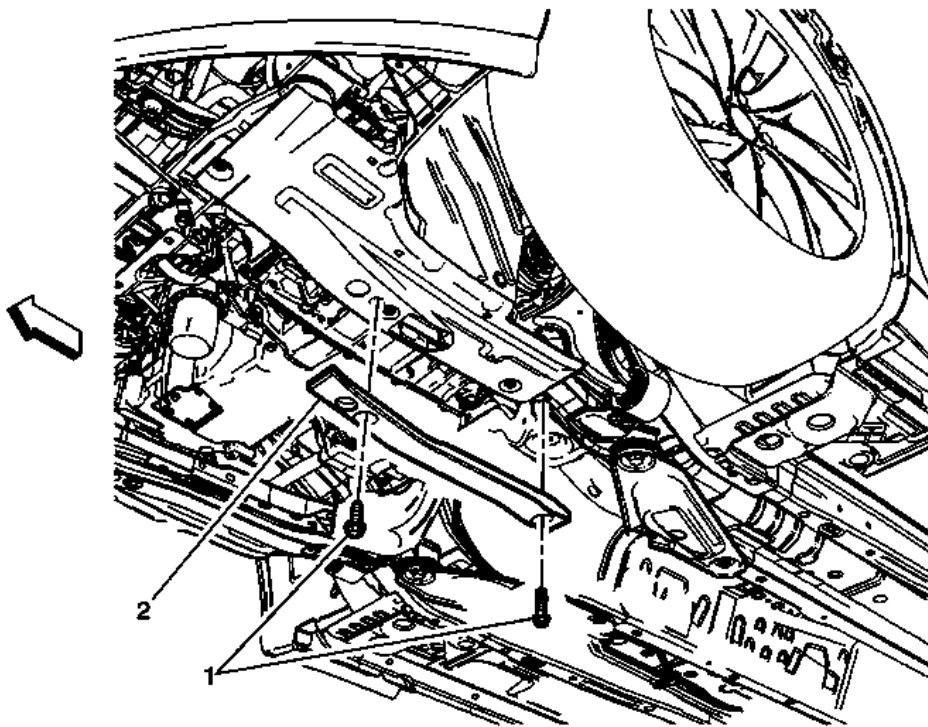


Fig. 2: Drivetrain and Front Suspension Frame Transmission Protector (AWD)
 Courtesy of GENERAL MOTORS COMPANY

Drivetrain and Front Suspension Frame Transmission Protector Replacement (AWD)

Callout	Component Name
Preliminary Procedures	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	CAUTION: Refer to <u>Fastener Caution</u> . Drivetrain and Front Suspension Frame Transmission Protector Fastener (Qty: 2) Tighten: 35 (26 lb ft)
2	Drivetrain and Front Suspension Frame Transmission Protector (Qty: 2)

UNDERBODY FRONT AIR DEFLECTOR REPLACEMENT - LEFT SIDE

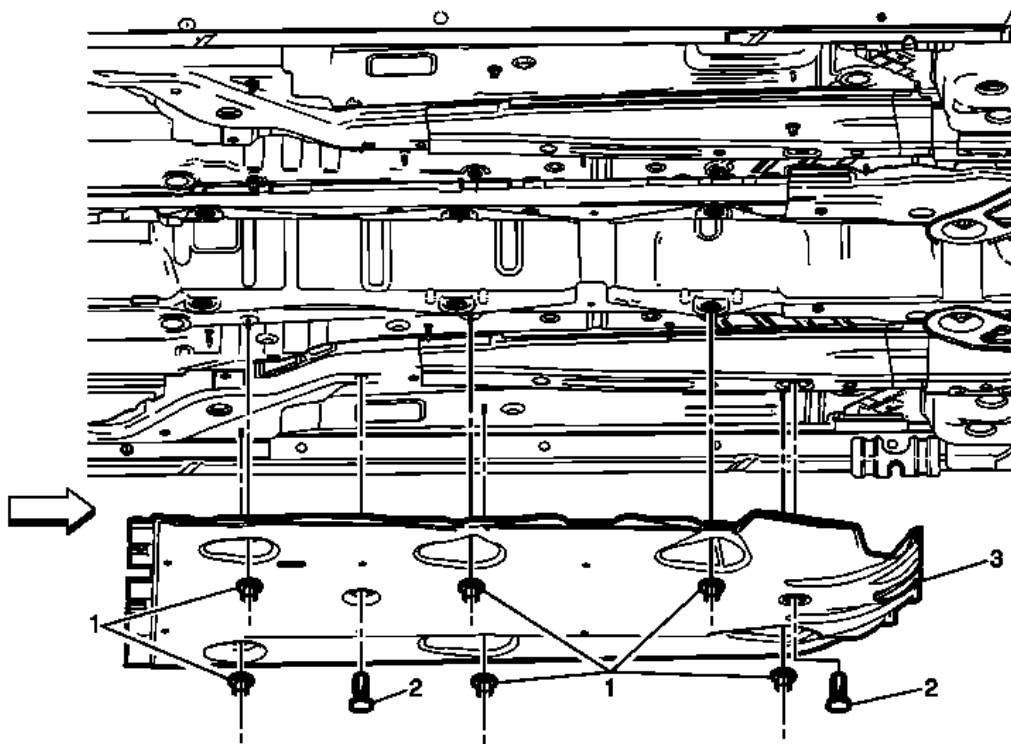


Fig. 3: Underbody Front Air Deflector - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Underbody Front Air Deflector Replacement - Left Side

Callout	Component Name
WARNING: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.	
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove rear air deflector replacement left side. Refer to <u>Underbody Rear Air Deflector Replacement - Left Side (HP6)</u>. 	
1	Underbody Front Air Deflector Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m (22 lb in)
2	Underbody Left Front Air Deflector Fastener (Qty: 2)
3	Underbody Left Front Air Deflector

UNDERBODY FRONT AIR DEFLECTOR REPLACEMENT - RIGHT SIDE

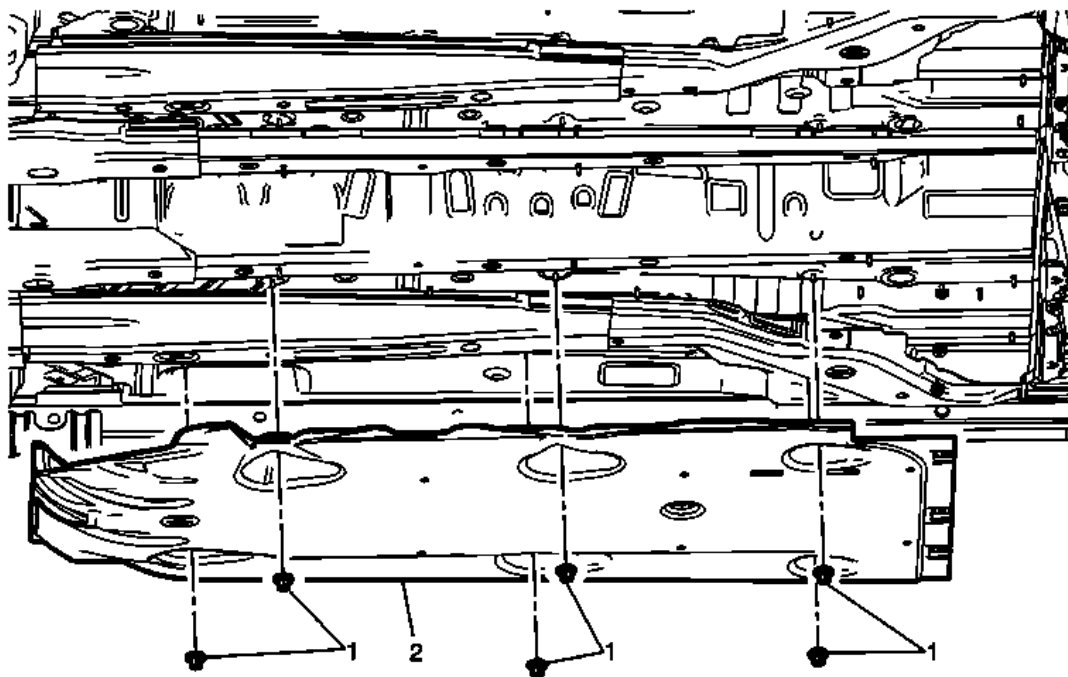


Fig. 4: Underbody Front Air Deflector - Right Side
Courtesy of GENERAL MOTORS COMPANY

Underbody Front Air Deflector Replacement - Right Side

Callout	Component Name
WARNING: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.	
Preliminary Procedure <ol style="list-style-type: none">1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .2. Remove rear air deflector replacement right side. Refer to <u>Underbody Rear Air Deflector Replacement - Right Side (HP6)</u>.	
1	Underbody Front Air Deflector Fastener (Qty: 8) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m (22 lb in)

UNDERBODY REAR AIR DEFLECTOR REPLACEMENT - LEFT SIDE (HP6)

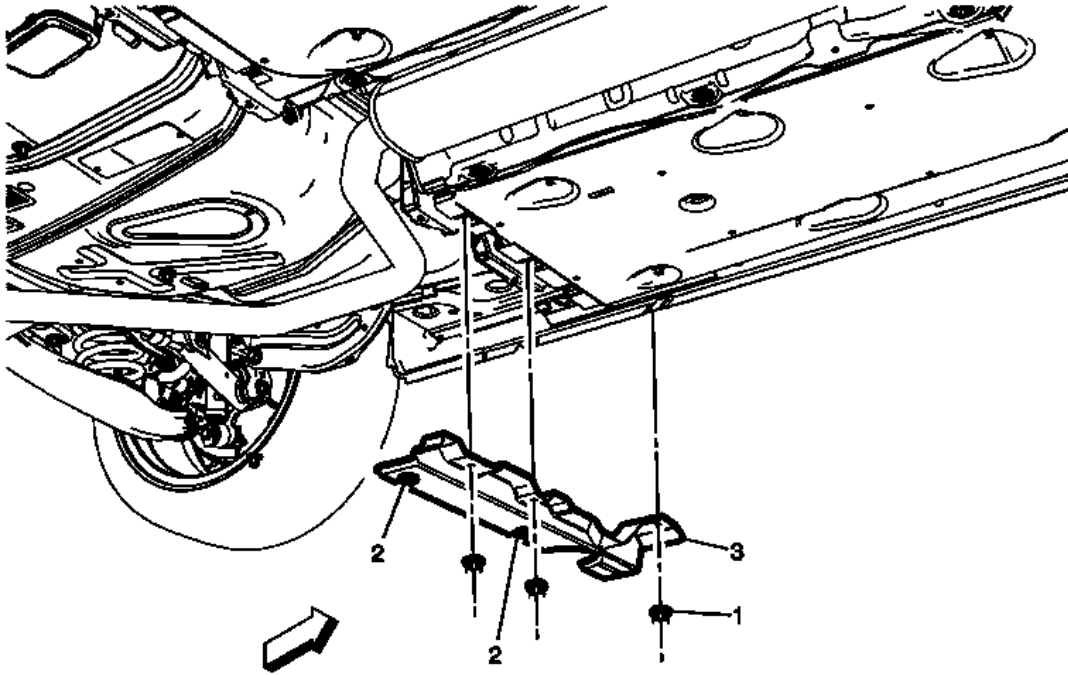


Fig. 5: Underbody Rear Air Deflector - Left Side (HP6)

Courtesy of GENERAL MOTORS COMPANY

Underbody Rear Air Deflector Replacement - Left Side (HP6)

Callout	Component Name
Preliminary Procedures	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Underbody Rear Air Deflector Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 3 (27 lb in)
2	Underbody Rear Air Deflector Retainers (Qty: 2)
3	Underbody Rear Air Deflector - Left Side

UNDERBODY REAR AIR DEFLECTOR REPLACEMENT - RIGHT SIDE (HP6)

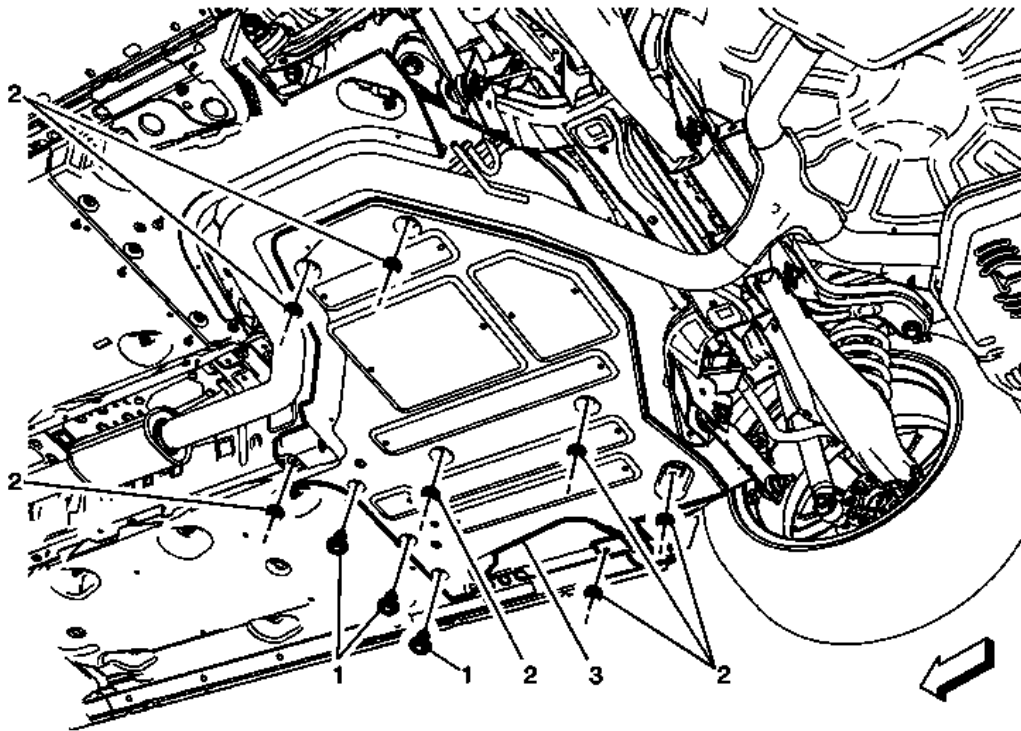


Fig. 6: Underbody Rear Air Deflector - Right Side (HP6)
 Courtesy of GENERAL MOTORS COMPANY

Underbody Rear Air Deflector Replacement - Right Side (HP6)

Callout	Component Name
Preliminary Procedures	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Underbody Rear Air Deflector Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 3 (27 lb in)
2	Underbody Rear Air Deflector Fasteners (Qty: 7) Tighten 3 (27 lb in)
3	Underbody Rear Air Deflector - Right Side

DRIVETRAIN AND FRONT SUSPENSION FRAME REPLACEMENT

Removal Procedure

NOTE: Vehicle alignment is not required if the cradle is being lowered or dropped

to perform another procedure. Only align id replacing the cradle with a **NEW** part and transferring components.

1. Install the engine support fixture. Refer to **Engine Support Fixture** .
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the front wheels. Refer to **Tire and Wheel Removal and Installation** .
4. Remove the front fascia. Refer to **Front Bumper Fascia Replacement** .

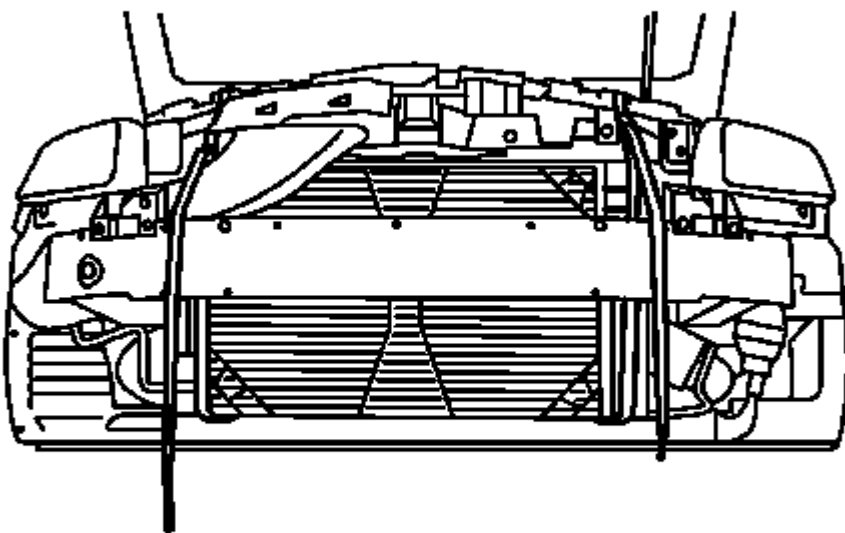


Fig. 7: Tying Radiator, Air Conditioning Condenser And Fan Module Assembly To Upper Radiator Support

Courtesy of GENERAL MOTORS COMPANY

5. Tie the radiator, air conditioning condenser, and fan module assembly to the upper radiator support to keep the assembly with the vehicle when the frame is lowered.
6. Disconnect the left and right stabilizer links from the strut assemblies. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .
7. Disconnect the tie rod ends from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .
8. Remove the two steering gear retaining fasteners. Refer to **Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)** , **Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)** , for EPS steering or **Electric Dual Pinion Rack and**

Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1) , **Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LTG, M7U, NJ1)** for rack and pinion steering.

9. Using mechanics wire suspend the steering gear from the powertrain.
10. Remove the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** , **Exhaust Front Pipe Replacement (LUK)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
11. If equipped with AWD, remove the propeller shaft. Refer to **Propeller Shaft Replacement** .

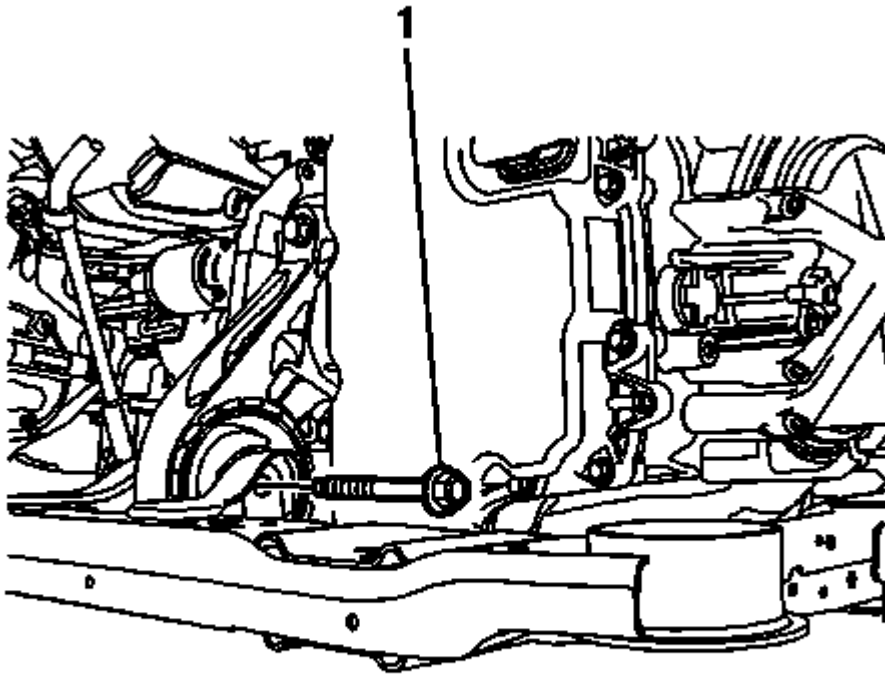


Fig. 8: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove the front transmission mount through bolt (1).

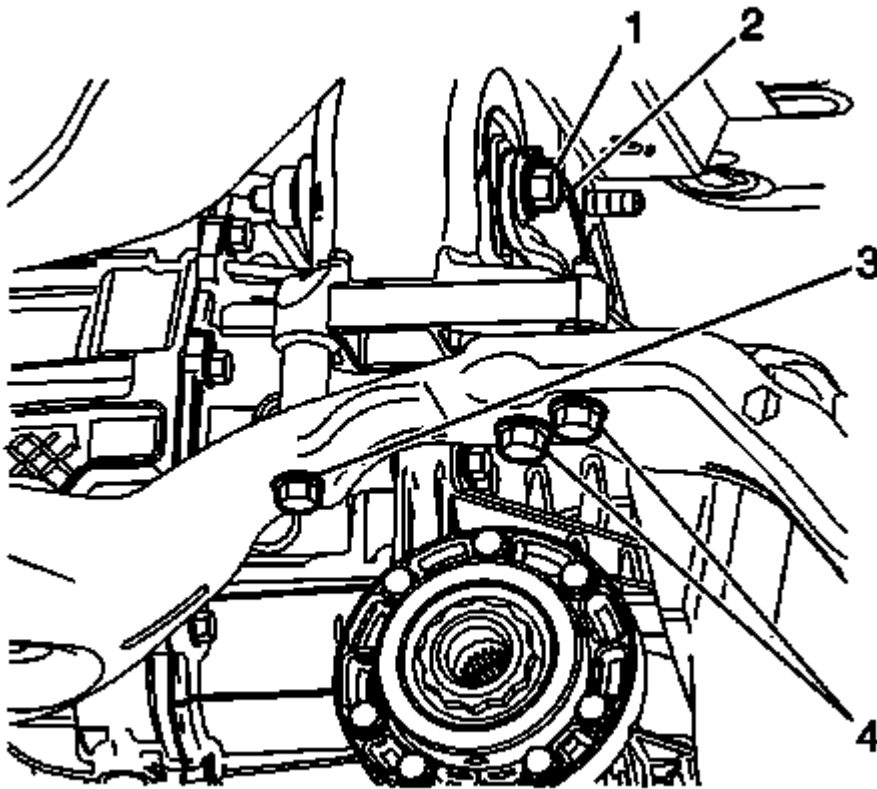


Fig. 9: Transaxle Mount Components

Courtesy of GENERAL MOTORS COMPANY

13. Remove the rear transmission mount fasteners (3, 4).
14. Separate the lower ball joints from the steering knuckles (1). Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .

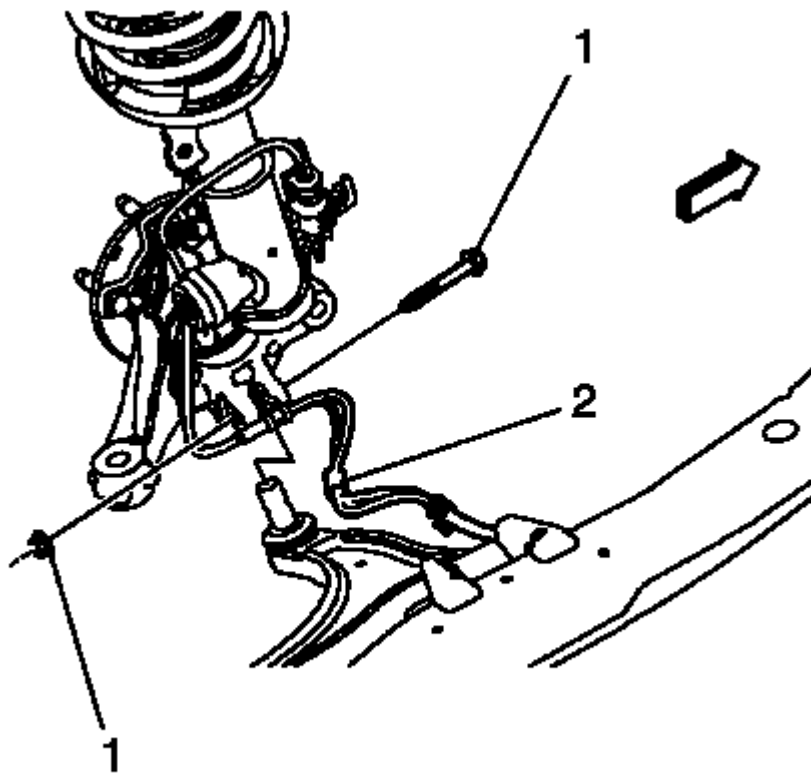


Fig. 10: Electrical Harness And Power Steering Cooler Line Clips
Courtesy of GENERAL MOTORS COMPANY

15. Remove the electrical harness and the power steering cooler line from the clips in the frame (2).
16. Mark the location of the frame using spray paint for correct positioning during installation.
17. Carefully lower the vehicle until the frame contacts the support table.

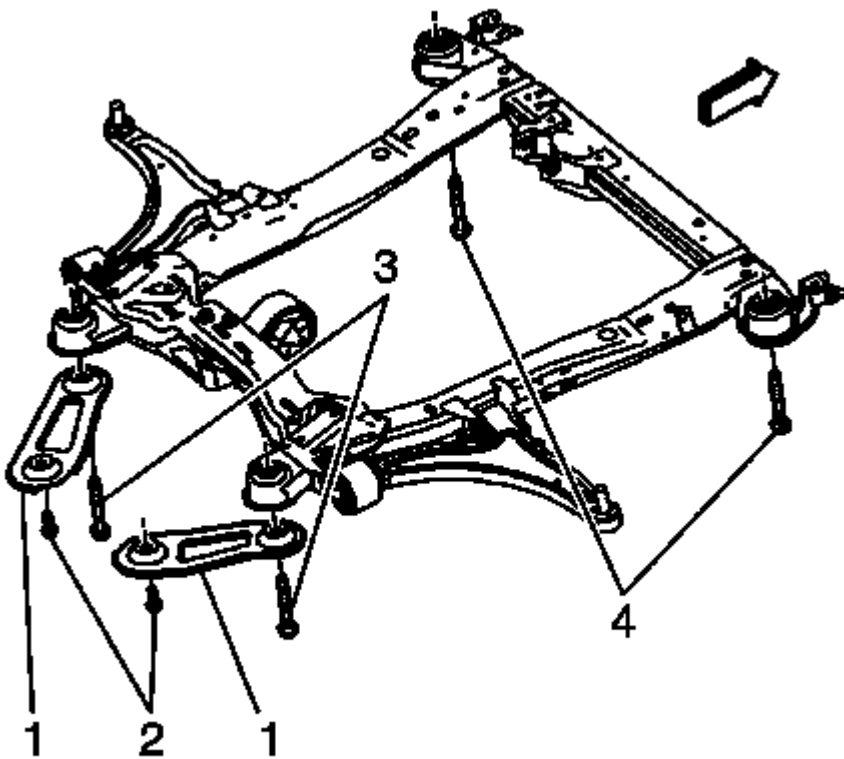


Fig. 11: Frame And Mounting Hardware
Courtesy of GENERAL MOTORS COMPANY

18. Remove the reinforcement bolts (2). DISCARD the bolts.
19. Remove the rear frame to body bolts (3).
20. Remove the reinforcements (1) from the vehicle.
21. Remove the front frame-to-body bolts (4).
22. Carefully raise the vehicle to separate the frame from the body.

NOTE: Do not separate the stabilizer bar bracket from the insulator and stabilizer bar when transferring parts.

23. If replacing the frame, transfer components as necessary.

Installation Procedure

1. Carefully lower the vehicle until contacts the frame assembly and is correctly positioned within the spray painted areas.

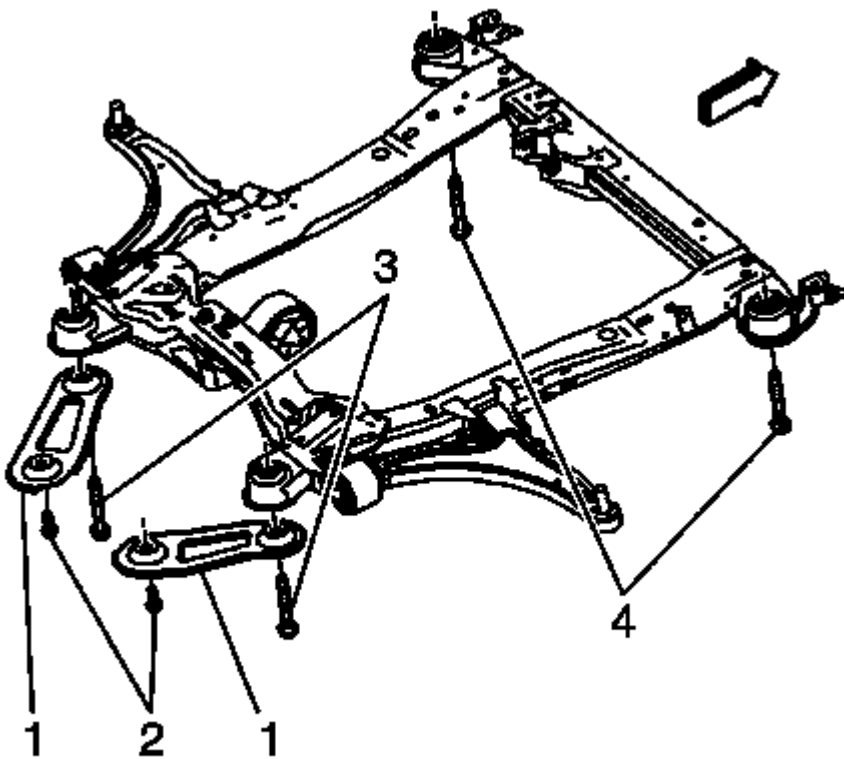


Fig. 12: Frame And Mounting Hardware
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the frame retaining fasteners (3, 4) and tighten to 160 (118 lb ft).
3. Install NEW frame reinforcement fasteners (2) and tighten to 60 N.m (31 lb ft) plus 30 degrees.

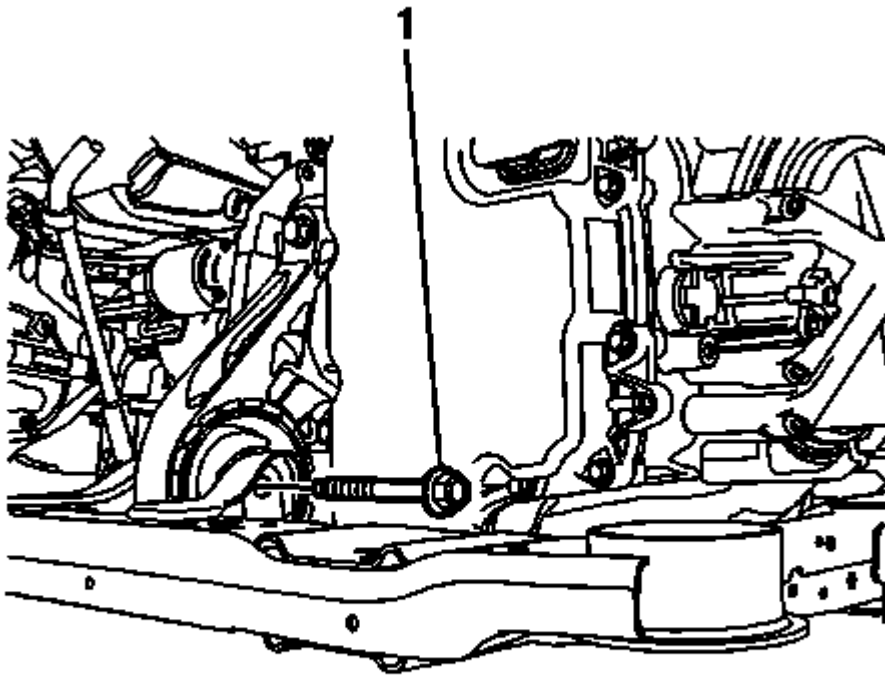


Fig. 13: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the front transmission mount through bolt (1) and tighten to 100 (74 lb ft).

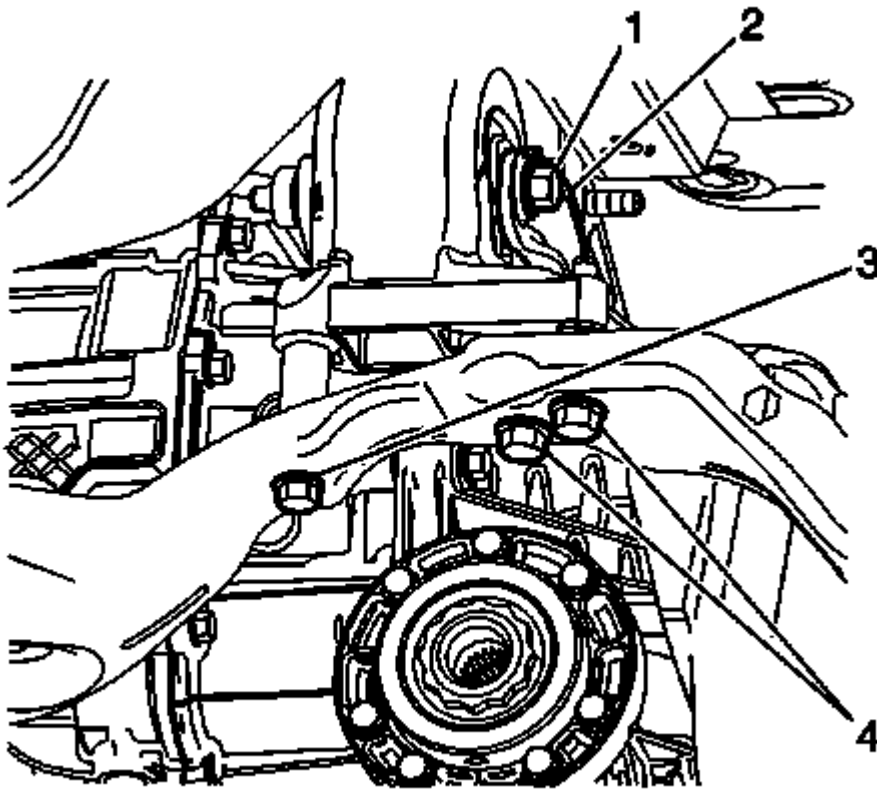


Fig. 14: Transaxle Mount Components
Courtesy of GENERAL MOTORS COMPANY

5. Install the rear transmission mount fastener (3) and tighten to 62 (46 lb ft).
6. Install the rear transmission mount fasteners (4) and tighten to 100 (74 lb ft).
7. Remove the mechanics wire and install the steering gear with NEW fasteners and tighten to 110 N.m (81 lb ft) plus 150 degrees, plus 15 degrees.

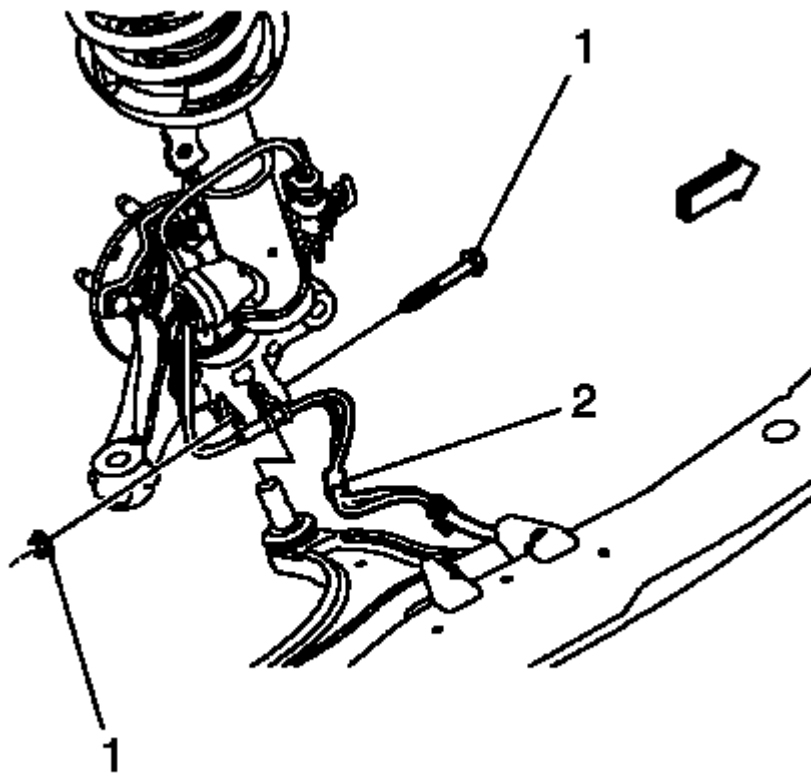


Fig. 15: Electrical Harness And Power Steering Cooler Line Clips
Courtesy of GENERAL MOTORS COMPANY

8. Install the electrical harness and the power steering cooler line to the clips in the frame (2).
9. Connect the ball joint studs to the steering knuckles (1). Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
10. Untie the radiator, air conditioning condenser, and fan module assembly from the upper radiator support.
11. Connect the left and right stabilizer links to the strut assemblies. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .
12. Connect the tie rod ends to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .
13. Install the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** , **Exhaust Front Pipe Replacement (LUK)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
14. If equipped with AWD, install the propeller shaft. Refer to **Propeller Shaft Replacement** .
15. Remove the engine support fixture.
16. Install the front fascia. Refer to **Front Bumper Fascia Replacement** .
17. Install the front wheels. Refer to **Tire and Wheel Removal and Installation** .
18. Lower the vehicle.
19. Check the wheel alignment if replacing the drivetrain and front suspension frame. Refer to **FRONT CAMBER ADJUSTMENT (GNB)** or **FRONT CAMBER ADJUSTMENT (GNA) Wheel Alignment**

- Steering Wheel Angle and/or Front Toe Adjustment .

REAR SUSPENSION SUPPORT REPLACEMENT (GNC)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the rear tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the rear muffler assembly. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
4. Disconnect the stabilizer shaft from stabilizer shaft links. Refer to **Stabilizer Shaft Replacement (GNC)** .
5. Remove the park brake cables from the support. Refer to **Parking Brake Rear Cable Replacement** .
6. Remove the lower control arms from the vehicle. Refer to **Rear Axle Lower Control Arm Replacement (GNC)** .
7. Remove the adjust links from the from the vehicle. Refer to **Adjust Link Replacement (GNC)** .
8. Remove the upper control arm inner fasteners. Refer to **Rear Axle Upper Control Arm Replacement (GNC)** .
9. Position a transmission jack under the rear support and firmly secure the support to the jack with straps.
10. Mark the location of the frame using spray paint for correct positioning during installation.

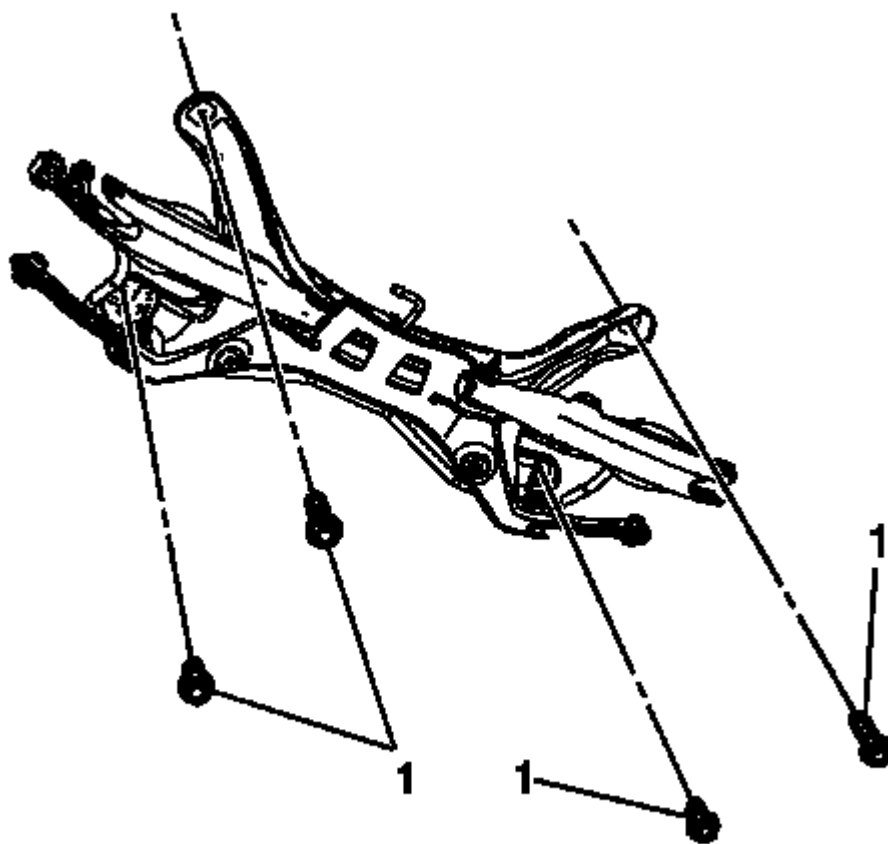


Fig. 16: Identifying Support Assembly To Body Bolts (Sedan/Coupe)
Courtesy of GENERAL MOTORS COMPANY

11. Remove the support fastener and discard them.
12. With the aid of an assistant, lower the support from the transmission jack stand.
13. Remove the stabilizer shaft from the rear support.

Installation Procedure

NOTE: When transferring any suspension components, refer to each suspension component replacement procedure for the proper torque specifications.

1. Install the stabilizer shaft assembly on to the support. Refer to **Stabilizer Shaft Replacement (GNC)** .
2. With the aid of an assistant, position the rear support onto the transmission jack and firmly secure the support to the jack with straps.
3. Carefully lower the vehicle until contacts the frame assembly and is correctly positioned within the spray painted areas.

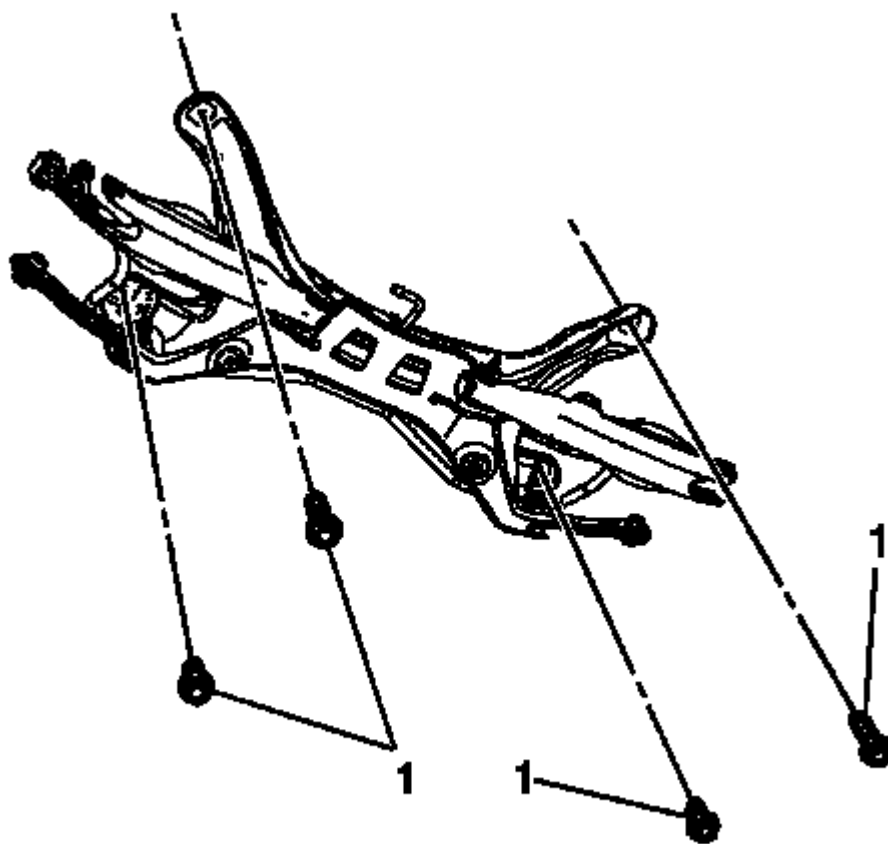


Fig. 17: Identifying Support Assembly To Body Bolts (Sedan/Coupe)
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the NEW support fastener and tighten to 90 N.m (66 lb ft).
5. Tighten the support fastener an additional 120 degrees .
6. Remove the transmission jack stand.
7. Install the upper control arm inner fasteners. Refer to Rear Axle Upper Control Arm Replacement (GNC) .
8. Install the adjust links to the support. Refer to Adjust Link Replacement (GNC) .
9. Install the lower control arms. Refer to Rear Axle Lower Control Arm Replacement (GNC) .
10. Install the park brake cables to the rear support. Refer to Parking Brake Rear Cable Replacement .
11. Install the rear muffler assembly. Refer to Exhaust Muffler Replacement (Dual) , Exhaust Muffler Replacement (Single)
12. Connect the stabilizer shaft links to the stabilizer shaft. Refer to Stabilizer Shaft Replacement (GNC) .
13. Install the rear tire and wheel assemblies. Refer to Tire and Wheel Removal and Installation .

14. Lower the vehicle.
15. Realign the rear suspension. Refer to Wheel Alignment Measurement .

REAR SUSPENSION SUPPORT REPLACEMENT (GNE)

Removal Procedure

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tires and wheels. Refer to Tire and Wheel Removal and Installation .
3. Remove the exhaust muffler. Refer to Exhaust Muffler Replacement (Dual) , Exhaust Muffler Replacement (Single) .
4. Remove the park brake cables from the support. Refer to Parking Brake Rear Cable Replacement .
5. Remove the shock absorber lower fastener. Refer to Shock Absorber Replacement (GNE) .
6. Remove the rear wheel hub brackets. Refer to Rear Wheel Hub Bracket Replacement .
7. Remove the lower control arms from the vehicle. Refer to Rear Axle Lower Control Arm Replacement (GNE) .
8. Remove the upper control arms from the vehicle. Refer to Rear Axle Upper Control Arm Replacement (GNE) .

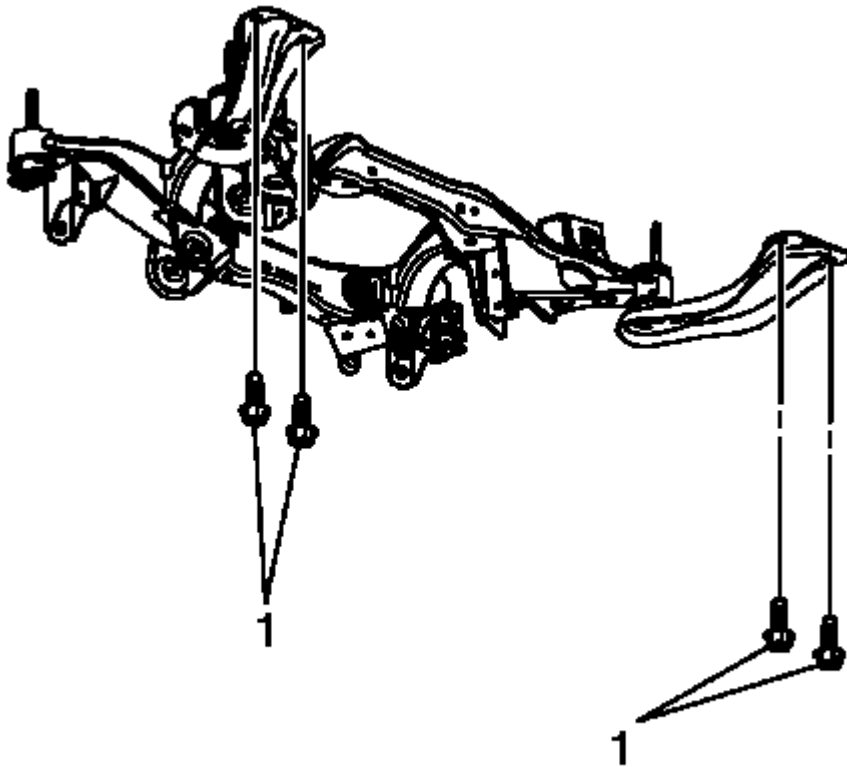


Fig. 18: Reinforcement Arm Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove reinforcement arm bolts (1) to body.
10. Remove the outer fastener adjustment links. Refer to **Adjust Link Replacement (GNE)** .
11. Remove the rear wheel drive shafts. Refer to **Rear Wheel Drive Shaft Replacement** .
12. Remove the differential carrier assembly. Refer to **Differential Carrier Assembly Replacement** .
13. Position a transmission jack under the rear support and firmly secure the support to the jack with straps.
14. Mark the location of the frame using spray paint for correct positioning during installation.

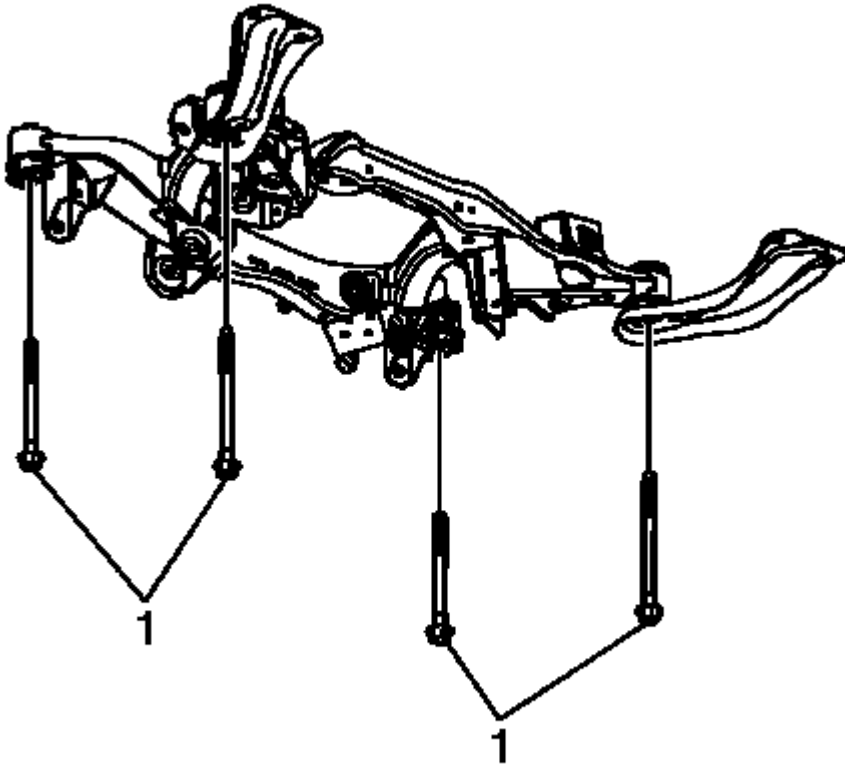


Fig. 19: Rear Support To Body Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the 4 rear support to body bolts (1).
16. Remove the rear support assembly from the vehicle.
17. Remove the inner fastener from adjustments links. Refer to **Adjust Link Replacement (GNE)** .
18. With the aid of an assistant, remove the rear support from the transmission jack and place it on the floor.

Installation Procedure

NOTE: When transferring any suspension components, refer to each suspension component replacement procedure for the proper torque specifications.

1. With the aid of an assistant, position the rear support onto the transmission jack and firmly secure the support to the jack with straps.
2. Install the inner fastener to adjustments links. Refer to **Adjust Link Replacement (GNE)** .
3. Carefully lower the vehicle until contacts the frame assembly and is correctly positioned within the spray painted areas.

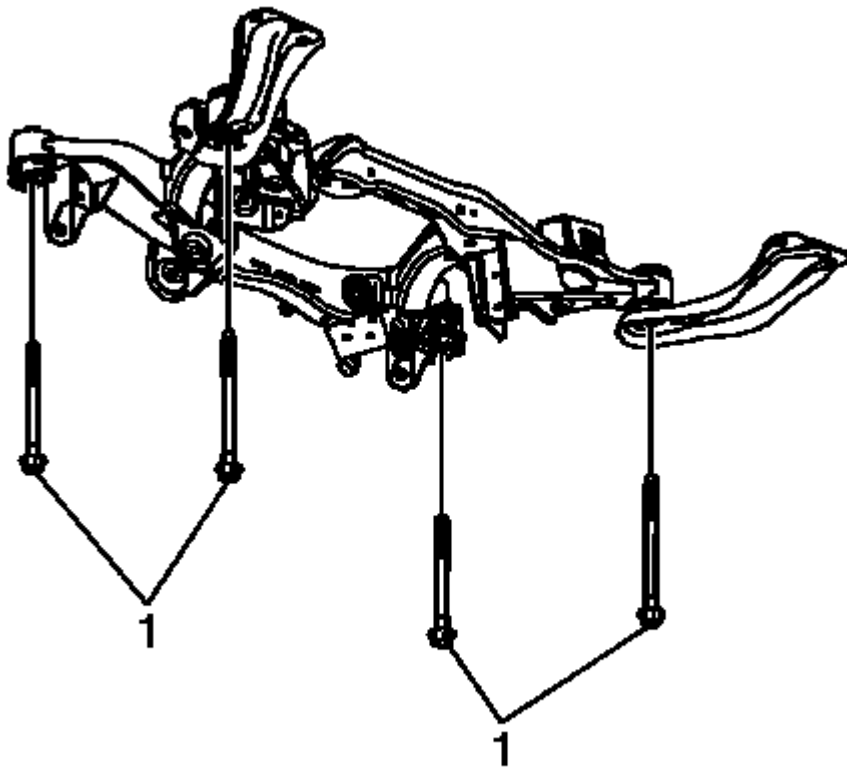


Fig. 20: Rear Support To Body Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

4. Install 4 NEW rear support to body bolts (1) and tighten to:
 - First Pass: 90 N.m (66 lb ft)
 - Second Pass: plus 180 degrees
 - Final Pass: plus 15 degrees
5. Install the differential. Refer to **Differential Carrier Assembly Replacement** .
6. Install the rear wheel drive shafts. Refer to **Rear Wheel Drive Shaft Replacement** .
7. Install the outer fastener adjustment links. Refer to **Adjust Link Replacement (GNE)** .

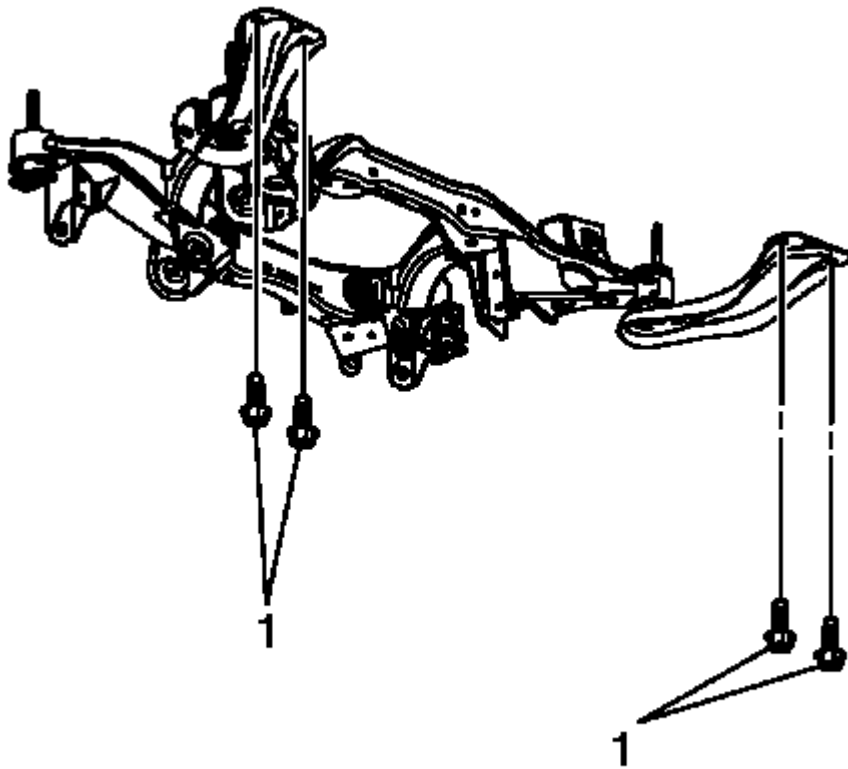


Fig. 21: Reinforcement Arm Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Install NEW reinforcements arm bolts (1) to body and tighten to:
 - First Pass: 150 N.m (111 lb ft)
 - Second Pass: plus 30 degrees
 - Final Pass: plus 15 degrees
9. Install the upper control arms. Refer to **Rear Axle Upper Control Arm Replacement (GNE)** .
10. Install the lower control arms. Refer to **Rear Axle Lower Control Arm Replacement (GNE)** .
11. Install the rear wheel hub brackets. Refer to **Rear Wheel Hub Bracket Replacement** .
12. Install the shock absorber lower fastener. Refer to **Shock Absorber Replacement (GNE)** .
13. Install the park brake cable. Refer to **Parking Brake Rear Cable Replacement** .
14. Install the exhaust muffler. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
15. Install the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
16. Check the rear alignment. Refer to **Wheel Alignment Measurement** .

REAR SUSPENSION SUPPORT BUSHING REPLACEMENT (GNC)

Special Tools

- **CH-48377** Remover/Installer
- **CH-49233** Bushing Tool
- **CH-50196** Bushing Installer
- **DT-49126-10** Bushing Remov and Install Kit

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the exhaust muffler. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
4. Remove shock absorber lower fastener. Refer to **Shock Absorber Replacement (GNC)** .
5. Remove rear springs. Refer to **Rear Spring, Insulator, and Jounce Bumper Replacement** .
6. Disconnect the electrical connection.

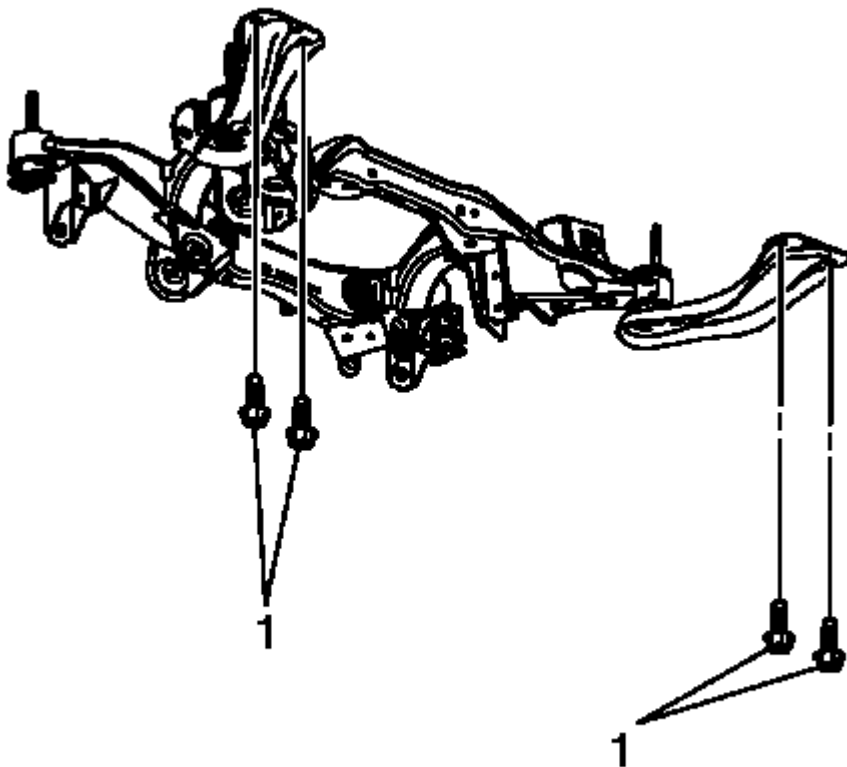


Fig. 22: Reinforcement Arm Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove reinforcement arm bolts (1) to body.
8. Remove the propeller shaft. Refer to **Propeller Shaft Replacement** .

9. Position a transmission jack under the rear support and firmly secure the support to the jack with straps.
10. Mark up support position to body with spray paint.

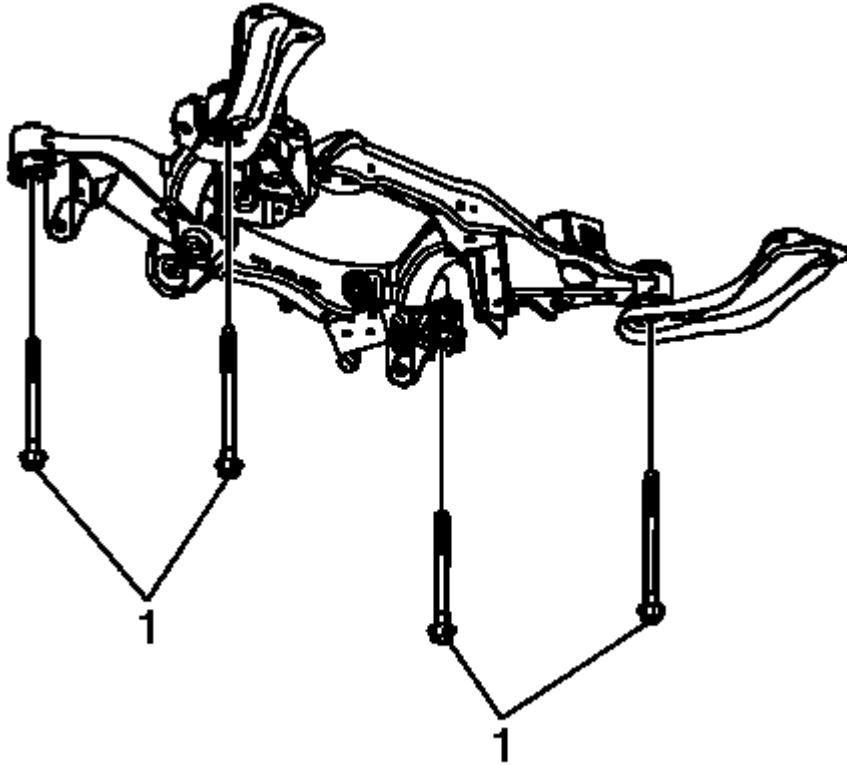


Fig. 23: Rear Support To Body Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the 4 rear support to body bolts (1).
12. Remove the rear support assembly from the vehicle.
13. With the aid of an assistant, remove the rear support from the transmission jack and place it on the floor.
14. Remove the washers from the front bushings.

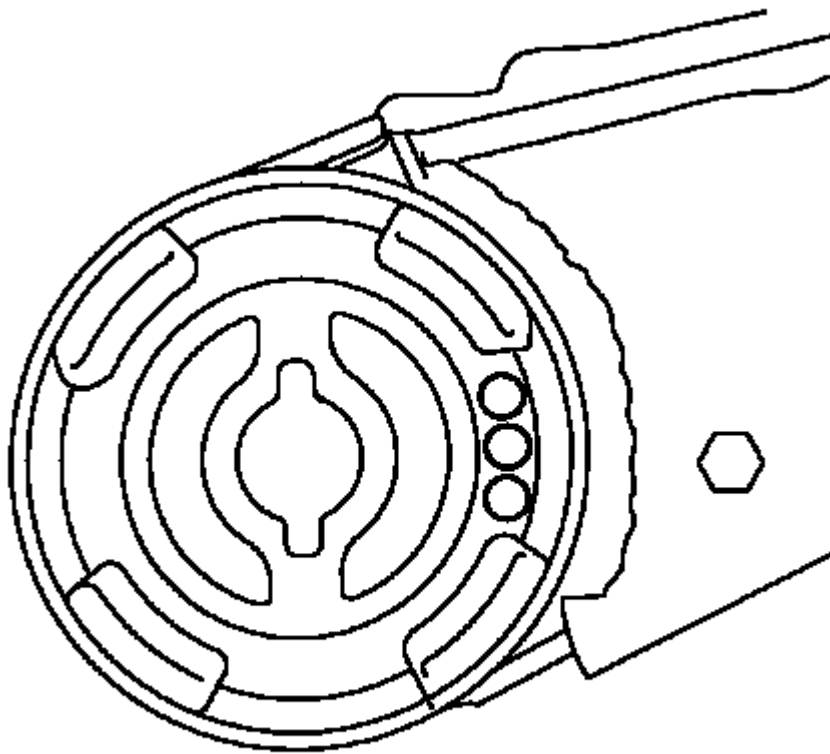


Fig. 24: Rubber Bushing

Courtesy of GENERAL MOTORS COMPANY

15. Drill through rubber bushings with drill 8 mm. See diagram.

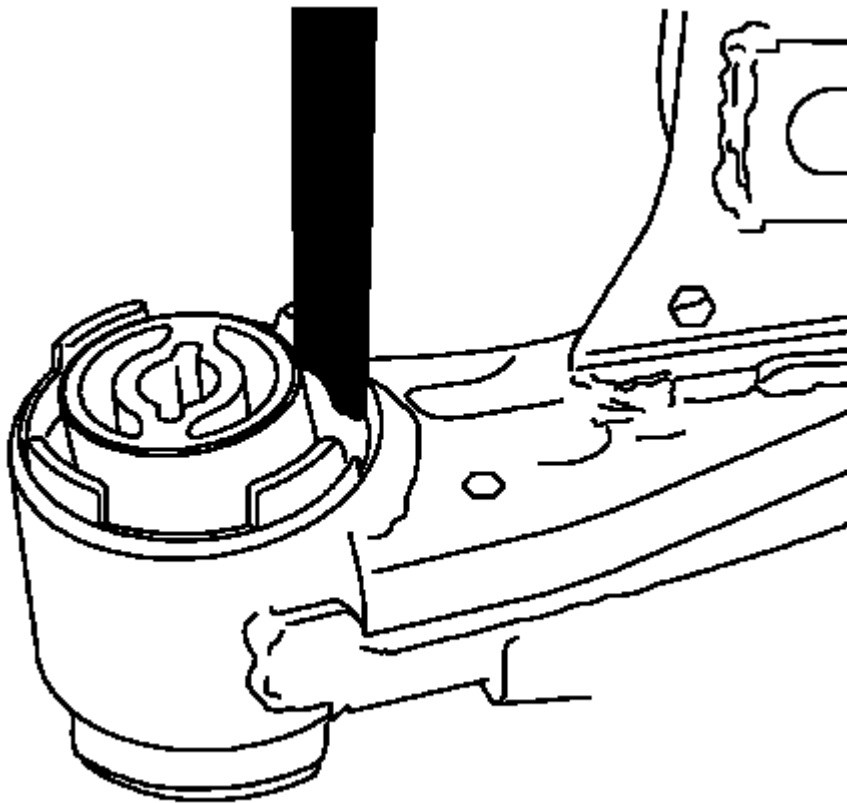


Fig. 25: Removing Bushings

Courtesy of GENERAL MOTORS COMPANY

16. Remove the bushings by placing **CH-48377-1** drift mandrel between bushings and wall of rear axle and drift out.

Installation Procedure

NOTE: When transferring any suspension components, refer to each suspension component replacement procedure for the proper torque specifications.

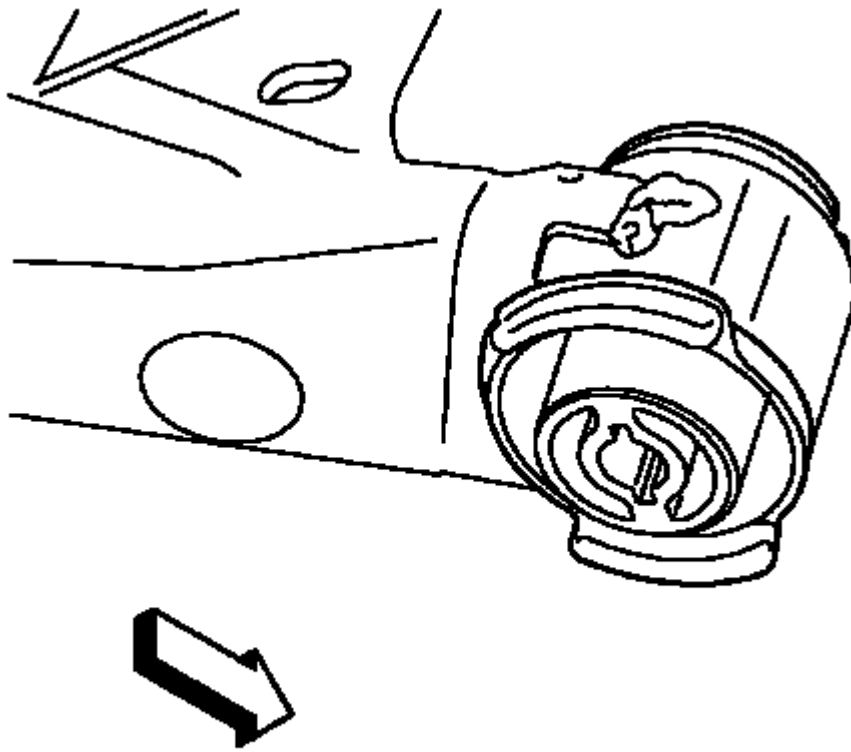


Fig. 26: Locating Front Bushings

Courtesy of GENERAL MOTORS COMPANY

1. Locate the front bushings as shown in the picture.

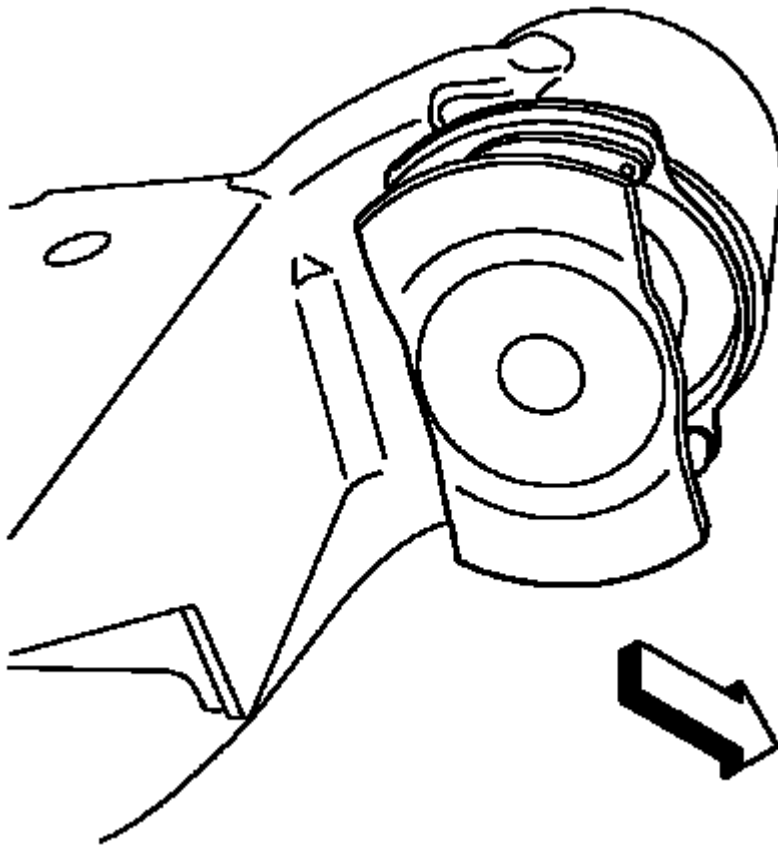


Fig. 27: Rear Bushing

Courtesy of GENERAL MOTORS COMPANY

NOTE: The bushing can be damaged if it is pressed to deep. The bushing should be pressed so that the flange on the bushing is resting on the rear suspension support.

2. Position the rear bushings in the frame.

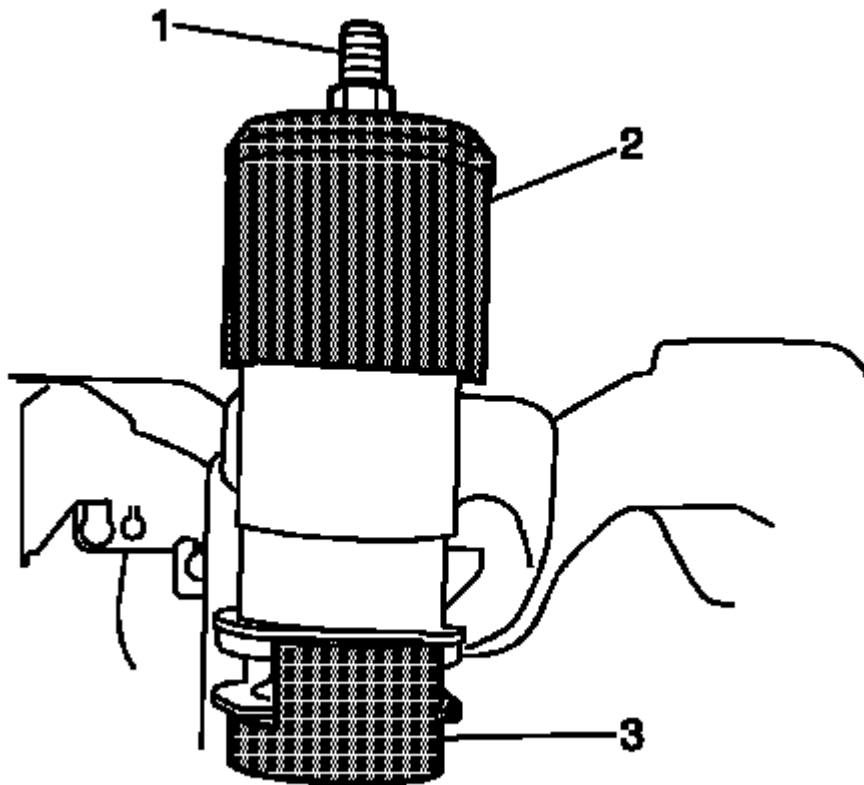


Fig. 28: Removing/Installing Bushings
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply a small amount of silicone grease on the bushing prior to installing.

3. Use the **DT-49126-10** tool (1), **CH-50196** tool (3) and the **CH-49233** tool (2), install the bushing.
4. With the aid of an assistant, position the rear support onto the transmission jack and firmly secure the support to the jack with straps.
5. Position the rear support assembly to the vehicle.

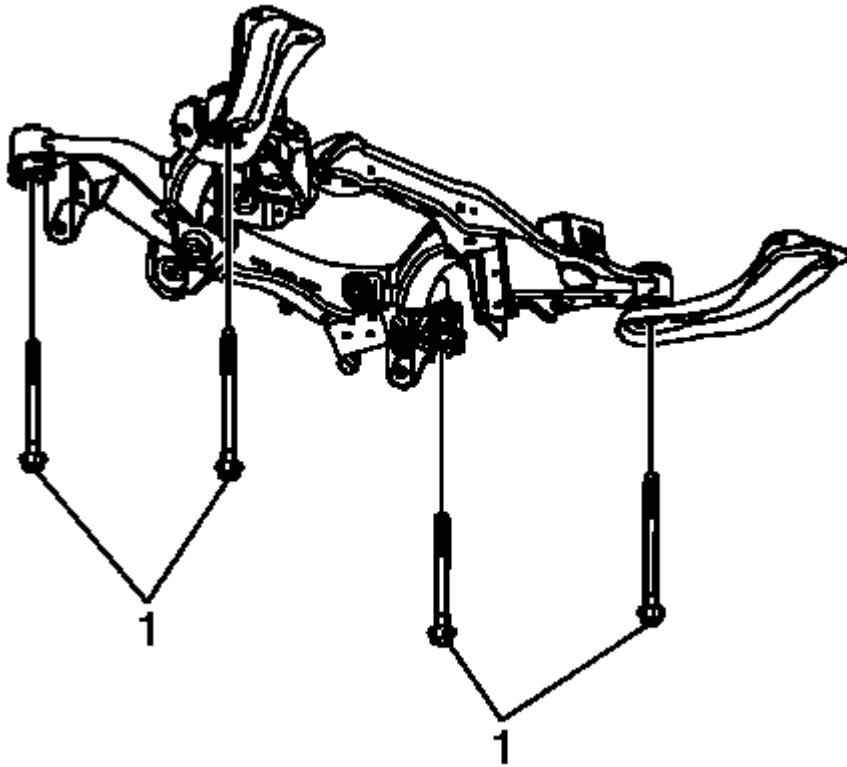


Fig. 29: Rear Support To Body Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Install 4 NEW rear support to body bolts (1).

Tighten

Tighten to 90 N.m (66 lb ft) + 180 degrees + 15 degrees.

7. Connect the electrical connection.
8. Install rear springs. Refer to Rear Spring, Insulator, and Jounce Bumper Replacement .
9. Install the propeller shaft. Refer to Propeller Shaft Replacement .

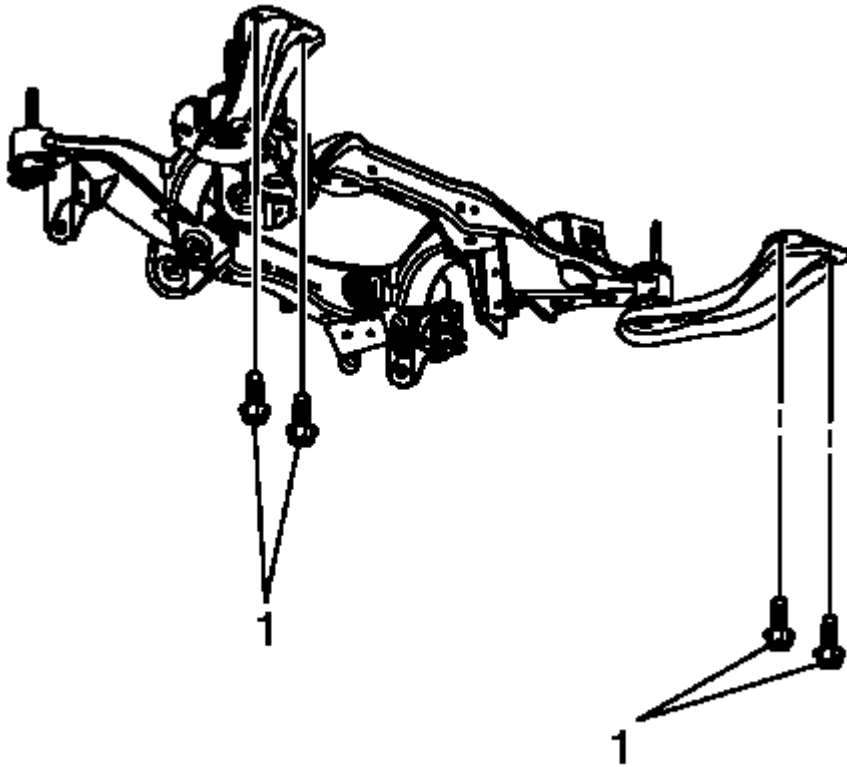


Fig. 30: Reinforcement Arm Bolts

Courtesy of GENERAL MOTORS COMPANY

10. Install NEW reinforcements arm bolts (1) to body.

Tighten

Tighten the bolts to 150 N.m (111 lb ft) + 30 degrees + 15 degrees.

11. Install shock absorber lower fastener. Refer to **Shock Absorber Replacement (GNC)** .
12. Install the exhaust muffler. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
13. Install the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
14. Lower the vehicle.
15. Check the rear alignment. Refer to **Wheel Alignment Measurement** .

DRIVETRAIN AND FRONT SUSPENSION FRAME INSULATOR REPLACEMENT

Special Tools

- **J-45296-1** Frame Insulator Remover and Installer
- **J-45725-2** Bushing Replacer

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Separate the frame from the body approximately 70 mm. Refer to **Drivetrain and Front Suspension Frame Replacement**.

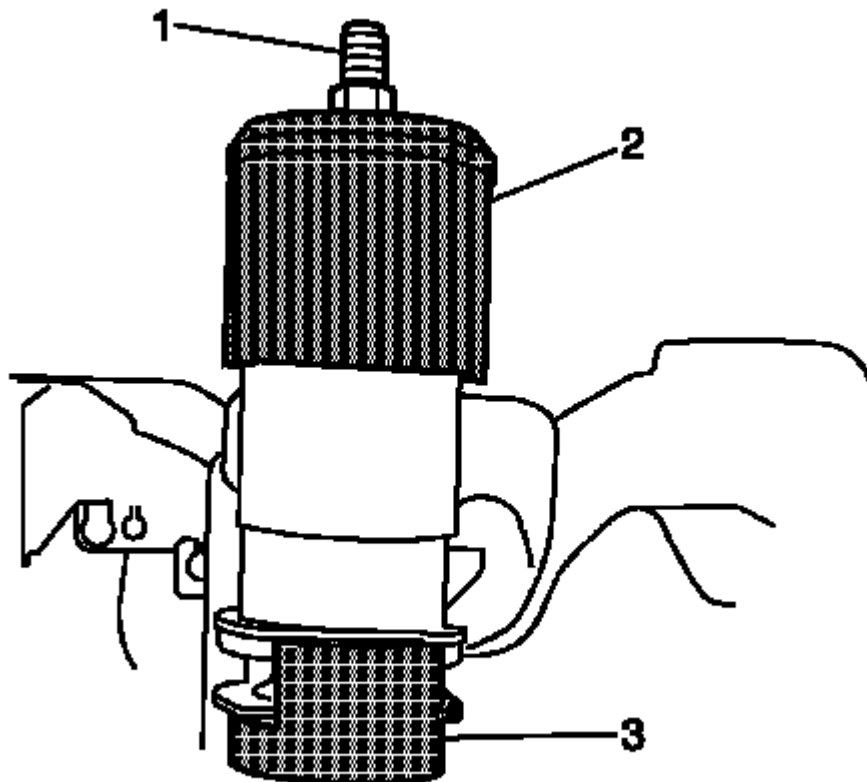


Fig. 31: Removing/Installing Bushings
Courtesy of GENERAL MOTORS COMPANY

2. Remove the bushings using **J-45296-1** remover and installer and **J-45725-2** replacer (2) .

Installation Procedure

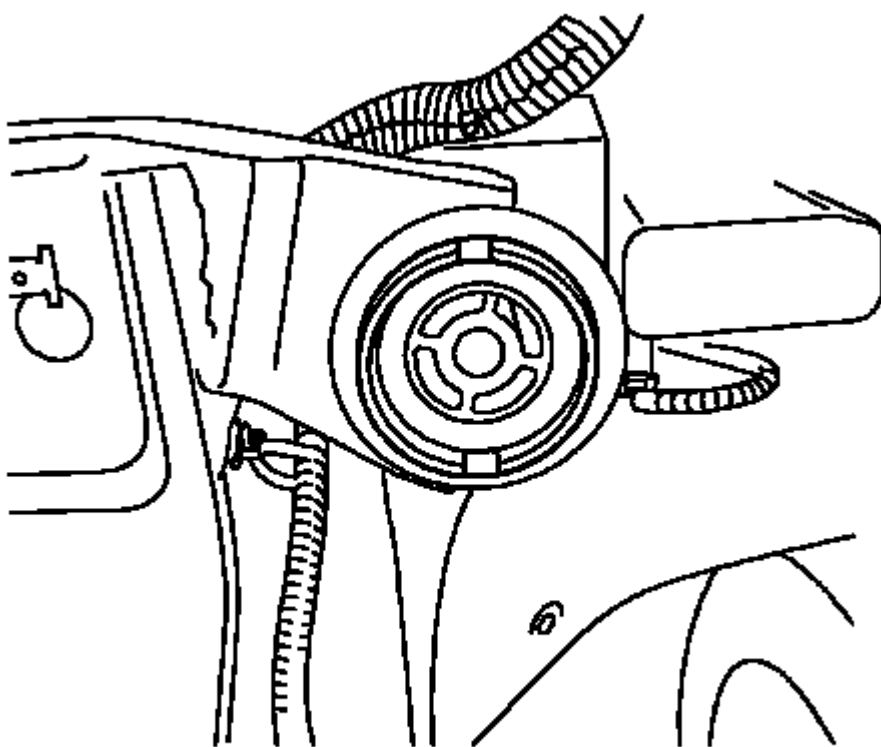


Fig. 32: Locating Front Bushing

Courtesy of GENERAL MOTORS COMPANY

1. Locate the front bushings as shown.

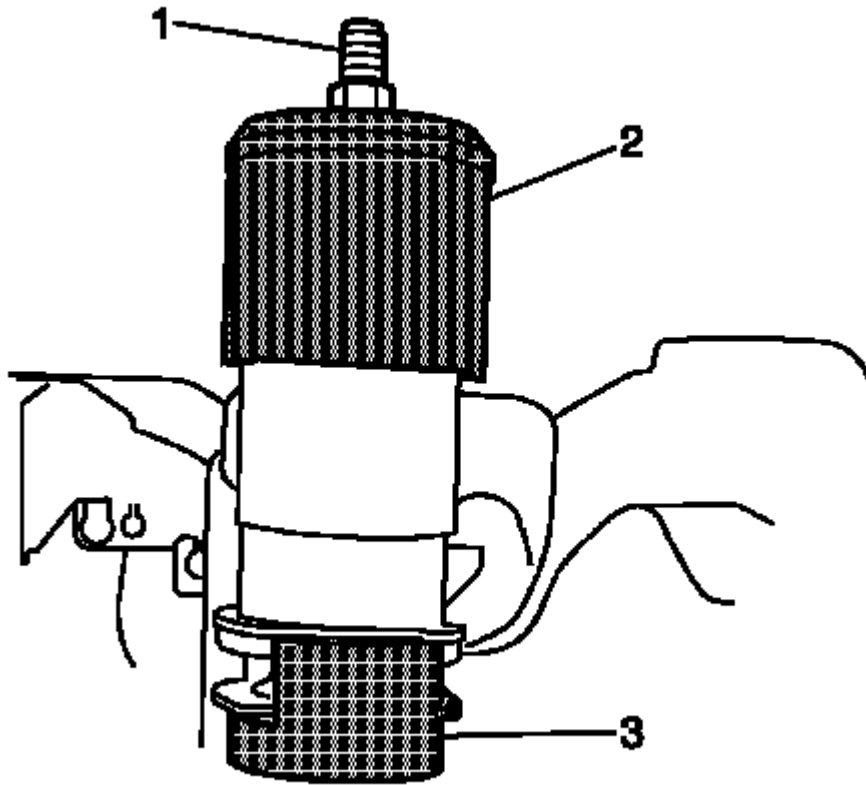


Fig. 33: Removing/Installing Bushings
Courtesy of GENERAL MOTORS COMPANY

2. Install the bushings using **J-45296-1** remover and installer and **J-45725-2** replacer (2).
3. Install the frame to the body. Refer to **Drivetrain and Front Suspension Frame Replacement**.

FRONT WHEELHOUSE FRONT LINER REPLACEMENT

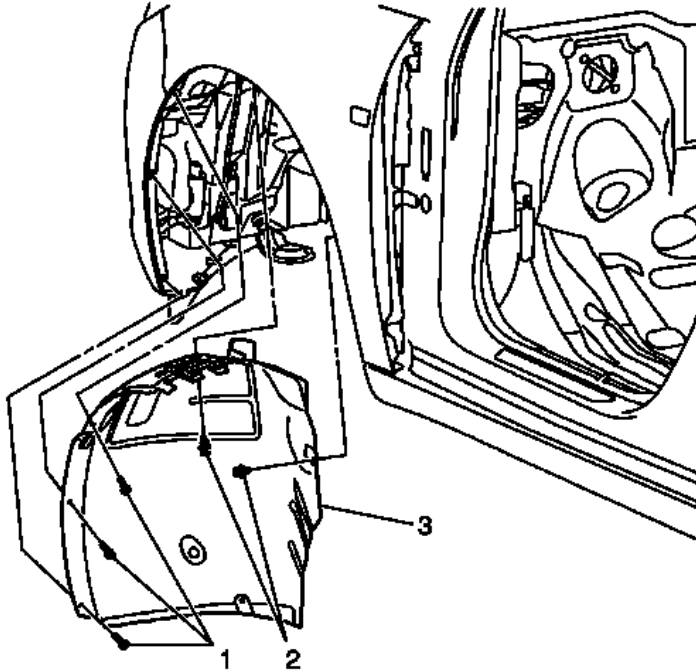


Fig. 34: Front Wheelhouse Front Liner & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Front Wheelhouse Front Liner Replacement

Callout	Component Name
Preliminary Procedure Remove the tire and wheel. Refer to <u>Tire and Wheel Removal and Installation</u> .	
1	Front Wheelhouse Front Liner Fastener (Qty: 3)
2	Front Wheelhouse Front Liner Retainer (Qty: 4) Procedure Use a BO-569-A lifter to aid in the removal of the front wheelhouse front liner. Special Tools BO-569-A Plug Lifter For equivalent regional tools, refer to <u>Special Tools</u> .
3	Front Wheelhouse Front Liner

FRONT WHEELHOUSE REAR LINER REPLACEMENT

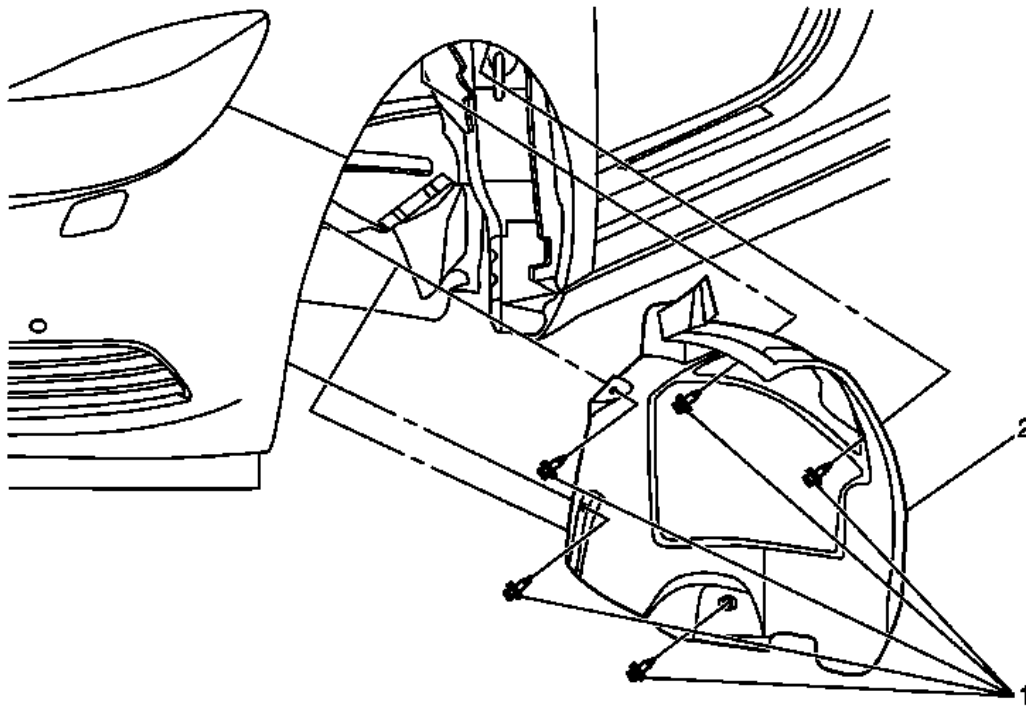


Fig. 35: Front Wheelhouse Rear Liner & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Front Wheelhouse Rear Liner Replacement

Callout	Component Name
Preliminary Procedure Remove the tire and wheel. Refer to <u>Tire and Wheel Removal and Installation</u> .	
1	Front Wheelhouse Rear Liner Retainer (Qty: 5) Procedure Use a BO-569-A lifter to aid in the removal of the front wheelhouse rear liner. Special Tools BO-569-A Plug Lifter For equivalent regional tools, refer to <u>Special Tools</u> .
2	Front Wheelhouse Rear Liner

REAR WHEELHOUSE LINER REPLACEMENT

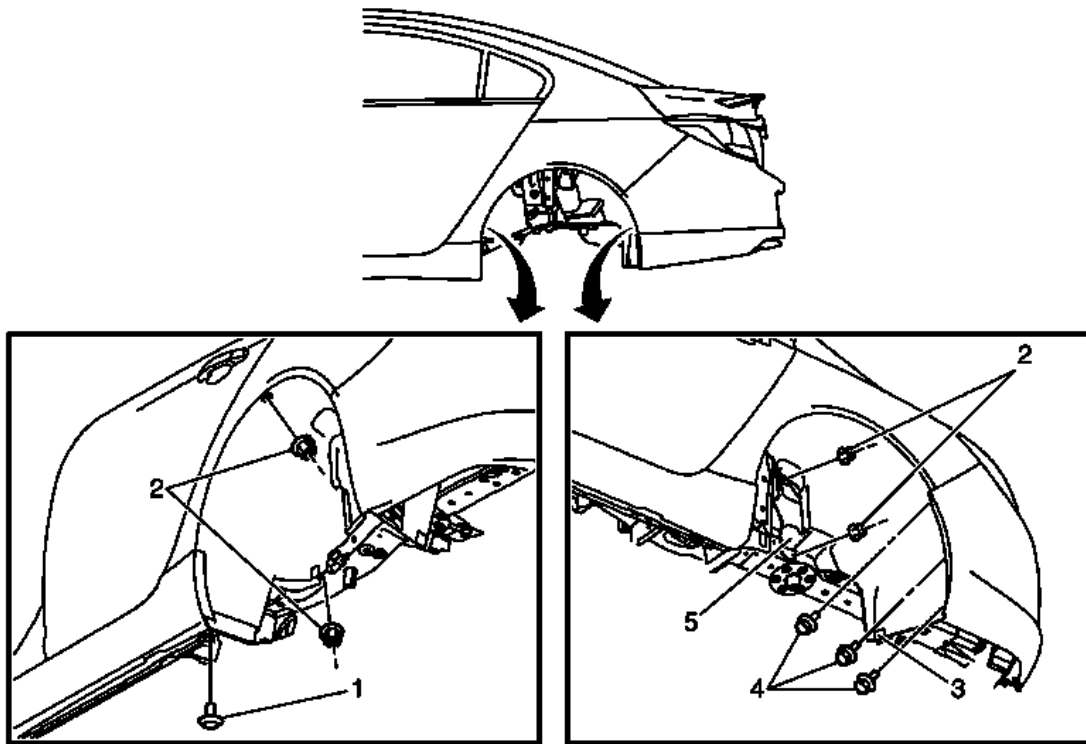


Fig. 36: Rear Wheelhouse Panel Liner & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

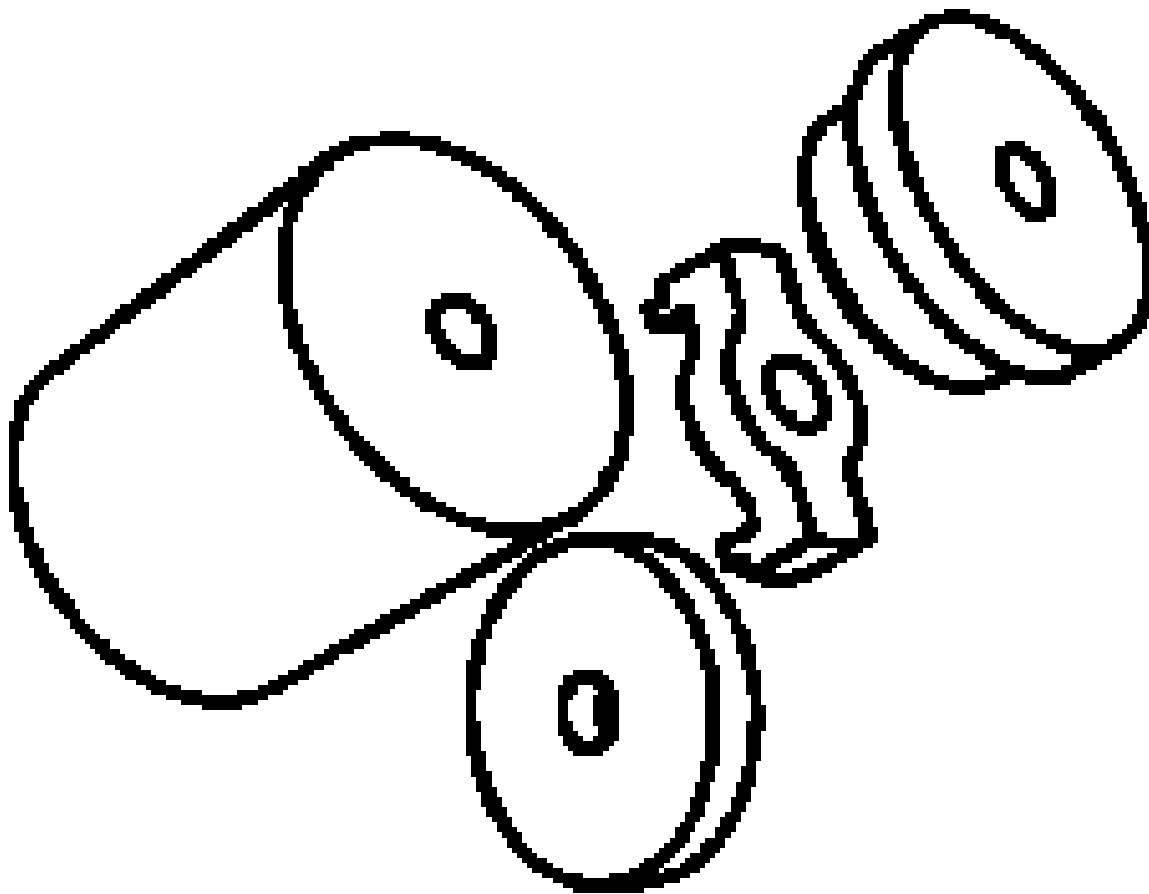
Rear Wheelhouse Liner Replacement

Callout	Component Name
Preliminary Procedure	
Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> .	
1	Rear Wheelhouse Liner Panel Retainer
2	Rear Wheelhouse Liner Panel Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .
3	Rear Wheelhouse Liner Panel Retainer
4	Rear Wheelhouse Liner Panel Fastener (Qty: 3)
5	Rear Wheelhouse Liner Panel

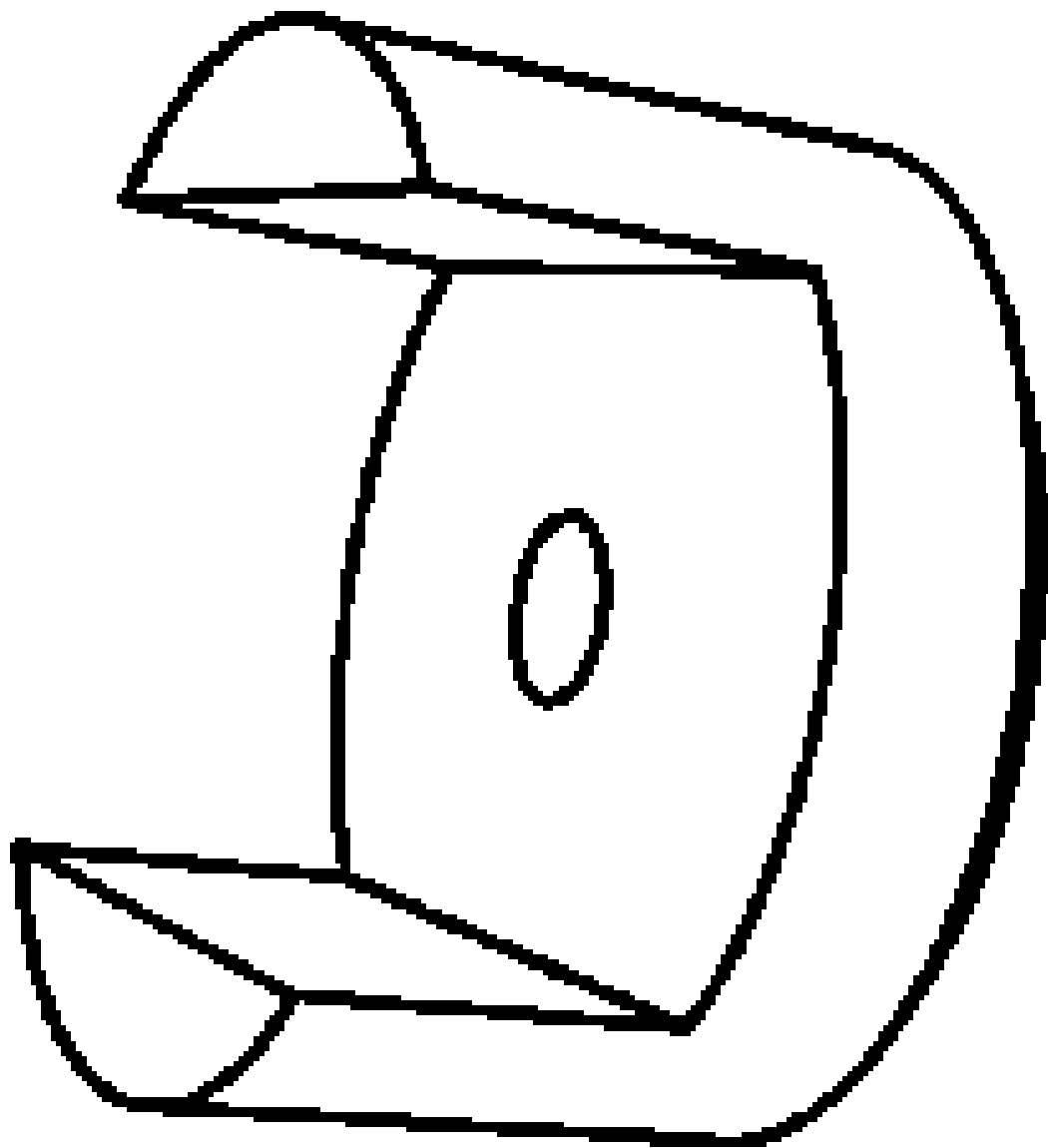
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

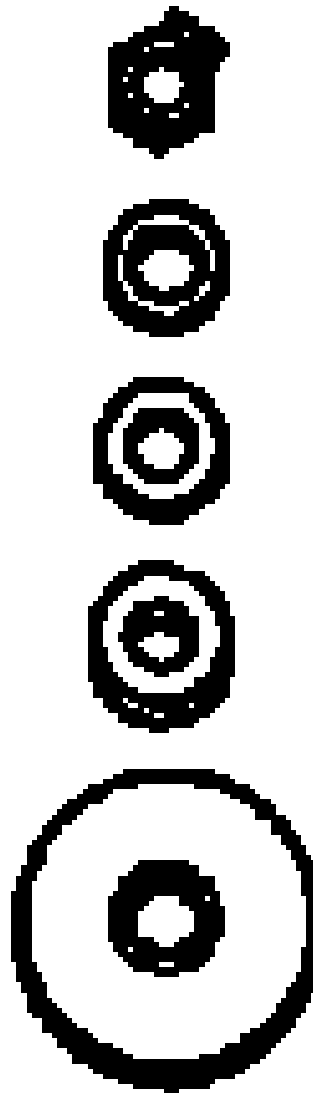
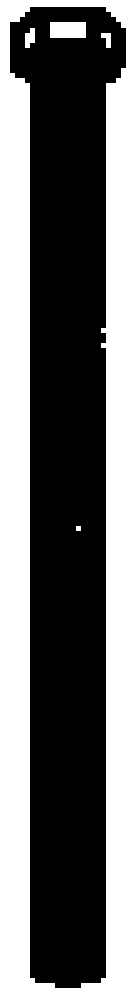
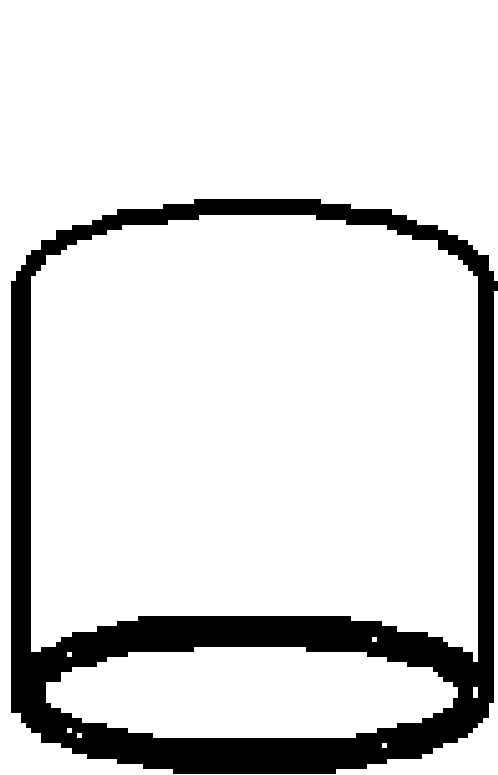
Illustration	Tool Number/ Description



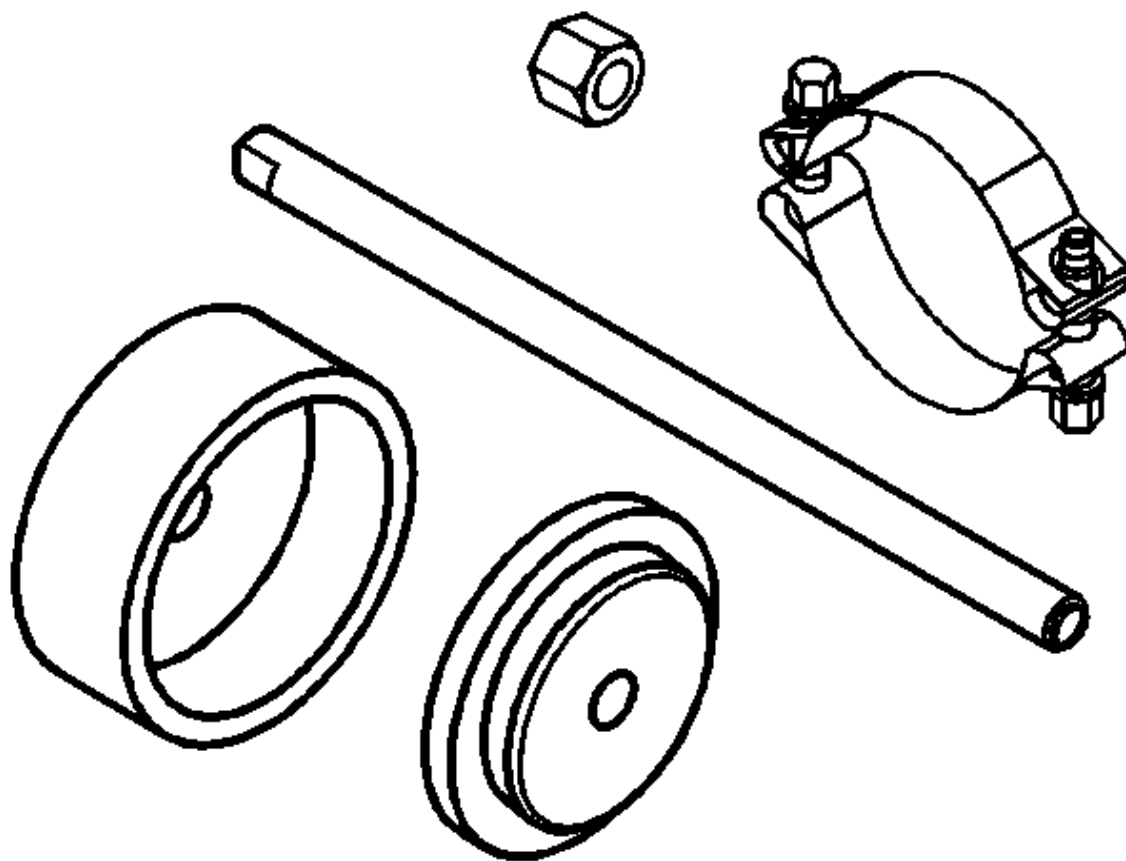
CH-49158
RDM
Bushing
Removal
Tool



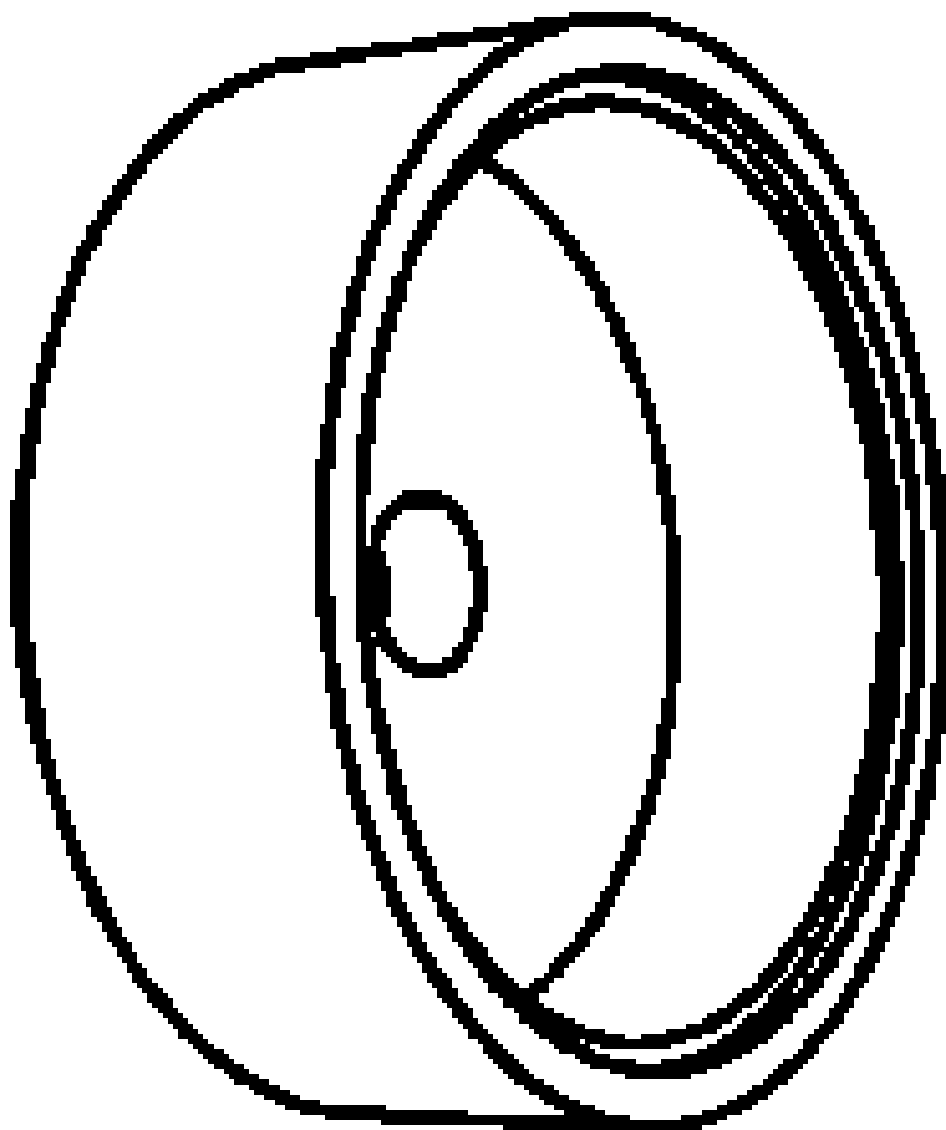
CH-49233
Bushing
Tool



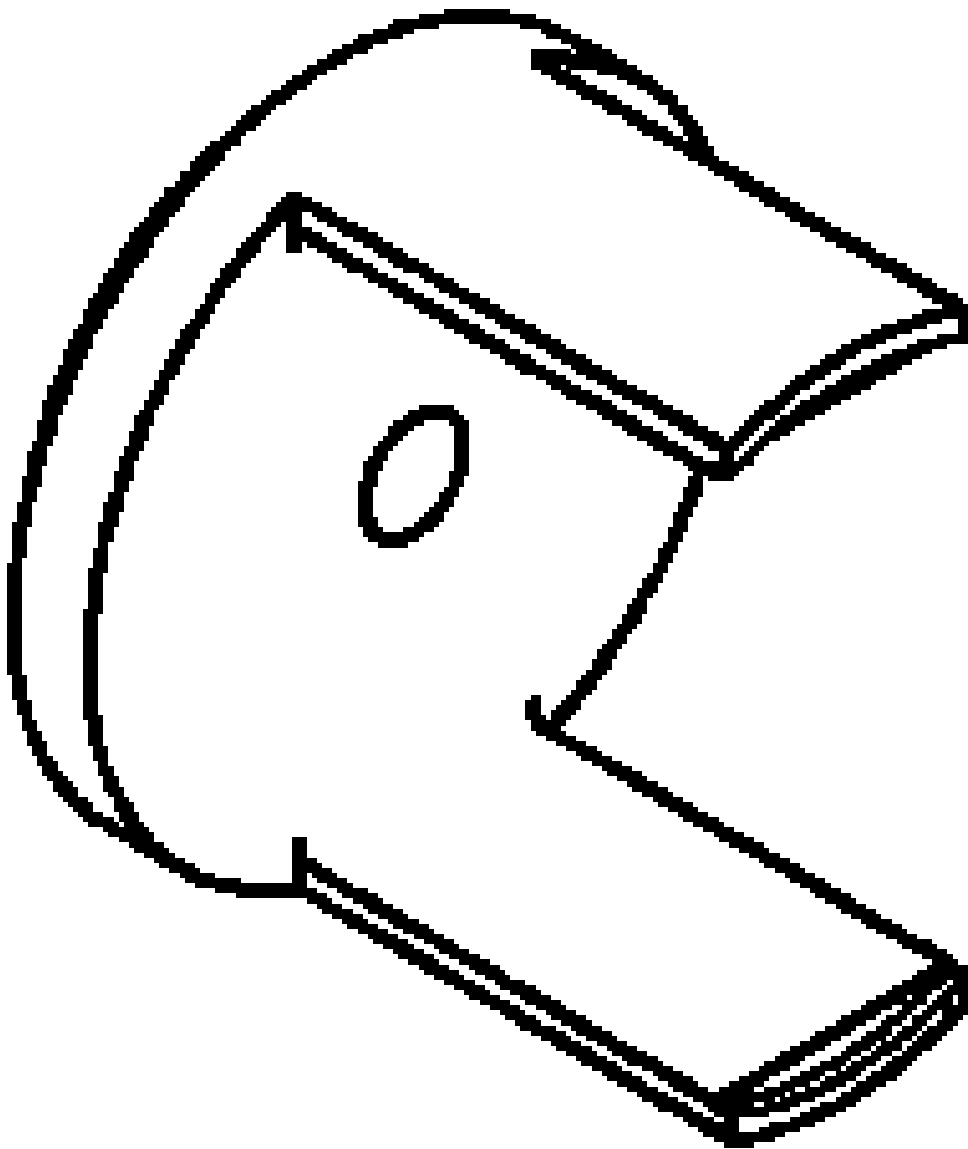
J-45296-1
Frame
Insulator
Remover
and
Installer



J-45725-2
Bushings
Replacer



CH-50196
Bushings
Installer



DT-49126
Kit,
Bushings
Replacer
Hardware

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Front of Vehicle/Engine Compartment Component Views

FRONT OF VEHICLE/ENGINE COMPARTMENT COMPONENT VIEWS

FRONT OF VEHICLE COMPONENTS

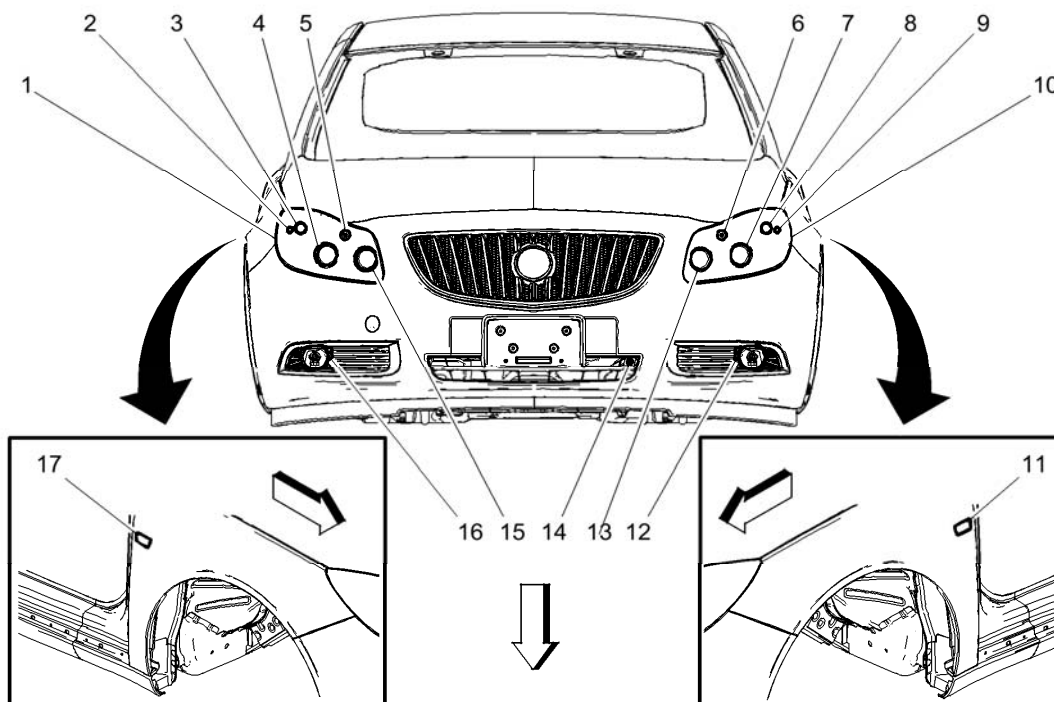


Fig. 1: Front Of Vehicle Components
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: E13R Headlamp - Right
- 2: E2RF Side Marker Lamp - Right Front E2RF Side Marker Lamp - Right Front (T4A)
- 3: E4P Park/Turn Signal Lamp - Right (T4A) E4P Park/Turn Signal Lamp - Right (T4A)
- 4: E4H Headlamp - Right Low Beam E4H Headlamp - Right Low Beam (T4A) E4H Headlamp - Right Low Beam (T4F)
- 5: E4RF Turn Signal Lamp - Right Front
- 6: E4LF Turn Signal Lamp - Left Front
- 7: E4G Headlamp - Left Low Beam E4G Headlamp - Left Low Beam (T4A) E4G Headlamp - Left Low Beam (T4F)
- 8: E4N Park/Turn Signal Lamp - Left (T4A) E4N Park/Turn Signal Lamp - Left (T4A)
- 9: E2LF Side Marker Lamp - Left Front E2LF Side Marker Lamp - Left Front (T4A)

- 10: E13L Headlamp - Left
 11: E4Y Turn Signal Repeater Lamp - Left
 12: E29LF Fog Lamp - Left Front E29LF Fog Lamp - Left Front CZ2 E29LF Fog Lamp - Left Front T3U except CZ2
 13: E4E Headlamp - Left High Beam (T4A) E4E Headlamp - Left High Beam (T4A)
 14: B9 Ambient Air Temperature Sensor B9 Ambient Air Temperature Sensor
 15: E4F Headlamp - Right High Beam (T4A) E4F Headlamp - Right High Beam (T4A)
 16: E29RF Fog Lamp - Right Front E29RF Fog Lamp - Right Front CZ2 E29RF Fog Lamp - Right Front T3U except CZ2
 17: E4Z Turn Signal Repeater Lamp - Right

HEADLAMP COMPONENTS (T4F)

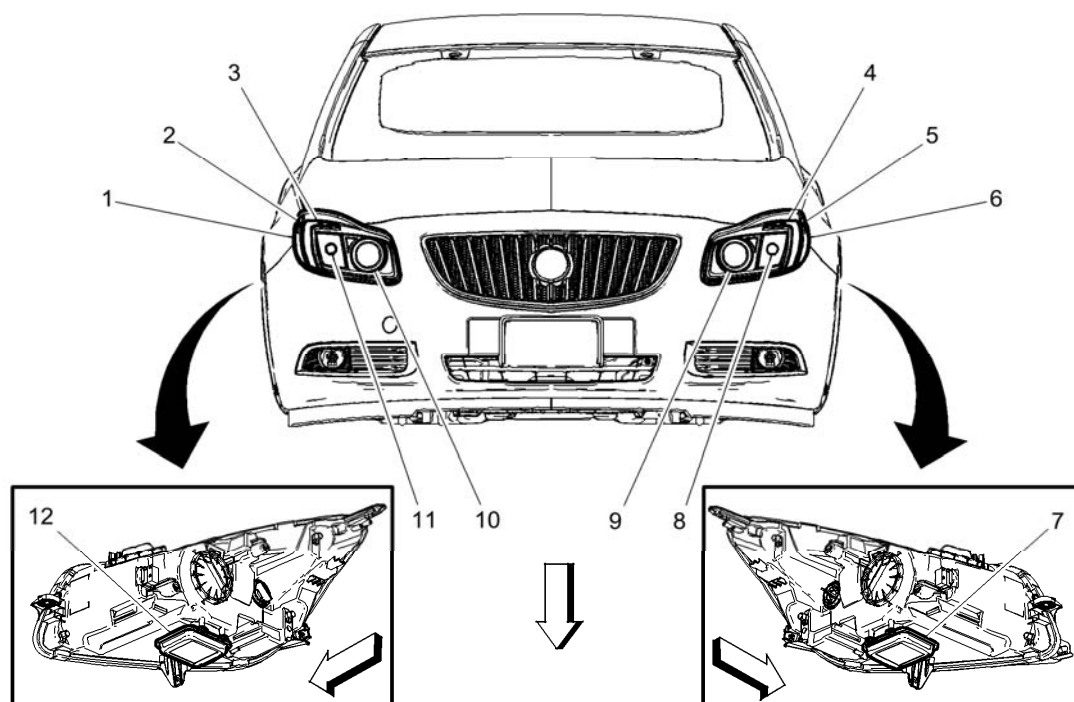


Fig. 2: Headlamp Components (T4F)
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1: E13R Headlamp - Right
 2: E2RF Side Marker Lamp - Right Front E2RF Side Marker Lamp - Right Front (T4A)
 3: E4K Park Lamp - Right Front (T4F)
 4: E4J Park Lamp - Left Front (T4F)
 5: E2LF Side Marker Lamp - Left Front E2LF Side Marker Lamp - Left Front (T4A)
 6: E13L Headlamp - Left
 7: T7L Headlamp Ballast - Left (T4F) T7L Headlamp Ballast - Left (T4F)

- 8: E4LF Turn Signal Lamp - Left Front
 9: E4G Headlamp - Left Low Beam **E4G Headlamp - Left Low Beam (T4A)** **E4G Headlamp - Left Low Beam (T4F)**
 10: E4H Headlamp - Right Low Beam **E4H Headlamp - Right Low Beam (T4A)** **E4H Headlamp - Right Low Beam (T4F)**
 11: E4RF Turn Signal Lamp - Right Front
 12: T7R Headlamp Ballast - Right (T4F) **T7R Headlamp Ballast - Right (T4F)**

RADIATOR SUPPORT COMPONENTS

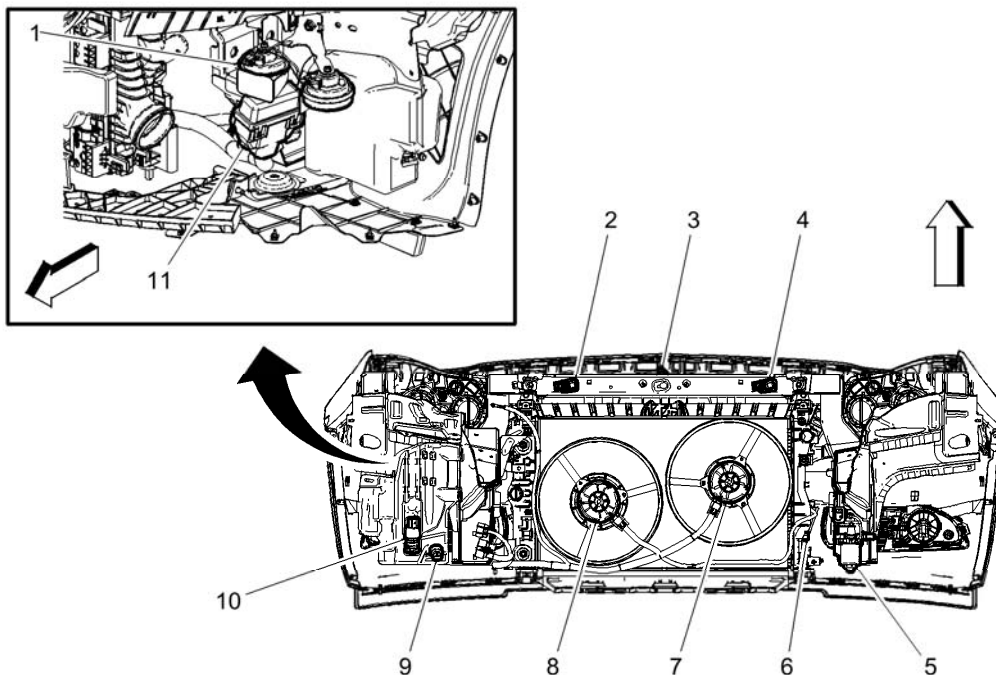


Fig. 3: Radiator Support Components
 Courtesy of GENERAL MOTORS COMPANY

Items
1: P13 Horn Assembly <u>P13 Horn Assembly</u>
2: B59L Front Impact Sensor - Left (except CZ2) <u>B59L Front Impact Sensor - Left except CZ2</u>
3: B55 Hood Ajar Switch <u>B55 Hood Ajar Switch</u>
4: B59R Front Impact Sensor - Right (except CZ2) <u>B59R Front Impact Sensor - Right except CZ2</u>
5: KR14 Brake Booster Pump Motor Relay <u>KR14 Brake Booster Pump Motor Relay X1</u> <u>(LUK/LAF/LTD) KR14 Brake Booster Pump Motor Relay X2</u>
6: B1 A/C Refrigerant Pressure Sensor <u>B1 A/C Refrigerant Pressure Sensor</u>
7: G10R Cooling Fan Motor - Right (LUK/ LHU/ LDK) <u>G10R Cooling Fan Motor - Right LHU/LDK</u> <u>G10R Cooling Fan Motor - Right LUK</u>
8: G10L Cooling Fan Motor - Left (LHU/LDK) <u>G10L Cooling Fan Motor - Left LHU</u> <u>G10L Cooling</u>

Fan Motor - Left LUK

9: B118B Windshield Washer Fluid Level Switch **B118B Windshield Washer Fluid Level Switch**

10: G24 Windshield Washer Pump **G24 Windshield Washer Pump**

11: X70A Relay Block - Underhood

ENGINE COOLING FAN COMPONENTS (LHU)

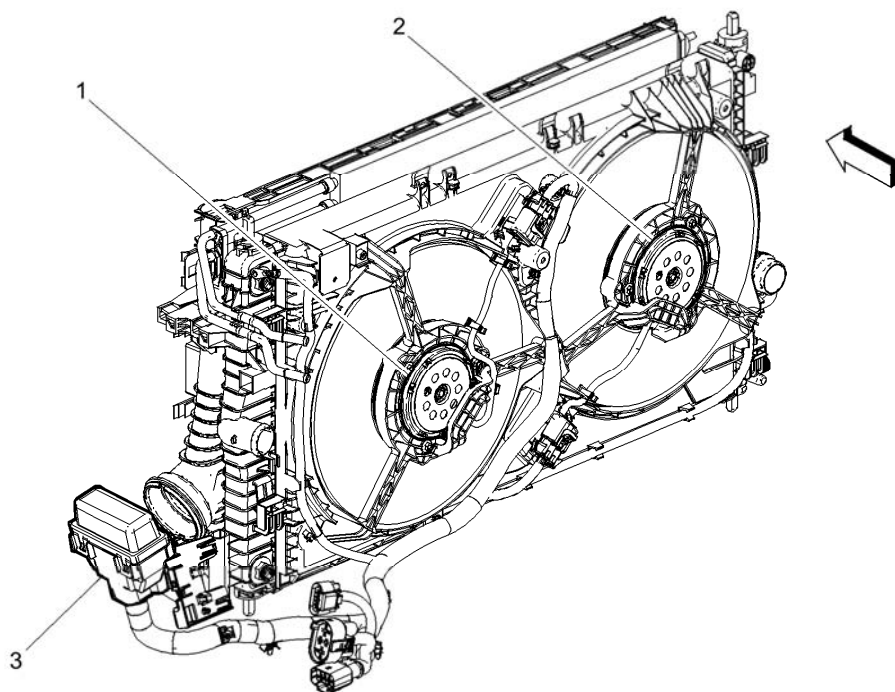


Fig. 4: Engine Cooling Fan Components (LHU)

Courtesy of GENERAL MOTORS COMPANY

Items

1: G10L Cooling Fan Motor - Left (LHU/LDK) **G10L Cooling Fan Motor - Left LHU** **G10L Cooling Fan Motor - Left LUK**

2: G10R Cooling Fan Motor - Right (LUK/ LHU/ LDK) **G10R Cooling Fan Motor - Right LHU/LDK** **G10R Cooling Fan Motor - Right LUK**

3: X70A Relay Block - Underhood

LEFT SIDE OF ENGINE COMPARTMENT COMPONENTS

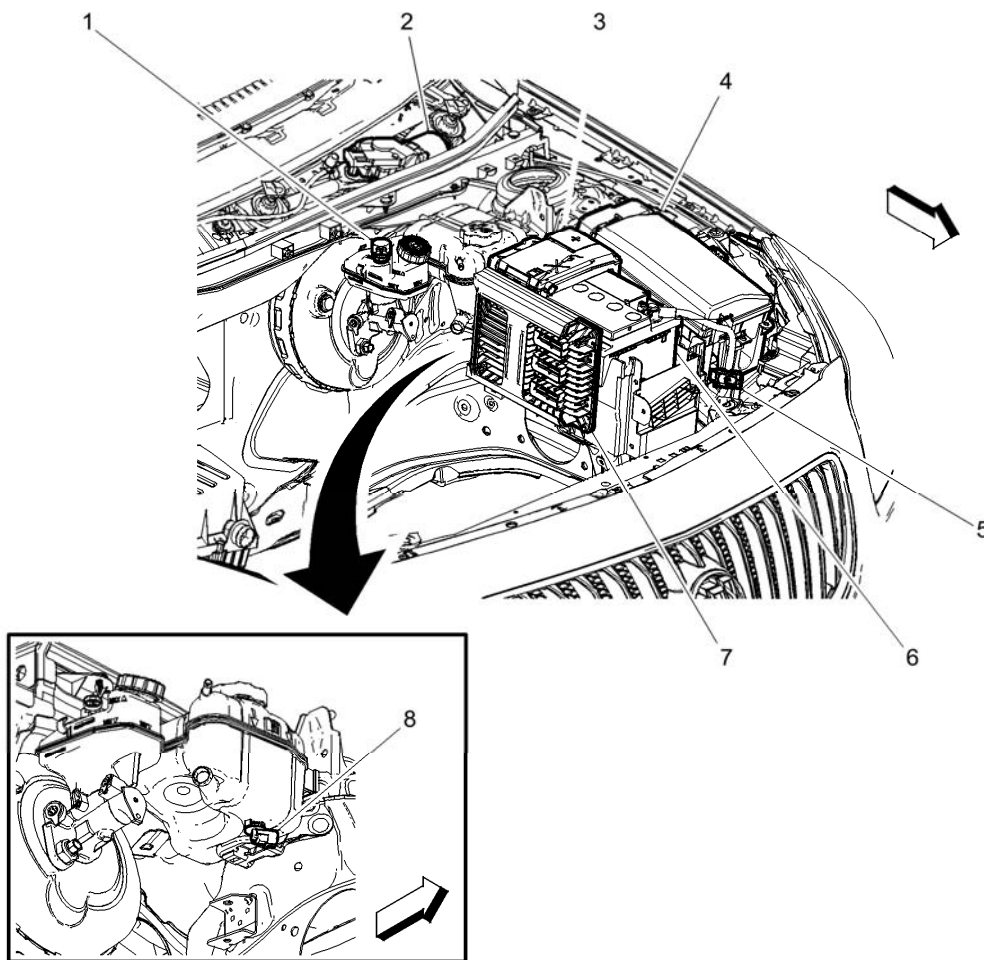


Fig. 5: Left Side Of Engine Compartment Components
 Courtesy of GENERAL MOTORS COMPANY

Items
1: M75 Windshield Wiper Motor <u>M75 Windshield Wiper Motor</u>
2: B20 Brake Fluid Level Switch <u>B20 Brake Fluid Level Switch</u>
3: X50D Fuse Block - Battery <u>X50D Fuse Block - Battery X1 X50D Fuse Block - Battery X2 X50D Fuse Block - Battery X5 X50D Fuse Block - Battery X6 (CZ2) X50D Fuse Block - Battery X6 (except CZ2) X50D Fuse Block - Battery X7 (CZ2) X50D Fuse Block - Battery X7 (except CZ2)</u>
4: X50A Fuse Block - Underhood <u>X50A Fuse Block - Underhood X1 (CZ2) X50A Fuse Block - Underhood X1 (except CZ2) X50A Fuse Block - Underhood X2 (CZ2) X50A Fuse Block - Underhood X2 (except CZ2) X50A Fuse Block - Underhood X3 (LDK) X50A Fuse Block - Underhood X3 (LHU) X50A Fuse Block - Underhood X3 (LLU) X50A Fuse Block - Underhood X3 (LTD) X50A Fuse Block - Underhood X3 (LUK) X50A Fuse Block - Underhood X4 X50A Fuse Block - Underhood X5 (HP6) X50A Fuse Block - Underhood X6 (NJ1)</u>
5: B18 Battery Current Sensor <u>B18 Battery Current Sensor</u>
6: C1 Battery <u>C1 Battery (+) C1 Battery (-) (Battery Negative Cable) C1 Battery (-) (Body Harness)</u>
7: K20 Engine Control Module <u>K20 Engine Control Module X1 (LAF) K20 Engine Control Module</u>

X1 (LDK) K20 Engine Control Module X1 (LHU) K20 Engine Control Module X1 (LLU) K20 Engine Control Module X1 (LTD) K20 Engine Control Module X1 (LUK) K20 Engine Control Module X2 (LHU) K20 Engine Control Module X2 (LLU) K20 Engine Control Module X2 (LTD) K20 Engine Control Module X2 (LUK with NU6) K20 Engine Control Module X2 (LUK without NU6) K20 Engine Control Module X2 LAF K20 Engine Control Module X2 LDK K20 Engine Control Module X3 (LAF) K20 Engine Control Module X3 (LDK) K20 Engine Control Module X3 (LHU) K20 Engine Control Module X3 (LUK)

8: B33 Engine Coolant Level Switch

RIGHT SIDE OF ENGINE COMPARTMENT COMPONENTS

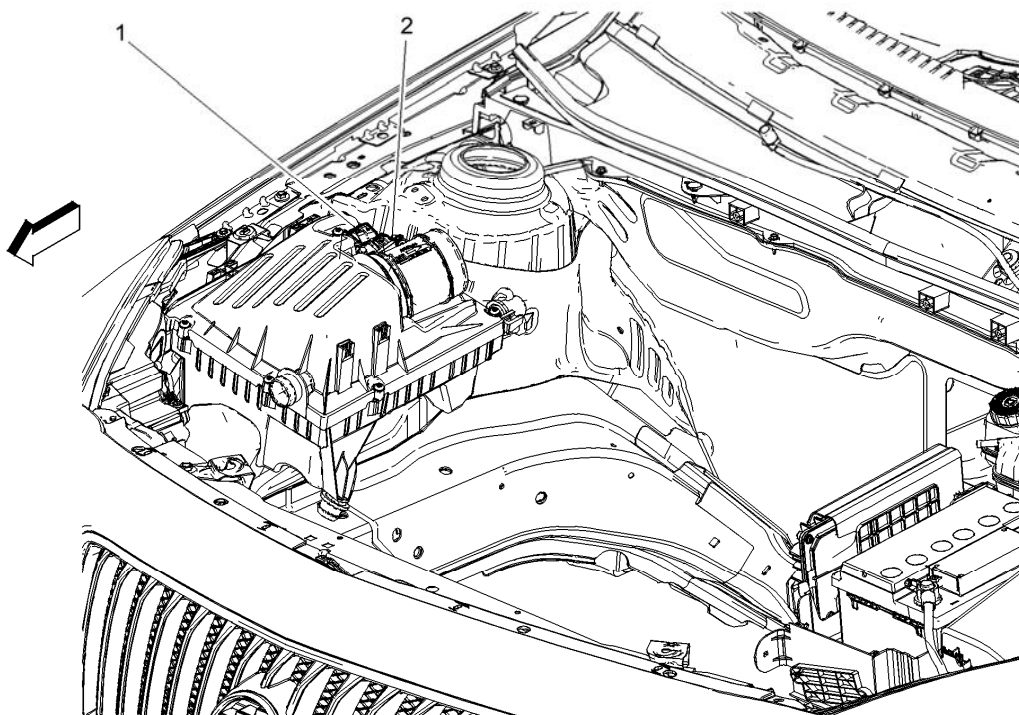


Fig. 6: Right Side Of Engine Compartment Components

Courtesy of GENERAL MOTORS COMPANY

Items

1: B17 Barometric Pressure Sensor **B17 Barometric Pressure Sensor (LDK)**

2: B75B Mass Air Flow/Intake Air Temperature Sensor (LUK/ LTD/ LLU) **B75B Mass Air Flow/Intake Air Temperature Sensor LUK/LTD**

Suspension

Front Suspension

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Lower Control Arm Front Bolt (GNA, GNB) (1)		
• First Pass	100 N.m	74 lb ft
• Final Pass	Plus 90 Degrees	
Front Lower Control Arm Rear Bolt (GNA, GNB) (1)		
• First Pass	100 N.m	74 lb ft
• Final Pass	Plus 90 Degrees	
Front Lower Control Arm Rear Bushing Bolt (GNA, GNB) (1)		
• First Pass	55 N.m	41 lb ft
• Final Pass	Plus 100 Degrees	
Front Suspension Strut Mount Nut (GNA, GNB)	55 N.m	41 lb ft
Front Suspension Strut Nut (GNA, GNB)	70 N.m	52 lb ft
Front Suspension Strut Yoke Nut (GNB)	70 N.m	52 lb ft
Front Wheel Bearing and Hub Assembly Bolt (GNA) (1)		
• First Pass	100 N.m	74 lb ft
• Final Pass	Plus 75 Degrees	
Front Wheel Bearing and Hub Assembly Bolt (GNB) (1)		
• First Pass	100 N.m	74 lb ft
• Final Pass	Plus 60 Degrees	
Stabilizer Shaft Insulator Clamp Bolt (GNA, GNB) (1)		
• First Pass	22 N.m	16 lb ft
• Final Pass	Plus 30 Degrees	
Stabilizer Shaft Link Nut (GNA, GNB)	65 N.m	48 lb ft
Steering Knuckle Camber Adjust Nut (Lower Nut) (GNB)		
• First Pass	115 N.m	85 lb ft
• Final Pass	Plus 45 Degrees	
Steering Knuckle Camber Adjust Nut (Upper Nut) (GNB)		
• First Pass	70 N.m	52 lb ft

• Final Pass	Plus 60 Degrees	
Steering Knuckle King Pin Bushing Nut (GNB)	70 N.m	52 lb ft
Steering Knuckle Nut (at Lower Control Arm) (GNA)		
• First Pass	50 N.m	37 lb ft
• Second Pass	Loosen 120 Degrees	
• Third Pass	50 N.m	37 lb ft
• Final Pass	Plus 45 Degrees	
Steering Knuckle Nut (at Lower Control Arm) (GNB) (1)		
• First Pass	115 N.m	85 lb ft
• Final Pass	Plus 120 Degrees	
Steering Knuckle Nut (at Steering Knuckle Upper Ball Stud) (GNB)		
• First Pass	45 N.m	33 lb ft
• Final Pass	Plus 45 Degrees	
Steering Knuckle Nut (at Strut Assembly) (GNA) (1)		
• First Pass	85 N.m	63 lb ft
• Final Pass	Plus 60 Degrees	
1. Use NEW fastener.		

REPAIR INSTRUCTIONS

STABILIZER SHAFT REPLACEMENT (GNA, GNB)

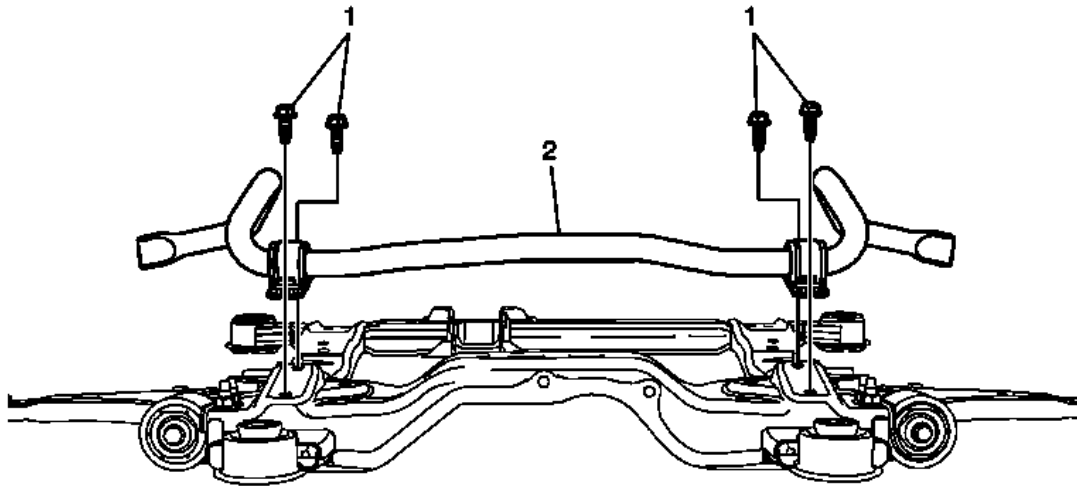


Fig. 1: Stabilizer Shaft & Clamp Bolts (GNA, GNB)
 Courtesy of GENERAL MOTORS COMPANY

Stabilizer Shaft Replacement (GNA, GNB)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Disconnect the stabilizer shaft links from the stabilizer shaft. Refer to <u>Stabilizer Shaft Link Replacement (GNA, GNB)</u>. 4. Lower the rear of the drivetrain and front suspension frame to gain enough clearance to remove the stabilizer shaft. Refer to <u>Drivetrain and Front Suspension Frame Replacement</u> . 	
1	Stabilizer Shaft Insulator Clamp Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

	Procedure Remove and discard the bolts. DO NOT reuse, replace with NEW only. Tighten 22 N.m (16 lb ft) + 30 degrees
2	Stabilizer Shaft

STABILIZER SHAFT LINK REPLACEMENT (GNA, GNB)

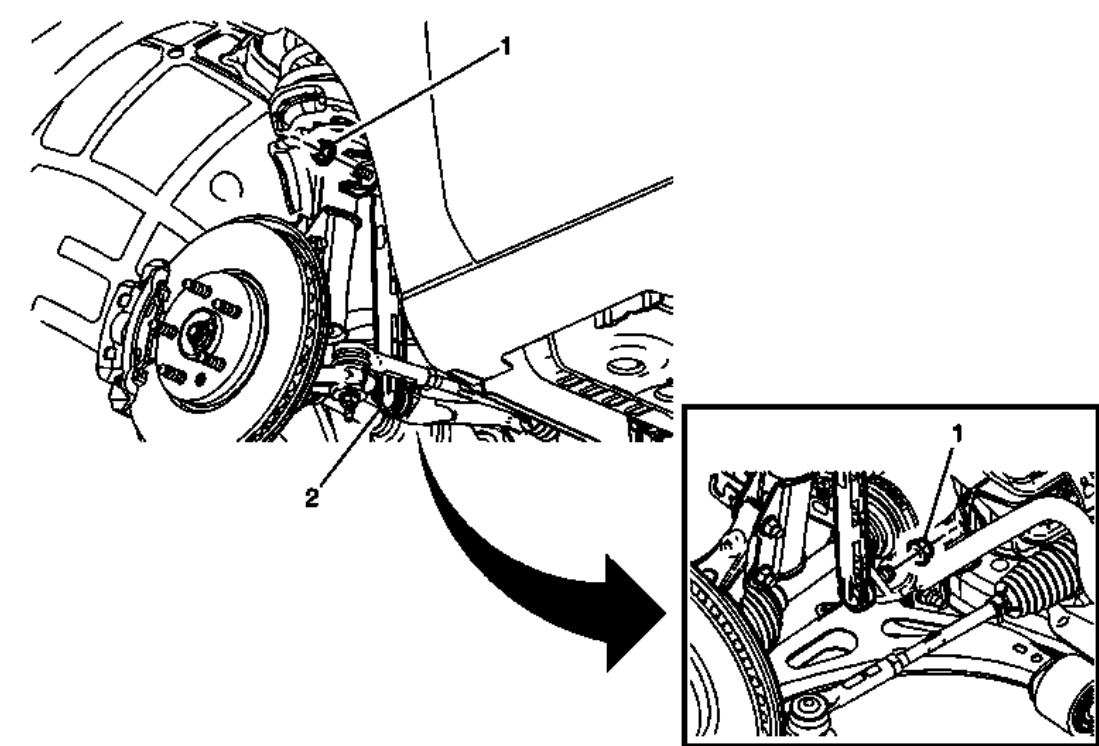


Fig. 2: Stabilizer Shaft Link (GNA, GNB)
 Courtesy of GENERAL MOTORS COMPANY

Stabilizer Shaft Link Replacement (GNA, GNB)

Callout	Component Name
Preliminary Procedure	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Disconnect any harnesses or retainers secured to the stabilizer shaft link. Note any attaching points to aid in installation.	
1	Stabilizer Shaft Link Nut (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 65 N.m (48 lb ft)
2	Stabilizer Shaft Link

STABILIZER SHAFT INSULATOR REPLACEMENT

The stabilizer shaft insulator is not serviced separately, but with the stabilizer shaft. For the stabilizer shaft replacement, refer to **Stabilizer Shaft Replacement (GNA, GNB)**.

FRONT WHEEL BEARING AND HUB REPLACEMENT (GNB)

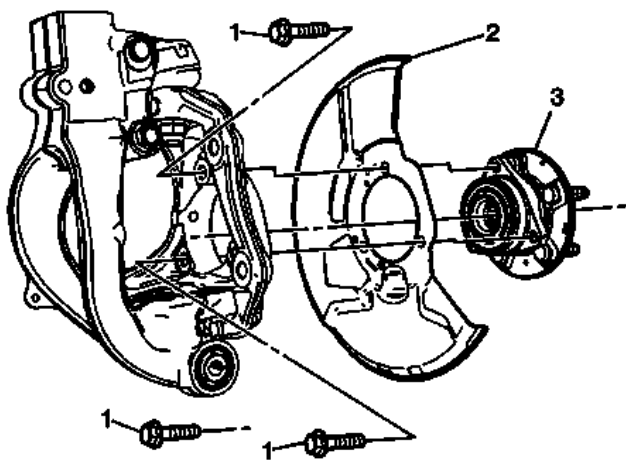


Fig. 3: Front Wheel Bearing And Hub Assembly, Front Brake Shield & Bolts (GNB)
 Courtesy of GENERAL MOTORS COMPANY

Front Wheel Bearing and Hub Replacement (GNB)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the front suspension strut yoke. Refer to <u>Front Suspension Strut Yoke Replacement (GNB)</u>. 	
1	Front Wheel Bearing and Hub Assembly Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or

	component. Procedure Remove and discard the bolts. DO NOT re-use, replace with NEW only. Tighten 100 N.m (74 lb ft) + 60 degrees
2	Front Brake Shield
3	Front Wheel Bearing and Hub Assembly

FRONT WHEEL BEARING AND HUB REPLACEMENT (GNA)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Disconnect the front wheel drive shaft from the front wheel bearing and hub assembly. Refer to **Front Wheel Drive Shaft Replacement - Left Side** , or **Front Wheel Drive Shaft Replacement - Right Side** .
4. Remove the front brake rotor. Refer to **Front Brake Rotor Replacement (J60, J61)** , **Front Brake Rotor Replacement (J64)** .
5. Remove the front wheel speed sensor. Refer to **Front Wheel Speed Sensor Replacement (Without F45)** , **Front Wheel Speed Sensor Replacement (With F45)** .

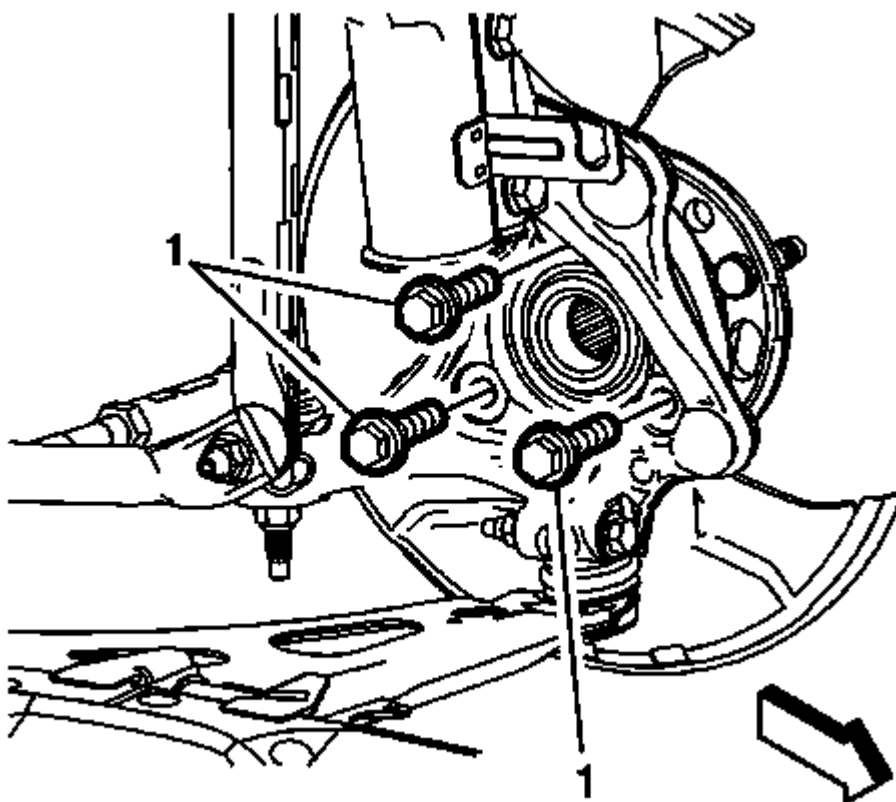


Fig. 4: Front Wheel Bearing And Hub Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Remove the front wheel bearing and hub assembly bolts (1).

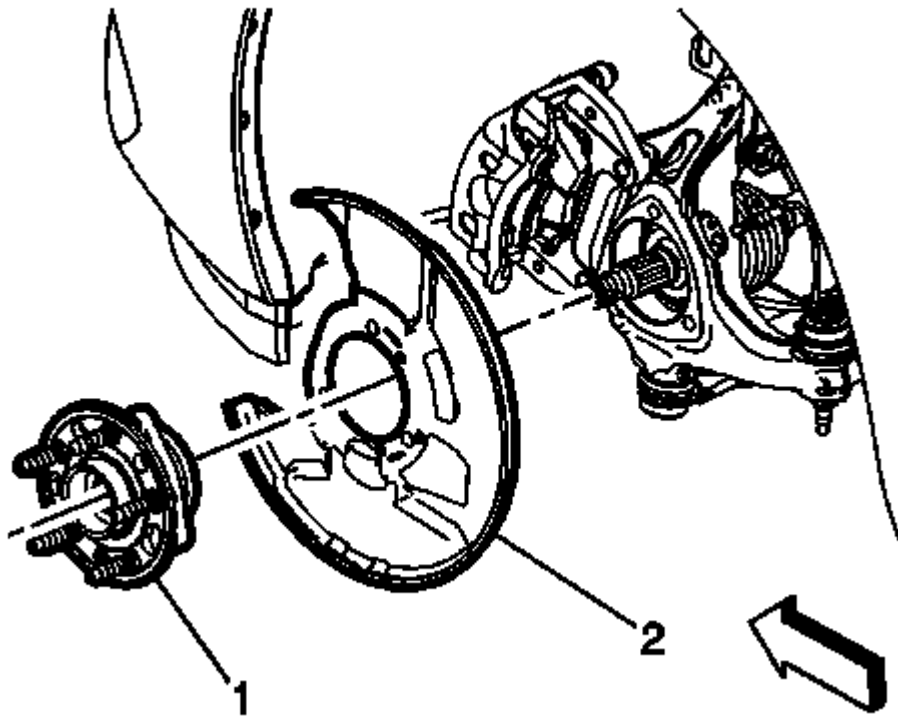


Fig. 5: Front Wheel Bearing And Hub Assembly And Front Brake Shield
Courtesy of GENERAL MOTORS COMPANY

7. Remove the front wheel bearing and hub assembly (1) and front brake shield (2) from the steering knuckle.

Installation Procedure

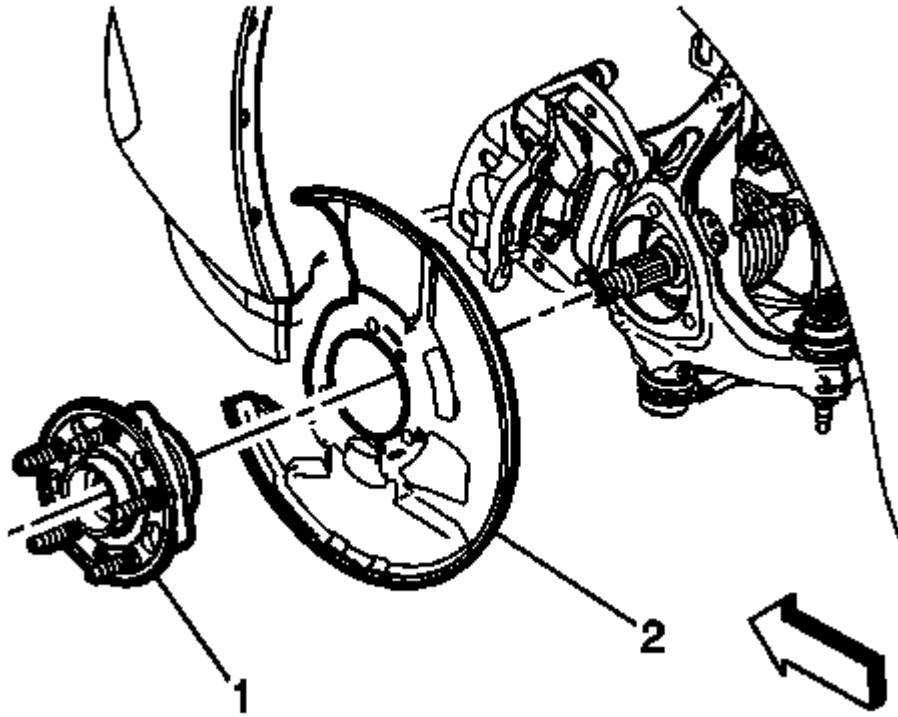


Fig. 6: Front Wheel Bearing And Hub Assembly And Front Brake Shield
Courtesy of GENERAL MOTORS COMPANY

1. Position the front brake shield (2) and wheel bearing and hub assembly (1) on the steering knuckle.

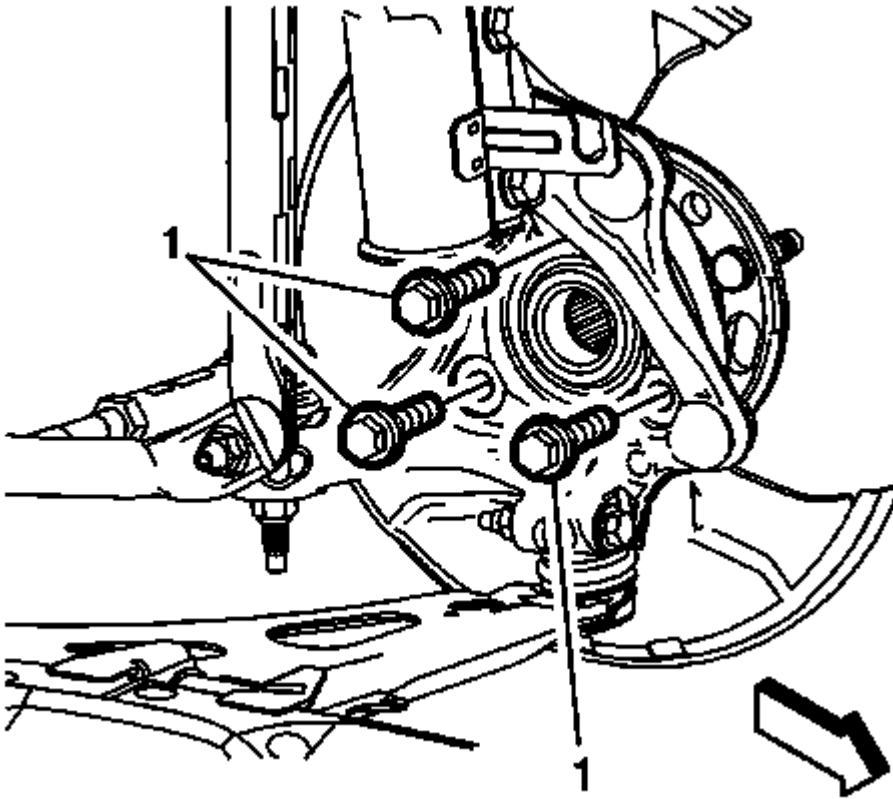


Fig. 7: Front Wheel Bearing And Hub Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the front wheel bearing and hub assembly bolts (1) and tighten to 100 N.m (74 lb ft) + 75 degrees.
3. Install the front wheel speed sensor. Refer to Front Wheel Speed Sensor Replacement (Without F45) , Front Wheel Speed Sensor Replacement (With F45) .
4. Install the front brake rotor. Refer to Front Brake Rotor Replacement (J60, J61) , Front Brake Rotor Replacement (J64) .
5. Connect the front wheel drive shaft to the front wheel bearing and hub assembly. Refer to Front Wheel Drive Shaft Replacement - Left Side , or Front Wheel Drive Shaft Replacement - Right Side .
6. Install the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .

STEERING KNUCKLE REPLACEMENT (GNA)

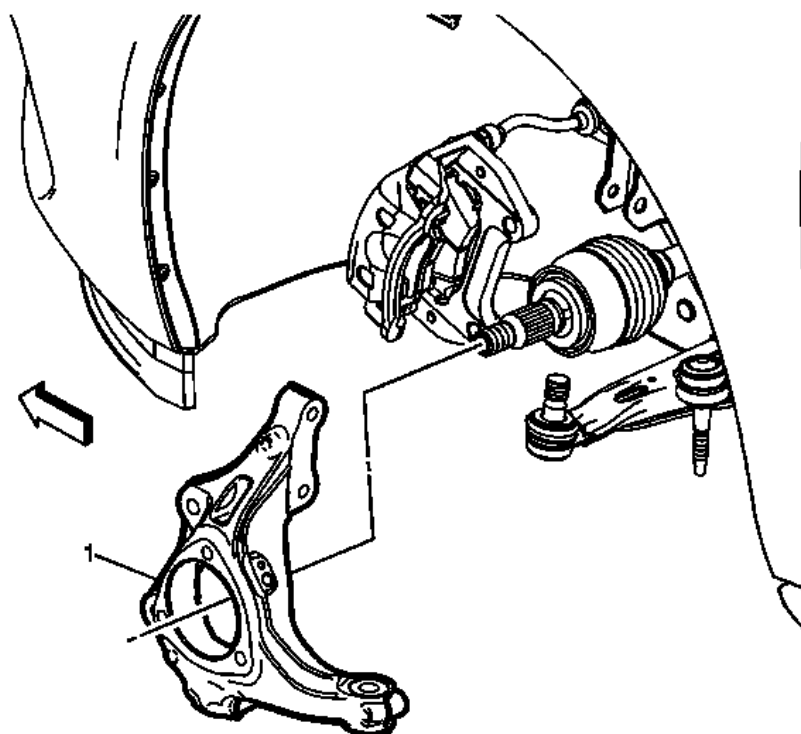


Fig. 8: Steering Knuckle (GNA)

Courtesy of GENERAL MOTORS COMPANY

Steering Knuckle Replacement (GNA)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Remove the front wheel bearing and hub assembly. Refer to <u>Front Wheel Bearing and Hub Replacement (GNA)</u>. 	
1	Steering Knuckle CAUTION: Do not pry in such a way that the ball joint seal is contacted. Damage to the seal may result. <ol style="list-style-type: none"> 1. Disconnect the steering linkage outer tie rod from the steering knuckle. Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> . 2. Disconnect the strut assembly from the steering knuckle. Refer to <u>Strut Assembly Removal and Installation (GNA)</u>. 3. Disconnect the lower control arm from the steering knuckle. Refer to <u>Lower Control Arm Replacement (GNA)</u>.

STEERING KNUCKLE REPLACEMENT (GNB)

Removal Procedure

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front suspension strut yoke. Refer to Front Suspension Strut Yoke Replacement (GNB).
3. Remove the front wheel bearing and hub assembly. Refer to Front Wheel Bearing and Hub Replacement (GNB).

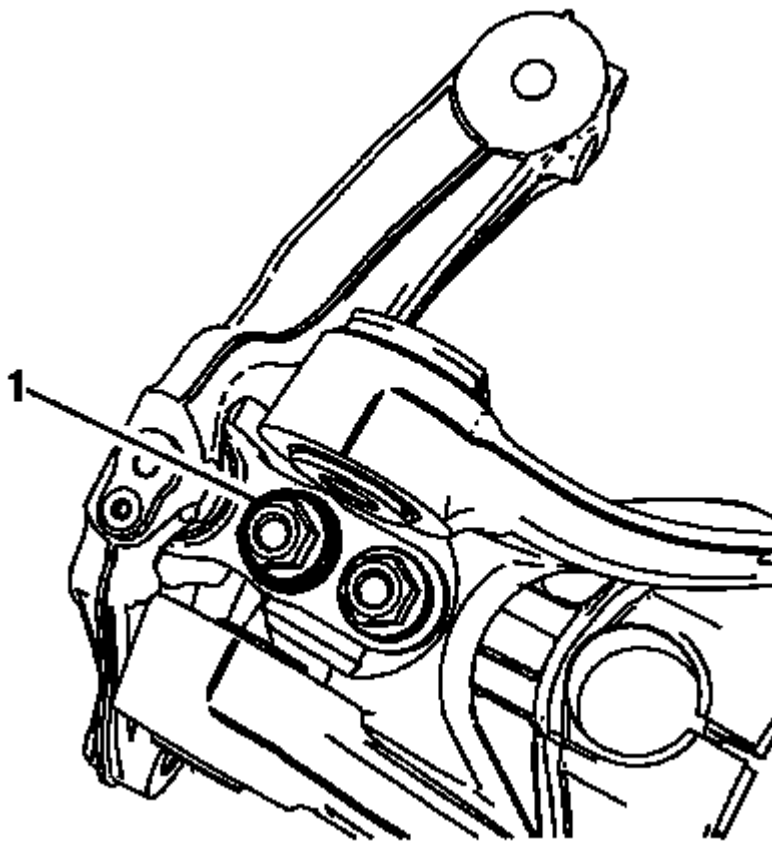


Fig. 9: King Pin Bushing Nuts

Courtesy of GENERAL MOTORS COMPANY

4. Loosen the steering knuckle king pin bushing nuts (1) until they are even with the steering knuckle king pin bushing studs or two or three threads of each nut are exposed.
5. Use a hammer and brass punch to drive both of the steering knuckle king pin bushing studs partially inward to release the knurls from the steering knuckle king pin bushing.
6. Completely remove the steering knuckle king pin bushing nuts.
7. Disconnect the steering knuckle upper ball stud from the steering knuckle. Refer to Steering Knuckle Upper Ball Stud Replacement (GNB).

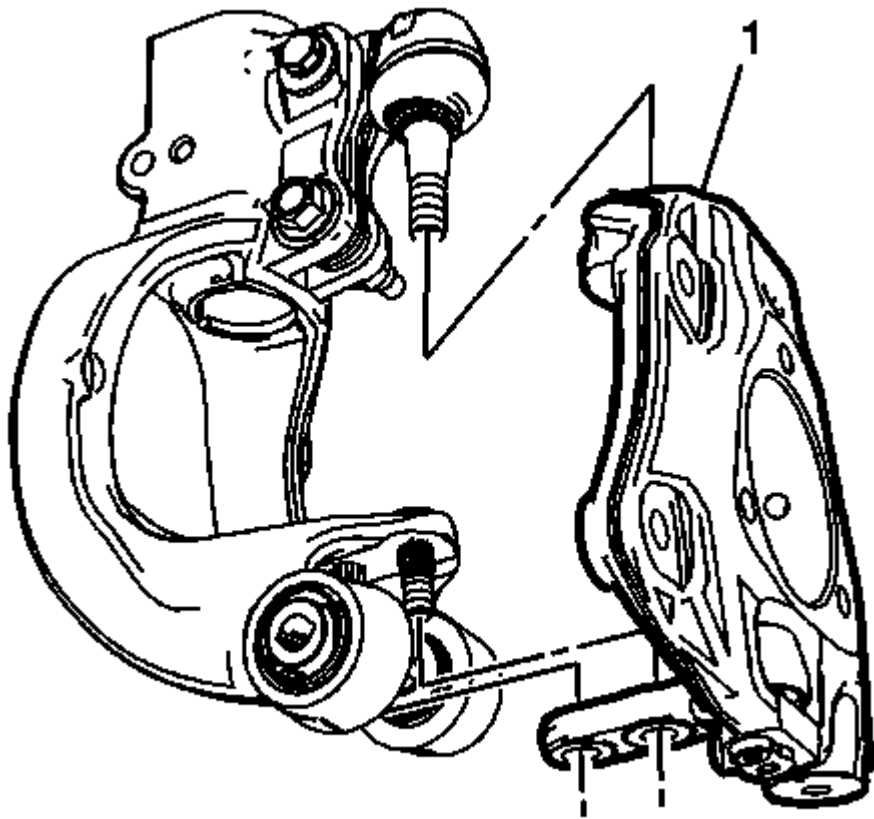


Fig. 10: Steering Knuckle

Courtesy of GENERAL MOTORS COMPANY

8. Remove the steering knuckle (1) from the front suspension strut yoke.

Installation Procedure

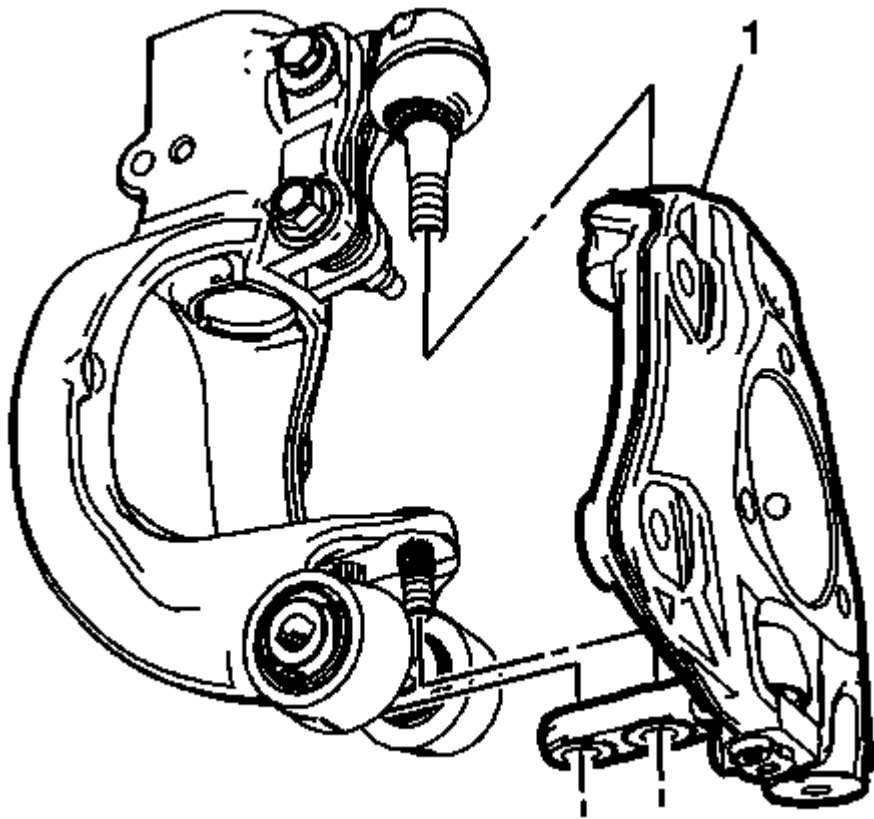


Fig. 11: Steering Knuckle

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the steering knuckle upper ball stud is properly aligned in the steering knuckle.

1. Position the steering knuckle (1) in the front suspension strut yoke.
2. Connect the steering knuckle upper ball stud to the steering knuckle. Refer to **Steering Knuckle Upper Ball Stud Replacement (GNB)**.

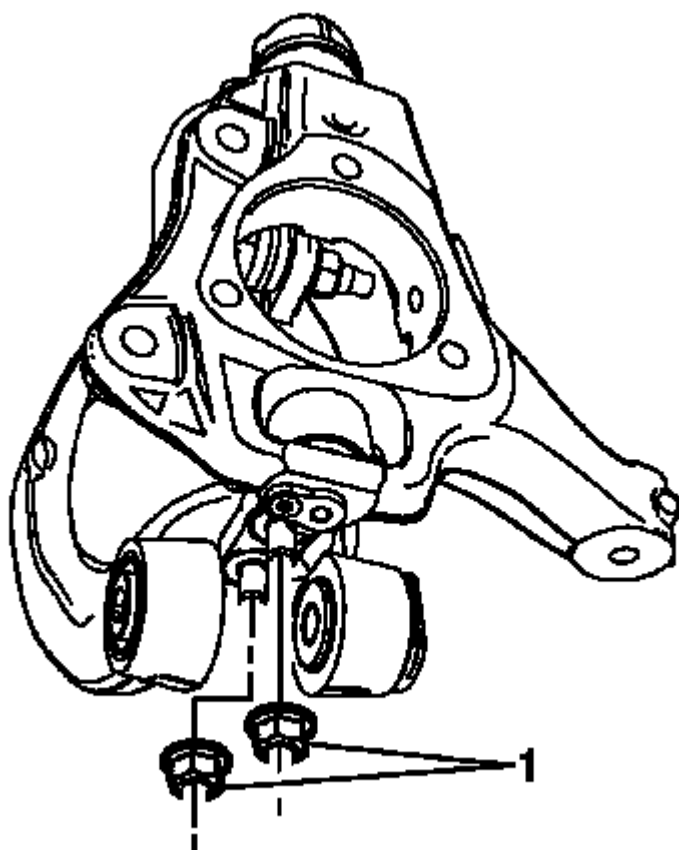


Fig. 12: King Pin Bushing Nuts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: The steering knuckle king pin bushing nuts should be tightened in small increments to ensure the steering knuckle king pin bushing bolts are drawn into the front suspension strut yoke correctly.

3. Tighten the steering knuckle king pin bushing nuts (1) in small, equal increments to 70 N.m (52 lb ft).
4. Install the front wheel bearing and hub assembly. Refer to Front Wheel Bearing and Hub Replacement (GNB).
5. Install the front suspension strut yoke. Refer to Front Suspension Strut Yoke Replacement (GNB).

STEERING KNUCKLE UPPER BALL STUD REPLACEMENT (GNB)

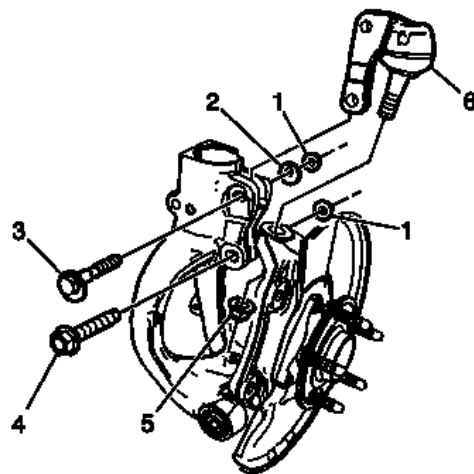


Fig. 13: Steering Knuckle Upper Ball Stud (GNB)

Courtesy of GENERAL MOTORS COMPANY

Steering Knuckle Upper Ball Stud Replacement (GNB)

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the front suspension strut yoke. Refer to <u>Front Suspension Strut Yoke Replacement (GNB)</u>. 	
1	<p>Steering Knuckle Camber Adjust Nut (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>NOTE:</p> <ul style="list-style-type: none"> • The steering knuckle camber adjust nuts are two different sizes. Note the position of the nuts prior to removing or replacing them. • Do not completely tighten the steering knuckle camber adjust nuts during installation. Tighten the nuts to specification after the front suspension alignment is completed. <p>Tighten</p> <ul style="list-style-type: none"> • Upper Nut to 70 (52 lb ft) + 60 degrees • Lower Nut to 115 (85 lb ft) + 45 degrees
2	Steering Knuckle Camber Adjust Washer
3	Steering Knuckle Camber Adjust Bolt
4	Steering Knuckle Bolt
	Steering Knuckle Nut

5	<p>Procedure Use a suitable tool to hold the steering knuckle upper ball stud while removing the steering knuckle nut.</p> <p>Tighten 45 (33 lb ft) + 45 degrees</p>
6	<p>Steering Knuckle Upper Ball Joint</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Use the CH-43631 separator to remove the steering knuckle upper ball joint from the steering knuckle. 2. Align the front suspension. Refer to <u>Wheel Alignment Specifications</u> . <p>Special Tools CH-43631 Ball Joint Separator For regional equivalent tools, refer to <u>Special Tools</u>.</p>

LOWER CONTROL ARM REPLACEMENT (GNA)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Disconnect any harnesses or retainers secured to the lower control arm. Note any attaching points to aid in installation.

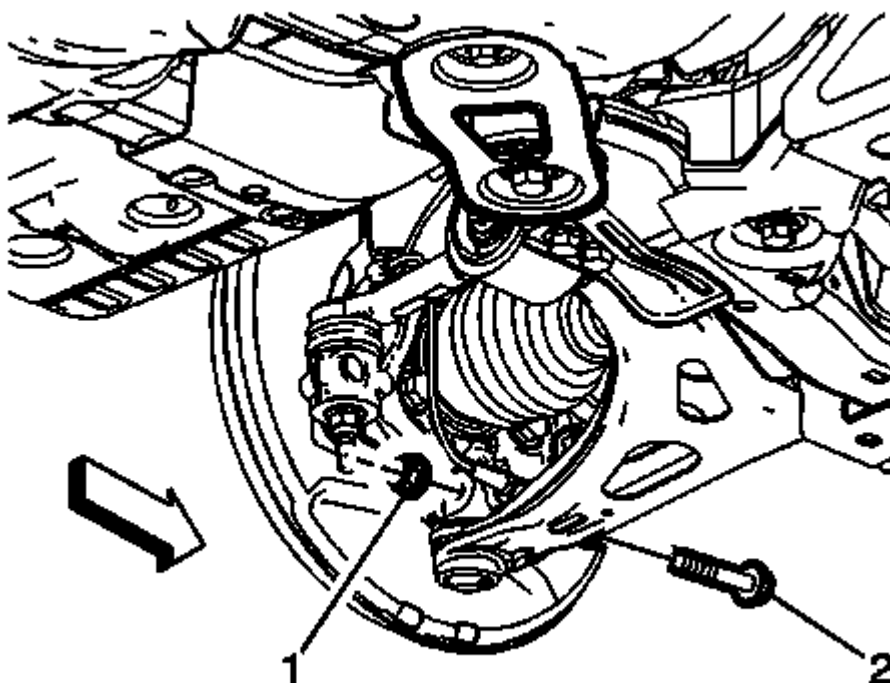


Fig. 14: Steering Knuckle

Courtesy of GENERAL MOTORS COMPANY

4. Remove the steering knuckle nut (1) and bolt (2). Discard the bolt.

NOTE: Always use the appropriate tools to pry open the pinch joint on the steering knuckle at the lower control arm ball joint.

5. Pry open the pinch joint to separate the lower control arm ball joint from the steering knuckle.
6. Support the lower control arm with a jackstand or other suitable tool.

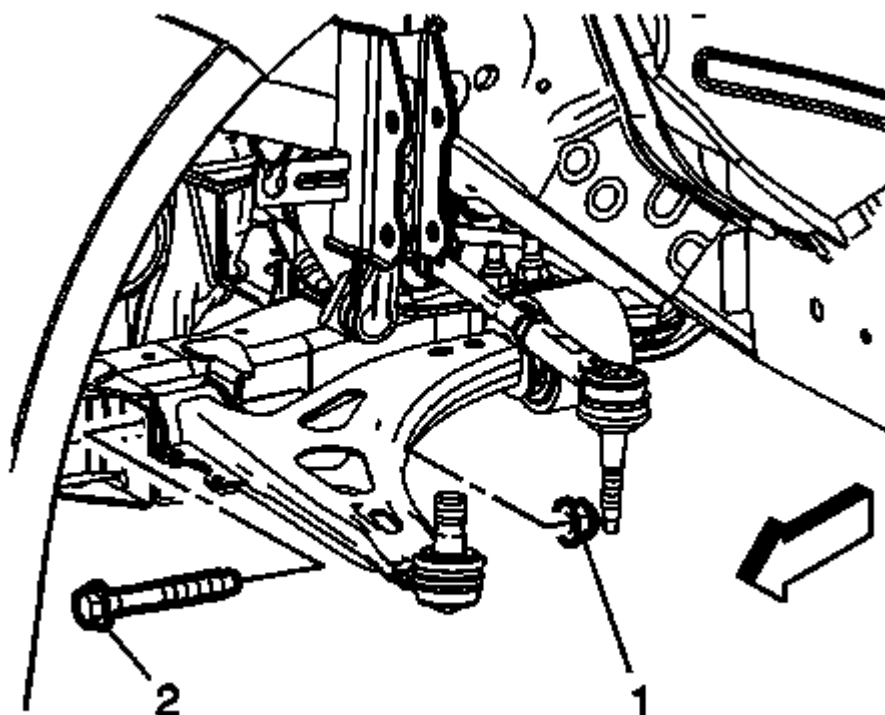


Fig. 15: Front Lower Control Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE: The steering knuckle is not shown for clarity only. It is not necessary to remove the steering knuckle to service the lower control arm.

7. Remove the front lower control arm front nut (1) and bolt (2). Discard the bolt.

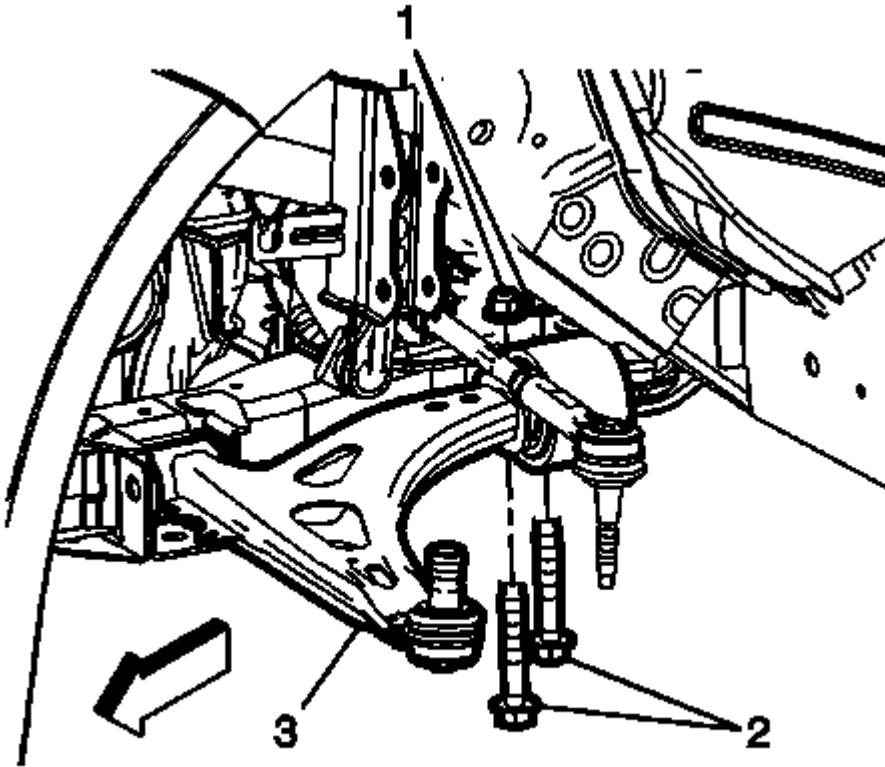


Fig. 16: Front Lower Control Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE: The steering knuckle is not shown for clarity only. It is not necessary to remove the steering knuckle to service the lower control arm.

8. Remove the front lower control arm rear nuts (1) and bolts (2). Discard the bolts.
9. Remove the lower control arm (3) from the vehicle.
10. Transfer components as necessary.

Installation Procedure

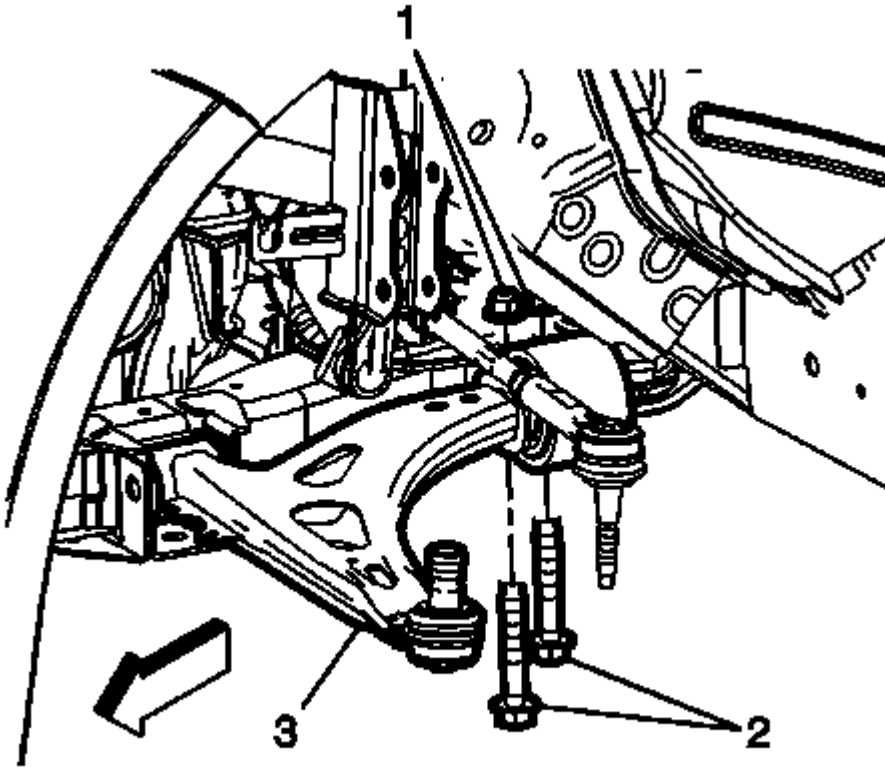


Fig. 17: Front Lower Control Arm
Courtesy of GENERAL MOTORS COMPANY

1. Support the lower control arm (3) with a jackstand or other suitable tool and position the control arm on the vehicle.
2. Start the NEW front lower control arm rear bolts (2) and OLD nuts (1) by hand. Do not tighten.

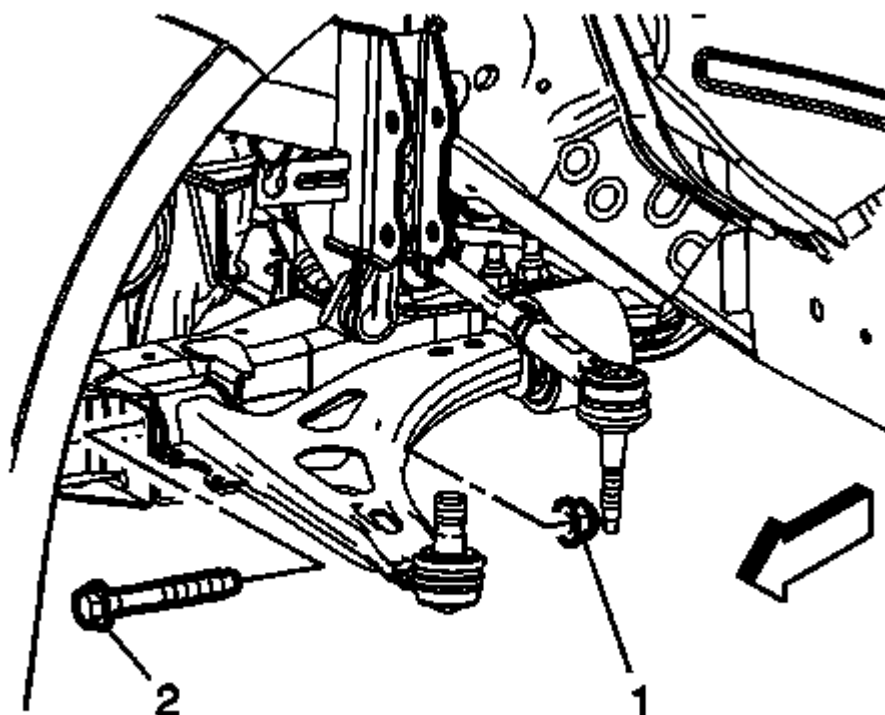


Fig. 18: Front Lower Control Arm
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

3. Install the OLD front lower control arm front nut (1) and NEW bolt (2) and tighten the bolt to 100 N.m (74 lb ft) + 90 degrees.

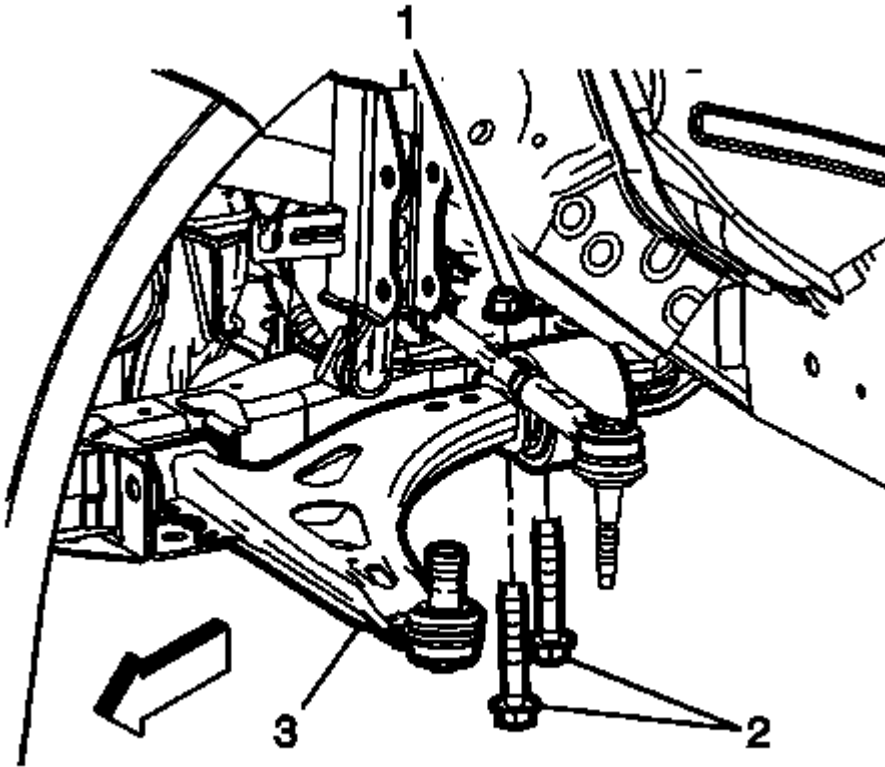


Fig. 19: Front Lower Control Arm
Courtesy of GENERAL MOTORS COMPANY

4. Tighten the NEW front lower control arm rear bolts (2) to 100 N.m (74 lb ft) + 90 degrees.
5. Connect the lower control arm ball joint to the steering knuckle.

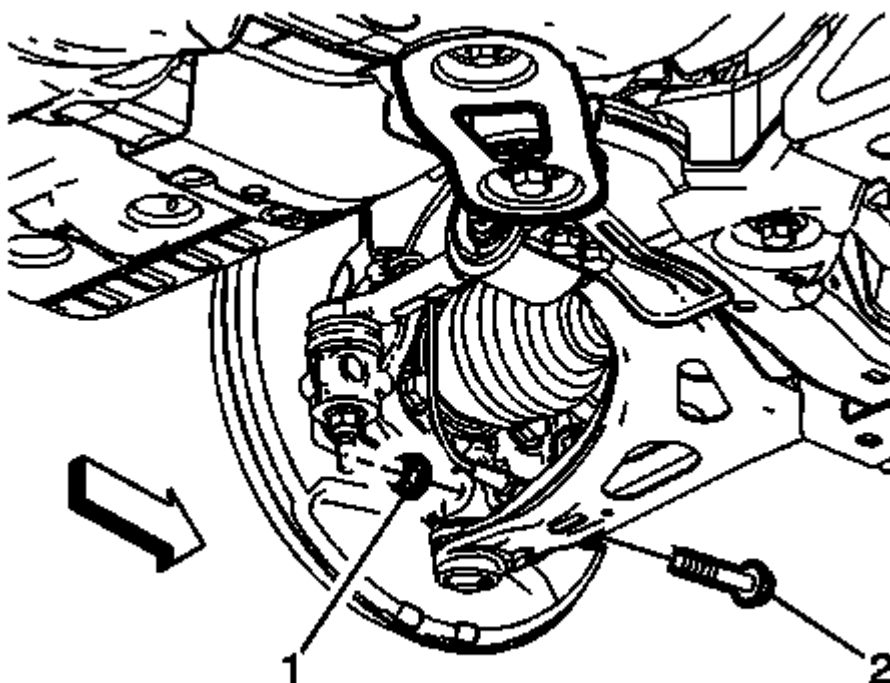


Fig. 20: Steering Knuckle

Courtesy of GENERAL MOTORS COMPANY

6. Install the NEW steering knuckle bolt (2) and OLD steering knuckle nut (1).
7. Tighten the OLD steering knuckle nut (1) to 50 N.m (37 lb ft).
8. After the initial tightening, loosen the steering knuckle nut (1) 120 degrees.
9. After loosening the steering knuckle nut (1), tighten the nut to 50 N.m (37 lb ft) + 45 degrees.
10. Connect any harnesses or retainers previously disconnected from the lower control arm.
11. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
12. After repairs, verify the front wheel alignment and adjust if necessary. Refer to **Wheel Alignment Measurement** .

LOWER CONTROL ARM REPLACEMENT (GNB)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. If equipped, disconnect the electronic suspension front position sensor from the lower control arm.
4. Disconnect any harnesses or retainers secured to the front lower control arm. Note any attaching points to

aid in installation.

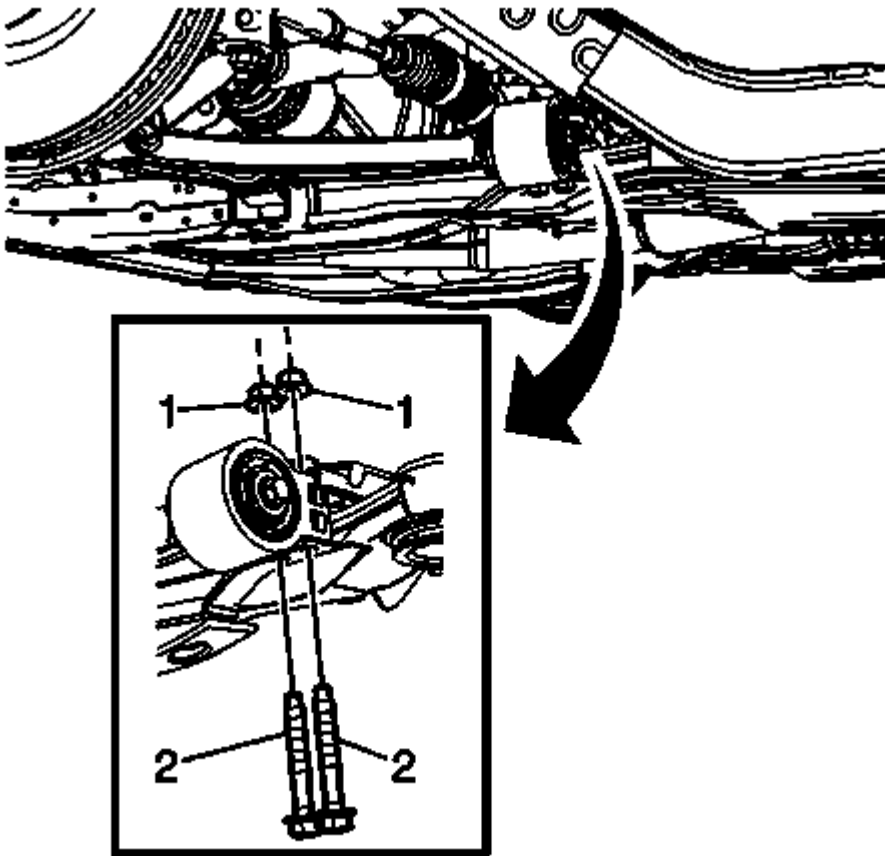


Fig. 21: Front Lower Control Arm Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the front lower control arm rear nuts (1) and bolts (2). Discard the nuts and bolts.

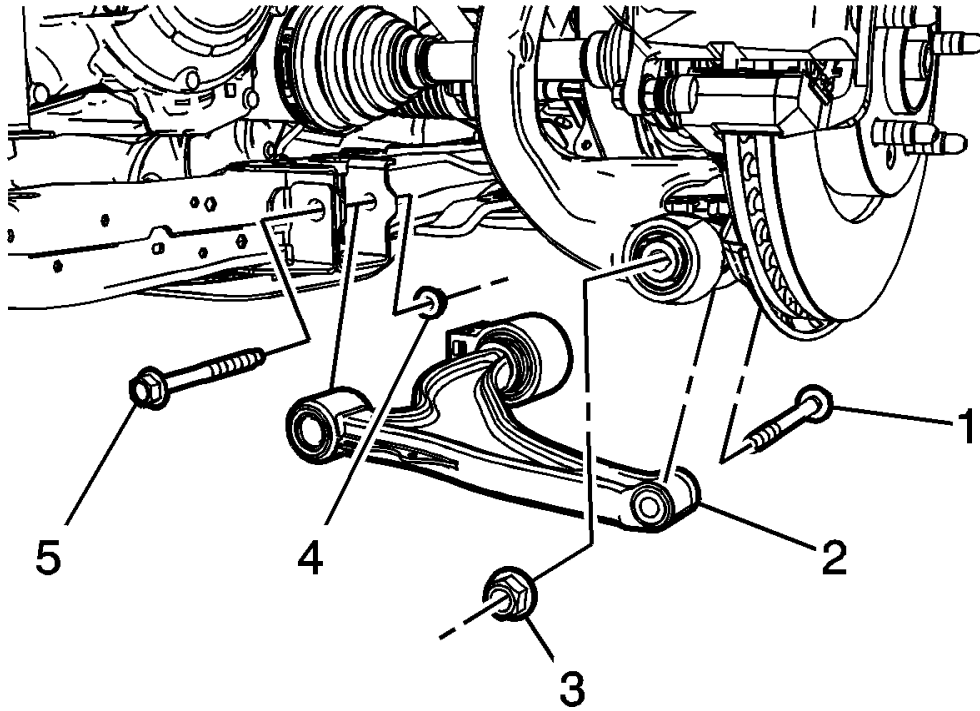


Fig. 22: Front Lower Control Arm, Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the steering knuckle nut (3) and bolt (1). Discard the nut and bolt.
7. Remove the steering knuckle bolt (1) at the front lower control arm. Discard the bolt.
8. Remove the front lower control arm front nut (4) and rear nut. Discard the nuts.
9. Remove the front lower control arm front bolts (5). Discard the bolts.
10. Remove the front lower control arm (2) from the vehicle.

Installation Procedure

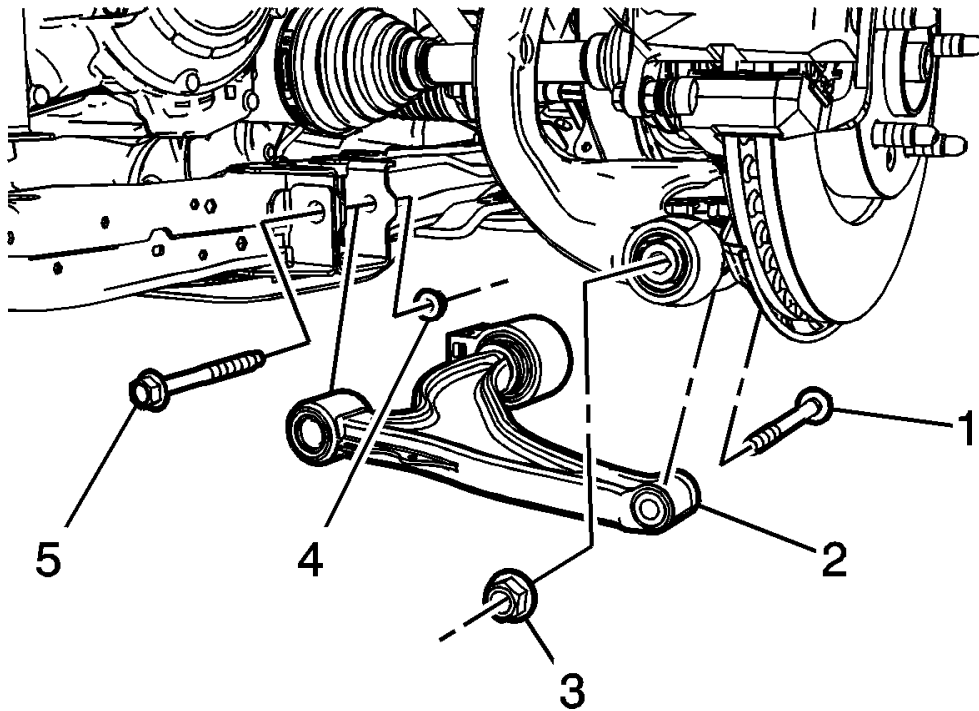


Fig. 23: Front Lower Control Arm, Nuts And Bolts
 Courtesy of GENERAL MOTORS COMPANY

1. Position the front lower control arm (2) on the vehicle.

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE:

- Install all of the front lower control arm bolts before tightening to hold the front lower control arm in place.
- Use a suitable support to bring the front lower control arm and suspension up to proper trim height before proceeding to apply final

torque.

2. Install the NEW front lower control arm front bolt (5) and NEW front lower control arm front nut (4) and tighten the bolt to 100 N.m (74 lb ft) + 90 degrees.
3. Install the NEW steering knuckle bolt (1) and NEW steering knuckle nut (3) and tighten the nut to 115 N.m (85 lb ft) + 120 degrees.

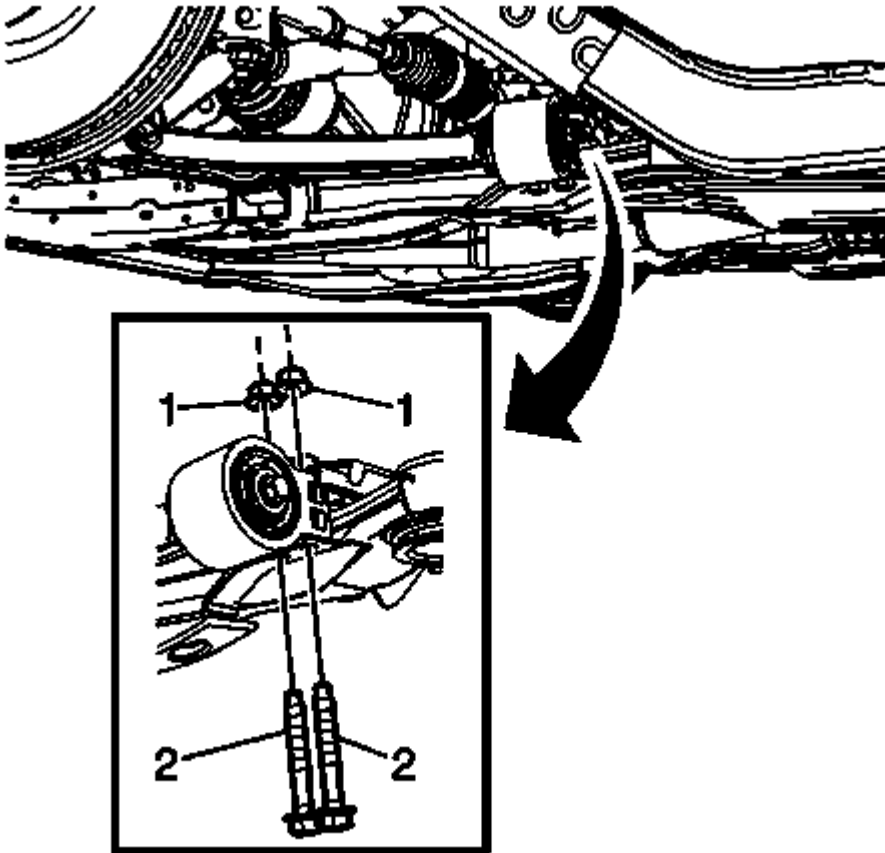


Fig. 24: Front Lower Control Arm Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the NEW front lower control arm rear bolts (2) and NEW front lower control arm rear nuts (1) and tighten the bolts to 100 N.m (74 lb ft) + 90 degrees.
5. Connect any harnesses or retainers previously disconnected from the front lower control arm.
6. If equipped, connect the electronic suspension front position sensor to the lower control arm.
7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

FRONT LOWER CONTROL ARM REAR BUSHING REPLACEMENT (GNA, GNB)

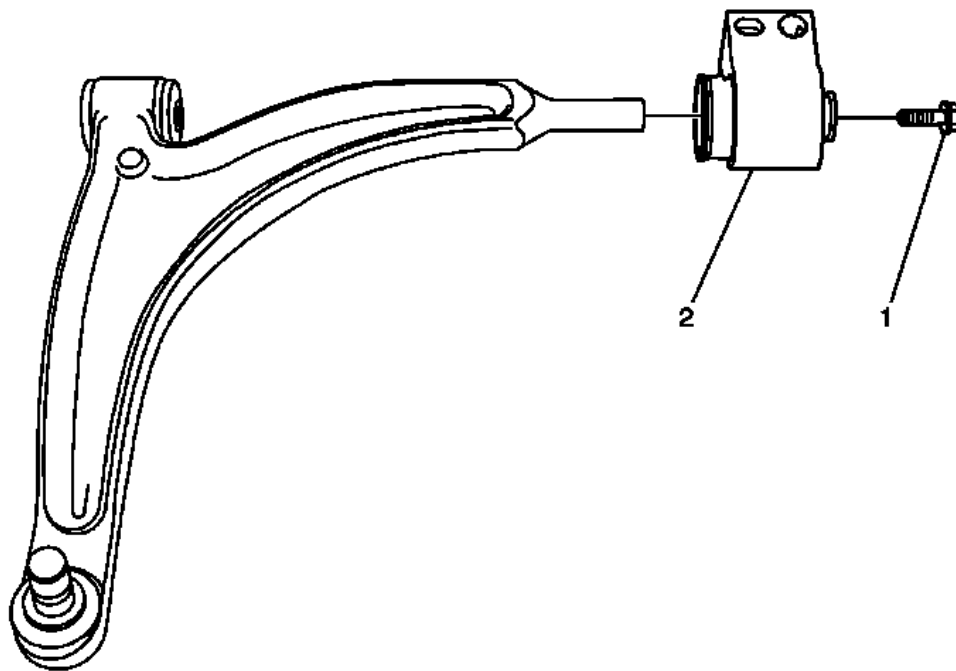


Fig. 25: Front Lower Control Arm Rear Bushing & Bolt (GNA, GNB)
 Courtesy of GENERAL MOTORS COMPANY

Front Lower Control Arm Rear Bushing Replacement (GNA, GNB)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Remove the lower control arm. Refer to <u>Lower Control Arm Replacement (GNA)</u>, <u>Lower Control Arm Replacement (GNB)</u>. 	
1	Front Lower Control Arm Rear Bushing Bolt CAUTION: Refer to <u>Fastener Caution</u> . CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component. Procedure Discard the bolt. DO NOT re-use, replace with NEW.

	NOTE: Tighten the bolt with the vehicle at ride height. Tighten 55 N.m (41 lb ft) + 100 degrees
2	Front Lower Control Arm Rear Bushing

WHEEL STUD REPLACEMENT

Special Tools

CH-43631 Ball Joint Separator

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the front wheel bearing and hub assembly. Refer to **Front Wheel Bearing and Hub Replacement (GNB)**, **Front Wheel Bearing and Hub Replacement (GNA)**.

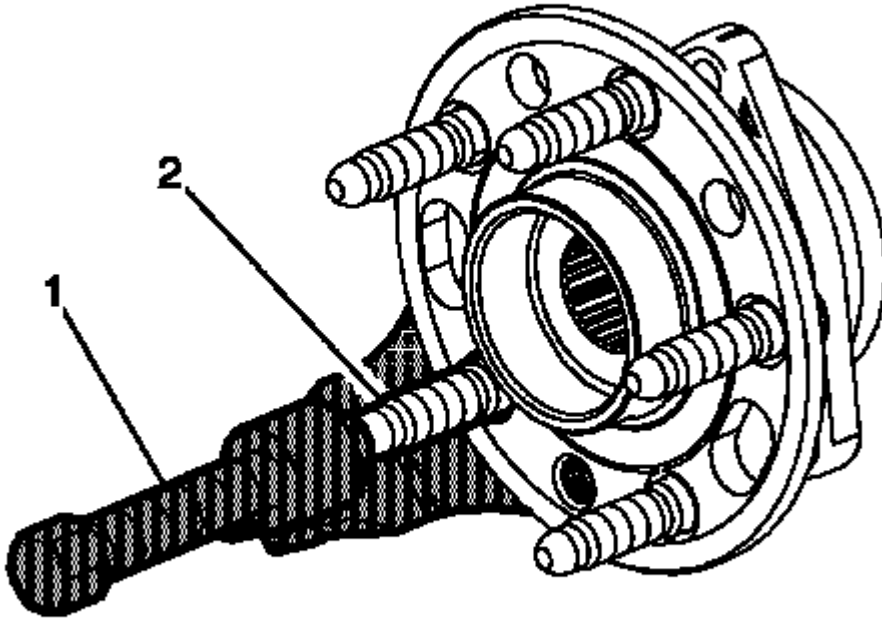


Fig. 26: Removing Wheel Stud

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH-43631** separator (1) to remove the wheel stud (2) from the front wheel bearing and hub assembly. Discard the stud.

Installation Procedure

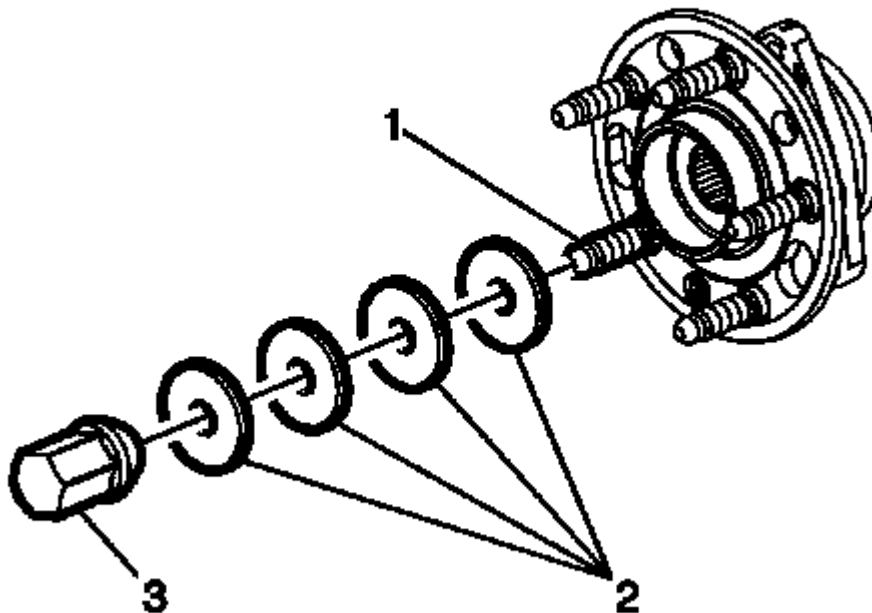


Fig. 27: Installing Wheel Stud

Courtesy of GENERAL MOTORS COMPANY

1. Position the NEW wheel stud (1) in the front wheel bearing and hub assembly.
2. Install flat washers (2) and an old wheel nut (3) on the wheel stud.
3. Use a suitable tool to prevent the flange on the front wheel bearing and hub assembly from turning.
4. Tighten the wheel nut until the wheel stud is firmly seated.
5. Remove the wheel nut and flat washers.
6. Install the front wheel bearing and hub assembly. Refer to **Front Wheel Bearing and Hub Replacement (GNB)**, **Front Wheel Bearing and Hub Replacement (GNA)**.

STRUT AND SHOCK ABSORBER INSPECTION

NOTE: The strut assembly **DOES NOT** have to be removed from the vehicle to perform the following inspection procedure.

NOTE: A light film of oil on the top portion of the strut is normal. **DO NOT** replace the strut for this condition.

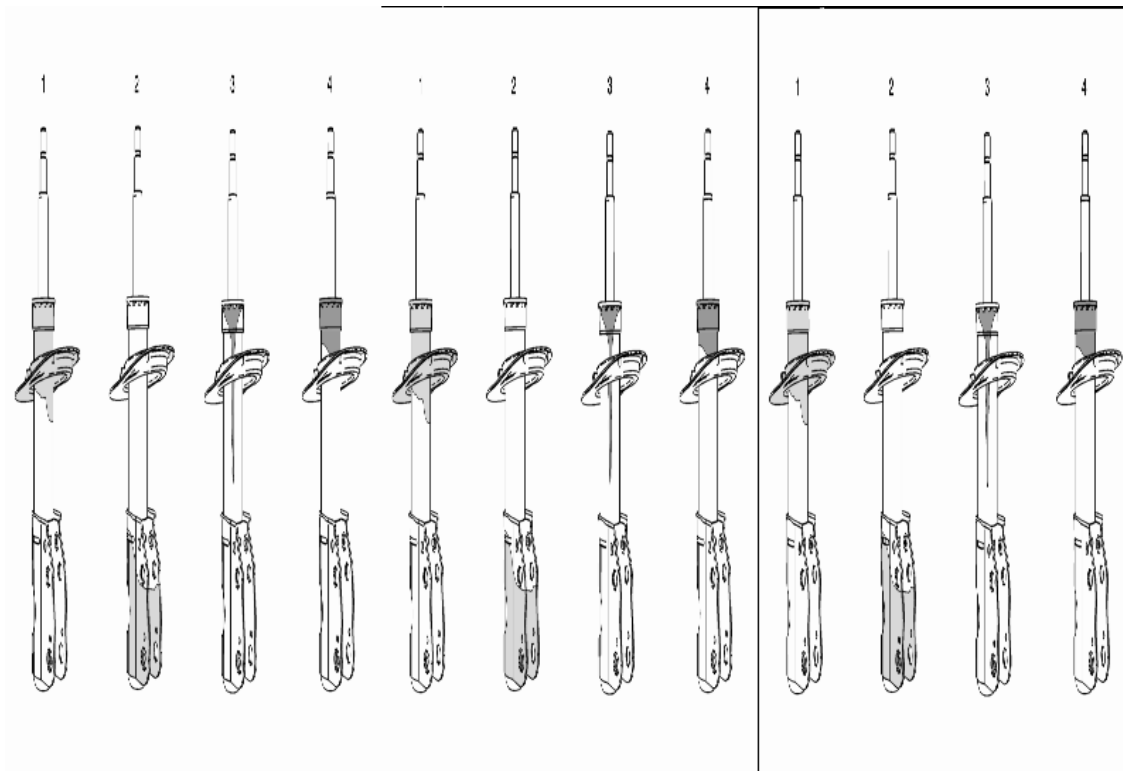


Fig. 28: Illustrating Of Strut Conditions
Courtesy of **GENERAL MOTORS COMPANY**

Condition 1

Oil or fluid residue only on the bottom of the strut tube or on other strut components and not originating from the shaft seal, is not a strut related problem. **DO NOT** replace the strut, look for other external leaks.

Condition 2

Light film/residue on the strut tube, but not on the spring seat and originating from the shaft seal, is a **NORMAL** condition. **DO NOT** replace the strut.

Condition 3

Oil drip or trail down the strut tube and originating from the shaft seal, is an **ABNORMAL** condition. Replace the strut.

Condition 4

Extreme wet film of oil covering the strut tube and pooling in the spring seat and originating from the shaft seal, is an **ABNORMAL** condition. Replace the strut.

Inspection

1. Verify the customer's concern is present. If the concern is present, continue to the next step. If the concern

is not present, then the vehicle is operating normally.

NOTE: **The strut assembly DOES NOT have to be removed from the vehicle to perform the following inspection procedure.**

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Visually inspect each of the shock absorbers or struts for external fluid leaks. Refer to the following conditions 1, 2 , 3 , and 4 for visual inspection.
 - If conditions 1 or 2 are found, continue to step 4.
 - If conditions 3 or 4 are found, replace strut. Refer to Strut Replacement.
4. If equipped with electronic suspension control system, ensure that the system is working properly. Refer to Diagnostic Starting Point-Electronic Suspension Control.
5. Use your hands in order to lift up and push down on each corner of the vehicle 3 times. Remove your hands from the vehicle. If the corner motion exceeds 2 cycles, replace the strut. If the strut does not exceed 2 cycles, NO repair is necessary.

STRUT ASSEMBLY REMOVAL AND INSTALLATION (GNB)

Special Tools

CH-49375 Spanner

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
2. Disconnect the front wheel drive shaft from the steering knuckle. Refer to **Front Wheel Drive Shaft Replacement - Left Side** , or **Front Wheel Drive Shaft Replacement - Right Side** .
3. Remove the front brake rotor. Refer to **Front Brake Rotor Replacement (J60, J61)** , **Front Brake Rotor Replacement (J64)** .
4. Disconnect the steering linkage outer tie rod from the steering knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .
5. Disconnect the stabilizer shaft link from the strut assembly. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)**.
6. Remove the front brake hose from the bracket on the strut assembly.
7. Remove the front wheel speed sensor from the steering knuckle. Refer to **Front Wheel Speed Sensor Replacement (Without F45)** , **Front Wheel Speed Sensor Replacement (With F45)** .
8. Disconnect the lower control arm from the steering knuckle. Refer to **Lower Control Arm Replacement (GNB)**.

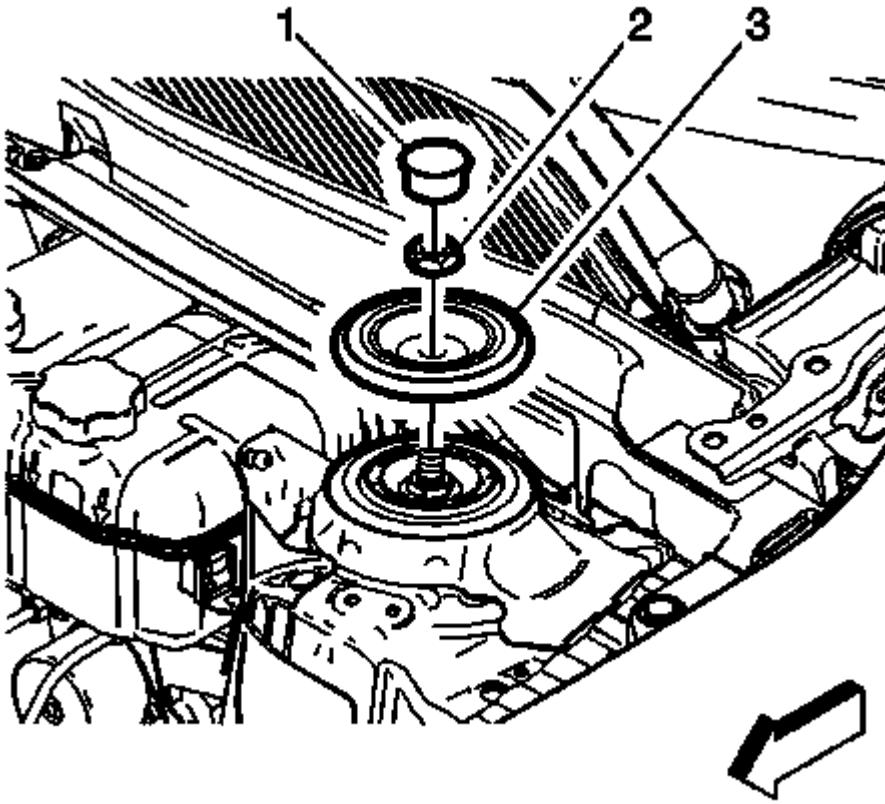


Fig. 29: Front Suspension Strut Mount
Courtesy of GENERAL MOTORS COMPANY

9. Lower the vehicle and remove the front suspension strut mount nut cap (1).
10. Use the **CH-49375** spanner to remove the front suspension strut mount nut (2).
11. Remove the front suspension strut bumper stop (3).
12. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

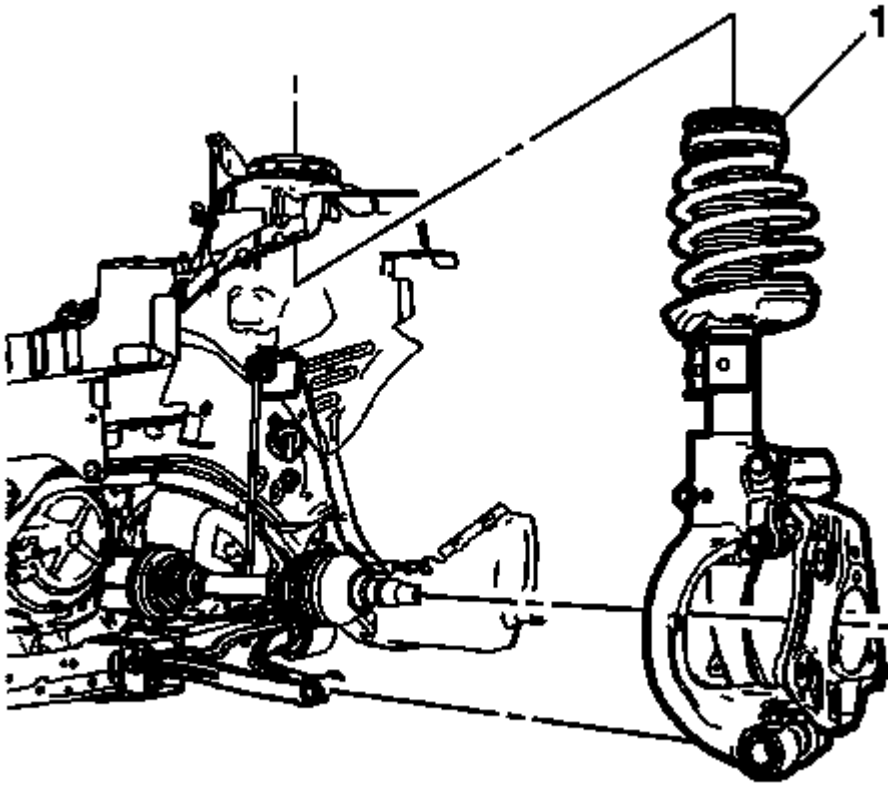


Fig. 30: Front Suspension Strut Assembly
Courtesy of GENERAL MOTORS COMPANY

13. Remove the strut assembly (1) and front suspension strut yoke from the vehicle.

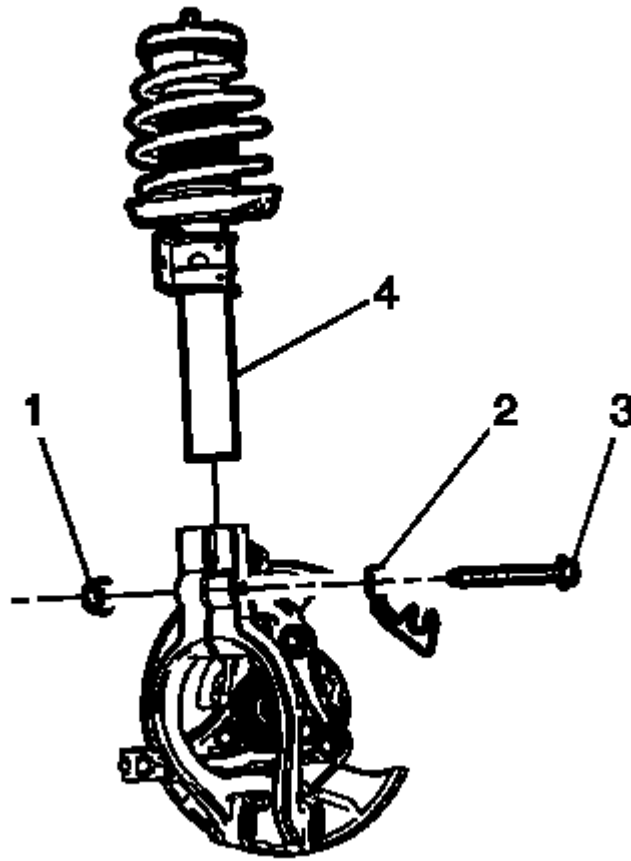


Fig. 31: Front Shock Assembly

Courtesy of GENERAL MOTORS COMPANY

14. Remove the front suspension strut yoke nut (1).
15. Remove the bracket (2) and front suspension strut yoke bolt (3).
16. Separate the strut assembly (4) from the front suspension strut yoke.

Installation Procedure

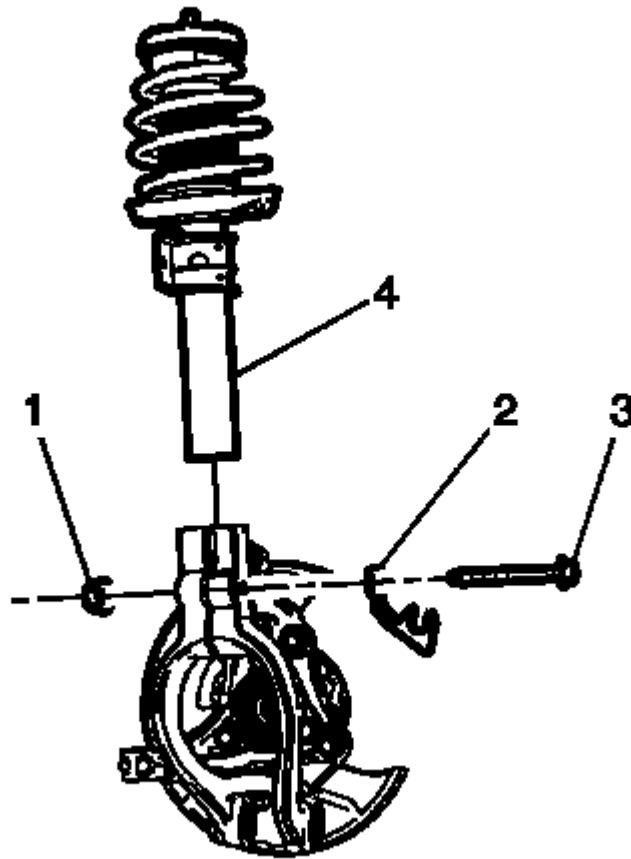


Fig. 32: Front Shock Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Install the strut assembly (4) in the front suspension strut yoke.

CAUTION: Be sure to orient the bolt so the head of the bolt is forward in vehicle and the nut is rearward in the vehicle. Failure to orient the bolt and nut correctly may cause the bolt to come into contact with the brake hose causing premature wear of the hose.

2. Install the bracket (2) and front suspension strut yoke bolt (3).

CAUTION: Refer to Fastener Caution .

3. Install the front suspension strut yoke nut (1) and tighten to 70 (52 lb ft).

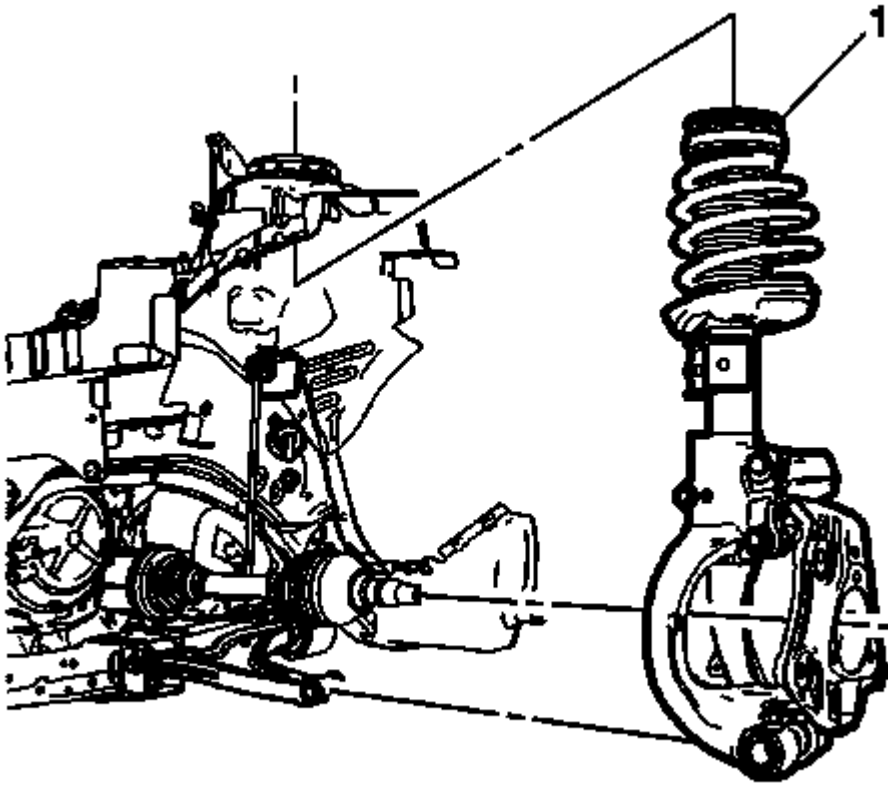


Fig. 33: Front Suspension Strut Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Install the strut assembly (1) and front suspension strut yoke on the vehicle.

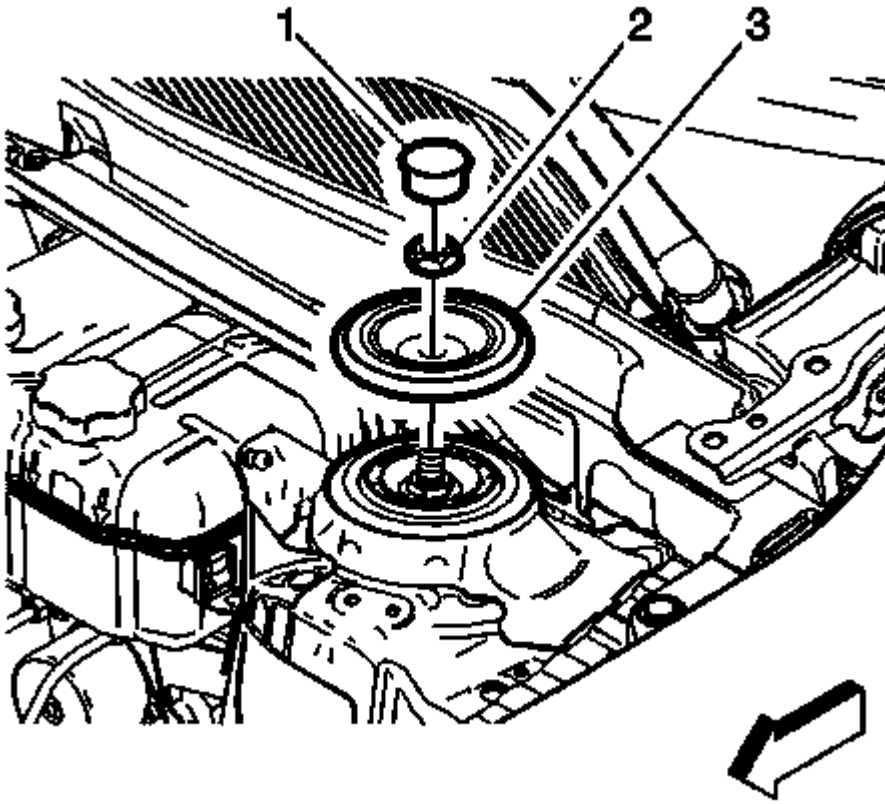


Fig. 34: Front Suspension Strut Bumper Stop
 Courtesy of GENERAL MOTORS COMPANY

5. Lower the vehicle and position the front suspension strut bumper stop (3) on the strut assembly tower.

NOTE: Do not tighten the front suspension strut mount nut to specification until the vehicle is completely on the ground.

6. Start the front suspension strut mount nut (2) by hand but do not tighten to specification.
7. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
8. Connect the lower control arm to the steering knuckle. Refer to **Lower Control Arm Replacement (GNB)**.
9. Install the front wheel speed sensor in the steering knuckle. Refer to **Front Wheel Speed Sensor Replacement (Without F45)** , **Front Wheel Speed Sensor Replacement (With F45)** .
10. Install the front brake rotor. Refer to **Front Brake Rotor Replacement (J60, J61)** , **Front Brake Rotor Replacement (J64)** .
11. Install the front brake hose in the bracket on the strut assembly.
12. Connect the stabilizer shaft link to the strut assembly. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)**.
13. Connect the steering linkage outer tie rod to the steering knuckle. Refer to **Steering Linkage Outer Tie**

Rod Replacement

14. Connect the front wheel drive shaft to the steering knuckle. Refer to **Front Wheel Drive Shaft Replacement - Left Side** , or **Front Wheel Drive Shaft Replacement - Right Side** .
15. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
16. Lower the vehicle until the vehicle is resting fully on the ground.

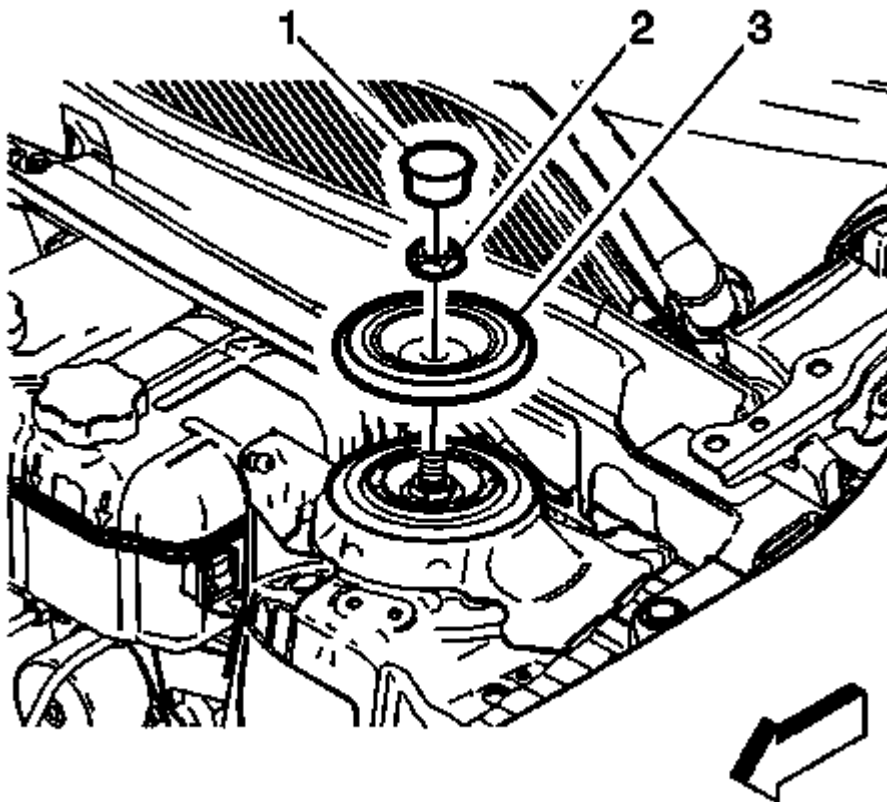


Fig. 35: Front Suspension Strut Bumper Stop
Courtesy of GENERAL MOTORS COMPANY

17. Use the **CH-49375** spanner to install the front suspension strut mount nut (2) and tighten to 55 (41 lb ft).
18. Install the front suspension strut mount nut cap (1).
19. Measure and adjust the front wheel alignment specifications. Refer to **Wheel Alignment Specifications** .

STRUT ASSEMBLY REMOVAL AND INSTALLATION (GNA)

Special Tools

CH-49375 Spanner

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Disconnect the stabilizer shaft link from the strut assembly. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)**.
4. Remove the front brake hose from the bracket on the strut assembly.
5. Remove the front wheel speed sensor from the steering knuckle. Refer to **Front Wheel Speed Sensor Replacement (Without F45)** , **Front Wheel Speed Sensor Replacement (With F45)** .

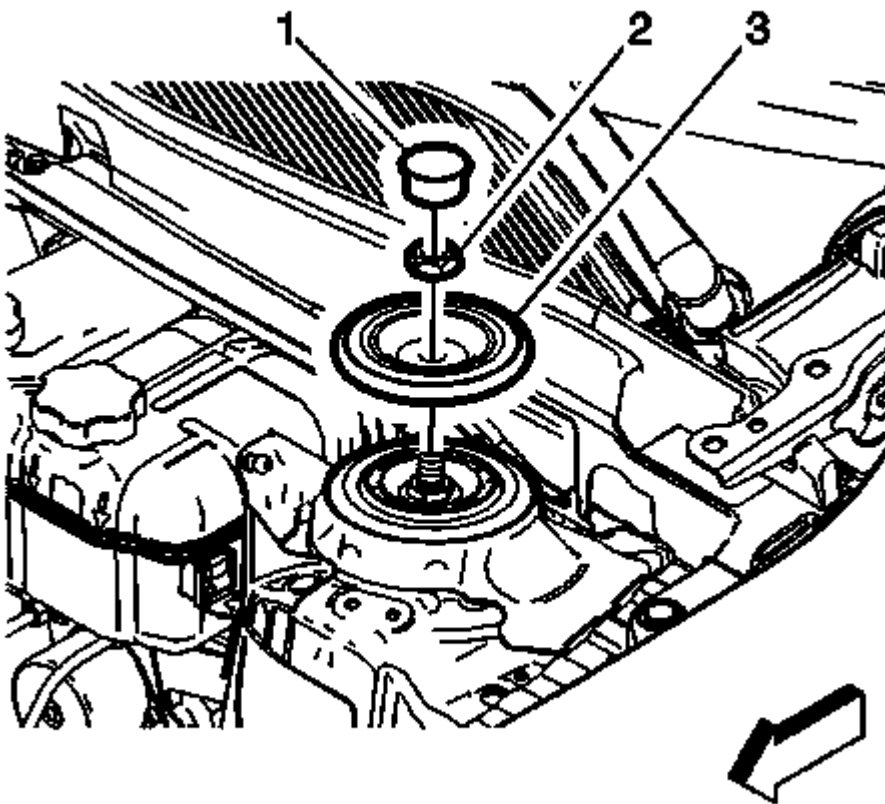


Fig. 36: Front Suspension Strut Mount
Courtesy of GENERAL MOTORS COMPANY

6. Lower the vehicle and remove the front suspension strut mount nut cap (1).
7. Use the **CH-49375** spanner to remove the front suspension strut mount nut (2).
8. Remove the front suspension strut bumper stop (3).
9. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

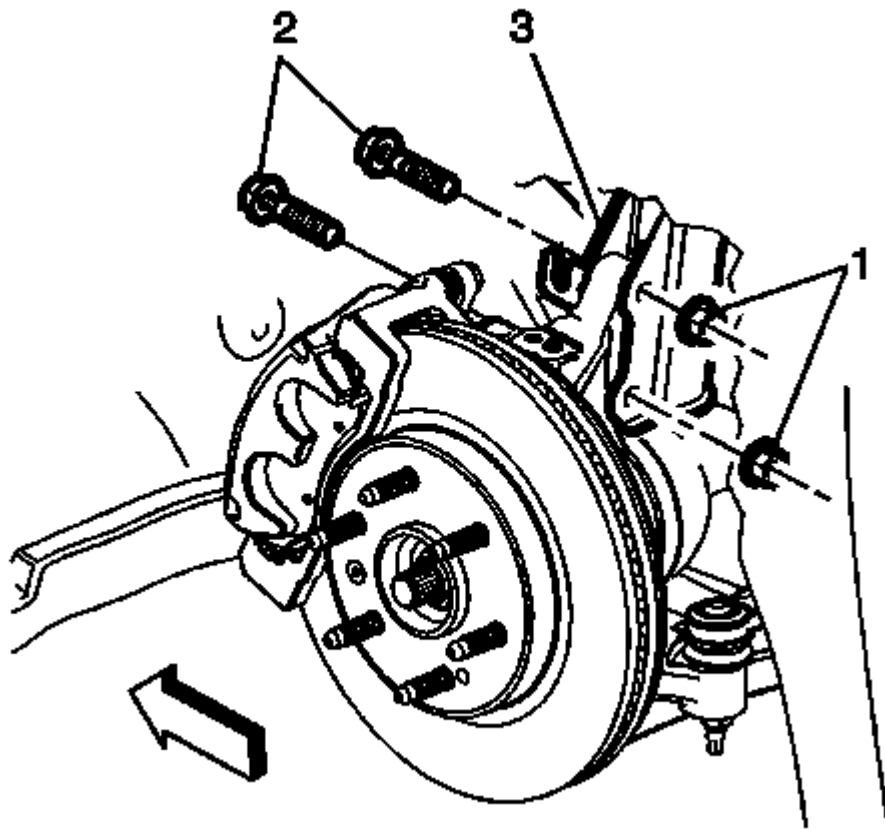


Fig. 37: Strut Assembly, Steering Knuckle & Nuts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the steering knuckle nuts (1) and bolts (2) from the strut assembly (3) and steering knuckle. DISCARD the bolts.
11. Separate the strut assembly (3) from the steering knuckle and remove from the vehicle.

Installation Procedure

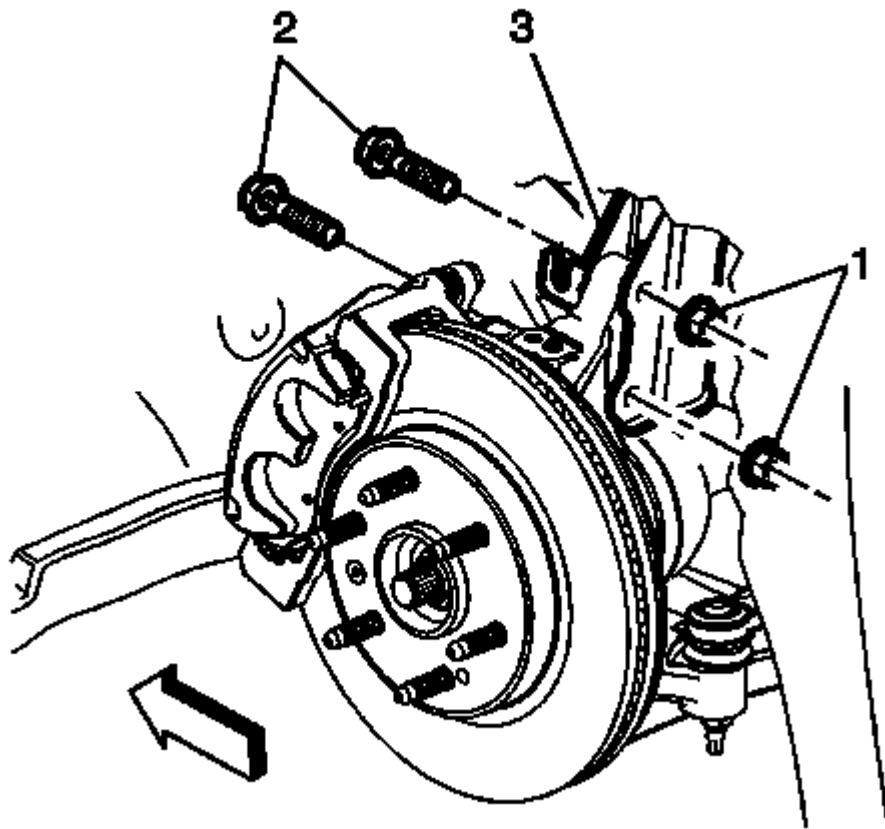


Fig. 38: Strut Assembly, Steering Knuckle & Nuts
Courtesy of GENERAL MOTORS COMPANY

1. Position the strut assembly (3) on the vehicle.
2. Start the NEW steering knuckle bolts (2) and nuts (1) by hand but do not tighten.

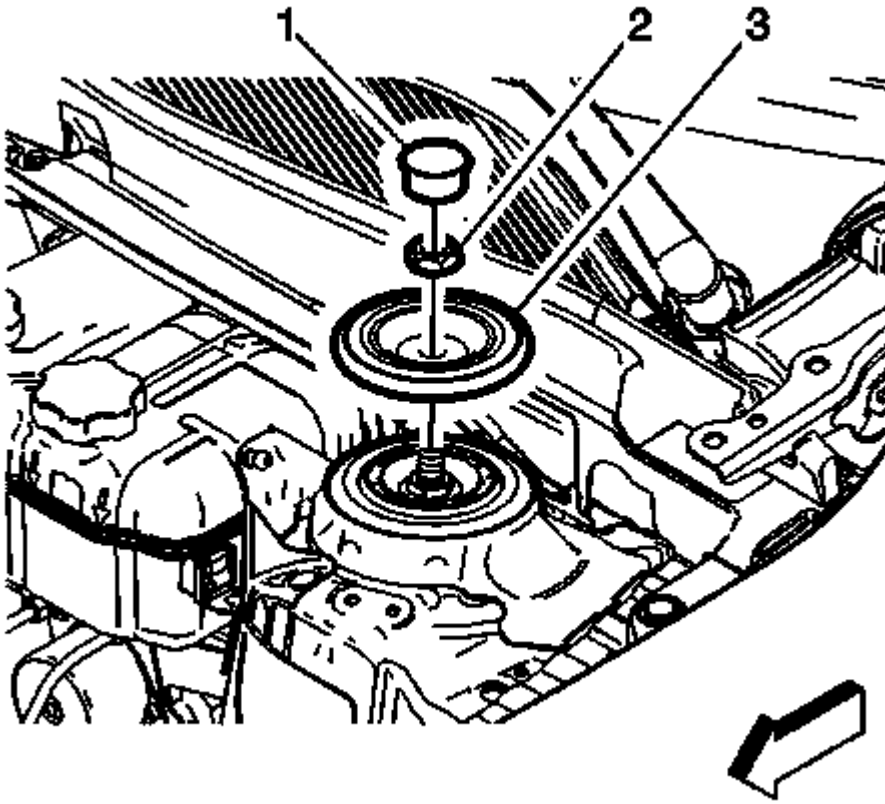


Fig. 39: Front Suspension Strut Bumper Stop
Courtesy of GENERAL MOTORS COMPANY

3. Lower the vehicle and position the front suspension strut bumper stop (3) on the strut assembly tower.

NOTE: Do not tighten the front suspension strut mount nut to specification until the vehicle is completely on the ground.

4. Start the front suspension strut mount nut (2) by hand but do not tighten to specification.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

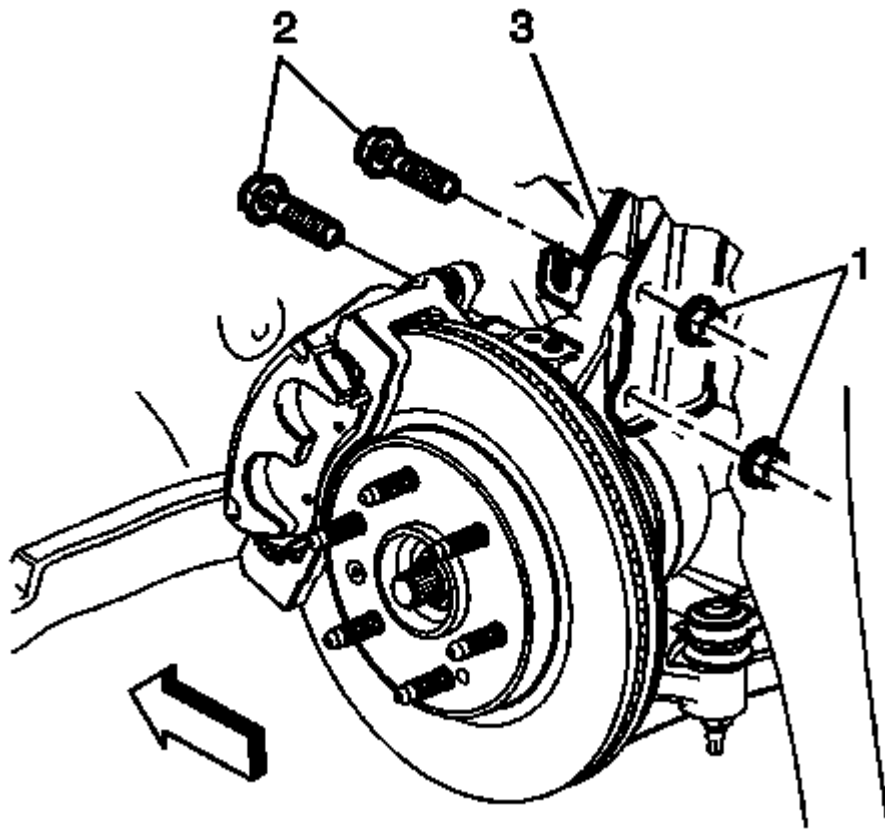


Fig. 40: Strut Assembly, Steering Knuckle & Nuts
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

6. Tighten the steering knuckle nuts (1) to 85 (63 lb ft) + 60 degrees.
7. Connect the stabilizer shaft link to the strut assembly. Refer to Stabilizer Shaft Link Replacement (GNA, GNB).
8. Install the front wheel speed sensor in the steering knuckle. Refer to Front Wheel Speed Sensor Replacement (Without F45) , Front Wheel Speed Sensor Replacement (With F45) .
9. Install the front brake hose in the bracket on the strut assembly.
10. Install the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
11. Lower the vehicle until the vehicle is resting fully on the ground.

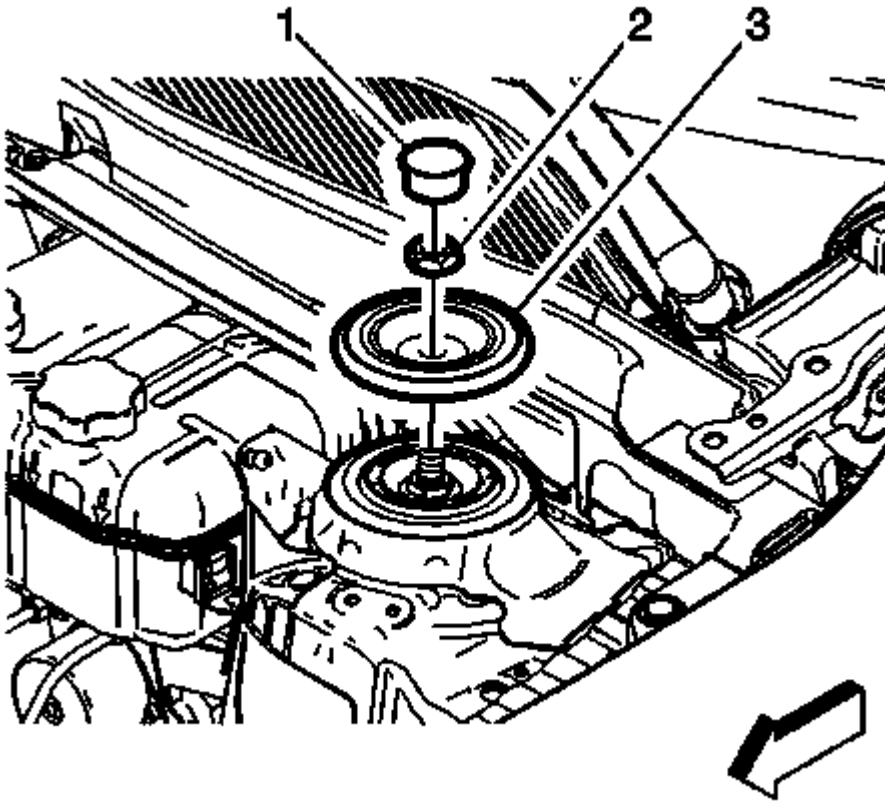


Fig. 41: Front Suspension Strut Mount
 Courtesy of GENERAL MOTORS COMPANY

12. Use the **CH-49375** spanner to install the front suspension strut mount nut (2) and tighten to 55 (41 lb ft).
13. Install the front suspension strut mount nut cap (1).

FRONT SUSPENSION STRUT YOKE REPLACEMENT (GNB)

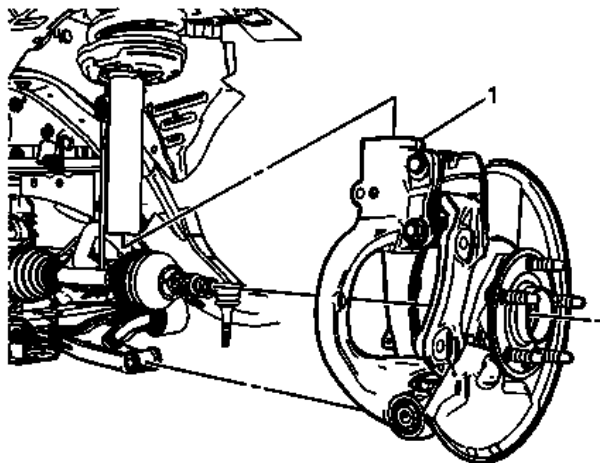


Fig. 42: Front Suspension Strut Yoke
 Courtesy of GENERAL MOTORS COMPANY

Front Suspension Strut Yoke Replacement (GNB)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Disconnect the steering linkage outer tie rod from the steering knuckle. Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> . 4. Disconnect the front wheel drive shaft from the front wheel bearing and hub assembly. Refer to <u>Front Wheel Drive Shaft Replacement - Left Side</u> , or <u>Front Wheel Drive Shaft Replacement - Right Side</u> . 5. Remove the front brake rotor from the steering knuckle. Refer to <u>Front Brake Rotor Replacement (J60, J61)</u> , <u>Front Brake Rotor Replacement (J64)</u> . 	
1	Front Suspension Strut Yoke Procedure <ol style="list-style-type: none"> 1. If equipped, disconnect the electronic front suspension wiring harness from the strut assembly. 2. Remove the front wheel speed sensor from the steering knuckle. Refer to <u>Front Wheel Speed Sensor Replacement (Without F45)</u> , <u>Front Wheel Speed Sensor Replacement (With F45)</u> . 3. Disconnect the strut assembly from the front suspension strut yoke. Refer to <u>Strut Assembly Removal and Installation (GNB)</u>. 4. Disconnect the lower control arm from the steering knuckle. Refer to <u>Lower Control Arm Replacement (GNB)</u>. 5. Support the lower control arm with a jackstand. 6. If servicing the front suspension strut yoke, remove the steering knuckle. Refer to <u>Steering Knuckle Replacement (GNB)</u>, and <u>Steering Knuckle Upper Ball Stud Replacement (GNB)</u>.

SUSPENSION STRUT DISPOSAL

WARNING: Use the proper eye protection when drilling to prevent metal chips from causing physical injury.

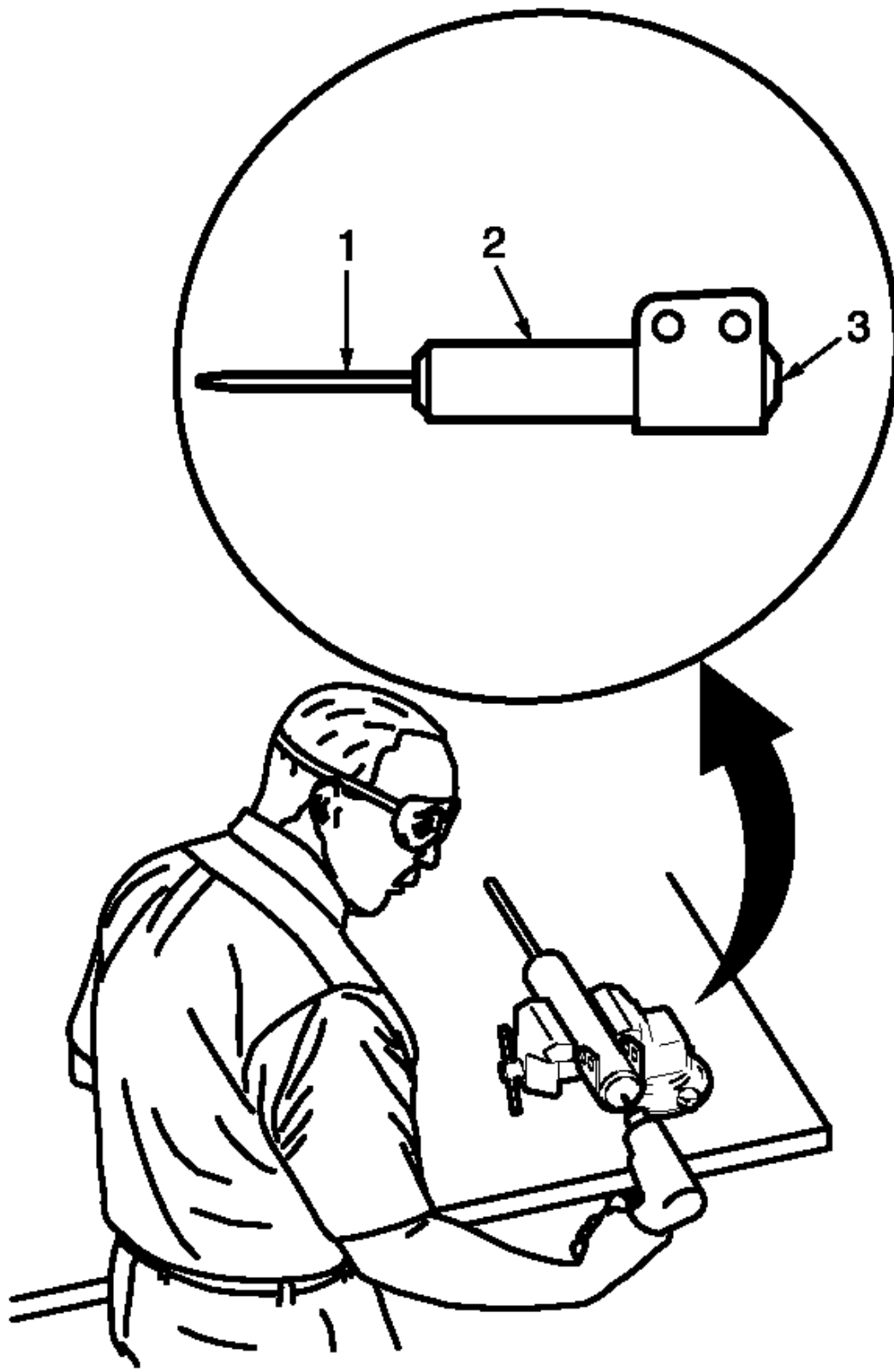


Fig. 43: Drilling Hole In Strut At Center Of End Cap

Courtesy of GENERAL MOTORS COMPANY

1. Clamp the strut in a vise horizontally with the rod (1) completely extended.
2. Drill a hole in the strut at the center of the end cap (3) using a 5 mm (3/16 in) drill bit. Gas or a gas/oil mixture will exhaust when the drill bit penetrates the strut. Use shop towels in order to contain the escaping oil.
3. Remove the strut from the vise.
4. Hold the strut over a drain pan vertically with the hole down.
5. Move the rod (1) in and out of the tube (2) to completely drain the oil from the strut.

STRUT, STRUT COMPONENT, OR SPRING REPLACEMENT (GNA, GNB)

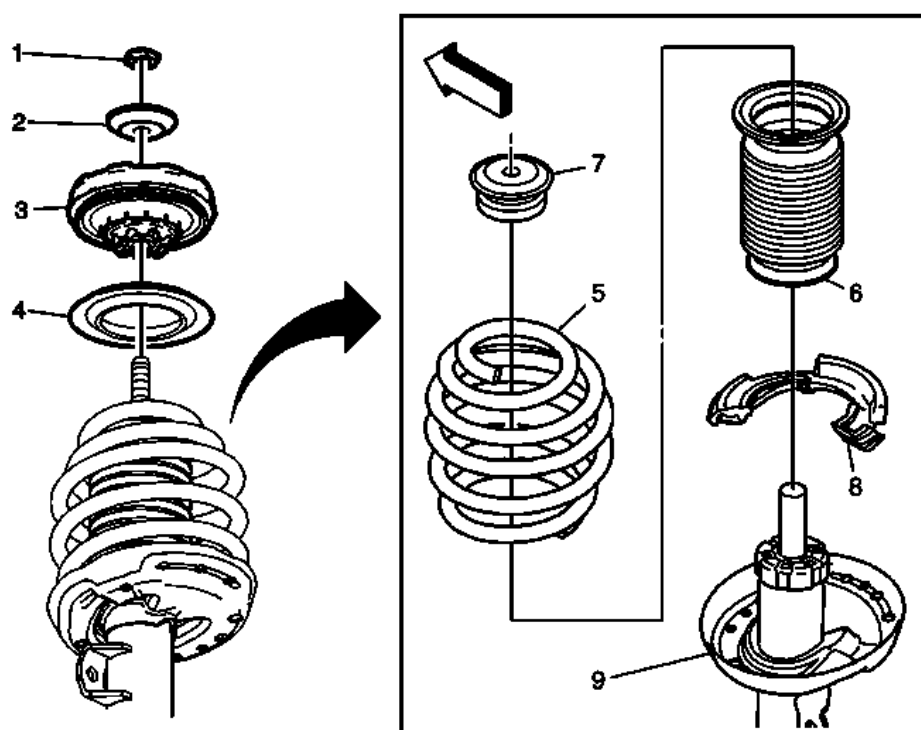


Fig. 44: Strut Components And Spring

Courtesy of GENERAL MOTORS COMPANY

Strut, Strut Component, or Spring Replacement (GNA, GNB)

Callout	Component Name
<p>WARNING:</p> <p>To prevent personal injury and/or component damage, use the proper tools to support and compress the coil spring prior to removal of the strut shaft nut when removing the coil spring. The coil spring is under extreme pressure and can become a projectile should the spring separate from the strut before all of the tension is relieved.</p> <p>Preliminary Procedure</p>	

1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the strut assembly. Refer to <u>Strut Assembly Removal and Installation (GNB)</u> , <u>Strut Assembly Removal and Installation (GNA)</u> .	
1	<p>Front Suspension Strut Nut</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Use the CH-48845 compressor to compress the front strut assembly. 2. Use the CH-49375 spanner and a suitable tool to remove the front suspension strut nut. <p>Tighten 70 (52 lb ft)</p> <p>Special Tool</p> <ul style="list-style-type: none"> • CH-48845 Strut Spring Compressor • CH-49375 Spanner <p>For equivalent regional tools, refer to <u>Special Tools</u>.</p>
2	Front Suspension Strut Mount Washer
3	Front Suspension Strut Mount
4	Front Coil Spring Upper Insulator
5	Front Coil Spring
6	Front Shock Absorber Boot
7	<p>Front Suspension Strut Bumper</p> <p>Inspect the front suspension strut bumper for the following:</p> <ul style="list-style-type: none"> • Cracks or structural damage • Wetness from oil contamination • Loose fit to strut rod or excessive play from damage to the inner diameter retention fingers <p>If any issues are noted, replace the front suspension strut bumper.</p>
8	Front Coil Spring Lower Insulator
9	Front Suspension Strut

DESCRIPTION AND OPERATION

GENERAL DESCRIPTION (GNB)

HiPerStrut Front Suspension:

The front suspension has 2 primary purposes:

- Isolate the driver from irregularities in the road surface.
- Define the ride and handling characteristics of the vehicle.

The front suspension absorbs the impact of the tires travelling over irregular road surfaces and dissipates this energy throughout the suspension system. This process isolates the vehicle occupants from the road surface. The rate at which the suspension dissipates the energy and the amount of energy that is absorbed is how the suspension defines the vehicles ride characteristics. Ride characteristics are controlled by the Electronic Suspension Control system. The Electronic Suspension Control system individually controls the damping force of each of the 4 shock absorbers. The suspension system must allow for the vertical movement of the tire and wheel assembly as the vehicle travels over irregular road surfaces while maintaining the tire's horizontal relationship to the road.

This requires that the steering knuckle be suspended between a lower control arm via the yoke assembly to the strut assembly. The lower control arm outermost point is attached to the yoke assembly and then through the king pin bushing to the steering knuckle. The innermost end of the control arm attached at 2 points to the vehicle frame through semi-rigid bushings. The upper portion of the steering knuckle is attached to the yoke assembly via a ball stud. The yoke assembly then connects to the strut assembly and vehicle body by way of an upper bushing. The steering knuckle is allowed to travel up and down independent of the vehicle body structure and frame.

This up and down motion of the steering knuckle as the vehicle travels over bumps is absorbed predominantly by the coil spring. This spring is retained under tension over the strut assembly. A strut is used in conjunction with this system in order to dampen out the oscillations of the coil spring. The strut is filled with oil and has a moveable shaft that connects to a piston inside the strut. Valves inside the shock absorber offer resistance to oil flow and consequently inhibit rapid movement of the piston and shaft. Each end of the shock absorber is connected in such a fashion to utilize this recoil action of a spring alone. Each end of the strut is designed as the connection point of the suspension system to the vehicle and acts as the coil spring seat. This allows the strut to utilize the dampening action to reduce the recoil of a spring alone. The lower control arm is allowed to pivot at the vehicle frame in a vertical fashion. The ball joint allows the steering knuckle to maintain the perpendicular relationship to the road surface.

Front suspensions systems utilize a stabilizer shaft. The stabilizer bar connects between the left and right strut assemblies through the stabilizer link and stabilizer shaft insulators. This bar controls the amount of independent movement of the suspension when the vehicle turns. Limiting the independent movement defines the vehicles handling characteristics on turns.

The advantage of the HiPerStrut front suspension (GNB) over the McPherson-type wheel suspension is less spindle length which leads to:

- Reduced smooth road shake
- Less torque steer

- Increased cornering power, no camber loss during cornering
- Robustness against wheel imbalance

All in all the HiPerStrut design provides improved ride and handling performance with a premium steering feel.

The design enables bigger wheels.

The design allows camber adjustment with screws on the steering knuckle upper ball stud.

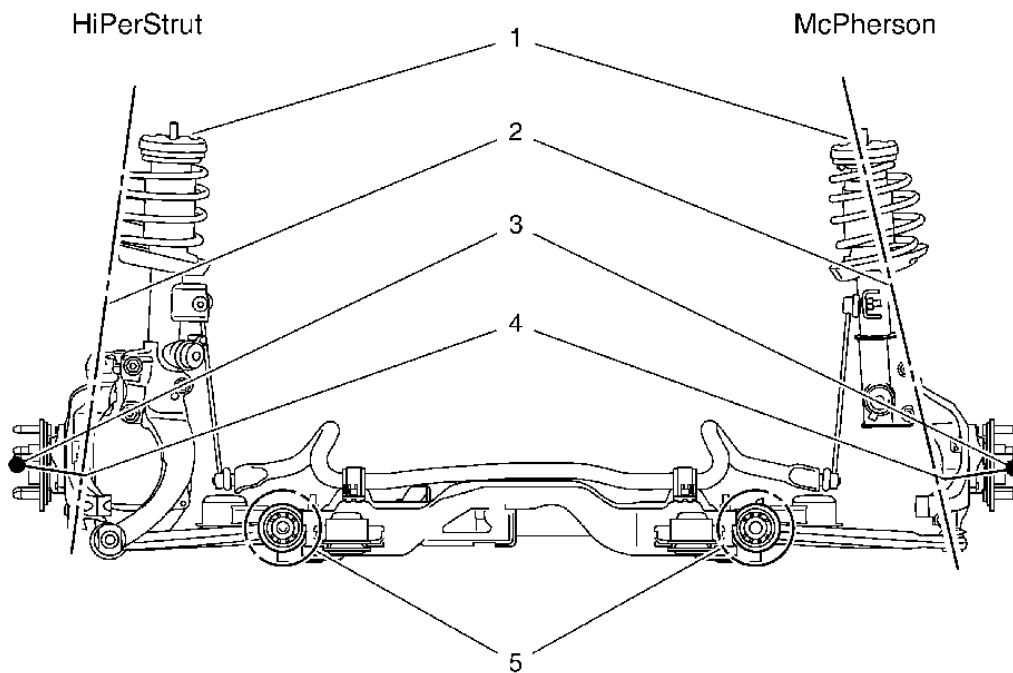


Fig. 45: HiPerStrut And McPherson Strut Design Comparison
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Upper Body Attachment (Same Points)
2	Kingpin Axis
3	Wheel Center
4	Spindle Length
5	Lower Body Attachment (Same Points)

GENERAL DESCRIPTION (GNA)

The front suspension has 2 primary purposes:

- Isolate the driver from irregularities in the road surface.

- Define the ride and handling characteristics of the vehicle.

The front suspension absorbs the impact of the tires travelling over irregular road surfaces and dissipates this energy throughout the suspension system. This process isolates the vehicle occupants from the road surface. The rate at which the suspension dissipates the energy and the amount of energy that is absorbed is how the suspension defines the vehicles ride characteristics. Ride characteristics are designed into the suspension system and are not adjustable. The ride characteristics are mentioned in this description in order to aid in the understanding of the functions of the suspension system. The suspension system must allow for the vertical movement of the tire and wheel assembly as the vehicle travels over irregular road surfaces while maintaining the tire's horizontal relationship to the road.

This requires that the steering knuckle be suspended between a lower control arm and a strut assembly. The lower control arm attaches from the steering knuckle at the outermost point of the control arm. The attachment is through a ball and socket type joint. The innermost end of the control arm attached at 2 points to the vehicle frame through semi-rigid bushings. The upper portion of the steering knuckle is attached to a strut assembly. The strut assembly then connects to the vehicle body by way of an upper bearing. The steering knuckle is allowed to travel up and down independent of the vehicle body structure and frame.

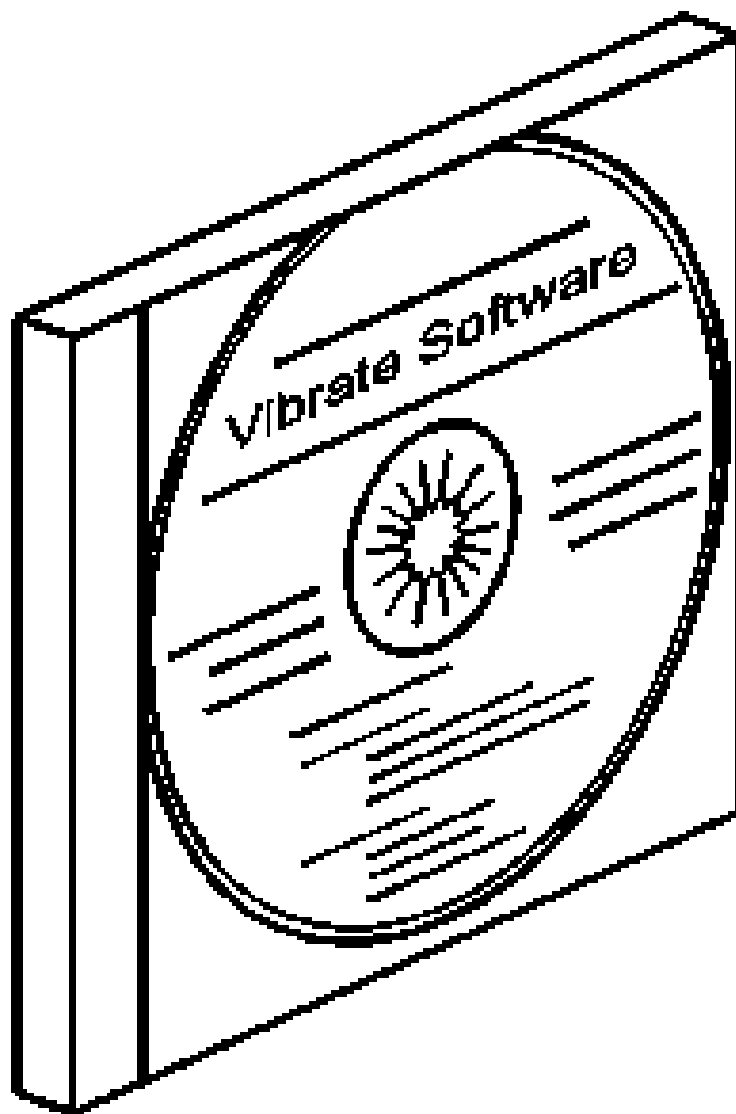
This up and down motion of the steering knuckle as the vehicle travels over bumps is absorbed predominantly by the coil spring. This spring is retained under tension over the strut assembly. A strut is used in conjunction with this system in order to dampen out the oscillations of the coil spring. A strut is a basic hydraulic cylinder. The strut is filled with oil and has a moveable shaft that connects to a piston inside the strut. Valves inside the shock absorber offer resistance to oil flow and consequently inhibit rapid movement of the piston and shaft. Each end of the shock absorber is connected in such a fashion to utilize this recoil action of a spring alone. Each end of the strut is designed as the connection point of the suspension system to the vehicle and acts as the coil spring seat. This allows the strut to utilize the dampening action to reduce the recoil of a spring alone. The lower control arm is allowed to pivot at the vehicle frame in a vertical fashion. The ball joint allows the steering knuckle to maintain the perpendicular relationship to the road surface.

Front suspensions systems utilize a stabilizer shaft. The stabilizer bar connects between the left and right lower control arm assemblies through the stabilizer link and stabilizer shaft insulators. This bar controls the amount of independent movement of the suspension when the vehicle turns. Limiting the independent movement defines the vehicles handling characteristics on turns.

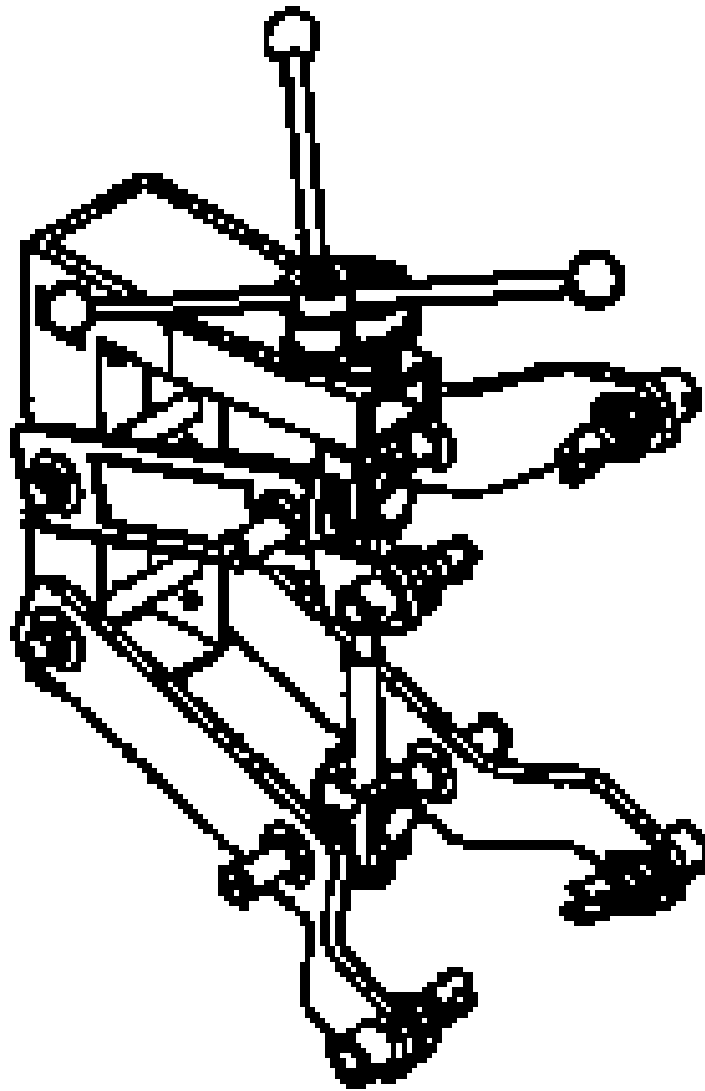
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

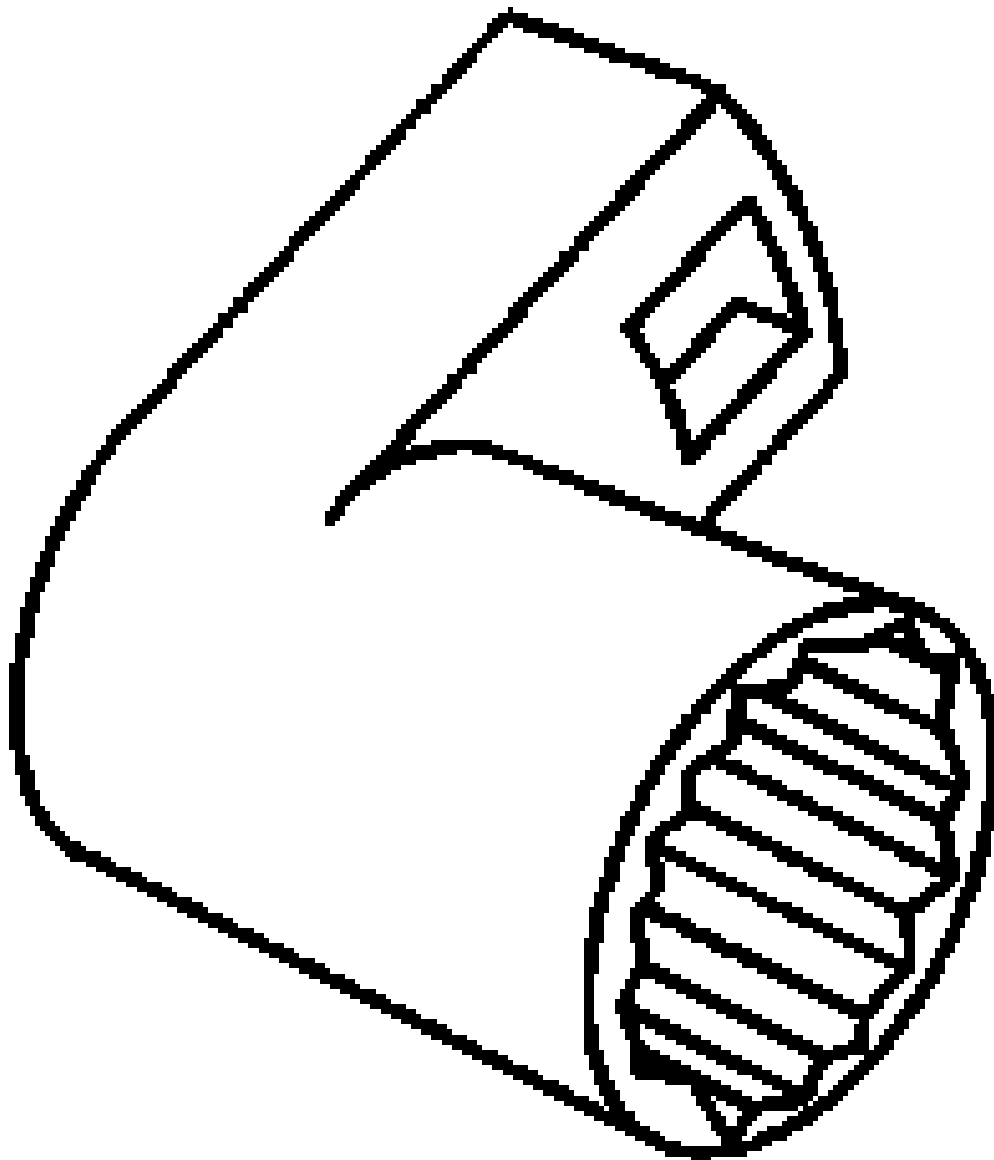
Illustration	Tool Number/Descrip



CH-43631
CH-49455
J-43631
Ball Joint Separa



CH-48845
Strut Spring
Compressor



CH-49375
Spanner (wrenc

GENERAL INFORMATION

General Cooling System Service

*** PLEASE READ THIS FIRST ***

This article is generic in nature and all information does not apply to all vehicles including those without a liquid cooling system. For vehicle specific information, see the appropriate articles in the ENGINE category.

DESCRIPTION

The liquid cooling system consists of a radiator, water pump, thermostat, electric or belt-driven cooling fan, pressure cap, heater, and various connecting hoses and cooling passages in the engine block and cylinder head.

MAINTENANCE

DRAINING

Remove radiator cap and open heater control valve to maximum heat position. Open drain cocks or remove plugs in bottom of radiator and engine block. In-line engines usually have one plug or drain cock, while "V" type engines have 2, one in each bank of cylinders.

FLUSHING

CAUTION: Some manufacturers use an aluminum and plastic radiator. Flushing solution must be compatible with aluminum.

Radiator

Connect flushing gun to water outlet of radiator. Disconnect water inlet hose. To prevent flooding engine, use a hose connected to radiator inlet. Use air in short bursts to prevent damage to radiator. Continue flushing until water runs clear.

Engine Block

To flush engine, remove thermostat. Connect flushing gun to water outlet of radiator. Use air in short bursts to prevent damage to radiator. Continue flushing until water runs clear.

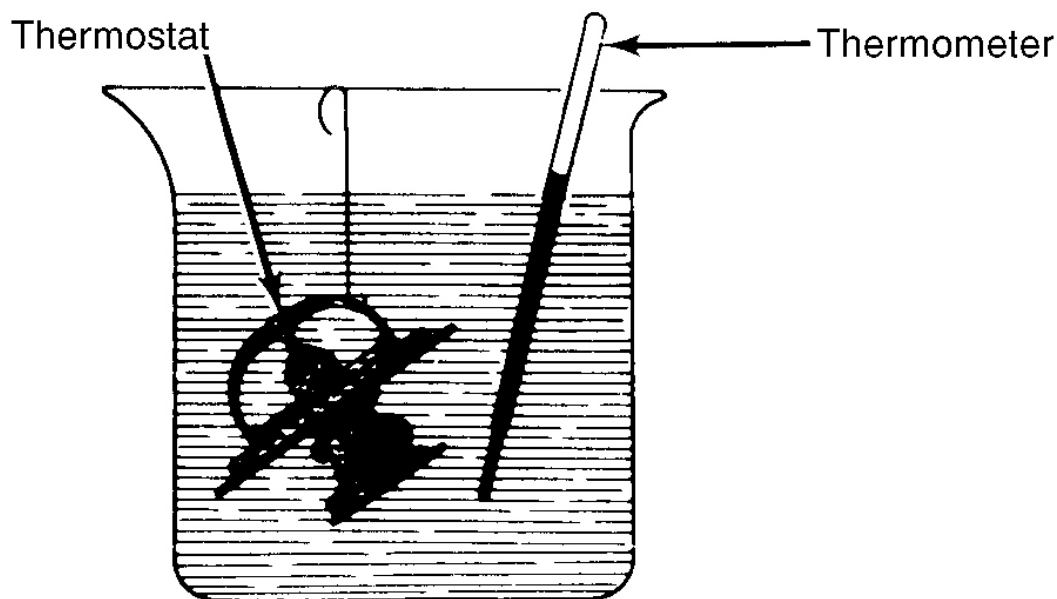
REFILLING

To prevent air from being trapped in engine block, engine should be running when refilling cooling system. After system is full, continue running engine until thermostat is open, then recheck fill level. Do not overfill system.

TESTING

THERMOSTAT

1. Remove and inspect thermostat for corrosion and proper seating of valve. If okay, suspend thermostat and thermometer in a 50/50 mixture of coolant and water. See **Fig. 1**. DO NOT allow thermostat or thermometer to touch bottom or container. Heat water until thermostat begins to open.
2. Read temperature on thermometer. This is the initial opening temperature and should be within specification. Continue heating water until thermostat is fully open and note temperature. This is the fully open temperature. If either reading is not to specification, replace thermostat.



95B14671

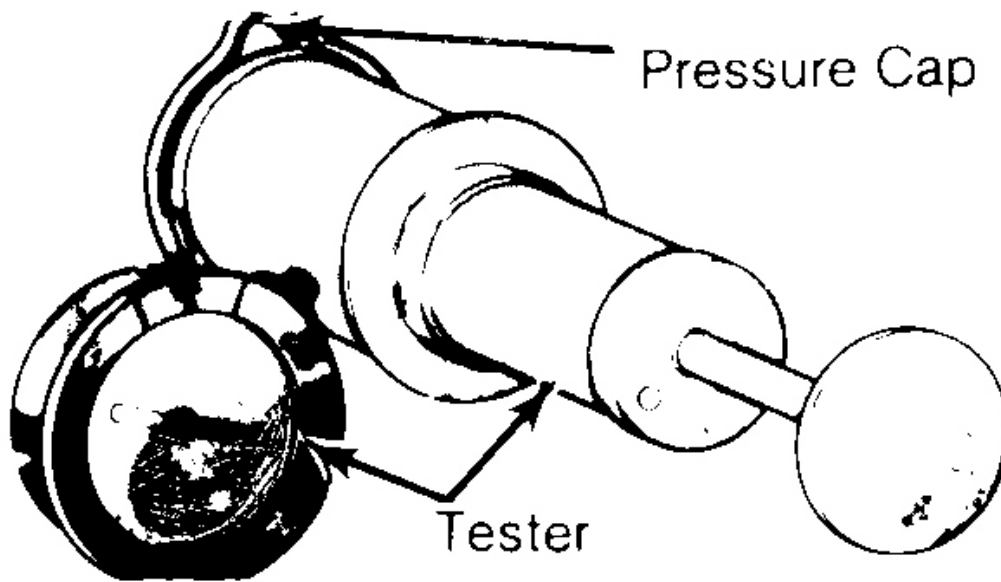
Fig. 1: Testing Thermostat in Coolant/Water Solution

PRESSURE TESTING

A pressure tester is used to check both radiator cap and complete cooling system. Follow pressure tester manufacturer instructions and test components as follows:

Radiator Cap

Visually inspect radiator cap. If cap looks okay, connect pressure tester to cap. See **Fig. 2**. Pressurize tester to full radiator cap specification. Replace cap if it fails to hold pressure.



95C14672

Fig. 2: Pressure Testing Radiator Cap

Cooling System

1. Turn ignition off and allow engine to cool. Ensure radiator is filled to correct level. Remove cap and attach pressure tester to radiator. Pressurize tester to full radiator rating specification.
2. If pressure drops, check for external leaks. If no leaks are found, start engine and allow to idle. If pressure builds up immediately, check cylinder head and block for cracks. If pressure does not build up immediately, go to next step.

CAUTION: DO NOT allow excess pressure to build in cooling system or damage may result.

3. Using pressure tester, pump cooling system up to pressure specified on radiator cap. If pump gauge pointer vibrates, compression or combustion leak into cooling system is indicated. Isolate leak by shorting each spark plug wire to cylinder block. Gauge pointer vibration will stop or decrease when leaking cylinder is shorted.

General Information

General Information

INTRODUCTION

ARROWS AND SYMBOLS

This service manual uses various symbols in order to describe different service operations.

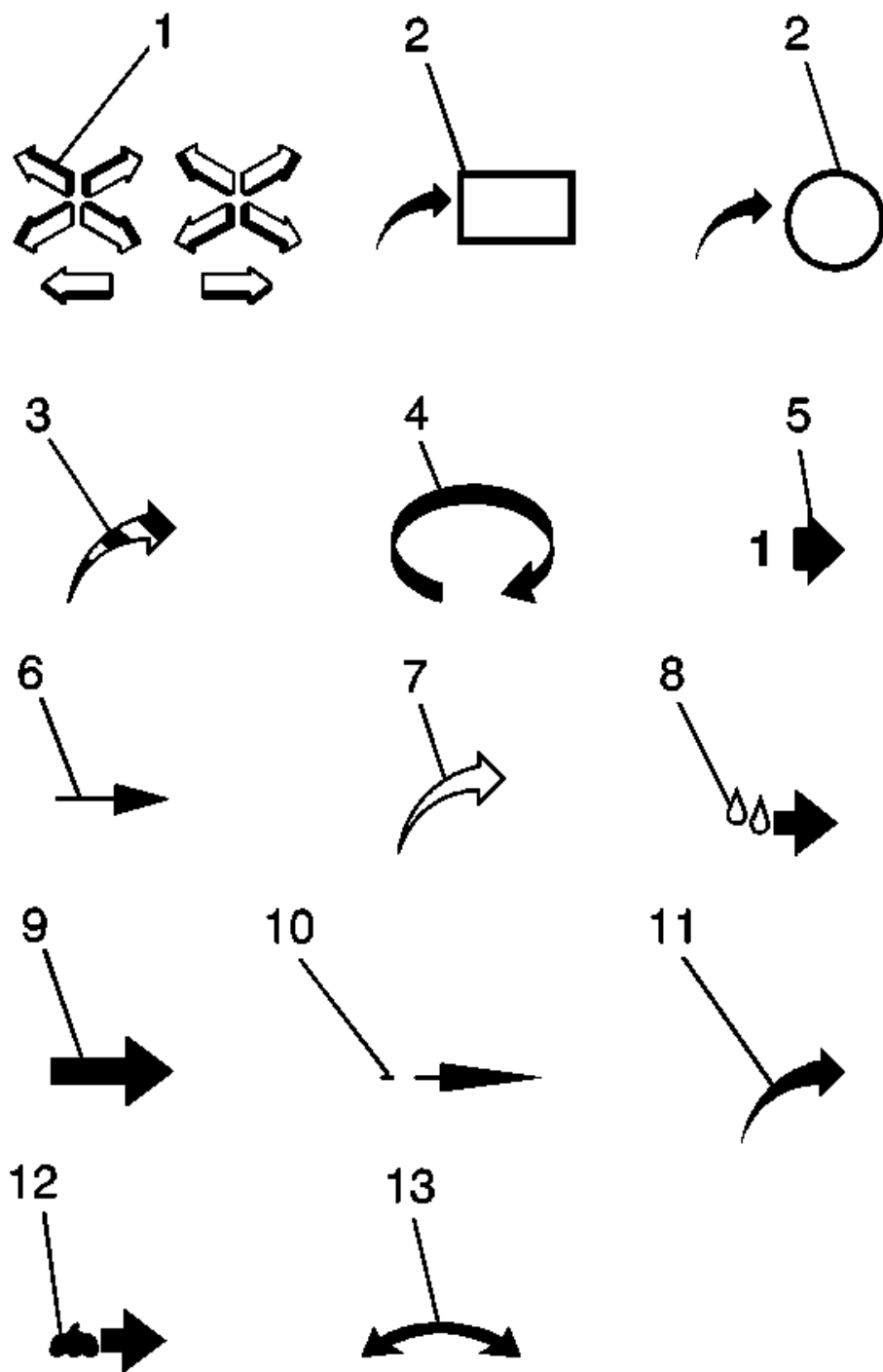


Fig. 1: Identifying Different Service Operations Symbols
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
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1	Front of Vehicle
2	View Detail
2	View Detail
3	Ambient Air Mixed with Another Gas or Indicate Temperature Change
4	Motion or Direction
5	View Angle
6	Dimension (1:2)
7	Ambient/Clean Air Flow or Cool Air Flow
8	Lubrication Point- Oil or Fluid
9	Task Related
10	Sectioning (1:3)
11	Gas Other Than Ambient Air or Hot Air Flow
12	Lubrication Point- Grease or Jelly
13	Multidirectional Arrow

ACRONYMS AND UNITS

Acronyms

Acronym	Meaning	Definition
2WD	Two-Wheel Drive	Indicates that a vehicle has 2 driven wheels OR that a 4WD vehicle uses only 2 wheels for propulsion. So it can be the description of a vehicle configuration OR the operational mode of the drivetrain.
4WD	Four-Wheel Drive	Four-wheeled vehicle with a drivetrain that allows all four wheels to receive power from the engine simultaneously which provides better control on various surfaces. Can be used to describe the configuration of the vehicle OR as the operational mode of the drivetrain. 4WD vehicles usually can turn 2 wheels off to be in a 2WD mode. See also AWD.
A/C	Air Conditioning	The cooling and dehumidification of indoor air for thermal comfort.
A/D	Analog to Digital	Used in context of converting electrical analog signals to digital signals.
ABS	Antilock Braking System	System on motor vehicles which prevents the wheels from locking while braking which helps the driver maintain control in heavy braking conditions.
AC	Alternating Current	An electrical current whose magnitude and direction vary cyclically.
AM	Amplitude Modulation	Method of impressing data onto an alternating-current (AC) carrier waveform.
APP	Accelerator Pedal Position	A pedal that controls the throttle valve.
		All-wheel-drive systems are designed to function on

AWD	All-Wheel Drive	all types of surfaces, both on- and off-road, and most of them cannot be switched off. This can also be called full-time four wheel drive. See also 4WD.
AWG	American Wire Gauge	American wire gauge is a standardized wire gauge system used since 1857 predominantly in the United States for the diameters of round, solid, nonferrous, electrically conducting wire. E.g. a wire of AWG10 has a diameter of 2.588mm, AWG20 corresponds to a diameter of 0.812mm.
B+	Battery Positive Voltage	The electrical potential on the positive terminal of the battery.
BARO	Barometric Pressure	Atmospheric pressure as measured by a barometer.
BCM	Body Control Module	This module supplies vehicle occupants with visual and audible information and controls various vehicle functions,
BECM	Battery Energy Control Module	Control module used to regulate the battery voltage.
BPP	Brake Pedal Position	Position of the foot pedal that moves a piston in the master brake cylinder.
CAN	Controller Area Network	Serial data connection between control modules by Bosch
CCM	Chassis Control Module	The module that controls various vehicle functions on the Chassis, like Engine/Trans Mount, Active Grille Air Shutter, Load Leveling, etc...
CD	Compact Disc	A small optical disk on which data such as music, text, or graphic images is digitally encoded.
CNG	Compressed Natural Gas	This a substitute for gasoline or diesel fuel. It is made by compressing natural gas (which is mainly composed by methane (CH ₄), in a percentage range of 70% to 98%)
CO	Carbon Monoxide	This is a product of the incomplete combustion of carbon-containing compounds, at room temperature this is a gas. It consists of one carbon atom covalently bonded to one oxygen atom.
CO ₂	Carbon Dioxide	Chemical compound composed of two oxygen atoms covalently bonded to a single carbon atom.
CPA	Connector Position Assurance	Part of an electrical connector that prevents the connector from moving out of its socket. Usually needs to be pressed to unlock the connector when disconnecting it.
CPP	Clutch Pedal Position	A lever operated with the foot that controls the coupling that connects or disconnects driving and driven parts of a driving mechanism.
CV	Constant Velocity	Used in conjunction with CV joints, which connect two shafts at an angle while both shafts always have the same rotational speed without variations.

CVT	Continuously Variable Transmission	A transmission in which the ratio of the rotational speeds of two shafts, as the input shaft and output shaft of a vehicle or other machine, can be varied continuously within a given range, providing an infinite number of possible ratios which improves fuel economy.
D	Drive	D on the transmission gear selector lever.
DAB	Digital Audio Broadcast	Technology for broadcasting of audio using digital radio (carries information via digital signal) transmission.
DC	Direct Current	Continuous current, constant flow of electric charge.
DLC	Data Link Connector	This is an electronic connector typically located underneath the driver's side dashboard, just above the pedals. The connector has 16 pins.
DMM	Digital Multimeter	Electronic measuring instrument that combines several functions in one unit. The most basic instruments include an ammeter, voltmeter, and ohmmeter.
DOHC	Dual Overhead Camshaft	Dual overhead camshafts (DOHC) are higher performance engines, they produce more power, and can run at higher speeds because they allow an engine to have four valves per cylinder. Each camshaft operates two of the valves, one camshaft handles the intake valves, and one handles the exhaust valves
DPF	Diesel Particulate Filter	Device designed to remove diesel particulate matter or soot from the exhaust gas of a diesel engine.
DRL	Daytime Running Lamps	White lights mounted on the front of an automobile that automatically switch on when the key is turned and are intended for daytime use, to increase the visibility of the automobile.
DSCC	Distance Sensing Cruise Control	A type of cruise control that automatically maintains the distance between vehicles.
DSP	Digital Signal Processor	A specialized microprocessor designed specifically for digital signal processing, generally in real-time computing.
DTC	Diagnostic Trouble Code	An electronic signal stored in an automotive computer, indicating the presence of a fault detected by that computer.
DVD	DVD	A popular optical disc storage media format the size of a CD. Used mainly for movies but also for data. DVD has no spelled out version (officially it does not mean Digital Video Disc or Digital Versatile Disc, it just means DVD).
EBCM	Electronic Brake Control Module	This module contains a microprocessor and software for antilock braking system operation.

ECM	Engine Control Module	This electronic module works with a vehicle's sensors and engine control devices to insure that the engine operates at maximum efficiency and performance. It performs three vital functions. Receives electronic signals from engine sensors. Analyzes the data and makes an engine performance decision (based on the pre-set parameters within the unit). Sends an "output command" to an actuator that adjusts engine performance.
ECT	Engine Coolant Temperature	A measure of how hot or cold the fluid which flows through the engine in order to prevent its overheating, transferring the heat produced by the device to other devices that utilize or dissipate it.
EEPROM	Electrically Erasable Programmable Read-Only Memory	A non-volatile storage chip used in computers and other devices to store small amounts of volatile data, e.g. calibration tables or device configuration.
EGR	Exhaust Gas Recirculation	Is an NOx (nitrogen oxide and nitrogen dioxide) reduction technique used in most gasoline and diesel engines. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders.
EMI	Electromagnetic Interference	Electromagnetic interference (also called radio frequency interference) is a disturbance that affects an electrical circuit due to either electromagnetic conduction or electromagnetic radiation emitted from an external source.
ESD	Electrostatic Discharge	The sudden and momentary electric current that flows between two objects at different electrical potentials.
EV	Electric Vehicle	A category of vehicles that only have an electric drive system.
EVAP	Evaporative Emission	A system that controls the fuel fumes in the fuel tank.
FM	Frequency Modulation	In telecommunication this is a way to convey information over a carrier wave by varying its frequency.
FWD	Front-Wheel Drive	A form of engine/transmission layout used in motor vehicles, where the engine drives the front wheels only.
GMLAN	General Motors Local Area Network	A local-area network is a computer network covering a small geographic area, like a home or vehicle. This specific type of LAN connects several controllers inside the vehicle and was developed by General Motors.
GPS	Global Positioning System	Satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense.
GSM	Global System for Mobile Communications	Globally accepted standard for digital cellular communication.

GVW	Gross Vehicle Weight	Maximum total weight of a road vehicle or trailer that is loaded, including the weight of the vehicle itself plus fuel, passengers, cargo, and trailer tongue weight.
HD	Heavy Duty	Robust design to accommodate large work loads.
HID	High Intensity Discharge	A type of light that produces a bright light by using gas filled bulbs. (gas is usually mercury, metal halide, and high-pressure sodium) Uses very little battery power and is a very "cool" light.
HO2S	Heated Oxygen Sensor	Heated oxygen sensors have an internal heater circuit that brings the sensor up to operating temperature more quickly than an unheated sensor. An oxygen sensor must be hot (about 600-650°F) before it will generate a voltage signal. The hot exhaust from the engine will provide enough heat to bring an O2 sensor up to operating temperature.
HVAC	Heating Ventilation Air Conditioning	This system is sometimes referred to as climate control. Ventilation air ducts installed throughout a vehicle that supply conditioned air to a room through rectangular or round outlet vents.
I ² C	Inter-Integrated Circuit	Serial data connection between Integrated Circuits (microchips) inside a control module invented by Phillips
IAT	Intake Air Temperature	Temperature of the air entering intake air flow system of the engine.
ICE	Internal Combustion Engine	An engine in which the combustion of fuel and an oxidizer (typically air) occurs in a confined space called a combustion chamber.
ID	Identification	Number or Code that identifies a component or control module. Can be written on the part or be transmitted on a bus or via radio.
ISP	Internet Service Provider	A company that furnishes corporations and individual consumers with various services, mainly access to the Internet.
ISS	Input Shaft Speed	Rotational speed of the input shaft of a transmission.
LAN	Local Area Network	Standard network connection PC's.
LCD	Liquid Crystal Display	A thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector.
LED	Light Emitting Diode	Small light bulbs that fit easily into an electrical circuit they do not have a filament that will burn out, and they do not get especially hot. They are illuminated solely by the movement of electrons in a semiconductor material.
LIN	Local Interconnect Network	Computer networking bus system used within automotive network architectures. Similar to CAN,

		but cheaper and less powerful.
LPG	Liquefied Petroleum Gas	A mixture of mainly propane and butane, produced commercially and stored under pressure to keep it in a liquid state.
MAF	Mass Air Flow	The amount of air drawn into the engine
MAP	Manifold Absolute Pressure	Pressure in the engine intake system after the throttle valve referenced to a perfect vacuum.
MDI	Multiple Diagnostics Interface	A device used by GM dealers that enables a PC to communicate with the control modules in a vehicle.
MIL	Malfunction Indicator Lamp	An indicator of the internal status of a car engine.
MOST	Media Oriented Systems Transport	Serial communication bus to transmit audio and video information.
N	Neutral	A state of the transmission in which it is not engaged.
NiMH	Nickel Metal Hydride	A type of rechargeable battery that uses a hydrogen absorbing alloy for the negative electrode.
NOx	Nitrogen Oxides	Refers to any of the following oxygen compounds of nitrogen or a mixture of them. Nitric Oxide, Nitrogen dioxide, Nitrous Oxide, Dinitrogen trioxide, Dinitrogen tetroxide, Dinitrogen pentoxide.
O2	Oxygen	A colorless, odorless, tasteless, gaseous chemical element with the chemical symbol O and atomic number 8.
O2S	Oxygen Sensor	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed.
OBD	On-Board Diagnostic	A generic term referring to a vehicle's self-diagnostic and reporting capability.
OEM	Original Equipment Manufacturer	A producer that provides a product to its customers, who proceed to modify or bundle it before distributing it to their customers.
OSS	Output Shaft Speed	Rotational speed of the output shaft of a transmission.
P	Park	A state in which the transmission is set so one can leave the vehicle.
PCB	Printed Circuit Board	A thin plate on which chips and other electronic components are placed.
PCM	Powertrain Control Module	A control module that features the functions of both, the engine and the transmission control module.
PCMCIA	Personal Computer Memory Card Industry Association	An international standards body and trade association with over 100 member companies that was founded in 1989 to establish standards for Integrated Circuit cards and to promote interchangeability among mobile computers where ruggedness, low power, and small size were critical.
PIN	Personal Identification Number	A secret numeric password shared between a user and a system that can be used to authenticate the user to the system.

PPE	Personal Protective Equipment	Protective clothing, helmets, goggles, or other garment designed to protect the wearer's body from injury.
PRNDL	Park, Reverse, Neutral, Drive, Low	Park, Reverse, Neutral, Drive, Low (automatic transmission positions).
PTC	Positive Temperature Coefficient	Refers to materials that experience an increase in electrical resistance when their temperature is raised.
PTO	Power Take-Off	A splined driveshaft, usually on a tractor or truck that can be used to provide power to an attachment or separate machine. This mechanism allows implements to draw energy from the tractor's engine.
PVC	Polyvinyl Chloride	A thermoplastic copolymer.
PWM	Pulse Width Modulation	Square shaped type of signal that carries the information in the ratio between on and off times.
R	Reverse	Rearward: directed or moving toward the rear;
RAM	Random Access Memory	A type of computer data storage. It today takes the form of integrated circuits that allow the stored data to be accessed in any order.
RCT	Radiator Coolant Temperature	This is the heat intensity of the radiator coolant measured in degrees. The radiator is a part of the cooling system that removes the engine heat. Coolant is a mixture of water and antifreeze (ethylene glycol) which lowers the freezing point of the water in the coolant system, this fluid also picks up heat from the engine and transfers it to the air.
RDS	Radio Data System	A standard from the European Broadcasting Union for sending small amounts of digital information using conventional FM radio broadcasts.
RF	Radio Frequency	A frequency or rate of oscillation within the range of about 3 Hz and 300 GHz. This range corresponds to frequency of alternating current electrical signals used to produce and detect radio waves.
ROM	Read-Only Memory	A class of storage media used in computers and other electronic devices. Data stored in ROM cannot be modified.
RPO	Regular Production Option	A three digit/letter code given to parts, assemblies, and systems originally installed on the vehicle. These RPO codes designate options and are assigned by General Motors.
RSA	Rear Seat Audio	An auxiliary set of controls that operate the main audio system from the rear seat. Rear passengers can also operate a different media source than the front passengers.
RWD	Rear-Wheel Drive	A common engine/transmission layout in which the engine is in the front of the vehicle, but the front mid-engine, rear mid-engine and rear engine layouts are

		also used.
SCV	Speed Controlled Volume	The volume control is set for a desired sound level in the vehicle as the vehicle increases its speed, the sound level is adjusted.
SDM	Sensing and Diagnostic Module	The name given to air bag modules used in General Motors vehicles.
SIM	Subscriber Identity Module	Part of a removable smart card Integrated Circuit Card. This is used for mobile cellular telephone devices such as mobile computers and mobile phones. SIM cards securely store the service-subscriber key used to identify a subscriber. The SIM card allows users to change phones by simply removing the SIM card from one mobile phone and inserting it into another mobile phone or broadband telephony device.
SIR	Supplemental Inflatable Restraint	Technical term for the air bag. Air bag is a stretchable membrane, which inflates during an automobile accident to provide cushioning to the passenger's head and torso to prevent injury to the passengers.
SPI	Serial Peripheral Interface	This is an interface that enables the serial (one bit at a time) exchange of data between two devices. An SPI operates in full duplex mode. This means that data can be transferred in both directions at the same time. It is a standard bus technology like CAN or I2C.
SPS	Service Programming System	System that enables repair facilities to update the software in control modules.
SUV	Sport Utility Vehicle	A passenger vehicle which combines the towing capacity of a pickup truck with the passenger-carrying space of a minivan.
SVS	Service Vehicle Soon	Indicator lamp or symbol for a malfunction related to a vehicle component or system.
TA	Traffic Announcement	Message spoken on radio regarding the movement of vehicles or pedestrians through an area or along a route. The buttons on radios that enable this announcements are also often labeled TA.
TAC	Throttle Actuator Control	A motor which moves the engine throttle plate or valve, controlled by the engine control module. A throttle plate limits the amount of air entering a internal combustion gasoline engine.
TAP	Transmission Adaptive Pressure	The transmission control module learns each component's characteristics and adjusts fluid pressure accordingly.
TCC	Torque Converter Clutch	Resides in a torque converter to connect an engine to an automatic transmission. The clutch is applied when conditions are correct to achieve a 1:1 ratio of engine crankshaft to transmission input shaft.
		A module that controls electronic automatic

TCM	Transmission Control Module	transmissions. It uses sensors from the vehicle as well as data provided by the Engine Control Module to calculate how and when to change gears in the vehicle for optimum performance, fuel economy and shift quality.
TDC	Top Dead Center	The piston is in its highest position relative to the combustion chamber.
TIS	Techline Information System	The PC-based global dealership diagnostic software that provides the technician the ability to reference the most recent service information via the service department's computer.
TPA	Terminal Position Assurance	An additional locking mechanism inside an electric connector that holds the pins in place.
TV	Television	A telecommunication system for broadcasting and receiving moving pictures and sound over a distance.
USB	Universal Serial Bus	A type of communication bus connection between a computer and a peripheral device.
VCI	Vehicle Communications Interface	A diagnostic tool that communicates to modules of multiple communication protocols in a vehicle by converting vehicle serial data into PC serial data communication.
VIN	Vehicle Identification Number	Used by manufacturers to uniquely identify motor vehicles using 17 characters.
VSCM	Vehicle Stability Control Module	This module uses information from several sensors to detect a loss of vehicle traction, then works with the antilock brake system to apply individual brakes to help keep the vehicle on its intended path.
VSS	Vehicle Speed Sensor	Sends data regarding how fast the car is traveling at the moment of driving. It is designed to be able to record the rate at which the vehicle's crankshaft is spinning.
WOT	Wide Open Throttle	When the throttle blade or valve is at its maximum open position, allowing maximum air to enter an internal combustion gasoline engine.
WLAN	Wireless Local Area Network	Standard to transmit digital data via radio frequency.
XM	XM (Satellite Radio)	XM Satellite Radio Holdings (XM) is one of two satellite radio services in the United States and Canada. XM provides pay-for-service radio, analogous to cable television. Its service includes 73 different music channels, 39 news, sports, talk, and entertainment channels, 21 regional traffic and weather channels and 23 play-by-play sports channels (2008).
XML	Extensible Markup Language	A markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

Units

Unit	Meaning	Definition
m ²	Square Meter	Area
A	Ampere	Electrical
Ah	Ampere Hour	Electrical
C	Coulomb	Electrical
dBm	Decibel Meter	Electrical
dBmV	Decibel Millivolt	Electrical
mV/DIV	Millivolts per Division	Electrical
mV/s	Millivolts per Second	Electrical
ohms	Ohm	Electrical
V	Volt	Electrical
V/DIV	Volts per Division	Electrical
V/ms	Volts per Millisecond	Electrical
W	Watt	Electrical
mm ³ /stroke	Cubic Millimeters per Stroke	Flow
gal/h	Gallons per Hour	Flow
g/s	grams per second	Flow
g/stroke	Grams per Stroke	Flow
kg/100km	Kilograms per 100 Kilometer	Flow
kg/h	Kilograms per Hour	Flow
km/L	kilometer/liter	Flow
L/100km	Liters per 100 Kilometers	Flow
L/h	Liters per Hour	Flow
L/min	Liters per Minute	Flow
MPG	Miles per Gallon	Flow
mg/s	Milligrams per Second	Flow
mg/stroke	Milligrams per stroke	Flow
ft	feet	Length
in	Inch	Length
m	Meter	Length
mi	Mile	Length
bar	Bar	Mechanical
bar/min	Bars per Minute	Mechanical
in. H2O	Inches of Water	Mechanical
in. H2O/s	Inches of Water per second	Mechanical
kPa/s	Kilopascals per Second	Mechanical
N	Newton	Mechanical
	Newton Meter	Mechanical
Pa	Pascal	Mechanical
Pa/s	Pascals per Second	Mechanical

lb ft	Pound Foot	Mechanical
PSI	Pound-Force per Square Inch	Mechanical
Counts	Counts	Misc.
Cycles	Cycles	Misc.
dB	Decibel	Misc.
°	Degree	Misc.
°C	Degree Centigrade	Misc.
°CA	Degree Crankshaft Angle	Misc.
°F	Degree Fahrenheit	Misc.
°/s	Degree per Second	Misc.
Hz	Hertz	Misc.
kbit/s	Kilobit per second	Misc.
lx	Lux	Misc.
ppm	Parts per Million	Misc.
%	Percent	Misc.
%/min	Percents per Minute	Misc.
%/sec	Percents per Second	Misc.
Pulses	Pulses	Misc.
:1	Ratio	Misc.
RPM	Revolutions per Minute	Misc.
Steps	Steps	Misc.
W/m ²	Watts per Square Meter	Misc.
g	g (Acceleration)	Movement
km/h	Kilometers per Hour	Movement
m/s	Meters per Second	Movement
m/s ³	Meters per Second Cubed	Movement
m/s ²	Meters per Second Squared	Movement
MPH	Miles per Hour	Movement
mm/s	Millimeters per Second	Movement
d	Day	Time
h	Hour	Time
hh:mm:ss	Hour:Minute:Second	Time
ms/DIV	Milliseconds per Division	Time
min	Minute	Time
s	Second	Time
s/DIV	Seconds per Division	Time
yy-mm-dd	Year-Month-Day (2 digits)	Time
yyyy-mm-dd	Year-Month-Day (4 digits, preferred)	Time
m ³	Cubic Meter	Volume
gal	Gallon	Volume

L	Liter	Volume
mL	milliliters	Volume
US gal	US Gallon	Volume
US pt	US Pint	Volume
US qt	US Quart	Volume
kg	Kilogram	Weight

CUSTOMER CONCERN VERIFICATION SHEETS

The GM Customer Concern Verification Sheets have been designed to improve communications between the service customer and the technician. The more clearly the technician understands the concern and its symptoms, the more likely the concern will be fixed right the first time.

The GM-wide Customer Concern Verification Sheets are available in DealerWorld. The Customer Concern Verification Sheets may be printed and reproduced locally.

TRAINING

Dealers

All U.S. GM Dealers participating in the Center of Learning / GM Service Technical College (STC) Programs can enroll through the Center of Learning website at <https://www.centerlearning.com>. Within the website, there are individual training paths that are designed to assist in planning the training needs for each individual and their job role. Dealers who have questions about Center of Learning Training should contact the Center of Learning help desk at 1-888-748-2687. The help desk is available Monday through Friday, 8:00 am - 9:00 pm Eastern Standard Time, excluding holidays. For GM Access support, contact the GM Access Help Desk at 1-888-337-1010.

Fleets

GM Fleet customers with GM Warranty In-Shop agreements are able to participate in service technical training through the Center of Learning/GM Service Technical College (STC).

Assistance for GM fleet registered customers using GM STC training is provided by the Center of Learning help desk at 1-888-748-2687. The help desk is available Monday through Friday, 8:00 am-9:00 pm Eastern Standard Time, excluding holidays. For GM Access support, contact the GM Access Help Desk at 1-888-337-1010.

Most GM STC course materials have associated charges.

To purchase authentic GM STC Training Materials, contact the GM Training Materials Headquarters at 1-800-393-4831.

Non-GM Dealer Technicians

Technician training for non-GM dealers is available through ACDelco. This training is for ACDelco PSC and Fleet program members employed in the automotive or truck service industry.

ACDelco courses are available at approved GM STC Training Centers. Availability and schedules can be obtained by calling 1-800-825-5886 (prompt 1) or contact us via the web at www.acdelcotechconnect.com and select the Training tab. Seminars are also offered through the ACDelco Warehouse Distribution channel. Contact your Local ACDelco representative or distributor directly for more information.

VEHICLE, ENGINE AND TRANSMISSION ID AND VIN LOCATION, DERIVATIVE AND USAGE

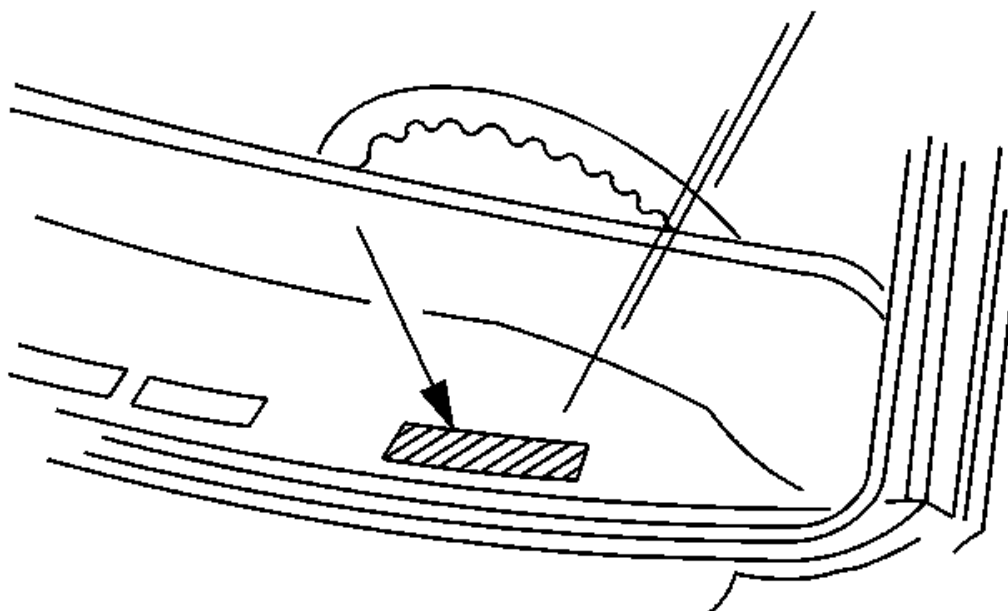


Fig. 2: Locating Vehicle Identification Number (VIN) Plate
Courtesy of GENERAL MOTORS COMPANY

The vehicle identification number (VIN) plate is the legal identifier of the vehicle. The VIN plate is located on the upper left corner of the instrument panel (I/P) and can be seen through the windshield from the outside of the vehicle:

Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage

Position	Definition	Character	Description
1	Region of Build	2	Canada

2	Manufacturer	G	General Motors
3	Make	4	Passenger Car
4 5	Carline/Series	G/K	Leather Group
		G/L	Leather Group AWD
		G/M	Premium Group I eAssist
		G/N	Premium Group I
		G/P	Premium Group I AWD
		G/R	Premium Group II
		G/S	Premium Group II AWD
		G/T	GS
		G/U	GS AWD
		G/8	(Export - Non US, Non Canada)
6	Body Style	5	69 - Sedan, 4-Door, 4 Window, Notchback
7	Restraint System	E	AY0 - Active Manual Belts, Airbags-Driver and Passenger-Front (1st row), Front Seat Side (1st row), Roof Side (all seating rows)
		G	AW7 - Active Manual Belts, Airbags-Driver and Passenger-Front (1st row), Front Seat Side (1st) and Rear Seat Side (2nd row), Roof Side (all seating rows)
8	Engine Type	R	RPO LUK Engine - Gas, 4 Cylinder, 2.4L, DI, Aluminum, DOHC, BAS, ECOTEC
		X	RPO LTG Engine - Gas, 4 Cylinder, 2.0L, SIDI, L4, Aluminum, DOHC, VVT, Turbo E85 MAX
9	Check Digit	-	Check Digit
10	Model Year	E	2014
11	Plant Location	1	Oshawa #1
12-17	Plant Sequence Number	-	Plant Sequence Number

2.0L (LTG) Engine ID and VIN Derivative Location

Refer to [Engine Identification](#) .

2.4L (LEA, LUK) Engine ID and VIN Derivative Location

Refer to [Engine Identification \(LEA, or LUK\)](#) .

6T40 (MH8, MHH) Transmission ID and VIN Derivative Location

Refer to [Transmission Identification Information](#) .

6T70 (M7U, M7W) Transmission ID and VIN Derivative Location

Refer to Transmission Identification Information .

VEHICLE CERTIFICATION, TIRE PLACARD, ANTI-THEFT, AND SERVICE PARTS ID LABEL

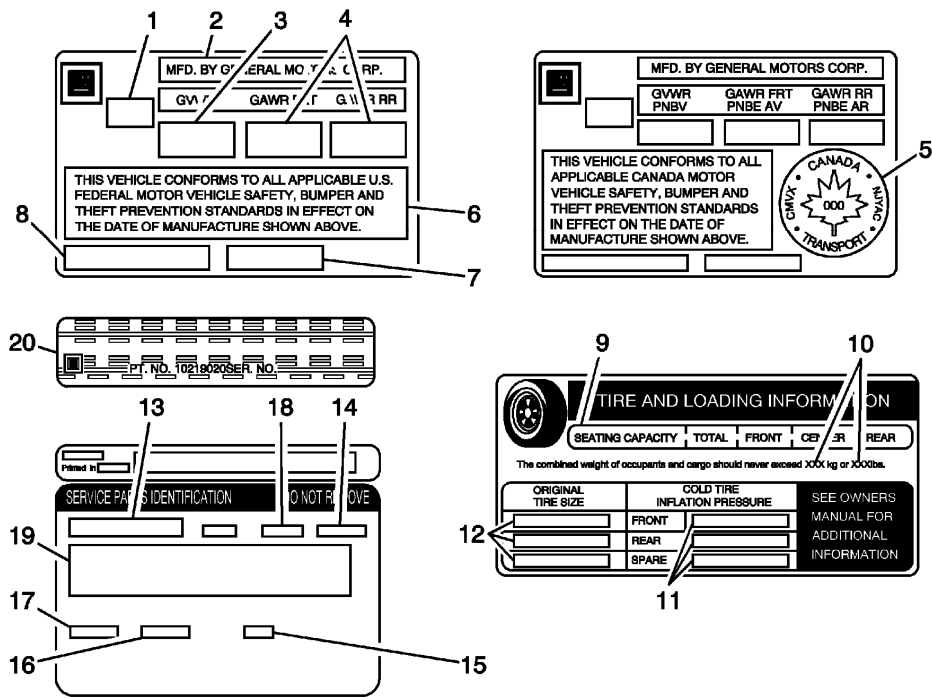


Fig. 3: Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label
Courtesy of GENERAL MOTORS COMPANY

Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label

Callout	Description
Vehicle Certification Label	
The vehicle certification label is located on the left hand side of the B pillar and displays the following assessments:	
<ul style="list-style-type: none">• Gross Vehicle Weight Rating (GVWR)• Gross Axle Weight Rating (GAWR), front and rear• The gross vehicle weight (GVW) is the weight of the vehicle and everything it carries. The gross vehicle weight must not exceed the Gross Vehicle Weight Rating. Include the following items when figuring the GVW:<ul style="list-style-type: none">○ The base vehicle weight (factory weight)○ The weight of all vehicles accessories○ The weight of the driver and the passengers○ The weight of the cargo	

1	Name of Manufacturer
2	Gross Vehicle Weight Rating
3	Gross Axle Weight Rating (Front, Rear)
4	Canadian Safety Mark (w/RPO Z49)
5	Certification Statement
6	Vehicle Class Type (Pass Car, etc.)
7	Vehicle Identification Number
8	Date of Manufacture (Mo/Yr)
Tire Placard	
The tire placard label is located on the forward portion of the center pillar and displays the following assessments:	
9	Specified Occupant Seating Positions
10	Maximum Vehicle Capacity Weight
11	Tire Pressure, Front, Rear, and Spare (Cold)
12	Original Equipment Tire Size
Service Parts ID Label	
The vehicle service parts identification label is located in the rear compartment attached to the left side of the spare tire well. The label is use to help identify the vehicle original parts and options.	
13	Vehicle Identification Number
14	Engineering Model Number (Vehicle Division, Line, and Body Style)
15	Interior Trim Level and Decor
16	Exterior (Paint Color) WA Number
17	Paint Technology
18	Special Order Paint Colors and Numbers
19	Vehicle Option Content
Anti-Theft Label	
20	<p>The Federal law requires that General Motors label certain body parts on this vehicle with the VIN. The purpose of the law is to reduce the number of motor vehicle thefts by helping in the tracing and recovery of parts from stolen vehicles.</p> <p>Labels are permanently affixed to an interior surface of the part. The label on the replacement part contains the letter R, the manufacturer's logo, and the DOT symbol.</p> <p>The anti-theft label must be covered before any painting, rustproofing procedures, and uncovered after the procedures. Failure to follow the precautionary steps may result in liability for violation of the Federal Vehicle Theft Prevention Standard and possible suspicion to the owner that the part was stolen.</p>

RPO CODE LIST

The following table provides the description of the Regular Production Option (RPO) codes that are available on the vehicle. The vehicle's RPO list is printed on the Service Parts Identification Label.

RPO	Description
01A	TRIM COLOR SEAT - JET BLACK VAR 1

01B	TRIM COLOR SEAT - LT NEUTRAL
05E	TRIM COLOR SEAT - SADDLE UP
1AB	TRIM COLOR DR PANEL - JET BLACK
1AC	TRIM COLOR DR PANEL - LT NEUTRAL
1BE	TRIM COLOR DR PANEL - COCOA
2D1	MOLDING DOOR INTR - DIAMO BLACK
2D5	MOLDING DOOR INTR - ECHELON WARM
2GX	MOLDING DOOR INTR - RHYTHM WOOD
3CY	MOLDING I/P - ECHELON WARM
3CZ	MOLDING I/P - DIAMO BLACK
3ET	MOLDING I/P - RHYTHM WOOD
4AA	INTERIOR TRIM - JET BLACK
4AB	INTERIOR TRIM - COCOA
4C6	INTERIOR TRIM - COCOA/SADDLE UP
5A7	WHEEL SPARE - NONE
5XQ	ACCESSORY - WHEEL - 19 X 8.5 - J - ALUMINUM - DESIGN 3
9L3	TIRE SPARE - NONE
A45	MEMORY - SEAT ADJUSTER, MIRROR, POWER, DRIVER, PERSONALIZATION
A51	SEAT - FRT BKT, CUSTOM
A69	RESTRAINT - SEAT BELT TENSIONER, FRT, VAR. 2
A6C	ADJUSTER PASS ST - MANUAL, 4 WAY, PWR VERT
A70	RESTRAINT - SEAT BELT TENSIONER, FRT
A90	LOCK CONTROL RR CMPT - LID, REM CONT ELEC RELEASE
AE2	LATCH - RR COMPARTMENT, SAFETY, MANUAL RELEASE
AE4	SEAT - FRT BKT, SPORT
AEF	WINDOW REG PASS DR - POWER OPERATED, EXPRESS UP/DOWN
AEQ	WINDOW REG REAR DR - POWER OPERATED, EXPRESS DOWN
AFL	INTERIOR TRIM CONFIG - #12
AFM	INTERIOR TRIM CONFIG - #13
AFN	INTERIOR TRIM CONFIG - #14
AFP	INTERIOR TRIM CONFIG - #44
AG1	ADJUSTER FRT ST - POWER, MULTI - DIRECTIONAL, DRIVER
AG2	ADJUSTER PASS ST - POWER, MULTI-DIRECTIONAL
AJC	RESTRAINT - HEAD, FRT SEAT, UP/DOWN ADJUSTMENT
AKL	WINDSHIELD TYPE - HEAT REFLECTIVE
AKP	WINDOW TYPE - SOLAR ABSORBING
AKX	WINDSHIELD TYPE - SOLAR ABSORBING
AL0	SENSOR INDICATOR - INFLATABLE RESTRAINT, FRT PASS/CHILD PRESENCE DETECTOR
AP9	NET - CONVENIENCE

APG	CONTROL - SEAT, POWER LUMBAR, LH (DO NOT USE FOR NEXT NEW MAJOR)
APH	CONTROL - SEAT, POWER LUMBAR, RH (DO NOT USE FOR NEXT NEW MAJOR)
AQQ	LOCK CONTROL, ENTRY - REMOTE ENTRY, EXTENDED RANGE (MY 09 AND FUTURE)
ASV	EQUIPMENT - SENSOR AIR MOISTURE AND W/S TEMP
ATH	LOCK CONTROL, ENTRY - REMOTE ENTRY, EXTENDED RANGE, PASSIVE ENTRY, ALL DOORS
AW7	RESTRAINT SYSTEM - SEAT, INFLATABLE, DRIVER AND PASS FRT, FRT SEAT SIDE AND RR SEAT SIDE, ROOF SIDE
AXG	WINDOW REG DRVR DR - POWER OPERATED, EXPRESS UP/DOWN
AXJ	VEHICLE TYPE - PASSENGER CAR
AY0	RESTRAINT SYSTEM - SEAT, INFLATABLE, DRIVER AND PASS FRT, SEAT SIDE, ROOF SIDE
B34	COVERING FRT - FLOOR MATS, CARPETED INSERT
B35	COVERING REAR - FLOOR MATS, CARPETED INSERT
B7Y	PLATE - DOOR SILL COVER, CHROME
BTM	SWITCH - ENGINE START, KEYLESS
BTT	ALARM - REMOTE PANIC
BTV	REMOTE START - ENGINE
C59	VENT - AIR, CONSOLE, RR
CAV	ACCESSORY - TRAY - TRUNK/CARGO AREA
CF5	ROOF - SUN, GLASS, SLIDING, ELEC
CJ2	HVAC SYSTEM - AIR CONDITIONER FRT, AUTO TEMP CONT, AUX TEMP CONT
CV3	COUNTRY - MEXICO
D70	RATIO - TRANSAXLE FINAL DRIVE 2.77
D7A	HANDLE O/S DOOR - BODY COLOR, CHROME STRIP
DA1	ARM REST - RR SEAT, STORAGE
DBZ	HANDLE, REAR CLOSURE - O/S, DECKLID/TAILGATE, SATIN CHROME
DD8	MIRROR I/S R/V - LT SENSITIVE
DH6	MIRROR I/S FRT VAN - LH AND RH, SUNSHADE, ILLUM
DWK	MIRROR O/S - LH AND RH, RC, ELEC, HEAT, FLAT/DRVR, MANFOLD, CNVX/PASS, TURN SIG IND
EA1	POCKET - FRONT SEAT BACK, LH
EA2	POCKET - FRONT SEAT BACK, RH
EAI	TRIM SEAT - LEATHER, SOLEIL KEISEL
EF7	COUNTRY - UNITED STATES OF AMERICA (USA)
EPM	MODEL CONVERSION - ALL WHEEL DRIVE
F07	RATIO - TRANSAXLE FINAL DRIVE 3.39

F45	CHASSIS - CONTINUOUSLY VARIABLE REAL TIME DAMPING
F46	CHASSIS DRIVE LINE - ALL WHEEL DRIVE (AWD), FULL TIME
FBF	TRIM DOOR - VINYL, SHEFFIELD
FE9	CERTIFICATION - EMISSION, FEDERAL
FHO	VEHICLE FUEL - GASOLINE E10
FX3	RIDE AND HANDLING - AUTOMATIC ELECTRONIC CONTROLLED
FXJ	RATIO - TRANSAXLE FINAL DRIVE 2.64
G7P	PRIMARY COLOR - EXTERIOR, TIN ROOF RUSTED MET (138X)
G96	AXLE POSITRACTION - LIMITED SLIP, ELECTRONIC
GAN	PRIMARY COLOR - EXTERIOR, SWITCHBLADE SILVER MET (G) 636R
GAZ	PRIMARY COLOR - EXTERIOR, SUMMIT WHITE (G) 8624
GBA	PRIMARY COLOR - EXTERIOR, BLACK (G) 8555
GBE	PRIMARY COLOR - EXTERIOR, CRYSTAL CLARET TINTCOAT (G) 505Q
GBN	PRIMARY COLOR - EXTERIOR, WHITE DIAMOND TRICOAT (G) 800J
GLJ	PRIMARY COLOR - EXTERIOR, ASHEN GRAY METALLIC 810T
GLK	PRIMARY COLOR - EXTERIOR, BLACK DIAMOND TRICOAT 815T
GNA	CHASSIS EQUIP FRONT - STRUT ASM
GNB	CHASSIS EQUIP FRONT - STRUT ASM, PERFORMANCE
GNC	CHASSIS EQUIP REAR - REAR AXLE, 4-LINK
GNE	CHASSIS EQUIP REAR - REAR AXLE, H-ARM
GWT	PRIMARY COLOR - EXTERIOR, CHAMPAGNE SILVER MET (102V)
GXH	PRIMARY COLOR - BERLIN BLUE MET (122V)
GY6	RATIO - TRANSAXLE FINAL DRIVE 3.76
HP6	HYBRID PROPULSION - ELECTRIC, PARALLEL, 14KW CONTINUOUS POWER
I14	ENGINEERING YEAR - 2014
IO5	RADIO - INFOTAINMENT SYSTEM - UPLEVEL HMI, ENHANCED CONNECTIVITY
IO6	RADIO - INFOTAINMENT SYSTEM - UPLEVEL HMI, ENHANCED CONNECTIVITY, EMBEDDED NAVIGATION
J60	BRAKE SYSTEM - POWER, FRT AND RR DISC, ABS, 16"
J61	BRAKE SYSTEM - POWER, FRT AND RR DISC, ABS, 17"
J64	BRAKE SYSTEM - POWER, FRT AND RR DISC, ABS, 18+
J71	BRAKE PARKING - POWER OPERATED
JF5	PEDALS - SPORTY, ALLOY
JJ2	BRAKE LINING - BRAKE NOISE AND DUST PERFORMANCE
K05	HEATER ENG - BLOCK
K09	GENERATOR - 120 AMP
K34	CRUISE CONTROL - AUTOMATIC, ELECTRONIC
KA1	HEATER SEAT FRT - DRVR AND PASS
KB5	CONTROL - ECM GRADE BRAKING

KC5	RECEPTACLE - ELECTRICAL, ACCESSORY
KD4	RECEPTACLE - ELECTRICAL, FRT CONSOLE
KG4	GENERATOR - 150 AMP
KG8	GENERATOR - 130 AMP
KI6	RECEPTACLE - ELECTRICAL, FRT CONSOLE RR 110 VOLT
KOT	CONTROL - CONSOLE, INFOTAINMENT, REDUNDANT CONTROLS, TOUCH PAD
KSG	CRUISE CONTROL - AUTOMATIC, ADAPTIVE, WITH STOP/GO
KTI	KIT, TIRE - INFLATOR
KY2	GENERATOR - HYBRID MOTOR, BAS+, 120 AMP
LEA	ENGINE - GAS, 4 CYL, 2.4L, SIDI, DOHC, E85 MAX, ALUM, GM
LHD	VEHICLE DRIVE - LEFTHAND DRIVE
LTG	ENGINE - GAS, 4 CYL, 2.0L, SIDI, L4, ALUM DOHC, VVT, DCVCP, TURBO, E0-E100, ALUM
LUK	ENGINE - GAS, 4 CYL, 2.4L, DI, ALUM, DOHC, BAS, ECOTEC
M7U	TRANSMISSION - AUTO 6 SPD, 6T70, AWD, GEN 2
M7W	TRANSMISSION - AUTO 6 SPD, 6T70, FWD, GEN 2
MAH	MARKETING AREA - US, PUERTO RICO/USVI
MBC	MARKETING AREA - CANADA
MCR	RECEPTACLE - MEMORY CARD
MCX	MARKETING AREA - MEXICO
MDE	MOLDING B/S UPPER - BRIGHT, WINDOW ALL AROUND
MDJ	MOLDING B/S UPPER - SATIN CHROME, WINDOW ALL AROUND
MH8	TRANSMISSION - AUTO 6 SPD, HMD, X23F
MHH	TRANSMISSION - AUTO 6 SPD, HMD, GM, BAS+, 6T40, HYBRID, FWD
MR6	TRANSMISSION - MAN 6 SPD, OPEL, 83MM, 3.92 1ST, 0.62 6TH (F40 WR), REDUCE HELIX
MWN	TAILPIPE - DUAL, INTEGRATED IN FASCIA
N34	STEERING WHEEL - LEATHER, 3 SPOKES
N37	STEERING COLUMN - TILT, TELESCOPING
N55	STEERING WHEEL - LEATHER, 3 SPOKES, SPORT, ERGONOMIC
NCG	LOCK - ELECTRICAL CHILD LOCK SYSTEM (REAR DOOR LATCH)
NE1	CERTIFICATION - EMISSION, GEOGRAPHICALLY RESTRICTED REGISTRATION FOR VEHICLES UP TO 14,000 LBS GVW (USE 2003 MDL YR
NJ1	STEERING - POWER, NON-VARIABLE RATIO, ELECTRIC
NJ2	STEERING - ELECTRIC, BELT DRIVE
NT7	EMISSION SYSTEM - FEDERAL, TIER 2
NU5	EMISSION SYSTEM - CALIFORNIA, BIN 4
NU6	EMISSION SYSTEM - CALIFORNIA, PZEV
OSH	PLANT CODE - OSHAWA 1, ONT, CANADA
PXR	WHEEL - 18 X 8.0, J, ALUMINUM, DESIGN 15

Q6Y	WHEEL - 18 X 8.0, J, ALUMINUM, DESIGN 7
QCL	TIRE SPARE - T125/70R17 SL 98M BW SPR
QI9	TIRE ALL - 255/35R20-97Y BW R/ST TL HW4 (DO NOT USE AFTER 2011 ON NEW/MAJOR PROGRAMS)
QKE	TIRE ALL - P235/50R18 SL 97V BW AL3
RAF	TIRE ALL - P235/50R17 SL 95T BW ALS
REH	WHEEL - 19 X 8.5, J, ALUMINUM, DESIGN 19
RP2	TIRE ALL - P245/40R19-94W BW R/ST TL AL3 (DO NOT USE AFTER 2011 ON NEW/MAJOR PROGS)
RSB	WHEEL - 17 X 7.0, J, ALUMINUM, DESIGN 1
RTJ	WHEEL - 20 X 8.5, J, ALUMINUM, DESIGN 4
RV9	WHEEL SPARE - 17 X 4.0, T, STEEL, DESIGN 1
RVZ	WHEEL SPARE - 16 X 4.0, T, STEEL, DESIGN 1
RWS	ACCESSORY - FLOOR MATS - CARPET
RYT	ACCESSORY - FIRST AID KIT
S02	ACCESSORY - HEADPHONES - NOISE CANCELING
S07	ACCESSORY - HEATER KIT - PARKING
S0L	ACCESSORY - ILLUMINATED CUP HOLDERS
S0O	ACCESSORY - ILLUMINATED FOOT WELLS
S5X	ACCESSORY - PARK ASSIST - REAR
S6P	ACCESSORY - REMOTE START KIT
SAO	ACCESSORY - SMOKERS PACKAGE
SE4	ACCESSORY - WHEEL - 18" - ALUMINUM - DESIGN 1
SE7	ACCESSORY - WHEEL - 18" - ALUMINUM - DESIGN 4
SSG	GRAPHIC - SWITCH FUNCTION SYMBOL
T3U	LAMP FRT FOG - FRT FOG
T4A	HEADLAMPS - HALOGEN
T4F	HEADLAMPS - HIGH INTENSITY DISCHARGE
T67	BATTERY - LN3, FLA, 12V, 70AH, 512 ENCCA
T83	CONTROL, HEADLAMPS - AUTOMATIC ON-OFF
TG5	PLAYER - COMPACT DISC AND MP3
TM7	BATTERY - LN2, FLA, 12V, 60AH, 438 ENCCA
TSP	LAMP PACKAGE - INTERIOR, CUSTOM
TTV	SPOILER - RR, LID/LIFTGATE, SPORT
TU2	LAMP - MARKER, SIDE
U19	SPEEDOMETER - INST, KILO AND MILES, KILO ODOMETER
U2J	DIGITAL AUDIO SYSTEM - S-BAND - NONE
U2M	DIGITAL AUDIO SYSTEM - S-BAND AND HD
U65	SPEAKER SYSTEM - 7, PREMIUM
U77	ANTENNA - RR WINDOW, RADIO
U80	DISPLAY - COMPASS

UD5	PARK ASSIST - FRONT AND REAR
UD7	PARK ASSIST - REAR
UDD	DISPLAY INSTRUMENT - DRIVER INFO ENHANCED (MULTI COLOR STANDARD GRAPHIC)
UE1	COMMUNICATION SYSTEM - VEHICLE, ONSTAR
UE4	SENSOR INDICATOR - FOLLOWING DISTANCE
UEU	SENSOR INDICATOR - FORWARD COLLISION ALERT
UFG	SENSOR INDICATOR - REAR CROSS TRAFFIC ALERT
UFL	LANE ACTIVE SAFETY - DEPARTURE WARNING
UG1	OPENER - GARAGE DOOR, UNIVERSAL
UGN	COLL IMMINENT BRK - VEHICLE FORWARD MOVEMENT, BRAKE PREFILL AND INTELLIGENT BRAKE ASSIST
UHS	DISPLAY INSTRUMENT - DRIVER INFO ENHANCED (MULTI COLOR ENHANCED GRAPHIC)
UJ5	ACCESSORY - DVD ENTERTAINMENT SYSTEM - HEADREST - DUAL
UJM	TIRE PRESS INDICATOR - MANUAL LEARN
UKC	SIDE ACTIVE SAFETY - OBSTACLE DETECTION ENHANCED
UMN	SPEEDOMETER - INST, MILES AND KILO, MILES ODOMETER
UQA	SPEAKER SYSTEM - PREMIUM AUDIO BRANDED WITH AMPLIFIER
UTJ	THEFT DETERENT - ELECTRICAL, UNAUTHORIZED ENTRY
UVC	VISION - REAR VIEW, MONO
UVD	HEATER - STEERING WHEEL
V33	TOOL KIT - ROAD, EMERGENCY
V8C	VEHICLE STATEMENT - MEXICO
V8D	VEHICLE STATEMENT - US
V8E	VEHICLE STATEMENT - CANADA
VAT	ACCESSORY - GRILLE/GRILLE INSERTS - ALTERNATE FINISH - CHROME
VAV	ACCESSORY - FLOOR MATS - ALL WEATHER
VC5	LABEL - SHIPPING, EXCEPT US, US POSSESSIONS, OR JAPAN
VEB	ACCESSORY - PEDAL COVER SET
VK3	LICENSE PLATE FRONT - FRT MOUNTING PKG
VKX	ACCESSORY - SPARE WHEEL AND TIRE
VKY	ACCESSORY - DOOR HANDLES - ALTERNATE FINISH - CHROME
VLI	ACCESSORY - MAT - TRUNK/CARGO AREA
VQK	ACCESSORY - SPLASH GUARDS - CUSTOM MOLDED
VZ3	LABEL - MERCURY DISPOSAL NOTIFICATION
VZE	VIN MODEL YEAR - 2014
W1Y	CONTROL - STEERING WHEEL, RADIO, REDUNDANT CONTROLS
WF9	ORNAMENTATION - LETTERING RR "AWD"
XFE	FUEL ECONOMY - EXTRA FUEL ECONOMY
XJ3	CHASSIS OPTIONS - SPORT, LOWERED, MODIFIED

XL7	FREQUENCIES RATING - 315 MHZ, LONG DISTANCE
Y3E	MODEL CONVERSION - GS WITH OPC LOOK
Y4W	MODEL CONVERSION - GS WITH OPC LOOK AND AWD
YF5	CERTIFICATION - EMISSION, CALIFORNIA
Z49	COUNTRY - CANADA
ZAM	TIRE SPARE - T125/80R16 SL 97M BW SPR

FASTENERS (BASE)

Metric Fasteners

This vehicle provides fastener dimensions using the metric system. Most metric fasteners are approximate in diameter to equivalent English fasteners. Make replacements using fasteners of the same nominal diameter, thread pitch, and strength.

A number marking identifies the OE metric fasteners except cross-recess head screws. The number also indicates the strength of the fastener material. A Posidrive® or Type 1A cross-recess identifies a metric cross-recess screw. For best results, use a Type 1A cross-recess screwdriver, or equivalent, in Posidrive® recess head screws.

GM Engineering Standards and North American Industries have adopted a portion of the ISO-defined standard metric fastener sizes. The purpose was to reduce the number of fastener sizes used while retaining the best thread qualities in each thread size. For example, the metric M6.0 X 1 screw, with nearly the same diameter and 25.4 threads per inch replaced the English 1/4-20 and 1/4-28 screws. The thread pitch is midway between the English coarse and fine thread pitches.

Fastener Strength Identification

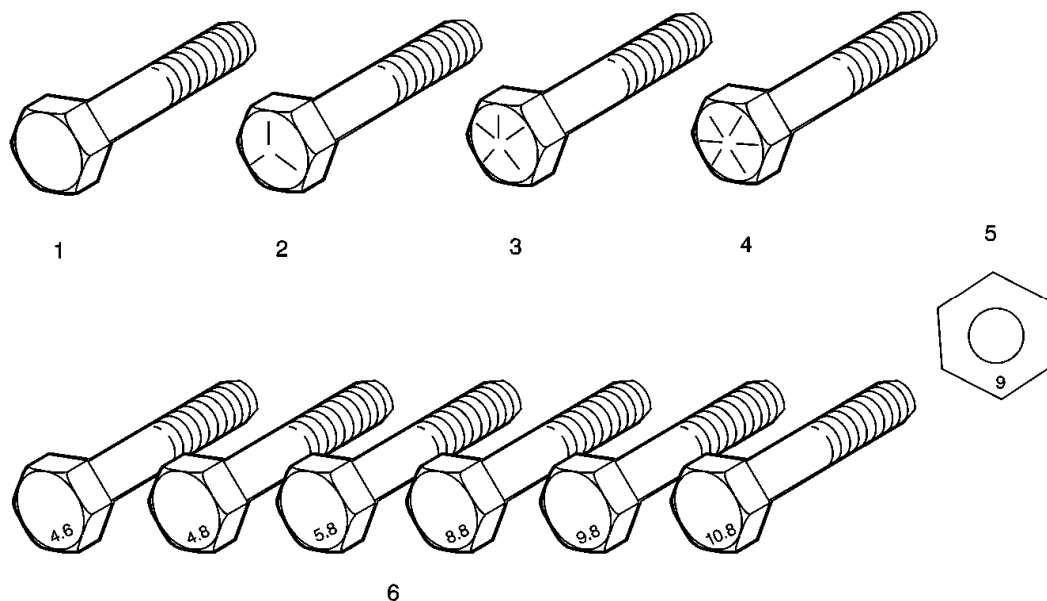


Fig. 4: Identifying Fastener Strength Marks
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	English Bolt, Grade 2 (Strength Class)
2	English Bolt, Grade 5 (Strength Class)
3	English Bolt, Grade 7 (Strength Class)
4	English Bolt, Grade 8 (Strength Class)
5	Metric Nut, Strength Class 9
6	Metric Bolts, Strength Class Increases as Numbers Increase

The most commonly used metric fastener strength property classes are 9.8 and 10.9. The class identification is embossed on the head of each bolt. The English, inch strength classes range from grade 2 to grade 8. Radial lines are embossed on the head of each bolt in order to identify the strength class. The number of lines on the head of the bolt is 2 lines less than the actual grade. For example, a grade 8 bolt will have 6 radial lines on the bolt head. Some metric nuts are marked with a single digit strength identification number on the nut face.

The correct fasteners are available through GM SPO. Many metric fasteners available in the aftermarket parts channels are designed to metric standards of countries other than the United States, and may exhibit the following:

- Lower strength
- No numbered head marking system
- Wrong thread pitch

The metric fasteners on GM products are designed to new, international standards. The following are the common sizes and pitches, except for special applications:

- M6.0 X 1
- M8 X 1.25
- M10 X 1.5
- M12 X 1.75
- M14 X 2.00
- M16 X 2.00

Prevailing Torque Fasteners

Prevailing torque fasteners create a thread interface between the fastener and the fastener counterpart in order to prevent the fastener from loosening.

All Metal Prevailing Torque Fasteners

These fasteners accomplish the thread interface by a designed distortion or deformation in the fastener.

Nylon Interface Prevailing Torque Fasteners

These fasteners accomplish the thread interface by the presence of a nylon material on the fastener threads.

Adhesive Coated Fasteners

These fasteners accomplish the thread interface by the presence of a thread-locking compound on the fastener threads. Refer to the appropriate repair procedure in order to determine if the fastener may be reused and the applicable thread-locking compound to apply to the fastener.



1



2



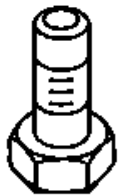
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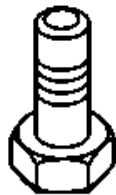
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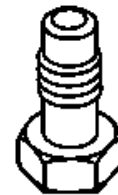
6



7



8



9

Fig. 5: Identifying Adhesive Coated Fasteners
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Prevailing Torque Nut, Center Lock Type
2	Prevailing Torque Nut, Top Lock Type
3	Prevailing Torque Nut, Nylon Patch Type
4	Prevailing Torque Nut, Nylon Washer Insert Type
5	Prevailing Torque Nut, Nylon Insert Type
6	Prevailing Torque Bolt, Dry Adhesive Coating Type
7	Prevailing Torque Bolt, Thread Profile Deformed Type
8	Prevailing Torque Bolt, Nylon Strip Type
9	Prevailing Torque Bolt, Out-of-Round Thread Area Type

A prevailing torque fastener may be reused ONLY if:

- The fastener and the fastener counterpart are clean and not damaged
- There is no rust on the fastener
- The fastener develops the specified minimum torque against its counterpart prior to the fastener seating

Metric Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
• 6 mm	0.4 N.m	4 lb in
• 8 mm	0.8 N.m	7 lb in
• 10 mm	1.4 N.m	12 lb in
• 12 mm	2.1 N.m	19 lb in
• 14 mm	3 N.m	27 lb in
• 16 mm	4.2 N.m	37 lb in
• 20 mm	7 N.m	62 lb in
• 24 mm	10.5 N.m	93 lb in
Nylon Interface Prevailing Torque Fasteners		
• 6 mm	0.3 N.m	3 lb in
• 8 mm	0.6 N.m	5 lb in
• 10 mm	1.1 N.m	10 lb in
• 12 mm	1.5 N.m	13 lb in
• 14 mm	2.3 N.m	20 lb in
• 16 mm	3.4 N.m	30 lb in
• 20 mm	5.5 N.m	49 lb in
• 24 mm	8.5 N.m	75 lb in

English Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
• 1/4 in	0.5 N.m	4.5 lb in
• 5/16 in	0.8 N.m	7.5 lb in
• 3/8 in	1.3 N.m	11.5 lb in
• 7/16 in	1.8 N.m	16 lb in
• 1/2 in	2.3 N.m	20 lb in
• 9/16 in	3.2 N.m	28 lb in

• 5/8 in	4 N.m	36 lb in
• 3/4 in	7 N.m	54 lb in
Nylon Interface Prevailing Torque Fasteners		
• 1/4 in	0.3 N.m	3 lb in
• 5/16 in	0.6 N.m	5 lb in
• 3/8 in	1 N.m	9 lb in
• 7/16 in	1.3 N.m	12 lb in
• 1/2 in	1.8 N.m	16 lb in
• 9/16 in	2.5 N.m	22 lb in
• 5/8 in	3.4 N.m	30 lb in
• 3/4 in	5 N.m	45 lb in

THREAD INSERTS

General Purpose Thread Repair Kits.

These kits are available commercially.

Repair Procedure

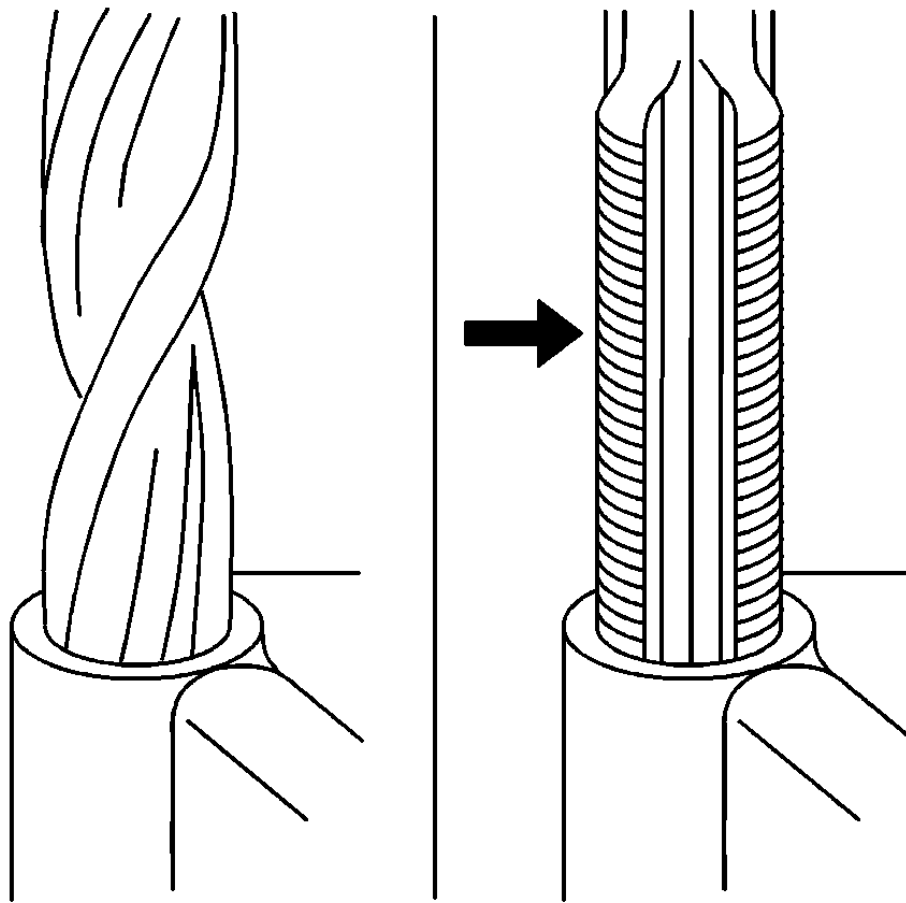


Fig. 6: Drilling & Tapping Damaged Threads
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

NOTE: Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and tap to use.

Avoid any buildup of chips. Back out the tap every few turns and remove the chips.

1. Determine the size, the pitch, and the depth of the damaged thread. If necessary, adjust the stop collars on the cutting tool and tap to the required depth.
2. Drill out the damaged threads. Clean out any chips.
3. Lubricate the tap with light engine oil. Tap the hole. Clean the threads.

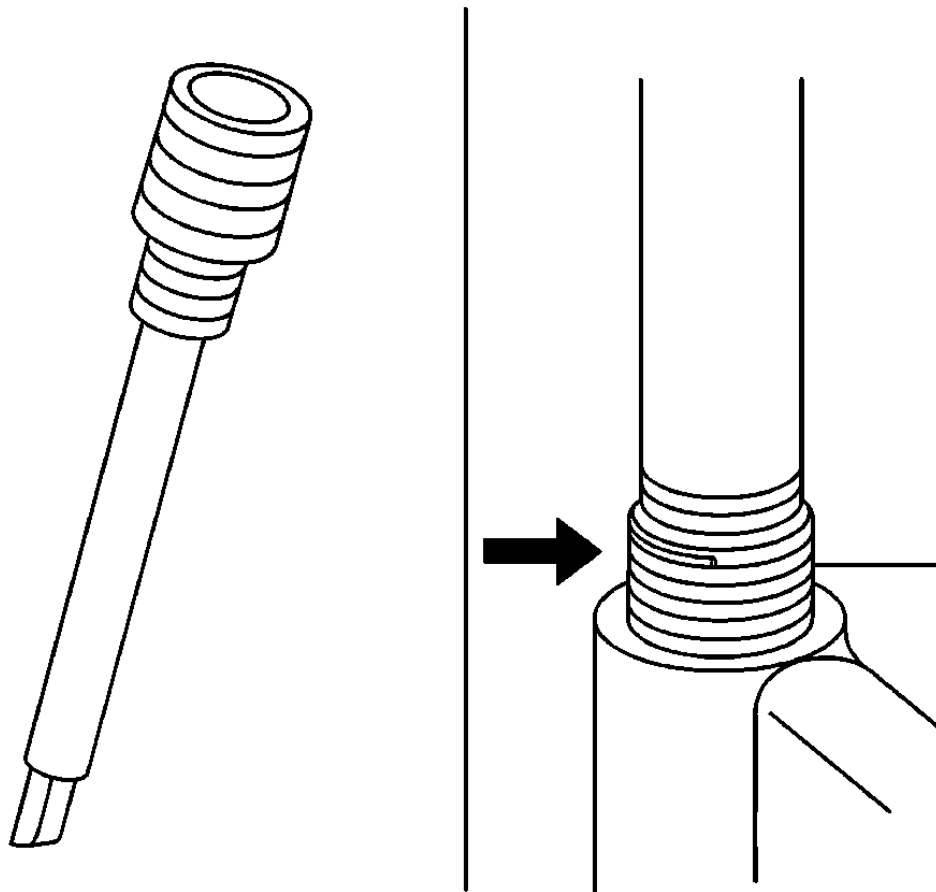


Fig. 7: View Of Thread Insert

Courtesy of GENERAL MOTORS COMPANY

4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.

NOTE: **The insert should be flush to one turn below the surface.**

5. Lubricate the insert with light engine oil, except when installing in aluminum and install the insert.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

REGISTERED AND NON-REGISTERED TRADEMARKS

Listed below are Registered Trademarks (®) or Non-Registered Trademarks (™) which may appear in this service manual.

Registered and Non-Registered Trademarks

A
AC®
ACCUTURN®
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Active Fuel Management™
Acuzinc®
Airbank®
Allison®
AMMCO®
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Bendix®
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BON-AMI®
Bosch®
Bose®
C
Catapillar®
CAT®
C-Quam®
D
Delco®
Delco Bose®
Delco Electronics®
Delco Freedom®
Delco LOC II®
Delco Moraine®
Delco Remy®
Delco Sound®
Delco Supreme®
Delco Tech®
DELCORE®
Delphi®
DEX-COOL®
DEXOIL®
DEXRON®
DEXSTEER™
DNR®
Dolby®
DR®

Duraguard®
Durastop®
Duramax™
E
Eaton Corporation®
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F
FLO-LITE®
G
General Motors®
GM®
GM Goodwrench Service®
GM Optikleen®
GM Parts™
GM Pass®
GM Ultralite®
GMAC®
Goodwrench®
GTP®
H
Homelink™
HYDRA-MATIC®
I
Illumination®
INSTA-TRAC®
Intune®
L
LOCTITE™
M
MAGNASTEER®
Maxifuse®
Metripack®
Micropack®
Minifuse®
Mr Goodwrench®
N
Northstar®
O
OnStar®
Optikleen®

PASS-KEY®
PASS-KEYII®
PASSLOCK™
PK3®
Posidrive®
Pro®
Q
Quad 4®
R
RAINSENSE™
Rapid Fire®
S
ScotchBrite™
Scotchguard™
Signals®
Sikkens™
Soft-Ray®
Solar-Ray®
Stabilitrak®
Sunrayce®
Superlube®
Syclone®
T
Tech 2®
Techline®
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Theft-I®
Theftlock®
Tiltmaster®
TORX®
Transjel®
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U
Ultralite®
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W
Weatherpack™

DOOR LOCK AND IGNITION LOCK FOLDING KEY BLADE REMOVAL AND INSTALLATION

Special Tools

BO-51098 Flip Key Blade Fixture

For equivalent region tools, refer to **Special Tools**.

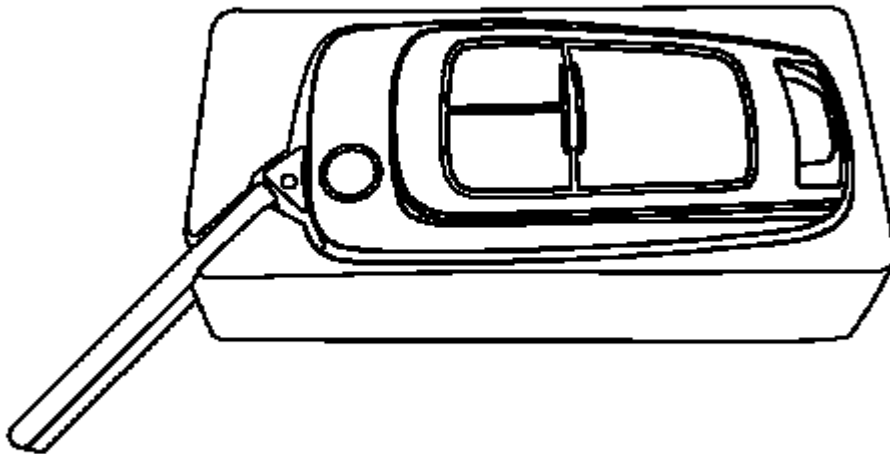


Fig. 8: Remote Keyless Entry (RKE) Transmitter Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Failure to properly support the Remote Keyless Entry (RKE) transmitter assembly while replacing the key blade may cause internal damage to the transmitter assembly.

1. Insert the RKE transmitter in the fixture as shown.

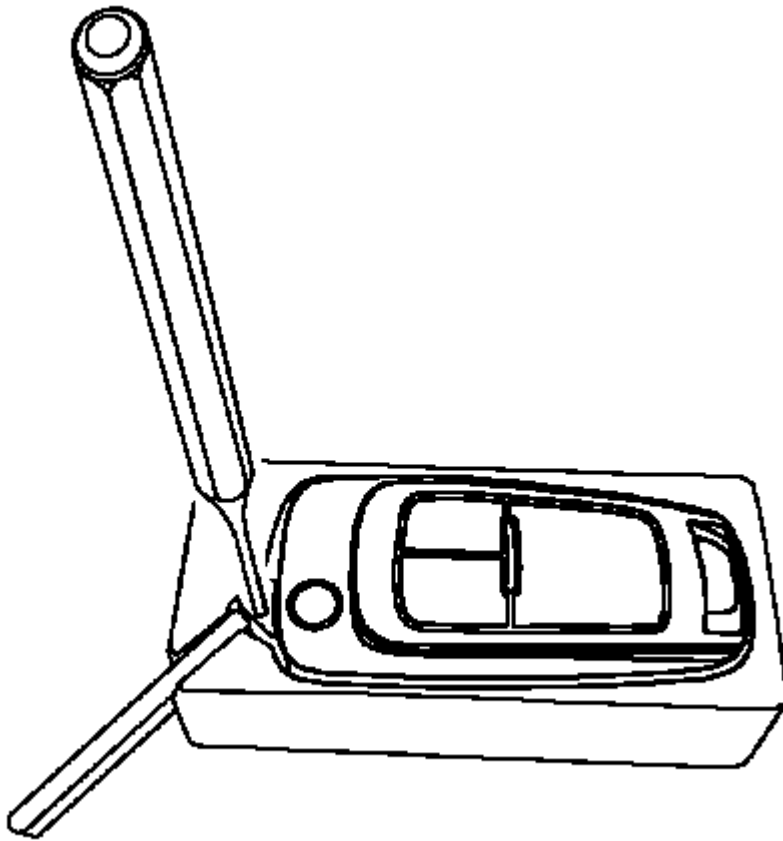


Fig. 9: Flip Key Blade Fixture & Transmitter Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: It may be necessary to dress the pin drift on a grinder to maintain the diameter in order to drive the pin through the housing.

2. Using the **BO-51098** fixture , drive the retention pin from the transmitter assembly as shown.

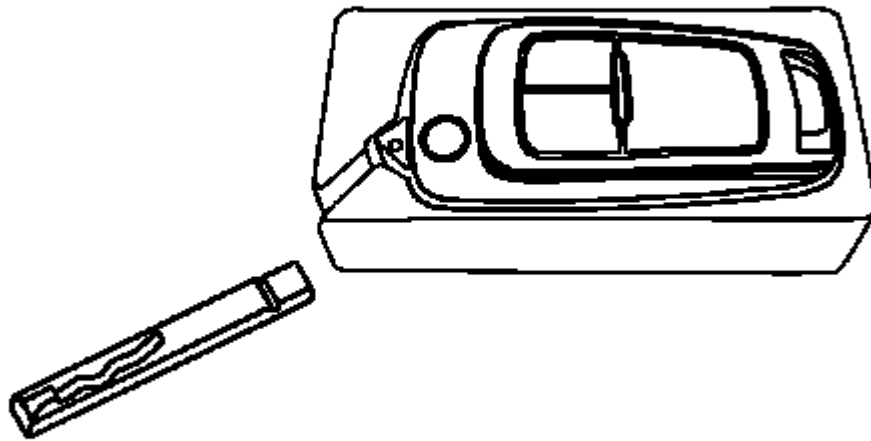


Fig. 10: Transmitter Assembly & Key Blade
Courtesy of GENERAL MOTORS COMPANY

3. Remove the key blade from the transmitter assembly.
4. Install the coded blank into the transmitter assembly, insure the indentation on the key blade faces the retention pin.

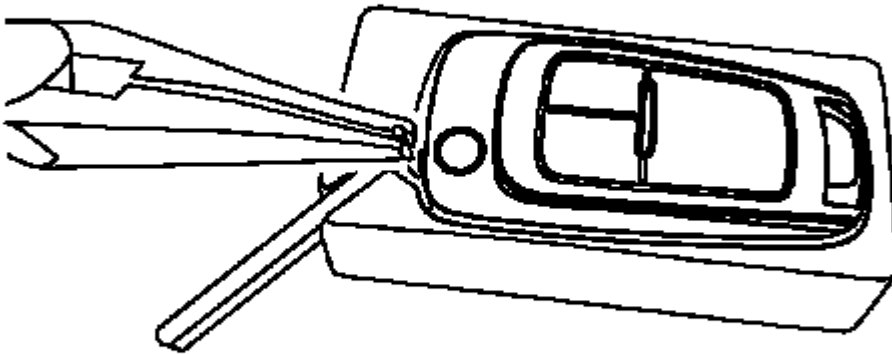


Fig. 11: Inserting Transmitter Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use caution not to damage the surface, chrome plating, in the following steps.

5. Using needle nose pliers, insert the pin half way into the transmitter assembly.

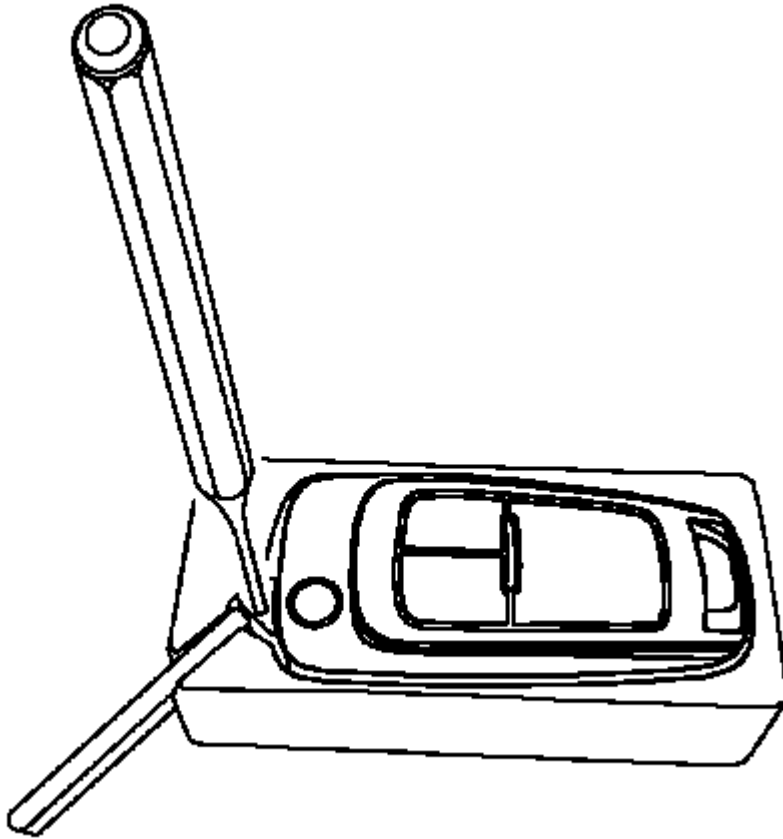


Fig. 12: Flip Key Blade Fixture
Courtesy of GENERAL MOTORS COMPANY

6. Using the **BO-51098** fixture , drive the roll pin flush to the surface.

FRONT SIDE DOOR LOCK CYLINDER CODING (FREE WHEELING)

Special Tools

BO-49753 Assembly Tool

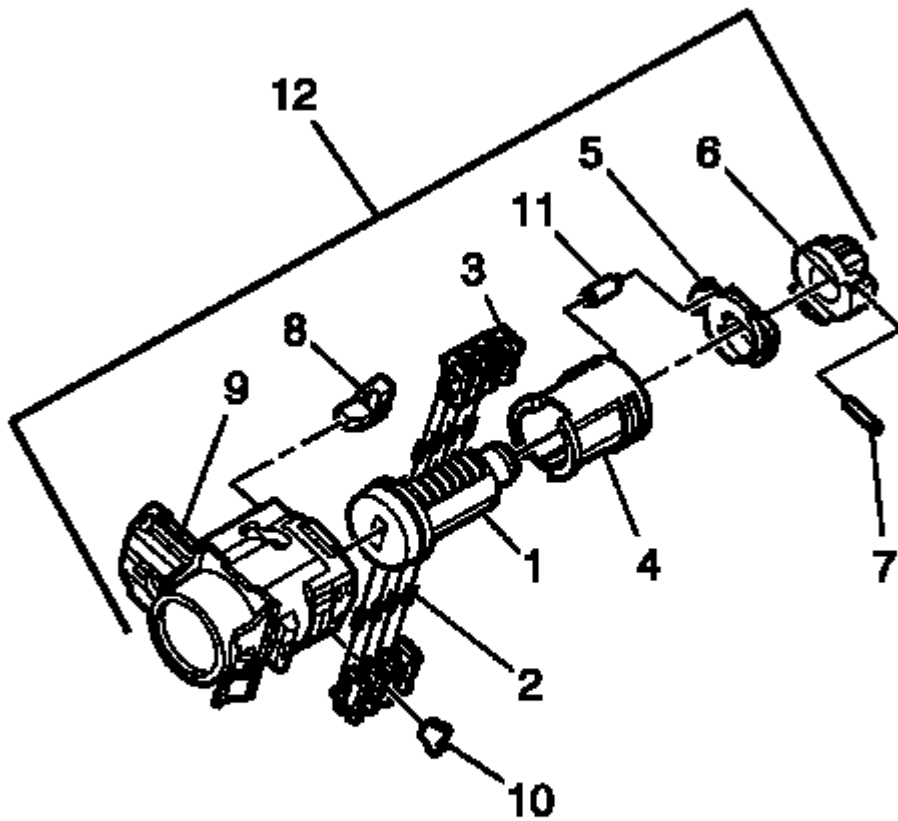


Fig. 13: Identifying Lock Components
 Courtesy of GENERAL MOTORS COMPANY

The door lock cylinder uses 8 of the 8 cut positions. The tumbler positions are staggered from side to side, 4 on one side and 4 on the other, are not self-retaining, and are not snap in.

NOTE: All lock cylinders for side milled keys have right and left tumblers. The location of the tooth of the tumbler determines whether it is right or left.

Illustrations in this procedure show the right tumblers on the top and the left tumblers on the bottom. All tumblers are marked 1R, 1L, 2R, or 2L. The number being cut depth and the letter meaning right or left.

1. Hold the door lock cylinder (1) so the side with the 4 tumbler spring pockets faces up, pocket nearest to the cylinder head.
2. Insert the tumbler springs (2) into the 4 spring pockets. This side uses left tumblers.
3. Install the tumbler (3) for key cut position one in the slot nearest to the front of the lock cylinder. Install the remaining tumblers, key cut positions 3, 5, and 7, following the key code and same process. Press the tumblers in place until they are secure.
4. Check the correct loading of the tumblers by inserting the key into the cylinder. All tumblers should be flush with the lock cylinder body.
5. Turn the cylinder so the side with the 4 tumbler spring wells faces up. This side uses right tumblers.
6. Insert the tumbler springs into the 4 spring pockets.
7. The first tumbler closest to the front of the lock cylinder to be loaded will be the second key cut position, the second number in the key code. Install the remaining tumblers for the key cut positions 4, 6, and 8. Press the tumblers in place until they are secure.
8. Check the correct loading of the tumblers by inserting the key into the cylinder. All tumblers should be flush with the lock cylinder body.
9. Insert the key and lightly lubricate the cylinder body diameter and tumbler surfaces and a small amount in the head of the cylinder using the supplied grease.
10. Insert the sleeve (4) onto the cylinder assembly.
11. Insert the clutch (5) and driver (6) onto the cylinder (1).

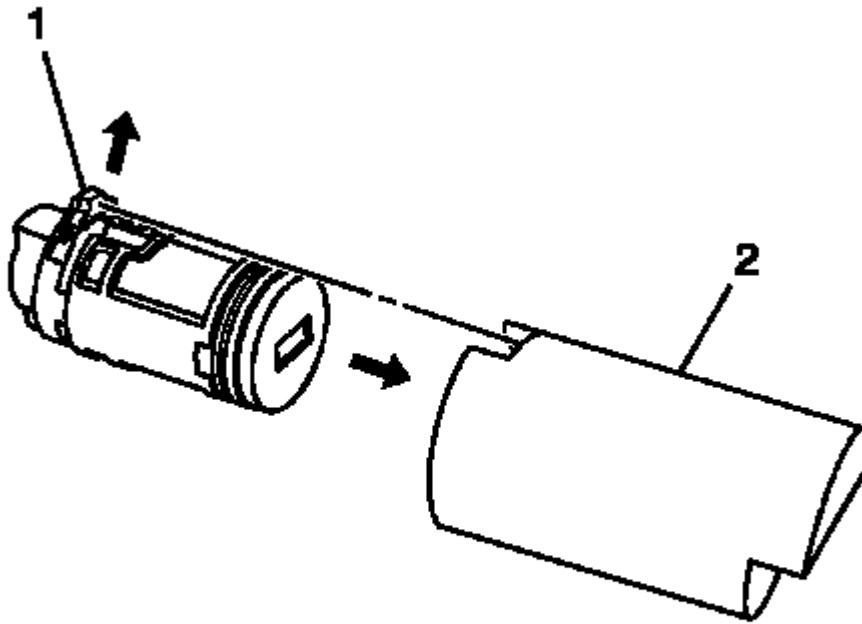


Fig. 14: Loading Cylinder Into Special Tool
Courtesy of GENERAL MOTORS COMPANY

12. Load the cylinder into the **BO-49753** assembly tool so that the clutch (1) indexes with the notch in the opening of the tool (2).

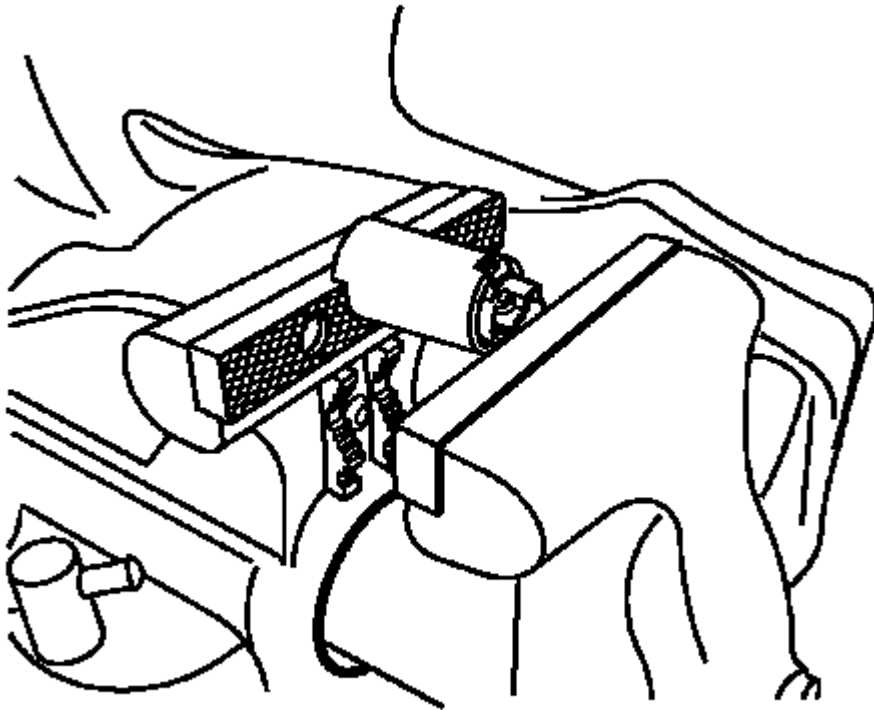


Fig. 15: Loading Assembly Tool Into Vice
Courtesy of GENERAL MOTORS COMPANY

13. Load the assembly tool with the lock cylinder into a vice and tighten the vice ONLY enough to hold the tool and lock the cylinder in place.

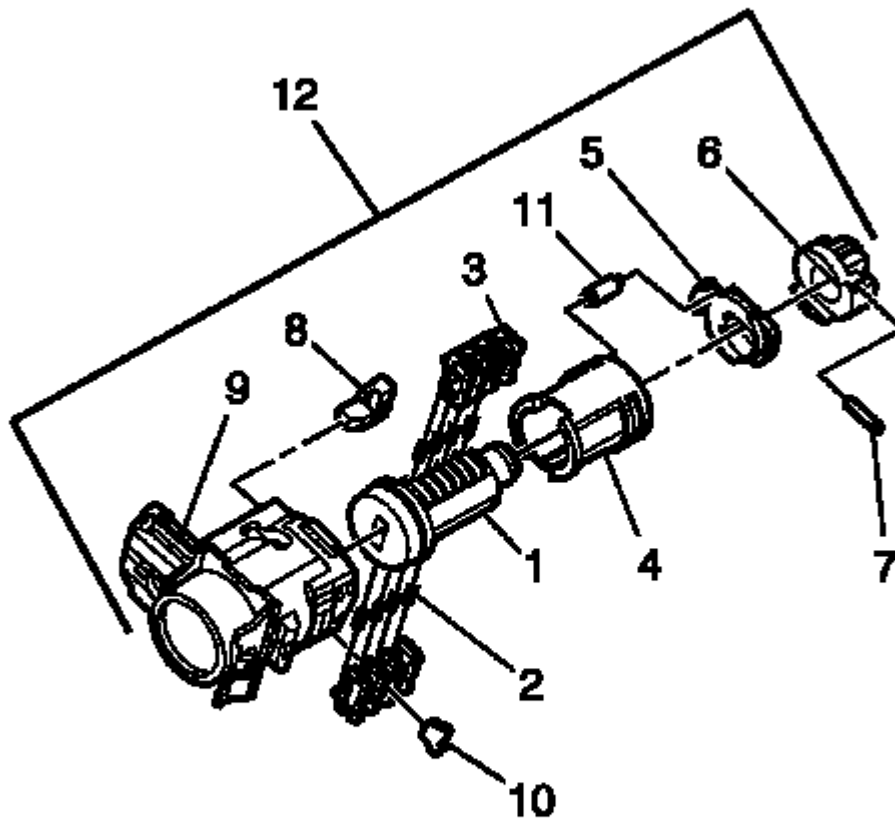


Fig. 16: Identifying Lock Components
Courtesy of GENERAL MOTORS COMPANY

14. Insert the roll pin (7) into the driver (6) and install it using a 1/16 inch pin punch.
15. Insert the buffer (8) in the case (9), verify the buffer is properly seated.
16. Install the free wheel pin (11) in the sleeve (4) and clutch (5) and insert the assembly into the case (9).
17. With the lock cylinder assembly installed in the case (9), install the retainer (10) and stake the retainer in place using a small punch and hammer to peen the case material onto the exposed ends of the installed

retainer (10).

18. Insert the key into the lock and function the lock to check for proper assembly and smooth operation.

FRONT SIDE DOOR LOCK CYLINDER CODING (NON FREE WHEELING)

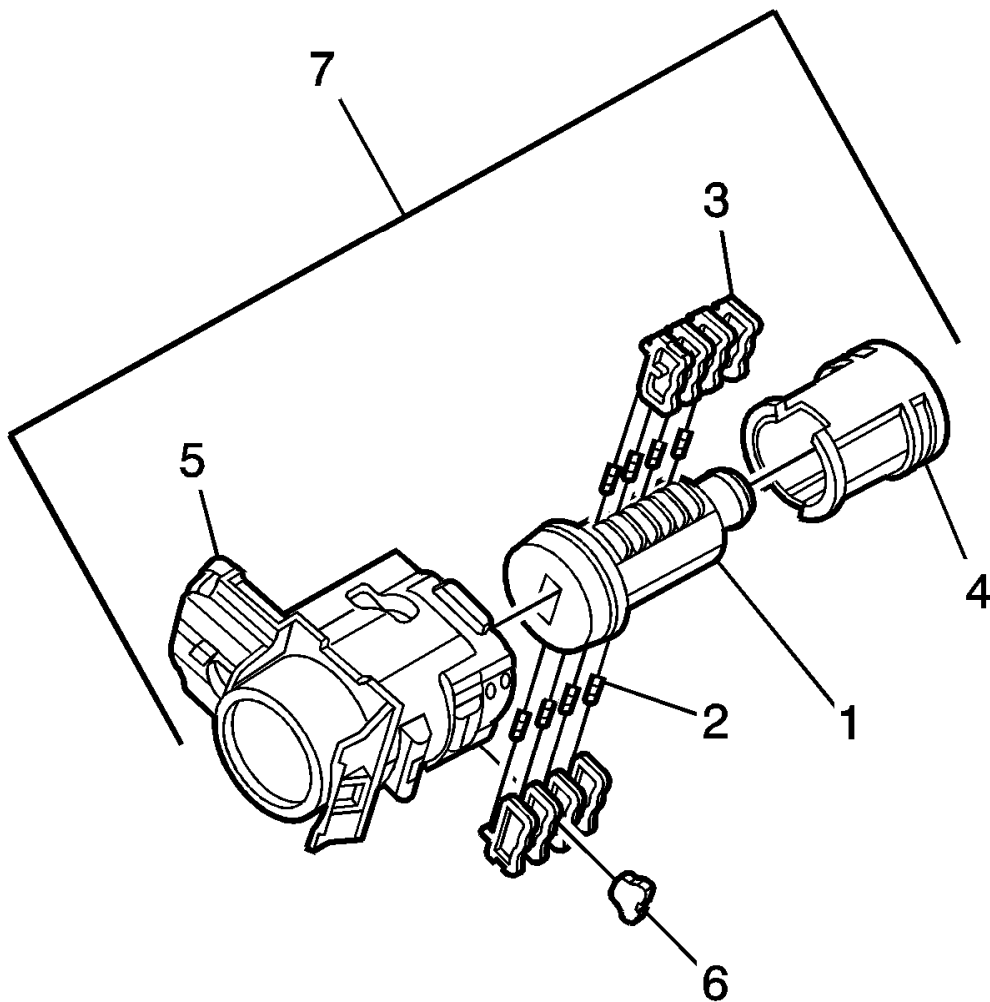


Fig. 17: Door Lock Cylinder Components (Non-Free Wheeling)
 Courtesy of GENERAL MOTORS COMPANY

The door lock cylinder uses 8 of the 8 cut positions. The tumbler positions are staggered from side to side, 4 on

one side and 4 on the other, are not self-retaining, and are not snap in.

NOTE: All lock cylinders for side milled keys have right and left tumblers. The location of the tooth of the tumbler determines whether it is right or left. Illustrations in this procedure show the right tumblers on the top and the left tumblers on the bottom. All tumblers are marked 1R, 1L, 2R, or 2L. The number being cut depth and the letter meaning right or left.

1. Hold the door lock cylinder (1) so the side with the 4 tumbler spring pockets faces up, pocket nearest to the cylinder head.
2. Insert the tumbler springs (2) into the 4 spring pockets. This side uses left tumblers.
3. Install the tumbler (3) for key cut position one in the slot nearest to the front of the lock cylinder. Install the remaining tumblers, key cut positions 3, 5, and 7, following the key code and same process. Press the tumblers in place until they are secure.
4. Check the correct loading of the tumblers by inserting the key into the cylinder. All tumblers should be flush with the lock cylinder body.
5. Turn the cylinder so the side with the 4 tumbler spring wells faces up. This side uses right tumblers.
6. Insert the tumbler springs into the 4 spring pockets.
7. The first tumbler closest to the front of the lock cylinder to be loaded will be the second key cut position, the second number in the key code. Install the remaining tumblers for the key cut positions 4, 6, and 8. Press the tumblers in place until they are secure.
8. Check the correct loading of the tumblers by inserting the key into the cylinder. All tumblers should be flush with the lock cylinder body.
9. Insert the key and lightly lubricate the cylinder body diameter and tumbler surfaces and a small amount in the head of the cylinder using the supplied grease.
10. Insert the sleeve (4) onto the cylinder assembly.
11. Insert the assembly into the case (5).
12. With the lock cylinder assembly installed in the case (5), install the retainer (6) and stake the retainer in place using a small punch and hammer to peen the case material onto the exposed ends of the installed retainer (6).
13. Insert the key into the lock and function the lock to check for proper assembly and smooth operation.

LOCK CYLINDER CODING - IGNITION

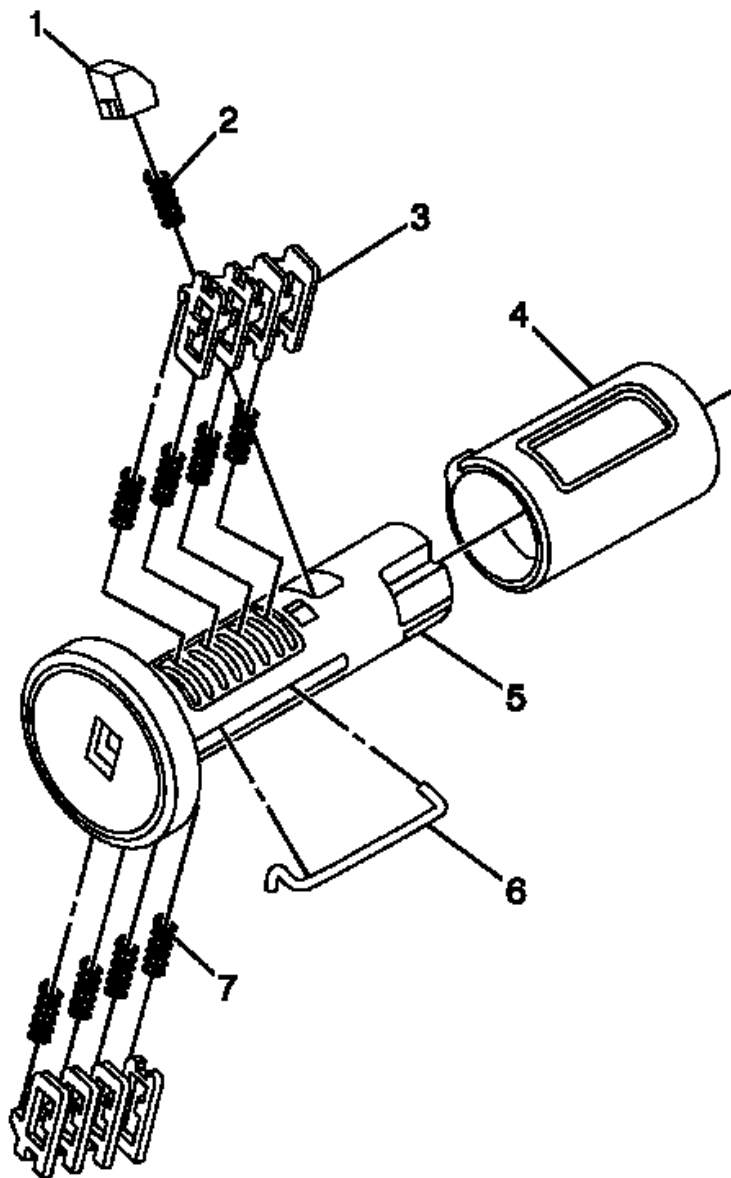


Fig. 18: Lock Cylinder Components - Ignition
 Courtesy of GENERAL MOTORS COMPANY

The ignition lock cylinder uses 8 key cut positions, 1-8. The ignition cylinder tumblers (3) are located on alternate sides of the cylinder (5). They are not snap-in and are not self-retaining. It follows the key code with

the first tumbler being the first depth of the key code, closest to the head of the key.

NOTE: All lock cylinders for side milled keys have right and left tumblers. The location of the tooth of the tumbler determines whether it is right or left. Illustrations in this procedure show the right tumblers on the top and the left tumblers on the bottom. All tumblers are marked 1R, 1L, 2R, or 2L. The number being cut depth and the letter meaning right or left.

1. Hold the ignition cylinder assembly (5) so the side with the tumbler spring pocket located closest to the head of the cylinder is facing up.
2. Insert the tumbler spring (7) into each of the 4 spring pockets of the cylinder assembly. This side of the cylinder used left tumblers.
3. The first tumbler (3) to be loaded will be the first key cut position, which is the first number in the key code. Install the tumbler in the slot over the spring. Install the remaining right tumblers following the key code and same process, pressing the tumblers in place until they are secure.
4. Rotate the cylinder assembly. Insert the tumbler spring into each of the spring pockets of the cylinder assembly. This side of the cylinder used right tumblers.
5. The first tumbler (3) to be loaded will be the second key cut position, the second number in the key code. Install the first tumbler in the slot over the spring. Install the remaining left tumblers following the key code and same process, pressing the tumblers in place until they are secure.
6. Inspect for correct loading of the tumblers by inserting the key into the cylinder. All tumblers should drop flush with the lock cylinder body diameter.
7. With the key in the cylinder assembly insert the round connector (6), insert the retainer spring (2) in the retainer slot located in the cylinder assembly. Insert the retainer (1) lining it up in the slot over the spring. Depress the retainer and hold.
8. Insert the cylinder into the sleeve (4) as shown in the print. Make sure the actuator stays located properly in the cylinder.
9. When the key is removed, the lock should stay together.
10. Lightly lubricate the outside surface in the tumbler area of in the lock body and down the key slot using the provided grease. Insert and extract the key 5 times to lubricate the keyway.
11. Insert the key and function the lock 3 times to distribute the grease inside the sleeve.
12. Verify the key position for inserting the lock into the column.

LIFTING AND JACKING THE VEHICLE

NOTE: The use of a LOW PROFILE LIFT ARMS SYSTEM may be required to avoid unwanted contact with the vehicle's body and structure depending on lifting equipment used. Refer to the manufacture's recommendation for their applications of low profile lift arms system for their lifting equipment.

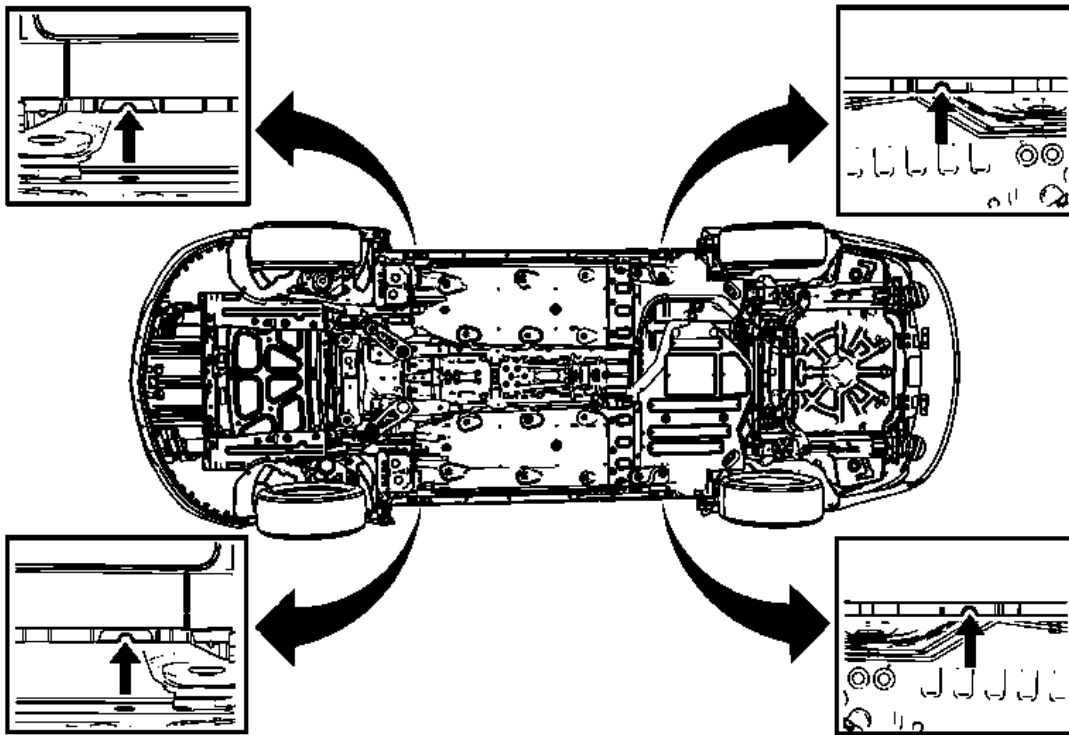


Fig. 19: Lifting and Jacking Vehicle
Courtesy of GENERAL MOTORS COMPANY

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: To avoid any vehicle damage, serious personal injury or death, always use the jackstands to support the vehicle when lifting the vehicle with a jack.

CAUTION: Perform the following steps before beginning any vehicle lifting or jacking procedure:

- Remove or secure all of the vehicle contents in order to avoid any shifting or any movement that may occur during the vehicle lifting or jacking procedure.
- The lifting equipment or the jacking equipment weight rating must meet or exceed the weight of the vehicle and any vehicle contents.
- The lifting equipment or the jacking equipment must meet the operational standards of the lifting equipment or jacking equipment manufacturer.

- Perform the vehicle lifting or jacking procedure on a clean, hard, dry, level surface.
- Perform the vehicle lifting or jacking procedure only at the identified lift points. DO NOT allow the lifting equipment or jacking equipment to contact any other vehicle components.

Failure to perform the previous steps could result in damage to the lifting equipment or the jacking equipment, the vehicle, and/or the vehicle contents.

Vehicle Lifting- Frame Contact Lift

Front Lift Pads

When lifting the vehicle with a frame-contact lift, place the front lift pads on the rocker outer panel weld flange, as shown.

Rear Lift Pads

When lifting the vehicle with a frame-contact lift, place the rear lift pads on the rocker outer panel weld flange, as shown.

Vehicle Jacking

CAUTION: When you are jacking the vehicle at the front locations, be certain that the jack or the jack lift pad does not contact the front fascia, front fascia air dam, or the front fenders. If such contact occurs, vehicle damage may result. When jacking at selected front locations additional clearance may be required for the jacking points.

NOTE: When you are lifting a vehicle with a service jack, block the wheels at the opposite end from which you are lifting. Use jack stands to provide additional support.

Front of Vehicle

When using a service jack under the front of the vehicle use one of the following locations:

Place the service jack pad in the same location as shown for the front lift pads.

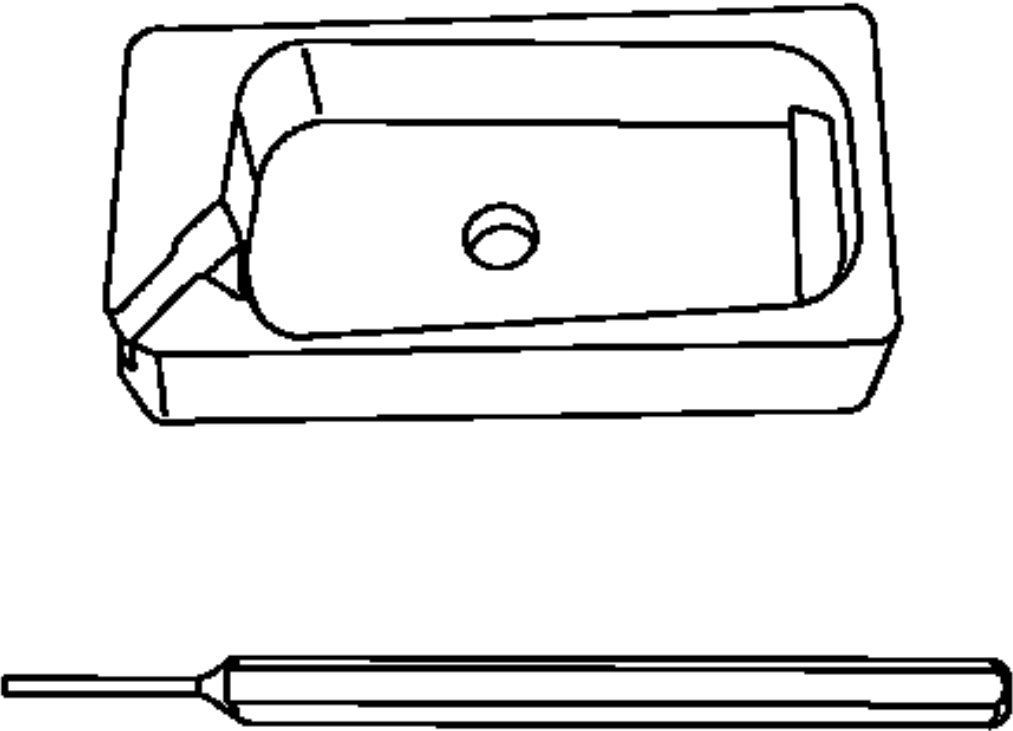
Rear of Vehicle

NOTE: Place jackstands **ONLY** under strong and stable vehicle structures.

Place the service jack pad in the same location as shown for the rear lift pads.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
 <p>The illustration shows two items. The top item is a rectangular flip key blade fixture, labeled BO-51098. It has a central circular hole and a small tab on the right side. The bottom item is a long, thin key blade with a pointed tip.</p>	<p>BO-51098 Flip Key Blade Fixture</p>

ELECTRICAL

Wiring Systems and Power Management - Ground Distribution Wiring Schematics

SCHEMATIC WIRING DIAGRAMS

GROUND DISTRIBUTION WIRING SCHEMATICS

G100, G102, and G103 (except CZ2)

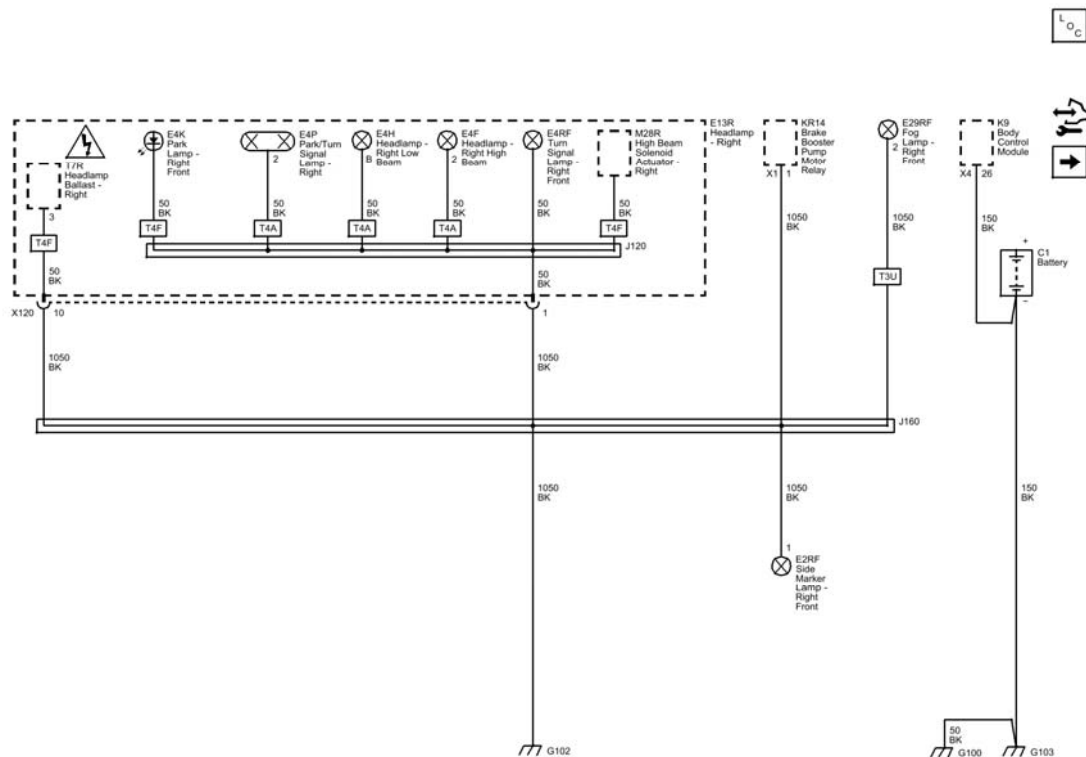


Fig. 1: G100, G102, and G103 (except CZ2)

Courtesy of GENERAL MOTORS COMPANY

G106, G109 (1 of 2), G110, G111, and G112 except CZ2

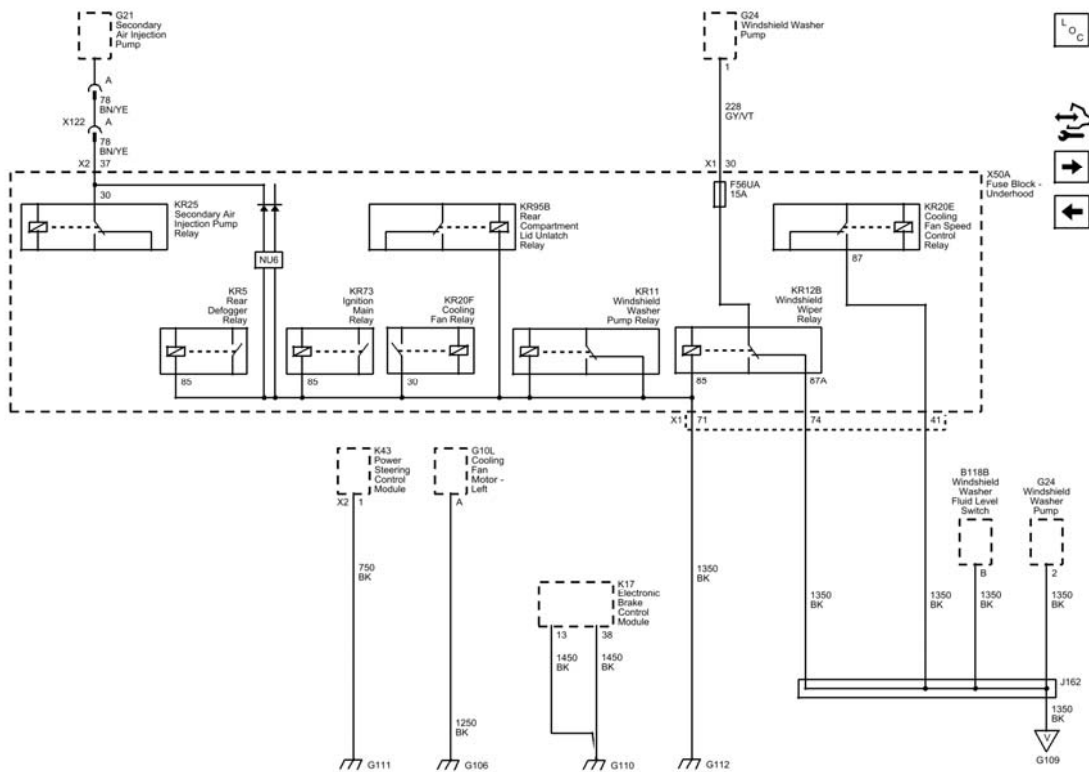


Fig. 2: G106, G109 (1 of 2), G110, G111, and G112 except CZ2
Courtesy of GENERAL MOTORS COMPANY

G102, G105, and G109 (2 of 2) except CZ2

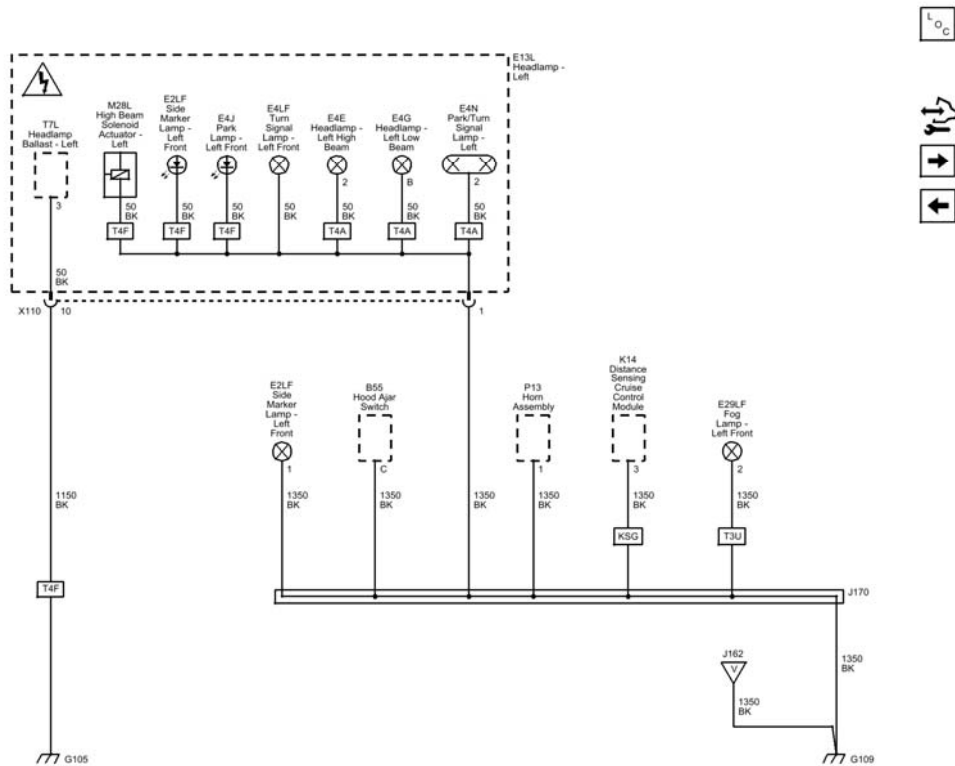


Fig. 3: G102, G105, and G109 (2 of 2) except CZ2
Courtesy of GENERAL MOTORS COMPANY

G120, G121, and G122 except CZ2

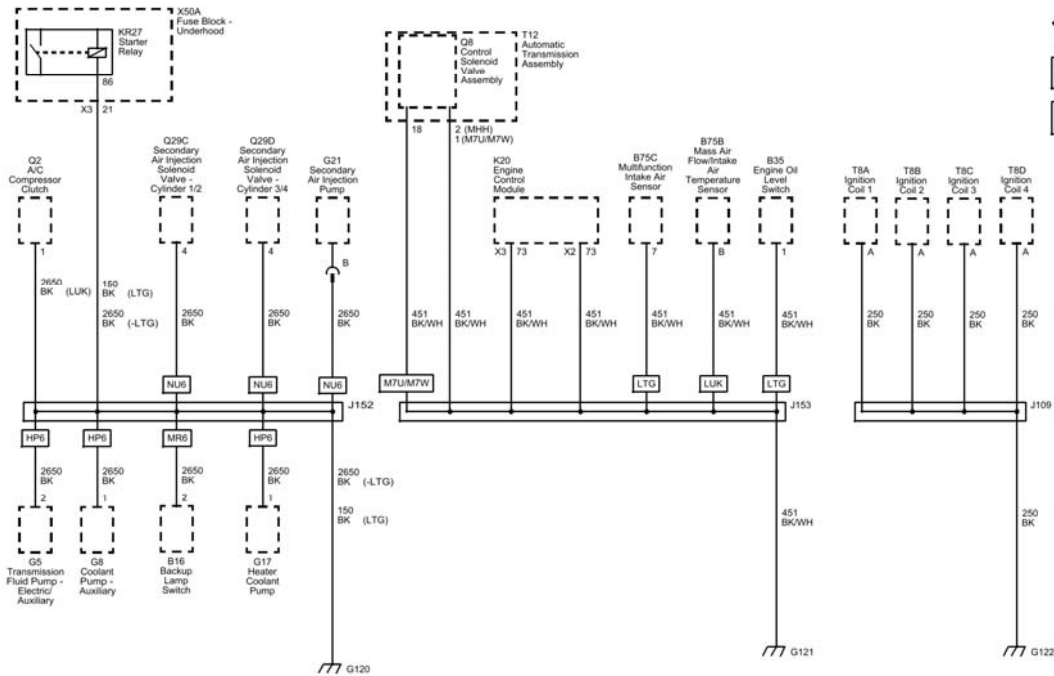


Fig. 4: G120, G121, and G122 except CZ2
Courtesy of GENERAL MOTORS COMPANY

G201 (except CZ2)

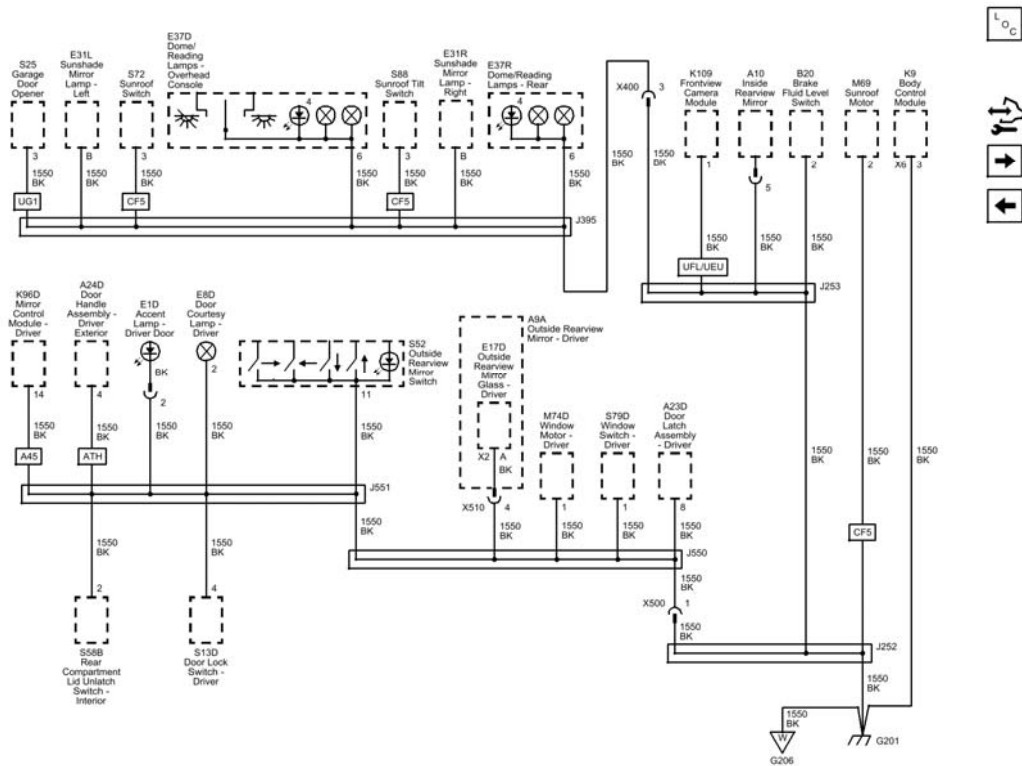


Fig. 5: G201 (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

G205 except CZ2

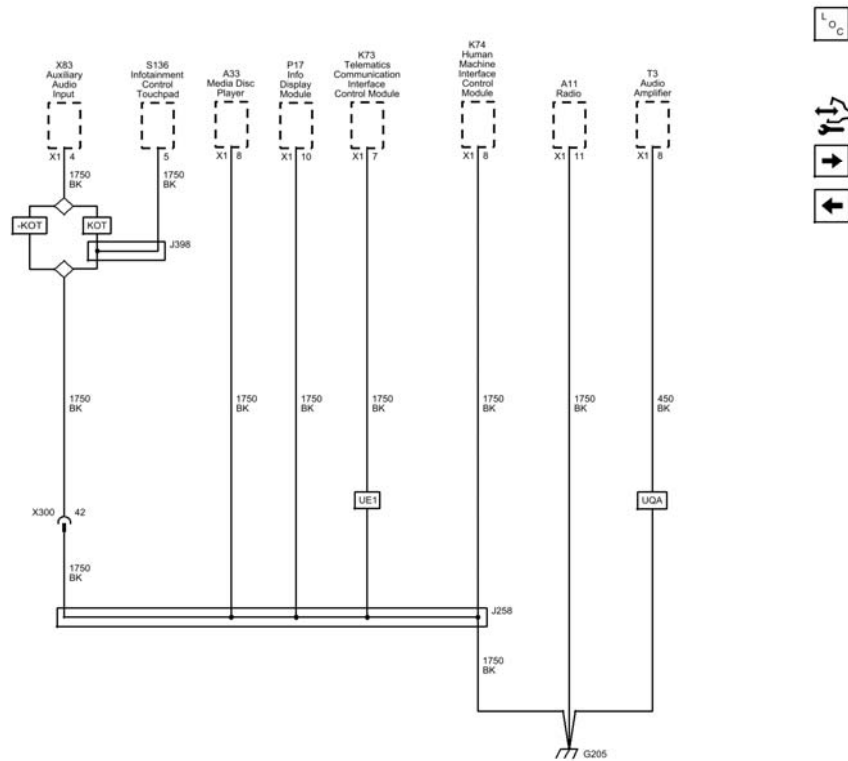


Fig. 6: G205 except CZ2
Courtesy of GENERAL MOTORS COMPANY

G206 (1 of 2) except CZ2

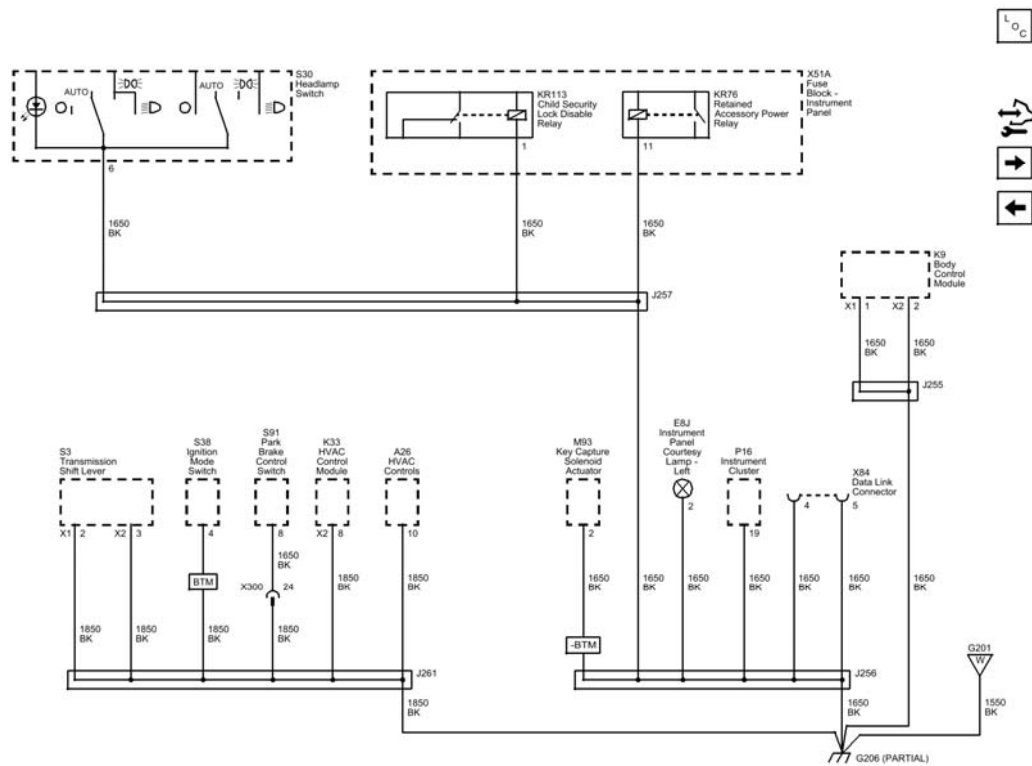


Fig. 7: G206 (1 of 2) except CZ2
Courtesy of GENERAL MOTORS COMPANY

G206 (2 of 2) except CZ2

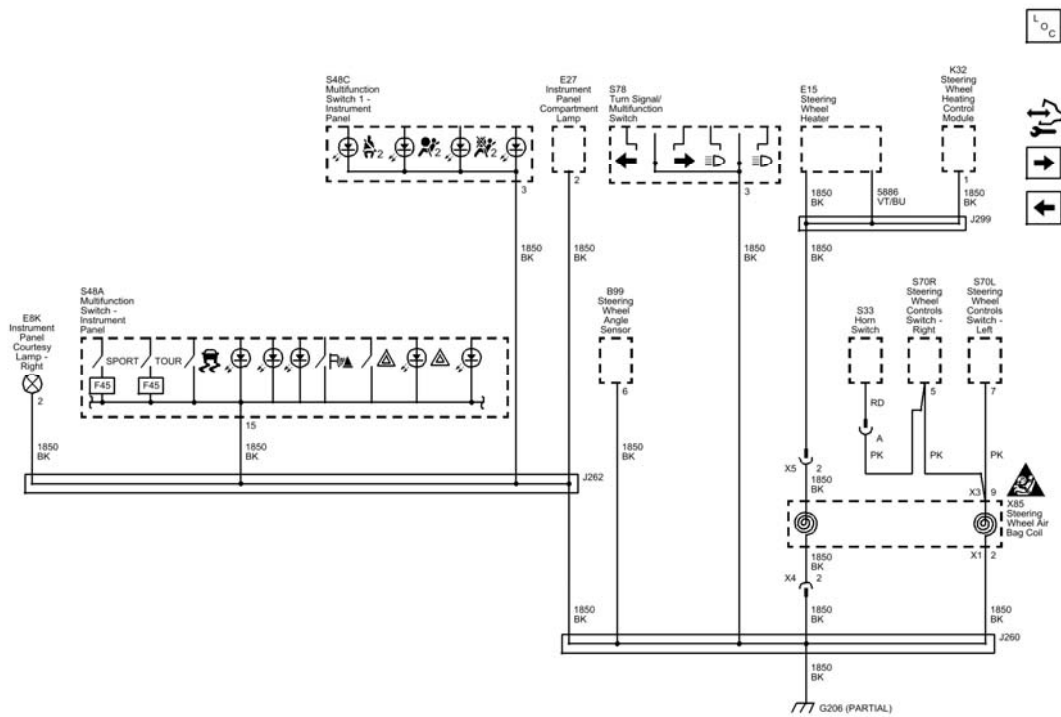


Fig. 8: G206 (2 of 2) except CZ2
Courtesy of GENERAL MOTORS COMPANY

G302 except CZ2

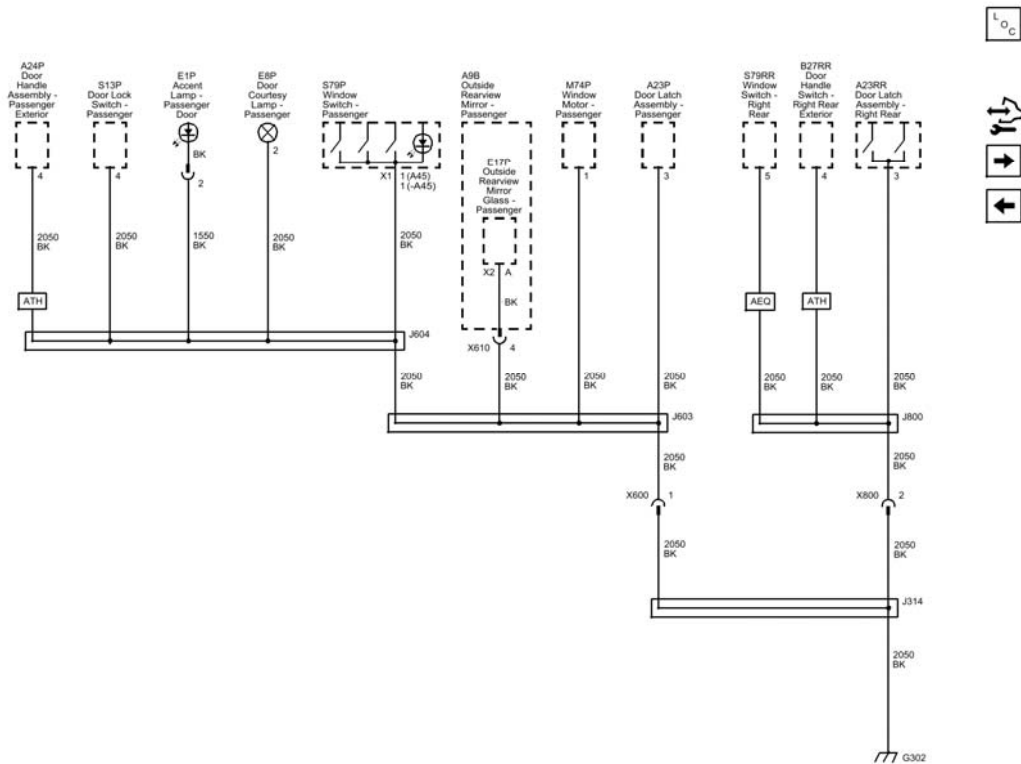


Fig. 9: G302 except CZ2
Courtesy of GENERAL MOTORS COMPANY

G303 (except CZ2)

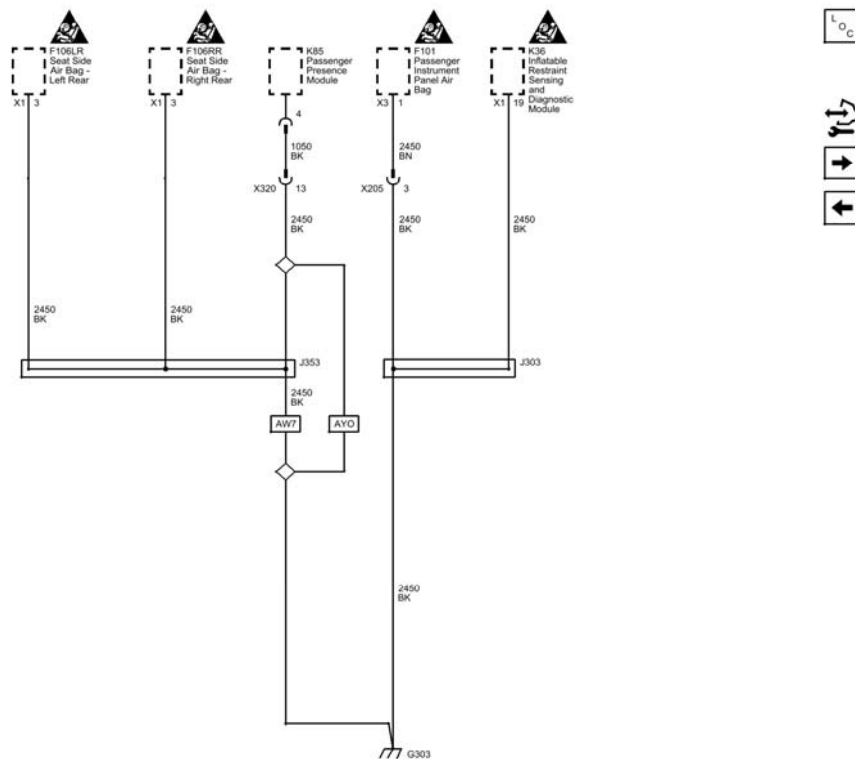


Fig. 10: G303 (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

G305 (except CZ2)



Courtesy of GENERAL MOTORS COMPANY

G401 (2 of 2) except CZ2

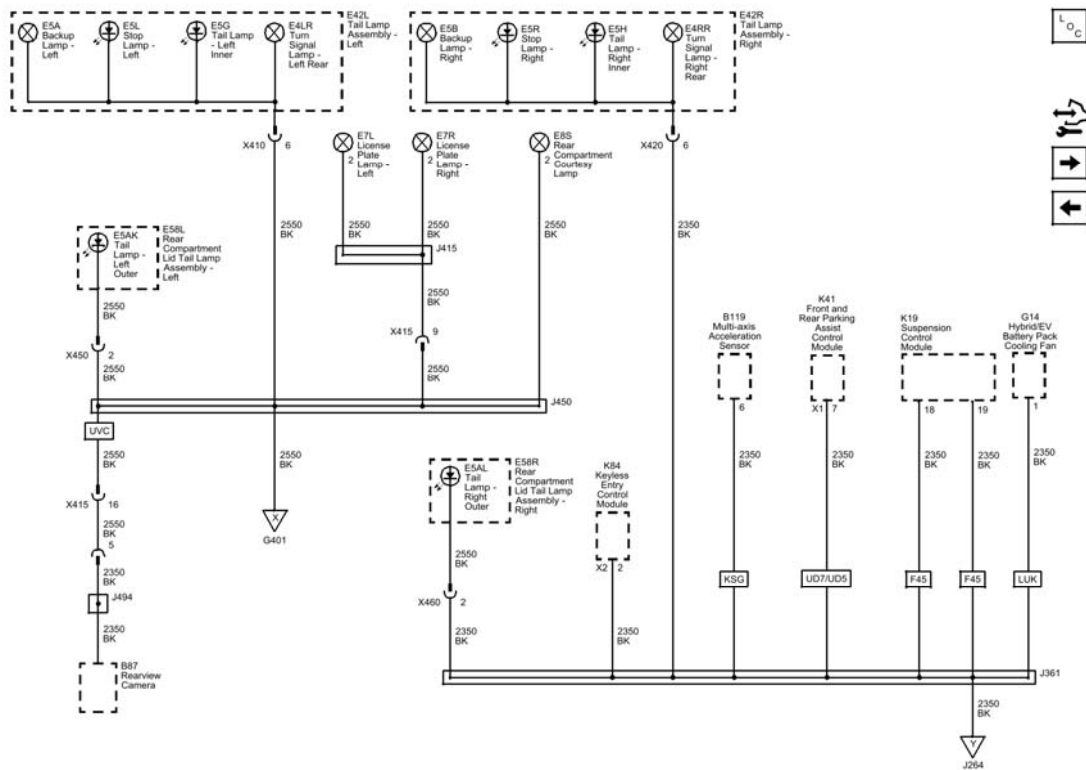


Fig. 12: G401 (2 of 2) except CZ2
Courtesy of GENERAL MOTORS COMPANY

G401 (1 of 2), G404, and G406 (except CZ2)

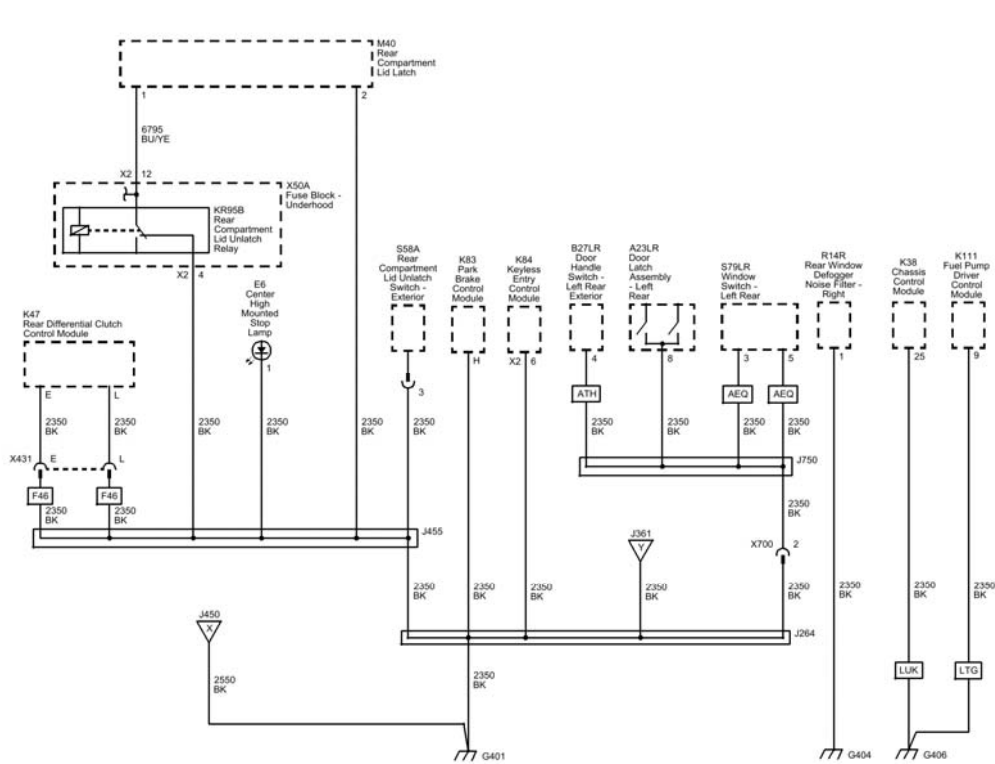


Fig. 13: G401 (1 of 2), G404, and G406 (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

G100, G102, and G103 (CZ2)

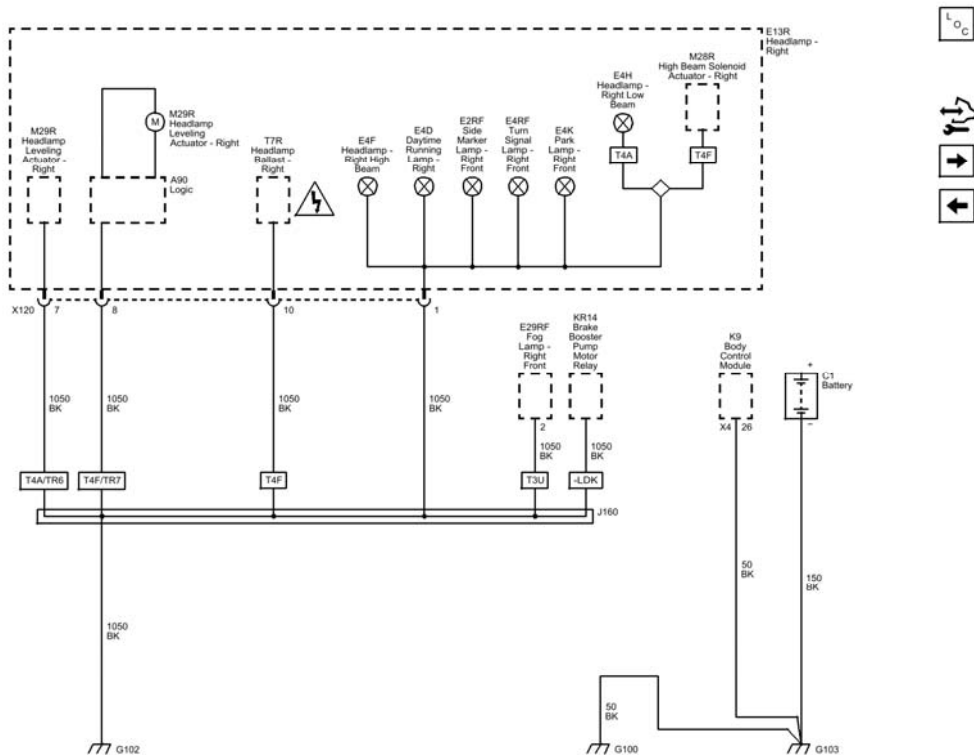


Fig. 14: G100, G102, and G103 (CZ2)
Courtesy of GENERAL MOTORS COMPANY

G104 (CZ2)

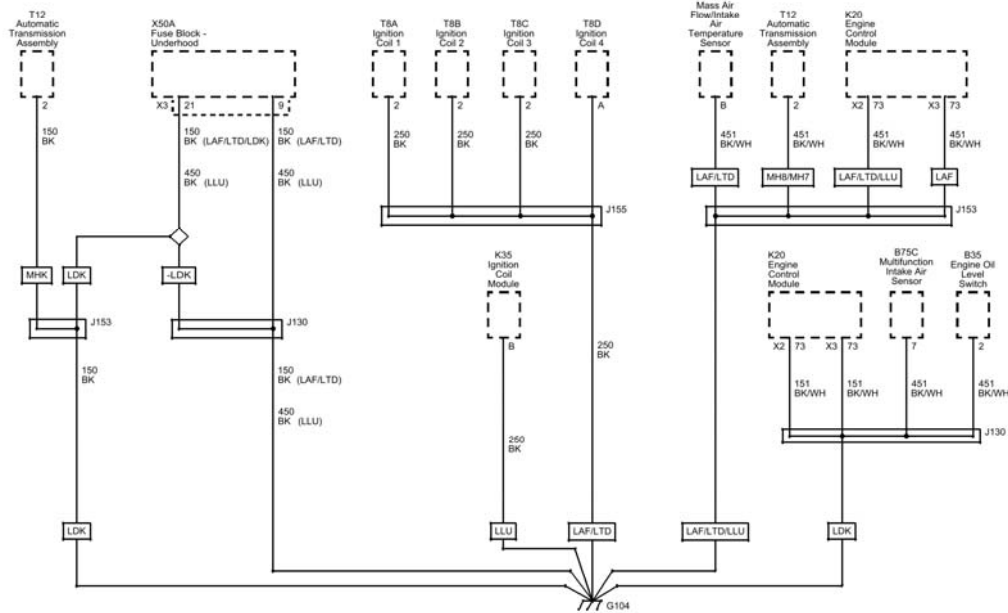


Fig. 15: G104 (CZ2)
Courtesy of GENERAL MOTORS COMPANY

G106, G107, G109 (2 of 2), and G110 CZ2

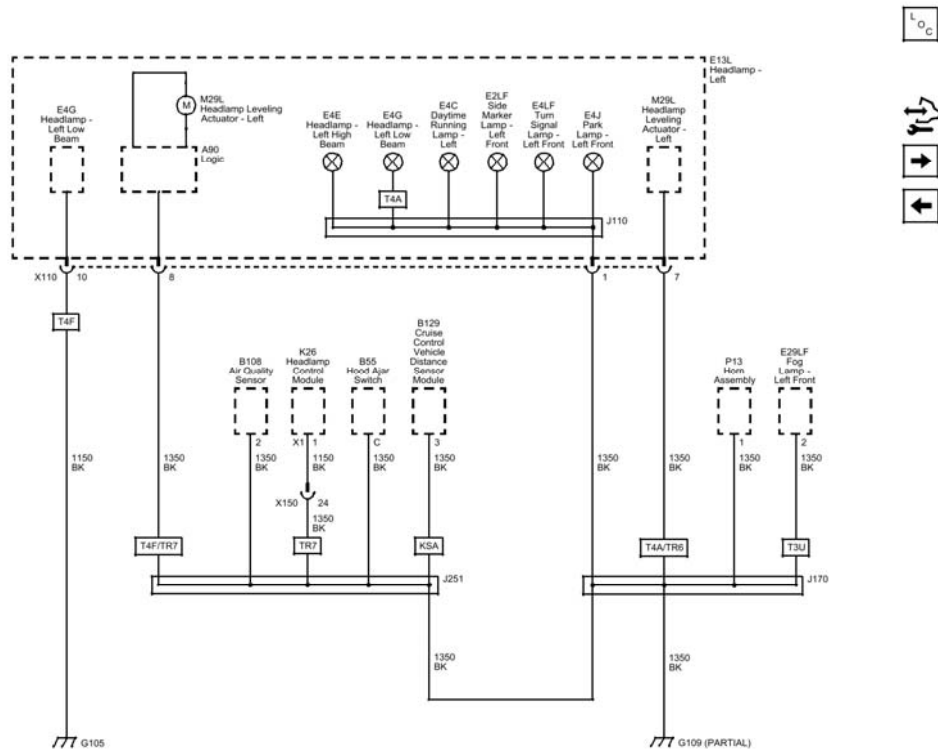


Fig. 16: G106, G107, G109 (2 of 2), and G110 CZ2
Courtesy of GENERAL MOTORS COMPANY

G120 and G201 CZ2

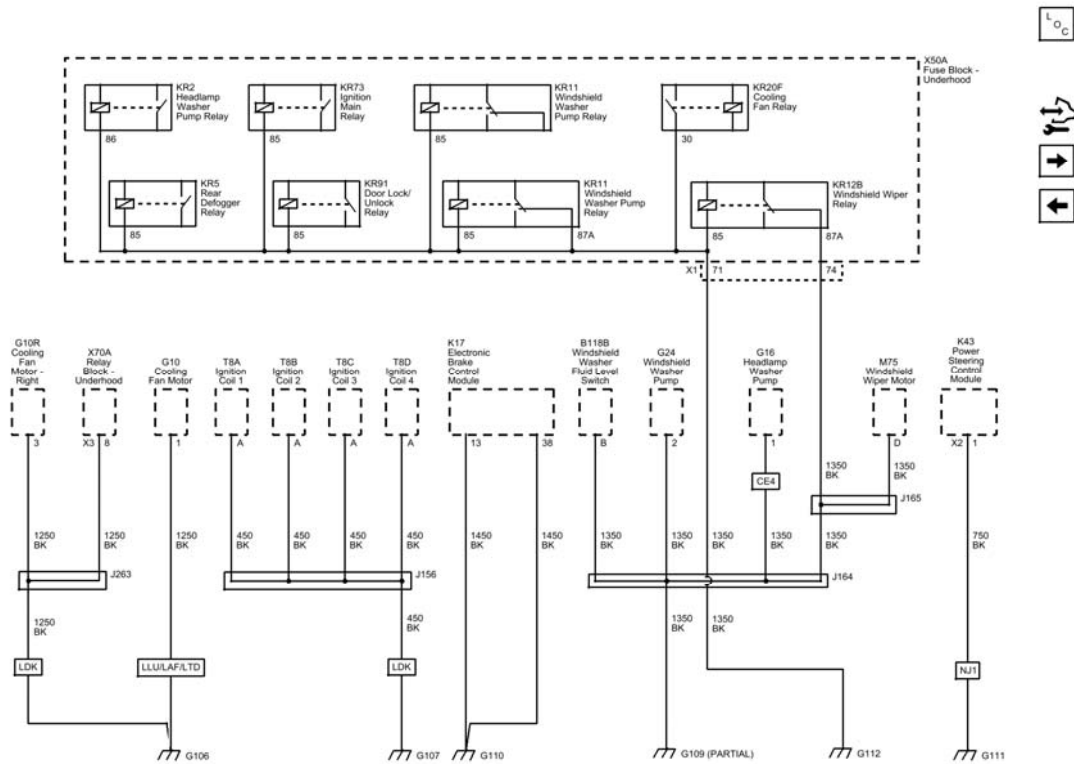


Fig. 17: G120 and G201 CZ2
Courtesy of GENERAL MOTORS COMPANY

G120, G201, and G203 (CZ2)

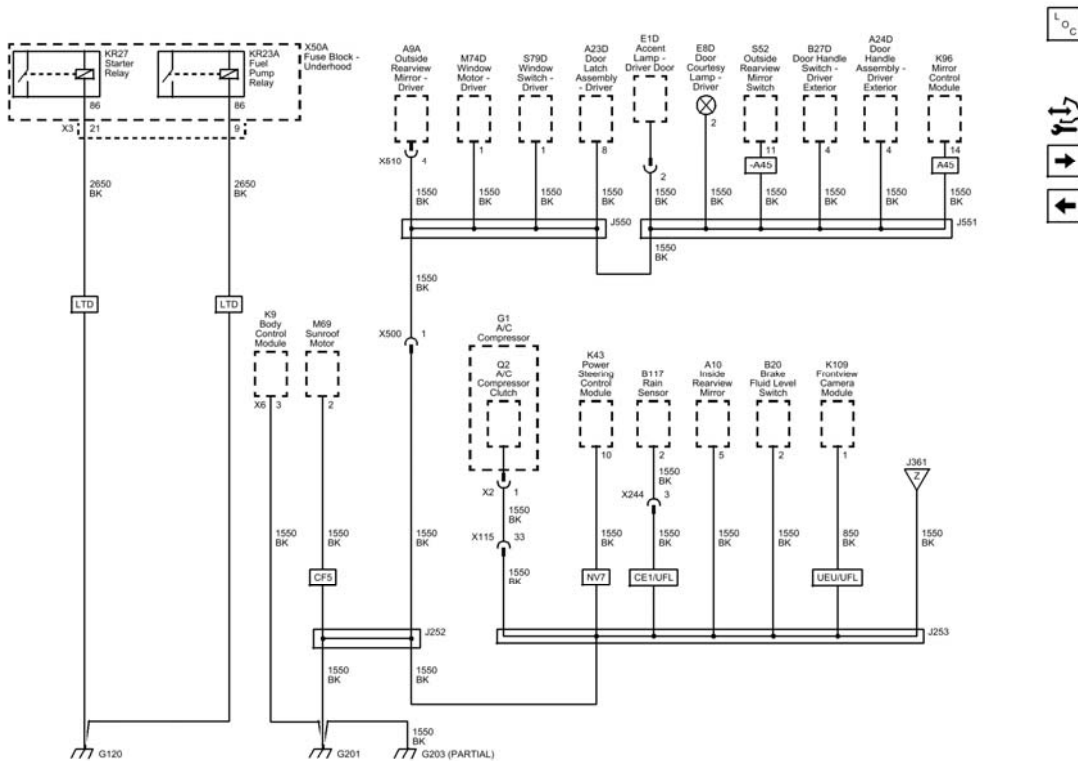


Fig. 18: G120, G201, and G203 (CZ2)
Courtesy of GENERAL MOTORS COMPANY

G205 CZ2

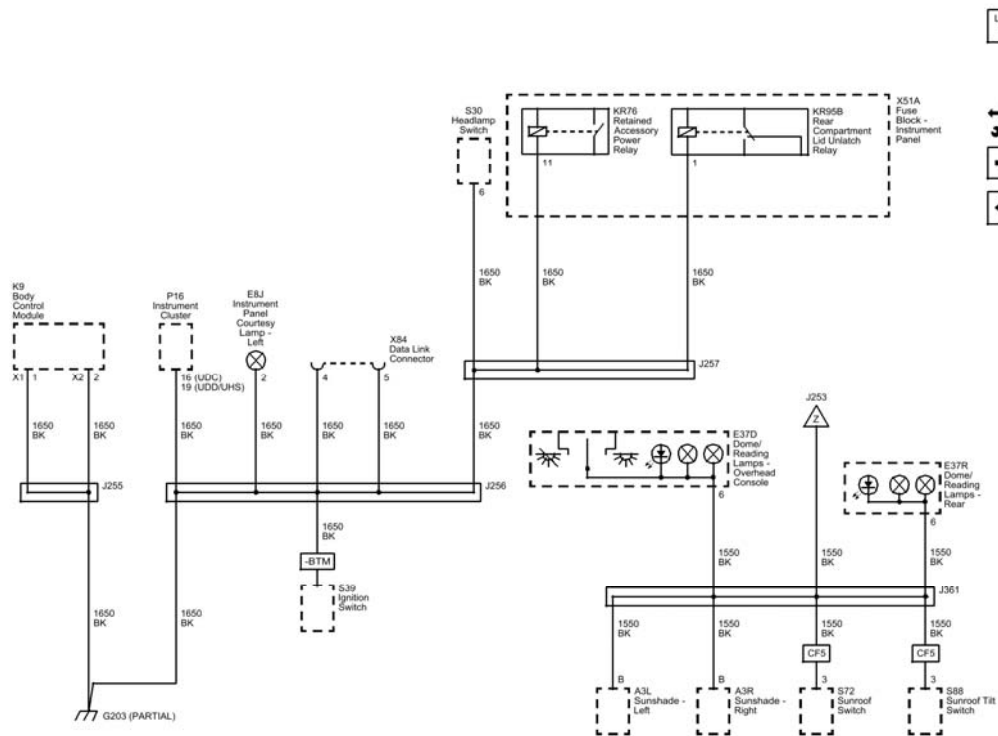


Fig. 19: G205 CZ2
Courtesy of GENERAL MOTORS COMPANY

G206 CZ2

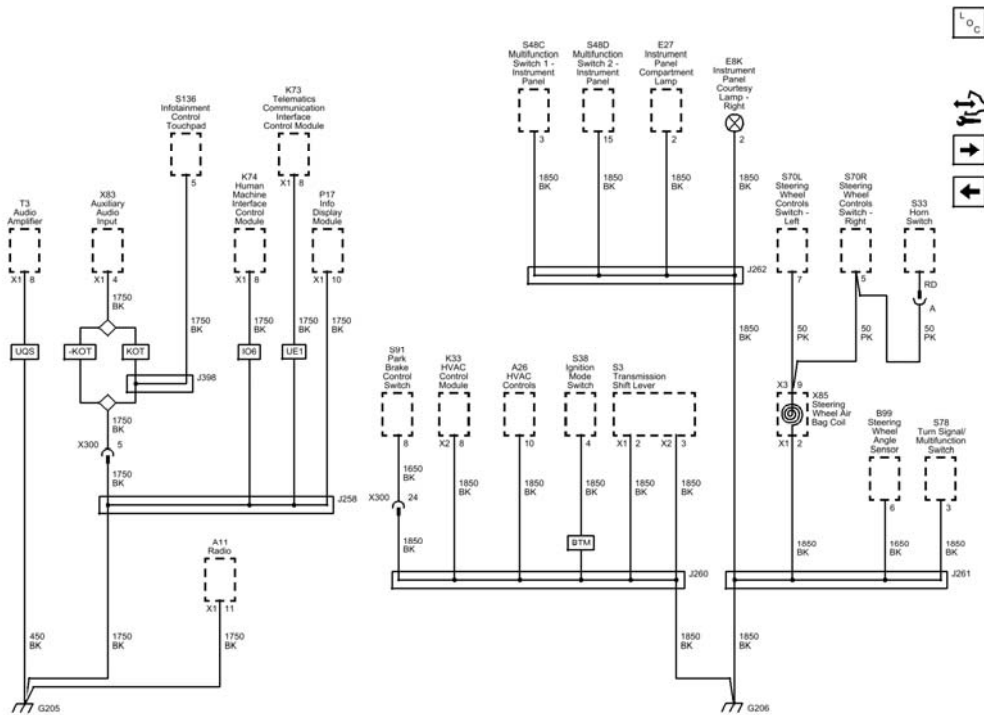


Fig. 20: G206 CZ2
Courtesy of GENERAL MOTORS COMPANY

G302 and G303 CZ2

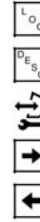
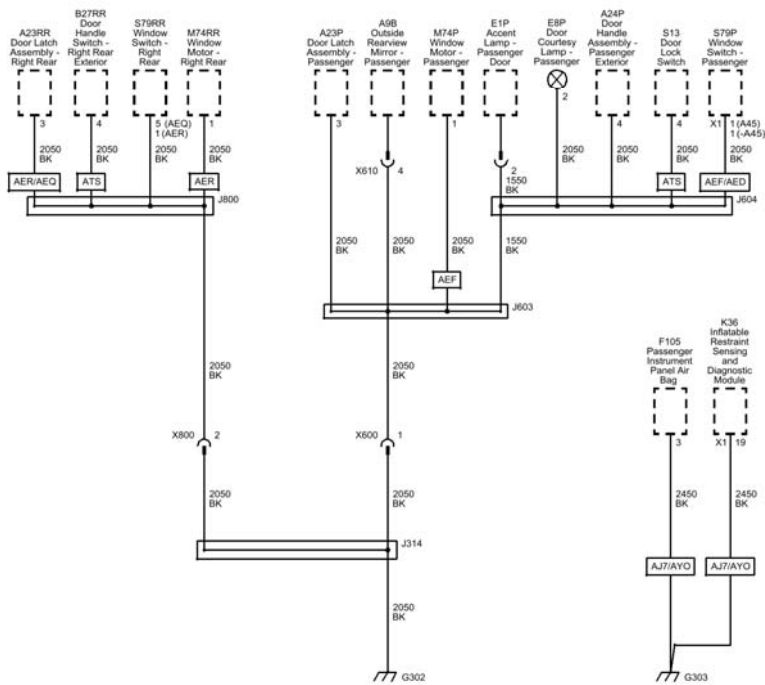


Fig. 21: G302 and G303 CZ2
Courtesy of GENERAL MOTORS COMPANY

G305 CZ2

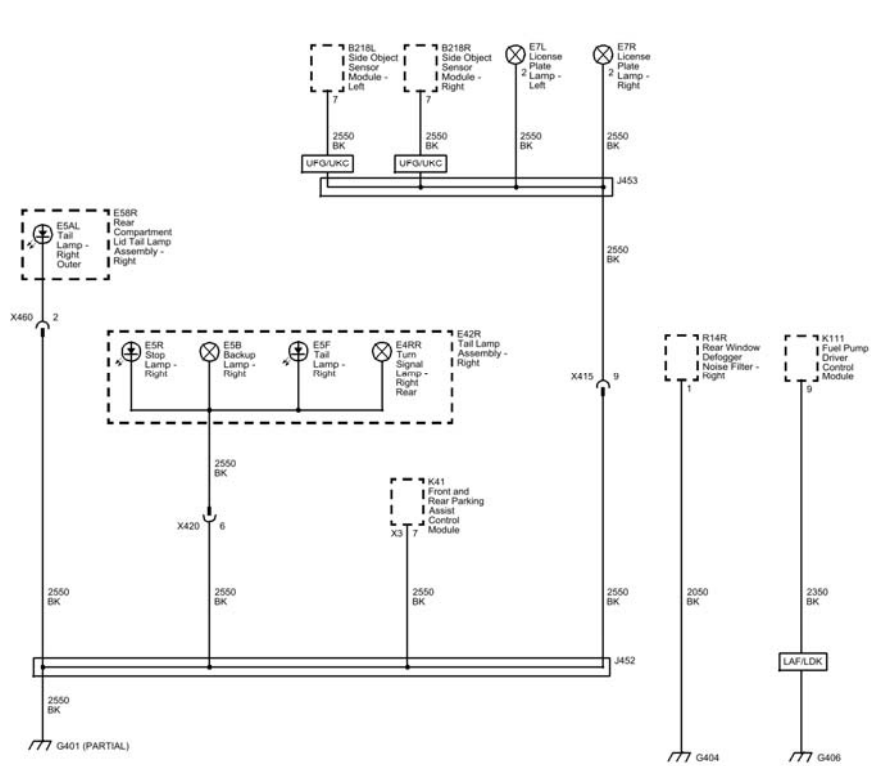


Fig. 24: G401 (2 of 2), G404, and G406 CZ2
Courtesy of GENERAL MOTORS COMPANY

HVAC

Heating, Ventilation, and Air Conditioning

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Air Conditioning Compressor and Condenser Hose Bolt (LUK)	20 (15 lb ft)	(15 lb ft)
Air Conditioning Compressor and Condenser Hose Nut (LUK)	20 (15 lb ft)	(15 lb ft)
Air Conditioning Compressor Bolt	22 (16 lb ft)	(16 lb ft)
Air Conditioning Compressor Bracket Bolts	22 (16 lb ft)	(16 lb ft)
Air Conditioning Compressor Heat Shield Bolt	7.5 (66 lb in)	(66 lb in)
Air Conditioning Compressor Hose Assembly Bolt	22 (16 lb ft)	(16 lb ft)
Air Conditioning Compressor Hose Assembly Nut	22 (16 lb ft)	(16 lb ft)
Air Conditioning Compressor Hose Retaining Fasteners	9 (80 lb in)	(80 lb in)
Air Conditioning Compressor Nut	22 (16 lb ft)	(16 lb ft)
Air Conditioning Compressor Stud	9 (80 lb in)	(80 lb in)
Air Conditioning Compressor Tube Assembly Nut	22 (16 lb ft)	(16 lb ft)
Air Conditioning Evaporator Hose Assembly Nut	22 (16 lb ft)	(16 lb ft)
Air Conditioning Evaporator Hose Fastener (LUK)	20 (15 lb ft)	(15 lb ft)
Air Conditioning Evaporator Hose Stud Bolt (LUK)	9 (80 lb in)	(80 lb in)
Air Conditioning Refrigerant Pressure Sensor	7.4 (65 lb in)	(65 lb in)
Compressor Pressure Relief Valve	8 (71 lb in)	(71 lb in)
Receiver and Dehydrator Plug (LTG)	12 (9 lb ft)	(9 lb ft)
Receiver and Dehydrator Plug	7 (62 lb in)	(62 lb in)

REFRIGERANT SYSTEM SPECIFICATIONS

Refrigerant System Specifications

Application	Specification	
	Metric	English
Abrupt Refrigerant Loss	60 ml ¹	2.0 oz ¹
PAG Oil GM P/N 12378526 for United States PAG Oil GM P/N 88900060 for Canada		
Compressor Replacement		
NOTE:		

Compressor failure can occur if the oil removed during refrigerant recovery is not replaced.

The service compressor is shipped with 74 ml² (2.5 oz²) or 40 ml² (1.4 oz²) of PAG oil. Refer to the oil balance instructions for information regarding the specific service compressor oil charge.

Condenser Replacement	30 ml ²	1.0 oz ²
Evaporator Replacement	90 ml ²	3.0 oz ²
Any Line Set (Hose/Tube or Tube Assembly) Replacement	30 ml ²	1.0 oz ²
• Total System PAG Oil Capacity	110.0 ml	3.7 oz
R-134a		
• Refrigerant Charge -LEA/LUK	0.68 kg	1.50 lb
• Refrigerant Charge - LTG	0.60 kg	1.30 lb

¹ Abrupt refrigerant loss due to large leak, hose rupture, collision, or pressure relief valve opening. Conditions that allow the refrigerant to seep or bleed off over time do not cause this oil loss. Upon replacement of a component that caused a large refrigerant loss, also add the required amount of oil for the particular component.

² If more than the specified amount of PAG oil was drained from a component, add the amount drained.

DIAGNOSTIC INFORMATION AND PROCEDURES

LEAK TESTING

Special Tools

- **GE-39400-A** Halogen Leak Detector
- **GE-41447** R-134A A/C Tracer Dye-Box of 24
- **GE-42220** Universal 12V Leak Detection Lamp
- **GE-43872** Fluorescent Dye Cleaner
- **GE-46297** A/C Dye Injector Kit
- **GE-46297-12** Replacement Dye Cartridges

For equivalent regional tools. Refer to **Special Tools** .

Refrigerant Leak Testing

NOTE: **General Motors vehicles are now manufactured with fluorescent dye installed directly into the air conditioning (A/C) system.**

The fluorescent dye mixes and flows with the polyalkylene glycol (PAG) oil throughout the refrigerant system.

Verifying some passive leaks may require using the **GE-39400-A** Halogen Leak Detector , even though the A/C system contains fluorescent dye.

The only time that adding additional fluorescent dye is required is after flushing the A/C system.

Fluorescent Leak Detector

Fluorescent dye will assist in locating any leaks in the A/C system.

NOTE: PAG oil is water soluble.

- Condensation on the evaporator core or the refrigerant lines may wash the PAG oil and fluorescent dye away from the actual leak. Condensation may also carry dye through the HVAC module drain.
- Leaks in the A/C system will be indicated in a light green or yellow color when using the leak detection lamp.

Use the leak detection lamp in the following areas:

- All fittings or connections that use seal washers or O-rings
- All of the A/C components
- The A/C compressor shaft seal
- The A/C hoses and pressure switches
- The HVAC module drain tube, if the evaporator core is suspected of leaking
- The service port sealing caps

The sealing cap is the primary seal for the service ports.

- Follow the instructions supplied with the **GE-42220** Universal 12V Leak Detection Lamp.
- To prevent false diagnosis in the future, thoroughly clean the residual dye from any area where leaks were found. Use a rag and the approved **GE-43872** Fluorescent Dye Cleaner.

Fluorescent Dye Injection

NOTE: Use only fluorescent dye approved by General Motors.

- **GE-41447 R-134A A/C Tracer Dye-Box of 24 can be poured directly into a removed A/C component.**
- **GE-46297-12 Replacement Dye Cartridges is injected into the low side port using GE-46297 A/C Dye Injector Kit.**
- Not all of the fluorescent dyes are compatible with PAG oil. Some types of dye decrease the oil viscosity or may chemically react with the oil.
- R-134A leak detection dye requires time to work. Depending upon the leak rate, a leak may not become visible for between 15 minutes and 7 days.

NOTE: Do NOT overcharge the A/C system with dye. Use only one 7.39 ml (0.25 oz) charge.

- To prevent false diagnosis, thoroughly clean any residual dye from the service port with a rag and the approved fluorescent dye cleaner **GE-43872** Fluorescent Dye Cleaner.

Halogen Leak Detector

WARNING: Do not operate the detector in a combustible atmosphere since its sensor operates at high temperatures or personal injury and/or damage to the equipment may result.

Ensure that the vehicle has at least 0.45 kg (1 lb) of refrigerant in the A/C refrigeration system in order to perform a leak test. Refer to **Refrigerant Recovery and Recharging** for recharging the A/C system.

NOTE: Halogen leak detectors are sensitive to the following items:

- Windshield washing solutions
- Many solvents and cleaners
- Some adhesives used in the vehicle

Clean and dry all surfaces in order to prevent a false warning. Liquids will damage the detector.

NOTE: Follow a continuous path in order to ensure that you will not miss any possible leaks. Test all areas of the system for leaks.

Follow the instructions supplied with the **GE-39400-A** Halogen Leak Detector.

AIR CONDITIONING (A/C) SYSTEM PERFORMANCE TEST

This test measures the operating efficiency of the A/C system under the following conditions:

- The current ambient air temperature
- The current relative humidity
- The high side pressure of the A/C system
- The low side pressure of the A/C system
- The temperature of the air being discharged into the passenger compartment

Test Description

The numbers below refer to the step numbers on the diagnostic table.

1

This step determines if the A/C system has at least the minimum refrigerant charge required to operate the system without damage.

2

This step measures the performance of the A/C system.

3

This step is to allow for vehicle variations as well as high ambient temperatures.

Air Conditioning (A/C) System Performance Test

Step	Action	Values	Yes	No
NOTE: <ul style="list-style-type: none"> • The ambient air temperature must be at least 16°C (60°F). • Do not induce additional air flow across the front of the vehicle during the test. • If you were sent here from a DTC diagnostic table, clear the DTC upon completion of this test. 				
1	<ol style="list-style-type: none"> 1. Park the vehicle inside or in the shade. 2. Open the windows in order to ventilate the interior of the vehicle. 3. If the A/C system was operating, allow the A/C system to equalize for about 2 minutes. 4. Turn OFF the ignition. 5. Install the J 43600 ACR 2000 Air Conditioning Service Center. 6. Record the ambient air temperature displayed on the J 43600 ACR 2000 Air Conditioning Service Center. 7. Record the low and high side STATIC pressure readings. <p>Are both the low side and high side pressures within the specified value?</p>	<p>More than 16°C (60°F) - 345 kPa (50 psi)</p> <p>More than 24°C (75°F) - 483 kPa (70 psi)</p> <p>More than 33°C (90°F) - 690 kPa (100 psi)</p>	Go to Step 2	Go to <u>Leak Testing</u>
	<p>NOTE: Record the relative humidity and the ambient air temperature at the time of the test.</p> <ol style="list-style-type: none"> 1. Close the vehicle doors and windows. 2. Open the drivers door window 12.7-15.2 cm (5-6 in). 3. Select the following HVAC control settings: <ul style="list-style-type: none"> • The A/C is ON. • The coldest temperature setting 			

2	<ul style="list-style-type: none"> • The maximum blower speed • Recirculation mode • The instrument panel (I/P) panel outlet mode • All I/P panel outlets are OPEN. <p>4. Install the temperature probes of the J 43600 ACR 2000 Air Conditioning Service Center in the left and right center panel air outlets.</p> <p>5. Apply the parking brake.</p> <p>6. Place the transaxle/transmission in one of the following positions:</p> <ul style="list-style-type: none"> • PARK (Automatic) • NEUTRAL (Manual) <p>7. Start the engine and warm to operating temperature.</p> <p>8. Operate the A/C system for 5 minutes.</p> <p>9. Inspect A/C components for the following conditions:</p> <ul style="list-style-type: none"> • Abnormal frost areas • Unusual noises <p>NOTE: Press the RESET button, before using the print function of the J 43600 ACR 2000 Air Conditioning Service Center.</p> <p>10. Print the following information:</p> <ul style="list-style-type: none"> • The panel outlet air temperatures • The low-side pressure • The high-side pressure <p>11. Compare the low and high side pressures and the panel output temperatures to the A/C Performance Table below.</p> <p>Does all the data recorded fall within the specified ranges of the A/C Performance Table below?</p>	-	Go to Step 5	Go to Step 3
	<p>If the pressures and temperatures recorded do not fall within the specified ranges:</p> <p>1. Continue to operate the A/C system for an</p>			

3	<p>additional 5 minutes.</p> <p>2. RESET the J 43600 ACR 2000 Air Conditioning Service Center and record the pressures and temperatures again.</p> <p>3. Compare the low and high side pressures and the panel output temperature to the table below.</p>	-		
	Does all the data recorded fall within the specified ranges of the table below?			
4	<p>Perform the necessary repairs. Refer to <u>A/C Diagnostics Chart</u>.</p> <p>Is the action complete?</p>	-	Go to Step 5	-
5	<p>Operate the system in order to verify the test results.</p> <p>Did you find the same results?</p>	-	System OK	Go to <u>Symptoms - HVAC Systems - Automatic</u>

A/C Performance Table

Ambient Temperature	Relative Humidity	Low Side Service Port Pressure	High Side Service Port Pressure	Maximum Left Center Discharge Air Temperature
13-18°C (55-65°F)	0-100%	151-220 kPa (22-32 psi)	950-1102 kPa (138-160 psi)	8°C (45°F)
19-24°C (66-75°F)	Below 40%	151-248 kPa (22-36 psi)	1178-1378 kPa (171-200 psi)	8°C (46°F)
	Above 40%	165-268 kPa (24-39 psi)	1109-1336 kPa (161-194 psi)	12°C (52°F)
25-29°C (76-85°F)	Below 35%	192-275 kPa (28-40 psi)	1329-1543 kPa (193-224 psi)	12°C (52°F)
	35-50%	199-289 kPa (29-42 psi)	13209-1543 kPa (190-224 psi)	13°C (54°F)
	Above 50%	213-310 kPa (31-45 psi)	1288-1543 kPa (187-224 psi)	14°C (57°F)
30-35°C (86-95°F)	Below 30%	227-316 kPa (33-46 psi)	1460-1722 kPa (212-250 psi)	14°C (57°F)
	30-50%	234-330 kPa (34-48 psi)	1460-1743 kPa (212-253 psi)	15°C (59°F)
	Above 50%	248-351 kPa (36-51 psi)	1460-1777 kPa (212-258 psi)	18°C (63°F)
36-41°C (96-105°F)	Below 20%	261-351 kPa (38-51 psi)	1619-1880 kPa (235-273 psi)	18°C (63°F)
	20-40%	268-365 kPa (39-53 psi)	1632-1922 kPa (237-279 psi)	18°C (64°F)

	Above 40%	282-378 kPa (41-55 psi)	1646-1970 kPa (239-286 psi)	19°C (66°F)
42-46°C (106-115°F)	Below 20%	303-378 kPa (44-55 psi)	1770-2011 kPa (257-292 psi)	20°C (68°F)
	Above 20%	310-399 kPa (45-58 psi)	1798-2080 kPa (261-302 psi)	22°C (70°F)
47-49°C (116-120°F)	Below 30%	344-427 kPa (50-62 psi)	1929-2197 kPa (280-319 psi)	24°C (75°F)

A/C DIAGNOSTICS CHART

A/C Diagnostics Chart

Low Side Gauge Reading	High Side Gauge Reading	Potential Causes
Low	Low	Low Refrigerant Charge
		Restriction between Compressor and High Side port
	Low/Normal	Evaporator Freezing
	High	Restriction between the Low Side and High Side ports or Restricted TXV/Orifice Tube
		Compressor Stuck at Maximum Displacement
High	Low	Compressor has Low Displacement or Internal Malfunction
		Malfunctioning Cooling Fans
	High	Refrigerant Overcharge
		Restriction between the Low Side Port and Compressor Inlet
		Restricted Condenser Air Flow
		Expansion Device Stuck Open
		Air in A/C System
Normal/High	Normal/High	Refrigerant Contamination
		PAG or POE Oil Overcharge

HEATING PERFORMANCE DIAGNOSTIC

Heating Performance Diagnostic

Step	Action	Yes	No
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to Symptoms - HVAC Systems - Automatic
2	1. Start the engine. 2. Allow the engine to idle.		

	Does the engine reach a normal operating temperature?	Go to Step 3	Go to Step 9
3	<p>WARNING: Refer to <u>Moving Parts and Hot Surfaces Warning</u> .</p> <ol style="list-style-type: none"> 1. Allow the engine to idle. 2. Select the FLOOR mode. 3. Select the minimum blower speed. 4. Select the warmest temperature setting. 5. Feel the temperature of the inlet and outlet heater hoses at the heater core. <p>Does the inlet heater hose feel warmer than the outlet heater hose?</p>	Go to Step 7	Go to Step 4
4	<ol style="list-style-type: none"> 1. Install a thermometer into the center I/P PANEL air outlet. 2. Secure a thermometer to the heater core outlet hose. 3. Select the PANEL mode. 4. Select the maximum blower speed. 5. Select the warmest temperature setting. 6. Record the temperature at the following locations: <ul style="list-style-type: none"> • The center I/P PANEL air outlet • The heater core outlet hose 7. Compare the recorded temperatures. <p>Are the 2 temperature readings about equal?</p>	Go to Step 5	Go to Step 6
5	<ol style="list-style-type: none"> 1. Inspect and repair the following areas of the vehicle for cold air leaks: <ul style="list-style-type: none"> • The cowl • The recirculation door • The HVAC module case 2. Perform the necessary repairs. <p>Are the repairs complete?</p>	Go to Step 10	-
6	<ol style="list-style-type: none"> 1. Inspect the temperature door operation. Refer to <u>Diagnostic System Check - Vehicle</u> . 2. Perform any necessary repairs. <p>Are the repairs complete?</p>	Go to Step 10	-

7	<ol style="list-style-type: none"> 1. Turn OFF the engine. 2. Backflush the heater core. 3. Start the engine. 4. Select the FLOOR mode. 5. Select the minimum blower speed. 6. Select the warmest temperature setting. 7. Feel the temperature of the inlet and outlet heater hoses at the heater core. <p>Does the inlet heater hose feel warmer than the outlet heater hose?</p>	Go to Step 8	Go to Step 10
8	<p>Replace the heater core. Refer to <u>Heater Core Replacement (LHD)</u>.</p> <p>Is the repair complete?</p>	Go to Step 10	-
9	<p>Repair the low engine temperature concern. Refer to <u>Engine Fails To Reach Normal Operating Temperature</u>.</p> <p>Is the repair complete?</p>	Go to Step 10	-
10	<p>Operate the system in order to verify the repair.</p> <p>Did you find and correct the condition?</p>	System OK	Go to Step 2

DEFROSTING INSUFFICIENT

Defrosting Insufficient

Step	Action	Yes	No
DEFINITION: Time required to defrost the windshield is longer than normal.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to <u>Symptoms - HVAC Systems - Automatic</u>
2	<ol style="list-style-type: none"> 1. Start the engine. 2. Select the DEFROST mode. 3. Select the maximum blower speed. <p>Does sufficient air flow from the defroster outlets?</p>	Go to Step 3	Go to Step 10
3	<p>Measure the engine operating temperature.</p> <p>Does engine reach a normal operating temperature?</p>	Go to Step 4	Go to Step 8
4	<ol style="list-style-type: none"> 1. Select the minimum blower speed. 2. Select the maximum temperature setting. <p>WARNING: Refer to <u>Moving Parts and Hot Surfaces Warning</u>.</p>		

	3. Feel the temperature of the inlet and outlet hoses at the heater core. Does the inlet hose feel warmer than the outlet hose?	Go to Step 11	Go to Step 5
5	Test the operation of the A/C compressor clutch. Does the A/C compressor clutch engage?	Go to Step 7	Go to Step 6
6	Repair the A/C compressor clutch. Refer to <u>Air Conditioning Compressor Replacement (LUK)</u> , <u>Air Conditioning Compressor Replacement (LTG)</u> , <u>Air Conditioning Compressor Replacement (LEA)</u> . Is the repair complete?	Go to Step 14	-
7	Perform the A/C system performance test. Refer to <u>Air Conditioning (A/C) System Performance Test</u> . Is the A/C system operating within the specifications?	Go to Step 9	Go to Step 12
8	Repair the low engine temperature concern. Refer to <u>Engine Fails To Reach Normal Operating Temperature</u> . Is the repair complete?	Go to Step 14	-
9	Inspect for correct operation of the recirculation door. Is the recirculation door operating correctly?	Go to Step 14	Go to Step 13
10	Repair the air delivery concern. Is the repair complete?	Go to Step 14	-
11	Repair the heating concern. Refer to Air Temperature Malfunction . Is the repair complete?	Go to Step 14	-
12	Repair the A/C performance concern. Refer to <u>Air Conditioning (A/C) System Performance Test</u> . Is the repair complete?	Go to Step 14	-
13	Repair the recirculation door concern. Is the repair complete?	Go to Step 14	-
14	Operate the system in order to verify the repair. Did you find and correct the problem?	System OK	Go to Step 2

NOISE DIAGNOSIS - BLOWER MOTOR

Noise Diagnosis - Blower Motor

Step	Action	Yes	No
DEFINITION: Noise originating from the blower motor.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to <u>Symptoms - HVAC Systems - Automatic</u>
2	Inspect the air inlet grille for debris. Is debris present?	Go to Step 8	Go to Step 3
	1. Sit inside the vehicle.		

3	<ol style="list-style-type: none"> 2. Close the vehicle doors and windows. 3. Turn ON the ignition, with the engine OFF. 4. Cycle the blower motor through all of the speeds and modes in order to determine where and when the noise occurs. <p>Is a noise evident during the blower operation?</p>	Go to Step 4	Go to Step 11
4	<p>Inspect for excessive vibration at each blower motor speed by feeling the blower case.</p> <p>Is excess vibration present?</p>	Go to Step 6	Go to Step 5
5	<p>Listen to the blower motor at each speed.</p> <p>Is the blower motor making a squeaking or chirping noise?</p>	Go to Step 9	Go to Step 11
6	<ol style="list-style-type: none"> 1. Remove the blower motor. Refer to <u>Blower Motor Replacement</u>. 2. Inspect the blower motor impeller for deposits of foreign material. 3. Inspect the blower motor for deposits of foreign material. <p>Did you find any foreign material on the blower motor or blower motor impeller?</p>	Go to Step 8	Go to Step 7
7	<p>Inspect the blower motor for the following conditions:</p> <ul style="list-style-type: none"> • Cracked blades • A loose impeller retainer • Improper impeller alignment <p>Did you find any of these conditions?</p>	Go to Step 9	Go to Step 10
8	<p>Remove the foreign material.</p> <p>Is the action complete?</p>	Go to Step 10	-
9	<p>Replace the blower motor. Refer to <u>Blower Motor Replacement</u>.</p> <p>Is the repair complete?</p>	Go to Step 11	-
10	<p>Install the blower motor. Refer to <u>Blower Motor Replacement</u>.</p> <p>Is the action complete?</p>	Go to Step 11	-
11	<p>Operate the system in order to verify the repair.</p> <p>Did you find and correct the condition?</p>	System OK	Go to Step 2

AIR CONDITIONING COMPRESSOR OIL DIAGNOSIS

Air Conditioning Compressor Oil Diagnosis

Condition	Corrective Action
NOTE: To avoid repeat compressor failure, always inspect the condition of the refrigerant oil and take the appropriate corrective action before installing the replacement compressor.	
Clean Oil no debris present	No corrective action necessary.
Clean Oil with debris present	<ul style="list-style-type: none"> • Replace desiccant or component containing the desiccant. • Replace desiccant filter if applicable. • Remove and inspect high pressure side filter (if applicable). • Remove, inspect, clean, or replace orifice tube (if applicable). • If the system has a front orifice tube and is equipped with a filter in the rear auxiliary line, remove, inspect, clean, or replace the filter.
Dark brown/black and/or pungent/unusual odor with no debris present	<ul style="list-style-type: none"> • Replace desiccant or component containing the desiccant. • Replace desiccant filter if applicable. • Flush refrigerant system.
Dark brown/black and/or pungent/unusual odor with debris present	<ul style="list-style-type: none"> • Replace desiccant or component containing the desiccant. • Replace desiccant filter if applicable. • Flush refrigerant system. • Remove and inspect high pressure side filter (if applicable). • Remove, inspect, clean, or replace orifice tube (if applicable). • If the system has a front orifice tube and is equipped with a filter in the rear auxiliary line, remove, inspect, clean, or replace the filter.
Oil Overcharge	Flush refrigerant system.
Refrigerant Contamination	Flush refrigerant system.
Hybrid Polyolester Refrigerant Oil (POE) Contamination	<ul style="list-style-type: none"> • Flush refrigerant system. • Replace desiccant or component containing the desiccant. • Replace desiccant filter if applicable.

NOISE DIAGNOSIS - AIR CONDITIONING (A/C) SYSTEM

Noise Diagnosis - Air Conditioning (A/C) System

Step	Action	Yes	No
DEFINITION: Noise originating from the A/C compressor, drive belt, or the A/C lines.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to <u>Symptoms - HVAC Systems - Automatic</u>
	1. A/C system noises can be generally categorized into 3 areas: <ul style="list-style-type: none"> • Screeching, squealing, chirping noises 		

2	<ul style="list-style-type: none"> • Moaning noises • Vibration/rattle noises <ol style="list-style-type: none"> 2. Start the engine. 3. Ensure that the A/C is ON. <p>Is a screeching, squealing noise heard when the A/C is engaged?</p>	Go to Step 3	Go to Step 9
3	<p>With the engine OFF, inspect the drive belt for excessive wear. Refer to the appropriate procedure: <u>Drive Belt Falls Off and Excessive Wear Diagnosis</u> , for the 2.4 engine or <u>DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS</u> for the 2.0 engine.</p> <p>Is the drive belt excessively worn?</p>	Go to Step 18	Go to Step 4
4	<p>Inspect the drive belt tension. Refer to the appropriate procedure: <u>Drive Belt Tensioner Diagnosis</u> , for the 2.4 engine or <u>DRIVE BELT TENSIONER DIAGNOSIS</u> for the 2.0 engine.</p> <p>Is the drive belt tension correct?</p>	Go to Step 5	Go to Step 19
5	<p>Inspect the drive belt for excessive oil coverage.</p> <p>Is the drive belt covered with oil?</p>	Go to Step 17	Go to Step 6
6	<ol style="list-style-type: none"> 1. Start the engine. 2. Ensure that the A/C is ON. 3. Inspect the compressor and the clutch. <p>Is the A/C compressor locked up?</p>	Go to Step 24	Go to Step 7
7	<p>Is the A/C compressor clutch slipping?</p>	Go to Step 23	Go to Step 8
8	<p>WARNING: Refer to <u>Moving Parts and Hot Surfaces Warning</u> .</p> <p>Using a stethoscope, listen to the A/C compressor for any abnormal noises. Is the compressor causing an abnormal noise?</p>	Go to Step 15	Go to Step 10
9	<p>Does a moaning noise exist when the A/C clutch is engaged?</p>	Go to Step 10	Go to Step 12
10	<p>Listen to the A/C compressor components and mounting for noise concerns using a stethoscope. Are any of these components loose, damaged, or excessively worn?</p>	Go to Step 20	Go to Step 11
	<ol style="list-style-type: none"> 1. Idle the engine. 2. Engage the A/C compressor clutch. 3. Using a stethoscope, move around the entire 		

11	refrigerant plumbing system. Listening for any abnormal noises caused by a component of the A/C system touching another component. Are any of the A/C components grounding out and causing a vibration noise?	Go to Step 22	Go to Step 13
12	Does a vibration or rattle noise exist when the A/C clutch is engaged?	Go to Step 13	Go to Step 14
13	Does the noise stop when the A/C clutch is disengaged?	Go to Step 15	Go to Step 25
14	1. Idle the engine in PARK with the A/C compressor clutch engaged. 2. Using a stethoscope, move around the entire A/C system testing for any abnormal noises caused by a component. Do any of the A/C components cause an abnormal noise?	Go to Step 21	Go to Step 25
15	Verify that the A/C system is properly charged. Refer to Refrigerant System Specifications . Is the A/C system properly charged?	Go to Step 26	Go to Step 16
16	Recharge the A/C system to specification. Refer to Refrigerant Recovery and Recharging . Is the abnormal compressor noise still present?	Go to Step 24	Go to Step 26
17	Repair the oil leak. Refer to the appropriate procedure: Oil Leak Diagnosis , for the 2.4 engine or OIL LEAK DIAGNOSIS for the 2.0 engine. Is the repair complete?	Go to Step 18	-
18	Replace the drive belt. Refer to the appropriate procedure: Drive Belt Replacement (LEA) , Drive Belt Replacement (LUK) , for the 2.4 engine or DRIVE BELT REPLACEMENT for the 2.0 engine. Is the replacement complete?	Go to Step 26	-
19	Replace the drive belt tensioner. Refer to the appropriate procedure: Is the replacement complete? Drive Belt Tensioner Replacement (LUK) , Drive Belt Tensioner Replacement (LEA) , for the 2.4 engine or DRIVE BELT TENSIONER REPLACEMENT for the 2.0 engine.	Go to Step 26	-
20	Repair or replace the A/C compressor mounting component. Is the repair complete?	Go to Step 26	-
21	Repair or replace the component which is causing the moaning concern as needed. Is the repair complete?	Go to Step 26	-

22	Correctly route or insulate the A/C component. Is the repair complete?	Go to Step 26	-
23	Replace the A/C compressor clutch. Refer to <u>Air Conditioning Compressor Replacement (LUK)</u> , <u>Air Conditioning Compressor Replacement (LTG)</u> , <u>Air Conditioning Compressor Replacement (LEA)</u> . Is the repair complete?	Go to Step 26	-
24	Replace the A/C compressor. Refer to <u>Air Conditioning Compressor Replacement (LUK)</u> , <u>Air Conditioning Compressor Replacement (LTG)</u> , <u>Air Conditioning Compressor Replacement (LEA)</u> . Is the repair complete?	Go to Step 26	-
25	The concern may be caused by an engine related component. Refer to <u>Vibration Analysis - Engine</u> . Did you find and correct the condition?	Go to Step 26	-
26	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

NOISE DIAGNOSIS - HVAC MODULE

Noise Diagnosis - HVAC Module

Step	Action	Yes	No
DEFINITION: Noise originating from the HVAC module.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to <u>Symptoms - HVAC Systems - Automatic</u>
2	<ol style="list-style-type: none"> Start the engine. Cycle through all of the following: <ul style="list-style-type: none"> Blower motor speeds HVAC modes Temperature control settings Determine the type of noise: <ul style="list-style-type: none"> Scrape, pop Tick/click, chirp or groaning Air rush/whistle <p>Is a scrape or pop noise evident when selecting modes or temperature settings?</p>	Go to Step 6	Go to Step 3
3	Is a tick/click, chirping, groaning or scraping noise present, but decreases as blower motor speed is decreased?	Go to Step 6	Go to Step 4
4	Is an air rush/whistle noise evident in all modes but not all temperature settings?	Go to Step 6	Go to Step 5

5	Is an air rush/whistle noise evident only in defrost or floor mode?	Go to Step 6	Go to Step 6
6	Remove the instrument panel (I/P) carrier. Refer to <u>Instrument Panel Tie Bar Replacement</u> . Is the action complete?	Go to Step 7	-
7	<ul style="list-style-type: none"> Inspect the air flow doors for proper operation. Inspect the ducts for obstructions or foreign materials. Were any of these conditions found?	Go to Step 10	Go to Step 8
8	Inspect the mode and temperature doors and seals for warping or cracking. Are the doors in normal condition?	Go to Step 11	Go to Step 9
9	Replace the appropriate door and/or seals. Is the repair complete?	Go to Step 11	-
10	Remove any obstructions or foreign material found. Is the action complete?	Go to Step 11	-
11	Install the I/P carrier. Refer to <u>Instrument Panel Tie Bar Replacement</u> . Is the action complete?	Go to Step 12	-
12	Operate the system to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

ODOR DIAGNOSIS

Odor Diagnosis

Step	Action	Yes	No
DEFINITION: Odor originating or noticed through the HVAC system.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to <u>Symptoms - HVAC Systems - Automatic</u>
2	<ol style="list-style-type: none"> Sit inside the vehicle. Close all of the doors and windows. Start the engine. Allow the engine idle at normal operating temperature. Select the maximum blower speed. Select the PANEL air outlet mode. Select the coldest temperature setting. Cycle through all of the blower speeds, modes and temperatures to define what type of odor is present. <ul style="list-style-type: none"> Musty smell 		

	<ul style="list-style-type: none"> • Coolant smell • Oil smell 		
	Does the odor have a musty smell?	Go to Step 3	Go to Step 8
3	Inspect the HVAC filter and the air inlet grille for debris. Is debris present?	Go to Step 4	Go to Step 5
4	Remove any debris. Is the action complete?	Go to Step 15	-
5	Inspect for wet carpeting. Is the carpet wet?	Go to Step 6	Go to Step 8
6	Inspect for the following conditions: <ul style="list-style-type: none"> • Water leaks around the windshield • Blockage of the HVAC module drain • Leaks around the door seals Is a leak present?	Go to Step 7	Go to Step 15
7	Repair the leak as necessary. Is the repair complete?	Go to Step 15	-
8	Does the odor have a coolant smell?	Go to Step 9	Go to Step 12
9	Inspect the cooling system for leaks. Refer to <u>Loss of Coolant</u> . Is a leak present?	Go to Step 10	Go to Step 12
10	Inspect for coolant leaking inside the vehicle or for a film build-up on the windshield. Is the condition present?	Go to Step 11	Go to Step 15
11	Inspect and if necessary replace the heater core. Refer to <u>Heater Core Replacement (LHD)</u> . Is the repair complete?	Go to Step 15	-
12	Does the odor have an oily smell?	Go to Step 13	Go to Step 15
13	1. Inspect the engine compartment for any leaks. Refer to the following procedures: <ul style="list-style-type: none"> • <u>Cooling System Leak Testing</u> for 2.0L or for 2.4L • <u>Fluid Leak Diagnosis (Non Hybrid)</u> , <u>Fluid Leak Diagnosis (Hybrid)</u> 2. Repair any oil leaks.		-
	Is the repair complete?	Go to Step 15	
	A musty odor can be caused by mold or mildew build-up on the evaporator or the heater core or		

14	inside of the HVAC module. Refer to <u>Odor Correction</u> . Is the action complete?	Go to Step 15	-
15	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

REPAIR INSTRUCTIONS

ODOR CORRECTION

Eliminating Air Conditioning Odor

Odors may be emitted from the air conditioning system primarily at start up in hot, humid climates. The following conditions may cause the odor:

- Debris is present in the HVAC module.
- Microbial growth on the evaporator core

When the blower motor fan is turned on, the microbial growth may release an unpleasant musty odor into the passenger compartment. To remove odors of this type, the microbial growth must be eliminated. Perform the following procedure:

Deodorize the evaporator core using Deodorizing Aerosol Kit.

Perform the following steps in order to deodorize the A/C system:

1. Ensure that the plenum that draws outside air into the HVAC module is clear of debris.
2. Disable the A/C compressor clutch operation by disconnecting the clutch coil electrical connector.
3. Dry the evaporator core by performing the following steps:
 1. Start the engine.
 2. Select the maximum temperature setting.
 3. Select the recirculation mode.
 4. Run the blower motor on high for 10 minutes.
4. Locate an area in the air conditioning duct between the blower motor and the evaporator core downstream of the blower motor.
5. Drill a 3.175 mm (0.125 in) hole where the hole will not interfere with or damage the following components:
 - The blower motor
 - The evaporator core
 - Any other operating part the of system
6. Wear safety goggles and latex gloves in order to perform the following actions:
 1. Select the maximum blower speed.
 2. Insert the deodorizer extension tube into the hole to the mark on the extension tube.

3. Use short spray bursts and vary the direction of spray for a 2-3 minute period of time.
7. Shut the engine OFF. Allow the vehicle to sit for 3-5 minutes.
8. Seal the 3.175 mm (0.125 in) hole with body sealer or RTV gasket compound.
9. Start the engine.
10. Operate the blower motor on high for 15-20 minutes to dry.
11. Reconnect the A/C compressor clutch coil electrical connector.
12. Verify proper clutch operation.
13. Using the scan tool enable the afterblow. Refer to **Heating, Ventilation and Air Conditioning Control Module Scan Tool Information** .

REFRIGERANT RECOVERY AND RECHARGING

WARNING: To prevent personal injury, avoid breathing A/C Refrigerant and lubricant vapor or mist. Work in a well ventilated area. To remove refrigerant from the A/C System, use service equipment designed for recovery that is certified to meet the requirements of the appropriate SAE Standards. If an accidental system discharge occurs, ventilate the work area before continuing service. Additional health and safety information may be obtained from the refrigerant, refrigerant recovery, and lubricant manufacturers.

WARNING: For personal protection, goggles and lint-free gloves should be worn and a clean cloth wrapped around fittings, valves, and connections when doing work that includes opening the refrigerant system. If refrigerant comes in contact with any part of the body severe frostbite and personal injury can result. The exposed area should be flushed immediately with cold water and prompt medical help should be obtained.

CAUTION: You must replace the desiccant if the A/C refrigerant system has been open to atmosphere for more than four hours, or if the A/C refrigerant oil has been contaminated. Failure to replace the desiccant will result in damage to the A/C refrigerant system.

CAUTION: To avoid system damage use only R-134a dedicated tools when servicing the A/C system.

CAUTION: R-134a is the only approved refrigerant for use in this vehicle. The use of any other refrigerant may result in poor system performance or component failure.

CAUTION: Use only Polyalkylene Glycol Synthetic Refrigerant Oil (PAG) for internal circulation through the R-134a A/C system and only 525 viscosity mineral oil on fitting threads and O-rings. If lubricants other than those specified

are used, compressor failure and/or fitting seizure may result.

CAUTION: R-12 refrigerant and R-134a refrigerant must never be mixed, even in the smallest of amounts, as they are incompatible with each other. If the refrigerants are mixed, compressor failure is likely to occur. Refer to the manufacturer instructions included with the service equipment before servicing.

The A/C service station is a complete air conditioning service center for refrigerant. The service station recovers, recycles, evacuates and recharges A/C refrigerant quickly, accurately and automatically. The unit has a display screen that contains the function controls and displays prompts that will lead the technician through the recover, recycle, evacuate and recharge operations. A/C refrigerant is recovered into and charged out of an internal storage vessel.

The A/C service station has a built in A/C refrigerant identifier that will test for contamination, prior to recovery and will notify the technician if there are foreign gases present in the A/C system. If foreign gases are present, the station will not recover the refrigerant from the A/C system.

For information on the actual equipment, please refer to the manual of the equipment in question.

Always recharge the A/C System with the proper amount of refrigerant. Refer to **Refrigerant System Specifications** for the correct amount.

A/C Refrigerant System Oil Charge Replenishing

If oil was removed from the A/C system during the recovery process or due to component replacement, the oil must be replenished. Oil can be injected into a charged system. For the proper quantities of oil to add to the A/C refrigerant system, refer to **Refrigerant System Specifications**.

FLUSHING

NOTE: This procedure is not used in Europe.

Special Tools

- **GE-8800** ACR 2000 Air Conditioning Service Center
- **GE-41447** Leak Detection Dye
- **GE-42220** Universal 12V Leak Detection Lamp
- **GE-45268** Flush Adapter Kit

For equivalent regional tools. Refer to **Special Tools** .

NOTE: Flushing with the GE-8800 ACR 2000 Air Conditioning Service Center is not intended to remove metal from the A/C system.

Flushing is intended to remove the following:

- Contaminated polyalkylene glycol (PAG) oil
- Desiccant, following a desiccant bag failure
- Overcharge of PAG oil
- Refrigerant contamination

NOTE: Warmer engine or ambient temperature decreases the refrigerant recovery time during the A/C flush procedure.

1. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**.
2. Remove the thermal expansion valve (TXV). Refer to **Air Conditioning Evaporator Thermal Expansion Valve Replacement**.
3. Install the stud for the **GE-45268** Flush Adapter Kit onto the J 45268-115.
4. Install the J 45268-115 in place of the TXV.

CAUTION: Refer to **Fastener Caution** .

5. Install the TXV mounting bolts.

Tighten

Tighten the bolts to 7 N.m (62 lb in).

6. Connect the evaporator line to the J 45268-115.
7. Install the TXV block fitting nut.

Tighten

Tighten the bolts to 17 N.m (12.5 lb ft).

8. Remove the A/C compressor. Refer to **Air Conditioning Compressor Replacement (LUK)**, **Air Conditioning Compressor Replacement (LTG)**, **Air Conditioning Compressor Replacement (LEA)**.
9. Install J 45268-10 to the A/C compressor hose assembly.
10. Install the nut and bolt from the **J 45268** Flush Adapter Kit to the J 45268-10 and compressor hose assembly.

Tighten

Tighten the bolts to 17 N.m (12.5 lb ft).

11. Forward flow refrigerant flushing is recommended for contaminated refrigerant or PAG oil.

Perform the following procedure:

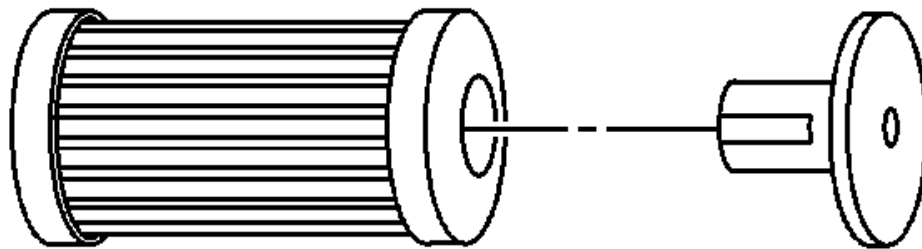


Fig. 1: View Of A/C Filter & Check Valve
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The filter inside GE 45268-1 is serviceable. Remove and discard the check valve from the filter.**

1. Service the filter with ACDelco P/N GF 470, before each flush.
2. Install the port plugs GE 45268-9 onto the GE 45268-10.
3. Install the fitting GE 45268-7 onto the GE 45268-10.
4. Install the fitting GE 45268-8 onto the GE 45268-10.
5. Connect GE 45268-1 flush filter to the suction port of GE 45268-7 flush adapter.
6. Connect the blue hose from the **GE-8800** ACR 2000 Air Conditioning Service Center to the GE 45268-1 flush filter adapter.
7. Connect the red hose from the **GE-8800** ACR 2000 Air Conditioning Service Center to the GE 45268-8 flush adapter.

12. Reverse flow refrigerant flush is recommended for desiccant bag failure. Replace the A/C condenser when the A/C flush is complete and perform the following procedure:

NOTE: The filter inside GE 45268-1 is serviceable. Remove and discard the check valve from the filter.

1. Service the filter with ACDelco P/N GF 470, before each flush.
2. Install the port plugs GE 45268-9 onto the GE 45268-10.
3. Install the fitting GE 45268-7 onto the GE 45268-10.
4. Install the fitting GE 45268-8 onto the GE 45268-10.
5. Connect GE 45268-1 flush filter to the discharge port of GE 45268-7 flush adapter.
6. Connect the blue hose from **GE-8800** ACR 2000 Air Conditioning Service Center to the GE 45268-1 flush filter adapter.
7. Connect the red hose from **GE-8800** ACR 2000 Air Conditioning Service Center to the GE 45268-8 flush adapter.

NOTE: Close the valve on the external refrigerant tank, before starting the flush process.

13. Flush the A/C system. Follow the instructions supplied with the **GE-8800** ACR 2000 Air Conditioning Service Center.
14. Disconnect the red hose on the **GE-8800** ACR 2000 Air Conditioning Service Center from the GE 45268-10.
15. Disconnect the blue hose on the **GE-8800** ACR 2000 Air Conditioning Service Center from the GE 45268-1.
16. Remove GE 45268-1 from the GE 45268-10.
17. Remove the GE 45268-10 from the A/C compressor hose assembly.

NOTE: The A/C system must be replenished with the correct amount of PAG oil.

Flushing will remove all the PAG oil from the A/C system.

18. If you will reinstall the removed A/C compressor, perform the following procedure:
 1. Remove the A/C compressor drain plug.
 2. Drain the PAG oil from the A/C compressor. Rotate the compressor input shaft to assist in draining the PAG oil from the compressor.
 3. Install the A/C compressor drain plug.

Tighten

Tighten the drain plug to 16 N.m (12 lb ft).

4. Add the total system capacity of PAG oil to the A/C compressor. Refer to **Refrigerant System**

Specifications.

19. If you will replace the A/C compressor after flushing the system, perform the following procedure:
 1. Determine if the new service compressor is shipped with PAG oil. Refer to the **Refrigerant System Specifications.**
 2. If the service compressor is shipped with PAG oil, DO NOT drain the new PAG oil from the compressor.
 3. Deduct the amount of PAG oil shipped with the service compressor from the amount of PAG oil listed in the capacities table. Refer to **Refrigerant System Specifications.**
 4. Add the calculated amount to the compressor, as needed.

NOTE: **Flushing will remove the fluorescent leak detection dye from the A/C system.**

20. Add one bottle of **GE-41447** Leak Detection Dye directly to the A/C Compressor.
21. Install the A/C compressor. Refer to **Air Conditioning Compressor Replacement (LUK), Air Conditioning Compressor Replacement (LTG), Air Conditioning Compressor Replacement (LEA).**
22. Remove GE 45268-115.
23. Inspect the TXV for debris. Clean or replace as needed.
24. Install the TXV. Refer to **Air Conditioning Evaporator Thermal Expansion Valve Replacement.**
25. Evacuate and recharge the A/C system. Refer to **Refrigerant Recovery and Recharging.**
26. Leak test the fittings using **GE-42220** Universal 12V Leak Detection Lamp.

AIR CONDITIONING COMPRESSOR OIL BALANCING

Draining Procedure

NOTE: **Drain and measure as much of the refrigerant oil as possible from the rear head ports of the REMOVED compressor.**

1. Drain the refrigerant oil from the crankcase and rear head ports into a clean, graduated container.

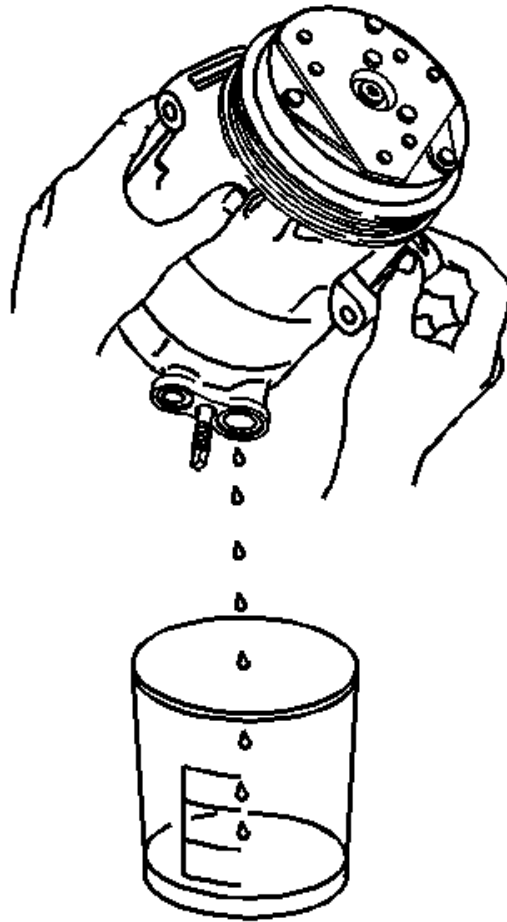


Fig. 2: Draining A/C Refrigerant Oil From Compressor
Courtesy of GENERAL MOTORS COMPANY

2. Rotate the compressor shaft to assist in draining the compressor.
3. Measure and record the amount of oil drained from the removed compressor.

This measurement will be used during installation of the replacement compressor.

4. Inspect oil drained from removed compressor. Refer to **Air Conditioning Compressor Oil Diagnosis**.
5. Properly discard the used refrigerant oil.
6. Clean the graduated cylinder.

NOTE: **Drain and measure as much of the refrigerant oil as possible from the rear head ports of the NEW compressor.**

7. Remove the drain bolt and drain the refrigerant oil from the crankcase and rear head ports into a clean, graduated container.
8. Rotate the compressor shaft to assist in draining the compressor.

Balancing Procedure

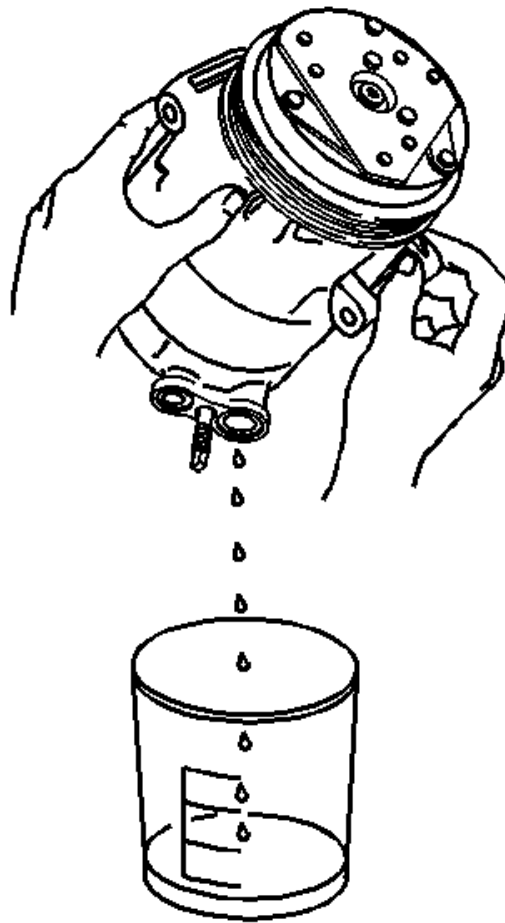


Fig. 3: Draining A/C Refrigerant Oil From Compressor
Courtesy of GENERAL MOTORS COMPANY

NOTE: The refrigerant oil in the A/C system must be balanced during compressor replacement.

The replacement compressor is shipped with a service charge of 74 ml (2.5 fl. oz) or 40 ml (1.4 fl. oz) of refrigerant oil.

1. Refer to the amount of refrigerant oil recorded during the compressor removal.
2. If the amount of oil recorded from the removed compressor is less than or equal to the service charge of oil in the new compressor, add back the full amount of the new PAG oil back into the new compressor through the compressor suction port.
3. If the amount of oil recorded from the removed compressor is greater than the service charge of oil in the new compressor, add back the full new PAG oil back into the new compressor and supplement with new PAG to the new compressor through the compressor suction port.

4. Rotate the clutch driver three times to lubricate the internal compressor components.

NOTE: If additional A/C components are replaced during compressor replacement, add the PAG oil directly to the A/C compressor to compensate the A/C system.

5. If necessary, refer to Refrigerant System Specifications.

AIR CONDITIONING COMPRESSOR REPLACEMENT (LUK)

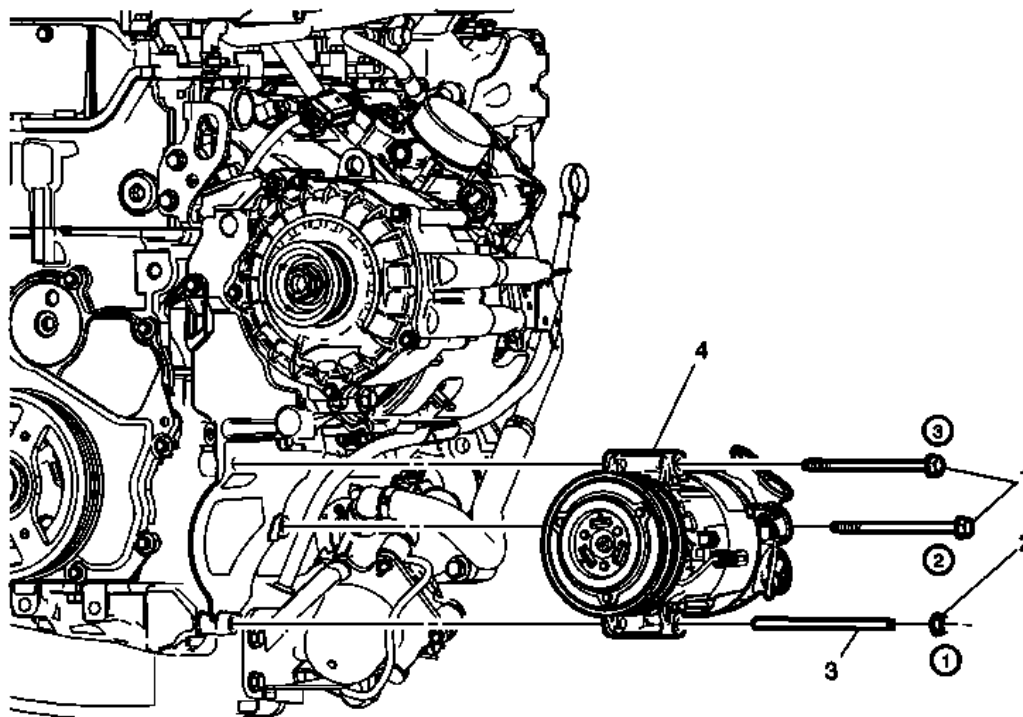


Fig. 4: Air Conditioning Compressor (LUK)
Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Compressor Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
1.	Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u> .
2.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .
3.	Remove the drive belt. Refer to <u>Drive Belt Replacement (LUK)</u> .
4.	Disconnect the air conditioning (A/C) compressor electrical connector.
5.	Remove the air conditioning compressor and condenser hose from the compressor. Refer to <u>Air Conditioning Compressor and Condenser Hose Replacement (LUK)</u> .
6.	Remove the lower drive belt tensioner bolt and loosen the upper bolt to pivot the belt tensioner out

of the way. Refer to **Drive Belt Tensioner Replacement (LUK)** .

7. Remove the secondary air injection pump assembly, if equipped. Refer to **Secondary Air Injection Pump Replacement (LEA, LUK)** .

1	<p>A/C Compressor Bolt (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>NOTE: Tighten the air conditioning compressor mounting fasteners in sequence.</p> <p>Tighten 22 (16 lb ft)</p>
2	<p>A/C Compressor Nut</p> <p>Tighten 22 (16 lb ft)</p>
3	<p>A/C Compressor Stud</p> <p>Tighten 9 (80 lb in)</p>
4	<p>A/C Compressor</p> <p>Procedure</p> <ol style="list-style-type: none">1. Remove the air conditioning compressor assembly from the vehicle.2. Remove and discard sealing washers, replace with NEW only. Refer to <u>Air Conditioning System Seal Replacement</u>.3. When replacing the A/C compressor, balance the compressor oil. Refer to <u>Air Conditioning Compressor Oil Balancing</u>.

AIR CONDITIONING COMPRESSOR REPLACEMENT (LTG)

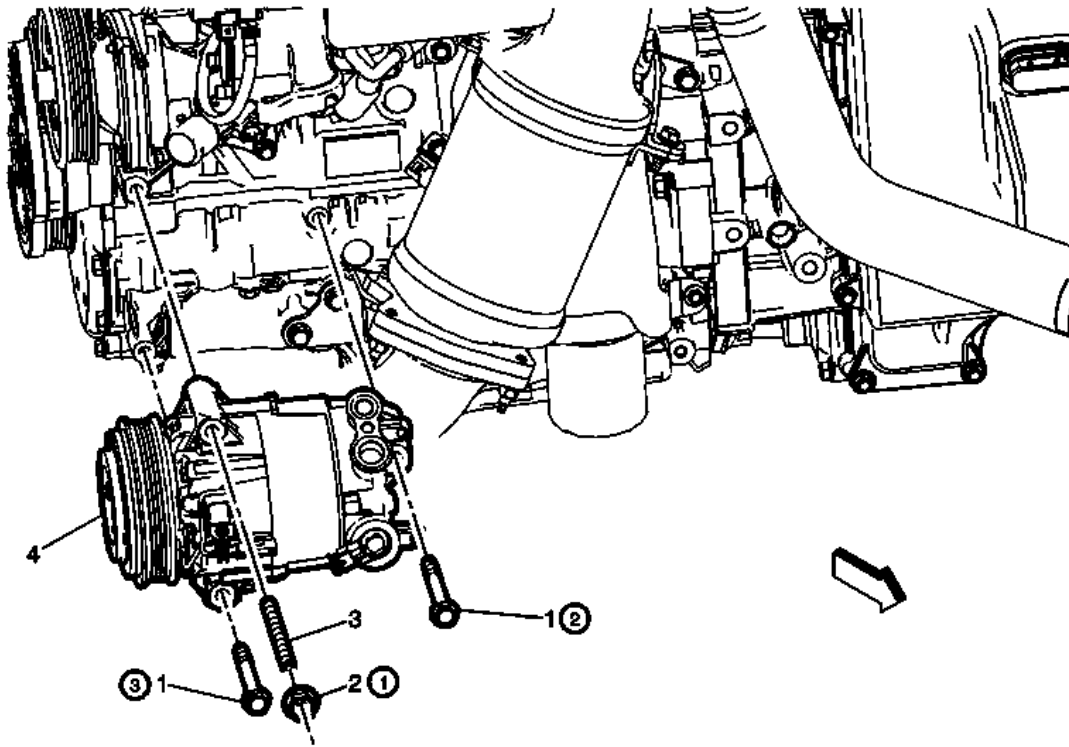


Fig. 5: Air Conditioning Compressor (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Compressor Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>. 3. Remove the drive belt. Refer to <u>Drive Belt Replacement</u>. 4. Remove the air conditioning compressor hose from the compressor. Refer to <u>Air Conditioning Compressor Hose Replacement (LTG)</u>. 5. Remove the right front compartment splash shield. Refer to <u>Front Compartment Splash Shield Replacement</u>. 6. Remove the right front wheelhouse liner. Refer to <u>Front Wheelhouse Front Liner Replacement</u>. 7. Remove the air conditioning compressor heat shield. Refer to <u>Air Conditioning Compressor Heat Shield Replacement (LTG)</u>. 8. Disconnect the air conditioning compressor electrical connector. 	
	Air Conditioning Compressor Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

1	<p>NOTE: Tighten the air conditioning compressor mounting fasteners in sequence.</p> <p>Tighten 22 (12 lb ft)</p>
2	<p>Air Conditioning Compressor Nut Tighten 22 (12 lb ft)</p>
3	<p>Air Conditioning Compressor Stud Tighten 9 (80 lb in)</p>
4	<p>Air Conditioning Compressor</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove and discard the old sealing washers and replace with NEW sealing washers. Refer to <u>Air Conditioning System Seal Replacement.</u> 2. When replacing the air conditioning compressor, balance the compressor oil. Refer to <u>Air Conditioning Compressor Oil Balancing.</u>

AIR CONDITIONING COMPRESSOR REPLACEMENT (LEA)

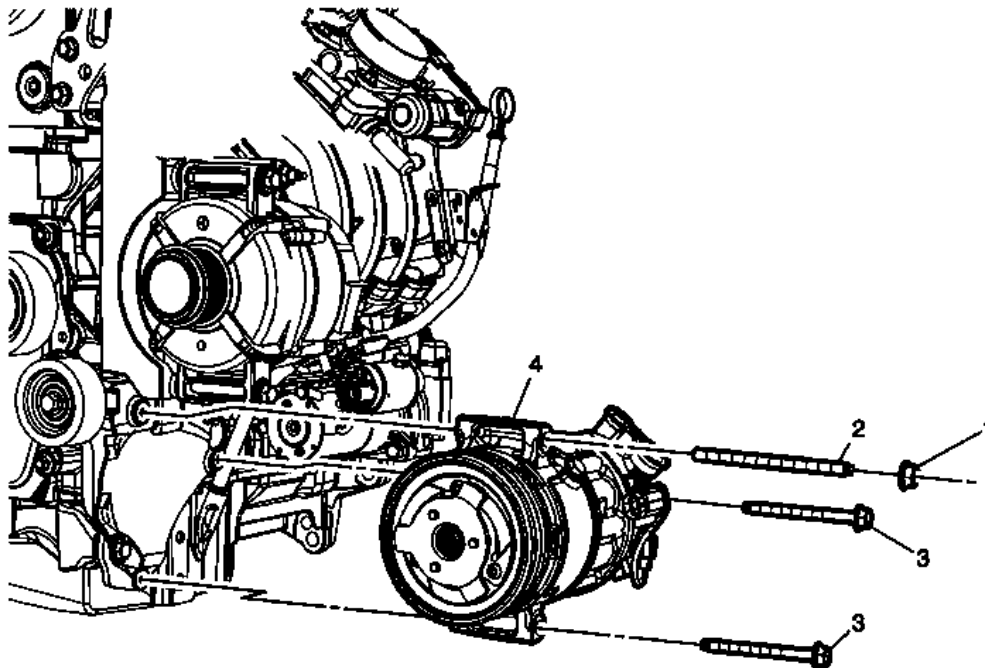


Fig. 6: Air Conditioning Compressor (LEA)
Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Compressor Replacement (LEA)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none">1. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u>.2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .3. Remove front compartment splash shield. Refer to <u>Front Compartment Splash Shield Replacement</u> .4. Reposition the drive belt. Refer to <u>Drive Belt Replacement (LEA)</u> .5. Disconnect the A/C compressor electrical connector.6. Remove the air conditioning compressor and condenser hose. Refer to <u>Air Conditioning Compressor and Condenser Hose Replacement (LUK)</u>.	
1	A/C Compressor Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
2	A/C Compressor Stud Tighten 22 N.m (16 lb ft)
3	A/C Compressor Bolt (Qty: 2) Tighten 22 N.m (16 lb ft)
4	A/C Compressor

COMPRESSOR PRESSURE RELIEF VALVE REPLACEMENT (LTG, LUK)

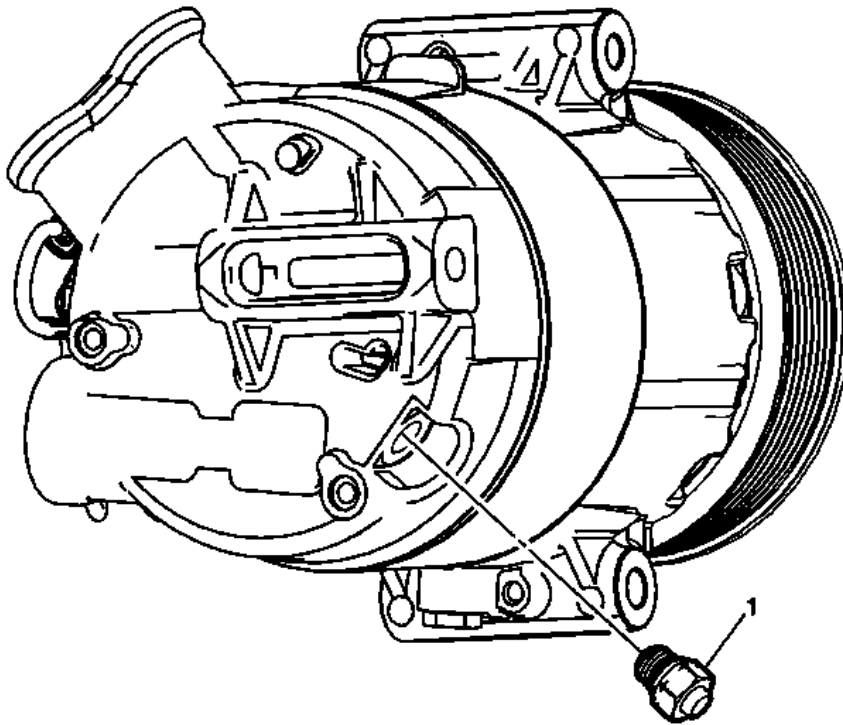


Fig. 7: Compressor Pressure Relief Valve (LTG, LUK)

Courtesy of GENERAL MOTORS COMPANY

Compressor Pressure Relief Valve Replacement (LTG, LUK)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u>. 2. Remove the air conditioning compressor. Refer to <u>Air Conditioning Compressor Replacement (LUK)</u>, <u>Air Conditioning Compressor Replacement (LTG)</u>. 	
1	<p>Compressor Pressure Relief Valve</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Remove and discard sealing washers. Refer to <u>Air Conditioning System Seal Replacement</u>. Tighten 8 N.m (70 lb in)</p>

COMPRESSOR PRESSURE RELIEF VALVE REPLACEMENT (LEA)

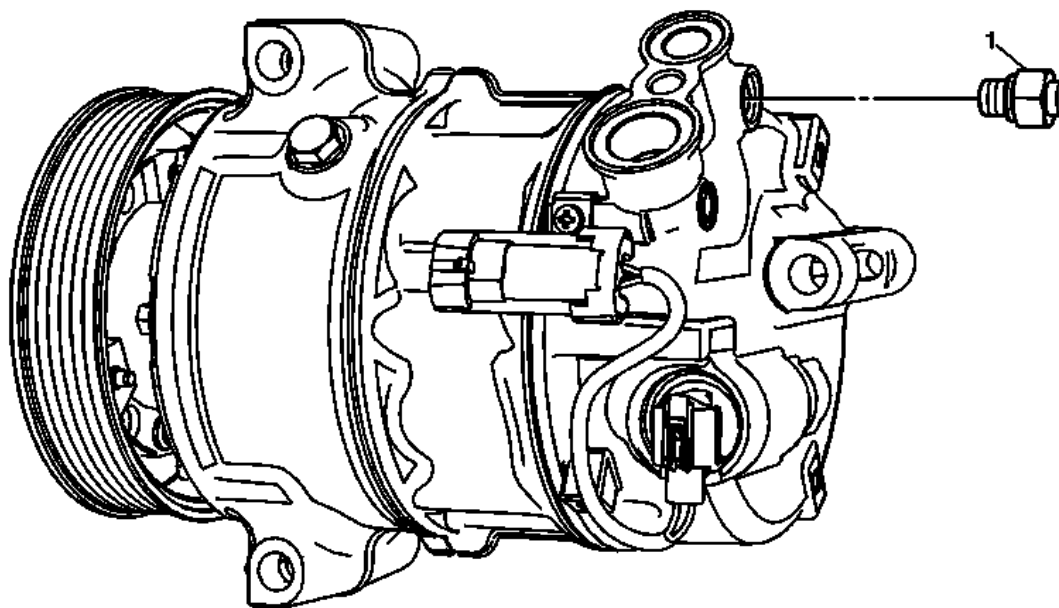


Fig. 8: Compressor Pressure Relief Valve (LEA)
 Courtesy of GENERAL MOTORS COMPANY

Compressor Pressure Relief Valve Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
Remove the air conditioning compressor. Refer to <u>Air Conditioning Compressor Replacement (LEA)</u> .	
1	<p>Compressor Pressure Relief Valve</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Remove and discard sealing washers. Refer to <u>Air Conditioning System Seal Replacement</u>. Tighten 8 N.m (70 lb in)</p>

AIR CONDITIONING COMPRESSOR BRACKET REPLACEMENT

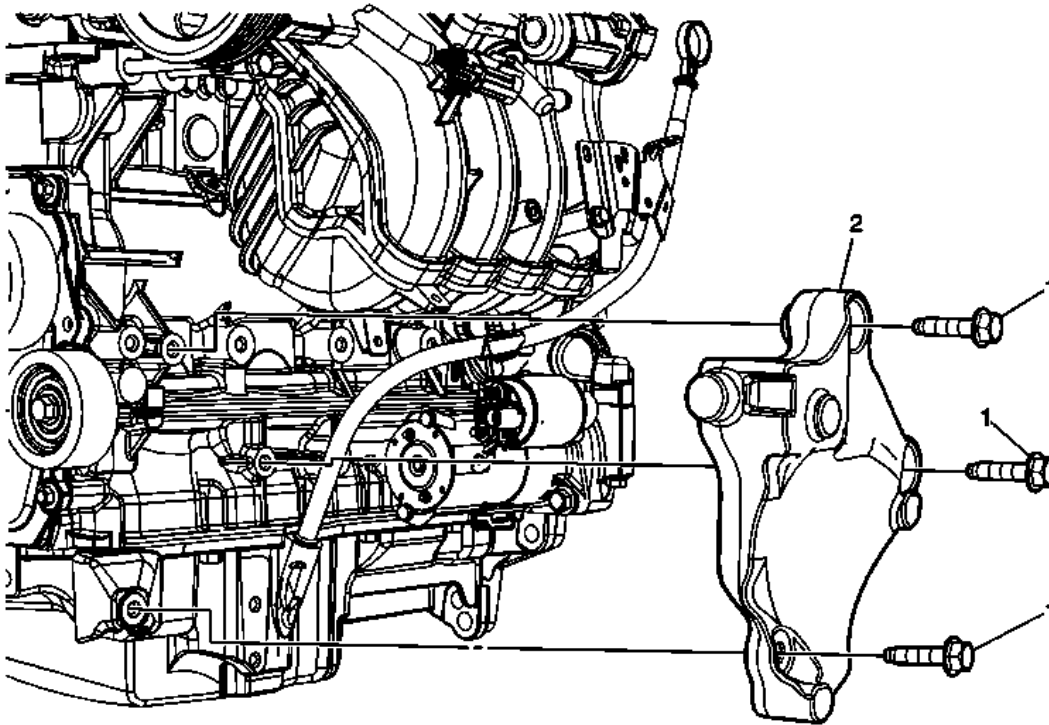


Fig. 9: Air Conditioning Compressor Bracket
 Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Compressor Bracket Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the compressor. Refer to <u>Air Conditioning Compressor Replacement (LUK)</u>, <u>Air Conditioning Compressor Replacement (LTG)</u>, <u>Air Conditioning Compressor Replacement (LEA)</u> 2. Remove the drive belt idler pulley. 	
1	A/C Compressor Bracket Bolts (Qty 3). CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
2	A/C Comperssor Bracket

AIR CONDITIONING COMPRESSOR HEAT SHIELD REPLACEMENT (LTG)

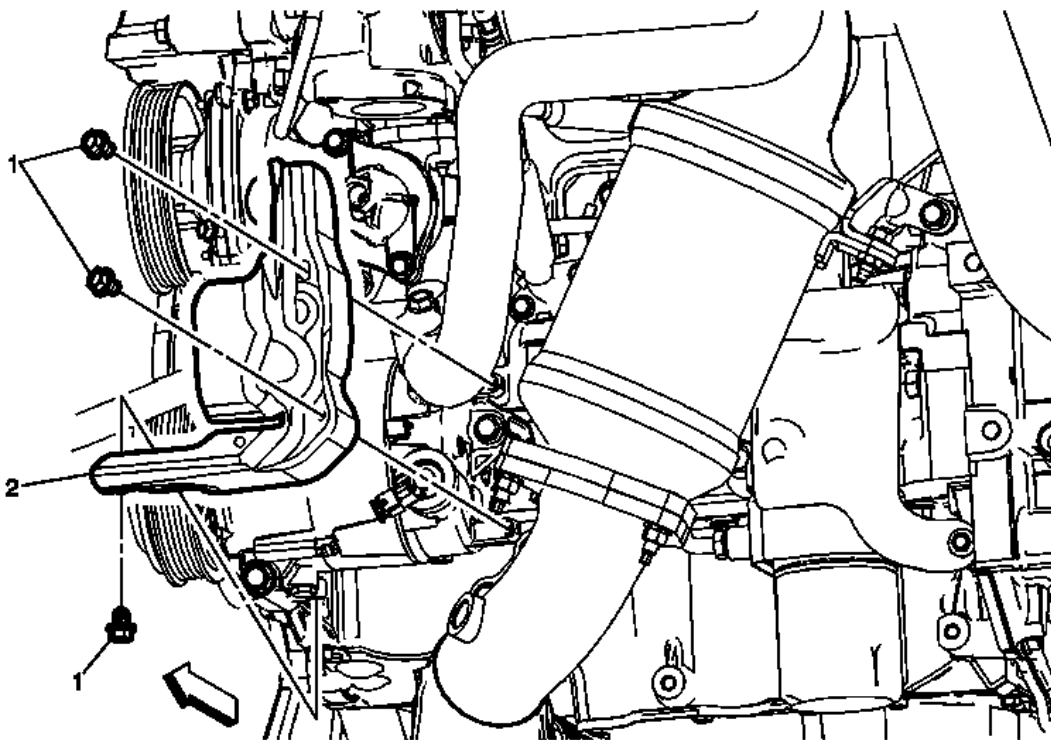


Fig. 10: Air Conditioning Compressor Heat Shield (LTG)

Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Compressor Heat Shield Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	A/C Compressor Heat Shield Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 7.5 (66 lb in)
2	A/C Compressor Heat Shield

AIR CONDITIONING SYSTEM SEAL REPLACEMENT

Removal Procedure

1. Disassemble the A/C refrigerant components. Refer to the appropriate repair procedure.

NOTE: Cap or tape the open A/C refrigerant components immediately to prevent system contamination.

2. Cap or tape the A/C refrigerant components.

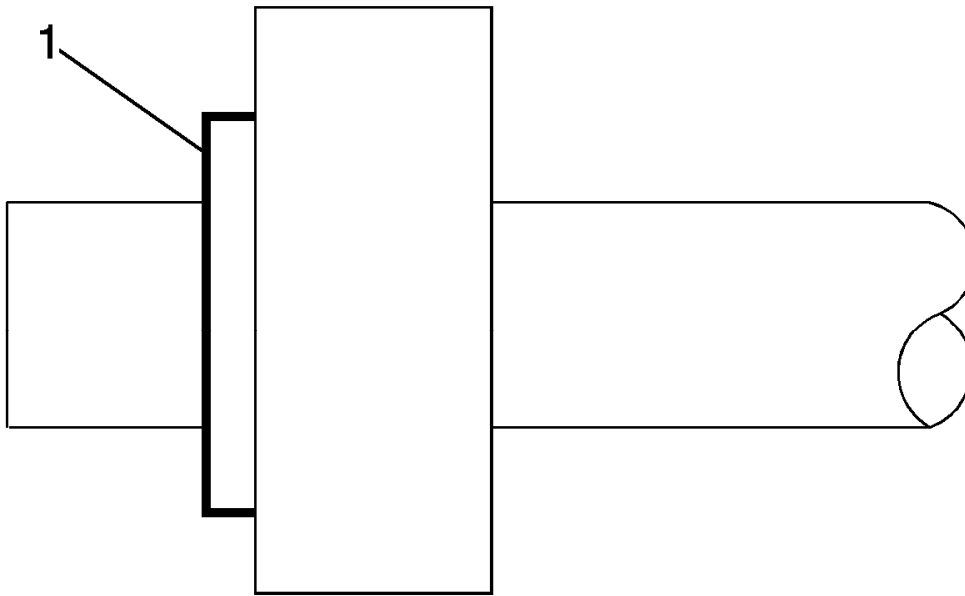


Fig. 11: Sealing Washer

Courtesy of GENERAL MOTORS COMPANY

3. Remove the sealing washer (1) from the A/C refrigerant component.
4. Inspect the seal washer for signs of damage to help determine the root cause of the failure.
5. Inspect the A/C refrigerant components for damage or burrs. Repair if necessary.

NOTE: DO NOT reuse sealing washer.

6. DISCARD the sealing washer.

Installation Procedure

NOTE: Flat washer type seals do not require lubrication.

1. Inspect the new sealing washer for any signs of cracks, cuts, or damage.

Do not use a damaged sealing washer.

2. Remove the cap or tape from the A/C refrigerant components.

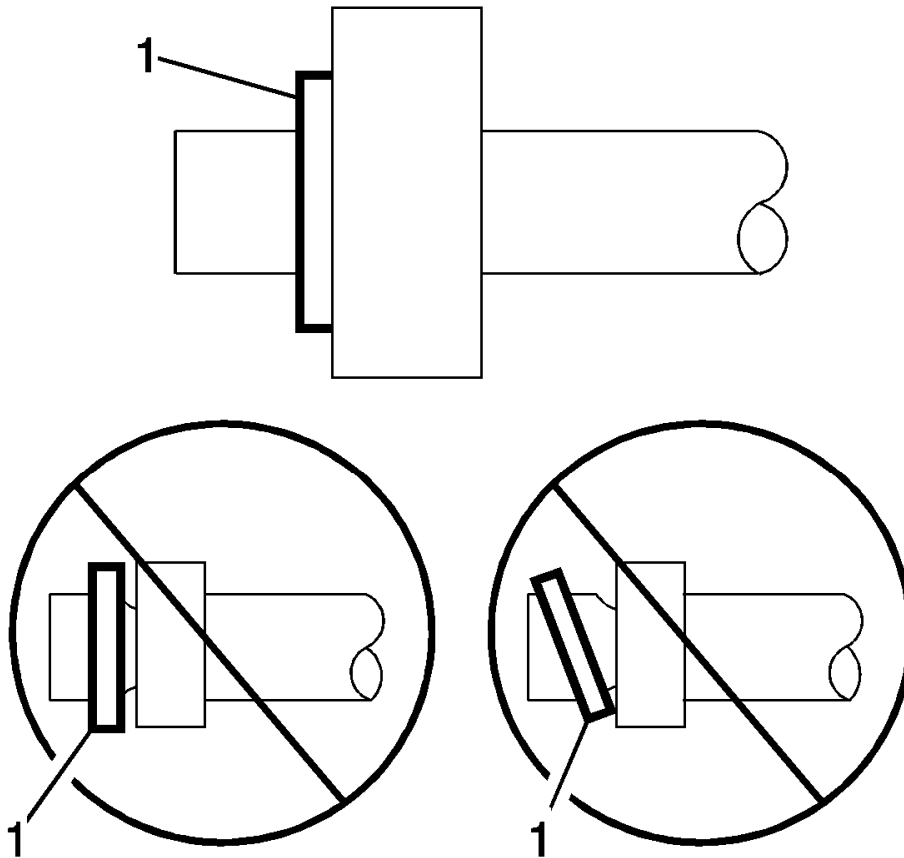


Fig. 12: Identifying Proper Seating Of A/C Refrigerant O-Ring
Courtesy of GENERAL MOTORS COMPANY

3. Using a lint-free clean, dry cloth, clean the sealing surfaces of the A/C refrigerant components.
4. Carefully install the NEW sealing washer (1) onto the A/C refrigerant component.

The sealing washer (1) must completely bottom against the surface of the fitting.

NOTE: After tightening the A/C components, there should be a slight sealing gap of approximately 1.2 mm (3/64 in) between the A/C line and the A/C component.

5. Assemble the remaining A/C refrigerant components. Refer to the appropriate repair procedure.

AIR CONDITIONING O-RING SEAL REPLACEMENT

Removal Procedure

1. Disassemble the A/C refrigerant components. Refer to the appropriate repair procedure

NOTE: Cap or tape the open A/C refrigerant components immediately to prevent system contamination.

2. Cap or tape the A/C refrigerant components.

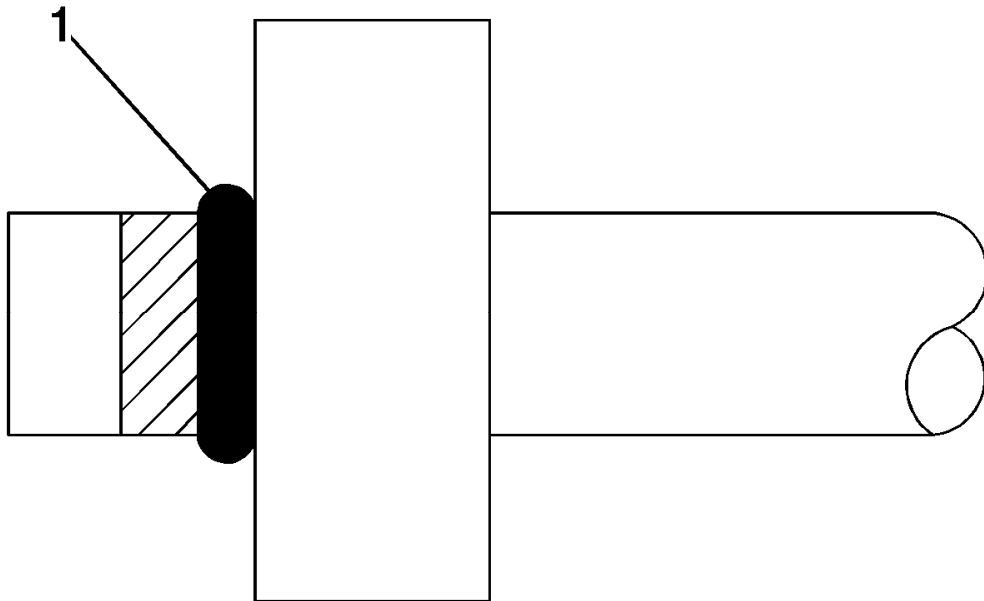


Fig. 13: O-ring seal

Courtesy of GENERAL MOTORS COMPANY

3. Remove the O-ring seal (1) from the A/C refrigerant component.
4. Inspect the O-ring seal for signs of damage to help determine the root cause of the failure.
5. Inspect the A/C refrigerant components for damage or burrs. Repair if necessary.
6. DISCARD the O-ring seal.

Installation Procedure

1. Inspect the new O-ring seal for any sign of cracks, cuts, or damage.
2. Remove the cap or tape from the A/C refrigerant components.
3. Using a lint-free clean, dry cloth, carefully clean the sealing surfaces of the A/C refrigerant components.

NOTE: **DO NOT allow any of the mineral base 525 viscosity refrigerant oil on the new O-ring seal to enter the refrigerant system.**

4. Lightly coat the new O-ring seal with mineral base 525 viscosity refrigerant oil.

NOTE: **DO NOT reuse O-ring seals.**

5. Carefully slide the NEW O-ring seal (1) onto the A/C refrigerant component.

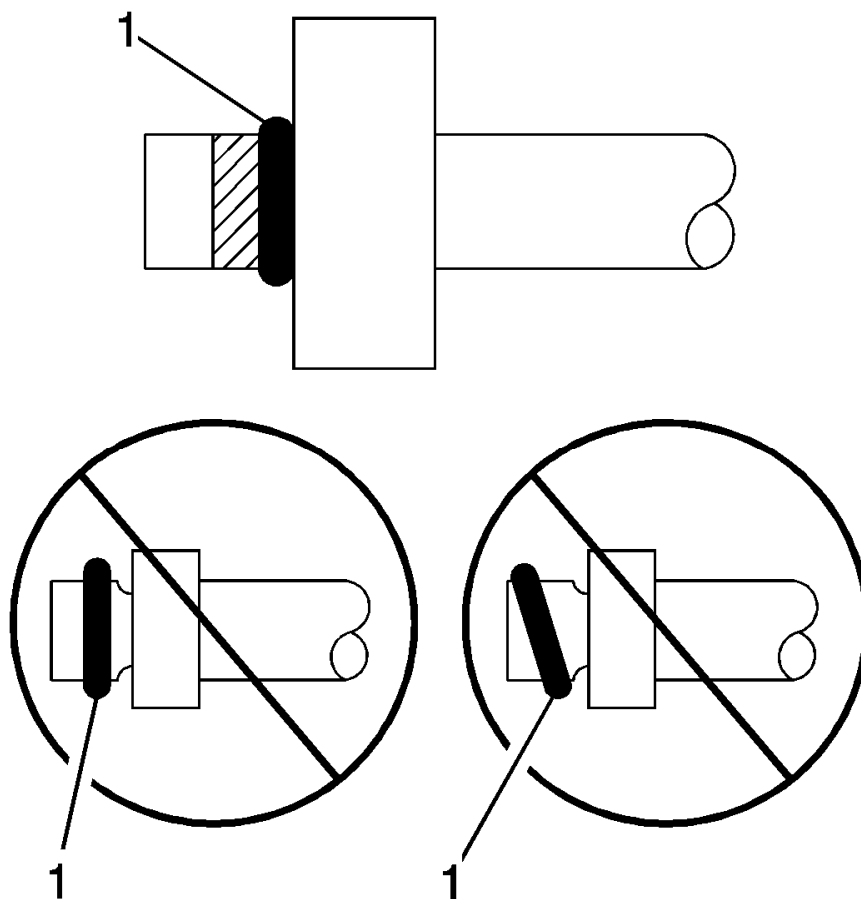


Fig. 14: Identifying Good & Bad Sealing Washer Positions
Courtesy of GENERAL MOTORS COMPANY

6. The O-ring seal (1) must be fully seated.
7. Assemble the A/C components.

Refer to the appropriate repair procedure.

AIR CONDITIONING COMPRESSOR HOSE REPLACEMENT (LTG)

Removal Procedure

1. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
3. Remove the front bumper fascia assembly. Refer to **Front Bumper Fascia Replacement**.
4. Remove the charge air cooler inlet air tube. Refer to **Charge Air Cooler Inlet Air Tube Replacement**

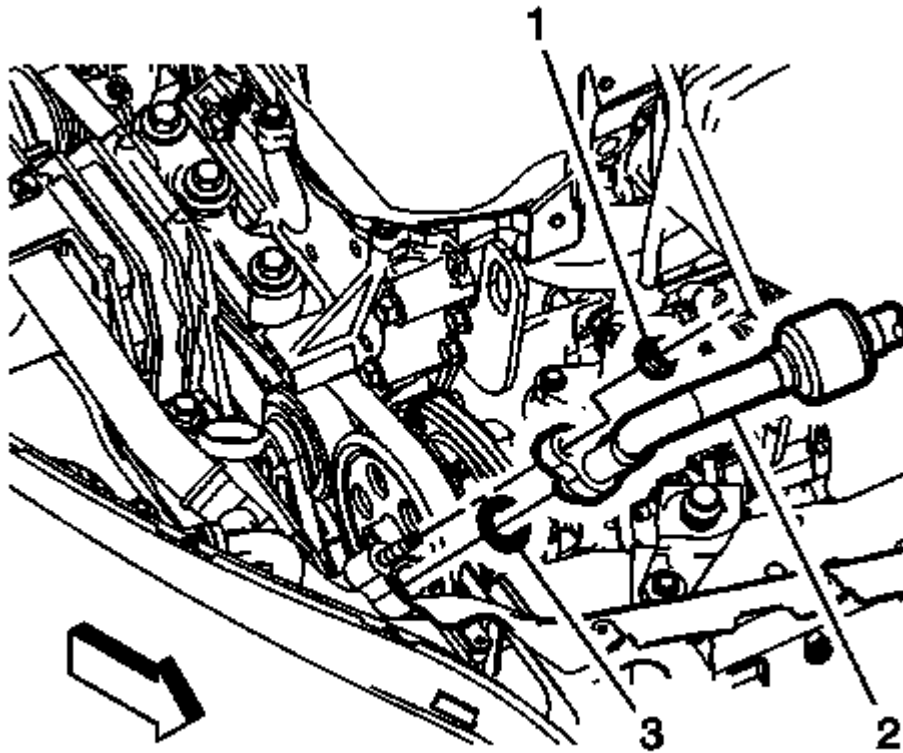


Fig. 15: Air Conditioning Compressor Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Remove the air conditioning compressor hose assembly nut (1) from the evaporator hose assembly. **Air Conditioning Compressor Hose Replacement (LTG)**.
6. Remove the air conditioning compressor hose assembly (2) from the evaporator hose assembly.

7. Remove and discard the old sealing washers (3).

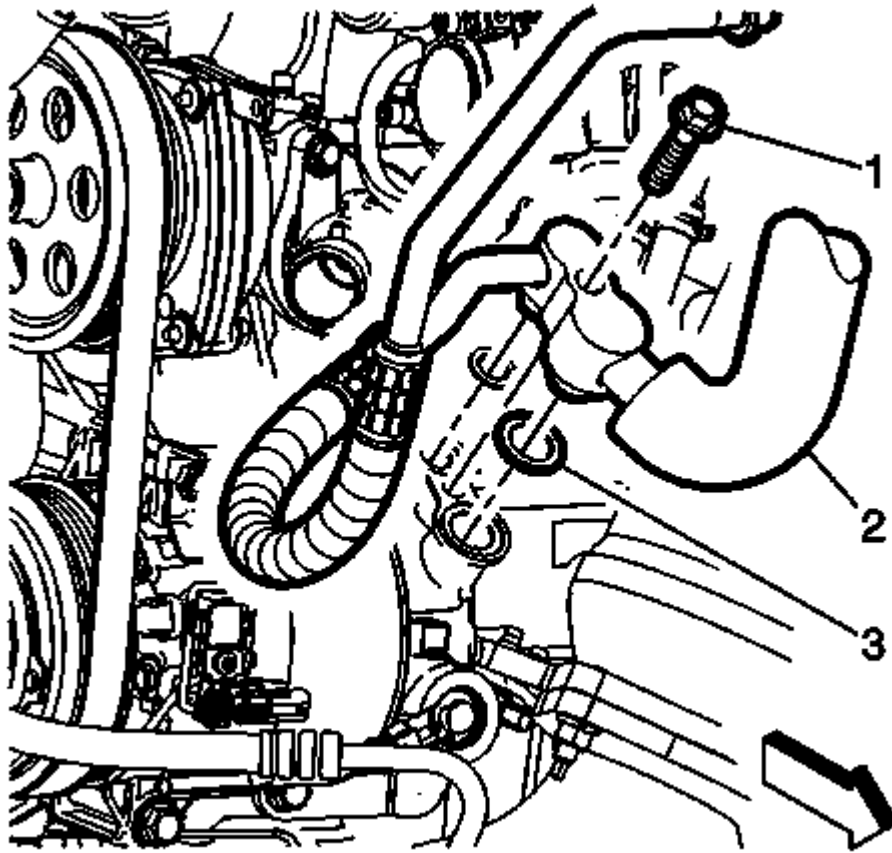


Fig. 16: Air Conditioning Compressor Hose Assembly Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove air conditioning compressor hose assembly bolt (1) from the air conditioning compressor.
9. Remove air conditioning compressor hose assembly (2) from the air conditioning compressor.
10. Remove and discard the old sealing washers (3).

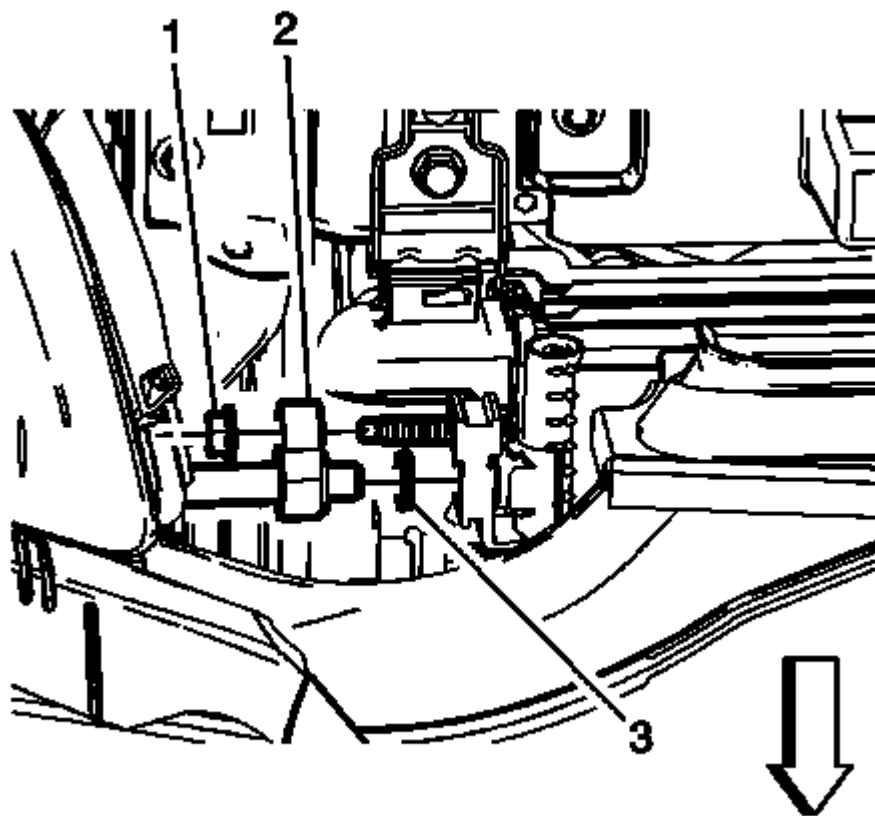


Fig. 17: Air Conditioning Compressor Hose Assembly Nut
Courtesy of GENERAL MOTORS COMPANY

11. Remove air conditioning compressor hose assembly nut (1) from the air conditioning condenser.
12. Remove air conditioning compressor hose assembly (2) from air conditioning condenser.
13. Remove and discard the old sealing washers (3).

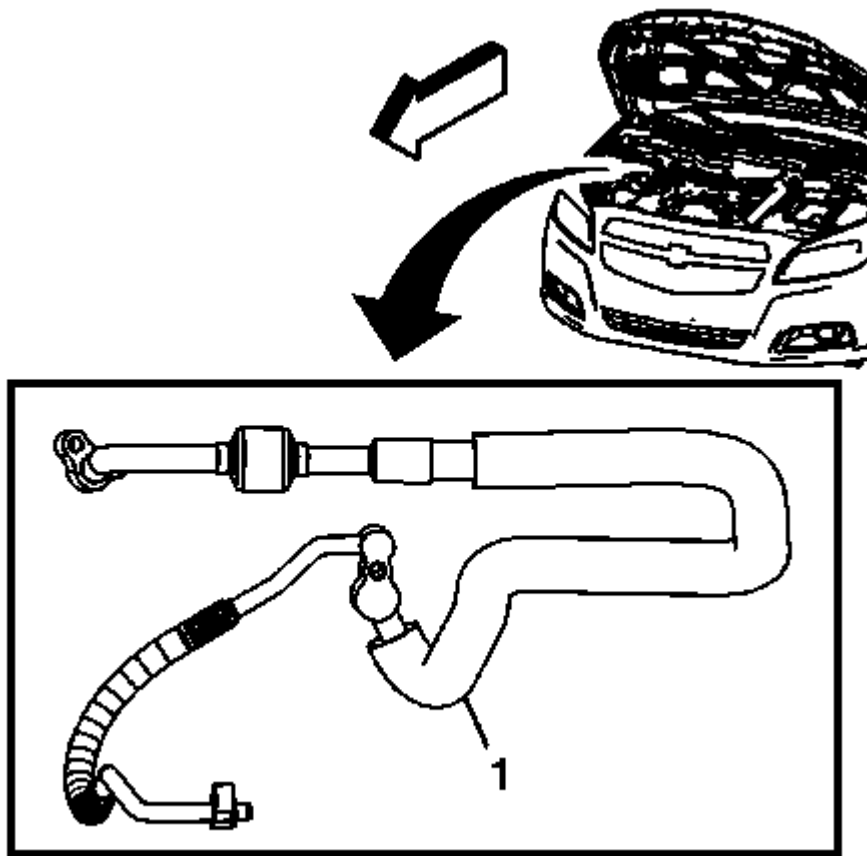


Fig. 18: Air Conditioning Compressor Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

14. Remove air conditioning compressor hose assembly (1) from the vehicle.
15. Transfer all required parts

Installation Procedure

1. Install air conditioning compressor hose assembly into the vehicle.

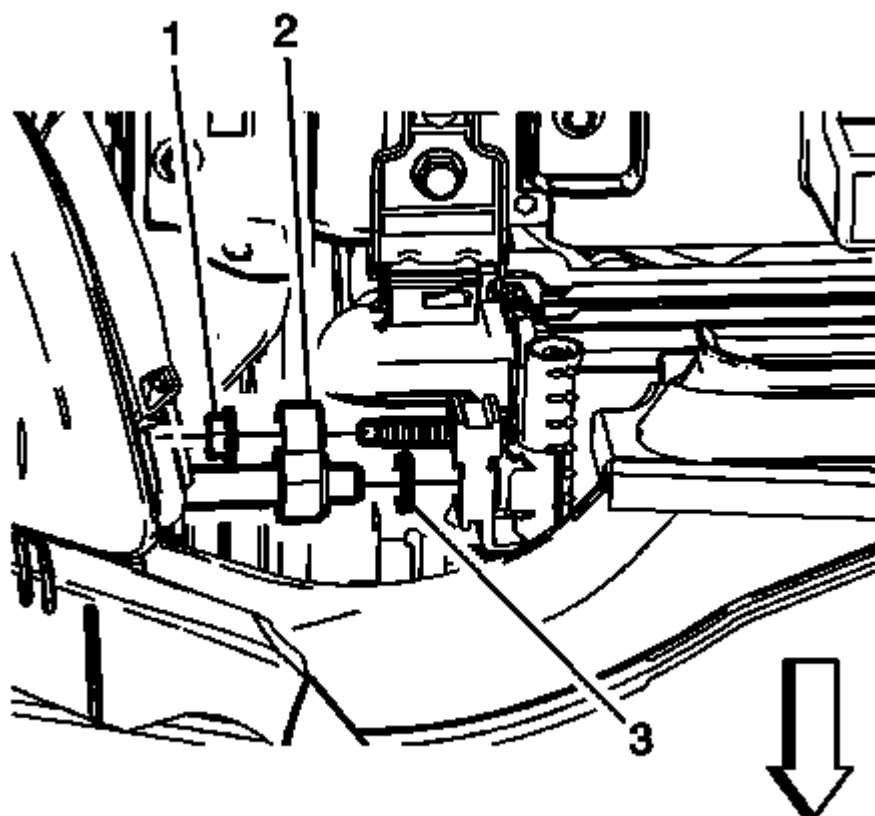


Fig. 19: Air Conditioning Compressor Hose Assembly Nut
Courtesy of GENERAL MOTORS COMPANY

2. Install NEW air conditioning sealing washer (3) to the air conditioning compressor hose assembly (2).
3. Install the air conditioning compressor hose assembly (2) to the air conditioning condenser assembly.

CAUTION: Refer to Fastener Caution .

4. Install the air conditioning compressor hose assembly nut (1) and tighten the nut to 22 N.m (16 lb ft).

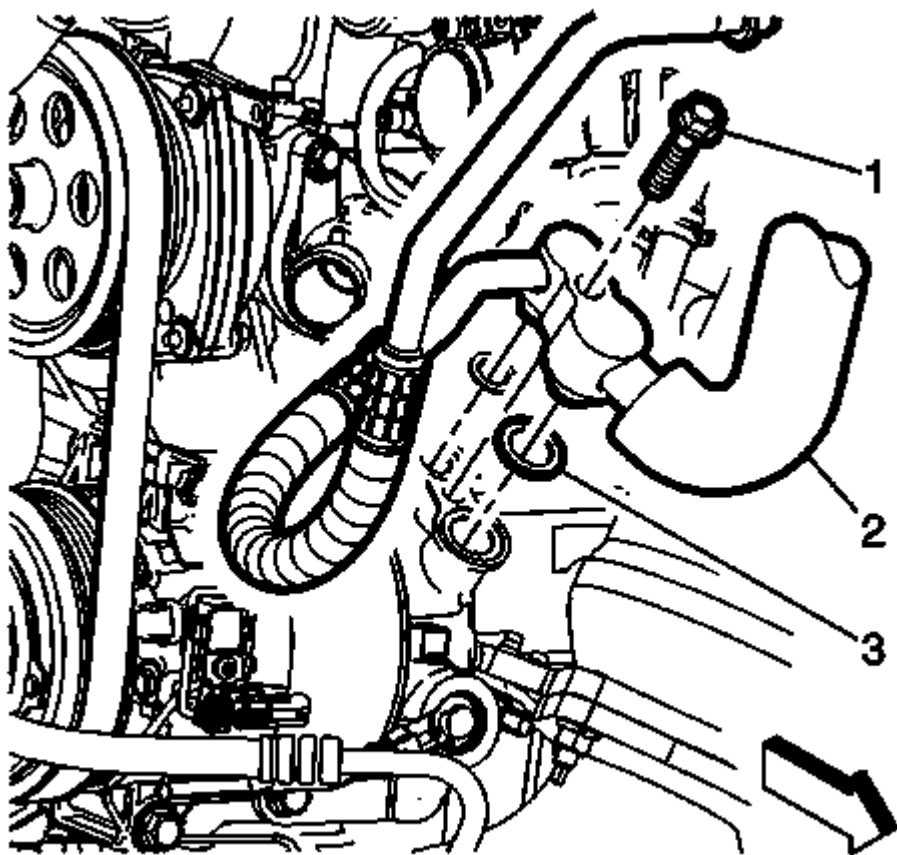


Fig. 20: Air Conditioning Compressor Hose Assembly Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install NEW air conditioning sealing washers (3) to the air conditioning compressor hose assembly.
6. Install the air conditioning compressor hose assembly (2) to the air conditioning compressor assembly.
7. Install the air conditioning compressor hose assembly bolt (1) and tighten the bolt to 22 N.m (16 lb ft).

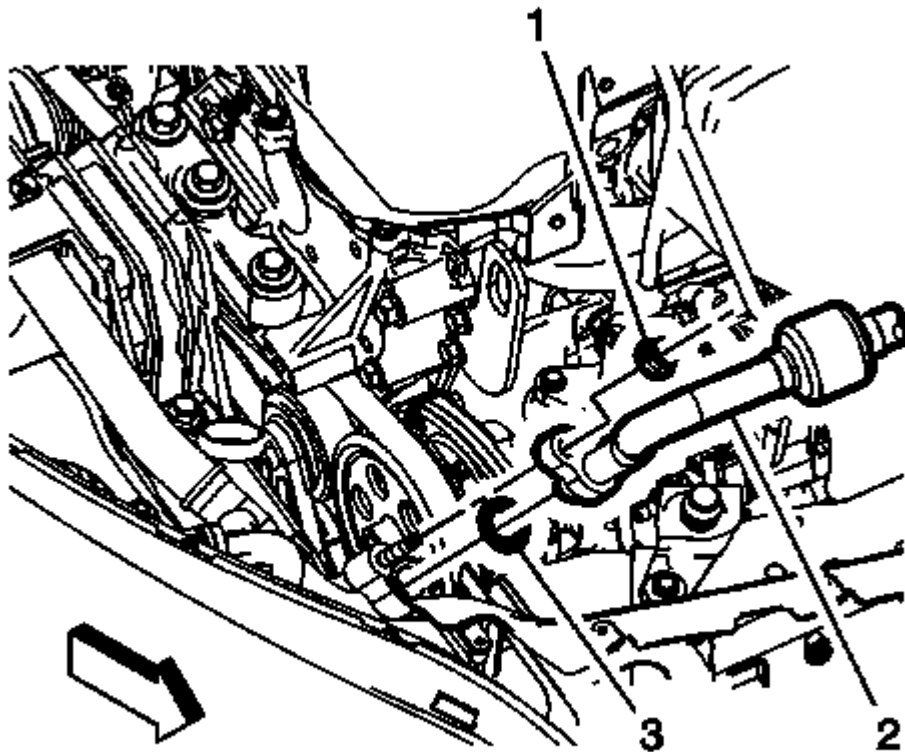


Fig. 21: Air Conditioning Compressor Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Install NEW air conditioning sealing washer (3) to the air conditioning compressor hose assembly (2).
9. Install the air conditioning compressor hose assembly (2) to the evaporator hose assembly.
10. Install the air compressor hose assembly nut (1) and tighten the nut to 22 N.m (16 lb ft).
11. Install the charge air cooler inlet air tube. Refer to **Charge Air Cooler Inlet Air Tube Replacement**
12. Install the front bumper fascia assembly. Refer to **Front Bumper Fascia Replacement** .
13. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
14. Evacuate and recharge the refrigerant system. Refer to **Refrigerant Recovery and Recharging**.

AIR CONDITIONING COMPRESSOR AND CONDENSER HOSE REPLACEMENT (LUK)

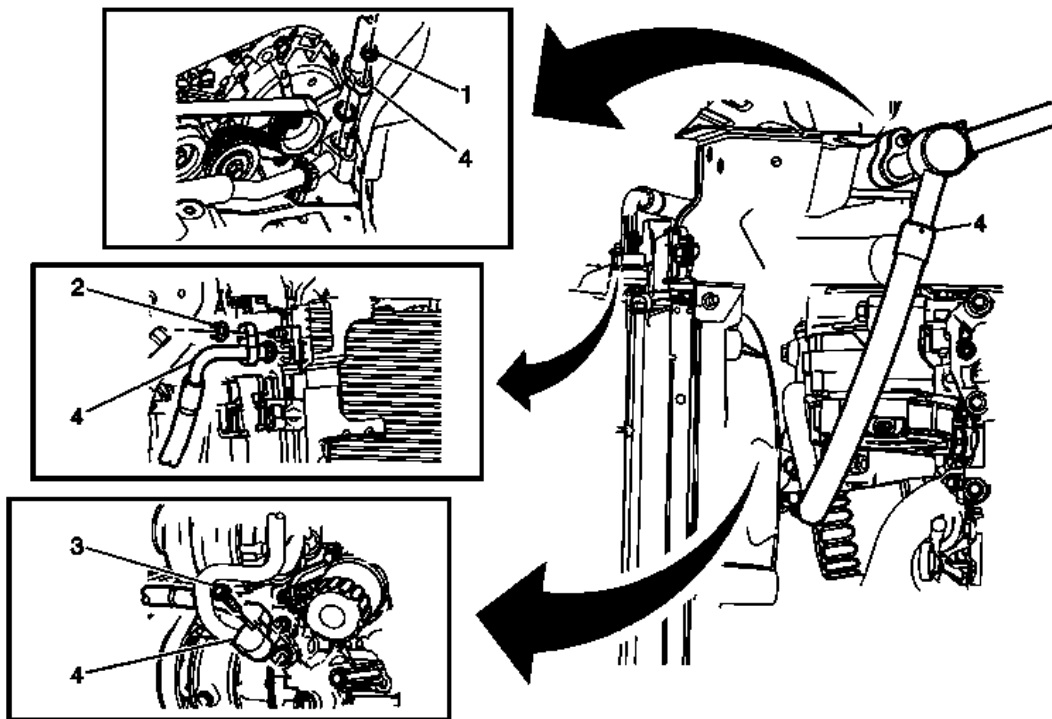


Fig. 22: Air Conditioning Compressor & Condenser Hose
 Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Compressor and Condenser Hose Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the air cleaner outlet duct assembly, if non-turbo equipped. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 3. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u> . 4. Remove the front bumper fascia assembly. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	A/C Compressor and Condenser Hose Nut CAUTION: Refer to <u>Fastener Caution</u> . Procedure Remove and discard sealing washer. Refer to <u>Air Conditioning System Seal Replacement</u> . Tighten 20 N.m (15 lb ft)
	A/C Compressor and Condenser Hose Nut

2	Procedure Remove and discard sealing washer. Refer to <u>Air Conditioning System Seal Replacement.</u> Tighten 20 N.m (15 lb ft)
3	A/C Compressor and Condenser Hose Bolt Procedure Remove and discard sealing washer. Refer to <u>Air Conditioning System Seal Replacement.</u> Tighten 20 N.m (15 lb ft)
4	A/C Compressor and Condenser Hose

AIR CONDITIONING EVAPORATOR HOSE ASSEMBLY REPLACEMENT (LUK)

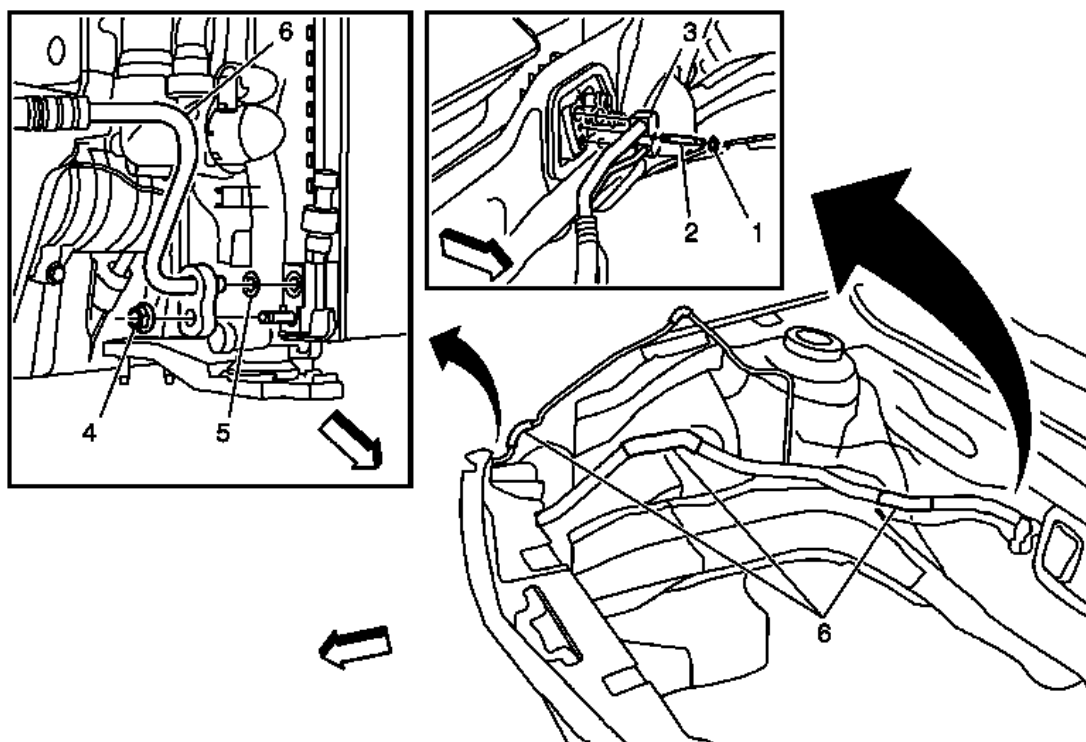


Fig. 23: Air Conditioning Evaporator Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Evaporator Hose Assembly Replacement (LUK)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging.</u> 2. Remove the front bumper fascia assembly. Refer to <u>Front Bumper Fascia Replacement .</u> 3. Remove the Headlamp-Right Side. Refer to <u>Headlamp Replacement .</u> 4. Remove the Engine Mount. Refer to <u>Engine Mount Replacement ,</u> or <u>Engine Mount</u> 	

Replacement .

5. Remove the A/C Compressor and Condenser Hose from the A/C Evaporator Hose. Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LUK)**.

1	A/C Evaporator Hose Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 20 N.m (15 lb ft)
2	A/C Evaporator Hose Stud Bolt Tighten 15 N.m (11 lb in)
3	A/C Evaporator Hose Assembly Procedure 1. Remove the A/C Evaporator hose from the thermal expansion valve (TXV). 2. Remove and discard sealing washer. Refer to <u>Air Conditioning System Seal Replacement</u> .
4	A/C Evaporator Hose Fastener Procedure Remove the A/C Evaporator Hose from the A/C Condenser and cap hose. Tighten 20 N.m (15 lb ft)
5	Sealing Washer Procedure Remove and discard sealing washer. Refer to <u>Air Conditioning System Seal Replacement</u> .
6	Air Conditioning Evaporator Hose Assembly Procedure 1. Release the A/C Evaporator Hose from the attaching clips. 2. When the installation is postponed, close the off lines and connections.

AIR CONDITIONING EVAPORATOR HOSE ASSEMBLY REPLACEMENT (LTG)

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
3. Recover the refrigerant from the air conditioning system. Refer to **Refrigerant Recovery and Recharging**.
4. Remove the right engine mount. Refer to **Engine Mount Replacement** .

5. Remove the front bumper fascia assembly. Refer to **Front Bumper Fascia Replacement** .

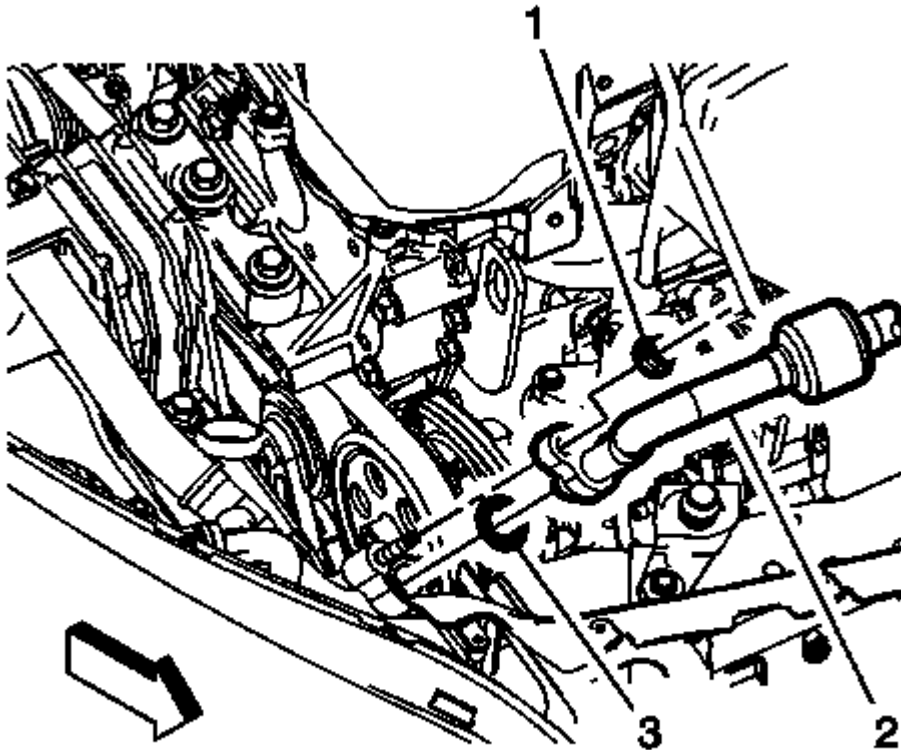


Fig. 24: Air Conditioning Compressor Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Remove the air conditioning compressor hose assembly nut (1) from the evaporator hose assembly (2).
7. Remove the air conditioning compressor hose assembly (2) from the evaporator hose assembly and reposition out of the way.
8. Remove and discard the old sealing washers (3) and replace with NEW sealing washers.

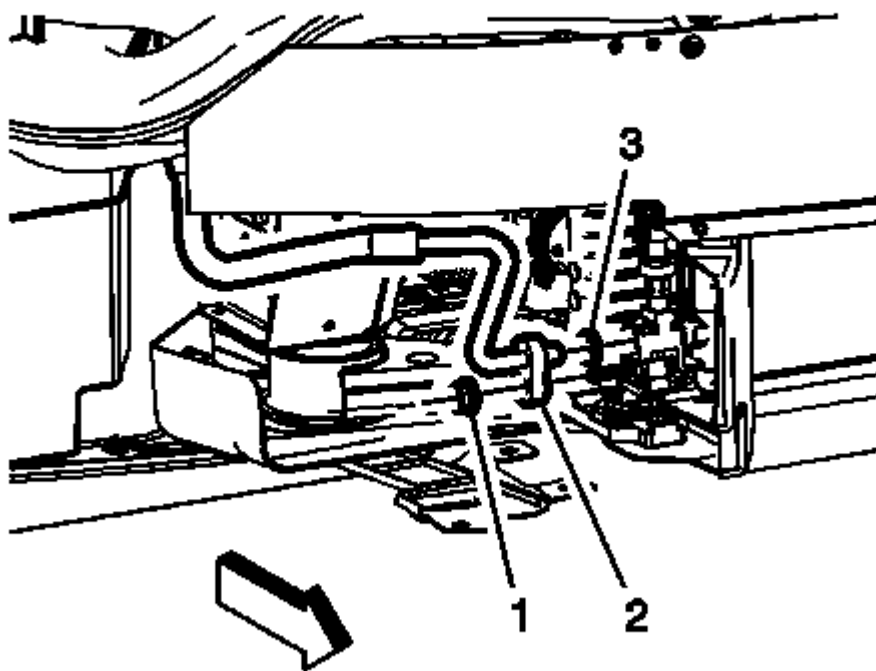


Fig. 25: Conditioning Evaporator Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Remove the air conditioning evaporator hose assembly nut (1) at condenser.
10. Remove the air conditioning evaporator hose assembly (2) from condenser.
11. Remove and discard the old sealing washers (3) and replace with NEW sealing washers.

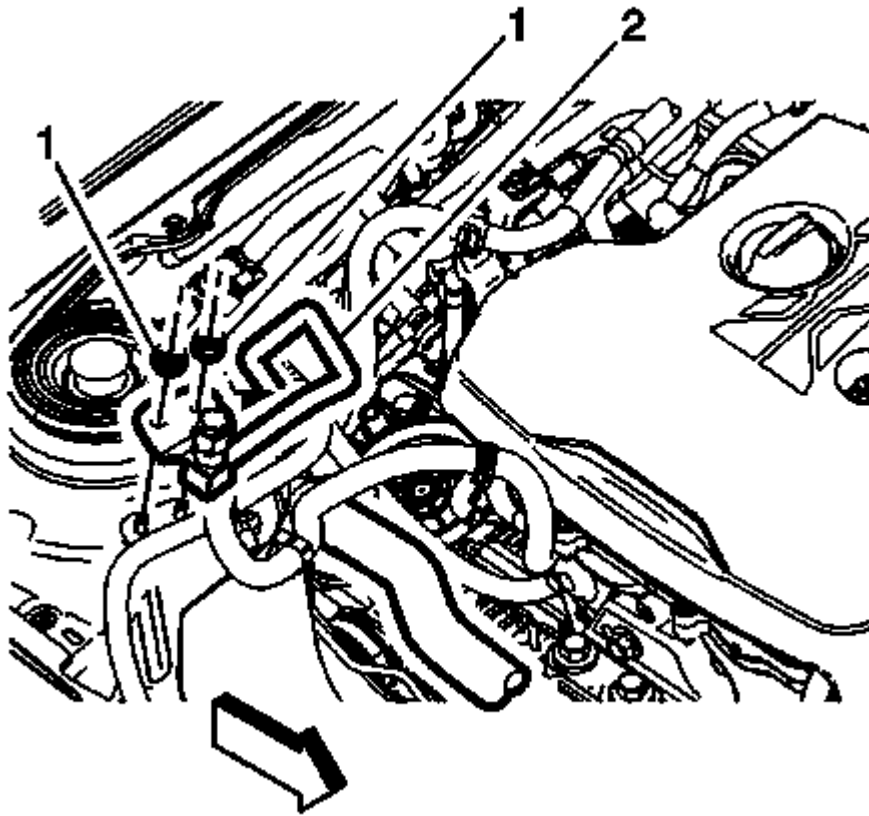


Fig. 26: Air Conditioning Evaporator Hose Assembly & Retaining Fasteners
Courtesy of GENERAL MOTORS COMPANY

12. Remove the air conditioning evaporator hose assembly retaining fasteners (1) from the front suspension strut housing.
13. Remove the air conditioning evaporator hose assembly (2) from the front suspension strut housing.

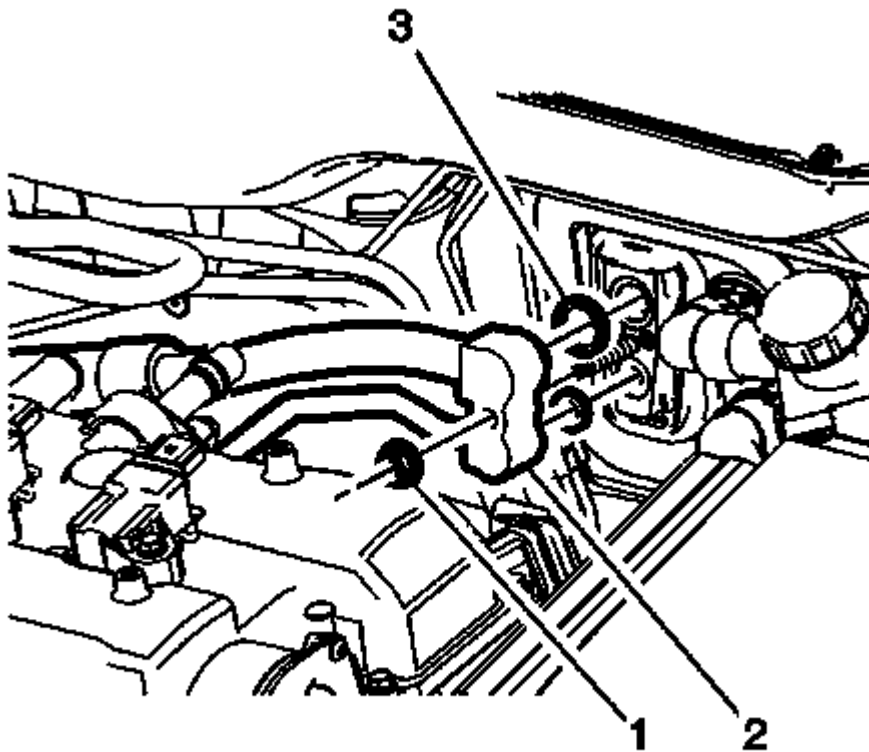


Fig. 27: Air Conditioning Evaporator Hose Assembly Nut
Courtesy of GENERAL MOTORS COMPANY

14. Remove the air conditioning evaporator hose assembly nut (1) at thermal expansion valve.
15. Remove the air conditioning evaporator hose assembly (2) from thermal expansion valve.
16. Remove and discard the old sealing washers (3) and replace with NEW sealing washers.
17. Remove the air conditioning evaporator hose from the retainers.

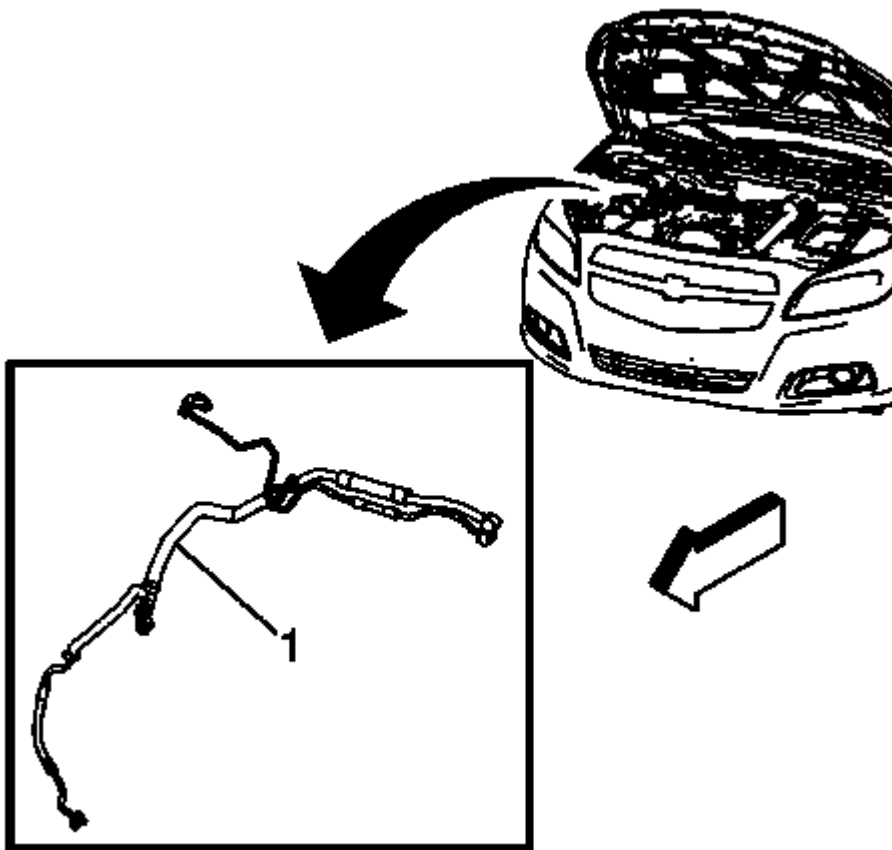


Fig. 28: Air Conditioning Evaporator Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

18. Remove the air conditioning evaporator hose assembly (1) from vehicle.

Installation Procedure

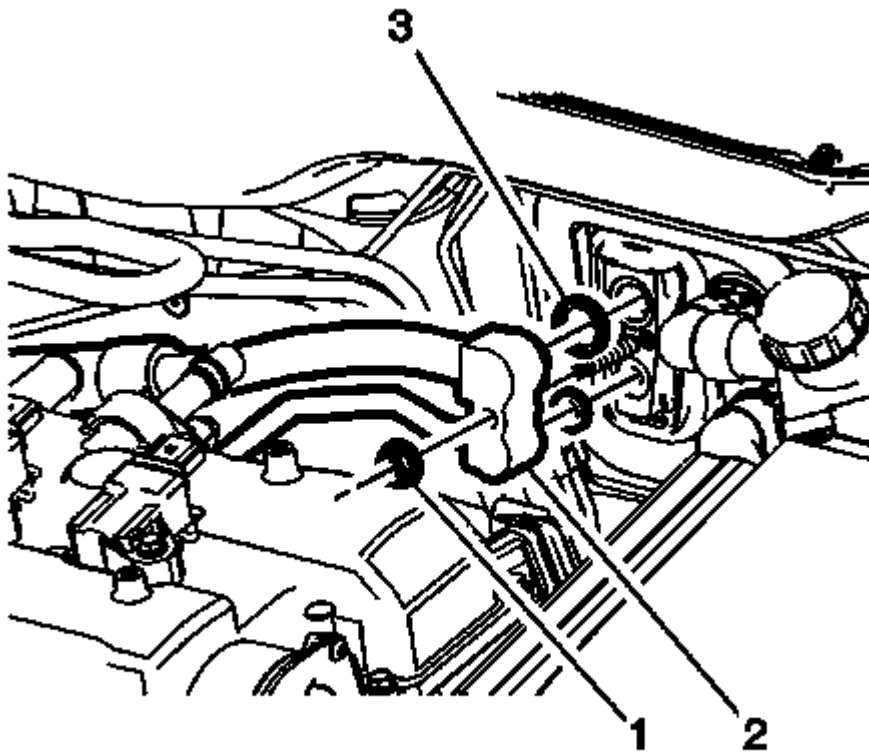


Fig. 29: Air Conditioning Evaporator Hose Assembly Nut
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW sealing washers (3) to the air conditioning evaporator hose assembly (2). Refer to **Air Conditioning System Seal Replacement**.
2. Install the air conditioning evaporator hose assembly (2) to the vehicle.
3. Install the air conditioning evaporator hose (2) to the retainers.
4. Install the air conditioning evaporator hose assembly (2) to the thermal expansion valve.

CAUTION: Refer to Fastener Caution .

5. Install the air conditioning evaporator hose assembly nut (1) at thermal expansion valve and tighten to 22 N.m (16 lb ft).

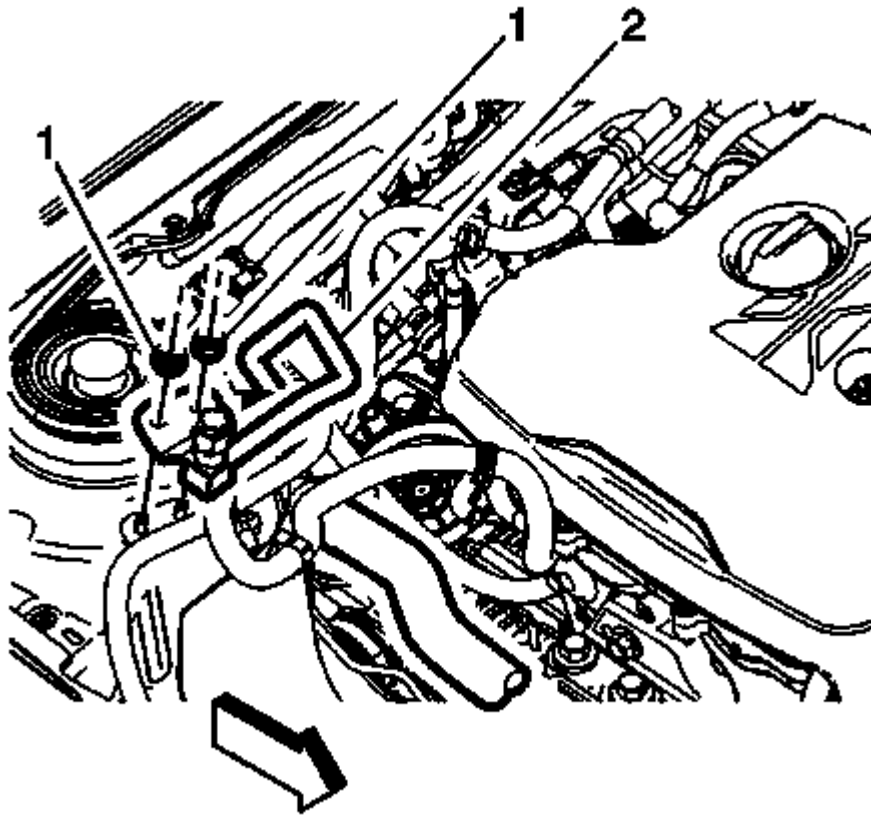


Fig. 30: Air Conditioning Evaporator Hose Assembly & Retaining Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Install the air conditioning evaporator hose assembly (2) to the front suspension strut housing.
7. Install the air conditioning compressor hose retaining fasteners (1) to the front suspension strut housing and tighten to 9 (80 lb in).

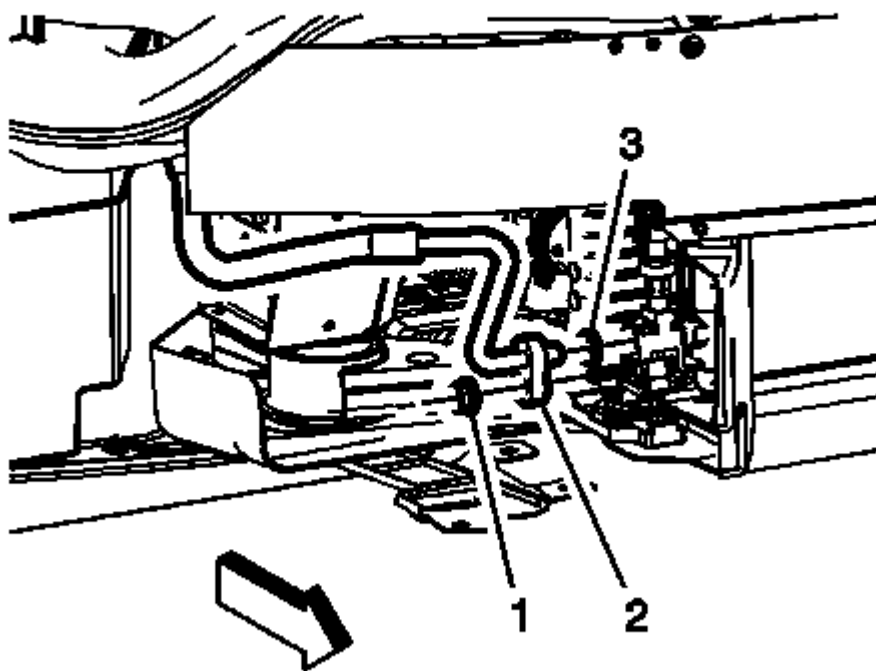


Fig. 31: Conditioning Evaporator Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Install NEW sealing washers (3) to the air conditioning evaporator hose assembly (2). Refer to **Air Conditioning System Seal Replacement**.
9. Install the air conditioning evaporator hose assembly (2) to the condenser.
10. Install the air conditioning evaporator hose assembly nut (1) at condenser and tighten to 22 N.m (16 lb ft).

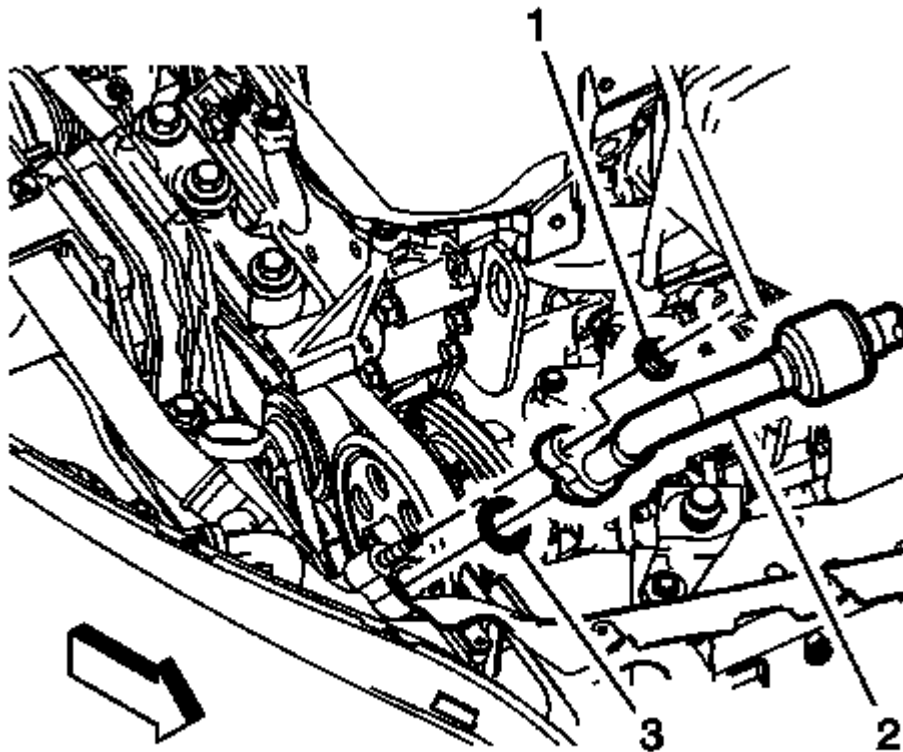


Fig. 32: Air Conditioning Compressor Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Install NEW sealing washers (3) to the air conditioning compressor hose assembly (2). Refer to **Air Conditioning System Seal Replacement**.
12. Install the air conditioning compressor hose assembly (2) to the evaporator hose assembly.
13. Install the air conditioning compressor hose assembly nut (1) to the evaporator hose and tighten to 22 N.m (16 lb ft).
14. Install the front bumper fascia assembly. Refer to **Front Bumper Fascia Replacement**.
15. Install the right engine mount. Refer to **Engine Mount Replacement**.
16. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
17. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
18. Evacuate and charge the air conditioning system. Refer to **Refrigerant Recovery and Recharging**.

AIR CONDITIONING REFRIGERANT DESICCANT REPLACEMENT (LTG)

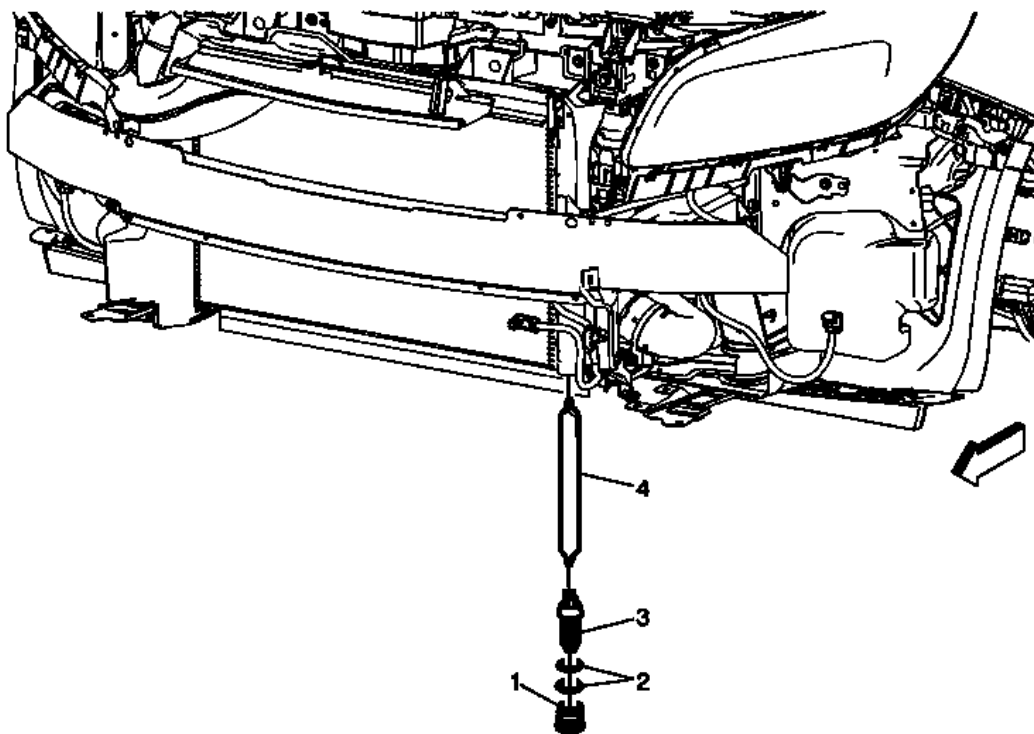


Fig. 33: Air Conditioning Refrigerant Desiccant (LTG)
 Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Refrigerant Desiccant Replacement (LTG)

Callout	Component Name
Preliminary Procedure	
1. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Receiver and Dehydrator Plug CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 (9 lb ft)
2	Receiver and Dehydrator O-ring (Qty: 2)
3	Air Conditioning Refrigerant Filter
4	Air Conditioning Refrigerant Desiccant

RECEIVER AND DEHYDRATOR REPLACEMENT

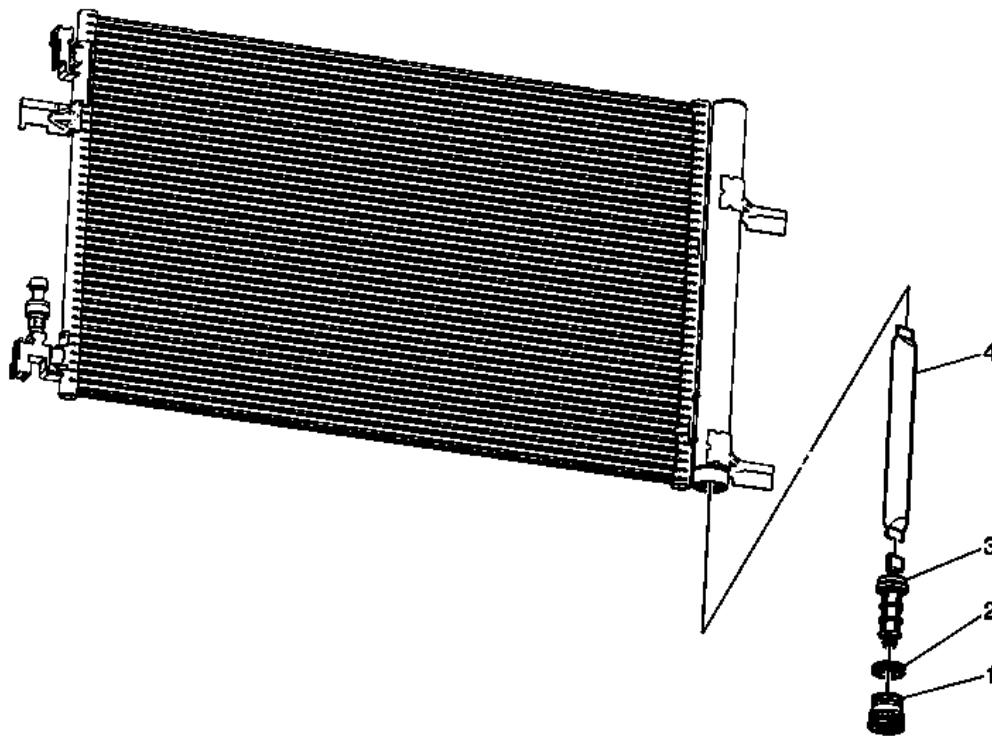


Fig. 34: Receiver And Dehydrator
 Courtesy of GENERAL MOTORS COMPANY

Receiver and Dehydrator Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Recover the refrigerant from the air conditioning system. Refer to <u>Refrigerant Recovery and Recharging</u>. 2. Support the left side of the condenser and radiator assembly with mechanics wire or equivalent. 3. Remove the left radiator support bracket. Refer to <u>Radiator Support Bracket Replacement (LUK)</u>. 	
1	Receiver and Dehydrator Plug CAUTION: Refer to <u>Fastener Caution</u> . Tighten 12 (9 lb ft)
2	Receiver and Dehydrator O-Ring
3	A/C Refrigerant Filter
4	A/C Refrigerant Dryer

AIR CONDITIONING EVAPORATOR THERMAL EXPANSION VALVE REPLACEMENT

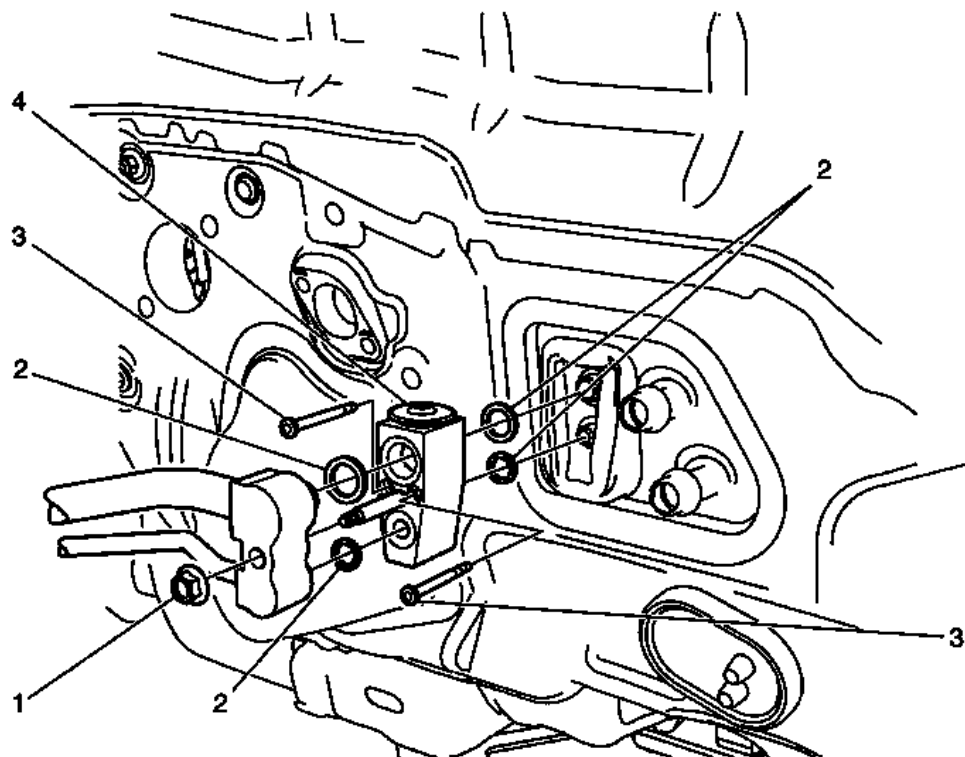


Fig. 35: Air Conditioning Evaporator Thermal Expansion Valve Components
Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Evaporator Thermal Expansion Valve Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u>. 2. Unclip and reposition the brake and fuel lines aside to gain access to the thermal expansion valve (TXV). 3. Remove the air conditioning evaporator hose assembly from the TXV only. Refer to <u>Air Conditioning Evaporator Hose Assembly Replacement (LUK)</u>, <u>Air Conditioning Evaporator Hose Assembly Replacement (LTG)</u>. 	
1	A/C Compressor Tube Assembly Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
	Sealing Washer (Qty: 4)

2	Procedure Use new sealing washer. Refer to <u>Air Conditioning System Seal Replacement</u> .
3	Thermal Expansion Valve Bolt (Qty: 2) Tighten 7 N.m (62 lb in)
4	Air Conditioning Evaporator Thermal Expansion Valve (TXV)

AIR CONDITIONING (A/C) REFRIGERANT PRESSURE SENSOR REPLACEMENT

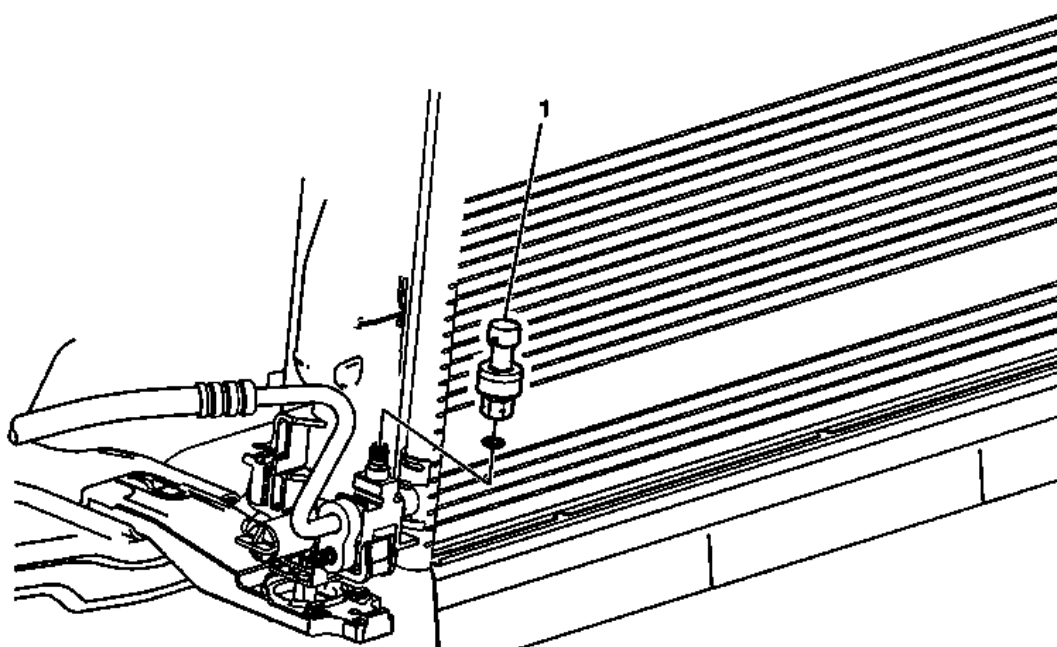


Fig. 36: Air Conditioning (A/C) Refrigerant Pressure Sensor (LUK)
Courtesy of GENERAL MOTORS COMPANY

Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedures	
Remove the front bumper fascia assembly. Refer to <u>Front Bumper Fascia Replacement</u>	
1	<p>Air Conditioning (AC) Refrigerant Pressure Sensor</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <p>1. Disconnect the electrical connector from A/C refrigerant pressure sensor.</p>

2. Remove the A/C refrigerant pressure sensor from the A/C condenser.
3. Remove and discard the O-ring. Refer to **Air Conditioning O-Ring Seal Replacement**

Tighten

7.4 N.m(66 lb in)

AIR CONDITIONING CONDENSER REPLACEMENT (LTG)

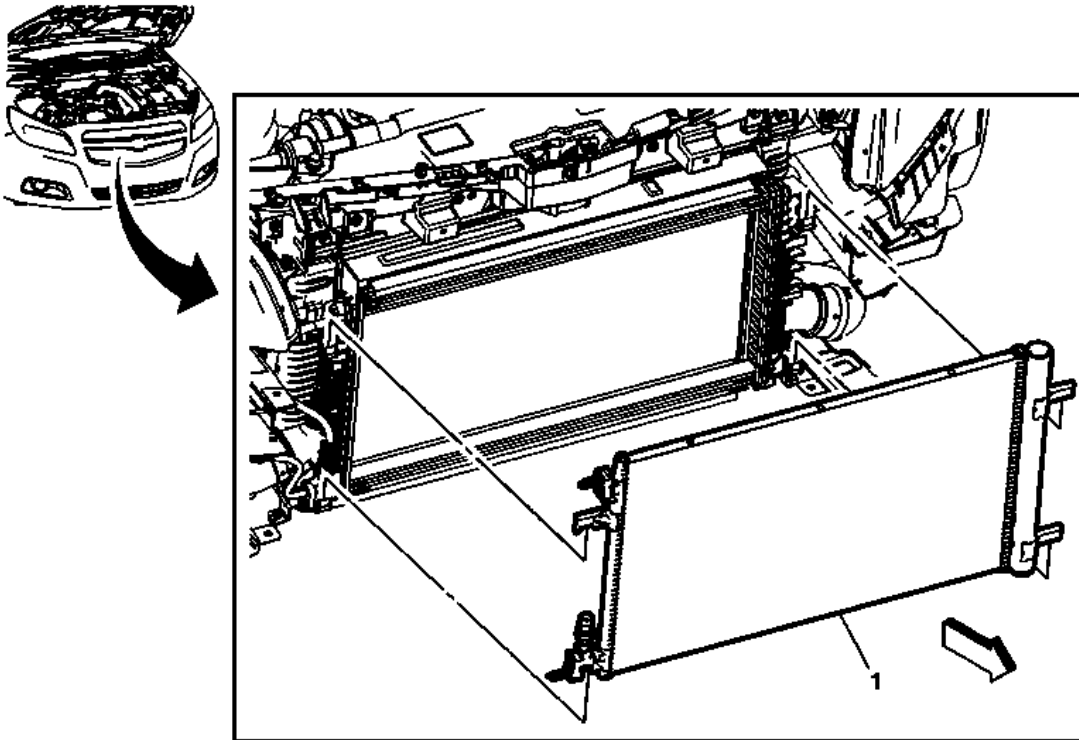


Fig. 37: Air Conditioning Condenser (LTG)

Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Condenser Replacement (LTG)

Callout	Component Name
Preliminary Procedure	
1.	Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u> .
2.	Remove the front bumper impact bar. Refer to <u>Front Bumper Impact Bar Replacement</u> .
3.	Remove the radiator air upper baffle and deflector. Refer to <u>Radiator Air Upper Baffle and Deflector Replacement (LTG)</u> .
4.	Remove the left and right radiator air side baffle and deflectors. <u>Radiator Air Side Baffle and Deflector Replacement (Right LUK)</u> .
5.	Remove the air compressor hose assembly from the condenser and position out of the way. Refer

to Air Conditioning Compressor Hose Replacement (LTG).

6. Remove the air conditioning evaporator hose assembly from the condenser and position out of the way. Refer to Air Conditioning Evaporator Hose Assembly Replacement (LTG).

1	Air Conditioning Condenser Assembly Procedure Transfer all necessary components.
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AIR CONDITIONING CONDENSER REPLACEMENT (LUK)

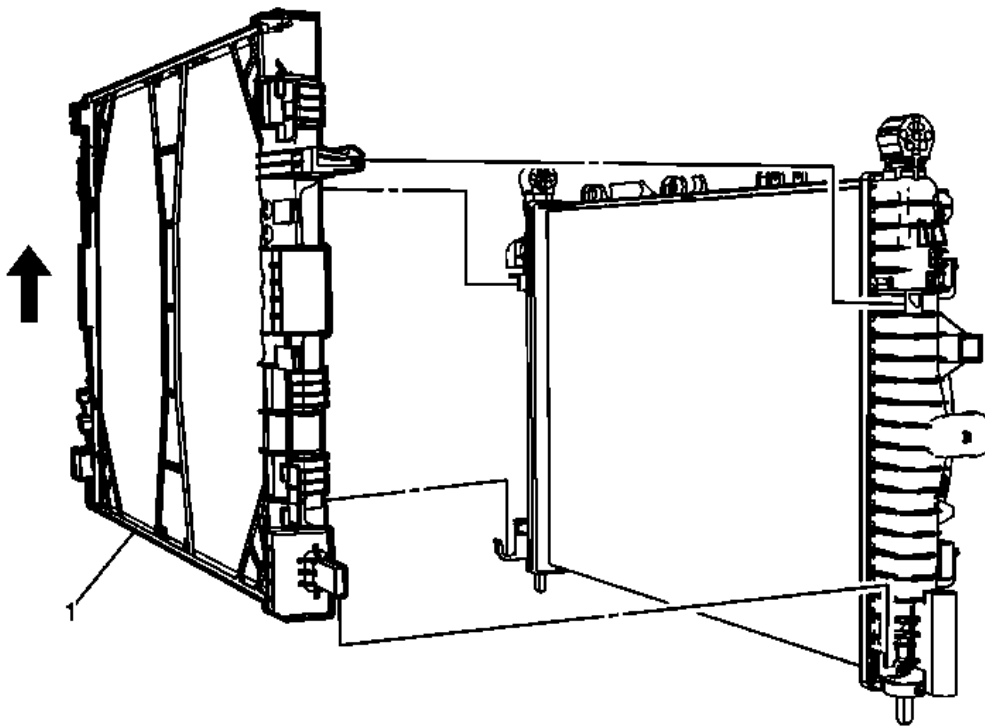


Fig. 38: Air Conditioning Condenser (LUK)
Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Condenser Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u>.2. Remove the front fascia. Refer to <u>Front Bumper Fascia Replacement</u>.3. Remove the AC Compressor and Condenser Hose from condenser assembly. Refer to <u>Air Conditioning Compressor and Condenser Hose Replacement (LUK)</u>.4. Remove the AC Evaporator Hose from condenser. Refer to <u>Air Conditioning Evaporator Hose Assembly Replacement (LUK)</u>.5. Remove the AC refrigerant pressure sensor. Refer to <u>Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement</u>.	

6. Support the radiator and condenser assembly, then remove the radiator support brackets. Refer to **Radiator Support Bracket Replacement (LUK)** .

Air Conditioning Condenser Assembly

NOTE:

Remove the condenser assembly from below.

1

Procedure

1. Lower the radiator and condenser assembly enough to access condenser assembly retainers.
2. Release the 2 condenser assembly retainers.

HEATER AND AIR CONDITIONING EVAPORATOR AND BLOWER MODULE REMOVAL AND INSTALLATION

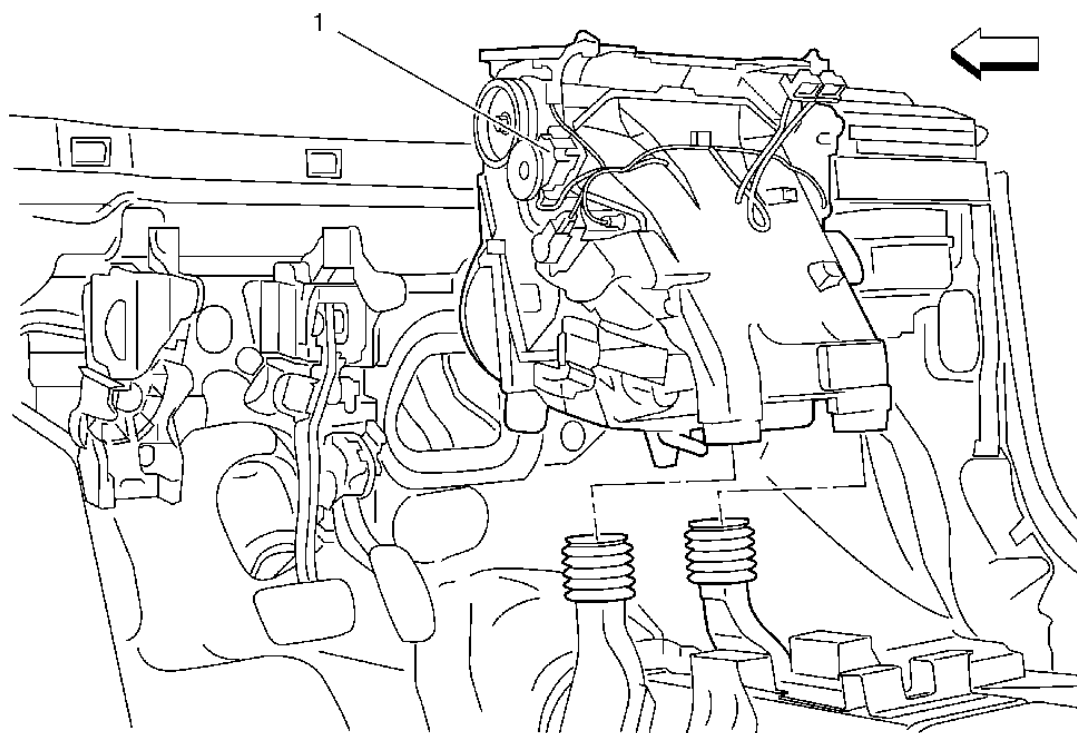


Fig. 39: Heater And Air Conditioning Evaporator & Blower Module

Courtesy of GENERAL MOTORS COMPANY

Heater and Air Conditioning Evaporator and Blower Module Removal and Installation

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Recover the refrigerant. Refer to <u>Refrigerant Recovery and Recharging</u>. 	

2. Remove the heater inlet hose from the heater core tube. Refer to **Heater Inlet Hose Replacement (LUK)**, **Heater Inlet Hose Replacement (LTG)**, **Heater Inlet Hose Replacement (LEA)**.
3. Remove the heater outlet hose from the heater core tube. Refer to **Heater Outlet Hose Replacement (LUK)**, **Heater Outlet Hose Replacement (LTG)**, **Heater Outlet Hose Replacement (LEA)**.
4. Remove the evaporator hose assembly from the thermal expansion valve. Refer to **Air Conditioning Evaporator Thermal Expansion Valve Replacement**.
5. Remove the Air Inlet Grille Panel Water Deflector . Refer to **Air Inlet Grille Panel Water Deflector Replacement** .
6. Remove the instrument panel assembly. Refer to **Instrument Panel Assembly Replacement** .
7. Remove the instrument panel tie bar. Refer to **Instrument Panel Tie Bar Replacement** .

1	Heater and Air Conditioning Evaporator and Blower Module Procedure With the aid of an assistant, remove the heater and air conditioning evaporator and blower module from the vehicle.
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HEATER AND AIR CONDITIONING EVAPORATOR AND BLOWER UPPER CASE REPLACEMENT

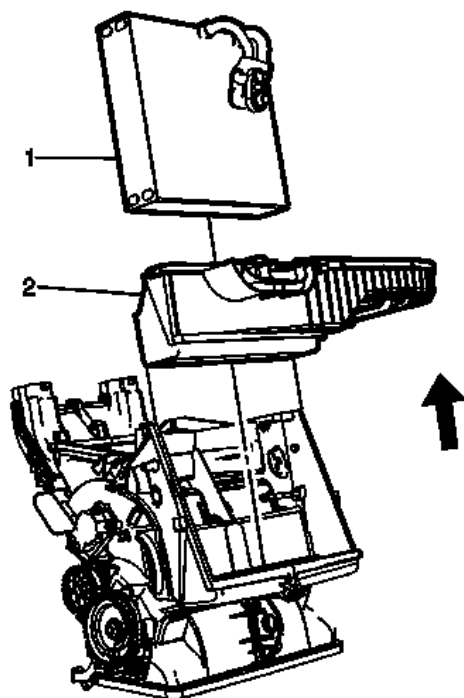


Fig. 40: Heater & Air Conditioning Evaporator & Blower Upper Case
Courtesy of GENERAL MOTORS COMPANY

Heater and Air Conditioning Evaporator and Blower Upper Case Replacement

Call out	Component Name
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Preliminary Procedure

Remove the heater and air conditioning evaporator and blower lower case. Refer to **Heater and Air Conditioning Evaporator and Blower Lower Case Replacement**.

1	Air Conditioning Evaporator Assembly
2	Heater and Air Conditioning Evaporator and Blower Upper Case

HEATER AND AIR CONDITIONING EVAPORATOR AND BLOWER LOWER CASE REPLACEMENT

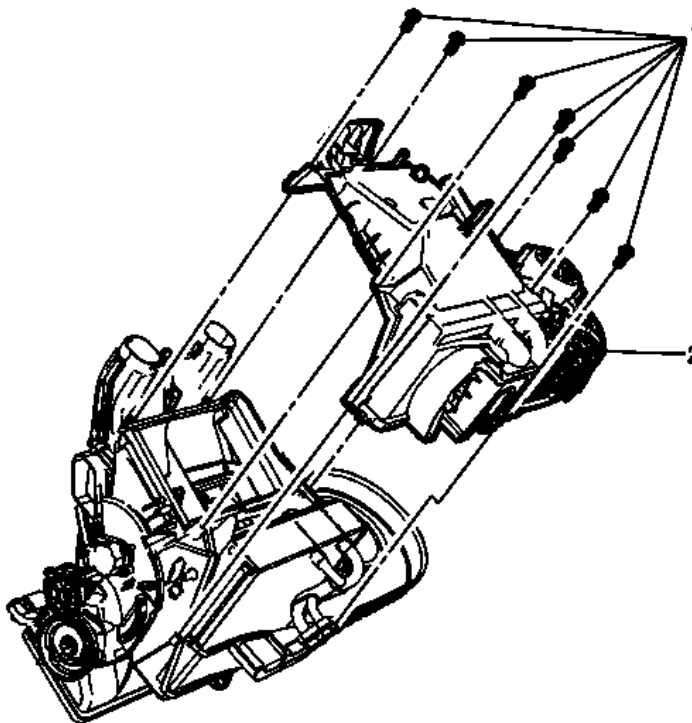


Fig. 41: Heater & Air Conditioning Evaporator & Blower Lower Case
Courtesy of GENERAL MOTORS COMPANY

Heater and Air Conditioning Evaporator and Blower Lower Case Replacement

Call out	Component Name
Preliminary Procedures	
1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
2. Remove the air inlet housing. Refer to <u>Air Inlet Housing Replacement</u> .	
3. Remove the heater core assembly. Refer to <u>Heater Core Replacement (LHD)</u> .	
4. Remove the heater and air conditioning evaporator and blower control module. Refer to <u>Heater and Blower and Air Conditioning Control Module Replacement</u> .	
	Heater and Air Conditioning Evaporator and Blower Lower Case Fastener (Qty: 7)

1	CAUTION: Refer to <u>Fastener Caution</u> .
2	Heater and Air Conditioning Evaporator and Blower Lower Case Procedures <ol style="list-style-type: none"> 1. Transfer the blower motor assembly. Refer to <u>Blower Motor Replacement</u>. 2. Transfer the components as necessary.

AIR CONDITIONING EVAPORATOR CORE REPLACEMENT

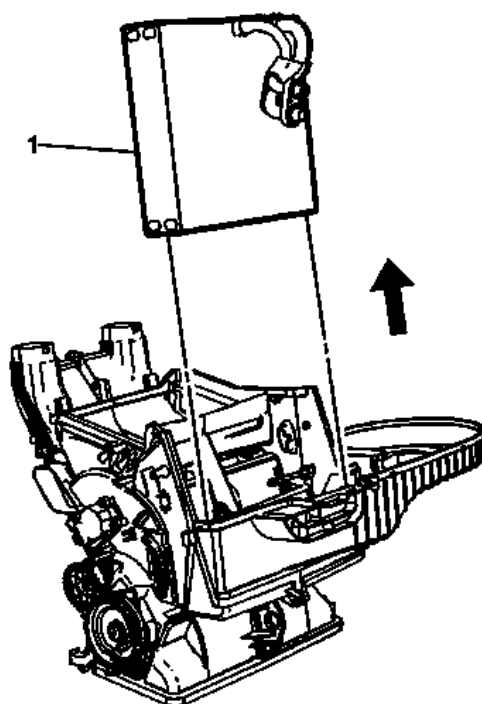


Fig. 42: Air Conditioning Evaporator
Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Evaporator Core Replacement

Call out	Component Name
Preliminary Procedure Remove the heater and air conditioning evaporator and blower lower case. Refer to <u>Heater and Air Conditioning Evaporator and Blower Lower Case Replacement</u> .	
1	Air Conditioning Evaporator Assembly

AIR CONDITIONING EVAPORATOR AND BLOWER MODULE DRAIN HOSE REPLACEMENT

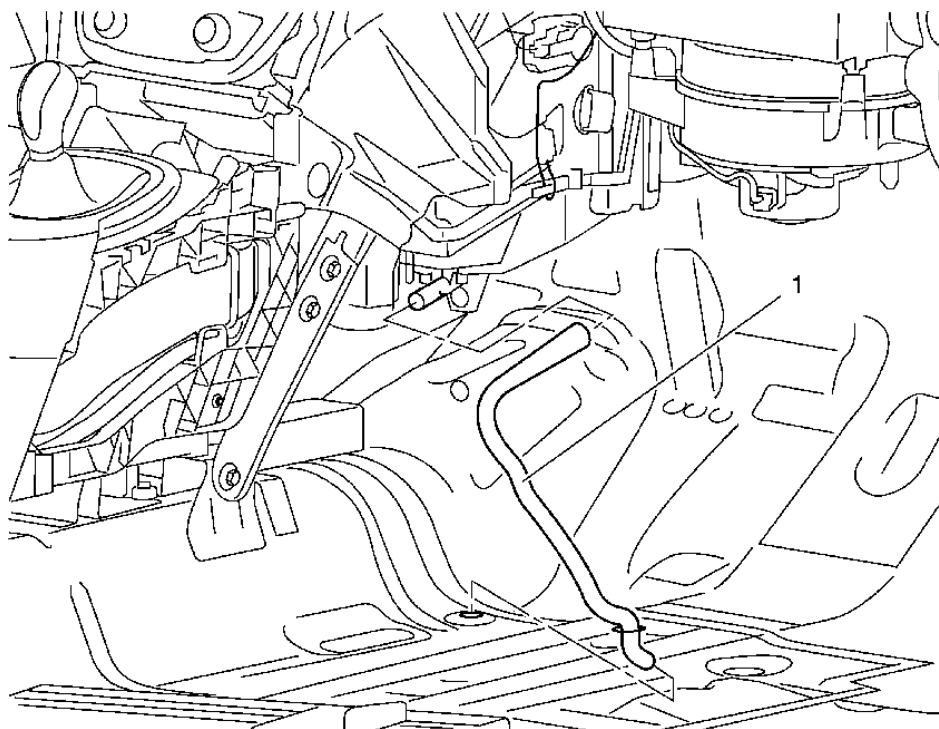


Fig. 43: Air Conditioning Evaporator and Blower Module Drain Hose
Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Evaporator and Blower Module Drain Hose Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> . 2. Remove the front floor console extension panel. Refer to <u>Front Floor Console Extension Panel Replacement</u> . 3. Remove the instrument panel (I/P) lower extension side trim panel. Refer to <u>Instrument Panel Lower Extension Side Trim Panel Replacement</u> . 4. Remove the floor air outlet duct. Refer to <u>Floor Air Outlet Duct Replacement - Right Side</u>. 	
1	Air Conditioning Evaporator and Blower Module Drain Hose Procedure <ol style="list-style-type: none"> 1. Loosen the carpet in the area of the front floor console. 2. Release and pull off the drain hose from the HVAC module assembly, and remove the drain fitting grommet from the front floor panel.

HEATER INLET HOSE REPLACEMENT (LUK)

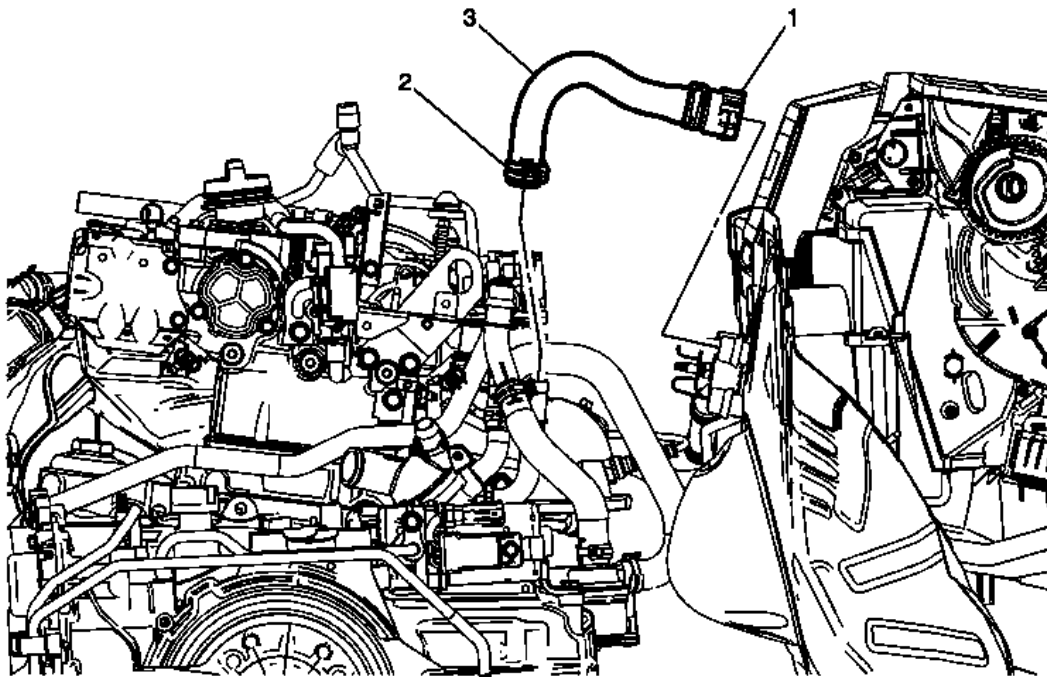


Fig. 44: Heater Inlet Hose, Clamp & Quick Disconnect (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Heater Inlet Hose Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Heater Inlet Hose Quick Disconnect Procedure Release the clip and remove the heater inlet hose from the heater core tube.
2	Heater Inlet Hose Clamp Procedure Reposition the heater inlet hose clamp using BO-38185 pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
3	Heater Inlet Hose

HEATER INLET HOSE REPLACEMENT (LTG)

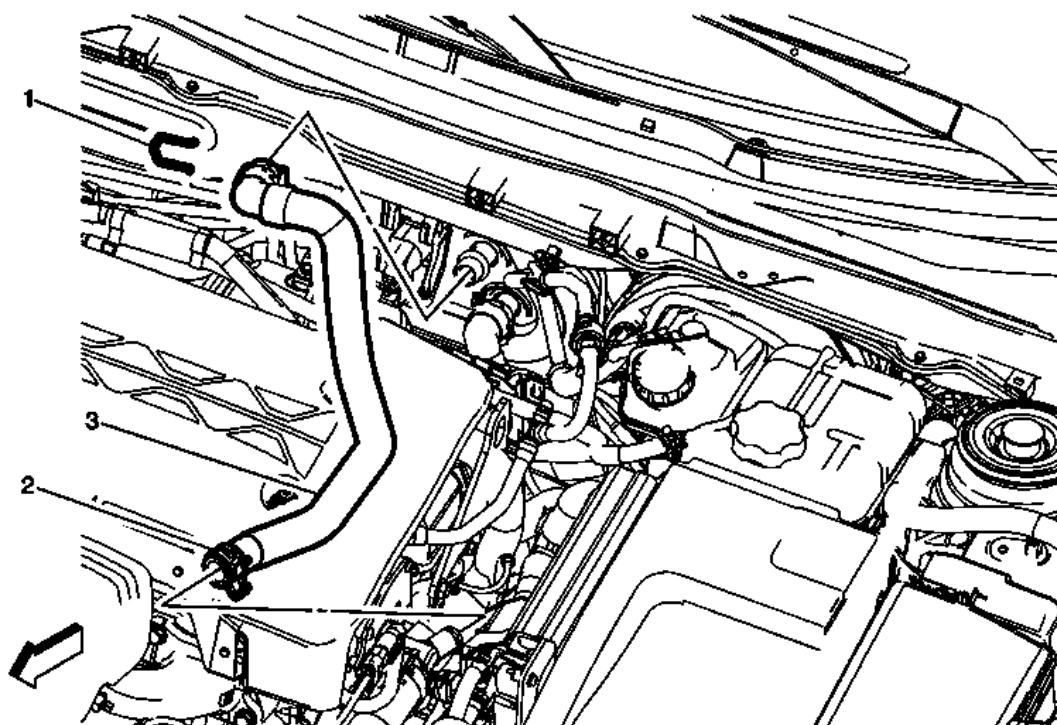


Fig. 45: Heater Inlet Hose (LTG)

Courtesy of GENERAL MOTORS COMPANY

Heater Inlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) . 2. Remove the engine control module. Refer to Engine Control Module Replacement . 	
1	Heater Inlet Hose Quick Connect Retainer
2	Heater Inlet Hose Clamp Procedure Reposition the heater inlet hose clamp using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools. Refer to Special Tools .
3	Heater Inlet Hose Procedure <ol style="list-style-type: none"> 1. Fill the cooling system to the proper level. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) . 2. Inspect the cooling system for leaks. Refer to Cooling System Leak Testing .

HEATER INLET HOSE REPLACEMENT (LEA)

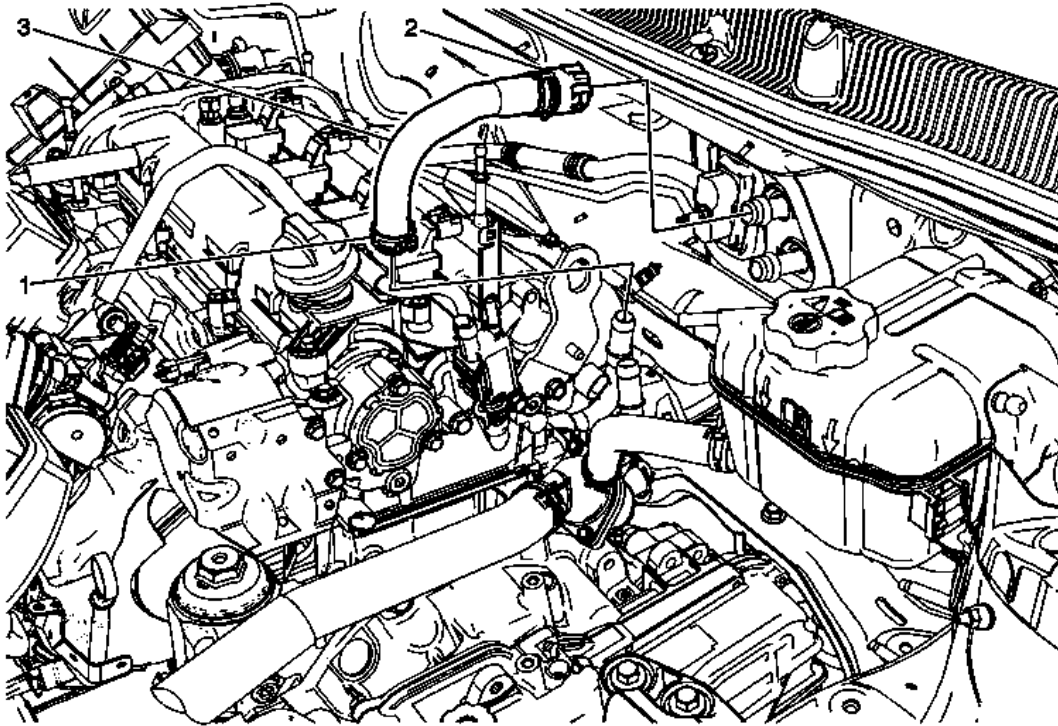


Fig. 46: Heater Inlet Hose, Clamp & Disconnect (LEA)
Courtesy of GENERAL MOTORS COMPANY

Heater Inlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .	
2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .	
1	Heater Inlet Hose Quick Disconnect Procedure Release the clip and remove the heater inlet hose from the heater core tube.
2	Heater Inlet Hose Clamp Procedure Reposition the heater inlet hose clamp using J 38185 pliers. Special Tools J 38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
3	Heater Inlet Hose

HEATER OUTLET HOSE REPLACEMENT (LUK)

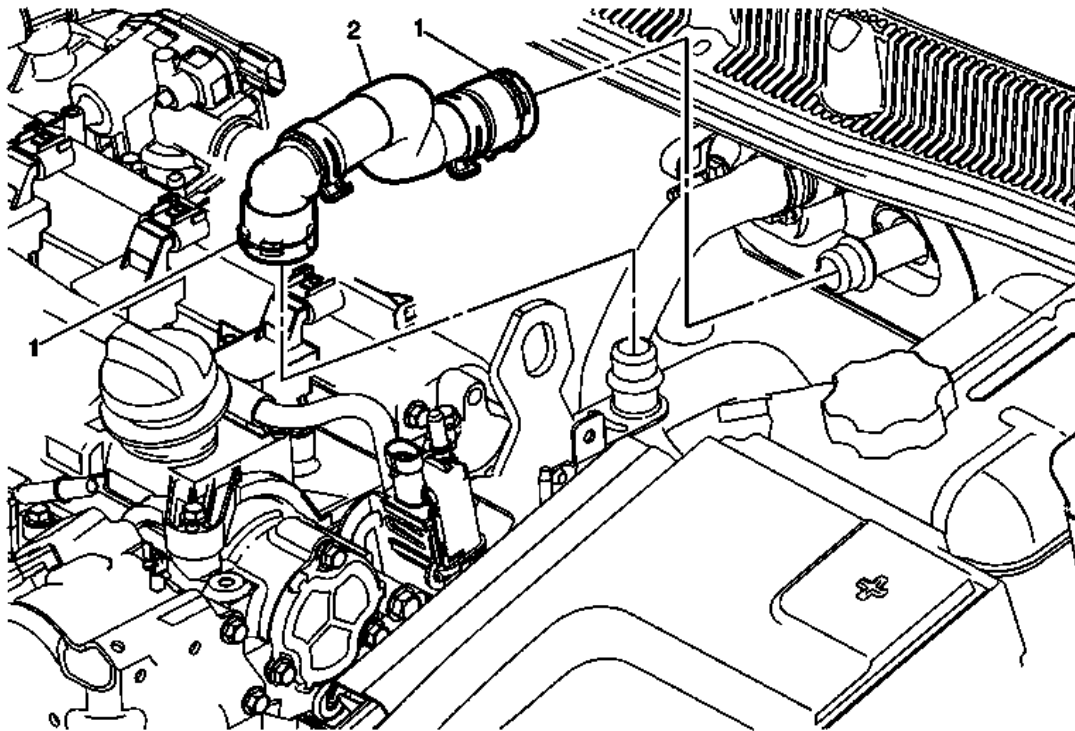


Fig. 47: Heater Outlet Hose & Quick Disconnect (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Heater Outlet Hose Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Heater Outlet Hose Quick Disconnect Procedure Release the clips and remove the heater outlet hose from the heater core tube.
2	Heater Outlet Hose

HEATER OUTLET HOSE REPLACEMENT (LTG)

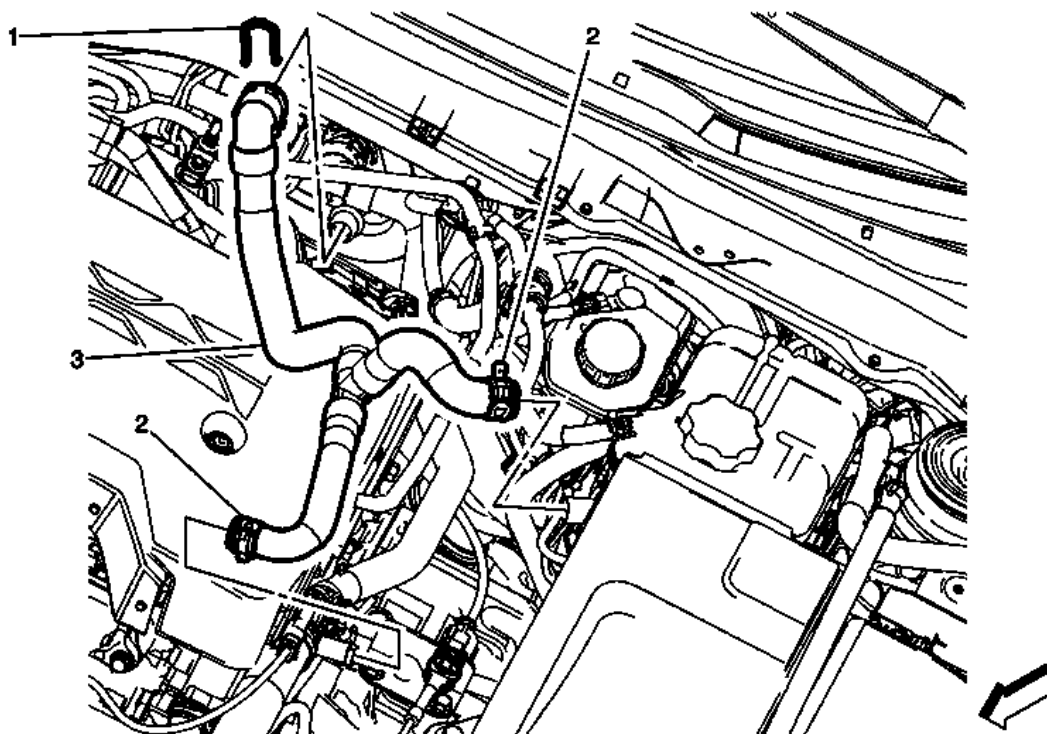


Fig. 48: Heater Outlet Hose (LTG)

Courtesy of GENERAL MOTORS COMPANY

Heater Outlet Hose Replacement (LTG)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Remove the engine control module. Refer to <u>Engine Control Module Replacement</u> . 2. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 	
1	Heater Outlet Hose Connector Retaining Clip
2	Heater Outlet Hose Clamp (Qty: 2) Procedure Reposition the heater outlet hose clamps using the BO-38185 hose clamp pliers. Special Tools BO-38185 Hose Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
3	Heater Outlet Hose Procedure <ol style="list-style-type: none"> 1. Fill the cooling system to the proper level. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Inspect the cooling system for leaks. Refer to <u>Cooling System Leak Testing</u> .

HEATER OUTLET HOSE REPLACEMENT (LEA)

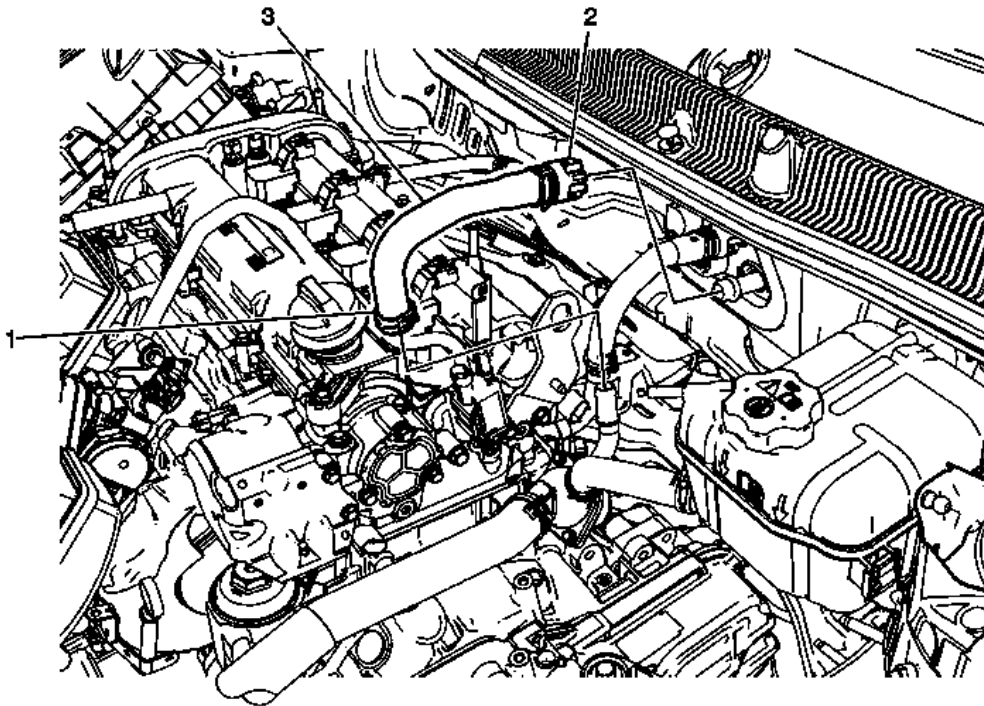


Fig. 49: Heater Outlet Hose, Clamp & Quick Disconnect (LEA)
Courtesy of GENERAL MOTORS COMPANY

Heater Outlet Hose Replacement (LEA)

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .	
2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .	
1	Heater Outlet Hose Quick Disconnect Procedure Release the clip and remove the heater outlet hose from the heater core tube.
2	Heater Outlet Hose Clamp Procedure Reposition the heater outlet hose clamp using J 38185 pliers. Special Tools J 38185 Hose Clamp Pliers For equivalent regional tools, refer to Special Tools .
3	Heater Outlet Hose

HEATER CORE OUTLET TUBE REPLACEMENT

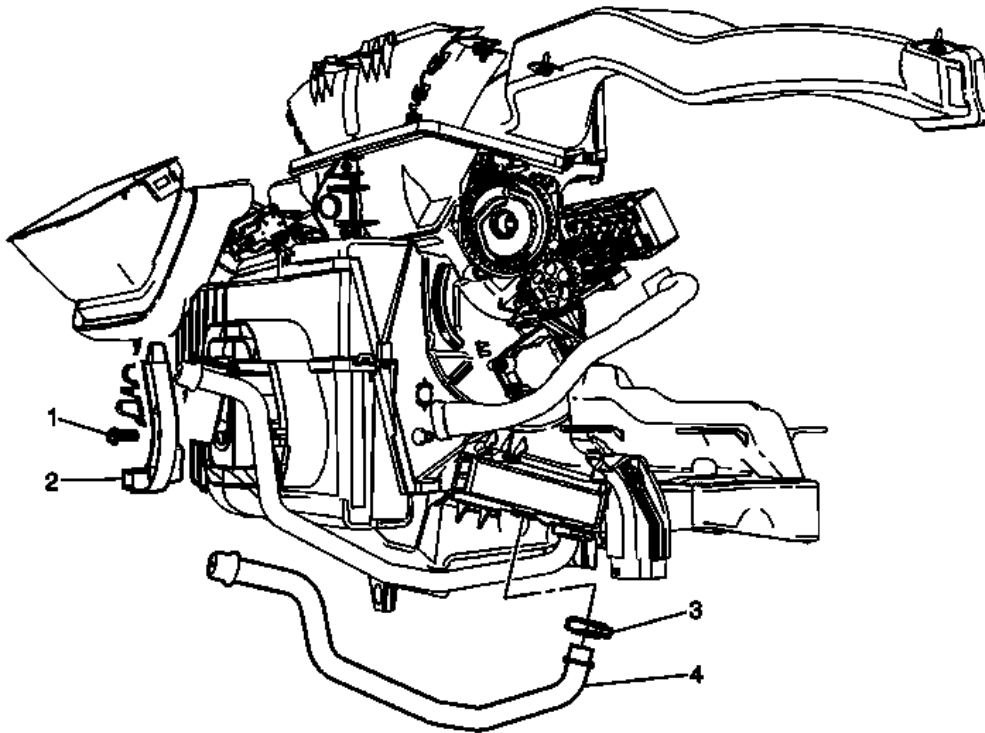


Fig. 50: Heater Core Outlet Tube & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Heater Core Outlet Tube Replacement

Callout	Component Name
Preliminary Procedure Remove the heater and air conditioning evaporator case. Refer to <u>Heater and Air Conditioning Evaporator and Blower Module Removal and Installation</u> .	
1	Bracket Heater Core Outlet Tube Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m (23 lb in)
2	Heater Core Outlet Tube Brace
3	Heater Core Outlet Tube Clamp
4	Heater Core Outlet Tube

HEATER CORE INLET TUBE REPLACEMENT

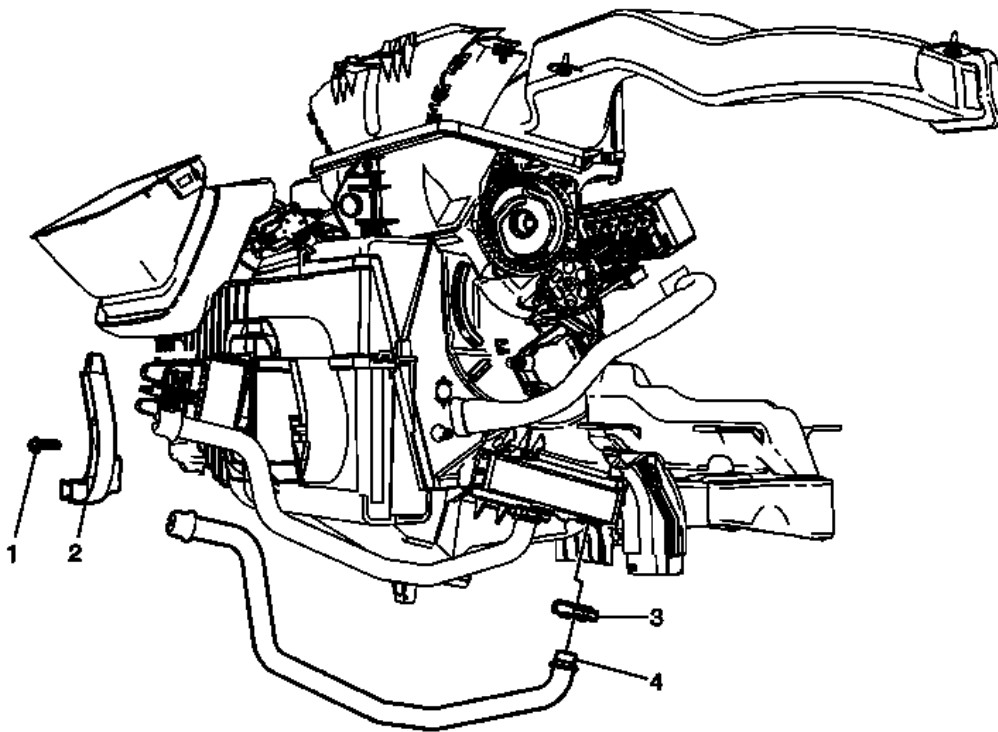


Fig. 51: Heater Core Inlet Tube & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Heater Core Inlet Tube Replacement

Callout	Component Name
Preliminary Procedure Remove the heater and air conditioning evaporator case. Refer to <u>Heater and Air Conditioning Evaporator and Blower Module Removal and Installation</u> .	
1	Bracket Heater Core Inlet Tube Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m (23 lb in)
2	Heater Core Outlet Tube Brace
3	Heater Core Outlet Tube Clamp
4	Heater Core Outlet Tube

PASSENGER COMPARTMENT AIR FILTER REPLACEMENT

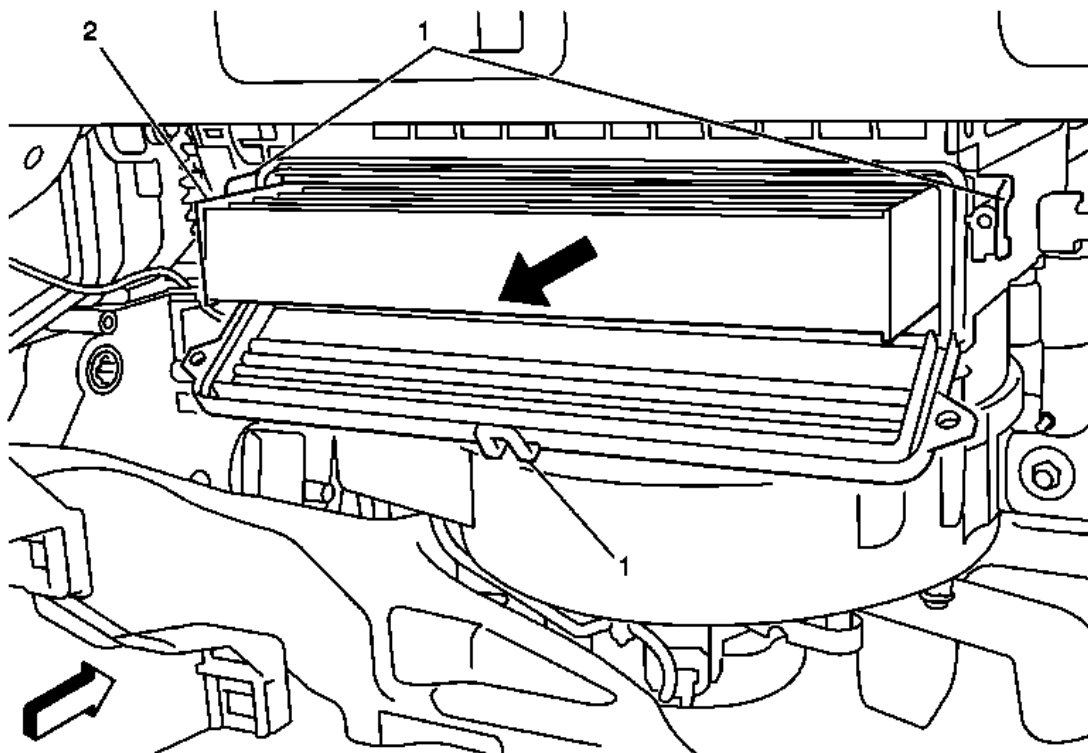


Fig. 52: Passenger Compartment Air Filter (Front)
 Courtesy of GENERAL MOTORS COMPANY

Passenger Compartment Air Filter Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove instrument panel outer trim cover. Refer to <u>Instrument Panel Outer Trim Cover Replacement - Right Side</u> . 2. Remove instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> .	
1	Passenger Compartment Air Filter Service Lid Retainer (Qty: 3) Procedure Release the retainer and open the service lid.
2	Passenger Compartment Air Filter

AIR INLET HOUSING REPLACEMENT

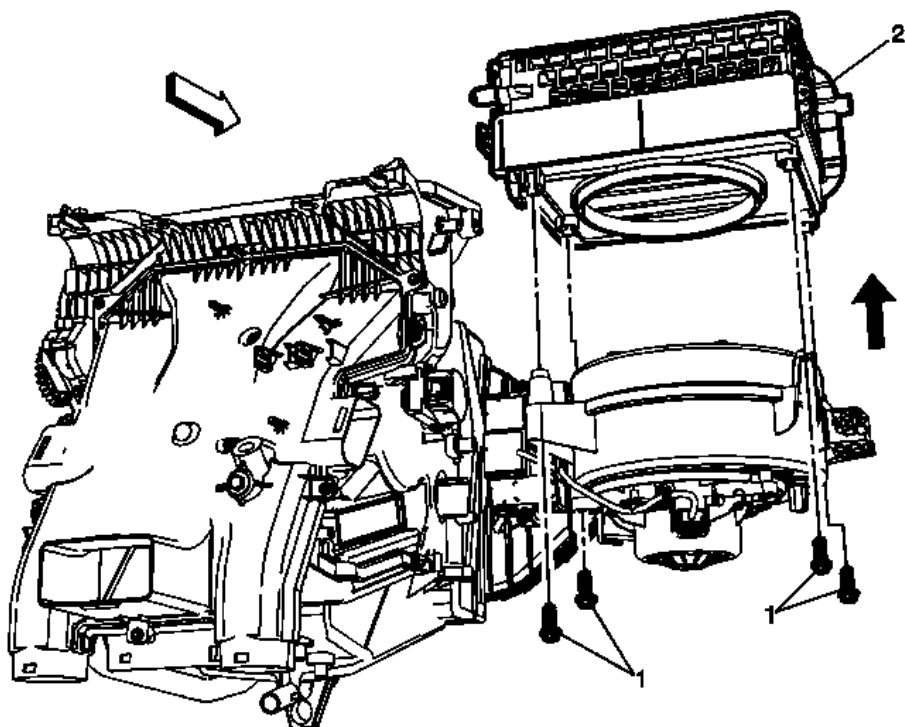


Fig. 53: Air Inlet Housing & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Air Inlet Housing Replacement

Call out	Component Name
Preliminary Procedures	
1. Remove the heater and air conditioning evaporator and blower module assembly. Refer to <u>Heater and Air Conditioning Evaporator and Blower Module Removal and Installation</u> . 2. Disconnect the electrical connectors as necessary.	
1	Air Inlet Housing Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .
2	Air Inlet Housing Assembly Procedure Transfer all part as necessary.

BLOWER MOTOR REPLACEMENT

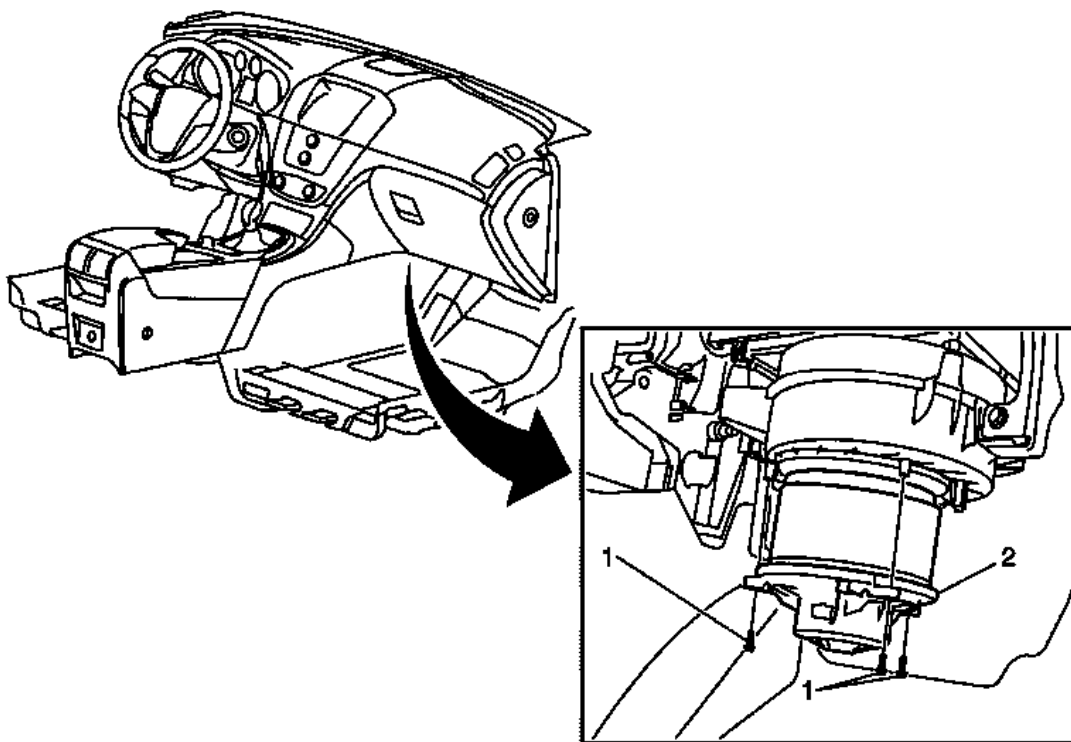


Fig. 54: Blower Motor & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Blower Motor Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the floor air outlet duct. Refer to <u>Floor Air Outlet Duct Replacement - Right Side.</u> 2. Disconnect the blower motor electrical connector.	
1	Blower Motor Fastener (Qty: 3)
2	Blower Motor

SIDE WINDOW DEFOGGER OUTLET GRILLE REPLACEMENT - LEFT SIDE

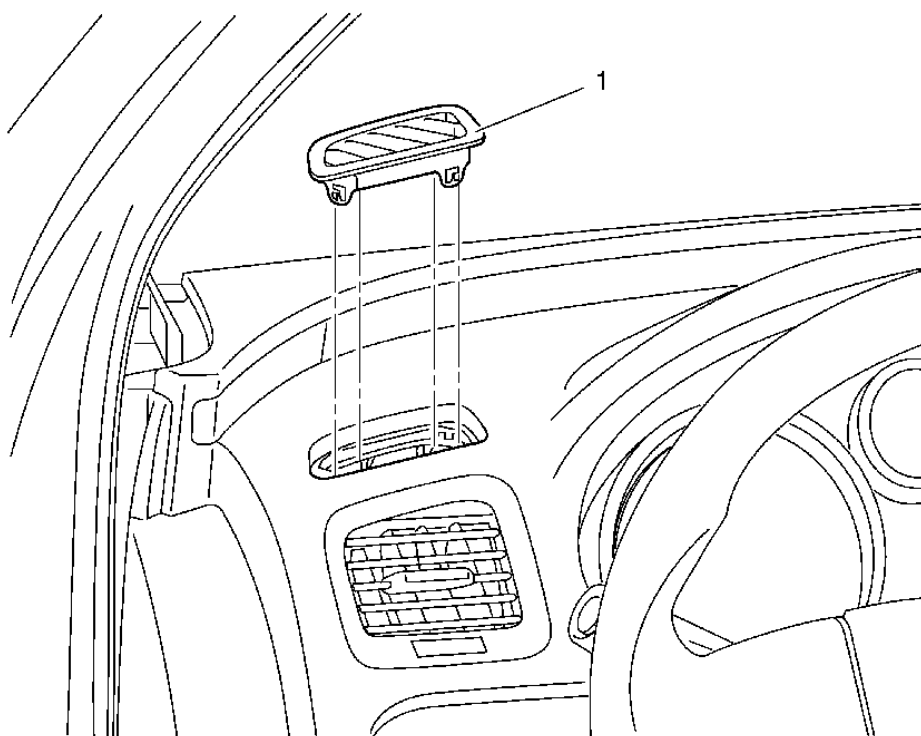


Fig. 55: Side Window Defogger Outlet Grille - Left Side
Courtesy of GENERAL MOTORS COMPANY

Side Window Defogger Outlet Grille Replacement - Left Side

Callout	Component Name
1	Side Window Defogger Outlet Grille Replacement TIP: Use a flat-bladed plastic trim tool in order to release the left side window defogger outlet grille.

SIDE WINDOW DEFOGGER OUTLET GRILLE REPLACEMENT - RIGHT SIDE

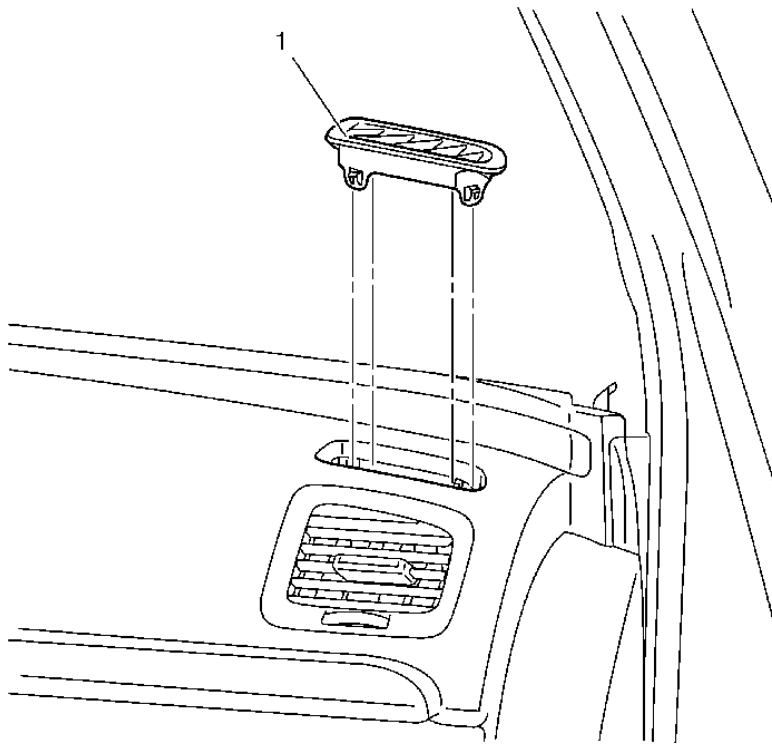


Fig. 56: Side Window Defogger Outlet Grille - Right Side
Courtesy of GENERAL MOTORS COMPANY

Side Window Defogger Outlet Grille Replacement - Right Side

Callout	Component Name
1	Side Window Defogger Outlet Grille Replacement TIP: Use a flat-bladed plastic trim tool in order to release the right side window defogger outlet grille.

AIR DISTRIBUTOR CASE REPLACEMENT

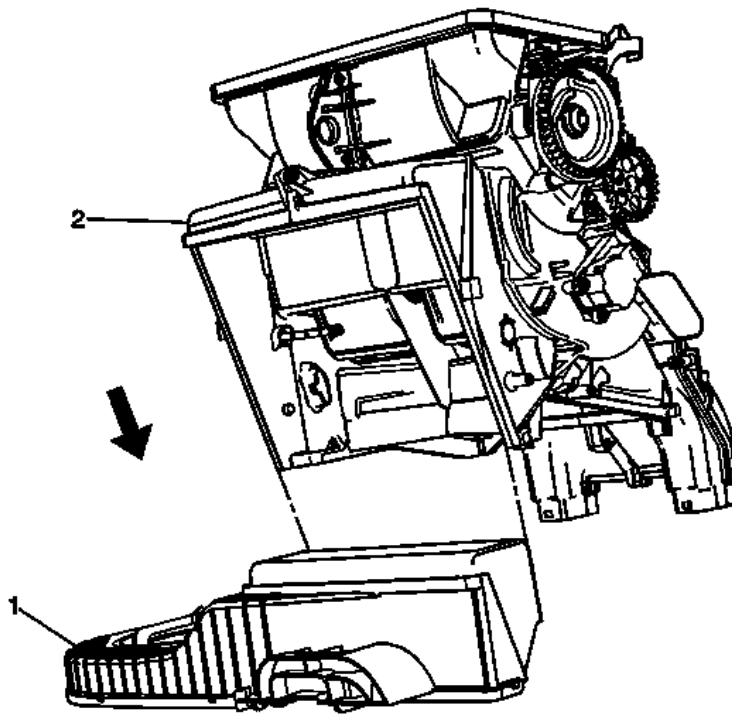


Fig. 57: Air Distributor Case
 Courtesy of GENERAL MOTORS COMPANY

Air Distributor Case Replacement

Call out	Component Name
1	Heater and Air Conditioning Evaporator and Blower Upper Case Refer to <u>Heater and Air Conditioning Evaporator and Blower Upper Case Replacement.</u>
2	Air Distributor Case Procedure <ol style="list-style-type: none"> 1. Remove the right side temperature actuator. Refer to <u>Temperature Valve Actuator Replacement - Right Side</u> . 2. Remove the left side temperature actuator. Refer to <u>Temperature Valve Actuator Replacement - Left Side (Left Hand Drive)</u> . 3. Remove the mode control cam actuator. Refer to <u>Mode Control Cam Actuator Replacement (Left Hand Drive)</u> . 4. Transfer the components as necessary.

INSTRUMENT PANEL OUTER AIR OUTLET DEFLECTOR REPLACEMENT - LEFT SIDE

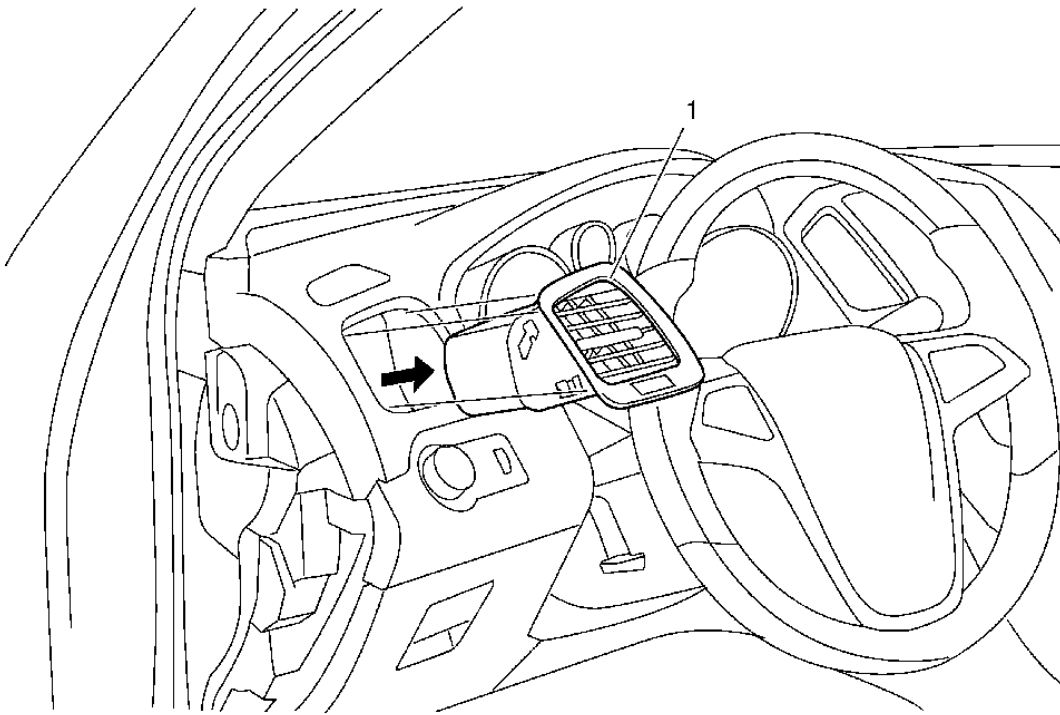


Fig. 58: Instrument Panel Outer Air Outlet Deflector - Left Side
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Outer Air Outlet Deflector Replacement - Left Side

Callout	Component Name
Preliminary Procedure Remove the instrument panel outer trim cover. Lower center trim panel. Refer to <u>Instrument Panel Outer Trim Cover Replacement - Left Side</u> .	
1	Instrument Panel Outer Air Outlet Deflector Procedure Push out the air outlet deflector housing from behind.

INSTRUMENT PANEL OUTER AIR OUTLET DEFLECTOR REPLACEMENT - RIGHT SIDE

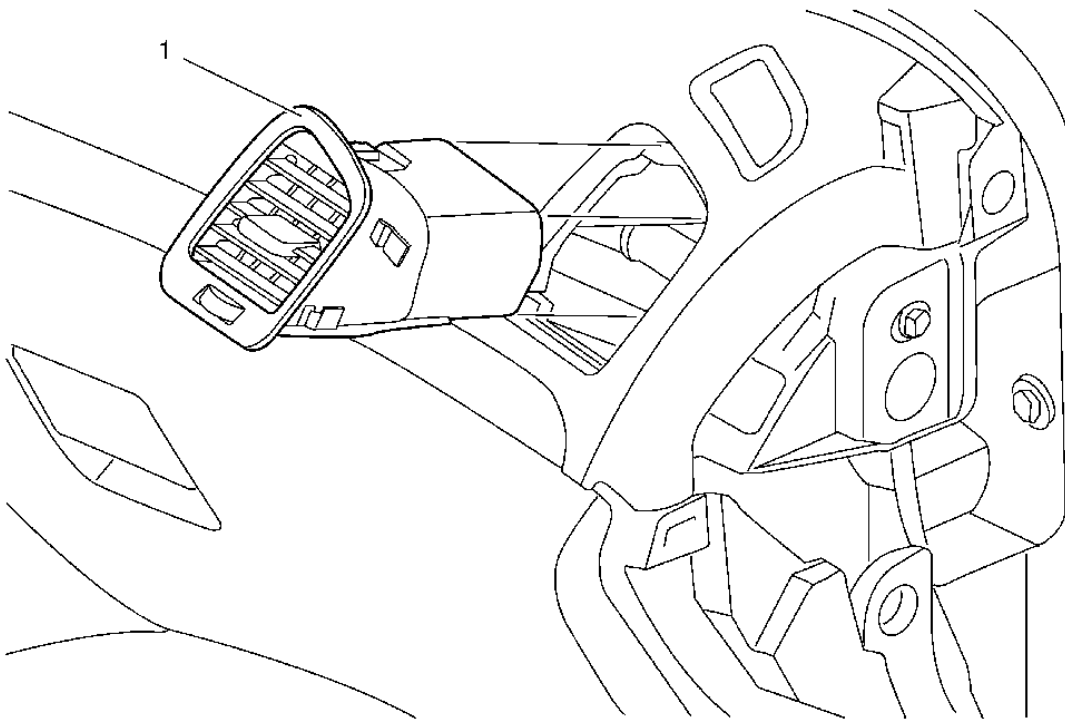


Fig. 59: Instrument Panel Outer Air Outlet Deflector - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Outer Air Outlet Deflector Replacement - Right Side

Callout	Component Name
Preliminary Procedure Remove the instrument panel outer trim cover. Lower center trim panel. Refer to <u>Instrument Panel Outer Trim Cover Replacement - Right Side</u> .	
1	Instrument Panel Outer Air Outlet Deflector Procedure Push out the air outlet deflector housing from behind.

RADIO COOLING DUCT REPLACEMENT

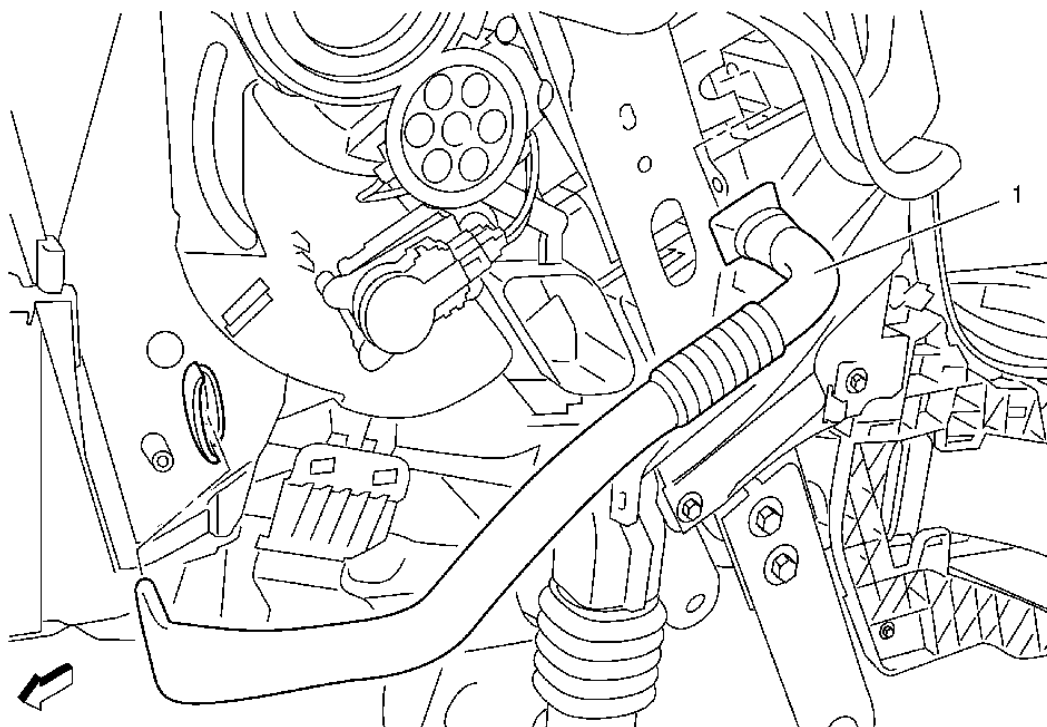


Fig. 60: Radio Cooling Duct
 Courtesy of GENERAL MOTORS COMPANY

Radio Cooling Duct Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the instrument panel lower trim panel- left side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> . 2. Remove the floor air outlet duct- left side. Refer to <u>Floor Air Outlet Duct Replacement - Left Side</u> .	
1	Radio Cooling Duct Procedure Pull off the radio cooling duct from the HVAC module and release the duct from the I/P center reinforcement.

FRONT FLOOR CONSOLE FRONT AIR DUCT REPLACEMENT

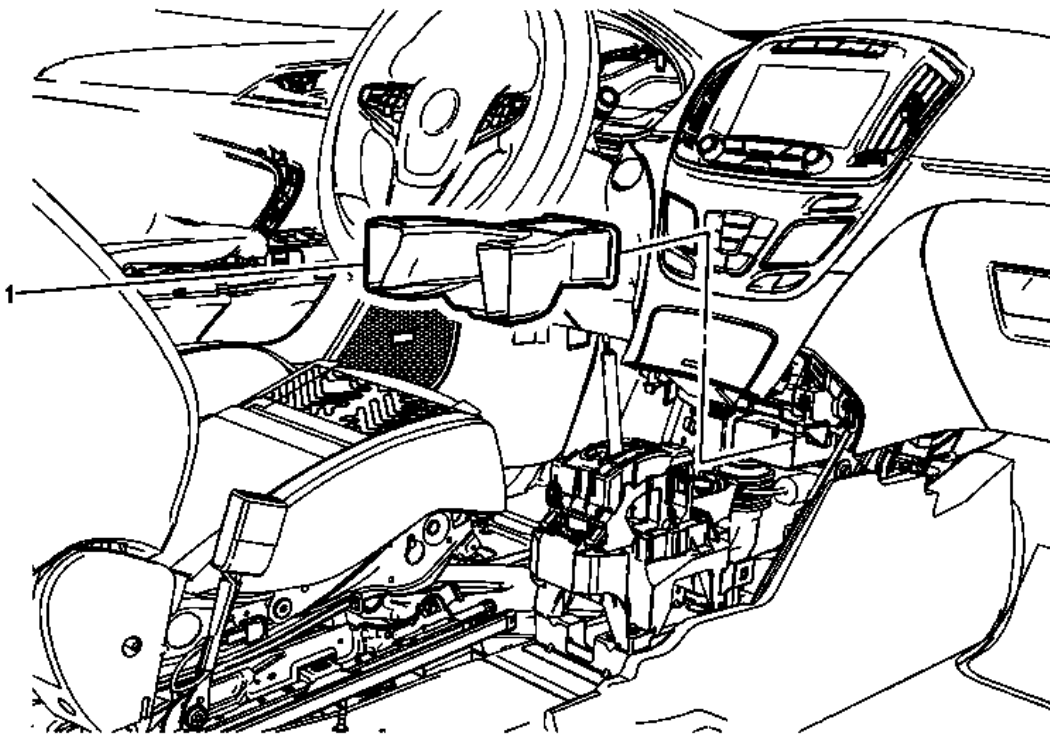


Fig. 61: Front Floor Console Front Air Duct
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Front Air Duct Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front floor console assembly. Refer to <u>Front Floor Console Replacement</u> .	
1	Front Floor Console Front Air Duct

FRONT FLOOR CONSOLE REAR AIR DUCT REPLACEMENT

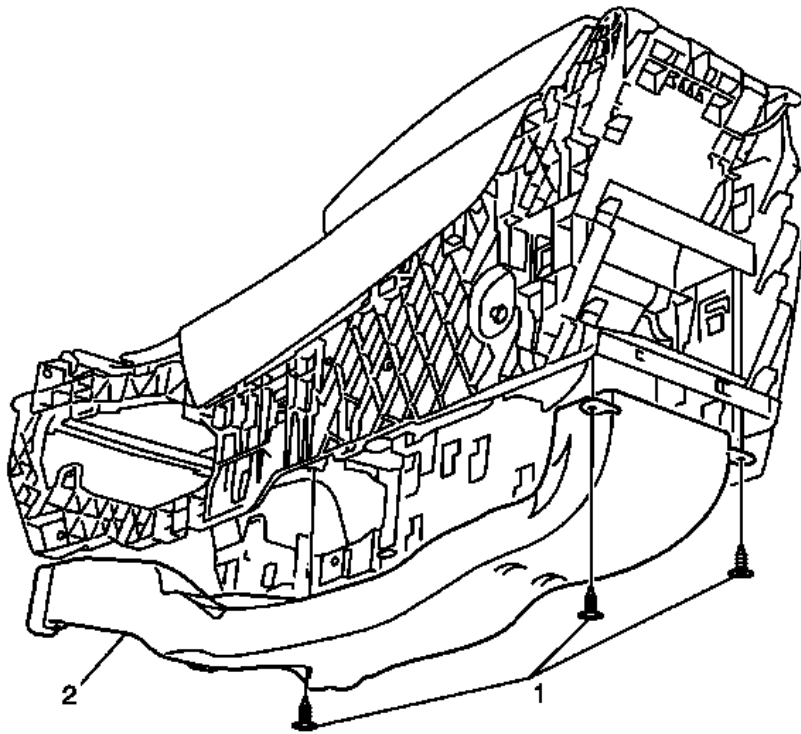


Fig. 62: Front Floor Console Rear Air Duct & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Rear Air Duct Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the front floor console. Refer to <u>Front Floor Console Replacement</u> 2. Remove the front floor console rear cover. Refer to <u>Front Floor Console Rear Cover Replacement</u>	
1	Front Floor Console Rear Air Duct Fastener (Qty: 3)
2	Front Floor Console Rear Air Duct

FRONT FLOOR CONSOLE REAR AIR OUTLET DEFLECTOR HOUSING REPLACEMENT

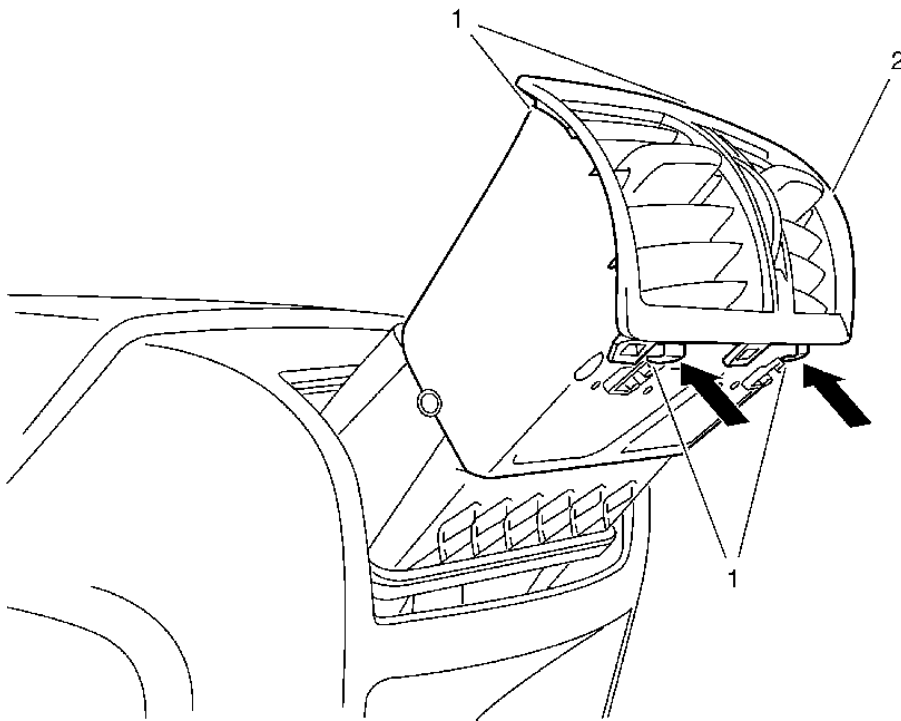


Fig. 63: Front Floor Console Rear Air Outlet Deflector Housing & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Rear Air Outlet Deflector Housing Replacement

Callout	Component Name
1	Front Floor Console Rear Air Outlet Deflector Housing Retainer (Qty: 4) TIP: Use a flat-bladed plastic trim tool to release the rear air outlet deflector housing assembly from the front floor console.
2	Front Floor Console Rear Air Outlet Deflector Housing

INSTRUMENT PANEL OUTER AIR OUTLET DUCT REPLACEMENT

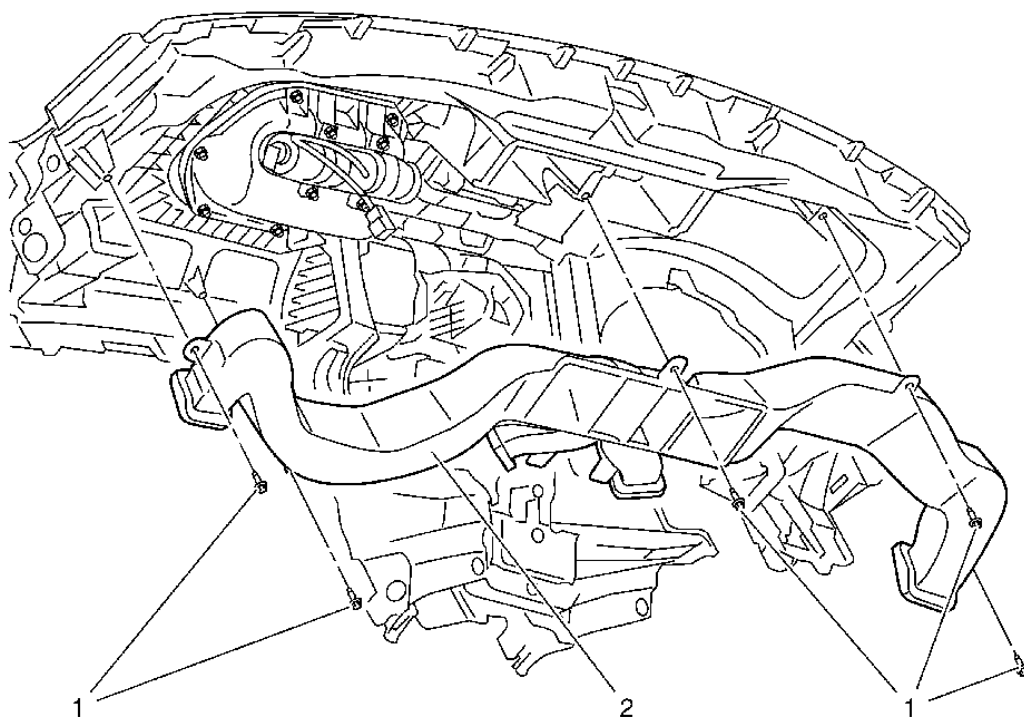


Fig. 64: Instrument Panel Outer Air Outlet Duct & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Outer Air Outlet Duct Replacement

Callout	Component Name
Preliminary Procedure	
Remove the instrument panel assembly. Refer to <u>Instrument Panel Assembly Replacement</u> .	
1	Instrument Panel Outer Air Outlet Duct Fastener (Qty: 5)
2	Instrument Panel Outer Air Outlet Duct

INSTRUMENT PANEL CENTER AIR OUTLET DEFLECTOR HOUSING REPLACEMENT

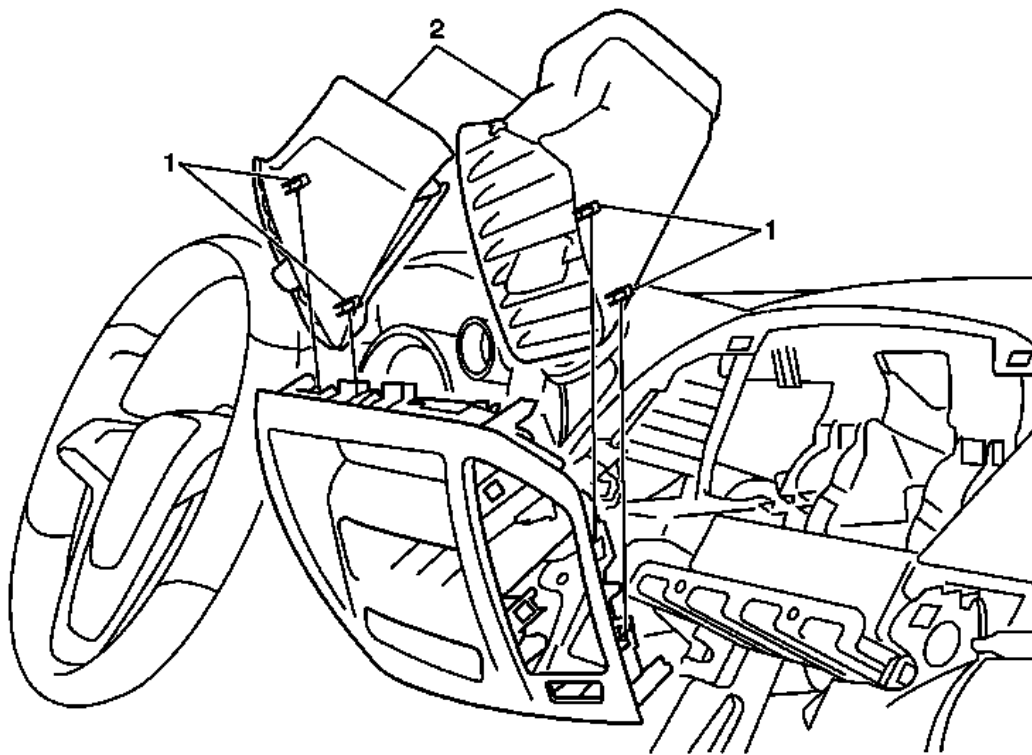


Fig. 65: Instrument Panel Center Air Outlet Deflector Housing & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Center Air Outlet Deflector Housing Replacement

Callout	Component Name
Preliminary Procedure	
Remove the instrument panel (I/P) upper center trim panel. Refer to <u>Instrument Panel Upper Center Trim Panel Replacement</u> .	
1	Instrument Panel Center Air Outlet Deflector Housing Fastener (Qty: 4)
2	Instrument Panel Center Air Outlet Deflector Housing

WINDSHIELD DEFROSTER NOZZLE DUCT REPLACEMENT

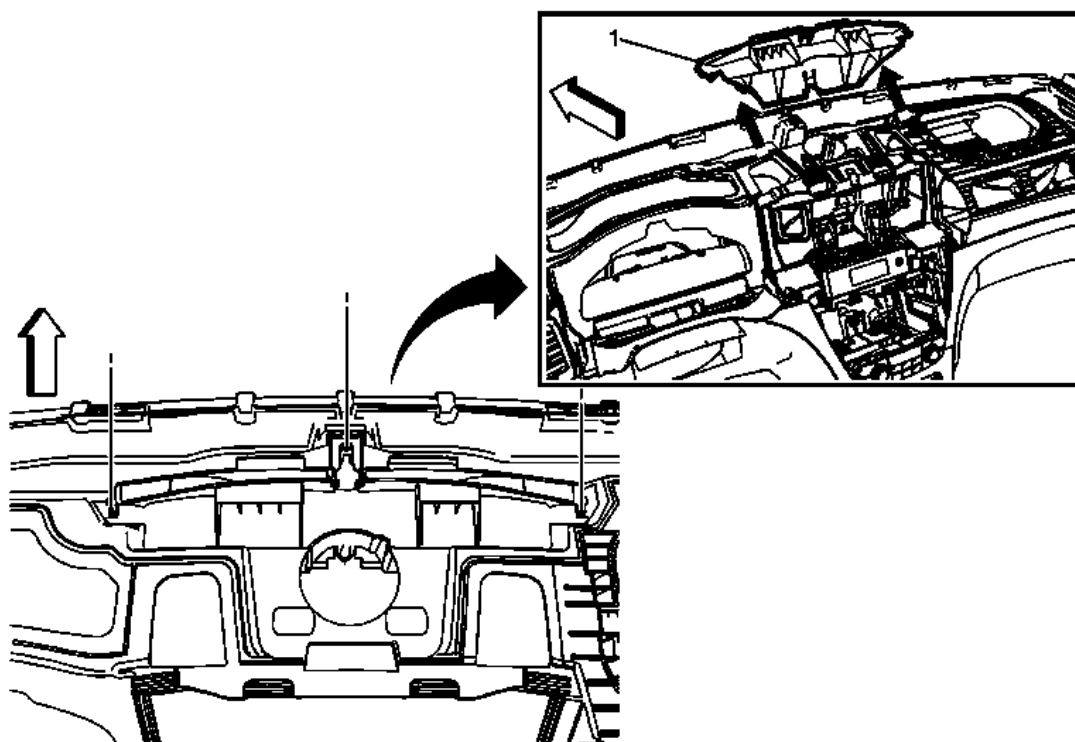


Fig. 66: Windshield Defroster Nozzle Duct
 Courtesy of GENERAL MOTORS COMPANY

Windshield Defroster Nozzle Duct Replacement

Callout	Component Name
Preliminary Procedure	
Remove the instrument panel assembly. Refer to <u>Instrument Panel Assembly Replacement</u> .	
1	Windshield Defroster Nozzle Duct NOTE: Release tabs on the windshield defroster nozzle duct.

FLOOR AIR OUTLET DUCT REPLACEMENT - LEFT SIDE

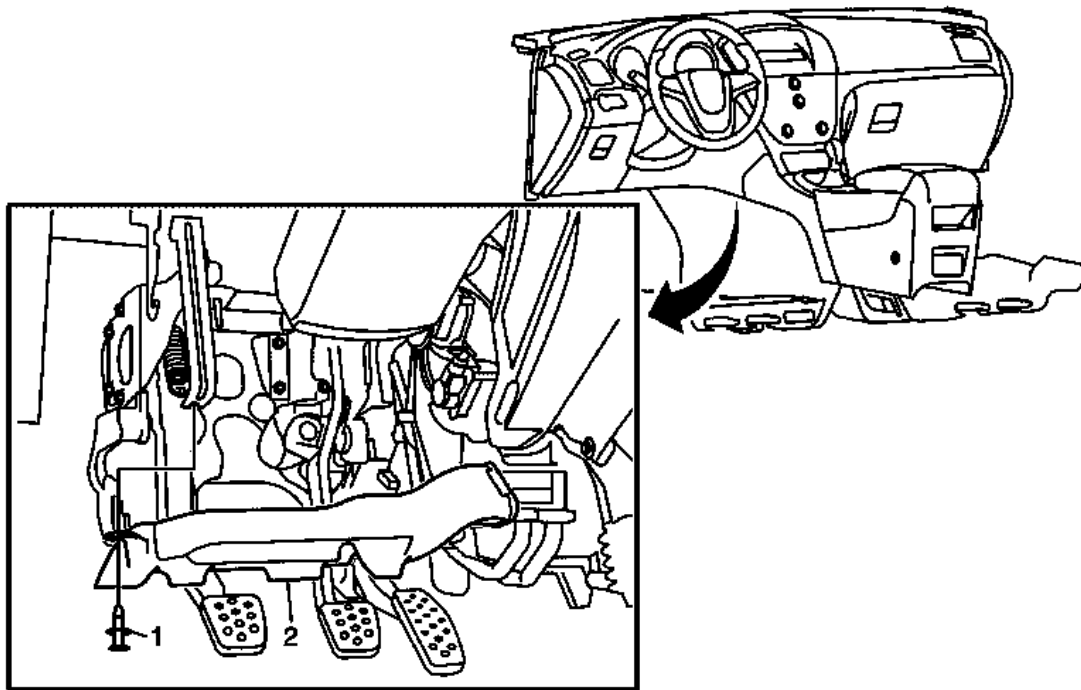


Fig. 67: Floor Air Outlet Duct - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Floor Air Outlet Duct Replacement - Left Side

Callout	Component Name
Preliminary Procedures	
1.	Remove the instrument panel (I/P) lower trim panel - left side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> .
2.	Remove the I/P lower trim panel insulator. Refer to <u>Instrument Panel Lower Trim Panel Insulator Replacement</u> .
1	Floor Air Outlet Duct Retainer
2	Floor Air Outlet Duct

FLOOR AIR OUTLET DUCT REPLACEMENT - RIGHT SIDE

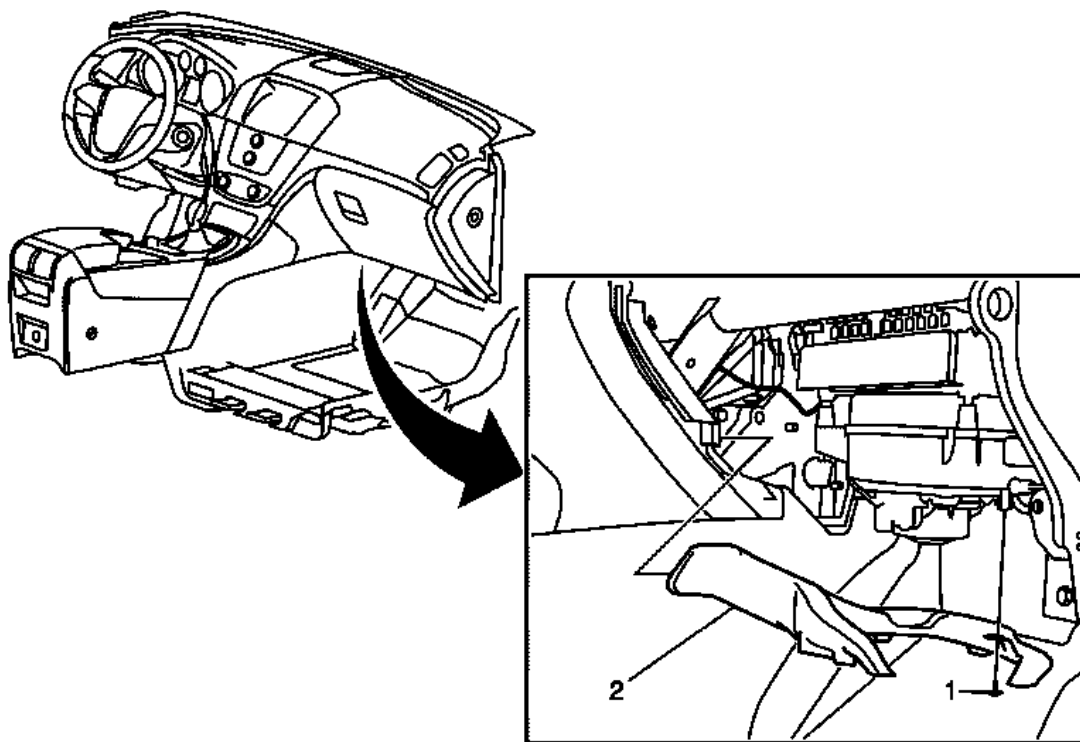


Fig. 68: Floor Air Outlet Duct - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Floor Air Outlet Duct Replacement - Right Side

Callout	Component Name
Preliminary Procedures	
Remove instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> .	
1	Floor Air Outlet Duct Fastener
2	Floor Air Outlet Duct

FLOOR REAR AIR OUTLET DUCT REPLACEMENT - LEFT SIDE

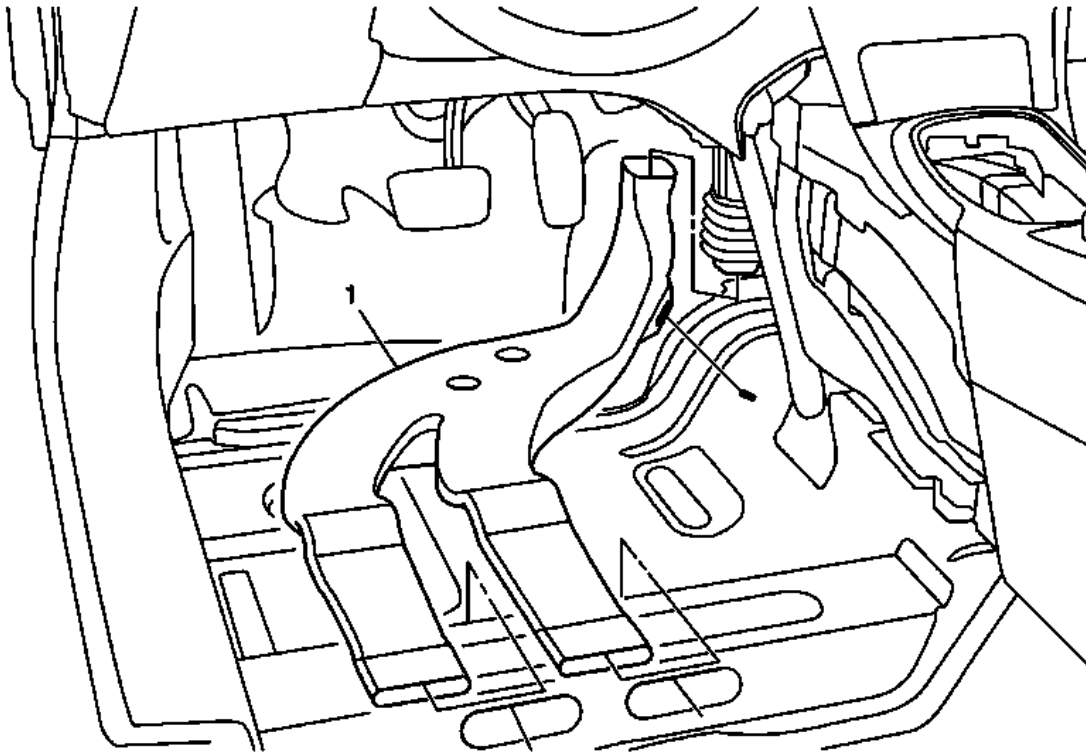


Fig. 69: Floor Rear Air Outlet Duct - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Floor Rear Air Outlet Duct Replacement - Left Side

Callout	Component Name
Preliminary Procedure	
Remove the Front Floor Panel Carpet. Refer to Front Floor Panel Carpet Replacement .	
1	Floor Rear Air Outlet Duct Procedures <ol style="list-style-type: none"> 1. Remove the Floor Rear Air Outlet Duct from the retainer and the Heater Air Conditioning Evaporator and Blower Module. 2. Remove the Floor Rear Air Outlet Duct from vehicle.

FLOOR REAR AIR OUTLET DUCT REPLACEMENT - RIGHT SIDE

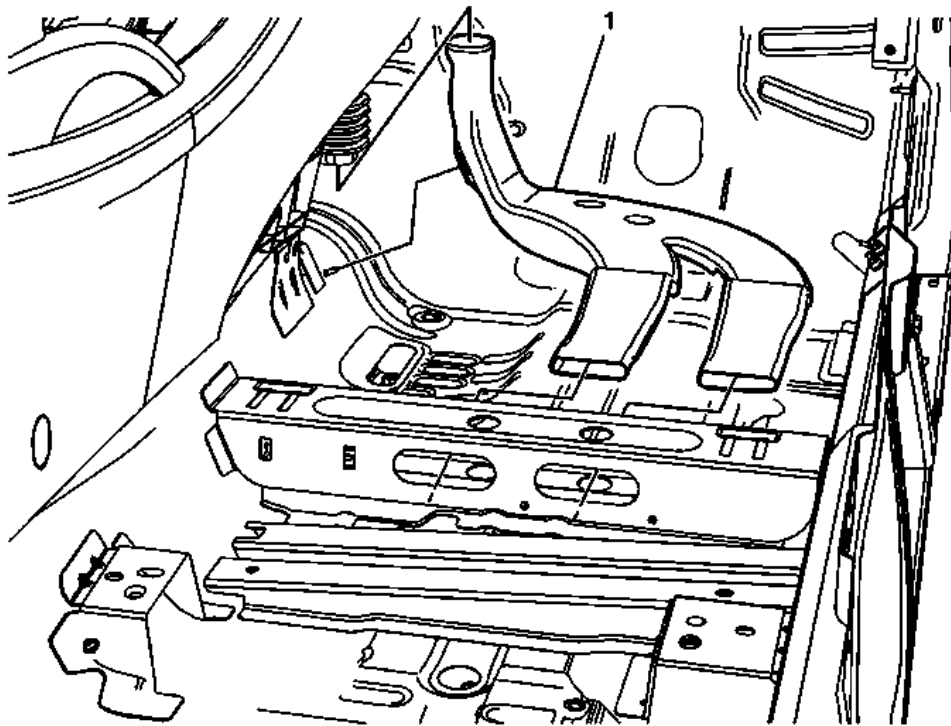


Fig. 70: Floor Rear Air Outlet Duct - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Floor Rear Air Outlet Duct Replacement - Right Side

Callout	Component Name
Preliminary Procedure	
Remove the front floor panel carpet. Refer to <u>Front Floor Panel Carpet Replacement</u> .	
1	Floor Rear Air Outlet Duct
	Procedure
	<ol style="list-style-type: none"> 1. Remove the floor rear air outlet duct from the retainer and the heater air conditioning evaporator and blower module. 2. Remove the floor rear air outlet duct from vehicle.

HEATER AND AIR CONDITIONING REMOTE CONTROL REPLACEMENT

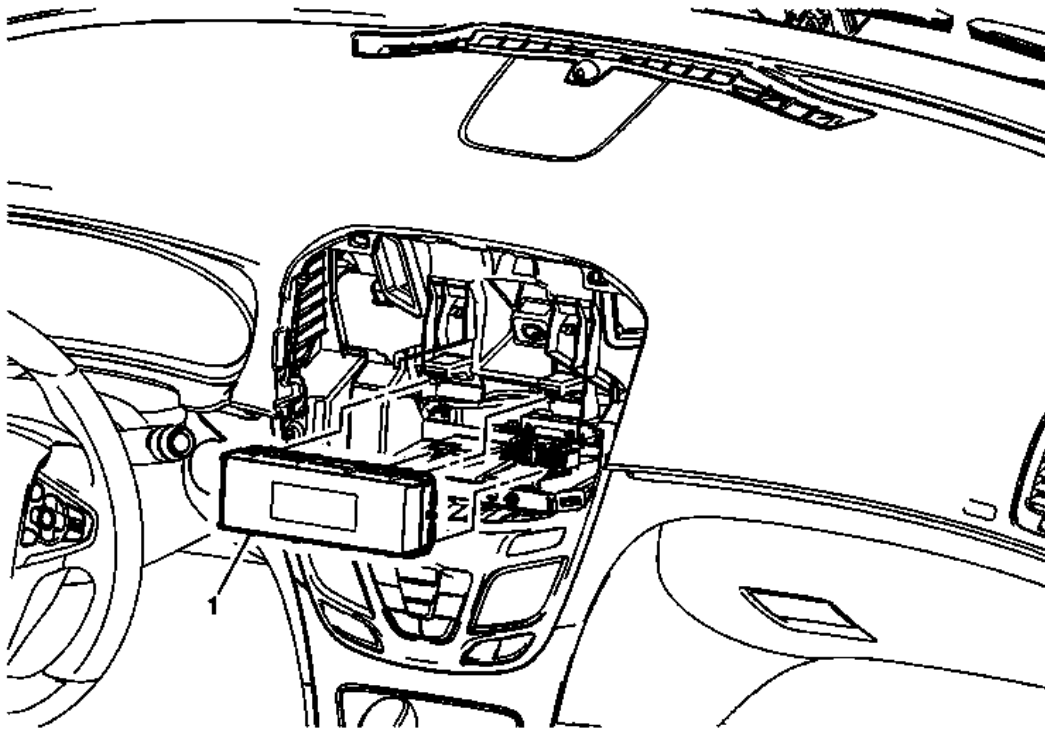


Fig. 71: Heater and Air Conditioning Remote Control
 Courtesy of GENERAL MOTORS COMPANY

Heater and Air Conditioning Remote Control Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel upper center trim panel. Refer to <u>Instrument Panel Upper Center Trim Panel Replacement</u> .	
1	Heater And Air Conditioning Remote Control Module Procedures <ol style="list-style-type: none"> 1. Disconnect the heater and air conditioning remote control module connectors. 2. Perform the HVAC system control module programming and setup procedure. Refer to <u>HVAC System Control Module Programming and Setup</u> . 3. Perform the actuator re-calibration procedure. Refer to <u>Actuator Recalibration</u> .

HEATER CORE REPLACEMENT (LHD)

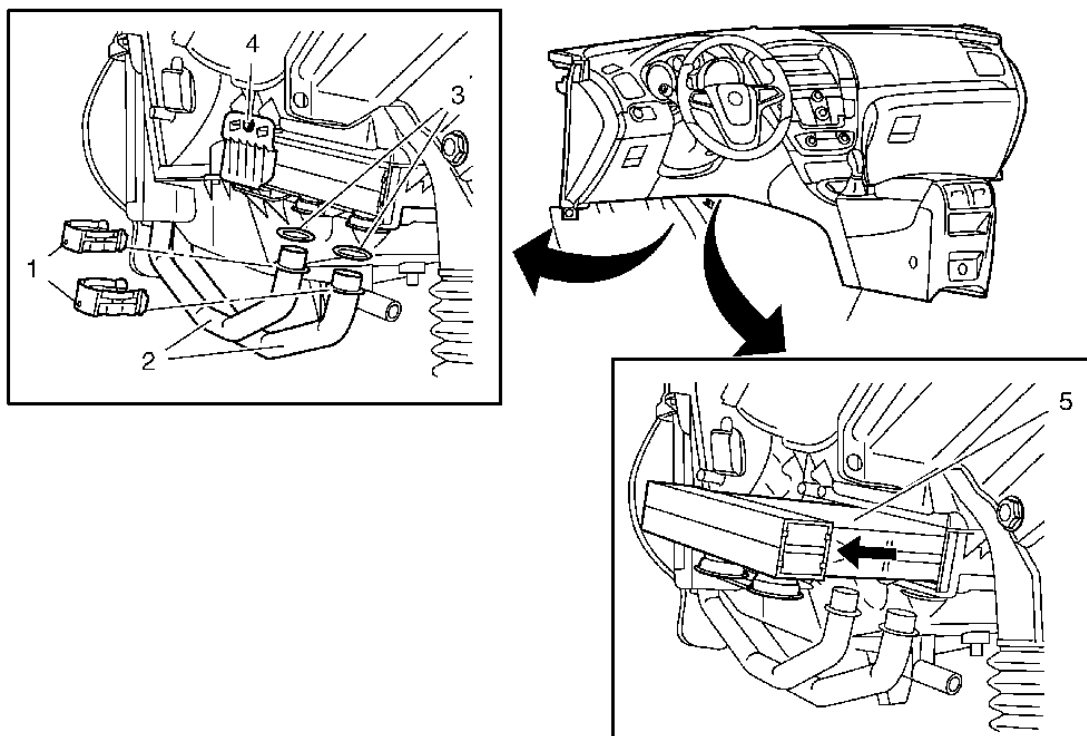


Fig. 72: Heater Core (LHD)

Courtesy of GENERAL MOTORS COMPANY

Heater Core Replacement (LHD)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the heater inlet hose from the heater core tube. Refer to <u>Heater Inlet Hose Replacement (LUK)</u>, <u>Heater Inlet Hose Replacement (LTG)</u>, <u>Heater Inlet Hose Replacement (LEA)</u>. 2. Remove the heater outlet hose from the heater core tube. Refer to <u>Heater Outlet Hose Replacement (LUK)</u>, <u>Heater Outlet Hose Replacement (LTG)</u>, <u>Heater Outlet Hose Replacement (LEA)</u>. 3. Remove the left side console extension. Refer to <u>Front Floor Console Extension Panel Replacement</u>. 4. Place a protective mat over the carpet. 	
1	Heater Core Tube Clamp (Qty: 2) Procedure Loosen the carpet in the area of the heater core.
2	Heater Core Tube Assembly Procedure Before disconnecting the heater core tubes from the heater core, place a small drain pan under the heater core tubes to capture any coolant drainage.
3	Heater Core Tube Seal (Qty: 2)
4	Heater Core Bracket Fastener

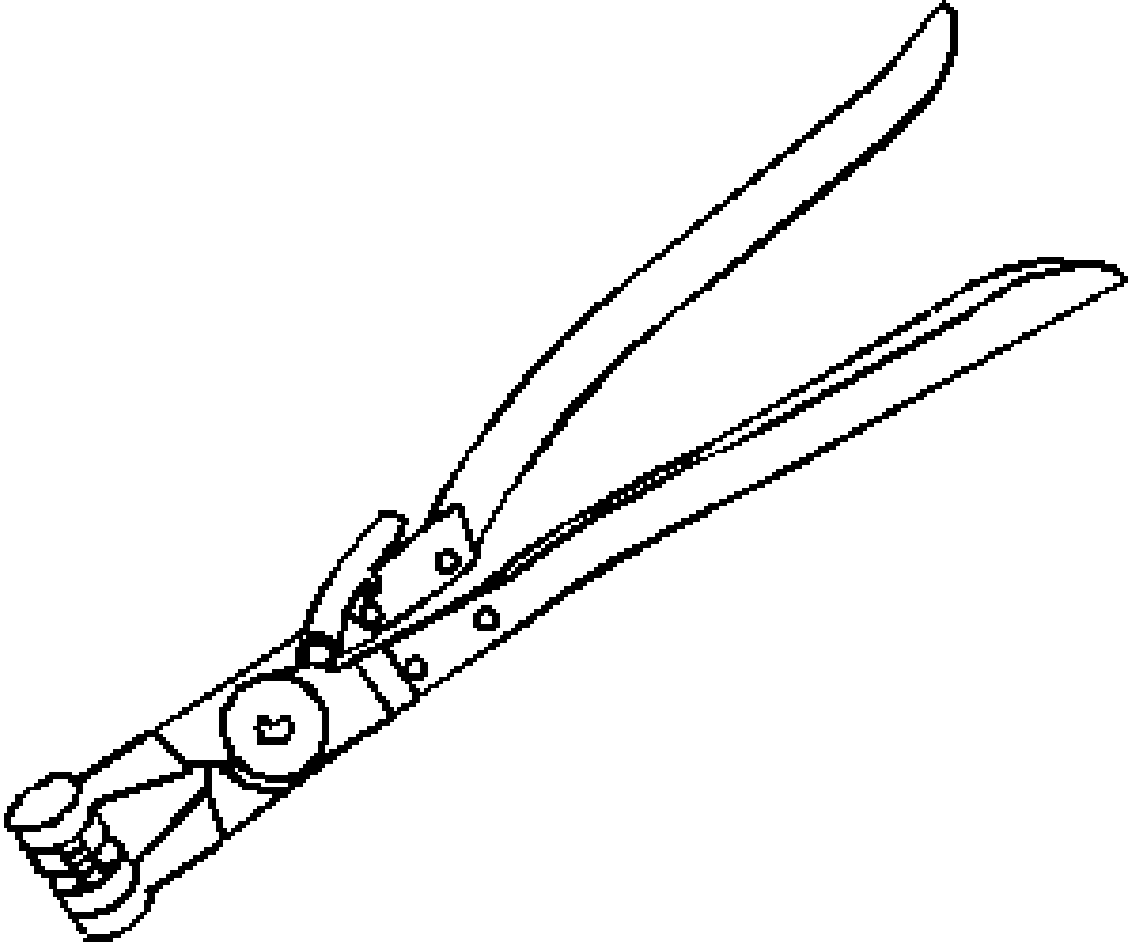
5

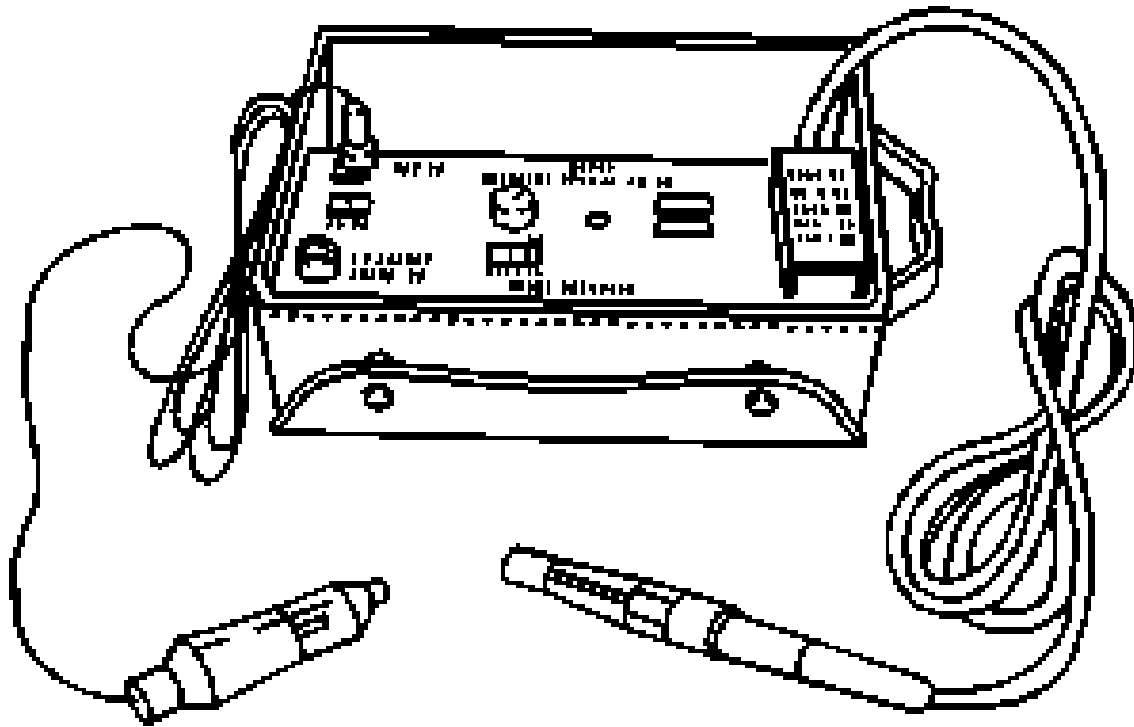
Heater Core

Procedure

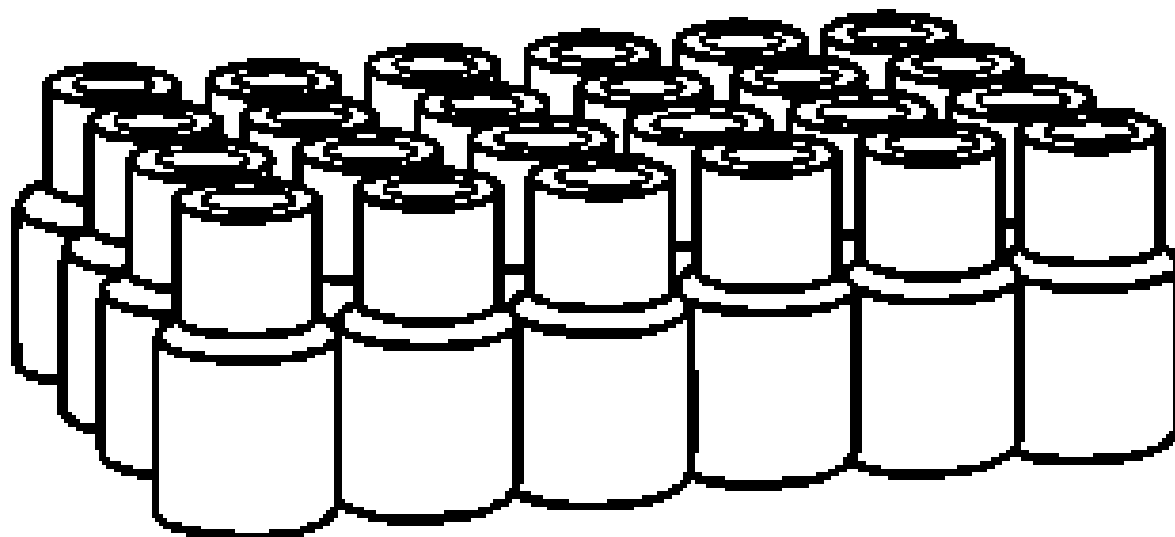
Pull out the heater core.

SPECIAL TOOLS AND EQUIPMENT**SPECIAL TOOLS**

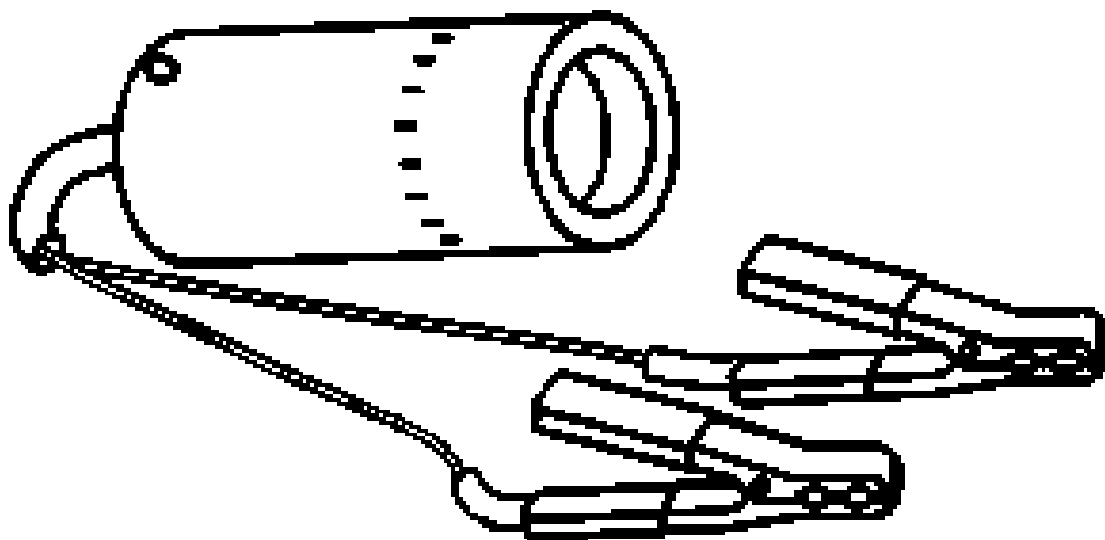
Illustration	Tool Number / Description
	BO 38185 J 38185 Hose Clamp Pliers



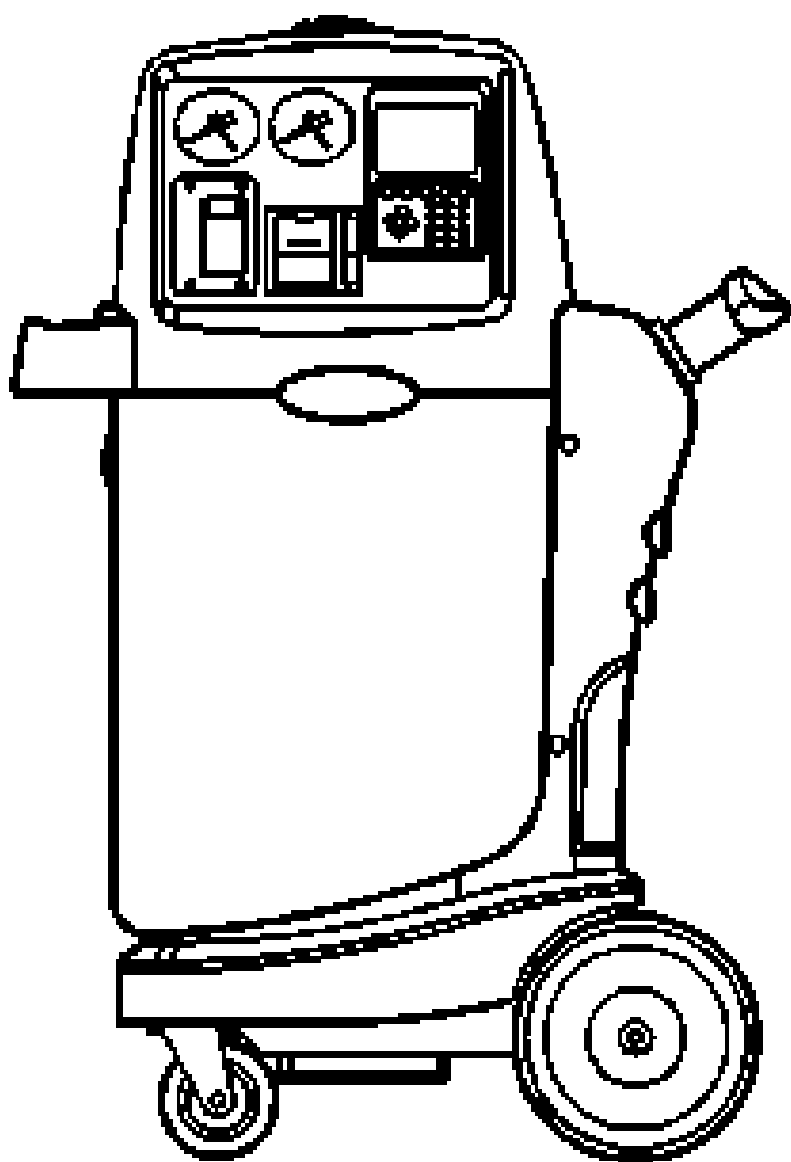
GE 39400-A
J 39400-A
Halogen Leak
Detector



GE 41447
J 41447
Europe - Use
local equivalent
R-134a A/C
Tracer Dye - Box
of 24



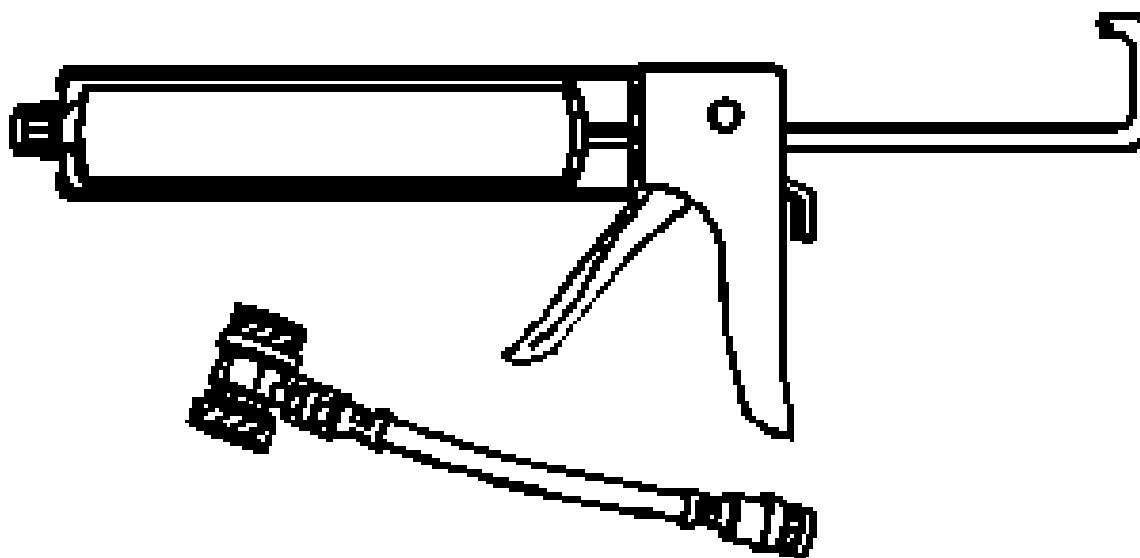
GE 42220
J 42220
Universal 12V
Leak Detection
Lamp



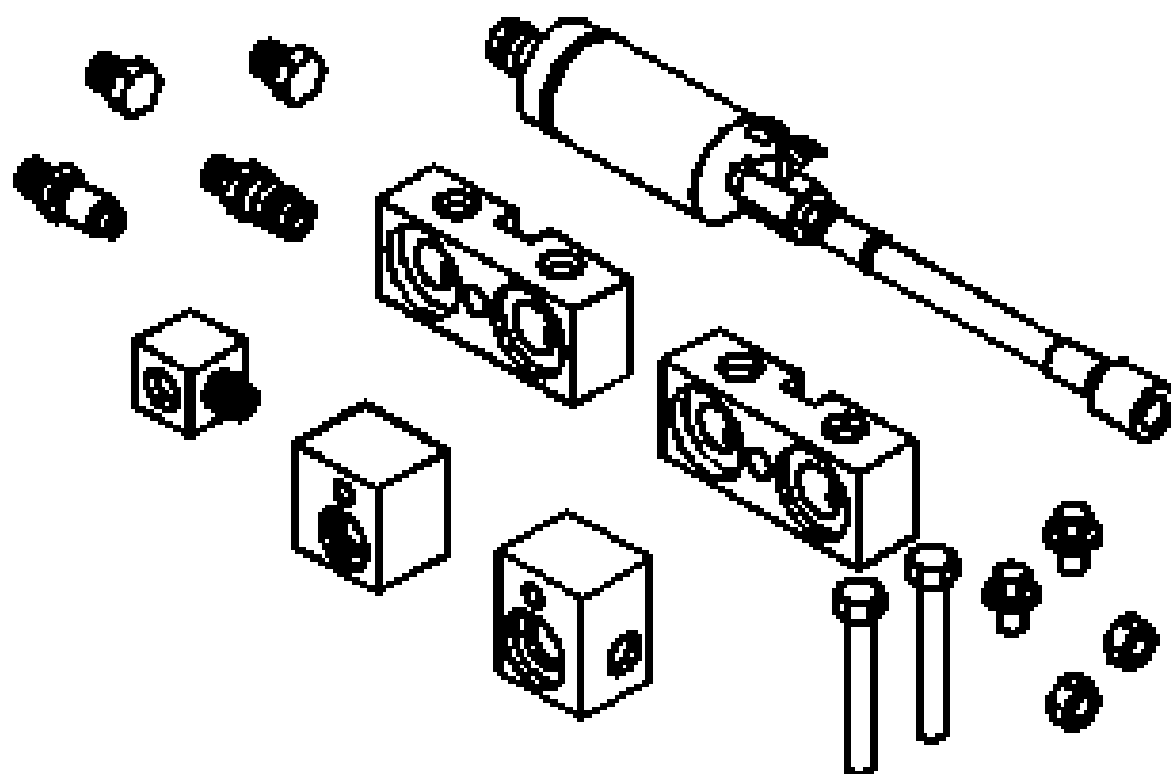
GE-8800
J 43600
Europe - Use
local equivalent
ACR 2000 Air
Conditioning
Service Center



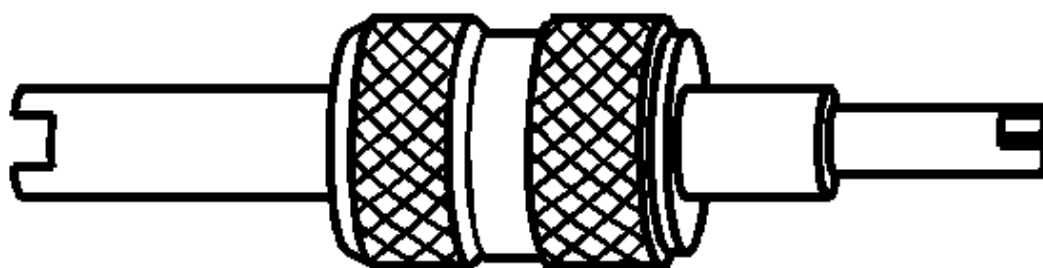
GE 43872
J 43872
Fluorescent Dye
Cleaner



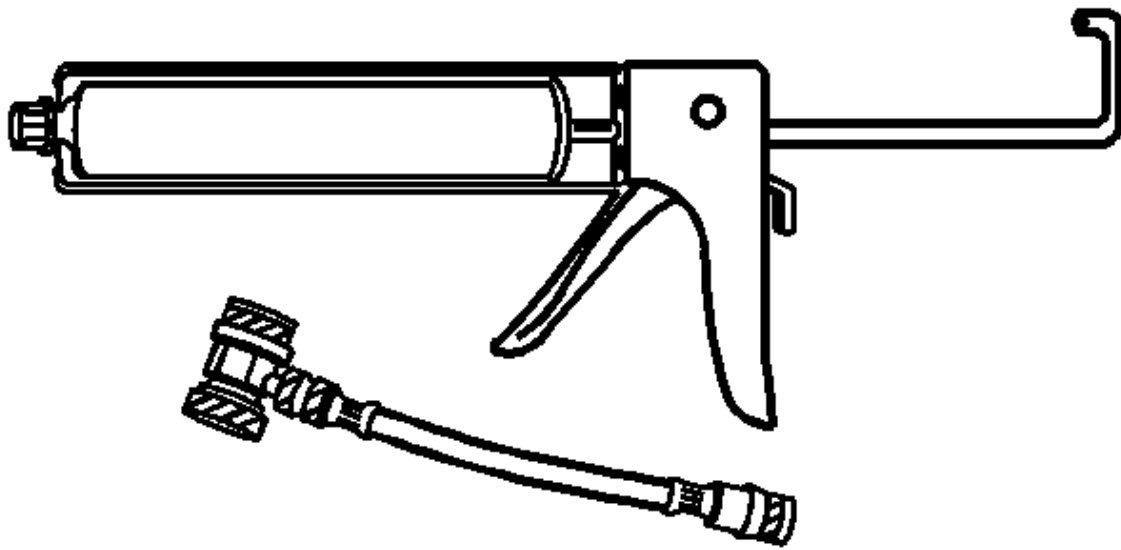
GE 45037 A
J 45037 A
A/C Oil Injector



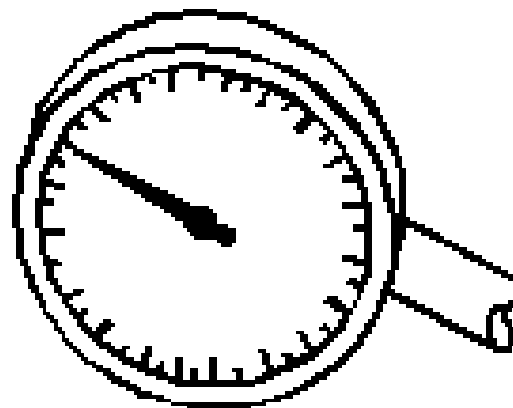
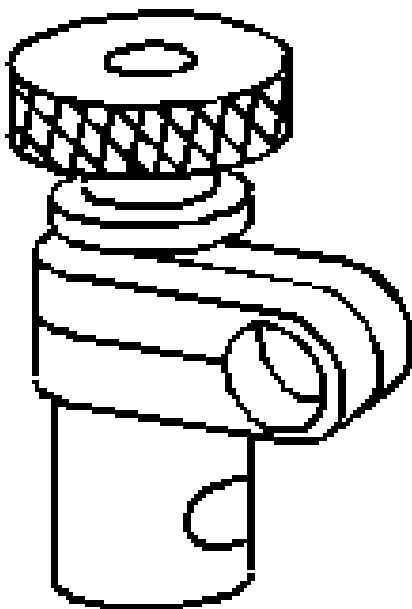
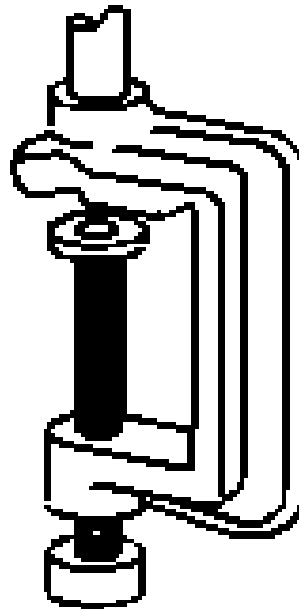
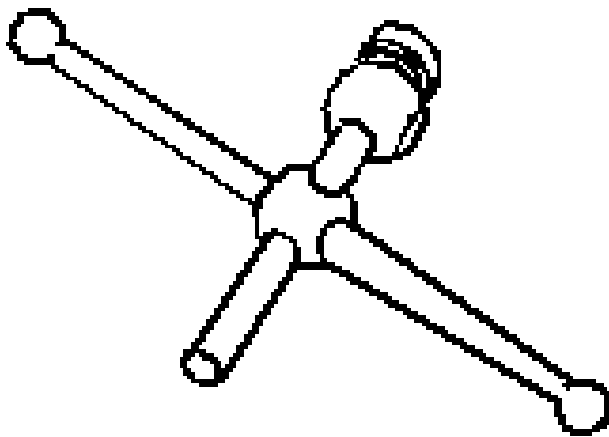
GE 45268
J 45268
Not used in
Europe
A/C Flushing
Adapter Kit



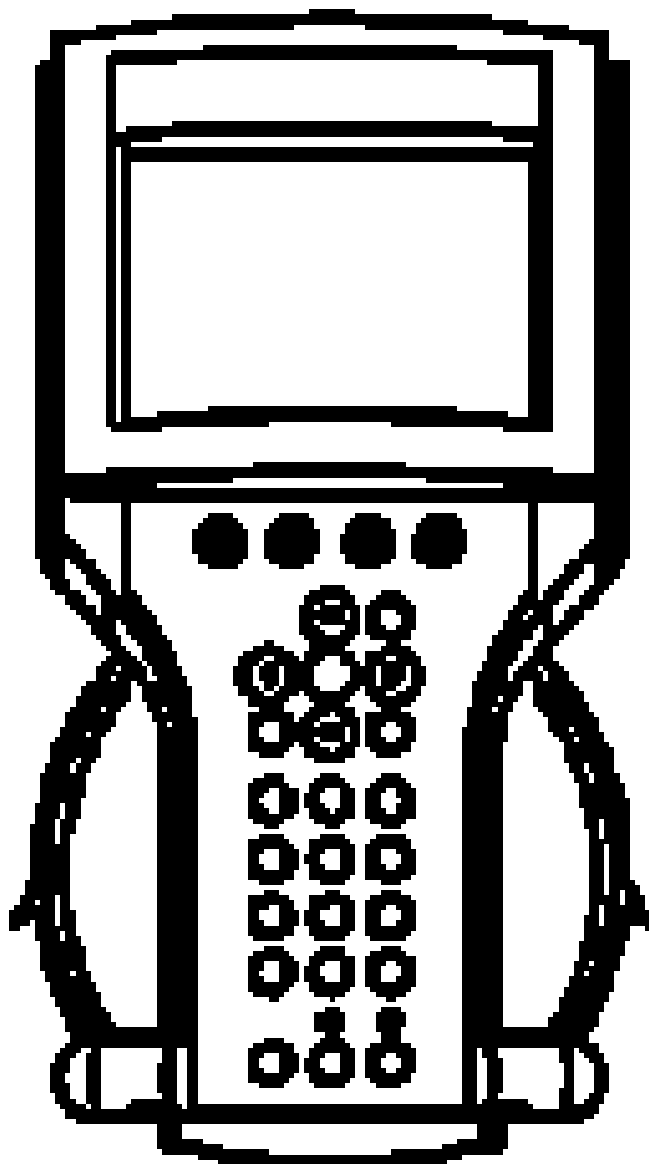
GE 46246
J 46246
Charge Port
Valve Core
Remover/Installer



GE 46297
J 46297
Europe - Use
local equivalent
A/C Dye Injector
Kit



GE 46297-12
J 46297-12
Europe - Use
local equivalent
Replacement Dye
Cartridges



7001081-32MB
Scan Tool
Used for
diagnosis of
vehicle electrical
system.

ACCESSORIES & EQUIPMENT

Horns

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Horn Fastener	17	13 lb ft
Steering Wheel Horn Switch Fastener	10.2	89 lb in

SCHEMATIC WIRING DIAGRAMS

HORN WIRING SCHEMATICS

Horn System

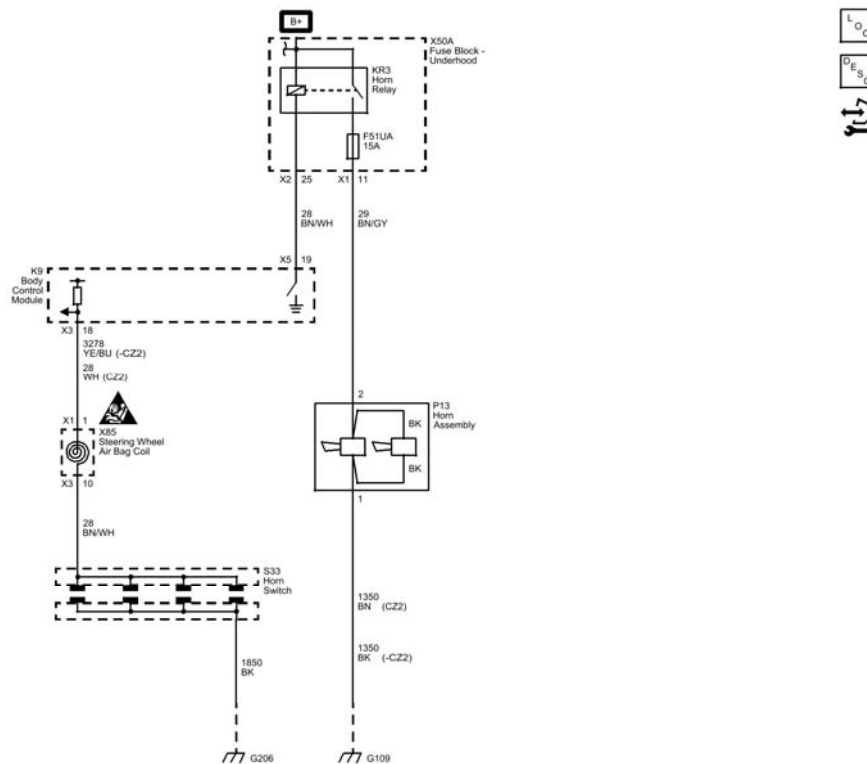


Fig. 1: Horn System
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B2750</u>	DTC B2750 01 Horn Relay Secondary Circuit Short to Battery DTC B2750 02 Horn Relay Secondary Circuit Short to Ground DTC B2750 04 Horn Relay Secondary Circuit Open

DTC B2750: HORN RELAY SECONDARY CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2750 01

Horn Relay Secondary Circuit Short to Battery

DTC B2750 02

Horn Relay Secondary Circuit Short to Ground

DTC B2750 04

Horn Relay Secondary Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	B2750 02	B2750 04	B2750 01	-

Circuit/System Description

The Body Control Module provides a ground for the Horn PCB relay within the underhood fuse block. The underhood fuse block will then provide B+ voltage to the horn control circuit, sounding the horn.

Conditions for Running the DTC

When the horn output is actively being requested by the Body Control Module

Conditions for Setting the DTC

B2750 01

The Body Control Module detects a short to voltage in the horn relay control circuit.

B2750 02

The Body Control Module detects a short to ground in the horn relay control circuit.

B2750 04

The Body Control Module detects an open/high resistance in the horn relay control circuit.

Action Taken When the DTC Sets

B2750 01, B2750 04

The horn will be inoperative.

B2750 02

The horn will sound continuously until the horn is disconnected or when the horn overheats and becomes inoperative.

Conditions for Clearing the DTC

- The DTC clears when the fault is no longer detected.
- The current DTC will become history when the request for the output is removed.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Horn Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Horns System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the P13 Horn Assembly turns On and Off when commanding the Horn Relay On and Off with a scan tool.
 - **If the P13 Horn Assembly does not turn On and Off**

Refer to Circuit/System Testing.
 - **If the P13 Horn Assembly turns On and Off**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the X50A Fuse Block-Underhood, ignition ON.
2. Verify the P13 Horn Assembly is not activated.
 - **If the P13 Horn Assembly is activated**
 1. Ignition OFF, disconnect the harness connector at the P13 Horn Assembly, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the P13 Horn Assembly.
 - **If the P13 Horn Assembly is not activated**
3. Connect a 15A fused jumper wire between the control circuit terminal 11 and B+.
4. Verify the P13 Horn Assembly activates.
 - **If the P13 Horn Assembly does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the P13 Horn Assembly, ignition ON.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, test or replace the P13 Horn Assembly.
- **If the P13 Horn Assembly activates**
- 5. Ignition OFF, connect the X1 harness connector at the X50A Fuse Block-Underhood. Disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
- 6. Verify the P13 Horn Assembly is not activated.
 - **If the P13 Horn Assembly is activated**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block-Underhood.
 2. Test for infinite resistance between the control circuit terminal 19 X5 at the K9 Body Control Module and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the X50A Fuse Block-Underhood.
 - **If the P13 Horn Assembly is not activated**
- 7. Connect a 3 A fused jumper wire between the control circuit terminal 19 and ground.
- 8. Verify the P13 Horn Assembly activates.
 - **If the P13 Horn Assembly does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the X50A Fuse Block-Underhood, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 19 X5 at the K9 Body Control Module and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the X50A Fuse Block-Underhood.
 - **If the P13 Horn Assembly activates**
- 9. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuse Block Replacement**
- **Control Module References** for Body Control Module replacement, programming and setup

SYMPTOMS - HORNS

IMPORTANT: The following steps must be completed before using the symptom tables:

1. Perform **Diagnostic System Check - Vehicle** , before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set

- The control modules can communicate via the serial data link
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Horns System Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the horn system. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Perform the following if a horn buzzes or has a harsh tone.
 - Inspect for debris in the joint where the horn fastens to the vehicle.
 - Test the torque of the horn mounting hardware. The horn mounting hardware should be tightened to a torque of 10 N.m (7 lb ft).

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure Horns Malfunction in order to diagnose the symptom.

HORNS MALFUNCTION

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Horn Switch Signal	1	2	2	-
Horn Relay Control	B2750 02	B2750 04	B2750 01	-
Horn Assembly Control	2	2	1	-
Horn Assembly Ground	-	2	-	-
Horn Switch Ground	-	2	-	-
1. Horn Always On 2. Horn Inoperative				

Circuit/System Description

The body control module monitors the horn switch signal circuit, when the horn pad is pressed, the body control module detects the drop in the horn switch signal circuit and provides a ground for the Horn printed circuit board relay within the underhood fuse block. The underhood fuse block will then provide B+ voltage to the horn control circuit, sounding the horns

Diagnostic Aids

OnStar® RemoteLink™ applications or "apps" downloads are available to owners of certain mobile devices. Unwanted or inadvertent horn activations have been associated with these applications to which the customer may be unaware. Contact the GM Technical Assistance Center regarding information on a remedy for this situation.

A short to ground in the horn relay control circuit or a short to voltage in the horn control circuit will cause the horns to sound continuously until the horns overheat and become inoperative.

Rotate the steering wheel while pressing the horn pad to identify intermittent and poor connections within the steering column.

If diagnosing a Horn- Poor Tone condition, inspect the following:

- Debris or water in the horn assembly
- Proper horn mounting hardware torque-Refer to **Fastener Tightening Specifications**.
- Debris in the joint where the horns attach to the vehicle
- Debris in direct contact with the horn
- Vehicle components vibrating while the horn is sounding

Reference Information

Schematic Reference

Horn Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Horns System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Horn Switch parameter changes between Active and Inactive when pressing and releasing the horn pad.
 - **If the parameter does not change**
Refer to Circuit/System Testing - Horn Switch Malfunction.
 - **If the parameter changes**
3. Verify the P13 Horn Assembly turns ON and OFF and emit a clear and even tone when commanding the Horn Relay On and Off with a scan tool.
 - **If the P13 Horn Assembly does not turn ON and OFF**
Refer to Circuit/System Testing - Horns or Horn Command Malfunction.
 - **If the sound emitted is not clear and even**
Refer to Circuit/System Testing - Horn - Poor Tone.
 - **If the P13 Horn Assembly turns ON and OFF and emit a even and clear tone**
4. All OK.

Circuit/System Testing

Horn Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S33 Horn Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal A and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.

4. Verify the scan tool Horn Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal B and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal B and the ground circuit terminal A.
6. Verify the scan tool Horn Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
7. Test or replace the S33 Horn Switch.

Horns or Horn Command Malfunction

1. Ignition OFF, and all vehicle systems OFF. Disconnect the harness connector at the P13 Horn Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 1 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 2 and ground, ignition ON.
4. Verify the test lamp does not turn ON and OFF when commanding the Horn Relay On and Off with a scan tool.
 - **If the test lamp turns ON and OFF**

Test or replace the P13 Horn Assembly.
 - **If the test lamp does not turn ON and OFF**

5. Ignition OFF, connect the harness connector at the P13 Horn Assembly. Disconnect the X1 harness connector at the X50A Fuse Block-Underhood, ignition ON.
6. Verify the P13 Horn Assembly is not activated.
 - **If the P13 Horn Assembly is activated**
 1. Ignition OFF, disconnect the harness connector at the P13 Horn Assembly, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the P13 Horn Assembly.
 - **If the P13 Horn Assembly is not activated**
7. Connect a 15 A fused jumper wire between the control circuit terminal 11 and B+.
8. Verify the P13 Horn Assembly activates.
 - **If the P13 Horn Assembly does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the P13 Horn Assembly, ignition ON.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the P13 Horn Assembly.
 - **If the P13 Horn Assembly activates**
9. Ignition OFF, connect the X1 harness connector at the X50A Fuse Block-Underhood. Disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
10. Verify the P13 Horn Assembly is not activated.
 - **If the P13 Horn Assembly is activated**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block-Underhood.
 2. Test for infinite resistance between the X50A Fuse Block-Underhood control circuit terminal 25 and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the X50A Fuse Block-Underhood.
 - **If the P13 Horn Assembly is not activated**
11. Connect a 3 A fused jumper wire between the control circuit terminal 19 and ground.
12. Verify the P13 Horn Assembly activates.
 - **If the P13 Horn Assembly does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the X50A Fuse Block-Underhood, ignition ON.
 2. Test for less than 1 V between the X50A Fuse Block-Underhood control circuit terminal 25 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the X50A Fuse Block-Underhood.
- **If the P13 Horn Assembly activates**
- 13. Replace the K9 Body Control Module.

Horn - Poor Tone

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the P13 Horn Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 1 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the high resistance in the circuit.
 - If less than 2 ohms, repair high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition OFF, disconnect the X1 harness connector at the X50A Fuse Block-Underhood.
4. Test for less than 2 ohms between the P13 Horn Assembly control circuit terminal 2 and the X50A Fuse Block-Underhood control circuit terminal 11 X1.
 - **If 2 ohms or greater**

Repair the high resistance in the control circuit.
 - **If less than 2 ohms**
5. Test or replace the P13 Horn Assembly.

Component Testing

Horn Test

1. Ignition OFF, disconnect the harness connector at the P13 Horn Assembly.
2. Install a 15 A fused jumper wire between the control terminal 2 and 12 V. Install a jumper wire between the ground terminal 1 and ground.
3. Verify the P13 Horn Assembly turns ON and OFF
 - **If the P13 Horn Assembly does not turn ON and OFF**

Replace the P13 Horn Assembly.
 - **If the P13 Horn Assembly turns ON and OFF**
4. All OK

Horn Switch

1. Ignition OFF, disconnect the harness connector at the S33 Horn Switch.
2. Test for infinite resistance between the signal terminal B and the ground terminal A with the switch in the open position.

- **If less than infinite resistance**

Replace the S33 Horn Switch.

- **If infinite resistance**

3. Test for less than 3 ohms between the signal terminal B and the ground terminal A with the switch in the closed position.

- **If 3 ohms or greater**

Replace the S33 Horn Switch.

- **If less than 3 ohms**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Steering Wheel Horn Switch Replacement**
- **Horn Replacement**
- **Underhood Electrical Center or Junction Block Replacement**
- **Control Module References** for body control module replacement, programming and setup

REPAIR INSTRUCTIONS

HORN REPLACEMENT

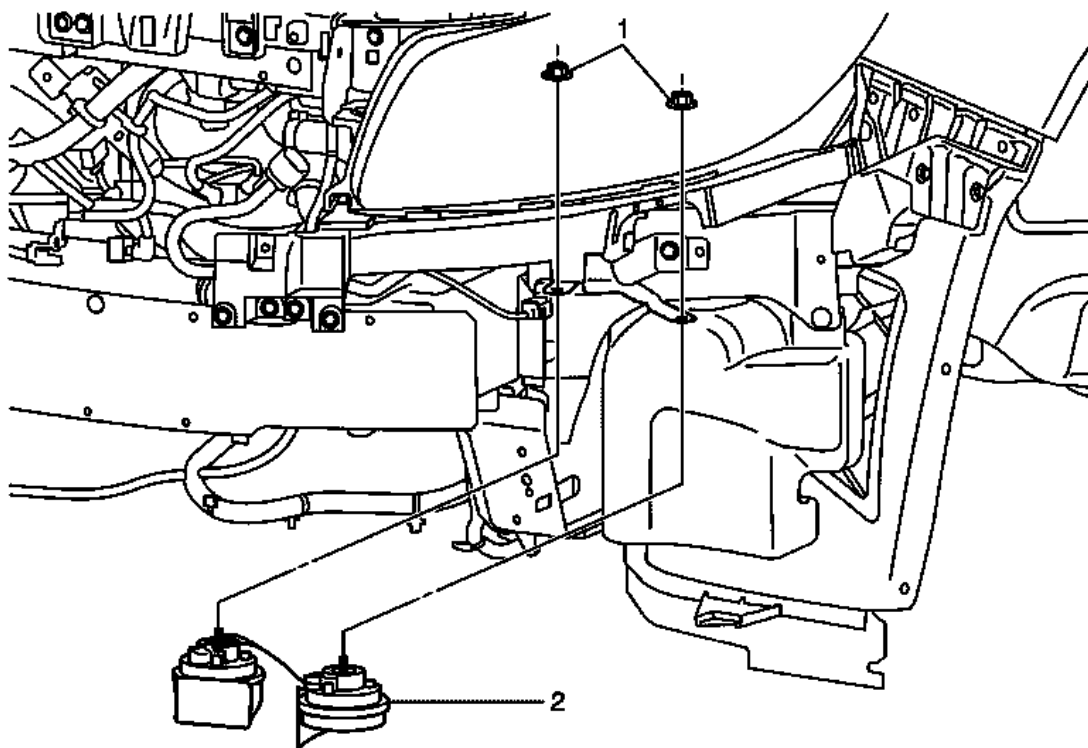


Fig. 2: Horns

Courtesy of GENERAL MOTORS COMPANY

Horn Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Horn Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 17 N.m (13 lb ft)
2	Horn Procedure Disconnect the electrical connectors.

STEERING WHEEL HORN SWITCH REPLACEMENT

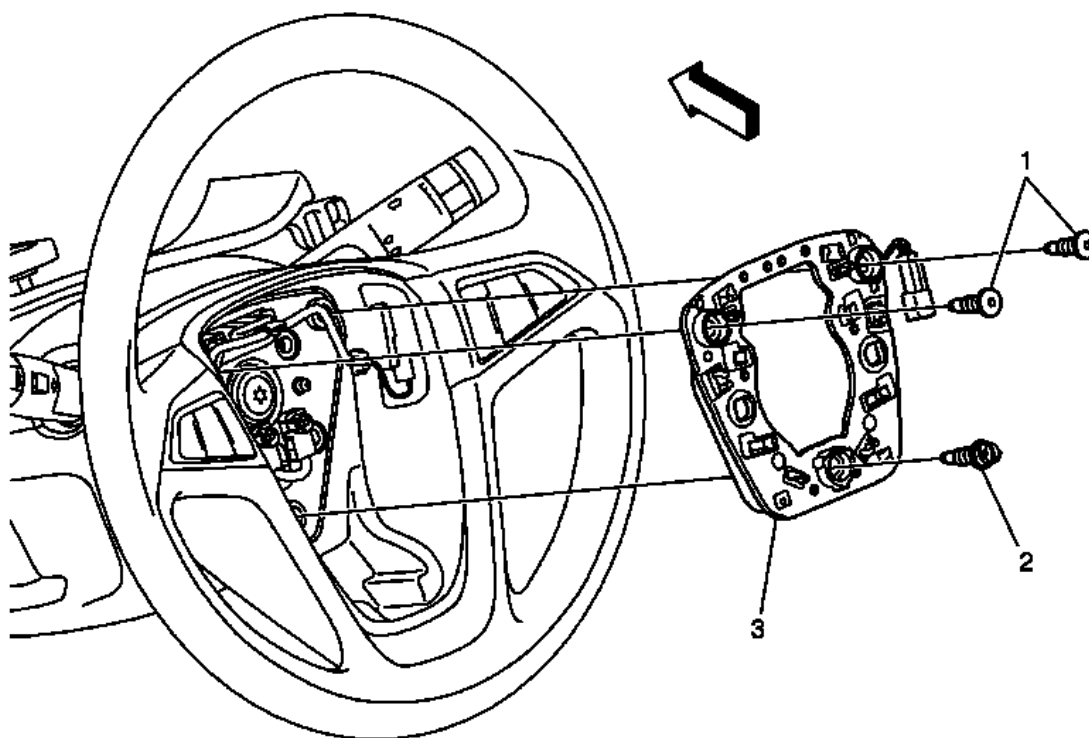


Fig. 3: Steering Wheel Horn Switch Components
 Courtesy of GENERAL MOTORS COMPANY

Steering Wheel Horn Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the inflatable restraint steering wheel module. Refer to Airbag Steering Wheel Module Replacement .	
1	Steering Wheel Horn Switch Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 10.2 N.m (89 lb in)
2	Steering Wheel Horn Switch Fastener With Spring Tighten 10.2 N.m (89 lb in)
3	Steering Wheel Horn Switch Procedure 1. Disconnect the steering wheel control switches electrical connectors.

2. Disconnect Steering Wheel Horn Switch electrical connector.

DESCRIPTION AND OPERATION

HORNS SYSTEM DESCRIPTION AND OPERATION

System Description

The horn system consists of the following components:

- HORN fuse
- Horn relay
- Horn switch
- Horn assembly
- Body control module (BCM)

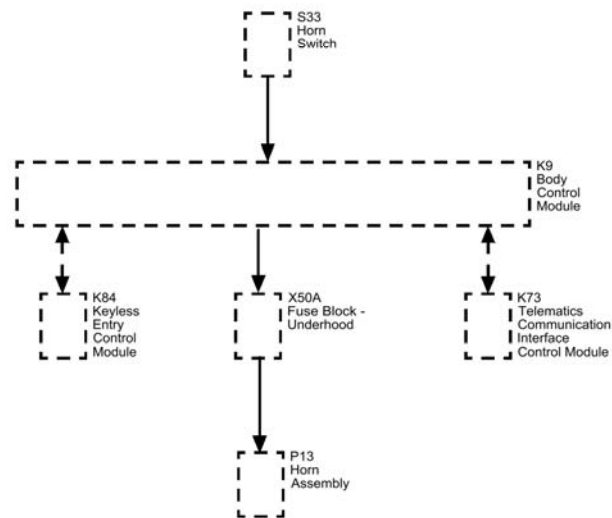


Fig. 4: Horns System Description Chart
Courtesy of GENERAL MOTORS COMPANY

System Operation

The vehicle horn system is activated under the following conditions:

- When the horn switch is depressed

- The BCM commands the horns ON under any of the following conditions:
 - When the content theft deterrent system detects a vehicle intrusion-For further information refer to **Theft Systems Description and Operation** .
 - When the panic button is depressed on the remote control door lock transmitter-For further information refer to **Keyless Entry System Description and Operation (without BTM)** , **Keyless Entry System Description and Operation (with BTM)** .
 - When the keyless entry system is used to lock the vehicle, a horn chirp may sound to notify the driver that the vehicle has been locked. The notification feature may be enabled or disabled through personalization. For further information refer to **Keyless Entry System Description and Operation (without BTM)** , **Keyless Entry System Description and Operation (with BTM)** .
 - When the OnStar® system is used to sound the horns if equipped-For further information, refer to **OnStar Description and Operation** .

Circuit Operation

Battery positive voltage is applied at all times to the horn relay coil and the horn relay switch. Pressing either of the horn switches applies ground to the horn relay control circuit. The BCM may also apply ground to the horn relay control circuit as described above. When the horn relay control circuit is grounded, the horn relay is energized and battery positive voltage is applied to the horns through the horn control circuit. The horns sound as long as ground is applied to the horn relay control circuit.

ELECTRICAL

Wiring Systems and Power Management - Wiring Schematic Diagrams - How to Use Electrical Schematics

SCHEMATIC WIRING DIAGRAMS

HOW TO USE ELECTRICAL SCHEMATICS

Information Overview

The following explains some of the key parts of the GM wiring diagrams. Included are:

- Color Abbreviations
- Electronic Delivery Navigation Features

Color Abbreviations

The following sequence is used when depicting wire colors:

1. Color modifier of the wire, such as light or dark (if applicable)
2. Primary color of the wire
3. Secondary color of the wire (tracer/stripe)

Wire insulation and connector body colors in schematic information are abbreviated with a two character code as listed below.

Abbreviation	Color	Abbreviation	Color
AM	Amber	OG	Orange
BARE	Bare	PK	Pink
BG	Beige	PU	Purple
BK	Black	RD	Red
BN	Brown	RU	Rust
BU	Blue	SR	Silver
CL	Clear	TL	Teal
CR	Cream	TN	Tan
CU	Curry	TQ	Turquoise
GD	Gold	VT	Violet
GN	Green	WH	White
GY	Gray	YE	Yellow
NA	Natural	-	-
Color Modifiers			
L	Light	D	Dark

Additionally, industry standard cable types are not identified by color, but are listed by cable type as follows:

Abbreviation	Cable Type
COAX	Coax Cable
FW	Flat Wire
HDMI	High Definition Multimedia Interface
TWINAX	Twinax Cable
USB	Universal Serial Bus

HVAC

HVAC - Automatic

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Air Inlet Valve Actuator Screw	1.5 N.m	13 lb in
Auxiliary Heater and Blower and Air Conditioning Control Module Screws	1.5 N.m	13 lb in
Heater and Blower and Air-conditioning Control Module Screw	1.5 N.m	13 lb in
Inside Air Valve Actuator Screw	1.5 N.m	13 lb in
Mode Control Cam Actuator Screw	1.5 N.m	13 lb in
Temperature Valve Actuator Screw	1.5 N.m	13 lb in

SCHEMATIC WIRING DIAGRAMS

HVAC WIRING SCHEMATICS

Power, Ground, Serial Data, HVAC and Blower Controls

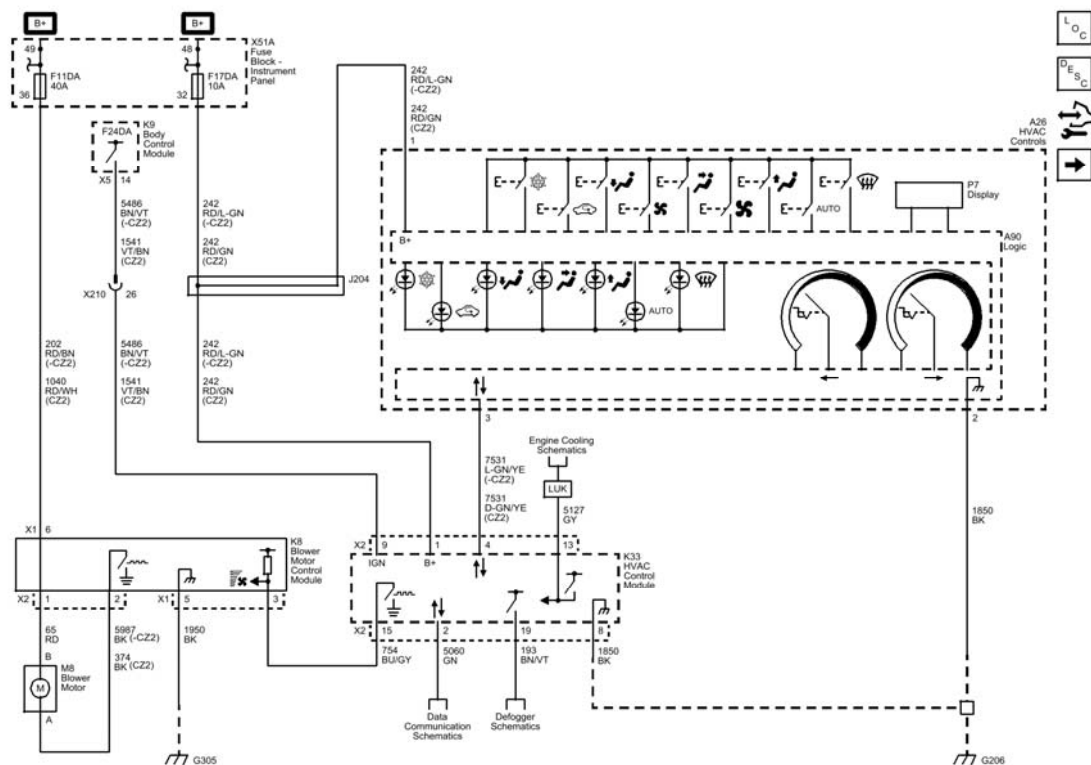


Fig. 1: Power, Ground, Serial Data, HVAC and Blower Controls
Courtesy of GENERAL MOTORS COMPANY

Temperature Sensors and Compressor Controls (-CZ2)

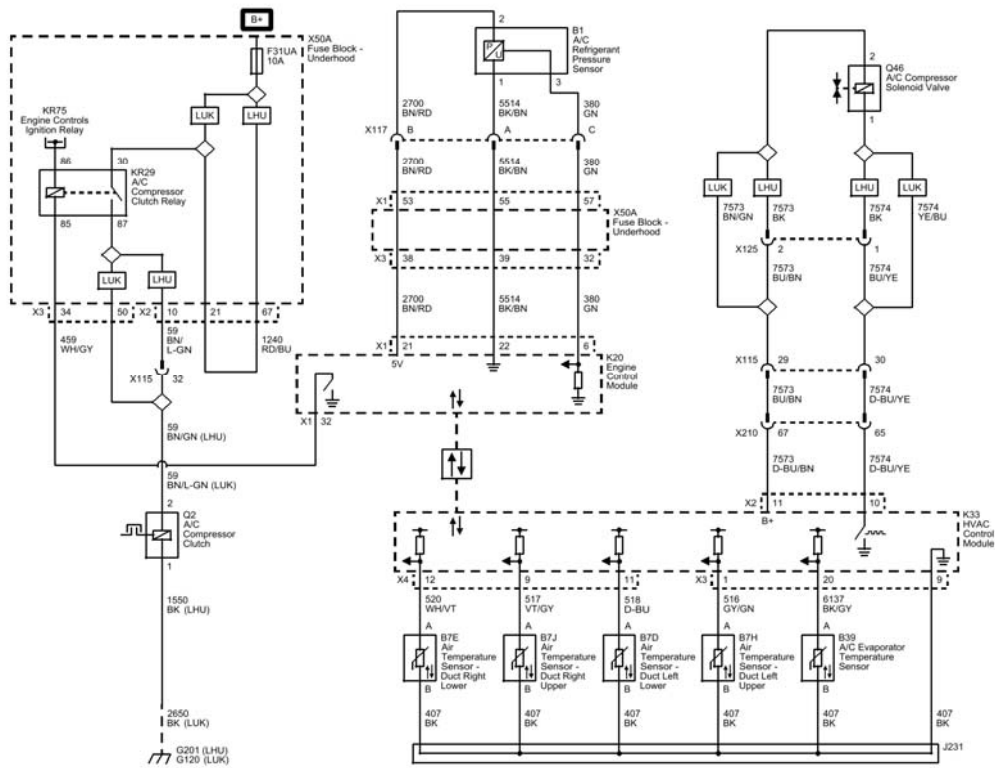


Fig. 2: Temperature Sensors and Compressor Controls (-CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Ambient Light/Sunload and Windshield Sensors (-CZ2)

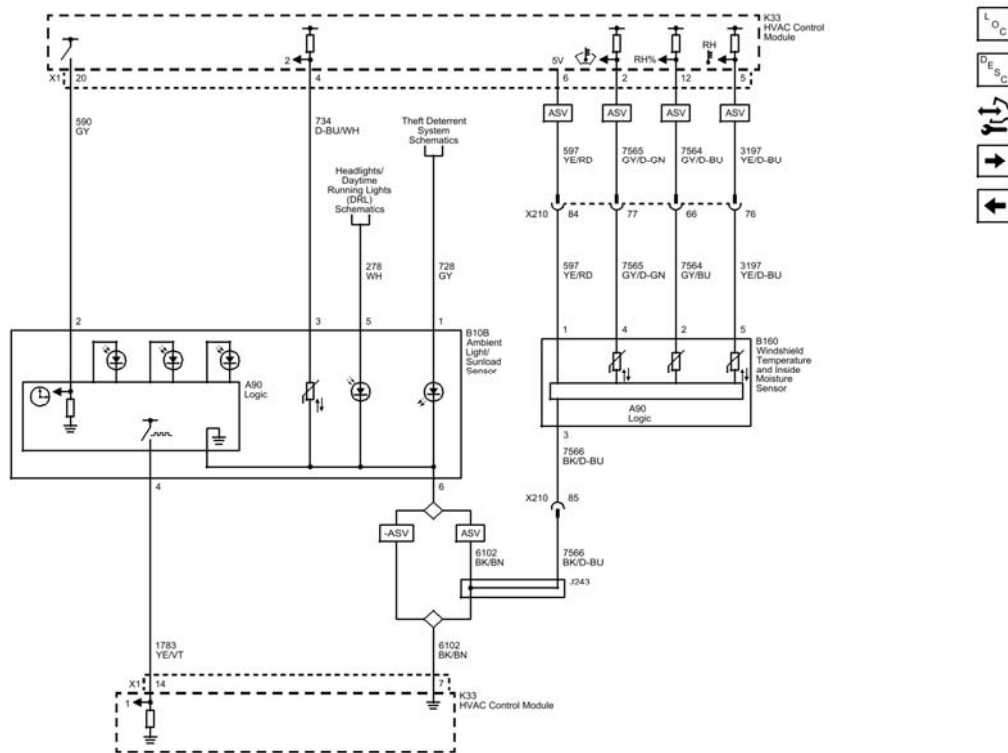


Fig. 3: Ambient Light/Sunload and Windshield Sensors (-CZ2)
Courtesy of GENERAL MOTORS COMPANY

Air Delivery and Temperature Control (-CZ2)

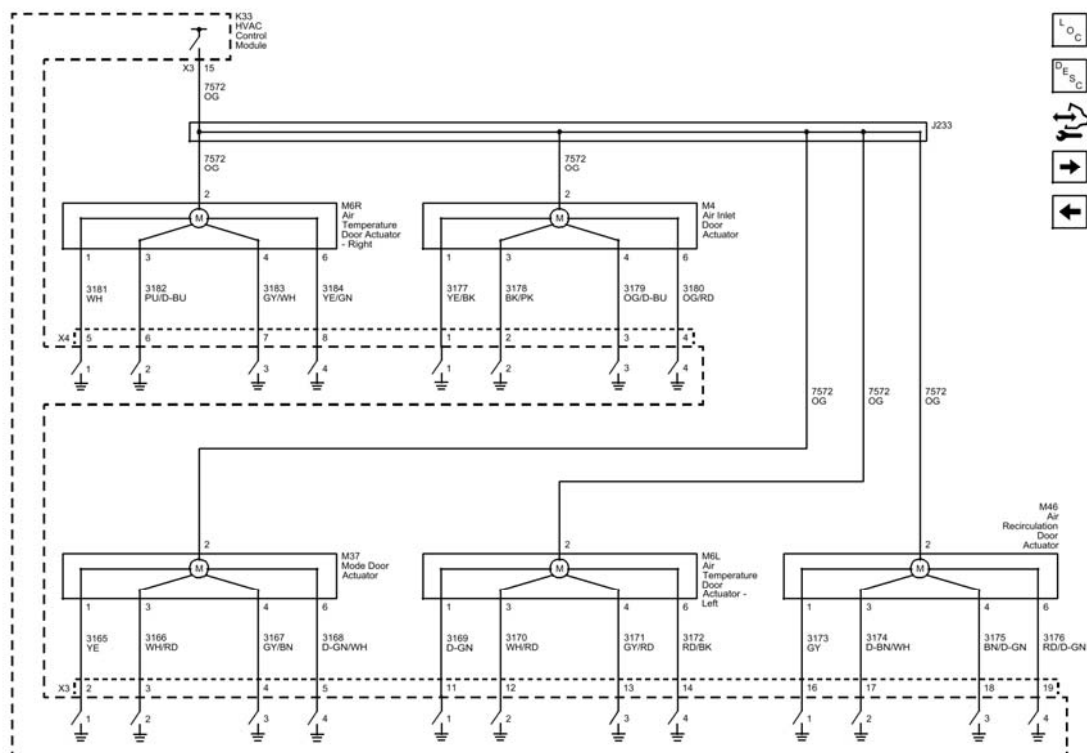


Fig. 4: Air Delivery and Temperature Control (-CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Sensors (CZ2)

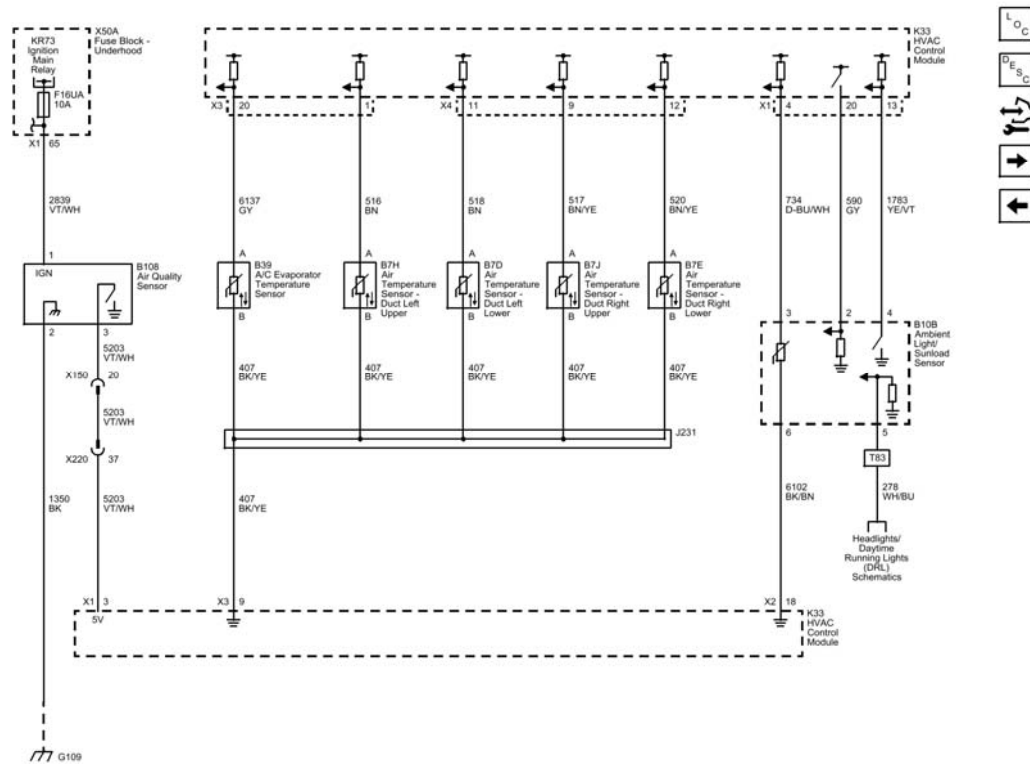


Fig. 5: Sensors (CZ2)

Courtesy of GENERAL MOTORS COMPANY

A/C Compressor Control (CZ2)

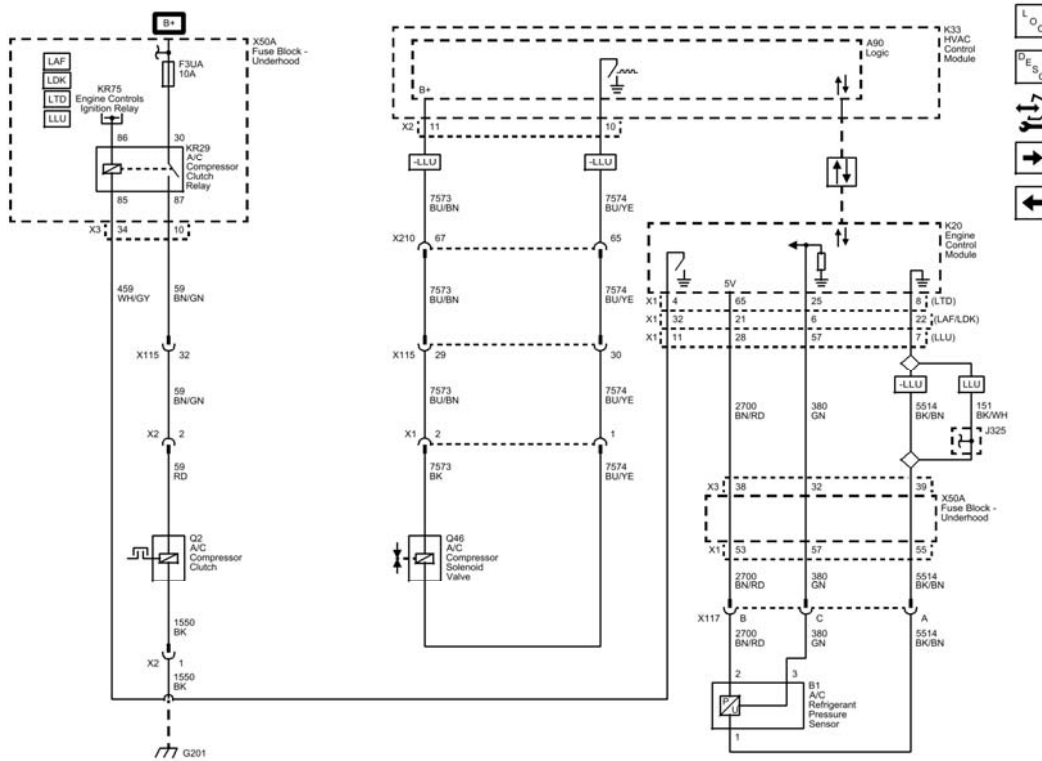


Fig. 6: A/C Compressor Control (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Air Delivery and Temperature Controls (CZ2)

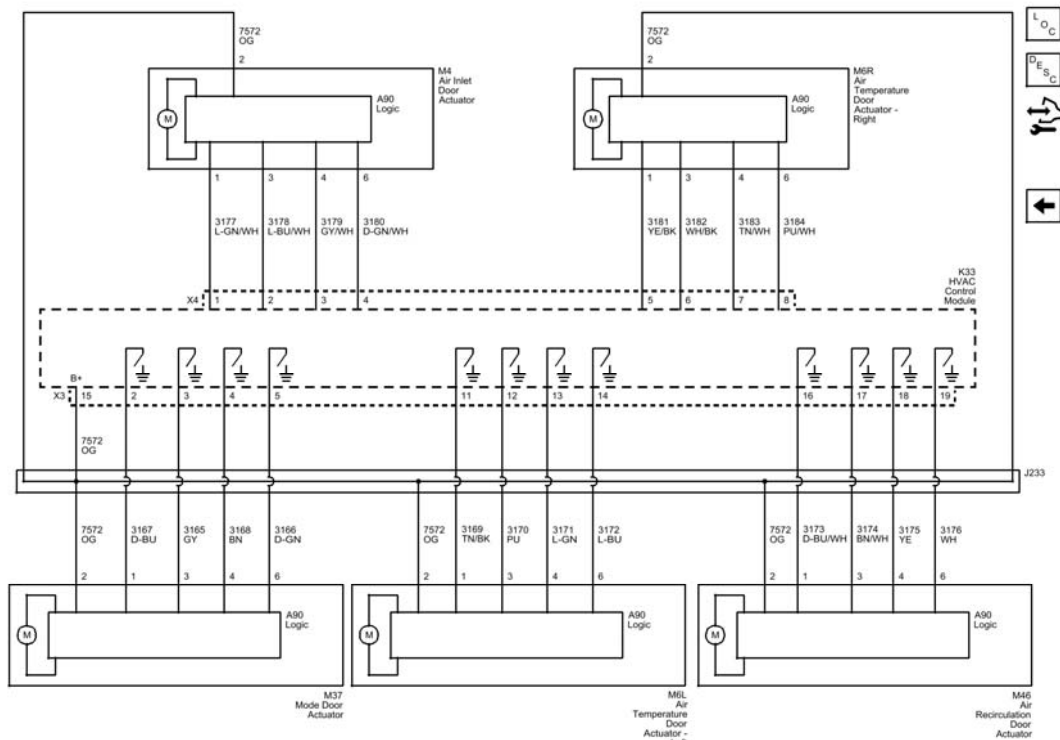


Fig. 7: Air Delivery and Temperature Controls (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

HVAC COMPONENT REPLACEMENT REFERENCE

HVAC Component Replacement Reference

Scan Tool Name	Component Code / Schematic Name	Service Name	Repair Instruction Name
Air Inlet Door	M4 Air Inlet Door Actuator	Air Inlet Door Actuator	<u>Inside Air Valve Actuator Replacement</u>
Air Recirculation Door	M46 Air Recirculation Door Actuator	Air Recirculation Door Actuator	<u>Air Inlet Valve Actuator Replacement (Left Hand Drive and CJ2)</u>
Right Temperature Door	M6R Air Temperature Door Actuator - Right	Right Air Temperature Door Actuator	<u>Temperature Valve Actuator Replacement - Right Side</u>
Left Temperature Door	M6L Air Temperature Door Actuator - Left	Left Air Temperature Door Actuator	<u>Temperature Valve Actuator Replacement - Left Side (Left Hand Drive)</u>

Mode Door	M37 Mode Door Actuator	Mode Door Actuator	<u>Mode Control Cam Actuator Replacement (Left Hand Drive)</u>
Upper Left Duct Air Temperature Sensor	B7H Air Temperature Sensor - Duct Left Upper	Duct Air Temperature Sensor- Upper Left	<u>Duct Air Temperature Sensor Replacement - Upper Left Side (Left Hand Drive)</u>
Lower Left Duct Air Temperature Sensor	B7D Air Temperature Sensor - Duct Left Lower	Duct Air Temperature Sensor- Lower Left	<u>Duct Air Temperature Sensor Replacement - Lower Left Side (Left Hand Drive)</u>
Upper Right Duct Air Temperature Sensor	B7J Air Temperature Sensor - Duct Right Upper	Duct Air Temperature Sensor- Upper Right	<u>Duct Air Temperature Sensor Replacement - Upper Right Side</u>
Lower Right Duct Air Temperature Sensor	B7E Air Temperature Sensor - Duct Right Lower	Duct Air Temperature Sensor- Lower Right	<u>Duct Air Temperature Sensor Replacement - Lower Right Side (Left Hand Drive with CJ2)</u>
A/C Evaporator Temperature Sensor	B39 A/C Evaporator Temperature Sensor	Evaporator Temperature Sensor	<u>Air Conditioning Refrigerant Temperature Sensor Replacement</u>
Passenger Compartment Air Temperature Sensor and Sunload Sensor	B10B Ambient Light/Sunload Sensor	Inside Air Temperature, Ambient Light and Sun Load sensor	<u>Sun Load Temperature and Headlamp Automatic Control Ambient Light Sensor Replacement</u>
Windshield Temperature and Inside Moisture Sensor	B160 Windshield Temperature and Inside Moisture Sensor	Windshield Temperature and Inside Moisture Sensor	<u>Inside Air Moisture and Windshield Temperature Sensor Replacement (ASV), Inside Air Moisture and Windshield Temperature Sensor Replacement (ASV UFL)</u>
Blower Motor Control Module	K8 Blower Motor Control Module	Blower Motor Control Module	<u>Heater and Blower and Air Conditioning Control Module Replacement</u>
A/C High Side Pressure Sensor	B1 A/C Refrigerant Pressure Sensor	A/C Refrigerant Pressure Sensor	<u>Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement</u>
A/C Compressor Clutch	Q2 A/C Compressor Clutch	A/C Compressor Clutch	<u>Air Conditioning Compressor Replacement (LUK) ,</u>

			<u>Air Conditioning Compressor Replacement (LTG) , Air Conditioning Compressor Replacement (LEA)</u>
A/C Compressor Solenoid Valve	Q46 A/C Compressor Solenoid Valve	A/C Compressor Solenoid Valve	<u>Air Conditioning Compressor Replacement (LUK) , Air Conditioning Compressor Replacement (LTG) , Air Conditioning Compressor Replacement (LEA)</u>
Heater Coolant Pump	G17 Heater Coolant Pump	Heater Coolant Pump	-
HVAC Controls	A26 HVAC Controls	HVAC Controls	<u>Heater and Air Conditioning Control Replacement</u>
Remote Heater and Air Conditioning Control Module	K33 HVAC Control Module	HVAC Control Module	<u>Heater and Air Conditioning Remote Control Replacement</u>

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B0163</u>	DTC B0163 02 Passenger Compartment Temperature Sensor Circuit Short to Ground DTC B0163 05 Passenger Compartment Temperature Sensor Circuit High Voltage/Open
<u>DTC B0173, B0178, B0509, B0514 or B3933</u>	DTC B0173 02 Upper Left Duct Air Temperature Sensor Circuit Short to Ground DTC B0173 05 Upper Left Duct Air Temperature Sensor Circuit High Voltage/Open DTC B0178 02 Lower Left Duct Air Temperature Sensor Circuit Short to Ground DTC B0178 05 Lower Left Duct Air Temperature Sensor Circuit High Voltage/Open DTC B0509 02 Upper Right Duct Air Temperature Sensor Circuit Short to Ground DTC B0509 05 Upper Right Duct Air Temperature Sensor Circuit High Voltage/Open DTC B0514 02 Lower Right Duct Air Temperature Sensor Circuit Short to Ground

	DTC B0514 05 Lower Right Duct Air Temperature Sensor Circuit High Voltage/Open DTC B3933 02 Air Conditioning Evaporator Temperature Sensor Circuit Short to Ground DTC B3933 05 Air Conditioning Evaporator Temperature Sensor Circuit High Voltage/Open
<u>DTC B0183</u>	DTC B0183 02 Solar Load Sensor Circuit Short to Ground DTC B0183 05 Solar Load Sensor Circuit High Voltage/Open
<u>DTC B0193</u>	DTC B0193 01 Front Blower Motor Speed Circuit Short to Battery DTC B0193 06 Front Blower Motor Speed Circuit Low Voltage/Open
<u>DTC B0223, B022A, B0233, B023A, B0408, or B0418</u>	DTC B0223 01 Recirculate Position Command 1 Circuit Short to Battery DTC B0223 06 Recirculate Position Command 1 Circuit Low Voltage/Open DTC B022A 01 Recirculate Position Command 2 Circuit Short to Battery DTC B022A 06 Recirculate Position Command 2 Circuit Low Voltage/Open DTC B0233 01 Air Flow Control Circuit Short to Battery DTC B0233 06 Air Flow Control Circuit Low Voltage/Open DTC B023A 02 HVAC Actuators Supply Voltage Short to Ground DTC B0408 01 Main Temperature Control Circuit Short to Battery DTC B0408 06 Main Temperature Control Circuit Low Voltage/Open DTC B0418 01 Right Temperature Control Circuit Short to Battery DTC B0418 06 Right Temperature Control Circuit Low Voltage/Open
<u>DTC B269A, B269C, or B269D</u>	DTC B269A Heater Coolant Pump Control Circuit Open DTC B269C Heater Coolant Pump Control Circuit Low DTC B269D Heater Coolant Pump Control Circuit High
<u>DTC B393B</u>	DTC B393B 04 Air Conditioning Compressor Valve Control Circuit Open DTC B393B 0B Air Conditioning Compressor Valve Control Circuit High Current
<u>DTC P0532 or P0533</u>	DTC P0532 Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit Low Voltage DTC P0533 Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit High Voltage
<u>DTC P0645, P0646, or P0647</u>	DTC P0645 Air Conditioning (A/C) Compressor Clutch Relay Control Circuit DTC P0646 Air Conditioning (A/C) Compressor Clutch Relay Control Circuit Low Voltage DTC P0647 Air Conditioning (A/C) Compressor Clutch Relay Control Circuit High Voltage

DTC B0163: PASSENGER COMPARTMENT TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0163 02

Passenger Compartment Temperature Sensor Circuit Short to Ground

DTC B0163 05

Passenger Compartment Temperature Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B0163 02	B0163 05	B0163 05	1
Low Reference	-	B0163 05, B0183 05	-	-
1. HVAC Malfunction				

Circuit/System Description

The ambient light/sunload sensor integrates the sunload sensor and passenger compartment temperature sensor.

The solar sensor is connected to ground and to a 5 V voltage supply from the HVAC control module. As the sunload increases, the sensor signal voltage also increases. The signal varies between 1.4-4.5 V and is provided to the HVAC control module.

The passenger compartment temperature sensor is a negative temperature coefficient thermistor. A signal and low reference circuit enables the sensor to operate. As the air temperature increases, the sensor resistance decreases. The sensor signal varies between 0-5 V.

Bright or high intensity light causes the vehicles interior temperature to increase. The HVAC system compensates for the increased temperature by diverting additional cool air into the vehicle.

Conditions for Running the DTC

- Ignition ON
- The HVAC control module is ON.

Conditions for Setting the DTC

The HVAC control module detects the sensor signal out of range. The signal voltage is less than 0.1 V or greater than 4.9 V for more than 50 ms.

Action Taken When the DTC Sets

The system operates using a default value.

Conditions for Clearing the DTC

The sensor signal is within specified range between 0.1-4.9 V.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic HVAC Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B10B Ambient Light/Sunload Sensor. It may take up to 10 min for all vehicle systems to power down.

NOTE: **The scan tool must be disconnected from the vehicle before performing the next test.**

2. Test for less than 10 ohms between the low reference circuit terminal 6 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Passenger Compartment Air Temperature (Unfiltered) parameter is less than -37°C (-

35°F).

- **If -37°C (-35°F) or greater**

1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K33 HVAC Control Module.

- **If less than -37°C (-35°F)**

5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the low reference circuit terminal 6.
6. Verify the scan tool parameter Passenger Compartment Air Temperature (Unfiltered) parameter is greater than 113°C (235°F).
 - **If 113°C (235°F) or less**
 1. Ignition OFF, remove the jumper wire and disconnect the harness connector at the K33 HVAC Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If greater than 113°C (235°F)**
7. Test or replace the B10B Ambient Light/Sunload Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

DTC B0173, B0178, B0509, B0514 OR B3933: DUCT AIR TEMPERATURE SENSOR/EVAPORATOR TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0173 02

Upper Left Duct Air Temperature Sensor Circuit Short to Ground

DTC B0173 05

Upper Left Duct Air Temperature Sensor Circuit High Voltage/Open

DTC B0178 02

Lower Left Duct Air Temperature Sensor Circuit Short to Ground

DTC B0178 05

Lower Left Duct Air Temperature Sensor Circuit High Voltage/Open

DTC B0509 02

Upper Right Duct Air Temperature Sensor Circuit Short to Ground

DTC B0509 05

Upper Right Duct Air Temperature Sensor Circuit High Voltage/Open

DTC B0514 02

Lower Right Duct Air Temperature Sensor Circuit Short to Ground

DTC B0514 05

Lower Right Duct Air Temperature Sensor Circuit High Voltage/Open

DTC B3933 02

Air Conditioning Evaporator Temperature Sensor Circuit Short to Ground

DTC B3933 05

Air Conditioning Evaporator Temperature Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Upper Left Duct Air Temperature Sensor Signal	B0173 02	B0173 05	B0173 05	-
Lower Left Duct Air				

Temperature Sensor Signal	B0178 02	B0178 05	B0178 05	-
Upper Right Duct Air Temperature Sensor Signal	B0509 02	B0509 05	B0509 05	-
Lower Right Duct Air Temperature Sensor Signal	B0514 02	B0514 05	B0514 05	-
Air Conditioning Evaporator Temperature Sensor Signal	B3933 02	B3933 05	B3933 05	-
Low Reference	-	B0173 05, B0178 05, B0509 05, B0514 05, B3933 05	B0173 05, B0178 05, B0509 05, B0514 05, B3933 05	-

Circuit/System Description

The air temperature sensors are a 2-wire negative temperature coefficient thermistor. The vehicle uses the following air temperature sensors:

- Air temperature sensor - left upper
- Air temperature sensor - left lower
- Air temperature sensor - right upper
- Air temperature sensor - right lower
- A/C evaporator temperature sensor

This sensor operates using signal and low reference circuits. As the air temperature surrounding the sensor increases, the sensor resistance decreases. The sensor is capable of reading temperatures ranging from -40 to +115°C (-40 to +240°F), with a signal voltage between 0-5 V. If the HVAC control module detects a malfunctioning sensor the software uses a default air temperature value. The default action ensures that the HVAC system can adjust the inside air temperature near the desired temperature until the condition is corrected.

Conditions for Running the DTC

- Ignition ON.
- The HVAC control module is ON.

Conditions for Setting the DTC

The HVAC control module detects the sensor signal out of range. The signal voltage is less than 0.1 V or greater than 4.9 V for more than 50 ms.

Action Taken When the DTC Sets

The system operates using a default value.

Conditions for Clearing the DTC

The sensor signal is within specified range between 0.1-4.9 V.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic HVAC Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the appropriate temperature sensor has a parameter displayed in HVAC scan tool information.
 - **If there is no scan tool parameter**

Refer to Circuit/System Testing - Without Scan Tool Support.

- **If there is a scan tool parameter**
3. Refer to Circuit/System Testing - With Scan Tool Support

Circuit/System Testing

With Scan Tool Support

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate temperature sensor. It may take up to 10 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal B and ground.

- **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the appropriate scan tool temperature sensor parameter is less than -37°C (-35°F)
 - **If greater than -37°C (-35°F)**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for infinite resistance between the signal circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K33 HVAC Control Module.
 - **If -37°C (-35°F) or less**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B.
- 6. Verify the scan tool temperature sensor parameter is greater than 110°C (230°F).
 - **If less than 110°C (230°F)**
 1. Ignition OFF, remove the jumper wire and disconnect the harness connector at the K33 HVAC Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Ignition OFF
 - 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If 110°C (230°F) or greater**
- 7. Test or replace the temperature sensor.

Without Scan Tool Support

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate temperature sensor. It may take up to 10 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal B and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K33 HVAC Control Module.
- **If less than 10 ohms**
- 3. Test for 4.8-5.2 V between the signal circuit terminal A and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K33 HVAC Control Module.
 - **If between 4.8-5.2 V**
- 4. Test or replace the temperature sensor.
- 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
- 6. Verify the DTC does not set.
 - **If the DTC sets**

Replace the K33 HVAC Control Module.
 - **If the DTC does not set**
- 7. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

DTC B0183: SOLAR LOAD SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0183 02

Solar Load Sensor Circuit Short to Ground

DTC B0183 05

Solar Load Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B0183 05	B0183 02	B0183 02	-
Low Reference	-	B0163 05, B0183 05	-	-

Circuit/System Description

The ambient light/sunload sensor integrates the sunload sensor and passenger compartment temperature sensor.

The solar sensor is connected to ground and to a 5 V reference voltage through the HVAC control module. As the sunload increases, the sensor signal voltage also increases. The signal varies between 1.4-4.5 V and is provided to the HVAC control module.

The passenger compartment temperature sensor is a negative temperature coefficient thermistor. A signal and low reference circuit enables the sensor to operate. As the air temperature increases, the sensor resistance decreases. The sensor signal varies between 0-5 V.

Bright or high intensity light causes the vehicles interior temperature to increase. The HVAC system compensates for the increased temperature by diverting additional cool air into the vehicle.

Conditions for Running the DTC

- Ignition ON
- The HVAC Control Module is ON.

Conditions for Setting the DTC

B0183 02

The input signal is out of range. The voltage is less than 0.1 V.

B0183 05

The input signal is out of range. The voltage is greater than 4.9 V.

Action Taken When the DTC Sets

- The system will use the last valid values as default.
- If no value is read at the time of fault, the HVAC control module uses 0 W/m² as intensity.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic HVAC Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B10B Ambient Light/Sunload Sensor. It may take up to 10 min for all vehicle systems to power down.

NOTE: **The scan tool must be disconnected from the vehicle before performing the next test.**

2. Test for less than 10 ohms between the low reference circuit terminal 6 and ground.
 - **If 10 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the signal circuit terminal 4 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K33 HVAC Control Module.
 - **If between 4.8-5.2 V**
 - 5. Test or replace the B10B Ambient Light/Sunload Sensor.
 - 6. Verify DTC B0183 does not set or the symptom does not occur while operating the vehicle within the Conditions for Running the DTC.
 - **If DTC B0183 does set.**

Replace the K33 HVAC Control Module.
 - **If DTC B0183 does not reset**
 - 7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

DTC B0193: FRONT BLOWER MOTOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0193 01

Front Blower Motor Speed Circuit Short to Battery

DTC B0193 06

Front Blower Motor Speed Circuit Low Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B0193 06	B0193 06	-	-
Control	B0193 06	B0193 06	B0193 01	-
Ground	-	B0193 06	-	-

Circuit/System Description

The blower motor control module is an interface between the HVAC control module and the blower motor. The blower motor control module has 4 circuits: a B+ input, a signal input from the HVAC module, a B+ output to the blower motor, and a low side pulse width modulation (PWM) output. The HVAC control module provides a low side (PWM) signal to the blower motor control module in order to request the blower motor speed. The blower motor control module grounds the blower motor using a low side PWM signal in order to vary the blower motor speed.

Conditions for Running the DTC

- Ignition ON.
- The HVAC control module is ON.

Conditions for Setting the DTC

B0193 01

The voltage at the HVAC control module output to the blower motor control module is always high.

B0193 06

The voltage at the HVAC control module output to the blower motor control module is always low or fluctuating.

Action Taken When the DTC Sets

The blower motor is inoperative.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Diagnostic Aids

Inspect the motor shaft for rust or other foreign material which may prohibit proper motor operation.

If the motor operates properly please reinstall it and check for Preliminary Information or Technical Service Bulletins.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the K8 Blower Motor Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 6 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Disconnect the X2 harness connector at the K8 Blower Motor Control Module and disconnect the harness connector at the M8 Blower Motor.
 4. Test for infinite resistance between the M8 Blower Motor B+ circuit terminal B and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the M8 Blower Motor.
 - **If the test lamp illuminates**
5. Remove the test lamp.
6. Verify the resistance between the control circuit terminal 3 and ground varies from 500 ohms to 230K ohms while changing blower speeds.
 - **If the resistance does not change from 500 ohms to 230K ohms**
 1. Ignition OFF, disconnect the X2 harness connector at the K33 HVAC Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms replace the K33 HVAC Control Module.

- **If the resistance does change from 500 ohms to 230K ohms**
- 7. Ignition OFF, connect the X1 harness connector at the K8 Blower Motor Control Module and disconnect the harness connector at the M8 Blower Motor, ignition ON and blower ON.
- 8. Verify a test lamp illuminates between the B+ terminal B and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the K8 Blower Motor Control Module.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms replace the K8 Blower Motor Control Module.
 - **If the test lamp illuminates**
- 9. Connect a test lamp between the B+ circuit terminal B and control circuit terminal A, ignition ON.

NOTE: **Once the highest fan speed is reached the test lamp may not decrease intensity with a commanded decrease in fan speed, and in order to perform the test again you must first move the fan speed command back to low then OFF.**

10. Verify the test lamp becomes progressively brighter as the blower speed is increased and progressively dimmer as the blower speed is decreased.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp and disconnect the X2 harness connector at the K8 Blower Motor Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms replace the K8 Blower Motor Control Module.
 - **If the test lamp illuminates, but does not change in brightness**
 1. Ignition OFF, remove the test lamp and disconnect the X2 harness connector at the K8 Blower Motor Control Module.
 2. Test for infinite resistance between the control circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K8 Blower Motor Control Module.
 - **If the test lamp changes in brightness as the blower speed is changed**
11. Test or replace the M8 Blower Motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

DTC B0223, B022A, B0233, B023A, B0408, OR B0418: RECIRCULATE POSITION/AIR FLOW CONTROL/HVAC ACTUATORS/TEMPERATURE CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B0223 01

Recirculate Position Command 1 Circuit Short to Battery

DTC B0223 06

Recirculate Position Command 1 Circuit Low Voltage/Open

DTC B022A 01

Recirculate Position Command 2 Circuit Short to Battery

DTC B022A 06

Recirculate Position Command 2 Circuit Low Voltage/Open

DTC B0233 01

Air Flow Control Circuit Short to Battery

DTC B0233 06

Air Flow Control Circuit Low Voltage/Open

DTC B023A 02

HVAC Actuators Supply Voltage Short to Ground

DTC B0408 01

Main Temperature Control Circuit Short to Battery

DTC B0408 06

Main Temperature Control Circuit Low Voltage/Open

DTC B0418 01

Right Temperature Control Circuit Short to Battery

DTC B0418 06

Right Temperature Control Circuit Low Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Stepper Motors 12 V Reference	B022A 06, B023A 02, B0223 06, B0233 06, B0408 06, B0418 06	B022A 06, B0223 06, B0233 06, B0408 06, B0418 06	-	-
Air Inlet Actuator Control 1	B022A 06	B022A 06	B022A 01	1
Air Inlet Actuator Control 2	B022A 06	B022A 06	B022A 01	1
Air Inlet Actuator Control 3	B022A 06	B022A 06	B022A 01	1
Air Inlet Actuator Control 4	B022A 06	B022A 06	B022A 01	1
Recirculation Actuator Control 1	B0223 06	B0223 06	B0223 01	1
Recirculation Actuator Control 2	B0223 06	B0223 06	B0223 01	1
Recirculation Actuator Control 3	B0223 06	B0223 06	B0223 01	1
Recirculation Actuator Control 4	B0223 06	B0223 06	B0223 01	1
Air Temperature Actuator Control 1	B0408 06	B0408 06	B0408 01	1
Air Temperature Actuator Control 2	B0408 06	B0408 06	B0408 01	1
Air Temperature Actuator Control 3	B0408 06	B0408 06	B0408 01	1
Air Temperature Actuator Control 4	B0408 06	B0408 06	B0408 01	1
Passenger Air Temperature Actuator Control 1	B0418 06	B0418 06	B0418 01	1
Passenger Air Temperature Actuator Control 2	B0418 06	B0418 06	B0418 01	1
Passenger Air Temperature Actuator Control 3	B0418 06	B0418 06	B0418 01	1
Passenger Air Temperature Actuator Control 4	B0418 06	B0418 06	B0418 01	1
Mode Actuator Control 1	B0233 06	B0233 06	B0233 01	1
Mode Actuator Control 2	B0233 06	B0233 06	B0233 01	1

Mode Actuator Control 3	B0233 06	B0233 06	B0233 01	1
Mode Actuator Control 4	B0233 06	B0233 06	B0233 01	1
1. HVAC Malfunction				

Circuit/System Description

Stepper motors are used for temperature regulation, air distribution control and recirculation door control.

With the switches and dials on the HVAC controls, air temperature door position, mode door position and recirculation door position can be selected. The selected values are passed to the HVAC control module via serial data. The HVAC control module supplies a 12 V control voltage to the stepper motors and energizes the 4 stepper motor coils with a pulsed ground signal. The stepper motors move the appropriate doors into the calculated positions, in order to reach the desired positions.

Conditions for Running the DTC

- Ignition ON.
- The HVAC control module is ON.

Conditions for Setting the DTC

B023A 02

The stepper motors supply output is shorted to ground.

B0223 01, B022A 01, B0233 01, B023A 01, B0408 01 or B0418 01

At least one control circuits of the appropriate stepper motor is shorted to voltage when motor starts moving. Faults are not detected when motor is already running or target position is already reached.

B0223 06, B022A 06, B0233 06, B0233 06, B0408 06 or B0418 06

At least one control circuits of the appropriate stepper motor is shorted to ground or open when motor starts moving. Faults are not detected when motor is already running or target position is already reached.

Action Taken When the DTC Sets

B023A

- The affected output will be switched off for hardware protection.
- All stepper motors are deactivated.

B0223, B022A, B0233, B0408 or B0418,

- The affected output will be switched off for hardware protection.
- The affected stepper motor is deactivated.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Perform the Actuator Recalibration procedure.
2. Verify the concern or DTC has been corrected.
 - **If the concern or DTC has not been corrected**
 1. Verify DTC B023A is not set.
 - If DTC B023A is set

Refer to Circuit/System Testing - DTC B023A.
 - If DTC B023A is not set

Refer to Circuit/System Testing - DTC B0223, B022A, B0233, B0408 or B0418.
 - **If the concern or DTC has been corrected**
3. All OK.

Circuit/System Testing

DTC B023A

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the components listed below. It may take up to 2 min for all vehicle systems to power down.
 - M4 Air Inlet Door Actuator
 - M37 Mode Door Actuator
 - M46 Air Recirculation Door Actuator
 - M6L Air Temperature Door Actuator - Left
 - M6R Air Temperature Door Actuator - Right
2. Disconnect the X3 and X4 harness connectors at the K33 HVAC Control Module.
3. Test for infinite resistance between the K33 HVAC Control Module 12 V reference circuit terminal 15 X3 and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
4. Ignition ON.
5. Test for less than 1 V between the K33 HVAC Control Module 12 V reference circuit terminal 15 X3 and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.
 - **If less than 1 V**
6. Connect the X3 and X4 harness connectors at the K33 HVAC Control Module, ignition ON.
7. Clear all DTCs.
8. Verify DTC B023A is not set.
 - **If the DTC is set.**

Replace the K33 HVAC Control Module.
 - **If the DTC is not set.**
9. Verify DTC B023A does not set after connecting each of the components listed below one at a time and operating them through their full range.
 - M4 Air Inlet Door Actuator
 - M37 Mode Door Actuator
 - M46 Air Recirculation Door Actuator
 - M6L Air Temperature Door Actuator - Left
 - M6R Air Temperature Door Actuator - Right

- **If the DTC sets**

Replace the component that was connected immediately before the DTC set.

- **If the DTC does not set**

10. All OK.

DTC B0223, B022A, B0233, B0408 or B0418

1. Ignition OFF, disconnect the harness connector at the appropriate door actuator, ignition ON.
2. Verify a test lamp flashes when connected between the 12 V reference circuit terminal 2 and ground.
 - **If the test lamp does not flash**
 1. Ignition OFF, remove the test lamp and disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for less than 2 ohms in the 12 V control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If the test lamp flashes**
3. Connect a test lamp between each control circuit listed below and B+.
 - Control Circuit - terminal 1
 - Control Circuit - terminal 3
 - Control Circuit - terminal 4
 - Control Circuit - terminal 6
4. Command the appropriate door actuator in both directions.
5. Verify the test lamp turns ON and then OFF during at least one of the directional commands.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp and disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K33 HVAC Control Module.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp and disconnect the harness connector at the K33 HVAC Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF
 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If the test lamp turns ON and then OFF**
6. Replace the door actuator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

DTC B269A, B269C, OR B269D: HEATER COOLANT PUMP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B269A

Heater Coolant Pump Control Circuit Open

DTC B269C

Heater Coolant Pump Control Circuit Low

DTC B269D

Heater Coolant Pump Control Circuit High

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Control	B269C	B269A	B269D	-

Circuit/System Description

The primary purpose of the heater core coolant pump is to circulate engine coolant through the HVAC heater core when heat is required in the cabin for comfort. This normally happens when the vehicle is in an Auto Stop and the mechanical pump is not spinning. If the HVAC control module has determined heat is needed for the cabin, a request is sent via serial data to the engine control module to turn the pump ON. The engine control module controls the auxiliary coolant pump relay via the heater core coolant pump relay control circuit. The

heater core coolant pump relay supplies voltage to the heater core coolant pump.

Conditions for Running the DTC

- The 12 V battery voltage is greater than or equal to 9 V.
- The auxiliary heater coolant pump enable is commanded.

Conditions for Setting the DTC

The engine control module detects the auxiliary heater coolant pump relay enable circuit is open, shorted to voltage or shorted to ground.

Action Taken When the DTC Sets

DTCs B269A, B269C, and B269D are type B DTCs.

Conditions for Clearing the DTC

DTCs B269A, B269C, and B269D are type B DTCs.

Reference Information

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the KR33 Auxiliary Heater Coolant Pump Relay, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance,
 3. Test for greater than 5 ohms between the control circuit terminal 87 and ground.
 - If less than 5 ohms, repair the short to ground on the circuit.
 - If greater than 5 ohms, test or replace the KR33 Auxiliary Heater Coolant Pump Relay.
 - **If the test lamp illuminates**
3. Verify a test lamp illuminates between the B+ circuit terminal 86 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - **If the test lamp illuminates**
4. Connect a test lamp between the B+ circuit terminal 86 and the control circuit terminal 85.
5. Verify the test lamp turns ON and OFF when commanding the Engine Control Module Heater Coolant Pump On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF
 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp turns ON and OFF**
6. Verify a test lamp does not illuminate between the control circuit terminal 87 and ground.
 - **If the test lamp illuminates**

Repair the short to voltage on the circuit.
 - **If the test lamp does not illuminate**
7. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G17 Heater Coolant Pump. It may take up to 2 min for all systems to power down.
8. Test for less than 10 ohms between the G17 Heater Coolant Pump ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
9. Connect the harness connector at the G17 Heater Coolant Pump.
10. Ignition ON, connect a 5 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
11. Verify the G17 Heater Coolant Pump is activated.
 - **If the G17 Heater Coolant Pump does not activate**
 1. Ignition OFF, remove the jumper wire.
 2. Test for less than 2 ohms in the control circuit terminal 87 end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the G17 Heater Coolant Pump.
 - **If the G17 Heater Coolant Pump activates**
12. Test or replace the KR33 Auxiliary Heater Coolant Pump Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR33 Auxiliary Heater Coolant Pump Relay.
2. Test for 60-180 ohms between terminals 85 and 86.
 - **If less than 60 ohms or greater than 180 ohms**

Replace the KR33 Auxiliary Heater Coolant Pump Relay.

- **If between 60-180 ohms**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

- **If less than infinite resistance**

Replace the KR33 Auxiliary Heater Coolant Pump Relay.

- **If infinite resistance**

4. Install a 10 A fused jumper wire between relay terminal 86 and 12 V. Install a jumper wire between relay terminal 85 and ground.

5. Test for less than 2 ohms between terminals 30 and 87.

- **If 2 ohms or greater**

Replace the KR33 Auxiliary Heater Coolant Pump Relay.

- **If less than 2 ohms**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

DTC B393B: AIR CONDITIONING COMPRESSOR VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B393B 04

Air Conditioning Compressor Valve Control Circuit Open

DTC B393B 0B

Air Conditioning Compressor Valve Control Circuit High Current

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B393B 0B	B393B 04	-	-
Control Circuit	B393B 04	B393B 04	B393B 0B	-

Circuit/System Description

This A/C system uses a conventional clutch to engage and mechanically turn the compressor and a variable displacement solenoid valve to alter the amount of displacement created by the turning of the compressor. The HVAC control module provides both battery voltage and a pulse width modulated ground to the variable displacement solenoid valve. When the A/C switch is pressed, the HVAC control module grounds the variable displacement solenoid using a low side (PWM) signal in order to determine the amount of compressor displacement. The performance of the A/C compressor is based on adjusted interior temperature and engine load.

Conditions for Running the DTC

- Ignition ON.
- The HVAC control module is ON.

Conditions for Setting the DTC

B393B 04

A PWM greater than 10% is sent but no current is read back.

B393B 0B

Measured current is above threshold of 815 mA.

Action Taken When the DTC Sets

B393B 04

The A/C compressor is disabled.

B393B 0B

- The A/C compressor is disabled.
- Output will be switched off for hardware protection.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

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HVAC Schematics

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q46 A/C Compressor Solenoid Valve, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 2 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp and disconnect the harness connectors at the K33 HVAC Control Module.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect a test lamp between the control circuit terminal 1 and the B+ circuit terminal 2, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the Q46 A/C Compressor Refrigerant

Solenoid Valve On and Off with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, remove the test lamp and disconnect the harness connector at the K33 HVAC Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Ignition OFF.
4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp and disconnect the harness connectors at the K33 HVAC Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K33 HVAC Control Module.

- **If the test lamp turns ON and OFF**

5. Test or replace the G1 A/C Compressor.

Component Testing

A/C Compressor Solenoid Valve Test

1. Ignition OFF, disconnect the harness connector at the Q46 A/C Compressor Solenoid Valve.
2. Test for 7-15 ohms between B+ terminal 2 and control terminal 1.
 - **If less than 7 ohms or greater than 15 ohms**

Replace the G1 A/C Compressor.

- **If between 7-15 ohms**

3. Test for infinite resistance between each terminal and the Q46 A/C Compressor Solenoid Valve housing/case.
 - **If less than infinite resistance**

Replace the G1 A/C Compressor.

- **If infinite resistance**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

DTC P0532 OR P0533: AIR CONDITIONING (A/C) REFRIGERANT PRESSURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of the diagnostic category.

DTC Descriptors

DTC P0532

Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit Low Voltage

DTC P0533

Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0532, P0641	P0532	P0533	-
Signal	P0532	P0532	P0533	-
Low Reference	-	P0533	-	-

Circuit/System Description

The engine control module (ECM) monitors the high side refrigerant pressure through the A/C refrigerant pressure sensor. The ECM supplies a 5 V reference and a low reference to the sensor. Changes in the A/C refrigerant pressure cause the sensor signal to the ECM to vary. When the pressure is high, the signal voltage is high. When the pressure is low, the signal voltage is low. The ECM may use this information to turn the cooling fans on as well as to monitor clutch engagement. The HVAC module will receive the A/C refrigerant pressure information from the ECM via serial data.

Conditions for Running the DTC

- Engine is running.
- Any of the conditions for setting the DTC are met for 15 s.
- Battery voltage is between 11-18 V.

Conditions for Setting the DTC

P0532

The ECM detects that the A/C pressure is less than 1 psi (0.25 V).

P0533

The ECM detects that the A/C pressure is more than 428 psi (4.92 V).

Action Taken When the DTC Sets

- The A/C compressor is disabled.
- The ECM will illuminate the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Diagnostic Aids

A malfunction within the refrigerant system causing high pressure can cause this DTC to set.

Reference Information

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON
2. Verify the scan tool engine control module A/C High Side Pressure Sensor parameter is between 6.8 kPa (1 psi) and 2950 kPa (428 psi).
 - **If not between 6.8 kPa (1 psi) and 2950 kPa (428 psi)**

Refer to Circuit/System Testing

- **If between 6.8 kPa (1 psi) and 2950 kPa (428 psi)**
3. All OK

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B1 A/C Refrigerant Pressure Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**
- 5. Verify the scan tool ECM A/C High Side Pressure Sensor parameter is less than .25 V.
 - **If .25 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than .25 V**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 2.
- 7. Verify the scan tool ECM A/C High Side Pressure Sensor parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4.8 V**
- 8. Test or replace the B1 A/C Refrigerant Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for engine control module replacement, programming and setup

DTC P0645, P0646, OR P0647: AIR CONDITIONING (A/C) COMPRESSOR CLUTCH RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0645

Air Conditioning (A/C) Compressor Clutch Relay Control Circuit

DTC P0646

Air Conditioning (A/C) Compressor Clutch Relay Control Circuit Low Voltage

DTC P0647

Air Conditioning (A/C) Compressor Clutch Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0645	P0645	-	-
Relay Switch B+	1	1	-	-
Relay Coil Control	P0646	P0645	P0647	-
Relay Switch Control	1	1	1	-
Ground	-	1	-	-
1. A/C Compressor Malfunction				

Circuit/System Description

When the A/C switch is pressed, the HVAC control module sends an A/C request message to the engine control module (ECM) via serial data. The ECM then grounds the A/C compressor clutch relay coil control circuit, closing the relay contacts. The closed relay contacts provide voltage to the compressor clutch causing it to engage.

Conditions for Running the DTC

- Engine is running.
- The HVAC control module is ON.
- The A/C switch is active.

Conditions for Setting the DTC

P0645 or P0646

The ECM detects a short to ground or an open at the A/C compressor clutch relay control circuit.

P0647

The ECM detects a short to voltage at the A/C compressor clutch relay control circuit.

Action Taken When the DTC Sets

P0645 or P0646

The A/C compressor is inoperative or always active. The A/C compressor solenoid is commanded to 0% displacement. This causes warm air from the ducts, even with unwanted clutch engagement.

P0647

The A/C compressor is inoperative.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

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HVAC Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the KR29 A/C Compressor Clutch Relay, ignition ON.

2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Disconnect the harness connector at the Q2 A/C Compressor Clutch.
 4. Test for infinite resistance between the control circuit terminal 87 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the Q2 A/C Compressor Clutch.
 - **If the test lamp illuminates**
 - 3. Ignition ON.
 - 4. Verify a test lamp illuminates between the ignition circuit terminal 86 and ground.
 - **If the test lamp does not illuminate**

Refer to **Power Mode Mismatch** .

- **If the test lamp illuminates**
5. Connect a test lamp between the ignition circuit terminal 86 and the control circuit terminal 85.
 6. Verify the test lamp turns ON and OFF when commanding the ECM A/C Compressor Clutch Relay On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp and disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp and disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp turns ON and OFF**
7. Verify a test lamp does not illuminate between the control circuit terminal 87 and ground.
 - **If the test lamp illuminates**

Repair the short to voltage on the circuit.
 - **If the test lamp does not illuminate**
8. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the Q2 A/C Compressor Clutch. It may take up to 2 min for all vehicle systems to power down.
9. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
10. Connect the harness connector at the Q2 A/C Compressor Clutch.
11. Ignition ON, connect a 10 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
12. Verify the Q2 A/C Compressor Clutch is engaged.
 - **If the Q2 A/C Compressor Clutch does not engage**
 1. Ignition OFF, disconnect the harness connector at the Q2 A/C Compressor Clutch.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the Q2 A/C Compressor Clutch.
 - **If the Q2 A/C Compressor Clutch is engaged**
13. Test or replace the KR29 A/C Compressor Clutch Relay.

Component Testing

1. Ignition OFF, disconnect the KR29 A/C Compressor Clutch Relay.
2. Test for 60-180 ohms between terminals 85 and 86.
 - **If not between 60-180 ohms**

Replace the KR29 A/C Compressor Clutch Relay.
 - **If between 60-180 ohms**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87
- **If less than infinite resistance**

Replace the KR29 A/C Compressor Clutch Relay.

- **If infinite resistance**

4. Install a 15 A fused jumper wire between terminal 86 and 12 V. Install a jumper wire between terminal 85 and ground.

5. Test for less than 2 ohms between terminals 30 and 87.

- **If 2 ohms or greater**

Replace the KR29 A/C Compressor Clutch Relay.

- **If less than 2 ohms**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for engine control module replacement, programming and setup

SYMPTOMS - HVAC SYSTEMS - AUTOMATIC

NOTE: **The following steps must be completed before using the symptom tables:**

1. Perform the **Diagnostic System Check - Vehicle** before using the HVAC System Malfunction procedure in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Automatic HVAC Description and Operation**.

Visual/Physical Inspection

NOTE: **Shutting one or more outlets may adversely affect the Automatic HVAC system by producing erroneous duct air temperature sensor readings in the duct connecting to the closed outlet. Where possible, always operate**

the Automatic HVAC system with all outlets open.

- Inspect for aftermarket devices which may affect the operation of the HVAC System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Verify the A/C compressor turns freely and is not seized.
- Verify that the customer is using the correct key to enable personalization and is not inadvertently activating auxiliary HVAC controls.
- The A/C compressor will not operate in cold outside air temperatures.
- The following conditions may cause window fogging:
 - Wet carpet or mats
 - High humidity
 - Interior water leak
 - Blocked A/C evaporator drain tube
 - Maximum passenger capacity
 - Blocked body pressure relief valves
- Inspect the air distribution system for causes of reduced air flow:
 - Obstructed or dirty passenger compartment air filter, if equipped
 - Blocked or damaged air inlet or outlet vents

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to **HVAC System Malfunction** in order to diagnose the symptom.

HVAC SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Aids

Check the following mechanical fault sources:

- Air distribution box

- Air distribution hoses/air distribution ducts

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HVAC Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Special Tools

J43600 ACR Air Conditioning Service Center

Circuit/System Verification

NOTE: Check for bulletins before proceeding.

1. Ignition ON.
2. Verify every applicable scan tool Switch parameter changes when pressing the appropriate switch on the A26 HVAC Controls.
 - **If any parameter does not change**
 Replace the A26 HVAC Controls.
 - **If all parameters change**
3. Verify the blower motor operates properly with the blower motor switch in each speed position.
 - **If the blower motor does not operate in each speed position**

Refer to **DTC B0193**.

- **If the blower motor operates properly in each speed position**
- 4. Verify the HVAC doors listed below move when pressing the appropriate switch.
 - Driver Temperature
 - Passenger Temperature
 - Mode
 - Recirculation
 - Air Inlet
- **If any HVAC door does not move**

Refer to **DTC B0223, B022A, B0233, B023A, B0408, or B0418**.

- **If all HVAC doors move**
- 5. Install the **J43600** ACR Air Conditioning Service Center.
- 6. Verify the high side pressure reading on the Air Conditioning Service Center is within 10% of the scan tool ECM A/C High Side Pressure Sensor parameter.
 - **If the reading is not within 10%**

Refer to **DTC P0532 or P0533**.

- **If the reading is within 10%**
- 7. Verify the A/C High Side Pressure Sensor parameter is between 269-2929 kPa (39-425 PSI).
 - **If the reading is not between 269-2929 kPa (39-425 PSI)**

Refer to **Air Conditioning (A/C) System Performance Test** .

- **If the reading is between 269-2929 kPa (39-425 PSI)**
- 8. Verify the scan tool parameters listed below are within 10% of ambient temperature.
 - Lower Left Duct Air Temperature Sensor
 - Upper Left Duct Air Temperature Sensor
 - Lower Right Duct Air Temperature Sensor
 - Upper Right Duct Air Temperature Sensor
 - A/C Evaporator Temperature Sensor
- **If not within 10% of ambient temperature**

Refer to **DTC B0173, B0178, B0509, B0514 or B3933**.

- **If within 10% of ambient temperature**
- 9. Verify the scan tool parameters listed below are within 10% of actual conditions.
 - Passenger Compartment Humidity
 - Passenger Compartment Humidity Sensor Temperature

- Passenger Compartment Windshield Temperature
- **If not within 10% of actual conditions**

Refer to **DTC B0173, B0178, B0509, B0514 or B3933: Duct Air Temperature Sensor/Evaporator Temperature Sensor.**

- **If within 10% of actual conditions**

10. Engine ON, A/C system ON.

11. Verify cool air flows from the ducts with the temperature control in the coldest position.

- **If the air is not cool**

1. Verify the Q2 A/C Compressor Clutch is engaged.

- If the Q2 A/C Compressor Clutch is not engaged, refer to **Air Conditioning Compressor Malfunction.**
- If the Q2 A/C Compressor Clutch is engaged, refer to **Air Conditioning (A/C) System Performance Test** , and **DTC B393B.**

- **If the air is cool**

12. Verify warm air flows from the ducts with the temperature control in the warmest position.

- **If the air is not warm**

Refer to **Heating Performance Diagnostic** .

- **If the air is warm**

13. Engine OFF, ignition ON.

14. Verify the scan tool Sunload parameter changes while covering the B10B Ambient Light/Sunload Sensor with a shop towel and changes when shining a bright light on it.

- **If the Sunload parameter does not change**

Refer to **DTC B0163: Passenger Compartment Temperature Sensor, DTC B0183: Solar Load Sensor** or **DTC B1405 (WITH REAR PARK ASSIST): CONTROL MODULE VOLTAGE REFERENCE OUTPUT 2** , **DTC B1405 (WITH FRONT AND REAR PARK ASSIST): CONTROL MODULE VOLTAGE REFERENCE OUTPUT 2** .

- **If the Sunload parameter changes**

15. Verify the actual inside air temperature, using a thermometer, is less than 3°C (5°F) difference from the scan tool Inside Passenger Compartment Air Temp. Sensor parameter.

- **If greater than a 3°C (5°F) difference**

Refer to **DTC B0163: Passenger Compartment Temperature Sensor, DTC B0183: Solar Load Sensor** or **DTC B1405 (WITH REAR PARK ASSIST): CONTROL MODULE VOLTAGE REFERENCE OUTPUT 2** , **DTC B1405 (WITH FRONT AND REAR PARK ASSIST): CONTROL MODULE VOLTAGE REFERENCE OUTPUT 2** .

- **If less than a 3°C (5°F) difference**

16. Verify the vehicle is equipped with RPO code HP6.

- **If the vehicle is not equipped with RPO code HP6.**

Refer to step 18.

- **If the vehicle is equipped with RPO code HP6.**

17. Verify the G17 Heater Coolant Pump turns On and Off when commanded with a scan tool.

- **If the G17 Heater Coolant Pump does not turn On and Off**

Refer to **DTC B269A, B269C, or B269D.**

- **If the G17 Heater Coolant Pump does turn On and Off**

18. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

AIR CONDITIONING COMPRESSOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The A/C compressor uses a conventional belt driven magnetic clutch to engage and mechanically turn the compressor. When the A/C switch is pressed, the HVAC control module sends an A/C request message to the ECM via serial data. If specific criteria is met, the ECM then grounds the A/C compressor clutch relay control circuit, which will switch the A/C compressor clutch relay. With the relay contacts closed, battery voltage is supplied to the permanently grounded A/C compressor clutch. The A/C compressor clutch will then be activated.

This A/C system utilizes a variable displacement solenoid valve to alter the amount of displacement created by the turning of the compressor. The HVAC control module provides both battery voltage and a pulse width modulated ground to the variable displacement solenoid valve. When the A/C switch is pressed, the HVAC control module grounds the variable displacement solenoid using a (PWM) signal in order to determine the amount of compressor displacement. The performance of the A/C compressor is regulated based on the adjusted interior temperature.

Diagnostic Aids

The following conditions must be met in order to turn on the A/C compressor:

- Battery voltage is between 9-18 V.
- Engine coolant temperature is less than 124°C (255°F).
- Engine speed is greater than 600 RPM.
- Engine speed is less than 5 500 RPM.
- A/C high side pressure is between 269-2 929 kPa (39-425 PSI).
- Throttle position is less than 100%.
- Evaporator temperature is greater than 3°C (38°F).
- ECM does not detect excessive torque load.
- ECM does not detect insufficient idle quality.
- The ambient temperature sensor senses above 1°C (34°F).
- Blower motor is ON.

Reference Information

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Refer to **HVAC System Malfunction** before performing this procedure.

1. Ignition ON, press and release the A/C Switch.

2. Verify the HVAC control module scan tool A/C Switch parameter changes between Active and Inactive.

- **If the parameter does not change**

Replace the A26 HVAC Controls.

- **If the parameter changes**

3. Set A/C system to coolest setting with blower ON.

4. Press and release the A/C switch several times.

5. Verify the ECM scan tool A/C Request Signal parameter changes between Active and Inactive.

- **If the parameter does not change**

Replace the K33 HVAC Control Module.

- **If the parameter changes**

6. Verify the A/C compressor clutch engages when commanding the ECM A/C Relay output function On and Off with a scan tool.

- **If the A/C compressor clutch does not engage**

Refer to **DTC P0645, P0646, or P0647**

- **If the A/C compressor clutch engages**

7. Engine ON.

8. Verify the HVAC control module scan tool A/C Compressor Refrigerant Solenoid Valve Command parameter changes with varying cooling loads.

- **If the parameter does not change**

Refer to **DTC B393B**

- **If the parameter does change**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HVAC Component Replacement Reference**
- **Control Module References** for HVAC control module replacement, programming and setup

AFTERBLOW ENABLING

The afterblow mode can be enabled using the scan tool. The afterblow mode allows the blower motor to operate after the engine has been turned off. This operation of the blower motor dries the evaporator core, which reduces the amount of microbial growth which can create undesirable odors.

Use the following procedure in order to enable the afterblow mode:

1. Connect the Scan Tool.
2. Turn ON the ignition, with the engine OFF.
3. Build the vehicle with the scan tool.
4. Select Module Diagnosis.
5. Select Remote Heater and Air Conditioning Control Module.
6. Select Configuration/Reset Functions.
7. Select HVAC Afterblow Configuration.

When afterblow has been enabled by the scan tool the blower motor will operate at 68% blower speed, following the sequence below up to 5 times. This could last up to an hour:

1. The blower motor will be OFF for 7-11 minutes.
2. The blower motor will RUN for 25-30 seconds.

The following conditions must be met for the HVAC module to operate the afterblow:

- The engine must be turned off for at least 30 min.
- The outside air temperature must be at least 21°C (70°F).
- The A/C compressor must have operated for more than 2 minutes before shut down during the latest key cycle.
- The system voltage must be at least 12 V.

ACTUATOR RECALIBRATION

HVAC Control Module Replacement

When replacing or disconnecting the HVAC control module, it will be necessary to perform a recalibration process. When installing or reconnecting the HVAC control module, be sure to perform the following:

Preferred Method (with Scan Tool)

NOTE: **Do not adjust any controls on the HVAC control module while the HVAC control module is self-calibrating. If interrupted, improper HVAC performance will result.**

1. Ignition OFF.
2. Disconnect the scan tool.
3. Install/connect the HVAC control module.
4. Connect all previously disconnected components.
5. Start the vehicle.
6. With the scan tool, initiate the HVAC Actuators Learn feature of the HVAC control module Special

Functions menu.

7. Operate system and verify that no DTCs have set as current DTCs.
8. If DTC B101E 4B is set after attempting the actuator recalibration procedure, perform the following:
 1. Verify which actuator does not have a scan tool learn status parameter status of complete.
 2. Verify the unlearned actuator is physically rotating - A common cause of DTC B101E 4B is an actuator that is electrically OK but fails to physically rotate (e.g. stripped gears).
 3. If the unlearned actuator is not physically rotating, replace the actuator, otherwise replace the HVAC control module.

Alternate Method (without Scan Tool)

NOTE: Do not adjust any controls on the HVAC control module while the HVAC control module is self-calibrating. If interrupted, improper HVAC performance will result.

1. Clear all DTCs.
2. Ignition OFF.
3. Install/connect the HVAC control module.
4. Connect all previously disconnected components.
5. Remove the HVAC control module fuse for a minimum of 10 s.
6. Install the HVAC control module fuse.
7. Start the vehicle.
8. Wait 40 s for the HVAC control module to self-calibrate.

Actuator Replacement

When replacing an HVAC actuator it will be necessary to allow the HVAC control module to perform a recalibration process. When installing an HVAC actuator be sure to perform one of the following:

Preferred Method (with Scan Tool)

NOTE: Do not adjust any controls on the HVAC control module while the HVAC control module is self-calibrating. If interrupted, improper HVAC performance will result.

1. Clear all DTCs.
2. Ignition OFF.
3. Install the HVAC actuator.
4. Connect all previously disconnected components.
5. Start the vehicle.
6. With the scan tool, initiate the HVAC Actuators Relearn feature of the HVAC control module Special Functions menu.

7. Operate system and verify that no DTCs have set as current DTCs.
8. If DTC B101E 4B is set after attempting the actuator recalibration procedure, perform the following:
 1. Verify which actuator does not have a scan tool learn status parameter status of complete.
 2. Verify the unlearned actuator is physically rotating - A common cause of DTC B101E 4B is an actuator that is electrically OK but fails to physically rotate (e.g. stripped gears).
 3. If the unlearned actuator is not physically rotating, replace the actuator, otherwise replace the HVAC control module.

Alternate Method (without Scan Tool)

NOTE: **Do not adjust any controls on the HVAC control module while the HVAC control module is self-calibrating. If interrupted, improper HVAC performance will result.**

1. Clear all DTCs.
2. Ignition OFF.
3. Install the HVAC actuator.
4. Connect all previously disconnected components.
5. Remove the HVAC control module fuse for a minimum of 10 s.
6. Install the HVAC control module fuse.
7. Start the vehicle.
8. Wait 40 s for the HVAC control module to self-calibrate.

REPAIR INSTRUCTIONS

HEATER AND AIR CONDITIONING CONTROL REPLACEMENT

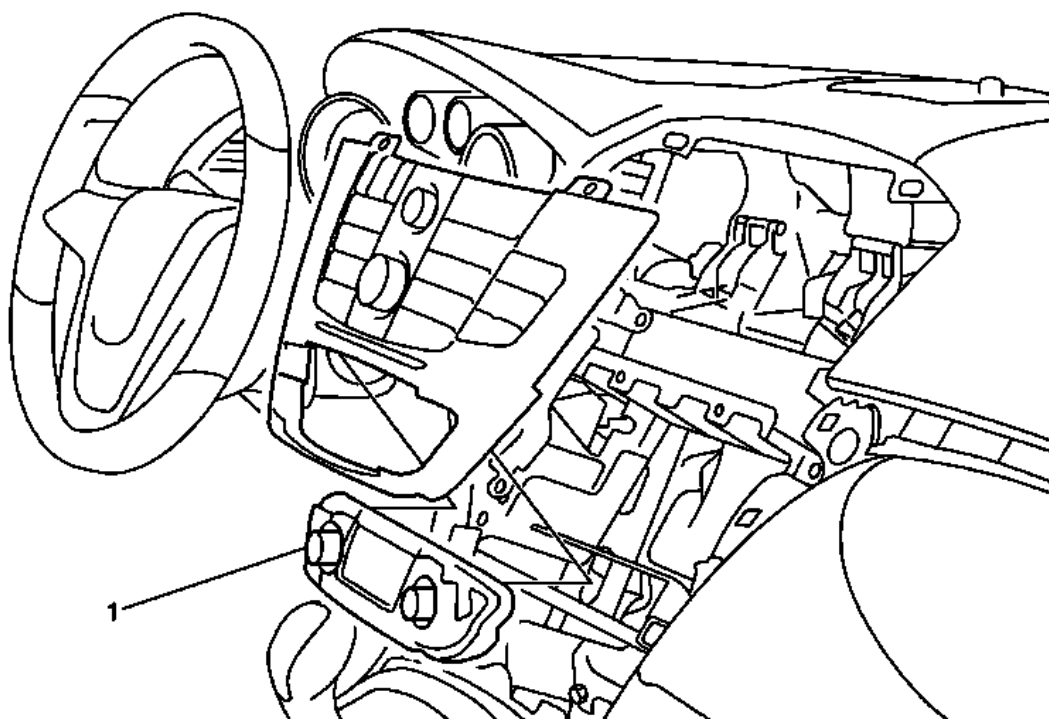


Fig. 8: Heater and Air Conditioning Control
 Courtesy of GENERAL MOTORS COMPANY

Heater and Air Conditioning Control Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the instrument panel lower center trim panel. Refer to <u>Instrument Panel Lower Center Trim Panel Replacement</u> . 3. Remove the radio control bracket. Refer to 	
1	Heater and Air Conditioning Control Procedure <ol style="list-style-type: none"> 1. Disconnect the heater and air conditioning control electrical connector. 2. Use a flat-bladed plastic trim tool, to remove the heater and air conditioning control from the instrument panel lower center trim panel. 3. For programming and set up information, refer to <u>Control Module References</u> .

AIR CONDITIONING MODULE WIRING HARNESS REPLACEMENT

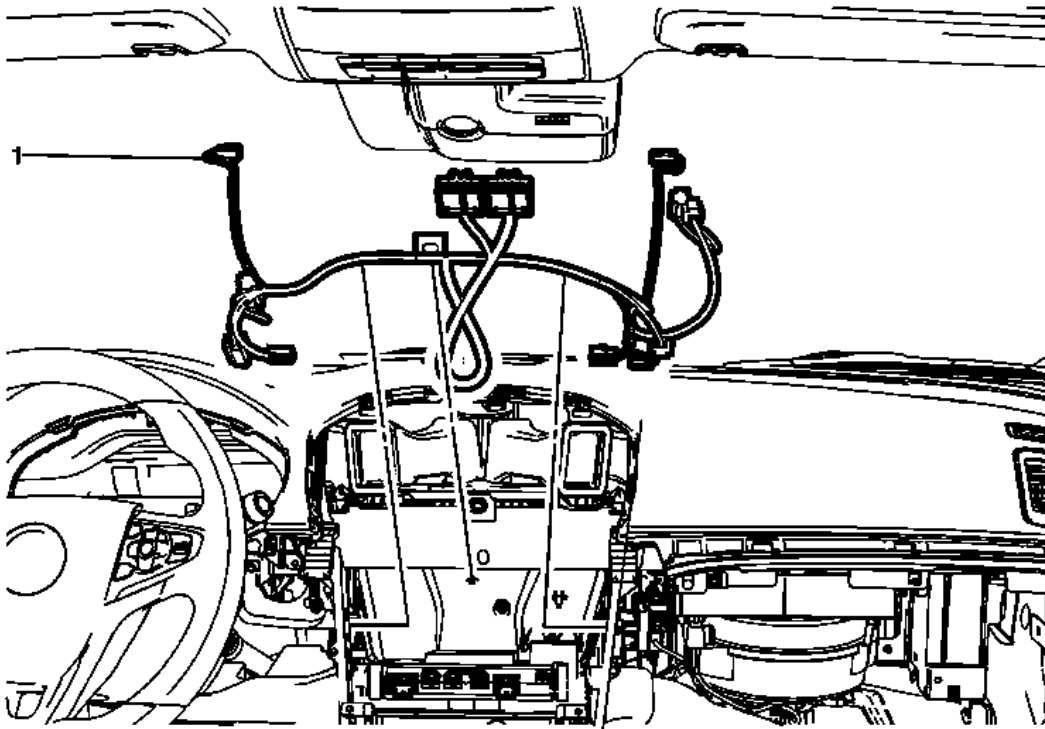


Fig. 9: Air Conditioning Module Wiring Harness
 Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Module Wiring Harness Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the heater and air conditioning remote control. Refer to <u>Heater and Air Conditioning Remote Control Replacement</u> . 2. Remove the instrument panel lower center trim panel. Refer to <u>Instrument Panel Lower Center Trim Panel Replacement</u> . 3. Remove the instrument panel lower extension side trim panel. Refer to <u>Instrument Panel Lower Extension Side Trim Panel Replacement</u> . 4. Remove the instrument panel lower trim panel - left side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> . 5. Remove the instrument cluster. Refer to <u>Instrument Cluster Replacement</u> . 	
	Air Conditioning Module Wiring Harness
1	Procedures <ol style="list-style-type: none"> 1. Disconnect the electrical connections from the actuators and the temperature sensors. 2. Maneuver the air conditioning module wiring harness out from behind the drive side of instrument panel assembly.

HEATER AND BLOWER AND AIR CONDITIONING CONTROL MODULE REPLACEMENT

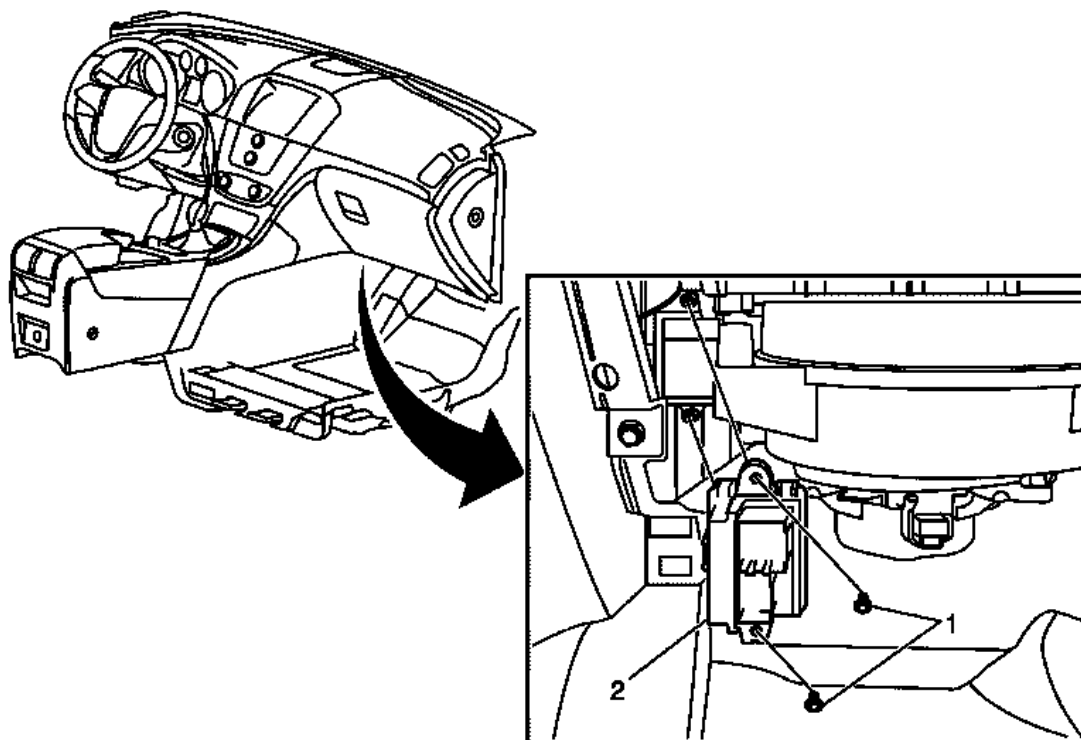


Fig. 10: Heater And Blower & Air Conditioning Control Module With Fasteners
Courtesy of GENERAL MOTORS COMPANY

Heater and Blower and Air Conditioning Control Module Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> .	
2. Remove the floor air outlet duct. Refer to <u>Floor Air Outlet Duct Replacement - Right Side</u> .	
3. Disconnect the heater and blower and air conditioning control module electrical connectors.	
1	Heater and Blower and Air Conditioning Control Module Fastener (Qty: 2)
2	Heater and Blower and Air Conditioning Control Module

MODE VALVE LEVER REPLACEMENT

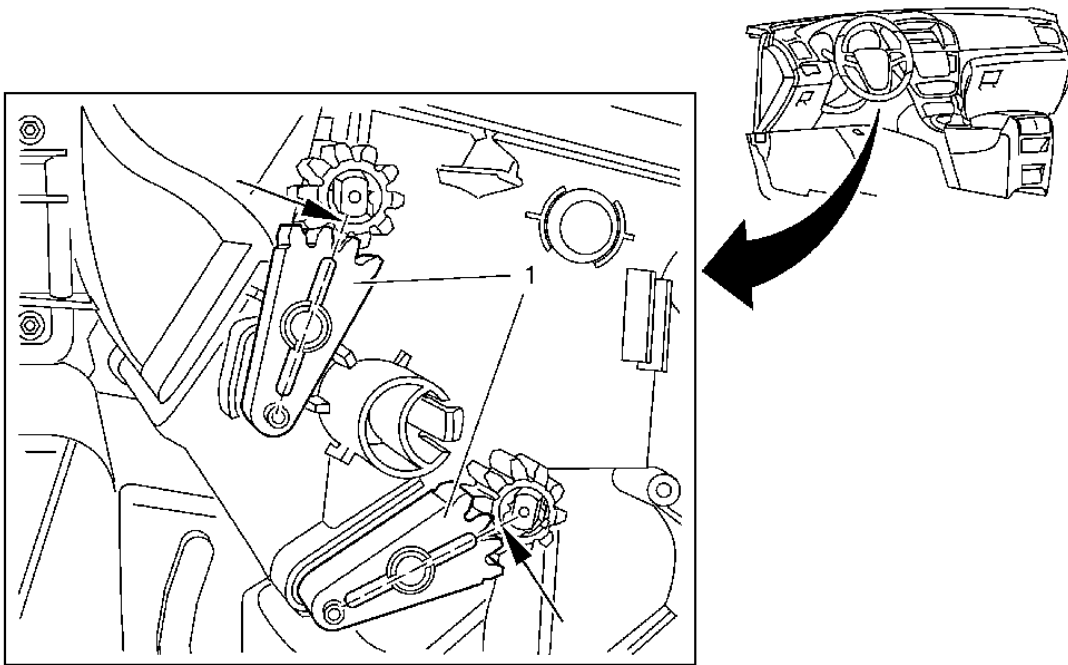


Fig. 11: Mode Valve Lever
 Courtesy of GENERAL MOTORS COMPANY

Mode Valve Lever Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the mode control cam actuator. Refer to <u>Mode Control Cam Actuator Replacement (Left Hand Drive)</u> . 2. Remove the instrument cluster. Refer to <u>Instrument Cluster Replacement</u> . 3. Remove the mode control cam. Refer to <u>Mode Control Cam Replacement</u> .	
1	Mode Valve Lever Procedure Move the valve to the middle position and mark the position of the mode valve lever notch to the mode valve gear. TIP: Use the indentation for the correct positioning of the lever arms.

MODE VALVE GEAR REPLACEMENT

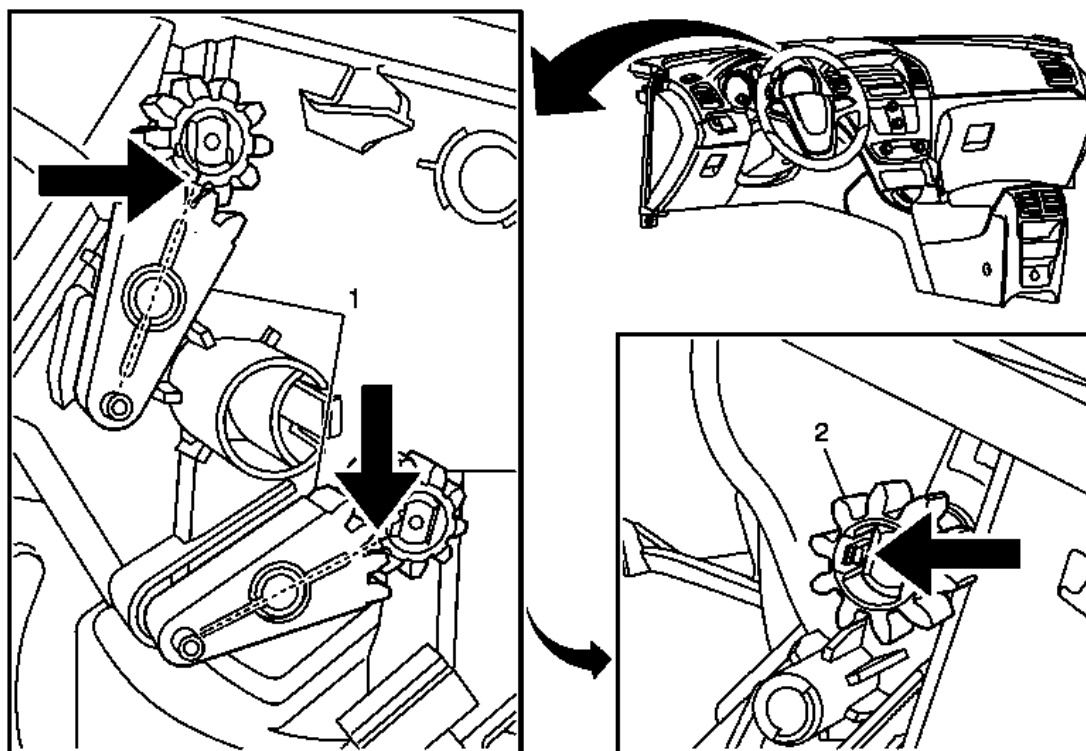


Fig. 12: Mode Valve Gear And Lever
 Courtesy of GENERAL MOTORS COMPANY

Mode Valve Gear Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the mode control cam actuator. Refer to <u>Mode Control Cam Actuator Replacement (Left Hand Drive)</u>. 2. Remove the instrument cluster. Refer to <u>Instrument Cluster Replacement</u>. 3. Remove the mode control cam. Refer to <u>Mode Control Cam Replacement</u>. 	
1	Mode Valve Lever Procedure <ol style="list-style-type: none"> 1. Move the valve to the middle position and mark the position of the mode valve lever notch to the mode valve gear. 2. Remove the mode valve lever.
2	Mode Valve Gear Procedure Release and remove the mode valve gear. <ol style="list-style-type: none"> 1. When replacing the valve gear, transfer the mark to the new part. 2. The mode valve gear can only be fitted in one position.

3. Use the indentation for the correct positioning of the lever arms.

AIR INLET VALVE ACTUATOR REPLACEMENT (LEFT HAND DRIVE AND CJ2)

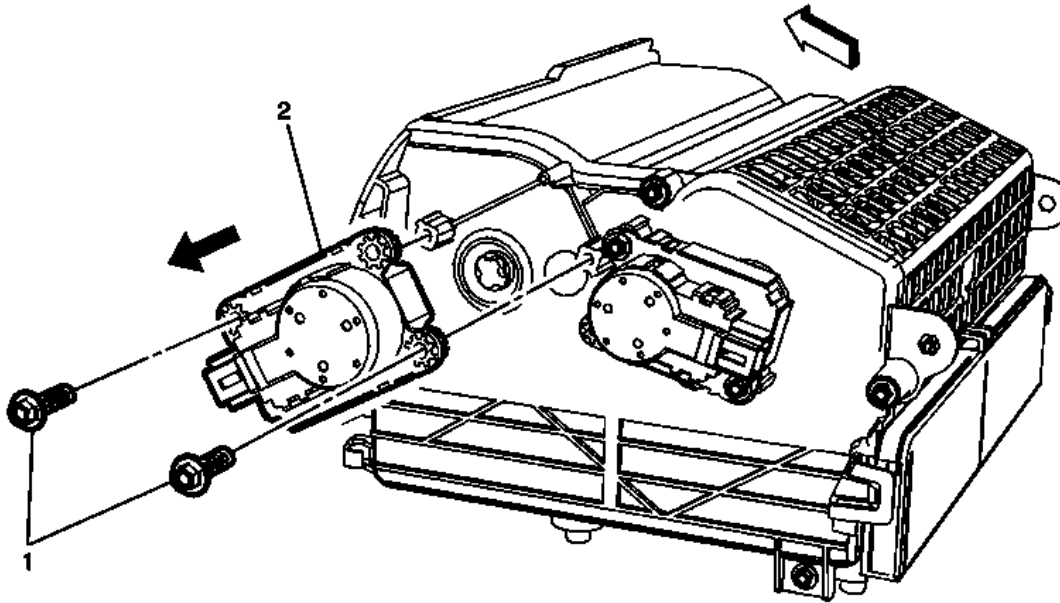


Fig. 13: Air Inlet Valve Actuator (CJ2)
Courtesy of GENERAL MOTORS COMPANY

Air Inlet Valve Actuator Replacement (Left Hand Drive and CJ2)

Call out	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the air inlet housing assembly. Refer to <u>Air Inlet Housing Replacement</u> . 	
1	Air Inlet Valve Actuator Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Air Inlet Valve Actuator Procedure Disconnect the air inlet valve actuator electrical connector. NOTE: The actuator is self-calibrating when connecting the battery.

INSIDE AIR VALVE ACTUATOR REPLACEMENT

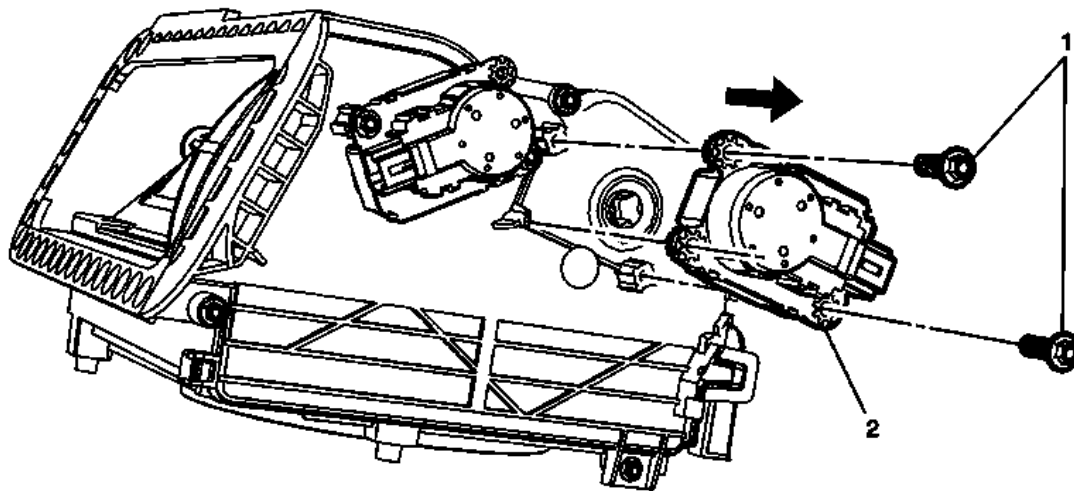


Fig. 14: Inside Air Valve Actuator (CJ2)
Courtesy of GENERAL MOTORS COMPANY

Inside Air Valve Actuator Replacement

Call out	Component Name
Preliminary Procedures	
1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
2. Remove air inlet housing assembly. Refer to <u>Air Inlet Housing Replacement</u> .	
1	Inside Air Valve Actuator Fastener (Qty: 2)
2	Inside Air Valve Actuator Procedure Disconnect the inside air valve actuator electrical connector. NOTE: The actuator is self-calibrating when connecting the battery

MODE CONTROL CAM ACTUATOR REPLACEMENT (LEFT HAND DRIVE)

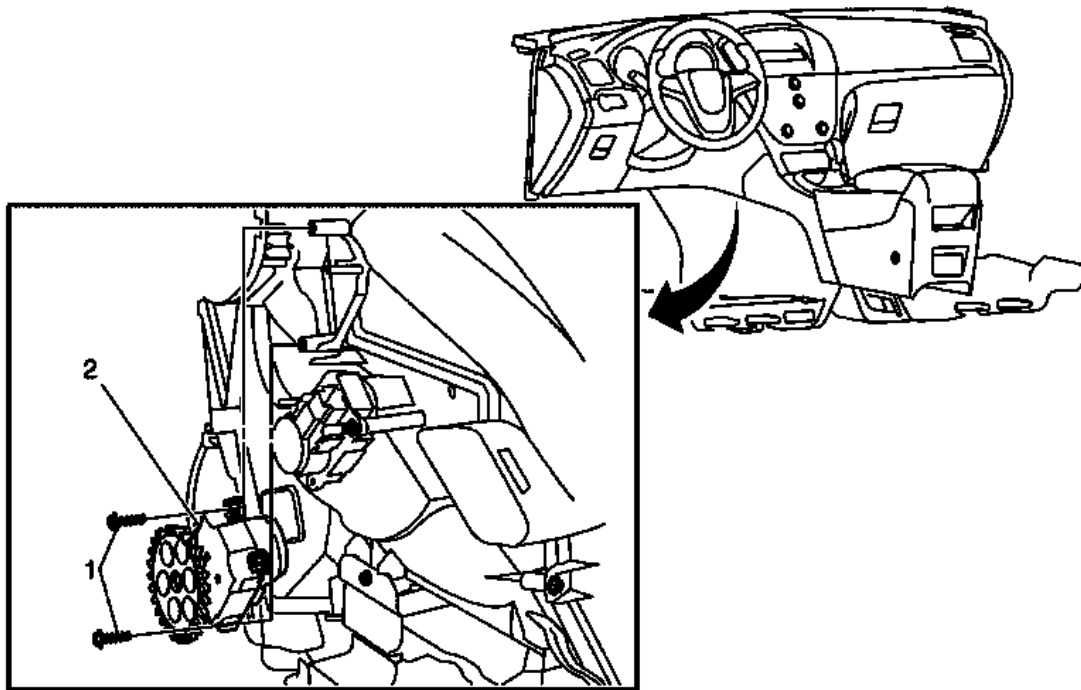


Fig. 15: Mode Control Cam Actuator & Fasteners (Left Hand Drive)
 Courtesy of GENERAL MOTORS COMPANY

Mode Control Cam Actuator Replacement (Left Hand Drive)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the instrument panel lower trim panel - left side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> . 3. Remove the floor air outlet duct - left side. Refer to <u>Floor Air Outlet Duct Replacement - Left Side</u> . 	
1	Mode Control Cam Actuator Fastener (Qty: 2) Procedure Disconnect the mode control cam actuator electrical connector.
2	Mode Control Cam Actuator TIP: The actuator is self-calibrating when connecting the battery.

MODE CONTROL CAM REPLACEMENT

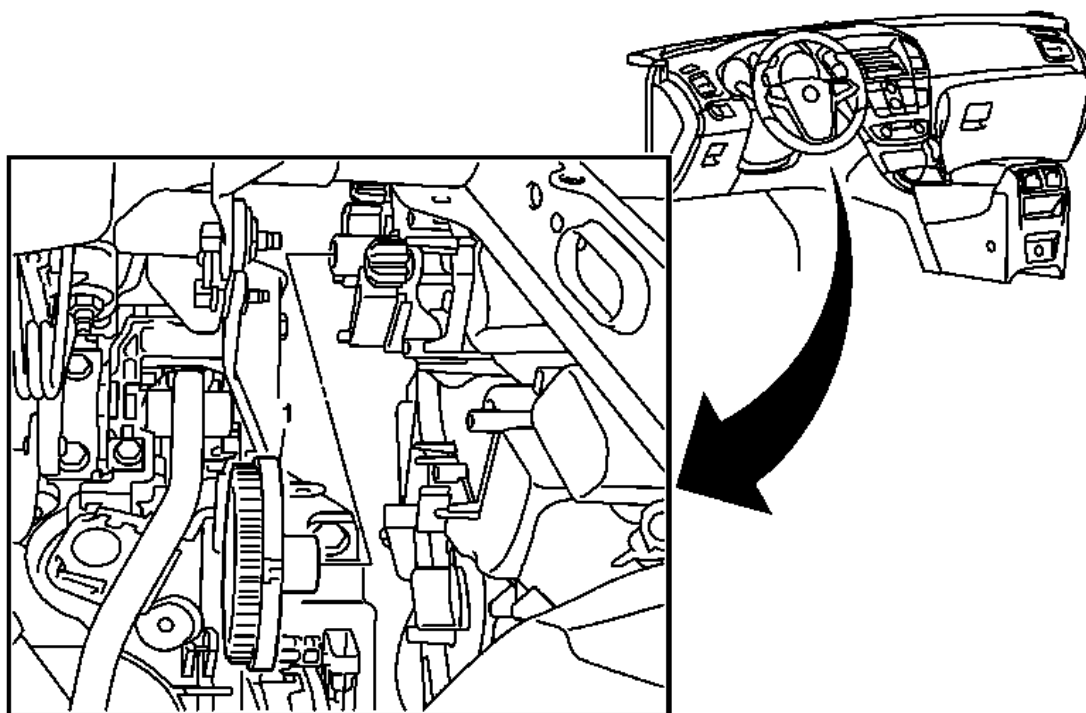


Fig. 16: Mode Control Cam
 Courtesy of GENERAL MOTORS COMPANY

Mode Control Cam Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the instrument panel lower trim panel - driver side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> . 2. Remove the floor air outlet duct - driver side. Refer to <u>Floor Air Outlet Duct Replacement - Left Side</u> . 3. Remove the mode control cam actuator. Refer to <u>Mode Control Cam Actuator Replacement (Left Hand Drive)</u>. 	
1	Mode Control Cam Procedure <ol style="list-style-type: none"> 1. Release and pull off the control cam. 2. The mode control cam can only be fitted in one position.

TEMPERATURE VALVE ACTUATOR REPLACEMENT - RIGHT SIDE

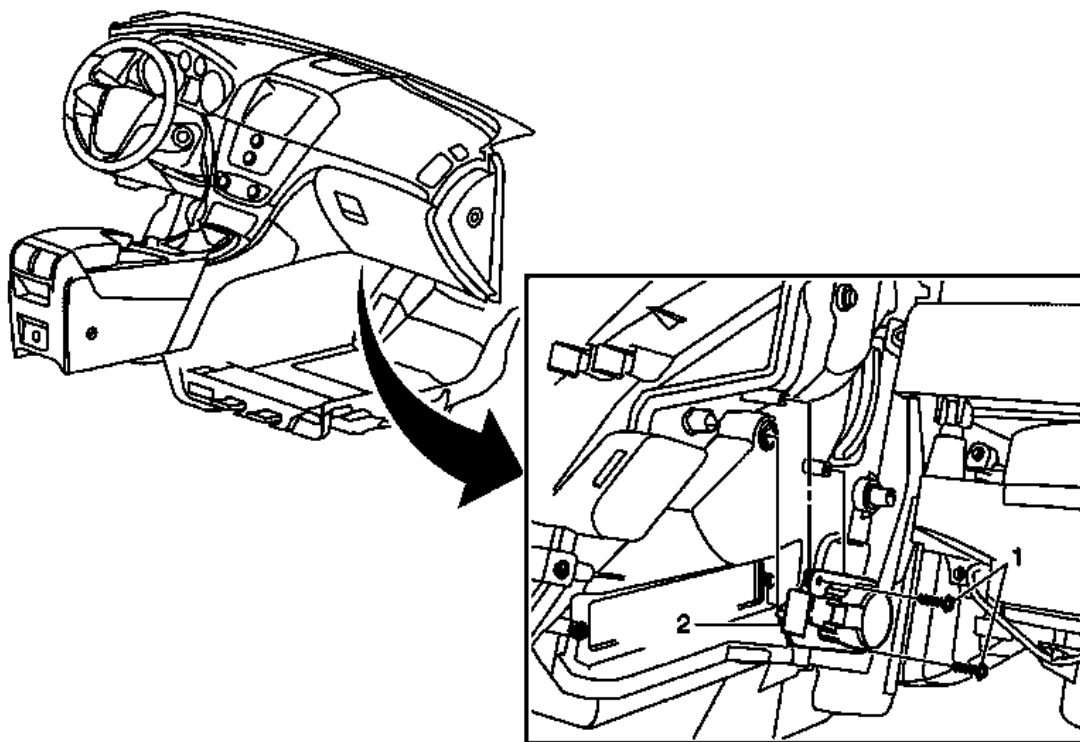


Fig. 17: Temperature Valve Actuator - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Temperature Valve Actuator Replacement - Right Side

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> . 3. Remove the floor air outlet duct - right side. Refer to <u>Floor Air Outlet Duct Replacement - Right Side</u> . 	
1	Temperature Valve Actuator Fastener (Qty: 2) Procedure Disconnect the temperature actuator electrical connector.
2	Temperature Valve Actuator TIP: Actuator is self-calibrating when connecting the battery.

TEMPERATURE VALVE ACTUATOR REPLACEMENT - LEFT SIDE (LEFT HAND DRIVE)

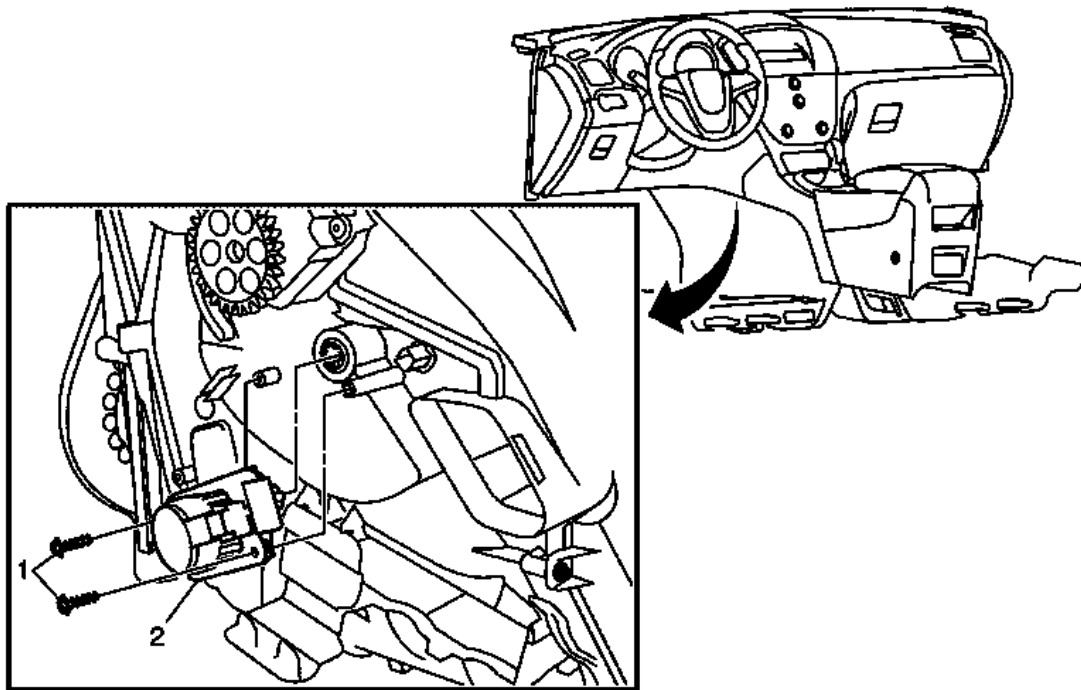


Fig. 18: Temperature Valve Actuator - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Temperature Valve Actuator Replacement - Left Side (Left Hand Drive)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the instrument panel lower trim panel - driver side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> . 3. Remove the floor air outlet duct - left side. Refer to <u>Floor Air Outlet Duct Replacement - Left Side</u> . 	
1	Temperature Valve Actuator Fastener (Qty: 2) Procedure Disconnect the temperature actuator electrical connector.
2	Temperature Valve Actuator TIP: Actuator is self-calibrating when connecting the battery.

AIR CONDITIONING REFRIGERANT TEMPERATURE SENSOR REPLACEMENT

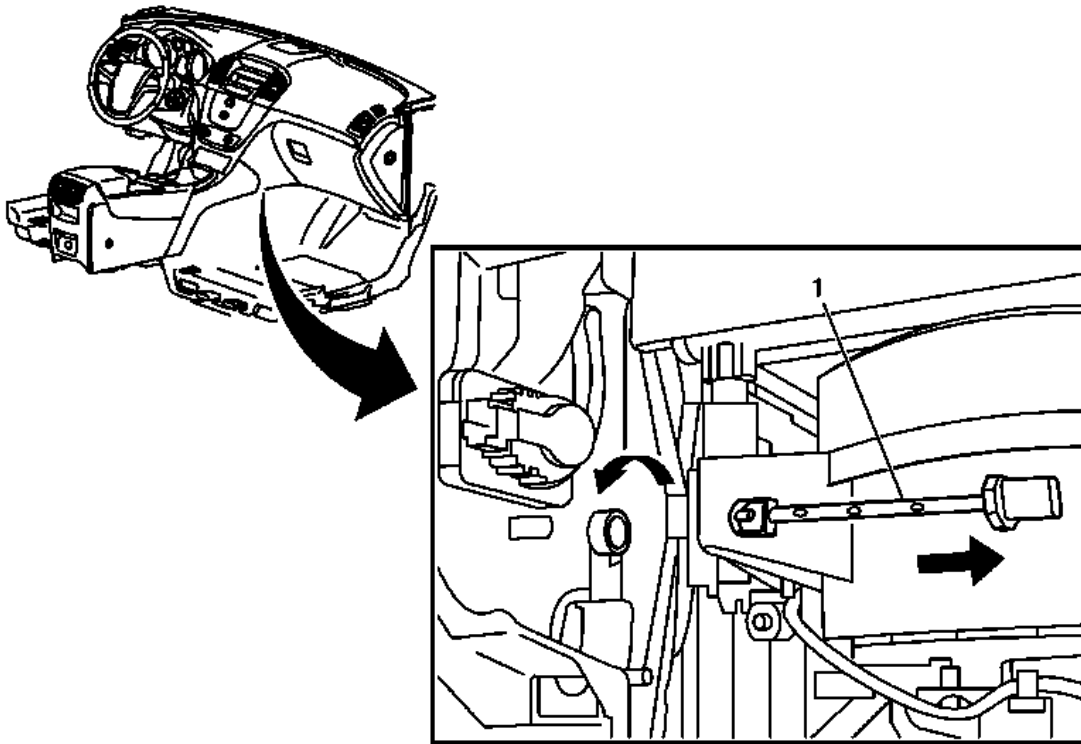


Fig. 19: Air Conditioning Refrigerant Temperature Sensor
 Courtesy of GENERAL MOTORS COMPANY

Air Conditioning Refrigerant Temperature Sensor Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> . 2. Remove the floor air outlet duct - right side. Refer to <u>Floor Air Outlet Duct Replacement - Right Side</u> .	
1	Air Conditioning Refrigerant Temperature Sensor Procedure <ol style="list-style-type: none"> 1. Disconnect the refrigerant temperature sensor electrical connector. 2. Twist and pull the refrigerant temperature sensor from the HVAC module assembly.

DUCT AIR TEMPERATURE SENSOR REPLACEMENT - UPPER RIGHT SIDE

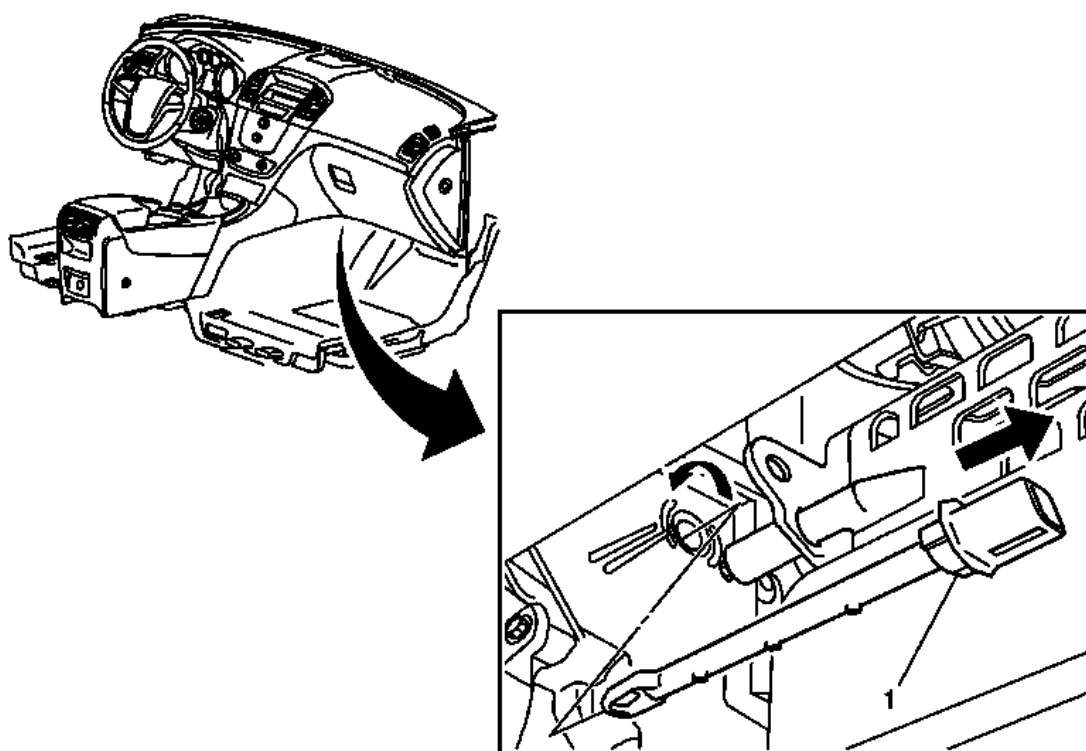


Fig. 20: Duct Air Temperature Sensor - Upper Right Side
 Courtesy of GENERAL MOTORS COMPANY

Duct Air Temperature Sensor Replacement - Upper Right Side

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the instrument panel lower extension side trim panel. Refer to <u>Instrument Panel Lower Extension Side Trim Panel Replacement</u> . 3. Remove the temperature valve actuator- right side. Refer to <u>Temperature Valve Actuator Replacement - Right Side</u>. 4. Remove the heater and blower and air conditioning control module. Refer to <u>Heater and Blower and Air Conditioning Control Module Replacement</u>. 5. Remove the recirculation actuator. Refer to <u>Inside Air Valve Actuator Replacement</u>. 	
1	Duct Air Temperature Sensor- Upper Right Side Procedure <ol style="list-style-type: none"> 1. Disconnect the air temperature sensor electrical connector. 2. Twist and pull the upper air temperature sensor from the HVAC module assembly.

DUCT AIR TEMPERATURE SENSOR REPLACEMENT - UPPER LEFT SIDE (LEFT HAND

DRIVE)

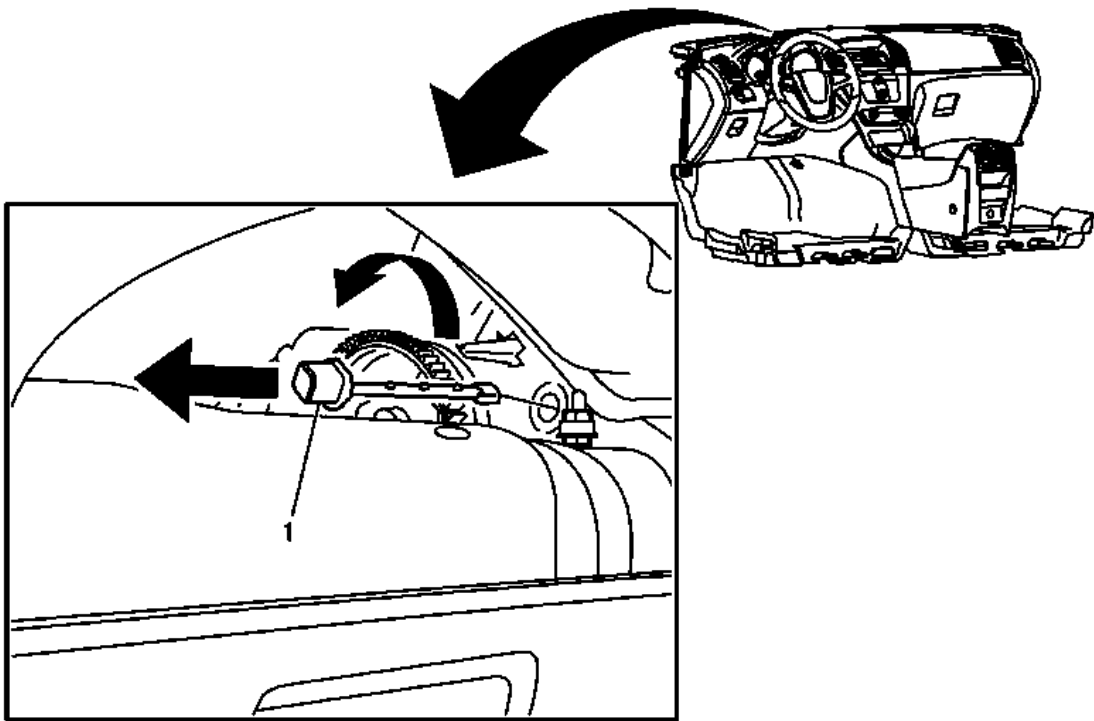


Fig. 21: Duct Air Temperature Sensor - Upper Left Side (Left Hand Drive)
Courtesy of GENERAL MOTORS COMPANY

Duct Air Temperature Sensor Replacement - Upper Left Side (Left Hand Drive)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Remove the instrument panel lower trim panel- driver side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> .2. Remove the floor air outlet duct- left side. Refer to <u>Floor Air Outlet Duct Replacement - Left Side</u> .3. Remove the instrument cluster. Refer to <u>Instrument Cluster Replacement</u> .	
1	<div>Duct Air Temperature Sensor- Upper Left Side</div> <div>Procedure<ol style="list-style-type: none">1. Disconnect the air temperature sensor electrical connector.2. Twist and pull the upper air temperature sensor from the HVAC module assembly.</div>

DUCT AIR TEMPERATURE SENSOR REPLACEMENT - LOWER LEFT SIDE (LEFT HAND DRIVE)

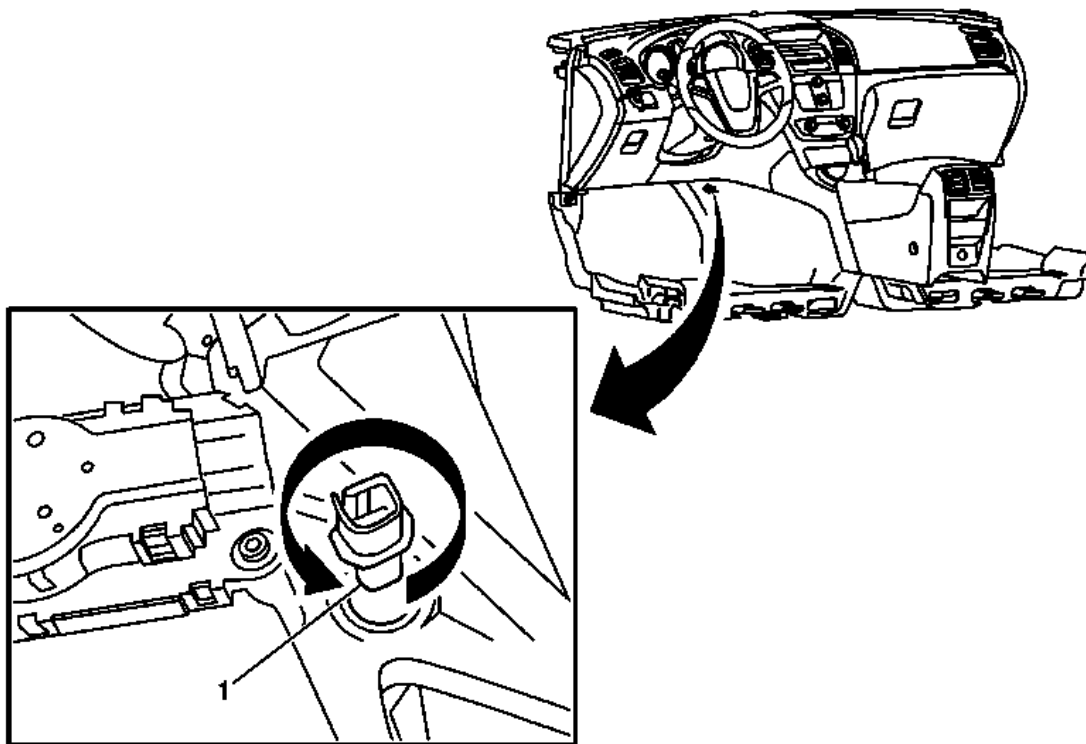


Fig. 22: Duct Air Temperature Sensor - Lower Left Side (Left Hand Drive)
 Courtesy of GENERAL MOTORS COMPANY

Duct Air Temperature Sensor Replacement - Lower Left Side (Left Hand Drive)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the instrument panel lower trim panel- driver side. Refer to <u>Instrument Panel Lower Trim Panel Replacement - Left Side</u> . 2. Remove the floor air outlet duct- left side. Refer to <u>Floor Air Outlet Duct Replacement - Left Side</u> . 	
1	Duct Air Temperature Sensor- Lower Left Side Procedure <ol style="list-style-type: none"> 1. Disconnect the duct air temperature sensor electrical connector. 2. Twist and pull the lower air temperature sensor from the HVAC module assembly.

DUCT AIR TEMPERATURE SENSOR REPLACEMENT - LOWER RIGHT SIDE (LEFT HAND DRIVE WITH CJ2)

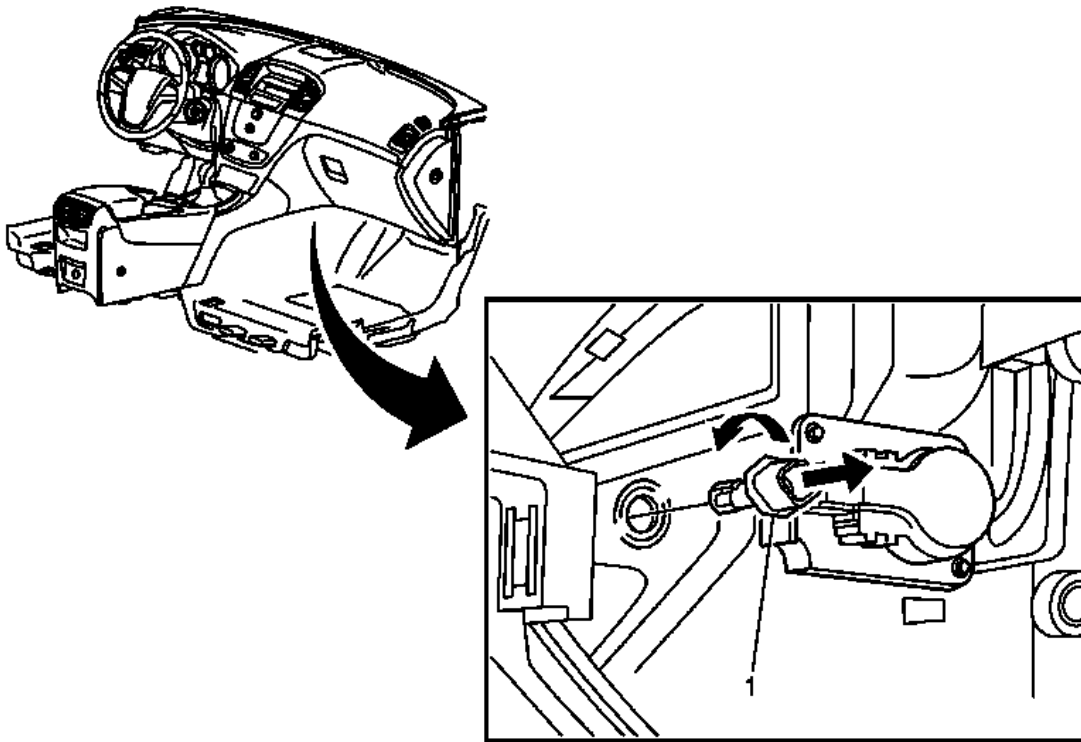


Fig. 23: Duct Air Temperature Sensor - Lower Right Side (Left Hand Drive CJ2)
 Courtesy of GENERAL MOTORS COMPANY

Duct Air Temperature Sensor Replacement - Lower Right Side (Left Hand Drive with CJ2)

Callout	Component Name
Preliminary Procedures	
1. Remove instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> . 2. Remove the floor air outlet duct- right side. Refer to <u>Floor Air Outlet Duct Replacement - Right Side</u> .	
1	Duct Air Temperature Sensor- Lower Right Side Procedure <ol style="list-style-type: none"> 1. Disconnect the duct air temperature sensor electrical connector. 2. Twist and pull the lower air temperature sensor from the HVAC module assembly.

AMBIENT AIR QUALITY SENSOR REPLACEMENT

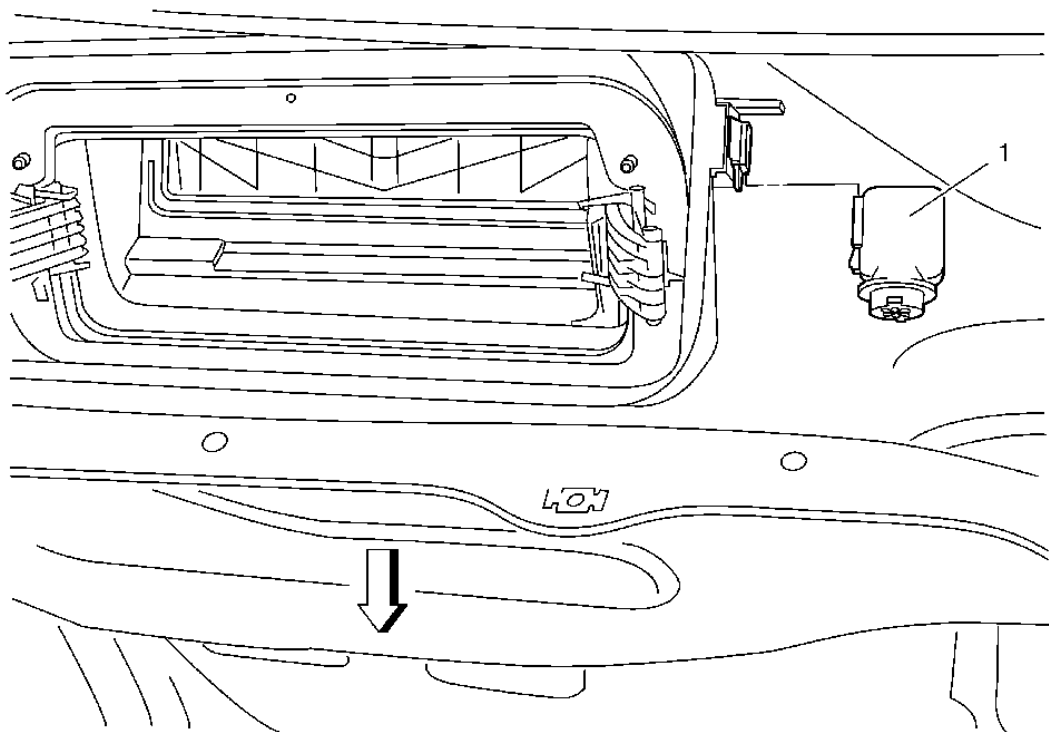


Fig. 24: Ambient Air Quality Sensor
 Courtesy of GENERAL MOTORS COMPANY

Ambient Air Quality Sensor Replacement

Callout	Component Name
Preliminary Procedure	
Remove air inlet panel water deflector. Refer to <u>Air Inlet Grille Panel Water Deflector Replacement</u> .	
1	Ambient Air Quality Sensor Procedures <ol style="list-style-type: none"> 1. Unsnap the ambient air quality sensor and move it forward. 2. Disconnect the electrical connector.

INSIDE AIR MOISTURE AND WINDSHIELD TEMPERATURE SENSOR REPLACEMENT (ASV)

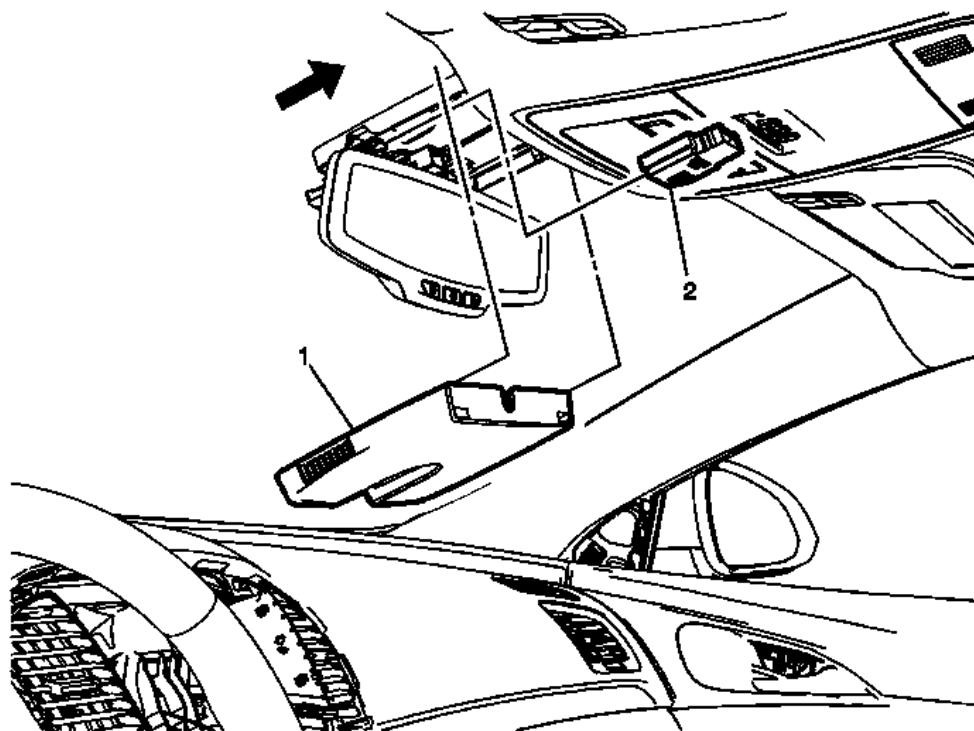


Fig. 25: Inside Air Moisture and Windshield Temperature Sensor (ASV)
Courtesy of GENERAL MOTORS COMPANY

Inside Air Moisture and Windshield Temperature Sensor Replacement (ASV)

Callout	Component Name
1	Inside Rear view Mirror Mount Plate Cover Procedure Unsnap the inside rear view mirror mount plate cover from the windshield inside rear view mirror cover bracket.
2	Inside Air Moisture and Windshield Temperature Sensor Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Pull down the inside air moisture and windshield temperature sensor out slightly, and slide out from the inside rear view mirror cover bracket.

INSIDE AIR MOISTURE AND WINDSHIELD TEMPERATURE SENSOR REPLACEMENT (ASV UFL)

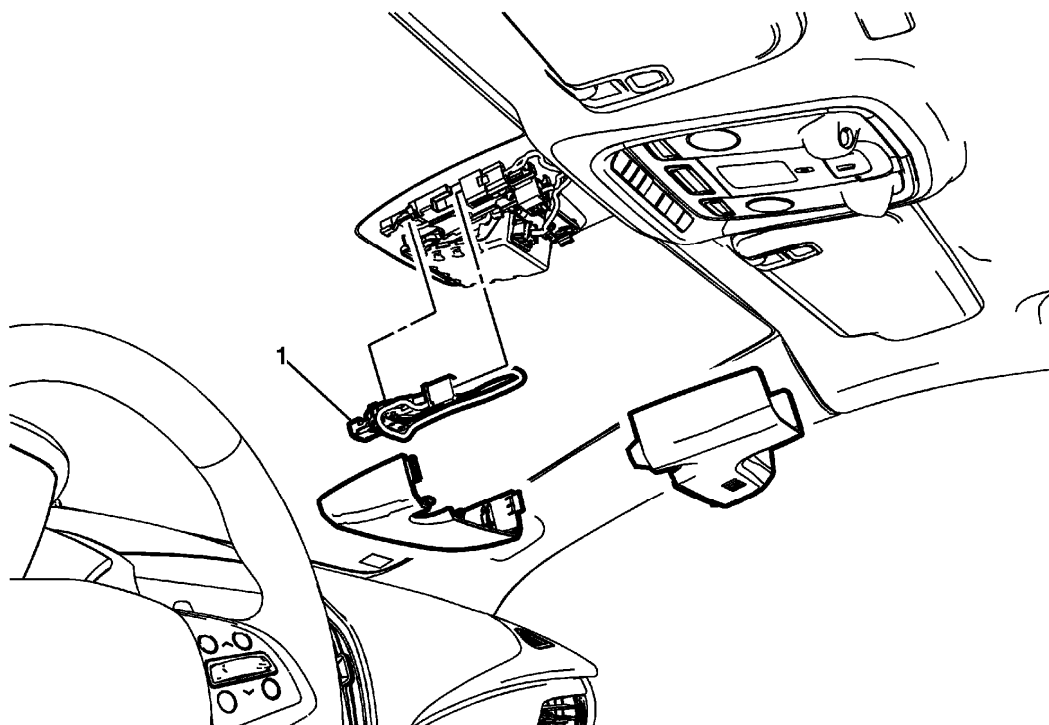


Fig. 26: Inside Air Moisture and Windshield Temperature Sensor (ASV UFL)
Courtesy of GENERAL MOTORS COMPANY

Inside Air Moisture and Windshield Temperature Sensor Replacement (ASV UFL)

Callout	Component Name
Preliminary Procedure	
Remove the inside rearview mirror. Refer to <u>Inside Rearview Mirror Replacement</u> .	
1	Inside Air Moisture and Windshield Temperature Sensor
	Procedures <ol style="list-style-type: none"> 1. Unlatch the inside air moisture and windshield temperature sensor, from the inside rear view mirror support bracket. 2. Disconnect the inside air moisture and windshield temperature sensor connector.

SUN LOAD TEMPERATURE AND HEADLAMP AUTOMATIC CONTROL AMBIENT LIGHT SENSOR REPLACEMENT

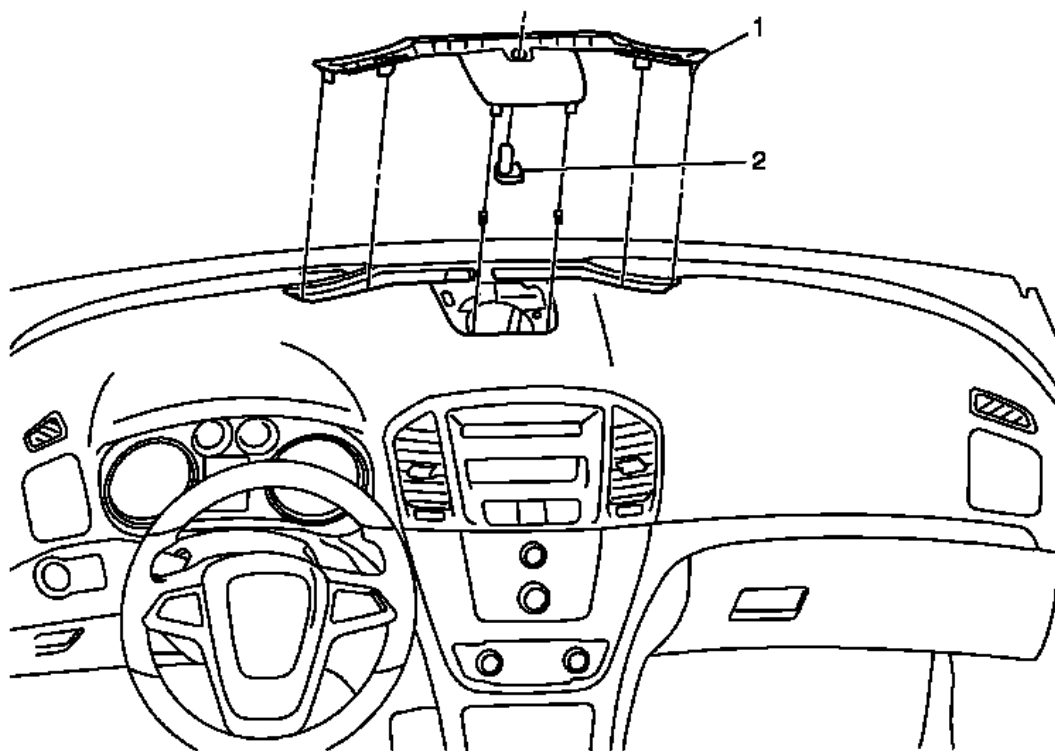


Fig. 27: Headlamp Automatic Control Ambient Light Sensor
 Courtesy of GENERAL MOTORS COMPANY

Sun Load Temperature and Headlamp Automatic Control Ambient Light Sensor Replacement

Callout	Component Name
1	Windshield Defroster Nozzle Grille Retainer (Qty: 8) Procedure Disconnect the electrical connector. TIP: Use a flat-bladed plastic trim tool to aid in the removal of the windshield defroster nozzle grille.
2	Sun Load Temperature and Headlamp Automatic Control Ambient Light Sensor

DESCRIPTION AND OPERATION

AUTOMATIC HVAC DESCRIPTION AND OPERATION

The air temperature and the air delivery description and operation are divided into eight areas:

- HVAC Control Components
- Air Speed
- Air Delivery
- Heating and A/C Operation
- Recirculation Operation
- Automatic Operation

- Engine Coolant
- A/C Cycle

HVAC Control Components

HVAC Controls

The HVAC controls contains all switches, which are required to control the functions of HVAC and serve as interface between the operator and the HVAC control module. The selected values are passed to the HVAC control module via LIN-Bus.

HVAC Control Module

The HVAC control module is a GMLAN device that interfaces between the operator and the HVAC system to maintain and control desired air temperature and air distribution settings. The battery positive voltage circuit provides power that the HVAC control module uses for keep alive memory. If the battery positive voltage circuit loses power, all HVAC DTCs and settings will be erased from keep alive memory. The body control module (BCM), which is the vehicle mode master, provides a device ON-Signal. The HVAC control module provides blower, air delivery mode and air temperature settings.

The HVAC control module supports the following features:

Feature	Availability
Afterblow	Available if reprogrammed by the technician
Personalization	Yes
Actuator Calibration	Yes

Mode Actuator

The mode actuator is a 5-wire stepper motor. The HVAC control module supplies a 12 V reference voltage to the stepper motor and energizes the 4 stepper motor coils with a pulsed ground signal. The stepper motor puts the mode flap into the calculated position in order to reach the selected position. The null point of the stepper motor will be calibrated, if the stepper motor is new. When the stepper motor is calibrated, the HVAC control module can drive the applicable coil to reach exactly the desired position of the flap.

Air Temperature Actuators

The interior temperature can be selected separately for the driver and passenger. For this purpose, two stepper motors are used that regulates two mixed air flaps independently of each other. The air temperature actuators are 5-wire stepper motors. The HVAC control module supplies a 12 V reference voltage to each stepper motor and energizes the 4 stepper motor coils with a pulsed ground signal. The left air temperature actuator moves the left mixed air flap into the calculated position, in order to reach the selected temperature of the left temperature switch. The right air temperature actuator puts the right mixed air flap into the calculated position, in order to reach the selected temperature of the right temperature switch. The null point of the stepper motor will be calibrated, if the stepper motor is new. When the stepper motor is calibrated, the HVAC control module can drive the applicable coil to reach exactly the desired position of the flap.

Recirculation Actuator

The recirculation actuator is a 5-wire stepper motor. The HVAC control module supplies a 12 V reference voltage to the stepper motor and energizes the 4 stepper motor coils with a pulsed ground signal. The stepper motor puts the recirculation flap into the calculated position in order to reach the desired position. The null point of the stepper motor will be calibrated, if the stepper motor is new. When the stepper motor is calibrated, the HVAC control module can drive the applicable coil to reach exactly the desired position of the flap.

Air Inlet Actuator

The air inlet actuator is a 5-wire stepper motor. The HVAC control module supplies a 12 V reference voltage to the stepper motor and energizes the 4 stepper motor coils with a pulsed ground signal. The stepper motor moves the air inlet flap into the calculated position, in order to reach the selected position. The null point of the stepper motor will be calibrated, if the stepper motor is new. When the stepper motor is calibrated, the HVAC control module can drive the applicable coil to reach exactly the desired position of the flap.

Blower Motor Control Module

The blower motor control module controls the speed of the blower motor by increasing or decreasing the voltage drop on the ground side of the blower motor. The HVAC control module provides a low side pulse width modulation (PWM) signal to the blower motor control module via the blower motor speed control circuit. As the requested blower speed increases, the HVAC control module increases the amount of time that the speed signal is modulated to ground. As the requested blower speed decreases, the HVAC control module decreases the amount of time that the signal is modulated to ground.

Air Quality Sensor

The HVAC control module detects exhaust gas by an air quality sensor. The air quality sensor is a 3-wire sensor with an ignition voltage circuit, a ground circuit and a signal circuit. The HVAC control module evaluates the information of the air quality sensor and closes the recirculation flap, while in automatic mode, as soon as the concentration of pollutants exceeds a predefined value.

Duct Temperature Sensors

The air temperature sensors are 2-wire negative temperature co-efficient thermistors. The sensors operate within a temperature range of -40 to +85°C (-40 to +185°F). The sensors are installed in the air distribution ducts and measure the temperature of the air that streams from the ducts. The HVAC control module uses these values to calculate the mixed air flap position.

Evaporator Temperature Sensor

The evaporator temperature sensor is a 2-wire negative temperature co-efficient thermistor. The sensor operates within a temperature range of -40 to +85°C (-40 to +185°F). The sensor is installed at the evaporator and measures its temperature. If the temperature drops under 3°C (38°F), the compressor will be switched off in order to prevent a frozen evaporator.

A/C Refrigerant Pressure Sensor

The A/C refrigerant pressure sensor is a 3-wire piezoelectric pressure transducer. A 5 V reference voltage, low reference, and signal circuits enable the sensor to operate. The A/C pressure signal can be between 0.2-4.8 V. When the A/C refrigerant pressure is low, the signal value is near 0 V. When the A/C refrigerant pressure is high, the signal value is near 5 V. The engine control module (ECM) converts the voltage signal to a pressure value. When pressure is too high or too low, the ECM will not allow the A/C compressor clutch to engage.

A/C Compressor

The A/C compressor is constantly belt driven. The performance of the A/C compressor is regulated per a lifting magnet in the A/C compressor. The HVAC control module supplies battery voltage to the A/C compressor. When the A/C switch is pressed, the HVAC control module provides a pulse width modulation (PWM) signal to the A/C compressor in order to command the performance of the A/C compressor. The performance of the A/C compressor is regulated according to adjusted interior temperature on the basis of characteristic lines. Therefore the HVAC control module grounds the A/C compressor with the PWM signal.

Ambient Light/Sunload Sensor

The ambient light/sunload sensor includes the sunload sensor and passenger compartment temperature sensor.

This sensor assembly provides information about:

- Sun heat intensity
- Elevation
- Azimuth
- Passenger compartment temperature

The sunload sensor is connected to ground and to a 12 V clocked power supply through the HVAC control module. This clocked power supply is to power the sensor electronics and to work as a clock generator to the sunload sensor micro controller. The sensor uses a pulse signal for data identification and transferring the sun intensity measurement. At each positive transition from the clocked supply input, the sunload sensor micro controller will shift channels enabling new intensity measurement on the signal output to the HVAC control module. The signal voltage varies between 0-4 V.

The passenger compartment temperature sensor is a negative temperature co-efficient thermistor. A signal and low reference circuit enables the sensor to operate. As the air temperature increases, the sensor resistance decreases. The sensor signal varies between 0-5 V.

Bright or high intensity light causes the vehicles interior temperature to increase. The HVAC system compensates for the increased temperature by diverting additional cool air into the vehicle.

Heater Core Coolant Pump

The primary purpose of the heater core coolant pump is to circulate engine coolant through the HVAC heater core when heat is required in the cabin for comfort. This normally happens when the vehicle is in an Auto Stop and the mechanical pump is not spinning. If the HVAC control module has determined heat is needed for the cabin, a request is sent via serial data to the engine control module to turn the pump ON. The engine control module controls the auxiliary coolant pump relay via the heater core coolant pump relay control circuit. The

heater core coolant pump relay supplies voltage to the heater core coolant pump.

Air Speed

The blower control switch is part of the HVAC controls. The selected value of the blower switch position is sent to the HVAC control module via LIN-Bus.

The blower motor control module is an interface between HVAC control module and blower motor. The blower motor control module regulates supply voltage and ground circuits to blower motor. The HVAC control module provides a PWM signal to the blower motor control module in order to command the desired blower motor speed. The blower motor control module supplies battery voltage to the blower motor and uses the blower motor ground as a low side control to adjust the blower motor speed. The voltage amounts between 2-13 V and changes linear to the height of the PWM signal.

Air Delivery

The HVAC control module controls the distribution of air by the use of recirculation and mode actuator. The modes that may be selected are:

- Defrost
- Defog
- Panel
- Floor

The desired air distribution mode can be selected with the air distribution switches at the HVAC controls. The HVAC controls delivers the values to the HVAC control module via LIN-Bus. The HVAC control module controls the air distribution actuator so that it drives the flap to the calculated position. Depending on the position of the flap, air is distributed through various ducts leading to the outlets in the dash. Turning the mode flap to the defrost position, the HVAC control module will move the recirculation actuator to outside air, reducing window fogging. When defrost is selected, the blower motor will be activated, regardless of the coolant temperature. The HVAC control module enables a high volume of air delivered to the front defrost vents. A/C is available in all modes.

The rear window defogger does not affect the HVAC system.

Heating and A/C Operation

The purpose of the heating and A/C system is to provide heated and cooled air to the interior of the vehicle. The A/C system will also remove humidity from the interior and reduce windshield fogging. Regardless of the temperature setting, the following can affect the rate that the HVAC system can achieve the desired temperature:

- Recirculation actuator setting
- Difference between inside and desired temperature
- Blower motor speed setting
- Mode setting

When the A/C switch or the AUTO switch is pressed, the HVAC controls send a signal to the HVAC control module via LIN-Bus. The HVAC control module evaluates this signal and sends an A/C request signal to the ECM via CAN-Bus. The ECM checks all preconditions before releasing and if all conditions are met sends a release signal back to the HVAC control module. The A/C compressor is activated by the HVAC control module. The HVAC control module supplies battery voltage to the A/C compressor. When the A/C switch is pressed, the HVAC control module provides a pulse width modulation (PWM) signal to the A/C compressor in order to command the performance of the A/C compressor. The performance of the A/C compressor is regulated according to adjusted interior temperature on the basis of characteristic lines. Therefore the HVAC control module grounds the A/C compressor with the PWM signal.

The following conditions must be met in order to activate the A/C compressor:

- Battery voltage is between 9-18 V
- Engine coolant temperature is less than 124°C (255°F)
- Engine speed is greater than 600 RPM
- Engine speed is less than 5 500 RPM
- A/C high side pressure is between 269-2 929 kPa (39-425 PSI)
- Throttle position is less than 100%
- Evaporator temperature is greater than 3°C (38°F)
- ECM does not detect immoderate torque load
- ECM does not detect insufficient idle quality
- The ambient temperature is above 1°C (34°F)

The sensor information is used by the ECM to determine the following:

- The A/C high side pressure
- An A/C system load on the engine
- An immoderate A/C high side pressure
- The heat load at the A/C condenser

The air streams into the passenger compartment through the heater core and the evaporator core. The air temperature actuator drives the mixed air flap to induce the airflow. If the interior temperature should be increased, the mixed air flap is put into the position in which more air streams through the heater core. If the interior temperature should be decreased, the mixed air flap is put into the position in which more air streams through the evaporator core.

Recirculation Operation

The recirculation switch is integrated into the HVAC controls. The selected recirculation switch position is sent to the HVAC control module via LIN-Bus. The HVAC control module controls the air intake through the air inlet actuator and recirculation actuator. In the recirculation mode the air inlet flap closes and the recirculation flap opens in order to circulate the air within the vehicle. In fresh air mode the air inlet flap opens and the recirculation flap is closed again in order to route outside air into the vehicle. Recirculation is only available if the defrost mode is not active. When the defrost mode is active, the recirculation actuator opens the recirculation flap and the air inlet actuator opens the air inlet flap and outside air is circulated to the windshield

to reduce fogging.

The HVAC control module evaluates the information of the air quality sensor and closes the recirculation flap while in the automatic mode as soon as the concentration of pollutants exceeds a predefined value.

Automatic Operation

In automatic operation, the HVAC control module maintains the comfort level inside of the vehicle by controlling the A/C compressor clutch, the blower motor, the air temperature actuators, mode actuator and recirculation actuator.

To put the HVAC system in automatic mode, the following is required:

1. The auto switch must be activated.
2. The air temperature switch must be in any other position than full hot or full cold position.

Once the desired temperature is reached, the blower motor, mode, recirculation and temperature actuators automatically adjust to maintain the temperature selected. The HVAC control module performs the following functions to maintain the desired air temperature:

- Monitors the following sensors:
 - Ambient air temperature sensor
 - Lower left air temperature sensor
 - Lower right air temperature sensor
 - Upper left air temperature sensor
 - Upper right air temperature sensor
 - Ambient light/sunload sensor
 - Air quality sensor
- Regulate blower motor speed
- Position the air temperature actuators
- Position the mode actuator
- Position the recirculation actuator
- Position the air inlet actuator
- Request A/C operation
- Control of the A/C compressor

When the warmest position is selected in automatic operation the blower speed will increase gradually until the vehicle reaches normal operating temperature. When normal operating temperature is reached the blower stays on high speed and the air temperature actuators stays in the full heat position.

When the coldest position is selected in automatic operation the blower stays on high and the air temperature actuators stay in full cold position. The mode actuator remains in the panel position and the recirculation actuator will remain in the recirculation position.

Under cold ambient temperatures, the automatic HVAC system provides heat in the most efficient manner. The operator can select an extreme temperature setting but the system will not warm the vehicle any faster. Under warm ambient temperatures, the automatic HVAC system also provides air conditioning in the most efficient manner. Selecting an extreme cool temperature will not cool the vehicle any faster.

The HVAC control module evaluates the information of the air quality sensor and closes the recirculation flap while in the automatic mode, as soon as the concentration of pollutants exceeds a predefined value.

Engine Coolant

Engine coolant is the essential element of the heating system. The thermostat controls the normal engine operating coolant temperature. The thermostat also creates a restriction for the cooling system that promotes a positive coolant flow and helps prevent cavitation.

Coolant enters the heater core through the inlet heater hose, in a pressurized state. The heater core is located inside the HVAC module. The ambient air drawn through the HVAC module absorbs the heat of the coolant flowing through the heater core. Heated air is distributed to the passenger compartment, through the HVAC module, for passenger comfort. Opening or closing the air temperature flap controls the amount of heat delivered to the passenger compartment. The coolant exits the heater core through the return heater hose and recirculates back to the engine cooling system.

A/C Cycle

Refrigerant is the key element in an air conditioning system. R-134a is presently the only Environmental Protection Agency approved refrigerant for automotive use. R-134a is a very low temperature gas that can transfer the undesirable heat and moisture from the passenger compartment to the outside air.

The compressor builds pressure on the vapor refrigerant. Compressing the refrigerant also adds heat to the refrigerant. The refrigerant is discharged from the compressor, through the discharge hose, and forced to flow to the condenser and then through the balance of the A/C system. The A/C system is mechanically protected with the use of a high pressure relief valve. If the A/C refrigerant pressure sensor fails or if the refrigerant system becomes restricted and refrigerant pressure continued to rise, the high pressure relief will pop open and release refrigerant from the system.

Compressed refrigerant enters the condenser in a high temperature, high pressure vapor state. As the refrigerant flows through the condenser, the heat of the refrigerant is transferred to the ambient air passing through the condenser. Cooling the refrigerant causes the refrigerant to condense and change from a vapor to a liquid state.

The condenser is located in front of the radiator for maximum heat transfer. The condenser is made of aluminum tubing and aluminum cooling fins, which allows rapid heat transfer for the refrigerant. The semi-cooled liquid refrigerant exits the condenser and flows to the Receiver/Dehydrator(R/D).

The R/D contains desiccant that absorbs moisture that may be in the refrigerant system. The R/D also acts as a storage vessel to ensure that a steady flow of liquid reaches the Thermal Expansion Valve. The refrigerant exits the R/D and flows through the liquid line to the Thermal Expansion Valve.

The Thermal Expansion Valve is located at the front of dash and attaches to the evaporator inlet and outlet pipes. The Thermal Expansion Valve is the dividing point for the high and the low pressure sides of the A/C

system. As the refrigerant passes through the Thermal Expansion Valve, the pressure on the refrigerant is lowered. The Thermal Expansion Valve also meters the amount of liquid refrigerant that can flow into the evaporator.

Refrigerant exiting the Thermal Expansion Valve flows into the evaporator core in a low pressure, liquid state. Ambient air is drawn through the HVAC module and passes through the evaporator core. Warm and moist air will cause the liquid refrigerant boil inside of the evaporator core. The boiling refrigerant absorbs heat from the ambient air and draws moisture onto the evaporator. The refrigerant exits the evaporator through the suction line and back to the A/C compressor, in a vapor state, and completing the A/C cycle of heat removal. At the A/C compressor, the refrigerant is compressed again and the cycle of heat removal is repeated.

The conditioned air is distributed through the HVAC module for passenger comfort. The heat and moisture removed from the passenger compartment will also change form, or condense, and is discharged from the HVAC module as water.

HVAC

HVAC - Manual - Schematic Wiring Diagrams

SCHEMATIC WIRING DIAGRAMS

HVAC WIRING SCHEMATICS

Power, Ground, Serial Data, Blower Control and HVAC Control Inputs

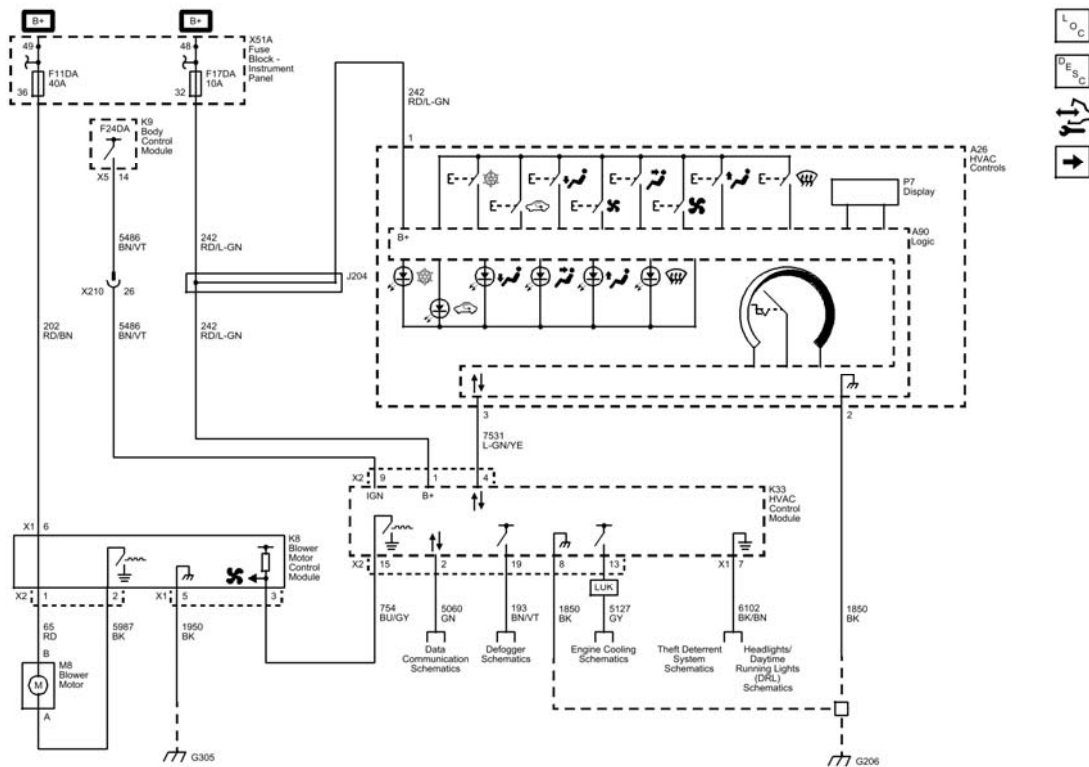


Fig. 1: Power, Ground, Serial Data, Blower Control and HVAC Control Inputs
Courtesy of GENERAL MOTORS COMPANY

Mode and Temperature Control Actuators

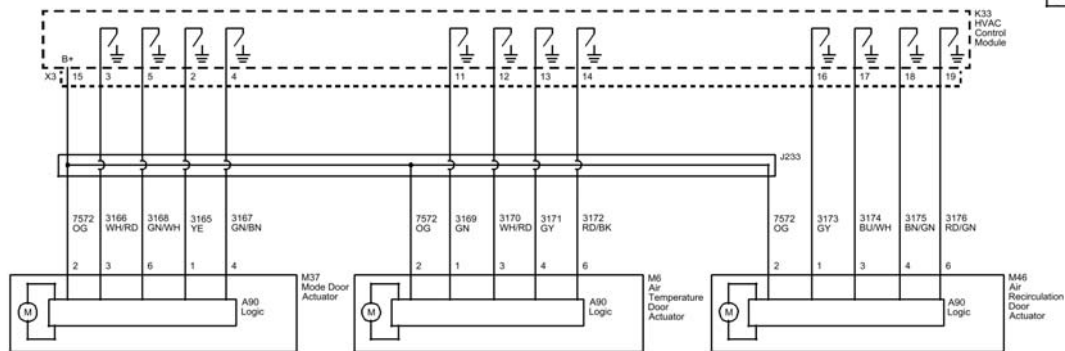


Fig. 2: Mode and Temperature Control Actuators
Courtesy of GENERAL MOTORS COMPANY

Temperature Sensor and Compressor Controls

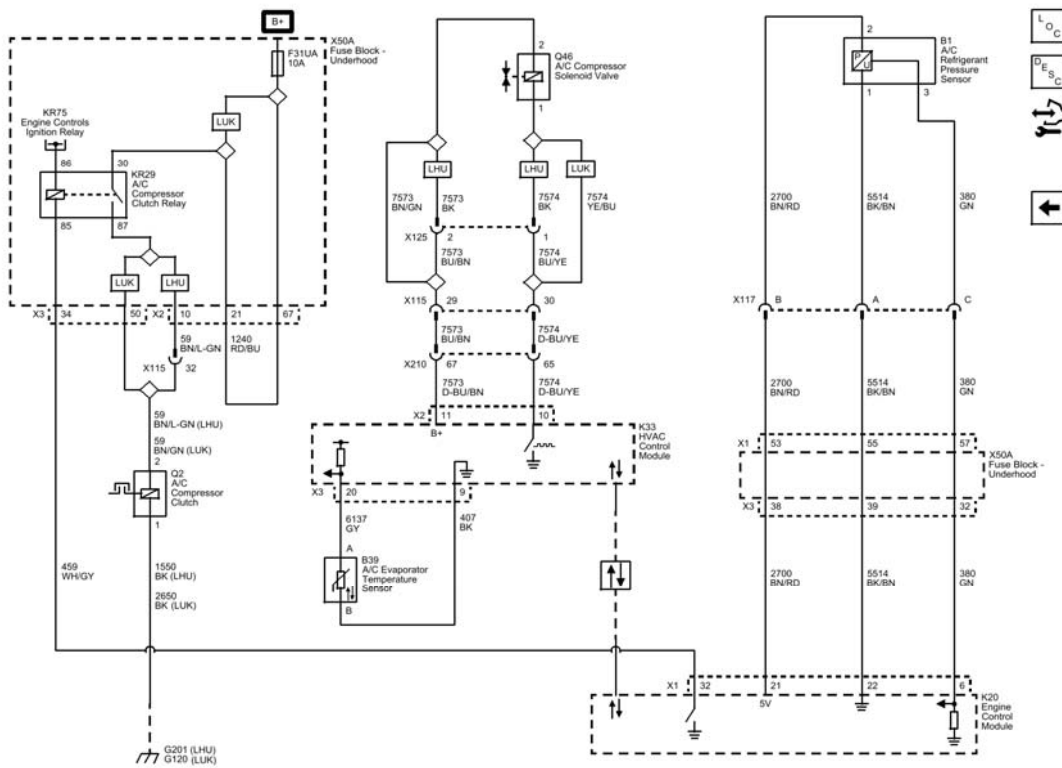


Fig. 3: Temperature Sensor and Compressor Controls
Courtesy of GENERAL MOTORS COMPANY

Engine

Hybrid/EV Controls

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE

Drive Motor Temperature Sensor

°C	°F	OHMS (±10%)
Temperature vs Resistance Values (Approximate)		
220	428	130
210	410	155
200	392	187
190	374	228
180	356	279
170	338	345
160	320	430
150	302	542
140	284	689
130	266	887
120	248	1155
110	230	1525
100	212	2036
90	194	2750
80	176	3775
70	158	5270
60	140	7500
50	122	10,800
40	104	16,050
30	86	24,270
20	68	37,300
10	50	59,100
0	32	96,200
-10	14	162,500
-20	-4	283,600
-30	-22	513,000
-40	-40	965,600

SCHEMATIC WIRING DIAGRAMS

HYBRID/EV CONTROLS WIRING SCHEMATICS

Drive Motor Monitoring

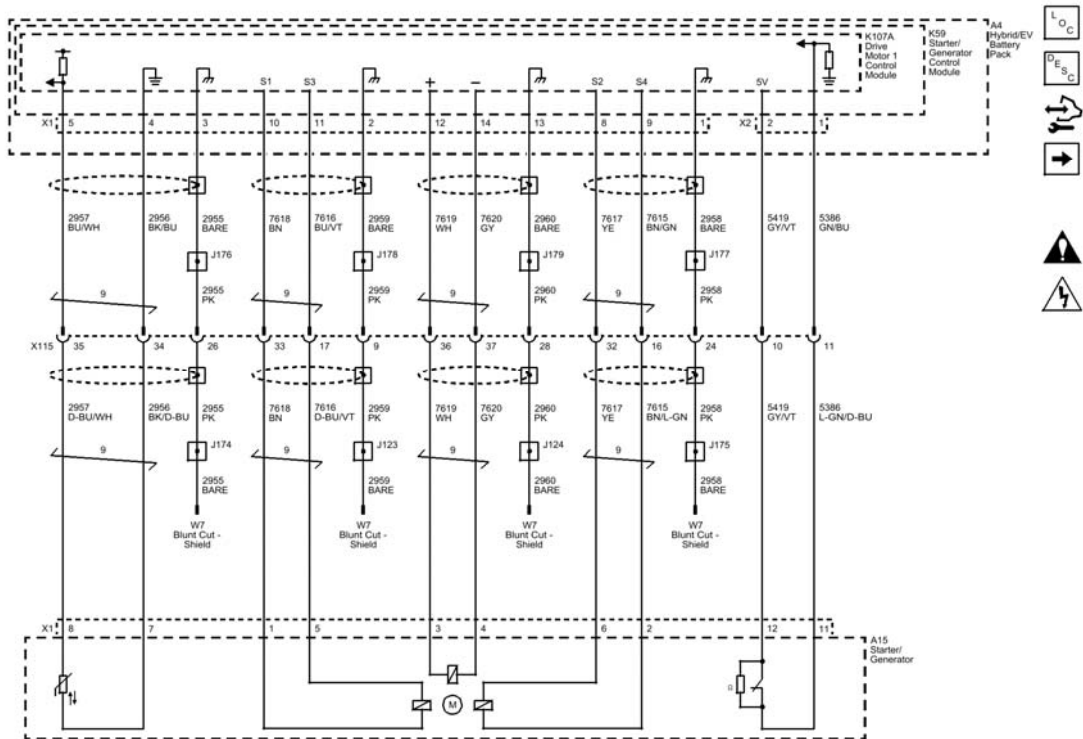


Fig. 1: Drive Motor Monitoring
Courtesy of GENERAL MOTORS COMPANY

Brake Apply and Drive Motor Control

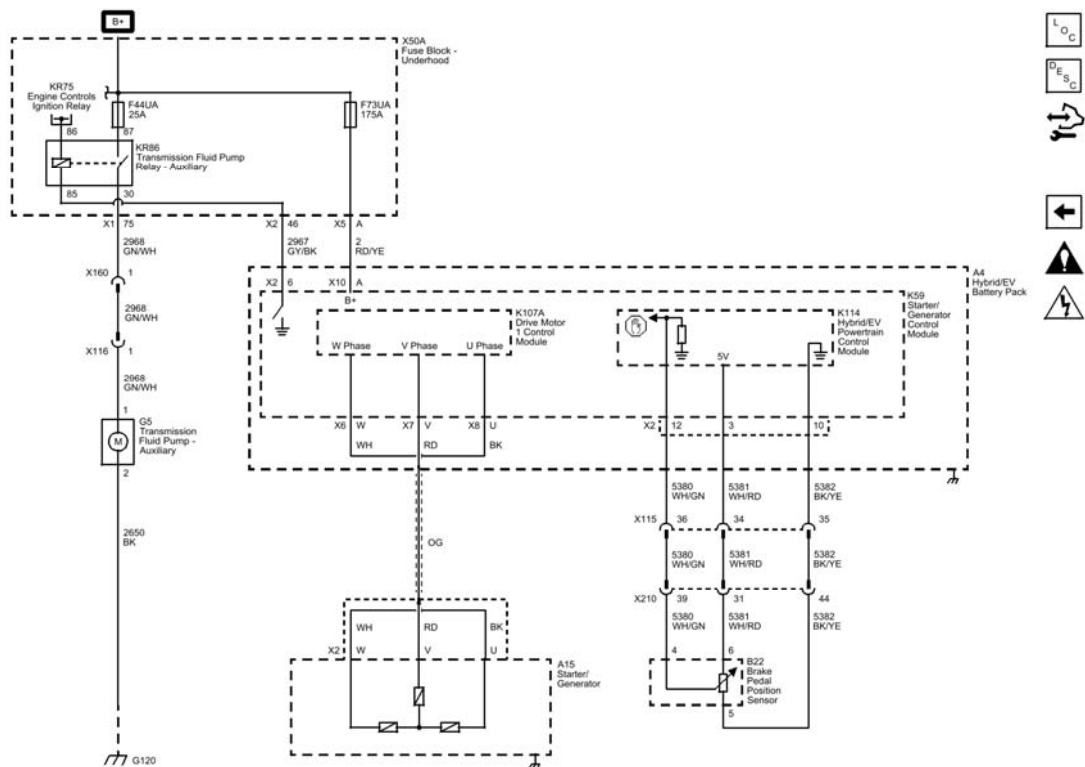


Fig. 2: Brake Apply and Drive Motor Control
 Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

HYBRID CONTROLS COMPONENT VIEWS

Starter Generator, Drive Motor Tensioner, Drive Motor Battery Cable, and Components

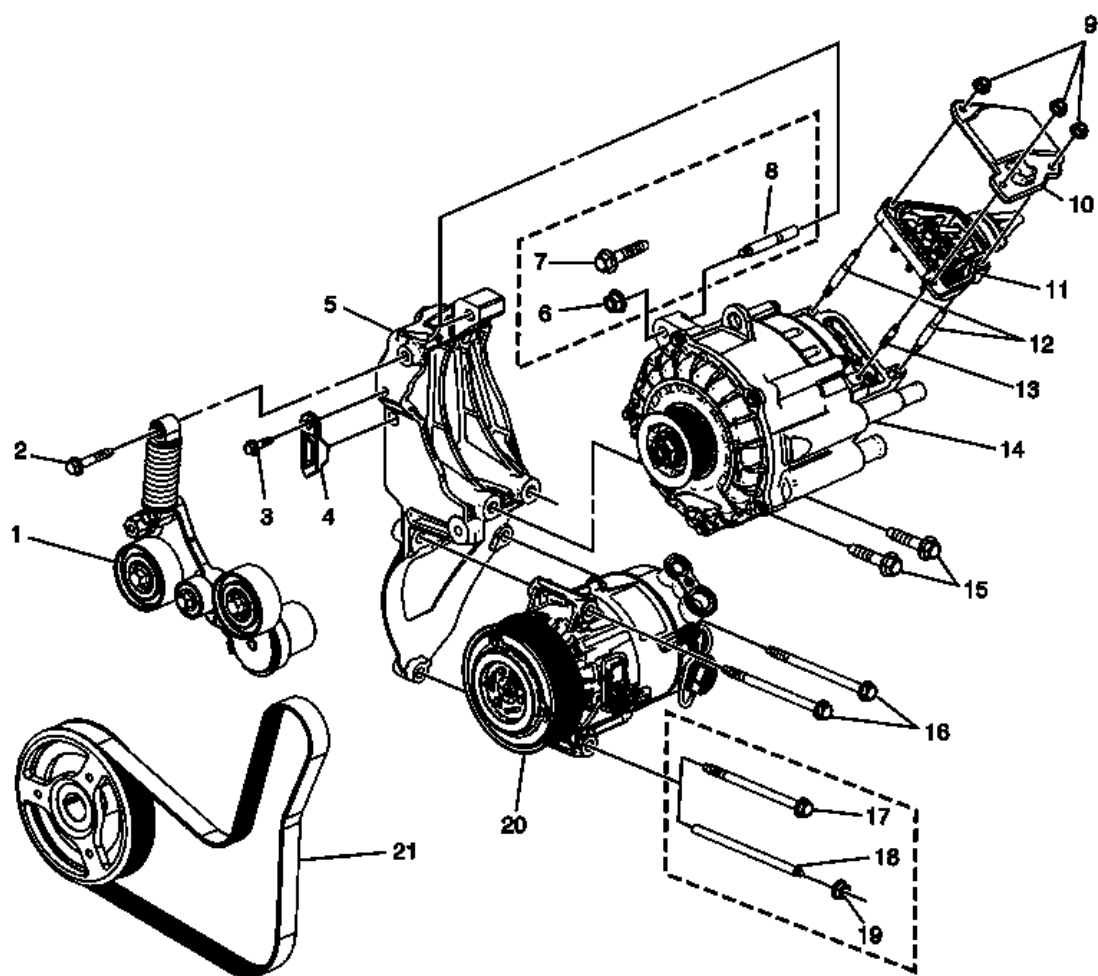


Fig. 3: Starter Generator, Drive Motor Tensioner, Drive Motor Battery Cable, and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Drive Belt Tensioner Assembly
2	Drive Belt Tensioner Bolt
3	Drive Belt Tensioner Stop Bolt
4	Tensioner Stop
5	Generator and A/C Compressor Bracket
6	Starter Generator Nut - Production
7	Starter Generator Bolt - Service
8	Starter Generator Stud - Production
9	Drive Motor Generator Battery Cable Cover Nuts
10	Drive Motor Generator Battery Cable Cover
11	Drive Motor Generator Battery Cable
12	Starter Generator Stud - Long
13	Starter Generator Stud - Short

14	Starter Generator
15	Starter Generator Bolt
16	A/C Compressor Bolts
17	A/C Compressor Bolt - Service
18	A/C Compressor Stud - Production
19	A/C Compressor Nut - Production
20	A/C Compressor
21	Generator and A/C Compressor Belt

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P057B-P057E</u>	DTC P057B Brake Pedal Position Sensor Performance DTC P057C Brake Pedal Position Sensor Circuit Low Voltage DTC P057D Brake Pedal Position Sensor Circuit High Voltage DTC P057E Brake Pedal Position Sensor Circuit Erratic
<u>DTC P0601-P0604, P0606, P061B, P062F, or P262B (Hybrid Powertrain Control Module)</u>	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P0606 Control Module Processor Performance DTC P061B Internal Control Module Torque Calculation Performance DTC P062F Control Module Long Term Memory Performance DTC P262B Control Module Power Off Timer Performance
<u>DTC P0697</u>	DTC P0697 5V Reference 3 Circuit
<u>DTC P06AF</u>	DTC P06AF Torque Management System Performance - Forced Engine Shutdown
<u>DTC P06B1 or P06B2</u>	DTC P06B1 Sensor Supply Positive Voltage Circuit Low Voltage DTC P06B2 Sensor Supply Positive Voltage Circuit High Voltage
<u>DTC P0A1B, P1A50, P1A51, P1ADC, or P1EB6</u>	DTC P0A1B Drive Motor Control Module Performance DTC P1A50 Drive Motor Control Module Random Access Memory DTC P1A51 Drive Motor Control Module Read Only Memory DTC P1ADC Drive Motor Control Module Long Term Memory Performance DTC P1EB6 Drive Motor Control Module Long Term Memory Reset
<u>DTC P0A2B-P0A2D</u>	DTC P0A2B Drive Motor Temperature Sensor Performance DTC P0A2C Drive Motor Temperature Sensor Circuit Low Voltage DTC P0A2D Drive Motor Temperature Sensor Circuit High Voltage
<u>DTC P0A2F</u>	DTC P0A2F Drive Motor High Temperature
<u>DTC P0A3F, P0A40, P0C52, P0C53, P0C5C,</u>	DTC P0A3F Drive Motor Position Sensor Circuit DTC P0A40 Drive Motor Position Sensor Performance

<u>P0C5D, or P1B03</u>	DTC P0C52 Drive Motor Position Sensor Circuit 1 Low Voltage DTC P0C53 Drive Motor Position Sensor Circuit 1 High Voltage DTC P0C5C Drive Motor Position Sensor Circuit 2 Low Voltage DTC P0C5D Drive Motor Position Sensor Circuit 2 High Voltage DTC P1B03 Drive Motor Position Sensor Circuit Tracking Lost
<u>DTC P0A78</u>	DTC P0A78 Drive Motor Inverter Performance
<u>DTC P0A88 or P0A89</u>	DTC P0A88 14V Power Module Input Current Sensor Circuit Low Current DTC P0A89 14V Power Module Input Current Sensor Circuit High Current
<u>DTC P0A8D or P0A8E</u>	DTC P0A8D 14V Power Module System Voltage Low Voltage DTC P0A8E 14V Power Module System Voltage High Voltage
<u>DTC P0A8F</u>	DTC P0A8F 14V Power Module System Voltage Performance
<u>DTC P0A90</u>	DTC P0A90 Drive Motor Performance
<u>DTC P0AB9</u>	DTC P0AB9 Hybrid/EV System Performance
<u>DTC P0AEE, P0AEF, or P0AF0</u>	DTC P0AEE Drive Motor Inverter Temperature Sensor Performance DTC P0AEF Drive Motor Inverter Temperature Sensor Circuit Low Voltage DTC P0AF0 Drive Motor Inverter Temperature Sensor Circuit High Voltage
<u>DTC P0B09</u>	DTC P0B09 Auxiliary Transmission Fluid Pump Supply Voltage Relay Control Circuit
<u>DTC P0BE6-P0BE8, P0BEE, P0BEF, or P0BF0</u>	DTC P0BE6 Drive Motor Phase U Current Sensor Performance DTC P0BE7 Drive Motor Phase U Current Sensor Circuit Low Voltage DTC P0BE8 Drive Motor Phase U Current Sensor Circuit High Voltage DTC P0BEE Drive Motor Phase W Current Sensor Performance DTC P0BEF Drive Motor Phase W Current Sensor Circuit Low Voltage DTC P0BF0 Drive Motor Phase W Current Sensor Circuit High Voltage
<u>DTC P0BFD</u>	DTC P0BFD Drive Motor Phase U-V-W Not Plausible
<u>DTC P0C01</u>	DTC P0C01 Drive Motor High Current
<u>DTC P0C05</u>	DTC P0C05 Drive Motor Phase U-V-W Circuits
<u>DTC P0C0B</u>	DTC P0C0B Drive Motor Inverter Supply Voltage Circuit
<u>DTC P0C11</u>	DTC P0C11 Drive Motor Inverter Phase U High Temperature
<u>DTC P0C19</u>	DTC P0C19 Drive Motor Torque Delivered Performance
<u>DTC P0C76</u>	DTC P0C76 Hybrid/EV Battery System High Voltage Present
<u>DTC P0C9E or P0C9F</u>	DTC P0C9E 14V Power Module Output Current Sensor Circuit Low Current DTC P0C9F 14V Power Module Output Current Sensor Circuit High Current
<u>DTC P0CA2</u>	DTC P0CA2 14V Power Module Step Down Voltage Performance
<u>DTC P0CC5</u>	DTC P0CC5 14V Power Module Input-Output Current Sensors Not Plausible
<u>DTC P15F0</u>	DTC P15F0 Engine Torque Delivered Signal Message Counter Incorrect
<u>DTC P15F4</u>	DTC P15F4 Drive Motor Torque Delivered Signal Message Counter Incorrect
<u>DTC P15F5</u>	DTC P15F5 Crankshaft Torque Command Signal Message Counter Incorrect
<u>DTC P16F3</u>	DTC P16F3 Control Module Redundant Memory Performance
<u>DTC P1A56</u>	DTC P1A56 Hybrid/EV System Voltage Discharge Circuit
<u>DTC P1A6F</u>	DTC P1A6F Drive Motor No Crank at Restart

<u>DTC P1A71-P1A73</u>	DTC P1A71 14V Power Module Temperature Sensor 2 Performance DTC P1A72 14V Power Module Temperature Sensor 2 Circuit Low Voltage DTC P1A73 14V Power Module Temperature Sensor 2 Circuit High Voltage
<u>DTC P1A90-P1A92</u>	DTC P1A90 14V Power Module Temperature Sensor 1 Performance DTC P1A91 14V Power Module Temperature Sensor 1 Circuit Low Voltage DTC P1A92 14V Power Module Temperature Sensor 1 Circuit High Voltage
<u>DTC P1ADE or P1ADF</u>	DTC P1ADE Drive Motor Control Module System Voltage Low Voltage DTC P1ADF Drive Motor Control Module System Voltage High Voltage
<u>DTC P1AE8 or P1AE9</u>	DTC P1AE8 Drive Motor Control Module Hybrid/EV Battery Voltage Sense Circuit Low Voltage DTC P1AE9 Drive Motor Control Module Hybrid/EV Battery Voltage Sense Circuit High Voltage
<u>DTC P1AEC or P1AEE</u>	DTC P1AEC Drive Motor Control Module Hybrid/EV Battery System Voltage DTC P1AEE Drive Motor Control Module Hybrid/EV Battery System Voltage High Voltage
<u>DTC P1AF0</u>	DTC P1AF0 Drive Motor Control Module Hybrid/EV Battery Voltage System Isolation Lost
<u>DTC P1AF4 or P1AF5</u>	DTC P1AF4 Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage DTC P1AF5 Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage
<u>DTC P1B0B or P1B0C</u>	DTC P1B0B Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage DTC P1B0C Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage
<u>DTC P1B0D</u>	DTC P1B0D Drive Motor Control Module Drive Motor Overspeed
<u>DTC P1B41</u>	DTC P1B41 Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Performance
<u>DTC P1E0A</u>	DTC P1E0A Drive Motor Control Module Torque Calculation Performance
<u>DTC P1E3B</u>	DTC P1E3B Drive Motor Rotor High Temperature
<u>DTC P1E3C</u>	DTC P1E3C Control Module Calculated Hybrid/EV Battery Performance
<u>DTC P2534 or P2535</u>	DTC P2534 Ignition On/Start Switch Circuit Low Voltage DTC P2535 Ignition On/Start Switch Circuit High Voltage
<u>DTC P2537</u>	DTC P2537 Ignition Accessory Switch Circuit Low Voltage
<u>DTC P2797</u>	DTC P2797 Auxiliary Transmission Fluid Pump Performance

DTC P057B-P057E: BRAKE PEDAL POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P057B

Brake Pedal Position Sensor Performance

DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

DTC P057E

Brake Pedal Position Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Pedal Position Sensor 5 V Reference	P057C, P0641, P1B3F	P057C	P057C, P0641	-
Brake Pedal Position Sensor Signal	P057C	P057C	P057D	P057E, P057B
Brake Pedal Position Sensor Low Reference	-	P057D	-	-

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The brake pedal position (BPP) sensor is used to sense the action of the driver application of the brake pedal. The BPP sensor provides an analog voltage signal that will increase as the brake pedal is applied. The BPP sensor contains two independent sensor assemblies. The hybrid powertrain control module located in the generator control module, and the body control module are connected to their respective sensor assembly. Each module provides a low reference signal and a 5-volt reference voltage to their respective BPP sensor. The hybrid powertrain control module also monitors the PRNDL state for inferred brake pedal application when transitioning in and out of the Park position.

Conditions for Running the DTC

- Ignition voltage must be greater than 10 V.
- Drive motor control and hybrid powertrain control module are awake.

P057B

- Vehicle speed is greater than 5 km/h (3 mph).
- Transmission is not in Park.
- Accelerator pedal position less than 5 percent.
- DTCs P0722, P0723, P077C, P077D, U0101, U0073, P182E, P1915, P2122, P2123, P2127, P2128 or P2138 not set.

Conditions for Setting the DTC

DTC P057B

The hybrid powertrain control module detects no change in brake pedal position after brake applied.

DTC P057C

- The hybrid powertrain control module detects a short to voltage in the BPP sensor 5 V reference circuit.
- The hybrid powertrain control module detects a short to ground or an open/high resistance in the BPP sensor 5 V reference circuit.
- The hybrid powertrain control module detects a short to ground or an open/high resistance in the BPP sensor signal circuit.

DTC P057D

- The hybrid powertrain control module detects a short to voltage in the BPP sensor signal circuit.
- The hybrid powertrain control module detects an open/high resistance in the BPP sensor low reference circuit.

DTC P057E

The hybrid powertrain control module detects the BPP sensor signal is changing faster than possible under normal operating conditions.

Actions Taken When the DTC Sets

- The hybrid powertrain control module disables the following functions: Autostop, Autostart, and Regenerative Braking.
- DTC P057B is a type A DTC.
- DTCs P057C-P057E are type B DTCs.

Conditions for Clearing the DTC

- DTC P057B is a type A DTC.
- DTCs P057C-P057E are type B DTCs.

Diagnostic Aids

P057B

Inspect the connector at the Brake Pedal Position sensor for a high resistance connection.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- Exterior Lighting Systems Description and Operation
- Starter Generator Description and Operation
- Generator Control Module Description and Operation
- Hybrid Modes of Operation Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

DTC P057C and P057D

1. Verify that DTC P0562 or P0563 is not set.
 - If DTC P0562 or P0563 is set, refer to DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563 for Hybrid (HP6).
2. Ignition OFF, disconnect the harness connector at the B22 brake pedal position sensor.
3. Ignition ON, verify that a test lamp illuminates between B+ and the low reference circuit terminal 5.
 - If the test lamp does not illuminate, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.

4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 6 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K59 starter generator control module.
5. Test for less than 0.3 V between the signal circuit terminal 4 and ground.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K59 starter generator control module.
6. Test for 4.8-5.2 V between the 5 V reference circuit terminal 6 and the signal circuit terminal 4.
 - If less than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
7. Ignition OFF, disconnect the X2 harness connector at the K59 starter generator control module.
8. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than the specified range, test the signal circuit for a short to ground.
9. If all circuits test normal, replace the B22 brake pedal position sensor.

DTC P057B

Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.

- If DTC P057B resets as current, replace the B22 brake pedal position sensor.

DTC P057E

1. Replace the brake pedal position sensor.
2. Perform the brake pedal position sensor calibration procedure. Refer to **Brake Pedal Position Sensor Calibration**.
3. Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.
 - If DTC P057E resets as current, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Brake Pedal Position Sensor Calibration**
- **Brake Pedal Position Sensor Replacement**
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup

DTC P0601-P0604, P0606, P061B, P062F, OR P262B (HYBRID POWERTRAIN CONTROL MODULE): CONTROL MODULE MEMORY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P061B

Internal Control Module Torque Calculation Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P262B

Control Module Power Off Timer Performance

Circuit/System Description

The starter/generator control module, often referred to as the generator control module, is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non-serviceable parts of the starter/generator control module. This is an internal fault detection of the starter/generator control module and no external circuits are involved.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is greater than 9.5V.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

P0602

A service module has been installed but not yet programmed.

Action Taken When the DTC Sets

- DTCs P0601-P0604, P0606, P061B, and P062F are Type A DTCs.
- DTC P262B is a Type B DTC.

P0601, P0602, P0604, P0606, P061B, and P262B

The hybrid powertrain control module requests the high voltage contactor relay open.

Conditions for Clearing the DTC

- DTCs P0601-P0604, P0606, P061B, and P062F are Type A DTCs.
- DTC P262B is a Type B DTC.

Diagnostic Aids

DTC P0606 may cause DTCs U0073, U0074, U0293, U1817 to set.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify DTC P0562 is not set.

- **If DTC is set**

Refer to **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563** .

- **If the DTC does not set**

2. Verify P0601-P0604, P0606, P061B, P062F, or P262B is not set.

- **If any of the DTCs are set**

1. Program the K59 Starter/Generator Control Module.
2. Verify the DTC does not set.
 - If the DTC sets, replace the K59 Starter/Generator Control Module.
 - If the DTC does not set
3. All OK.

- **If none of the DTCs are set**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for K59 Starter/Generator Control Module, often referred to as the Generator Control Module, replacement, programming and setup.

DTC P0697: 5V REFERENCE 3 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0697

5V Reference 3 Circuit

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module has three internal 5 V reference circuits. Each internal reference circuit provides a 5 V reference for one or more sensors. A short to ground or short to voltage on one external 5 V

reference circuit can affect all components connected to the same internal 5 V reference circuit.

Conditions for Running the DTC

- Ignition is on.
- Ignition voltage is greater than 10 V.

Conditions for Setting the DTC

The hybrid powertrain control module detects a voltage out of range on the 5 V reference 3 circuit for greater than 5 seconds.

Action Taken When the DTC Sets

DTC P0697 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0697 is a Type B DTC.

Diagnostic Aids

The 5 V reference 3 circuit provides 5 V to internal circuitry contained in the generator control module.

Reference Information

Schematic Reference

- **Hybrid/EV Controls Schematics**
- **Hybrid/EV Energy Storage Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P06AF: TORQUE MANAGEMENT SYSTEM PERFORMANCE - FORCED ENGINE SHUTDOWN

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P06AF

Torque Management System Performance - Forced Engine Shutdown

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module monitors a state of health message that the ECM transmits to verify the ECM is functioning properly.

Conditions for Running the DTC

- Ignition is On.
- The system voltage is greater than 9.5 V.

Conditions for Setting the DTC

The hybrid powertrain control module does not detect a valid state of health message from the ECM.

Action Taken When the DTC Sets

DTC P06AF is a Type A DTC.

Conditions for Clearing the DTC

DTC P06AF is a Type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. Verify that ECM DTC P0606 is not set.
 - If the DTC is set, Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the K59 starter generator control module X3 connector and the K20 ECM X1 connector.
3. Test for less than 1 ohms between the serial data circuits listed below:
 - K59 starter generator control module X3 connector terminal 16 and K20 ECM X1 connector terminal 36
 - K59 starter generator control module X3 connector terminal 17 and K20 ECM X1 connector terminal 37
 - If greater than the specified range, test the serial data circuit for an open/high resistance condition. If the circuit tests normal, replace the K20 ECM.
4. If the DTC resets, program the K59 starter generator control module. If the DTC resets, replace the K59

starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for ECM or Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P06B1 OR P06B2: SENSOR SUPPLY POSITIVE VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06B1

Sensor Supply Positive Voltage Circuit Low Voltage

DTC P06B2

Sensor Supply Positive Voltage Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The motor control modules are part of the generator control module. The drive motor control module uses an internal 15 V reference power supply in order to operate the drive motor sensors and processor. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

The drive motor control module is awake.

Conditions for Setting the DTC

P06B1

The reference voltage is less than 9.7 V for 1 second.

P06B2

The reference voltage is greater than 18 V for 1 second.

Action Taken When the DTC Sets

DTCs P06B1 and P06B2 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P06B1 and P06B2 are Type B DTCs.

Diagnostic Aids

This DTC may set due to low or high 12 V system voltage.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

Verify P0562 or P0563 is not set.

- If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
- If DTC P06B1 or P06B2 is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup

DTC P0A1B, P1A50, P1A51, P1ADC, OR P1EB6: DRIVE MOTOR CONTROL MODULE MEMORY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0A1B

Drive Motor Control Module Performance

DTC P1A50

Drive Motor Control Module Random Access Memory

DTC P1A51

Drive Motor Control Module Read Only Memory

DTC P1ADC

Drive Motor Control Module Long Term Memory Performance

DTC P1EB6

Drive Motor Control Module Long Term Memory Reset

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This fault is handled inside the drive motor control module and no external circuits are involved.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 9.5 V.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

DTCs P0A1B, P1A50, P1A51, P1ADC and P1EB6 are Type A DTCs.

P0A1B, P1A50, and P1A51

The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTCs P0A1B, P1A50, P1A51, P1ADC and P1EB6 are Type A DTCs.

Diagnostic Aids

DTC P0A1B may cause DTCs U0073, U0074, U0293, U1817 to set.

Reference Information

Description and Operation

- Starter Generator Description and Operation
- Generator Control Module Description and Operation
- Hybrid Modes of Operation Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0A2B-P0A2D: DRIVE MOTOR TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0A2B

Drive Motor Temperature Sensor Performance

DTC P0A2C

Drive Motor Temperature Sensor Circuit Low Voltage

DTC P0A2D

Drive Motor Temperature Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Motor Temperature Sensor Signal	P0A2C	P0A2D	P0A2D	P0A2B
Motor Temperature Sensor Low Reference	-	P0A2D	-	P0A2B

Typical Scan Tool Data

Drive Motor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON Parameter Normal Range: -39°C (-38°F) to 214°C (417°F)			
Motor Temperature Signal	215°C (419°F)	-40°C (-40°F)	Sensor Damage Possible
Motor Temperature Sensor Low Reference	-	-40°C (-40°F)	-

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The motor temperature sensor is a non-serviceable part of the starter generator assembly, often referred to as the drive motor assembly. The motor temperature sensor is a thermistor, or a resistor that changes value when the temperature changes. The motor temperature sensor is located in the stator. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, and as the temperature decreases, the resistance increases. The motor control module supplies a 5 V reference signal to the sensor and measures the voltage drop in the circuit. When the motor is cold, the sensor resistance is high. As the motor temperature increases, the resistance of the sensor decreases, which lowers the signal voltage.

Conditions for Running the DTC

P0A2B

- DTC P0A2B, P0A2C, P0A2D, P0A2F, P0AEE, P0AEF, P0AF0, P1A71, P1A72, P1A73, P1A90, P1A91, P1A92, P0C11, or P262B is not set.
- The Engine off time is greater than 8 hours.
- The Ignition is ON.
- Ignition voltage is between 9-16V.

P0A2C

The drive motor control module and the hybrid powertrain control module are awake.

P0A2D

Vehicle has been driven with starter generator torque greater than 10 N.m (89 lb in) for at least 90 seconds.

Conditions for Setting the DTC

P0A2B

The Motor temperature is more than 25°C (45°F) greater than the average of the 14 volt power module temperature sensors and the power inverter module temperature.

P0A2C

Motor temperature sensor signal is greater than 215°C (419°F) for 1 second.

P0A2D

Motor temperature sensor signal is less than -40°C (-40°F) for 1 second after a warm up condition when drive motor generator torque is greater than 10 N.m (89 lb in) for 90 seconds.

Action Taken When the DTC Sets

DTCs P0A2B-P0A2D are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0A2B-P0A2D are Type B DTCs.

Diagnostic Aids

The motor temperature sensor can be damaged by excessive electric current. Test the sensor for an open condition whenever a short to voltage condition is observed.

Reference Information

Schematic Reference

- **Hybrid/EV Controls Schematics**
- **Hybrid/EV Energy Storage Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

P0A2B-P0A2D

1. Allow the vehicle to cool to ambient temperature by leaving the ignition OFF for at least 8 hours.
2. Ignition ON, observe the motor temperature scan tool parameters.

The temperature parameter should be within 25°C (45°F) of ambient temperature.

Circuit/System Testing

1. Ignition OFF, disconnect the starter generator X1 harness connector from the A15 starter generator.
2. Ignition ON, test the harness side for less than 12 ohms between the low reference circuit terminal 7 and

ground.

- If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
- 3. Ignition ON, verify the scan tool motor temperature sensor parameter is -40°C (-40°F).
 - If more than the specified value, test the motor temperature sensor signal circuit for a short to ground. If the circuit tests normal, replace the K59 starter generator control module.
- 4. Install a 3-amp fused jumper wire between the signal circuit X1 terminal 8 and the low reference circuit X1 terminal 7 at the A15 starter generator. Verify the scan tool motor temperature sensor parameter is greater than 214°C (417°F):

NOTE: If a short to voltage is found, test the motor temperature sensor for an open circuit or physical damage.

- If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K59 starter generator control module.
- 5. Ignition OFF, measure and record the resistance between the sensor signal and low reference terminals. Compare the actual sensor and circuit resistance to the expected sensor resistance. Refer to **Temperature Versus Resistance**.
 - If the resistance is not near the expected value, replace the A15 starter generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Generator Replacement** for Drive Motor replacement
- **Control Module References** for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P0A2F: DRIVE MOTOR HIGH TEMPERATURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0A2F

Drive Motor High Temperature

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following

three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The starter generator is also referred to as the drive motor. The drive motor temperature sensor is a variable resistor that measures the temperature of the drive motor stator windings. The hybrid powertrain control module supplies 5 V to the signal circuit and a ground for the low reference circuit. The drive motor temperature sensor resistance changes with drive motor coolant temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The hybrid powertrain control module monitors the drive motor temperature sensor to determine the temperature of the drive motor.

Conditions for Running the DTC

- DTC P0A2B, P0A2C, and P0A2D is not set.
- The drive motor control module and hybrid powertrain control module are awake.

Conditions for Setting the DTC

The motor temperature sensor is greater than 165°C (329°F) for 5 seconds.

Action Taken When the DTC Sets

- DTC P0A2F is a Type B DTC.
- The hybrid powertrain control module system starts to reduce the maximum torque beginning at 155°C (311°F) down to 0 N.m as the drive motor stator temperature approaches 165°C (329°F).

Conditions for Clearing the DTC

DTC P0A2F is a Type B DTC.

Diagnostic Aids

- Ask about the customer's driving habits, trailer towing, etc.
- Ensure the engine cooling system is functioning normally.
- Ensure the starter generator cooling system is functioning normally.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Check the cooling system for the correct amount of coolant. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
2. Verify that DTC P0A2C is not set.
 - If DTC P0A2C is set, Refer to **DTC P0A2B-P0A2D**.
3. Ignition ON, observe the scan tool motor temperature parameter. The reading should be less than 165°C (329°F). If greater than the specified value, replace the starter generator assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Starter Generator Replacement for Drive Motor replacement

DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, OR P1B03: DRIVE MOTOR POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0A3F

Drive Motor Position Sensor Circuit

DTC P0A40

Drive Motor Position Sensor Performance

DTC P0C52

Drive Motor Position Sensor Circuit 1 Low Voltage

DTC P0C53

Drive Motor Position Sensor Circuit 1 High Voltage

DTC P0C5C

Drive Motor Position Sensor Circuit 2 Low Voltage

DTC P0C5D

Drive Motor Position Sensor Circuit 2 High Voltage

DTC P1B03

Drive Motor Position Sensor Circuit Tracking Lost

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal* S1/S3	P0C5C, P0A3F, P0A40, P1B03	P1B03, P0A3F	P0C53, P0A3F	P1B03, P0A40
Signal* S2/S4	P0C52, P0A3F, P0A40, P1B03	P1B03, P0A3F	P0C5D, P0A3F	P1B03, P0A40
Reference* +/-	P0A3F, P0A40, P1B03	P0A3F	P0A3F	P1B03, P0A40
* Represents a differential circuit consisting of a pair of wires. See Circuit/System Description and schematic for detailed description.				

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The generator control module monitors the angular position, speed and direction of the starter generator rotor based upon the signals of the resolver-type motor position sensor. The position sensor contains a drive coil, two driven coils, and an irregular shaped metallic rotor. The metallic rotor is mechanically attached to the shaft of the starter generator.

At ignition ON, an AC voltage, 10 kHz excitation signal is output to the drive coil. The drive coil excitation signal creates a magnetic field surrounding the two driven coils and the irregular shaped rotor. The generator control module then monitors the two driven coil circuits for a return signal. The position of the irregular metallic rotor causes the magnetically-induced return signals of the driven coils to vary in size and shape. A comparison of the two driven coils signals allows the generator control module to determine the exact position, speed and direction of the starter generator rotor. The position sensor is a non-serviceable part of the starter generator.

Conditions for Running the DTC

- Ignition voltage is greater than 9.5V.
- The drive motor control module and hybrid powertrain control module are awake.

Conditions for Setting the DTC

P0A3F

Sin or Cos signal is less than 2.3V.

P0A40

Sin or Cos signal is greater than 4V.

P0C52

Drive Motor Position Sensor Circuit 1 reference voltage is less than 0.5 V.

P0C53

Drive Motor Position Sensor Circuit 1 reference voltage is greater than 4.5 V.

P0C5C

Drive Motor Position Sensor Circuit 2 reference voltage is less than 0.5 V.

P0C5D

Drive Motor Position Sensor Circuit 2 reference voltage is greater than 4.5 V.

P1B03

The generator control module tracking error is greater than 5 degrees.

Action Taken When the DTC Sets

- DTCs P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, and P1B03 are Type B DTCs.
- Starter generator operation is disabled.
- Autostop operation is disabled.
- Autostart operation is disabled.
- 14 volt power module remains active until hybrid battery power is depleted, or 14 volt power module power limits are exceeded, after which the high voltage contactor's relay is opened.

Conditions for Clearing the DTC

DTCs P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, and P1B03 are Type B DTCs.

Diagnostic Aids

- The starter generator position sensor circuits operate at very low current. These circuits are susceptible to moisture intrusion, coolant contamination, corrosion, and terminal damage. Extreme care must be taken when removing the starter generator, probing terminals and manipulating harnesses. Poor terminal connections can result in intermittent operation.
- If the customer comments that the problem occurs only during moist environmental conditions: rain, snow, vehicle wash, etc., inspect the sensor wiring and seals for signs of water intrusion.
- The sensor and reference circuit loops are a twisted pair with each pair covered in a grounded foil shield.
- The shield circuits are grounded inside the drive motor control module. Improperly grounded shield circuits may cause inaccurate sensor signals.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: You must perform the Component Testing before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the X1 harness connector at the A15 Starter Generator.
2. Ignition ON.
3. Test for 1.7-3.2 V between the signal circuit terminals listed below and ground:
 - Signal (S1) circuit terminal 1
 - Signal (S3) circuit terminal 5
 - Signal (S2) circuit terminal 6
 - Signal (S4) circuit terminal 2
 - **If less than 1.7 V**
1. Vehicle OFF, disconnect the X1 harness connector at the K59 Starter Generator Control Module.

NOTE: The following test must be performed at the K59 Starter Generator Control Module end of the wiring harness.

2. Test for infinite resistance between the appropriate signal circuit and the ground circuit listed below:
 - Signal (S1) circuit terminal 10 and ground circuit terminal 2
 - Signal (S3) circuit terminal 11 and ground circuit terminal 2
 - Signal (S2) circuit terminal 8 and ground circuit terminal 1
 - Signal (S4) circuit terminal 9 and ground circuit terminal 1
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for infinite resistance between the signal circuit and chassis ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter Generator Control Module.
 - **If greater than 3.2 V**
1. Ignition OFF, disconnect the X1 harness connector at the K59 Starter Generator Control Module, Ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K59 Starter Generator Control Module.
 - **If between 1.7-3.2 V**
4. Test for 6.5-8.5 V between the reference circuit terminals listed below and ground:

- Reference terminal 3
- Reference terminal 4
- **If less than 6.5 V**

1. Ignition OFF, disconnect the X1 harness connector at the K59 Starter Generator Control Module.

NOTE: The following test must be performed at the K59 Starter Generator Control Module end of the wiring harness.

2. Test for infinite resistance between the reference circuit and the following ground paths:

- Chassis ground
- Ground circuit terminal 13
- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 ohms in the reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K59 Starter Generator Control Module.

- **If greater than 8.5 V**

1. Ignition OFF, disconnect the X1 harness connector at the K59 Starter Generator Control Module, Ignition ON.

2. Test for less than 1 V DC between the reference circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K59 Starter Generator Control Module.

- **If between 6.5-8.5 V**

5. Verify DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, or P1B03 is not set.

- **If any of the DTCs are set**

1. Program the K59 Starter Generator Control Module.

2. Verify the DTC does not set.

- If the DTC sets, replace the K59 Starter Generator Control Module.
- If the DTC does not set

3. All OK.

- **If none of the DTCs are set**

6. All OK.

Component Testing

NOTE: If moist environmental conditions: rain, snow, vehicle wash, etc. are present please refer to the appropriate Diagnostic Aids section above before doing component tests.

1. Ignition OFF, disconnect the X1 harness connector at the A15 Starter Generator.

2. Test for 10-35 ohms between the reference terminal 3 and the reference terminal 4.

- **If not within the specified range**

Replace the A15 Starter Generator.

- **If within the specified range**

3. Test for 30-60 ohms between the signal (S1) terminal 1 and the signal (S3) terminal 5.

- **If not within the specified range**

Replace the A15 Starter Generator.

- **If within the specified range**

4. Test for 30-60 ohms between the signal (S4) terminal 2 and the signal (S2) terminal 6.

- **If not within the specified range**

Replace the A15 Starter Generator.

- **If within the specified range**

5. Test for greater than 10,000 ohms between the terminals listed below and A15 Starter Generator case:

- Signal (S1) terminal 1
- Signal (S4) terminal 2
- Reference terminal 3
- Reference terminal 4
- Signal (S3) terminal 5
- Signal (S2) terminal 6
- **If less than 10,000 ohms**

Replace the A15 Starter Generator.

- **If 10,000 ohms or greater**

6. Test for infinite resistance between the terminals listed below:

- Terminals 1 and 3
- Terminals 1 and 2
- Terminals 2 and 3
- **If less than infinite resistance**

Replace the A15 Starter Generator.

- **If infinite resistance**

7. Refer to Circuit/System Testing.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Generator Replacement**
- **Control Module References** for K59 Starter Generator Control Module, often referred to as Generator Control Module, replacement, programming and setup

DTC P0A78: DRIVE MOTOR INVERTER PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0A78

Drive Motor Inverter Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor, based upon hybrid powertrain control module commands. The drive motor control module controls the speed and output torque of the starter generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each insulated gate bipolar transistor assembly is monitored for fault conditions. The motor control module is part of the generator control module and is not serviced separately.

Conditions for Running the DTC

The high voltage contactor relay is closed.

Conditions for Setting the DTC

The drive motor control module detects excessive current flow through the switched portion of the insulated gate bipolar transistor.

Action Taken When the DTC Sets

- DTC P0A78 is a Type B DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P0A78 is a Type B DTC.

Reference Information

Schematic Reference

- Hybrid/EV Controls Schematics
- Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- Starter Generator Description and Operation
- Generator Control Module Description and Operation
- Hybrid Modes of Operation Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- Identify how to disable high voltage.

- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Perform the **High Voltage Disabling** procedure.
2. Remove the 3-phase cables from the K59 starter generator control module.
3. Test for infinite resistance between the 3-Phase cable terminals listed below and ground for each phase of the drive motor generator battery cable:
 - X8 phase U terminal
 - X7 phase V terminal
 - X6 phase W terminal
 - If less than infinite resistance, test each phase of the drive motor generator battery cable for a short to ground. If the cables test normal, replace the A15 starter generator.
4. Disconnect the 3-phase cables from the A15 starter generator.
5. Test for infinite resistance between the 3-Phase circuits listed below for each phase of the Drive Motor Generator Battery Cable:
 - Phase U and phase V
 - Phase V and phase W
 - Phase W and phase U
 - If less than infinite resistance, replace the Drive Motor Generator Battery Cable.
6. Replace the A15 starter generator and retest for the DTC. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Generator Replacement** for starter generator replacement.
- **Drive Motor Generator Battery Cable Replacement** for 3-Phase Cable Assembly replacement.
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0A88 OR P0A89: POWER MODULE INPUT CURRENT SENSOR: 14V POWER MODULE INPUT CURRENT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0A88

14V Power Module Input Current Sensor Circuit Low Current

DTC P0A89

14V Power Module Input Current Sensor Circuit High Current

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has 2 current sensors, one for input and one for output current measurements. This diagnostic checks the input current sensor. These current sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- The ignition is ON.
- 14V Power Module Status is Normal.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

P0A88

14 volt power module input current is Less than 0.5 amp for greater than 2 seconds.

P0A89

14 volt power module input current is greater than 22.5 amps for greater than 2 seconds.

Action Taken When the DTC Sets

- DTCs P0A88 and P0A89 are Type B DTCs.
- Autostop disabled.
- Autostart disabled.
- Power regeneration disabled.

Conditions for Clearing the DTC

DTCs P0A88 and P0A89 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P0A8D OR P0A8E: 14V POWER MODULE SYSTEM VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0A8D

14V Power Module System Voltage Low Voltage

DTC P0A8E

14V Power Module System Voltage High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has a voltage sensor that constantly monitors system output voltage. This diagnostic is intended to check the output voltage sensor's signal voltage, not the 12V system voltage. This sensor is internal to the 14V power module and is not serviced separately from the generator control module.

Conditions for Running the DTC

- The ignition is ON.
- 14V Power Module Status parameter is Normal.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

P0A8D

14V Power Module output voltage sensor value is less than 1 volt for greater than 2 seconds.

P0A8E

14V Power Module output voltage sensor value is greater than 20 volts for greater than 2 seconds.

Action Taken When the DTC Sets

DTCs P0A8D and P0A8E are Type B DTCs.

P0A8E

The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.

Conditions for Clearing the DTC

DTCs P0A8D and P0A8E are Type B DTCs.

P0A8D

14V Power Module output voltage sensor value is greater than 1.5 volts.

P0A8E

14V Power Module output voltage sensor value is less than 19.5 volts.

Diagnostic Aids

This DTC may set due to an open 175 amp fuse in the X50A fuse block-underhood.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- Starter Generator Description and Operation
- Generator Control Module Description and Operation
- Hybrid Modes of Operation Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

P0A8E

If the DTC is set, replace the K59 starter generator control module.

P0A8D

1. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
 - If not within the specified range, refer to **Battery Inspection/Test** for Hybrid (HP6).
2. Ignition ON, observe the scan tool Ignition 1 Signal parameter in the 14V Power Module data list. The parameter should be within 4.5 volts of the Low Voltage Circuit Voltage measured at the C1 12V battery.
 - If the voltage is not within the specified range, check the ignition circuit to the K59 starter generator control module for high resistance.
3. Remove the B+ terminal at the K59 starter generator control module.
4. Connect a test lamp between C1 12-volt positive battery post and the K59 starter generator control module terminal at the module.
5. Ignition ON, observe the scan tool parameter Low-Voltage Circuit Voltage in the 14V Power Module data list. The parameter should be within 0.5 volt of the actual 12-volt battery voltage.
 - If the voltage is not within the specified range, replace the K59 starter generator control module.
6. Ignition OFF, remove the positive connection at the C1 12-volt battery.
7. Measure the resistance of the 14 V Power Module positive harness between the X10 connector at the K59 starter generator control module and the X50A Fuse block-Underhood connection.
 - If the resistance is greater than 1.0 ohms, repair the open/high resistance condition in the 12-volt

circuit.

- If the resistance is less than 1.0 ohms, Test the 175 amp fuse in the X50A fuse block-underhood. If the fuse tests good, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P0A8F: 14V POWER MODULE SYSTEM VOLTAGE PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0A8F

14V Power Module System Voltage Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has a voltage sensor that constantly monitors system output voltage. This diagnostic is designed to test the performance of the voltage sensor. This sensor is internal to the 14V power module and is not serviced separately from the generator control module.

Conditions for Running the DTC

- The ignition is ON.
- 14V Power Module Status parameter is Normal.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

P0A8F

The difference between the Low Voltage Circuit Voltage and the ignition voltage value is greater than 4.5 volts for greater than 4 seconds.

Action Taken When the DTC Sets

- The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.
- DTC P0A8F is a Type B DTC.

Conditions for Clearing the DTC

DTC P0A8F is a Type B DTC.

Diagnostic Aids

- This DTC may set due to low 12 V system voltage.
- This DTC may set due to voltage stress to the underhood 175A fuse and junction block.

Reference Information

Schematic Reference

Power Distribution Schematics

Description and Operation

- Starter Generator Description and Operation
- Generator Control Module Description and Operation
- Hybrid Modes of Operation Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
 - If not within the specified range, refer to **Battery Inspection/Test** for Hybrid (HP6).
2. Ignition ON, observe the scan tool Ignition 1 Signal parameter in the 14V Power Module data list. The parameter should be within 4.5 volts of the Low Voltage Circuit Voltage measured at the C1 12V battery.
 - If the voltage is not within the specified range, check the ignition circuit to the K59 starter generator control module for high resistance.

Circuit/System Testing

1. Remove the generator control module cable cover. Refer to **Generator Control Module Cable Cover Replacement**.
2. Remove the X10 B+ cable at the K59 starter generator control module, and tape the cable ring terminal.

3. Connect a 3A fused jumper wire between C1 12-volt positive battery post and the K59 starter generator control module X10 B+ terminal.
4. Connect C1 12V battery negative terminal.
5. Ignition ON, observe the scan tool parameter Low-Voltage Circuit Voltage in the 14V Power Module data list. The parameter should be within 0.5 volt of the actual 12-volt battery voltage.
 - If the voltage is not within the specified range, replace the K59 starter generator control module.
6. Ignition OFF, remove the 3A fused jumper wire at the C1 12-volt battery.
7. Disconnect the C1 12V battery positive terminal and measure the resistance of the 14 V Power Module positive harness between the X10 connector at the K59 starter generator control module and the C1 12V battery positive terminal.
 - If the resistance is greater than 1.0 ohms, repair the high resistance condition in the 12-volt circuit.
 - If the resistance is less than 1.0 ohms, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0A90: DRIVE MOTOR PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0A90

Drive Motor Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has a starter generator also called a drive motor. The starter generator is mounted to the front of the engine and is mechanically connected to the crankshaft pulley by a serpentine belt.

The hybrid powertrain control module receives an engine RPM signal over serial data and compares that value to the starter generator rpm received from the drive motor control module. The hybrid powertrain control

module uses a ratio of these two speeds to determine if the drive belt is missing or slipping.

Conditions for Running the DTC

- Engine is running.
- The system voltage is at least 9.5 V.
- DTCs P0A3F, P0A40, P0B03, P0B0D, P0335, P0336, P0C19 or P1E0A are not set.

Conditions for Setting the DTC

The hybrid powertrain control module detects a speed difference between the engine and the starter generator of greater than 1000 rpm.

OR

The hybrid powertrain control module detects a speed difference between the engine and the starter generator of greater than 500 rpm multiple times on two consecutive ignition cycles with a Engine Off time of 30 minutes between key cycles.

Action Taken When the DTC Sets

DTC P0A90 is a Type A DTC.

Conditions for Clearing the DTC

- DTC P0A90 is a Type A DTC.
- The hybrid powertrain control module detects a speed difference between the engine and the starter generator of less than 500 rpm.

Diagnostic Aids

- The ratio between the crankshaft and the drive motor speeds is 2.3 to 1. When using a scan tool to determine belt slip the engine (crankshaft) RPM value must be multiplied by 2.3 to approximate the starter generator speed.
- Inspect the drive belt for cracks and oil contamination.
- Test drive the vehicle through the different modes of operation, performing Autostop and Autostart cycles. Accelerate up to 50 mph and brake moderately, and listen for any audible belt squeal. If drive belt noise is noticed check the drive belt tensioner assembly for proper operation and installation.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. If drive belt noise was noticed on an AutoStart, refer to **Drive Belt Tensioner Diagnosis** .
2. Inspect the drive belt for cracks, wear and contamination.
 - o If the belt is not OK, replace the drive belt.
3. If the DTC resets, replace the A15 starter generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Generator Replacement**
- **Drive Belt Replacement (LEA)** , **Drive Belt Replacement (LUK)**
- **Drive Belt Tensioner Replacement (LUK)** , **Drive Belt Tensioner Replacement (LEA)**

DTC P0AB9: HYBRID/EV SYSTEM PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0AB9

Hybrid/EV System Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has the ability to crank and start the engine using two different methods. The first method is a conventional 12 volt system. On every initial start up the conventional 12 volt starter and 12 volt battery are used to crank and start the engine.

The second starting method uses both the 115 Volt generator control and battery assembly, also called the hybrid EV battery pack, and the starter generator, also called the drive motor. The drive motor is a 3 phase AC induction machine. This device not only serves as a 115-volt AC generator, it is also used to provide engine

power assist and to start the engine when in auto-stop mode. If the system is in the auto-stop mode and fails to restart with the drive motor, the 12 volt conventional starter will automatically be engaged to start the engine.

The drive motor can quickly rotate the engine to operating speed (800 RPM). The hybrid powertrain control module can detect a condition where the engine is stalling and command the drive motor to rotate the engine to prevent a stall.

Conditions for Running the DTC

Engine Running.

Conditions for Setting the DTC

The hybrid powertrain control module detects that engine speed has fallen below a specific minimum speed indicating the engine has stalled.

Action Taken When the DTC Sets

DTC P0AB9 is a Type C DTC.

Conditions for Clearing the DTC

- DTC P0AB9 is a Type C DTC.
- Engine restarts with key cycle.

Diagnostic Aids

Any condition that causes the engine to stall and/or not start may set this DTC. Possible conditions include:

- Fuel conditions such as low level, low pressure, or contamination.
- Engine conditions such as low compression.
- Restricted exhaust or air intake systems.

Always inspect for DTCs that would cause an engine stall and/or no start condition.

This DTC may set if the vehicle is powered off while driving.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**

- **Hybrid Modes of Operation Description**

Circuit/System Verification

1. Verify that no other DTCs are set.
 - If other DTCs are set, diagnose them first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Start the engine. The engine should start and run.
 - If the engine fails to start, or stalls, diagnose the engine system. Refer to **Engine Cranks But Does Not Run** .
3. If the DTC is set, and the engine is running smoothly, program the K59 starter generator control module.
 - If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P0AEE, P0AEF, OR P0AF0: DRIVE MOTOR INVERTER TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0AEE

Drive Motor Inverter Temperature Sensor Performance

DTC P0AEF

Drive Motor Inverter Temperature Sensor Circuit Low Voltage

DTC P0AF0

Drive Motor Inverter Temperature Sensor Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control

module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the generator control module. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

- DTCs P1A90, P1A91, P1A92, P1A71, P1A72, P1A73, P0A2B, P0A2C, P0A2D, P0A2F, P0AEE, P0AEF, P0AF0, P0C11 and P262B are not set.
- Ignition voltage is between 9-16V.
- The drive motor control module and the hybrid powertrain control module are awake.

P0AEE

The engine OFF time is greater than 8 hours.

Conditions for Setting the DTC

P0AEE

The temperature average of the drive motor temperature sensor and 14V power module temperature sensors 1 and 2 are 20°C (36°F) different from the Phase U DC/AC Inverter Temperature value.

P0AEF

The inverter phase temperature sensor 1 is greater than 150°C (302°F) for 3 seconds.

P0AF0

The inverter phase temperature sensor 1 is less than -70°C (-94°F) for 3 seconds.

Action Taken When the DTC Sets

- DTCs P0AEE, P0AEF, and P0AF0 are Type B DTCs.
- The power inverter module limits the maximum torque of the starter generator to 10.8 N.m (95.6 lb in).
- Autostop will be disabled.

Conditions for Clearing the DTC

DTCs P0AEE, P0AEF, and P0AF0 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Allow the vehicle to cool to ambient temperature by leaving the ignition OFF for at least 8 hours.
2. Ignition ON, if the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P0B09: AUXILIARY TRANSMISSION FLUID PUMP SUPPLY VOLTAGE RELAY CONTROL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0B09

Auxiliary Transmission Fluid Pump Supply Voltage Relay Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Switch B+	P2797 **	P2797	-
Relay Coil Ignition	P0B09 **	P0B09	-
Relay Coil Control	P0B09 *	P0B09	P0B09
Relay Switch Control	P2797 **	P2797	P2797 *

Component Ground	-	***	-
* Auxiliary Transmission Fluid Pump - always On ** Will open the fuse *** Auxiliary Transmission Fluid Pump - inoperative			

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The transmission fluid pump - auxiliary is used to maintain transmission fluid line pressure to the transmission during Autostop mode. The transmission fluid pump - auxiliary is externally mounted to the transmission case assembly. The hybrid powertrain control module controls the auxiliary pump by providing the ground path to the transmission pump relay - auxiliary coil control circuit.

Conditions for Running the DTC

Ignition voltage is greater than 9 V.

Conditions for Setting the DTC

The generator control module detects an invalid voltage on the auxiliary transmission fluid pump relay control circuit for greater than 1 second.

Action Taken When the DTC Sets

- DTC P0B09 is a type B DTC.
- Autostop is disabled.

Conditions for Clearing the DTC

DTC P0B09 is a type B DTC.

Diagnostic Aids

Transmission Fluid Pump Relay Underhood Electrical Center Terminal Identification			
Front of Vehicle			
Left Side of Vehicle	Control	Load	Right Side of Vehicle
	B+	Ignition	

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**
- **Starter Generator Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the auxiliary transmission fluid pump relay turns on and off/clicks when commanding the auxiliary transmission fluid pump relay ON and OFF with a scan tool.
 - **If the relay does not click**

Refer to Circuit/System Testing.

- **If the relay clicks**

All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the KR86 Transmission Fluid Pump Relay - Auxiliary, Ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 86 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test or replace the KR86 Transmission Fluid Pump Relay - Auxiliary.
- **If the test lamp illuminates**
- 3. Connect a test lamp between the ignition circuit terminal 86 and the control circuit terminal 85.
- 4. Verify the test lamp turns ON and OFF when commanding the Auxiliary Transmission Pump Relay ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 - 1. Ignition OFF, disconnect the X2 harness connector at the K59 starter generator control module, ignition ON.
 - 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Ignition OFF.
 - 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 starter generator control module.
 - **If the test lamp is always ON**
 - 1. Ignition OFF, disconnect the harness connector at the K59 starter generator control module.
 - 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K59 starter generator control module.
 - **If the test lamp turns ON and OFF**
- 5. Replace the K59 starter generator control module.

Component Testing

1. Ignition OFF, disconnect the KR86 Transmission Fluid Pump Relay - Auxiliary.
2. Test for 85-130 ohms between terminals 85 and 86.
 - **If less than 85 ohms or greater than 130 ohms**
 - Replace the relay.
 - **If between 85-130 ohms**
3. Test for infinite resistance between the terminals listed below:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 ohms between terminals 30 and 87.

- **If 2 ohms or greater**

Replace the relay.

- **If less than 2 ohms**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)** for Transmission Fluid Pump Relay - Auxiliary replacement, Within an Electrical Center
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0BE6-P0BE8, P0BEE, P0BEF, OR P0BF0: DRIVE MOTOR PHASE U/W CURRENT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0BE6

Drive Motor Phase U Current Sensor Performance

DTC P0BE7

Drive Motor Phase U Current Sensor Circuit Low Voltage

DTC P0BE8

Drive Motor Phase U Current Sensor Circuit High Voltage

DTC P0BEE

Drive Motor Phase W Current Sensor Performance

DTC P0BEF

Drive Motor Phase W Current Sensor Circuit Low Voltage

DTC P0BF0

Drive Motor Phase W Current Sensor Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the generator control module. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

The control module runs the program to detect an internal fault when the drive motor control module is awake and the engine is off.

Conditions for Setting the DTC

- The control module has detected an internal malfunction.
- The motor phase U current is greater than 440 amps or less than -440 amps.
- The motor phase W current is greater than 440 amps or less than -440 amps.

Action Taken When the DTC Sets

- DTCs P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, and P0BF0 are Type B DTCs.
- The generator control module operates in a reduced power mode.
- Regenerative braking torque is reduced.
- Autostop and electric power assist are disabled.

Conditions for Clearing the DTC

DTCs P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, and P0BF0 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0BFD: DRIVE MOTOR PHASE U-V-W NOT PLAUSIBLE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0BFD

Drive Motor Phase U-V-W Not Plausible

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor, based upon hybrid powertrain control module commands. The drive motor control module controls the speed and output torque of the starter generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. The starter generator operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistors operates a single phase of the starter generator. Each phase is

individually identified as U, V and W. The drive motor control module monitors the current of phase U and W. The drive motor control module uses logic to calculate phase V current values. This information is used in order to detect over current conditions.

Because all starter generator phase circuits are electrically joined together, they should each flow about the same amount of current. The drive motor control module performs a mathematical calculation to verify that the phase current sensors are accurate. If the current sensors indicate about the same amount of phase current, the sum of the calculation should be near zero. If the currents are not similar, this DTC will set.

Conditions for Running the DTC

- The ignition is ON.
- The high voltage contactor relay is closed.
- DTCs P0BE6, POBE7, POBE8, P0BEE, POBEF, or P0BF0 are not set.

Conditions for Setting the DTC

The sum of the 3 phase current calculations is greater than 40 A.

Action Taken When the DTC Sets

- DTC P0BFD is a Type B DTC.
- The generator control module operates in a reduced power mode.
- Regeneration is limited.
- Autostop and electric assist is disabled.

Conditions for Clearing the DTC

DTC P0BFD is a Type B DTC.

Diagnostic Aids

The 14V power module remains active.

Reference Information

Schematic Reference

- **Hybrid/EV Controls Schematics**
- **Hybrid/EV Energy Storage Schematics**

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Perform the **High Voltage Disabling** procedure.
2. Remove the 3-phase cables from the K59 generator control module.
3. Test for infinite resistance between each of the 3-phase circuit terminals listed below and ground:
 - X8 phase U terminal
 - X7 phase V terminal
 - X6 phase W terminal
 - If not the specified value, disconnect the 3-phase cables from the A15 starter generator, and test the AC circuits for a short to ground. If the circuit tests normal, replace the A15 starter generator.
 - Replace the K59 starter generator control module. If the DTC resets replace the A15 starter

generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Generator Replacement**
- **Drive Motor Generator Battery Cable Replacement** for 3-Phase Cable Assembly replacement
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0C01: DRIVE MOTOR HIGH CURRENT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C01

Drive Motor High Current

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor based upon hybrid powertrain control module commands. The drive motor control module controls the speed and output torque of the starter generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each insulated gate bipolar transistor assembly is monitored for overcurrent conditions.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

One or more phase currents are greater than ± 396 A.

Action Taken When the DTC Sets

- DTC P0C01 is a Type B DTC.
- The starter generator regeneration and power assist functions are disabled.

Conditions for Clearing the DTC

DTC P0C01 is a Type B DTC.

Diagnostic Aids

The 14 V power module will still be active.

Reference Information

Schematic Reference

- **Hybrid/EV Controls Schematics**
- **Hybrid/EV Energy Storage Schematics**

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify DTCs P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, and P0BF0 are not set.
2. If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal

Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Perform the **High Voltage Disabling** .
2. Ignition OFF, disconnect the 3-phase cables from the K59 starter generator control module.
3. Test for infinite resistance to 3-phase circuit terminals listed below and ground:
 - X8 phase U terminal
 - X7 phase V terminal
 - X6 phase W terminal
 - If not the specified value, disconnect the 3-phase cables from the A15 starter generator, and test the 3-phase circuit for a short to ground. If the circuit tests normal, replace the A15 starter generator motor.
4. Replace the K59 starter generator control module. If the DTC resets replace the A15 starter generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Starter Generator Replacement**
- **Drive Motor Generator Battery Cable Replacement** for 3-Phase Cable Assembly replacement
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup

DTC P0C05: DRIVE MOTOR PHASE U-V-W CIRCUITS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C05

Drive Motor Phase U-V-W Circuits

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor. The drive motor control module controls the speed and output torque of the starter generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each insulated gate bipolar transistor assembly is monitored for overcurrent conditions.

Conditions for Running the DTC

- The ignition is ON.
- The high voltage input to the generator control module is above 50 volts.
- DTCs P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, P0BF0, or P0BFD are not set.
- The drive motor control module has applied greater than or equal to 25A to the drive motor.

Conditions for Setting the DTC

The drive motor control module detects at least one U-V-W phase current values is less than 9A.

Action Taken When the DTC Sets

- DTC P0C05 is a Type B DTC.
- The starter generator regeneration and power assist functions are disabled.

Conditions for Clearing the DTC

DTC P0C05 is a Type B DTC.

Diagnostic Aids

The 14v power module remains active.

Reference Information

Schematic Reference

- **Hybrid/EV Controls Schematics**
- **Hybrid/EV Energy Storage Schematics**

Description and Operation

- Starter Generator Description and Operation
- Generator Control Module Description and Operation
- Hybrid Modes of Operation Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Perform the **High Voltage Disabling** procedure.
2. Remove the 3-phase cable assembly from the K59 starter generator control module.
3. Test for less than 0.5 ohms at each phase by measuring between the following circuits at the cable with a DMM:
 - Phase U and phase V
 - Phase U and phase W
 - Phase V and phase W
 - **If within the specified value**
4. Inspect the 3-phase drive motor generator battery cable terminal fasteners at the K59 starter generator

control module.

- **If any fasteners were loose and no arc-flash damage is present**

Torque the fasteners and re-assemble the vehicle. Retest for the DTC.

- **If any fasteners were loose and arc-flash damage is present**

Replace the K59 starter generator control module assembly and the 3-phase drive motor generator battery cable assembly.

- **If not within the specified value**

5. Disconnect the 3-phase drive motor generator battery cable assembly from the A15 starter generator. Test each cable for continuity from the starter generator connection terminal to the K59 starter generator control module connection terminal.

- **If you measure greater than 0.5 ohms**

Replace the 3-phase drive motor generator battery cable assembly.

6. Replace the A15 starter generator and retest for the DTC. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Generator Replacement** for starter generator replacement.
- **Drive Motor Generator Battery Cable Replacement** for 3-Phase Cable Assembly replacement.
- **Control Module References** for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup

DTC P0C0B: DRIVE MOTOR INVERTER SUPPLY VOLTAGE CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C0B

Drive Motor Inverter Supply Voltage Circuit

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The inverter supply voltage circuit detects the loss of the bias power supply to the insulated gateway bi-polar transistors. This is an internal fault detection of the generator control module. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

- The ignition is on and greater than 7 volts.
- The drive motor control module is awake.

Conditions for Setting the DTC

The generator control module does not detect voltage at the insulated gate bi-polar transistor bias supply.

Action Taken When the DTC Sets

- DTC P0C0B is a Type A DTC.
- The drive motor will be disabled.

Conditions for Clearing the DTC

DTC P0C0B is a Type A DTC.

Diagnostic Aids

The 14V power module remains active.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify DTC P0562 is not set.
 - If the DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If DTC P0C0B is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0C11: DRIVE MOTOR INVERTER PHASE U HIGH TEMPERATURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C11

Drive Motor Inverter Phase U High Temperature

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator, also referred to as the drive motor, based upon hybrid powertrain control module commands. The drive motor control module controls the speed and output torque of the drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. The drive motor operates utilizing 3 phase AC. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. The drive motor control module monitors the temperature of the switching transistors in order to detect inverter module overtemperature conditions. The generator control module is air cooled.

Conditions for Running the DTC

- The drive motor control module and hybrid powertrain control module are awake.
- DTC P0AEE, P0AF0, and P0AEF are not set.

Conditions for Setting the DTC

The Phase U DC/AC Inverter Temperature 1 is greater than 118°C (245°F) for 5 seconds.

Action Taken When the DTC Sets

- DTC P0C11 is a Type B DTC.
- The hybrid powertrain control module system starts to reduce the maximum torque beginning at 110°C (230°F) linearly down to 0 N.m(0 lb in) as the drive motor stator temperature approaches 120°C (248°F).

Conditions for Clearing the DTC

DTC P0C11 is a Type B DTC.

Diagnostic Aids

Ask about the customer's driving habits, trailer towing, etc.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify P0C32, P0A81, P0A84, P0A85 or P0A7E are not set.
2. Ignition On, verify with a scan tool that the Phase U DC/AC Inverter Temperature 1 is less than 118°C (245°F).
 - If greater than 118°C (245°F), inspect for proper operation of the hybrid battery cooling fan and ducts.
 - If the hybrid cooling system tests normal, Reprogram K59 starter generator control module. If the DTC resets replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the starter generator control module, replacement, programming and setup.

DTC P0C19: DRIVE MOTOR TORQUE DELIVERED PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C19

Drive Motor Torque Delivered Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The starter generator also called the drive motor is controlled by the drive motor control module. The drive motor control module constantly monitors the requested torque and the delivered torque of the drive motor.

Conditions for Running the DTC

- DTCs P0BFD, P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, P0BF0, P1AE8, P1AE9, P1AEC, P1B0D, P0C52, P0C53, P0C5C, P0C5D, P0A3F, P1B03 and P0A40 are not set
- Drive motor is commanded to develop torque.

Conditions for Setting the DTC

The drive motor control module has detected that the difference between drive motor torque commanded and delivered is greater than 36 N.m (27 lb ft).

Action Taken When the DTC Sets

- DTC P0C19 is a Type B DTC.
- Commanded motor torque is limited to below 36 N.m (27 lb ft).

Conditions for Clearing the DTC

DTC P0C19 is a Type B DTC.

Diagnostic Aids

- Seized or binding engine
- Seized or binding accessory drive belt
- Seized or binding starter generator

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Start the engine. DTC P0C19 should not be set.
2. Verify DTC P0A90 is not set.
 - If the DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Verify the engine or AC compressor is not seized or binding.
 - If the engine is seized or binding, refer to **Symptoms - Engine Mechanical** .
 - If the AC Compressor is seized or binding, refer to **Noise Diagnosis - Air Conditioning (A/C) System** .
4. Verify the A15 starter generator is not seized or binding.
5. If DTC P0C19 is set, replace the A15 starter generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Starter Generator Replacement for starter generator replacement.

DTC P0C76: HYBRID/EV BATTERY SYSTEM HIGH VOLTAGE PRESENT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C76

Hybrid/EV Battery System High Voltage Present

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The generator control and battery module assembly contains a high voltage contactor. The high voltage contactor allows the high voltage DC batteries to be connected to the vehicle and safely contain the high voltage DC within the generator control and battery module assembly. The high voltage contactor is connected in series with the positive side of the DC voltage potential of the high voltage battery. The hybrid powertrain control module supplies ground to the control circuit of the high voltage contactor to close.

Conditions for Running the DTC

High Voltage Contactor Relay is commanded open.

Conditions for Setting the DTC

The high voltage circuit is greater than 65 V for 6.5 seconds after the contactor has been commanded open.

Action Taken When the DTC Sets

- DTC P0C76 is a Type A DTC.
- A clear DTC command will not clear this DTC or the Action Taken.

Conditions for Clearing the DTC

DTC P0C76 is a Type A DTC.

Diagnostic Aids

- A clear DTC command will not clear this DTC or the Action Taken.
- The DTC may set due to a low 12V battery condition.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Connect charger to 12V Battery.
2. Ignition ON, perform the hybrid powertrain control module scan tool Clear DTC output control. Cycle the ignition twice.
3. Refer to **Hybrid\EV Battery Voltage Present** . If the contactors test normal, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P0C9E OR P0C9F: POWER MODULE OUTPUT CURRENT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C9E

14V Power Module Output Current Sensor Circuit Low Current

DTC P0C9F

14V Power Module Output Current Sensor Circuit High Current

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following

three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has 2 current sensors, one for input and one for output current measurements. This diagnostic checks the output current sensor. These current sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- Ignition is ON.
- 14V Power Module Status parameter is Normal.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

P0C9E

Low Voltage Circuit Current is less than 2 amps for greater than 2 seconds.

P0C9F

Low Voltage Circuit Current is greater than 123 amps for greater than 2 seconds.

Action Taken When the DTC Sets

DTCs P0C9E and P0C9F are Type B DTCs.

P0C9F

- The 14V power module stops supplying power to the 12V system.
- The charge indicator will illuminate.

Conditions for Clearing the DTC

DTCs P0C9E and P0C9F are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**

- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P0CA2: 14V POWER MODULE STEP DOWN VOLTAGE PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0CA2

14V Power Module Step Down Voltage Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has switching transistors that allows it to convert high voltage from the Hybrid Battery to 12 volts. This diagnostic is designed to test for an electrical short in the MOSFET transistors. The transistors are internal to the 14V power module and cannot be serviced separately from the generator control module.

Conditions for Running the DTC

The ignition is ON and the 14V Power Module is enabled.

Conditions for Setting the DTC

The 14 V Power Module has detected a transistor failure for 25 mS.

Action Taken When the DTC Sets

- The 14V power module stops supplying power to the 12V system.
- The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.
- DTC P0CA2 is a Type A DTC.

Conditions for Clearing the DTC

- DTC P0CA2 is a Type A DTC.
- 14 V Power Module detects no transistor failures for 5 seconds.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 Starter Generator Control Module. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- Identify how to disable high voltage.

- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Perform the **High Voltage Disabling** procedure.
2. Remove the 3-phase cables from the K59 starter generator control module.
3. Test for infinite resistance between the 3-Phase cable terminals listed below and ground for each phase of the drive motor generator battery cable:
 - X8 Phase U terminal
 - X7 Phase V terminal
 - X6 Phase W terminal
 - If less than infinite resistance, test each phase of the drive motor generator battery cable for a short to ground. If the cables test normal, replace the A15 starter generator.
4. Retest for the DTC. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P0CC5: 14V POWER MODULE INPUT-OUTPUT CURRENT SENSORS NOT PLAUSIBLE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0CC5

14V Power Module Input-Output Current Sensors Not Plausible

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has 2 internal current sensors, one for input and one for output current measurements. The 14 volt power module monitors both input and output current, and then makes a correlation between them. This diagnostic will check range performance malfunctions of one or both of the current sensors. These current sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- Ignition is ON.
- Ignition voltage is between 9-16V.

Conditions for Setting the DTC

The difference between the calculated input power and calculated output power of the two current sensors is greater than 0.4 kW for greater than 4 seconds.

Action Taken When the DTC Sets

DTC P0CC5 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0CC5 is a Type B DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P15F0: ENGINE TORQUE DELIVERED SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P15F0

Engine Torque Delivered Signal Message Counter Incorrect

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This diagnostic applies to internal microprocessor integrity conditions within the hybrid powertrain control module. This is an internal fault detection of the hybrid powertrain control module and no external circuits are involved.

Conditions for Running the DTC

- Ignition is ON.
- The system voltage is greater than 9.5 V.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTC P15F0 is a Type A DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P15F0 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P15F4: DRIVE MOTOR TORQUE DELIVERED SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P15F4

Drive Motor Torque Delivered Signal Message Counter Incorrect

Circuit/System Description

The generator control module, also called the starter generator control module, is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the hybrid powertrain control module and no external circuits are involved.

Conditions for Running the DTC

- Ignition is ON.

- The system voltage is greater than 9.5 V.
- DTC U1817 is not set.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTC P15F4 is a Type A DTC.
- The HPCM commands the battery energy control module (BECM) to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P15F4 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

NOTE: **Diagnose and repair any communication DTCs prior to performing this testing.**

1. Ignition ON.
2. Verify DTC P15F4 is not set.
 - **If the DTC is set**
 1. Program the K59 Starter Generator Control Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K59 Starter Generator Control Module.
 - If the DTC does not set
 - 3. All OK
 - **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for K59 Starter Generator Control Module replacement, programming and setup

DTC P15F5: CRANKSHAFT TORQUE COMMAND SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P15F5

Crankshaft Torque Command Signal Message Counter Incorrect

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the hybrid powertrain control module and no external circuits are involved.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

- DTC P15F5 is a Type A DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P15F5 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that DTC P0562 is not set.
 - If DTC is set, refer to **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563** for Hybrid (HP6).

NOTE: **Diagnose and repair any communication DTCs prior to performing this testing.**

2. If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for generator control module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P16F3: CONTROL MODULE REDUNDANT MEMORY PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P16F3

Control Module Redundant Memory Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following

three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the hybrid powertrain control module and no external circuits are involved.

Conditions for Running the DTC

- The system voltage is greater than 9.5 V.
- Ignition is ON.

Conditions for Setting the DTC

The control module has detected that the redundant data does not match the primary data.

Action Taken When the DTC Sets

- DTC P16F3 is a Type A DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P16F3 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P1A56: HYBRID/EV SYSTEM VOLTAGE DISCHARGE CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1A56

Hybrid/EV System Voltage Discharge Circuit

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The generator control module contains DC high voltage capacitors and a resistor circuit intended to discharge the electrical energy stored within those capacitors. Whenever the high voltage contactors are opened, the hybrid powertrain control module connects the internal resistor circuit across the capacitor circuit. The level of the high voltage is monitored by the hybrid powertrain control module before and after the resistor circuit has been connected. If the voltage level remains high for too long, the hybrid powertrain control module sets this DTC and then commands the motor control module to connect the drive motor generator 3 phase circuits across the DC high voltage positive and negative circuits thereby discharging the capacitors.

Conditions for Running the DTC

High Voltage Contactors are commanded Open.

Conditions for Setting the DTC

Within 300 milliseconds after commanding contactors open, the high voltage bus voltage fails to decrease by at least 18 V.

Or

Within 300 milliseconds after commanding contactors open, the high voltage bus voltage is greater than 60 V.

Or

The active bus discharge circuit status is disabled.

Action Taken When the DTC Sets

- DTC P1A56 is a Type B DTC.
- The drive motor control module is commanded to discharge the capacitor through the drive motor generator 3 phase stator circuits.

Conditions for Clearing the DTC

DTC P1A56 is a Type B DTC.

Diagnostic Aids

A high-pitched whine may emanate from the drive motor whenever the HV DC capacitance is discharged through the drive motor stator circuits.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify other DTCs are not set.
 - If other DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P1A6F: DRIVE MOTOR NO CRANK AT RESTART

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1A6F

Drive Motor No Crank at Restart

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has the ability to crank and start the engine using two different methods. The first method is a conventional 12 volt system. On every initial start up the conventional 12 volt starter and 12 volt battery are used to crank and start the engine.

The second starting method uses the 115 Volt generator control and battery assembly also called the hybrid battery and the starter generator also called the drive motor. The drive motor is a 3 phase AC induction machine. This device not only serves as a 115-volt AC generator, it is also used to provide engine power assist and to start the engine when in auto-stop mode. If the system is in the auto-stop mode and fails to restart with the drive motor, the 12 volt conventional starter will automatically be engaged to start the engine.

Conditions for Running the DTC

Ignition is ON and the vehicle is in autostop.

Conditions for Setting the DTC

The hybrid powertrain control module detects that an autostart failed to take place successfully.

Action Taken When the DTC Sets

- DTC P1A6F is a Type B DTC.
- The 12 V starter will be engaged to start the engine and autostop will be disabled.

Conditions for Clearing the DTC

DTC P1A6F is a Type B DTC.

Diagnostic Aids

A slipping drive motor belt can cause belt noise on an AutoStart, inspect the drive belt tensioner assembly for proper operation and installation.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Circuit/System Verification

1. If drive belt noise was noticed on an AutoStart, refer to **Drive Belt Tensioner Diagnosis** .
2. Verify that no other hybrid control module or engine control modules DTCs are set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. If the DTC is set, program the K59 starter generator control module.
 - If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P1A71-P1A73: POWER MODULE TEMPERATURE SENSOR 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1A71

14V Power Module Temperature Sensor 2 Performance

DTC P1A72

14V Power Module Temperature Sensor 2 Circuit Low Voltage

DTC P1A73

14V Power Module Temperature Sensor 2 Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module constantly monitors its temperature to protect against overheat conditions. The module also monitors the performance of the temperature sensors to assure they are working properly. These sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- The Ignition is ON.
- Ignition voltage is between 9-16V.

P1A71

- DTCs P1A90, P1A91, P1A92, P1A71, P1A72, P1A73, P0A2B, P0A2C, P0A2D, P0A2F, P0AEE, P0AEF, P0AF0, P0C11, and P262B are not set.
- Ignition must be off for 8 hours or more.

Conditions for Setting the DTC

P1A71

14V Power Module Temperature Sensor 2 has a value of 20°C greater than the average value of 14V Power Module Temperature Sensor 1, Motor Generator Unit Temperature, and the Inverter Temperature for greater than 4 seconds.

P1A72

14V Power Module Temperature Sensor 2 is greater than 145°C (293°F) for greater than 4 seconds.

P1A73

14V Power Module Temperature Sensor 2 is less than -65°C (-85°F) for greater than 4 seconds.

Action Taken When the DTC Sets

- DTCs P1A71, P1A72, or P1A73 are Type B DTCs.
- The 14V power module stops supplying power to the 12V system.
- The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.

Conditions for Clearing the DTC

DTCs P1A71, P1A72, or P1A73 are Type B DTCs.

P1A72

14V Power Module Temperature Sensor 2 is less than 140°C (284°F).

P1A73

14V Power Module Temperature Sensor 2 is greater than -60°C (-76°F).

Diagnostic Aids

Verify 14V Power Module Temperature Sensor 2 reads between -59°C (-74°F) and +139°C (+282°F) and is within 20°C (36°F) of the average of 14V Power Module Temperature Sensor 1, Drive Motor Temperature, and 14V Power Module Temperature Sensor 2 after ignition has been off for 8 hours.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1A90-P1A92: POWER MODULE TEMPERATURE SENSOR 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1A90

14V Power Module Temperature Sensor 1 Performance

DTC P1A91

14V Power Module Temperature Sensor 1 Circuit Low Voltage

DTC P1A92

14V Power Module Temperature Sensor 1 Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module constantly monitors its temperature to protect against overheat conditions. The module also monitors the performance of the temperature sensors to assure they are working properly. These sensors are internal to the 14V power module and are not serviced separately from the generator control module.

Conditions for Running the DTC

- The Ignition is ON.
- Ignition voltage is between 9-16V.

P1A90

- DTCs P1A90, P1A91, P1A92, P1A71, P1A72, P1A73, P0A2B, P0A2C, P0A2D, P0A2F, P0AEE, P0AEF, P0AF0, P0C11, and P262B are not set.
- The Ignition has been off for 8 hours.

Conditions for Setting the DTC

P1A90

14V Power Module Temperature Sensor 1 has a value of 20°C greater than the average value of 14V Power Module Temperature Sensor 2 and Drive Motor Temperature for greater than 4 seconds.

P1A91

14V Power Module Temperature Sensor 1 is greater than 145°C (293°F) for greater than 4 seconds.

P1A92

14V Power Module Temperature Sensor 1 is less than -65°C (-85°F) for greater than 4 seconds.

Action Taken When the DTC Sets

DTCs P1A90, P1A91, or P1A92 are Type B DTCs.

P1A91

- The 14V power module stops supplying power to the 12V system.
- The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.

Conditions for Clearing the DTC

DTCs P1A90, P1A91, or P1A92 are Type B DTCs.

P1A91

14V Power Module Temperature Sensor 1 is less than 140°C (284°F).

P1A92

14V Power Module Temperature Sensor 1 is greater than -60°C (-76°F).

Diagnostic Aids

Under normal operation, the scan tool parameter 14V Power Module Temperature Sensor 1 should be between -59°C (-74°F) and +139°C (+282°F), and be within 20°C (36°F) of the average of 14V Power Module Temperature Sensor 2 and Drive Motor Temperature after ignition has been off for 8 hours.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1ADE OR P1ADF: DRIVE MOTOR CONTROL MODULE SYSTEM VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1ADE

Drive Motor Control Module System Voltage Low Voltage

DTC P1ADF

Drive Motor Control Module System Voltage High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator based upon hybrid powertrain control module information.

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The Ignition is ON.

Conditions for Setting the DTC

P1ADE

Drive motor control module ignition voltage is less than or equal to 10 V for 6 seconds.

P1ADF

Drive motor control module ignition voltage is greater than 18 Volts for 5 seconds.

Action Taken When the DTC Sets

DTCs P1ADE and P1ADF are Type C DTCs.

P1ADE

The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTCs P1ADE and P1ADF are Type C DTCs.

Diagnostic Aids

- A high or low voltage DTC set

Or

Voltage value in multiple modules/sensors indicates a concern in the charging system.

- A battery charger or vehicle jump start may have set DTC P1ADF.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
 - If not within the specified range, refer to **Battery Inspection/Test** for Hybrid (HP6).
2. Engine running, accessories OFF, measure and record the battery voltage at the C1 12V battery terminals. The voltage should be at least 1 V greater than the voltage measured in step 1 but less than 15 V.
 - If not within the specified range, refer to **Charging System Test** for Hybrid (HP6).
3. Observe the drive motor control module ignition 1 signal voltage parameter with a scan tool. The voltage readings should be within 1 V of the 12V battery voltage.

Circuit/System Testing

NOTE: Use the schematic to identify the following:

- Control modules the vehicle is equipped with
- The control modules ground, B+, and ignition circuit terminal IDs and connectors

1. Ignition OFF, disconnect the harness connectors at the K59 starter generator control module.

NOTE: Some control module ground circuits may require up to 20 minutes to achieve a resistance reading of less than 10 ohms. In most cases the readings will drop below 20 ohms within 1 minute indicating the control modules are going to sleep.

2. Ignition OFF, scan tool disconnected, open and close the driver door and wait 1 minute. Test for less than 10 ohms between each ground circuit terminal at the K59 starter generator control module harness and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Test for 10-18V between each B+ circuit terminal at the K59 starter generator control module harness and ground.
 - If less than the specified range, test the B+ circuit for a short to ground or an open/high resistance.

NOTE: If less than the specified range, test the B+ circuit for a short to ground or an open/high resistance.

4. Ignition ON, test for 10-18 V between each ignition circuit terminal and ground.
 - If less than the specified range, test the ignition circuit for a short to ground or an open/high resistance.
5. If all circuits test normal, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1AE8 OR P1AE9: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1AE8

Drive Motor Control Module Hybrid/EV Battery Voltage Sense Circuit Low Voltage

DTC P1AE9

Drive Motor Control Module Hybrid/EV Battery Voltage Sense Circuit High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator based upon generator control module commands. The hybrid powertrain control module is able to detect out of range low or out of range high conditions on the high voltage sensor circuit.

Conditions for Running the DTC

- The Ignition is ON.
- The high voltage contactor relay is closed.

Conditions for Setting the DTC

P1AE8

With the hybrid/EV battery system contactor closed, the starter generator control module detects high voltage sensor voltage less than 30V.

P1AE9

The drive motor control module detects high voltage sensor voltage greater than 190V.

Action Taken When the DTC Sets

- DTCs P1AE8 and P1AE9 are Type B DTCs.
- The hybrid powertrain control module opens the high voltage contactor relay.
- The battery indicator light will illuminate.

Conditions for Clearing the DTC

DTCs P1AE8 and P1AE9 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1AEC OR P1AEE: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY SYSTEM VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1AEC

Drive Motor Control Module Hybrid/EV Battery System Voltage

DTC P1AEE

Drive Motor Control Module Hybrid/EV Battery System Voltage High Voltage

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter generator based upon generator control module commands. The hybrid powertrain control module monitors the high voltage measurement and then will broadcast the high voltage measurement over serial data.

P1AEC

The drive motor control module compares the values in order to verify the hybrid battery high voltage measurement is accurate.

P1AEE

The hybrid powertrain control module monitors for high voltage that is greater than the system allows during normal operation.

Conditions for Running the DTC

P1AEC

DTC P1AE8 or P1AE9 is not set,

AND

High voltage is available and valid,

AND

Ignition is On,

AND

The high voltage contactor relays are closed.

P1AEE

Ignition voltage is greater than 7V.

Conditions for Setting the DTC

P1AEC

The difference between high voltage sensed and high voltage battery voltage measured is greater than 15V,

AND

The difference between high voltage sensed and the sum of the mid-pack voltages is greater than 10V.

P1AEE

The high voltage sensor voltage is greater than 150V,

OR

Hardware Overvoltage is detected.

Action Taken When the DTC Sets

- DTCs P1AEC and P1AEE are Type B DTCs.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTCs P1AEC and P1AEE are Type B DTCs.

Diagnostic Aids

Conditions such as loss of battery energy control module power or ground or removal of the high voltage manual disconnect while the vehicle was driving could create a voltage surge that may set DTC P1AEE. History DTC P1AEE may indicate that the high voltage contactor relays opened while large current flow was present.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that DTCs P0ABB, P0ABC, or P0ABD is not set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If the DTC is set, program the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1AF0: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE SYSTEM ISOLATION LOST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1AF0

Drive Motor Control Module Hybrid/EV Battery Voltage System Isolation Lost

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way: The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid

pack voltage and chassis ground. These voltage values are used by the Starter/Generator Control Module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

- Internal battery voltage sensor value is greater than 100 V
- None of the following DTCs are set: P0AA8, P0AAA, P1AE8, P1AE9, P1AEC, P1E0D, P1E10, P1E11, P1E13, P1E14

Conditions for Setting the DTC

The calculated resistance between the high voltage DC systems and vehicle chassis ground less than 225.6K ohms

Action Taken When the DTC Sets

- DTC P1AF0 is a type B DTC.
- If the DTC sets while there is a loss of communication with the sensing and diagnostic module (SDM), the Starter/Generator Control Module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTC P1AF0 is a type B DTC.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48900** HEV Safety Kit
- **EL-50772** Insulation Multimeter

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling .
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: The following continuity tests must be performed using the EL-50772 insulation multimeter. Select the Isolation test setting, then select the 500 V range.

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** insulation multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug
 - 3 phase cable terminal W - cable side lug
 - **If 400K ohms or less**
 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** insulation multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
 3. Replace the high voltage 3 phase cables.
 - **If greater than 400K ohms**

NOTE: The following continuity tests must be performed using the EL-50772 insulation multimeter. Select the Isolation test setting, then select the 500 V range.

4. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** insulation multimeter set on the Isolation test setting:
 - 3 phase terminal U - K59 Starter/Generator Control Module stud
 - 3 phase terminal V - K59 Starter/Generator Control Module stud

- 3 phase terminal W - K59 Starter/Generator Control Module stud
 - **If 400K ohms or less**
- 1. Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
- 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** insulation multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.
 - If greater than 400K ohms
- 3. Replace the two wiring junction blocks.
 - **If greater than 400K ohms**
- 5. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Drive Motor Generator Battery Cable Replacement**
- **Starter Generator Replacement**
- **Generator Battery Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P1AF4 OR P1AF5: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING CIRCUIT 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this repair.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1AF4

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage

DTC P1AF5

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground.

The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The Starter/Generator Control Module places an AC signal on the high voltage system and monitors its amplitude. A reduced amplitude return signal indicates a loss of resistance to chassis ground. This isolation monitor method is sometimes referred to as the active isolation monitor.

Conditions for Running the DTC

P1AF4

- Power mode is RUN or CRANK.
- Contactors are closed.

P1AF5

Power mode is RUN or CRANK.

Conditions for Setting the DTC

P1AF4

The positive mid-pack voltage is less than 5 V.

P1AF5

The positive mid-pack voltage minus the high voltage is greater than 10 V.

Action Taken When the DTC Sets

DTCs P1AF4 and P1AF5 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1AF4 and P1AF5 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether

the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1AF4 or P1AF5 is not set.
 - If DTC P1AF4 or P1AF5 is set

Replace the K59 Starter/Generator Control Module.

- If DTC P1AF4 and P1AF5 are not set
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P1B0B OR P1B0C: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING CIRCUIT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this repair.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1B0B

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage

DTC P1B0C

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The Starter/Generator Control Module places an AC signal on the high voltage system and monitors its amplitude. A reduced amplitude return signal indicates a loss of resistance to chassis ground. This isolation monitor method is sometimes referred to as the active isolation monitor.

Conditions for Running the DTC

P1B0B

- Power mode is RUN or CRANK.
- Contactors are closed.

P1B0C

Power mode is RUN or CRANK.

Conditions for Setting the DTC

P1B0B

The negative mid-pack voltage is less than 5 V.

P1B0OC

The negative mid-pack voltage minus the high voltage is greater than 10 V.

Action Taken When the DTC Sets

DTCs P1B0B and P1B0C are type B DTCs.

Conditions for Clearing the DTC

DTCs P1B0B and P1B0C are type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V

with leather protectors.

- Visually and functionally inspect the gloves before use.
- Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify P1B0B or P1B0C is not set.
 - If P1B0B or P1B0C is set

Replace the K59 Starter/Generator Control Module.

- If P1B0B and P1B0C are not set
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P1B0D: DRIVE MOTOR CONTROL MODULE DRIVE MOTOR OVERSPEED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1B0D

Drive Motor Control Module Drive Motor Overspeed

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor position sensor is monitored by the generator control module. The generator control module monitors the angular position, speed and direction of the starter generator based upon the signals of the resolver-type position sensor. The position sensor allows the drive motor control module to determine the exact position and speed of the starter generator.

Conditions for Running the DTC

The drive motor control module and hybrid powertrain control module are awake.

Conditions for Setting the DTC

Starter generator speed is greater than 18,000 RPM.

Action Taken When the DTC Sets

- DTC P1B0D is a Type B DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.
- The battery indicator light will illuminate.

Conditions for Clearing the DTC

DTC P1B0D is a Type B DTC.

Diagnostic Aids

Check for broken or missing drive belt.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify if DTC P0A3F, P0A40, P1B03, P0C52, P0C53, P0C5C, and P0C5D are not set.
 - If DTC P0A3F, P0A40, P1B03, P0C52, P0C53, P0C5C, and P0C5D is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If the DTC is set, program the generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called Starter Generator Control Module, replacement, programming and setup.

DTC P1B41: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1B41

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Performance

Circuit/System Description

The vehicle is equipped with a high voltage isolation sensor rationality or performance fault detection. The purpose of the isolation voltage sensor monitor is to test the rationality between the sum of the high voltage positive and negative current sensed voltages against the high voltage sensed value and also against the high voltage value from the battery pack energy control module. This is part of the passive isolation monitor.

Conditions for Running the DTC

Main contactor is commanded closed.

Conditions for Setting the DTC

All the following conditions exist:

- The mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage battery voltage is greater than 15 V and the mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage is greater than 10 V

- The mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage is greater than 10 V

Action Taken When the DTC Sets

DTC P1B41 is a type B DTC.

Conditions for Clearing the DTC

DTC P1B41 is a type B DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify P1B41 is not set.
 - If P1B41 is set

Replace the K59 Starter/Generator Control Module.

- If P1B41 is not set
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P1E0A: DRIVE MOTOR CONTROL MODULE TORQUE CALCULATION PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1E0A

Drive Motor Control Module Torque Calculation Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of generator control module and no external circuits are involved.

Conditions for Running the DTC

The ignition voltage is greater than 9.5 V.

Conditions for Setting the DTC

The difference between the redundant torque calculation and the primary calculation is greater than 36 N.m(27 lb ft).

Action Taken When the DTC Sets

- DTC P1E0A is a Type A DTC.
- The hybrid powertrain control module opens the high voltage contactor relay.

Conditions for Clearing the DTC

DTC P1E0A is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

Program the K59 starter generator control module. If the DTC resets replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1E3B: DRIVE MOTOR ROTOR HIGH TEMPERATURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1E3B

Drive Motor Rotor High Temperature

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The starter generator is also referred to as the drive motor. The drive motor temperature sensor is a variable resistor that measures the temperature of the drive motor stator windings. The hybrid powertrain control module supplies 5 V to the signal circuit and a ground for the low reference circuit. The hybrid powertrain control module calculates a value to estimate the drive motor rotor temperature. The hybrid powertrain control module uses the stator temperature, drive motor current, and commanded motor torque in order to calculate the value for the drive motor rotor temperature.

Conditions for Running the DTC

The drive motor control module and hybrid powertrain control module are awake.

Conditions for Setting the DTC

- DTCs P0A3F, P1A40, P1B03, P1B0D, P0C52, P0C53, P0C5C, P0C5D, P1AE8, P1AE9, P1AEC, P0BFD, P0BE6, P0BE7, P0BE8, P0BEE, P0BEF, and P0BF0 are not set.
- The motor rotor temperature calculation is greater than 197°C (387°F) for 8 seconds and has not fallen below 194°C (381°F).

Action Taken When the DTC Sets

- DTC P1E3B is a Type B DTC.
- The hybrid powertrain control module system starts to reduce the maximum torque beginning at 180°C (356°F) down to 0 NM as the calculated drive motor rotor temperature approaches 200°C (392°F).

Conditions for Clearing the DTC

DTC P1E3B is a Type B DTC.

Diagnostic Aids

- Ask about the customer's driving habits, trailer towing, etc.
- Ensure the engine cooling system is functioning normally.
- The drive motor stator temperature should be within 60°C (140°F) of the motor calculated rotor temperature.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Check the cooling system for the correct amount of coolant. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
2. Verify that DTC P0A2C, P0CC1-P0CC4 is not set.
 - If DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Start the engine and observe the scan tool motor A calculated rotor temperature parameter. The reading should be less than 180°C (356°F). If greater than the specified value, check the cooling system and pump for proper operation. If there is coolant and flow then monitor the calculated rotor temperature and verify that it drops below 180°C (356°F). If the temperature does not drop below 180°C (356°F) then reprogram the K59 starter generator control module. If the DTC resets, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P1E3C: DRIVE MOTOR ROTOR HIGH TEMPERATURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1E3C

Control Module Calculated Hybrid/EV Battery Performance

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module performs internal calculations multiple times and compares the results of these calculations to verify proper operation of the internal controller memory. The result of these calculations is a voltage value. This voltage value is an internal value and cannot be measured externally. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

- The 12 V battery voltage is greater than 9 V.
- The drive motor control module and the hybrid powertrain control module are awake.

Conditions for Setting the DTC

If the results of these calculations differ by more than one volt.

Action Taken When the DTC Sets

- DTC P1E3C is a type A DTC.
- The high voltage contactor relay will be opened.

Conditions for Clearing the DTC

DTC P1E3C is a type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**
- **Drive Motor Battery System Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

If the DTC is set, replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P2534 OR P2535: IGNITION ON/START SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2534

Ignition On/Start Switch Circuit Low Voltage

DTC P2535

Ignition On/Start Switch Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Ignition Voltage	P2534	P2534	P2535

Typical Scan Tool Data

Ignition 1 Signal

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Key ON Parameter Normal Range: 8-18 volts			
IGN	0 volts	0 volts	B+

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module monitors the system voltage on the ignition voltage circuit.

Conditions for Running the DTC

The generator control module is communicating on the serial data circuits.

P2534

Ignition is ON.

P2535

Ignition is OFF.

Conditions for Setting the DTC

P2535

The hybrid powertrain control module detects greater than 5 volts on the ignition voltage circuit at the generator control module when not enabled for greater than 10 seconds.

P2534

The hybrid powertrain control module detects less than 2 volts on the ignition voltage circuit at the generator control module for greater than 10 seconds.

Action Taken When the DTC Sets

DTCs P2534 and P2535 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P2534 and P2535 are Type A DTCs.

Diagnostic Aids

- Verify the charging system is functioning correctly.
- If the run crank circuit is shorted to voltage, the engine will continue to run with the ignition in the OFF position.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. Ignition OFF, measure and record the battery voltage at the battery terminals. The battery voltage should stabilize between 12.4 and 12.8V within a few minutes of turning the ignition OFF.
 - If not within the specified range, refer to **Battery Inspection/Test** .
2. Ignition OFF, disconnect K59 starter generator control module X3 connector.
3. Ignition ON, test for 8-18V between the K59 starter generator control module X3 connector ignition voltage circuit terminal 10 and ground.
 - If not within the specified range, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter Generator Control Module, also called the Starter generator Control Module, replacement, programming and setup.

DTC P2537: IGNITION ACCESSORY SWITCH CIRCUIT LOW VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2537

Ignition Accessory Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Accessory Voltage	P2537	P2537	-

Typical Scan Tool Data

Ignition Input Accessory

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Key ON Parameter Normal Range: Active			
Accessory	Inactive	Inactive	Active

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid powertrain control module monitors the system voltage on the accessory voltage circuit.

Conditions for Running the DTC

- The Ignition is ON.
- The generator control module is communicating on the serial data circuits.

Conditions for Setting the DTC

The generator control module detects less than 2 volts on the ignition voltage circuit at the generator control module for greater than 10 seconds.

Action Taken When the DTC Sets

P2537 is a Type C DTC.

Conditions for Clearing the DTC

P2537 is a Type C DTC.

Diagnostic Aids

Verify the charging system is functioning correctly.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. Ignition OFF, disconnect K59 starter generator control module X2 connector.
2. Ignition ON, test for 8-18V between the K59 starter generator control module X2 connector accessory voltage circuit terminal 8 and ground.
 - If not within the specified range, test the accessory voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the K59 starter generator control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter Generator Control Module, also called the Starter Generator Control Module, replacement, programming and setup.

DTC P2797: AUXILIARY TRANSMISSION FLUID PUMP PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2797

Auxiliary Transmission Fluid Pump Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Switch B+	P2797 **	P2797	-
Relay Coil Ignition	P0B09 **	P0B09	-
Relay Coil Control	P0B09 *	P0B09	P0B09
Relay Switch Control	P2797 **	P2797	P2797 *
Component Ground	-	***	-
* Auxiliary Transmission Fluid Pump - always On			
** The fuse opens			
*** Auxiliary Transmission Fluid Pump - inoperative			

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The transmission fluid pump - auxiliary is used to maintain transmission fluid line pressure to the transmission during Autostop mode. The transmission fluid pump - auxiliary is externally mounted to the transmission case assembly. The hybrid powertrain control module controls the auxiliary pump by providing the ground path to the transmission pump relay - auxiliary coil control circuit.

Conditions for Running the DTC

- The Ignition is ON.
- The system voltage is between 9.0 and 32.0 V.

Condition 1

The vehicle is in autostop mode.

Condition 2

- All conditions allowing an autostop have been met.
- A/C compressor ON.

Conditions for Setting the DTC

Condition 1

The calculated transmission slip speed is greater than 150 RPM during a vehicle launch from autostart mode, 7 consecutive times in the same key cycle.

Condition 2

The 14 volt power module output current does not increase by 100 watts or more when the auxiliary transmission fluid pump is commanded ON by the hybrid powertrain control module.

OR

The 14 volt power module output current does not decrease by greater than 250 watts when the auxiliary transmission fluid pump is commanded OFF by the hybrid powertrain control module.

Action Taken When the DTC Sets

- The hybrid powertrain control module disables the Autostop mode.
- DTC P2797 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2797 is a Type B DTC.

Diagnostic Aids

Driving a vehicle with an auxiliary transmission fluid pump failure that causes low or no pressure will cause a harsh transmission engagement on vehicle launch from an autostop.

Transmission Fluid Pump Relay Underhood Electrical Center Terminal Identification			
Front of Vehicle			
Left Side of Vehicle	Control	Load	Right Side of Vehicle
	B+	Ignition	

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**
- **Starter Generator Description and Operation**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other hybrid powertrain or transmission control module DTC is set.
 - **If any hybrid powertrain or transmission control module DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

2. Perform the **Transmission Fluid Level and Condition Check** to verify correct fluid level and condition.
3. Ignition ON.
4. Verify the auxiliary transmission fluid pump turns ON and OFF when commanding the auxiliary transmission fluid pump relay ON and OFF with a scan tool.
 - **If the pump does not operate**

Refer to Circuit/System Testing.

- **If the pump operates**

All OK. Refer to transmission **Line Pressure Check (Non Hybrid)** , **Line Pressure Check (Hybrid)** .

Circuit/System Testing

1. Ignition OFF, disconnect the KR86 transmission fluid pump relay - auxiliary, Ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Disconnect the X1 harness connector at the G5 Transmission Fluid Pump - Auxiliary, test for infinite resistance between the switched control circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the G5 Transmission Fluid Pump - Auxiliary.
 - **If the test lamp illuminates**
3. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the G5 Transmission Fluid Pump - Auxiliary. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 10 ohms between the G5 Transmission Fluid Pump - Auxiliary ground circuit X1 terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
5. Connect the harness connector at the G5 Transmission Fluid Pump - Auxiliary.
6. Connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the switch control circuit terminal 87. Ignition ON.
7. Verify the G5 Transmission Fluid Pump - Auxiliary is ON.
 - **If the Pump is not ON**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the switch control circuit terminal 87 end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the G5 Transmission Fluid Pump - Auxiliary.
 - **If the Pump is ON**
8. Test or replace the KR86 Transmission Fluid Pump Relay - Auxiliary.
 - **If the DTC resets**
9. Refer to transmission **Line Pressure Check (Non Hybrid)** , **Line Pressure Check (Hybrid)** .

Component Testing

1. Ignition OFF, disconnect the KR86 Transmission Fluid Pump Relay - Auxiliary.
2. Test for 85-130 ohms between terminals 85 and 86.
 - **If less than 85 ohms or greater than 130 ohms**

Replace the relay.

- **If between 85-130 ohms**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

- **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground.

5. Test for less than 2 ohms between terminals 30 and 87.

- **If 2 ohms or greater**

Replace the relay.

- **If less than 2 ohms**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Auxiliary Fluid Pump Removal (Hybrid)**
- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)** , Within an Electrical Center, for Transmission Fluid Pump Relay - Auxiliary replacement.

SYMPTOMS - HYBRID CONTROLS

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions.

Refer to the following procedures:

- **Generator Control Module Description and Operation**
- **High Voltage Monitoring Systems Description**

- **Hybrid Modes of Operation Description**
- **Starter Generator Description and Operation**
- **Transmission General Description**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Hybrid System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

DC Power Conversion Test

DC POWER CONVERSION TEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The generator control module also called the starter generator control module is comprised of the following three control modules; the hybrid powertrain control module, 14 volt power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14 volt power module supplies the energy that flows between the high voltage (115V) direct current (DC) and low voltage (14V) DC to charge the 12V battery and power accessories. The 14V power module receives a wake-up signal from the hybrid powertrain control module when the ignition is switched to On. After a successful initialization, the 14V power module receives an enable command from the hybrid powertrain control module to begin power conversion.

Diagnostic Aids

A poor connection at the B+ terminal of the 14V power module or open 300 Amp Mega-Fuse in the engine compartment, will prevent the 14V power module from operating.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Generator Control Module Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
 - If not within the specified range, refer to Battery Inspection/Test
2. Start and idle the engine, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be at least 1 V greater than the voltage measured in step 1 but less than 15 V.
 - If not within the specified range, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition ON, verify that no K1 14V power module or B18 battery current sensor DTCs are set that would cause a charging system concern.
 - If DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.4 V or greater at room temperature.
 - If not within the specified range, refer to Battery Inspection/Test
3. Connect a carbon pile tester to the C1 battery.
4. Start and idle the engine, turn all accessories off. Observe the voltage reading on the tester. The voltage should read between 12.6-15.5V.
5. Adjust the carbon pile tester so that the 12V current on the 14V power module data list is reading 120 amps. The voltage reading should remain between 12.6-15.5V.

- If not within the specified value, replace the K1 14V power module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for Generator Control Module replacement, programming, and setup for 14 Volt Power Module replacement.

REPAIR INSTRUCTIONS

STARTER GENERATOR REPLACEMENT

Special Tools

EN-48932 Hydraulic Belt Tensioner Compressor

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.

- Visually and functionally inspect the gloves before use.
- Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .
2. Disable the high voltage system. Refer to High Voltage Disabling .
3. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .
4. Reposition the secondary air injection pump inlet hose, if equipped. Refer to Secondary Air Injection Pump Inlet Hose Replacement (LEA, LUK) .

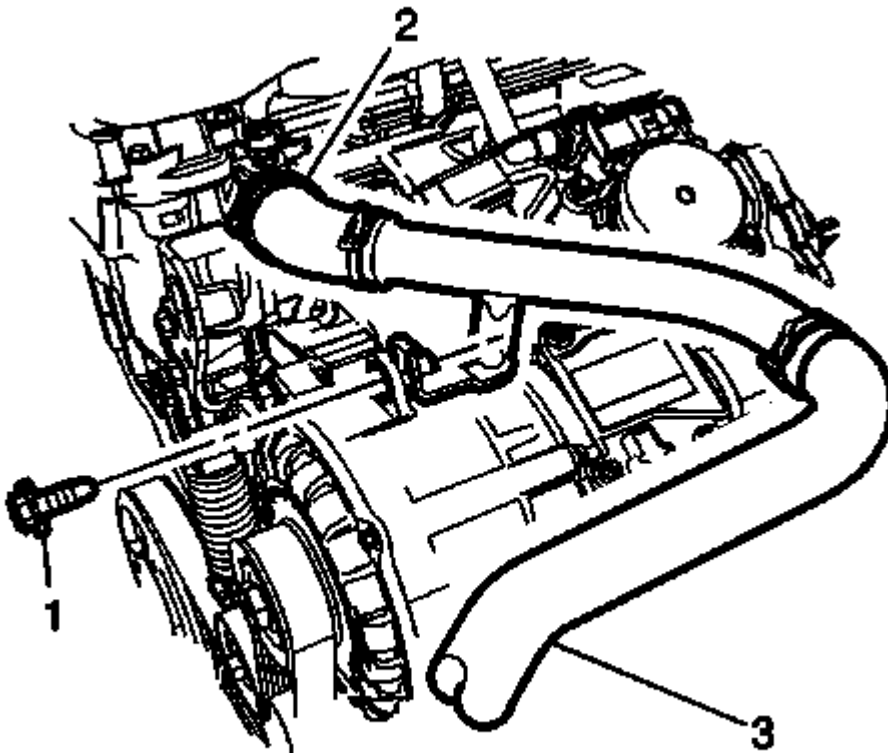


Fig. 4: Radiator Inlet Hose, Bracket & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the radiator inlet hose bracket bolt (1) and the radiator inlet hose clamp (2).
6. Reposition the radiator inlet hose (3).

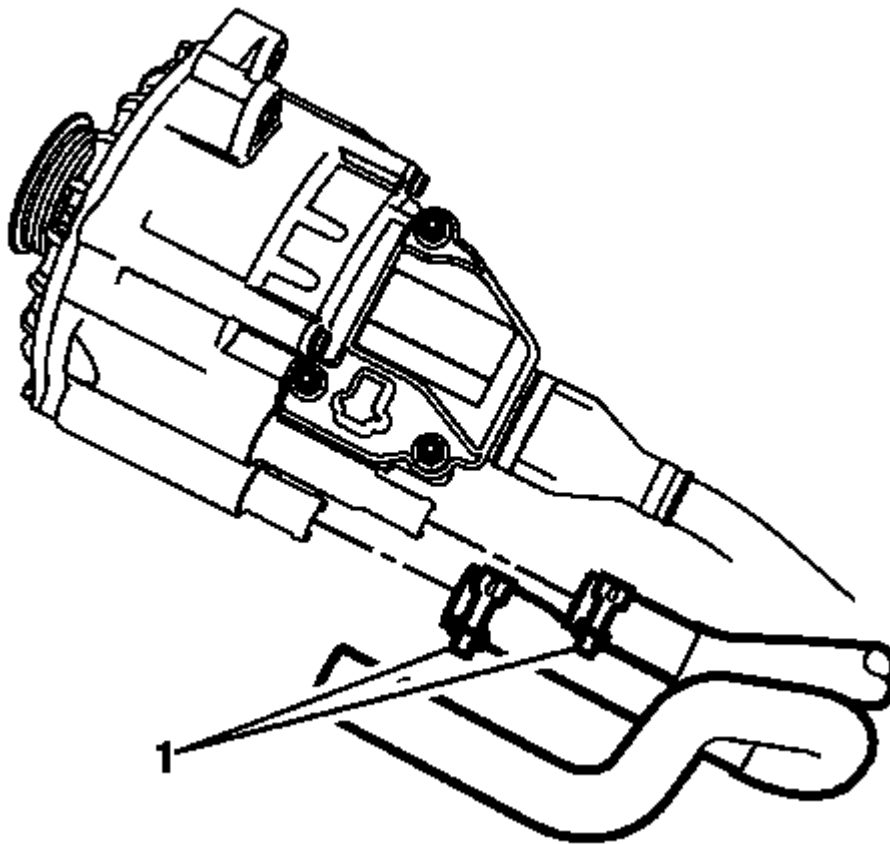


Fig. 5: Starter Generator Hoses

Courtesy of GENERAL MOTORS COMPANY

NOTE: Place a clean cloth in the starter generator coolant tubes to prevent coolant leakage.

7. Remove the starter generator hoses (1) and reposition hoses away from the Starter Generator.

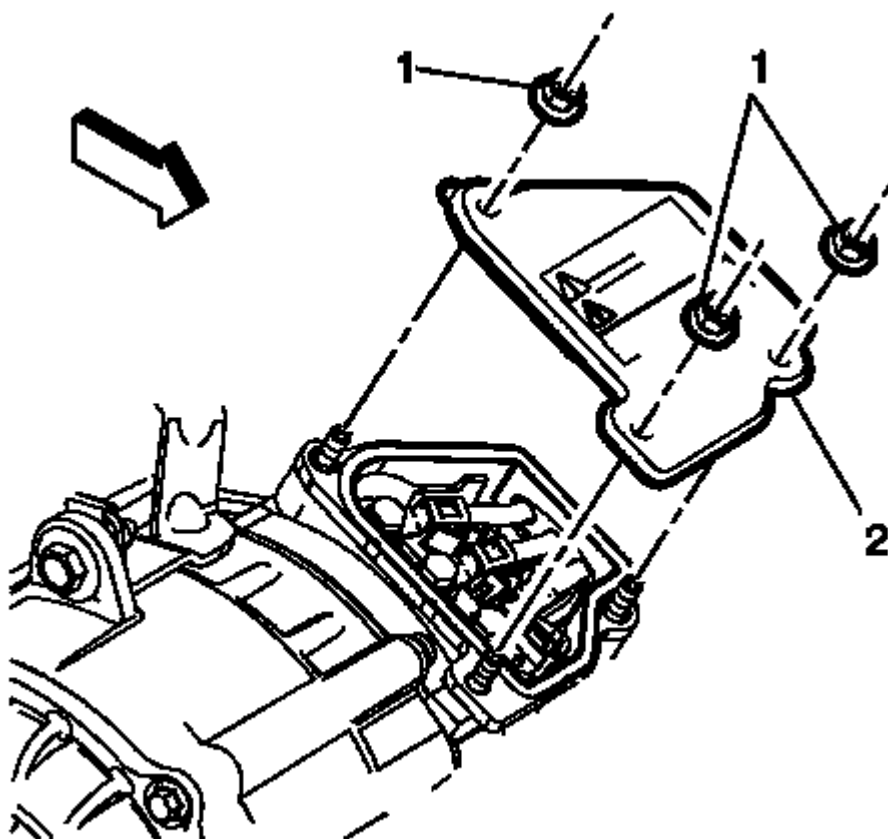


Fig. 6: Generator Starter Cover Nuts

Courtesy of GENERAL MOTORS COMPANY

8. Remove the drive motor generator battery cable cover nuts (1) and the drive motor generator battery cable cover (2).

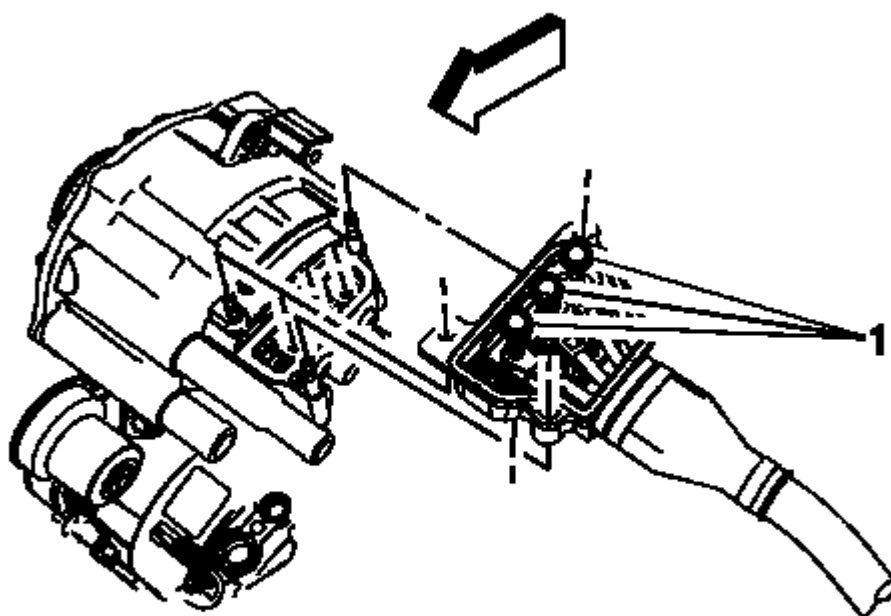


Fig. 7: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

NOTE: The terminals are very sensitive to contamination. Be sure to protect the terminals from engine coolant or debris.

9. Remove the drive motor generator battery cable terminal bolts (1) and reposition the drive motor generator battery cable.

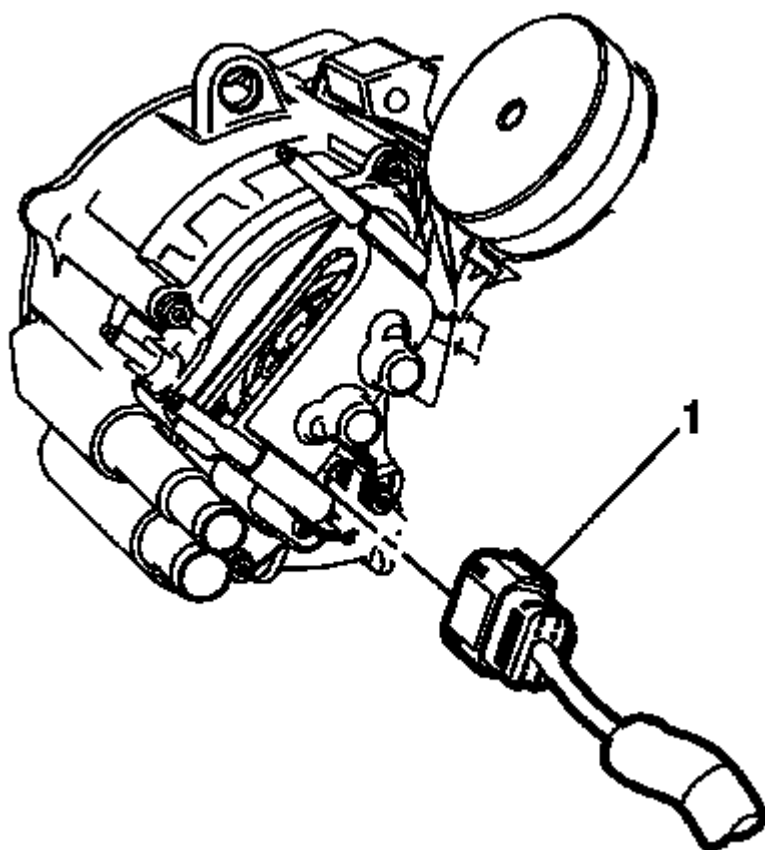


Fig. 8: Drive Motor Generator Battery Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: The terminals are very sensitive to contamination. Be sure to protect the connector from debris or engine coolant.

10. Remove and cover the drive motor generator battery connector (1).

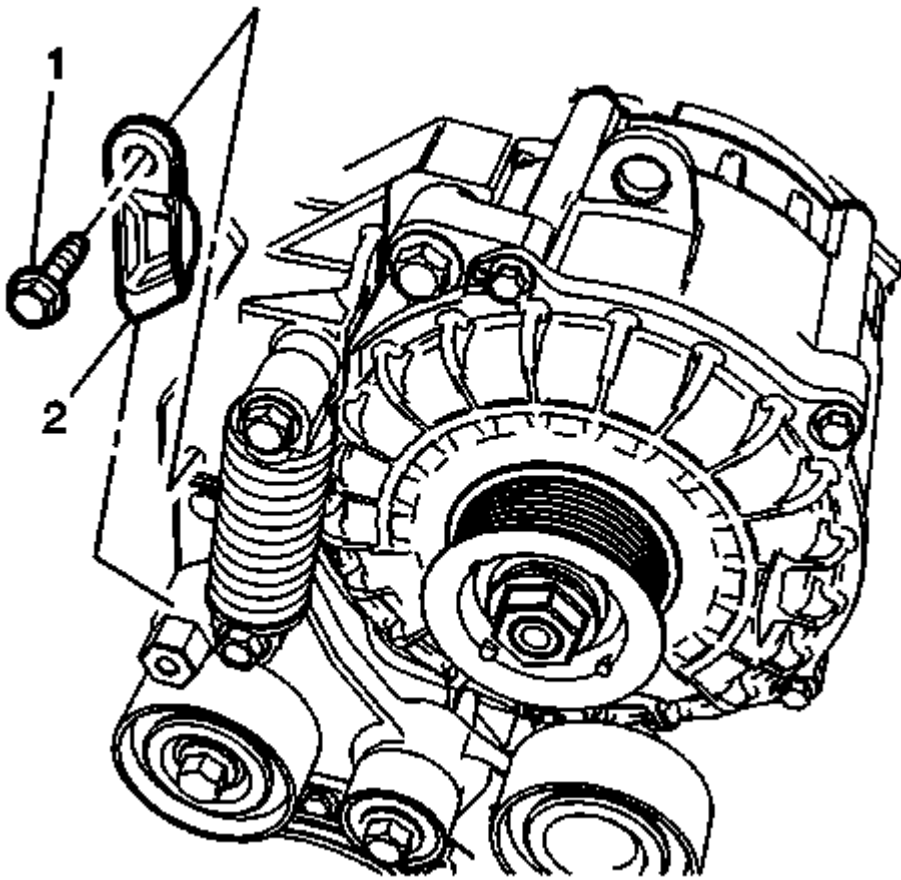


Fig. 9: Drive Belt Tensioner Stop Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Remove the drive belt tensioner stop bolt (1) and the drive belt tensioner stop (2).

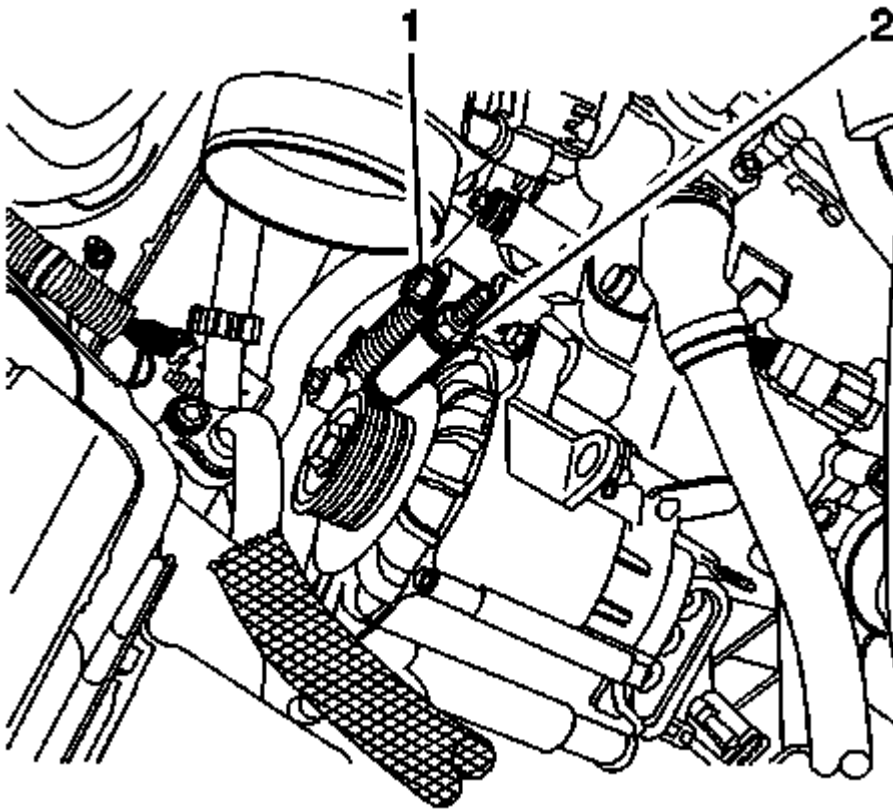


Fig. 10: Special Compressor Tool

Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the EN-48932 compressor tool is not on the Generator bracket and A/C Compressor bracket.

12. Install the **EN-48932** compressor tool (2) to the drive belt tensioner spring.
13. Tighten the nut (1) on the **EN-48932** compressor tool (2) until the tensioner spring reaches its internal stop.

NOTE: Try not to remove the drive belt from the other pulleys.

14. Release the tension from the other drive belt tensioner and remove the drive belt from the starter generator pulley.

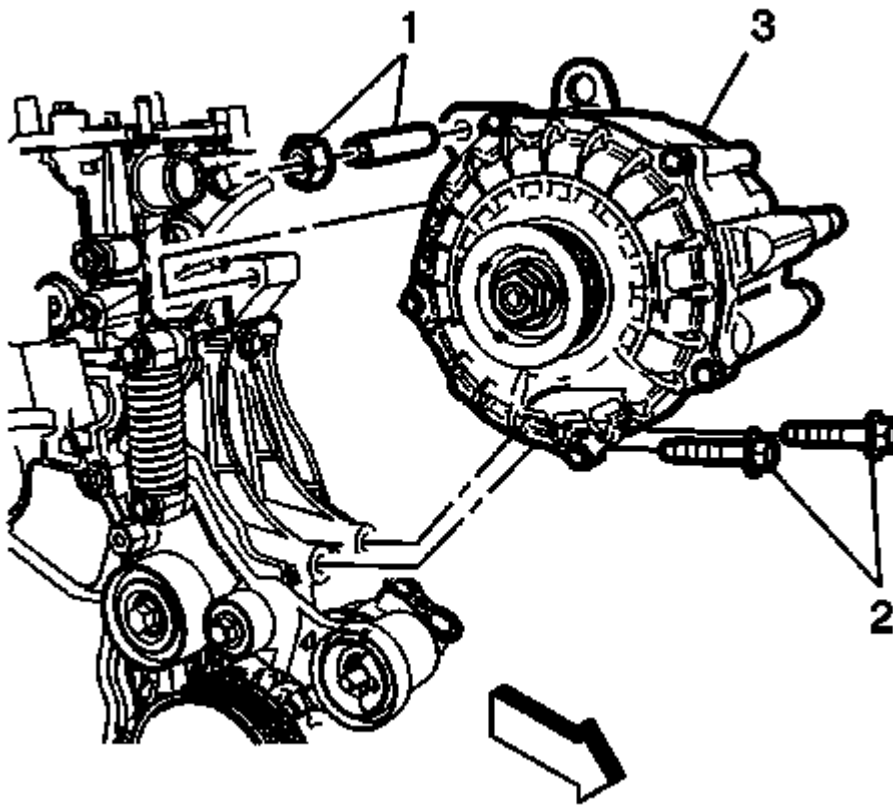


Fig. 11: Stud/Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: If stud is seized, place 2 nuts on the end of the stud and remove with a socket.

15. Remove the stud/nut (1) from the starter generator.
16. Raise the vehicle.
17. Remove the starter generator bolts (2).
18. Remove the starter generator (3).

Installation Procedure

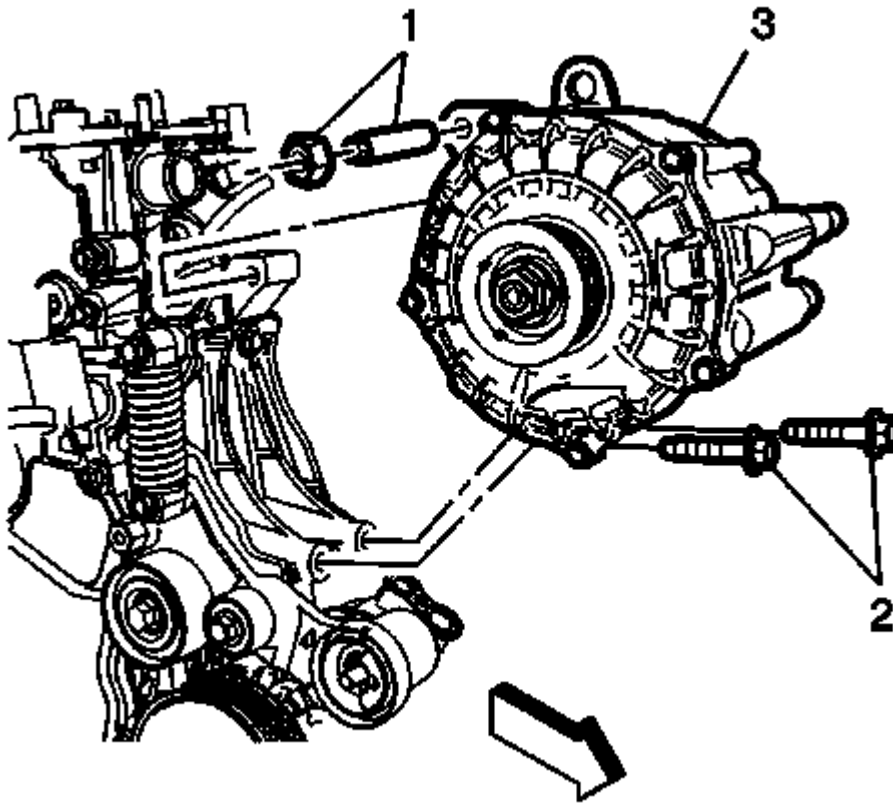


Fig. 12: Stud/Nut
Courtesy of GENERAL MOTORS COMPANY

1. Position the starter generator to the engine.

CAUTION: Refer to Fastener Caution .

2. For ease of service, replace the stud (1) with a new starter generator lower bolt (2) from the parts catalog and apply medium LOCTITE to the bolt. Tighten to 58 N.m (41 lb ft).
3. Install the starter generator lower bolts (2) and tighten to 58 N.m (41 lb ft).

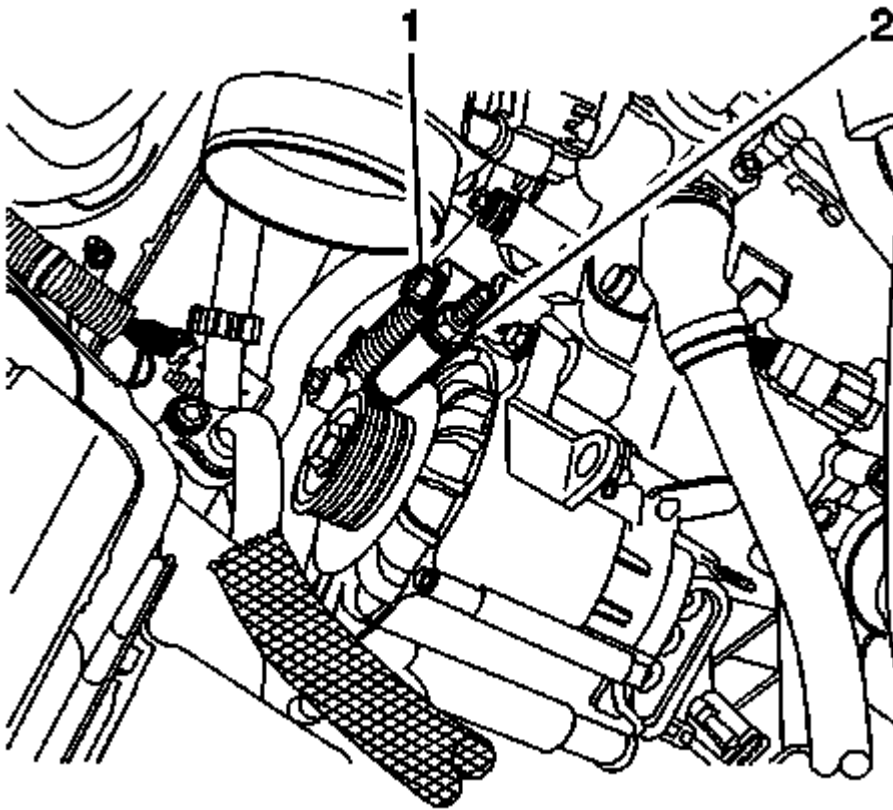


Fig. 13: Special Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

4. Remove the belt from the middle idler.
5. Install the drive belt onto the starter generator pulley.
6. Rotate the tensioner pulley clockwise and then install the belt around the middle idler.
7. Remove the **EN-48932** compressor tool (2) from the drive belt tensioner spring.

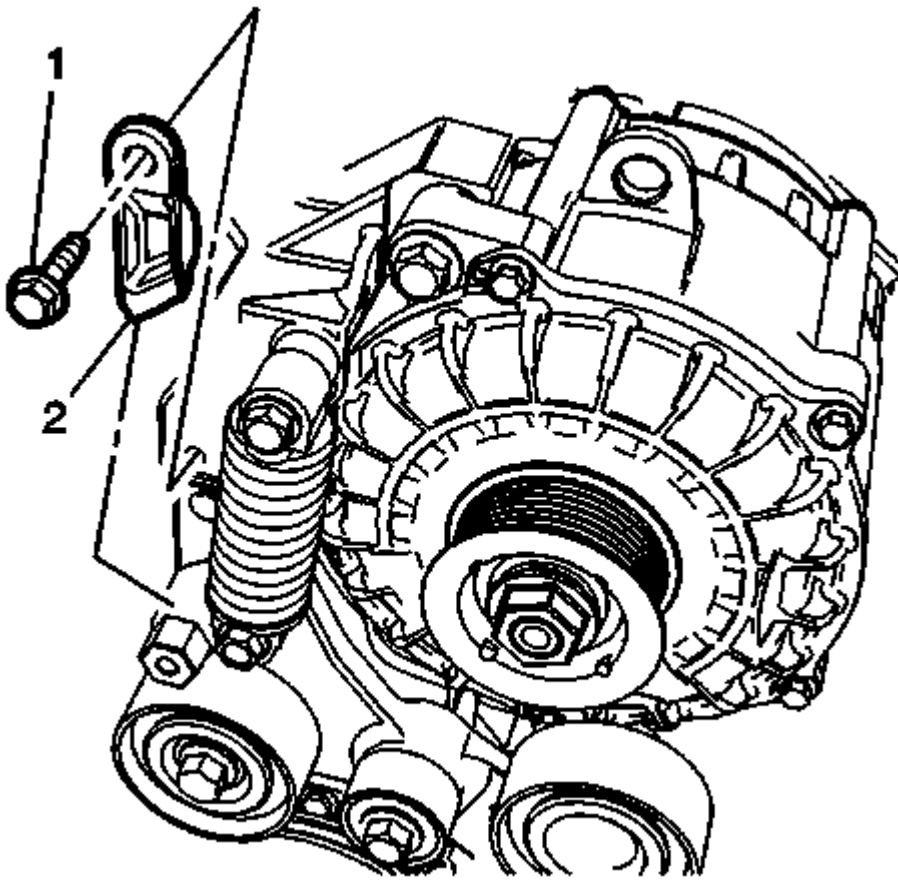


Fig. 14: Drive Belt Tensioner Stop Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the drive belt tensioner stop pin is aligned with the hole in the Generator and A/C Compressor bracket.

8. Install the drive belt tensioner stop bolt (1) and the drive belt tensioner stop. Tighten to 9 N.m (80 lb in).

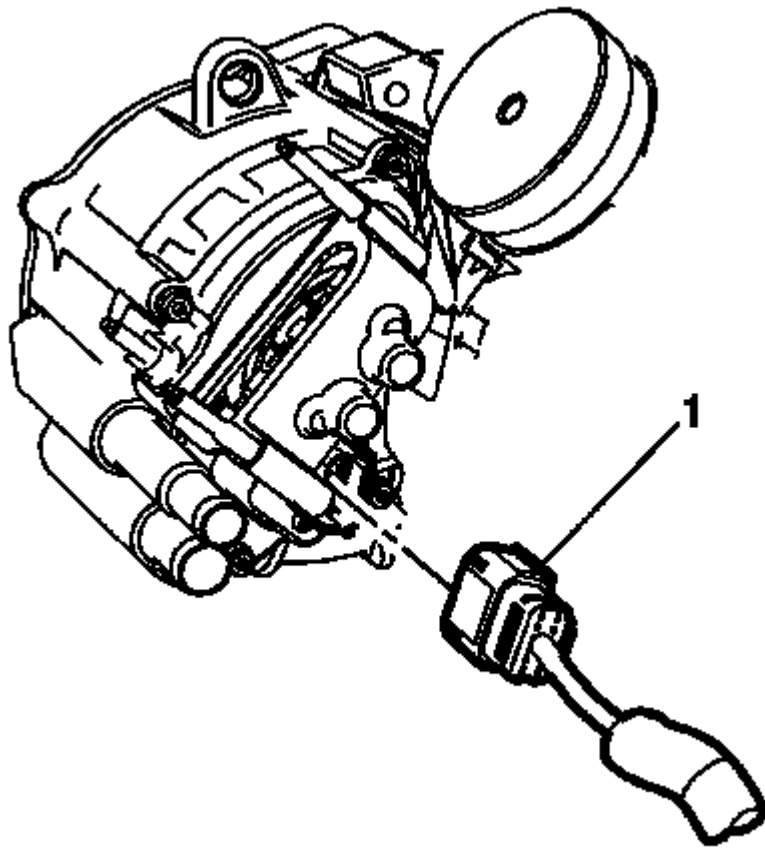


Fig. 15: Drive Motor Generator Battery Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Verify the connector is free of contamination prior to engagement.

9. Install the starter generator battery connector (1).

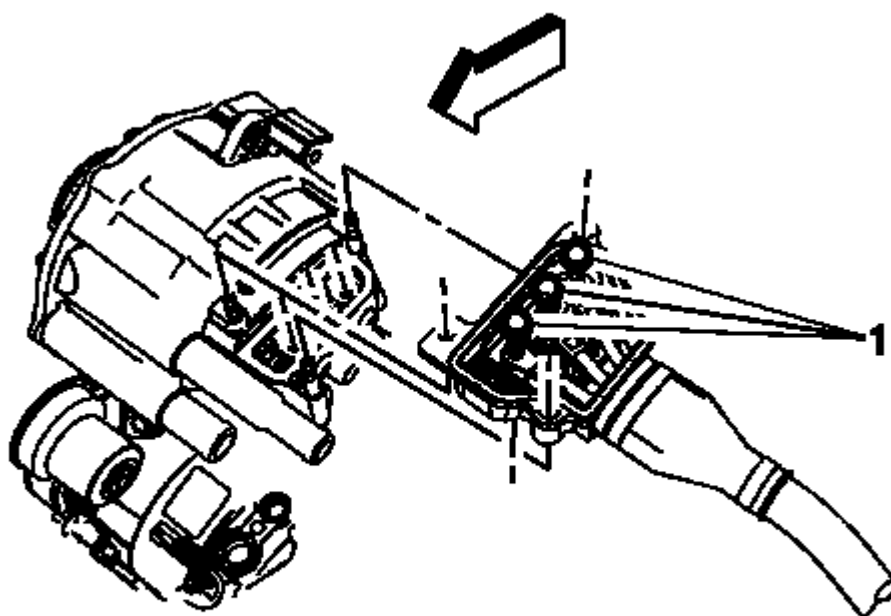


Fig. 16: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

NOTE: Be sure the drive motor generator battery cable cover is fully seated against the drive motor generator battery cable housing prior to installing and fastening the nuts. This will ensure proper alignment and engagement of HVIL terminals.

10. Install the drive motor generator battery cable to the starter generator assembly and tighten the nuts (1) to 9 N.m (80 lb in).

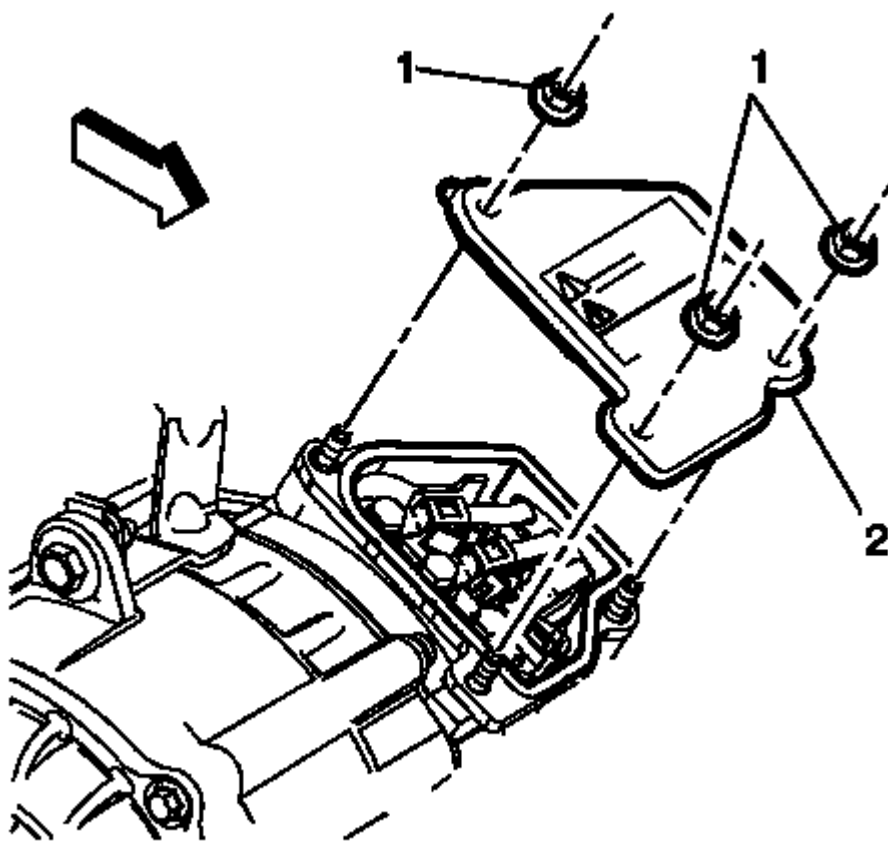


Fig. 17: Generator Starter Cover Nuts
Courtesy of GENERAL MOTORS COMPANY

11. Install the drive motor generator battery cable cover nuts (1) and the drive motor generator battery cable cover (2). Tighten to 9 N.m (80 lb in).

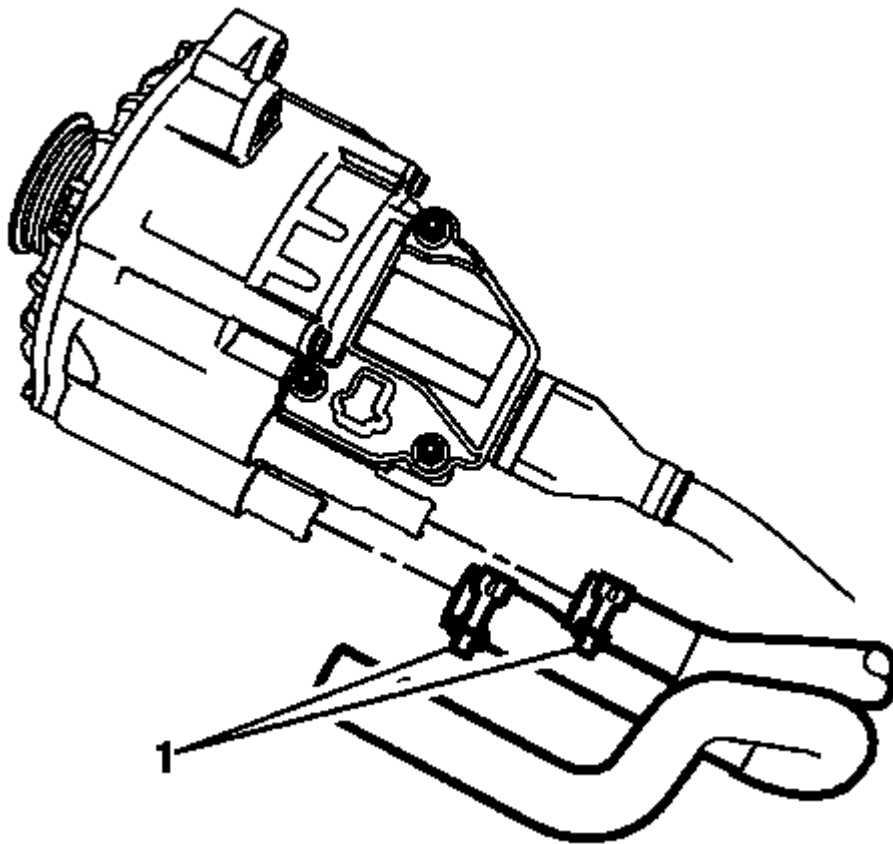


Fig. 18: Starter Generator Hoses

Courtesy of GENERAL MOTORS COMPANY

12. Install the starter generator hoses and clamps (1).

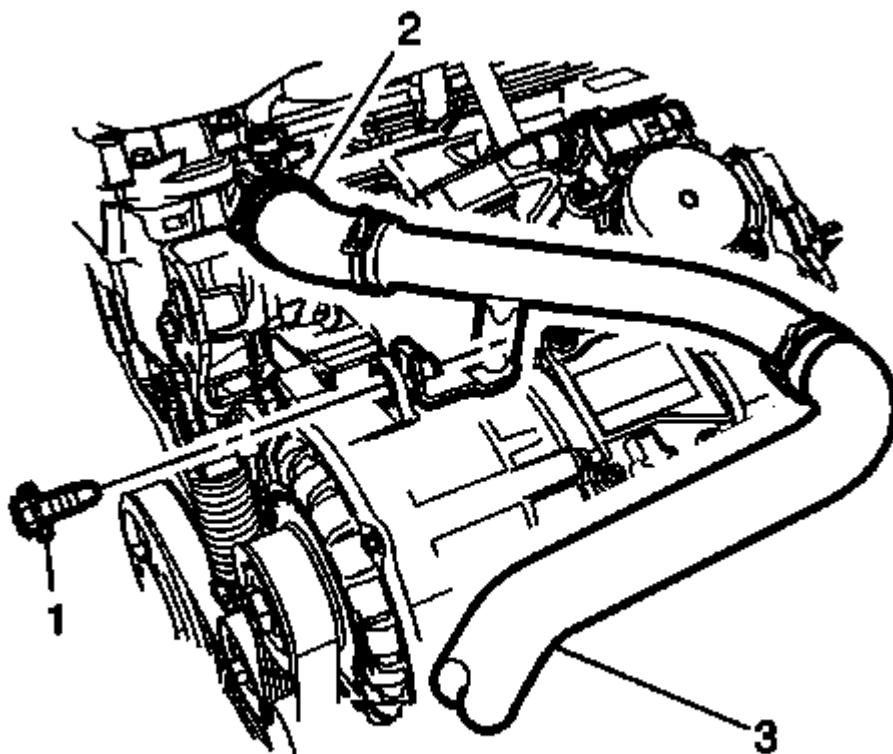


Fig. 19: Radiator Inlet Hose, Bracket & Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Install the radiator inlet hose (3), the radiator inlet hose clamps (2) and tighten the bracket bolt (1) to 9 N.m (80 lb in).
14. Install the secondary air injection pump inlet PCV pipe, if equipped. Refer to **Secondary Air Injection Pump Inlet Hose Replacement (LEA, LUK)** .
15. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
16. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
17. Enable the high voltage system. Refer to **High Voltage Enabling** .

DESCRIPTION AND OPERATION

STARTER GENERATOR DESCRIPTION AND OPERATION

Location

The starter generator, also referred to as the drive motor, is located in the engine compartment. The drive motor is mounted to the front of the engine in place of the alternator, directly above the air conditioning compressor. The drive motor is connected to the crankshaft pulley using a specially designed serpentine belt and drive belt

tensioner.

Operating Functions

The drive motor is a 3 phase AC induction machine. This device not only serves as a 115-volt AC generator, it is also used to provide engine power assist and to start the engine when in auto-stop mode. The 115-volt AC current flows between the drive motor and the generator control module, also referred to as the starter generator control module, through a three phase cable assembly.

As a generator, the drive motor provides up to 15 kW of AC power to the drive motor control module.

As a motor, the drive motor provides up to 11 kW of electric power assistance and engine starting. The motor receives three phase AC power from the drive motor control module which is internal and part of the generator control module.

The drive motor has 2 internal sensors that are not serviceable, the drive motor position sensor and the drive motor temperature sensor.

The ratio between the drive motor pulley and the crankshaft pulley is 2.38 to 1. The generator control module is capable of checking the integrity of the drive motor belt by receiving an engine RPM input from the ECM over serial data and comparing that against the drive motor speed input signal from the drive motor position sensor.

ELECTROMAGNETIC COMPATIBILITY DESCRIPTION

Overview

Vehicles are typically subject to certain legal requirements that limit the amount of electromagnetic interference (EMI) that can be generated by the vehicles electronic devices. Additionally, the electronic devices within the vehicle must be able to withstand a certain amount of EMI without effecting their operation. EMI is generated whenever electrical current flows through a circuit. The amount of EMI generated is usually dependent upon the amount of current flow and the switching frequency of current flow through the circuit. The EMI requirements are generally referred to as electromagnetic compatibility.

There are many ways of ensuring the vehicle meets electromagnetic compatibility requirements. These include:

- Adding capacitors and resistors to certain electrical circuits
- Regulating the frequency at which a component operates
- Shielding wires, cables and components

Circuit Design

The generator control module, often referred to as the drive motor control module, and the 14V power module each contain filter capacitors connected to the high voltage circuits. These capacitors are necessary to reduce the voltage spikes that occur as a result of the switching of current. Reducing voltage spikes reduces EMI. The switching frequency of the current is also closely regulated. Too high of a frequency can cause an increase in EMI generation.

Wiring/Cable Design

Different types of wire/cable shielding methods are utilized in the vehicle. Common types of shielding include twisted-pair and internal braid or foil. Twisted pair is typically used in circuits such as serial data circuits. The wire pair is twisted together at a particular turns-per-length ratio. Shielded cable is utilized for all other circuits requiring either protection from external EMI or to reduce EMI radiation of the cable itself into other nearby components or circuits.

High Voltage Cable

Drive Motor Generator Battery 3 Phase Cable Assembly

The high voltage cables utilize internal braid shielding. Typically, both ends of the internal braid shield are attached to chassis ground. All of the shielded high voltage cables are grounded at their cable end attachment points.

Low and Intermediate Voltage Wiring

The drive motor position sensor and temperature sensor circuits utilize internal foil shielding.

Component Shielding

Certain components utilize their structure to effectively shield EMI. Metal covers, chassis grounded metal cases and electro-magnetically conductive gaskets may all be part of a component's electromagnetic compatibility design.

Shielding Loss

A loss of proper shielding may result in poor AM band radio reception and/or incorrect sensor circuit readings depending upon the location of the shield loss. Damage that has penetrated to the insulated conductor of high voltage cables is not repairable. Certain Low and Intermediate voltage shielded wiring harnesses may be repairable. Refer to **Wiring Repairs** , and **Splicing Twisted or Shielded Cable** .

GENERATOR CONTROL MODULE DESCRIPTION AND OPERATION

Overview

The generator control module is also referred to as the starter generator control module. The generator control module is located in the generator control and battery module assembly which is located in the trunk directly behind the rear seat.

The generator control module is comprised of the following control modules:

- Hybrid powertrain control module
- 14 volt power module
- Drive motor control module

The generator control module functions as an inverter, inverting high voltage direct current (DC) electrical

energy to 3 phase alternating current (AC) electrical energy and vice versa. The generator control module also functions as a DC to DC converter, converting high voltage DC to 14 volts DC. The generator control module is located in the generator control and battery module assembly. The generator control and battery module assembly is air cooled.

High Voltage Circuits

Direct Current (DC)

The generator control module is connected to the positive and negative terminals of the high voltage, (DC) generator battery assembly. Both of the negative and positive high voltage DC battery poles are isolated from the vehicle chassis. The positive high voltage DC cable is switched ON or OFF by a high voltage, high current contactor relay contained within the generator control and battery module assembly. All high voltage DC negative and positive DC cables are orange in color to alert the technician to the potential presence of high voltage.

Three Phase Alternating Current (AC)

Three individual cables connect each phase of the drive motor to the generator control module. Each individually shielded cable is orange in color to alert the technician to the potential presence of high voltage. These three cables are routed from engine compartment to the rear of the vehicle in a single conduit.

Low Voltage Circuits

The 14V power module is an electronic device that converts high voltage (115V) DC to low voltage (14V) DC for operation of all low voltage modules and to charge the 12 volt accessory battery. The 14 volt power module is not serviced separately and is part of the generator control module.

Low Voltage (12V) Direct Current

Low voltage (12V) cables on the hybrid vehicle do not require unique coloring or servicing procedures.

Hybrid Powertrain Control Module

Location

The hybrid powertrain control module is a non-serviceable, flash-programmable micro-processor that is part of the generator control module.

Operating Functions

The hybrid powertrain control module is the main controller of powertrain operation. The hybrid powertrain control module determines when to perform normal operating modes such as auto stop, launch assist mode, and regenerative braking. The hybrid powertrain control module also operates in conjunction with the battery energy control module to determine when to enable and disable the DC high voltage circuits. The motor control module operates the drive motor based upon hybrid powertrain control module commands.

Communication and Hosted Diagnostics

The hybrid powertrain control module is the host controller for DTC and scan tool parameter information for the following control modules:

- 14V power module
- Drive motor control module
- Battery energy control module

These modules diagnose their own operation and determine when a fault condition is present. The 14V power module communicates diagnostic status to the hybrid powertrain control module over serial data.

The drive motor control module and the hybrid powertrain control module exchange information and commands on a serial peripheral interface bus internal communication circuit as well as the hi-speed serial data communication circuit.

In the event the battery energy control module (BECM) communicates a fault condition, the hybrid powertrain control module will determine if one or more operating modes are affected and notify the vehicle operator by requesting the MIL illuminate and/or by displaying a message in the Driver Information Center. In addition, the hybrid powertrain control module will store the associated DTC information for retrieval by a scan tool. Some hosted modules may require an ignition cycle to clear certain DTCs from the hybrid powertrain control module.

Circuit Inputs

In addition to data parameters, the hybrid powertrain control module directly monitors the following signal circuits:

- Engine crankshaft position sensor signal (via serial data message from ECM - not direct)
- High voltage interlock circuit
- Brake Pedal Position
- Drive Motor Temperature (via motor control module)
- Drive Motor Position (via motor control module)
- Hood switch
- Various internal signals (temps, etc.)

Circuit Outputs

In addition to control through other controllers, the hybrid powertrain control module directly controls:

- Cooling Fan
- Auxiliary Transmission fluid pump
- Drive Motor
- Drive Motor Cooling pump

Drive Motor Control Module

Location

The drive motor control module is a flash-programmable micro-processor. The drive motor control module is non serviceable and is part of the generator control module.

Operating Functions

The drive motor control module's main function is to monitor the drive motor input/output circuits and to control the insulated gate bipolar transistors that control the drive motor by inverting the high voltage DC electrical energy to 3 phase AC electrical energy and vice versa.

Communication and Hosted Diagnostics

The hybrid powertrain control module communicates with the drive motor control module using an internal serial data circuit. The drive motor control module does not store its own diagnostic trouble code (DTC) information. The hybrid powertrain control module will store the drive motor control module associated DTC information for retrieval by a scan tool. The scan tool can communicate directly with the drive motor control module in order to retrieve data parameters only.

Circuit Inputs

In addition to data parameters, the drive motor control module monitors the drive motor for:

- Voltage
- Current
- Speed and direction
- Temperature

Additionally, the drive motor control module monitors the insulated gate bipolar transistor components for temperature and proper operation. Some of the drive motor control modules operation data is shared with the hybrid powertrain control module.

Circuit Outputs

The drive motor control module controls the insulated gate bipolar transistor driver board which is located in the drive motor control module, that in-turn controls the drive motor. The drive motor is controlled by the 3-phase alternating current (AC). Three cables connect the drive motor to the drive motor control module which is part of the generator control module.

14 Volt Power Module

Location

The 14 volt power module is a non-serviceable device that is part of the generator control module.

Operating Functions

The 14V power module is the device which converts high voltage (115V) DC to low voltage (12V) DC for accessory electrical operation and to charge the 12 volt accessory battery. The 14 volt power module will

typically charge the 12 volt system at approximately 14.5 volts with a max power output of 1600 watts. The 14 volt power module is not programmable.

HIGH VOLTAGE MONITORING SYSTEMS DESCRIPTION

The hybrid system monitors several high voltage components for attempted access. Additionally, a minimum amount of isolation resistance is maintained at all times between both negative and positive poles of the hybrid battery and the vehicle chassis. The drive motor control module monitors the hybrid system for access and loss of isolation detection.

High Voltage Interlock Circuit

The High Voltage Interlock Circuit is a wire loop that passes through certain high voltage components. The high voltage interlock circuit is used to determine if access to high voltage components is being attempted. The opening of these high voltage components causes the high voltage interlock circuit to open. The hybrid system may react to the loss of high voltage interlock circuit continuity by opening the high voltage contactor relay and discharging the high voltage capacitors. The high voltage interlock circuit signal is generated by the drive motor control module. The high voltage interlock circuit status is monitored by the drive motor control module, the hybrid powertrain control module, and the drive motor control module.

High Voltage DC Chassis Isolation

The hybrid system monitors the electrical potential between high voltage and the vehicle chassis. High voltage should always be isolated from the vehicle chassis by a certain amount of resistance to avoid the potential for a life threatening current path. In the event that a high voltage leak path is detected to the vehicle chassis, the hybrid system will set a diagnostic trouble code (DTC). High voltage DC chassis isolation is monitored by the generator control module.

Testing for loss of isolation requires special tools and procedures. Because of the high voltages present in the hybrid system, a loss of isolation may occur due to insulation breakdown. Insulation breakdown typically occurs only when high voltages and/or current is present. Conditions such as insulation breakdown cannot be diagnosed with a typical DMM because high voltage is not used by the DMM when measuring resistance.

HYBRID MODES OF OPERATION DESCRIPTION

Automatic Engine Start/Stop

WARNING: Exiting the vehicle without first shifting into P (Park) may cause the vehicle to move. You or others may be injured. Because the vehicle has the automatic engine start/stop feature, the vehicle's engine might seem to be shut off; however, once the brake pedal is released, the engine will start up again.

Shift to P (Park) and turn the ignition to LOCK/OFF, before exiting the vehicle.

Vehicles with eAssist have an automatic (auto) engine start/stop feature. After the engine has started and reached operating temperature the auto stop feature may cause the engine to turn off when brakes are applied

and the vehicle has come to a complete stop. When the brake is released or the accelerator pedal applied, the engine will start. The engine will continue to run until the next auto stop or until the ignition switch is turned OFF.

AUTO STOP on the tachometer signifies that the engine is in auto stop mode. When the vehicle is turned off, the tachometer will move to OFF. If the driver door is opened while in auto stop mode, a chime will sound.

To restart the engine during auto stop, release the brake pedal or press the accelerator pedal. The engine starts immediately. The engine continues to run until the next stop.

There are several conditions which may prevent an auto stop or cause an auto start.

The Engine Will Remain Running When:

- The engine, transmission, or hybrid battery is not warmed up.
- The outside temperature is less than -15°C (5°F).
- The air conditioning or defrost system requires the A/C compressor to maintain vehicle comfort.
- The shift lever is in any position other than DRIVE.
- The hybrid battery pack charge is low.
- The 12-volt vehicle battery charge is low, or loads are high.
- The hood is not fully closed.

The Engine Will Restart When:

- The brake pedal is released.
- The accelerator pedal is applied.
- Shifting out of D (Drive) to any other gear.
- If the eco air conditioning button is selected, the duration of the auto stop will mainly depend on the outside temperature along with some other factors. This economy mode improves fuel economy by limiting the effects of the air conditioning. The warmer it is outside, the shorter the time before the engine is restarted to provide cabin cooling.
- The climate control system is turned from off to normal air conditioning or defrost.
- The engine is required to run for either heater or climate control performance.
- The hybrid battery pack charge is low and requires recharging.
- Auto stop time is greater than two minutes.

Regenerative Braking

Regenerative braking takes some of the energy from the moving vehicle and turns it into electrical energy. This energy is then used to charge the vehicle's hybrid battery system, which increases fuel efficiency.

The torque converter stays locked allowing the drive motor to be coupled to the wheels (through engine and trans) to recharge the hybrid batteries via regenerative braking.

The system works whenever you take your foot off the accelerator pedal while the vehicle is moving in a forward gear. This causes the vehicle to slow down more quickly. It may feel like the brake pedal is being pressed, even when it is not. When the brake pedal is depressed the system will deliver a higher percent of regenerative energy to the hybrid battery system than when in coast down.

Electric Power Assist

Significant internal transmission changes to clutch controls and hardware provide reduced spin losses while improving shift quality. The added electric power provided by the eAssist system allows for higher gearing to improve steady state efficiency without impacting acceleration performance or driveability. The system's capability of providing up to 11 kW of electric power assist at cruising speeds allows the driver to accelerate lightly, ascend mild grades without the transmission downshifting and helps performance during wide open throttle maneuvers.

Torque Smoothing

While not unique to the eAssist hybrid vehicle, expanded operational range is possible because the drive motor can react quickly to smooth driveline disturbances that would otherwise be objectionable.

Deceleration Fuel Cut-Off

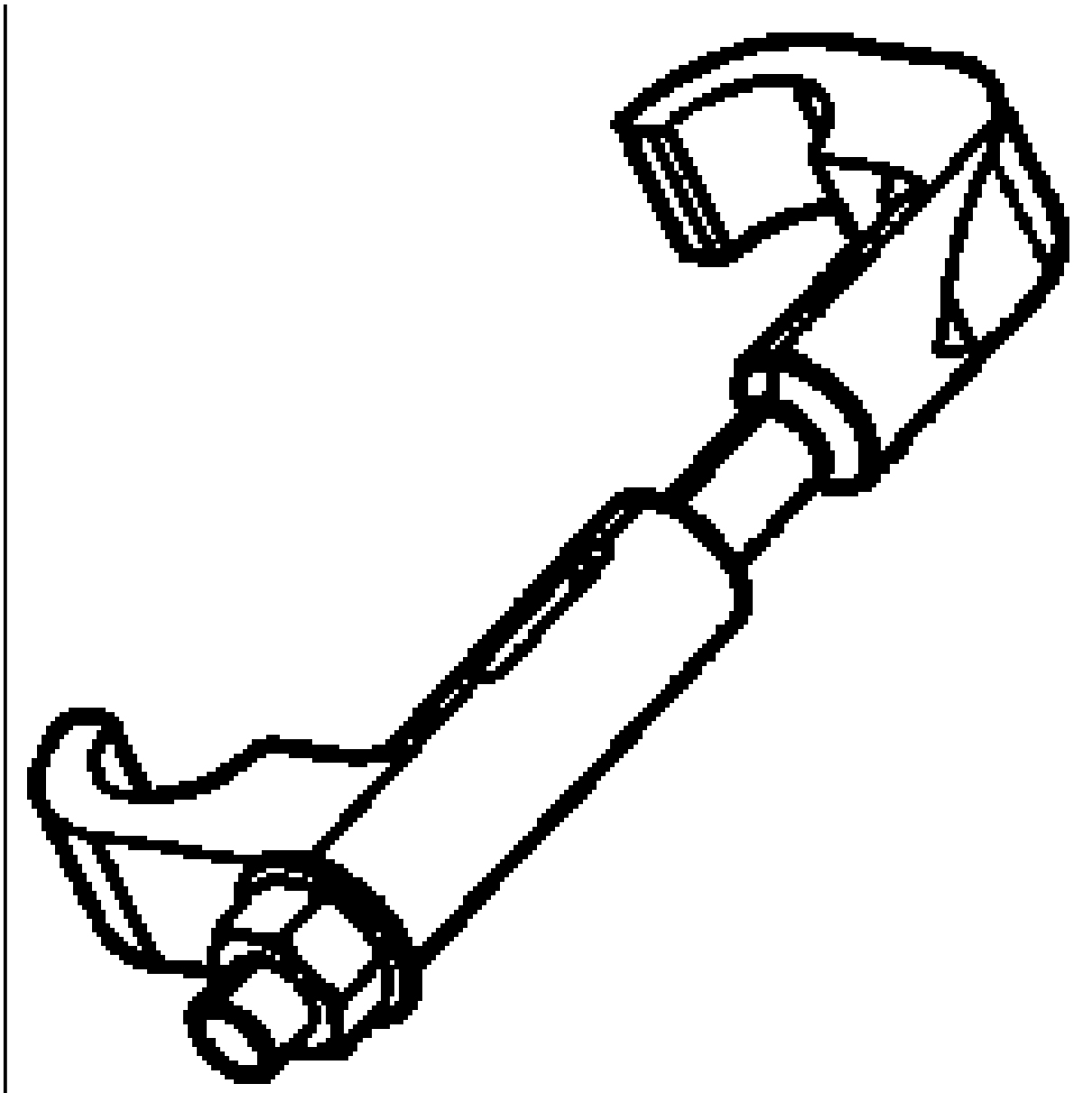
When the driver releases the accelerator pedal, air flow into the engine is reduced. The ECM monitors the corresponding changes in the throttle position, MAP, and MAF. The ECM shuts OFF fuel completely if the deceleration is very rapid, or for long periods, such as closed-throttle coast-down. The fuel shuts OFF in order to prevent damage to the catalytic converter and saves fuel by not running the engine. This mode is activated quickly and for a longer duration in the eAssist hybrid vehicle.

While in deceleration fuel cut-off mode, the torque converter stays locked allowing the drive motor to be coupled to the wheels (through engine and trans) to recharge the hybrid batteries via regenerative braking. The drive motor can also quickly react to help smooth driveline disturbances (downshifts), or provide assist for a smooth take off when the accelerator is depressed. If the vehicle is brought to a complete stop the drive motor spins the engine bringing it to a smooth stop and is properly positioned for a smooth restart.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description



EN-48932
Hydraulic
Belt
Tensioner
Compressor

ELECTRICAL

Hybrid/EV Cooling

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accessory DC Power Control Module Cooling Air Duct Fasteners	1.5 N.m	13 lb in
Air Conditioning and Drive Motor Cooling Compressor Bolt	22 N.m	16 lb ft
Air Conditioning and Drive Motor Cooling Compressor Nut	22 N.m	16 lb ft
Air Conditioning Compressor and Condenser Hose Bolt	22 N.m	16 lb ft
Air Conditioning Compressor and Condenser Hose Nut	17 N.m	12 lb ft
Air Conditioning Compressor Front Hose Bracket Bolt	17 N.m	12 lb ft
Air Conditioning Compressor Front Hose Bolt	22 N.m	16 lb ft
Air Conditioning Compressor Front Hose Nut	22 N.m	16 lb ft
Air Conditioning Compressor and Evaporator Hose Nut	17 N.m	12 lb ft
Air Conditioning Refrigerant Pressure Sensor	6 N.m	53 lb in
Air Conditioning Thermal Expansion Valve Bolt	7 N.m	62 lb in
Air Distribution Case Screw	3 N.m	27 lb in
Air Inlet Fastener	2.5 N.m	23 lb in
Air Inlet Housing Fastener	2.5 N.m	23 lb in
Air Inlet Valve Actuator Gear Screw	1.5 N.m	13 lb in
Blower Motor Control Module Screw	2 N.m	17 lb in
Bracket Heater Core Inlet Tube Bolt	2.5 N.m	23 lb in
Bracket Heater Core Outlet Tube Bolt	2.5 N.m	23 lb in
Drive Motor Battery Cooling Blower Motor Bracket Fastener	9 N.m	80 lb in
Heater Inlet and Outlet Pipe Bolt	17 N.m	12 lb ft
Heater Coolant Heater	9 N.m	80 lb in
Heater Water Shutoff Valve Nuts	9 N.m	80 lb in
HVAC Module Assembly Fastener	10 N.m	89 lb in
Instrument Panel Center Air Outlet Duct Fasteners	1.5 N.m	13 lb in
Mode Actuator Screw	1.5 N.m	13 lb in
Side Window Defogger Outlet Duct Fasteners	1.5 N.m	13 lb in

SCHEMATIC WIRING DIAGRAMS

Starter/Generator



Battery Pack

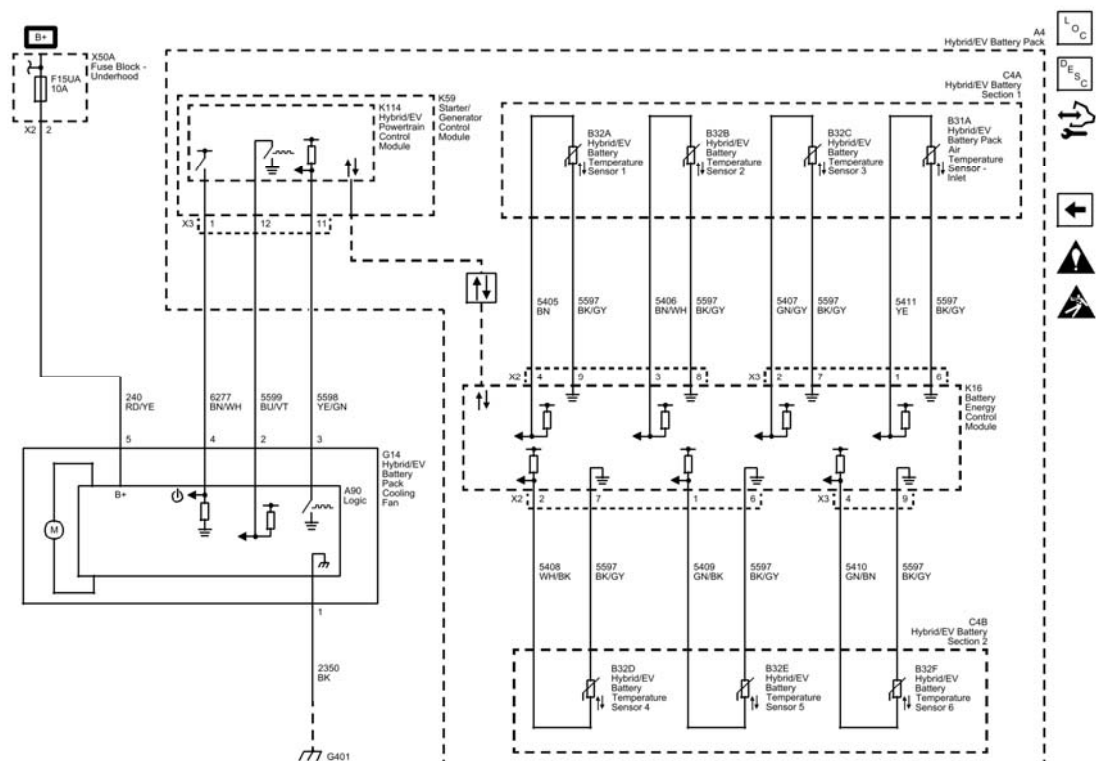


Fig. 2: Battery Pack

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P0AAD-P0AAF</u>	<p>DTC P0AAD Hybrid/EV Battery Pack Air Temperature Sensor 1 Performance</p> <p>DTC P0AAE Hybrid/EV Battery Pack Air Temperature Sensor 1 Circuit Low Voltage</p> <p>DTC P0AAF Hybrid/EV Battery Pack Air Temperature Sensor 1 Circuit High Voltage</p>
<u>DTC P0A7E</u>	DTC P0A7E Hybrid/EV Battery Pack High Temperature
<u>DTC P0A9C-P0A9E, P0AC6-P0AC8, P0ACB-P0ACD, P0AE9-P0AEB, P0BC3-P0BC5, or P0C34-P0C36</u>	<p>DTC P0A9C Hybrid/EV Battery Temperature Sensor 1 Performance</p> <p>DTC P0A9D Hybrid/EV Battery Temperature Sensor 1 Circuit Low Voltage</p> <p>DTC P0A9E Hybrid/EV Battery Temperature Sensor 1 Circuit High Voltage</p> <p>DTC P0AC6 Hybrid/EV Battery Temperature Sensor 2 Performance</p> <p>DTC P0AC7 Hybrid/EV Battery Temperature Sensor 2 Circuit Low</p>

	Voltage DTC P0AC8 Hybrid/EV Battery Temperature Sensor 2 Circuit High Voltage DTC P0ACB Hybrid/EV Battery Temperature Sensor 3 Performance DTC P0ACC Hybrid/EV Battery Temperature Sensor 3 Circuit Low Voltage DTC P0ACD Hybrid/EV Battery Temperature Sensor 3 Circuit High Voltage DTC P0AE9 Hybrid/EV Battery Temperature Sensor 4 Performance DTC P0AEA Hybrid/EV Battery Temperature Sensor 4 Circuit Low Voltage DTC P0AEB Hybrid/EV Battery Temperature Sensor 4 Circuit High Voltage DTC P0BC3 Hybrid/EV Battery Temperature Sensor 5 Performance DTC P0BC4 Hybrid/EV Battery Temperature Sensor 5 Circuit Low Voltage DTC P0BC5 Hybrid/EV Battery Temperature Sensor 5 Circuit High Voltage DTC P0C34 Hybrid/EV Battery Temperature Sensor 6 Performance DTC P0C35 Hybrid/EV Battery Temperature Sensor 6 Circuit Low Voltage DTC P0C36 Hybrid/EV Battery Temperature Sensor 6 Circuit High Voltage
<u>DTC P0C32</u>	DTC P0C32 Hybrid/EV Battery Pack Cooling System Performance
<u>DTC P0CBD-P0CBF</u>	DTC P0CBD Drive Motor Coolant Temperature Sensor Performance DTC P0CBE Drive Motor Coolant Temperature Sensor Circuit Low Voltage DTC P0CBF Drive Motor Coolant Temperature Sensor Circuit High Voltage

DTC P0AAD-P0AAF: HYBRID/EV BATTERY PACK AIR TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0AAD

Hybrid/EV Battery Pack Air Temperature Sensor 1 Performance

DTC P0AAE

Hybrid/EV Battery Pack Air Temperature Sensor 1 Circuit Low Voltage

DTC P0AAF

Hybrid/EV Battery Pack Air Temperature Sensor 1 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 3 X2	P0AAE	P0AAF	P0AAF	P0AAD
Low Reference - Terminal 8 X2	-	P0AAF	-	-

Circuit/System Description

The Battery Energy Control Module monitors an inlet air temperature sensor that is located at the inlet of the Hybrid/EV Battery Pack. This temperature sensor is a variable resistor that measures the air temperature of the incoming air which is used to heat and cool the Hybrid/EV Battery Sections and the internal electronics of the Starter/Generator Control Module. The Battery Energy Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The inlet air temperature sensor resistance changes with temperature of the incoming inlet air. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The Starter/Generator Control Module will control the Hybrid/EV Battery Pack Cooling Fan based on the inlet air temperature and hybrid/EV battery temperature sensors.

The Starter/Generator Control Module performs a rationality diagnostic that compares the air Inlet temperature sensor output signal to the average battery temperature of the six battery cell temperature sensors. This diagnostic gets one chance to run during a drive cycle after a specific vehicle off time.

Conditions for Running the DTC

P0AAD

- Ignition is RUN or CRANK
- Starter/generator control module off time is greater than six hours
- Starter/generator control module off time is not faulted (Starter/Generator Control Module internal clock diagnostic)
- None of the following DTCs are set: P0AAE, P0AAF, P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AEA, P0AEB, P0BC3, P0BC4, P0BC5, P0C34, P0C35, P0C36, P262B, U0100, U182A

P0AAE and P0AAF

- Ignition OFF
- The 12 V battery voltage is greater than 8.8 V.
- DTC P1A5D is not set

Conditions for Setting the DTC

P0AAD

The air inlet temperature is more than 10°C (18°F) higher or lower than the average battery cell temperature

P0AAE

The air temperature sensor signal is greater than 87°C (188.6°F)

P0AAF

The air temperature sensor signal is less than -39°C (-38.2°F)

Action Taken When the DTC Sets

DTCs P0AAD, P0AAE, and P0AAF are type B DTCs

Conditions for Clearing the DTC

DTCs P0AAD, P0AAE, and P0AAF are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hybrid Cooling System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON
2. Verify the scan tool Battery Energy Control Module Hybrid Battery Inlet Air Temperature parameter is between -39° and 60°C (-38.2 and 140°F).
 - **If not between -39° and 60°C (-38.2 and 140°F)**

Refer to Circuit/System Testing.

- **If between -39° and 60°C (-38.2 and 140°F)**
3. Verify the scan tool Battery Energy Control Module Hybrid Battery Inlet Air Temperature parameter is within 10°C (18°F) of the average battery cell temperature.
 - **If not within 10°C (18°F) of the average battery cell temperature**

Refer to Circuit/System Testing.

- **If within 10°C (18°F) of the average battery cell temperature.**
4. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters

(50 feet) of the vehicle, either indoors or outdoors.

- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling .
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Disconnect the X2 harness connector at the K16 Battery Energy Control Module.
4. Test for 8-13k ohms at 19-24°C (66.2-75.2°F) between the signal circuit terminal 3 and the low reference circuit terminal 8.
 - **If not between 8-13k ohms**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- **If between 8-13k ohms**

5. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Generator Battery Replacement
- Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P0A7E: HYBRID/EV BATTERY PACK HIGH TEMPERATURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0A7E

Hybrid/EV Battery Pack High Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 2 X2	P0A9D	P0A9E	P0A9E	P0A9C
Low Reference - Terminal 7 X2	-	P0A9E	-	-
Signal - Terminal 1 X2	P0AC7	P0AC8	P0AC8	P0AC6
Low Reference - Terminal 6 X2	-	P0AC8	-	-
Signal - Terminal 4 X2	P0ACC	P0ACC	P0ACD	P0ACB
Low Reference - Terminal 9 X2	-	P0ACC	-	-
Signal - Terminal 2 X3	P0AEA	P0AEA	P0AEB	P0AE9
Low Reference - Terminal 7 X3	-	P0AEA	-	-
Signal - Terminal 1 X3	P0BC4	P0BC4	P0BC5	P0BC3
Low Reference - Terminal 6 X3	-	P0BC4	-	-
Signal - Terminal 4 X3	P0C35	P0C35	P0C36	P0C34
Low Reference - Terminal 9 X3	-	P0C35	-	-

Circuit/System Description

Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The Battery Energy Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases.

Conditions for Running the DTC

- The Starter/Generator Control Module and Battery Energy Control Module are awake and communicating
- None of the following DTCs are set: P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0B45, P0B46, P0B47, P0B48, P0B4F, P0B50, P0B51, P0B52,

P0B63, P0B64, P0B65, P0B66, P0B95, P0B96, P0B97, P0B98, P0B9F, P0BA0, P0BA1, P0BA2, P0BC3, P0BC4, P0BC5, P0C34, P0C35, P0C36, or P1A5D

Conditions for Setting the DTC

The battery temperature as measured by the temperature sensors is greater than 72.3°C (162.1°F)

Action Taken When the DTC Sets

DTC P0A7E is a type B DTC

Conditions for Clearing the DTC

DTC P0A7E is a type B DTC

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

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Hybrid Cooling System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Visually inspect the inlet and outlet of the Hybrid/EV Battery Pack Cooling Fan ducts.
2. Verify the inlet and outlet are free of any debris or obstructions that will limit airflow through the duct.
 - **If any debris or obstructions are found**

Remove the obstruction to allow proper airflow and allow the Hybrid/EV Battery Pack to cool before retesting.

- **If no debris or obstructions are found**

3. Verify the Hybrid/EV Battery Pack Cooling Fan ducts are properly secured and are not crimped, crushed, or deformed in a manner that will limit airflow through the duct.
 - **If the ducts are unsecured or damaged**

Repair or replace as necessary and allow the Hybrid/EV Battery Pack to cool before retesting.

- **If the ducts are properly secured and undamaged**

4. Ignition ON.
5. Verify the scan tool Battery Energy Control Module Battery Temperature parameters are all be between -39° and 60°C (-38.2 and 140°F).
 - **If not between -39° and 60°C (-38.2 and 140°F)**

Refer to Circuit/System Testing.

- **If between -39° and 60°C (-38.2 and 140°F)**

6. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling .
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Determine which battery temperature sensor is not between -39° and 60°C (-38.2 and 140°F) by observing the scan tool Battery Energy Control Module Battery Temperature parameters.
4. Disconnect the X2 and X3 harness connectors at the K16 Battery Energy Control Module.
5. Test for 8-13k ohms at 19-24°C (66.2-75.2°F) between the appropriate temperature sensor signal circuit terminal and the low reference circuit terminal listed below:
 - Temperature sensor 1 - Signal circuit terminal 2 X2 and low reference circuit terminal 7 X2
 - Temperature sensor 2 - Signal circuit terminal 1 X2 and low reference circuit terminal 6 X2
 - Temperature sensor 3 - Signal circuit terminal 4 X2 and low reference circuit terminal 9 X2
 - Temperature sensor 4 - Signal circuit terminal 2 X3 and low reference circuit terminal 7 X3
 - Temperature sensor 5 - Signal circuit terminal 1 X3 and low reference circuit terminal 6 X3
 - Temperature sensor 6 - Signal circuit terminal 4 X3 and low reference circuit terminal 9 X3
 - **If not between 8-13k ohms**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- **If between 8-13k ohms**

6. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Battery Replacement**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DTC P0A81-P0A85, P0BC8-P0BCA, OR P0D64-P0D66: DRIVE MOTOR BATTERY COOLING BLOWER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0A81

Hybrid/EV Battery Pack Cooling Fan Control Circuit

DTC P0A84

Hybrid/EV Battery Pack Cooling Fan Control Circuit Low Voltage

DTC P0A85

Hybrid/EV Battery Pack Cooling Fan Control Circuit High Voltage

DTC P0BC8

Hybrid/EV Battery Pack Cooling Fan Performance

DTC P0BC9

Hybrid/EV Battery Pack Cooling Fan Feedback Circuit Low Voltage

DTC P0BCA

Hybrid/EV Battery Pack Cooling Fan Feedback Circuit High Voltage

DTC P0D64

Hybrid/EV Battery Pack Cooling Fan Enable Circuit

DTC P0D65

Hybrid/EV Battery Pack Cooling Fan Enable Circuit Low Voltage

DTC P0D66

Hybrid/EV Battery Pack Cooling Fan Enable Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0A84	P0A84	-	-
Control	P0D65	P0D66	P0D66	P0D64
Signal Terminal 2	P0BC9	P0BC9	P0BCA	P0BC8
Signal Terminal 3	P0A84	P0A84	P0A85	P0A81
Ground	-	P0A84	-	-

Circuit/System Description

The hybrid/EV battery pack cooling fan draws air through the hybrid/EV battery pack to control the temperature of the hybrid/EV battery pack. To operate, the cooling fan receives an enable signal from the starter/generator control module. The enable control is controlled by a discrete high side driver in the starter/generator control module. When the enable control circuit is high, the fan will be enabled. The fan speed is controlled by a fan control circuit from the starter/generator control module, by changing the duty cycle. Maximum fan speed is 3900 RPM. Hybrid/EV battery pack cooling fan enable circuit open and short to voltage diagnostics run continuously until hybrid/EV battery pack cooling fan is enabled to run while short to ground runs after it is enabled to run. These diagnostics detect and report a failure of the fan enable circuits.

Conditions for Running the DTC

P0A81, P0A84, or P0A85

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is enabled

P0BC8

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is enabled
- 12 V battery voltage is greater than 10 V
- The hybrid/EV battery pack cooling fan is commanded between 11-90%
- The hybrid/EV battery pack cooling fan enable delay timer is greater than 9 s

- DTC P0A84, P0A85, P0BC9, P0BCA, P0C32, P0D65, or P0D66 is not set

P0BC9 or P0BCA

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is enabled
- 12 V battery voltage is greater than 10 V
- The hybrid/EV battery pack cooling fan is commanded between 11-90%
- The hybrid/EV battery pack cooling fan enable delay timer is greater than 9 s

P0D64 or P0D66

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is not enabled

P0D65

- Ignition is RUN or CRANK
- The hybrid/EV battery pack cooling fan is enabled

Conditions for Setting the DTC

P0A81

An open is detected on the hybrid/EV battery pack cooling fan speed control circuit

P0A84

A short to ground is detected on the hybrid/EV battery pack cooling fan speed control circuit

P0A85

A short to voltage is detected on the hybrid/EV battery pack cooling fan speed control circuit

P0BC8

There is a excessive difference between the commanded hybrid/EV battery pack cooling fan speed and the hybrid/EV battery pack cooling fan speed feedback signal

P0BC9

The hybrid/EV battery pack cooling fan speed feedback signal is less than 8 Hz

P0BCA

The hybrid/EV battery pack cooling fan speed feedback signal is greater than 280 Hz

P0D64

An open is detected on the hybrid/EV battery pack cooling fan enable control circuit

P0D65

A short to ground is detected on the hybrid/EV battery pack cooling fan enable control circuit

P0D66

A short to voltage is detected on the hybrid/EV battery pack cooling fan enable control circuit

Action Taken When the DTC Sets

DTCs P0A81, P0A84, P0A85, P0BC8, P0BC9, P0BCA, P0D64, P0D65, and P0D66 are type B DTCs

Conditions for Clearing the DTC

DTCs P0A81, P0A84, P0A85, P0BC8, P0BC9, P0BCA, P0D64, P0D65, and P0D66 are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

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Hybrid Cooling System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Verify the actual G14 Hybrid/EV Battery Pack Cooling Fan speed increases and decreases when commanding the Hybrid/EV Battery Pack Cooling Fan with a scan tool.
 - **If the fan speed does not increase and decrease as commanded**

Refer to Circuit/System Testing.
 - **If the fan speed increases and decreases as commanded**
2. Verify the scan tool Hybrid Powertrain Control Module 14V Power Module Fan Speed parameter increases and decreases when commanding the Hybrid/EV Battery Pack Cooling Fan with a scan tool.
 - **If the parameter does not increase and decrease as commanded**

Refer to Circuit/System Testing.
 - **If the parameter increases and decreases as commanded**
3. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters

(50 feet) of the vehicle, either indoors or outdoors.

- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G14 Hybrid/EV Battery Pack Cooling Fan. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms between the ground circuit terminal 1 and ground.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the G14 Hybrid/EV Battery Pack Cooling Fan.
 - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 4 and ground.

6. Verify the test lamp turns ON when commanding the Hybrid/EV Battery Pack Cooling Fan with a scan tool and OFF when releasing the control.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. . Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, test the control circuit for a short to voltage.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If the test lamp turns ON and OFF**
7. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. . Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, test the signal circuit for a short to voltage.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If between 4.8-5.2 V**
8. Connect a 3 A fused jumper wire to the signal circuit terminal 2.
9. Verify the scan tool Hybrid Powertrain Control Module 14V Power Module Fan Speed parameter is greater than 0 RPM while rapidly tapping the jumper wire to ground.
 - **If 0 RPM**

Replace the K59 Starter/Generator Control Module
 - **If greater than 0 RPM**

10. Connect a test lamp between the signal circuit terminal 3 and B+.
11. Verify the test lamp becomes progressively dimmer as the fan speed is increased and progressively brighter as the fan speed is decreased when commanding the Hybrid/EV Battery Pack Cooling Fan with a scan tool.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, test the signal circuit for a short to voltage.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates, but does not change in brightness**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K59 Starter/Generator Control Module.
 - **If the test lamp brightness changes as commanded**
12. Test or replace the G14 Hybrid/EV Battery Pack Cooling Fan.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Drive Motor Battery Cooling Blower Replacement**
- **Control Module References** for starter/generator control module replacement, programming, and setup.

DTC P0A9C-P0A9E, P0AC6-P0AC8, P0ACB-P0ACD, P0AE9-P0AEB, P0BC3-P0BC5, OR P0C34-P0C36: HYBRID/EV BATTERY TEMPERATURE SENSOR 1-6

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0A9C

Hybrid/EV Battery Temperature Sensor 1 Performance

DTC P0A9D

Hybrid/EV Battery Temperature Sensor 1 Circuit Low Voltage

DTC P0A9E

Hybrid/EV Battery Temperature Sensor 1 Circuit High Voltage

DTC P0AC6

Hybrid/EV Battery Temperature Sensor 2 Performance

DTC P0AC7

Hybrid/EV Battery Temperature Sensor 2 Circuit Low Voltage

DTC P0AC8

Hybrid/EV Battery Temperature Sensor 2 Circuit High Voltage

DTC P0ACB

Hybrid/EV Battery Temperature Sensor 3 Performance

DTC P0ACC

Hybrid/EV Battery Temperature Sensor 3 Circuit Low Voltage

DTC P0ACD

Hybrid/EV Battery Temperature Sensor 3 Circuit High Voltage

DTC P0AE9

Hybrid/EV Battery Temperature Sensor 4 Performance

DTC P0AEA

Hybrid/EV Battery Temperature Sensor 4 Circuit Low Voltage

DTC P0AEB

Hybrid/EV Battery Temperature Sensor 4 Circuit High Voltage

DTC P0BC3

Hybrid/EV Battery Temperature Sensor 5 Performance

DTC P0BC4

Hybrid/EV Battery Temperature Sensor 5 Circuit Low Voltage

DTC P0BC5

Hybrid/EV Battery Temperature Sensor 5 Circuit High Voltage

DTC P0C34

Hybrid/EV Battery Temperature Sensor 6 Performance

DTC P0C35

Hybrid/EV Battery Temperature Sensor 6 Circuit Low Voltage

DTC P0C36

Hybrid/EV Battery Temperature Sensor 6 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 2 X2	P0A9D	P0A9E	P0A9E	P0A9C
Low Reference - Terminal 7 X2	-	P0A9E	-	-
Signal - Terminal 1 X2	P0AC7	P0AC8	P0AC8	P0AC6
Low Reference - Terminal 6 X2	-	P0AC8	-	-
Signal - Terminal 4 X2	P0ACC	P0ACC	P0ACD	P0ACB
Low Reference - Terminal 9 X2	-	P0ACC	-	-
Signal - Terminal 2 X3	P0AEA	P0AEA	P0AEB	P0AE9
Low Reference - Terminal 7 X3	-	P0AEA	-	-
Signal - Terminal 1 X3	P0BC4	P0BC4	P0BC5	P0BC3
Low Reference - Terminal 6 X3	-	P0BC4	-	-
Signal - Terminal 4 X3	P0C35	P0C35	P0C36	P0C34
Low Reference - Terminal 9 X3	-	P0C35	-	-

Circuit/System Description

Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The battery energy control module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases,

the sensor resistance decreases.

Conditions for Running the DTC

P0A9C, P0AC6, P0ACB, P0AE9, P0BC3, and P0C34

- Battery energy control module is awake and communicating
- None of the following DTCs are set: P0A9D, P0A9E, P0AC7, P0AC8, P0ACC, P0ACD, P0AEA, P0AEB, P0B45, P0B46, P0B47, P0B48, P0B4F, P0BC4, P0BC5, P0C35, P0C63, or P1A5D

P0A9D, P0A9E, P0AC7, P0AC8, P0ACC, P0ACD, P0AEA, P0AEB, P0BC4, P0BC5, P0C35, and P0C36

- The 12 V battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating
- DTC P1A5D is not set

Conditions for Setting the DTC

P0A9C, P0AC6, P0ACB, P0AE9, P0BC3, and P0C34

The difference between a single battery temperature sensor and an average of the other battery temperature sensors is greater than 25°C (45°F)

P0A9D, P0AC7, P0ACC, P0AEA, P0BC4, and P0C35

The hybrid battery temperature sensor is greater than 87°C (188.2°F)

P0A9E, P0AC8, P0ACD, P0AEB, P0BC5, and P0C36

The hybrid battery temperature sensor is less than -39°C (-38.2°F)

Action Taken When the DTC Sets

DTCs P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0BC3, P0BC4, P0BC5, P0C34, P0C35, and P0C36 are type B DTCs

Conditions for Clearing the DTC

DTCs P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0BC3, P0BC4, P0BC5, P0C34, P0C35, and P0C36 are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

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Hybrid Cooling System Description and Operation

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Battery Energy Control Module Battery Temperature parameters are all be between -39° and 60°C (-38.2 and 140°F).
 - **If not between -39° and 60°C (-38.2 and 140°F)**

Refer to Circuit/System Testing.
 - **If between -39° and 60°C (-38.2 and 140°F)**
3. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection

Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling** .
2. Determine which battery temperature sensor is not between -39° and 60°C (-38.2 and 140°F) by observing the scan tool Battery Energy Control Module Battery Temperature parameters.
3. Disconnect the X2 and X3 harness connectors at the K16 Battery Energy Control Module.
4. Test for 8-13k ohms at 19-24°C (66.2-75.2°F) between the appropriate temperature sensor signal circuit terminal and the low reference circuit terminal listed below:

- Temperature sensor 1 - Signal circuit terminal 2 X2 and low reference circuit terminal 7 X2
- Temperature sensor 2 - Signal circuit terminal 1 X2 and low reference circuit terminal 6 X2
- Temperature sensor 3 - Signal circuit terminal 4 X2 and low reference circuit terminal 9 X2
- Temperature sensor 4 - Signal circuit terminal 2 X3 and low reference circuit terminal 7 X3
- Temperature sensor 5 - Signal circuit terminal 1 X3 and low reference circuit terminal 6 X3
- Temperature sensor 6 - Signal circuit terminal 4 X3 and low reference circuit terminal 9 X3
- **If not between 8-13k ohms**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- **If between 8-13k ohms**

5. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Battery Replacement**
- **Control Module References** for battery energy control module replacement, programming, and setup.

DTC P0C32: HYBRID/EV BATTERY PACK COOLING SYSTEM PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C32

Hybrid/EV Battery Pack Cooling System Performance

Circuit/System Description

The Hybrid/EV Battery Pack Cooling Fan draws air through the Hybrid/EV Battery Pack to control the temperature of the Hybrid/EV Battery Pack. To operate, the cooling fan receives an enable signal from the Starter/Generator Control Module. The enable control is controlled by a discrete high side driver in the Starter/Generator Control Module. When the enable control circuit is high, the fan will be enabled. The fan speed is controlled by a fan control circuit in the Starter/Generator Control Module, by changing the duty cycle. Maximum fan speed is 3900 RPM.

The Hybrid/EV Battery Pack cooling system consists of the Hybrid/EV Battery Pack Cooling Fan pulling air through a set of porous ducts within the Hybrid/EV Battery Pack. These ducts direct air through the Hybrid/EV

Battery Sections and under the Starter/Generator Control Module, where the air passes by various heat sinks and cavities to cool the internal electronic components. The performance diagnostic for the hybrid battery pack cooling fan is a functional check for the fan. The fan control feature uses the outcome of this diagnostic to take emissions related remedial actions. The Hybrid/EV Battery Pack cooling system performance diagnostic determines if the cooling system is providing the expected amount of conditioning. The Hybrid/EV Battery Pack Cooling Fan not spinning at the commanded speed or a blocked duct are examples of conditions of reduced performance.

The Starter/Generator Control Module uses a temperature model to predict the temperature of the 14 volt power module, an internal electronic component of the Starter/Generator Control Module. The Starter/Generator Control Module compares this predicted temperature to the 14 volt power module temperature sensor 1. With the Hybrid/EV Battery Pack Cooling Fan operating, the predicted 14 volt power module temperature and the 14 volt power module temperature sensor 1 should be nearly the same.

Conditions for Running the DTC

- Ignition is RUN or CRANK
- No power mode DTCs are set
- None of the following DTCs are set: P0A81, P0A84, P0A85, P0A88, P0A89, P0AAD, P0AAE, P0AAF, P0D64, P0D65, P0D66, P1A90, P1A92, P1AE8, P1AE9, P1AEC, U182A
- Hybrid battery pack temperature is greater than -10°C (14°F)
- The battery pack inlet temperature sensor is greater than -10°C (14°F)
- The battery pack cooling fan speed is greater than 29%
- 14 volt power module power is greater than 0.1 Kwatt
- The number of non-faulted battery cell temperature sensors is greater than 4
- Propulsion system is active for a minimum of 150 seconds
- Within the past 180 seconds, the 14 volt power module power has not changed more than 0.6 Kwatts over a time of 30 seconds

Conditions for Setting the DTC

The predicted temperature of the Hybrid/EV Battery Pack is more than 15°C (27°F) higher or lower than the actual measured 14 volt power module temperature sensor 1

Action Taken When the DTC Sets

DTC P0C32 is a type B DTC

Conditions for Clearing the DTC

DTC P0C32 is a type B DTC

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hybrid Cooling System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following

Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Visually inspect the inlet and outlet of the Hybrid/EV Battery Pack Cooling Fan ducts.
2. Verify the inlet and outlet are free of any debris or obstructions that will limit airflow through the duct.
 - **If any debris or obstructions are found**

Remove the obstruction to allow proper airflow and allow the Hybrid/EV Battery Pack to cool before retesting.

- **If no debris or obstructions are found**

3. Verify the Hybrid/EV Battery Pack Cooling Fan ducts are properly secured and are not crimped, crushed, or deformed in a manner that will limit airflow through the duct.
 - **If the ducts are unsecured or damaged**

Repair or replace as necessary and allow the Hybrid/EV Battery Pack to cool before retesting.

- **If the ducts are properly secured and undamaged**

4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G14 Hybrid/EV Battery Pack Cooling Fan. It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms between the ground circuit terminal 1 and ground.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**
- 6. Ignition ON.
- 7. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the G14 Hybrid/EV Battery Pack Cooling Fan.
 - **If the test lamp illuminates**
- 8. Verify that the Hybrid/EV Battery Pack Cooling Fan speed increases and decreases as the Hybrid Battery Fan Speed is commanded from 10%-90% with a scan tool.
 - **If the fan speed does not change**

Replace the G14 Hybrid/EV Battery Pack Cooling Fan.
 - **If the fan speed changes**
- 9. Monitor the airflow at the intake duct and outlet duct while commanding the Hybrid Battery Fan Speed from 10%-90% with a scan tool. The actual airflow should increase as the fan speed is increased.
 - **If the airflow does not increase**
 1. Ignition OFF, disable the high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
 2. Remove any debris or obstructions that may limit airflow in the cooling ducts through the A4 Hybrid/EV Battery Pack and the heat sink under the K59 Starter/Generator Control Module.
 - **If the airflow increases**
- 10. Verify the scan tool Battery Energy Control Module Battery Temperature parameters are all between -39° and 60°C (-38.2 and 140°F).
 - **If not between -39° and 60°C (-38.2 and 140°F)**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.
 - **If between -39° and 60°C (-38.2 and 140°F)**
- 11. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Battery Replacement**
- **Drive Motor Battery Cooling Blower Outlet Duct Replacement**
- **Drive Motor Battery Cooling Air Outlet Duct Replacement**
- **Drive Motor Battery Cooling Air Inlet Upper Duct Replacement**
- **Drive Motor Battery Cooling Blower Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P0CC1-P0CC4: GENERATOR CONTROL MODULE COOLANT PUMP MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0CC1

Drive Motor Coolant Pump Control Circuit

DTC P0CC2

Drive Motor Coolant Pump Performance

DTC P0CC3

Drive Motor Coolant Pump Control Circuit Low Voltage

DTC P0CC4

Drive Motor Coolant Pump Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+	1	1	-	-
Relay Coil Ignition	1	1	-	-
Relay Coil Control	P0CC3	P0CC1	P0CC4	-
Relay Switch Control	2	1	1	-
Component Ground	-	1	-	-
1. Starter/generator control module coolant pump inoperative				

2. Starter/generator control module coolant pump always on

Circuit/System Description

The Starter/Generator Control Module coolant pump is a single speed ON/OFF pump that circulates coolant through the auxiliary radiator and the starter/generator to control the temperature of the starter/generator. The starter/generator cooling system is separate from the engine cooling system and does not share any coolant or components. The Starter/Generator Control Module coolant pump is controlled by the starter/generator coolant pump relay. This relay is a printed circuit board relay and integrated as part of the underhood fuse block. The relay switch and coil both receive B+. The Starter/Generator Control Module controls the relay coil by applying ground to the coil control circuit. With the coil grounded, the relay switch is closed and voltage is sent to the Starter/Generator Control Module coolant pump, which will begin circulating coolant.

The Starter/Generator Control Module uses the exponentially weighted moving average to calculate temperature fluctuations in the starter/generator cooling system. In addition, this diagnostic compares the temperature rate of change by a slope calculation within a set time when the Starter/Generator Control Module coolant pump turns ON. This diagnostic runs once after pump turns ON. If the temperature changes over time too quickly, the Starter/Generator Control Module will indicate a fault.

Conditions for Running the DTC

P0CC1 or P0CC3

- Ignition is RUN or CRANK
- Starter/generator control module coolant pump control is inactive

P0CC2

- Ignition is RUN or CRANK
- 12 V battery voltage is greater than 10 V
- Starter/generator control module coolant pump control is active
- DTC P0A2B, P0A2C, P0A2D, P0CC1, P0CC3, P0CC4, P0CBD, P0CBE, or P0CBF is not set
- The predicted difference between the coolant temperature in the starter/generator and the coolant temperature as measured by the hybrid electronics coolant temperature sensor is greater than 17°C (31°F)

P0CC4

- Ignition is RUN or CRANK
- Starter/generator control module coolant pump control is active

Conditions for Setting the DTC

P0CC1

An open is detected on the starter/generator coolant pump relay control circuit.

P0CC2

The coolant temperature is 0.25°C/s greater than the maximum cooling system performance temperature.

P0CC3

A short to ground is detected on the starter/generator coolant pump relay control circuit.

P0CC4

A short to voltage is detected on the starter/generator coolant pump relay control circuit.

Action Taken When the DTC Sets

DTCs P0CC1, P0CC2, P0CC3, and P0CC4 are type B DTCs

Conditions for Clearing the DTC

DTCs P0CC1, P0CC2, P0CC3, and P0CC4 are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

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Description and Operation

Hybrid Cooling System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Verify the coolant level of the starter/generator cooling system is normal.

- **If the coolant level is low**

Inspect the starter/generator cooling system for any leaks.

- **If the coolant level is normal**

2. Verify the starter/generator cooling system auxiliary radiator is clear of any debris, bent fins, or other damage which may inhibit airflow.

- **If debris are found**

Clean the auxiliary radiator.

- **If damage is found**

Replace the auxiliary radiator.

- **If the coolant level is normal**

3. Verify the starter/generator cooling system hoses are properly routed and are not kinked.

- **If any hoses are improperly routed or kinked**

Remove and properly route the hose.

- **If all hoses are routed properly and are not kinked**

4. Ignition ON.

5. Verify the G43 Starter/Generator Coolant Pump turns ON and OFF when commanding the Motor Coolant Pump Relay Enable ON and OFF with a scan tool. The G22 Starter/Generator Control Module coolant pump will make an audible noise during operation.

- **If the G43 Starter/Generator Coolant Pump does not turn ON and OFF**

Refer to Circuit/System Testing.

- **If the G43 Starter/Generator Coolant Pump turns ON and OFF**

6. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disconnect the X2 harness connector at the K50A Fuse Block - Underhood.
2. Connect a test lamp between the control circuit terminal 11 and B+, ignition ON.
3. Verify the test lamp turns ON and OFF when commanding the Motor Coolant Pump Relay Enable ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V

3. Ignition OFF.
4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K59 Starter/Generator Control Module.
 - **If the test lamp turns ON and OFF**
4. Ignition OFF and all vehicle systems OFF, connect the X2 harness connector at the K50A Fuse Block - Underhood. Disconnect the harness connector at the G43 Starter/Generator Coolant Pump. It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
6. Connect a test lamp between the control circuit terminal 1 and ground.
7. Verify the test lamp turns ON and OFF when commanding the Motor Coolant Pump Relay Enable ON and OFF with a scan tool.
 - **If the test lamp is always OFF and the circuit fuse is good**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A Fuse Block - Underhood.
 - **If the test lamp is always OFF and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the G43 Starter/Generator Coolant Pump.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block - Underhood, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the X50A Fuse Block - Underhood.
 - **If the test lamp turns ON and OFF**
8. Test or replace the G43 Starter/Generator Coolant Pump.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Control Module Coolant Pump Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P0CBD-P0CBF: DRIVE MOTOR COOLANT TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0CBD

Drive Motor Coolant Temperature Sensor Performance

DTC P0CBE

Drive Motor Coolant Temperature Sensor Circuit Low Voltage

DTC P0CBF

Drive Motor Coolant Temperature Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0CBE	P0CBF	P0CBF	P0CBD
Low Reference	-	P0CBF	-	-

Circuit/System Description

The hybrid electronics coolant temperature sensor is a variable resistor that measures the temperature of the starter/generator coolant. The Starter/Generator Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The hybrid electronics coolant temperature sensor resistance changes with starter/generator coolant temperature. As the temperature decreases, the sensor resistance increases. As the

temperature increases, the sensor resistance decreases. The Starter/Generator Control Module monitors the hybrid electronics coolant temperature sensor to determine the temperature of the starter/generator coolant. As the coolant temperature changes, the Starter/Generator Control Module will turn the Starter/Generator Control Module coolant pump ON or OFF to accommodate the starter/generator cooling requirements.

The Starter/Generator Control Module performs a rationality diagnostic that compares the hybrid electronics coolant temperature sensor signal to the average temperature of the starter/generator stator, engine intake air temperature, and transmission fluid temperature. This diagnostic gets one chance to run during a drive cycle after a specific vehicle OFF time.

Conditions for Running the DTC

P0CBD

- Ignition is RUN or CRANK
- Engine off time is greater than six hours
- Starter/generator control module internal clock diagnostic is not faulted
- None of the following DTCs are set: P0111, P0112, P0113, P0114, P0711, P0712, P0713, P0A2B, P0A2C, P0A2D, P0CBF, POCBE, P262B, U0100, U0101

P0CBE or P0CBF

- Ignition is RUN or CRANK
- Starter/generator control module internal coolant temperature monitoring and diagnostics are enabled

Conditions for Setting the DTC

P0CBD

The hybrid electronics coolant temperature sensor is more than 25°C (45°F) higher or lower than the average temperature of the starter/generator stator, engine intake air temperature, and transmission fluid temperature.

P0CBE

The drive motor coolant temperature sensor resistance is less than 100.7 ohms.

P0CBF

The drive motor coolant temperature sensor resistance is greater than 176,962 ohms.

Action Taken When the DTC Sets

DTC P0CBD-P0CBF are type B DTCs

Conditions for Clearing the DTC

DTC P0CBD-P0CBF are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

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Hybrid Cooling System Description and Operation

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Verify the coolant level of the starter/generator cooling system is normal.
 - **If the coolant level is low**

Inspect the starter/generator cooling system for any leaks.

- **If the coolant level is normal**
2. Verify the starter/generator cooling system auxiliary radiator is clear of any debris, bent fins, or other damage which may inhibit airflow.
 - **If debris are found**

Clean the auxiliary radiator.

- **If damage is found**

Replace the auxiliary radiator.

- **If no damage or debris are found**

3. Verify the starter/generator cooling system hoses are properly routed and are not kinked.

- **If any hoses are improperly routed or kinked**

Removed and properly route the hose.

- **If all hoses are routed properly and are not kinked**

4. Ignition ON.

5. Verify the scan tool Motor A Coolant Temperature Sensor parameter is between -40°C and 85°C.

- **If not between -40°C and 85°C**

Refer to Circuit/System Testing.

- **If between -40°C and 85°C**

6. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.

- **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disconnect the harness connector at the B235 Starter/Generator Coolant Temperature Sensor.
2. Test for less than 10 ohms between the low reference circuit terminal B and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 2 ohms between the low reference circuit terminal B and ground.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the signal circuit terminal A and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. . Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, test the signal circuit for a short to voltage.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If between 4.8-5.2 V**
5. Test or replace the B235 Starter/Generator Coolant Temperature Sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Auxiliary Radiator Replacement - Hybrid/EV battery pack coolant temperature sensor 1 replacement
- Control Module References for Starter/Generator Control Module replacement, programming, and setup

REPAIR INSTRUCTIONS

COOLANT RECOVERY RESERVOIR BRACKET REPLACEMENT

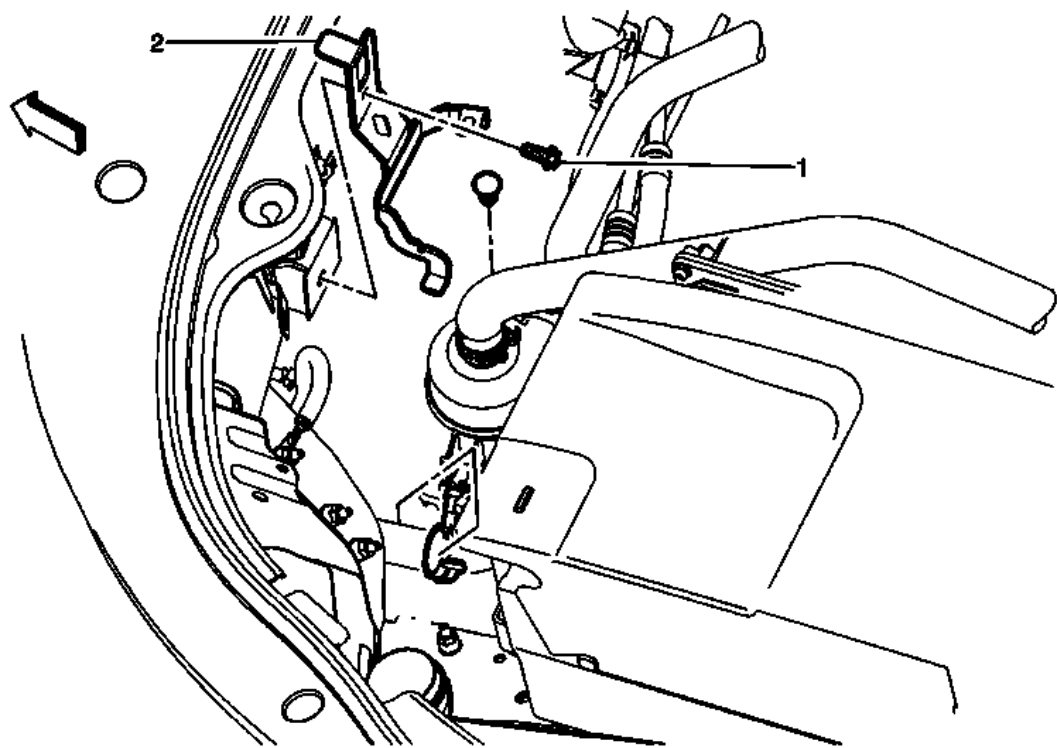


Fig. 3: Coolant Recovery Reservoir Bracket
Courtesy of GENERAL MOTORS COMPANY

Coolant Recovery Reservoir Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the drive motor battery cool air separator from the bracket without disconnecting any hoses. Refer to <u>Drive Motor Battery Coolant/Air Separator Replacement</u> .	
1	Coolant Recovery Reservoir Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 4 (35 lb in)
2	Coolant Recovery Reservoir Bracket

AUXILIARY RADIATOR REPLACEMENT

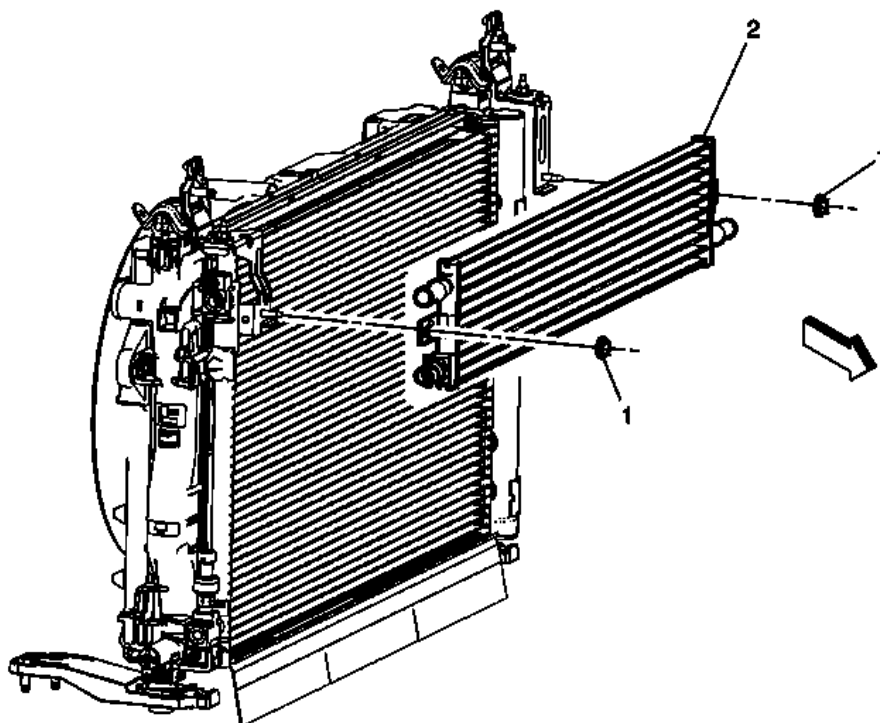


Fig. 4: Auxiliary Radiator & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Remove front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> . 3. Remove the auxiliary radiator inlet hose. Refer to <u>Auxiliary Radiator Inlet Hose Replacement</u>. 4. Remove the auxiliary radiator outlet hose. Refer to <u>Auxiliary Radiator Outlet Hose Replacement</u>. 	
1	Auxiliary Radiator Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
2	Auxiliary Radiator

RADIATOR SIDE MOUNT BRACKET REPLACEMENT - LEFT SIDE

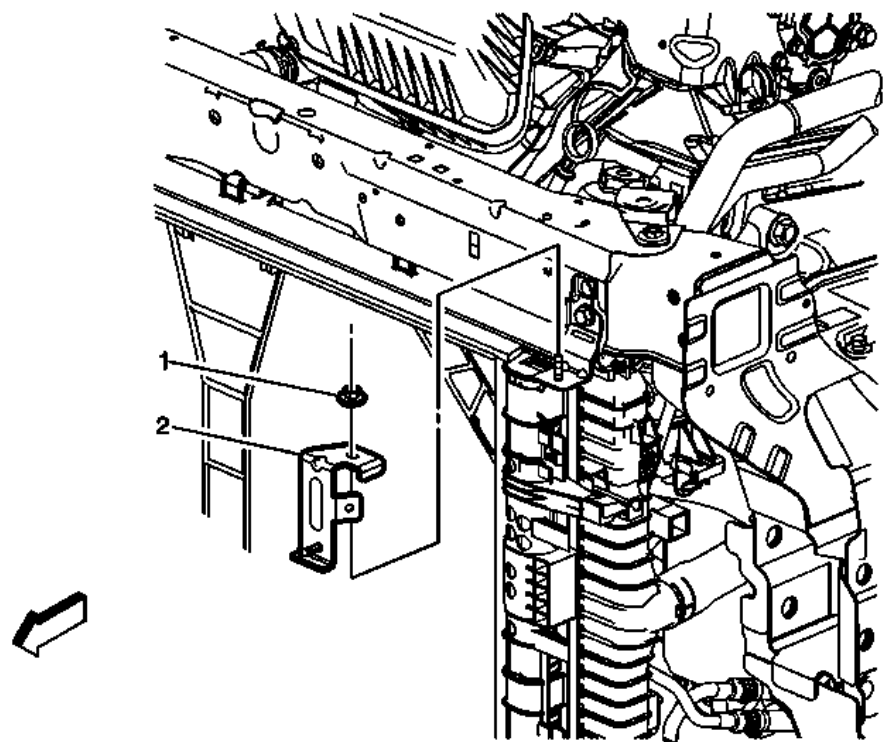


Fig. 5: Radiator Side Mount Bracket - Left Side
Courtesy of GENERAL MOTORS COMPANY

Radiator Side Mount Bracket Replacement - Left Side

Callout	Component Name
Preliminary Procedure Without disconnecting the cooler lines, remove the fasteners securing the auxiliary radiator to the brackets and reposition the auxiliary radiator out of the way. Refer to Auxiliary Radiator Replacement .	
1	Radiator Side Mount Bracket-Left Side Fastener CAUTION: Refer to Fastener Caution . Tighten 9 (80 lb in)
2	Radiator Side Mount Bracket

RADIATOR SIDE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

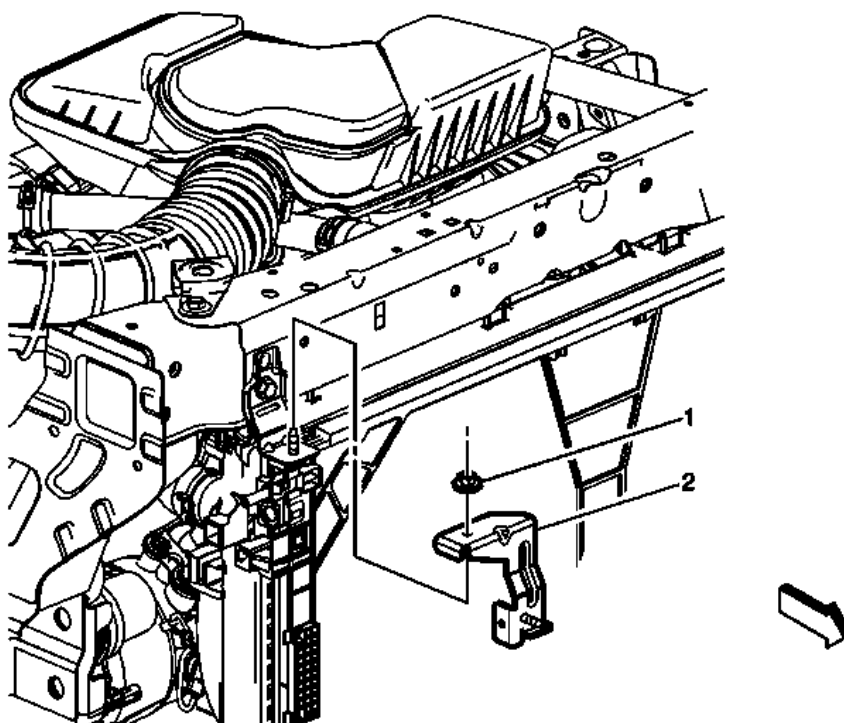


Fig. 6: Radiator Side Mount Bracket - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Radiator Side Mount Bracket Replacement - Right Side

Callout	Component Name
Preliminary Procedure Without disconnecting the cooler lines, remove the fasteners securing the auxiliary radiator to the brackets and reposition the auxiliary radiator out of the way. Refer to <u>Auxiliary Radiator Replacement</u> .	
1	Radiator Side Mount Bracket - Right Side Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Radiator Side Mount Bracket

AUXILIARY RADIATOR INLET HOSE REPLACEMENT

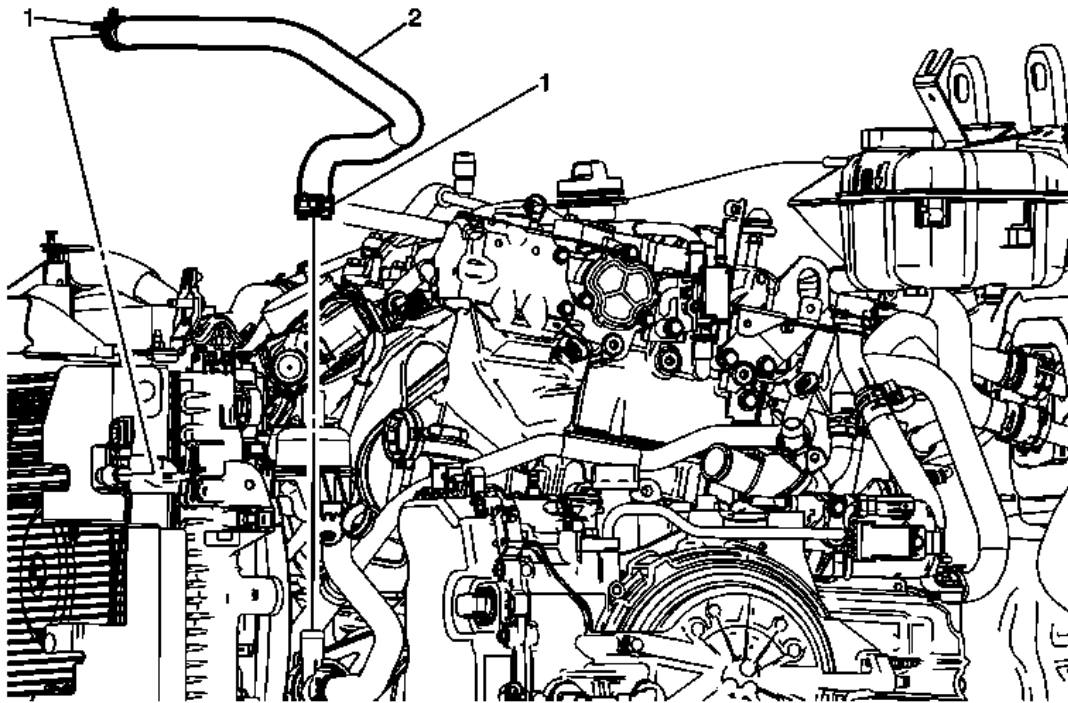


Fig. 7: Auxiliary Radiator Inlet Hose & Clamps
 Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Inlet Hose Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Auxiliary Radiator Inlet Hose Clamps
2	Auxiliary Radiator Inlet Hose

AUXILIARY RADIATOR OUTLET HOSE REPLACEMENT

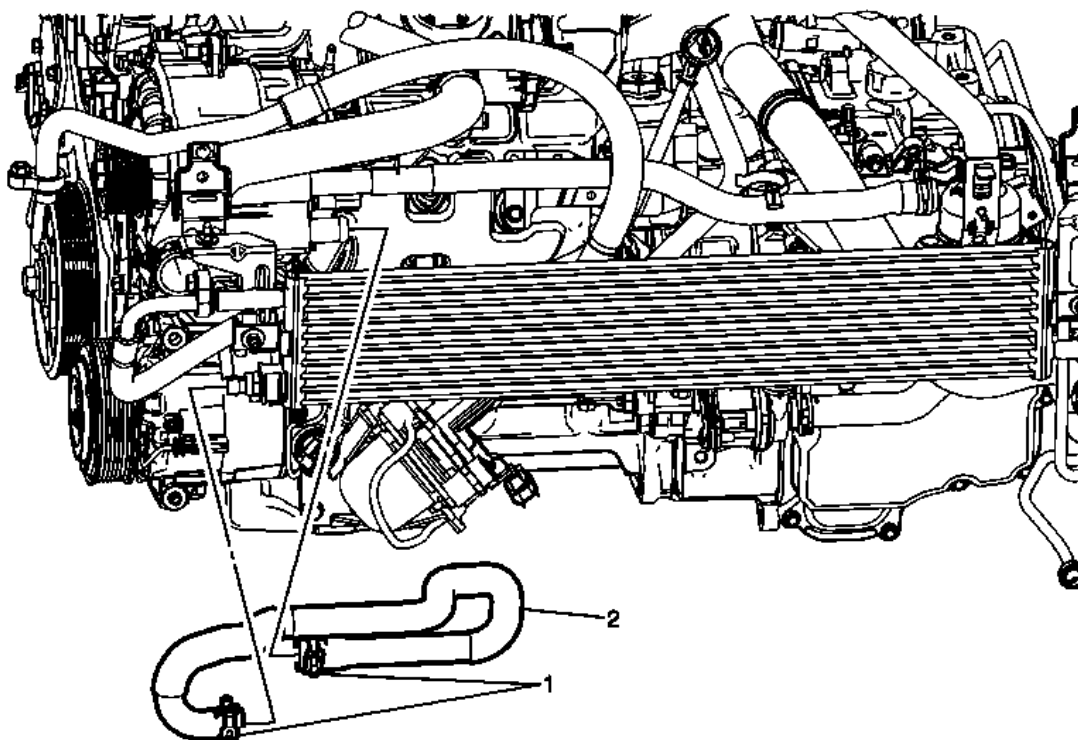


Fig. 8: Auxiliary Radiator Outlet Hose & Clamp
 Courtesy of GENERAL MOTORS COMPANY

Auxiliary Radiator Outlet Hose Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> .	
2. Remove the front bumper fascia. Refer to <u>Front Bumper Fascia Replacement</u> .	
1	Auxiliary Radiator Outlet Hose Clamp
2	Auxiliary Radiator Outlet Hose

GENERATOR CONTROL MODULE COOLING AIR INLET DUCT REPLACEMENT

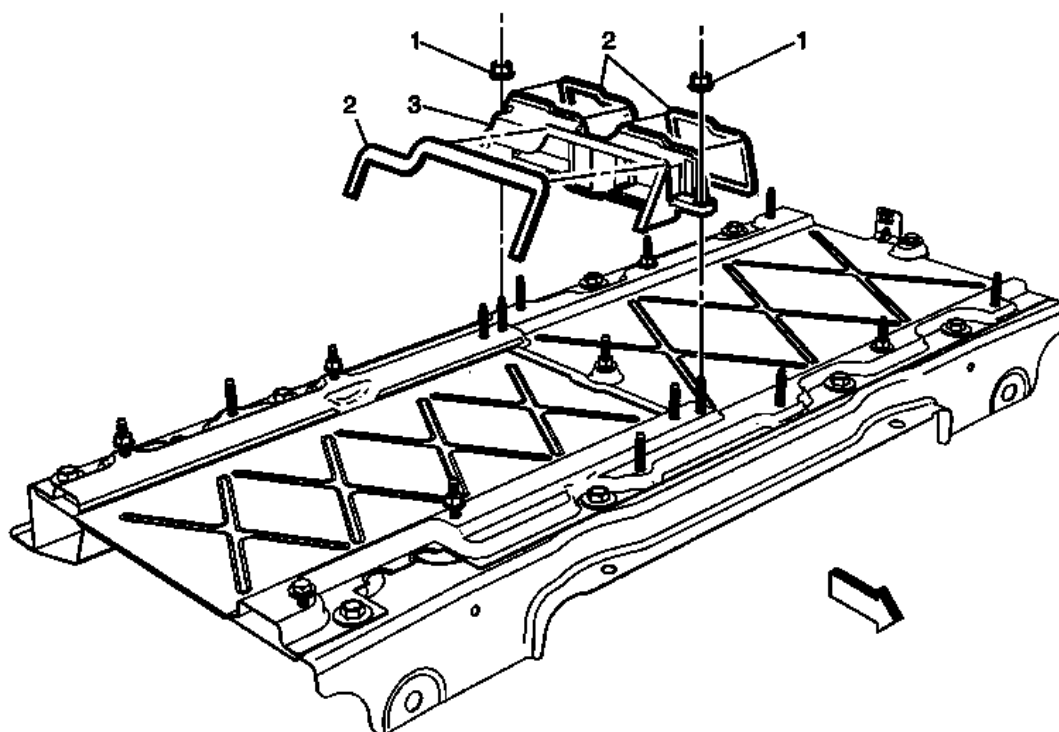


Fig. 9: Generator Control Module Cooling Air Inlet Duct, Seals & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Generator Control Module Cooling Air Inlet Duct Replacement

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Disable the hybrid battery. Refer to <u>High Voltage Disabling</u> . 2. Remove the generator battery. Refer to <u>Generator Battery Replacement</u> . 3. Remove the generator control module. Refer to <u>Generator Control Module Replacement</u> . 	
1	Generator Control Module Cooling Air Inlet Duct Fasteners CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in).
2	Generator Control Module Cooling Air Inlet Duct Seals NOTE: Replace seals if worn or damaged.
3	Generator Control Module Cooling Air Inlet Duct

GENERATOR CONTROL MODULE COOLING AIR OUTLET DUCT REPLACEMENT

Removal Procedure

1. Disable the hybrid battery. Refer to High Voltage Disabling .

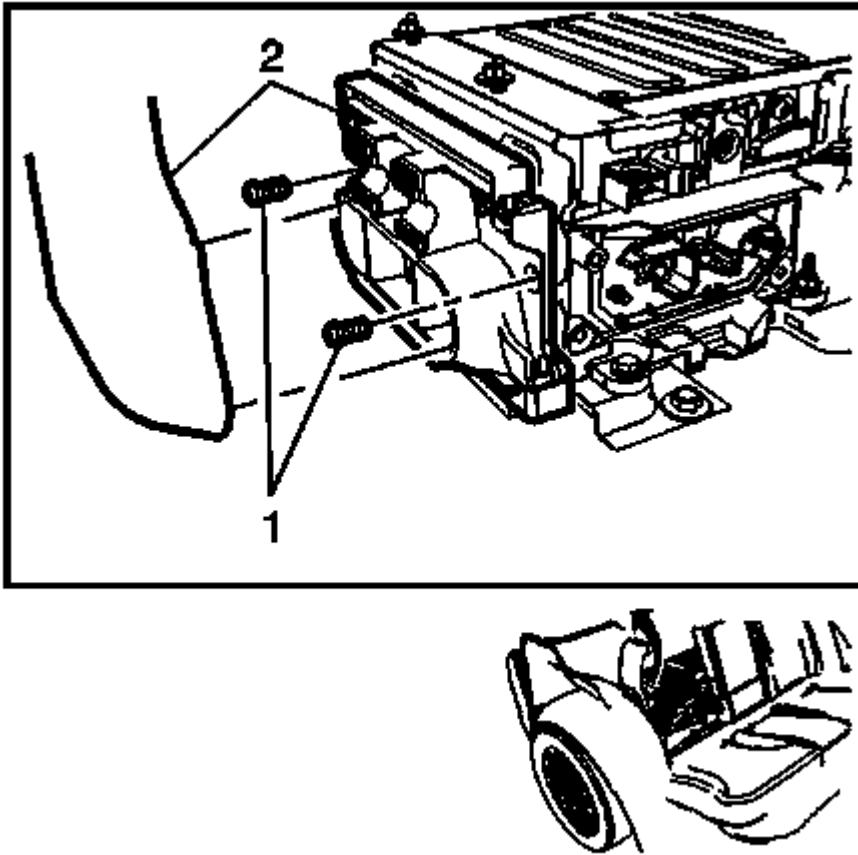


Fig. 10: Drive Motor Battery Cooling Blower Outlet Duct Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive motor battery cooling blower outlet duct fasteners (1).
3. Detach the drive motor cooling blower outlet duct. Refer to Drive Motor Battery Cooling Blower Outlet Duct Replacement.

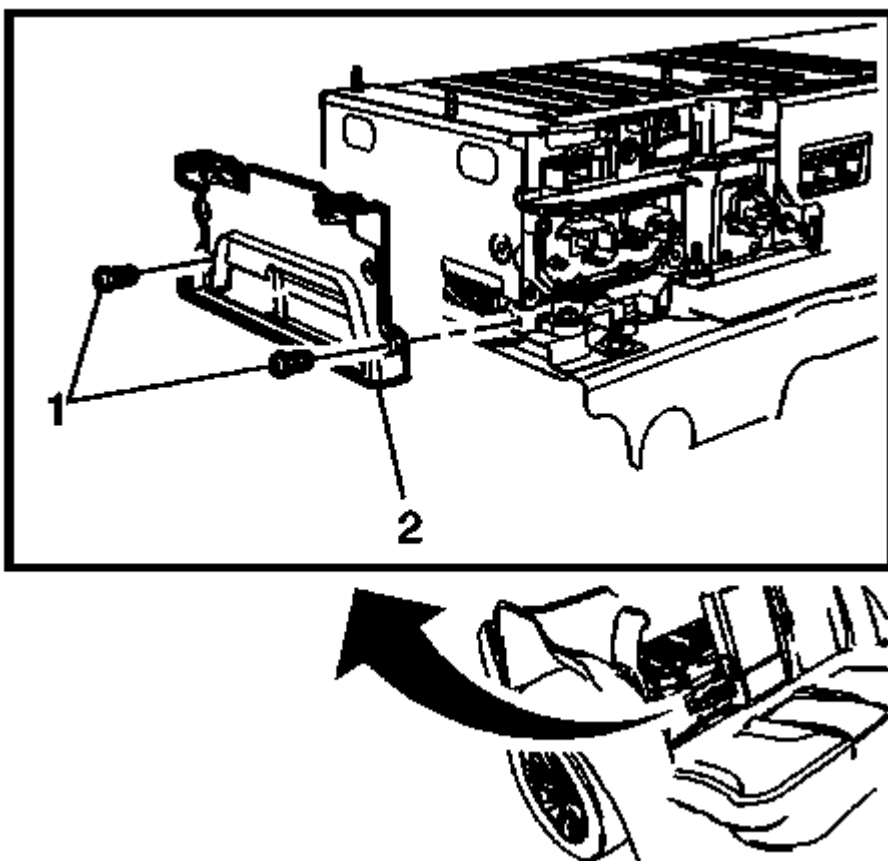


Fig. 11: Generator Control Module Cooling Air Outlet Duct And Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the generator control module cooling air outlet duct fasteners (1) and remove the generator control module cooling air outlet duct (2).

Installation Procedure

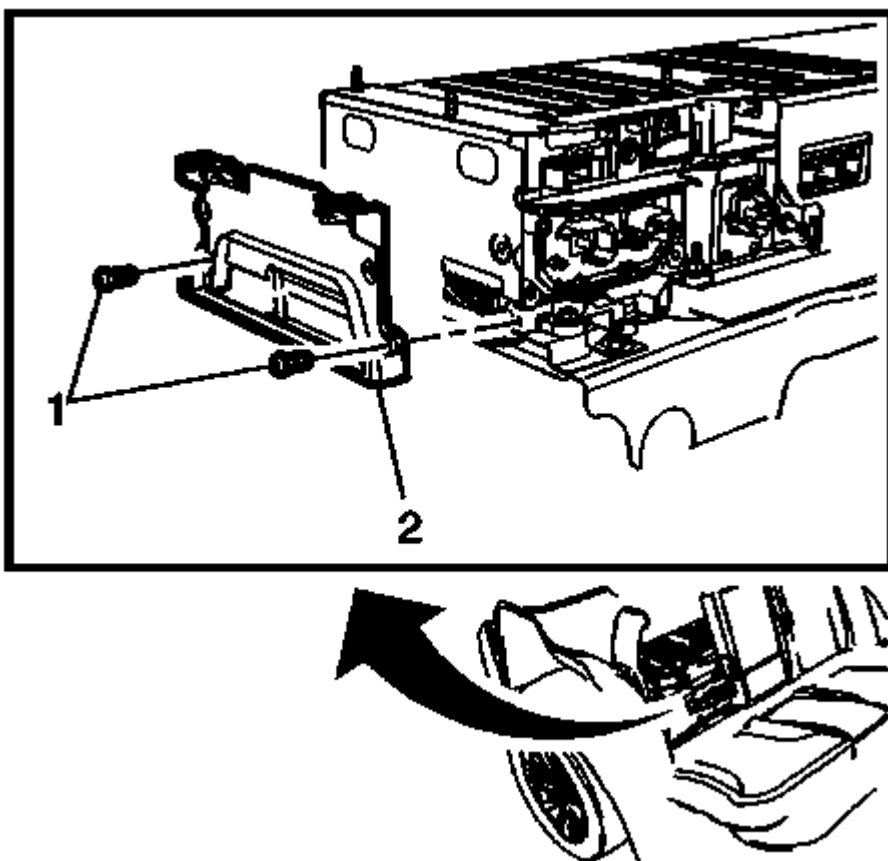


Fig. 12: Generator Control Module Cooling Air Outlet Duct And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the generator control module cooling air outlet duct (2) and tighten the fasteners (1) to 9 N.m (80 lb in).

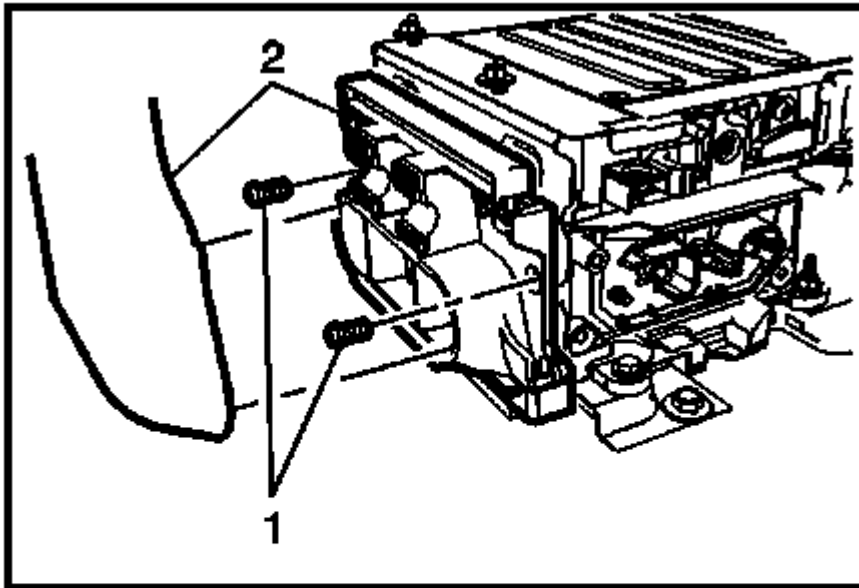


Fig. 13: Drive Motor Battery Cooling Blower Outlet Duct Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Install the drive motor battery cooling blower outlet duct (2) and tighten the fasteners (1) to 9 N.m (80 lb in).
3. Enable the hybrid battery. Refer to **High Voltage Enabling** .

GENERATOR CONTROL MODULE COOLANT PUMP HOSE REPLACEMENT

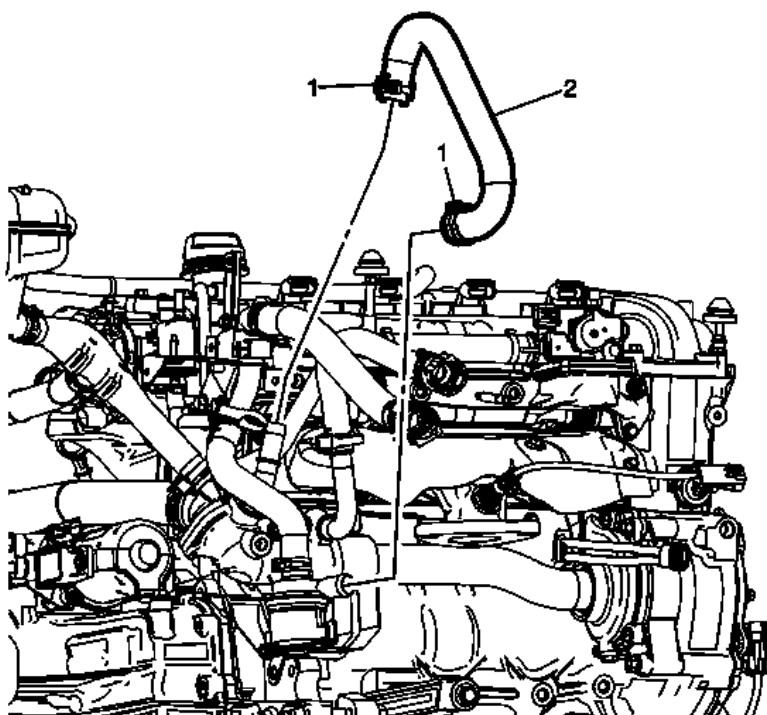


Fig. 14: Generator Control Module Coolant Pump Hose & Clamps
 Courtesy of GENERAL MOTORS COMPANY

Generator Control Module Coolant Pump Hose Replacement

Callout	Component Name
Preliminary Procedures	
Remove intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Hose Clamp (Qty:2)
2	Heater Coolant Pump Hose

GENERATOR CONTROL MODULE COOLANT OUTLET HOSE REPLACEMENT

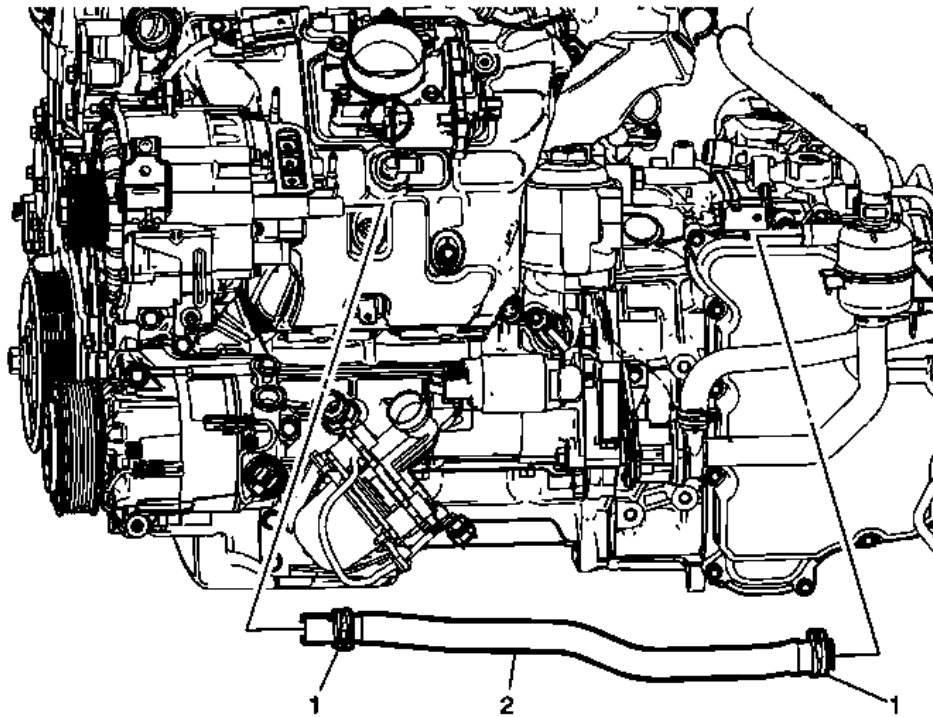


Fig. 15: Generator Control Module Coolant Outlet Hose & Clamps
 Courtesy of GENERAL MOTORS COMPANY

Generator Control Module Coolant Outlet Hose Replacement

Callout	Component Name
Preliminary Procedures	
Remove intake Manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Clamp (Qty: 2)
2	Generator Control Module Coolant Outlet Hose

GENERATOR CONTROL MODULE COOLANT PUMP REPLACEMENT

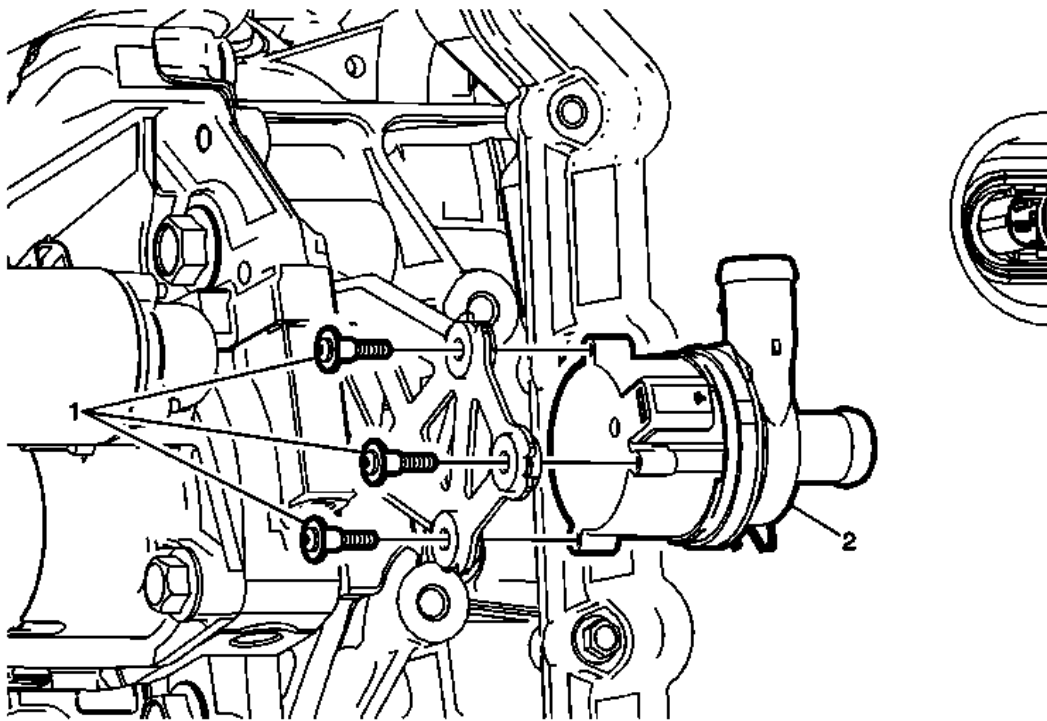


Fig. 16: Generator Control Module Coolant Pump & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Generator Control Module Coolant Pump Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove intake Manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Remove generator Control module coolant outlet hose. Refer to <u>Generator Control Module Coolant Outlet Hose Replacement</u> .	
1	Generator Control Module Coolant Pump Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
2	Generator Control Module Coolant Pump

HEATER COOLANT PUMP HOSE REPLACEMENT

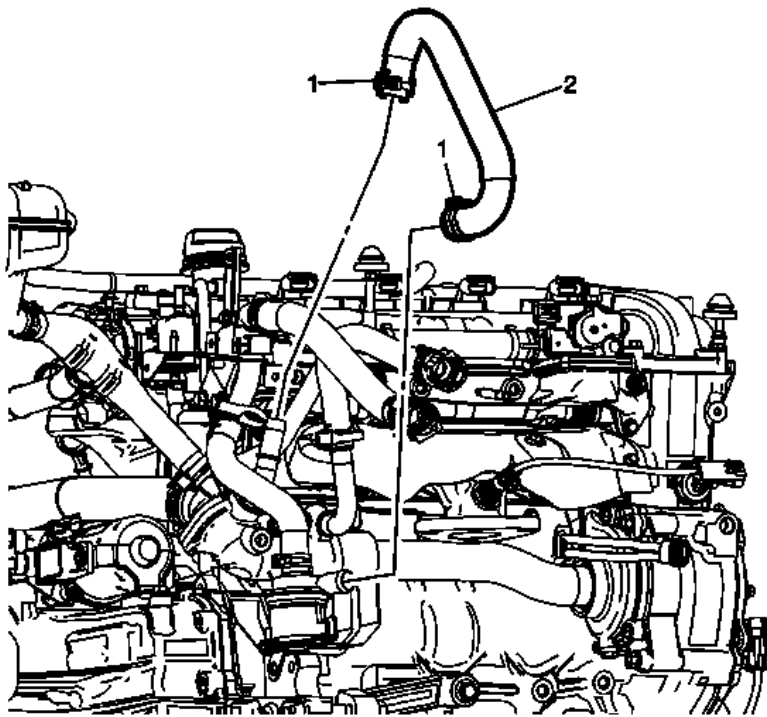


Fig. 17: Generator Control Module Coolant Pump Hose & Clamps
 Courtesy of GENERAL MOTORS COMPANY

Heater Coolant Pump Hose Replacement

Callout	Component Name
Preliminary Procedures	
Remove intake manifold cover. Refer to. <u>Intake Manifold Cover Replacement</u> .	
1	Hose clamp (Qty: 2)
2	Heater Coolant Pump Hose

HEATER OUTLET HOSE CLIP BRACKET REPLACEMENT

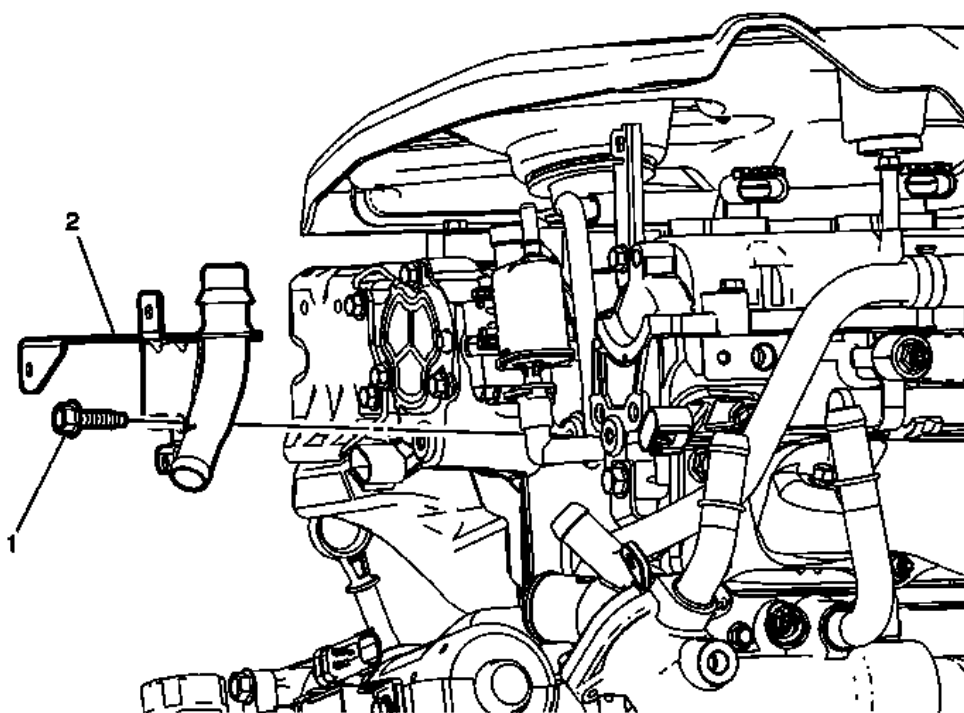


Fig. 18: Heater Outlet Hose Clip Bracket & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Heater Outlet Hose Clip Bracket Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove heater coolant pump hose. Refer to <u>Heater Coolant Pump Hose Replacement</u> .	
2. Remove heater inlet hose . Refer to <u>Heater Inlet Hose Replacement (LEA)</u> .	
1	Heater Outlet Hose Clip Bracket Fastener
2	Heater Outlet Hose Clip Bracket

DRIVE MOTOR BATTERY COOLING BLOWER REPLACEMENT

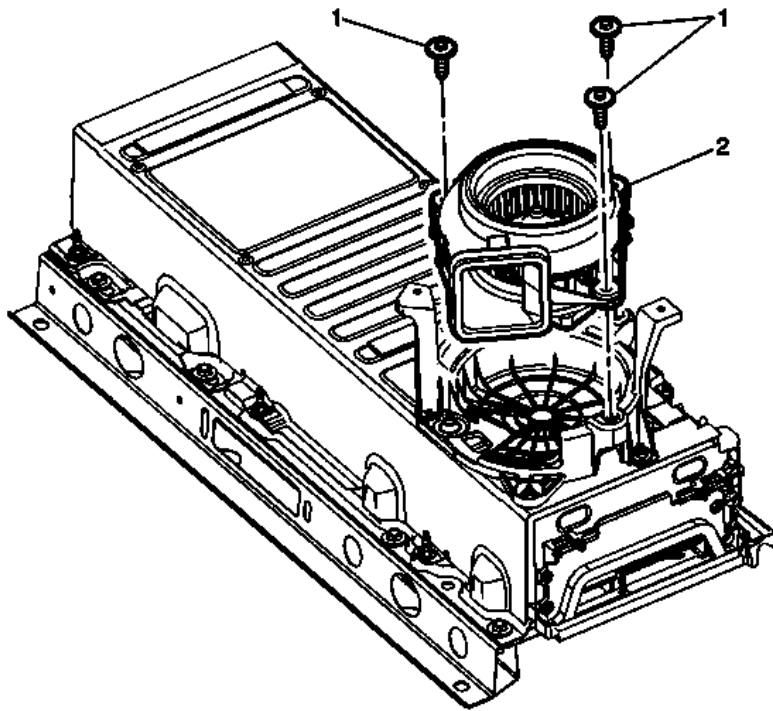


Fig. 19: Drive Motor Battery Cooling Blower Motor & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Cooling Blower Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the drive motor battery cooling blower outlet duct. Refer to <u>Drive Motor Battery Cooling Blower Outlet Duct Replacement</u>. 2. Remove the drive motor battery cooling air outlet duct. Refer to <u>Drive Motor Battery Cooling Air Outlet Duct Replacement</u>. 	
1	Drive Motor Battery Cooling Blower Motor Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Drive Motor Battery Cooling Blower Motor Procedure Disconnect the electrical connector.

DRIVE MOTOR GENERATOR BATTERY BRACKET REPLACEMENT

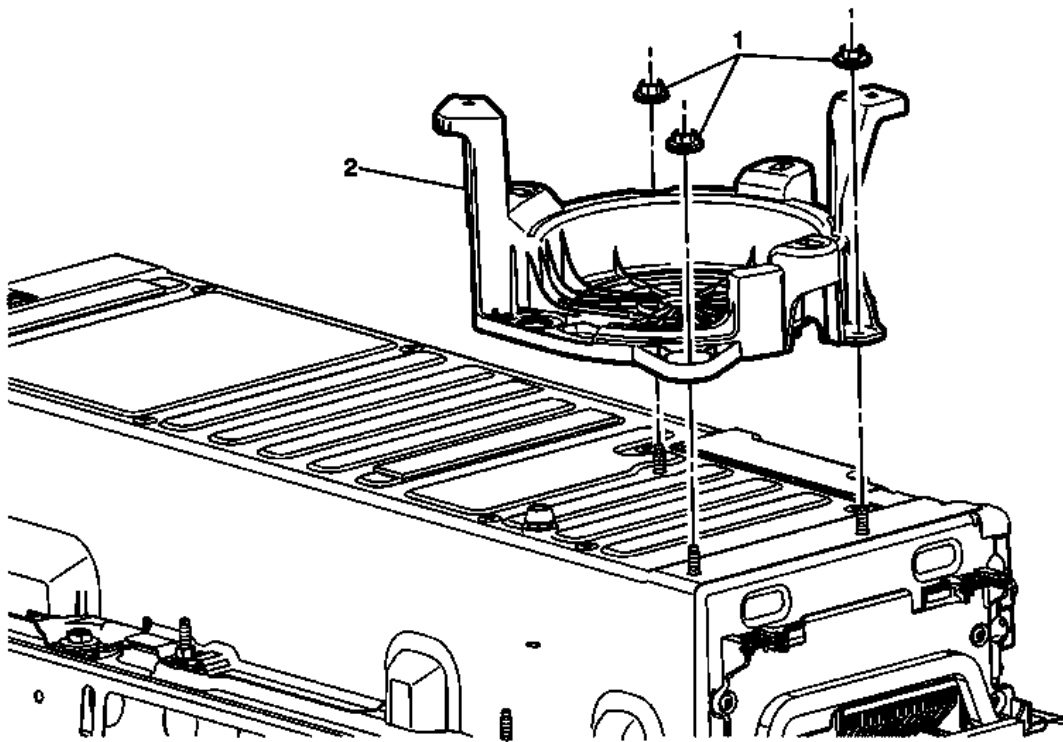


Fig. 20: Drive Motor Generator Battery Cooling Blower Motor Bracket & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Generator Battery Bracket Replacement

Callout	Component Name
Preliminary Procedures Remove the Drive Motor Battery Cooling Blower. Refer to <u>Drive Motor Battery Cooling Blower Replacement</u> .	
1	Drive Motor Generator Battery Bracket Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Drive Motor Generator Battery Bracket

DRIVE MOTOR BATTERY COOLING BLOWER OUTLET DUCT REPLACEMENT

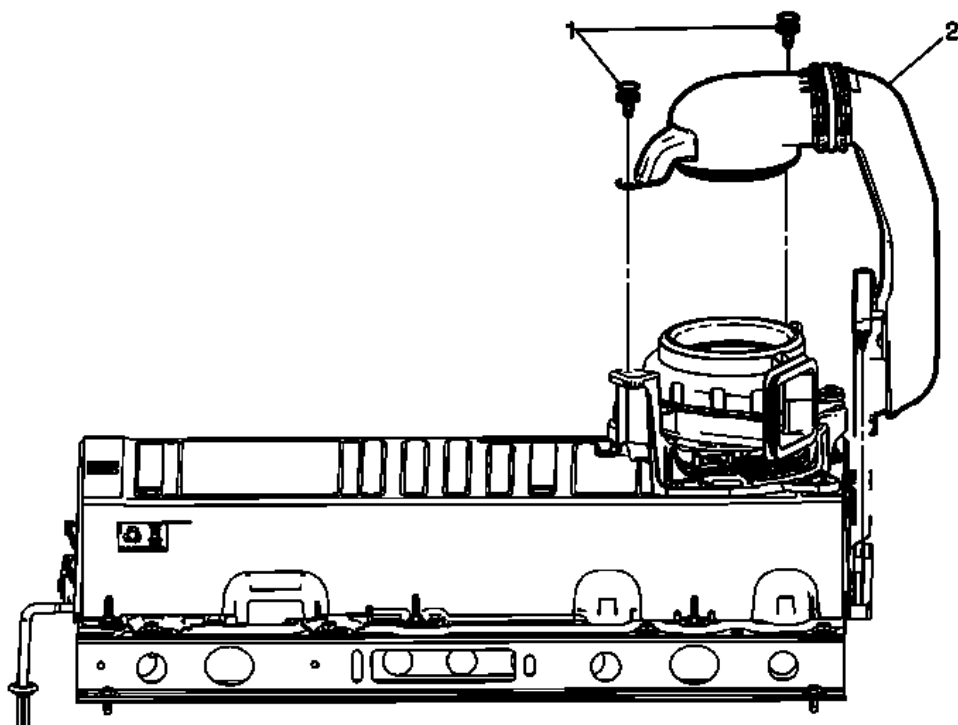


Fig. 21: Drive Motor Battery Cooling Blower Outlet Duct & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Cooling Blower Outlet Duct Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear window panel storage compartment. Refer to <u>Rear Window Panel Stowage Compartment Cover Replacement (with HP6)</u> .	
1	Drive Motor Battery Cooling Blower Outlet Upper Duct Fastener (Qty: 2)
2	Drive Motor Battery Cooling Blower Outlet Upper Duct

DRIVE MOTOR BATTERY COOLING AIR OUTLET DUCT REPLACEMENT

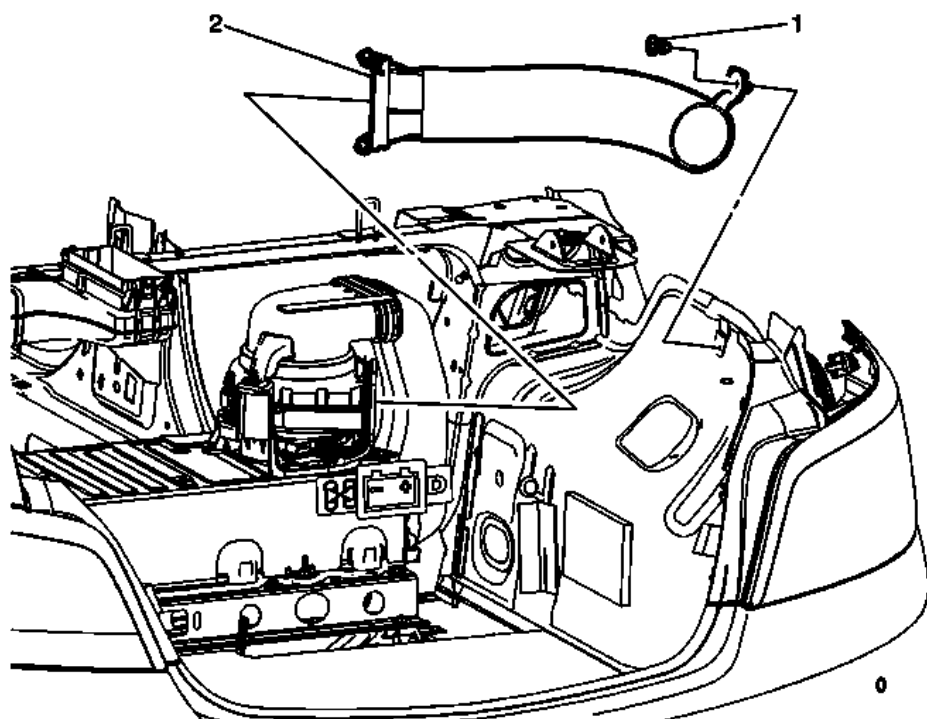


Fig. 22: Drive Motor Battery Cooling Air Outlet Duct & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Cooling Air Outlet Duct Replacement

Callout	Component Name
Preliminary Procedure Remove the right rear compartment side trim. Refer to <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Drive Motor Battery Cooling Outlet Duct Fastener
2	Drive Motor Battery Cooling Outlet Duct

DRIVE MOTOR BATTERY COOLING AIR INLET UPPER DUCT REPLACEMENT

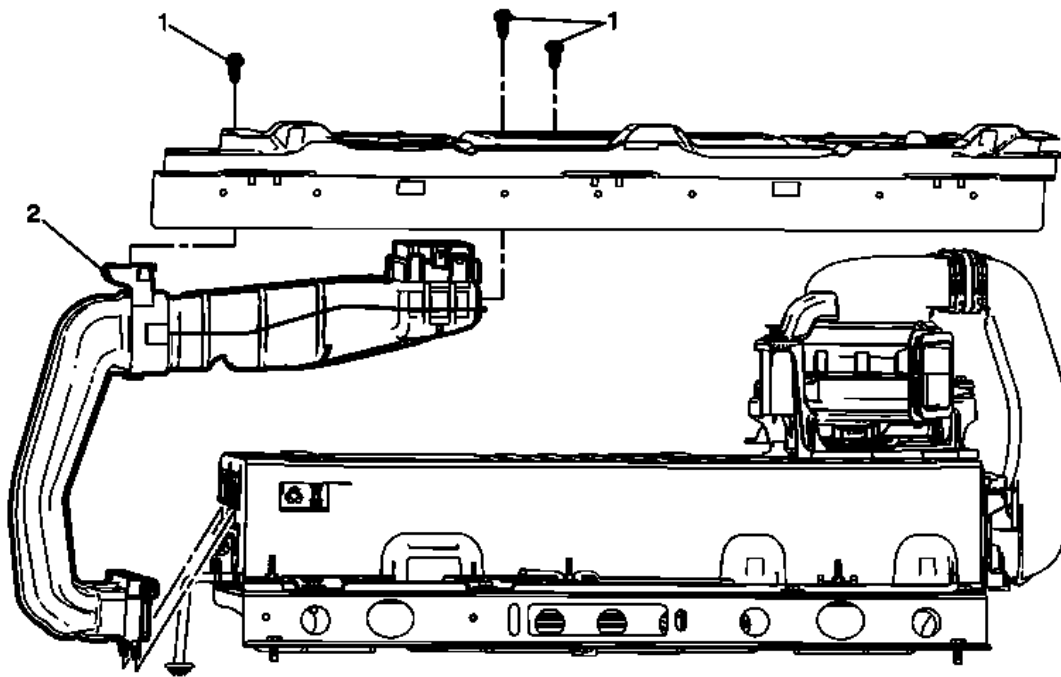


Fig. 23: Drive Motor Battery Cooling Air Inlet Upper Duct & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Cooling Air Inlet Upper Duct Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove rear window panel storage compartment. Refer to <u>Rear Window Panel Stowage Compartment Cover Replacement (with HP6)</u> . 2. Remove rear compartment side trim. Refer to <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Drive Motor Battery Cooling Air Inlet Upper Duct Fasteners (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
2	Drive Motor Battery Cooling Air Inlet Upper Duct

DRIVE MOTOR BATTERY COOLANT/AIR SEPARATOR REPLACEMENT

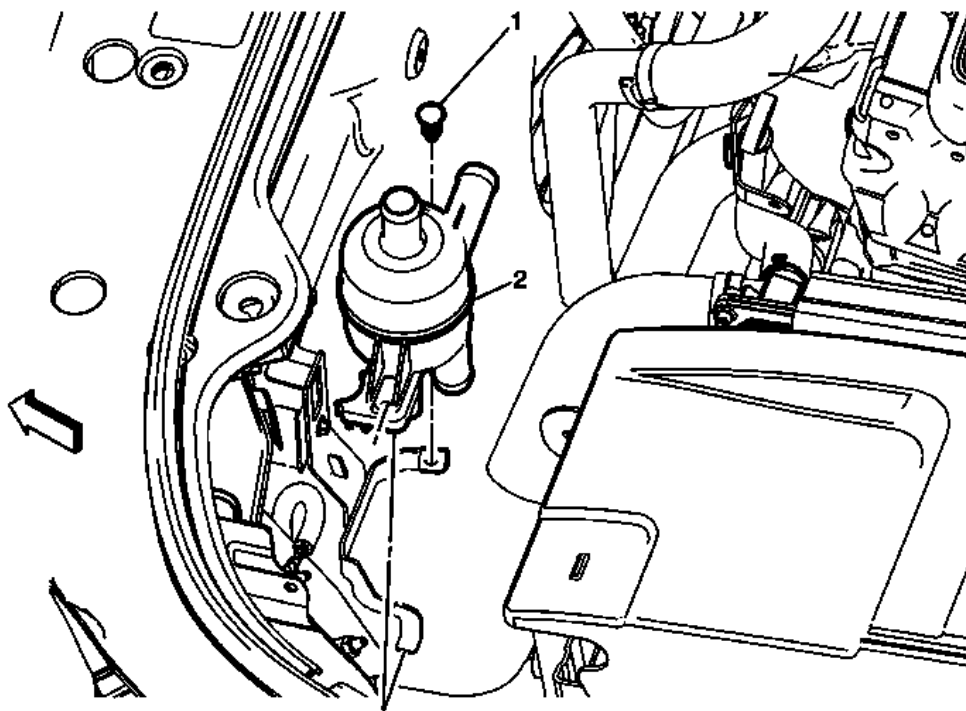


Fig. 24: Drive Motor Battery Coolant/Air Separator & Retainer
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Battery Coolant/Air Separator Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain the coolant. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> 2. Remove the surge tank outlet hose. Refer to <u>Radiator Surge Tank Outlet Hose Replacement (LUK)</u> . 3. Remove the generator control module coolant pump hose. Refer to <u>Generator Control Module Coolant Pump Hose Replacement</u> . 4. Remove generator control module coolant outlet hose. Refer to <u>Generator Control Module Coolant Outlet Hose Replacement</u> .	
1	Drive Motor Battery Coolant Air Separator Retainer
2	Drive Motor Battery Coolant Air Separator

BATTERY COOLING AIR INLET DUCT REPLACEMENT

Removal Procedure

1. Disable the hybrid battery. Refer to High Voltage Disabling .

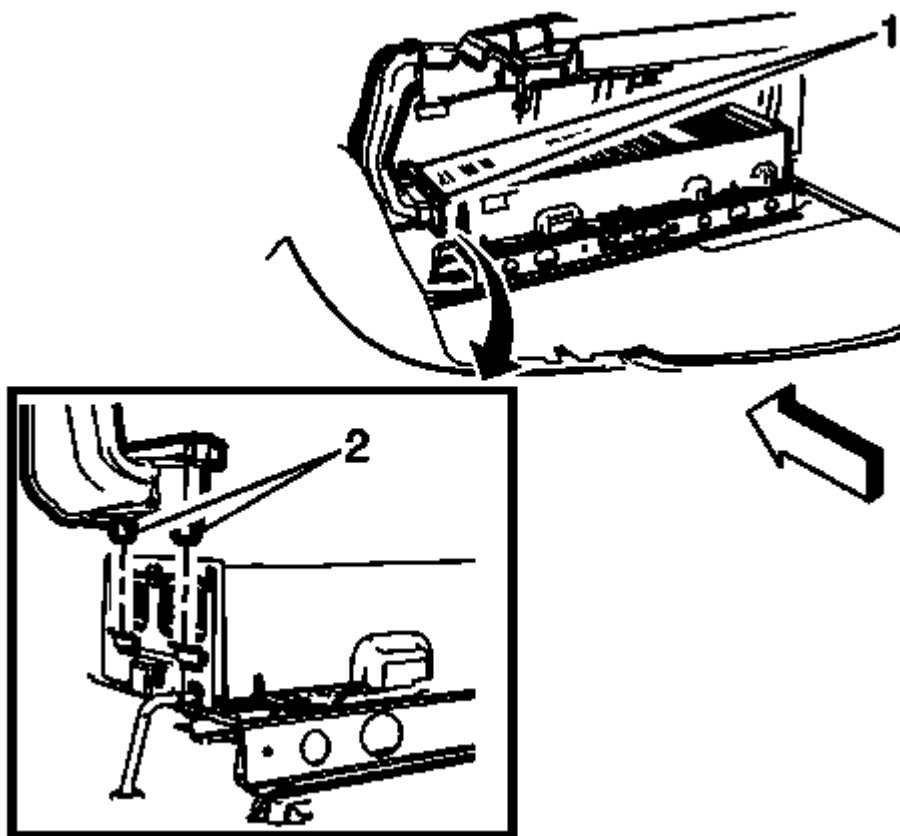


Fig. 25: Battery Cooling Air Inlet Duct And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive motor battery cooling air inlet upper duct retainers (1). Refer to **Drive Motor Battery Cooling Air Inlet Upper Duct Replacement**.

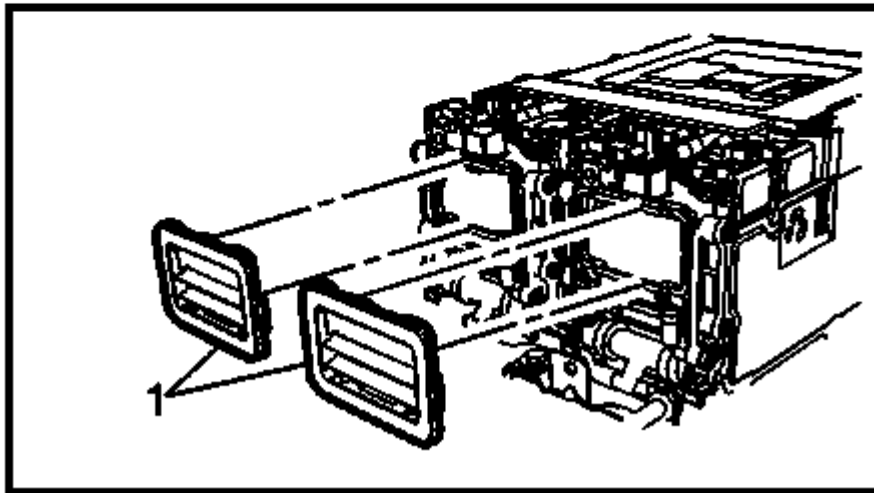
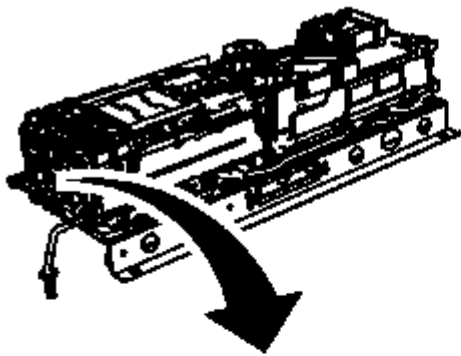


Fig. 26: Battery Cooling Air Inlet Ducts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not insert fingers into the vent area.

3. Detach the battery cooling air inlet ducts (1) by using a suitable pry tool on the outside.

Installation Procedure

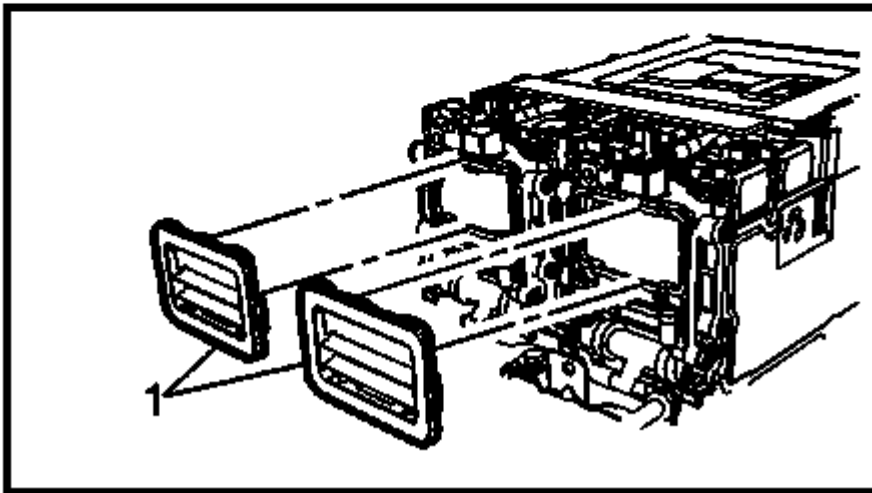
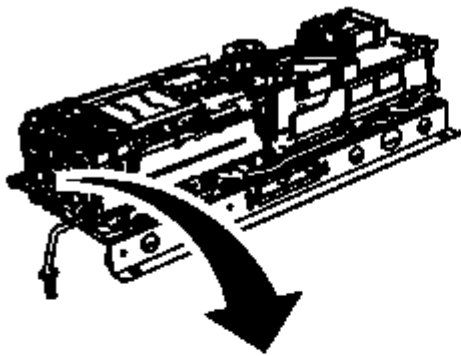


Fig. 27: Battery Cooling Air Inlet Ducts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not insert fingers into the vent area.

1. Attach the battery cooling air inlet ducts (1) into the slotted receivers.

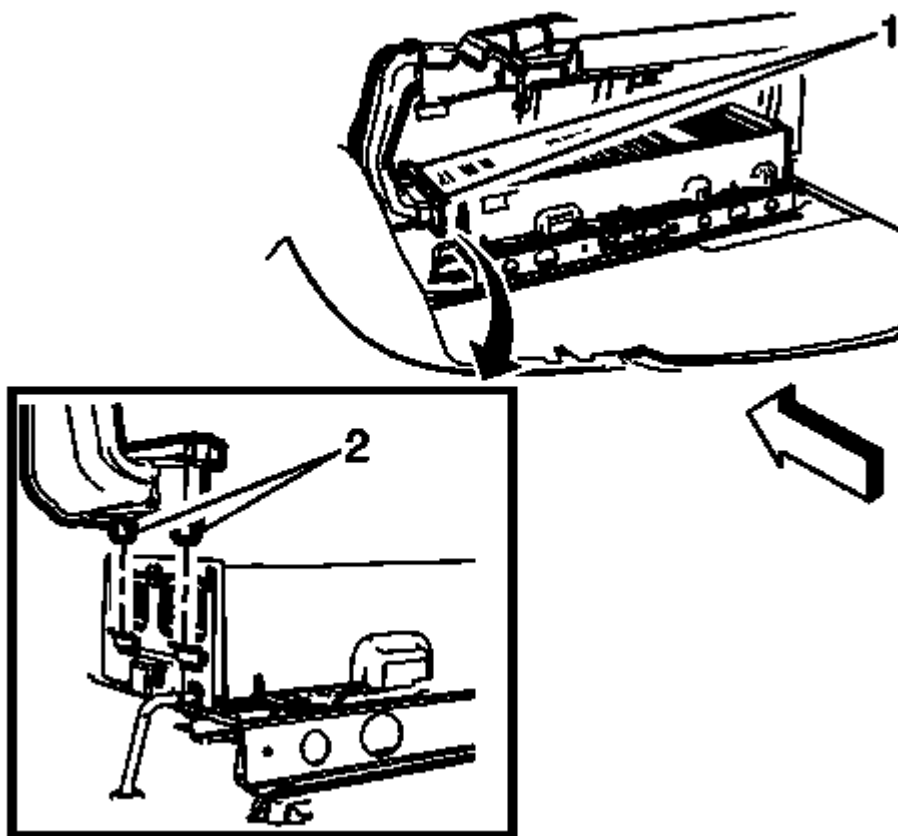


Fig. 28: Battery Cooling Air Inlet Duct And Retainers
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the cover.

2. Install the drive motor battery cooling air inlet upper duct into the slots with the retainers (1). Refer to **Drive Motor Battery Cooling Air Inlet Upper Duct Replacement**.
3. Enable the hybrid battery. Refer to **High Voltage Enabling** .

DESCRIPTION AND OPERATION

HYBRID COOLING SYSTEM DESCRIPTION AND OPERATION

Hybrid/EV Battery Pack Cooling

Within the Hybrid/EV Battery Pack, the Hybrid/EV Battery Section 1, Hybrid/EV Battery Section 2, and Starter/Generator Control Module are air cooled. Air is drawn in by the Hybrid/EV Battery Pack Cooling Fan from the vehicle's passenger compartment. This air travels through a series of ducts into the Hybrid/EV Battery Pack. Once inside the Hybrid/EV Battery Pack, the air travels through the Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2. The internal battery cells of the Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2 are arranged in a staggered manner that allows maximum cooling as air travels through the

battery sections. The air is then drawn under the Starter/Generator Control Module. The underside of the Starter/Generator Control Module have a series of heat sinks that allowing cooling of the internal electronics and capacitors. Air exits the Hybrid/EV Battery Pack through a duct and is drawn through the Hybrid/EV Battery Pack Cooling Fan. From the fan, air is exhausted into the vehicle's rear compartment through a series of ducts.

The cooling needs of the Hybrid/EV Battery Pack is determined through the use of a series of temperature sensors. Six temperature sensors are used to monitor the temperature of the Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2 cell groups. The Starter/Generator Control Module commands the Hybrid/EV Battery Pack Cooling Fan to provide more or less air as the battery temperature increases or decreases. A single temperature sensor is used to monitor the air temperature of the incoming cooling air.

The Hybrid/EV Battery Pack cooling system contains the following serviceable components:

- Hybrid/EV Battery Pack Case
- Hybrid/EV Battery Section 1
- Hybrid/EV Battery Section 2
- Battery Energy Control Module
- Starter/Generator Control Module
- Hybrid/EV Battery Pack Cooling Fan

Hybrid/EV Battery Pack

The Hybrid/EV Battery Pack is integral to the Hybrid/EV Battery Pack cooling system. Foam gaskets are adhered to the metal battery pack tray. This seals the underside of the Starter/Generator Control Module to ensure proper airflow under the control module for cooling purposes. The Hybrid/EV Battery Pack case cover also provides a mounting surface for the Hybrid/EV Battery Pack Cooling Fan and has openings where the plastic vents are allowed to pass into the Hybrid/EV Battery Pack to direct air through components which require cooling.

Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2

The hybrid battery sections are air cooled. Each battery case has an air inlet and an air outlet. Air is drawn through the battery case to cool the individual cells. Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group.

Battery Energy Control Module

The battery energy control module measures critical temperatures within the two battery sections and at the Hybrid/EV Battery Section 1 air inlet. Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The battery energy control module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature

sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The air inlet temperature sensor operates in much the same way, except that it measures the temperature of the incoming air used to cool the Hybrid/EV Battery Pack at the Hybrid/EV Battery Section 1 air inlet. None of the temperature sensors or the temperature sensor harness is serviceable. They are all serviced as part of the battery sections.

Starter/Generator Control Module

The Starter/Generator Control Module uses temperature information from the battery energy control module to control the Hybrid/EV Battery Pack Cooling Fan and increase or decrease the cooling capacity. As battery cell temperature increases, the start/generator control module will command the Hybrid/EV Battery Pack Cooling Fan speed to increase, increasing the air flow through the Hybrid/EV Battery Pack. The Starter/Generator Control Module may also command the fan on in low ambient temperatures to aid in the warming of the battery cells. If the ambient temperature of the air in the passenger compartment, where the cooling air is drawn from, is warmer than the battery cell temperatures, it may be used to help warm the cells more quickly. The Starter/Generator Control Module will use the air inlet temperature sensor to determine the temperature of the incoming air.

Hybrid/EV Battery Pack Cooling Fan

The Hybrid/EV Battery Pack Cooling Fan draws air through the Hybrid/EV Battery Pack to control the temperature of the Hybrid/EV Battery Section 1, Hybrid/EV Battery Section 2, and Starter/Generator Control Module. To operate, the cooling fan receives an enable signal from the Starter/Generator Control Module. The enable control is controlled by a discrete high side driver in the Starter/Generator Control Module. When the enable control circuit is high, the fan will be enabled. The fan speed is controlled by a pulsed high side driver in the Starter/Generator Control Module. The greater the duty cycle on the fan speed signal circuit, the higher the fan speed. Maximum fan speed is 3900 RPM. The Hybrid/EV Battery Pack Cooling Fan provides a low-side drive, pulse-width modulated feedback signal to the Starter/Generator Control Module. During normal operation, this feedback signal provides fan speed information. The Hybrid/EV Battery Pack Cooling Fan has limited self-diagnostic capability. If the fan determines there is an internal fault, it will provide this information on the feedback circuit.

Starter/Generator Cooling

The starter/generator is liquid cooling using a stand-alone cooling system that is separate from the engine's cooling system.

The starter/generator cooling system contains the following serviceable components:

- Starter/Generator Control Module
- Starter/Generator Coolant Temperature Sensor
- Starter/Generator Coolant Pump

Starter/Generator Control Module

The Starter/Generator Control Module monitors the starter/generator coolant temperature sensor. When the coolant temperature indicates that starter/generator cooling is required, the Starter/Generator Control Module

commands the starter/generator coolant pump on. The Starter/Generator Control Module provides ground to the starter/generator coolant pump relay coil through a dedicated low side driver. The will cause the starter/generator coolant pump relay switch to closed, providing B+ to the starter/generator coolant pump.

Starter/Generator Coolant Temperature Sensor

The starter/generator coolant temperature sensor is a variable resistor that measures the temperature of the starter/generator coolant. The Starter/Generator Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The starter/generator coolant temperature sensor resistance changes with starter/generator coolant temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The Starter/Generator Control Module monitors the starter/generator coolant temperature sensor to determine the temperature of the starter/generator coolant. As the coolant temperature changes, the Starter/Generator Control Module will turn the starter/generator coolant pump on or off to accommodate the starter/generator cooling requirements.

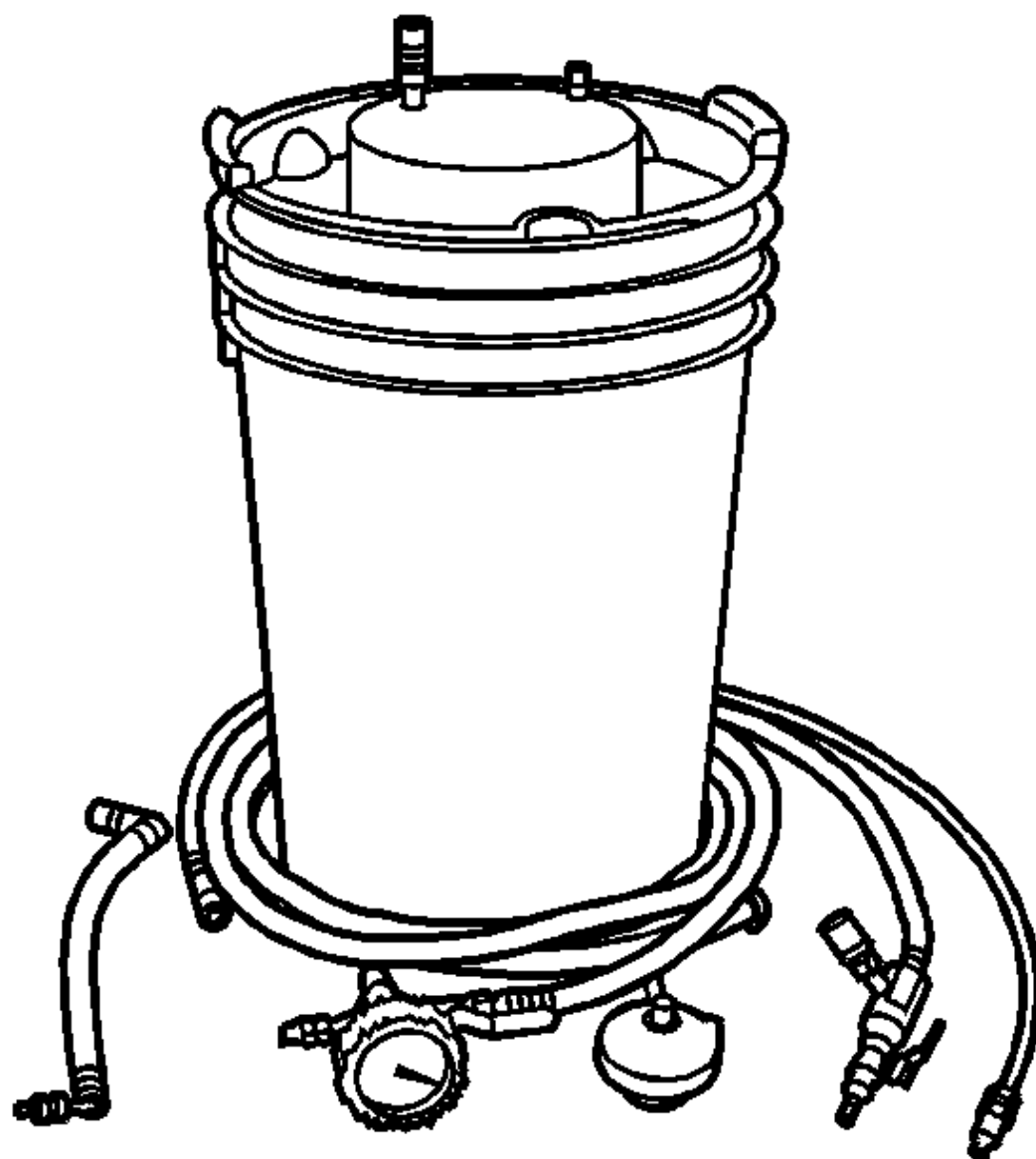
Starter/Generator Coolant Pump

The drive motor coolant pump is a single speed ON/OFF pump that circulates coolant through the starter/generator radiator and the starter/generator to control the temperature of the starter/generator.

SPECIAL TOOLS AND EQUIPMENT

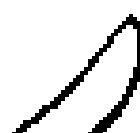
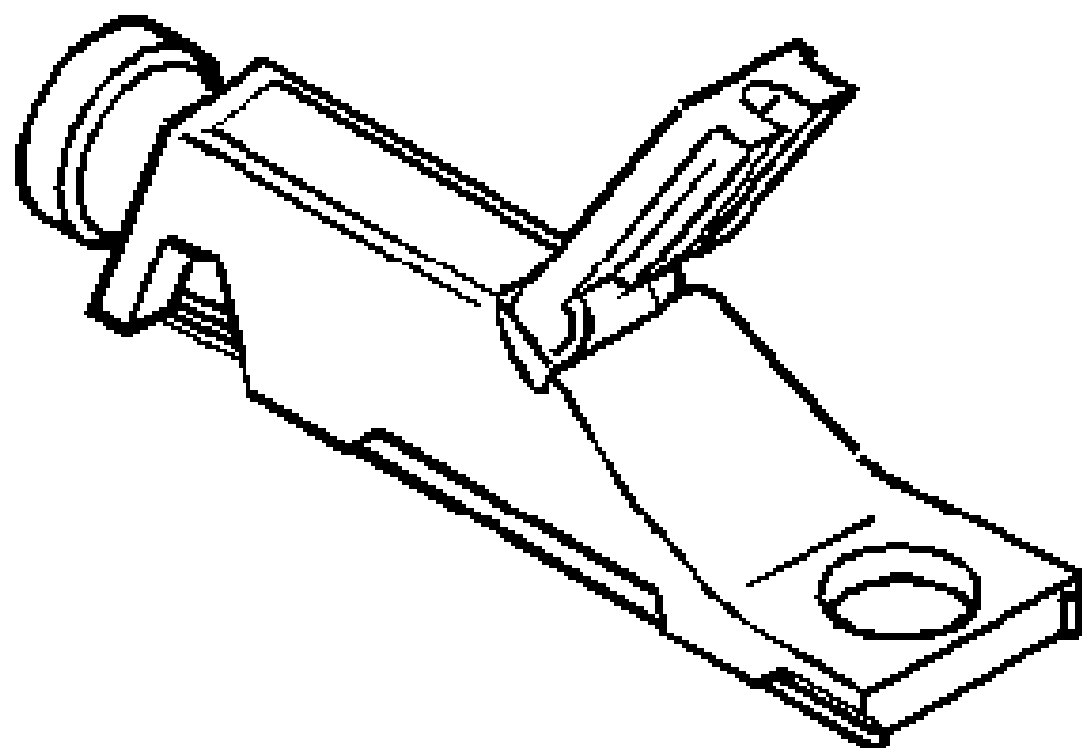
SPECIAL TOOLS

Illustration	Tool Number/ Description
	GE 47716 Vac-N-Fill Coolant Refill Tool



EN 24460-A
J 24460-A
Cooling
System
Pressure
Tester

GE 26568
J 26568
Coolant and
Battery
Tester



	BO 38185 J 38185 Hose Clamp Pliers
--	--

ELECTRICAL

Hybrid/EV Energy Storage

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

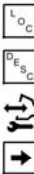
Fastener Tightening Specifications

Application	Specification	
	Metric	English
Battery Auxiliary Tray Fasteners	22 N.m	16 lb ft
Battery Energy Control Module Fasteners	9 N.m	80 lb in
Battery Energy Control Module Wiring Junction Block Fasteners	9 N.m	80 lb in
BDU Housing Fasteners	6 N.m	53 lb in
Cut-Off Switch Screw	4 N.m	35 lb in
Disconnect High Voltage Switch Mounting Fastener	9 N.m	80 lb in
Drive Motor Generator Battery Cable Bracket Fasteners	22 N.m	16 lb ft
Drive Motor Generator Battery Cable Tray Fasteners	22 N.m	16 lb ft
Drive Motor Generator Battery Cable U V W Terminal Fasteners	9 N.m	80 lb in
Generator Battery Disconnect Relay Fasteners	9 N.m	80 lb in
Generator Battery Fasteners	22 N.m	16 lb ft
Generator Battery Fuse Fasteners	9 N.m	80 lb in
Generator Control and Battery Module Mounting Fasteners	22 N.m	16 lb ft
Generator Control Module Cable Cover Fasteners	9 N.m	80 lb in
Generator Control Module Cover Fasteners	9 N.m	80 lb in
Generator Control Module Fasteners	9 N.m	80 lb in
High Voltage Cables-to-Battery Block Fasteners	9 N.m	80 lb in
HVIL Connector	4 N.m	35 lb in
Intermediate Duct to Power Pack Tray	9 N.m	80 lb in
Outlet Duct Adapter Fasteners	6 N.m	53 lb in

SCHEMATIC WIRING DIAGRAMS

HYBRID/EV ENERGY STORAGE WIRING SCHEMATICS

Power, Ground, and Serial Data



Contactors

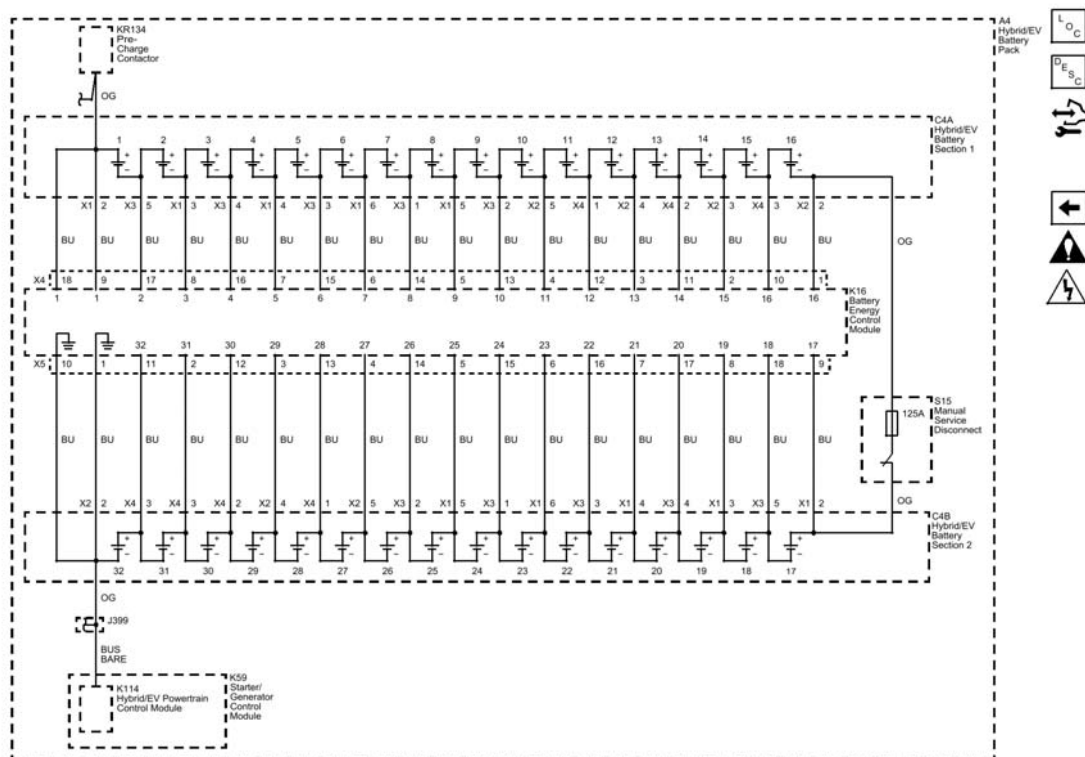


Fig. 3: Hybrid Battery Pack Monitoring
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

HIGH VOLTAGE SAFETY

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters

(50 feet) of the vehicle, either indoors or outdoors.

- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: High voltage circuits should only be tested using a digital multimeter (DMM) and test leads with at least a CAT III rating, such as the J 39200-A Digital Multimeter. Failure to follow the procedures may result in serious injury or death.

WARNING: This vehicle is equipped with a high voltage battery that is completely isolated from the chassis ground. Never utilize AC powered test equipment to probe the high voltage system. Serious injury, death and component damage could occur if the high voltage system is grounded through the electric utility.

Failure to follow the procedure exactly as written may result in serious injury or death.

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Precautions when Performing Service or Inspections

- Always verify that the high voltage has been disabled before working on or around high voltage components, wires, cables, or harnesses.
- Remove all metal objects such as rings and watches.
- The **EL-48900** HEV safety kit contains safety cones. Place the safety cones around the vehicle to alert other technicians that you are working on the high voltage system.
- Remove all vehicle keys and secure in a location outside the vehicle. If the vehicle is equipped with push button start, the keys must remain at least 3 meters (15 feet) from the vehicle.
- Ensure that the manual service disconnect lever is secured in the open position with a zip tie.
- Always wear certified and tested high voltage insulation gloves when inspecting or testing any high voltage wires and components.
- Use the "One Hand" rule:
 - Work with only one hand whenever possible.

- Keep the other hand behind your back.
- DO NOT carry any metal objects such as a mechanical pencil or a measuring tape that could fall and cause a short circuit.
- After removing any high voltage wires, protect and insulate the terminal ends immediately with UL® Listed or equivalent insulation tape rated at a minimum of 600 V.
- Always tighten the high voltage terminal fasteners to the specified torque. Insufficient or excessive torque will cause malfunctions or damage.
- After finishing work on the high voltage systems and before closing the manual service disconnect lever, inspect for the following:
 - Verify high voltage system integrity and that all connectors are installed.
 - Verify that all tools or loose components have been removed.

Labels for Components, Wire Harness, and Connectors

The wire harnesses and cables for high voltage circuits are encased in an orange colored covering. In addition, the high voltage energy storage device (battery) is affixed with a RED DANGER label and other high voltage components (e.g. Starter/Generator) are affixed with ORANGE WARNING labels.

High Voltage Insulation Glove Inspection Procedure

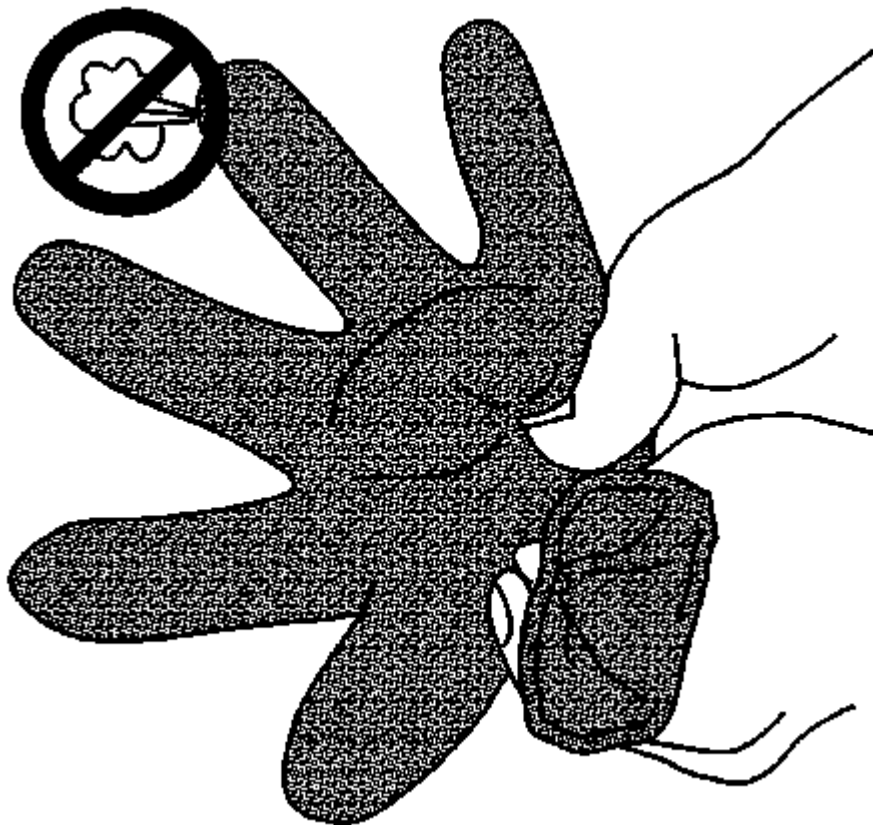


Fig. 4: Glove Inspection Procedure
Courtesy of GENERAL MOTORS COMPANY

The following procedure visually and functionally inspects the insulation gloves to be used while performing service on high voltage systems. This inspection procedure should be performed prior to any procedure that requires the use of class "0" insulation gloves rated at 1000 V.

1. Remove glove from leather protector.
2. Inflate glove and seal opening. Pinch the opening closed tightly to prevent any air loss.
3. Press glove to increase pressure.
4. Inspect for any of the following conditions:
 - Pin holes
 - Air leaks
 - Wear, tears, or abrasions
 - Damp or wet material
 - Certified up-to-date
 - If any of the above conditions exist, do not use the gloves.

HIGH VOLTAGE DISABLING

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.

- **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

Servicing the A4 Hybrid/EV Battery Pack, A15 Starter/Generator, High Voltage 3-Phase Cables, and General Vehicle Servicing

This disabling procedure should only be used when service is being performed on components that are located outside of the A4 Hybrid/EV Battery Pack, such as the A15 Starter/Generator and high voltage 3-phase cables, or when the A4 Hybrid/EV Battery Pack is being replaced as a complete assembly. This procedure will only verify that high voltage has been removed from locations outside the A4 Hybrid/EV Battery Pack. If testing or replacement requires disassembling the A4 Hybrid/EV Battery Pack and accessing any components within, Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack, located below, must be used. The Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack procedure must be used because of the constant presence of high voltage when the A4 Hybrid/EV Battery Pack is disassembled.

1. Review the high voltage safety information. Refer to **High Voltage Safety**.
2. Disconnect and remove any 12 V battery chargers.
3. Turn the ignition OFF and wait 5 minutes to allow the high voltage capacitors to discharge.
4. Remove all vehicle keys and secure in a location outside the vehicle. If the vehicle is equipped with push button start, the keys must remain at least 3 meters (10 feet) away from the vehicle.
5. Disconnect the 12 V battery. Refer to **Battery Negative Cable Disconnection and Connection** .
6. Lower the rear seatback and reposition the trunk liner to gain access to the A4 Hybrid/EV Battery Pack.

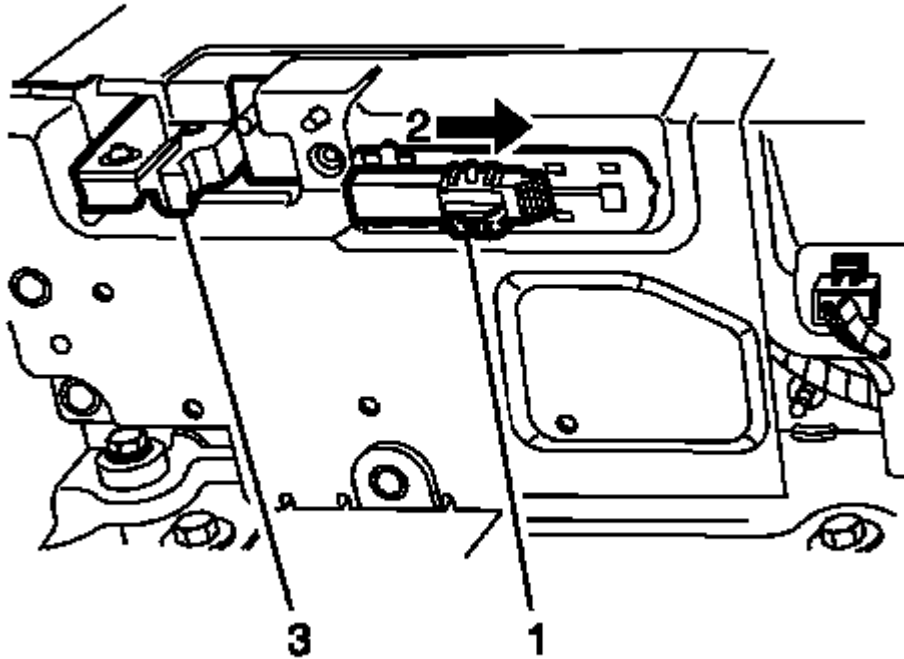


Fig. 5: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

7. Disengage the blue connector position assurance (1) from the high voltage interlock switch by pulling the CPA straight out. Do not fully remove the CPA from the switch or damage to the CPA will result.

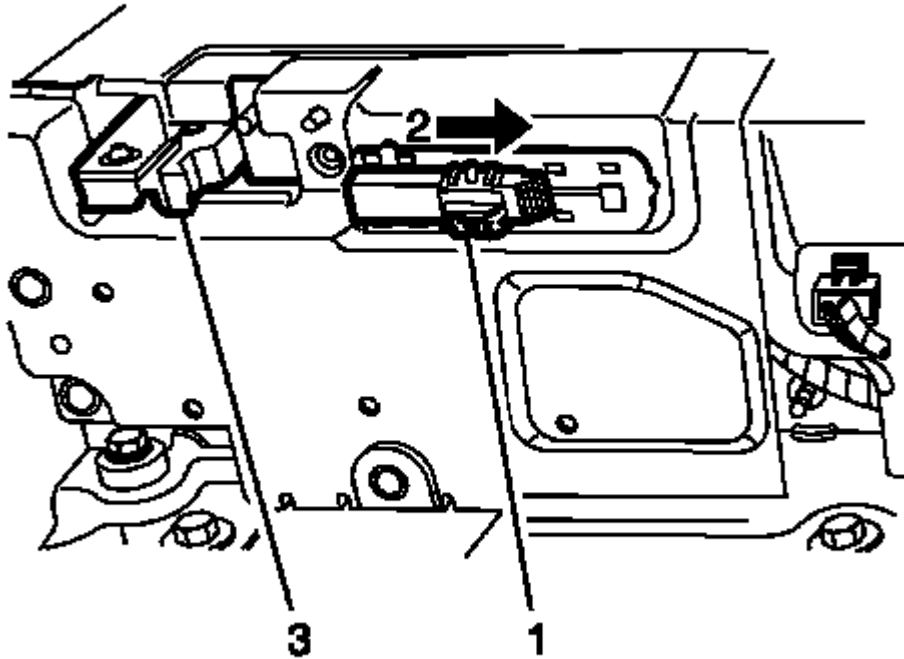


Fig. 6: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

8. Depress the tab on the high voltage interlock switch and slide the interlock switch toward the left side of the vehicle (2).

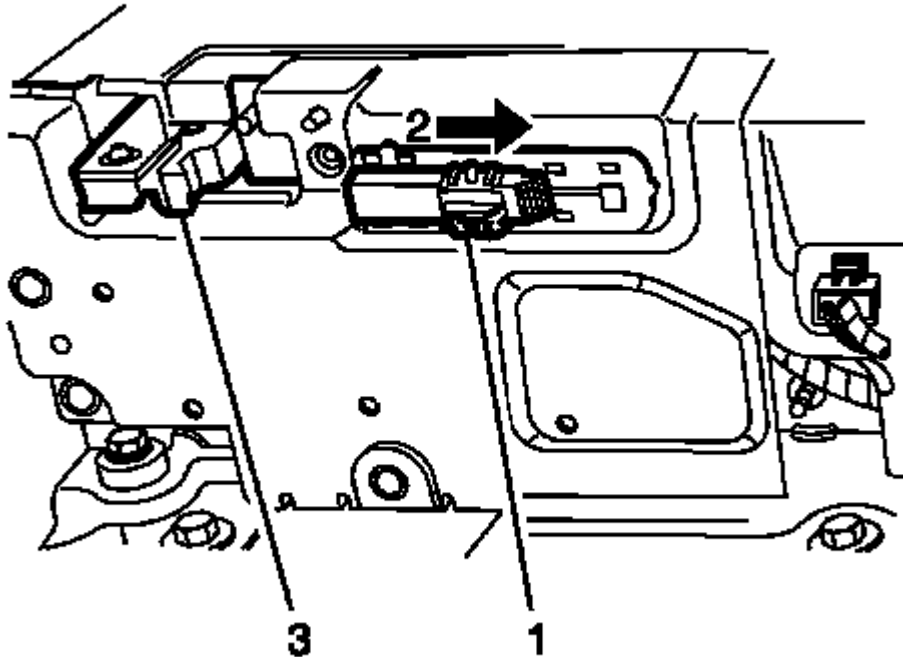


Fig. 7: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

9. Flip the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever, located on the A4 Hybrid/EV Battery Pack, toward the right side of the vehicle and secure in the open position with a zip tie (3).

WARNING: Wear high voltage insulation gloves with leather protectors until it has been determined that a high voltage exposure risk is no longer present. Failure to follow the procedures exactly as written may result in serious injury or death.

NOTE: Repeated removal of the cover during service may cause the cover spacers to become loose and eventually separate from the cover. Take care when removing the cover so that none of these potentially loose spacers fall into an inaccessible location.

10. Remove the F102 Hybrid/EV Battery Pack Cable Cover from the A4 Hybrid/EV Battery Pack.

NOTE: A 9 V DC battery can be used to test the DMM.

11. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.

- **If the DMM does not properly measure a 12 V battery**

Repair or replace the DMM.

- **If the DMM properly measures a 12 V battery**

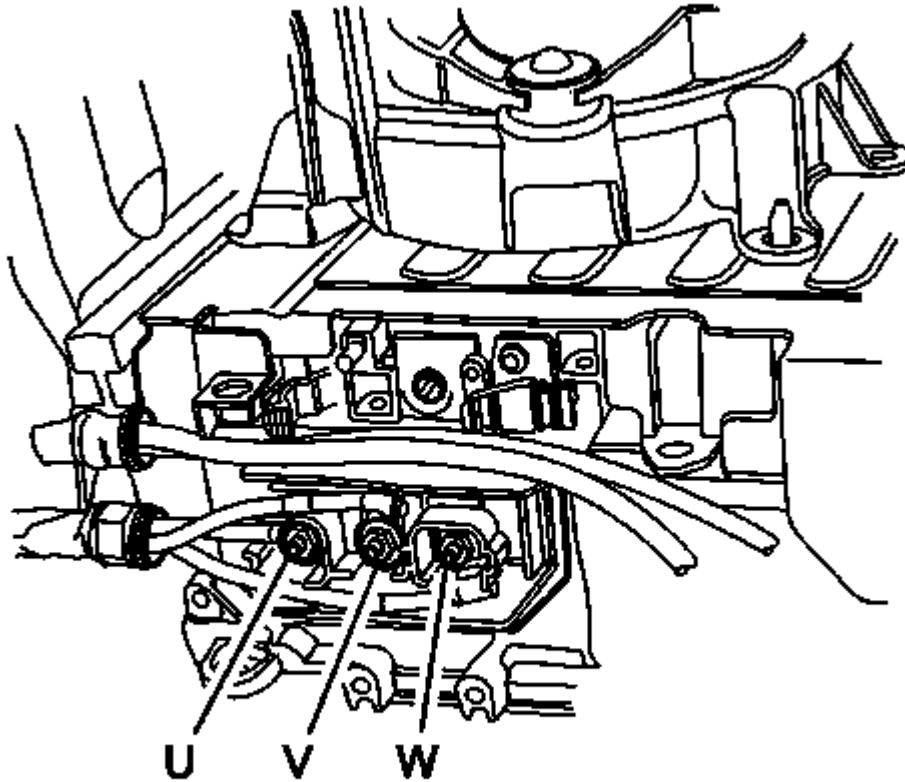


Fig. 8: Phase Terminal V, U And W

Courtesy of GENERAL MOTORS COMPANY

12. Verify that the voltage has been disabled at the energy storage system. Using the DMM on the DC voltage scale, test for less than 3 V at the following points:

- High voltage 3-Phase terminal V to vehicle chassis ground
- High voltage 3-Phase terminal W to vehicle chassis ground
- High voltage 3-Phase terminal U to vehicle chassis ground
- High voltage 3-Phase terminal U to High voltage 3-Phase terminal V
- High voltage 3-Phase terminal V to High voltage 3-Phase terminal W
- High voltage 3-Phase terminal W to High voltage 3-Phase terminal U

- **If 3 V or greater**

A contactor is stuck closed or a loss of isolation has occurred within the A4 Hybrid/EV Battery Pack. Refer to **Hybrid\EV Battery Voltage Present**.

- **If less than 3 V**

NOTE: A 9 V DC battery can be used to test the DMM.

13. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.

- **If the DMM does not properly measure a 12 V battery**

Repair or replace the DMM and perform Step 11 again.

- **If the DMM properly measures a 12 V battery**

14. If all the test results were less than 3 V, the A4 Hybrid/EV Battery Pack, A15 Starter/Generator, high voltage 3-phase cables, or general vehicle can now be serviced.

Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack

This disabling procedure should be used when any service is being performed on components that are internal to the A4 Hybrid/EV Battery Pack, such as the K59 Starter/Generator Control Module and K16 Battery Energy Control Module. If a diagnostic instructs to perform any testing or replacement of components within the A4 Hybrid/EV Battery Pack, this procedure must be used. This procedure will completely disconnect and isolate the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 from the vehicle, allowing testing or replacement to occur in a safer environment.

1. Review the high voltage safety information. Refer to **High Voltage Safety**.
2. Disconnect and remove any 12 V battery chargers.
3. Turn the ignition OFF and wait 5 minutes to allow the high voltage capacitors to discharge.
4. Remove all vehicle keys and secure in a location outside the vehicle. If the vehicle is equipped with push button start, the keys must remain at least 3 meters (10 feet) away from the vehicle.
5. Disconnect the 12 V battery. Refer to **Battery Negative Cable Disconnection and Connection** .
6. Lower the rear seatback and reposition the trunk liner to gain access to the A4 Hybrid/EV Battery Pack.

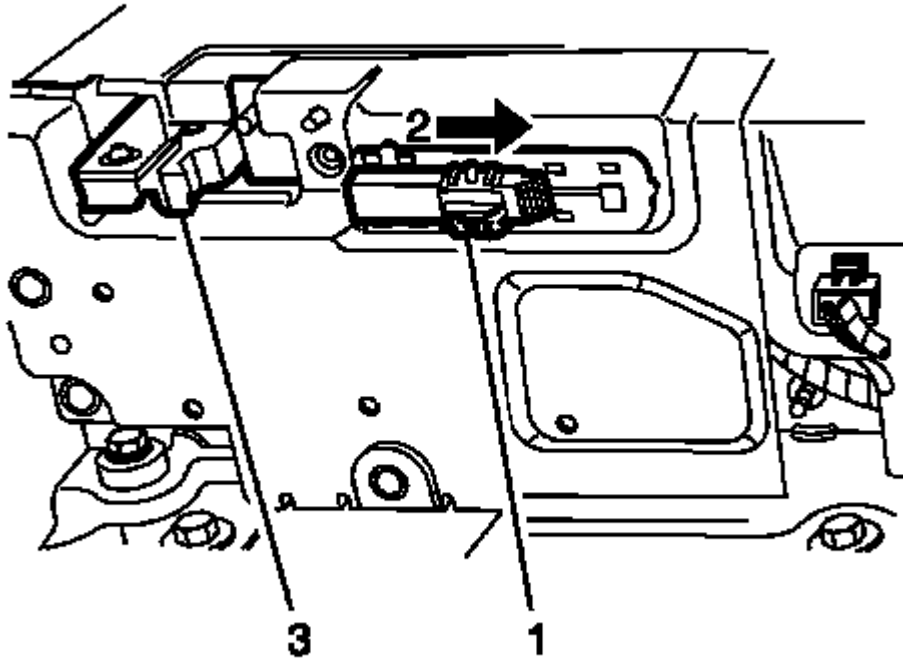


Fig. 9: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

7. Disengage the blue connector position assurance (1) from the high voltage interlock switch by pulling the CPA straight out. Do not fully remove the CPA from the switch or damage to the CPA will result.

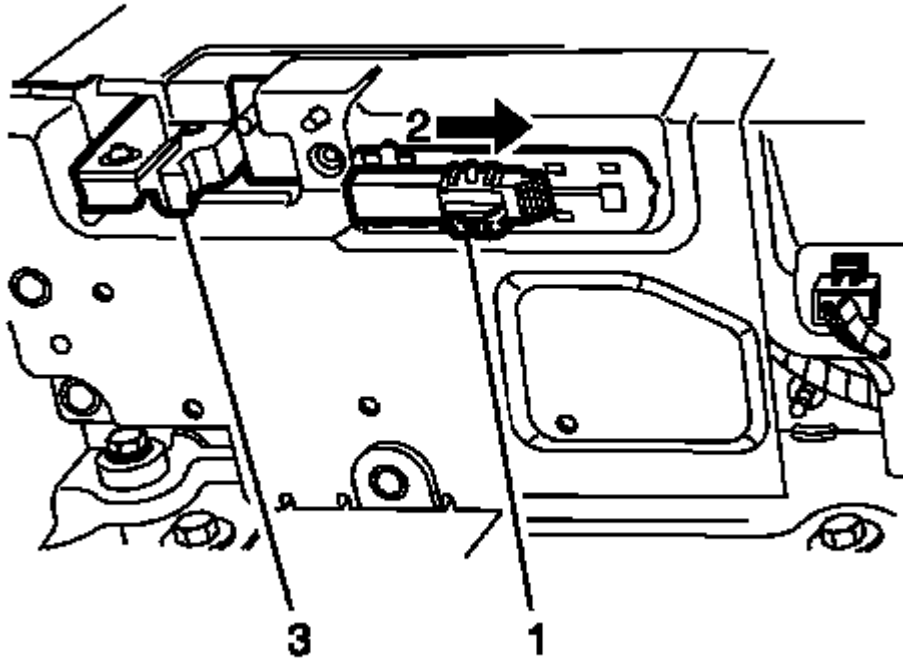


Fig. 10: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

8. Depress the tab on the high voltage interlock switch and slide the interlock switch (2) toward the left side of the vehicle.

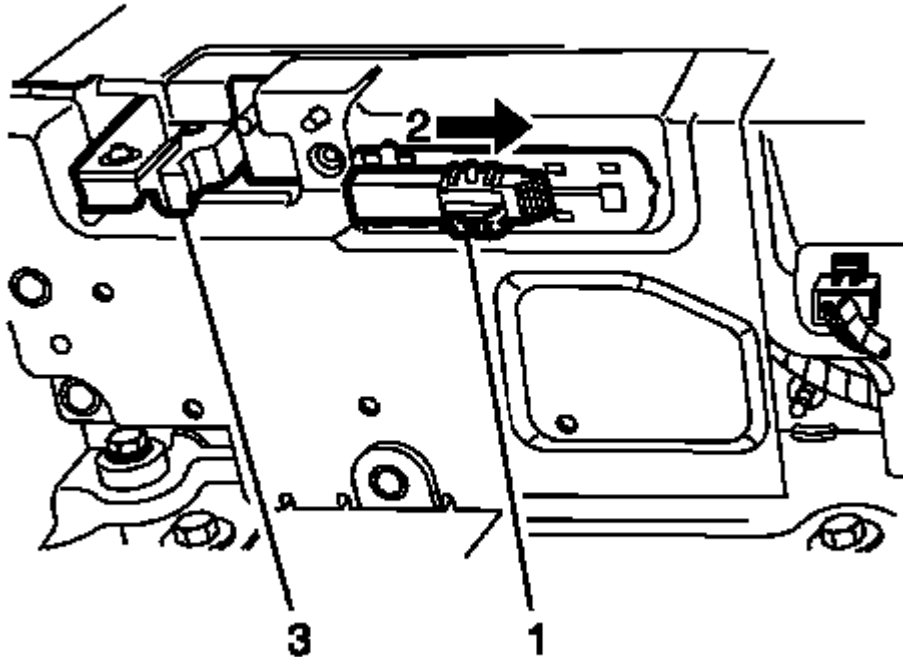


Fig. 11: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

9. Flip the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever, located on the A4 Hybrid/EV Battery Pack, toward the right side of the vehicle and secure in the open position with a zip tie (3).

WARNING: Wear high voltage insulation gloves with leather protectors until it has been determined that a high voltage exposure risk is no longer present. Failure to follow the procedures exactly as written may result in serious injury or death.

NOTE: Repeated removal of the cover during service may cause the cover spacers to become loose and eventually separate from the cover. Take care when removing the cover so that none of these potentially loose spacers fall into an inaccessible location.

10. Remove the F102 Hybrid/EV Battery Pack Cable Cover from the A4 Hybrid/EV Battery Pack.

NOTE: A 9 V DC battery can be used to test the DMM.

11. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.

- If the DMM does not properly measure a 12 V battery

Repair or replace the DMM.

- If the DMM properly measures a 12 V battery

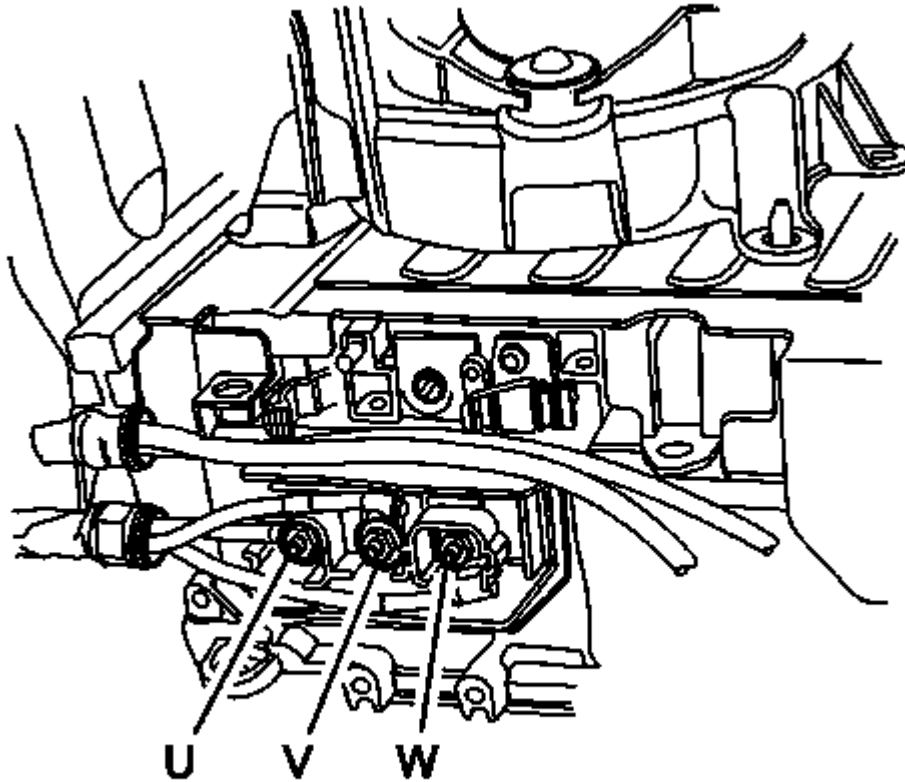


Fig. 12: Phase Terminal V, U And W

Courtesy of GENERAL MOTORS COMPANY

12. Verify that the voltage has been disabled at the energy storage system. Using the DMM on the DC voltage scale, test for less than 3 V at the following points:

- High voltage 3-Phase terminal V to vehicle chassis ground
- High voltage 3-Phase terminal W to vehicle chassis ground
- High voltage 3-Phase terminal U to vehicle chassis ground
- High voltage 3-Phase terminal U to High voltage 3-Phase terminal V
- High voltage 3-Phase terminal V to High voltage 3-Phase terminal W
- High voltage 3-Phase terminal W to High voltage 3-Phase terminal U

- **If 3 V or greater**

A contactor is stuck closed or a loss of isolation has occurred within the A4 Hybrid/EV Battery Pack. Refer to **Hybrid\EV Battery Voltage Present**.

- **If less than 3 V**

NOTE: **A 9 V DC battery can be used to test the DMM.**

13. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.

- **If the DMM does not properly measure a 12 V battery**

Repair or replace the DMM and perform Step 11 again.

- **If the DMM properly measures a 12 V battery**

WARNING: High voltage insulation gloves with leather protectors **MUST** be worn at all times when the A4 hybrid/EV battery pack cover has been removed. When testing within the A4 hybrid/EV battery pack, 60 V **WILL** be present. If the S15 hybrid/EV battery pack high voltage manual disconnect lever is compromised and stuck closed, 120 V **WILL** be present. Failure to follow the procedures exactly as written may result in serious injury or death.

14. Remove the A4 Hybrid/EV Battery Pack cover. Refer to **Generator Control Module Cover Replacement**.

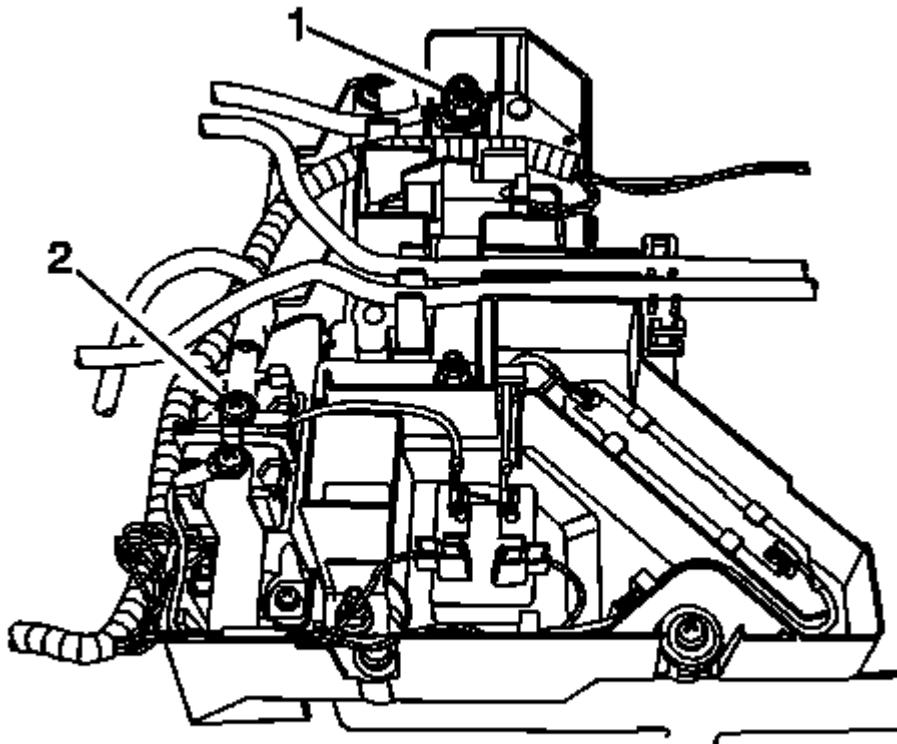


Fig. 13: High Voltage DC Terminal
Courtesy of GENERAL MOTORS COMPANY

15. Verify that the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever is functioning properly. Using the DMM on the DC voltage scale, test for less than 3 V between the High Voltage DC terminal (1) and the High Voltage DC terminal (2).

- **If 3 V or greater**

The S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever is stuck closed. Replace the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever immediately after completing this disabling procedure.

- **If less than 3 V**

WARNING: High voltage insulation gloves with leather protectors **MUST** be worn at all times when the A4 hybrid/EV battery pack cover has been removed. 120 V **WILL** be present at the battery terminals. Failure to follow the procedures exactly as written may result in serious injury or death.

16. Flip open the orange battery terminal covers at the C4A Hybrid/EV Battery Section 1 and C4B

Hybrid/EV Battery Section 2.

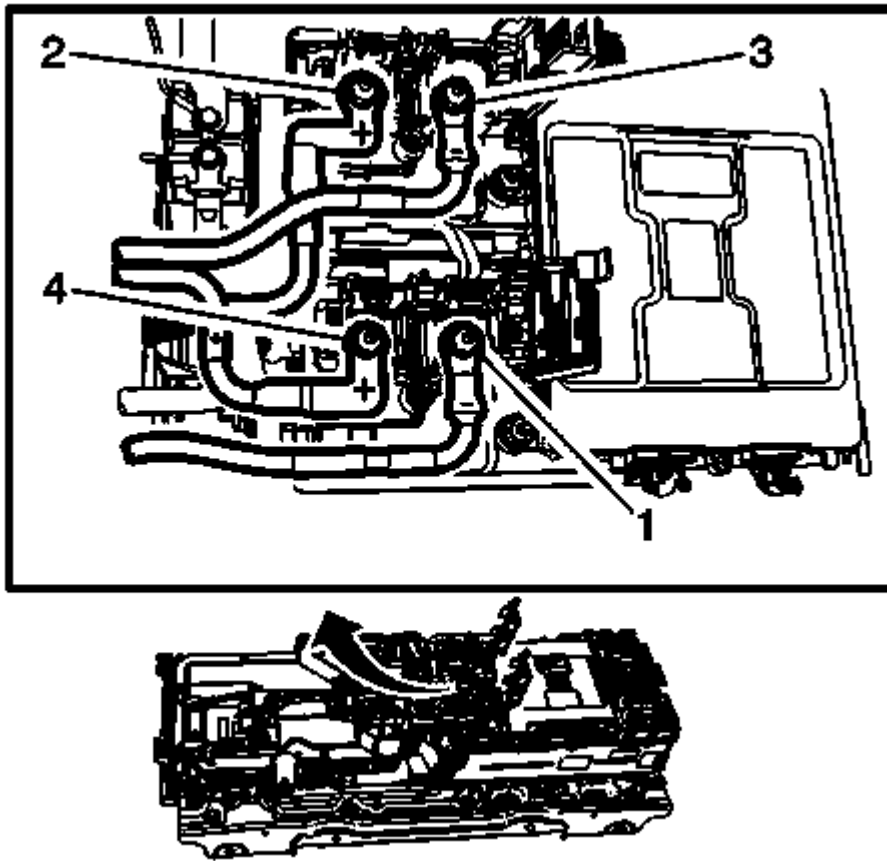


Fig. 14: C4A Hybrid/EV Battery Section And Battery Terminals
Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the battery terminals at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 in the order specified in the above graphic.
18. Remove the high voltage cables from the battery terminals and close the battery terminal covers, with the cables on the outside of the closed terminal covers.
19. Tape the battery terminal covers closed with UL® listed, or equivalent, insulation tape rated at a minimum of 600 V.

NOTE: A 9 V DC battery can be used to test the DMM.

20. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.
 - If the DMM does not properly measure a 12 V battery

Repair or replace the DMM and perform the disabling procedure again.
 - If the DMM properly measures a 12 V battery

21. Test for less than 1 ohms across the 125 A fuse located under the clear cover in the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever.

- **If 1 ohms or greater**

The 125 A fuse is open. If the fuse is open, verify the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever is also open by testing for infinite resistance across the switch terminals. Replace the fuse after high voltage testing is complete and a system repair has been made. Torque fasteners to 9 Y (80 lb in).

- **If less than 1 ohms**

22. With the high voltage cables disconnected and the battery terminal covers secured, the K59 Starter/Generator Control Module, K16 Battery Energy Control Module, S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever, KR38 Main Contactor, R25 Hybrid/EV Battery Pre-Charge Resistor, KR134 Pre-Charge Contactor, B30 Hybrid/EV Battery Pack Current Sensor, C4A Hybrid/EV Battery Section 1, C4B Hybrid/EV Battery Section 2, and any components within the A4 Hybrid/EV Battery Pack can now be serviced.

HIGH VOLTAGE ENABLING

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether

the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

Review the high voltage safety information prior to performing the High Voltage Enabling procedure. Refer to **High Voltage Safety**.

1. Verify that the 12 V battery is disconnected.

- **If the 12 V battery is connected**

Disconnect the 12 V battery. Refer to **Battery Negative Cable Disconnection and Connection** .

- **If the 12 V battery is disconnected**

NOTE: **Always tighten the high voltage fasteners to the specified torque.
Insufficient or excessive torque will cause malfunctions or damage.**

2. After completing testing or any repairs on the high voltage systems and before closing the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever, inspect for the following:
 - Verify that all tools and loose components have been removed from the A4 Hybrid/EV Battery Pack area and all items are accounted for.
 - Verify high voltage system integrity and that all connectors are installed.
 - Install any components or connectors that have been removed or replaced during diagnosis.

WARNING: High voltage insulation gloves with leather protectors **MUST** be worn at all times when the A4 hybrid/EV battery pack cover has been removed. When testing within the A4 hybrid/EV battery pack, 60 V **WILL** be present. If the S15 hybrid/EV battery pack high voltage manual disconnect lever is compromised and stuck closed, 120 V **WILL** be present. Failure to follow the procedures exactly as written may result in serious injury or death.

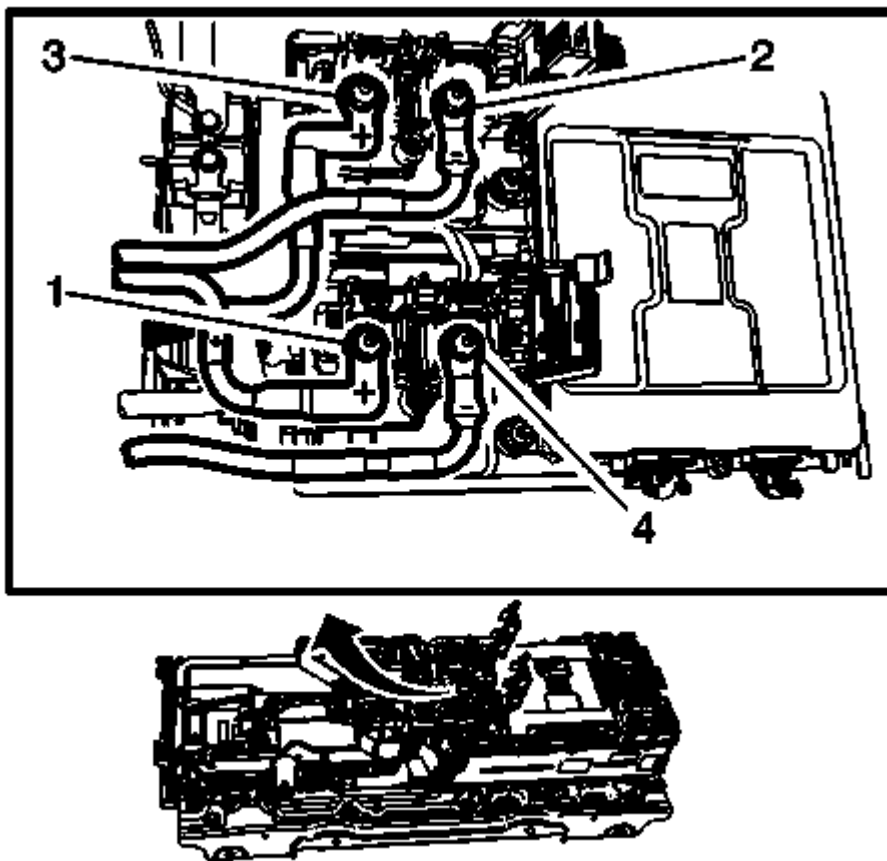


Fig. 15: C4A Hybrid/EV Battery And C4B Hybrid/EV Battery Section
Courtesy of GENERAL MOTORS COMPANY

3. If the battery terminals at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 have been removed, reconnect the high voltage battery cables in the order shown above and close the battery terminal covers. Torque fasteners to 9 Y (80 lb in).
4. If the A4 Hybrid/EV Battery Pack cover has been removed, reinstall the cover. Refer to **Generator Control Module Cover Replacement**.
5. Connect the U, V, and W 3-phase cables. Torque fasteners to 9 Y (80 lb in).
6. Connect the 12 V battery cable at the K59 Starter/Generator Control Module. Torque fastener to 9 Y (80 lb in).

NOTE:

- Ensure that all of the cover spacers are properly located behind each bolt hole in the cover. These spacers may become loose or separated from the cover during repeated servicing.
- Do not overtighten the F102 Hybrid/EV Battery Pack Cable Cover fasteners. Overtightening may cause the cover spacers to deform and become loose, possibly separating from the cover the next time the cover is removed.

7. Install the F102 Hybrid/EV Battery Pack Cable Cover. Torque fastener to 9 Y (80 lb in).

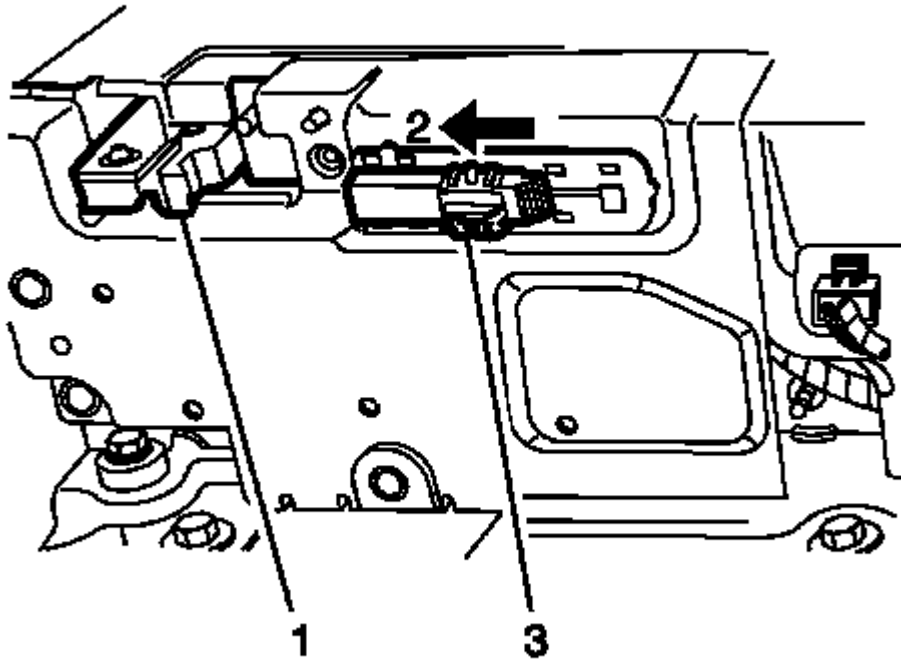


Fig. 16: S15 hybrid/EV Battery Pack High Voltage Manual Disconnect Lever
Courtesy of GENERAL MOTORS COMPANY

8. Push in the red safety plunger and flip the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever (1) to the closed position.
9. Slide the interconnect switch (2) to the closed position and push in the blue CPA (3).
10. Connect the 12 V battery. Refer to **Battery Negative Cable Disconnection and Connection** , . If a control module has been replaced, it should be programmed now. Refer to **Control Module References** .
11. Start the engine, then turn the ignition OFF.
12. Ignition ON, clear all DTC Information with a scan tool.
13. Ignition OFF, wait 2 minutes, ignition ON.
14. Verify no DTCs are set.
 - If any DTCs are set

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- If no DTCs are set

15. Start and idle the engine for 2 minutes.
16. Ignition OFF, wait 5 minutes, ignition ON.
17. Verify that the following DTCs have Ran Since Code Clear and have not set:
 - Contactor DTCs P0ADB, P0ADC, P0AE6, or P0AE7
 - Discharge and Pre-charge DTCs P0C77 or P0AFB.
 - High voltage loss of isolation DTCs P0AA6 or P1AF0
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If any of the DTCs have not Ran Since Code Clear**

Review and operate the vehicle according to the DTC Conditions for Running and ensure the DTCs run and pass.

- **If all the DTCs have Ran Since Code Clear and are not set**

18. All OK.

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P0641</u>	DTC P0641 5V Reference 1 Circuit
<u>DTC P0651, P0A0C, or P0A0D</u>	DTC P0651 5V Reference 2 Circuit DTC P0A0C High Voltage System Interlock Circuit 1 Low Voltage DTC P0A0D High Voltage System Interlock Circuit 1 High Voltage
<u>DTC P0A1F, P1A01, P1A05, P1A06, or P1A5C</u>	DTC P0A1F Battery Energy Control Module Performance DTC P1A01 Battery Energy Control Module Long Term Memory Performance DTC P1A05 Battery Energy Control Module Random Access Memory DTC P1A06 Battery Energy Control Module Read Only Memory DTC P1A5C Battery Energy Control Module Main Processor Performance
<u>DTC P0A80</u>	DTC P0A80 Replace Hybrid/EV Battery Pack
<u>DTC P0AA6</u>	DTC P0AA6 Hybrid/EV Battery Voltage System Isolation Lost
<u>DTC P0AA8-P0AAA</u>	DTC P0AA8 Hybrid/EV Battery Voltage Isolation Sensing Performance DTC P0AA9 Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage DTC P0AAA Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage
<u>DTC P0ABB, P0ABC, or P0ABD</u>	DTC P0ABB Hybrid/EV Battery Voltage Sensor Performance DTC P0ABC Hybrid/EV Battery Voltage Sensor Circuit Low Voltage

	DTC P0ABD Hybrid/EV Battery Voltage Sensor Circuit High Voltage
<u>DTC P0AC1, P0AC2, P1A07, or P1EBA</u>	DTC P0AC1 Hybrid/EV Battery Current Sensor Circuit Low Voltage DTC P0AC2 Hybrid/EV Battery Current Sensor Circuit High Voltage DTC P1A07 Battery Energy Control Module 5V Reference Circuit DTC P1EBA Hybrid/EV Battery Current Sensor Exceeded Learning Limit
<u>DTC P0ADB or P0ADC</u>	DTC P0ADB Hybrid/EV Battery Positive Contactor Control Circuit Low Voltage DTC P0ADC Hybrid/EV Battery Positive Contactor Control Circuit High Voltage
<u>DTC P0AE6 or P0AE7</u>	DTC P0AE6 Hybrid/EV Battery Precharge Contactor Control Circuit Low Voltage DTC P0AE7 Hybrid/EV Battery Precharge Contactor Control Circuit High Voltage
<u>DTC P0AF8</u>	DTC P0AF8 Hybrid/EV System Voltage
<u>DTC P0AFA or P0AFB</u>	DTC P0AFA Hybrid/EV Battery System Voltage Low Voltage DTC P0AFB Hybrid/EV Battery System Voltage High Voltage
<u>DTC P0B3B-P0BBB, P1B16-P1B2D, P1B3D, or P1B3E</u>	DTC P0B3B Hybrid/EV Battery 1 Circuit DTC P0B3C Hybrid/EV Battery 1 Circuit Performance DTC P0B3D Hybrid/EV Battery 1 Circuit Low Voltage DTC P0B3E Hybrid/EV Battery 1 Circuit High Voltage DTC P0B40 Hybrid/EV Battery 2 Circuit DTC P0B41 Hybrid/EV Battery 2 Circuit Performance DTC P0B42 Hybrid/EV Battery 2 Circuit Low Voltage DTC P0B43 Hybrid/EV Battery 2 Circuit High Voltage DTC P0B45 Hybrid/EV Battery 3 Circuit DTC P0B46 Hybrid/EV Battery 3 Circuit Performance DTC P0B47 Hybrid/EV Battery 3 Circuit Low Voltage DTC P0B48 Hybrid/EV Battery 3 Circuit High Voltage DTC P0B4A Hybrid/EV Battery 4 Circuit DTC P0B4B Hybrid/EV Battery 4 Circuit Performance DTC P0B4C Hybrid/EV Battery 4 Circuit Low Voltage DTC P0B4D Hybrid/EV Battery 4 Circuit High Voltage DTC P0B4F Hybrid/EV Battery 5 Circuit DTC P0B50 Hybrid/EV Battery 5 Circuit Performance DTC P0B51 Hybrid/EV Battery 5 Circuit Low Voltage DTC P0B52 Hybrid/EV Battery 5 Circuit High Voltage DTC P0B54 Hybrid/EV Battery 6 Circuit DTC P0B55 Hybrid/EV Battery 6 Circuit Performance DTC P0B56 Hybrid/EV Battery 6 Circuit Low Voltage DTC P0B57 Hybrid/EV Battery 6 Circuit High Voltage DTC P0B59 Hybrid/EV Battery 7 Circuit DTC P0B5A Hybrid/EV Battery 7 Circuit Performance DTC P0B5B Hybrid/EV Battery 7 Circuit Low Voltage DTC P0B5C Hybrid/EV Battery 7 Circuit High Voltage DTC P0B5E Hybrid/EV Battery 8 Circuit

DTC P0B5F Hybrid/EV Battery 8 Circuit Performance
DTC P0B60 Hybrid/EV Battery 8 Circuit Low Voltage
DTC P0B61 Hybrid/EV Battery 8 Circuit High Voltage
DTC P0B63 Hybrid/EV Battery 9 Circuit
DTC P0B64 Hybrid/EV Battery 9 Circuit Performance
DTC P0B65 Hybrid/EV Battery 9 Circuit Low Voltage
DTC P0B66 Hybrid/EV Battery 9 Circuit High Voltage
DTC P0B68 Hybrid/EV Battery 10 Circuit
DTC P0B69 Hybrid/EV Battery 10 Circuit Performance
DTC P0B6A Hybrid/EV Battery 10 Circuit Low Voltage
DTC P0B6B Hybrid/EV Battery 10 Circuit High Voltage
DTC P0B6D Hybrid/EV Battery 11 Circuit
DTC P0B6E Hybrid/EV Battery 11 Circuit Performance
DTC P0B6F Hybrid/EV Battery 11 Circuit Low Voltage
DTC P0B70 Hybrid/EV Battery 11 Circuit High Voltage
DTC P0B72 Hybrid/EV Battery 12 Circuit
DTC P0B73 Hybrid/EV Battery 12 Circuit Performance
DTC P0B74 Hybrid/EV Battery 12 Circuit Low Voltage
DTC P0B75 Hybrid/EV Battery 12 Circuit High Voltage
DTC P0B77 Hybrid/EV Battery 13 Circuit
DTC P0B78 Hybrid/EV Battery 13 Circuit Performance
DTC P0B79 Hybrid/EV Battery 13 Circuit Low Voltage
DTC P0B7A Hybrid/EV Battery 13 Circuit High Voltage
DTC P0B7C Hybrid/EV Battery 14 Circuit
DTC P0B7D Hybrid/EV Battery 14 Circuit Performance
DTC P0B7E Hybrid/EV Battery 14 Circuit Low Voltage
DTC P0B7F Hybrid/EV Battery 14 Circuit High Voltage
DTC P0B81 Hybrid/EV Battery 15 Circuit
DTC P0B82 Hybrid/EV Battery 15 Circuit Performance
DTC P0B83 Hybrid/EV Battery 15 Circuit Low Voltage
DTC P0B84 Hybrid/EV Battery 15 Circuit High Voltage
DTC P0B86 Hybrid/EV Battery 16 Circuit
DTC P0B87 Hybrid/EV Battery 16 Circuit Performance
DTC P0B88 Hybrid/EV Battery 16 Circuit Low Voltage
DTC P0B89 Hybrid/EV Battery 16 Circuit High Voltage
DTC P0B8B Hybrid/EV Battery 17 Circuit
DTC P0B8C Hybrid/EV Battery 17 Circuit Performance
DTC P0B8D Hybrid/EV Battery 17 Circuit Low Voltage
DTC P0B8E Hybrid/EV Battery 17 Circuit High Voltage
DTC P0B90 Hybrid/EV Battery 18 Circuit
DTC P0B91 Hybrid/EV Battery 18 Circuit Performance
DTC P0B92 Hybrid/EV Battery 18 Circuit Low Voltage
DTC P0B93 Hybrid/EV Battery 18 Circuit High Voltage
DTC P0B95 Hybrid/EV Battery 19 Circuit
DTC P0B96 Hybrid/EV Battery 19 Circuit Performance
DTC P0B97 Hybrid/EV Battery 19 Circuit Low Voltage
DTC P0B98 Hybrid/EV Battery 19 Circuit High Voltage
DTC P0B9A Hybrid/EV Battery 20 Circuit

DTC P0B9B Hybrid/EV Battery 20 Circuit Performance
DTC P0B9C Hybrid/EV Battery 20 Circuit Low Voltage
DTC P0B9D Hybrid/EV Battery 20 Circuit High Voltage
DTC P0B9F Hybrid/EV Battery 21 Circuit
DTC P0BA0 Hybrid/EV Battery 21 Circuit Performance
DTC P0BA1 Hybrid/EV Battery 21 Circuit Low Voltage
DTC P0BA2 Hybrid/EV Battery 21 Circuit High Voltage
DTC P0BA4 Hybrid/EV Battery 22 Circuit
DTC P0BA5 Hybrid/EV Battery 22 Circuit Performance
DTC P0BA6 Hybrid/EV Battery 22 Circuit Low Voltage
DTC P0BA7 Hybrid/EV Battery 22 Circuit High Voltage
DTC P0BA9 Hybrid/EV Battery 23 Circuit
DTC P0BAA Hybrid/EV Battery 23 Circuit Performance
DTC P0BAB Hybrid/EV Battery 23 Circuit Low Voltage
DTC P0BAC Hybrid/EV Battery 23 Circuit High Voltage
DTC P0BAE Hybrid/EV Battery 24 Circuit
DTC P0BAF Hybrid/EV Battery 24 Circuit Performance
DTC P0BB0 Hybrid/EV Battery 24 Circuit Low Voltage
DTC P0BB1 Hybrid/EV Battery 24 Circuit High Voltage
DTC P0BB3 Hybrid/EV Battery 25 Circuit
DTC P0BB4 Hybrid/EV Battery 25 Circuit Performance
DTC P0BB5 Hybrid/EV Battery 25 Circuit Low Voltage
DTC P0BB6 Hybrid/EV Battery 25 Circuit High Voltage
DTC P0BB8 Hybrid/EV Battery 26 Circuit
DTC P0BB9 Hybrid/EV Battery 26 Circuit Performance
DTC P0BBA Hybrid/EV Battery 26 Circuit Low Voltage
DTC P0BBB Hybrid/EV Battery 26 Circuit High Voltage
DTC P1B16 Hybrid/EV Battery 27 Circuit Performance
DTC P1B17 Hybrid/EV Battery 27 Circuit Low Voltage
DTC P1B18 Hybrid/EV Battery 27 Circuit High Voltage
DTC P1B19 Hybrid/EV Battery 28 Circuit Performance
DTC P1B1A Hybrid/EV Battery 28 Circuit Low Voltage
DTC P1B1B Hybrid/EV Battery 28 Circuit High Voltage
DTC P1B1C Hybrid/EV Battery 29 Circuit Performance
DTC P1B1D Hybrid/EV Battery 29 Circuit Low Voltage
DTC P1B1E Hybrid/EV Battery 29 Circuit High Voltage
DTC P1B1F Hybrid/EV Battery 30 Circuit Performance
DTC P1B20 Hybrid/EV Battery 30 Circuit Low Voltage
DTC P1B21 Hybrid/EV Battery 30 Circuit High Voltage
DTC P1B22 Hybrid/EV Battery 31 Circuit Performance
DTC P1B23 Hybrid/EV Battery 31 Circuit Low Voltage
DTC P1B24 Hybrid/EV Battery 31 Circuit High Voltage
DTC P1B25 Hybrid/EV Battery 32 Circuit Performance
DTC P1B26 Hybrid/EV Battery 32 Circuit Low Voltage
DTC P1B27 Hybrid/EV Battery 32 Circuit High Voltage
DTC P1B28 Hybrid/EV Battery 27 Circuit
DTC P1B29 Hybrid/EV Battery 28 Circuit
DTC P1B2A Hybrid/EV Battery 29 Circuit

	DTC P1B2B Hybrid/EV Battery 30 Circuit DTC P1B2C Hybrid/EV Battery 31 Circuit DTC P1B2D Hybrid/EV Battery 32 Circuit DTC P1B3D Hybrid/EV Battery Voltage Sense Low Reference 1 Circuit DTC P1B3E Hybrid/EV Battery Voltage Sense Low Reference 2 Circuit
<u>DTC P0BBE</u>	DTC P0BBE Hybrid/EV Battery Pack Voltage
<u>DTC P0C77 or P0C78</u>	DTC P0C77 Hybrid/EV Battery System Precharge Time Too Short DTC P0C78 Hybrid/EV Battery System Precharge Time Too Long
<u>DTC P1A0C</u>	DTC P1A0C Battery Energy Control Module System Voltage Low Voltage
<u>DTC P1A5D</u>	DTC P1A5D Battery Energy Control Module 5V Reference 2 Circuit
<u>DTC P1A5E or P1A5F</u>	DTC P1A5E Battery Energy Control Module Ignition On/Start Switch Circuit Low Voltage DTC P1A5F Battery Energy Control Module Ignition On/Start Switch Circuit High Voltage
<u>DTC P1A60</u>	DTC P1A60 Battery Energy Control Module Ignition Accessory Switch Circuit Low Voltage
<u>DTC P1B11</u>	DTC P1B11 Drive Motor Control Module Hybrid/EV AC Voltage System Isolation Lost
<u>DTC P1B33-P1B39</u>	DTC P1B33 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Circuit DTC P1B34 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 1 Performance DTC P1B35 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 2 Performance DTC P1B36 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 3 Performance DTC P1B37 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 4 Performance DTC P1B38 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 5 Performance DTC P1B39 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 6 Performance
<u>DTC P1B3F or P1B40</u>	DTC P1B3F High Voltage System Interlock Circuit 2 Low Voltage DTC P1B40 High Voltage System Interlock Circuit 2 High Voltage
<u>DTC P1E0C or P1E0D</u>	DTC P1E0C Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage DTC P1E0D Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage
<u>DTC P1E0F-P1E11</u>	DTC P1E0F Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 Low Voltage DTC P1E10 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 High Voltage DTC P1E11 Hybrid/EV Battery Voltage Isolation High Resolution

	Sensing Circuit 1 Performance
<u>DTC P1E12-P1E14</u>	DTC P1E12 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 Low Voltage DTC P1E13 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 High Voltage DTC P1E14 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 Performance
<u>DTC P1E3D</u>	DTC P1E3D Control Module Calculated Hybrid/EV Battery Performance
<u>DTC P1EAA</u>	DTC P1EAA Hybrid/EV Battery Voltage Balance Processor Multiplexer Performance
<u>DTC P1EAB</u>	DTC P1EAB Battery Energy Control Module Hybrid/EV Battery Cell High Voltage
<u>DTC P1EAC</u>	DTC P1EAC Hybrid/EV Battery Cell Overvoltage Signal Circuit Performance
<u>DTC P1EC0</u>	DTC P1EC0 Hybrid/EV Battery System Contactor(s) Stuck Open

DTC P0641: 5V REFERENCE 1 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0641

5V Reference 1 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P057C, P1B3F	P1B3F	P0641, P1B40	-
Signal	P1B3F	P1B3F	P1B40	-

Circuit/System Description

The high voltage interlock circuits are utilized to verify high voltage component integrity. The high voltage interlock circuits are two circuit loops that passes through certain high voltage components. The high voltage interlock circuits are used to determine if access to high voltage components is being attempted. The opening of these high voltage components causes high voltage interlock circuit to open. The Starter/Generator Control Module monitors both the high voltage interlock 5 V reference circuit voltage and the high voltage interlock

signal circuit voltage in order to detect circuit faults. When the Starter/Generator Control Module detects a loss of high voltage interlock circuit voltage, the high voltage contactors are commanded open.

The service cover for the Starter/Generator and the service cover for the Hybrid/EV Battery Pack each contain a high voltage interlock switch. When either cover is removed, the Starter/Generator Control Module will respond by opening the high voltage contacts. The 5 V reference circuits and signal circuits for each of the two high voltage interlock loops are completely separate from one another and are monitored as two separate loops, with each setting a specific DTC to indicate a circuit fault. The 5 V reference circuit that feeds the high voltage interlock switch on the Starter/Generator also supplies the 5 V reference to the Brake Pedal Position Sensor.

Conditions for Running the DTC

Ignition voltage is greater than 10 V

Conditions for Setting the DTC

Voltage on the 5 V reference circuit 1 is less than 4.39 V or greater than 5.43 V

Action Taken When the DTC Sets

DTCs P0641 is a type A DTC

Conditions for Clearing the DTC

DTCs P0641 is a type A DTC

Diagnostic Aids

- When a circuit fault is detected on the high voltage interlock loop that feeds the Starter/Generator and the vehicle hood is opened, the Starter/Generator Control Module will respond by turning off inverter switching. This will prevent the Starter/Generator from charging the Hybrid/EV Battery Pack and supplying voltage to the Starter/Generator Control Module 12 V output. Operating in this manner will cause an eventual discharge of both the high voltage Hybrid/EV Battery Pack and the 12 V battery.
- Because the 5 V reference circuit also supplies voltage to the brake pedal position sensor, a circuit fault on the high voltage interlock loop that feeds the Starter/Generator will also cause hybrid functions that rely on the brake pedal position, such as auto-stop and regenerative braking, to be disabled.

Reference Information

Schematic Reference

- Hybrid/EV Energy Storage Schematics
- Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V

with leather protectors.

- Visually and functionally inspect the gloves before use.
- Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor and disconnect the X1 harness connector at the A15 Starter/Generator, ignition ON.
2. Test for 4.3-5.5 V between the A15 Starter/Generator 5 V reference circuit terminal 12 X1 and ground.
 - **If less than 4.3 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the A15 Starter/Generator 5 V reference circuit terminal 12 X1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for infinite resistance between the B22 Brake Pedal Position Sensor 5 V reference circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 ohms in the A15 Starter/Generator 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If greater than 5.5 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the A15 Starter/Generator 5 V reference circuit terminal 12 X1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 1 V between the B22 Brake Pedal Position Sensor 5 V reference circuit terminal 6 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K59 Starter/Generator Control Module.
- **If between 4.3-5.5 V**
- 3. Ignition OFF, connect the harness connector at the A15 Starter/Generator, ignition ON.
- 4. Verify DTC P0641 does not set while operating the vehicle within the conditions for running the DTC.
 - **If the DTC sets**

Replace the A15 Starter/Generator.

- **If the DTC does not set**
- 5. Test or replace the B22 Brake Pedal Position Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Generator Replacement**
- **Brake Pedal Position Sensor Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P0651, P0A0C, OR P0A0D: 5V REFERENCE 2 CIRCUIT/HIGH VOLTAGE SYSTEM INTERLOCK CIRCUIT 1 VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0651

5V Reference 2 Circuit

DTC P0A0C

High Voltage System Interlock Circuit 1 Low Voltage

DTC P0A0D

High Voltage System Interlock Circuit 1 High Voltage

Diagnostic Fault Information

	Short to	Open/High	Short to	Signal
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Circuit	Ground	Resistance	Voltage	Performance
5 V Reference	P0651, P0A0C	P0A0C	P0651, P0A0D	-
Signal	P0A0C	P0A0C	P0651, P0A0D	-

Circuit/System Description

The high voltage interlock circuit is utilized to verify high voltage component integrity. High voltage interlock circuit is a circuit loop that passes through certain high voltage components. High voltage interlock circuit is used to determine if access to high voltage components is being attempted. The opening of these high voltage components causes high voltage interlock circuit to open. The starter/generator control module monitors both the high voltage interlock 5 V reference circuit voltage and the high voltage interlock signal circuit voltage in order to detect circuit faults. When the starter/generator control module detects a loss of high voltage interlock circuit voltage, the high voltage contactors are commanded open.

Conditions for Running the DTC

Battery voltage is greater than 6 V

Conditions for Setting the DTC

DTC P0651

Voltage on the 5 V reference circuit 2 is less than 4.39 V or greater than 4.61 V

DTC P0A0C

Voltage on the high voltage interlock signal circuit is less than 0.5 V

DTC P0A0D

Voltage on the high voltage interlock signal circuit is greater than 4.5 V

Action Taken When the DTC Sets

DTCs P0651, P0A0C, and P0A0D are type B DTCs

Conditions for Clearing the DTC

DTCs P0651, P0A0C, and P0A0D are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.

- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Connect the 12 V battery, ignition ON.

NOTE: Testing is performed at the interlock connector that the F102 Hybrid/EV Battery Pack Cable Cover secures to. The F102 Hybrid/EV Battery Pack Cable Cover was removed as part of the high voltage disabling procedure.

4. Test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disable high voltage at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. Refer to **High Voltage Disabling**. Perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. This will allow for safe access to the X4 harness connector, which is located under the A4 Hybrid/EV Battery Pack cover.
 2. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 3. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disable high voltage at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. Refer to **High Voltage Disabling**. Perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. This will allow for safe access to the X4

- harness connector, which is located under the A4 Hybrid/EV Battery Pack cover.
2. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 3. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If between 4.8-5.2 V**
 5. Verify DTC P0A0D is not set.
 - **If the DTC is set**
 1. Ignition OFF, disable high voltage at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. Refer to **High Voltage Disabling**. Perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. This will allow for safe access to the X4 harness connector, which is located under the A4 Hybrid/EV Battery Pack cover.
 2. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 3. Test for less than 1 V between the signal circuit terminal B and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If the DTC is not set**
 6. Ignition OFF, connect a 3 A fused jumper wire between the 5 V reference circuit terminal A and the signal circuit terminal B, ignition ON.
 7. Verify DTC P0A0C is not set.
 - **If the DTC is set**
 1. Ignition OFF, disable high voltage at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. Refer to **High Voltage Disabling**. Perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. This will allow for safe access to the X4 harness connector, which is located under the A4 Hybrid/EV Battery Pack cover.
 2. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 3. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the DTC is not set**
 8. Test or replace the F102 Hybrid/EV Battery Pack Cable Cover.

Component Testing

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.

NOTE:

- The high voltage interlock switch is part of the F102 Hybrid/EV

Battery Pack Cable Cover, which was removed as part of the High Voltage Disabling procedure.

- **Slightly flexing the switch while performing the measurement may assist in identifying a damaged switch.**

2. Test for 2.850k to 3.150k ohms between the high voltage interlock switch terminal A and terminal B.
 - **If not between 2.850k and 3.150k ohms**

Replace the F102 Hybrid/EV Battery Pack Cable Cover.

- **If between 2.850k and 3.150k ohms**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Control Module Cable Cover Replacement**
- **Battery Energy Control Module Wiring Harness Replacement (BDU,BECM and BPIM), Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**
- **Control Module References** for starter/generator control module replacement, programming, and setup

DTC P0A1F, P1A01, P1A05, P1A06, OR P1A5C: BATTERY ENERGY CONTROL MODULE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0A1F

Battery Energy Control Module Performance

DTC P1A01

Battery Energy Control Module Long Term Memory Performance

DTC P1A05

Battery Energy Control Module Random Access Memory

DTC P1A06

Battery Energy Control Module Read Only Memory

DTC P1A5C

Battery Energy Control Module Main Processor Performance

Circuit/System Description

The Battery Energy Control Module performs various internal fault detection test to determine if a software or hardware concern exists within the module. No external circuits are involved.

Conditions for Running the DTC

P0A1F, P1A01, P1A05, P1A06

12 V battery voltage is greater than 8.8 V.

P1A5C

- Ignition ON
- 12 V battery voltage is greater than 8.8 V.

Conditions for Setting the DTC

An internal fault is detected in the Battery Energy Control Module.

Action Taken When the DTC Sets

No action is taken.

Conditions for Clearing the DTC

No internal faults are detected in the Battery Energy Control Module.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether

the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1A01, P1A05, P1A06, or P1A5C is not set.
 - If any of the DTCs are set

Replace the K16 Battery Energy Control Module

- If none of the DTCs are set
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P0A80: REPLACE HYBRID/EV BATTERY PACK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0A80

Replace Hybrid/EV Battery Pack

Circuit/System Description

The Starter/Generator Control Module monitors the internal battery resistance of the battery pack as a means to determine if the battery has reached its end of life.

Conditions for Running the DTC

- Average battery temperature is greater than -10° C.
- Battery state estimator mode is active.
- Battery state of charge is great than 10%, but less than 90%.
- None of the following DTCs are set: P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0B45, P0B46, P0B47, P0B48, P0B4F, P0B50, P0B51, P0B52, P0B63, P0B64, P0B65, P0B66, P0B95, P0B96, P0B97, P0B98, P0B9F, P0BA0, P0BA1, P0BA2, P0BC3, P0BC4, P0BC5, P0C34, P0C35, P0C36, P1ASD, or P1A5D.

Conditions for Setting the DTC

The battery pack internal resistance is greater than the end of life battery pack resistance.

Action Taken When the DTC Sets

DTC P0A80 is a type A DTC.

Conditions for Clearing the DTC

DTC P0A80 is a type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P0A80 is not set.
 - **If the DTC is set**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Generator Battery Replacement

DTC P0AA6: HYBRID/EV BATTERY VOLTAGE SYSTEM ISOLATION LOST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0AA6

Hybrid/EV Battery Voltage System Isolation Lost

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. These voltage values are used by the Starter/Generator Control Module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

- Engine idling
- Contactors are closed

Conditions for Setting the DTC

Active isolation resistance is less than 150 kohms

OR

Case isolation resistance is less than 300 kohms

Action Taken When the DTC Sets

- DTC P0AA6 is a type A DTC.
- If the DTC sets while there is a loss of communication with the Inflatable Restraint Sensing and Diagnostic Module, the Starter/Generator Control Module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTC P0AA6 is a type A DTC.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48900** HEV Safety Kit
- **EL-50772** Insulation Multimeter

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery

Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: **The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.**

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug
 - 3 phase cable terminal W - cable side lug
 - **If 400K ohms or less**
 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
 3. Replace the high voltage 3 phase cables.
 - **If greater than 400K ohms**

NOTE: **The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.**

4. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase terminal U - K59 Starter/Generator Control Module stud
 - 3 phase terminal V - K59 Starter/Generator Control Module stud
 - 3 phase terminal W - K59 Starter/Generator Control Module stud
 - **If 400K ohms or less**
 1. Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.
 - If greater than 400K ohms

3. Replace the two wiring junction blocks.
 - **If greater than 400K ohms**
5. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Drive Motor Generator Battery Cable Replacement**
- **Starter Generator Replacement**
- **Generator Battery Replacement**
- **Drive Motor Battery Wire Junction Block Relay Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P0AA8-P0AAA: HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0AA8

Hybrid/EV Battery Voltage Isolation Sensing Performance

DTC P0AA9

Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage

DTC P0AAA

Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. These voltage values are used by the starter/generator control module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too

low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

P0AA8

- Power mode is RUN or CRANK.
- The starter/generator control module internal voltage sensor has no reported faults.
- None of the following DTCs are set: P0AA9, P0AAA, P1E0C, or P1E0D.

P0AA9

- Power mode is RUN or CRANK.
- Contactors are closed.

P0AAA

- Power mode is RUN or CRANK.
- None of the following DTCs are set: P0AA9, P0AAA, P1E0C, or P1E0D.

Conditions for Setting the DTC

P0AA8

The difference between the voltage measured at the starter/generator control module internal motor control processor and the sum of the mid-pack voltage positive sensor value and mid-pack voltage negative sensor value is greater than 15 V.

P0AA9

Voltage measured at the negative mid-pack voltage sensor is less than 5 V.

P0AAA

The difference between the voltage measured at the negative mid-pack voltage sensor and the starter/generator control module internal motor control processor high voltage value is greater than 15 V.

Action Taken When the DTC Sets

- DTCs P0AA8-P0AAA are type B DTCs.
- If the DTC sets while there is a loss of communication with the inflatable restraint sensing and diagnostic module (SDM), the starter/generator control module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTCs P0AA8-P0AAA are type B DTCs.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P0AA8, P0AA9, or P0AAA is not set.
 - If any of the DTCs are set

Replace the K59 Starter/Generator Control Module.

- If none of the DTCs are set
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for starter/generator control module replacement, programming, and setup

DTC P0ABB, P0ABC, OR P0ABD: HYBRID/EV BATTERY VOLTAGE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0ABB

Hybrid/EV Battery Voltage Sensor Performance

DTC P0ABC

Hybrid/EV Battery Voltage Sensor Circuit Low Voltage

DTC P0ABD

Hybrid/EV Battery Voltage Sensor Circuit High Voltage

Circuit/System Description

The Hybrid/EV Battery Pack contains a total of 32 cell groups in the Hybrid/EV Battery Pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The Battery Energy Control Module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the Battery Energy Control Module, located directly above the Hybrid/EV Battery Pack. The Battery Energy Control Module also monitors the Hybrid/EV Battery Pack voltage in it's entirety. The Battery Energy Control Module compares the voltage of the entire pack to that of the sum of the voltages measures at each cell.

Diagnostics and system status are communicated from the Battery Energy Control Module to Hybrid Powertrain Control Module through serial data.

Conditions for Running the DTC

P0ABB

None of the following DTCs are set: P0ABC, P0ABD, P0B3D, P0B42, P0B47, P0B4C, P0B51, P0B56, P0B5B, P0B60, P0B65, P0B6A, P0B6F, P0B74, P0B79, P0B7E, P0B83, P0B88, P0B8D, P0B92, P0B97, P0B9C, P0BA1, P0BA6, P0BAB, P0BB0, P0BB5, P0BBA, P1B17, P1B1A, P1B1D, P1B20, P1B23, P1B26, P0B3E, P0B43, P0B48, P0B4D, P0B52, P0B57, P0B5C, P0B61, P0B66, P0B6B, P0B70, P0B75, P0B7A, P0B7F, P0B84, P0B89, P0B8E, P0B93, P0B98, P0B9D, P0BA2, P0BA7, P0BAC, P0BB1, P0BB6, P0BBB, P1B18, P1B1B, P1B1E, P1B21, P1B24, P1B27, P0B3B, P0B40, P0B45, P0B4A, P0B4F, P0B54, P0B59, P0B5E, P0B63, P0B68, P0B6D, P0B72, P0B77, P0B7C, P0B81, P0B86, P0B8B, P0B90, P0B95, P0B9A, P0B9F,

P0BA4, P0BA9, P0BAE, P0BB3, P0BB8, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D, P0B3C, P0B41, P0B46, P0B4B, P0B50, P0B55, P0B5A, P0B5F, P0B64, P0B69, P0B6E, P0B73, P0B78, P0B7D, P0B82, P0B87, P0B8C, P0B91, P0B96, P0B9B, P0BA0, P0BA5, P0BAA, P0BAF, P0BB4, P0BB9, P1B16, P1B19, P1B1C, P1B1F, P1B22, P1B25.

P0ABC or P0ABD

- Battery voltage is greater than 9.6 V.
- Battery energy control module is awake and communicating.

Conditions for Setting the DTC

P0ABB

The calculated battery pack voltage based on the average cell voltage values is more than 5.49 V different than the actual measured battery pack voltage.

P0ABC

The battery pack voltage is less than 30 V.

P0ABD

The battery pack voltage is greater than 190 V.

Action Taken When the DTC Sets

- DTCs P0ABB, P0ABC, and P0ABD are type B DTCs.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTCs P0ABB, P0ABC, and P0ABD are type B DTCs.

Diagnostic Aids

Opening the service disconnect without first disconnecting the 12 V battery or reconnecting the 12 V battery while the service disconnect is open may result in the setting of DTC P0ABB or P0ABC. Due to the nature of the Hybrid/EV Battery Pack design, the vehicle's 12 V electrical system will continue to discharge the high voltage battery, even though the service disconnect is open. This will eventually lower the voltage of the Hybrid/EV Battery Pack and set DTC P0ABB or P0ABC. If this occurs, close the service disconnect and operate the vehicle as normal. The Hybrid/EV Battery Pack will be charged and the voltage will return to normal.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify the 12 V battery is not connected while the service disconnect is open.
 - **If the 12 V battery is connected and the service disconnect is open**

It is normal to set DTC P0ABB or P0ABC when the service disconnect is open and the 12 V battery is connected. After service is complete, return the vehicle to its normal state, close the service disconnect, connect the 12 V battery, and clear all DTCs.

- **If the 12 V battery is connected and the service disconnect is closed**
3. Verify DTC P0ABB, P0ABC, or P0ABD is not set.
 - **If any of the DTCs are set**

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Verify the Battery Energy Control Module high voltage measuring harness is not cut, chafed, or otherwise damaged.

- If the harness is damaged, replace the harness.
- If the harness is not damaged
- 3. Replace the K16 Battery Energy Control Module
 - **If none of the DTCs are set**
- 4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Energy Control Module Wiring Harness Replacement (BDU,BECM and BPIM), Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DTC P0AC1, P0AC2, P1A07, OR P1EBA: HYBRID/EV BATTERY CURRENT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0AC1

Hybrid/EV Battery Current Sensor Circuit Low Voltage

DTC P0AC2

Hybrid/EV Battery Current Sensor Circuit High Voltage

DTC P1A07

Battery Energy Control Module 5V Reference Circuit

DTC P1EBA

Hybrid/EV Battery Current Sensor Exceeded Learning Limit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P1A07	P0AC2	P1A07	-

Signal	P0AC1	P0AC2	P1A07	-
Low Reference	-	P0AC2	-	-

Circuit/System Description

The Battery Energy Control Module uses a single battery current sensor to determine the current flow out of the Hybrid/EV Battery Pack. The Battery Energy Control Module applies 5 volts and provides a low reference to power the sensor. Current measurement is communicated to the Battery Energy Control Module via a signal circuit.

Conditions for Running the DTC

P0AC1, P0AC2

- 12 V battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating
- DTC P1A07 is not set.

P1A07

- 12 V battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating

P1EBA

- 12 V battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating
- Contactors are open
- DTC P1A07 is not set.

Conditions for Setting the DTC

P0AC1

Current sensor signal voltage is less than 0.2 V

P0AC2

Current sensor signal voltage is greater than 4.8 V

P1A07

- Current sensor 5 volt reference voltage is greater than 5.2 V
- Current sensor 5 volt reference voltage is less than 4.8 V

P1EBA

- Current sensor value is more than 2.43 V greater than sensor offset upper limit
- Current sensor value is more than 2.57 V less than sensor offset lower limit

Action Taken When the DTC Sets

DTC P0AC1, P0AC2, P1A07, and P1EBA are type B DTCs

Conditions for Clearing the DTC

DTC P0AC1, P0AC2, P1A07, and P1EBA are type B DTCs

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Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Hybrid/EV Battery Pack Low Resolution Current Sensor parameter is between 85 A and -85 A and varies as the vehicle is driven.
 - **If not between 85 A and -85 A or does not vary**

Refer to Circuit/System Testing.

- **If between 85 A and -85 A and varies**
3. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack

assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Connect the 12 V battery.
4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B30 Hybrid/EV Battery Pack Current Sensor. It may take up to 2 min for all vehicle systems to power down.
5. Test for less than 10 ohms between the low reference circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K16 Battery Energy Control Module.
 - **If less than 10 ohms**
6. Ignition ON.
7. Test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K16 Battery Energy Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K16 Battery Energy Control Module.
 - **If between 4.8-5.2 V**
8. Verify the scan tool Hybrid/EV Battery Pack Low Resolution Current Sensor parameter is greater than 25

A.

- **If 25 A or less**

1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module.
2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K16 Battery Energy Control Module.

- **If greater than 50 A**

9. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
10. Verify the scan tool Hybrid/EV Battery Pack Low Resolution Current Sensor parameter is less than -25 A.

- **If -25 A or greater**

1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Ignition ON.
4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K16 Battery Energy Control Module.

- **If less than -25 A**

11. Test or replace the B30 Hybrid/EV Battery Pack Current Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Energy Control Module Wiring Harness Replacement (BDU,BECM and BPIM), Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DTC P0ADB OR P0ADC: HYBRID/EV BATTERY POSITIVE CONTACTOR CONTROL CIRCUIT VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0ADB

Hybrid/EV Battery Positive Contactor Control Circuit Low Voltage

DTC P0ADC

Hybrid/EV Battery Positive Contactor Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U0293, U1817*	P0ADB, P0AE6	-	-
Pre-charge Contactor Control	P0AE6, P0C76**	P0AE6	P1A56***	-
Main Contactor Control	P0ADB, P0C76**	P0ADB	P1A56***	-
*Fuse F23UA open; no communication with starter generator control module **The starter generator control module cannot control the contactor to disable high voltage ***The starter generator control module cannot control the contactor to enable high voltage				

Circuit/System Description

The hybrid battery system voltage is controlled by two high voltage contactors. The high voltage contactors allow the high voltage DC batteries to be connected to the vehicle or safely contain the high voltage DC within the Hybrid/EV Battery Pack assembly. Of the two contactors, one is a pre-charge contactor and the other is the primary contactor. The two contactors are closed in a specific sequence by the Starter/Generator Control Module. The pre-charge contactor is closed first. This causes high voltage to flow through the pre-charge resistor, allowing system voltage to build slowly. Once the system voltage has raised and stabilized, the primary contactor is closed. Both contactors are controlled by the Starter/Generator Control Module. The Starter/Generator Control Module supplies B+ to each contactor at all times. When the contactors are to be closed, the Starter/Generator Control Module will provide a ground to the contactor through a low side driver.

Conditions for Running the DTC

The 12 V battery voltage is greater than 6.0 V

Conditions for Setting the DTC

P0ADB

- An open is detected on the primary contactor control circuit when the contactor control is commanded ON and measured resistance is greater than 200K ohms
- A short to voltage is detected on the primary contactor control circuit when the contactor control is commanded ON and current sense feedback is less than 0.5 A

P0ADC

A short to ground is detected on the primary contactor control circuit when the contactor control is commanded OFF and current sense feedback is less than 0.5 A

Action Taken When the DTC Sets

DTCs P0ADB and P0ADC are type B DTCs

Conditions for Clearing the DTC

DTCs P0ADB and P0ADC are type B DTCs

Reference Information

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Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0AE6 or P0AE7 is not set.
 - **If either of the DTCs are set**

Refer to **DTC P0AE6 or P0AE7**.

- **If none of the DTCs are set**
3. Refer to Circuit/System Testing

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Connect the 12 V battery.
4. Disconnect the X1 harness connector at the KR38 Main Contactor, ignition ON.
5. Verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
6. Ignition OFF, connect the harness connector at the KR38 Main Contactor. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module, ignition ON.
7. Test for less than 1 V between the control circuit terminal 5 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the KR38 Main Contactor.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the KR38 Main Contactor.
 - **If less than 1 V**
8. Ignition OFF.
9. Test for infinite resistance between the control circuit terminal 5 and ground.
 - **If less than infinite resistance**
 1. Ignition OFF, disconnect the X1 harness connector at the KR38 Main Contactor.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the KR38 Main Contactor.
 - **If infinite resistance**
10. Test for 20-40 ohms between the B+ circuit terminal 4 and the control circuit terminal 5.
 - **If not between 20-40 ohms**
 1. Ignition OFF, disconnect the X1 harness connector at the KR38 Main Contactor.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the KR38 Main Contactor.

- **If between 20-40 ohms**

11. Replace the K59 Starter/Generator Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P0AE6 OR P0AE7: HYBRID/EV BATTERY PRECHARGE CONTACTOR CONTROL CIRCUIT VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0AE6

Hybrid/EV Battery Precharge Contactor Control Circuit Low Voltage

DTC P0AE7

Hybrid/EV Battery Precharge Contactor Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U0293, U1817*	P0ADB, P0AE6	-	-
Pre-charge Contactor Control	P0AE6, P0C76**	P0AE6	P1A56***	-
Main Contactor Control	P0ADB, P0C76**	P0ADB	P1A56***	-
*Fuse F23UA open; no communication with starter generator control module **The starter generator control module cannot control the contactor to disable high voltage ***The starter generator control module cannot control the contactor to enable high voltage				

Circuit/System Description

The hybrid battery system voltage is controlled by two high voltage contactors. The high voltage contactors allow the high voltage DC batteries to be connected to the vehicle or safely contain the high voltage DC within the Hybrid/EV Battery Pack assembly. Of the two contactors, one is a pre-charge contactor and the other is the

primary contactor. The two contactors are closed in a specific sequence by the Starter/Generator Control Module. The pre-charge contactor is closed first. This causes high voltage to flow through the pre-charge resistor, allowing system voltage to build slowly. Once the system voltage has raised and stabilized, the primary contactor is closed. Both contactors are controlled by the Starter/Generator Control Module. The Starter/Generator Control Module supplies B+ to each contactor at all times. When the contactors are to be closed, the Starter/Generator Control Module will provide a ground to the contactor through a low side driver.

Conditions for Running the DTC

The 12 V battery voltage is greater than 6.0 V

Conditions for Setting the DTC

P0AE6

- An open is detected on the Pre-Charge Contactor control circuit when the contactor control is commanded ON and measured resistance is greater than 200K ohms
- A short to voltage is detected on the Pre-Charge Contactor control circuit when the contactor control is commanded ON and current sense feedback is less than 0.5 A

P0AE7

A short to ground is detected on the Pre-Charge Contactor control circuit when the contactor control is commanded OFF and current sense feedback is less than 0.5 A

Action Taken When the DTC Sets

DTCs P0AE6 and P0AE7 are type B DTCs

Conditions for Clearing the DTC

DTCs P0AE6 and P0AE7 are type B DTCs

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Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Connect the 12 V battery.
4. Disconnect the X1 harness connector at the KR134 Pre-Charge Contactor, ignition ON.
5. Verify a test lamp illuminates between the B+ circuit terminal A and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
6. Ignition OFF, connect the harness connector at the KR134 Pre-Charge Contactor. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module, ignition ON.
7. Test for less than 1 V between the control circuit terminal 6 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the KR134 Pre-Charge Contactor.
 - **If less than 1 V**
8. Ignition OFF.
9. Test for infinite resistance between the control circuit terminal 6 and ground.
 - **If less than infinite resistance**
 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor
 2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test or replace the KR134 Pre-Charge Contactor.
- **If infinite resistance**
- 10. Test for 90-115 ohms between the B+ circuit terminal 4 and the control circuit terminal 6.
 - **If not between 90-115 ohms**
 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the KR134 Pre-Charge Contactor.
 - **If between 20-40 ohms**
- 11. Replace the K59 Starter/Generator Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P0AF8: HYBRID/EV SYSTEM VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0AF8

Hybrid/EV System Voltage

Circuit/System Description

As a means to verify the Battery Energy Control Module's voltage measuring ability, the Battery Energy Control Module compares it's own measurement of the Hybrid/EV Battery Pack voltage to that measured internally at the Starter/Generator Control Module when the contactors are closed. This provides a second source of the Battery Energy Control Module's Hybrid/EV Battery Pack voltage rationality.

Conditions for Running the DTC

- Main contactor is closed
- None of the following DTCs are set: P0ABB, P0ABC, P0ABD, P1A5D, U182A

Conditions for Setting the DTC

The difference between the high voltage battery voltage measured at the Battery Energy Control Module and the voltage measured at the motor controller, internal to the Starter/Generator Control Module, is greater than 5.77 V.

Action Taken When the DTC Sets

- DTC P0AF8 is a type B DTC
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur

Conditions for Clearing the DTC

DTC P0AF8 is a type B DTC

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Verify no other DTCs are set in the in the K59 Starter/Generator Control Module.
 - If other DTCs are set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- **If no other DTCs are set**
- 2. Ignition ON, observe and record the 32 scan tool Hybrid Battery Cell Voltage parameters. Add the values together to calculate Hybrid/EV Battery Pack voltage based on the cell voltages.
- 3. Verify the calculated Hybrid/EV Battery Pack voltage from step 2 is within 5.77 V of the scan tool High Voltage Battery Voltage parameter.
 - **If not within 5.77 V**

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Verify the Battery Energy Control Module high voltage measuring harness is not cut, chafed, or otherwise damaged.
 - If the harness is damaged, replace the harness.
 - If the harness is not damaged
3. Replace the K16 Battery Energy Control Module
 - **If within 5.77 V**
4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Battery Energy Control Module Wiring Harness Replacement (BDU,BECM and BPIM), Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)
- Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P0AFA OR P0AFB: HYBRID/EV BATTERY SYSTEM VOLTAGE

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0AFA

Hybrid/EV Battery System Voltage Low Voltage

DTC P0AFB

Hybrid/EV Battery System Voltage High Voltage

Circuit/System Description

The hybrid/EV battery pack contains a total of 32 cells. These cells are electrically connected in series. Each individual cell is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cells.

The battery energy control module monitors the voltage of the 32 battery cells. A voltage sense circuit is attached to each individual cell. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable high voltage measuring harness connects the voltage sense circuits to the battery energy control module, located directly above the hybrid battery section 1 and hybrid battery section 2. The battery energy control module also monitors the hybrid/EV battery pack voltage in its entirety. The battery energy control module compares the voltage of the entire pack to that of the sum of the voltages measures at each cell.

Conditions for Running the DTC

None of the following DTCs are set: P0ABB, P0ABC, P0ABD, P0AF8, P1A5D, U182A

OR

None of the following DTCs are set: P0B3B, P0B3C, P0B3D, P0B3E, P0B40, P0B41, P0B42, P0B43, P0B45, P0B46, P0B47, P0B48, P0B4A, P0B4B, P0B4C, P0B4D, P0B4F, P0B50, P0B51, P0B52, P0B54, P0B55, P0B56, P0B57, P0B59, P0B5A, P0B5B, P0B5C, P0B5E, P0B5F, P0B60, P0B61, P0B63, P0B64, P0B65, P0B66, P0B68, P0B69, P0B6A, P0B6B, P0B6D, P0B6E, P0B6F, P0B70, P0B72, P0B73, P0B74, P0B75, P0B77, P0B78, P0B79, P0B7A, P0B7C, P0B7D, P0B7E, P0B7F, P0B81, P0B82, P0B83, P0B84, P0B86, P0B87, P0B88, P0B89, P0B8B, P0B8C, P0B8D, P0B8E, P0B90, P0B91, P0B92, P0B93, P0B95, P0B96, P0B97, P0B98, P0B9A, P0B9B, P0B9C, P0B9D, P0B9F, P0BA0, P0BA1, P0BA2, P0BA4, P0BA5, P0BA6, P0BA7, P0BA9, P0BAA, P0BAB, P0BAC, P0BAE, P0BAF, P0BB0, P0BB1, P0BB3, P0BB4, P0BB5, P0BB6, P0BB8, P0BB9, P0BBA, P0BBB, P1B16, P1B17, P1B18, P1B19, P1B1A, P1B1B, P1B1C, P1B1D, P1B1E, P1B1F, P1B20, P1B21, P1B22, P1B23, P1B24, P1B25, P1B26, P1B27, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D

Conditions for Setting the DTC

DTC P0AFA

Battery pack voltage is less than 61.91 V.

OR

Any individual cell voltage is less than 1.93 V.

DTC P0AFB

Battery pack voltage is greater than 136.49 V.

OR

Any individual cell voltage is greater than 4.26 V.

Action Taken When the DTC Sets

- DTCs P0AFA and P0AFB are type B DTCs.
- The vehicle operates without any hybrid functions with the high voltage contactors open, but it will continue to charge the 12V battery with the starter/generator acting as a conventional generator.

Conditions for Clearing the DTC

- DTCs P0AFA and P0AFB are type B DTCs.
- DTCs P0AFA and P0AFB are secure DTCs. The Clear Secured High Voltage DTCs procedure must be performed to prevent resetting the DTC.

Diagnostic Aids

The following two tables should be used to determine the switch setting when using the **EL-48571-30** High Voltage Battery Pin Out Box.

Battery Cells (1-16)		
Connector X5		
Switch Designation	Switch Position	Battery Cell
A	1	16
A	2	15
A	3	14
A	4	13
A	5	12
A	6	11
B	7	10
B	8	9
B	9	8
B	10	7
B	11	6
B	12	5
C	13	4
C	14	3
C	15	2
C	16	1

Battery Cells (17-32)

Connector X4		
Switch Designation	Switch Position	Battery Cell
A	1	32
A	2	31
A	3	30
A	4	29
A	5	28
A	6	27
B	7	26
B	8	25
B	9	24
B	10	23
B	11	22
B	12	21
C	13	20
C	14	19
C	15	18
C	16	17

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48571-30** High Voltage Battery Pin Out Box
- **EL-48900** HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

1. Ignition ON.
2. Verify that each of the scan tool Hybrid Battery Cell Voltage 1-32 parameters are between 3.0-4.1 V and all parameters are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**

Refer to Circuit/System Testing.

- **If all parameter are between 3.0-4.1 V and are within 0.1 V of each other**

3. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.

- **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the X4 and X5 harness connectors at the K16 Battery Energy Control Module .
3. Connect the **EL-48571-30** High Voltage Battery Pin Out Box to the appropriate K16 Battery Energy Control Module harness connector.
4. Insert the DMM probes into the EL-48571-30 test cavities.

NOTE:

- **The DMM must be set to the DC voltage setting.**
- **Not all 24 switch positions of the EL-48571-30 will be used.**

5. Measure and record the voltage of each of the cells by cycling the EL-48571-30 through each of the 16 switch positions.
6. Verify that each cell voltage reading is 3.0-4.1 V and all cell voltage readings are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**
 1. Inspect the appropriate voltage signal circuit and low reference circuit for a short to ground or an open/high resistance.
 - If a short to ground or an open/high resistance is found, replace the appropriate K16 Battery Energy Control Module high voltage measuring harness.
 - If a short to ground or an open/high resistance is not found
 2. Replace the C4A Hybrid/EV Battery Section 1, C4B Hybrid/EV Battery Section 2, and K16 Battery Energy Control Module.
 - **If all parameter are between 3.0-4.1 V and are within 0.1 V of each other**
7. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Battery Replacement**
- **Battery Energy Control Module Wiring Harness Replacement (BDU,BECM and BPIM), Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**
- **Control Module References** for battery energy control module replacement, programming, and setup.

DTC P0B3B-P0BBB, P1B16-P1B2D, P1B3D, OR P1B3E: HYBRID/EV BATTERY 1-32

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

DTC Descriptors

DTC P0B3B

Hybrid/EV Battery 1 Circuit

DTC P0B3C

Hybrid/EV Battery 1 Circuit Performance

DTC P0B3D

Hybrid/EV Battery 1 Circuit Low Voltage

DTC P0B3E

Hybrid/EV Battery 1 Circuit High Voltage

DTC P0B40

Hybrid/EV Battery 2 Circuit

DTC P0B41

Hybrid/EV Battery 2 Circuit Performance

DTC P0B42

Hybrid/EV Battery 2 Circuit Low Voltage

DTC P0B43

Hybrid/EV Battery 2 Circuit High Voltage

DTC P0B45

Hybrid/EV Battery 3 Circuit

DTC P0B46

Hybrid/EV Battery 3 Circuit Performance

DTC P0B47

Hybrid/EV Battery 3 Circuit Low Voltage

DTC P0B48

Hybrid/EV Battery 3 Circuit High Voltage

DTC P0B4A

Hybrid/EV Battery 4 Circuit

DTC P0B4B

Hybrid/EV Battery 4 Circuit Performance

DTC P0B4C

Hybrid/EV Battery 4 Circuit Low Voltage

DTC P0B4D

Hybrid/EV Battery 4 Circuit High Voltage

DTC P0B4F

Hybrid/EV Battery 5 Circuit

DTC P0B50

Hybrid/EV Battery 5 Circuit Performance

DTC P0B51

Hybrid/EV Battery 5 Circuit Low Voltage

DTC P0B52

Hybrid/EV Battery 5 Circuit High Voltage

DTC P0B54

Hybrid/EV Battery 6 Circuit

DTC P0B55

Hybrid/EV Battery 6 Circuit Performance

DTC P0B56

Hybrid/EV Battery 6 Circuit Low Voltage

DTC P0B57

Hybrid/EV Battery 6 Circuit High Voltage

DTC P0B59

Hybrid/EV Battery 7 Circuit

DTC P0B5A

Hybrid/EV Battery 7 Circuit Performance

DTC P0B5B

Hybrid/EV Battery 7 Circuit Low Voltage

DTC P0B5C

Hybrid/EV Battery 7 Circuit High Voltage

DTC P0B5E

Hybrid/EV Battery 8 Circuit

DTC P0B5F

Hybrid/EV Battery 8 Circuit Performance

DTC P0B60

Hybrid/EV Battery 8 Circuit Low Voltage

DTC P0B61

Hybrid/EV Battery 8 Circuit High Voltage

DTC P0B63

Hybrid/EV Battery 9 Circuit

DTC P0B64

Hybrid/EV Battery 9 Circuit Performance

DTC P0B65

Hybrid/EV Battery 9 Circuit Low Voltage

DTC P0B66

Hybrid/EV Battery 9 Circuit High Voltage

DTC P0B68

Hybrid/EV Battery 10 Circuit

DTC P0B69

Hybrid/EV Battery 10 Circuit Performance

DTC P0B6A

Hybrid/EV Battery 10 Circuit Low Voltage

DTC P0B6B

Hybrid/EV Battery 10 Circuit High Voltage

DTC P0B6D

Hybrid/EV Battery 11 Circuit

DTC P0B6E

Hybrid/EV Battery 11 Circuit Performance

DTC P0B6F

Hybrid/EV Battery 11 Circuit Low Voltage

DTC P0B70

Hybrid/EV Battery 11 Circuit High Voltage

DTC P0B72

Hybrid/EV Battery 12 Circuit

DTC P0B73

Hybrid/EV Battery 12 Circuit Performance

DTC P0B74

Hybrid/EV Battery 12 Circuit Low Voltage

DTC P0B75

Hybrid/EV Battery 12 Circuit High Voltage

DTC P0B77

Hybrid/EV Battery 13 Circuit

DTC P0B78

Hybrid/EV Battery 13 Circuit Performance

DTC P0B79

Hybrid/EV Battery 13 Circuit Low Voltage

DTC P0B7A

Hybrid/EV Battery 13 Circuit High Voltage

DTC P0B7C

Hybrid/EV Battery 14 Circuit

DTC P0B7D

Hybrid/EV Battery 14 Circuit Performance

DTC P0B7E

Hybrid/EV Battery 14 Circuit Low Voltage

DTC P0B7F

Hybrid/EV Battery 14 Circuit High Voltage

DTC P0B81

Hybrid/EV Battery 15 Circuit

DTC P0B82

Hybrid/EV Battery 15 Circuit Performance

DTC P0B83

Hybrid/EV Battery 15 Circuit Low Voltage

DTC P0B84

Hybrid/EV Battery 15 Circuit High Voltage

DTC P0B86

Hybrid/EV Battery 16 Circuit

DTC P0B87

Hybrid/EV Battery 16 Circuit Performance

DTC P0B88

Hybrid/EV Battery 16 Circuit Low Voltage

DTC P0B89

Hybrid/EV Battery 16 Circuit High Voltage

DTC P0B8B

Hybrid/EV Battery 17 Circuit

DTC P0B8C

Hybrid/EV Battery 17 Circuit Performance

DTC P0B8D

Hybrid/EV Battery 17 Circuit Low Voltage

DTC P0B8E

Hybrid/EV Battery 17 Circuit High Voltage

DTC P0B90

Hybrid/EV Battery 18 Circuit

DTC P0B91

Hybrid/EV Battery 18 Circuit Performance

DTC P0B92

Hybrid/EV Battery 18 Circuit Low Voltage

DTC P0B93

Hybrid/EV Battery 18 Circuit High Voltage

DTC P0B95

Hybrid/EV Battery 19 Circuit

DTC P0B96

Hybrid/EV Battery 19 Circuit Performance

DTC P0B97

Hybrid/EV Battery 19 Circuit Low Voltage

DTC P0B98

Hybrid/EV Battery 19 Circuit High Voltage

DTC P0B9A

Hybrid/EV Battery 20 Circuit

DTC P0B9B

Hybrid/EV Battery 20 Circuit Performance

DTC P0B9C

Hybrid/EV Battery 20 Circuit Low Voltage

DTC P0B9D

Hybrid/EV Battery 20 Circuit High Voltage

DTC P0B9F

Hybrid/EV Battery 21 Circuit

DTC P0BA0

Hybrid/EV Battery 21 Circuit Performance

DTC P0BA1

Hybrid/EV Battery 21 Circuit Low Voltage

DTC P0BA2

Hybrid/EV Battery 21 Circuit High Voltage

DTC P0BA4

Hybrid/EV Battery 22 Circuit

DTC P0BA5

Hybrid/EV Battery 22 Circuit Performance

DTC P0BA6

Hybrid/EV Battery 22 Circuit Low Voltage

DTC P0BA7

Hybrid/EV Battery 22 Circuit High Voltage

DTC P0BA9

Hybrid/EV Battery 23 Circuit

DTC P0BAA

Hybrid/EV Battery 23 Circuit Performance

DTC P0BAB

Hybrid/EV Battery 23 Circuit Low Voltage

DTC P0BAC

Hybrid/EV Battery 23 Circuit High Voltage

DTC P0BAE

Hybrid/EV Battery 24 Circuit

DTC P0BAF

Hybrid/EV Battery 24 Circuit Performance

DTC P0BB0

Hybrid/EV Battery 24 Circuit Low Voltage

DTC P0BB1

Hybrid/EV Battery 24 Circuit High Voltage

DTC P0BB3

Hybrid/EV Battery 25 Circuit

DTC P0BB4

Hybrid/EV Battery 25 Circuit Performance

DTC P0BB5

Hybrid/EV Battery 25 Circuit Low Voltage

DTC P0BB6

Hybrid/EV Battery 25 Circuit High Voltage

DTC P0BB8

Hybrid/EV Battery 26 Circuit

DTC P0BB9

Hybrid/EV Battery 26 Circuit Performance

DTC P0BBA

Hybrid/EV Battery 26 Circuit Low Voltage

DTC P0BBB

Hybrid/EV Battery 26 Circuit High Voltage

DTC P1B16

Hybrid/EV Battery 27 Circuit Performance

DTC P1B17

Hybrid/EV Battery 27 Circuit Low Voltage

DTC P1B18

Hybrid/EV Battery 27 Circuit High Voltage

DTC P1B19

Hybrid/EV Battery 28 Circuit Performance

DTC P1B1A

Hybrid/EV Battery 28 Circuit Low Voltage

DTC P1B1B

Hybrid/EV Battery 28 Circuit High Voltage

DTC P1B1C

Hybrid/EV Battery 29 Circuit Performance

DTC P1B1D

Hybrid/EV Battery 29 Circuit Low Voltage

DTC P1B1E

Hybrid/EV Battery 29 Circuit High Voltage

DTC P1B1F

Hybrid/EV Battery 30 Circuit Performance

DTC P1B20

Hybrid/EV Battery 30 Circuit Low Voltage

DTC P1B21

Hybrid/EV Battery 30 Circuit High Voltage

DTC P1B22

Hybrid/EV Battery 31 Circuit Performance

DTC P1B23

Hybrid/EV Battery 31 Circuit Low Voltage

DTC P1B24

Hybrid/EV Battery 31 Circuit High Voltage

DTC P1B25

Hybrid/EV Battery 32 Circuit Performance

DTC P1B26

Hybrid/EV Battery 32 Circuit Low Voltage

DTC P1B27

Hybrid/EV Battery 32 Circuit High Voltage

DTC P1B28

Hybrid/EV Battery 27 Circuit

DTC P1B29

Hybrid/EV Battery 28 Circuit

DTC P1B2A

Hybrid/EV Battery 29 Circuit

DTC P1B2B

Hybrid/EV Battery 30 Circuit

DTC P1B2C

Hybrid/EV Battery 31 Circuit

DTC P1B2D

Hybrid/EV Battery 32 Circuit

DTC P1B3D

Hybrid/EV Battery Voltage Sense Low Reference 1 Circuit

DTC P1B3E

Hybrid/EV Battery Voltage Sense Low Reference 2 Circuit

Circuit/System Description

The hybrid/EV battery pack contains a total of 32 cell groups in the hybrid/EV battery pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The battery energy control module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the battery energy control module, located directly above the hybrid/EV battery pack.

Diagnostics and system status are communicated from the battery energy control module to hybrid powertrain control module through serial data.

Conditions for Running the DTC

DTC P0B3B, P0B40, P0B45, P0B4A, P0B4F, P0B54, P0B59, P0B5E, P0B63, P0B68, P0B6D, P0B72, P0B77, P0B7C, P0B81, P0B86, P0B88, P0B90, P0B95, P0B9A, P0B9F, P0BA4, P0BA9, P0BAE, P0BB3, P0BB8, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D

- 12 V battery voltage is greater than 9 V.
- None of the following DTCs are set: P0B3D, P0B42, P0B47, P0B4C, P0B51, P0B56, P0B5B, P0B60, P0B65, P0B6A, P0B6F, P0B74, P0B79, P0B7E, P0B83, P0B88, P0B8D, P0B92, P0B97, P0B9C, P0BA1, P0BA6, P0BAB, P0BB0, P0BB5, P0BBA, P1B17, P1B1A, P1B1D, P1B20, P1B23, P1B26, P1B33, P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

DTC P0B3C, P0B41, P0B46, P0B4B, P0B50, P0B55, P0B5A, P0B5F, P0B64, P0B69, P0B6E, P0B73, P0B78, P0B7D, P0B82, P0B87, P0B8C, P0B91, P0B96, P0B9B, P0BA0, P0BA5, P0BAA, P0BAF, P0BB4, P0BB9, P1B16, P1B19, P1B1C, P1B1F, P1B22, P1B25

All of the following conditions exist:

- Average cell voltage movement is greater than 0.045 V.
- DTC U182A is not set.

DTC P0B3D, P0B3E, P0B42, P0B43, P0B47, P0B48, P0B4C, P0B4D, P0B51, P0B52, P0B56, P0B57, P0B5B, P0B5C, P0B60, P0B61, P0B65, P0B66, P0B6A, P0B6B, P0B6F, P0B70, P0B74, P0B75, P0B79, P0B7A, P0B7E, P0B7F, P0B83, P0B84, P0B88, P0B89, P0B8D, P0B8E, P0B92, P0B93, P0B97, P0B98, P0B9C, P0B9D, P0BA1, P0BA2, P0BA6, P0BA7, P0BAB, P0BAC, P0BB0, P0BB1, P0BB5, P0BB6, P0BBA, P0BBB, P1B17, P1B18, P1B1A, P1A1B, P1B1D, P1B1E, P1B20, P1B21, P1B23, P1B24, P1B26, P1B27

- 12 V battery voltage is greater than 9 V.
- The battery energy control module is awake and communicating.
- None of the following DTCs are set: P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

P1B3D, P1B3E

- 12 V battery voltage is greater than 8.8 V.
- None of the following DTCs are running: P1EAA, P1EAC.
- None of the following DTCs are set: P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

Conditions for Setting the DTC

DTC P0B3B, P0B40, P0B45, P0B4A, P0B4F, P0B54, P0B59, P0B5E, P0B63, P0B68, P0B6D, P0B72, P0B77, P0B7C, P0B81, P0B86, P0B88, P0B90, P0B95, P0B9A, P0B9F, P0BA4, P0BA9, P0BAE, P0BB3, P0BB8, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D

The appropriate battery voltage sense circuit is open.

DTC P0B3C, P0B41, P0B46, P0B4B, P0B50, P0B55, P0B5A, P0B5F, P0B64, P0B69, P0B6E, P0B73, P0B78, P0B7D, P0B82, P0B87, P0B8C, P0B91, P0B96, P0B9B, P0BA0, P0BA5, P0BAA, P0BAF, P0BB4, P0BB9, P1B16, P1B19, P1B1C, P1B1F, P1B22, P1B25

Measured individual battery cell voltage movement is not in the same direction as the average battery cell voltage movement.

P0B3D, P0B42, P0B47, P0B4C, P0B51, P0B56, P0B5B, P0B60, P0B65, P0B6A, P0B6F, P0B74, P0B79, P0B7E, P0B83, P0B88, P0B8D, P0B92, P0B97, P0B9C, P0BA1, P0BA6, P0BAB, P0BB0, P0BB5, P0BBA, P1B17, P1B1A, P1B1D, P1B20, P1B23, P1B26

Measured individual battery cell voltage is less than 1.4 V.

P0B3E, P0B43, P0B48, P0B4D, P0B52, P0B57, P0B5C, P0B61, P0B66, P0B6B, P0B70, P0B75, P0B7A, P0B7F, P0B84, P0B89, P0B8E, P0B93, P0B98, P0B9D, P0BA2, P0BA7, P0BAC, P0BB1, P0BB6, P0BBB, P1B18, P1B1B, P1B1E, P1B21, P1B24, P1B27

Measured individual battery cell voltage is greater than 4.65 V.

P1B3D

Cell sense voltage is less than 1.4 V.

AND

Battery 16 cell voltage change is greater than 0.5 V over a 200ms sample time.

P1B3E

Cell sense voltage is less than 1.4 V.

AND

Battery 32 cell voltage change is greater than 0.5 V over a 200ms sample time.

Action Taken When the DTC Sets

- DTC P0B3B-P0BBB, P1B16-1B2D, P1B3D, and P1B3E are type B DTCs.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTC P0B3B-P0BBB, P1B16-1B2D, P1B3D, and P1B3E are type B DTCs.

Diagnostic Aids

The following two tables should be used to determine the switch setting when using the **EL-48571-30** High Voltage Battery Pin Out Box.

Battery Cells (1-16)		
Connector X5		
Switch Designation	Switch Position	Battery Cell
A	1	16
A	2	15
A	3	14
A	4	13
A	5	12
A	6	11
B	7	10
B	8	9
B	9	8
B	10	7
B	11	6
B	12	5
C	13	4
C	14	3
C	15	2

C	16	1
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Battery Cells (17-32)		
Connector X4		
Switch Designation	Switch Position	Battery Cell
A	1	32
A	2	31
A	3	30
A	4	29
A	5	28
A	6	27
B	7	26
B	8	25
B	9	24
B	10	23
B	11	22
B	12	21
C	13	20
C	14	19
C	15	18
C	16	17

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48571-30** High Voltage Battery Pin Out Box
- **EL-48900** HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

1. Ignition ON.
2. Verify that each of the scan tool Hybrid Battery Cell Voltage 1-32 parameters are between 3.0-4.1 V and all parameters are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**

Refer to Circuit/System Testing.

- **If all parameter are between 3.0-4.1 V and are within 0.1 V of each other**

3. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**

- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the X4 and X5 harness connectors K16 Battery Energy Control Module.
3. Connect the **EL-48571-30** High Voltage Battery Pin Out Box to the appropriate K16 Battery Energy Control Module harness connector.
4. Insert the DMM probes into the EL-48571-30 test cavities.

NOTE:

- **The DMM must be set to the DC voltage setting.**
- **Not all 24 switch positions of the EL-48571-30 will be used.**

5. Measure and record the voltage of each of the cells by cycling the EL-48571-30 through each of the 16 switch positions.
 6. Verify that each cell voltage reading is 3.0-4.1 V and all cell voltage readings are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**
1. Inspect the appropriate voltage signal circuit and low reference circuit for a short to ground or an open/high resistance.
 - If a short to ground or an open/high resistance is found, replace the appropriate K16 Battery Energy Control Module high voltage measuring harness.
 - If a short to ground or an open/high resistance is not found
 2. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- If all parameter are between 3.0-4.1 V and are within 0.1 V of each other

7. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Generator Battery Replacement
- Battery Energy Control Module Wiring Harness Replacement (BDU,BECM and BPIM), Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)
- Control Module References for battery energy control module replacement, programming, and setup.

DTC P0BBE: HYBRID/EV BATTERY PACK VOLTAGE

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0BBE

Hybrid/EV Battery Pack Voltage

Circuit/System Description

The hybrid/EV battery pack contains a total of 32 cell groups in the hybrid/EV battery pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The battery energy control module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the battery energy control module, located directly above the hybrid/EV battery pack.

Conditions for Running the DTC

None of the following DTCs are set: P0B3B, P0B3C, P0B3D, P0B3E, P0B40, P0B41, P0B42, P0B43, P0B45, P0B46, P0B47, P0B48, P0B4A, P0B4B, P0B4C, P0B4D, P0B4F, P0B50, P0B51, P0B52, P0B54, P0B55, P0B56, P0B57, P0B59, P0B5A, P0B5B, P0B5C, P0B5E, P0B5F, P0B60, P0B61, P0B63, P0B64, P0B65, P0B66, P0B68, P0B69, P0B6A, P0B6B, P0B6D, P0B6E, P0B6F, P0B70, P0B72, P0B73, P0B74, P0B75, P0B77, P0B78, P0B79, P0B7A, P0B7C, P0B7D, P0B7E, P0B7F, P0B81, P0B82, P0B83, P0B84, P0B86, P0B87, P0B88, P0B89, P0B8B, P0B8C, P0B8D, P0B8E, P0B90, P0B91, P0B92, P0B93, P0B95, P0B96, P0B97, P0B98, P0B9A, P0B9B, P0B9C, P0B9D, P0B9F, P0BA0, P0BA1, P0BA2, P0BA4, P0BA5, P0BA6,

P0BA7, P0BA9, P0BAA, P0BAB, P0BAC, P0BAE, P0BAF, P0BB0, P0BB1, P0BB3, P0BB4, P0BB5, P0BB6, P0BB8, P0BB9, P0BBA, P0BBB, P1B16, P1B17, P1B18, P1B19, P1B1A, P1B1B, P1B1C, P1B1D, P1B1E, P1B1F, P1B20, P1B21, P1B22, P1B23, P1B24, P1B25, P1B26, P1B27, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D

Conditions for Setting the DTC

The maximum cell voltage and minimum cell voltage differ by more than 0.3 V.

Action Taken When the DTC Sets

- DTC P0BBE is a type B DTC.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTC P0BBE is a type B DTC.

Diagnostic Aids

The following two tables should be used to determine the switch setting when using the **EL-48571-30** High Voltage Battery Pin Out Box.

Battery Cells (1-16)		
Connector X5		
Switch Designation	Switch Position	Battery Cell
A	1	16
A	2	15
A	3	14
A	4	13
A	5	12
A	6	11
B	7	10
B	8	9
B	9	8
B	10	7
B	11	6
B	12	5
C	13	4
C	14	3
C	15	2
C	16	1

Battery Cells (17-32)		
Connector X4		
Switch Designation	Switch Position	Battery Cell
A	1	32
A	2	31
A	3	30
A	4	29
A	5	28
A	6	27
B	7	26
B	8	25
B	9	24
B	10	23
B	11	22
B	12	21
C	13	20
C	14	19
C	15	18
C	16	17

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48571-30** High Voltage Battery Pin Out Box
- **EL-48900** HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

1. Ignition ON.
2. Verify that each of the scan tool Hybrid Battery Cell Voltage 1-32 parameters are between 3.0-4.1 V and all parameters are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**

Refer to Circuit/System Testing.

- **If all parameter are between 3.0-4.1 V and are within 0.1 V of each other**
3. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.

- **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the X4 and X5 harness connectors K16 Battery Energy Control Module.
3. Connect the **EL-48571-30** High Voltage Battery Pin Out Box to the appropriate K16 Battery Energy Control Module harness connector.
4. Insert the DMM probes into the EL-48571-30 test cavities.

NOTE:

- **The DMM must be set to the DC voltage setting.**
- **Not all 24 switch positions of the EL-48571-30 will be used.**

5. Measure and record the voltage of each of the cells by cycling the EL-48571-30 through each of the 16 switch positions.
6. Verify that each cell voltage reading is 3.0-4.1 V and all cell voltage readings are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**
 1. Inspect the appropriate voltage signal circuit and low reference circuit for a short to ground or an open/high resistance.
 - If a short to ground or an open/high resistance is found, replace the appropriate K16 Battery Energy Control Module high voltage measuring harness.
 - If a short to ground or an open/high resistance is not found
 2. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.
 - **If all parameter are between 3.0-4.1 V and are within 0.1 V of each other**
7. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Battery Replacement**
- **Battery Energy Control Module Wiring Harness Replacement (BDU,BECM and BPIM), Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**
- **Control Module References** for battery energy control module replacement, programming, and setup.

DTC P0C77 OR P0C78: HYBRID/EV BATTERY SYSTEM PRECHARGE TIME

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0C77

Hybrid/EV Battery System Precharge Time Too Short

DTC P0C78

Hybrid/EV Battery System Precharge Time Too Long

Circuit/System Description

The hybrid battery system voltage is controlled by two high voltage contactors. The high voltage contactors allow the high voltage DC batteries to be connected to the vehicle or safely contain the high voltage DC within the Hybrid/EV Battery Pack assembly. Of the two contactors, one is a pre-charge contactor and the other is the primary contactor. The two contactors are closed in a specific sequence by the Starter/Generator Control Module. The pre-charge contactor is closed first. This causes high voltage to flow through the pre-charge resistor, allowing system voltage to build slowly. Once the system voltage has raised and stabilized, the primary contactor is closed. Both contactors are controlled by the Starter/Generator Control Module. The Starter/Generator Control Module supplies B+ to each contactor at all times. When the contactors are to be closed, the Starter/Generator Control Module will provide a ground to the contactor through a low side driver.

Conditions for Running the DTC

P0C77

- No faults are set against the battery current sensor
- No faults are set against the internal bus voltage sensor
- Bus voltage is less than 50% before the start of precharge

P0C78

- No faults are set against the battery current sensor
- No faults are set against the internal battery voltage sensor
- No faults are set against the internal bus voltage sensor

Conditions for Setting the DTC

P0C77

Bus voltage is greater than 95% in less than 75 ms after the start of precharge

P0C78

Bus voltage has not reached 95% in less than 1 second after the start of precharge

OR

Battery current is greater than 5 A for longer than 100 ms after the start of precharge

Action Taken When the DTC Sets

DTCs P0C77 and P0C78 are type B DTCs

Conditions for Clearing the DTC

DTCs P0C77 and P0C78 are type B DTCs

Diagnostic Aids

Some conditions than may cause a too long pre-charge are:

- Pre-charge contactor that is inoperative and does not close
- Excessive resistance in the closed contacts of the pre-charge contactor
- Excessive resistance in the pre-charge resistor
- An open or excessive resistance in any of the high voltage (orange) circuits or terminal supplying voltage to the pre-charge resistor and contactor

Some conditions than may cause a too short pre-charge are:

- Primary contactor or pre-charge contractor stuck in the closed position
- Primary contactor control circuit shorted to ground, causing the primary contactor to remain closed even when not commanded closed by the Starter/Generator Control Module
- Too little resistance in the pre-charge resistor

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following

Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Disconnect the X1 and X2 harness connectors at the KR134 Pre-Charge Contactor.
4. Connect the 12 V battery, ignition ON.
5. Verify a test lamp illuminates between the B+ circuit terminal A X1 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
6. Test for less than 1 V between the control circuit terminal A X2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If less than 1 V**
7. Install a 10 A fused jumper wire between the B+ terminal A X1 and 12 V. Install a jumper wire between the control terminal A X2 and ground.

NOTE: **This step checks the resistance of the closed contactor. Excessive resistance in the closed contacts may cause a slow pre-charge. To verify the resistance, the contactor must be closed. To close the contactor, all terminals at the contactor must be removed and the contactor B+ and control circuits jumpered to B+ and ground. This will close the contacts and allow the resistance of the contacts to be measured.**

8. Test for less than 2 ohms between the high voltage terminals of the closed KR134 Pre-Charge Contactor.
- **If 2 ohms or greater**

Replace the KR134 Pre-Charge Contactor.

- **If less than 2 ohms**
9. Ignition OFF, connect the X1 and X2 harness connectors at the KR134 Pre-Charge Contactor. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
10. Test for infinite resistance between the control circuit terminal 6 and ground.
- **If less than infinite resistance**
 - 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor
 - 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the KR134 Pre-Charge Contactor.
 - **If infinite resistance**
11. Test for 90-115 ohms between the B+ circuit terminal 4 and the control circuit terminal 6.
- **If not between 90-115 ohms**
 - 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor.
 - 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the KR134 Pre-Charge Contactor.
 - **If between 90-115 ohms**
12. Test for infinite resistance between the control circuit terminal 5 and ground.
- **If less than infinite resistance**
 - 1. Ignition OFF, disconnect the X1 harness connector at the KR38 Main Contactor.
 - 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the KR38 Main Contactor.

- **If infinite resistance**

13. Test for infinite resistance between the high voltage terminals of the open KR38 Main Contactor.

- **If not infinite resistance**

Replace the KR38 Main Contactor.

- **If infinite resistance**

14. Test for 5-10 ohms between the R25 Hybrid/EV Battery Pre-Charge Resistor terminals.

- **If not between 5-10 ohms**

Replace the R25 Hybrid/EV Battery Pre-Charge Resistor.

- **If between 5-10 ohms**

15. Test each of the high voltage circuits and terminals supplying the R25 Hybrid/EV Battery Pre-Charge Resistor and KR134 Pre-Charge Contactor for less than 2 ohms end to end.

- **If 2 ohms or greater**

Replace the appropriate harness.

- **If less than 2 ohms**

16. Replace the K59 Starter/Generator Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P1A0C: BATTERY ENERGY CONTROL MODULE SYSTEM VOLTAGE LOW VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1A0C

Battery Energy Control Module System Voltage Low Voltage

Circuit/System Description

The Battery Energy Control Module is the interface and controller for the Hybrid/EV Battery Pack. The Battery

Energy Control Module monitors and balances the cell voltages and also monitors the cell temperatures.

Conditions for Running the DTC

Battery energy control module is awake and communicating.

Conditions for Setting the DTC

12 V battery voltage is less than 8.8 V.

Action Taken When the DTC Sets

- DTCs P1A0C is a type C DTC.
- 12 V battery voltage is greater than 8.8 V.

Conditions for Clearing the DTC

DTCs P1A0C is a type C DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify that DTC P1A0C is not set.
 - If the DTC is set

Test and inspect the 12 V battery. Refer to **Battery Inspection/Test** .

- If the DTC is not set

3. All OK.

DTC P1A5D: BATTERY ENERGY CONTROL MODULE 5V REFERENCE 2 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1A5D

Battery Energy Control Module 5V Reference 2 Circuit

Circuit/System Description

The Hybrid/EV Battery Pack has 6 battery temperature sensors. The battery temperature sensors are located on the top of the batteries. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The Battery Energy Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The Battery Energy Control Module uses the battery temperature sensors to determine the temperature of the Hybrid/EV Battery Pack assembly. The Hybrid Powertrain Control Module will control the Hybrid/EV Battery Pack cooling fan based on the Hybrid/EV Battery Pack temperature.

Conditions for Running the DTC

- Battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating

Conditions for Setting the DTC

- Temperature sensor 5 volt reference voltage is greater than 5.15 V
- Temperature sensor 5 volt reference voltage is less than 4.85 V

Action Taken When the DTC Sets

DTC P1A5D is a type A DTC

Conditions for Clearing the DTC

DTC P1A5D is a type A DTC

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hybrid Cooling System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and

personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1A5D is not set.
 - If the DTC is set

Replace the K16 Battery Energy Control Module

- If the DTC is not set
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P1A5E OR P1A5F: BATTERY ENERGY CONTROL MODULE IGNITION ON/START SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1A5E

Battery Energy Control Module Ignition On/Start Switch Circuit Low Voltage

DTC P1A5F

Battery Energy Control Module Ignition On/Start Switch Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P1A5E, P0AC4, P2534	P1A5E, P0AC4	P1A5F, P0AC4, P2535	-

Circuit/System Description

The RUN/CRANK relay applies ignition voltage to the ignition 1 circuit when the ignition is in the RUN or CRANK position. The ignition 1 circuit supplies ignition voltage to the Starter/Generator Control Module. The ignition 1 circuit also continues through the Starter/Generator Control Module in a pass-thru manner and continues to the Battery Energy Control Module. The Battery Energy Control Module also monitors the power mode message which is broadcast via serial data and compares the power mode message to the actual power mode as indicated by voltage on the ignition 1 circuit.

Controlled by the Body Control Module (BCM), the accessory wakeup circuit supplies voltage to the Starter/Generator Control Module as a means to wake the control module and initiate serial data communications. Like the ignition 1 circuit, the accessory wakeup circuit continues through the Starter/Generator Control Module in a pass-thru manner and continues to the Battery Energy Control Module.

Conditions for Running the DTC

- 12 V battery voltage is greater than 8.86 V
- Battery energy control module is awake and communicating
- Serial data indicates the power mode is RUN/CRANK
- DTC U180B is not set

Conditions for Setting the DTC

The power mode message received via serial data does not match the power mode indicated by the status of the ignition 1 circuit.

Action Taken When the DTC Sets

DTC P1A5E and P1A5F are type B DTCs

Conditions for Clearing the DTC

DTC P1A5E and P1A5F are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Hybrid Powertrain Control Module Ignition 1 parameter is 0 V with the ignition OFF

and B+ with the ignition ON.

- **If not 0 V with the ignition OFF and B+ with the ignition ON**

Refer to Circuit/System Testing.

- **If 0 V with the ignition OFF and B+ with the ignition ON**

3. Verify the scan tool Battery Energy Control Module Power Mode parameter matches the actual vehicle power mode as the ignition is turned ON and OFF.

- **If the parameter does not match the actual power mode**

Refer to Circuit/System Testing.

- **If the parameter matches the actual power mode**

4. All OK.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program.

Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
2. Verify a test lamp does not illuminate between the ignition circuit terminal 10 and ground.
 - **If the test lamp illuminates**
 1. Disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for less than 1 V between the ignition circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, refer to **Power Mode Mismatch** .
 - **If the test lamp does not illuminate**
3. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 10 and ground.
 - **If the test lamp does not illuminate**
 1. Disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, refer to **Power Mode Mismatch** .
 - **If the test lamp illuminates**
5. Connect the X3 harness connector at the K59 Starter/Generator Control Module.

NOTE: In **High Voltage Disabling** , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

6. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
7. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
8. Disconnect the X1 harness connector at the K16 Battery Energy Control Module.
9. Connect the 12 V battery.
10. Verify a test lamp does not illuminate between the ignition circuit terminal 9 and ground.
 - **If the test lamp illuminates**
 1. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.

2. Test for less than 1 V between the ignition circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If the test lamp does not illuminate**
11. Ignition ON.
12. Verify a test lamp illuminates between the ignition circuit terminal 9 and ground.
 - **If the test lamp does not illuminate**
 1. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
13. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Battery Energy Control Module or Starter/Generator Control Module replacement, programming, and setup

DTC P1A60: BATTERY ENERGY CONTROL MODULE IGNITION ACCESSORY SWITCH CIRCUIT LOW VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1A60

Battery Energy Control Module Ignition Accessory Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Ignition	P1A60	P1A60	-	-
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Circuit/System Description

The ignition main relay applies ignition voltage to the ignition circuit when the ignition is in the RUN or CRANK position. The ignition circuit supplies ignition voltage to the starter/generator control module. The ignition circuit also continues through the starter/generator control module in a pass-thru manner and continues to the battery energy control module. The battery energy control module also monitors the power mode message which is broadcast via serial data and compares the power mode message to the actual power mode as indicated by voltage on the ignition circuit.

Controlled by the body control module (BCM), the accessory wakeup circuit supplies voltage to the starter/generator control module as a means to wake the control module and initiate serial data communications. Like the ignition circuit, the accessory wakeup circuit continues through the starter/generator control module in a pass-thru manner and continues to the battery energy control module.

Conditions for Running the DTC

- Battery voltage is greater than 9.6 V
- Battery energy control module is awake and communicating
- Serial data indicates the power mode is RUN/CRANK
- Propulsion system is active

Conditions for Setting the DTC

The accessory wakeup serial data circuit is not active

Action Taken When the DTC Sets

DTC P1A60 is a type B DTC

Conditions for Clearing the DTC

DTC P1A60 is a type B DTC

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U2099 or P2537 is not set.
 - **If either DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If the DTCs are not set**
3. Refer to Circuit/System Testing

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and

personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling , perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Disconnect the X1 harness connector at the K16 Battery Energy Control Module.
4. Connect the 12 V battery, ignition ON.
5. Verify a test lamp illuminates between the ignition circuit terminal 20 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
6. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for battery energy control module or starter/generator control module replacement, programming, and setup

DTC P1B11: DRIVE MOTOR CONTROL MODULE HYBRID/EV AC VOLTAGE SYSTEM ISOLATION LOST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1B11

Drive Motor Control Module Hybrid/EV AC Voltage System Isolation Lost

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. These voltage values are used by the starter/generator control module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

This DTC runs at all times.

Conditions for Setting the DTC

The starter/generator control module detects an AC voltage short to chassis ground.

Action Taken When the DTC Sets

- DTC P1B11 is a type A DTC.
- If the DTC sets while there is a loss of communication with the inflatable restraint sensing and diagnostic module, the starter/generator control module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTC P1B11 is a type A DTC.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Diagnostic Aids

For intermittent concerns, drive the vehicle while monitoring the scan tool Drive Motor Control Module Negative Supply Isolation Voltage parameter and the scan tool Drive Motor Control Module Positive Supply Isolation Voltage parameter using the Graphical Data Display function of the scan tool. An intermittent loss of isolation will result in a large spike in the graph. This spike will correspond with the setting of the DTC. If normal isolation testing reveals no isolation faults and testing indicates an intermittent isolation fault while driving the vehicle, replace the A15 Starter/Generator.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48900** HEV Safety Kit
- **EL-50772** Insulation Multimeter

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug
 - 3 phase cable terminal W - cable side lug
 - **If 400K ohms or less**
 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
 3. Replace the high voltage 3 phase cables.
 - **If greater than 400K ohms**

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

4. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase terminal U - K59 Starter/Generator Control Module stud
 - 3 phase terminal V - K59 Starter/Generator Control Module stud
 - 3 phase terminal W - K59 Starter/Generator Control Module stud
 - **If 400K ohms or less**
 1. Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.

- If greater than 400K ohms
- 3. Replace the two wiring junction blocks.
 - **If greater than 400K ohms**
- 5. Replace the A15 Starter/Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Drive Motor Generator Battery Cable Replacement**
- **Starter Generator Replacement**
- **Generator Battery Replacement**
- **Drive Motor Battery Wire Junction Block Relay Replacement**
- **Control Module References** for starter/generator control module replacement, programming, and setup

DTC P1B33-P1B39: BATTERY ENERGY CONTROL MODULE HYBRID/EV BATTERY VOLTAGE BALANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1B33

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Circuit

DTC P1B34

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 1 Performance

DTC P1B35

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 2 Performance

DTC P1B36

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 3 Performance

DTC P1B37

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 4 Performance

DTC P1B38

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 5 Performance

DTC P1B39

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 6 Performance

Circuit/System Description

The Hybrid/EV Battery Pack contains a total of 32 cell groups in the Hybrid/EV Battery Pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The Battery Energy Control Module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the Battery Energy Control Module, located directly above the Hybrid/EV Battery Pack.

To ensure proper battery function and lengthen battery life, the Battery Energy Control Module balances the voltage of the cells so that each cells maintains the same voltage level. The Battery Energy Control Module uses internal voltage gates to transfer voltage from cells with a higher voltage level to those cells with a lower voltage level. To maintain a similar state of charge on the cell groups, the Starter/Generator Control Module monitors the cell voltages and determines which cells need energy removed in order to maintain the cells at a similar state of charge. A resistor wired in parallel with the cell and a transistor switch in series with the resistor internal to the Battery Energy Control Module. The Starter/Generator Control Module sends a command to the Battery Energy Control Module to begin cell balancing.

Conditions for Running the DTC

DTC P1B33

- Battery voltage is greater than 8.8 V.
- Battery energy control module is awake and communicating.
- Internal cell balancing is not in progress.

DTC P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

- Battery voltage is greater than 9.6 V.
- Battery energy control module is awake and communicating.

Conditions for Setting the DTC

DTC P1B33

The balancing switch status does not equal the balancing switch command.

DTC P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

An internal communication fault has occurred within the Battery Energy Control Module.

Action Taken When the DTC Sets

- DTCs P1B33, P1B34, P1B35, P1B36, P1B37, P1B38, and P1B39 are type B DTCs.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTCs P1B33, P1B34, P1B35, P1B36, P1B37, P1B38, and P1B39 are type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Verify there are no customer installed devices located near the A4 Hybrid/EV Battery Pack and that any customer installed antenna or antenna cables are routed away from the A4 Hybrid/EV Battery Pack.
 - **If any customer installed devices, antenna, or antenna cables are located near the A4 Hybrid/EV Battery Pack**

Remove or relocated the devices, antenna, or antenna cables.

- **If no customer installed devices, antenna, or antenna cables are located near the A4 Hybrid/EV Battery Pack**

2. Ignition ON.

3. Verify DTC P1B33, P1B34, P1B35, P1B36, P1B37, P1B38, or P1B39 is not set.

- **If any of the DTCs are set**

Replace the K16 Battery Energy Control Module

- **If none of the DTCs are set**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P1B3F OR P1B40: HIGH VOLTAGE SYSTEM INTERLOCK CIRCUIT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1B3F

High Voltage System Interlock Circuit 2 Low Voltage

DTC P1B40

High Voltage System Interlock Circuit 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P057C, P1B3F	P1B3F	P0641, P1B40	-
Signal	P1B3F	P1B3F	P1B40	-

Circuit/System Description

The high voltage interlock circuits are utilized to verify high voltage component integrity. The high voltage interlock circuits are two circuit loops that pass through certain high voltage components. The high voltage interlock circuits are used to determine if access to high voltage components is being attempted. The opening of these high voltage components causes the high voltage interlock circuit to open. The Starter/Generator Control Module monitors both the high voltage interlock 5 V reference circuit voltage and the high voltage interlock signal circuit voltage in order to detect circuit faults. When the Starter/Generator Control Module detects a loss of high voltage interlock circuit voltage, the high voltage contactors are commanded open.

The service cover for the Starter/Generator and the service cover for the Hybrid/EV Battery Pack each contain a high voltage interlock switch. When either cover is removed, the starter/generator control module will respond by opening the high voltage contacts. The 5 V reference circuits and signal circuits for each of the two high voltage interlock loops are completely separate from one another and are monitored as two separate loops, with each setting a specific DTC to indicate a circuit fault. The 5 V reference circuit that feeds the high voltage interlock switch on the Starter/Generator also supplies the 5 V reference to the brake pedal position sensor.

Conditions for Running the DTC

The Starter/Generator Control Module is awake and communicating

Conditions for Setting the DTC

DTC P1B3F

Voltage on the high voltage interlock signal circuit is less than 0.5 V

DTC P1B40

Voltage on the high voltage interlock signal circuit is greater than 4.5 V

Action Taken When the DTC Sets

DTCs P1B3F and P1B40 are type B DTCs

Conditions for Clearing the DTC

DTCs P1B3F and P1B40 are type B DTCs

Diagnostic Aids

- When a circuit fault is detected on the high voltage interlock loop that feeds the Starter/Generator and the vehicle hood is opened, the Starter/Generator Control Module will respond by turning off inverter switching. This will prevent the Starter/Generator from charging the Hybrid/EV Battery Pack and supplying voltage to the Starter/Generator Control Module 12 V output. Operating in this manner will cause an eventual discharge of both the high voltage battery pack and the 12 V battery.
- Because the 5 V reference circuit also supplies voltage to the brake pedal position sensor, a circuit fault on the high voltage interlock loop that feeds the Starter/Generator will also cause hybrid functions that rely on the brake pedal position, such as auto-stop and regenerative braking, to be disabled.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641 is not set.
 - **If the DTC is set**

Refer to **DTC P0641**.
 - **If the DTC is not set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disconnect the X2 harness connector at the K59 Starter/Generator Control Module, ignition ON.
2. Test for less than 1 V between the following circuit terminals and ground:
 - 5 V Reference circuit terminal 2
 - Signal circuit terminal 1
 - **If 1 V or greater**
1. Disconnect the harness connector at the A15 Starter/Generator.
2. Test for less than 1 V between the following circuit terminals and ground:

- K59 Starter/Generator Control Module 5 V reference circuit terminal 2 X2
- K59 Starter/Generator Control Module signal circuit terminal 1 X2
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
- 3. Replace the A15 Start/Generator.
 - **If less than 1 V**
- 3. Ignition OFF.
- 4. Test for infinite resistance between the following circuit terminals and ground:
 - 5 V Reference circuit terminal 2
 - Signal circuit terminal 1
 - **If less than infinite resistance**
- 1. Disconnect the harness connector at the A15 Starter/Generator.
- 2. Test for infinite resistance between the following circuit terminals and ground:
 - K59 Starter/Generator Control Module 5 V reference circuit terminal 2 X2
 - K59 Starter/Generator Control Module signal circuit terminal 1 X2
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
- 3. Disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
- 4. Remove the A15 Starter/Generator battery cable access cover.

NOTE: **The 5 V reference and signal circuits pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block before connecting to a resistor located in the A15 Start/Generator battery cable access cover.**

- 5. Verify the terminal integrity of the 5 V reference and signal circuits as they pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block. Verify none of these terminals are not damaged in a manner that would cause them to be shorted to ground.
 - If any of the terminals are damaged, repair or replace the appropriate component as necessary.
 - If none of the terminals are damaged.
- 6. Replace the A15 Start/Generator.
 - **If infinite resistance**
- 5. Test for 2.5k - 3.5k ohms between the 5 V reference circuit terminal 2 and the signal circuit terminal 1.
 - **If less than 2.5k ohms**
- 1. Disconnect the harness connector at the A15 Starter/Generator.
- 2. Test for infinite resistance between the K59 Starter/Generator Control Module 5 V reference circuit terminal 2 and the K59 Starter/Generator Control Module signal circuit terminal 1.
 - If less than infinite resistance, repair the shorted together circuits.
 - If infinite resistance

3. Connect the harness connector at the A15 Starter/Generator.
4. Disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
5. Remove the A15 Starter/Generator battery cable access cover,
6. Test for infinite resistance between the K59 Starter/Generator Control Module 5 V reference circuit terminal 2 and the K59 Starter/Generator Control Module signal circuit terminal 1.
 - If less than infinite resistance, verify the terminal integrity of the 5 V reference and signal circuits as they pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block. Verify these terminals are not damaged in a manner that would cause them to be shorted to together.
 - If infinite resistance
7. Test the A15 Starter/Generator battery cable access cover. Refer to Component Testing.
 - If the A15 Starter/Generator battery cable access cover does not pass the Component Test, replace the A15 Starter/Generator battery cable access cover.
 - If the A15 Starter/Generator battery cable access cover passes the Component Test
8. Replace the A15 Starter/Generator.
 - **If greater than 3.5k ohms**
1. Disconnect the harness connector at the A15 Starter/Generator.
2. Test for infinite resistance between the K59 Starter/Generator Control Module 5 V reference circuit terminal 2 and the K59 Starter/Generator Control Module signal circuit terminal 1.
 - If less than infinite resistance, repair the shorted together circuits.
 - If infinite resistance
3. Test for less than 2 ohms between the following circuit terminals:
 - K59 Starter/Generator Control Module 5 V reference circuit terminal 2 X2 and the A15 Start/Generator 5 V reference circuit terminal 12
 - K59 Starter/Generator Control Module signal circuit terminal 1 X2 and the A15 Start/Generator signal circuit terminal 11
 - If 2 ohms or greater, repair the open circuit.
 - If less than 2 ohms
4. Connect the harness connector at the A15 Starter/Generator.
5. Disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
6. Remove the A15 Starter/Generator battery cable access cover.
7. Test the A15 Starter/Generator battery cable access cover. Refer to Component Testing.
 - If the A15 Starter/Generator battery cable access cover does not pass the Component Test, replace the A15 Starter/Generator battery cable access cover.
 - If the A15 Starter/Generator battery cable access cover passes the Component Test

NOTE: **The 5 V reference and signal circuits pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block before connecting to a resistor located in the A15 Start/Generator battery cable access cover.**

8. Verify the terminal integrity of the 5 V reference and signal circuits as they pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block. Verify none of these terminals are not damaged in a manner that would cause them to be open.
 - If any of the terminals are damaged, repair or replace the appropriate component as necessary.
 - If none of the terminals are damaged
9. Replace the A15 Starter/Generator.
 - **If between 2.5k - 3.5k ohms**
6. Test or replace the K59 Starter/Generator Control Module

Component Testing

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
2. Remove the A15 Starter/Generator battery cable access cover.
3. Test for 2.5k-3.5k ohms between the A15 Starter/Generator battery cable access cover high voltage interlock 5 V reference terminal and the A15 Starter/Generator battery cable access cover high voltage interlock signal terminal.
 - **If not between 2.5k-3.5k ohms**

Replace the A15 Starter/Generator battery cable access cover

- **If between 2.5k-3.5k ohms**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Generator Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P1E0C OR P1E0D: HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING CIRCUIT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1E0C

Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage

DTC P1E0D

Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. These voltage values are used by the Starter/Generator Control Module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

P1E0C

- Power mode is RUN or CRANK.
- Contactors are closed.

P1E0D

- Power mode is RUN or CRANK.
- The Starter/Generator Control Module internal voltage sensor has no reported faults.

Conditions for Setting the DTC

P1E0C

Voltage measured at the negative mid-pack voltage sensor is less than 5 V.

P1E0D

The difference between the voltage measured at the negative mid-pack voltage sensor and the Starter/Generator Control Module internal motor control processor high voltage value is greater than 15 V.

Action Taken When the DTC Sets

- DTCs P1E0C and P1E0D are type B DTCs.
- If the DTC sets while there is a loss of communication with the Inflatable Restraint Sensing and Diagnostic Module (SDM), the Starter/Generator Control Module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTCs P1E0C and P1E0D are type B DTCs.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1E0C or P1E0D is not set.
 - If either of the DTCs are set

Replace the K59 Starter/Generator Control Module.

- If none of the DTCs are set
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P1E0F-P1E11: HYBRID/EV BATTERY VOLTAGE ISOLATION HIGH RESOLUTION

SENSING CIRCUIT 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1E0F

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 Low Voltage

DTC P1E10

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 High Voltage

DTC P1E11

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 Performance

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. These voltage values are used by the Starter/Generator Control Module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

P1E0F

- Power mode is RUN or CRANK.
- Contactors are closed.

P1E10

- Power mode is RUN or CRANK.
- The Starter/Generator Control Module internal voltage sensor has no reported faults.
- Mid-pack voltage positive sensor is less than 7.5 V.
- DTC P0AAA is not set.

P1E11

- Mid-pack voltage positive sensor is less than 7.5 V.
- DTC P1E0F or P1E10 is not set.

Conditions for Setting the DTC

P1E0F

Voltage measured at the positive mid-pack high resolution voltage sensor is less than 3 V.

P1E10

The difference between the voltage measured at the positive mid-pack high resolution voltage sensor and the Starter/Generator Control Module internal motor control processor high voltage value is greater than 5 V.

P1E11

The difference between the mid-pack voltage positive sensor and the positive mid-pack high resolution voltage sensor is greater than 3 V.

Action Taken When the DTC Sets

- DTCs P1E0F-P1E11 are type B DTCs.
- If the DTC sets while there is a loss of communication with the Inflatable Restraint Sensing and Diagnostic Module (SDM), the Starter/Generator Control Module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTCs P1E0F-P1E11 are type B DTCs.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether

the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1E0F, P1E10, or P1E11 is not set.
 - If any of the DTCs are set

Replace the K59 Starter/Generator Control Module.

- If none of the DTCs are set
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P1E12-P1E14: HYBRID/EV BATTERY VOLTAGE ISOLATION HIGH RESOLUTION SENSING CIRCUIT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1E12

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 Low Voltage

DTC P1E13

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 High Voltage

DTC P1E14

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 Performance

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. These voltage values are used by the starter/generator control module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

P1E12

Contactors are closed.

P1E13

- Power mode is RUN or CRANK.
- The starter/generator control module internal voltage sensor has no reported faults.
- Mid-pack voltage negative sensor is less than 7.5 V.
- DTC P1E0D is not set.

P1E14

- Mid-pack voltage negative sensor is less than 7.5 V.
- DTC P1E10 or P1E11 is not set.

Conditions for Setting the DTC

P1E12

Voltage measured at the negative mid-pack high resolution voltage sensor is less than 3 V.

P1E13

The difference between the voltage measured at the negative mid-pack high resolution voltage sensor and the starter/generator control module internal motor control processor high voltage value is greater than 5 V.

P1E14

The difference between the mid-pack voltage negative sensor and m the negative mid-pack high resolution

voltage sensor is greater than 3 V.

Action Taken When the DTC Sets

- DTCs P1E12-P1E14 are type B DTCs.
- If the DTC sets while there is a loss of communication with the inflatable restraint sensing and diagnostic module (SDM), the starter/generator control module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTCs P1E12-P1E14 are type B DTCs.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure. .

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: The following continuity tests must be performed using the **EL-50772 Insulation Multimeter**. Select the Isolation test setting, then select the 500 V range.

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug
 - 3 phase cable terminal W - cable side lug
 - **If 400K ohms or less**
 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
 3. Replace the high voltage 3 phase cables.
 - **If greater than 400K ohms**

NOTE: The following continuity tests must be performed using the **EL-50772 Insulation Multimeter**. Select the Isolation test setting, then select the 500 V range.

4. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase terminal U - K59 Starter/Generator Control Module stud
 - 3 phase terminal V - K59 Starter/Generator Control Module stud
 - 3 phase terminal W - K59 Starter/Generator Control Module stud
 - **If 400K ohms or less**
 1. Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.
 - If greater than 400K ohms
 3. Replace the two wiring junction blocks.
 - **If greater than 400K ohms**
5. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for starter/generator control module replacement, programming, and setup

DTC P1E3D: CONTROL MODULE CALCULATED HYBRID/EV BATTERY PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1E3D

Control Module Calculated Hybrid/EV Battery Performance

Circuit/System Description

As a means of checking microprocessor integrity, the Starter/Generator Control Module calculates and compares voltage at various locations within itself. The Starter/Generator Control Module calculates three separate voltage values, representing voltage measured at different locations within the Hybrid/EV Battery Pack. The Starter/Generator Control Module performs these calculations at different locations within the microprocessor. As an indicator of microprocessor integrity, the voltage calculations should all be the same.

Conditions for Running the DTC

This DTC runs continuously.

Conditions for Setting the DTC

The difference between the calculated voltages is greater than 1 V.

Action Taken When the DTC Sets

- DTC P1E3D is a type A DTC.
- The high voltage contactors open and hybrid functions are disabled.
- 12 V output from the Starter/Generator Control Module is maintained.

Conditions for Clearing the DTC

DTC P1E3D is a type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following

Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1E3D is not set.
 - If the DTC is set

Replace the K59 Starter/Generator Control Module.

- If the DTC is not set
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P1EAA: HYBRID/EV BATTERY VOLTAGE BALANCE PROCESSOR MULTIPLEXER PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1EAA

Hybrid/EV Battery Voltage Balance Processor Multiplexer Performance

Circuit/System Description

The Hybrid/EV Battery Pack contains a total of 32 cell groups in the Hybrid/EV Battery Pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The Battery Energy Control Module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the Battery Energy Control Module, located directly above the Hybrid/EV Battery Pack.

To ensure proper battery function and lengthen battery life, the battery energy control processor balances the voltage of the cells so that each cells maintains the same voltage level. The Battery Energy Control Module uses internal voltage gates to transfer voltage from cells with a higher voltage level to those cells with a lower voltage level. This voltage balancing is an internal function to the Battery Energy Control Module.

The cell voltages are read through multiplexer circuits which take the voltages from multiple battery cells and supplies them to one single analog to digital converter. To determine if the multiplexer is operating correctly, the balancing gates are operated by the Battery Energy Control Module one at a time, shifting each cell voltage while the balance gate is on. This cell voltage pattern is analyzed by the Starter/Generator Control Module to determine if there is a cell voltage multiplexer malfunction.

Conditions for Running the DTC

- Ignition mode transitions from RUN or CRANK to OFF.
- Contactor status is open.
- Propulsion system active while contactors are open for greater than 2.5 seconds is not true.
- DTC U182A is not set.

Conditions for Setting the DTC

- The balance process did not occur at ignition OFF.
- The balance process occurred at any time other than ignition OFF.
- The cell voltage movement during the balance process is more than 0.1 V from the expected voltage movement.

Action Taken When the DTC Sets

- DTC P1EAA is a type A DTC.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTC P1EAA is a type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Drive Motor Battery System Description

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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Verify no communication DTCs are set in the K59 Starter/Generator Control Module.
 - If any communication DTCs are set in the K59 Starter/Generator Control Module

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- If no communication DTCs are set in the K59 Starter/Generator Control Module

2. Verify DTC P1A5E or P1A5F are not set.

- If DTC P1A5E or P1A5F is set

Refer to **DTC P1A5E or P1A5F**.

- If DTC P1A5E and P1A5F are not set

3. Verify DTC P1A60 is not set.

- If DTC P1A60 is set

Refer to **DTC P1A60**.

- If DTC P1A60 is not set

4. Verify DTC P1EAA or P1EAC is not set as current.

- If DTC P1EAA or P1EAC is set as current

Replace the K16 Battery Energy Control Module.

NOTE: DTC P1EAA or P1EAC may be difficult to reproduce and no repair should be made unless the DTC is set as current. Operate the vehicle within the Conditions for Running the DTC when attempting to reproduce the DTC.

- If DTC P1EAA or P1EAC is not set or is set as history

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P1EAB: BATTERY ENERGY CONTROL MODULE HYBRID/EV BATTERY CELL HIGH VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1EAB

Battery Energy Control Module Hybrid/EV Battery Cell High Voltage

Circuit/System Description

The Hybrid/EV Battery Pack contains a total of 32 cell groups in the Hybrid/EV Battery Pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The Battery Energy Control Module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the Battery Energy Control Module, located directly above the Hybrid/EV Battery Pack.

The Battery Energy Control Module also monitors the cell voltage with internal hardware that is independent from the normal cell voltage path. This alternate method produces a true and false signal that indicates whether or not any cell voltage is too high. This signal is encoded and transmitted via serial data to the Starter/Generator Control Module.

Conditions for Running the DTC

The DTC monitor runs at all times, except when the control module self test is running or DTC P1EAC or U182A is set.

Conditions for Setting the DTC

Battery cell voltage is greater than 4.35 V

Action Taken When the DTC Sets

- DTC P1EAB is a type A DTC
- The vehicle operates without any hybrid functions with the high voltage contactors open, but it will continue to charge the 12V battery with the starter/generator acting as a conventional generator.

Conditions for Clearing the DTC

- DTC P1EAB is a type A DTC
- DTC P1EAB is a secure DTC. The **Clear Secured High Voltage DTCs** procedure must be performed to prevent resetting the DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack

assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1B34, P1B35, P1B36, P1B37, P1B38, or P1B39 is not set.

- **If any of the DTCs are set**

Refer to **DTC P1B33-P1B39**, . After the repair is complete, the **Clear Secured High Voltage DTCs** procedure must be performed to clear the secured DTC P1EAB.

- **If none of the DTCs are set**

3. Verify DTC P0B3B-P0BBB or P1B16-P1B2D is not set.

- **If any of the DTCs are set**

Refer to **DTC P0B3B-P0BBB, P1B16-P1B2D, P1B3D, or P1B3E**, . After the repair is complete, the **Clear Secured High Voltage DTCs** procedure must be performed to clear the secured DTC P1EAB.

- **If none of the DTCs are set**

4. Verify DTC P1EAB is not set.

- **If the DTC is set and any scan tool Hybrid/EV Battery voltage parameter is greater than 4.35 V**

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. After the repair is complete, the **Clear Secured High Voltage DTCs** procedure must be performed to clear the secured DTC P1EAB.

- **If the DTC is set and all the scan tool Hybrid/EV Battery voltage parameters are 4.35 V or less**

1. Program the K16 Battery Energy Control Module.
2. Clear any DTCs. It may be necessary to perform the **Clear Secured High Voltage DTCs** procedure to clear any secured DTCs.
3. Operate the vehicle within the Conditions for Running the DTC.
4. Verify the DTC does not set.
 - If the DTC sets, replace the K16 Battery Energy Control Module.
 - If the DTC does not set

5. All OK.

- **If the DTC is not set**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Battery Replacement**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DTC P1EAC: HYBRID/EV BATTERY CELL OVERVOLTAGE SIGNAL CIRCUIT PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1EAC

Hybrid/EV Battery Cell Overvoltage Signal Circuit Performance

Circuit/System Description

The 2nd protection is a redundant method to monitor cell group overvoltage. The battery energy control modules independently reads and tests each cell group and communicates this to the hybrid powertrain control module. The hybrid powertrain control module diagnoses this message to determine when a cell group overvoltage condition exists.

The battery energy control module diagnoses the function of the redundant monitor, once, every power down cycle. When run/crank input signal transitions low and after a calibrated delay, the battery energy control module informs the hybrid powertrain control module, via serial data, that it is about to run the diagnostics on the 2nd protection circuit. The battery energy control module then proceeds to run the check on the serial data cell overvoltage true or false message. If any pulses are missing from the serial data message, the starter/generator control module will report this as a fault.

Conditions for Running the DTC

- Ignition mode transitions from RUN or CRANK to OFF.
- 2nd protection fault test bit is active.
- No faults are set that would cause the contactors to become open when propulsion is active.
- DTC U182A is not set.

Conditions for Setting the DTC

- The test active bit is active for 12 seconds.

OR

- The test active bit does not transition to active.

OR

- The enumerated results does not match the expected result or not enough "True" responses are received.

Action Taken When the DTC Sets

- DTC P1EAC is a type A DTC.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTC P1EAC is a type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Verify no communication DTCs are set in the K59 Starter/Generator Control Module.
 - If any communication DTCs are set in the K59 Starter/Generator Control Module

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- If no communication DTCs are set in the K59 Starter/Generator Control Module

2. Verify DTC P1A5E or P1A5F are not set.

- If DTC P1A5E or P1A5F is set

Refer to **DTC P1A5E or P1A5F**.

- If DTC P1A5E and P1A5F are not set

3. Verify DTC P1A60 is not set.

- If DTC P1A60 is set

Refer to **DTC P1A60**.

- If DTC P1A60 is not set

4. Verify DTC P1EAA or P1EAC is not set as current.

- If DTC P1EAA or P1EAC is set as current

Replace the K16 Battery Energy Control Module.

NOTE: DTC P1EAA or P1EAC may be difficult to reproduce and no repair should be made unless the DTC is set as current. Operate the vehicle within the Conditions for Running the DTC when attempting to reproduce the DTC.

- If DTC P1EAA or P1EAC is not set or is set as history

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for battery energy control module replacement, programming, and setup

DTC P1EC0: HYBRID/EV BATTERY SYSTEM CONTACTOR(S) STUCK OPEN

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1EC0

Hybrid/EV Battery System Contactor(s) Stuck Open

Circuit/System Description

At times, it may be necessary to disconnect high voltage from the vehicle, both during normal operation and when a system fault is identified. The Starter/Generator Control Module controls the Main Contactor and pre-charge contactor to disconnect and connect high voltage from the vehicle. The high voltage contactors are switches that are controlled much like a relay. To disable high voltage from the vehicle, the main and pre-charge contactors are commanded open. This will open the contactors and physically disconnect the hybrid/EV battery positive cable. To connect high voltage to the vehicle, first the pre-charge contactor is closed. With the pre-charge contactor closed, current flows through the pre-charge resistor. This allows high voltage to slowly build in the system, as the resistor decreases current flow. Once high voltage is brought up through the pre-charge contactor, the Main Contactor is close and high voltage is active. If the high voltage builds too quickly or too slowly, the Starter/Generator Control Module will set a fault.

If a system fault occurs that does not allow the contactors to open, the Starter/Generator Control Module will be unable to disconnect high voltage from the vehicle. In instances such as this, the manual disconnect lever will disconnect high voltage from the vehicle when servicing.

Conditions for Running the DTC

Contactors are commanded closed

Conditions for Setting the DTC

The Starter/Generator Control Module does not detect high voltage after the contactors have been commanded closed.

Action Taken When the DTC Sets

DTC P1EC0 is a type A DTC.

Conditions for Clearing the DTC

DTC P1EC0 is a type A DTC.

Diagnostic Aids

- This diagnostic is used when high voltage has not been disabled when the contactors have been commanded closed. This indicates that one or both contactors are stuck open. The High Voltage Disabling procedure should still be completed, using the procedure for Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack. This will disconnect the battery terminals at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 and limit high voltage exposure when performing diagnosis.
- Be sure to check for any DTCs that may be set. These DTCs may lead to the cause of the stuck contactors and DTC diagnosis should be performed before enabling high voltage. This will help ensure a repeat fault with the contactors does not occur. After diagnosis any DTCs, return to this procedure to test and repair any contactor that may be mechanically stuck open.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Verify DTC P0ADB, P0ADC, P0AE6, or P0AE7 is not set.
 - **If any of the DTCs are set**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- **If none of the DTCs are set**

NOTE: The following steps will test the KR38 Main Contactor, KR134 Pre-Charge Contactor, and the S15 Manual Service Disconnect as a type of component test. These components must be removed from the A4 Hybrid/EV Battery Pack to ensure proper test results.

4. Remove the KR38 Main Contactor, KR134 Pre-Charge Contactor, and the S15 Manual Service Disconnect from the A4 Hybrid/EV Battery Pack.

5. Install a 10 A fused jumper wire between the KR38 Main Contactor B+ terminal 1 X1 and 12 V. Install a jumper wire between the KR38 Main Contactor control terminal 2 X1 and ground.
6. Test for less than 10 ohms between the high voltage terminals at the KR38 Main Contactor.

- **If 10 ohms or greater**

The KR38 Main Contactor is stuck in the open position. Replace the KR38 Main Contactor.

- **If less than 10 ohms**

7. Install a 10 A fused jumper wire between the KR134 Pre-Charge Contactor B+ terminal A X1 and 12 V. Install a jumper wire between the KR134 Pre-Charge Contactor control terminal A X2 and ground.
8. Test for less than 10 ohms between the high voltage terminals at the KR134 Pre-Charge Contactor.

- **If 10 ohms or greater**

The KR134 Pre-Charge Contactor is stuck in the open position. Replace the KR134 Pre-Charge Contactor.

- **If less than 10 ohms**

9. Test for less than 10 ohms between the high voltage terminals at the S15 Manual Service Disconnect with the lever in the closed position.

- **If 10 ohms or greater**

The S15 Manual Service Disconnect is stuck in the open position. Replace the S15 Manual Service Disconnect.

- **If less than 10 ohms**

10. Replace the K59 Starter/Generator Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Starter/Generator Control Module replacement, programming, and setup.

LOSS OF ISOLATION IN THE HIGH VOLTAGE SYSTEM

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground.

The isolation monitoring system measures the resistance between the high voltage system and chassis ground.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48900** HEV Safety Kit
- **EL-50772** Insulation Multimeter

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the EL-50772 Insulation Multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug

- 3 phase cable terminal W - cable side lug
- **If 400K ohms or less**
- 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
- 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
- 3. Replace the high voltage 3 phase cables.
 - **If greater than 400K ohms**

NOTE: **The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.**

4. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase terminal U - K59 Starter/Generator Control Module stud
 - 3 phase terminal V - K59 Starter/Generator Control Module stud
 - 3 phase terminal W - K59 Starter/Generator Control Module stud
 - **If 400K ohms or less**
 - 1. Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
 - 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.
 - If greater than 400K ohms
 - 3. Replace the two wiring junction blocks.
 - **If greater than 400K ohms**
5. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Drive Motor Generator Battery Cable Replacement**
- **Starter Generator Replacement**
- **Generator Battery Replacement**
- **Control Module References** for hybrid powertrain control module replacement, programming, and setup

HYBRID\EV BATTERY VOLTAGE PRESENT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

At times, it may be necessary to disconnect high voltage from the vehicle, both during normal operation and when a system fault is identified. The starter/generator control module controls the Main Contactor and pre-charge contactor to disconnect and connect high voltage from the vehicle. The high voltage contactors are switches that are controlled much like a relay. To disable high voltage from the vehicle, the main and pre-charge contactors are commanded open. This will open the contactors and physically disconnect the hybrid/EV battery positive cable. To connect high voltage to the vehicle, first the pre-charge contactor is closed. With the pre-charge contactor closed, current flows through the pre-charge resistor. This allows high voltage to slowly build in the system, as the resistor decreases current flow. Once high voltage is brought up through the pre-charge contactor, the Main Contactor is close and high voltage is active. If the high voltage builds too quickly or too slowly, the starter/generator control module will set a fault.

If a system fault occurs that does not allow the contactors to open, the starter/generator control module will be unable to disconnect high voltage from the vehicle. In instances such as this, the manual disconnect lever will disconnect high voltage from the vehicle when servicing.

Diagnostic Aids

- This diagnostic is used when high voltage has not been disabled after following the High Voltage Disabling procedure. This indicates that one or both contactors are stuck closed and the manual service disconnect is also stuck closed. The High Voltage Disabling procedure should still be completed, using the procedure for Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack. This will disconnect the battery terminals at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 and limit high voltage exposure when performing diagnosis.
- Be sure to check for any DTCs that may be set. These DTCs may lead to the cause of the stuck contactors and DTC diagnosis should be performed before enabling high voltage. This will help ensure a repeat fault with the contactors does not occur. After diagnosis any DTCs, return to this procedure to test and repair any contactor that may be mechanically stuck closed.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.

- Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Verify no high voltage system DTCs are set.
 - If any high voltage system DTCs are set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- If no high voltage system DTCs are set
3. Test for infinite resistance between the high voltage terminals at the KR38 Main Contactor.
 - If not infinite resistance

The KR38 Main Contactor is stuck in the closed position. Replace the KR38 Main Contactor.

- If infinite resistance
4. Test for infinite resistance between the high voltage terminals at the KR134 Pre-Charge Contactor.
 - If not infinite resistance

The KR134 Pre-Charge Contactor is stuck in the closed position. Replace the KR134 Pre-Charge Contactor.

- If infinite resistance
5. Test for infinite resistance between the high voltage terminals at the S15 Hybrid/EV Battery Pack high voltage manual disconnect lever.
 - If not infinite resistance

The S15 Hybrid/EV Battery Pack high voltage manual disconnect lever is stuck in the closed

position. Replace the S15 Hybrid/EV Battery Pack high voltage manual disconnect lever.

- **If infinite resistance**

6. Replace the K59 Starter/Generator Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for starter/generator control module replacement, programming, and setup

REPAIR INSTRUCTIONS

HIGH VOLTAGE SYSTEM INSPECTION

A complete inspection of the high voltage system and components must be performed if the vehicle has been involved in a collision.

Vehicle Collision Detection

As a safety precaution, the Starter/Generator Control Module monitors the collision event messages from the Inflatable Restraint Sensing and Diagnostic Module (SDM). This message is broadcast by the SDM via serial data to inform various control module that a collision event has occurred so they can take appropriate action. This message does not indicate the severity of the collision, nor does it indicate that airbag deployment has been commanded.

If a collision event message is received by the Starter/Generator Control Module, it will enter a collision event detected state and respond by opening the high voltage contactors. This will help isolate the high voltage battery from the rest of the vehicle and reduce the possibility of a compromised high voltage system creating a hazard.

If the Starter/Generator Control Module has entered the collision event detected state, the high voltage system inspection procedure must be performed to ensure the high voltage system has not been compromised. If compromised, any necessary repairs should be made. The collision event detected condition will remain active until cleared using the **Clear Secured High Voltage DTCs**.

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to **Special Tools**.

Inspection Procedure

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: High voltage circuits should only be tested using a digital multimeter (DMM) and test leads with at least a CAT III rating, such as the J 39200-A Digital Multimeter. Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, perform a visual inspection of the following high voltage components listed. Remove any trim covers, carpet, or shields to gain access. DO NOT remove the metal A4 Hybrid/EV Battery Pack cover. Inspect the assembly and verify there are no case cracks, dents, pinched, cut or frayed high voltage cables, low voltage cables, or other physical damage.
 - A4 Hybrid/EV Battery Pack
 - A15 Starter/Generator
 - G14 Hybrid/EV Battery Pack Cooling Fan
 - G14 Hybrid/EV Battery Pack Cooling Fan inlet and outlet ducts for proper positioning to the A4 Hybrid/EV Battery Pack. Refer to Drive Motor Battery Cooling Air Inlet Upper Duct

Replacement , **Drive Motor Battery Cooling Blower Outlet Duct Replacement** , and **Drive Motor Battery Cooling Air Outlet Duct Replacement** for proper duct installation and routing.

- High voltage cables between the K59 Starter/Generator Control Module and the A15 Starter/Generator
- **If any damage is found**

Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**, . If vehicle damage does not allow for access to the S15 Hybrid/EV Battery Pack high voltage manual disconnect lever, disconnect the 12V battery and remove the damaged portion of the vehicle until the S15 Hybrid/EV Battery Pack high voltage manual disconnect lever can be accessed and the **High Voltage Disabling** procedure can be completed. Replace any components and cables that have been identified as damaged. Continue to step 2 after repairs have been completed.

- **If no damage is found**

2. Enable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Enabling**.
3. Ignition ON.
4. Verify no DTCs are set.

- **If any DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs are set**

5. Clear the Crash Event Detected disable condition after all damaged high voltage components have been replaced. Refer to **Clear Secured High Voltage DTCs**.
6. Perform the required body repairs using the approved service procedures.

BATTERY ENERGY CONTROL MODULE REPLACEMENT

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.

- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Disable the hybrid battery. Refer to High Voltage Disabling.

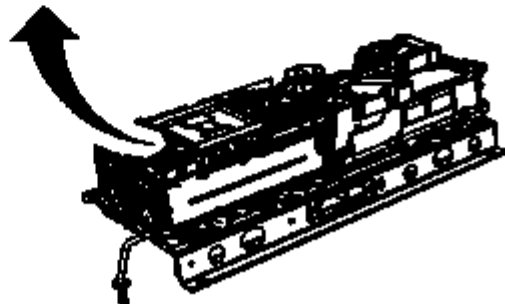
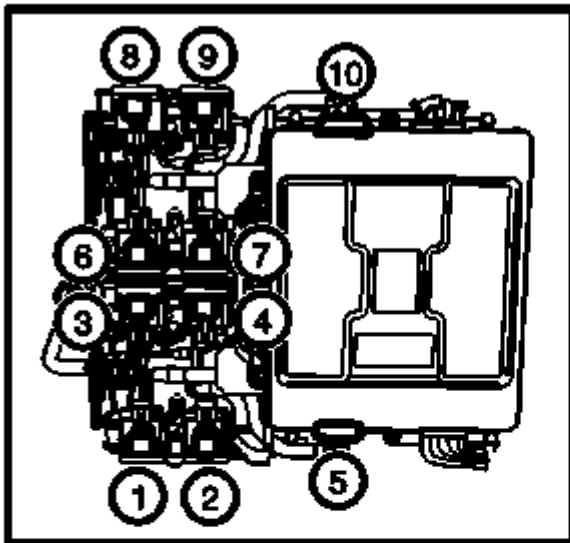


Fig. 17: Identifying Connectors Sequence
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the following connectors, in the above sequence shown, from the battery energy control module.

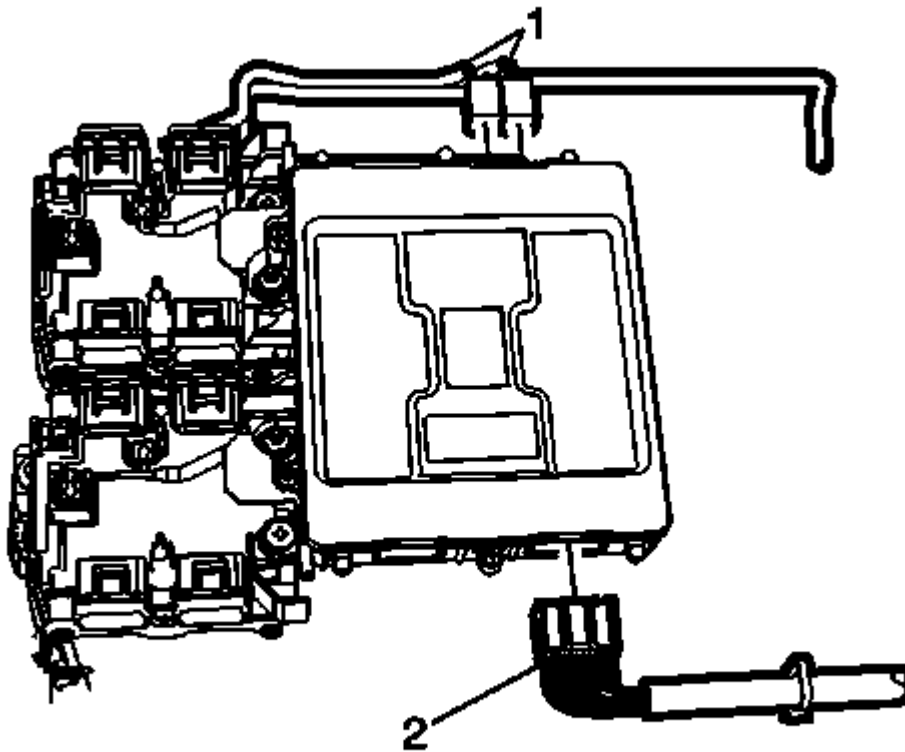


Fig. 18: Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Remove the connectors (1) and the connector (2).

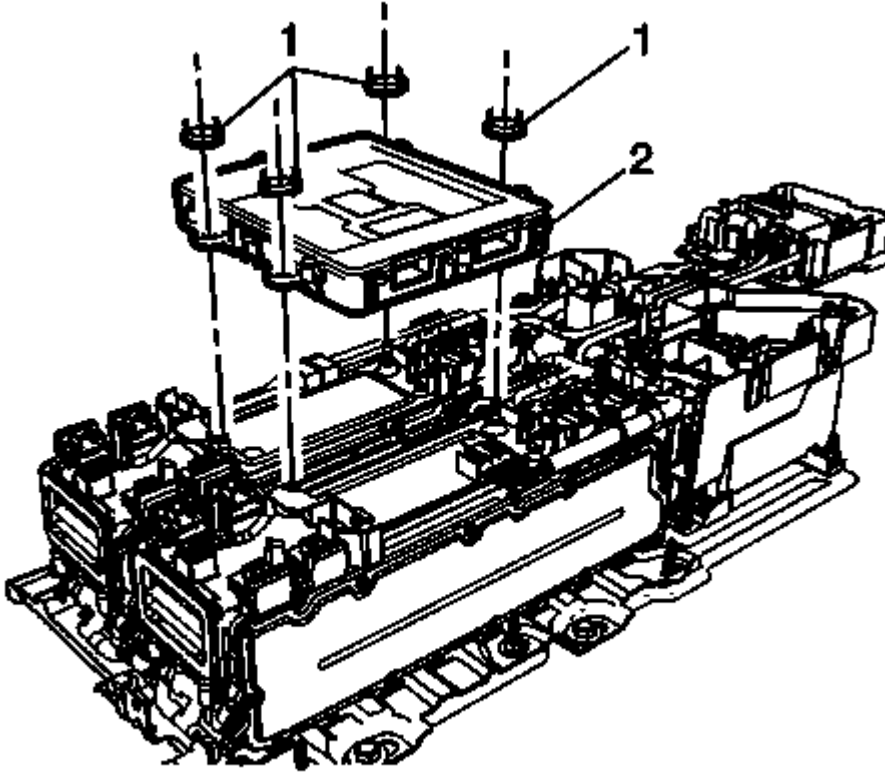


Fig. 19: Battery Energy Control Module Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery energy control module fasteners (1) and remove the battery energy control module (2) from the mounting studs.

Installation Procedure

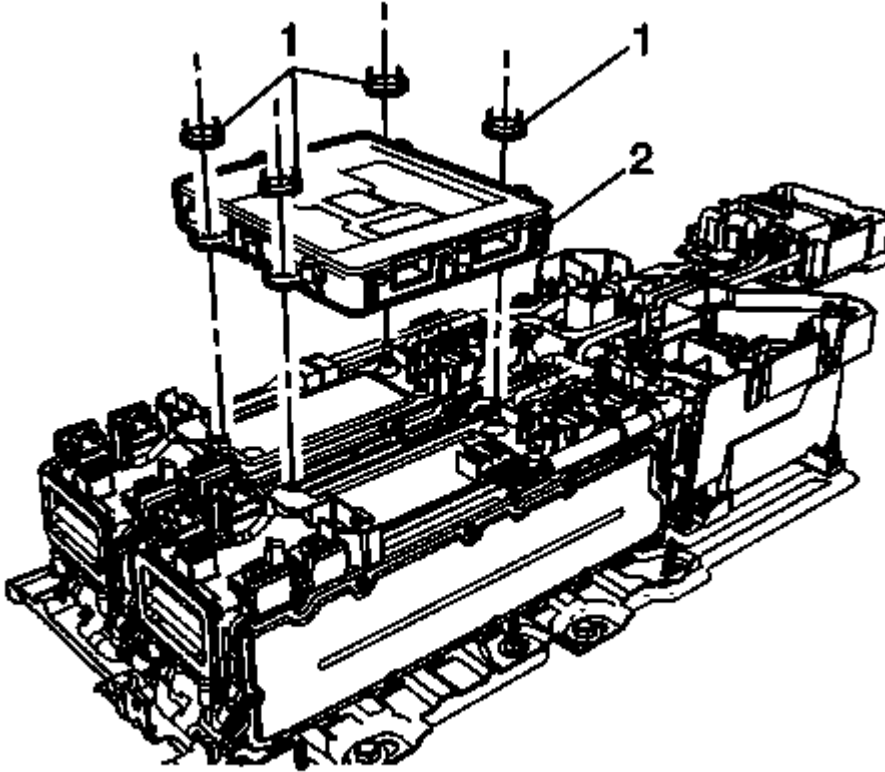


Fig. 20: Battery Energy Control Module Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the battery energy control module (2) to the mounting studs and tighten the fasteners (1) to 9 N.m (80 lb in).

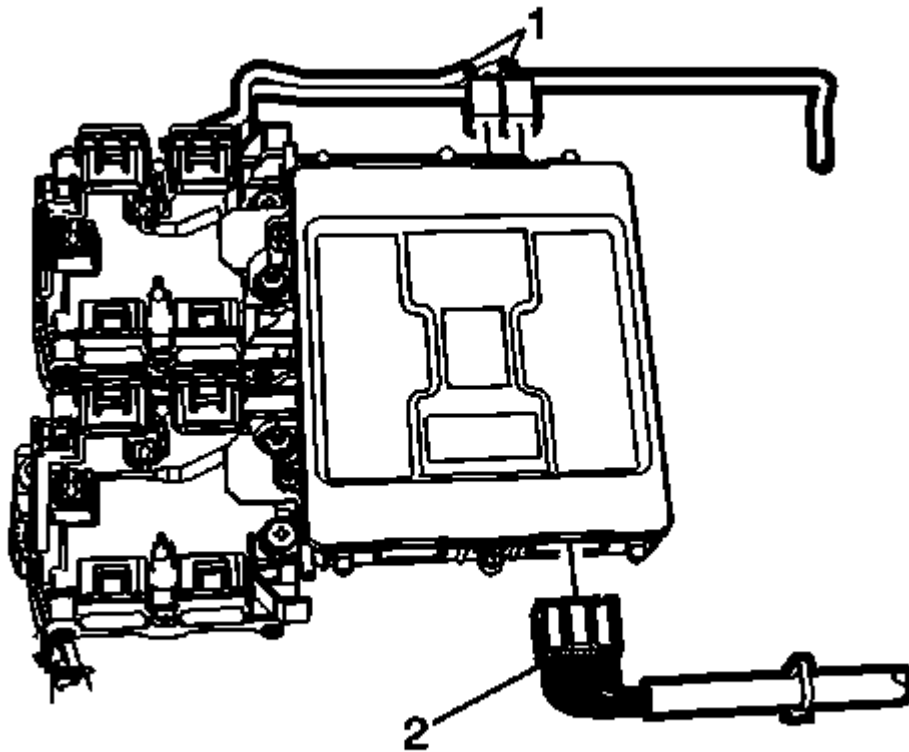


Fig. 21: Connectors

Courtesy of GENERAL MOTORS COMPANY

2. Install the connectors (1) and connector (2).

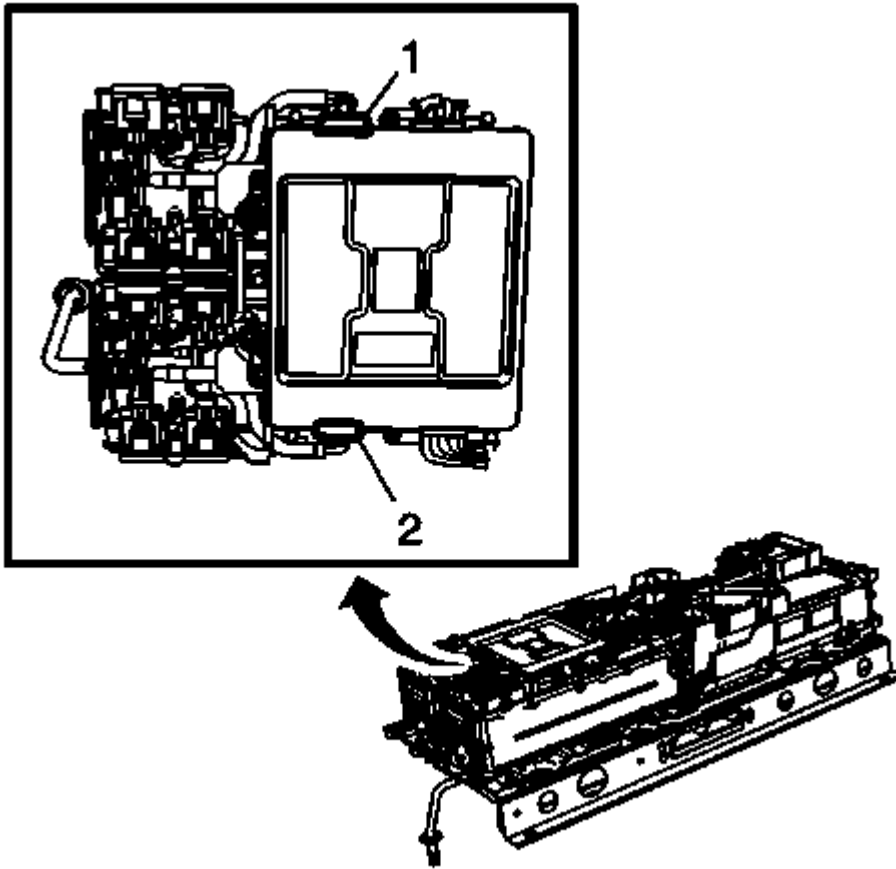


Fig. 22: identifying Connectors Disconnect/Connect Sequence
Courtesy of GENERAL MOTORS COMPANY

3. Connect the remaining connectors, in the above sequence, to the battery energy control module.
4. Enable the hybrid battery. Refer to **High Voltage Enabling**.
5. Program the battery energy control module. Refer to **Battery Energy Control Module Programming and Setup** .

GENERATOR CONTROL AND BATTERY MODULE REPLACEMENT AND SHIPPING PREPARATION

Special Tools

- **EL-48264** Battery Pack Lifting Adapter
- **EL-48900** High Voltage Safety Kit

For equivalent regional tools , refer to **Special Tools**.

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to

follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Remove both rear compartment floor trim panels. Refer to **Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6)** , **Rear Compartment Floor Panel Trim Replacement (with Blower Cover, HP6)** .
2. Ignition OFF, disable high voltage at the A4 hybrid battery pack. Refer to **High Voltage Disabling**.
3. Remove the rear end trim finish panel. Refer to **Rear End Trim Finish Panel Replacement** .

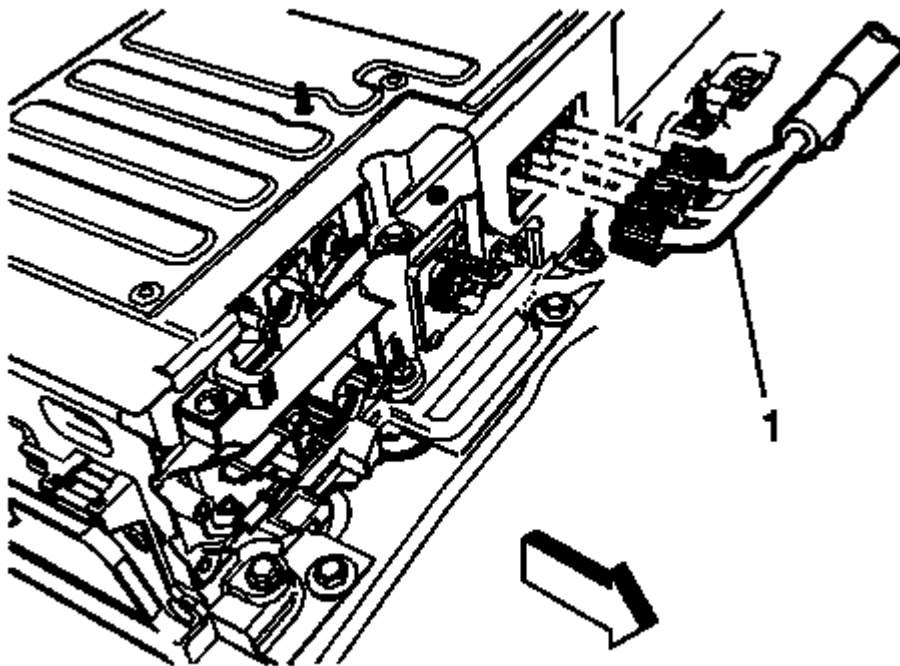


Fig. 23: Body Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

4. Remove the body harness connectors (1) from the generator control and battery module.

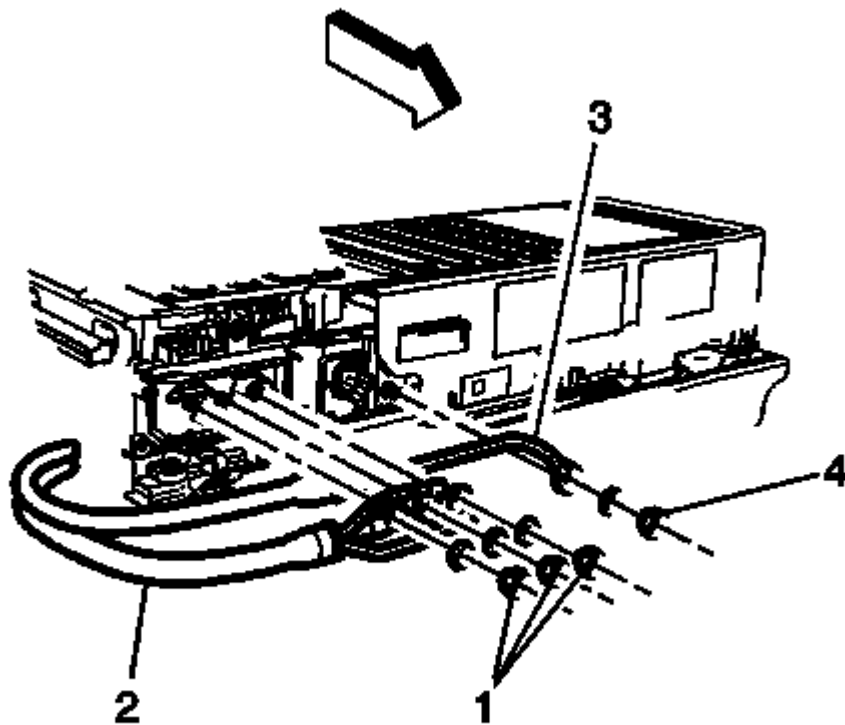


Fig. 24: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

5. Remove the high voltage 3-phase cable terminal nuts (1) and the 12V terminal branch nut (4).
6. Remove the high voltage cable (2) and the 12V cable (3) from the generator control and battery module.

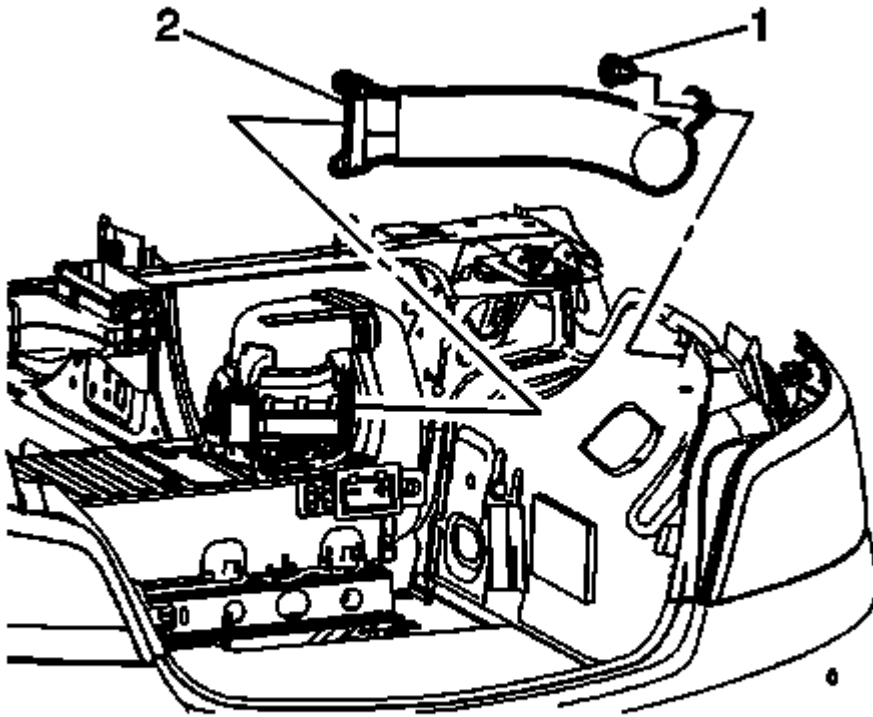


Fig. 25: Drive Motor Battery Cooling Air Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

7. Remove the drive motor battery cooling air outlet duct (2). Refer to **Drive Motor Battery Cooling Air Outlet Duct Replacement** .

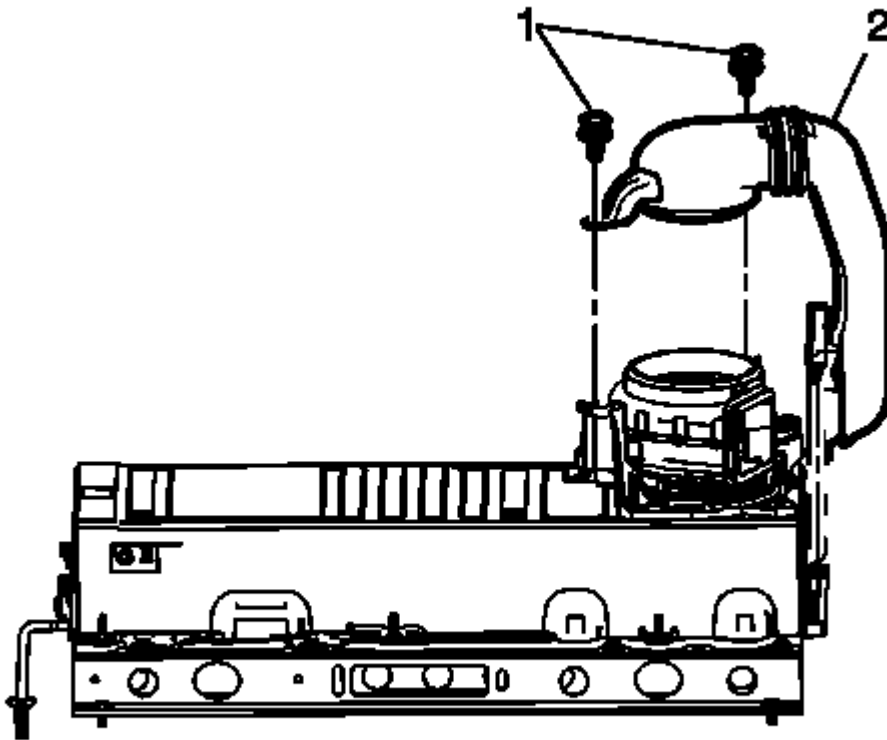


Fig. 26: Drive Motor Battery Cooling Blower Outlet Upper Duct Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the drive motor battery cooling blower outlet upper duct fasteners (1) and remove the drive motor battery cooling blower outlet upper duct (2). Refer to **Drive Motor Battery Cooling Blower Outlet Duct Replacement** .

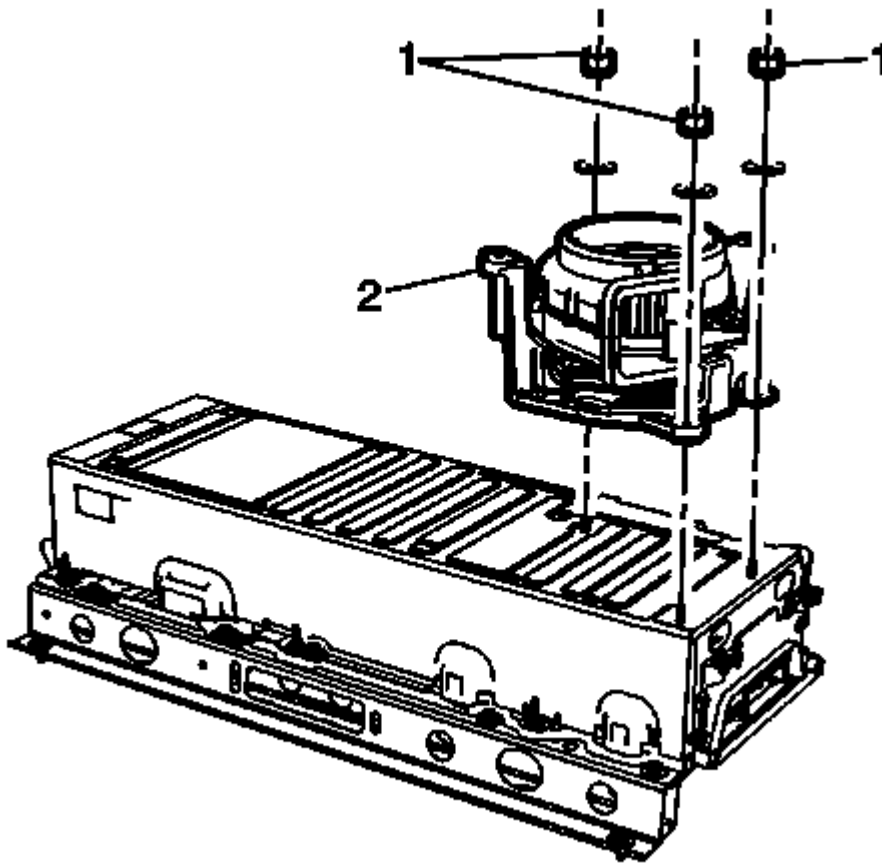


Fig. 27: Drive Motor Battery Cooling Blower Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Remove the drive motor generator bracket and cooling blower fasteners (1).
10. Remove the drive motor battery cooling blower assembly (2).

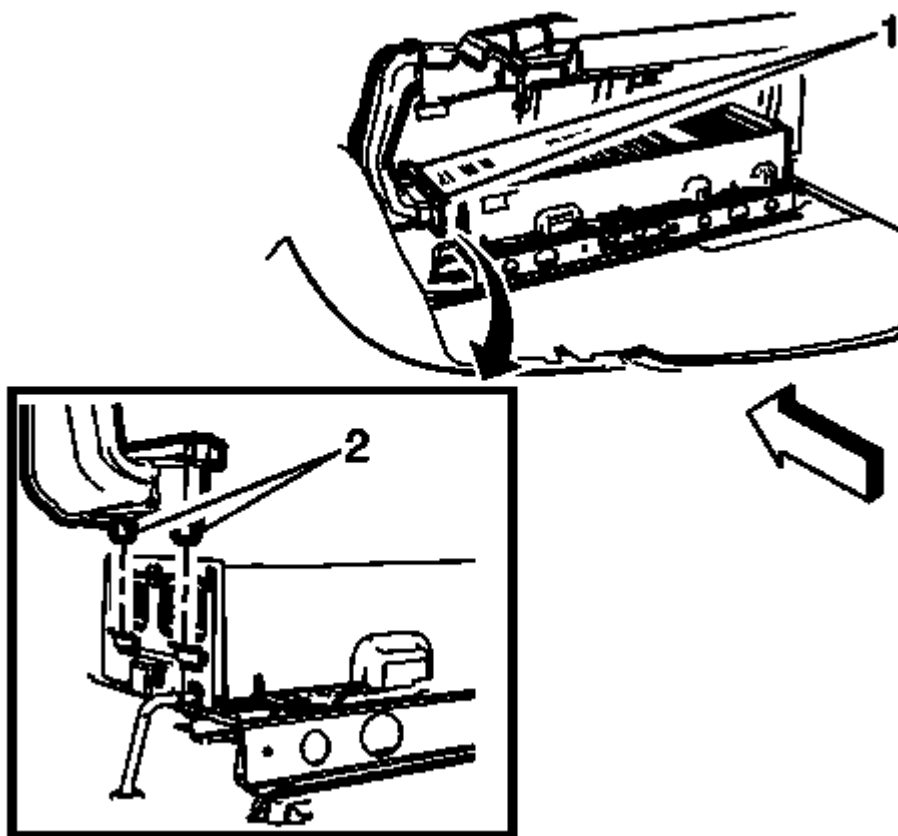


Fig. 28: Battery Cooling Air Inlet Duct And Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the seal for efficient generator control and battery module cooling.

11. Remove the drive motor battery cooling air inlet lower duct retainers (1).

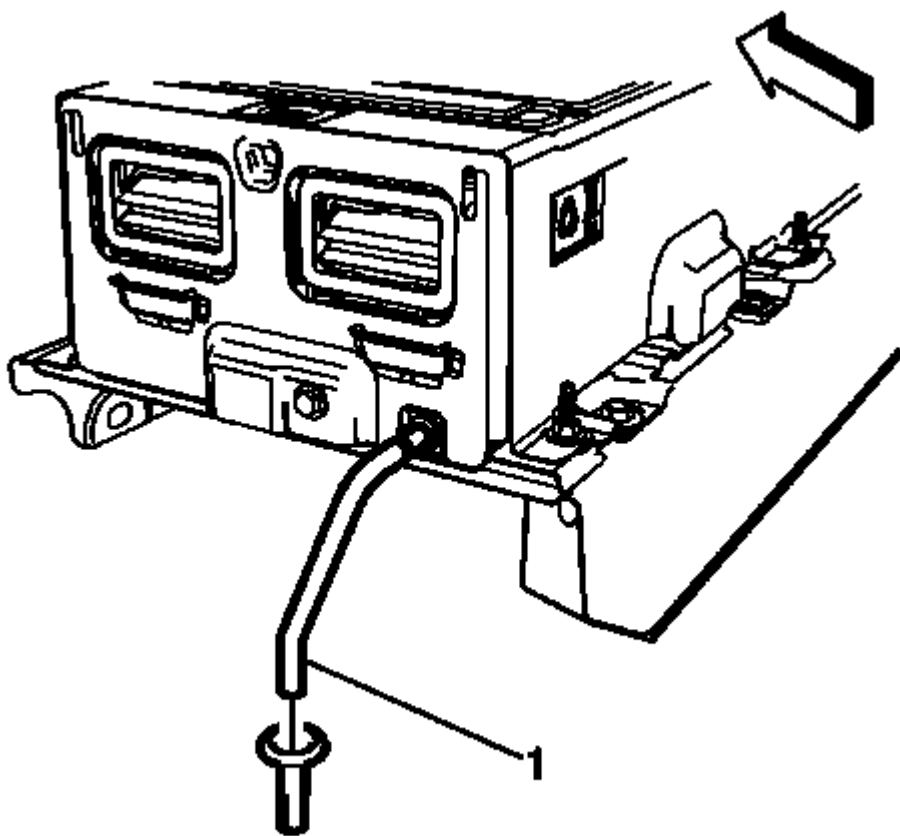


Fig. 29: Generator Control And Battery Module Vent Tube
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not bend the vent tube.

12. Remove the generator control and battery module vent tube (1).

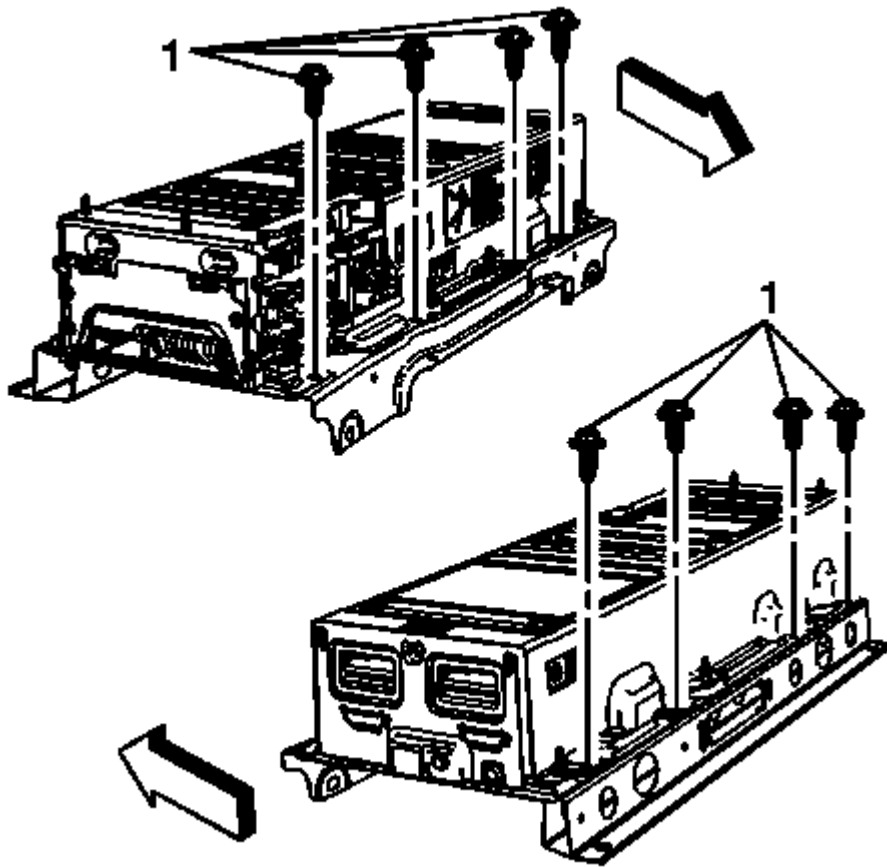


Fig. 30: Generator Control And Battery Module Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the generator control and battery module mounting bolts (1).

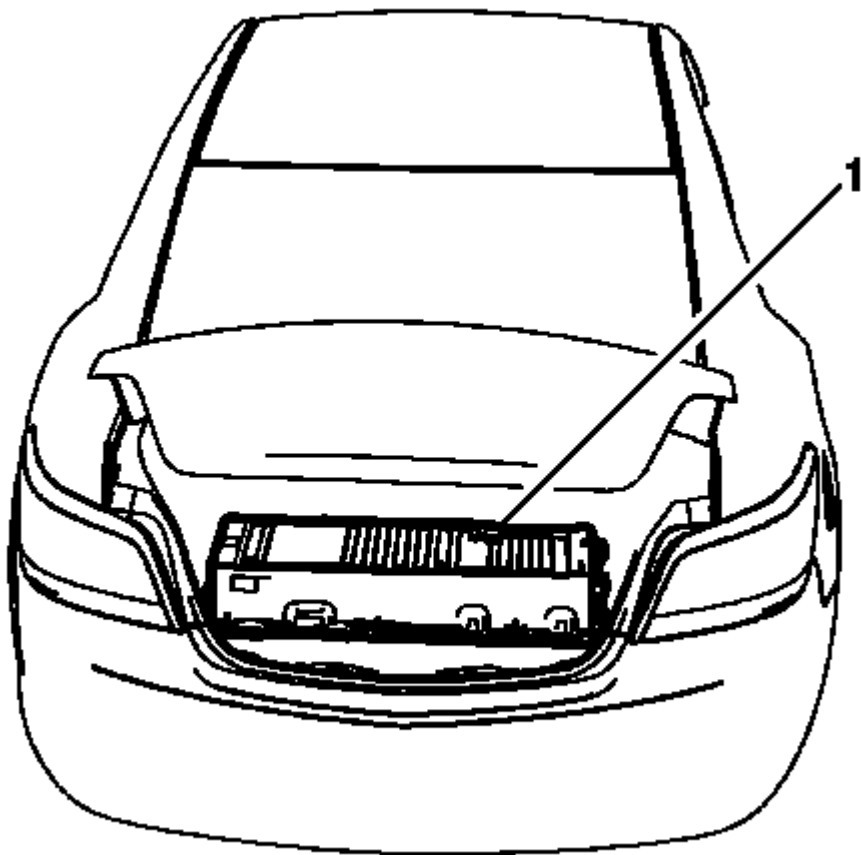


Fig. 31: Protective Cloth Over Trunk-To-Rear Bumper Area
Courtesy of GENERAL MOTORS COMPANY

14. Place a protective cloth over the trunk-to-rear bumper area.

NOTE: Do not insert fingers into vent area of the generator control and battery module while rotating.

15. With assistance, use gloves to slide the generator control and battery module (1) into the trunk area.

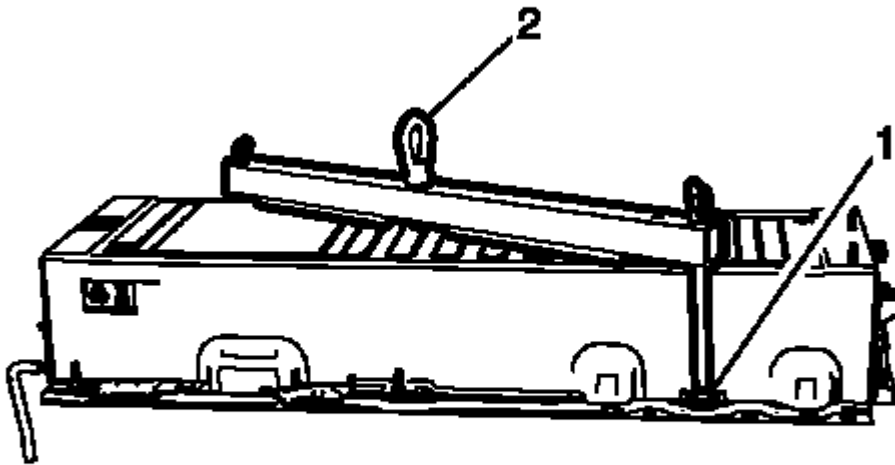


Fig. 32: Battery Pack Lifting Adapter Center Eye Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Using the **EL-48264** battery pack lifting adapter center the eye bolt (2) on the generator control and battery module and insert the hooks (1) into the generator control and battery module holes.
17. Attach a portable lift to the center eye bolt (2) of the battery pack lifting adapter.

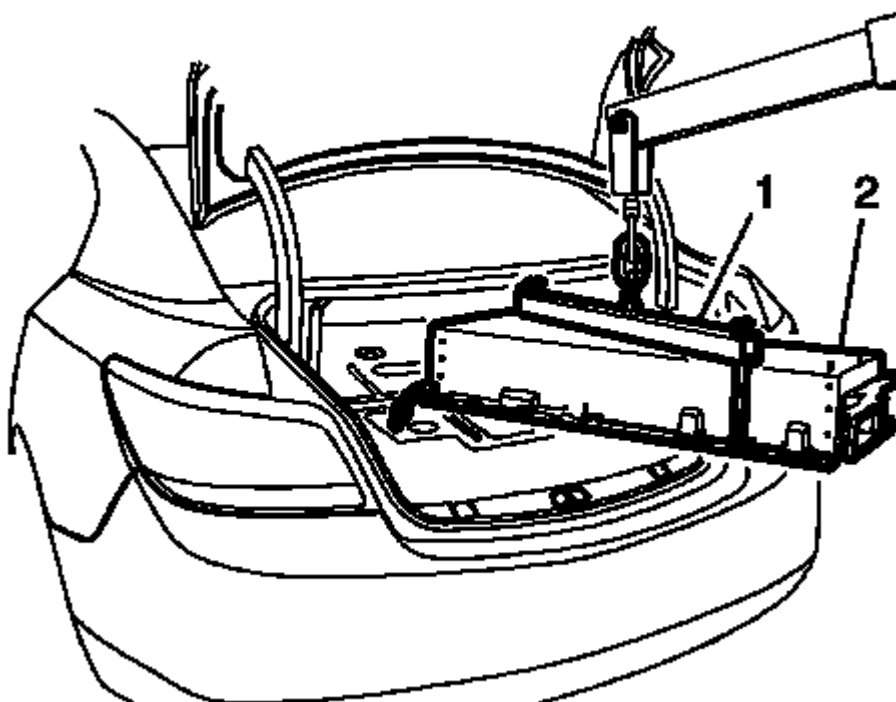


Fig. 33: Generator Control And Battery Module
Courtesy of GENERAL MOTORS COMPANY

18. Remove the generator control and battery module (2) from the rear trunk area.

Installation Procedure

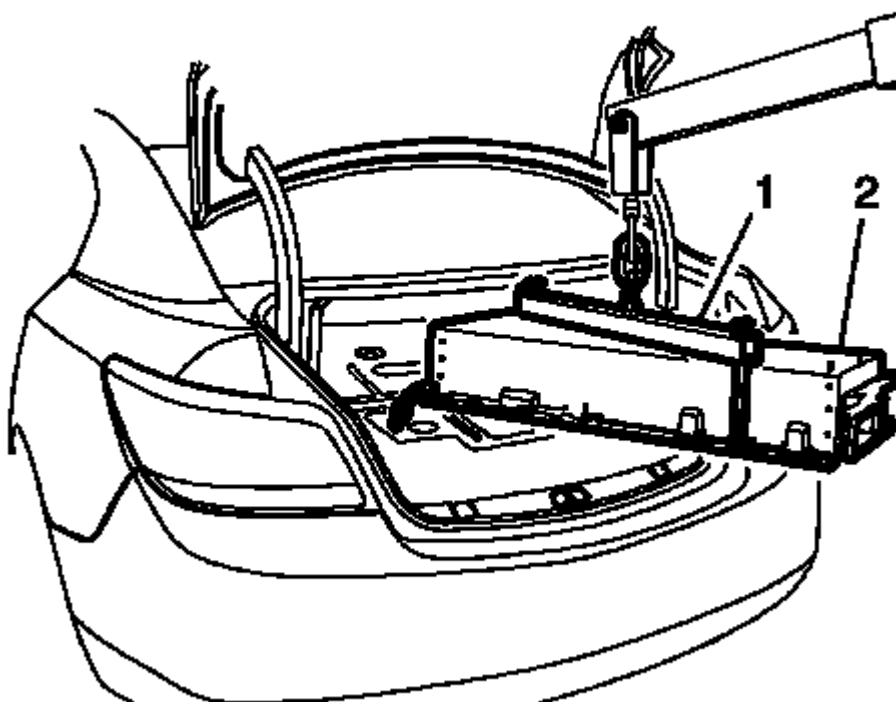


Fig. 34: Generator Control And Battery Module
Courtesy of GENERAL MOTORS COMPANY

1. Install the generator control and battery module (2) in through the trunk opening.

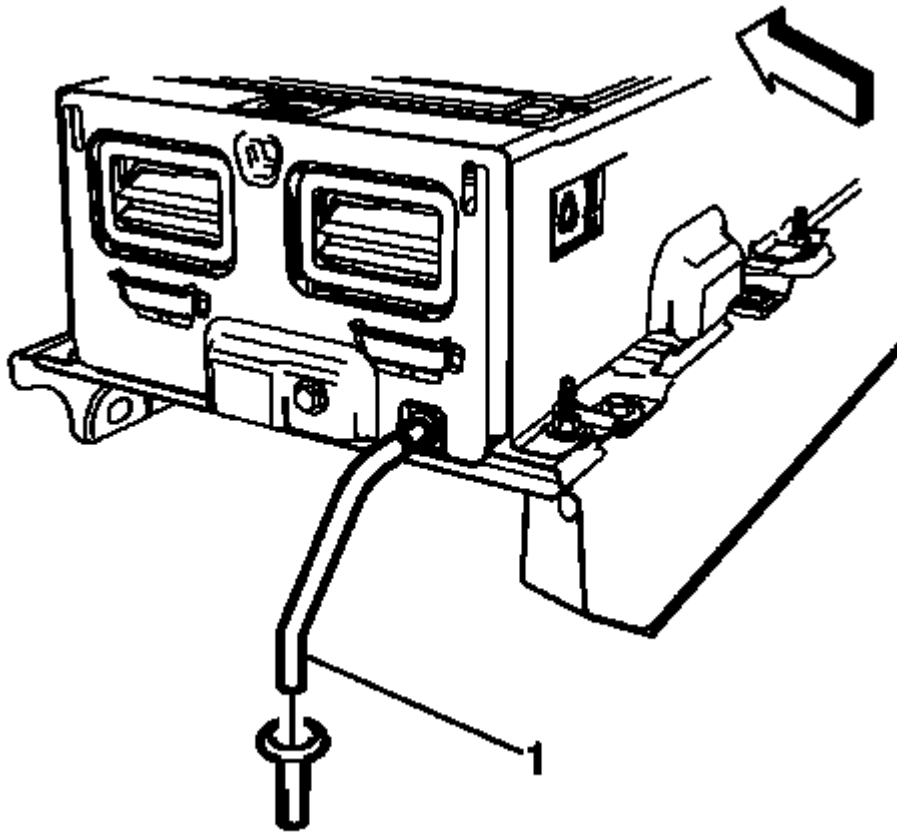


Fig. 35: Generator Control And Battery Module Vent Tube
Courtesy of GENERAL MOTORS COMPANY

2. Slide the generator control and battery module into position and install the vent tube (1) into the floor.
3. Remove the **EL-48264** battery pack lifting adapter.

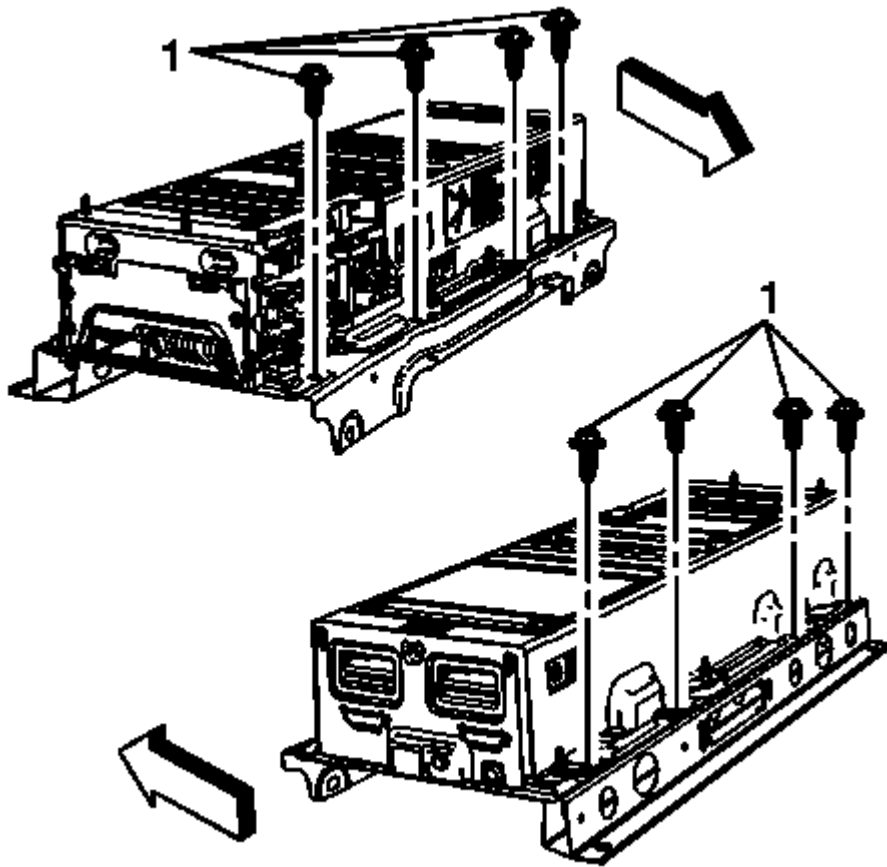


Fig. 36: Generator Control And Battery Module Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the generator control and battery module into position and tighten the mounting bolts (1) to 22 N.m (16 lb ft).

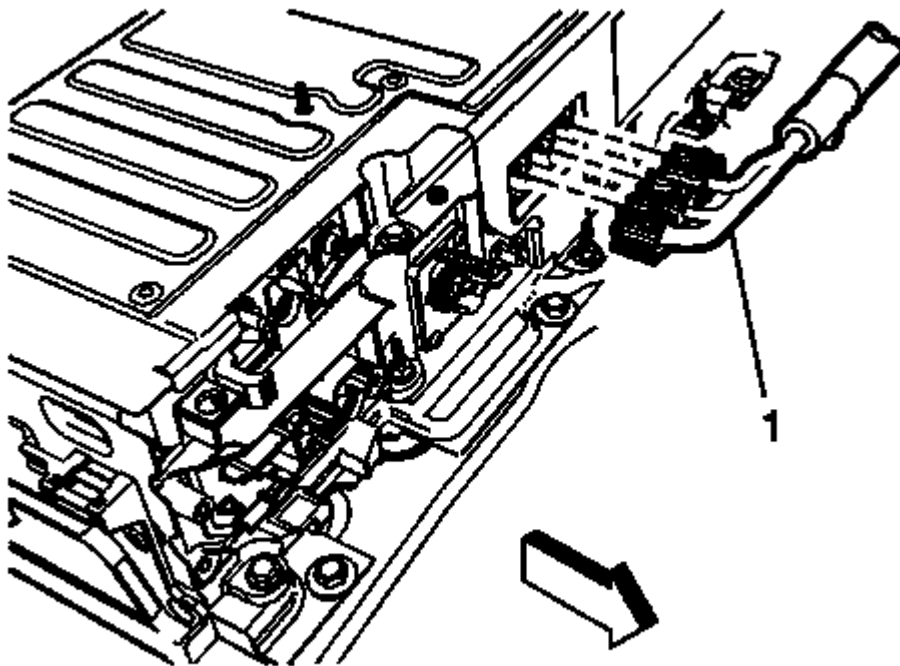


Fig. 37: Body Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

5. Install the body harness connectors (1).

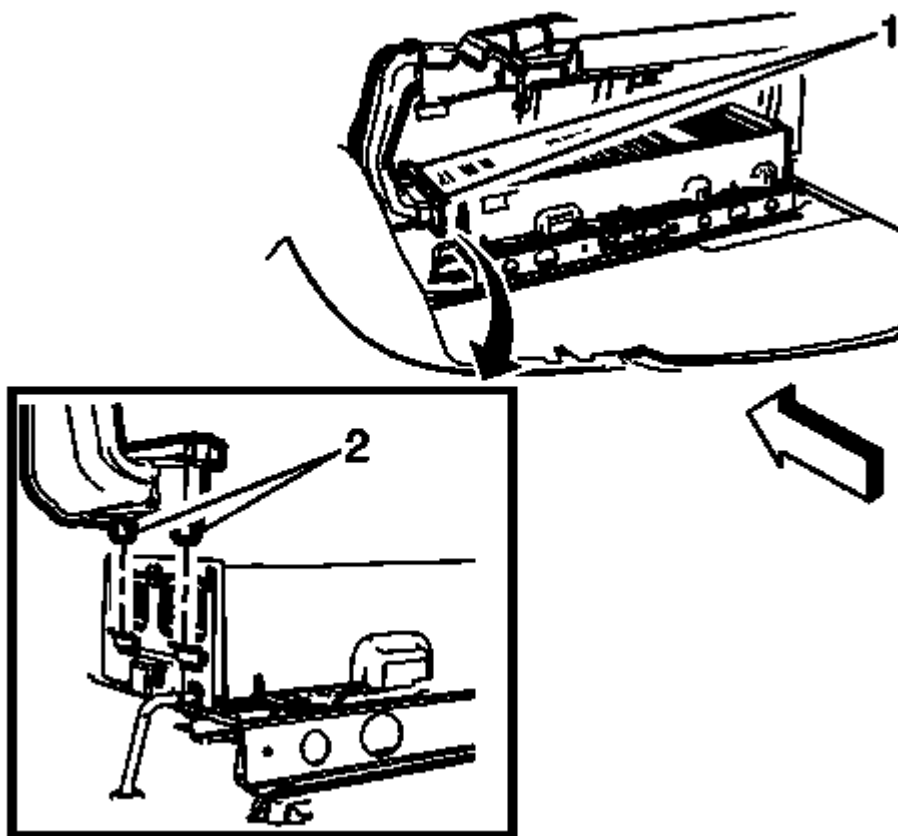


Fig. 38: Battery Cooling Air Inlet Duct And Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the seal for efficient generator control and battery module cooling.

6. Install the drive motor battery cooling air inlet lower duct retainers (1).

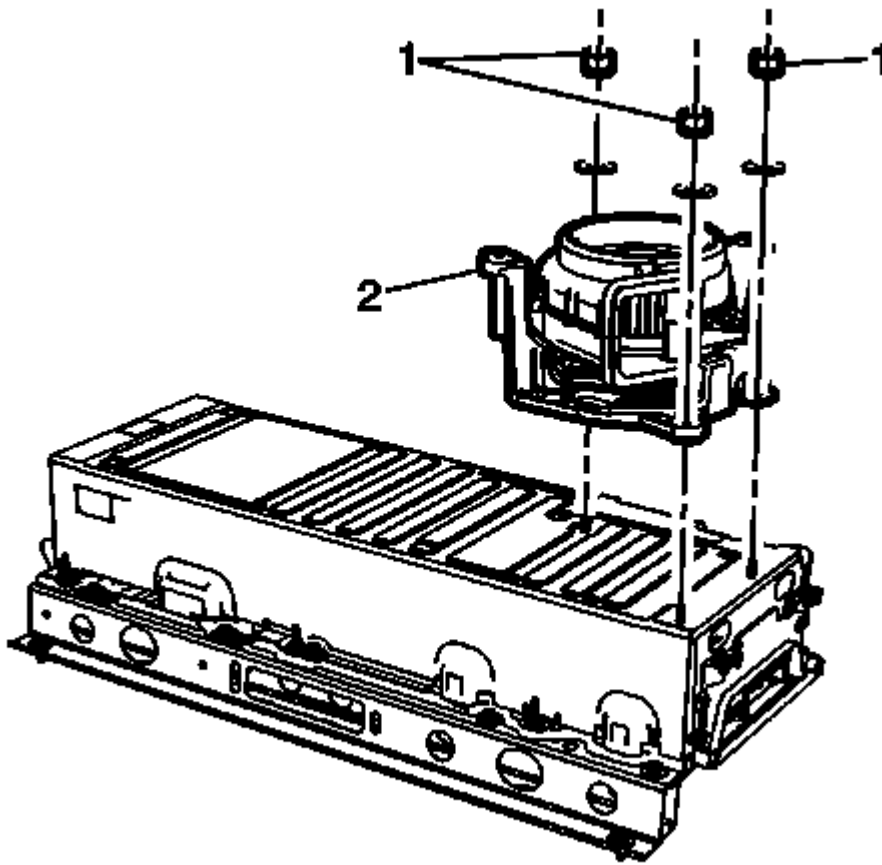


Fig. 39: Drive Motor Battery Cooling Blower Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Install the drive motor generator bracket and drive motor battery cooling blower (2). Tighten the fasteners (1) to 9 N.m (80 lb in).

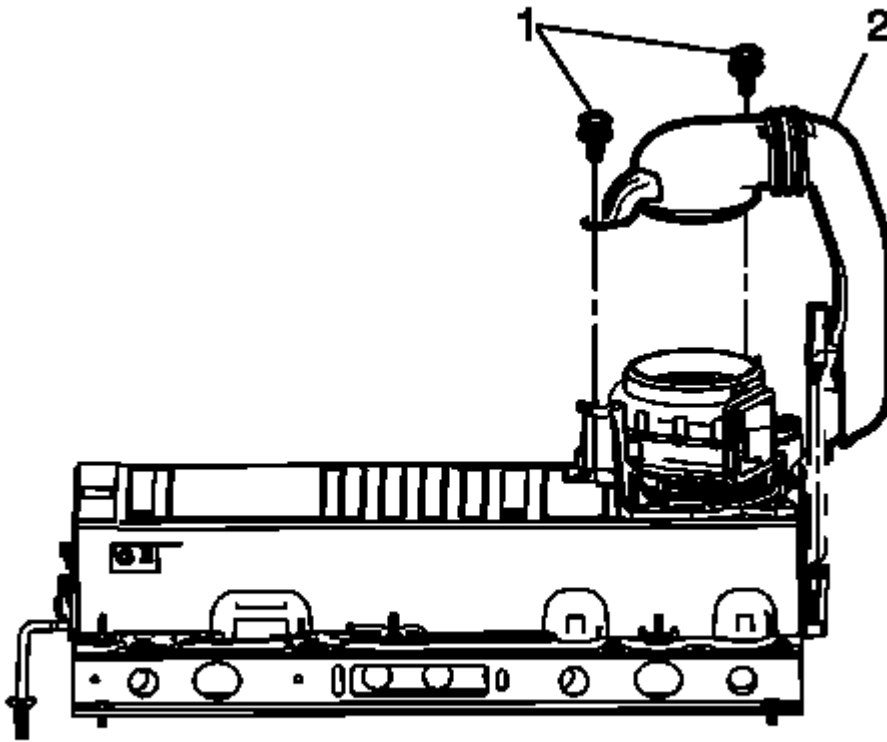


Fig. 40: Drive Motor Battery Cooling Blower Outlet Upper Duct Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the seal for efficient generator control and battery module cooling.

8. Install the drive motor battery cooling blower outlet upper duct (2) and tighten the fasteners to 9 N.m (80 lb in).

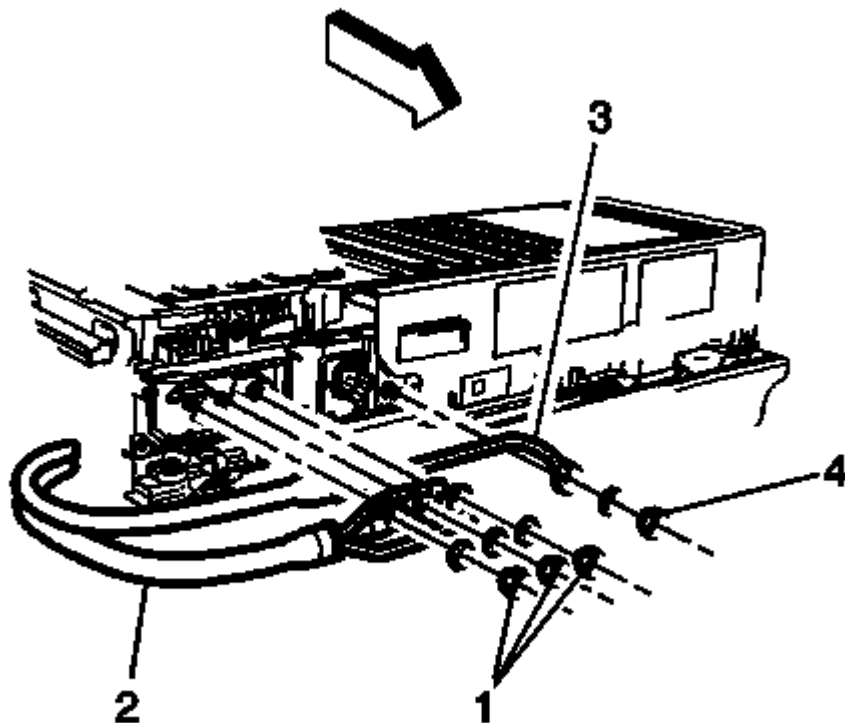


Fig. 41: High Voltage 3-phase Cable
 Courtesy of GENERAL MOTORS COMPANY

9. Install the high voltage 3-phase cable (2) to the generator control and battery module. Tighten the nuts (1) to 9 N.m (80 lb in).
10. Install the 12V cable (3) to the generator control and battery module. Tighten the nut (4) to 9 N.m (80 lb in).
11. Install both rear compartment floor panels. Refer to **Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6)** , **Rear Compartment Floor Panel Trim Replacement (with Blower Cover, HP6)** .
12. Install the rear end trim finish panels. Refer to **Rear End Trim Finish Panel Replacement** .
13. Enable the high voltage battery. Refer to **High Voltage Enabling**.
14. Program the generator control module, if replaced. Refer to **Control Module References** .
15. Program the battery energy control module, if replaced. Refer to **Battery Energy Control Module Programming and Setup** .

DRIVE MOTOR GENERATOR BATTERY CABLE REPLACEMENT

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Ignition OFF, disable the high voltage at the A4 hybrid battery pack. Refer to **High Voltage Disabling**.
2. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
3. Remove the left front underbody air deflector. Refer to **Underbody Front Air Deflector Replacement - Left Side**.
4. Remove the left front frame reinforcement. Refer to **Drivetrain and Front Suspension Frame Replacement**.

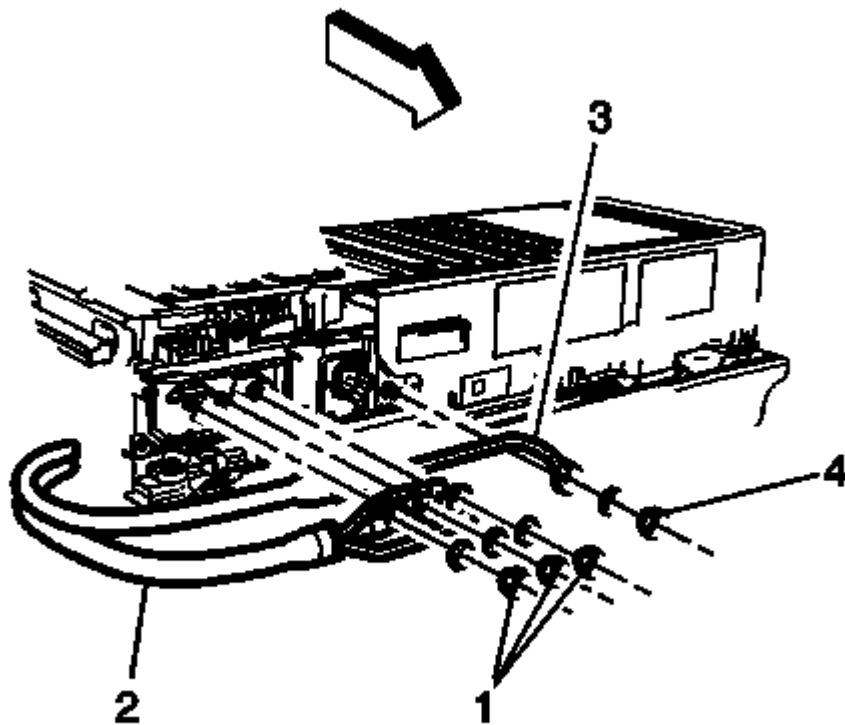


Fig. 42: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

5. Remove the high voltage 3-phase cable terminal nuts (1) and the 12V terminal branch nut (4).
6. Remove the high voltage cable (2) and the 12V cable (3) from the generator battery.

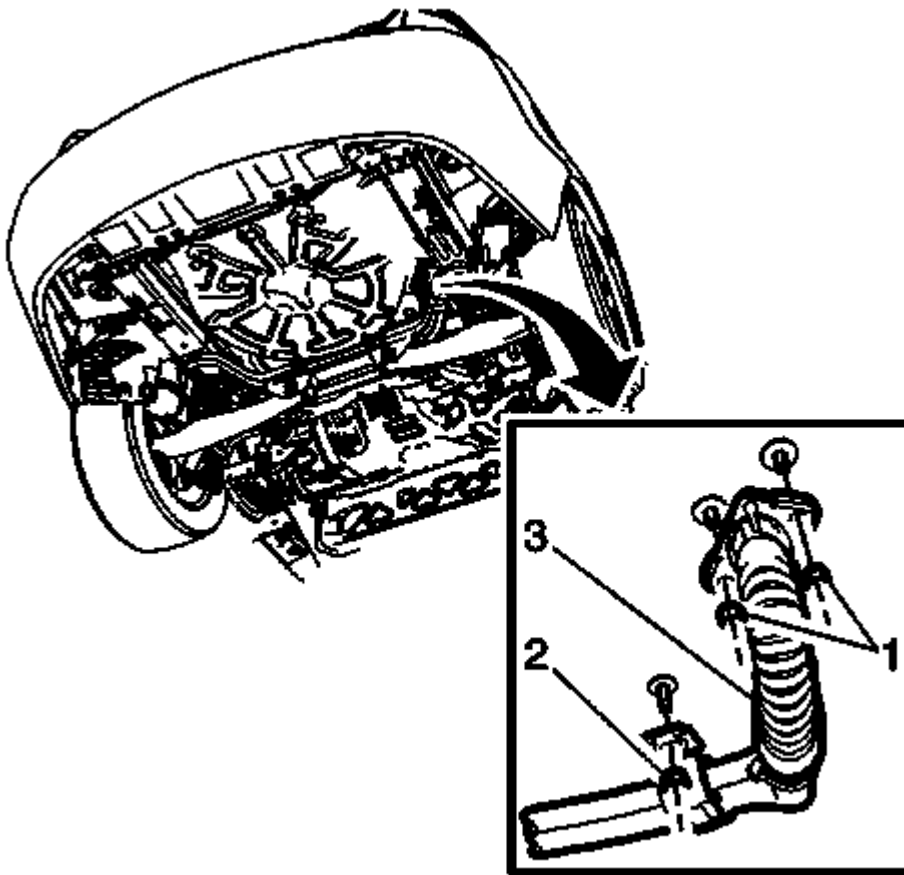


Fig. 43: Drive Motor Generator Cable
Courtesy of GENERAL MOTORS COMPANY

7. Remove the drive motor generator battery bracket nuts (1) and the cable retainer nut (2).
8. Pull the drive motor generator cable (3) through the grommet opening.

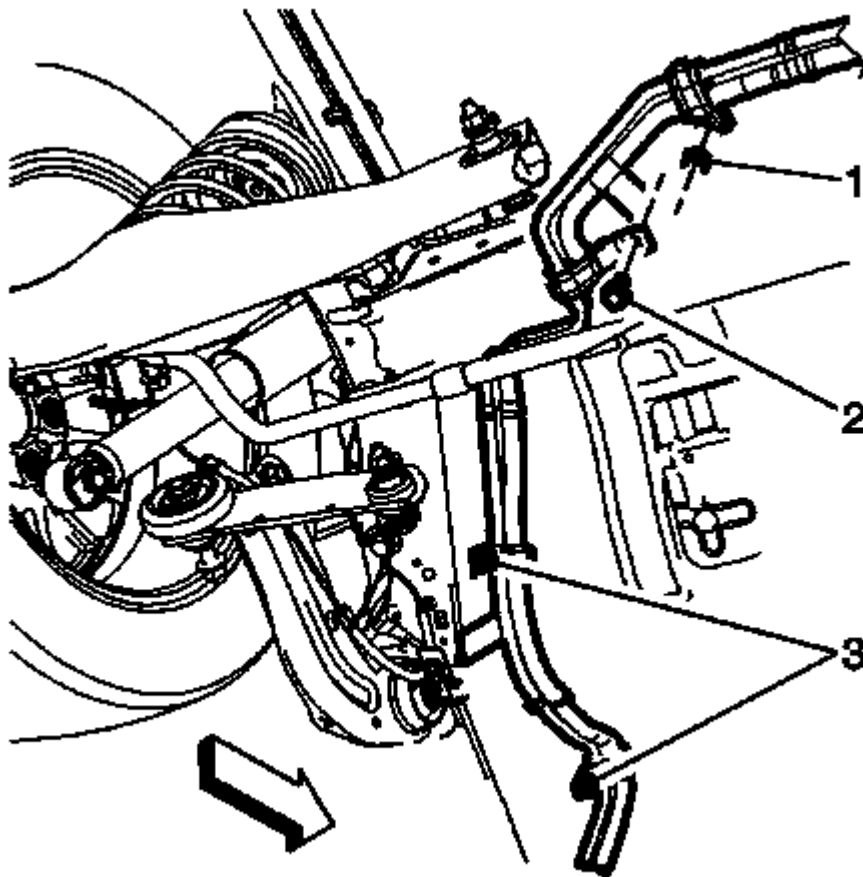


Fig. 44: Drive Motor Generator Retainer Nut
Courtesy of GENERAL MOTORS COMPANY

9. Remove the drive motor generator retainer nut (1) and bolt (2).

NOTE: Replace the fasteners (3) if re-using the drive motor generator battery cable.

10. Detach the drive motor generator battery cable fasteners (3).

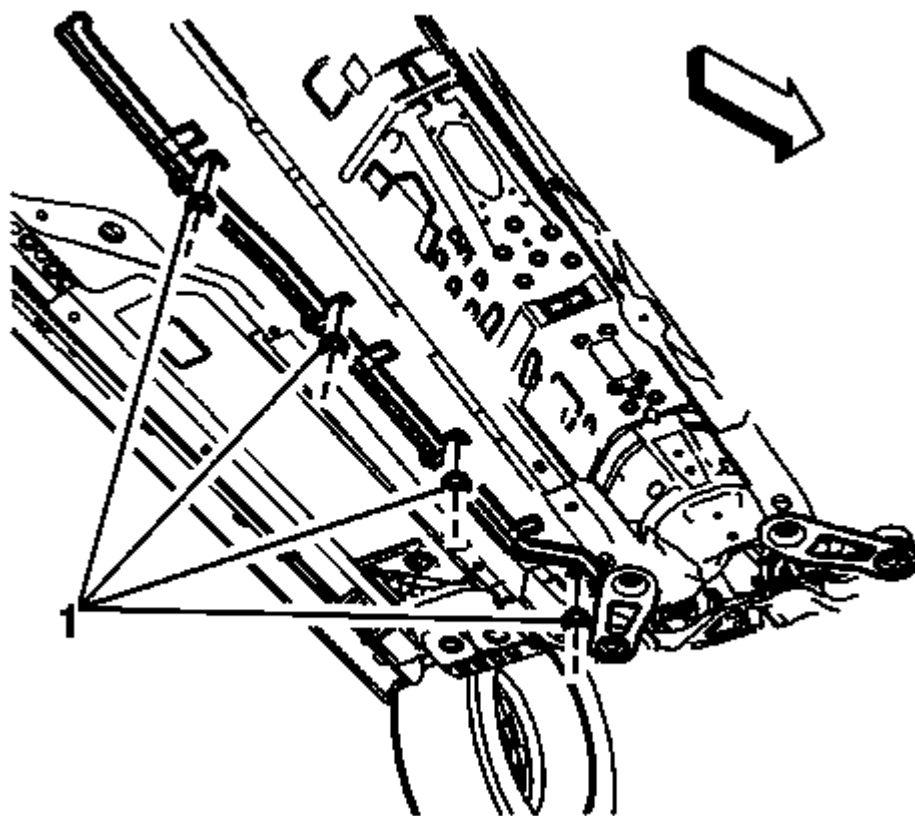


Fig. 45: Drive Motor Generator Battery Fastener Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the drive motor generator battery fastener bolts (1).

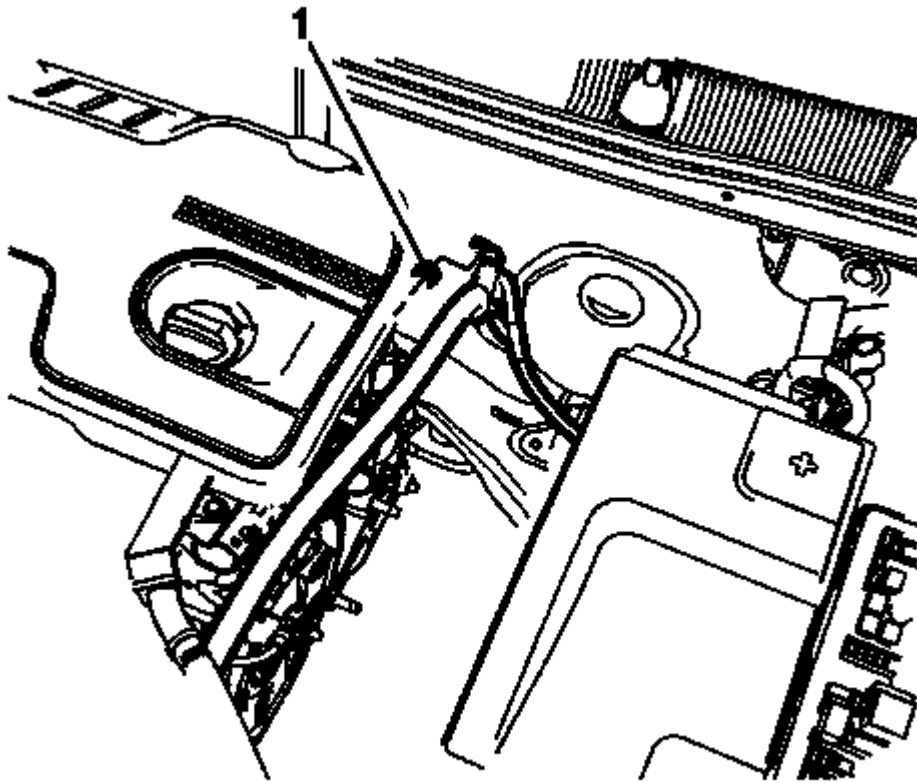


Fig. 46: Drive Motor Generator Battery Cable Retainer Nut
Courtesy of GENERAL MOTORS COMPANY

12. Within the rear engine compartment, remove the drive motor generator battery cable retainer nut (1).

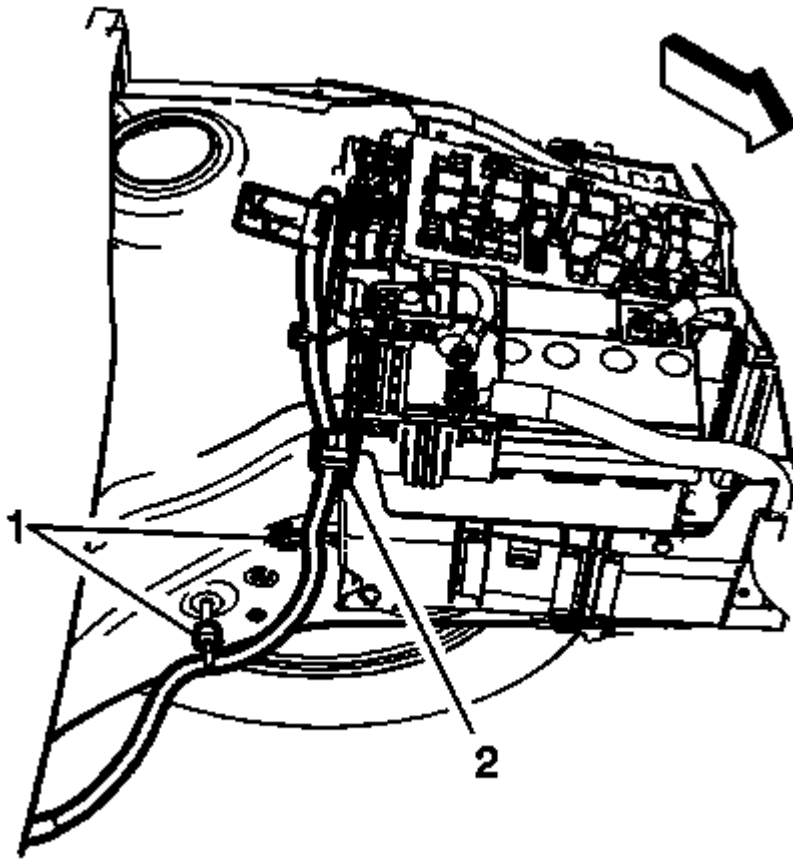


Fig. 47: Drive Motor Generator Battery Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Replace the retainers (1) if re-using the drive motor generator battery cable.

13. Disconnect the drive motor generator battery cable retainers (1) and the battery tray cable clip (2).

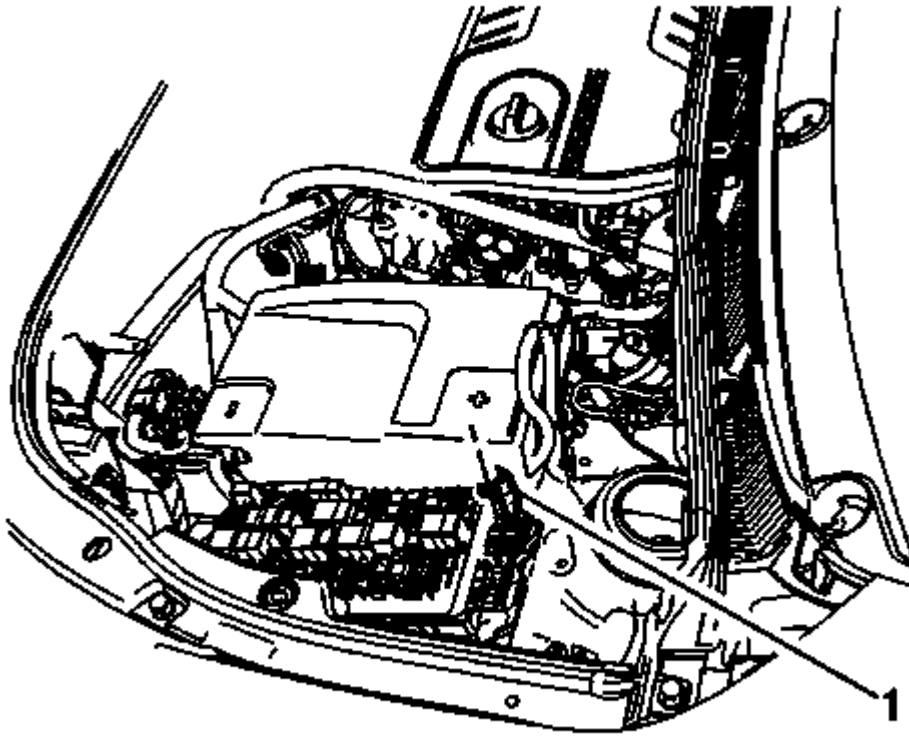


Fig. 48: Drive Motor Generator Battery Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

14. Remove the drive motor generator battery cable terminal (1) , from the underhood fuse block.

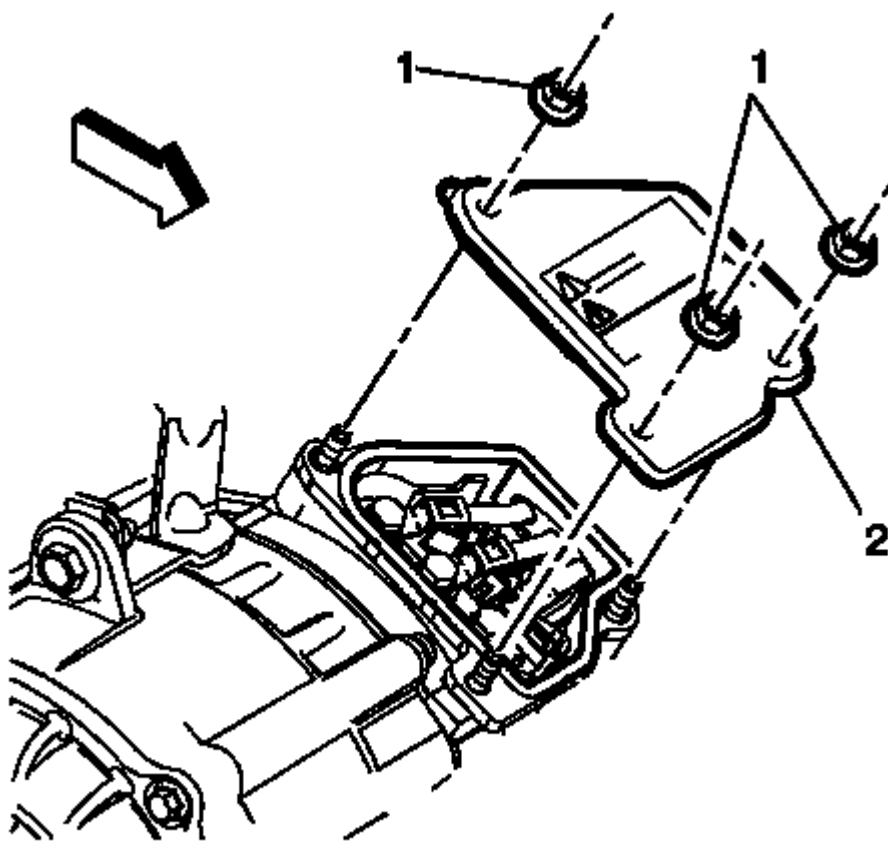


Fig. 49: Generator Starter Cover Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the generator starter cover nuts (1) and remove the cover (2).

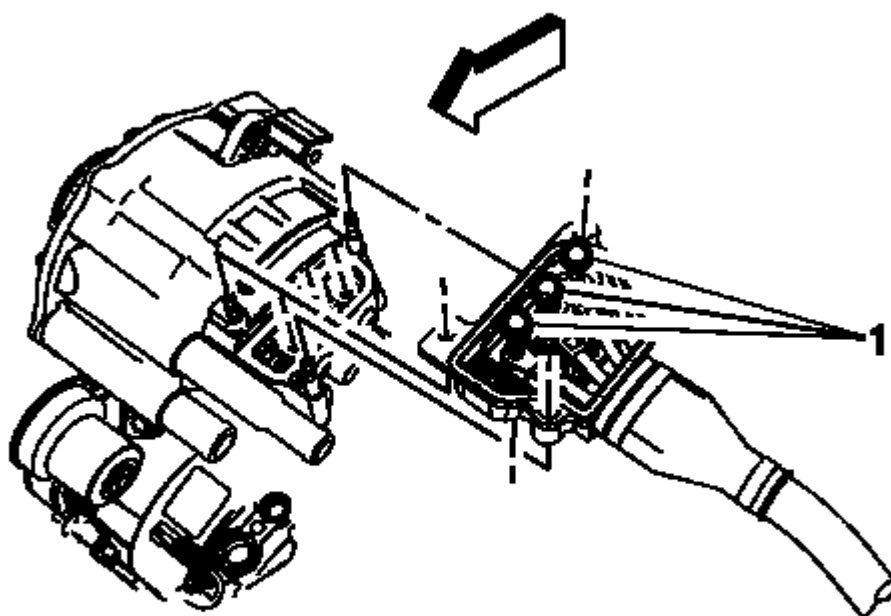


Fig. 50: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

16. Remove the bolts (1) and detach the drive motor generator battery cable from the generator starter.

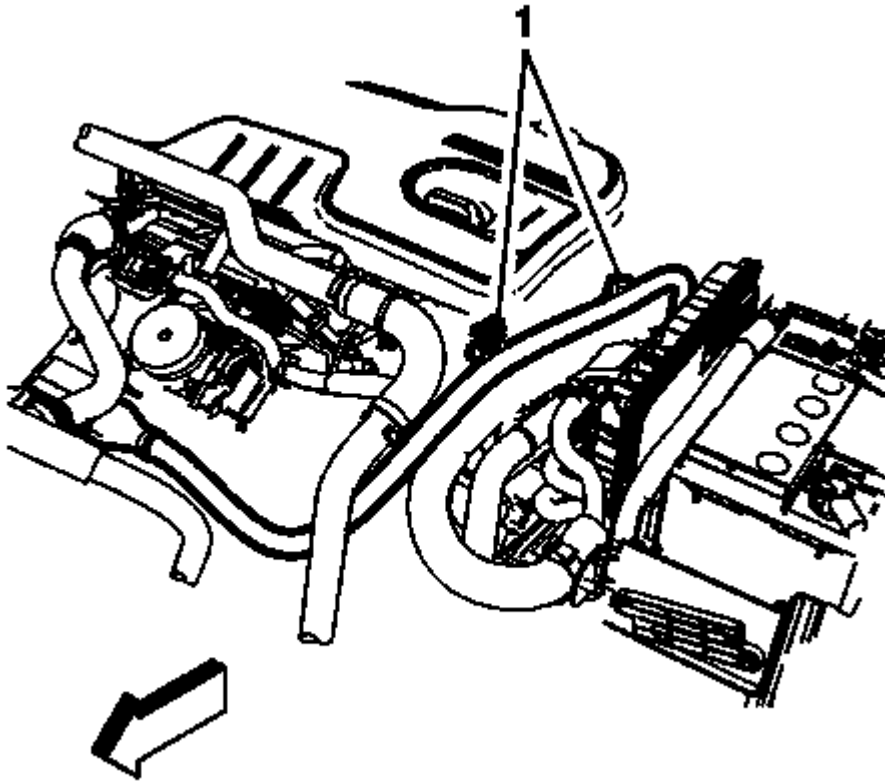


Fig. 51: Drive Motor Generator Battery Cable
Courtesy of GENERAL MOTORS COMPANY

17. Detach the retainers (1) holding the drive motor generator battery cable to the fuel pump cover and the heater outlet bracket.

NOTE: **Replace the retainers (1) if re-using the drive motor generator battery cable.**

18. Remove the drive motor generator battery cable from the vehicle.

Installation Procedure

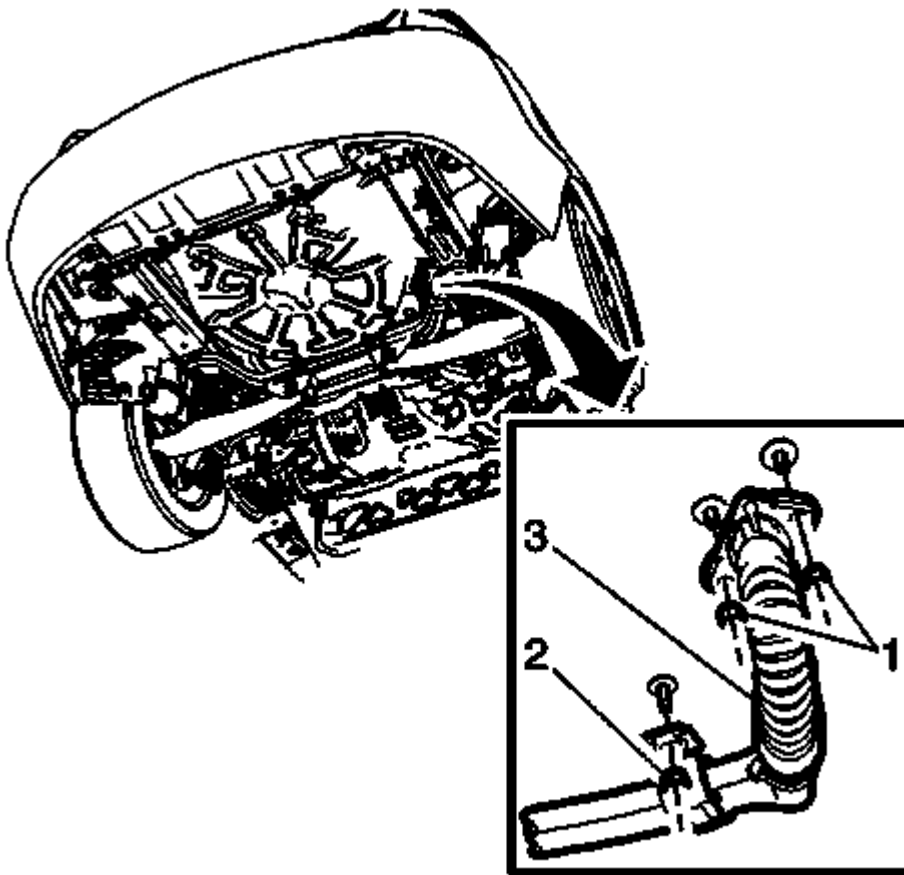


Fig. 52: Drive Motor Generator Cable
Courtesy of GENERAL MOTORS COMPANY

1. Starting at the rear of the vehicle, feed the drive motor generator battery cable through the opening in the floor.

CAUTION: Refer to Fastener Caution .

2. Position the pass-through grommet seal and bracket. Tighten the bracket nuts (1) to 22 N.m (16 lb ft).
3. Tighten the retainer nut (2) to 22 N.m (16 lb ft).

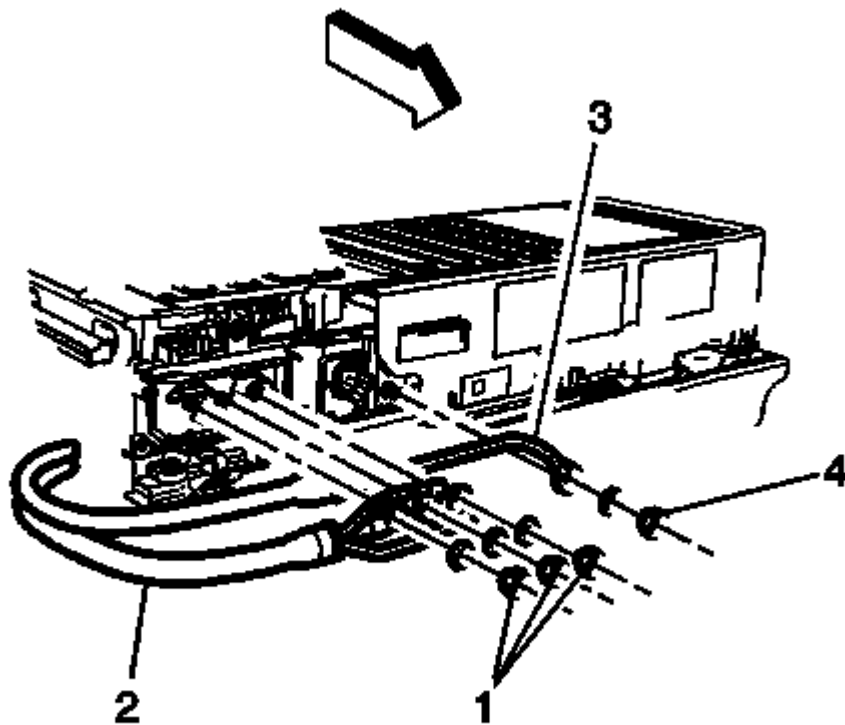


Fig. 53: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

4. Install the high voltage 3-phase branch terminals (2) to the generator battery. Tighten the nuts (1) to 9 N.m (80 lb in).
5. Install the 12V cable (3) and tighten the nut (4) to 9 N.m (80 lb in).

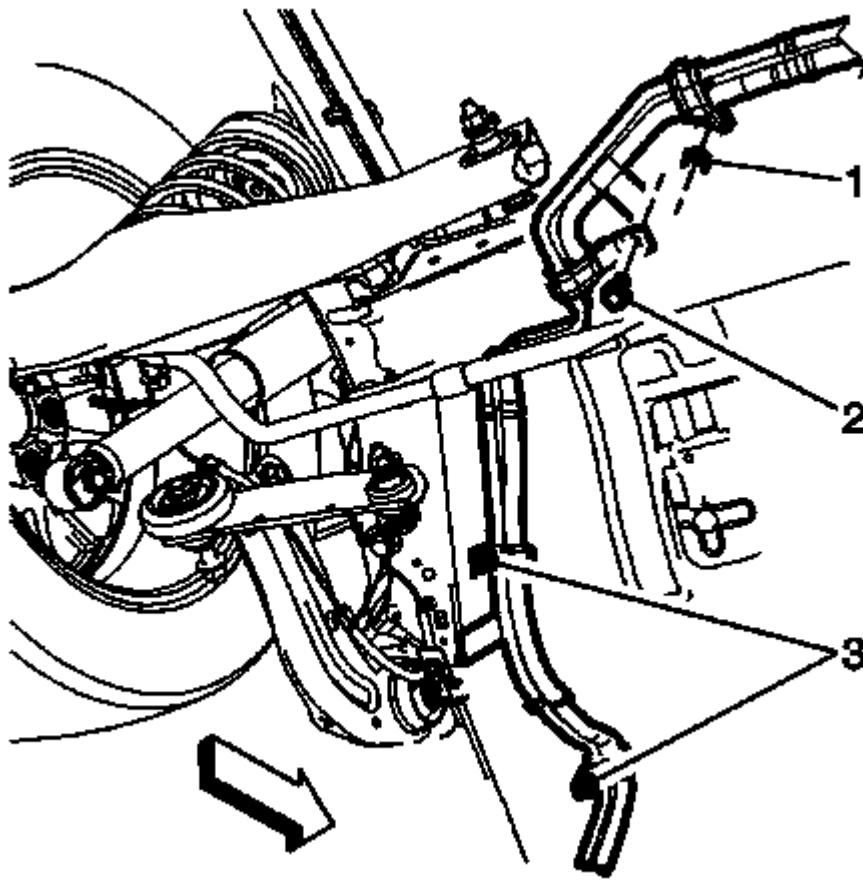


Fig. 54: Drive Motor Generator Retainer Nut
Courtesy of GENERAL MOTORS COMPANY

6. At the left rear frame rail, attach the drive motor generator battery cable to the frame with NEW fasteners (3).
7. Install the retainer nut (1) and bolt (2) to the underbody. Tighten to 22 N.m (16 lb ft).

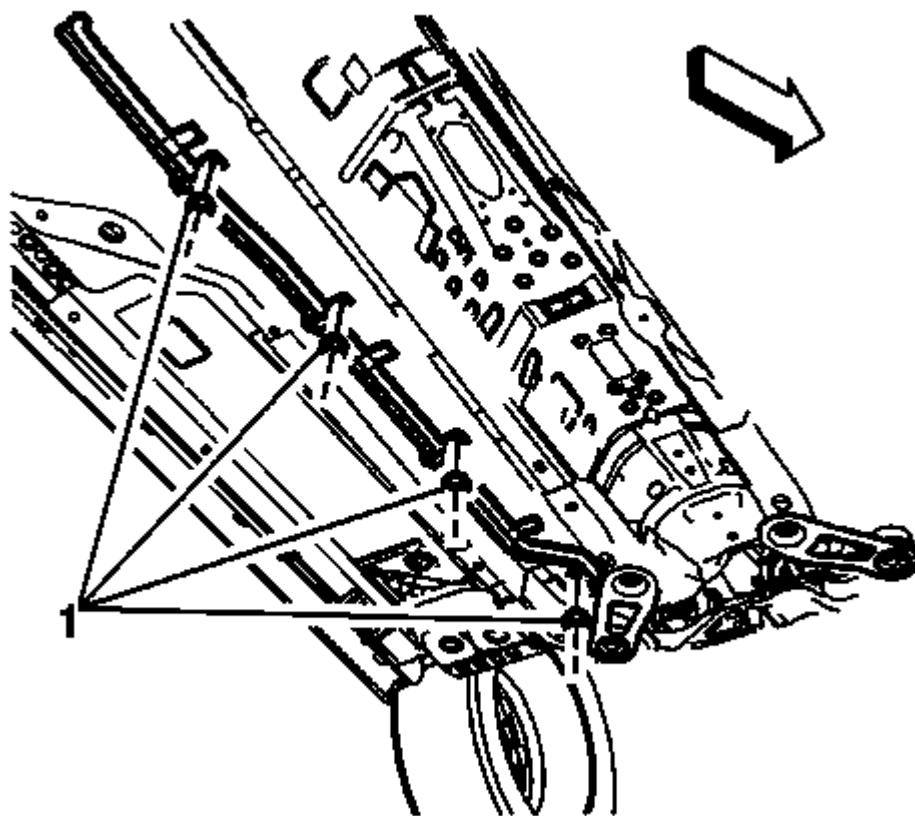


Fig. 55: Drive Motor Generator Battery Fastener Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Working towards the front of the vehicle, attach the drive motor generator battery cable to the underbody. Tighten the nuts (1) to 22 N.m (16 lb ft).

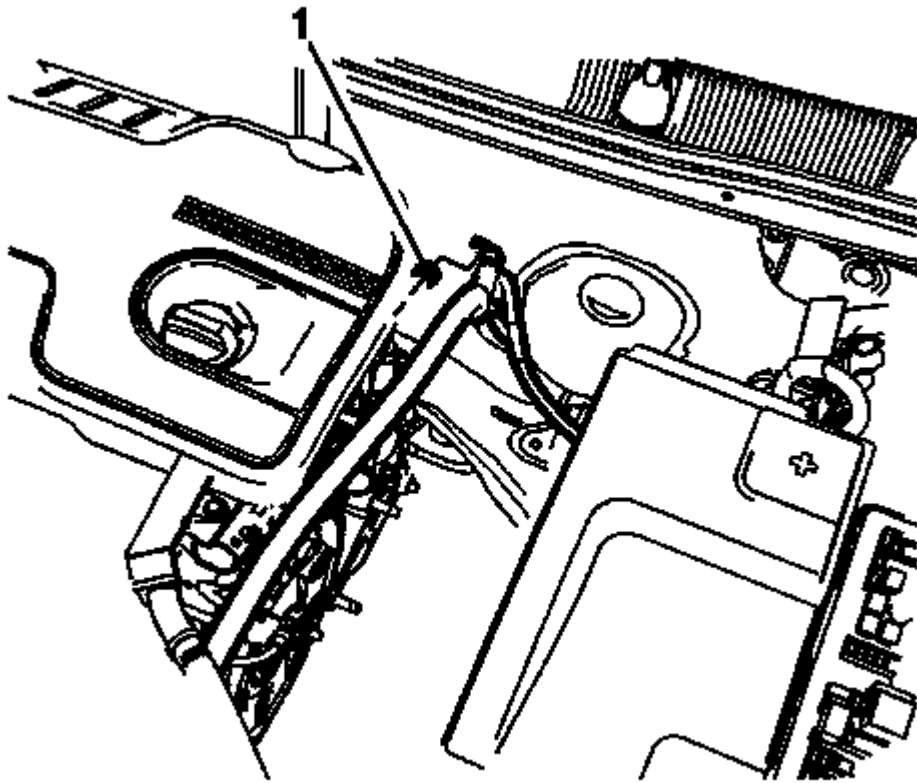


Fig. 56: Drive Motor Generator Battery Cable Retainer Nut
Courtesy of GENERAL MOTORS COMPANY

9. Feed the drive motor generator battery cable into the engine compartment and install to the plenum. Tighten the nut (1) to 22 N.m (16 lb ft).

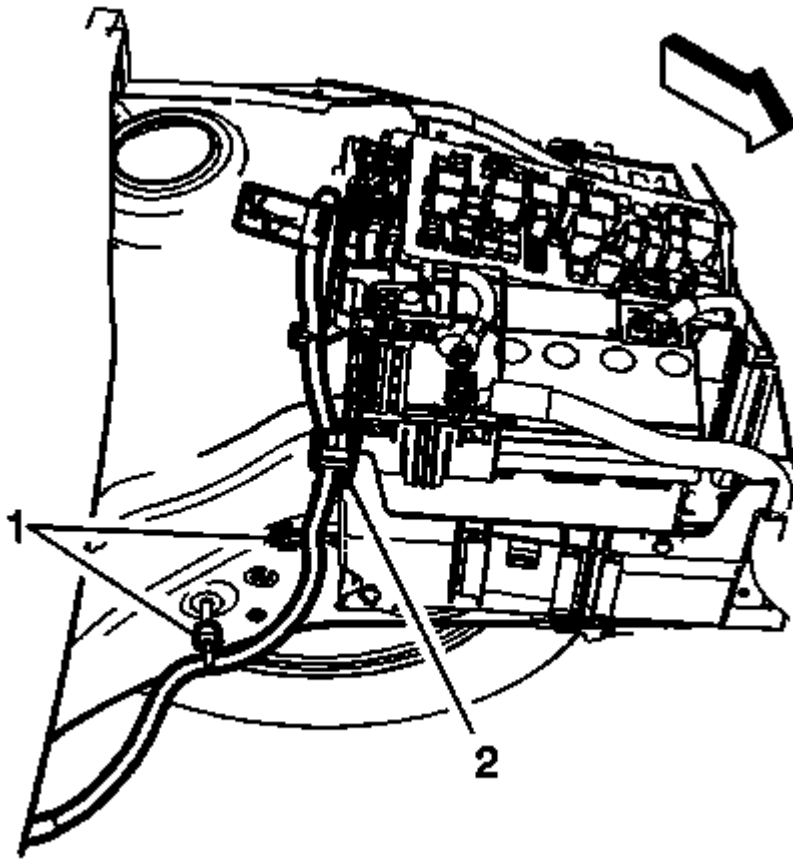


Fig. 57: Drive Motor Generator Battery Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

10. Install the drive motor generator battery 12V branch, to the left front frame rail, with NEW fasteners (1).
11. Secure the cable to the battery tray with clip (2).

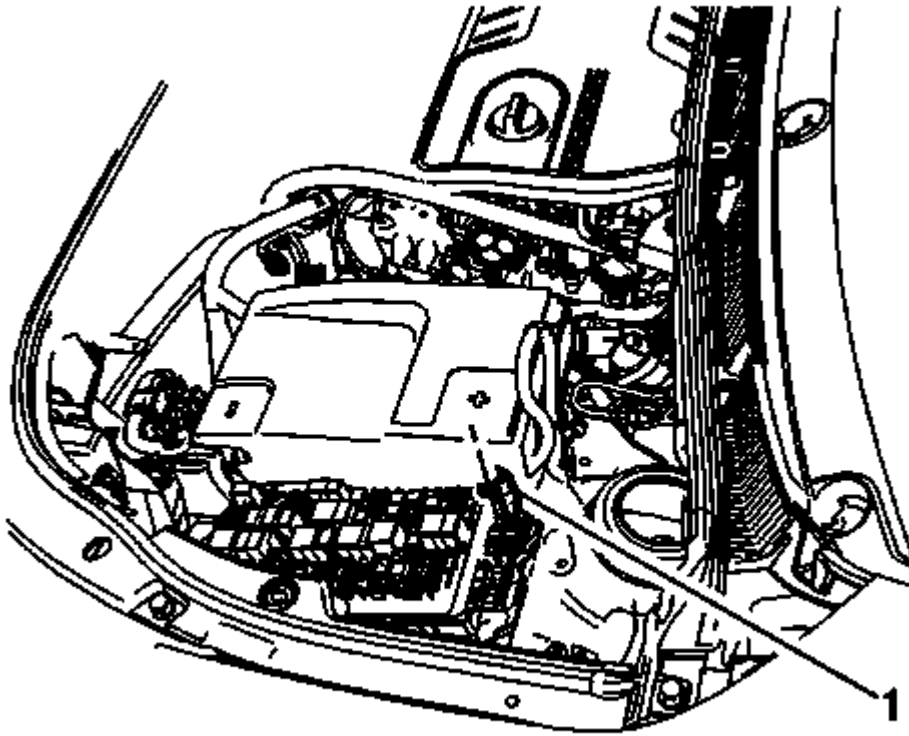


Fig. 58: Drive Motor Generator Battery Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

12. Install the 12V terminal (1) to the underhood fuse block and tighten the nut to 9 N.m (80 lb in).

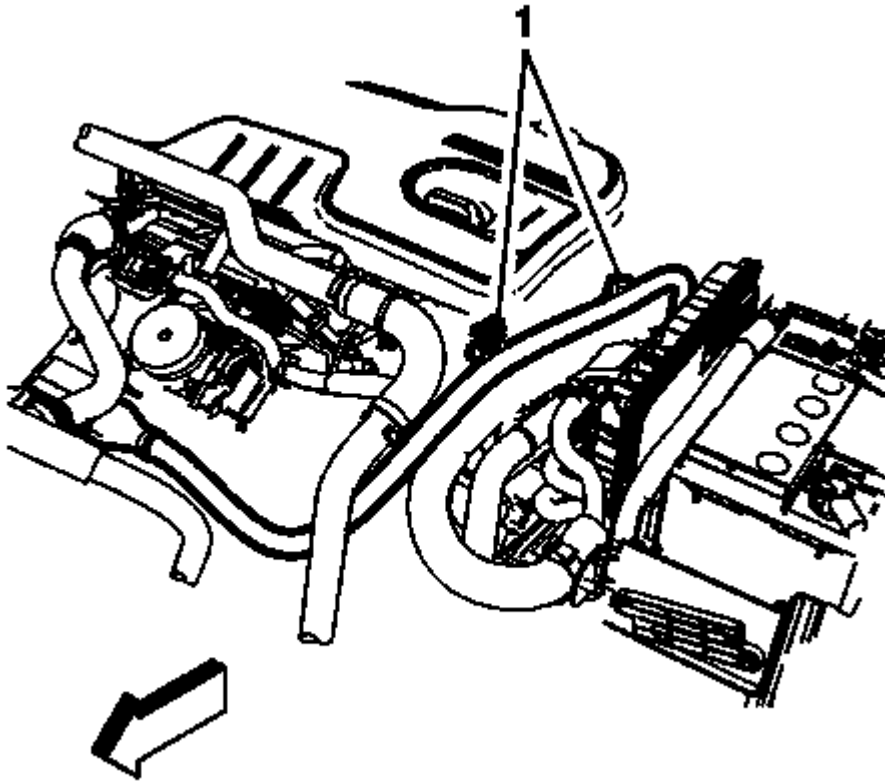


Fig. 59: Drive Motor Generator Battery Cable
Courtesy of GENERAL MOTORS COMPANY

13. Fasten the drive motor generator battery cable to the heater outlet bracket and fuel pump cover with NEW fasteners (1).

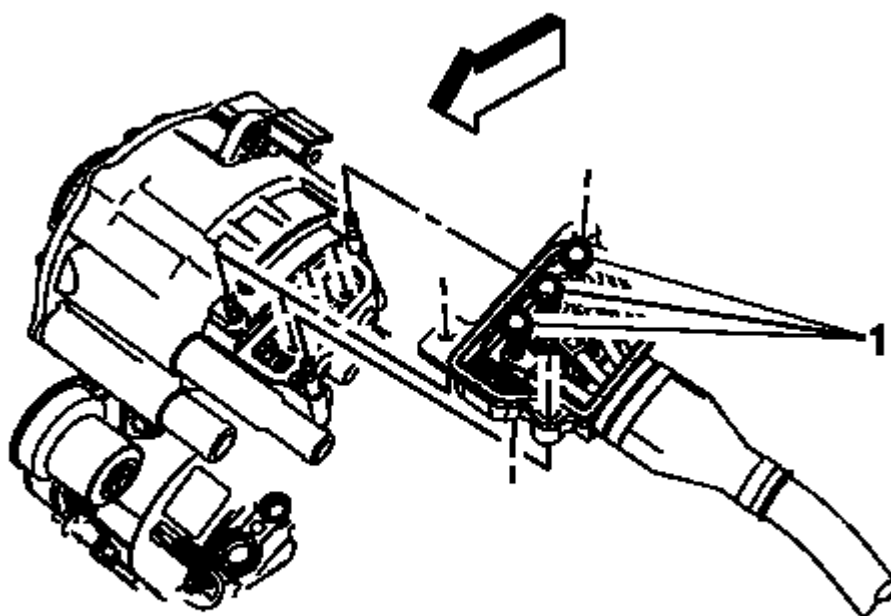


Fig. 60: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

NOTE: Be sure the drive motor generator battery cable cover is fully seated against the drive motor generator battery cable housing prior to installing and fastening the nuts. This will ensure proper alignment and engagement of HVIL terminals.

14. Position the drive motor generator battery cable to the starter generator assembly studs. Tighten the bolts (1) to 9 N.m (80 lb in).

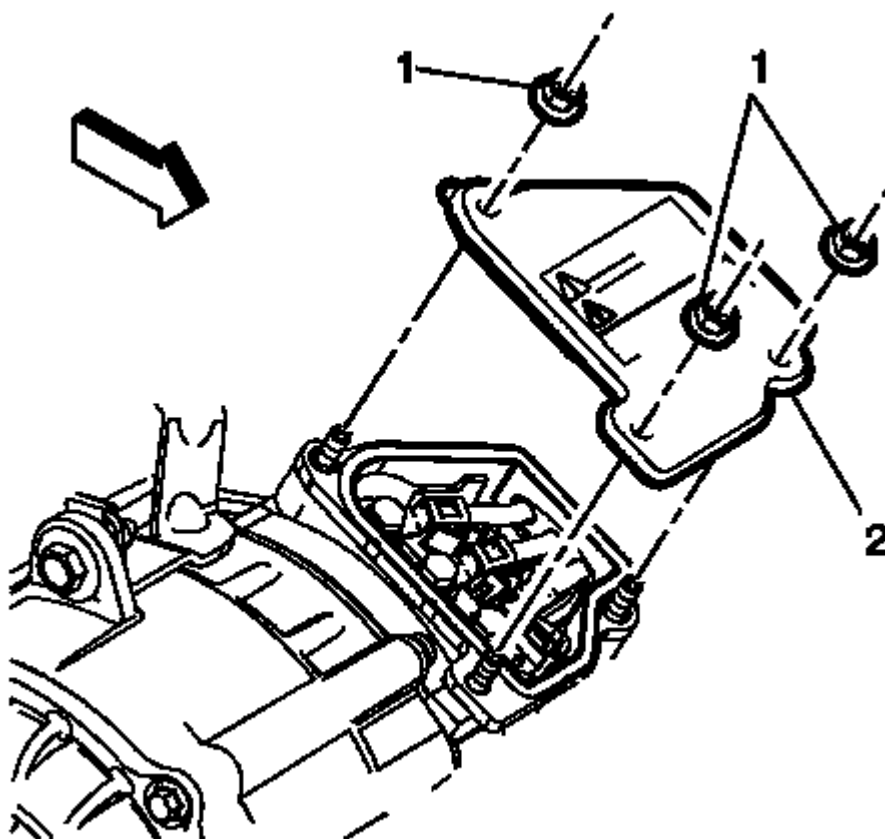


Fig. 61: Generator Starter Cover Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Install the cover (2) and tighten the nuts (1) to 9 N.m (80 lb in).
16. Install the left front frame reinforcement. Refer to **Drivetrain and Front Suspension Frame Replacement** .
17. Install the left front underbody air deflector. Refer to **Underbody Front Air Deflector Replacement - Left Side** .
18. Install the fuel tank. Refer to **Fuel Tank Replacement** .
19. Enable the high voltage system. Refer to **High Voltage Enabling**.

BATTERY ENERGY CONTROL MODULE WIRING HARNESS REPLACEMENT (HV MEASURING HARNESS 1 AND 2)

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Ignition OFF, disable the high voltage at the A4 hybrid battery pack. Refer to **High Voltage Disabling**.

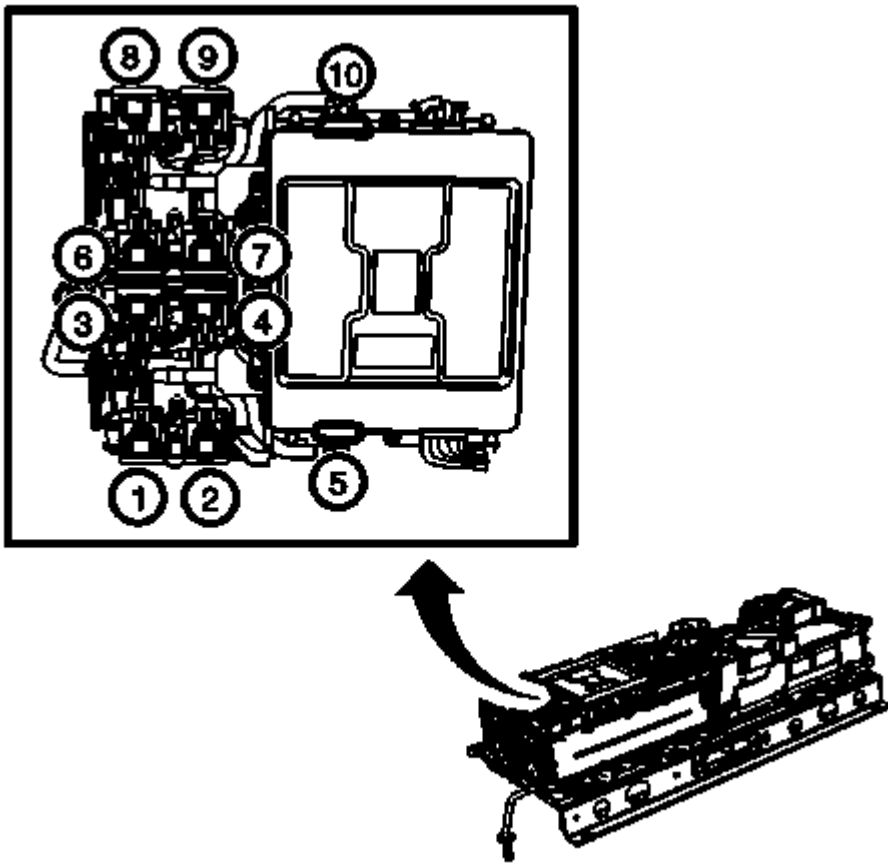


Fig. 62: Identifying Connectors Sequence
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the following connectors, in the above graphic sequence shown, from the battery energy control module.

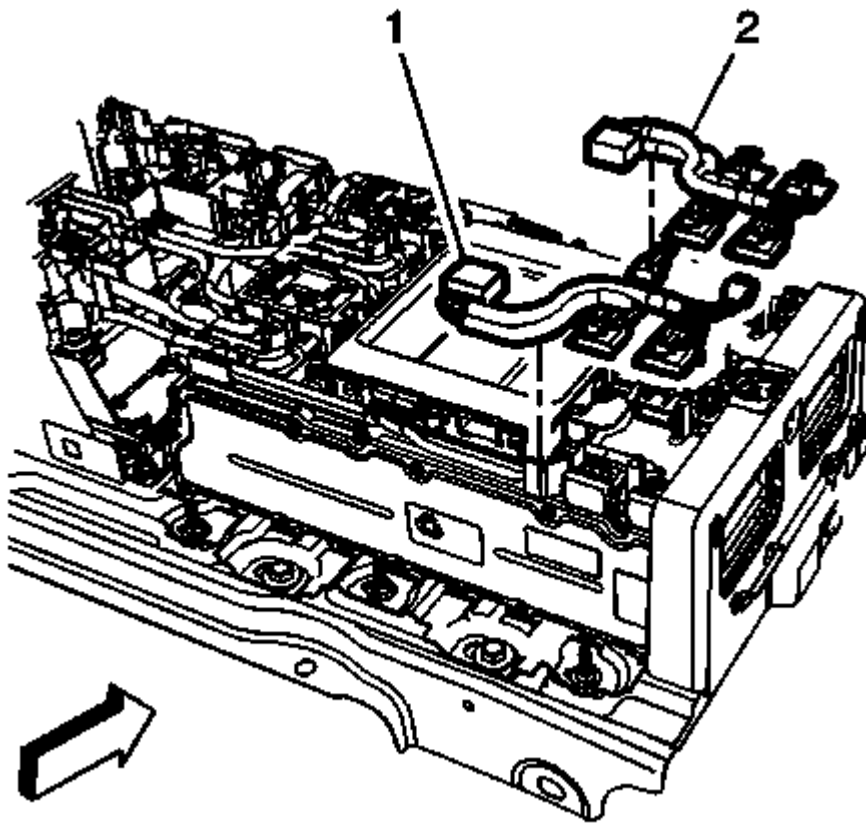


Fig. 63: Battery Energy Control Module Right Side Harness
Courtesy of GENERAL MOTORS COMPANY

3. Remove the battery energy control module right side harness (1) and the left side harness (2).

Installation Procedure

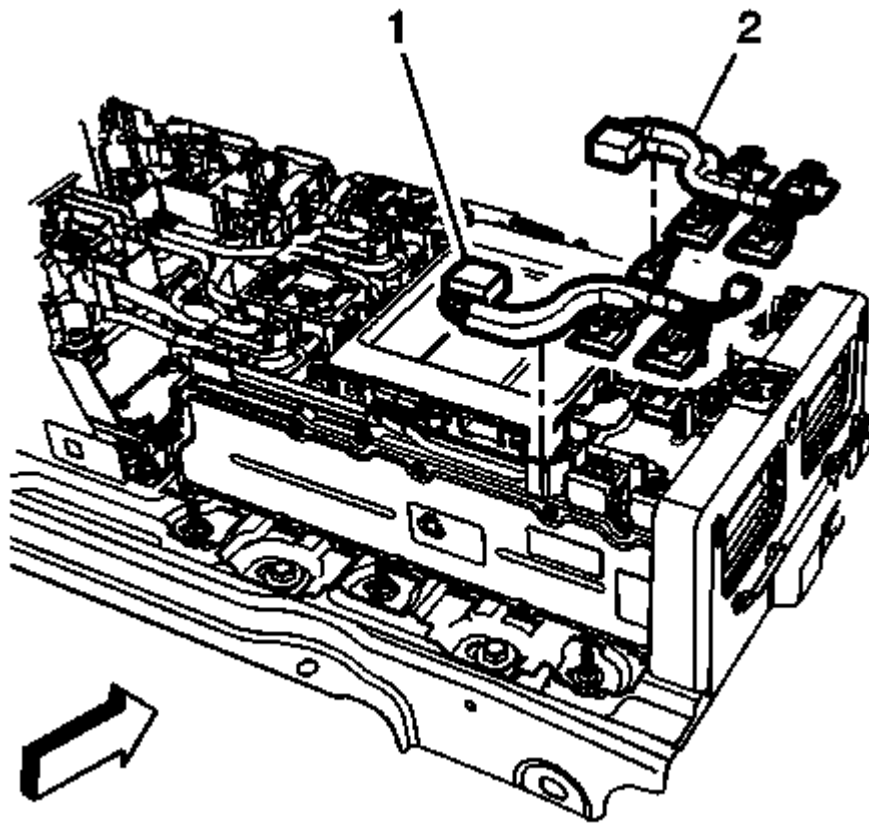


Fig. 64: Battery Energy Control Module Right Side Harness
Courtesy of GENERAL MOTORS COMPANY

1. Install the right side battery energy control module harness (1) and the left side harness (2), into the harness conduit.

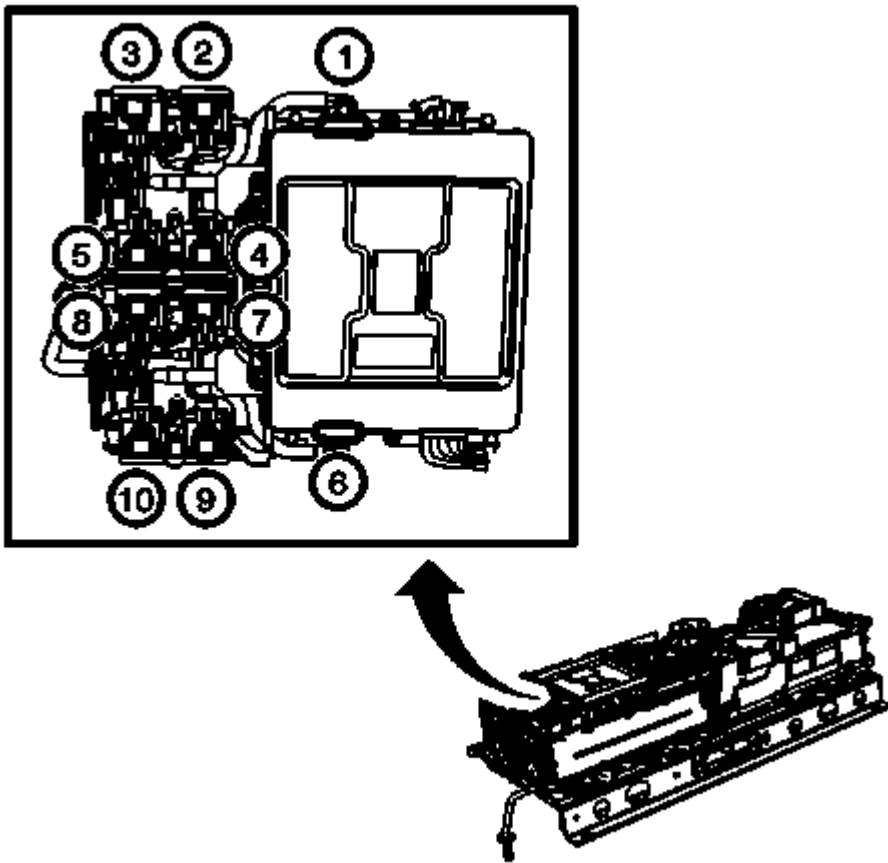


Fig. 65: Battery Energy Control Module Connector Sequence
Courtesy of GENERAL MOTORS COMPANY

2. Connect the battery energy control module connectors in the above graphic sequence.
3. Enable the hybrid battery. Refer to **High Voltage Enabling**.

BATTERY ENERGY CONTROL MODULE WIRING HARNESS REPLACEMENT (BDU,BECM AND BPIM)

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Ignition OFF, disable the high voltage at the A4 hybrid battery pack. Refer to **High Voltage Disabling**.

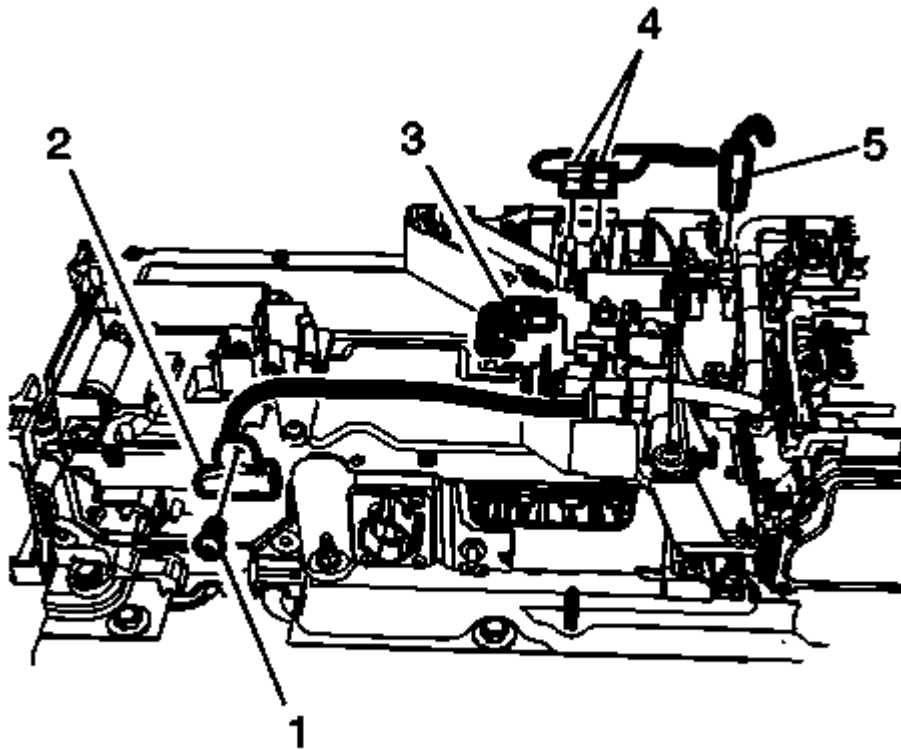


Fig. 66: Cut-Off Switch Fastener

Courtesy of GENERAL MOTORS COMPANY

2. Remove the cut-off switch fastener (1) and the cut-off switch (2) from the battery energy control module wiring junction block.
3. Remove the current sensor connector (3); the pre-charge contacts (4) and the contactor connector (5).

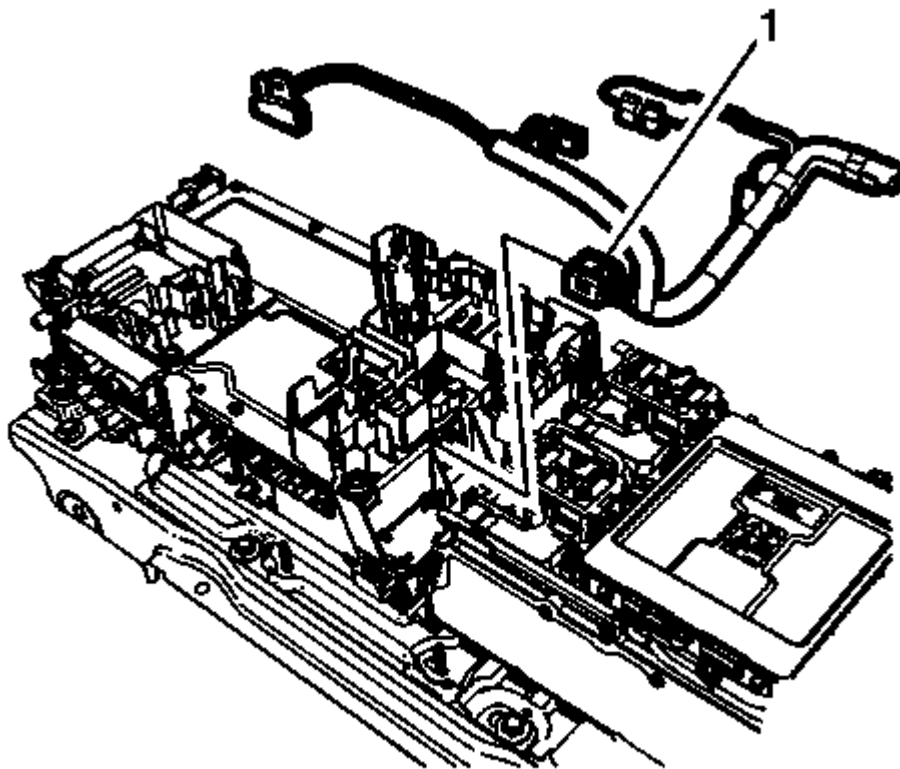


Fig. 67: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove the generator control module connector (1).

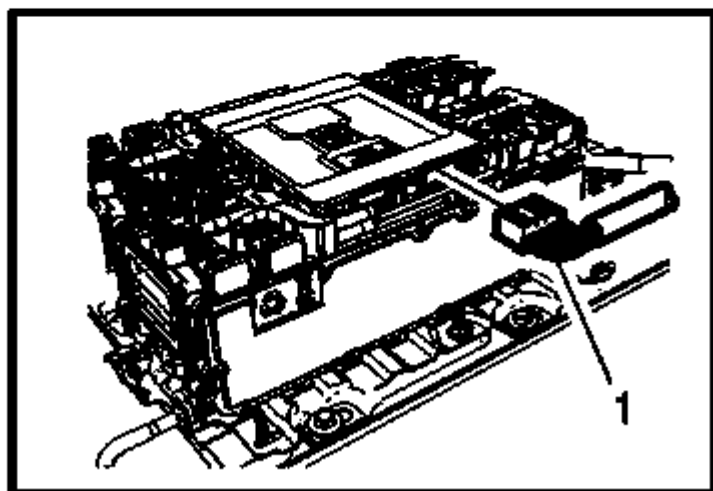
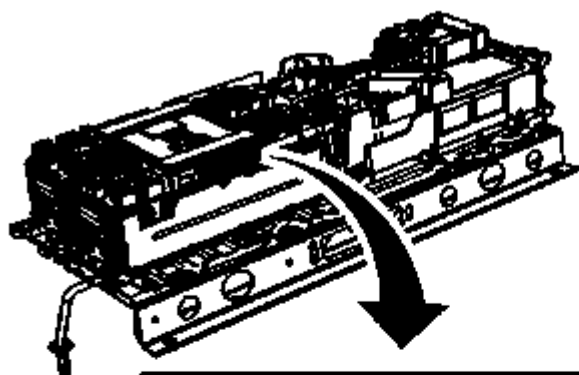


Fig. 68: Battery Energy Control Module
Courtesy of GENERAL MOTORS COMPANY

5. Remove the connector (1) from the battery energy control module.

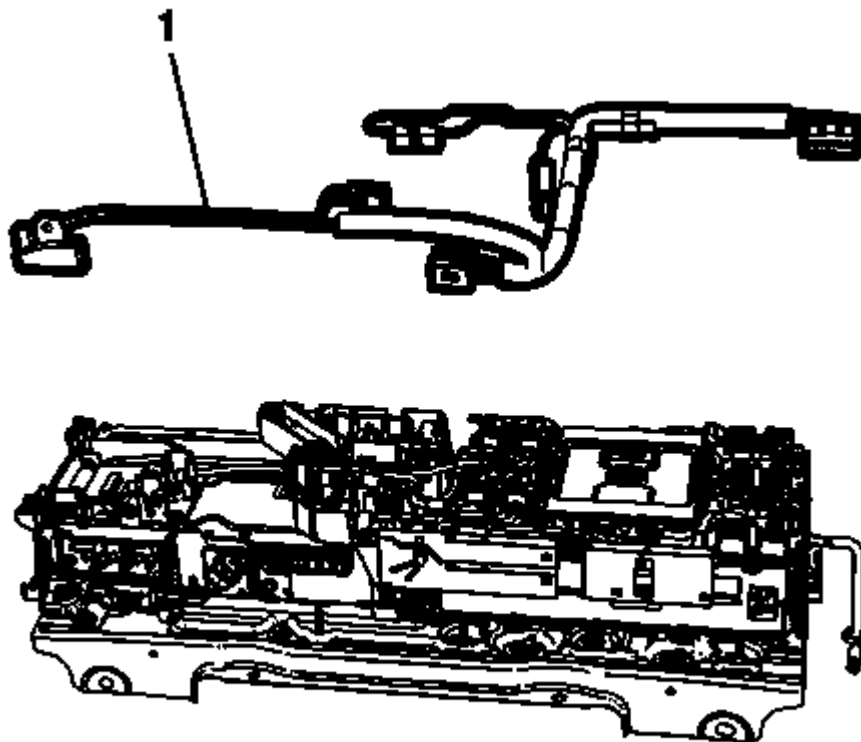


Fig. 69: Battery Energy Control Harness
Courtesy of GENERAL MOTORS COMPANY

6. Remove the battery energy control harness (1).

Installation Procedure

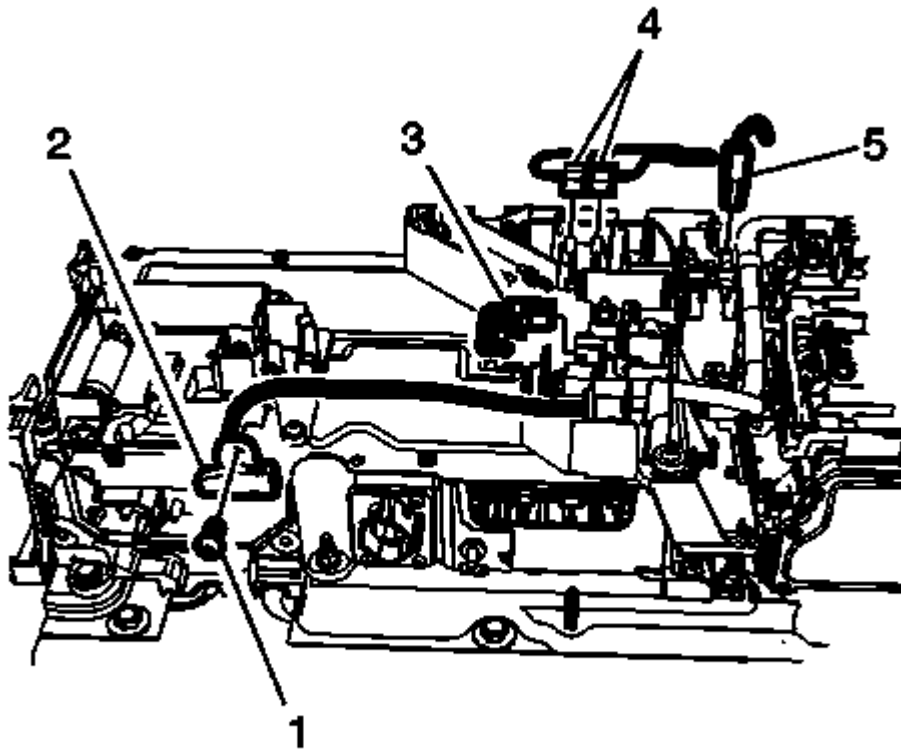


Fig. 70: Cut-Off Switch Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the cut-off switch (2) to the battery energy control module wiring harness junction block and tighten the fasteners (1) to 4 N.m (35 lb in).
2. Connect the following to the generator battery disconnect relay block:
 - Current Sensor Connector (3).
 - Pre-Charge Contacts (4).
 - Contactor Connector (5).

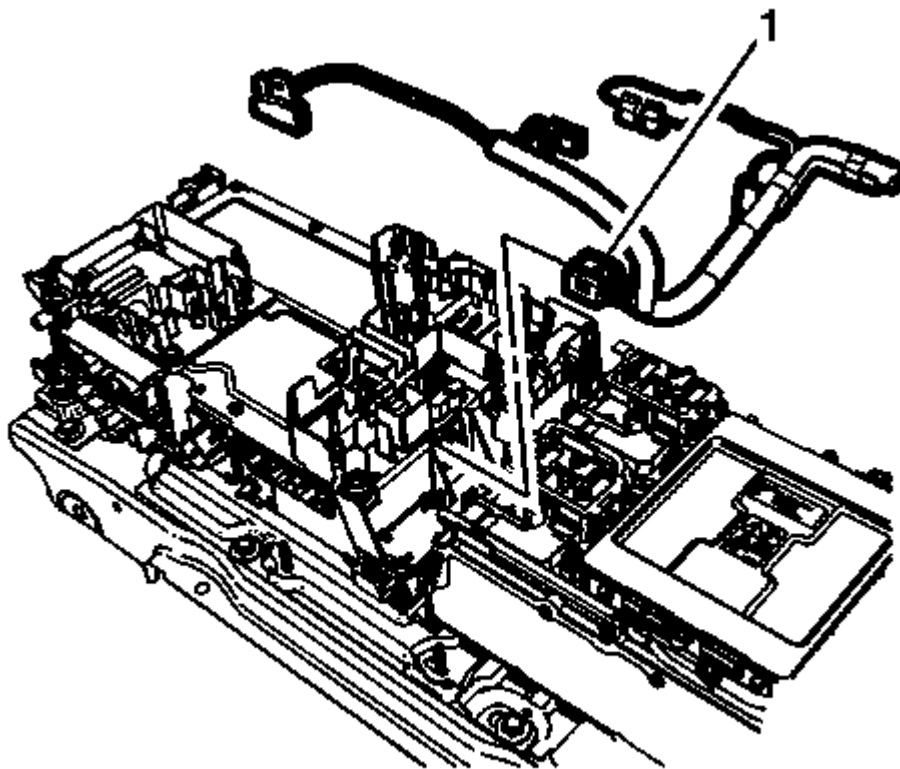


Fig. 71: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the connector (1) to the generator control module.

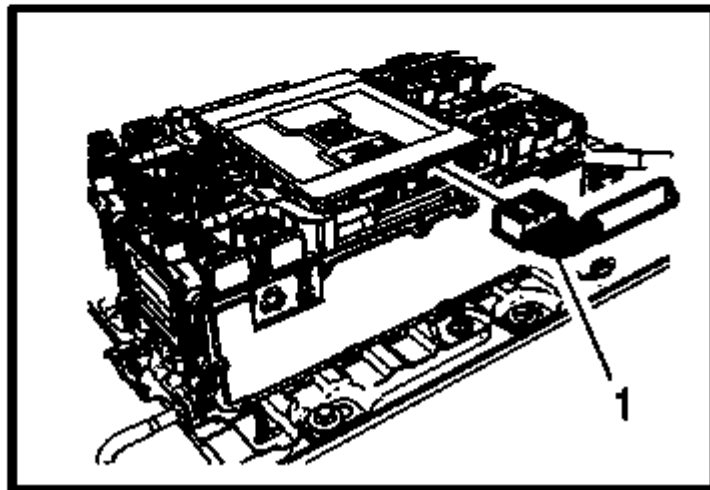
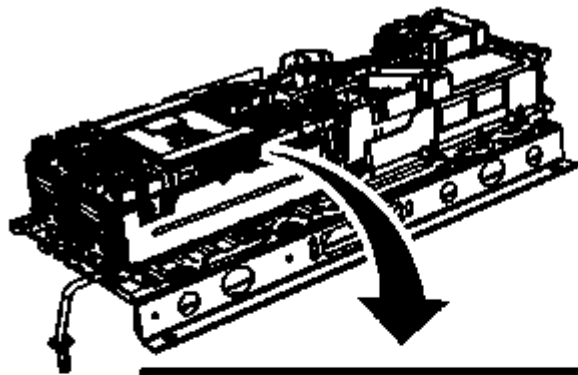


Fig. 72: Battery Energy Control Module
Courtesy of GENERAL MOTORS COMPANY

4. Install the connector (1) to the battery energy control module.
5. Enable the hybrid battery. Refer to **High Voltage Enabling**.

GENERATOR BATTERY REPLACEMENT

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Disable the hybrid battery. Refer to **High Voltage Disabling**.
2. Remove the battery energy control module. Refer to **Battery Energy Control Module Replacement**.
3. Remove the battery energy control module wiring harness - BDU, BECM and BPIM. Refer to **Battery Energy Control Module Wiring Harness Replacement (BDU,BECM and BPIM)**, **Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**.

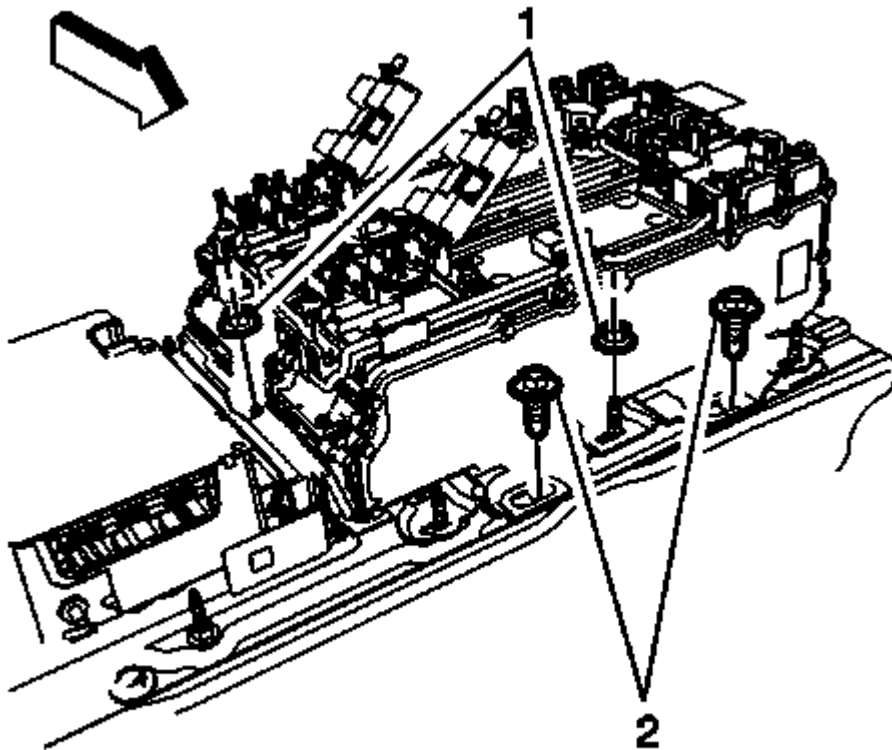


Fig. 73: Generator Battery Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: Remember the location of fastener (1) as not to interfere with the installation of the generator control and battery module cover.

4. Remove the generator battery fasteners (1) and (2).

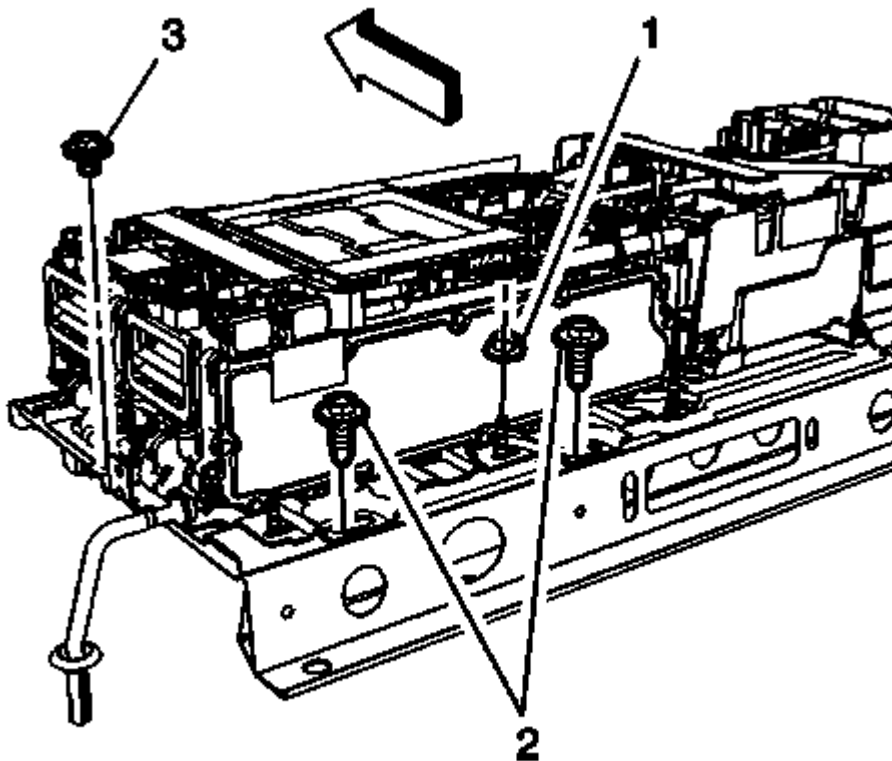


Fig. 74: Mounting Location Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: Remember the location of fastener (1) as not to interfere with the installation of the generator control and battery module cover.

5. Remove the fasteners (1) and (2).
6. Remove the mounting location fastener (3).

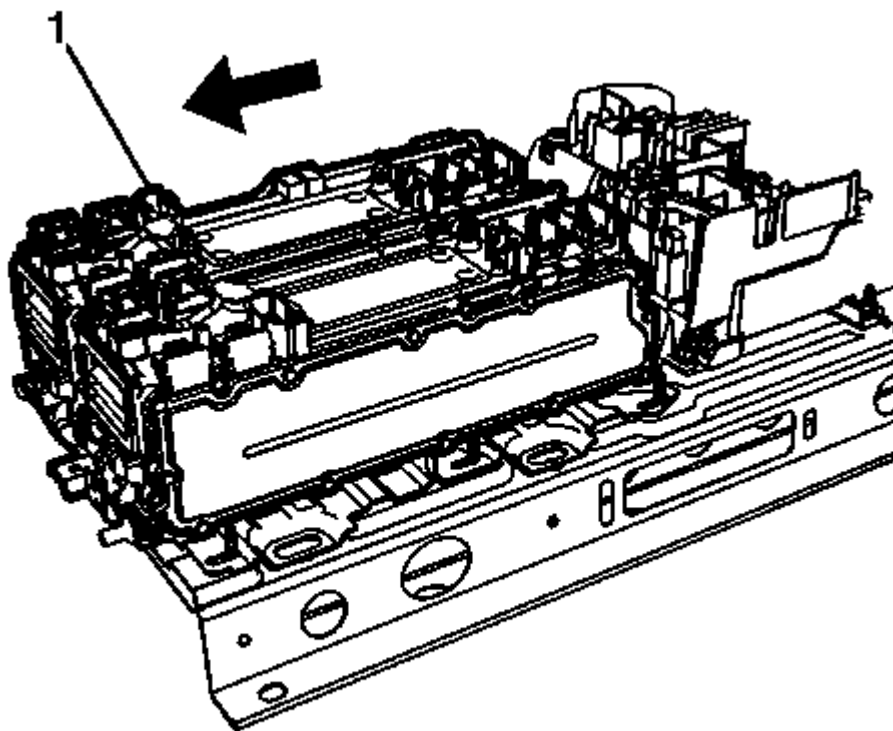


Fig. 75: Generator Battery

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use high voltage protective gloves.

7. Slide the generator battery (1) in the direction shown.

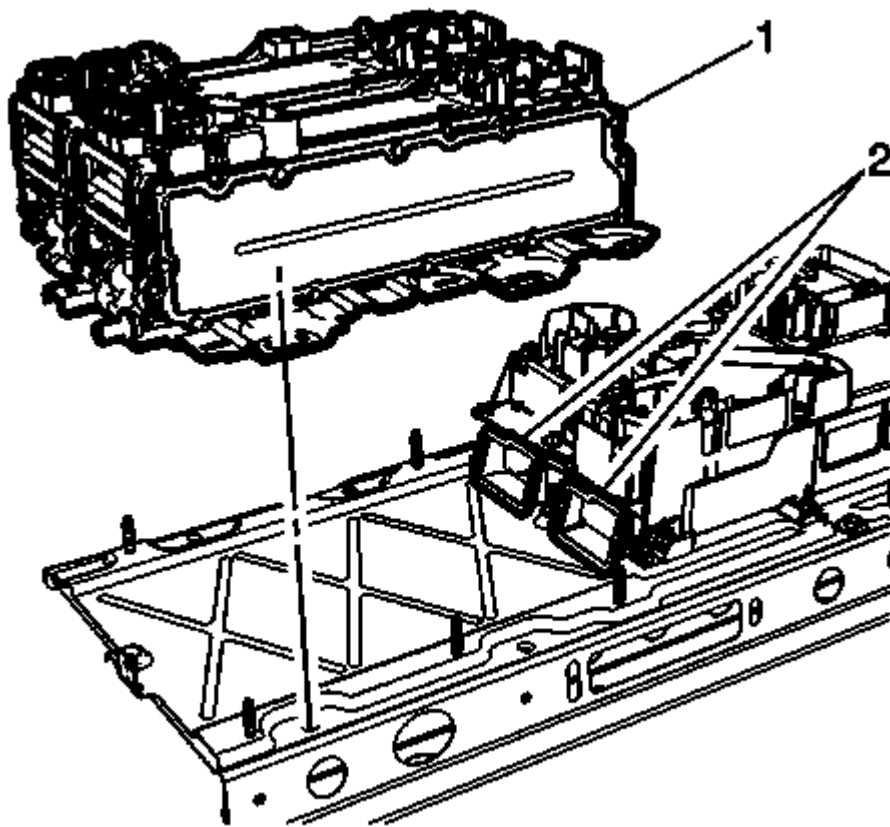


Fig. 76: Intermediate Duct Seals

Courtesy of GENERAL MOTORS COMPANY

8. With the help of a second technician, lift the generator battery (1) into the rear compartment area.
9. Inspect the intermediate duct seals (2) and replace if damaged.

Installation Procedure

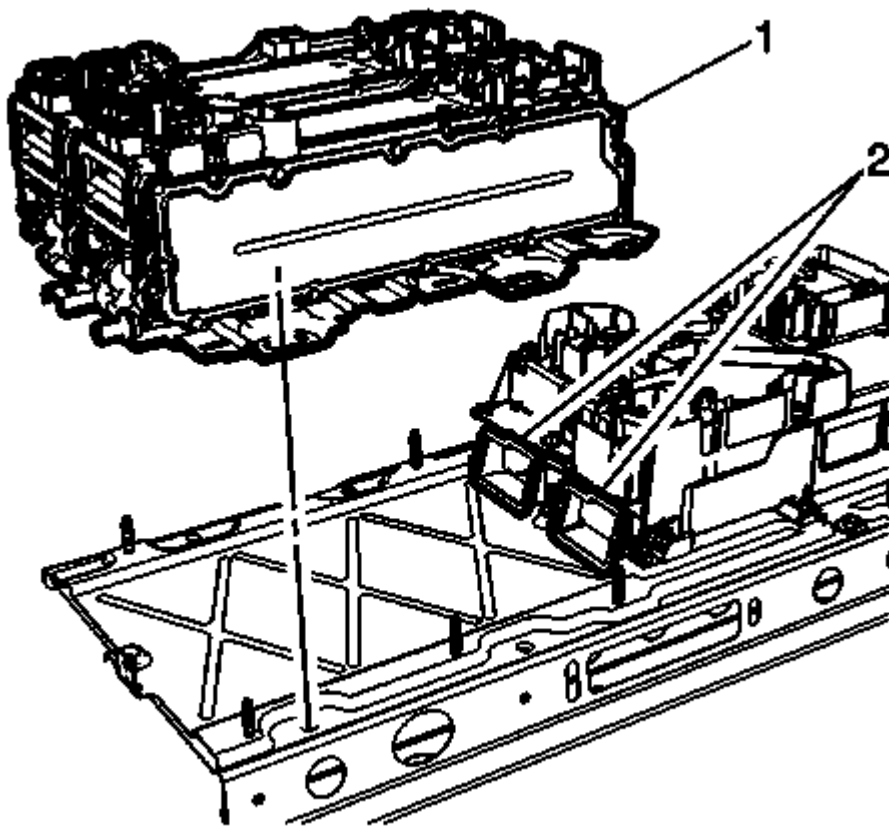


Fig. 77: Intermediate Duct Seals

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. With the help of a technician, install the generator battery (1) to the mounting studs.

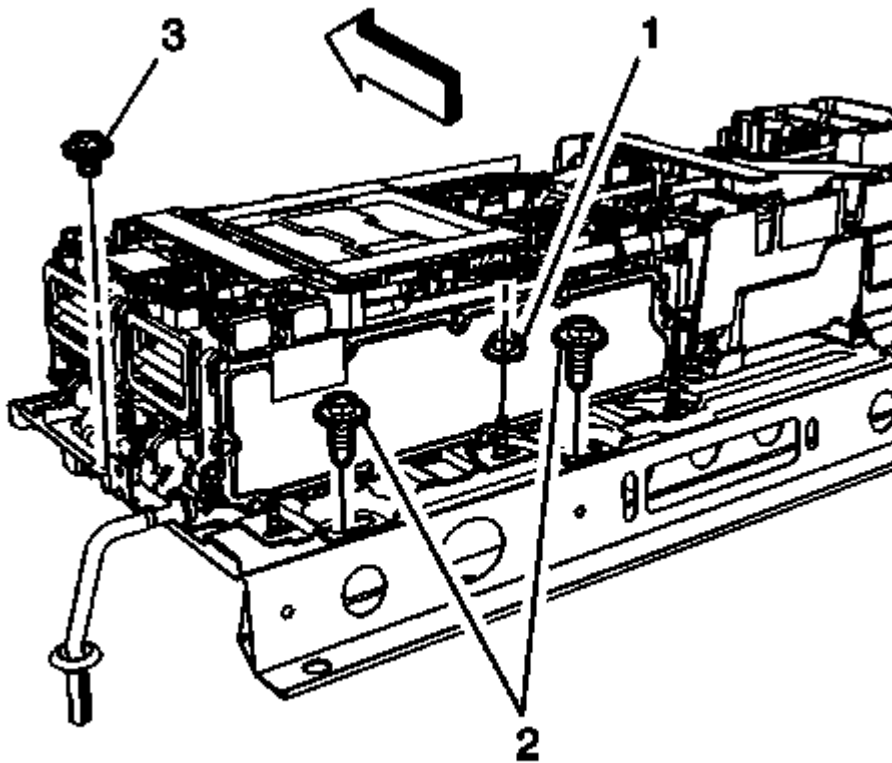


Fig. 78: Mounting Location Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Slide the generator battery towards the intermediate duct seals and install the locating fastener (3). Tighten the fastener (3) to 22 N.m (16 lb ft).
3. Install the generator battery fastener (2) and tighten to 22 N.m (16 lb ft).
4. Install the generator battery fasteners (2) and tighten to 22 N.m (16 lb ft).

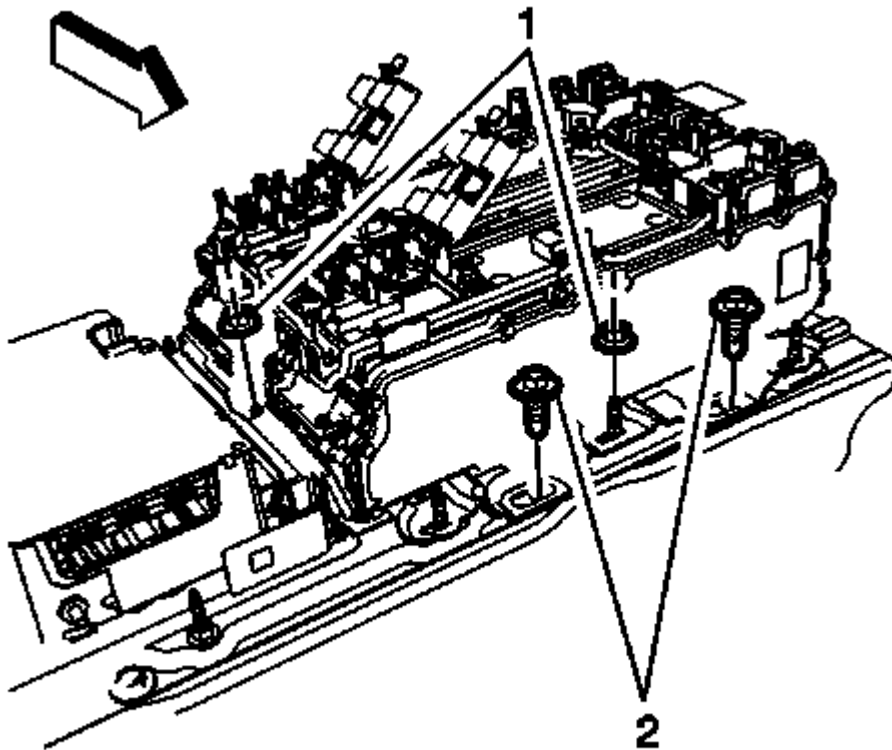


Fig. 79: Generator Battery Fasteners
 Courtesy of GENERAL MOTORS COMPANY

5. Install the generator battery fasteners (1) and tighten to 22 N.m (16 lb ft).
6. Install the generator battery fasteners (2) and tighten to 22 N.m (16 lb ft).
7. Install the battery energy control module. Refer to **Battery Energy Control Module Replacement**.
8. Install the battery energy control module harness - BDU, BECM and BPIM. Refer to **Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)**, **Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**.
9. Enable the hybrid battery. Refer to **High Voltage Enabling**.

BATTERY VENT TUBE REPLACEMENT

Removal Procedure

For equivalent regional tools , refer to **Special Tools**.

1. Remove the rear compartment floor panel with battery cover. Refer to **Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6)** , **Rear Compartment Floor Panel Trim Replacement (with Blower Cover, HP6)** .

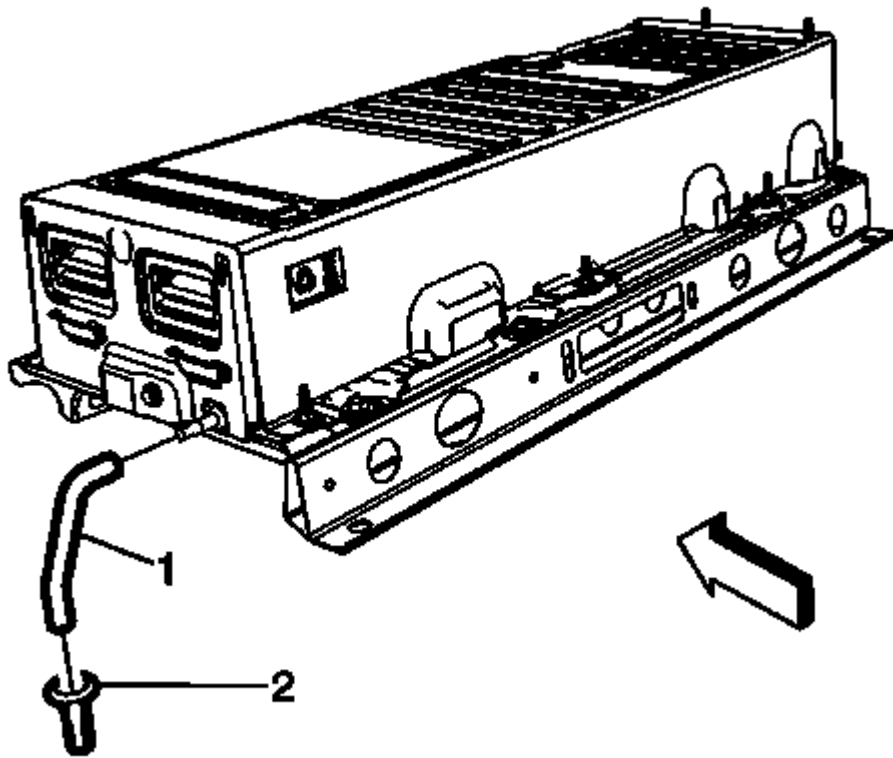


Fig. 80: Battery Vent Tube

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not bend or disfigure the battery vent tube.

NOTE: Battery vent tube and rear compartment grommet are replaced as an assembly.

2. Remove the battery vent tube (1) with the rear compartment grommet (2).

Installation Procedure

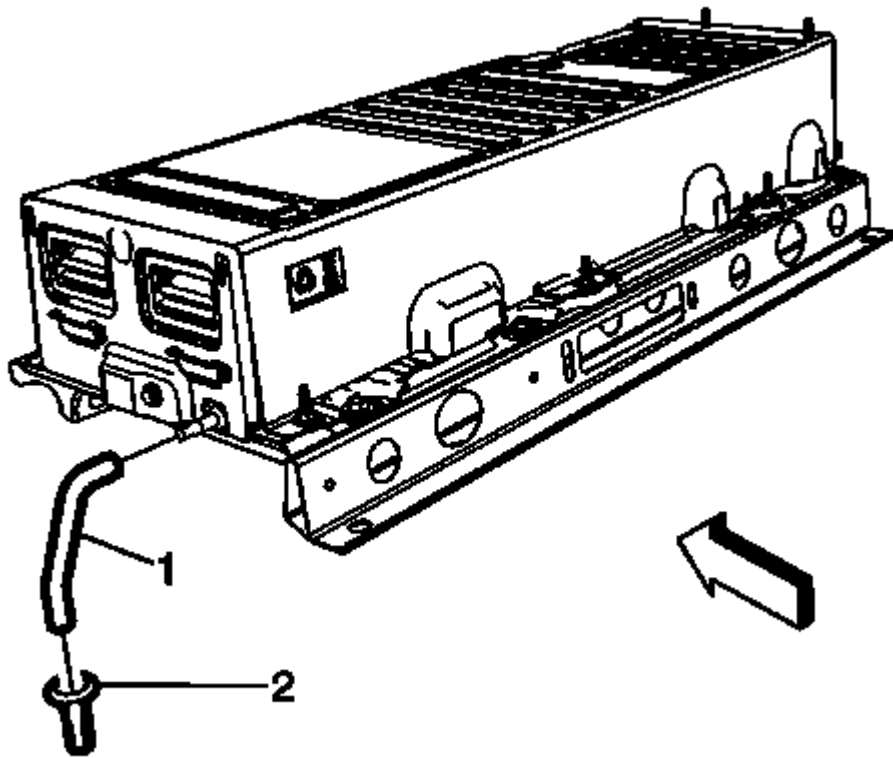


Fig. 81: Battery Vent Tube

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not bend or disfigure the battery vent tube.

NOTE: Battery vent tube and rear compartment grommet are replaced as an assembly.

1. Install the battery vent tube (1) with the rear compartment grommet (2).
2. Install the rear compartment floor panel with battery cover. Refer to **Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6)** , **Rear Compartment Floor Panel Trim Replacement (with Blower Cover, HP6)** .

DRIVE MOTOR BATTERY WIRE JUNCTION BLOCK RELAY REPLACEMENT

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Ignition OFF, disable the high voltage at the A4 hybrid battery pack. Refer to **High Voltage Disabling**.

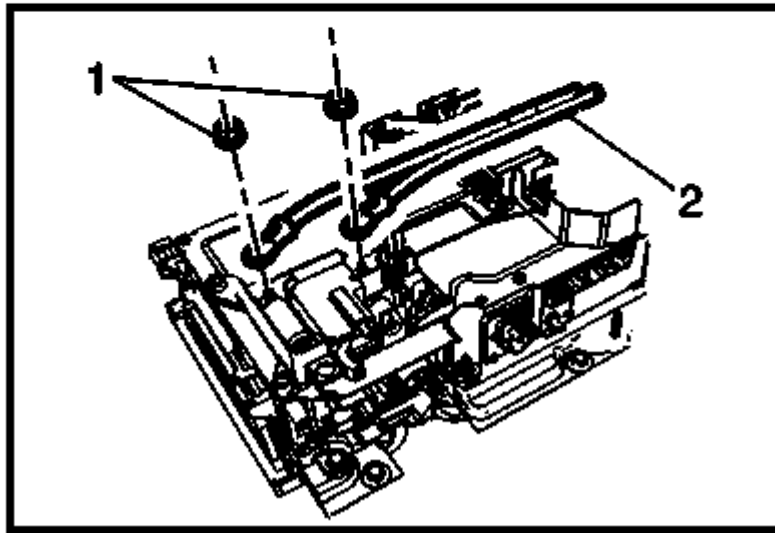
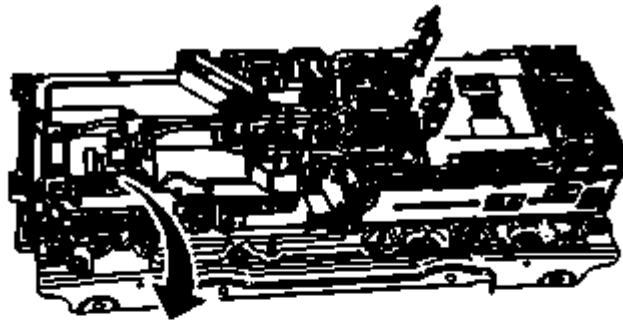


Fig. 82: High Voltage Fasteners And Cables
Courtesy of GENERAL MOTORS COMPANY

2. Remove the high voltage fasteners (1) and the high voltage cables (2) from the battery energy control module wiring junction block.

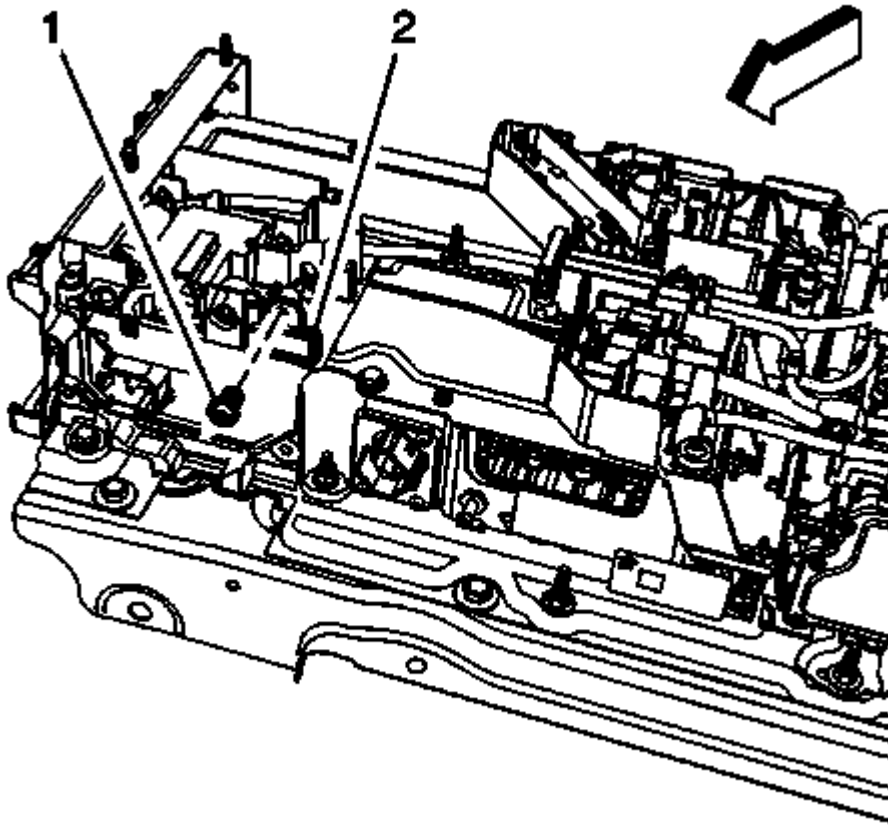


Fig. 83: Cut-Off Switch Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the cut-off switch fastener (1) and set aside the cut-off switch (2).

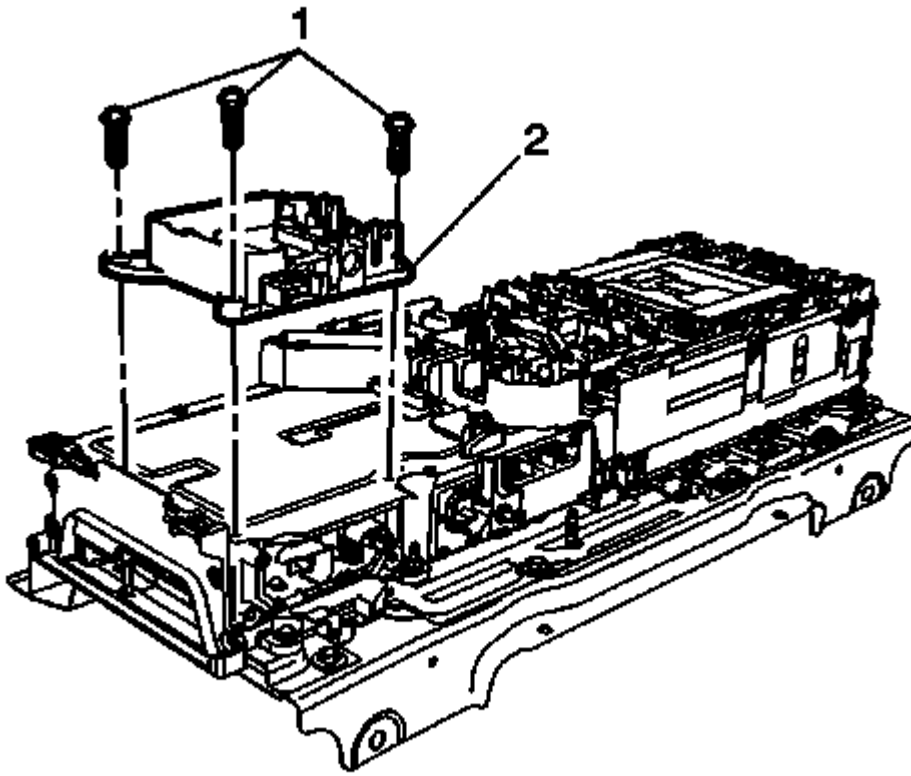


Fig. 84: Generator Battery Disconnect Relay Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery energy control module wiring junction block fasteners (1) and remove the battery energy control module wiring junction block (2).

Installation Procedure

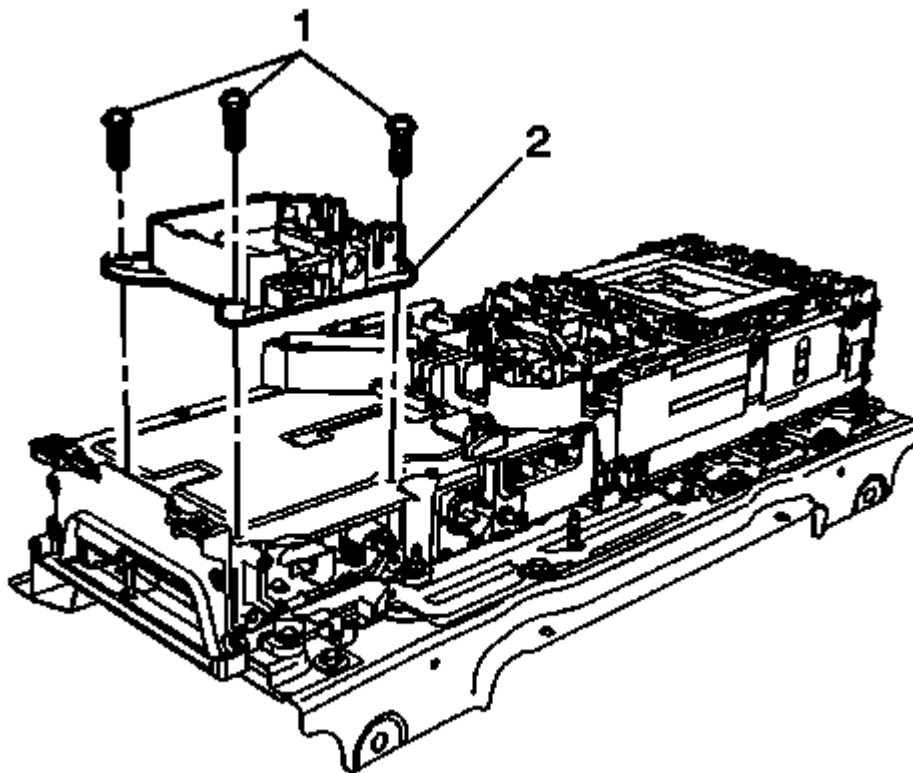


Fig. 85: Generator Battery Disconnect Relay Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the battery energy control module wiring junction block (2) to the generator control module and tighten the fasteners (1) to 9 N.m (80 lb in).

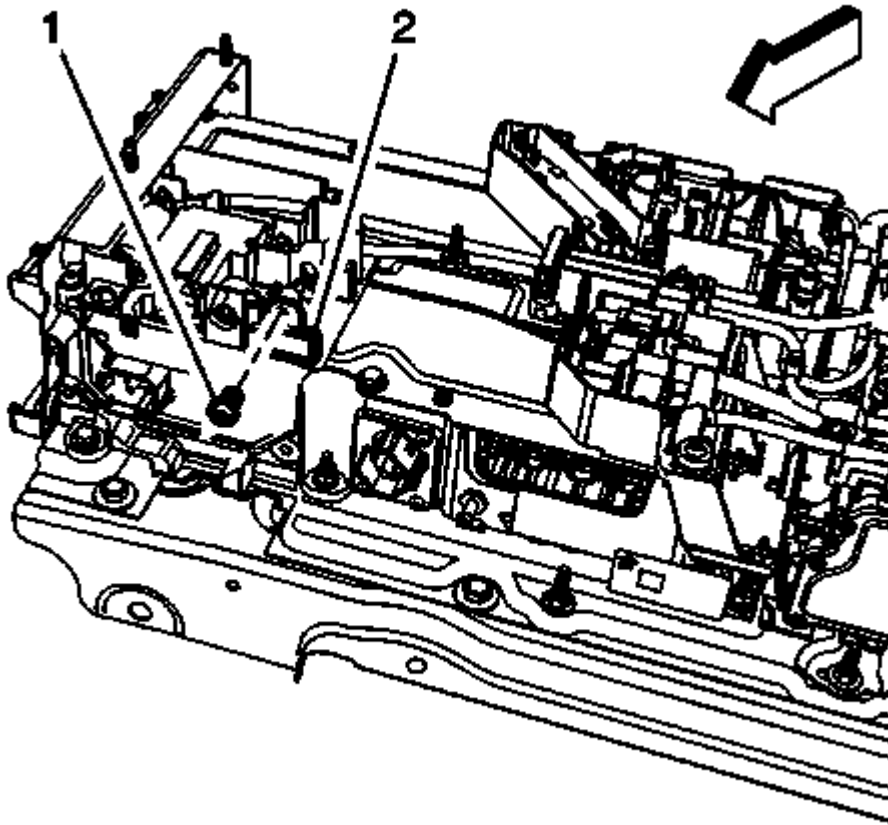


Fig. 86: Cut-Off Switch Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Install the cut-off switch (2) to the drive motor battery junction block relay and tighten the fastener (1) to 4 N.m (35 lb in).

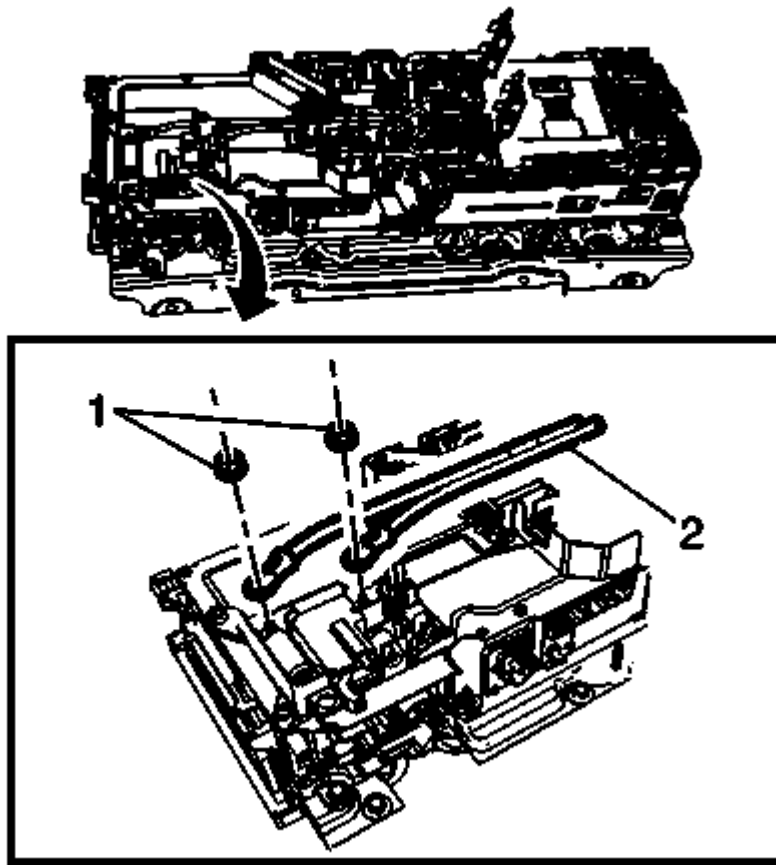


Fig. 87: High Voltage Fasteners And Cables
Courtesy of GENERAL MOTORS COMPANY

3. Install the high voltage cables (2) to the battery energy control module wiring junction block and tighten the fasteners (1) to 9 N.m (80 lb in).
4. Enable the hybrid battery. Refer to **High Voltage Enabling**.

BATTERY ENERGY CONTROL MODULE WIRING JUNCTION BLOCK REPLACEMENT

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Ignition OFF, disable the high voltage at the A4 hybrid battery pack. Refer to **High Voltage Disabling**.

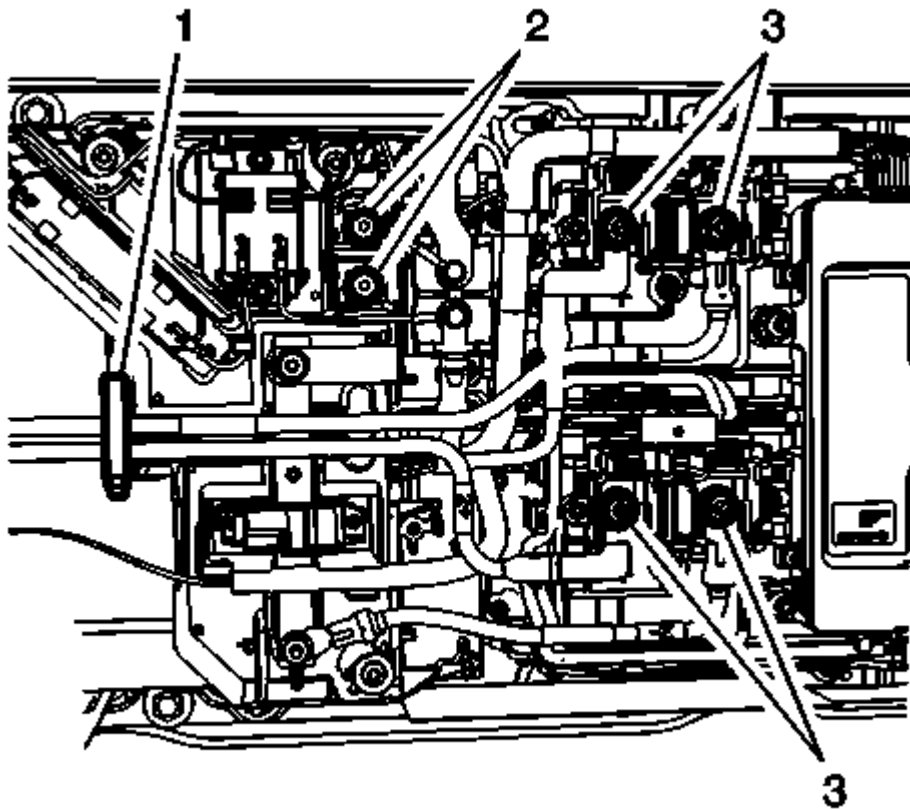


Fig. 88: High Voltage Battery Cables-To-Batteries Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fasteners (3) retaining the high voltage battery cables to the batteries.
3. Disengage the cable retaining clip (1) and reposition the high voltage cables.
4. Remove the fasteners (2) retaining the junction block to the generator control module.

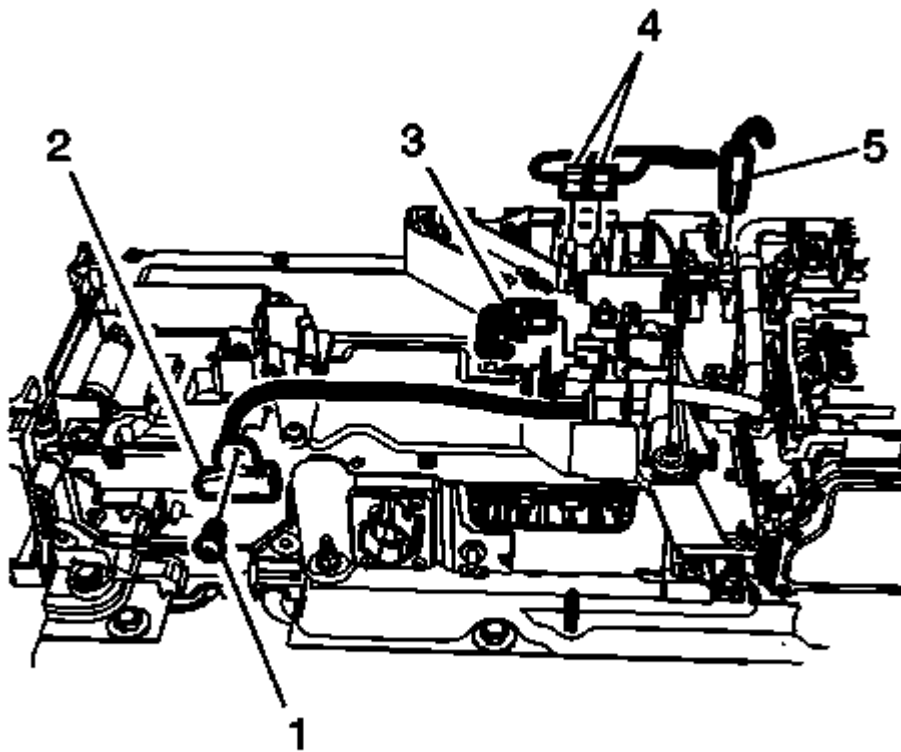


Fig. 89: Cut-Off Switch Fastener

Courtesy of GENERAL MOTORS COMPANY

5. Remove the current sensor connector (3), the pre-charge contacts (4) and the contactor connector (5).

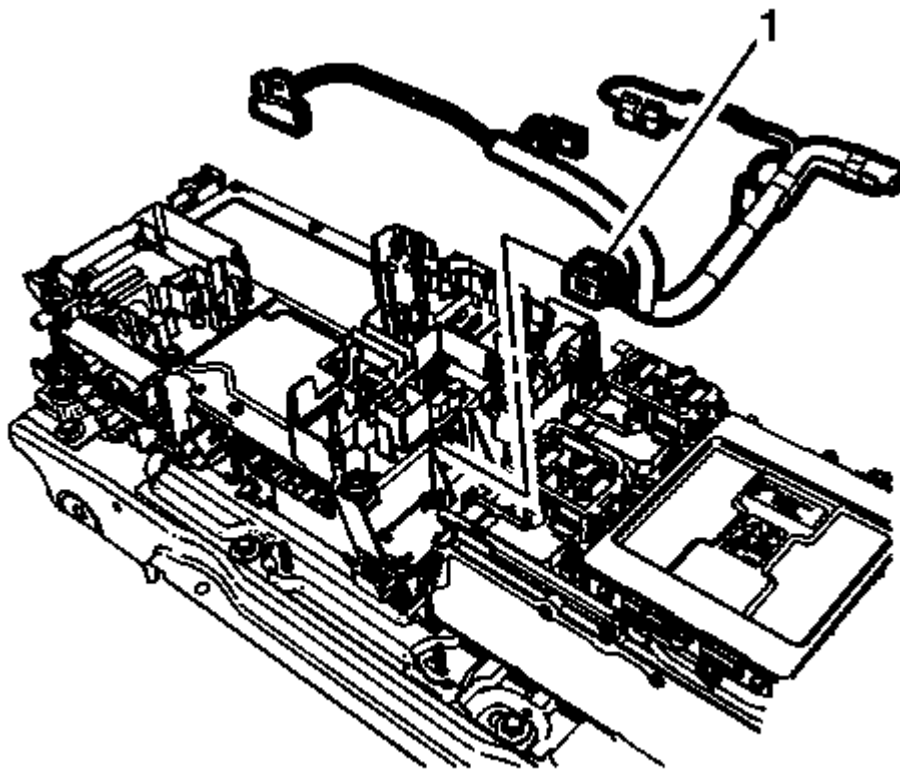


Fig. 90: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

6. Remove the generator control module connector (1).

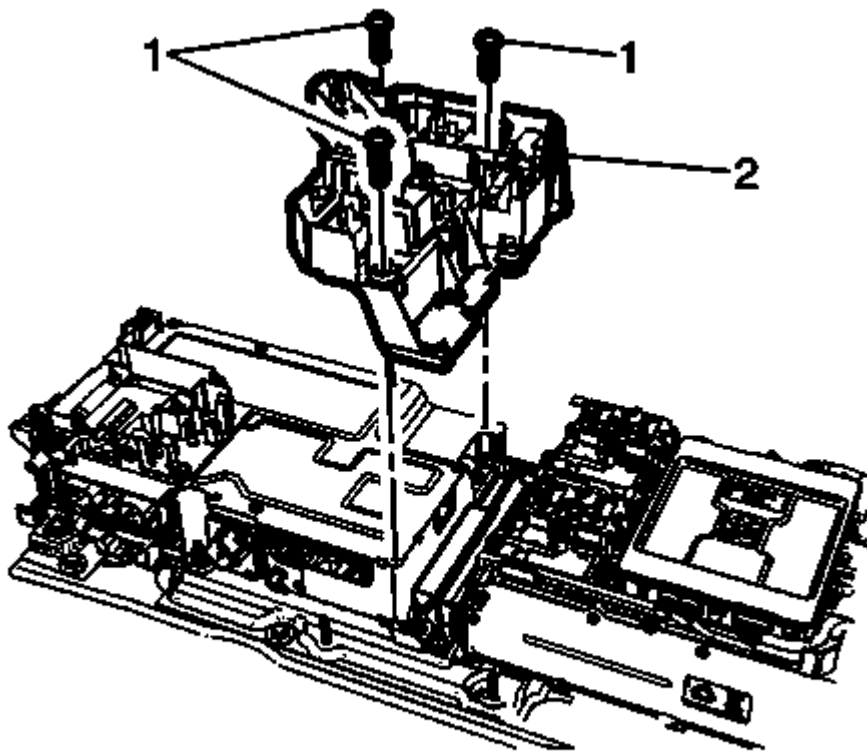


Fig. 91: Battery Energy Control Module Junction Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the drive motor battery wire junction block relay fasteners (1) and remove the drive motor battery wire junction block relay (2).

Installation Procedure

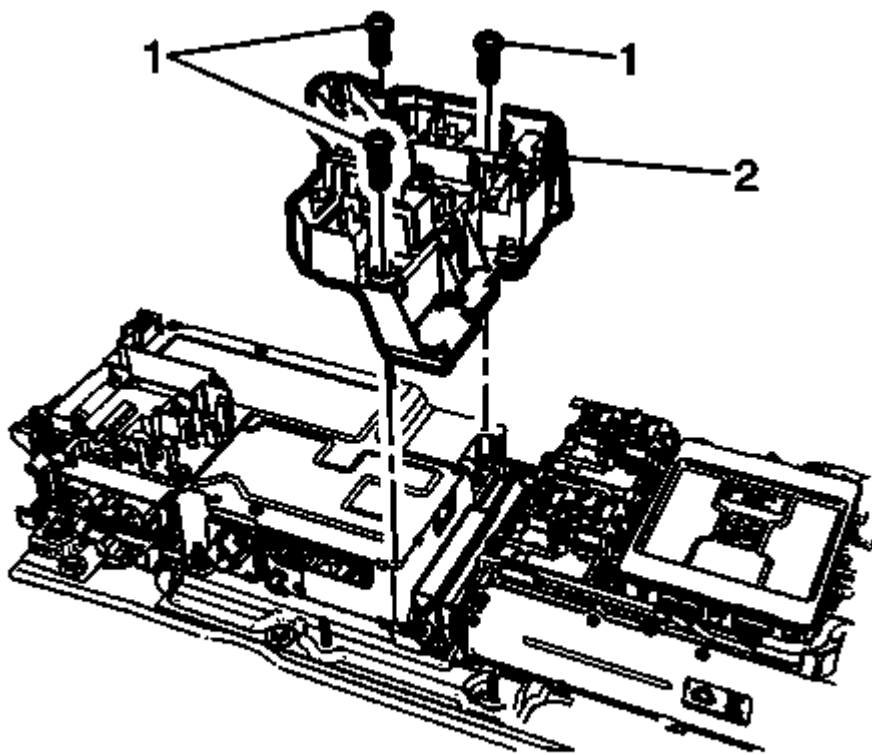


Fig. 92: Battery Energy Control Module Junction Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the drive motor battery wire junction block relay (2) and tighten the fasteners (1) to 9 N.m (80 lb in).

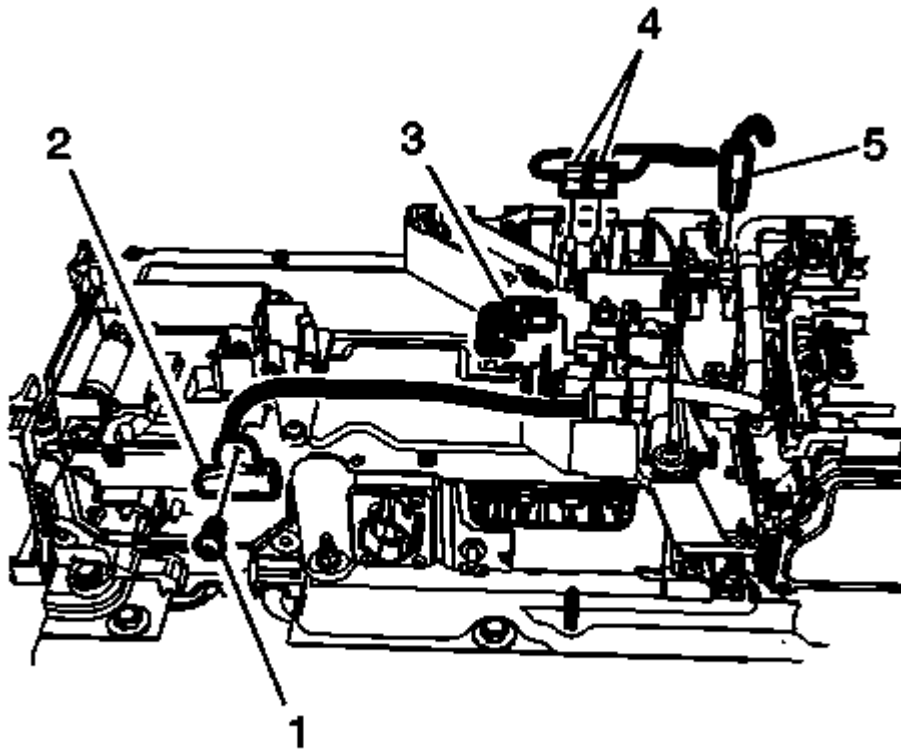


Fig. 93: Cut-Off Switch Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Connect the following to the generator battery disconnect relay junction block :
 - Current Sensor Connector (3).
 - Pre-Charge Contacts (4).
 - Contactor Connector (5).

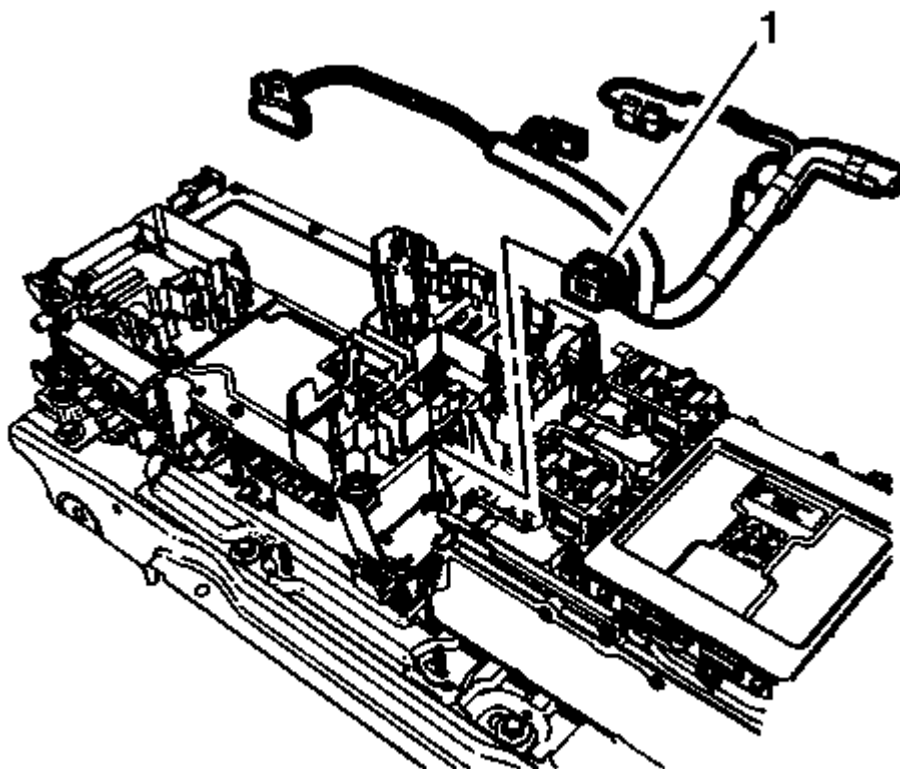


Fig. 94: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the connector (1) to the generator control module.

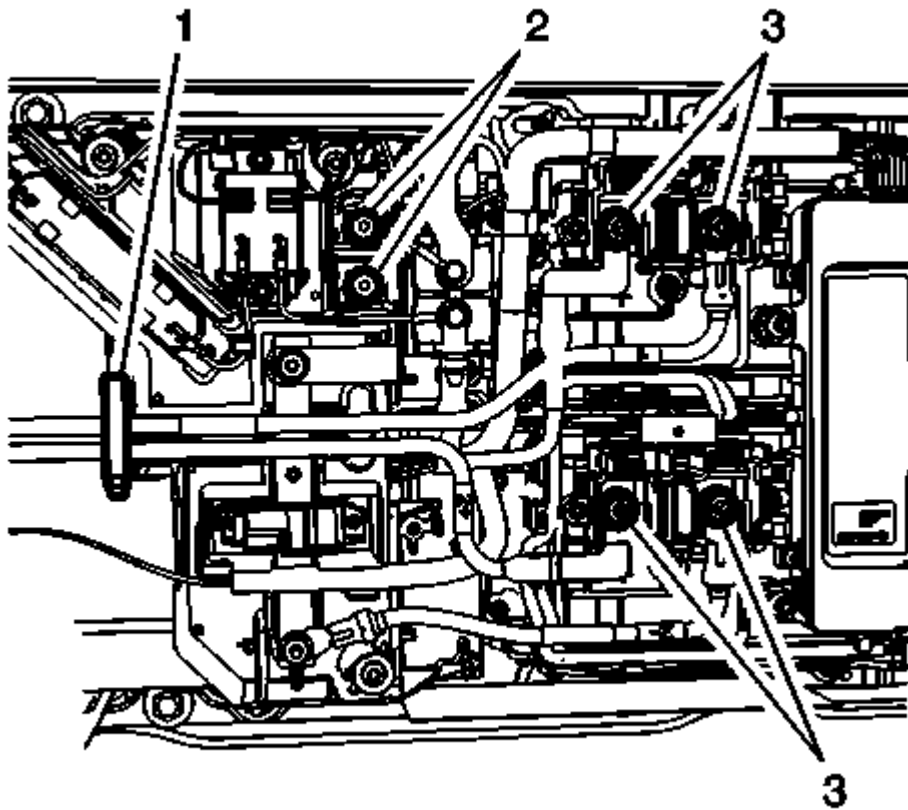


Fig. 95: High Voltage Battery Cables-To-Batteries Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the fasteners (2) retaining the junction block to the generator control module.
5. Position the high voltage cables through the cable retaining clip (1).
6. Install the high voltage cables to the batteries and tighten the fasteners (3) to 9 N.m (80 lb in).
7. Enable the hybrid battery. Refer to **High Voltage Enabling**.

DRIVE MOTOR GENERATOR CONTROL MODULE TRAY REPLACEMENT

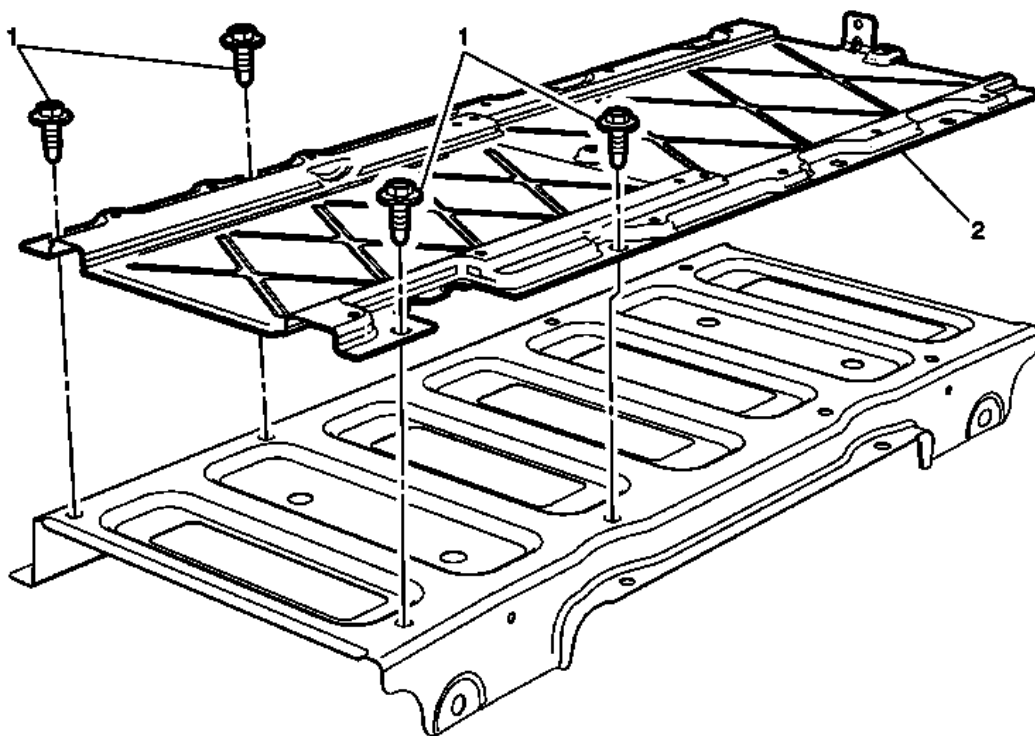


Fig. 96: Drive Motor Generator Control Module Tray
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Generator Control Module Tray Replacement

Callout	Component Name
<p>WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.</p> <p>WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.</p> <p>The High Voltage Disabling procedure includes the following steps:</p> <ul style="list-style-type: none"> • Identify how to disable high voltage. • Identify how to test for the presence of high voltage. • Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed. <p>Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:</p> <ul style="list-style-type: none"> • Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors. 	

- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

Preliminary Procedure

1. Remove the generator battery. Refer to **Generator Battery Replacement**.
2. Remove the generator control module. Refer to **Generator Control Module Replacement**.

1	Drive Motor Generator Control Module Cable Tray Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft).
2	Drive Motor Generator Control Module Cable Tray NOTE: Replace the drive motor generator control module seal.

GENERATOR CONTROL MODULE REPLACEMENT

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Ignition OFF, disable the high voltage at the A4 hybrid battery pack. Refer to High Voltage Disabling, for Servicing Internal Components within the A4 Hybrid/EV Battery Pack **High Voltage Disabling**.

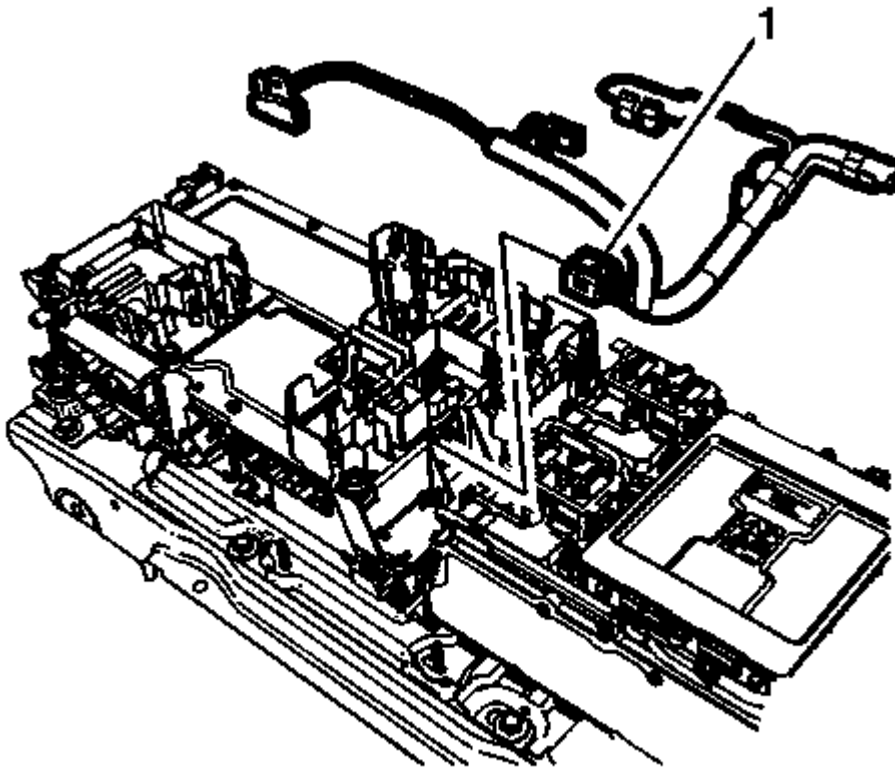


Fig. 97: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the generator control module X4 connector (1).

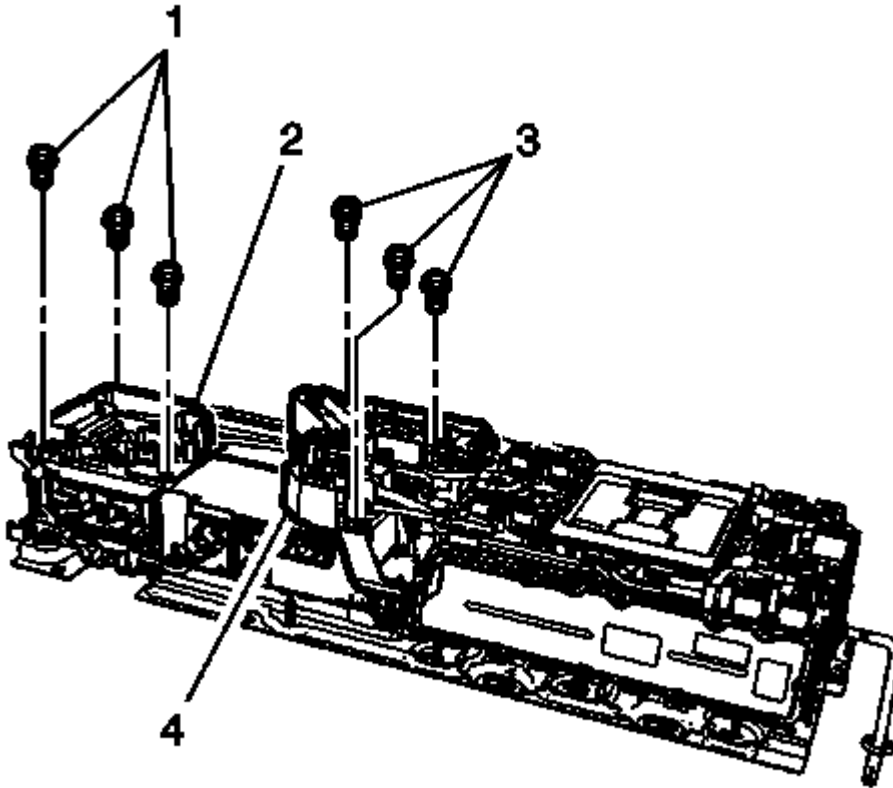


Fig. 98: Drive Motor Battery Wire Junction Block Relay
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fasteners (1) securing the battery energy control module wiring junction block assembly (2), to the top of the generator control module.
4. Remove the fasteners (3), securing the drive motor battery wire junction block relay assembly (4), to the top of the generator control module.

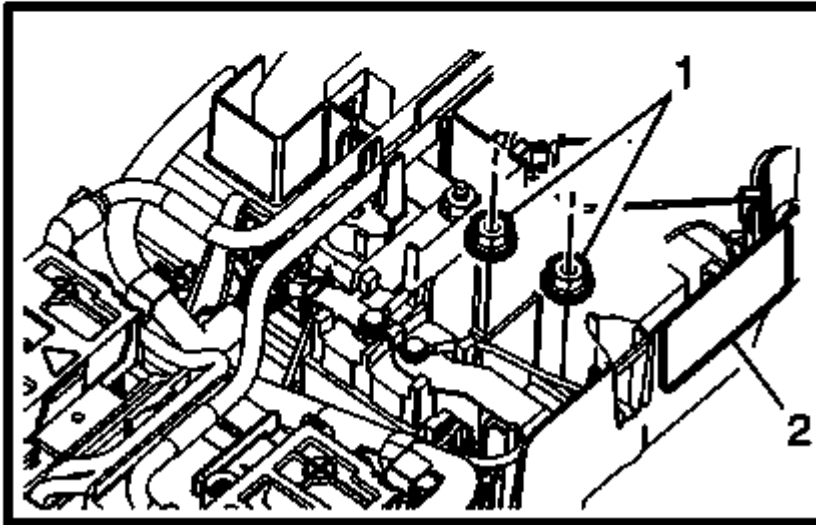
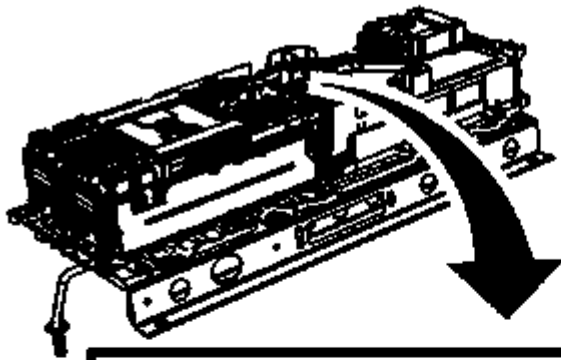


Fig. 99: High Voltage Bus Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the high voltage bus fasteners (1) from the drive motor battery wiring junction block relay assembly (2).

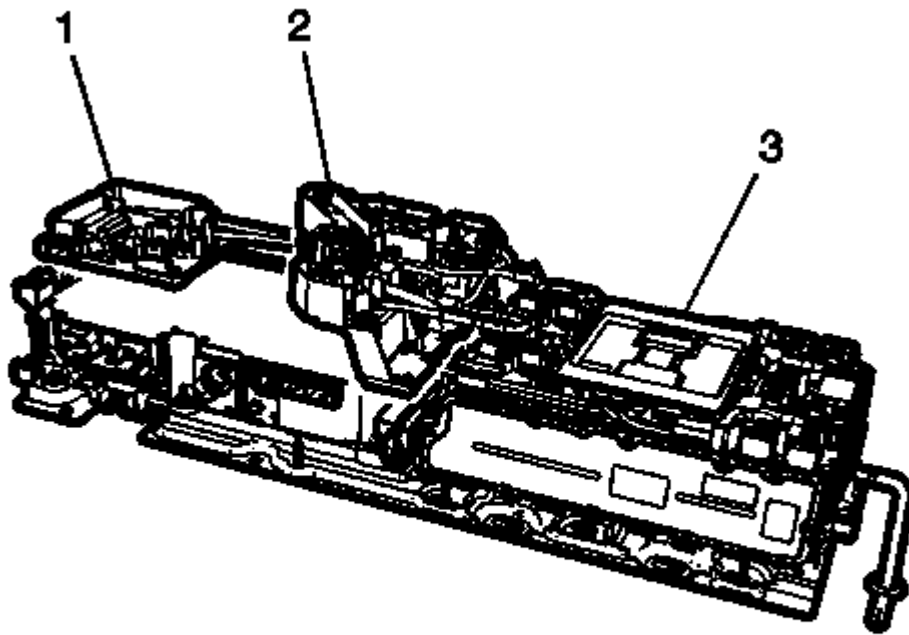


Fig. 100: Drive Motor Battery Wire Junction Block Relay
Courtesy of GENERAL MOTORS COMPANY

6. Lift the drive motor battery wire junction block relay (2) and the battery energy control module wiring junction block (1) with the harness attached, and place on top of the battery energy control module (3).

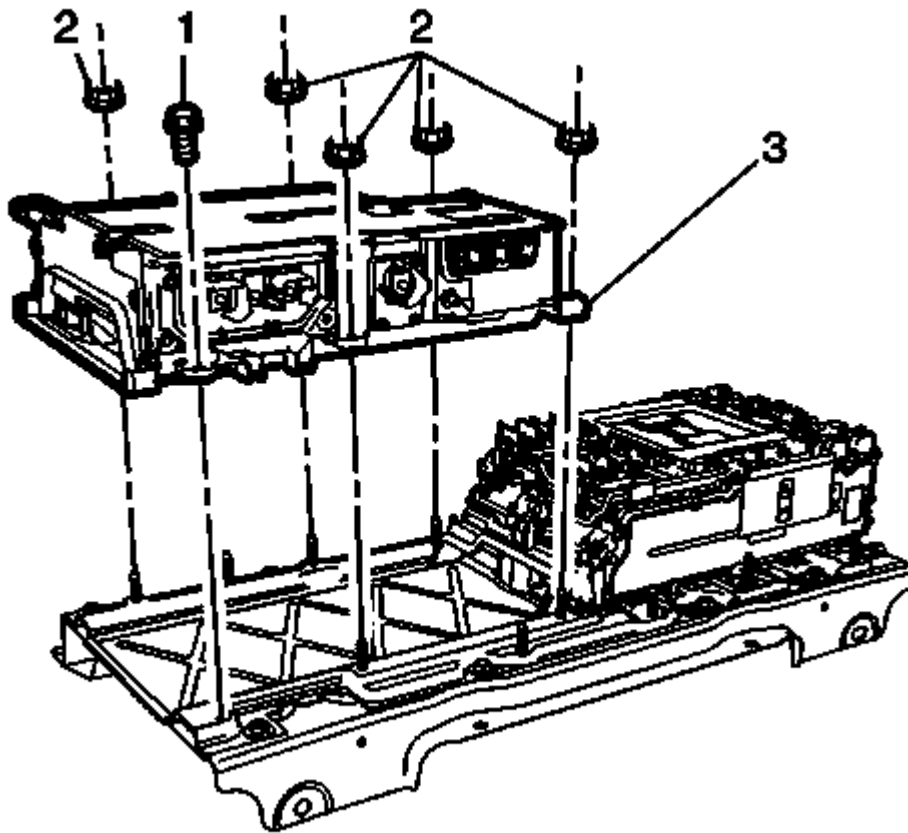


Fig. 101: Generator Control Module
Courtesy of GENERAL MOTORS COMPANY

7. Remove the generator control module mounting fasteners (1) and (2).
8. Remove the generator control module (3) from the support tray.

Installation Procedure

1. Inspect the foam seals for tears and leak paths, to ensure they will not compromise the internal air flow through the generator control module assembly.

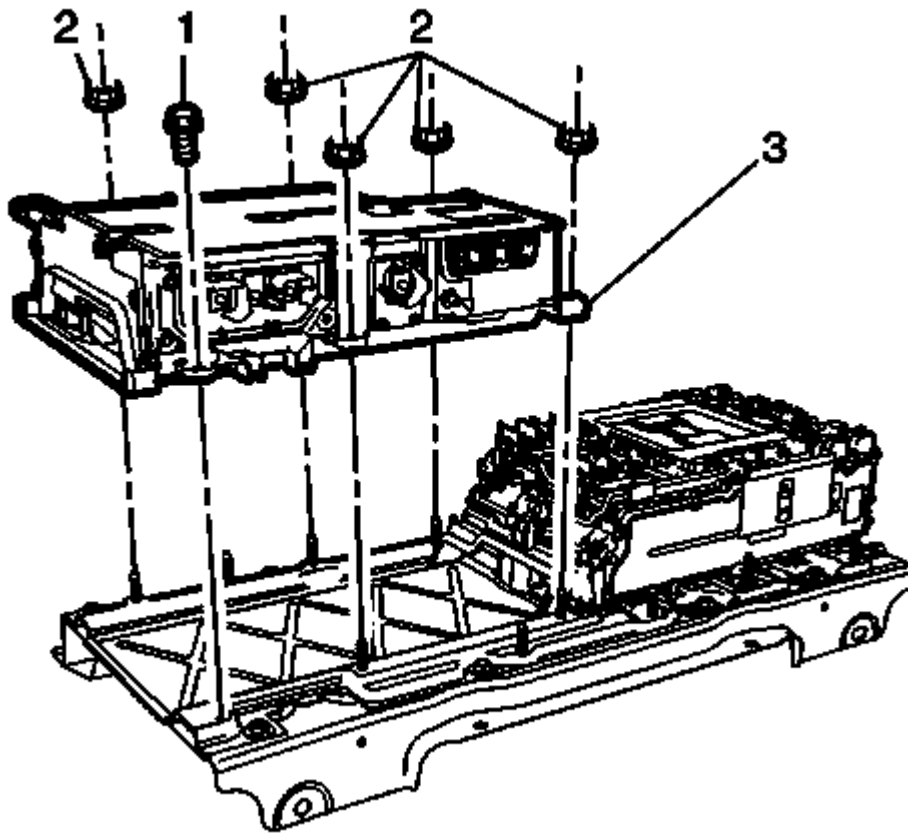


Fig. 102: Generator Control Module
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Do not slide the generator control module on the foam seals as the seals may become damaged.

2. Install the generator control module (3) to the support tray studs. Tighten the fastener (1) to 9 N.m (80 lb in).
3. Tighten the remaining fasteners (2) to 9 N.m (80 lb in).

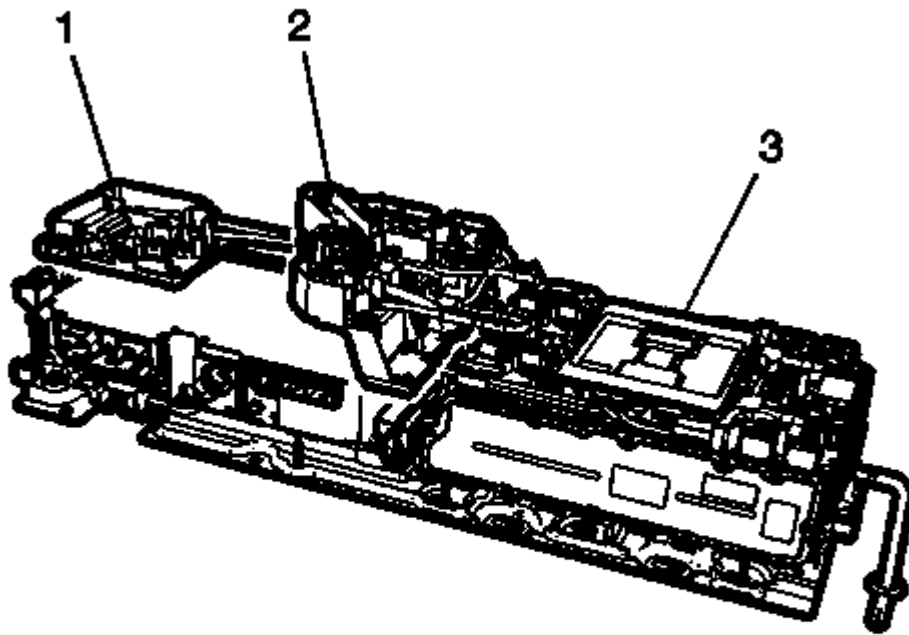


Fig. 103: Drive Motor Battery Wire Junction Block Relay
Courtesy of GENERAL MOTORS COMPANY

4. Place the drive motor battery wire junction block relay (2) and the battery energy control module wiring junction block (1), on top of the generator control module.

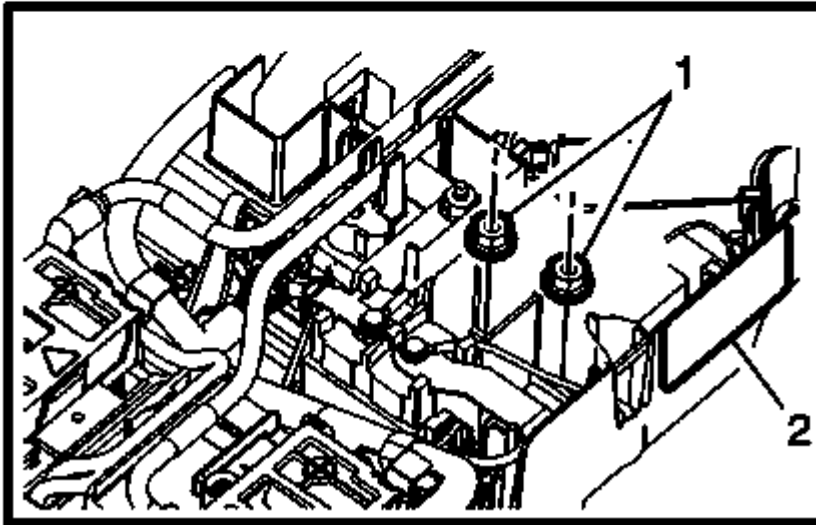
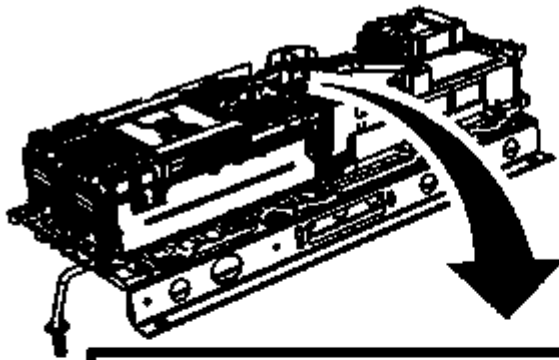


Fig. 104: High Voltage Bus Fasteners

Courtesy of GENERAL MOTORS COMPANY

5. Install the high voltage bus fasteners (1) to the drive motor battery wiring junction block relay assembly (2) and tighten to 9 N.m (80 lb in).

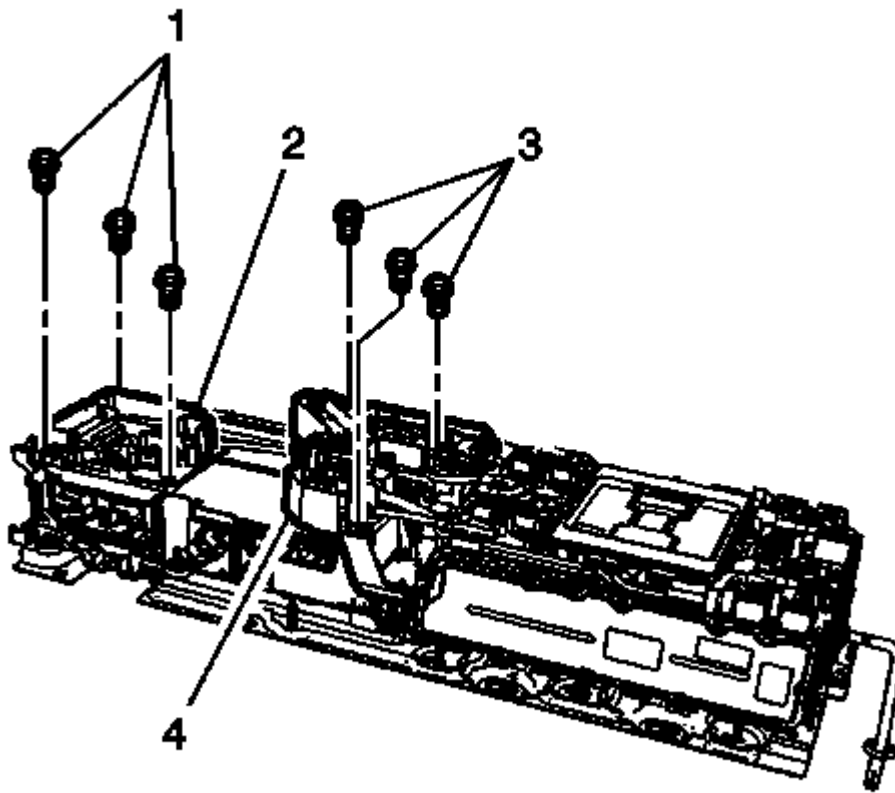


Fig. 105: Drive Motor Battery Wire Junction Block Relay
Courtesy of GENERAL MOTORS COMPANY

6. Install the battery energy control module wiring junction block fasteners (1) and tighten to 9 N.m (80 lb in).
7. Install the drive motor battery wiring junction block relay fasteners (3) and tighten to 9 N.m (80 lb in).

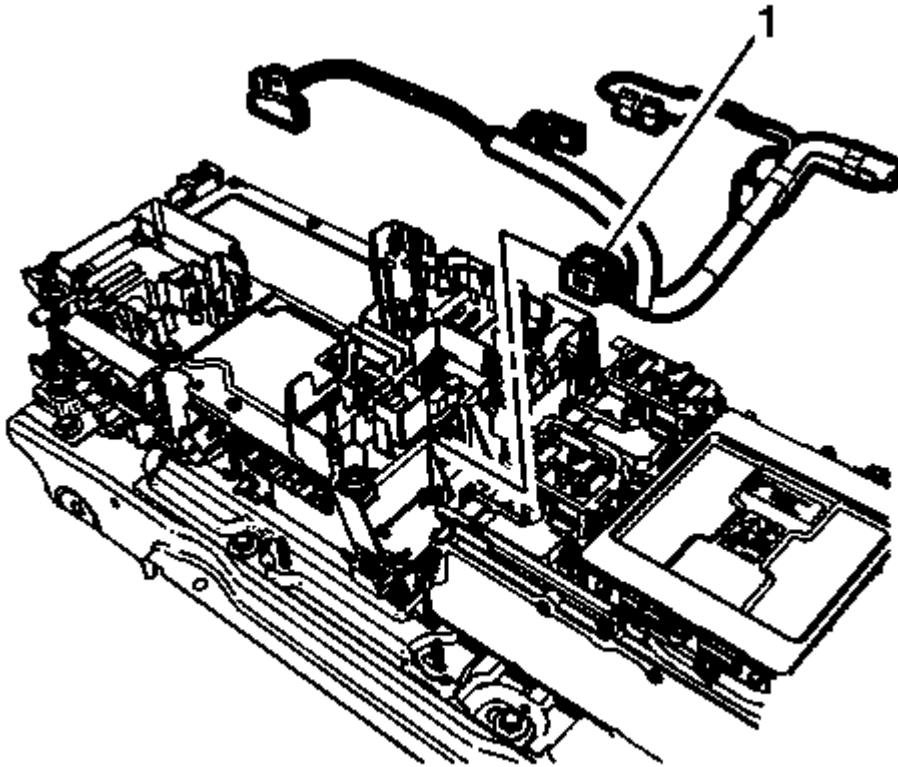


Fig. 106: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

8. Connect the generator control module X4 connector (1).
9. Enable the high voltage at the A4 hybrid battery pack. Refer to **High Voltage Enabling**.
10. Program the generator control module. Refer to **Control Module References** .

GENERATOR CONTROL MODULE COVER REPLACEMENT

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Remove both rear compartment floor panels. Refer to Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6) , Rear Compartment Floor Panel Trim Replacement (with Blower Cover, HP6) .
2. Remove the drive motor battery cooling blower outlet duct. Refer to Drive Motor Battery Cooling Blower Outlet Duct Replacement .

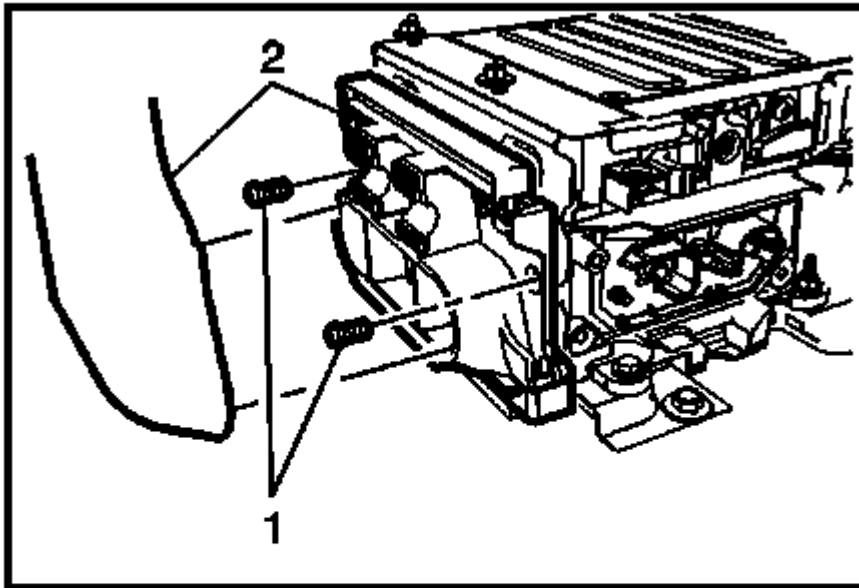


Fig. 107: Drive Motor Battery Cooling Blower Outlet Duct Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the upper fasteners (1) on the generator control module cooling air outlet duct.

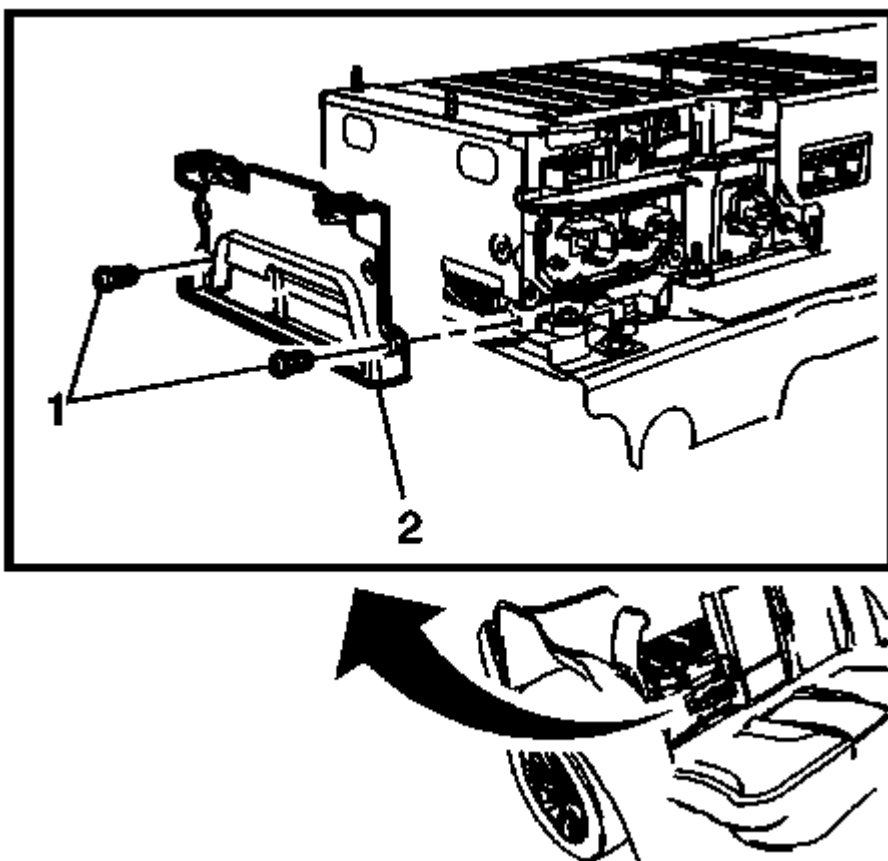


Fig. 108: Generator Control Module Cooling Air Outlet Duct And Tighten Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the lower fasteners (1) holding the generator control module and remove the cooling air outlet duct.

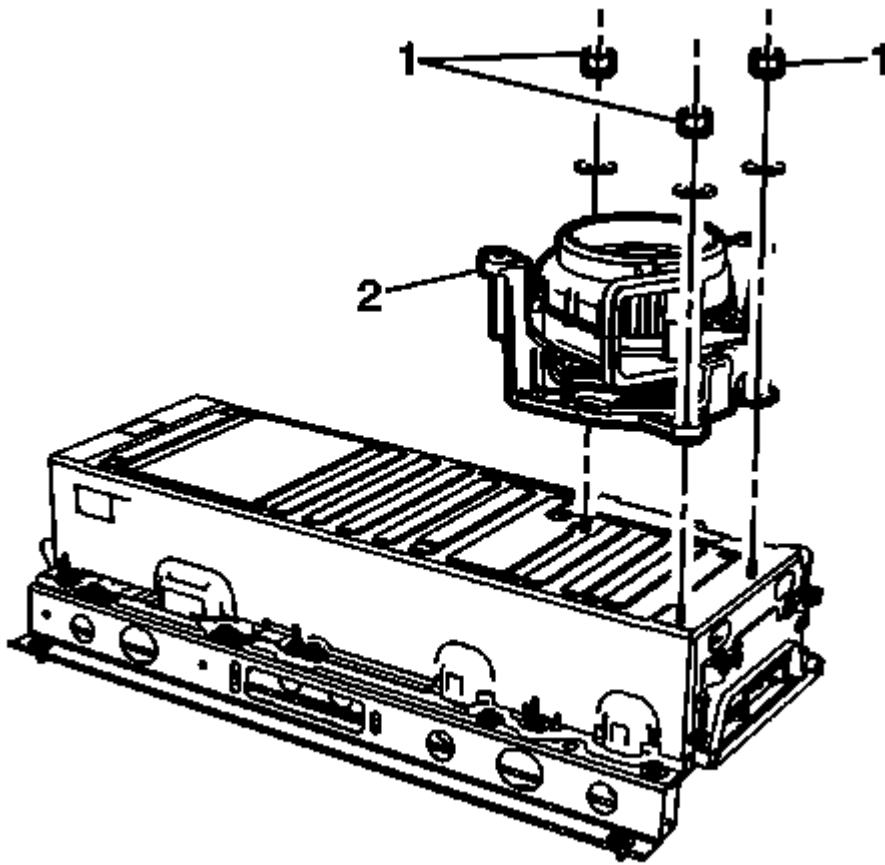


Fig. 109: Drive Motor Battery Cooling Blower Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect and unclip the drive motor battery cooling blower electrical harness.
6. Remove the drive motor battery cooling blower and bracket fasteners (1).
7. Remove the drive motor battery cooling blower and bracket (2) as an assembly.
8. If the hybrid battery has not been disabled in a previous step, disable the hybrid battery. Refer to high voltage disabling for servicing any internal components within the A4 Hybrid/EV Battery Pack. **High Voltage Disabling.**

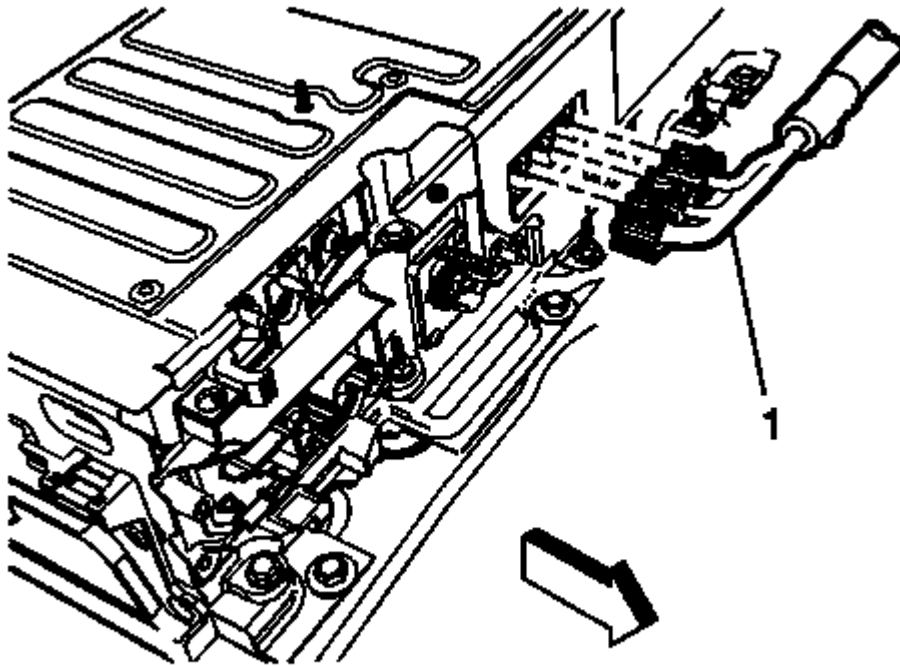


Fig. 110: Body Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

9. Remove the body harness connectors (1) from the generator control and battery module.

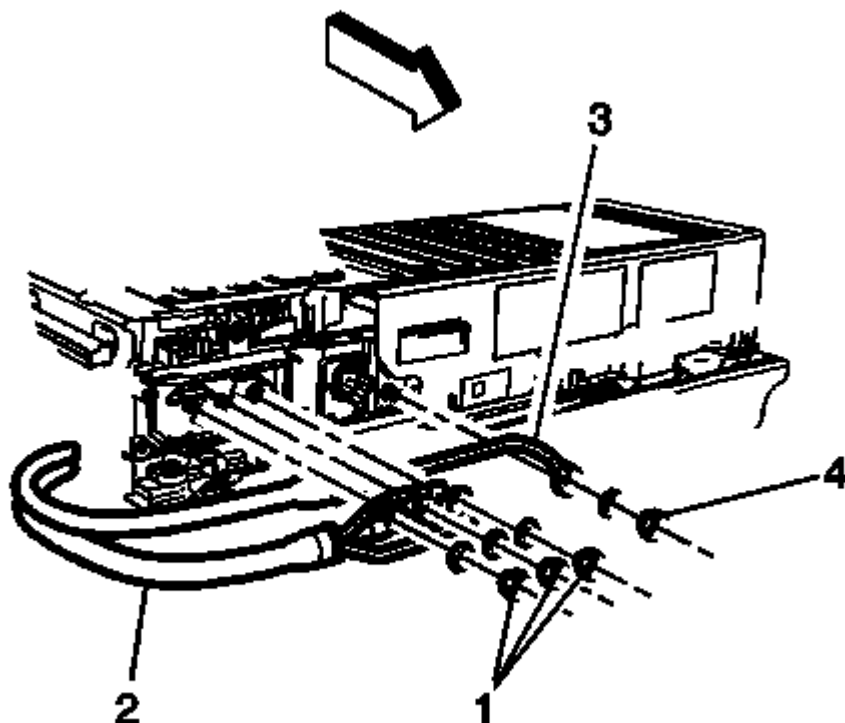


Fig. 111: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

10. Remove the high voltage 3-phase cable terminal nuts (1) and the 12V terminal branch nut (4).
11. Remove the high voltage cable (2) and the 12V cable (3) from the generator control and battery module.

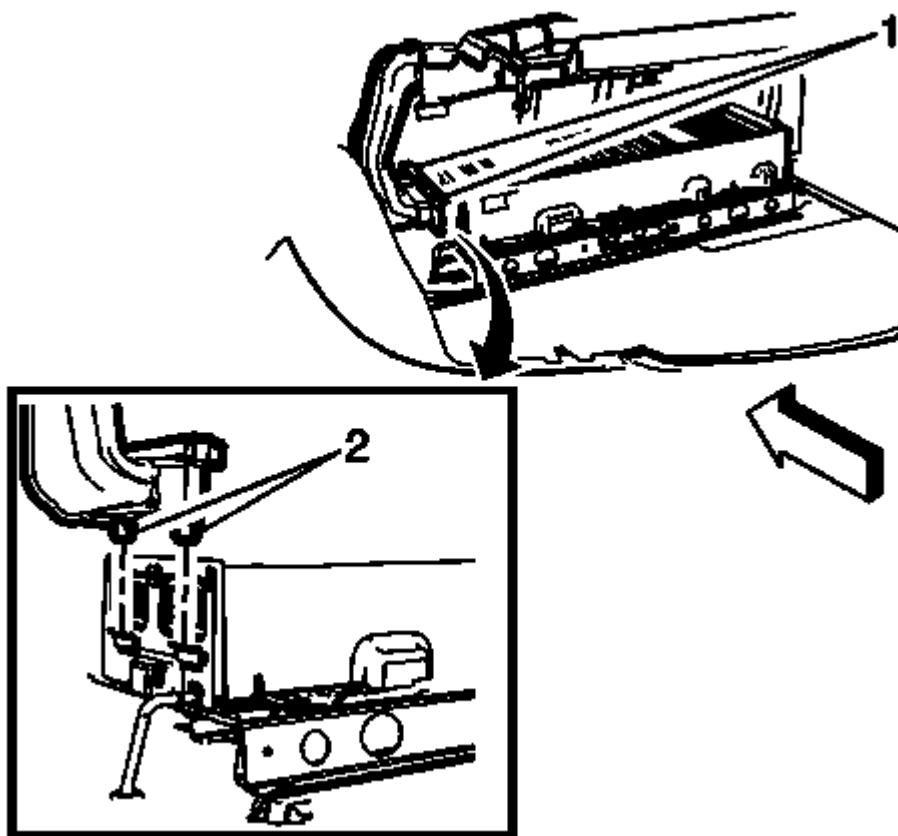


Fig. 112: Battery Cooling Air Inlet Duct And Retainers
Courtesy of GENERAL MOTORS COMPANY

12. Detach the drive motor battery cooling air inlet upper duct retainers (1).

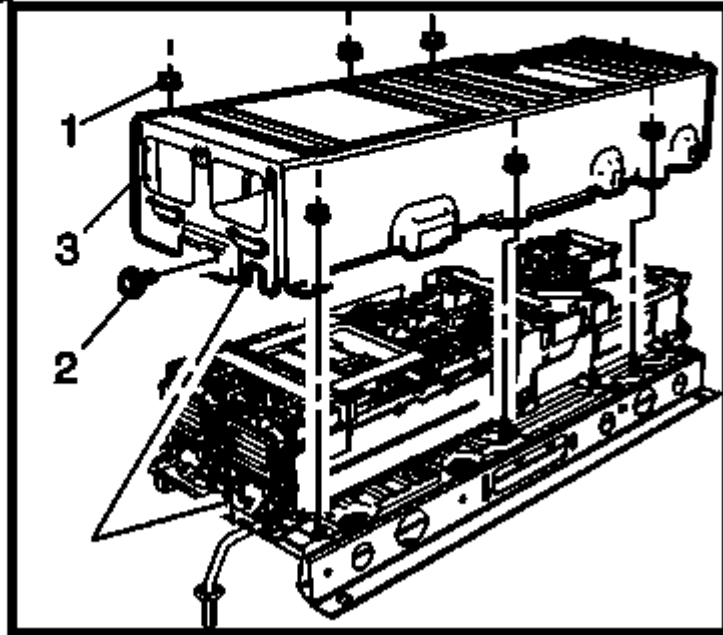


Fig. 113: Generator Control Module Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

13. Remove the generator control module cover fasteners (1).
14. Remove the generator control module cover fastener (2) and remove the generator control module cover (3).
15. If servicing components internal to the A4 Hybrid/EV Battery Pack, continue with the high voltage disabling procedure. Refer to high voltage disabling for servicing any internal components within the A4 Hybrid/EV Battery Pack. **High Voltage Disabling.**

Installation Procedure

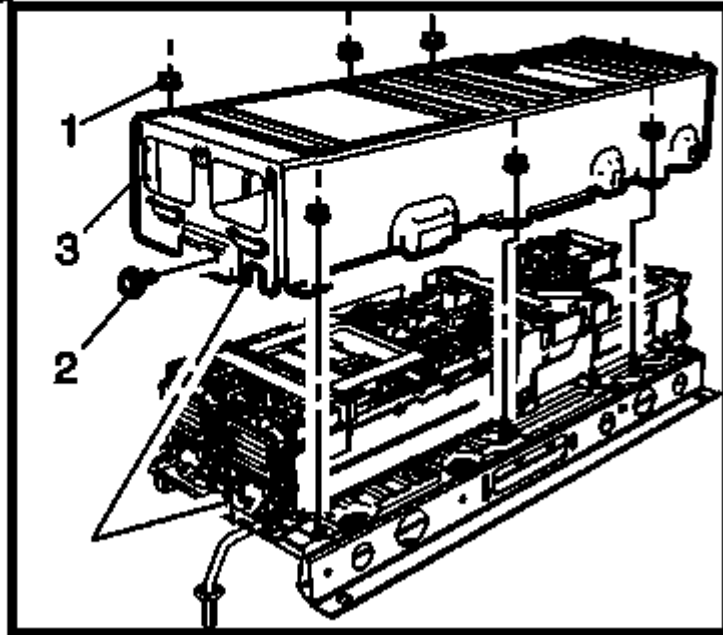


Fig. 114: Generator Control Module Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the generator control module cover (3).
2. Install the generator control module cover fasteners (1) and tighten to 9 N.m (80 lb in).
3. Install the generator control module cover fastener (2) and tighten to 9 N.m (80 lb in).

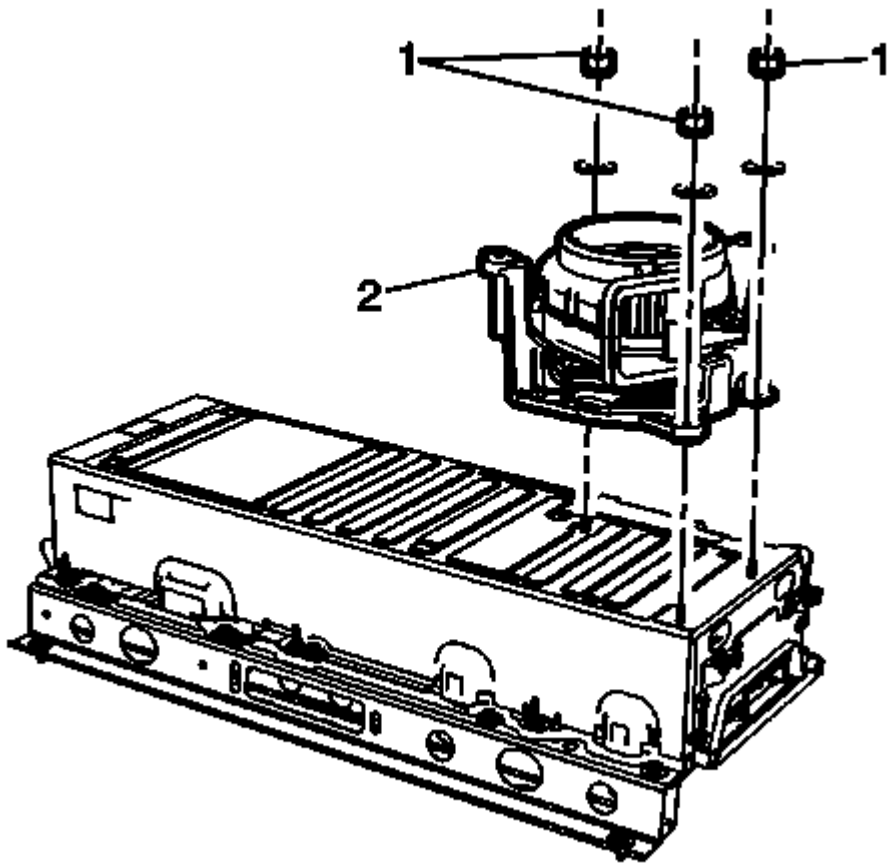


Fig. 115: Drive Motor Battery Cooling Blower Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Install the drive motor battery cooling blower motor and bracket (2). Tighten the fasteners (1) to 9 N.m (80 lb in).

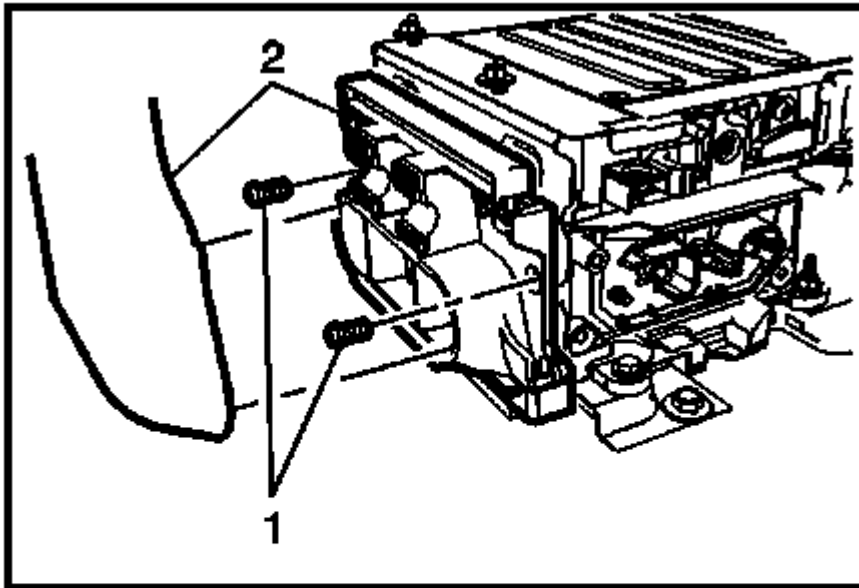


Fig. 116: Drive Motor Battery Cooling Blower Outlet Duct Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Install the generator control module air outlet duct (2) and tighten the upper fasteners (1) to 9 N.m (80 lb in).

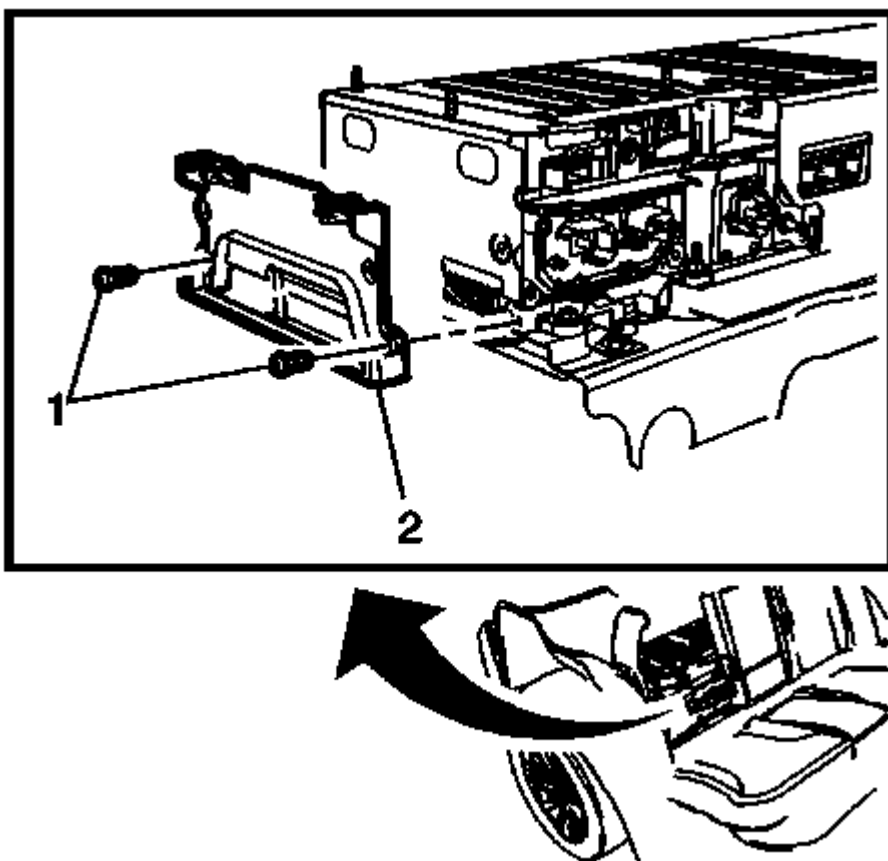


Fig. 117: Generator Control Module Cooling Air Outlet Duct And Tighten Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Install the lower generator control module cooling air outlet duct lower fasteners (1) and tighten to 9 N.m (80 lb in).

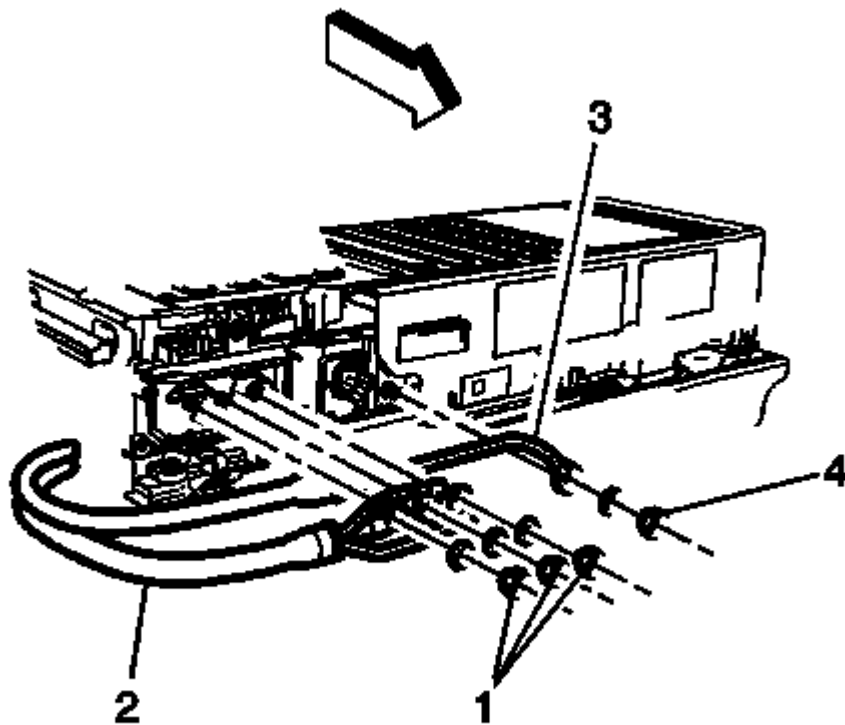


Fig. 118: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

7. Install the high voltage 3-phase cable (2) to the generator control and battery module. Tighten the nuts (1) to 9 N.m (80 lb in).
8. Install the 12V cable (3) to the generator control and battery module. Tighten the nut (4) to 9 N.m (80 lb in).

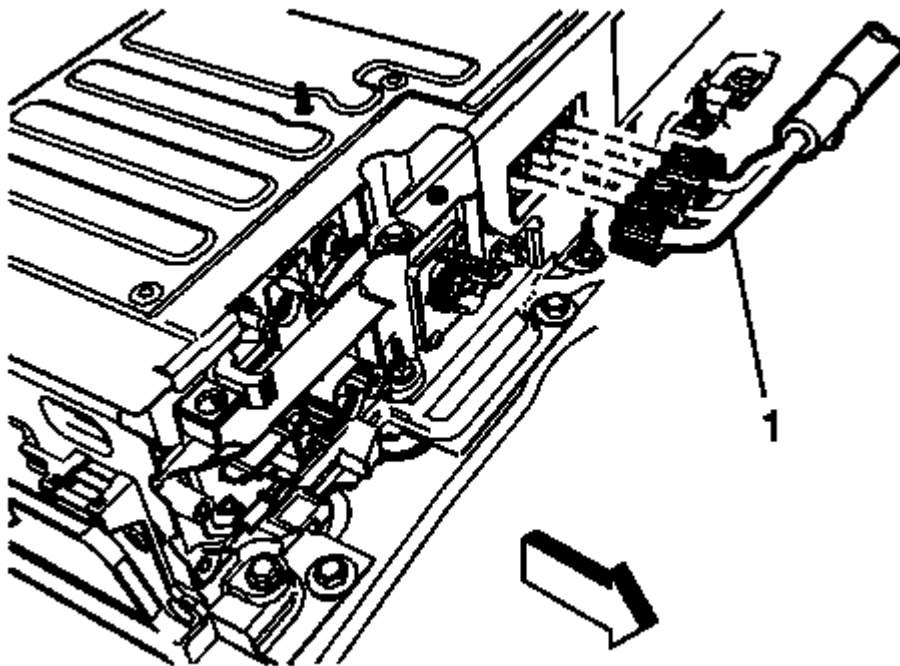


Fig. 119: Body Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

9. Install the body harness connectors (1).

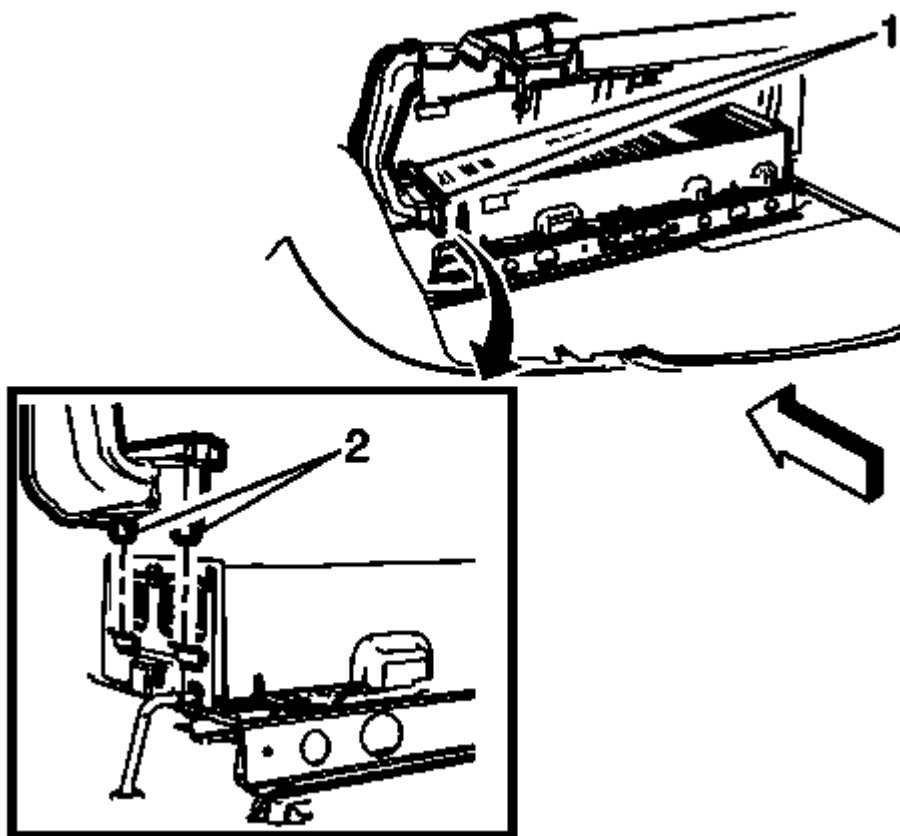


Fig. 120: Battery Cooling Air Inlet Duct And Retainers
Courtesy of GENERAL MOTORS COMPANY

10. Install the drive motor battery cooling air inlet lower duct.

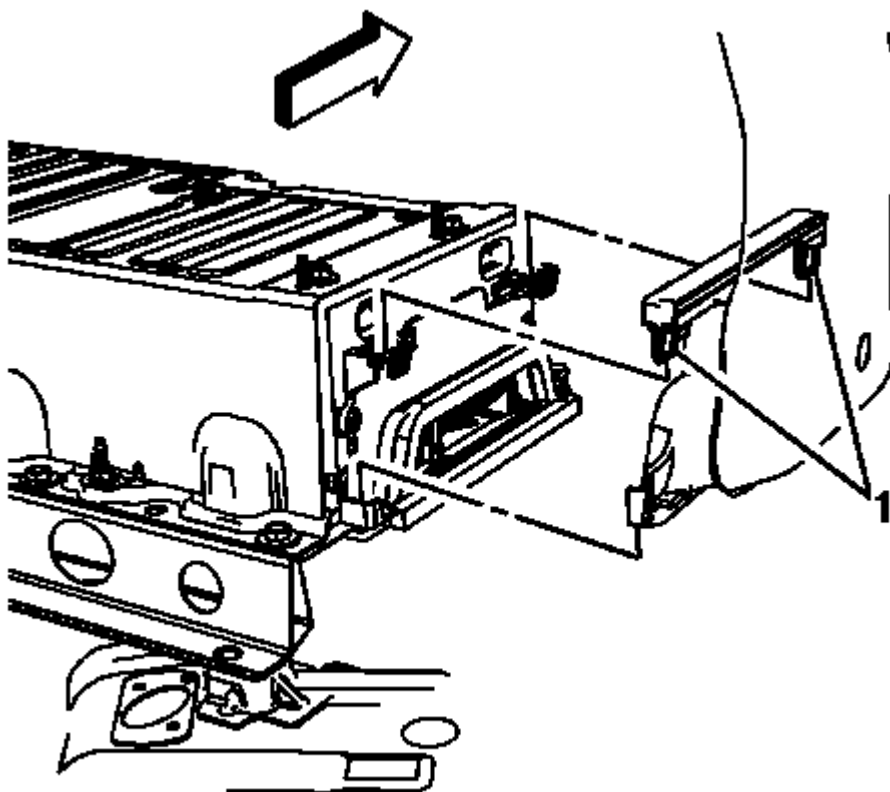


Fig. 121: Intermediate Duct Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the seal for efficient generator control and battery module cooling.

11. Install the drive motor battery cooling blower outlet duct (1). Refer to **Drive Motor Battery Cooling Blower Outlet Duct Replacement** .
12. Enable the hybrid battery. Refer to **High Voltage Enabling**.

GENERATOR CONTROL MODULE CABLE COVER REPLACEMENT

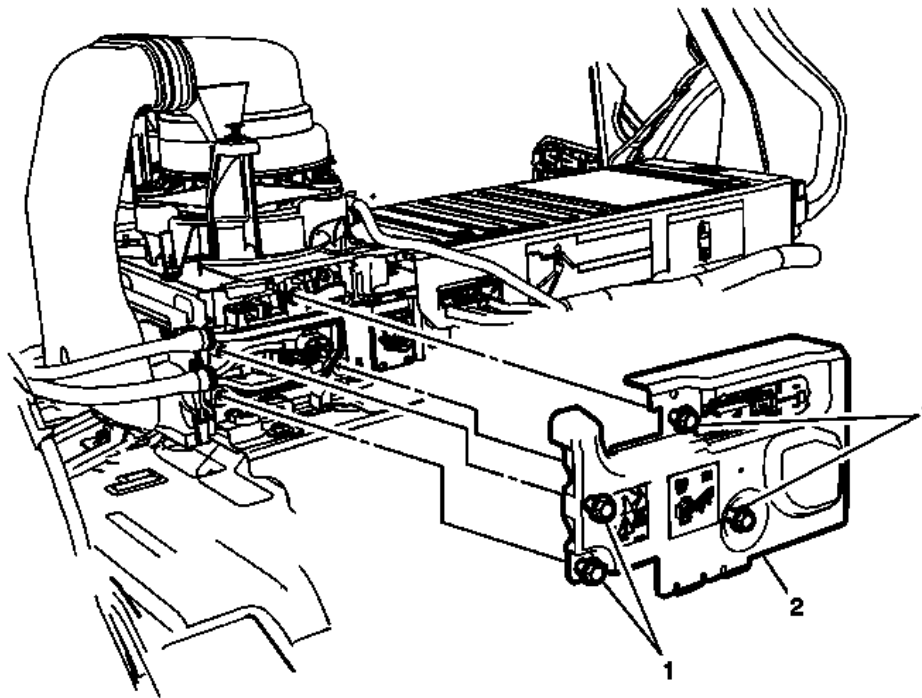


Fig. 122: Generator Control Module Cable Cover
 Courtesy of GENERAL MOTORS COMPANY

Generator Control Module Cable Cover Replacement

Callout	Component Name
<p>WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.</p> <p>WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.</p> <p>The High Voltage Disabling procedure includes the following steps:</p> <ul style="list-style-type: none"> • Identify how to disable high voltage. • Identify how to test for the presence of high voltage. • Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed. <p>Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:</p> <ul style="list-style-type: none"> • Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors. 	

- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

Preliminary Procedure Disable the high voltage system. Refer to High Voltage Disabling.

1	Generator Control Module Cable Cover Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Generator Control Module Cable Cover

GENERATOR BATTERY CONTROL WIRING HARNESS REPLACEMENT (B1 AND B2 TO BECM JUNCTION BLOCK)

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.

- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Disable the hybrid battery. Refer to High Voltage Disabling.

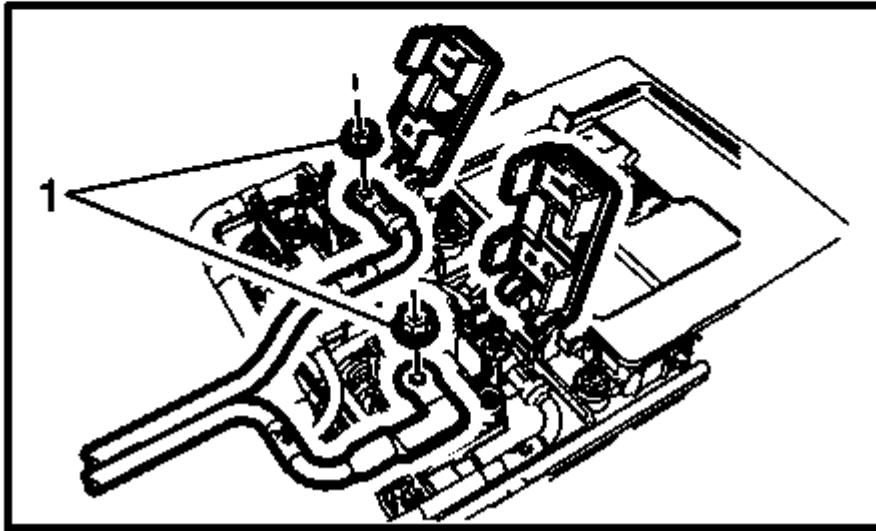


Fig. 123: High Voltage Cable Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Remove the high voltage cable fasteners (1) from the B1 and B2 studs.

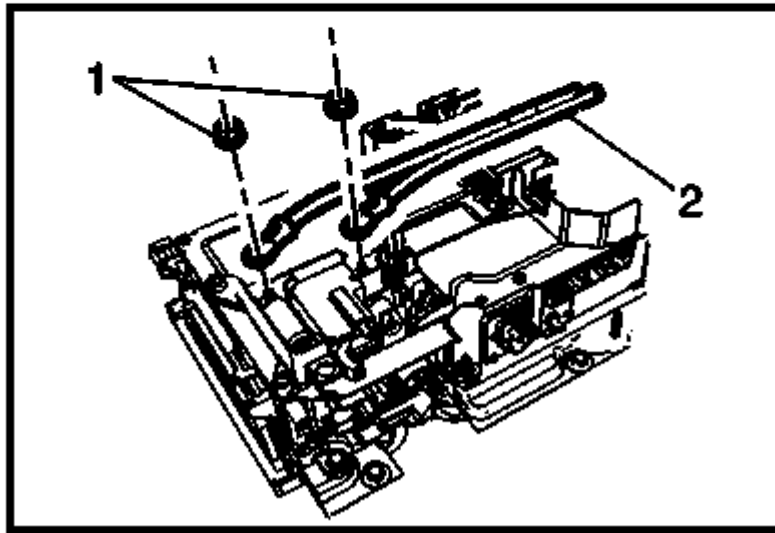
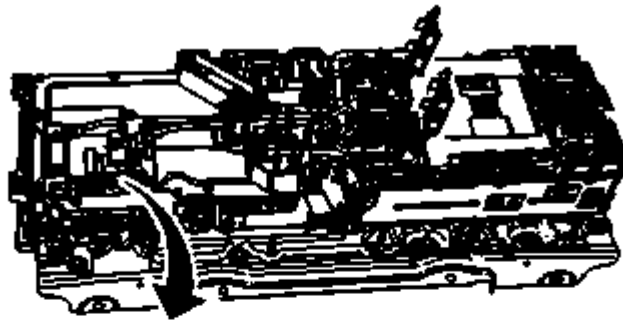


Fig. 124: High Voltage Fasteners And Cables
Courtesy of GENERAL MOTORS COMPANY

3. Remove the high voltage cable fasteners (1) from the battery energy control module (BECM) junction block.
4. Remove the high voltage cables (2) from the BECM junction block.

Installation Procedure

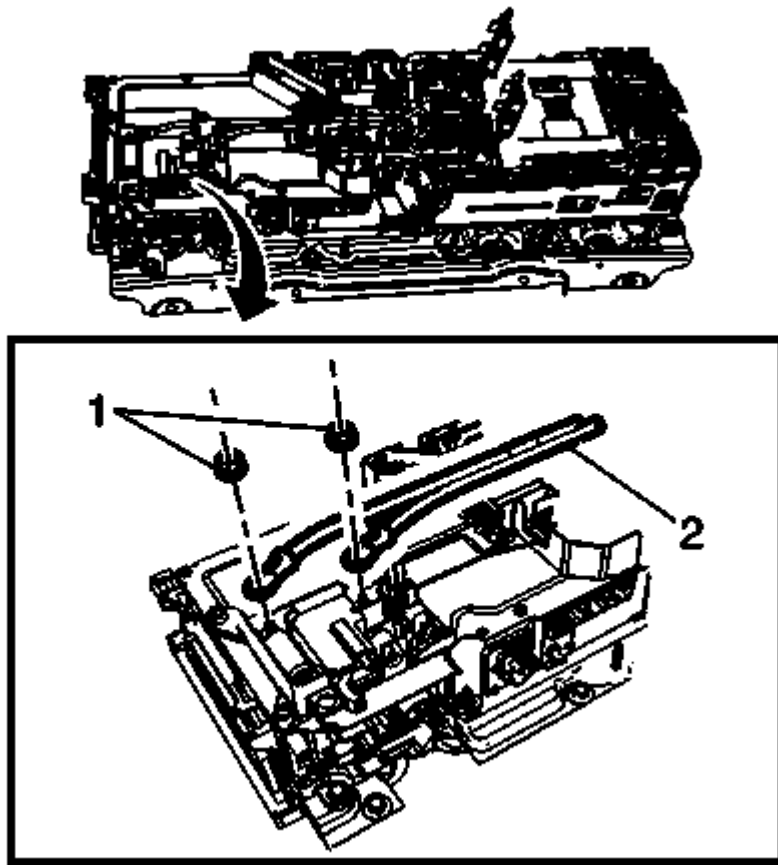


Fig. 125: High Voltage Fasteners And Cables
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the high voltage cable (2) to the BECM junction block and tighten the fasteners (1) to 9 N.m (80 lb in).
2. Enable the hybrid battery. Refer to High Voltage Enabling.

GENERATOR BATTERY CONTROL WIRING HARNESS REPLACEMENT (B2 TO BDU1 CONTACTOR)

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to

servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

1. **Disable the hybrid battery. Refer to High Voltage Disabling.**

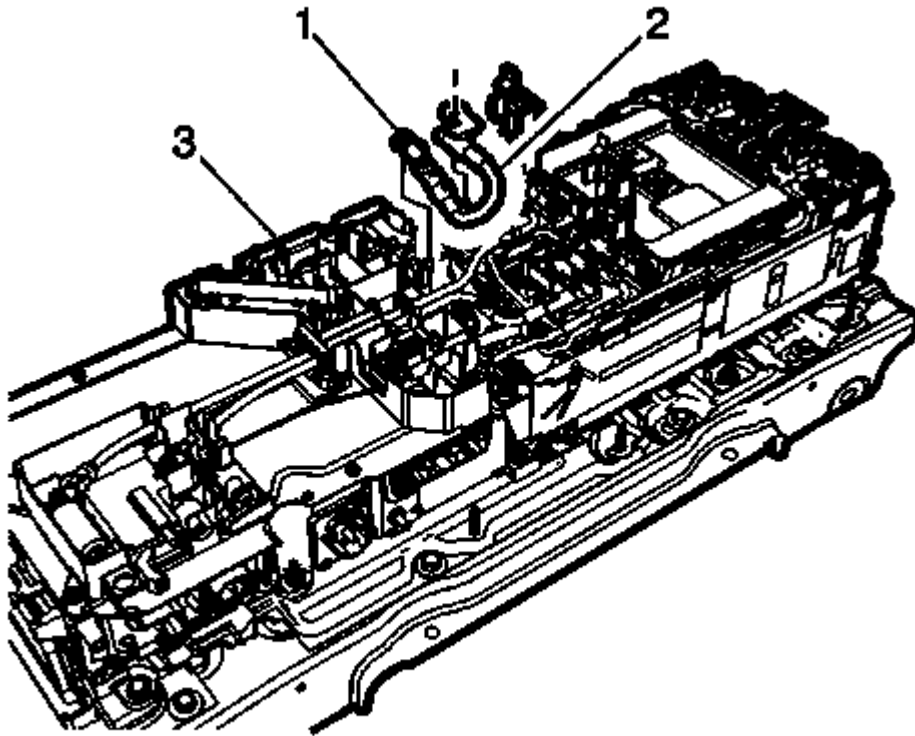


Fig. 126: High Voltage Cable, Fasteners And Junction Block
Courtesy of GENERAL MOTORS COMPANY

2. Remove the high voltage cable fastener (1) and the high voltage cable (2), from the generator battery disconnect relay junction block (3).

Installation Procedure

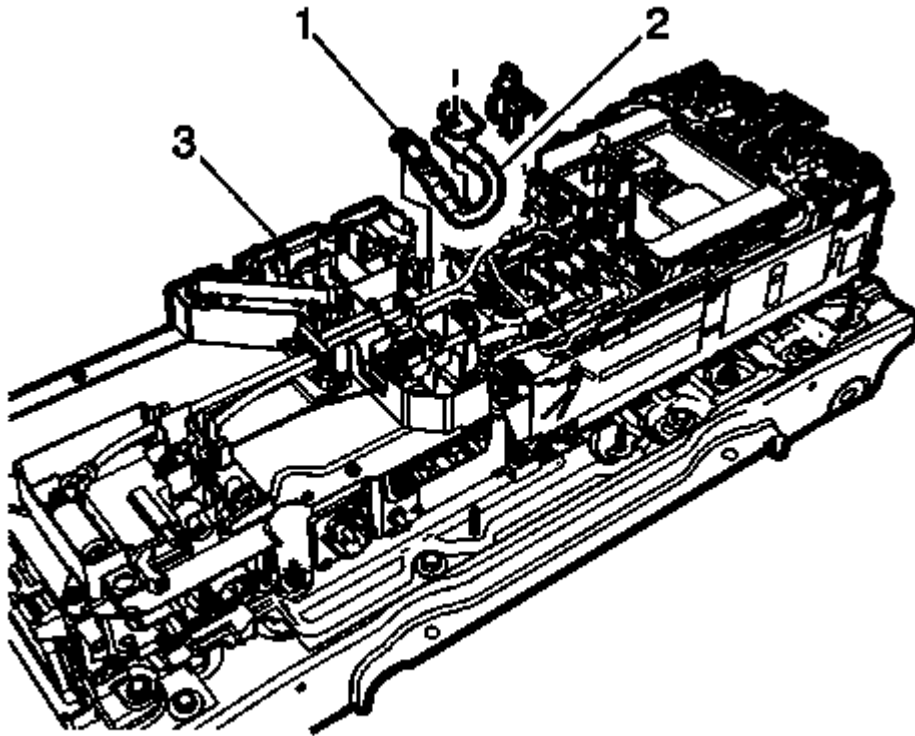


Fig. 127: High Voltage Cable, Fasteners And Junction Block
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the the high voltage cable (2), to the generator battery disconnect relay junction block (3) and tighten the fastener (1) to 9 N.m (80 lb in).
2. Enable the hybrid battery. Refer to High Voltage Enabling.

GENERATOR BATTERY CONTROL WIRING HARNESS REPLACEMENT (GENERATOR BATTERY DISCON RELAY TO B2)

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to

servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

1. Disable the hybrid battery. Refer to **High Voltage Disabling**.
2. Remove the generator control module cover. Refer to **Generator Control Module Cover Replacement**.

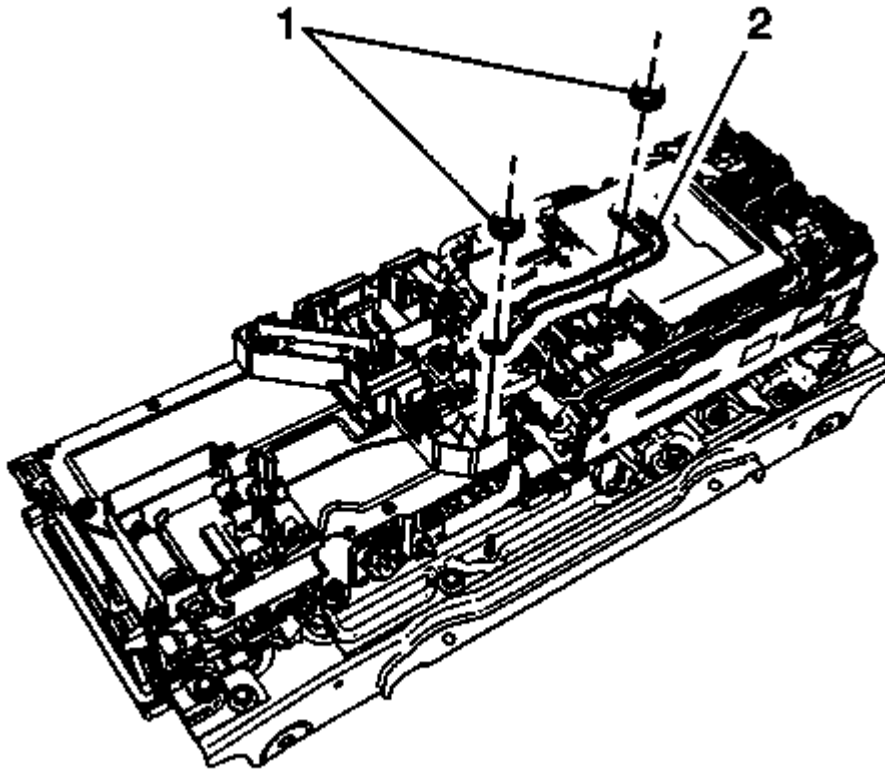


Fig. 128: High Voltage Cable Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Remove the high voltage cable fastener (1) from the generator battery disconnect relay junction block-to-B2.
4. Remove the high voltage cable (2).

Installation Procedure

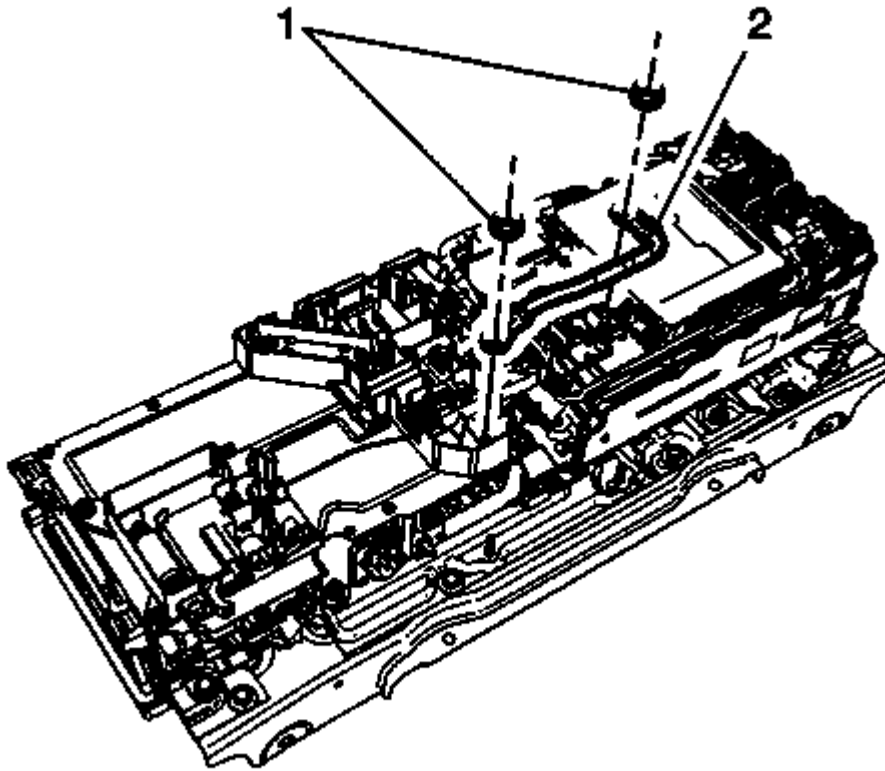


Fig. 129: High Voltage Cable Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the high voltage cable (2) to the generator battery disconnect relay junction block and tighten the fasteners (1) to 9 N.m (80 lb in).
2. Install the generator control module cover. Refer to Generator Control Module Cover Replacement.
3. Enable the hybrid battery. Refer to High Voltage Enabling.

GENERATOR BATTERY FUSE REPLACEMENT

Removal Procedure

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Always perform the High Voltage Disabling procedure prior to

servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure includes the following steps:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

1. Ignition OFF, disable the high voltage at the A4 hybrid battery pack. Refer to **High Voltage Disabling**.

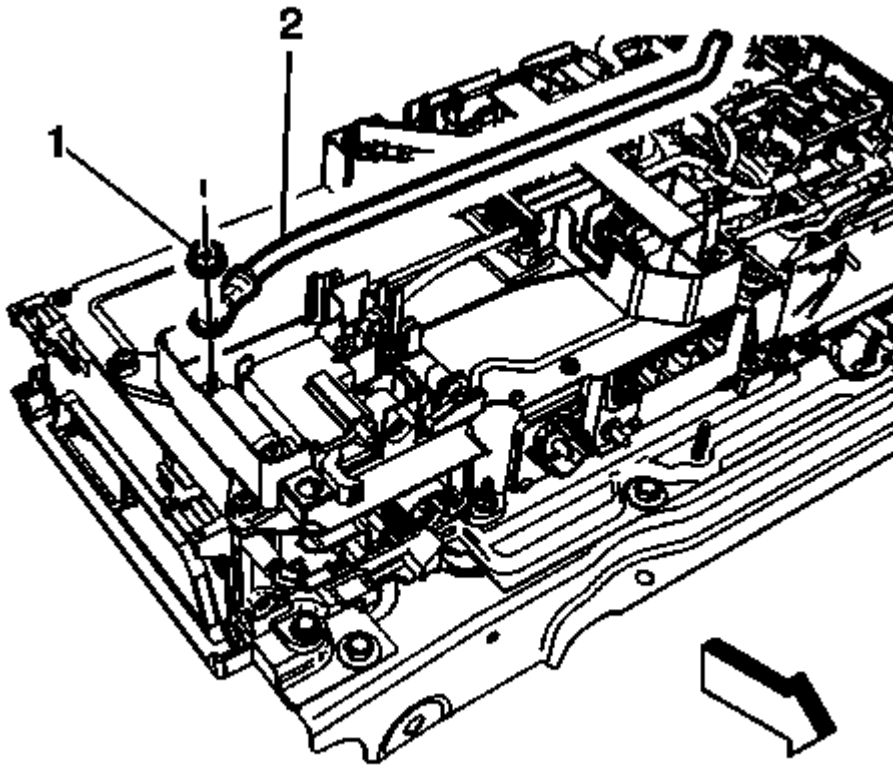


Fig. 130: High Voltage Fasteners And High Voltage Cables
Courtesy of GENERAL MOTORS COMPANY

2. Remove the high voltage fasteners (1) and the high voltage cables (2) from the generator battery fuse.

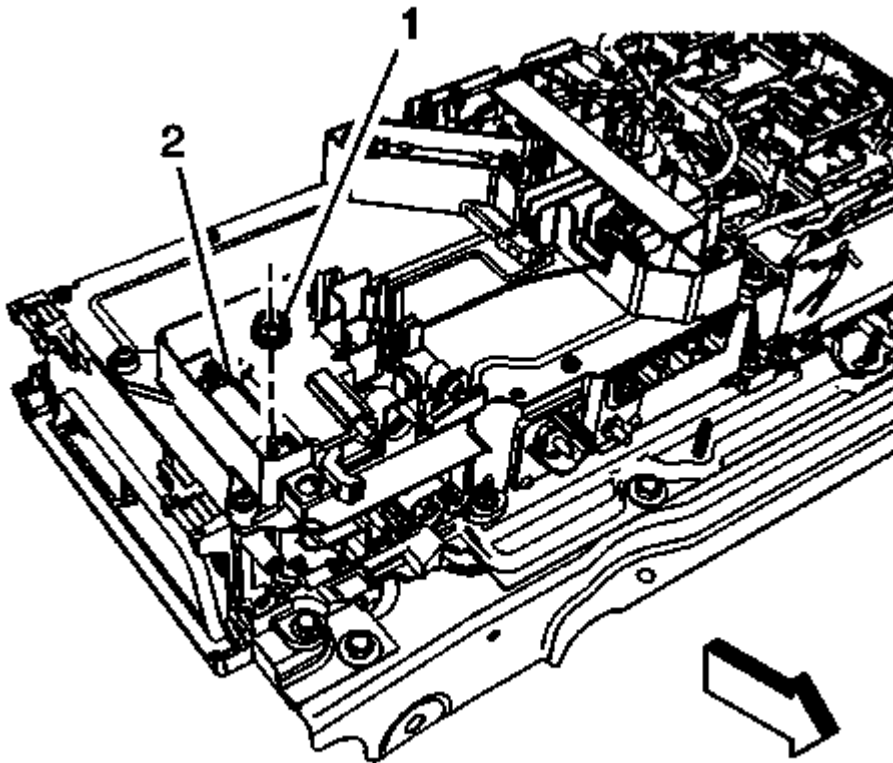


Fig. 131: Generator Fuse Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the generator fuse fastener (1) and remove the generator battery fuse (2).

Installation Procedure

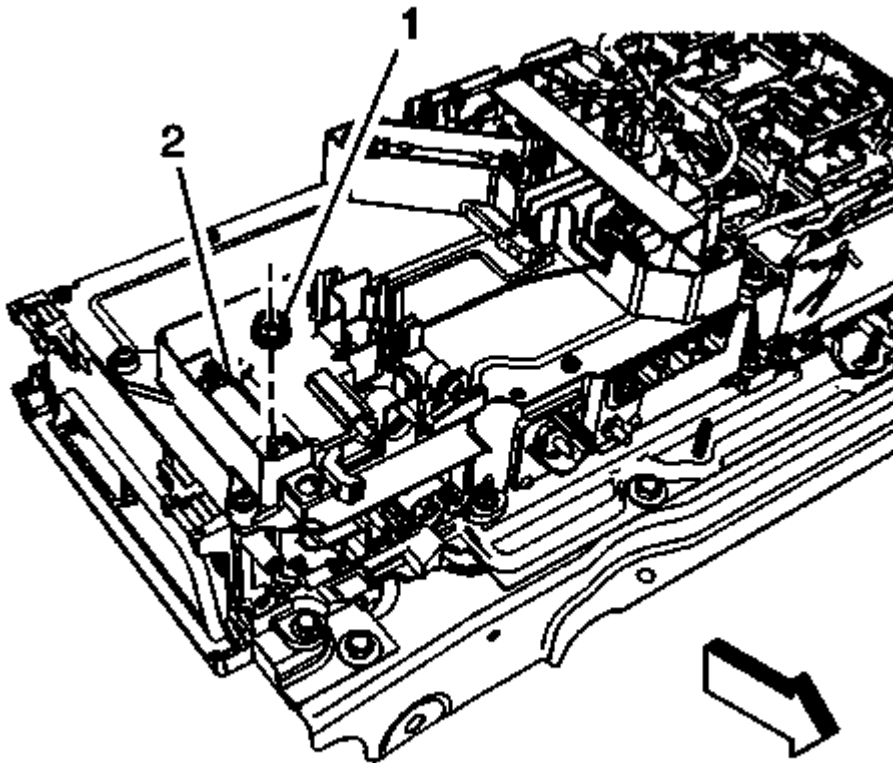


Fig. 132: Generator Fuse Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the generator battery fuse (2) and tighten the fastener (1) to 9 N.m (80 lb in).

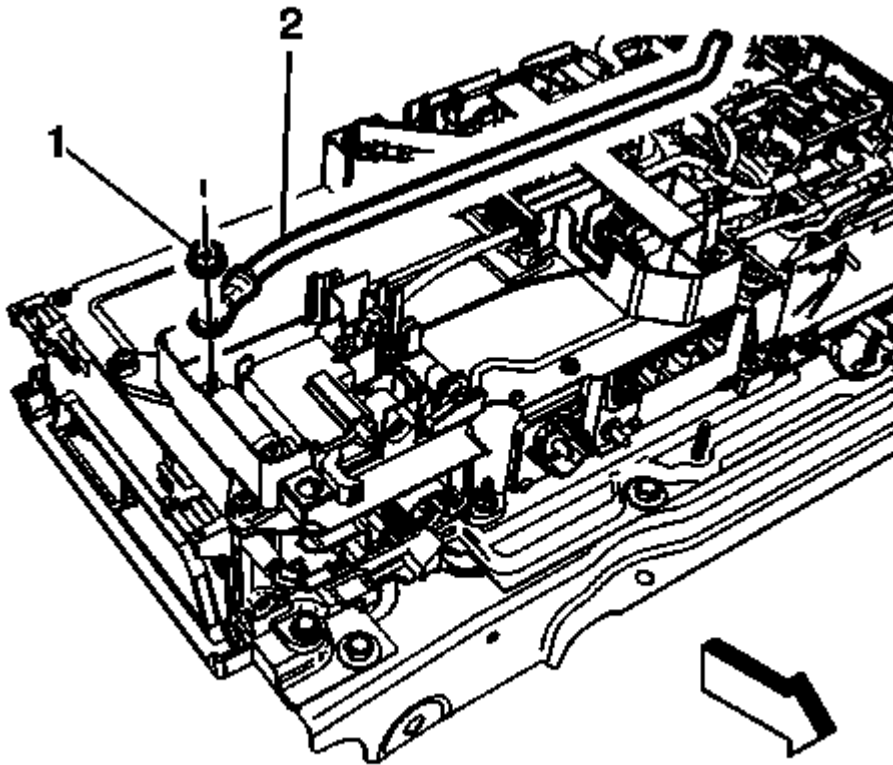


Fig. 133: High Voltage Fasteners And High Voltage Cables
Courtesy of GENERAL MOTORS COMPANY

2. Install the high voltage cable (2) to the generator battery fuse and tighten the fastener (1) to 9 N.m (80 lb in).
3. Enable the hybrid battery. Refer to **High Voltage Enabling**.

BATTERY AUXILIARY TRAY REPLACEMENT

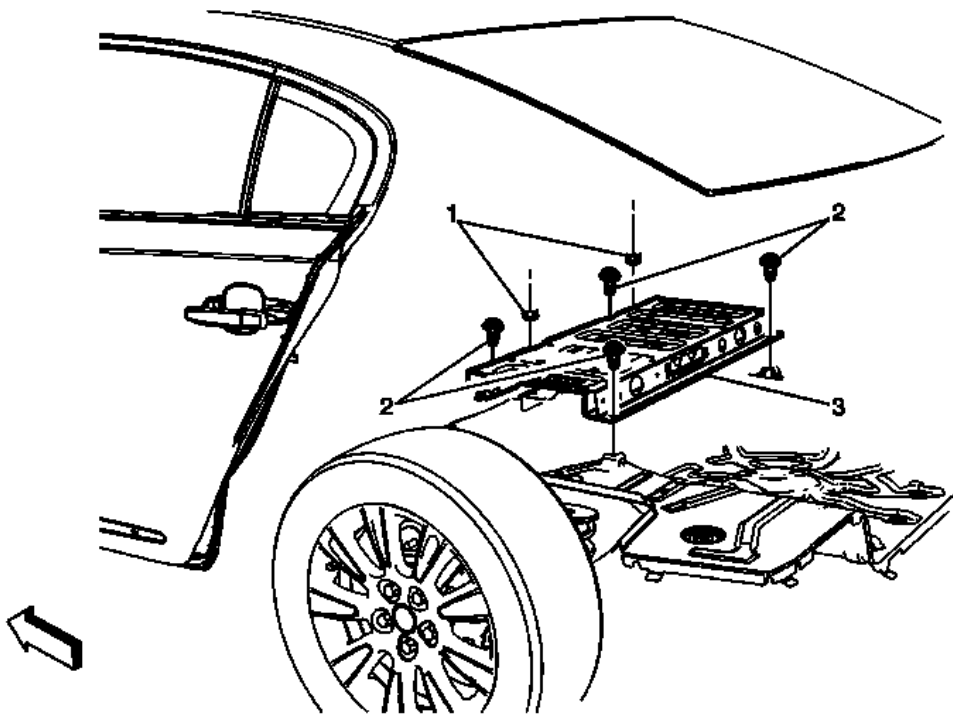


Fig. 134: Battery Auxiliary Tray And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Battery Auxiliary Tray Replacement

Callout	Component Name
<p>WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.</p> <p>WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.</p> <p>The High Voltage Disabling procedure includes the following steps:</p> <ul style="list-style-type: none"> • Identify how to disable high voltage. • Identify how to test for the presence of high voltage. • Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed. <p>Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:</p> <ul style="list-style-type: none"> • Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors. 	

- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
 - **Visually and functionally inspect the gloves before use.**
 - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

Preliminary Procedure Remove the generator control and battery module. Refer to **Generator Control and Battery Module Replacement and Shipping Preparation**.

1	Battery Auxiliary Tray Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft).
2	Battery Auxiliary Tray Fasteners (Qty: 4) Tighten 58 N.m (43 lb ft).
3	Battery Auxiliary Tray

CLEAR SECURED HIGH VOLTAGE DTCS

The Clear Secured High Voltage DTCs procedure must be completed when a latched DTC is set, a vehicle crash event has been detected, or when the Starter/Generator Control Module has been replaced.

Clearing DTCs After a Vehicle Crash Event

NOTE: **Before clearing any DTCs after a vehicle crash event, inspect and ensure the high voltage system integrity has not been compromised during the crash event. Refer to High Voltage System Inspection.**

1. Connect a scan tool to the vehicle.
2. Ignition ON, select Clear Secured High Voltage DTCs in the Hybrid Powertrain Control Module Control Functions list.
3. Select Hybrid Powertrain Control Module.

NOTE: **A command reject may appear on the scan tool after the first Clear Secured High Voltage DTCs request. If this occurs, ignore this command reject and continue to the next step.**

4. Follow the scan tool directions to complete the procedure.
5. When complete, exit out of the Clear Secured High Voltage DTCs menu.

6. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
7. Ignition ON, select Clear Secured High Voltage DTCs in the Hybrid Powertrain Control Module Control Functions list.
8. Select Battery Energy Control Module.
9. Follow the scan tool directions to complete the procedure.
10. When complete, exit out of the Clear Secured High Voltage DTCs menu.
11. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
12. Ignition ON, select Clear Secured High Voltage DTCs in the Hybrid Powertrain Control Module Control Functions list.
13. Select Hybrid Powertrain Control Module.

NOTE: **A command reject may appear on the scan tool after the first Clear Secured High Voltage DTCs request. If this occurs, ignore this command reject and continue to the next step.**

14. Follow the scan tool directions to complete the procedure.
15. When complete, exit out of the Clear Secured High Voltage DTCs menu.
16. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
17. Ignition ON, clear any DTCs that may be set.

Clearing High Voltage DTCs

1. Connect a scan tool to the vehicle.
2. Ignition ON, select Clear Secured High Voltage DTCs in the Hybrid Powertrain Control Module Control Functions list.
3. Select Battery Energy Control Module.
4. Follow the scan tool directions to complete the procedure.
5. Clear any DTCs that may be set.
6. Ignition OFF and all vehicle systems OFF. Wait 2 min.
7. Ignition ON, clear any DTCs that may be set.

DESCRIPTION AND OPERATION

DRIVE MOTOR BATTERY SYSTEM DESCRIPTION

The hybrid energy storage system uses a number of modules and components to store electricity for use by the eAssist system. The hybrid energy storage system stores 115 V DC in two lithium-ion battery sections. Current flows from the battery sections through a series of contactors and a service disconnect. This allows the system to control the disconnect of high voltage from the vehicle and also creates a redundant disconnect to ensure voltage is disabled when servicing high voltage components. To ensure optimum life of the lithium-ion batteries, the hybrid energy storage system monitors the state of charge of each battery cell. The system will equalize the state of charge of each cell through a balancing process. The hybrid energy storage system is also responsible for monitoring and controlling the charging and the discharging of the high voltage battery.

The high voltage battery is charged during normal vehicle driving. During normal operation, the high voltage battery is kept at or near an optimum level of charge. In some case, such as the installation of a replacement high voltage battery, the battery state of charge may be low and require charging before the eAssist system functions begin to operate normally. To charge the battery, drive the vehicle or allow the vehicle to idle with the transmission in Park or Neutral. To decrease charging time, raise the engine speed to 2,500 - 3,000 RPM with the transmission in Neutral. This will increase the charging rate and decrease charging time.

The primary component of the hybrid energy storage system is the Hybrid/EV Battery Pack. The Hybrid/EV Battery Pack is a modular battery pack assembly that not only contains the lithium-ion battery sections, but also many of the control modules and components used by the eAssist system.

The Hybrid/EV Battery Pack contains the following serviceable components:

- Hybrid/EV Battery Section 1
- Hybrid/EV Battery Section 2
- Battery Energy Control Module
- Starter/Generator Control Module
- Main Contactor - located in the generator battery disconnect relay assembly
- Pre-Charge Contactor - located in the generator battery disconnect relay assembly
- Hybrid/EV Battery Pre-Charge Resistor - located in the generator battery disconnect relay assembly
- Hybrid/EV Battery Pack Current Sensor - located in the generator battery disconnect relay assembly
- Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever - located in the battery energy control module wiring junction block assembly
- Generator Battery Fuse - located in the battery energy control module wiring junction block assembly
- High Voltage Interlock Switch

Hybrid/EV Battery Pack

The Hybrid/EV Battery Pack is located in the rear compartment of the vehicle, directly behind the rear passenger seat, and serves as a modular assembly to contain many of the eAssist control modules and system components. The Hybrid/EV Battery Pack may also be referred to as the following names:

- Energy Storage System
- Power Pack
- Generator Control and Battery Module Assembly

The Hybrid/EV Battery Pack first consists of a metal tray that is fixed to the vehicle floor. This provides a strong mount for other components to secure to. Within the Hybrid/EV Battery Pack, the hybrid/EV battery section 1 and hybrid/EV battery section 2 are located nearest to the left side of the vehicle. Directly above the battery sections is the battery energy control module. To the right of the battery sections and nearest to the right side of the vehicle is the Starter/Generator Control Module. Above the Starter/Generator Control Module is the generator battery disconnect relay assembly and battery energy control module wiring junction block assembly. A case cover is secured over the top of all components, effectively creating the Hybrid/EV Battery Pack and preventing access to any high voltage components without first disabling the high voltage system.

The Hybrid/EV Battery Pack is also integral to the hybrid/EV cooling system. Foam gaskets are adhered to the metal battery pack tray. This seals the underside of the Starter/Generator Control Module to ensure proper airflow under the control module for cooling purposes. The Hybrid/EV Battery Pack case cover also provides a mounting surface for the Hybrid/EV Battery Pack Cooling Fan and has openings where the plastic vents are allowed to pass into the Hybrid/EV Battery Pack to direct air through components which require cooling.

Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2

The hybrid/EV battery section 1 and hybrid/EV battery section 2 are a pair of lithium-ion batteries connected in series to make up the 115 V DC battery. The two sections are diagnosed and serviced as a single battery assembly. The individual battery sections are not serviced separately.

The hybrid battery contains a total of 32 cell groups, with each section containing 16 cells that are connected in series using internal bus bars. The two battery sections are externally connected in series using high voltage cable. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC.

The hybrid battery sections are air cooled. Each battery case has an air inlet and an air outlet. Air is drawn through the battery case to cool the individual cells. Attached to each case is a vent tube. In the event of a damaged or ruptured battery, any outgassing will be vented to the outside of the vehicle.

A voltage sense circuit is attached to each individual cell. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connects the voltage sense circuits to the battery energy control module, located directly above the battery sections. The sensor itself is a part of the battery cell and is not serviceable.

Battery Energy Control Module

The battery energy control module is located directly above the hybrid/EV battery section 1 and hybrid/EV battery section 2. The module is responsible for monitoring the hybrid/EV battery section 1 and hybrid/EV battery section 2 parameters and reporting this to the Starter/Generator Control Module. The battery energy control module may also be referred to as the following names:

- BECM
- Voltage Current Temperature Module
- Voltage Temperature Interface Module (VTIM)

The battery energy control module monitors the voltage of each battery cell section. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connects the voltage sense circuits to the battery energy control module, located directly above the battery sections. The sensor itself is a part of the battery cell and is not serviceable.

The battery energy control module also measures critical temperatures within the two battery sections and at the hybrid/EV battery section 1 air inlet. Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The battery energy control

module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The air inlet temperature sensor operates in much the same way, except that it measures the temperature of the incoming air used to cool the Hybrid/EV Battery Pack at the hybrid/EV battery section 1 air inlet. None of the temperature sensors or the temperature sensor harness is serviceable. They are all serviced as part of the battery sections.

The battery energy control module is responsible for the cell balancing process. During operation, individual cells may charge or discharge at different rates. To ensure proper battery health and optimal life, these voltages are balanced, with energy from a higher voltage cell being transferred to a lower voltage cell. This keeps the voltage consistent between all 32 cell groups. Cell balancing is an internal process of the battery energy control module. Internal gates allow energy to flow between cells using the same circuits that are used to monitor cell voltage.

Starter/Generator Control Module

The Starter/Generator Control Module is a multifunction module that is involved in many eAssist system operations. The Starter/Generator Control Module contains two internal microprocessors: a battery control processor and a motor control processor. The battery control processor is responsible for the following:

- Communicating with the battery energy control module to determine the status of the high voltage battery
- Controlling the battery and Starter/Generator cooling systems
- Controlling the main and pre-charge contactors
- Monitoring the high voltage interlock loops
- Monitoring for isolation faults
- Supplying 12 V to the vehicle

Internal to the Starter/Generator Control Module, the motor control processor is responsible for propulsion activities and the 14 V control module is responsible for maintaining 12 V to the vehicle. The Starter/Generator Control Module may also be referred to as the following names:

- SGCM
- Hybrid Powertrain Control Module (HPCM)
- Accessory Power Module (APM)
- Battery Power Inverter Module (BPIM)
- Power Inverter Module (PIM)

Hybrid/EV Battery Control

The Starter/Generator Control Module interfaces with the battery energy control module to determine the status of the battery voltage and battery temperature. The Starter/Generator Control Module uses voltage information from the battery energy control module to make decisions about the battery state of health, how the battery should be charged or discharged, and when to initiate cell balancing.

Hybrid/EV Battery and Starter/Generator Cooling

The Starter/Generator Control Module uses temperature information from the battery energy control module to control the Hybrid/EV Battery Pack Cooling Fan. The Starter/Generator Control Module also monitors the Starter/Generator coolant temperature sensor and will control the Starter/Generator coolant pump relay, which controls the Starter/Generator coolant pump.

High Voltage Contactors

At times, it may be necessary to disconnect high voltage from the vehicle, both during normal operation and when a system fault is identified. The Starter/Generator Control Module controls the main contactor and pre-charge contactor to disconnect and connect high voltage from the vehicle.

High Voltage Interlock

The high voltage interlock is a fail-safe to disable high voltage when the Starter/Generator Control Module identifies that a high voltage area has been accessed. The Hybrid/EV Battery Pack has a high voltage interlock switch located on the service access cover. The Starter/Generator also has a high voltage interlock switch on the access cover. When either cover is removed, the interlock loop is opened. The Starter/Generator Control Module will open the contactors to prevent technician contact with high voltage.

High Voltage Isolation

The Starter/Generator Control Module monitors the electrical potential between high voltage and the vehicle chassis. High voltage should always be isolated from the vehicle chassis by a certain amount of resistance to avoid the potential for a life threatening current path. In the event that a high voltage leak path is detected to the vehicle chassis, the Starter/Generator Control Module will set a DTC and open the contactors to remove high voltage.

Testing for loss of isolation requires special tools and procedures. Because of the high voltages present in the hybrid system, a loss of isolation may occur due to insulation breakdown. Insulation breakdown typically occurs only when high voltage is present. Conditions such as insulation breakdown cannot be diagnosed with a typical DMM because high voltage is not used by the DMM when measuring resistance.

12 V Output

The Starter/Generator Control Module essentially takes the place of the generator on a traditional vehicle. The Starter/Generator Control Module converts high voltage DC to a 12 V DC for accessory electrical operation and to charge the 12 V battery.

Main Contactor, Pre-Charge Contactor, and Pre-Charge Resistor

The high voltage contactors are switches that are controlled like a relay. To disable high voltage from the vehicle, the main and pre-charge contactors are commanded open. This will open the contactors and physically disconnect the hybrid/EV battery positive cable. To connect high voltage to the vehicle, first the pre-charge contactor is closed. With the pre-charge contactor closed, current flows through the pre-charge resistor. This allows high voltage to slowly build in the system. Once high voltage is brought up through the pre-charge contactor, the main contactor is closed and high voltage is active. If the high voltage builds too quickly or too slowly, the Starter/Generator Control Module will set a fault.

Both the main contactor and the pre-charge contactor are controlled in a similar manner. B+ is applied at all times to each contactor. Each contactor is controlled by an independent low side driver in the Starter/Generator Control Module. When the Starter/Generator Control Module commands the contactor closed, ground is applied to the contactor through the low side driver and the contactor is closed.

Both contactors and the pre-charge resistor are located in the generator battery disconnect relay assembly. The generator battery disconnect relay assembly is a plastic tray that is secured to the top of the Starter/Generator Control Module. The generator battery disconnect relay assembly also contains the Hybrid/EV Battery Pack current sensor and a series of bus bars and cables that electrically connect the hybrid/EV battery to the Starter/Generator Control Module.

Hybrid/EV Battery Pack Current Sensor

The Hybrid/EV Battery Pack current sensor is a three-wire hall effect sensor that measures current flow from the hybrid/EV battery. The battery energy control module applies 5 volt and provides a low reference to power the sensor. Current measurement is communicated to the battery energy control module via a signal circuit.

The Hybrid/EV Battery Pack current sensor is located in the generator battery disconnect relay assembly. The generator battery disconnect relay assembly is a plastic tray that is secured to the top of the Starter/Generator Control Module. The generator battery disconnect relay assembly also contains the high voltage contactors, pre-charge resistor, and a series of bus bars and cables that electrically connect the hybrid/EV battery to the Starter/Generator Control Module. The Hybrid/EV Battery Pack current sensor monitors current on the hybrid/EV battery negative bus bar.

Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever and Generator Battery Fuse

The Hybrid/EV Battery Pack high voltage manual disconnect lever provides a redundant method to disconnect high voltage from vehicle when performing service on the system. With the switch open, high voltage is physically disconnected from the hybrid/EV battery positive cable. Together with the high voltage interlock and the high voltage contactors, the manual disconnect provides a means of disconnecting high voltage at two points in the system. This provides a double-layer of protection.

The generator battery fuse is a 125 A fuse to prevent an overcurrent condition in the 115 V DC system.

The Hybrid/EV Battery Pack high voltage manual disconnect lever and generator battery fuse are located in the battery energy control module wiring junction block assembly. The battery energy control module wiring junction block assembly is a plastic tray that is secured to the top of the Starter/Generator Control Module.

High Voltage Interlock Switch

The high voltage system uses two high voltage interlock switches to indicate that an area of the vehicle that contains a high voltage connection has been exposed. These locations are at the Starter/Generator and the Hybrid/EV Battery Pack. The two interlock switches are completely separate and are not tied together.

The Starter/Generator Control Module applies a constant 5 V reference to the high voltage interlock switch and monitors the voltage. Each high voltage interlock switch contains a resistor. With the high voltage interlock connected, the 5 V reference voltage travels through the resistor and is reduced by a specific amount. This indicates that the high voltage interlock switch is closed and no circuit faults have occurred. If the high voltage

interlock switch is removed or a circuit fault occurs, the voltage will change and the Starter/Generator Control Module will open the contactors.

The Hybrid/EV Battery Pack high voltage interlock switch is part of the Hybrid/EV Battery Pack cable cover. When the cover is removed, the high voltage interlock switch is also removed. To remove the cover, the Hybrid/EV Battery Pack high voltage manual disconnect lever must also be opened, providing a second means of disconnecting high voltage.

The Starter/Generator high voltage interlock switch is part of the Starter/Generator cable cover. When the cover is removed, the high voltage interlock switch is also removed.

Vehicle Collision Detection

As a safety precaution, the Starter/Generator Control Module monitors the collision event messages from the Inflatable Restraint Sensing and Diagnostic Module (SDM). This message is broadcast by the SDM via serial data to inform various control module that a collision event has occurred so they can take appropriate action. This message does not indicate the severity of the collision, nor does it indicate that airbag deployment has been commanded.

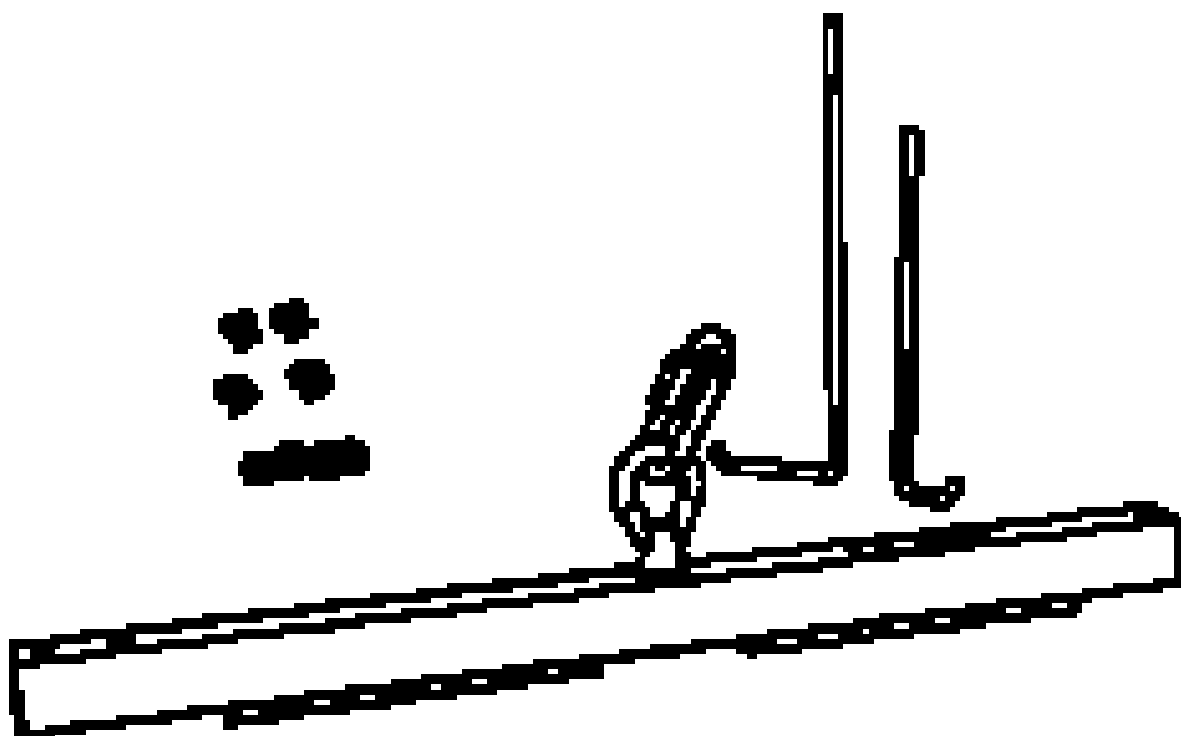
If a collision event message is received by the Starter/Generator Control Module, it will enter a collision event detected state and respond by opening the high voltage contactors. This will help isolate the high voltage battery from the rest of the vehicle and reduce the possibility of a compromised high voltage system creating a hazard.

If the Starter/Generator Control Module has entered the collision event detected state, the **High Voltage System Inspection**, procedure must be performed to ensure the high voltage system has not been compromised. If compromised, any necessary repairs should be made. The collision event detected condition will remain active until cleared using the **Clear Secured High Voltage DTCs**.

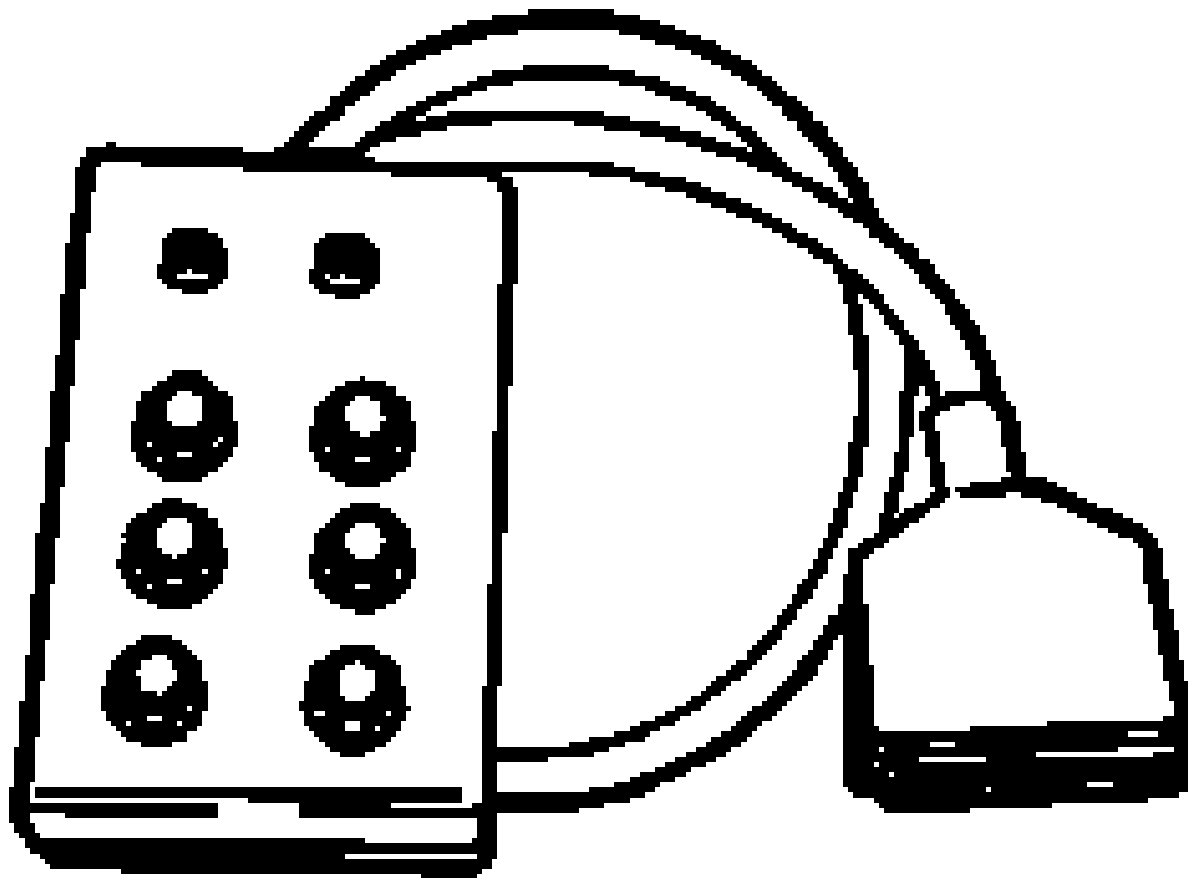
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

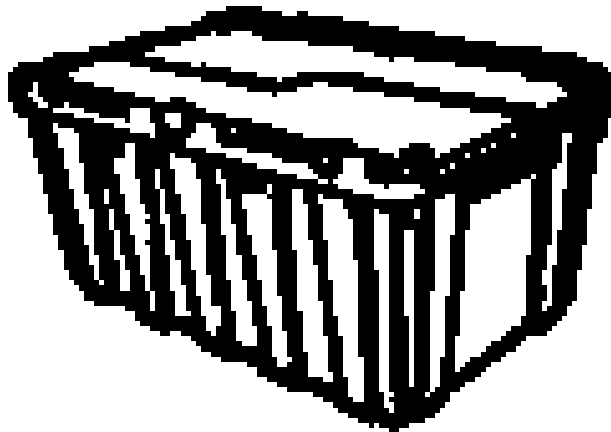
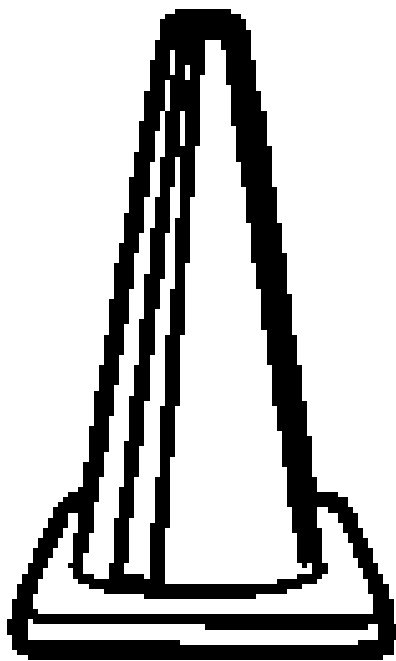
Illustration	Tool Number/ Description



EL-48264
Battery
Pack
Lifting
Adapter

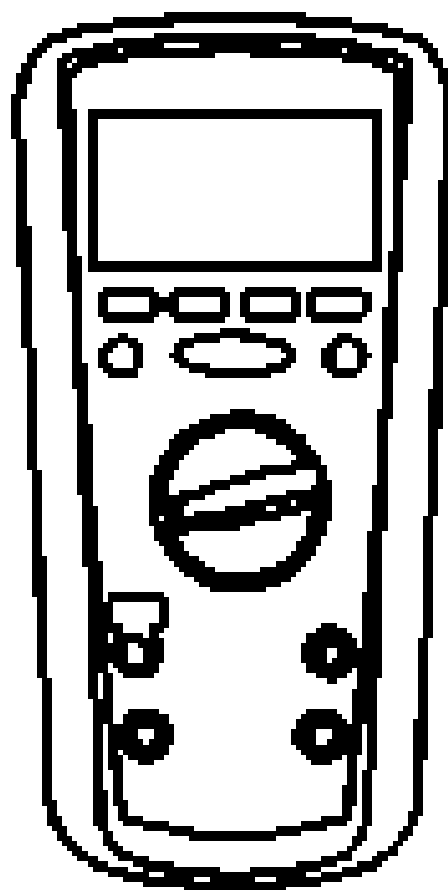
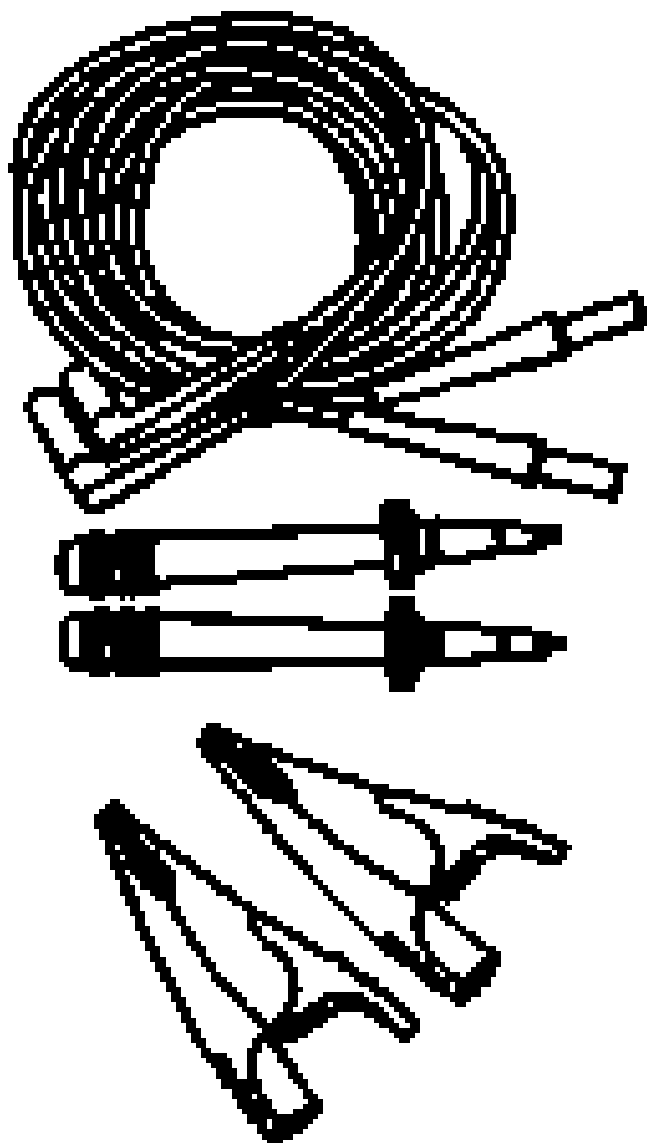


EL-48571-1
High
Voltage
Battery Pin
Out Box



EL-48900
High
Voltage
Safety Kit





EL-50772
Insulation
Multimeter

Brakes

Hydraulic Brakes

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake and Accelerator Pedal Assembly Bolt	22 N.m	16 lb ft
Brake Hose Fitting Bolt	40 N.m	30 lb ft
Brake Pipe Fitting	18 N.m	13 lb ft
Master Cylinder Nut	50 N.m	37 lb ft
Master Cylinder Reservoir Bolt	4 N.m	35 lb in
Power Brake Booster Pump Nut	10 N.m	89 lb in
Power Vacuum Brake Booster Bolt	19 N.m	14 lb ft

BRAKE COMPONENT SPECIFICATIONS

Brake Component Specifications

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve- Front	14 N.m	124 lb in
Brake Caliper Bleeder Valve- Rear	14 N.m	124 lb in

BRAKE SYSTEM SPECIFICATIONS

Brake System Specifications

Application	Specification	
	Metric	English
Brake Pedal Travel	48-58 mm	1.9-2.3 in
<ul style="list-style-type: none">Maximum specification with 450 N (101 lbs) of force applied to the pedal with the ignition OFF and the booster power reserve depleted.		

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
	DOT 4 Hydraulic		

SCHEMATIC WIRING DIAGRAMS

HYDRAULIC BRAKE SYSTEM WIRING SCHEMATIC

Hydraulic Brakes (except CZ2)

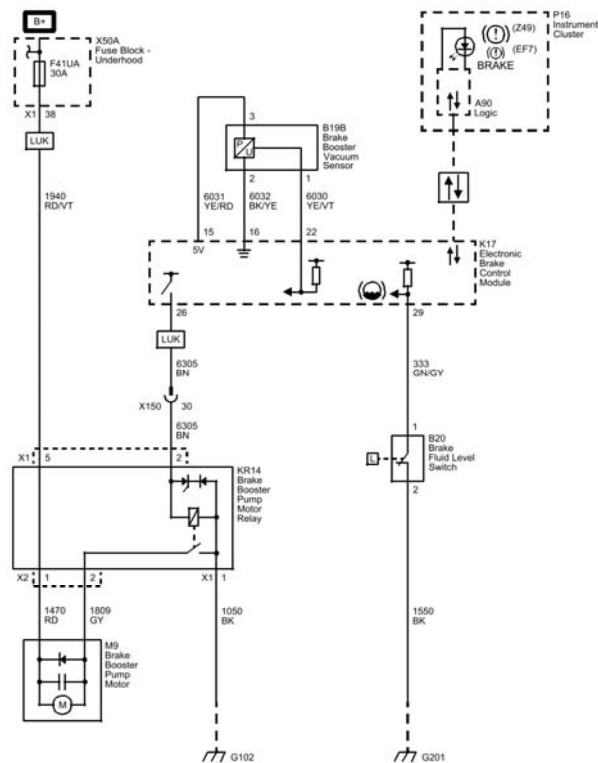


Fig. 1: Hydraulic Brakes (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Hydraulic Brakes (CZ2)

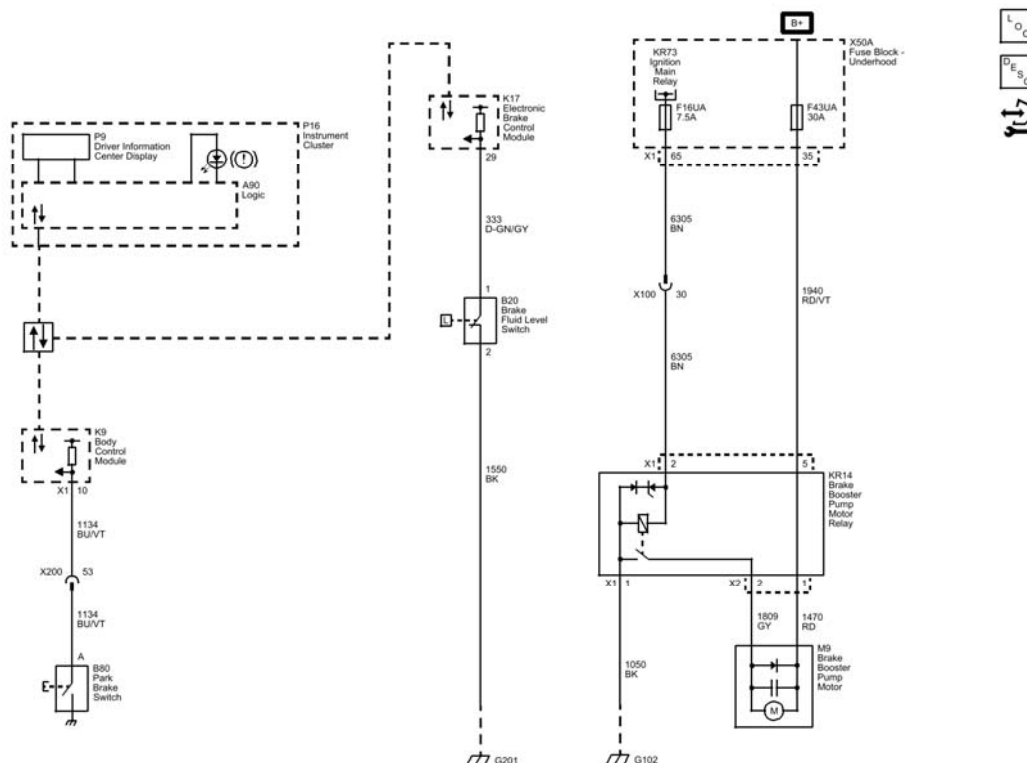


Fig. 2: Hydraulic Brakes (CZ2)

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC C0267</u>	DTC C0267 Low Brake Fluid Indicated
<u>DTC C0273</u>	DTC C0273 Brake Fluid Level Switch Circuit
<u>DTC C027B</u>	DTC C027B 00 Brake Booster Electric Vacuum Pump
<u>DTC C0299</u>	DTC C0299 56 Brake Booster Large Vacuum Leak Detected Too Many Transitions
<u>DTC C025E</u>	DTC C025E Brake Booster Vacuum Sensor Circuit

DTC C0267: LOW BRAKE FLUID INDICATED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0267

Low Brake Fluid Indicated

For symptom byte information refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	-	C0267 00	-	-
Ground	-	C0267 00	-	-

Circuit/System Description

The brake fluid level switch monitors the level of the brake fluid in the brake fluid reservoir. When the electronic brake control module sees low brake fluid level, the DTC is set.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

Low brake fluid level is detected for 8 s.

Action Taken When the DTC Sets

- The electronic brake control module disables the traction control and stability control for the duration of the ignition cycle.
- The traction control/stability control-active indicator turns ON.
- The brake warning indicator turns ON.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Warning System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the brake is above minimum level.
 - **If low**

Refer to **Brake Fluid Loss**.

- **If above minimum level**

Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Brake Fluid Level Sensor parameter is Low.
 - **If the parameter is not Low**

1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K17 Electronic Brake Control Module.
- **If the parameter is Low**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.
6. Verify the scan tool Brake Fluid Level Sensor parameter is Ok.
 - **If the parameter is not Ok**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the parameter is Ok**
7. Test or replace the B20 Brake Fluid Level Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Brake Fluid Level Indicator Switch Replacement**
- **Control Module References** for electronic brake control module replacement, programming and setup.

DTC C0273: BRAKE FLUID LEVEL SWITCH CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0273

Brake Fluid Level Switch Circuit

For symptom byte information refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	C0267 00	C0273 05	C0273 05	-
Ground	-	C0273 05	-	-

Circuit/System Description

The brake fluid level switch monitors the level of the brake fluid in the brake fluid reservoir. When the electronic brake control module sees the brake fluid level switch input open, the DTC is set.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

A open or short to battery is detected on the signal circuit.

Action Taken When the DTC Sets

- The brake warning indicator turns ON.
- ABS indicator turns ON.
- Traction control indicator turns ON.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hydraulic Brake System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Brake Fluid Level Sensor parameter is OK.
 - **If the parameter is not OK**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K17 Electronic Brake Control Module.
 - **If the parameter is OK**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.
6. Verify the scan tool Brake Fluid Level Sensor parameter is Low.
 - **If the parameter is not Low**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the parameter is Low**
7. Test or replace the B20 Brake Fluid Level Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Brake Fluid Level Indicator Switch Replacement**
- **Control Module References** for electronic brake control module replacement, programming and setup.

DTC C027B: BRAKE BOOSTER ELECTRIC VACUUM PUMP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C027B 00

Brake Booster Electric Vacuum Pump

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Vacuum Pump Relay B+	-	-	-	-
Vacuum Pump Relay Control	C027B 00	C027B 00	C027B 00	-
Vacuum Pump Relay Ground	-	-	-	-

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module. When the vacuum within the system becomes weak, the electronic brake control module turns ON the brake booster pump motor by providing battery voltage to the brake booster pump motor relay. The relay activates and supplies ground to the brake booster pump motor.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

A short to ground, short to voltage or open/high resistance is detected on the control circuit.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Assist System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.
 - **If damage, leakage or incorrect installation is found**

Refer to **Brake Assist System Diagnosis**

- **If no damage, leakage or incorrect installation is found**
2. Ignition ON.
3. Verify the brake booster pump motor turns ON and OFF when commanding the brake booster electric vacuum pump ON and OFF with a scan tool.
 - **If the brake booster pump motor does not turn ON and OFF**

Refer to Circuit/System Testing.

- **If the brake booster pump motor turn ON and OFF**
4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the KR14 Brake Booster Pump Motor Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M9 Brake Booster Pump Motor.
 - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 2 and ground.
6. Verify the test lamp turns ON and OFF when commanding the brake booster electric vacuum pump ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K17 Electronic Brake Control Module.
 - **If the test lamp turns ON and OFF**
7. Replace the KR14 Brake Booster Pump Motor Relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Brake Booster Pump Replacement (LTG)**, **Power Brake Booster Pump Replacement (LUK)**
- **Control Module References** for electronic brake control module replacement, programming and setup.

DTC C0299: BRAKE BOOSTER LARGE VACUUM LEAK DETECTED TOO MANY TRANSITIONS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0299 56

Brake Booster Large Vacuum Leak Detected Too Many Transitions

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The EBCM detected a too low vacuum in the brake booster assembly for 120 s.

Action Taken When the DTC Sets

The brake warning indicator turns ON.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.

- The electronic brake control module will turn OFF the indicator in the next ignition cycle.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Assist System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Ignition ON.
2. Verify that DTC C1100 is not set.
 - **If the DTC is set**

Refer to **DTC C025E: Brake Booster Vacuum Sensor Circuit.**

- **If the DTC is not set**
3. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.
 - **If damage, leakage or incorrect installation is found**

Refer to **Brake Assist System Diagnosis.**

- **If the inspection is OK**
4. Replace the B19B Brake Booster Vacuum Sensor.
5. Verify the DTC does not set while operating the vehicle under the Conditions for Running the DTC.
 - **If the DTC sets**

Replace the K17 Electronic Brake Control Module.

- **If the DTC does not set**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Electronic Brake Control Module replacement, programming and setup.

DTC C025E: BRAKE BOOSTER VACUUM SENSOR CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C025E

Brake Booster Vacuum Sensor Circuit

For symptom byte information refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	C025E 00	C025E 06	C025E 00	-
Sensor Signal	C025E 06	C025E 06	C025E 01	C025E 1F, C025E 5A
Low Reference	-	C025E 01	-	-

Circuit/System Description

The brake booster vacuum sensor monitors the pressure in the brake booster. The electronic brake control module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module.

Conditions for Running the DTC

C025E 00, C025E 01, C025E 06, C025E 1F

Ignition ON

C025E 5A

- Ignition ON.
- Brakes are not applied.

Conditions for Setting the DTC

C025E 00

- A short to ground is detected on the 5V reference circuit.
- A short to voltage is detected on the 5V reference circuit.

C025E 01

- A short to voltage is detected on the signal circuit.
- An open/high resistance is detected on the low reference circuit.

C025E 06

- An open/high is detected on the signal circuit.
- A short to ground is detected on the signal circuit.
- An open/high is detected on the 5V reference circuit.

C025E 1F

The vacuum sensor signal is erratic.

C025E 5A

The vacuum sensor signal is not plausible.

Action Taken When the DTC Sets

Service Brake Assist message is displayed on the driver information center

Conditions for Clearing the DTC

The DTC clears when the diagnostic runs and passes

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Assist System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.
 - **If damage, leakage or incorrect installation is found**

Refer to **Brake Assist System Diagnosis**

- **If no damage, leakage or incorrect installation is found**
2. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B19B Brake Booster Vacuum Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If less than 10 ohms**

3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K17 Electronic Brake Control Module.
 - **If between 4.8-5.2 V**
5. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, Ignition ON.
6. Test for less than 1 V between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and ground.
 - **If greater than 1 V**

Repair the short to voltage on the circuit.
 - **If less than 1 V**
7. Ignition OFF.
8. Test for infinite resistance between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
9. Test for less than 2 ohms between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and the K17 Electronic Brake Control Module signal circuit terminal 34.
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.
 - **If less than 2 ohms**

10. Test or replace the B19B Brake Booster Vacuum Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Brake Booster Vacuum Sensor Replacement**
- **Control Module References** for electronic brake control module replacement, programming and setup

BRAKE BOOSTER PUMP MOTOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Vacuum Pump Relay B+	2	2	-	-
Vacuum Pump Relay Control	2	2	1	-
Vacuum Pump Relay Ground	2	2	-	-
Brake Booster Vacuum Sensor 5V Reference	C025E 00	C025E 06	C025E 00	-
Brake Booster Vacuum Sensor Signal	C025E 06	C025E 06	C025E 01	C025E 1F, C025E 5A
Brake Booster Vacuum Sensor Low Reference	-	C025E 01	-	-
Brake Booster Pump Motor Control	2	2	1	-
Brake Booster Pump Motor Ground	1	2	-	-
1. Brake Booster Pump Motor Always ON 2. Brake Booster Pump Motor Always OFF				

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module. When the vacuum within the system becomes weak, the electronic brake control module turns ON the brake booster pump motor by providing battery voltage to the brake booster pump motor relay. The relay activates and supplies ground to the brake booster pump motor.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Booster Vacuum Assist Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C025E is not set.
 - **If the DTC is set**

Refer to **DTC C025E**.

- **If the DTC is not set**

3. Verify the brake booster pump motor turns ON and OFF when commanding the Brake Booster Electric Vacuum Pump On and Off with a scan tool.
 - **If the brake booster pump motor does not turn ON and OFF**

Refer to Circuit/System Testing.

- **If the brake booster pump motor turn ON and OFF**

4. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.
 - **If damage, leakage or incorrect installation is found**

Refer to **Brake Assist System Diagnosis**.

- **If the inspection is OK**

5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the KR14 Brake Booster Pump Motor Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M9 Brake Booster Pump Motor.
 - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 2 and ground.
6. Verify the test lamp turns ON and OFF when commanding the Brake Booster Electric Vacuum Pump On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module,

ignition ON.

2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K17 Electronic Brake Control Module.

- **If the test lamp turns ON and OFF**

7. Ignition OFF, connect the X1 harness connector at the KR14 Brake Booster Pump Motor Relay. Disconnect the X2 harness connector at the KR14 Brake Booster Pump Motor Relay.
8. Connect a test lamp between the ground circuit terminal 2 and the B+ circuit terminal 1 at the KR14 Brake Booster Pump Motor Relay, ignition ON.
9. Verify the test lamp turns ON and OFF when commanding the Brake Booster Electric Vacuum Pump On and Off with a scan tool.
 - **If the test lamp does not turn ON and OFF**

Replace the KR14 Brake Booster Pump Motor Relay.

- **If the test lamp turns ON and OFF**

10. Install a 30 A fused jumper wire between the M9 Brake Booster Pump Motor terminal 1 and B+. Install a jumper wire between the M9 Brake Booster Pump Motor terminal 2 and ground.
11. Verify the M9 Brake Booster Pump Motor activates.
 - **If the brake booster pump motor does not activate**

Replace the M9 Brake Booster Pump Motor.

- **If the brake booster pump motor activates**

12. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Brake Booster Pump Replacement (LTG), Power Brake Booster Pump Replacement (LUK)**
- **Relay Replacement (Within an Electrical Center) , Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup.

BRAKE WARNING INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	C0267	1	1	-
Ground	-	1	-	-
1. Brake Warning Indicator Malfunction				

Circuit/System Description

The electronic brake control module monitors the brake fluid level in the brake fluid reservoir. When the fluid within the brake fluid reservoir is below the MIN level, contacts within the brake fluid level switch closes causing the voltage within the signal circuit to drop. The electronic brake control module will detect the voltage drop and will send a serial data message to the instrument cluster commanding the brake warning indicator to illuminate.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Warning System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the brake fluid has the proper level. The fluid level should be above minimum level.
 - **If low**

Refer to **Brake Fluid Loss**.

- **If above minimum level**
- 2. Ignition ON.
- 3. Verify the scan tool Brake Fluid Level Sensor parameter. The reading should be Ok.

- **If the parameter is Low**

Refer to Circuit/System Testing

- **If the parameter is Ok**

- 4. Verify the brake warning indicator turns ON and OFF, when commanding the instrument cluster All Indicators ON and OFF with a scan tool.
- **If the brake warning indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster.

- **If the brake warning indicator turns ON and OFF**

- 5. All OK.

Circuit/System Testing

- 1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch. It may take up to 2 min for all vehicle systems to power down.
- 2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the scan tool Brake Fluid Level Sensor parameter is Low.
 - **If the parameter is not Low**
 - 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 - 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K17 Electronic Brake Control Module.
 - **If the parameter is Low**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.
- 6. Verify the scan tool Brake Fluid Level Sensor parameter is Ok.
 - **If the parameter is Low**
 - 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the parameter is Ok**
7. Test or replace the B20 Brake Fluid Level Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Brake Fluid Level Indicator Switch Replacement**
- **Control Module References** for electronic brake control module and instrument cluster replacement, programming and setup.

BRAKE PULSATION

Brake Pulsation

Step	Action	Yes	No
DEFINITION: Fluctuation or pulsation is felt through the brake pedal, steering wheel, seat, floor, and/or in the vehicle ONLY when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	1. Inspect the disc brake system for the following conditions. <ul style="list-style-type: none"> • Excessive thickness variation of rotor friction surfaces • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Hard spots, heat checks, bluing discoloration of rotor friction surfaces; possibly due to brake drag • Excessive corrosion of rotor friction surfaces; including red, gray or black oxidation • Loose, damaged or missing caliper or lining hardware • Bent or damaged caliper or mounting component 		

	<ul style="list-style-type: none"> Excessive LRO of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 3	Go to <u>Diagnostic Starting Point - Vehicle</u>
3	<p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.</p> <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKE SYSTEM NOISE

Brake System Noise

Step	Action	Yes	No
DEFINITION: Vehicle exhibits abnormal noise when braking; vehicle may exhibit abnormal noise during motion just after brake pedal release.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	<p>1. Inspect the disc brake system for the following conditions.</p> <ul style="list-style-type: none"> Lining wear indicator contact with rotor Debris trapped between rotor and splash shield or backing plate; and/or debris trapped between rotor and linings Contaminated linings Aftermarket linings Glazed linings Distorted, cracked or damaged linings Excessively worn linings Damaged or excessively worn caliper hardware and/or lining hardware Incorrectly installed, loose or missing caliper hardware and/or lining hardware Lack of lubrication or excessive corrosion on metal to metal contact surfaces 		

	<ul style="list-style-type: none"> • Bent or damaged splash shield or backing plate • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p>		
	Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	<p>1. Inspect the brake assist system for the following conditions.</p> <ul style="list-style-type: none"> • Lack of lubrication or excessively worn pushrod or pedal pivots or pivot bushings • Bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster and/or check valve, if equipped <p>2. Adjust, repair or replace components as necessary.</p>		
	Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	<p>1. Inspect the hydraulic brake system for the following conditions.</p> <ul style="list-style-type: none"> • Improper operation of caliper pistons • Contaminated brake fluid <p>2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.</p>		
	Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	<p>Inspect the park brake system for proper operation.</p> <p>Did you find and correct a condition?</p>	Go to Step 6	Go to <u>Diagnostic Starting Point - Vehicle</u>
6	<p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.</p>		
	Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - PULLS TO ONE SIDE

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4

Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

5

Steering components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

Braking Action Uneven - Pulls to One Side

Step	Action	Yes	No
DEFINITION: Vehicle pulls to one side only when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	<ol style="list-style-type: none">Inspect the hydraulic brake system for the following conditions.<ul style="list-style-type: none">Kinked, pinched or damaged brake pipe or flexible brake hoseSticking or improperly operating caliper pistonBrake fluid leakAdjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. <p>Did you find and correct a condition?</p>	Go to Step 6	Go to Step 3
3	<ol style="list-style-type: none">Inspect the disc brake system for the following conditions.<ul style="list-style-type: none">Contaminated liningsGlazed liningsDistorted, cracked or damaged linings on one sideLoose, damaged or missing caliper hardware and/or lining hardwareIncorrect linings on one sideHard spots, heat checks, blueing		

	<p>discoloration of rotor friction surfaces; possibly due to brake drag</p> <ul style="list-style-type: none"> • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p>		
	Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	<p>1. Inspect the suspension system for the following conditions.</p> <ul style="list-style-type: none"> • Incorrect tire pressures • Loose suspension component connections • Excessively worn or damaged suspension components <p>2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Vehicle</u>.</p>		
	Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	<p>1. Inspect the steering system for the following conditions.</p> <ul style="list-style-type: none"> • Loose steering component connections • Excessively worn or damaged steering components <p>2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Vehicle</u>.</p>		
	Did you find and correct a condition?	Go to Step 6	Go to <u>Diagnostic Starting Point - Vehicle</u>
6	<p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.</p>		
	Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - FRONT TO REAR

Test Descriptions

The number below refers to the step number on the diagnostic table.

4

Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

Braking Action Uneven - Front to Rear

Step	Action	Yes	No
DEFINITION: Braking action or stopping force sensitive or grabbing and/or more pronounced at the front or at the rear axle. Sensitive or grabbing brakes: Excessive brake jump-in force relative to brake pedal input.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Vehicle
2	<ol style="list-style-type: none">1. Inspect the hydraulic brake system for the following conditions:<ul style="list-style-type: none">• Improper operation of caliper pistons• Kinked, pinched or damaged brake pipe or flexible brake hose• Brake fluid leak2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	<ol style="list-style-type: none">1. Inspect the disc brake system for the following conditions:<ul style="list-style-type: none">• Contaminated linings• Glazed linings• Distorted, cracked or damaged linings• Excessively worn linings• Aftermarket linings• Damaged or excessively worn caliper hardware and/or lining hardware• Hard spots, heat checks, blueing discoloration of rotor friction surfaces• Glazed rotor friction surfaces2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 5	Go to Step 4

4	<ol style="list-style-type: none"> Inspect the suspension system for the following conditions: <ul style="list-style-type: none"> Loose suspension component connections Excessively worn or damaged suspension components Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Vehicle</u>. 		
	Did you find and correct a condition?	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
5	<ol style="list-style-type: none"> Install or connect components that were removed or disconnected during diagnosis. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>. 		
	Is the condition still present?	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE TRAVEL

Brake Pedal Excessive Travel

Step	Action	Yes	No
DEFINITION: Brake pedal travels further than expected to obtain firm pedal and/or firm pedal cannot be obtained, pedal fades away, or pedal is spongy.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	<p>Inspect the travel and feel of brake pedal applies. Perform the following:</p> <ol style="list-style-type: none"> Apply the brake pedal several times to fully deplete the power reserve. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel. Apply the brake pedal with light, steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply. 		-

	Did you complete the brake pedal travel and feel inspections?	Go to Step 3	
3	<ol style="list-style-type: none"> Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections: <ul style="list-style-type: none"> Pedal feel was spongy <ul style="list-style-type: none"> Air in hydraulic system External brake fluid leaks Soft, weak or damaged hydraulic hoses; expanding under pressure Pedal fell away and/or traveled to or almost to floor <ul style="list-style-type: none"> External brake fluid leaks Poor brake fluid quality; low boiling point Internal brake fluid leaks; improperly functioning master cylinder Pedal was somewhat firm then dropped slightly, or pedal rose with successive applies, or pedal travel was different between slow and quick applies <ul style="list-style-type: none"> Internal brake fluid leaks; improperly functioning master cylinder Poor brake fluid quality; low boiling point Pedal returned to rest slowly after any of the applies <ul style="list-style-type: none"> Internally damaged flexible brake hoses; hindering fluid return Binding caliper pistons Internal brake fluid leaks; improperly functioning master cylinder Repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. Re-inspect brake pedal apply travel and feel. 		
	Did you find and correct a condition?	Go to Step 8	Go to Step 4
	<ol style="list-style-type: none"> Inspect the disc brake system for the following conditions: <ul style="list-style-type: none"> Cracked, excessively worn or damaged linings 		

4	<ul style="list-style-type: none"> • Cracked, excessively worn or damaged rotors • Improperly operating, binding or damaged caliper hardware and/or lining hardware • Loose or missing caliper hardware and/or lining hardware • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p> <p>3. Re-inspect brake pedal apply travel and feel.</p> <p>Did you find and correct a condition?</p>	Go to Step 8	Go to Step 5
5	<p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p>	Go to Step 7	Go to Step 6
6	<ol style="list-style-type: none"> 1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. 2. Inspect the brake pedal bushings for binding, excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. 3. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. <p>Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?</p>	Go to Step 8	Go to Step 7
7	<ol style="list-style-type: none"> 1. Inspect the brake assist system for the following conditions: <ul style="list-style-type: none"> • Vacuum leaks and/or improperly operating check valve, if equipped with vacuum assist • Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary. <p>Did you find and correct a condition?</p>	Go to Step 8	Go to <u>Diagnostic Starting Point - Vehicle</u>
8	<ol style="list-style-type: none"> 1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road</u> 		

<u>Test.</u>		
Is the condition still present?	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE EFFORT

Brake Pedal Excessive Effort

Step	Action	Yes	No
DEFINITION: Brake pedal requires an increased amount of input from the driver to obtain good braking action and/or stopping distance is increased.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	<ol style="list-style-type: none"> Inspect the brake assist system for the following conditions: <ul style="list-style-type: none"> Vacuum leaks, if equipped with vacuum power assist Lack of lubrication, binding or excessively worn pushrod or pedal pivots or pivot bushings Bent or damaged pedal pushrod, pedal, or pedal bracket Damaged or improperly operating brake booster assembly Adjust, repair or replace components as necessary. <p>Did you find and correct a condition?</p>	Go to Step 5	Go to Step 3
3	<ol style="list-style-type: none"> Inspect the hydraulic brake system for the following conditions: <ul style="list-style-type: none"> Binding caliper pistons Internally damaged flexible brake hoses; hindering fluid flow Kinked or damaged flexible brake hoses and/or pipes Internal brake fluid leaks; improperly operating master cylinder Poor brake fluid quality; low boiling point Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. <p>Did you find and correct a condition?</p>	Go to Step 5	Go to Step 4

4	<ol style="list-style-type: none"> Inspect the disc brake system for the following conditions: <ul style="list-style-type: none"> Excessively worn linings Glazed linings Cracked, distorted or damaged linings Contaminated linings Binding, damaged or excessively worn caliper hardware and/or lining hardware Lack of lubrication or excessive corrosion on metal to metal contact surfaces Excessively worn or corroded rotor friction surfaces Glazed rotor friction surfaces Hard spots, heat checks, blueing discoloration of rotor friction surfaces Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>. <p>Did you find and correct a condition?</p>	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
5	<ol style="list-style-type: none"> Install or connect components that were removed or disconnected during diagnosis. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>. <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKES DRAG

Brakes Drag

Step	Action	Yes	No
DEFINITION: Brake system does not fully release or has delayed release; vehicle motion may be hindered by brake system without applying brakes.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?	Go to Step 3	Go to Step 7
	<ol style="list-style-type: none"> Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 		

3	<p>2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing.</p> <p>Did you find and correct a condition?</p>	Go to Step 11	Go to Step 7
4	<p>Inspect the park brake system for proper operation.</p> <p>Did you find and correct a condition?</p>	Go to Step 11	Go to Step 5
5	<p>1. Inspect the disc brake system for the following conditions:</p> <ul style="list-style-type: none"> • Binding, incorrectly installed or missing caliper hardware and/or lining hardware- Ensure free movement of linings and of caliper, if equipped with sliding type caliper • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Distorted or damaged linings • Damaged or excessively worn caliper hardware and/or lining hardware • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 11	Go to Step 6
6	<p>1. Separate the brake booster pushrod from the brake pedal.</p> <p>2. Inspect the brake corners to determine if the brake drag condition is still present.</p> <p>Do the brake corners still exhibit the brake drag condition?</p>	Go to Step 8	Go to Step 7
7	<p>1. Inspect the pushrod for improper positioning and/or damage. Correctly position or replace the pushrod if necessary.</p> <p>2. Inspect the brake pedal assembly for damage and replace if necessary.</p> <p>Did you complete the repair or replacement?</p>	Go to Step 11	-
	<p>1. For vacuum boost systems, disconnect the vacuum check valve from the booster to relieve vacuum reserve.</p> <p>2. Separate the master cylinder from the brake</p>		

8	<p>booster. Do not disconnect any brake pipes.</p> <p>3. Inspect the brake corners to determine if the brake drag condition is still present.</p> <p>Do the brake corners still exhibit the brake drag condition?</p>	Go to Step 10	Go to Step 9
9	<p>Replace the brake booster assembly.</p> <p>Did you complete the replacement?</p>	Go to Step 11	-
10	<p>1. Inspect the hydraulic brake system for the following conditions.</p> <ul style="list-style-type: none"> • Improper operation of caliper pistons • Contaminated brake fluid • Internally damaged flexible brake hoses; hindering brake release • Damaged or improperly operating master cylinder <p>2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 11	Go to <u>Diagnostic Starting Point - Vehicle</u>
11	<p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.</p> <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKE SYSTEM SLOW RELEASE

Brake System Slow Release

Step	Action	Yes	No
DEFINITION: Brake system releases and returns to rest slowly; vehicle motion is hindered by brake system briefly after release of brake pedal.			
1	<p>Were you sent here from the Hydraulic Brake Symptom table?</p>	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
	<p>1. Inspect the hydraulic brake system for the following conditions:</p> <ul style="list-style-type: none"> • Improper operation of caliper pistons • Internally damaged flexible brake hoses; hindering brake release 		

2	<ul style="list-style-type: none"> • Contaminated brake fluid • Damaged or improperly operating master cylinder <p>2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 5	Go to Step 3
3	<p>1. Inspect the brake assist system for the following conditions:</p> <ul style="list-style-type: none"> • Binding, bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster, if equipped • Damaged or improperly operating hydraulic booster, if equipped <p>2. Adjust, repair or replace components as necessary.</p> <p>Did you find and correct a condition?</p>	Go to Step 5	Go to Step 4
4	<p>1. Inspect the disc brake system for the following conditions:</p> <ul style="list-style-type: none"> • Damaged or excessively worn caliper hardware and/or lining hardware • Distorted or damaged linings • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Bent or damaged caliper or mounting component <p>2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 5	Go to Diagnostic Starting Point - Vehicle
5	<p>1. Install or connect components that were removed or disconnected during diagnosis.</p> <p>2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.</p> <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKE FLUID LOSS

Brake Fluid Loss

Step	Action	Yes	No
DEFINITION: Brake fluid level is low not related to lining wear.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	<ol style="list-style-type: none"> Inspect the following hydraulic brake system components for brake fluid leaks: <ul style="list-style-type: none"> Flexible brake hose connections; threaded and bolted Flexible brake hose crimp joints Brake pipe fittings Caliper piston seals Master cylinder reservoir Master cylinder reservoir low pressure hose, if equipped Repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. <p>Did you find and correct a condition?</p>	Go to Step 6	Go to Step 3
3	Is the vehicle equipped with a vacuum brake booster?	Go to Step 4	Go to Step 6
4	<ol style="list-style-type: none"> Disconnect the vacuum check valve from the booster to relieve vacuum reserve. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Inspect the rear of the master cylinder for a brake fluid leak. Inspect for brake fluid in the vacuum brake booster. <p>Did you find a brake fluid leak?</p>	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
5	<p>Replace the brake master cylinder and the vacuum brake booster.</p> <p>Did you complete the replacement?</p>	Go to Step 6	-
6	<ol style="list-style-type: none"> Install or connect components that were removed or disconnected during diagnosis. Road test the vehicle to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>. <p>Is the condition still present?</p>	Go to Step 2	System OK

DISC BRAKE SYSTEM DIAGNOSIS

Test Description

The numbers below refer to the step numbers on the diagnostic table:

9

Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

10

Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

12

Disc brake rotor shields/backing plates that come in contact with disc brake rotors may cause brake system noise.

15

Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

19

Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

22

Disc brake rotor assembled lateral runout (LRO) that exceeds the maximum acceptable level can lead to thickness variation.

Disc Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
	Visually inspect the disc brake pads for the following conditions: Refer to <u>Brake Pad Inspection</u> . <ul style="list-style-type: none">• Lining thickness below specifications		

2	<ul style="list-style-type: none"> • Uneven and/or abnormal wear - edge-to-edge and/or side-to-side • Looseness or damage - including pad hardware • Evidence of contamination from an external substance <p>Did you find any conditions to indicate a concern with any of the front and/or rear disc brake pads?</p>	Go to Step 3	Go to Step 12
3	Are any of the front and/or rear disc brake pads contaminated?	Go to Step 8	Go to Step 4
4	Are any of the front and/or rear disc brake pads worn unevenly?	Go to Step 7	Go to Step 5
5	Are any of the front and/or rear disc brake pads and/or pad hardware loose or damaged?	Go to Step 7	Go to Step 6
6	<ol style="list-style-type: none"> 1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage. 2. Replace the worn disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement (J60, J61)</u> , <u>Front Disc Brake Pads Replacement (J64)</u> , and/or <u>Rear Disc Brake Pads Replacement</u> . <p>Did you complete the inspection and replacement?</p>	Go to Step 12	-
	<p>CAUTION:</p> <p>Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.</p> <p>NOTE:</p> <p>Do NOT disconnect the hydraulic brake flex hoses from the calipers.</p> <ol style="list-style-type: none"> 1. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets or from the suspension knuckles and support the calipers. Refer to <u>Front Brake Caliper Replacement (J60, J61)</u> , <u>Front Brake Caliper Replacement (J64)</u> , and/or <u>Rear Brake Caliper Replacement</u> . 		

7	<p>2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions:</p> <p>Refer to <u>Front Disc Brake Mounting and Hardware Inspection</u> , and/or <u>Rear Disc Brake Mounting and Hardware Inspection</u> .</p> <ul style="list-style-type: none"> • Binding or seized hardware • Worn, damaged or missing hardware components • Loose, bent, cracked, or damaged caliper mounting bracket <p>3. Replace components as required. Refer to the following procedures, as required:</p> <ul style="list-style-type: none"> • <u>Front Brake Caliper Bracket Replacement</u> • <u>Rear Brake Caliper Bracket Replacement</u> <p>4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement (J60, J61)</u> , <u>Front Disc Brake Pads Replacement (J64)</u> , and/or <u>Rear Disc Brake Pads Replacement</u> .</p> <p>Did you complete the inspection and replacement?</p>		-
8	<p>1. Inspect the disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak.</p> <p>2. Replace any components found to be leaking brake fluid. Refer to the following procedures as required:</p> <ul style="list-style-type: none"> • <u>Front Brake Caliper Replacement (J60, J61)</u> , <u>Front Brake Caliper Replacement (J64)</u> • <u>Rear Brake Caliper Replacement</u> • <u>Front Brake Hose Replacement (J60, J61)</u>, <u>Front Brake Hose Replacement (J64)</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> <p>Did you find and correct the source of the leak causing</p>		

	contamination of the pads?	Go to Step 11	Go to Step 9
9	<ol style="list-style-type: none"> 1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak. 2. Replace any wheel drive shaft seal that is found to be leaking grease which may be the source of the contamination to the pads. <p>Did you find and correct the source of the leak causing contamination of the pads?</p>	Go to Step 11	Go to Step 10
10	<ol style="list-style-type: none"> 1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 2. Inspect the power steering system hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 3. Replace any components found to be leaking fluid which may be the source of the contamination to the pads. <p>Did you find and correct the source of the leak causing contamination of the pads?</p>	Go to Step 11	-
	<ol style="list-style-type: none"> 1. Clean the remaining disc brake system components to remove any traces of the contaminant. <p>CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.</p> <p>NOTE: Do NOT disconnect the hydraulic brake flex hoses from the calipers.</p> <ol style="list-style-type: none"> 2. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to <u>Front Brake Caliper Replacement (J60, J61)</u> , <u>Front Brake</u> 		

11	<p><u>Caliper Replacement (J64)</u> , and/or <u>Rear Brake Caliper Replacement</u> .</p> <p>3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions:</p> <p><u>Front Disc Brake Mounting and Hardware Inspection</u> , and/or <u>Rear Disc Brake Mounting and Hardware Inspection</u> .</p> <ul style="list-style-type: none"> • Binding or seized hardware • Distorted, worn, damaged or missing hardware components <p>4. Replace the caliper mounting/sliding hardware components as required.</p> <p>5. Replace the contaminated disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement (J60, J61)</u> , <u>Front Disc Brake Pads Replacement (J64)</u> , and/or <u>Rear Disc Brake Pads Replacement</u> .</p> <p>Did you complete the cleaning, inspection and replacement?</p>	Go to Step 12	-
12	<p>Visually inspect each of the rear disc brake rotor shields/backing plates, if equipped, for evidence of contact with the brake rotors.</p> <p>Are any of the brake rotor shields/backing plates contacting the brake rotors?</p>	Go to Step 13	Go to Step 14
13	<p>Repair or replace the disc brake rotor shields/backing plates as required. Refer to <u>Front Brake Shield Replacement</u> , or <u>Rear Brake Shield Replacement</u> .</p> <p>Did you complete the repair or replacement?</p>	Go to Step 14	-
14	<p>1. Check the thickness of each of the disc brake rotors.</p> <p>NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements.</p> <p>Refer to <u>Brake Rotor Thickness Measurement</u> .Does the disc brake rotor meet the minimum requirements for REFINISHING?</p>	Go to Step 15	Go to Step 18

15	<p>NOTE: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Thickness Variation Measurement</u> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?</p>	Go to Step 17	Go to Step 16
16	<p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <p>Refer to <u>Brake Rotor Surface and Wear Inspection</u> .</p> <ul style="list-style-type: none"> • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level <p>NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection.</p> <p>If the brake rotor exhibits any of the conditions listed previously, it requires refinishing.</p> <p>Does the brake rotor require REFINISHING?</p>	Go to Step 17	Go to Step 22
17	<p>1. Refinish the brake rotor. Refer to <u>Brake Rotor Refinishing</u> .</p> <p>2. Inspect the brake rotor thickness. Refer to <u>Brake Rotor Thickness Measurement</u> .</p> <p>Were you able to REFINISH the brake rotor within the minimum requirements?</p>	Go to Step 22	Go to Step 21
18	Is the brake rotor at or below the DISCARD requirements?	Go to Step 21	Go to Step 19
	NOTE:		

19	<p>Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Thickness Variation Measurement</u> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?</p>	Go to Step 21	Go to Step 20
20	<p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <p>Refer to <u>Brake Rotor Surface and Wear Inspection</u> .</p> <ul style="list-style-type: none"> • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level <p>NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection.</p> <p>If the brake rotor exhibits any of the conditions listed previously, it requires replacement.</p> <p>Does the brake rotor require REPLACEMENT?</p>	Go to Step 21	Go to Step 22
21	<p>NOTE: Whenever a brake rotor is replaced, the assembled lateral runout (LRO) of the rotor must be measured to ensure optimum performance of the disc brakes.</p> <p>Replace the brake rotor. Refer to <u>Front Brake Rotor Replacement (J60, J61)</u> , <u>Front Brake Rotor Replacement (J64)</u> , or <u>Rear Brake Rotor Replacement</u> .Did you complete the replacement?</p>	Go to Step 24	-
	<p>NOTE: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.</p>		

22	Inspect each of the disc brake rotors for assembled LRO that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Assembled Lateral Runout Measurement</u> .Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level?	Go to Step 23	Go to Step 24
23	Correct the LRO for each brake rotor that was determined to have LRO exceeding the maximum acceptable level. Refer to <u>Brake Rotor Assembled Lateral Runout Measurement</u> . Did you complete the operation?	Go to Step 24	-
24	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Disc Brake System OK Return to Symptom Table	-

HYDRAULIC BRAKE SYSTEM DIAGNOSIS

Hydraulic Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the hydraulic brake system in order to determine if the hydraulic brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	Inspect and adjust the brake fluid level in the brake master cylinder. Was the brake fluid level low?	Go to Step 3	Go to Step 4
3	<ol style="list-style-type: none"> Inspect the brake fluid for the following conditions, indicating brake fluid contamination: <ul style="list-style-type: none"> Fluid separation, indicating 2 types of fluid are present <ul style="list-style-type: none"> Swirled appearance-Oil-based substance Layered appearance-Silicone-based substance Fluid discoloration <ul style="list-style-type: none"> Cloudy appearance-Moisture Dark appearance/suspended particles in fluid-Dirt, rust, corrosion, brake dust Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. <p>Do any of the above conditions exist?</p>	Go to Step 5	Go to Step 6

4	<ol style="list-style-type: none"> 1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination: <ul style="list-style-type: none"> • Fluid separation, indicating 2 types of fluid are present <ul style="list-style-type: none"> ○ Swirled appearance- Oil-based substance ○ Layered appearance -Silicone-based substance • Fluid discoloration <ul style="list-style-type: none"> ○ Cloudy appearance-Moisture ○ Dark appearance/suspended particles in fluid-Dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. <p>Do any of the above conditions exist?</p>	Go to Step 5	Go to Step 12
5	<ol style="list-style-type: none"> 1. Flush the hydraulic brake system. 2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following steps. Refer to the procedures indicated. <ol style="list-style-type: none"> 1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. 2. Clean out the hydraulic brake pipes using denatured alcohol, or equivalent. 3. Dry the brake pipes using non-lubricated, filtered air. 4. Repair or replace ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. <ul style="list-style-type: none"> • <u>Master Cylinder Replacement (LEA, LUK) or Master Cylinder Replacement (LTG)</u> • <u>Master Cylinder Reservoir Replacement</u> • Replace the brake master cylinder reservoir cap diaphragm. 		-

	<ul style="list-style-type: none"> • <u>Front Brake Hose Replacement (J60, J61), Front Brake Hose Replacement (J64)</u> • <u>Rear Brake Hose Replacement</u> • Inspect front caliper. • Inspect rear caliper. <p>3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system.</p> <p>4. Refill and bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual), Hydraulic Brake System Bleeding (Pressure)</u>.</p> <p>Did you complete the operation and any required repairs and/or replacements?</p>		
6	<p>1. Inspect the following hydraulic brake system components for external fluid leaks Repair or replace any of the components found to be leaking brake fluid. Refer to the appropriate procedures:</p> <ul style="list-style-type: none"> • <u>Master Cylinder Replacement (LEA, LUK) or Master Cylinder Replacement (LTG)</u> • Brake master cylinder reservoir cap diaphragm • <u>Front Brake Hose Replacement (J60, J61), Front Brake Hose Replacement (J64)</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> • Inspect front caliper. • Inspect rear calliper. <p>2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual), Hydraulic Brake System Bleeding (Pressure)</u>. While bleeding the hydraulic brake system, observe for the following conditions:</p> <ul style="list-style-type: none"> • The presence of air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced • An unrestricted and even flow of brake fluid per axle during the bleeding procedure 		

Go to **Step 9**

	Did you find and correct a condition?	Go to Step 7	Go to Step 12
7	Was there air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced?	Go to Step 18	Go to Step 8
8	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 9	Go to Step 10
9	Inspect the hydraulic function of the brake calipers for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection</u> . Was the hydraulic function of the brake calipers operating properly?	Go to Step 20	Go to Step 14
10	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to Step 13	Go to Step 11
11	Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?	Go to Step 17	-
12	Inspect the hydraulic function of the brake calipers for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection</u> . Was the hydraulic function of the brake calipers operating properly?	Go to Step 15	Go to Step 13
13	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly: <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Open the suspected caliper bleeder valve. 4. Using a large C-clamp, compress the caliper piston and observe for an unrestricted flow of brake fluid and for free movement of the caliper piston. 5. Close the caliper bleeder valve. Was the flow of brake fluid unrestricted and did the caliper piston move freely?	Go to Step 17	Go to Step 14
14	Repair or replace any brake caliper that was not operating properly. Refer to the appropriate procedure. <ul style="list-style-type: none"> • <u>Front Brake Caliper Replacement (J60, J61)</u> , <u>Front Brake Caliper Replacement (J64)</u> • <u>Rear Brake Caliper Replacement</u> 		-

	Did you complete the repair and/or replacement?	Go to Step 20	
15	Bleed the hydraulic brake system to observe for the presence of air in the system and to observe for an unrestricted and even flow of brake fluid per axle during the bleeding procedure. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> , <u>Hydraulic Brake System Bleeding (Pressure)</u> . Was there air in the system?	Go to Step 18	Go to Step 16
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 20	Go to Step 17
17	<ol style="list-style-type: none"> 1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to <u>Brake Pipe and Hose Inspection</u>. 2. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched, or damaged. Refer to the following procedures as necessary: <ul style="list-style-type: none"> • <u>Front Brake Hose Replacement (J60, J61)</u>, <u>Front Brake Hose Replacement (J64)</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> 3. If none of the hydraulic brake pipes or flexible brake hoses were visibly bent, kinked, pinched, or damaged, replace the hydraulic brake flex hose at the restricted location. Did you find and correct a condition?	Go to Step 20	Go to Step 18
18	<ol style="list-style-type: none"> 1. Inspect the hydraulic brake system components for brake fluid seepage at a seal and/or fitting location, which may have drawn air into the system. 2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system. 3. Repair or replace any of the components found to be installed incorrectly or seeping brake fluid. Did you find and correct a condition?	Go to Step 20	Go to Step 19
19	<ol style="list-style-type: none"> 1. Inspect the brake master cylinder for internal fluid leaks. Refer to <u>Brake System Internal Leak Test</u>. 2. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to <u>Master Cylinder Replacement (LEA, LUK)</u> or 		

	<u>Master Cylinder Replacement (LTG).</u>		Return to Symptom Table
	Did you find and correct a condition?	Go to Step 20	
20	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Hydraulic Brake System OK Return to Symptom Table	-

BRAKE ASSIST SYSTEM DIAGNOSIS

Brake Assist System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the brake ASSIST system in order to determine if the brake ASSIST system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 3	Go to Step 2
2	Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
3	Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection.</u> Is the brake pedal travel distance within the acceptable limits?	Go to Step 5	Go to Step 4
4	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. <ul style="list-style-type: none"> Inspect the brake pedal for a misaligned, bent and/or damaged condition. Inspect the brake pedal bushings for excessive wear and/or damage. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 5	Go to <u>Hydraulic Brake System Diagnosis</u> to check for internal and external fluid leaks and air in the hydraulic brake system
5	Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to <u>Brake System Vacuum Source Test.</u> Is the vacuum reading within the acceptable limits?	Go to Step 6	Go to Engine Controls Diagnostics Information to check for vacuum issues, including vacuum pump operation, if equipped
6	Does the condition occur during cold start-up conditions?	Go to Step 7	Go to Step 8

7	Check engine vacuum, and vacuum pump operation, if equipped, under the same cold start-up conditions. Refer to Engine Controls Diagnostics. Did you find and correct a condition?	Go to Step 22	Go to Step 9
8	During the vacuum source test, did the vacuum booster check valve operate properly?	Go to Step 10	Go to Step 9
9	Replace the vacuum booster check valve. Refer to <u>Power Brake Booster Vacuum Sensor Replacement</u> , or <u>Power Brake Booster Vacuum Pipe Replacement (LUK)</u> , <u>Power Brake Booster Vacuum Pipe Replacement (LTG)</u> . Did you complete the replacement?	Go to Step 10	-
10	If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot, or damage. Does the vacuum sensor grommet exhibit any of the conditions listed?	Go to Step 11	Go to Step 12
11	Replace the vacuum sensor grommet. Did you complete the replacement?	Go to Step 12	-
12	<ol style="list-style-type: none"> 1. If the vehicle is equipped with a vacuum sensor, install a scan tool. 2. Using the Data Display function, determine if brake booster vacuum sensor data is available within either the chassis brake controls area or the powertrain engine controls area. <p>Is vacuum sensor data available through the scan tool?</p>	Go to Step 13	Go to Step 16
13	<p>Perform the vacuum booster leak-down test using a scan tool:</p> <ol style="list-style-type: none"> 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. <p>NOTE: Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level.</p>		

	<p>6. Determine the rate of vacuum leak.</p> <p>Specification</p> <p>Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds</p> <p>Was the rate of vacuum leak within the specified allowable range?</p>	Go to Step 18	Go to Step 14
14	<ol style="list-style-type: none"> 1. Deplete the vacuum reserve by pressing the brake pedal several times, or by removing the vacuum booster check valve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Refer to <u>Master Cylinder Replacement (LEA, LUK)</u> or <u>Master Cylinder Replacement (LTG)</u>. 3. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. Replace the vacuum seal as necessary. 4. Carefully reinstall the master cylinder to the brake booster. Refer to <u>Master Cylinder Replacement (LEA, LUK)</u> or <u>Master Cylinder Replacement (LTG)</u>. <p>Did you complete the operation?</p>	Go to Step 15	-
15	<p>Perform the vacuum booster leak-down test using a scan tool:</p> <ol style="list-style-type: none"> 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. <p>NOTE: Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level.</p>		

	<p>6. Determine the rate of vacuum leak.</p> <p>Specification</p> <p>Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds</p> <p>Was the rate of vacuum leak within the specified allowable range?</p>	Go to Step 22	Go to Step 21
16	<p>1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by removing the check valve or applying the brake pedal several times. Refer to <u>Master Cylinder Replacement (LEA, LUK)</u> or <u>Master Cylinder Replacement (LTG)</u>.</p> <p>2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder.</p> <p>3. If equipped with a vacuum seal that is part of the booster, inspect the seal for damage.</p> <p>Does the vacuum seal exhibit any of the conditions listed?</p>	Go to Step 17	Go to Step 18
17	<p>1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as necessary. Ensure the seal is positioned correctly during installation.</p> <p>2. If equipped with a vacuum seal that requires replacement and which is part of the booster, the booster assembly must be replaced.</p> <p>3. Carefully reinstall the master cylinder to the brake booster. Refer to <u>Master Cylinder Replacement (LEA, LUK)</u> or <u>Master Cylinder Replacement (LTG)</u>.</p> <p>Did you complete the replacement?</p>	Go to Step 18	-
	<p>Perform the vacuum boost functional test:</p> <p>1. If still separated, reinstall the master cylinder to the booster. Refer to <u>Master Cylinder Replacement (LEA, LUK)</u> or <u>Master Cylinder Replacement (LTG)</u>.</p>		

18	<p>2. If the engine was started after reinstalling the master cylinder to the booster, perform the following:</p> <p>With the engine OFF, depress the brake pedal several times to deplete the vacuum reserve.</p> <p>3. Depress and maintain moderate foot pressure on the brake pedal.</p> <p>4. Start the engine and observe pedal operation.</p> <p>5. Observe for audible vacuum leaks.</p> <p>The brake pedal should fall slightly, then hold.</p> <p>Is there an audible vacuum leak coming from the brake pedal area?</p>	Go to Step 21	Go to Step 19
19	<p>Did the brake pedal fall slightly after the engine was started, then hold?</p>	Go to Step 20	Go to Step 21
20	<p>Perform the vacuum booster leak-down test:</p> <ol style="list-style-type: none"> 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Wait 60 seconds. 5. Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. <ul style="list-style-type: none"> • Both pedal applies should be assisted • The amount of assist could diminish slightly with the second apply <p>Were both pedal applies power assisted?</p>	Go to Step 22	Go to Step 21
21	<p>Replace the vacuum brake booster. Refer to <u>Power Vacuum Brake Booster Replacement</u>.</p> <p>Did you complete the replacement?</p>	Go to Step 22	-
22	<p>Install or connect any components that were removed or disconnected during diagnosis.</p> <p>Did you complete the operation?</p>	Brake Assist System OK Return to Symptom Table	-

BRAKE SYSTEM VEHICLE ROAD TEST

Preliminary Inspections

1. Visually inspect easily accessible brake system components for obvious damage and/or leaks which may indicate that the vehicle should not be driven until further inspections have been completed.
2. Inspect the brake master cylinder reservoir fluid level and adjust only if necessary for brake system road testing.
3. Inspect the tire inflation pressures and adjust as necessary.
4. Inspect the tire tread patterns to ensure that they are the same or very similar, especially per axle.
5. Ensure that the vehicle is not loaded unevenly prior to brake system road testing.

Road Testing Procedure

WARNING: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

1. Start the engine and allow it to idle.
2. Check to see if the brake system warning lamp remains illuminated.
3. If the brake system warning lamp remains illuminated, DO NOT proceed to test drive the vehicle until it is diagnosed and repaired. Refer to **Diagnostic Starting Point - Vehicle** .
4. Select a smooth, dry, clean and level road or large lot that is as free of traffic and obstacles as possible for brake system low speed road testing.
5. With the transmission in PARK, lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
6. If the brake pedal travel was excessive, DO NOT drive the vehicle until it is repaired.
7. If the brake pedal travel was not excessive, proceed to step 8.
8. Release and apply the brakes.
9. While continuing to apply the brakes, shift the transmission into DRIVE, release the brakes and allow the engine to idle the vehicle away from the stopped position. Observe for a slow release of the brake system.
10. With the aid of an assistant to observe the vehicle's performance from outside of the vehicle, drive the vehicle at a low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to them, while you observe both the pedal effort and the pedal travel.
11. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
12. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 13.
13. Drive the vehicle in the opposite direction, at the same low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to him.

14. Drive the vehicle at a low speed and shift the transmission into NEUTRAL without applying the brakes. Observe for a rapid deceleration in vehicle speed, indicating possible brake drag.
15. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
16. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
17. While continuing to drive the vehicle at a moderate speed, perform several light applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system noise, pulsation and/or brake drag.
18. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
19. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 20.
20. While continuing to drive the vehicle at a moderate speed, perform several moderate applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system pulsation and/or uneven braking action - either side to side, or front to rear.

A small amount of vehicle front end dip is expected during a moderate apply of the brakes.

21. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.

BRAKE PEDAL TRAVEL MEASUREMENT AND INSPECTION

Special Tools

CH-28662 Brake Pedal Effort Gauge

For equivalent regional tools, refer to **Special Tools**.

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal becomes firm, in order to deplete the brake booster power reserve.
2. Install the **CH-28662** Brake Pedal Effort Gauge to the brake pedal.

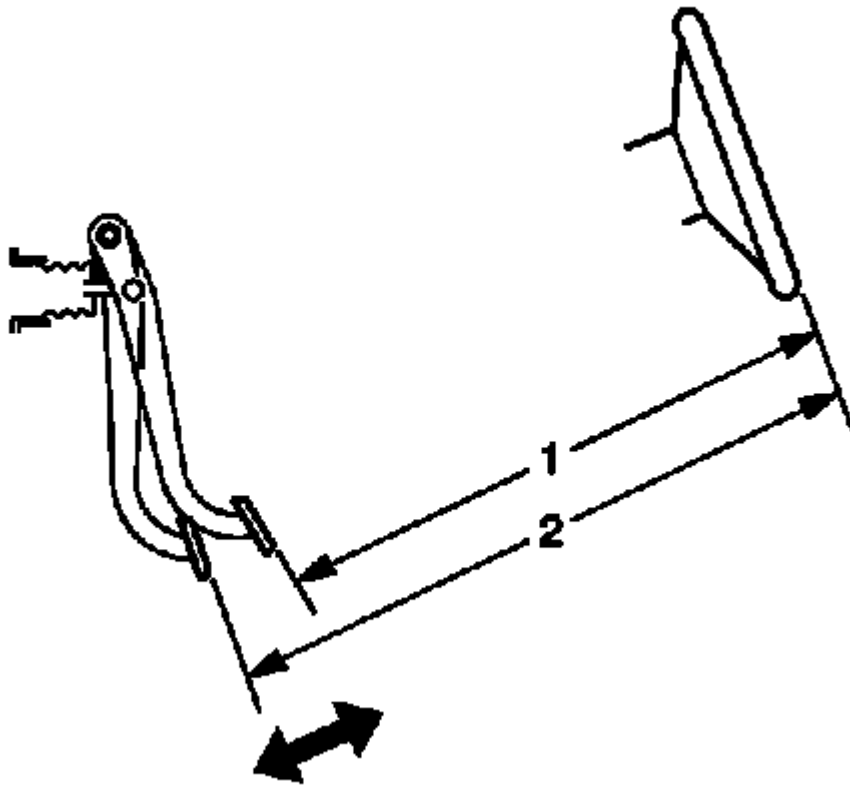


Fig. 3: Measuring Brake Pedal Travel
Courtesy of GENERAL MOTORS COMPANY

3. Measure and record the distance (1) from the brake pedal to the rim of the steering wheel; note the points of measurement.
4. Apply and maintain the brakes with 450 N (101 lb) of force to the brake pedal, as indicated on the brake pedal effort gauge.
5. While maintaining 450 N (101 lb) of force to the brake pedal, measure and record the distance (2) from the same point on the brake pedal to the same point on the rim of the steering wheel.
6. Release the brakes and repeat steps 4 and 5 to obtain a second measurement. After obtaining a second measurement, proceed to step 7.
7. Average the first and second measurements recorded during the two applies of the brakes.
8. Subtract the initial measurement, unapplied (1), from the averaged, applied measurement (2) to obtain the brake pedal travel distance.

Specification

Maximum brake pedal travel (measured with the ignition OFF, brake booster power assist depleted, and the brakes cool): 48-58 mm (1.89-2.28 in).

BRAKE SYSTEM VACUUM SOURCE TEST

NOTE:

- Engine temperature, accessory load, and elevation level will affect engine vacuum.
- Vacuum readings will decrease by approximately 2.7 kPa (0.8 in Hg) for every 305 m (1000 ft) of elevation above sea level.

1. Disconnect the engine vacuum hose from the vacuum brake booster check valve or brake booster vacuum sensor, if equipped.
2. Install a vacuum gauge to the engine vacuum hose.
3. Start the engine and allow the engine to idle until normal operating temperatures are reached.
4. With the vehicle in PARK, the engine idling, and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is within the specified normal engine vacuum range.

Specification

- Engine Driven Mechanical Vacuum Pump: 90-95 kPa (27-28 in Hg)
 - Electric Vacuum Pump: 40-70 kPa (12-21 in Hg)
5. Turn the ignition OFF.
 6. If the engine vacuum reading is within the specified normal range, proceed to step 10.
 7. If the engine vacuum reading is NOT within the specified normal range, inspect the engine vacuum hose for the following conditions:
 - Loose connection to the engine
 - Collapse, deformation or contamination
 - Cracks, cuts, dry-rot
 8. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2-4.
 9. If none of these conditions were found with the engine vacuum hose, then there is an engine vacuum source problem, check the engine vacuum system.
 10. Remove the vacuum brake booster check valve or the brake booster vacuum sensor, if equipped, from the power vacuum brake booster.
 11. Install the check valve or brake booster vacuum sensor, if equipped, to the engine vacuum hose.
 12. Install the vacuum gauge to the check valve or brake booster vacuum sensor, if equipped.
 13. Start the engine and allow the engine to idle in PARK with the A/C system OFF, until normal operating temperatures are reached.
 14. Turn the ignition OFF.
 15. Ensure the engine vacuum reading is maintained within the specified normal engine vacuum range.

Specification

- Engine Driven Mechanical Vacuum Pump: 90-95 kPa (27-28 in Hg)
 - Electric Vacuum Pump: 40-70 kPa (12-21 in Hg)
16. If the engine vacuum reading is maintained within the specified normal range, proceed to step 18.

17. If the engine vacuum reading is NOT maintained within the specified normal range, replace the brake booster check valve or brake booster vacuum sensor, if equipped, then repeat steps 11-15.
18. Inspect the brake booster check valve grommet for the following conditions:
 - Loose connection to the vacuum brake booster
 - Deformation or contamination
 - Cracks, cuts, dry-rot
19. If any of these conditions were found with the check valve grommet, replace the grommet.

BRAKE SYSTEM EXTERNAL LEAK INSPECTION

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. In order to inspect for external brake fluid leaks, first check the fluid level in the master cylinder.

While a slight brake fluid level drop can be considered a normal condition due to brake lining wear, a very low level may indicate a brake fluid leak in the hydraulic system.

2. If the fluid level is abnormally low, adjust the brake fluid level.
3. Start the engine and allow it to idle.
4. Apply constant, moderate foot pressure to the brake pedal.

If the brake pedal gradually falls away while under foot pressure, there may be a brake fluid leak.

5. Turn OFF the ignition.
6. Visually inspect the following brake system components for brake fluid leaks, excessive corrosion, and damage. Give particular attention to all brake pipe and flexible hose connections to ensure that there are not any slight brake fluid leaks - even though the brake pedal may feel firm and hold steady:
 - Master cylinder brake pipe fittings
 - All brake pipe connections
 - Brake pipes
 - Brake hoses and connections
 - Brake calipers and/or wheel cylinders, if equipped
7. While slight dampness around the master cylinder reservoir can be considered acceptable, brake fluid leaking from any of the brake system components requires immediate attention. If any of these components exhibit signs of brake fluid leakage, repair or replace those components. After the repair or replacement, reinspect the hydraulic brake system to assure proper function.

BRAKE SYSTEM INTERNAL LEAK TEST

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Start the engine and allow it to idle.
2. Apply light, steady pressure to the brake pedal. Observe both the brake pedal feel and travel.
3. Release the brakes and turn OFF the ignition.
4. If the brake pedal apply felt spongy, but the brake pedal travel was not excessive, perform the following steps:
 1. Inspect the brake system for external leaks. Refer to Brake System External Leak Inspection.
 2. Pressure bleed the brake system in order to purge any air that may be trapped in the system. Refer to Hydraulic Brake System Bleeding (Manual), Hydraulic Brake System Bleeding (Pressure).

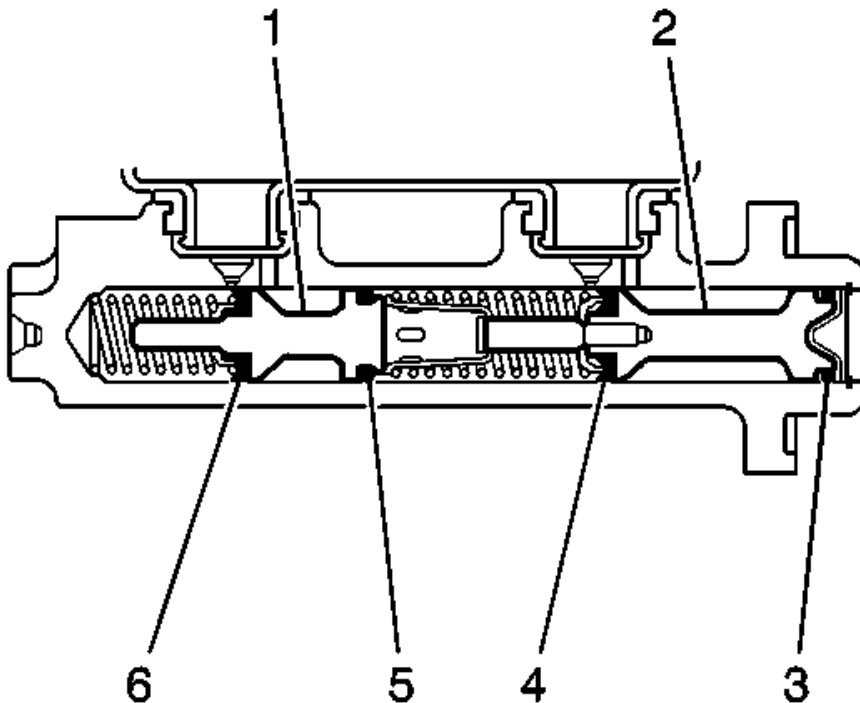


Fig. 4: Identifying Brake Master Cylinder (Cross Sectional View)

Courtesy of GENERAL MOTORS COMPANY

5. If the brake pedal apply did not feel spongy, but the brake pedal travel was excessive, perform the following steps:
 1. Loosen the master cylinder-to-brake power booster mounting nuts.
 2. Carefully pull the master cylinder away from the brake power booster just enough to inspect the mounting surface of the master cylinder.
 3. Inspect the master cylinder mounting surface at the primary piston (2) for brake fluid leaks.
6. If the master cylinder exhibits any leakage around the primary piston (2), then the primary piston primary seal (4) and/or secondary seal (3) is leaking and the master cylinder requires overhaul or replacement.
7. If the master cylinder primary piston (2) does not exhibit any leakage, pressure bleed the brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.
8. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, but then gradually fell, then the master cylinder requires overhaul or replacement due to an internal leak past the secondary piston (1) from the secondary piston primary seal (6) or secondary seal (5).

HYDRAULIC BRAKE COMPONENT OPERATION VISUAL INSPECTION

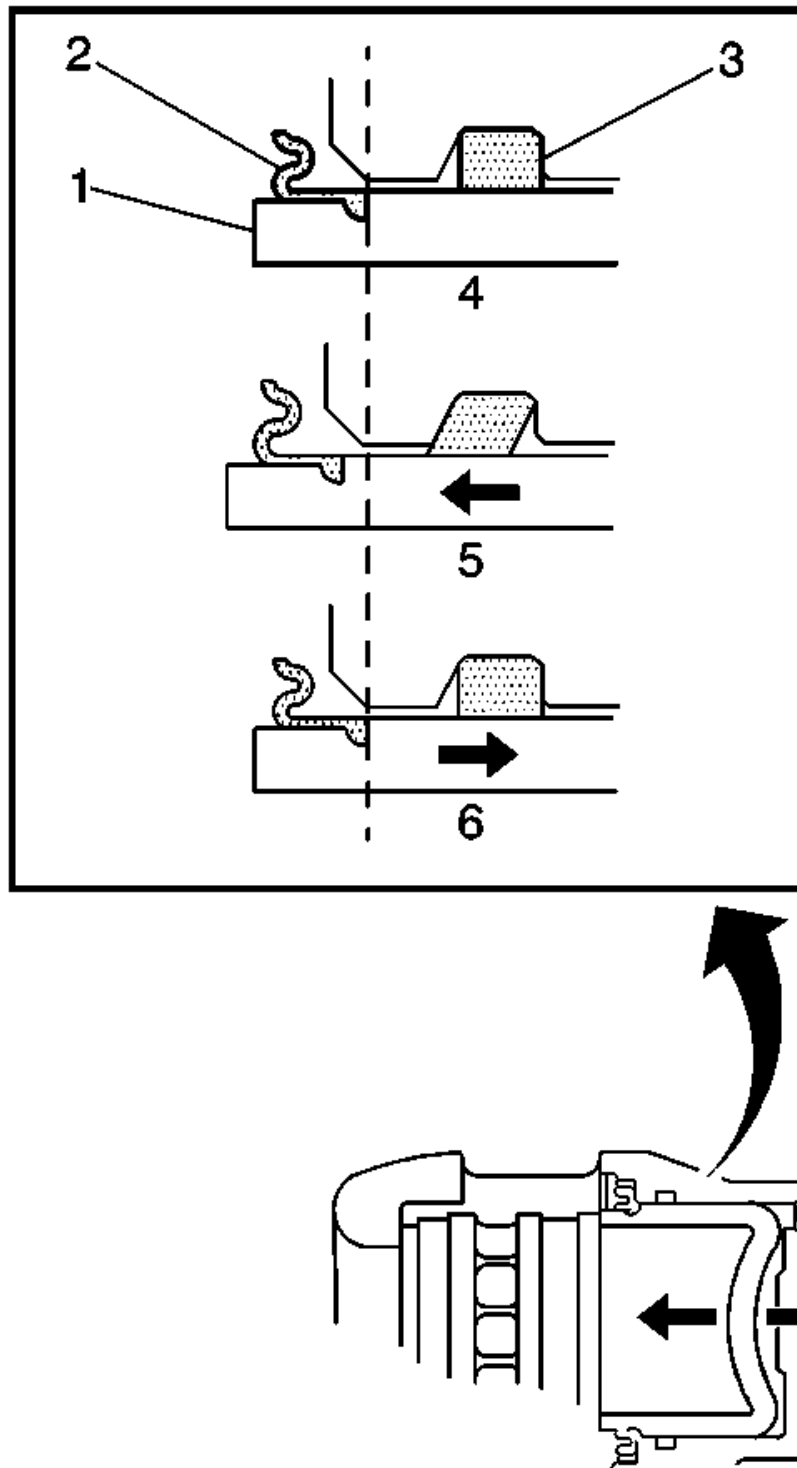


Fig. 5: Identifying Brake Caliper/Pad Inspection Areas
 Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. With the tire and wheel assemblies removed and the brake rotors retained by wheel lug nuts, visually inspect the caliper piston dust boot (2) sealing area to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the caliper piston (1) in relation to the caliper housing.
4. Have an assistant apply and release the brake pedal several times while you observe the operation of the hydraulic brake caliper.
 1. Observe the caliper piston (1) for unrestricted and even movement during each apply of the brake system (5).
 2. Observe the caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the caliper piston (1) did not exhibit unrestricted and even movement during brake system apply and/or release, the piston square seal (3) may be worn or damaged and the caliper may require overhaul or replacement.

BRAKE PIPE AND HOSE INSPECTION

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Visually inspect all of the brake pipes for the following conditions:
 - Kinks, improper routing, missing or damaged retainers
 - Leaking fittings, excessive corrosion
2. If any of the brake pipes exhibited any of the conditions listed, then the identified pipe, or pipes, require replacement.
3. Ensure that the vehicle axles are properly supported at ride height in order to maintain the proper relationship of the flexible brake hoses to the chassis.

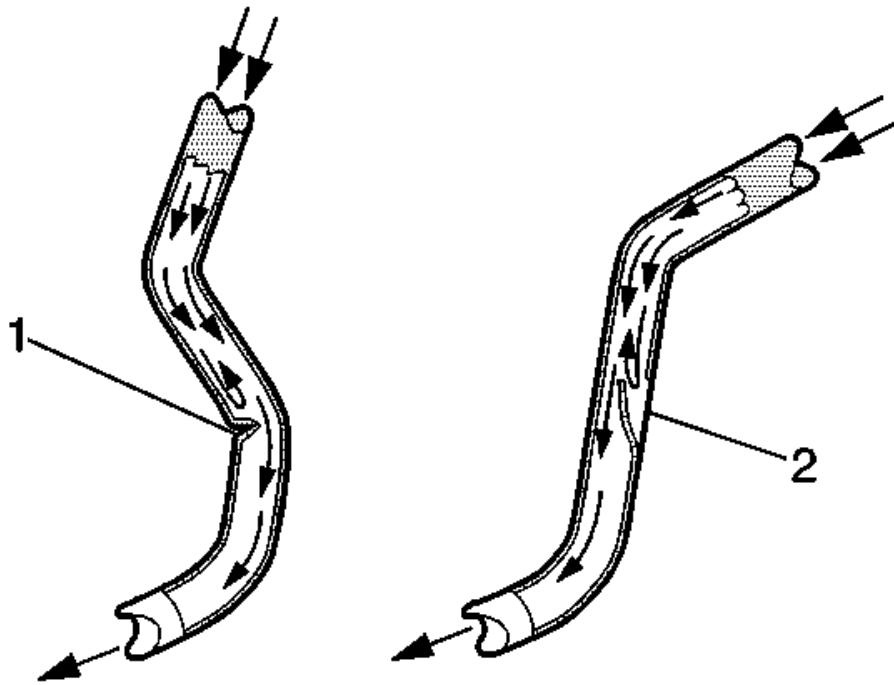


Fig. 6: Identifying Flexible Brake Hose Failure Conditions
Courtesy of GENERAL MOTORS COMPANY

4. Visually inspect all of the flexible brake hoses for the following conditions:
 - Kinks (1), improper routing, twists, chafing, missing or damaged retainers
 - Leaking connections, cracking, dry-rot, blisters, bulges
5. If any of the flexible brake hoses exhibited any of the conditions listed, then the identified flexible brake hose, or hoses require replacement.
6. Squeeze the flexible brake hoses with firm finger pressure to check for soft spots (2), indicating an internal restriction. Check the entire length of each flexible brake hose.
7. If any of the flexible brake hoses were found to have soft spots (2), then the identified flexible brake hose, or hoses require replacement.

REPAIR INSTRUCTIONS

MASTER CYLINDER RESERVOIR FILLING

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Visually inspect the brake fluid level through the brake master cylinder reservoir.
2. If the brake fluid level is at or below the half-full point during routine fluid checks, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the half-full point during routine fluid checks, and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped-off up to the maximum-fill level.
4. If brake system service was just completed, the brake fluid may be topped-off up to the maximum-fill level.
5. If the brake fluid level is above the half-full point, adding brake fluid is not recommended under normal conditions.
6. If brake fluid is to be added to the master cylinder reservoir, clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm. Use only GM approved brake fluid from a clean, sealed brake fluid container.

MASTER CYLINDER RESERVOIR REPLACEMENT

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Using a suitable tool, remove and properly discard the brake fluid from the master cylinder reservoir.
2. Disconnect the brake fluid level indicator switch electrical connector.

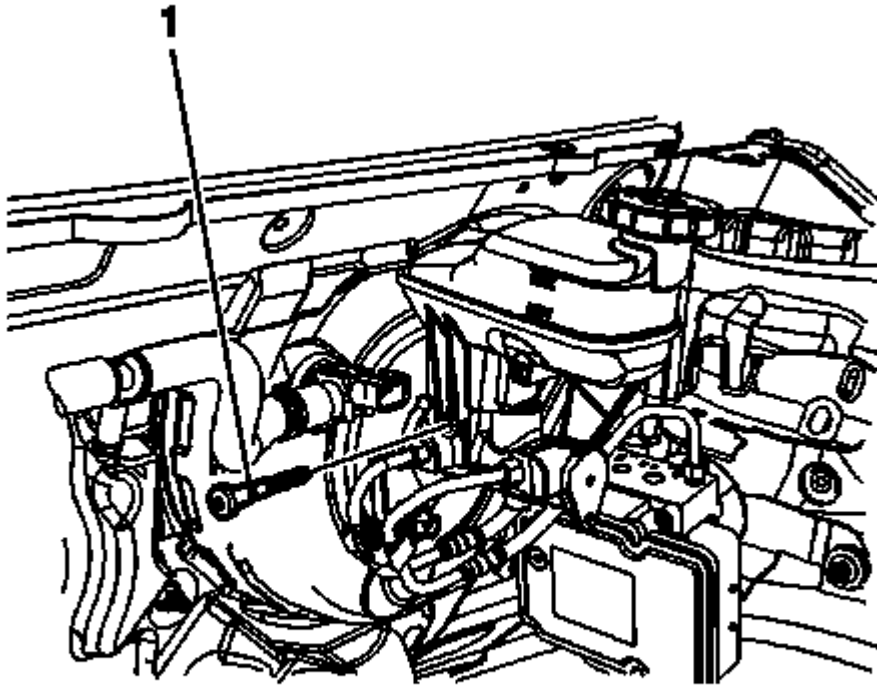


Fig. 7: Master Cylinder Reservoir Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the master cylinder reservoir bolt (1).

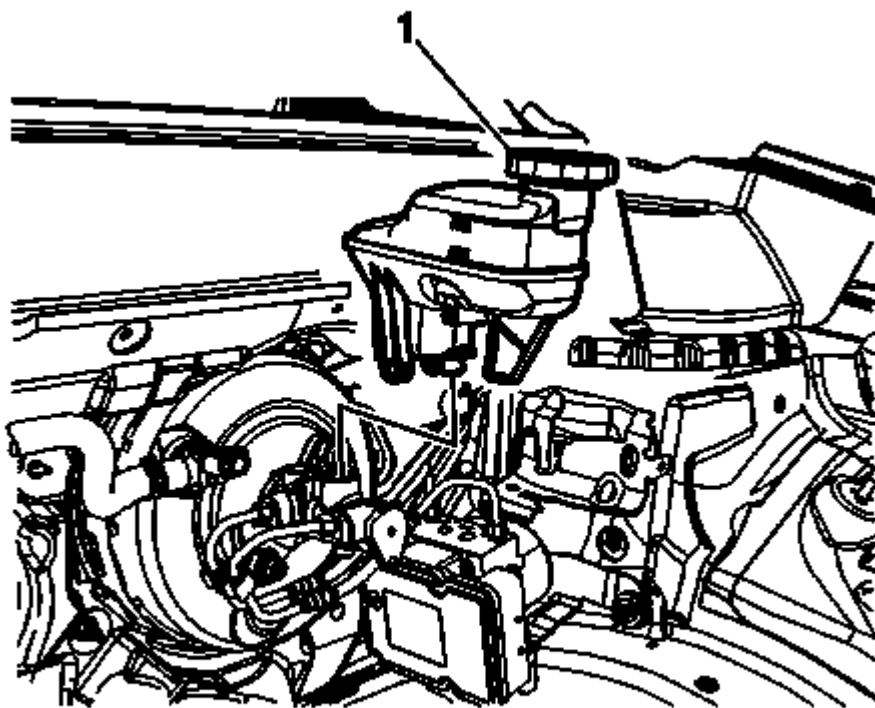


Fig. 8: View Of Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

4. Lift the master cylinder reservoir (1) upward to release the reservoir from the reservoir seals and the master cylinder.

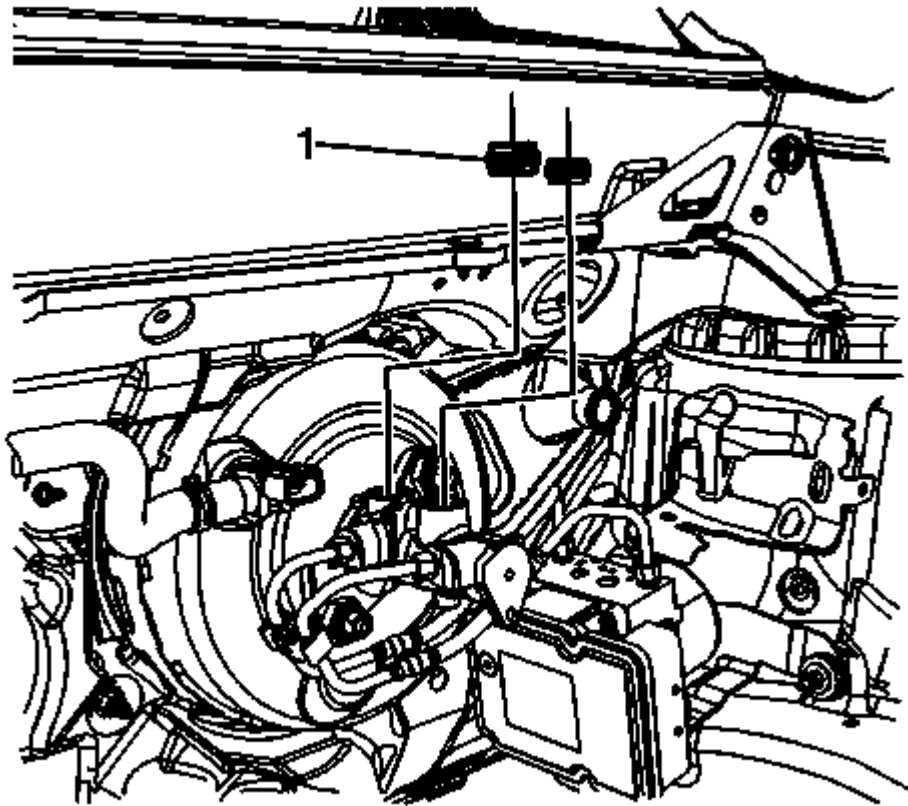


Fig. 9: Master Cylinder Reservoir Seals
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 2 master cylinder reservoir seals (1).

Installation Procedure

1. Lubricate the master cylinder reservoir seals with GM approved brake fluid from a clean, sealed, brake fluid container.

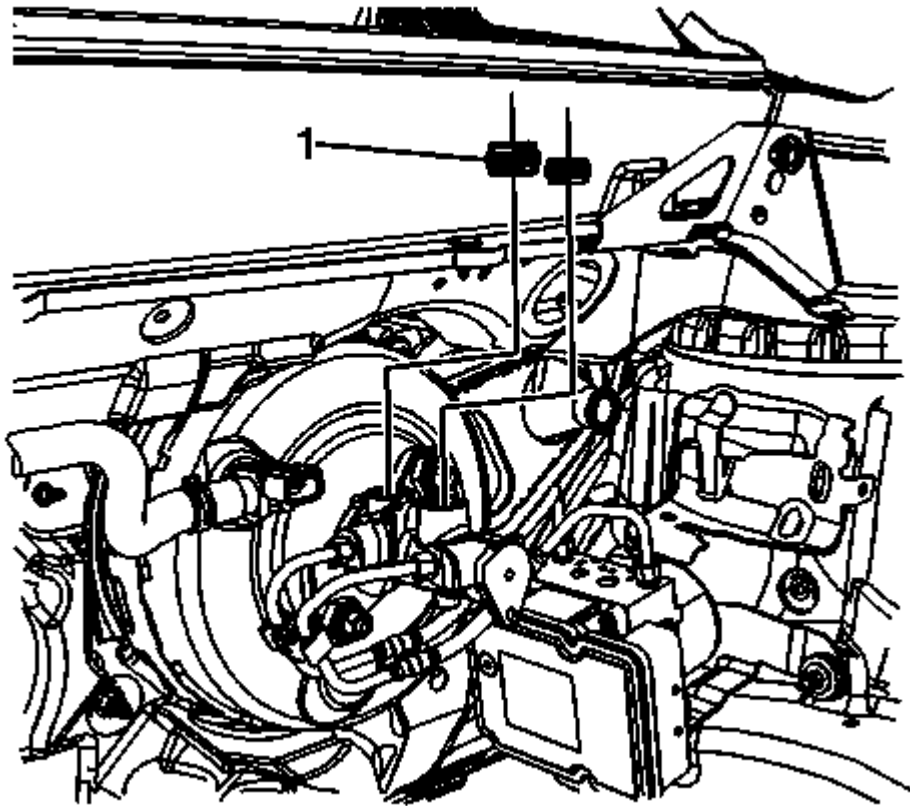


Fig. 10: Master Cylinder Reservoir Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the reservoir seals are fully seated in the master cylinder.

2. Install the 2 master cylinder reservoir seals (1).

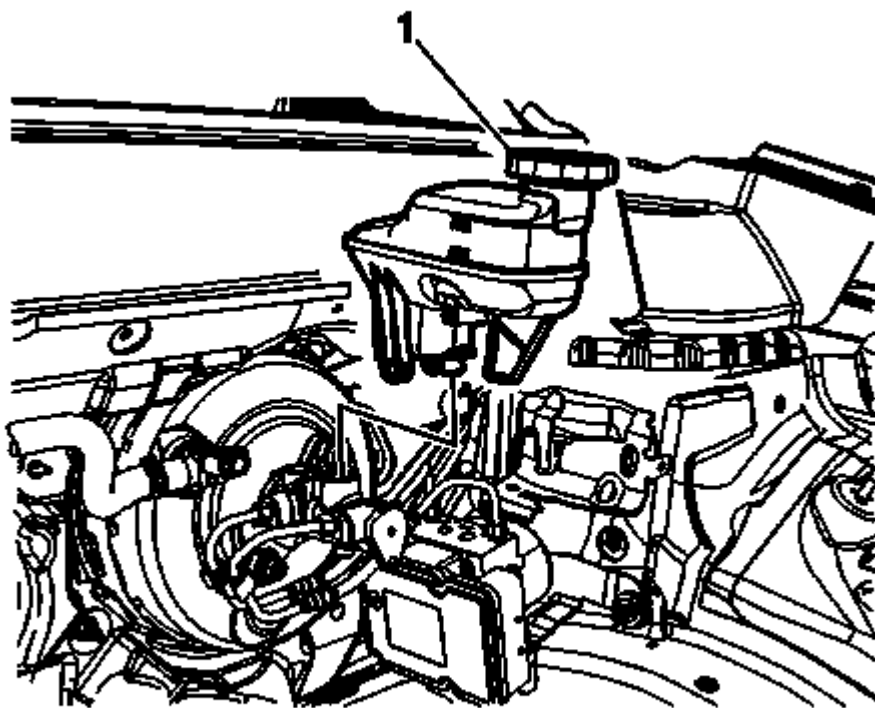


Fig. 11: View Of Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the master cylinder reservoir is fully seated in the master cylinder.

3. Firmly and squarely press the master cylinder reservoir (1) into the master cylinder.

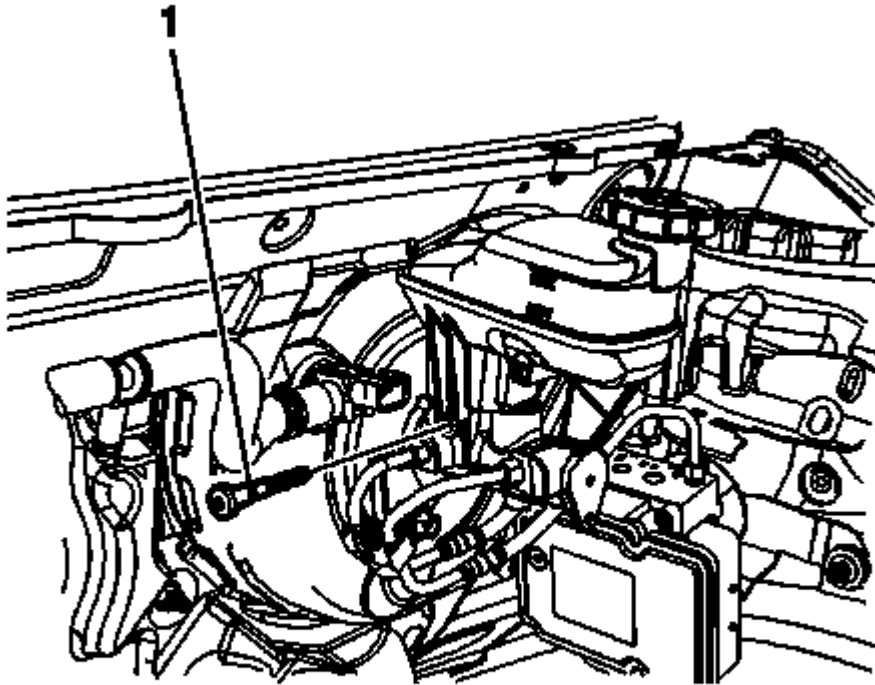


Fig. 12: Master Cylinder Reservoir Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the master cylinder reservoir bolt (1) and tighten to 4 N.m (35 lb in).
5. Connect the brake fluid level indicator switch electrical connector.
6. Fill the master cylinder reservoir. Refer to Master Cylinder Reservoir Filling.

MASTER CYLINDER REPLACEMENT (LEA, LUK)

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Turn the ignition switch to the OFF position.
2. Apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
3. Remove the intake manifold cover, if necessary. Refer to **Intake Manifold Cover Replacement** for the 2.4L engine.
4. Using a suitable tool, remove and properly dispose of the brake fluid from the master cylinder reservoir.
5. Without draining the coolant and without disconnecting the hoses, remove and position aside the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LUK)** .
6. If equipped with the manual transmission, disconnect the clutch master cylinder reservoir hose. Refer to **Clutch Master Cylinder Reservoir Hose Replacement** .
7. Disconnect the brake fluid level indicator switch electrical connector.

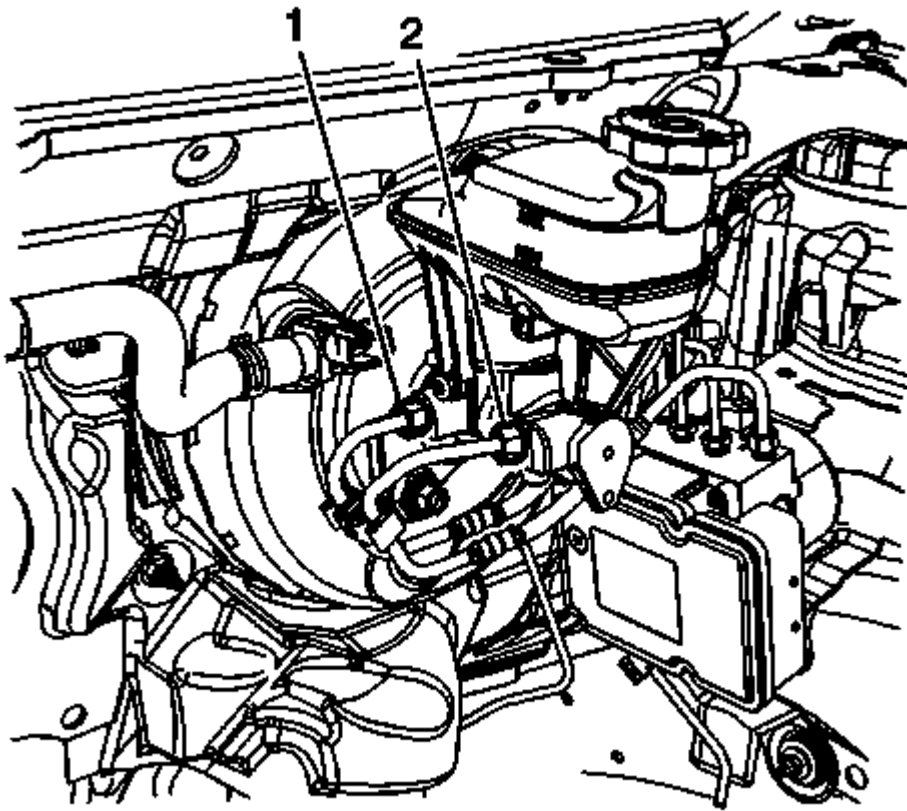


Fig. 13: Master Cylinder Primary And Secondary Brake Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the master cylinder primary brake pipe fitting (1).
9. Cap the brake pipe fitting to prevent brake fluid loss and contamination.
10. Disconnect the master cylinder secondary brake pipe fitting (2).
11. Cap the brake pipe fitting to prevent brake fluid loss and contamination.

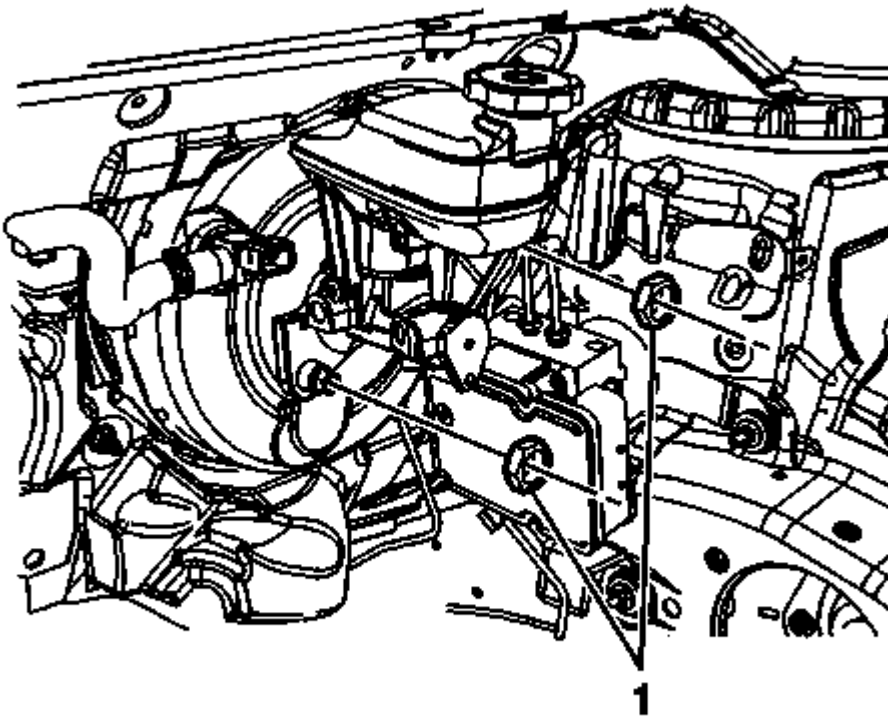


Fig. 14: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

12. Remove the master cylinder nuts (1).

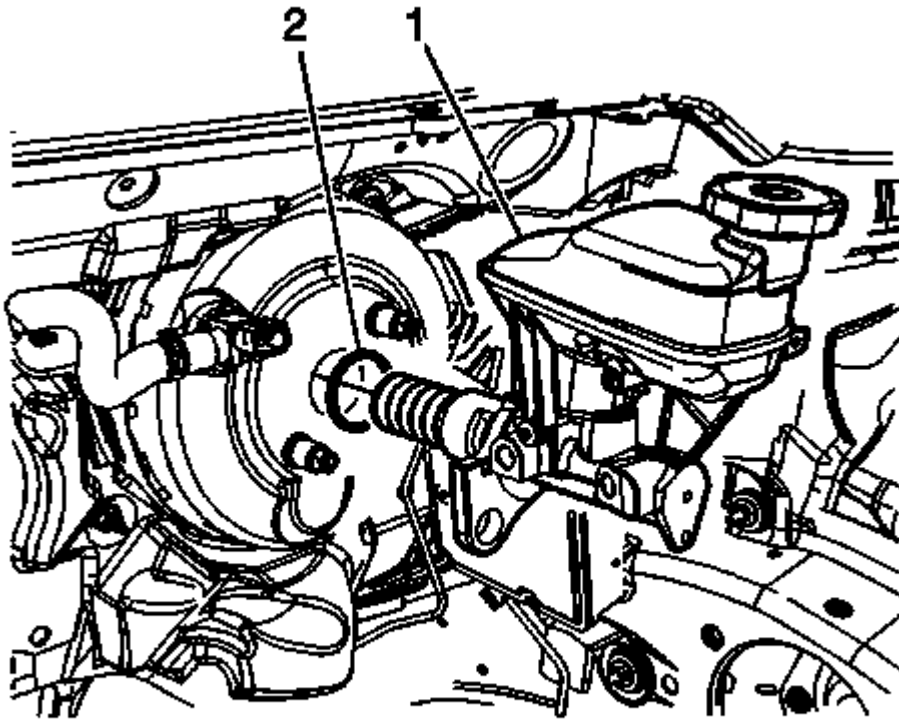


Fig. 15: Master Cylinder & O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

13. Remove the master cylinder (1).
14. Remove the master cylinder O-ring seal (2).

Installation Procedure

1. If installing a new master cylinder, bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.

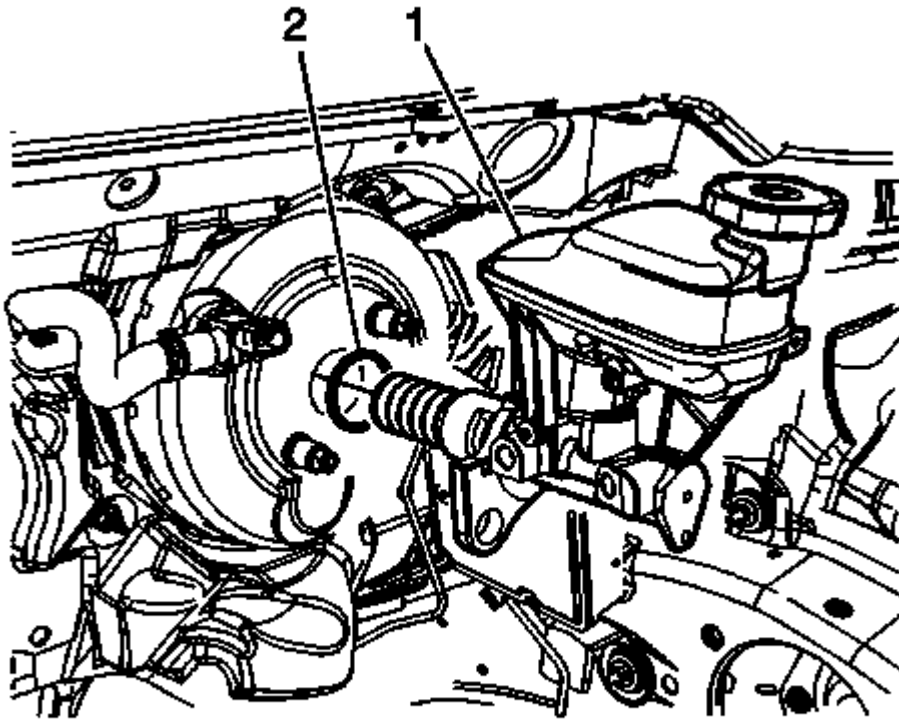


Fig. 16: Master Cylinder & O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the O-ring seal is properly seated in the groove in the master cylinder body and is not distorted.

2. Install the master cylinder (1) and master cylinder O-ring seal (2).

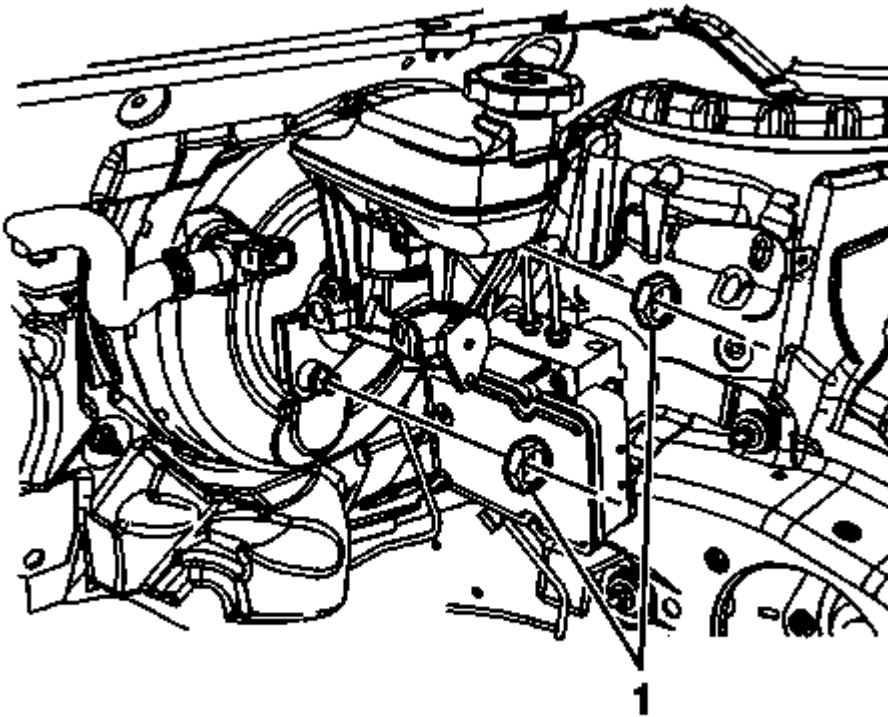


Fig. 17: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the master cylinder nuts (1) and tighten to 50 N.m (37 lb ft).

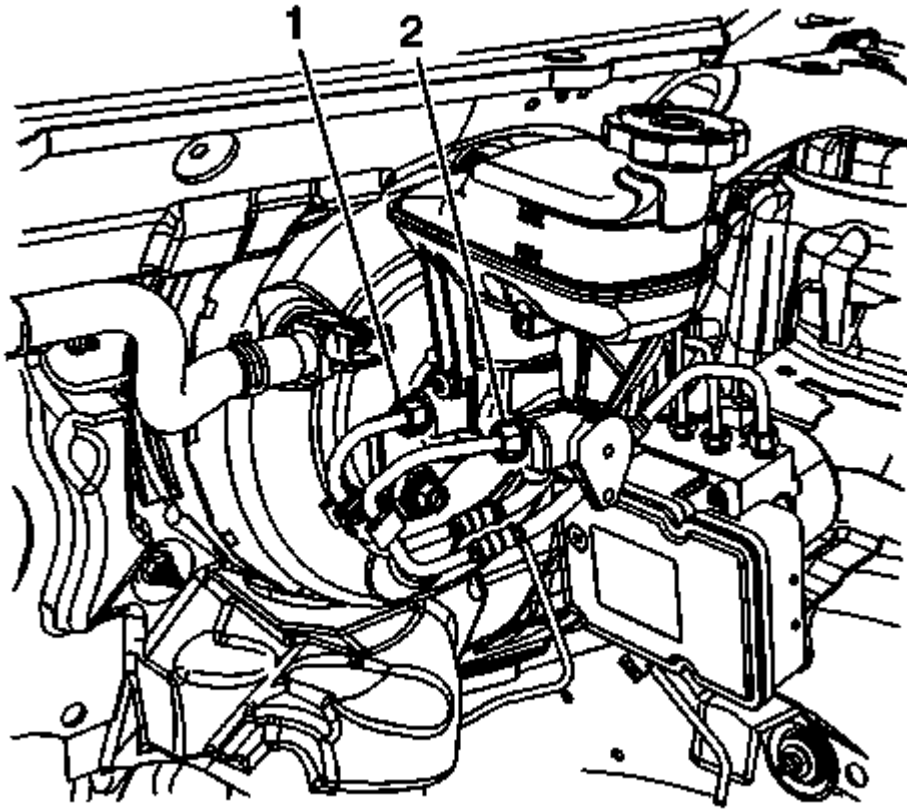


Fig. 18: Master Cylinder Primary And Secondary Brake Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

4. Connect the master cylinder primary brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).
5. Connect the master cylinder secondary brake pipe fitting (2) and tighten to 18 N.m (13 lb ft).
6. Connect the brake fluid level indicator switch electrical connector.
7. If equipped with the manual transmission, connect the clutch master cylinder reservoir hose. Refer to **Clutch Master Cylinder Reservoir Hose Replacement** .
8. Install the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LUK)** .
9. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.
10. Install the intake manifold cover, if removed. Refer to **Intake Manifold Cover Replacement** for the 2.4L engine.

MASTER CYLINDER REPLACEMENT (LTG)

Removal Procedure

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Turn the ignition switch to the OFF position.
2. Apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
3. Remove the intake manifold cover, if necessary. Refer to **INTAKE MANIFOLD COVER REPLACEMENT** for the 2.0L engine.
4. Using a suitable tool, remove and properly dispose of the brake fluid from the master cylinder reservoir.
5. Without draining the coolant and without disconnecting the hoses, remove and position aside the radiator surge tank. Refer to **RADIATOR SURGE TANK REPLACEMENT (LTG)**
6. If equipped with the manual transmission, disconnect the clutch master cylinder reservoir hose. Refer to **Clutch Master Cylinder Reservoir Hose Replacement** .
7. Disconnect the brake fluid level indicator switch electrical connector.

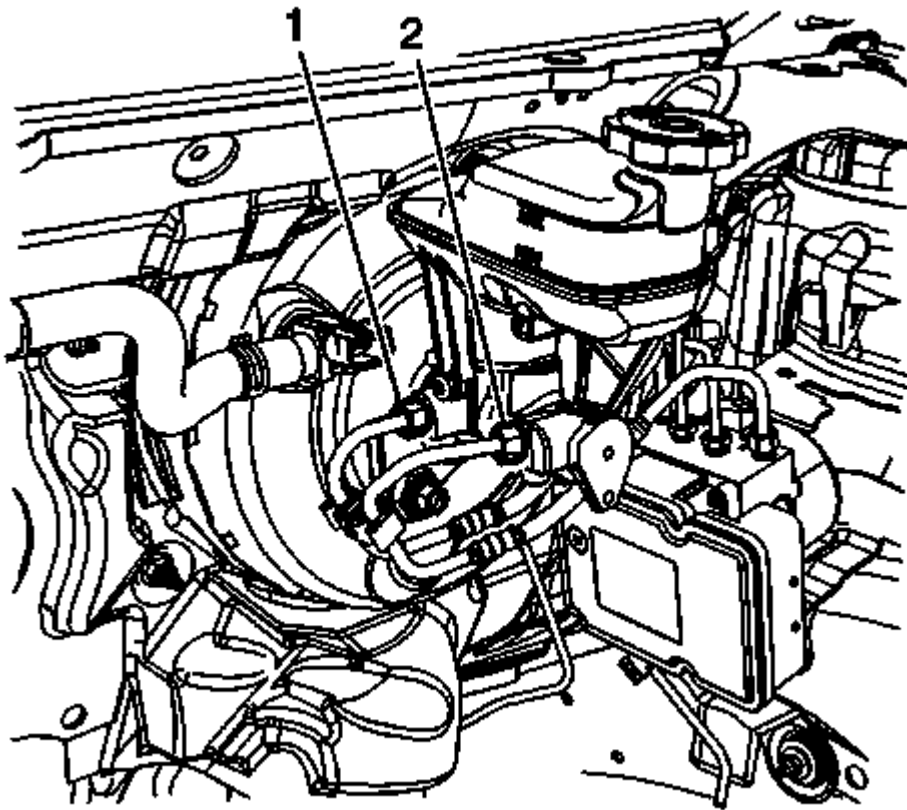


Fig. 19: Master Cylinder Primary And Secondary Brake Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the master cylinder primary brake pipe fitting (1).

9. Cap the brake pipe fitting to prevent brake fluid loss and contamination.
10. Disconnect the master cylinder secondary brake pipe fitting (2).
11. Cap the brake pipe fitting to prevent brake fluid loss and contamination.

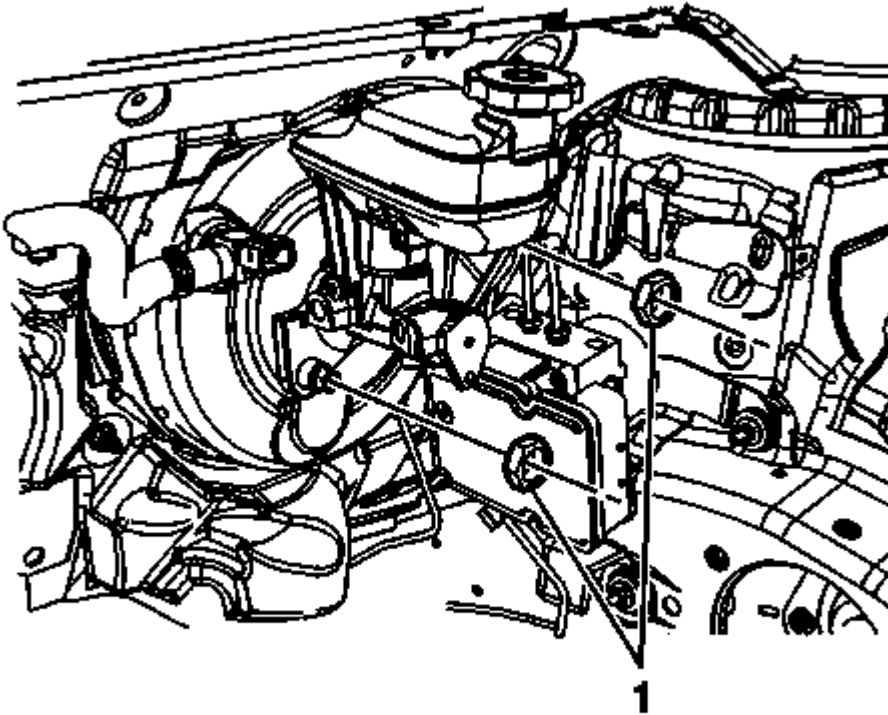


Fig. 20: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the master cylinder nuts (1).

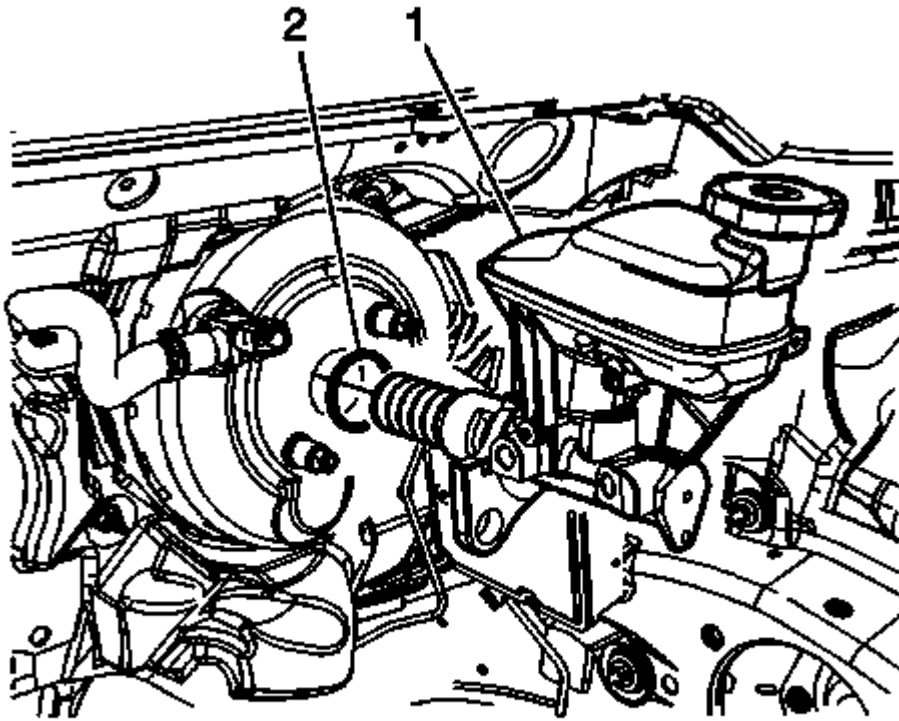


Fig. 21: Master Cylinder & O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

13. Remove the master cylinder (1).
14. Remove the master cylinder O-ring seal (2).

Installation Procedure

1. If installing a new master cylinder, bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.

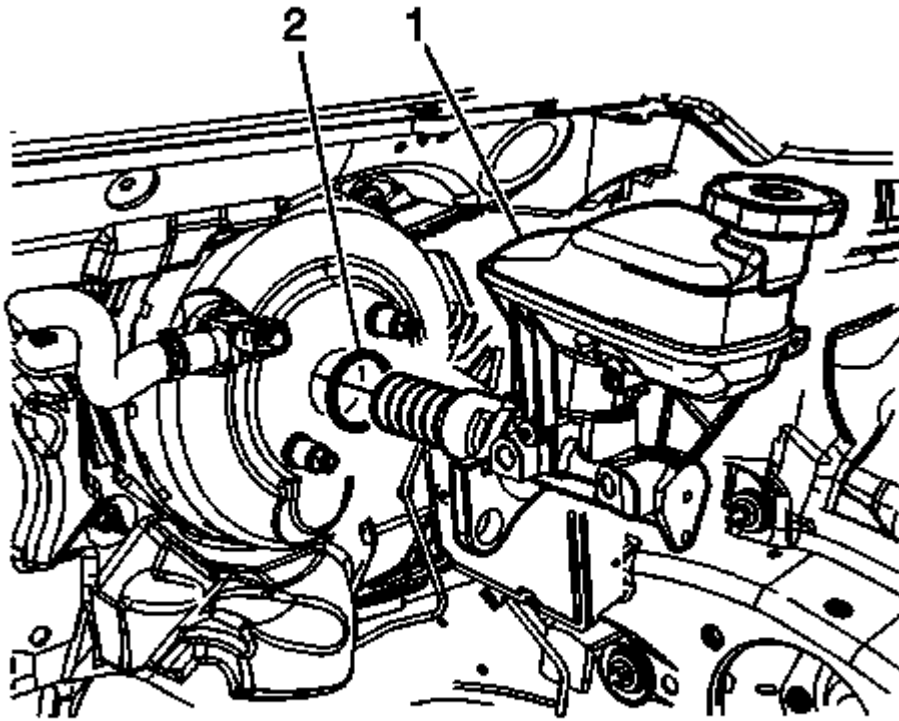


Fig. 22: Master Cylinder & O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the O-ring seal is properly seated in the groove in the master cylinder body and is not distorted.

2. Install the master cylinder (1) and master cylinder O-ring seal (2).

CAUTION: Refer to Fastener Caution .

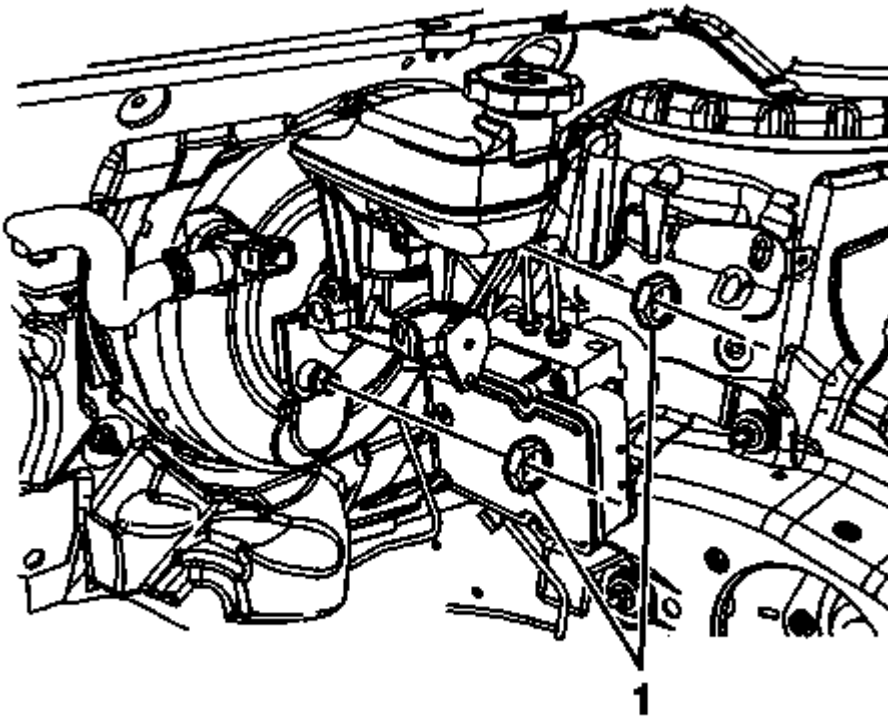


Fig. 23: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

3. Install the master cylinder nuts (1) and tighten to 50 N.m (37 lb ft).

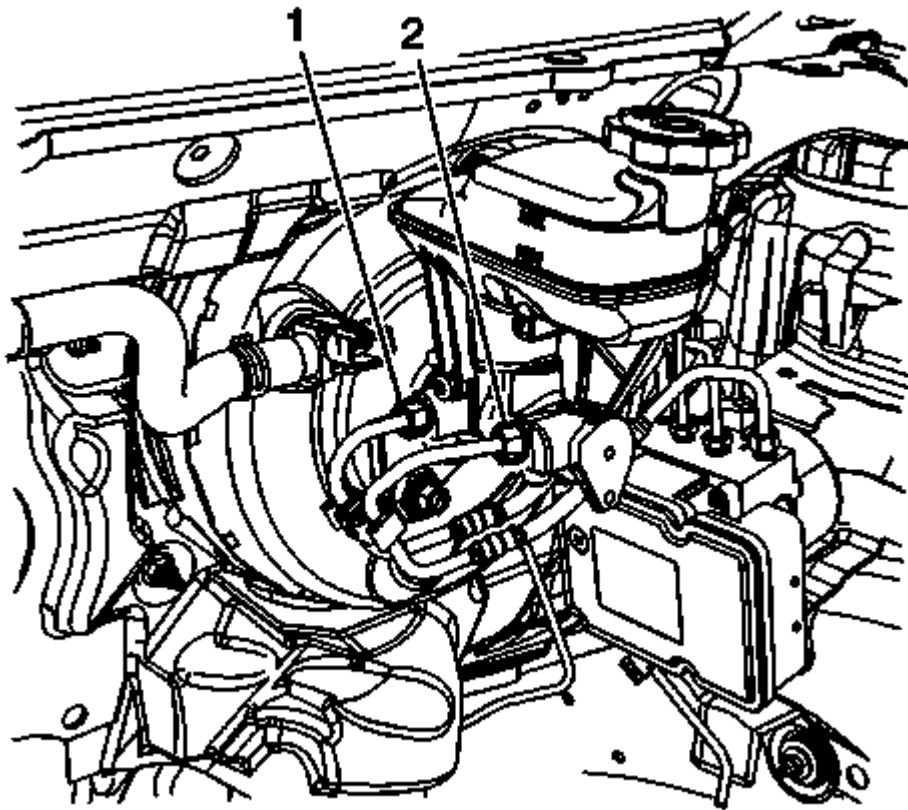


Fig. 24: Master Cylinder Primary And Secondary Brake Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

4. Connect the master cylinder primary brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).
5. Connect the master cylinder secondary brake pipe fitting (2) and tighten to 18 N.m (13 lb ft).
6. Connect the brake fluid level indicator switch electrical connector.
7. If equipped with the manual transmission, connect the clutch master cylinder reservoir hose. Refer to **Clutch Master Cylinder Reservoir Hose Replacement** .
8. Install the radiator surge tank. Refer to **RADIATOR SURGE TANK REPLACEMENT (LTG)**
9. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.
10. Install the intake manifold cover, if removed. Refer to **INTAKE MANIFOLD COVER REPLACEMENT** for the 2.0L engine.

MASTER CYLINDER BENCH BLEEDING

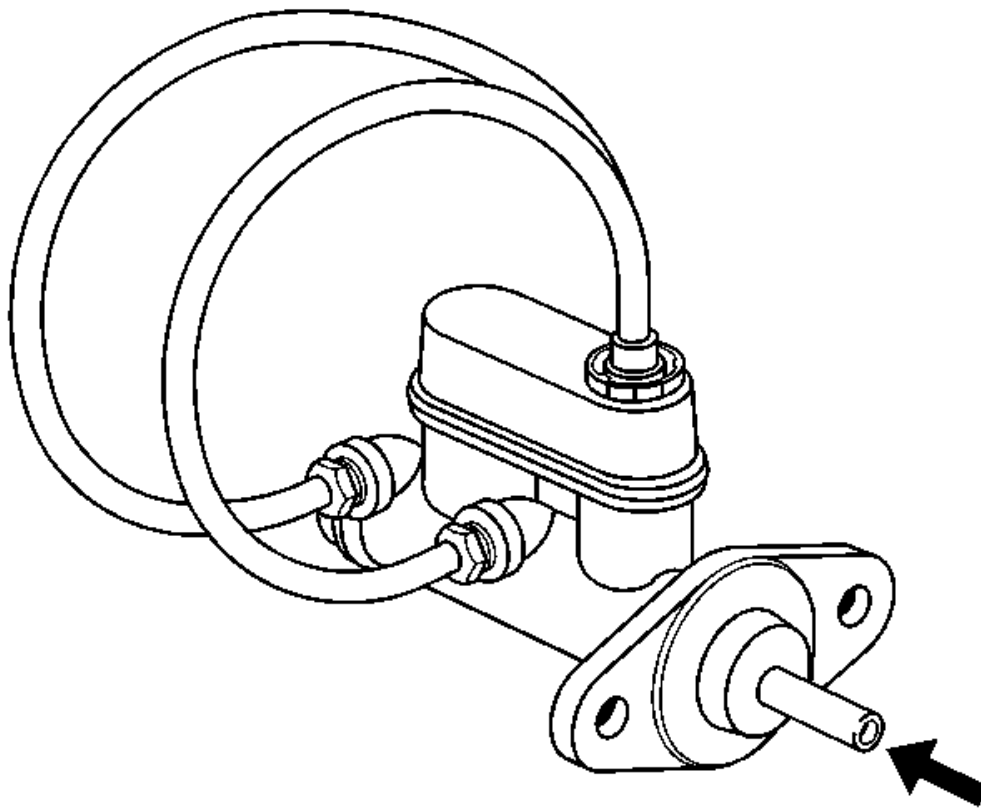


Fig. 25: Bleeding Master Cylinder
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components
Caution .

1. Secure the mounting flange of the brake master cylinder in a bench vise so that the rear of the primary piston is accessible.
2. Remove the master cylinder reservoir cap and diaphragm.
3. Install suitable fittings to the master cylinder ports that match the type of flare seat required and also provide for hose attachment.
4. Install transparent hoses to the fittings installed to the master cylinder ports, then route the hoses into the master cylinder reservoir.

5. Fill the master cylinder reservoir to at least the half-way point with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Master Cylinder Reservoir Filling**.
6. Ensure that the ends of the transparent hoses running into the master cylinder reservoir are fully submerged in the brake fluid.
7. Using a smooth, round-ended tool, depress and release the primary piston as far as it will travel, a depth of about 25 mm (1 in), several times. Observe the flow of fluid coming from the ports.

As air is bled from the primary and secondary pistons, the effort required to depress the primary piston will increase and the amount of travel will decrease.

8. Continue to depress and release the primary piston until fluid flows freely from the ports with no evidence of air bubbles.
9. Remove the transparent hoses from the master cylinder reservoir.
10. Install the master cylinder reservoir cap and diaphragm.
11. Remove the fittings with the transparent hoses from the master cylinder ports. Wrap the master cylinder with a clean shop cloth to prevent brake fluid spills.
12. Remove the master cylinder from the vise.

BRAKE FLUID LEVEL INDICATOR SWITCH REPLACEMENT

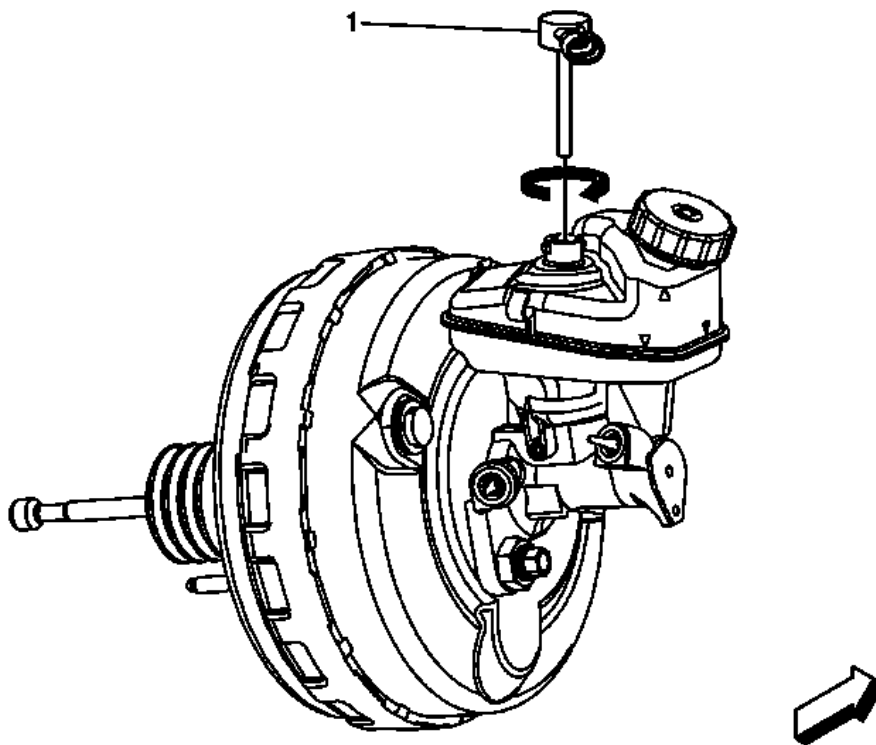


Fig. 26: Brake Fluid Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

Brake Fluid Level Indicator Switch Replacement

Callout	Component Name
1	Brake Fluid Level Indicator Switch
	Procedure <ul style="list-style-type: none"> • Disconnect the electrical connector. • Turn the indicator switch clockwise to release.

BRAKE AND ACCELERATOR PEDAL ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the instrument panel tie bar. Refer to **Instrument Panel Tie Bar Replacement**
2. Disconnect the accelerator pedal position sensor electrical connector.
3. Remove the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement**

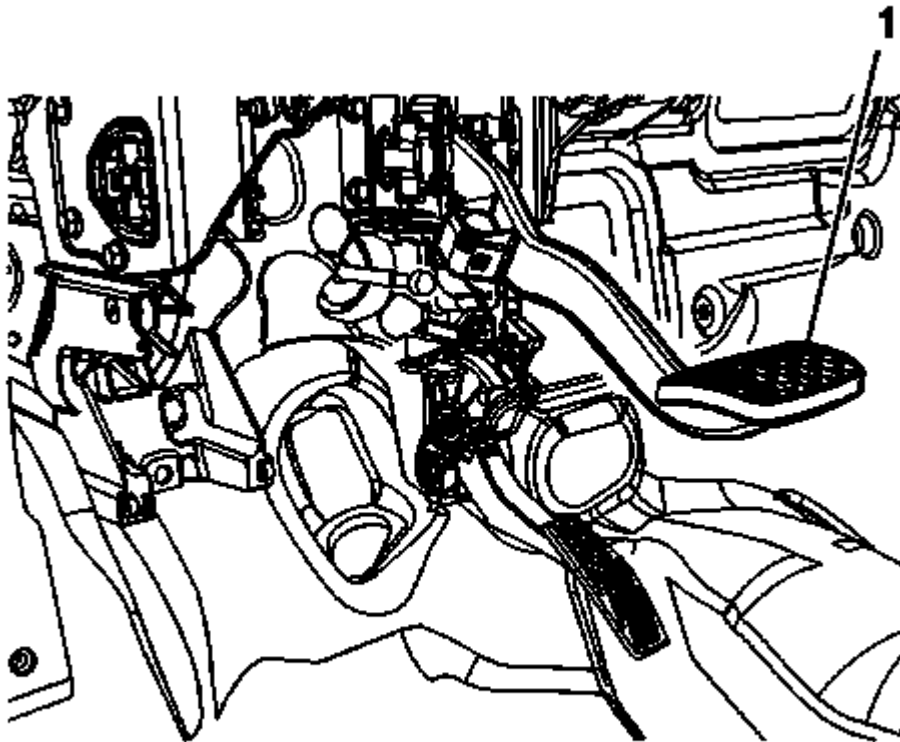


Fig. 27: Brake Pedal

Courtesy of GENERAL MOTORS COMPANY

4. Pull the brake pedal (1) rearward to release the power vacuum brake booster pushrod retainer.

NOTE: Do not reuse the power vacuum brake booster pushrod retainer.

5. Remove and discard the power vacuum brake booster pushrod retainer.
6. Remove the power vacuum brake booster. Refer to **Power Vacuum Brake Booster Replacement**

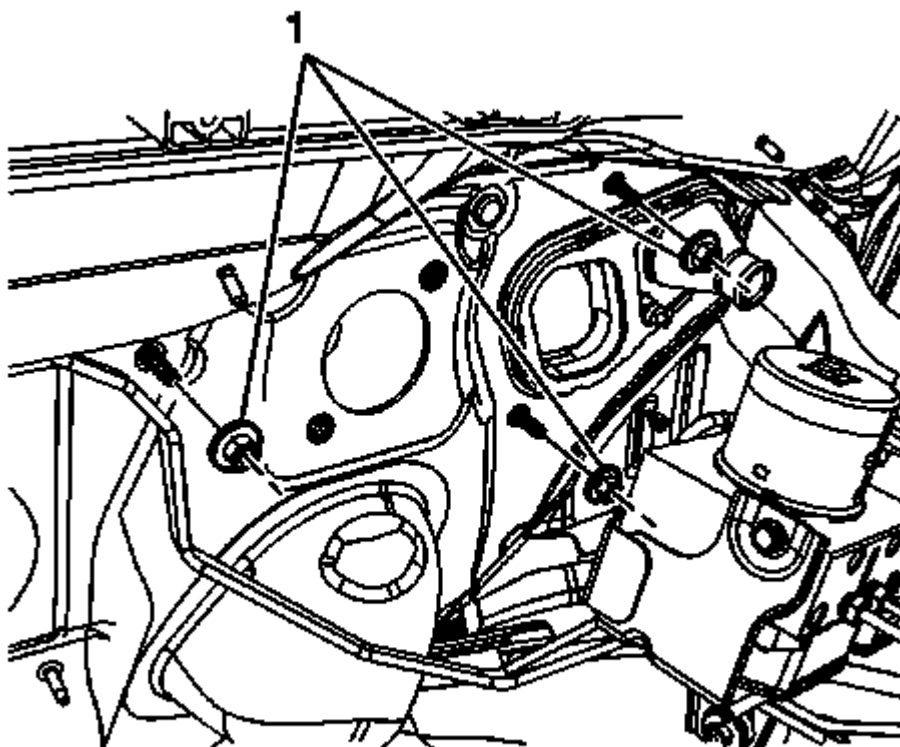


Fig. 28: Brake Pedal Assembly And Nuts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the brake pedal assembly nuts (1).
8. Remove the brake pedal assembly.

Installation Procedure

1. Install the brake pedal assembly.

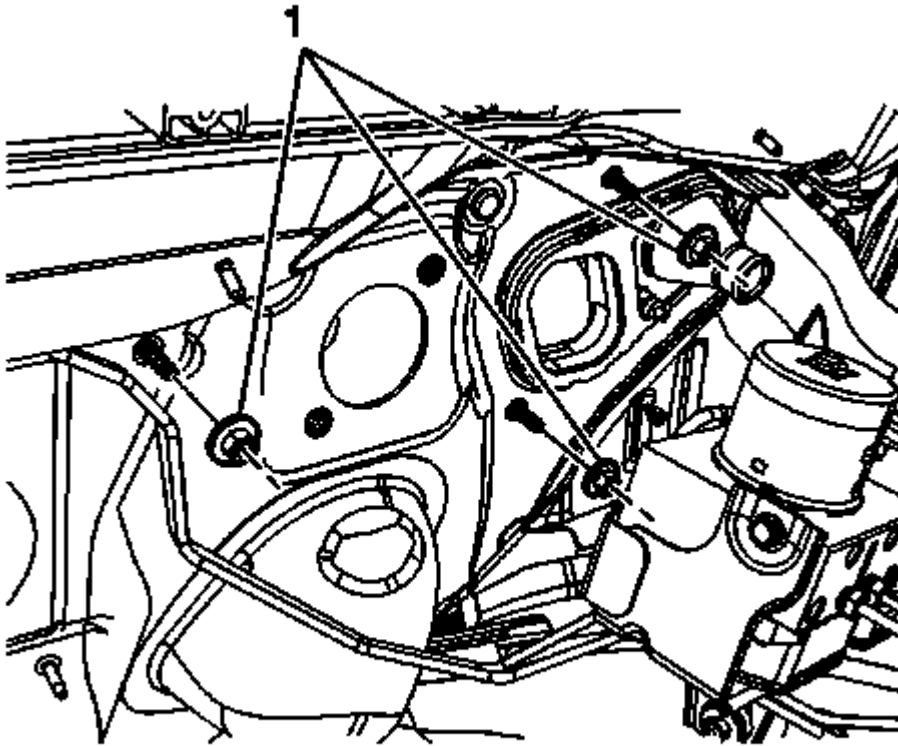


Fig. 29: Brake Pedal Assembly And Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution

2. Install the brake pedal assembly nuts (1) and tighten to 22 N.m (16 lb ft).
3. Install the power vacuum brake booster. Refer to **Power Vacuum Brake Booster Replacement**

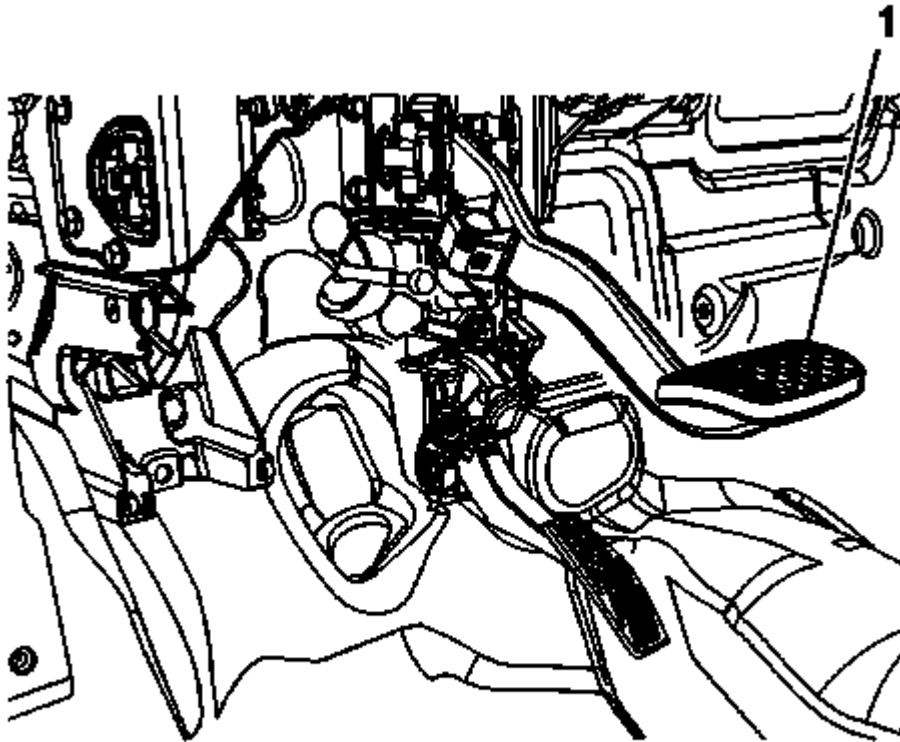


Fig. 30: Brake Pedal

Courtesy of GENERAL MOTORS COMPANY

NOTE: Install a new power vacuum brake booster pushrod retainer.

4. Install a new power vacuum brake booster pushrod retainer to the power vacuum brake booster pushrod.

NOTE: Ensure the power vacuum brake booster pushrod retainer is fully seated in the brake pedal arm.

5. Install the power vacuum brake booster pushrod retainer to the brake pedal (1).
6. Install the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement**
7. Connect the accelerator pedal position sensor electrical connector.
8. Install the instrument panel tie bar. Refer to **Instrument Panel Tie Bar Replacement**

BRAKE PRESSURE MODULATOR VALVE PRIMARY PIPE REPLACEMENT (LEFT HAND DRIVE)

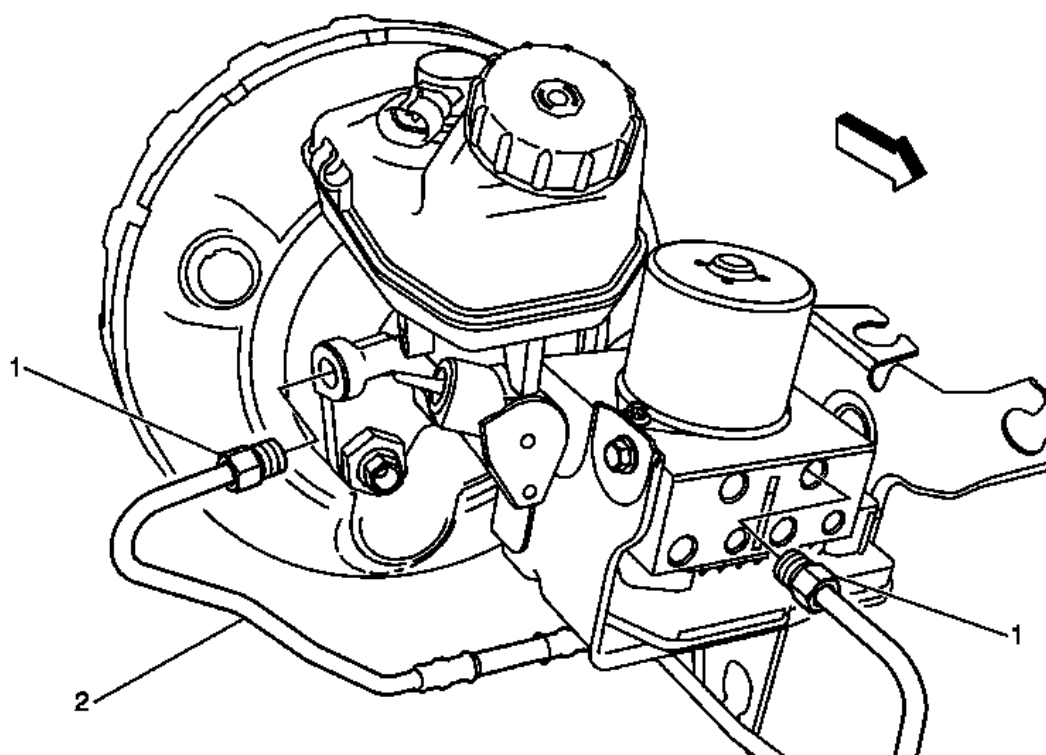


Fig. 31: Brake Pressure Modulator Valve Primary Pipe (Left Hand Drive)
 Courtesy of GENERAL MOTORS COMPANY

Brake Pressure Modulator Valve Primary Pipe Replacement (Left Hand Drive)

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
Preliminary Procedures Remove the surge tank. Refer to <u>Radiator Surge Tank Replacement (LUK)</u> , <u>Radiator Surge Tank Replacement (LTG)</u> .	
1	Brake Pipe Fitting CAUTION: Refer to <u>Fastener Caution</u> . Procedure Cap the brake pipe fitting to prevent brake fluid loss and contamination. Tighten 18 N.m (13 lb ft)
2	Brake Pressure Modulator Valve Primary Pipe Procedure Bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> , <u>Hydraulic Brake System Bleeding (Pressure)</u> .

BRAKE PRESSURE MODULATOR VALVE SECONDARY PIPE REPLACEMENT (LEFT HAND DRIVE)

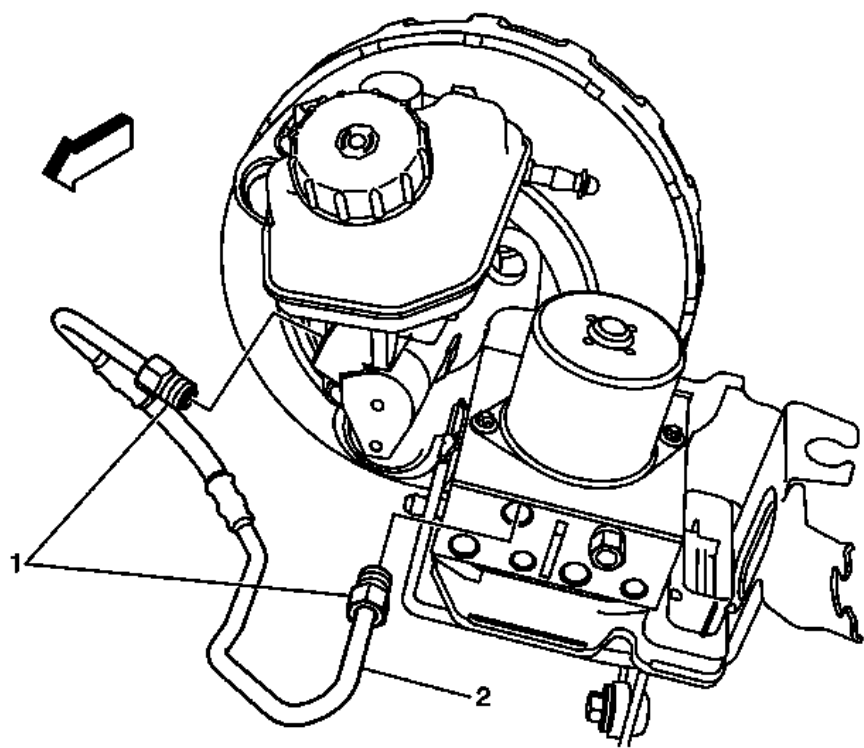


Fig. 32: Brake Pressure Modulator Valve Secondary Pipe (Left Hand Drive)
Courtesy of GENERAL MOTORS COMPANY

Brake Pressure Modulator Valve Secondary Pipe Replacement (Left Hand Drive)

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
Preliminary Procedures Remove the surge tank. Refer to <u>Radiator Surge Tank Replacement (LUK)</u> , <u>Radiator Surge Tank Replacement (LTG)</u> .	
1	<p>Brake Pipe Fitting</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Cap the brake pipe fitting to prevent brake fluid loss and contamination. Tighten 18 N.m (13 lb ft)</p>
	<p>Brake Pressure Modulator Valve Secondary Pipe</p> <p>Procedure</p>

BRAKE PIPE REPLACEMENT

Special Tools

CH-45405 Brake Pipe Flaring Tool Kit

For equivalent regional tools, refer to Special Tools.

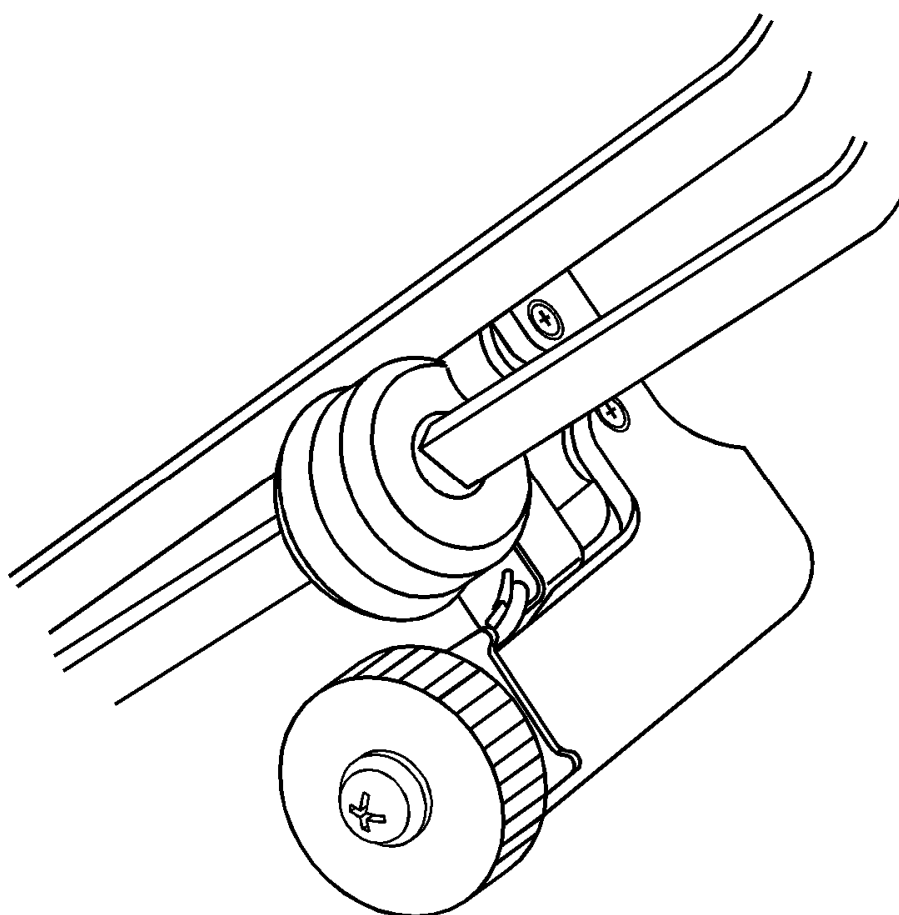


Fig. 33: Sectioning Brake Pipe Using Pipe Cutter
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Fluid Irritant Warning .

WARNING: Always use double walled steel brake pipe when replacing brake

pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the correct fasteners and the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and cause brake system failure.

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

NOTE: When servicing the brake pipes, note the following:

- **If sectioning the brake pipe, use replacement pipe of the same type and outside diameter.**
- **Use fittings of the appropriate size and type.**
- **Only create flares of the same type or design as originally equipped on the vehicle.**

1. Inspect the area of brake pipe to be repaired or replaced.
2. Release the brake pipe to be replaced from the retainers, as required.
3. Select an appropriate location to section the brake pipe, if necessary.
 - Allow adequate clearance in order to maneuver the **CH-45405** Brake Pipe Flaring Tool Kit.
 - Avoid sectioning the brake pipe at bends or mounting points.
4. Using a string or wire, measure the length of the pipe to be replaced including all pipe bends.
5. Add to the measurement taken the appropriate additional length required for each flare to be created.

Specification

- 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe
- 9.50 mm (0.374 in) for 6.35 mm (1/4 in) diameter pipe
- 12.67 mm (0.499 in) for 7.94 mm (5/16 in) diameter pipe

NOTE: Ensure that the brake pipe end to be flared is cut at a square, 90 degree angle to the pipe length.

6. Using the pipe cutter included in the **CH-45405** Brake Pipe Flaring Tool Kit , carefully cut the brake pipe squarely to the measured length.
7. Remove the sectioned brake pipe from the vehicle.
8. Select the appropriate size of brake pipe and tube nuts, as necessary. The brake pipe outside diameter determines brake pipe size.

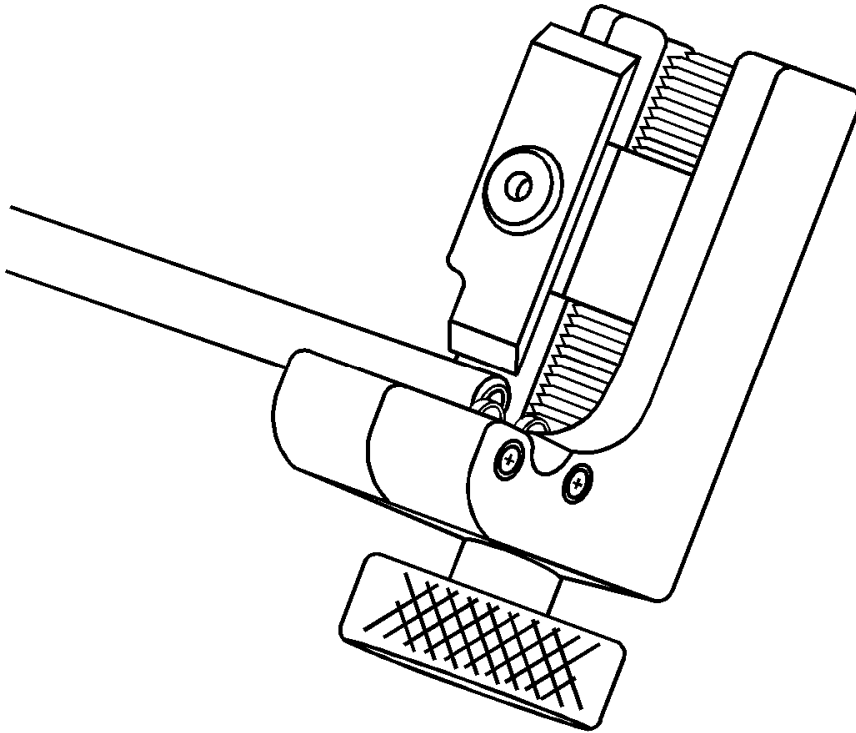


Fig. 34: Stripping Nylon Coating From Brake Pipe Ends
Courtesy of GENERAL MOTORS COMPANY

9. Strip the nylon coating from the brake pipe end to be flared, if necessary.
 - Select the appropriate blade on the coating stripping tool included in the **CH-45405** Brake Pipe Flaring Tool Kit , by unthreading the blade block from the stripping tool and installing the block with the desired blade facing the tool rollers.

Specification

- 6.35 mm (0.250 in) blade for 4.76 mm (3/16 in) diameter pipe
- 9.50 mm (0.374 in) blade for 6.35 mm (1/4 in) and 7.94 mm (5/16 in) diameter pipe
- Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
- While holding the brake pipe firmly against the stripping tool roller ledges, rotate the thumbwheel of the tool until the blade contacts the brake pipe coated surface.

NOTE: **Do not gouge the metal surface of the brake pipe.**

- Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against the tool roller ledges.
- After each successive revolution of the stripping tool, carefully rotate the thumbwheel of the tool clockwise, in order to continue stripping the coating from the brake pipe until the metal pipe surface is exposed.
- Loosen the thumbwheel of the tool and remove the brake pipe.

NOTE: **Ensure that all loose remnants of the nylon coating have been removed from the brake pipe.**

- Inspect the stripped end of the brake pipe to ensure that the proper amount of coating has been removed.

Specification

- 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe
- 9.50 mm (0.374 in) for 6.35 mm (1/4 in) and 7.94 mm (5/16 in) diameter pipe

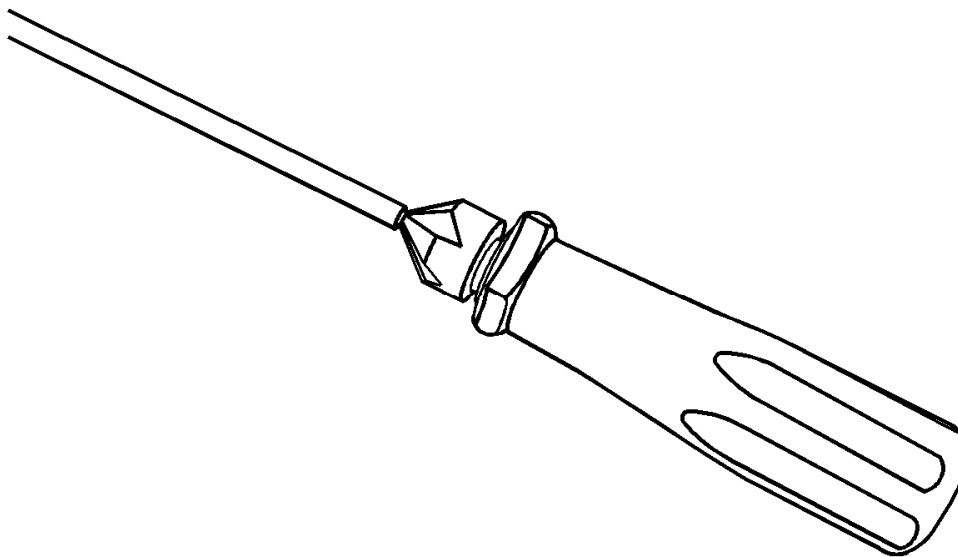


Fig. 35: Chamfering Pipe Using De-Burring Tool
Courtesy of GENERAL MOTORS COMPANY

10. Chamfer the inside and outside diameter of the pipe with the de-burring tool included in the **CH-45405** Brake Pipe Flaring Tool Kit.
11. Install the tube nuts on the brake pipe, noting their orientation.
12. Clean the brake pipe and the **CH-45405** Brake Pipe Flaring Tool Kit of lubricant, contaminants, and debris.

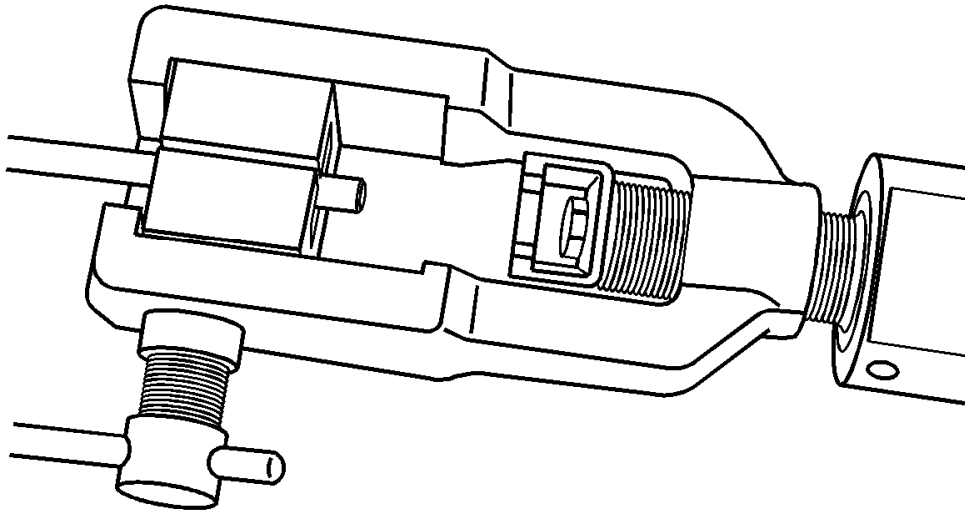


Fig. 36: Installing Die Halves Into Die Cage
Courtesy of GENERAL MOTORS COMPANY

13. Loosen the die clamping screw of the **CH-45405** Brake Pipe Flaring Tool Kit.
14. Select the corresponding die set and install the die halves into the die cage with the full, flat face of one die facing the clamping screw, and the counterbores of both dies facing the forming ram.

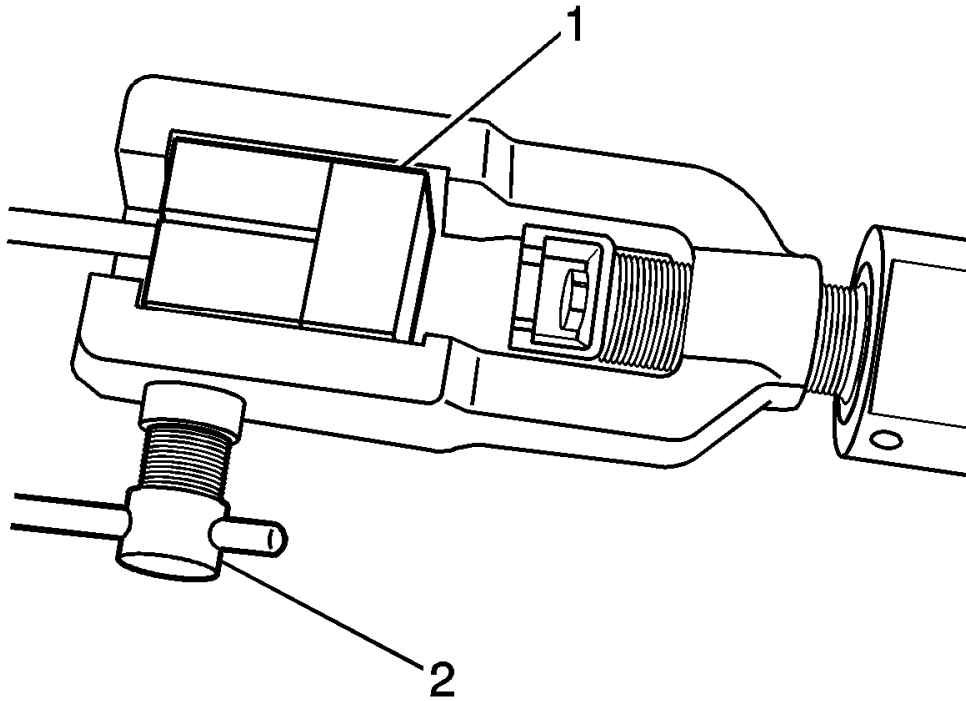


Fig. 37: View Of Clamping Screw & Unused Die
Courtesy of GENERAL MOTORS COMPANY

15. Place the flat face of an unused die (1) against the die halves in the clamping cage and hold firmly against the counterbored face of the dies.
16. Insert the prepared end of the pipe to be flared through the back of the dies until the pipe is seated against the flat surface of the unused die (1).
17. Remove the unused die (1).
18. Ensure that the rear of both dies are seated firmly against the enclosed end of the die cage.
19. Firmly hand tighten the clamping screw (2) against the dies.

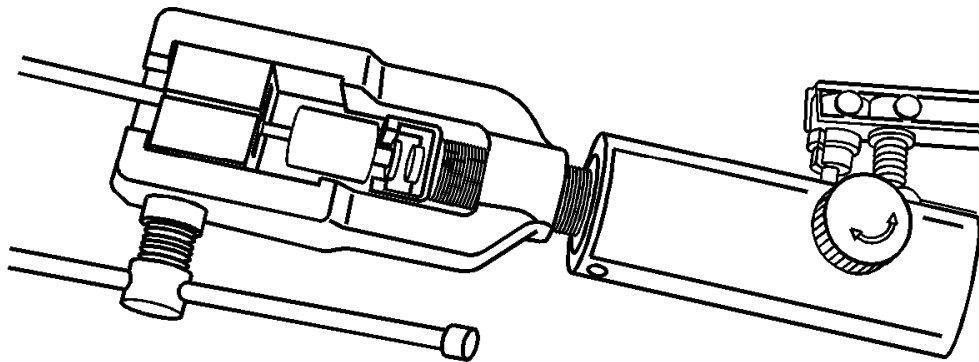


Fig. 38: Rotating J 45405 To Bottom Against Die Cage
Courtesy of GENERAL MOTORS COMPANY

20. Select the appropriate forming mandrel and place into the forming ram.
21. Rotate the hydraulic fluid control valve clockwise to the closed position.
22. Rotate the body of the **CH-45405** Brake Pipe Flaring Tool Kit until it bottoms against the die cage.

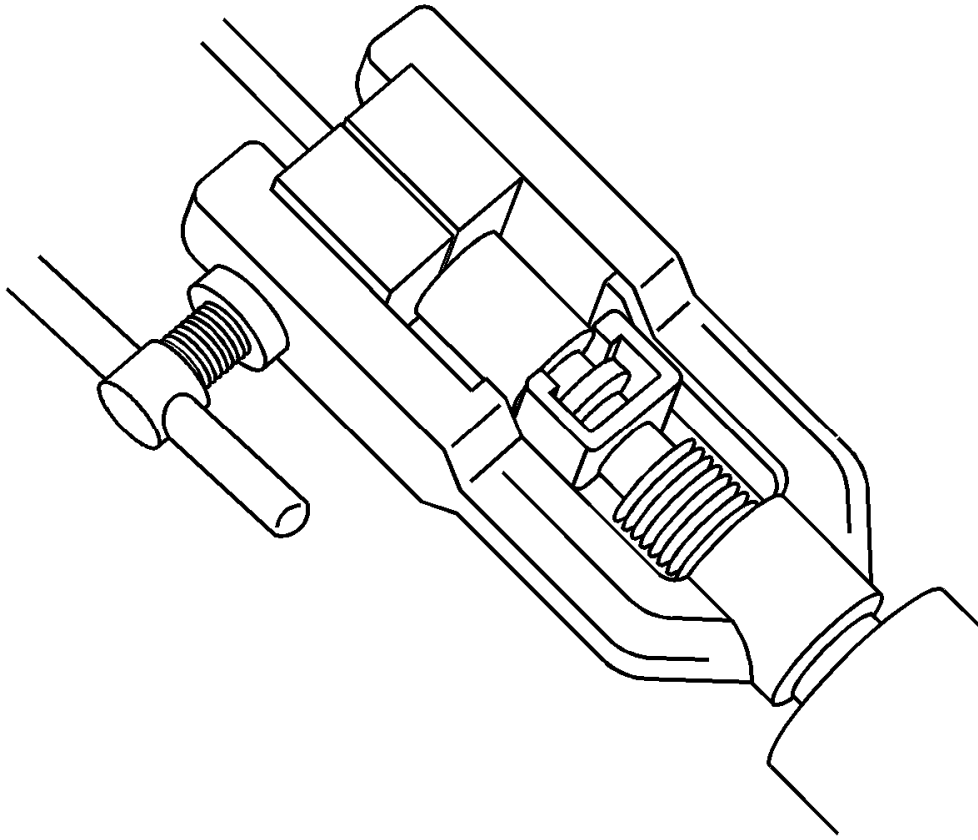


Fig. 39: Bottoming Forming Mandrel Against Clamping Dies Using Pipe Flaring Tool
Courtesy of GENERAL MOTORS COMPANY

23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the **CH-45405** Pipe Flaring Tool Kit until the forming mandrel bottoms against the clamping dies.
24. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.

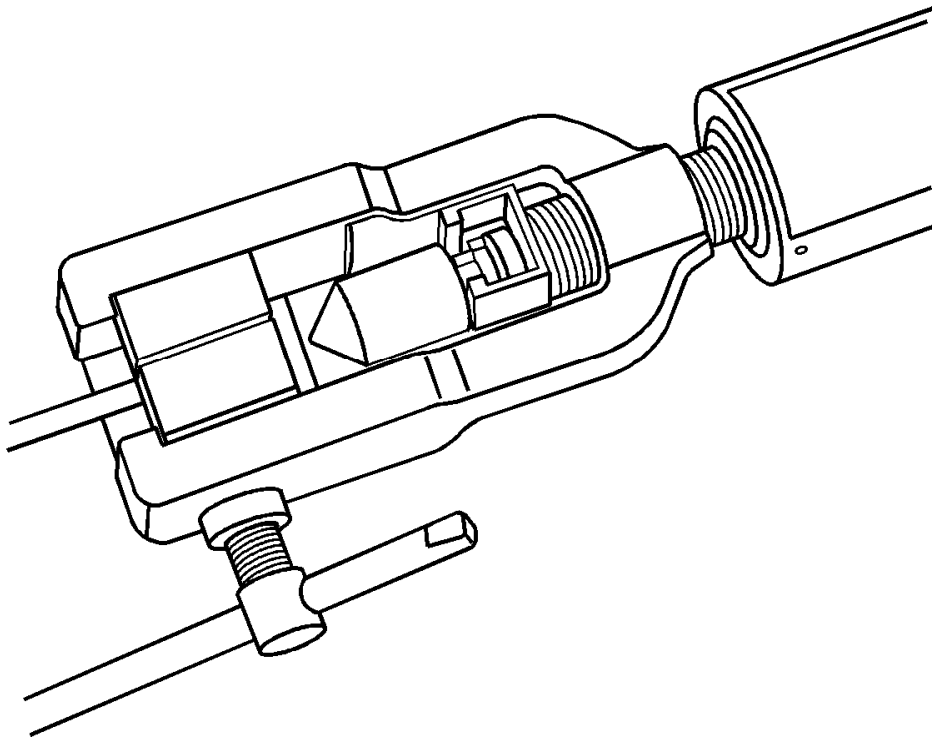


Fig. 40: Using Pipe Flaring Tool
Courtesy of GENERAL MOTORS COMPANY

25. Insert the finishing cone into the forming ram.
26. Rotate the hydraulic fluid control valve clockwise to the closed position.
27. Rotate the body of the **CH-45405** Brake Pipe Flaring Tool Kit until it bottoms against the die cage.
28. While guiding the finishing cone into the exposed end of pipe to be flared, operate the lever of the **CH-45405** Brake Pipe Flaring Tool Kit until the finishing cone bottoms against the dies.
29. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.
30. Loosen the die clamping screw and remove the dies and pipe.
31. If necessary, lightly tap the dies until the die halves separate.

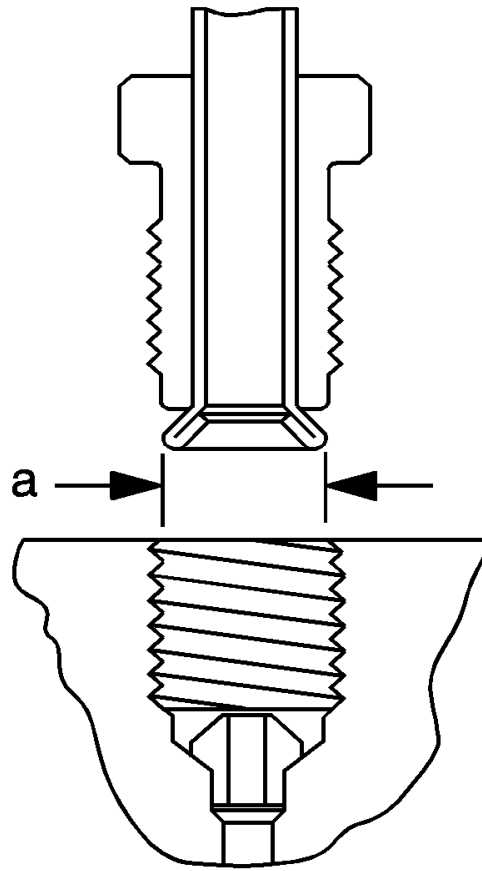


Fig. 41: Identifying Correct Brake Pipe Flare Shape & Diameter
Courtesy of GENERAL MOTORS COMPANY

32. Inspect the brake pipe flare for correct shape and diameter (a).

Specification

- 6.74-7.10 mm (0.265-0.279 in) flare diameter for 4.76 mm (3/16 in) diameter pipe
 - 8.57-9.27 mm (0.344-0.358 in) flare diameter for 6.35 mm (1/4 in) diameter pipe
 - 10.42-10.79 mm (0.410-0.425 in) flare diameter for 7.94 mm (5/16 in) diameter pipe
33. If necessary, using the removed section of brake pipe as a template, shape the new pipe with a suitable brake pipe bending tool.

NOTE: **When installing the pipe, maintain a clearance of 19 mm (3/4 in) from all moving or vibrating components.**

34. Install the pipe to the vehicle with the appropriate brake pipe unions, as required.
35. If previously released, secure the brake pipe to the retainers.

36. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.
37. With the aid of an assistant, inspect the brake pipe flares for leaks by starting the engine and applying the brakes.

FRONT BRAKE PIPE REPLACEMENT - RIGHT SIDE

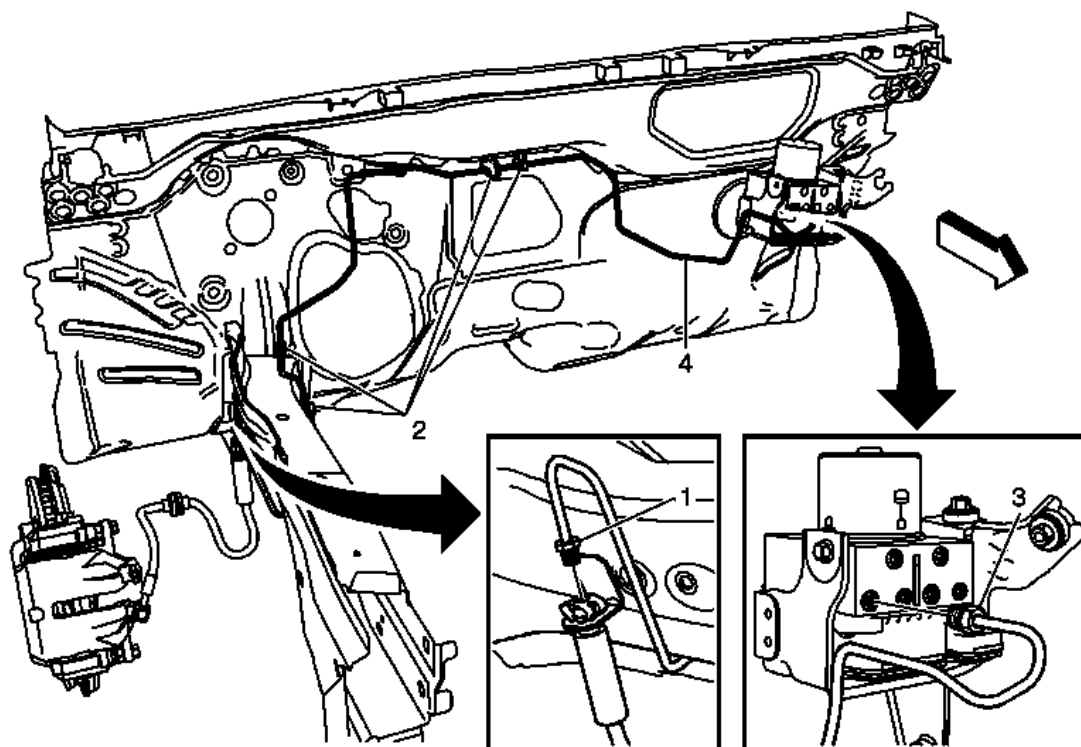


Fig. 42: Front Brake Pipe - Right Side
Courtesy of GENERAL MOTORS COMPANY

Front Brake Pipe Replacement - Right Side

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Remove the surge tank. Refer to <u>Radiator Surge Tank Replacement (LUK)</u> , <u>Radiator Surge Tank Replacement (LTG)</u> . 4. Move the air cleaner assembly to make space.	
	Front Brake Pipe Fitting

	CAUTION: Refer to <u>Fastener Caution</u> .
1	Procedure Cap the brake pipe fitting to prevent brake fluid loss and contamination. Tighten 18 N.m (13 lb ft)
2	Brake Pipe Clip (Qty: 3)
3	Front Brake Pipe Fitting Procedure Cap the brake pipe fitting to prevent brake fluid loss and contamination. Tighten 18 N.m (13 lb ft)
4	Front Brake Pipe Procedure Bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> , <u>Hydraulic Brake System Bleeding (Pressure)</u> .

FRONT BRAKE PIPE REPLACEMENT - LEFT SIDE

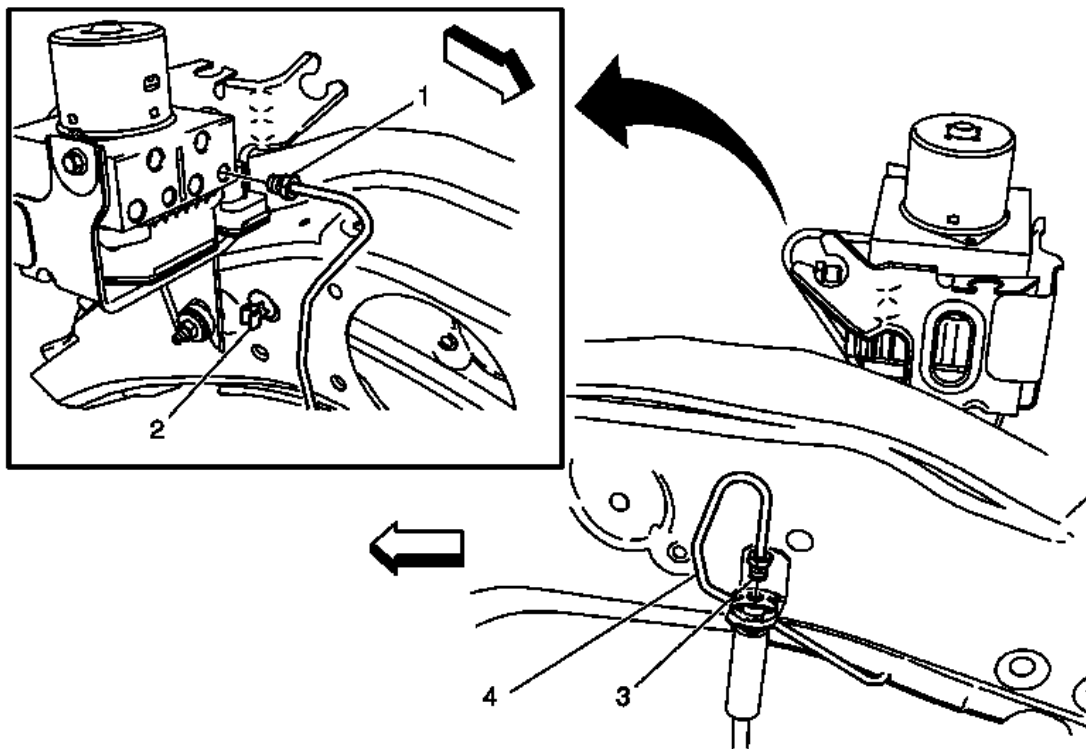


Fig. 43: Front Brake Pipe - Left Side
Courtesy of GENERAL MOTORS COMPANY

Front Brake Pipe Replacement - Left Side

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Remove the surge tank. Refer to <u>Radiator Surge Tank Replacement (LUK)</u> , <u>Radiator Surge Tank Replacement (LTG)</u> . 	
1	Front Brake Pipe Fitting CAUTION: Refer to <u>Fastener Caution</u> . Procedure Cap the brake pipe fitting to prevent brake fluid loss and contamination. Tighten 18 N.m (13 lb ft)
2	Brake Pipe Clip
3	Front Brake Pipe Fitting Procedure Cap the brake pipe fitting to prevent brake fluid loss and contamination. Tighten 18 N.m (13 lb ft)
4	Front Brake Pipe Procedure Bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> , <u>Hydraulic Brake System Bleeding (Pressure)</u> .

FRONT BRAKE HOSE REPLACEMENT (J60, J61)

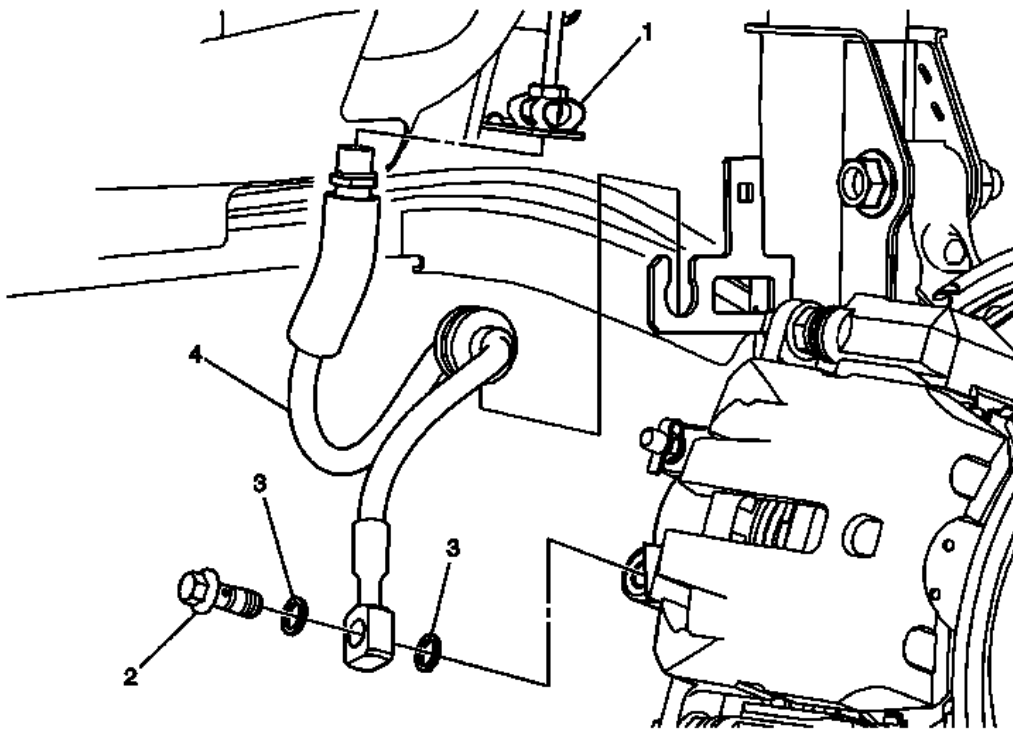


Fig. 44: Front Brake Hose (J60, J61)
 Courtesy of GENERAL MOTORS COMPANY

Front Brake Hose Replacement (J60, J61)

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
WARNING: Refer to <u>Brake Dust Warning</u> .	
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> .	
1	Brake Pipe Fitting CAUTION: Refer to <u>Fastener Caution</u> . Procedure Cap the brake pipe fitting to prevent brake fluid loss and contamination. Tighten

	18 N.m (13 lb ft)
2	Brake Hose Fitting Bolt Tighten 40 N.m (30 lb ft)
3	Brake Hose Fitting Gasket (Qty: 2) Procedure Install new brake hose fitting gaskets.
4	Front Brake Hose Procedure Bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> , <u>Hydraulic Brake System Bleeding (Pressure)</u> .

FRONT BRAKE HOSE REPLACEMENT (J64)

Removal Procedure

WARNING: Refer to Brake Dust Warning .

WARNING: Refer to Brake Fluid Irritant Warning .

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .

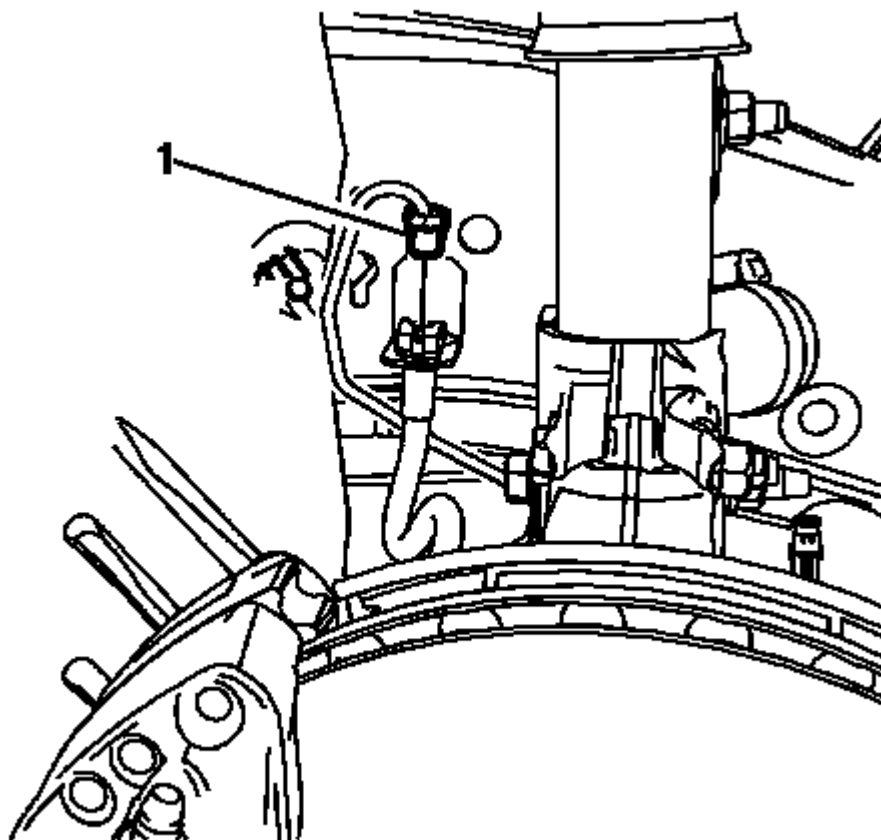


Fig. 45: Brake Pipe Fitting

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the brake pipe fitting (1) from the brake hose.
4. Cap the brake pipe fitting to prevent brake fluid loss and contamination.
5. Remove the brake hose retaining clip.

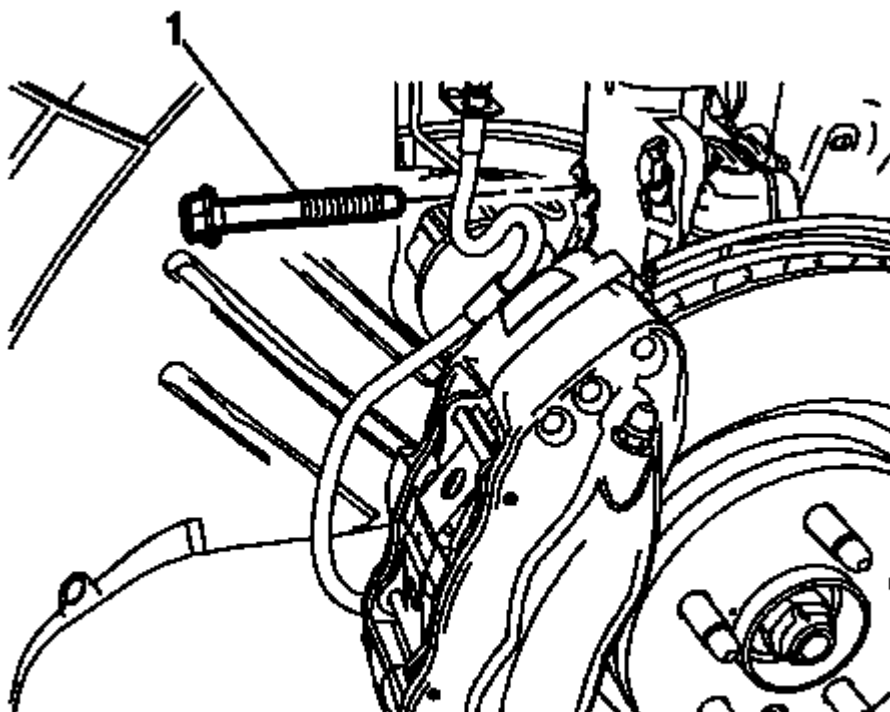


Fig. 46: Front Strut Assembly Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the front strut assembly pinch bolt (1) from the steering knuckle and brake hose bracket.

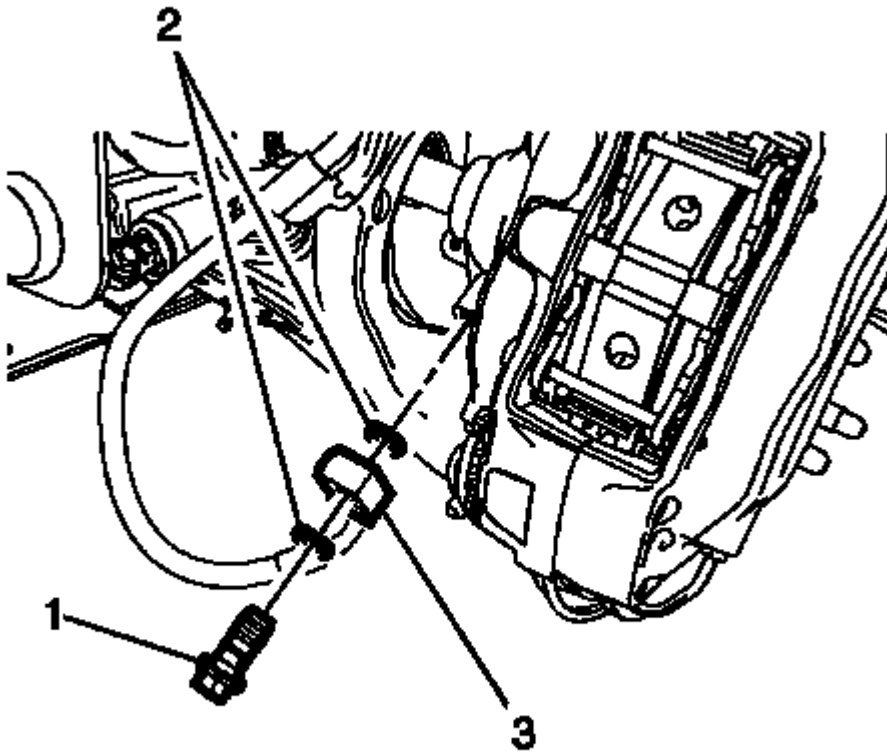


Fig. 47: Brake Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the brake hose fitting bolt (1).

NOTE: Do not reuse the brake hose fitting gaskets.

8. Remove and discard the brake hose fitting gaskets (2) from the brake hose fitting (3).
9. Remove the brake hose.

Installation Procedure

1. Install the brake hose.

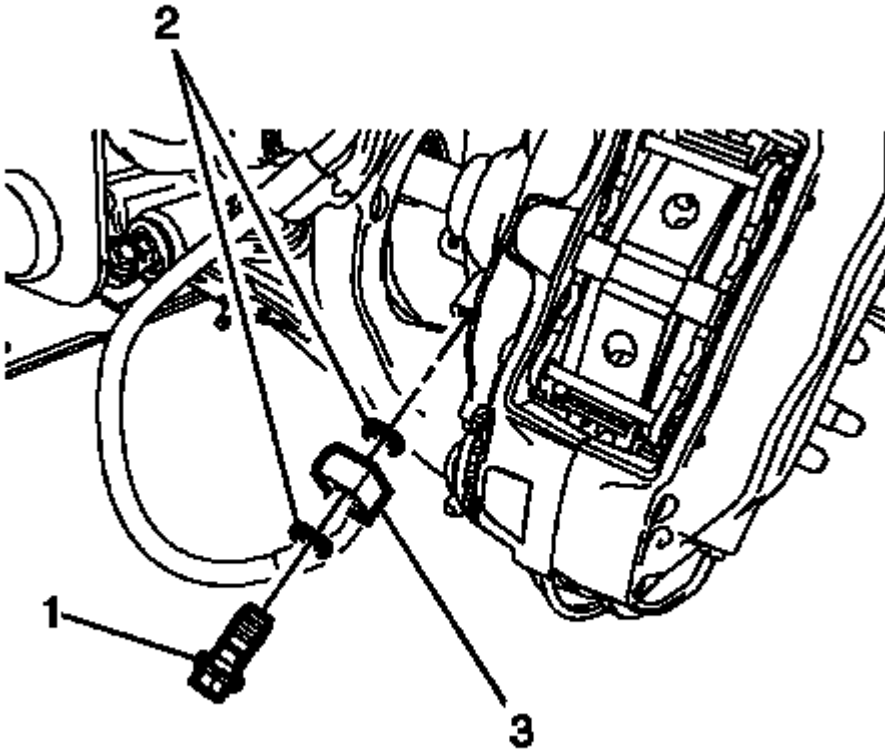


Fig. 48: Brake Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Assemble the brake hose fitting bolt (1), with new brake hose fitting gaskets (2) to the brake hose fitting (3).

CAUTION: Refer to Fastener Caution .

3. Install the brake hose assembly to the brake caliper and tighten the brake hose fitting bolt to 40 N.m (30 lb ft).

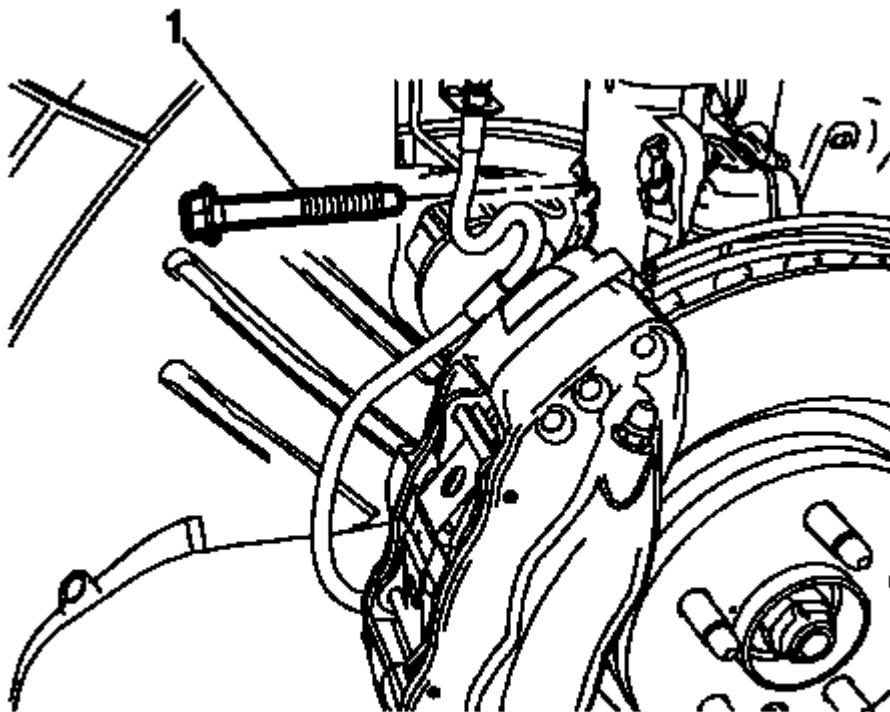


Fig. 49: Front Strut Assembly Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the front strut assembly pinch bolt (1) to the steering knuckle and brake hose bracket. Refer to **Strut Assembly Removal and Installation (GNB)** , **Strut Assembly Removal and Installation (GNA)** .
5. Install the front brake hose to the wheelhouse bracket.
6. Install the brake hose retaining clip.

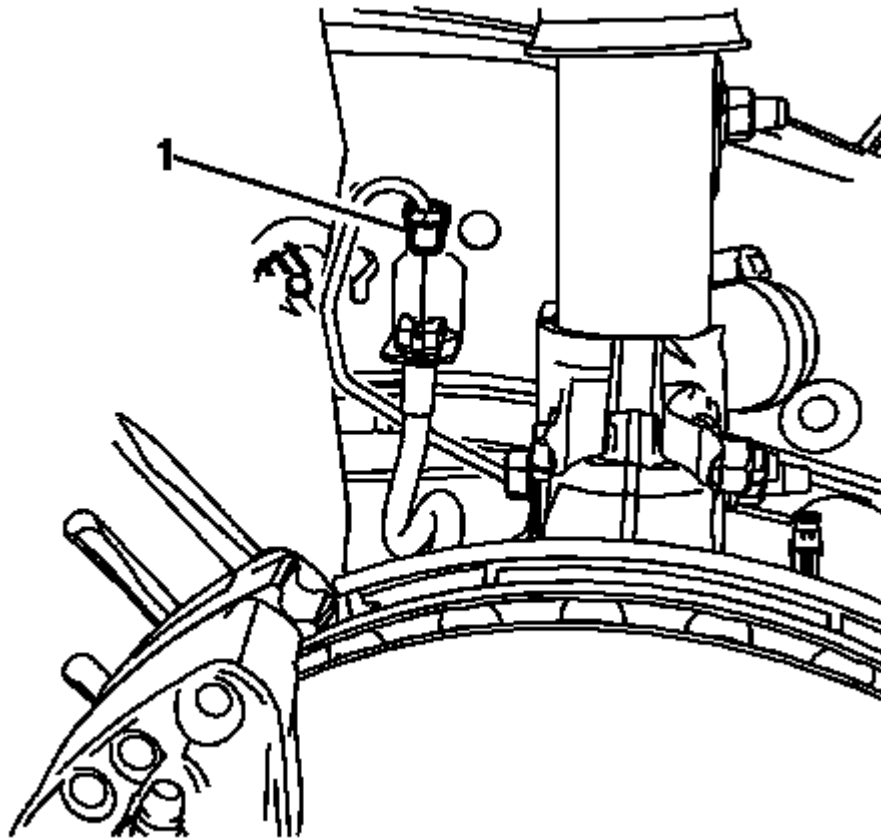


Fig. 50: Brake Pipe Fitting

Courtesy of GENERAL MOTORS COMPANY

7. Connect the brake pipe fitting (1) to the brake hose.
8. Tighten the brake pipe fitting to 18 N.m (13 lb ft).
9. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.
10. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

REAR BRAKE HOSE REPLACEMENT

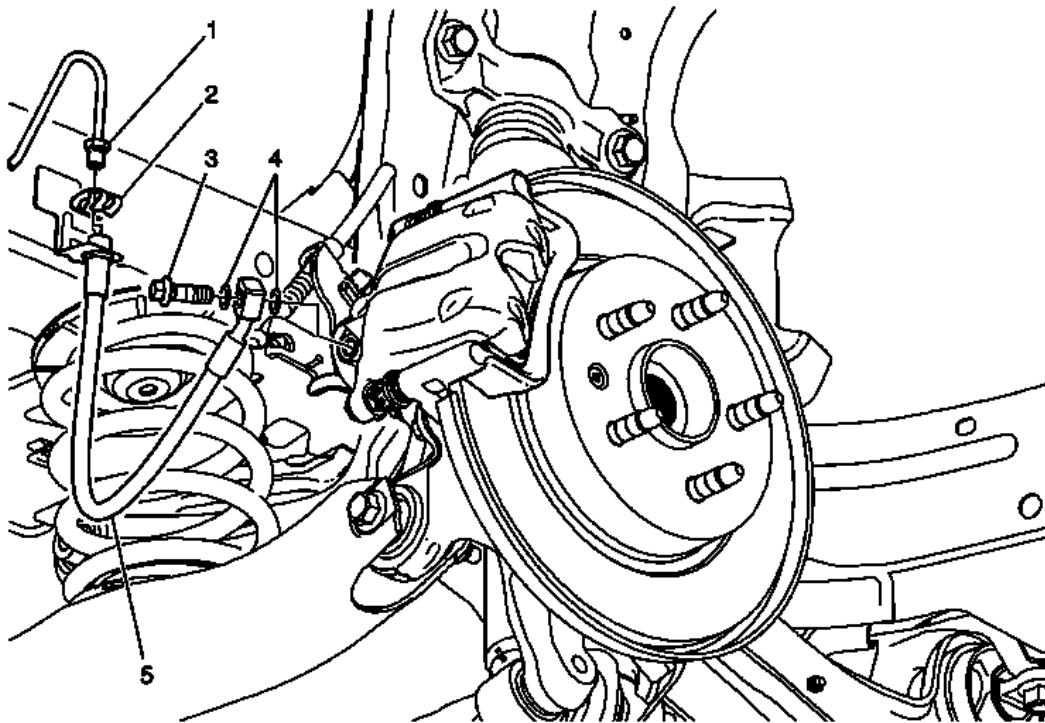


Fig. 51: Rear Brake Hose & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Rear Brake Hose Replacement

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
WARNING: Refer to <u>Brake Dust Warning</u> .	
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel. Refer to <u>Tire and Wheel Removal and Installation</u> . 	
1	Brake Pipe Fitting CAUTION: Refer to <u>Fastener Caution</u> . Procedure Cap the brake pipe fitting to prevent brake fluid loss and contamination. Tighten

	18 N.m (13 lb ft)
2	Brake Hose Retainer
3	Brake Hose Fitting Bolt Tighten 40 N.m (30 lb ft)
4	Brake Hose Fitting Gasket (Qty: 2) Procedure Install new brake hose fitting gaskets.
5	Rear Brake Hose Procedure Bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> , <u>Hydraulic Brake System Bleeding (Pressure)</u> .

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

CAUTION: Only use products that comply with GM specifications and check manufacturer information respectively. We recommend the use of GM genuine products. Instructions must be followed at all times. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

If hydraulic components were serviced on only one wheel hydraulic circuit, perform the following procedure.

Bleeding a Single Hydraulic Brake Circuit

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to Fluid and Lubricant Recommendations .
5. Install a proper box-end wrench onto the wheel hydraulic circuit bleeder valve which has been serviced.
6. Install a transparent hose over the end of the bleeder valve.

7. Submerge the open end of the transparent hose into a transparent container partially filled with brake fluid from a clean, sealed brake fluid container.
8. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
9. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
10. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
11. Wait 15 seconds, then repeat steps 8-10 until all air is purged from the wheel hydraulic circuit.
12. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.
13. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
14. Slowly press and release the brake pedal. Observe the brake pedal feel.
15. If the brake pedal feels spongy, perform the Bleeding the Complete Brake Hydraulic System procedure:
16. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

NOTE: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

17. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

Bleeding the Complete Brake Hydraulic System

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to **Fluid and Lubricant Recommendations** .
5. If the master cylinder was replaced, the master cylinder must be bench bled. Refer to **Master Cylinder Bench Bleeding**.
6. If the brake pipes have been removed from the master cylinder, the following steps must be performed.
 1. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe fitting from the front port of the brake master cylinder.
 2. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder. Capture and properly dispose of the brake fluid in an approved container.
 3. Install the front brake pipe fitting to the front port of the brake master cylinder and tighten the fitting. Refer to **Fastener Tightening Specifications**.
 4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
 5. Loosen the front brake pipe fitting from the front port of the brake master cylinder to purge air from the master cylinder port.
 6. Tighten the front brake pipe fitting, then have the assistant slowly release the brake pedal.

7. Wait 15 seconds, then repeat steps 6.4-6.6 until all air is purged from the front brake pipe fitting of the front port of the master cylinder.
 8. After all air is purged from the front port of the brake master cylinder, tighten the front master cylinder brake pipe fitting. Refer to **Fastener Tightening Specifications**.
 9. With the front brake pipe fitting installed securely to the front port of the brake master cylinder, loosen and separate the rear brake pipe fitting from the rear port of the brake master cylinder.
 10. Repeat steps 6.2-6.7 for the rear port of the brake master cylinder.
 11. After all air is purged from the rear port of the brake master cylinder, tighten the rear master cylinder brake pipe fitting. Refer to **Fastener Tightening Specifications**.
 12. Slowly press and release the brake pedal. Observe the brake pedal feel.
 13. If the brake pedal feels spongy, proceed to step 7.
 14. If the brake pedal feels firm, proceed to step 24.
7. If the brake pipes have been removed from the brake pressure modulator valve (BPMV) assembly, if equipped, or the brake proportion valve assembly, if equipped, air must be purged from each port of the respective assembly beginning with the feed pipes from the master cylinder.
1. Loosen and separate one of the master cylinder brake pipe fittings from the inlet port of the assembly to be bled.
 2. Allow a small amount of brake fluid to gravity bleed from the open port of the assembly. Capture and properly dispose of the brake fluid in an approved container.
 3. Install the brake pipe fitting and to the inlet port of the assembly and tighten securely.
 4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
 5. Loosen the same brake pipe fitting to purge air from the open port of the assembly.
 6. Tighten the brake pipe fitting, then have the assistant slowly release the brake pedal.
 7. Wait 15 seconds, then repeat steps 7.4-7.6 until all air is purged from the brake pipe fitting of the assembly.
 8. Repeat steps 7.1-7.7 for all of the remaining ports of the assembly.
 9. After bleeding each port of the assembly, tighten all of the brake pipe fittings on the assembly. Refer to **Fastener Tightening Specifications**.
 10. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.
 11. Slowly press and release the brake pedal. Observe the brake pedal feel.
 12. If the brake pedal feels spongy, proceed to step 8.
 13. If the brake pedal feels firm, proceed to step 24.
8. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
9. Install a transparent hose over the end of the bleeder valve.
10. Submerge the open end of the transparent hose into a transparent container partially filled with GM approved brake fluid from a clean, sealed brake fluid container.
11. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the brake pedal.
12. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
13. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.

14. Wait 15 seconds, then repeat steps 11-13 until all air is purged from the wheel hydraulic circuit.
15. Tighten the RIGHT REAR hydraulic wheel circuit bleeder valve securely.
16. Install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
17. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
18. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
19. After completing the final wheel hydraulic circuit bleeding procedure, tighten all of the wheel hydraulic circuit bleeder valves and install the bleeder valve dust caps.
20. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.
21. Slowly press and release the brake pedal. Observe the brake pedal feel.
22. If the brake pedal feels spongy, perform the following procedure.
 1. If equipped with antilock brakes, install a scan tool and perform the **Antilock Brake System Automated Bleed** to remove air which may be trapped in the BPMV.
 2. Inspect the hydraulic brake system for external leaks. Refer to **Brake System External Leak Inspection**.
 3. Repeat the Bleeding the Complete Brake Hydraulic System procedure.
23. If the brake pedal still feels spongy, pressure bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**
24. Turn the ignition switch ON with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

NOTE: **DO NOT allow the vehicle to be driven until the brake system is diagnosed and repaired.**

25. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

CAUTION: Only use products that comply with GM specifications and check manufacturer information respectively. We recommend the use of GM genuine products. Instructions must be followed at all times. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber

seals and/or rubber linings of hydraulic brake system components.

If hydraulic components were serviced on only one wheel hydraulic circuit, perform the following procedure.

Bleeding a Single Hydraulic Brake Circuit

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .

NOTE: **The pressure bleeding equipment must be the diaphragm type. The rubber diaphragm between the air supply and the brake fluid prevents air, moisture, oil, and other contaminants from entering the hydraulic system.**

5. Following the brake pressure bleeder manufacturer's instructions, fill the brake pressure bleeder with GM approved brake fluid from a clean, sealed brake fluid container.
6. Install the appropriate master cylinder reservoir adapter and connect the brake pressure bleeder.
7. Charge the brake pressure bleeder air tank to 170-200 kPa/1.7-2.0 bar (25-30 psi), or as recommended by the brake pressure bleeder manufacturer's instructions.
8. Open the brake pressure bleeder fluid tank valve to allow pressurized brake fluid to enter the brake hydraulic system.

NOTE: **Any brake fluid leaks identified require repair prior to completing this procedure.**

9. Wait approximately 30 seconds, then inspect the entire hydraulic brake system for external brake fluid leaks.
10. Install a proper box-end wrench onto the wheel hydraulic circuit bleeder valve which has been serviced.
11. Install a transparent hose over the end of the bleeder valve.
12. Submerge the open end of the transparent hose into a transparent container partially filled with brake fluid from a clean, sealed brake fluid container.
13. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
14. Allow fluid to flow until air bubbles stop flowing from the bleeder.
15. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.

NOTE: **The brake reservoir may have residual pressure after the bleeding operation is complete. Wrap a clean shop towel around the bleeder adapter and all hose connections before disconnecting the pressure bleeding equipment to prevent brake fluid from contacting and damaging**

vehicle components and painted surfaces.

16. Close the brake pressure bleeder fluid tank valve then disconnect the brake pressure bleeder from the master cylinder reservoir bleeder adapter.
17. Remove the master cylinder reservoir bleeder adapter from the master cylinder reservoir.
18. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
19. Slowly press and release the brake pedal. Observe the brake pedal feel.
20. If the brake pedal feels spongy, perform the Bleeding the Complete Brake Hydraulic System procedure:
21. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

NOTE: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

22. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

Bleeding the Complete Brake Hydraulic System

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .
5. If the master cylinder was replaced, the master cylinder must be bench bled. Refer to **Master Cylinder Bench Bleeding**.
6. If the brake pipes have been removed from the master cylinder, the following steps must be performed.
 1. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe fitting from the front port of the brake master cylinder.
 2. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder. Capture and properly dispose of the brake fluid in an approved container.
 3. Install the front brake pipe fitting to the front port of the brake master cylinder and tighten the fitting.
 4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
 5. Loosen the front brake pipe fitting from the front port of the brake master cylinder to purge air from the master cylinder port.
 6. Tighten the front brake pipe fitting, then have the assistant slowly release the brake pedal.
 7. Wait 15 seconds, then repeat steps 6.4-6.6 until all air is purged from the front brake pipe fitting of the front port of the master cylinder.
 8. After all air is purged from the front port of the brake master cylinder, tighten the front master cylinder brake pipe fitting. Refer to **Fastener Tightening Specifications**.

9. With the front brake pipe fitting installed securely to the front port of the brake master cylinder, loosen and separate the rear brake pipe fitting from the rear port of the brake master cylinder.
 10. Repeat steps 6.2-6.7 for the rear port of the brake master cylinder.
 11. After all air is purged from the rear port of the brake master cylinder, tighten the rear master cylinder brake pipe fitting. Refer to **Fastener Tightening Specifications**.
 12. Slowly press and release the brake pedal. Observe the brake pedal feel.
 13. If the brake pedal feels spongy, proceed to step 7.
 14. If the brake pedal feels firm, proceed to step 24.
7. If the brake pipes have been removed from the brake pressure modulator valve (BPMV) assembly, if equipped, or the brake proportion valve assembly, if equipped, air must be purged from each port of the respective assembly beginning with the feed pipes from the master cylinder.
1. Loosen and separate one of the master cylinder brake pipe fittings from the inlet port of the assembly to be bled.
 2. Allow a small amount of brake fluid to gravity bleed from the open port of the assembly. Capture and properly dispose of the brake fluid in an approved container.
 3. Install the brake pipe fitting and to the inlet port of the assembly and tighten securely.
 4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
 5. Loosen the same brake pipe fitting to purge air from the open port of the assembly.
 6. Tighten the brake pipe fitting, then have the assistant slowly release the brake pedal.
 7. Wait 15 seconds, then repeat steps 7.4-7.6 until all air is purged from the brake pipe fitting of the assembly.
 8. Repeat steps 7.1-7.7 for all of the remaining ports of the assembly.
 9. After bleeding each port of the assembly, tighten all of the brake pipe fittings on the assembly. Refer to **Fastener Tightening Specifications**.
 10. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.
 11. Slowly press and release the brake pedal. Observe the brake pedal feel.
 12. If the brake pedal feels spongy, proceed to step 8.
 13. If the brake pedal feels firm, proceed to step 24.

NOTE: **The pressure bleeding equipment must be the diaphragm type. The rubber diaphragm between the air supply and the brake fluid prevents air, moisture, oil, and other contaminants from entering the hydraulic system.**

8. Following the brake pressure bleeder manufacturer's instructions, fill the brake pressure bleeder with GM approved brake fluid from a clean, sealed brake fluid container.
9. Install the appropriate master cylinder reservoir adapter and connect the brake pressure bleeder.
10. Charge the brake pressure bleeder air tank to 170-200 kPa/1.7-2.0 bar (25-30 psi), or as recommended by the brake pressure bleeder manufacturer's instructions.
11. Open the brake pressure bleeder fluid tank valve to allow pressurized brake fluid to enter the brake hydraulic system.

NOTE: **Any brake fluid leaks identified require repair prior to completing this procedure.**

12. Wait approximately 30 seconds, then inspect the entire hydraulic brake system for external brake fluid leaks.
13. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
14. Install a transparent hose over the end of the bleeder valve.
15. Submerge the open end of the transparent hose into a transparent container partially filled with GM approved brake fluid from a clean, sealed brake fluid container.
16. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the brake pedal.
17. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
18. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
19. Wait 15 seconds, then repeat steps 11-13 until all air is purged from the wheel hydraulic circuit.
20. Tighten the RIGHT REAR hydraulic wheel circuit bleeder valve securely.
21. Install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve, then repeat steps 9-14.
22. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14.
23. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14.
24. After completing the final wheel hydraulic circuit bleeding procedure, tighten all of the wheel hydraulic circuit bleeder valves and install the bleeder valve dust caps.
25. Close the brake pressure bleeder fluid tank valve.

NOTE: **The brake reservoir may have residual pressure after the bleeding operation is complete. Wrap a clean shop towel around the bleeder adapter and all hose connections before disconnecting the pressure bleeding equipment to prevent brake fluid from contacting and damaging vehicle components and painted surfaces.**

26. Remove the brake pressure bleeding equipment from the vehicle.
27. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .
28. Slowly press and release the brake pedal. Observe the brake pedal feel.
29. If the brake pedal feels spongy, perform the following procedure.
 1. If equipped with antilock brakes, install a scan tool and perform the **Antilock Brake System Automated Bleed** to remove air which may be trapped in the BPMV.
 2. Inspect the hydraulic brake system for external leaks. Refer to **Brake System External Leak Inspection**.
 3. Repeat the Bleeding the Complete Brake Hydraulic System procedure.
30. If the brake pedal still feels spongy, pressure bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)** .

31. Turn the ignition switch ON with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

NOTE: **DO NOT allow the vehicle to be driven until the brake system is diagnosed and repaired.**

32. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

HYDRAULIC BRAKE SYSTEM FLUSHING

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

CAUTION: Only use products that comply with GM specifications and check manufacturer information respectively. We recommend the use of GM genuine products. Instructions must be followed at all times. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:
 - Fluid separation, indicating 2 types of fluid are present; a substance other than the recommended brake fluid has been introduced into the brake hydraulic system
 - Swirled appearance-oil-based substance
 - Layered appearance- silicone-based substance
 - Fluid discoloration, indicating the presence of moisture or particles that have been introduced into the brake hydraulic system
 - Cloudy appearance - moisture
 - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust
2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating brake fluid contamination.
3. If the brake fluid WAS contaminated with an oil-based or a silicone-based substance, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following:
 1. Remove ALL of the following components listed from the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Replacement (LEA, LUK)** or **Master Cylinder Replacement (LTG)**
 - **Front Brake Hose Replacement (J60, J61)**, **Front Brake Hose Replacement (J64)**
 - **Rear Brake Hose Replacement**
 - **Front Brake Caliper Replacement (J60, J61)** , **Front Brake Caliper Replacement (J64)**
 - **Rear Brake Caliper Replacement**
 - **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement**
2. Clean out all the hydraulic brake pipes using denatured alcohol, or equivalent.
 3. Dry the brake pipes using non-lubricated, filtered air.
 4. Repair or replace ALL of the following components listed and install them to the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Replacement (LEA, LUK)** or **Master Cylinder Replacement (LTG)** -
Also perform the following:

Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to **Master Cylinder Reservoir Replacement**.

Replace the brake master cylinder reservoir cap diaphragm.

- **Front Brake Hose Replacement (J60, J61)**, **Front Brake Hose Replacement (J64)**
 - **Rear Brake Hose Replacement**
 - **Front Brake Caliper Replacement (J60, J61)** , **Front Brake Caliper Replacement (J64)**
 - **Rear Brake Caliper Replacement**
 - **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement**
4. If the brake fluid was NOT contaminated with an oil-based or a silicone-based substance, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed the moisture or particles to enter the hydraulic system.
 5. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .
 6. Pressure bleed the hydraulic brake system; begin the procedure with the pressure bleeder reservoir filled to the maximum-fill level with the correct brake fluid as indicated. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.

POWER VACUUM BRAKE BOOSTER REPLACEMENT

Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Without draining the coolant and without disconnecting the hoses, remove and position aside the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LUK)** , **Radiator Surge Tank Replacement (LTG)** .
3. Disconnect the brake pedal position sensor electrical connector. Refer to **Brake Pedal Position Sensor Replacement** .

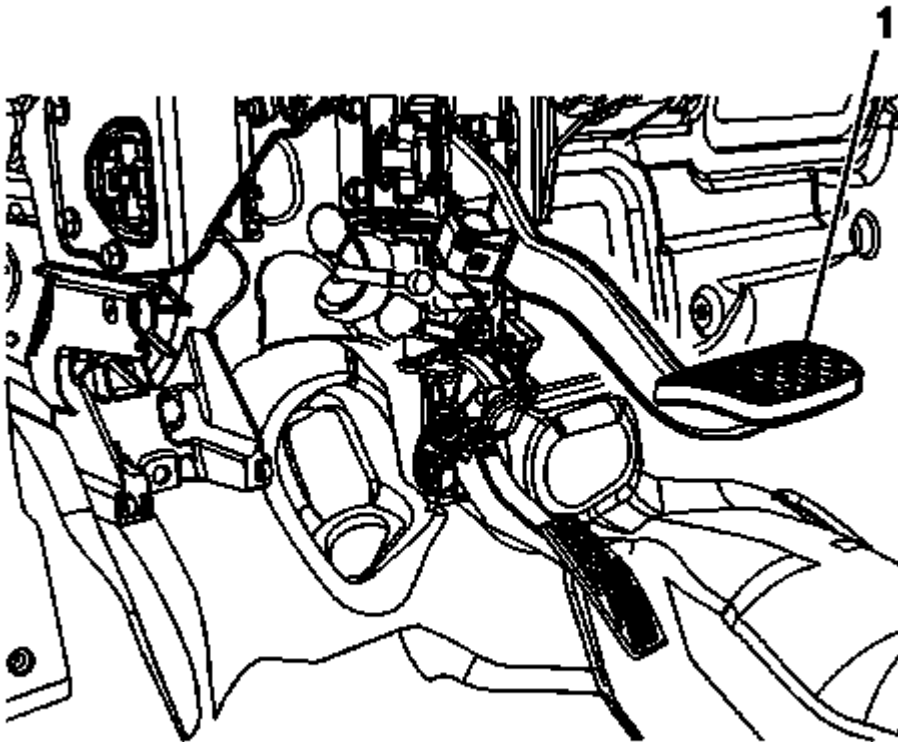


Fig. 52: Brake Pedal
Courtesy of GENERAL MOTORS COMPANY

4. Release the brake pedal (1) from the power vacuum brake booster pushrod by lifting the pedal upward.

NOTE: **Do not reuse the brake pedal retainer.**

5. Remove and discard the brake pedal retainer.
6. Disconnect the power vacuum brake booster vacuum sensor electrical connector.

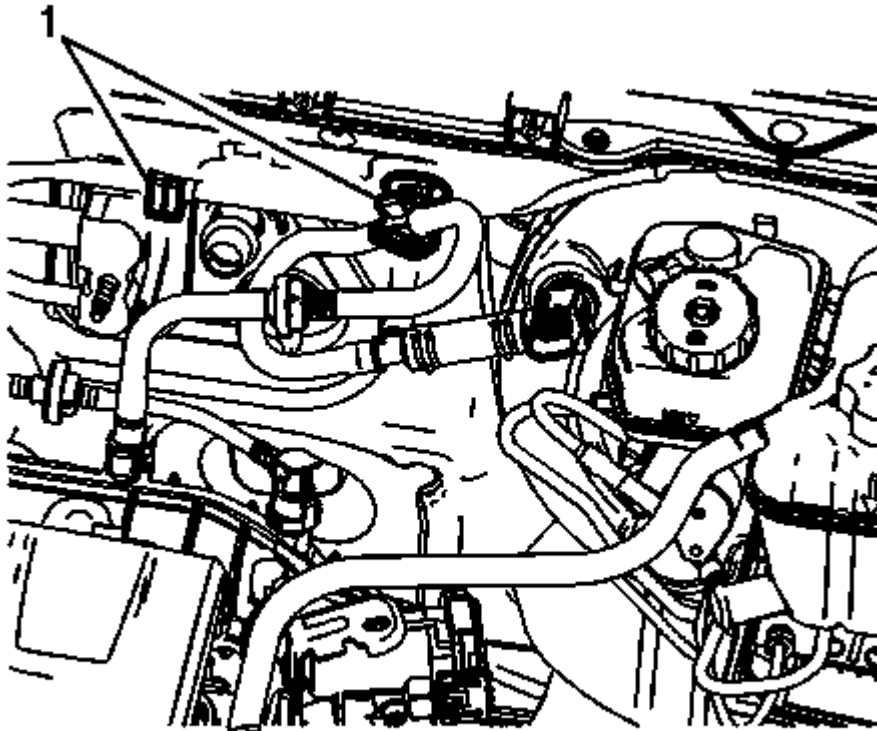


Fig. 53: Power Brake Booster Vacuum Rear Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Release the power brake booster vacuum inlet pipe from the retainers (1) on the dash panel.

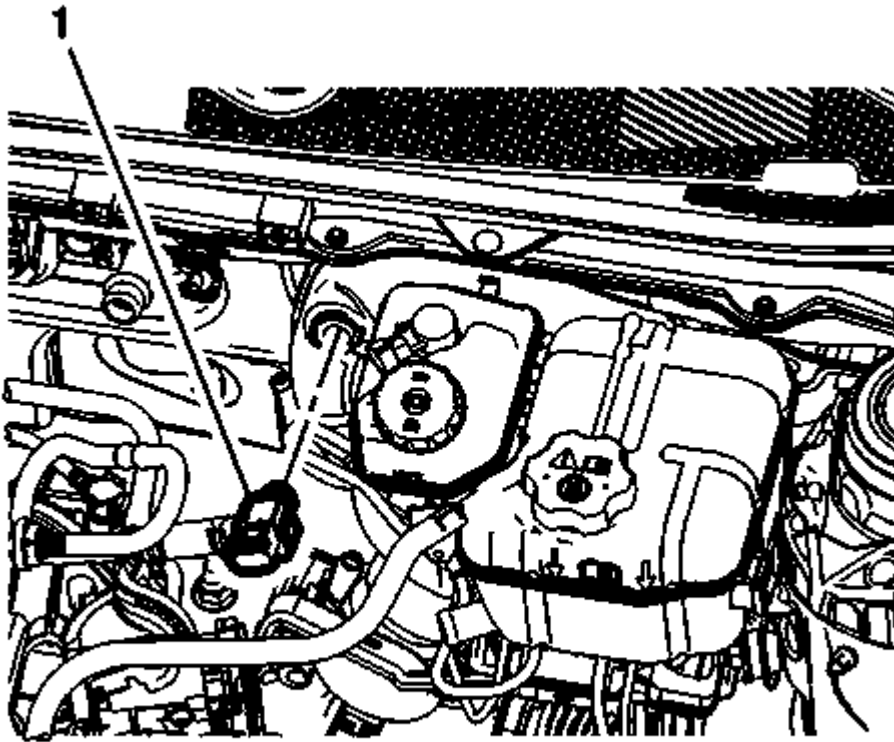


Fig. 54: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power brake booster vacuum sensor (1) from the power vacuum brake booster and position aside.
9. Disconnect the brake fluid level indicator switch electrical connector.
10. Remove the electronic brake and traction control module (EBTCM). Refer to **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement** .

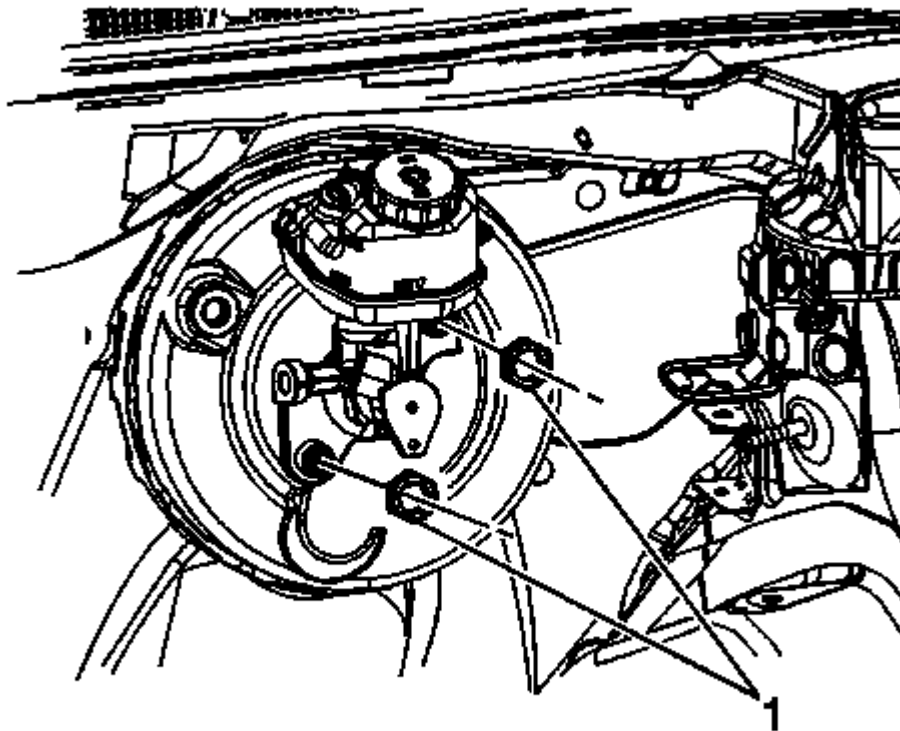


Fig. 55: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

11. Remove the master cylinder nuts (1).

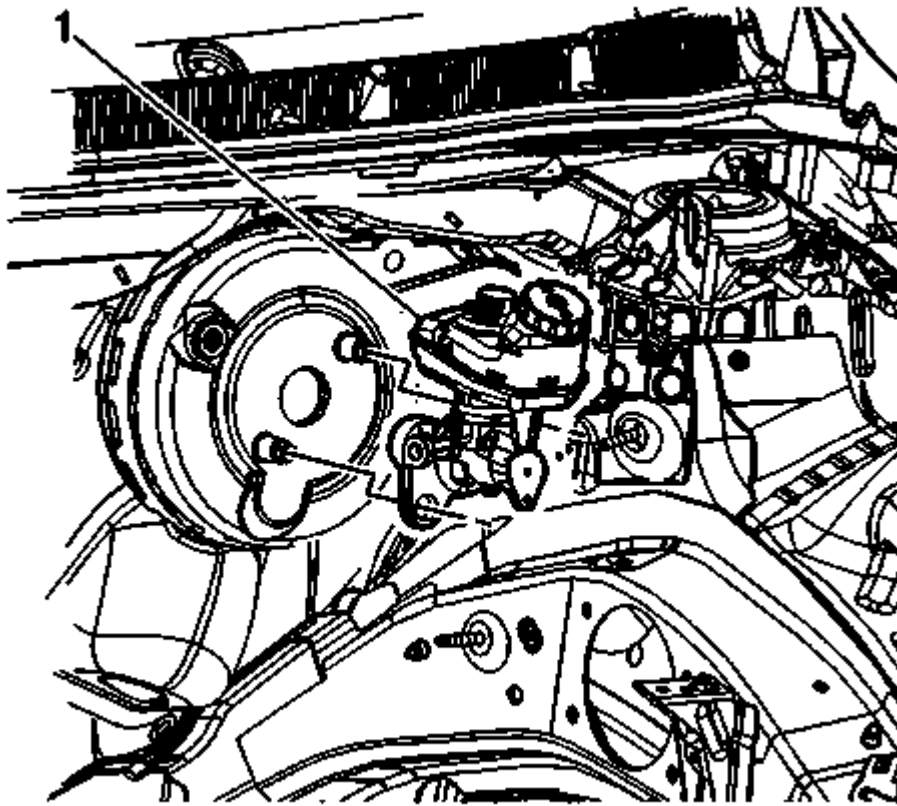


Fig. 56: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

12. Remove the master cylinder (1).
13. Inspect the master cylinder O-ring seal for damage and replace, if necessary.

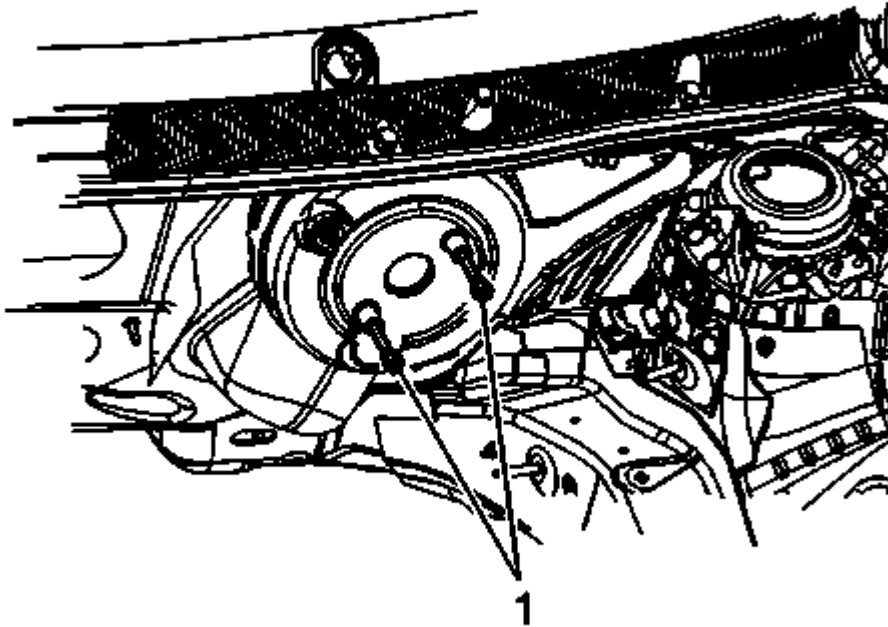


Fig. 57: Power Vacuum Brake Booster Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Completely loosen the power vacuum brake booster bolts (1).

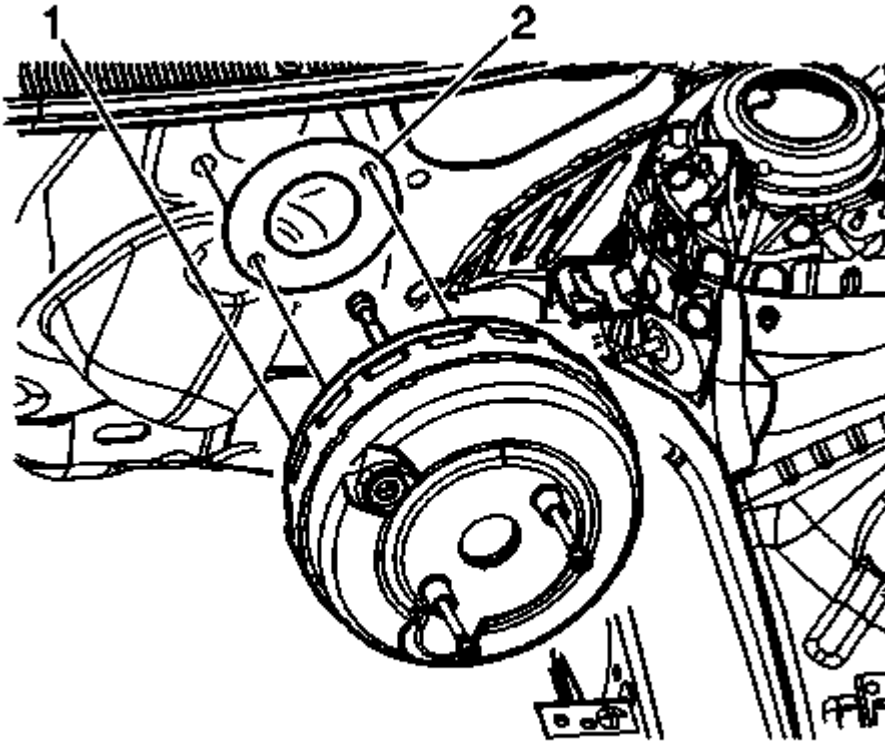


Fig. 58: Power Vacuum Brake Booster
Courtesy of GENERAL MOTORS COMPANY

15. Remove the power vacuum brake booster (1).
16. Inspect the power vacuum brake booster gasket (2) for damage and replace, if necessary.

Installation Procedure

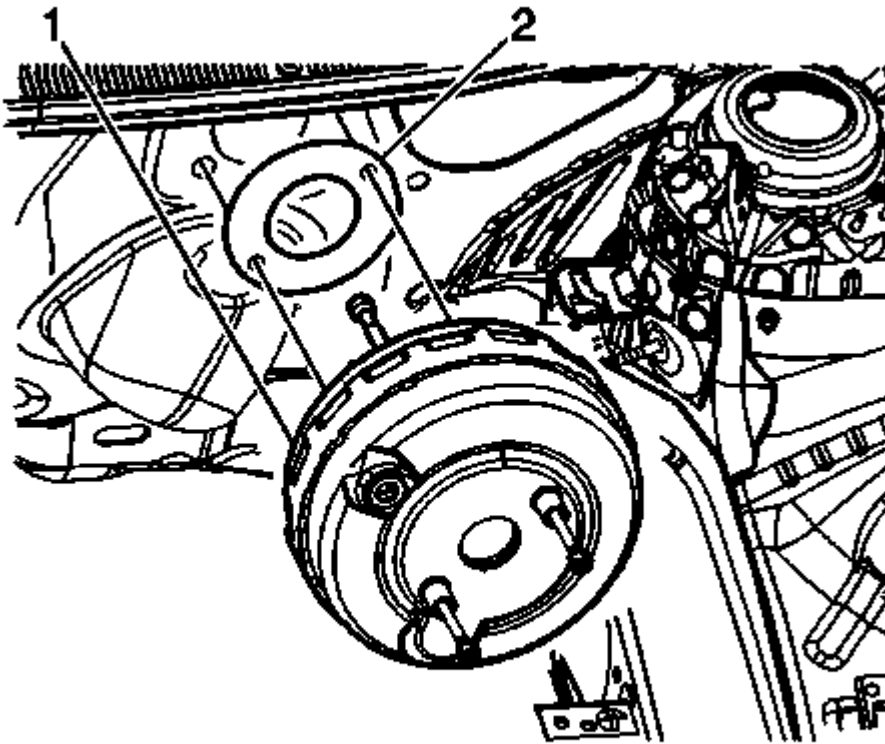


Fig. 59: Power Vacuum Brake Booster
Courtesy of GENERAL MOTORS COMPANY

1. Install the power vacuum brake booster (1) and gasket (2).

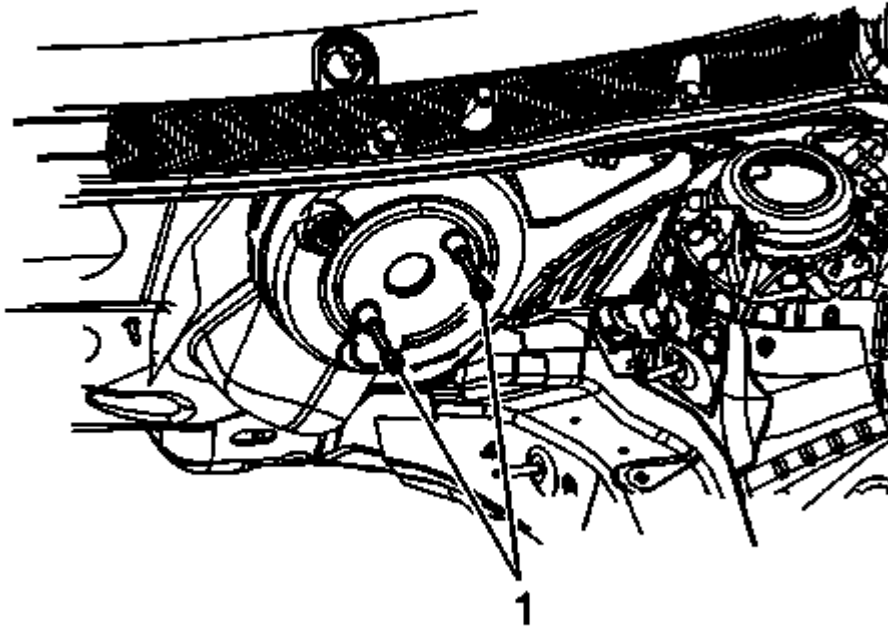


Fig. 60: Power Vacuum Brake Booster Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Do not over tighten the power vacuum brake booster bolts. If the power vacuum brake booster bolts are over tightened, the brake pedal may remain applied after a high pressure brake pedal application.

2. Install the power vacuum brake booster bolts (1) and tighten to 19 N.m (14 lb ft).

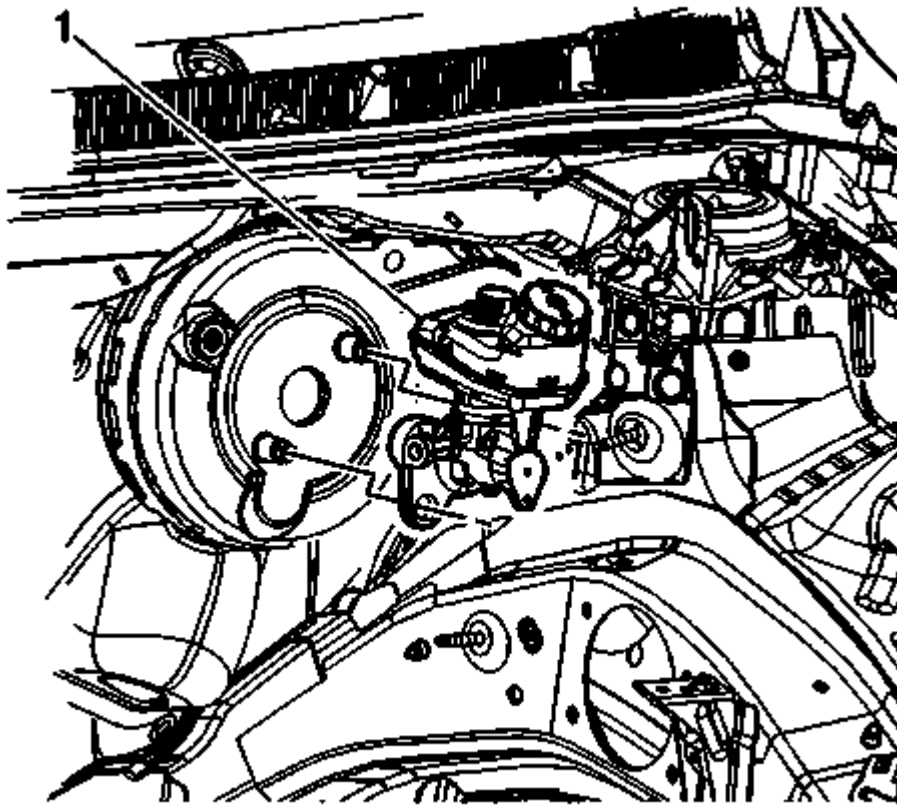


Fig. 61: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

3. Install the master cylinder (1) to the power vacuum brake booster.

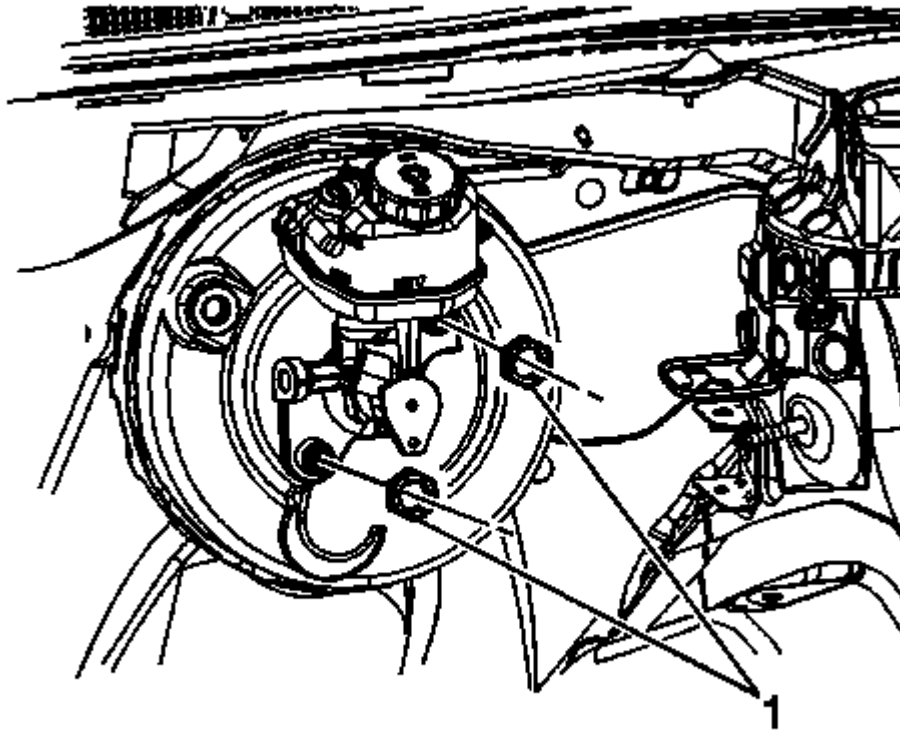


Fig. 62: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

4. Install the master cylinder nuts (1) and tighten to 50 N.m (37 lb ft).
5. Connect the brake fluid level indicator switch electrical connector.
6. Install the EBTCM. Refer to **Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement** .

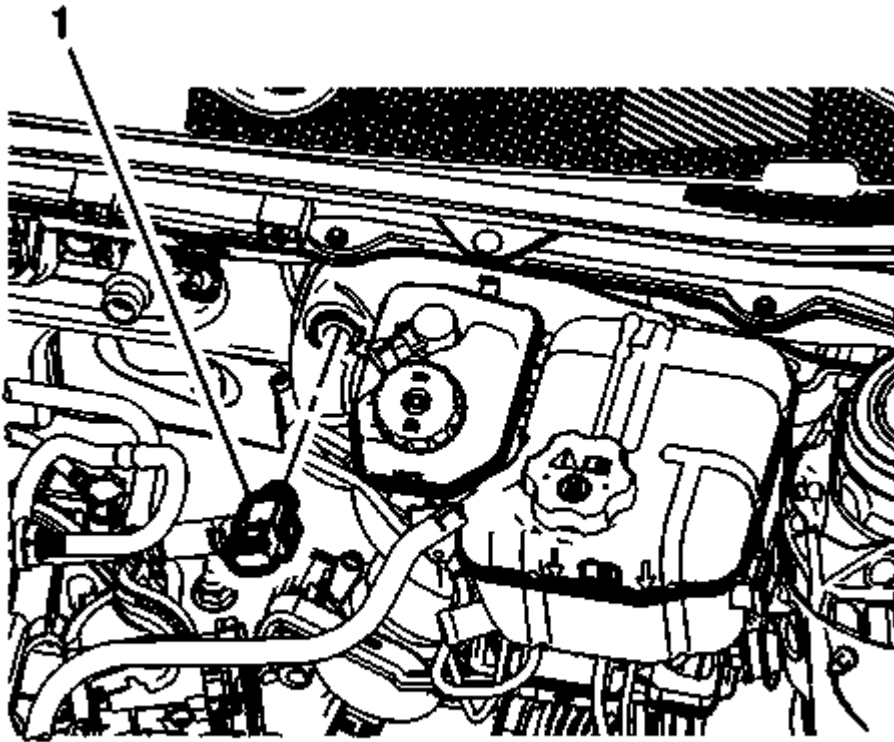


Fig. 63: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: A small amount of denatured alcohol may be used as a lubricant to assist the installation of the power brake booster vacuum sensor.

7. Install the power brake booster vacuum sensor (1) to the power vacuum brake booster.

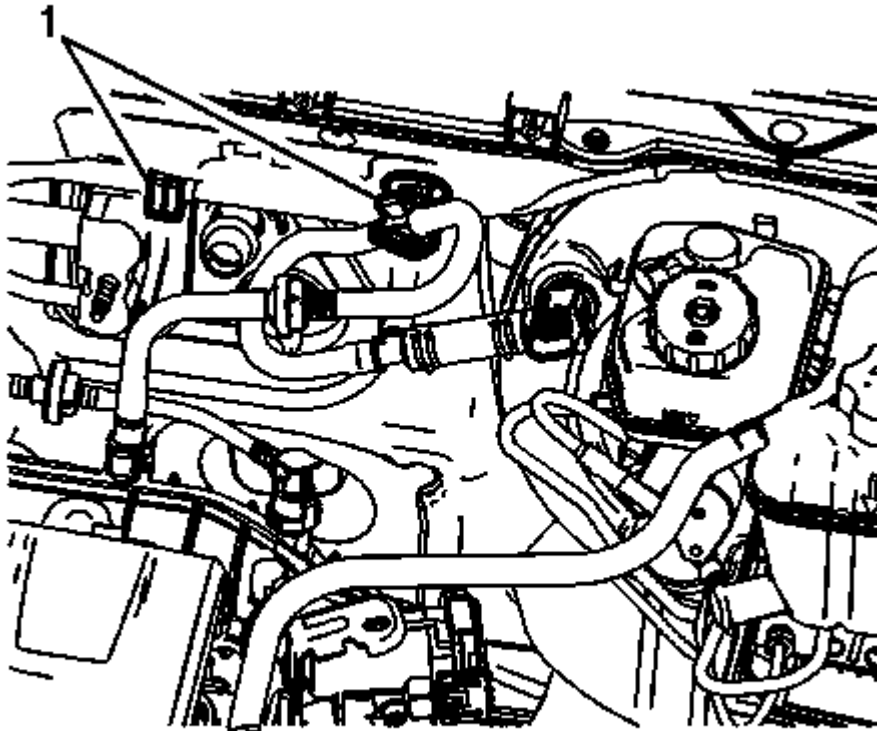


Fig. 64: Power Brake Booster Vacuum Rear Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Install the power brake booster vacuum inlet pipe to the retainers (1) on the dash panel.
9. Connect the power vacuum brake booster vacuum sensor electrical connector.

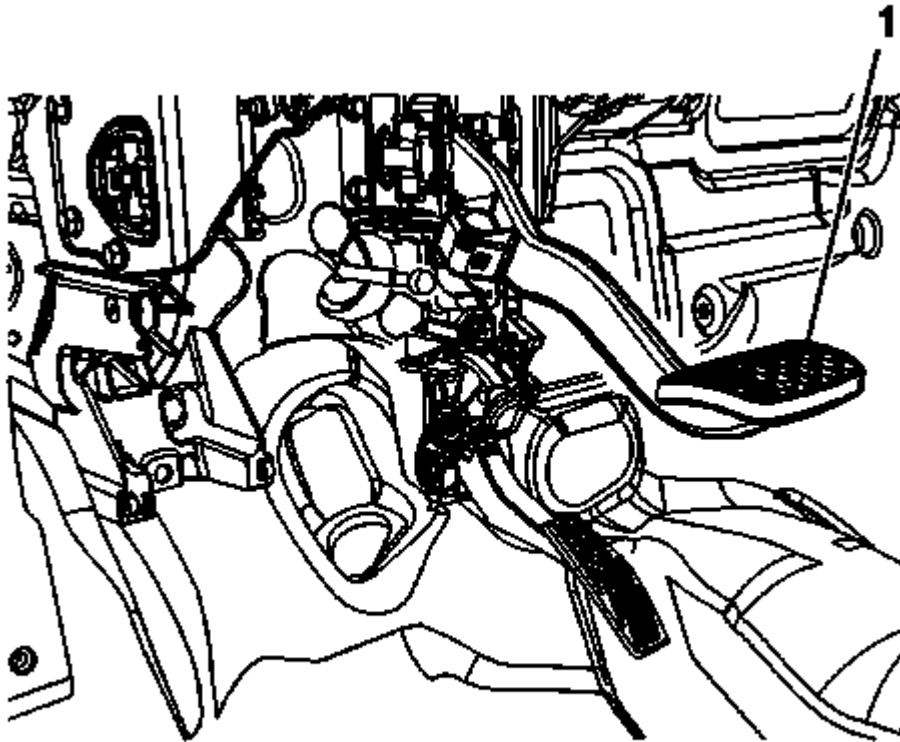


Fig. 65: Brake Pedal

Courtesy of GENERAL MOTORS COMPANY

NOTE: Install a new power vacuum brake booster pushrod retainer.

10. Install a new power vacuum brake booster pushrod retainer to the power vacuum brake booster pushrod.

NOTE: Ensure the power vacuum brake booster pushrod retainer is fully seated in the brake pedal arm.

11. Connect the power vacuum brake booster pushrod retainer (1) to the brake pedal.
12. Connect the brake pedal position sensor electrical connector. Refer to **Brake Pedal Position Sensor Replacement** .
13. Install the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LUK)** , **Radiator Surge Tank Replacement (LTG)** .

POWER BRAKE BOOSTER VACUUM SENSOR REPLACEMENT

Removal Procedure

1. Apply the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum

brake booster vacuum reserve.

2. Disconnect the power brake booster vacuum sensor electrical connector.

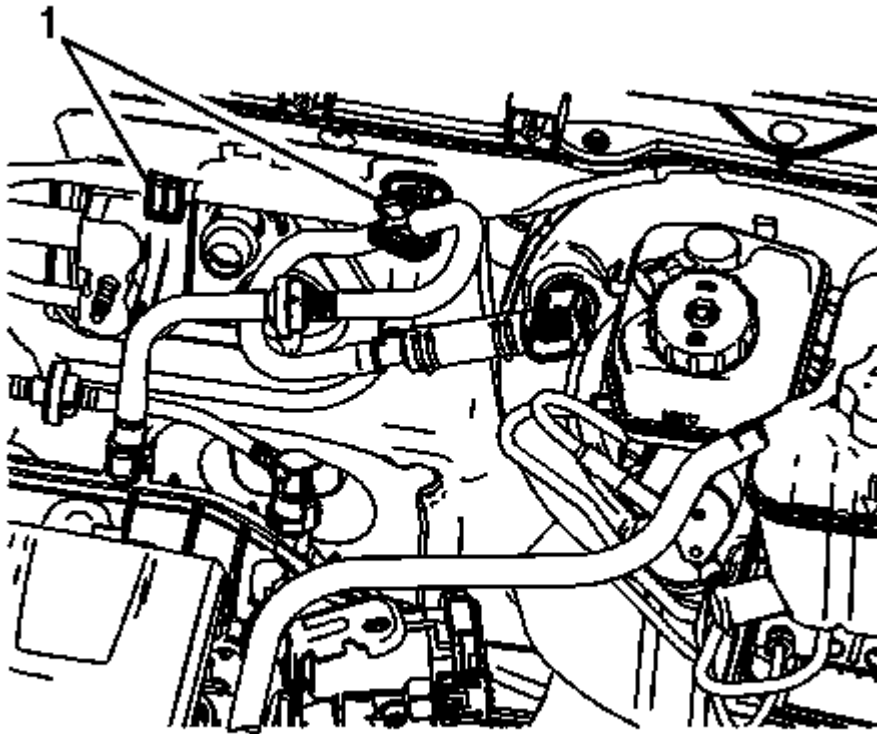


Fig. 66: Power Brake Booster Vacuum Rear Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Release the power brake booster vacuum rear pipe from the clips (1) on the vehicle front of dash.

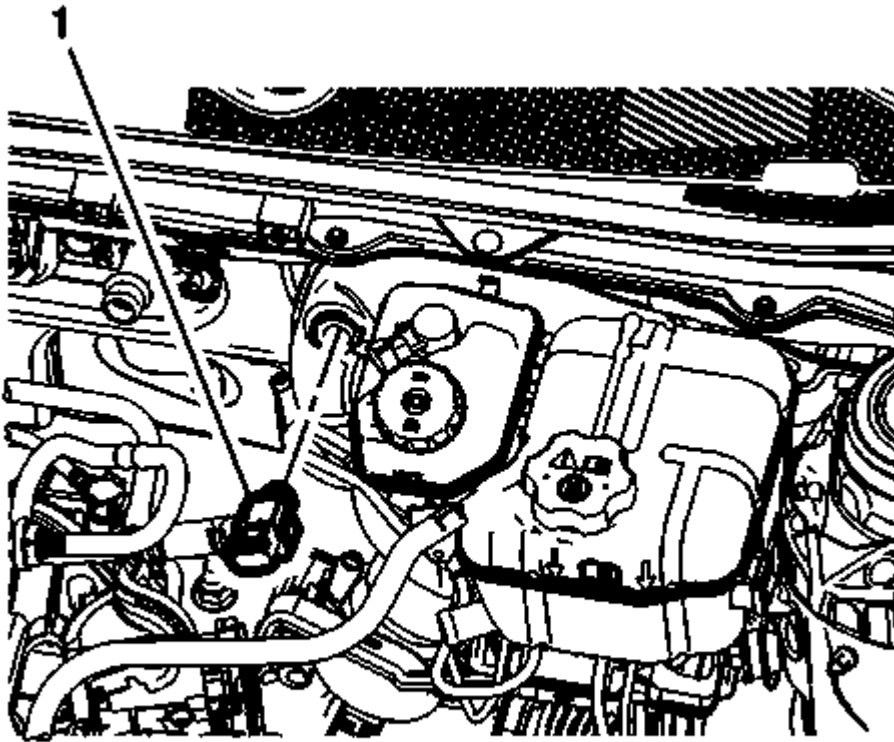


Fig. 67: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove the power brake booster vacuum sensor (1) from the power vacuum brake booster.

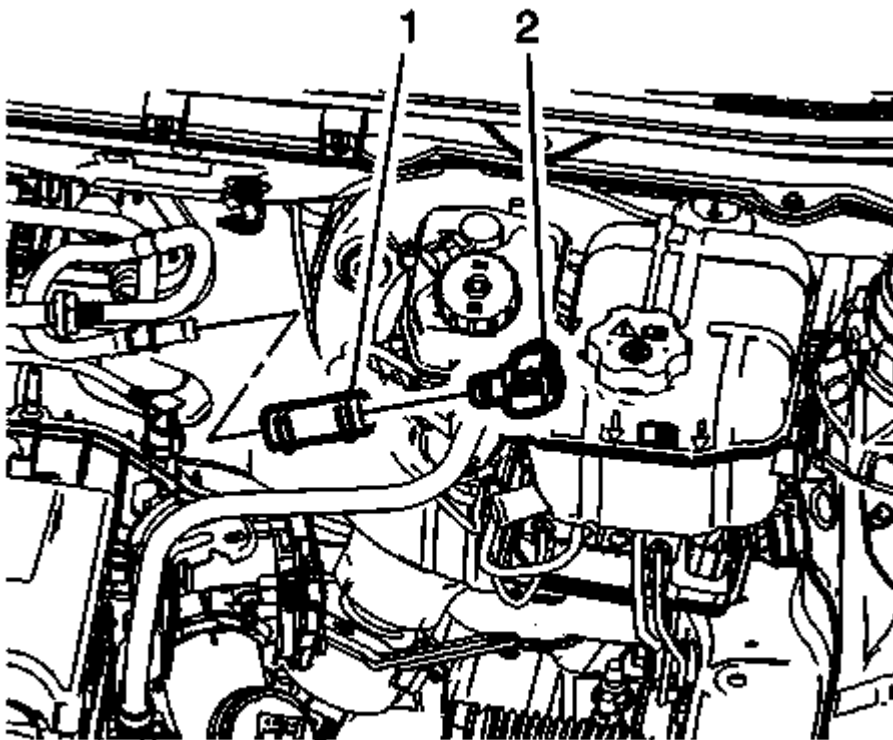


Fig. 68: Power Brake Booster Vacuum Rear Pipe Hose
Courtesy of GENERAL MOTORS COMPANY

5. Release the clamps and remove the power brake booster vacuum rear pipe hose (1) from the power brake booster vacuum sensor (2) and the power vacuum brake booster.

Installation Procedure

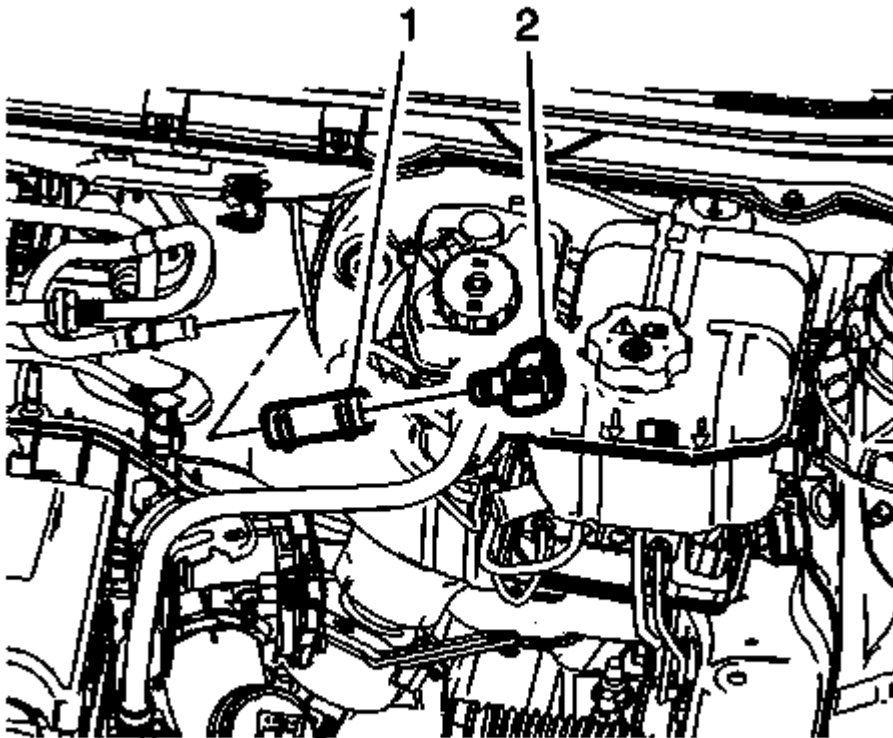


Fig. 69: Power Brake Booster Vacuum Rear Pipe Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install the power brake booster vacuum rear pipe hose (1) to the power brake booster vacuum rear pipe and secure the clamp.
2. Install the power brake booster vacuum sensor (2) to the power brake booster vacuum rear pipe and secure the clamp.

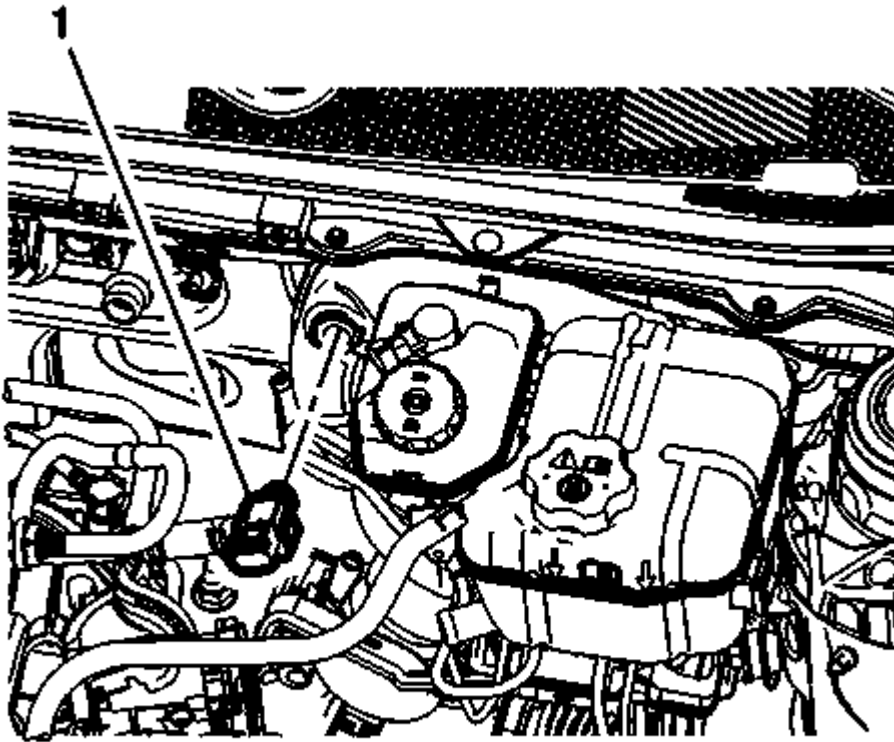


Fig. 70: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Install the power brake booster vacuum sensor (1) to the power vacuum brake booster.

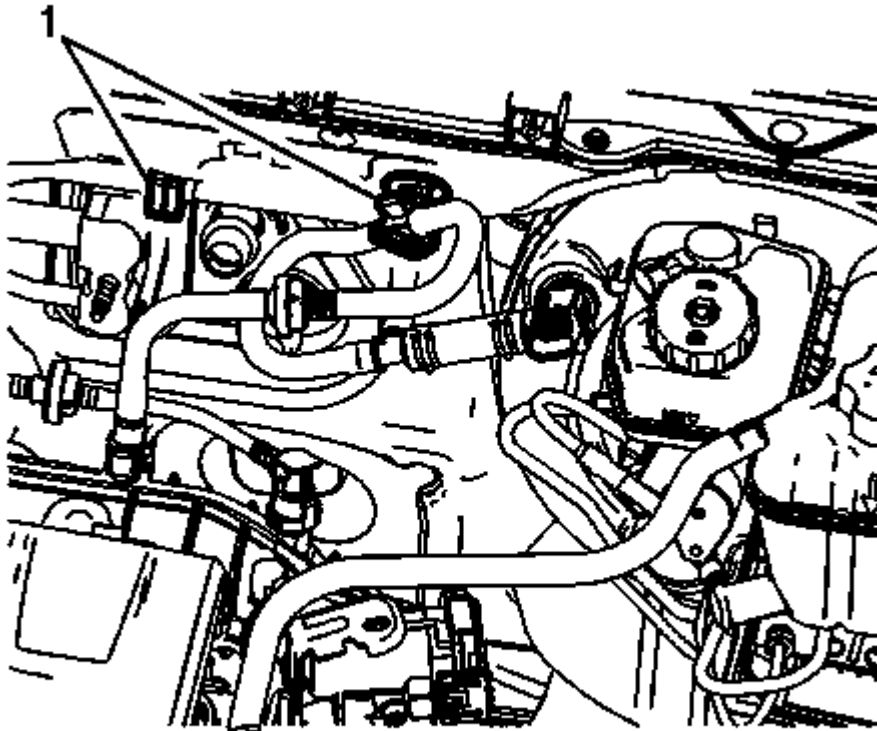


Fig. 71: Power Brake Booster Vacuum Rear Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Install the power brake booster vacuum rear pipe to the clips (1) on the vehicle front of dash.
5. Connect the power brake booster vacuum sensor electrical connector.

POWER BRAKE BOOSTER VACUUM PIPE REPLACEMENT (LTG)

Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.

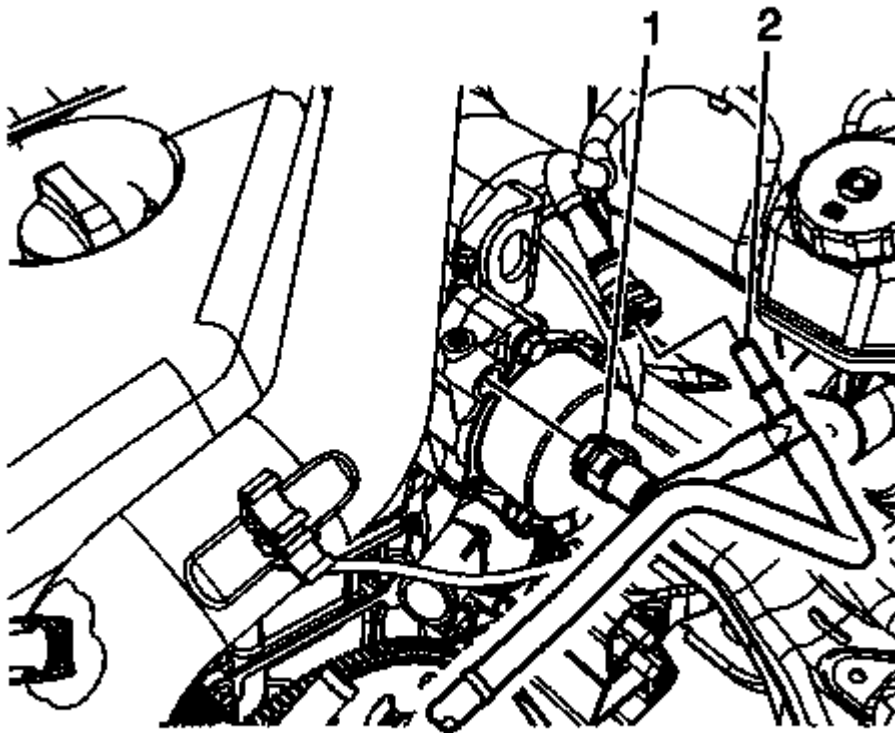


Fig. 72: Power Brake Booster Vacuum Pipe Quick Connection
Courtesy of GENERAL MOTORS COMPANY

2. Release the power brake booster vacuum pipe quick connect (1) from the power brake booster pump.
3. Remove the power brake booster vacuum pipe (2) by releasing the power brake booster vacuum rear pipe quick connect.

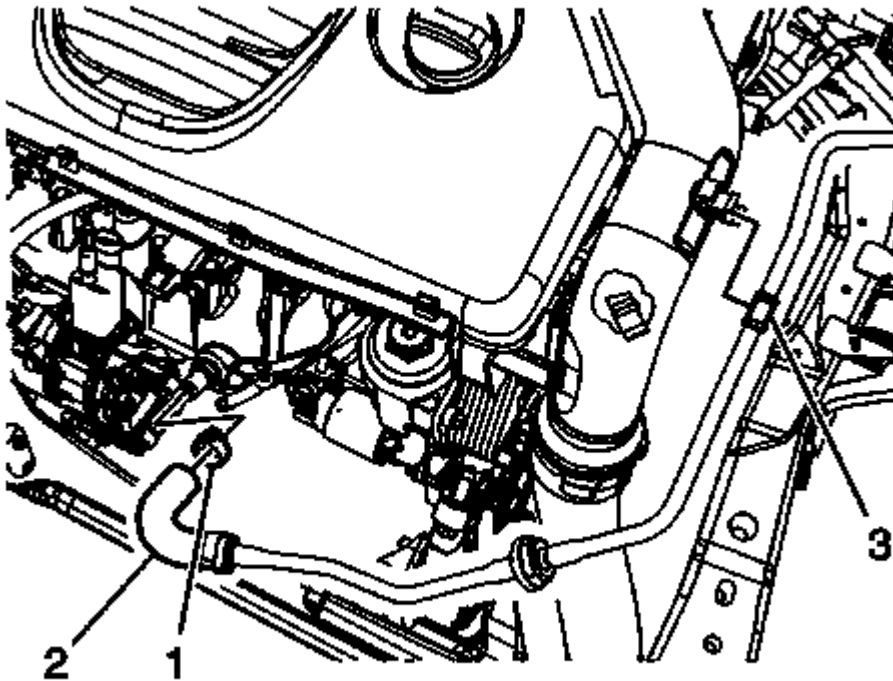


Fig. 73: Power Brake Booster Vacuum Pipe Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the power brake booster vacuum pipe clamp (1).
5. Remove the power brake booster vacuum pipe hose (2) from the vacuum port on the intake manifold.
6. Release the power brake booster vacuum pipe (3) from the retainer on the charge air cooler intake pipe.
7. Remove the power brake booster vacuum pipe assembly.

Installation Procedure

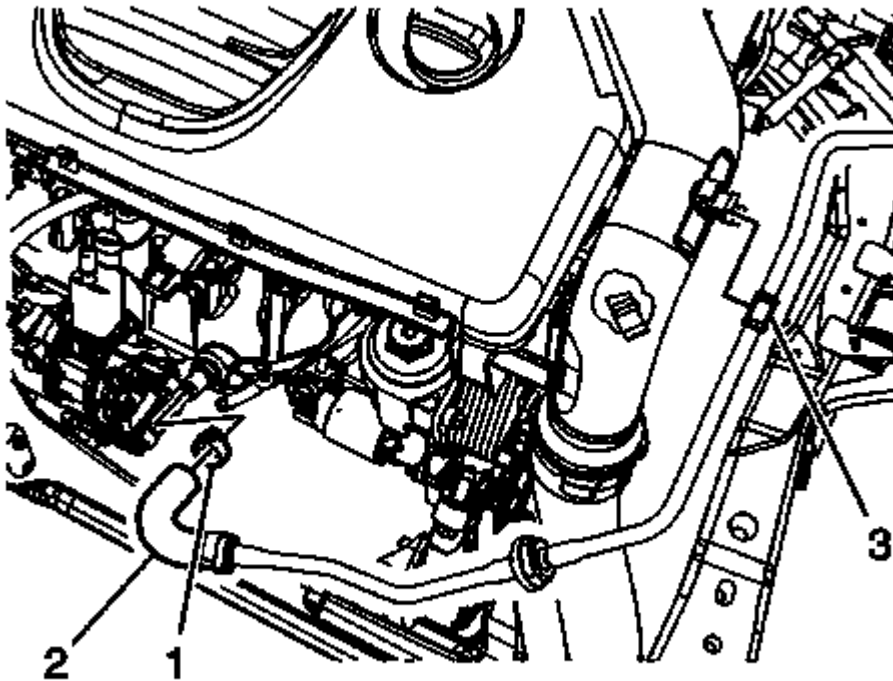


Fig. 74: Power Brake Booster Vacuum Pipe Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install a new power brake booster vacuum pipe clamp (1) to the power brake booster vacuum pipe hose (2).
2. Install the power brake booster vacuum pipe hose to the vacuum port on the intake manifold.
3. Secure the power brake booster vacuum pipe clamp.
4. Install the power brake booster vacuum pipe (3) to the retainer on the charge air cooler intake pipe.

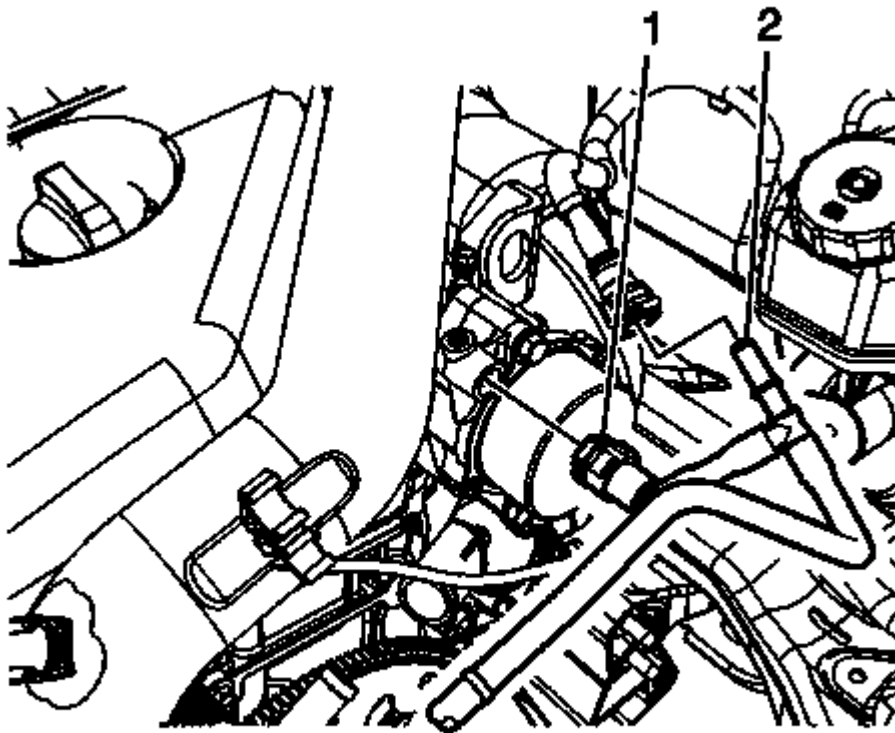


Fig. 75: Power Brake Booster Vacuum Pipe Quick Connection
Courtesy of GENERAL MOTORS COMPANY

5. Install the power brake booster vacuum pipe quick connect (1) to the power brake booster pump.
6. Install the power brake booster vacuum pipe (2) to the power brake booster vacuum rear pipe quick connect.

POWER BRAKE BOOSTER VACUUM PIPE REPLACEMENT (LUK)

Removal Procedure

1. Turn the engine OFF.

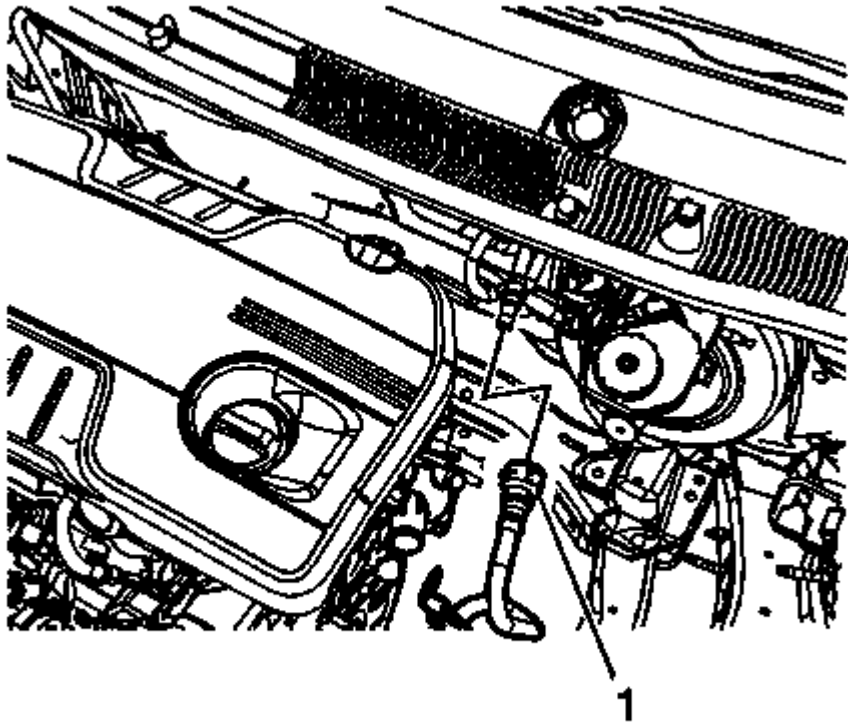


Fig. 76: Power Brake Booster Vacuum Pipe Quick Connect
Courtesy of GENERAL MOTORS COMPANY

2. Apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
4. Disconnect the power brake booster vacuum pipe quick connect (1).

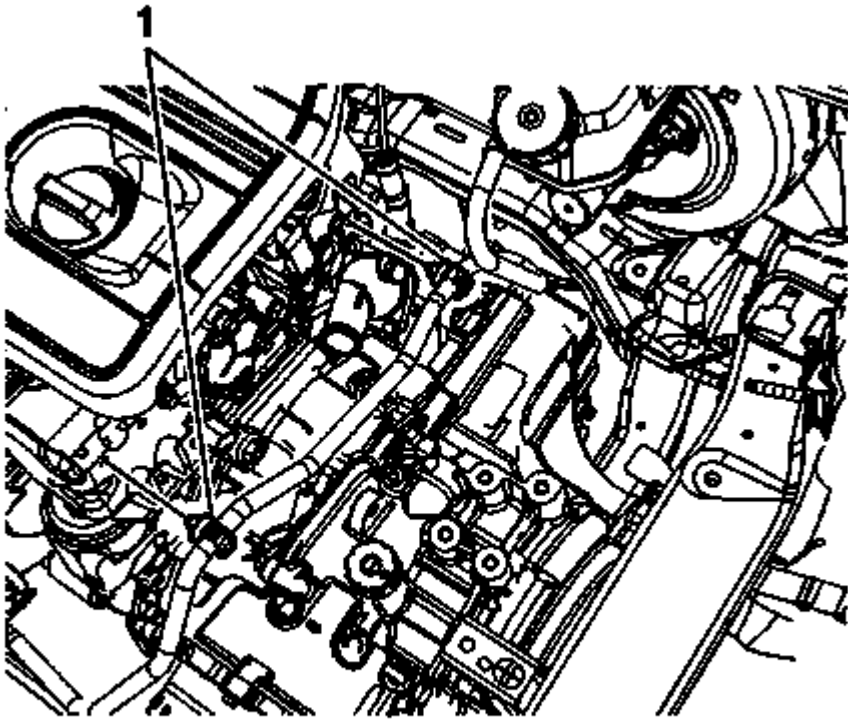


Fig. 77: Power Brake Booster Vacuum Pipe Clips
Courtesy of GENERAL MOTORS COMPANY

5. Release the power brake booster vacuum pipe clips (1).

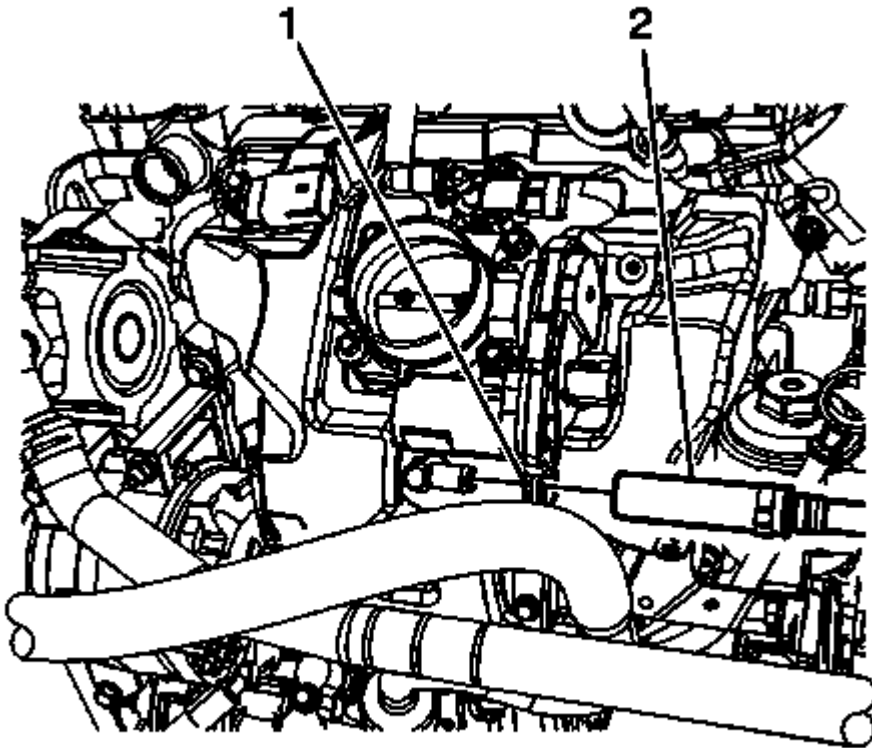


Fig. 78: Power Brake Booster Vacuum Pipe And Clamp
Courtesy of GENERAL MOTORS COMPANY

6. Release the clamp (1) and remove the power brake booster vacuum pipe (2) from the intake manifold vacuum port.

Installation Procedure

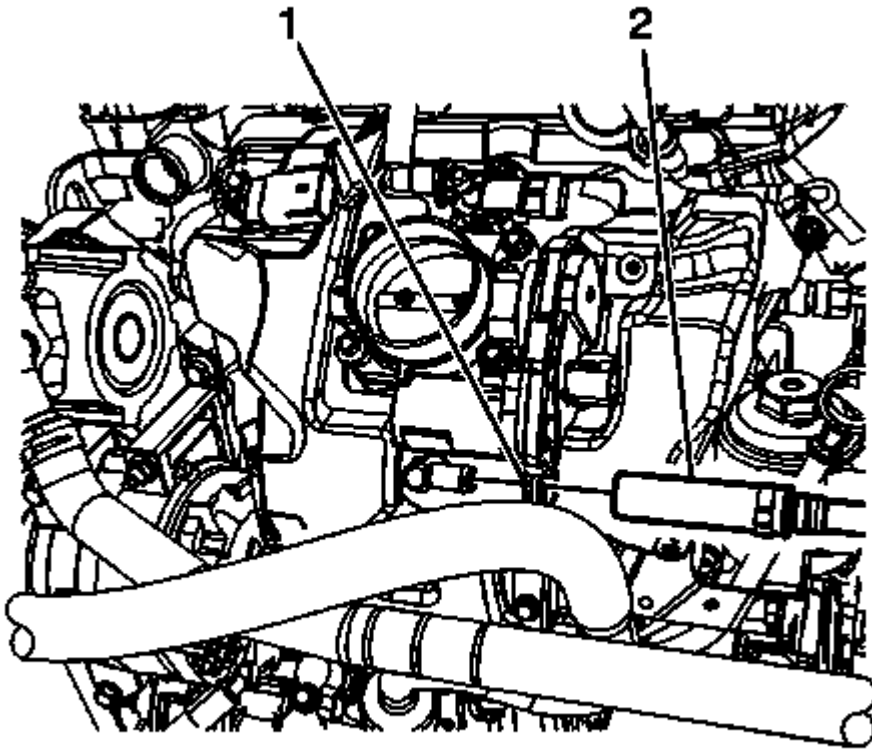


Fig. 79: Power Brake Booster Vacuum Pipe And Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install the clamp (1) and install the power brake booster vacuum pipe (2) to the intake manifold vacuum port.

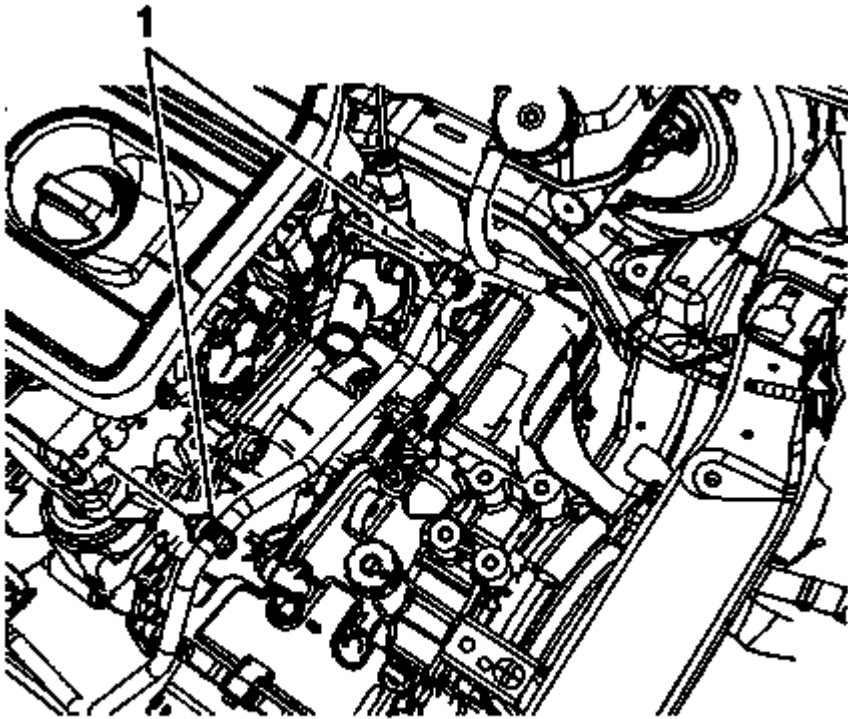


Fig. 80: Power Brake Booster Vacuum Pipe Clips
Courtesy of GENERAL MOTORS COMPANY

2. Install the power brake booster vacuum pipe to the clips (1).

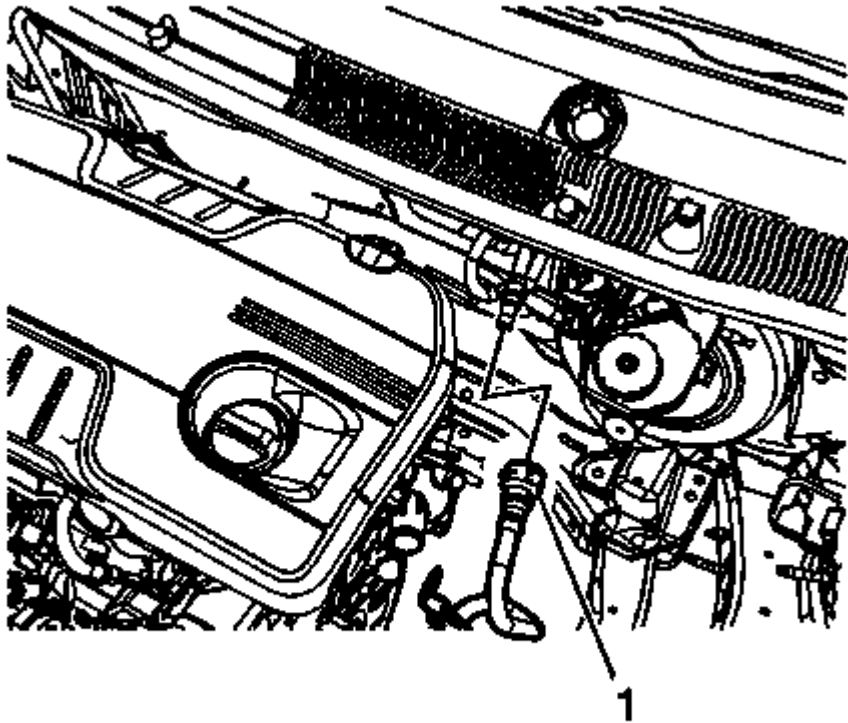


Fig. 81: Power Brake Booster Vacuum Pipe Quick Connect
Courtesy of GENERAL MOTORS COMPANY

3. Connect the power brake booster vacuum pipe quick connect (1).
4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

POWER BRAKE BOOSTER VACUUM REAR PIPE REPLACEMENT (LTG)

Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.

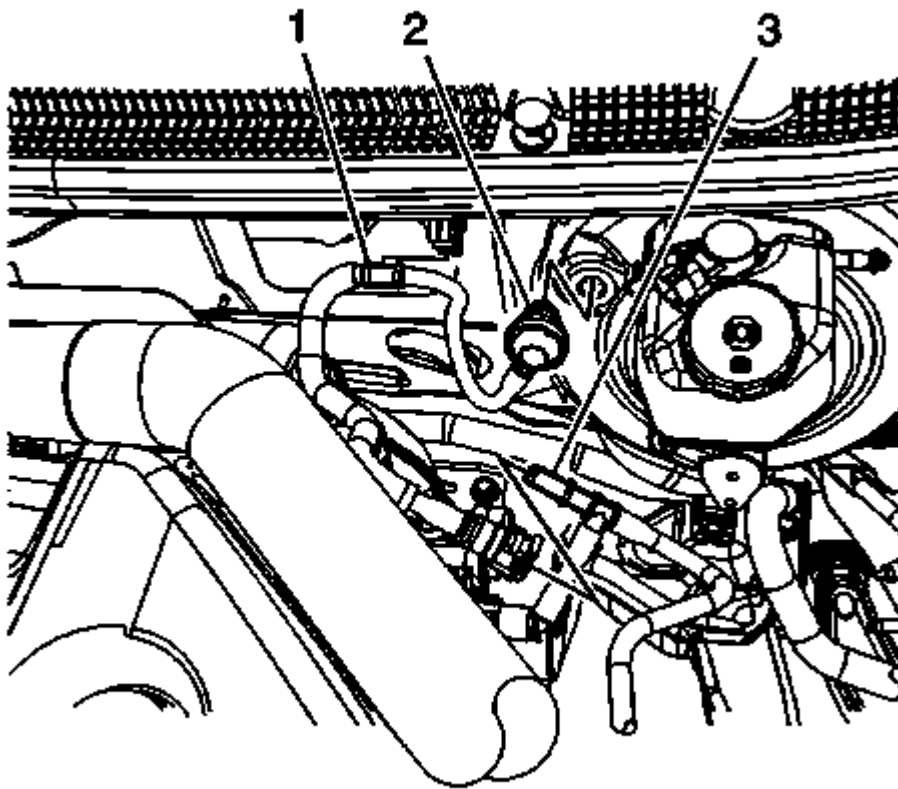


Fig. 82: Power Brake Booster Vacuum Rear Pipe Vacuum Check Valve
Courtesy of GENERAL MOTORS COMPANY

2. Release the power brake booster vacuum rear pipe (1) from the retainer.
3. Remove the power brake booster vacuum rear pipe vacuum check valve (2) from the power vacuum brake booster.
4. Release the power brake booster vacuum rear pipe quick connect and disconnect the power brake booster vacuum pipe (3).
5. Remove the power brake booster vacuum rear pipe assembly.

Installation Procedure

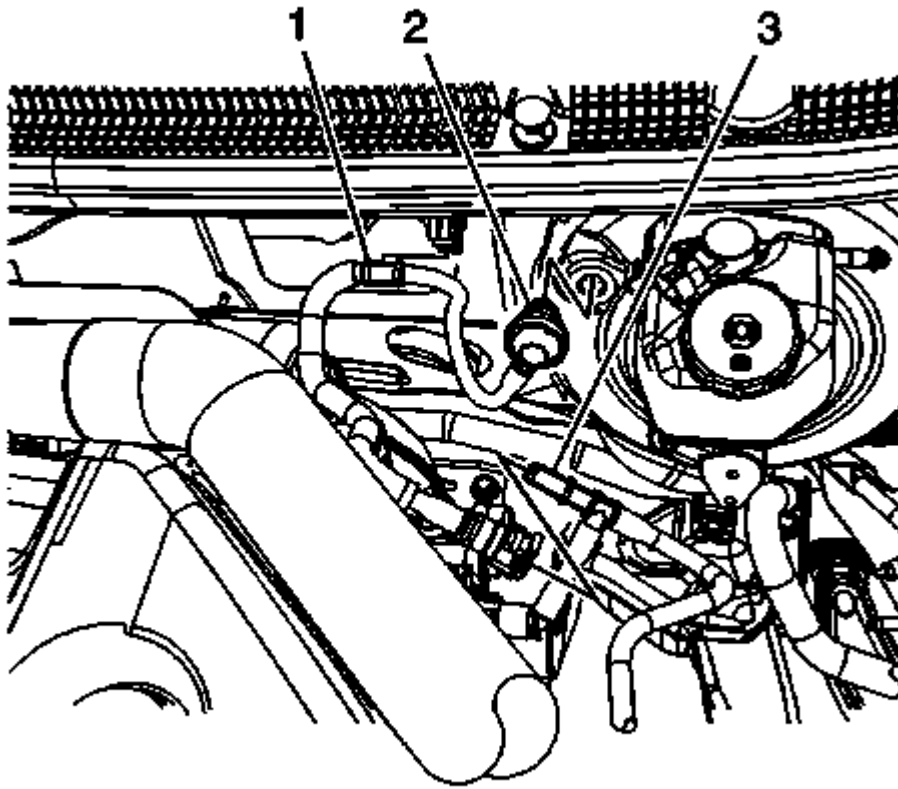


Fig. 83: Power Brake Booster Vacuum Rear Pipe Vacuum Check Valve
Courtesy of GENERAL MOTORS COMPANY

1. Install the power brake booster vacuum rear pipe (1) to the retainer.
2. Install the power brake booster vacuum rear pipe vacuum check valve (2) to the power vacuum brake booster.
3. Connect the power brake booster vacuum rear pipe quick connect to the power brake booster vacuum pipe (3).

POWER BRAKE BOOSTER VACUUM REAR PIPE REPLACEMENT (LUK)

Removal Procedure

1. Turn the ignition OFF.
2. Apply the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.

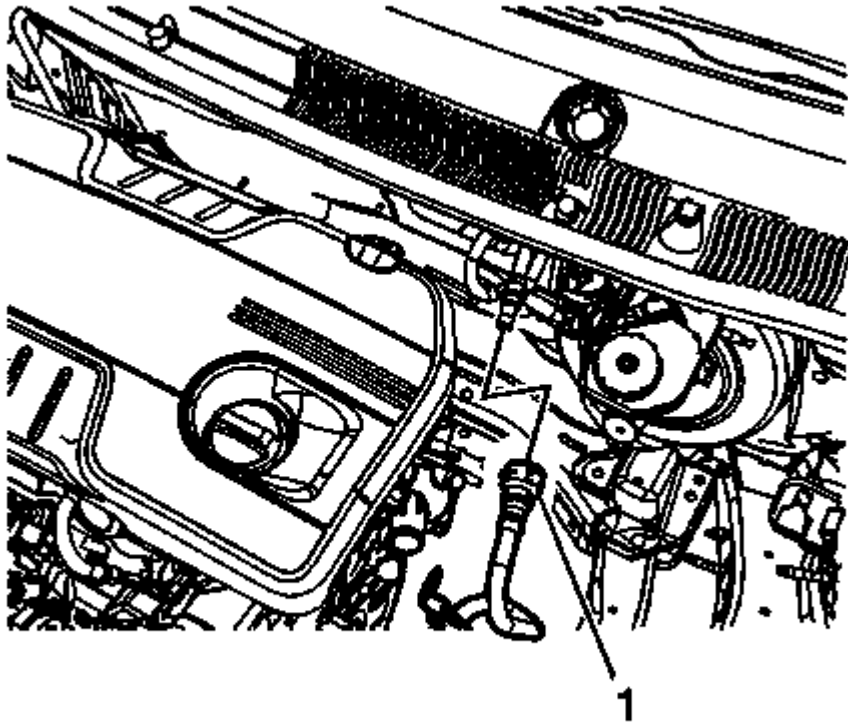


Fig. 84: Power Brake Booster Vacuum Pipe Quick Connect
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the power brake booster vacuum pipe quick connect (1).

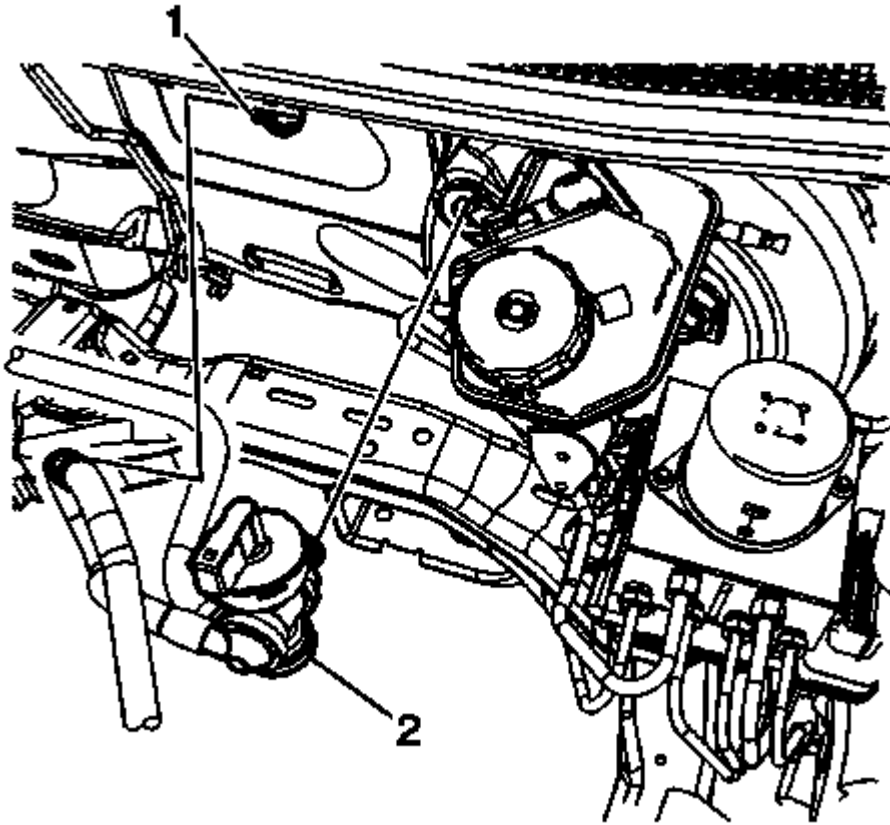


Fig. 85: Power Brake Booster Vacuum Rear Pipe Retainer & Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the power brake booster vacuum sensor electrical connector.
5. Release the power brake booster vacuum rear pipe from the retainer (1) on the dash panel.
6. Remove the power brake booster vacuum rear pipe vacuum sensor and check valve (2) from the power vacuum brake booster.

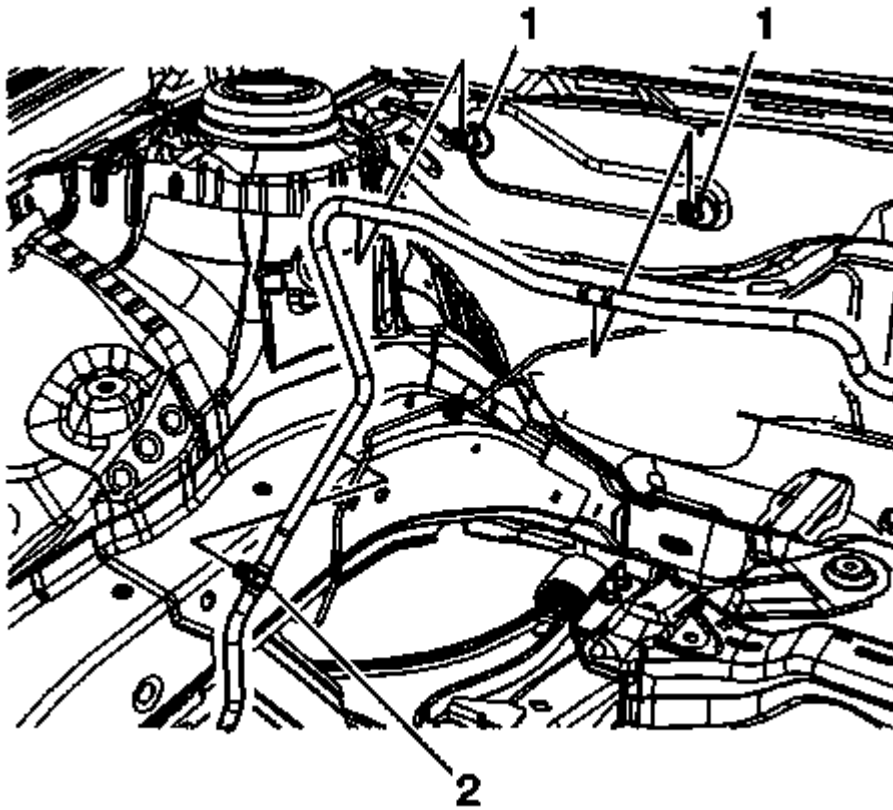


Fig. 86: Power Brake Booster Vacuum Rear Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Remove the power brake booster vacuum rear pipe from the retainers (1) on the dash panel.
8. Release the power brake booster vacuum rear pipe from the retainer (2) on the right front brake pipe.
9. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
10. Remove the right front wheelhouse front liner. Refer to **Front Wheelhouse Front Liner Replacement** .

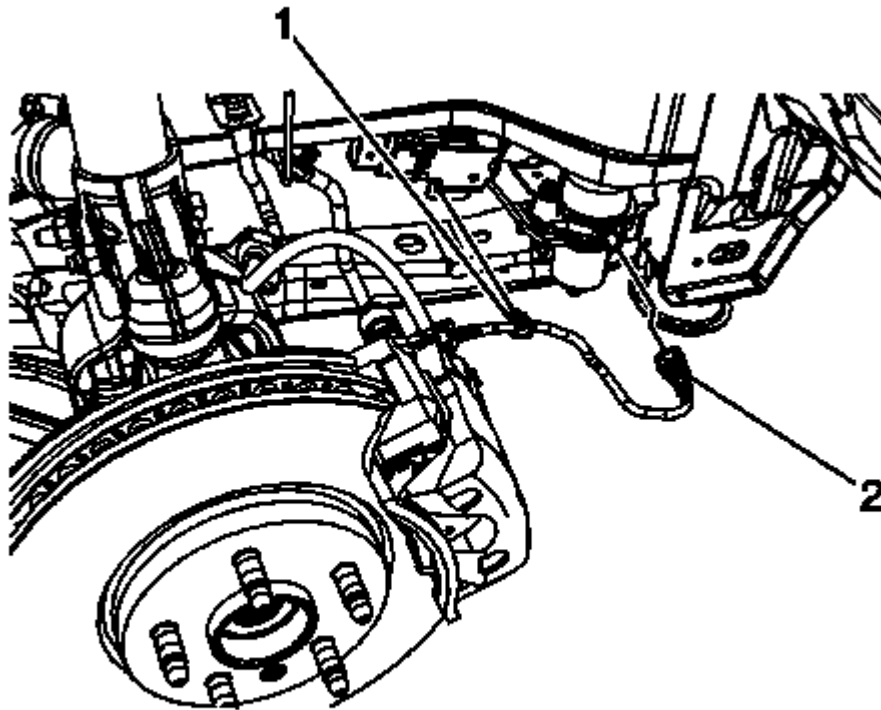


Fig. 87: Power Brake Booster Vacuum Rear Pipe Quick Connect And Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Release the power brake booster vacuum rear pipe retainer (1) from the power brake booster pump bracket.
12. Disconnect the power brake booster vacuum rear pipe quick connect (2).
13. Remove the power brake booster vacuum rear pipe from the vehicle.

Installation Procedure

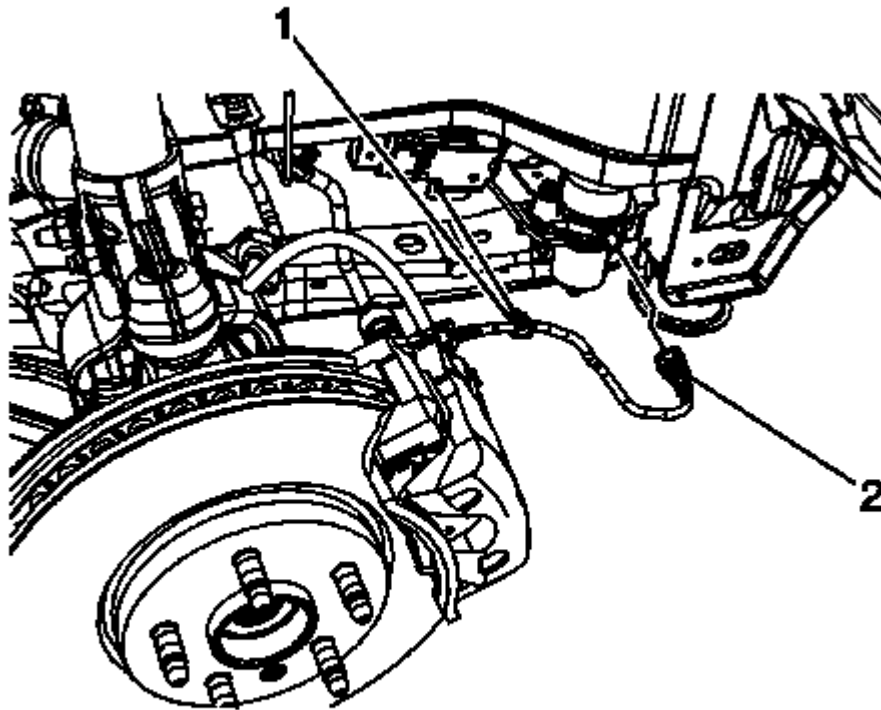


Fig. 88: Power Brake Booster Vacuum Rear Pipe Quick Connect And Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Position the power brake booster vacuum rear pipe to the vehicle.
2. Install the power brake booster vacuum rear pipe retainer (1) to the power brake booster pump bracket.
3. Connect the power brake booster vacuum rear pipe quick connect (2).
4. Install the right front wheelhouse front liner. Refer to **Front Wheelhouse Front Liner Replacement** .

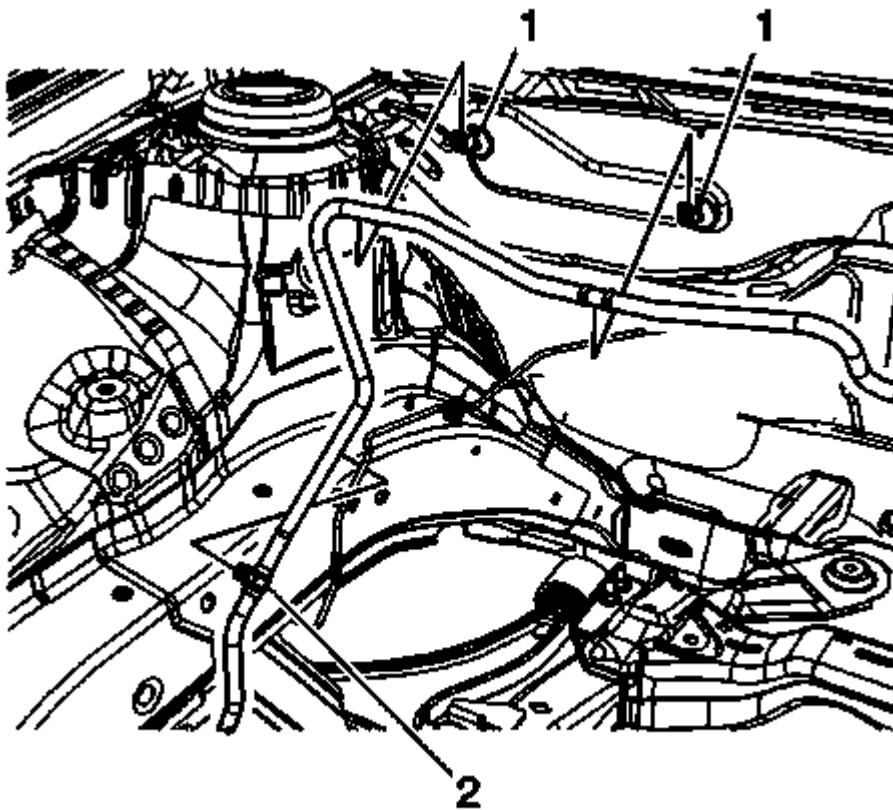


Fig. 89: Power Brake Booster Vacuum Rear Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

5. Install the power brake booster vacuum rear pipe to the retainers (1) on the dash panel.
6. Install the power brake booster vacuum rear pipe to the retainer (2) on the right front brake pipe.

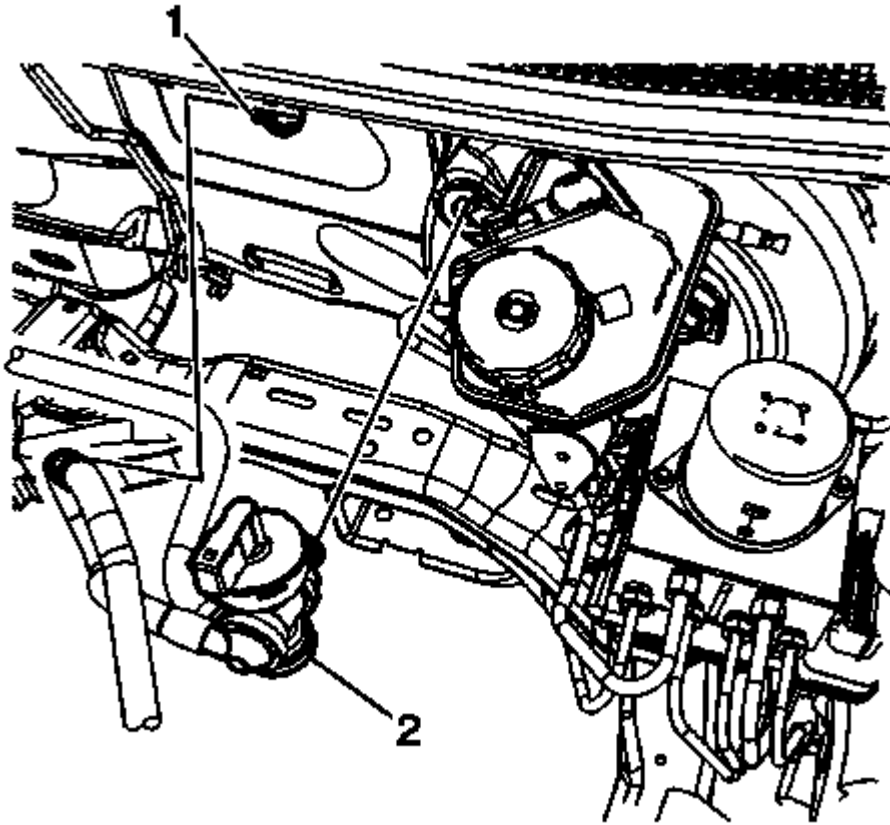


Fig. 90: Power Brake Booster Vacuum Rear Pipe Retainer & Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Install the power brake booster vacuum rear pipe to the retainer (1) on the dash panel.
8. Install the power brake booster vacuum rear pipe vacuum sensor and check valve (2) to the power vacuum brake booster.
9. Connect the power brake booster vacuum sensor electrical connector.

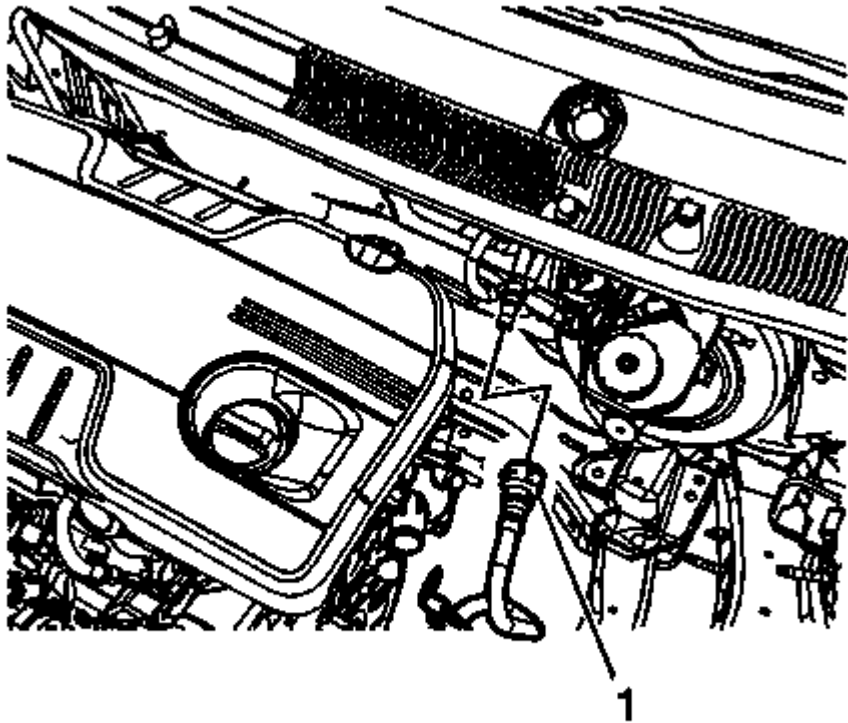


Fig. 91: Power Brake Booster Vacuum Pipe Quick Connect
Courtesy of GENERAL MOTORS COMPANY

10. Connect the power brake booster vacuum pipe quick connect (1).

POWER BRAKE BOOSTER PUMP REPLACEMENT (LTG)

Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.

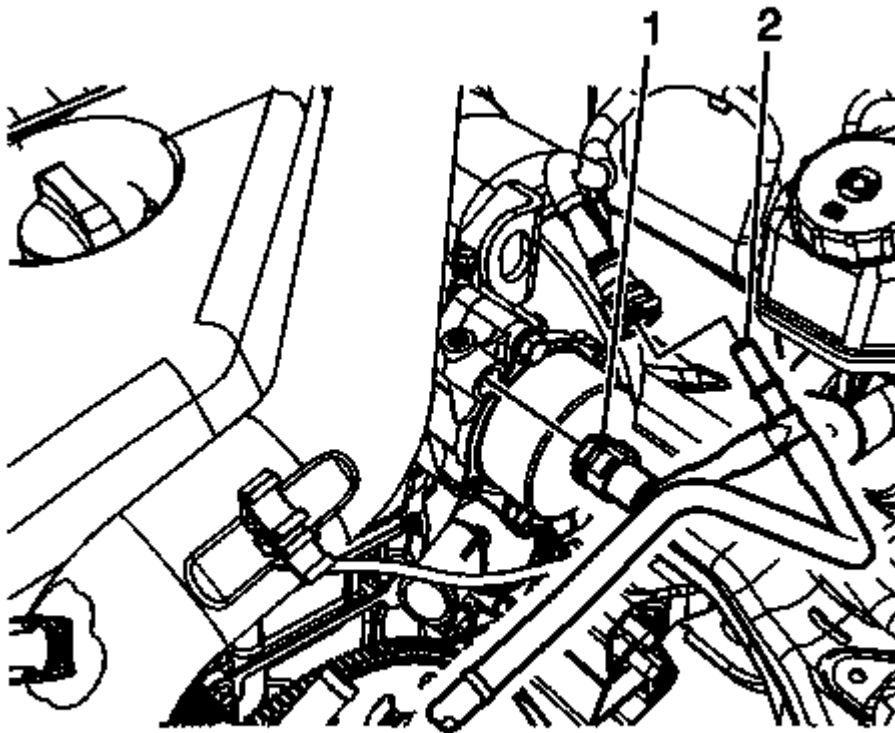


Fig. 92: Power Brake Booster Vacuum Pipe Quick Connection
Courtesy of GENERAL MOTORS COMPANY

2. Release the power brake booster vacuum pipe quick connect (1) from the power brake booster pump.
3. Remove the power brake booster vacuum pipe (2) by releasing the power brake booster vacuum rear pipe quick connect.
4. Release the power brake booster vacuum pipe from the retainer on the charge air cooler intake pipe.
5. Position the power brake booster vacuum pipe aside.

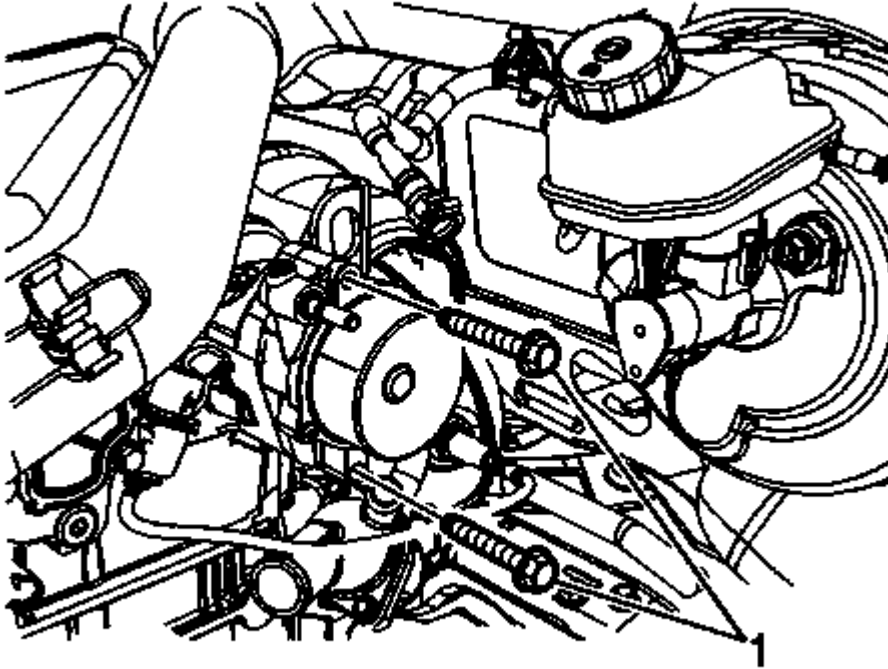


Fig. 93: Power Brake Booster Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the power brake booster pump bolts (1).

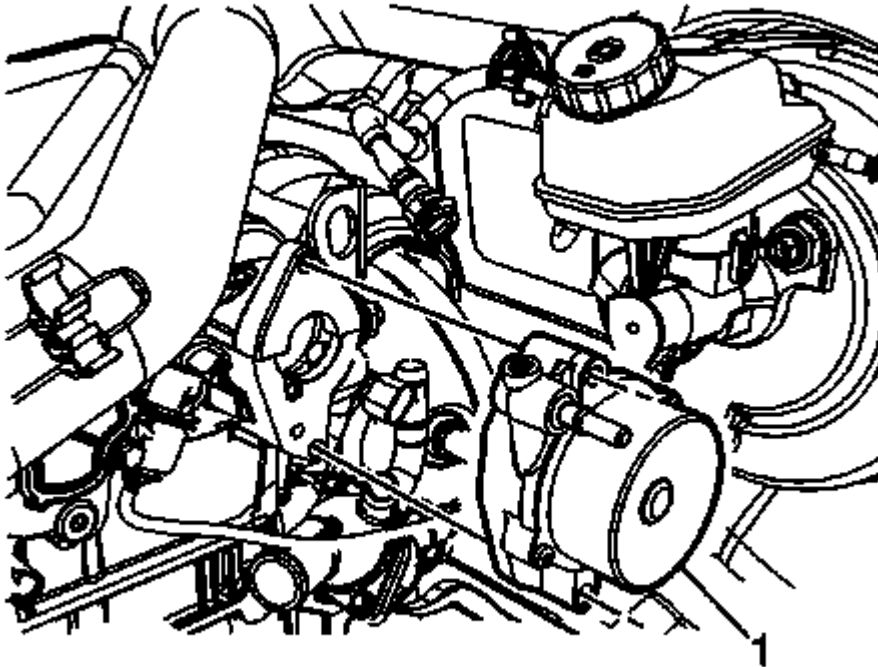


Fig. 94: Power Brake Booster Pump
Courtesy of GENERAL MOTORS COMPANY

7. Remove the power brake booster pump (1).
8. Inspect the power brake booster pump seal for damage and replace, if necessary.

Installation Procedure

1. Install the power brake booster pump seal to the power brake booster pump.

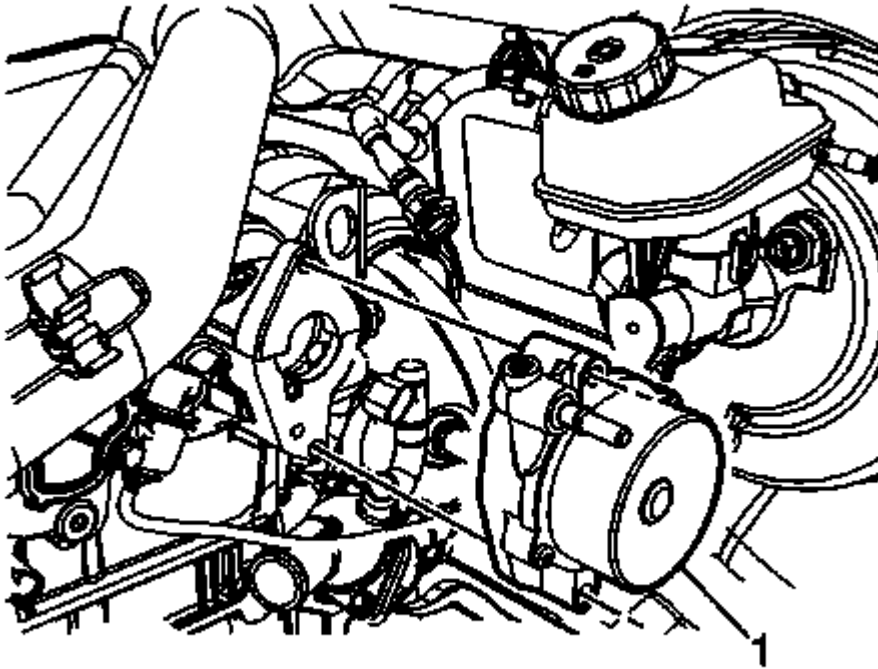


Fig. 95: Power Brake Booster Pump
Courtesy of GENERAL MOTORS COMPANY

2. Align the power brake booster pump drive to the camshaft and install the power brake booster pump (1).

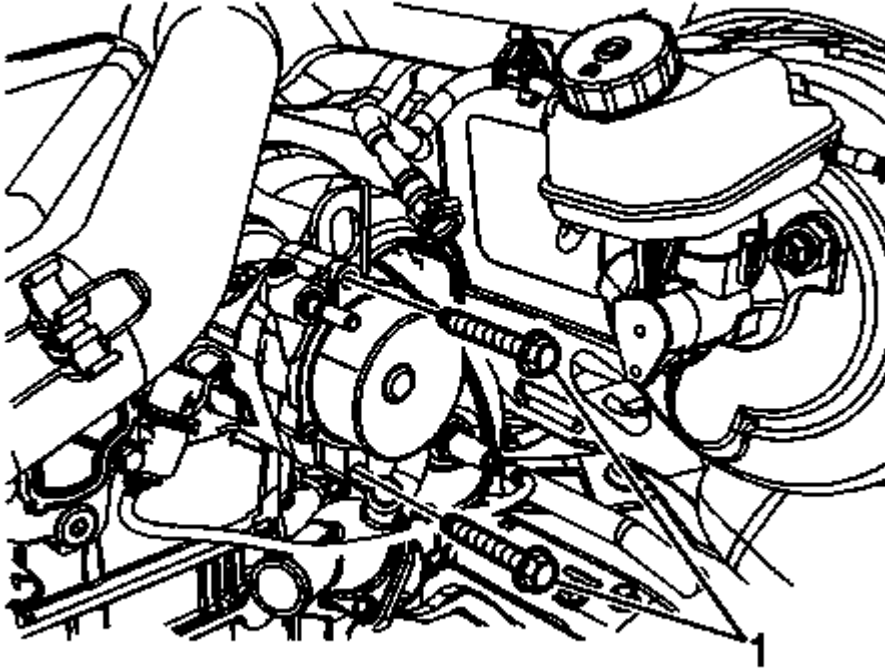


Fig. 96: Power Brake Booster Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the power brake booster pump bolts (1) and tighten to 25 N.m (18 lb ft).

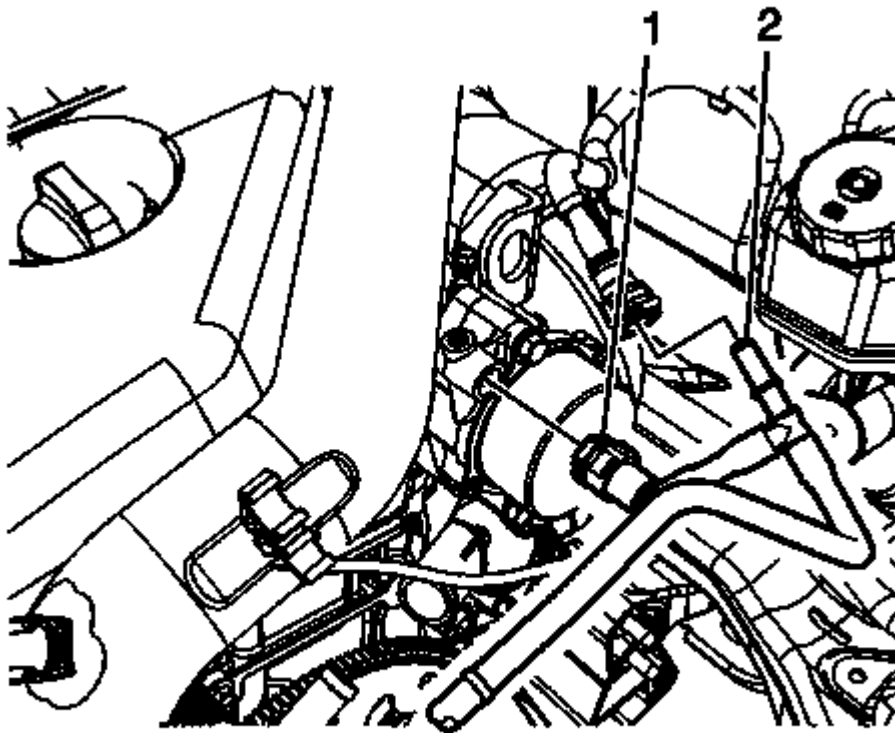


Fig. 97: Power Brake Booster Vacuum Pipe Quick Connection
Courtesy of GENERAL MOTORS COMPANY

4. Connect the power brake booster vacuum pipe quick connect (1) to the power brake booster pump.
5. Connect the power brake booster vacuum pipe (2) to the power brake booster vacuum rear pipe quick connect.
6. Install the power brake booster vacuum pipe to the retainer on the charge air cooler intake pipe.

POWER BRAKE BOOSTER PUMP REPLACEMENT (LUK)

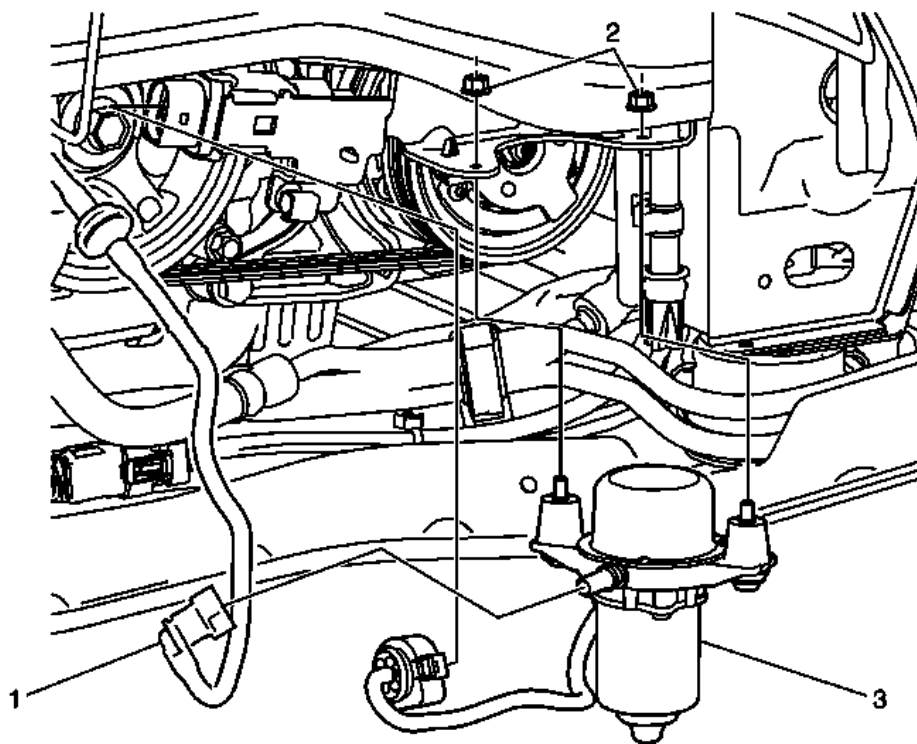


Fig. 98: Power Brake Booster Pump

Courtesy of GENERAL MOTORS COMPANY

Power Brake Booster Pump Replacement (LUK)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. With the engine OFF, apply the brake pedal several times until the brake pedal becomes firm to deplete the vacuum brake booster vacuum reserve. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 3. Remove the right front tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 4. Remove the right front wheelhouse front liner. Refer to <u>Front Wheelhouse Front Liner Replacement</u> . 	
1	Power Brake Booster Vacuum Pipe Procedure <ol style="list-style-type: none"> 1. Release the power brake booster vacuum pipe quick connect. 2. Disconnect the power brake booster pump electrical connector.
	Power Brake Booster Pump Nut (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

2	Tighten 10 N.m (89 lb in)
3	Power Brake Booster Pump

DESCRIPTION AND OPERATION

BRAKE ASSIST SYSTEM DESCRIPTION AND OPERATION

System Component Description

The brake assist system consists of the following:

Brake Pedal

Multiplies the braking effort applied by the driver.

Brake Pedal Pushrod

Transfers multiplied input force received from the brake pedal to the vacuum brake booster.

Vacuum Brake Booster

Uses source vacuum to decrease effort required by the driver when applying the brakes.

Vacuum Brake Booster Control Valve

Regulates the vacuum/atmospheric pressure within the vacuum brake booster. The calibration of the control valve gives more powerful vacuum assistance during low brake pedal pressure.

Vacuum Source

The source vacuum is either derived from the intake manifold or delivered from a pump, mechanically or electrically driven. For further information refer to **Brake Booster Vacuum Assist Description and Operation**.

Vacuum Source Delivery System

Enables delivery and retention of source vacuum for vacuum brake booster.

System Operation

Brake system input force from the driver is multiplied by the brake pedal and transferred by the pedal pushrod to the hydraulic brake master cylinder. Effort required to apply the brake system is reduced by the operation of the vacuum brake booster.

At rest, source vacuum is applied to both sides of each of the diaphragms in the dual booster. Return springs maintain the booster in a rest position.

When brake system force is applied, vacuum to the rear of the diaphragms is cut off, and air at atmospheric pressure is admitted in its place. The vacuum acts to pull the diaphragms forward, while the atmospheric pressure acts to push from behind. As a result, the amount of effort required by the driver is reduced. When input force is removed, vacuum again replaces atmospheric pressure within the vacuum power brake booster to help return the booster to rest. Return springs maintain the system in a rest position.

BRAKE BOOSTER VACUUM ASSIST DESCRIPTION AND OPERATION

System Component Description

Hydraulic Brakes Block Diagram

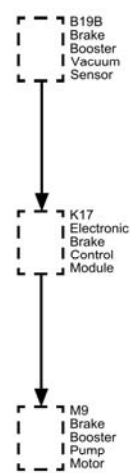


Fig. 99: Hydraulic Brake Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
HW	Hard-Wired
B19B	B19B Brake Booster Vacuum Sensor
K17	K17 Electronic Brake Control Module
M9	M9 Brake Booster Pump Motor

The Brake Booster Vacuum Assist system consists of the following:

Brake Booster Auxiliary Vacuum Pump

The Brake Booster Vacuum Pump is a secondary vacuum supply to the brake booster used to maintain sufficient vacuum for brake assist.

Brake Booster Vacuum Sensor

The vacuum sensor is used to measure the level of vacuum available in the brake booster. The Electronic Brake Control Module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor is located in the brake booster or vacuum hose. The Brake Booster Vacuum Sensor supplies a voltage signal in relation to the pressure in the brake booster to the Electronic Brake Control Module.

Electronic Brake Control Module

The Electronic Brake Control Module monitors the vacuum in the brake booster using the Brake Booster Vacuum Sensor. When the vacuum within the system drops the Electronic Brake Control Module turns ON the Brake Booster Auxiliary Vacuum Pump.

Vacuum Brake Booster

When brake system input force is applied, air at atmospheric pressure is admitted to the rear of both vacuum diaphragms, providing a decrease in brake pedal effort required. When input force is removed, vacuum replaces the atmospheric pressure within the booster. The booster uses source vacuum to decrease the effort required by driver when applying the brake.

Vacuum Source

Vacuum is supplied by the engine vacuum or by the Brake Booster Auxiliary Vacuum Pump.

System Operation

The pump can be switched on and off by the Electronic Brake Control Module based on the required vacuum. Pressure variations during braking can be measured, and the pump can be activated to generate additional vacuum if required to increase the braking force.

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

Brake Warning Indicator

Brake Warning Block Diagram

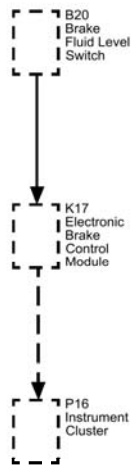


Fig. 100: Brake Warning Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
DA	Serial Data
P16	P16 Instrument Cluster
B20	B20 Brake Fluid Level Switch
K17	K17 Electronic Brake Control Module

The instrument cluster turns the brake warning indicator ON when the following occurs:

- The instrument cluster performs the bulb check. The brake warning indicator illuminates for 5 s.
- When the electronic brake control module (EBCM) detects low brake fluid level it sets DTC C0267 and sends a serial data message to the instrument cluster, which will illuminate the red brake indicator.

Driver Information Center Messages

When the electronic brake control module (EBCM) detects low brake fluid level it sets DTC C0267 and sends a serial data message to the Driver Information Center , which will display Brake Fluid Low message.

HYDRAULIC BRAKE SYSTEM DESCRIPTION AND OPERATION

System Component Description

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Fluid Reservoir

Contains supply of brake fluid for the hydraulic brake system.

Hydraulic Brake Master Cylinder

Converts mechanical input force into hydraulic output pressure.
Hydraulic output pressure is distributed from the master cylinder through 2 hydraulic circuits, supplying diagonally-opposed wheel apply circuits.

Hydraulic Brake Pressure Balance Control System

Regulates brake fluid pressure delivered to hydraulic brake wheel circuits, in order to control the distribution of braking force.
Pressure balance control is achieved through dynamic rear proportioning (DRP), which is a function of the ABS modulator.

Hydraulic Brake Pipes and Flexible Brake Hoses

Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components

Converts hydraulic input pressure into mechanical output force.

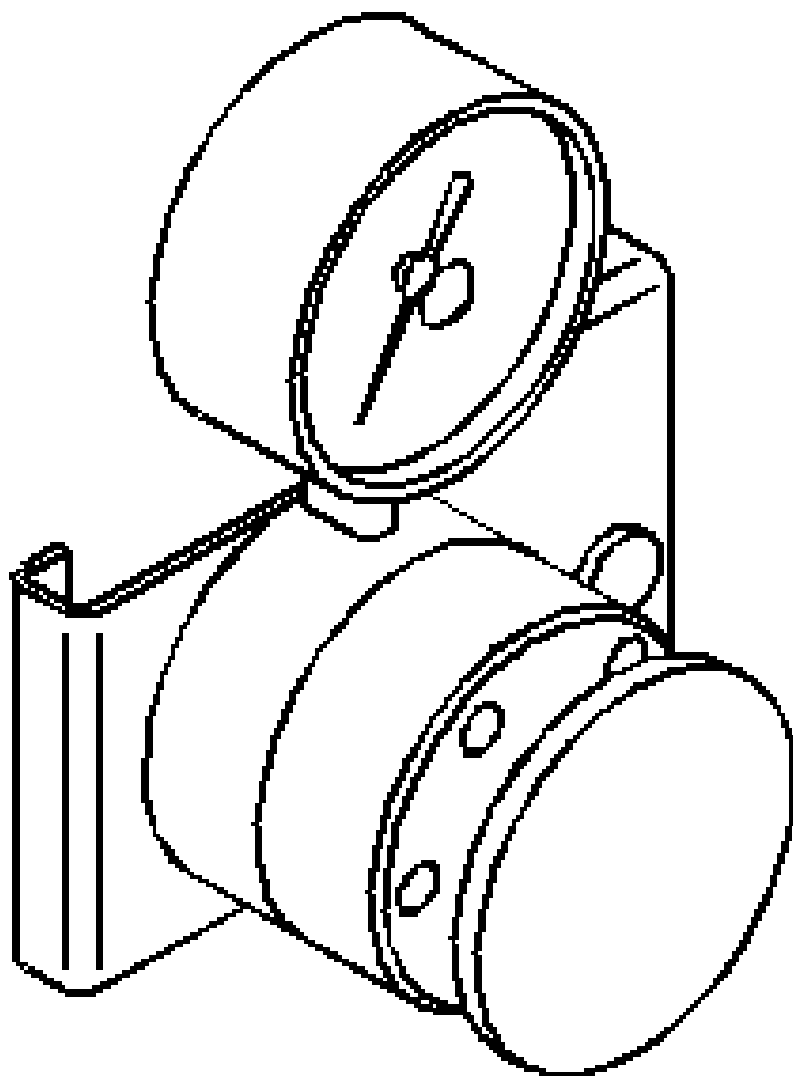
System Operation

Mechanical force is converted into hydraulic pressure by the master cylinder, regulated to meet braking system demands by the pressure balance control system, and delivered to the hydraulic brake wheel circuits by the pipes and flexible hoses. The wheel apply components then convert the hydraulic pressure back into mechanical force which presses linings against rotating brake system components.

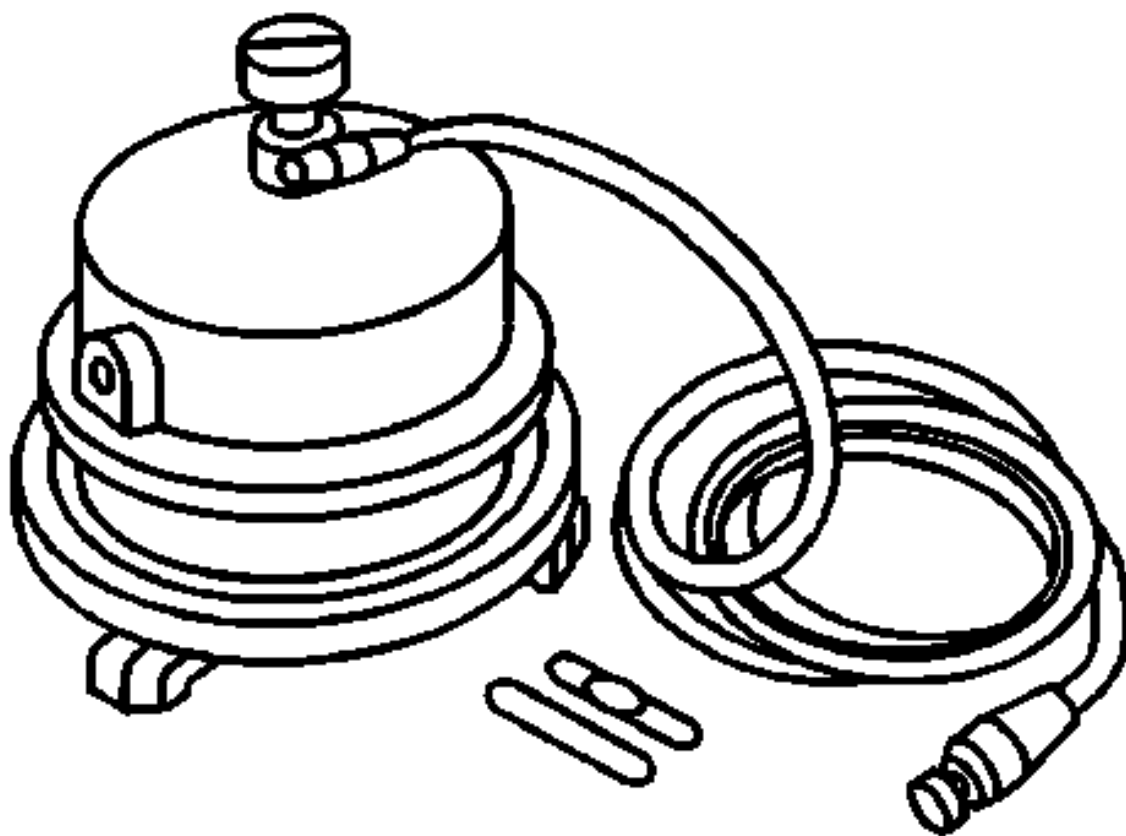
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

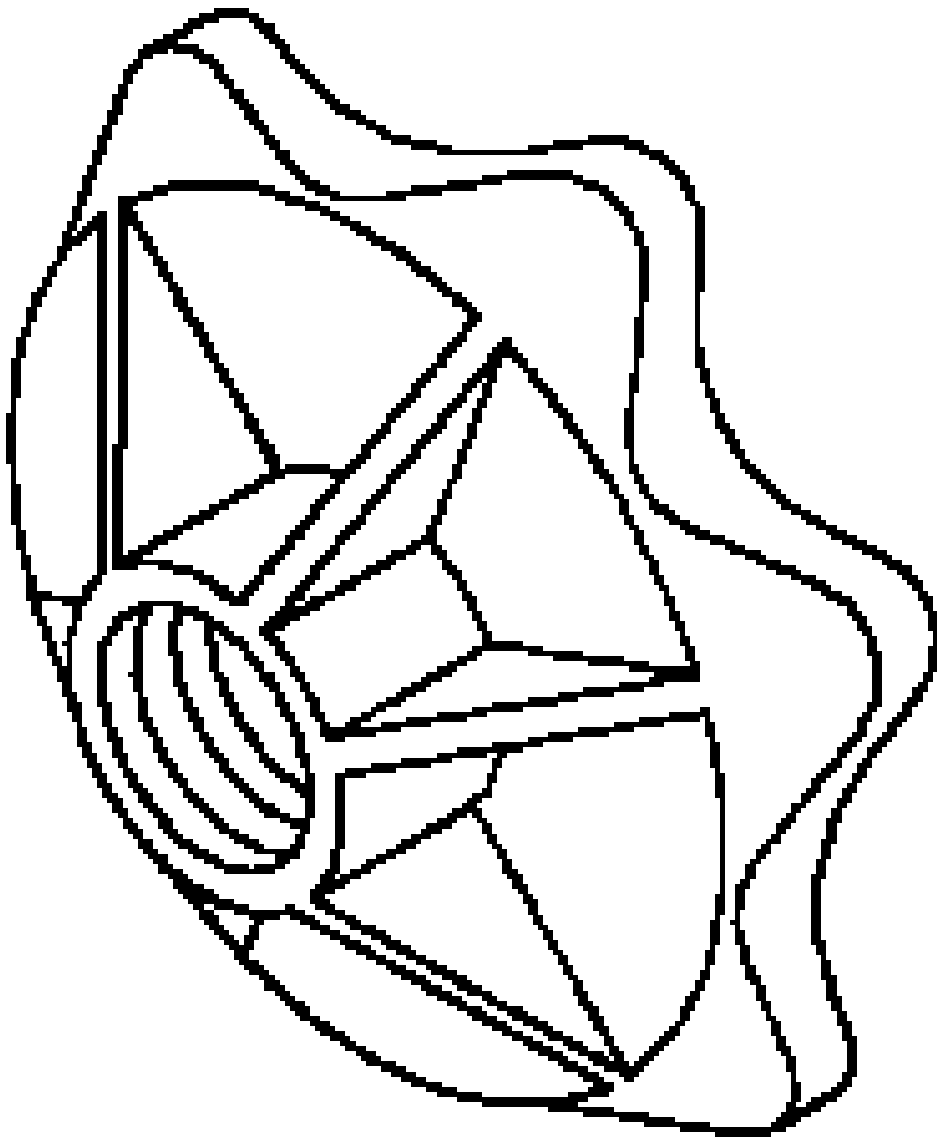
Illustration	Tool Number/ Description



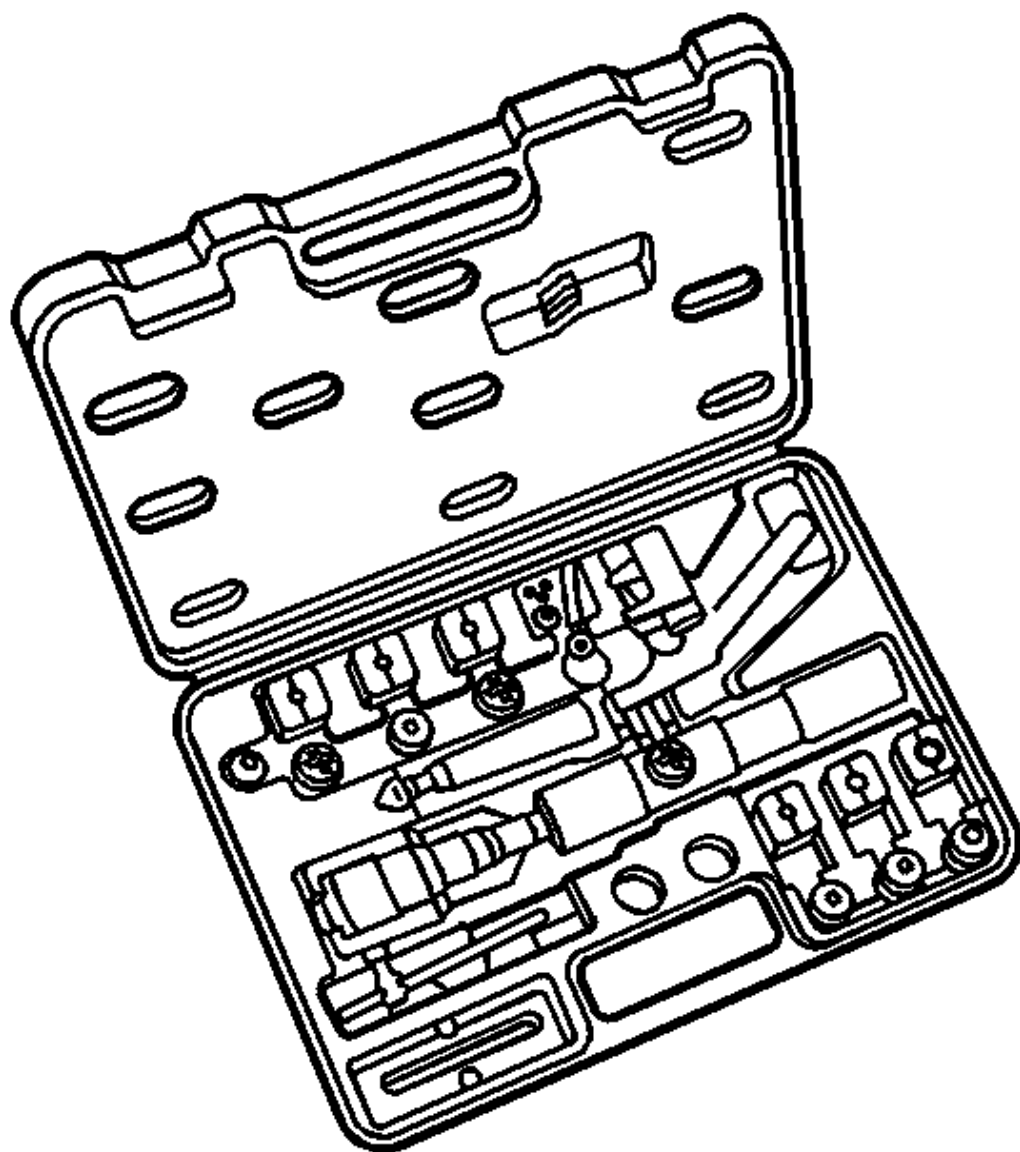
CH 28662
J 28662
Brake Pedal
Effort
Gauge



CH 29532-
B
J 29532-B
Pressure
Brake
Bleeder, or
equivalent



CH 35798
J 35798
Brake
Pressure
Bleeder
Adapter



CH 45405
J 45405
Brake Pipe
Flaring Kit

2014 ELECTRICAL

Wiring Systems and Power Management - Schematic Diagrams - Ignition Lock Schematics

SCHEMATIC WIRING DIAGRAMS

IGNITION LOCK WIRING SCHEMATICS

Ignition Lock

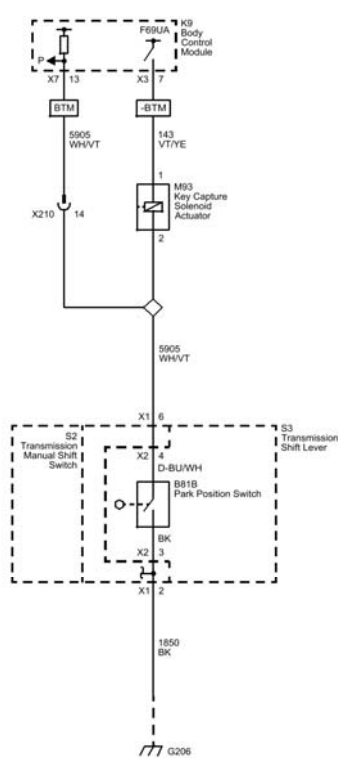


Fig. 1: Ignition Lock

Courtesy of GENERAL MOTORS COMPANY

Immobilizer

IMMOBILIZER WIRING SCHEMATICS

Wiring diagram for the 2002 Ford Focus 1.8L V6, showing the immobilizer system. The diagram includes a 12V battery, a 12V fuse, and a 12V relay. It shows the connection of the immobilizer control module (K89) to the instrument cluster (P16) and the engine control module (K20). The diagram also shows the connection of the immobilizer control module to the body control module (K9) and the power inverter module (T6). The diagram includes a legend for the symbols used.

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B2955 (with BTM)</u>	DTC B2955 Security Sensor Data Circuit
<u>DTC B2955 (without BTM)</u>	DTC B2955 Security Sensor Data Circuit
<u>DTC B302A</u>	DTC B302A Mobile Telephone Communications Interface Requested

	Immobilization
<u>DTC B3031</u>	DTC B3031 Security Controller In Learn Mode
<u>DTC B3055</u>	DTC B3055 No Transponder Modulation or No Transponder
<u>DTC B305C</u>	DTC B305C Immobilizer Transponder of Wrong Type Programmed
<u>DTC B3060</u>	DTC B3060 Unprogrammed Transponder Identification Code Received
<u>DTC B389A</u>	DTC B389A Environment Identification
<u>DTC B3902</u>	DTC B3902 Incorrect Immobilizer Identifier Received
<u>DTC B3935</u>	DTC B3935 Transponder Authentication
<u>DTC B3976</u>	DTC B3976 Unconfigured Transponder
<u>DTC B3984</u>	DTC B3984 Device 1 Environment Identifier Not Programmable
<u>DTC P0513</u>	DTC P0513 Immobilizer Key Incorrect
<u>DTC P0633</u>	DTC P0633 Immobilizer Key Not Programmed
<u>DTC P162B</u>	DTC P162B Remote Vehicle Speed Limiting Signal Message Counter Incorrect
<u>DTC P1631</u>	DTC P1631 Immobilizer Fuel Enable Signal Not Correct
<u>DTC P1649</u>	DTC P1649 Immobilizer Security Code Not Programmed

DTC B2955 (WITH BTM): SECURITY SENSOR DATA CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2955

Security Sensor Data Circuit

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	B2955 00	B2955 00	-	-
Serial Data	B2955 00	B2955 00	B2955 00	B2955 00
Low Reference	-	B2955 00	-	-

Circuit/System Description

When a keyless entry transmitter is inserted into the transmitter pocket/slot and the ignition mode switch is

pressed, the transponder embedded in the transmitter is energized by the immobilizer antenna exciter coil. The transponder transmits a signal to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

Conditions for Running the DTC

Ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The BCM detects a circuit fault on the immobilizer antenna circuits.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator in the instrument cluster will be illuminated. A service message will be displayed in the driver information center.

Conditions for Clearing the DTC

- A current DTC will be cleared when the condition for setting the DTC are no longer present.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K89 Immobilizer Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Verify a test lamp illuminates between the low reference circuit terminal 1 and B+.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
3. Ignition ON.

NOTE: In some instances, the K9 Body Control Module may only apply voltage for 3 s immediately after the ignition is turned ON. It may be necessary to monitor the DMM while turning the ignition ON to observe the voltage.

4. Test for greater than 9 V between the ignition circuit terminal 3 and ground.
 - **If 9 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 9 V**
5. Ignition ON.
6. Test for 10-13 V between the serial data circuit terminal 2 and ground.
 - **If less than 10 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the serial data circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the serial data circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 13 V**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If between 10-13 V**
7. Replace the K89 Immobilizer Control Module.
8. Verify DTC B2955 does not set while operating the vehicle under the conditions for running the DTC.
 - **If DTC B2955 is set**

Replace the K9 Body Control Module.

 - **If DTC B2955 is not set**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module or immobilizer control module replacement, programming, and setup

DTC B2955 (WITHOUT BTM): SECURITY SENSOR DATA CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2955

Security Sensor Data Circuit

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B2955 00	B2955 00	-	-
Serial Data	B2955 00	B2955 00	B2955 00	B2955 00
Low Reference	-	B2955 00	-	-

Circuit/System Description

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the key is energized by the exciter coil surrounding the ignition lock cylinder. The transponder transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

Conditions for Running the DTC

Ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The BCM detects a circuit fault on the immobilizer antenna circuits.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator in the instrument cluster will be illuminated. A service message will be displayed in the driver information center.

Conditions for Clearing the DTC

- A current DTC will be cleared when the condition for setting the DTC are no longer present.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K89 Immobilizer Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Verify a test lamp illuminates between the low reference circuit terminal 1 and B+.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
3. Ignition ON.

NOTE: In some instances, the K9 Body Control Module may only apply voltage for 3 s immediately after the ignition is turned ON. It may be necessary to monitor the DMM while turning the ignition ON to observe the voltage.

4. Test for greater than 9 V between the B+ circuit terminal 3 and ground.
 - **If 9 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 9 V**
5. Test for greater than 4 V between the serial data circuit terminal 2 and ground.
 - **If 4 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the serial data circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance

3. Test for less than 2 ohms in the serial data circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 Body Control Module.

- **If greater than 4 V**

6. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module, ignition ON.

7. Test for less than 1 V between the K89 Immobilizer Control Module serial data circuit terminal 2 and ground.

- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

8. Replace the K89 Immobilizer Control Module.

9. Verify DTC B2955 does not set while operating the vehicle under the conditions for running the DTC.

- **If DTC B2955 is set**

Replace the K9 Body Control Module.

- **If DTC B2955 is not set**

10. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module or immobilizer control module replacement, programming, and setup.

DTC B302A: MOBILE TELEPHONE COMMUNICATIONS INTERFACE REQUESTED IMMOBILIZATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B302A

Mobile Telephone Communications Interface Requested Immobilization

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

As part of the vehicle telematics enhanced services, a request may be sent to the body control module (BCM) to disable vehicle starting. If a valid message is received by the BCM requesting that starting be disabled, the start enable message will not be sent to the engine control module (ECM).

Conditions for Running the DTC

The BCM continuously monitors for this DTC.

Conditions for Setting the DTC

A start disable message has been received from the telematics module.

Action Taken When the DTC Sets

Vehicle starting will be suspended and the security indicator will be illuminated.

Conditions for Clearing the DTC

- A current DTC will clear when the telematics start disable request is no longer received.
- A history DTC will clear after 100 ignition cycles in which the telematic start disable request is not seen.

Diagnostic Aids

- DTC B302A is only an indicator that a start disable request has been received from the vehicle telematics system and does not indicate a fault in the immobilizer or telematics system.
- To remove the start disable request, the vehicle account must be updated with the OnStar stolen vehicle team. This will require that a law enforcement agency or the customer contact OnStar to indicate that the vehicle has been successfully and safely recovered.
- If the OnStar system has been disabled or damaged during a theft attempt, the system will not be able to communicate and the start disable request will not be removed. OnStar must be functioning properly for the start disable request to be removed.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the OnStar system is not damaged and is operating properly, with no DTCs set.
 - **If the OnStar system is damaged, inoperative, or any OnStar DTCs are set**

These concerns must be corrected before the start disable can be removed.
 - **If the OnStar system is not damaged and is operating properly**
2. Press the blue OnStar button and ask the advisor to be transferred to the stolen vehicle team to verify the vehicle account has been updated.
3. Verify that OnStar is aware the vehicle has been recovered and that the vehicle account has been updated.
 - **If OnStar has not been notified that the vehicle has been recovered**

Contact the customer and advise them that for security purposes, they must contact OnStar and the law enforcement agency to update the vehicle account.

- **If the account has been properly updated**
4. Once the vehicle account has been updated and the start disable request has been removed, DTC B302A will transition to a history DTC. Clear the history DTC.

DTC B3031: SECURITY CONTROLLER IN LEARN MODE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3031

Security Controller In Learn Mode

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

When learning a coded key, the body control module (BCM) is placed in learn mode. DTC B3031 will set automatically as an indicator that the system is in learn mode and not as a fault indicator. Once the coded key is learned, learn mode will be exited and the DTC cleared. If the BCM does not exit learn mode, DTC B3031 will remain current and indicate a fault. The instrument cluster security indicator will illuminate and the driver information center will display a message.

Conditions for Running the DTC

The immobilizer system is the learn coded keys state.

Conditions for Setting the DTC

The DTC will set any time the BCM enters the learn coded keys state.

Action Taken When the DTC Sets

The security indicator will illuminate. The driver information center will display a message.

Conditions for Clearing the DTC

- A current DTC B3031 will be cleared upon the successful exit of learn mode.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify all available keys are correct for the vehicle. This can be accomplished by comparing the part number that is laser etched on the key to the part number listed in the parts catalog.
 - **If a key is not correct**

Replace the key
 - **If all keys are correct**
2. Perform the Replacing Keys procedure. Refer to **Key with Integrated Transmitter Programming (with BTM), Key with Integrated Transmitter Programming (without BTM)**.
3. Verify the K9 Body Control Module learns the vehicle key and exits the learn coded key state. The scan tool Master Keys Learned parameter should increment to 1.
 - **If the K9 Body Control Module does not exit the learn coded key state after the programming attempt**

Replace the K9 Body Control Module
 - **If the K9 Body Control Module exits the learn coded key state after the programming attempt**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module replacement, programming, and setup.

DTC B3055: NO TRANSPONDER MODULATION OR NO TRANSPONDER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3055

No Transponder Modulation or No Transponder

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Without BTM and/or ATH/ATS

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the key is energized by the exciter coil surrounding the ignition lock cylinder. The transponder transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

With BTM and/or ATH/ATS

When a ignition key is inserted into the key pocket/slot and the ignition mode switch is pressed, the transponder embedded in the key is energized by the immobilizer antenna exciter coil. The transponder transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

Conditions for Running the DTC

Ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The BCM is unable to measure the ignition key transponder value.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator will illuminate. A service message will be displayed in the driver information center.

Conditions for Clearing the DTC

- A current DTC will be cleared when the BCM detects a valid transponder value from the ignition key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

Diagnostic Aids

- Because DTC B3055 may be caused by a malfunctioning vehicle key, it is necessary to have all available vehicle keys at the time of diagnosis. A possible scenario would be a customer leaving the vehicle with a spare key during the service visit, but the key which they use everyday, not the spare key, is the cause of

the DTC. Not having all available keys in this instance would result in the customer concern not being duplicate or a misdiagnosis.

- Ensure that the immobilizer control module is properly installed and fully seated. An audible and/or tactile click will indicate that the immobilizer control module is fully seated. To ensure proper transponder communication, the key must be in a specific location in relation to the immobilizer control module. If the immobilizer control module is not fully seated, transponder communication may not occur and DTC B3055 will set.
- For vehicle without BTM and/or ATH/ATS, verify the customer is not attempting to turn the ignition with the vehicle key partially folded. To ensure proper transponder communication, the key must be in a specific location in relation to the immobilizer control module. Attempting to start the vehicle with the key in the ignition and partially folded will result in no transponder communication and DTC B3055 will set.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Without BTM and/or ATH/ATS

1. Ignition ON.
2. Verify that DTC B1370, B1380, or B1441 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

3. Verify the scan tool body control module Accessory parameter changes between Active and Inactive when turning the ignition ON and OFF.

- **If the parameter does not change**

Refer to **Vehicle Will Not Change Power Mode** .

- **If the parameter changes**

4. Verify all available keys are correct for the vehicle. This can be accomplished by comparing the part number that is laser etched on the key to the part number listed in the parts catalog.

- **If a key is not correct**

Replace the appropriate key.

- **If all keys are correct**

5. Verify that DTC B3055 does not set while attempting to start the vehicle with each available key.

- **If DTC B3055 sets when attempting to start the vehicle with only one of the available keys**

Replace the appropriate key.

- **If DTC B3055 sets when attempting to start the vehicle with all of the available keys**

Replace the K89 Immobilizer Control Module.

- **If DTC B3055 does not set**

6. All OK.

With BTM and/or ATH/ATS

1. Ignition ON.
2. Verify that DTC B1370, B1380, or B1441 is not set.

- **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

3. Verify the scan tool body control module Accessory parameter changes between Active and Inactive when turning the ignition ON and OFF.

- **If the parameter does not change**

Refer to **Power Mode Mismatch** .

- **If the parameter changes**

4. Verify all available keys are correct for the vehicle. This can be accomplished by comparing the part number that is laser etched on the key to the part number listed in the parts catalog.

- **If a key is not correct**

Replace the appropriate key.

- **If all keys are correct**

5. Remove the battery from each of the available vehicle keys.
6. Verify that DTC B3055 does not set while attempting to start the vehicle with each available key. To start the vehicle with the key battery removed, the key must be placed in the key pocket/slot.
 - **If DTC B3055 sets when attempting to start the vehicle with only one of the available keys**

Replace the appropriate key.

- **If DTC B3055 sets when attempting to start the vehicle with all of the available keys**

Replace the K89 Immobilizer Control Module.

- **If DTC B3055 does not set**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for immobilizer control module replacement, programming, and setup.

DTC B305C: IMMOBILIZER TRANSPONDER OF WRONG TYPE PROGRAMMED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B305C

Immobilizer Transponder of Wrong Type Programmed

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Without BTM and/or ATH/ATS

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the key is energized by the exciter coil surrounding the ignition lock cylinder. The transponder transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

With BTM and/or ATH/ATS

When a ignition key is inserted into the key pocket/slot and the ignition mode switch is pressed, the transponder embedded in the key is energized by the immobilizer antenna exciter coil. The transponder transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

Conditions for Running the DTC

- Ignition is in the Accessory or Run position
- Battery voltage is greater than 9 volts
- Transponder authentication has occurred

Conditions for Setting the DTC

- The programed transponder type does not match the equipped system on the vehicle.
- A transponder used for vehicles without BTM and/or ATH/ATS has been programmed to a vehicle with BTM and/or ATH/ATS.
- A transponder used for vehicles with BTM and/or ATH/ATS has been programmed to a vehicle without BTM and/or ATH/ATS.

Action Taken When the DTC Sets

No action is taken.

Conditions for Clearing the DTC

- A current DTC will be cleared when the BCM detects a programed transponder type that matches the equipped system on the vehicle.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify all available keys/transmitters are correct for the vehicle. This can be accomplished by comparing the part number that is laser etched on the key to the part number listed in the parts catalog.
 - **If a key is not correct**

Replace the appropriate key.
 - **If all keys are correct**
3. Verify the scan tool Key Part Number parameter displays a Key Part Number when turning the ignition ON with each key.
 - **If a Key Part Number is not read**

Replace the appropriate key.
 - **If a Key Part Number is read for each key**
4. All OK.

DTC B3060: UNPROGRAMMED TRANSPONDER IDENTIFICATION CODE RECEIVED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3060

Unprogrammed Transponder Identification Code Received

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Without BTM and/or ATH/ATS

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the key is energized by the exciter coil surrounding the ignition lock cylinder. The transponder transmits a signal to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

With BTM and/or ATH/ATS

When a keyless entry transmitter is inserted into the transmitter pocket/slot and the ignition mode switch is pressed, the transponder embedded in the transmitter is energized by the immobilizer antenna exciter coil. The transponder transmits a signal to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

Conditions for Running the DTC

Ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The transponder value measured by the BCM is incorrect or not learned to the vehicle.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator in the instrument cluster will be illuminated. The driver information center will display a service message.

Conditions for Clearing the DTC

- A current DTC will be cleared when the BCM detects a valid transponder value from the ignition key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Perform the Replacing Keys procedure. Refer to **Key with Integrated Transmitter Programming (with BTM), Key with Integrated Transmitter Programming (without BTM)**.
2. Verify the K9 Body Control Module learns the vehicle key. The scan tool Master Keys Learned parameter should increment to indicate another key has been learned.
 - **If the BCM does not learn the key**

Replace the key.
 - **If the BCM learns the key**
3. All OK.

DTC B389A: ENVIRONMENT IDENTIFICATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B389A

Environment Identification

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

When certain modules are programmed and configured during installation, the module learns a specific environment identifier which is unique to the vehicle. The environment identifier is used to prevent the swapping modules between vehicles. The body control module (BCM) is the keeper of the environment identifier. The Instrument Cluster, Electronic Brake Control Module, HVAC Control Module, Inflatable Restraint Sensing and Diagnostic Module, engine control module (ECM), and Steering Column Lock Module (if equipped) each learn the environment identifier during their configuration process. During vehicle operation, the BCM sends the immobilizer identifier as a challenge and each module responds to the challenge by sending the environment identifier back to the BCM. If the BCM sends an incorrect immobilizer identifier or a specific number of incorrect environment identifiers are received, vehicle starting is disabled.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

An incorrect immobilizer identifier was broadcast by the BCM.

Action Taken When the DTC Sets

- The security indicator in the instrument cluster will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

A current DTC will be cleared when the BCM broadcasts a correct immobilizer identifier.

Diagnostic Aids

If BCM programming is not completed after BCM replacement, the immobilizer identifier will not be learned. If DTC B389A sets immediately after the replacement and programming of a BCM, perform the programming procedure again.

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC B389A did not set immediately following the replacement and programming of the K9 Body Control Module.
 - **If the DTC set immediately after the replacement and programming of the K9 Body Control Module**

The immobilizer learn procedure was not properly completed. Perform the BCM immobilizer learn using the body control module IMMO Function with Existing Transponder or Remote Key in SPS. Refer to **Immobilizer System Component Programming (with BTM)**, **Immobilizer System Component Programming (without BTM)**.
 - **If the DTC did not set immediately after the replacement and programming of the K9 Body Control Module**
2. Verify DTC B3902 is not set in any of the control modules listed below:
 - K20 Engine Control Module
 - K36 Inflatable Restraint Sensing and Diagnostic Module
 - K17 Electronic Brake Control Module
 - K33 HVAC Control Module
 - P16 Instrument Cluster

- K60 Steering Column Lock Module (if equipped)
- **If DTC B3902 is set in any of the modules**

Refer to **DTC B3902**.

- **If DTC B3902 is not set in any of the modules**
3. Perform the K9 Body Control Module immobilizer learn using body control module IMMO Function with Existing Transponder or Remote Key in SPS. Refer to **Immobilizer System Component Programming (with BTM)**, **Immobilizer System Component Programming (without BTM)**.
 4. Verify DTC B389A does not set after programming.
 - **If the DTC sets after programming**

Replace the K9 Body Control Module.

- **If the DTC does not set after programming**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module replacement, programming, and setup.

DTC B3902: INCORRECT IMMOBILIZER IDENTIFIER RECEIVED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3902

Incorrect Immobilizer Identifier Received

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

When certain modules are programmed and configured during installation, the module learns a specific environment identifier which is unique to the vehicle. The environment identifier is used to prevent the swapping modules between vehicles. The body control module (BCM) is the keeper of the environment identifier. The Instrument Cluster, Electronic Brake Control Module, HVAC Control Module, Inflatable Restraint Sensing and Diagnostic Module, engine control module (ECM), and Steering Column Lock Module

(if equipped) each learn the environment identifier during their configuration process. During vehicle operation, the BCM sends the immobilizer identifier as a challenge and each module responds to the challenge by sending the environment identifier back to the BCM. If the BCM sends an incorrect immobilizer identifier or a specific number of incorrect environment identifiers are received, vehicle starting is disabled.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

The control module's environment identifier does not match the environment identifier stored by the BCM.

Action Taken When the DTC Sets

- The security indicator in the instrument cluster will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

A current DTC will be cleared when the module learns a correct environment identifier.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Perform the Programming and Setup procedure for the control module that set DTC B3902.
2. Verify DTC B3902 does not set after programming.

- **If the DTC sets after programming**

Replace the control module that set the DTC.

- **If the DTC does not set after programming**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Instrument Cluster, Electronic Brake Control Module, HVAC Control Module, Inflatable Restraint Sensing and Diagnostic Module, engine control module, or Steering Column Lock Module replacement, programming, and setup.

DTC B3935: TRANSPONDER AUTHENTICATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3935

Transponder Authentication

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Without BTM and/or ATH/ATS

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the key is energized by the exciter coil surrounding the ignition lock cylinder. The transponder transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

With BTM and/or ATH/ATS

When a ignition key is inserted into the key pocket/slot and the ignition mode switch is pressed, the transponder embedded in the key is energized by the immobilizer antenna exciter coil. The transponder transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

Conditions for Running the DTC

- Ignition is in the Accessory or Run position.
- A valid transponder value has been read.

Conditions for Setting the DTC

The transponder calculation of the challenge from the BCM does not match the BCM calculation.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator will illuminate. The driver information center will display a service message.

Conditions for Clearing the DTC

- A current DTC will be cleared when a valid transponder value has been read and authenticated.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Replace the suspected inoperative or malfunctioning key.
2. Verify DTC B3935 does not set while operating the vehicle under the conditions for running the DTC.
 - **If the DTC is set**

Replace the K9 Body Control Module.

- **If the DTC is not set**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module replacement, programming, and setup.

DTC B3976: UNCONFIGURED TRANSPONDER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3976

Unconfigured Transponder

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

Without BTM and/or ATH/ATS

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the key is energized by the exciter coil surrounding the ignition lock cylinder. The transponder

transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

With BTM and/or ATH/ATS

When a ignition key is inserted into the key pocket/slot and the ignition mode switch is pressed, the transponder embedded in the key is energized by the immobilizer antenna exciter coil. The transponder transmits a signal to the immobilizer control module. The immobilizer control module translates this signal to a serial data message which is sent to the body control module (BCM). The BCM then compares this value to a value stored in memory. If the value is correct, the BCM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the BCM will send the start disable password to the ECM.

Conditions for Running the DTC

- Ignition is in the Accessory or Run position.
- The BCM is in the learn coded key state.

Conditions for Setting the DTC

The BCM has determined the current key is not configured as a proper vehicle key.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator in the instrument cluster will be illuminated. A service message will be displayed in the driver information center.

Conditions for Clearing the DTC

- A current DTC will be cleared when the BCM detects a properly configured vehicle key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the engine starts with each available key.
 - **If the engine does not start with a key**

Replace the key.

- **If the engine starts with all keys**
2. All OK.

DTC B3984: DEVICE 1 ENVIRONMENT IDENTIFIER NOT PROGRAMMABLE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3984

Device 1 Environment Identifier Not Programmable

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

When certain modules are programmed and configured during installation, the module learns a specific environment identifier which is unique to the vehicle. The environment identifier is used to prevent the swapping modules between vehicles. The body control module (BCM) is the keeper of the environment identifier. The instrument cluster, electronic brake control module, HVAC control module, inflatable restraint sensing and diagnostic module, engine control module (ECM), and steering column lock module (if equipped)

each learn the environment identifier during their configuration process. During vehicle operation, the BCM sends the immobilizer identifier as a challenge and each module responds to the challenge by sending the environment identifier back to the BCM. If the BCM sends an incorrect immobilizer identifier or a specific number of incorrect environment identifiers are received, vehicle starting is disabled.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

An incorrect environment identifier is programmed or no environment identifier is programmed.

Action Taken When the DTC Sets

- The security indicator in the instrument cluster will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

A current DTC will be cleared when the module learns a correct environment identifier.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Perform the Programming and Setup procedure for the control module that set DTC B3984.
2. Verify DTC B3984 does not set after programming.

- **If the DTC sets after programming**

Replace the control module that set the DTC.

- **If the DTC does not set after programming**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for instrument cluster, electronic brake control module, HVAC control module, inflatable restraint sensing and diagnostic module, engine control module, and steering column lock module replacement, programming, and setup.

DTC P0513: IMMOBILIZER KEY INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0513

Immobilizer Key Incorrect

Circuit/System Description

The body control module (BCM) sends the pre-release information to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the BCM. Both the ECM and BCM perform a calculation on this challenge. If the calculated response from the BCM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

The calculated response from the BCM does not equal the calculation performed by the ECM.

Action Taken When the DTC Sets

- The security indicator in the instrument cluster will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC will be cleared when a valid calculation is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles.

Diagnostic Aids

DTC P0513 may be caused by a loose connection or intermittent poor continuity on the ECM ground or at the negative battery cable. Be sure to check the ECM ground(s) and negative battery cable if normal system diagnosis does not correct the concern.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify there are no immobilizer DTCs set in the K9 Body Control Module.
 - **If any immobilizer DTCs are set in the K9 Body Control Module**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no immobilizer DTCs are set in the K9 Body Control Module**

2. Perform the K9 Body Control Module immobilizer learn using the body control module IMMO Function with Existing Transponder or Remote Key in SPS. Refer to **Immobilizer System Component Programming (with BTM)**, **Immobilizer System Component Programming (without BTM)**.
3. Verify the engine starts after the K9 Body Control Module completes the learn procedure.
 - **If the engine does not start**

Perform the K20 Engine Control Module immobilizer learn using the engine control module IMMO Learn in SPS. Refer to **Immobilizer System Component Programming (with BTM)**, **Immobilizer System Component Programming (without BTM)**.

- **If the engine starts**

4. All OK.

DTC P0633: IMMOBILIZER KEY NOT PROGRAMMED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0633

Immobilizer Key Not Programmed

Circuit/System Description

When learning the immobilizer data, as well as the challenge and response sequence, the engine control module (ECM) is placed in learn mode. DTC P0633 will set automatically as an indicator that the system is in learn mode and not as a fault indicator. Once the immobilizer data and challenge/response are learned, learn mode will be exited when the engine is successfully started. If the ECM does not exit learn mode, DTC P0633 will remain current and indicate a fault.

Conditions for Running the DTC

The ECM is in learn mode.

Conditions for Setting the DTC

DTC P0633 will set any time the ECM enters learn mode.

Action Taken When the DTC Sets

The security indicator in the instrument cluster will illuminate.

Conditions for Clearing the DTC

- A current DTC will be cleared upon a successful engine start after exit of learn mode.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: DTC P0633 will clear upon a successful engine start. Any malfunction that will cause a no-start condition will prevent DTC P0633 from clearing. Prior to diagnosing DTC P0633, ensure that all power moding and engine control systems are operating properly and all conditions that may cause a no-start have been corrected. Do not replace the K20 Engine Control Module. Replacing the K20 Engine Control Module will not correct the no-start condition.

1. Verify there are no immobilizer DTCs set in the K9 Body Control Module.
 - If any immobilizer DTCs are set in the K9 Body Control Module

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no immobilizer DTCs are set in the K9 Body Control Module**
- 2. Perform the K20 Engine Control Module immobilizer learn using the engine control module IMMO Learn in SPS. Refer to **Immobilizer System Component Programming (with BTM)**, **Immobilizer System Component Programming (without BTM)**.
- 3. Verify the engine starts after the K20 Engine Control Module completes the learn procedure.
 - **If the engine does not start**

An undiagnosed no-start condition exists. Refer to the appropriate subsection and diagnostic to correct the no-start condition.

- **If the engine starts**
4. All OK.

DTC P162B: REMOTE VEHICLE SPEED LIMITING SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P162B

Remote Vehicle Speed Limiting Signal Message Counter Incorrect

Circuit/System Description

When a remote slow-down request is sent from OnStar, the vehicle communication interface control module sends a serial data message to the engine control module (ECM) indicating that reduced vehicle speed has been requested. Once the request is active, the ECM begins reducing engine torque to match the requested vehicle speed and the REDUCED ENGINE POWER message is displayed.

Conditions for Running the DTC

- The engine run time is greater than 5 s
- A remote slow-down request is sent from OnStar

Conditions for Setting the DTC

- The VIN embedded in the slow-down request does not match the VIN stored in the ECM.
- The rolling code counter embedded in the slow-down request does not increment for ten consecutive messages.

Action Taken When the DTC Sets

- ECM ignores all reduced vehicle speed request messages from the vehicle communication interface module.
- The ECM stores DTC P162B in history.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Remote Vehicle Speed Limiting Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Perform the Stolen Vehicle Slow-Down Clear procedure with the scan tool.
2. Verify DTC P162B is not set.
 - **If DTC P162B is set**
 1. Replace the K73 Telematics Communication Interface Control Module.
 2. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
 - If the DTC sets, replace the K20 Engine Control Module.

- If the DTC does not set
- 3. All OK.

- **If DTC P162B is not set**

- 3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for telematics communication interface control module or engine control module replacement, programming, and setup

DTC P1631: IMMOBILIZER FUEL ENABLE SIGNAL NOT CORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1631

Immobilizer Fuel Enable Signal Not Correct

Circuit/System Description

The body control module (BCM) sends the pre-release information to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the BCM. Both the ECM and BCM perform a calculation on this challenge. If the calculated response from the BCM equals the calculation performed by the ECM, the ECM will allow vehicle starting. The BCM follows this action by sending the remaining immobilizer data to the ECM. If the immobilizer data sent by the BCM matches that stored by the ECM, the ECM will allow the engine to remain running.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

The ECM receives incorrect immobilizer data from the BCM.

Action Taken When the DTC Sets

- The security indicator in the instrument cluster will illuminate.

- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC will be cleared when correct immobilizer data is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify there are no immobilizer DTCs set in the K9 Body Control Module.
 - **If any immobilizer DTCs are set in the K9 Body Control Module**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If no immobilizer DTCs are set in the K9 Body Control Module**
2. Perform the K9 Body Control Module immobilizer learn using the body control module IMMO Function with Existing Transponder or Remote Key in SPS. Refer to **Immobilizer System Component Programming (with BTM)**, **Immobilizer System Component Programming (without BTM)**.
3. Verify the engine starts after the K9 Body Control Module completes the learn procedure.
 - **If the engine does not start**

Perform the K20 Engine Control Module immobilizer learn using the engine control module IMMO Learn in SPS. Refer to **Immobilizer System Component Programming (with BTM)**, **Immobilizer System Component Programming (without BTM)**.

- If the engine starts

4. All OK.

DTC P1649: IMMOBILIZER SECURITY CODE NOT PROGRAMMED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1649

Immobilizer Security Code Not Programmed

Circuit/System Description

When learning the security code, as well as the challenge and response sequence, the engine control module (ECM) is placed in learn mode. Once the security code and challenge/response are learned, learn mode will be exited when the engine is successfully started.

Conditions for Running the DTC

The ECM is in learn mode.

Conditions for Setting the DTC

The ECM has not learned a security code.

Action Taken When the DTC Sets

The security indicator in the instrument cluster will illuminate.

Conditions for Clearing the DTC

- A current DTC will be cleared upon a successful engine start after exit of learn mode.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Verify there are no immobilizer DTCs set in the K9 Body Control Module.
 - **If any immobilizer DTCs are set in the K9 Body Control Module**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If no immobilizer DTCs are set in the K9 Body Control Module**
2. Perform the K20 Engine Control Module immobilizer learn using the engine control module IMMO Learn in SPS. Refer to **Immobilizer System Component Programming (with BTM)**, **Immobilizer System Component Programming (without BTM)**.
3. Verify the engine starts after the K20 Engine Control Module completes the learn procedure.
 - **If the engine does not start**

Replace the K20 Engine Control Module.
 - **If the engine starts**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for engine control module replacement, programming, and setup.

SYMPTOMS - IMMOBILIZER

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Immobilizer Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to **Checking Aftermarket Accessories**.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Symptom List

Refer to **OnStar Stolen Vehicle Slowdown Active** to diagnose the symptom.

ONSTAR STOLEN VEHICLE SLOWDOWN ACTIVE

Diagnostic Instructions

NOTE: This procedure is not used in Brazil.

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

When a remote slow-down request is sent from OnStar, the Telematics Communication Interface Control Module sends a serial data message to the engine control module (ECM) indicating that reduced vehicle speed has been requested. Once the request is active, the ECM begins reducing engine torque to match requested vehicle speed and the REDUCED ENGINE POWER message is displayed.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Remote Vehicle Speed Limiting Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the vehicle is not in the OnStar initiated Stolen Vehicle Slowdown mode. This can be accomplished by verifying the scan tool Telematics Enhanced Service Immobilization parameter is No.
 - **If the scan tool Telematics Enhanced Service Immobilization parameter is Yes**
 1. Perform the Remote Vehicle Speed Limiting Reset procedure with the scan tool.
 2. Press the blue OnStar button and inform the advisor that you need to be transferred to the stolen vehicle team to update the vehicle account.
 - **If the scan tool BCM Telematics Enhanced Service Immobilization parameter is No**
2. All OK.

REPAIR INSTRUCTIONS

THEFT DETERRENT MODULE REPLACEMENT (WITHOUT BTM)

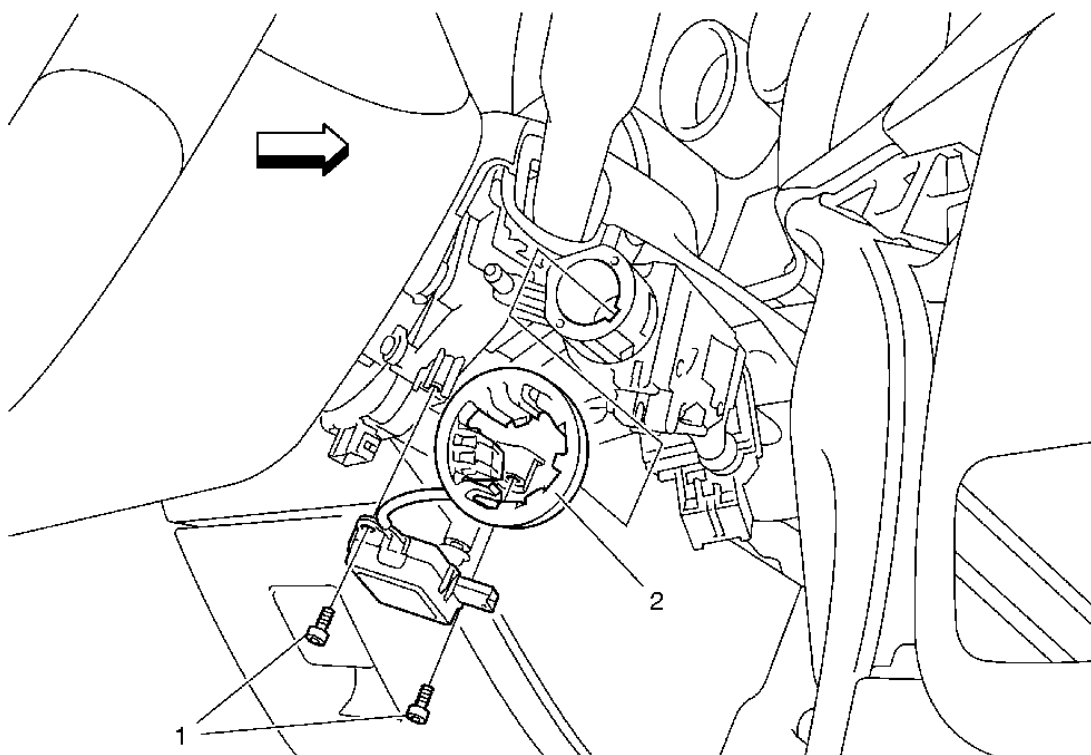


Fig. 2: Theft Deterrent Module & Fasteners (Without BTM)
 Courtesy of GENERAL MOTORS COMPANY

Theft Deterrent Module Replacement (Without BTM)

Callout	Component Name
Preliminary Procedure	
Remove the lower steering column trim cover. Refer to <u>Steering Column Trim Cover Replacement</u> .	
1	Theft Deterrent Module Fastener (Qty: 2) Procedure Disconnect the electrical connector.
2	Theft Deterrent Module Procedure Release the theft deterrent module from the ignition switch.

THEFT DETERRENT MODULE REPLACEMENT (WITH BTM)

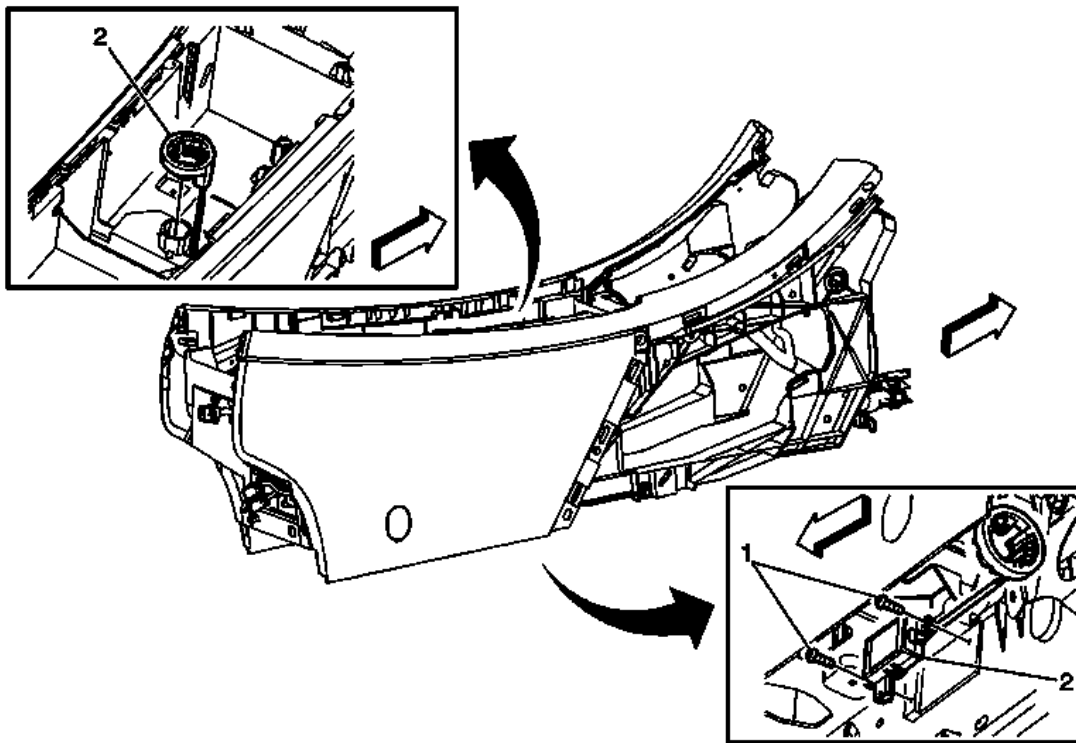


Fig. 3: Theft Deterrent Module (With BTM)
 Courtesy of GENERAL MOTORS COMPANY

Theft Deterrent Module Replacement (With BTM)

Callout	Component Name
Preliminary Procedures	
1. Remove the front floor console. Refer to <u>Front Floor Console Replacement</u> . 2. Remove the front floor console cup holder. Refer to <u>Front Floor Console Cup Holder Replacement</u> .	
1	Theft Deterrent Module Fastener (Qty: 2)
2	Theft Deterrent Module Assembly
	Procedure 1. Disconnect the electrical connector. 2. Program the theft deterrent control module after replacement. Refer to <u>Control Module References</u> .

IMMOBILIZER SYSTEM COMPONENT PROGRAMMING (WITH BTM)

This procedure will learn the immobilizer function and require greater than 15 minutes to complete. If the battery voltage is low, charge the battery before proceeding with the learn. If the body control module (BCM) or engine control module (ECM) have been replaced, they must be programmed before performing this learn procedure.

Depending on the immobilizer function being learned or the component replaced, different learn functions are required to be performed. These learn functions are as follows:

Immobilizer System Component Programming (with BTM)

Function name on SPS tool:	Function description:	When the function should be used:	Notes:
Body Control Module IMMO Function with Existing Transponder or Remote Key	The BCM will relearn the immobilizer passwords and data while reusing the existing vehicle keys	The BCM has been replaced and the existing vehicle keys are being reused or a diagnostic has instructed to perform the learn	-
Body Control Module IMMO Function with New Transponder or Remote Key	The BCM will relearn the immobilizer passwords and data while using new vehicle keys	The BCM has been replaced and new vehicle keys are being reused	-
Engine Control Module IMMO Learn	The ECM will relearn the immobilizer passwords and data	The ECM has been replaced or a diagnostic has instructed to perform the learn	-
Engine Control Module and Body Control Module IMMO Learn	The ECM and BCM will learn new immobilizer passwords and data	Both the ECM and BCM have been replaced (this selection will REQUIRE new vehicle keys be used)	Because both the ECM and BCM have been replaced and are learning new immobilizer passwords and data, all vehicle keys must also be replaced
Program Transponder or Remote Key (Add)	A new vehicle key will learn the immobilizer passwords and data	A new vehicle key is being added (does not affect other vehicle keys)	This function may not be available in all sales regions
Program Transponder or Remote Key (Delete)	All existing vehicle keys will be invalidated and any desired keys are relearned	All vehicle keys are desired to be invalidated and certain keys relearned or a diagnostic has instructed to perform the learn	This procedure may be used if a customer has had their keys lost or stolen and wishes to invalidate the keys, making them unable to start the vehicle

1. Connect a scan tool to the vehicle and access SPS.
2. Turn ON the ignition, with the engine OFF.
3. Ensure that all power consuming devices are turned OFF on the vehicle.
4. Select SPS application and follow the on-screen instructions.
5. Select Reprogram ECU.
6. Select IMMO Immobilizer Learn - Setup.

7. Select the appropriate programming function based on the component that was replaced or is being programmed. Refer to the table at the top of this document for assistance in choosing the correct programming function.

NOTE:

- **At multiple times during the learn procedure, SPS will instruct you to turn the ignition to the run position. Make sure the vehicle is actually in the run mode before continuing on the SPS terminal. If the ignition is not in the run mode, the learn procedure will fail. To verify the vehicle is in Run mode, verify the green LED is illuminated on the ignition mode switch.**
- **The key pocket is located inside the center console storage area, under the cup holder. To access the pocket, remove the rubber cup holder liner. Place the key into the pocket with the buttons facing up.**

8. Follow the on-screen instructions.

NOTE:

If the programming does not complete or hangs during the programming operation, refer to Unable to Complete Programming below.

9. After programming all keys "Programming Complete" is displayed.
10. Press and hold the ignition mode switch for 15 seconds.
11. Press the lock and unlock button on each transmitter that was programmed. This will awaken each transmitter and allow passive and active keyless entry functions to be established.
12. With a scan tool, clear any DTCs.
13. Verify each key is operating properly. Operate each of the keyless entry functions using the buttons on the transmitter and then start the vehicle. When verifying operation, make sure that no other keys are near the vehicle.

Unable to Complete Programming

When attempting to program immobilizer components, various conditions may prevent the programming operation from completing. These conditions may be caused by normal system operation, a system malfunction, or an external influence. Common symptoms of a incomplete programming is receiving an error message during the attempt or having the SPS application become unresponsive.

- DTCs are set in the body control module (BCM)

The immobilizer system is a function of the BCM software. If immobilizer DTCs are set in the BCM, such as DTC B2955, a fault has been identified in the immobilizer system. If this is not corrected before attempting to program components, the programming may not complete. Correct all immobilizer DTCs before attempting to program any immobilizer components.

- The key has been programmed to another vehicle or is not the correct type for the vehicle

A key can only be programmed to a single vehicle. Once a key is programming to a vehicle, it is paired

for the life of the key. The key can be learned to the same vehicle again and again, but it is not able to be programmed to a different vehicle.

Many vehicle are available with both a base keyless entry system and an optional passive entry system. These keys typically look identical but cannot be substituted for one another. To verify the key is correct, compare the part number that is etched on the key to the part number identified in the parts catalog. The key should be correct for the system installed in the vehicle.

- The theft deterrent module is not properly secured or the key is not properly positioned in the pocket/slot.

A theft deterrent module that is not fully seated or is otherwise not properly secured may prevent a coupling between the transponder located in the key and the theft deterrent module. Being out of place by as little as 1 mm may prevent programming from completing. Make sure the theft deterrent module is properly installed and fully seated in it's clip.

The key should be positioned in the proper orientation so that it lays flat in the pocket. If a large key ring or other item attached to the key prevents the key from laying flat, remove the key ring.

To determine if the theft deterrent module is properly secured, remove the battery from the key and place the key into the pocket/slot. Attempt to change the vehicle mode by pressing the vehicle ON/OFF switch. The vehicle should change modes. If the NO REMOTE DETECTED message is displayed on the DIC, the theft deterrent module may not be properly secured.

- External interference is interrupting the programming operation

External RF interference and EMI may interrupt the low frequency coupling between the key and theft deterrent module. This interference may come from many different locations. Devices plugged into the vehicle power outlets such as cell phone chargers, laptop computers, GPS devices, etc. may cause interference. Vehicle location may also cause interference. Locations near airports and military installations may causer interference. Remove all customer installed devices and, if necessary, move the vehicle if interference is suspected.

IMMOBILIZER SYSTEM COMPONENT PROGRAMMING (WITHOUT BTM)

This procedure will learn the immobilizer function. If the battery voltage is low, charge the battery before proceeding with the learn. If the body control module (BCM) or engine control module (ECM) have been replaced, they must be programmed before performing this learn procedure.

Depending on the immobilizer function being learned or the component replaced, different learn functions are required to be performed. These learn functions are as follows:

Immobilizer System Component Programming (without BTM)

Function name on SPS tool:	Function description:	When the function should be used:	Notes:
Body Control Module IMMO Function with	The BCM will relearn the immobilizer passwords	The BCM has been replaced and the existing vehicle keys are being	-

Existing Transponder or Remote Key	and data while reusing the existing vehicle keys	reused or a diagnostic has instructed to perform the learn	
Body Control Module IMMO Function with New Transponder or Remote Key	The BCM will relearn the immobilizer passwords and data while using new vehicle keys	The BCM has been replaced and new vehicle keys are being reused	-
Engine Control Module IMMO Learn	The ECM will relearn the immobilizer passwords and data	The ECM has been replaced or a diagnostic has instructed to perform the learn	-
Engine Control Module and Body Control Module IMMO Learn	The ECM and BCM will learn new immobilizer passwords and data	Both the ECM and BCM have been replaced (this selection will REQUIRE new vehicle keys be used)	Because both the ECM and BCM have been replaced and are learning new immobilizer passwords and data, all vehicle keys must also be replaced
Program Transponder or Remote Key (Add)	A new vehicle key will learn the immobilizer passwords and data	A new vehicle key is being added (does not affect other vehicle keys)	This function may not be available in all sales regions. Refer to the SPS application to determine if a particular vehicle is able to add keys using this method.
Program Transponder or Remote Key (Delete)	All existing vehicle keys will be invalidated and any desired keys are relearned	All vehicle keys are desired to be invalidated and certain keys relearned or a diagnostic has instructed to perform the learn	This procedure may be used if a customer has had their keys lost or stolen and wishes to invalidate the keys, making them unable to start the vehicle

1. Connect a scan tool to the vehicle and access SPS.
2. Turn ON the ignition, with the engine OFF.
3. Ensure that all power consuming devices are turned OFF on the vehicle.
4. Select SPS application and follow the on-screen instructions.
5. Select Reprogram ECU.
6. Select IMMO Immobilizer Learn - Setup.
7. Select the appropriate programming function based on the component that was replaced or is being programmed. Refer to the table at the top of this document for assistance in choosing the correct programming function.
8. Follow the on-screen instructions.
9. After programming all keys "Programming Complete" is displayed.

10. Press the lock and unlock button on each transmitter that was programmed. This will awaken each transmitter and allow keyless entry functions to be established.
11. With a scan tool, clear any DTCs.
12. Verify each key is operating properly. Operate each of the keyless entry functions using the buttons on the transmitter and then start the vehicle. When verifying operation, make sure that no other keys are near the vehicle.

KEY WITH INTEGRATED TRANSMITTER PROGRAMMING (WITH BTM)

Keys can be programming in various ways using the procedures outlined below. Using the Replacing Keys procedure will first erase all the known keys from the vehicle. Any existing keys and any new keys will then be programmed. This procedure should be used any time a key is required to be unlearned or erased from a vehicle. If a new key is being learned to a vehicle to replace a damaged, inoperative, missing, or stolen key, the Replacing Keys procedure must be used. This ensures that the old key cannot be used to access or start the vehicle after programming.

The Adding Keys procedure does not erase any keys prior to programming. The procedure will simply program the key into the next available slot. The Adding Keys procedure should only be used when adding an additional keys to the vehicle. The Adding Keys procedure should never be used to program a key to a vehicle that is having a key replaced, regardless of the cause for the replacement.

Replacing Keys (Without SPS)

NOTE:

- **This procedure will unlearn all previously learned keys. All keys that are to be programmed must be with the vehicle.**
- **A total of eight keys maybe be learned to a single vehicle.**
- **This procedure will only learn the vehicle key information. This procedure will not learn any immobilizer information between the body control module (BCM) and engine control module (ECM).**
- **This procedure may be used with or without existing learned keys being present. If existing keys are present, keep the keys away from the vicinity of the vehicle. Failure to keep learned keys away from the vehicle will result in the learn changing to the Adding Keys procedure.**
- **The keys to be learned must duplicate the mechanical cut of the current key.**

1. Insert the mechanical key of the new key into the key lock cylinder located on the outside of the driver door and turn the key to the unlock position five times within ten seconds. The Driver Information Center (DIC) will display Remote Learn Pending, Please Wait.
2. After ten minutes, the DIC will display Press Engine Start Button To Learn. Press the ignition mode switch. The DIC will again display Remote Learn Pending, Please Wait.
3. Repeat Step 2 two additional times, for a total of thirty minutes. All previously known keys have now been unlearned. Remaining keys can be learned during the next steps. The DIC display will now display Ready For Remote # 1.

NOTE: The key pocket is located inside the center console storage area, under the cup holder. To access the pocket, remove the rubber cup holder liner. Place the key into the pocket with the buttons facing up.

4. Place the new key into the key pocket.

NOTE: If the programming does not complete or hangs during the programming operation, refer to Unable to Complete Programming below.

5. Press the ignition mode switch. When the key is learned the DIC will indicate that it is ready to program the next key.
6. Remove the key from the key pocket and press the unlock button. To program additional keys, repeat Steps 4 through 6.
7. When all additional keys are programmed, press and hold the ignition mode switch for 5 seconds to exit programming mode.

Replacing Keys (With SPS)

NOTE:

- This procedure will unlearn all previously learned keys. All keys that are to be programmed must be with the vehicle.
- This procedure may be used with or without existing learned keys being present. If no existing keys are available, this procedure must be used.
- A total of eight keys maybe be learned to a single vehicle.
- This procedure will only learn the vehicle key information. This procedure will not learn any immobilizer information between the body control module (BCM) and engine control module (ECM).
- If the battery voltage is low, charge the battery before continuing with the procedure.

1. Connect a scan tool to the vehicle and access SPS.
2. Ensure that all power consuming devices are turned OFF on the vehicle.
3. Select the SPS application and follow the on-screen instructions.
4. Select Reprogram ECU.
5. Select IMMO Immobilizer Learn - Setup.
6. Select the Program Transponder or Remote Key (Delete) function.

NOTE:

- At multiple times during the learn procedure, SPS will instruct you to turn the ignition to the run position. Make sure the vehicle is actually in the run mode before continuing on the SPS terminal. If the ignition is not in the run mode, the learn procedure will fail.
- The key pocket is located inside the center console storage area, under the cup holder. To access the pocket, remove the rubber cup holder liner. Place the key into the pocket with the buttons facing up.

7. Follow the on-screen instructions.

NOTE: If the programming does not complete or hangs during the programming operation, refer to Unable to Complete Programming below.

8. After programming all keys, Programming Complete, is displayed.
9. Press and hold the ignition mode switch for 15 seconds.
10. Press the lock and unlock button on each key that was programmed. This will awaken each key and allow passive and active keyless entry functions to be established.
11. With a scan tool, clear any DTCs.
12. Verify each key is operating properly. Operate each of the keyless entry functions using the buttons on the key and then start the vehicle. When verifying operation, make sure that no other keys are near the vehicle.

Adding Keys (Without SPS)

- NOTE:**
- To initiate, this procedure requires that 1 learned key be available.
 - A total of eight keys maybe be learned to a single vehicle.
 - This procedure adds keys only. The procedure does not erase previously learned keys.
 - The keys to be learned must duplicate the mechanical cut of the current key.

1. Place the recognized key(s) in the vehicle cupholder.
2. Insert the mechanical key of the new key into the key lock cylinder located on the outside of the driver door and turn the key to the unlock position five times within ten seconds. The Driver Information Center (DIC) will display Ready For Remote #2, 3, 4 or 5.

NOTE: The key pocket is located inside the center console storage area, under the cup holder. To access the pocket, remove the rubber cup holder liner. Place the key into the pocket with the buttons facing up.

3. Place the new key into the key pocket.

NOTE: If the programming does not complete or hangs during the programming operation, refer to Unable to Complete Programming below.

4. Press the ignition mode switch. When the key is learned the DIC will indicate that it is ready to program the next key.
5. Remove the key from the key pocket and press the unlock button. To program additional keys, repeat Steps 3 through 5.
6. When all additional keys are programmed, press and hold the ignition mode switch for 5 seconds to exit programming mode.

Adding Keys (With SPS)

NOTE:

- This procedure may be used with or without existing learned keys being present. If no existing keys are available, this procedure must be used.
- A total of eight keys maybe be learned to a single vehicle.
- This procedure will only learn the vehicle key information.
- If the battery voltage is low, charge the battery before continuing with the procedure.

1. Connect a scan tool to the vehicle and access SPS. .
2. Ensure that all power consuming devices are turned OFF on the vehicle.
3. Select the SPS application and follow the on-screen instructions.
4. Select Reprogram ECU.
5. Select IMMO Immobilizer Learn - Setup.
6. Select the Program Transponder or Remote Key (Add) function.

NOTE:

- At multiple times during the learn procedure, SPS will instruct you to turn the ignition to the run position. Make sure the vehicle is actually in the run mode before continuing on the SPS terminal. If the ignition is not in the run mode, the learn procedure will fail.
- The key pocket is located inside the center console storage area, under the cup holder. To access the pocket, remove the rubber cup holder liner. Place the key into the pocket with the buttons facing up.

7. Follow the on-screen instructions.

NOTE:

If the programming does not complete or hangs during the programming operation, refer to Unable to Complete Programming below.

8. After programming all keys, Programming Complete, is displayed.
9. Press and hold the ignition mode switch for 15 seconds.
10. Press the lock and unlock button on each key that was programmed. This will awaken each key and allow passive and active keyless entry functions to be established.
11. With a scan tool, clear any DTCs.
12. Verify each key is operating properly. Operate each of the keyless entry functions using the buttons on the key and then start the vehicle. When verifying operation, make sure that no other keys are near the vehicle.

Unable to Complete Programming

When attempting to program immobilizer components, various conditions may prevent the programming operation from completing. These conditions may be caused by normal system operation, a system malfunction, or an external influence. Common symptoms of a incomplete programming is receiving an error message during

the attempt or having the SPS application become unresponsive.

- DTCs are set in the body control module (BCM)

The immobilizer system is a function of the BCM software. If immobilizer DTCs are set in the BCM, such as DTC B2955, a fault has been identified in the immobilizer system. If this is not corrected before attempting to program components, the programming may not complete. Correct all immobilizer DTCs before attempting to program any immobilizer components.

- The key has been programmed to another vehicle or is not the correct type for the vehicle

A key can only be programmed to a single vehicle. Once a key is programming to a vehicle, it is paired for the life of the key. The key can be learned to the same vehicle again and again, but it is not able to be programmed to a different vehicle.

Many vehicle are available with both a base keyless entry system and an optional passive entry system. These keys typically look identical but cannot be substituted for one another. To verify the key is correct, compare the part number that is etched on the key to the part number identified in the parts catalog. The key should be correct for the system installed in the vehicle.

- The theft deterrent module is not properly secured or the key is not properly positioned in the pocket/slot.

A theft deterrent module that is not fully seated or is otherwise not properly secured may prevent a coupling between the transponder located in the key and the theft deterrent module. Being out of place by as little as 1 mm may prevent programming from completing. Make sure the theft deterrent module is properly installed and fully seated in it's clip.

The key should be positioned in the proper orientation so that it lays flat in the pocket. If a large key ring or other item attached to the key prevents the key from laying flat, remove the key ring.

To determine if the theft deterrent module is properly secured, remove the battery from the key and place the key into the pocket/slot. Attempt to change the vehicle mode by pressing the vehicle ON/OFF switch. The vehicle should change modes. If the NO REMOTE DETECTED message is displayed on the DIC, the theft deterrent module may not be properly secured.

- External interference is interrupting the programming operation

External RF interference and EMI may interrupt the low frequency coupling between the key and theft deterrent module. This interference may come from many different locations. Devices plugged into the vehicle power outlets such as cell phone chargers, laptop computers, GPS devices, etc. may cause interference. Vehicle location may also cause interference. Locations near airports and military installations may causer interference. Remove all customer installed devices and, if necessary, move the vehicle if interference is suspected.

KEY WITH INTEGRATED TRANSMITTER PROGRAMMING (WITHOUT BTM)

Keys can be programming in various ways using the procedures outlined below. Using the Replacing Keys procedures will first erase all the known keys from the vehicle. Any existing keys and any new keys will then

be programmed. This procedure should be used any time a key is required to be unlearned or erased from a vehicle. If a new key is being learned to a vehicle to replace a damaged, inoperative, or stolen key, the Replacing Keys procedure must be used. This ensures that the old key cannot be used to access or start the vehicle after programming.

The Adding Keys procedure does not erase any keys prior to programming. The procedure will simply program the key into the next available slot. The Adding Keys procedure should only be used when adding an additional key to the vehicle. The Adding Keys procedure should never be used to program a key to a vehicle that is having a key replaced, regardless of the cause for the replacement.

Replacing Keys (With SPS)

NOTE:

- **This procedure may be used with or without existing learned keys being present.**
- **A total of eight keys maybe be learned to a single vehicle.**
- **This procedure will only learn the vehicle key information. This procedure will not learn any immobilizer information between the body control module (BCM) and engine control module (ECM).**
- **If the battery voltage is low, charge the battery before continuing with the procedure.**

1. Connect a scan tool to the vehicle and access SPS.
2. Ensure that all power consuming devices are turned OFF on the vehicle.
3. Select the SPS application and follow the on-screen instructions.
4. Select Reprogram ECU.
5. Select IMMO Immobilizer Learn - Setup.
6. Select the Program Transponder or Remote Key (Delete) function.
7. Follow the on-screen instructions.
8. After programming all keys, "Programming Complete" is displayed.
9. Press the lock and unlock button on each key that was programmed. This will awaken each key and allow keyless entry functions to be established.
10. With a scan tool, clear any DTCs.
11. Verify each key is operating properly. Operate each of the keyless entry functions using the buttons on the key and then start the vehicle. When verifying operation, make sure that no other keys are near the vehicle.

Replacing Keys (Without SPS) - United States only

NOTE:

- **This procedure should be used without existing learned keys being present.**
- **A total of eight keys maybe be learned to a single vehicle.**
- **This procedure will only learn the vehicle key information. This procedure will not learn any immobilizer information between the body control**

module (BCM) and engine control module (ECM).

- **If the battery voltage is low, charge the battery before continuing with the procedure.**

1. With an unlearned master vehicle key, turn ON the ignition, with the engine OFF.
2. Observe the security indicator, after approximately 10 min the indicator will turn off.
3. Turn OFF the ignition and wait 5 s.
4. Repeat steps 1 - 3 two more times for a total of 3 cycles or 30 min.

NOTE: **The body control module learns the key transponder information upon the ignition transition from OFF to ON. You must turn the ignition OFF before attempting to start the vehicle.**

5. Start the vehicle. The vehicle has now learned the key transponder information.
6. Additional keys may be learned using the Adding Keys procedure.
7. Clear all DTCs.

Adding Keys (Without SPS) - North America, except Canada

- NOTE:**
- **To initiate, this procedure requires that 1 learned key be available.**
 - **A total of eight keys maybe be learned to a single vehicle.**
 - **This procedure adds keys only. The procedure does not erase previously learned keys.**
 - **The keys to be learned must duplicate the mechanical cut of the current key.**

1. With a previously learned key, turn the ignition ON.
2. Turn the ignition OFF and remove the key.
3. Within 10 seconds of turning OFF the ignition, insert the key to be learned and turn ON the ignition. The vehicle has now learned the new key and key.

Adding Keys (Without SPS) - Canada, Europe, South America, Asia, and Middle East

- NOTE:**
- **To initiate, this procedure requires that 2 learned key be available.**
 - **A total of eight keys maybe be learned to a single vehicle.**
 - **This procedure adds keys only. The procedure does not erase previously learned keys.**
 - **The keys to be learned must duplicate the mechanical cut of the current key.**

1. With a previously learned key, turn the ignition ON.
2. Turn the ignition OFF and remove the key.

3. With a second previously learned key, turn the ignition ON.
4. Turn the ignition OFF and remove the key.
5. Within 10 seconds of turning OFF the ignition, insert the key to be learned and turn ON the ignition. The vehicle has now learned the new key and key.

Adding Keys (With SPS) - North America

NOTE:

- **This procedure may be used with or without existing learned keys being present.**
- **A total of eight keys maybe be learned to a single vehicle.**
- **This procedure will only learn the vehicle key information. This procedure will not learn any immobilizer information between the body control module (BCM) and engine control module (ECM).**
- **If the battery voltage is low, charge the battery before continuing with the procedure.**

1. Connect a scan tool to the vehicle and access SPS.
2. Ensure that all power consuming devices are turned OFF on the vehicle.
3. Select the SPS application and follow the on-screen instructions.
4. Select Reprogram ECU.
5. Select IMMO Immobilizer Learn - Setup.
6. Select the Program Transponder or Remote Key (Add) function.
7. Follow the on-screen instructions.
8. After programming all keys, "Programming Complete" is displayed.
9. Press the lock and unlock button on each key that was programmed. This will awaken each key and allow keyless entry functions to be established.
10. With a scan tool, clear any DTCs.
11. Verify each key is operating properly. Operate each of the keyless entry functions using the buttons on the key and then start the vehicle. When verifying operation, make sure that no other keys are near the vehicle.

DESCRIPTION AND OPERATION

IMMOBILIZER DESCRIPTION AND OPERATION

Without BTM

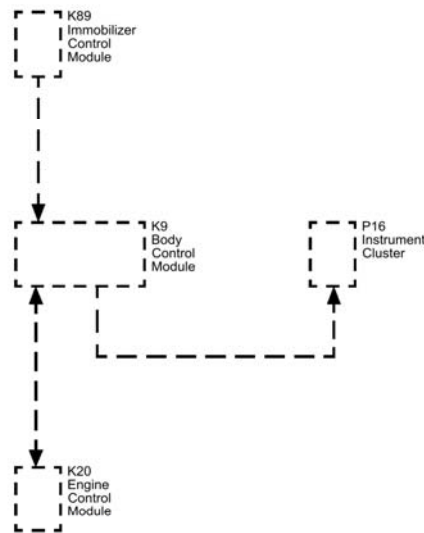


Fig. 4: Immobilizer Diagram Without BTM
 Courtesy of GENERAL MOTORS COMPANY

The immobilizer system functions are provided by the Immobilizer Control Module, the Body Control Module (BCM) and the Engine Control Module (ECM), as well as any modules which store and report the environment identifier.

When an ignition key is inserted into the ignition lock cylinder and the ignition is turned ON, the transponder in the key is energized by the immobilizer coil surrounding the ignition lock cylinder. This immobilizer coil is part of the Immobilizer Control Module. The transponder transmits a signal that contains its unique value, which is received by the BCM through the Immobilizer Control Module. The BCM then compares this value to a value stored in memory. The BCM also monitors various control modules to determine if the stored environment identifiers match.

If both the environment identifier and the value received from the transponder match, the BCM will send the prerelease password via serial data to the ECM. If the encrypted code's unique value is incorrect or the environment identifier does not match, the BCM will send the fuel disable message to the ECM.

When the ECM receives the BCM prerelease password, the ECM will challenge the password. The ECM sends this challenge to the BCM via serial data. Both the ECM and BCM perform a calculation on this challenge. If the BCM calculated response to the challenge equals the calculation performed by the ECM, the ECM will allow vehicle starting.

The components of the immobilizer system are as follows:

- BCM

- ECM
- Immobilizer Control Module
- Ignition key
- Security indicator
- Various control modules which store and report the environment identifier

With BTM

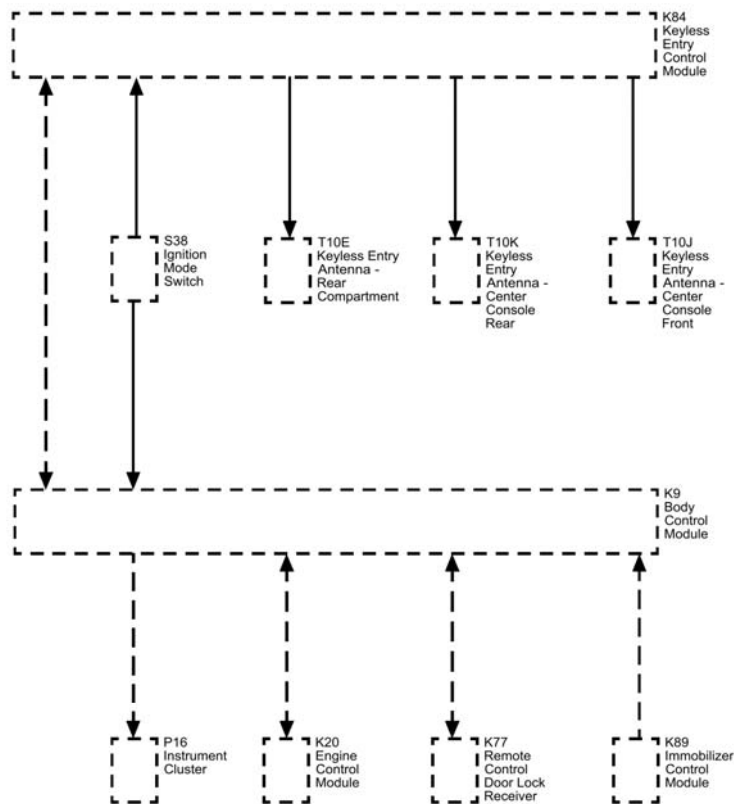


Fig. 5: Immobilizer Diagram With BTM
 Courtesy of GENERAL MOTORS COMPANY

The immobilizer system functions are provided by the Keyless Entry Control Module, the Remote Control Door Lock Receiver, the Immobilizer Control Module, the Body Control Module (BCM) and the Engine Control Module (ECM), as well as any control modules which store and report the environment identifier. The Keyless Entry Control Module uses low frequency antennas in three different locations on the vehicle to determine the location of the transmitter. Multiple antenna are used to ensure complete coverage of the vehicle interior and rear compartment.

When the vehicle ON/OFF switch is pressed, the low frequency antennas emit a challenge to the keyless entry transmitter. The transmitter receives this challenge and emits its response as an RF message. The transmitter transmits a signal that contains its unique value, which is received by the BCM through the Remote Control Door Lock Receiver. The BCM then compares this value to a value stored in memory. The BCM also monitors various control modules to determine if the stored environment identifiers match.

If both the environment identifier and the value received from the transponder match, the BCM will send the prerelease password via serial data to the ECM. If the encrypted code's unique value is incorrect or the environment identifier does not match, the BCM will send the fuel disable message to the ECM.

When the ECM receives the BCM prerelease password, the ECM will challenge the password. The ECM sends this challenge to the BCM via serial data. Both the ECM and BCM perform a calculation on this challenge. If the BCM calculated response to the challenge equals the calculation performed by the ECM, the ECM will allow vehicle starting.

If RF communication is interrupted, a "No Remote Detected" message will be displayed on the DIC. In these cases, the transmitter can be placed in the transmitter slot/slot. The Immobilizer Control Module is located in the immediate vicinity of the transmitter pocket/slot. Placing the transmitter in the pocket/slot will create a low powered coupling between the transmitter and Immobilizer Control Module, allowing communications to occur and enabling vehicle starting.

The components of the immobilizer system are as follows:

- BCM
- ECM
- Remote Control Door Lock Receiver
- Immobilizer Control Module
- Low frequency antenna
- Ignition key/Keyless entry transmitter
- Security indicator
- Various control modules which store and report the environment identifier

Body Control Module (BCM)

The immobilizer system is an integral part of the BCM and is controlled internally within the BCM. The BCM can learn up to 8 keys (transponder values).

The BCM uses the following inputs:

- Environment identifier exchange with various modules
- Encrypted code from the vehicle key, received by the Immobilizer Control Module
- Encrypted code from the vehicle key, received by the Remote Control Door Lock Receiver (with BTM)

The BCM uses the following outputs:

- Prerelease password communication with ECM
- Challenge/response with ECM

When a transponder value is received by the BCM, the BCM will compare this value to the learned key code stored in memory. The BCM then performs one of the following functions:

- If the encrypted code value matches the values stored in the BCM memory, the BCM will send the prerelease password to the ECM via serial data.
- If the encrypted code unique value does not match the value stored in the BCM, the BCM will send the start disable message to the ECM via serial data.
- If the BCM is unable to measure the ignition key encrypted code value, the BCM will not send any messages to the ECM.

Engine Control Module (ECM)

When the ECM receives the BCM prerelease password, the ECM will challenge the password. The ECM sends this challenge to the BCM via the serial data circuit. Both the ECM and BCM perform a calculation on this challenge. If the calculated response from the BCM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

The ECM will disable vehicle starting if any of the following immobilization conditions occur:

- The prerelease password is invalid.
- The start disable password is sent by the BCM.
- No passwords are received. There is no communication with the BCM.
- The BCM calculated response to the challenge does not equal the calculation performed by the ECM.

Immobilizer Control Module

The Immobilizer Control Module contains an immobilizer coil which surrounds the ignition cylinder (without BTM) or is located near the transmitter pocket/slot (with BTM). The coil passively powers the transponder located in the ignition key. When powered, the key transmits its unique value to the Immobilizer Control Module, which is then relayed to the BCM via a LIN serial data circuit. The Immobilizer Control Module also receives B+ and ground from the BCM.

The Immobilizer Control Module is used to:

1. Learn keys
2. To start vehicle with or without RF interference
3. To start vehicle when key battery is dead

Keyless Entry Control Module (with BTM)

The Keyless Entry Control Module uses low frequency antennas in three different locations on the vehicle to determine the location of the transmitter. Multiple antenna are used to ensure complete coverage of the vehicle

interior and rear compartment. The Keyless Entry Control Module monitors the ignition mode switch. When the ignition mode is changed, the Keyless Entry Control Module will command, or "ping", the low frequency antenna.

Low Frequency Antenna (with BTM)

When commanded, or "pinged", the low frequency antenna broadcast a challenge to the keyless entry transmitter. Because of the low power of the antenna, this challenge is only broadcast in an approximate three meter range of the antenna. Multiple antenna are used to ensure complete coverage of the vehicle interior and rear compartment.

Remote Control Door Lock Receiver (with BTM)

When the keyless entry transmitter is challenged by a low frequency antenna, it responds by emitting a response as an RF message. The transmitter transmits a signal that contains its unique value, which is received by the Remote Control Door Lock Receiver. The Remote Control Door Lock Receiver relays this information to the BCM via a discreet serial data circuit.

Ignition Key or Keyless Entry Transmitter

Each ignition key or keyless entry transmitter contains a transponder with a unique encrypted value. The transponder's encrypted value is fixed and unable to be changed. The immobilizer system uses the ignition key transponder value to determine if a valid ignition key is being used to start the vehicle.

Environment Identifier

Various modules throughout the vehicle learn a specific environment identifier during the module programming process. The environment identifier is learned by each individual module and matches the environment identifier stored in the BCM. Prior to starting after a battery disconnect, each of the modules which store an environment identifier will compare their identifier to that of the identifier stored in the BCM. If all the identifiers match, the engine starting process will continue. If the environment identifiers do not match, engine starting will be disabled.

Security Indicator

The BCM will command the Instrument Cluster to illuminate the security indicator when the ignition key is in the ON position to indicate a fault has occurred within the immobilizer system and when the engine starting is disabled.

REMOTE VEHICLE SPEED LIMITING DESCRIPTION AND OPERATION

Certain vehicles equipped with OnStar® now have an additional feature that allows for remote limiting of the vehicle's speed. This OnStar® feature is called Stolen Vehicle Slow-Down and is now part of the OnStar® Stolen Vehicle Assistance service. This feature, when used in conjunction with local law enforcement and strict guidelines at the OnStar® Call Center, will slow the vehicle by interacting with the engine control system.

When the engine control system receives a valid request from the OnStar® telematics communications interface module, it will enter into a reduced engine power/vehicle speed limiting mode, which will decelerate the

vehicle. Once the request is active the engine control module begins reducing engine torque to match requested vehicle speed and a REDUCED ENGINE POWER indication is displayed. No DTCs will be set during this process.

ACCESSORIES & EQUIPMENT

Instrument Panel and Console Trim

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Floor Console Cup Holder Fastener	1.2 N.m	11 lb in
Front Floor Console Fastener	2.5 N.m	22 lb in
Heater and Air Conditioning Evaporator and Blower Module Fastener	5 N.m	44 lb in
Instrument Panel Assembly Fastener	9 N.m	80 lb in
Instrument Panel Lower Trim Panel Fastener	2.5 N.m	22 lb in
Instrument Panel Lower Center Trim Panel Fastener	2.5 N.m	22 lb in
Instrument Panel Lower Extension Side Trim Panel Fastener	2.5 N.m	22 lb in
Instrument Panel Tie Bar Assembly Fastener	22 N.m	16 lb ft
Dash Panel Brace Fastener	22 N.m	16 lb ft

REPAIR INSTRUCTIONS

INSTRUMENT PANEL LOWER TRIM PANEL INSULATOR REPLACEMENT

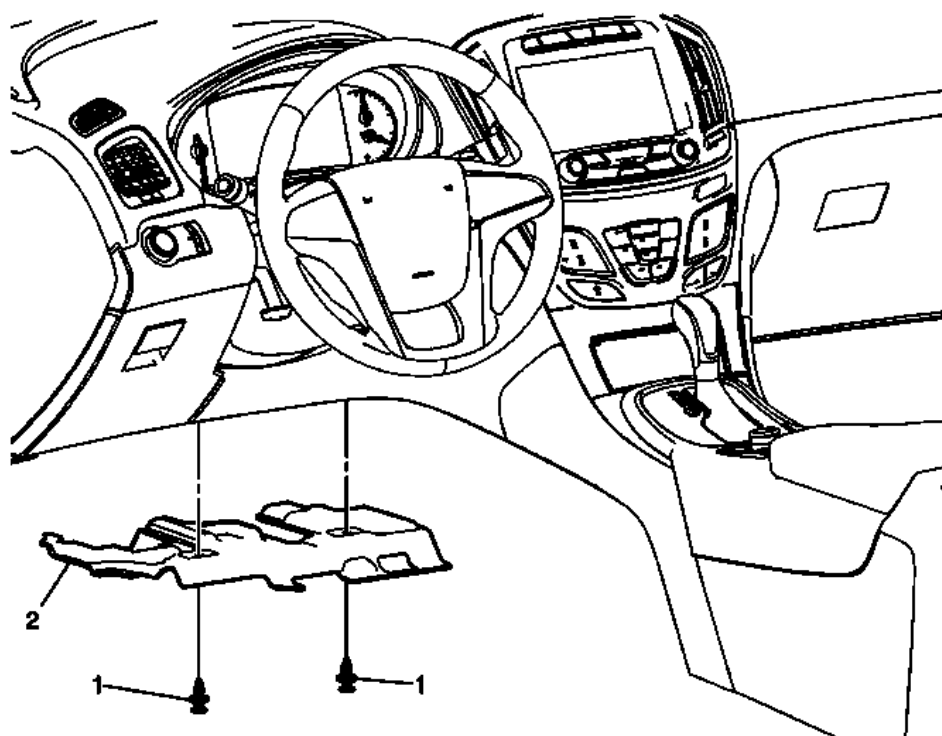


Fig. 1: Instrument Panel Lower Trim Panel Insulator
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Lower Trim Panel Insulator Replacement

Callout	Component Name
1	Instrument Panel Lower Trim Panel Insulator Push-Pin Fasteners (Qty: 2)
2	Instrument Panel Lower Trim Panel Insulator Procedures <ol style="list-style-type: none"> 1. Flex the insulator panel enough to manipulate it out from beneath the instrument panel assembly. 2. Disconnect the electrical connections, if applicable. 3. When replacing the instrument panel lower trim panel insulator, transfer all necessary components.

INSTRUMENT PANEL LOWER EXTENSION COMPARTMENT PANEL REPLACEMENT

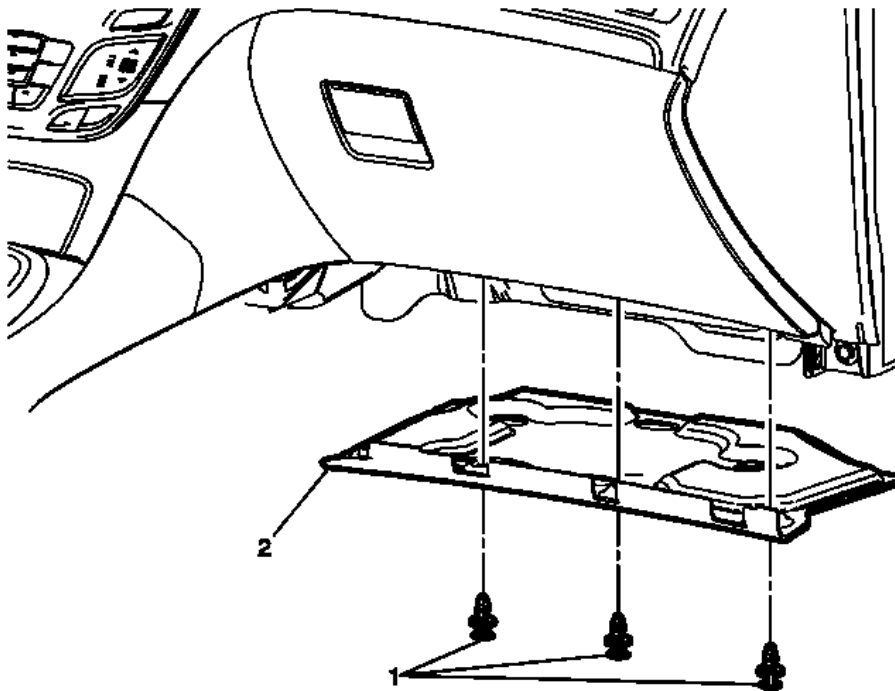


Fig. 2: Instrument Panel Lower Extension Compartment Panel
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Lower Extension Compartment Panel Replacement

Callout	Component Name
1	Instrument Panel Lower Extension Compartment Panel Retainer (Qty: 3)
2	Instrument Panel Lower Extension Compartment Panel Procedures <ol style="list-style-type: none"> 1. Disconnect electrical connections, if applicable. 2. When replacing the instrument panel lower extension compartment panel, transfer all necessary components.

INSTRUMENT PANEL COMPARTMENT LAMP SWITCH ACTUATOR REPLACEMENT

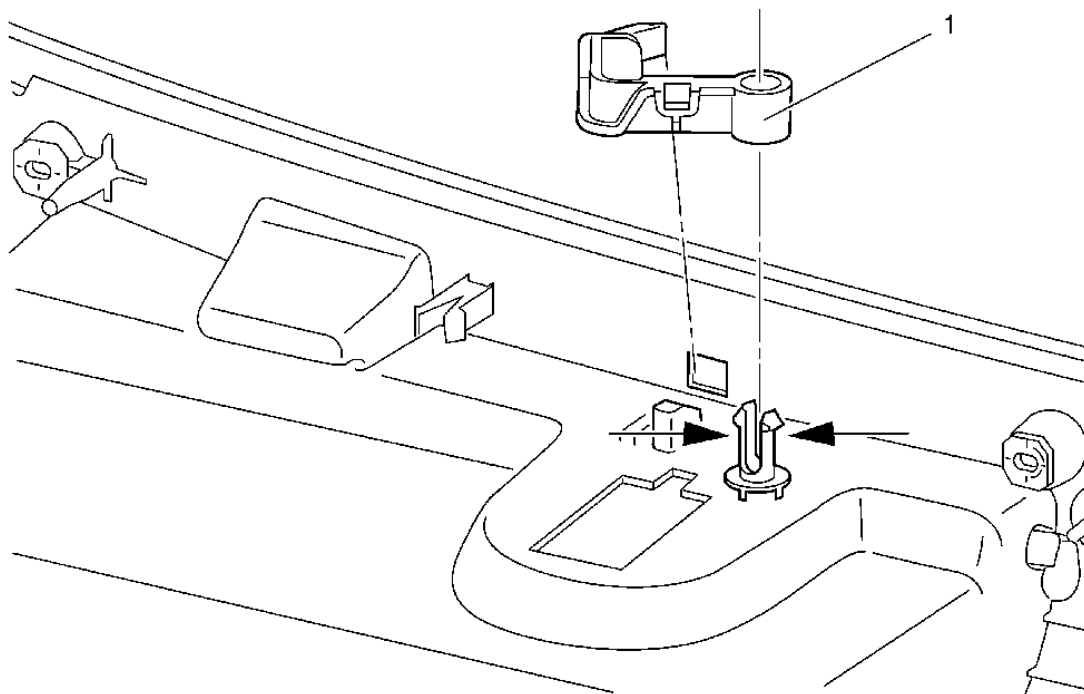


Fig. 3: Instrument Panel Compartment Lamp Switch Actuator
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Compartment Lamp Switch Actuator Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the instrument panel compartment lamp. Refer to <u>Instrument Panel Compartment Lamp Replacement</u> 2. Remove the instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u>	
1	Instrument Panel Compartment Lamp Switch Actuator Procedure Push in the retainers to release the lamp switch actuator from the instrument panel compartment.

INSTRUMENT PANEL OUTER COMPARTMENT REPLACEMENT

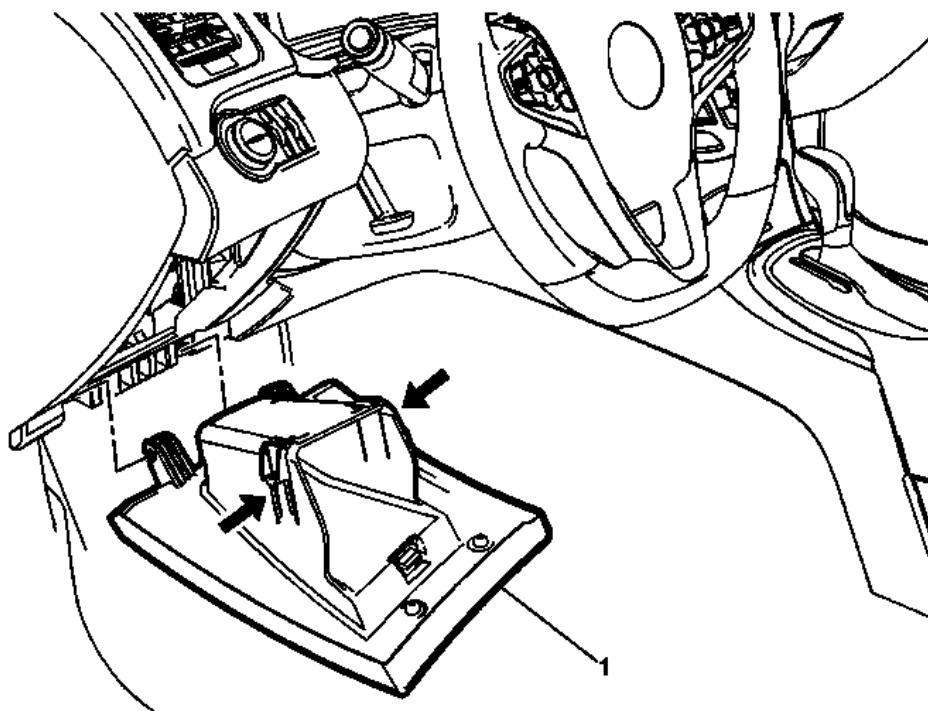


Fig. 4: Instrument Panel Outer Compartment
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Outer Compartment Replacement

Callout	Component Name
1	Instrument Panel Outer Compartment Procedures <ol style="list-style-type: none"> 1. Use an appropriate tool in order to release the tabs allowing the compartment to open past the stops. 2. Unsnap the compartment from the instrument panel lower trim panel.

INSTRUMENT PANEL ACCESSORY TRIM PLATE REPLACEMENT

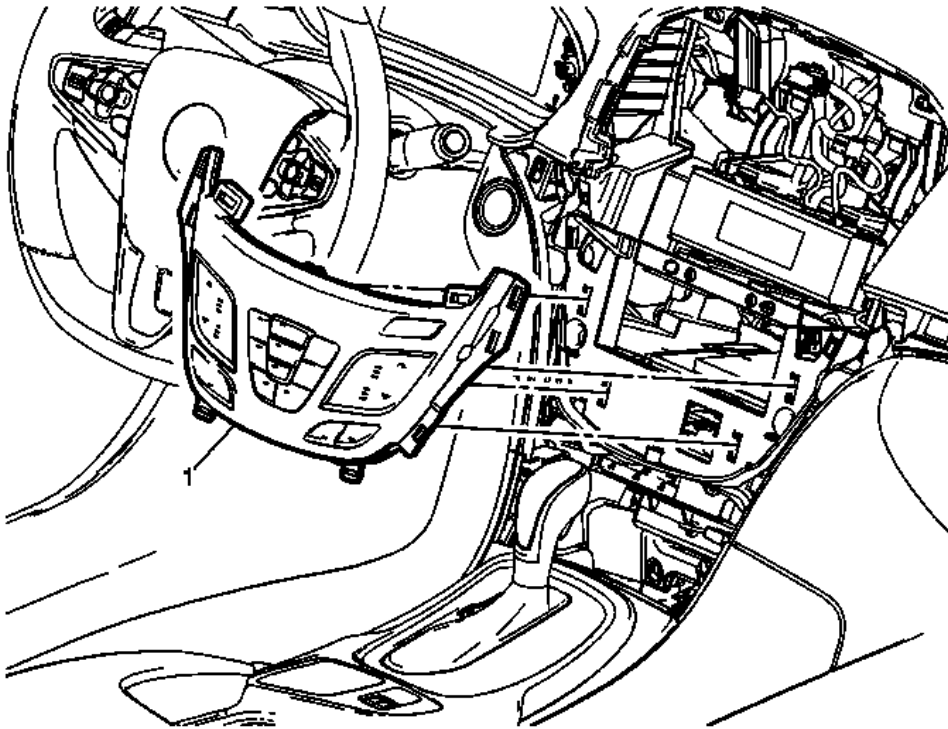


Fig. 5: Instrument Panel Accessory Trim Plate
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Accessory Trim Plate Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the instrument panel upper center trim panel. Refer to <u>Instrument Panel Upper Center Trim Panel Replacement</u>. 2. Remove the driver and passenger side instrument panel center upper molding. Refer to <u>Instrument Panel Center Upper Molding Replacement (Driver Side)</u>, <u>Instrument Panel Center Upper Molding Replacement (Passenger Side)</u>. 	
1	Instrument Panel Accessory Trim Plate Procedures <ol style="list-style-type: none"> 1. Disconnect the electrical connections. 2. When replacing the instrument panel accessory trim plate, transfer all necessary components,

INSTRUMENT PANEL UPPER MOLDING REPLACEMENT

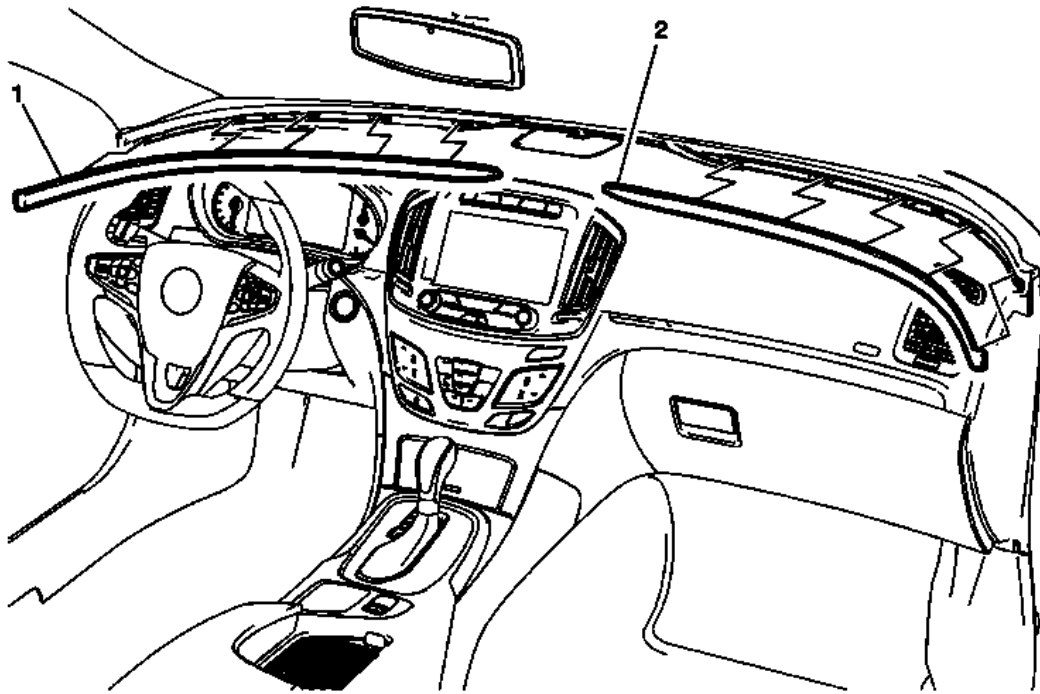


Fig. 6: Instrument Panel Upper Molding
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Upper Molding Replacement

Callout	Component Name
1	Instrument Panel Upper Molding - Left Procedure Use a flat-bladed plastic trim tool to release the instrument panel upper molding from the instrument panel.
2	Instrument Panel Upper Molding - Right Procedure Use a flat-bladed plastic trim tool to release the instrument panel upper molding from the instrument panel.

INSTRUMENT PANEL CENTER UPPER MOLDING REPLACEMENT (DRIVER SIDE)

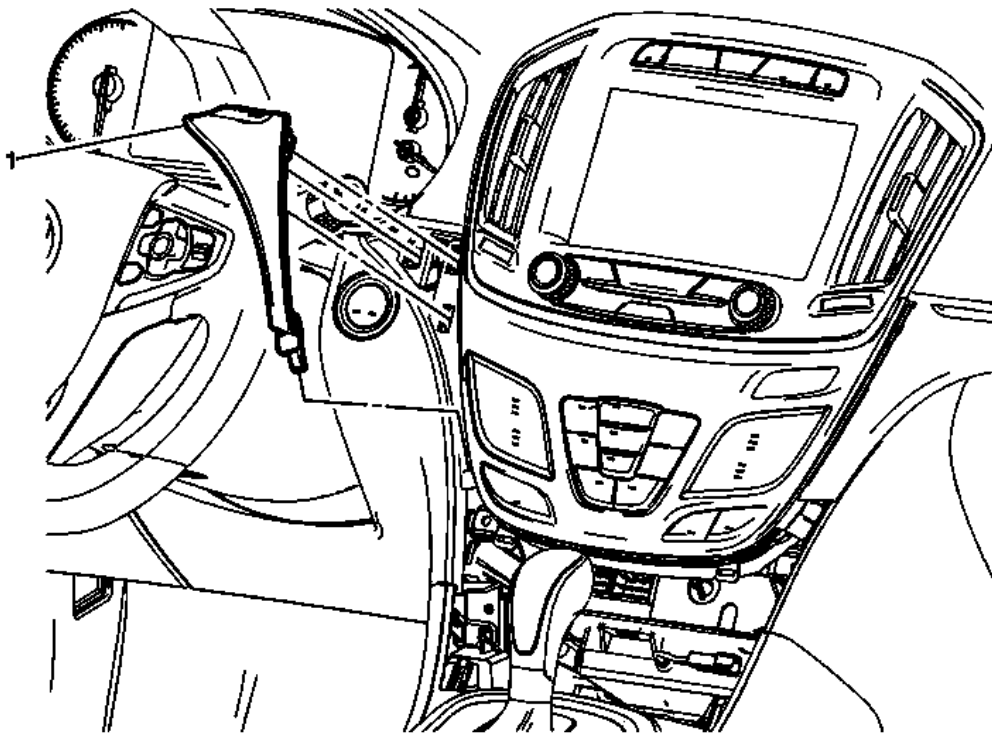


Fig. 7: Instrument Panel Center Upper Molding (Driver Side)
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Center Upper Molding Replacement (Driver Side)

Callout	Component Name
Preliminary Procedure Remove the instrument panel center compartment. Refer to <u>Instrument Panel Center Compartment Replacement</u> .	
1	Instrument Panel Center Upper Molding - Driver Side Procedure Use a flat-bladed plastic trim tool from above to release the instrument panel center upper molding from the instrument panel.

INSTRUMENT PANEL CENTER UPPER MOLDING REPLACEMENT (PASSENGER SIDE)

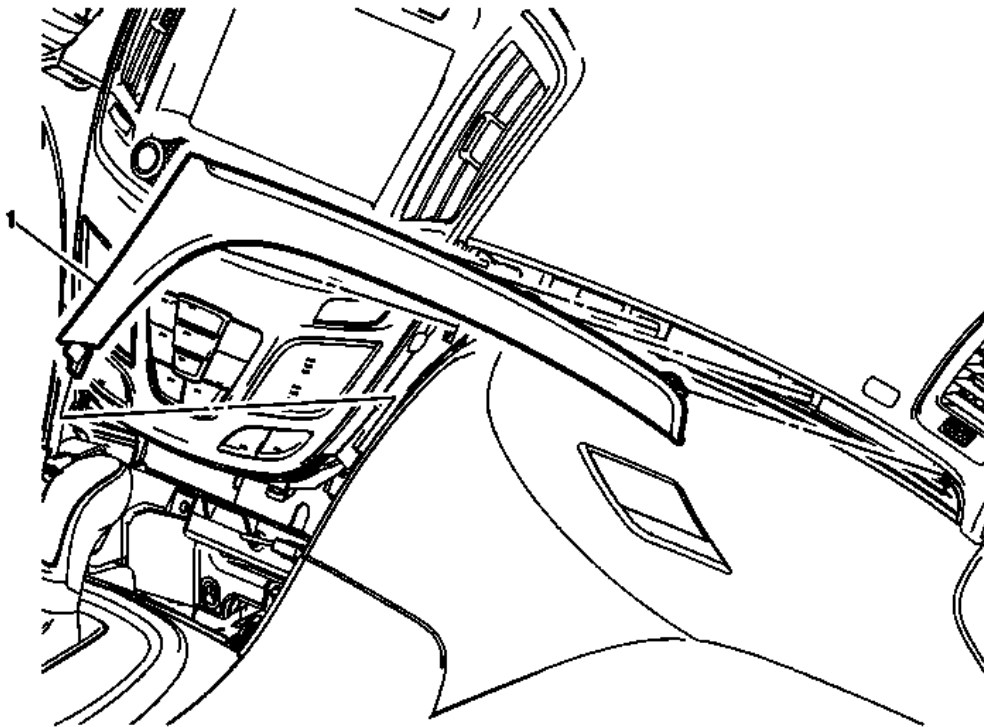


Fig. 8: Instrument Panel Center Upper Molding (Passenger Side)
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Center Upper Molding Replacement (Passenger Side)

Callout	Component Name
Preliminary Procedure Remove the instrument panel center compartment. Refer to <u>Instrument Panel Center Compartment Replacement</u> .	
1	Instrument Panel Center Upper Molding - Passenger Side Procedure Use a flat-bladed plastic trim tool from above to release the instrument panel center upper molding from the instrument panel.

INSTRUMENT PANEL UPPER CENTER TRIM PANEL REPLACEMENT

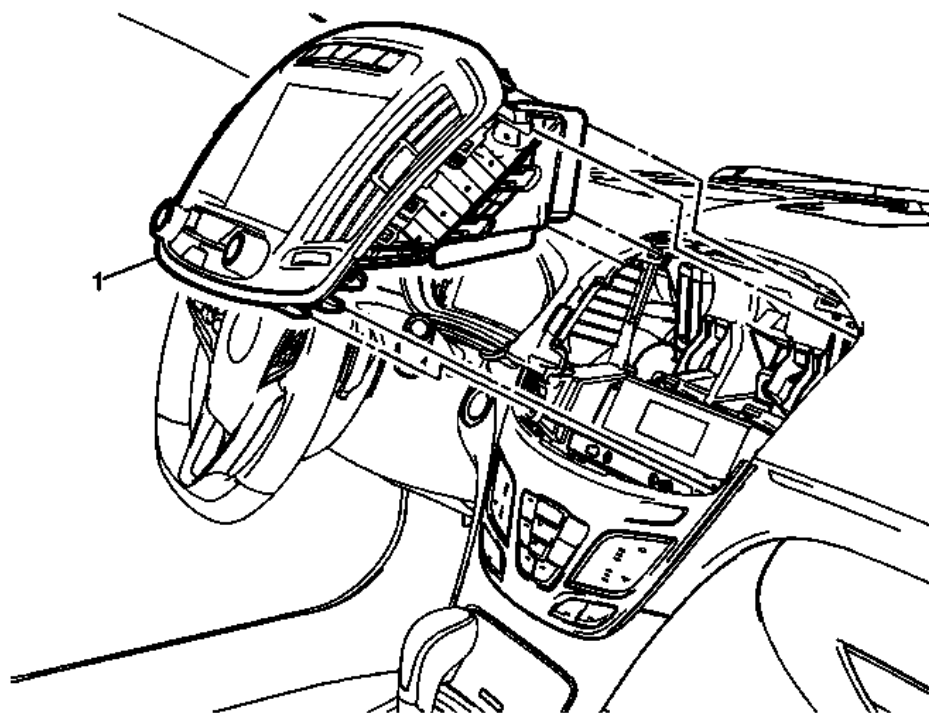


Fig. 9: Instrument Panel Upper Center Trim Panel
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Upper Center Trim Panel Replacement

Callout	Component Name
1	Instrument Panel Upper Center Trim Panel Procedure <ol style="list-style-type: none"> 1. Use a flat-bladed plastic trim tool in order to release the retaining clips securing the instrument panel upper center trim panel to the instrument panel. Start to release the center trim panel in the lower outer area. 2. Disconnect the electrical connections. 3. When replacing the instrument panel upper center trim panel, transfer all necessary parts.

INSTRUMENT PANEL CLUSTER TRIM PLATE REPLACEMENT

Removal Procedure

1. Remove the instrument cluster. Refer to **Instrument Cluster Replacement** .

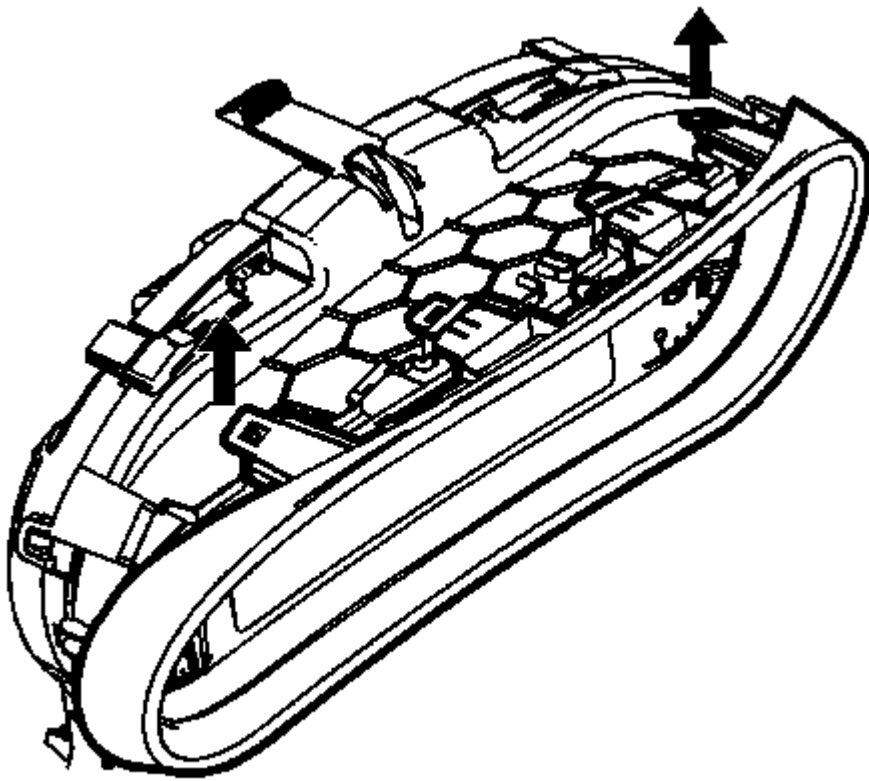


Fig. 10: Instrument Cluster Locking Tab
Courtesy of GENERAL MOTORS COMPANY

2. Release the locking tab from the instrument cluster.

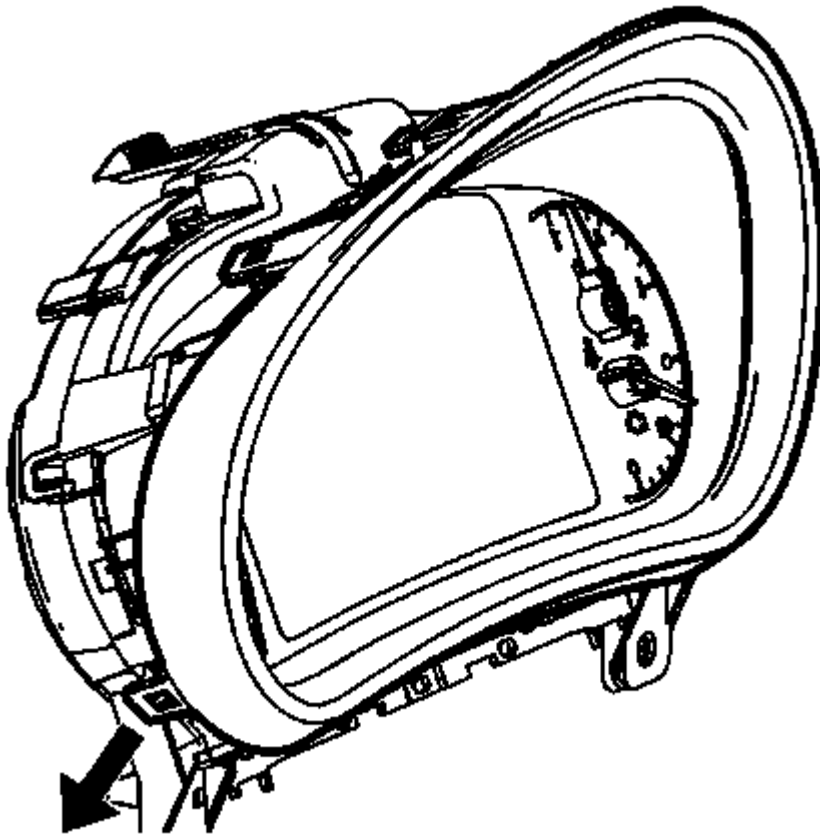


Fig. 11: Instrument Cluster Side Locking Tab
Courtesy of GENERAL MOTORS COMPANY

3. Release the locking tab from both sides of the instrument cluster.

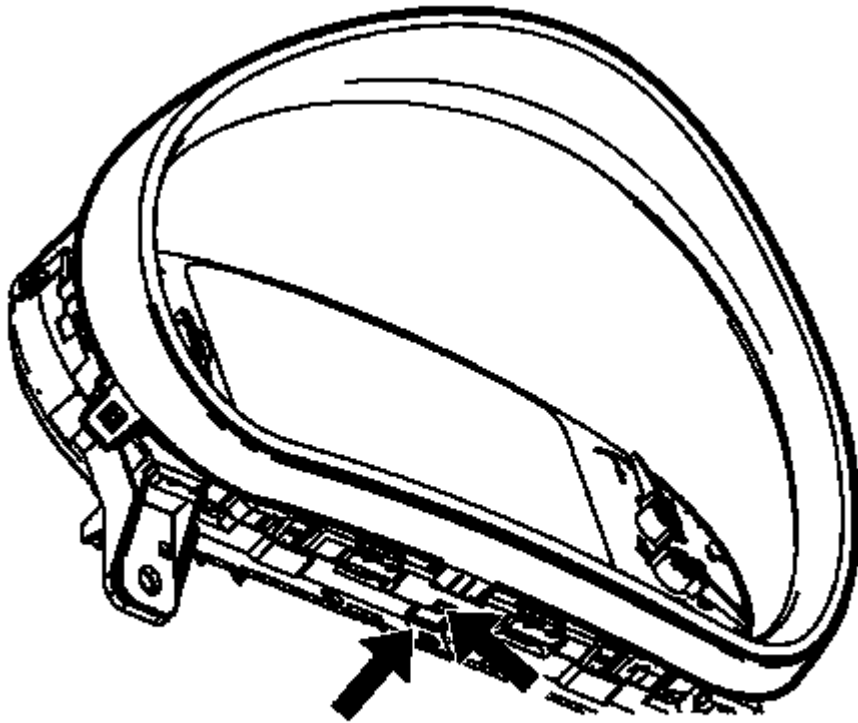


Fig. 12: Instrument Cluster Bottom Tab
Courtesy of GENERAL MOTORS COMPANY

4. Release the tab from the bottom of the instrument cluster.

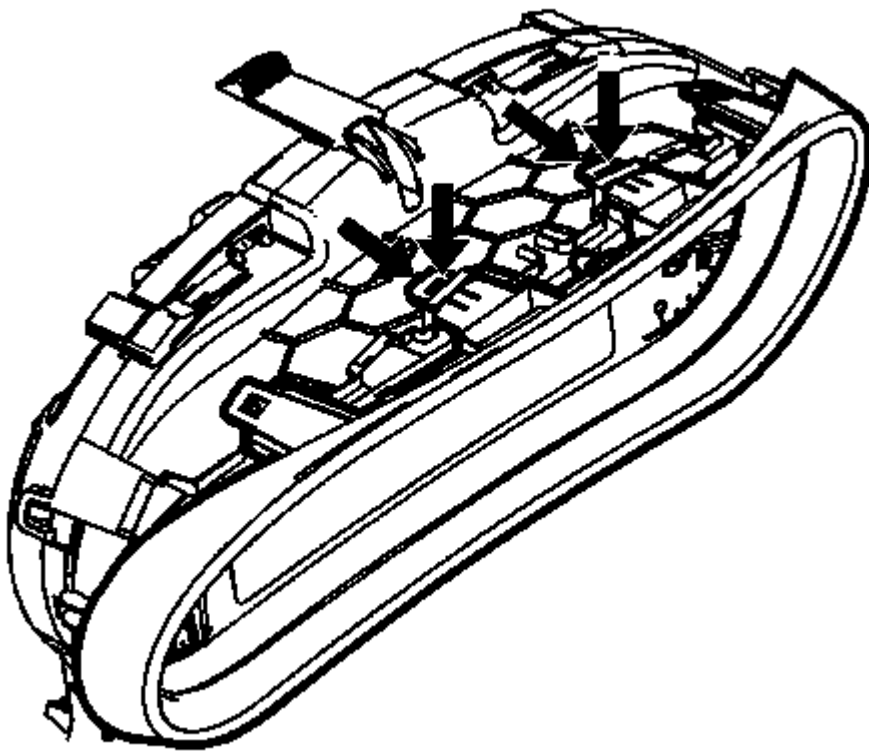


Fig. 13: Instrument Cluster Top Tabs
Courtesy of GENERAL MOTORS COMPANY

5. Release the tabs from the top of the instrument cluster.

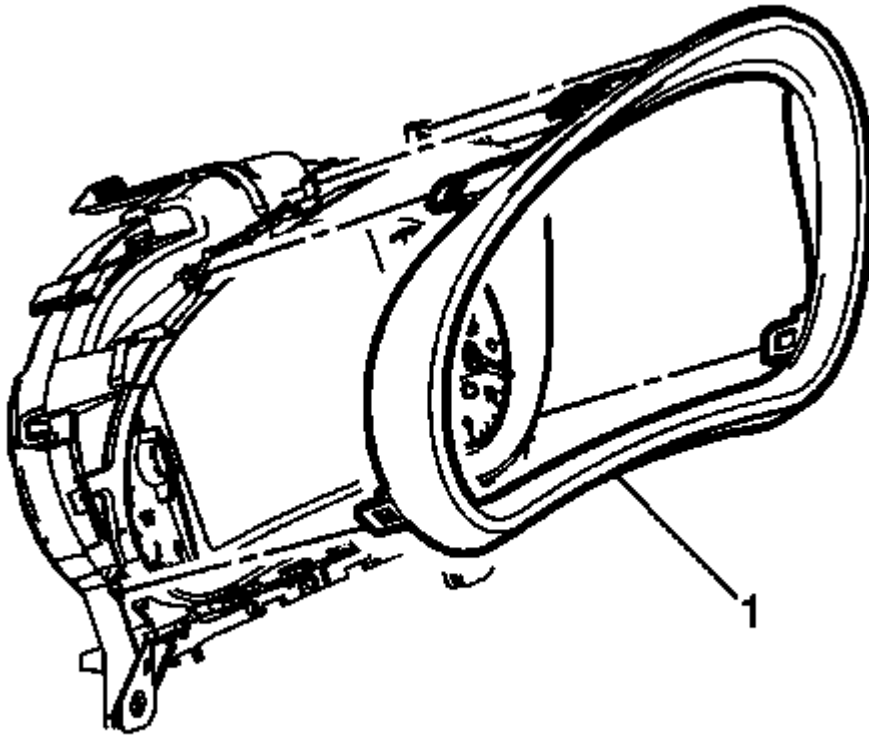


Fig. 14: Instrument Panel Cluster Trim Plate
Courtesy of GENERAL MOTORS COMPANY

6. Remove the instrument panel cluster trim plate (1) from the instrument cluster.

Installation Procedure

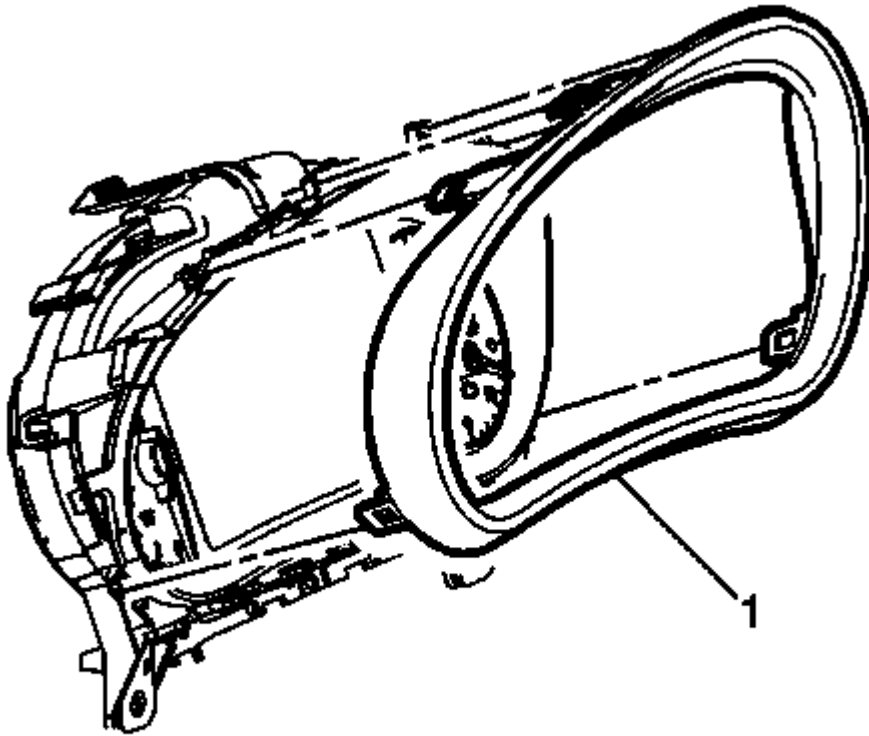


Fig. 15: Instrument Panel Cluster Trim Plate
Courtesy of GENERAL MOTORS COMPANY

1. Install the instrument panel cluster trim plate (1) to the instrument cluster.
2. Install the instrument cluster. Refer to **Instrument Cluster Replacement** .

INSTRUMENT PANEL OUTER TRIM COVER REPLACEMENT - RIGHT SIDE

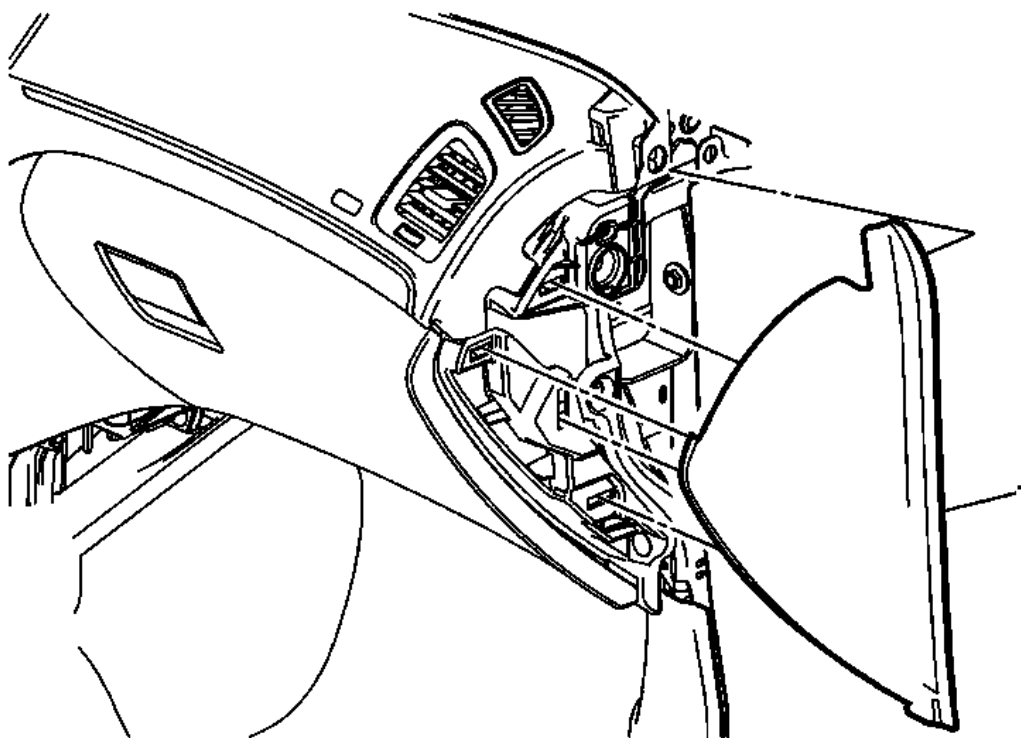


Fig. 16: Instrument Panel Outer Trim Cover - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Outer Trim Cover Replacement - Right Side

Callout	Component Name
1	Instrument Panel Outer Trim Cover
Procedure Use a flat-bladed plastic trim tool to aid in the removal of the outer trim cover.	

INSTRUMENT PANEL OUTER TRIM COVER REPLACEMENT - LEFT SIDE

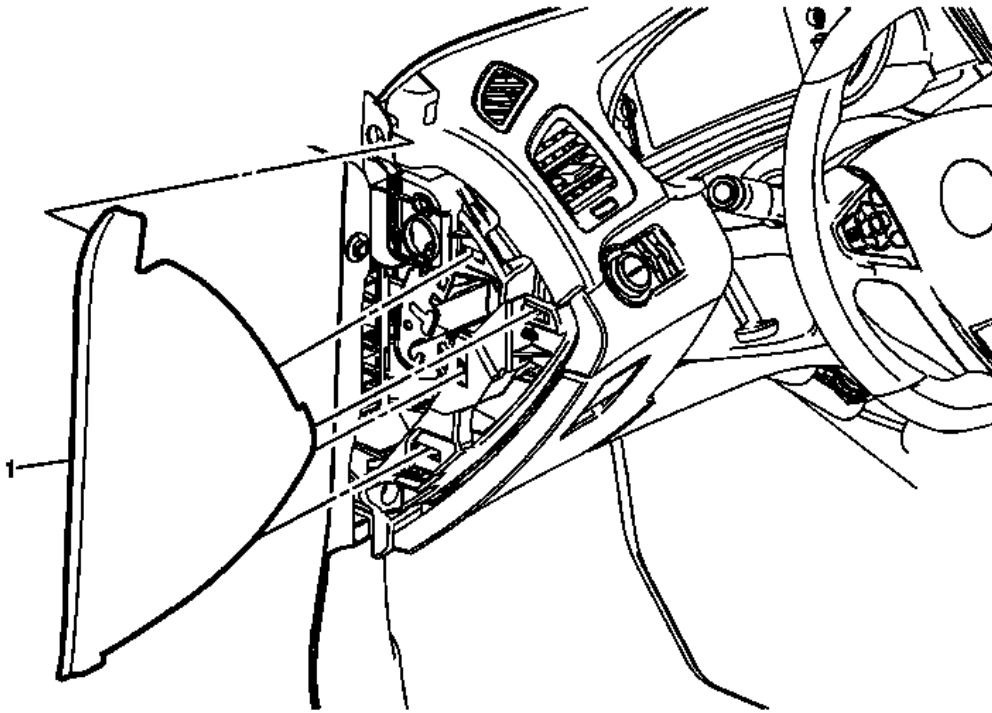


Fig. 17: Instrument Panel Outer Trim Cover - Left Side
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Outer Trim Cover Replacement - Left Side

Callout	Component Name
1	Instrument Panel Outer Trim Cover Procedure Use a flat-bladed plastic trim tool to aid in the removal of the outer trim cover.

INSTRUMENT PANEL LOWER TRIM PANEL REPLACEMENT - LEFT SIDE

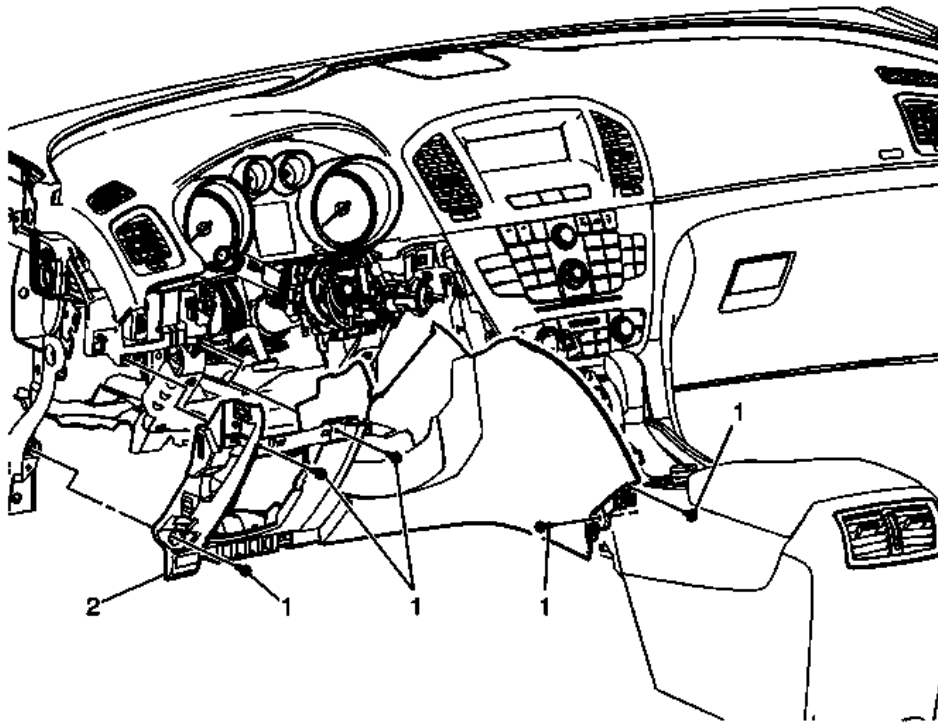


Fig. 18: Instrument Panel Lower Trim Panel - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Lower Trim Panel Replacement - Left Side

Callout	Component Name
Preliminary Procedures	
1. Remove the left instrument panel outer trim cover. Refer to <u>Instrument Panel Outer Trim Cover Replacement - Left Side.</u> 2. Remove the headlamp switch. Refer to <u>Headlamp Switch Molding Replacement.</u> 3. Remove the instrument panel outer compartment. Refer to <u>Instrument Panel Outer Compartment Replacement.</u> 4. Remove the driver side instrument panel center upper molding. Refer to <u>Instrument Panel Center Upper Molding Replacement (Driver Side), Instrument Panel Center Upper Molding Replacement (Passenger Side).</u> 5. Remove the steering column upper trim panel. Refer to <u>Steering Column Trim Cover Replacement .</u> 6. Remove the front floor console left extension panel. Refer to <u>Front Floor Console Extension Panel Replacement.</u>	
1	Instrument Panel Lower Trim Panel Fastener (Qty: 5) CAUTION: Refer to <u>Fastener Caution .</u>

	<p>Tighten 2.5 (22 lb in)</p>
2	<p>Instrument Panel Lower Trim Panel Assembly</p> <p>Procedures</p> <ol style="list-style-type: none"> 1. Disconnect the data link connector. 2. Disconnect the electrical connections, if applicable. 3. When replacing the instrument panel lower trim panel, transfer all necessary components.

INSTRUMENT PANEL LOWER CENTER TRIM PANEL REPLACEMENT

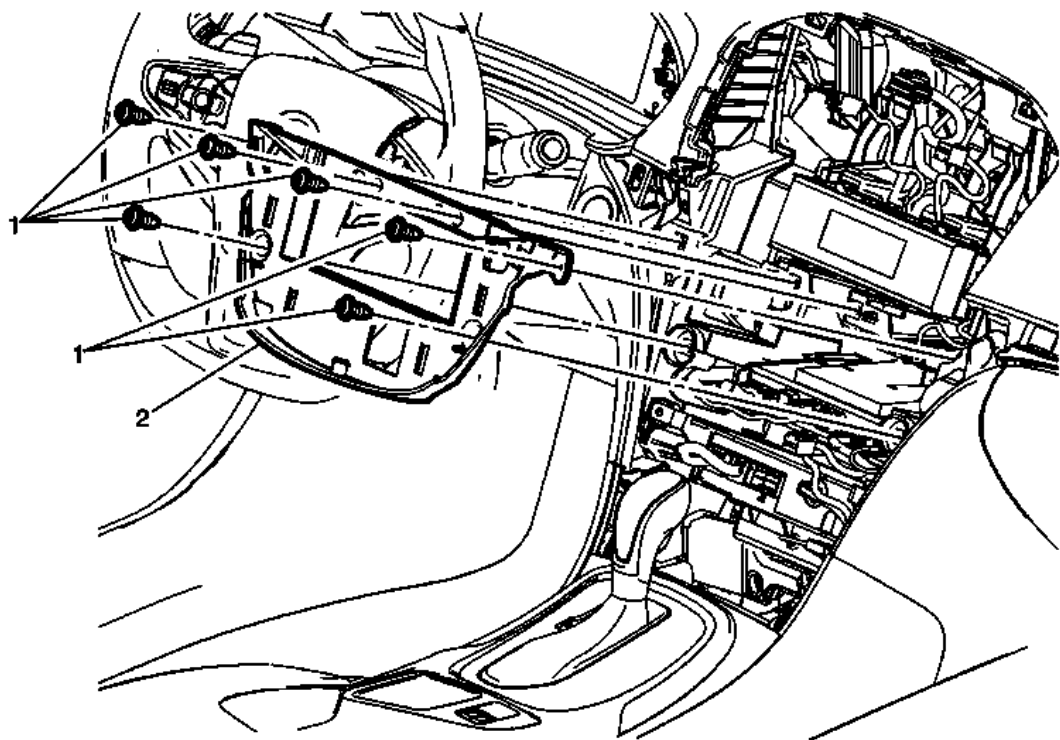


Fig. 19: Instrument Panel Lower Center Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Lower Center Trim Panel Replacement

Callout	Component Name
<p>Preliminary Procedure Remove the instrument panel accessory trim plate. Refer to <u>Instrument Panel Accessory Trim Plate Replacement</u>.</p>	
	Instrument Panel Lower Center Trim Panel Fastener (Qty: 6)

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 (22 lb in)
2	Instrument Panel Lower Center Trim Panel

INSTRUMENT PANEL CENTER COMPARTMENT REPLACEMENT

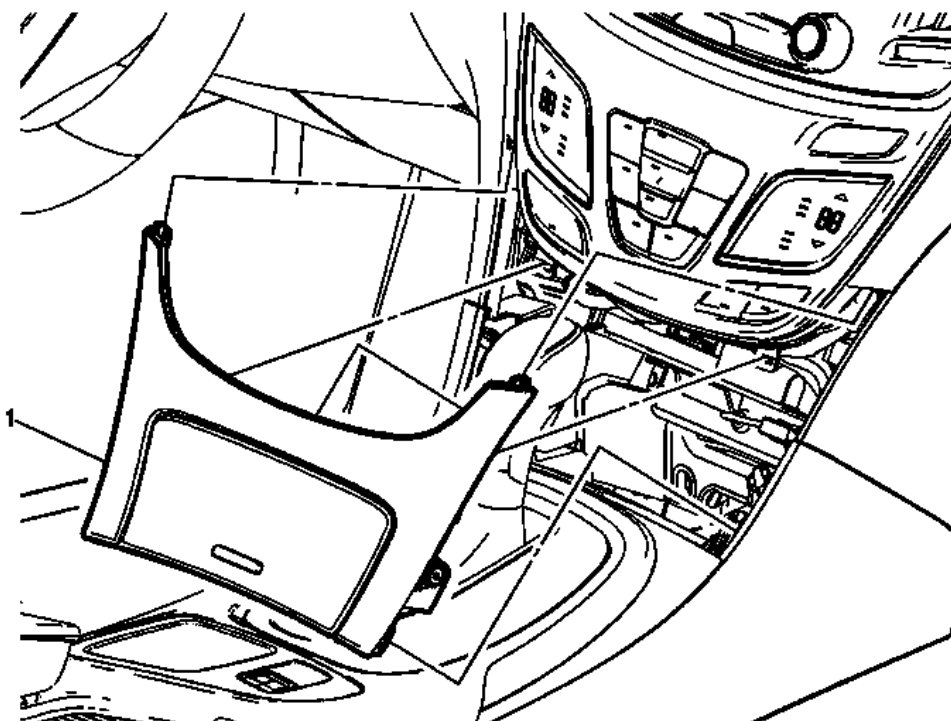


Fig. 20: Instrument Panel Center Compartment
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Center Compartment Replacement

Callout	Component Name
1	Instrument Panel Center Compartment Procedure <ol style="list-style-type: none"> 1. Use a flat-bladed plastic trim tool to release the I/P center compartment from the instrument panel. 2. Disconnect the electrical connections. 3. If replacing the I/P center compartment, transfer all necessary components.

INSTRUMENT PANEL COMPARTMENT REPLACEMENT

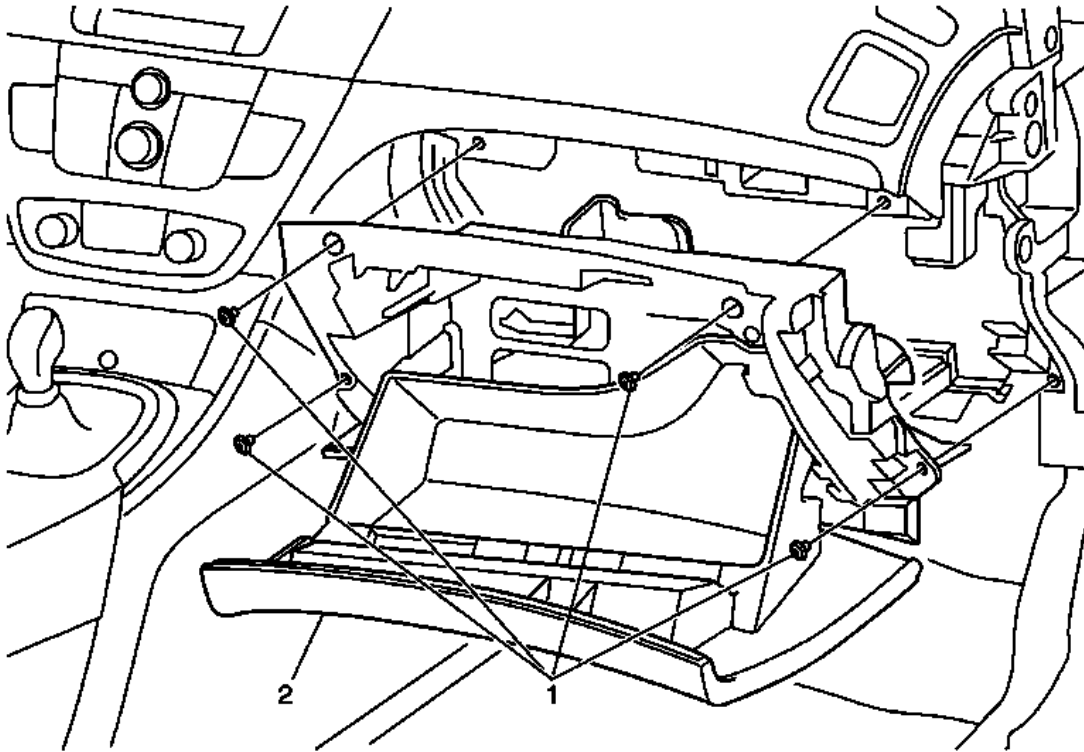


Fig. 21: Instrument Panel Compartment And Fasteners
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Compartment Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Remove the right outer trim cover. Refer to <u>Instrument Panel Outer Trim Cover Replacement - Right Side</u>.2. Remove the instrument panel lower extension compartment panel. Refer to <u>Instrument Panel Lower Extension Compartment Panel Replacement</u>.	
1	Instrument Panel Compartment Assembly Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .
2	Instrument Panel Compartment Assembly Procedure <ol style="list-style-type: none">1. Disconnect the electrical connections.2. When replacing the instrument panel compartment assembly, transfer all necessary components.

INSTRUMENT PANEL COMPARTMENT DOOR ASSEMBLY REPLACEMENT

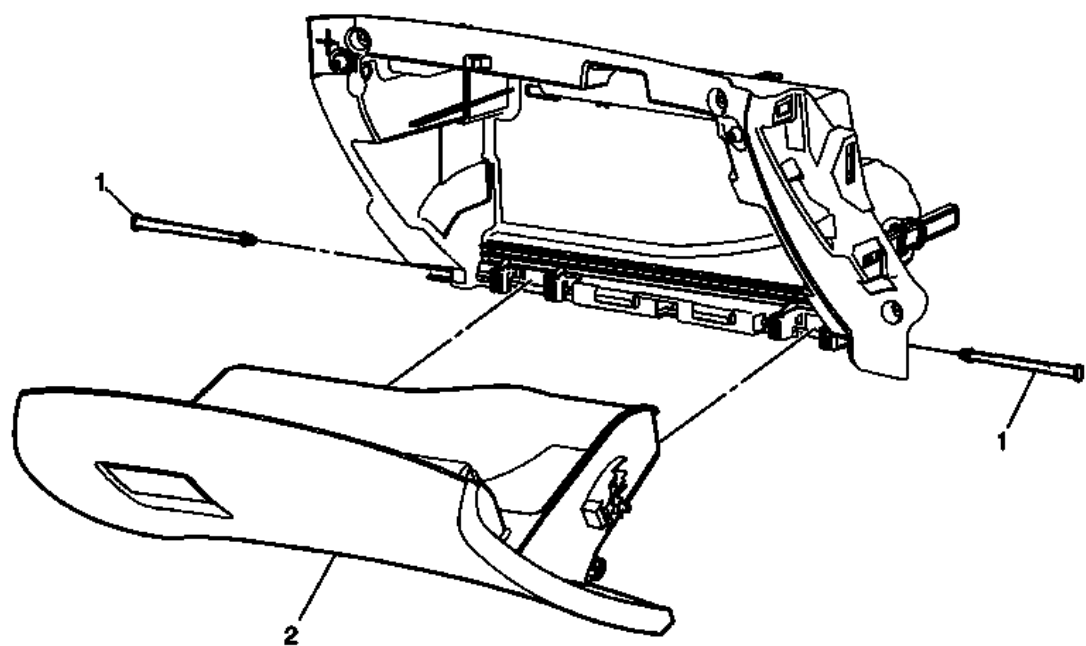


Fig. 22: Instrument Panel Compartment Door Assembly & Hinge Pins
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Compartment Door Assembly Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the instrument panel compartment assembly. Refer to <u>Instrument Panel Compartment Replacement</u> .	
2. Disconnect the compartment door dampener. Refer to <u>Instrument Panel Compartment Door Dampener Replacement</u> .	
1	Instrument Panel Compartment Door Hinge Pin (Qty: 2) Procedure Use an appropriate tool in order to remove the door hinge pins.
2	Instrument Panel Compartment Door Assembly

INSTRUMENT PANEL COMPARTMENT DOOR DAMPENER REPLACEMENT

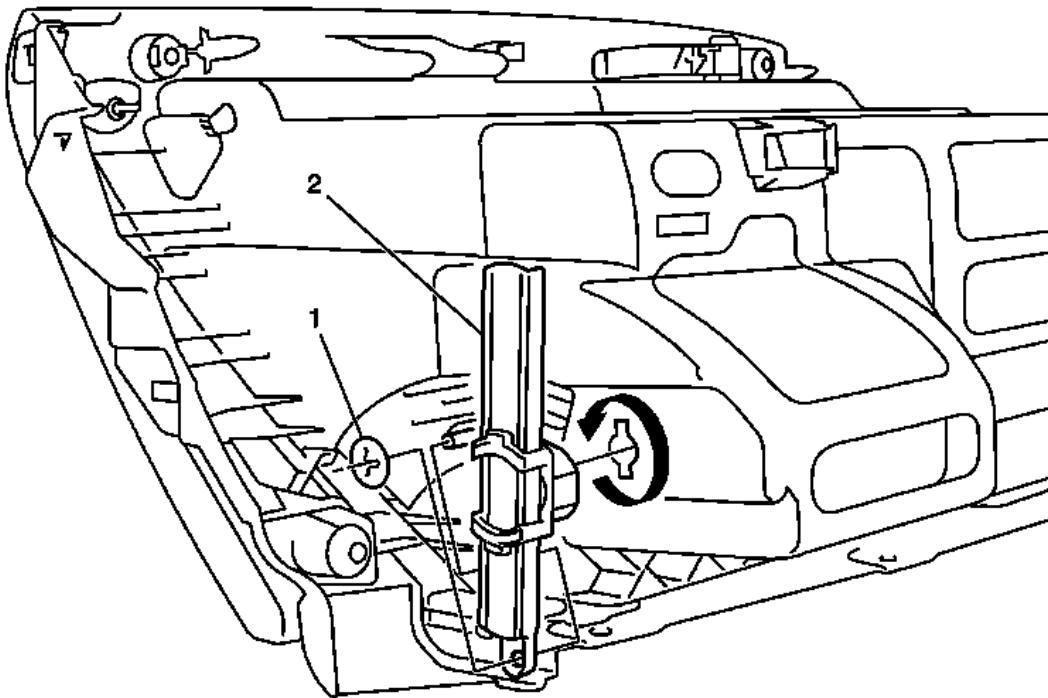


Fig. 23: Instrument Panel Compartment Door Dampener & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Compartment Door Dampener Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel compartment assembly. Refer to <u>Instrument Panel Compartment Replacement</u> .	
1	Instrument Panel Compartment Door Dampener Fastener CAUTION: Refer to <u>Fastener Caution</u> .
2	Instrument Panel Compartment Door Dampener Procedure Twist and pull the compartment door dampener from the instrument panel compartment assembly.

HEADLAMP SWITCH MOLDING REPLACEMENT

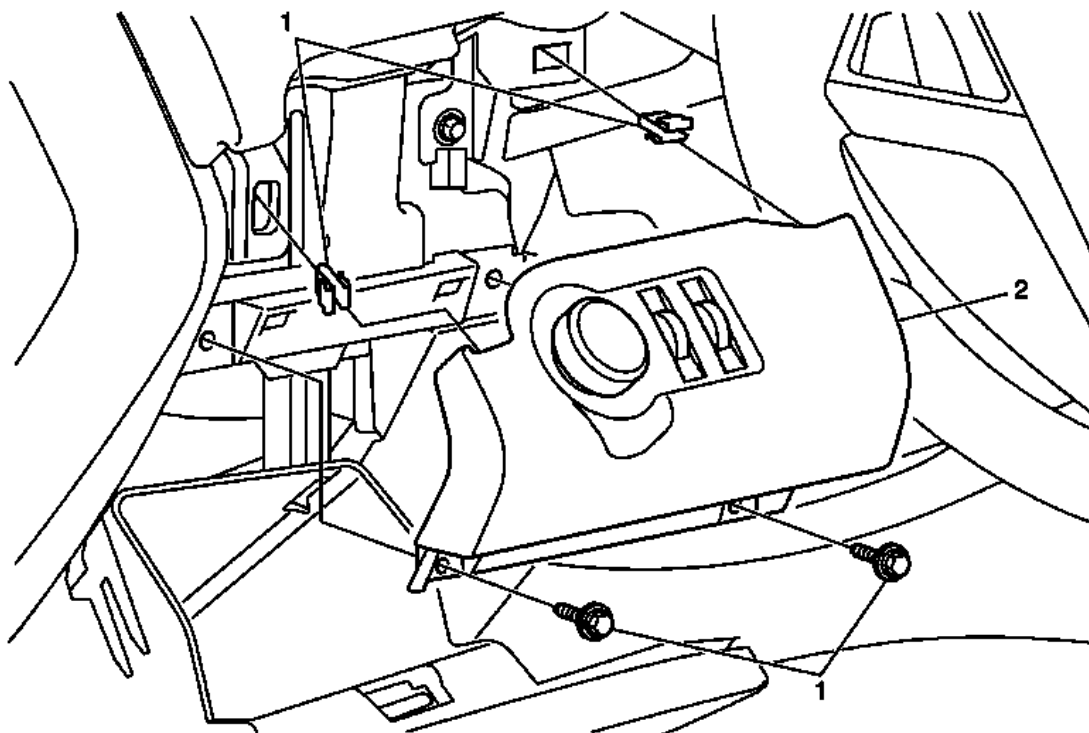


Fig. 24: Headlamp Switch Molding & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Headlamp Switch Molding Replacement

Callout	Component Name
1	Instrument Panel Headlamp Switch Molding Fastener (Qty: 4) Procedure 1. Open instrument panel outer compartment. TIP: Use a flat-bladed plastic trim tool to release the headlamp switch molding from the instrument panel. 2. Disconnect the electrical connections.
2	Instrument Panel Headlamp Switch Molding Procedure If replacing the instrument panel headlamp switch molding, transfer the headlamp switch.

INSTRUMENT PANEL LOWER EXTENSION SIDE TRIM PANEL REPLACEMENT

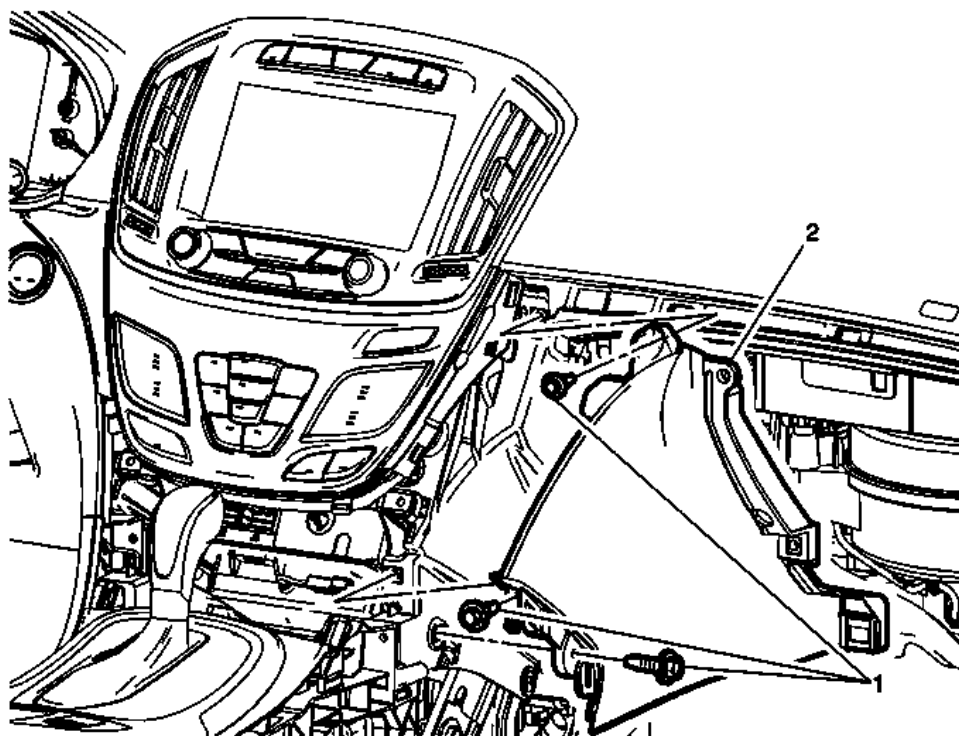


Fig. 25: Instrument Panel Lower Extension Side Trim Panel
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Lower Extension Side Trim Panel Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> . 2. Remove the right front floor console extension panel. Refer to <u>Front Floor Console Extension Panel Replacement</u> 3. Remove the passenger side instrument panel center upper molding. Refer to <u>Instrument Panel Center Upper Molding Replacement (Driver Side)</u> , <u>Instrument Panel Center Upper Molding Replacement (Passenger Side)</u> .	
1	Instrument Panel Lower Extension Side Trim Panel Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 (22 lb in)
2	Instrument Panel Lower Extension Side Trim Panel

WINDSHIELD DEFROSTER NOZZLE GRILLE REPLACEMENT

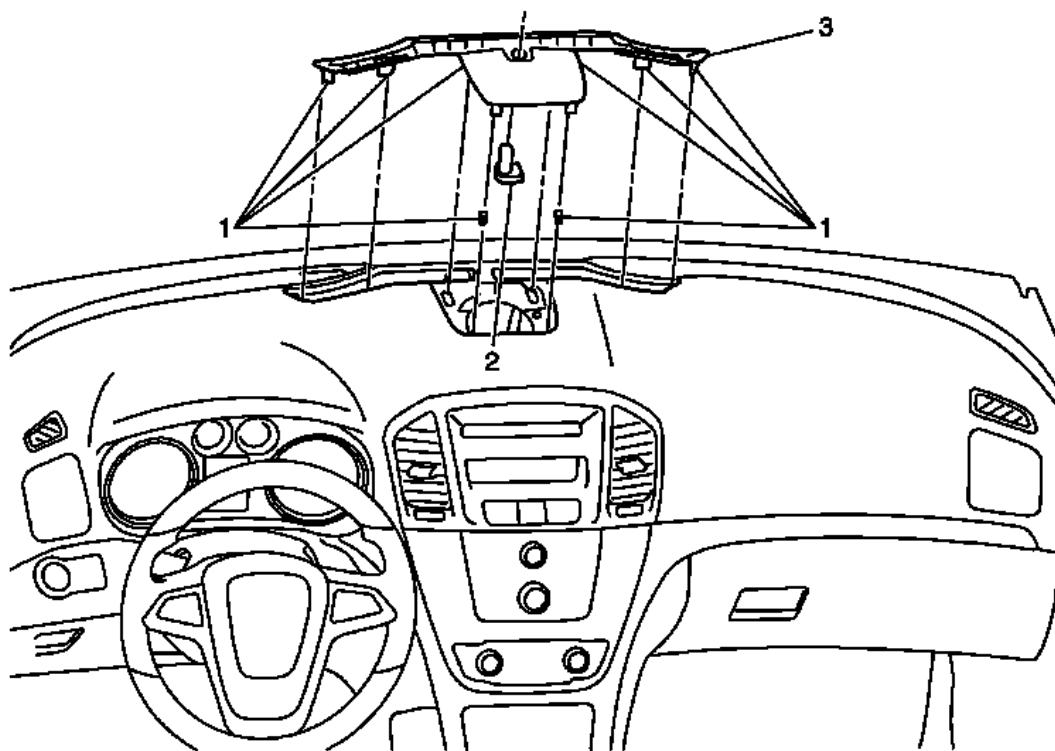


Fig. 26: Windshield Defroster Nozzle Grille, Ambient Light Sensor & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Windshield Defroster Nozzle Grille Replacement

Callout	Component Name
1	Windshield Defroster Nozzle Grille Retainer (Qty: 8) Procedure <ol style="list-style-type: none"> 1. Use a flat-bladed plastic trim tool to aid in the removal of the windshield defroster nozzle grille. 2. Disconnect the electrical connections.
2	Sun Load Temperature and Headlamp Automatic Control Ambient Light Sensor
3	Windshield Defroster Nozzle Grille

INSTRUMENT PANEL ASSEMBLY REPLACEMENT

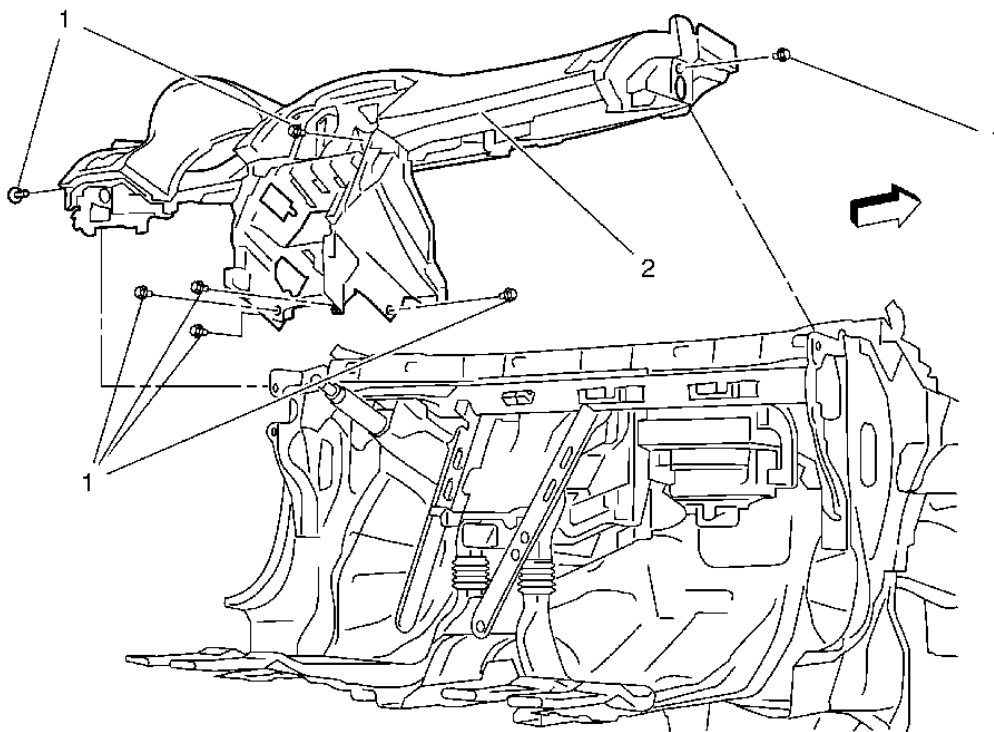


Fig. 27: Instrument Panel Assembly & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Assembly Replacement

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u> .	
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disable the SIR system. 2. Remove the instrument panel lower extension side trim panel. Refer to <u>Instrument Panel Lower Extension Side Trim Panel Replacement</u>. 3. Remove the instrument panel lower trim panel insulator. Refer to <u>Instrument Panel Lower Trim Panel Insulator Replacement</u>. 4. Remove the radio assembly. Refer to <u>Radio Replacement</u> . 5. Remove the HVAC remote control assembly. Refer to <u>Heater and Air Conditioning Remote Control Replacement</u> . 6. Remove the radio front speaker. Refer to <u>Radio Front Speaker Replacement</u> . 7. Remove the front floor console. Refer to <u>Front Floor Console Replacement</u>. 8. Remove the steering column trim covers. Refer to <u>Steering Column Trim Cover Replacement</u> . 9. Remove the instrument cluster. Refer to <u>Instrument Cluster Replacement</u> . 10. Remove both windshield side garnish moldings. Refer to <u>Windshield Side Garnish Molding</u> 	

<u>Replacement .</u>	
1	Instrument Panel Assembly Fastener (Qty: 7) CAUTION: Refer to <u>Fastener Caution .</u> Tighten 9 N.m (80 lb in)
2	Instrument Panel Assembly Procedures <ol style="list-style-type: none"> 1. Disconnect the wiring harness from the I/P assembly. 2. With the aid of an assistant, remove the I/P assembly from the vehicle. 3. If replacing the I/P assembly, transfer all necessary components.

INSTRUMENT PANEL TIE BAR REPLACEMENT

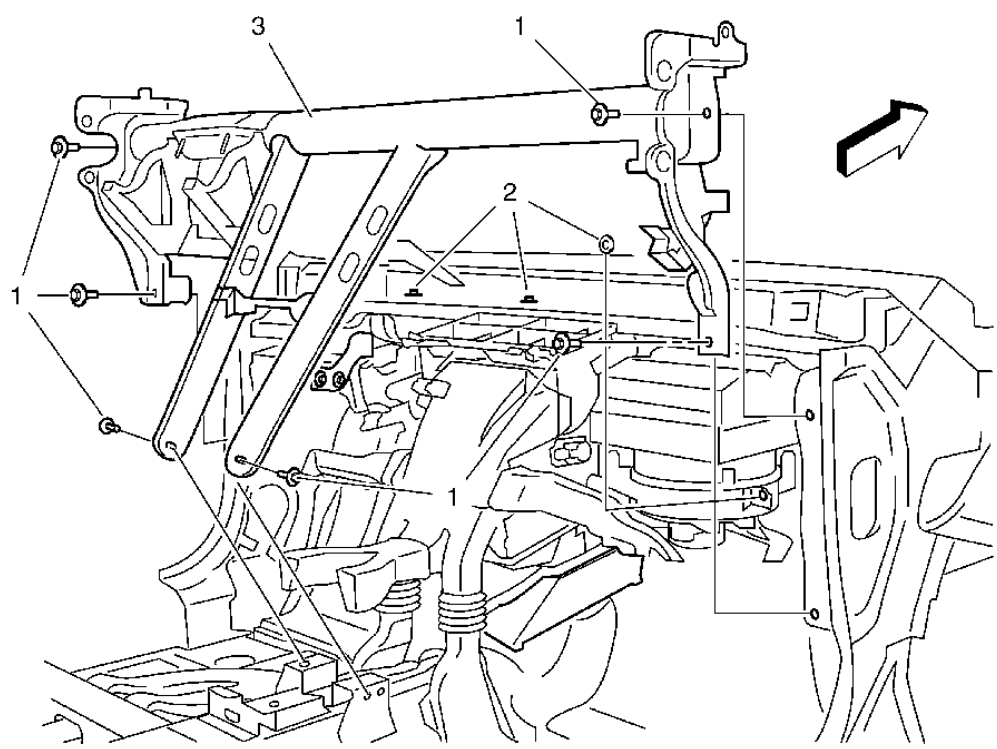


Fig. 28: Instrument Panel Tie Bar & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Tie Bar Replacement

Callout	Component Name

Preliminary Procedures

1. Remove the instrument panel (I/P) assembly. Refer to **Instrument Panel Assembly Replacement**.
2. Remove both front and rear side door sill trim plates. Refer to **Front and Rear Side Door Sill Trim Plate Replacement**.
3. Remove the steering column. Refer to **Steering Column Replacement**.
4. Remove the body control module bracket. Refer to **Body Control Module Bracket Replacement**.
5. Remove the fasteners securing the brake and accelerator pedal assembly to the tie bar. Refer to **Brake and Accelerator Pedal Assembly Replacement**.
6. Remove the instrument panel electrical center from the tie bar.

1	<p>Instrument Panel Tie Bar Assembly Fastener (Qty: 6)</p> <p>CAUTION: Refer to <u>Fastener Caution</u>.</p> <p>Tighten 22 N.m (16 lb ft)</p>
2	<p>Heater and Air Conditioning Evaporator and Blower Module Fastener (Qty: 3)</p> <p>Procedure Release the heater and air conditioning evaporator and blower module from the I/P tie bar and secure the module at the body.</p> <p>Tighten 5 N.m (44 lb in)</p>
3	<p>Instrument Panel Tie Bar Assembly</p> <p>Procedures</p> <ol style="list-style-type: none">1. Remove the hood release handle.2. Note location and routing of the I/P wiring harness prior to removal of the I/P tie bar assembly to ensure proper reinstallation.3. Disconnect the wiring harness from the I/P tie bar assembly.4. With the aid of an assistant, remove the I/P tie bar assembly from the vehicle.5. If replacing the I/P tie bar assembly, transfer all necessary components.

FRONT FLOOR CONSOLE WIRING HARNESS REPLACEMENT

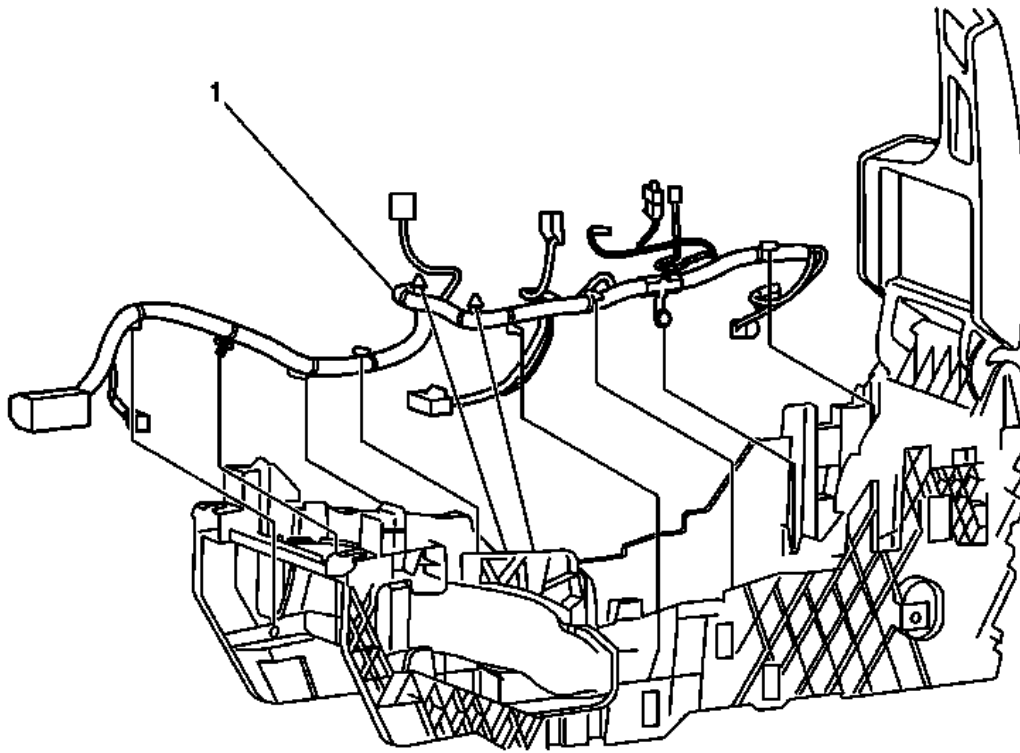


Fig. 29: Front Floor Console Wiring Harness
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Wiring Harness Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the front floor console. Refer to <u>Front Floor Console Replacement</u>. 2. Remove the front floor console rear cover. Refer to <u>Front Floor Console Rear Cover Replacement</u>. 3. Remove the front floor upper console trim plate. Refer to <u>Front Floor Upper Console Trim Plate Replacement</u>. 4. Remove the front floor console side covers. 	
1	Front Floor Console Wiring Harness Procedure <ol style="list-style-type: none"> 1. Release the front floor console wiring harness from the lower console. 2. When replacing the front floor console wiring harness, compare the wiring harnesses and transfer all necessary attaching parts.

FRONT FLOOR CONSOLE COVER REPLACEMENT

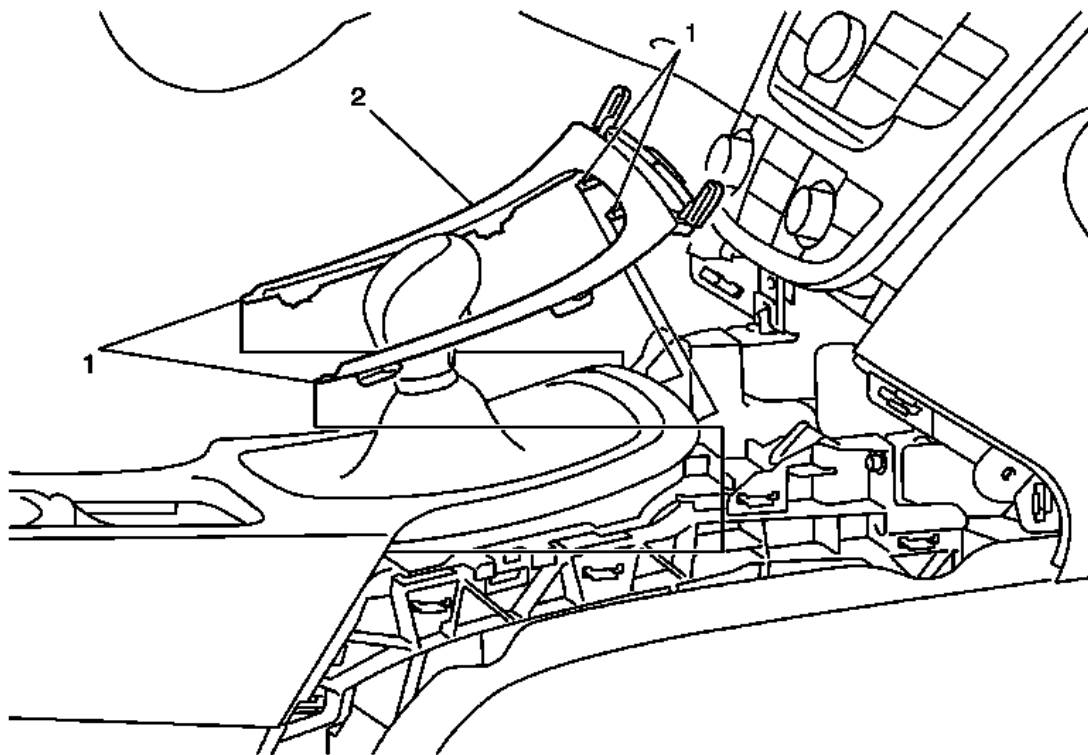


Fig. 30: Front Floor Console Cover & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Cover Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove both front floor console extension panels. Refer to <u>Front Floor Console Extension Panel Replacement</u> . 2. Remove instrument panel center compartment. Refer to <u>Instrument Panel Center Compartment Replacement</u> . 3. Loosen the front floor console. Refer to <u>Front Floor Console Replacement</u>	
1	Front Floor Console Cover Retainer (Qty: 4) Procedure Use a flat-bladed plastic trim tool to release the front floor console cover from the front floor upper console trim plate.
2	Front Floor Console Cover

FRONT FLOOR CONSOLE FRONT INSERT REPLACEMENT

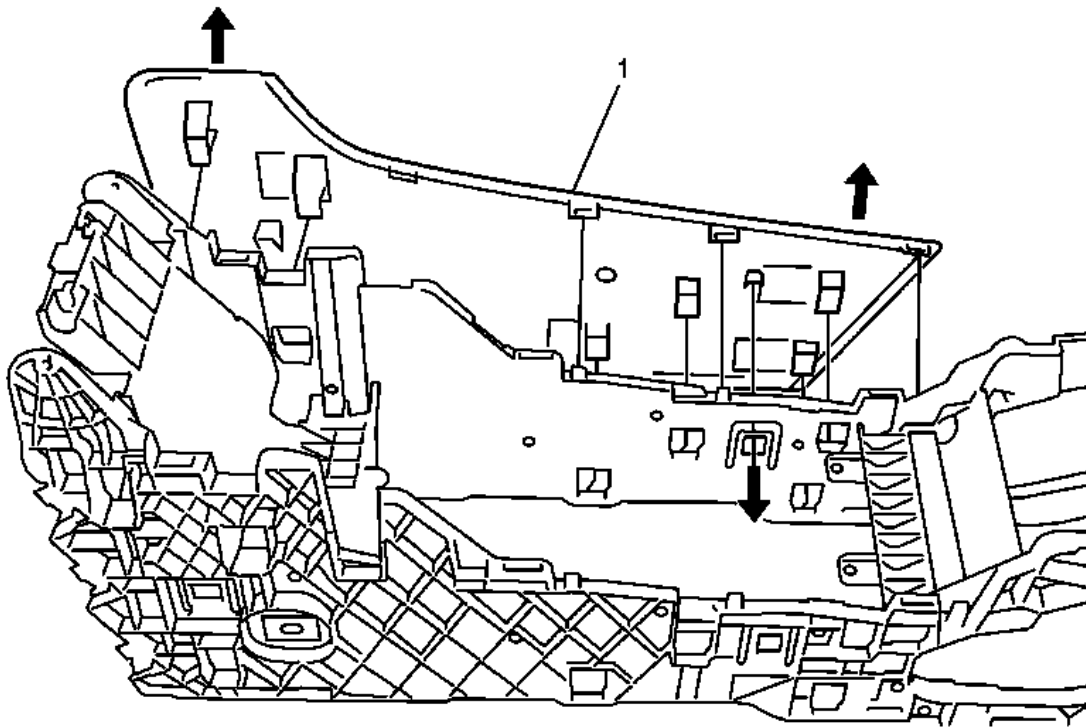


Fig. 31: Front Floor Console Side Cover
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Front Insert Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the front floor console. Refer to Front Floor Console Replacement . 2. Remove the front floor upper console trim plate. Refer to Front Floor Upper Console Trim Plate Replacement .	
1	Front Floor Console Front Insert Procedure Release the front floor console front insert from the lower console.

FRONT FLOOR CONSOLE CUP HOLDER REPLACEMENT

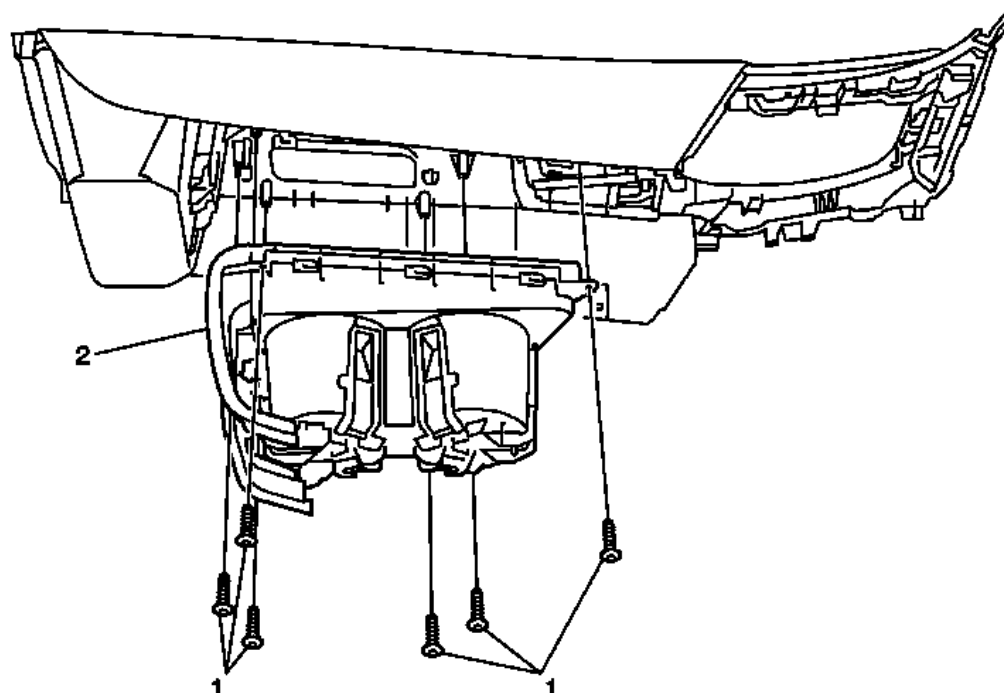


Fig. 32: Front Floor Console Cup Holder And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Cup Holder Replacement

Callout	Component Name
Preliminary Procedure Remove the front floor upper console trim plate. Refer to <u>Front Floor Upper Console Trim Plate Replacement</u> .	
1	Front Floor Console Cup Holder Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 1.2 (11 lb in)
2	Front Floor Console Cup Holder Procedure When replacing the front floor console cup holder, transfer all necessary components.

FRONT FLOOR CONSOLE ACCESSORY SWITCH MOUNT PLATE REPLACEMENT

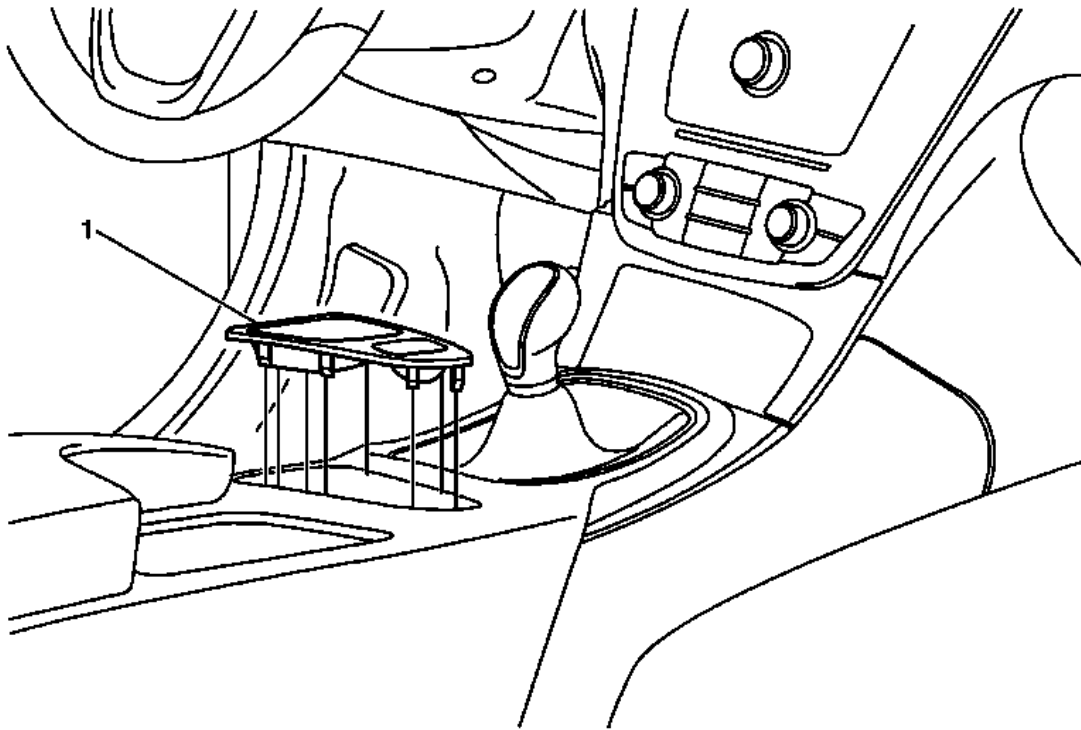


Fig. 33: Front Floor Console Front Compartment
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Accessory Switch Mount Plate Replacement

Callout	Component Name
1	Front Floor Console Accessory Switch Mount Plate Procedure <ol style="list-style-type: none"> 1. Use a flat-bladed plastic trim tool in order to release the retaining clips securing the plate to the front floor console assembly. 2. Disconnect the electrical connector. 3. Transfer components as necessary.

FRONT FLOOR CONSOLE COMPARTMENT REPLACEMENT

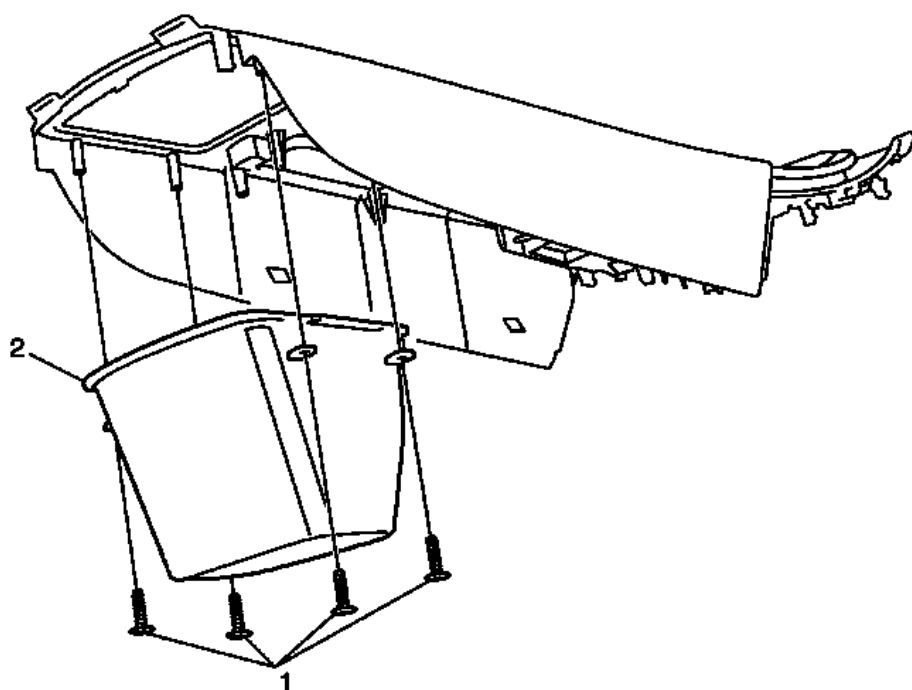


Fig. 34: Front Floor Console Compartment And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Compartment Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front floor upper console trim plate. Refer to <u>Front Floor Upper Console Trim Plate Replacement</u> .	
1	Front Floor Console Compartment Fastener (Qty: 4)
2	Front Floor Console Compartment

FRONT FLOOR UPPER CONSOLE TRIM PLATE REPLACEMENT

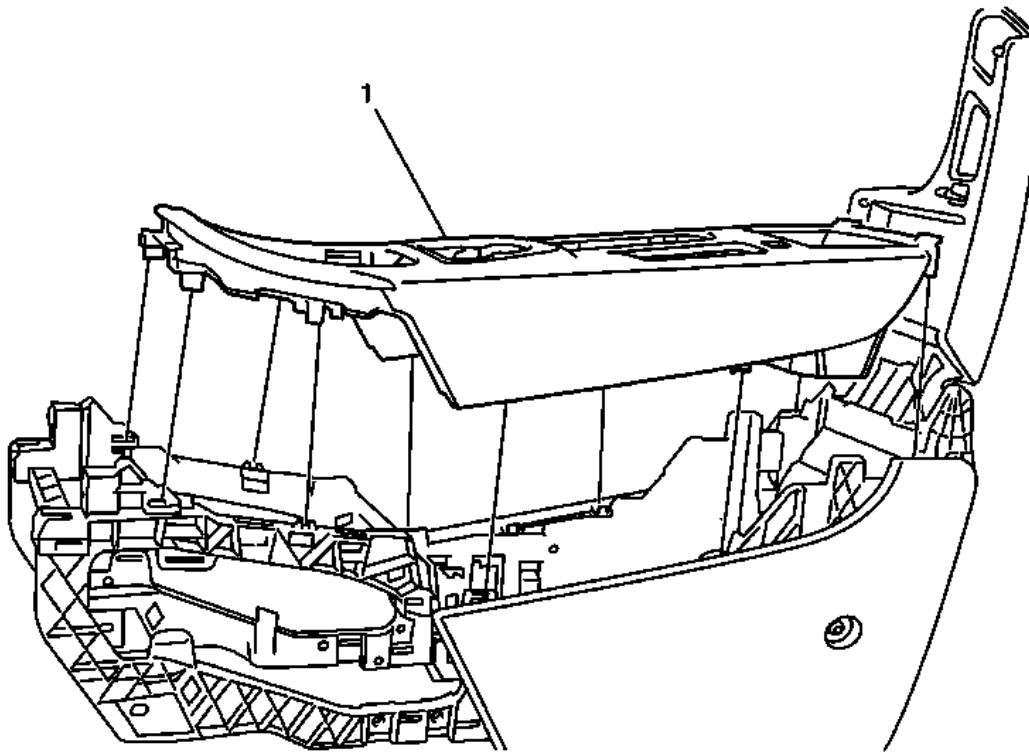


Fig. 35: Front Floor Upper Console Trim Plate
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Upper Console Trim Plate Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front floor console. Refer to Front Floor Console Replacement .	
1	Front Floor Upper Console Trim Plate Assembly
	Procedure
	1. Release the upper console trim plate from the front floor lower console.
	2. Disconnect the electrical connections.
	3. When replacing the front floor upper console trim plate, transfer all necessary parts.

FRONT FLOOR CONSOLE TRANSMISSION SHIFT OPENING BEZEL REPLACEMENT

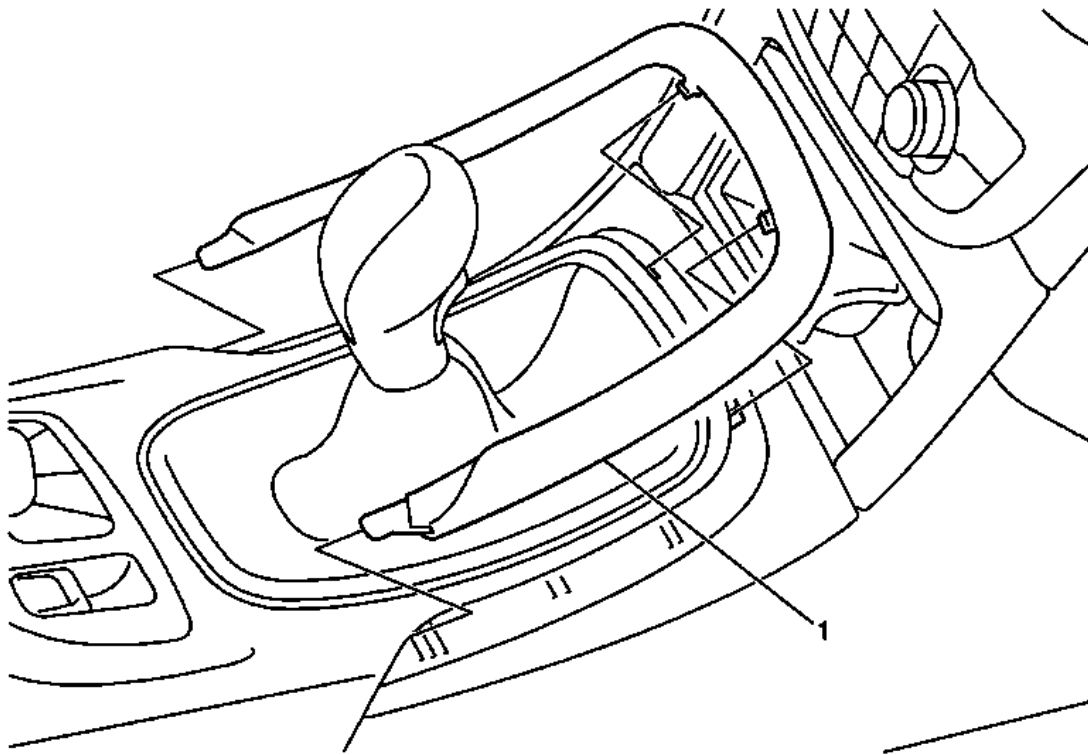


Fig. 36: Front Floor Console Transmission Shift Opening Bezel
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Transmission Shift Opening Bezel Replacement

Callout	Component Name
1	Front Floor Console Transmission Shift Opening Bezel Procedure Open the ashtray housing and pull off the shift opening bezel from the upper console trim plate. TIP: Use a flat-bladed plastic trim tool in order to release the front floor console transmission shift opening bezel from the front floor upper console trim plate.

FRONT FLOOR CONSOLE EXTENSION PANEL REPLACEMENT

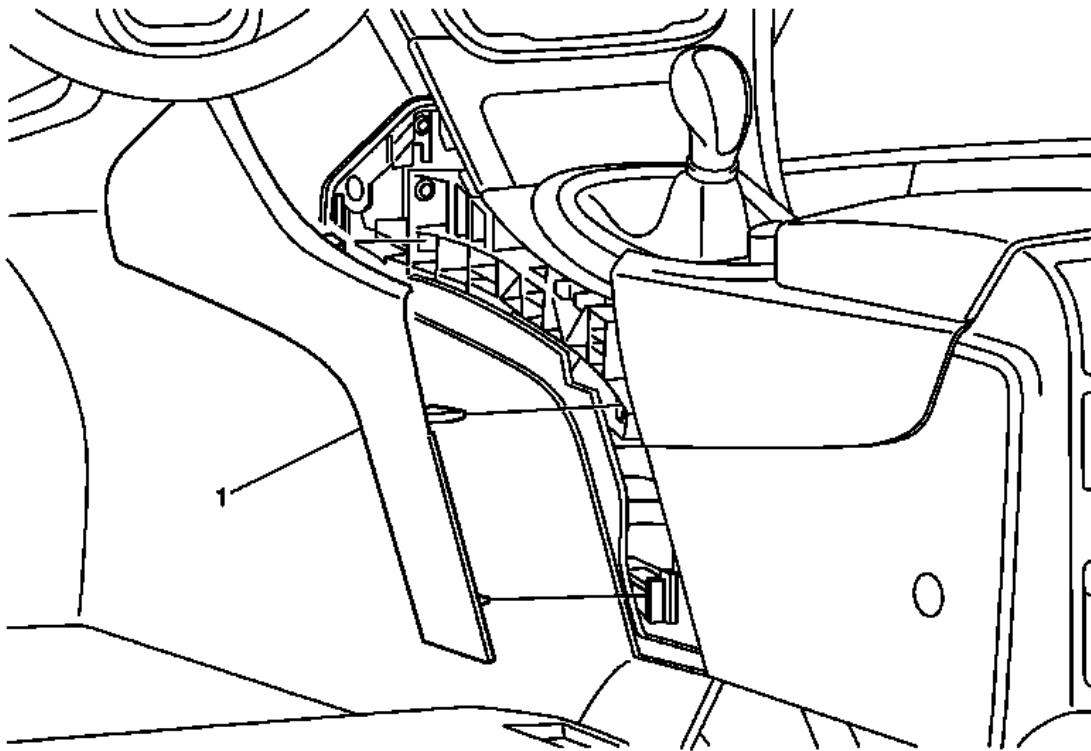


Fig. 37: Front Floor Console Extension Panel
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Extension Panel Replacement

Callout	Component Name
1	Front Floor Console Extension Panel Procedure Grasp the extension panel and pull outward disengaging the retainer clips securing the panel to the front floor console.

FRONT FLOOR CONSOLE REPLACEMENT

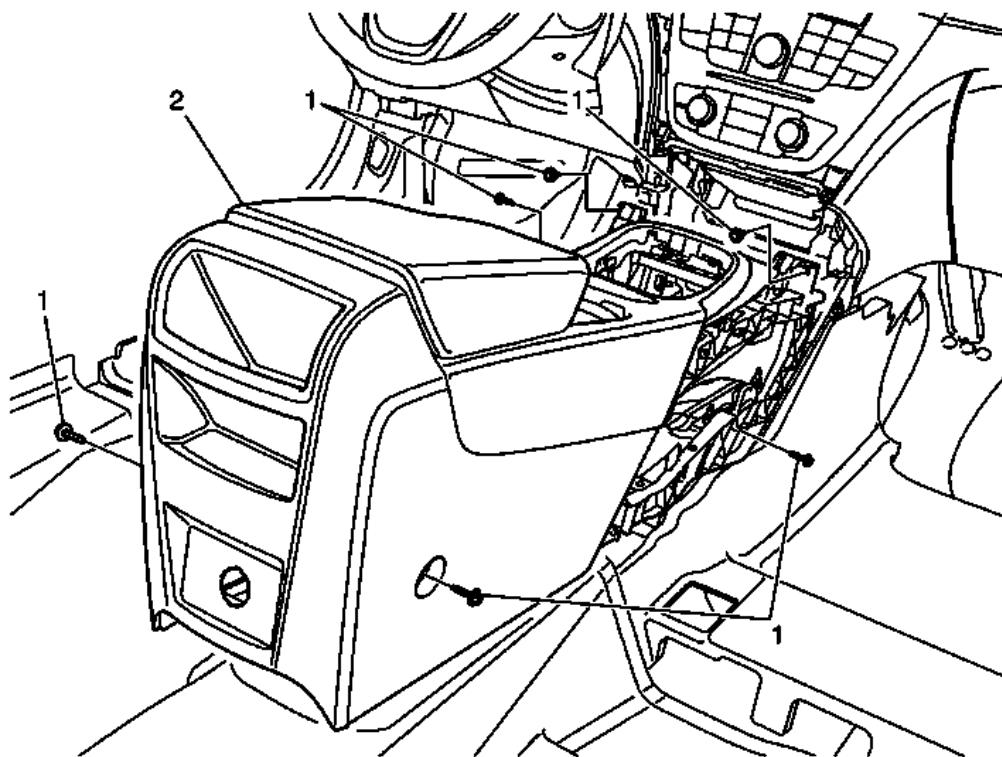


Fig. 38: Front Floor Console And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the transmission control lever boot. Refer to <u>Transmission Control Lever Boot Replacement</u> . 2. Remove the front floor console extension panels. Refer to <u>Front Floor Console Extension Panel Replacement</u> . 3. Remove the instrument panel center compartment. Refer to <u>Instrument Panel Center Compartment Replacement</u> .	
1	Front Floor Console Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Move the front seats forward or backward in order to access the fasteners for removal. Tighten 2.5 (22 lb in)
	Front Floor Console Assembly

2

Procedures

1. Disconnect the electrical connections.
2. When replacing the front floor console assembly, transfer all necessary components.

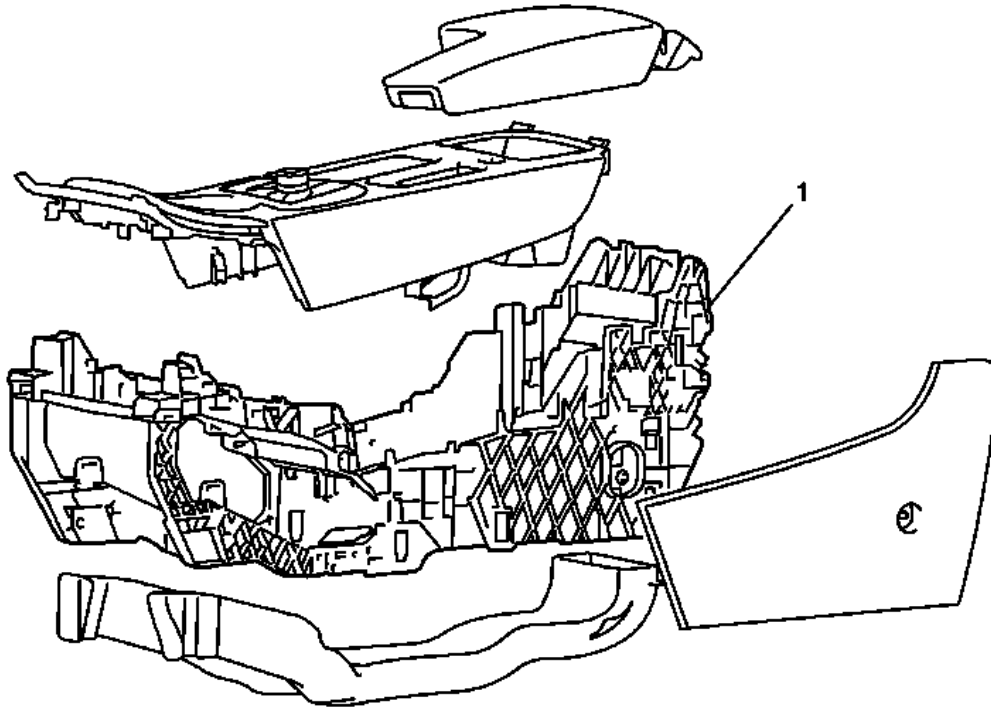
FRONT FLOOR LOWER CONSOLE REPLACEMENT

Fig. 39: Exploded View Of Front Floor Lower Console
Courtesy of GENERAL MOTORS COMPANY

Front Floor Lower Console Replacement

Callout	Component Name
Preliminary Procedures	
1.	Remove the front floor console. Refer to <u>Front Floor Console Replacement</u> .
2.	Remove the front floor upper console trim plate. Refer to <u>Front Floor Upper Console Trim Plate Replacement</u> .
3.	Remove the front floor console side covers.
4.	Remove the front floor console rear air duct. Refer to <u>Front Floor Console Rear Air Duct Replacement</u> .
5.	Remove the front floor console armrest. Refer to <u>Front Floor Console Armrest Replacement</u> .
6.	Remove the front floor console wiring harness. Refer to <u>Front Floor Console Wiring Harness Replacement</u> .

1	Front Floor Lower Console Procedure When replacing the front floor lower console, transfer all necessary components.
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FRONT FLOOR CONSOLE ARMREST REPLACEMENT

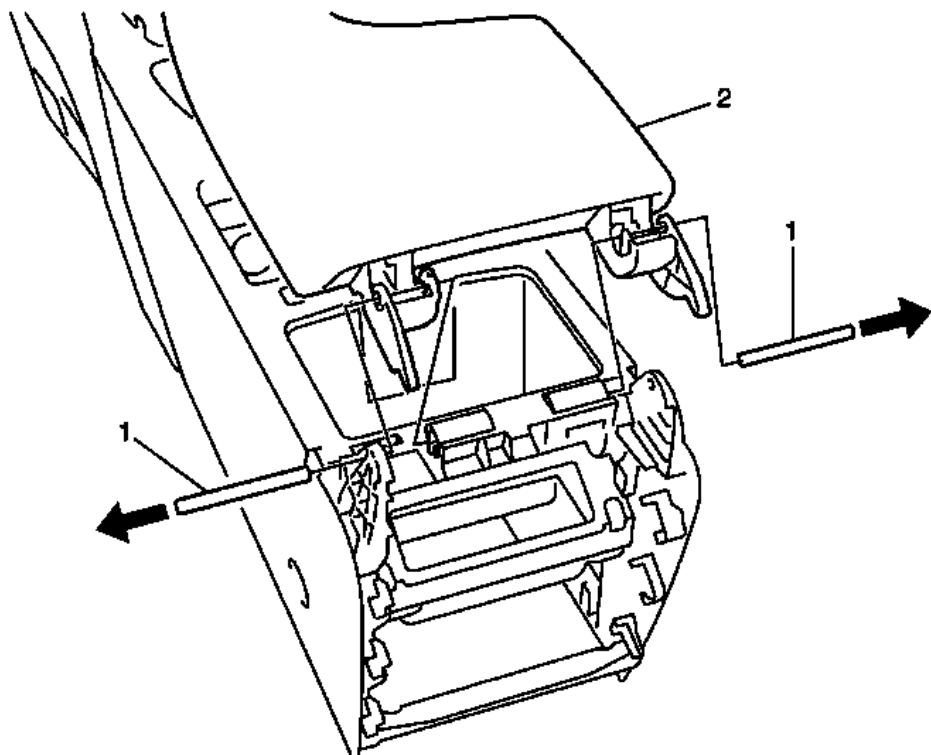


Fig. 40: Front Floor Console Armrest & Pins
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Armrest Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front floor console rear cover. Refer to Front Floor Console Rear Cover Replacement .	
1	Front Floor Console Armrest Assembly Pin (Qty: 2)
2	Front Floor Console Armrest Procedure Release the front floor console armrest from the armrest dampener.

FRONT FLOOR CONSOLE REAR COVER REPLACEMENT

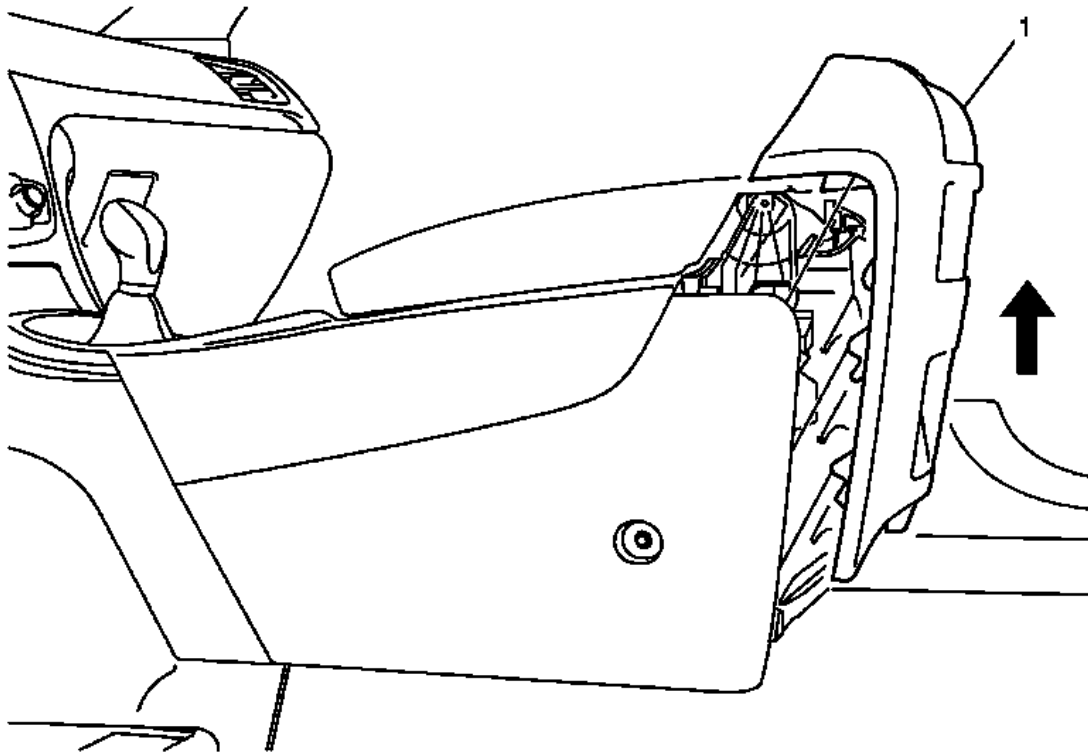


Fig. 41: Front Floor Console Rear Cover
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Console Rear Cover Replacement

Callout	Component Name
Preliminary Procedure Remove front floor console rear air outlet deflector housing. Refer to <u>Front Floor Console Rear Air Outlet Deflector Housing Replacement</u> .	
1	Front Floor Console Rear Cover Procedure <ol style="list-style-type: none"> 1. Release the front floor console rear cover. 2. Disconnect the electrical connectors.

ROOF CONSOLE REPLACEMENT

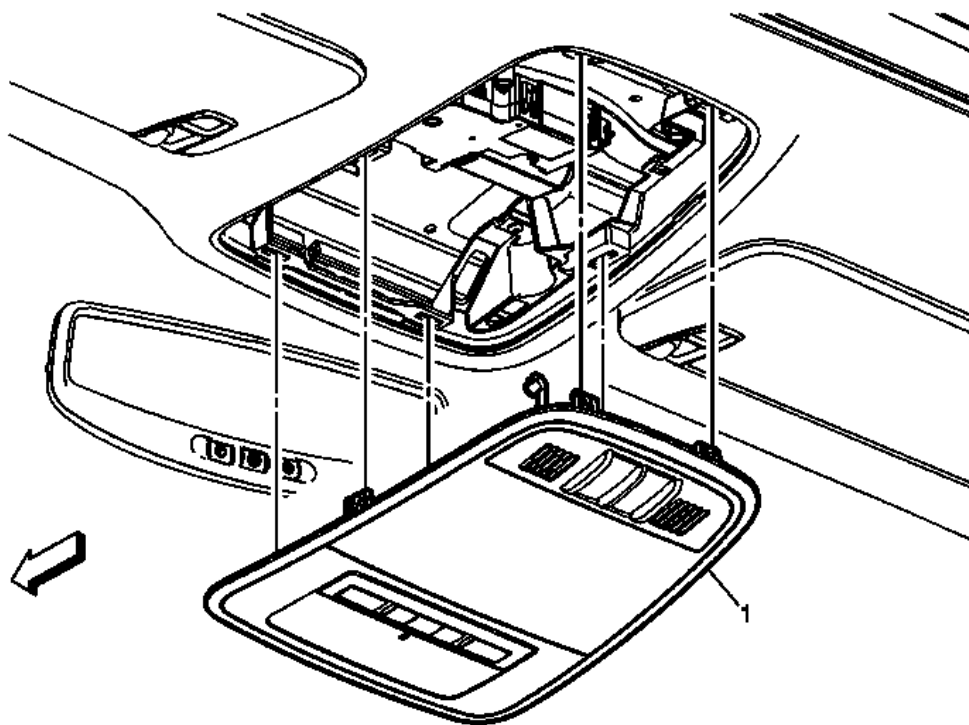


Fig. 42: Roof Console

Courtesy of GENERAL MOTORS COMPANY

Roof Console Replacement

Callout	Component Name
1	<p>Roof Console Assembly</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Use a flat-bladed plastic trim tool to release the 6 retainers securing the roof console to the headliner. 2. Disconnect the electrical connections. 3. When replacing the roof console assembly, transfer all necessary components.

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Instrument Panel/Center Console Component Views

INSTRUMENT PANEL/CENTER CONSOLE COMPONENT VIEWS

INSTRUMENT PANEL AND FLOOR CONSOLE COMPONENTS

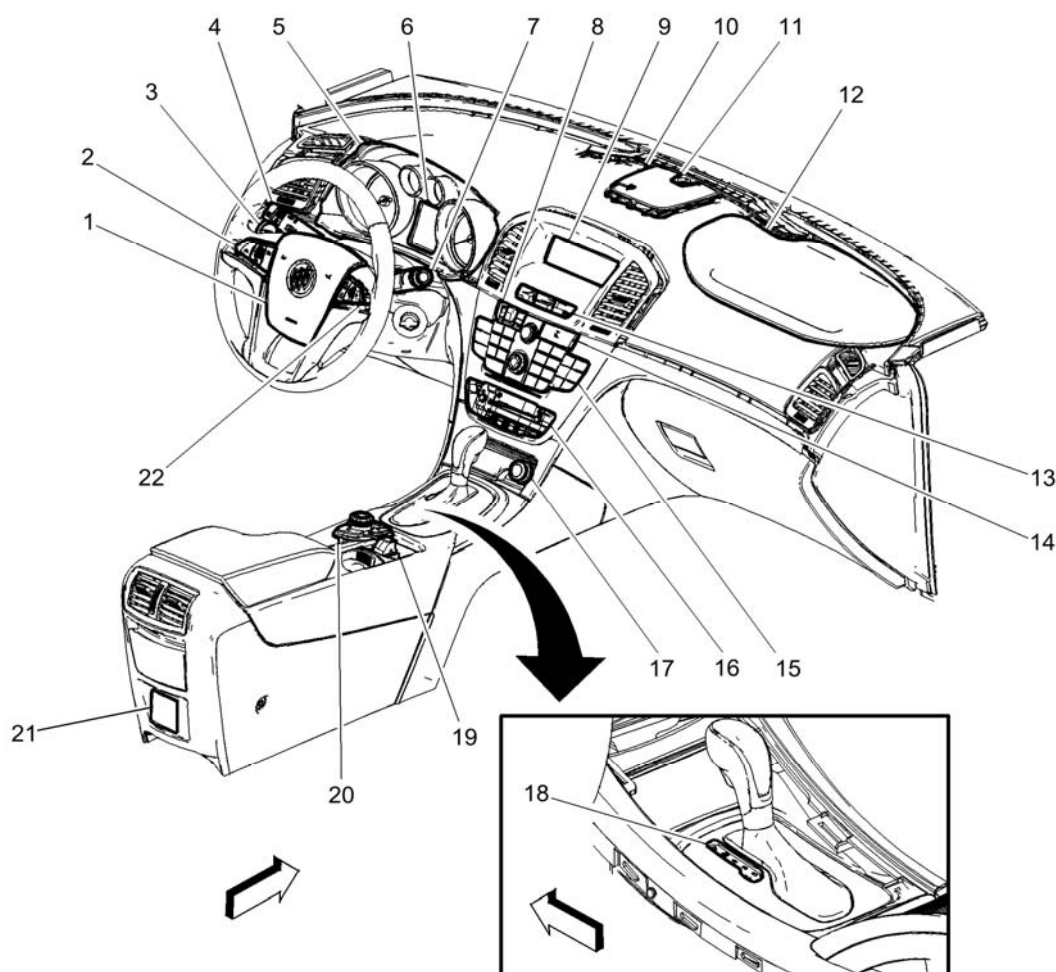


Fig. 1: Instrument Panel and Floor Console Component Locations
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: F107 Steering Wheel Air Bag **F107 Steering Wheel Air Bag X1 F107 Steering Wheel Air Bag X2**
- 2: S70L Steering Wheel Controls Switch - Left **S70L Steering Wheel Controls Switch - Left**
- 3: S30 Headlamp Switch **S30 Headlamp Switch**
- 4: S78 Turn Signal/Multifunction Switch **S78 Turn Signal/Multifunction Switch**

- 5:** P16 Instrument Cluster **P16 Instrument Cluster**
- 6:** P9 Driver Information Center Display
- 7:** S82 Windshield Wiper/Washer Switch **S82 Windshield Wiper/Washer Switch**
- 8:** S48D Multifunction Switch 2 - Instrument Panel **S48D Multifunction Switch 2 - Instrument Panel**
- 9:** P17 Info Display Module **P17 Info Display Module (UDK/UDN)** **P17 Info Display Module X1** **P17 Info Display Module X2 (UDY)** **P17 Info Display Module X2 (UTY)**
- 10:** P19B Speaker - Center Instrument Panel **P19B Speaker - Center Instrument Panel (U65)** **P19B Speaker - Center Instrument Panel (UQA/UQS)**
- 11:** B10B Ambient Light/Sunload Sensor **B10B Ambient Light/Sunload Sensor**
- 12:** F101 Passenger Instrument Panel Air Bag **F101 Passenger Instrument Panel Air Bag CZ2** **F101 Passenger Instrument Panel Air Bag X1 except CZ2** **F101 Passenger Instrument Panel Air Bag X2 except CZ2** **F101 Passenger Instrument Panel Air Bag X3 except CZ2**
- 13:** S48C Multifunction Switch 1 - Instrument Panel **S48C Multifunction Switch 1 - Instrument Panel (CZ2)** **S48C Multifunction Switch 1 - Instrument Panel (except CZ2)**
- 14:** S107 Parking Assist On/Off Switch (UD5 or UD7) **S107 Parking Assist On/Off Switch (UD5 or UD7)**
- 15:** A22 Radio Controls **A22 Radio Controls (UEW)** **A22 Radio Controls (UFU/UYE/UAG)**
- 16:** A26 HVAC Controls **A26 HVAC Control CZ2** **A26 HVAC Controls except CZ2**
- 17:** X80G Accessory Power Receptacle - Instrument Panel **X80G Accessory Power Receptacle - Instrument Panel**
- 18:** P2 Transmission Shift Lever Position Indicator (MDK, MH8, MHH or MHK) **P2 Transmission Shift Lever Position Indicator (MDK, MH8, MHH or MHK)**
- 19:** S91 Park Brake Control Switch **S91 Park Brake Control Switch**
- 20:** S56 Radio Control Multifunction Switch (KRJ) **S56 Radio Control Multifunction Switch (KRJ)**
- 21:** X81 Accessory Power Receptacle - 110V AC (KI6 or KIU) **X81 Accessory Power Receptacle - 110V AC X1 (KI6 or KIU)** **X81 Accessory Power Receptacle - 110V AC X2 (KI6 or KIU)**
- 22:** S70R Steering Wheel Controls Switch - Right **S70R Steering Wheel Controls Switch - Right**

STEERING COLUMN AND WHEEL COMPONENTS

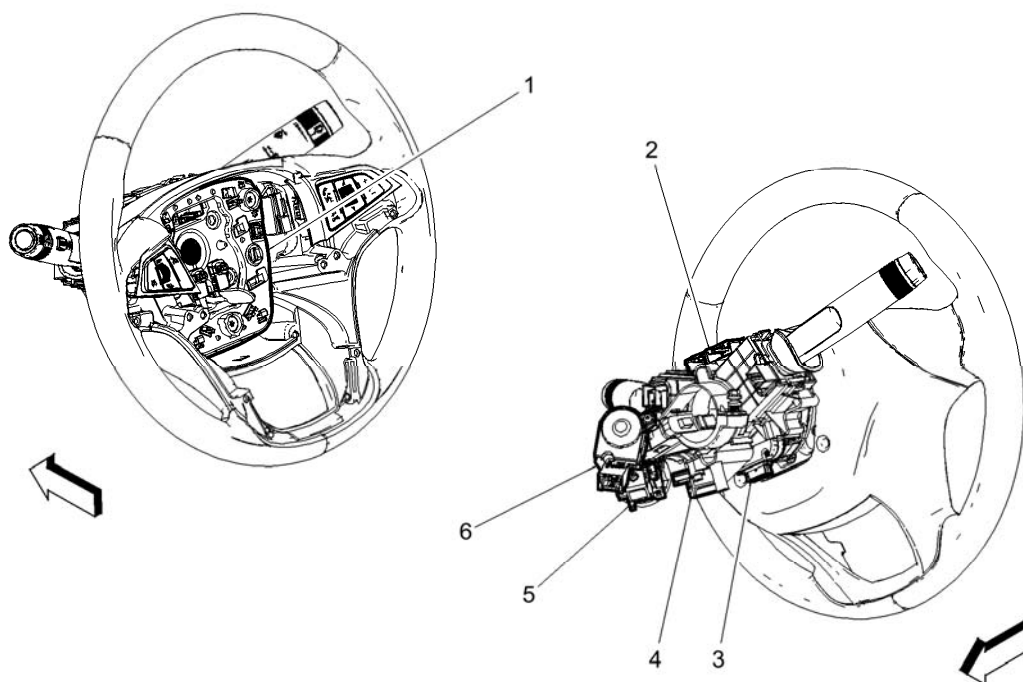


Fig. 2: Steering Column And Steering Wheel Component Locations
 Courtesy of GENERAL MOTORS COMPANY

Items
1: S33 Horn Switch <u>S33 Horn Switch</u>
2: X85 Steering Wheel Air Bag Coil <u>X85 Steering Wheel Air Bag Coil X1 X85 Steering Wheel Air Bag Coil X2 X85 Steering Wheel Air Bag Coil X3 X85 Steering Wheel Air Bag Coil X4 (UVD)</u>
3: B99 Steering Wheel Angle Sensor <u>B99 Steering Wheel Angle Sensor</u>
4: K89 Immobilizer Control Module <u>K89 Immobilizer Control Module</u>
5: M93 Key Capture Solenoid Actuator (MDK, MH8, MHH or MHK without BTM) <u>M93 Key Capture Solenoid Actuator (MDK, MH8, MHH or MHK without BTM)</u>
6: S39 Ignition Switch (without BTM) <u>S39 Ignition Switch (without BTM)</u>

BEHIND LOWER LEFT SIDE OF INSTRUMENT PANEL COMPONENTS

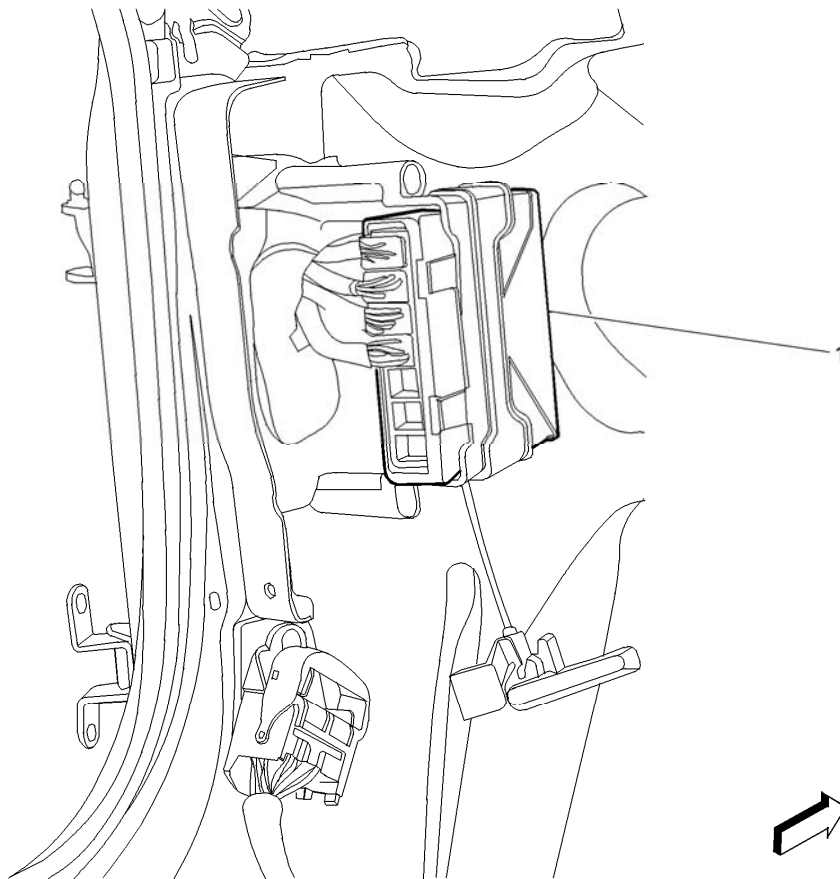


Fig. 3: Behind Lower Left Side of Instrument Panel Component Locations
Courtesy of GENERAL MOTORS COMPANY

Items

1: K9 Body Control Module **K9 Body Control Module X1** **K9 Body Control Module X2** **K9 Body Control Module X3** **K9 Body Control Module X4** **K9 Body Control Module X5** **K9 Body Control Module X6** **K9 Body Control Module X7**

BEHIND UPPER LEFT SIDE OF INSTRUMENT PANEL COMPONENTS

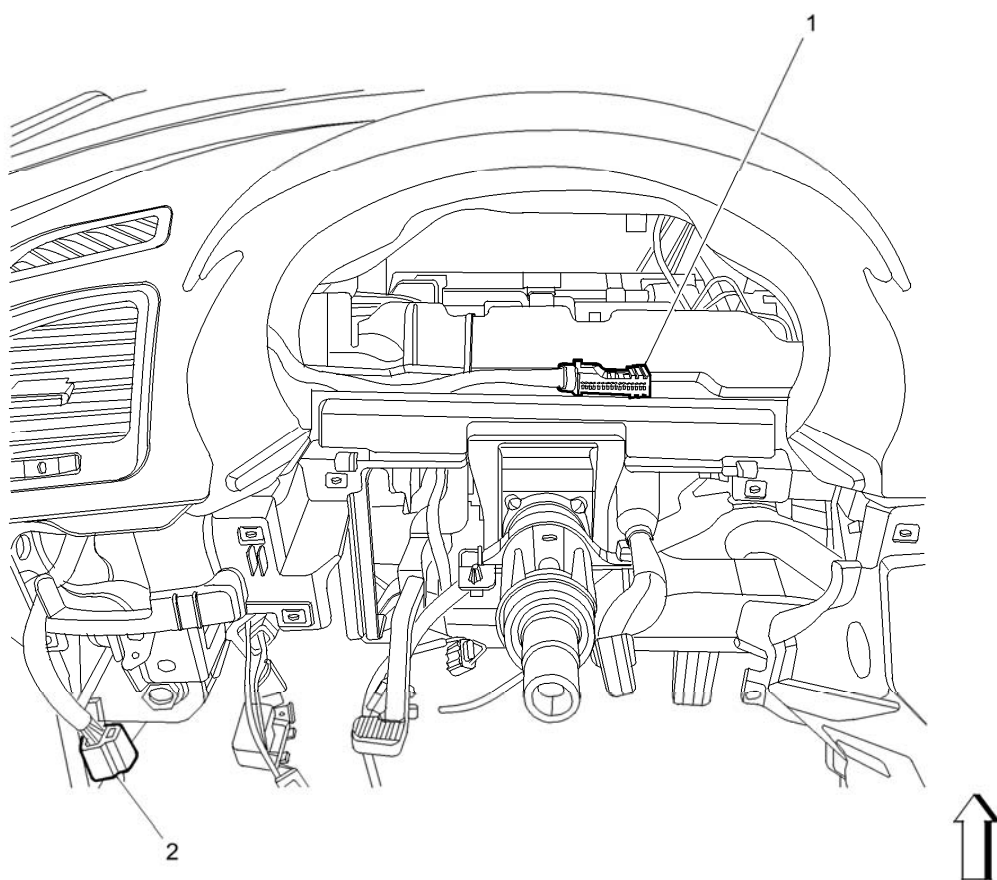


Fig. 4: Upper Left Side Of The I/P Component Locations
Courtesy of GENERAL MOTORS COMPANY

Items	
1: P16 Instrument Cluster	<u>P16 Instrument Cluster</u>
2: S30 Headlamp Switch	<u>S30 Headlamp Switch</u>

HVAC MODULE COMPONENTS

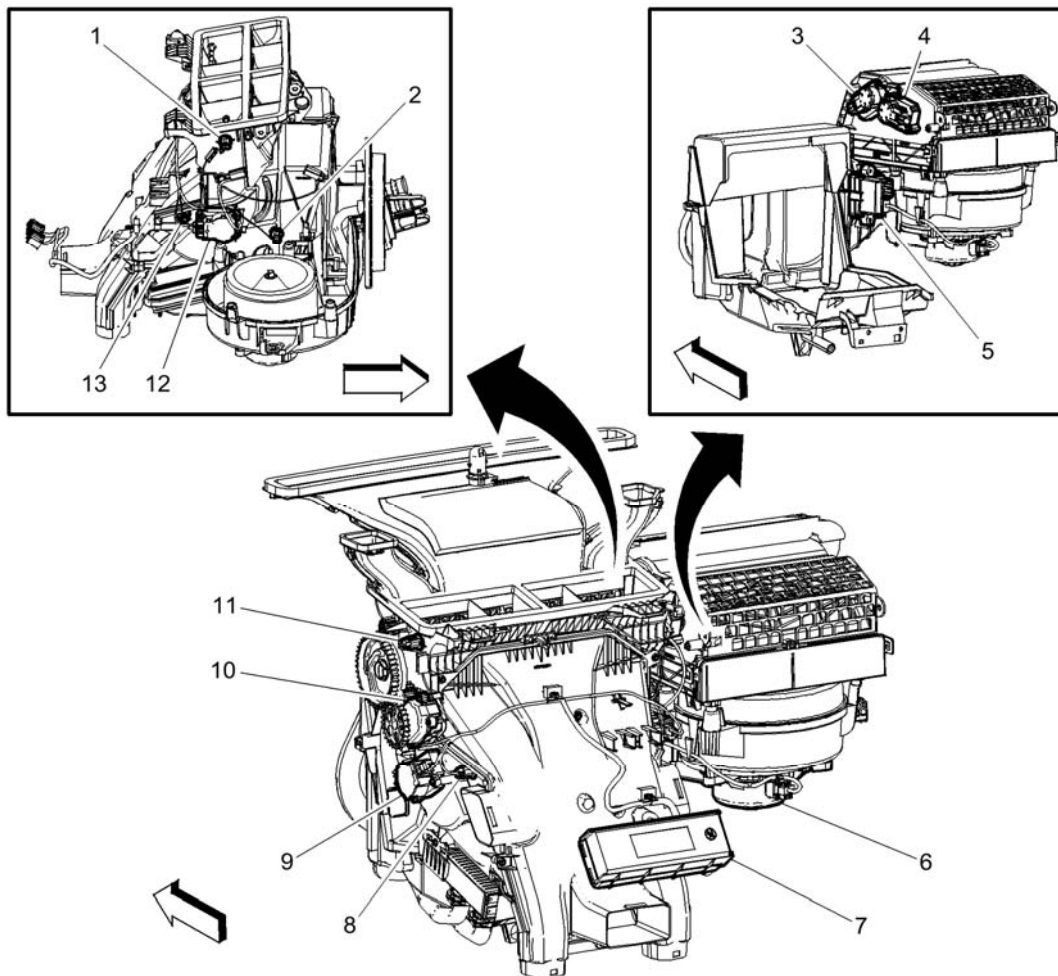


Fig. 5: HVAC Module Component Locations
 Courtesy of GENERAL MOTORS COMPANY

Items
1: B7J Air Temperature Sensor - Duct Right Upper (CJ2) <u>B7J Air Temperature Sensor - Duct Right Upper (CJ2)</u>
2: B39 A/C Evaporator Temperature Sensor <u>B39 A/C Evaporator Temperature Sensor</u>
3: M4 Air Inlet Door Actuator (CJ2) <u>M4 Air Inlet Door Actuator (CJ2)</u>
4: M46 Air Recirculation Door Actuator <u>M46 Air Recirculation Door Actuator</u>
5: K8 Blower Motor Control Module <u>K8 Blower Motor Control Module X1 K8 Blower Motor Control Module X2</u>
6: M8 Blower Motor <u>M8 Blower Motor</u>
7: K33 HVAC Control Module <u>K33 HVAC Control Module X1 K33 HVAC Control Module X2 K33 HVAC Control Module X3 K33 HVAC Control Module X4 (CJ2)</u>
8: B7D Air Temperature Sensor - Duct Left Lower (CJ2) <u>B7D Air Temperature Sensor - Duct Left Lower (CJ2)</u>
9: M6L Air Temperature Door Actuator - Left (CJ2) <u>M6L Air Temperature Door Actuator - Left</u>

(CJ2)

10: M37 Mode Door Actuator **M37 Mode Door Actuator**

11: B7H Air Temperature Sensor - Duct Left Upper (CJ2) **B7H Air Temperature Sensor - Duct Left Upper (CJ2)**

12: M6R Air Temperature Door Actuator - Right (CJ2) **M6R Air Temperature Door Actuator - Right (CJ2)**

13: B7E Air Temperature Sensor - Duct Right Lower (CJ2) **B7E Air Temperature Sensor - Duct Right Lower (CJ2)**

FLOOR CONSOLE COMPONENTS

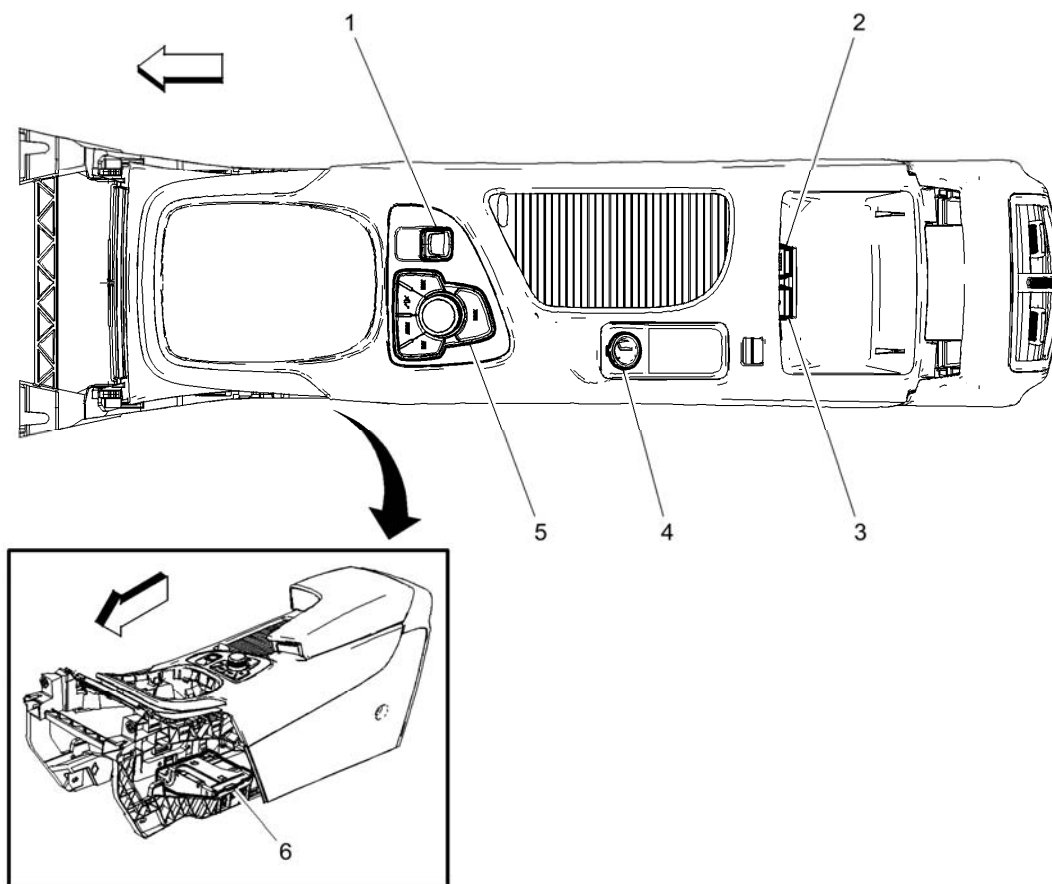


Fig. 6: Floor Console Components

Courtesy of GENERAL MOTORS COMPANY

Items

1: S91 Park Brake Control Switch **S91 Park Brake Control Switch**

2: X92 USB Receptacle **X92 Universal Serial Bus (USB) Connector**

- 3:** X83 Auxiliary Audio Input X83 Auxiliary Audio Input X1 (CZ2) X83 Auxiliary Audio Input X1 (except CZ2) X83 Auxiliary Audio Input X2 (except CZ2)
- 4:** X80H Accessory Power Receptacle - Center Console X80H Accessory Power Receptacle - Center Console
- 5:** S56 Radio Control Multifunction Switch (KRJ) S56 Radio Control Multifunction Switch (KRJ)
- 6:** T1 Accessory DC/AC Power Inverter Module (KI6 or KIU) T1 Accessory DC/AC Power Inverter Module (KI6 or KIU)

AUTOMATIC TRANSMISSION SHIFTER COMPONENTS (MDK, MH8, MHH, OR MHK)

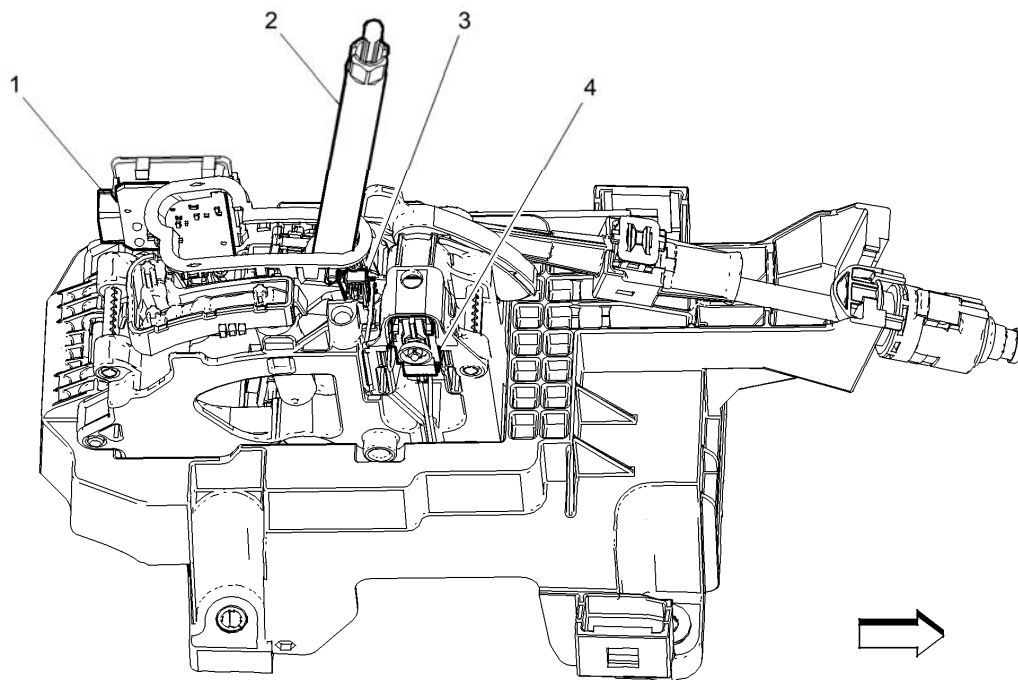


Fig. 7: Automatic Transmission Shifter Components (MDK, MH8, MHH, or MHK)
 Courtesy of GENERAL MOTORS COMPANY

Items
1: S2 Transmission Manual Shift Switch (MDK, MH8, MHH or MHK) <u>S2 Transmission Manual Shift Switch X1 (MDK, MH8, MHH or MHK)</u> <u>S2 Transmission Manual Shift Switch X2 (MDK, MH8, MHH or MHK)</u>
2: S3 Transmission Shift Lever (MDK, MH8, MHH or MHK) <u>S3 Transmission Manual Shift Switch X1 (MDK/MH7)</u> <u>S3 Transmission Shift Lever X1 (MDK,MH8,MHH, or MHK)</u> <u>S3 Transmission Shift Lever X2 (MDK/MH7/CZ2)</u> <u>S3 Transmission Shift Lever X2 (MDK/MH8/MHH/MHK)</u>
3: B81B Park Position Switch (MDK or MH8)
4: M7 Transmission Shift Lock Control Solenoid Actuator (MDK, MH8, MHH or MHK) <u>M7 Transmission Shift Lock Control Solenoid Actuator (MDK, MH8, MHH or MHK)</u>

ACCESSORIES & EQUIPMENT

Interior Trim and Interior Paneling

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Assist Handle Screws	2.5 N.m	22 lb in
Cargo Tie Down Hook Fastener	20 N.m	15 lb ft
Front Side Door Armrest Pull Cup Fastener	1.8 N.m	15 lb in
Front Side Door Inside Handle Fastener	1.8 N.m	15 lb in
Rear Side Door Armrest Pull Cup Fastener	1.8 N.m	15 lb in
Rear Side Door Inside Handle Fastener	1.8 N.m	15 lb in
Sunshade Support Screw	2.5 N.m	22 lb in
Sunshade Screws	2.5 N.m	22 lb in

REPAIR INSTRUCTIONS

FRONT SIDE DOOR PULL HANDLE COVER REPLACEMENT

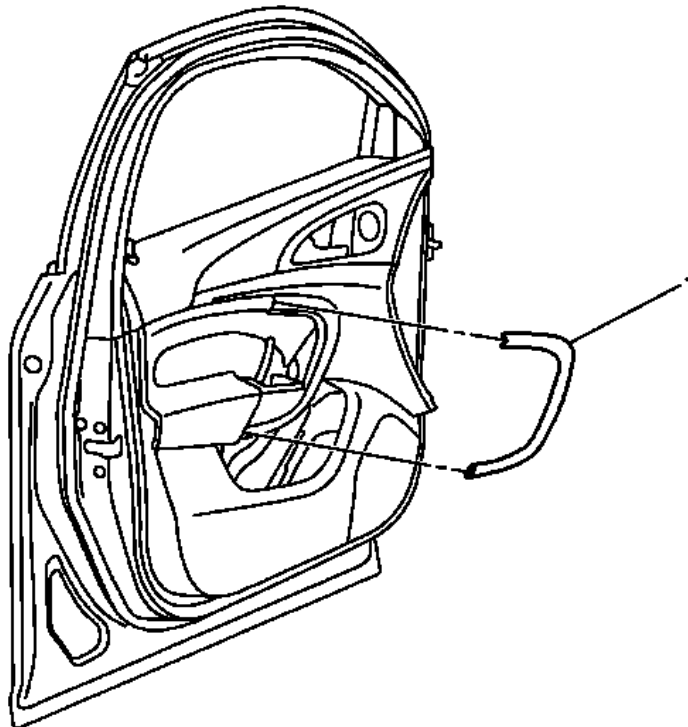


Fig. 1: Front Side Door Pull Handle Cover
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Pull Handle Cover Replacement

Callout	Component Name
1	Front Side Door Pull Handle Cover TIP: Use a small flat-bladed tool to release the front side door handle cover.

REAR SIDE DOOR PULL HANDLE COVER REPLACEMENT

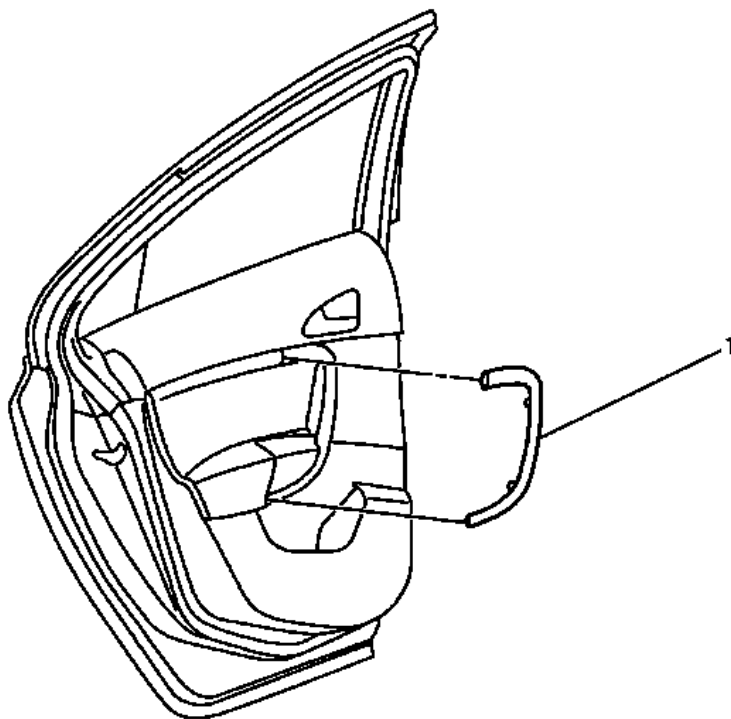


Fig. 2: Rear Side Door Pull Handle Cover
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Pull Handle Cover Replacement

Callout	Component Name
1	Rear Side Door Pull Handle Cover TIP: Use a small flat-bladed tool to release the rear side door handle cover.

FRONT SIDE DOOR OUTSIDE REARVIEW MIRROR FILLER REPLACEMENT

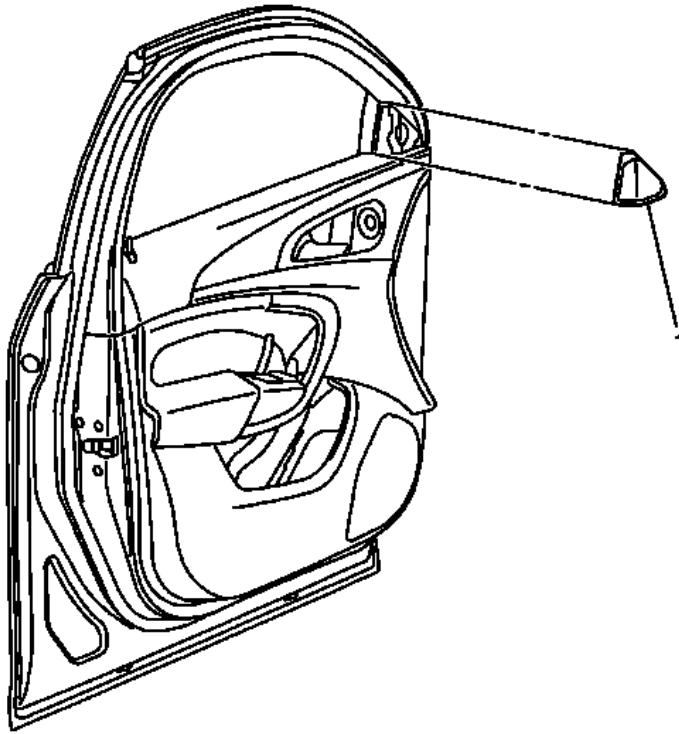


Fig. 3: Front Side Door Outside Rearview Mirror Filler
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Outside Rearview Mirror Filler Replacement

Callout	Component Name
1	Front Side Door Outside Rearview Mirror Filler Procedure Disconnect the electrical connector. TIP: Use a small flat-bladed tool to remove the front side door outside rearview mirror filler.

FRONT SIDE DOOR TRIM PANEL REPLACEMENT

Removal Procedure

1. Remove the front side door outside rearview mirror filler. Refer to **Front Side Door Outside Rearview Mirror Filler Replacement**.

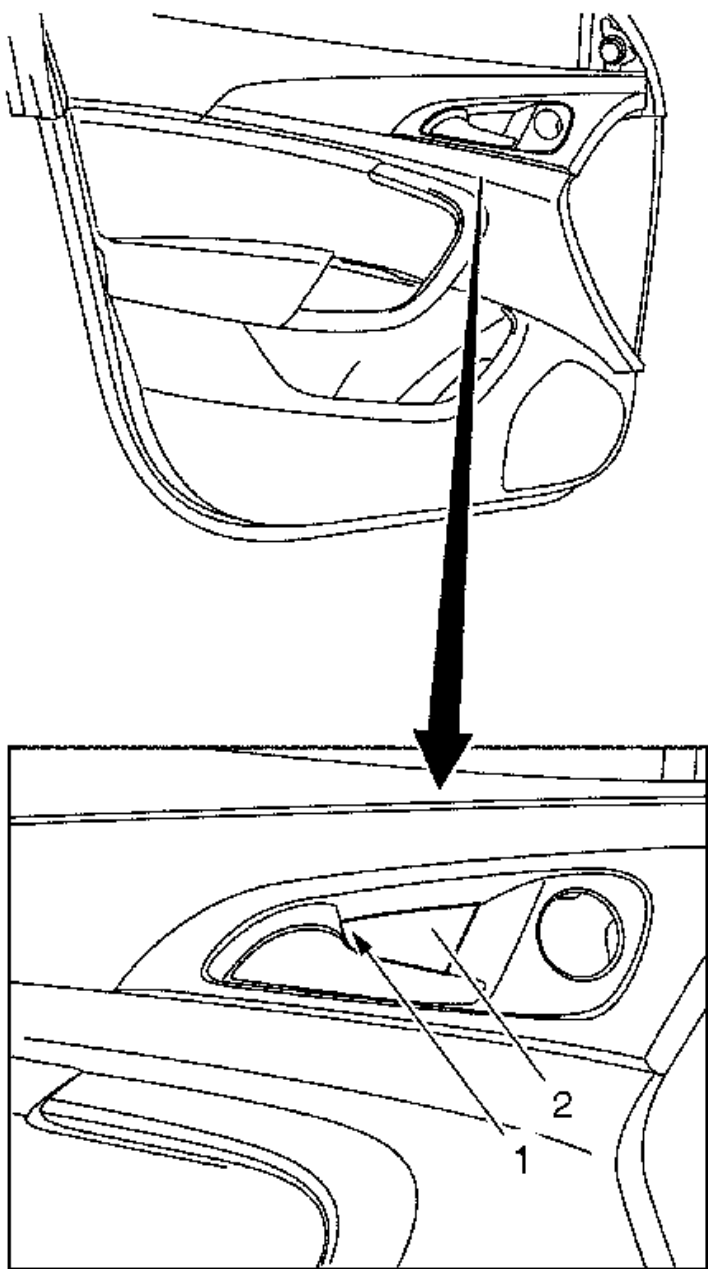


Fig. 4: Front Side Door Handle Cover
Courtesy of GENERAL MOTORS COMPANY

2. Use a small flat bladed tool in the corner (1) to release the front side door handle cover.

3. Remove the front side door handle cover (2).

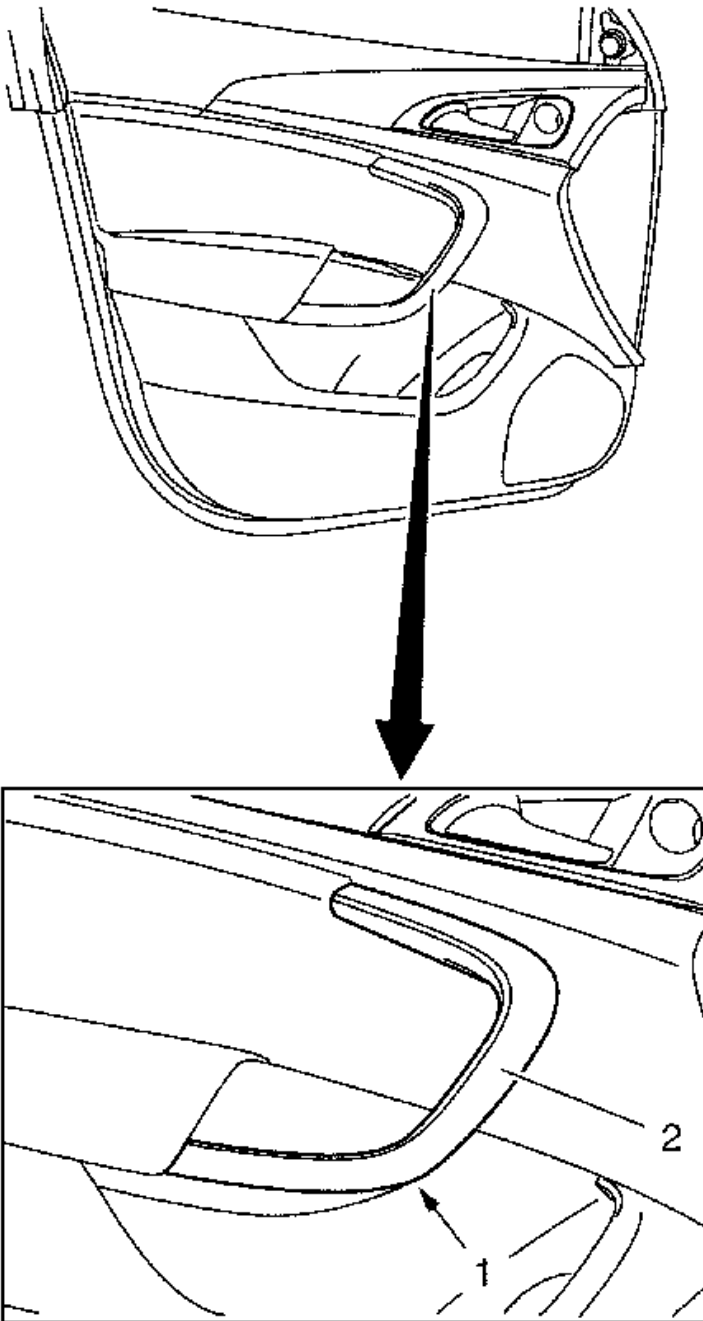


Fig. 5: Front Side Door Pull Handle Cover
Courtesy of GENERAL MOTORS COMPANY

4. Use a small flat bladed tool to release the front side door pull handle cover in the area (1).
5. Remove the front side door pull handle cover (2).

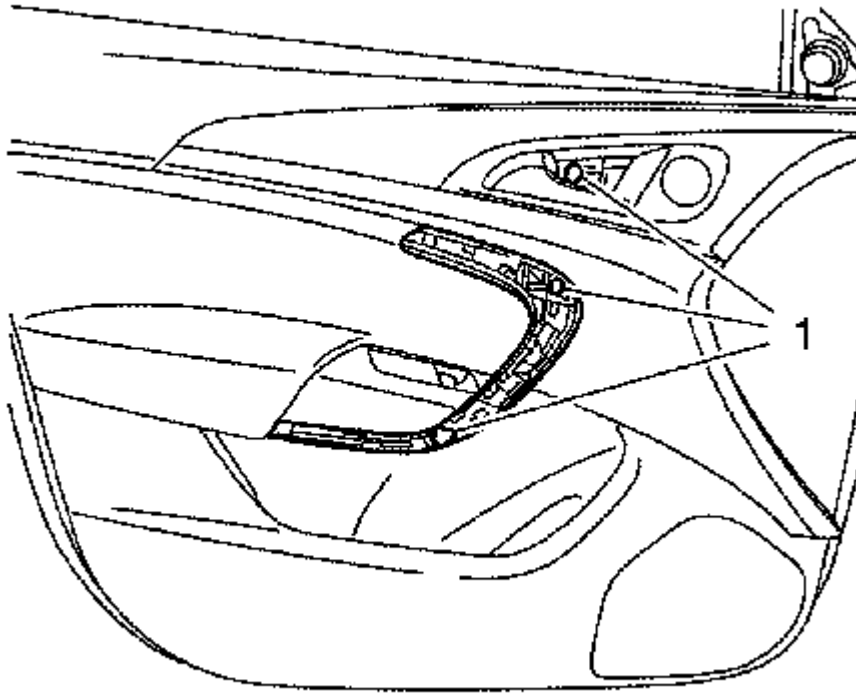


Fig. 6: Front Side Door Trim Panel Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the three front side door trim panel fasteners (1).

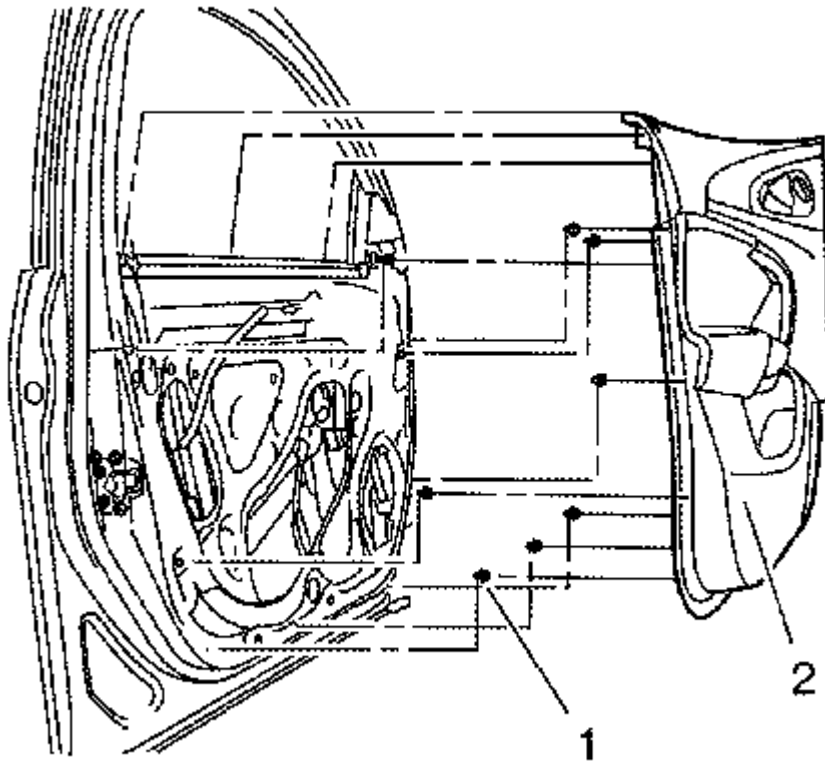


Fig. 7: Front Side Door Trim Panel Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Put the window downwards to make the removal easier.

Note the number and locations of the retainers for installation of the front side door trim panel.

7. Release the 8 front side door trim panel retainers (1). Start releasing front side door trim panel retainer at the bottom.
8. Release the door lock retainer cable to disengage.
9. Disconnect the electrical connector.
10. Remove the front side door trim panel (2).

Installation Procedure

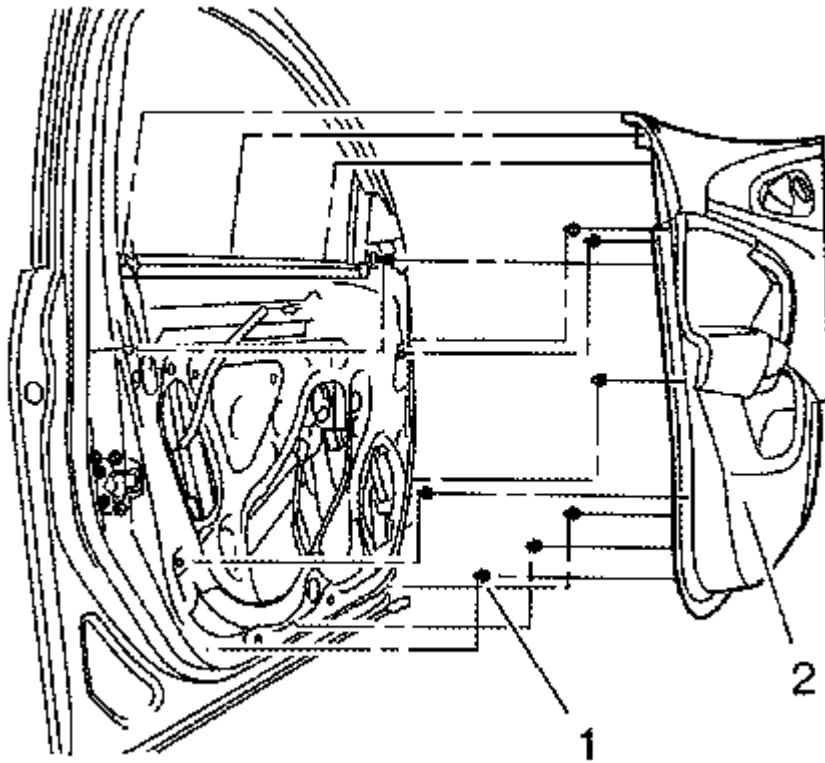


Fig. 8: Front Side Door Trim Panel Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use new retainer (1) before installing the front side door trim panel.

1. Install the front side door trim panel (2). Use five new blue retainers and three new green retainers.
2. Connect the electrical connector.
3. Install the door lock retainer cable to engage.

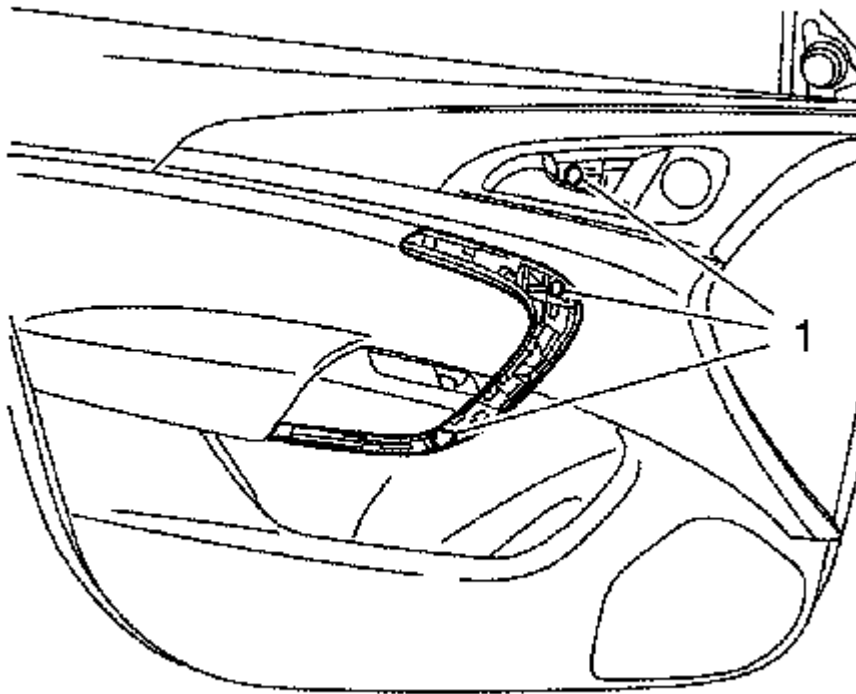


Fig. 9: Front Side Door Trim Panel Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the three front side door trim panel fasteners (1).

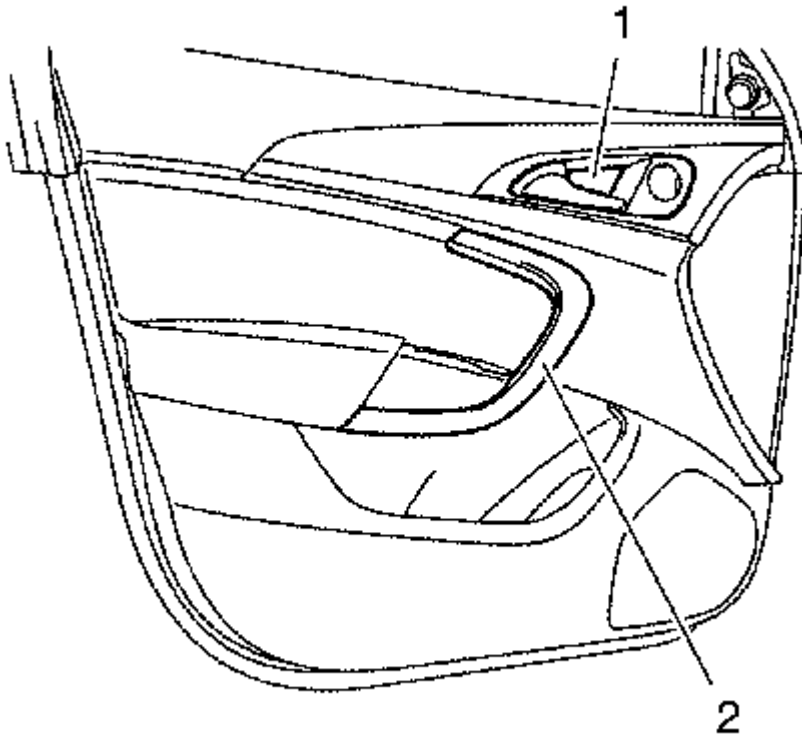


Fig. 10: Front Side Door Handle Cover
Courtesy of GENERAL MOTORS COMPANY

5. Install the front side door handle cover (1).
6. Install the front side door pull handle cover (2).
7. Install the front side door outside rearview mirror filler. Refer to **Front Side Door Outside Rearview Mirror Filler Replacement**.

REAR SIDE DOOR TRIM PANEL REPLACEMENT

Removal Procedure

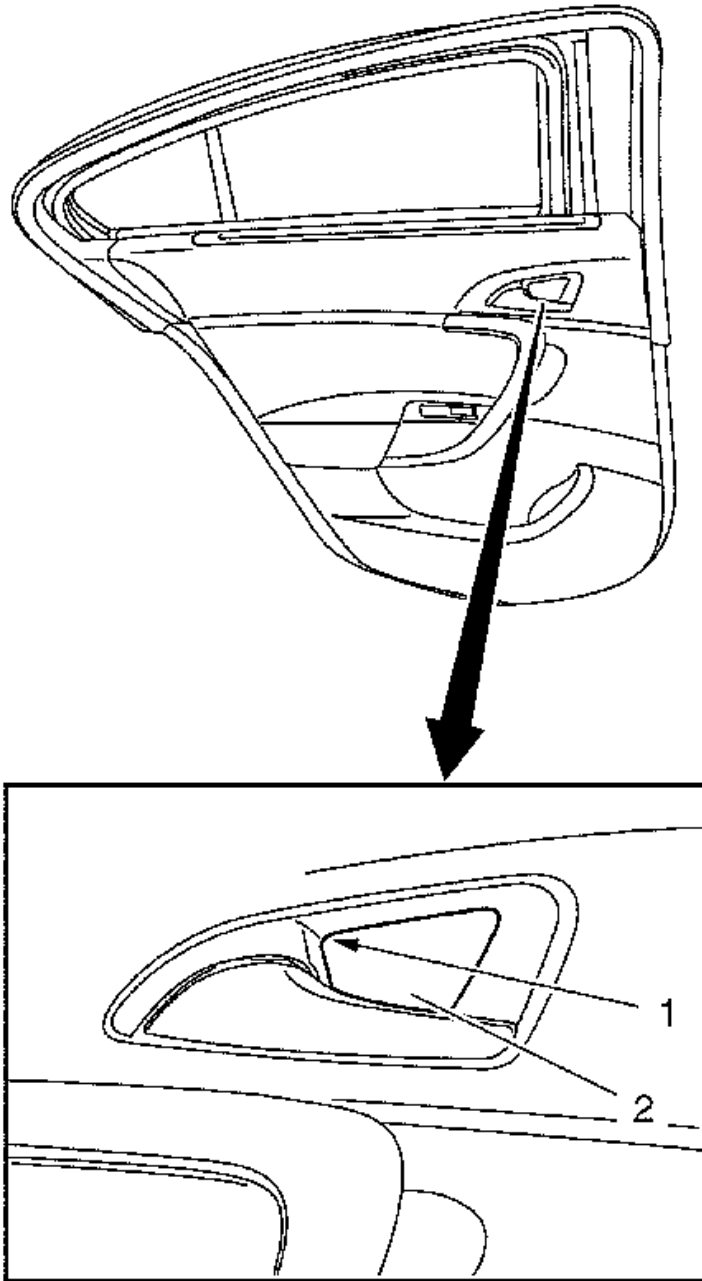


Fig. 11: Rear Side Door Handle Cover
Courtesy of GENERAL MOTORS COMPANY

1. Use a small flat bladed tool in the corner (1) to release the rear side door handle cover.

2. Remove the rear side door handle cover (2).

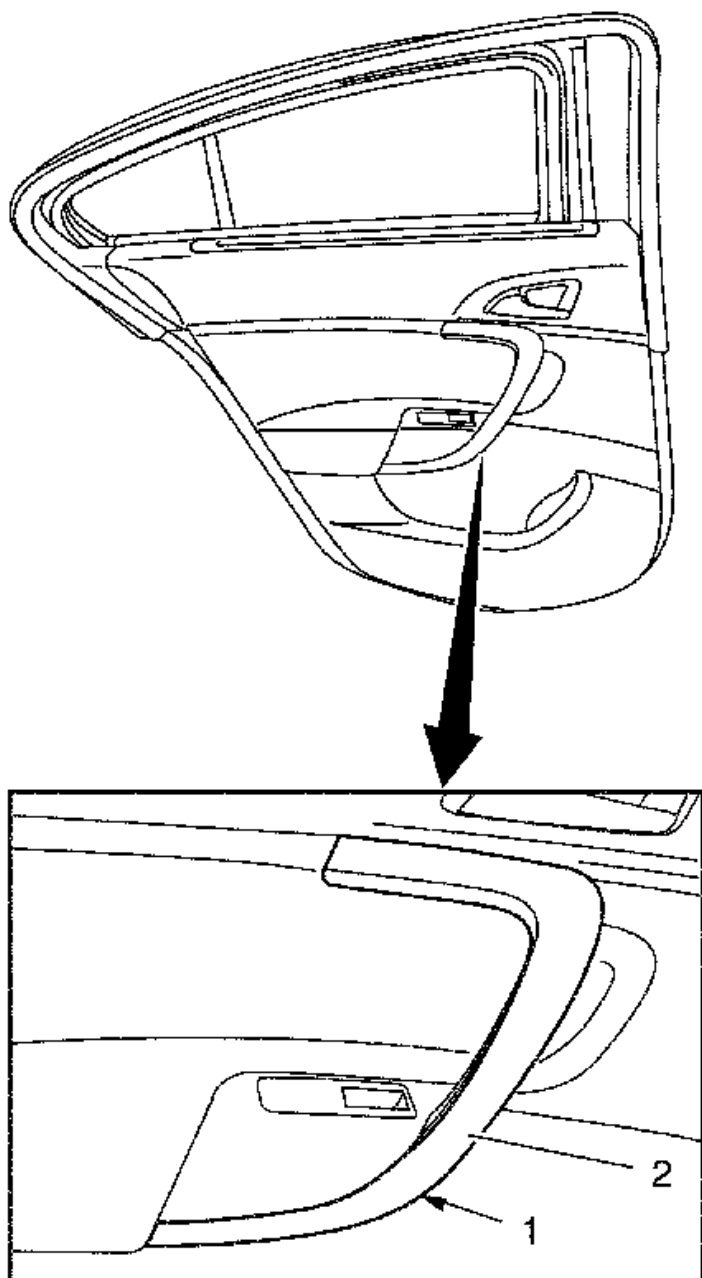


Fig. 12: Rear Side Door Pull Handle Cover
Courtesy of GENERAL MOTORS COMPANY

3. Use a small flat bladed tool to release the rear side door pull handle cover in the area (1).
4. Remove the rear side door pull handle cover (2).

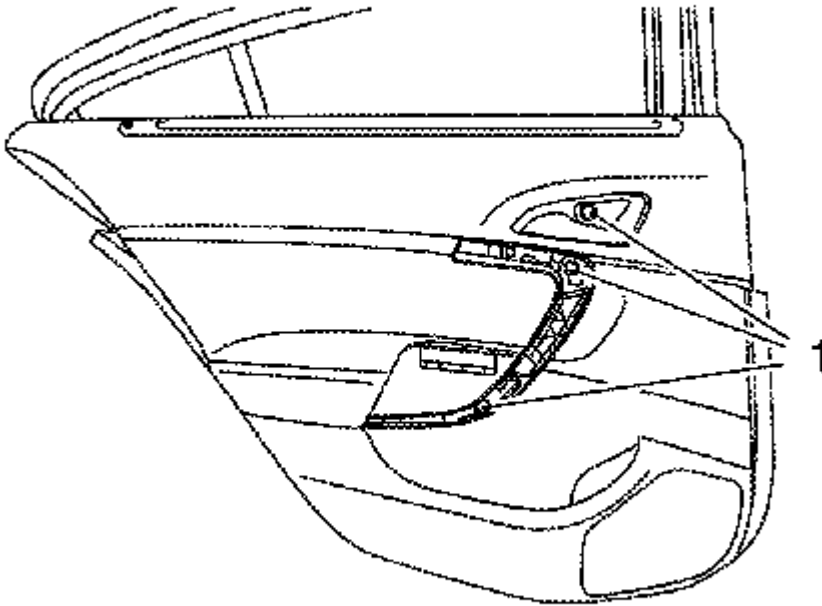


Fig. 13: Rear Side Door Handle Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 3 rear side door handle cover fasteners (1).

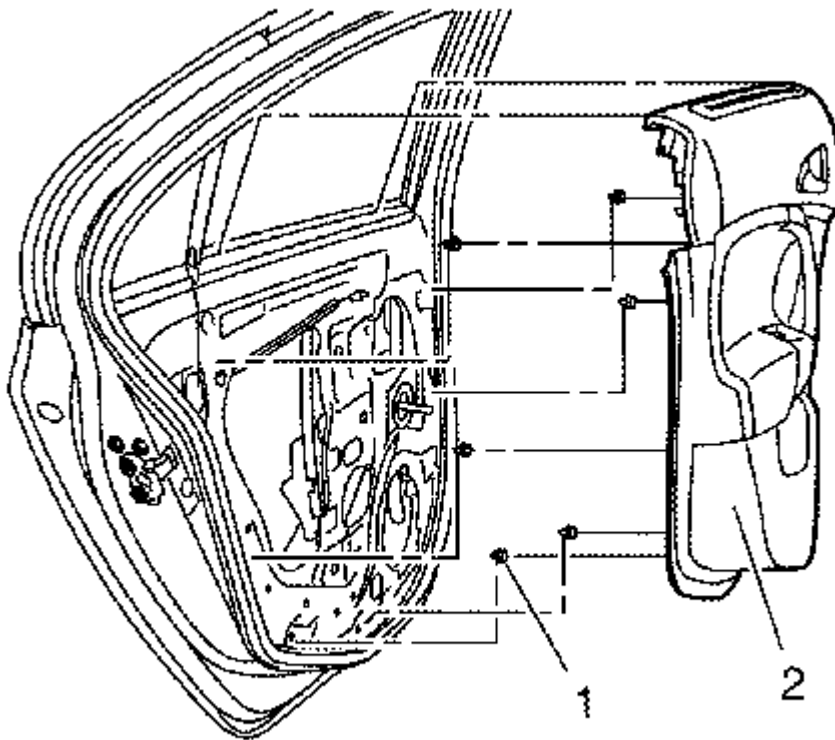


Fig. 14: Rear Side Door Trim Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: Put the window downwards to make the removal easier.

Note the number and locations of the retainers for installation of the rear side door trim panel.

6. Release the 6 rear side door trim panel retainers (1). Start releasing rear side door trim panel retainer at the bottom.
7. Release the door lock retainer cable to disengage.
8. Disconnect the electrical connector.
9. Remove the rear side door trim panel (2).

Installation Procedure

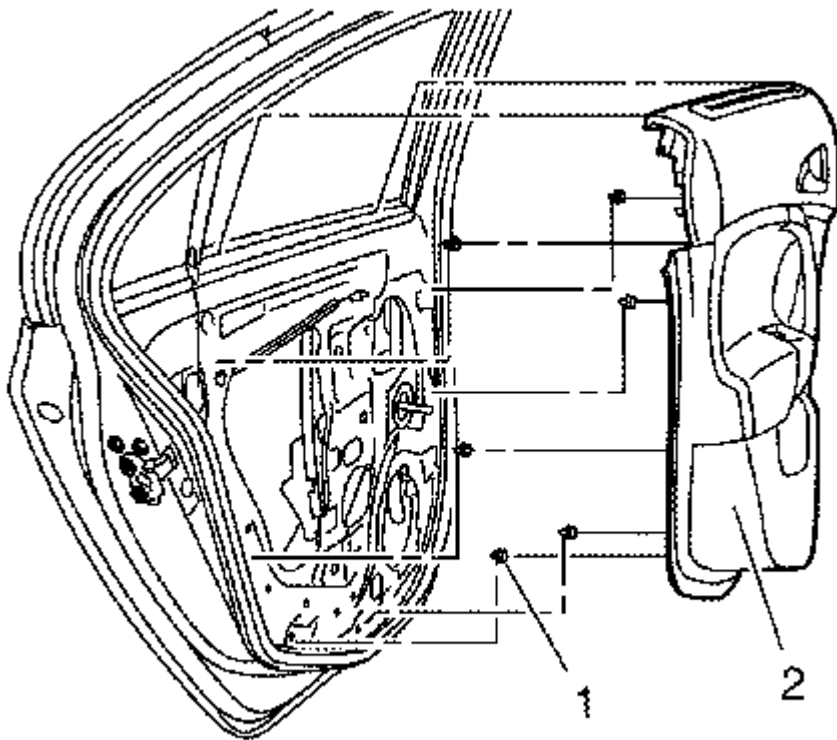


Fig. 15: Rear Side Door Trim Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use new retainer (1) before installing the rear side door trim panel.

1. Install the rear side door trim panel (2). Use 4 new blue retainers and 2 new green retainers.
2. Connect the electrical connector.
3. Install the door lock retainer cable to engage.

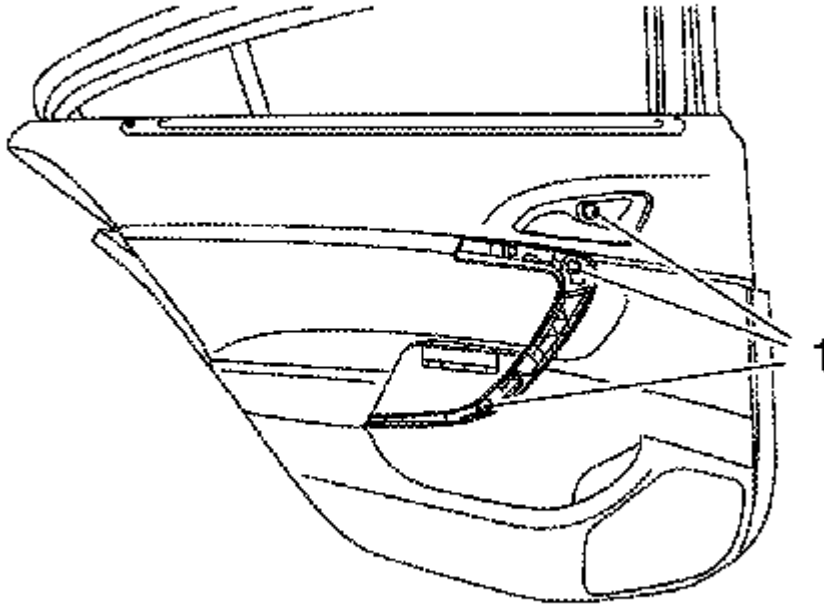


Fig. 16: Rear Side Door Handle Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the 3 rear side door trim panel fasteners (1).

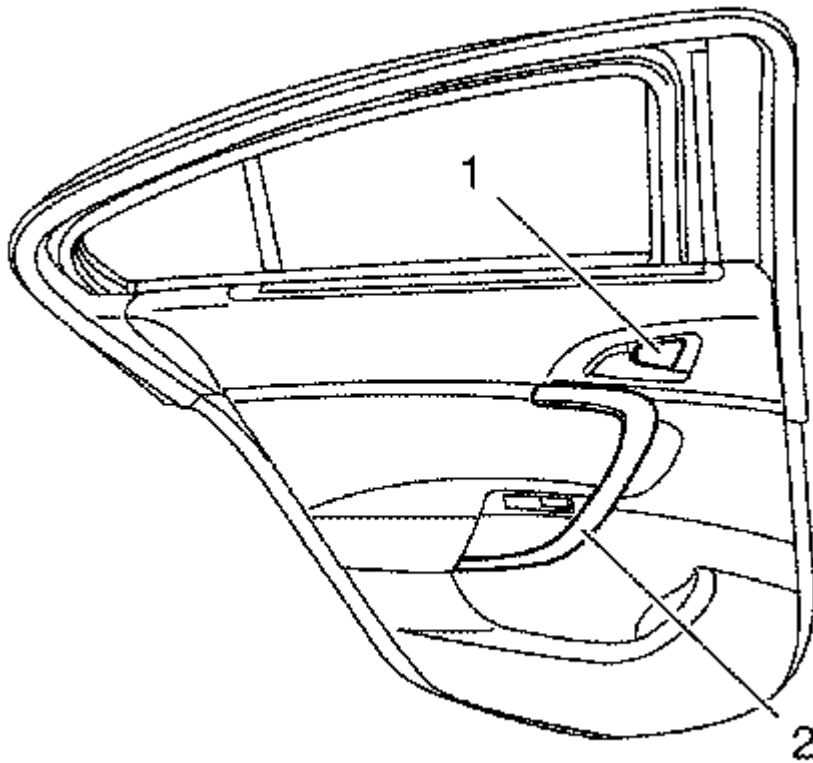


Fig. 17: Rear Side Door Handle And Pull Handle Covers
Courtesy of GENERAL MOTORS COMPANY

5. Install the rear side door handle cover (1).
6. Install the rear side door pull handle cover (2).

FRONT SIDE DOOR WATER DEFLECTOR REPLACEMENT

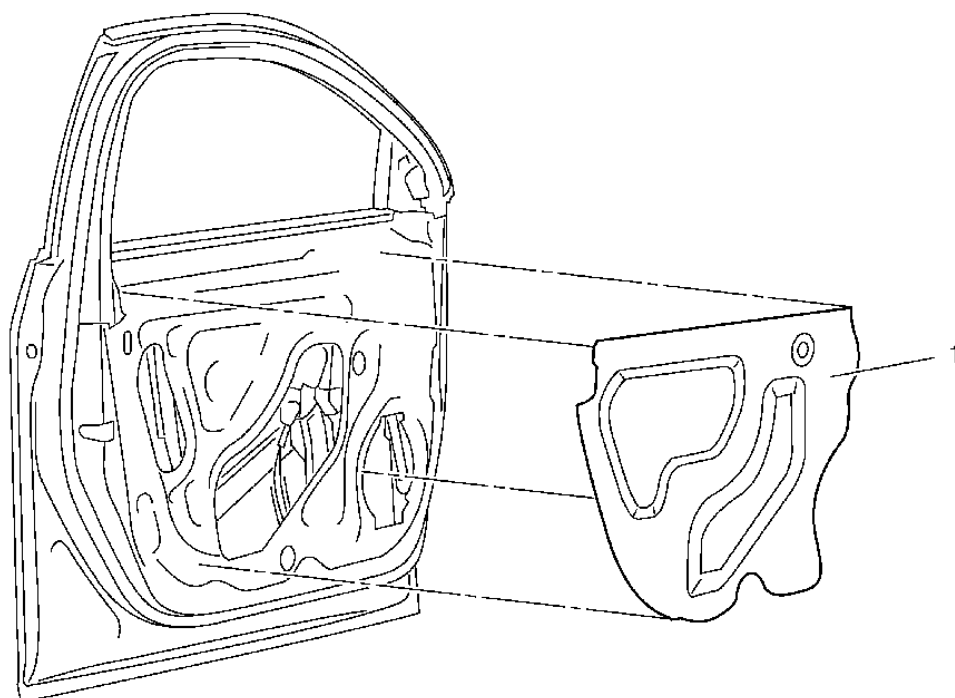


Fig. 18: Front Side Door Water Deflector
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Water Deflector Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front side door trim panel. Refer to Front Side Door Trim Panel Replacement .	
1	Front Side Door Water Deflector Procedure Guide electrical connectors and door lock cable through the water deflector while removing it from the door.

REAR SIDE DOOR WATER DEFLECTOR REPLACEMENT

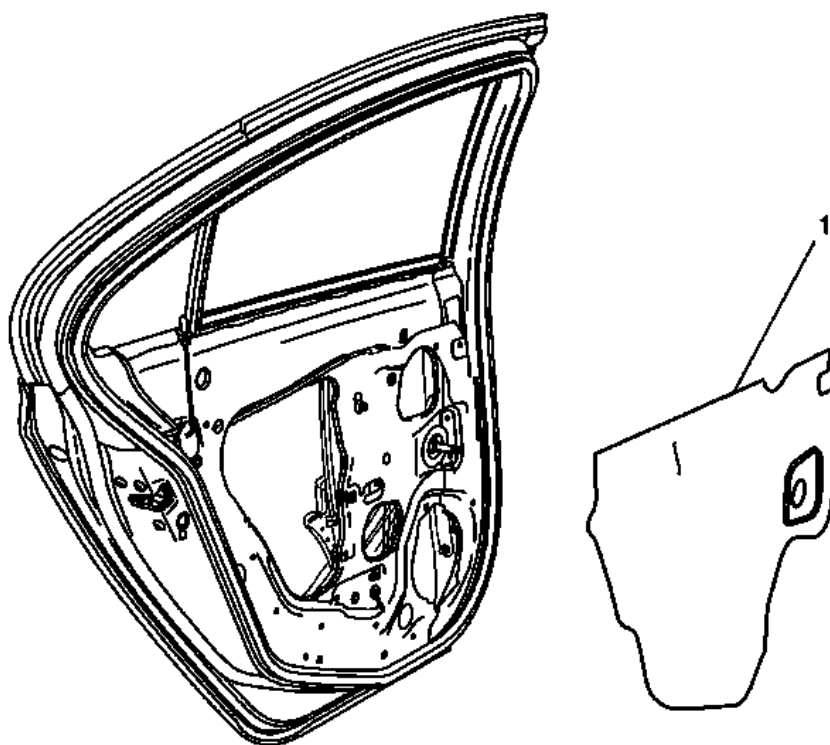


Fig. 19: Rear Side Door Water Deflector
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Water Deflector Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u>	
1	Rear Side Door Water Deflector TIP: Guide electrical connectors and door lock cable through the rear side door water deflector while removing it from the door.

FRONT SIDE DOOR WINDOW FRAME GARNISH MOLDING REPLACEMENT

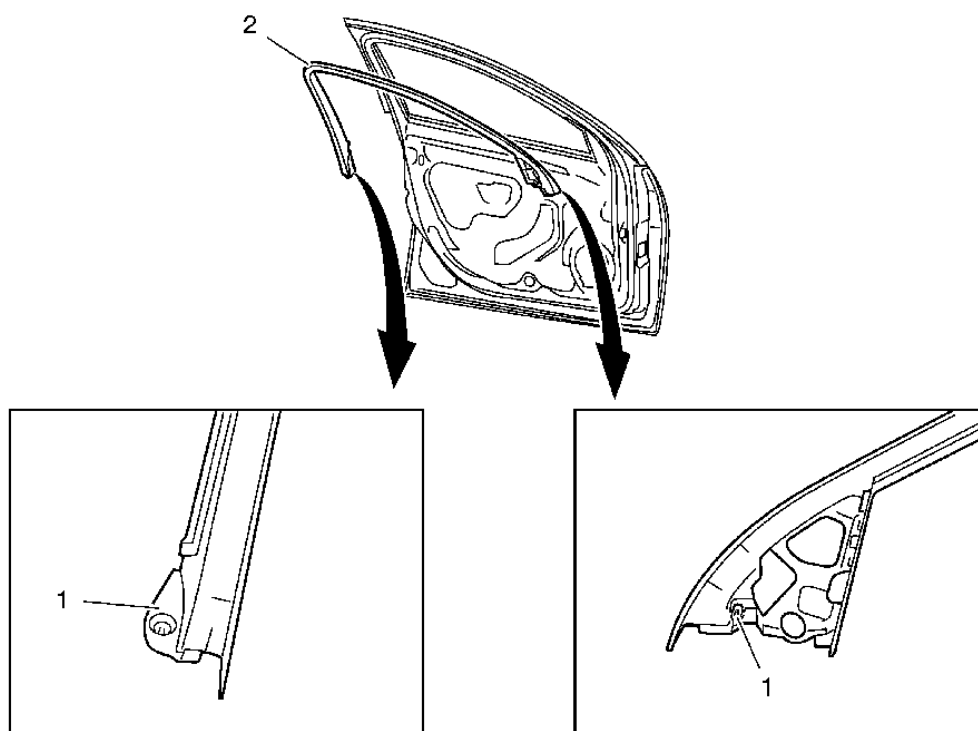


Fig. 20: Front Side Door Window Frame Garnish Molding & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Window Frame Garnish Molding Replacement

Callout	Component Name
Preliminary Procedure Remove the front side door trim panel. Refer to Front Side Door Trim Panel Replacement .	
1	Front Side Door Window Frame Garnish Molding Retainer (Qty: 2) Procedure Pull the inner front side door window frame garnish molding away from the inner window flange to remove.
2	Front Side Door Window Frame Garnish Molding Procedure When installing the new front side door window frame garnish molding, start at the upper inside corner of the door frame.

REAR SIDE DOOR WINDOW FRAME GARNISH MOLDING REPLACEMENT

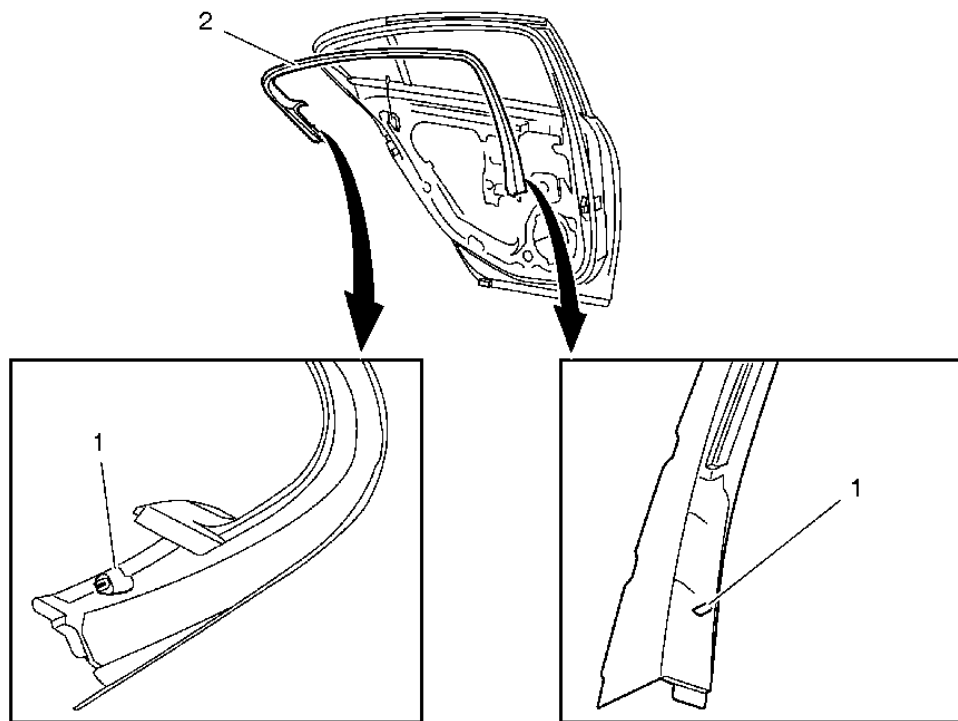


Fig. 21: Rear Side Door Window Frame Garnish Molding
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Window Frame Garnish Molding Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear side door trim panel. Refer to <u>Rear Side Door Trim Panel Replacement</u> .	
1	Rear Side Door Window Frame Garnish Molding Fastener (Qty: 2)
2	Rear Side Door Window Frame Garnish Molding Procedure <ol style="list-style-type: none"> 1. Pull the inner rear side door window frame garnish molding away from the inner window flange to remove. 2. When installing the new rear side door window frame garnish molding, start at the upper inside corner of the door frame.

FRONT AND REAR SIDE DOOR SILL TRIM PLATE REPLACEMENT

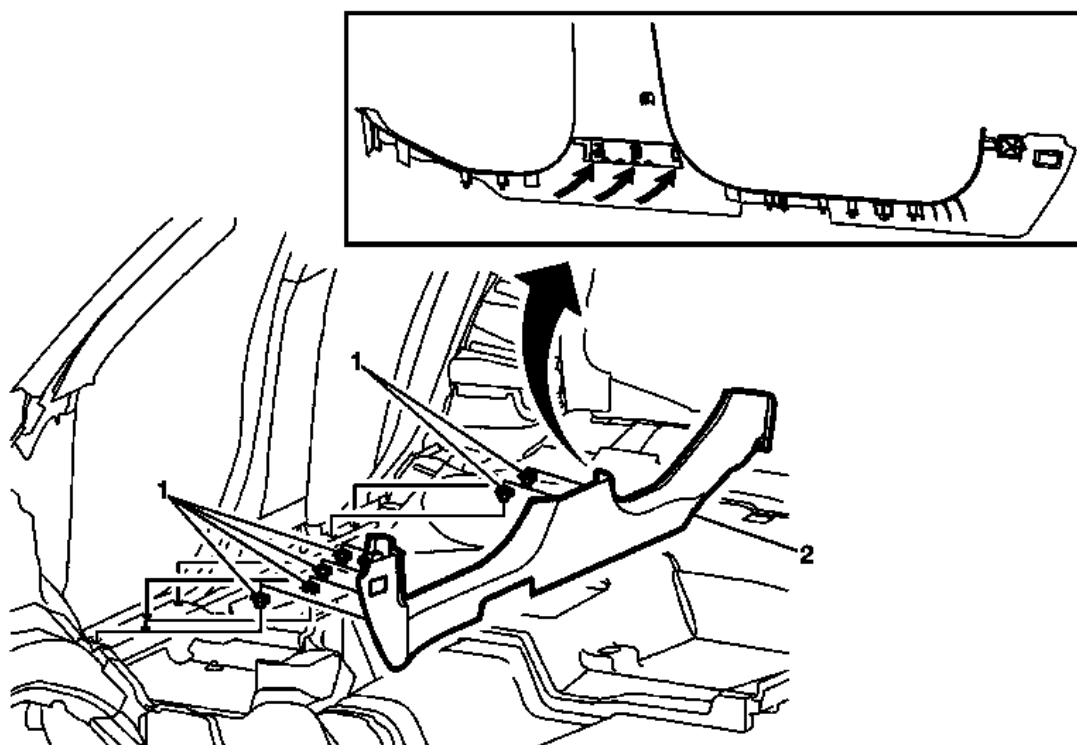


Fig. 22: Front and Rear Side Door Sill Trim Plate & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Front and Rear Side Door Sill Trim Plate Replacement

Callout	Component Name
Preliminary Procedure	
Remove the driver or passenger front seat. Refer to <u>Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)</u> .	
1	Front and Rear Side Door Sill Trim Plate Retainer (Qty: 6)
2	Front and Rear Side Door Sill Trim Plate
	Procedure
	<ol style="list-style-type: none"> 1. Use a small flat-bladed tool to carefully disengage 3 integral clips that mate the center pillar lower trim panel to the front and rear side door sill trim plate. 2. Disconnect the electrical connector.

REAR COMPARTMENT SIDE TRIM PANEL REPLACEMENT (HP6, LEFT SIDE)

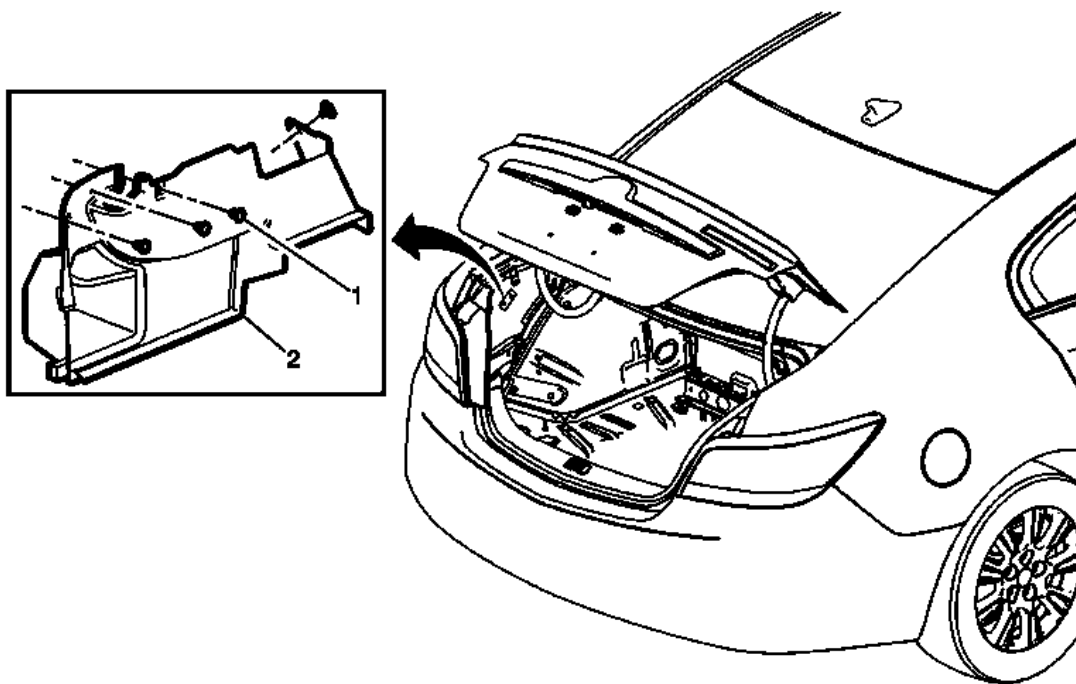


Fig. 23: Rear Compartment Side Trim Panel (HP6, Left Side)

Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Side Trim Panel Replacement (HP6, Left Side)

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none"> 1. Remove the rear compartment floor panel trim (with battery cover, HP6) Refer to <u>Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6)</u>, <u>Rear Compartment Floor Panel Trim Replacement (with Blower Cover, HP6)</u>. 2. Fold down rear seat to access retainer. 	
1	Rear Compartment Side Trim Panel Retainer (Qty: 4)
2	Rear Compartment Side Trim Panel Assembly

REAR COMPARTMENT SIDE TRIM PANEL REPLACEMENT (HP6, RIGHT SIDE)

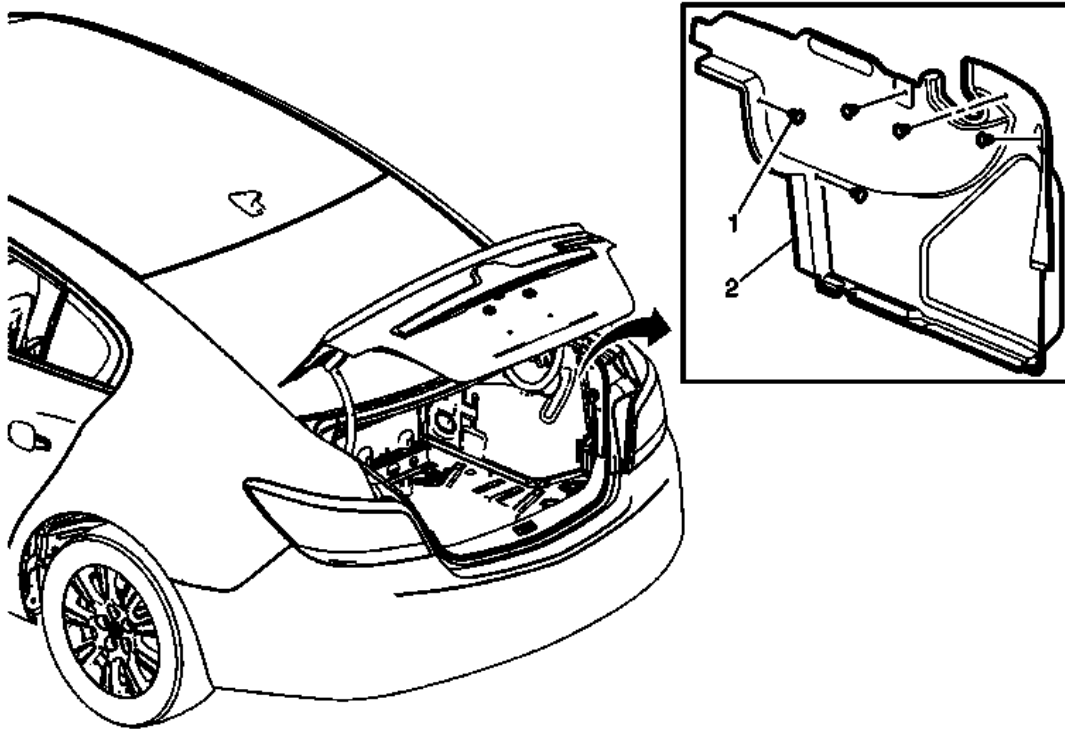


Fig. 24: Rear Compartment Side Trim Panel (HP6, Right Side)
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Side Trim Panel Replacement (HP6, Right Side)

Callout	Component Name
Preliminary Procedure Remove the rear compartment floor panel trim (with blower cover,HP6). Refer to <u>Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6)</u> , <u>Rear Compartment Floor Panel Trim Replacement (with Blower Cover, HP6)</u> .	
1	Rear Compartment Side Trim Panel Retainer (Qty: 5)
2	Rear Compartment Side Trim Panel Assembly

REAR COMPARTMENT SIDE TRIM PANEL REPLACEMENT (WITHOUT HP6)

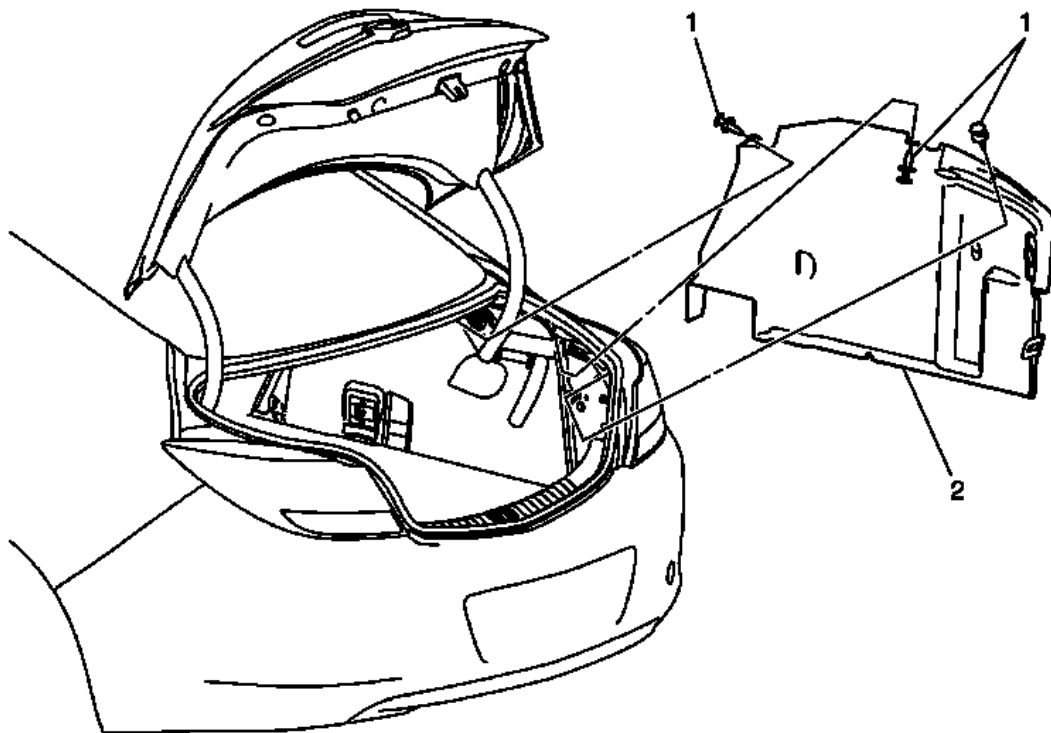


Fig. 25: Rear Compartment Side Trim Panel & Retainers (without HP6)
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Side Trim Panel Replacement (without HP6)

Callout	Component Name
Preliminary Procedures	
1. Fold down rear seat to access retainer.	
2. Remove the rear end trim finish panel. Refer to <u>Rear End Trim Finish Panel Replacement</u> .	
1	Rear Compartment Side Trim Panel Retainer (Qty: 3)
2	Rear Compartment Side Trim Panel

ROOF RAIL FRONT ASSIST HANDLE REPLACEMENT

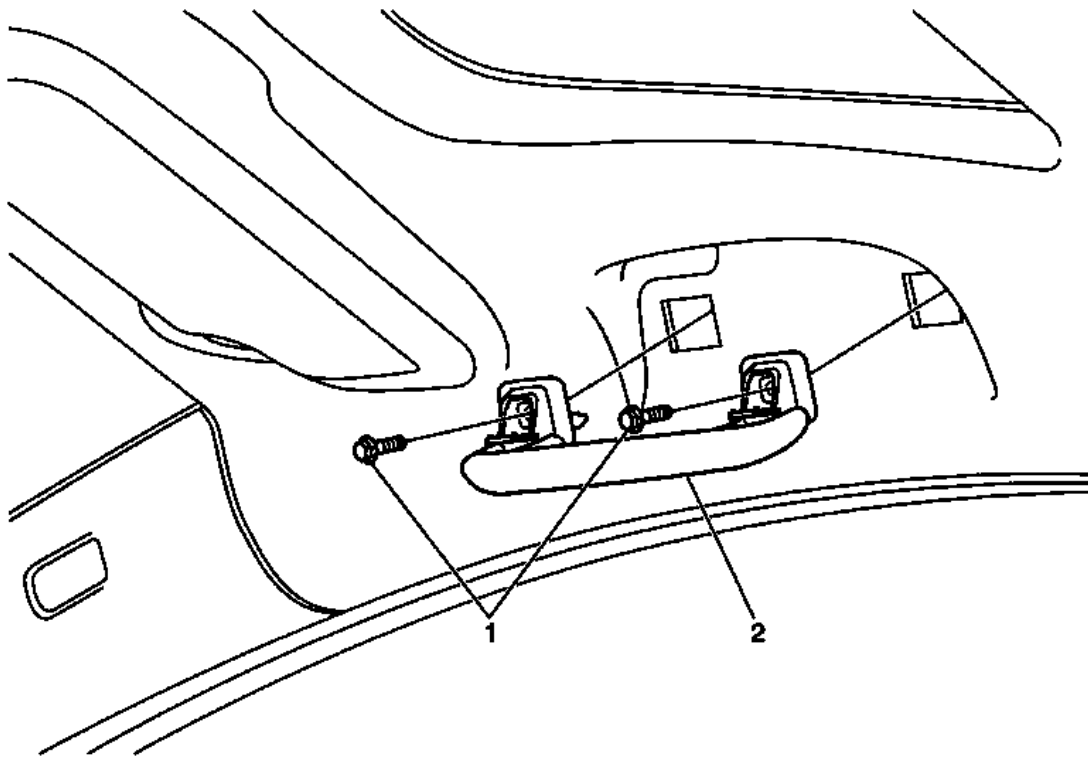


Fig. 26: Roof Rail Front Assist Handle & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Roof Rail Front Assist Handle Replacement

Callout	Component Name
1	Roof Rail Front Assist Handle Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Fold the assist handle downward and hold. 2. Use a small flat-bladed tool to release the cover to access the fastener.
2	Roof Rail Front Assist Handle

INSIDE REARVIEW MIRROR MOUNT PLATE COVER REPLACEMENT

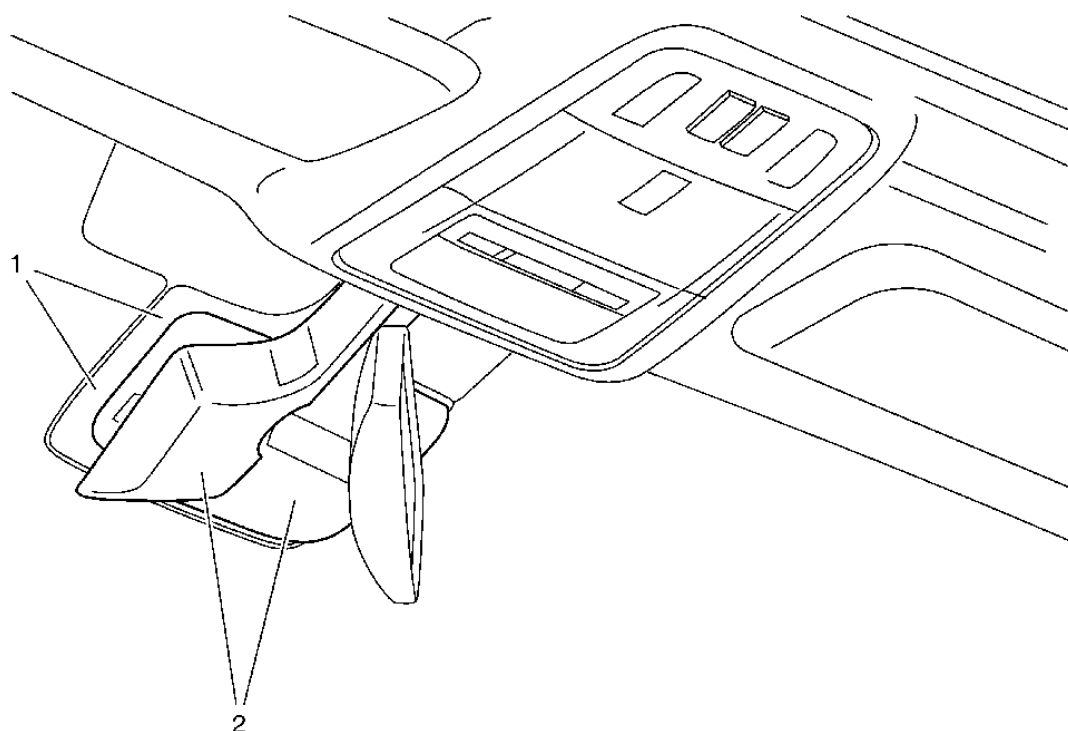


Fig. 27: Inside Rearview Mirror Mount Plate Cover & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Inside Rearview Mirror Mount Plate Cover Replacement

Callout	Component Name
1	Inside Rearview Mirror Mount Plate Cover Retainer (Qty: 4) TIP: Use a small flat-bladed tool to release the locking retainer from the inside rearview mirror mount plate cover, left and right side.
2	Inside Rearview Mirror Mount Plate Cover

SUNSHADE REPLACEMENT

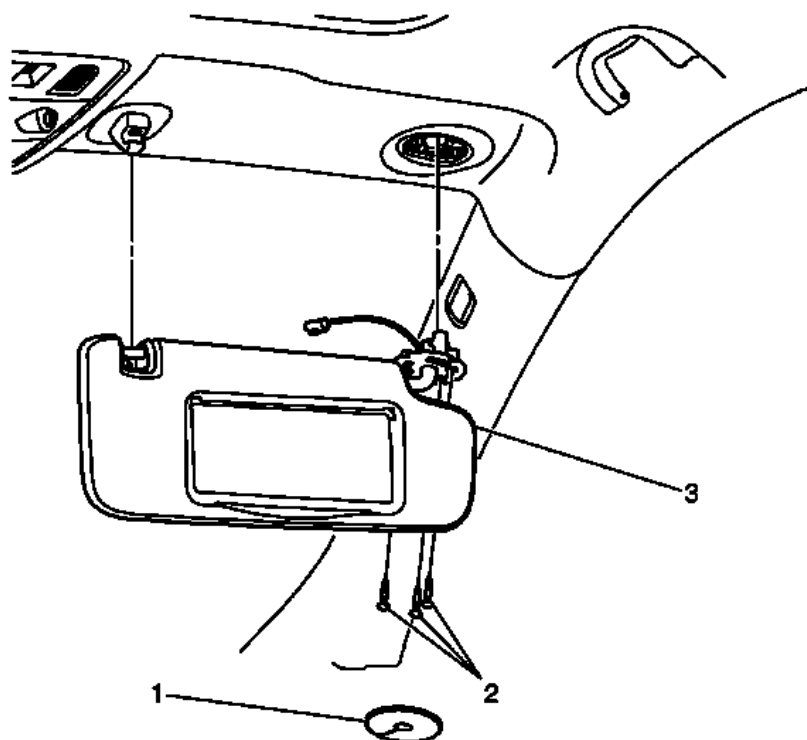


Fig. 28: Sunshade & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Sunshade Replacement

Callout	Component Name
Preliminary Procedure Lower the front of the headlining trim panel to access the sunshade electrical connector, if necessary. Refer to <u>Headlining Trim Panel Replacement (With Sunroof)</u> , <u>Headlining Trim Panel Replacement (Without Sunroof)</u> .	
1	Sunshade Support Fastener Cover
2	Sunshade Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .
3	Sunshade Assembly Procedure 1. Disconnect the electrical connector. 2. Remove the sunshade anchor from the roof by unsnapping, if needed.

SUNSHADE SUPPORT REPLACEMENT

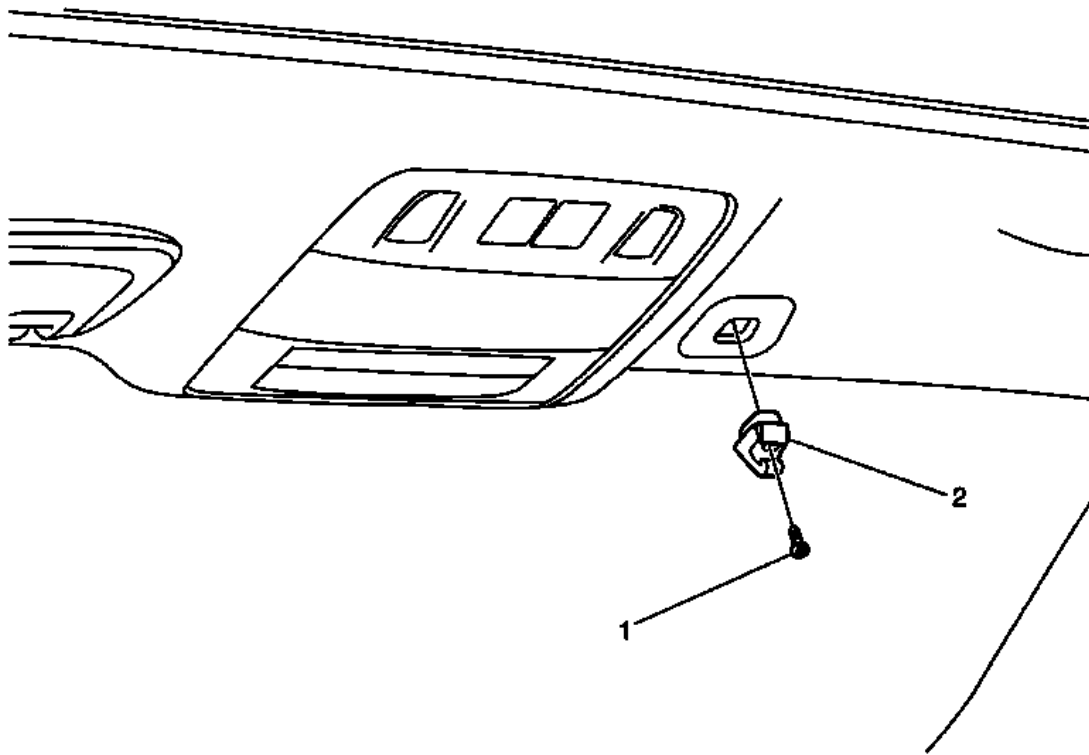


Fig. 29: Sunshade Support & Fastener
Courtesy of GENERAL MOTORS COMPANY

Sunshade Support Replacement

Callout	Component Name
1	Sunshade Support Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Pull cover downward to access fastener.
2	Sunshade Support

THEFT DETERRENT SENSOR OPENING TRIM PLATE REPLACEMENT

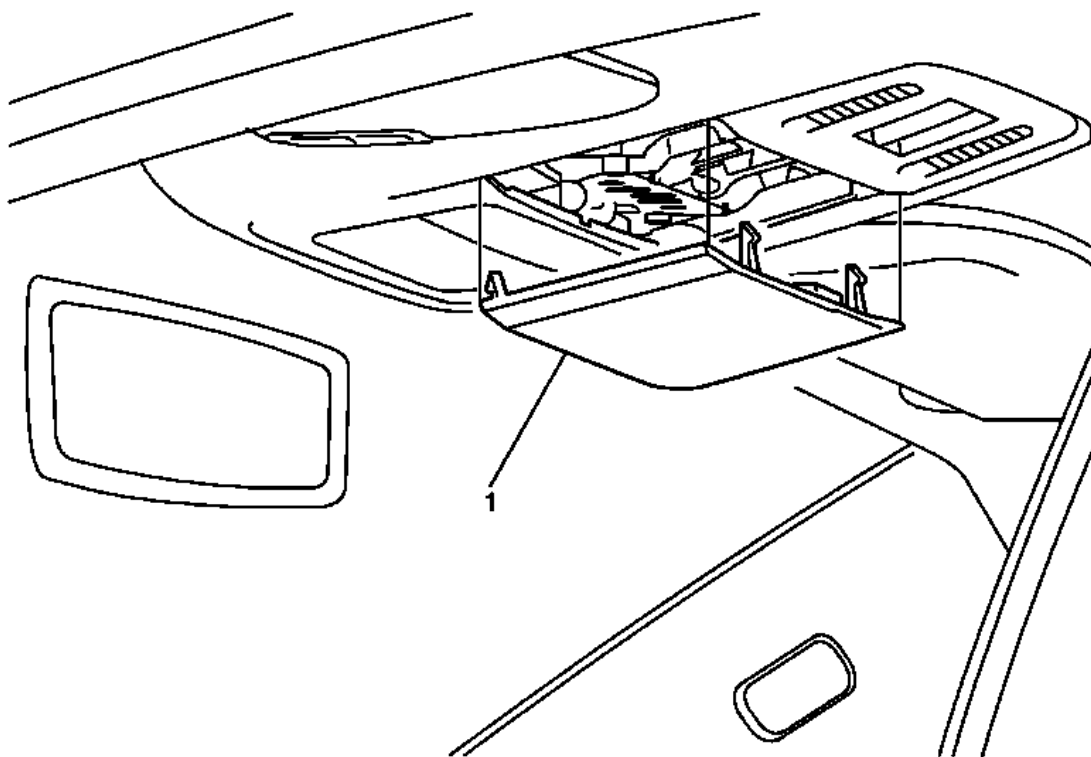


Fig. 30: Theft Deterrent Sensor Opening Trim Plate
 Courtesy of GENERAL MOTORS COMPANY

Theft Deterrent Sensor Opening Trim Plate Replacement

Callout	Component Name
1	Theft Deterrent Sensor Opening Molding Procedure Carefully use a flat bladed tool, and release the retainer from the theft deterrent sensor opening molding to the roof console.

WINDSHIELD SIDE GARNISH MOLDING REPLACEMENT

Removal Procedure

CAUTION: If a vehicle is equipped with a head curtain inflator module ensure that the inflator module and tether are undamaged. If tether or curtain airbag are damaged in any way, they must be replaced.

CAUTION: Use care when working around the head curtain inflator module. Sharp tools may puncture the curtain airbag. If the head curtain inflator module is damaged in any way, it must be replaced.

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .

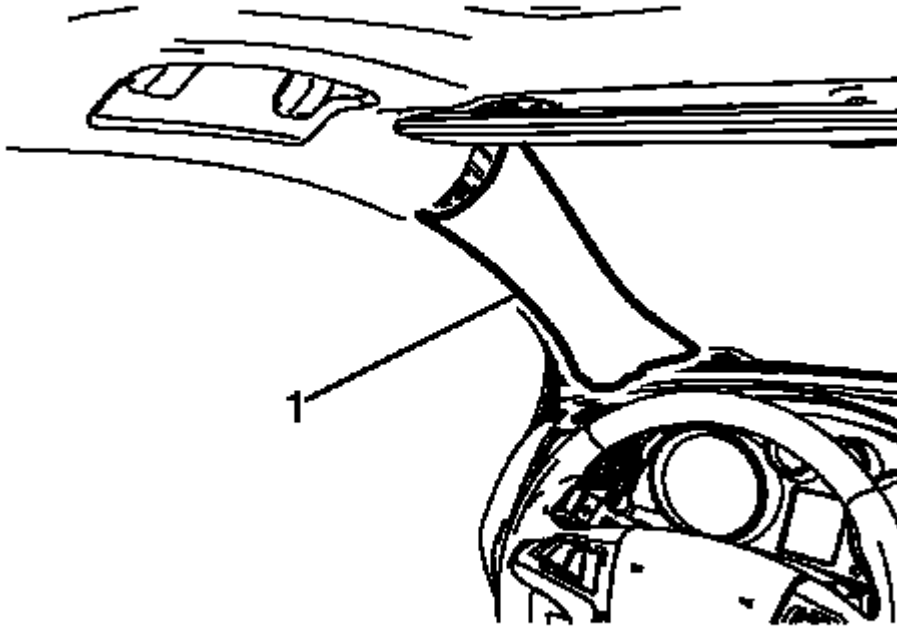


Fig. 31: Upper Side Of The Windshield Side Garnish Molding
Courtesy of GENERAL MOTORS COMPANY

2. First release the upper side of the windshield side garnish molding (1).

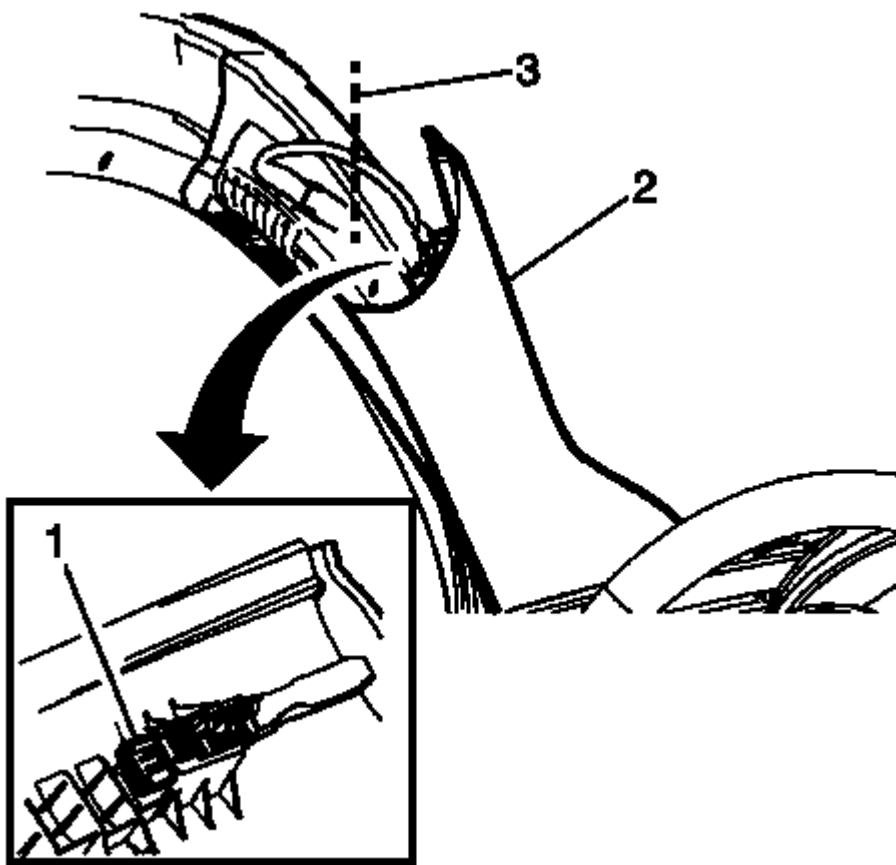


Fig. 32: Pulling Upper Side Of The Windshield Side Garnish Molding
Courtesy of GENERAL MOTORS COMPANY

3. Pull and release gently the upper side of the windshield side garnish molding (2) .
4. Cut the retainer at the cutline (3).

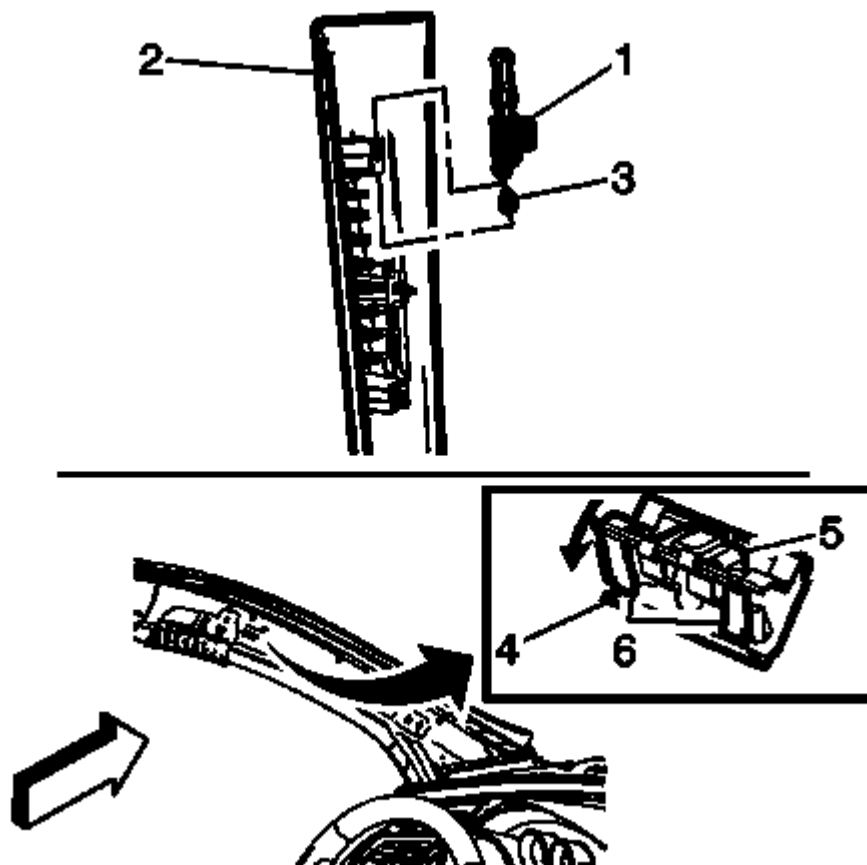


Fig. 33: Windshield Side Garnish Molding Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the rest of the windshield side garnish molding retainer (1) by releasing the clip (3) and sliding the retainer (1) upward out of the windshield side garnish molding (2).

NOTE: **Take care not to drop any portion of the retaining clip into the bodyside hinge pillar. This could cause an irreversible rattle condition.**

6. Remove the windshield side garnish molding retainer (4) out of the body hinge pillar inner panel by doing the following:
 1. Remove the retainer (4) from the bodyside.
 2. Slide a small flat-bladed tool on the outboard side to disengage the center retainer (5), maintain pressure on the tab.
 3. Slide another small flat-bladed tool on the opposite side of the retainer to depress the outer tabs (6), maintain pressure on the tabs.
 4. Rotate the retainer out parallel to the upper reinforcement body hinge pillar.

Installation Procedure

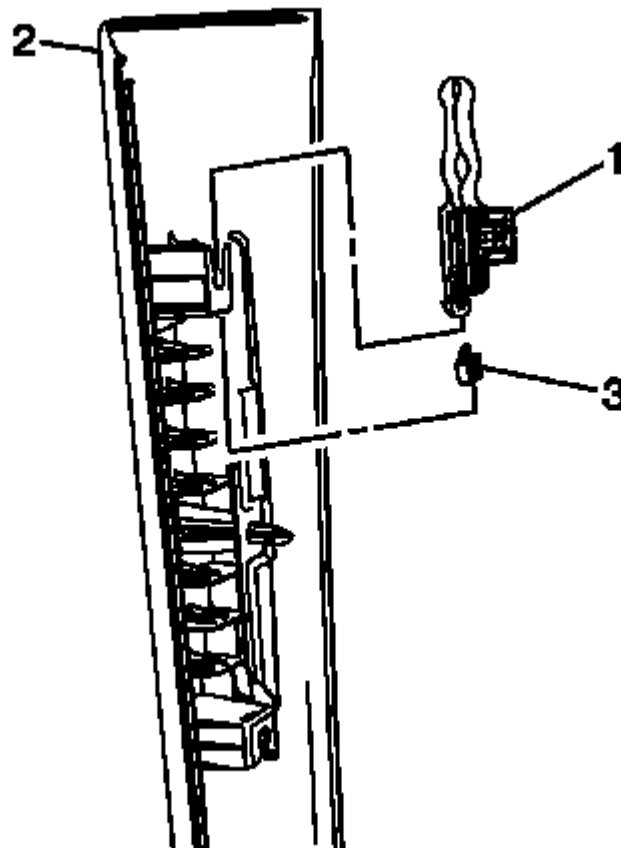


Fig. 34: Windshield Side Garnish Molding Retainer Clips
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a new windshield side garnish molding clip each time the molding is removed.

1. Install the new windshield side garnish molding retainer (1) at the windshield side garnish molding.
2. Install the new windshield side garnish molding clip (3) to the windshield side garnish molding (2).

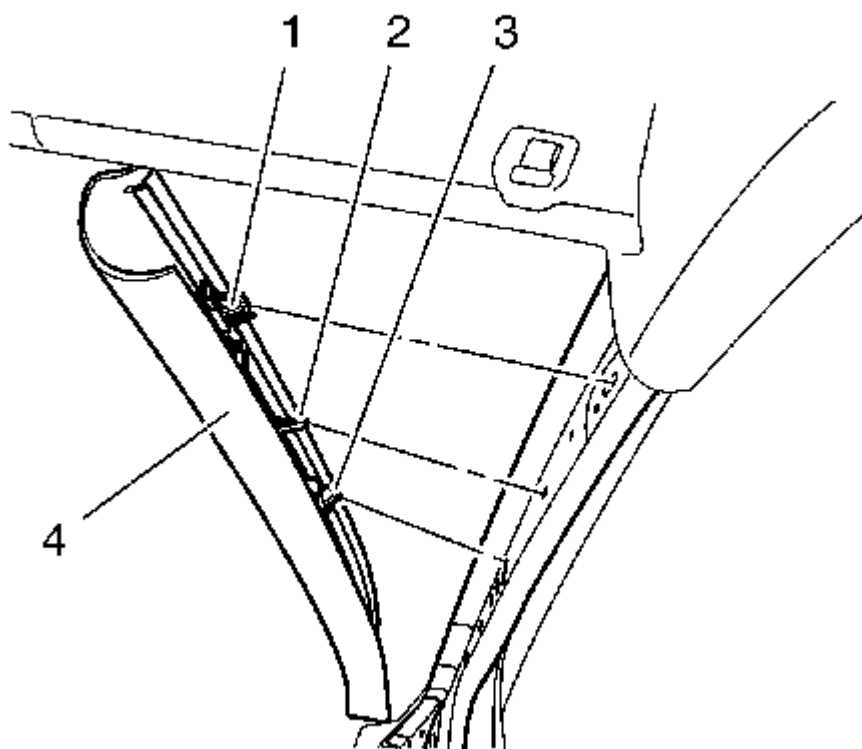


Fig. 35: Positioning Windshield Side Garnish Molding
Courtesy of GENERAL MOTORS COMPANY

3. Position the windshield side garnish molding (4) with the aid of the guide retainer (2).
4. Clip in the lower windshield side garnish molding retainer (3).
5. Push gently the upper side of the windshield side garnish molding to the body hinge pillar panel.
6. The windshield side garnish molding retainer (1) has to be in correct position to audible engage when connecting to the body hinge pillar panel.

CENTER PILLAR UPPER GARNISH MOLDING REPLACEMENT

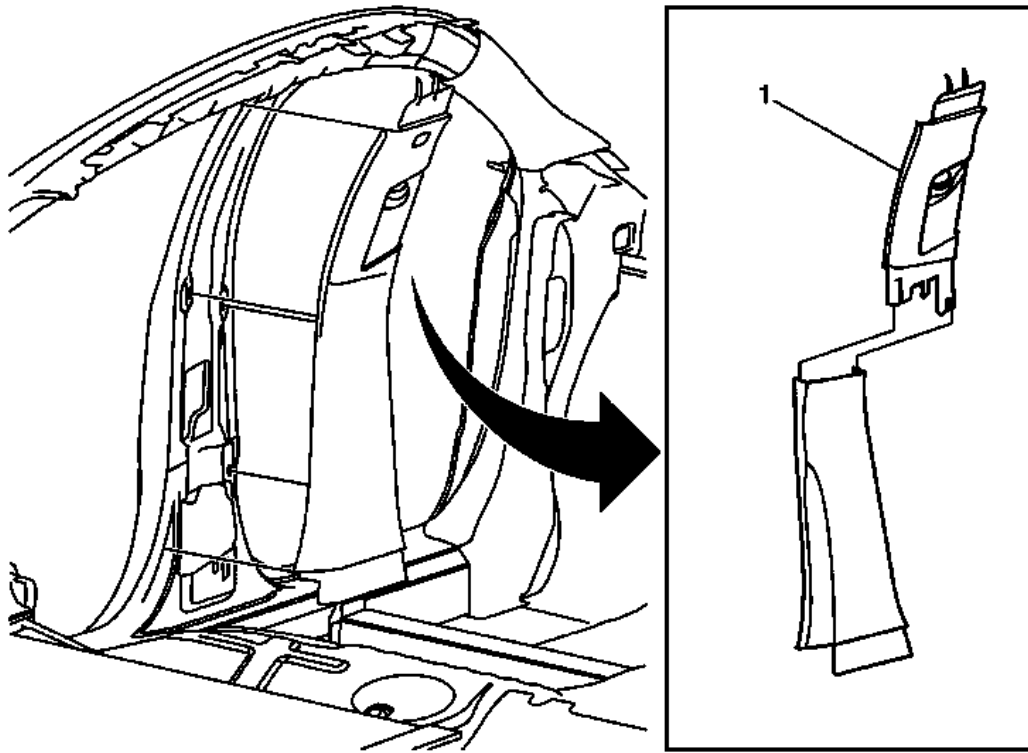


Fig. 36: Center Pillar Upper Garnish Molding
 Courtesy of GENERAL MOTORS COMPANY

Center Pillar Upper Garnish Molding Replacement

Callout	Component Name
Preliminary Procedure Remove the front and rear side door sill trim plate. Refer to <u>Front and Rear Side Door Sill Trim Plate Replacement</u> .	
1	Center Pillar Upper Garnish Molding Procedure <ol style="list-style-type: none"> 1. Remove the center pillar upper and lower garnish molding assembly as one piece. 2. Release the locking retainer on the rear side of the center pillar upper garnish molding to separate the upper from the lower.

CENTER PILLAR LOWER TRIM PANEL REPLACEMENT

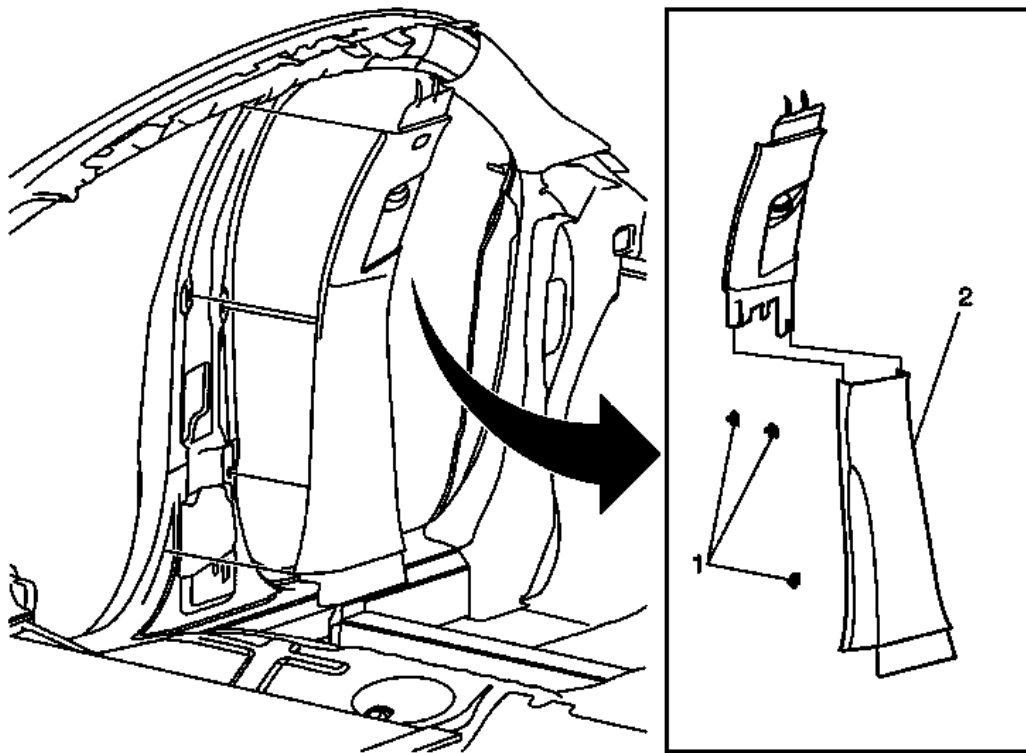


Fig. 37: Center Pillar Lower Trim Panel & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Center Pillar Lower Trim Panel Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the front and rear side door sill trim plate. Refer to <u>Front and Rear Side Door Sill Trim Plate Replacement</u> . 2. Move seat to full forward position.	
1	Center Pillar Lower Trim Panel Retainer (Qty: 3) Procedure <ol style="list-style-type: none"> 1. Remove the center pillar upper and lower garnish molding assembly as one piece. 2. Release the locking retainer on the rear side of the center pillar upper garnish molding to separate the upper from the lower.
2	Center Pillar Lower Trim Panel

BODY LOCK PILLAR UPPER TRIM PANEL REPLACEMENT (SEDAN)

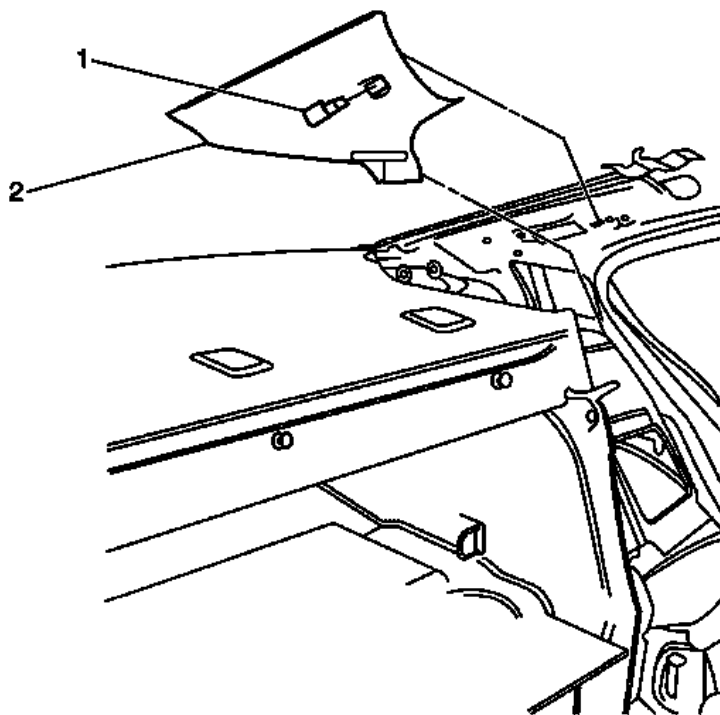


Fig. 38: Body Lock Pillar Upper Trim Panel (Sedan)
 Courtesy of GENERAL MOTORS COMPANY

Body Lock Pillar Upper Trim Panel Replacement (Sedan)

Callout	Component Name
Preliminary Procedure Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u> .	
1	Body Lock Pillar Upper Trim Panel Retainer TIP: Use a small flat-bladed tool to release the retainer from the body lock pillar upper trim panel.
2	Body Lock Pillar Upper Trim Panel

REAR WINDOW PANEL STOWAGE COMPARTMENT COVER REPLACEMENT (WITH HP6)

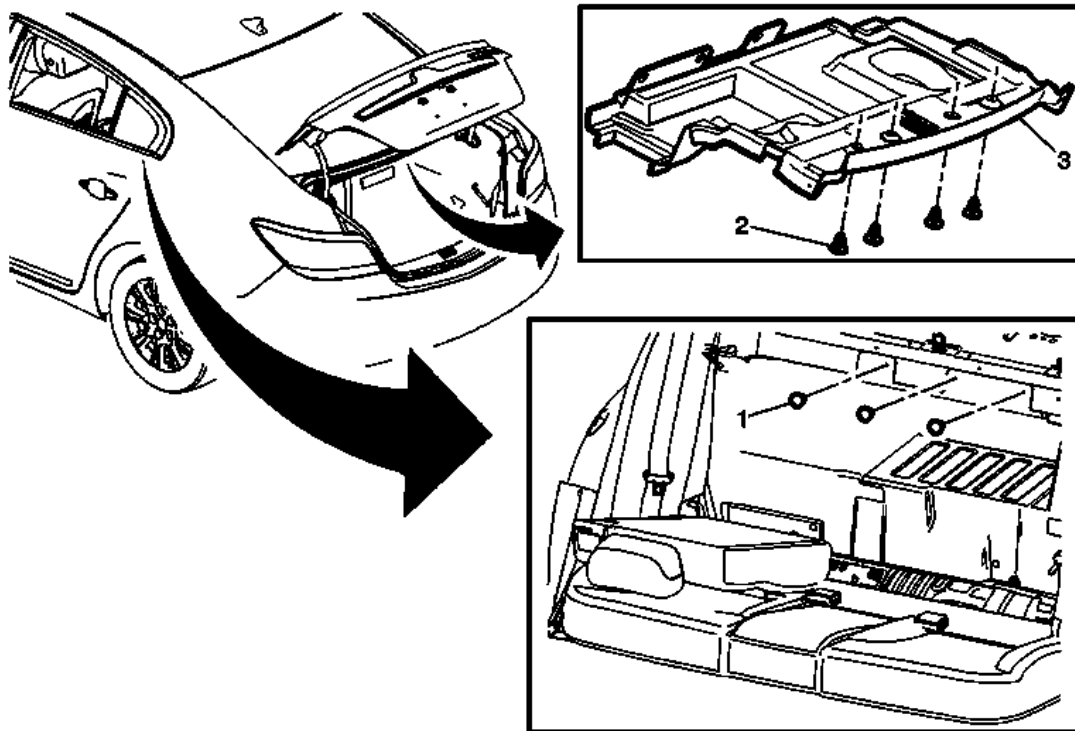


Fig. 39: Rear Window Panel Stowage Compartment Cover (with HP6)
Courtesy of GENERAL MOTORS COMPANY

Rear Window Panel Stowage Compartment Cover Replacement (with HP6)

Callout	Component Name
Preliminary Procedures	
Remove the rear window panel trim. Refer to Rear Window Panel Trim Replacement (with HP6) .	
1	Rear Window Panel Stowage Compartment Cover Retainers (Qty: 3) Procedure Use a trim removal tool to aid in the removal of the retainers.
2	Rear Window Panel Stowage Compartment Cover Retainers (Qty: 4) Procedures <ol style="list-style-type: none"> 1. Open rear compartment lid to access retainers. 2. Use a trim removal tool to aid in the removal of the retainers.
3	Rear Window Panel Stowage Compartment Cover Procedure Disconnect electrical connector.

REAR WINDOW PANEL TRIM REPLACEMENT (WITH HP6)

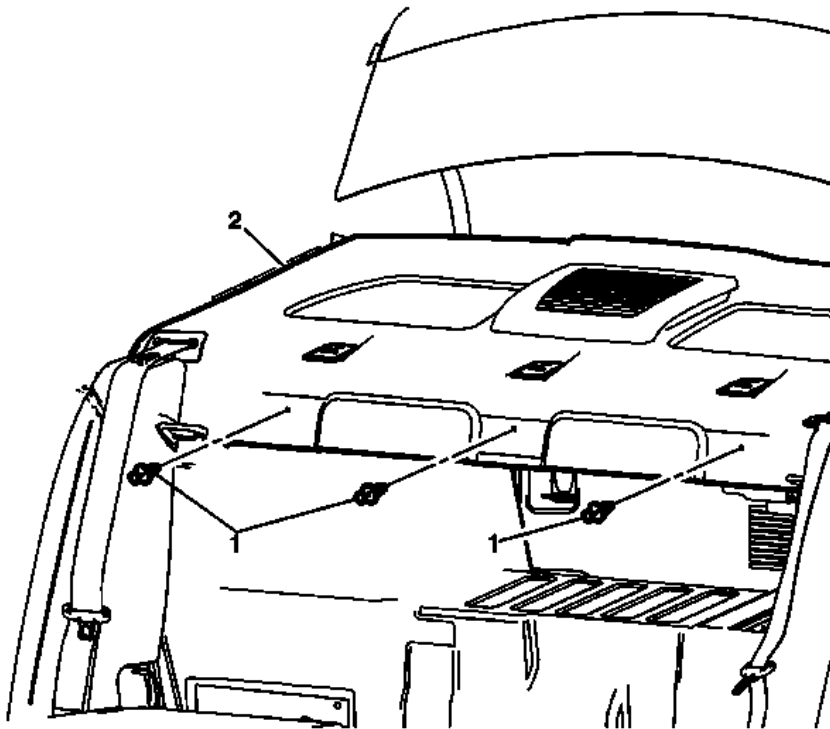


Fig. 40: Rear Window Panel Trim (with HP6)
Courtesy of GENERAL MOTORS COMPANY

Rear Window Panel Trim Replacement (with HP6)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Fold down the rear seat back cushions. 2. Remove the rear seat back cushion bolsters. Refer to <u>Rear Seat Back Bolster Replacement</u> . 	
1	Rear Window Panel Trim Retainer (Qty: 3)
2	Rear Window Panel Trim Assembly Procedure <ol style="list-style-type: none"> 1. Remove the seat belt guides and slide the belt through the slots in the panel. 2. Disconnect the electrical connector. 3. When replacing the rear window panel trim assembly, transfer all necessary components.

REAR WINDOW PANEL TRIM REPLACEMENT (WITHOUT HP6)

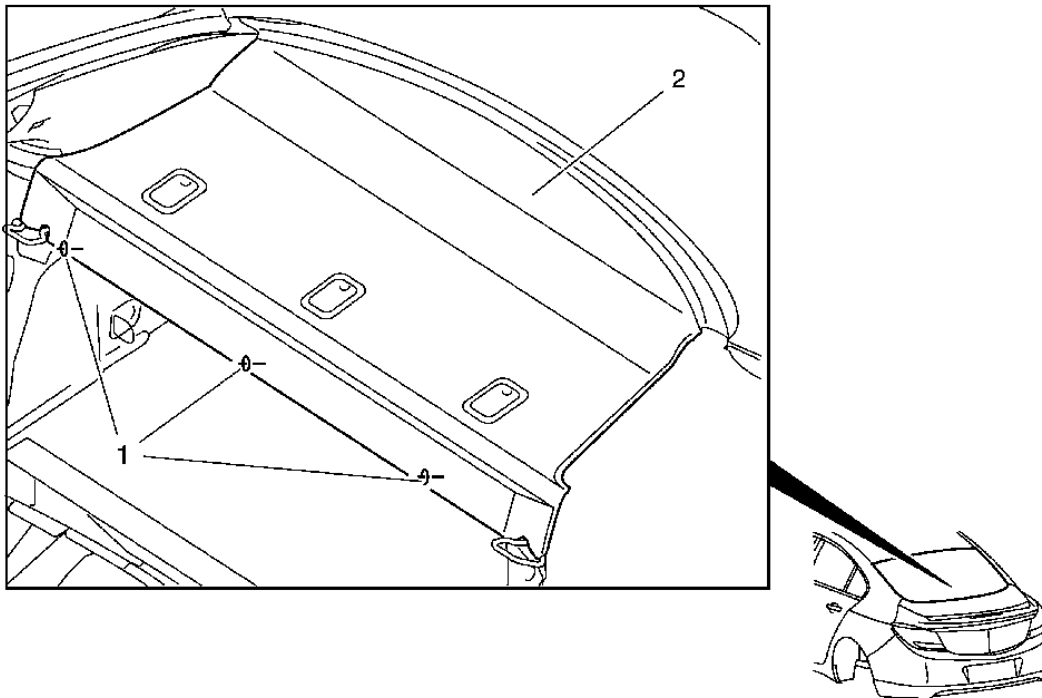


Fig. 41: Rear Window Panel Trim (without HP6)
 Courtesy of GENERAL MOTORS COMPANY

Rear Window Panel Trim Replacement (without HP6)

Callout	Component Name
Preliminary Procedures	
1. Fold the rear seat back forward to gain access to the retainers. 2. Remove the body lock pillar upper trim panel. Refer to <u>Body Lock Pillar Upper Trim Panel Replacement (Sedan)</u> .	
1	Rear Window Trim Finish Panel Retainer (Qty: 3)
2	Rear Window Trim Finish Panel Assembly
Procedure Disconnect the electrical connector.	

REAR END TRIM FINISH PANEL REPLACEMENT

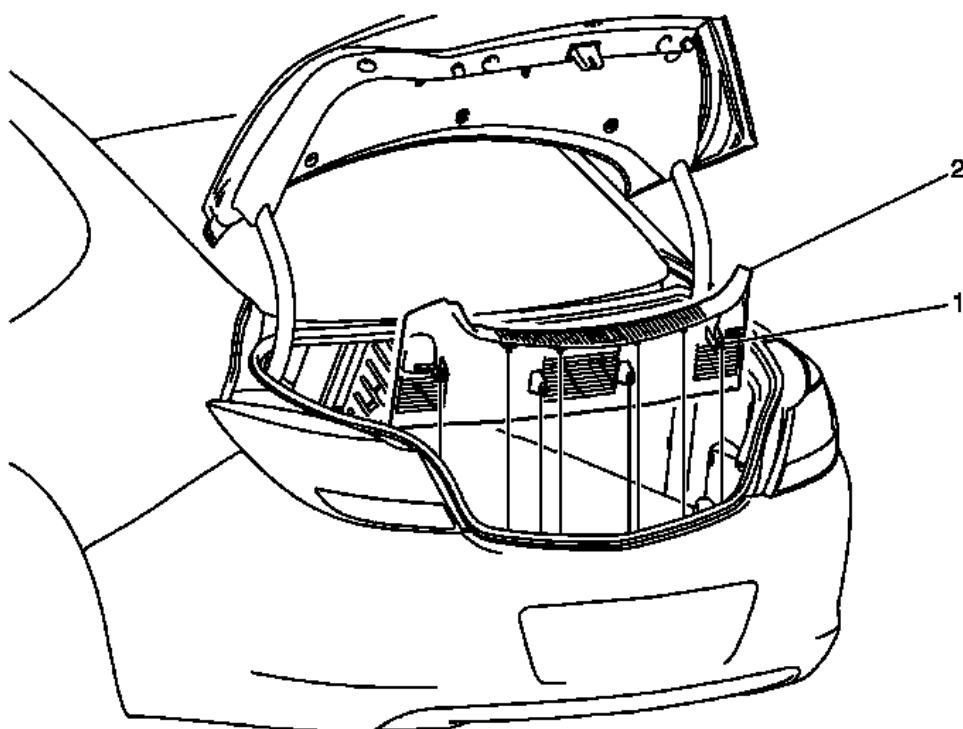


Fig. 42: Rear End Trim Finish Panel & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Rear End Trim Finish Panel Replacement

Callout	Component Name
1	Rear End Trim Finish Panel Retainer (Qty: 8)
2	Rear End Trim Finish Panel NOTE: Rear end sill plate seats over D-rings.

REAR COMPARTMENT FLOOR PANEL TRIM REPLACEMENT (WITH BLOWER COVER, HP6)

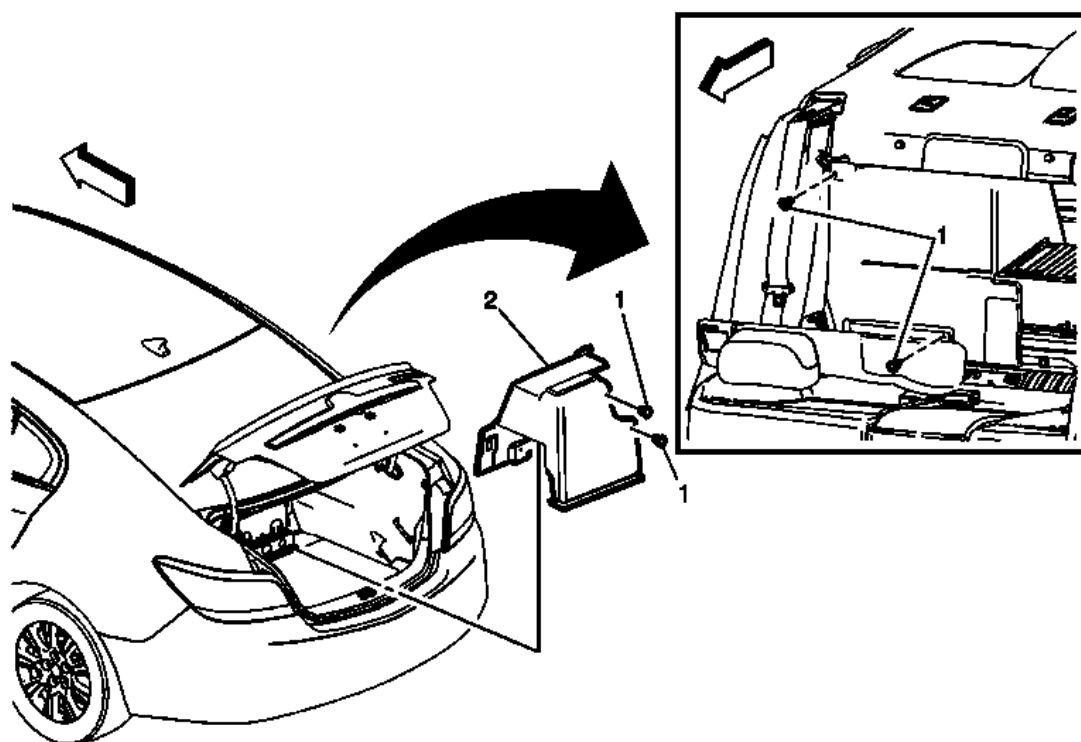


Fig. 43: Rear Compartment Floor Panel Trim (with Blower Cover, HP6)

Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Floor Panel Trim Replacement (with Blower Cover, HP6)

Callout	Component Name
1	<p>Rear Compartment Side Trim Panel (Push-In) Retainer (Qty: 4)</p> <p>Procedure Pull the rear seat back cushion latch release located on the top of the rear seat back cushion, and fold the rear seat back cushion forward to access two of the (Push-in) retainers. The other two can be accessed thru the rear compartment.</p> <p>NOTE: When reinstalling lower interior push-in retainer, lift seat 40-45 degrees above flat to gain sufficient hand room to get retainer seated.</p>
2	Rear Compartment Floor Panel Trim Assembly (with Blower Cover, HP6)

REAR COMPARTMENT FLOOR PANEL TRIM REPLACEMENT (WITH BATTERY COVER, HP6)

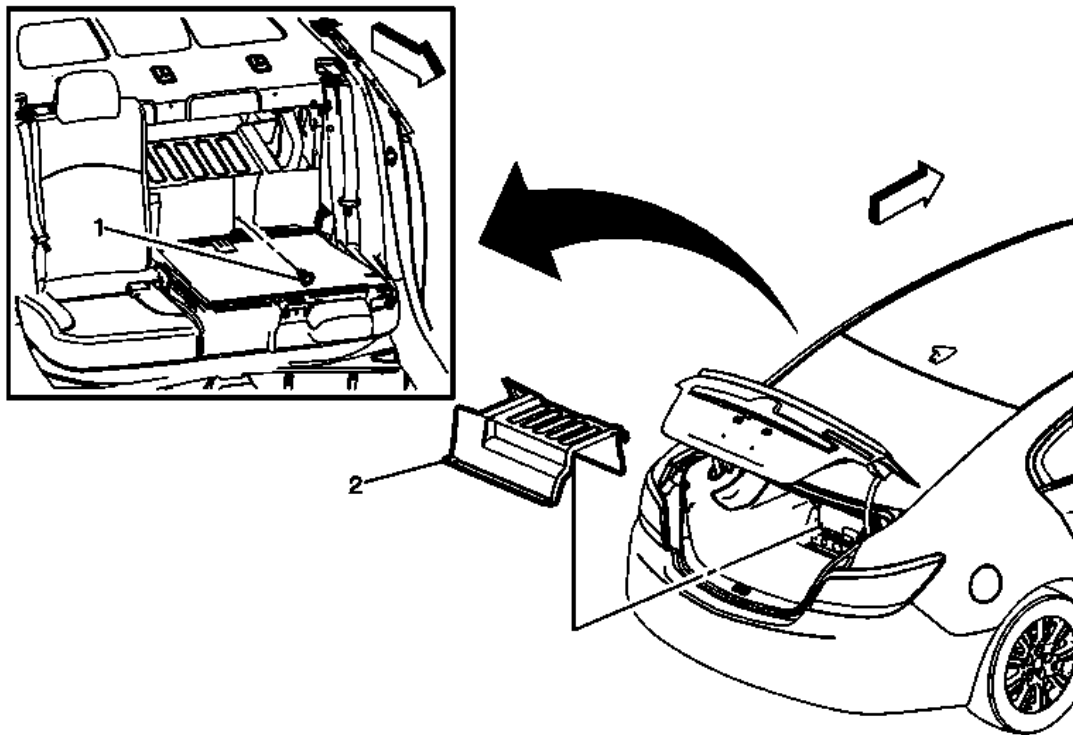


Fig. 44: Rear Compartment Floor Panel Trim (with Battery Cover, HP6)

Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6)

Callout	Component Name
Preliminary Procedure Remove the rear compartment floor panel trim (with blower cover,HP6). Refer to <u>Rear Compartment Floor Panel Trim Replacement (with Battery Cover, HP6).</u>	
1	Rear Compartment Side Trim Panel (Push-In) Retainer Procedure Pull the rear seat back cushion latch release located on the top of the rear seat back cushion, and fold the rear seat back cushion forward to access the rear compartment side trim panel (Push-In) retainer.
2	Rear Compartment Floor Panel Trim Assembly (with Battery Cover, HP6)

REAR COMPARTMENT LID INNER PANEL TRIM REPLACEMENT

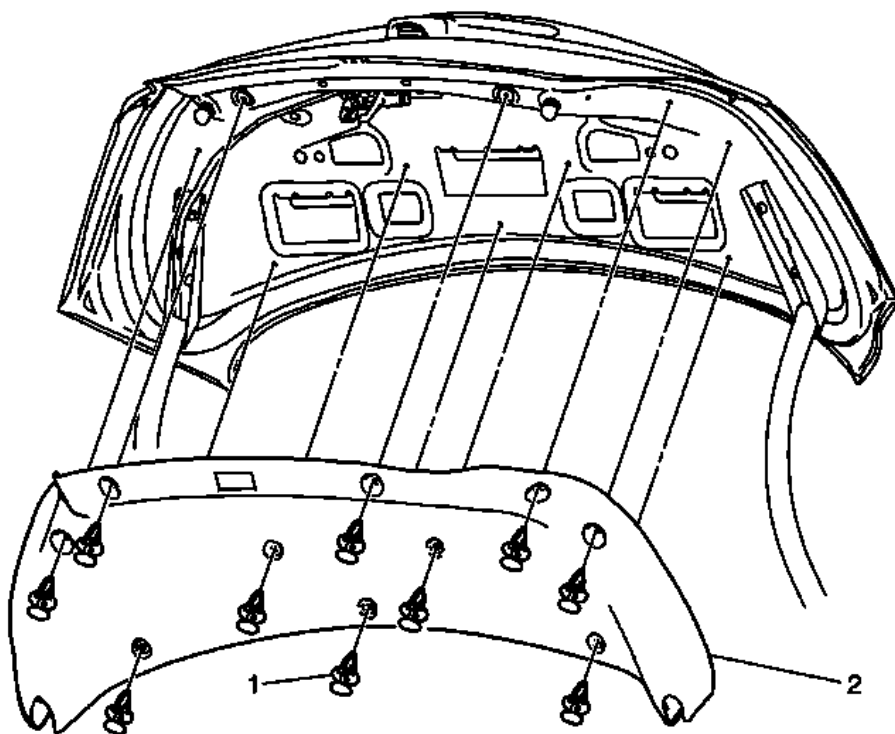


Fig. 45: Rear Compartment Lid Inner Panel Trim & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Inner Panel Trim Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment lid latch cover. Refer to <u>Rear Compartment Lid Latch Cover Replacement</u> .	
1	Rear Compartment Lid Inner Panel Trim Retainer (Qty: 9)
2	Rear Compartment Lid Inner Panel Trim
Procedure Disengage the pull handle from the compartment lid, transfer handle if necessary.	

REAR COMPARTMENT LID LATCH COVER REPLACEMENT

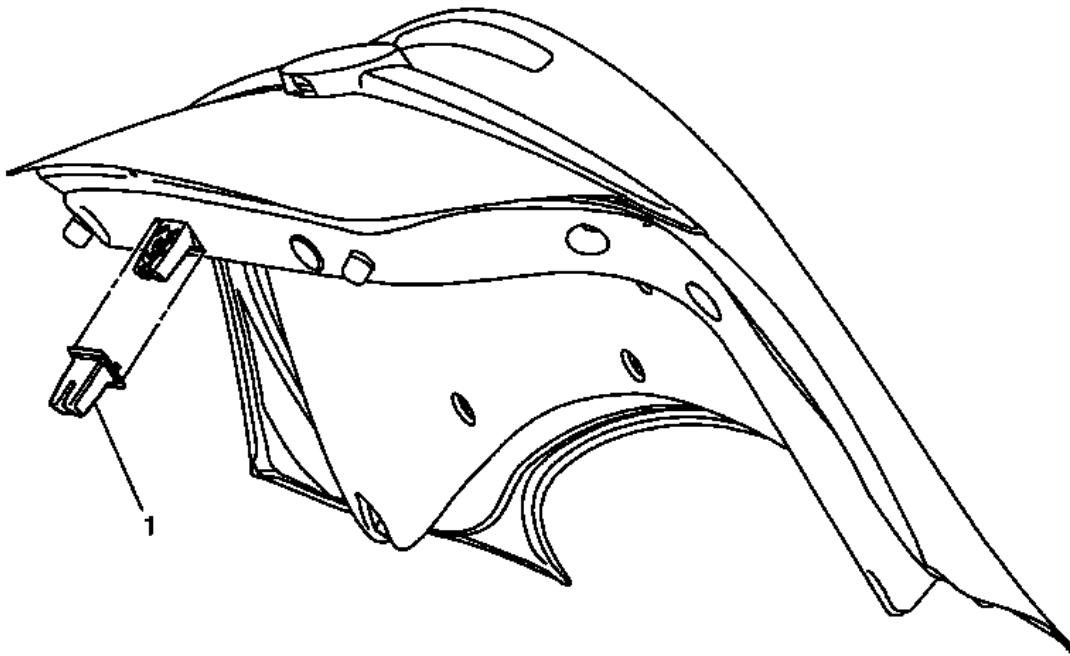


Fig. 46: Rear Compartment Lid Latch Cover
Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Latch Cover Replacement

Callout	Component Name
1	Rear Compartment Lid Latch Cover TIP: Use a small flat-bladed tool to pull and release the rear compartment lid latch cover.

QUARTER OUTER PANEL PRESSURE RELIEF VALVE REPLACEMENT

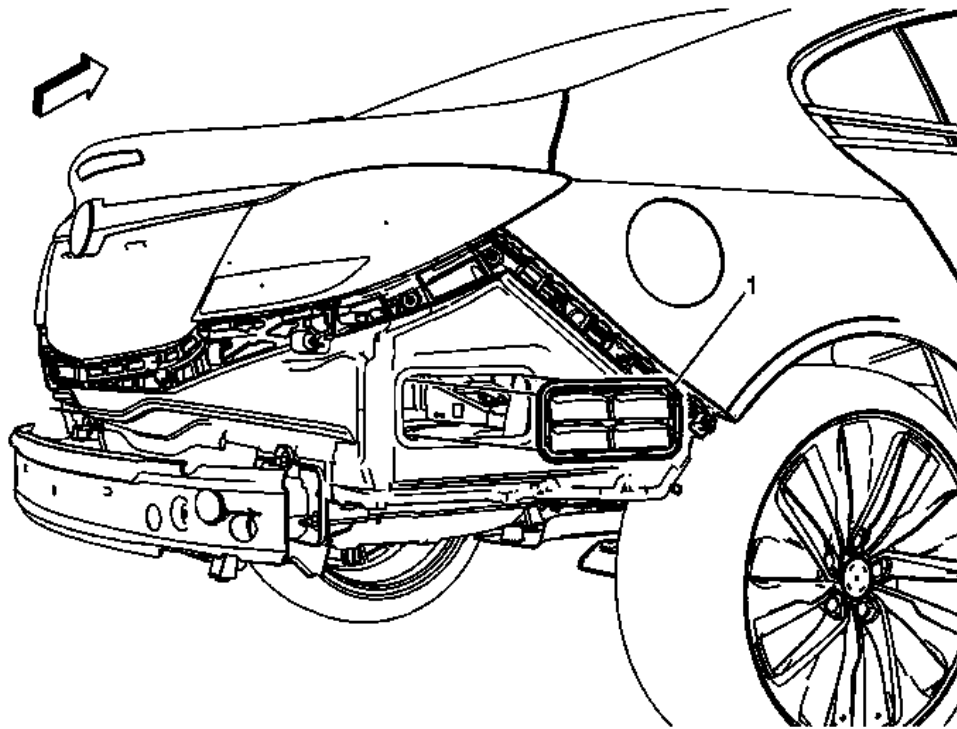


Fig. 47: Quarter Outer Panel Pressure Relief Valve
 Courtesy of GENERAL MOTORS COMPANY

Quarter Outer Panel Pressure Relief Valve Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
2. Reposition any wiring to gain access to pressure relief valve.	
1	Pressure Relief Valve

ACCESSORIES & EQUIPMENT

Remote Functions

SCHEMATIC WIRING DIAGRAMS

REMOTE FUNCTION WIRING SCHEMATICS

Garage Door Opener (Except CZ2)

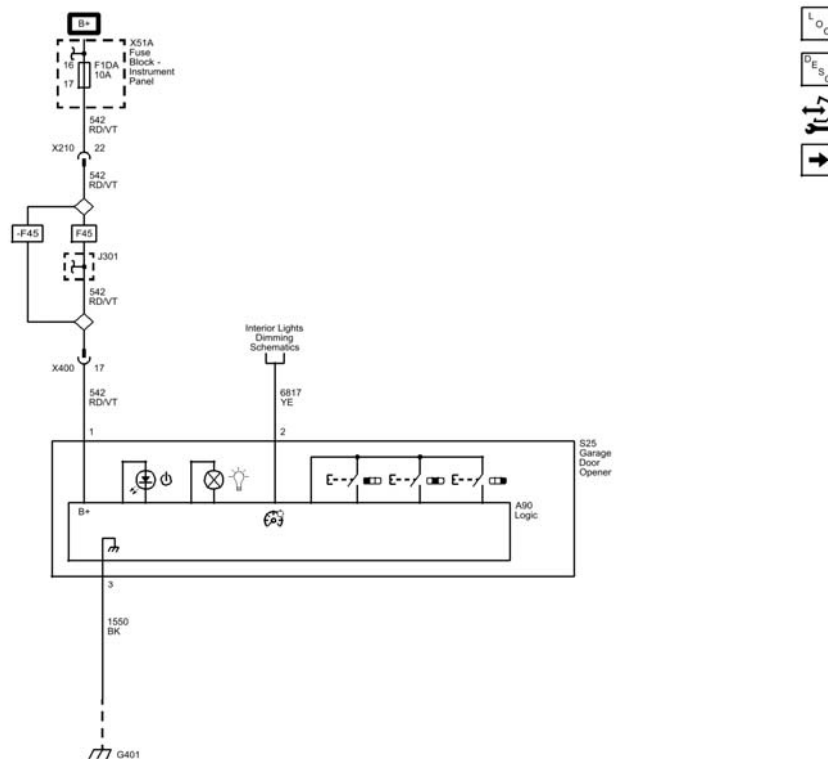


Fig. 1: Garage Door Opener (Except CZ2)

Courtesy of GENERAL MOTORS COMPANY

Passive Entry Power, Ground, Data Communications (ATH with BTM), and Remote Keyless Entry

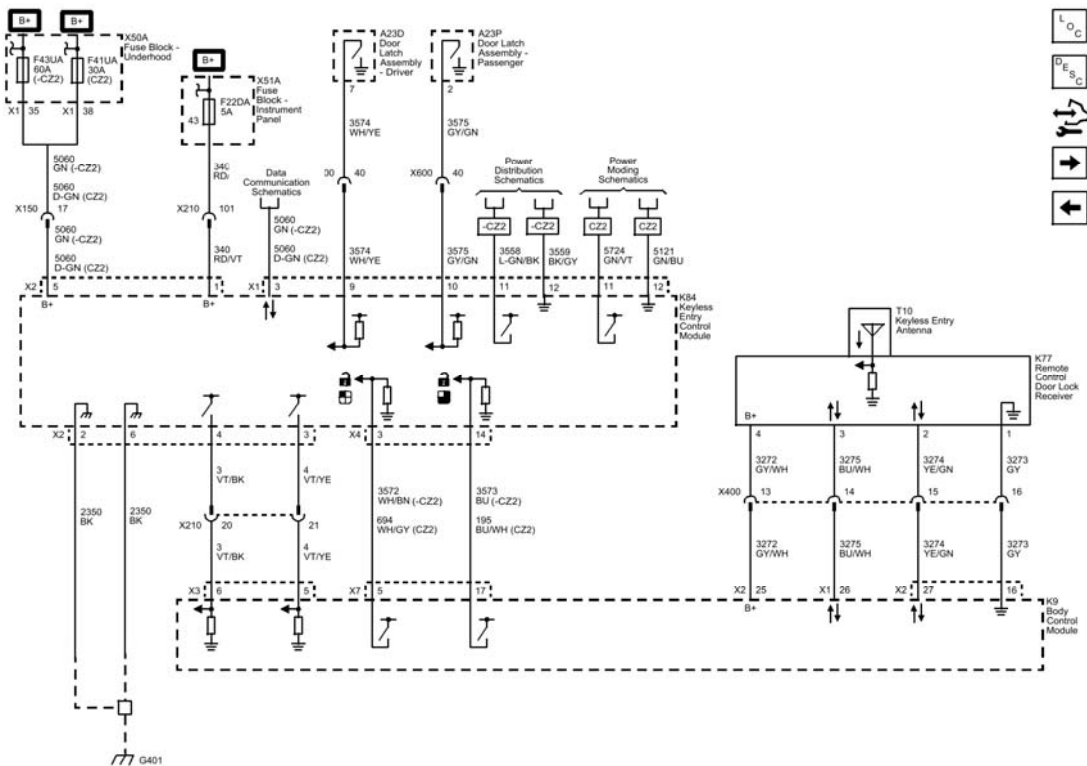


Fig. 2: Passive Entry Power, Ground, Data Communications (ATH with BTM), and Remote Keyless Entry
Courtesy of GENERAL MOTORS COMPANY

Passive Entry and Passive Start Antennas (ATH with BTM)

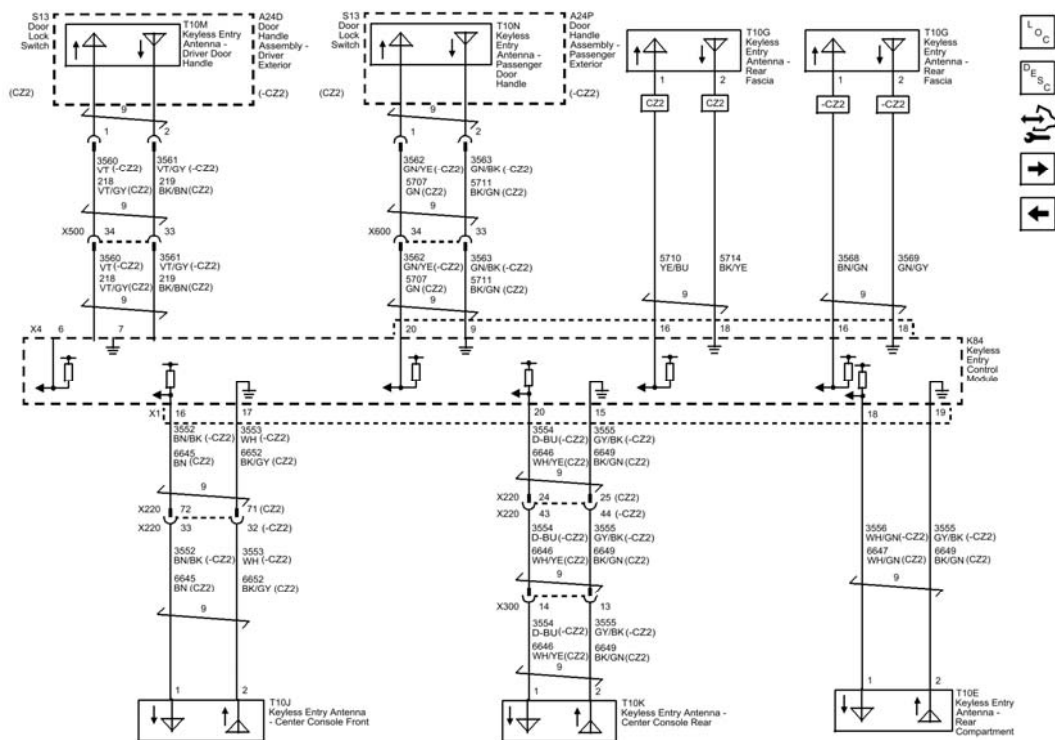


Fig. 3: Passive Entry and Passive Start Antennas (ATH with BTM)
Courtesy of GENERAL MOTORS COMPANY

Door Lock Switches and Unlatch Motors (ATS with BTM) (CZ2)

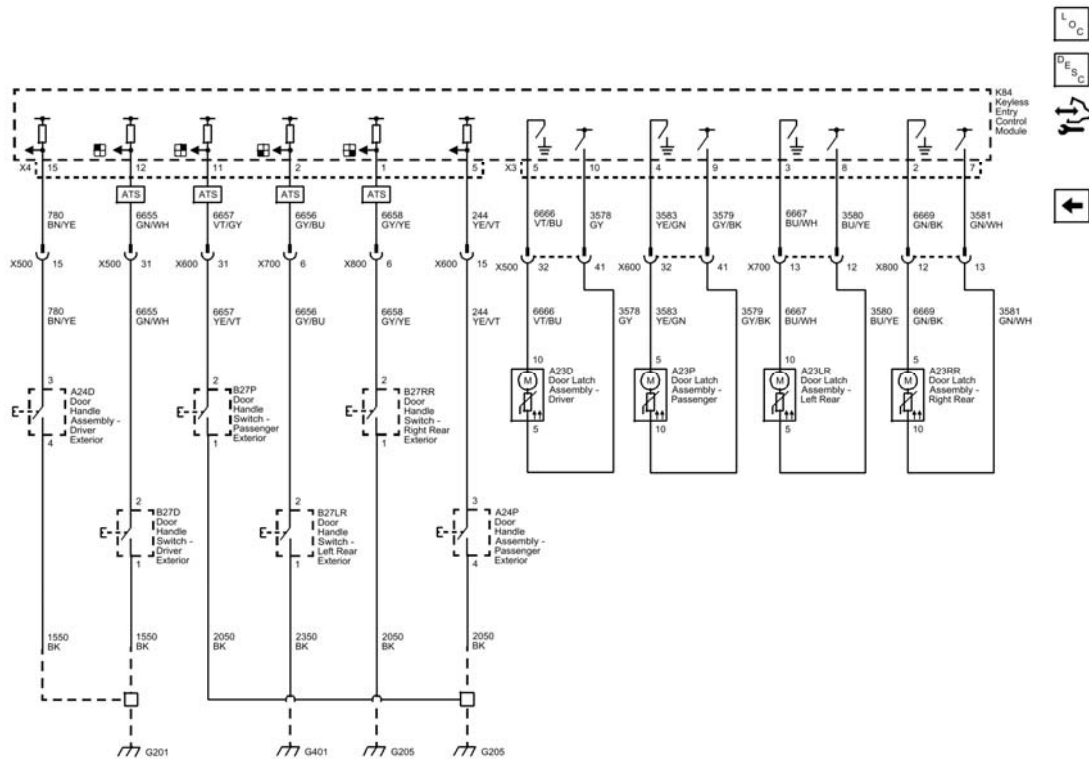


Fig. 4: Door Lock Switches and Unlatch Motors (ATS with BTM) (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Keyless Entry (Except CZ2)

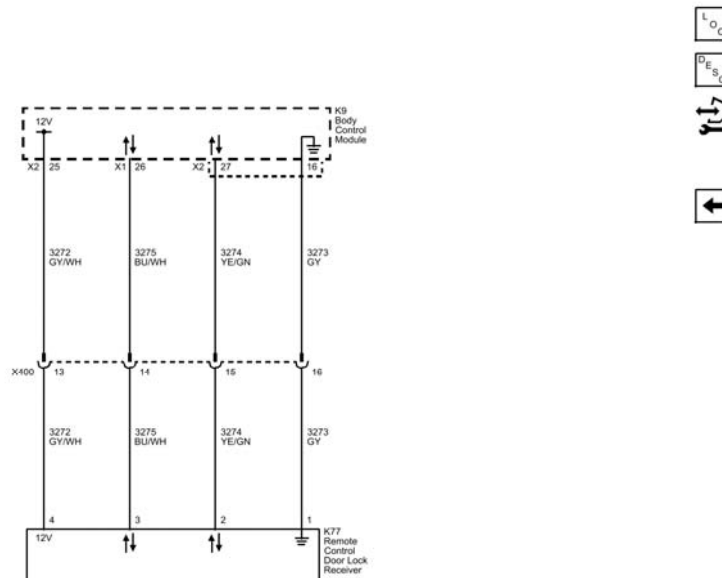


Fig. 5: Keyless Entry (Except CZ2)

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B3101</u>	DTC B3101 Keyless Entry Data Link Circuit
<u>DTC B3105</u>	DTC B3105 Keyless Entry Transmitters
<u>DTC B3106</u>	DTC B3106 Keyless Entry Data Link
<u>DTC B3109-B3113</u>	DTC B3109 Keyless Entry Transmitter 1 Battery DTC B3110 Keyless Entry Transmitter 2 Battery DTC B3111 Keyless Entry Transmitter 3 Battery DTC B3112 Keyless Entry Transmitter 4 Battery DTC B3113 Keyless Entry Transmitter 5 Battery
<u>DTC B310D-B310F</u>	DTC B310D Keyless Entry Transmitter 6 Battery DTC B310E Keyless Entry Transmitter 7 Battery DTC B310F Keyless Entry Transmitter 8 Battery
<u>DTC B3119</u>	DTC B3119 Keyless Entry Antenna 1
<u>DTC B3120</u>	DTC B3120 Keyless Entry Antenna 2 Short to Ground

	DTC B3120 Keyless Entry Antenna 2 High Voltage/Open
<u>DTC B3121</u>	DTC B3121 Keyless Entry Antenna 3
<u>DTC B3122</u>	DTC B3122 Keyless Entry Antenna 4
<u>DTC B3123</u>	DTC B3123 Keyless Entry Antenna 5
<u>DTC B3124</u>	DTC B3124 Keyless Entry Antenna 6 Short to Ground DTC B3124 Keyless Entry Antenna 6 High Voltage/Open

DTC B3101: KEYLESS ENTRY DATA LINK CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3101

Keyless Entry Data Link Circuit

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B3101 00	B3101 00	-	-
Serial Data - Enable Line	B3101 00	B3101 00	B3101 00	B3101 00
Serial Data - Receive	B3101 00	B3101 00	B3101 00	B3101 00
Low Reference	-	B3101 00	-	-

Circuit/System Description

The body control module communicates with the remote control door lock receiver through the keyless entry serial data circuits. When any button on the keyless entry transmitter is pressed, the transmitter sends a signal to the remote control door lock receiver. The remote control door lock receiver sends a function request to the body control module, depending on which button is pressed on the transmitter. The body control module receives the message and performs the appropriate function.

Conditions for Running the DTC

The body control module monitors for this DTC at all times.

Conditions for Setting the DTC

No response is received from the remote control door lock receiver after the body control module requests information from or sends configuration commands to the remote control door lock receiver.

Action Taken When the DTC Sets

In the case of power loss, the remote control door lock receiver is disabled for 65 s. Otherwise no action is taken.

Conditions for Clearing the DTC

- A current DTC will clear when the fault is no longer present.
- A history DTC will clear after 40 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Remote Function Schematics

Component Connector End Views

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, scan tool disconnected, disconnect the harness connector at the K77 Remote Control Door Lock Receiver. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 30 ohms between the low reference circuit terminal 1 and ground.
 - **If 30 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If less than 30 ohms**
3. Ignition ON.
4. Test for greater than 11.5 V between the B+ circuit terminal 4 and ground.
 - **If 11.5 V or less**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If Infinite resistance.
 3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 11.5 V**
 - 5. Test for 1-6 V between the serial data circuit terminal 2 and ground.
 - **If less than 1 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the serial data circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the serial data circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 6 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the serial data circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If between 3-6 V**
 6. Ignition OFF, disconnect the X1 and X2 harness connectors at the K9 Body Control Module, ignition ON.
 7. Test for less than 1 V between the K9 Body Control Module serial data circuit terminal 26 X1 and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

8. Ignition OFF.

9. Test for infinite resistance between the K9 Body Control Module serial data circuit terminal 26 X1 and ground.

- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

10. Test for less than 2 ohms between the K9 Body Control Module serial data circuit terminal 26 X1 and the K77 Remote Control Door Lock Receiver serial data circuit terminal 3.

- **If 2 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 ohms**

11. Replace the K77 Remote Control Door Lock Receiver.

12. Verify DTC B3101 does not set while operating the vehicle under the conditions for running the DTC.

- **If the DTC sets**

Replace the K9 Body Control Module

- **If the DTC does not set**

13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module or remote control door lock receiver replacement, programming, and setup.

DTC B3105: KEYLESS ENTRY TRANSMITTERS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3105

Keyless Entry Transmitters

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The body control module monitors the number of keyless entry transmitters programmed. Until at least one transmitter is programmed, the body control module determines a malfunction condition exists.

Conditions for Running the DTC

The body control module has been set up without transmitters being programmed.

Conditions for Setting the DTC

No keyless entry transmitter programmed to the body control module.

Action Taken When the DTC Sets

The keyless entry system is inoperative.

Conditions for Clearing the DTC

A current DTC is cleared when at least one transmitter has been programmed to the body control module.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the transmitter is a correct transmitter for the vehicle. This can be accomplished by comparing the part number printed on the transmitter to the appropriate part number in the parts catalog.

- **If the transmitter is incorrect**

Replace the transmitter.

- **If the transmitter is correct**

2. Program the transmitter. Refer to **Key with Integrated Transmitter Programming (with BTM)** , **Key with Integrated Transmitter Programming (without BTM)** .

3. Verify the transmitter has successfully completed the programming procedure.

- **If the transmitter does not program successfully**

Replace the transmitter.

- **If the transmitter programs successfully**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Key with Integrated Transmitter Programming (with BTM) , **Key with Integrated Transmitter Programming (without BTM)**

DTC B3106: KEYLESS ENTRY DATA LINK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3106

Keyless Entry Data Link

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The body control module communicates with the remote control door lock receiver through the keyless entry serial data circuits. When any button on the keyless entry transmitter is pressed, the transmitter sends a signal to the remote control door lock receiver. The remote control door lock receiver sends a function request to the body control module, depending on which button is pressed on the transmitter. The body control module receives the message and performs the appropriate function.

Conditions for Running the DTC

A keyless transmitter button is pressed.

Conditions for Setting the DTC

The transmitter that is sending a signal to the remote control door lock receiver is different from those transmitters stored in the body control module.

Action Taken When the DTC Sets

No action is taken.

Conditions for Clearing the DTC

- A current DTC will clear when the fault is no longer present and the ignition switch is cycled.
- A history DTC will clear after 40 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Remote Function Schematics

Component Connector End Views

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. With a valid and learned transmitter, press and release a button on the transmitter.
2. Verify that DTC B3106 is not set.

- **If DTC B3106 is set**

Replace the K77 Remote Control Door Lock Receiver.

- **If DTC B3106 is not set**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for remote control door lock receiver replacement, programming, and setup.

DTC B3109-B3113: KEYLESS ENTRY TRANSMITTER 1-5 BATTERY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3109

Keyless Entry Transmitter 1 Battery

DTC B3110

Keyless Entry Transmitter 2 Battery

DTC B3111

Keyless Entry Transmitter 3 Battery

DTC B3112

Keyless Entry Transmitter 4 Battery

DTC B3113

Keyless Entry Transmitter 5 Battery

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

With each press of a keyless entry transmitter button, a message containing the current battery state of the transmitter is sent to the remote control door lock receiver, along with the commanded keyless entry function. The remote control door lock receiver sends this to the body control module to perform the requested function.

Conditions for Running the DTC

A keyless transmitter button is pressed.

Conditions for Setting the DTC

Three consecutive low battery signals are received from the same transmitter.

Action Taken When the DTC Sets

The keyless entry system is inoperative.

Conditions for Clearing the DTC

The DTC is cleared when a normal transmitter voltage signal is received from the transmitter that set the DTC.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify none of the DTCs listed below are set:
 - DTC B3109
 - DTC B3110
 - DTC B3111
 - DTC B3112
 - DTC B3113
 - **If any of the DTCs are set**
 1. Replace the battery in the appropriate keyless entry transmitter and operate the transmitter three consecutive times.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the keyless entry transmitter.
 - If the DTC does not set
 3. All OK.
 - **If none of the DTCs are set**
2. All OK.

DTC B310D-B310F: KEYLESS ENTRY TRANSMITTER 6-8 BATTERY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B310D

Keyless Entry Transmitter 6 Battery

DTC B310E

Keyless Entry Transmitter 7 Battery

DTC B310F

Keyless Entry Transmitter 8 Battery

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

With each press of a keyless entry transmitter button, a message containing the current battery state of the transmitter is sent to the remote control door lock receiver, along with the commanded keyless entry function. The remote control door lock receiver sends this to the body control module to perform the requested function.

Conditions for Running the DTC

A keyless transmitter button is pressed.

Conditions for Setting the DTC

Three consecutive low battery signals are received from the same transmitter.

Action Taken When the DTC Sets

The keyless entry system is inoperative.

Conditions for Clearing the DTC

The DTC is cleared when a normal transmitter voltage signal is received from the transmitter that set the DTC.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify none of the DTCs listed below are set:
 - DTC B310D
 - DTC B310E
 - DTC B310F
 - **If any of the DTCs are set**
 1. Replace the battery in the appropriate keyless entry transmitter and operate the transmitter three consecutive times.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the keyless entry transmitter.
 - If the DTC does not set
 3. All OK.
 - **If none of the DTCs are set**
2. All OK.

DTC B3119: KEYLESS ENTRY ANTENNA 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3119

Keyless Entry Antenna 1

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Keyless Entry Antenna Signal - Driver Door	B3119 02	B3119 05	B3119 05	-
Keyless Entry Antenna Low Reference - Driver Door	B3119 02	B3119 05	B3119 05	-

Circuit/System Description

The driver door handle antenna is located in the driver door handle assembly and is used to establish low frequency communications with the keyless entry transmitter. As a vehicle with locked doors is approached with a keyless entry transmitter and the exterior door handle button is pressed, the keyless entry control module communicates with the driver door handle keyless entry antenna.

Conditions for Running the DTC

The exterior driver door handle button is pressed within 15 min of last door closing.

Conditions for Setting the DTC

B3119 02

The keyless entry control module detects a short to ground on the driver door keyless entry antenna signal circuit.

B3119 05

The keyless entry control module detects a short to voltage or an open on the driver door keyless entry antenna signal circuit.

Action Taken When the DTC Sets

Doors will not unlock/lock when the driver exterior door handle button is pressed.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B3122, B3123, or B3124 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the T10M Keyless Entry Antenna - Driver Door Handle, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

3. Ignition OFF, install a DMM between the signal circuit terminal 1 and ground. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
4. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the exterior door handle button.
5. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
6. Test for less than 1 V between the low reference circuit terminal 2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: **When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.**

7. Install a DMM between the signal circuit terminal 1 and the low reference circuit terminal 2. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
8. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the exterior door handle button.
9. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the low reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K84 Keyless Entry Control Module.

○ **If greater than 1 V**

10. Replace the T10M Keyless Entry Antenna - Driver Door Handle.
11. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the exterior door handle button.
12. Verify DTC B3119 is not set.
 - **If DTC B3119 is set**

Replace the K84 Keyless Entry Control Module.

○ **If DTC B3119 is not set**

13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Outside Handle Bracket Replacement (Base)**
- **Control Module References** for keyless entry control module replacement, programming, and setup

DTC B3120: KEYLESS ENTRY ANTENNA 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3120

Keyless Entry Antenna 2 Short to Ground

DTC B3120

Keyless Entry Antenna 2 High Voltage/Open

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

	Short to	Open/High	Short to	Signal
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Circuit	Ground	Resistance	Voltage	Performance
Keyless Entry Antenna Signal - Passenger Door	B3120 02	B3120 05	B3120 05	-
Keyless Entry Antenna Low Reference - Passenger Door	B3120 02	B3120 05	B3120 05	-

Circuit/System Description

The passenger front door handle antenna is located in the passenger front door handle assembly and is used to establish low frequency communications with the keyless entry transmitter. As a vehicle with locked doors is approached with a keyless entry transmitter and the exterior door handle button is pressed, the keyless entry control module communicates with the passenger front door handle keyless entry antenna.

Conditions for Running the DTC

The exterior door handle button in the passenger front door handle is pressed within 15 min of the last change of door ajar status for any door.

Conditions for Setting the DTC

B3120 02

The keyless entry control module detects a short to ground on the passenger front door keyless entry antenna signal circuit.

B3120 05

The keyless entry control module detects a short to B+ or an open on the passenger front door keyless entry antenna signal circuit.

Action Taken When the DTC Sets

Doors will not unlock/unlock when the passenger exterior door handle button is pressed.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B3122, B3123, or B3124 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the T10N Keyless Entry Antenna - Passenger Door Handle, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: **When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and**

manually set the DMM range to 000.0 V.

3. Ignition OFF, install a DMM between the signal circuit terminal 1 and ground. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
4. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the exterior door handle button.
5. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
6. Test for less than 1 V between the low reference circuit terminal 2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: **When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.**

7. Install a DMM between the signal circuit terminal 1 and the low reference circuit terminal 2. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
8. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the exterior door handle button.
9. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the low reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 3. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
- 10. Replace the T10N Keyless Entry Antenna - Passenger Door Handle.
- 11. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the exterior door handle button.
- 12. Verify DTC B3120 is not set.
 - **If DTC B3120 is set**

Replace the K84 Keyless Entry Control Module.

 - **If DTC B3120 is not set**
- 13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Outside Handle Bracket Replacement (Base)**
- **Control Module References** for keyless entry control module replacement, programming, and setup

DTC B3121: KEYLESS ENTRY ANTENNA 3

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3121

Keyless Entry Antenna 3

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Keyless Entry Antenna Signal -				

Rear Fascia	B3121 02	B3121 05	B3121 05	-
Keyless Entry Antenna Low Reference - Rear Fascia	B3121 02	B3121 05	B3121 05	-

Circuit/System Description

The rear fascia antenna is located in the rear fascia assembly and is used to establish low frequency communications with the keyless entry transmitter. As a vehicle with locked doors is approached with a keyless entry transmitter and the exterior rear closure touch pad is pressed, the keyless entry control module communicates with the rear fascia keyless entry antenna .

Conditions for Running the DTC

- The rear closure touch pad is pressed.
- The scan tool activates a device control function to simulate the above action.

Conditions for Setting the DTC

B3121 02

The keyless entry control module detects a short to ground on the rear fascia keyless entry antenna signal circuit.

B3121 05

The keyless entry control module detects a short to B+ or an open on the rear fascia keyless entry antenna signal circuit.

Action Taken When the DTC Sets

Rear closure will not open when rear closure touch pad is pressed.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B3122, B3123, or B3124 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the T10G Keyless Entry Antenna - Rear Fascia , ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

3. Ignition OFF, install a DMM between the signal circuit terminal 1 and ground. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
4. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the rear closure touch pad.
5. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
6. Test for less than 1 V between the low reference circuit terminal 2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: **When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.**

7. Install a DMM between the signal circuit terminal 1 and the low reference circuit terminal 2. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
8. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the rear closure touch pad.
9. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the low reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K84 Keyless Entry Control Module.

○ **If greater than 1 V**

10. Replace the T10G Keyless Entry Antenna - Rear Fascia .
11. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by pressing the rear closure touch pad.
12. Verify DTC B3121 is not set.
 - **If DTC B3121 is set**

Replace the K84 Keyless Entry Control Module.

○ **If DTC B3121 is not set**

13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Lock Key Transmitter Antenna Replacement - Rear Bumper Fascia**
- **Control Module References** for keyless entry control module replacement, programming, and setup

DTC B3122: KEYLESS ENTRY ANTENNA 4

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3122

Keyless Entry Antenna 4

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Keyless Entry Antenna Signal - Center Console Front	B3122 02	B3122 05	B3122 05	-
Keyless Entry Antenna Low				

Reference - Center Console Front	B3122 02	B3122 05	B3122 05	-
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Circuit/System Description

The front center console antenna is located in front of the center console assembly and is used to establish low frequency communications with the keyless entry transmitter. When the driver attempts to change the ignition status of the vehicle, the keyless entry control module communicates with the front center console antenna.

Conditions for Running the DTC

Pressing the ignition mode switch.

Conditions for Setting the DTC

B3122 02

The keyless entry control module detects a short to ground on the front center console keyless entry antenna signal circuit.

B3122 05

The keyless entry control module detects a short to B+ or an open on the front center console keyless entry antenna signal circuit.

Action Taken When the DTC Sets

Vehicle will not detect the transmitter in some locations inside the vehicle. If the transmitter is not detected then vehicle will not change ignition modes when ignition mode switch is pressed.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the T10J Keyless Entry Antenna - Center Console Front, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

3. Ignition OFF, install a DMM between the signal circuit terminal 1 and ground. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
4. Activate the antenna by pressing the ignition mode switch.
5. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K84 Keyless Entry Control Module.

- **If greater than 1 V**

6. Test for less than 1 V between the low reference circuit terminal 2 and ground.

- **If 1 V or greater**

1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.

- **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

7. Install a DMM between the signal circuit terminal 1 and the low reference circuit terminal 2. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.

8. Activate the antenna by pressing the ignition mode switch.

9. Verify the MAX voltage captured by the DMM is greater than 1 V.

- **If 1 V or less**

1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
2. Test for infinite resistance between the low reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.

- **If greater than 1 V**

10. Replace the T10J Keyless Entry Antenna - Center Console Front.

11. Activate the antenna by pressing the ignition mode switch.

12. Verify DTC B3122 is not set.

- **If DTC B3122 is set**

Replace the K84 Keyless Entry Control Module.

- **If DTC B3122 is not set**

13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Lock Key Transmitter Antenna Replacement - Instrument Panel**
- **Control Module References** for keyless entry control module replacement, programming, and setup

DTC B3123: KEYLESS ENTRY ANTENNA 5

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3123

Keyless Entry Antenna 5

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Keyless Entry Antenna Signal - Center Console Rear	B3123 02	B3123 05	B3123 05	-
Keyless Entry Antenna Low Reference - Center Console Rear	B3123 02	B3123 05	B3123 05	-

Circuit/System Description

The rear center console antenna is located in rear of the center console assembly and is used to establish low frequency communications with the keyless entry transmitter. When the driver attempts to change the ignition status of the vehicle, the keyless entry control module communicates with the rear center console antenna.

Conditions for Running the DTC

Pressing the ignition mode switch.

Conditions for Setting the DTC

B3123 02

The keyless entry control module detects a short to ground on the rear center console keyless entry antenna signal circuit.

B3123 05

The keyless entry control module detects a short to B+ or an open on the rear center console keyless entry antenna signal circuit.

Action Taken When the DTC Sets

Vehicle will not detect the transmitter in some locations inside the vehicle. If the transmitter is not detected then vehicle will not change ignition modes when ignition mode switch is pressed.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the T10K Keyless Entry Antenna - Center Console

Rear, ignition ON.

2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

3. Ignition OFF, install a DMM between the signal circuit terminal 1 and ground. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
4. Activate the antenna by pressing the ignition mode switch.
5. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
6. Test for less than 1 V between the low reference circuit terminal 2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

7. Install a DMM between the signal circuit terminal 1 and the low reference circuit terminal 2. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
8. Activate the antenna by pressing the ignition mode switch.
9. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the low reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
10. Replace the T10K Keyless Entry Antenna - Center Console Rear.
11. Activate the antenna by pressing the ignition mode switch.
12. Verify DTC B3123 is not set.
 - **If DTC B3123 is set**

Replace the K84 Keyless Entry Control Module.
 - **If DTC B3123 is not set**
13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Lock Key Transmitter Antenna Replacement - Floor Console**
- **Control Module References** for keyless entry control module replacement, programming, and setup

DTC B3124: KEYLESS ENTRY ANTENNA 6

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3124

Keyless Entry Antenna 6 Short to Ground

DTC B3124

Keyless Entry Antenna 6 High Voltage/Open

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Keyless Entry Antenna Signal - Rear Compartment	B3124 02	B3124 05	B3124 05	-
Keyless Entry Antenna Low Reference - Rear Compartment	B3124 02	B3124 05	B3124 05	-

Circuit/System Description

The rear compartment antenna is located on the rear compartment floor near the seat back, centered, and is used to establish low frequency communications with the keyless entry transmitter. When the driver attempts to change the ignition status of the vehicle, the keyless entry control module communicates with the rear compartment antenna.

Conditions for Running the DTC

Pressing the ignition mode switch.

Conditions for Setting the DTC

B3124 02

The keyless entry control module detects a short to ground on the rear compartment keyless entry antenna signal circuit.

B3124 05

The keyless entry control module detects a short to B+ or an open on the rear compartment keyless entry antenna signal circuit.

Action Taken When the DTC Sets

Vehicle will not detect the transmitter in some locations inside the vehicle. If the transmitter is not detected then vehicle will not change ignition modes when ignition mode switch is pressed.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the T10E Keyless Entry Antenna - Rear Compartment, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and

manually set the DMM range to 000.0 V.

3. Ignition OFF, install a DMM between the signal circuit terminal 1 and ground. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
4. Activate the antenna by pressing the ignition mode switch.
5. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
6. Test for less than 1 V between the low reference circuit terminal 2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: **When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.**

7. Install a DMM between the signal circuit terminal 1 and the low reference circuit terminal 2. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
8. Activate the antenna by pressing the ignition mode switch.
9. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the low reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K84 Keyless Entry Control Module.

○ **If greater than 1 V**

10. Replace the T10E Keyless Entry Antenna - Rear Compartment.
11. Activate the antenna by pressing the ignition mode switch.
12. Verify DTC B3124 is not set.

○ **If DTC B3124 is set**

Replace the K84 Keyless Entry Control Module.

○ **If DTC B3124 is not set**

13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Lock Key Transmitter Antenna Replacement - Rear Compartment**
- **Control Module References** for keyless entry control module replacement, programming, and setup

SYMPTOMS - REMOTE FUNCTIONS

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Keyless Entry System Description and Operation (without BTM)**, **Keyless Entry System Description and Operation (with BTM)**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Keyless Entry System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections, wiring, terminals, connectors, poor voltage and ground connections, temperature sensitivity, electromagnetic interference, electrical noise and/or incorrect control module installed may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Garage Door Opener Malfunction**
- **No Remote Detected**
- **Keyless Entry System Malfunction (Active), Keyless Entry System Malfunction (Passive)**
- **Remote Vehicle Start Malfunction**

GARAGE DOOR OPENER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Ground	-	1	-	-
1. Universal Home Remote Malfunction				

Circuit/System Description

The universal home remote is a transmitter operating between 288 and 434 MHz. The universal home remote has three buttons that may be programmed for individual transmitter/receiver combinations to control up to three garage doors, security gates, lighting systems, etc. Each button represents a unique transmitter code section, which operates independently of the other buttons, and may be considered a separate transmitter.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Garage Door Opener Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Special Tools

EL 41540 Universal Home Remote Tester

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S25 Garage Door Opener.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.

- **If 10 ohms or greater**

Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**

3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 1 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S25 Garage Door Opener.

- **If the test lamp illuminates**

5. Verify the LED on the S25 Garage Door Opener illuminates or flashes when each button on the S25 Garage Door Opener is pressed.

- **If the LED does not illuminate or flash when each button is pressed**

Replace the S25 Garage Door Opener.

- **If the LED illuminates or flashes when each button is pressed**

NOTE: This step will clear any learned transmitters from the S25 Garage Door Opener. This will require reprogramming by the customer to reestablish universal home remote functionality.

6. Press and hold the two outer buttons on the S25 Garage Door Opener for greater than 30 s. The LED on the S25 Garage Door Opener will illuminate for 20 s, then begin to flash quickly for another 10 s. When the LED stops flashing, the system has been cleared and placed into default mode.
7. Place the **EL 41540** Universal Home Remote Tester so that it is adjacent to the S25 Garage Door Opener.
8. Verify the appropriate **EL 41540** Universal Home Remote Tester Indicator Lights illuminate when each button on S25 Garage Door Opener the is pressed, one at a time

- **If the tester does not respond to each button press**

Replace the S25 Garage Door Opener.

- **If the tester responds to each button press**

9. Using the Hand Held Transmitter from the **EL 41540** Universal Home Remote Tester kit, program a single button on the S25 Garage Door Opener. Refer to the instructions provided with the **EL 41540** Universal Home Remote Tester for programming instructions.

NOTE: When performing step 10, press the button that was programmed in step 9.

10. Verify the Programmed indicator on the **EL 41540** Universal Home Remote Tester illuminates when the programmed button on the S25 Garage Door Opener is pressed.

- **If the Programmed indicator does not illuminate when the programmed button is pressed**

Replace the S25 Garage Door Opener.

- **If the Programmed indicator illuminates when the programmed button is pressed**

11. Instruct the customer to program the S25 Garage Door Opener to their device. Refer to the vehicle owners manual. If further malfunction occurs, a possible rolling code or incompatibility with the S25 Garage Door Opener will prevent programming.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for garage door opener replacement, programming, and setup

NO REMOTE DETECTED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Keyless Entry Antenna Signal - Center Console Front	B3122 02	B3122 05	B3122 05	-
Keyless Entry Antenna Low Reference - Center Console Front	B3122 02	B3122 05	B3122 05	-
Keyless Entry Antenna Signal - Center Console Rear	B3123 02	B3123 05	B3123 05	-
Keyless Entry Antenna Low Reference - Center Console Rear	B3123 02	B3123 05	B3123 05	-
Keyless Entry Antenna Signal - Rear Compartment	B3124 02	B3124 05	B3124 05	-
Keyless Entry Antenna Low Reference - Rear Compartment	B3124 02	B3124 05	B3124 05	-

Circuit/System Description

When a transmitter authentication is requested, the front console, rear console, and rear compartment antennas simultaneously broadcast a challenge within the passenger compartment to the transmitter. If the response from the transmitter via radio frequency (RF) is a valid response, the body control module (BCM) determines there is a transmitter within the vehicle. If no response is received, the BCM determines that no transmitter is in the vehicle, and NO REMOTE DETECTED will be displayed on the DIC.

Diagnostic Aids

A low transmitter battery or radio frequency (RF) interference from aftermarket devices such as 2-way radios, power inverters, cellular phone chargers, computers, 12 V power outlet USB converters, etc. may cause a system malfunction. High RF traffic areas, such as gas stations which use pay-at-the-pump RF transponders, may also cause interference that could lead to a malfunction.

Conditions caused by external influences such as these are considered to be normal. Following this diagnostic will not diagnose an RF interference condition. If RF interference is suspected, question the customer about the conditions or location where the NO REMOTE DETECTED condition occurs.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: This condition may be caused by low vehicle battery voltage. If the battery is not sufficiently charged (above 10 volts), the system will have difficulties detecting the transmitter and the NO REMOTE DETECTED message will be displayed. Correct the low battery voltage condition to eliminate this condition.

1. Verify that DTC B3119, B3120, B3121, B3122, B3123, or B3124 is not set.

- **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

2. Lock the vehicle using the keyless entry transmitter.
3. Verify that each door unlocks and opens by approaching the vehicle with a valid transmitter and operating their respective exterior door handle button.
 - **If both doors do not unlock/unlatch and open**

Refer to **Keyless Entry System Malfunction (Active), Keyless Entry System Malfunction (Passive)**.

- **If both doors unlock/unlatch and open**

4. Verify the vehicle starts with the transmitter located in the key pocket/slot.
 - **If the vehicle does not start**

Perform the **Key with Integrated Transmitter Programming (with BTM)** , **Key with Integrated Transmitter Programming (without BTM)** procedure.

- **If the vehicle starts**

5. Verify the NO REMOTE DETECTED message is not displayed on the DIC while attempting to start the vehicle, placing the keyless entry transmitter in various locations within the vehicle interior at each start attempt. The vehicle should start.

- **If the NO REMOTE DETECTED message is displayed at any time**

Refer to Circuit/System Testing.

- **If the NO REMOTE DETECTED message is not displayed and the vehicle starts**

6. Inspect for any sources of RF interference such as cell phone chargers, power supplies, etc. that would interrupt transmitter and antenna communication. If inspection does not reveal any items causing RF interference, discuss with the customer the conditions or location where the NO REMOTE DETECTED condition occurs. Discuss any devices that are normally kept in the vehicle, such as a laptop or cell phone charger, which may have been removed when the vehicle was brought in for service. It may be necessary to explain to the customer how RF interference degrades the performance of the system.

Circuit/System Testing

NOTE: To determine the appropriate T10 Keyless Entry Antenna to disconnect and diagnose, place the transmitter in various location within the vehicle's interior and attempt to start. The location of the transmitter when the NO REMOTE DETECTED message occurs will correspond with the T10 Keyless Entry Antenna that requires diagnosis.

1. Ignition OFF, disconnect the harness connector at the appropriate T10 Keyless Entry Antenna, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

3. Ignition OFF, install a DMM between the signal circuit terminal 1 and ground. Set the DMM to capture DC voltage using the MIN MAX function.
4. Activate the antenna by pressing the ignition mode switch.
5. Verify the MAX voltage captured by the DMM is greater than 1 V.

- **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
- **If greater than 1 V**
- 6. Test for less than 1 V between the low reference circuit terminal 2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

7. Install a DMM between the signal circuit terminal 1 and the low reference circuit terminal 2. Set the DMM to capture DC voltage using the MIN MAX function.
8. Activate the antenna by pressing the ignition mode switch.
9. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the low reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
10. Replace the appropriate T10 Keyless Entry Antenna.
11. Activate the antenna by pressing the ignition mode switch.
12. Verify the NO REMOTE DETECTED message is not displayed and the vehicle starts.
 - **If the NO REMOTE DETECTED message is displayed and the vehicle does not start**

Replace the K84 Keyless Entry Control Module.

- **If the NO REMOTE DETECTED message is not displayed and the vehicle starts**

13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Lock Key Transmitter Antenna Replacement - Instrument Panel**
- **Ignition Lock Key Transmitter Antenna Replacement - Floor Console**
- **Ignition Lock Key Transmitter Antenna Replacement - Rear Compartment**
- **Control Module References** for keyless entry control module replacement, programming, and setup

KEYLESS ENTRY SYSTEM MALFUNCTION (ACTIVE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The keyless entry transmitter is part of the vehicle key. The keyless entry system will unlock the vehicle doors or open/unlock the rear compartment when a corresponding button on the keyless entry transmitter is pressed. This is accomplished by the keyless entry transmitter sending a radio frequency to the remote control door lock receiver, which then sends the signal to the body control module (BCM). The BCM interprets the signal and activates the requested function. A low transmitter battery or radio frequency (RF) interference from aftermarket devices such as 2-way radios, power inverters, cellular phone chargers, computers, etc. may cause a system malfunction. High RF traffic areas, such as gas stations which use pay-at-the-pump RF transponders, may also cause interference that could lead to a malfunction.

Diagnostic Aids

- Unwanted or inadvertent door lock/unlock activation may be requested by the OnStar® Remote Link app. It is possible that a customer may be unaware of account usage, result in an unwanted or phantom door lock/unlock. If normal system diagnosis does results in an inability to verify the customer's concern, contact Technical Assistance Center (TAC).
- If available, the EL 43241 Keyless Entry Tester may be used to diagnose a low transmitter battery or a malfunctioning transmitter. To test, place the transmitter on the test pad of the EL 43241 and press each transmitter button one at a time, holding each button for three seconds. If the green light on the tester does not illuminate and a tone does not sound, first replace the transmitter battery and retest. If the malfunction continues after replacing the transmitter battery, replace the transmitter.
- When using the EL 43241 Keyless Entry Tester, first inspect the keyless entry transmitter part number to determine that it is the correct model for the vehicle. An incorrect part number transmitter may pass the

test, but it will not activate the keyless entry system.

- When the vehicle key is in the ignition, the keyless entry functions are disabled from all keyless entry transmitters.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 43241 Keyless Entry Tester

Circuit/System Verification

1. Verify that the vehicle key is correct for the vehicle. This can be accomplished by comparing the part number printed on the key to the appropriate part number in the parts catalog.
 - **If the vehicle key is incorrect**

Replace the vehicle key.
 - **If the vehicle key is correct**
2. Operate the transmitter while observing the scan tool Key Fob Function parameter for the appropriate transmitter.
3. Verify the scan tool Key Fob Function parameter corresponds with the function selected on the

transmitter.

- If the Key Fob Function parameter does not correspond with the transmitter selection

NOTE: Before replacing the transmitter, inspect the transmitter battery contacts for any corrosion or damage. If no corrosion or damage is found, replace the transmitter battery and retest before replacing the transmitter.

1. Replace the vehicle key.
2. Operate the new transmitter while observing the scan tool Key Fob Function parameter for the transmitter.
3. Verify the scan tool Key Fob Function parameter correspond with the function selected on the transmitter.
 - If the Key Fob Function parameter does not correspond with the transmitter selection, replace the K9 Body Control Module
 - If the Key Fob Function parameter corresponds with the transmitter selection

4. All OK.

- If the Key Fob Function parameter corresponds with the transmitter selection

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Key with Integrated Transmitter Programming (with BTM) , Key with Integrated Transmitter Programming (without BTM)**
- **Control Module References** for body control module replacement, programming, and setup

KEYLESS ENTRY SYSTEM MALFUNCTION (PASSIVE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Keyless Entry Antenna Signal - Driver Door	B3119 02	B3119 05	B3119 05	-
Keyless Entry Antenna Low Reference - Driver Door	B3119 02	B3119 05	B3119 05	-

Keyless Entry Antenna Signal - Passenger Door	B3120 02	B3120 05	B3120 05	-
Keyless Entry Antenna Low Reference - Passenger Door	B3120 02	B3120 05	B3120 05	-
Keyless Entry Antenna Signal - Rear Fascia	B3121 02	B3121 05	B3121 05	-
Keyless Entry Antenna Low Reference - Rear Fascia	B3121 02	B3121 05	B3121 05	-

Circuit/System Description

The keyless entry antennas are used as short range low frequency transmitters. As a vehicle with locked doors is approached with a keyless entry transmitter and the exterior door handle button/rear closure touch pad is pressed, the keyless entry antenna broadcasts a challenge to the transmitter in an approximate one meter range. If the response from the transmitter via radio frequency (RF) is valid, the locked door will be passively unlocked/unlatched and allow the door to be opened. A low transmitter battery or radio frequency (RF) interference from aftermarket devices such as 2-way radios, power inverters, cellular phone chargers, computers, etc. may cause a system malfunction. High RF traffic areas, such as gas stations which use pay-at-the-pump RF transponders, may also cause interference that could lead to a malfunction.

Diagnostic Aids

Unwanted or inadvertent door lock/unlock activation may be requested by the OnStar® Remote Link app. It is possible that a customer may be unaware of account usage, result in an unwanted or phantom door lock/unlock. If normal system diagnosis does results in an inability to verify the customer's concern, contact Technical Assistance Center (TAC).

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B3119, B3120, or B3121 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Verify that the vehicle key is correct for the vehicle. This can be accomplished by comparing the part number printed on the key to the appropriate part number in the parts catalog.
 - **If the vehicle key is incorrect**

Replace the vehicle key.

 - **If the vehicle key is correct**
 4. Verify the scan tool Exterior Driver Door Handle Switch, Exterior Passenger Door Handle Switch, and Trunk Lid Exterior Unlatch Switch parameters change between Active and Inactive while operating their respective exterior door handle button/rear closure touch pad.
 - **If any of the parameters does not change**

Refer to **Exterior Door Handle Switch Malfunction** .

- **If all of the parameters change**
5. Lock the vehicle using the keyless entry transmitter.
 6. Verify that each door and the rear compartment unlocks and opens by approaching the vehicle with a valid transmitter and operating their respective exterior door handle button/rear closure touch pad.
 - **If both doors and the rear compartment do not unlock/unlatch and open**

Refer to Passive Transmitter Malfunction in Circuit/System Testing.

- **If only one door or the rear compartment does not unlock/unlatch and open**

Refer to Antenna Circuit Malfunction in Circuit/System Testing.

- **If both doors and the rear compartment unlocks/unlatches and opens**
7. All OK.

Circuit/System Testing

Passive Transmitter Malfunction

1. Lock the vehicle using the keyless entry transmitter.
2. Verify that each door and rear compartment unlocks and opens by approaching the vehicle with a valid transmitter and operating their exterior door handle button/rear closure touch pad.
 - **If both doors and the rear compartment do not unlock/unlatch and open**
 1. Replace the transmitter battery.
 2. Lock the vehicle using the keyless entry transmitter.
 3. Verify that each door and rear compartment unlocks and opens by approaching the vehicle with a valid transmitter and operating their respective release handle/touch pad.
 - If both doors and the rear compartment do not unlock/unlatch and open, replace the vehicle key.
 - If both doors and the rear compartment unlock/unlatch and open
 - 4. All OK.
 - **If both doors and the rear compartment unlock/unlatch and open**
3. The concern may be caused by temporary RF interference. Discuss the conditions in which the concern occurs with the customer. RF interference from aftermarket devices such as 2-way radios, power inverters, cellular phone chargers, computers, etc. may cause a system malfunction. High RF traffic areas, such as gas stations which use pay-at-the-pump RF transponders, may also cause interference that could lead to a malfunction.

Antenna Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the inoperative T10 Keyless Entry Antenna, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.

3. Ignition OFF, install a DMM between the signal circuit terminal 1 and ground. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
4. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by operating the appropriate exterior door handle button/rear closure touch pad.

5. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1 V**
6. Test for less than 1 V between the low reference circuit terminal 2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
 2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K84 Keyless Entry Control Module.
 - **If less than 1 V**

NOTE: **When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.**

7. Install a DMM between the signal circuit terminal 1 and the low reference circuit terminal 2. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V.
8. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by operating the appropriate exterior door handle button/rear closure touch pad.
9. Verify the MAX voltage captured by the DMM is greater than 1 V.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the low reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If greater than 1V**
10. Replace the appropriate T10 Keyless Entry Antenna.

11. Lock the vehicle doors using the keyless entry transmitter. Activate the antenna by operating the appropriate exterior door handle button/rear closure touch pad.
12. Verify that the door/rear compartment unlocks and opens when the exterior door handle button/rear closure touch pad is operated.

- **If the door/rear compartment does not unlock and open**

Replace the K84 Keyless Entry Control Module.

- **If the door/rear compartment unlocks and opens**

13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Key with Integrated Transmitter Programming (with BTM) , Key with Integrated Transmitter Programming (without BTM)**
- **Front Side Door Outside Handle Bracket Replacement (Base)**
- **Ignition Lock Key Transmitter Antenna Replacement - Rear Bumper Fascia**
- **Control Module References** for keyless entry control module replacement, programming, and setup

REMOTE VEHICLE START MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of each diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

Remote vehicle start begins as a radio frequency message received by the body control module (BCM) from a keyless entry transmitter. The BCM monitors system conditions such as content theft deterrent, hood ajar status, and body DTCs to determine if a remote vehicle start event will occur. If conditions are determined to be acceptable, the remote vehicle start message is sent to the engine control module (ECM). The ECM monitors system conditions such as engine control parameters and vehicle theft deterrent to determine if engine starting will be allowed. If conditions are acceptable, the ECM will initiate engine starting. During the engine run time in a remote vehicle start attempt, before the operator enters the vehicle, the ECM may discontinue engine operation if system conditions require it or a message is received from the BCM requesting the engine be turned OFF.

Diagnostic Aids

- Unwanted or inadvertent door lock/unlock activation may be requested by the OnStar® Remote Link application. It is possible that a customer may be unaware of account usage, resulting in an unwanted or phantom door lock/unlock. If normal system diagnosis results in an inability to verify the customer's

concern, contact Technical Assistance Center (TAC).

- If the vehicle has a current DTC that illuminates the malfunction indicator lamp (MIL), the cause of the DTC must be diagnosed before proceeding with the Remote Vehicle Start Inoperative diagnostic.
- Only the first and second vehicle transmitters are able to control the remote vehicle start function.
- The remote vehicle start system will not operate if any of the following conditions are present:
 - A current vehicle DTC that illuminates the malfunction indicator lamp (MIL)
 - The vehicle is in valet mode
 - More than 2 remote starts have been attempted
 - The hazard switch is in the ON position
 - A current hazard switch DTC is set
 - The vehicle hood is ajar
 - A current hood ajar DTC is set
 - Incorrect BCM software is installed and vehicle start is not enabled
 - The content theft deterrent system detects an alarm trigger
 - Excessive engine RPM
 - Excessive coolant temperature
 - Accelerator pedal position greater than 0 percent
 - Vehicle not in park
 - Vehicle theft deterrent malfunction
 - A current automatic transmission shift lock control system DTC is set
 - A vehicle speed sensor signal is detected by the ECM

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation (without BTM), Keyless Entry System Description and Operation (with BTM)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the keyless entry functions operate with all available keyless entry transmitters.

- **If any keyless entry functions do not operate properly**

Refer to **Keyless Entry System Malfunction (Active)**, **Keyless Entry System Malfunction (Passive)**.

- **If all keyless entry functions operate properly**

2. Verify that no Diagnostic Status History or Start Disable items are present in the scan tool BCM Remote Start Diagnostic Status History and the ECM Remote Vehicle Start Disable History parameters.

- **If remote vehicle start disable history items are present**

Refer to the appropriate subsection in which the malfunction occurred.

- **If remote vehicle start disable history items are not present**

3. Verify all scan tool BCM Content Theft Trigger History parameters display None.

- **If any BCM Content Theft Trigger History parameter does not display None**

Refer to **Content Theft Deterrent Malfunction** .

- **If all BCM Content Theft Trigger History parameters display None**

4. All OK.

REPAIR INSTRUCTIONS

IGNITION LOCK KEY TRANSMITTER ANTENNA REPLACEMENT - INSTRUMENT PANEL

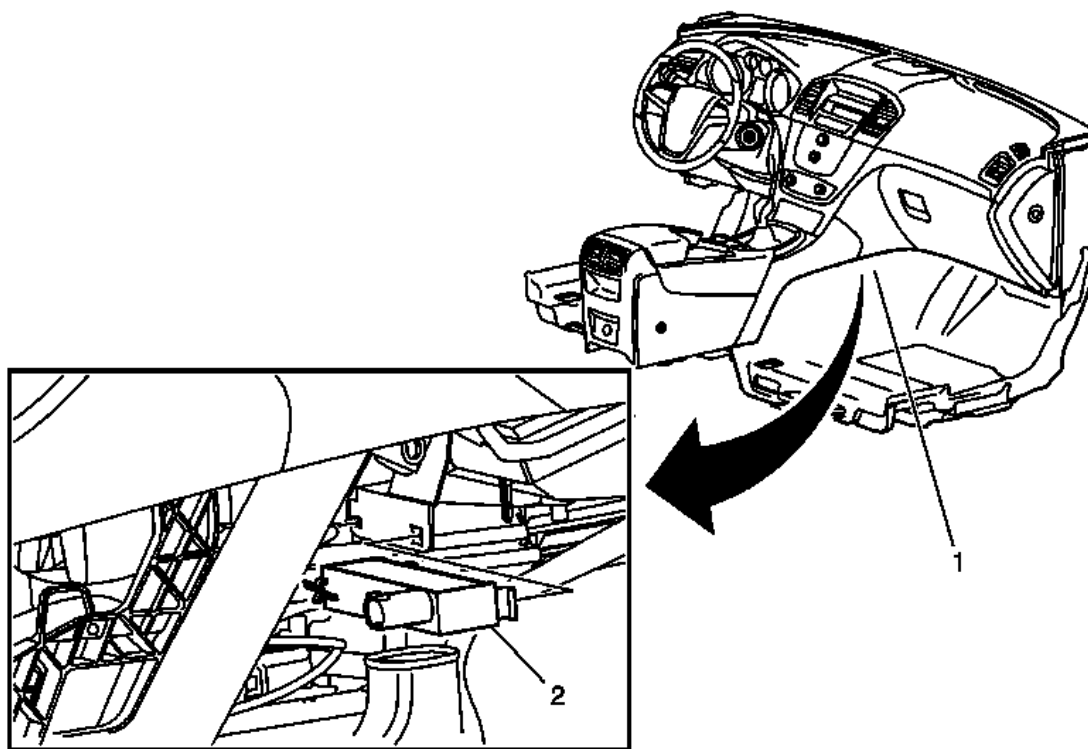


Fig. 6: Ignition Lock Key Transmitter Antenna - Instrument Panel
 Courtesy of GENERAL MOTORS COMPANY

Ignition Lock Key Transmitter Antenna Replacement - Instrument Panel

Callout	Component Name
Preliminary Procedure	
Remove the instrument panel compartment. Refer to Instrument Panel Compartment Replacement .	
1	Carpet
2	Ignition Lock Key Transmitter Antenna- Instrument Panel
	Procedure
	<ol style="list-style-type: none"> 1. Release the carpet in the area of centre console- right side. 2. Clip out the two fixing points. 3. Disconnect the wiring harness connector of ignition lock key transmitter antenna. 4. Remove the ignition lock key transmitter antenna.

IGNITION LOCK KEY TRANSMITTER ANTENNA REPLACEMENT - FLOOR CONSOLE

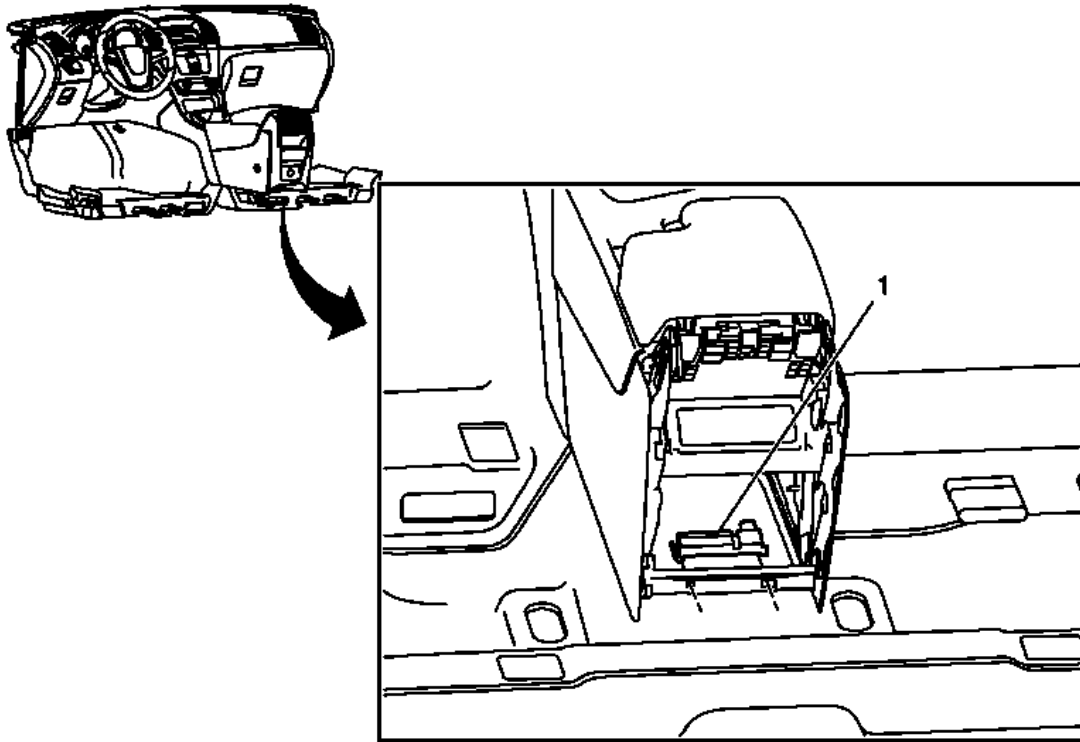


Fig. 7: Ignition Lock Key Transmitter Antenna - Floor Console
 Courtesy of GENERAL MOTORS COMPANY

Ignition Lock Key Transmitter Antenna Replacement - Floor Console

Callout	Component Name
Preliminary Procedure	
Remove the front floor console rear cover. Refer to <u>Front Floor Console Rear Cover Replacement</u> .	
1	Ignition Lock Key Transmitter Antenna- Floor Console Procedure <ol style="list-style-type: none"> 1. Clip out the two fixing points. 2. Disconnect the wiring harness connector of ignition lock key transmitter antenna. 3. Remove the ignition lock key transmitter antenna.

IGNITION LOCK KEY TRANSMITTER ANTENNA REPLACEMENT - REAR COMPARTMENT

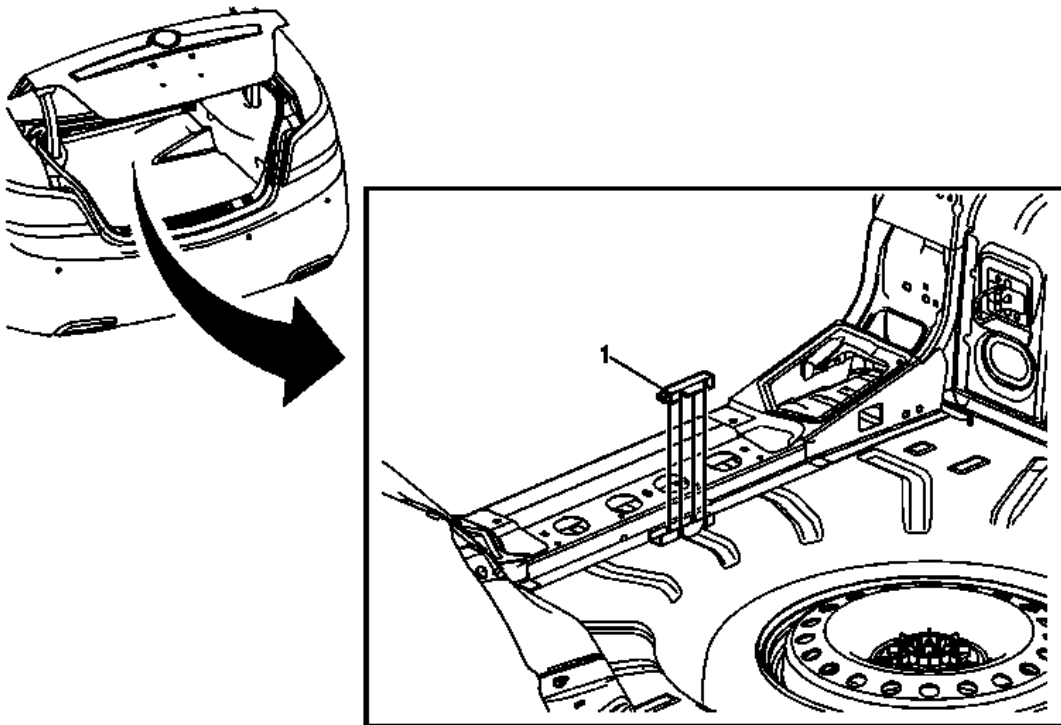


Fig. 8: Ignition Lock Key Transmitter Antenna - Rear Compartment
 Courtesy of GENERAL MOTORS COMPANY

Ignition Lock Key Transmitter Antenna Replacement - Rear Compartment

Callout	Component Name
Preliminary Procedure	
Remove the rear compartment floor panel carpet. Refer to .	
1	Ignition Lock Key Transmitter Antenna Procedures <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Depress the tabs and remove the ignition lock key transmitter antenna from the bracket.

IGNITION LOCK KEY TRANSMITTER ANTENNA REPLACEMENT - REAR BUMPER FASCIA

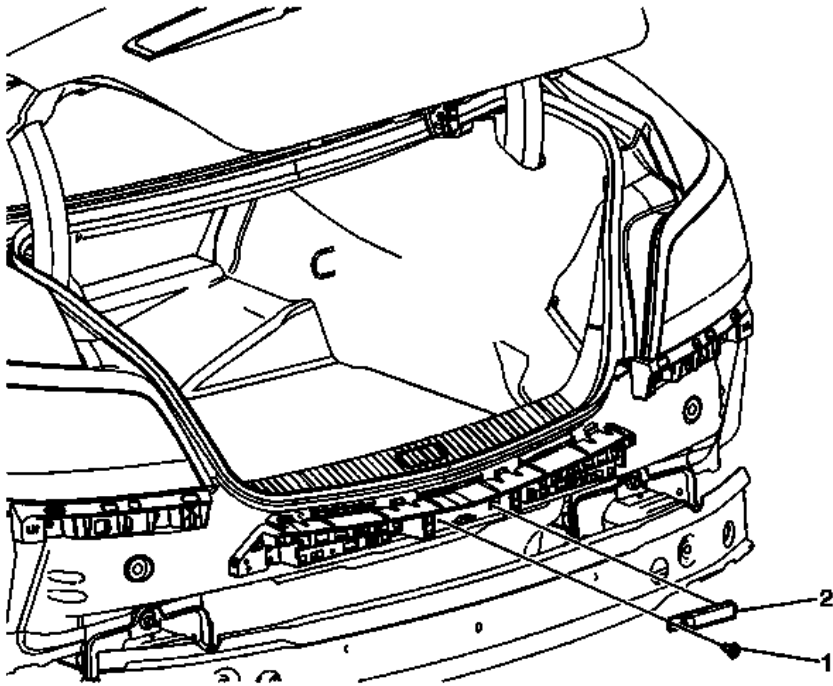


Fig. 9: Ignition Lock Key Transmitter Antenna - Rear Bumper Fascia
 Courtesy of GENERAL MOTORS COMPANY

Ignition Lock Key Transmitter Antenna Replacement - Rear Bumper Fascia

Callout	Component Name
Preliminary Procedure	
Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
1	Ignition Lock Key Transmitter Antenna Fastener
2	Ignition Lock Key Transmitter Antenna
Procedure	
Disconnect the electrical connector.	

KEYLESS ENTRY CONTROL MODULE REPLACEMENT

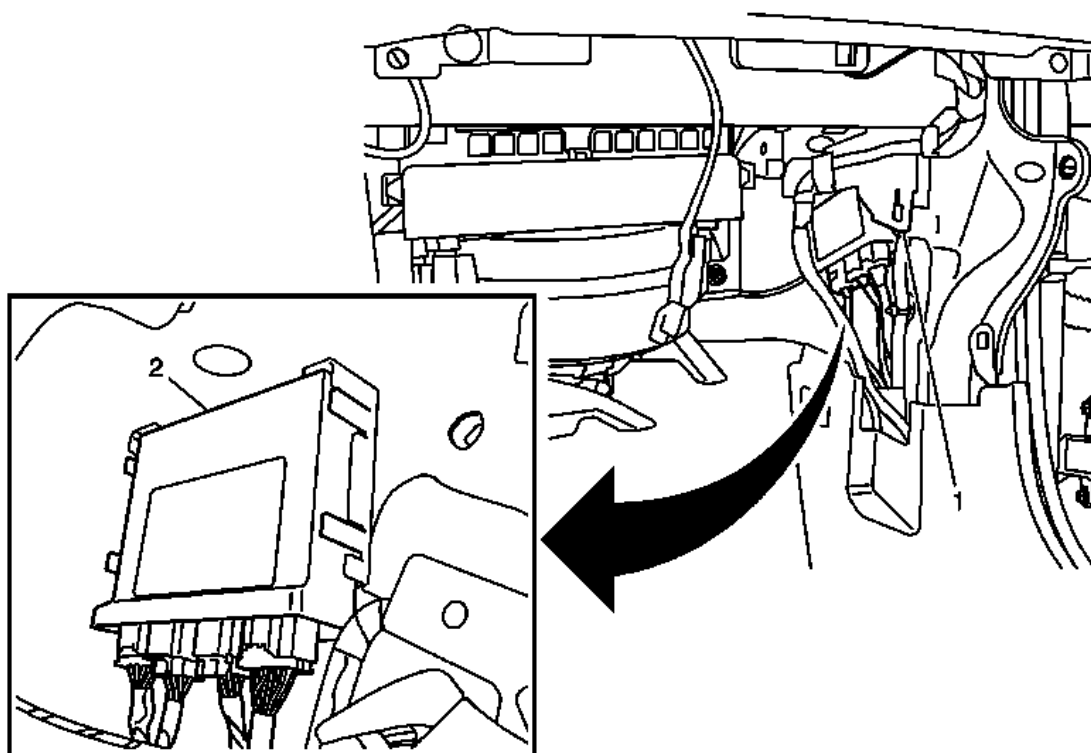


Fig. 10: Keyless Entry Control Module
Courtesy of GENERAL MOTORS COMPANY

Keyless Entry Control Module Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Disconnect the battery negative cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the instrument panel compartment. Refer to <u>Instrument Panel Compartment Replacement</u> . 	
1	Wiring Harness Bracket Procedure Release the wiring harness bracket.
2	Keyless Entry Control Module Procedure <ol style="list-style-type: none"> 1. Disconnect the wiring harness connectors. 2. Clip out the fixing points from the keyless entry control module. 3. Remove the keyless entry control module. 4. After repairs, for programming and set up information. Refer to <u>Control Module References</u> .

REMOTE CONTROL DOOR LOCK RECEIVER REPLACEMENT

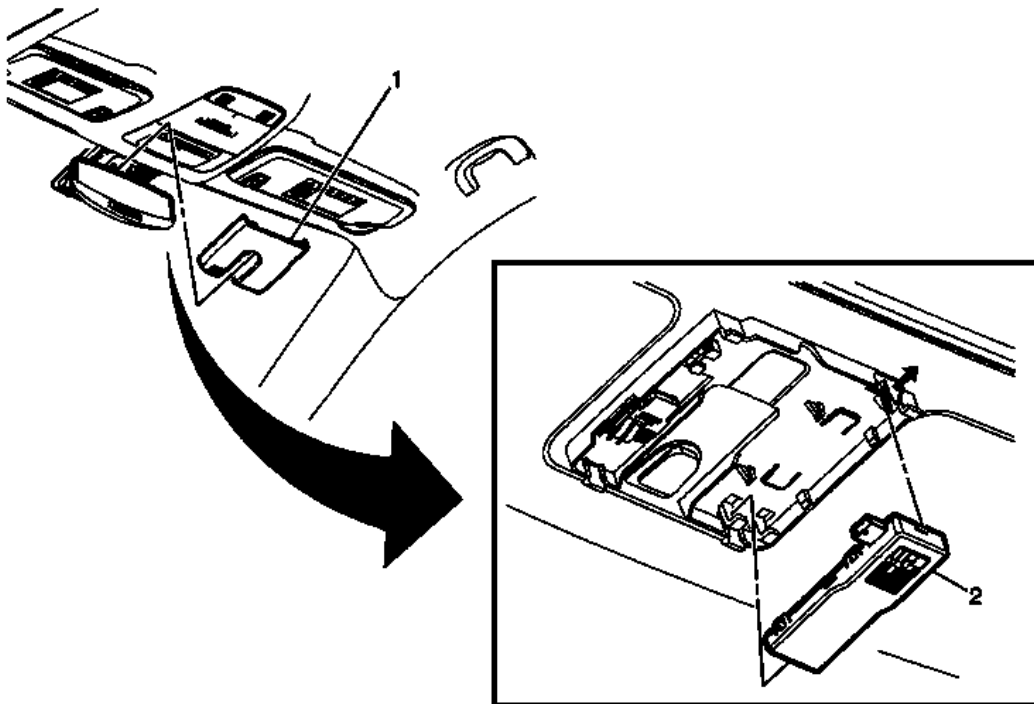


Fig. 11: Remote Control Door Lock Receiver
Courtesy of GENERAL MOTORS COMPANY

Remote Control Door Lock Receiver Replacement

Callout	Component Name
1	Windshield Outside Moisture Sensor Cover Procedure Unsnap the cover from the windshield.
2	Remote Control Door Lock Receiver Assembly Procedure 1. Disconnect the electrical connector. 2. Unsnap the receiver from the inside rear view mirror cover bracket.

GARAGE DOOR OPENER TRANSMITTER REPLACEMENT

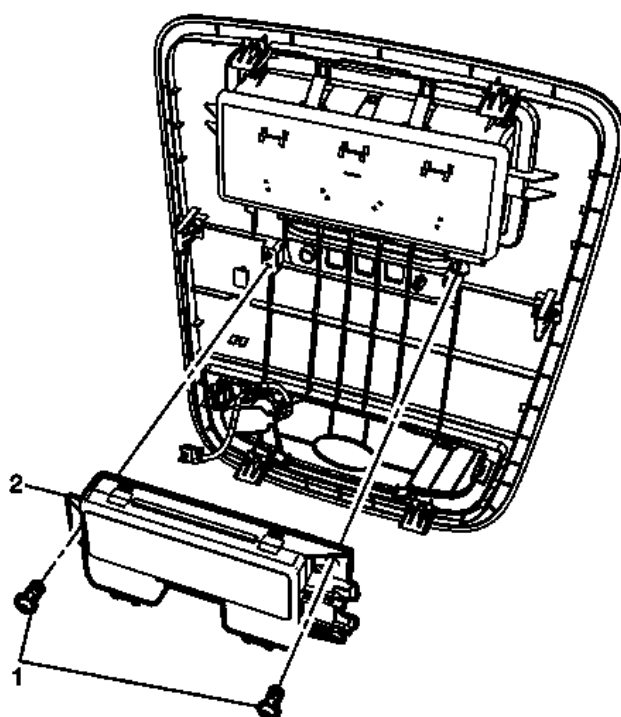


Fig. 12: Garage Door Opener Transmitter & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Garage Door Opener Transmitter Replacement

Callout	Component Name
Preliminary Procedure Remove the roof console. Refer to <u>Roof Console Replacement</u> .	
1	Garage Door Opener Transmitter Bolts (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u>
2	Garage Door Opener Transmitter Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Transfer components, as necessary. 3. Refer to <u>Control Module References</u> for programming and set-up procedures.

GARAGE DOOR OPENER TRANSMITTER PUSHBUTTON REPLACEMENT

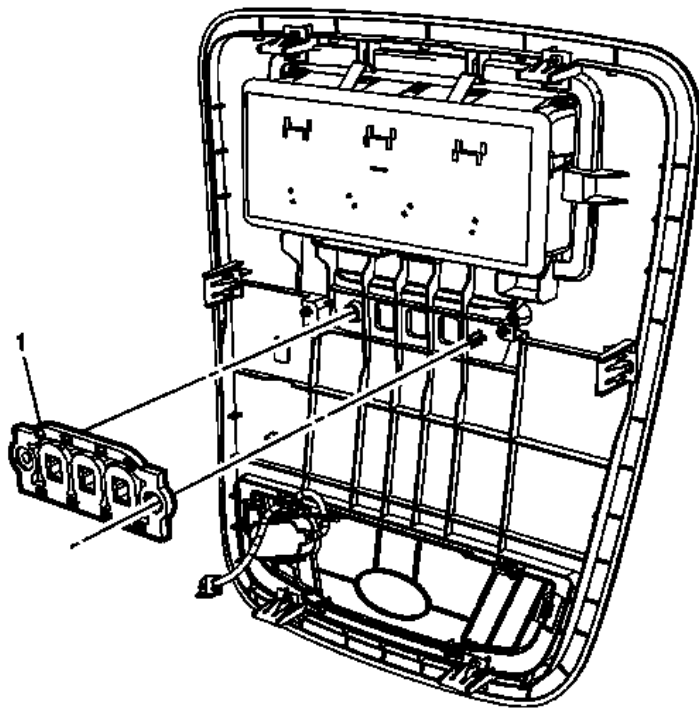


Fig. 13: Garage Door Opener Transmitter Pushbutton
 Courtesy of GENERAL MOTORS COMPANY

Garage Door Opener Transmitter Pushbutton Replacement

Callout	Component Name
Preliminary Procedure	
Remove the garage door opener transmitter. Refer to <u>Garage Door Opener Transmitter Replacement.</u>	
1	Garage Door Opener Transmitter Pushbutton

DESCRIPTION AND OPERATION

GARAGE DOOR OPENER DESCRIPTION AND OPERATION

The garage door opener is fixed and rolling code capable. Rolling code is a system that allows the code that the customers receiver receives from the garage door opener to change every time the garage door opener is used within operating range of the receiver. Rolling code programming requires the customer to push a learn/program button on the garage door opener receiver at their home. This button is usually located on the receiver unit under a cover (light cover) on one end of the unit. The customer must follow the garage door opener manufacturers instructions to program/learn the receiver to accept the Universal Home Remote System as an authorized opener for their unit . When the receiver and the garage door opener are initially programmed together, a code is established and a new code is created for every new transmission. The software in the receiver recognizes the garage door opener and accepts the new code.

The garage door opener is compatible with most, but not all types and brands of transmitters.

The garage door opener is a transmitter operating between 288-434 MHz. The power and range of the transmitter is limited to comply with laws governing the generation of radio frequency interference. The transmitter is programmed by the user to accept the signal generated by the user's transmitters.

The garage door opener has 3 buttons that may be programmed for individual transmitter/receiver combinations to control up to 3 garage door openers, security gates, lighting systems, etc. Each button represents a transmitter code section of the transmitter, which operates separately from any other button, and may be considered a separate transmitter. Operation consists of simply pressing a button to activate the corresponding transmitter.

KEYLESS ENTRY SYSTEM DESCRIPTION AND OPERATION (WITHOUT BTM)

The keyless entry system is a vehicle entry device. The keyless entry system is used in conjunction with the door locks to unlock the vehicle. Keyless entry will lock/unlock the vehicle doors or open the rear compartment lid when a corresponding button on the keyless entry transmitter is pressed. This is accomplished by the transmitter sending a radio frequency to the remote control door lock receiver antenna that has a direct link to the body control module (BCM). The BCM interprets the signal and activates the requested function or request the appropriate control module to activate the function via a serial data message. A low transmitter battery or radio frequency interference from aftermarket devices, such as 2-way radios, power inverters, computers, etc., may cause a system malfunction. High radio frequency traffic areas, such as gas stations that use pay-at-the-pump radio frequency transponders, may also cause interference that could lead to a malfunction. Keyless entry allows you to operate the following features:

- Door lock/unlock
- Liftgate lock/unlock, if equipped
- Trunk release, if equipped
- Power liftgate, if equipped
- Panic alarm/vehicle locator
- Remote vehicle starting, if equipped

The keyless entry system has the following components:

- Keyless entry transmitters
- Body control module
- Remote control door lock receiver

Keyless Entry Transmitters

NOTE: When the vehicle key is in the ignition, keyless entry functions from all keyless entry transmitter are disabled.

The keyless entry transmitters are used to perform various entry functions while away from the immediate area of the vehicle. Keyless entry functions may work at up to 20 m (65 ft) away from the vehicle. Ambient conditions may affect the performance of the keyless entry transmitter and reduce the range at which keyless entry functions operate. Up to eight transmitters may be programmed to a single vehicle. The keyless entry transmitter is an integral part of the vehicle key.

OnStar® Remote Link (if equipped)

A vehicle operator may have the ability to perform some of the keyless entry functions using applications on personal devices such as a smart phone. Unwanted or inadvertent door lock/unlock activation may be requested by the OnStar® Remote Link application. It is possible that a customer may be unaware of account usage, resulting in an unwanted or phantom door lock/unlock. If normal system diagnosis results in an inability to verify the customer's concern, contact Technical Assistance Center (TAC).

Body Control Module (BCM)

The BCM is a multifunction module that operates the keyless entry system. When a radio frequency message is received from a keyless entry transmitter, the BCM interprets this signal and performs the specific function, i.e. door lock, door unlock, or vehicle locate.

Remote Control Door Lock Receiver

The remote control door lock receiver acts as an antenna for the keyless entry system and communicates with the BCM through a dedicated serial data link. When a button is pressed on a keyless entry transmitter, the remote control door lock receiver receives this signal and sends the request to the BCM. The BCM interprets the signal and performs the specific function, i.e. door lock, door unlock, or vehicle locate.

Unlock Doors

Momentarily press the transmitter UNLOCK button in order to perform the following functions:

- Unlock only the driver door or all doors and liftgate (if equipped); this is customized through the DIC.
- Illuminate the interior lamps for a determined length of time or until the ignition is turned ON.
- Flash the exterior lights; this is customized through the DIC.
- Disarm the content theft deterrent system, if equipped.
- Deactivate the content theft deterrent system when in the alarm mode.

Lock All Doors

Press the transmitter LOCK button to perform the following functions:

- Lock all vehicle doors.
- Immediately turn OFF the interior lamps.
- Flash the exterior lights and/or sound the horn; this is customized through the DIC.
- Arm the content theft deterrent system.

Trunk Release, if equipped

Press the trunk release button on the transmitter to open the trunk.

Power Liftgate, if equipped

Press and hold the power liftgate button to perform the following functions:

- Open or close the liftgate using the power liftgate function.
- Flash the tail lamps.
- Sound the interior power liftgate chime.

Vehicle Locator/Panic Alarm

A single press of the panic button performs the following functions. Some functions may be dependent on personalization settings:

- Pulse the horn three times.
- Flash the exterior lamps three times.

A press and hold of the panic button performs the following functions:

- Illuminate the interior lamps.
- Pulse the horn and flash the exterior lamps for 30 seconds or until the following conditions occur:
 - The panic button is pressed.
 - The ignition switch is turned to the RUN position with a valid key.

Remote Vehicle Start, if equipped

The remote vehicle start function allows engine starting while not in the vehicle. It also allows the vehicle HVAC system and other vehicle systems to enable, providing a comfortable vehicle upon entry. The remote vehicle start sequence begins by pressing and releasing the lock button and then pressing and holding the remote vehicle start buttons on the keyless entry transmitter. The turn signal lamps will illuminate to indicate the vehicle has received the remote start request. Each time a remote vehicle start is performed, the vehicle doors are locked, however they may then be unlocked/locked with the transmitter at any time. Only the first and second vehicle transmitters are able to control the remote vehicle start function. Any additional remote transmitters programmed to the vehicle will perform all other remote functions. Once activated, the engine is allowed to run for 10 minutes. The remote vehicle start time may be extended by an additional 10 minutes by again pressing and releasing the lock button and then pressing and holding the remote vehicle start buttons on the transmitter. This feature is called a remote vehicle start continue and allows a maximum of 20 minutes of engine running. If the remote vehicle start continue is performed at 7 minutes into the initial 10 minute time-out, a total of 17 minutes of engine running would occur. The remote vehicle start event may be suspended at any time by pressing only the remote vehicle start button on the transmitter or by entering the vehicle and turning ON the hazard lamps.

In between ignition cycles, only two remote vehicle start events may occur or be attempted. Once two events or attempts have been made, future remote vehicle start events will be suspended until the vehicle is started using the ignition.

Enable/Disable Remote Vehicle Start

Using the driver information center, remote vehicle start may be enabled or disabled as a part of vehicle

personalization. Refer to the vehicle owners manual for more information.

Hood Ajar Switch

The hood switch provides status of the hood to the BCM for remote vehicle start purposes. The switch is integrated into the hood latch assembly.

Remote Vehicle Start Circuit Description

The BCM receives a signal from the keyless entry transmitter indicating a remote vehicle start request. A message is then sent to the BCM which determines if a crank request message will be sent to the ECM to allow engine starting. To determine if conditions are correct for a remote vehicle start event, the BCM will ensure the following conditions are met:

- A valid hood ajar switch closed signal is present.
- The doors are locked.
- The hazard switch is OFF.
- The vehicle power mode is correct.
- No content theft deterrent alarm triggers are present.

When the BCM determines all conditions meet those required for a remote vehicle start event, a message is sent via serial data to the ECM. The ECM relies on the remote vehicle start message from the BCM to enable remote vehicle start when the crank request signal is received. If the ECM does not receive a valid remote vehicle start message, it will not attempt to start the engine. While the ECM is in remote vehicle start mode it will suspend engine operation if any of the following additional conditions occur:

- Vehicle speed is greater than 0
- Transmission is not in PARK
- Excessive engine coolant temperature
- Low oil pressure
- The malfunction indicator lamp (MIL) is commanded ON
- Engine crank time is greater than 30 seconds
- Excessive engine speed
- Accelerator pedal position too high
- Remote start timer equals 0
- Immobilizer system indicates tamper

Keyless Entry Personalization

Vehicle lock/unlock functions and remote vehicle start settings may be personalized. For functional descriptions and personalization instructions, refer to the vehicle owners manual.

KEYLESS ENTRY SYSTEM DESCRIPTION AND OPERATION (WITH BTM)

PEPS Standard Block Diagram

DB	Serial Data - GMLAN Low Speed
B27RR	B27RR Door Handle Switch - Right Rear Exterior
B27LR	B27LR Door Handle Switch - Left Rear Exterior
B27P	B27P Door Handle Switch - Passenger Exterior
B27D	B27D Door Handle Switch - Driver Exterior
S58A	S58A Rear Compartment Lid Unlatch Switch - Exterior
K84	K84 Keyless Entry Control Module
K9	K9 Body Control Module
T10G	T10G Keyless Entry Antenna - Rear Fascia
T10E	T10E Keyless Entry Antenna - Rear Compartment
T10N	T10N Keyless Entry Antenna - Passenger Door Handle
T10K	T10K Keyless Entry Antenna - Center Console Rear
T10M	T10M Keyless Entry Antenna - Driver Door Handle
T10J	T10J Keyless Entry Antenna - Center Console Front
K77	K77 Remote Control Door Lock Receiver

Keyless Entry System Description and Operation - Active

The keyless entry system is a vehicle entry device. The keyless entry system is used in conjunction with the door locks to unlock the vehicle. Keyless entry will lock/unlock a door or open the rear compartment lid when a corresponding button on the keyless entry transmitter is pressed. This is accomplished by the transmitter sending a radio frequency to the remote control door lock receiver antenna that has a direct link to the body control module (BCM). The BCM interprets the signal and activates the requested function or requests the appropriate ECU to activate the function via a serial data message. A low transmitter battery or radio frequency interference from aftermarket devices, such as 2-way radios, power inverters, computers, 12 V power outlet USB adapters, etc., may cause a system malfunction. High radio frequency traffic areas, such as gas stations that use pay-at-the-pump radio frequency transponders, may also cause interference that could lead to a malfunction. Keyless entry allows you to operate the following features:

- Door lock/unlock
- Rear compartment lid release
- Illuminated entry lamps
- Panic alarm/vehicle locator
- Remote vehicle start
- Automatic window express down, if equipped. Automatic window express up, if equipped

Keyless Entry System Description and Operation - Passive

Passive keyless entry allows entry to a locked vehicle without pressing any buttons on the keyless entry transmitter. You must only have the transmitter with you. The passive entry system use low frequency antennas in several different areas on the vehicle to determine the location of the transmitter. When passively opening a locked door or the rear compartment, you must have a programmed transmitter with you in your pocket, purse, or briefcase within a one meter range.

When an exterior door handle button is pressed or the rear compartment touch pad is pressed, the BCM sends a serial data message to the keyless entry control module directing the keyless entry control module to send a low frequency challenge from the keyless entry antenna to the keyless entry transmitter. Because of the low frequency, communication range is limited. The antenna will emit the challenge in a one meter range. The transmitter must be within this range to receive the challenge. The transmitter receives this challenge and emits its response as an RF message, which is received by the remote control door lock receiver. If the response is correct, entry into the vehicle will be allowed.

As a customer convenience feature, the keyless entry system will notify the driver if the transmitter has been left in the vehicle after exiting by chirping the vehicle horn three times. This may be turned off using vehicle personalization. Also, if the transmitter is left in the vehicle after the central door lock switch has been used to lock the vehicle, the driver door will remain unlocked after exiting the vehicle. This is intended to prevent locking the transmitter in the vehicle and being unable to access it.

Keyless Entry System Description and Operation - Keyless Start

The keyless start portion of the keyless entry system allows vehicle starting, having only the transmitter as your key. The keyless start system uses low frequency antennas in three different locations on the vehicle to determine the location of the transmitter. Multiple antennas are used to ensure complete coverage of the vehicle interior and rear compartment. When using the keyless start system, a programmed transmitter must be in the vehicle's interior, in the driver's pocket, purse, or briefcase.

When the ignition mode switch is pressed, the low frequency antennas emit a challenge to the keyless entry transmitter. The transmitter receives this challenge and emits its response as an RF message, which is received by the remote control door lock receiver. If the response is correct, vehicle starting will be allowed. If RF communication is interrupted, a "No Remote Detected" message will be displayed on the DIC. In these cases, the transmitter can be placed in the transmitter pocket located in the center console, under the cupholder. The immobilizer antenna coil is located directly beneath the transmitter pocket. Placing the transmitter in the pocket will create a low powered coupling between the transmitter and immobilizer antenna, allowing communications to occur and enabling vehicle starting.

The keyless entry system has the following components:

- Keyless entry integrated key/transmitter
- Driver and front passenger door antennas (part of the door handle assembly)
- Driver and front passenger door handle switches (part of the door handle assembly)
- Rear fascia antenna
- Front console antenna
- Rear console antenna
- Trunk antenna (rear compartment)
- Body control module (BCM)
- Keyless entry control module
- Immobilizer antenna coil assembly
- Remote control door lock receiver

Keyless Entry Transmitters

By operating any of the exterior door handle buttons, a nearby transmitter is challenged by a keyless entry antenna. The transmitter will send an RF response to the remote control door lock receiver, which communicates with the BCM. The BCM will interpret this communication and either allow entry into the vehicle or deny it.

Door Antennas

The keyless entry door antennas are used to transmit low frequency communications to the keyless entry transmitters.

The keyless entry door antennas are located in the left front and right front exterior door handle bracket. The antennas are serviced as part of the door handle assembly. The antennas are controlled by the keyless entry control module. When the exterior door handle button is pressed, the respective antenna will send out a challenge to the keyless entry transmitter, which begins the passive entry communications.

Rear Fascia Antenna

The rear fascia antenna is used to transmit low frequency communication to the keyless entry transmitters for entry to rear compartment.

The rear fascia antenna is located behind the rear fascia. The antenna is controlled by the keyless entry control module. When the rear compartment touch pad is pressed, the antenna sends out a challenge to the keyless entry transmitter, which begins the passive entry communications.

Front Console Passive (Instrument Panel) Antenna

This antenna is located in the lower instrument panel near the front of the center console.

The front console antenna is used for vehicle starting functions. When the ignition mode switch is pressed, the antenna is energized or "pinged". This emits a low frequency challenge signal that is received by the keyless entry transmitter. The transmitter will then reply to this challenge with a response and, if correct, vehicle starting will occur.

Rear Console Antenna

This antenna is located in the rear of the center console.

The rear console antenna is used for vehicle starting functions. When the ignition mode switch is pressed, the antenna is energized or "pinged". This emits a low frequency challenge signal that is received by the keyless entry transmitter. The transmitter will then reply to this challenge with a response and, if correct, vehicle starting will occur.

Rear Compartment Antenna

This antenna is located in the center of the rear compartment metal floor pan, near the seatback.

The rear compartment antenna is used for vehicle starting functions. When the ignition mode switch is pressed, the antenna is energized or "pinged". This emits a low frequency challenge signal that is received by the keyless entry transmitter. The transmitter will then reply to this challenge with a response and, if correct, vehicle starting will occur.

Immobilizer Antenna Coil Assembly

The immobilizer coil assembly is located in the center console, directly beneath the transmitter pocket. If the transmitter battery is dead, weak, or the RF signal is being interrupted, the transmitter may be placed in the pocket to create a low powered coupling between the transmitter and immobilizer antenna, allowing communications to occur and enabling vehicle starting.

The immobilizer antenna coil is controlled by the BCM. The immobilizer control module is also active when learning vehicle keys.

Keyless Entry Control Module

The keyless entry control module is a multi-function module which performs the following keyless entry system functions:

- Activating vehicle antennas for passive keyless entry functions
- Activating vehicle antennas for keyless start functions
- Backup control for the ECM accessory wakeup and the run/crank relay
- If equipped, controls the electronic steering column lock
- Receiver of the exterior door handle switch inputs and door open switch (not the door ajar switch)
- Ignition mode switch monitoring

OnStar® Remote Link (if equipped)

A vehicle operator may have the ability to perform some of the keyless entry functions using applications on personal devices such as but not limited to smart phones. A condition may appear as if there is a malfunction in the vehicle. If it is suspected that this may be the case contact Technical Assistance if a condition cannot be determined through normal vehicle diagnostics.

Body Control Module (BCM)

The BCM is a multi-function module that performs the following functions:

- Receive and authenticate active transmitter and keyless start signals from the remote control door lock receiver
- Determines the functionality requested by the transmitter signal
- Performs the function requested by the transmitter signal

Unlock Driver Door Only - Active

Momentarily press the transmitter UNLOCK button in order to perform the following functions:

- Unlock only the driver door
- Illuminate the interior lamps for a determined length of time, or until the ignition is turned ON
- Flash the exterior lights, if enabled through personalization
- Disarm the Content Theft Deterrent (CTD) system
- Deactivate the CTD system when in the alarm mode

Unlock All Doors - Second Operation - Active

Momentarily press the transmitter UNLOCK button a second time, within 5 seconds of the first press, to perform the following function:

Unlock the remaining doors

Unlock Driver Door Only - Passive

If enabled through personalization, approach the driver door with a valid keyless entry transmitter and press the door handle button to perform the following functions:

- Unlock and open only the driver door
- Disarm the CTD system, if equipped
- Deactivate the CTD system when in the alarm mode

Unlock All Doors - Passive

Approach any non driver door (front or rear) or, if enabled through personalization, the driver door with a valid keyless entry transmitter and press the door handle button to perform the following functions:

- Unlock all vehicle doors
- Disarm the CTD system, if equipped
- Deactivate the CTD system when in the alarm mode

Lock All Doors - Active

Press the transmitter LOCK button to perform the following functions:

- Lock all vehicle doors
- Immediately turn off the interior lamps
- Flash the exterior lights, if enabled through personalization
- Chirp the horn, if enabled through personalization
- Arm the CTD system

Lock All Doors - Passive

Exit the vehicle (with ignition off) with the keyless entry transmitter to automatically perform the following

functions, if equipped.

- Lock all vehicle doors after a delay
- Flash the exterior lights, if enabled through personalization
- Chirp horn, if enabled through personalization
- Arm the CTD system

When all doors are closed, they can also be locked from the exterior by pressing a front door handle button while having a valid transmitter within range.

If more than one keyless entry transmitter is within a vehicle and the Keyless Entry System detects that one or more transmitters have been left in the vehicle after vehicle is locked, any transmitter left within the vehicle will be temporarily deactivated until:

- A button on the deactivated key fob is pressed (will only activate the fob whose button is pressed)
- A passive unlock of vehicle occurs
- Change in power mode occurs

Rear Compartment Lid Release - Active

If the vehicle transaxle is in PARK or NEUTRAL and the ignition is in the OFF position, a single press of the transmitter rear compartment release button will open the rear compartment lid.

Rear Compartment Lid Release - Passive

Approach the rear of the vehicle with a valid keyless entry transmitter. Press the rear compartment lid release touch pad. The rear compartment lid will open.

If vehicle is not equipped with trunk antenna, a keyless entry transmitter left inside the truck will allow the trunk to be reopened at any time. This feature will not allow a customer to lock the transmitter in the trunk.

If vehicle has a trunk antenna and one or more transmitters are left in the trunk or interior of the vehicle, those transmitter(s) will be deactivated when the vehicle becomes locked.

Vehicle Locator/Panic Alarm/Active

A single press of the panic button performs the following functions. Some functions may be dependent on personalization settings:

- Pulses the horn three times
- Flashes the exterior lamps three times

A press and hold of the panic button performs the following functions:

- A press and hold of the panic button performs the following functions:
- Pulses the horn and flashes the parking lamps for 30 second or until the following conditions occur:

- The panic button is pressed
- The ignition switch is turned to the RUN position with a valid key

Remote Vehicle Start/Active

The remote vehicle start function allows engine starting while not in the vehicle. It also allows the vehicle HVAC system and other vehicle systems to enable, providing a comfortable vehicle upon entry. The remote vehicle start sequence begins by pressing and releasing the lock button and then pressing and holding the remote vehicle start buttons on the keyless entry transmitter. The turn signal lamps will illuminate to indicate the vehicle has received the remote start request. Each time a remote vehicle start is performed, the vehicle doors are locked, however they may then be unlocked/locked with the transmitter at any time. Only the first and second vehicle transmitters are able to control the remote vehicle start function. Any additional remote transmitters programmed to the vehicle will perform all other remote functions. Once activated, the engine is allowed to run for 10 minutes. The remote vehicle start time may be extended by an additional 10 minutes by again pressing and releasing the lock button and then pressing and holding the remote vehicle start buttons on the transmitter. This feature is called a remote vehicle start continue and allows a maximum of 20 minutes of engine running. If the remote vehicle start continue is performed at 7 minutes into the initial 10 minute time-out, a total of 17 minutes of engine running would occur. The remote vehicle start event may be suspended at any time by pressing only the remote vehicle start button on the transmitter or by entering the vehicle and turning ON the hazard lamps.

In between ignition cycles, only two remote vehicle start events may occur or be attempted. Once two events or attempts have been made, future remote vehicle start events will be suspended until the vehicle is started using the ignition.

Enable/Disable Remote Vehicle Start/Active

Using the driver information center, remote vehicle start may be enabled or disabled as a part of vehicle personalization. Refer to the vehicle owners manual for more information.

Hood Ajar Switch/Active

The hood switch provides status of the hood to the BCM for remote vehicle start purposes. The switch is integrated into the hood latch assembly. The hood ajar switch provides 2 separate inputs to the BCM. These separate inputs allow the BCM to actively monitor for a hood ajar switch fault.

Remote Vehicle Start Circuit Description/Active

The BCM receives a signal from the keyless entry transmitter indicating a remote vehicle start request. The BCM uses the following inputs to verify the system is ready for a remote vehicle start event:

- Vehicle is not in valet mode
- All vehicle doors are closed
- Rear compartment lid is not ajar
- The hood is closed
- The doors are locked

- The hazard switch is OFF
- Battery reconnect has not occurred
- Vehicle power mode is correct

When the BCM determines all conditions meet those required for a remote vehicle start event, a message is sent via serial data to the ECM. The ECM relies on the remote vehicle start message from the BCM to enable remote vehicle start when the crank request signal is received. If the ECM does not receive a valid remote vehicle start message, it will not ground the control circuit of the crank relay and start the engine. While the ECM is in remote vehicle start mode it will cut fuel to the engine if any of the following additional conditions occur:

- Vehicle speed is greater than 0
- Transmission is not in P
- Excessive engine coolant temperature
- Low oil pressure
- The malfunction indicator lamp (MIL) is commanded ON
- Engine crank time is greater than 30 seconds
- Excessive engine speed
- Accelerator pedal position too high
- Remote start timer equals 0
- Immobilizer system indicates a theft attempt

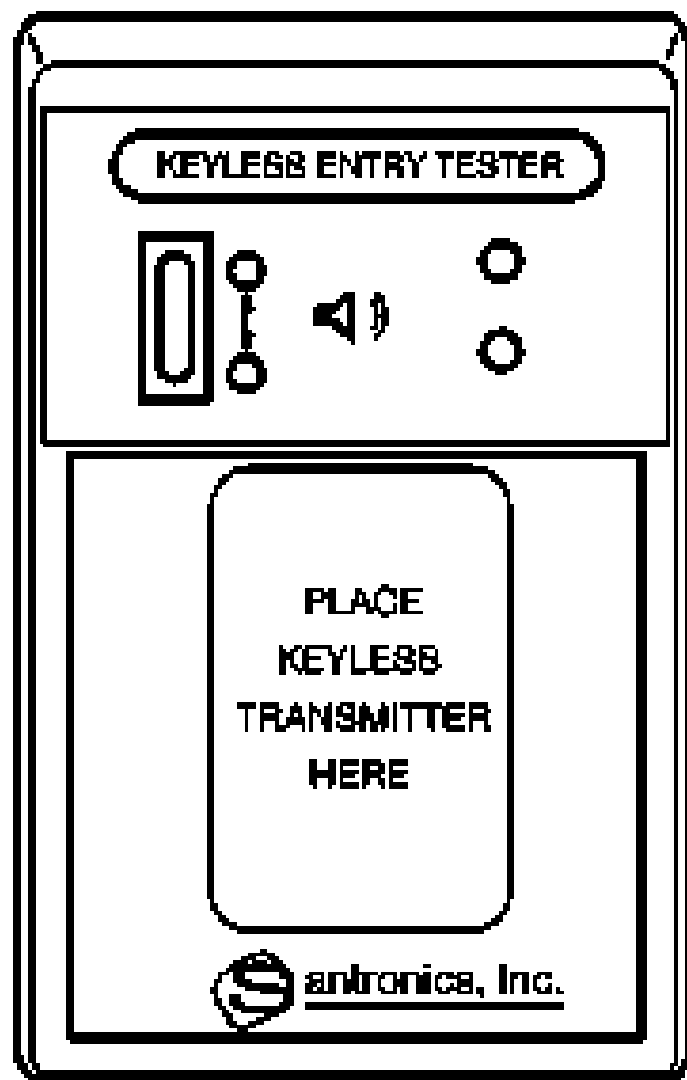
Keyless Entry Personalization

Vehicle lock/unlock functions and remote vehicle start settings may be personalized for the vehicle. For functional descriptions and programming instructions, refer to the vehicle owners manual.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description



EL 43241
Keyless
Entry
Tester

ACCESSORIES & EQUIPMENT

Lighting - Description and Operation

DESCRIPTION AND OPERATION

EXTERIOR LIGHTING SYSTEMS DESCRIPTION AND OPERATION

Exterior Lamps

The exterior lighting system consist of the following lamps:

- Headlamps
- Daytime running lamps (DRL)
- Front fog lamps
- Park, tail, license and marker lamps
- Turn signal lamps
- Hazard warning lamps
- Stop lamps
- Backup lamps

Low Beam Headlamps

The headlamps consist of 2 interchangeable single filament bulbs on each side of the vehicle which provide high and low beams. The lower bulb in the headlamp is the high beam and the upper bulb is the low beam.

The headlamps may be turned ON in 3 different ways:

- When the headlamp switch is placed in the ON position, for normal operation.
- When the headlamp switch is placed in the AUTOMATIC LIGHT position, for automatic lamp control.
- When the headlamp switch is placed in the AUTOMATIC LIGHT position, with the windshield wipers ON in daylight conditions, after a 6 s delay.

The body control module (BCM) controls the headlamps based on the inputs explained above. When a low beam request is received, the BCM applies B+ to both low beam headlamps through the left low beam and right low beam control circuits, illuminating the low beam headlamps.

Automatic Lamp Control

Automatic Light is switched ON as default. It can be switched OFF by turning the headlamp switch to OFF position. It will be switched ON again by doing so again. Automatic Light is only available if a rain sensor or rain/light sensor module is installed in the car. The rain/light sensor module will send the actual ambient light state (day/night) to the BCM. If Automatic Light is enabled, BCM will react on the message received from the rain/light sensor module by switching ON/OFF low beams.

Flash to Pass

When the low beam headlamps are on and the turn signal/multifunction switch is momentarily placed in the flash to pass position, ground is applied to the turn signal/multifunction switch. The turn signal/multifunction switch applies ground to the BCM through the flash to pass switch signal circuit. The BCM then applies ground to the high beam relay control circuit. This energizes the high beam relay, closing the switch side contacts of the high beam relay, applying battery voltage to the left and right high beam fuses. Battery voltage is applied from the high beam fuses through the high beam voltage supply circuit to the high beam headlamp assemblies. This causes the high beam headlamps to illuminate at full brightness momentarily or until the flash to pass switch is released.

Daytime Running Lamps

The DRL bulbs are combined with the park lamps. One filament is for the DRL and one for the park lamps. The DRL will operate when the following conditions are met:

1. Engine is running.
2. Headlamp switch in AUTOMATIC LIGHT position.
3. The high and low beam headlamps are OFF.

By turning the headlamp switch in the OFF position the automatic light function and the DRL will be deactivated.

The ambient light sensor is used to monitor outside lighting conditions. The ambient light sensor provides a voltage signal that will vary between 0.2-4.9 V depending on outside lighting conditions. The HVAC control module provides a low reference ground and 5 V reference signals to the ambient light sensor. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either DRL or low beam when the headlamp switch is in the AUTOMATIC LIGHT position. In daylight conditions, the BCM will command the DRL ON by applying battery voltage to the left and right DRL lamps. Any function or condition that turns on the headlamps will cancel DRL operation.

Front Fog Lamps

The front fog lamp relay is supplied with battery voltage at all times. The front fog lamp switch signal circuit is grounded momentarily by pressing the front fog lamp switch. The body control module (BCM) energizes the front fog lamp relay by applying ground to the front fog lamp relay control circuit. When the front fog lamp relay is energized, the relay switch contacts close and battery voltage is applied through the front fog lamp fuse to the front fog lamp supply voltage circuit which illuminates the front fog lamps.

Park, Tail, License and Marker Lamps

The rear tail, stop, and turn signal functions are performed by light emitting diodes (LED) in the tail lamp assemblies. The rear side marker lamps uses LEDs and are part of the tail lamp assemblies which wraps around the corner of the vehicle. The front park and side marker lamps are part of the front headlamp assembly. The front side markers uses LEDs the front position lamps use an incandescent bulb. The BCM sends out a PWM signal to illuminate all park, tail, license, and marker lamps as soon when the headlamp switch is placed in the PARK LAMP or HEADLAMP position or anytime the headlights are requested. The park lamps are also turned on with the front fog lamps.

Turn Signal Lamps

Ground is applied at all times to the turn signal/multifunction switch. The turn signal lamps may only be activated with the ignition switch in the ON or START position. When the turn signal/multifunction switch is placed in either the TURN RIGHT or TURN LEFT position, ground is applied to the BCM through either the right turn or left turn signal switch signal circuit. The BCM then applies a pulsating voltage to the front and rear turn signal lamps through their respective voltage supply circuits. When a turn signal request is received by the BCM, a serial data message is sent to the instrument cluster requesting the respective turn signal indicator be pulsed ON and OFF.

Hazard Flasher Lamps

The hazard flashers may be activated in any power mode. The hazard switch is permanently grounded. When the hazard switch is placed in the ON position, ground is applied through the hazard switch signal circuit to the BCM. The BCM supplies battery voltage to all turn signal lamps in an ON and OFF duty cycle. When the hazard switch is activated, the BCM sends a serial data message to the instrument cluster requesting both turn signal indicators to be cycled ON and OFF.

Stop Lamps

NOTE: Brake system does not use a brake switch, stoplight switch or brakelight switch. System uses a Brake Pedal Position Sensor to control these functions.

The brake pedal position (BPP) sensor is used to sense the action of the driver application of the brake pedal. The BPP sensor provides an analog voltage signal that will increase as the brake pedal is applied. The BCM provides a low reference signal and a 5 V reference voltage to the BPP sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the stop lamp control circuit and center high mounted stop lamp control circuit. When the control circuit is energized the stop lamps are illuminated.

Backup Lamps

When the transmission is placed in the reverse position, the engine control module (ECM) sends a serial data message to the BCM. The message indicates that the gear selector is in the reverse position. The BCM applies battery voltage to the backup lamps. The backup lamps are permanently grounded. Once the driver moves the gear selector out of the reverse position, a message is sent by the ECM via serial data requesting the BCM to remove battery voltage from the backup lamp control circuit.

Battery Run Down Protection/Inadvertent Power

To provide battery run down protection, the exterior lamps will be deactivated automatically under certain conditions. The BCM monitors the state of the headlamp switch. If the park or headlamp switch is ON when the ignition switch is placed in either the CRANK or RUN position and then placed in the OFF position, the BCM initiates a 10 min timer. At the end of the 10 min, the BCM will turn OFF the control power output to the park and headlamp relay coils, deactivating the exterior lamps. This feature will be cancelled if any power mode other than OFF becomes active. The BCM will disable battery run down protection if any of the following conditions exist. The park or headlamp switch is placed in the ON to OFF position, and back to the ON position during battery run down protection. The BCM determined that the park or headlamp switch was not active when

the ignition was turned OFF.

INTERIOR LIGHTING SYSTEMS DESCRIPTION AND OPERATION

Interior Lamps

The interior lamps consist of 2 groups, those which can dim from the instrument panel cluster lamps dimmer switch and those that can not dim.

Courtesy/Illuminated Entry Lamps

The following lamps may be manually turned ON by placing the interior lamp switch in the ON position, or by opening a door while the switch is in the AUTO position.

- The dome lamp
- The liftgate lamps
- Courtesy lamps

The courtesy lamp supply voltage circuit of the body control module (BCM) supplies battery positive voltage to the dome lamp, the liftgate lamps and courtesy lamps. When any door is opened, the door jamb switch contacts close providing a door open input to the BCM. The BCM then provides a B+ to the interior lamps with the switch in the AUTO position. The interior lamps receive a ground when the switch is in the ON position.

NOTE: If the liftgate is opened after all the modules go to sleep, the dome light will not come on. The liftgate ajar switch input to the BCM will not wake up the BCM once it has gone to sleep, so the dome light will not come on. Once the BCM gets an input to wake it up, from remote keyless entry or a door handle, the dome light will turn on when the liftgate is opened.

If the driver inadvertently leaves any interior lamp ON, the BCM will turn it OFF after a 20 min time-out.

The courtesy lamps will turn OFF immediately if the ignition switch is turned to the ON position or approximately 20 s after all doors are closed.

Keyless Entry Interior Illumination

When the BCM receives a door unlock command from the remote keyless entry transmitter, the BCM will flash the park lamps several times, illuminate the courtesy and park lamps, and illuminate the low beam headlamps at low intensity. The lamps will remain on until the ignition key is turned from the OFF position, a keyless entry transmitter door lock command is received, or after an approximate 20 s delay.

Interior Lamps Dimming

This group includes lamps which may dim. This group may use a combination of vacuum fluorescent illumination, LEDs and incandescent lamps.

- HVAC control module, head assembly

- Rear HVAC control module, head assembly
- Radio
- Rear seat audio
- The instrument panel cluster
- The PRNDL lamp, with the exception of the current gear select position
- Power window switches
- Various switches

When the ignition switch is turned to the ON position, the vacuum fluorescent display, radio, turns ON at maximum brightness. When the park lamps or low beams are ON, all incandescent back lighting turn ON at the dimming level indicated by the instrument panel cluster dimmer switch. At the same time all fluorescent display displays dim to match the indicated dimming level. When the headlamp switch is placed in the PARK or in HEADLAMPS position, the headlamp switch supplies an input signal to the BCM. The BCM then supplies voltage to the instrument panel cluster dimmer switch through the dimming control circuit. The setting of the instrument panel cluster dimmer switch determines the amount of voltage that the instrument panel cluster dimmer switch supplies to the BCM. The BCM then sends a PWM voltage to all the interior lamps. All the fluorescent display and incandescent back lighting lamps are provided a specific voltage.

NOTE: **For vehicles which are equipped with automatic light function, the interior backlighting can only be dimmed when the ambient light sensor detects night conditions.**

When the headlight switch is turned to the park lamp or headlamp position, all incandescent back lighting turn ON at the dimming level indicated by the instrument panel cluster dimmer switch. When the instrument panel cluster dimmer switch is moved from minimum to maximum, all fluorescent display displays, as well as all incandescent back lighting respond from minimum intensity to maximum brightness in response to the instrument panel cluster dimmer switch.

Inadvertent Power

The BCM used in this vehicle controls the lighting system through circuits that enable the interior lamps. The BCM opens these enabling circuits shortly after the ignition switch is turned OFF with no lamp switch activity. If the ignition switch is turned to any position other than OFF, or if a lamp switch is activated during this period, the timer will reset itself.

ACCESSORIES & EQUIPMENT

Lighting - Diagnostic Code Index

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B096A</u>	DTC B096A 01 Hazard Lamps Switch Backlighting Circuit Short to Battery DTC B096A 02 Hazard Lamps Switch Backlighting Circuit Short to Ground DTC B096A 04 Hazard Lamps Switch Backlighting Circuit Open
<u>DTC B1405, B1529, or B257B</u>	DTC B1405 02 Control Module Voltage Reference Output 2 Circuit Short to Ground DTC B1405 03 Control Module Voltage Reference Output 2 Circuit Low Voltage DTC B1405 07 Control Module Voltage Reference Output 2 Circuit High Voltage DTC B1529 03 Control Module Voltage Reference Output 5 Circuit Low Voltage DTC B1529 07 Control Module Voltage Reference Output 5 Circuit High Voltage DTC B257B 03 Lighting Control Switch Signal Low Voltage DTC B257B 07 Lighting Control Switch Signal High Voltage
<u>DTC B1461 or B1462</u>	DTC B1461 00 Left Headlamp Horizontal Motor Circuit Malfunction DTC B1462 00 Right Headlamp Horizontal Motor Circuit Malfunction
<u>DTC B1480</u>	DTC B1480 02 Battery Rundown Protection Circuit Short to Ground
<u>DTC B2530</u>	DTC B2530 01 Front Fog Lamps Control Circuit Short to Battery DTC B2530 02 Front Fog Lamps Control Circuit Short to Ground DTC B2530 04 Front Fog Lamps Control Circuit Open
<u>DTC B2545</u>	DTC B2545 01 Backup Lamps Circuit Short to Battery DTC B2545 02 Backup Lamps Circuit Short to Ground DTC B2545 04 Backup Lamps Circuit Open
<u>DTC B255D</u>	DTC B255D 02 Passenger Compartment Lamp Control 2 Circuit Short to Ground
<u>DTC B2570</u>	DTC B2570 02 Trunk Lamp Control Circuit Short to Ground
<u>DTC B2575 or B2699</u>	DTC B2575 01 Headlamps Control Circuit Short to Battery DTC B2575 02 Headlamps Control Circuit Short to Ground DTC B2575 04 Headlamps Control Circuit Open DTC B2699 01 Right Headlamp Control Circuit Short to Battery DTC B2699 02 Right Headlamp Control Circuit Short to Ground DTC B2699 04 Right Headlamp Control Circuit Open
<u>DTC B257A</u>	DTC B257A 00 Headlamp Switch Input Signals Correlation Malfunction
<u>DTC B257C or B257D</u>	DTC B257C 00 Left Headlamp Assembly Malfunction DTC B257D 00 Right Headlamp Assembly Malfunction
<u>DTC B2580</u>	DTC B2580 01 Headlamp High Beam Control Circuit Short to Battery

	DTC B2580 02 Headlamp High Beam Control Circuit Short to Ground DTC B2580 04 Headlamp High Beam Control Circuit Open
<u>DTC B2585 or B3867</u>	DTC B2585 01 Left Park Lamps Control Circuit Short to Battery DTC B2585 02 Left Park Lamps Control Circuit Short to Ground DTC B2585 04 Left Park Lamps Control Circuit Open DTC B3867 01 Right Park Lamps Control Circuit Short to Battery DTC B3867 02 Right Park Lamps Control Circuit Short to Ground DTC B3867 04 Right Park Lamps Control Circuit Open
<u>DTC B258A</u>	DTC B258A 01 Low Beam Control Circuit Short to Battery DTC B258A 02 Low Beam Control Circuit Short to Ground DTC B258A 04 Low Beam Control Circuit Open
<u>DTC B259A or B259B</u>	DTC B259A 01 Left Cornering Lamp Relay Control Circuit Short to Battery DTC B259B 01 Right Cornering Lamp Relay Control Circuit Short to Battery
<u>DTC B2600 or B2605</u>	DTC B2600 01 Left Daytime Running Lamps Control Circuit short to Battery DTC B2600 02 Left Daytime Running Lamps Control Circuit Short to Ground DTC B2600 04 Left Daytime Running Lamps Control Circuit Open DTC B2605 01 Right Daytime Running Lamps Control Circuit short to Battery DTC B2605 02 Right Daytime Running Lamps Control Circuit Short to Ground DTC B2605 04 Right Daytime Running Lamps Control Circuit Open
<u>DTC B2610</u>	DTC B2610 02 Passenger Compartment Dimming 1 Circuit Short to Ground
<u>DTC B2615</u>	DTC B2615 02 Passenger Compartment Dimming 2 Circuit Short to Ground
<u>DTC B2625</u>	DTC B2625 02 Display Dimming Pulse Width Modulation Output Circuit Short to Ground
<u>DTC B2645</u>	DTC B2645 03 Ambient Light Sensor Circuit Low Voltage DTC B2645 07 Ambient Light Sensor Circuit High Voltage
<u>DTC B3410 or B3420</u>	DTC B3410 01 AHLD Front Axle Sensor Signal Circuit Short to Battery DTC B3410 06 AHLD Front Axle Sensor Signal Circuit Low Voltage/Open DTC B3420 01 AHLD Rear Axle Sensor Signal Circuit Short to Battery DTC B3420 06 AHLD Rear Axle Sensor Signal Circuit Low Voltage/Open
<u>DTC B3415</u>	DTC B3415 01 AHLD Front Axle Sensor Supply Circuit Short to Battery DTC B3415 02 AHLD Front Axle Sensor Supply Circuit Short to Ground
<u>DTC B3435 or B3440</u>	DTC B3435 00 AHLD Left Servo Driver Circuit DTC B3435 03 AHLD Left Servo Driver Circuit Short to Ground DTC B3440 00 AHLD Right Servo Driver Circuit DTC B3440 03 AHLD Right Servo Driver Circuit Short to Ground
<u>DTC B3596</u>	DTC B3596 00 Hazard Lamps Request Circuit Malfunction
<u>DTC B3650</u>	DTC B3650 08 High Beam Request Signal Circuit Performance - Signal Invalid
<u>DTC B3806</u>	DTC B3806 00 High Beam and Headlamp Flash Select Circuit Malfunction
<u>DTC B3883</u>	DTC B3883 01 License Plate Lamp Circuit Short to Battery

	DTC B3883 02 License Plate Lamp Circuit Short to Ground DTC B3883 04 License Plate Lamp Circuit Open
<u>DTC B3948 or B3949</u>	DTC B3948 01 Left Front Turn Signal Circuit Short to Battery DTC B3948 02 Left Front Turn Signal Circuit Short to Ground DTC B3948 04 Left Front Turn Signal Circuit Open DTC B3949 01 Right Front Turn Signal Circuit Short to Battery DTC B3949 02 Right Front Turn Signal Circuit Short to Ground DTC B3949 04 Right Front Turn Signal Circuit Open
<u>DTC B3950 or B3951</u>	DTC B3950 01 Left Rear Turn Signal Circuit Short to Battery DTC B3950 02 Left Rear Turn Signal Circuit Short to Ground DTC B3950 04 Left Rear Turn Signal Circuit Open DTC B3951 01 Right Rear Turn Signal Circuit Short to Battery DTC B3951 02 Right Rear Turn Signal Circuit Short to Ground DTC B3951 04 Right Rear Turn Signal Circuit Open
<u>DTC C0010</u>	DTC C0010 5A Reverse Gear Signal Circuit Not Plausible
<u>DTC C0277 or C0890</u>	DTC C0277 06 Brake Pedal Position Sensor Circuit Low Voltage/Open DTC C0277 07 Brake Pedal Position Sensor Circuit High Voltage DTC C0277 09 Brake Pedal Position Sensor Circuit Too Fast Transitions DTC C0277 4B Brake Pedal Position Sensor Circuit Calibration Not Learned DTC C0890 03 Control Module Voltage Reference Output 3 Circuit Low Voltage DTC C0890 07 Control Module Voltage Reference Output 3 Circuit High Voltage
<u>DTC C0297</u>	DTC C0297 02 Brake Applied Output Circuit Short to Ground

ACCESSORIES & EQUIPMENT

Lighting - Diagnostic Information and Procedures

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B096A

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B096A 01

Hazard Lamps Switch Backlighting Circuit Short to Battery

DTC B096A 02

Hazard Lamps Switch Backlighting Circuit Short to Ground

DTC B096A 04

Hazard Lamps Switch Backlighting Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Hazard Switch LED Backlighting Control	B096A 02	B096A 01, B096A 04	1	-
Multifunction Switch 1 - Instrument Panel Ground	-	B096A 01, B096A 04	-	-
1. Hazard Lamps Malfunction				

Circuit/System Description

The instrument panel dimmer switch controls are located on the headlamp switch assembly and are used to increase and decrease the brightness of the interior backlighting components. When the instrument panel dimmer switch is placed in a desired brightness position, the body control module (BCM) receives a signal from the instrument panel dimmer switch and responds by applying a pulse width modulated (PWM) voltage to the hazard warning switch LED backlighting control circuit illuminating the LED to the desired level of brightness.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Park lamps ON.

Conditions for Setting the DTC

DTC B096A 01

- The BCM detects an open/high resistance in the hazard warning switch LED backlighting control circuit.
- The BCM detects an open/high resistance in the hazard warning switch ground circuit.

DTC B096A 02

The BCM detects a short to ground in the hazard warning switch LED backlighting control circuit.

DTC B096A 04

- The BCM detects an open/high resistance in the hazard warning switch LED backlighting control circuit.
- The BCM detects an open/high resistance in the hazard warning switch ground circuit.

Actions Taken When the DTC Sets

The hazard warning switch LED backlighting will not illuminate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S48C multifunction switch 1 - instrument panel. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 7 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Connect a test lamp between the control circuit terminal 5 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the Hazard Lamps Switch Backlight ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the S48C multifunction switch 1 - instrument panel.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for BCM replacement, programming, and setup

DTC B1405, B1529, OR B257B

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1405 02

Control Module Voltage Reference Output 2 Circuit Short to Ground

DTC B1405 03

Control Module Voltage Reference Output 2 Circuit Low Voltage

DTC B1405 07

Control Module Voltage Reference Output 2 Circuit High Voltage

DTC B1529 03

Control Module Voltage Reference Output 5 Circuit Low Voltage

DTC B1529 07

Control Module Voltage Reference Output 5 Circuit High Voltage

DTC B257B 03

Lighting Control Switch Signal Low Voltage

DTC B257B 07

Lighting Control Switch Signal High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Instrument Panel Dimmer Switch B+	B1405 03, B1529 03, B257B 03	B257B 03	-	-
Instrument Panel Dimmer Switch Signal	B257B 03	B257B 03	B257B 07	-
LED Backlight Dimming Control Terminal 8 X2	B2610 02	1	1	-
LED Backlight Dimming Control Terminal 9 X7	B2610 02	1	1	-
Hazard Warning Switch LED Backlight Dimming Control	B096A 02	B096A 01, B096A 04	1	-
1. Interior Backlighting Malfunction				

Circuit/System Description

The instrument panel dimmer switch is used to increase and decrease the brightness of the interior backlighting components. The instrument panel dimmer switch provides a voltage signal to the body control module (BCM) that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The BCM provides B+ and a low reference signal to the instrument panel dimmer switch. When the instrument panel dimmer switch is placed in the desired position, the dimmed voltage setting is applied from the instrument panel dimmer switch through the instrument panel dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies a pulse width modulated (PWM) voltage through the LED dimming control circuits illuminating the interior backlighting to the requested level of brightness.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Park Lamps ON.

Conditions for Setting the DTC

DTC B1405 03, B1529 03, or B257B 03

- The BCM detects a short to ground or an open/high resistance in the instrument panel dimmer switch B+ circuit.
- The BCM detects a short to ground or an open/high resistance in the instrument panel dimmer switch signal circuit.

DTC B257B 07

The BCM detects a short to voltage in the instrument panel dimmer switch signal circuit.

Actions Taken When the DTC Sets

The BCM will not dim any interior backlighting. All interior backlighting will default to the level selected prior to the fault being present.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S30 Headlamp Switch, ignition ON.
2. Test for B+ between the B+ circuit terminal 1 and ground.
 - **If less than B+**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If B+**

3. Verify a test lamp does not illuminate between the B+ circuit terminal 1 and the signal circuit terminal 12.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp does not illuminate**
4. Test for B+ between the B+ circuit terminal 1 and the signal circuit terminal 12.
 - **If less than B+**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 12 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If B+**
5. Test or replace the S30 Headlamp Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Switch Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B1461 OR B1462

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1461 00

Left Headlamp Horizontal Motor Circuit Malfunction

DTC B1462 00

Right Headlamp Horizontal Motor Circuit Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LIN Serial Data - Left Headlamp Leveling Actuator	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	-
LIN Serial Data - Right Headlamp Leveling Actuator	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	-
Headlamp Control Module B+	1	1	-	-
Headlamp Leveling Actuator - Left B+	1	1	-	-
Headlamp Leveling Actuator - Right B+	1	1	-	-
Headlamp Control Module Ground	-	1	-	-
Headlamp Leveling Actuator - Left Ground	-	B3435 03	-	-
Headlamp Leveling Actuator - Right Ground	-	B3440 03	-	-
1. Adaptive Forward Lighting Malfunction				

Circuit/System Description

Battery positive voltage is applied to the headlamp control module at all times. The headlamp control module has a normal operational voltage range of about 12.5-16 V and is only fully functional with the ignition switch is in the RUN position and the headlamp switch in the AUTOMATIC LIGHT position. The communications enable signal from the body control module (BCM) wakes the headlamp control module microprocessor. The headlamp control module receives serial data messages from the engine control module (ECM), transmission control module (TCM), electronic brake control module (EBCM), and BCM with information regarding power mode, speed, steering angle, transmission gear selection, and headlamp switch status. The headlamp control module calculates the headlamp angle and sends commands to the left and right adaptive forward lighting system headlamp actuators. The headlamp actuators drive the headlamps to the position commanded by the headlamp control module. The headlamp control module monitors the headlamp actuator motor control circuits for proper circuit continuity and for shorts to ground or voltage. If a malfunction is detected, a DTC will be stored in memory and the driver will be notified with a message displayed over the driver information center located on the instrument cluster.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.

- Ignition ON.
- Headlamps ON.

Conditions for Setting the DTC

DTC B1461 00

The headlamp leveling control module detects an internal malfunction in the left headlamp adaptive actuator.

DTC B1462 00

The headlamp leveling control module detects an internal malfunction in the right headlamp adaptive actuator.

Actions Taken When the DTC Sets

- When DTC B1461 or DTC B1462 sets, the headlamp leveling control module will attempt to return the lamps to a nominal position and disable all requests to all headlamp actuators.
- The instrument cluster will display AFL Malfunction - Contact Service.
- On vehicles equipped with both AFL and headlamp leveling, the headlamp leveling system will be disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists and the ignition is cycled.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate E13 headlamp.
2. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E13L headlamp - left terminal 8 with A1LL
 - E13R headlamp - right terminal 8 with A1LL
 - E13L headlamp - left terminal 7 with A1SL
 - E13R headlamp - right terminal 7 with A1SL
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the appropriate B+ circuit terminal listed below and ground.
 - E13L headlamp - left terminal 6 with A1LL
 - E13R headlamp - right terminal 6 with A1LL
 - E13L headlamp - left terminal 8 with A1SL
 - E13R headlamp - right terminal 8 with A1SL
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A fuse block - underhood.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A fuse block - underhood.
 - **If the test lamp illuminates**
5. Test or replace the K26 headlamp control module.
6. Ignition ON.
7. Verify the appropriate headlamp operates to the LEFT and RIGHT positions when commanding the appropriate Headlamp Horizontal Motor control LEFT and RIGHT with a scan tool.
 - If the appropriate headlamp does not operate LEFT and RIGHT, test or replace the appropriate headlamp assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Replacement**
- **Front Compartment Fuse Block Housing Replacement**
- **Control Module References** for headlamp control module replacement, programming, and setup

DTC B1480

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1480 02

Battery Rundown Protection Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Courtesy Lamps Control - Terminal 2 X7	B1480 02	1	1	-
Dome Lamps Control	B2615 02	2	2	-
Dome/Reading Lamps - Overhead Console Ground	-	1, 2	-	-
Dome/Reading Lamps - Rear Ground	-	1, 2	-	-
Instrument Panel Compartment Lamp Ground	-	1	-	-
Sunshade Mirror Lamp - Left Ground	-	1	-	-
Sunshade Mirror Lamp - Right Ground	-	1	-	-
1. Courtesy Lamps Malfunction 2. Dome Lamps Malfunction				

Circuit/System Description

The body control module (BCM) supplies battery voltage to the front and rear reading lamps, left and right

sunshade lamps, center console compartment lamp, and instrument panel compartment lamp via the courtesy lamp control circuit. When the instrument panel compartment or a sunshade mirror is opened, the switch contacts close allowing battery voltage to flow illuminating the respective lamps. The front and rear reading lamps are controlled by individual switches that are activated by the operator when additional cabin lighting is required. In the event that any of these courtesy lamps were to remain illuminated for more than 10 minutes with the ignition switch in the OFF position and no doors opened, the BCM will deactivate the courtesy lamp control circuit to prevent total battery discharge.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The BCM detects a short to ground in the courtesy lamps control circuit.

Actions Taken When the DTC Sets

The BCM will disable the circuit and all lamps controlled by the courtesy lamp control circuit will be inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, exterior lamps OFF, disconnect the harness connectors at the components listed below.
 - E27 instrument panel compartment lamp
 - E31L sunshade - left
 - E31R sunshade - right
 - E37D dome/reading lamps - overhead console
 - E37R dome/reading lamps - rear
2. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
 - E27 instrument panel compartment lamp terminal 1
 - E31L sunshade mirror lamp - left terminal A
 - E31R sunshade mirror lamp - right terminal A
 - E37D dome/reading lamps - overhead console terminal 1
 - E37R dome/reading lamps - rear terminal 1
3. Verify the test lamp turns ON and OFF when commanding the Inadvertent Load ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
4. Test or replace the appropriate courtesy lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Sunshade Replacement**

- **Instrument Panel Compartment Lamp Replacement**
- **Dome and Reading Lamp Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2530

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2530 01

Front Fog Lamps Control Circuit Short to Battery

DTC B2530 02

Front Fog Lamps Control Circuit Short to Ground

DTC B2530 04

Front Fog Lamps Control Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Front Fog Lamp and Instrument Panel Dimmer Switch B+	B257B 03, B1405 03	B257B 03	-	-
Front Fog Lamp and Instrument Panel Dimmer Switch Signal	B257B 03	B257B 03	1	-
Front Fog Lamp Relay Control	B2530 02, B2530 04	B2530 02, B2530 04	B2530 01	-
Front Fog Lamp Control	1	1	1	-
Front Fog Lamp Ground - Left	-	1	-	-
Front Fog Lamp Ground - Right	-	1	-	-
1. Front Fog Lamps Malfunction				

Circuit/System Description

The front fog lamp switch is an input to the body control module (BCM) and is contained in the headlamp switch assembly. The BCM supplies voltage to the front fog lamp switch via the front fog lamp and instrument

panel dimmer switch B+ circuit. When the front fog lamp switch is pressed, voltage from the B+ circuit is pulled down through the front fog lamp switch resistor. The front fog lamp resistor is part of the resistor ladder that also provides the dimming signals for the instrument panel dimmer switches. The BCM receives the voltage signal through the front fog lamp and instrument panel dimmer switch signal circuit.

The front fog lamp relay is supplied with battery voltage at all times. The front fog lamp switch signal circuit is grounded momentarily by pressing the front fog lamp switch. The body control module (BCM) energizes the front fog lamp relay by applying ground to the front fog lamp relay control circuit. When the front fog lamp relay is energized, the relay switch contacts close and battery voltage is applied through the FRT FOG fuse to the front fog lamp control circuit which illuminates the front fog lamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Front fog lamps ON.

Conditions for Setting the DTC

DTC B2530 01

The BCM detects a short to voltage in the front fog lamp relay control circuit for 5 seconds or greater.

DTC B2530 02

The BCM detects a short to ground in the front fog lamp relay control circuit.

DTC B2530 04

The BCM detects an open in the front fog lamp relay control circuit.

Actions Taken When the DTC Sets

DTC B2530 01 and B2530 04

The front fog lamps will not operate when the park lamps are ON and the front fog lamp switch is active.

DTC B2530 02

The front fog lamps always ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Fog Lights Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the control circuit terminal 10 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A fuse block - underhood.
 2. Test for infinite resistance between the control circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A fuse block - underhood.
 - **If the test lamp illuminates**
3. Ignition OFF, connect a 3 A fused jumper between the control circuit terminal 10 and ground.
4. Remove the F48UA fuse at the X50A fuse block - underhood, ignition ON.
5. Verify a test lamp illuminates between the F48UA fuse B+ switch control terminal and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A fuse block - underhood, ignition ON.

2. Test for less than 1 V between the control circuit terminal 10 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the X50A fuse block - underhood.

○ **If the test lamp illuminates**

6. Test or replace the K9 body control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuse Block Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2545

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2545 01

Backup Lamps Circuit Short to Battery

DTC B2545 02

Backup Lamps Circuit Short to Ground

DTC B2545 04

Backup Lamps Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F32DA Fuse B+	1	1	-	-
Backup Lamp Switch Signal (Manual Transmission)	1	1	1	C0010 5A
Backup Lamps Control	B2545 02	B2545 04	B2545 01	-
Backup Lamp Switch Ground (Manual Transmission)	-	1	-	-

Backup Lamp Ground - Left	-	1	-	-
Backup Lamp Ground - Right	-	1	-	-
1. Backup Lamps Malfunction				

Circuit/System Description

Automatic Transmission

With the engine running and the transmission in the reverse position, the transmission control module (TCM) sends a serial data message to the body control module (BCM). The message indicates that the gear selector is in the reverse position. The BCM applies battery voltage to the backup lamps control circuit illuminating the backup lamps. Once the driver moves the gear selector out of the reverse position, a message is sent by the TCM via serial data requesting the BCM to remove battery voltage from the backup lamps control circuit. The engine must be running for the backup lamps to operate.

Manual Transmission

The engine control module (ECM) provides a signal circuit to the backup lamp switch which is permanently grounded. With the engine running and the transmission in the reverse position, the backup lamp switch signal circuit is pulled low and the ECM responds by sending a serial data message to the body control module (BCM). The message indicates that the gear selector is in the reverse position. The BCM applies battery voltage to the backup lamps control circuit illuminating the backup lamps. Once the driver moves the gear selector out of the reverse position, a message is sent by the ECM via serial data requesting the BCM to remove battery voltage from the backup lamps control circuit. The engine must be running for the backup lamps to operate.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Engine RUNNING.
- Transmission placed in REVERSE gear.

Conditions for Setting the DTC

DTC B2545 01

The BCM detects a short to voltage in the backup lamps control circuit.

DTC B2545 02

The BCM detects a short to ground in the backup lamps control circuit.

DTC B2545 04

The BCM detects an open/high resistance in the backup lamps control circuit.

Actions Taken When the DTC Sets

DTC B2545 02 and B2545 04

The backup lamps will not operate.

DTC B2545 01

The backup lamps are always ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

- **Exterior Lights Schematics**
- **Body Control System Schematics**

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.

2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X5 harness connector at the K9 Body Control Module.
4. Ignition OFF, exterior lamps OFF, trunk latch latched, remove the appropriate E5 Backup Lamp at the appropriate E42 Tail Lamp Assembly.
5. Test for less than 5 ohms between the ground circuit at the socket terminal and ground.
 - **If 5 ohms or greater**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
6. Connect a test lamp between the control circuit at the socket terminal and ground, ignition ON.
7. Verify the test lamp turns ON and OFF when commanding the Backup Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 - 1. Ignition OFF, disconnect the X7 harness connector at the K9 Body Control Module.
 - 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 - 1. Ignition OFF, disconnect the X7 harness connector at the K9 Body Control Module, ignition ON.
 - 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
8. Test or replace the appropriate E5 Backup Lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Tail Lamp Bulb Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B255D

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B255D 02

Passenger Compartment Lamp Control 2 Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flood Lamp Control - Terminal 23 X1	B255D 02	1	1	-
Flood Lamp - Driver Door Pocket Ground	-	1	-	-
Flood Lamp - Passenger Door Pocket Ground	-	1	-	-
1. Interior Accent Lighting Malfunction				

Circuit/System Description

The body control module (BCM) supplies battery voltage to front door flood lamps via the flood lamp control circuit. When a door is opened the BCM applies battery voltage to the flood lamp control circuit illuminating the driver and passenger door pocket flood lamps. The flood lamps will remain illuminated until all doors are closed and the ignition is OFF.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The BCM detects a short to ground in the flood lamp control circuit terminal 23 X1

Actions Taken When the DTC Sets

The BCM will disable the flood lamp control circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate E55 flood lamp.
2. Connect a test lamp between the control circuit terminal 1 and ground.
3. Verify the test lamp turns ON and OFF when commanding the Accent Lighting ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
- 4. Test or replace the appropriate E55 flood lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Sill Courtesy Lamp Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2570

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2570 02

Trunk Lamp Control Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F24DA Fuse B+	1	1	-	-
Rear Compartment Courtesy Lamp Control	B2570 02	1	1	-
Rear Compartment Courtesy Lamp Ground	-	1	-	-

1. Rear Compartment Lamp Malfunction

Circuit/System Description

The body control module (BCM) applies battery voltage to the rear compartment courtesy lamp through the rear compartment lamp control circuit. When the BCM receives a rear compartment lid open input from the rear compartment lid latch, the BCM applies battery voltage to the rear compartment lamp control circuit illuminating the rear compartment courtesy lamp. In the event that the rear compartment lamp were to remain illuminated for more than 10 minutes with the ignition switch in the OFF position and no doors opened, the BCM will deactivate the rear compartment lamp control circuit to prevent total battery discharge.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Rear compartment OPEN.

Conditions for Setting the DTC

The BCM detects a short to ground on the rear compartment courtesy lamp control circuit.

Actions Taken When the DTC Sets

The rear compartment lamp is inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, exterior lamps OFF, trunk latch latched, disconnect the harness connector at the E8S rear compartment courtesy lamp.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Connect a test lamp between the control circuit terminal 1 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the Trunk Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the E8S rear compartment courtesy lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Compartment Courtesy Lamp Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2575 OR B2699

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2575 01

Headlamps Control Circuit Short to Battery

DTC B2575 02

Headlamps Control Circuit Short to Ground

DTC B2575 04

Headlamps Control Circuit Open

DTC B2699 01

Right Headlamp Control Circuit Short to Battery

DTC B2699 02

Right Headlamp Control Circuit Short to Ground

DTC B2699 04

Right Headlamp Control Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F9DA Fuse B+	B2699 01, B2699 04	B2699 01, B2699 04	-	-
F8DA Fuse B+	B2575 01, B2575 04	B2575 01, B2575 04	-	-
Low Beam Headlamp Control -		B2575 01, B2575		

Left (T4A)	B2575 02	04	1	-
Low Beam Headlamp Control - Right (T4A)	B2699 02	B2699 01, B2699 04	1	-
Headlamp Ground - Left	-	1	-	-
Headlamp Ground - Right	-	1	-	-
1. Headlamps Malfunction				

Circuit/System Description

With the headlamp switch in the ON position, the headlamp switch headlamp ON signal circuit is grounded through the headlamp switch. The body control module (BCM) responds by applying battery positive voltage to the left and right low beam headlamp control circuits illuminating the low beam headlamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Low beam headlamps ON.

Conditions for Setting the DTC

DTC B2575 01 and B2575 04

- The BCM detects an open/high resistance in the left low beam headlamp control circuit.
- The BCM detects a short to ground or an open/high resistance in the F8DA fuse B+ circuit.

DTC B2575 02

The BCM detects a short to ground in the left low beam headlamp control circuit.

DTC B2699 01 and B2699 04

- The BCM detects an open/high resistance in the right low beam headlamp control circuit.
- The BCM detects a short to ground or an open/high resistance in the F9DA fuse B+ circuit.

DTC B2699 02

The BCM detects a short to ground in the right low beam headlamp control circuit.

Actions Taken When the DTC Sets

- When DTC B2575 sets, the left low beam headlamp will be inoperative.
- When DTC B2699 sets, the right low beam headlamp will be inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.

- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

- **Headlights/Daytime Running Lights (DRL) Schematics**
- **Body Control System Schematics**

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

DTC B2575

1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 3 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the F8DA fuse at the X51A fuse block - instrument panel.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the F8DA fuse at the X51A fuse block - instrument panel.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K9 body control module.
 - **If the test lamp illuminates**
 - 3. Ignition OFF, connect the X1 harness connector at the K9 body control module.
 - 4. Install the F8DA fuse.
 - 5. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the E4G headlamp - left low beam.
 - 6. Test for less than 5 ohms between the ground circuit terminal B and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
 - 7. Connect a test lamp between the control circuit terminal A and ground, ignition ON.
 - 8. Verify the test lamp turns ON and OFF when commanding the Left Low Beam/Daytime Running Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
9. Test or replace the E4G headlamp - left low beam.

DTC B2699

1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the F9DA fuse at the X51A fuse block - instrument panel.
 2. Test for less than 2 ohms in the B+ circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
- **If the test lamp does not illuminate and the circuit fuse is open**
- 1. Ignition OFF, remove the F9DA fuse at the X51A fuse block - instrument panel.
- 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
- **If the test lamp illuminates**
- 3. Ignition OFF, connect the X1 harness connector at the K9 body control module.
- 4. Install the F9DA fuse.
- 5. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the E4H headlamp - right low beam.
- 6. Test for less than 5 ohms between the ground circuit terminal B and ground.
 - **If 5 ohms or greater**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
- 7. Connect a test lamp between the control circuit terminal A and ground, ignition ON.
- 8. Verify the test lamp turns ON and OFF when commanding the Right Low Beam/Daytime Running Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 - 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 - 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 - 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 - 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
- 9. Test or replace the E4H headlamp - right low beam.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Replacement**
- **Headlamp Bulb Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B257A

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B257A 00

Headlamp Switch Input Signals Correlation Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Switch Park Lamps ON Signal	2	B257A 00	2	-
Headlamp Switch Headlamps OFF Signal	B257A 00	1	1	-
Headlamp Switch Headlamps ON Signal	B257A 00	1	1	-
Headlamp Switch Ground	-	1	-	-
1. Headlamps Malfunction 2. Park, License, and/or Tail Lamps Malfunction				

Circuit/System Description

For headlamp operation, the body control module (BCM) monitors three signal circuits from the headlamp switch. When the headlamp switch is in the AUTO position, the three signal circuits are unaffected and the BCM relies on the ambient light sensor input to turn the headlamps and daytime running lamps (DRLs) ON and OFF. When the headlamp switch is placed in the OFF position, the headlamp switch headlamps OFF signal circuit is grounded, indicating to the BCM that the exterior lamps should be turned OFF. With the headlamp switch in the PARK LAMPS position, the headlamp switch park lamps ON signal circuit is grounded, indicating that the park lamps have been requested. When the headlamp switch is in the HEADLAMP position, both the headlamp switch park lamps ON signal circuit and the headlamp switch headlamps ON signal circuit

are grounded. The BCM responds by commanding the park lamps and headlamps ON.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

- The BCM detects an open/high resistance in the headlamp switch park lamps ON signal circuit.
- The BCM detects a short to ground in the headlamp switch headlamps ON signal circuit.
- The BCM detects a short to ground in the headlamp switch headlamps OFF signal circuit.

Actions Taken When the DTC Sets

- When DTC B257A 00 is present on the headlamp switch headlamps OFF signal circuit, the low beam headlamps are always ON in the AUTO position. The headlamp switch operates in all positions other than AUTO. The AUTO headlamp defeat is inoperative.
- When DTC B257A 00 is present on the headlamp switch headlamps ON signal circuit, the low beam headlamps are always ON. The BCM disregards all headlamp switch inputs.
- When DTC B257A 00 is present on the headlamp switch park lamps ON signal circuit, the park lamps and low beam headlamps are inoperative in the PARK and HEAD positions. Headlamps and park lamps operate in AUTO position.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, all doors closed, all accessories OFF, disconnect the harness connector at the S30 headlamp switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 6 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool Automatic Headlamps Disable Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the ground circuit terminal 6.
6. Verify the scan tool Automatic Headlamps Disable Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
7. Verify the scan tool Park Lamps Switch parameter is Inactive.
 - **If not Inactive**

1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
- **If Inactive**
8. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 6.
9. Verify the scan tool Park Lamps Switch parameter is Active.
 - **If not Active**
 - 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 - 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
10. Verify the scan tool Headlamps On Switch parameter is Inactive.
 - **If not Inactive**
 - 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 - 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**
11. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the ground circuit terminal 6.
12. Verify the scan tool Headlamps On Switch parameter is Active.
 - **If not Active**
 - 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 - 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
13. Test or replace the S30 headlamp switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Switch Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B257C OR B257D

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B257C 00

Left Headlamp Assembly Malfunction

DTC B257D 00

Right Headlamp Assembly Malfunction

Circuit/System Description

The headlamp leveling control module calculates the headlamp angle and sends commands to the left and right adaptive forward lighting system headlamp actuators. The headlamp actuators drive the headlamps to the position commanded by the headlamp leveling control module. The headlamp leveling control module monitors the headlamp actuator motor control circuits for proper circuit continuity and for shorts to ground or voltage. If a malfunction is detected, a DTC will be stored in memory and the driver will be notified with a "Service AFL Lamp" message displayed over the driver information center located on the instrument cluster.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Engine RUNNING.
- Headlamps ON.

Conditions for Setting the DTC

DTC B257C 00

The headlamp leveling control module receives a serial data message from the left headlamp internal logic module that an internal headlamp malfunction has occurred.

DTC B257D 00

The headlamp leveling control module receives a serial data message from the right headlamp internal logic module that an internal headlamp malfunction has occurred.

Actions Taken When the DTC Sets

- The headlamp leveling control module disables the AFL system.
- The driver information center (DIC) will display AFL Lamps Need Service.
- On vehicles equipped with both AFL and headlamp leveling, the headlamp leveling system will remain active.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

DTC B257C and B257D will set when there is an internal malfunction within the left or right headlamp assemblies. No parts are serviceable within the headlamp assemblies so complete headlamp assembly replacement is necessary.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B257C or B257D is not set.
 - **If DTC B257C or B257D is set**
 1. Program the headlamp leveling control module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the appropriate headlamp assembly.
 - If the DTC does not set
 3. All OK.
 - **If DTC B257C or B257D is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Replacement**
- **Control Module References** for Headlamp Leveling Control Module replacement, programming, and setup

DTC B2580

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2580 01

Headlamp High Beam Control Circuit Short to Battery

DTC B2580 02

Headlamp High Beam Control Circuit Short to Ground

DTC B2580 04

Headlamp High Beam Control Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp High Beam Relay Control	B2580 02, B2580 04	B2580 02, B2580 04	B2580 01	-
High Beam Headlamp Control - Left	1	1	1	-
High Beam Headlamp Control - Right	1	1	1	-
Headlamp Ground - Left	-	1	-	-
Headlamp Ground - Right	-	1	-	-
1. Headlamps Malfunction				

Circuit/System Description

The high beam and flash to pass functions are contained within the turn signal/multifunction switch. The BCM provides the turn signal/multifunction switch with two signal circuits, the high beam signal circuit and the flash to pass signal circuit. When the low beam headlamps are ON and the turn signal/multifunction switch is placed in the high beam position, ground is applied to the BCM through the high beam signal circuit. The BCM responds to the high beam request by applying ground to the high beam relay control circuit which energizes the high beam relay. With the high beam relay energized, the switch contacts close allowing battery voltage to flow through the high beam fuses to the high beam control circuits illuminating the high beam headlamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- High beam headlamps ON.

Conditions for Setting the DTC

DTC B2580 01

The BCM detects a short to voltage in the headlamp high beam relay control circuit.

DTC B2580 02

The BCM detects a short to ground in the headlamp high beam relay control circuit.

DTC B2580 04

The BCM detects an open in the headlamp high beam relay control circuit.

Actions Taken When the DTC Sets

The high beam headlamps and flash to pass will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the control circuit terminal 18 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A fuse block - underhood.
 2. Test for infinite resistance between the control circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A fuse block - underhood.
 - **If the test lamp illuminates**
3. Ignition OFF, connect a 3 A fused jumper between the control circuit terminal 18 and ground.
4. Remove the F38UA fuse at the X50A fuse block - underhood, ignition ON.

5. Verify a test lamp illuminates between the F38UA fuse B+ switch control terminal and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A fuse block - underhood, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 18 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the X50A fuse block - underhood.
 - **If the test lamp illuminates**
6. Test or replace the K9 body control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuse Block Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2585 OR B3867

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2585 01

Left Park Lamps Control Circuit Short to Battery

DTC B2585 02

Left Park Lamps Control Circuit Short to Ground

DTC B2585 04

Left Park Lamps Control Circuit Open

DTC B3867 01

Right Park Lamps Control Circuit Short to Battery

DTC B3867 02

Right Park Lamps Control Circuit Short to Ground

DTC B3867 04

Right Park Lamps Control Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F3DA Fuse B+	B2585 01, B2585 04	B2585 01, B2585 04	-	-
F24DA Fuse B+	B3867 01, B3867 04	B3867 01, B3867 04	-	-
Headlamp Switch Park Lamps ON Signal	2	B257A 00	2	-
Park Lamps Control - Left	B2585 02	B2585 01, B2585 04	B2585 01, B2585 04	-
Park Lamps Control - Right	B3867 02	B3867 01, B3867 04	B3867 01, B3867 04	-
Headlamp Switch Ground	-	2	-	-
Park/Turn Signal Lamp Ground - Left Front	-	1	-	-
Park/Turn Signal Lamp Ground - Right Front	-	1	-	-
Side Marker Lamp Ground - Left Front	-	1	-	-
Side Marker Lamp Ground - Right Front	-	1	-	-
Tail Lamp Ground - Left	-	1	-	-
Tail Lamp Ground - Right	-	1	-	-
1. Park, License, and/or Tail Lamps Malfunction 2. Park Lamp Switch Malfunction				

Circuit/System Description

When the headlamp switch is placed in the HEAD or PARK position, ground is applied to the park lamp switch ON signal circuit to the body control module (BCM). The BCM responds by applying voltage to the park lamps, tail lamps, and license lamps control circuits illuminating the park, tail, and license lamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Park lamps ON.

Conditions for Setting the DTC

DTC B2585 01 and B2585 04

- The BCM detects a short to voltage or an open/high resistance in the left park lamps control circuit.
- The BCM detects a short to ground or an open/high resistance in the F3DA fuse B+ circuit.

DTC B2585 02

The BCM detects a short to ground in the left park lamps control circuit.

DTC B3867 01 and B3867 04

- The BCM detects a short to voltage or an open/high resistance in the right park lamps control circuit.
- The BCM detects a short to ground or an open/high resistance in the F24DA fuse B+ circuit.

DTC B3867 02

The BCM detects a short to ground in the right park lamps control circuit.

Actions Taken When the DTC Sets

DTC B2585 01

The left park lamps are always ON.

DTC B2585 02 and B2585 04

The left park lamps are always OFF.

DTC B3867 01

The right park lamps are always ON.

DTC B3867 02 and B3867 04

The right park lamps are always OFF.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

- **Exterior Lights Schematics**
- **Body Control System Schematics**

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

DTC B2585

1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 3 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X2 harness connector at the K9 body control module.
4. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate left park lamp.
5. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.

- E4N park/turn signal lamp - left terminal 2 (with T4A)
 - E2LF side marker lamp - left front terminal 1 (with T4A)
 - E13L headlamp - left terminal 1 (with T4F)
 - E5AK tail lamp - left outer terminal 3
 - E5G tail lamp - left inner terminal 2
 - **If 5 ohms or greater**
1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
6. Connect a test lamp between the appropriate control circuit terminal listed below and ground, ignition ON.
 - E4N park/turn signal lamp - left terminal 3 (with T4A)
 - E2LF side marker lamp - left front terminal 2 (with T4A)
 - E13L headlamp - left terminal 7 (with T4F)
 - E5AK tail lamp - left outer terminal 1
 - E5G tail lamp - left inner terminal 3
 7. Verify the test lamp turns ON and OFF when commanding the Left Park Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
 8. Test or replace the appropriate left park lamp.

DTC B3867

1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.

2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If the test lamp illuminates**
 - 3. Ignition OFF, connect the X1 harness connector at the K9 body control module.
 - 4. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate right park lamp.
 - 5. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E4P park/turn signal lamp - right terminal 2 (with T4A)
 - E2RF side marker lamp - right front terminal 1 (with T4A)
 - E13R headlamp - right terminal 1 (with T4F)
 - E5AL tail lamp - right outer terminal 3
 - E5H tail lamp - right inner terminal 2
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
 - 6. Connect a test lamp between the appropriate control circuit terminal listed below and ground, ignition ON.
 - E4P park/turn signal lamp - right terminal 3 (with T4A)
 - E2RF side marker lamp - right front terminal 2 (with T4A)
 - E13R headlamp - right terminal 7 (with T4F)
 - E5AL tail lamp - right outer terminal 1
 - E5H tail lamp - right inner terminal 3
 - 7. Verify the test lamp turns ON and OFF when commanding the Right Park Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 - 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 - 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
- 8. Test or replace the appropriate right park lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Replacement**
- **Headlamp Bulb Replacement**
- **Tail Lamp Replacement**
- **Tail Lamp Bulb Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B258A

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B258A 01

Low Beam Control Circuit Short to Battery

DTC B258A 02

Low Beam Control Circuit Short to Ground

DTC B258A 04

Low Beam Control Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Low Beam Relay Control	B258A 02, B258A 04	B258A 02, B258A 04	B258A 01	-
Low Beam Headlamp Control - Left	1	1	1	-
Low Beam Headlamp Control - Right	1	1	1	-
Headlamp Ground - Left	-	1	-	-
Headlamp Ground - Right	-	1	-	-
1. Headlamps Malfunction				

Circuit/System Description

With the headlamp switch in the ON position, the headlamp switch headlamp ON signal circuit is grounded through the headlamp switch. The body control module (BCM) responds by applying ground to the low beam relay control circuit which energizes the low beam relay. With the low beam relay energized, the switch contacts close allowing battery voltage to flow through the low beam fuses to the low beam control circuits illuminating the low beam headlamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Low beam headlamps ON.

Conditions for Setting the DTC

DTC B258A 01

The BCM detects a short to voltage in the headlamp low beam relay control circuit.

DTC B258A 02

The BCM detects a short to ground in the headlamp low beam relay control circuit.

DTC B258A 04

The BCM detects an open in the headlamp low beam relay control circuit.

Actions Taken When the DTC Sets

DTC B258A 01 or B258A 04

The low beam headlamps will not operate.

DTC B258A 02

The low beam headlamps will always be ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the KR49 headlamp low beam relay.
2. Connect a test lamp between the control circuit terminal 85 and B+, ignition ON.
3. Verify the test lamp turns ON and OFF when commanding the Low Beams ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V
- 3. Ignition OFF.
- 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
 4. Test or replace the KR49 headlamp low beam relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for BCM replacement, programming, and setup

DTC B259A OR B259B

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B259A 01

Left Cornering Lamp Relay Control Circuit Short to Battery

DTC B259B 01

Right Cornering Lamp Relay Control Circuit Short to Battery

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Corning Lamp - Left Control	1	1	B259A 01	-

(T4F/CZ2)				
Corning Lamp - Right Control (T4F/CZ2)	1	1	B259B 01	-
Corning Lamp - Left Ground (T4F/CZ2)	-	1	-	-
Corning Lamp - Right Ground (T4F/CZ2)	-	1	-	-
1. Daytime Running Lamps Malfunction				

Circuit/System Description

The ambient light sensor is used to monitor outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor. Depending on outside lighting conditions, the ambient light sensor provides a voltage signal to the BCM that will vary between 0.2 and 4.9 volts. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic headlamp system control when the headlamp switch is in the AUTO position. In daylight conditions, the BCM will command the DRLs. Any function or condition that turns on the headlamps will cancel DRL operation.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Headlamp switch in AUTO position.

Conditions for Setting the DTC

DTC B259A 01

The BCM detects a short to voltage in the left cornering lamp control circuit.

DTC B259B 01

The BCM detects a short to voltage in the right cornering lamp control circuit.

Actions Taken When the DTC Sets

- When DTC B259A sets, the left cornering lamp will be inoperative.
- When DTC B259B sets, the right cornering lamp will be inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, exterior lamps OFF, remove the appropriate E4 Cornering Lamp bulb.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 9 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the appropriate Cornering Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X2 harness connector at the K26 Headlamp Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K26 Headlamp Control Module.
- **If the test lamp is always ON**
- 1. Ignition OFF, disconnect the X2 harness connector at the K26 Headlamp Control Module, ignition ON.
- 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K26 Headlamp Control Module.
- **If the test lamp turns ON and OFF**
- 5. Test or replace the appropriate E4 Cornering Lamp bulb.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Headlamp Control Module replacement, programming, and setup

DTC B2600 OR B2605

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2600 01

Left Daytime Running Lamps Control Circuit short to Battery

DTC B2600 02

Left Daytime Running Lamps Control Circuit Short to Ground

DTC B2600 04

Left Daytime Running Lamps Control Circuit Open

DTC B2605 01

Right Daytime Running Lamps Control Circuit short to Battery

DTC B2605 02

Right Daytime Running Lamps Control Circuit Short to Ground

DTC B2605 04

Right Daytime Running Lamps Control Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Light Sensor Signal	B2645 03	B2645 07	B2645 07	-
Daytime Running Lamp Control - Left (T4F)	B2600 02	B2600 04	B2600 01	-
Daytime Running Lamp Control - Right (T4F)	B2605 02	B2605 04	B2605 01	-
Low Beam Headlamp Control - Left (T4A)	B2575 02	B2575 01, B2575 04	B2575 01	-
Low Beam Headlamp Control - Right (T4A)	B2699 02	B2699 01, B2699 04	B2699 01	-
Ambient Light Sensor Ground	-	B2645 07	2	-
Daytime Running Lamp Ground - Left (T4F)	-	2	-	-
Daytime Running Lamp Ground - Right (T4F)	-	2	-	-
Headlamp Ground - Left	-	1	-	-
Headlamp Ground - Right	-	1	-	-
1. Headlamps Malfunction 2. Daytime Running Lamps Malfunction				

Circuit/System Description

The ambient light sensor is used to monitor outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor. Depending on outside lighting conditions, the ambient light sensor provides a voltage signal to the BCM that will vary between 0.2 and 4.9 volts. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic headlamp system control when the headlamp switch is in the AUTO position. In daylight conditions, the BCM will command the DRLs. Any function or condition that turns on the headlamps will cancel DRL operation.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Headlamp switch in AUTO position.

Conditions for Setting the DTC

DTC B2600 01

The BCM detects a short to voltage in the left DRL control circuit.

DTC B2600 02

The BCM detects a short to ground in the left DRL control circuit.

DTC B2600 04

The BCM detects an open/high resistance in the left DRL control circuit.

DTC B2605 01

The BCM detects a short to voltage in the right DRL control circuit.

DTC B2605 02

The BCM detects a short to ground in the right DRL control circuit.

DTC B2605 04

The BCM detects an open/high resistance in the right DRL control circuit.

Actions Taken When the DTC Sets

- When DTC B2600 sets, the left DRL will be inoperative.
- When DTC B2605 sets, the right DRL will be inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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Exterior Lighting Systems Description and Operation

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate E13 headlamp.
2. Test for less than 5 ohms between the ground circuit terminal 1 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Connect a test lamp between the control circuit terminal 4 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the appropriate Front Park Lamp/Daytime Running Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the appropriate E13 headlamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2610

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2610 02

Passenger Compartment Dimming 1 Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Instrument Panel Dimmer Switch B+	B1405 03, B1529 03, B257B 03	B257B 03	-	-
Instrument Panel Dimmer Switch Signal	B257B 03	B257B 03	B257B 07	-
LED Backlight Dimming Control Terminal 8 X2	B2610 02	1	1	-
LED Backlight Dimming Control Terminal 9 X7	B2610 02	1	1	-
Switch Indicator LED Backlight Dimming Control Terminal 5 X1	B2625 02	1	1	-
Dome/Reading Lamps - Overhead Console Ground	-	1	-	-
Dome/Reading Lamps - Rear Ground	-	1	-	-
Garage Door Opener Ground	-	1	-	-
Headlamp Switch Ground	-	1	-	-
Ignition Mode Switch Ground	-	1	-	-
Multifunction Switch 1 - Instrument Panel Ground	-	1	-	-
Multifunction Switch 2 - Instrument Panel Ground	-	1	-	-

Outside Rearview Mirror Switch Ground	-	1	-	-
Park Assist ON/OFF Switch Ground	-	1	-	-
Park Brake Control Switch Ground	-	1	-	-
Steering Wheel Controls Switch - Left Ground	-	1	-	-
Steering Wheel Controls Switch - Right Ground	-	1	-	-
Sunroof Switch Ground	-	1	-	-
Sunroof Tilt Switch Ground	-	1	-	-
Window Switch - Passenger Ground	-	1	-	-
1. Interior Backlighting Malfunction				

Circuit/System Description

The instrument panel dimmer switch is used to increase and decrease the brightness of the interior backlighting components. The instrument panel dimmer switch provides a voltage signal to the body control module (BCM) that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The BCM provides a low reference signal and a B+ reference circuit to the instrument panel dimmer switch. When the instrument panel dimmer switch is placed in the desired position, the dimmed voltage setting is applied from the instrument panel dimmer switch through the instrument panel dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies a pulse width modulated (PWM) voltage through the LED dimming control circuits illuminating the interior backlighting to the requested level of brightness.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Park lamps ON.

Conditions for Setting the DTC

The BCM detects a short to ground in the LED backlight dimming control circuit terminal 8 X2 or terminal 9 X7.

Actions Taken When the DTC Sets

The BCM will disable the LED backlight dimming control circuits.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

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Interior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: Each component with backlighting may need to be disconnected to isolate a short to voltage or short to ground. Use the schematics to identify the following:

- Backlighting components the vehicle is equipped with
- Each component's control and ground circuit terminals
- Component locations on the backlighting control circuit

1. Ignition OFF, all doors closed, all accessories OFF, disconnect the harness connector at the component with inoperative backlighting. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the appropriate ground circuit terminal and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**

3. Connect a test lamp between the appropriate control circuit terminal and ground.
4. Verify the test lamp turns ON and OFF when commanding the LED Backlight Dimming ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the appropriate harness connector listed below at the K9 body control module.
 - X2
 - X7
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the appropriate harness connector listed below at the K9 body control module, ignition ON.
 - X2
 - X7
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
 - 5. Test or replace the component with inoperative backlighting.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Window Switch Replacement**
- **Headlamp Switch Replacement**
- **Sunroof Switch Replacement**
- **Reading Lamp Replacement**
- **Sunroof Sunshade Switch Replacement**
- **Ignition and Start Switch Replacement (Without BTM) , Ignition and Start Switch Replacement (With BTM)**
- **Outside Rearview Mirror Remote Control Switch Replacement**
- **Parking Brake Actuator Switch Replacement**
- **INSTRUMENT PANEL ACCESSORY TRIM PLATE REPLACEMENT**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2615

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2615 02

Passenger Compartment Dimming 2 Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F32UA Fuse B+	B2615 02	B2615 02	-	-
Dome/Courtesy Lamps Control - Terminal 5 X2	B2615 02	1	1	-
Dome/Reading Lamps - Overhead Console Ground	-	1	-	-
Dome/Reading Lamps - Rear Ground	-	1	-	-
Door Courtesy Lamp - Driver Ground	-	1	-	-
Door Courtesy Lamp - Passenger Ground	-	1	-	-
Instrument Panel Courtesy Lamp - Left Ground	-	1	-	-
Instrument Panel Courtesy Lamp - Right Ground	-	1	-	-
1. Dome Lamps Malfunction				

Circuit/System Description

The dome lamp switch has 3 positions: DOOR, OFF, and ON. The ON position provides a ground for continuous operation and the dome/courtesy lamps will remain illuminated until the switch is placed in either the DOOR or OFF position. When in the DOOR position, the dome lamps operation is controlled by the body control module (BCM). When any door is opened, the door ajar switch contacts close and the BCM receives a door-open input. The BCM illuminates the dome lamps, door courtesy lamps, and instrument panel courtesy lamps when any door is opened or a door lock/unlock request is activated with the key fob. After all doors have been closed, the dome lamps, door courtesy lamps, and instrument panel courtesy lamps will remain illuminated approximately 3 seconds after the last door closes. When the driver places the dome lamp switch in the OFF position, the dome/courtesy lamps will be disabled. In the event that the dome/courtesy lamps were to remain

illuminated for more than 10 minutes with the ignition switch in the OFF position and no doors opened, the BCM will deactivate the dome/courtesy lamps control circuit to prevent total battery discharge.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The BCM detects a short to ground in the dome lamps control circuit.

Actions Taken When the DTC Sets

The BCM will disable the dome lamps control circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

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Interior Lighting Systems Description and Operation

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: Each component on the control circuit may need to be disconnected to isolate a short to voltage or short to ground. Use the schematics to identify the following:

- Lighting components the vehicle is equipped with
- Each component's control and ground circuit terminals
- Component locations on the backlighting control circuit

1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X5 harness connector at the K9 Body Control Module.
4. Ignition OFF, all doors closed, all accessories OFF, disconnect the harness connectors at the components listed below.
 - E37D dome/reading lamps - overhead console
 - E37R dome/reading lamps - rear
 - E8D door courtesy lamp - driver
 - E8P door courtesy lamp - passenger
 - E8J instrument panel courtesy lamp - left
 - E8K instrument panel courtesy lamp - right
5. Test for less than 10 ohms between the appropriate ground circuit terminal listed below and ground.
 - E37D dome/reading lamps - overhead console terminal 6
 - E37R dome/reading lamps - rear terminal 6
 - E8D door courtesy lamp - driver terminal 2
 - E8P door courtesy lamp - passenger terminal 2
 - E8J instrument panel courtesy lamp - left terminal 2
 - E8K instrument panel courtesy lamp - right terminal 2
 - **If 10 ohms or greater**
 1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
6. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
 - E37D dome/reading lamps - overhead console terminal 2
 - E37R dome/reading lamps - rear terminal 2
 - E8D door courtesy lamp - driver terminal 1
 - E8P door courtesy lamp - passenger terminal 1
 - E8J instrument panel courtesy lamp - left terminal 1
 - E8K instrument panel courtesy lamp - right terminal 1
7. Verify the test lamp turns ON and OFF when commanding the Courtesy Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
 - 8. Test or replace the appropriate dome/courtesy lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Dome and Reading Lamp Replacement**
- **Front Floor Flood Lamp Replacement**
- **Front Side Door Courtesy Lamp Lens Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2625

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2625 02

Display Dimming Pulse Width Modulation Output Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Switch Indicator LED Backlight Dimming Control Terminal 5 X1	B2625 02	1	1	-
1. Interior Backlighting Malfunction				

Circuit/System Description

The instrument panel dimmer switch is used to increase and decrease the brightness of the interior backlighting components. The instrument panel dimmer switch provides a voltage signal to the body control module (BCM) that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The BCM provides a low reference signal and B+ to the instrument panel dimmer switch. When the instrument panel dimmer switch is placed in the desired position, the dimmed voltage setting is applied from the instrument panel dimmer switch through the instrument panel dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies a pulse width modulated (PWM) voltage through the LED backlight dimming control circuit illuminating the LED backlighting to the requested level of brightness.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Park lamps ON.

Conditions for Setting the DTC

The BCM detects a short to ground in the LED backlight dimming control circuit terminal 5 X1.

Actions Taken When the DTC Sets

The LED backlight dimming control circuit driver is shut down.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

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Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for the scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors at the following components.
 - S48D multifunction switch 2 - instrument panel (with F45)
 - S107 parking assist ON/OFF switch
2. Connect a test lamp between the control circuit terminal 3 and ground.
3. Verify the test lamp turns ON and OFF when commanding the LED Backlight Dimming ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 body control module.
- **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
- **If the test lamp turns ON and OFF**
 4. Test or replace the appropriate switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **INSTRUMENT PANEL ACCESSORY TRIM PLATE REPLACEMENT**
- **Control Module References** for BCM replacement, programming, and setup

DTC B2645

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2645 03

Ambient Light Sensor Circuit Low Voltage

DTC B2645 07

Ambient Light Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Light Sensor Signal	B2645 03	B2645 07	B2645 07	-
Daytime Running Lamp Control - Left (T4F)	B2600 02	B2600 04	B2600 01	-
Daytime Running Lamp Control - Right (T4F)	B2605 02	B2605 04	B2605 01	-
Ambient Light Sensor Low				

Reference	-	B2645 07	1	-
Daytime Running Lamp Ground - Left (T4F)	-	1	-	-
Daytime Running Lamp Ground - Right (T4F)	-	1	-	-
1. Daytime Running Lamps Malfunction				

Circuit/System Description

The ambient light sensor is used to monitor outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor. Depending on outside lighting conditions, the ambient light sensor provides a voltage signal to the BCM that will vary between 0.2 and 4.9 volts. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic headlamp system control when the headlamp switch is in the AUTO position. In daylight conditions, the BCM will command the DRLs ON by applying voltage to the DRL control circuits illuminating the DRLs. Any function or condition that turns on the headlamps will cancel DRL operation.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

DTC B2645 03

The BCM detects a short to ground in the ambient light sensor signal circuit.

DTC B2645 07

- The BCM detects a short to voltage or an open/high resistance in the ambient light sensor signal circuit.
- The BCM detects an open/high resistance in the ambient light sensor low reference circuit.

Actions Taken When the DTC Sets

- Automatic headlamp system and daytime running lamps are inoperative.
- The BCM defaults to low light status and commands the low beam headlamps ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, open and close drivers door, disconnect the harness connector at the B10B ambient light/sunload sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the low reference circuit terminal 6 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K33 HVAC control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC control module.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool Ambient Light Sensor parameter is greater than 4.65 V.
 - **If 4.65 V or less**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If greater than 4.65 V**
5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the low reference circuit

terminal 6.

6. Verify the scan tool Ambient Light Sensor parameter is less than 0.196 V.
 - **If 0.196 V or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If less than 0.196 V**
7. Test or replace the B10B ambient light/sunload sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Automatic Control Ambient Light Sensor Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B3410 OR B3420

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3410 01

AHLD Front Axle Sensor Signal Circuit Short to Battery

DTC B3410 06

AHLD Front Axle Sensor Signal Circuit Low Voltage/Open

DTC B3420 01

AHLD Rear Axle Sensor Signal Circuit Short to Battery

DTC B3420 06

AHLD Rear Axle Sensor Signal Circuit Low Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LIN Serial Data - Left Headlamp Leveling Actuator	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	-
LIN Serial Data - Right Headlamp Leveling Actuator	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	-
Headlamp Control Module B+	1	1	-	-
Headlamp Leveling Actuator - Left B+	B3435 03	B3435 03	B3435 00	-
Headlamp Leveling Actuator - Right B+	B3440 03	B3440 03	B3440 00	-
Suspension Position Sensor 5V Reference - Left Front	B3415 02	1	B3415 01	-
Suspension Position Sensor 5V Reference - Left Rear	B3415 02	1	B3415 01	-
Suspension Position Sensor Signal - Left Front	B3410 06	B3410 06	B3410 01	B3410 08
Suspension Position Sensor Signal - Left Rear	B3420 06	B3420 06	B3420 01	B3420 08
Suspension Position Sensor Low Reference - Left Front	-	1	-	-
Suspension Position Sensor Low Reference - Left Rear	-	1	-	-
Headlamp Control Module Ground	-	1	-	-
Headlamp Leveling Actuator - Left Ground	-	B3435 03	-	-
Headlamp Leveling Actuator - Right Ground	-	B3440 03	-	-
1. Headlamp Leveling Malfunction				

Circuit/System Description

Each headlamp assembly contains a headlamp leveling motor that is controlled by the headlamp control module. The front and rear suspension position sensors provide the headlamp control module with suspension position information. Each sensor receives a 5-volt reference, signal, and low reference circuits from the headlamp control module. The sensors are connected to the control arms of the front and rear suspension. As the

vehicle travels, the suspension compresses and rebounds moving the suspension position sensor arms. This causes the signal output of the sensor to change. The headlamp control module compares the information from both suspension position sensors and adjusts the headlamp leveling as needed.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Engine RUNNING.
- Headlamps ON.

Conditions for Setting the DTC

DTC B3410 01

The headlamp control module detects a short to voltage in the front suspension position sensor signal circuit.

DTC B3410 06

The headlamp control module detects a short to ground or an open/high resistance in the front suspension position sensor signal circuit.

DTC B3420 01

The headlamp control module detects a short to voltage in the rear suspension position sensor signal circuit.

DTC B3420 06

The headlamp control module detects a short to ground or an open/high resistance in the rear suspension position sensor signal circuit.

Actions Taken When the DTC Sets

- The headlamp control module disables the headlamp leveling system.
- The driver information center (DIC) will display AFL Lamps Need Service.
- On vehicles equipped with both AFL and headlamp leveling, the AFL system will remain active.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B51 Suspension Height Sensor, ignition ON.
2. Verify a test lamp illuminates between the low reference circuit terminal 2 and B+.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K26 Headlamp Control Module.
 - **If the test lamp illuminates**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K26 Headlamp Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module, ignition ON.

2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K26 Headlamp Control Module.
 - **If between 4.8-5.2 V**
5. Verify the appropriate scan tool Leveling Position Sensor parameter is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K26 Headlamp Control Module.
 - **If less than 1 V**
6. Install a 3 A fused jumper wire between the 5-volt reference circuit terminal 1 and the signal circuit terminal 3.
7. Engine RUNNING, verify the appropriate scan tool Leveling Position Sensor parameter is greater than 4.8 V.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K26 Headlamp Control Module.
 - **If 4.8 V or greater**
8. Test or replace the appropriate B51 Suspension Height Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HEADLAMP LEVELING FRONT SUSPENSION HEIGHT SENSOR REPLACEMENT**
- **HEADLAMP LEVELING REAR SUSPENSION HEIGHT SENSOR REPLACEMENT**
- **Control Module References** for headlamp control module replacement, programming, and setup

DTC B3415

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3415 01

AHLD Front Axle Sensor Supply Circuit Short to Battery

DTC B3415 02

AHLD Front Axle Sensor Supply Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LIN Serial Data - Left Headlamp Leveling Actuator	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	-
LIN Serial Data - Right Headlamp Leveling Actuator	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	-
Headlamp Control Module B+	1	1	-	-
Headlamp Leveling Actuator - Left B+	B3435 03	B3435 03	B3435 00	-
Headlamp Leveling Actuator - Right B+	B3440 03	B3440 03	B3440 00	-
Suspension Position Sensor 5V Reference - Left Front	B3415 02	1	B3415 01	-
Suspension Position Sensor 5V Reference - Left Rear	B3415 02	1	B3415 01	-
Suspension Position Sensor Signal - Left Front	B3410 06	B3410 06	B3410 01	B3410 08
Suspension Position Sensor Signal - Left Rear	B3420 06	B3420 06	B3420 01	B3420 08
Suspension Position Sensor Low Reference - Left Front	-	1	-	-
Suspension Position Sensor Low Reference - Left Rear	-	1	-	-
Headlamp Control Module Ground	-	1	-	-
Headlamp Leveling Actuator - Left Ground	-	B3435 03	-	-
Headlamp Leveling Actuator - Right Ground	-	B3440 03	-	-

1. Headlamp Leveling Malfunction

Circuit/System Description

Each headlamp assembly contains a headlamp leveling motor that is controlled by the headlamp control module. The front and rear suspension position sensors provide the headlamp control module with suspension position information. Each sensor receives a 5-volt reference, signal, and low reference circuits from the headlamp control module. The sensors are connected to the control arms of the front and rear suspension. As the vehicle travels, the suspension compresses and rebounds moving the suspension position sensor arms. This causes the signal output of the sensor to change. The headlamp control module compares the information from both suspension position sensors and adjusts the headlamp leveling as needed.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Engine RUNNING.
- Headlamps ON.

Conditions for Setting the DTC

DTC B3415 01

The headlamp control module detects a short to voltage in the suspension position sensor 5V reference circuit.

DTC B3415 02

The headlamp control module detects a short to ground or an open/high resistance in the suspension position sensor 5V reference circuit.

Actions Taken When the DTC Sets

- The headlamp control module disables the headlamp leveling system.
- The driver information center (DIC) will display AFL Lamps Need Service.
- On vehicles equipped with both AFL and headlamp leveling, the AFL system will remain active.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B51 Suspension Height Sensor, ignition ON.
2. Verify a test lamp illuminates between the low reference circuit terminal 2 and B+.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K26 Headlamp Control Module.
 - **If the test lamp illuminates**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K26 Headlamp Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module, ignition ON.

2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K26 Headlamp Control Module.
 - **If between 4.8-5.2 V**
5. Verify the appropriate scan tool Leveling Position Sensor parameter is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K26 Headlamp Control Module.
 - **If less than 1 V**
6. Install a 3 A fused jumper wire between the 5-volt reference circuit terminal 1 and the signal circuit terminal 3.
7. Engine RUNNING, verify the appropriate scan tool Leveling Position Sensor parameter is greater than 4.8 V.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K26 Headlamp Control Module.
 - **If 4.8 V or greater**
8. Test or replace the appropriate B51 Suspension Height Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HEADLAMP LEVELING FRONT SUSPENSION HEIGHT SENSOR REPLACEMENT**
- **HEADLAMP LEVELING REAR SUSPENSION HEIGHT SENSOR REPLACEMENT**
- **Control Module References** for headlamp control module replacement, programming, and setup

DTC B3435 OR B3440

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3435 00

AHLD Left Servo Driver Circuit

DTC B3435 03

AHLD Left Servo Driver Circuit Short to Ground

DTC B3440 00

AHLD Right Servo Driver Circuit

DTC B3440 03

AHLD Right Servo Driver Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LIN Serial Data - Left Headlamp Leveling Actuator	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	-
LIN Serial Data - Right Headlamp Leveling Actuator	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	-
Headlamp Control Module B+	1	1	-	-
Headlamp Leveling Actuator - Left B+	B3435 03	B3435 03	B3435 00	-
Headlamp Leveling Actuator - Right B+	B3440 03	B3440 03	B3440 00	-
Suspension Position Sensor 5V Reference - Left Front	B3415 02	1	B3415 01	-
Suspension Position Sensor 5V Reference - Left Rear	B3415 02	1	B3415 01	-
Suspension Position Sensor Signal - Left Front	B3410 06	B3410 06	B3410 01	B3410 08
Suspension Position Sensor Signal - Left Rear	B3420 06	B3420 06	B3420 01	B3420 08
Suspension Position Sensor Low Reference - Left Front	-	1	-	-
Suspension Position Sensor Low				

Reference - Left Rear	-	1	-	-
Headlamp Control Module Ground	-	1	-	-
Headlamp Leveling Actuator - Left Ground	-	B3435 03	-	-
Headlamp Leveling Actuator - Right Ground	-	B3440 03	-	-
1. Headlamp Leveling Malfunction				

Circuit/System Description

Each headlamp assembly contains a headlamp leveling actuator that is controlled by the headlamp leveling control module. The front and rear suspension position sensors provide the headlamp leveling control with suspension position information. Each sensor receives a 5 V reference, signal, and low reference circuits from the headlamp leveling control module. The sensors are connected to the control arms of the front and rear suspension. As the vehicle travels, the suspension compresses and rebounds moving the suspension position sensor arms. This causes the signal output of the sensor to change. The headlamp leveling control module compares the information from both suspension position sensors and adjusts the headlamp leveling as needed. The headlamp leveling control module communicates with the left and right headlamp leveling actuators via the LIN serial data circuit.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Ignition ON.
- Headlamps ON.

Conditions for Setting the DTC

DTC B3435 00

- The headlamp leveling control module detects a short to ground or an open/high resistance in the left headlamp leveling actuator LIN bus circuit.
- The headlamp leveling control module detects an open/high resistance in the left headlamp leveling actuator ground circuit.

DTC B3435 03

- The headlamp leveling control module detects a short to ground or an open/high resistance in the left headlamp leveling actuator B+ circuit.
- The headlamp leveling control module detects an open/high resistance in the left headlamp leveling actuator ground circuit.

DTC B3440 00

- The headlamp leveling control module detects a short to ground or an open/high resistance in the right

headlamp leveling actuator LIN bus circuit.

- The headlamp leveling control module detects an open/high resistance in the right headlamp leveling actuator ground circuit.

DTC B3440 03

- The headlamp leveling control module detects a short to ground or an open/high resistance in the right headlamp leveling actuator B+ circuit.
- The headlamp leveling control module detects an open/high resistance in the right headlamp leveling actuator ground circuit.

Actions Taken When the DTC Sets

- When DTC B3435 or DTC B3440 sets, the headlamp leveling control module will attempt to return the lamps to a nominal position and disable all requests to all headlamp actuators.
- The instrument cluster will display Headlamp Leveling Malfunction - Contact Service.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists and the ignition is cycled.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate E13 headlamp.
2. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E13L headlamp - left terminal 8 with A1LL
 - E13R headlamp - right terminal 8 with A1LL
 - E13L headlamp - left terminal 7 with A1SL
 - E13R headlamp - right terminal 7 with A1SL
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the appropriate B+ circuit terminal listed below and ground.
 - E13L headlamp - left terminal 6 with A1LL
 - E13R headlamp - right terminal 6 with A1LL
 - E13L headlamp - left terminal 8 with A1SL
 - E13R headlamp - right terminal 8 with A1SL
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A fuse block - underhood.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A fuse block - underhood.
 - **If the test lamp illuminates**
5. Test or replace the K26 headlamp control module.
6. Ignition ON.
7. Verify the appropriate headlamp operates to the UP and DOWN positions when commanding the DHL Motor Control UP and DOWN with a scan tool.
 - If the appropriate headlamp does not operate UP and DOWN, test or replace the appropriate headlamp assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Replacement**
- **Control Module References** for headlamp control module replacement, programming, and setup

DTC B3596

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3596 00

Hazard Lamps Request Circuit Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Hazard Warning Switch Signal	1	1	1	B3596 00
Hazard Warning Switch LED Backlighting Control	2	2	2	-
Hazard Warning Switch Ground	-	1	-	-
1. Hazard Lamps Malfunction 2. Hazard Warning Switch Backlighting Malfunction				

Circuit/System Description

The hazard flashers may be activated in any power mode. The hazard warning switch signal circuit is momentarily grounded when the hazard warning switch is pressed. The body control module (BCM) responds to the hazard warning switch signal input by supplying battery voltage to all four turn signal lamps in an ON and OFF duty cycle. When the hazard warning switch is activated, the BCM sends a serial data message to the instrument cluster requesting both turn signal indicators to be cycled ON and OFF.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Hazard lamps ON.

Conditions for Setting the DTC

The hazard warning switch input is Active for longer than 60 seconds.

Actions Taken When the DTC Sets

The hazard lamps are inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

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Description and Operation

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S48C multifunction switch 1 - instrument panel. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 7 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**

3. Ignition ON.
4. Verify the scan tool Hazard Lamps Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 10 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 10 and ground.
6. Verify the scan tool Hazard Lamps Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 10 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
7. Test or replace the S48C multifunction switch 1 - instrument panel.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **INSTRUMENT PANEL UPPER CENTER TRIM PANEL REPLACEMENT** center trim panel
- **Control Module References** for BCM replacement, programming, and setup

DTC B3650

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3650 08

High Beam Request Signal Circuit Performance - Signal Invalid

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Switch Headlamps OFF Signal	B257A 00	1	1	-
Headlamp Switch Headlamps ON Signal	B257A 00	1	1	-
Headlamp Switch Park Lamps ON Signal	2	B257A 00	2	-
Turn Signal/Multifunction Switch Flash To Pass Signal	B3806 00	1	1	-
Turn Signal/Multifunction Switch High Beam Signal	B3650 08	1	1	-
Headlamp Switch Ground	-	1	-	-
Turn Signal/Multifunction Switch Ground	-	1	-	-
1. Headlamps Malfunction 2. Park, License, and/or Tail Lamps Malfunction				

Circuit/System Description

When the low beam headlamps are on and the turn signal/multifunction switch is placed in the high beam position, ground is applied to the body control module (BCM) through the high beam signal circuit. The BCM responds to the high beam request by applying ground to the high beam relay control circuit which energizes the high beam relay. With the high beam relay energized, the switch contacts close allowing battery voltage to flow through the high beam fuses to the high beam control circuits illuminating the high beam headlamps.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The BCM detects a short to ground in the turn signal/multifunction switch high beam signal circuit.

Actions Taken When the DTC Sets

The high beam headlamps will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S78 turn signal/multifunction switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 3 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool High Beam Select Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**

5. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 3.
6. Verify the scan tool High Beam Select Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
7. Test or replace the S78 turn signal/multifunction switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **TURN SIGNAL SWITCH REPLACEMENT**
- **Control Module References** for BCM replacement, programming, and setup

DTC B3806

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3806 00

High Beam and Headlamp Flash Select Circuit Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Switch Headlamps OFF Signal	B257A 00	1	1	-
Headlamp Switch Headlamps ON Signal	B257A 00	1	1	-
Headlamp Switch Park Lamps ON	2	B257A 00	2	-

Signal				
Turn Signal/Multifunction Switch Flash To Pass Signal	B3806 00	1	1	-
Turn Signal/Multifunction Switch High Beam Signal	B3650 08	1	1	-
Headlamp Switch Ground	-	1	-	-
Turn Signal/Multifunction Switch Ground	-	1	-	-
1. Headlamps Malfunction 2. Park, License, and/or Tail Lamps Malfunction				

Circuit/System Description

When the turn signal/multifunction switch is momentarily placed in the flash to pass position, ground is applied to the body control module (BCM) through the flash to pass signal circuit. The BCM responds to the flash to pass request by applying ground to the high beam relay control circuit which energizes the high beam relay. With the high beam relay energized, the switch contacts close allowing battery voltage to flow through the high beam fuses to the high beam control circuits illuminating the high beam headlamps. The high beam headlamps will only illuminate for as long as the flash to pass switch is activated.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The BCM detects a short to ground in the turn signal/multifunction switch flash to pass signal circuit.

Actions Taken When the DTC Sets

The high beam lamps and the high beam indicator on the instrument panel cluster (IPC) are always ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S78 turn signal/multifunction switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 3 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool Headlamps Flash Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the ground circuit terminal 3.
6. Verify the scan tool Headlamps Flash Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
- **If Active**
- 7. Test or replace the S78 turn signal/multifunction switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **TURN SIGNAL SWITCH REPLACEMENT**
- **Control Module References** for BCM replacement, programming, and setup

DTC B3883

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3883 01

License Plate Lamp Circuit Short to Battery

DTC B3883 02

License Plate Lamp Circuit Short to Ground

DTC B3883 04

License Plate Lamp Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F23DA Fuse B+	B3883 01, B3883 04	B3883 01, B3883 04	-	-
License Plate Lamp Control	B3883 02	B3883 01, B3883 04	B3883 01	-
License Plate Lamp Ground -		B3883 01, B3883		

Right	-	04	-	-
License Plate Lamp Ground - Left	-	B3883 01, B3883 04	-	-

Circuit/System Description

When the headlamp switch is placed in the HEAD or PARK position, ground is applied to the park lamp switch ON signal circuit to the body control module (BCM). The BCM responds by applying voltage to the park lamps, tail lamps, and license lamps control circuits illuminating the park, tail, and license lamps.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

DTC B3883 01

Headlamp switch in OFF position.

DTC B3883 02 or B3883 04

Headlamp switch in PARK or ON positions.

Conditions for Setting the DTC

DTC B3883 01

- The BCM detects a short to voltage in the license lamps control circuit.
- The BCM detects an open/high resistance in the license lamps ground circuit.
- The BCM detects a short to ground or an open/high resistance in the F23DA fuse B+ circuit.

DTC B3883 02

The BCM detects a short to ground in the license lamps control circuit.

DTC B3883 04

- The BCM detects an open/high resistance in the license lamps control circuit.
- The BCM detects an open/high resistance in the license lamps ground circuit.
- The BCM detects a short to ground or an open/high resistance in the F23DA fuse B+ circuit.

Actions Taken When the DTC Sets

DTC B3883 01

License lamps always ON.

DTC B3883 02 or B3883 04

License lamps inoperative.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X2 harness connector at the K9 body control module.
4. Ignition OFF, exterior lamps OFF, trunk latch latched, remove both E7 license plate lamp bulbs.
5. Test for less than 5 ohms between each ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
6. Connect a test lamp between the E7L license plate lamp - left control circuit terminal 1 and ground, ignition ON.
7. Verify the test lamp turns ON and OFF when commanding the License Plate Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
8. Ignition OFF.
9. Connect a test lamp between the E7R license plate lamp - right control circuit terminal 1 and ground, ignition ON.
10. Verify the test lamp turns ON and OFF when commanding the License Plate Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**

1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - **If the test lamp turns ON and OFF**
11. Test or replace the appropriate E7 license plate lamp bulb.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear License Plate Lamp Replacement**
- **Rear License Plate Lamp Bulb Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B3948 OR B3949

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3948 01

Left Front Turn Signal Circuit Short to Battery

DTC B3948 02

Left Front Turn Signal Circuit Short to Ground

DTC B3948 04

Left Front Turn Signal Circuit Open

DTC B3949 01

Right Front Turn Signal Circuit Short to Battery

DTC B3949 02

Right Front Turn Signal Circuit Short to Ground

DTC B3949 04

Right Front Turn Signal Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F2DA Fuse B+	B3951 01, B3951 04	B3951 01, B3951 04	-	-
F32UA Fuse B+	B3950 01, B3950 04	B3950 01, B3950 04	-	-
Turn Signal Switch Signal - Left	1	1	1	-
Turn Signal Switch Signal - Right	1	1	1	-
Turn Signal Control - Left Front	B3948 02	B3948 04	B3948 01, B3948 04	-
Stop/Turn Signal Lamp Control - Left	B3950 02	B3950 04	B3950 01, B3950 04	-
Turn Signal Control - Right Front	B3949 02	B3949 04	B3949 01, B3949 04	-
Stop/Turn Signal Lamp Control - Right	B3951 02	B3951 04	B3951 01, B3951 04	-
Turn Signal Lamp Ground - Left Front	-	B3948 01, B3948 04	-	-
Turn Signal Lamp Ground - Right Front	-	B3949 01, B3949 04	-	-
Turn Signal Lamp Ground - Left Rear	-	B3950 01, B3950 04	-	-
Turn Signal Lamp Ground - Right Rear	-	B3951 01, B3951 04	-	-
Turn Signal Repeater Lamp - Left Ground	-	B3948 01, B3948 04	-	-
Turn Signal Repeater Lamp - Right Ground	-	B3949 01, B3949 04	-	-
Turn Signal/Multifunction Switch Ground	-	1	-	-
1. Turn Signal Lamps and/or Indicators Malfunction				

Circuit/System Description

Ground is applied at all times to the turn signal/multifunction switch. The turn signal lamps may only be activated with the ignition switch in the ON or START positions. When the turn signal/multifunction switch is placed in either the turn right or turn left position, ground is applied to the body control module (BCM) through

either the right turn or left turn signal switch signal circuit. The BCM responds to the turn signal switch input by applying a pulsating voltage to the front and rear turn signal lamps through their respective control circuits. When a turn signal request is received by the BCM, a serial data message is sent to the instrument cluster requesting the respective turn signal indicator be pulsed ON and OFF.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

DTC B3948 01 and B3948 04

- The BCM detects an open/high resistance in the left front turn signal control circuit.
- The BCM detects an open/high resistance in the left front turn signal ground circuit.

DTC B3948 02

The BCM detects a short to ground in the left front turn signal control circuit.

DTC B3949 01 and B3949 04

- The BCM detects an open/high resistance in the right front turn signal control circuit.
- The BCM detects an open/high resistance in the right front turn signal ground circuit.

DTC B3949 02

The BCM detects a short to ground in the right front turn signal control circuit.

Actions Taken When the DTC Sets

DTC B3948

- The left front turn signal is inoperative.
- The left turn signal indicator on the instrument cluster flashes rapidly.

DTC B3949

- The right front turn signal is inoperative.
- The right turn signal indicator on the instrument cluster flashes rapidly.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

When testing at the front turn signal lamp bulb socket, make sure all measurements and test lamp connections are in the correct terminal location and do not come in contact with each other during testing.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

DTC B3948

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate turn signal lamp - left.
2. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E4LF Turn Signal Lamp - left Front socket terminal
 - E4N Park/Turn Signal Lamp - Left terminal 2 (with T4A)
 - A9A Outside Rearview Mirror - Driver terminal 4
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 5 ohms**
- 3. Connect a test lamp between the appropriate control circuit terminal listed below and ground, ignition ON.
 - E4LF Turn Signal Lamp - left Front socket terminal
 - E4N Park/Turn Signal Lamp - Left terminal 1 (with T4A)
 - A9A Outside Rearview Mirror - Driver terminal 16
- 4. Verify the test lamp turns ON and OFF when commanding the Left Front Turn Signal Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
- 5. Test or replace the appropriate turn signal lamp - left.

DTC B3949

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate turn signal lamp - right.
2. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E4RF Turn Signal Lamp - Right Front socket terminal
 - E4P Park/Turn Signal Lamp - Right terminal 2 (with T4A)
 - A9A Outside Rearview Mirror - Passenger terminal 4
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**

3. Connect a test lamp between the appropriate control circuit terminal listed below and ground, ignition ON.
 - E4RF Turn Signal Lamp - Right Front socket terminal
 - E4P Park/Turn Signal Lamp - Right terminal 1 (with T4A)
 - A9A Outside Rearview Mirror - Passenger terminal 16
4. Verify the test lamp turns ON and OFF when commanding the Right Front Turn Signal Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the appropriate turn signal lamp - right.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Turn Signal Lamp Bulb Replacement**
- **Outside Rearview Mirror Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC B3950 OR B3951

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3950 01

Left Rear Turn Signal Circuit Short to Battery

DTC B3950 02

Left Rear Turn Signal Circuit Short to Ground

DTC B3950 04

Left Rear Turn Signal Circuit Open

DTC B3951 01

Right Rear Turn Signal Circuit Short to Battery

DTC B3951 02

Right Rear Turn Signal Circuit Short to Ground

DTC B3951 04

Right Rear Turn Signal Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F2DA Fuse B+	B3951 01, B3951 04	B3951 01, B3951 04	-	-
F32UA Fuse B+	B3950 01, B3950 04	B3950 01, B3950 04	-	-
Turn Signal Switch Signal - Left	1	1	1	-
Turn Signal Switch Signal - Right	1	1	1	-
Turn Signal Control - Left Front	B3948 02	B3948 04	B3948 01, B3948 04	-
Stop/Turn Signal Lamp Control - Left	B3950 02	B3950 04	B3950 01, B3950 04	-
Turn Signal Control - Right Front	B3949 02	B3949 04	B3949 01, B3949 04	-
Stop/Turn Signal Lamp Control - Right	B3951 02	B3951 04	B3951 01, B3951 04	-
Turn Signal Lamp Ground - Left Front	-	B3948 01, B3948 04	-	-
Turn Signal Lamp Ground - Right Front	-	B3949 01, B3949 04	-	-

Turn Signal Lamp Ground - Left Rear	-	B3950 01, B3950 04	-	-
Turn Signal Lamp Ground - Right Rear	-	B3951 01, B3951 04	-	-
Turn Signal Repeater Lamp - Left Ground	-	B3948 01, B3948 04	-	-
Turn Signal Repeater Lamp - Right Ground	-	B3949 01, B3949 04	-	-
Turn Signal/Multifunction Switch Ground	-	1	-	-
1. Turn Signal Lamps and/or Indicators Malfunction				

Circuit/System Description

Ground is applied at all times to the turn signal/multifunction switch. The turn signal lamps may only be activated with the ignition switch in the ON or START positions. When the turn signal/multifunction switch is placed in either the turn right or turn left position, ground is applied to the body control module (BCM) through either the right turn or left turn signal switch signal circuit. The BCM responds to the turn signal switch input by applying a pulsating voltage to the front and rear turn signal lamps through their respective control circuits. When a turn signal request is received by the BCM, a serial data message is sent to the instrument cluster requesting the respective turn signal indicator be pulsed ON and OFF.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

DTC B3950 01 or B3950 04

- The BCM detects a short to ground or an open/high resistance in the F32UA fuse B+ circuit.
- The BCM detects an open/high resistance in the left rear turn signal control circuit.
- The BCM detects an open/high resistance in the left rear turn signal ground circuit.

DTC B3950 02

The BCM detects a short to ground in the left rear turn signal control circuit.

DTC B3951 01 or B3951 04

- The BCM detects a short to ground or an open/high resistance in the F2DA fuse B+ circuit.
- The BCM detects an open/high resistance in the right rear turn signal control circuit.
- The BCM detects an open/high resistance in the right rear turn signal ground circuit.

DTC B3951 02

The BCM detects a short to ground in the right rear turn signal control circuit.

Actions Taken When the DTC Sets

DTC B3950

- The left rear turn signal is inoperative.
- The "Check Left Rear Turn Signal Lamp" message is displayed on the driver information center (DIC) display.
- The left turn signal indicator on the instrument cluster flashes rapidly.

DTC B3951

- The right rear turn signal is inoperative.
- The "Check Right Rear Turn Signal Lamp" message is displayed on the driver information center (DIC) display.
- The right turn signal indicator on the instrument cluster flashes rapidly.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

When testing at the rear turn signal lamp bulb socket, make sure all measurements and test lamp connections are in the correct terminal location and do not come in contact with each other during testing.

Reference Information

Schematic Reference

- **Exterior Lights Schematics**
- **Body Control System Schematics**

Connector End View Reference

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Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

DTC B3950

1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X5 harness connector at the K9 body control module.
4. Ignition OFF, exterior lamps OFF, remove the E5AM stop/turn signal lamp bulb - left.
5. Test for less than 5 ohms between the ground circuit terminal 3 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
6. Connect a test lamp between the control circuit terminal 2 and ground, ignition ON.
7. Verify the test lamp turns ON and OFF when commanding the Left Rear Turn Signal/Brake Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 - 1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
 - 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
- 8. Test or replace the E5AM stop/turn signal lamp bulb - left.

DTC B3951

1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 3 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 - 1. Ignition OFF.
 - 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X5 harness connector at the K9 body control module.
4. Ignition OFF, exterior lamps OFF, remove the E5AN stop/turn signal lamp bulb - right.
5. Test for less than 5 ohms between the ground circuit terminal 3 and ground.
 - **If 5 ohms or greater**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
6. Connect a test lamp between the control circuit terminal 2 and ground, ignition ON.

7. Verify the test lamp turns ON and OFF when commanding the Right Rear Turn Signal/Brake Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
8. Test or replace the E5AN stop/turn signal lamp bulb - right.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Tail Lamp Replacement**
- **Tail Lamp Bulb Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC C0010

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0010 5A

Reverse Gear Signal Circuit Not Plausible

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F32DA Fuse B+	1	1	-	-
Backup Lamp Switch Signal	1	1	1	C0010 5A
Backup Lamps Control	B2545 02	B2545 04	B2545 01	-
Backup Lamp Switch Ground	-	1	-	-
Backup Lamp Ground - Left	-	1	-	-
Backup Lamp Ground - Right	-	1	-	-
1. Backup Lamps Malfunction				

Circuit/System Description

The engine control module (ECM) provides a signal circuit to the backup lamp switch which is permanently grounded. With the engine running and the transmission in the reverse position, the backup lamp switch signal circuit is pulled low and the ECM responds by sending a serial data message to the body control module (BCM). The message indicates that the gear selector is in the reverse position. The BCM applies battery voltage to the backup lamps control circuit illuminating the backup lamps. Once the driver moves the gear selector out of the reverse position, a message is sent by the ECM via serial data requesting the BCM to remove battery voltage from the backup lamps control circuit. The engine must be running for the backup lamps to operate.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Engine ON.

Conditions for Setting the DTC

The ECM detects a stuck backup lamp switch.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 50 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Backup Lamp Switch Malfunction

1. Ignition OFF, exterior lamps OFF, all doors closed, disconnect the harness connector at the B16 backup lamp switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Ignition ON.
4. Verify the scan tool Reverse Position Switch parameter is Off.
 - **If not Off**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 engine control module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 engine control module.
 - **If Off**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 2.
6. Verify the scan tool Reverse Position Switch parameter is On.
 - **If not On**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 engine control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V

3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 engine control module.

- **If On**

7. Test or replace the B16 backup lamp switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Backup Lamp Switch Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DTC C0277 OR C0890

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0277 06

Brake Pedal Position Sensor Circuit Low Voltage/Open

DTC C0277 07

Brake Pedal Position Sensor Circuit High Voltage

DTC C0277 09

Brake Pedal Position Sensor Circuit Too Fast Transitions

DTC C0277 4B

Brake Pedal Position Sensor Circuit Calibration Not Learned

DTC C0890 03

Control Module Voltage Reference Output 3 Circuit Low Voltage

DTC C0890 07

Control Module Voltage Reference Output 3 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F2DA Fuse B+	B3951 01, B3951 04	B3951 01, B3951 04	-	-
F32UA Fuse B+	B3950 01, B3950 04	B3950 01, B3950 04	-	-
Brake Pedal Position Sensor 5 V Reference	C0277 06, C0890 03, C0161 71	C0277 06, C0161 71, C0161 5A	C0277 07, C0890 07, C0161 71	-
Brake Pedal Position Sensor Signal	C0277 06, U0140 71	C0277 06, C0161 71, C0161 5A	C0277 07, C0890 07, C0161 71	C0277 09
Center High Mounted Stop Lamp Control	2	2	2	-
Stop/Turn Signal Lamp Control - Left	B3950 02	B3950 04	B3950 01, B3950 04	-
Stop/Turn Signal Lamp Control - Right	B3951 02	B3951 04	B3951 01, B3951 04	-
Brake Pedal Position Sensor Low Reference	-	C0277 07, C0161 71	U0151 00, U0184 00	-
Center High Mounted Stop Lamp Ground	-	2	-	-
Tail Lamp Ground - Left	-	1	-	-
Tail Lamp Ground - Right	-	1	-	-
1. Stop Lamps Malfunction 2. Center High Mounted Stop Lamp Malfunction				

Circuit/System Description

The brake pedal position (BPP) sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module provides a low reference signal and a 5 V reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the left and right stop lamp control circuits as well as the center high mounted stop lamp (CHMSL) control circuit illuminating the left and right stop lamps and the CHMSL.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Brakes APPLIED.

Conditions for Setting the DTC

DTC C0277 06

- The BCM detects a short to ground or an open/high resistance in the BPP sensor 5 V reference circuit.
- The BCM detects a short to ground or an open/high resistance in the BPP sensor signal circuit.

DTC C0277 07

- The BCM detects a short to voltage in the BPP sensor 5 V reference circuit.
- The BCM detects a short to voltage in the BPP sensor signal circuit.
- The BCM detects an open/high resistance in the BPP sensor low reference circuit.

DTC C0277 09

The BCM detects the BPP sensor signal is changing faster than possible under normal operating conditions.

DTC C0277 4B

The DTC will set when the BPP sensor home position is not learned.

DTC C0890 03

The BCM detects a short to ground in the BPP sensor 5 V reference circuit.

DTC C0890 07

- The BCM detects a short to voltage in the BPP sensor 5 V reference circuit.
- The BCM detects a short to voltage in the BPP sensor low reference circuit.

Actions Taken When the DTC Sets

- The Traction Control indicator is commanded ON.
- For DTC C0277 4B, the stop lamps may not activate at the expected brake pedal positions.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- For DTC C0277 07 the ignition must be cycled before the code can be cleared.
- For DTC C0277 4B a successful brake pedal position sensor calibration has been performed.
- A history DTC will clear once 50 malfunction-free ignition cycles have occurred.
- A DTC will not clear the current status until the next ignition cycle.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

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Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

DTC C0277 or C0890

1. Ignition OFF, disconnect the harness connector at the B22 brake pedal position sensor, ignition ON.
2. Verify a test lamp illuminates between the appropriate low reference circuit terminal listed below and B+.
 - Terminal 1 - without MR6
 - Terminal C - with MR6
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp illuminates**
3. Ignition ON.
4. Test for 4.8-5.2 V between the appropriate 5 V reference circuit terminal listed below and ground.
 - Terminal 2 - without MR6
 - Terminal A - with MR6
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
- 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If greater than 5.2 V**
- 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
- 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If between 4.8-5.2 V**
- 5. Verify the scan tool Brake Pedal Applied parameter is Inactive.
 - **If not Inactive**
- 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
- 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If Inactive**
- 6. Install a 3 A fused jumper wire between the appropriate 5 V reference and signal circuit terminals listed below.
 - 5 V reference terminal 2 and signal terminal 3 - without MR6
 - 5 V reference terminal A and signal terminal B - with MR6
- 7. Verify the scan tool Brake Pedal Applied parameter is Active.
 - **If not Active**
- 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module.
- 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
- 8. Test or replace the B22 brake pedal position sensor.

DTC C0277 4B

1. Verify DTC C0277 4B is not set.
 - **If DTC C0277 4B is set**
1. Ignition ON

2. Perform the BPP sensor recalibration procedure for the K9 body control module. Refer to **Brake Pedal Position Sensor Calibration**.
 3. Verify the DTC does not reset while operating the vehicle under the conditions for setting the DTC.
 - If the DTC resets, replace the B22 brake pedal position sensor.
 - If the DTC does not reset
 4. All OK.
 - **If DTC C0277 4B is not set**
2. All OK.

DTC C0277 09

1. Verify DTC C0277 09 is not set.
 - **If DTC C0277 09 is set**
 1. Replace the B22 brake pedal position sensor.
 2. Perform the BPP sensor recalibration procedure for the K9 body control module. Refer to **Brake Pedal Position Sensor Calibration**.
 3. Verify the DTC does not reset while operating the vehicle under the conditions for running the DTC.
 - If the DTC resets, replace the K9 body control module.
 - If the DTC does not reset
 4. All OK.
 - **If DTC C0277 09 is not set**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Brake Pedal Position Sensor Replacement**
- **Brake Pedal Position Sensor Calibration**
- **Control Module References** for BCM replacement, programming, and setup

DTC C0297

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0297 02

Brake Applied Output Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Applied Signal	C0297 02	C0297 02	1	-
1. Cruise Control Malfunction				

Circuit/System Description

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module (BCM) provides a low reference signal and a 5 V reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the right and left stop lamp control circuits, engine control module (ECM), and center high mounted stop lamp control circuit.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.
- Brakes APPLIED.

Conditions for Setting the DTC

The BCM detects a short to ground or an open/high resistance on the brake applied signal circuit.

Actions Taken When the DTC Sets

The cruise control system is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

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Description and Operation

- **Cruise Control Description and Operation** , **Cruise Control Description and Operation (Adaptive Cruise Control)**
- **Exterior Lighting Systems Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20 engine control module.
2. Connect a test lamp between the signal circuit terminal 57 and ground, ignition ON.
3. Verify the test lamp turns ON and OFF while pressing and releasing the brake pedal.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
4. Replace the K20 engine control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming, and setup

SYMPTOMS - LIGHTING

NOTE: **The following steps must be completed before using a symptom table.**

- Perform the **Diagnostic System Check - Vehicle** before using a symptom table in order to verify that all of the following conditions are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
- Review the system description and operation in order to familiarize yourself with the system functions. Refer to the following:
 - **Exterior Lighting Systems Description and Operation**
 - **Interior Lighting Systems Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the lighting system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Thoroughly inspect the wiring and connectors. An incomplete inspection of the wiring and connectors may result in misdiagnosis causing part replacement with the reappearance of the malfunction. If an intermittent malfunction exists, refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Backup Lamps Malfunction (Automatic Transmission), Backup Lamps Malfunction (Manual Transmission)**
- **Courtesy Lamps Malfunction**
- **Daytime Running Lamps Malfunction**
- **Dome Lamps Malfunction**
- **Front Fog Lamps Malfunction**
- **Hazard Lamps Malfunction**
- **Headlamps Malfunction**
- **Interior Accent Lighting Malfunction**
- **Interior Backlighting Malfunction**
- **Park, License, and/or Tail Lamps Malfunction**

- **Rear Compartment Lamp Malfunction**
- **Stop Lamps Malfunction**
- **Turn Signal Lamps and/or Indicators Malfunction**

BACKUP LAMPS MALFUNCTION (AUTOMATIC TRANSMISSION)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F32DA Fuse B+	1	1	-	-
Backup Lamps Control	B2545 02	B2545 04	B2545 01	-
Backup Lamp Ground - Left	-	1	-	-
Backup Lamp Ground - Right	-	1	-	-
1. Backup Lamps Malfunction				

Circuit/System Description

With the engine running and the transmission in the reverse position, the transmission control module (TCM) sends a serial data message to the body control module (BCM). The message indicates that the gear selector is in the reverse position. The BCM applies battery voltage to the backup lamps control circuit illuminating the backup lamps. Once the driver moves the gear selector out of the reverse position, a message is sent by the TCM via serial data requesting the BCM to remove battery voltage from the backup lamps control circuit. The engine must be running for the backup lamps to operate.

Diagnostic Aids

When testing at the backup lamp bulb socket, make sure all measurements and test lamp connections are in the correct terminal location and do not come in contact with each other during testing.

Reference Information

Schematic Reference

- **Exterior Lights Schematics**
- **Body Control System Schematics**

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X5 harness connector at the K9 Body Control Module.
4. Ignition OFF, exterior lamps OFF, trunk latch latched, remove the appropriate E5 Backup Lamp at the appropriate E42 Tail Lamp Sssembly.
5. Test for less than 5 ohms between the ground circuit at the socket terminal and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 5 ohms**
- 6. Connect a test lamp between the control circuit at the socket terminal and ground, ignition ON.
- 7. Verify the test lamp turns ON and OFF when commanding the Backup Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
- 8. Test or replace the appropriate E5 Backup Lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Tail Lamp Replacement**
- **Tail Lamp Bulb Replacement**
- **Control Module References** for BCM replacement, programming, and setup

BACKUP LAMPS MALFUNCTION (MANUAL TRANSMISSION)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F32DA Fuse B+	1	1	-	-

Backup Lamp Switch Signal (Manual Transmission)	1	1	1	C0010 5A
Backup Lamps Control	B2545 02	B2545 04	B2545 01	-
Backup Lamp Switch Ground (Manual Transmission)	-	1	-	-
Backup Lamp Ground - Left	-	1	-	-
Backup Lamp Ground - Right	-	1	-	-
1. Backup Lamps Malfunction				

Circuit/System Description

The engine control module (ECM) provides a signal circuit to the backup lamp switch which is permanently grounded. With the engine running and the transmission in the reverse position, the backup lamp switch signal circuit is pulled low and the ECM responds by sending a serial data message to the body control module (BCM). The message indicates that the gear selector is in the reverse position. The BCM applies battery voltage to the backup lamps control circuit illuminating the backup lamps. Once the driver moves the gear selector out of the reverse position, a message is sent by the ECM via serial data requesting the BCM to remove battery voltage from the backup lamps control circuit. The engine must be running for the backup lamps to operate.

Diagnostic Aids

When testing at the backup lamp bulb socket, make sure all measurements and test lamp connections are in the correct terminal location and do not come in contact with each other during testing.

Reference Information

Schematic Reference

- **Exterior Lights Schematics**
- **Body Control System Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine ON.
2. Verify the scan tool Reverse Position Switch parameter changes between ON and OFF while shifting the vehicle between the neutral and reverse gears.

- **If the parameter does not change**

Refer to Backup Lamp Switch Malfunction.

- **If the parameter changes**

3. Verify the backup lamps turn ON and OFF when commanding the Backup Lamps ON and OFF with a scan tool.

- **If the backup lamps do not turn ON and OFF**

Refer to Backup Lamps Malfunction.

- **If the backup lamps turn ON and OFF**

4. All OK.

Circuit/System Testing

Backup Lamp Switch Malfunction

1. Ignition OFF, exterior lamps OFF, all doors closed, disconnect the harness connector at the B16 Backup Lamp Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.

- **If 5 ohms or greater**

1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 5 ohms**

3. Ignition ON.

4. Verify the scan tool Reverse Position Switch parameter is Off.

- **If not Off**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal 1 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K20 Engine Control Module.

- **If Off**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 2.
6. Verify the scan tool Reverse Position Switch parameter is On.

- **If not On**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If On**

7. Test or replace the B16 Backup Lamp Switch.

Backup Lamps Malfunction

1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X5 harness connector at the K9 Body Control Module.
4. Ignition OFF, exterior lamps OFF, trunk latch latched, remove the appropriate E5 Backup Lamp at the appropriate E42 Tail Lamp Assembly.
5. Test for less than 5 ohms between the ground circuit at the socket terminal and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 5 ohms**
- 6. Connect a test lamp between the control circuit at the socket terminal and ground, ignition ON.
- 7. Verify the test lamp turns ON and OFF when commanding the Backup Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
- 8. Test or replace the appropriate E5 Backup Lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Tail Lamp Bulb Replacement**
- **Backup Lamp Switch Replacement**
- **Control Module References** for BCM or ECM replacement, programming, and setup

COURTESY LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Courtesy Lamps Control -	B1480 02	1	1	-

Terminal 2 X7				
Dome Lamps Control	B2615 02	2	2	-
Dome/Reading Lamps - Overhead Console Ground	-	1, 2	-	-
Dome/Reading Lamps - Rear Ground	-	1, 2	-	-
Instrument Panel Compartment Lamp Ground	-	1	-	-
Sunshade Mirror Lamp - Left Ground	-	1	-	-
Sunshade Mirror Lamp - Right Ground	-	1	-	-
1. Courtesy Lamps Malfunction 2. Dome Lamps Malfunction				

Circuit/System Description

The body control module (BCM) supplies battery voltage to the front and rear reading lamps, left and right sunshade lamps, center console compartment lamp, and instrument panel compartment lamp via the courtesy lamp control circuit. When the instrument panel compartment or a sunshade mirror is opened, the switch contacts close allowing battery voltage to flow illuminating the respective lamps. The front and rear reading lamps are controlled by individual switches that are activated by the operator when additional cabin lighting is required. In the event that any of these courtesy lamps were to remain illuminated for more than 10 minutes with the ignition switch in the OFF position and no doors opened, the BCM will deactivate the courtesy lamp control circuit to prevent total battery discharge.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the inoperative courtesy lamp. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the appropriate ground circuit terminal listed below and ground.
 - E27 instrument panel compartment lamp terminal 2
 - E31L sunshade mirror lamp - left terminal B
 - E31R sunshade mirror lamp - right terminal B
 - E37D dome/reading lamps - overhead console terminal 6
 - E37R dome/reading lamps - rear terminal 6
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
 - E27 instrument panel compartment lamp terminal 1
 - E31L sunshade mirror lamp - left terminal A
 - E31R sunshade mirror lamp - right terminal A
 - E37D dome/reading lamps - overhead console terminal 1
 - E37R dome/reading lamps - rear terminal 1
4. Verify the test lamp turns ON and OFF when commanding the Inadvertent Load ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K9 body control module.
- **If the test lamp turns ON and OFF**

5. Test or replace the appropriate courtesy lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Sunshade Replacement**
- **Instrument Panel Compartment Lamp Replacement**
- **Dome and Reading Lamp Replacement**
- **Control Module References** for BCM replacement, programming, and setup

DAYTIME RUNNING LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F9DA Fuse B+	1	1	-	-
F23DA Fuse B+	1	1	-	-
Ambient Light Sensor Signal	B2645 03	B2645 07	B2645 07	-
Daytime Running Lamp Control - Left (T4F)	B2600 02	B2600 04	B2600 01	-
Daytime Running Lamp Control - Right (T4F)	B2605 02	B2605 04	B2605 01	-
Ambient Light Sensor Low Reference	-	B2645 07	1	-
Daytime Running Lamp Ground - Left (T4F)	-	1	-	-
Daytime Running Lamp Ground - Right (T4F)	-	1	-	-
1. Daytime Running Lamps Malfunction				

Circuit/System Description

The ambient light sensor is used to monitor outside lighting conditions. The body control module (BCM)

provides a 5-volt reference signal to the ambient light sensor. Depending on outside lighting conditions, the ambient light sensor provides a voltage signal to the BCM that will vary between 0.2 and 4.9 volts. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic headlamp system control when the headlamp switch is in the AUTO position. In daylight conditions, the BCM will command the DRLs ON by applying voltage to the DRL control circuits illuminating the DRLs. Any function or condition that turns on the headlamps will cancel DRL operation.

Reference Information

Schematic Reference

- **Headlights/Daytime Running Lights (DRL) Schematics**
- **Body Control System Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the left daytime running lamp turns ON and OFF while commanding the Left Front Park Lamp/Daytime Running Lamp ON and OFF with a scan tool.

- **If the left daytime running lamp does not turn ON and OFF**

Refer to Daytime Running Lamps Malfunction.

- **If the left daytime running lamp turns ON and OFF**

3. Verify the right daytime running lamp turns ON and OFF while commanding the Right Front Park Lamp/Daytime Running Lamp ON and OFF with a scan tool.

- **If the right daytime running lamp does not turn ON and OFF**

Refer to Daytime Running Lamps Malfunction.

- **If the right daytime running lamp turns ON and OFF**

4. Refer to Ambient Light Sensor Malfunction.

Circuit/System Testing

Daytime Running Lamps Malfunction

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate E13 headlamp.
2. Test for less than 5 ohms between the ground circuit terminal 1 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Connect a test lamp between the control circuit terminal 4 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the appropriate Front Park Lamp/Daytime Running Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the appropriate E13 headlamp.

Ambient Light Sensor Malfunction

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, open and close drivers door,

disconnect the harness connector at the B10B ambient light/sunload sensor. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 15 ohms between the low reference circuit terminal 6 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K33 HVAC control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC control module.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool Ambient Light Sensor parameter is greater than 4.65 V.
 - **If 4.65 V or less**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If greater than 4.65 V**
5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the low reference circuit terminal 6.
6. Verify the scan tool Ambient Light Sensor parameter is less than 0.196 V.
 - **If 0.196 V or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If less than 0.196 V**
7. Test or replace the B10B ambient light/sunload sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Replacement**
- **Headlamp Automatic Control Ambient Light Sensor Replacement**
- **Control Module References** for BCM or HVAC control module replacement, programming, and setup

DOMELAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Dome Lamp Switch Cancel Signal	2	2	2	-
Dome Lamp Switch ON Signal	2	2	2	-
Dome/Courtesy Lamps Control - Terminal 5 X2	B2615 02	1	1	-
Dome/Reading Lamps - Overhead Console Ground	-	1	-	-
Dome/Reading Lamps - Rear Ground	-	1	-	-
Door Courtesy Lamp - Driver Ground	-	1	-	-
Door Courtesy Lamp - Passenger Ground	-	1	-	-
Instrument Panel Courtesy Lamp - Left Ground	-	1	-	-
Instrument Panel Courtesy Lamp - Right Ground	-	1	-	-
1. Dome Lamps Malfunction 2. Dome Lamp Switch Malfunction				

Circuit/System Description

The dome lamp switch has 3 positions: DOOR, OFF, and ON. The ON position provides a ground for continuous operation and the dome/courtesy lamps will remain illuminated until the switch is placed in either the DOOR or OFF position. When in the DOOR position, the dome lamps operation is controlled by the body control module (BCM). When any door is opened, the door ajar switch contacts close and the BCM receives a door-open input. The BCM illuminates the dome lamps, door courtesy lamps, and instrument panel courtesy lamps when any door is opened or a door lock/unlock request is activated with the key fob. After all doors have been closed, the dome lamps, door courtesy lamps, and instrument panel courtesy lamps will remain illuminated approximately 3 seconds after the last door closes. When the driver places the dome lamp switch in the OFF position, the dome/courtesy lamps will be disabled. In the event that the dome/courtesy lamps were to remain illuminated for more than 10 minutes with the ignition switch in the OFF position and no doors opened, the BCM will deactivate the dome/courtesy lamps control circuit to prevent total battery discharge.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Door Ajar Sw. parameter changes between Active and Inactive while opening and closing each vehicle door.
 - **If the parameter does not change**

Refer to **Door Ajar Indicator Malfunction** .
 - **If the parameter changes**
3. Verify the scan tool Interior/Courtesy Lighting Master Switch parameter changes between Door, On, and Cancel while placing the dome lamp switch in the Door, On, and Cancel positions.
 - **If the parameter does not change**

Refer to Dome Lamp Switch Malfunction.
 - **If the parameter changes**
4. Verify the dome/courtesy lamps turn ON and OFF while commanding the Courtesy Lamps ON and OFF with a scan tool.
 - **If the dome/courtesy lamps do not turn ON and OFF**

Refer to Dome/Courtesy Lamps Malfunction.
 - **If the dome/courtesy lamps turn ON and OFF**

5. All OK.

Circuit/System Testing

Dome Lamp Switch Malfunction

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the E37D dome/reading lamps - overhead console. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 6 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Interior/Courtesy Lighting Master Switch parameter is Door.
 - **If Cancel**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If On**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Door**
5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the ground circuit terminal 6.
6. Verify the scan tool Interior/Courtesy Lighting Master Switch parameter is Cancel.
 - **If not Cancel**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.

- **If Cancel**

7. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the ground circuit terminal 6.
8. Verify the scan tool Interior/Courtesy Lighting Master Switch parameter is On.

- **If not On**

1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.

- **If On**

9. Test or replace the E37D dome/reading lamps - overhead console.

Dome/Courtesy Lamps Malfunction

NOTE: Each component on the control circuit may need to be disconnected to isolate a short to voltage or short to ground. Use the schematics to identify the following:

- Lighting components the vehicle is equipped with
- Each component's control and ground circuit terminals
- Component locations on the backlighting control circuit

1. Ignition OFF, all doors closed, all accessories OFF, disconnect the harness connectors at the components listed below.
 - E37D dome/reading lamps - overhead console
 - E37R dome/reading lamps - rear
 - E8D door courtesy lamp - driver
 - E8P door courtesy lamp - passenger
 - E8J instrument panel courtesy lamp - left
 - E8K instrument panel courtesy lamp - right
2. Test for less than 10 ohms between the appropriate ground circuit terminal listed below and ground.
 - E37D dome/reading lamps - overhead console terminal 6
 - E37R dome/reading lamps - rear terminal 6
 - E8D door courtesy lamp - driver terminal 2
 - E8P door courtesy lamp - passenger terminal 2
 - E8J instrument panel courtesy lamp - left terminal 2
 - E8K instrument panel courtesy lamp - right terminal 2

- **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
- 3. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
 - E37D dome/reading lamps - overhead console terminal 2
 - E37R dome/reading lamps - rear terminal 2
 - E8D door courtesy lamp - driver terminal 1
 - E8P door courtesy lamp - passenger terminal 1
 - E8J instrument panel courtesy lamp - left terminal 1
 - E8K instrument panel courtesy lamp - right terminal 1
- 4. Verify the test lamp turns ON and OFF when commanding the Courtesy Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
- 5. Test or replace the appropriate dome/courtesy lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Dome and Reading Lamp Replacement**
- **Front Floor Flood Lamp Replacement**
- **Front Side Door Courtesy Lamp Lens Replacement**
- **Control Module References** for BCM replacement, programming, and setup

FRONT FOG LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Front Fog Lamp and Instrument Panel Dimmer Switch B+	B257B 03, B1405 03	B257B 03	-	-
Front Fog Lamp and Instrument Panel Dimmer Switch Signal	B257B 03	B257B 03	1	-
Front Fog Lamp Relay Control	B2530 02, B2530 04	B2530 02, B2530 04	B2530 01	-
Front Fog Lamp Control	1	1	1	-
Front Fog Lamp Ground - Left	-	1	-	-
Front Fog Lamp Ground - Right	-	1	-	-
1. Front Fog Lamps Malfunction				

Circuit/System Description

The front fog lamp switch is an input to the body control module (BCM) and is contained in the headlamp switch assembly. The BCM supplies voltage to the front fog lamp switch via the front fog lamp and instrument panel dimmer switch B+ circuit. When the front fog lamp switch is pressed, voltage from the B+ circuit is pulled down through the front fog lamp switch resistor. The front fog lamp resistor is part of the resistor ladder that also provides the dimming signals for the instrument panel dimmer switches. The BCM receives the voltage signal through the front fog lamp and instrument panel dimmer switch signal circuit.

The front fog lamp relay is supplied with battery voltage at all times. The front fog lamp switch signal circuit is grounded momentarily by pressing the front fog lamp switch. The body control module (BCM) energizes the front fog lamp relay by applying ground to the front fog lamp relay control circuit. When the front fog lamp relay is energized, the relay switch contacts close and battery voltage is applied through the FRT FOG fuse to the front fog lamp control circuit which illuminates the front fog lamps.

Reference Information

Schematic Reference

Fog Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, headlamps ON.
2. Verify the scan tool Front Fog Lamps Switch parameter changes between Active and Inactive while commanding the front fog lamps ON and OFF with the front fog lamp switch.
 - **If the parameter does not change**

Refer to Front Fog Lamp Switch Malfunction.
 - **If the parameter changes**
3. Verify the front fog lamps turn ON and OFF when commanding the Front Fog Lamps ON and OFF with a scan tool.
 - **If the front fog lamps do not turn ON and OFF**

Refer to Front Fog Lamps Malfunction.
 - **If the front fog lamps turn ON and OFF**
4. Verify the front fog lamp indicator on the instrument cluster turns ON and OFF while commanding the front fog lamps ON and OFF with the front fog lamp switch.
 - **If the front fog lamp indicator does not turn ON and OFF**

Refer to Front Fog Lamp Indicator Malfunction.
 - **If the front fog lamp indicator turns ON and OFF**
5. All OK.

Circuit/System Testing

Front Fog Lamp Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S30 headlamp switch, ignition ON.
2. Test for B+ between the B+ circuit terminal 1 and ground.
 - **If less than B+**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If B+**
3. Verify the scan tool LED Backlight Dimming Command parameter is greater than 40%.
 - **If 40% or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 12 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If greater than 40%**
4. Install a 3 A fused jumper wire between the signal circuit terminal 12 and the B+ circuit terminal 1.
5. Verify the scan tool LED Backlight Dimming Command parameter is less than 30%.
 - **If 30% or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If less than 30%**
6. Test or replace the S30 headlamp switch.

Front Fog Lamps Malfunction

1. Ignition OFF, disconnect the X2 harness connector at the X50A fuse block - underhood.
2. Connect a test lamp between the control circuit terminal 19 and B+, ignition ON.
3. Verify the test lamp turns ON and OFF when commanding the Front Fog Lamps ON and OFF with a scan

tool.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Ignition OFF.
4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module.
2. Test for infinite resistance between the control circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.

- **If the test lamp turns ON and OFF**

4. Ignition OFF, connect the X2 harness connector at the X50A fuse block - underhood.
5. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate E29 fog lamp.
6. Test for less than 5 ohms between the ground circuit terminal 2 and ground.

- **If 5 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 5 ohms**

7. Connect a test lamp between the control circuit terminal 1 and ground, ignition ON.
8. Verify the test lamp turns ON and OFF when commanding the Front Fog Lamps ON and OFF with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the X1 harness connector at the X50A fuse block - underhood.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A fuse block - underhood.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the X1 harness connector at the X50A fuse block - underhood, ignition

ON.

2. Test for less than 1 V between the control circuit terminal and ground.

- If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the X50A fuse block - underhood.

- **If the test lamp turns ON and OFF**

9. Test or replace the appropriate E29 fog lamp.

Front Fog Lamp Indicator Malfunction

1. Ignition ON.

2. Verify the front fog lamp indicator turns ON and OFF when commanding the Instrument Cluster All Indicators Test ON and OFF with a scan tool.

- **If the front fog lamp indicator is always OFF or remains ON**

Replace the P16 instrument cluster.

- **If the front fog lamp indicator turns ON and OFF**

3. Replace the K9 body control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Switch Replacement**

- **Front Fog Lamp Replacement**

- **Front Fog Lamp Bulb Replacement**

- **Underhood Electrical Center or Junction Block Replacement**

- **Control Module References** for BCM or Instrument Cluster replacement, programming, and setup

HAZARD LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Hazard Warning Switch Signal	1	1	1	B3596 00
Hazard Warning Switch LED	2	2	2	-

Backlighting Control				
Hazard Warning Switch Ground	-	1	-	-
1. Hazard Lamps Malfunction 2. Hazard Warning Switch Backlighting Malfunction				

Circuit/System Description

The hazard flashers may be activated in any power mode. The hazard warning switch signal circuit is momentarily grounded when the hazard warning switch is pressed. The body control module (BCM) responds to the hazard warning switch signal input by supplying battery voltage to all four turn signal lamps in an ON and OFF duty cycle. When the hazard warning switch is activated, the BCM sends a serial data message to the instrument cluster requesting both turn signal indicators to be cycled ON and OFF.

The instrument panel dimmer switch controls are located on the headlamp switch assembly and are used to increase and decrease the brightness of the interior backlighting components. When the instrument panel dimmer switch is placed in a desired brightness position, the body control module (BCM) receives a signal from the instrument panel dimmer switch and responds by applying a pulse width modulated (PWM) voltage to the hazard warning switch LED backlighting control circuit illuminating the LED to the desired level of brightness.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Hazard Lamps Switch parameter changes between Active and Inactive while commanding the hazard lamps ON and OFF with the hazard warning switch.
 - **If the parameter does not change**

Refer to Hazard Warning Switch Malfunction.
 - **If the parameter changes**
3. Verify all left and right turn signal lamps turn ON and OFF while commanding the hazard lamps ON and OFF with the hazard warning switch.
 - **If all turn signal lamps do not turn ON and OFF**

Refer to **Turn Signal Lamps and/or Indicators Malfunction**
 - **If all turn signal lamps turn ON and OFF**
4. Verify the hazard warning switch backlighting turns ON and OFF while commanding the Hazard Lamps Switch Backlight ON and OFF with a scan tool.
 - **If the hazard warning switch backlighting does not turn ON and OFF**

Refer to Hazard Warning Switch Backlighting Malfunction.
 - **If the hazard warning switch backlighting turns ON and OFF**
5. All OK.

Circuit/System Testing

Hazard Warning Switch Malfunction

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S48C multifunction switch 1 - instrument panel. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 7 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool Hazard Lamps Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module.

2. Test for infinite resistance between the signal circuit terminal 10 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 10 and ground.
6. Verify the scan tool Hazard Lamps Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 10 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
7. Test or replace the S48C multifunction switch 1 - instrument panel.

Hazard Warning Switch Backlighting Malfunction

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S48C multifunction switch 1 - instrument panel. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 7 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Connect a test lamp between the control circuit terminal 5 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the Hazard Lamps Switch Backlight ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 body control module.
- **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
- **If the test lamp turns ON and OFF**
- 5. Test or replace the S48C multifunction switch 1 - instrument panel.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

-
- **Control Module References** for BCM or Instrument Cluster replacement, programming, and setup

HEADLAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F9DA Fuse B+	B2699 01, B2699 04	B2699 01, B2699 04	-	-
F8DA Fuse B+	B2575 01, B2575 04	B2575 01, B2575 04	-	-
Headlamp Switch Headlamps OFF Signal	B257A 00	3	3	-
Headlamp Switch Headlamps ON Signal	B257A 00	3	3	-
Headlamp Switch Park Lamps ON Signal	3	B257A 00	3	-
Turn Signal/Multifunction Switch Flash To Pass Signal	B3806 00	4	4	-
Turn Signal/Multifunction Switch High Beam Signal	B3650 08	4	4	-
Headlamp Low Beam Relay Control	B258A 02,	B258A 02,	B258A 01	-

	B258A 04	B258A 04		
Headlamp High Beam Relay Control	B2580 02, B2580 04	B2580 02, B2580 04	B2580 01	-
Low Beam Headlamp Control - Left (T4A)	B2575 02	B2575 01, B2575 04	1	-
Low Beam Headlamp Control - Right (T4A)	B2699 02	B2699 01, B2699 04	1	-
Low Beam Headlamp Control - Left (T4F)	1	1	1	-
Low Beam Headlamp Control - Right (T4F)	1	1	1	-
High Beam Headlamp Control - Left	2	2	2	-
High Beam Headlamp Control - Right	2	2	2	-
Headlamp Ground - Left	-	1	-	-
Headlamp Ground - Right	-	1	-	-
Headlamp Switch Ground	-	3	-	-
Turn Signal/Multifunction Switch Ground	-	4	-	-
1. Headlamps Malfunction - Low Beam 2. Headlamps Malfunction - High Beam 3. Headlamp Switch Malfunction 4. Turn Signal/Multifunction Switch Malfunction				

Circuit/System Description

Low Beams - with T4A

The body control module (BCM) monitors three signal circuits from the headlamp switch. When the headlamp switch is in the AUTO position, all three signal circuits are open. When placed in the AUTO position, the BCM monitors inputs from the ambient light sensor to determine if headlamps are required or if daytime running lamps will be activated based on outside lighting conditions. When the headlamp switch is placed in the OFF position, the headlamp switch headlamps OFF signal circuit is grounded, indicating to the BCM that the exterior lamps should be turned OFF. With the headlamp switch in the PARK position, the headlamp switch park lamps ON signal circuit is grounded, indicating that the park lamps have been requested. When the headlamp switch is placed in the HEADLAMP position, both the headlamp switch park lamps ON signal circuit and the headlamp switch headlamps ON signal circuit are grounded. The BCM responds to the inputs by illuminating the park lamps and headlamps. When the low beam headlamps are requested, the BCM applies B+ to both low beam headlamp control circuits illuminating the low beam headlamps.

Low Beams - with T4F

The body control module (BCM) monitors three signal circuits from the headlamp switch. When the headlamp switch is in the AUTO position, all three signal circuits are open. When placed in the AUTO position, the BCM monitors inputs from the ambient light sensor to determine if headlamps are required or if daytime running lamps will be activated based on outside lighting conditions. When the headlamp switch is placed in the OFF

position, the headlamp switch headlamps OFF signal circuit is grounded, indicating to the BCM that the exterior lamps should be turned OFF. With the headlamp switch in the PARK position, the headlamp switch park lamps ON signal circuit is grounded, indicating that the park lamps have been requested. When the headlamp switch is placed in the HEADLAMP position, both the headlamp switch park lamps ON signal circuit and the headlamp switch headlamps ON signal circuit are grounded. The BCM responds to the low beam request by applying ground to the low beam relay control circuit which energizes the low beam relay. With the low beam relay energized, the switch contacts close allowing battery voltage to flow through the low beam fuses to the low beam control circuits illuminating the low beam headlamps.

The high beam and flash to pass functions are contained within the turn signal/multifunction switch. The BCM provides the turn signal/multifunction switch with two signal circuits, the high beam signal circuit and the flash to pass signal circuit. When the low beam headlamps are ON and the turn signal/multifunction switch is placed in the high beam position, ground is applied to the BCM through the high beam signal circuit. The BCM responds to the high beam request by applying ground to the high beam relay control circuit which energizes the high beam relay. With the high beam relay energized, the switch contacts close allowing battery voltage to flow through the high beam fuses to the high beam control circuits illuminating the high beam headlamps.

When the turn signal/multifunction switch is momentarily placed in the flash to pass position, ground is applied to the BCM through the flash to pass signal circuit. The BCM responds by applying ground to the high beam relay control circuit which energizes the high beam relay illuminating the high beams for a brief moment or until the flash to pass switch is released.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

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Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Headlamps On Switch parameter changes between Active and Inactive while commanding the headlamp ON and OFF with headlamp switch.
 - **If the parameter does not change**

Refer to Headlamp Switch Malfunction.
 - **If the parameter changes**
3. Verify the scan tool Automatic Headlamps Disable Switch parameter changes between Active and Inactive while commanding the automatic lamp control ON and OFF with the turn signal/multifunction switch.
 - **If the parameter does not change**

Refer to Headlamp Switch Malfunction.
 - **If the parameter changes**
4. Verify the scan tool Headlamps Flash Switch parameter changes between Active and Inactive while commanding the flash to pass ON and OFF with the turn signal/multifunction switch.
 - **If the parameter does not change**

Refer to Turn Signal/Multifunction Switch Malfunction.
 - **If the parameter changes**
5. Verify the scan tool High Beam Select Switch parameter changes between Active and Inactive while commanding the high beams ON and OFF with the turn signal/multifunction switch.
 - **If the parameter does not change**

Refer to Turn Signal/Multifunction Switch Malfunction.
 - **If the parameter changes**
6. Verify the left low beam headlamp turns ON and OFF when commanding the Left Headlamp Low Beam ON and OFF with a scan tool.
 - **If the left low beam/daytime running lamp does not turn ON and OFF**

Refer to Headlamps Malfunction - Low Beam.
 - **If the left low beam/daytime running lamp turns ON and OFF**
7. Verify the right low beam headlamp turns ON and OFF when commanding the Right Headlamp Low Beam ON and OFF with a scan tool.
 - **If the right low beam/daytime running lamp does not turn ON and OFF**

Refer to Headlamps Malfunction - Low Beam.

- **If the right low beam/daytime running lamp turns ON and OFF**

8. Verify the high beams turn ON and OFF when commanding the High Beams ON and OFF with a scan tool.

- **If the high beams do not turn ON and OFF**

Refer to Headlamps Malfunction - High Beam.

- **If the high beams turn ON and OFF**

9. Verify the high beam indicator on the instrument cluster turns ON and OFF while commanding the All Indicators Test ON and OFF with a scan tool.

- **If the high beam indicator does not turn ON and OFF**

Refer to High Beam Indicator Malfunction.

- **If the high beam indicator turns ON and OFF**

10. All OK.

Circuit/System Testing

Headlamp Switch Malfunction

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S30 Headlamp Switch. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 15 ohms between the ground circuit terminal 6 and ground.

- **If 15 ohms or greater**

1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 15 ohms**

3. Ignition ON.

4. Verify the scan tool Automatic Headlamps Disable Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module.

2. Test for infinite resistance between the signal circuit terminal 5 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K9 Body Control Module.

- **If Inactive**

5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the ground circuit terminal 6.

6. Verify the scan tool Automatic Headlamps Disable Switch parameter is Active.

- **If not Active**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
- **If Active**
- 7. Verify the scan tool Park Lamps Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
- 8. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 6.
- 9. Verify the scan tool Park Lamps Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
- 10. Verify the scan tool Headlamps On Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
- 11. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the ground circuit terminal 6.
- 12. Verify the scan tool Headlamps On Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module, ignition ON.

2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
- **If Active**
13. Test or replace the S30 Headlamp Switch.

Turn Signal/Multifunction Switch Malfunction

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S78 Turn Signal/Multifunction Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 3 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool High Beam Select Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 3.
6. Verify the scan tool High Beam Select Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If Active**
- 7. Verify the scan tool Headlamps Flash Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
- 8. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the ground circuit terminal 3.
- 9. Verify the scan tool Headlamps Flash Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
- 10. Test or replace the S78 Turn Signal/Multifunction Switch.

Headlamps Malfunction - Low Beam (with T4A)

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate E4 Headlamp - Low Beam.
2. Test for less than 5 ohms between the ground circuit terminal B and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Connect a test lamp between the control circuit terminal A and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the appropriate Headlamp Low Beam ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 - 1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
 - 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
- 5. Test or replace the appropriate E4 Headlamp - Low Beam.

Headlamps Malfunction - Low Beam (with T4F)

1. Ignition OFF, disconnect the KR49 Headlamp Low Beam Relay, ignition ON
2. Verify a test lamp illuminates between the B+ circuit terminal 86 and ground.
 - **If the test lamp does not illuminate**
 - Replace the X50A Fuse Block - Underhood.
 - **If the test lamp illuminates**
3. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate**
 - Replace the X50A Fuse Block - Underhood.
 - **If the test lamp illuminates**
4. Connect a test lamp between the control circuit terminal 85 and B+, ignition ON.
5. Verify the test lamp turns ON and OFF when commanding the Low Beams Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 - 1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
 - 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Ignition OFF.
 - 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**

1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
6. Ignition OFF, exterior lamps OFF, connect the KR49 Headlamp Low Beam Relay.
7. Disconnect the harness connector at the appropriate E13 headlamp.
8. Test for less than 5 ohms between the ground circuit terminal 10 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
9. Connect a test lamp between the control circuit terminal 3 and ground, ignition ON.
10. Verify the test lamp turns ON and OFF when commanding the Low Beam Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 harness connector at the X50A Fuse Block - Underhood.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the KR49 Headlamp Low Beam Relay.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X1 harness connector at the X50A Fuse Block - Underhood, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the KR49 Headlamp Low Beam Relay.
 - **If the test lamp turns ON and OFF**
 - 11. Ignition OFF, replace the appropriate T7 Headlamp Ballast.
 - 12. Ignition ON, verify the appropriate low beam headlamp illuminates when commanded ON with the headlamp switch.
 - **If the low beam headlamp does not illuminate**
 1. Replace the appropriate E4 Headlamp - Low Beam bulb.
 - **If the low beam headlamp illuminates**

13. All OK.

Headlamps Malfunction - High Beam

1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
2. Verify a test lamp illuminates between the control circuit terminal 18 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for infinite resistance between the control circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A Fuse Block - Underhood.
 - **If the test lamp illuminates**
3. Ignition OFF, connect a 3 A fused jumper between the control circuit terminal 18 and ground.
4. Remove the left high beam fuse (F38UA) at the X50A Fuse Block - Underhood, ignition ON.
5. Verify a test lamp illuminates between the left high beam fuse (F38UA) B+ switch control terminal and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X1 harness connector at the X50A Fuse Block - Underhood, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the X50A Fuse Block - Underhood.
 - **If the test lamp illuminates**
6. Ignition OFF, connect the X5 harness connector at the K9 Body Control Module.
7. Install the left high beam fuse (F38UA) at the X50A Fuse Block - Underhood.
8. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate headlamp - high beam.
9. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E4 HighBeam Headlamp - terminal 2 (T4A)
 - M28 High Beam Headlamp Solenoid Actuator - terminal 1 (T4F)
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**

10. Connect a test lamp between the appropriate control circuit terminal listed below and ground, ignition ON.
 - E4 HighBeam Headlamp - terminal 1 (T4A)
 - M28 High Beam Headlamp Solenoid Actuator - terminal 2 (T4F)
11. Verify the test lamp turns ON and OFF when commanding the High Beams ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 harness connector at the X50A Fuse Block - Underhood.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X1 harness connector at the X50A Fuse Block - Underhood, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
12. Test or replace the appropriate headlamp - high beam.

High Beam Indicator Malfunction

1. Ignition ON.
2. Verify the high beam indicator turns ON and OFF when commanding the Instrument Cluster All Indicators Test ON and OFF with a scan tool.
 - **If the high beam indicator is always OFF or remains ON**

Replace the P16 Instrument Cluster.
 - **If the high beam indicator turns ON and OFF**
3. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Ballast Replacement**
- **Headlamp Switch Replacement**

- **Headlamp Replacement**
- **Headlamp Bulb Replacement**
- **Relay Replacement (Within an Electrical Center) , Relay Replacement (Attached to Wire Harness)**
- **TURN SIGNAL SWITCH REPLACEMENT**
- **Fuse Block Replacement**
- **Control Module References** for BCM or Instrument Cluster replacement, programming, and setup

HEADLAMP LEVELING MALFUNCTION (AUTOMATIC)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LIN Serial Data - Left Headlamp Leveling Actuator	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	B3440 03, U1511 00, U1521 00, U1531 00	-
LIN Serial Data - Right Headlamp Leveling Actuator	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	B3435 00, U1512 00, U1522 00, U1532 00	-
Headlamp Control Module B+	1	1	-	-
Headlamp Leveling Actuator - Left B+	B3435 03	B3435 03	B3435 00	-
Headlamp Leveling Actuator - Right B+	B3440 03	B3440 03	B3440 00	-
Suspension Position Sensor 5V Reference - Left Front	B3415 02	1	B3415 01	-
Suspension Position Sensor 5V Reference - Left Rear	B3415 02	1	B3415 01	-
Suspension Position Sensor Signal - Left Front	B3410 06	B3410 06	B3410 01	B3410 08
Suspension Position Sensor Signal - Left Rear	B3420 06	B3420 06	B3420 01	B3420 08
Suspension Position Sensor Low Reference - Left Front	-	1	-	-
Suspension Position Sensor Low Reference - Left Rear	-	1	-	-

Headlamp Control Module Ground	-	1	-	-
Headlamp Leveling Actuator - Left Ground	-	B3435 03	-	-
Headlamp Leveling Actuator - Right Ground	-	B3440 03	-	-
1. Headlamp Leveling Malfunction				

Circuit/System Description

Each headlamp assembly contains a headlamp leveling actuator that is controlled by the headlamp leveling control module. The front and rear suspension position sensors provide the headlamp leveling control with suspension position information. Each sensor receives a 5 V reference, signal, and low reference circuits from the headlamp leveling control module. The sensors are connected to the control arms of the front and rear suspension. As the vehicle travels, the suspension compresses and rebounds moving the suspension position sensor arms. This causes the signal output of the sensor to change. The headlamp leveling control module compares the information from both suspension position sensors and adjusts the headlamp leveling as needed. The headlamp leveling control module communicates with the left and right headlamp leveling actuators via the LIN serial data circuit.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Front Leveling Position Sensor Voltage parameter is between 0.5 and 4.9 V.
 - **If the parameter is not between 0.5 and 4.9 V**

Refer to Headlamp Leveling Sensor Malfunction.
 - **If the parameter is between 0.5 and 4.9 V**
3. Verify the scan tool Rear Leveling Position Sensor Voltage parameter is between 0.5 and 4.9 V.
 - **If the parameter is not between 0.5 and 4.9 V**

Refer to Headlamp Leveling Sensor Malfunction.
 - **If the parameter is between 0.5 and 4.9 V**
4. Verify the left and right headlamps operate to the UP and DOWN positions when commanding the DHL Motor Control UP and DOWN with a scan tool.
 - **If the left and right headlamps do not operate UP and DOWN**

Refer to Headlamp Leveling Actuator Malfunction
 - **If the left and right headlamps operate UP and DOWN**
5. All OK.

Circuit/System Testing

Headlamp Leveling Actuator Malfunction

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate E13 Headlamp Assembly.
2. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E13LA Headlamp Assembly - left terminal 8 with A1LL
 - E13RA Headlamp Assembly - right terminal 8 with A1LL
 - E13LA Headlamp Assembly - left terminal 7 with A1SL
 - E13RA Headlamp Assembly - right terminal 7 with A1SL
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the appropriate B+ circuit terminal listed below and ground.
 - E13LA Headlamp Assembly - left terminal 6 with A1LL

- E13RA Headlamp Assembly - right terminal 6 with A1LL
- E13LA Headlamp Assembly - left terminal 8 with A1SL
- E13RA Headlamp Assembly - right terminal 8 with A1SL
- **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A Fuse Block - Underhood.
 - **If the test lamp illuminates**
- 5. Test or replace the K26 Headlamp Control Module.
- 6. Ignition ON.
- 7. Verify the appropriate headlamp operates to the UP and DOWN positions when commanding the DHL Motor Control UP and DOWN with a scan tool.
 - If the appropriate headlamp does not operate UP and DOWN, test or replace the appropriate headlamp assembly.

Headlamp Leveling Sensor Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate B51 Suspension Height Sensor, ignition ON.
2. Verify a test lamp illuminates between the low reference circuit terminal 2 and B+.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K26 Headlamp Control Module.
 - **If the test lamp illuminates**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K26 Headlamp Control Module.
- **If greater than 5.2 V**
- 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module, ignition ON.
- 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K26 Headlamp Control Module.
- **If between 4.8-5.2 V**
- 5. Verify the appropriate scan tool Leveling Position Sensor parameter is less than 1 V.
 - **If 1 V or greater**
 - 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module, ignition ON.
 - 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K26 Headlamp Control Module.
 - **If less than 1 V**
- 6. Install a 3 A fused jumper wire between the 5-volt reference circuit terminal 1 and the signal circuit terminal 3.
- 7. Engine RUNNING, verify the appropriate scan tool Leveling Position Sensor parameter is greater than 4.8 V.
 - **If less than 4.8 V**
 - 1. Ignition OFF, disconnect the harness connector at the K26 Headlamp Control Module.
 - 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K26 Headlamp Control Module.
 - **If 4.8 V or greater**
- 8. Test or replace the appropriate B51 Suspension Height Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **HEADLAMP LEVELING FRONT SUSPENSION HEIGHT SENSOR REPLACEMENT**
- **HEADLAMP LEVELING REAR SUSPENSION HEIGHT SENSOR REPLACEMENT**
- **Control Module References** for headlamp control module replacement, programming, and setup

INTERIOR ACCENT LIGHTING MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flood Lamp Control - Terminal 23 X1	B255D 02	1	1	-
Flood Lamp - Driver Door Pocket Ground	-	1	-	-
Flood Lamp - Passenger Door Pocket Ground	-	1	-	-
1. Interior Accent Lighting Malfunction				

Circuit/System Description

The body control module (BCM) supplies battery voltage to front door flood lamps via the flood lamp control circuit. When a door is opened the BCM applies battery voltage to the flood lamp control circuit illuminating the driver and passenger door pocket flood lamps. The flood lamps will remain illuminated until all doors are closed and the ignition is OFF.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the appropriate E55 flood lamp. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 2 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Connect a test lamp between the control circuit terminal 1 and ground.
4. Verify the test lamp turns ON and OFF when commanding the Accent Lighting ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the appropriate E55 flood lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Sill Courtesy Lamp Replacement**
- **Control Module References** for BCM replacement, programming, and setup

INTERIOR BACKLIGHTING MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Instrument Panel Dimmer Switch B+	B1405 03, B1529 03, B257B 03	B257B 03	-	-
Instrument Panel Dimmer Switch Signal	B257B 03	B257B 03	B257B 07	-
LED Backlight Dimming Control Terminal 8 X2	B2610 02	2	2	-
LED Backlight Dimming Control Terminal 9 X7	B2610 02	2	2	-
Switch Indicator LED Backlight Dimming Control Terminal 5 X1	B2625 02	2	2	-
Dome/Reading Lamps - Overhead Console Ground	-	2	-	-
Dome/Reading Lamps - Rear Ground	-	2	-	-
Garage Door Opener Ground	-	2	-	-
Headlamp Switch Ground	-	1	-	-
Ignition Mode Switch Ground	-	2	-	-
Multifunction Switch 1 - Instrument Panel Ground	-	2	-	-
Multifunction Switch 2 - Instrument Panel Ground	-	2	-	-
Outside Rearview Mirror Switch Ground	-	2	-	-
Park Assist ON/OFF Switch Ground	-	2	-	-
Park Brake Control Switch Ground	-	2	-	-
Steering Wheel Controls Switch - Left Ground	-	2	-	-
Steering Wheel Controls Switch - Right Ground	-	2	-	-
Sunroof Switch Ground	-	2	-	-
Sunroof Tilt Switch Ground	-	2	-	-

Window Switch - Passenger Ground	-	2	-	-
1. Dimmer Switch Malfunction 2. Interior Backlighting Malfunction				

Circuit/System Description

The instrument panel dimmer switch is used to increase and decrease the brightness of the interior backlighting components. The instrument panel dimmer switch provides a voltage signal to the body control module (BCM) that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The BCM provides a low reference signal and a B+ reference circuit to the instrument panel dimmer switch. When the instrument panel dimmer switch is placed in the desired position, the dimmed voltage setting is applied from the instrument panel dimmer switch through the instrument panel dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies a pulse width modulated (PWM) voltage through the LED dimming control circuits illuminating the interior backlighting to the requested level of brightness.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool LED Backlight Dimming Command parameter changes between a high percentage to a low percentage while operating the dimmer switch from high to low.

- **If the parameter does not change**

Refer to Dimmer Switch Malfunction.

- **If the parameter changes**

3. Verify all backlighting components turn ON and OFF while commanding the LED Backlight Dimming ON and OFF with a scan tool.

- **If all backlighting components do not turn ON and OFF**

Refer to Interior Backlighting Malfunction.

- **If all backlighting components turn ON and OFF**

4. All OK.

Circuit/System Testing

Dimmer Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S30 Headlamp Switch, ignition ON.
2. Test for B+ between the B+ circuit terminal 1 and ground.
 - **If less than B+**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If B+**
3. Verify a test lamp does not illuminate between the B+ circuit terminal 1 and the signal circuit terminal 12.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp does not illuminate**
4. Test for B+ between the B+ circuit terminal 1 and the signal circuit terminal 12.
 - **If less than B+**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 12 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
- **If B+**
- 5. Test or replace the S30 Headlamp Switch.

Interior Backlighting Malfunction

NOTE: Each component with backlighting may need to be disconnected to isolate a short to voltage or short to ground. Use the schematics to identify the following:

- Backlighting components the vehicle is equipped with
- Each component's control and ground circuit terminals
- Component locations on the backlighting control circuit

1. Ignition OFF, all doors closed, all accessories OFF, disconnect the harness connector at the component with inoperative backlighting. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the appropriate ground circuit terminal and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Connect a test lamp between the appropriate control circuit terminal and ground.
4. Verify the test lamp turns ON and OFF when commanding the LED Backlight Dimming ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the appropriate harness connector listed below at the K9 body control module.
 - X2
 - X7
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 body control module.
- **If the test lamp is always ON**
- 1. Ignition OFF, disconnect the appropriate harness connector listed below at the K9 body control module, ignition ON.
 - X2
 - X7
- 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
- **If the test lamp turns ON and OFF**
- 5. Test or replace the component with inoperative backlighting.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Window Switch Replacement**
- **Headlamp Switch Replacement**
- **Sunroof Switch Replacement**
- **Reading Lamp Replacement**
- **Sunroof Sunshade Switch Replacement**
- **Ignition and Start Switch Replacement (Without BTM) , Ignition and Start Switch Replacement (With BTM)**
- **Outside Rearview Mirror Remote Control Switch Replacement**
- **Parking Brake Actuator Switch Replacement**
- **INSTRUMENT PANEL ACCESSORY TRIM PLATE REPLACEMENT**
- **Control Module References** for BCM replacement, programming, and setup

PARK, LICENSE, AND/OR TAIL LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F3DA Fuse B+	B2585 01, B2585 04	B2585 01, B2585 04	-	-

F24DA Fuse B+	B3867 01, B3867 04	B3867 01, B3867 04	-	-
Headlamp Switch Park Lamps ON Signal	2	B257A 00	2	-
Park Lamps Control - Left	B2585 02	B2585 01, B2585 04	B2585 01, B2585 04	-
Park Lamps Control - Right	B3867 02	B3867 01, B3867 04	B3867 01, B3867 04	-
Headlamp Switch Ground	-	2	-	-
Park/Turn Signal Lamp Ground - Left Front	-	1	-	-
Park/Turn Signal Lamp Ground - Right Front	-	1	-	-
Side Marker Lamp Ground - Left Front	-	1	-	-
Side Marker Lamp Ground - Right Front	-	1	-	-
Tail Lamp Ground - Left	-	1	-	-
Tail Lamp Ground - Right	-	1	-	-
1. Park, License, and/or Tail Lamps Malfunction 2. Park Lamp Switch Malfunction				

Circuit/System Description

When the headlamp switch is placed in the HEAD or PARK position, ground is applied to the park lamp switch ON signal circuit to the body control module (BCM). The BCM responds by applying voltage to the park lamps, tail lamps, and license lamps control circuits illuminating the park, tail, and license lamps.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Park Lamp Switch parameter changes between Active and Inactive while commanding the park lamps ON and OFF with the turn signal/multifunction switch.
 - **If the parameter does not change**

Refer to Headlamp Switch Malfunction.
 - **If the parameter changes**
3. Verify the left park lamps turn ON and OFF when commanding the Left Park Lamps ON and OFF with a scan tool.
 - **If the left park lamps do not turn ON and OFF**

Refer to Park Lamps Malfunction.
 - **If the left park lamps turn ON and OFF**
4. Verify the right park lamps turn ON and OFF when commanding the Right Park Lamps ON and OFF with a scan tool.
 - **If the right park lamps do not turn ON and OFF**

Refer to Park Lamps Malfunction.
 - **If the right park lamps turn ON and OFF**
5. Verify the license plate lamps turn ON and OFF when commanding the License Plate Lamps ON and OFF with a scan tool.
 - **If the license plate lamps do not turn ON and OFF**

Refer to License Plate Lamps Malfunction.
 - **If the license plate lamps turn ON and OFF**
6. All OK.

Circuit/System Testing

Headlamp Switch Malfunction

1. Ignition OFF, all doors closed, all accessories OFF, disconnect the harness connector at the S30 headlamp switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 6 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool Park Lamps Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 6.
6. Verify the scan tool Park Lamps Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
7. Test or replace the S30 headlamp switch.

Park Lamps Malfunction

1. Ignition OFF, exterior lamps OFF, trunk latch latched, disconnect the harness connector at the inoperative park/marker/tail lamp.
2. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E4N park/turn signal lamp - left terminal 2 (with T4A)
 - E2LF side marker lamp - left front terminal 1 (with T4A)
 - E13L headlamp - left terminal 1 (with T4F)
 - E5AK tail lamp - left outer terminal 3

- E5G tail lamp - left inner terminal 2
 - E4P park/turn signal lamp - right terminal 2 (with T4A)
 - E2RF side marker lamp - right front terminal 1 (with T4A)
 - E13R headlamp - right terminal 1 (with T4F)
 - E5AL tail lamp - right outer terminal 3
 - E5H tail lamp - right inner terminal 2
 - **If 5 ohms or greater**
1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Connect a test lamp between the appropriate control circuit terminal listed below and ground, ignition ON.
 - E4N park/turn signal lamp - left terminal 3 (with T4A)
 - E2LF side marker lamp - left front terminal 2 (with T4A)
 - E13L headlamp - left terminal 7 (with T4F)
 - E5AK tail lamp - left outer terminal 1
 - E5G tail lamp - left inner terminal 3
 - E4P park/turn signal lamp - right terminal 3 (with T4A)
 - E2RF side marker lamp - right front terminal 2 (with T4A)
 - E13R headlamp - right terminal 7 (with T4F)
 - E5AL tail lamp - right outer terminal 1
 - E5H tail lamp - right inner terminal 3
 4. Verify the test lamp turns ON and OFF when commanding the appropriate Park Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the appropriate park/marker/tail lamp.

License Plate Lamps Malfunction

1. Ignition OFF, exterior lamps OFF, remove both E7 license plate lamp bulbs.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Connect a test lamp between the license plate lamp - left control circuit terminal 1 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the License Plate Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
5. Connect a test lamp between the license plate lamp - right control circuit terminal 1 and ground, ignition ON.
6. Verify the test lamp turns ON and OFF when commanding the License Plate Lamps ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
- 7. Test or replace the appropriate E7 license plate lamp bulb.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Switch Replacement**
- **Headlamp Replacement**
- **Rear License Plate Lamp Replacement**
- **Tail Lamp Replacement**
- **Tail Lamp Bulb Replacement**
- **Rear License Plate Lamp Bulb Replacement**
- **Control Module References** for BCM replacement, programming, and setup

REAR COMPARTMENT LAMP MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F24DA Fuse B+	1	1	-	-
Rear Compartment Courtesy Lamp Control	B2570 02	1	1	-
Rear Compartment Courtesy Lamp Ground	-	1	-	-
1. Rear Compartment Lamp Malfunction				

Circuit/System Description

The body control module (BCM) applies battery voltage to the rear compartment courtesy lamp through the rear compartment lamp control circuit. When the BCM receives a rear compartment lid open input from the rear

compartment lid latch, the BCM applies battery voltage to the rear compartment lamp control circuit illuminating the rear compartment courtesy lamp. In the event that the rear compartment lamp were to remain illuminated for more than 10 minutes with the ignition switch in the OFF position and no doors opened, the BCM will deactivate the rear compartment lamp control circuit to prevent total battery discharge.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, exterior lamps OFF, trunk latch latched, disconnect the harness connector at the E8S rear compartment courtesy lamp.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Connect a test lamp between the control circuit terminal 1 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the Trunk Lamp ON and OFF with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the X7 harness connector at the K9 body control module, ignition ON.
2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.

- **If the test lamp turns ON and OFF**

5. Test or replace the E8S rear compartment courtesy lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Compartment Courtesy Lamp Replacement**
- **Control Module References** for BCM replacement, programming, and setup

STOP LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F2DA Fuse B+	B3951 01, B3951 04	B3951 01, B3951 04	-	-
F32UA Fuse B+	B3950 01, B3950 04	B3950 01, B3950 04	-	-
Brake Pedal Position Sensor 5 V Reference	C0277 06, C0890 03, C0161 71	C0277 06, C0161 71, C0161 5A	C0277 07, C0890 07, C0161 71	-

Brake Pedal Position Sensor Signal	C0277 06, U0140 71	C0277 06, C0161 71, C0161 5A	C0277 07, C0890 07, C0161 71	C0277 09
Center High Mounted Stop Lamp Control	2	2	2	-
Stop/Turn Signal Lamp Control - Left	B3950 02	B3950 04	B3950 01, B3950 04	-
Stop/Turn Signal Lamp Control - Right	B3951 02	B3951 04	B3951 01, B3951 04	-
Brake Pedal Position Sensor Low Reference	-	C0277 07, C0161 71	U0151 00, U0184 00	-
Center High Mounted Stop Lamp Ground	-	2	-	-
Tail Lamp Ground - Left	-	1	-	-
Tail Lamp Ground - Right	-	1	-	-
1. Stop Lamps Malfunction 2. Center High Mounted Stop Lamp Malfunction				

Circuit/System Description

The brake pedal position (BPP) sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module provides a low reference signal and a 5 V reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the left and right stop lamp control circuits as well as the center high mounted stop lamp (CHMSL) control circuit illuminating the left and right stop lamps and the CHMSL.

Diagnostic Aids

When testing at the rear turn signal lamp bulb socket, make sure all measurements and test lamp connections are in the correct terminal location and do not come in contact with each other during testing.

Reference Information

Schematic Reference

- Exterior Lights Schematics
- Body Control System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Brake Pedal Applied parameter changes between Active and Inactive while pressing and releasing the brake pedal.
 - **If the parameter does not change**

Refer to Brake Pedal Position Sensor Malfunction.
 - **If the parameter changes**
3. Verify the left brake lamp turns ON and OFF when commanding the Left Rear Turn Signal/Brake Lamp ON and OFF with a scan tool.
 - **If the left brake lamp does not turn ON and OFF**

Refer to Stop Lamps Malfunction.
 - **If the left brake lamp turns ON and OFF**
4. Verify the right brake lamp turns ON and OFF when commanding the Right Rear Turn Signal/Brake Lamp ON and OFF with a scan tool.
 - **If the right brake lamp does not turn ON and OFF**

Refer to Stop Lamps Malfunction.
 - **If the right brake lamp turns ON and OFF**
5. Verify the center high mounted stop lamp turns ON and OFF when commanding the Center Brake Lamp ON and OFF with a scan tool.
 - **If the center high mounted stop does not turn ON and OFF**

Refer to Center High Mount Stop Lamp Malfunction.
 - **If the center high mounted stop turns ON and OFF**
6. All OK.

Circuit/System Testing

Brake Pedal Position Sensor Malfunction

1. Ignition OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor, ignition ON.
2. Test for less than 1 V between the appropriate low reference circuit terminal listed below and ground.
 - Terminal 1 without MR6
 - Terminal C with MR6
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the low reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If less than 1 V**
3. Test or replace the B22 Brake Pedal Position Sensor.

Stop Lamps Malfunction

1. Ignition OFF, exterior lamps OFF, remove the appropriate E5 Stop/Turn Signal Lamp.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 2 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the appropriate Rear Turn Signal/Brake Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the appropriate harness connector listed below at the K9 Body Control Module.
 - X5 left stop lamp
 - X4 right stop lamp
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the appropriate harness connector listed below at the K9 Body Control Module, ignition ON.
 - X5 left stop lamp
 - X4 right stop lamp
2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.

- **If the test lamp turns ON and OFF**

5. Test or replace the appropriate E5 Stop/Turn Signal Lamp.

Center High Mount Stop Lamp Malfunction

1. Ignition OFF, exterior lamps OFF, trunk latch latched, disconnect the harness connector at the E6 Center High Mounted Stop Lamp.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Connect a test lamp between the control circuit terminal 2 and ground, ignition ON.
4. Verify the test lamp turns ON and OFF when commanding the Center Brake Lamp ON and OFF with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.

- **If the test lamp turns ON and OFF**

5. Test or replace the E6 Center High Mounted Stop Lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **High Mount Stop Lamp Replacement**
- **Tail Lamp Replacement**
- **Tail Lamp Bulb Replacement**
- **Brake Pedal Position Sensor Replacement**
- **Brake Pedal Position Sensor Calibration**
- **Control Module References** for BCM replacement, programming, and setup

TURN SIGNAL LAMPS AND/OR INDICATORS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F2DA Fuse B+	B3951 01, B3951 04	B3951 01, B3951 04	-	-
F32UA Fuse B+	B3950 01, B3950 04	B3950 01, B3950 04	-	-
Turn Signal Switch Signal - Left	2	2	2	-
Turn Signal Switch Signal - Right	2	2	2	-
Turn Signal Control - Left Front	B3948 02	B3948 04	B3948 01, B3948 04	-
Stop/Turn Signal Lamp Control - Left	B3950 02	B3950 04	B3950 01, B3950 04	-
Turn Signal Control - Right Front	B3949 02	B3949 04	B3949 01, B3949 04	-
Stop/Turn Signal Lamp Control - Right	B3951 02	B3951 04	B3951 01, B3951 04	-
Turn Signal Lamp Ground - Left Front	-	1	-	-
Turn Signal Lamp Ground - Right Front	-	1	-	-
Turn Signal Lamp Ground - Left				

Rear	-	1	-	-
Turn Signal Lamp Ground - Right Rear	-	1	-	-
Turn Signal Repeater Lamp - Left Ground	-	1	-	-
Turn Signal Repeater Lamp - Right Ground	-	1	-	-
Turn Signal/Multifunction Switch Ground	-	2	-	-
1. Turn Signal Lamps and/or Indicators Malfunction 2. Turn Signal/Multifunction Switch Malfunction				

Circuit/System Description

Ground is applied at all times to the turn signal/multifunction switch. The turn signal lamps may only be activated with the ignition switch in the ON or START positions. When the turn signal/multifunction switch is placed in either the turn right or turn left position, ground is applied to the body control module (BCM) through either the right turn or left turn signal switch signal circuit. The BCM responds to the turn signal switch input by applying a pulsating voltage to the front and rear turn signal lamps through their respective control circuits. When a turn signal request is received by the BCM, a serial data message is sent to the instrument cluster requesting the respective turn signal indicator be pulsed ON and OFF.

Diagnostic Aids

When testing at the rear turn signal lamp bulb socket, make sure all measurements and test lamp connections are in the correct terminal location and do not come in contact with each other during testing.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Right Turn Signal Switch and Left Turn Signal Switch parameters change between Active and Inactive while cycling the turn signal switch between the right and left positions.
 - **If the parameters do not change**

Refer to Turn Signal/Multifunction Switch Malfunction.

- **If the parameters change**
3. Verify the left front turn signal lamps turn ON and OFF while commanding the Left Front Turn Signal Lamp ON and OFF with a scan tool.
 - **If the left front turn signal lamps do not turn ON and OFF**

Refer to Turn Signal Lamps Malfunction.

- **If the left front turn signal lamps turn ON and OFF**
4. Verify the right front turn signal lamps turn ON and OFF while commanding the Right Front Turn Signal Lamp ON and OFF with a scan tool.
 - **If the right front turn signal lamps do not turn ON and OFF**

Refer to Turn Signal Lamps Malfunction.

- **If the right front turn signal lamps turn ON and OFF**
5. Verify the left rear turn signal lamp turns ON and OFF while commanding the Left Rear Turn Signal/Brake Lamp ON and OFF with a scan tool.
 - **If the left rear turn signal lamp does not turn ON and OFF**

Refer to Turn Signal Lamps Malfunction.

- **If the left rear turn signal lamp turns ON and OFF**
6. Verify the right rear turn signal lamp turns ON and OFF while commanding the Right Rear Turn Signal/Brake Lamp ON and OFF with a scan tool.
 - **If the right rear turn signal lamp does not turn ON and OFF**

Refer to Turn Signal Lamps Malfunction.

- **If the right rear turn signal lamp turns ON and OFF**

7. Verify the left and right turn signal indicators turn ON and OFF while commanding the All Indicators Test ON and OFF with a scan tool.

- **If the left or right turn signal indicators do not turn ON and OFF**

Refer to Turn Signal Indicators Malfunction.

- **If the left and right turn signal indicators turn ON and OFF**

8. All OK.

Circuit/System Testing

Turn Signal/Multifunction Switch Malfunction

1. Ignition OFF, scan tool disconnected, all doors closed, all accessories OFF, disconnect the harness connector at the S78 turn signal/multifunction switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 ohms between the ground circuit terminal 3 and ground.
 - **If 15 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 15 ohms**
3. Ignition ON.
4. Verify the scan tool Left Turn Signal Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 3.
6. Verify the scan tool Left Turn Signal Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 body control module.
 - **If Active**
- 7. Verify the scan tool Right Turn Signal Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module.
 2. Test for infinite resistance between the signal circuit terminal 7 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 - **If Inactive**
- 8. Install a 3 A fused jumper wire between the signal circuit terminal 7 and the ground circuit terminal 3.
- 9. Verify the scan tool Right Turn Signal Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 7 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If Active**
- 10. Test or replace the S78 turn signal/multifunction switch.

Turn Signal Lamps Malfunction

1. Ignition OFF, exterior lamps OFF, disconnect the harness connector at the appropriate turn signal lamp.
2. Test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
 - E4LF park/turn signal lamp - left socket terminal
 - E4N park/turn signal lamp - left terminal 2 (with T4A)
 - A9A outside rearview mirror - driver terminal 4
 - E5AM stop/turn signal lamp bulb - left terminal 3
 - E4RF park/turn signal lamp - right socket terminal
 - E4P park/turn signal lamp - right terminal 2 (with T4A)
 - A9A outside rearview mirror - passenger terminal 4
 - E5AN stop/turn signal lamp bulb - right terminal 3
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
 - E4LF park/turn signal lamp - left socket terminal
 - E4N park/turn signal lamp - left terminal 1 (with T4A)
 - A9A outside rearview mirror - driver terminal 16
 - E5AM stop/turn signal lamp bulb - left terminal 2
 - E4RF park/turn signal lamp - right socket terminal
 - E4P park/turn signal lamp - right terminal 1 (with T4A)
 - A9A outside rearview mirror - passenger terminal 16
 - E5AN stop/turn signal lamp bulb - right terminal 2
 4. Verify the test lamp turns ON and OFF when commanding the appropriate Turn Signal Lamp ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the appropriate harness connector listed below at the K9 body control module.
 - X4 right turn signals
 - X5 left turn signals
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the appropriate harness connector listed below at the K9 body control module, ignition ON.
 - X4 right turn signals
 - X5 left turn signals
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
 5. Test or replace the appropriate turn signal lamp.

Turn Signal Indicators Malfunction

1. Ignition ON.
2. Verify the left and right turn signal indicators turn ON and OFF while commanding the All Indicators

Test ON and OFF with a scan tool.

- **If the left or right turn signal indicators are always OFF or remain ON**

Replace the P16 instrument cluster.

- **If the left and right turn signal indicators turn ON and OFF**

3. Replace the K9 body control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Replacement**
- **Tail Lamp Replacement**
- **Tail Lamp Bulb Replacement**
- **TURN SIGNAL SWITCH REPLACEMENT**
- **Front Turn Signal Lamp Bulb Replacement**
- **Control Module References** for BCM or Instrument Cluster replacement, programming, and setup

ACCESSORIES & EQUIPMENT

Lighting - Fastener Tightening Specifications

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Headlamp Bolts	2.5 N.m	22 lb in
Tail Lamp Nuts	2.5 N.m	22 lb in

ACCESSORIES & EQUIPMENT

Lighting - Repair Instructions

REPAIR INSTRUCTIONS

BRAKE PEDAL POSITION SENSOR CALIBRATION

NOTE: Brake system does not use a brake switch, stoplight switch or brakelight switch. System uses a Brake Pedal Position Sensor to control these functions.

Calibration Criteria

NOTE: Do not apply the brake pedal during the brake pedal position sensor calibration procedure. Any movement of the brake pedal during this procedure will cause the calibration procedure to fail. If this occurs, the brake pedal position sensor calibration must be repeated.

Brake pedal position sensor calibration must be performed after the brake pedal position sensor, body control module (BCM), or engine control module (ECM) have been serviced. The calibration procedure will set the brake pedal position sensor home value. This value is used by the BCM and ECM to determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via serial data.

Calibration Procedure

1. Apply the parking brake.
2. Ignition ON, engine OFF, place the transmission in the PARK position for automatic transmission or NEUTRAL position for manual transmission.
3. Install a scan tool.
4. Clear all DTCs before proceeding.
5. Navigate to the Configuration/Reset Functions menu of the BCM.
6. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
7. Navigate to the Configuration/Reset Functions menu of the ECM.
8. Select the Learn Functions menu.
9. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.

BRAKE PEDAL POSITION SENSOR REPLACEMENT

NOTE: Brake system does not use a brake switch, stoplight switch or brakelight switch. System uses a Brake Pedal Position Sensor to control these functions.

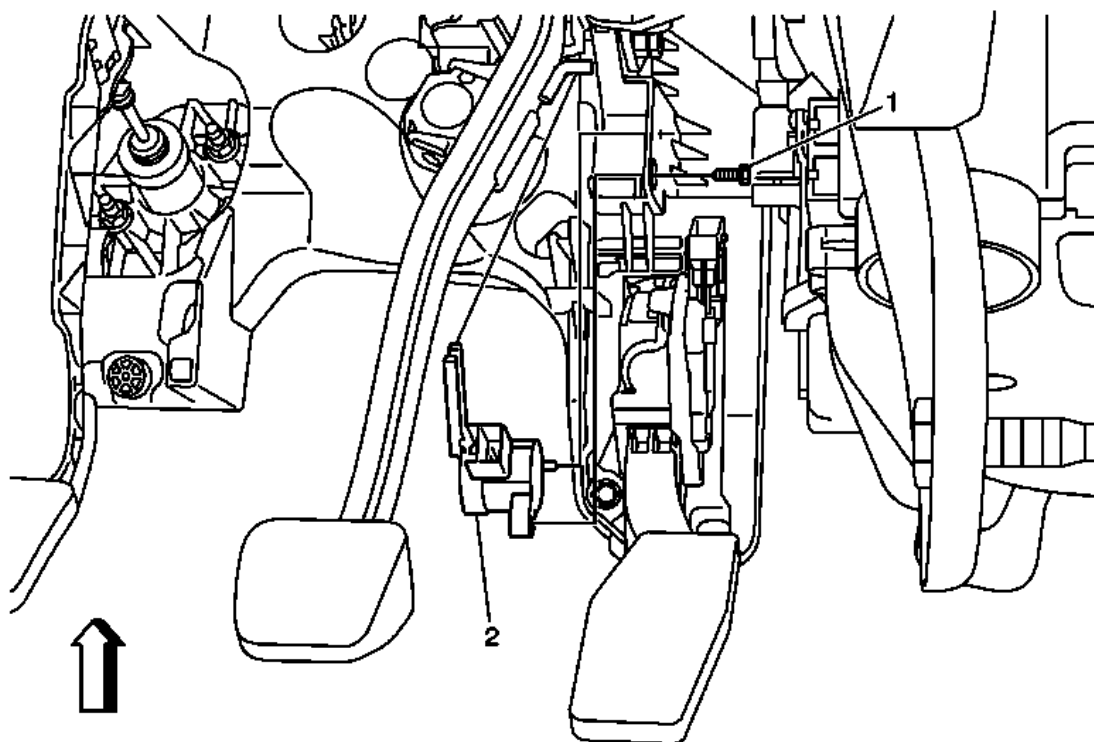


Fig. 1: Brake Pedal Position Sensor
 Courtesy of GENERAL MOTORS COMPANY

Brake Pedal Position Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower trim panel insulator. Refer to <u>Instrument Panel Lower Trim Panel Insulator Replacement</u> .	
1	Brake Pedal Position Sensor Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2 N.m (18 lb in)
2	Brake Pedal Position Sensor Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Calibrate the brake pedal position sensor. Refer to <u>Brake Pedal Position Sensor Calibration</u>.

HEADLAMP SWITCH REPLACEMENT

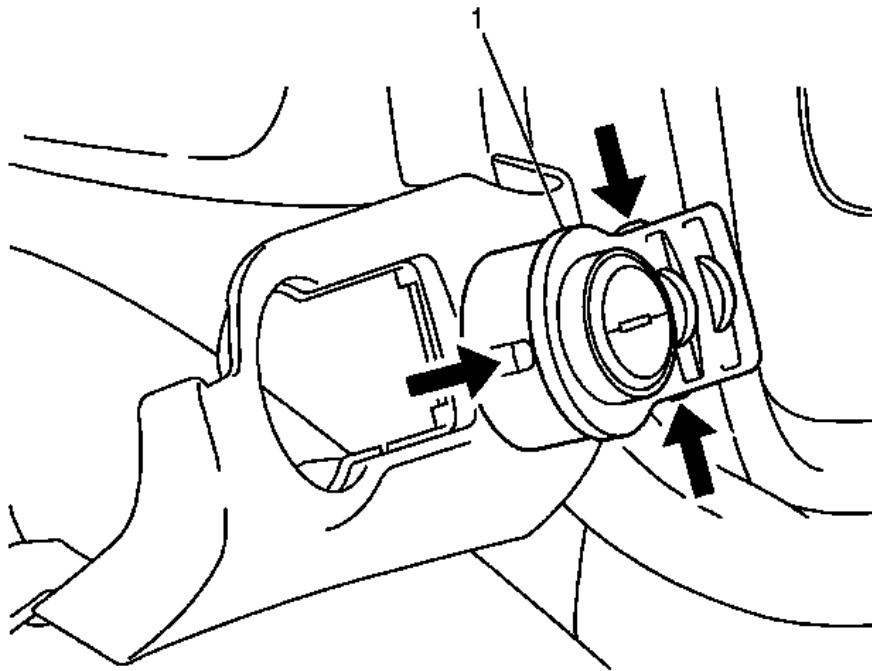


Fig. 2: Headlamp Switch

Courtesy of GENERAL MOTORS COMPANY

Headlamp Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel headlamp switch molding. Refer to <u>Headlamp Switch Molding Replacement</u> .	
1	Headlamp Switch Procedure Disconnect the electrical connector. TIP: Use a flat-bladed plastic trim tool in order to release the retaining clips.

HEADLAMP AUTOMATIC CONTROL AMBIENT LIGHT SENSOR REPLACEMENT

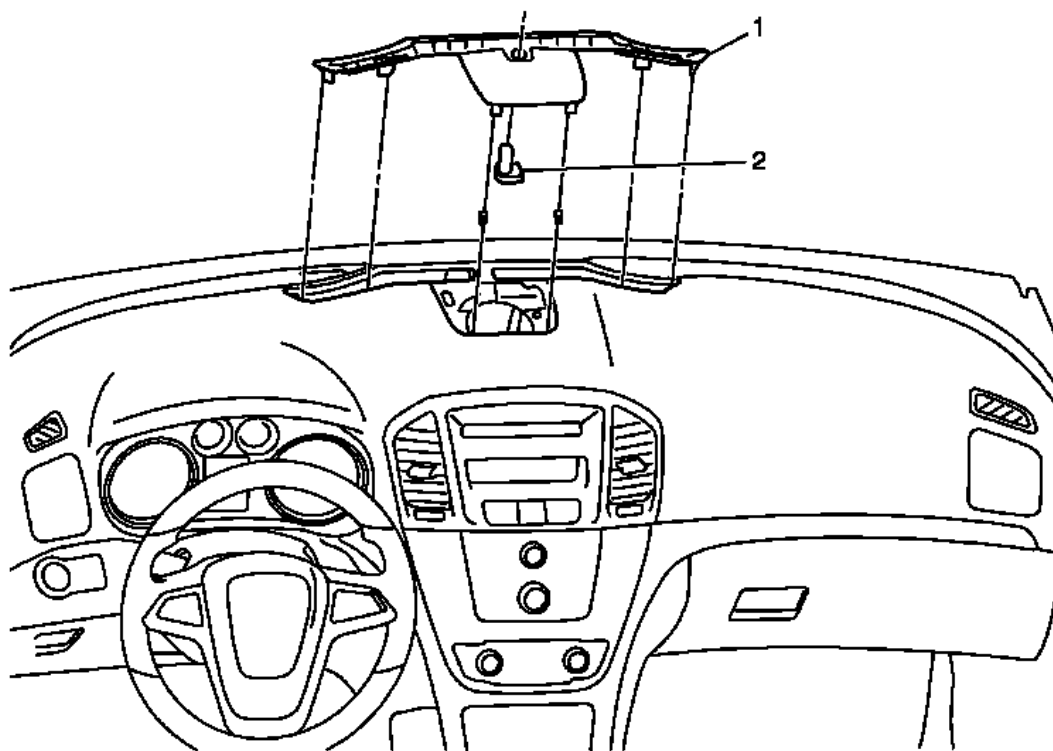


Fig. 3: Headlamp Automatic Control Ambient Light Sensor
 Courtesy of GENERAL MOTORS COMPANY

Headlamp Automatic Control Ambient Light Sensor Replacement

Callout	Component Name
1	Windshield Defroster Nozzle Grille Retainer (Qty: 8) Procedure Disconnect the electrical connections. TIP: Use a flat-bladed plastic trim tool to aid in the removal of the windshield defroster nozzle grille.
2	Headlamp Automatic Control Ambient Light Sensor

WINDSHIELD OUTSIDE MOISTURE AND HEADLAMP AUTOMATIC CONTROL AMBIENT LIGHT SENSOR REPLACEMENT

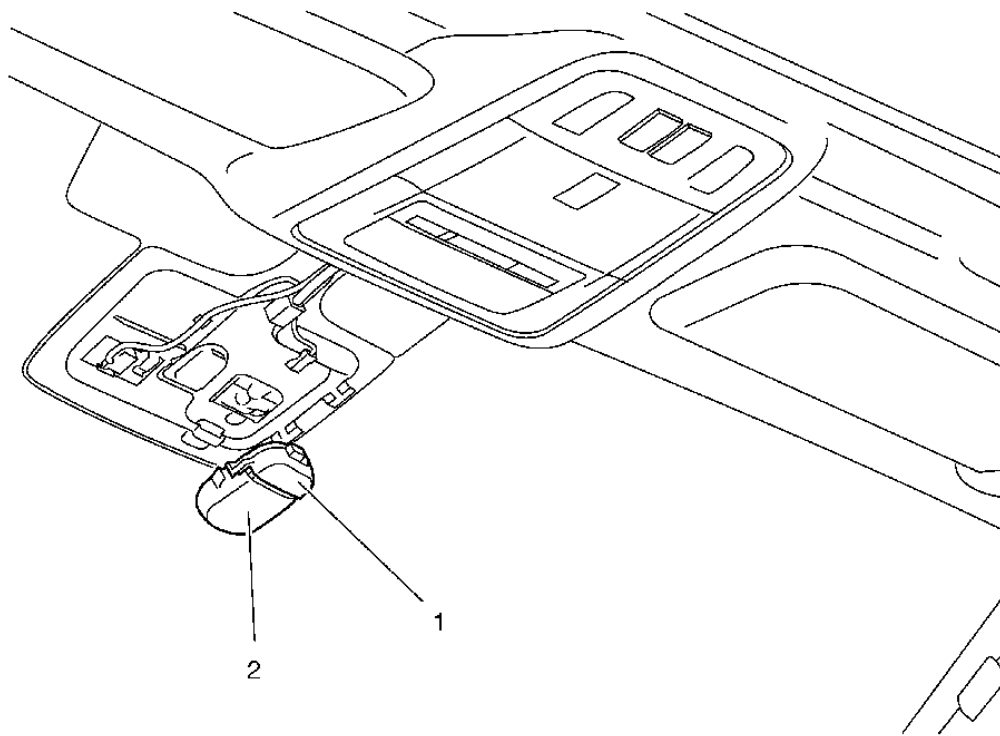


Fig. 4: Windshield Outside Moisture and Headlamp Automatic Control Ambient Light Sensor
 Courtesy of GENERAL MOTORS COMPANY

Windshield Outside Moisture and Headlamp Automatic Control Ambient Light Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the inside rearview mirror mount plate cover. Refer to <u>Inside Rearview Mirror Mount Plate Cover Replacement</u>	
1	Windshield Outside Moisture and Headlamp Automatic Control Ambient Light Sensor Retainer TIP: Use a small flat-bladed tool to release the locking retainer on the windshield outside moisture and headlamp automatic control ambient light sensor and push the cap upwards.
2	Windshield Outside Moisture and Headlamp Automatic Control Ambient Light Sensor

READING LAMP BULB REPLACEMENT

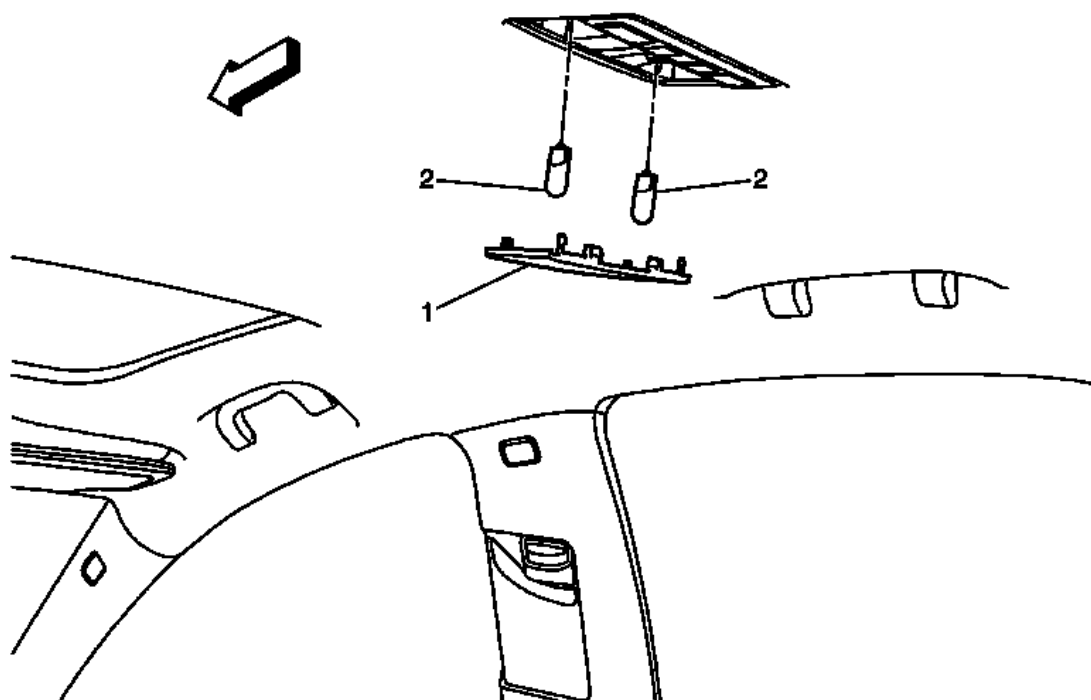


Fig. 5: Reading Lamp Bulb

Courtesy of GENERAL MOTORS COMPANY

Reading Lamp Bulb Replacement

Callout	Component Name
1	Dome and Reading Lamp Lens TIP: Carefully use a flat-bladed tool, and release the tabs retaining the dome and reading lamp lens to the reading lamp.
2	Reading Lamp Bulb CAUTION: Refer to <u>Avoid Touching the Bulb Caution</u> TIP: Service the bulb, as needed.

READING LAMP REPLACEMENT

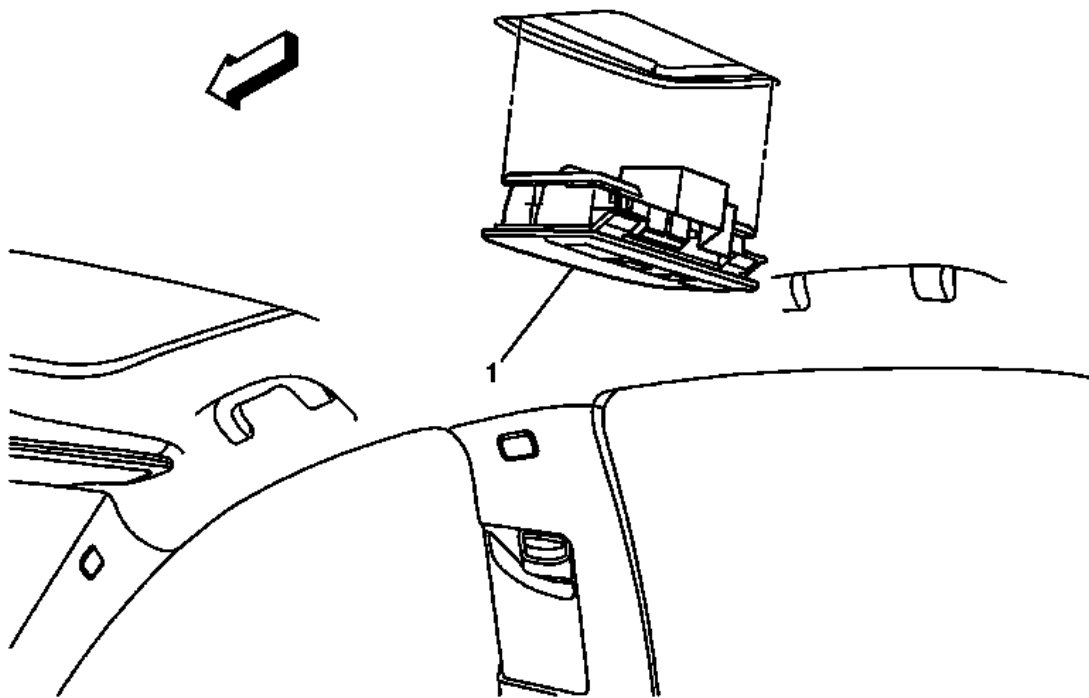


Fig. 6: Reading Lamp
 Courtesy of GENERAL MOTORS COMPANY

Reading Lamp Replacement

Callout	Component Name
1	Reading Lamp Procedure Disconnect the electrical connector. TIP: Carefully use a flat-bladed tool, release the retainer from the reading lamp to the headliner.

DOMES AND READING LAMP REPLACEMENT

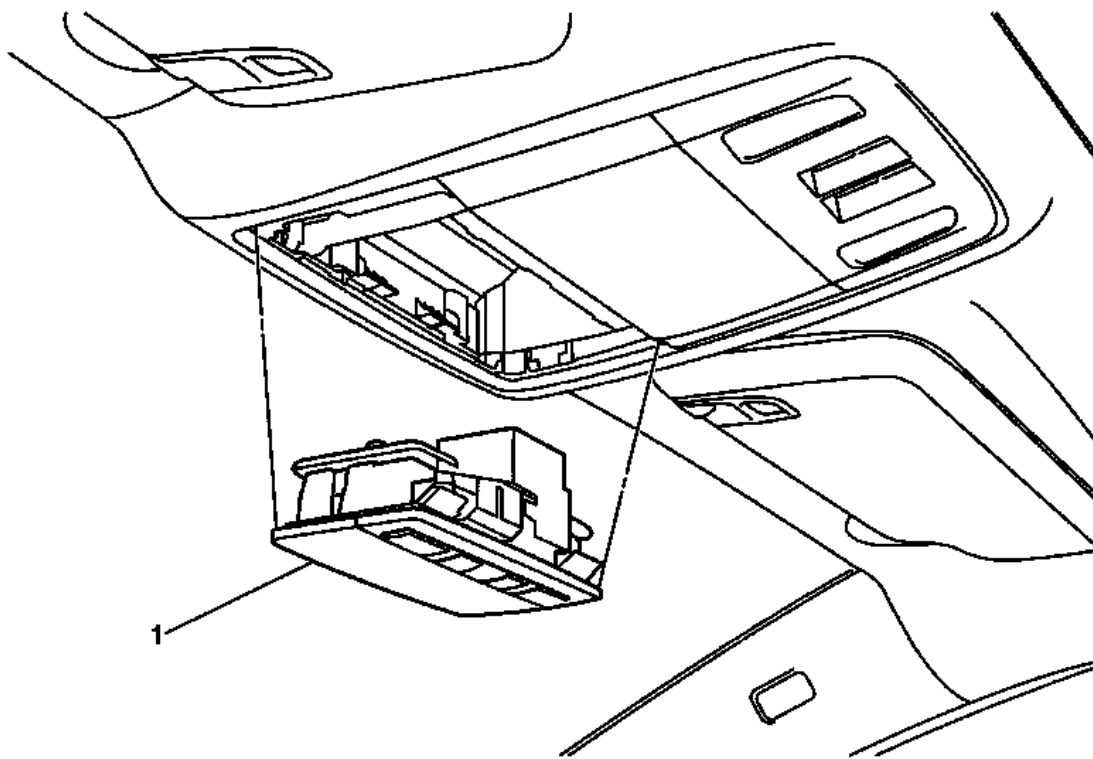


Fig. 7: Dome and Reading Lamp
 Courtesy of GENERAL MOTORS COMPANY

Dome and Reading Lamp Replacement

Callout	Component Name
Preliminary Procedure Remove the roof console reading lamp bezel.	
1	Dome and Reading Lamp TIP: Carefully use a flat-bladed tool to release the retainer from the dome and reading lamp to the roof console.

DOMES AND READING LAMP LENS REPLACEMENT

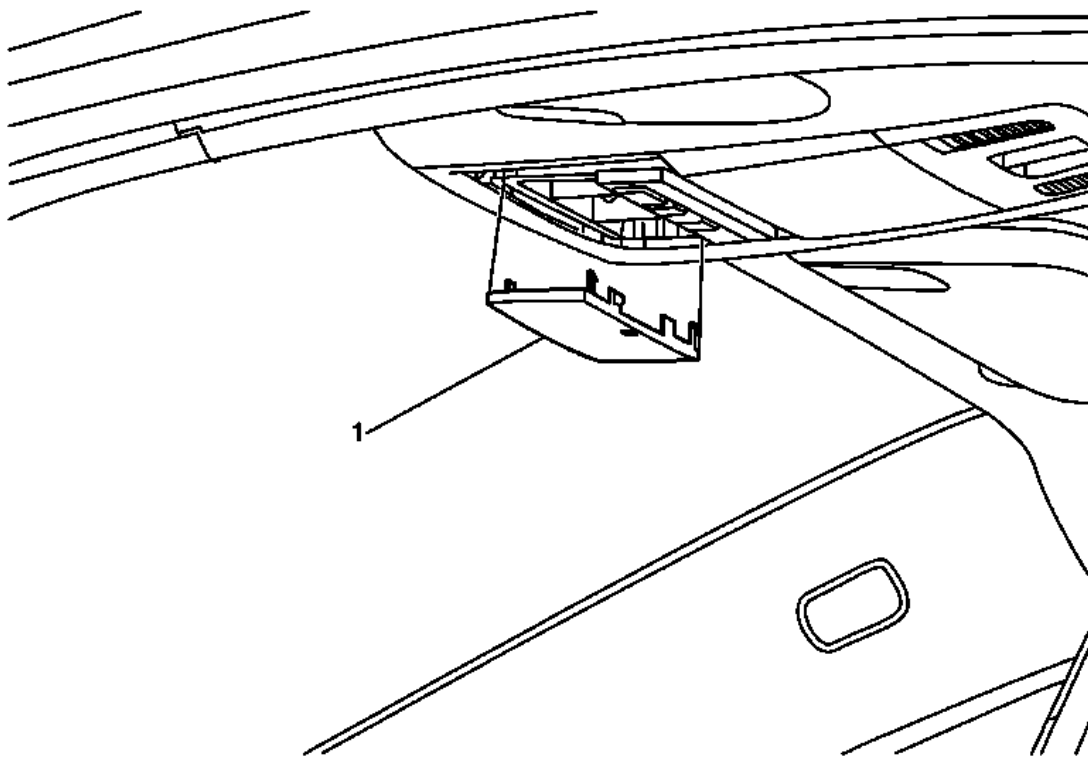


Fig. 8: Dome and Reading Lamp Lens
 Courtesy of GENERAL MOTORS COMPANY

Dome and Reading Lamp Lens Replacement

Callout	Component Name
Preliminary Procedure	
Remove the roof console reading lamp bezel.	
1	Dome and Reading Lamp Lens TIP: Carefully use a flat-bladed tool to release the retainer from the dome and reading lamp lens to the dome and reading lamp.

FRONT SIDE DOOR COURTESY LAMP LENS REPLACEMENT

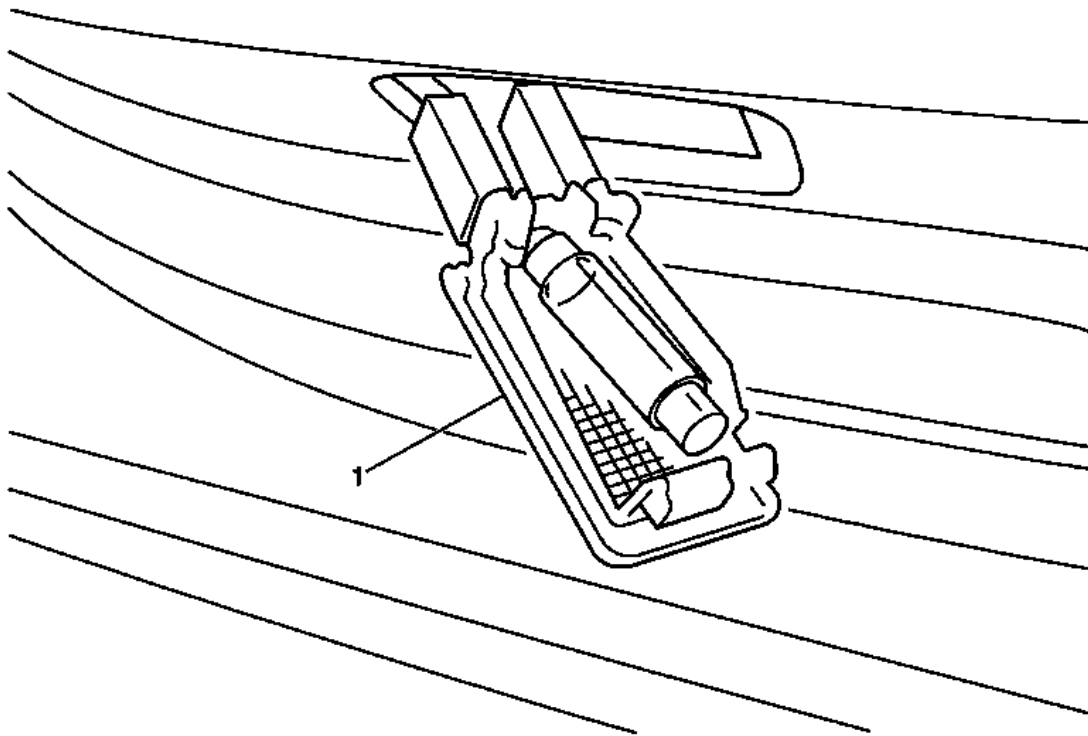


Fig. 9: Front Side Door Courtesy Lamp Lens
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Courtesy Lamp Lens Replacement

Callout	Component Name
1	Front Side Door Courtesy Lamp Lens Procedure <ol style="list-style-type: none"> 1. Release and pull off the front side door courtesy lamp lens. 2. Disconnect the electrical connector. TIP: Carefully use a flat-bladed tool, and release the compartment lamp.

FRONT FLOOR FLOOD LAMP REPLACEMENT

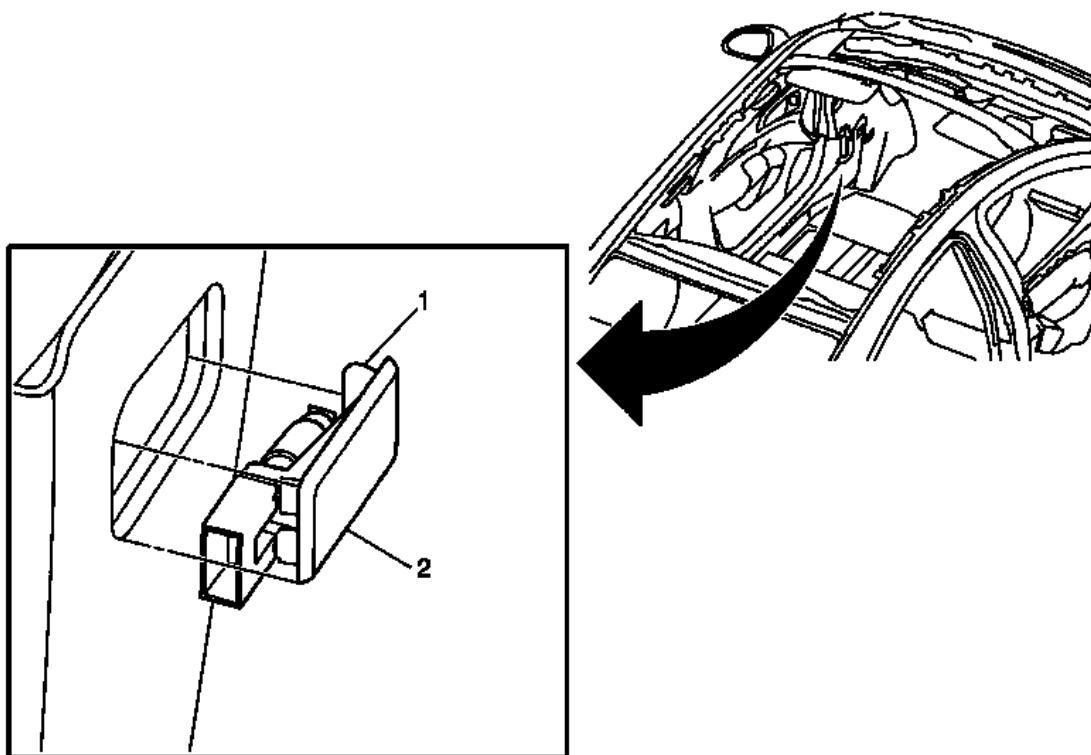


Fig. 10: Front Floor Flood Lamp
 Courtesy of GENERAL MOTORS COMPANY

Front Floor Flood Lamp Replacement

Callout	Component Name
1	Front Floor Flood Lamp Retainer TIP: Use a small flat-bladed tool to pull the right side down out from the front and rear side door sill trim plate opening.
2	Front Floor Flood Lamp Procedure Disconnect the front floor flood lamp electrical connector.

INSTRUMENT PANEL COMPARTMENT LAMP REPLACEMENT

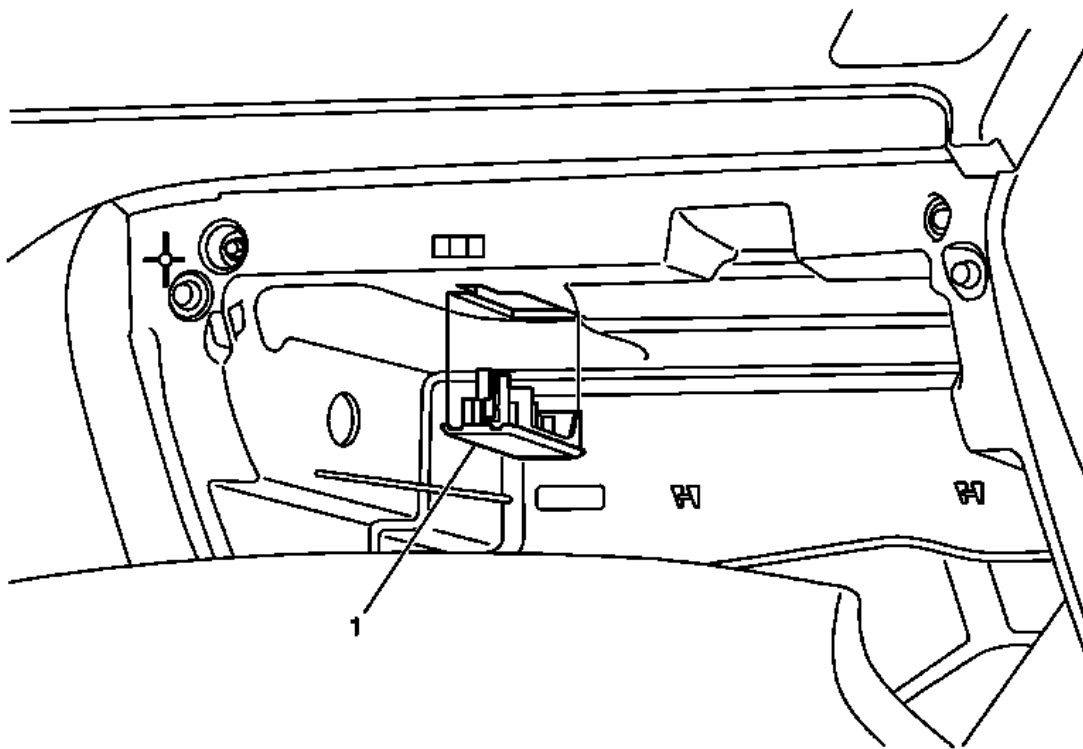


Fig. 11: Instrument Panel Compartment Lamp
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Compartment Lamp Replacement

Callout	Component Name
1	<p>Instrument Panel Compartment Lamp</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Release and pull off the instrument panel compartment lamp. 2. Disconnect the electrical connector. <p>TIP: Carefully use a flat-bladed tool, and release the compartment lamp from the instrument panel compartment.</p>

DOMELAMP BULB REPLACEMENT

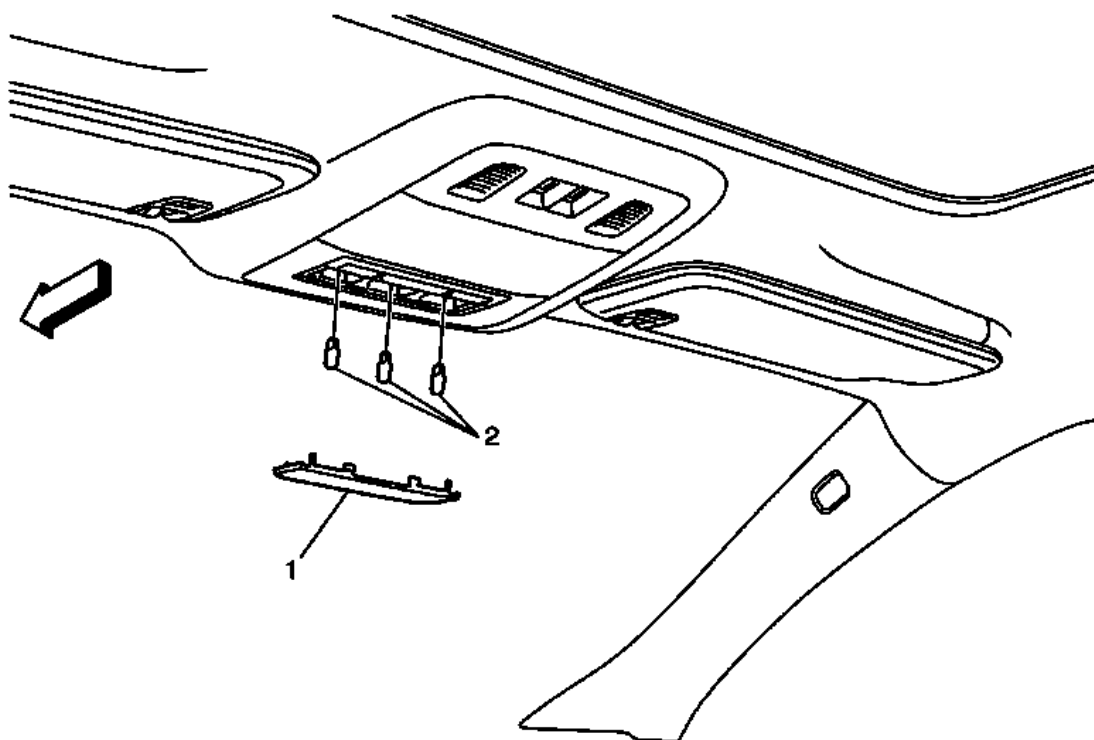


Fig. 12: Dome Lamp Bulb
 Courtesy of GENERAL MOTORS COMPANY

Dome Lamp Bulb Replacement

Callout	Component Name
1	Dome and Reading Lamp Lens TIP: Use a small flat-bladed tool to remove the dome and reading lamp lens.
2	Dome Lamp Bulb CAUTION: Refer to <u>Avoid Touching the Bulb Caution</u> . TIP: Service the bulb, as needed.

FRONT SIDE DOOR SILL COURTESY LAMP REPLACEMENT

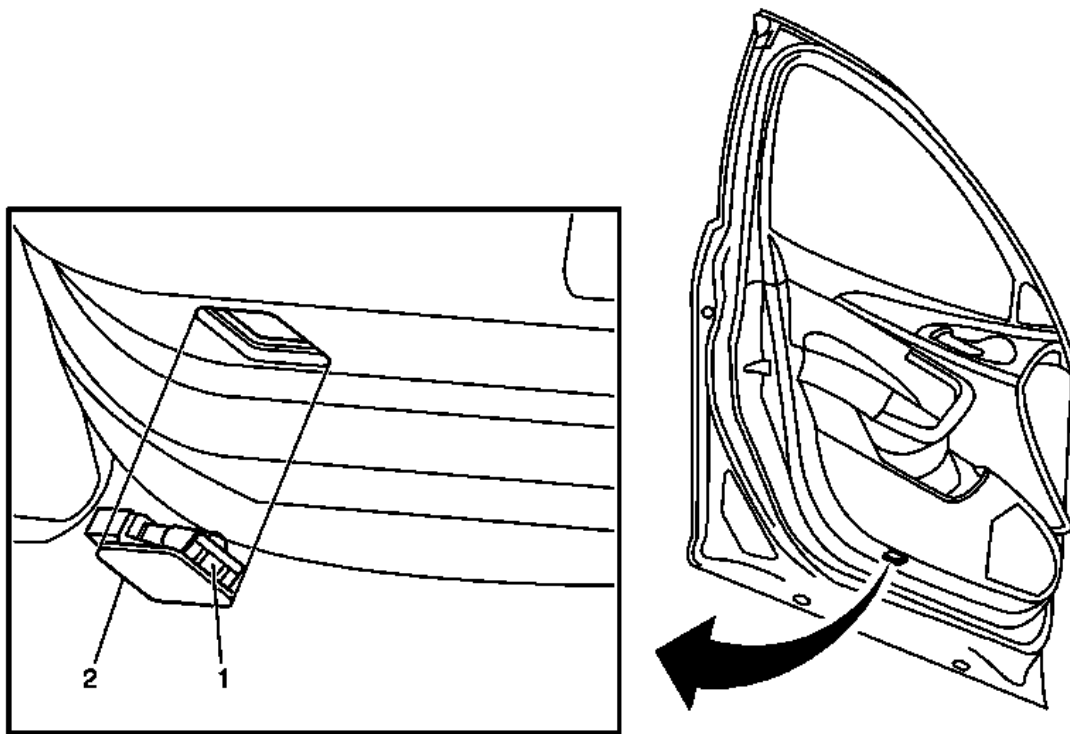


Fig. 13: Front Side Door Sill Courtesy Lamp
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Sill Courtesy Lamp Replacement

Callout	Component Name
1	Front Side Door Sill Courtesy Lamp Retainer TIP: Use a small flat-bladed tool to pull the right side down out from the front side door trim panel opening.
2	Front Side Door Sill Courtesy Lamp Procedure Disconnect the front side door sill courtesy lamp electrical connector.

HEADLAMP REPLACEMENT

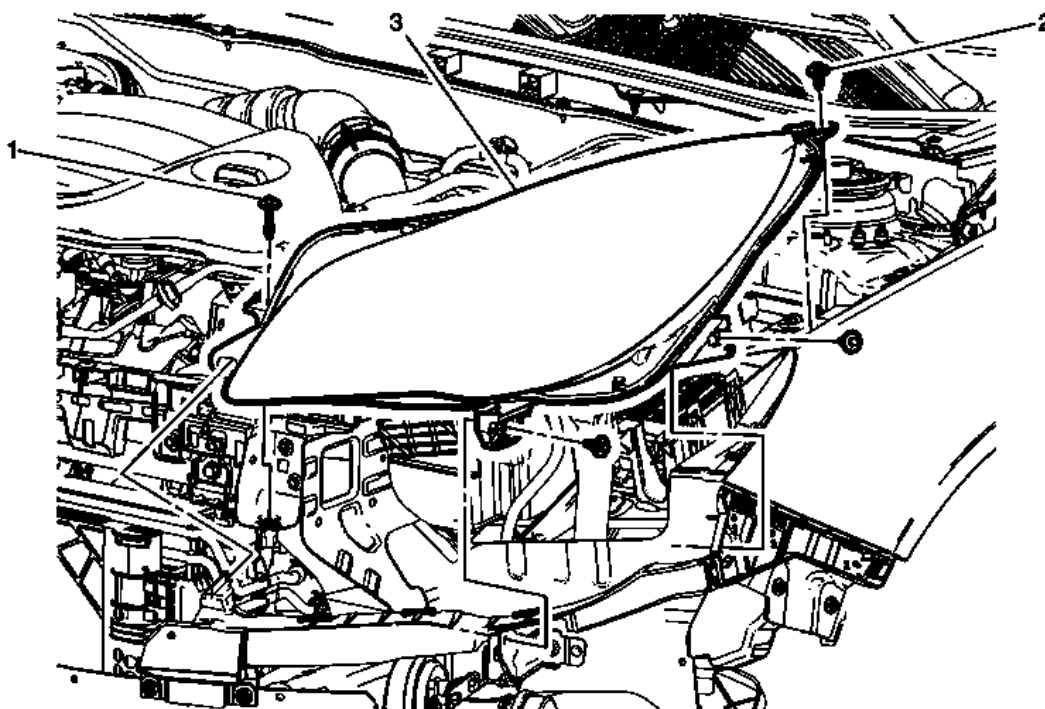


Fig. 14: Headlamp

Courtesy of GENERAL MOTORS COMPANY

Headlamp Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Headlamp Bolt CAUTION: Refer to Fastener Caution .
2	Headlamp Bolt (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 2.5 N.m(22 lb in)
3	Headlamp Procedure 1. Disconnect the electrical wiring harness and remove the headlamp.

2. Aim the headlamp after replacement. Refer to **Headlamp Aiming**.

HEADLAMP BALLAST REPLACEMENT

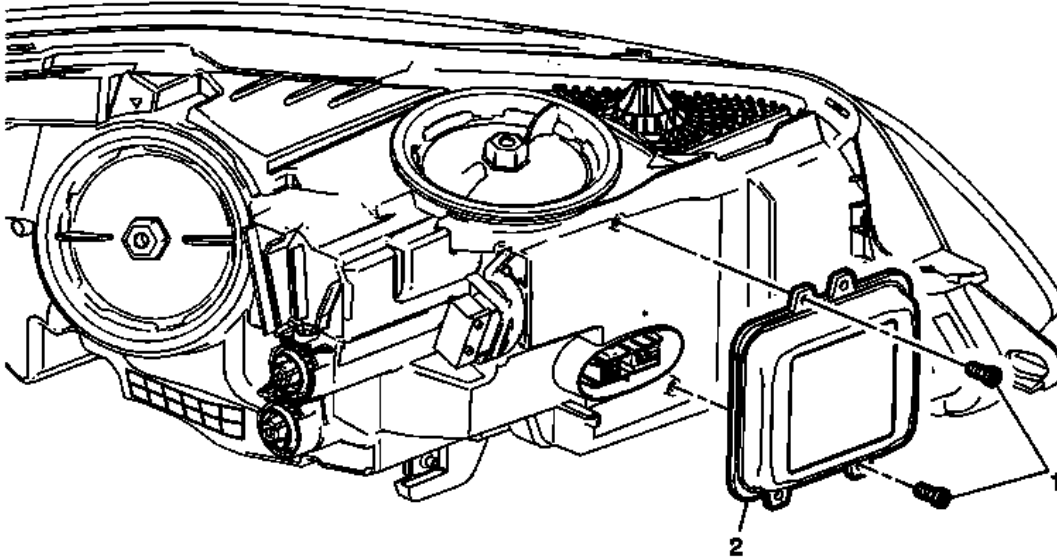


Fig. 15: Headlamp Ballast
Courtesy of GENERAL MOTORS COMPANY

Headlamp Ballast Replacement

Callout	Component Name
Preliminary Procedure Remove the headlamp. Refer to Headlamp Replacement .	
1	Headlamp Ballast Bolt (Qty: 2) CAUTION: Refer to Fastener Caution .
2	Headlamp Ballast

HEADLAMP BULB REPLACEMENT

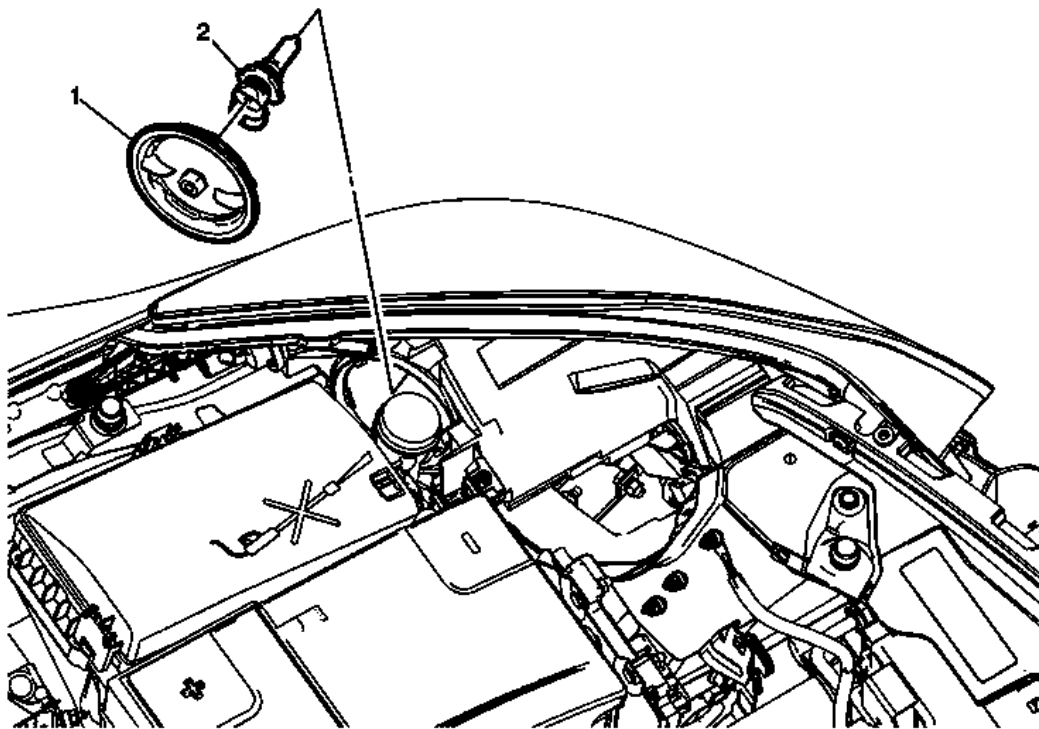


Fig. 16: Headlamp Bulb
 Courtesy of GENERAL MOTORS COMPANY

Headlamp Bulb Replacement

Callout	Component Name
Preliminary Procedure	
Open and support the hood.	
1	Headlamp Opening Cover
2	Headlamp Bulb WARNING: Refer to <u>Halogen Bulb Warning</u> . Procedure 1. Disconnect the electrical connector. 2. Turn the headlamp bulb a quarter turn counterclockwise and pull from the headlamp.

HEADLAMP BRACKET REPLACEMENT

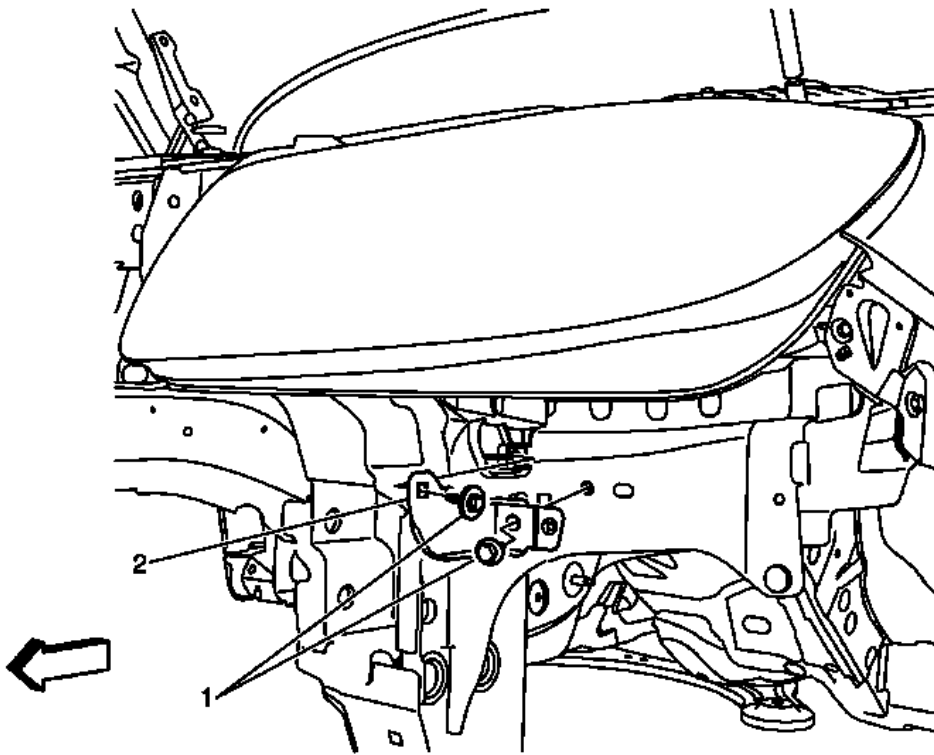


Fig. 17: Headlamp Bracket
 Courtesy of GENERAL MOTORS COMPANY

Headlamp Bracket Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .	
1	Headlamp Bracket Fastener (Qty: 2) Procedure Hand tighten the fasteners only.
2	Headlamp Bracket

HEADLAMP AIMING

Aiming Headlamps (Visual Aim)

NOTE: Some state and local laws specify requirements for headlamp aim. All of these laws must be complied with when performing any headlamp aiming operations.

Headlamp aim should be checked:

- When a new headlamp capsule is installed.
- If service or repairs to the front end area have (or may have) disturbed the headlamps or their mounting.
- Suspension components have been replaced or repaired.

- The area will consist of a level surface large enough to allow for a vehicle and an additional 7.62 m (25 ft) measured from face of lamps to the front of the aiming screen.
- The screen will be 1.52 m (5 ft) high x 3.66 m (12 ft) wide with a matte white surface well shaded from extraneous light, and properly adjusted to the floor on which the vehicle stands. Provisions may be made for moving the screen so it can be aligned parallel with the vehicle.
- The screen shall be provided with a fixed vertical centerline, 2 laterally adjustable vertical tapes, and 1 vertically adjustable horizontal tape.
- If a regular commercial aiming screen is not available, the screen may consist of a vertical wall having a clear uninterrupted area approximately 1.83 m (6 ft) high and 3.66 m (12 ft) wide. The surface should be finished with a washable non-gloss white paint.

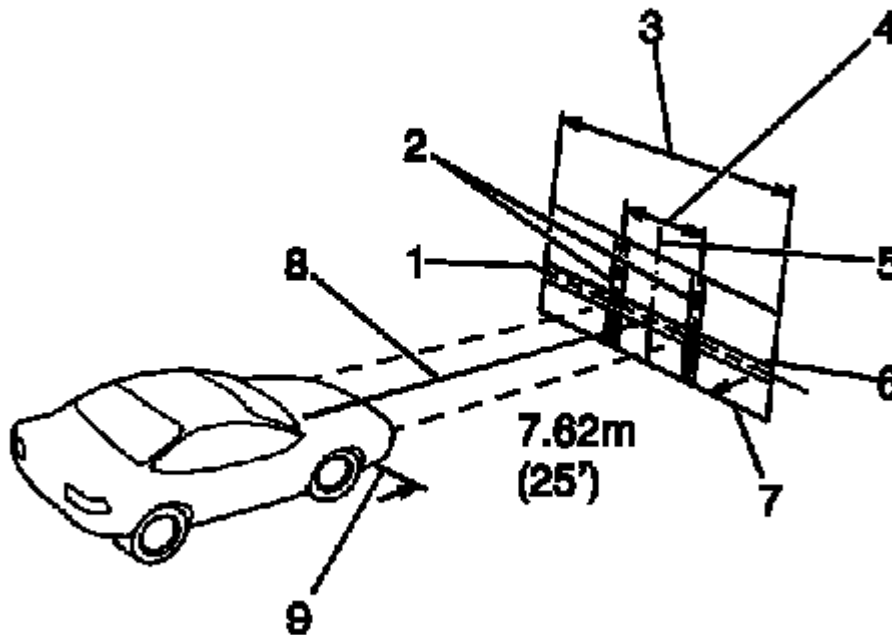


Fig. 18: Headlamp Aiming/Adjusting
 Courtesy of GENERAL MOTORS COMPANY

- After the aiming screen has been set up in its permanent location, it is necessary to paint a reference line on the floor directly under the lens of the lamps to indicate the proper location of the headlamps when they are being aimed:
 - Distance between headlamps (1)
 - Center line of screen (2)

- Adjustable vertical pointer (3)
- Adjustable horizontal tape (4)
- Diagram of light screen (5)
- Vertical center line ahead of right headlamp pointer position (6)
- 7.62 m (25 ft) (7)
- Car centerline axis (8)

Prior to aiming the headlamps, the following steps must be taken:

1. Remove any snow, ice or mud from the vehicle.
2. The vehicle must have a full tank of gas.
3. Stop all other work on the vehicle.
4. If any service has been performed on the vehicle, make sure that all of the components are back in their original place.
5. The vehicle must be on a level surface.

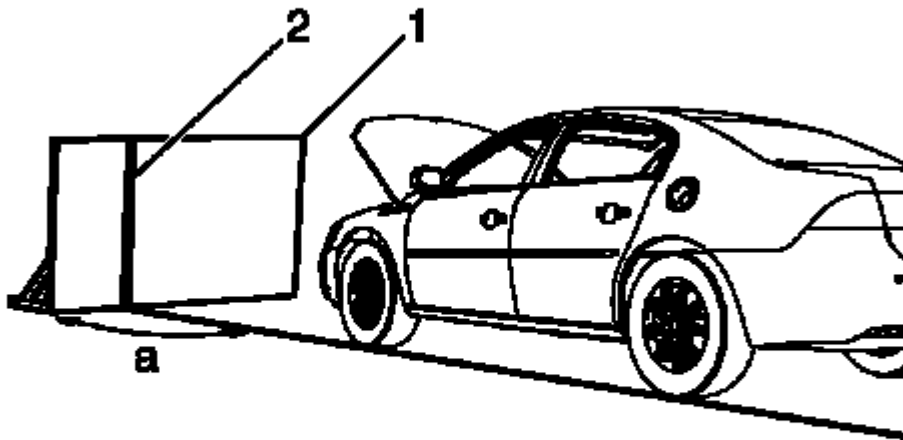


Fig. 19: Aligning Left Tires With Reference Line
 Courtesy of GENERAL MOTORS COMPANY

6. The vehicle left tires must be aligned with the reference line extending from the screen with the headlamps aligned with the vertical reference line (2).
7. Do not load any cargo in the vehicle.
8. The vehicle must contain 1 person or 72.56 kg (160 lb) on the driver's seat.
9. Inflate the tires to the proper pressure.
10. Simulate the vehicle loads if the intended use of the vehicle is for hauling heavy loads or towing a trailer.
11. Rock the vehicle in order to stabilize the suspension.
12. Turn ON the headlamps to low beam and observe the left and the top edges of the high intensity zone on the screen. The edges of the high intensity zone should fall within the specifications.

Headlamp Aiming Procedure

1. Open the hood.

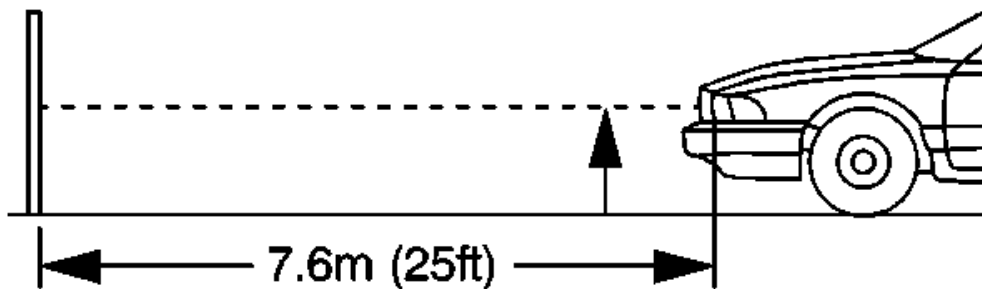


Fig. 20: Measuring Distance Between Headlamps Face & Aiming Screen
Courtesy of GENERAL MOTORS COMPANY

2. Measure from the floor to the center of the headlamp bulb, some headlamps have an aim dot marked on the headlamp lens.
3. At the screen, measure from the floor and place the horizontal tape at the measured distance.
4. Measure from the reference line on the floor to the left headlamp bulb centerline.
5. At the screen, measure from the reference line and place the vertical tape at the measured distance.
6. Measure from the reference line on the floor to the right headlamp bulb centerline.
7. At the screen, measure from the reference line and place the vertical tape at the measured distance.

NOTE: **Do not cover the headlamp, this may cause excessive heat build up.**

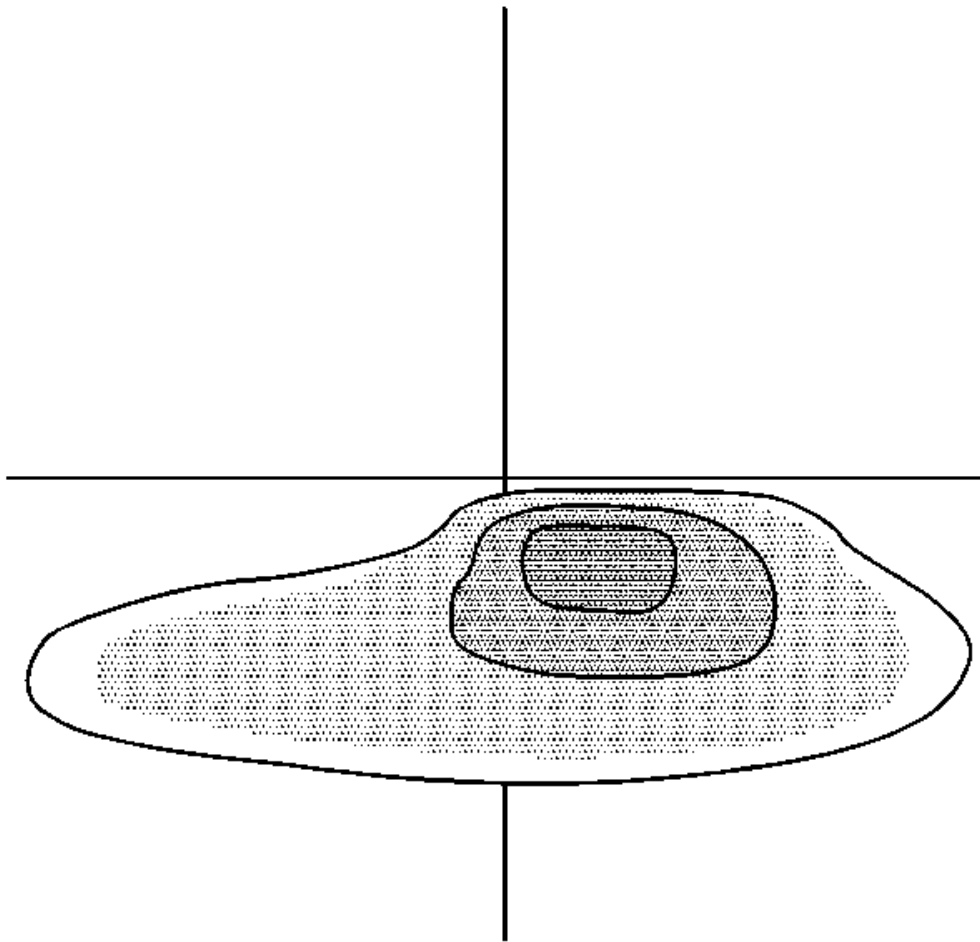


Fig. 21: Identifying Right Side Low Beam Proper Screen Positioning
Courtesy of GENERAL MOTORS COMPANY

8. Turn on the low beam headlamps and block the light from projecting onto the screen from the passenger side headlamp.

NOTE: **Horizontal headlamp adjustment does not exist.**

9. Adjust the vertical aim of the headlamps to the specifications required by the state and the local authorities, or as shown in step number 8.
10. Rotate the headlamp adjuster to change the vertical aim of the headlamp.
11. Repeat the aiming procedure for the passenger side headlamp while blocking the light from projecting onto the screen from the driver side headlamp.
12. Close the hood.

HEADLAMP LEVELING FRONT SUSPENSION HEIGHT SENSOR REPLACEMENT

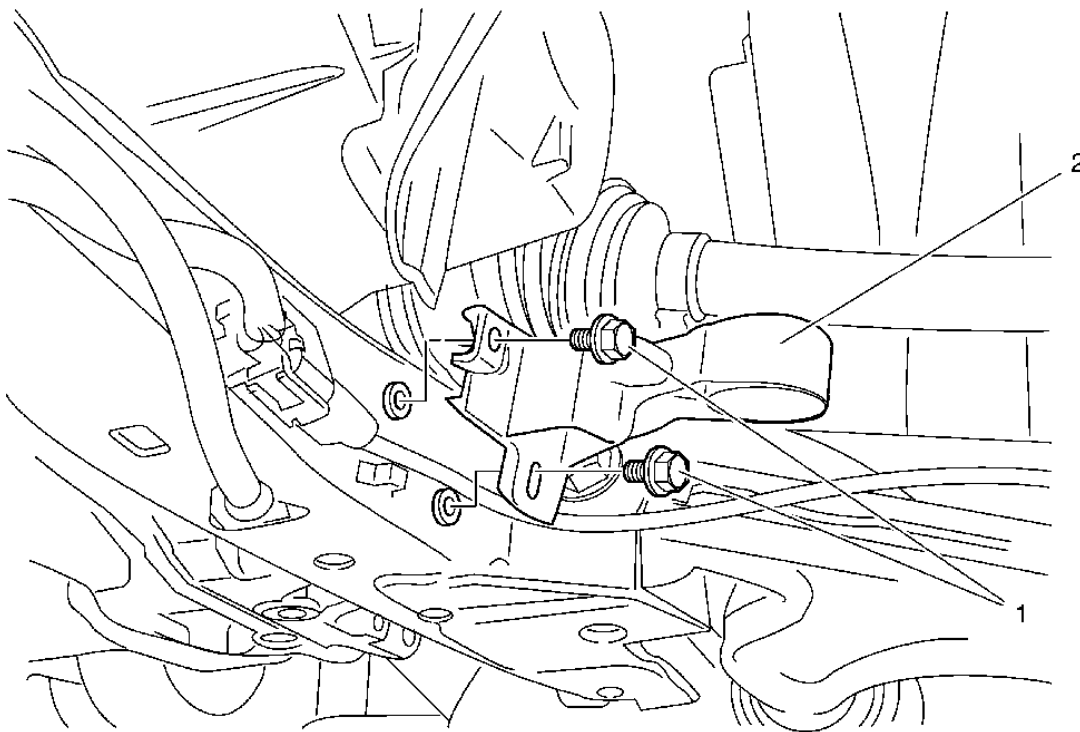


Fig. 22: Headlamp Leveling Front Suspension Height Sensor
Courtesy of GENERAL MOTORS COMPANY

Headlamp Leveling Front Suspension Height Sensor Replacement

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Headlamp Leveling Front Suspension Height Sensor Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 5 N.m (44 lb in)
2	Headlamp Leveling Front Suspension Height Sensor Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Set up and program the headlamp control module. Refer to <u>Control Module References</u> .

HEADLAMP LEVELING REAR SUSPENSION HEIGHT SENSOR REPLACEMENT

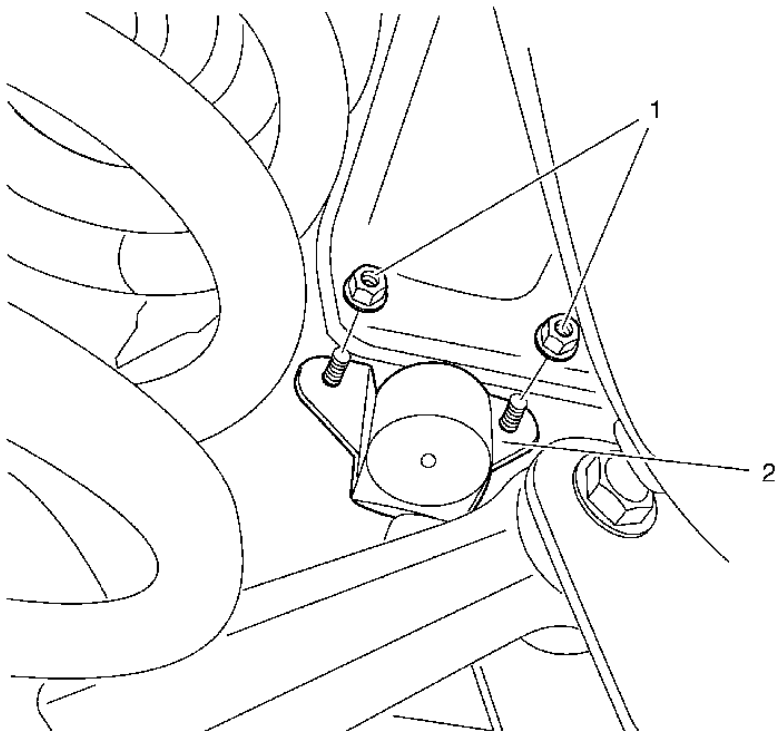


Fig. 23: Headlamp Leveling Rear Suspension Height Sensor And Fasteners
Courtesy of GENERAL MOTORS COMPANY

Headlamp Leveling Rear Suspension Height Sensor Replacement

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Headlamp Leveling Rear Suspension Height Sensor Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

	<p>Tighten 5 N.m (44 lb in)</p>
2	<p>Headlamp Leveling Rear Suspension Height Sensor</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Set up and program the headlamp control module. Refer to <u>Control Module References</u> .

HEADLAMP CONTROL MODULE REPLACEMENT

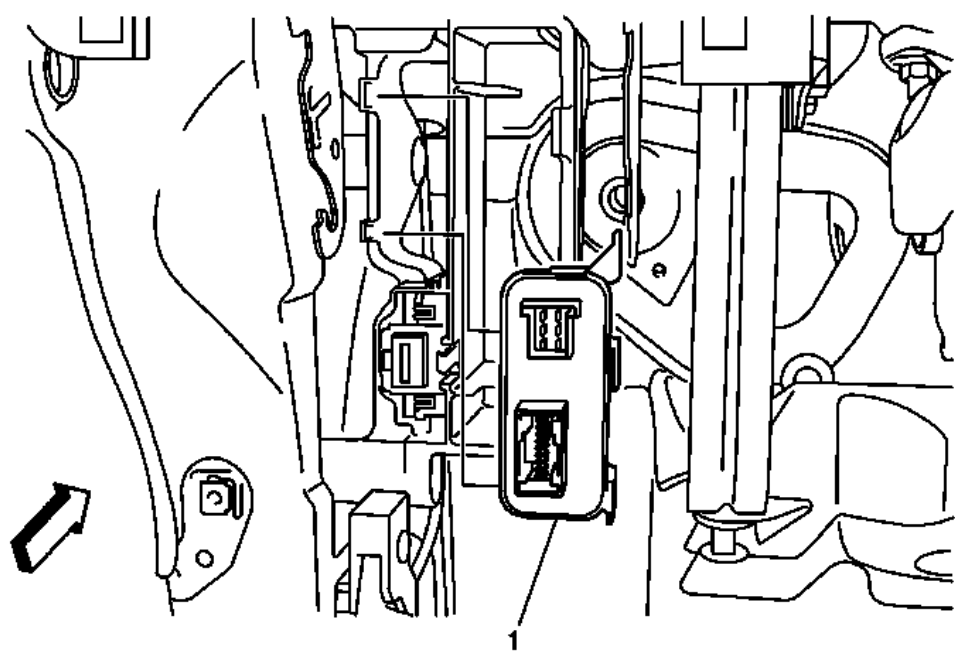


Fig. 24: Headlamp Control Module
Courtesy of GENERAL MOTORS COMPANY

Headlamp Control Module Replacement

Callout	Component Name
Preliminary Procedures	
	<ol style="list-style-type: none"> 1. Remove the instrument panel lower trim pad cover. Refer to <u>Instrument Panel Lower Trim Panel Insulator Replacement</u> . 2. Remove the body control module. Refer to <u>Body Control Module Replacement (Left Hand Drive)</u> .

	Headlamp Control Module
	Procedure
1	<ol style="list-style-type: none"> 1. Disconnect the electrical connectors. 2. Remove the headlamp control module. 3. Set up and program the headlamp control module. Refer to <u>Control Module References</u> .

FRONT FOG LAMP REPLACEMENT

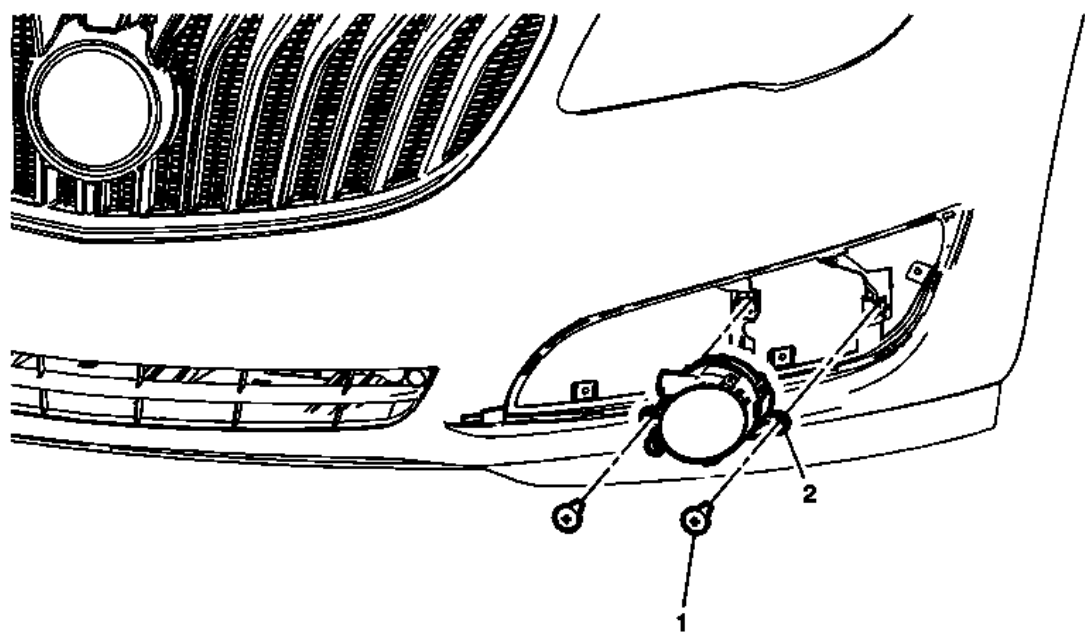


Fig. 25: Front Fog Lamp
 Courtesy of GENERAL MOTORS COMPANY

Front Fog Lamp Replacement

Callout	Component Name
Preliminary Procedure Remove the front bumper fascia outer insert. Refer to <u>Front Bumper Fascia Outer Insert Replacement</u> .	
1	Front Fog Lamp Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
	Front Fog Lamp

Procedure	
2	<ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Pull the front fog lamp straight forward from the front bumper fascia. 3. Aim the front fog lamp after replacement. Refer to <u>Fog Lamp Aiming</u>.

FRONT FOG LAMP BULB REPLACEMENT

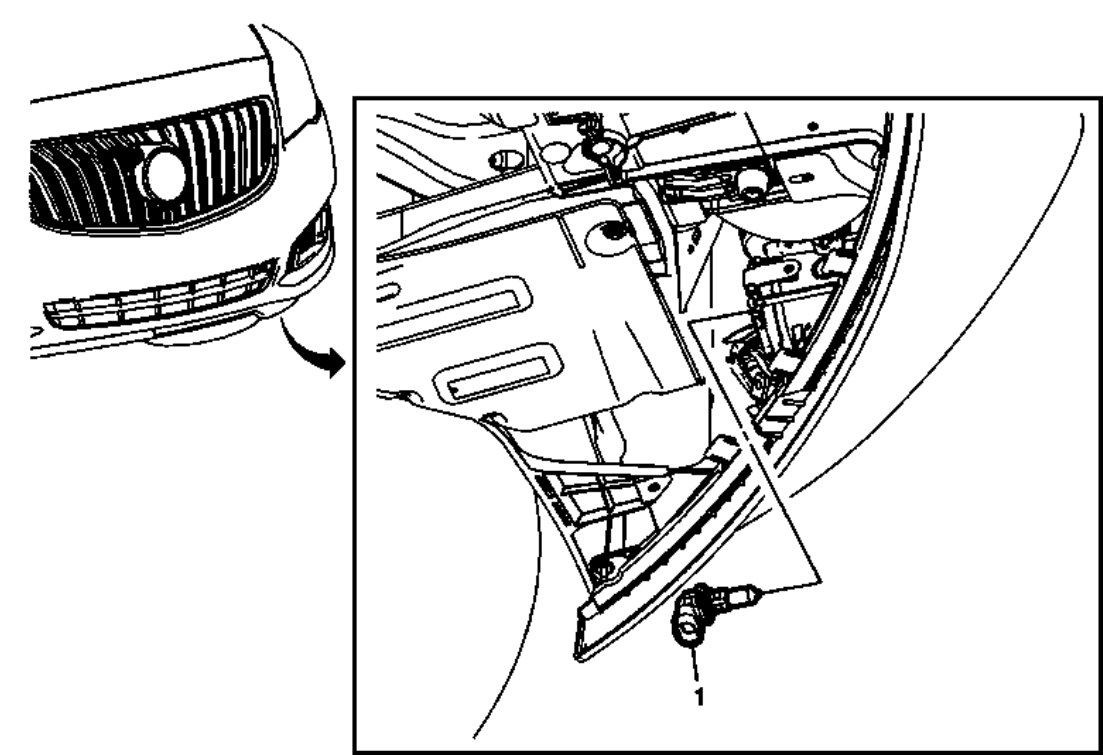


Fig. 26: Front Fog Lamp Bulb
 Courtesy of GENERAL MOTORS COMPANY

Front Fog Lamp Bulb Replacement

Callout	Component Name
Preliminary Procedure Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Front Fog Lamp Bulb Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector 2. Rotate the front fog lamp bulb counterclockwise and pull straight back to remove from the front fog lamp.

FOG LAMP AIMING

Adjustment Procedure

Proper road illumination and safety require the fog lamps to be aimed. The front fog lamp aim should be checked when a new front fog lamp assembly is installed, or if any service repairs have been performed to the vehicle which disturb the front fog lamp mounting or the vehicle ride height.

There are no horizontal adjustments for aiming the front fog lamp assemblies on this vehicle.

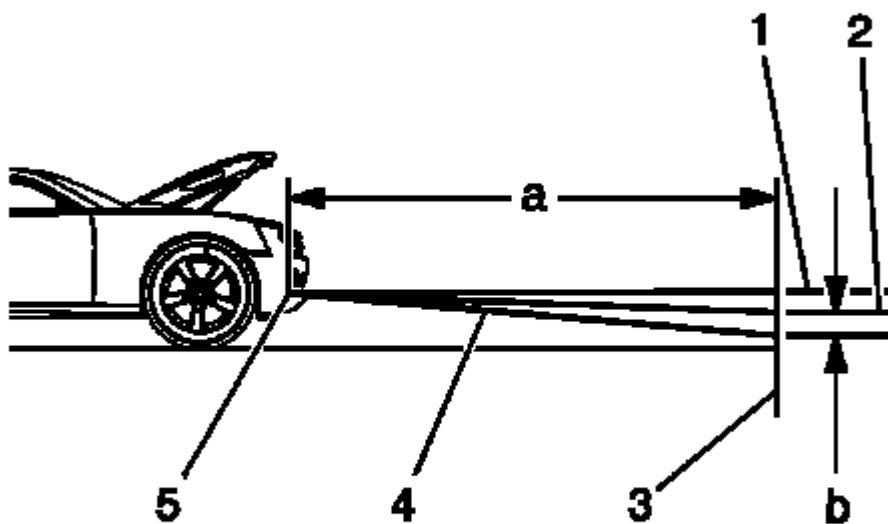


Fig. 27: Fog Lamp Aiming

Courtesy of GENERAL MOTORS COMPANY

1. To ensure accurate vertical front fog lamp aiming, first perform the following steps to prepare the vehicle.
 - Make sure that all the components are in place on the vehicle, the tires are properly inflated, and there is not any mud or snow clinging to the vehicle.
 - Stop all other operations of work on the vehicle.
 - Make sure the fuel level is 1/2 full or more.
 - Jounce the vehicle to settle the suspension.
 - Place the vehicle on a level surface 7.6 m (25 ft) from the target screen.
 - Measure the distance from the floor to the center of the fog lamp (5).
 - Using this measurement, mark the horizontal centerline of the fog lamp (1) on the target screen

directly in front of the vehicle.

- Start the vehicle in order to level the electronic suspension.
 - Turn off the vehicle.
2. Turn the front fog lamps ON.
 3. Turn the adjusting screw located on the exterior lower outer insert molding assembly, bottom corner of the fog lamp projector and adjust the fog lamp projector aim beam.
 4. Adjust the fog lamp up or down until the top edge of the high intensity zone on the screen is 102 mm (4 in) below the horizontal centerline.
 5. Turn OFF the front fog lamps.

FRONT TURN SIGNAL LAMP BULB REPLACEMENT

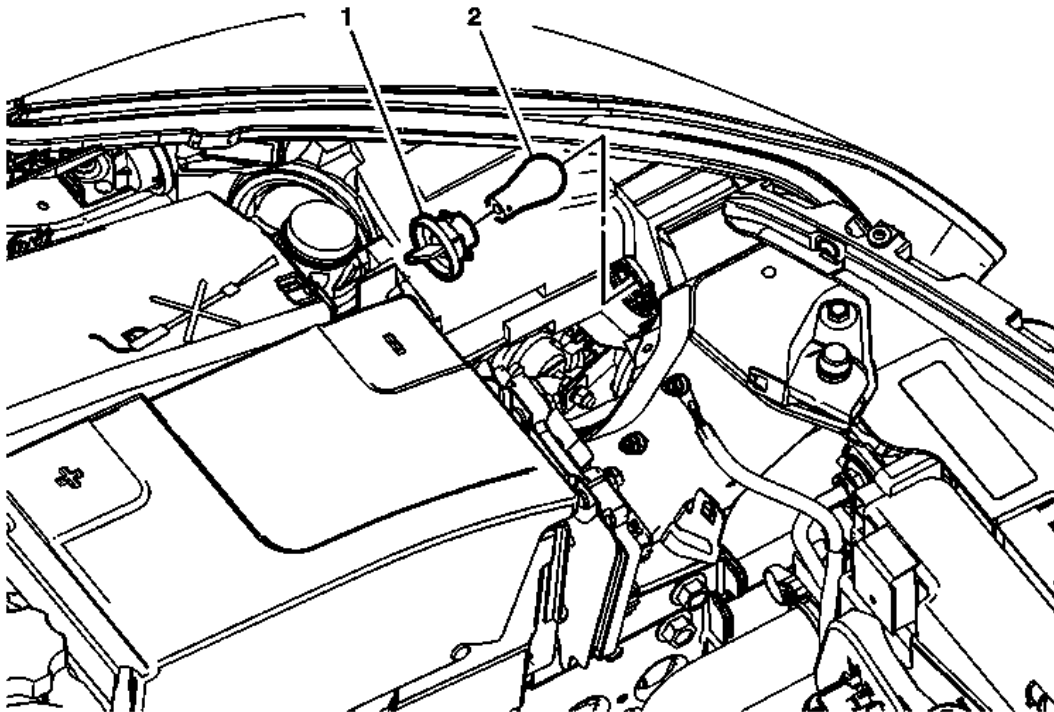


Fig. 28: Front Turn Signal Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

Front Turn Signal Lamp Bulb Replacement

Callout	Component Name
Preliminary Procedure Open and support the hood.	
1	Front Turn Signal Lamp Bulb Socket Procedure Turn the front turn signal lamp bulb socket counterclockwise and pull from the headlamp.
2	Front Turn Signal Lamp Bulb Procedure

Pull the front turn signal lamp bulb straight out of the front turn signal lamp bulb socket.

HIGH MOUNT STOP LAMP REPLACEMENT

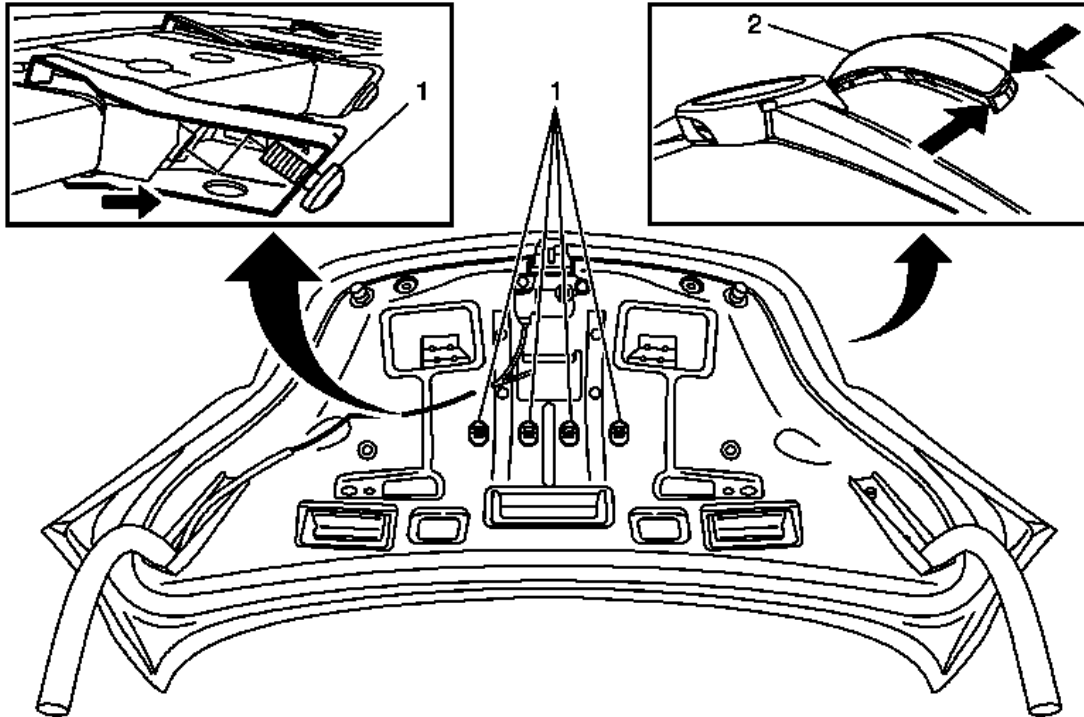


Fig. 29: High Mount Stop Lamp
Courtesy of GENERAL MOTORS COMPANY

High Mount Stop Lamp Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment lid inner panel trim. Refer to <u>Rear Compartment Lid Inner Panel Trim Replacement</u> .	
1	High Mount Stop Lamp Fastener (Qty: 4) Procedure Press screwdriver onto the screw and unfasten it with about 4-5 rotations still pressing the screwdriver onto the screw. After that, push back the clip. To make sure the screw does not fall into the trunk lid, use a magnetic screwdriver.
2	High Mount Stop Lamp Procedure <ol style="list-style-type: none">1. Disconnect the electrical connector at the high mount stop lamp.2. Use a small flat-bladed tool to release the high mount stop lamp locking retainer starting at the left or right side of the lid compartment.

3. Use new seal.
4. Reinstall clips and screws. Hand tighten only, no torque required.
5. Insert lamp and press in place until all retainers are engaged.

REAR LICENSE PLATE LAMP REPLACEMENT

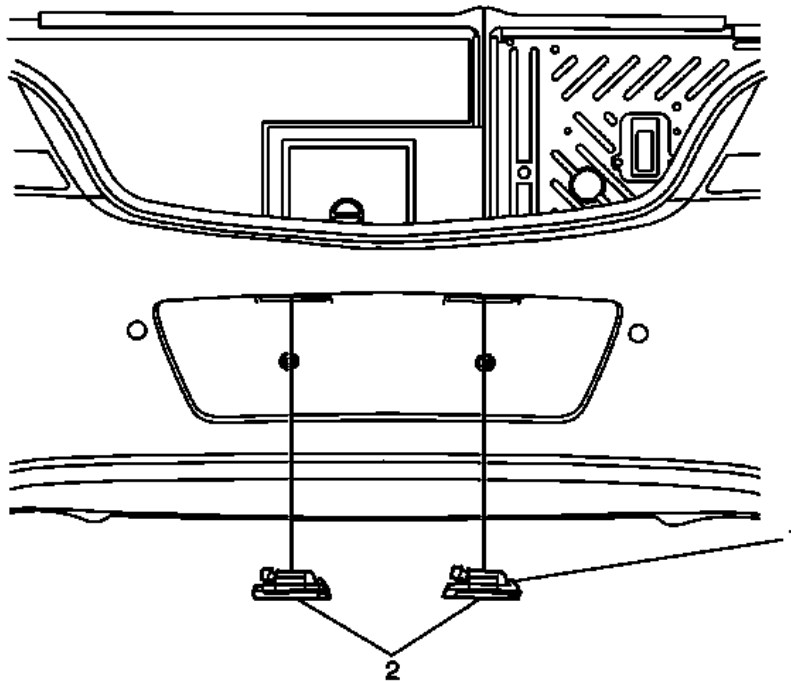


Fig. 30: Rear License Plate Lamp
 Courtesy of GENERAL MOTORS COMPANY

Rear License Plate Lamp Replacement

Callout	Component Name
1	Rear License Plate Lamp Tap TIP: Using a small flat-bladed tool, pull the right side down out from the rear bumper opening.
2	Rear License Plate Lamp Procedure Disconnect the rear license lamp electrical connector.

REAR LICENSE PLATE LAMP BULB REPLACEMENT

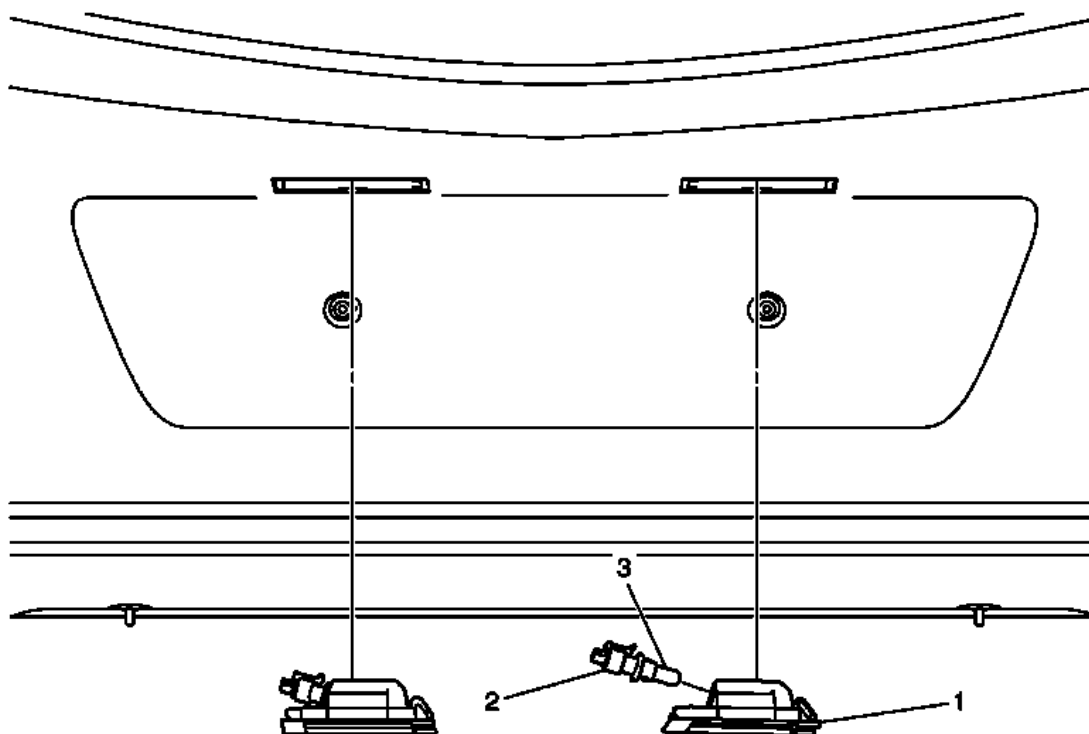


Fig. 31: Rear License Plate Lamp Bulb
 Courtesy of GENERAL MOTORS COMPANY

Rear License Plate Lamp Bulb Replacement

Callout	Component Name
1	Rear License Lamp Retainer TIP: Using a small flat-bladed tool, pull the right side down out from the rear bumper fascia opening.
2	Rear License Lamp Socket TIP: Rotate the lamp socket counter clock wise and remove.
3	Rear License Lamp Bulb CAUTION: Refer to <u>Avoid Touching the Bulb Caution</u> . TIP: Service the bulb, as needed.

TAIL LAMP REPLACEMENT

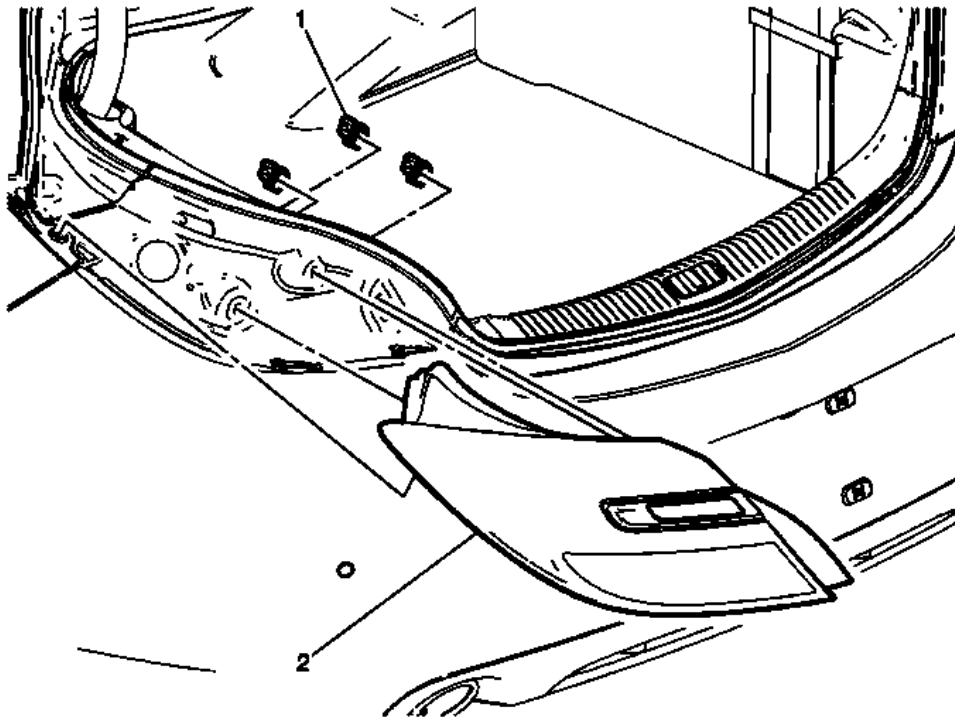


Fig. 32: Tail Lamp
 Courtesy of GENERAL MOTORS COMPANY

Tail Lamp Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment side trim panel. Refer to <u>Rear Compartment Side Trim Panel Replacement (without HP6)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Tail Lamp Nut (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 N.m(22 lb in)
2	Tail Lamp Procedure 1. Grasp the most forward edge and firmly pull up to release the retainer. 2. Disconnect the electrical connector and remove the tail lamp from vehicle.

TAIL LAMP BULB REPLACEMENT

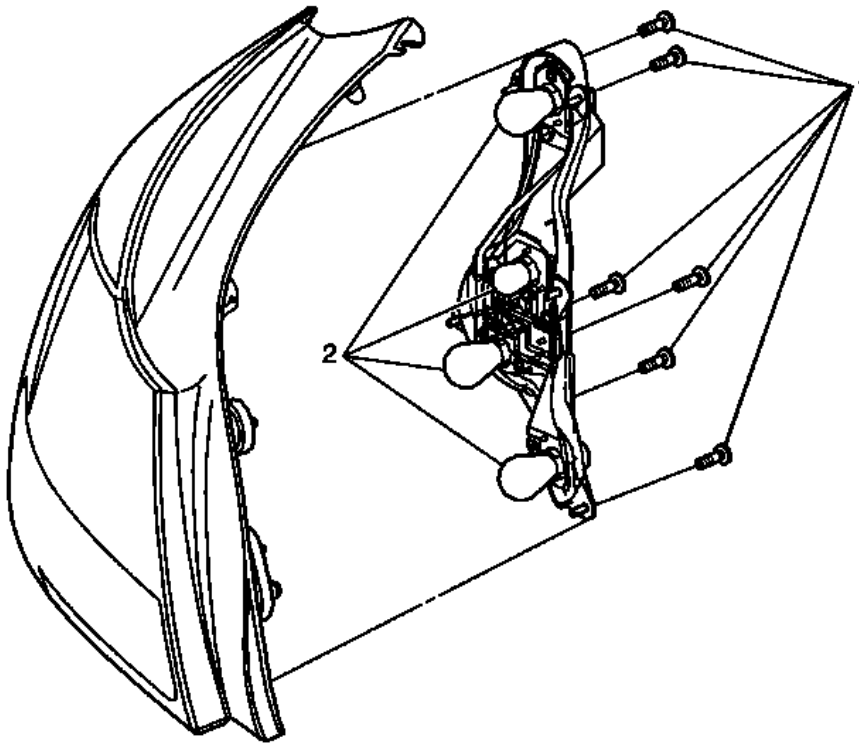


Fig. 33: Tail Lamp Bulb
 Courtesy of GENERAL MOTORS COMPANY

Tail Lamp Bulb Replacement

Callout	Component Name
Preliminary Procedure	
Remove the tail lamp. Refer to <u>Tail Lamp Replacement</u> .	
1	Tail Lamp Harness Socket Fastener (Qty: 6)
2	Tail Lamp Bulb CAUTION: Refer to <u>Avoid Touching the Bulb Caution</u> . Procedure 1. Service the bulb, as needed. 2. Pull the bulb straight from the lamp harness socket.

REAR COMPARTMENT COURTESY LAMP REPLACEMENT

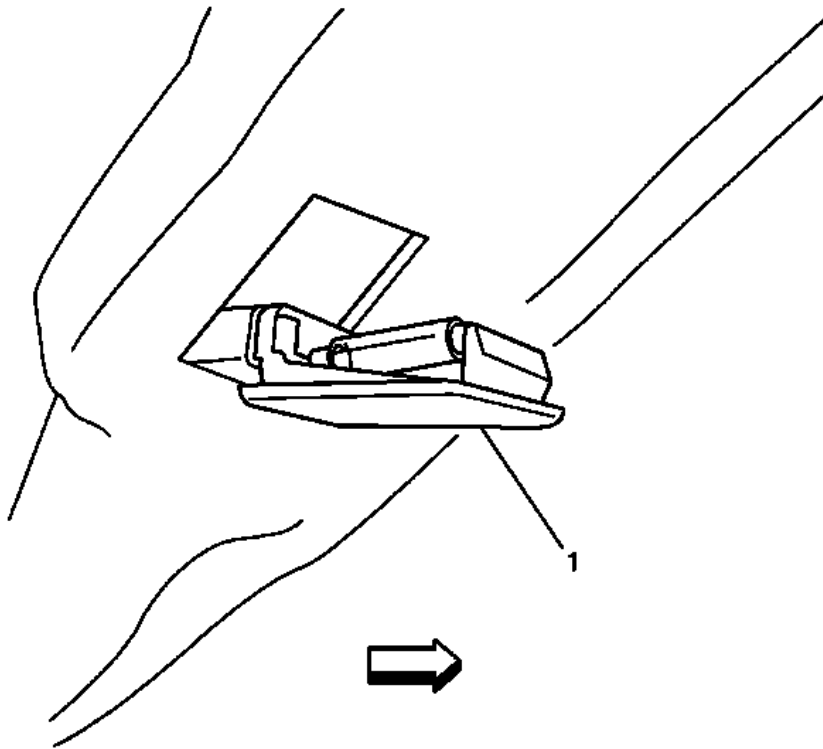


Fig. 34: Rear Compartment Courtesy Lamp
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Courtesy Lamp Replacement

Callout	Component Name
1	Rear Compartment Courtesy Lamp Procedure <ol style="list-style-type: none"> 1. Release and pull off the rear compartment courtesy lamp. 2. Disconnect the electrical connector. TIP: Carefully use a flat-bladed tool, and release the compartment lamp.

ELECTRICAL

Lighting - Schematic Wiring Diagrams

SCHEMATIC WIRING DIAGRAMS

HEADLIGHTS/DAYTIME RUNNING LIGHTS (DRL) WIRING SCHEMATICS

Headlamp Controls

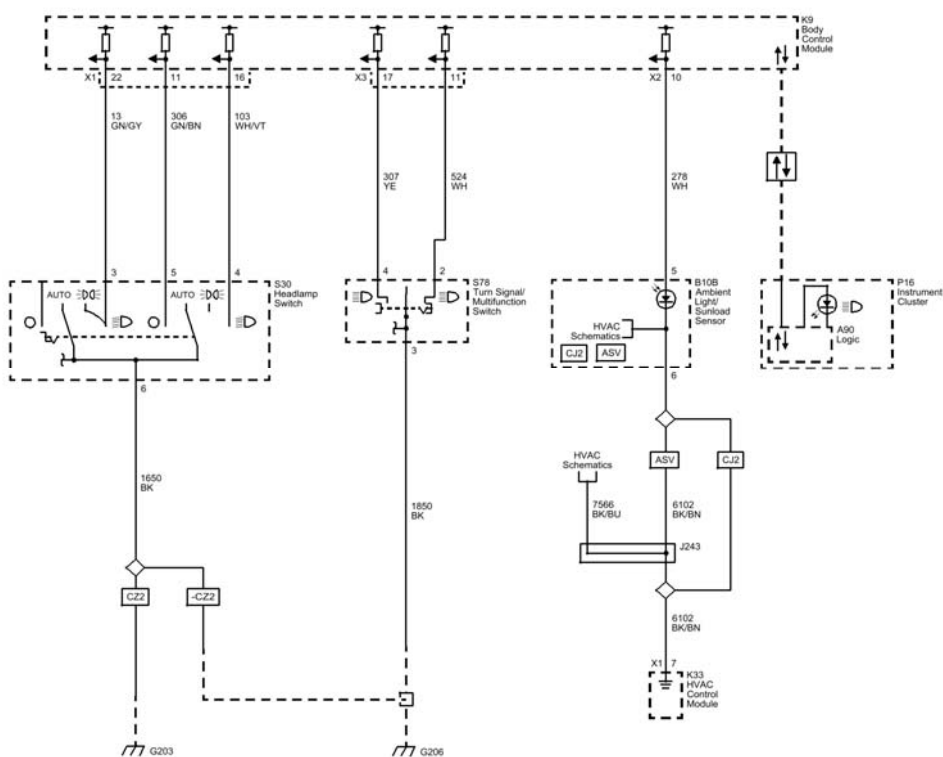


Fig. 1: Headlamp Controls

Courtesy of GENERAL MOTORS COMPANY

Lamps (T4A/Except CZ2)

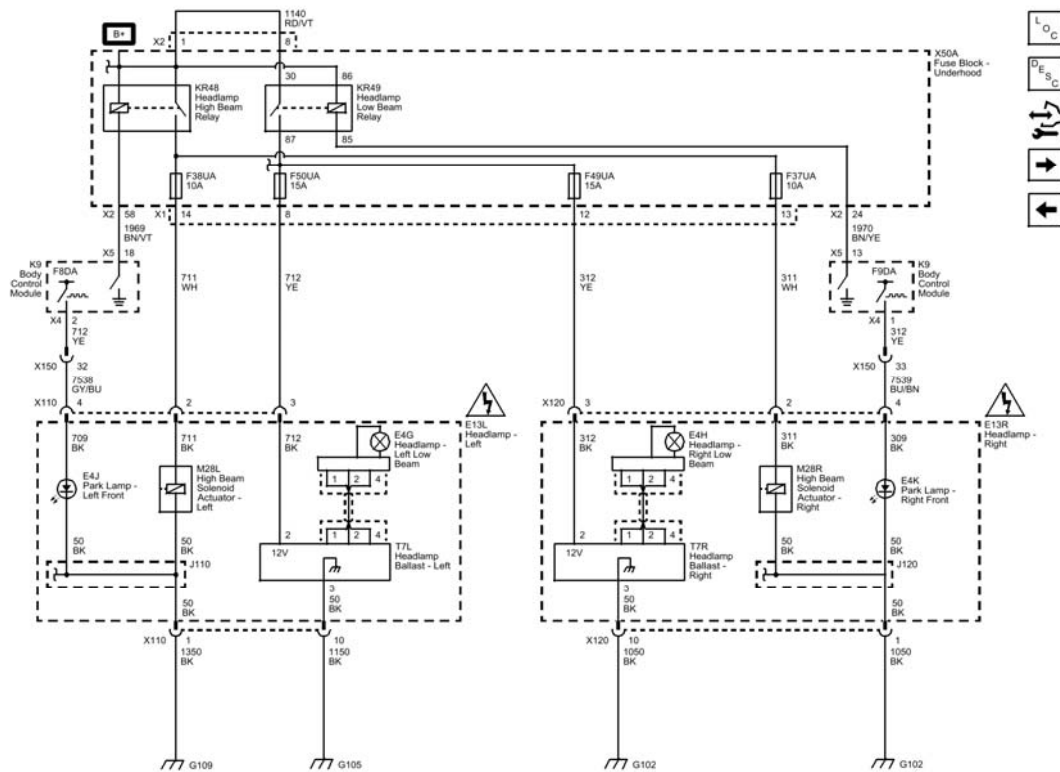


Fig. 3: Lamps (T4F Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Headlamps Low Beam (T4A) and High Beam (CZ2)

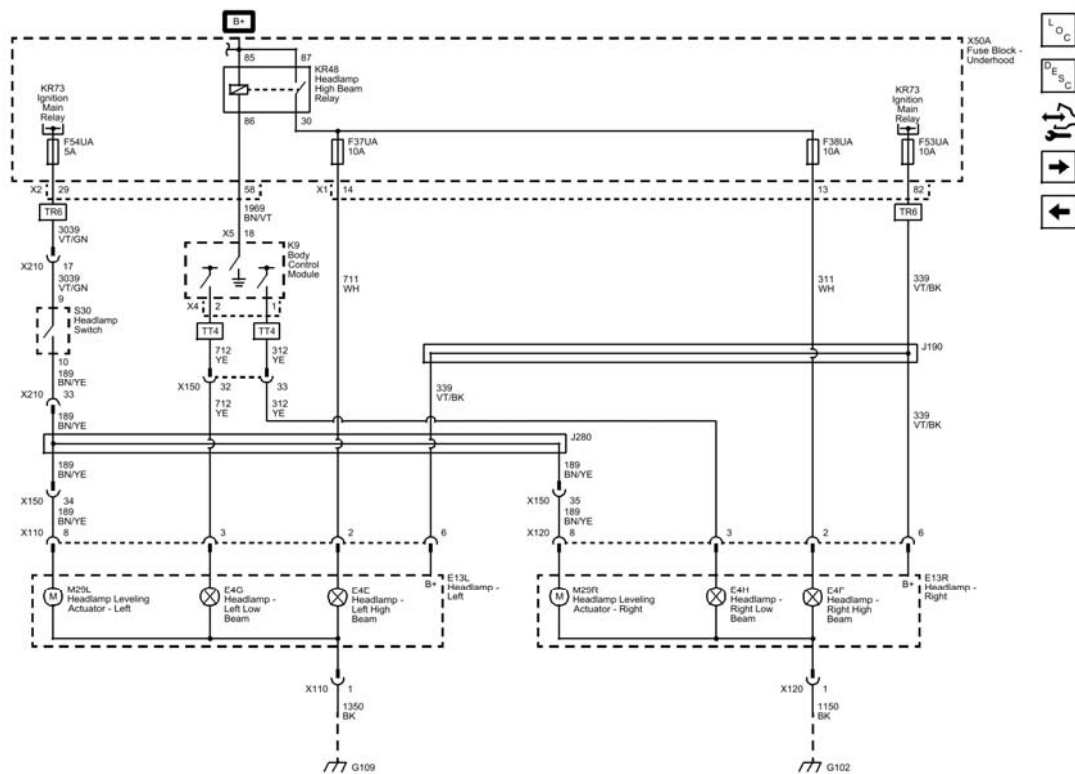


Fig. 4: Headlamps Low Beam (T4A) and High Beam (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Headlamps Low Beam and Cornering Lamps (T4F/CZ2)

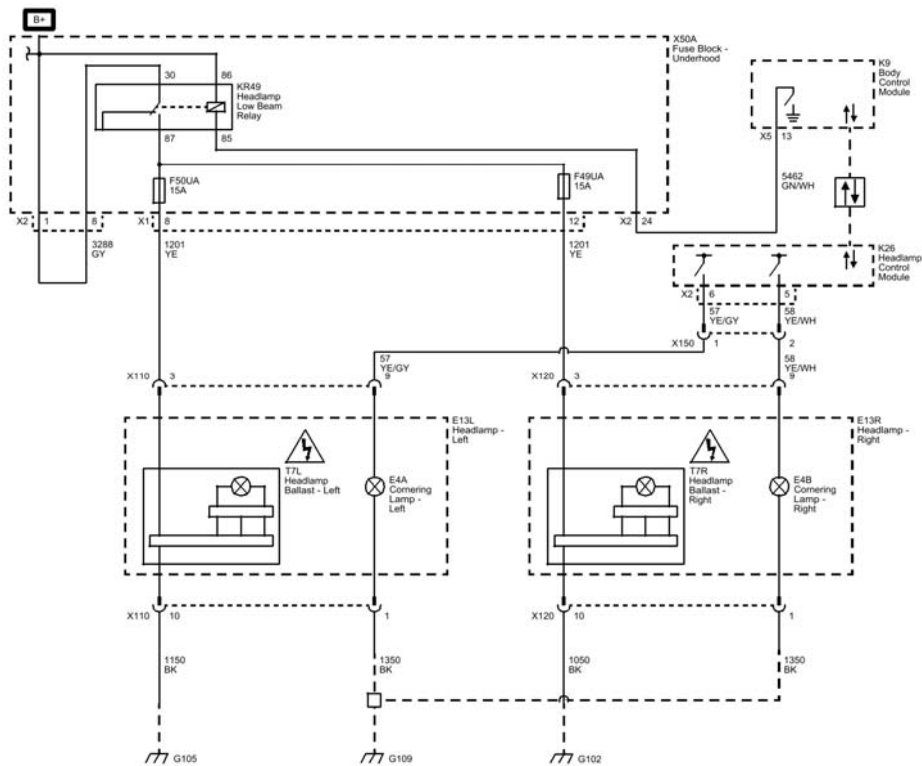


Fig. 5: Headlamps Low Beam and Cornering Lamps (T4F/CZ2)
Courtesy of GENERAL MOTORS COMPANY

Headlamps Leveling (TR7/CZ2)

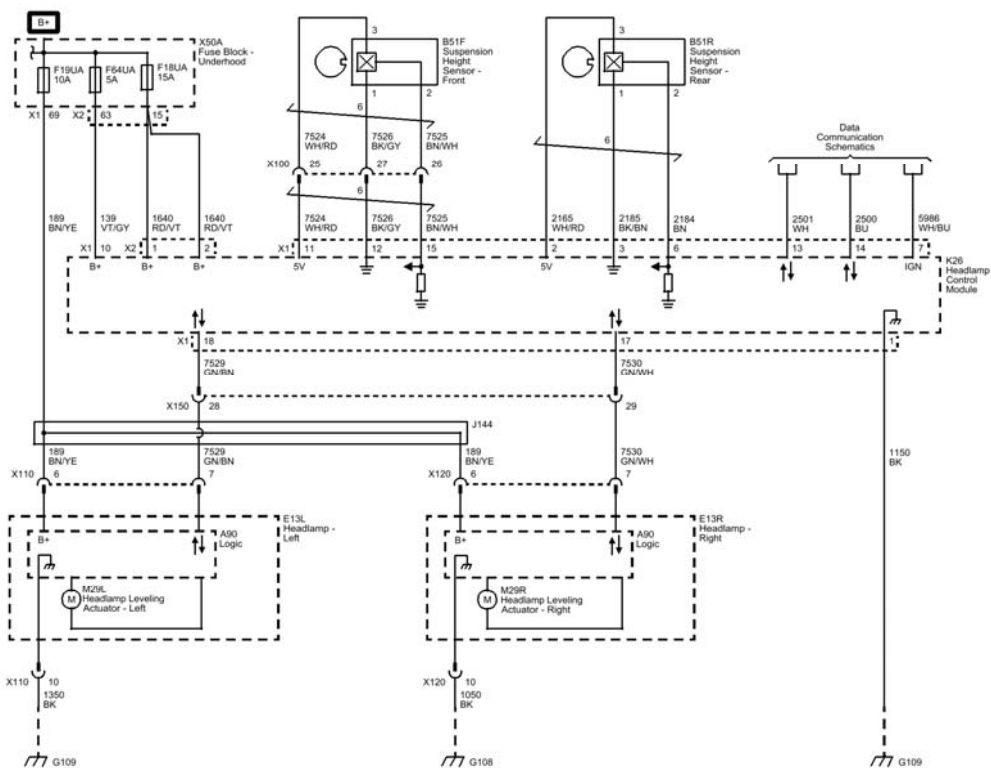


Fig. 6: Headlamps Leveling (TR7/CZ2)
 Courtesy of GENERAL MOTORS COMPANY

FOG LIGHTS WIRING SCHEMATICS

Fog Lights

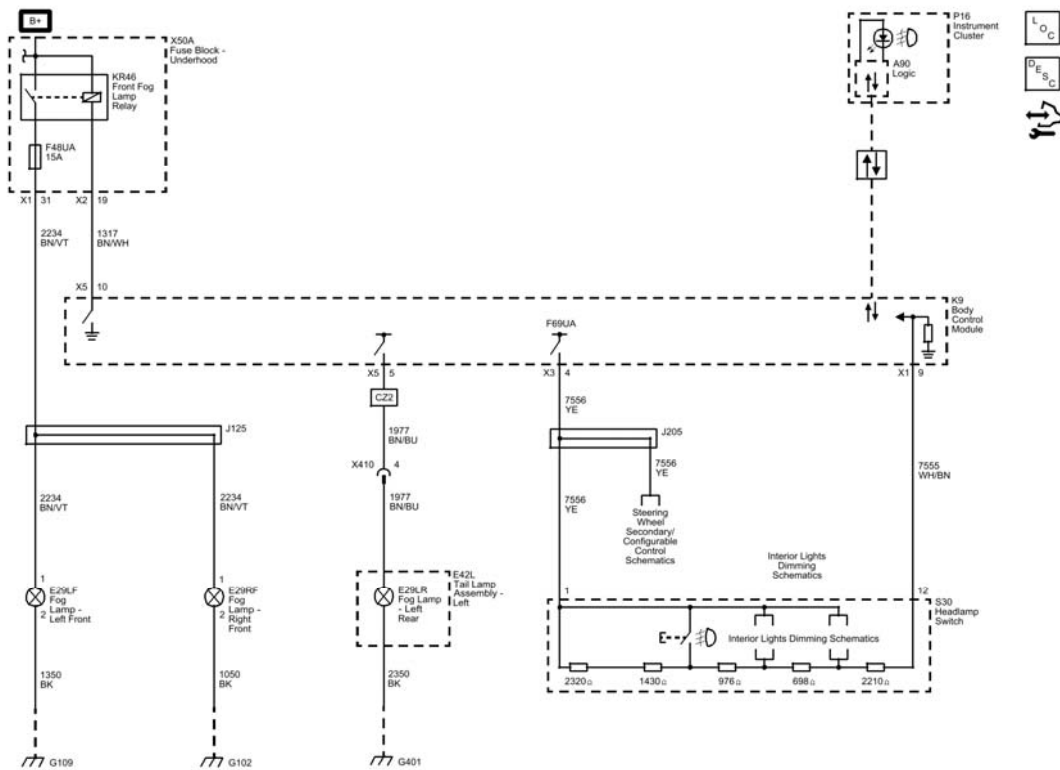


Fig. 7: Fog Lights

Courtesy of GENERAL MOTORS COMPANY

EXTERIOR LIGHTS WIRING SCHEMATICS

Controls and Indicators

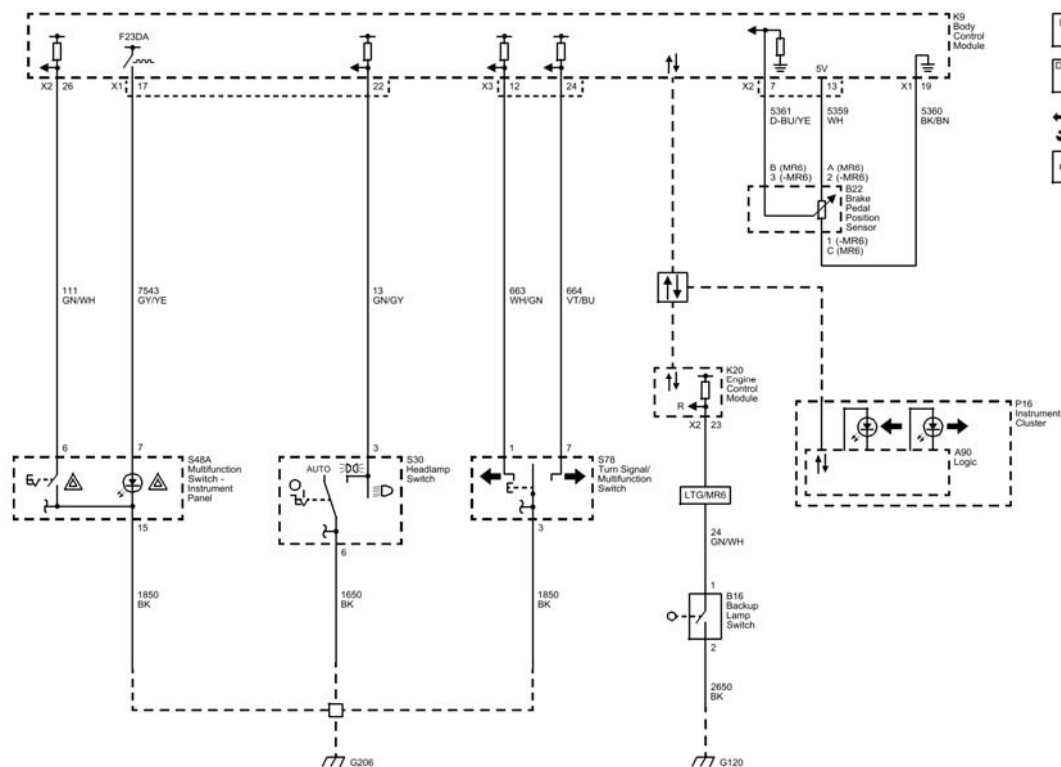


Fig. 8: Controls and Indicators
 Courtesy of GENERAL MOTORS COMPANY

Front Lamps (T4A)

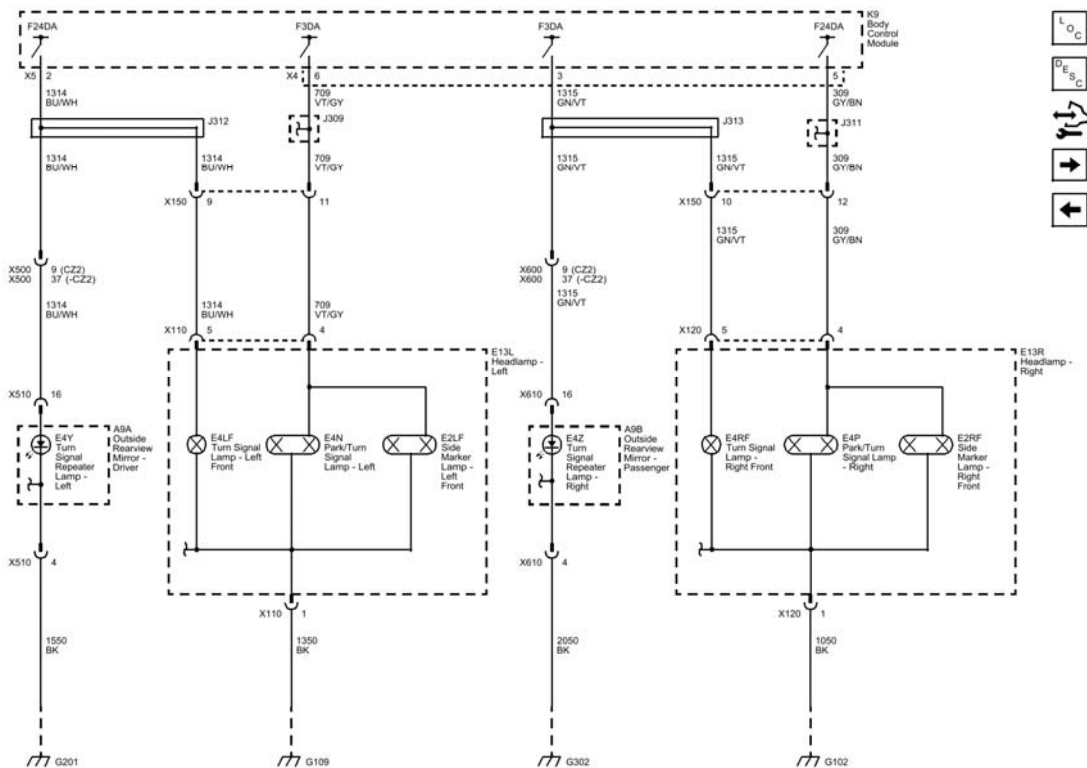


Fig. 9: Front Lamps (T4A)
 Courtesy of GENERAL MOTORS COMPANY

Front Lamps (T4F)

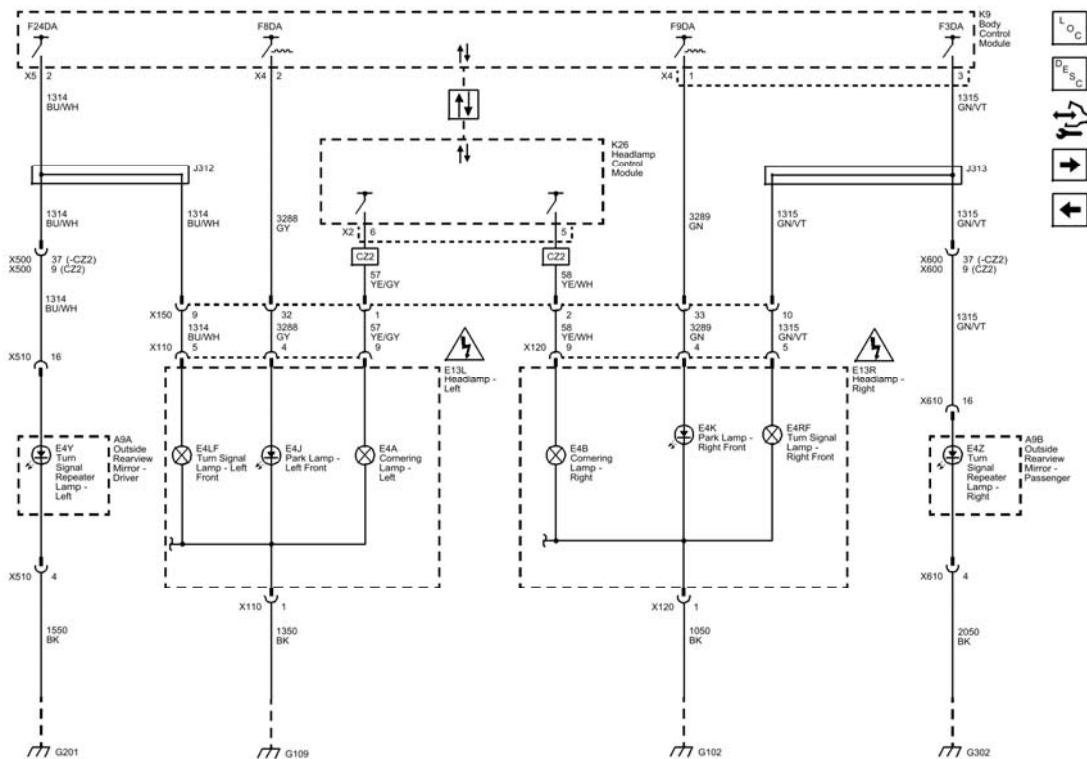


Fig. 10: Front Lamps (T4F)
Courtesy of GENERAL MOTORS COMPANY

License, Stop, Tail, and Rear Turn Signal Lamps

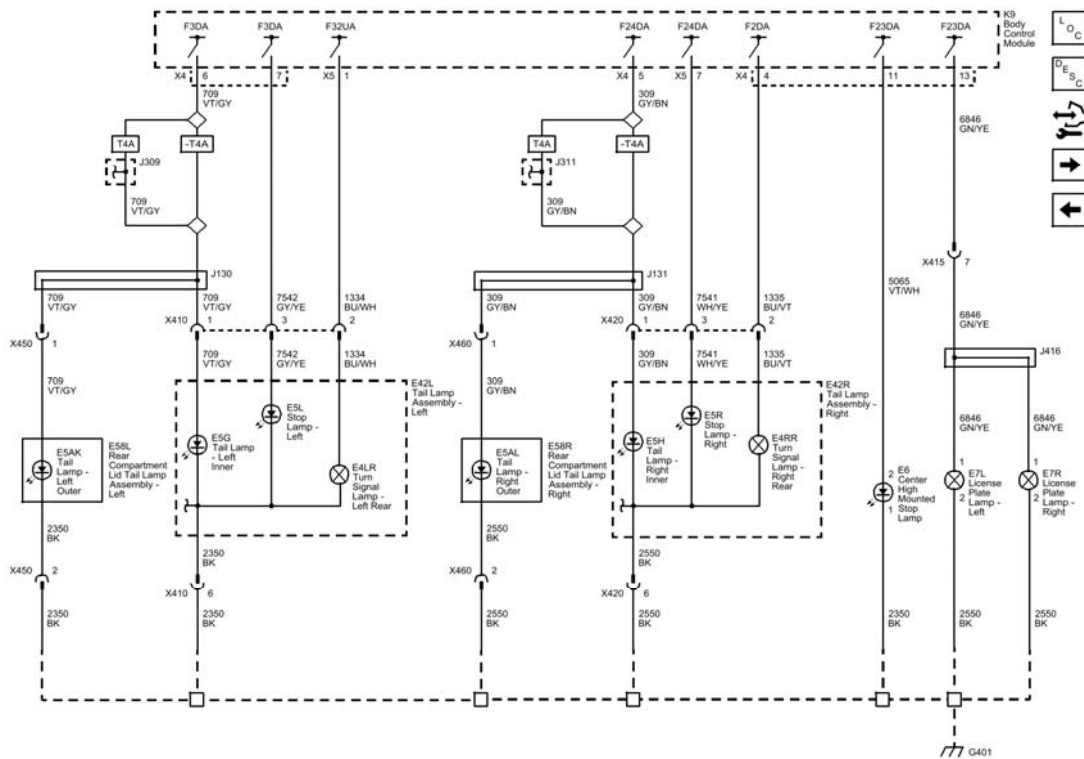


Fig. 11: License, Stop, Tail, and Rear Turn Signal Lamps
Courtesy of GENERAL MOTORS COMPANY

Backup Lamps

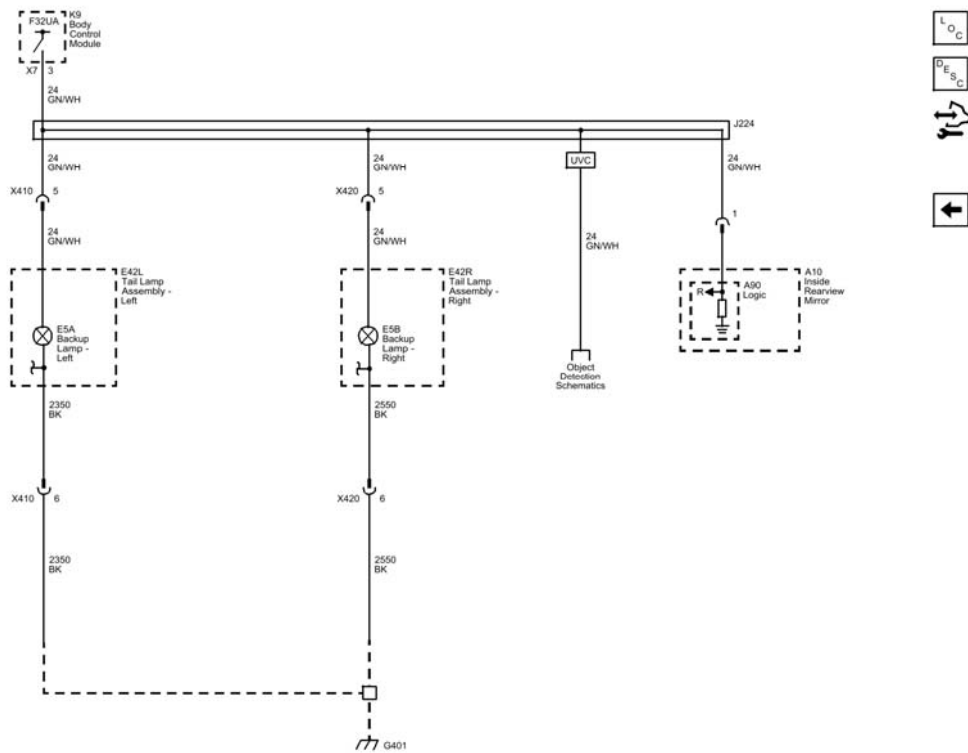


Fig. 12: Backup Lamps
 Courtesy of GENERAL MOTORS COMPANY

INTERIOR LIGHTS WIRING SCHEMATICS

Controls and Door Pocket Lamps

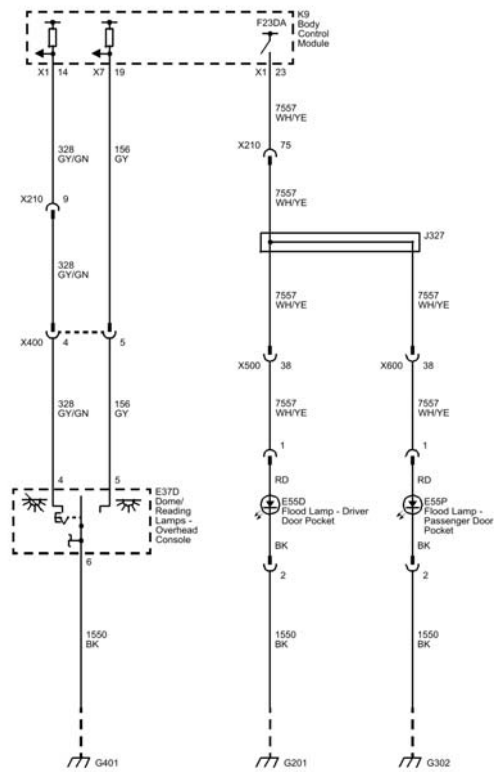


Fig. 13: Controls and Door Pocket Lamps
 Courtesy of GENERAL MOTORS COMPANY

Courtesy Lamps

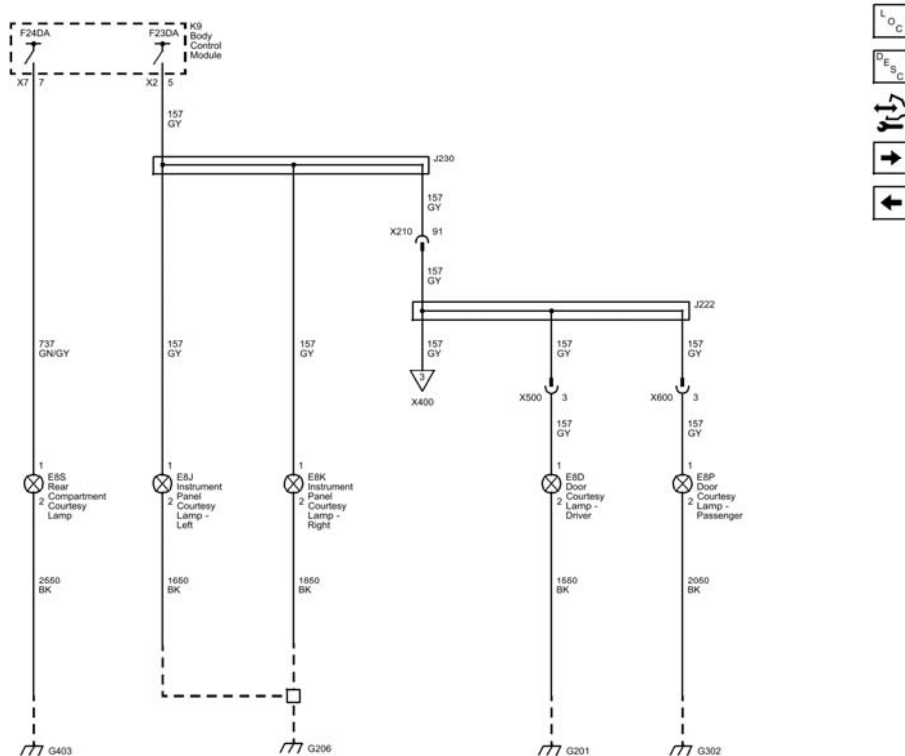


Fig. 14: Courtesy Lamps
Courtesy of GENERAL MOTORS COMPANY
Overhead and Instrument Panel Compartment Lamps

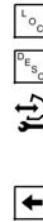
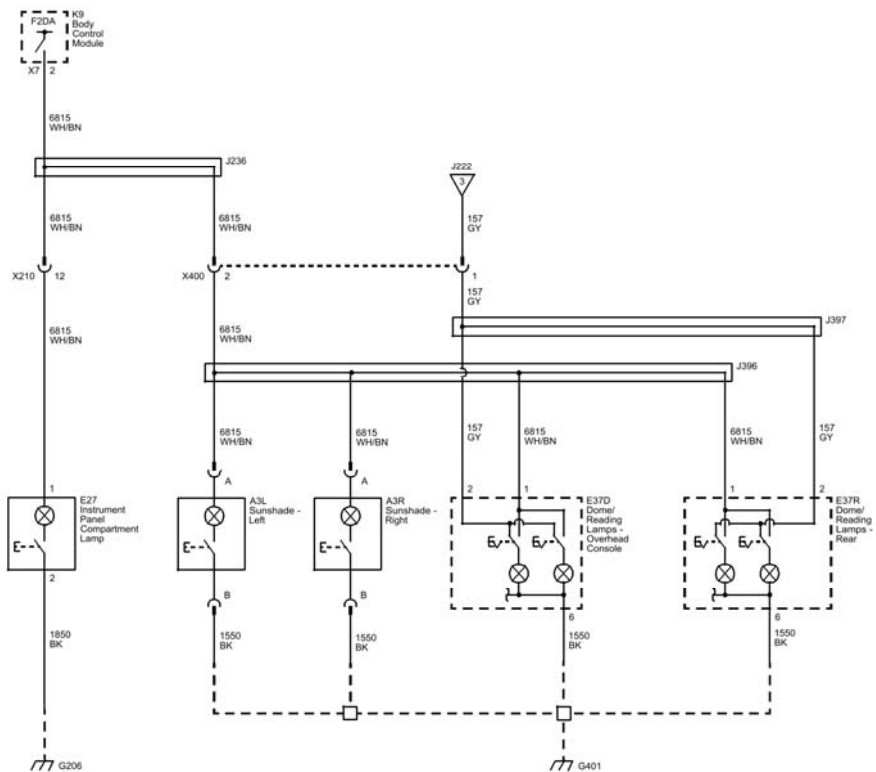


Fig. 15: Overhead and Instrument Panel Compartment Lamps
Courtesy of GENERAL MOTORS COMPANY

Accent Lamps

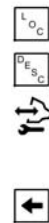
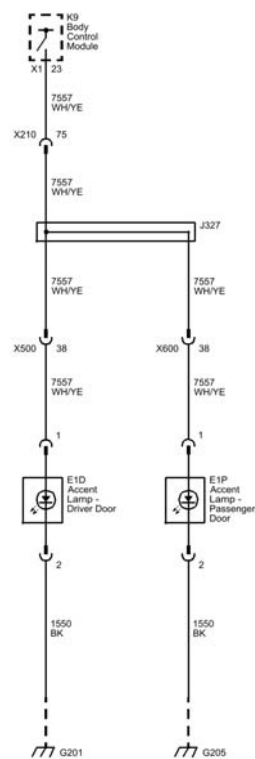


Fig. 16: Accent Lamps

Courtesy of GENERAL MOTORS COMPANY

INTERIOR LIGHTS DIMMING WIRING SCHEMATICS

Controls, Doors, and Overhead Lamps

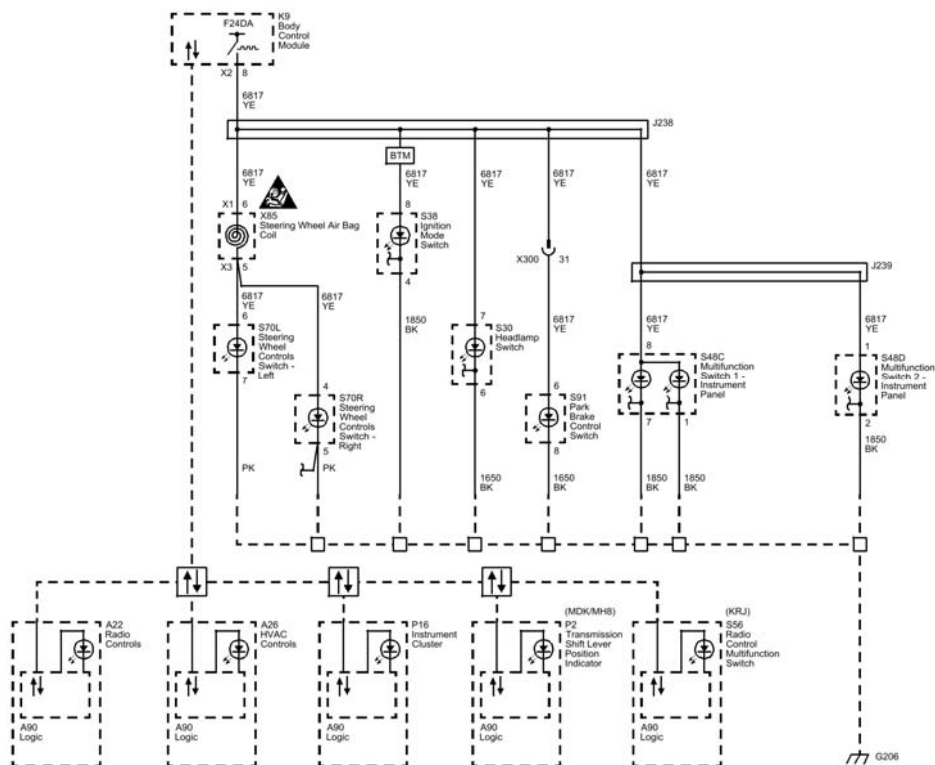


Fig. 18: Instrument Panel and Floor Console Lamps
Courtesy of GENERAL MOTORS COMPANY

Headlamp, Door Lock, Outside Rearview Mirror, and Window Switches

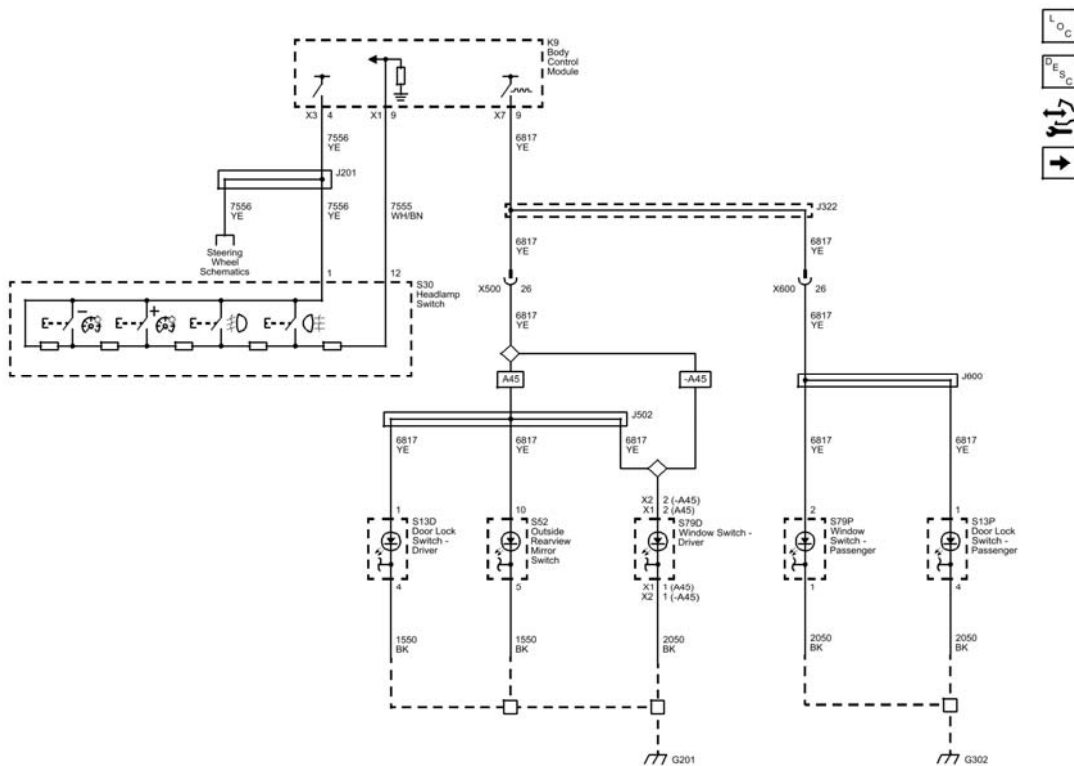


Fig. 19: Headlamp, Door Lock, Outside Rearview Mirror, and Window Switches
 Courtesy of GENERAL MOTORS COMPANY

Instrument Panel and Steering Wheel Switches

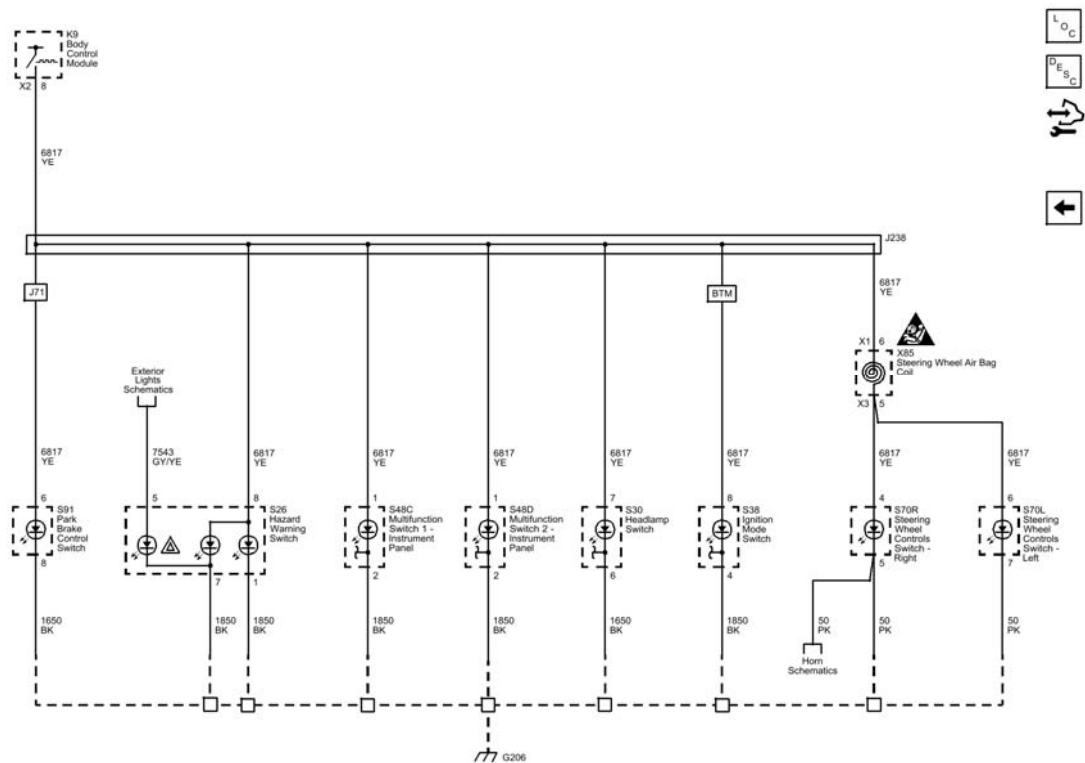


Fig. 20: Instrument Panel and Steering Wheel Switches
Courtesy of GENERAL MOTORS COMPANY

Cigarette Lighter Receptacles, Dome/Reading Lamps, Seat Memory Switch, and Sunroof Switches

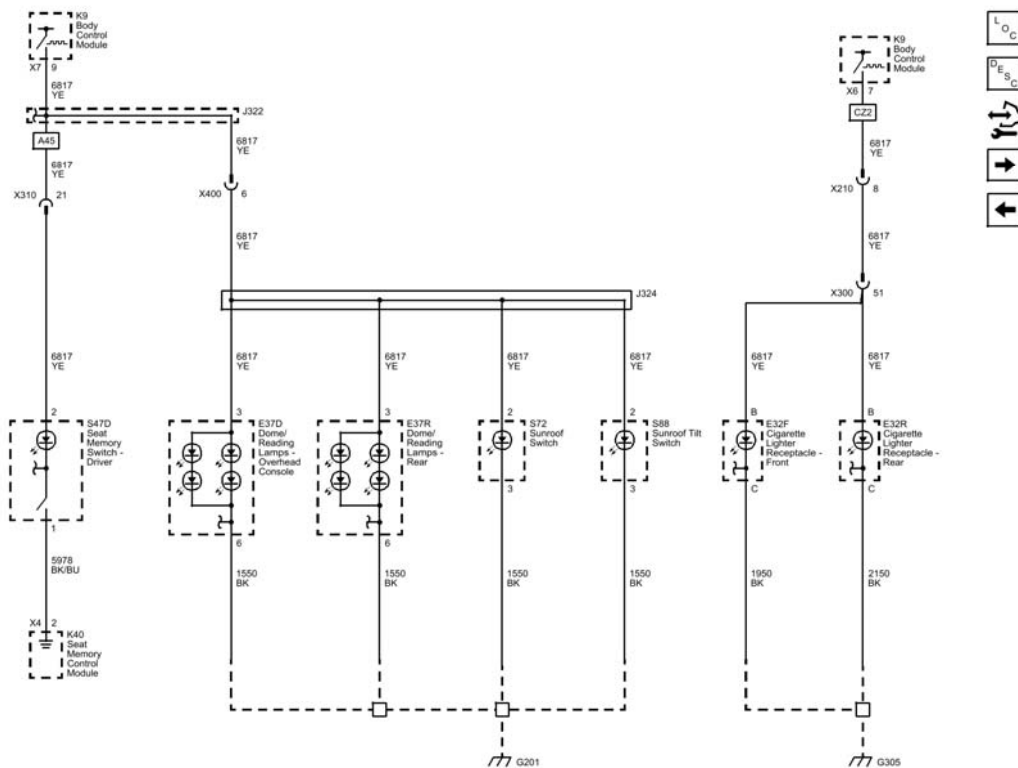


Fig. 21: Cigarette Lighter Receptacles, Dome/Reading Lamps, Seat Memory Switch, and Sunroof Switches
 Courtesy of GENERAL MOTORS COMPANY

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Luggage Compartment/Rear of Vehicle Component Views

LUGGAGE COMPARTMENT/REAR OF VEHICLE COMPONENT VIEWS

REAR OF VEHICLE COMPONENTS

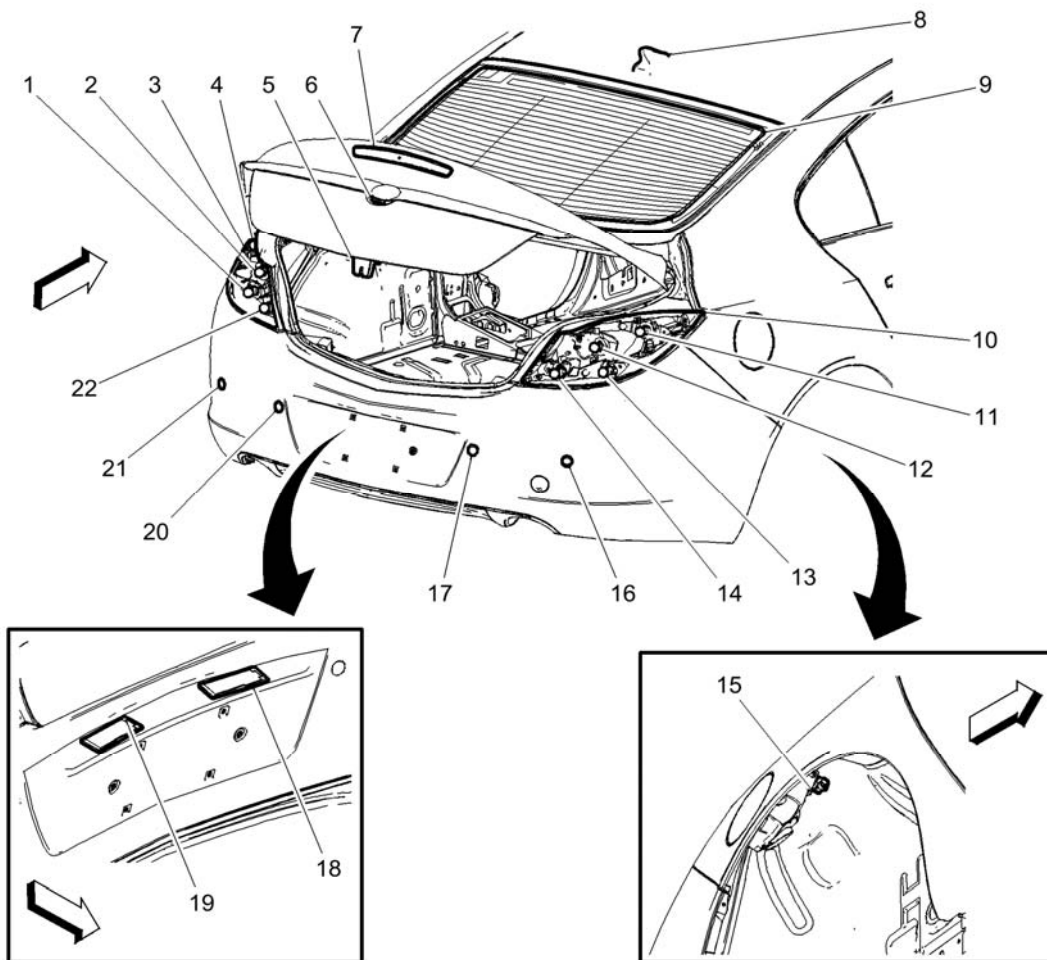


Fig. 1: Rear Of Vehicle Components

Courtesy of GENERAL MOTORS COMPANY

Items

- 1: E5AM Stop/Turn Signal Lamp - Left E5AM Stop/Turn Signal Lamp - Left
- 2: E5G Tail Lamp - Left Inner E5G Tail Lamp - Left Inner
- 3: E42L Tail Lamp Assembly - Left E42L Tail Lamp Assembly - Left (CZ2)
- 4: E5AK Tail Lamp - Left Outer E5AK Tail Lamp - Left Outer

5: M40 Rear Compartment Lid Latch **M40 Rear Compartment Lid Latch**
6: S58A Rear Compartment Lid Unlatch Switch - Exterior **S58A Rear Compartment Lid Unlatch Switch - Exterior**
7: E6 Center High Mounted Stop Lamp **E6 Center High Mounted Stop Lamp**
8: T4G Cellular Phone, Navigation, and Digital Radio Antenna
9: E18 Rear Defogger Grid **E18 Rear Defogger Grid X1 CZ2 E18 Rear Defogger Grid X1 except CZ2 E18 Rear Defogger Grid X2 CZ2 E18 Rear Defogger Grid X2 except CZ2**
10: E42R Tail Lamp Assembly - Right **E42R Tail Lamp Assembly - Right CZ2**
11: E5AL Tail Lamp - Right Outer **E5AL Tail Lamp - Right Outer**
12: E5H Tail Lamp - Right Inner **E5H Tail Lamp - Right Inner**
13: E5AN Stop/Turn Signal Lamp - Right **E5AN Stop/Turn Signal Lamp - Right**
14: E5B Backup Lamp - Right **E5B Backup Lamp - Right**
15: M97 Fuel Door Lock Actuator **M97 Fuel Door Lock Actuator**
16: B78H Rear Object Sensor - Right Outer (UD5 or UD7) **B78H Rear Object Sensor - Right Outer (UD5 or UD7)**
17: B78F Rear Object Sensor - Right Middle (UD5 or UD7) **B78F Rear Object Sensor - Right Middle (UD5 or UD7)**
18: E7R License Plate Lamp - Right **E7R License Plate Lamp - Right**
19: E7L License Plate Lamp - Left **E7L License Plate Lamp - Left**
20: B78E Rear Object Sensor - Left Middle (UD5 or UD7) **B78E Rear Object Sensor - Left Middle (UD5 or UD7)**
21: B78G Rear Object Sensor - Left Outer (UD5 or UD7) **B78G Rear Object Sensor - Left Outer (UD5 or UD7)**
22: E5A Backup Lamp - Left **E5A Backup Lamp - Left**

HYBRID/EV BATTERY PACK (HP6)

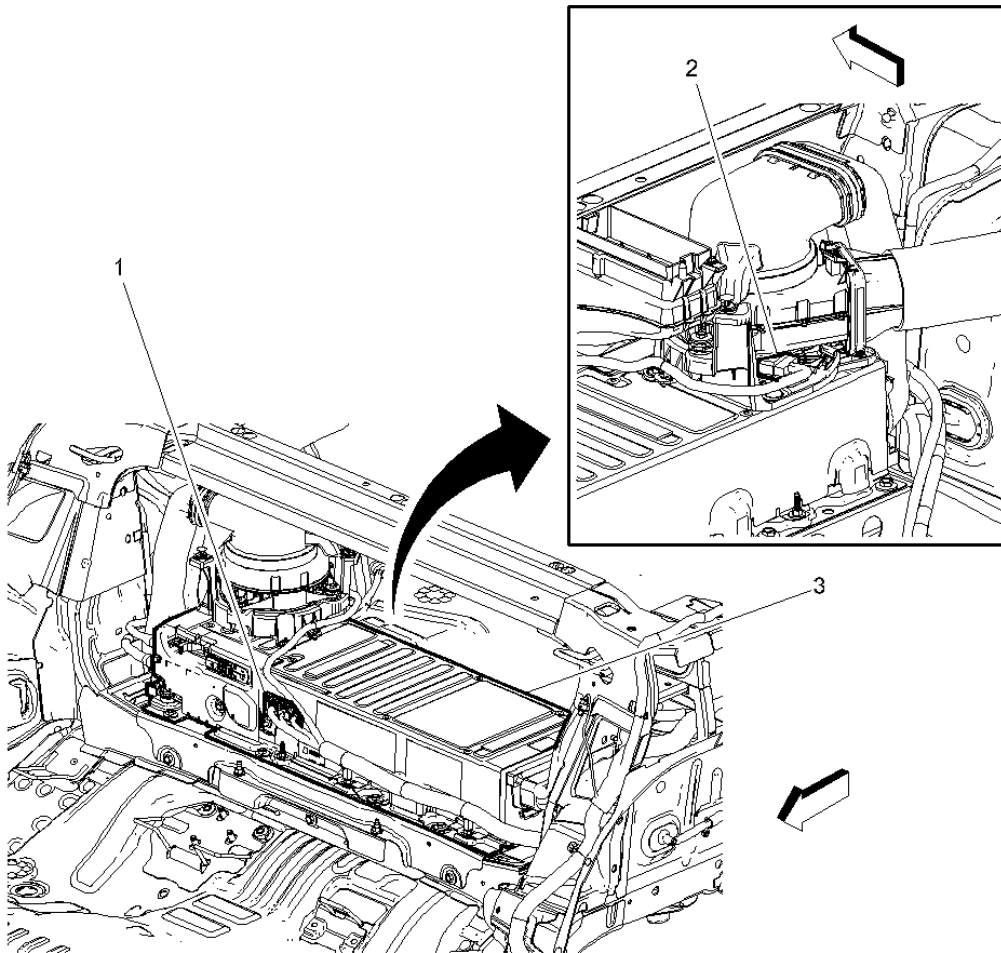


Fig. 2: Hybrid/EV Battery Pack (HP6)
 Courtesy of GENERAL MOTORS COMPANY

Items	
1: K59 Starter/Generator Control Module (HP6)	<u>K59 Starter/Generator Control Module X1 (HP6)</u> <u>K59 Starter/Generator Control Module X2 (HP6)</u> <u>K59 Starter/Generator Control Module X3 (HP6)</u> <u>K59 Starter/Generator Control Module X4 (HP6)</u>
2: G14 Hybrid/EV Battery Pack Cooling Fan (HP6)	<u>G14 Hybrid/EV Battery Pack Cooling Fan (HP6)</u>

LEFT SIDE OF THE LUGGAGE COMPARTMENT COMPONENTS

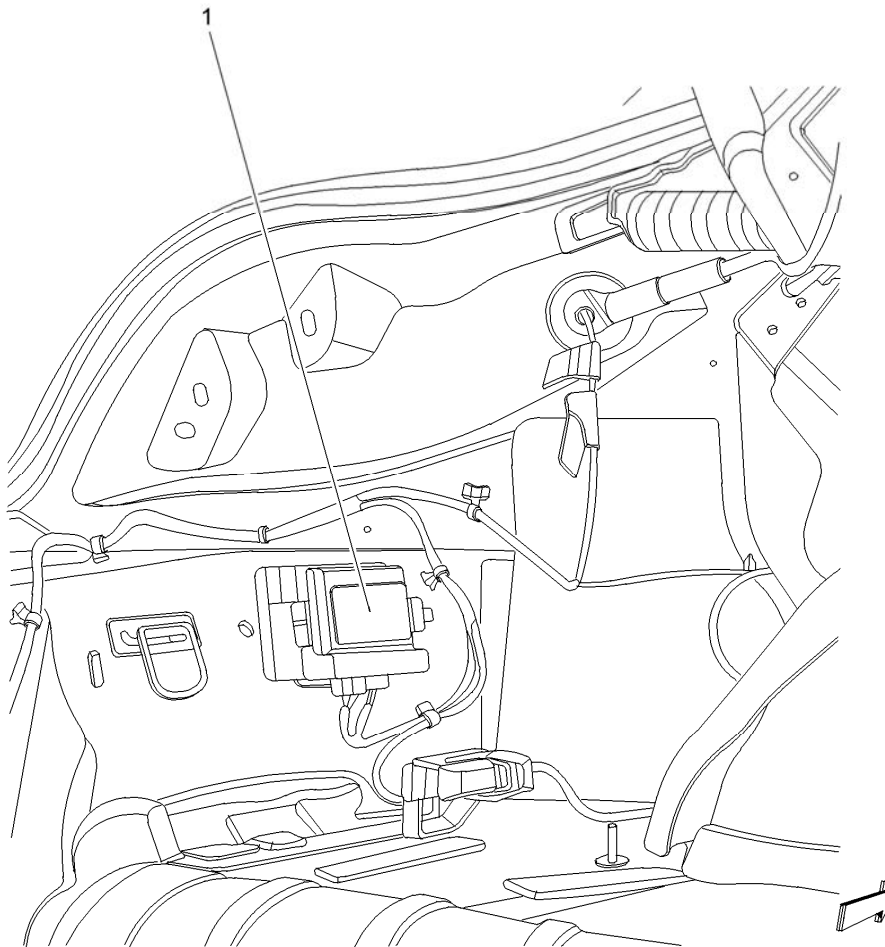


Fig. 3: Left Side Of Luggage Compartment Components
 Courtesy of GENERAL MOTORS COMPANY

Items

1: K41R Rear Parking Assist Control Module (UD7) K41R Rear Parking Assist Control Module X1 (UD7) K41R Rear Parking Assist Control Module X2 (UD7) K41R Rear Parking Assist Control Module X3 (UD7 with F45)

RIGHT SIDE OF THE LUGGAGE COMPARTMENT COMPONENTS

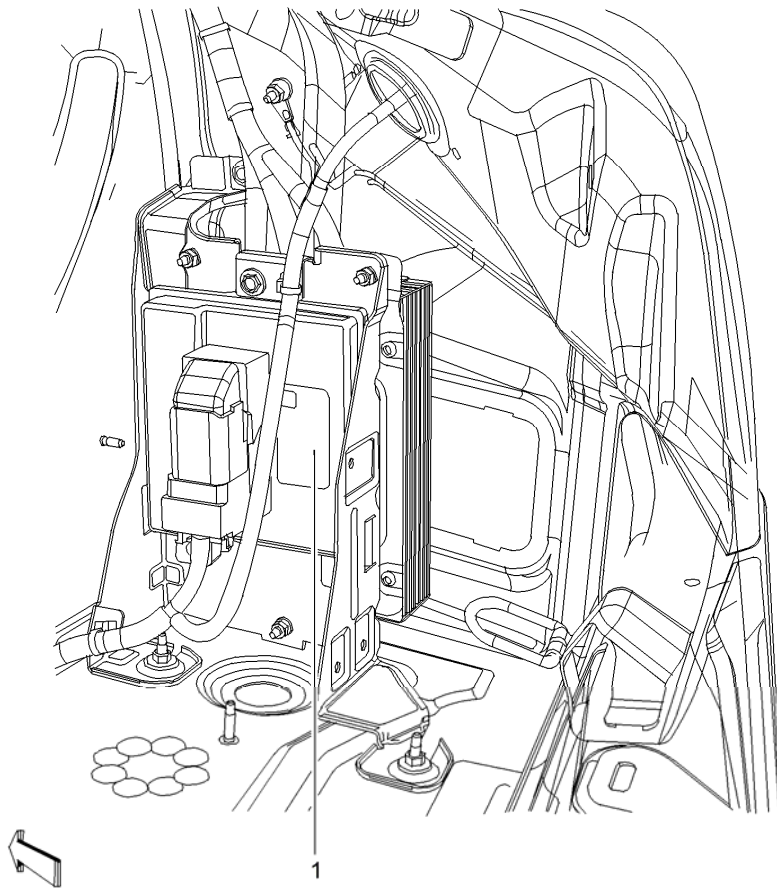


Fig. 4: Right Side Of Luggage Compartment Components
Courtesy of GENERAL MOTORS COMPANY

Items

1: K27 Fuel Pump Control Module (LUK/ LDK/ LTD) K38 Chassis Control Module (LUK)

LUGGAGE COMPARTMENT COMPONENTS

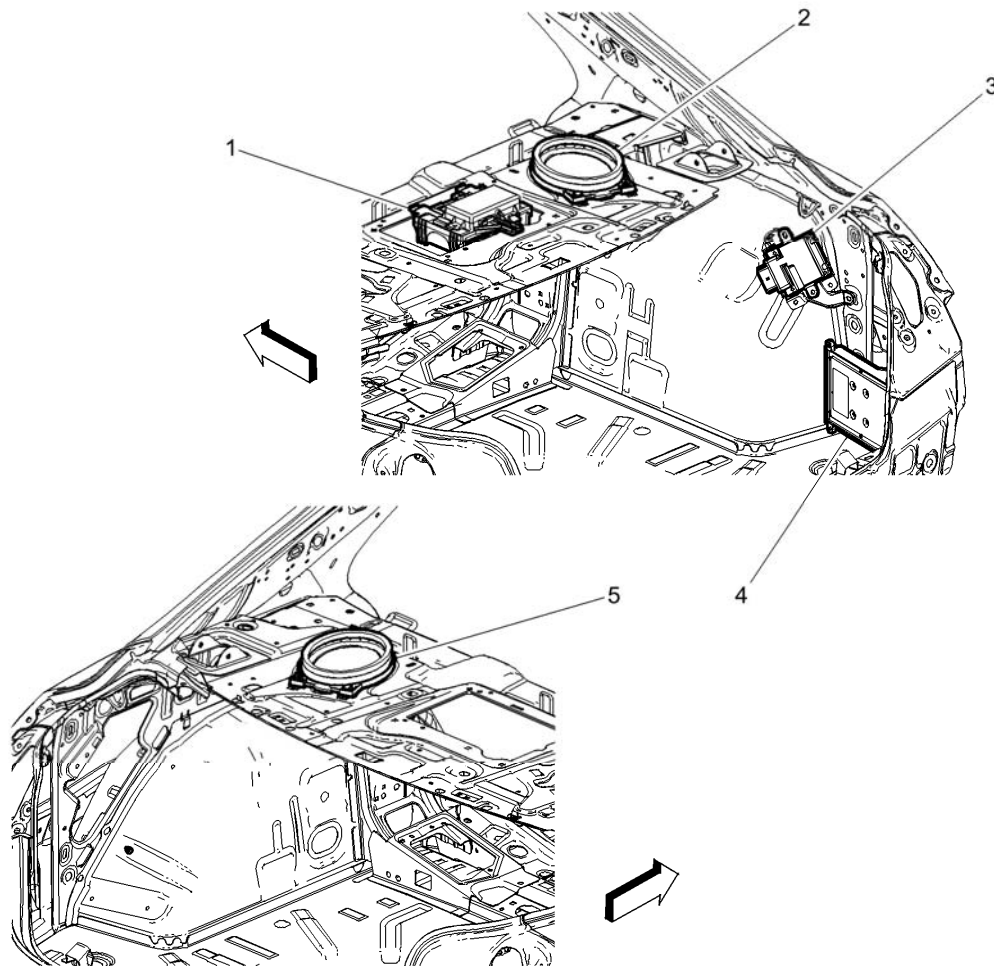


Fig. 5: Luggage Compartment Components
 Courtesy of GENERAL MOTORS COMPANY

Items
1: K73 Telematics Communication Interface Control Module <u>K73 Telematics Communication Interface Control Module X1 (UE1)</u> <u>K73 Telematics Communication Interface Control Module X2 (UE1)</u>
2: P19AA Speaker - Right Subwoofer (UQA) <u>P19AA Speaker - Right Subwoofer</u>
3: K111 Fuel Pump Driver Control Module (LHU) <u>K111 Fuel Pump Driver Control Module (LTG/LAF/LDK)</u>
4: T3 Audio Amplifier (UQA/ UQS) <u>T3 Audio Amplifier X1 (UQA)</u> <u>T3 Audio Amplifier X2 (UQA)</u> <u>T3 Audio Amplifier X2 (UQS)</u> <u>T3 Audio Amplifier X3 (UQA)</u> <u>T3 Audio Amplifier X3 (UQS)</u>
5: P19N Speaker - Left Subwoofer (UQA) <u>P19N Speaker - Left Subwoofer (UQA/UQS)</u>

General Information

Maintenance and Lubrication

SPECIFICATIONS

APPROXIMATE FLUID CAPACITIES

The following approximate capacities are given in US English and metric conversions. See **Fluid and Lubricant Recommendations** for more information. All capacities are approximate. When adding, be sure to fill to the approximate level as recommended in this manual. Recheck fluid level after filling.

Approximate Fluid Capacities

Application	Specification	
	Metric	English
Cooling System		
• 2.0L L4 Engine	7.8 liters	8.2 quarts
• 2.4L L4 Engine	9.6 liters	10.1 quarts
Engine Oil with Filter		
• 2.0L L4 Engine	6.0 liters	6.3 quarts
• 2.4L L4 Engine	4.7 liters	5.0 quarts
Fuel Tank		
2.0L, 2.4L L4 Engine with NU5 and NT7 Emissions	70.4 liters	18.6 gallons
2.4L L4 Engine with NU6 Emissions	59.8 liters	15.8 gallons
Transmission Fluid (Drain and Refill)		
• 2.0L L4 Engine, 6-Speed Automatic	6.7 liters	7.1 quarts
• 2.4L L4 Engine, 6-Speed Automatic	8.4 liters	8.9 quarts
• Manual Transmission F40	1.6 liters	1.7 quarts
Transfer Case	0.65 liter	0.687 quart

FLUID AND LUBRICANT RECOMMENDATIONS

Fluid and Lubricant Recommendations

Usage	Fluid/Lubricant
Engine Oil	Use only engine oil licensed to the dexos1 specification, or equivalent, of the proper SAE viscosity grade. ACDelco dexos1 Synthetic Blend is recommended.
Engine Coolant	Always use the pre-mixed 50/50 mixture of deionized water and DEX-COOL Coolant available at your dealer.
Hydraulic Brake/Clutch System	DOT 3 Hydraulic Brake Fluid GM P/N 19299818 (Canadian P/N 19299819)
	Automotive windshield washer fluid that meets regional freeze protection

Windshield Washer	requirements.
Hydraulic Power Steering System	DEXRON®-VI Automatic Transmission Fluid.
Automatic Transmission	DEXRON®-VI Automatic Transmission Fluid.
Manual Transmission	Manual Transmission Fluid GM P/N 19259104 (Canadian P/N 19259105)
Key Lock Cylinders	Multi-Purpose Lubricant, Superlube GM P/N 12346241 (Canadian P/N 10953474)
Hood Latch Assembly, Secondary Latch, Pivots, Spring Anchor, and Release Pawl	Lubriplate Lubricant Aerosol GM P/N 89021668 (Canadian P/N 89021674) or lubricant meeting requirements of NLGI #2, Category LB or GC-LB
Hood and Door Hinges	Multi-Purpose Lubricant, Superlube GM P/N 12346241 (Canadian P/N 10953474)
Weather-strip Conditioning	Weather-strip Lubricant GM P/N 3634770 (Canadian P/N 10953518) or Dielectric Silicone Grease GM P/N 12345579 (Canadian P/N 10953481)

MAINTENANCE ITEMS

The Normal Maintenance Replacement Parts information will only be found in the Owner's Manual. Refer to the Maintenance Schedule subsection of the Owner's Manual.

You may be able to use the Search information function using the words Replacement Parts.

MAINTENANCE

MAINTENANCE SCHEDULE

The Maintenance Schedule information will only be found in the Owner's Manual.

Refer to the Maintenance Schedule subsection of the Owner's Manual, or you may be able to use the Search information function using the words Scheduled Maintenance.

GM OIL LIFE SYSTEM RESETTNG

The vehicle has a computer system that has a CHANGE ENGINE OIL light indicating when to change the engine oil and filter. This is based on engine revolutions and engine temperature, and not on mileage. Based on driving conditions, the mileage at which an oil change will be indicated can vary considerably. For the oil life system to work properly, the system must be reset every time the oil is changed. When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. The CHANGE ENGINE OIL light will come on. The oil must be changed as soon as possible. It is possible that, if the vehicle is driven under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at that time the system must be reset. If the system is ever reset accidentally, the oil must be changes at 5,000 km (3,000 miles) since the last oil change. Remember to reset the oil life system whenever the oil and filter are changed.

To reset the OIL LIFE SYSTEM do the following:

1. Display OIL LIFE RESET on the driver information center (DIC).
2. Press and hold the ENTER button for at least one second. An ACKNOWLEDGED display message will appear for 3 seconds or until the next button is pressed. This will tell you the system has been reset.
3. Turn the key OFF. If the CHANGE ENGINE OIL light comes back on and stays on when you start the vehicle, the engine oil life system has not been reset. Repeat the procedure.

REMINDER INDICATOR RESET PROCEDURES

CHANGE TRANS FLUID MESSAGE

NOTE: To determine the appropriate reset procedure, refer to CHANGE TRANS FLUID MESSAGE RESET INDEX. Only the vehicles listed in this index have a **CHANGE TRANS FLUID MESSAGE** reset.

CHANGE TRANS FLUID MESSAGE RESET INDEX

Model & Year	Reset Procedure
Aurora	
1995-99	<u>Change Trans Fluid Message Reset - Procedure 4</u>
Concours	
1994-98	<u>Change Trans Fluid Message Reset - Procedure 1</u>
1999	<u>Change Trans Fluid Message Reset - Procedure 2</u>
CTS	
2003	<u>Change Trans Fluid Message Reset - Procedure 3</u>
2004	<u>Change Trans Fluid Message Reset - Procedure 2</u>
DeVille	
1992-97	<u>Change Trans Fluid Message Reset - Procedure 1</u>
1998-04	<u>Change Trans Fluid Message Reset - Procedure 2</u>
Eldorado	
1992-98	<u>Change Trans Fluid Message Reset - Procedure 1</u>
1999-00	<u>Change Trans Fluid Message Reset - Procedure 2</u>
2001-02	<u>Change Trans Fluid Message Reset - Procedure 1</u>
Seville	
1992-97	<u>Change Trans Fluid Message Reset - Procedure 1</u>
1998-04	<u>Change Trans Fluid Message Reset - Procedure 2</u>
SRX	
2004	<u>Change Trans Fluid Message Reset - Procedure 2</u>

CHANGE TRANS FLUID MESSAGE RESET - PROCEDURE 1

This message will appear on the Driver Information Center (DIC) when transaxle fluid change is due. Change fluid in both the oil pan and side cover.

1. To reset display, turn ignition ON with engine OFF.
2. On the climate control panel, press and hold OFF and REAR DEFOG buttons until TRANS FLUID RESET message appears in DIC (about 5-20 seconds).

CHANGE TRANS FLUID MESSAGE RESET - PROCEDURE 2

The CHANGE TRANS FLUID message will appear on the Driver Information Center (DIC) when transaxle fluid change is due. Percentage of transaxle fluid life remaining may be checked at any time by pressing INFO button several times until TRANS FLUID LIFE message appears.

1. To reset display, turn ignition key ON with engine OFF.
2. Press the INFO button until TRANS FLUID LIFE message appears.
3. Press and hold INFO RESET button until display shows 100 percent TRANS FLUID LIFE. Transaxle fluid life index is now reset.

CHANGE TRANS FLUID MESSAGE RESET - PROCEDURE 3

Resetting With Base Audio System

Press CLR button located to the right of the DIC display to acknowledge the CHANGE TRANS FLUID message. This will clear the message from the display and reset it. To reset transmission fluid life indicator, press up or down arrow on INFO button located to the right of the DIC display to access the DIC menu. Once percentage TRANS FLUID LIFE menu item is highlighted, press and hold CLR button. Percentage will return to 100, and transmission fluid life indicator will be reset. Repeat if percentage does not return to 100.

Resetting With Navigation System

Press multifunction button located to the right of the DIC display, next to the OK prompt to acknowledge the CHANGE TRANS FLUID message. This will clear the message form the display and reset it. To reset transmission fluid life indicator, turn system on by pressing PWR/VOL knob once. PWR/VOL knob is located to the lower left of the DIC display. Press INFO button located to the left of the DIC display to access the VEHICLE INFO menu. Turn TUNE/SEL knob located to the lower right of the DIC display until TRANS FLUID LIFE is highlighted. Press knob once to select it. Once percentage TRANS FLUID LIFE is displayed, press multifunction button next to the RESET prompt in the upper right corner of the display. Percentage will return to 100, and transmission fluid life indicator will be reset. Repeat if percentage does not return to 100.

CHANGE TRANS FLUID MESSAGE RESET - PROCEDURE 4

1. The Driver Information Center (DIC) displays estimated percentage of the remaining useful life of transaxle fluid. When remaining fluid life is 0 percent, the display will show CHANGE TRNS FLUID NOW. After changing transaxle fluid, reset oil life display.
2. To reset the display, turn ignition on with engine off. Press ENG button to select the TRNS FLUID LIFE percentage display. Then, press and hold in RESET for at least 5 seconds.
3. The word RESET will appear. Then, TRNS FLUID 100 will be displayed.

CHECK ENGINE LIGHT

NOTE: To determine the appropriate reset procedure, refer to CHECK ENGINE LIGHT RESET INDEX. Only vehicles listed in this index have a check engine light reset.

CHECK ENGINE LIGHT RESET INDEX

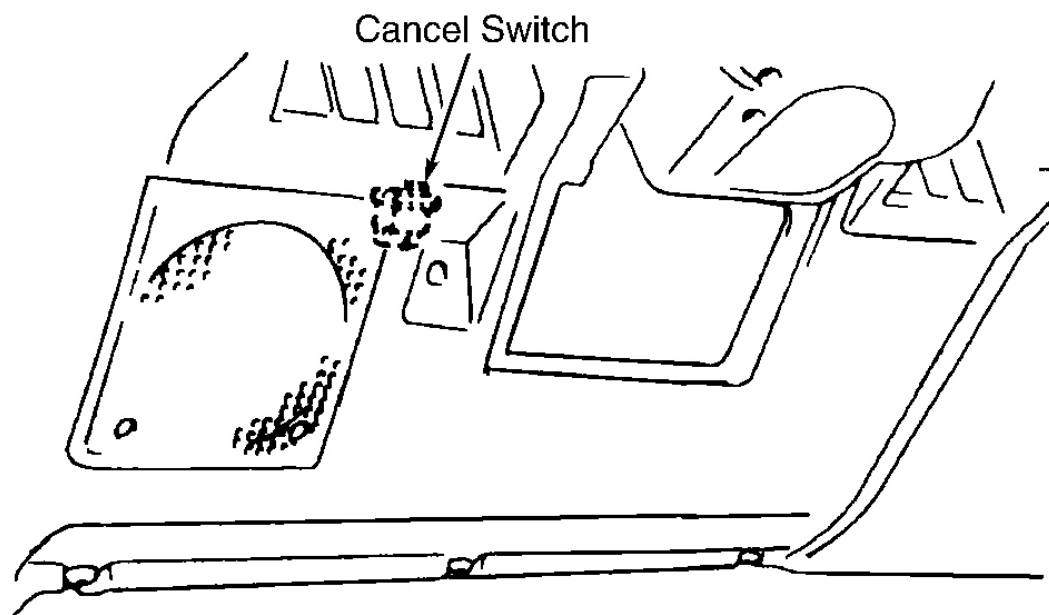
Model & Year	Reset Procedure
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CHECK ENGINE LIGHT RESET - PROCEDURE 1**Federal Emissions**

1. CHECK ENGINE light functions as a service reminder indicator and emission system service. CHECK ENGINE light will come on each 50,000 miles (PCV and EGR), each 80,000 miles (oxygen sensor) and each 100,000 miles (charcoal canister) to indicate needed emission system service.
2. After servicing and/or replacing components, reset CHECK ENGINE light by sliding cancel switch to its opposite position. See **CHECK ENGINE LIGHT RESET SWITCH LOCATION (GEO TRACKER)** for switch location.

CHECK ENGINE LIGHT RESET SWITCH LOCATION (GEO TRACKER)

Application	Location
1989-91	Behind Access Panel, Directly Below Steering Column
1992-94	(1) Behind Instrument Panel, Next To Left Speaker
(1) See Fig. 1 .	



G50F12299

Fig. 1: Check Engine Light Reset Switch Location (1992-94 Geo Tracker - Federal Emissions)
Courtesy of GENERAL MOTORS CORP.

California Emissions

CHECK ENGINE light indicates when it is necessary to have emission system serviced, regardless of mileage. CHECK ENGINE light comes on briefly when starting as a bulb check. If light does not come on or stays on constantly, repair as necessary.

FUEL FILTER LIFE

NOTE: To determine the appropriate reset procedure, refer to Fuel Filter Life Reset Index. Only vehicles listed in this index have a fuel filter life reset.

FUEL FILTER LIFE RESET INDEX

Application	Reset Procedure
Some Models	<u>Fuel Filter Life Reset - Procedure 1</u>

NOTE: ALWAYS reset the FUEL FILTER LIFE system (if equipped) after a fuel filter change.

"FUEL FILTER LIFE" message will appear when a reset is performed either by using the steering wheel controls or performing manual reset procedure.

FUEL FILTER LIFE RESET - PROCEDURE 1

1. On vehicles with steering wheel controls, press and hold the select button for 5 seconds while the FUEL FILTER LIFE message is displayed. This message will appear on the Driver Information Center (DIC) for 10 seconds.
2. On vehicles without steering wheel controls, go to next step.
3. Without pressing the pedals, turn the ignition key to the ON position, engine off. Wait 5 seconds.
4. Completely depress the brake and accelerator pedals simultaneously and hold for 10 seconds. The system is now reset. Turn ignition key OFF.
5. On all vehicles, the next time engine is started, the message will no longer be displayed.

OIL CHANGE REMINDER

NOTE: Most 1981-88 General Motors vehicles do not use a Service Reminder Indicator (SRI).

NOTE: To determine the appropriate reset procedure, refer to Oil Change Reminders Reset Index. Only vehicles listed in this index have an oil change reminder reset.

OIL CHANGE REMINDERS RESET INDEX

Model & Year	Reset Procedure
Alero	

1999-03	<u>Oil Change Reminder Reset - Procedure 1</u>
2004	<u>Oil Change Reminder Reset - Procedure 3</u>
Acadia	
2007-10	<u>Oil Change Reminder Reset - Procedure 16</u>
2011-15	<u>Oil Change Reminder Reset - Procedure 6</u>
Allante	
1989-93	<u>Oil Change Reminder Reset - Procedure 23</u>
ATS	
2013-14	<u>Oil Change Reminder Reset - Procedure 33</u>
Aurora	
1995-99	<u>Oil Change Reminder Reset - Procedure 27</u>
2001-03	<u>Oil Change Reminder Reset - Procedure 6</u>
Avalanche	
2002-06	<u>Oil Change Reminder Reset - Procedure 3</u>
2007-13	<u>Oil Change Reminder Reset - Procedure 6</u>
Aveo	
2009-11	<u>Oil Change Reminder Reset - Procedure 3</u>
Aztek	
2001-05	<u>Oil Change Reminder Reset - Procedure 3</u>
Bravada	
2002-04	<u>Oil Change Reminder Reset - Procedure 11</u>
Bonneville	
2003-05	<u>Oil Change Reminder Reset - Procedure 6</u>
Brougham	
1992	<u>Oil Change Reminder Reset - Procedure 3</u>
Camaro	
1998-02	<u>Oil Change Reminder Reset - Procedure 1</u>
2010-14	<u>Oil Change Reminder Reset - Procedure 18</u>
Canyon	
2004-12	<u>Oil Change Reminder Reset - Procedure 10</u>
Caprice	
1994	<u>Oil Change Reminder Reset - Procedure 2</u>
1995-96	<u>Oil Change Reminder Reset - Procedure 3</u>
2011-14	<u>Oil Change Reminder Reset - Procedure 18</u>
Captive Sport	
2012-15	<u>Oil Change Reminder Reset - Procedure 6</u>
Classic	
2005	<u>Oil Change Reminder Reset - Procedure 4</u>
Cobalt & G5 Pursuit (Canadian)	
2005-09	<u>Oil Change Reminder Reset - Procedure 4</u>
Colorado	
2004-12	

	<u>Oil Change Reminder Reset - Procedure 10</u>
Concours	
1994-96	<u>Oil Change Reminder Reset - Procedure 19</u>
1997-99	<u>Oil Change Reminder Reset - Procedure 6</u>
Corvette	
1990-96	<u>Oil Change Reminder Reset - Procedure 5</u>
1997-13	<u>Oil Change Reminder Reset - Procedure 6</u>
2014	<u>Oil Change Reminder Reset - Procedure 33</u>
Cruze	
2011-14	<u>Oil Change Reminder Reset - Procedure 18</u>
CTS	
2003-04	<u>Oil Change Reminder Reset - Procedure 20</u>
2005-08	<u>Oil Change Reminder Reset - Procedure 22</u>
2009	<u>Oil Change Reminder Reset - Procedure 6</u>
2010-11	<u>Oil Change Reminder Reset - Procedure 3</u> or <u>Oil Change Reminder Reset - Procedure 19</u>
2012-14	<u>Oil Change Reminder Reset - Procedure 6</u>
Cutlass Calais, Cutlass Supreme, Cutlass Ciera, Cutlass Cruiser & Touring Sedan	
1990-91	<u>Oil Change Reminder Reset - Procedure 28</u>
DeVille	
1991-93	<u>Oil Change Reminder Reset - Procedure 25</u>
1994-99	<u>Oil Change Reminder Reset - Procedure 19</u>
2000-05	<u>Oil Change Reminder Reset - Procedure 16</u>
DTS	
2006-11	<u>Oil Change Reminder Reset - Procedure 6</u>
Eighty Eight & Ninety Eight	
1990-91	<u>Oil Change Reminder Reset - Procedure 28</u>
1992-94	<u>Oil Change Reminder Reset - Procedure 29</u>
1995-97	<u>Oil Change Reminder Reset - Procedure 30</u>
Eldorado	
1989-91	<u>Oil Change Reminder Reset - Procedure 24</u>
1992-93	<u>Oil Change Reminder Reset - Procedure 26</u>
1994-97	<u>Oil Change Reminder Reset - Procedure 19</u>
1997-02	<u>Oil Change Reminder Reset - Procedure 6</u>
ELR	
2014	<u>Oil Change Reminder Reset - Procedure 33</u>
Enclave	
2008-15	<u>Oil Change Reminder Reset - Procedure 16</u>
Encore	
2013-14	<u>Oil Change Reminder Reset - Procedure 18</u>
Envoy/ XL	

2002-06	<u>Oil Change Reminder Reset - Procedure 6</u>
2007-09	<u>Oil Change Reminder Reset - Procedure 4</u>
Equinox	
2005-09	<u>Oil Change Reminder Reset - Procedure 3</u>
2011-14	<u>Oil Change Reminder Reset - Procedure 6</u>
Escalade Series	
2002-06	<u>Oil Change Reminder Reset - Procedure 3</u>
2007-14	<u>Oil Change Reminder Reset - Procedure 6</u>
2015	<u>Oil Change Reminder Reset - Procedure 33</u>
Express/ Cutaway/ RV	
2003-14	<u>Oil Change Reminder Reset - Procedure 3</u>
Firebird	
1998-02	<u>Oil Change Reminder Reset - Procedure 6</u>
Fleetwood	
1991-92	<u>Oil Change Reminder Reset - Procedure 25</u>
1993-96	<u>Oil Change Reminder Reset - Procedure 3</u>
Grand Am	
1999-02	<u>Oil Change Reminder Reset - Procedure 2</u>
2003-05	<u>Oil Change Reminder Reset - Procedure 3</u>
Grand Prix	
1998-03	<u>Oil Change Reminder Reset - Procedure 3</u>
2004-08	<u>Oil Change Reminder Reset - Procedure 6</u>
GTO	
2004-06	<u>Oil Change Reminder Reset - Procedure 3</u>
G5	
2007-09	<u>Oil Change Reminder Reset - Procedure 4</u>
G6	
2005-10	<u>Oil Change Reminder Reset - Procedure 32</u>
G8	
2008-09	<u>Oil Change Reminder Reset - Procedure 9</u>
HHR	
2006-11	<u>Oil Change Reminder Reset - Procedure 4</u>
Impala	
2000-06	<u>Oil Change Reminder Reset - Procedure 8</u>
2007-13	<u>Oil Change Reminder Reset - Procedure 6</u>
2014-15	<u>Oil Change Reminder Reset - Procedure 33</u>
Impala Limited	
2014	<u>Oil Change Reminder Reset - Procedure 6</u>
Intrigue	
1998-02	<u>Oil Change Reminder Reset - Procedure 3</u>
LaCrosse & Allure	
2005-14	

	<u>Oil Change Reminder Reset - Procedure 18</u>
LeSabre	
1994-99	<u>Oil Change Reminder Reset - Procedure 12</u>
2000-05	<u>Oil Change Reminder Reset - Procedure 14</u>
Lucerne	
2006-10	<u>Oil Change Reminder Reset - Procedure 6</u>
2011	<u>Oil Change Reminder Reset - Procedure 18</u>
Lumina	
1997-01	<u>Oil Change Reminder Reset - Procedure 6</u>
Malibu	
2004-07	<u>Oil Change Reminder Reset - Procedure 13</u>
2008-12	<u>Oil Change Reminder Reset - Procedure 4</u>
2013-15	<u>Oil Change Reminder Reset - Procedure 18</u>
Montana	
2000-05	<u>Oil Change Reminder Reset - Procedure 3</u>
2006	<u>Oil Change Reminder Reset - Procedure 6</u>
Monte Carlo	
1997-99	<u>Oil Change Reminder Reset - Procedure 6</u>
2000-06	<u>Oil Change Reminder Reset - Procedure 8</u>
2007	<u>Oil Change Reminder Reset - Procedure 6</u>
Park Avenue	
1991-94	<u>Oil Change Reminder Reset - Procedure 15</u>
1995-96	<u>Oil Change Reminder Reset - Procedure 12</u>
1997-05	<u>Oil Change Reminder Reset - Procedure 14</u>
Pickup/Cab & Chassis (C/K)	
1996-00	<u>Oil Change Reminder Reset - Procedure 3</u>
Rainier	
2004-07	<u>Oil Change Reminder Reset - Procedure 17</u>
Regal	
1997-04	<u>Oil Change Reminder Reset - Procedure 6</u>
2011-14	<u>Oil Change Reminder Reset - Procedure 18</u>
Rendezvous	
2002-07	<u>Oil Change Reminder Reset - Procedure 17</u>
Roadmaster	
1994	<u>Oil Change Reminder Reset - Procedure 15</u> or <u>Oil Change Reminder Reset - Procedure 2</u>
1995-96	<u>Oil Change Reminder Reset - Procedure 3</u>
Savana/ Cutaway/ RV	
2003-14	<u>Oil Change Reminder Reset - Procedure 3</u>
Seville	
1989-91	<u>Oil Change Reminder Reset - Procedure 24</u>

1992-93	<u>Oil Change Reminder Reset - Procedure 26</u>
1994-97	<u>Oil Change Reminder Reset - Procedure 19</u>
1998-04	<u>Oil Change Reminder Reset - Procedure 16</u>
Sierra 1500/ 2500/ 3500	
1999-06	<u>Oil Change Reminder Reset - Procedure 3</u>
2007-15	<u>Oil Change Reminder Reset - Procedure 6</u>
Silhouette	
2000-01	<u>Oil Change Reminder Reset - Procedure 3</u>
2002-04	<u>Oil Change Reminder Reset - Procedure 6</u>
Silverado 1500/ 2500/ 3500	
2001-06	<u>Oil Change Reminder Reset - Procedure 3</u>
2007-15	<u>Oil Change Reminder Reset - Procedure 6</u>
Solstice	
2006-10	<u>Oil Change Reminder Reset - Procedure 4</u>
Sonic	
2012-14	<u>Oil Change Reminder Reset - Procedure 18</u>
Spark	
2013-14	<u>Oil Change Reminder Reset - Procedure 18</u>
SRX	
2004	<u>Oil Change Reminder Reset - Procedure 20</u>
2005-06	<u>Oil Change Reminder Reset - Procedure 22</u>
2007-09	<u>Oil Change Reminder Reset - Procedure 6</u>
2010-12	<u>Oil Change Reminder Reset - Procedure 18</u>
2013-15	<u>Oil Change Reminder Reset - Procedure 33</u>
SS	
2014	<u>Oil Change Reminder Reset - Procedure 18</u>
SSR	
2004	<u>Oil Change Reminder Reset - Procedure 3</u>
2005-06	<u>Oil Change Reminder Reset - Procedure 6</u>
STS	
2005-11	<u>Oil Change Reminder Reset - Procedure 7</u>
Suburban	
2000-06	<u>Oil Change Reminder Reset - Procedure 3</u>
2007-15	<u>Oil Change Reminder Reset - Procedure 6</u>
Tahoe	
2000-06	<u>Oil Change Reminder Reset - Procedure 3</u>
2007-15	<u>Oil Change Reminder Reset - Procedure 6</u>
Terrain	
2011-14	<u>Oil Change Reminder Reset - Procedure 6</u>
Tornado	
1989-92	<u>Oil Change Reminder Reset - Procedure 31</u>
Torrent	

2006-09	<u>Oil Change Reminder Reset - Procedure 3</u>
Trailblazer	
2002-09	<u>Oil Change Reminder Reset - Procedure 11</u>
Traverse	
2009-14	<u>Oil Change Reminder Reset - Procedure 6</u>
Uplander, Montana SV6 (Canadian)	
2005-08	<u>Oil Change Reminder Reset - Procedure 6</u>
Venture	
2000-04	<u>Oil Change Reminder Reset - Procedure 3</u>
2005	<u>Oil Change Reminder Reset - Procedure 6</u>
Verano	
2012-14	<u>Oil Change Reminder Reset - Procedure 18</u>
Volt	
2011-14	<u>Oil Change Reminder Reset - Procedure 21</u>
XLR	
2004	<u>Oil Change Reminder Reset - Procedure 6</u>
2005-09	<u>Oil Change Reminder Reset - Procedure 19</u>
XTS	
2013-14	<u>Oil Change Reminder Reset - Procedure 33</u>
Yukon/ XL	
2000-06	<u>Oil Change Reminder Reset - Procedure 3</u>
2007-13	<u>Oil Change Reminder Reset - Procedure 6</u>

OIL CHANGE REMINDER RESET - PROCEDURE 1

1. The CHANGE OIL (or CHANGE ENGINE OIL) message is displayed when its time to change engine oil, usually between 3000 and 7500 miles since last oil change.
2. To reset the oil life monitor, turn the ignition switch to RUN position, with engine off. Press the TRIP/OIL RESET button on the instrument panel for 12 seconds. The OIL CHANGE light will start to flash to confirm that system is reset (on some models a chime will also sound). Reset is complete when OIL CHANGE light goes out.

OIL CHANGE REMINDER RESET - PROCEDURE 2

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the engine oil is nearly worn out. A CHANGE OIL light on the instrument cluster is illuminated when it is time to change the engine oil. To reset CHANGE OIL light:

1. Remove IP fuse block cover (cover can be seen when driver's door is open).
2. Turn ignition ON, engine OFF.
3. Press OIL RESET button and hold for 5 seconds.
4. If Oil Life light does not reset, repeat procedure with ignition OFF.

OIL CHANGE REMINDER RESET - PROCEDURE 3

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the engine oil is nearly worn out. A CHANGE OIL light on the instrument cluster is illuminated when it is time to change the engine oil.

1. To reset oil life monitor and turn off CHANGE OIL light, turn ignition switch to ON position with engine off.
2. Depress accelerator pedal to wide open throttle 3 times within 5 seconds. This throttle signal will inform the PCM to reset the oil life monitor and turn off the light. If light does not turn off, turn ignition off and repeat procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 4

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1,000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

Reset Procedure

1. Turn the ignition key to RUN with the engine OFF.
2. Press the INFO and RESET buttons on the Driver Information Center (DIC) at the same time to enter the personalization menu.
3. Press the INFO button to scroll through the available personalization menu modes until the DIC display shows OIL-LIFE RESET.
4. Press the INFO and RESET buttons at the same time for one second and release.
5. Press and hold the reset button until the DIC display shows ACKNOWLEDGED. This will tell you the system has been reset.
6. Turn the key to LOCK/OFF.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 5

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the oil is nearly worn out. A CHANGE OIL light on left side of instrument cluster is illuminated when it is time to change oil. To reset oil life monitor:

1. Turn ignition on.
2. Depress ENG MET button on trip monitor and release.
3. Within 5 seconds, depress and release ENG MET button again.
4. Within 5 seconds, depress and hold the ENG MET or GAUGES button again. The CHANGE OIL light should flash.
5. Depress and hold the RANGE or GAUGES button until the CHANGE OIL light stops flashing and goes out. When the light goes out, the engine oil life monitor is reset. This should take about 10 seconds.

NOTE: If the light does not reset, turn ignition off and repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 6

The Driver Information Center (DIC) will display a CHANGE OIL message when an oil change is due. The instrument cluster may also have a CHANGE OIL light. To reset the oil life monitor:

Reset Procedure

1. Turn ignition switch to RUN position, with engine off.
2. Press the TRIP (on some models SELECT or SET/RESET) button, located on the DIC, until the OIL LIFE display appears. Message will display percentage of oil life remaining.

NOTE: On models without DIC buttons, use the TRIP/ODOMETER reset stem.

3. Press and hold SET/RESET button (on some models, the check-symbol button) on DIC for at least 5 seconds. The message will change to indicate that the Oil Life has been reset. On some models, 3 chimes will also sound.
4. Turn ignition off.
5. Turn the key to OFF. If the light or message comes back on when you start your vehicle, the oil life system has not reset. Repeat the procedure.

NOTE: On some models, if oil life system does not reset, try turning ignition OFF after displaying oil life message. Then press and hold reset button.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 7

When the system has calculated that oil life has been diminished, it indicates that an oil change is necessary. A

CHANGE ENGINE OIL SOON message in the DIC comes on. Reset the system whenever the engine oil is changed so that the system can calculate the next engine oil change. To reset the system:

1. Press the up or down arrow to scroll the DIC to show OIL LIFE.
2. Once the XXX% ENGINE OIL LIFE menu item is highlighted, press and hold the RESET button until the percentage shows 100%

OIL CHANGE REMINDER RESET - PROCEDURE 8

The CHANGE ENGINE OIL message is displayed when its time to change engine oil, usually between 3000 and 7500 miles since last oil change. The oil change interval is not based on mileage, but on engine revolutions and engine operating temperature.

1. There are 2 ways to reset the engine oil life monitor. To reset the engine oil life monitor using the accelerator pedal, go to step 4. To reset the engine oil life monitor using the radio, turn the radio off. Turn ignition to ACC or ON, with the engine off. Press and hold the DISP (on some models, TUNE DISP) button (or knob) on the radio for at least 5 seconds until SETTINGS is displayed.
2. Press the SEEK (on some models, SEEK PTYPE or SEEK PSCAN) up or down arrow to scroll through the main menu. Scroll until OIL LIFE appears on the display. Press the PREV or NEXT button to enter the sub-menu. RESET will be displayed.
3. Press the DISP/TUNE DISP button to reset. A chime will sound to verify the new setting and DONE will be displayed for one second. Once the message indicator has been reset, scroll through the menu until EXIT appears on the display. Press the DISP/TUNE DISP button to exit the program. A chime will sound to verify the exit.
4. To reset the engine oil life monitor using the accelerator pedal, turn ignition on with engine off. Fully depress and release the accelerator pedal slowly 3 times within 5 seconds. If CHANGE ENGINE OIL light flashes, oil life monitor is reset. If the CHANGE ENGINE OIL light comes back on and stays on, oil life monitor has not reset. Repeat reset procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 9

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE message will come on. Change the engine oil as soon as possible within the next 600 miles (1000 km). It is possible that, if driving under the best conditions, the oil life may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

To reset the Engine Oil Life System, do the following:

1. Press and hold the TRIP button on the steering wheel while turning on the ignition. Do not start the engine.
2. The instrument panel cluster will prompt to clear the service code.
3. Release the button.
4. Press and hold ENTER Switch on the left side of the steering wheel for approximately one second.
5. Turn off the ignition.

If the CHANGE ENGINE OIL SOON message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 10

1. Turn ignition ON, with engine off.
2. Press and release reset stem on instrument panel while OIL LIFE message is displayed.
3. Once the alternating OIL LIFE and RESET messages appear, press and hold stem in until several beeps will sound. This confirms that oil life system has been reset. Turn ignition off or full LOCK position. If CHANGE OIL messages comes back after starting engine, repeat reset procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 11

Reset Procedure

If vehicle is equipped with a Driver Information Center (DIC), reset oil life monitor by pressing the Driver Information Center SELECT button for 5 seconds while ENGINE OIL LIFE is displayed.

Alternate Method

To reset the oil life monitor, turn ignition switch to ON or RUN position with engine off. Depress accelerator pedal slowly to wide open throttle 3 times within 5 seconds. If CHANGE ENG OIL light flashes for 5 seconds, oil life monitor is reset. If the CHANGE ENG OIL light does not flash, oil life monitor has not reset. Repeat this step.

OIL CHANGE REMINDER RESET - PROCEDURE 12

1. CHANGE OIL SOON light will come on when engine oil has broken down enough to require changing. After changing oil, reset oil life display.
2. To reset light, turn ignition on. Open glove box to access oil reset button. Press and hold oil reset button in glove box for at least 5 seconds, but not longer than 60 seconds. The CHANGE OIL SOON light will flash 4 times to indicate light has been reset.

OIL CHANGE REMINDER RESET - PROCEDURE 13

GM Oil Life System calculates when to change your engine oil and filter based on vehicle use. Anytime oil is changed, reset the system so it can calculate when the next oil change is required. If a situation occurs where you change your oil prior to a Change Oil Soon message being turned on, reset the system. After changing the engine oil, reset the system.

1. Display OIL LIFE RESET on the DIC.
2. Press and hold ENTER button for at least one second. An ACKNOWLEDGED display message will appear for 3 seconds or until the next button is pressed. This will tell you the system has been reset.
3. Turn key to OFF.
4. If Change Oil Soon message comes back on when you start your vehicle, engine oil life system has not reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 14

1. To display this light, press the GAGE INFO or GAGES button on the Driver Information Center (DIC). When oil life index is less than 10 percent, display will show OIL LIFE INDEX CHANGE OIL. After changing oil, reset system.
2. To reset light, display OIL LIFE INDEX. Hold RESET button for more than 5 seconds. After reset, oil life will change to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 15

1. CHANGE OIL SOON light will come on when engine oil has broken down enough to require changing. After changing oil, reset oil life display.
2. To reset light, locate reset button hole under the dash near passenger door. Use a pencil or similar object to push and hold button (inside hole) for 5 seconds. The CHANGE OIL SOON light will flash 4 times to indicate light has been reset.

OIL CHANGE REMINDER RESET - PROCEDURE 16

Vehicles WITHOUT Driver Information Center (DIC) Buttons

1. Turn the ignition to ON/RUN, with the engine off. The vehicle must be in P (Park) to access this display. Press the trip odometer reset stem until OIL LIFE REMAINING displays.
2. Press and hold the trip odometer reset stem until OIL LIFE REMAINING shows "100%." Three chimes sound and the CHANGE ENGINE OIL SOON message goes off.
3. Turn the key to LOCK/OFF. If the CHANGE ENGINE OIL SOON message comes back on when the vehicle is started, the engine oil life system has not been reset. Repeat the procedure.

Vehicles WITH Driver Information Center (DIC) Buttons

1. Turn the ignition to ON/RUN position, with the engine off.
2. Press the VEHICLE INFORMATION BUTTON (i) until OIL LIFE REMAINING displays.
3. Press and hold the SET/RESET button (check-mark symbol) until "100%" is displayed. Three chimes sound (on some models) and the CHANGE ENGINE OIL SOON message goes off.
4. Turn ignition to LOCK/OFF position. If the CHANGE ENGINE OIL SOON message comes back on when engine is started, repeat reset procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 17

Reset Procedure

1. Turn the ignition to ON, with the engine off.
2. Press the MODE button until the Driver Information Center (DIC) reads OIL LIFE LEFT/HOLD SET TO RESET.
3. Press and hold the SET button until 100% is displayed. You will hear three chimes and the CHANGE ENGINE OIL message will go off. Turn the key to OFF.

4. If the CHANGE ENGINE OIL message comes back on when engine is started, the engine oil life system has not reset. Repeat the procedure.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 18

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL message or light will come on. Change the engine oil as soon as possible within the next 600 miles (1 000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

NOTE: **Be careful not to reset the oil life display accidentally at any time other than after the oil is changed. It cannot be reset accurately until the next oil change.**

Vehicles with Driver Information Center (DIC)

1. Turn the ignition to ON/RUN with the engine off.
2. Press the DIC MENU button on the turn signal lever to enter the Vehicle Information Menu. Use the thumbwheel to scroll through the menu items until you reach REMAINING OIL LIFE. See **Fig. 2**.
3. Press the SET/CLR button (on some models, the check-symbol button) while the oil life display is active. After a few seconds, there will be a single chime (on some models) and the oil life will be reset to 100%.
4. Turn the ignition to LOCK/OFF.

The system is reset when the CHANGE OIL message is off and the REMAINING OIL LIFE 100% message is displayed.

NOTE: **If the CHANGE OIL message comes back on or Code 82 DIC message comes on when the vehicle is started, the engine oil life system has not been reset. Repeat the procedure.**

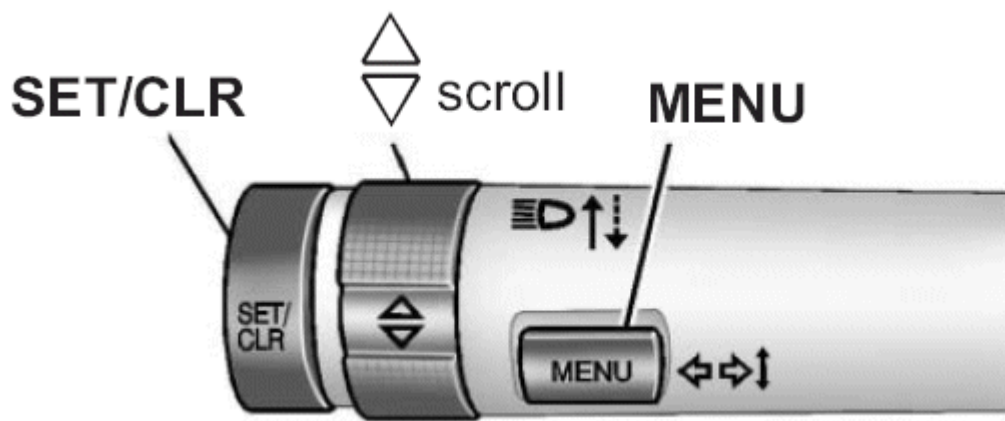


Fig. 2: Identifying DIC Controls (Turn Signal Lever)
 Courtesy of GENERAL MOTORS CORP.

Vehicles without DIC (Some Models)

1. With the engine OFF, turn the ignition key to RUN.
2. Fully press and release the accelerator pedal slowly three times within five seconds.
3. Turn the key to OFF, then start the vehicle.

Reset Using Diagnostic Scan Tool (Some Models)

1. Turn on ignition.
2. Connect scan tool.
3. Select Module Diagnosis.
4. Select Engine Control Module.
5. Select Configuration/Reset function.
6. Select Engine Oil System Reset.
7. Push Enter button to run function.
8. Confirm Executed successfully.
9. Turn ignition off and confirm.
10. Turn ignition on and confirm.

OIL CHANGE REMINDER RESET - PROCEDURE 19

1. The Driver Information Center (DIC) will display remaining oil life as a percentage estimate of the useful life of oil.
2. When remaining oil life is 10 percent or less, the system will display CHANGE OIL SOON. When oil life expires, display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset oil life display, press INFORMATION (or INFORMATION SKIP) button to display OIL LIFE LEFT. Press and hold RESET (or RESET NO) button until 100 OIL LIFE LEFT (0.0 OIL LIFE LEFT on some early models) is displayed.

OIL CHANGE REMINDER RESET - PROCEDURE 20

With Base Audio System

Press up or down arrow on the INFO button located to right of Driver Information Center (DIC) display to access DIC menu. Once 100 percent ENGINE OIL LIFE menu item is highlighted, press and hold the CLR button. Percentage will return to 100 and oil life indicator will be reset. Repeat procedure if the percentage does not return to 100.

With Navigation System

Turn the system on by pressing PWR/VOL knob once. PWR/VOL knob is located to lower left of DIC display. Press INFO button located to left of the display to access Vehicle Information menu. Turn TUNE/SEL knob located to lower right of the display until ENGINE OIL LIFE is highlighted. Press TUNE/SEL knob once to select it. When 100 percent Engine Oil Life is displayed, press multifunction button next to reset prompt in upper right corner of the display. Percentage will return to 100 and the oil life indicator will be reset. Repeat procedure if the percentage does not return to 100.

OIL CHANGE REMINDER RESET - PROCEDURE 21

1. Use the SELECT knob to select OIL LIFE on the DIC menu.
2. Press SELECT to start the OIL LIFE reset procedure.
3. The DIC menu will display "Are you sure that you want to reset?" Use SELECT to choose YES to reset oil life or NO to exit and return to the previous menu.
4. If YES is selected, the DIC menu will display RESET OIL LIFE for a short time and then 100% OIL LIFE will be display when OIL LIFE is successfully reset.

OIL CHANGE REMINDER RESET - PROCEDURE 22

With Base Audio System

1. Press the CLR button located to the right of the driver information center (DIC) display to acknowledge the Change Engine Oil message. This will clear the message from the display and reset it.
2. Press the up or down arrow on the INFO button located to the right of the Driver Information Center (DIC) display to access the DIC menu.
3. Once 100% ENGINE OIL LIFE menu item is highlighted, press and hold the CLR button. The percentage will return to 100 and the oil life indicator will be reset. Repeat the steps if the percentage does not return to 100.
4. Turn OFF the key. If the Change Engine Oil message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

Without DIC

1. With the engine OFF, turn the ignition key to RUN.
2. Fully press and release the accelerator pedal slowly three times within five seconds.
3. Turn the key to OFF, then start the vehicle.

With Navigation System

1. Press the multifunction button, next to the OK prompt in the upper right of the display to acknowledge the Change Engine Oil message. This will clear the message from the display and reset it.
2. Turn the system on by pressing the PWR/VOL knob once. The PWR/VOL knob is located to the lower left of the driver information center (DIC) display.
3. Press the INFO button located to the left of the display to access the Vehicle Information menu.
4. Turn the TUNE/SEL knob located to the lower right of the display until Engine Oil Life is highlighted. Press the knob once to select it.
5. Once the 100% Engine Oil Life is displayed, press the multifunction button next to the Reset prompt in the upper right corner of the display. The percentage will return to 100 and the oil life indicator will be reset. Repeat the steps if the percentage does not return to 100.
6. Turn OFF the key. If the Change Engine Oil message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 23

1. An OIL LIFE INDEX is one of the displays on Driver Information Center (DIC). It will display remaining oil life as a percentage estimate of the useful life of oil.
2. It will show 100 percent when the system is reset. When the oil life is 0 percent, the display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset service reminder on 1989 models, press RANGE button until OIL LIFE INDEX appears on display. Depress and hold in AVG ECON and RANGE buttons for more than 5 seconds or until 100 is displayed. This will reset remaining oil life to 100 percent.
4. On 1990-93 models, press RANGE button until OIL LIFE INDEX appears on DIC display. Depress and hold in AVG SPEED and RANGE buttons for more than 5 seconds or until 100 is displayed. This will reset remaining oil life to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 24

1. An OIL LIFE INDEX is one of 4 displays on Driver Information Center (DIC). It will display remaining oil life as a percentage estimate of the useful life of oil.
2. Display will show 100 percent when the system is reset. When remaining oil life is 10 percent or less, the system will display CHANGE OIL SOON. When the oil life expires, the display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset oil life display, press ENG DATA button until OIL LIFE INDEX appears on DIC display. Depress and hold in ENG DATA and RANGE buttons until 100 is displayed. This will reset remaining oil life to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 25

1. An OIL LIFE INDEX is one of the displays on Driver Information Center (DIC). It will display remaining oil life as a estimated percentage of the useful life of oil.
2. It will show 100 percent when the system is reset. When the oil life is 0 percent, the display will show CHANGE ENGINE OIL. After performing necessary services, reset service reminder.

3. To reset service reminder, turn ignition to on position. Do not start engine. Depress and hold RANGE and FUEL USED buttons until OIL LIFE INDEX appears on DIC display. Depress and hold RANGE and RESET buttons for 5-60 seconds.
4. When CHANGE OIL SOON light flashes 4 times, remaining oil life index is reset to 100 percent. If CHANGE OIL SOON comes on and stays on for 5 seconds, display did not reset. Repeat step 3.

OIL CHANGE REMINDER RESET - PROCEDURE 26

1. Oil change reminder display on the Driver Information Center (DIC) is similar to 1990-91 models, but reset procedures are different. After changing oil, reset oil life display.
2. To reset, press INFORMATION button to display OIL LIFE INDEX. Press and hold STORE/RECALL button until 100 is displayed. This will reset oil life display to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 27

1. The Driver Information Center (DIC) displays estimated percentage of the remaining useful life of engine oil or transaxle fluid. When remaining oil or fluid life is 0 percent, the display will show CHANGE OIL NOW or CHANGE TRNS FLUID NOW. After changing engine oil or transaxle fluid, reset oil life display.
2. To reset the display, turn ignition on with engine off. Press ENG button to select the OIL LIFE or TRNS FLUID LIFE percentage display. Then, press and hold in RESET for at least 5 seconds.
3. The word RESET will appear. Then, OIL LIFE 100 or TRNS FLUID 100 will be displayed.

OIL CHANGE REMINDER RESET - PROCEDURE 28

1. An oil change reminder displays estimated percentage of the remaining useful life of the oil. When engine is started, a tone will sound and approximate distance to next oil change will be displayed.
2. When remaining oil life is 10 percent or less, the system will calculate distance to next oil change. When the oil life is 0 percent, the display will show CHANGE OIL NOW. After changing oil, reset oil life display.
3. To reset the display, press and hold in OIL button to select the oil life display. Then, press and hold in RESET and OIL buttons for at least 5 seconds. This will reset oil life display to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 29

1. To reset the display, press and release the TEST button.
2. Press and release the OIL button.
3. Press and hold the RESET button for at least 7 seconds. This will reset oil life display to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 30

1. To reset the display, press and release RESET button on Driver Information Center (DIC).
2. Press SEL button (with down arrow) to select OIL.
3. Press SEL button (with left and right arrows) to display oil life.

4. Press and hold RESET button for about 5 seconds.
5. A reset message will display, then oil life will display 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 31

With Information Center Display

OIL LIFE INDEX is one of 4 engine data displays used on models with Information Center display. It will display remaining oil life as estimated percentage of the useful life of oil. It will show 100 percent when the system is reset. After changing oil, reset oil life display.

1. To reset the display, press ENG DATA button (1989-90) or OPTIONS button (1991-92) until oil life index is displayed.
2. Then, press and hold in ENG DATA and GAGE buttons (1989) or RESET/ENTER button (1990-92) for at least 5 seconds. This will reset remaining oil life to 100 percent.

With Visual Information Center

OIL LIFE is one of the displays used on models with a Visual Information Center (VIC). It will display data regarding previous oil change. A bar graph display shows full when oil is changed. Bar graph will go down as vehicle is driven and oil ages. When bar graph reaches CHANGE OIL mark, oil should be changed. After changing oil, reset oil life display.

1. To reset the display, press INFO hard key and then OIL LIFE soft key to display oil life index.
2. Press RESET soft key.
3. A reset confirmation page will appear and ask if oil has been changed. Press YES soft key to reset bar graph, and update last oil change date and mileage information.

OIL CHANGE REMINDER RESET - PROCEDURE 32

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

To reset the Engine Oil Life System, do the following:

1. With the CHANGE OIL SOON message displayed, press any of the three driver information center (DIC) buttons to clear the CHANGE OIL SOON message.
2. Display OIL LIFE RESET on the DIC.
3. Press and hold the ENTER button for at least one second. An ACKNOWLEDGED display message will appear for three seconds or until the next button is pressed. This will tell you the system has reset.
4. Turn the ignition to OFF.

If the CHANGE ENGINE OIL message comes back on when you start the vehicle the Engine Oil Life System

has not reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 33

This vehicle has a computer system that indicates when to change the engine oil and filter. This is based on a combination of factors which include engine revolutions, engine temperature, and miles driven. Based on driving conditions, the mileage at which an oil change is indicated can vary considerably. For the oil life system to work properly, the system must be reset every time the oil is changed. To reset the system:

Reset Procedure

- 1. Using the DIC controls on the right side of the steering wheel, display REMAINING OIL LIFE on the driver information center (DIC).
- 2. Press SEL on the DIC controls and hold SEL down for a few seconds to clear the CHANGE ENGINE OIL SOON message and reset the oil life at 100%.

NOTE: Be careful not to reset the oil life display accidentally at any time other than after the oil is changed. It cannot be reset accurately until the next oil change.

Alternate Method (Some Models)

- 1. Turn the ignition key to RUN with the engine off.
- 2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
- 3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

OXYGEN SENSOR REMINDER FLAG

NOTE: To determine the appropriate reset procedure, refer to OXYGEN SENSOR REMINDER FLAG RESET. Only vehicles listed in this index have an oxygen sensor reminder flag reset.

OXYGEN SENSOR REMINDER FLAG RESET INDEX

Model & Year	Reset Procedure
Some Models	
1980	<u>Oxygen Sensor Reminder Flag - Procedure 1</u>

OXYGEN SENSOR REMINDER FLAG - PROCEDURE 1

- 1. Every 30,000 miles, a reminder flag appears in speedometer face, indicating service of oxygen sensor is necessary. See **Fig. 3**. Inspect and service oxygen sensor as necessary and reset flag.
- 2. To reset flag, remove instrument panel trim plate. Remove instrument cluster lens. Using pointed tool, apply light downward pressure on notches of flag until it is reset. An alignment mark will appear in left

center of odometer window when flag is fully reset.

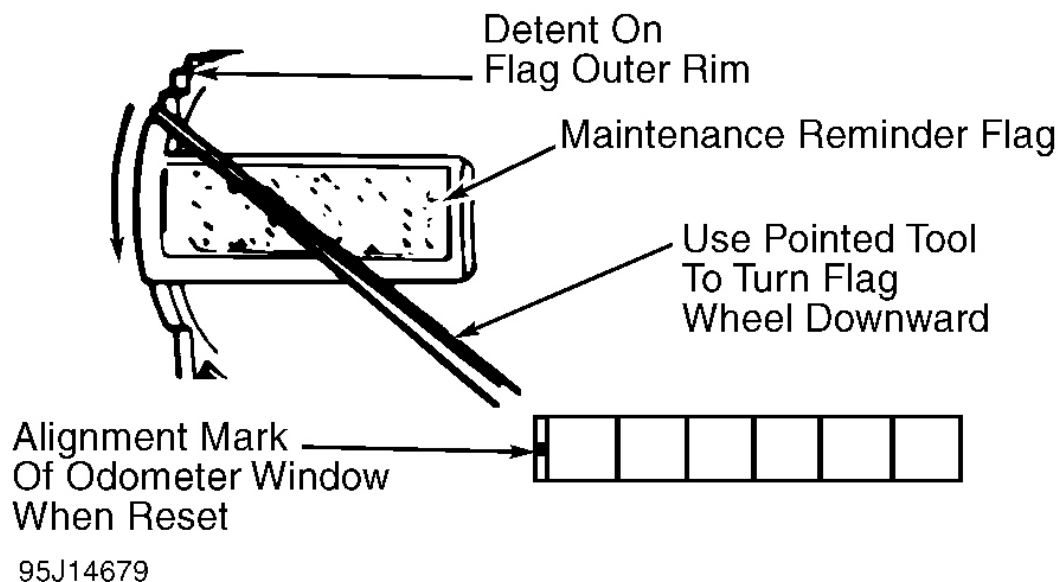


Fig. 3: Resetting Reminder Flag
Courtesy of GENERAL MOTORS CORP.

OXYGEN SENSOR WARNING LIGHT

NOTE: To determine the appropriate reset procedure, refer to OXYGEN SENSOR WARNING LIGHT RESET INDEX. Only vehicles listed in this index have an oxygen sensor warning light reset.

OXYGEN SENSOR WARNING LIGHT RESET INDEX

Model & Year	Reset Procedure
Sprint	
1985-86	<u>Oxygen Sensor Warning Light Reset - Procedure 1</u>

OXYGEN SENSOR WARNING LIGHT RESET - PROCEDURE 1

At 30,000 mile intervals, a SENSOR light in dash will start flashing, indicating oxygen sensor needs replacement. To reset mileage counter (after sensor replacement), locate SENSOR light cancel switch on right side of fuse box. Return cancel switch to OFF position. Start engine to ensure light remains off.

SERVICE REMINDER MESSAGE

NOTE: To determine the appropriate reset procedure, refer to Service Reminder Reset

Index. Only vehicles listed in this index have a Service Reminder reset.

SERVICE REMINDER RESET INDEX

Model & Year	Reset Procedure
6000 STE	
1987-89	<u>Service Reminder Message Reset - Procedure 1</u>
Bonneville	
1988-91	<u>Service Reminder Message Reset - Procedure 1</u>
Caprice	
2011	<u>Service Reminder Message Reset - Procedure 2</u>

SERVICE REMINDER MESSAGE RESET - PROCEDURE 1

The SERVICE REMINDER message light is used on models with a Driver Information Center (DIC). After performing necessary services, reset service reminder light.

1. To reset service reminder, push DIC button until desired service item is displayed.
2. Press and hold down the DIC button. With button pressed, the distance display will decrease in increments of 500 miles.
3. Release button when desired distance is displayed on the DIC.

SERVICE REMINDER MESSAGE RESET - PROCEDURE 2

The displayed service reminder is reset using a scan tool or by the following procedure:

1. Turn the ignition to the OFF position.
2. Press and hold the TRIP button.
3. Turn the ignition to the ON position.
4. Release the TRIP button.
5. Once in the Service Reset screen, press and hold the ENTER switch for 3-5 seconds. A confirmation beep will sound upon reset.
6. Turn the ignition to the OFF position.

NOTE: If the service reminder comes back on when you start the vehicle, the Service Reminder Display has not reset. Repeat the procedure.

TIRE PRESSURE MONITOR SYSTEM (TPMS)

NOTE: To determine the appropriate reset procedure, refer to **TPMS RESET INDEX**. Only vehicles listed in this index have a TPMS reset.

TPMS RESET INDEX

Model	Application	Procedure
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Buick		
Allure	2007	<u>TPMS Reset - Procedure 1</u>
	2008-09	<u>TPMS Reset - Procedure 2</u>
Century	1999-05	(1) <u>TPMS Reset - Procedure 21</u>
Enclave	2008-12	<u>TPMS Reset - Procedure 2</u>
	2013-15	<u>TPMS Reset - Procedure 9</u>
Encore	2013-14	<u>TPMS Reset - Procedure 25</u>
LaCrosse	2006-09	<u>TPMS Reset - Procedure 2</u>
	2010-12	<u>TPMS Reset - Procedure 11</u>
	2013-14	<u>TPMS Reset - Procedure 26</u>
LaSabre	2002-05	(1) <u>TPMS Reset - Procedure 20</u>
Lucerne	2006	(1) <u>TPMS Reset - Procedure 22</u>
	2007-11	<u>TPMS Reset - Procedure 2</u>
Park Avenue	1998-05	(1) <u>TPMS Reset - Procedure 20</u>
Rainier	2006-07	<u>TPMS Reset - Procedure 1</u>
Regal	1999-04	(1) <u>TPMS Reset - Procedure 21</u>
	2011-12	<u>TPMS Reset - Procedure 11</u>
	2013-14	<u>TPMS Reset - Procedure 26</u>
Rendezvous	2003-07	(1) <u>TPMS Reset - Procedure 24</u>
Verano	2012	<u>TPMS Reset - Procedure 11</u>
	2013-14	<u>TPMS Reset - Procedure 26</u>
Cadillac		
ATS	2013-14	<u>TPMS Reset - Procedure 11</u>
CTS	2004-11	<u>TPMS Reset - Procedure 31</u>
	2012	With RPO UH3: <u>TPMS Reset - Procedure 9</u> W/O RPO UH3: <u>TPMS Reset - Procedure 10</u>
	2013-14	<u>TPMS Reset - Procedure 9</u>
Deville	2001-05	<u>TPMS Reset - Procedure 4</u>
DTS	2006-11	<u>TPMS Reset - Procedure 2</u>
ELR	2014	<u>TPMS Reset - Procedure 11</u>
Escalade Series	2004-06	<u>TPMS Reset - Procedure 1</u>
	2008-12	<u>TPMS Reset - Procedure 2</u>
	2013-14	<u>TPMS Reset - Procedure 9</u>
	2015	<u>TPMS Reset - Procedure 11</u>
Seville	2001-04	<u>TPMS Reset - Procedure 4</u>
SRX	2008-11	<u>TPMS Reset - Procedure 2</u>
	2012-14	<u>TPMS Reset - Procedure 11</u>
STS	2005-11	<u>TPMS Reset - Procedure 3</u>

XLR	2008	<u>TPMS Reset - Procedure 2</u>
XTS	2013-14	<u>TPMS Reset - Procedure 11</u>
Chevrolet		
Avalanche	2004-07	<u>TPMS Reset - Procedure 1</u>
	2008-11	<u>TPMS Reset - Procedure 2</u>
	2012	<u>TPMS Reset - Procedure 3</u>
	2013	<u>TPMS Reset - Procedure 9</u>
Aveo	2008-11	⁽²⁾ <u>TPMS Reset - Procedure 7</u>
Camaro	2010-11	<u>TPMS Reset - Procedure 2</u>
	2012	<u>TPMS Reset - Procedure 11</u>
	2013-14	<u>TPMS Reset - Procedure 25</u>
Caprice	2011-13	<u>TPMS Reset - Procedure 31</u>
	2014	<u>TPMS Reset - Procedure 25</u>
Captiva Sport	2012-14	<u>TPMS Reset - Procedure 2</u>
Cobalt	2008-10	<u>TPMS Reset - Procedure 3</u>
Colorado	2006-12	<u>TPMS Reset - Procedure 1</u>
Corvette	1987-96	⁽¹⁾ <u>TPMS Reset - Procedure 20</u>
	1997-04	<u>TPMS Reset - Procedure 6</u>
	2005-06	<u>TPMS Reset - Procedure 3</u>
	2007-13	<u>TPMS Reset - Procedure 9</u>
	2014	<u>TPMS Reset - Procedure 8</u>
Cruze	2011-12	<u>TPMS Reset - Procedure 11</u>
	2013-14	<u>TPMS Reset - Procedure 25</u>
Equinox	2007	<u>TPMS Reset - Procedure 5</u>
	2008-11	<u>TPMS Reset - Procedure 2</u>
	2012	<u>TPMS Reset - Procedure 11</u>
	2013-14	<u>TPMS Reset - Procedure 25</u>
HHR	2008-11	<u>TPMS Reset - Procedure 3</u>
G-Series Van	2008-12	<u>TPMS Reset - Procedure 2</u>
	2013-14	<u>TPMS Reset - Procedure 27</u>
Impala	2000-02	⁽¹⁾ <u>TPMS Reset - Procedure 13</u>
	2003-05	⁽¹⁾ <u>TPMS Reset - Procedure 14</u>
	2006-07	<u>TPMS Reset - Procedure 5</u>
	2008-12	<u>TPMS Reset - Procedure 2</u>
	2013	<u>TPMS Reset - Procedure 9</u>
	2014	<u>TPMS Reset - Procedure 28</u>
Impala Limited	2014	<u>TPMS Reset - Procedure 9</u>
Malibu/Classic	2008-11	<u>TPMS Reset - Procedure 3</u>
	2012	<u>TPMS Reset - Procedure 2</u>
	2013-14	<u>TPMS Reset - Procedure 25</u>

	2015	<u>TPMS Reset - Procedure 28</u>
Monte Carlo	2000-02	(1) <u>TPMS Reset - Procedure 13</u>
	2003-05	(1) <u>TPMS Reset - Procedure 14</u>
	2006-07	<u>TPMS Reset - Procedure 5</u>
Orlando (Canada)	2012	<u>TPMS Reset - Procedure 11</u>
Silverado Series	2006-07	<u>TPMS Reset - Procedure 1</u>
	2008-11	<u>TPMS Reset - Procedure 2</u>
	2012	<u>TPMS Reset - Procedure 3</u>
	2013	<u>TPMS Reset - Procedure 27</u>
	2014-15	<u>TPMS Reset - Procedure 26</u>
Sonic	2012	<u>TPMS Reset - Procedure 11</u>
	2013-14	<u>TPMS Reset - Procedure 25</u>
Spark	2012-14	<u>TPMS Reset - Procedure 29</u>
Spark EV	2014-15	<u>TPMS Reset - Procedure 30</u>
SS	2014	<u>TPMS Reset - Procedure 25</u>
Suburban	2004-07	<u>TPMS Reset - Procedure 1</u>
	2008-11	<u>TPMS Reset - Procedure 2</u>
	2012	<u>TPMS Reset - Procedure 3</u>
	2013-14	<u>TPMS Reset - Procedure 9</u>
	2015	<u>TPMS Reset - Procedure 26</u>
Tahoe	2004-07	<u>TPMS Reset - Procedure 1</u>
	2008-11	<u>TPMS Reset - Procedure 2</u>
	2012	<u>TPMS Reset - Procedure 3</u>
	2013-14	<u>TPMS Reset - Procedure 9</u>
	2015	<u>TPMS Reset - Procedure 26</u>
TrailBlazer	2006-07	<u>TPMS Reset - Procedure 1</u>
Traverse	2009-12	<u>TPMS Reset - Procedure 2</u>
	2013-15	<u>TPMS Reset - Procedure 9</u>
Uplander	2008	<u>TPMS Reset - Procedure 3</u>
Volt	2011-12	<u>TPMS Reset - Procedure 11</u>
	2013-14	<u>TPMS Reset - Procedure 30</u>
GMC		
Acadia	2007-11	<u>TPMS Reset - Procedure 3</u>
	2012	<u>TPMS Reset - Procedure 2</u>
	2013-15	<u>TPMS Reset - Procedure 9</u>
Canyon	2006-12	<u>TPMS Reset - Procedure 1</u>
Envoy	2006-09	<u>TPMS Reset - Procedure 1</u>
Savana Series	2008-12	<u>TPMS Reset - Procedure 2</u>
	2013-14	<u>TPMS Reset - Procedure 27</u>
Sierra Series	2006-07	<u>TPMS Reset - Procedure 1</u>
	2008-11	<u>TPMS Reset - Procedure 2</u>

	2012	<u>TPMS Reset - Procedure 3</u>
	2013	<u>TPMS Reset - Procedure 9</u>
	2014-15	<u>TPMS Reset - Procedure 26</u>
Terrain	2010-11	<u>TPMS Reset - Procedure 2</u>
	2012-14	<u>TPMS Reset - Procedure 12</u>
Yukon Series	2004-07	<u>TPMS Reset - Procedure 1</u>
	2008-11	<u>TPMS Reset - Procedure 2</u>
	2012	<u>TPMS Reset - Procedure 3</u>
	2013-14	<u>TPMS Reset - Procedure 9</u>
	2015	<u>TPMS Reset - Procedure 26</u>
Oldsmobile		
Alero	1999-00	(1) <u>TPMS Reset - Procedure 16</u>
Aurora	2001-03	(1) <u>TPMS Reset - Procedure 17</u>
Pontiac		
Aztek	2003-05	(1) <u>TPMS Reset - Procedure 23</u>
Bonneville	2000-05	(1) <u>TPMS Reset - Procedure 15</u>
G3	2009	<u>TPMS Reset - Procedure 2</u>
G5	2008-09	<u>TPMS Reset - Procedure 2</u>
G6	2008-10	<u>TPMS Reset - Procedure 2</u>
G8	2008-09	<u>TPMS Reset - Procedure 2</u>
Grand Am	1999-05	(1) <u>TPMS Reset - Procedure 18</u>
Grand Prix	2008	<u>TPMS Reset - Procedure 2</u>
Solstice	2008-10	<u>TPMS Reset - Procedure 2</u>
Torrent	2008-09	<u>TPMS Reset - Procedure 2</u>
Wave	2008	<u>TPMS Reset - Procedure 2</u>
Vibe	2005-07	(1) <u>TPMS Reset - Procedure 19</u>
(1) This is an Indirect TPM System. A tire sensor activation tool is not required for this procedure.		
(2) A tire sensor activation tool cannot be used for this procedure.		

TPMS RESET - PROCEDURE 1

NOTE: When the wheels have been rotated, or a tire pressure sensor or EGM/LGM has been replaced, retrain tire pressure sensors.

NOTE: The DIC will display the "SERVICE TIRE MONITOR" message if one or more of the tire pressure sensors has malfunctioned or if all of the sensors have not been programmed successfully. If, after the relearn procedure, the warning indicators are still on, there is a problem in the TPM system.

NOTE: If this procedure is performed following replacement and reprogramming of the Liftgate Module (LGM), DIC may display a low tire pressure fault and all tire pressures read 0 psi. If this problem occurs, see appropriate manufacturer service information.

NOTE: The TPM system will cancel the learn mode if more than 2 minutes have passed and no sensors have been learned, or if the system has been in learn mode for more than 5 minutes. If the learn mode is canceled before any sensor has been learned, the EGM/LGM will remember all current sensor IDs and their locations. As soon as the first sensor ID code is learned, all other IDs are erased from the EGM/LGM's memory. On models that display the individual tire pressure on DIC, updated tire pressures will not be displayed until EGM/LGM receives 2 more valid transmissions from each sensor.

NOTE: Before proceeding with the steps below, ensure that no other sensor learn procedure is being performed simultaneously, or that tire pressures are not being adjusted on a TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF. Apply parking brake.

NOTE: If Learn Mode cannot be enabled, TPM system is not enabled in EGM/LGM. See appropriate manufacturer service information.

3. To enable Learn Mode, turn headlight switch from OFF to parking lamps 4 times within 4 seconds. A double horn chirp will sound and the low tire pressure indicator will begin to flash to indicate the learn mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, turn ignition switch to OFF position to exit Learn Mode.
7. Test drive the vehicle above 25 mph for at least 2 minutes before viewing tire pressures on DIC.

TPMS RESET - PROCEDURE 2

NOTE: If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be retrained.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: Under the following conditions, the TPM system may not function properly:

- If one or more of the tire pressure sensors are missing or inoperable.
- A compact spare tire is used.

NOTE: If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be retrained.

NOTE: The relearn procedure must be completed within 15 minutes from when the vehicle is stationary after being driven at 20 mph (32 km/h), or greater, for 10 seconds.

NOTE: The learn mode will cancel if the ignition is cycled to OFF or if more than 2 minutes has elapsed for any sensor that has not been learned. If the learn mode is cancelled before the first sensor is learned, the original sensor IDs will be maintained. If the learn mode is canceled after the first sensor is learned, the following will occur:

- All stored sensor IDs will be invalidated in the RCDLR memory.
- If equipped, the DIC will display dashes instead of tire pressures.
- DTC C0775 will be set.

These conditions will now require the learn procedure to be repeated for the system to function properly.

IMPORTANT: Ensure that no other learn procedure is being performed simultaneously or that tire pressures are not being adjusted on another TPM equipped vehicle within close proximity. Stray signals from other TPM equipped vehicles just driving by can be inadvertently learned. If any random horn chirps are heard from the vehicle while performing the learn procedure, most likely a stray sensor has been learned and the procedure will need to be cancelled and repeated. Under these circumstances, performing the TPM Learn Procedure away from other vehicles would be highly recommended. In the event a particular sensor activation does not cause the horn to chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.

1. Turn ignition switch to ACC position. Apply parking brake.
2. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
3. To enable Learn Mode:
 - On vehicles equipped with keyless entry, simultaneously press the keyless entry transmitters lock and unlock buttons until a double horn chirp sounds indicating the Learn Mode has been enabled. On vehicles with DIC, a TIRE LEARN message may be displayed. The left front turn signal will

also be illuminated.

- On vehicles not equipped with keyless entry, press and release the driver information center (DIC) INFO button until the TIRE LEARN message appears on the DIC display. Press and hold the SET/RESET button until a double horn chirp sounds indicating the Learn Mode has been enabled. The left front turn signal will also be illuminated.

4. Ignition ON.
5. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
6. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
7. After left rear sensor has been learned, turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 3

NOTE: If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: In vehicles without the "UH3" option, each turn signal will illuminate one at a time indicating which location is to be learn.

NOTE: The TPM system will cancel the learn mode if more than 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to ACC position. Apply parking brake.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.

NOTE: The left front turn signal will also illuminate to indicate the learn mode has been enabled.

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 4

NOTE: If the wheels have been rotated, or tire pressure sensor or Remote Control Door Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.

NOTE: If the TPM Learn Mode cannot be enabled, ensure the TPM option is enabled in the RCDLR. See appropriate manufacturer service information.

3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled.

NOTE: If a horn chirp does not sound after 15 seconds, remove, then re-apply TPM sensor relearn magnet.

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
6. After the left rear sensor ID is learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn the ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 5

NOTE: If the wheels have been rotated, or tire pressure sensor or Remote Control Door Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
6. After the left rear sensor ID is learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn the ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 6

NOTE: If the wheels have been rotated, or tire pressure sensor or Remote Control Door

Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.
3. Press RESET button on DIC in order to clear any warning messages.
4. Press and release OPTIONS button until display is blank.
5. Press and hold RESET button for 3 seconds.

NOTE: If the DIC does not display "TIRE TRAINING" message, ensure TPM option is enabled in the RCDLR. See appropriate manufacturer service information.

6. Press and release OPTIONS button until "TIRE TRAINING" is displayed.
7. Press and release RESET button. The DIC should display "LEARN L FRONT TIRE", verifying Learn Mode has been enabled.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
10. Turn the ignition switch to OFF position to exit the learn mode.

TPMS RESET - PROCEDURE 7

NOTE: An OEM scan tool or Pressure Increase/Decrease Method is used to perform this procedure.

NOTE: Before proceeding with this process, ensure that no other learn procedure is being performed simultaneously or that tire pressures are not being adjusted on another TPM equipped vehicle within close proximity. Stray signals from

other TPM equipped vehicles just driving by can be inadvertently learned. If any random horn chirps are heard from the vehicle while performing the learn procedure, most likely a stray sensor has been learned and the procedure will need to be cancelled and repeated. Under these circumstances, performing the TPM Learn Procedure away from other vehicles would be highly recommended. In the event a particular sensor activation does not cause the horn to chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.

1. Ignition ON with engine OFF, apply the parking brake.
2. Using a scan tool, initiate the TPM Learn Mode.
3. Perform the procedure by following the menu selections. A double horn chirp will sound and the IPC tire pressure monitor indicator warning lamp icon will flash indicating Learn Mode is enabled.
4. Starting with the left front tire, active the sensors by one of the following methods:
 - Hold the antenna of the scan tool, aimed upward, against the tire sidewall close to the wheel rim at the valve stem location. Press and release the activate button and wait for a horn chirp. Once the horn chirp has sounded, the sensor information is learned.
 - Increase/decrease the tire pressure for 8-10 seconds then wait for a horn chirp. The horn chirp may occur before or up to 30 seconds after the 8-10 second pressure increase/decrease time period has been reached. Once the horn chirp has sounded, the sensor information has been learned.
5. After the horn chirp has sounded, repeat step 4 for the remaining 3 sensors in the following order: Right front, Right rear, Left rear.
6. After the left rear sensor is learned, a double horn chirp will sound indicating all sensor IDs have been learned and the tire pressure module will exit the Learn mode turning OFF the IPC tire pressure monitor warning indicator lamp icon.
7. Ignition OFF, adjust all tires to the recommended pressures. Refer to the tire placard label.

TPMS RESET - PROCEDURE 8

Automatic Sensor Learn Process

Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the tires or replacing one or more of the TPMS sensors. When a tire is installed, the vehicle must be stationary for about 20 minutes before the system recalculates. The following relearn process takes up to 10 minutes, driving at a minimum speed of 12 mph (19 km/h). A dash (-) or pressure value will display in the DIC. A warning message displays in the DIC if a problem occurs during the relearn process.

TPMS RESET - PROCEDURE 9

NOTE: If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.

NOTE: When the tire pressure warning light illuminates and warning message appears

on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel the learn mode if more than 2 minutes have passed and no sensors have been learned, or if the ignition switch is turned to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to RUN position. Apply parking brake.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 10

NOTE: If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel the learn mode if more than 2 minutes have passed and no sensors have been learned, or if the ignition switch is turned to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first

sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Depending on ignition type:
 - With standard ignition switch, place the switch in the RUN position.
 - With electronic keyless ignition, place the switch in the ACC position.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 11

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Place the vehicle power mode in ON/RUN/START.
4. Make sure the Tire Pressure info display option is turned on. The info displays on the DIC can be turned on and off through the Settings menu.
5. Use the five-way DIC control on the right side of the steering wheel to scroll to the Tire Pressure screen under the DIC info page.
6. Press and hold the SEL button located in the center of the five-way DIC control. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen
7. Start with the driver side front tire. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position.
8. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
9. After left rear sensor has been learned, the horn sounds two times to indicate the sensor identification code has been matched to the driver side rear tire, and the TPMS sensor matching process is no longer active. The TIRE LEARNING ACTIVE message on the DIC display screen goes off.
10. Press STOP to turn the ignition off.

TPMS RESET - PROCEDURE 12

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine off.
4. Use the MENU button (center console) to select the Vehicle Information Menu in the Driver Information Center (DIC). Use the arrow keys to scroll to the Tire Pressure screen
5. Press the SET/CLR button to begin the sensor matching process. A message requesting acceptance of the process should display.
6. Press the SET/CLR button again to confirm the selection. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
7. Start with the driver side front tire. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position.
8. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
9. After left rear sensor has been learned, the horn sounds two times to indicate the sensor identification code has been matched to the driver side rear tire, and the TPMS sensor matching process is no longer active. The TIRE LEARNING ACTIVE message on the DIC display screen goes off.
10. Turn the ignition to LOCK/OFF.

TPMS RESET - PROCEDURE 13

LOW TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi (kPa) less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, if air pressure is adjusted or when vehicle battery is disconnected. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.

1. There are 2 ways to reset the tire inflation monitor. To reset the tire inflation monitor using the exterior or interior lamp controls, go to step 4. To reset tire inflation monitor using the radio, turn the radio off. Turn ignition to ACC or ON, with the engine OFF. Press and hold the TUNE DISP button on the radio for at least 5 seconds until settings is displayed.
2. To scroll through the main menu:
 - On Impala, press the SEEK PTYPE up or down arrow.
 - On Monte Carlo, press the SEEK PSCAN up or down arrow.On all models, scroll until TIRE MON appears on the display. Press the 1 PREV or 2 NEXT button to enter the sub-menu. RESET will be displayed.
3. Press the TUNE DISP button to reset. A chime will sound to verify the new setting and DONE will be displayed for one second. Once the message has been reset, scroll through the menu until EXIT appears on the display. Press the TUNE DISP button to exit the program. A chime will sound to verify the exit.
4. Reset the tire inflation monitor:
 - On Impala, using the interior lighting controls, turn the switch from OFF to ON position 3 times with ignition switch in ON position.

- On Monte Carlo, using the exterior lighting controls, turn the switch from OFF to parking lamps 3 times with ignition switch in ON position.

TPMS RESET - PROCEDURE 14

NOTE: There are 3 different ways to reset the Tire Pressure Monitor (TPM) system. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the 3 speed ranges to complete the calibration process.

Using Exterior Lamp Switch

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn ignition ON with engine OFF.
3. Cycle the exterior lamp switch from OFF to parking lamps 3 times within 5 seconds.
4. Use the scan tool in order to clear the TPM DTC.

Using RDS Radio, If Equipped

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn the ignition to ACC or ON, with the engine OFF.
3. Turn the radio OFF.
4. Press and hold the DISP button until SETTINGS is displayed.
5. Press the SEEK up or down arrows until TIRE MON is displayed.
6. Press the PREV or NEXT button to enter the sub-menu. RESET will be displayed.
7. Press the DISP button, A chime will sound and DONE will be displayed.
8. Scroll until EXIT is displayed.
9. Press the DISP button to exit the TPM reset mode. A chime will sound to verify exit.
10. Use the scan tool in order to clear the TPM DTC.

Using Scan Tool

1. Adjust all tire pressures to the recommended kPa/psi.
2. Install the scan tool.
3. Turn ignition ON with engine OFF.
4. With the scan tool select Special Functions.
5. Select TIM Reset.
6. Press the Reset soft key.
7. Use the scan tool in order to clear the TPM DTC.

TPMS RESET - PROCEDURE 15

CHECK TIRE PRESSURE or TIRE PRESS message will come on if air pressure in one tire is lower than the

other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, or if air pressure is adjusted. Message will stay on until system is recalibrated. Check and adjust air pressure in all 4 tires before recalibrating system.

NOTE: If vehicle is equipped with Systems Monitor, go to step 2.

1. To recalibrate vehicle equipped with Driver Information Center (DIC), turn ignition ON with engine OFF. Using the MODE and SELECT button on DIC, change display until TIRE PRESSURE appears. Press and hold RESET button for 5 seconds. TIRE PRESSURE RESET should now appear on display. If TIRE PRESSURE RESET does not appear on display after 5 seconds, repair system as necessary. Using a scan tool, clear TPM DTC.
2. To recalibrate vehicle equipped with Systems Monitor, turn ignition ON with engine OFF. Press and hold TIRE PRESS RESET button for 5 seconds. TIRE PRESS light on the Systems Monitor should begin to flash. Release the TIRE PRESS RESET button. TIRE PRESS light should go out and system is now reset. If TIRE PRESS light does not begin to flash after 5 seconds, repair system as necessary. Using a scan tool, clear TPM DTC.

TPMS RESET - PROCEDURE 16

CHECK TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi (kPa) less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, or if air pressure is adjusted. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.

1. To reset tire inflation monitor, turn ignition ON with engine OFF. Press and release the RESET button. RESET button is located inside of driver's side instrument panel fuse block (left end of instrument panel). The CHANGE OIL indicator light will begin to flash.
2. Press and release the RESET button again. The CHANGE OIL indicator light will turn off, and the CHECK TIRE PRESSURE indicator light will begin to flash. While the CHECK TIRE PRESSURE indicator light is flashing, press and hold the RESET button until the chime sounds indicating system is reset. If CHECK TIRE PRESSURE light does not go out, repeat reset procedure. If system still will not reset, repair system as necessary.

TPMS RESET - PROCEDURE 17

NOTE: When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.

NOTE: When the low tire pressure warning messages appear, immediately check air pressure of all tires and adjust to the specified pressure. If warning messages are still displayed, there is a malfunction in the TPM system. See appropriate manufacturer service information.

NOTE: Under the following conditions, the system may not function properly:

- **More than one tire is low.**

- Only one tire is replaced with a new tire during service.
- Vehicle is moving faster than 65 mph (105 km/h).
- The system is not yet calibrated.
- Tire treadwear is uneven.
- Compact spare tire is installed.
- Tire chains are being used.
- Vehicle is being driven on a rough or frozen road.
- If ABS warning light is on.

CAUTION: DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.

NOTE: There are 2 ways to recalibrate the Tire Pressure Monitor (TPM) system:

- *Using DIC Reset Button* (if no scan tool is available)
- *Using Scan Tool* (if an OBD-II compatible scan tool is available).

Using DIC Reset Button

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press SELECT right arrow button until "GAGE" is displayed.
5. Press SELECT down arrow button until "TIRE PRESSURE" is displayed.
6. Press and hold RESET button until "TIRE PRESSURE RESET" is displayed.
7. Release RESET button. DIC should display "TIRE PRESSURE NORMAL".
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
 - 15-40 mph (24-64 km/h).
 - 40-70 mph (64-113 km/h).
 - 70-90 mph (113-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

Using Scan Tool

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Connect scan tool. Turn ignition ON with engine OFF.
4. Using scan tool, select "SPECIAL FUNCTIONS".
5. Select "TIRE PRESSURE RESET".
6. Press RESET soft key. A "TIRE PRESSURE NORMAL" message should appear on display.
7. If necessary, use scan tool to clear any TPM Diagnostic Trouble Codes (DTCs).
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
 - 15-40 mph (24-64 km/h).
 - 40-70 mph (64-113 km/h).
 - 70-90 mph (113-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

TPMS RESET - PROCEDURE 18

The Tire Pressure Monitor (TPM) system alerts the driver when a large change in the pressure of one tire exists, while the vehicle is being driven. The TPM system uses the Electronic Brake Control Module (EBCM), ABS wheel speed sensor inputs, class 2 serial data circuit, and the Driver Information Center (DIC) to perform the system functions. The EBCM contains software to calculate relative tire pressure differences. The software requires approximately 30 minutes of straight line driving in 3 different speed ranges to complete the calibration process to have full capability for detecting a tire pressure condition. The speed ranges are 15-40 mph, 40-70 mph and 70-90 mph.

1. LOW TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, if air pressure is adjusted or if vehicle battery is disconnected. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.
2. To reset tire inflation monitor, turn ignition ON with engine OFF. Press and release the RESET button. RESET button is located inside of driver's side instrument panel fuse block (left end of instrument panel). The CHANGE OIL indicator light will begin to flash.
3. Press and release the RESET button again. The CHANGE OIL indicator light will turn off, and the LOW

TIRE PRESSURE indicator light will begin to flash. While the LOW TIRE PRESSURE indicator light is flashing, press and hold the RESET button until the chime sounds indicating system is reset. If the LOW TIRE PRESSURE indicator light does not go out, repeat reset procedure. If system still will not reset, repair system as necessary.

TPMS RESET - PROCEDURE 19

NOTE: After resetting, the tire pressure monitoring (TPM) system requires 60 minutes or more of driving at a speed of 30 km/h (19 mph) or above to complete the calibration process to have full capability for detecting a tire pressure condition.

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn ignition ON with engine OFF.
3. Press and hold the tire pressure warning reset switch until the tire pressure warning indicator blinks 3 times at one second intervals.
4. If the tire pressure warning indicator does not blink, repeat the procedure starting at step 2.
5. Drive the vehicle for 60 minutes or more at a speed of 30 km/h (19 mph).
6. Verify the system has initialized. Turn ignition ON with engine OFF and observe the tire pressure warning indicator.
 - System Initialized: light on for 3 seconds.
 - System not initialized: light on for 4 seconds.

TPMS RESET - PROCEDURE 20

NOTE: When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.

CAUTION: DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.

NOTE: When the tire pressure warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning message is still displayed, there is a malfunction in the TPM system. See appropriate manufacturer service information.

NOTE: Under the following conditions, the system may not function properly:

- More than one tire is low.
- Vehicle is moving faster than 65 mph (105 km/h).
- The system is not yet calibrated.

- Tire treadwear is uneven.
- Compact spare tire is installed.
- Tire chains are being used.
- Vehicle is being driven on a rough or frozen road.
- If ABS warning light is on.

NOTE: There are 2 ways to recalibrate the Tire Pressure Monitor (TPM) system:

- *Using DIC Reset Button* (if no scan tool is available)
- *Using Scan Tool* (if an OBD-II compatible scan tool is available).

Using DIC Reset Button

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold appropriate button (located on left side of steering column) until "TIRE PRESSURE" message appears on display:
 - 1997-99 models: Press and hold GAGES button
 - 2000-05 models: Press and hold GAGES INFO button
5. Press and hold RESET button for 5 seconds. After 5 seconds, "TIRE PRESSURE RESET" message should appear on display.
6. Release RESET button. A "TIRE PRESSURE NORMAL" message should appear on display.
7. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
 - 15-40 mph (24-64 km/h).
 - 40-70 mph (64-113 km/h).
 - 70-90 mph (113-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

Using Scan Tool

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.

3. Connect scan tool. Turn ignition ON with engine OFF.
4. Using scan tool, select SPECIAL FUNCTIONS.
5. Select TIM RESET.
6. Press RESET soft key. A "TIRE PRESSURE NORMAL" message should appear on display.
7. If necessary, use scan tool to clear any TPM Diagnostic Trouble Codes (DTCs).
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
 - 15-40 mph (24-64 km/h).
 - 40-70 mph (64-113 km/h).
 - 70-90 mph (113-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

TPMS RESET - PROCEDURE 21

Using Reset Button (1999-05 Models)

1. Adjust all tire pressures to the recommended Psi (kPa). See vehicle's Loading Information Label for recommended tire pressure. Turn ignition ON with engine OFF.
2. Press and hold the red RESET button located in the passenger side instrument panel fuse block.
3. The LOW TIRE indicator will flash 3 times, then turn off.
4. Use scan tool to clear the TPM DTC.

Using Scan Tool (2003-05 Models)

1. Adjust all tire pressures to the recommended Psi (kPa). See vehicle's Loading Information Label for recommended tire pressure. Turn ignition ON with engine OFF.
2. Install scan tool. Turn ignition ON with engine OFF.
3. With scan tool, select Special Functions.
4. Select TIM Reset.
5. Press Reset soft key.
6. LOW TIRE indicator will flash 3 times, then turn OFF.
7. Clear the TPM DTC.

TPMS RESET - PROCEDURE 22

NOTE: When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.

CAUTION: DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold the MODE button until DIC display reads "LOW TIRE PRESSURE HOLD SET TO RESET".
5. Press and hold SET button chime sounds and "TIRE PRESSURE RESET" is displayed and a chime sounds 3 times.
6. Release SET button and DIC will display "TIRE PRESSURE NORMAL".

NOTE: If low tire pressure warning message is still set, TPM system has not reset. Repeat procedure. If it does not work after two tries, refer to appropriate service information.

7. After resetting, the TPM system requires up to 5 miles of driving in each of the following speed ranges to complete the calibration process:
 - 25-40 mph (40-64 km/h).
 - 40-60 mph (65-96 km/h).
 - 60-85 mph (96-136 km/h).

NOTE: Learning process does not need to be completed during a single trip.

TPMS RESET - PROCEDURE 23

1. Check and adjust air pressure in all 4 tires before resetting system. Refer to tire placard located on the inside edge of the driver's door. Turn ignition ON, with engine OFF.
2. Press the MODE button on the Driver Information System until LOW TIRE PRESSURE HOLD SET TO RESET is displayed.
3. Press and hold the SET button until a chime sounds and TIRE PRESSURE RESET is displayed and a chime sounds 3 times.
4. Release the SET button and TIRE PRESSURE NORMAL will be displayed.

TPMS RESET - PROCEDURE 24

NOTE: When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.

CAUTION: DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold the MODE button until DIC display reads "LOW TIRE PRESSURE HOLD SET TO RESET".
5. Press and hold SET button until a chime sounds and "TIRE PRESSURE RESET" is displayed.
6. System will now sound a chime 3 times, and DIC will display "TIRE PRESSURE NORMAL".

NOTE: If low tire pressure warning message is still set, TPM system has not reset. Repeat procedure.

7. After resetting, the TPM system requires up to 5 miles (8 km) of flat, smooth road, straight line driving in each of the 4 speed ranges (about 10-20 minutes in each range) to complete the calibration process:
 - 19-40 mph (31-65 km/h).
 - 40-59 mph (65-95 km/h).
 - 59-74.5 mph (95-120 km/h).
 - 74.5-90 mph (120-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Calibration Mode, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Detection Mode, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

TPMS RESET - PROCEDURE 25

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/ RUN with the engine OFF or place the vehicle power mode in ON/ RUN/ START. See **Fig. 4**.
4. Use the MENU button to select the VEHICLE INFORMATION MENU in the Driver Information Center (DIC). See **Fig. 5**.
5. Use the thumbwheel (or up and down arrows) to scroll to the TIRE PRESSURE MENU item screen.
6. Press the SET/CLR button to begin the sensor matching process. A message requesting acceptance of the

process should display.

7. Press the SET/CLR button again to confirm the selection. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

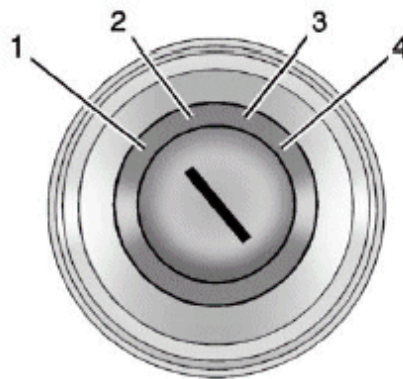
Ignition Positions

Keyless Access



Pressing the button cycles it through three modes: ACC/ACCESSORY, ON/RUN/START, and Stopping the Engine/OFF.

Key Access



The ignition switch has four different positions.

Fig. 4: Ignition Positions (Key & Keyless)
Courtesy of GENERAL MOTORS CORP.

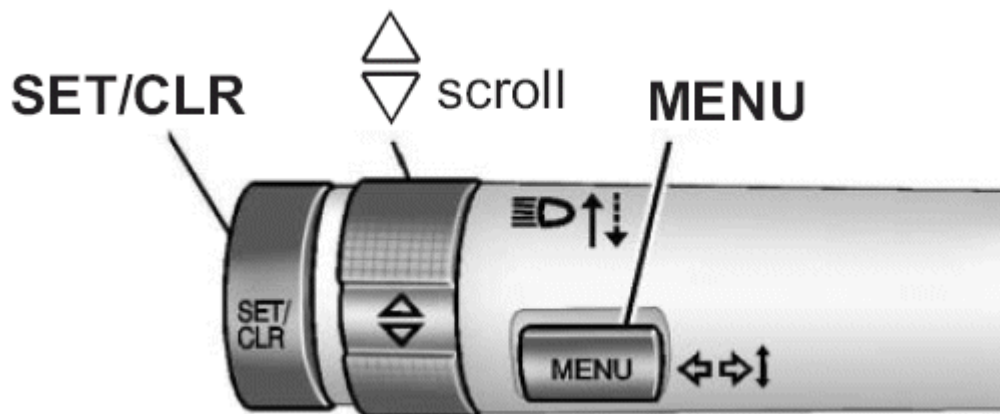


Fig. 5: Identifying DIC Controls (Turn Signal Lever)

Courtesy of GENERAL MOTORS CORP.

TPMS RESET - PROCEDURE 26

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine OFF.
4. Up-level Driver Information Center (DIC) Only: Make sure the TIRE PRESSURE INFO page option is turned on. The info pages on the DIC can be turned on and off through the SETTINGS menu.
5. If the vehicle has an up-level DIC, use the DIC controls (arrow buttons) on the right side of the steering wheel to scroll to the TIRE PRESSURE screen under the DIC info page. If the vehicle has a base-level DIC, use the TRIP ODOMETER RESET stem to scroll to the TIRE PRESSURE screen.
6. If the vehicle has an up-level DIC, press and hold the SET/RESET button (check-mark symbol) located in the center of the DIC controls. If the vehicle has a base-level DIC, press and hold the TRIP ODOMETER RESET stem for about five seconds. A message asking if the process should begin should appear. Select YES and press the TRIP ODOMETER RESET stem to confirm the selection.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 27

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to ON/RUN position, with engine OFF.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled. The TIRE LEARNING ACTIVE message displays on the DIC screen.

NOTE: If the vehicle does not have RKE, press the Driver Information Center (DIC) vehicle information button until the PRESS (check mark symbol) TO RELEARN TIRE POSITIONS message displays. The horn sounds twice to signal the receiver is in relearn mode and TIRE LEARNING ACTIVE message displays on the DIC screen. If the vehicle does not have RKE or DIC buttons, press the trip odometer reset stem on the instrument cluster until the PRESS (check mark symbol) TO RELEARN TIRE POSITIONS message displays. The horn sounds twice to signal the receiver is in relearn mode and TIRE LEARNING ACTIVE message displays on the DIC screen.

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 28

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/ RUN with the engine OFF or place the vehicle power mode in ON/ RUN/ START. See **Fig. 4**.
4. Make sure the Tire Pressure info page option is turned on. The info pages on the Driver Information Center (DIC) can be turned on and off through the Settings menu.
5. Use the DIC controls on the right side of the steering wheel to scroll to the Tire Pressure screen under the DIC info page.
6. Press and hold the SET/RESET button (check mark symbol) located in the center of the DIC controls.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 29

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine OFF.
4. Press the MENU button once on the Driver Information Center (DIC).
5. Press the up or down arrow button until the Tire Learn screen is displayed.
6. Press and hold the SET/CLR button to begin the sensor matching process.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have

been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 30

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Put the vehicle in ON/ RUN and place the vehicle in P (Park).
4. If the Driver Information Center (DIC) display is minimized, press the SELECT knob to maximize it.
5. Use the SELECT knob to scroll to the Tire Pressure display screen.
6. Press and hold the SELECT knob for five seconds to begin the sensor matching process. A message displays confirming to begin the process.
7. Use the SELECT knob to select YES with the highlighted selection, and press the SELECT knob again to confirm the selection.
8. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
9. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
10. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
11. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 31

NOTE: **You have two minutes to match the first tire/wheel position, and five minutes overall to match all four tire/wheel positions. If it takes longer, the matching process stops and must be restarted.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine off.
4. Enter the learn sequence from the TPM Learn screen, located under the Customization Menu in the instrument panel cluster. Press SRCE button until you see Customize Options and then press ENTER (left pointing arrow). Move the thumbwheel up or down to scroll through the available options. Press ENTER to select an item. To exit the current menu, or go back, use the thumbwheel to select BACK (left arrow) at the top of the screen and then press ENTER.
5. Start with the driver side front tire. The driver side front indicator lamp also comes on to indicate that corner's sensor is ready to be learned. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position
6. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
7. After the driver side rear TPMS sensor has been learned the horn chirps two times. The driver side rear

indicator lamp turns off and the TPMS sensor matching process is done. Turn the ignition switch to LOCK/OFF.

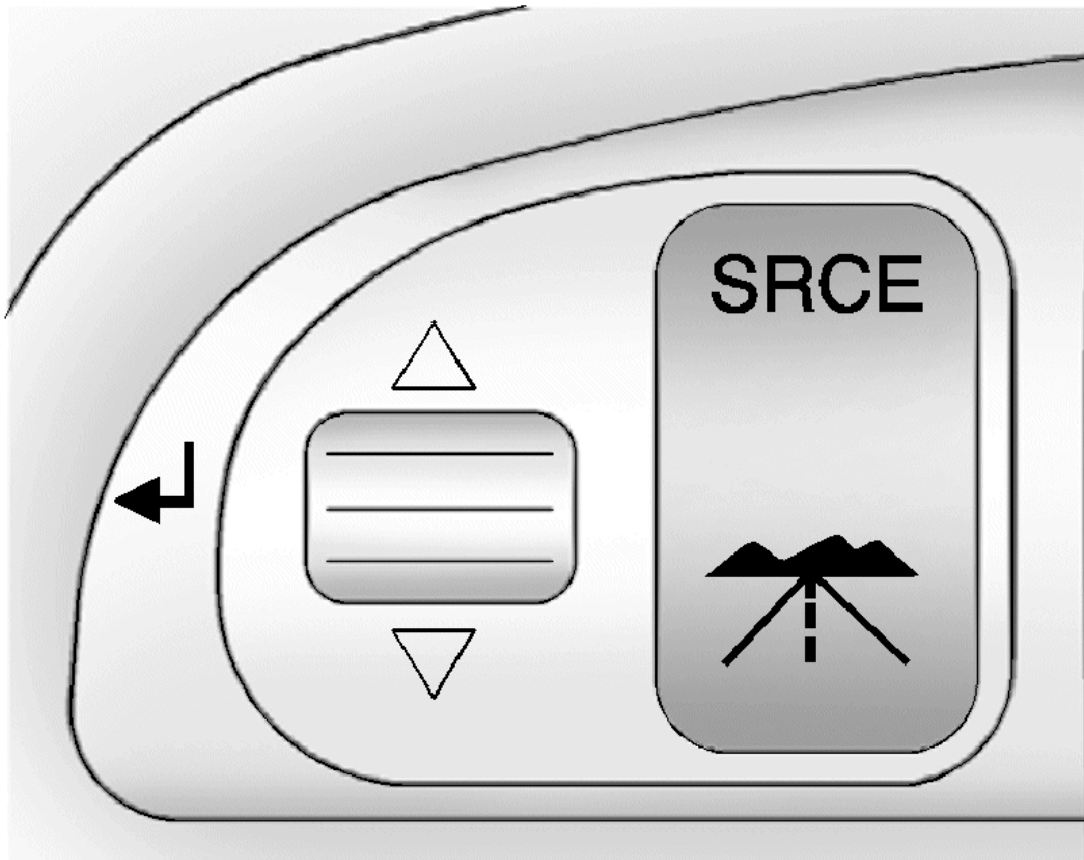


Fig. 6: Identifying DIC Controls
Courtesy of GENERAL MOTORS CORP.

TRANSMISSION

Manual Transmission - F40 (MR6)

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Backup Lamp Switch	28	21 lb ft
Shift Control Housing Bolt	26 N.m	19 lb ft
Transmission Control Bolt	8 N.m	71 lb in
Transmission Drain Plug	30 N.m	22 lb ft
Transmission Fasteners M10	40 N.m	30 lb ft
Transmission Fasteners M12	60 N.m	44 lb ft
Transmission Filler Plug	30 N.m	22 lb ft
Transmission Front Mount through Bolt	100 N.m	74 lb ft
Transmission Front Mount to Transmission Bolt	100 N.m	74 lb ft
Transmission Mount - Left Side to Body Bolt	22 N.m	16 lb ft
Transmission Mount - Left Side to Bracket Bolt		
• First Pass	50 N.m (1)	37 lb ft (1)
• Second Pass	60 degrees	
• Final Pass	15 degrees	
Transmission Mount - Left Side to Transmission Bolt	100 N.m	74 lb ft
Transmission Rear Mount Bracket through Bolt	100 N.m	74 lb ft
Transmission Rear Mount Bracket to Transmission Bolt	100 N.m	74 lb ft
Transmission Rear Mount to Suspension Frame Bolt		
• First Pass	100 N.m (1)	74 lb ft (1)
• Final Pass	120 degrees - 120 degrees	
1 = Use NEW Fastener		

MANUAL TRANSMISSION SPECIFICATIONS

Manual Transmission Specifications

Name	Specification
Transmission Type	F40-6
Transmission Content	Fully synchronized with final drive gear and differential
1st Gear Ratio	3.917

2nd Gear Ratio	2.040
3rd Gear Ratio	1.321
4th Gear Ratio	0.954
5th Gear Ratio	0.755
6th Gear Ratio	0.623
Reverse	3.750
Transmission Weight Dry (Approximate)	53.5-55.5 kg

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Input Shaft Lubrication	GNV 202	Refer to Electronic Parts Catalog	Refer to Electronic Parts Catalog
Manual Transmission Fluid	Castrol BOT 303	19259104	19259105
Transmission Control Lever Lubricant	Silicone Grease	Refer to Electronic Parts Catalog	

SCHEMATIC WIRING DIAGRAMS

MANUAL TRANSMISSION WIRING SCHEMATICS

MR6

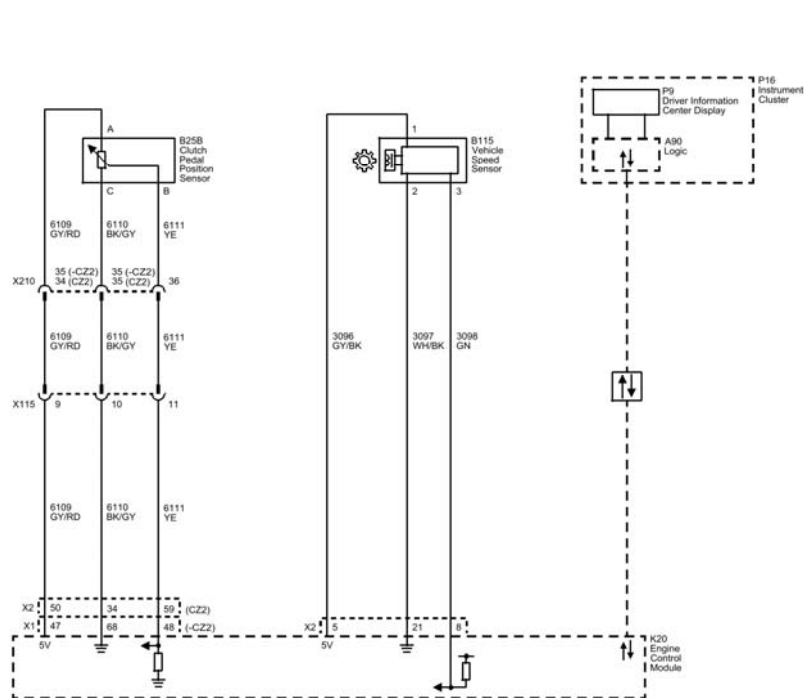


Fig. 1: MR6

Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

MANUAL TRANSMISSION COMPONENT VIEWS

Shift Control and Shift Lever/Selector Lever Cable Components

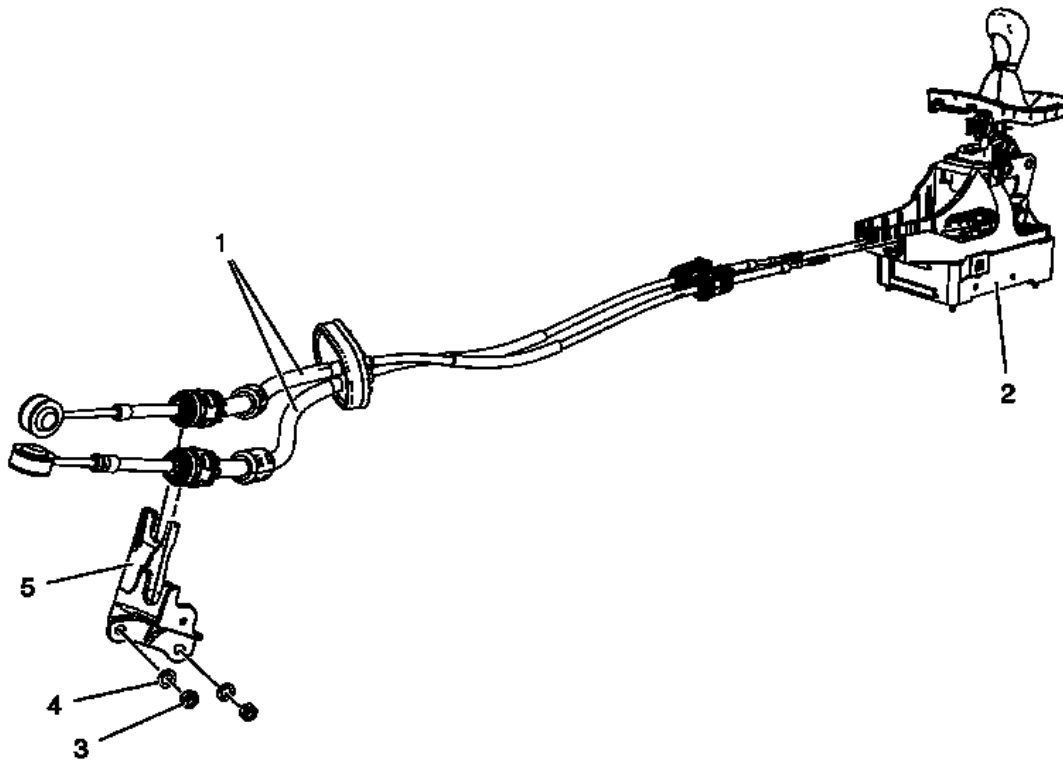


Fig. 2: Shift Control and Shift Lever/Selector Lever Cable Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Manual Transmission Shift Lever and Selector Lever Cable
2	Shift Control Housing
3	Manual Transmission Selector and Shift Lever Cable Bracket Nut (Qty: 2)
4	Manual Transmission Selector and Shift Lever Cable Bracket Nut Washer (Qty: 2)
5	Manual Transmission Selector and Shift Lever Cable Bracket

Shift Shaft Components

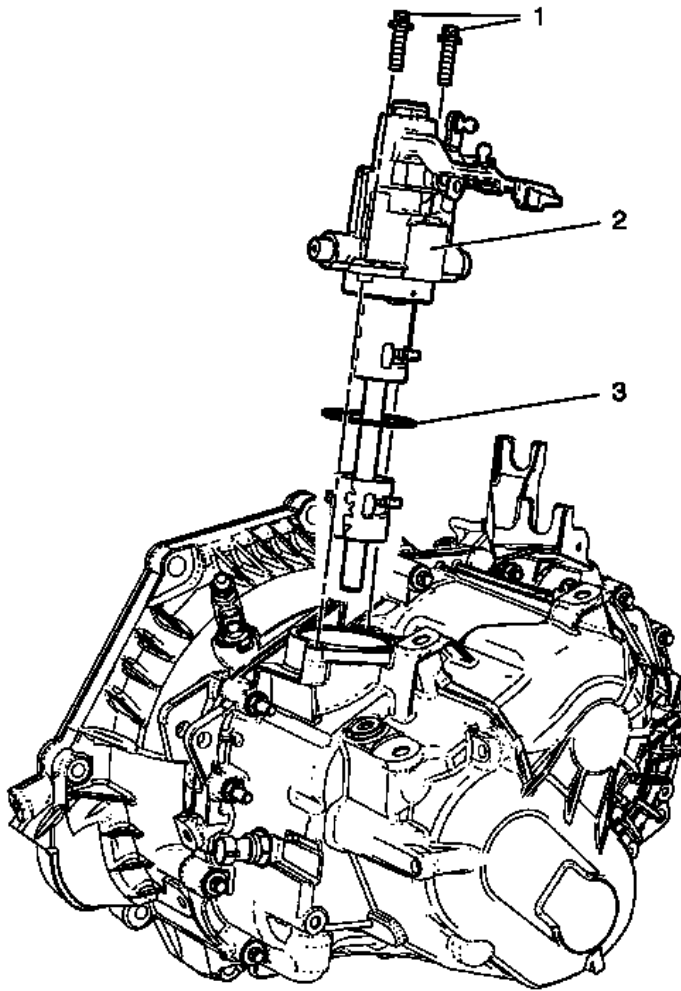


Fig. 3: Shift Shaft Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Shift Shaft Bolts (Qty: 2)
2	Shift Shaft
3	Shift Shaft O-Ring

Clutch Housing Components

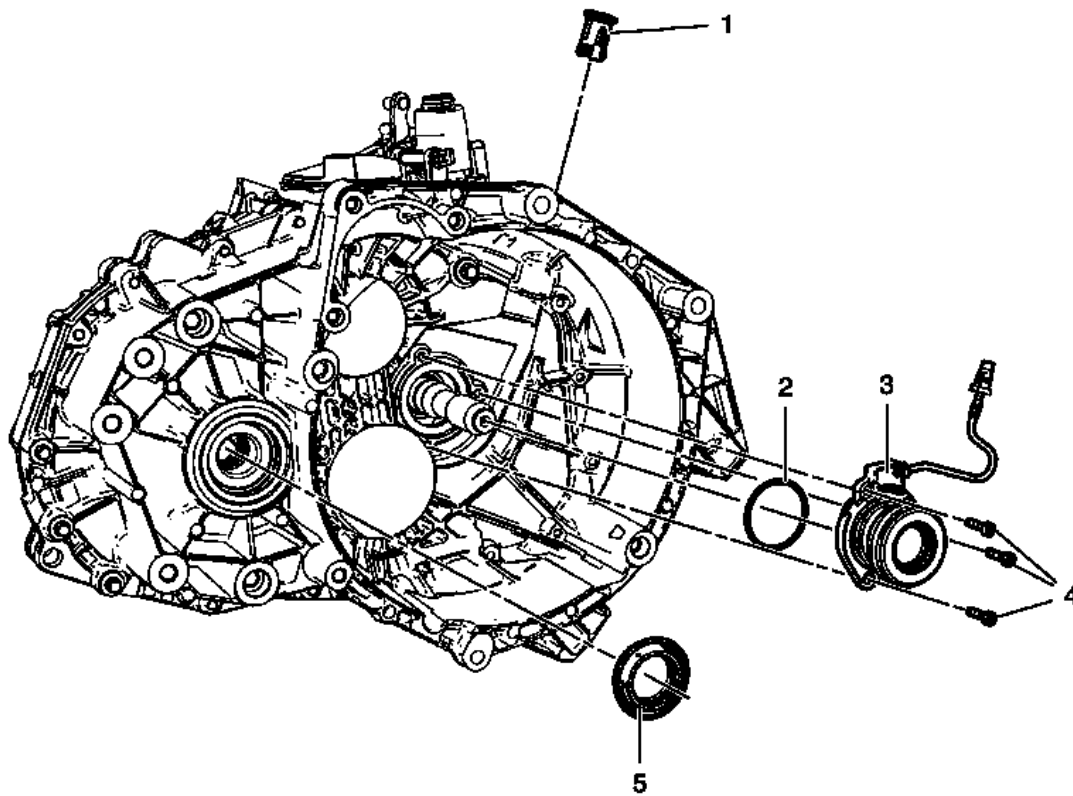


Fig. 4: Clutch Housing Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Clutch Actuator Cylinder Pipe Sleeve
2	Clutch Actuator Cylinder O-Ring
3	Clutch Actuator Cylinder
4	Clutch Actuator Cylinder Bolts (Qty: 3)
5	Front Wheel Drive Shaft Oil Seal

Transmission Housing Components

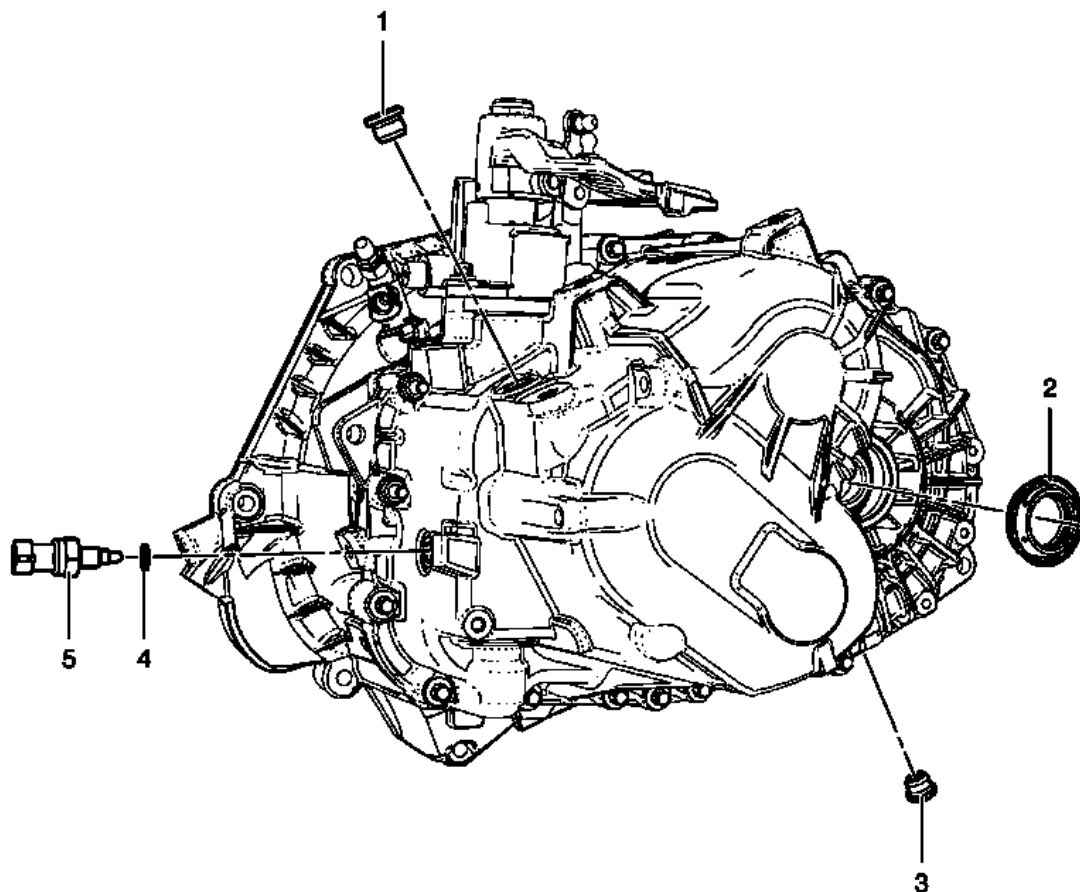


Fig. 5: Transmission Housing Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Transmission Oil Filler Plug
2	Front Wheel Drive Shaft Oil Seal
3	Transmission Oil Drain Plug
4	Backup Lamp Switch Washer
5	Backup Lamp Switch

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P0502 or P0503</u>	DTC P0502 Vehicle Speed Sensor Circuit Low Voltage

	DTC P0503 Vehicle Speed Sensor Circuit Intermittent
<u>DTC P0806-P0808</u>	DTC P0806 Clutch Pedal Position (CPP) Sensor Performance DTC P0807 Clutch Pedal Position (CPP) Sensor Circuit Low Voltage DTC P0808 Clutch Pedal Position (CPP) Sensor Circuit High Voltage
<u>DTC P080A</u>	DTC P080A Clutch Pedal Position (CPP) Not Learned

DTC P0502 OR P0503: VEHICLE SPEED SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0502

Vehicle Speed Sensor Circuit Low Voltage

DTC P0503

Vehicle Speed Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Operating Conditions: Engine Running, drive wheels turning.				
5 V Reference	P0502, P0503	P0502, P0503	P0502, P0503	P0503
VSS Signal	P0502, P0503	P0502, P0503	P0502, P0503	P0503
Low Reference	-	P0502, P0503	-	-

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Operating Conditions: Engine Running, drive wheels turning.				
5 V Reference	0 km/h (0 MPH)	0 km/h (0 MPH)	0 km/h (0 MPH)	-
VSS Signal	0 km/h (0 MPH)	0 km/h (0 MPH)	0 km/h (0 MPH)	-
Low Reference	-	0 km/h (0 MPH)	-	-

Circuit/System Description

The vehicle speed sensor (VSS) is a 3 wire sensor. The engine control module (ECM) provides a 5 volt reference circuit, low reference circuit and a signal circuit to the VSS. The VSS is a Hall Effect type sensor that produces a square wave output signal to the ECM. As vehicle speed increases, the output frequency of the VSS signal increases. The ECM converts the square wave output signal into vehicle speed shown as km/h (MPH). The ECM supplies the VSS signal to other control modules on the vehicle through the serial data communications line.

Conditions for Running the DTC

P0502

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0300, P0301, P0302, P0303, P0304, P0305, P0306, or P0503 is not set.
- Ignition voltage is between 11-32 V.
- Throttle position is 8 % or greater.
- Engine speed is between 1,500-6,500 RPM.

P0503

- Ignition voltage is between 11-32 V.
- Engine speed is between 200-7,500 RPM for 5 s or greater.
- VSS signal is 200 RPM or greater for 2 s or greater.
- Change in VSS signal is 150 RPM or less for 2 s or greater.

Conditions for Setting the DTC

P0502

VSS signal is less than 60 RPM for 4.5 s.

P0503

Change in VSS signal is 350 RPM or greater for 3.3 s.

Action Taken When the DTC Sets

P0502 and P0503 are Type B DTCs.

Conditions for Clearing the DTC

P0502 and P0503 are Type B DTCs.

Diagnostic Aids

The battery must be fully charged. Refer to **Battery Inspection/Test** .

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Transmission System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

K20 Engine Control Module: Scan Tool Information

Special Tools

J-38522-A Vehicle Signal Generator

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

CAUTION: Support the lower control arms in the normal horizontal position in order to avoid damage to the drive axles. Do not operate the vehicle in gear with the wheels hanging down at full travel.

1. Raise and support the drive wheels in a horizontal position.
2. Start and idle the engine.
3. Place the transmission in second gear and release the clutch pedal.

4. Verify the scan tool Vehicle Speed Sensor parameter increases as the drive wheel speed increases.

- **If the Vehicle Speed Sensor parameter does not increase**

Refer to Circuit/System Testing.

- **If the Vehicle Speed Sensor parameter does increase**

5. Operate the vehicle within the conditions for running the DTC to verify the DTC does not set. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the harness connector at the B115 Vehicle Speed Sensor. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.

- **If 10 ohms or greater**

1. Disconnect the X2 harness connector at the K20 Engine Control Module.

2. Test for less than 2 ohms in the circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K20 Engine Control Module.

- **If less than 10 ohms**

3. Ignition ON.

4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the 5 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

3. Test for less than 2 ohms in the 5 V reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, Ignition ON.

2. Test for less than 1 V between the 5 V reference circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**
- 5. Ignition OFF, connect the test leads of the J-38522-A vehicle signal generator as follows:
 - Red test lead to the signal circuit terminal 3 at the B115 Vehicle Speed Sensor wire harness connector.
 - Black test lead to ground at the transmission case.
 - Double black power and ground lead wire to B+ and ground.
- 6. Set and adjust the J-38522-A vehicle signal generator to the following switch positions:
 - Signal switch to 5 V.
 - Frequency switch to 600 Hz.
 - Duty cycle switch to 50% or normal position.
- 7. Ignition ON.
- 8. Verify the scan tool Vehicle Speed Sensor parameter displays between 41-51 km/h (25-32 mph).
 - **If the vehicle speed sensor parameter is not within the specified range**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If the vehicle speed sensor parameter is within the specified range**
- 9. Replace the B115 Vehicle Speed Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Vehicle Speed Sensor Replacement**
- **Control Module References** for ECM replacement, programming and setup.

DTC P0806-P0808: CLUTCH PEDAL POSITION (CPP) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0806

Clutch Pedal Position (CPP) Sensor Performance

DTC P0807

Clutch Pedal Position (CPP) Sensor Circuit Low Voltage

DTC P0808

Clutch Pedal Position (CPP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0651, P0807	P0807	P0651, P0808	-
Signal	P0807	P0807	P0808	P0806
Low Reference	-	P0808	P0808	-

Typical Scan Tool Data

CPP Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. CPP Sensor Voltage Parameter Normal Range: 1 V with clutch pedal applied to 4 V when clutch pedal is released.			
5 V Reference	0 V	0 V	5 V
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

CPP Sensor Percentage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. CPP Sensor Percent Parameter Normal Range: 0% with clutch pedal released to 100% when clutch pedal is applied.			
5 V Reference	100%	100%	0-100%
Signal	100%	100%	100%
Low Reference	-	0%	-

Circuit/System Description

The clutch pedal position (CPP) sensor is a three wire sensor, connected to a 5 V reference circuit, a low

reference circuit, and a signal circuit. The engine control module supplies 5 V to the CPP sensor, and also provides a sensor ground path on the low reference circuit. The CPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage near 4 V when the clutch pedal is released, to a voltage near 1 V when the clutch pedal is applied.

Conditions for Running the DTC

P0806

- DTC P0335, P0336, P0502, P0503, P0807, or P0808 is not set.
- The vehicle speed is greater than 8 kmh (5 mph).
- The ignition is ON.

P0807 and P0808

- DTC P0651 is not set.
- The system voltage is more than 9 V.
- The ignition is ON.

Conditions for Setting the DTC

P0806

The CPP sensor is stuck in range.

P0807

The CPP sensor voltage is less than 0.1 V for more than 1 s.

P0808

The CPP sensor voltage is more than 5.2 V for more than 1 s.

Action Taken When the DTC Sets

DTC P0806 - P0808 are Type A DTCs.

Conditions for Clearing the DTC

DTC P0806 - P0808 are Type A DTCs.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

K20 Engine Control Module: Scan Tool Information for scan tool information

Circuit/System Verification

1. If DTC P0651 or P080A is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON.
3. Verify the scan tool CPP Sensor percent parameter varies from 0% when the clutch pedal is released, to 100% when the clutch pedal is in the apply position.
 - **If the percentage does not vary from 0% to 100%**

Refer to Circuit/System Testing.

- **If the percentage varies from 0% to 100%**
4. Operate the vehicle within the conditions for running the DTC to verify the DTC does not set. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - **If the DTC sets**

Refer to Circuit/System Testing.

 - **If the DTC does not set**
 5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector of the B25B Clutch Pedal Position Sensor.
2. Test for less than 5 ohms between the low reference circuit terminal C and ground:
 - **If 5 ohms or greater**
 1. Disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground:
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
5. Verify the scan tool CPP Sensor voltage parameter is less than 0.1 V.
 - **If 0.1 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, Ignition ON.
 2. Test for less than 1 V between the signal circuit terminal B and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 0.1 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal C.
7. Verify the scan tool CPP Sensor voltage parameter is greater than 4.9 V.
 - **If 4.9 V or less**
 1. Ignition OFF, remove the jumper wire, disconnect the X1 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal B and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms , replace the K20 Engine Control Module.
 - **If greater than 4.9 V**
8. Test or replace the B25B Clutch Pedal Position Sensor.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector of the B25B Clutch Pedal Position Sensor.
2. Measure the resistance between the signal terminal B and the low reference terminal C at the B25B Clutch Pedal Position Sensor. Depress the clutch pedal through the entire range. The resistance should vary from low to high and vice versa without any spikes or dropouts.
 - **If the resistance is erratic with spikes or dropouts**

Replace the B25B Clutch Pedal Position Sensor.
 - **If the resistance is not erratic without spikes or dropouts**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Clutch Pedal Position Sensor Replacement**
- **Control Module References** for ECM replacement, programming and setup.

DTC P080A: CLUTCH PEDAL POSITION (CPP) NOT LEARNED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P080A

Clutch Pedal Position (CPP) Not Learned

Circuit/System Description

The clutch pedal position (CPP) is a 3-wire sensor, connected to a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module supplies 5 V to the CPP sensor, and also provides a sensor ground path on the low reference circuit. The CPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage near 5 V when the clutch pedal is released to a voltage less than or equal to 1.5 V when the clutch pedal is applied.

Conditions for Running the DTC

Clutch pedal fully applied.

Conditions for Setting the DTC

Clutch pedal position not learned.

Action Taken When the DTC Sets

P080A is a Type A DTC.

Conditions for Clearing the DTC

P080A is a Type A DTC.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

K20 Engine Control Module: Scan Tool Information

Circuit/System Verification

Perform the clutch pedal position sensor learn procedure.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Clutch Pedal Position Sensor Learn**
- **Control Module References** for replacement, programming and setup.

CLUTCH PEDAL POSITION SENSOR LEARN

NOTE: The clutch pedal position (CPP) sensor learn procedure is required when the following service procedures have been performed regardless of whether DTC P080A is set:

- An engine control module (ECM) replacement
- A CPP sensor replacement
- Any repairs which affect the CPP sensor relationship

1. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P080A, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
3. With a scan tool, select Clutch Pedal Position Learn under Module Setup in Manual Transmission, and perform the following instructions displayed on the scan tool screen.

NOTE: The CPP sensor learn procedure cannot be performed more than once per ignition cycle. The clutch pedal needs to be fully depressed and held steady throughout this procedure in order to perform a correct learning.

4. The scan tool will display under CPP Learn Status: Not Learned, In Process, Complete, Fail - Low Volt, Fail - High Volt, or Fail Moving. The scan tool will display under CPP Learn Status Complete if the process was successful.
5. If the scan tool indicates that DTC P080A ran and passed this ignition the CPP sensor learn procedure is complete. If the scan tool indicates DTC P080A failed or did not run this ignition, refer to **DTC P080A**, . If any other DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC.
6. Turn OFF the ignition for 30 s after the learn procedure has successfully completed in order to store the CPP sensor variation values in ECM history.

SYMPTOMS - MANUAL TRANSMISSION

Symptoms - Manual Transmission

Complaint/Condition	Possible Cause	correction
Knock at Low Speeds	<ul style="list-style-type: none"> • Worn drive axle joint • Worn side gear or pinion gear bores 	<ul style="list-style-type: none"> • Inspect drive axle joint and replace if necessary. • Inspect differential case and replace if necessary.
Noisy Around Turns	Worn differential gears	Inspect differential gears and replace if necessary.
Clunk or Acceleration or Deceleration	<ul style="list-style-type: none"> • Loose engine mounts • Worn inboard drive axle joint • Worn differential pinion shaft • Worn side gear hub counterbore 	<ul style="list-style-type: none"> • Inspect engine mounts and tighten if necessary. • Inspect inboard drive axle joint and replace if necessary. • Inspect differential pinion shaft and replace if necessary. • Inspect side gear hub counterbore and replace if necessary.
Click Noise On Turns	Worn outboard drive axle C/V joint	Inspect C/V joint and replace if necessary.
Noisy in Neutral With Engine Running	<ul style="list-style-type: none"> • Worn input gear bearing • Worn speed gear bearing • Worn bearing races 	<ul style="list-style-type: none"> • Inspect bearing and replace if necessary. • Inspect bearing and replace if necessary. • Inspect bearing race and replace if necessary.
Noisy in First Gear Only	<ul style="list-style-type: none"> • Worn, chipped, or scored 1st speed constant-mesh gears • Worn, shipped, or scored 1st/2nd synchronizer 	<ul style="list-style-type: none"> • Inspect gears and replace if necessary. • Inspect synchronizer and replace if necessary.
Noisy in Second Gear Only	<ul style="list-style-type: none"> • Worn, chipped, or scored 2nd speed constant-mesh gears • Worn, chipped, or scored 1st/2nd synchronizer 	<ul style="list-style-type: none"> • Inspect gears and replace if necessary. • Inspect synchronizer and replace if necessary.
Noisy in Third Gear Only	<ul style="list-style-type: none"> • Worn, chipped, or scored 3rd speed constant-mesh gears 	<ul style="list-style-type: none"> • Inspect gears and replace if necessary. • Inspect synchronizer and

	<ul style="list-style-type: none"> • Worn, chipped, or scored 3rd/4th synchronizer 	replace if necessary.
Noisy in Fourth Gear Only	<ul style="list-style-type: none"> • Worn, chipped, or scored 4th speed constant-mesh gears • Worn, chipped, or scored 3rd/4th synchronizer • Worn, chipped, or scored output gear • Worn, chipped, or scored output gear 	<ul style="list-style-type: none"> • Inspect gears and replace if necessary. • Inspect synchronizer and replace if necessary. • Inspect gear and replace if necessary. • Inspect gear and replace if necessary.
Noisy in Fifth Gear Only	<ul style="list-style-type: none"> • Worn, chipped, or scored 5th speed constant-mesh gears • Worn, chipped, or scored 5th synchronizer • Worn, chipped, or scored output gear 	<ul style="list-style-type: none"> • Inspect gears and replace if necessary. • Inspect synchronizer and replace if necessary. • Inspect gear and replace if necessary.
Noisy in Reverse Only	<ul style="list-style-type: none"> • Worn, chipped, or scored reverse speed constant-mesh gears • Worn or damaged output gear 	<ul style="list-style-type: none"> • Inspect gear and replace if necessary. • Inspect gear and replace if necessary.
Noisy in All Gears	<ul style="list-style-type: none"> • Fluid level low • Worn or damaged wheel bearings • Worn, chipped, or scored input/output shaft gear • Worn output gear bearing • Loose shift rail guide bolt • Worn, chipped, or scored 1st, 2nd, 3rd, 4rd, 5th, or Reverse gears. 	<ul style="list-style-type: none"> • Add fluid to proper level. • Inspect wheel bearing and replace if necessary. • Inspect gear and replace if necessary. • Inspect output gear bearing and replace if necessary. • Tighten shift rail guide bolt. • Inspect components and replace as necessary.
Slips Out of Gear	<ul style="list-style-type: none"> • Loose transaxle mounts • Bent or worn cables • Broken or loose input gear bearing retainer • Worn or bent shift fork • Dirty clutch housing and 	<ul style="list-style-type: none"> • Tighten or replace mounts. • Inspect cables and replace if necessary. • Inspect shift fork and replace if necessary. • Inspect shift fork and replace if necessary.

	<ul style="list-style-type: none"> engine Stiff shift lever seal Manual transaxle internal shift mechanism malfunction 	<ul style="list-style-type: none"> Clean clutch housing and engine. Inspect seal and replace if necessary. Disassemble transaxle, repair as necessary.
Slips Out of Gear While Accelerating	<ul style="list-style-type: none"> Missing or misadjusted first gear thrust bearing or washer Worn or damaged first gear spline lock on 1st/2nd synchronizer Worn or damaged second gear spline lock on 1st/2nd synchronizer Worn or damaged third gear spline lock on 3rd/4th synchronizer Worn or damaged fourth gear spline lock on 3rd/4th synchronizer Worn or damaged 5th gear spline lock on the 5th/Reverse synchronizer Worn or damaged Reverse gear spline lock on the 5th/Reverse synchronizer Worn or damaged 1st, 2nd, 3rd, 4th, 5th or reverse gear spline lock Manual transaxle internal shift mechanism malfunction 	<ul style="list-style-type: none"> Inspect bearing and washer and replace if necessary. Inspect spline lock and replace if necessary. Inspect spline lock and replace if necessary. Inspect spline lock and replace if necessary. Inspect spline lock and replace if necessary. Inspect spline lock and replace if necessary. Inspect spline lock and replace if necessary. Inspect spline lock and replace if necessary. Disassemble transaxle, repair as necessary.
Slips Out of Gear While Coasting	<ul style="list-style-type: none"> Damaged, worn, or missing shift rails Manual transaxle internal shift mechanism malfunction 	<ul style="list-style-type: none"> Inspect shift rails and replace if necessary. Disassemble transaxle, repair as necessary.
	<ul style="list-style-type: none"> Fluid level high Damaged axle shaft seals Vent cap plugged 	<ul style="list-style-type: none"> Drain excess fluid. Inspect axle shaft seals and replace if necessary. Clear or replace vent cap.

Fluid Leakage	<ul style="list-style-type: none"> • Poor sealing on shift cover • Poor sealing between case and clutch housing • Poor sealing on rear cover • Poor sealing or loose back-up lamp switch • Poor sealing or loose vehicle speed sensor 	<ul style="list-style-type: none"> • Replace sealer on shift cover. • Replace sealer between case and clutch housing and tighten. • Replace sealant on rear cover and tighten. • Tighten switch or replace sealant as needed. • Tighten sensor or replace sealant as needed.
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REPAIR INSTRUCTIONS - ON VEHICLE

TRANSMISSION FLUID DRAIN AND FILL

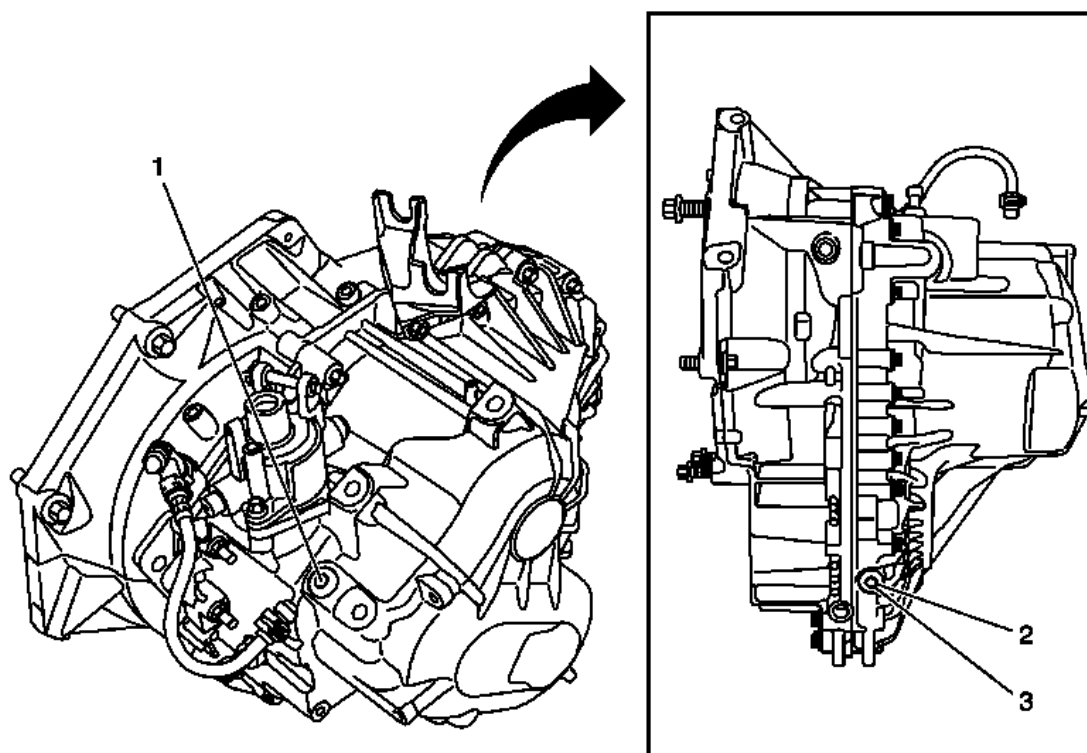


Fig. 6: Transmission Fluid Drain and Fill Components
Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Drain and Fill

Callout	Component Name
Preliminary Procedure	
Remove the battery tray. Refer to Battery Tray Replacement .	

1	<p>Transmission Filler Plug</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>NOTE: A NEW filler plug must be installed.</p> <p>Tighten 30 (22 lb ft)</p>
2	<p>Transmission Drain Plug</p> <p>WARNING: When the transmission is at operating temperatures, take necessary precautions when removing the check/fill plug, to avoid being burned by draining fluid.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Place pan under transmission to collect fluid. 2. Allow transmission fluid to drain out for approximately 10 minutes. <p>NOTE: A NEW drain plug must be installed.</p> <p>Tighten 30 (22 lb ft)</p>
3	<p>Transmission Fluid</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. On FWD vehicles, fill the transmission with 2.2 liters of transmission fluid, a residue of approximately 0.2 liters remains in the transmission. For recommended fluid, refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. 2. On AWD vehicles, fill the transmission with 1,6 liters of transmission fluid, a residue of approximately 0.2 liters remains in the transmission. For recommended fluid, refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> <p>NOTE: If a new transmission is installed during servicing, this must be filled with 1.8 liters of transmission fluid because the new transmissions are already filled with 0.68 liters of transmission fluid from the factory.</p>

TRANSMISSION CONTROL LEVER BOOT REPLACEMENT

The transmission control lever boot and shift knob are replaced as an assembly. To remove the assembly refer to Transmission Control Lever Knob Replacement.

TRANSMISSION CONTROL LEVER KNOB REPLACEMENT

Removal Procedure

NOTE: The control lever knob and boot are replaced as an assembly.

1. Remove transmission control lever boot from front floor console, gently pulling boot frame on front side upwards.

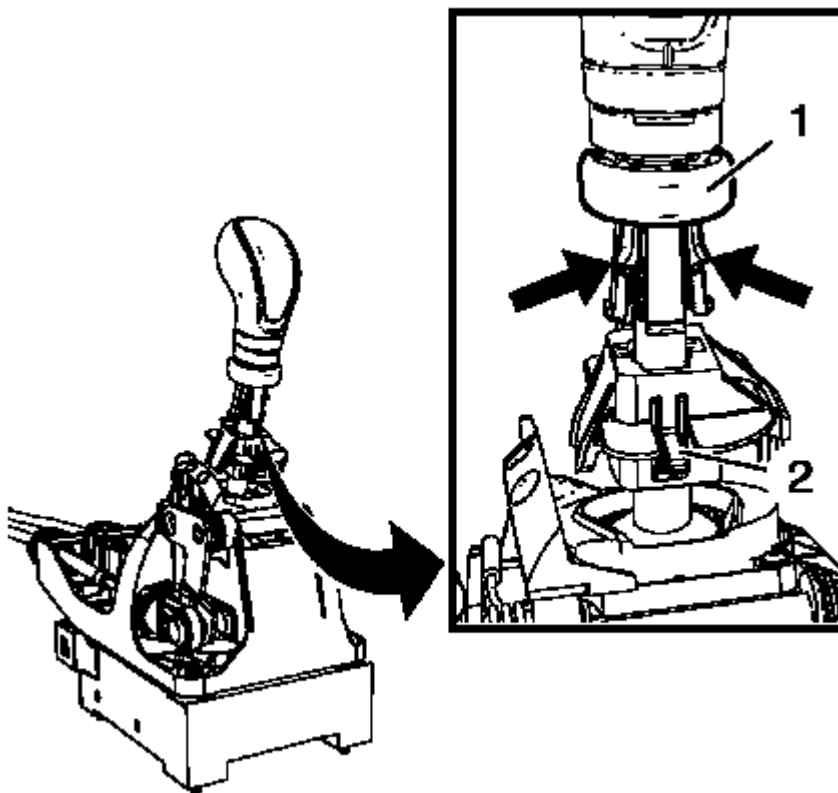


Fig. 7: Transmission Control Lever Retainer Ring
Courtesy of GENERAL MOTORS COMPANY

2. Slide transmission control lever boot upwards.
3. Press in on the 2 tabs shown by the arrows.
4. Slide the blue lock ring (1) upward to release the retainers on the knurled shaft.
5. Remove the knob from the shifter by pulling up to release the knob from the knurled shaft.
6. Pull trigger (2) upwards.
7. Remove the reverse block out boot assembly from the shifter.

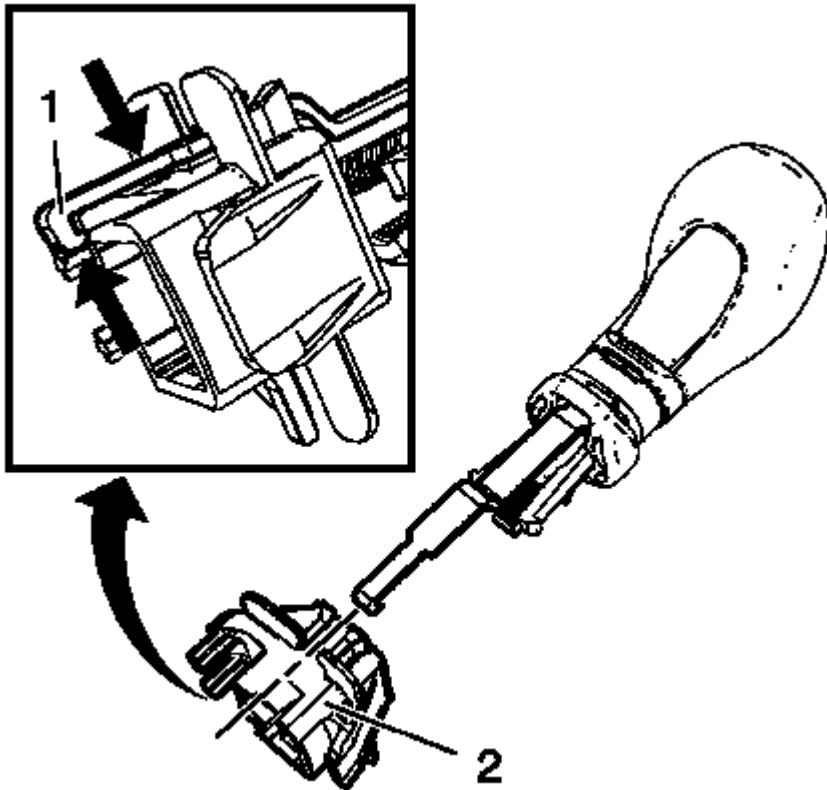


Fig. 8: Pull Latch

Courtesy of GENERAL MOTORS COMPANY

8. Press pull latch (1) in direction of arrows.
9. Remove reverse gear block (2) from transmission shifter boot assembly.

Installation Procedure

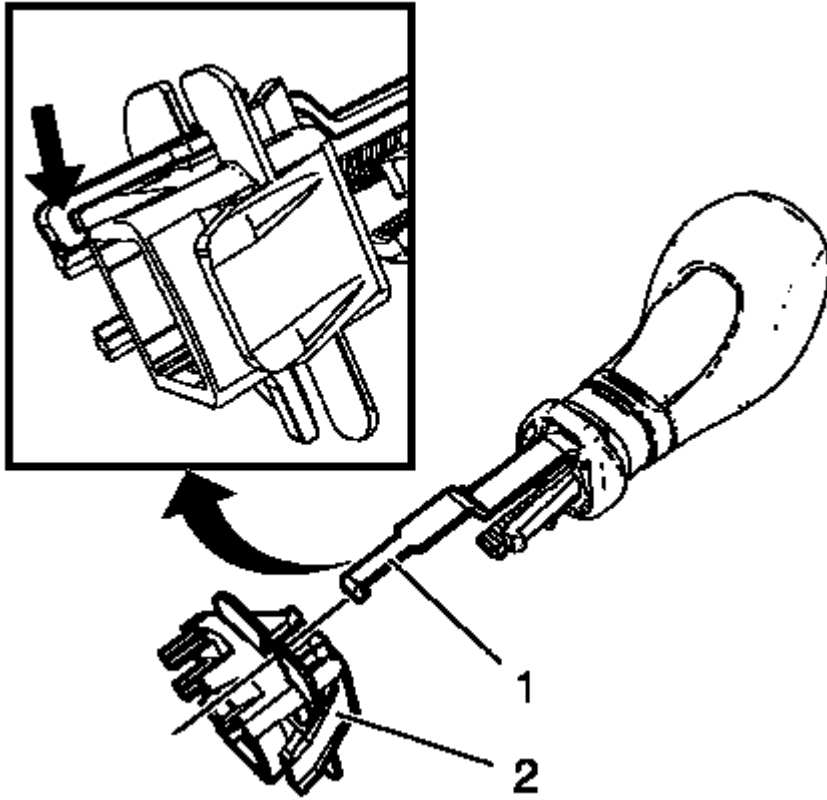


Fig. 9: Reverse Gear Block & Hook
Courtesy of GENERAL MOTORS COMPANY

1. Install reverse gear block (2) to transmission control lever knob.
2. Let the hook (1) engage hearable (arrow).

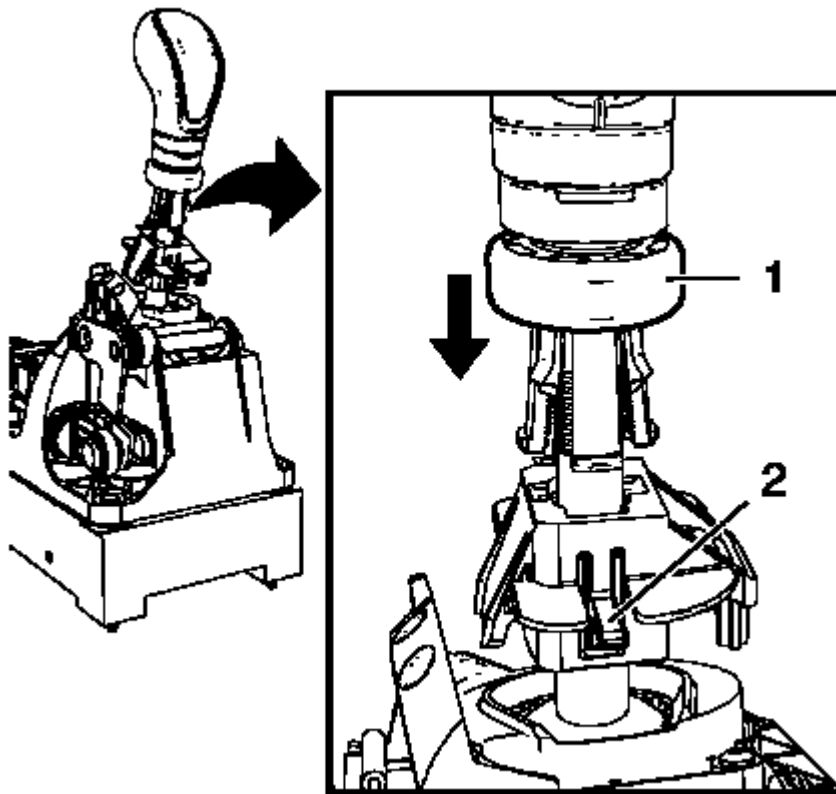


Fig. 10: Transmission Control Lever Retainer Ring & Trigger
Courtesy of GENERAL MOTORS COMPANY

3. Install transmission control lever knob.
4. Push trigger (2) upwards.
5. Press the transmission control lever knob during installation completely down.
6. Clip transmission control lever boot into front floor console.

SHIFT CONTROL LEVER REPLACEMENT

Removal Procedure

1. Remove the front floor console. Refer to **Front Floor Console Replacement** .

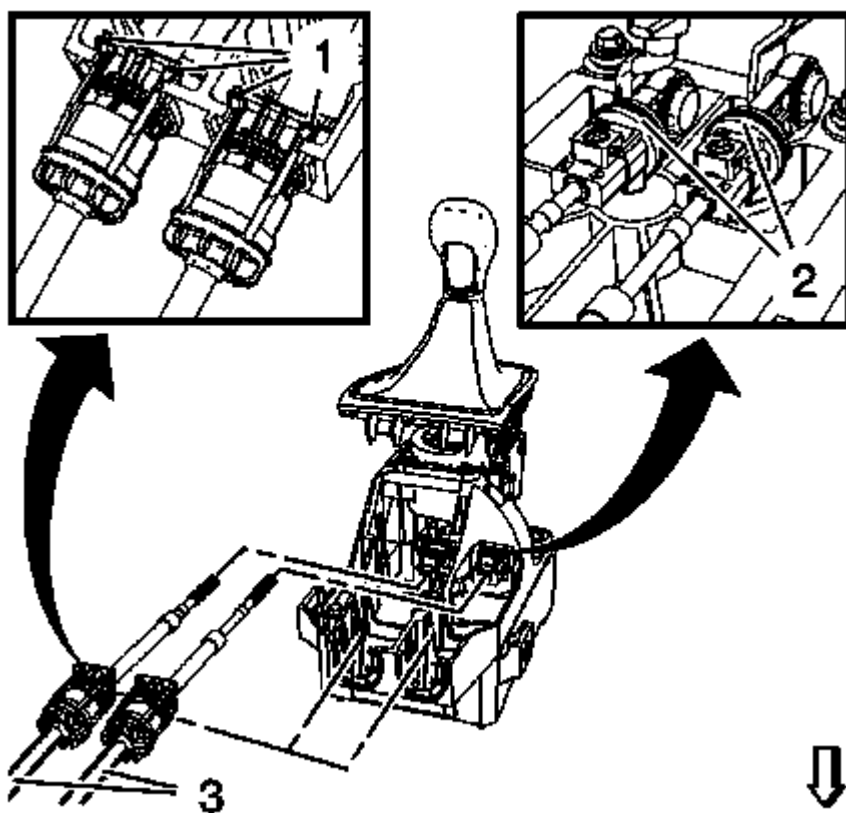


Fig. 11: Selector Lever Cable, Adjust Locks And Transmission Control Lever Housing
Courtesy of GENERAL MOTORS COMPANY

2. Unlock shift lever and selector lever cable adjust locks (2).
3. Clip shift lever and selector lever cable (3) out of transmission control lever housing (1).

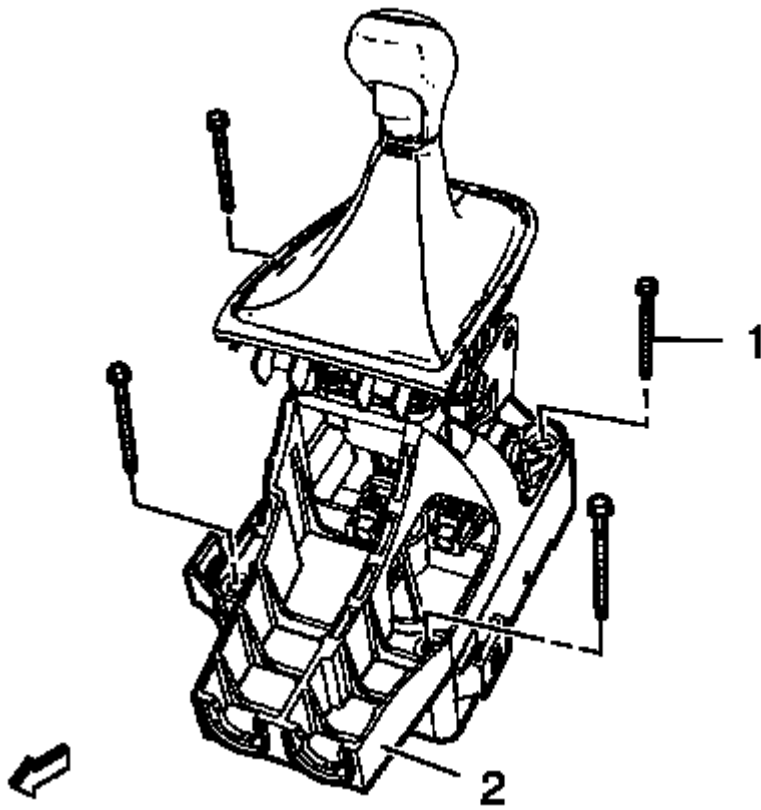


Fig. 12: Transmission Control Lever And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the four transmission control lever fasteners (1).
5. Remove transmission control lever (2).

Installation Procedure

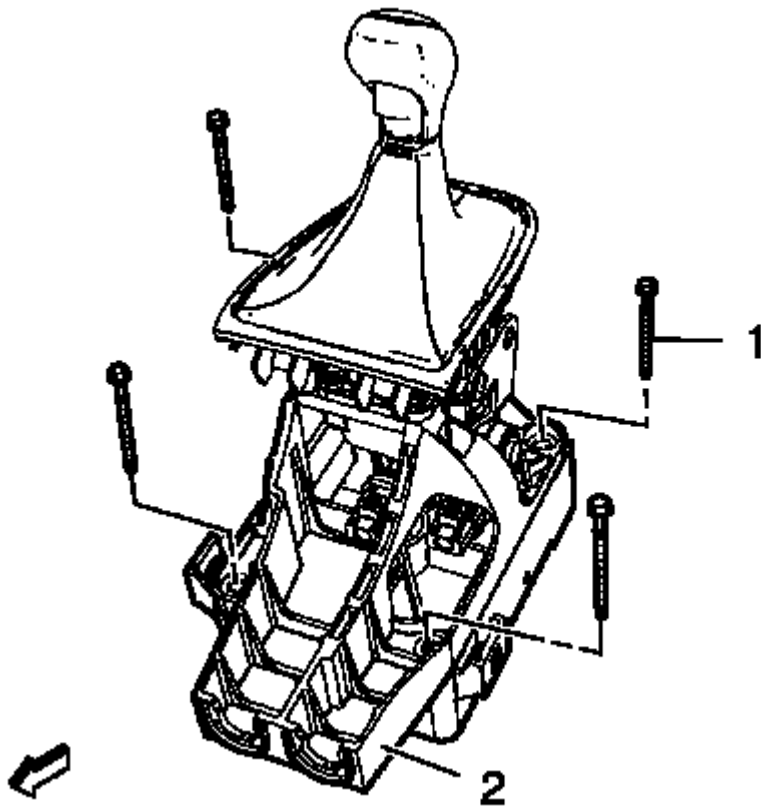


Fig. 13: Transmission Control Lever And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW transmission control lever (2).

CAUTION: Refer to Fastener Caution in the Preface section.

2. Install the four transmission control lever fasteners (1) and tighten to 8 N.m (71 lb in).

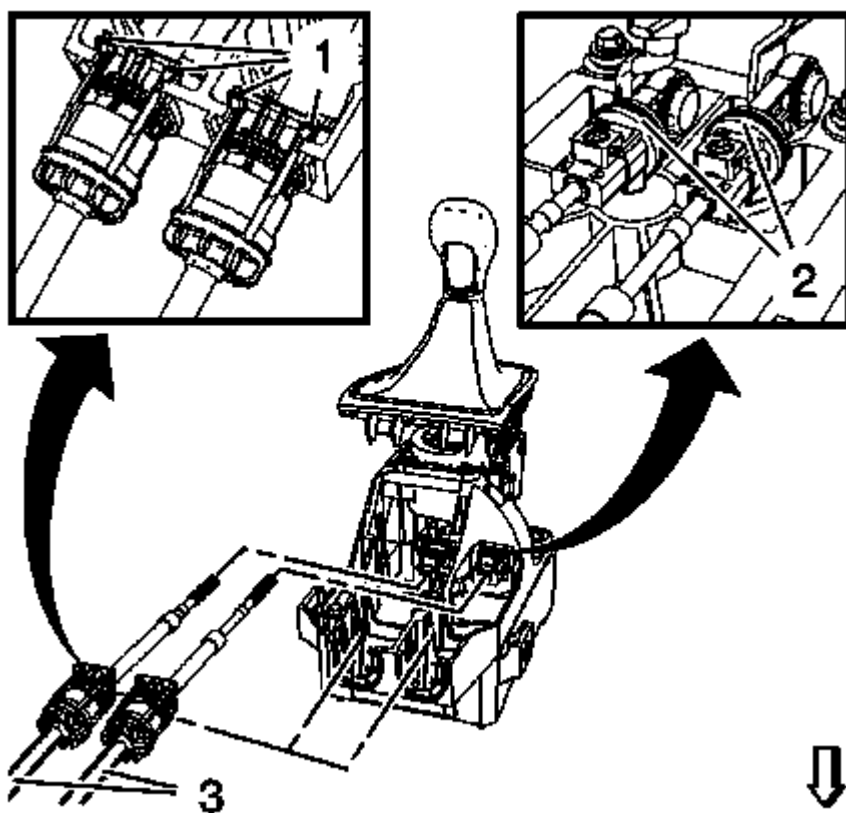


Fig. 14: Selector Lever Cable, Adjust Locks And Transmission Control Lever Housing
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not lock yet.

3. Slide shift lever and selector lever cable into shift lever and selector lever cable adjust locks (2).
4. Clip shift lever and selector lever cable (3) into transmission control lever housing (1).
5. Adjust shift lever and selector lever cable. Refer to Manual Transmission Shift Lever Cable Adjustment.
6. Install the front floor console. Refer to Front Floor Console Replacement .

MANUAL TRANSMISSION SHIFT LEVER AND SELECTOR LEVER CABLE ADJUSTMENT

Special Tools

DT-527-A Adjuster or 5mm drill bit

For equivalent regional tools, refer to Special Tools.

NOTE: Not using the specified tools may lead to shift system mis-adjustment.

1. Shift transmission into NEUTRAL.
2. Remove the front floor console cover. Refer to Front Floor Console Replacement .

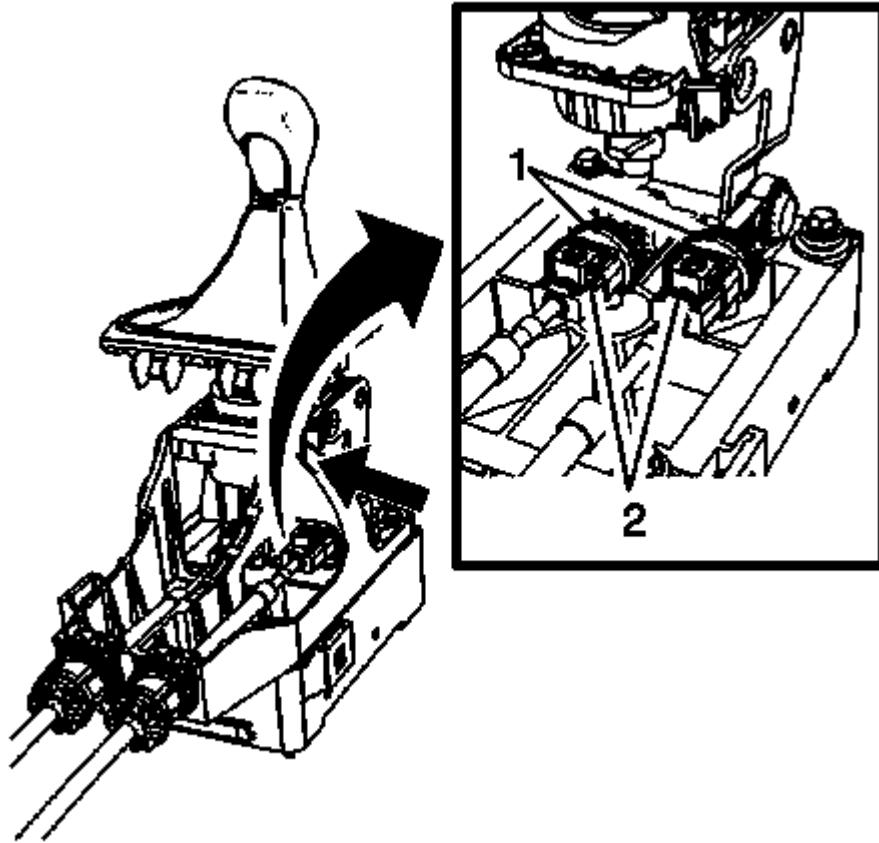


Fig. 15: Cable Lock Adjusters & Sliding Ring
Courtesy of GENERAL MOTORS COMPANY

3. Unlock the cable lock adjusters (2), by pushing back the spring force loaded black sliding ring (1) until self-locking. One for each cable.

NOTE: **The driver side slider ring can be accessed through side panel of console using a suitable tool.**

4. Slide transmission control lever boot upwards.

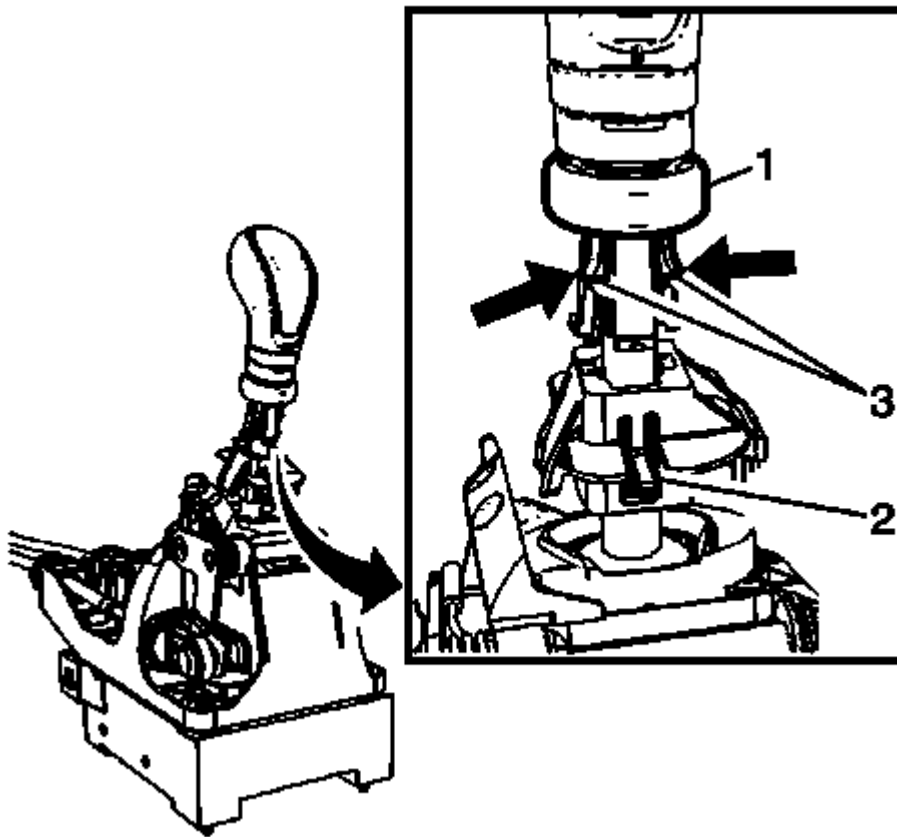


Fig. 16: Control Lever Retaining Ring & Latches
Courtesy of GENERAL MOTORS COMPANY

5. Disengage control lever retaining ring by pressing both latches (3) while sliding up retaining ring (1) until loose.
6. Lock the position of the shift control lever by rotating the reverse lockout device with the following instructions:

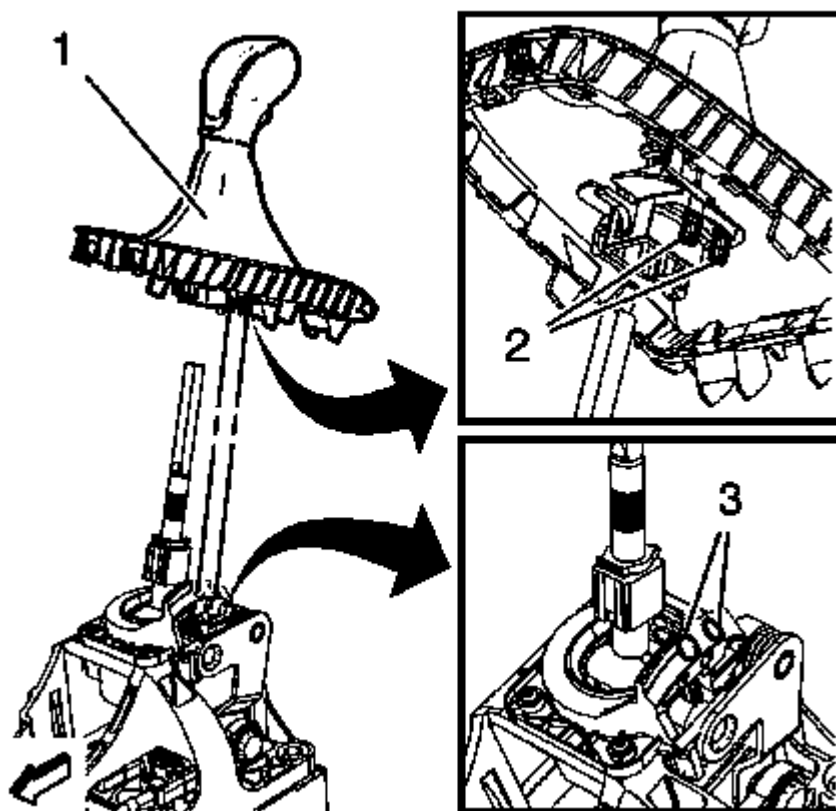


Fig. 17: Transmission Control Lever Knob
Courtesy of GENERAL MOTORS COMPANY

1. Slide up shift control lever until almost removed.
 2. Rotate complete shift control lever assembly 180 degrees so the reverse inhibitor button on lever is facing toward the rear.
 3. Secure integral pins (2) on reverse lockout device in holes located on shifter base (3) by pushing downward on device until seated.
7. Remove engine control module from battery tray and lay aside.

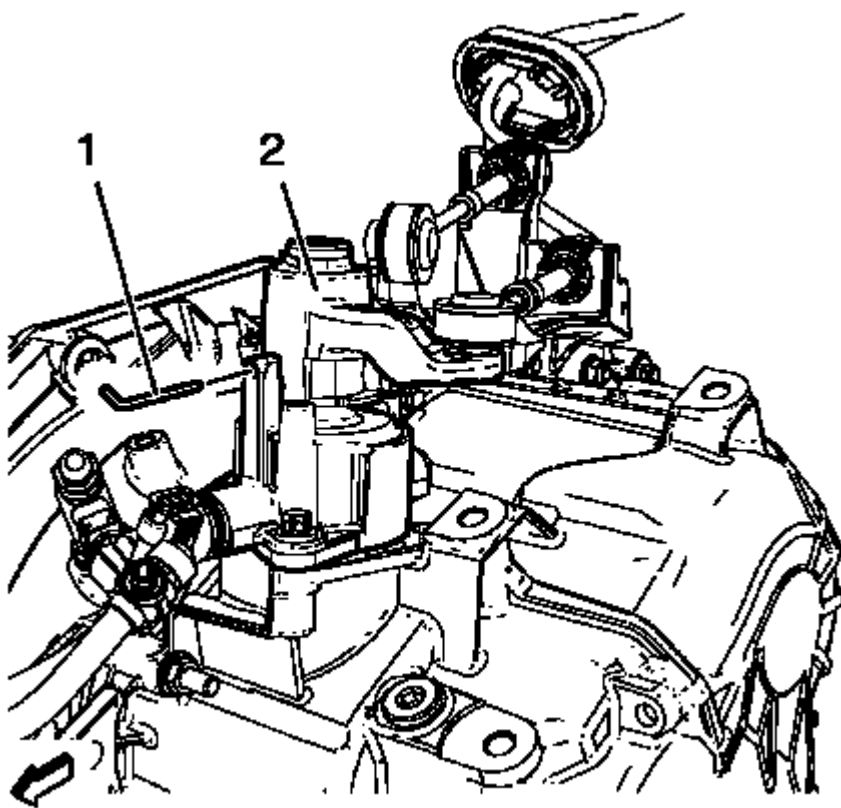


Fig. 18: Transmission Control Housing
Courtesy of GENERAL MOTORS COMPANY

NOTE: The hole of the transmission gear control (2) must be aligned to the hole in the base so the pin (1) can pass thru both. The transmission gear control will be locked in the 1-2 neutral position.

8. Lock the transmission gear control (2) with DT-527-A pin (1) or 5mm drill bit.

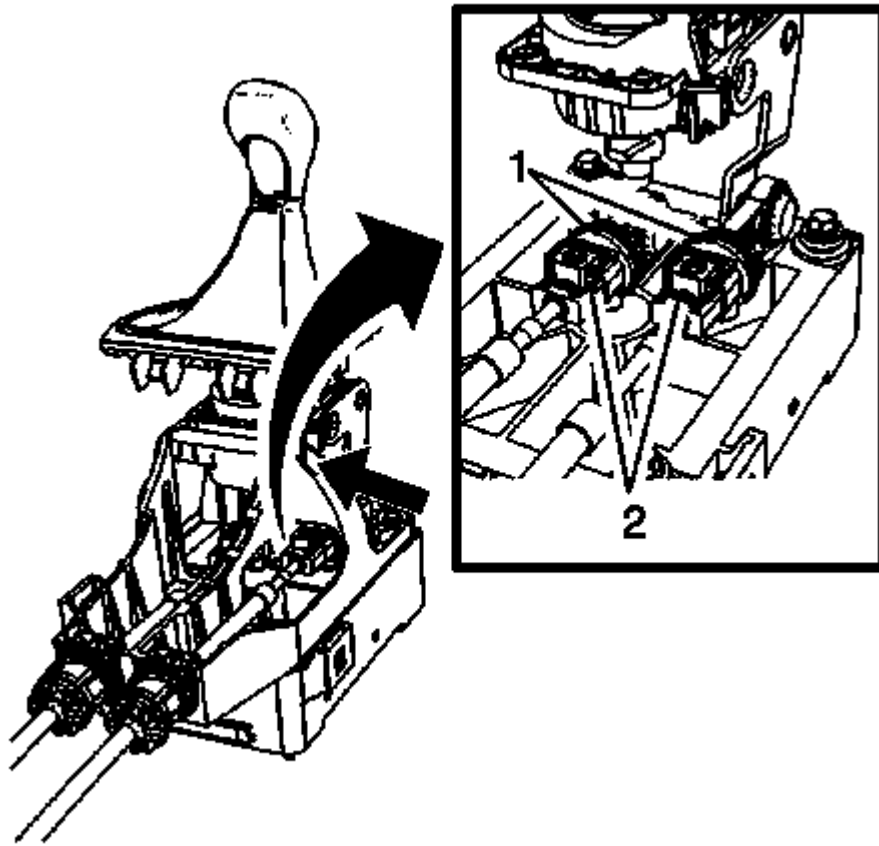


Fig. 19: Cable Lock Adjusters & Sliding Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- During this procedure **DO NOT** touch or preload the fixed shift lever as this may cause mis-adjustment to the shift system.
- The lock adjuster on the driver side is accessed through the hole (3) at top of shift housing using an adequate tool.
- When locking the adjuster locks (1) a defined snap noise should be audible, a snap effect should be felt.

9. Secure lock adjusters (2), by pushing down the lock tab. One lock adjuster for each cable.

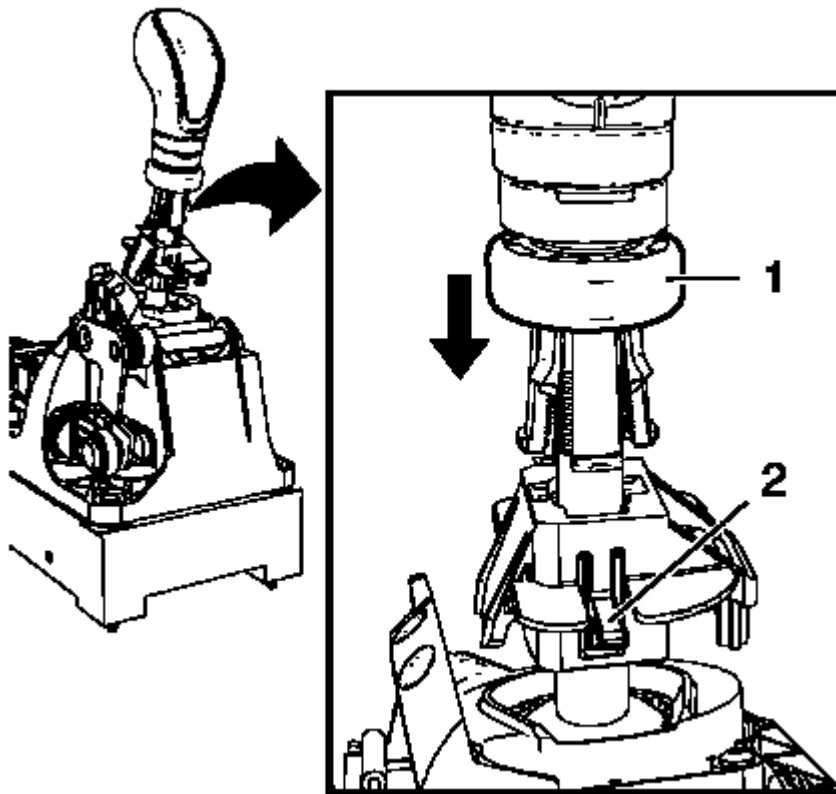


Fig. 20: Transmission Control Lever Retainer Ring & Trigger
 Courtesy of GENERAL MOTORS COMPANY

10. Reposition the reverse lockout device with the following instructions:
 1. Push down on tab (2) and pull up on device to release from installed position.
 2. Slide up shift control lever until almost removed.
 3. Rotate complete shift control lever assembly 180 degrees so the reverse inhibitor button on lever is facing toward the front.
 4. Push down on reverse lock out device until fully seated.
 5. Push down retaining ring (1) until it snaps into position until fully seated.
11. Remove the DT-527-A adjuster or 5mm drill bit from the transmission gear control.
12. Check correct shifting function.
13. If necessary repeat adjusting procedure.
14. Install the front floor console cover. Refer to **Front Floor Console Replacement** .
15. Install the engine control module.

TRANSMISSION CONTROL (TRANSMISSION SHIFT LEVER) REPLACEMENT

Removal Procedure

1. Remove the front floor console. Refer to Front Floor Console Replacement .

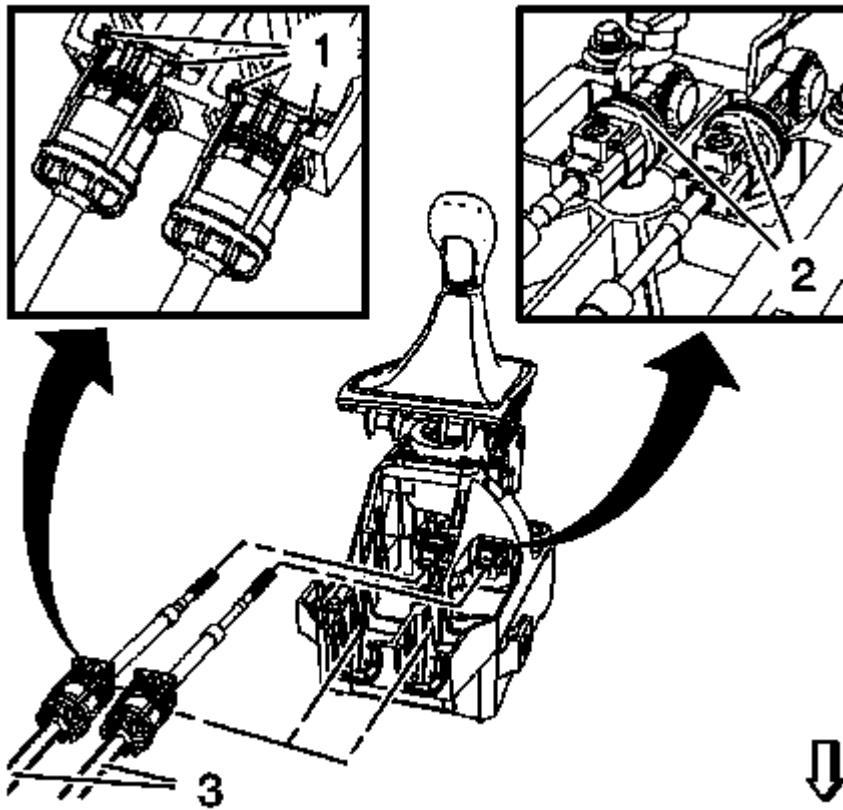


Fig. 21: Selector Lever Cable, Adjust Locks And Transmission Control Lever Housing
Courtesy of GENERAL MOTORS COMPANY

2. Unlock shift lever and selector lever cable adjust locks (2).
3. Clip shift lever and selector lever cable (3) out of transmission control lever housing (1).

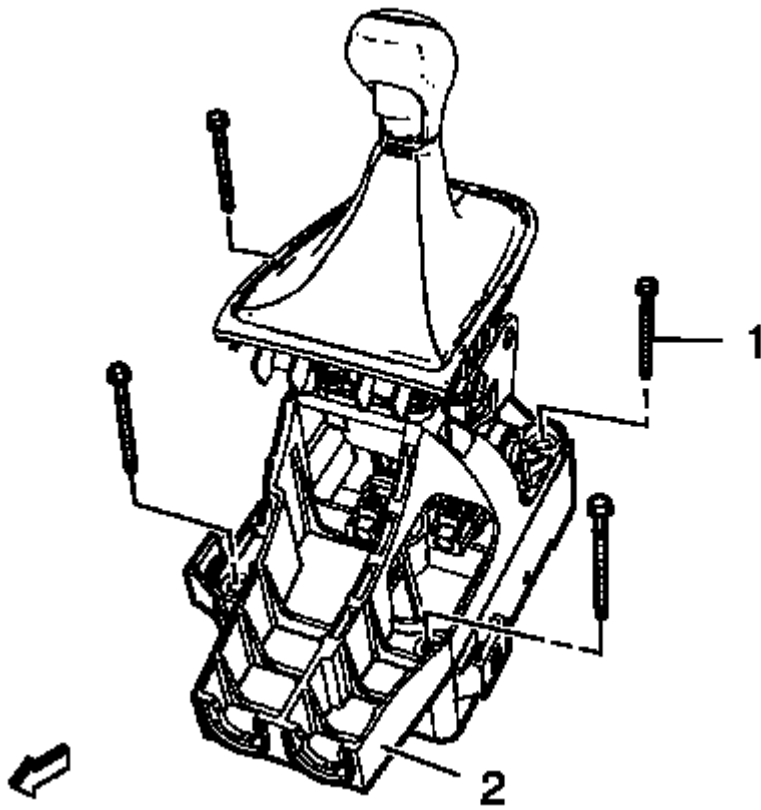


Fig. 22: Transmission Control Lever And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the four transmission control lever fasteners (1).
5. Remove the transmission control (2).

Installation Procedure

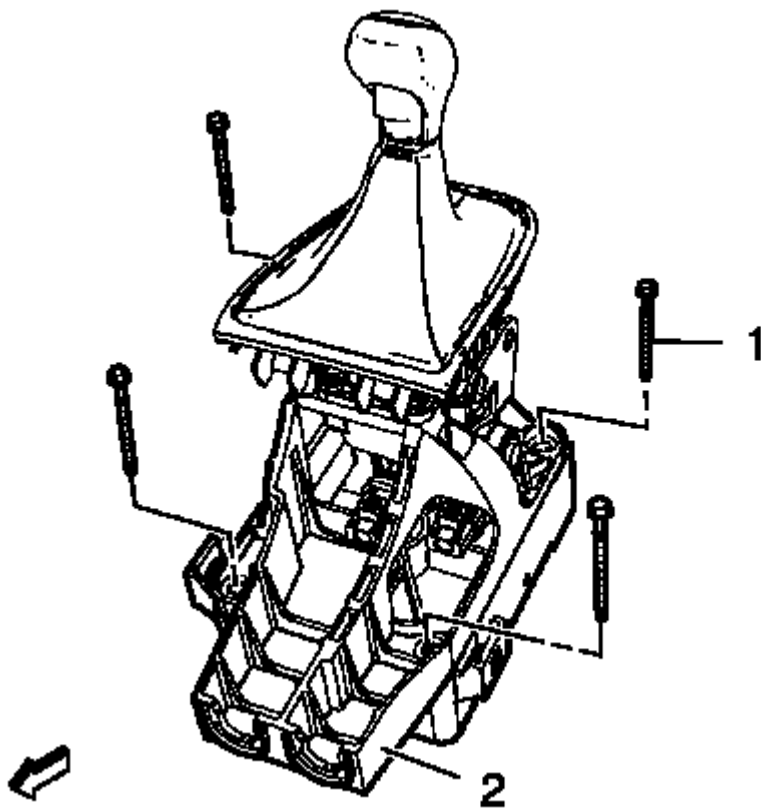


Fig. 23: Transmission Control Lever And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW transmission control (2).

CAUTION: Refer to Fastener Caution .

2. Install the four transmission control lever fasteners (1) and tighten to 8 N.m (71 lb in).

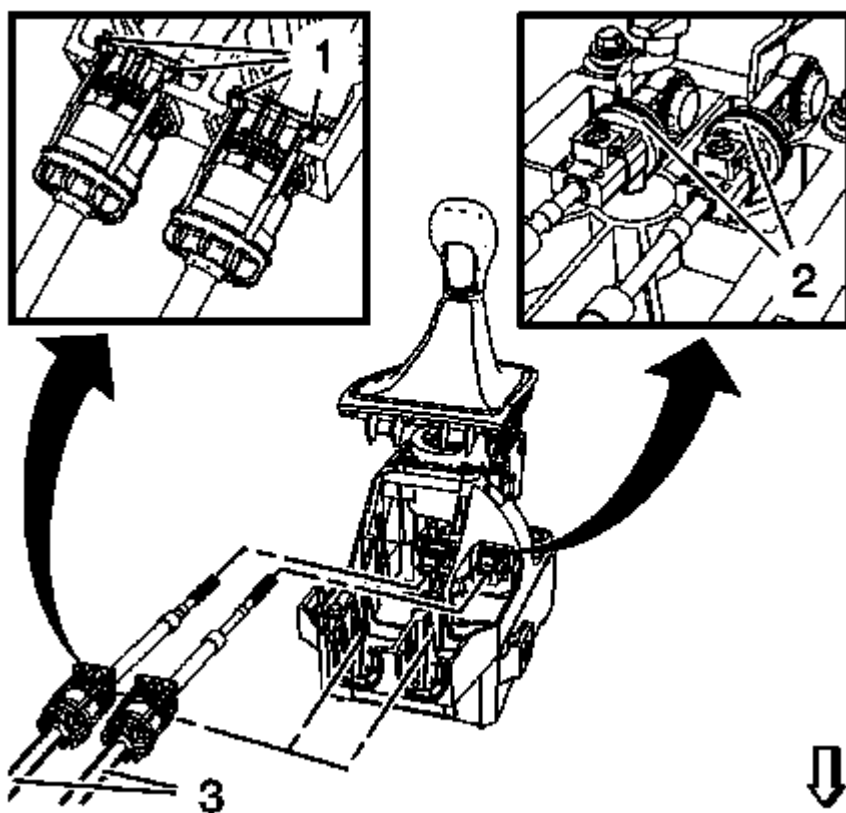


Fig. 24: Selector Lever Cable, Adjust Locks And Transmission Control Lever Housing
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not lock yet.

3. Slide shift lever and selector lever cable into shift lever and selector lever cable adjust locks (2).
4. Clip shift lever and selector lever cable (3) into transmission control lever housing (1).
5. Adjust shift lever and selector lever cable.
6. Install the front floor console. Refer to **Front Floor Console Replacement** .

MANUAL TRANSMISSION SHIFT LEVER CABLE REPLACEMENT

Removal Procedure

1. Remove the battery tray. Refer to **Battery Tray Replacement** .

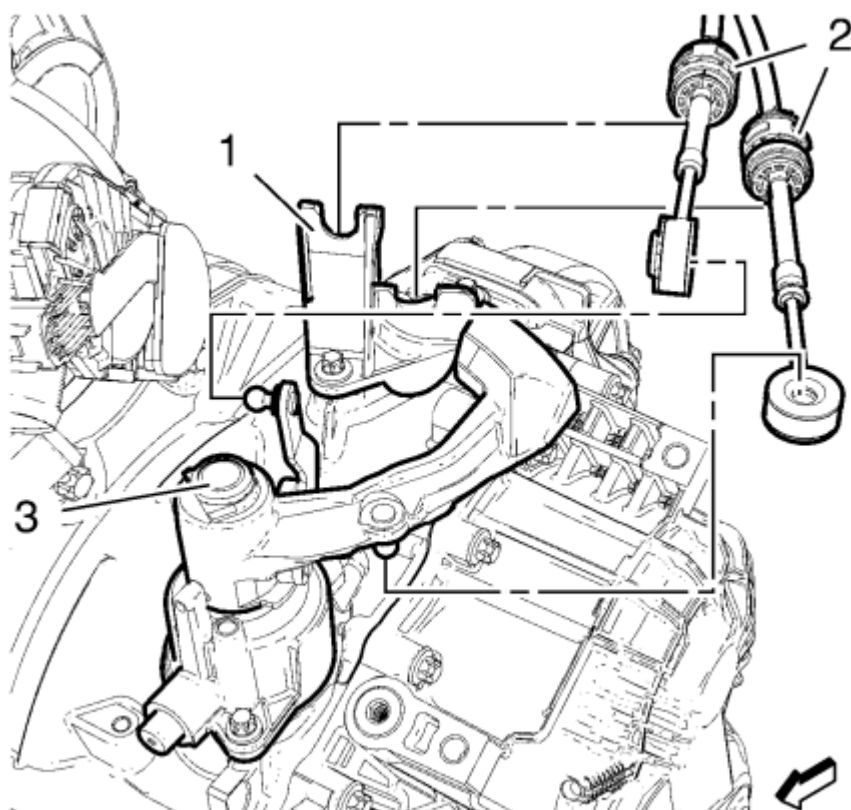


Fig. 25: Selector Lever Cable, Bracket And Transmission Control Housing
Courtesy of GENERAL MOTORS COMPANY

2. Remove shift lever and selector lever cable (2) from transmission control housing (3).
3. Remove shift lever and selector lever cable from shift lever and selector lever cable bracket (1) by pushing back locking rings in counterclockwise direction.

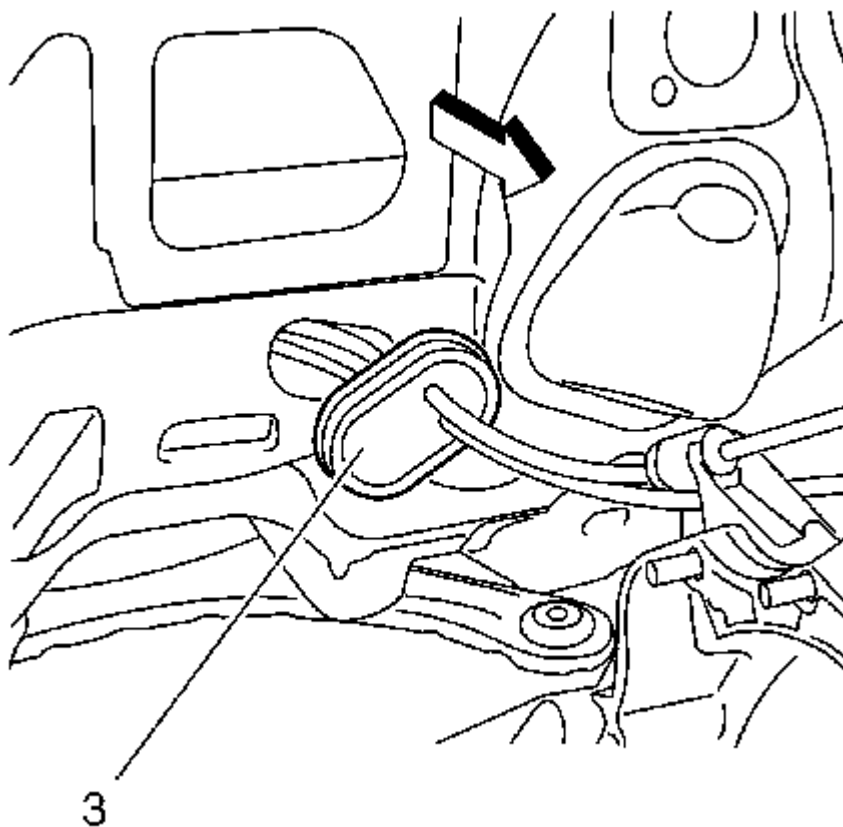


Fig. 26: Shift Lever And Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

4. Remove shift lever and selector lever cable (3) from bulkhead.
5. Remove the front floor console. Refer to **Front Floor Console Replacement** .

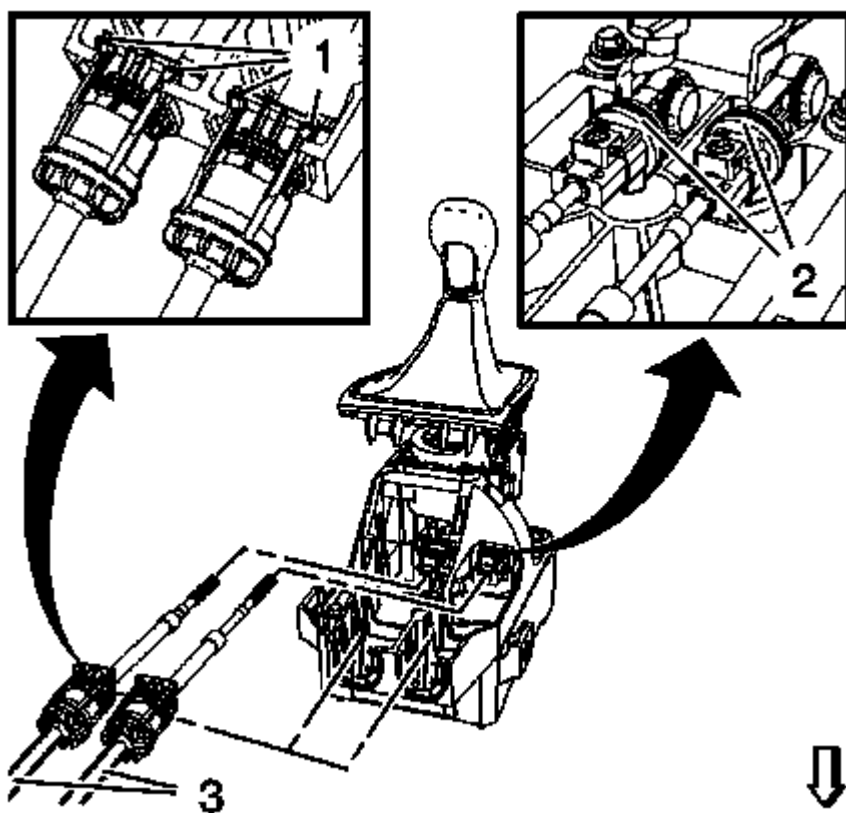


Fig. 27: Selector Lever Cable, Adjust Locks And Transmission Control Lever Housing
Courtesy of GENERAL MOTORS COMPANY

6. Unlock shift lever and selector lever cable adjust locks (2).
7. Clip shift lever and selector lever cable (3) out of transmission control lever housing (1).

Installation Procedure

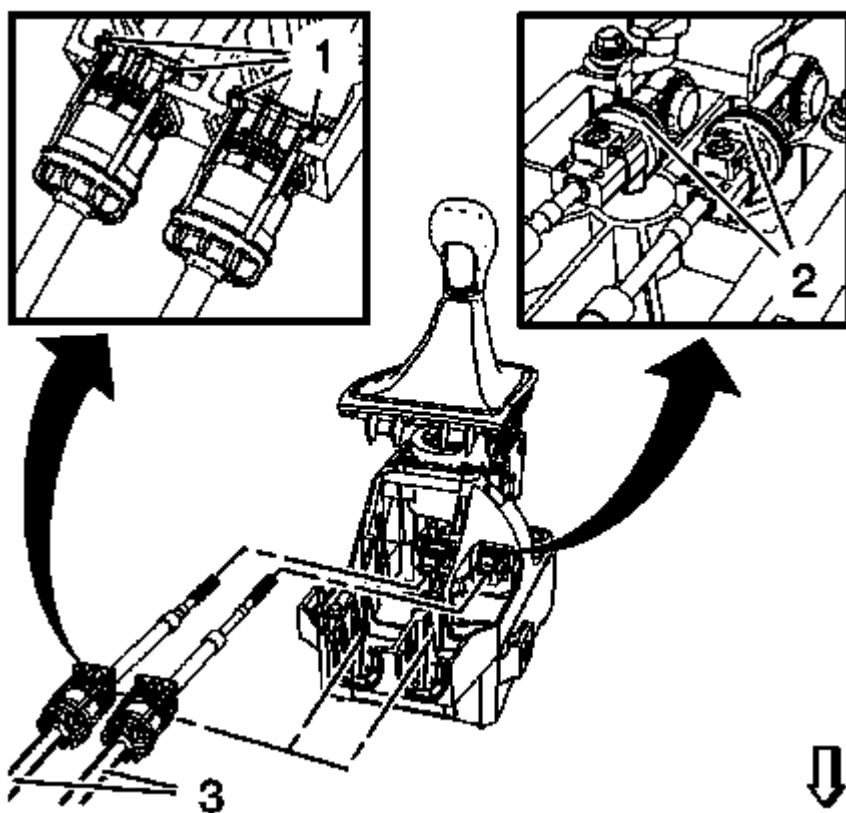


Fig. 28: Selector Lever Cable, Adjust Locks And Transmission Control Lever Housing
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not lock yet.**

1. Slide shift lever and selector lever cable into shift lever and selector lever cable adjust locks (2).
2. Clip shift lever and selector lever cable (3) into transmission control lever housing (1).
3. Install shift lever and selector lever cable from inside the vehicle.

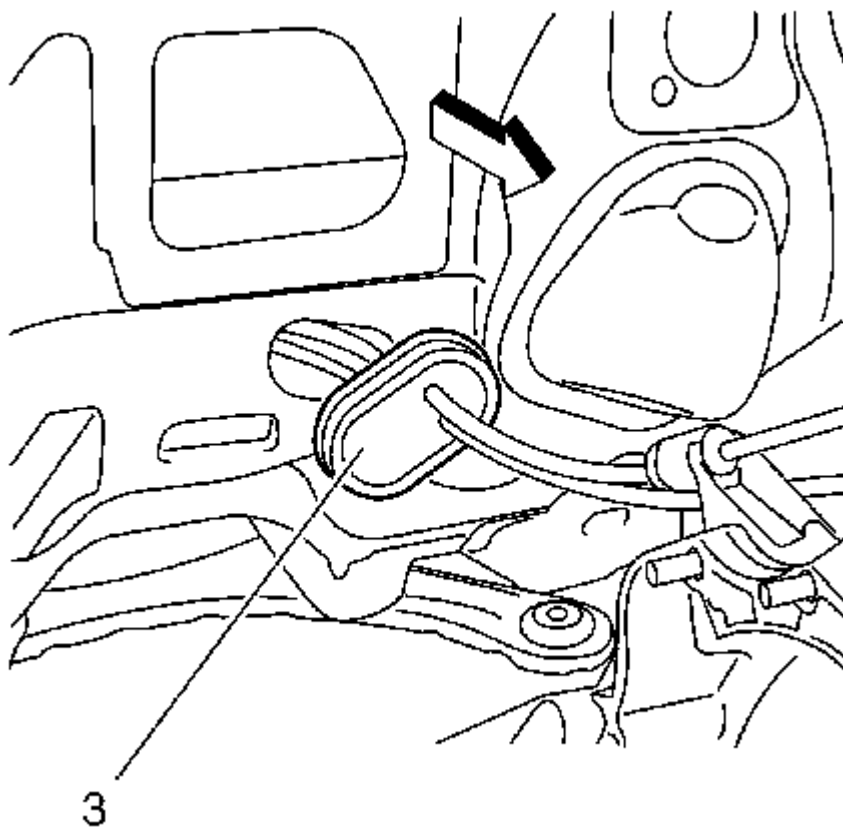


Fig. 29: Shift Lever And Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the guide with the white marking upwards to the bulkhead. Do not cross the cables.**

4. Install shift lever and selector lever cable (3) to bulkhead.
5. Check for correct fit.

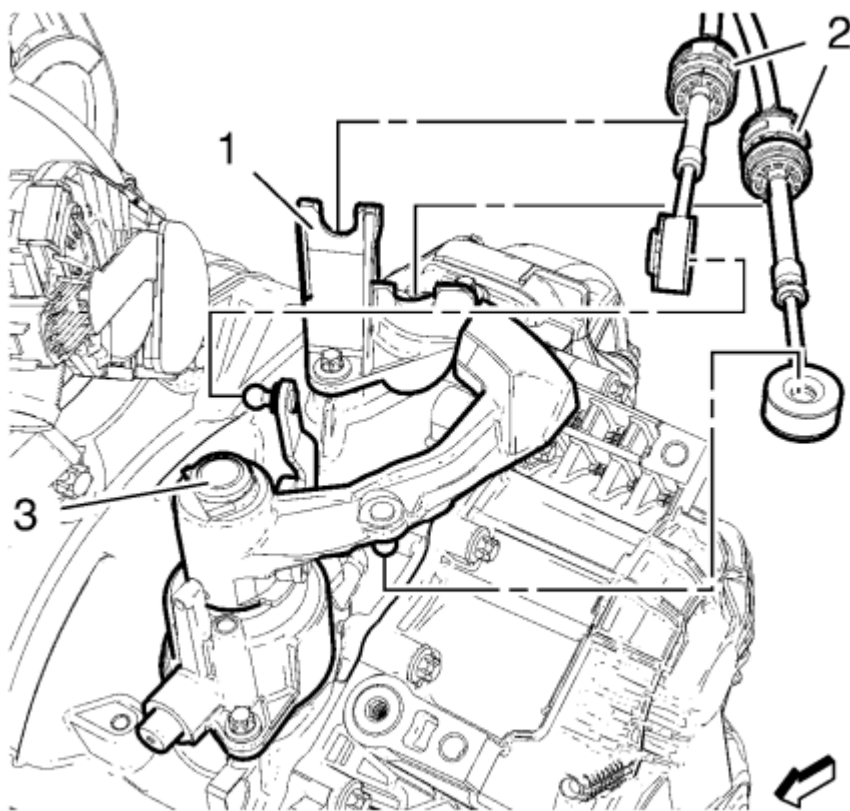


Fig. 30: Selector Lever Cable, Bracket And Transmission Control Housing
Courtesy of GENERAL MOTORS COMPANY

6. Install shift lever and selector lever cable (2) to shift lever and selector lever cable bracket (1).
7. Install shift lever and selector lever cable to transmission control housing (3).
8. Install the battery tray. Refer to **Battery Tray Replacement** .
9. Adjust shift lever and selector lever cable. Refer to **Manual Transmission Shift Lever Cable Adjustment**.
10. Install the front floor console. Refer to **Front Floor Console Replacement** .

MANUAL TRANSMISSION SHIFT LEVER AND SELECTOR LEVER CABLE REPLACEMENT

Removal Procedure

1. Remove the battery tray. Refer to **Battery Tray Replacement** .

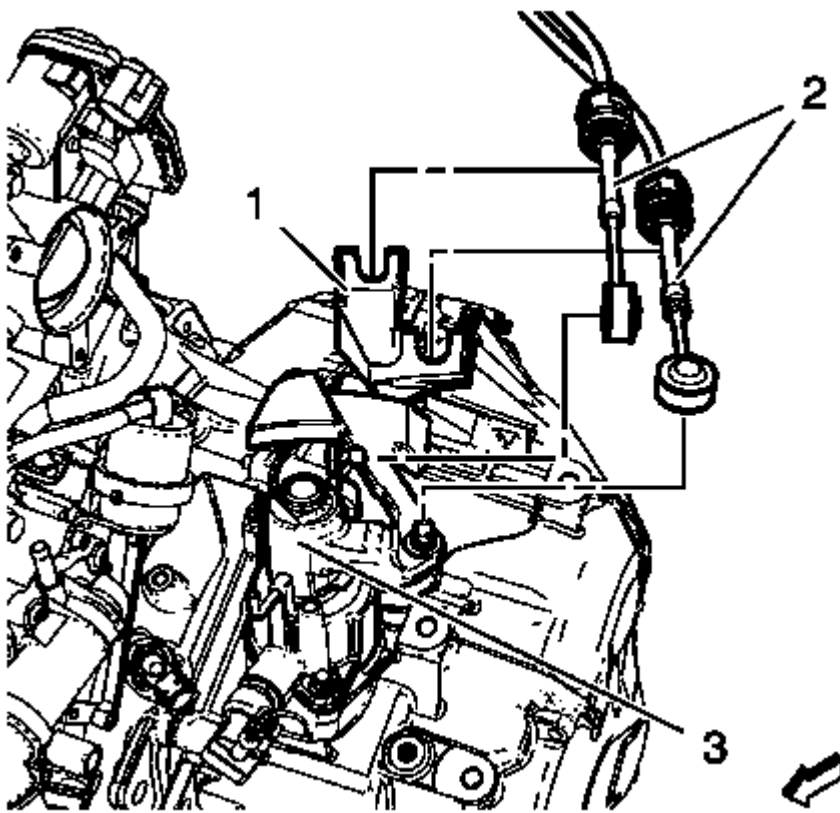


Fig. 31: Shift Lever And Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

2. Remove the shift lever and selector lever cable (2) from the transmission control housing (3).
3. Remove the shift lever and selector lever cable from the shift lever and selector lever cable bracket (1) by pushing back locking rings in counter driving direction.

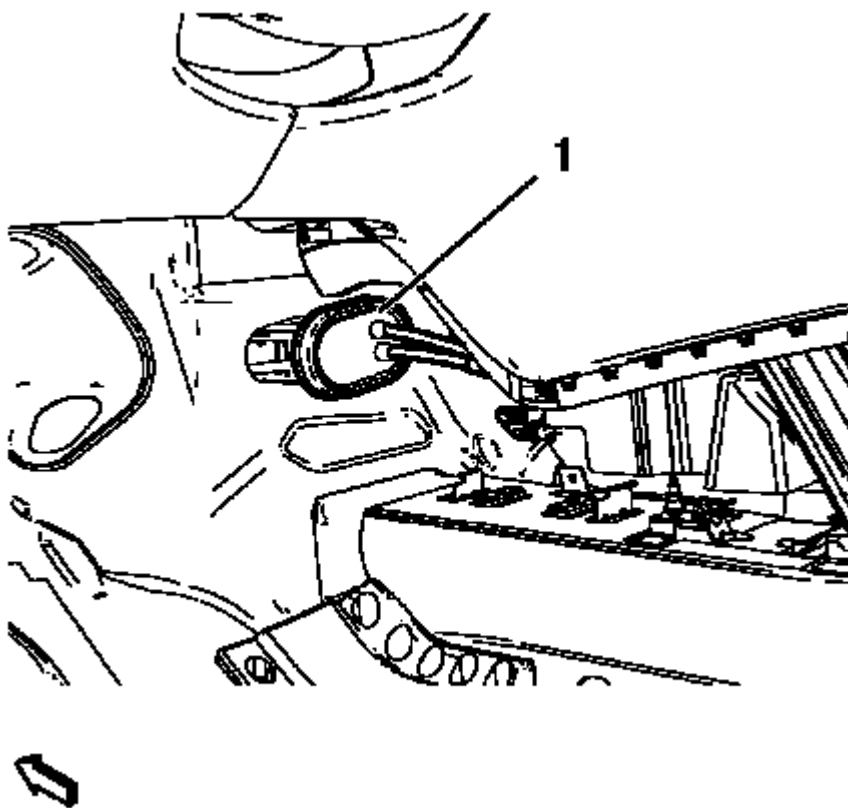


Fig. 32: Selector Lever Cable

Courtesy of GENERAL MOTORS COMPANY

4. Remove the shift lever and selector lever cable grommet (1) from the bulkhead.
5. Remove the front floor console. Refer to **Front Floor Console Replacement** .

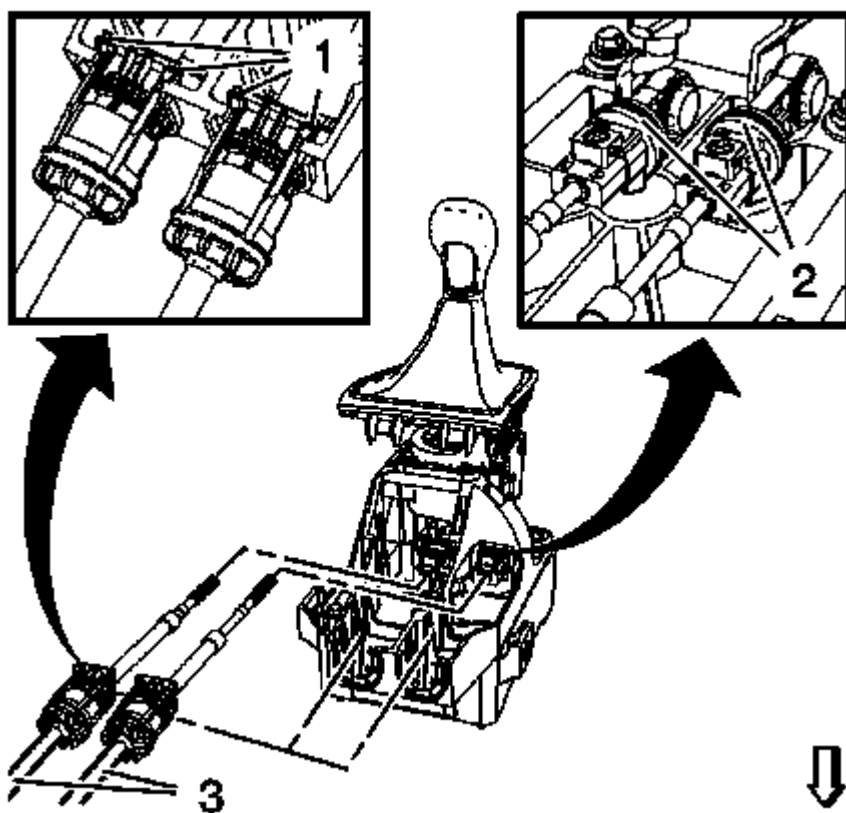


Fig. 33: Selector Lever Cable, Adjust Locks And Transmission Control Lever Housing
Courtesy of GENERAL MOTORS COMPANY

6. Unlock the shift lever and selector lever cable adjust locks (2).
7. Clip the shift lever and selector lever cable (3) out of the transmission control lever housing (1).

Installation Procedure

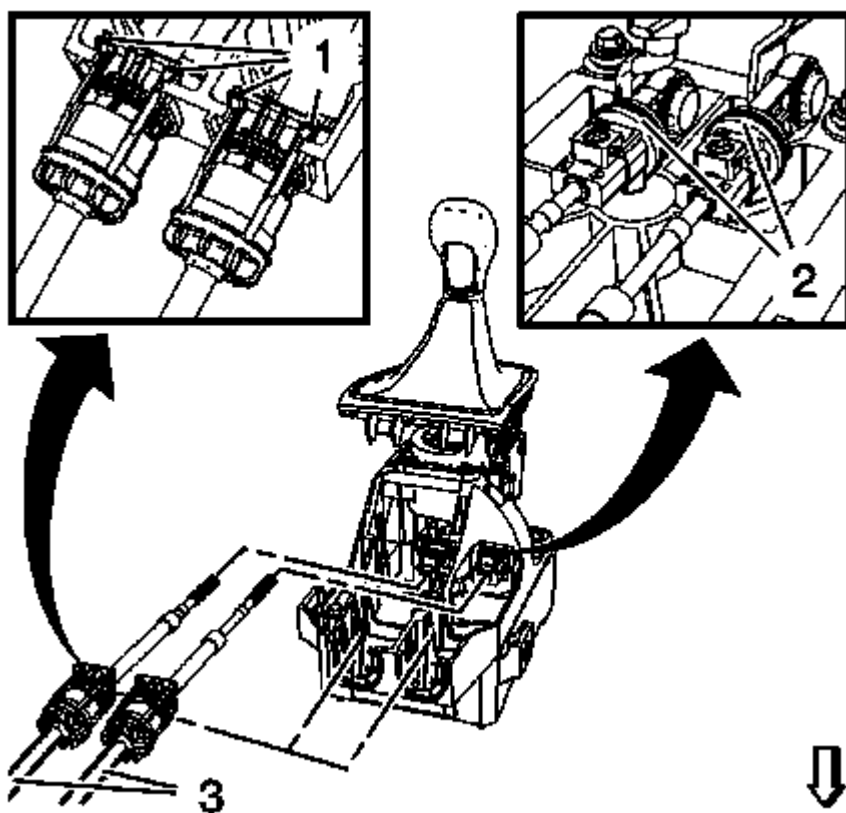


Fig. 34: Selector Lever Cable, Adjust Locks And Transmission Control Lever Housing
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not lock yet.

1. Slide the shift lever and selector lever cable into the shift lever and selector lever cable adjust locks (2).
2. Clip the shift lever and selector lever cable (3) into the transmission control lever housing (1).
3. Install shift lever and selector lever cable from inside the vehicle.

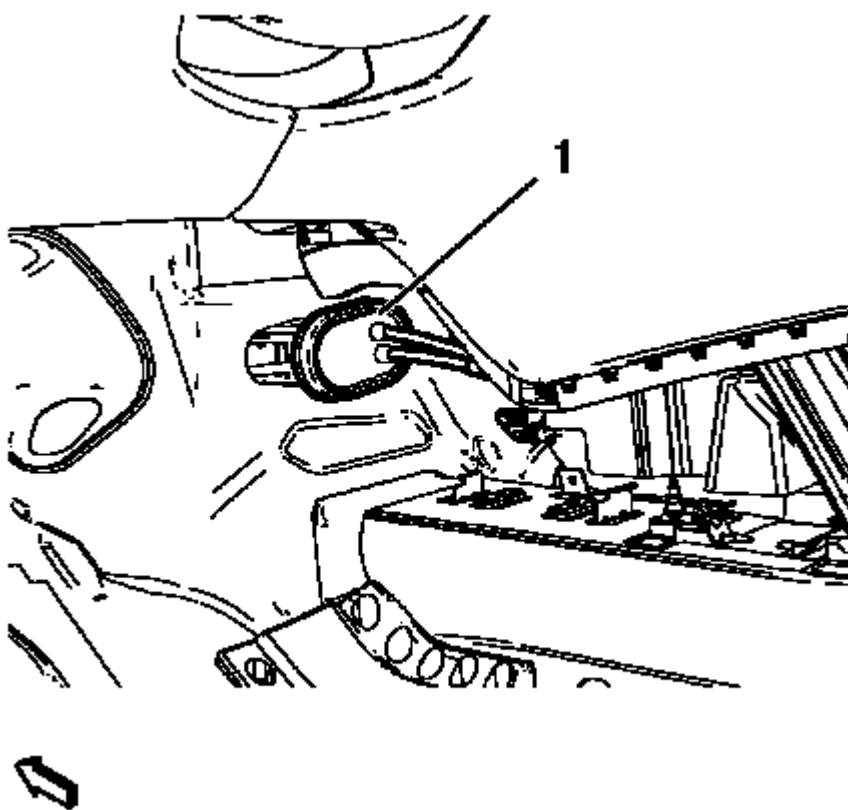


Fig. 35: Selector Lever Cable

Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the guide with the white marking upwards to the bulkhead. Do not cross the cables.**

4. Install the shift lever and selector lever cable grommet (1) to the bulkhead.
5. Check for correct fit.

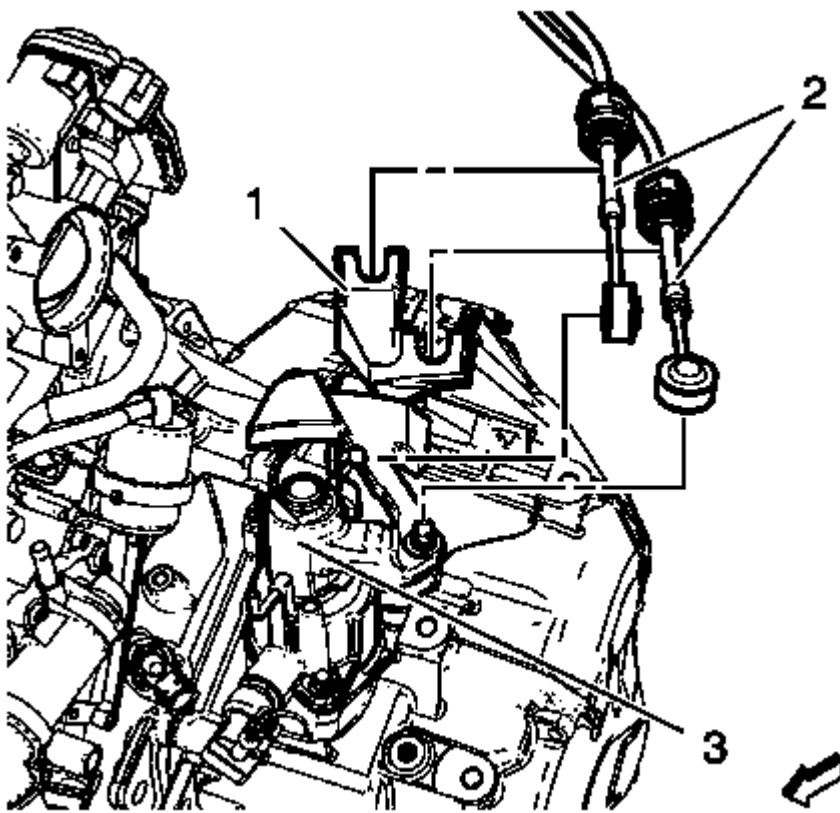


Fig. 36: Shift Lever And Selector Lever Cable
 Courtesy of GENERAL MOTORS COMPANY

6. Install the shift lever and selector lever cable (2) to the shift lever and selector lever cable bracket (1).
7. Install the shift lever and selector lever cable to the transmission control housing (3).
8. Install the battery tray. Refer to **Battery Tray Replacement** .
9. Adjust the shift lever and selector lever cable. Refer to **Manual Transmission Shift Lever and Selector Lever Cable Adjustment**.
10. Install the front floor console. Refer to **Front Floor Console Replacement** .

MANUAL TRANSMISSION SHIFT LEVER CABLE ADJUSTMENT

Special Tools

DT-527-A Adjuster

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Shift transmission into NEUTRAL.
2. Remove the front floor console. Refer to **Front Floor Console Replacement** .

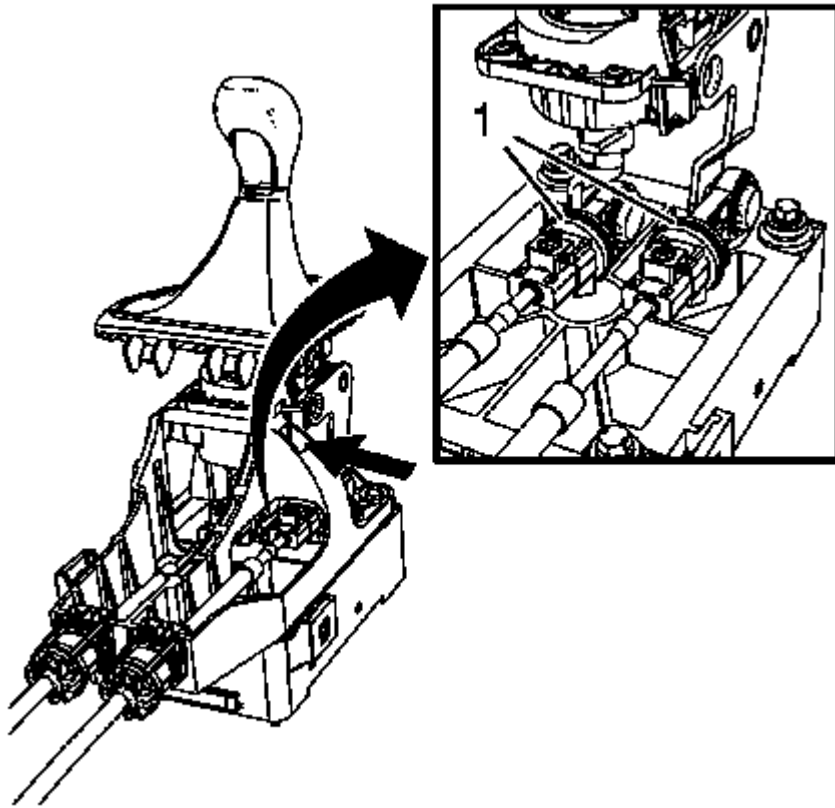


Fig. 37: Shift Lever And Selector Lever Cable Adjust Locks
Courtesy of GENERAL MOTORS COMPANY

3. Unlock shift lever and selector lever cable adjust locks (1), by pushing back the spring force loaded black sliding ring until self-locking.
4. Unlock the left cable trough the opening at the housing (arrow) using a suitable tool.
5. Remove transmission control lever boot. Refer to **Transmission Control Lever Boot Replacement**.

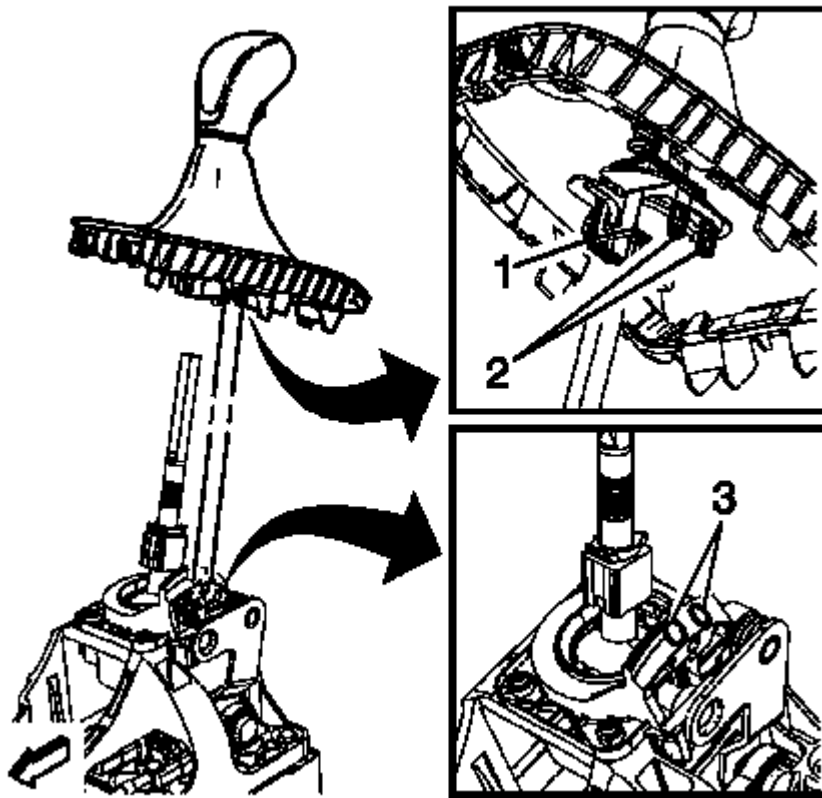


Fig. 38: Reverse Blocker Assembly, Pins & Holes
Courtesy of GENERAL MOTORS COMPANY

6. Turn transmission reverse blocker assembly (1) 180 degrees and install to transmission control lever.
7. Push the 2 pins (2) into the 2 holes (3).
8. Remove engine control module from battery tray and lay aside.

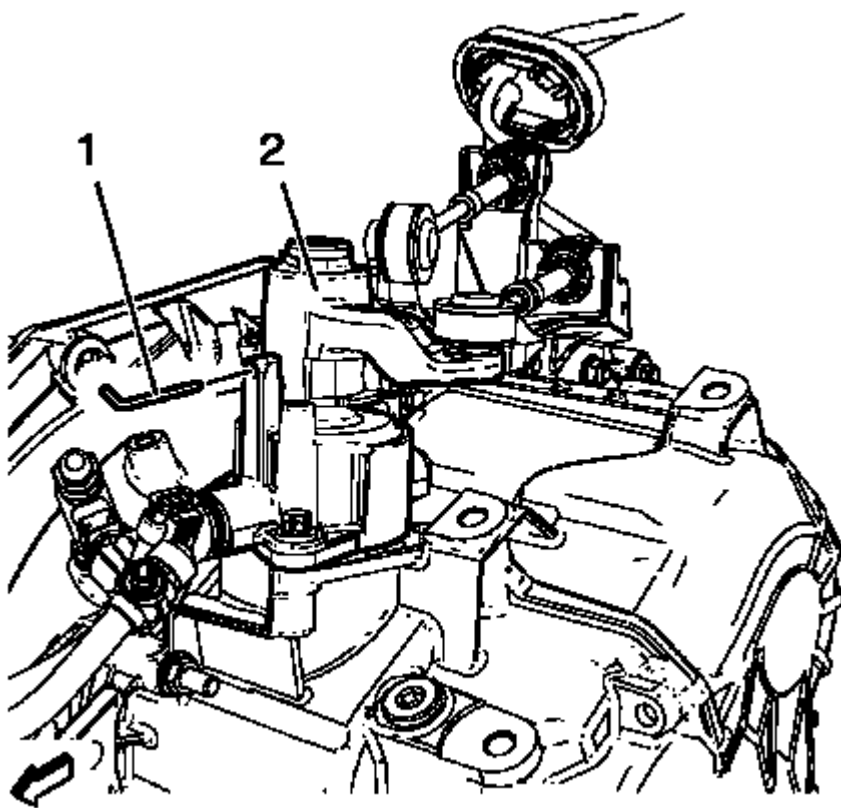


Fig. 39: Transmission Control Housing
Courtesy of GENERAL MOTORS COMPANY

9. Block transmission control housing (2) using **DT-527-A** adjuster (1) or equivalent.

Installation Procedure

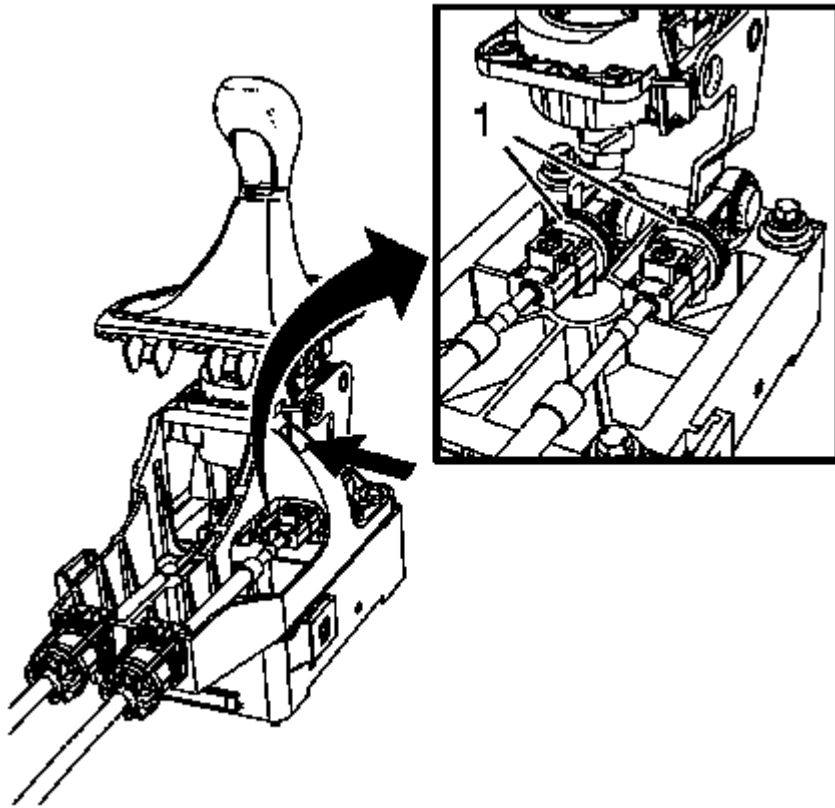


Fig. 40: Shift Lever And Selector Lever Cable Adjust Locks
Courtesy of GENERAL MOTORS COMPANY

NOTE: When locking the adjuster locks (1) a defined snap noise should be audible / a snap effect should be felt.

1. Lock shift lever and selector lever cable adjust locks.
2. Lock shift lever and selector lever cable adjust locks (1), by pushing down the two blue locking pieces **WITHOUT** touching/preloading the fixed shift lever.
3. Install transmission control lever knob.

Turn the transmission control lever knob back 180 degrees.

4. Remove **DT-527-A** adjuster from transmission control housing.
5. Check correct shifting function.
6. If necessary repeat adjusting procedure.
7. Install the front floor console. Refer to **Front Floor Console Replacement** .

VEHICLE SPEED SENSOR REPLACEMENT

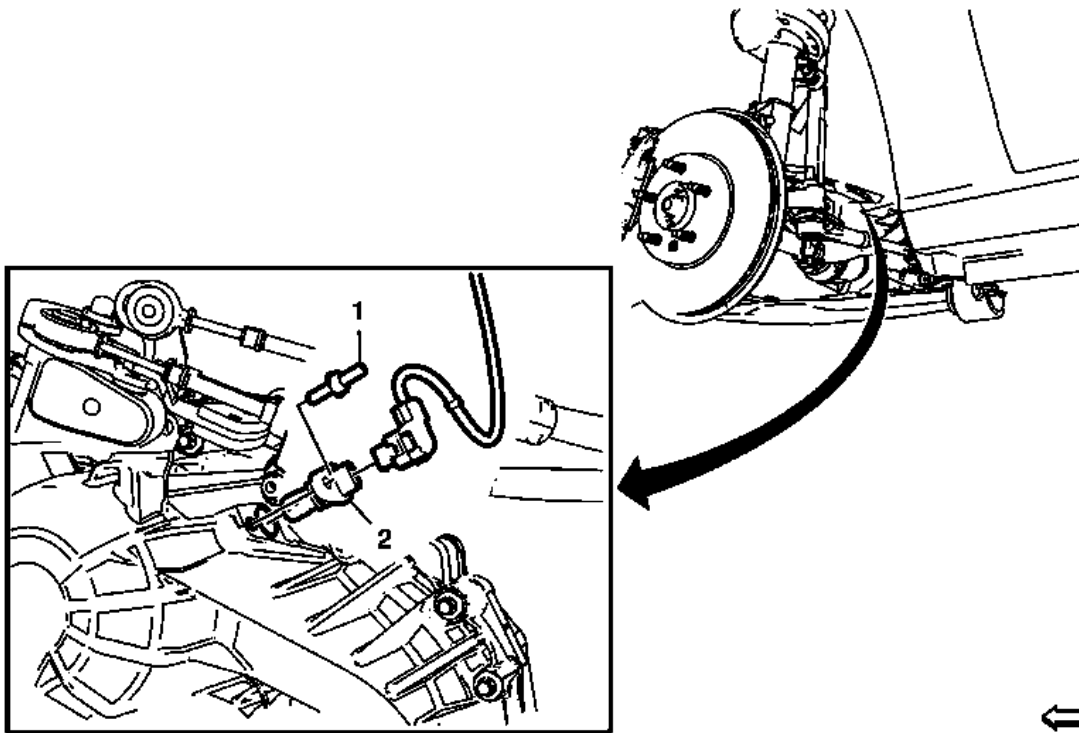


Fig. 41: Vehicle Speed Sensor & Bolt
 Courtesy of GENERAL MOTORS COMPANY

Vehicle Speed Sensor Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the left front wheel. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Disconnect the vehicle speed sensor electrical connector. 	
1	Vehicle Speed Sensor Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 8 (71 lb in)
2	Vehicle Speed Sensor

BACKUP LAMP SWITCH REPLACEMENT

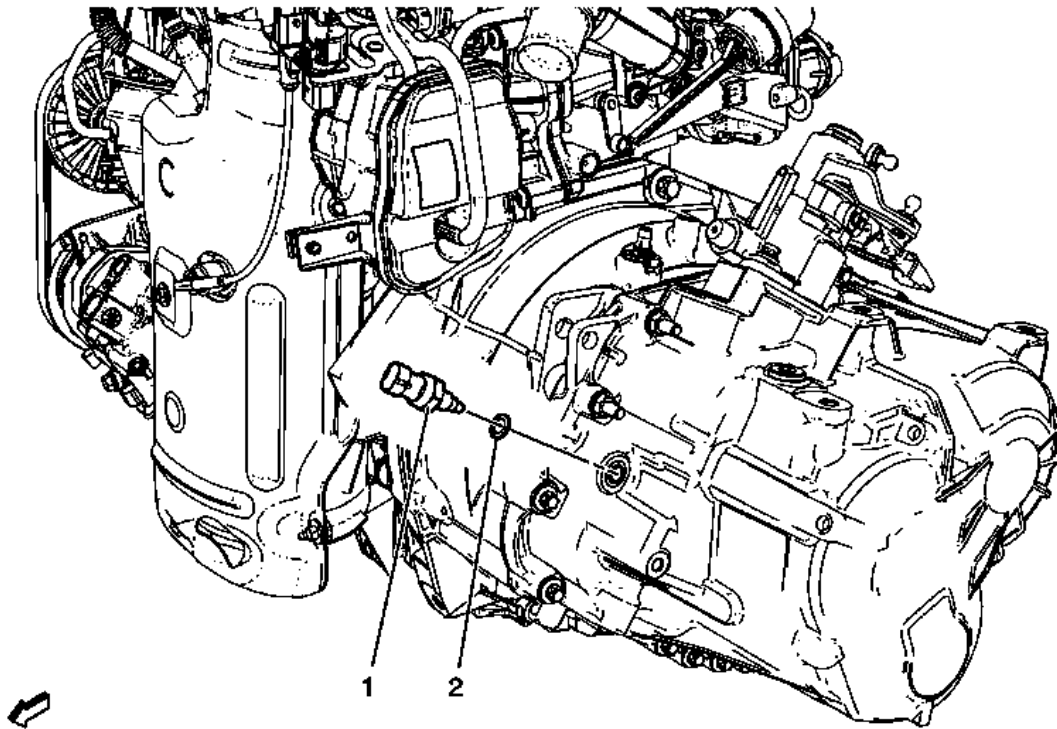


Fig. 42: Backup Lamp Switch & Seal Ring
 Courtesy of GENERAL MOTORS COMPANY

Backup Lamp Switch Replacement

Callout	Component Name
1	Backup Lamp Switch Procedure <ol style="list-style-type: none"> 1. Remove the electrical connector. 2. Install NEW seal ring. Tighten 25 (18 lb ft)
2	Seal Ring

SHIFT CONTROL HOUSING REPLACEMENT

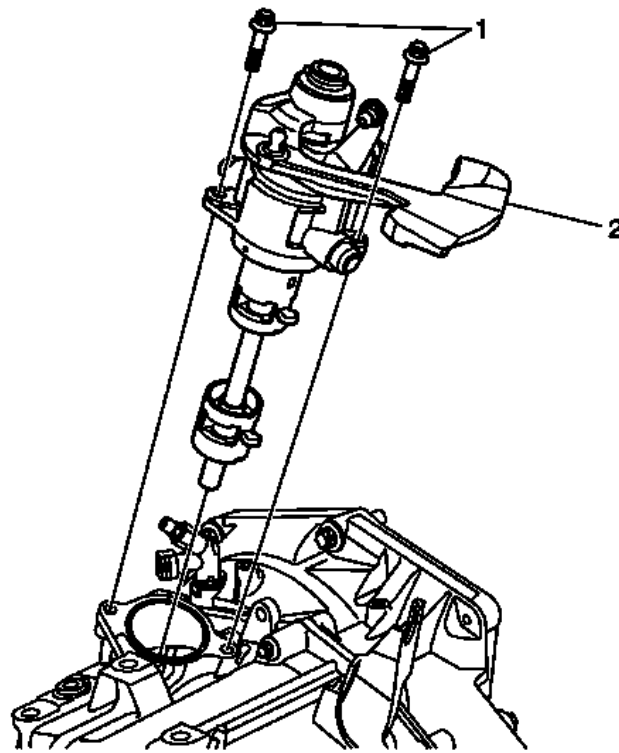


Fig. 43: Shift Control Housing & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Shift Control Housing Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the battery and battery tray. Refer to Battery Tray Replacement . 2. Remove the brake pressure modulator. Refer to Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement . 3. Remove the manual transmission shift lever and selector lever cable from the shift control housing. Refer to Manual Transmission Shift Lever and Selector Lever Cable Replacement. 4. Lock the transmission control housing with DT-527-A adjuster or equivalent. 	
Special Tools DT-527-A AdjusterFor equivalent regional tools, refer to Special Tools .	
1	Shift Control Housing Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 26 (19 lb ft)
	Shift Control Housing

Procedure

1. Detach the cables from the shift linkage lever.
2. Remove the shift cables.
3. Install a NEW seal.
4. After installation, adjust the manual transmission shift lever cable. Refer to **Manual Transmission Shift Lever and Selector Lever Cable Adjustment**.

NOTE:

Shift transmission into NEUTRAL.

TRANSMISSION FRONT MOUNT REPLACEMENT

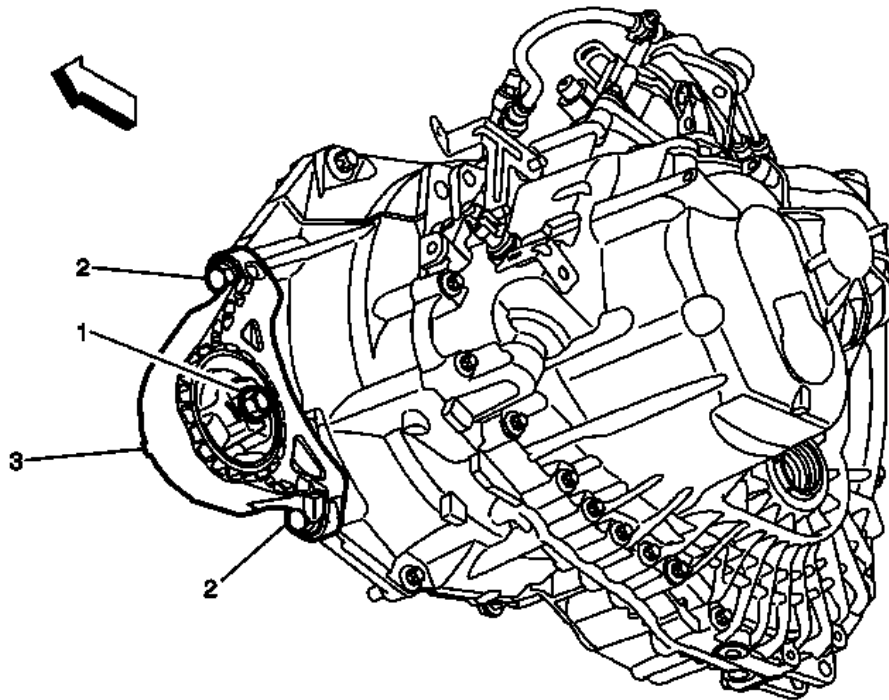


Fig. 44: Transmission Front Mount & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Transmission Front Mount Replacement

Callout	Component Name
WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.	
WARNING:	

Refer to Safety Glasses Warning .

CAUTION:

In order to avoid oil pan damage and possible engine failure, insert a block of wood that spans the width of the oil pan bottom between the oil pan and the jack support.

Preliminary Procedure

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle .

1	Transmission Mount to Frame Through Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 100 N.m (74 lb ft)
2	Transmission Front Mount Fastener (Qty: 2) Tighten 100 N.m (74 lb ft)
3	Transmission Front Mount Procedure Support the transmission.

TRANSMISSION REAR MOUNT REPLACEMENT

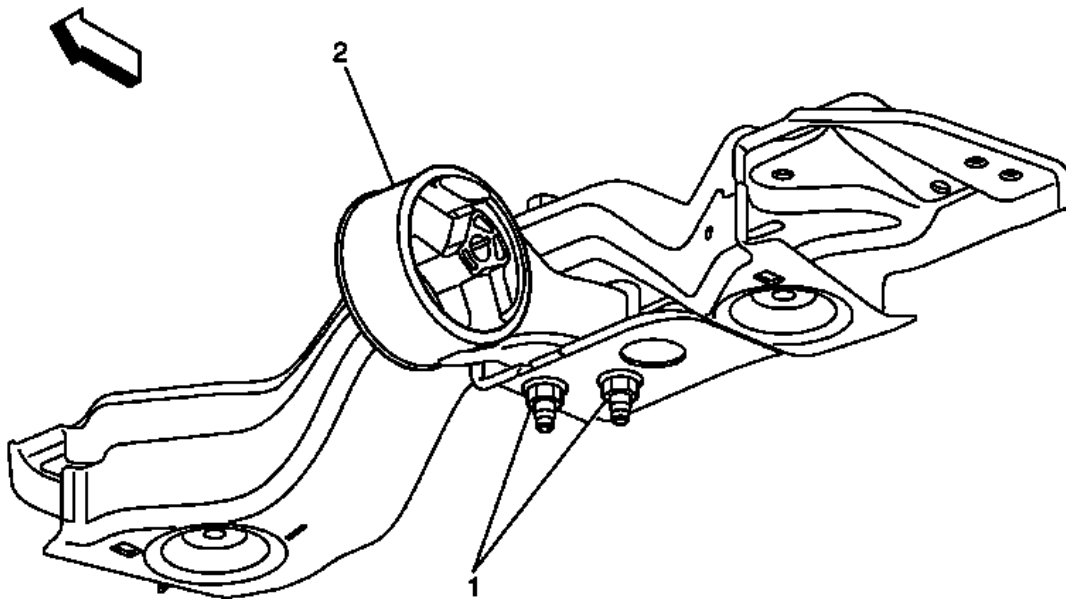


Fig. 45: Transmission Rear Mount & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Transmission Rear Mount Replacement

Callout	Component Name
WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.	
WARNING: Refer to <u>Safety Glasses Warning</u> .	
CAUTION: In order to avoid oil pan damage and possible engine failure, insert a block of wood that spans the width of the oil pan bottom between the oil pan and the jack support.	
Preliminary Procedures	
1. Raise and suitably support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
2. Remove the transmission rear mount bracket. Refer to <u>Transmission Mount Bracket Replacement - Rear</u> .	
3. Reposition the steering gear if equipped with electric power steering, NJ0 or NJ1. Refer to <u>STEERING GEAR REPLACEMENT</u> .	

1	Transmission Rear Mount Fastener (Qty: 2)
	CAUTION: Refer to <u>Fastener Caution</u> .
	NOTE: Use NEW bolts only.
	Tighten 100 (74 lb ft) plus 120-130 degrees
2	Transmission Rear Mount Procedure Support the transmission before removing the transmission rear mount.

TRANSMISSION MOUNT REPLACEMENT - LEFT SIDE

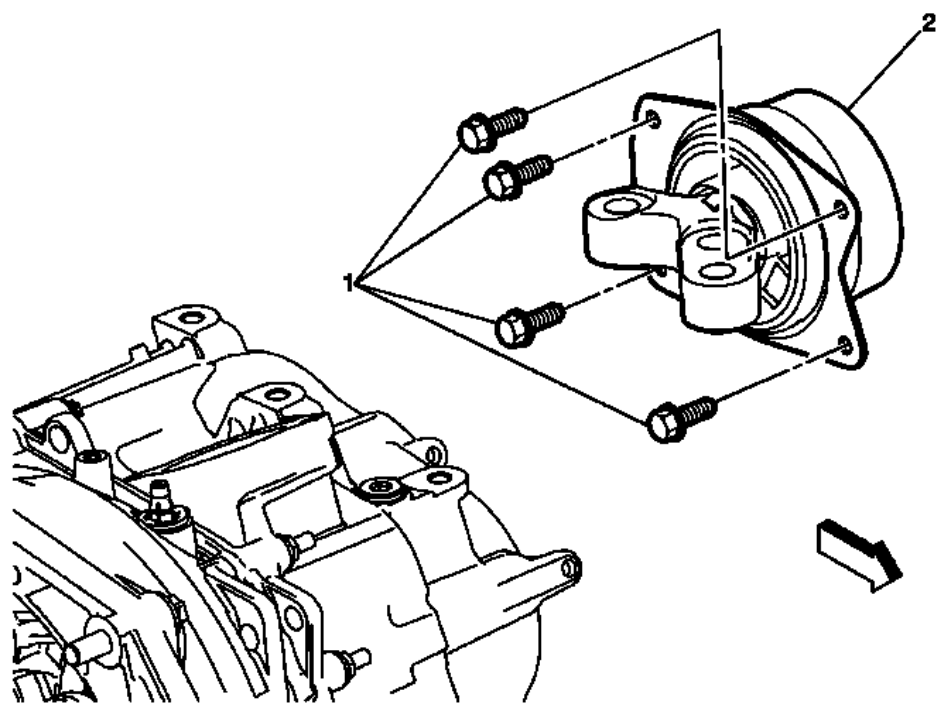


Fig. 46: Transmission Mount & Fasteners - Left Side
Courtesy of GENERAL MOTORS COMPANY

Transmission Mount Replacement - Left Side

Callout	Component Name
WARNING: Refer to <u>Safety Glasses Warning</u> .	

Preliminary Procedure Remove the transmission mount bracket. Refer to **Transmission Mount Bracket Replacement - Left Side.**

1	Transmission Mount Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
2	Transmission Mount

TRANSMISSION REAR MOUNT BRACKET REPLACEMENT

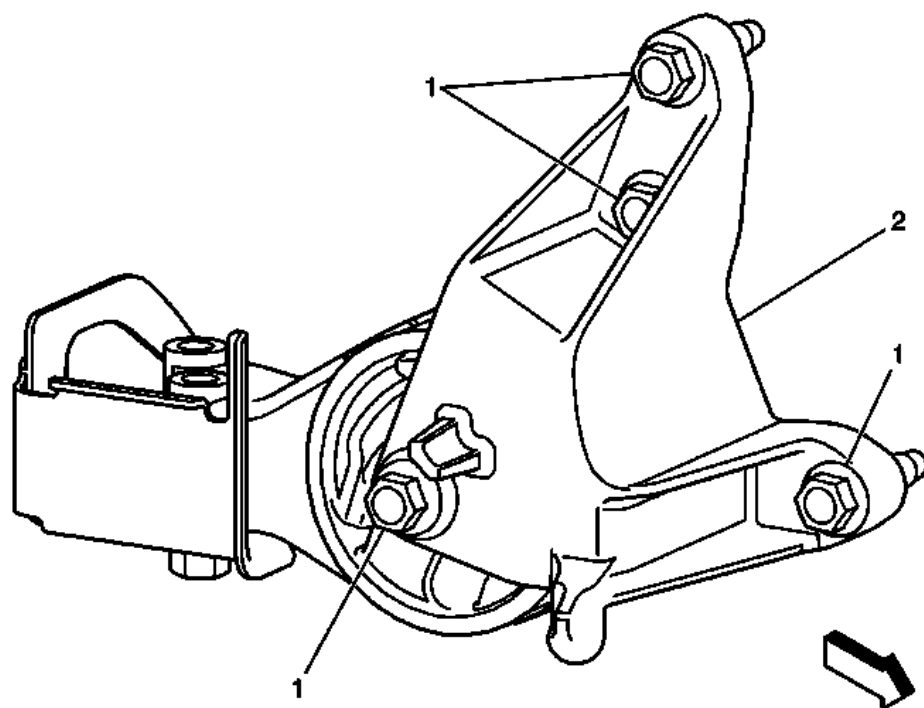


Fig. 47: Transmission Rear Mount Bracket & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Transmission Rear Mount Bracket Replacement

Callout	Component Name
WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.	

WARNING:

Refer to Safety Glasses Warning .

CAUTION:

In order to avoid oil pan damage and possible engine failure, insert a block of wood that spans the width of the oil pan bottom between the oil pan and the jack support.

Preliminary Procedure Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle .

1	Transmission Rear Mount Bracket Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Support the transmission. Tighten 100 (74 lb ft)
2	Transmission Rear Mount Bracket

TRANSMISSION MOUNT BRACKET REPLACEMENT - REAR

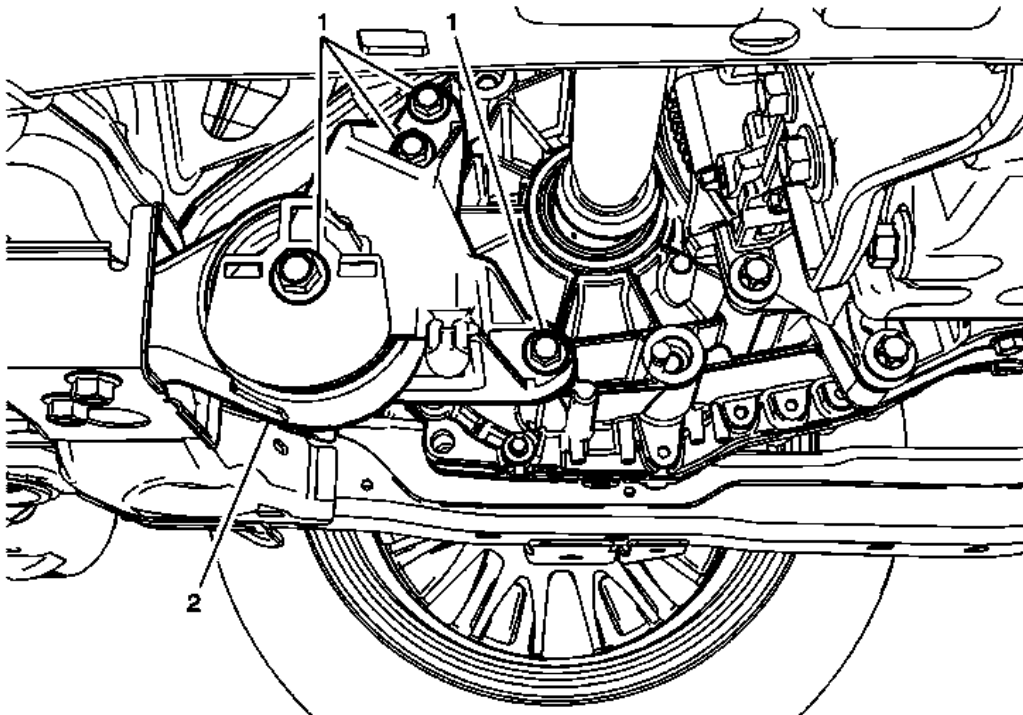


Fig. 48: Transmission Mount Bracket - Rear
Courtesy of GENERAL MOTORS COMPANY

Transmission Mount Bracket Replacement - Rear

Callout	Component Name
<p>WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.</p> <p>WARNING: Refer to <u>Safety Glasses Warning</u> .</p> <p>Preliminary Procedure Raise and suitably support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .</p>	
1	<p>Transmission Rear Mount Bracket Fastener (Qty: 4)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Support the transmission. Tighten 100 N.m (74 lb ft)</p>
2	Transmission Rear Mount Bracket

TRANSMISSION MOUNT BRACKET REPLACEMENT - LEFT SIDE

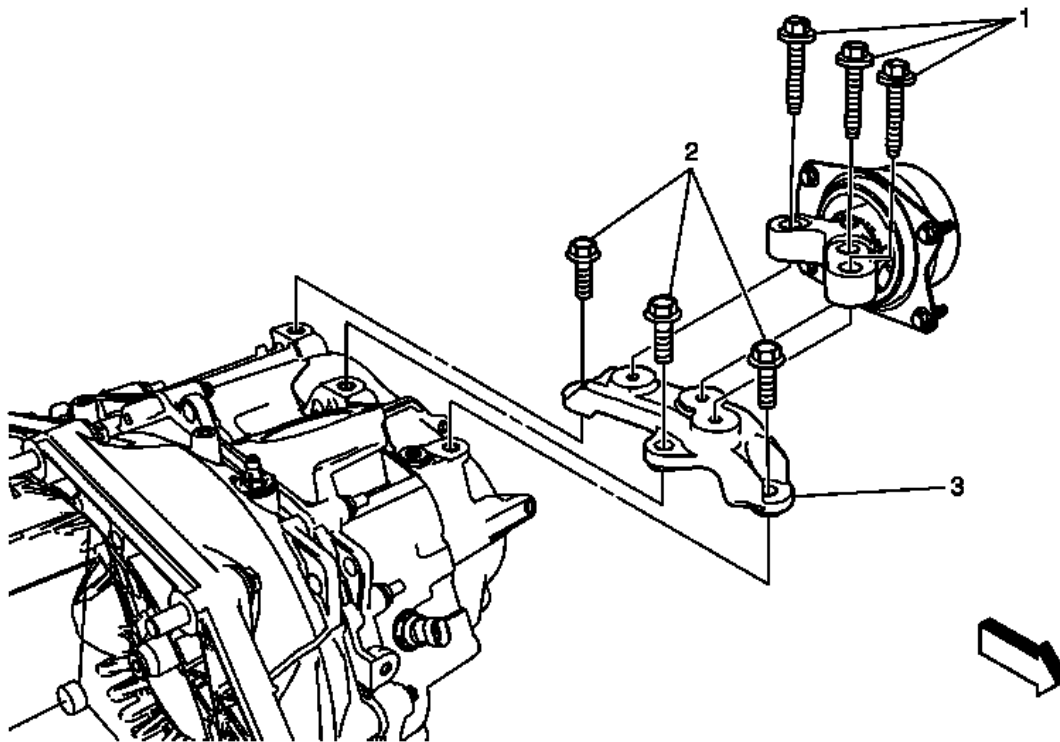


Fig. 49: Transmission Mount Bracket - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Transmission Mount Bracket Replacement - Left Side

Callout	Component Name
WARNING: Refer to <u>Safety Glasses Warning</u> .	
Preliminary Procedures	
1. Install the engine support fixture. Refer to <u>ENGINE SUPPORT FIXTURE</u> , for the 2.0L engine. 2. Remove the battery tray. Refer to <u>Battery Tray Replacement</u> .	
1	Transmission Mount Bracket to Mount Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Install NEW bolts. Tighten 50 (37 lb ft) + 60 degrees + 15 degrees
2	Transmission Mount Bracket Fastener (Qty: 3) Tighten

	100 (74 lb ft)
3	Transmission Mount Bracket NOTE: Adjust support fixture as necessary to allow bracket removal.

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - LEFT SIDE

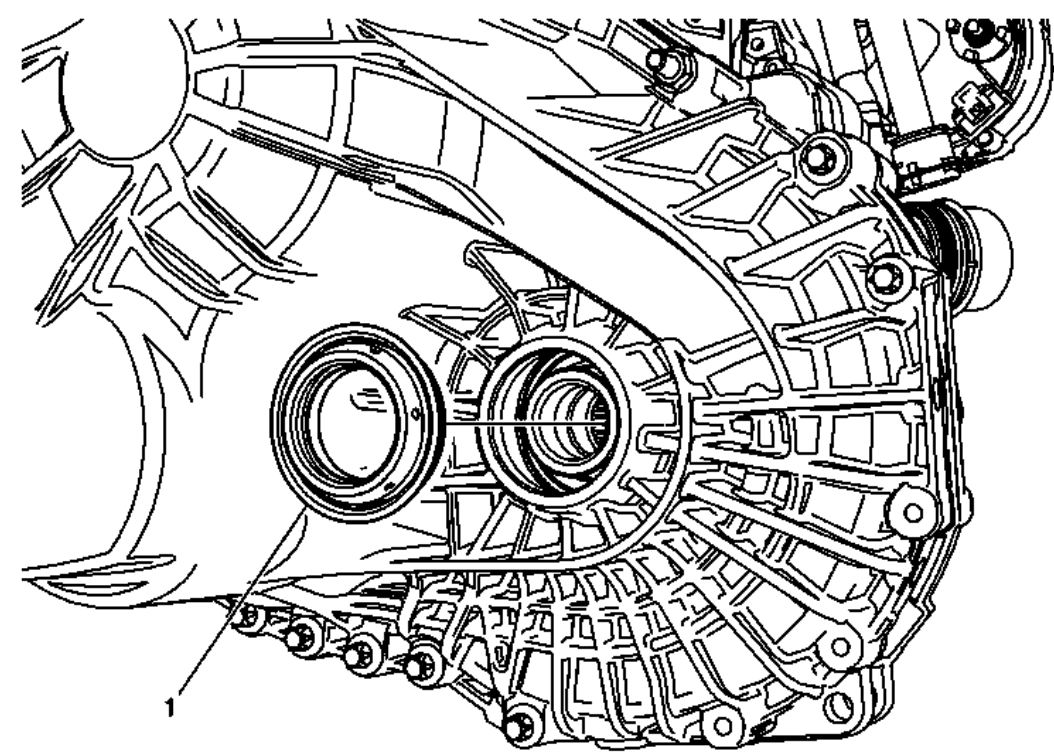


Fig. 50: Front Wheel Drive Shaft Seal - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Left Side

Callout	Component Name
WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.	
WARNING: Refer to <u>Safety Glasses Warning</u> .	
Preliminary Procedures	
1. Raise and suitably support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	

2. Remove the front wheel drive shaft from the transmission. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
3. Place a drain pan underneath to collect transmission fluid.

Front Wheel Drive Shaft Seal

Procedure

1. Remove drive axle shaft seal ring with **DT-586** hammer and **DT-7004** hook.
2. Coat new axle shaft seal ring with transmission fluid.
3. Install the drive axle shaft seal ring flush into transmission with **DT-519** installer.
4. Check transmission fluid level. Refer to **Transmission Fluid Drain and Fill**.

1

Special Tools

- **DT-519** Seal Installer
- **DT-586** Slide Hammer
- **DT-7004** Remover Hook

For equivalent regional tools, refer to **Special Tools**.

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - RIGHT SIDE

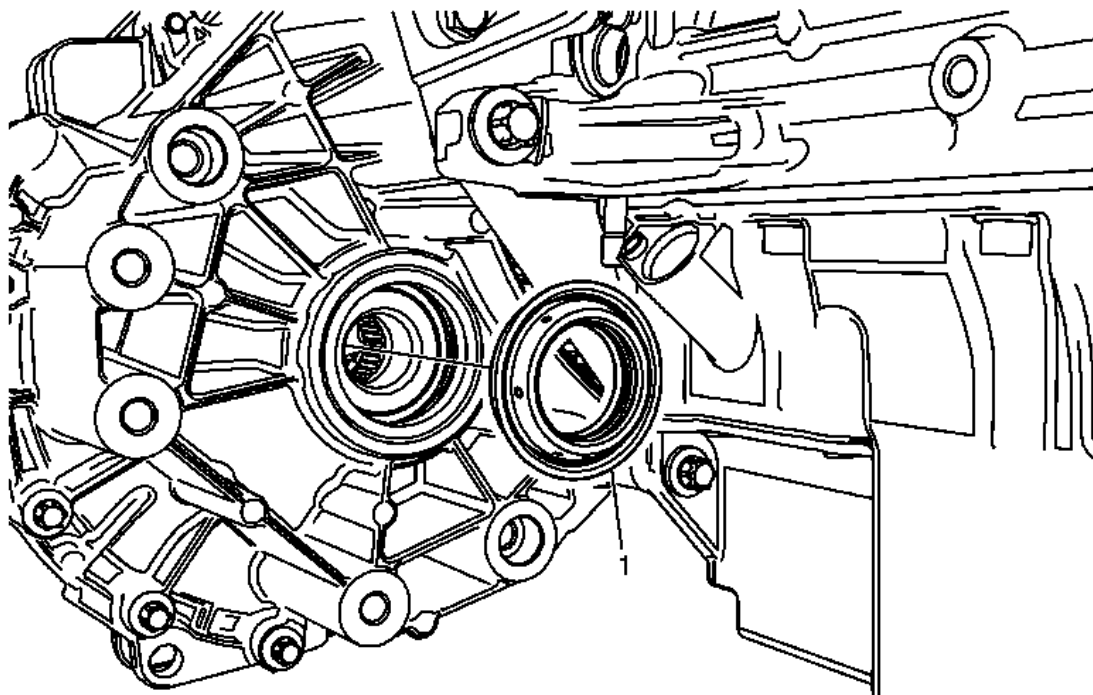


Fig. 51: Front Wheel Drive Shaft Seal - Right Side

Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Shaft Seal Replacement - Right Side

Callout	Component Name
<p>WARNING:</p> <p>To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.</p> <p>WARNING:</p> <p>Refer to <u>Safety Glasses Warning</u> .</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none">1. Raise and suitably support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .2. Remove the intermediate shaft. Refer to <u>Front Wheel Drive Intermediate Shaft Replacement (with MR6)</u> , <u>Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)</u> .3. Place a drain pan underneath to collect transmission fluid.	
1	<p>Front Wheel Drive Shaft Seal</p> <p>Procedure</p> <ol style="list-style-type: none">1. Remove drive axle shaft seal ring with DT-7004 hook and DT-586 hammer.2. Coat new axle shaft seal ring with transmission fluid.3. Install the drive axle shaft seal ring flush into transmission with DT-519 installer.4. Check transmission fluid level. Refer to <u>Transmission Fluid Drain and Fill</u>. <p>Special Tools</p> <ul style="list-style-type: none">• DT-519 Seal Installer• DT-586 Slide Hammer• DT-7004 Remover Hook <p>For equivalent regional tools, refer to <u>Special Tools</u>.</p>

TRANSMISSION REPLACEMENT

Special Tools

DT-48783 Special Socket

For equivalent regional tools, refer to Special Tools.

Removal Procedure

1. Remove the battery tray. Refer to **Battery Tray Replacement** .
2. Remove the shift lever cable from the selector on the transmission. Refer to **Manual Transmission Shift Lever Cable Replacement**.
3. Remove the clutch actuator cylinder hose. Refer to **Clutch Actuator Cylinder Pipe Replacement** .
4. Remove the fasteners and brackets for the wiring harness on the transmission.
5. Remove the connector to the reverse light switch. Refer to **Backup Lamp Switch Replacement**.

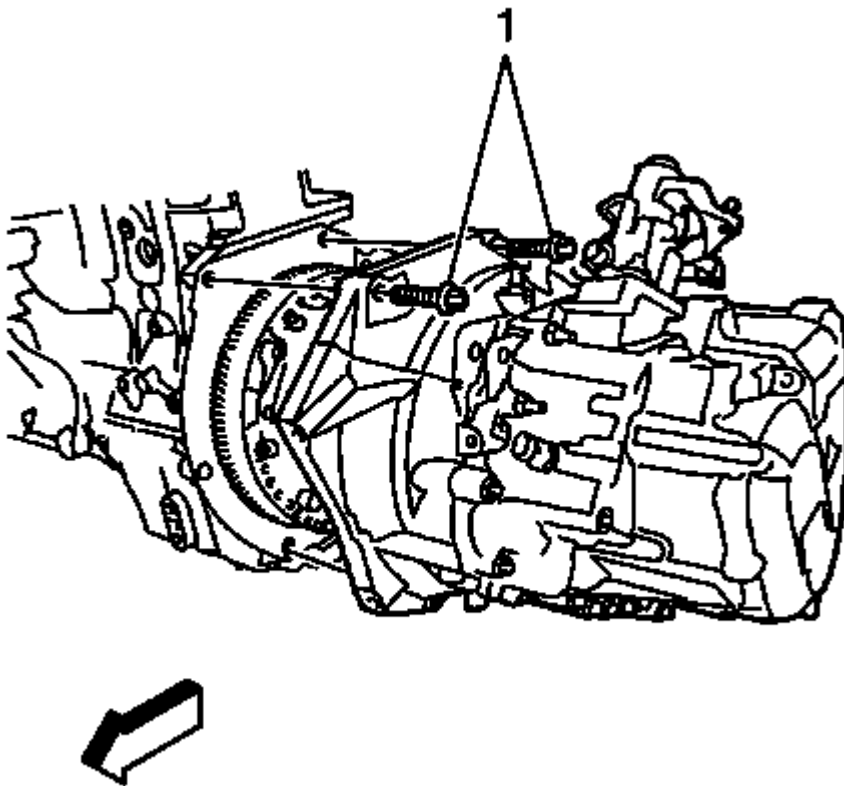


Fig. 52: Upper Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove upper transmission fasteners (1) using the **DT-48783** special socket or equivalent E-Torx socket.
7. Remove the starter motor. Refer to **Starter Replacement (LUK)** , **Starter Replacement (LTG)** .
8. Install the engine support fixture. Refer to **ENGINE SUPPORT FIXTURE** for the 2.0L engine.
9. Remove the subframe. Refer to **Drivetrain and Front Suspension Frame Replacement** .
10. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** .
11. Remove the rear transmission bracket. Refer to **Transmission Rear Mount Bracket Replacement**.
12. Remove the transmission front mount. Refer to **Transmission Front Mount Replacement**.
13. Drain the transmission fluid. Refer to **Transmission Fluid Drain and Fill**.

14. Pull out the left drive shaft from the transmission. Refer to **Front Wheel Drive Shaft Replacement - Left Side**.
15. Pull out the right drive shaft from the intermediate shaft and remove the intermediate shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)**, **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)**.
16. Lower the vehicle.
17. Remove the fasteners to the transmission bracket left side. Refer to **Transmission Mount Bracket Replacement - Left Side**.
18. Lower the engine enough with support fixture to access the transmission.
19. Raise the vehicle.
20. Place an appropriate transmission jack under the vehicle and support the transmission.

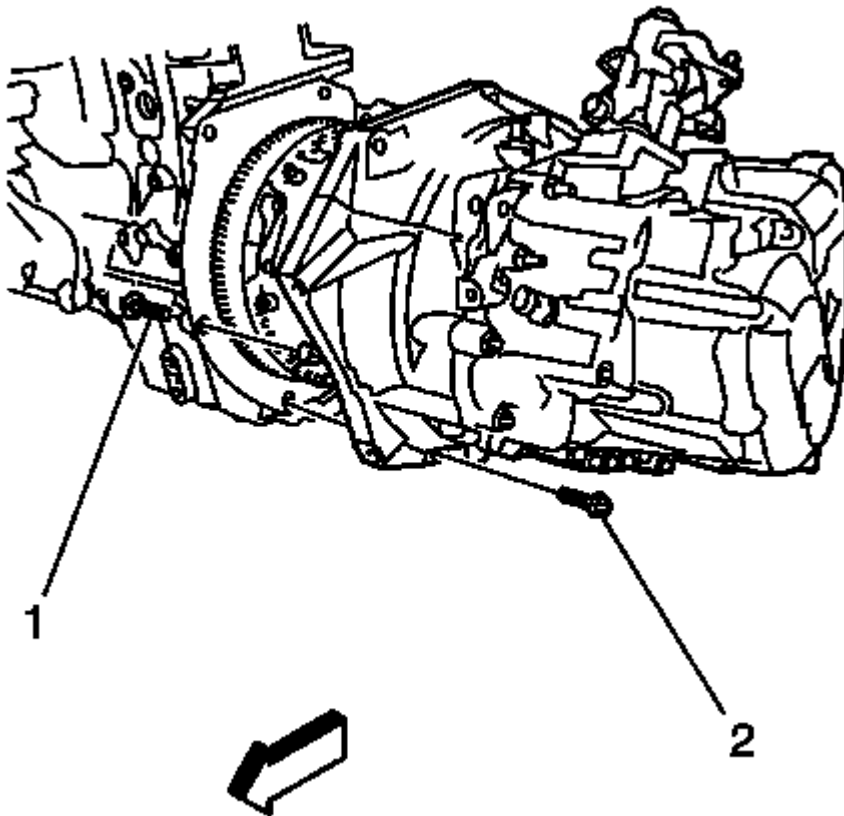


Fig. 53: Lower Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

21. Remove the lower transmission fasteners (1).

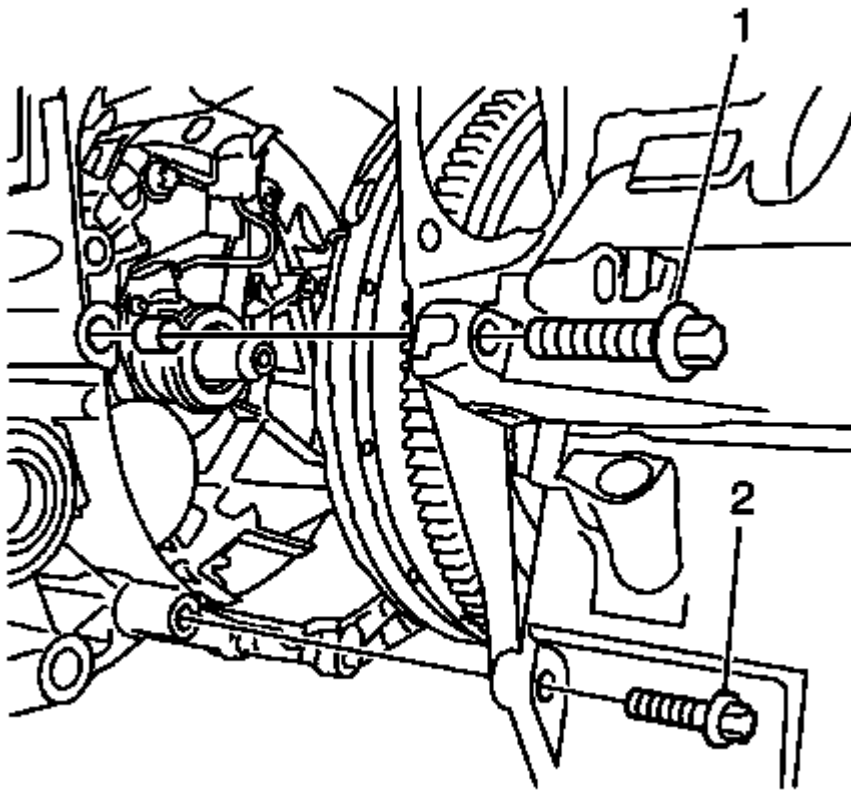


Fig. 54: View Of Lower Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

22. Remove lower transmission fasteners (1).
23. Separate the transmission from the engine.
24. Lower the transmission away from the vehicle. With assistance, place transmission in suitable work area.

Installation Procedure

1. Lubricate input shaft splines and the two guiding sleeves.
2. Place the transmission to the engine support fixture.
3. Attach transmission to the engine.

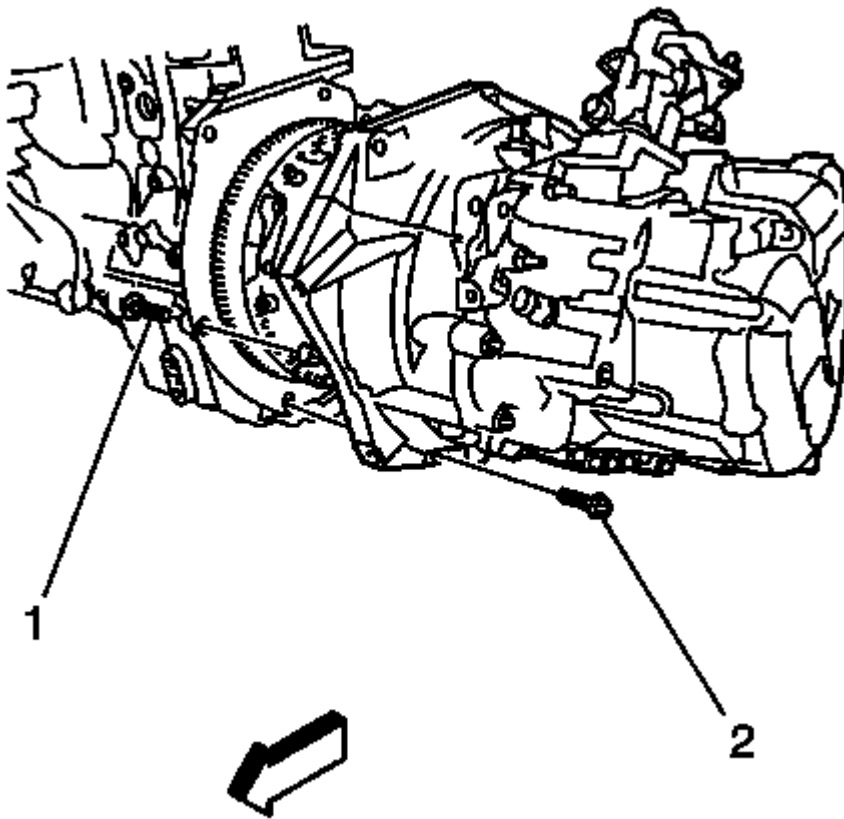


Fig. 55: Lower Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the transmission fasteners.
 - Tighten the fastener (1) to 60 (44 lb ft).
 - Tighten the fastener (2) to 40 (30 lb ft).

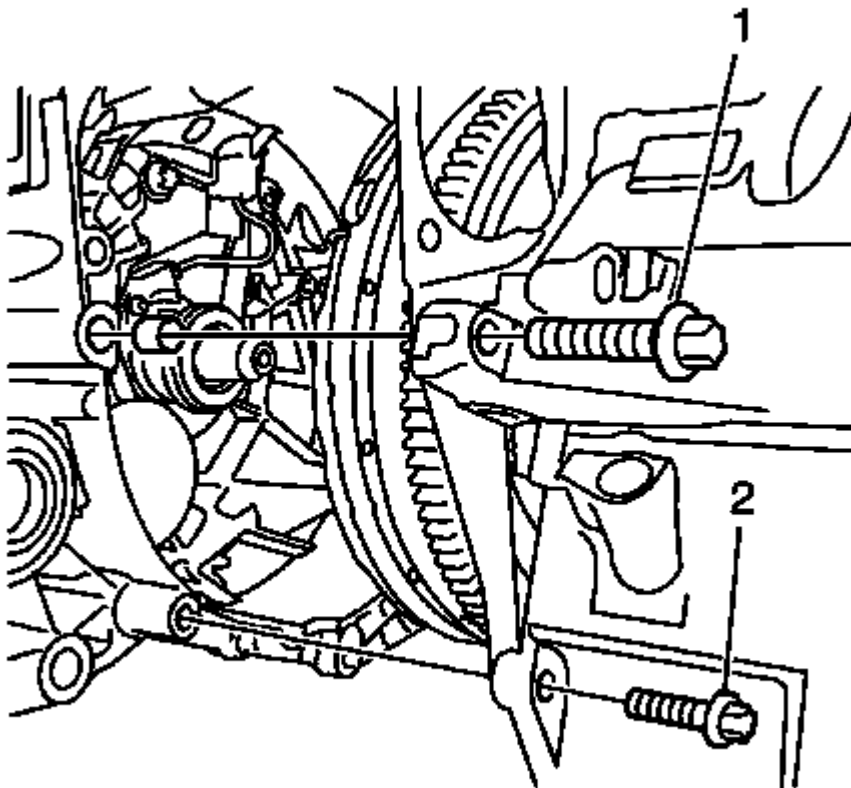


Fig. 56: View Of Lower Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission fasteners.
 - Tighten the fastener (1) to 60 (44 lb ft).
 - Tighten the fastener (2) to 40 (30 lb ft).
6. Install the starter motor. Refer to **Starter Replacement (LTG)** .
7. Lower the vehicle.
8. Raise the engine to the correct level with the engine support fixture.
9. Install the fasteners to the transmission bracket left side. Refer to **Transmission Mount Bracket Replacement - Left Side.**
10. Remove the engine support fixture.
11. Install the ground cable and the upper fasteners to the starter motor. Refer to **Starter Replacement (LTG)** .
12. Raise the vehicle.
13. Install the rear transmission bracket. Refer to **Transmission Rear Mount Bracket Replacement.**
14. Install the transmission front mount. Refer to **Transmission Front Mount Replacement.**
15. Install the intermediate shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)** , **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)** .
16. Install the left drive shaft to the transmission. Refer to **Front Wheel Drive Shaft Replacement - Left**

Side .

17. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LTG) .**
18. Install the subframe. Refer to **Drivetrain and Front Suspension Frame Replacement .**
19. Fill up the transmission fluid. Refer to **Transmission Fluid Drain and Fill.**
20. Install the clutch actuator cylinder hose. Refer to **Clutch Actuator Cylinder Pipe Replacement .**

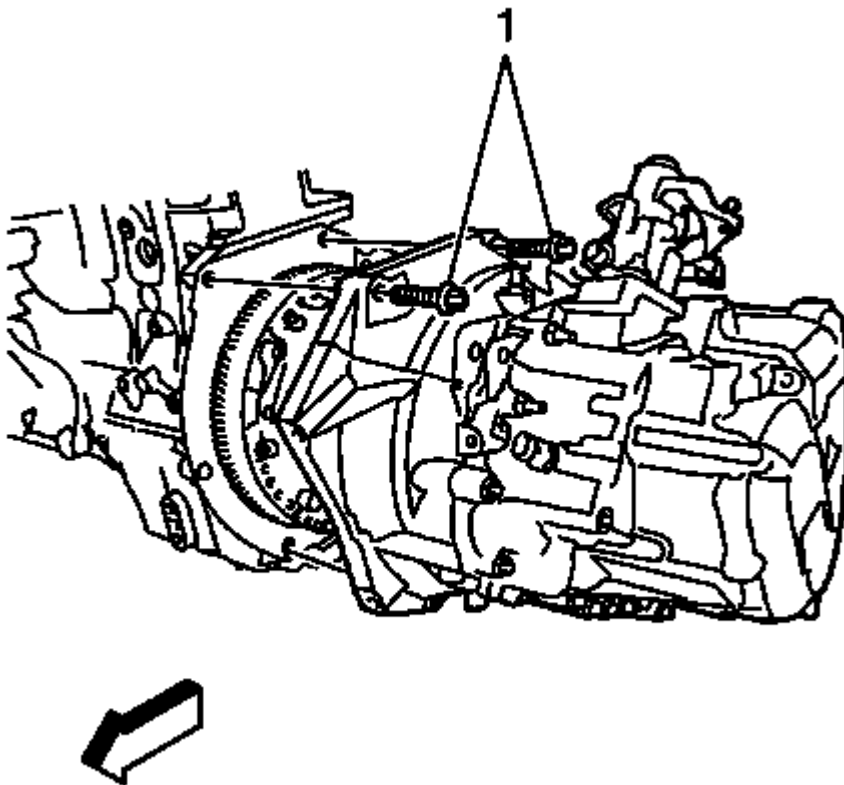


Fig. 57: Upper Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

21. Install the upper transmission fasteners (1) using the **DT-48783** special socket. Tighten the fasteners to 60 (44 lb ft).
22. Install the shift lever cable to the selector on the transmission. Refer to **Manual Transmission Shift Lever Cable Replacement.**
23. Install the fasteners and brackets for the wiring harness to the transmission.
24. Install the connector to the reverse light switch.
25. Install the battery tray. Refer to **Battery Tray Replacement .**

DESCRIPTION AND OPERATION

TRANSMISSION SYSTEM DESCRIPTION AND OPERATION

The F40-6 is a 6-speed manual transmission. This manual transmission is an all-synchromesh 3-shaft transmission.

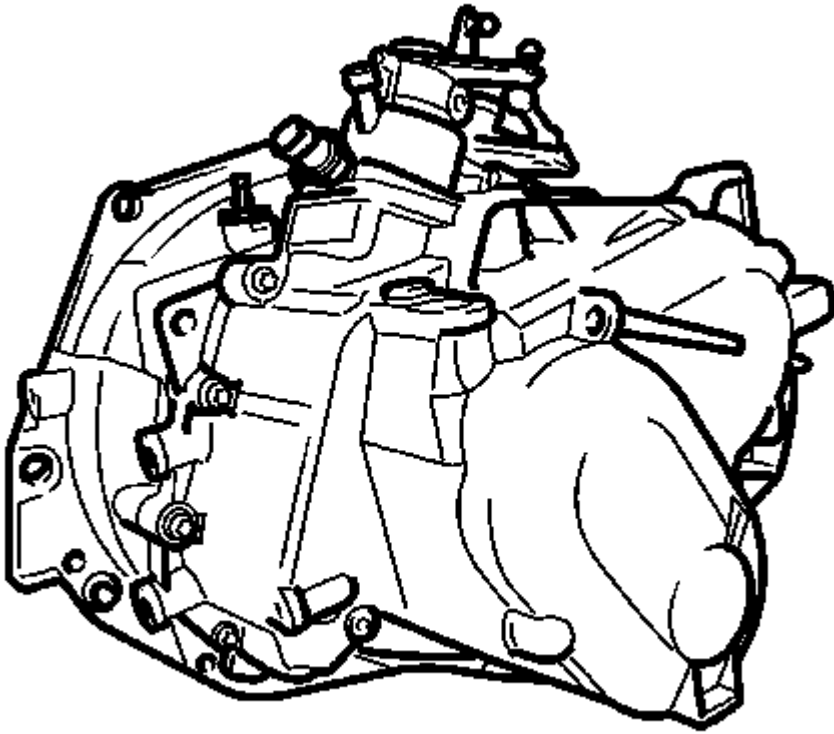


Fig. 58: Manual Transmission
Courtesy of GENERAL MOTORS COMPANY

This 3-shaft transmission has the following advantages:

- Compact construction
- Improved smooth-running performance
- Better shift quality
- High torque transmission

Location of the Shafts and the Differential in the Transmission Housing

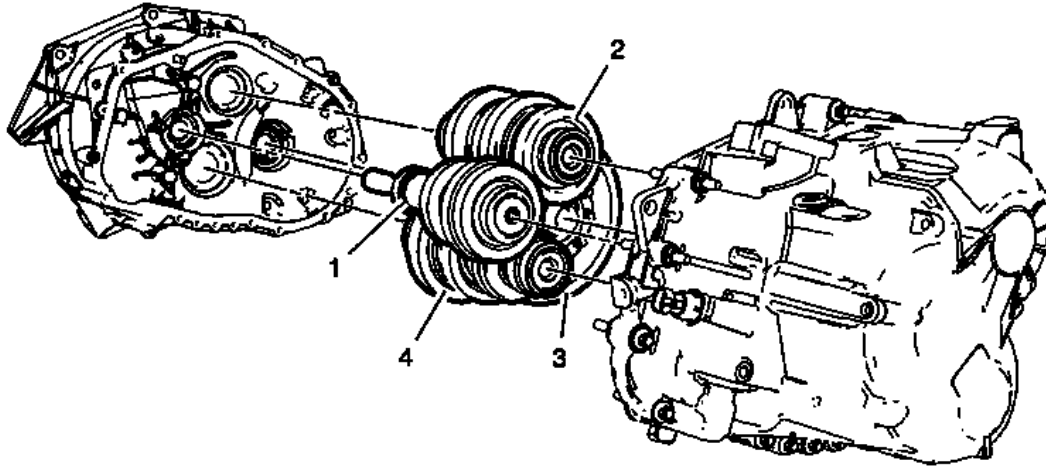


Fig. 59: Transmission Housing Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Input shaft
2	Upper main shaft
3	Differential gear
4	Lower main shaft

In this transmission angular cone bearings are used for all shafts. These bearings require a certain amount of play and pretension. The required amount of bearing play and pretension is achieved at the production stage by using shims under the angular cone bearing in the transmission housing.

Location of the Shafts and the Differential

This diagram shows the location of the respective shafts and differential gear.

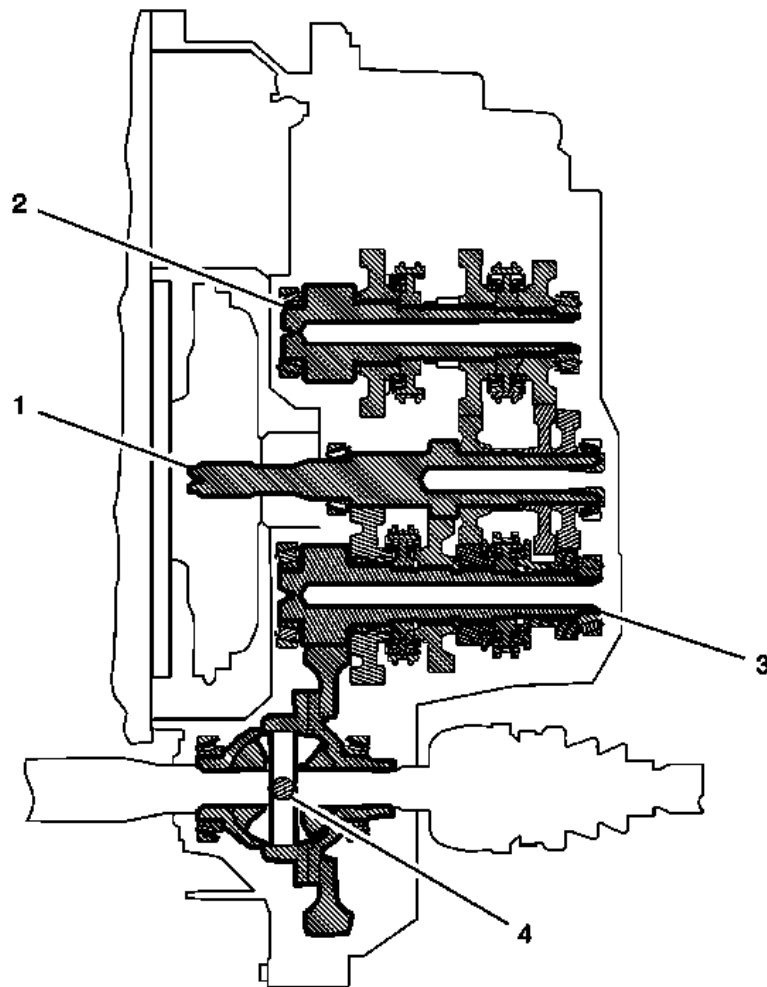


Fig. 60: Location Of Shafts & Differential
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Input shaft
2	Upper main shaft
3	Lower main shaft
4	Differential gear

Location of the Gear Wheels

This diagram shows the location of the gear wheels on the respective shaft.

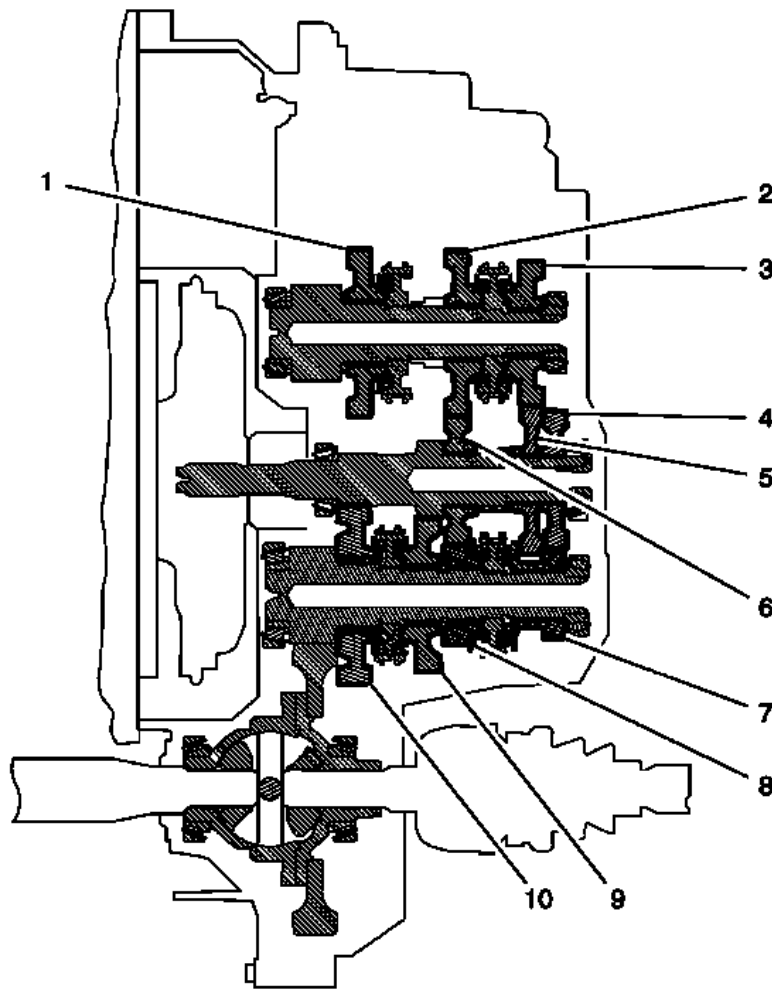


Fig. 61: Location Of Gear Wheels
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Reverse gear wheel - Upper Main Shaft
2	3rd gear wheel - Upper Main Shaft
3	4th gear wheel - Upper Main Shaft
4	6th gear wheel - Input Shaft with 1st/Reverse Gear and 2nd Gear
5	4th gear wheel - Input Shaft with 1st/Reverse Gear and 2nd Gear
6	3rd/5th gear wheel - Input Shaft with 1st/Reverse Gear and 2nd Gear
7	6th gear wheel - Lower Main Shaft
8	5th gear wheel - Lower Main Shaft
9	2nd gear wheel - Lower Main Shaft
10	1st gear wheel - Lower Main Shaft

Particular benefits of this 3-shaft transmission are that gear wheel for 3rd gear is also used for 5th gear and that 1st gear wheel is used for reversal of the rotating direction for reverse gear.

Power Flow in the Individual Gears

The following diagrams show the flow of power in the individual gears.

1st Gear

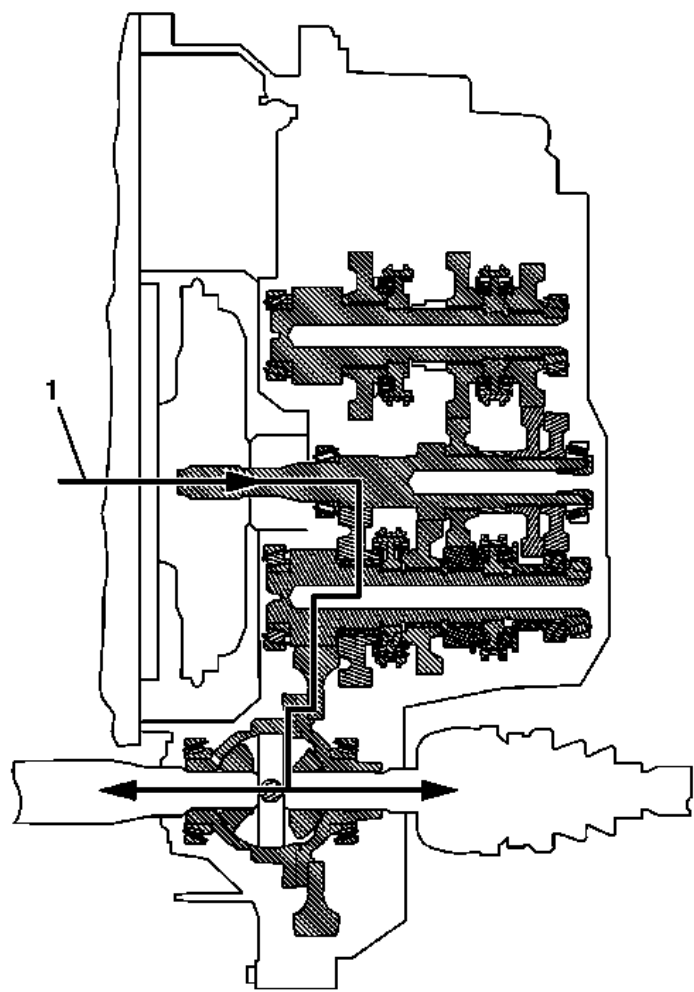


Fig. 62: 1st Gear
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	1st gear power flow

2nd Gear

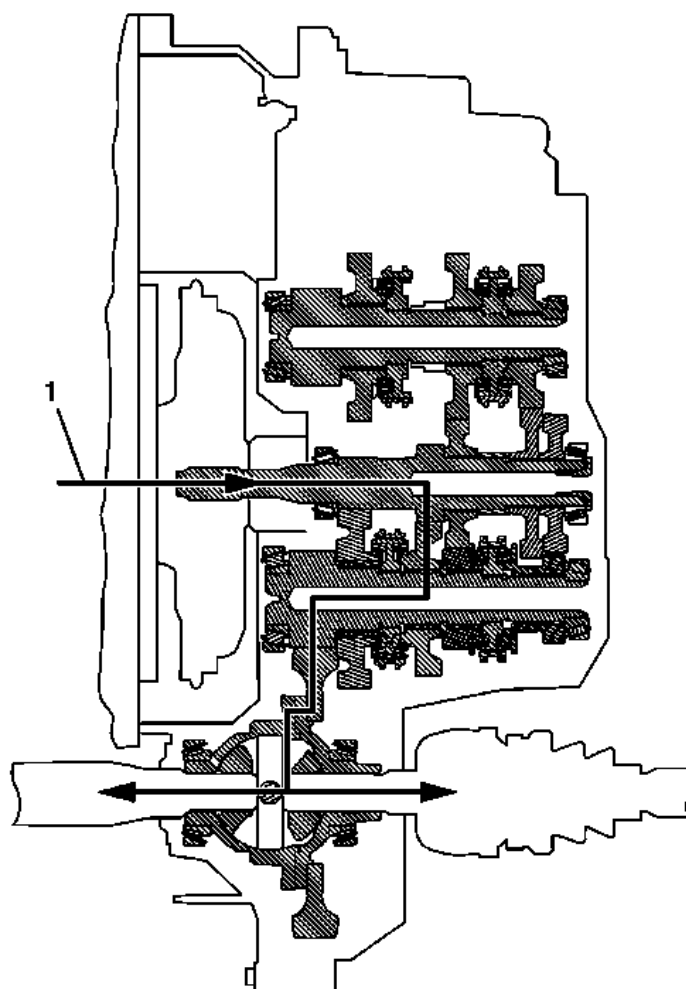


Fig. 63: 2nd Gear
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	2nd gear power flow

3rd Gear

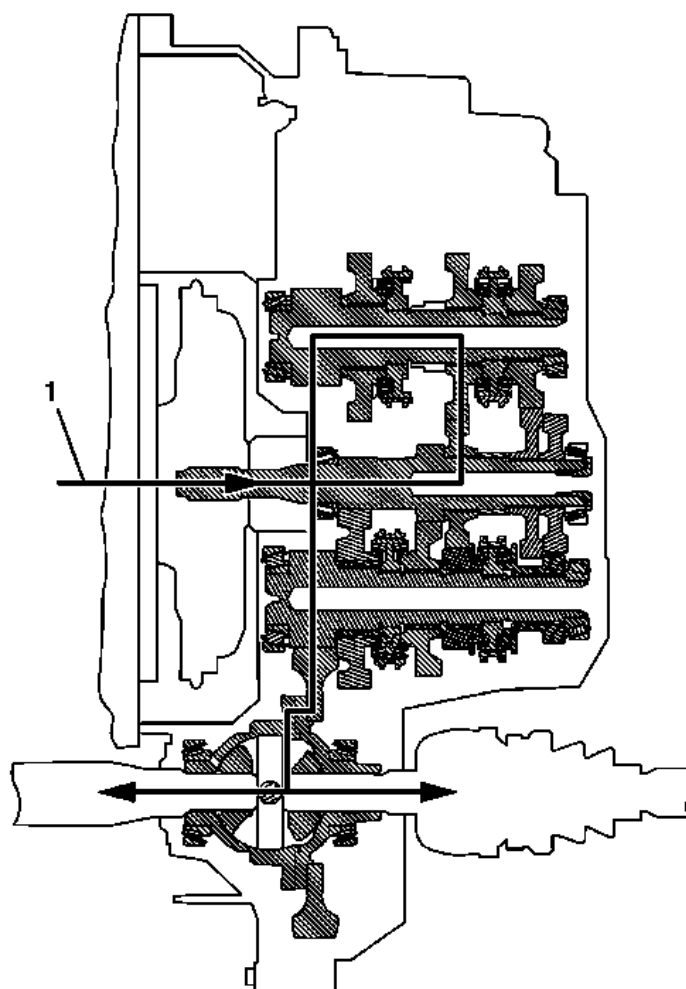


Fig. 64: 3rd Gear
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	3rd gear power flow

4th Gear

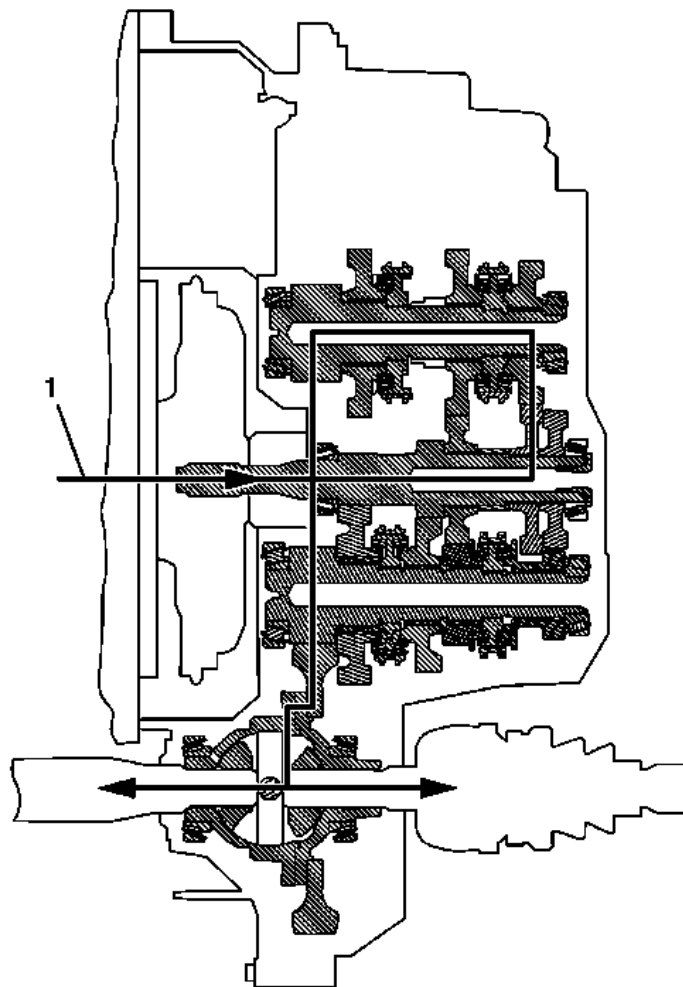


Fig. 65: 4th Gear
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	4th gear power flow

5th Gear

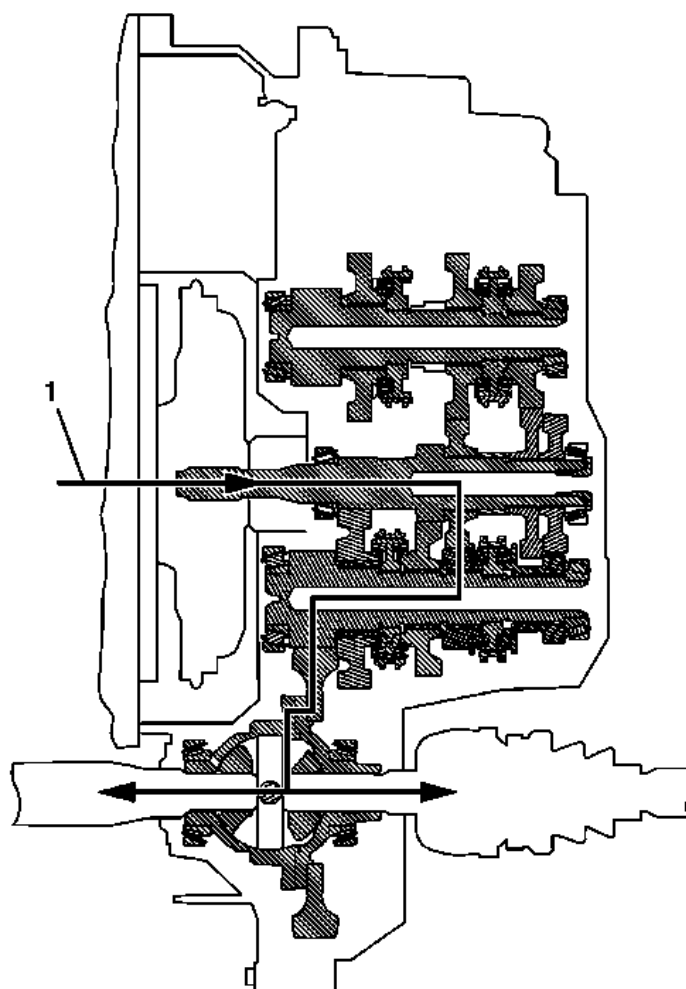


Fig. 66: 5th Gear
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	5th gear power flow

6th Gear

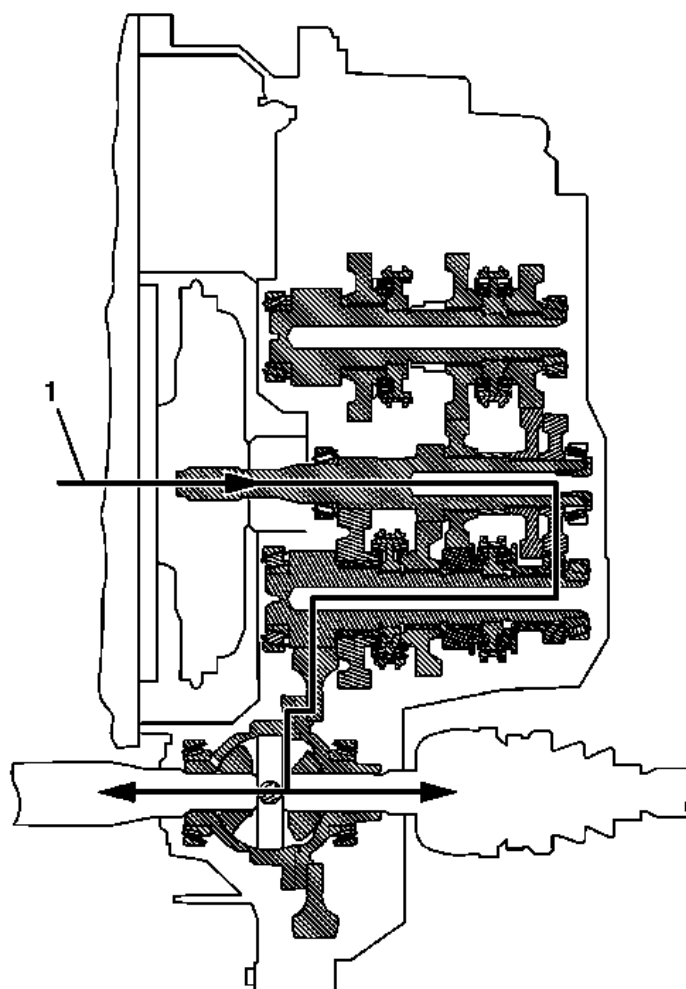


Fig. 67: 6th Gear
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	6th gear power flow

Reverse Gear

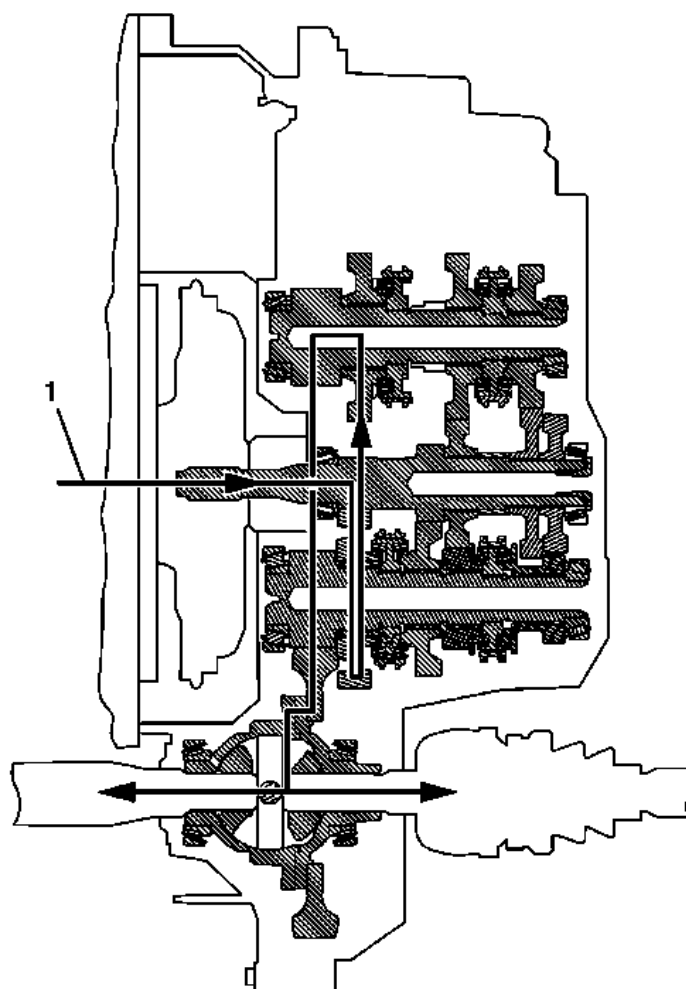


Fig. 68: Reverse Gear
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Reverse gear power flow

Transmission Shift Linkage

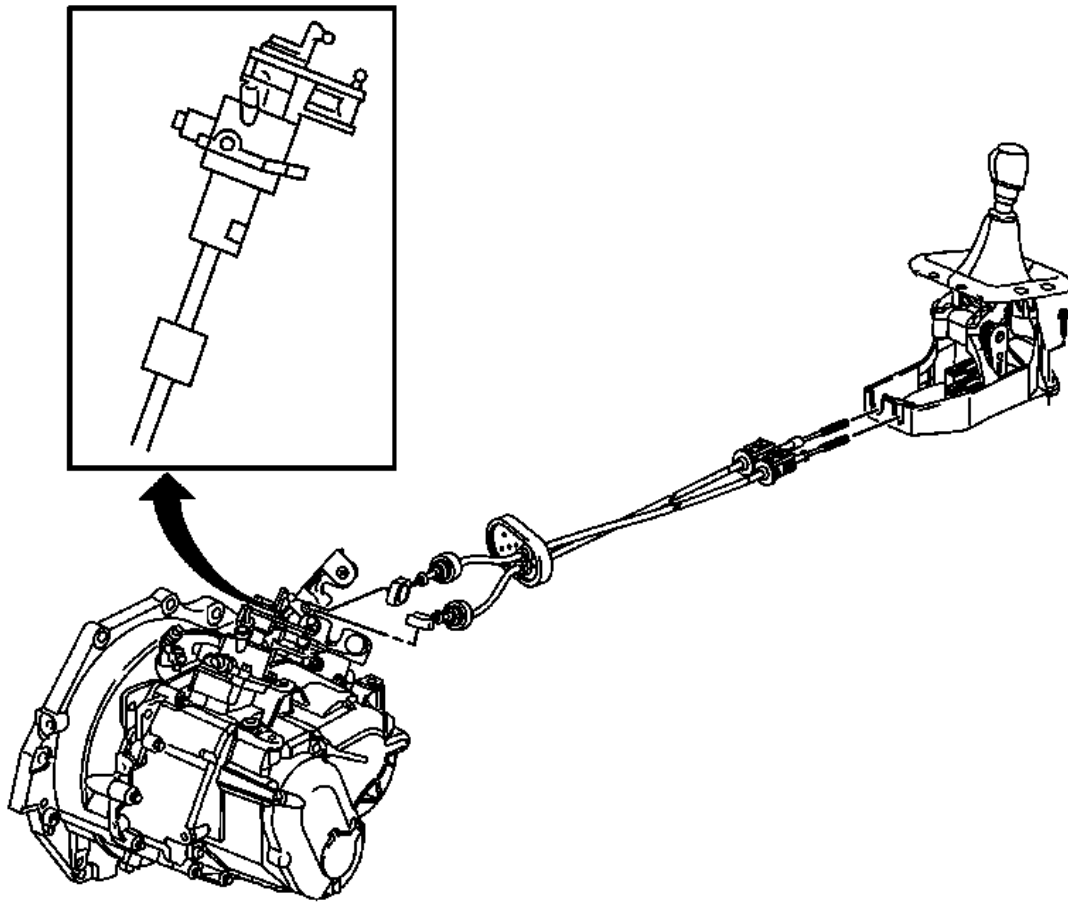


Fig. 69: Reverse Gear
Courtesy of GENERAL MOTORS COMPANY

The gears of the F40-6 transmission will be shifted via a cable linkage system.

TRANSMISSION IDENTIFICATION INFORMATION

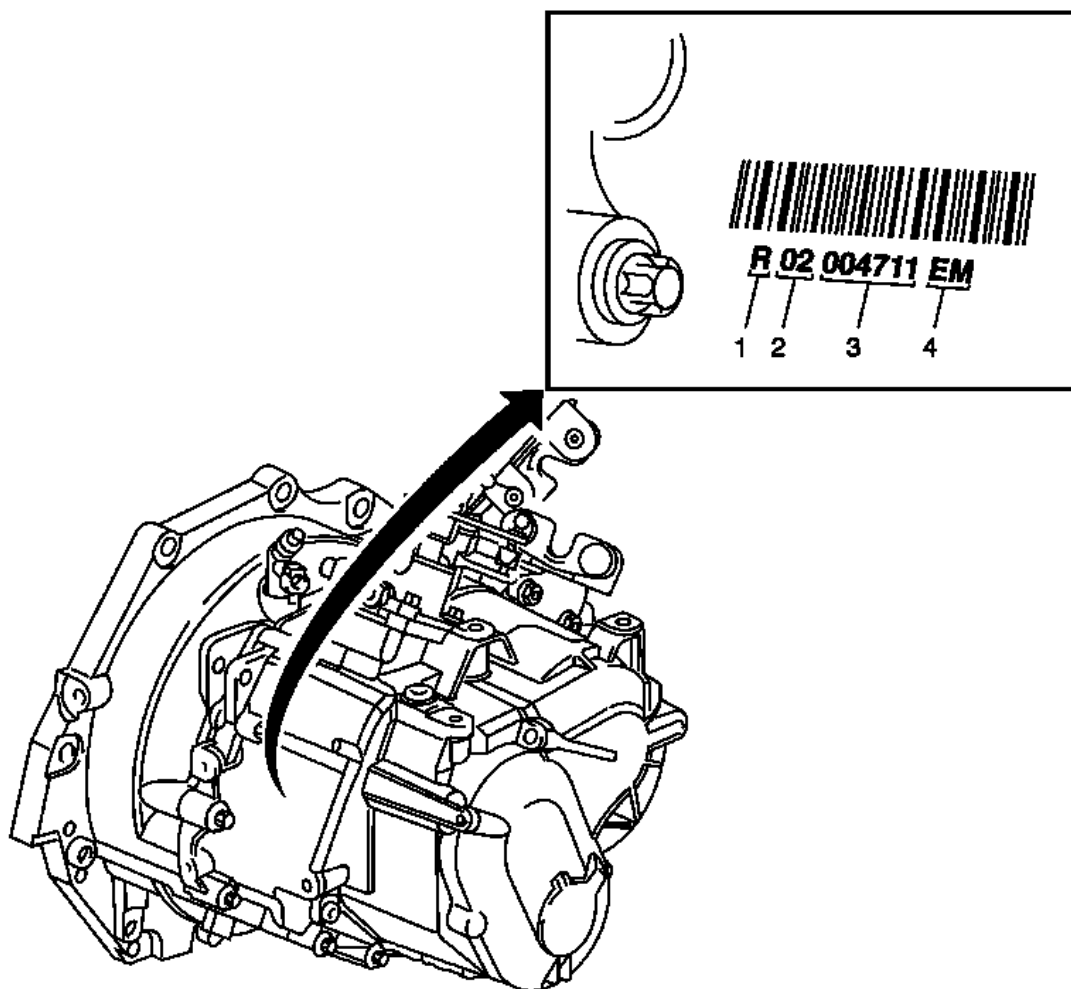


Fig. 70: Transmission Identification
 Courtesy of GENERAL MOTORS COMPANY

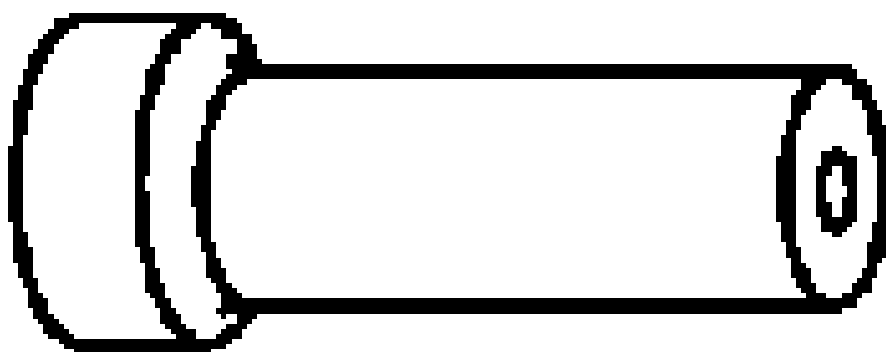
The code for the F40-6 transmission is located at the front of the transmission housing.

- Manufacturing plant (1)
- Last two digits of year (example 02 = 2002) (2)
- Serial number (3)
- Alpha code (4)

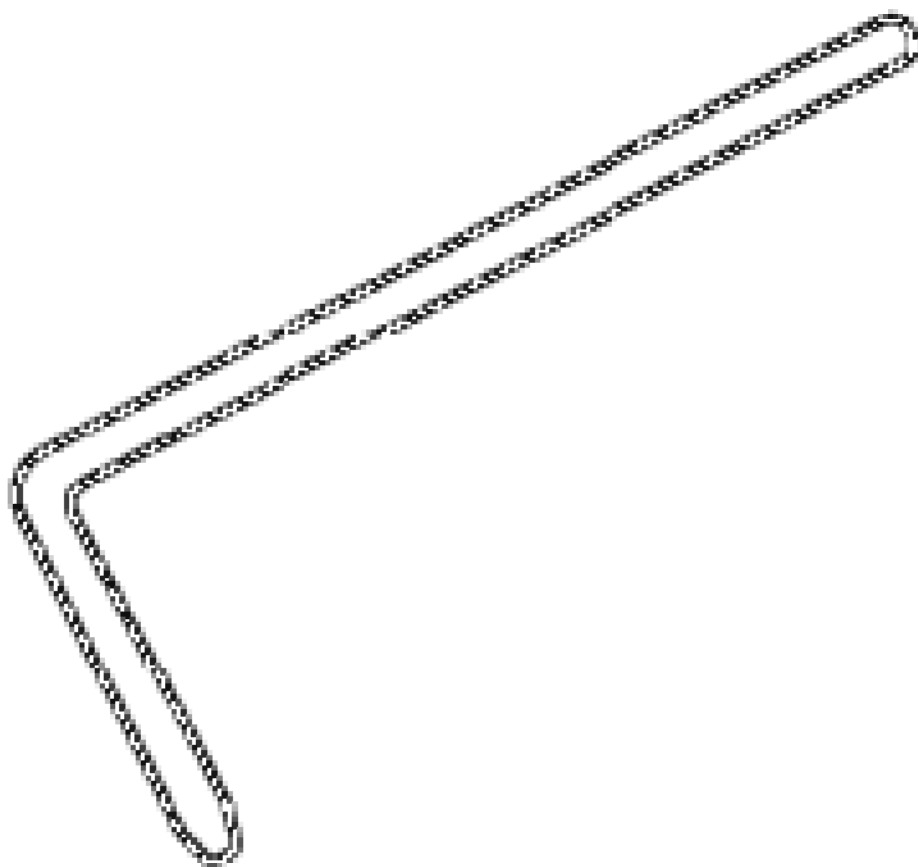
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

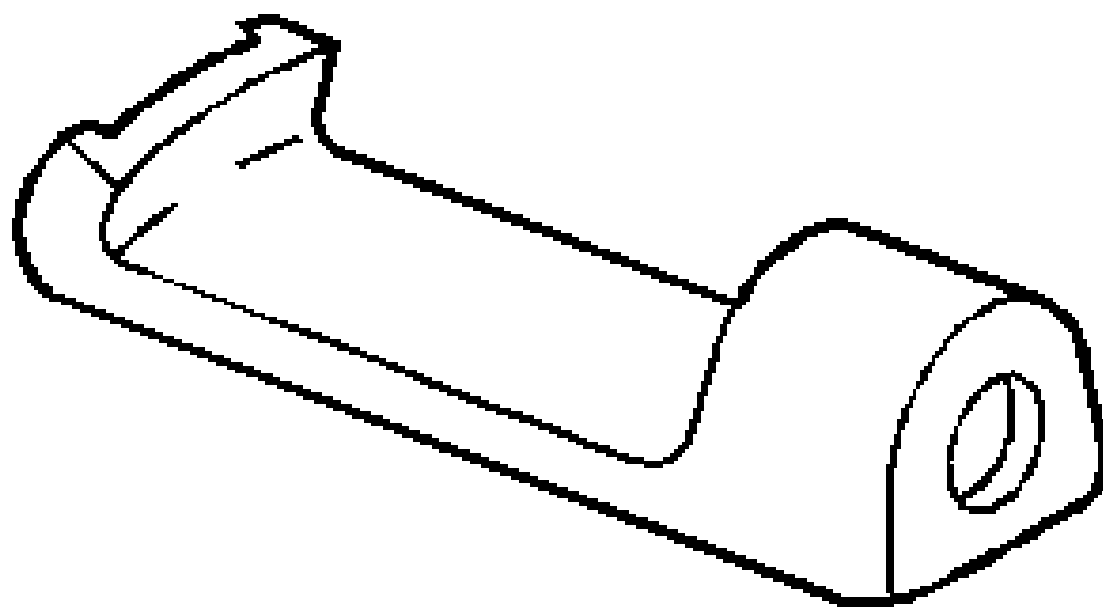
Illustration	Tool Number/Descrip



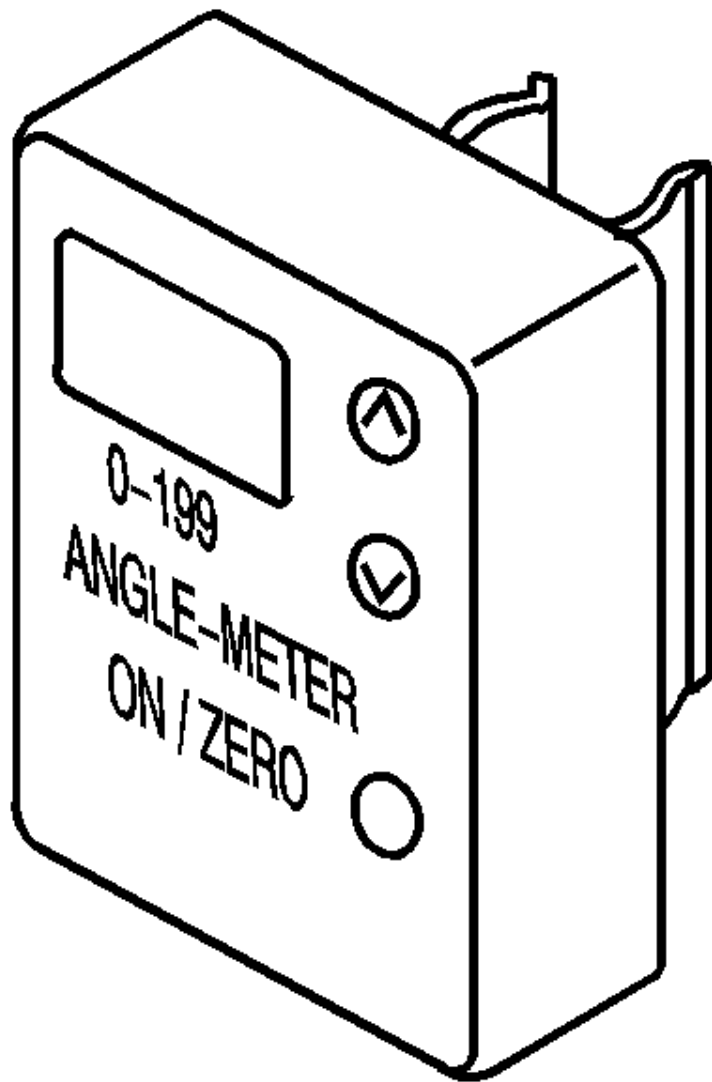
DT-519
KM-519
Seal Installer



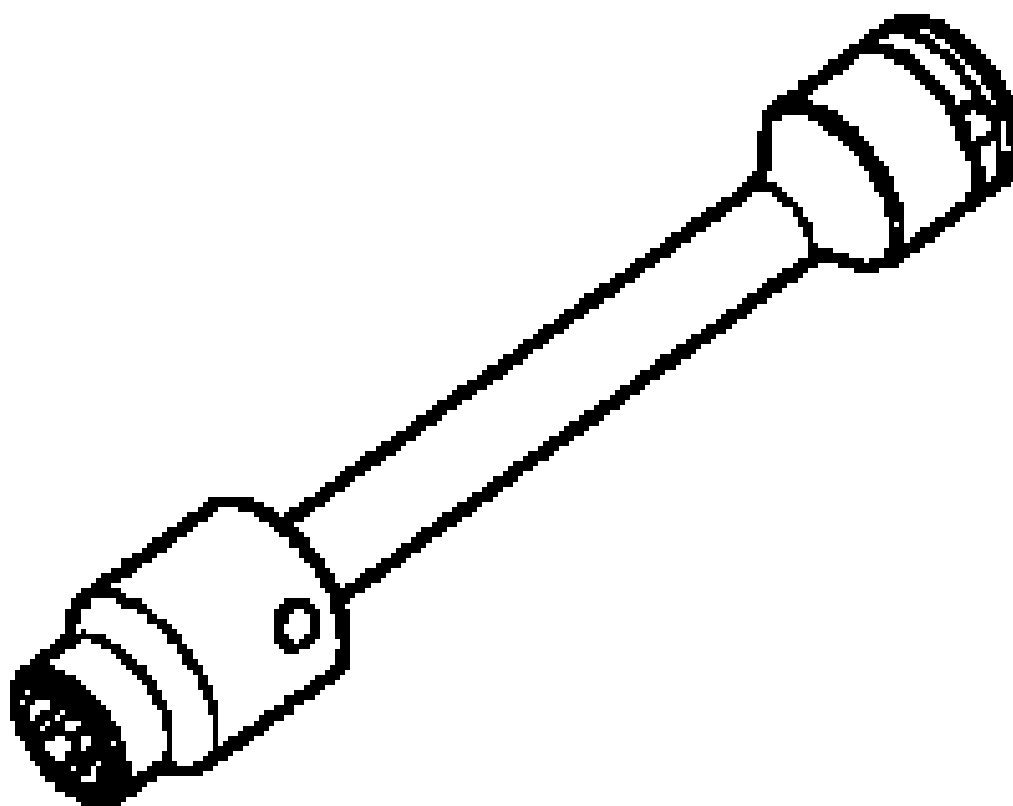
DT-527-A
KM-527-A
Adjusting Too



DT-586
KM-586
Remover Hool



DT-7004
KM-J-7004
J-6125-1B
Remover Hool



DT-48793
Special Socket

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Master Electrical Component List

MASTER ELECTRICAL COMPONENT LIST

Master Electrical Component List

Code	Name	Option	Location	Locator View	Connector En
A3L	Sunshade - Left	-	In the passenger compartment, left front, mounted to the headliner at left front	<u>Headliner Components</u>	<u>A3L Sunshade - Left</u>
A3R	Sunshade - Right	-	In the passenger compartment, right front, mounted to the headliner at right front	<u>Headliner Components</u>	<u>A3R Sunshade - Right</u>
A4	Hybrid/EV Battery Pack	HP6	In the luggage compartment, right behind rear of the seats	-	-
A7	Fuel Pump and Level Sensor Assembly	-	In the vehicle underbody, near rear center, mounted to the fuel tank, below rear seats	<u>Fuel Tank Components</u>	<u>A7 Fuel Pump and Level Sensor Assembly</u>
A9A	Outside Rearview Mirror - Driver	-	On the outside of the driver door, at front	<u>Driver Door Components</u>	<u>A9A Outside Rearview Mirror - Driver CZ2</u>
A9B	Outside Rearview Mirror - Passenger	-	On the outside of the passenger door, at front	<u>Passenger Door Components</u>	<u>A9B Outside Rearview Mirror - Passenger CZ2</u>
A10	Inside Rearview Mirror	-	In the passenger compartment, front center, mounted to the top center of windshield	<u>Inside of Roof and Windshield Components</u>	<u>A10 Inside Rearview Mirror</u>
			In the passenger compartment, center near		<ul style="list-style-type: none"> • <u>A11 Radio X1</u> • <u>A11 Radio X1</u>

A11	Radio	-	front, mounted to the instrument panel, behind radio controls	-	<ul style="list-style-type: none"> • <u>A11 Radio X4</u> • <u>A11 Radio X4</u> • <u>A11 Radio X5</u> • <u>A11 Radio X5</u>
A14D	Seat Lumbar Support Pump - Driver	APG	In the passenger compartment, left center, in driver seat back outboard side	<u>Rear of Driver Seat Components</u>	<u>A14D Seat Lumbar Pump - Driver (APG)</u>
A14P	Seat Lumbar Support Pump - Passenger	APH	In the passenger compartment, right center, in passenger seat back outboard side	<u>Rear of Passenger Seat Components</u>	<u>A14P Seat Lumbar Pump - Passenger (APH)</u>
A15	Starter/Generator	HP6	In the engine compartment, on the engine	<u>Left Front of Engine Components (LUK 1 of 2)</u>	<u>A15 Starter/Generator</u>
A22	Radio Controls	-	In the passenger compartment, center near front, in the center area of the instrument panel, above HVAC controls	<u>Instrument Panel and Floor Console Components</u>	<ul style="list-style-type: none"> • <u>A22 Radio Controls (UEW)</u> • <u>A22 Radio Controls (UFU/UYE/UYF)</u>
A23D	Door Latch Assembly - Driver	-	Inside the driver door, at rear middle	<u>Driver Door Components</u>	<u>A23D Door Latch Assembly - Driver</u>
A23LR	Door Latch Assembly - Left Rear	-	Inside the left rear door, at rear middle	<u>Left Rear Door Components</u>	<u>A23LR Door Latch Assembly - Left Rear</u>
A23P	Door Latch Assembly - Passenger	-	Inside the passenger door, at rear middle	<u>Passenger Door Components</u>	<u>A23P Door Latch Assembly - Passenger</u>
A23RR	Door Latch Assembly - Right Rear	-	Inside the right rear door, at rear middle	<u>Right Rear Door Components</u>	<u>A23RR Door Latch Assembly - Right Rear</u>
A24D	Door Handle Assembly - Driver Exterior	ATH	On the outside of the driver door	-	<u>A24D Door Handle Assembly - Driver Exterior (ATH)</u>
A24P	Door Handle Assembly - Passenger Exterior	ATH	On the outside of the passenger door	-	<u>A24P Door Handle Assembly - Passenger Exterior (ATH)</u>
			In the passenger		

A26	HVAC Controls	-	compartment, center near front, in the center area of the instrument panel, below radio controls	<u>Instrument Panel and Floor Console Components</u>	<ul style="list-style-type: none"> • <u>A26 HVAC C except CZ2</u> • <u>A26 HVAC C</u>
B1	A/C Refrigerant Pressure Sensor	-	In the engine compartment, right front, mounted to the right bottom of the condenser	<u>Radiator Support Components</u>	<u>B1 A/C Refrigerant Sensor</u>
B5LF	Wheel Speed Sensor - Left Front	without F45	In the vehicle underbody, left front, part of the hub assembly, mounted to the left steering knuckle	<u>Front Wheel Speed Sensor Components</u>	<ul style="list-style-type: none"> • <u>B5LF Wheel S</u> <u>- Left Front (-</u> • <u>B5LF Wheel S</u> <u>- Left Front (-</u>
B5LR	Wheel Speed Sensor - Left Rear	-	In the vehicle underbody, left rear, part of the hub assembly, mounted to the left suspension knuckle	-	<u>B5LR Wheel Speed Rear</u>
B5RF	Wheel Speed Sensor - Right Front	without F45	In the vehicle underbody, right front, part of the hub assembly, mounted to the right steering knuckle	<u>Front Wheel Speed Sensor Components</u>	<u>B5RF Wheel Speed Right Front (withou</u>
B5RR	Wheel Speed Sensor - Right Rear	-	In the vehicle underbody, right rear, part of the hub assembly, mounted to the right suspension knuckle	-	<u>B5RR Wheel Speed Right Rear</u>
B7D	Air Temperature Sensor - Duct Left	CJ2	In the passenger compartment, mounted to	<u>HVAC Module</u>	<u>B7D Air Temperatu</u>

	Lower		lower left of the HVAC module	<u>Components</u>	<u>Duct Left Lower (C</u>
B7E	Air Temperature Sensor - Duct Right Lower	CJ2	In the passenger compartment, mounted to lower right of the HVAC module	<u>HVAC Module Components</u>	<u>B7E Air Temperatu</u> <u>Duct Right Lower (C</u>
B7H	Air Temperature Sensor - Duct Left Upper	CJ2	In the passenger compartment, mounted to upper left of the HVAC module, behind instrument cluster	<u>HVAC Module Components</u>	<u>B7H Air Temperatu</u> <u>Duct Left Upper (C</u>
B7J	Air Temperature Sensor - Duct Right Upper	CJ2	In the passenger compartment, mounted to upper right of the HVAC module, behind instrument compartment	<u>HVAC Module Components</u>	<u>B7J Air Temperatu</u> <u>Duct Right Upper (C</u>
B9	Ambient Air Temperature Sensor	-	At the front of vehicle, mounted to the backside of lower center grille	<u>Front of Vehicle Components</u>	<u>B9 Ambient Air Ter</u> <u>Sensor</u>
B10B	Ambient Light/Sunload Sensor	-	In the passenger compartment, mounted to the speaker grille forward of center speaker	<u>Instrument Panel and Floor Console Components</u>	<u>B10B Ambient Ligh</u> <u>Sensor</u>
B12A	Transmission Fluid Pressure Switch	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
			In the engine compartment,		

B13	Transmission Fluid Temperature Sensor	MDK	mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
B13	Transmission Fluid Temperature Sensor	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
B14A	Transmission Output Shaft Speed Sensor	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
B14A	Transmission Output Shaft Speed Sensor	MH8	In the engine compartment, mounted inside the transmission	<u>Automatic Transmission Components (MH8)</u>	-
B14C	Transmission Input Shaft Speed Sensor	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
B14C	Transmission Input Shaft Speed Sensor	MH8	In the engine compartment, mounted to the left side the transmission	<u>Automatic Transmission Components (MH8)</u>	-
B15	Transmission Internal Mode Switch	MH8	In the engine compartment, mounted inside the transmission, around shift shaft	<u>Automatic Transmission Components (MH8)</u>	-
B16	Backup Lamp Switch	MR6	In the engine compartment, mounted to the front middle of the transmission	<u>Manual Transmission Components (MR6)</u>	<u>B16 Backup Lamp Switch (MR6)</u>
			Top of the		

B17	Barometric Pressure Sensor	-	engine at the throttle assembly	<u>Engine Components - Rear (LLU)</u>	<u>B17 Barometric Pre (LDK)</u>
B18	Battery Current Sensor	-	In the engine compartment, left front, mounted to the negative battery cable	<u>Left Side of Engine Compartment Components</u>	<u>B18 Battery Curren</u>
B19B	Brake Booster Vacuum Sensor	-	In the engine compartment, mounted to the front right of the vacuum brake booster	-	<u>B19B Brake Booster Sensor</u>
B19C	Brake Booster Vacuum Switch	-	At the right side of the engine compartment	-	<u>B19C Brake Booste Switch</u>
B20	Brake Fluid Level Switch	-	In the engine compartment, left rear, mounted to the top of the brake fluid reservoir	<u>Left Side of Engine Compartment Components</u>	<u>B20 Brake Fluid Le</u>
B22	Brake Pedal Position Sensor	-	In the passenger compartment, mounted to the top of the brake pedal in the driver foot well	-	<ul style="list-style-type: none"> • <u>B22 Brake Pe Sensor (MR6)</u> • <u>B22 Brake Pe Sensor (witho except CZ2)</u> • <u>B22 Brake Pe Sensor (witho</u>
B23	Camshaft Position Sensor	LLU	In the engine compartment, on the left side of the engine, near the top	<ul style="list-style-type: none"> • <u>Engine Components - Front (LLU)</u> 	<u>B23 Camshaft Posit (LLU)</u>
B23E	Camshaft Position Sensor - Exhaust	-	In the engine compartment, mounted to the cylinder head, on rear left side	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LHU)</u> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine</u> 	<ul style="list-style-type: none"> • <u>B23E Camsha Sensor - Exha LUK/LHU</u> • <u>B23E Camsha Sensor - Exha</u> • <u>B23E Camsha Sensor - Exha</u>

				<u>Components - Rear (LAF)</u> <ul style="list-style-type: none"> • <u>Engine Components - Rear (LTD)</u> 	<ul style="list-style-type: none"> • <u>B23E Camsha Sensor - Exha</u>
B23F	Camshaft Position Sensor - Intake	-	In the engine compartment, mounted to the cylinder head, on front left side	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 1 of 2)</u> • <u>Engine Components - Front (LAF 1 of 2)</u> 	<ul style="list-style-type: none"> • <u>B23F Camsha Sensor - Intak</u> • <u>B23F Camsha Sensor - Intak</u> • <u>B23F Camsha Sensor - Intak</u> • <u>B23F Camsha Sensor - Intak</u>
B24	Cellular Phone Microphone	UE1	In the passenger compartment, mounted to the overhead console	<u>Headliner Components</u>	<ul style="list-style-type: none"> • <u>B24 Cellular I Microphone U</u> • <u>B24 Cellular I Microphone (I</u>
B25B	Clutch Pedal Position Sensor	MR6/ MR5	In the passenger compartment, mounted to the top of the clutch pedal in the driver foot well	-	<ul style="list-style-type: none"> • <u>B25B Clutch I Position Senc</u> • <u>B25B CLUTC POSITION SI (MR6)</u>
B26	Crankshaft Position Sensor	-	In the engine compartment, mounted to the front of block near oil filter housing	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 2 of 2)</u> • <u>Engine Components - Front (LAF 1 of 2)</u> • <u>Engine Components - Front (LDK)</u> • <u>Engine Components - Front (LTD)</u> • <u>Engine</u> 	<ul style="list-style-type: none"> • <u>B26 Cranksha Sensor LHU</u> • <u>B26 Cranksha Sensor LAF/L</u> • <u>B26 Cranksha Sensor (LDK)</u> • <u>B26 Cranksha Sensor (LTD)</u> • <u>B26 Cranksha Sensor (LLU)</u>

				<u>Components - Rear (LLU)</u>	
B27D	Door Handle Switch - Driver Exterior	ATH	In the passenger compartment, at the driver door handle	-	<u>B27D Door Handle Driver Exterior (ATH)</u>
B27D	Door Handle Switch - Driver Exterior	ATS	Part of the driver door handle	-	<u>B27D Door Handle Driver Exterior (ATS)</u>
B27LR	Door Handle Switch - Left Rear	ATH	Rear of the left rear door, behind the door trim panel on the door latch	-	<u>B27LR DOOR HAN SWITCH - LEFT R EXTERIOR (ATS)</u>
B27LR	Door Handle Switch - Left Rear Exterior	ATS	At the rear of the left rear door, behind the door trim panel on the door latch	-	<u>B27LR Door Handl Left Rear Exterior (ATS)</u>
B27P	Door Handle Switch - Passenger Exterior	ATH	In the passenger compartment, at the passenger door handle	-	<u>B27P Handle Switch Exterior (ATH)</u>
B27P	Door Handle Switch - Passenger Exterior	ATS	Part of the passenger door handle	-	<u>B27P Door Handle S Passenger Exterior (ATS)</u>
B27RR	Door Handle Switch - Right Rear	ATH	Rear of the right rear door, behind the door trim panel on the door latch	-	<u>B27RR Door Handl Right Rear Exterior</u>
B27RR	Door Handle Switch - Right Rear Exterior	ATS	At the rear of the right rear door, behind the door trim panel, on the door latch	-	<u>B27RR Door Handl Right Rear Exterior</u>
B30	Hybrid/EV Battery Pack Current Sensor	HP6	In the luggage compartment, part of the starter/generator control module	-	<u>B30 Hybrid/EV Bat Current Sensor (HP6)</u>
B33	Engine Coolant Level Switch	-	In the engine compartment, inside the	<ul style="list-style-type: none"> <u>Left Side of Engine Compartment</u> 	-

			coolant reservoir	<u>Components</u>	
B34	Engine Coolant Temperature Sensor	-	In the engine compartment, mounted to the thermostat housing on left rear of engine	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine Components - Rear (LAF)</u> • <u>Engine Components - Rear (LTD)</u> 	<ul style="list-style-type: none"> • <u>B34 Engine C Temperature LAF/LUK</u> • <u>B34 Engine C Temperature (LDK)</u> • <u>B34 Engine C Temperature</u> • <u>B34 Engine C Temperature (LLU)</u>
B34A	Engine Coolant Temperature Sensor 1	LHU	In the engine compartment, mounted to the thermostat housing on left rear of engine	<u>Left Rear of Engine Components (LHU)</u>	<u>B34A Engine Coolant Temperature Sensor</u>
B34B	Engine Coolant Temperature Sensor 2	LHU	In the engine compartment, mounted to the radiator, right side	-	<u>B34B Engine Coolant Temperature Sensor</u>
B35	Engine Oil Level Switch	LHU/ LDK	In the engine compartment, on the front lower of engine mounted to the oil pan	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Engine Components - Front (LDK)</u> 	<u>B35 Engine Oil Level LHU/LDK</u>
B35	Engine Oil Level Switch	LLU	In the oil pan, bottom of the engine	<u>Engine Components - Rear (LLU)</u>	<u>B35 Engine Oil Level (LLU)</u>
B37	Engine Oil Pressure Switch	-	In the engine compartment, mounted to the front of block near oil filter	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 2 of 2)</u> • <u>Engine Components - Front (LAF 1 of 2)</u> • <u>Engine</u> 	<ul style="list-style-type: none"> • <u>B37 Engine Oil Switch LUK/LHU/LAF</u> • <u>B37 Engine Oil</u>

			housing	<u>Components - Front (LDK)</u> <ul style="list-style-type: none"> • <u>Engine Components - Front (LTD)</u> • <u>Engine Components - Front (LLU)</u> 	<u>Switch (LLU)</u>
B39	A/C Evaporator Temperature Sensor	-	In the passenger compartment, mounted to the HVAC module behind instrument compartment	<u>HVAC Module Components</u>	<u>B39 A/C Evaporator Temperature Sensor</u>
B47	Fuel Pressure Sensor	-	In the vehicle underbody, mounted to the fuel line forward of the fuel tank	<u>Fuel Tank Components</u>	<u>B47 Fuel Pressure S</u>
B47	Fuel Pressure Sensor	LDK	In the engine compartment, mounted to the upper right rear of engine	<u>Engine Components - Top (LDK)</u>	<u>B47 Fuel Pressure S</u>
B47B	Fuel Rail Pressure Sensor	LUK	In the engine compartment, mounted to the fuel rail, between fuel injector 2 and fuel injector 3	-	<u>B47B Fuel Rail Pres (LUK)</u>
B47B	Fuel Rail Pressure Sensor	LHU	In the engine compartment, mounted to the fuel rail at end	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Engine Components - Front (LAF 2 of 2)</u> • <u>Engine Components - Front (LDK)</u> 	<u>B47B Fuel Rail Pres LHU/LDK</u>
B51F	Suspension Height Sensor - Front	TR7	Lower left rail	-	<u>B51F Suspension H Front (TR7)</u>
	Suspension Height		Under the		<u>B51R Suspension H</u>

B51R	Sensor - Rear	TR7	vehicle, on the rear suspension	-	<u>- Rear (TR7)</u>
B52A	Heated Oxygen Sensor 1	LUK/ LHU/ LAF/ LTD	In the engine compartment, mounted to the top of the catalytic converter	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LUK)</u> • <u>Left Rear of Engine Components (LHU)</u> • <u>Engine Components - Rear (LAF)</u> 	<u>B52A Heated Oxygen Sensor 1 (LUK/LHU/LAF/LTD)</u>
B52A	Heated Oxygen Sensor 1	LDK	In the engine compartment, left rear side of the engine	-	<u>B52A Heated Oxygen Sensor 1 (LDK)</u>
B52A	Heated Oxygen Sensor 1	LLU	In the engine compartment, left front side of the engine	<u>Engine Components - Front (LLU)</u>	<u>B52A Heated Oxygen Sensor 1 (LLU)</u>
B52B	Heated Oxygen Sensor 2	LUK/ LHU/ LAF	In the vehicle underbody, mounted to the lower side of the catalytic converter	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LUK)</u> • <u>Left Rear of Engine Components (LHU)</u> • <u>Engine Components - Rear (LAF)</u> 	<u>B52B Heated Oxygen Sensor 2 (LUK/LHU/LAF/LTD)</u>
B52B	Heated Oxygen Sensor 2	LDK	In the engine compartment, left rear side of the engine	-	<u>B52B Heated Oxygen Sensor 2 (LDK)</u>
B52B	Heated Oxygen Sensor 2	LTD	In the engine compartment, left rear side of the engine	-	<u>B52B Heated Oxygen Sensor 2 (LTD)</u>
B52B	Heated Oxygen Sensor 2	LLU	In the engine compartment, left front side of the engine	<u>Engine Components - Rear (LLU)</u>	<u>B52B Heated Oxygen Sensor 2 (LLU)</u>
			In the engine		

B55	Hood Ajar Switch	-	compartment, part of the hood latch, at front center	<u>Radiator Support Components</u>	<u>B55 Hood Ajar Swit</u>
B59	Front Impact Sensor	CZ2	At the front of the engine compartment, near the hood latch, center of the grill	-	<u>B59 Front Impact S</u>
B59L	Front Impact Sensor - Left	except CZ2	In the engine compartment, mounted to the upper radiator support, on left side	<u>Radiator Support Components</u>	<u>B59L Front Impact except CZ2</u>
B59R	Front Impact Sensor - Right	except CZ2	In the engine compartment, mounted to the upper radiator support, on right side	<u>Radiator Support Components</u>	<u>B59R Front Impact Right except CZ2</u>
B60	Passenger Presence Sensor	-	In the passenger compartment, part of the passenger presence detection module, in the passenger seat cushion	<u>Bottom of the Passenger Seat Components (2 of 2)</u>	<u>B60 Passenger Pres</u>
B63LF	Side Impact Sensor - Left Front	-	In the passenger compartment, mounted to the lower left B-pillar	<u>Left Side of Passenger Compartment Components</u>	<u>B63LF Side Impact Front</u>
B63LR	Side Impact Sensor - Left Rear	AW7	In the passenger compartment, mounted to the lower left C-pillar	<u>Left Side of Passenger Compartment Components</u>	<u>B63LR Side Impact Left Rear (AW7)</u>
B63RF	Side Impact Sensor - Right Front	-	In the passenger compartment, mounted to the lower right B-	<ul style="list-style-type: none"> • <u>Center and Right Side of Passenger Compartment Components</u> • <u>Lower Right Side</u> 	<u>B63RF Side Impact Right Front</u>

			pillar	<u>of the Passenger Compartment Components</u>	
B63RR	Side Impact Sensor - Right Rear	AW7	In the passenger compartment, mounted to the lower right C- pillar	<u>Center and Right Side of Passenger Compartment Components</u>	<u>B63RR Side Impact Right Rear (AW7)</u>
B65	Intake Manifold Pressure and Air Temperature Sensor	LDK	At the front of the engine, in the intake	<u>Engine Components - Front (LDK)</u>	<u>B65 Intake Manifold and Air Temperature (LDK)</u>
B65	Intake Manifold Pressure and Air Temperature Sensor	LLU	In the engine compartment, left front of the engine, in the intake	<u>Engine Components - Front (LLU)</u>	<u>B65 Intake Manifold and Air Temperature (LLU)</u>
B68	Knock Sensor	LUK/ LAF/ LTD	In the engine compartment, mounted to the front of block near oil filter housing	<ul style="list-style-type: none"> • <u>Left Front of Engine Components (LUK 2 of 2)</u> • <u>Engine Components - Front (LAF 1 of 2)</u> 	<u>B68 Knock Sensor LUK/LAF/LTD</u>
B68	Knock Sensor	LLU	In the engine compartment, mounted to the front of block near oil filter housing	<u>Engine Components - Rear (LLU)</u>	<u>B68 Knock Sensor (</u>
B68A	Knock Sensor 1	LHU/ LDK	In the engine compartment, mounted to the front of block near A/C compressor	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Engine Components - Front (LDK)</u> • <u>Engine Components - Front (LTD)</u> 	<u>B68A Knock Sensor LHU/LDK</u>
B68B	Knock Sensor 2	LHU/ LDK	In the engine compartment, mounted to the front of block near oil filter housing	<u>Engine Components - Front (LDK)</u>	<u>B68B Knock Sensor</u>
			In the engine		

B74	Manifold Absolute Pressure Sensor	LUK/ LTD	compartment, mounted to the top of the intake manifold rearward of throttle body	<u>Left Front of Engine Components (LUK 1 of 2)</u>	<u>B74 Manifold Absolute Sensor LUK/LTD</u>
B74	Manifold Absolute Pressure Sensor	LHU/ LDK	In the engine compartment, mounted to the top of the intake manifold above the throttle body	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Engine Components - Front (LAF 2 of 2)</u> • <u>Engine Components - Top (LDK)</u> • <u>Engine Components - Front (LTD)</u> • <u>Engine Components - Rear (LLU)</u> 	<u>B74 Manifold Absolute Sensor LHU/LDK</u>
B75B	Mass Air Flow/Intake Air Temperature Sensor	LUK/ LTD/ LLU	In the engine compartment, right middle, mounted to the upper air cleaner housing	<ul style="list-style-type: none"> • <u>Right Side of Engine Compartment Components</u> • <u>Engine Components - Front (LTD)</u> 	<ul style="list-style-type: none"> • <u>B75B Mass Air Flow/Intake Air Temperature LUK/LTD</u>
B75C	Multifunction Intake Air Sensor	LHU/ LDK	In the engine compartment, right middle, mounted to the upper air cleaner housing	-	<u>B75C Multifunction Sensor LHU/LDK</u>
B78A	Front Object Sensor - Left Outer	UD5	In the front fascia, left outer position	-	<u>B78A Front Object Outer (UD5)</u>
B78B	Front Object Sensor - Right Outer	UD5	In the front fascia, right outer position	-	<u>B78B Front Object Right Outer (UD5)</u>
B78C	Front Object Sensor - Left Middle	UD5	In the front fascia, left middle position	-	<u>B78C Front Object Middle (UD5)</u>
B78D	Front Object Sensor	UD5	In the front fascia, right	-	<u>B78D Front Object</u>

	- Right Middle		middle position		<u>Right Middle (UD5)</u>
B78E	Rear Object Sensor - Left Middle	UD5 or UD7	At the rear of the vehicle, mounted to the rear bumper cover, left of center	<u>Rear of Vehicle Components</u>	<u>B78E Rear Object S Middle (UD5 or UD</u>
B78F	Rear Object Sensor - Right Middle	UD5 or UD7	At the rear of the vehicle, mounted to the rear bumper cover, right of center	<u>Rear of Vehicle Components</u>	<u>B78F Rear Object S Middle (UD5 or UD</u>
B78G	Rear Object Sensor - Left Outer	UD5 or UD7	At the rear of the vehicle, mounted to the rear bumper cover, near left corner	<u>Rear of Vehicle Components</u>	<u>B78G Rear Object S Outer (UD5 or UD7</u>
B78H	Rear Object Sensor - Right Outer	UD5 or UD7	At the rear of the vehicle, mounted to the rear bumper cover, near right corner	<u>Rear of Vehicle Components</u>	<u>B78H Rear Object S Right Outer (UD5 o</u>
B80	Park Brake Switch	except J71/CZ2	Under the center console	-	<u>B80 Park Brake Sw J71/CZ2</u>
B81B	Park Position Switch	MDK or MH8	In the passenger compartment, part of the transmission shift lever	<u>Automatic Transmission Shifter Components (MDK, MH8, MHH, or MHK)</u>	-
B88D	Seat Belt Switch - Driver	-	In the passenger compartment, mounted to the inboard side of the driver seat, part of the seat belt buckle	<u>Rear of Driver Seat Components</u>	<u>B88D Seat Belt Swit</u>
B88LR	Seat Belt Switch - Left Rear	-	In the passenger compartment, part of the left rear seat belt buckle	-	<u>B88LR Seat Belt Sw Rear CZ2</u>
	Seat Belt Switch -		In the passenger compartment,	<u>Lower Right Side of the</u>	<u>B88MR Seat Belt Sv</u>

B88MR	Rear Middle	-	part of the middle rear seat belt buckle	<u>Passenger Compartment Components</u>	<u>Middle CZ2</u>
B88P	Seat Belt Switch - Passenger	-	In the passenger compartment, mounted to the inboard side of the passenger seat, part of the seat belt buckle	<u>Rear of Passenger Seat Components</u>	<u>B88P Seat Belt Switch - Passenger</u>
B88RR	Seat Belt Switch - Right Rear	CZ2	In the passenger compartment, part of the right rear seat belt buckle	<u>Lower Right Side of the Passenger Compartment Components</u>	<u>B88RR Seat Belt Switch - Right Rear CZ2</u>
B99	Steering Wheel Angle Sensor	-	In the passenger compartment, in the steering column, behind steering wheel air bag coil	<u>Steering Column and Wheel Components</u>	<u>B99 Steering Wheel Angle Sensor</u>
B107	Accelerator Pedal Position Sensor	-	In the passenger compartment, mounted to the bulkhead, in driver foot well	-	<u>B107 Accelerator Pedal Position Sensor</u>
B108	Air Quality Sensor	CZ2	At the left rear of the engine compartment, near the windshield	-	<u>B108 Air Quality Sensor</u>
B111B	Turbocharger Boost/Intake Air Temperature Sensor	LHU	In the engine compartment, in the intake duct below the throttle body	<u>Front of Engine Components (LHU)</u>	<u>B111B Turbocharger Boost/Intake Air Temperature Sensor (LHU)</u>
B115	Vehicle Speed Sensor	MR6	In the engine compartment, on the top of the transmission	<u>Manual Transmission Components (MR6)</u>	<u>B115 Vehicle Speed Sensor (MR6)</u>
B117	Rain Sensor	CE1	On the top center of the windshield	-	<u>B117 Rain Sensor (CE1)</u>
B118B	Windshield Washer	-	In the left front wheel well, forward of	<u>Radiator Support</u>	<u>B118B Windshield Washer</u>

	Fluid Level Switch		wheel, mounted to the washer fluid reservoir	<u>Components</u>	<u>Level Switch</u>
B119	Multi-axis Acceleration Sensor	-	In the passenger compartment, below the floor console, mounted to the floor	<u>Center and Right Side of Passenger Compartment Components</u>	<u>B119 Multi-axis Acc Sensor</u>
B150	Fuel Tank Pressure Sensor	-	In the vehicle underbody, mounted to the EVAP canister, below rear seats	<u>Fuel Tank Components</u>	<u>B150 Fuel Tank Pre</u>
B153D	Seat Belt Buckle - Driver	-	In the passenger compartment, mounted to the inboard side of the driver seat	-	-
B153P	Seat Belt Buckle - Passenger	-	In the passenger compartment, mounted to the inboard side of the passenger seat	-	-
B157	Secondary Air Injection Pressure Sensor	LUK	In the engine compartment, right rear of the engine upper position	<u>Left Rear of Engine Components (LUK)</u>	-
B160	Windshield Temperature and Inside Moisture Sensor	-	In the passenger compartment, mounted to the top of windshield right of center	<u>Inside of Roof and Windshield Components</u>	<u>B160 Windshield Te and Inside Moisture</u>
B161LF	Vertical Suspension Acceleration Sensor - Left Front	F45	In the vehicle underbody, mounted to left strut, near bottom	-	-
B161RF	Vertical Suspension Acceleration Sensor - Right Front	F45	In the vehicle underbody, mounted to right strut, near bottom	-	-

B162LF	Vertical Body Acceleration Sensor - Left Front	F45	In the engine compartment, forward of left strut mounting	-	<u>B162LF Vertical Body Acceleration Sensor (F45)</u>
B162R	Vertical Body Acceleration Sensor - Rear	F45	In the rear compartment, behind trim, at left front of compartment	-	<u>B162R Vertical Body Acceleration Sensor</u>
B162RF	Vertical Body Acceleration Sensor - Right Front	F45	In the engine compartment, forward of right strut mounting	-	<u>B162RF Vertical Body Acceleration Sensor Front (F45)</u>
B182	Gear Shift Position Sensor	MDK	In the engine compartment, part of the transmission control module, mounted to the top of the transmission	-	-
B192	Throttle Inlet Absolute Pressure Sensor	LHU	In the engine compartment, near the throttle body	-	<u>B192 Throttle Inlet Pressure Sensor</u>
B198	Fuel Composition Sensor	FHS	In the vehicle underbody, forward of middle near center	-	<u>B198 Fuel Composition (FHS)</u>
B235	Starter/Generator Coolant Temperature Sensor	HP6	In the vehicle engine compartment, mounted to the starter/generator	-	<u>B235 Starter/Generator Temperature Sensor</u>
C1	Battery	-	In the engine compartment, near left front, under fuse block - battery	<u>Left Side of Engine Compartment Components</u>	<ul style="list-style-type: none"> • <u>C1 Battery (-) Negative Cable</u> • <u>C1 Battery (-) Harness</u> • <u>C1 Battery (+)</u>
C3	Telematics Communication Interface Control	-	In the passenger compartment, mounted to the instrument panel, below the telematics	-	<u>C3 Telematics Communication Interface Control Module Battery</u>

	Module Battery		communication interface control module		
E1C	Accent Lamp - Driver Door Handle	-	In the passenger compartment, on the driver door, near the inside door handle	-	<u>E1C Accent Lamp - Handle</u>
E1D	Accent Lamp - Driver Door	-	In the passenger compartment, on the driver door	-	<u>E1D Accent Lamp -</u>
E1M	Accent Lamp - Passenger Door Handle	-	In the passenger compartment, on the passenger door, near the inside door handle	-	<u>E1M Accent Lamp - Door Handle</u>
E1P	Accent Lamp - Passenger Door	-	In the passenger compartment, on the passenger door	-	<u>E1P Accent Lamp - Door</u>
E2LF	Side Marker Lamp - Left Front	T4A	At the front of the vehicle, in the left headlamp, most outboard lamp	<u>Front of Vehicle Components</u>	<u>E2LF Side Marker Front (T4A)</u>
E2LF	Side Marker Lamp - Left Front	T4F	At the front of the vehicle, in the left headlamp, most outboard lamp	<u>Headlamp Components (T4F)</u>	-
E2RF	Side Marker Lamp - Right Front	T4A	At the front of the vehicle, in the right headlamp, most outboard lamp	<u>Front of Vehicle Components</u>	<u>E2RF Side Marker Right Front (T4A)</u>
E2RF	Side Marker Lamp - Right Front	T4F	At the front of the vehicle, in the right headlamp, most outboard lamp	<u>Headlamp Components (T4F)</u>	-
E4E	Headlamp - Left	T4A	At the front of the vehicle, in the left	<u>Front of Vehicle</u>	<u>E4E Headlamp - Le</u>

	High Beam		headlamp, lower inboard lamp	<u>Components</u>	<u>Beam (T4A)</u>
E4F	Headlamp - Right High Beam	T4A	At the front of the vehicle, in the right headlamp, lower inboard lamp	<u>Front of Vehicle Components</u>	<u>E4F Headlamp - Ri Beam (T4A)</u>
E4G	Headlamp - Left Low Beam	T4A	At the front of the vehicle, in the left headlamp, lower outboard lamp	<u>Front of Vehicle Components</u>	<u>E4G Headlamp - Le (T4A)</u>
E4G	Headlamp - Left Low Beam	T4F	At the front of the vehicle, in the left headlamp, lower inboard lamp	<u>Headlamp Components (T4F)</u>	<u>E4G Headlamp - Le (T4F)</u>
E4H	Headlamp - Right Low Beam	T4A	At the front of the vehicle, in the right headlamp, lower outboard lamp	<u>Front of Vehicle Components</u>	<u>E4H Headlamp - Ri Beam (T4A)</u>
E4H	Headlamp - Right Low Beam	T4F	At the front of the vehicle, in the right headlamp, lower inboard lamp	<u>Headlamp Components (T4F)</u>	<u>E4H Headlamp - Ri Beam (T4F)</u>
E4J	Park Lamp - Left Front	T4F	At the front of the vehicle, in the left headlamp, upper outboard corner	<u>Headlamp Components (T4F)</u>	-
E4K	Park Lamp - Right Front	T4F	At the front of the vehicle, in the right headlamp, upper outboard corner	<u>Headlamp Components (T4F)</u>	-
			At the front of the vehicle, in		

E4LF	Turn Signal Lamp - Left Front	T4A	the left headlamp, upper inner lamp	<u>Front of Vehicle Components</u>	-
E4LF	Turn Signal Lamp - Left Front	T4F	At the front of the vehicle, in the left headlamp, lower middle lamp	<u>Headlamp Components (T4F)</u>	-
E4N	Park/Turn Signal Lamp - Left	T4A	At the front of the vehicle, in the left headlamp, upper middle lamp	<u>Front of Vehicle Components</u>	<u>E4N Park/Turn Signal Left (T4A)</u>
E4P	Park/Turn Signal Lamp - Right	T4A	At the front of the vehicle, in the right headlamp, upper middle lamp	<u>Front of Vehicle Components</u>	<u>E4P Park/Turn Signal Right (T4A)</u>
E4RF	Turn Signal Lamp - Right Front	T4A	At the front of the vehicle, in the right headlamp, upper inner lamp	<u>Front of Vehicle Components</u>	-
E4RF	Turn Signal Lamp - Right Front	T4F	At the front of the vehicle, in the right headlamp, lower middle lamp	<u>Headlamp Components (T4F)</u>	-
E4Y	Turn Signal Repeater Lamp - Left	-	At the left of the vehicle, in the right headlamp, lower middle lamp	<u>Front of Vehicle Components</u>	-
E4Z	Turn Signal Repeater Lamp - Right	-	At the right of the vehicle, in the right headlamp, lower middle lamp	<u>Front of Vehicle Components</u>	-
			At the rear of		

E5A	Backup Lamp - Left	-	the vehicle, left tail lamp assembly, lower inboard lamp	<u>Rear of Vehicle Components</u>	<u>E5A Backup Lamp</u>
E5AK	Tail Lamp - Left Outer	-	At the rear of the vehicle, on left side, upper outboard lamp	<u>Rear of Vehicle Components</u>	<u>E5AK Tail Lamp - L</u>
E5AL	Tail Lamp - Right Outer	-	At the rear of the vehicle, on right side, upper outboard lamp	<u>Rear of Vehicle Components</u>	<u>E5AL Tail Lamp - R</u>
E5AM	Stop/Turn Signal Lamp - Left	-	At the rear of the vehicle, left tail lamp assembly, lower outboard lamp	<u>Rear of Vehicle Components</u>	<u>E5AM Stop/Turn Signal Lamp - Left</u>
E5AN	Stop/Turn Signal Lamp - Right	-	At the rear of the vehicle, right tail lamp assembly, lower outboard lamp	<u>Rear of Vehicle Components</u>	<u>E5AN Stop/Turn Signal Lamp - Right</u>
E5B	Backup Lamp - Right	-	At the rear of the vehicle, right tail lamp assembly, lower inboard lamp	<u>Rear of Vehicle Components</u>	<u>E5B Backup Lamp</u>
E5G	Tail Lamp - Left Inner	-	At the rear of the vehicle, left tail lamp assembly, upper inboard lamp	<u>Rear of Vehicle Components</u>	<u>E5G Tail Lamp - Left</u>
E5H	Tail Lamp - Right Inner	-	At the rear of the vehicle, right tail lamp assembly, upper inboard lamp	<u>Rear of Vehicle Components</u>	<u>E5H Tail Lamp - Right</u>
E6	Center High Mounted Stop Lamp	-	At the rear of the vehicle, mounted to the rear compartment lid	<u>Rear of Vehicle Components</u>	<u>E6 Center High Mounted Stop Lamp</u>
	License Plate Lamp		At the rear of the vehicle, mounted to the	<u>Rear of Vehicle</u>	

E7L	- Left	-	rear bumper cover, left of center, above license plate	<u>Components</u>	<u>E7L License Plate I</u>
E7R	License Plate Lamp - Right	-	At the rear of the vehicle, mounted to the rear bumper cover, right of center, above license plate	<u>Rear of Vehicle Components</u>	<u>E7R License Plate I</u>
E8D	Door Courtesy Lamp - Driver	-	On the driver door, mounted to bottom of door trim panel	<u>Driver Door Components</u>	<u>E8D Door Courtesy Driver</u>
E8J	Instrument Panel Courtesy Lamp - Left	-	In the passenger compartment, mounted to the kick panel, left side of the driver foot well	-	<u>E8J Instrument Par Lamp - Left</u>
E8K	Instrument Panel Courtesy Lamp - Right	-	In the passenger compartment, mounted to the kick panel, right side of the passenger foot well	-	<u>E8K Instrument Pa Lamp - Right</u>
E8P	Door Courtesy Lamp - Passenger	-	On the passenger door, mounted to bottom of door trim panel	<u>Passenger Door Components</u>	<u>E8P Door Courtesy Passenger</u>
E8S	Rear Compartment Courtesy Lamp	-	At the rear of the vehicle, inside the rear compartment, forward of opening	-	<u>E8S Rear Comparti Courtesy Lamp</u>
E13L	Headlamp - Left	-	At the front of the vehicle, left side	<ul style="list-style-type: none"> • <u>Front of Vehicle Components</u> • <u>Headlamp Components (T4F)</u> 	-
E13R	Headlamp - Right	-	At the front of the vehicle,	<ul style="list-style-type: none"> • <u>Front of Vehicle Components</u> 	-

			right side	<ul style="list-style-type: none"> • <u>Headlamp Components (T4F)</u> 	
E14A	Seat Heating Element - Driver Back	KA1	In the passenger compartment, driver seat back cover	<u>Bottom of Driver Seat Components (except A45)</u>	<u>E14A Seat Heating Driver Back (KA1)</u>
E14B	Seat Heating Element - Driver Cushion	KA1	In the passenger compartment, driver seat cushion cover	<u>Rear of Driver Seat Components</u>	<u>E14B Seat Heating Driver Cushion KA</u>
E14C	Seat Heating Element - Passenger Back	KA1	In the passenger compartment, passenger seat back cover	<u>Bottom of Passenger Seat Components (1 of 2)</u>	<u>E14C Seat Heating Passenger Back (KA</u>
E14D	Seat Heating Element - Passenger Cushion	KA1	In the passenger compartment, passenger seat cushion cover	<ul style="list-style-type: none"> • <u>Rear of Passenger Seat Components</u> • <u>Bottom of the Passenger Seat Components (2 of 2)</u> 	<u>E14D Seat Heating Passenger Cushion (</u>
E17D	Outside Rearview Mirror Glass - Driver	-	On the outside of the driver door, part of the outside rearview mirror - driver, at front	<u>Driver Door Components</u>	<ul style="list-style-type: none"> • <u>E17D Outside Mirror Glass</u> • <u>E17D Outside Mirror Glass</u>
E17P	Outside Rearview Mirror Glass - Passenger	-	On the outside of the passenger door, part of the outside rearview mirror - passenger, at front	<u>Passenger Door Components</u>	<ul style="list-style-type: none"> • <u>E17P Outside Mirror Glass X1</u> • <u>E17P Outside Mirror Glass X2</u>
E18	Rear Defogger Grid	except CZ2	At the rear of the passenger compartment, part of the rear window	<u>Rear of Vehicle Components</u>	<ul style="list-style-type: none"> • <u>E18 Rear Def X1 except CZ</u> • <u>E18 Rear Def X2 except CZ</u>
E18	Rear Defogger Grid	CZ2	At the rear of the passenger compartment, part of the rear window	<u>Rear of Vehicle Components</u>	<ul style="list-style-type: none"> • <u>E18 Rear Def X1 CZ2</u> • <u>E18 Rear Def X2 CZ2</u>
	Instrument Panel		In the passenger compartment, top of the		<u>E27 Instrument Par</u>

E27	Compartment Lamp	-	instrument panel compartment	-	<u>Compartment Lamp</u>
E29LF	Fog Lamp - Left Front	T3U except CZ2	At the front of the vehicle, left side lower	<u>Front of Vehicle Components</u>	<u>E29LF Fog Lamp - T3U except CZ2</u>
E29LF	Fog Lamp - Left Front	CZ2	At the front of the vehicle, left side lower	<u>Front of Vehicle Components</u>	<u>E29LF Fog Lamp - CZ2</u>
E29LR	Fog Lamp - Left Rear	CZ2	Outside the vehicle, part of the left tail lamp assembly	-	-
E29RF	Fog Lamp - Right Front	T3U except CZ2	At the front of the vehicle, right side lower	<u>Front of Vehicle Components</u>	<u>E29RF Fog Lamp - T3U except CZ2</u>
E29RF	Fog Lamp - Right Front	CZ2	At the front of the vehicle, right side lower	<u>Front of Vehicle Components</u>	<u>E29RF Fog Lamp - CZ2</u>
E31L	Sunshade Mirror Lamp - Left	CZ2	On the left front of the headliner	-	<u>E31L Sunshade Mirror Lamp - Left CZ2</u>
E31R	Sunshade Mirror Lamp - Right	CZ2	On the right front of the headliner	-	<u>E31R Sunshade Mirror Lamp - Right CZ2</u>
E32F	Cigarette Lighter Receptacle - Front	CZ2	Under the center console	-	<u>E32F Cigarette Lighter Receptacle - Front CZ2</u>
E32R	Cigarette Lighter Receptacle - Rear	CZ2	Inside the center console compartment	-	<u>E32R Cigarette Lighter Receptacle - Rear CZ2</u>
E37D	Dome/Reading Lamps - Front Overhead Console	-	In the passenger compartment, mounted to the overhead console at front center of roof	<u>Headliner Components</u>	<u>E37D Dome/Reading Lamps - Front Overhead Console</u>
E37R	Dome/Reading Lamps - Rear	-	In the passenger compartment, mounted to the headliner rear of center	<u>Headliner Components</u>	<u>E37R Dome/Reading Lamps - Rear</u>
E41	Engine Coolant Thermostat Heater	LLU	Inside the engine compartment, attached to the thermostat housing located	<u>Engine Components - Front (LLU)</u>	-

			at the rear of the engine, above the transmission		
E42L	Tail Lamp Assembly - Left	-	At the rear of vehicle, left corner	-	<u>E42L Tail Lamp As (CZ2)</u>
E42R	Tail Lamp Assembly - Right	-	At the rear of vehicle, right corner	-	<u>E42R Tail Lamp As Right CZ2</u>
E45	Positive Crankcase Ventilation Heater	LLU	On the top front right side of the engine	<u>Engine Components - Front (LLU)</u>	<u>E45 Positive Crankcase Ventilation Heater I</u>
E55D	Flood Lamp - Driver Door Pocket	-	In the driver door trim panel, above door compartment	<u>Driver Door Components</u>	<u>E55D Flood Lamp - Pocket</u>
E55P	Flood Lamp - Passenger Door Pocket	-	In the passenger door trim panel, above door compartment	<u>Passenger Door Components</u>	<u>E55P Flood Lamp - Door Pocket</u>
F101	Passenger Instrument Panel Air Bag	except CZ2	In the passenger compartment, mounted behind the passenger side of the instrument panel, above compartment	<u>Instrument Panel and Floor Console Components</u>	<ul style="list-style-type: none"> • <u>F101 Passenger Instrument Panel Air Bag X1 except CZ2</u> • <u>F101 Passenger Instrument Panel Air Bag X2 except CZ2</u> • <u>F101 Passenger Instrument Panel Air Bag X3 except CZ2</u>
F101	Passenger Instrument Panel Air Bag	CZ2	In the passenger compartment, mounted behind the passenger side of the instrument panel, above compartment	<u>Instrument Panel and Floor Console Components</u>	<u>F101 Passenger Instrument Panel Air Bag CZ2</u>
F102	Hybrid/EV Battery Pack Cable Cover	HP6	In the luggage compartment, part of the starter/generator control module	-	<u>F102 Hybrid/EV Battery Pack Cable Cover (HP6)</u>
	Roof Rail Air Bag -		In the passenger compartment, behind the	<u>Inside of Roof and</u>	

F105L	Left	-	headliner, mounted to the roof, at left side	<u>Windshield Components</u>	<u>F105L Roof Rail Air Bag</u>
F105R	Roof Rail Air Bag - Right	-	In the passenger compartment, behind the headliner, mounted to the roof, at right side	<u>Inside of Roof and Windshield Components</u>	<u>F105R Roof Rail Air Bag</u>
F106LF	Seat Air Bag - Left Front	-	In the passenger compartment, mounted to the outboard side of the left front seat back frame	<u>Bottom of Driver Seat Components (except A45)</u>	<ul style="list-style-type: none"> • <u>F106LF Seat Air Bag Left Front except A45</u> • <u>F106LF Seat Air Bag Left Front C/Z</u>
F106LR	Seat Air Bag - Left Rear	AW7	In the passenger compartment, mounted to the outboard side of the left rear seat	-	<u>F106LR Seat Air Bag (AW7)</u>
F106RF	Seat Air Bag - Right Front	-	In the passenger compartment, mounted to the outboard side of the right front seat back frame	<u>Bottom of Passenger Seat Components (1 of 2)</u>	<ul style="list-style-type: none"> • <u>F106RF Seat Air Bag Right Front except A45</u> • <u>F106RF Seat Air Bag Right Front C/Z</u>
F106RR	Seat Air Bag - Right Rear	AW7	In the passenger compartment, mounted to the outboard side of the right rear seat	-	<u>F106RR Seat Air Bag Rear (AW7)</u>
F107	Steering Wheel Air Bag	-	In the passenger compartment, mounted to the center of the steering wheel	<u>Instrument Panel and Floor Console Components</u>	<ul style="list-style-type: none"> • <u>F107 Steering Wheel Air Bag X1</u> • <u>F107 Steering Wheel Air Bag X2</u>
F112D	Seat Belt Retractor Pretensioner - Driver	-	In the passenger compartment, mounted to the base of the driver B-pillar	<u>Left Side of Passenger Compartment Components</u>	<u>F112D Seat Belt Retractor Pretensioner - Driver</u>
	Seat Belt Retractor		In the passenger compartment,	<ul style="list-style-type: none"> • <u>Center and Right Side of Passenger Compartment</u> 	

F112P	Pretensioner - Passenger	-	mounted to the base of the passenger B-pillar	<u>Components</u> <ul style="list-style-type: none"> <u>Lower Right Side of the Passenger Compartment Components</u> 	<u>F112P Seat Belt Ret Pretensioner - Passe</u>
F113D	Seat Belt Anchor Pretensioner - Driver	-	In the passenger compartment, mounted to the outboard side of the driver seat cushion frame	<u>Bottom of Driver Seat Components (except A45)</u>	<u>F113D Seat Belt An Pretensioner - Drive</u>
F113P	Seat Belt Anchor Pretensioner - Passenger	-	In the passenger compartment, mounted to the outboard side of the passenger seat cushion frame	<u>Bottom of Passenger Seat Components (1 of 2)</u>	<u>F113P Seat Belt An Pretensioner - Passe</u>
G5	Transmission Fluid Pump - Auxiliary	HP6	In the engine compartment on the transmission assembly	-	<u>G5 Transmission Fl Auxiliary (HP6)</u>
G8	Coolant Pump - Auxiliary	HP6	In the engine compartment mounted to the engine	-	<u>G8 Coolant Pump - (HP6)</u>
G10	Cooling Fan Motor	LAF	In the engine compartment, rearward of the radiator support	-	<u>G10 Cooling Fan M</u>
G10	Cooling Fan Motor	LTD	In the engine compartment, rearward of the radiator support	-	<u>G10 Cooling Fan M</u>
G10L	Cooling Fan Motor - Left	LHU/LDK	In the engine compartment, rearward of the radiator support, left of center	<ul style="list-style-type: none"> <u>Radiator Support Components</u> <u>Engine Cooling Fan Components (LHU)</u> 	<ul style="list-style-type: none"> <u>G10L Cooling Left LUK</u> <u>G10L Cooling Left LHU</u>
G10R	Cooling Fan Motor - Right	LUK/ LHU/ LDK	In the engine compartment, rearward of the radiator support, right of center	<ul style="list-style-type: none"> <u>Radiator Support Components</u> <u>Engine Cooling Fan Components (LHU)</u> 	<ul style="list-style-type: none"> <u>G10R Cooling Right LUK</u> <u>G10R Cooling Right LHU/L</u>

G12	Fuel Pump	LTD	Under the vehicle, in the fuel tank	-	<u>G12 Fuel Pump LTD</u>
G13	Generator	-	In the engine compartment, at right front of engine	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Engine Components - Front (LAF 1 of 2)</u> • <u>Engine Components - Front (LDK)</u> • <u>Engine Components - Front (LTD)</u> • <u>Engine Components - Rear (LLU)</u> 	<ul style="list-style-type: none"> • <u>G13 Generator LHU/LDK</u> • <u>G13 Generator</u> • <u>G13 Generator</u> • <u>G13 Generator</u>
G14	Hybrid/EV Battery Pack Cooling Fan	HP6	In the trunk compartment, front side under the rear shelf	<u>Hybrid/EV Battery Pack (HP6)</u>	<u>G14 Hybrid/EV Battery Pack Cooling Fan (HP6)</u>
G16	Headlamp Washer Pump	CE4/CZ2	In the engine compartment, left side of the engine	-	<u>G16 Headlamp Washer Pump CE4/CZ2</u>
G17	Heater Coolant Pump	HP6	In the engine compartment	-	<u>G17 Heater Coolant Pump (HP6)</u>
G18	High Pressure Fuel Pump	-	In the engine compartment, at left front upper of engine	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 1 of 2)</u> • <u>Engine Components - Front (LAF 1 of 2)</u> 	<u>G18 High Pressure Fuel Pump</u>
G21	Secondary Air Injection Pump	NU6	In the engine compartment, middle center lower, at front of engine mounted to oil pan	<ul style="list-style-type: none"> • <u>Left Front of Engine Components (LUK 1 of 2)</u> 	<u>G21 Secondary Air Injection Pump (NU6)</u>

G24	Windshield Washer Pump	-	In the left front wheel well, forward of wheel, mounted to the washer fluid reservoir	<u>Radiator Support Components</u>	<u>G24 Windshield Washer Pump</u>
G25D	Seat Lumbar Adjuster Pump - Driver	APG	In the driver seat back	-	<u>G25D Seat Lumbar Adjuster Pump - Driver (APG)</u>
G25P	Seat Lumbar Adjuster Pump - Passenger	APG	In the passenger seat back	-	<u>G25P Seat Lumbar Adjuster Pump - Passenger (APG)</u>
G43	Starter/Generator Coolant Pump	HP6	In the engine compartment, left lower front corner of engine	<u>Left Front of Engine Components (LUK 1 of 2)</u>	<u>G43 Starter/Generator Coolant Pump (HP6)</u>
K8	Blower Motor Control Module	-	In the passenger compartment, mounted to HVAC module, in passenger foot well	<u>HVAC Module Components</u>	<ul style="list-style-type: none"> • <u>K8 Blower Motor Control Module X1</u> • <u>K8 Blower Motor Control Module X2</u>
K9	Body Control Module	-	In the passenger compartment, mounted to the instrument panel behind driver knee bolster	<u>Behind Lower Left Side of Instrument Panel Components</u>	<ul style="list-style-type: none"> • <u>K9 Body Control Module X1</u> • <u>K9 Body Control Module X2</u> • <u>K9 Body Control Module X3</u> • <u>K9 Body Control Module X4</u> • <u>K9 Body Control Module X5</u> • <u>K9 Body Control Module X6</u> • <u>K9 Body Control Module X7</u>
K16	Battery Energy Control Module	HP6	In the trunk, front on the battery pack, under the rear shelf	-	<ul style="list-style-type: none"> • <u>K16 Battery Energy Control Module</u> • <u>K16 Battery Energy Control Module</u> • <u>K16 Battery Energy Control Module</u> • <u>K16 Battery Energy Control Module</u>

					<u>Control Modu</u> <ul style="list-style-type: none"> • <u>K16 Battery F</u> <u>Control Modu</u>
K17	Electronic Brake Control Module	-	In the engine compartment, left rear, forward of the vacuum brake booster	-	<u>K17 Electronic Bral</u> <u>Module</u>
K19	Suspension Control Module	F45	In the rear compartment, behind trim, at left rear of compartment	-	<u>K19 Suspension Coi</u> <u>(F45)</u>
K20	Engine Control Module	-	In the engine compartment, near left front, mounted to the right of the battery	<u>Left Side of Engine</u> <u>Compartment</u> <u>Components</u>	<ul style="list-style-type: none"> • <u>K20 Engine C</u> <u>Module X1 (L</u> • <u>K20 Engine C</u> <u>Module X1 (L</u> • <u>K20 Engine C</u> <u>Module X1 (L</u> • <u>K20 Engine C</u> <u>Module X1 (L</u> • <u>K20 Engine C</u> <u>Module X1 (L</u> • <u>K20 Engine C</u> <u>Module X1 (L</u> • <u>K20 Engine C</u> <u>Module X2 (L</u> • <u>K20 Engine C</u> <u>Module X2 (L</u> <u>NU6)</u> • <u>K20 Engine C</u> <u>Module X2 (L</u> <u>NU6)</u> • <u>K20 Engine C</u> <u>Module X2 L/</u> • <u>K20 Engine C</u> <u>Module X2 LI</u> • <u>K20 Engine C</u> <u>Module X2 (L</u> • <u>K20 Engine C</u> <u>Module X2 (L</u> • <u>K20 Engine C</u>

					<u>Module X3 (L</u> <ul style="list-style-type: none"> • <u>K20 Engine C</u> <u>Module X3 (L</u> • <u>K20 Engine C</u> <u>Module X3 (L</u> • <u>K20 Engine C</u> <u>Module X3 (L</u>
K26	Headlamp Control Module	TR7	-	-	<ul style="list-style-type: none"> • <u>K26 Headlam</u> <u>Module X1 (T</u> • <u>K26 Headlam</u> <u>Module X2 (T</u>
K29	Seat Heating Control Module	KA1	In the passenger compartment, mounted to the bottom of driver seat	<u>Bottom of Driver Seat Components (except A45)</u>	<ul style="list-style-type: none"> • <u>K29 Seat Hea</u> <u>Module X1 (K</u> • <u>K29 Seat Hea</u> <u>Module X2 (K</u> • <u>K29 Seat Hea</u> <u>Module X3 (K</u>
K32	Steering Wheel Heating Control Module	UVD	-	-	<u>K32 Steering Wheel Control Module (U</u>
K33	HVAC Control Module	-	In the passenger compartment, mounted to the instrument panel, behind info display module	<u>HVAC Module Components</u>	<ul style="list-style-type: none"> • <u>K33 HVAC C</u> <u>Module X1</u> • <u>K33 HVAC C</u> <u>Module X2</u> • <u>K33 HVAC C</u> <u>Module X3</u> • <u>K33 HVAC C</u> <u>Module X4 (C</u>
K35	Ignition Control Module	LLU	Inside engine compartment, located at top center of engine	<u>Engine Components - Front (LLU)</u>	<u>K35 Ignition Contr</u> <u>(LLU)</u>
K36	Inflatable Restraint Sensing and Diagnostic Module	-	In the passenger compartment, below the instrument panel, mounted to the floor	<u>Center and Right Side of Passenger Compartment Components</u>	<ul style="list-style-type: none"> • <u>K36 Inflatable</u> <u>Sensing and D</u> <u>Module X1</u> • <u>K36 Inflatable</u> <u>Sensing and D</u> <u>Module X2 (A</u> • <u>K36 Inflatable</u> <u>Sensing and D</u> <u>Module X2 (A</u> • <u>K36 Inflatable</u>

					<u>Sensing and D</u> <u>Module X2 (C</u>
K38	Chassis Control Module	LUK	In the rear compartment, behind trim, at right rear of compartment	<u>Right Side of the Luggage Compartment Components</u>	<u>K38 Chassis Contro</u> <u>(LUK)</u>
K40	Seat Memory Control Module	KA1 + A45	Inside of the passenger compartment, mounted to the driver seat, bottom, forward center	<u>Bottom of the Driver Seat Components (with A45)</u>	<ul style="list-style-type: none"> • <u>K40 Seat Men</u> <u>Module X1 A4</u> • <u>K40 Seat Men</u> <u>Module X2 A4</u> • <u>K40 Seat Men</u> <u>Module X3 A4</u> • <u>K40 Seat Men</u> <u>Module X4 A4</u> • <u>K40 Seat Men</u> <u>Module X5 A4</u>
K41	Front and Rear Parking Assist Control Module	UD5	In the rear compartment, behind trim, at left rear of compartment	-	<ul style="list-style-type: none"> • <u>K41 Front and</u> <u>Parking Assis</u> <u>Module X1 (U</u> • <u>K41 Front and</u> <u>Parking Assis</u> <u>Module X2 (U</u> • <u>K41 Front and</u> <u>Parking Assis</u> <u>Module X3 (U</u>
K41R	Rear Parking Assist Control Module	UD7	In the rear compartment, behind trim, at left rear of compartment	<u>Left Side of the Luggage Compartment Components</u>	<ul style="list-style-type: none"> • <u>K41R Rear P4</u> <u>Control Modu</u> • <u>K41R Rear P4</u> <u>Control Modu</u> • <u>K41R Rear P4</u> <u>Control Modu</u> <u>with F45)</u>
K43	Power Steering Control Module	NV7 or NXC	In the passenger compartment, mounted to the instrument panel, behind left knee bolster	-	<u>K43 Power Steering</u> <u>Module (NV7 or NX</u>
K43	Power Steering Control Module	NJ1	Underneath the vehicle, mounted inside the steering	-	<ul style="list-style-type: none"> • <u>K43 Power St</u> <u>Control Modu</u> • <u>K43 Power St</u> <u>Control Modu</u>

			gear assembly		<ul style="list-style-type: none"> • <u>K43 Power St Control Modu</u>
K46	Radio Antenna Module	-	In the passenger compartment, mounted to the right of the rear window	<u>Rear of Passenger Compartment Components</u>	<u>K46 Radio Antenn: CZ2</u>
K59	Starter/Generator Control Module	HP6	In the luggage compartment, part of the starter/generator control module, top of the assembly	<u>Hybrid/EV Battery Pack (HP6)</u>	<ul style="list-style-type: none"> • <u>K59 Starter/G Control Modu</u> • <u>K59 Starter/G Control Modu</u> • <u>K59 Starter/G Control Modu</u> • <u>K59 Starter/G Control Modu</u>
K61	Sunroof Control Module	CF5/CZ2	In the passenger compartment, center of roof, in between left front door and right front door	-	<u>K61 Sunroof Contr CF5/CZ2</u>
K70	Clutch Pedal Position Sensor Signal Converter Module	MR6	In the passenger compartment Left front, mounted on the clutch pedal bracket	-	<u>K70 Clutch Pedal P Sensor Signal Conve (MR6)</u>
K71	Transmission Control Module	MDK	In the engine compartment, mounted to the top of the transmission	<u>Automatic Transmission Components (MDK)</u>	<ul style="list-style-type: none"> • <u>K71 Transmis Module X1 (M</u> • <u>K71 Transmis Module X2 (M</u>
K71	Transmission Control Module	MH8	In the engine compartment, part of the Q8 Control Solenoid Valve Assembly, mounted to the valve body inside the transmission	-	-
K73	Telematics Communication	-	In the passenger compartment, mounted to the	<u>Luggage Compartment</u>	<ul style="list-style-type: none"> • <u>K73 Telemati Communicati Control Modu</u>

	Interface Control Module		instrument panel, below the radio	<u>Components</u>	<ul style="list-style-type: none"> • <u>K73 Telematics Communication Control Module</u>
K77	Remote Control Door Lock Receiver	-	In the passenger compartment, mounted to windshield, to the right of inside rear view mirror	-	<u>K77 Remote Control Receiver</u>
K82	Mobile Telephone Control Module	CZ2	-	-	<u>K82 Mobile Telephone Module CZ2</u>
K83	Parking Brake Control Module	-	In the vehicle underbody, mounted in the left rear wheel well, rear of wheel	<u>Left Rear Wheel Housing Components</u>	<u>K83 Parking Brake Module</u>
K84	Keyless Entry Control Module	ATH or ATS	In the passenger compartment, below the right side of the instrument panel, behind the passenger kick panel	-	<ul style="list-style-type: none"> • <u>K84 Keyless Entry Module X1 (A)</u> • <u>K84 Keyless Entry Module X2 (A)</u> • <u>K84 Keyless Entry Module X3 (A)</u> • <u>K84 Keyless Entry Module X4 (A)</u>
K85	Passenger Presence Module	-	In the passenger compartment, mounted to the bottom of the seat cushion, above frame in passenger seat	<u>Rear of Passenger Seat Components</u>	<u>Rear Headliner Trim Molding</u>
K89	Immobilizer Control Module	-	In the passenger compartment, mounted to bottom of the steering column, near ignition lock cylinder	<u>Steering Column and Wheel Components</u>	<u>K89 Immobilizer Control Module</u>
K111	Fuel Pump Driver Control Module	LTG/LAF/LDK	In luggage compartment, right rear, behind trim	<u>Luggage Compartment Components</u>	<u>K111 Fuel Pump Driver Module (LTG/LAF/LDK)</u>

			panel, mounted to inboard side of bracket		
KR14	Brake Booster Pump Motor Relay	-	In the right front wheel well, mounted to the frame, forward of the axle shaft	-	<ul style="list-style-type: none"> • <u>KR14 Brake I Pump Motor] (LUK/LAF/L</u> • <u>KR14 Brake I Pump Motor]</u>
KR38	Main Contactor	HP6	In the luggage compartment, part of the starter/generator control module	-	<u>KR38 Main Contac</u>
M4	Air Inlet Door Actuator	CJ2	In the passenger compartment, mounted to the HVAC module, at top right	<u>HVAC Module Components</u>	<u>M4 Air Inlet Door A (CJ2)</u>
M6	Air Temperature Door Actuator	C67	In the passenger compartment, mounted to the HVAC module	-	<u>M6 Air Temperatur Actuator (C67)</u>
M6L	Air Temperature Door Actuator - Left	CJ2	In the passenger compartment, mounted to the HVAC module, at left	<u>HVAC Module Components</u>	<u>M6L Air Temperatu Actuator - Left (CJ</u>
M6R	Air Temperature Door Actuator - Right	CJ2	In the passenger compartment, mounted to the HVAC module, at center	<u>HVAC Module Components</u>	<u>M6R Air Temperatu Actuator - Right (C</u>
M7	Transmission Shift Lock Control Solenoid Actuator	MDK, MH8, MHH or MHK	In the passenger compartment, center, in the floor console, part of the transmission shift lever	<u>Automatic Transmission Shifter Components (MDK, MH8, MHH, or MHK)</u>	<u>M7 Transmission Sl Control Solenoid Ac (MDK, MH8, MHH</u>
M8	Blower Motor	-	In the passenger compartment, mounted to HVAC module, in passenger foot well	<u>HVAC Module Components</u>	<u>M8 BLOWER MO</u>

M9	Brake Booster Pump Motor	-	In the right front wheel well, mounted to the frame, forward of the axle shaft	<u>Radiator Support Components</u>	-
M27	Fuel Door Unlatch Actuator	-	At the rear of vehicle, mounted to backside of fuel door	-	<u>M27 Fuel Door Unlatch Actuator CZ2</u>
M28L	High Beam Solenoid Actuator - Left	T4F	At the left front of vehicle, within the headlamp assembly - left	-	-
M28R	High Beam Solenoid Actuator - Right	T4F	At the right front of vehicle, within the headlamp assembly - right	-	-
M37	Mode Door Actuator	-	In the passenger compartment, mounted to the HVAC module, at left upper	<u>HVAC Module Components</u>	<u>M37 Mode Door Actuator</u>
M40	Rear Compartment Lid Latch	-	At the rear of vehicle, mounted to backside of rear compartment lid	<u>Rear of Vehicle Components</u>	<u>M40 Rear Compartment Latch</u>
M46	Air Recirculation Door Actuator	-	In the passenger compartment, mounted to the HVAC module, at top right	<u>HVAC Module Components</u>	<u>M46 Air Recirculation Door Actuator</u>
M50D	Seat Front Vertical Motor - Driver	-	In the passenger compartment, mounted to the bottom of the driver seat at front	<ul style="list-style-type: none"> • <u>Bottom of Driver Seat Components (except A45)</u> • <u>Bottom of the Driver Seat Components (with A45)</u> 	<u>M50D Seat Front Vertical Motor - Driver</u>
			In the passenger	<ul style="list-style-type: none"> • <u>Bottom of Passenger Seat</u> 	

M50P	Seat Front Vertical Motor - Passenger	AG2	compartment, mounted to the bottom of the passenger seat at front	<u>Components (1 of 2)</u> <ul style="list-style-type: none"> • <u>Bottom of the Passenger Seat Components (2 of 2)</u> 	<u>M50P Seat Front Vertical Motor - Passenger (AG2)</u>
M51D	Seat Horizontal Motor - Driver	-	In the passenger compartment, mounted to the bottom of the driver seat at middle	<ul style="list-style-type: none"> • <u>Bottom of Driver Seat Components (except A45)</u> • <u>Bottom of the Driver Seat Components (with A45)</u> 	<u>M51D Seat Horizontal Motor - Driver</u>
M51P	Seat Horizontal Motor - Passenger	AG2	In the passenger compartment, mounted to the bottom of the passenger seat at middle	<ul style="list-style-type: none"> • <u>Bottom of Passenger Seat Components (1 of 2)</u> • <u>Bottom of the Passenger Seat Components (2 of 2)</u> 	<u>M51P Seat Horizontal Motor - Passenger (AG2)</u>
M55D	Seat Rear Vertical Motor - Driver	-	In the passenger compartment, mounted to the bottom of the driver seat, forward of middle	<ul style="list-style-type: none"> • <u>Bottom of Driver Seat Components (except A45)</u> • <u>Bottom of the Driver Seat Components (with A45)</u> 	<u>M55D Seat Rear Vertical Motor - Driver</u>
M55P	Seat Rear Vertical Motor - Passenger	AG2	In the passenger compartment, mounted to the bottom of the passenger seat, forward of middle	<ul style="list-style-type: none"> • <u>Bottom of Passenger Seat Components (1 of 2)</u> • <u>Bottom of the Passenger Seat Components (2 of 2)</u> 	<u>M55P Seat Rear Vertical Motor - Passenger (AG2)</u>
M56D	Seat Recline Motor - Driver	-	In the passenger compartment, mounted the driver seat back frame inboard side	<u>Rear of Driver Seat Components</u>	<u>M56D Seat Recline Motor - Driver</u>
			In the passenger compartment,		

M56P	Seat Recline Motor - Passenger	AG2	mounted the passenger seat back frame inboard side	<u>Rear of Passenger Seat Components</u>	<u>M56P Seat Recline] Passenger (AG2)</u>
M64	Starter Motor	-	In the engine compartment, mounted to the front of block below the oil filter housing	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 1 of 2)</u> • <u>Engine Components - Front (LAF 1 of 2)</u> • <u>Engine Components - Front (LDK)</u> • <u>Engine Components - Front (LTD)</u> • <u>Engine Components - Rear (LLU)</u> 	<ul style="list-style-type: none"> • <u>M64 Starter M</u> • <u>M64 Starter M (LLU)</u> • <u>M64 Starter M</u> • <u>M64 Starter M (Positive Batt</u> • <u>(LAF)</u> • <u>M64 Starter M (Generator H</u> • <u>(LAF)</u>
M69	Sunroof Motor	CF5	In the passenger compartment, mounted to roof above overhead console	<u>Inside of Roof and Windshield Components</u>	<u>M69 Sunroof Motor</u>
M72	Variable Power Steering Solenoid Valve	NV7 or NXC	In the engine compartment, mounted to the steering rack	-	<u>M72 Variable Power Solenoid Valve (NV</u>
M72	Variable Effort Steering Actuator	-	On the power steering assembly	-	<u>M72 VARIABLE PO STEERING SOLEN VALVE (NV7 OR N</u>
M73A	Seat Blower Motor - Driver Back	-	In the driver seat back	-	<u>M73A Seat Blower] Driver Back (KU1)</u>
M73B	Seat Blower Motor - Passenger Back	-	In the passenger seat back	-	<u>M73B Seat Blower] Passenger Back (KU</u>
M73C	Seat Blower Motor - Driver Cushion	-	Under the driver seat	-	<u>M73C Seat Blower] Driver Cushion (KU</u>
M73D	Seat Blower Motor - Passenger Cushion	-	Under the passenger seat cushion	-	<u>M73D Seat Blower] Passenger Cushion]</u>
			Inside the		

M74D	Window Motor - Driver	-	driver door, at center, mounted to window regulator	<u>Driver Door Components</u>	<u>M74D Window Mot</u>
M74LR	Window Motor - Left Rear	-	Inside the left rear door, at center, mounted to window regulator	<u>Left Rear Door Components</u>	<ul style="list-style-type: none"> • <u>M74LR Wind Left Rear (AF CZ2)</u> • <u>M74LR Wind Left Rear (AF</u> • <u>M74LR Wind Left Rear (CZ</u>
M74P	Window Motor - Passenger	-	Inside the passenger door, at center, mounted to window regulator	<u>Passenger Door Components</u>	<ul style="list-style-type: none"> • <u>M74P Window Passenger (AF</u> • <u>M74P Window Passenger (AF</u>
M74RR	Window Motor - Right Rear	-	Inside the right rear door, at center, mounted to window regulator	<u>Right Rear Door Components</u>	<ul style="list-style-type: none"> • <u>M74RR Wind Right Rear (A CZ2)</u> • <u>M74RR Wind Right Rear (A</u> • <u>M74RR Wind Right Rear (C AEQ)</u>
M75	Windshield Wiper Motor	-	In the engine compartment, at the rear, left of center under cowl	<u>Left Side of Engine Compartment Components</u>	<u>M75 WINDSHIELD MOTOR</u>
M77D	Outside Rearview Mirror Motor - Driver	-	On the outside of the driver door, part of the outside rearview mirror - driver, behind glass, at front	<u>Driver Door Components</u>	<u>M77D Outside Rear Motor - Driver</u>
M77P	Outside Rearview Mirror Motor - Passenger	-	On the outside of the passenger door, part of the outside rearview mirror - passenger, behind glass, at front	<u>Passenger Door Components</u>	<u>M77P Outside Rear Motor - Passenger</u>

M93	Key Capture Solenoid Actuator	MDK, MH8, MHH or MHK without BTM	In the passenger compartment, part of the ignition switch, mounted to steering column	<u>Steering Column and Wheel Components</u>	<u>M93 Key Capture S Actuator (MDK, M MHK without BTM</u>
M97	Fuel Door Lock Actuator	-	At the rear of vehicle, mounted to backside of body near fuel door	<u>Rear of Vehicle Components</u>	<u>M97 Fuel Door Loc</u>
P2	Transmission Shift Lever Position Indicator	MDK, MH8, MHH or MHK	In the passenger compartment, at the front of the floor console surrounding the shift lever	<u>Instrument Panel and Floor Console Components</u>	<u>P2 Transmission Sh Position Indicator (MHH or MHK)</u>
P9	Driver Information Center Display	-	In the passenger compartment, part of the instrument cluster, at center	<u>Instrument Panel and Floor Console Components</u>	-
P13	Horn Assembly	-	In the left front wheel well forward of the washer fluid reservoir	<u>Radiator Support Components</u>	<u>P13 Horn Assembly</u>
P16	Instrument Cluster	-	In the passenger compartment, mounted to the driver side of instrument panel, forward of the steering wheel	<ul style="list-style-type: none"> • <u>Instrument Panel and Floor Console Components</u> • <u>Behind Upper Left Side of Instrument Panel Components</u> 	<u>P16 Instrument Clu</u>
P17	Info Display Module	-	In the passenger compartment, mounted to the instrument panel, between the center HVAC outlets	<u>Instrument Panel and Floor Console Components</u>	<ul style="list-style-type: none"> • <u>P17 Info Disp X1</u> • <u>P17 Info Disp X2 (UDY)</u> • <u>P17 Info Disp X2 (UTY)</u> • <u>P17 Info Disp (UDK/UDN)</u>
			In the passenger		

P19AA	Speaker - Right Subwoofer	UQA	compartment, mounted to shelf rearward of rear seats on right side	<u>Rear of Passenger Compartment Components</u>	<u>P19AA Speaker - Right Subwoofer</u>
P19AD	Speaker - Left Surround	UQS	In the rear compartment	-	<u>P19AD Speaker - Left Surround (UQS)</u>
P19AE	Speaker - Right Surround	UQS	In the rear compartment	-	<u>P19AE Speaker - Right Surround (UQS)</u>
P19AG	Speaker - Left Front Door	-	Inside the driver door, at front lower, behind trim panel	<u>Driver Door Components</u>	<u>P19AG Speaker - Left Front Door</u>
P19AH	Speaker - Right Front Door	-	Inside the passenger door, at front lower, behind trim panel	<u>Passenger Door Components</u>	<ul style="list-style-type: none"> • <u>P19AH Speaker - Right Front Door (UQA/UQS)</u> • <u>P19AH Speaker - Right Front Door (UQS)</u> • <u>P19AH Speaker - Right Front Door (UQA)</u>
P19AL	Speaker - Left Rear Door	-	Inside the left rear door, at front lower, behind trim panel	<u>Left Rear Door Components</u>	<u>P19AL Speaker - Left Rear Door</u>
P19AM	Speaker - Right Rear Door	-	Inside the right rear door, at front lower, behind trim panel	<u>Right Rear Door Components</u>	<u>P19AM Speaker - Right Rear Door</u>
P19B	Speaker - Center Instrument Panel	-	In the passenger compartment, mounted to the upper center instrument panel behind grille	<u>Instrument Panel and Floor Console Components</u>	<ul style="list-style-type: none"> • <u>P19B Speaker - Center Instrument Panel (UQA/UQS)</u> • <u>P19B Speaker - Center Instrument Panel (UQS)</u>
P19H	Speaker - Left Front Tweeter	-	Inside the driver door, at front upper	<u>Driver Door Components</u>	<u>P19H Speaker - Left Front Tweeter</u>
P19N	Speaker - Left Subwoofer	UQA	In the passenger compartment, mounted to shelf rearward of rear seats on	<u>Rear of Passenger Compartment Components</u>	<u>P19N Speaker - Left Subwoofer (UQA/UQS)</u>

			left side		
P19V	Speaker - Right Front Tweeter	-	Inside the passenger door, at front upper	<u>Passenger Door Components</u>	<u>P19V Speaker - Right Front Tweeter</u>
Q2	A/C Compressor Clutch	-	In the engine compartment, on the right side of the engine, lower position	<ul style="list-style-type: none"> • <u>Left Front of Engine Components (LUK 1 of 2)</u> • <u>Engine Components - Front (LAF 1 of 2)</u> • <u>Engine Components - Front (LTD)</u> • <u>Engine Components - Front (LLU)</u> 	<ul style="list-style-type: none"> • <u>Q2 A/C Compressor Clutch (LUK/)</u> • <u>Q2 A/C Compressor Clutch (LDK/)</u> • <u>Q2 A/C Compressor Clutch (LTD/)</u>
Q6E	Camshaft Position Actuator Solenoid Valve - Exhaust	-	In the engine compartment, on top left of engine, mounted to the camshaft cover rearward of center	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LHU)</u> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine Components - Rear (LAF)</u> • <u>Engine Components - Top (LDK)</u> • <u>Engine Components - Top (LTD)</u> 	<ul style="list-style-type: none"> • <u>Q6E Camshaft Actuator Solenoid Exhaust (LUK/)</u> • <u>Q6E Camshaft Actuator Solenoid Exhaust (LAF)</u> • <u>Q6E CAMSHAFT POSITION ACTUATOR SOLENOID VALVE EXHAUST (LDK)</u> • <u>Q6E Camshaft Actuator Solenoid Exhaust (LTD)</u>
Q6F	Camshaft Position Actuator Solenoid Valve - Intake	-	In the engine compartment, on top left of engine, mounted to the camshaft cover	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LHU)</u> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine Components -</u> 	<ul style="list-style-type: none"> • <u>Q6F Camshaft Actuator Solenoid Intake (LUK/)</u> • <u>Q6F Camshaft Actuator Solenoid Intake (LAF)</u> • <u>Q6F Camshaft</u>

			forward of center	<u>Rear (LAF)</u> <ul style="list-style-type: none"> • <u>Engine Components - Top (LDK)</u> • <u>Engine Components - Top (LTD)</u> 	<u>Actuator Solenoid Intake (LDK)</u> <ul style="list-style-type: none"> • <u>Q6F Camshaft Actuator Solenoid Intake (LDK/)</u>
Q8	Control Solenoid Valve Assembly	MH8, MHH or MHK	In the engine compartment, mounted to the valve body inside the transmission	<ul style="list-style-type: none"> • <u>Automatic Transmission Components (MH8)</u> • <u>Automatic Transmission Components (MDK)</u> 	<ul style="list-style-type: none"> • <u>Q8 Control Solenoid Assembly X1 (MH8/MHH/MDK/CZ2)</u> • <u>Q8 Control Solenoid Assembly X1 (MH8/MHK/MDK)</u> • <u>Q8 Control Solenoid Assembly X2 (MH8/MHK/MDK or MHK)</u> • <u>Q8 Control Solenoid Assembly X2 (MH8/MHK/MDK)</u> • <u>Q8 Control Solenoid Assembly X3 (MH8/MHH/MDK/CZ2)</u> • <u>Q8 Control Solenoid Assembly X3 (MH8/MHK/MDK)</u> • <u>Q8 Control Solenoid Assembly X4 (MH8/MHH/MDK/CZ2)</u> • <u>Q8 Control Solenoid Assembly X4 (MH8/MHK/MDK)</u>
Q12	Evaporative Emission Purge	-	In the engine compartment, mounted to the top of the intake	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine Components - Rear (LAF)</u> 	<ul style="list-style-type: none"> • <u>Q12 Evaporative Emission Purge Solenoid (LUK/LHU)</u> • <u>Q12 Evaporative Emission Purge Solenoid</u>

	Solenoid Valve		manifold above the throttle body	<ul style="list-style-type: none"> • <u>Engine Components - Top (LDK)</u> • <u>Engine Components - Front (LTD)</u> • <u>Engine Components - Rear (LLU)</u> 	<u>(LAF/LDK/L</u> <ul style="list-style-type: none"> • <u>Q12 Evaporat Purge Solenoi (LLU)</u>
Q13	Evaporative Emission Vent Solenoid Valve	-	In the vehicle underbody, mounted to the EVAP canister, below rear seats	<u>Fuel Tank Components</u>	<u>Q13 Evaporative Er Solenoid Valve</u>
Q17A	Fuel Injector 1	-	In the engine compartment, mounted to the front of the cylinder head, at cylinder 1	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 2 of 2)</u> • <u>Engine Components - Front (LAF 2 of 2)</u> • <u>Engine Components - Top (LTD)</u> • <u>Engine Components - Rear (LLU)</u> 	<ul style="list-style-type: none"> • <u>Q17A Fuel In (LUK/LAF)</u> • <u>Q17A Fuel In (LHU/LDK)</u> • <u>Q17A Fuel In (LTD)</u> • <u>Q17A Fuel In (LLU)</u>
Q17B	Fuel Injector 2	-	In the engine compartment, mounted to the front of the cylinder head, at cylinder 2	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 2 of 2)</u> • <u>Engine Components - Front (LAF 2 of 2)</u> • <u>Engine Components - Top (LTD)</u> • <u>Engine</u> 	<ul style="list-style-type: none"> • <u>Q17B Fuel Inj (LUK/LAF)</u> • <u>Q17B Fuel Inj (LHU/LDK)</u> • <u>Q17B Fuel Inj (LTD)</u> • <u>Q17B Fuel Inj (LLU)</u>

				<u>Components - Rear (LLU)</u>	
Q17C	Fuel Injector 3	-	In the engine compartment, mounted to the front of the cylinder head, at cylinder 3	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 2 of 2)</u> • <u>Engine Components - Front (LAF 2 of 2)</u> • <u>Engine Components - Top (LTD)</u> • <u>Engine Components - Rear (LLU)</u> 	<ul style="list-style-type: none"> • <u>Q17C Fuel In (LUK/LAF)</u> • <u>Q17C Fuel In (LHU/LDK)</u> • <u>Q17C Fuel In (LTD)</u> • <u>Q17C Fuel In (LLU)</u>
Q17D	Fuel Injector 4	-	In the engine compartment, mounted to the front of the cylinder head, at cylinder 4	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 2 of 2)</u> • <u>Engine Components - Front (LAF 2 of 2)</u> • <u>Engine Components - Top (LTD)</u> • <u>Engine Components - Rear (LLU)</u> 	<ul style="list-style-type: none"> • <u>Q17D Fuel In (LUK/LAF)</u> • <u>Q17D Fuel In (LHU/LDK)</u> • <u>Q17D Fuel In (LTD)</u> • <u>Q17D Fuel In (LLU)</u>
Q23	Line Pressure Control Solenoid Valve	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
Q27A	Pressure Control Solenoid Valve 1	MDK	In the engine compartment, mounted to the valve body	<u>Automatic Transmission Components (MDK)</u>	-

			inside the transmission		
Q27A	Pressure Control Solenoid Valve 1	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
Q27B	Pressure Control Solenoid Valve 2	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
Q27B	Pressure Control Solenoid Valve 2	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
Q27C	Pressure Control Solenoid Valve 3	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
Q27C	Pressure Control Solenoid Valve 3	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
Q27D	Pressure Control Solenoid Valve 4	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-

Q27D	Pressure Control Solenoid Valve 4	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
Q27E	Pressure Control Solenoid Valve 5	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
Q29	Secondary Air Injection Solenoid Valve	NU6	In the engine compartment, right of center, at rear of cylinder head, above exhaust manifold	<u>LEFT REAR OF ENGINE COMPONENTS (LUK)</u>	<u>Q29 Secondary Air Solenoid Valve NU6</u>
Q29C	Secondary Air Injection Solenoid Valve - Bank 1	NU6	In the engine compartment, right of center, at rear of cylinder head, above exhaust manifold	-	<u>Q29C Secondary Air Solenoid Valve - Cy NU6</u>
Q29D	Secondary Air Injection Solenoid Valve - Bank 2	NU6	In the engine compartment, right of center, at rear of cylinder head, above exhaust manifold	-	<u>Q29D Secondary Air Solenoid Valve - Cy NU6</u>
Q32A	Shift Solenoid Valve 1	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
			In the engine compartment,		

Q32A	Shift Solenoid Valve 1	MH8	part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
Q32B	Shift Solenoid Valve 2	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
Q32B	Shift Solenoid Valve 2	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
Q37LF	Shock Absorber Actuator - Left Front	F45	In the vehicle underbody, mounted to left front knuckle	-	-
Q37LR	Shock Absorber Actuator - Left Rear	F45	In the vehicle underbody, at left rear suspension	-	<u>Q37LR SHOCK ABSORBER ACTUATOR - LEFT REAR (F45)</u>
Q37RF	Shock Absorber Actuator - Right Front	F45	In the vehicle underbody, mounted to right front knuckle	-	-
Q37RR	Shock Absorber Actuator - Right Rear	F45	In the vehicle underbody, at right rear suspension	-	<u>Q37RR SHOCK ABSORBER ACTUATOR - RIGHT REAR (F45)</u>
Q38	Throttle Body	LUK	In the engine compartment, mounted to top of intake manifold, on front of engine	<u>Left Front of Engine Components (LUK 1 of 2)</u>	<u>Q38 Throttle Body (LUK 1 of 2)</u>
				• <u>Front of Engine</u>	

Q38	Throttle Body	except LUK	In the engine compartment, mounted to bottom of intake manifold, on front of engine	<u>Components (LHU)</u> <ul style="list-style-type: none"> • <u>Engine Components - Front (LAF 1 of 2)</u> • <u>Engine Components - Front (LDK)</u> • <u>Engine Components - Front (LTD)</u> • <u>Engine Components - Front (LLU)</u> 	<ul style="list-style-type: none"> • <u>Q38 Throttle</u> • <u>Q38 Throttle (LAF/LDK)</u> • <u>Q38 Throttle</u> • <u>Q38 Throttle</u>
Q39A	Torque Converter Clutch Pressure Control Solenoid Valve	MDK	In the engine compartment, mounted to the valve body inside the transmission	<u>Automatic Transmission Components (MDK)</u>	-
Q39A	Torque Converter Clutch Pressure Control Solenoid Valve	MH8	In the engine compartment, part of the control solenoid valve assembly, mounted to the valve body inside the transmission	-	-
Q40	Turbocharger Bypass Solenoid Valve	LHU/ LDK/ LLU	In the engine compartment, mounted to bottom of intake manifold, on front of engine	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Engine Components - Top (LDK)</u> • <u>Engine Components - Rear (LLU)</u> 	<ul style="list-style-type: none"> • <u>Q40 Turbocharger Solenoid Valve</u> • <u>Q40 Turbocharger Solenoid Valve</u>
Q42	Turbocharger Wastegate Solenoid Valve	LHU/ LDK/ LLU	In the engine compartment, mounted to the turbocharger, on the rear of engine	<ul style="list-style-type: none"> • <u>Engine Components - Front (LLU)</u> • <u>Left Rear of Engine Components (LHU)</u> 	<ul style="list-style-type: none"> • <u>Q42 Turbocharger Wastegate Sol (LHU)</u> • <u>Q42 Turbocharger Wastegate Sol (LLU)</u>

Q46	A/C Compressor Solenoid Valve	-	In the engine compartment, part of A/C compressor, at lower right front of engine	<ul style="list-style-type: none"> • <u>Front of Engine Components (LHU)</u> • <u>Left Front of Engine Components (LUK 1 of 2)</u> 	<u>Q46 A/C Compressor Valve (LHU/LUK)</u>
Q51D	Seat Lumbar Support Valve Assembly - Driver	-	In the passenger compartment, mounted to the driver seat back	<u>Rear of Driver Seat Components</u>	<u>Q51D Seat Lumbar Valve Assembly - Driver</u>
Q51P	Seat Lumbar Support Valve Assembly - Passenger	APH	In the passenger compartment, mounted to the passenger seat back	<u>Rear of Passenger Seat Components</u>	<u>Q51P Seat Lumbar Valve Assembly - Passenger (APH)</u>
R14L	Rear Window Defogger Noise Filter - Left	-	In the passenger compartment, attached to the left C-pillar	<u>Rear of Passenger Compartment Components</u>	<u>R14L Rear Window Noise Filter - Left</u>
R14R	Rear Window Defogger Noise Filter - Right	-	In the passenger compartment, attached to the right C-pillar	<u>Rear of Passenger Compartment Components</u>	-
S2	Transmission Manual Shift Switch	MDK, MH8, MHH or MHK	In the passenger compartment, center, in the floor console, part of the transmission shift lever	<u>Automatic Transmission Shifter Components (MDK, MH8, MHH, or MHK)</u>	<ul style="list-style-type: none"> • <u>S2 Transmission Shift Switch X (MDK, MH8, MHH or MHK)</u> • <u>S2 Transmission Shift Switch X (MDK, MH8, MHH or MHK)</u>
S3	Transmission Shift Lever	MDK, MH8, MHH or MHK	In the passenger compartment, in the floor console, mounted to the floor	<u>Automatic Transmission Shifter Components (MDK, MH8, MHH, or MHK)</u>	<ul style="list-style-type: none"> • <u>S3 Transmission Lever X1 (MDK, MH8, MHH or MHK)</u> • <u>S3 Transmission Lever X2 (MDK/MH8/MHH or MHK)</u>
		MDK/ MH7/ CZ2	In the passenger compartment, in the floor console, mounted to the floor	-	<ul style="list-style-type: none"> • <u>S3 Transmission Shift Switch X (MDK/MH7)</u> • <u>S3 Transmission Lever X2 (MDK/MH7/CZ2)</u>
			In the passenger		

S25	Garage Door Opener	UG1	compartment, at the center of the roof console	-	<u>S25 Garage Door O</u>
S26	Hazard Warning Switch	CZ2	In the center of the instrument panel	-	<u>S26 Hazard Warnin (CZ2)</u>
S30	Headlamp Switch	-	In the passenger compartment, mounted to the instrument panel left of the steering column	<ul style="list-style-type: none"> • <u>Instrument Panel and Floor Console Components</u> • <u>Behind Upper Left Side of Instrument Panel Components</u> 	<u>S30 Headlamp Swit</u>
S33	Horn Switch	-	In the passenger compartment, mounted to the steering wheel behind air bag	<u>Steering Column and Wheel Components</u>	<u>S33 Horn Switch</u>
S38	Ignition Mode Switch	BTM	In the passenger compartment, center of the instrument panel, to the right of the steering column	-	<ul style="list-style-type: none"> • <u>S38 Ignition M (BTM)(except</u> • <u>S38 Ignition M (BTM)(CZ2)</u>
S39	Ignition Switch	without BTM	In the passenger compartment, mounted to the steering column on the right side, lower	<u>Steering Column and Wheel Components</u>	<u>S39 Ignition Switch BTM)</u>
S47D	Seat Memory Switch - Driver	A45/CZ2	Under the driver seat cushion	-	<u>S47D Seat Memory Driver (A45/CZ2)</u>
S48C	Multifunction Switch 1 - Instrument Panel	-	In the passenger compartment, mounted to the instrument panel, below the info display module	<u>Instrument Panel and Floor Console Components</u>	<ul style="list-style-type: none"> • <u>S48C Multifunction 1 - Instrument Panel (except CZ2)</u> • <u>S48C Multifunction 1 - Instrument Panel</u>
S48D	Multifunction Switch 2 - Instrument Panel	-	In the passenger compartment, mounted to the instrument panel, above the radio controls	<u>Instrument Panel and Floor Console Components</u>	<u>S48D Multifunction Instrument Panel</u>

S51	Telematics Button Assembly	-	In the passenger compartment, part of the inside rearview mirror, mounted to the top center of windshield	<u>Inside of Roof and Windshield Components</u>	-
S52	Outside Rearview Mirror Switch	-	On the interior side of the driver door, mounted to trim panel	<u>Driver Door Components</u>	<u>S52 Outside Rearview Mirror Switch</u>
S56	Radio Control Multifunction Switch	KRJ	In the passenger compartment, mounted to the floor console, forward of the armrest	<ul style="list-style-type: none"> • <u>Instrument Panel and Floor Console Components</u> • <u>Floor Console Components</u> 	<u>S56 Radio Control Multifunction Switch (KRJ)</u>
S58A	Rear Compartment Lid Unlatch Switch - Exterior	-	At the rear of the vehicle, on bottom side of rear compartment trim	<u>Rear of Vehicle Components</u>	<u>S58A Rear Compartment Lid Unlatch Switch - Exterior</u>
S64D	Seat Adjuster Switch - Driver	-	In the passenger compartment, mounted to the outboard side of the driver seat cushion	-	<ul style="list-style-type: none"> • <u>S64D Seat Adjuster Switch - Driver (AG1)</u> • <u>S64D Seat Adjuster Switch - Driver (AG1)</u> • <u>S64D Seat Adjuster Switch - Driver (A6A)</u>
S64P	Seat Adjuster Switch - Passenger	A6C or AG2	In the passenger compartment, mounted to the outboard side of the passenger seat cushion	<u>Bottom of Passenger Seat Components (1 of 2)</u>	<ul style="list-style-type: none"> • <u>S64P Seat Adjuster Switch - Passenger (AG1)</u> • <u>S64P Seat Adjuster Switch - Passenger (A6A)</u>
S65D	Seat Lumbar Support Switch - Driver	-	In the passenger compartment, mounted to the outboard side of the driver seat cushion	-	<u>S65D Seat Lumbar Support Switch - Driver</u>
	Seat Lumbar		In the passenger compartment, mounted to the	<u>Bottom of Passenger</u>	<u>S65P Seat Lumbar Support Switch</u>

S65P	Support Switch - Passenger	APH	outboard side of the passenger seat cushion	<u>Seat Components (1 of 2)</u>	<u>Switch - Passenger (</u>
S70L	Steering Wheel Controls Switch - Left	-	In the passenger compartment, mounted to the steering wheel on left side	<u>Instrument Panel and Floor Console Components</u>	<u>S70L Steering Wheel Switch - Left</u>
S70R	Steering Wheel Controls Switch - Right	-	In the passenger compartment, mounted to the steering wheel on right side	<u>Instrument Panel and Floor Console Components</u>	<u>S70R Steering Wheel Switch - Right</u>
S72	Sunroof Switch	CF5	In the passenger compartment, mounted to the overhead console	<u>Headliner Components</u>	<u>S72 Sunroof Switch</u>
S78	Turn Signal/Multifunction Switch	-	In the passenger compartment, mounted to the left side of the steering column	<u>Instrument Panel and Floor Console Components</u>	<u>S78 Turn Signal/Multifunction Switch</u>
S79D	Window Switch - Driver	-	On the interior side of the driver door, mounted to trim panel, near center	<u>Driver Door Components</u>	<ul style="list-style-type: none"> • <u>S79D WINDOW SWITCH - DRIVER (CZ2)</u> • <u>S79D Window Switch - Driver (CZ2)</u>
S79LR	Window Switch - Left Rear	-	On the interior side of the left rear door, mounted to trim panel, near center	<u>Left Rear Door Components</u>	<ul style="list-style-type: none"> • <u>S79LR Window Switch - Left Rear (AEF/AED exc A45)</u> • <u>S79LR Window Switch - Left Rear (AEF/AED exc A45)</u>
S79P	Window Switch - Passenger	-	On the interior side of the passenger door, mounted to trim panel, near center.	<u>Passenger Door Components</u>	<ul style="list-style-type: none"> • <u>S79P Window Switch - Passenger (AEF/AED exc A45)</u> • <u>S79P Window Switch - Passenger (CZ2)</u> • <u>S79P Window Switch - Passenger X1 (A45)</u> • <u>S79P Window Switch - Passenger X2</u>

					<u>A45)</u>
S79RR	Window Switch - Right Rear	-	On the interior side of the right rear door, mounted to trim panel, near center	<u>Right Rear Door Components</u>	<ul style="list-style-type: none"> • <u>S79RR Window Switch - Right Rear (A45)</u> • <u>S79RR Window Switch - Right Rear (A45)</u>
S82	Windshield Wiper/Washer Switch	-	In the passenger compartment, mounted to the right side of the steering column	<u>Instrument Panel and Floor Console Components</u>	<u>S82 Windshield Wiper/Washer Switch</u>
S88	Sunroof Tilt Switch	CF5	In the passenger compartment, mounted to the overhead console	<u>Headliner Components</u>	<u>S88 Sunroof Tilt Switch</u>
S91	Park Brake Control Switch	-	In the passenger compartment, mounted to the floor console, forward of the armrest	<ul style="list-style-type: none"> • <u>Instrument Panel and Floor Console Components</u> • <u>Floor Console Components</u> 	<u>S91 Park Brake Control Switch</u>
S107	Parking Assist On/Off Switch	UD5 or UD7	In the passenger compartment, mounted to the instrument panel, above the radio controls	<u>Instrument Panel and Floor Console Components</u>	<u>S107 Parking Assist Switch (UD5 or UD7)</u>
T1	Accessory DC/AC Power Inverter Module	KI6 or KIU	In the passenger compartment, mounted to the bottom of the floor console	<u>Floor Console Components</u>	<u>T1 Accessory DC/AC Inverter Module (KI6 or KIU)</u>
T3	Audio Amplifier	UQA/ UQS	In the rear compartment, behind trim, at right rear of compartment	<u>Luggage Compartment Components</u>	<ul style="list-style-type: none"> • <u>T3 Audio Amplifier (UQA)</u> • <u>T3 Audio Amplifier (UQA)</u> • <u>T3 Audio Amplifier (UQA)</u> • <u>T3 Audio Amplifier (UQS)</u>
T4G	Cellular Phone, Navigation, and Digital Radio	-	On the roof, at rear center	<u>Rear of Vehicle Components</u>	-

	Antenna				
T4M	Radio Antenna	-	In the passenger compartment, part of rear window, on glass	<u>Rear of Passenger Compartment Components</u>	<u>T4M Radio Antenn:</u>
T4S	Wireless Communication Antenna - Bluetooth	-	In the passenger compartment, mounted to the telematics communication interface control module, mounted to package tray, center	-	-
T7L	Headlamp Ballast - Left	T4F	At the front of vehicle, mounted to bottom of left headlamp	<u>Headlamp Components (T4F)</u>	<u>T7L Headlamp Ball (T4F)</u>
T7R	Headlamp Ballast - Right	T4F	At the front of vehicle, mounted to bottom of right headlamp	<u>Headlamp Components (T4F)</u>	<u>T7R Headlamp Ball (T4F)</u>
T8A	Ignition Coil 1	-	In the engine compartment, mounted to the camshaft cover, above cylinder 1	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LHU)</u> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine Components - Rear (LAF)</u> • <u>Engine Components - Top (LDK)</u> • <u>Engine Components - Top (LTD)</u> 	<u>T8A Ignition Coil 1</u>
				<ul style="list-style-type: none"> • <u>Left Rear of Engine</u> 	

T8B	Ignition Coil 2	-	In the engine compartment, mounted to the camshaft cover, above cylinder 2	<u>Components (LHU)</u> <ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine Components - Rear (LAF)</u> • <u>Engine Components - Top (LDK)</u> • <u>Engine Components - Top (LTD)</u> 	<u>T8B Ignition Coil 2</u>
T8C	Ignition Coil 3	-	In the engine compartment, mounted to the camshaft cover, above cylinder 3	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LHU)</u> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine Components - Rear (LAF)</u> • <u>Engine Components - Top (LDK)</u> • <u>Engine Components - Top (LTD)</u> 	<u>T8C Ignition Coil 3</u>
T8D	Ignition Coil 4	-	In the engine compartment, mounted to the camshaft cover, above cylinder 4	<ul style="list-style-type: none"> • <u>Left Rear of Engine Components (LHU)</u> • <u>Left Rear of Engine Components (LUK)</u> • <u>Engine Components - Rear (LAF)</u> • <u>Engine</u> 	<u>T8D IGNITION CC</u>

				<u>Components - Top (LDK)</u> • <u>Engine Components - Top (LTD)</u>	
T10E	Keyless Entry Antenna - Rear Compartment	ATH	In the rear compartment	-	<u>T10E Keyless Entry Rear Compartment</u>
T10G	Keyless Entry Antenna - Rear Fascia	ATH	Left center area of rear bumper fascia	-	<u>T10G Keyless Entry Rear Fascia (ATH)</u>
T10J	Keyless Entry Antenna - Center Console Front	ATH	Under the center console	-	<u>T10J Keyless Entry Center Console Fro</u>
T10K	Keyless Entry Antenna - Center Console Rear	ATH	Under the center console	-	<u>T10K Keyless Entry Center Console Rea</u>
T10M	Keyless Entry Antenna - Driver Door Handle	-	Inside the driver door	-	<u>T10M Keyless Entr Driver Door Handle</u>
T10N	Keyless Entry Antenna - Passenger Door Handle	-	Inside the passenger door	-	<u>T10N Keyless Entry Passenger Door Hai</u>
T11	Multimedia Player Interface Module X1	KTA	-	-	• <u>T11 Multimed Interface Mod (KTA)</u> • <u>T11 Multimed Interface Mod (KTA)</u>
T12	Automatic Transmission Assembly	MDK or MH8	In the engine compartment, left of center, mounted to left side of engine	-	-
T15	Navigation Antenna Signal Splitter	UYS with UE1	In the passenger compartment, mounted to the instrument panel behind compartment	-	-
X50A	Fuse Block - Underhood	-	In the engine compartment, near left front	<u>Left Side of Engine Compartment Components</u>	<u>Electrical Center Id Views</u>
			In the engine compartment,	<u>Left Side of Engine</u>	

X50D	Fuse Block - Battery	-	near left front, mounted to the top of the battery	<u>Compartment Components</u>	<u>Electrical Center Id Views</u>
X51A	Fuse Block - Instrument Panel	-	In the passenger compartment, mounted to the instrument panel, behind driver knee bolster	-	<u>Electrical Center Id Views</u>
X70A	Relay Block - Underhood	-	At left front of vehicle, mounted to the outside of the radiator support, below horn assembly	<ul style="list-style-type: none"> • <u>Radiator Support Components</u> • <u>Engine Cooling Fan Components (LHU)</u> 	<u>Electrical Center Id Views</u>
X80D	Accessory Power Receptacle - Center Console	-	In the passenger compartment, mounted to the floor console, rearward of park brake control switch	<u>Floor Console Components</u>	<u>X80D Accessory Po Receptacle - Center</u>
X80G	Accessory Power Receptacle - Instrument Panel	-	In the passenger compartment, at bottom center of instrument panel, below HVAC controls	<u>Instrument Panel and Floor Console Components</u>	<u>X80G Accessory Po Receptacle - Instrur</u>
X80H	Accessory Power Receptacle - Center Console	-	In the passenger compartment, mounted to the floor console, rearward of park brake control switch	<u>Floor Console Components</u>	<u>X80H Accessory Po Receptacle - Center</u>
X81	Accessory Power Receptacle - 110V AC	KI6 or KIU	In the passenger compartment, mounted to the rear of the floor console	<u>Instrument Panel and Floor Console Components</u>	<ul style="list-style-type: none"> • <u>X81 Accessory Receptacle - 1 (KI6 or KIU)</u> • <u>X81 Accessory Receptacle - 1 (KI6 or KIU)</u>
			In the passenger		<ul style="list-style-type: none"> • <u>X83 Auxiliary X1 (except C7</u>

X83	Auxiliary Audio Input	-	compartment, in the floor console compartment	<u>Floor Console Components</u>	<ul style="list-style-type: none"> • <u>X83 Auxiliary X2 (except CZ</u> • <u>X83 Auxiliary X1 (CZ2)</u>
X84	Data Link Connector	-	In the passenger compartment, mounted to bottom of driver knee bolster	-	<u>X84 Data Link Con</u>
X85	Steering Wheel Air Bag Coil	-	In the passenger compartment, in the steering column behind the steering wheel	<u>Steering Column and Wheel Components</u>	<ul style="list-style-type: none"> • <u>X85 Steering ' Bag Coil X1</u> • <u>X85 Steering ' Bag Coil X2</u> • <u>X85 Steering ' Bag Coil X3</u> • <u>X85 Steering ' Bag Coil X4 (l</u>
X92	USB Receptacle	-	In the passenger compartment, in the floor console compartment	<u>Floor Console Components</u>	<u>X92 Universal Seri</u> <u>Connect</u>
X100	Forward Lamp Harness to Front Bumper Harness (8 cavities)	UD5	Located under the front bumper cover, left front side	-	<u>X100 Forward Lam</u> <u>Front Bumper Har</u> <u>except CZ2</u>
X105	Power Steering Harness to Forward Lamp Harness (2 cavities)	NV7 or NXC	In the engine compartment, mounted to lower rear of radiator support, on left side	-	<u>X105 Power Steerin</u> <u>Forward Lamp Har</u> <u>NXC)</u>
X110	Forward Lamp Harness to Headlamp - Left Harness (10 cavities)	-	At the front of vehicle, at the back of headlamp - left	<u>Body Harness Routing - Left Front of Vehicle</u>	<u>X110 Forward Lam</u> <u>Left Headlamp Har</u>
X115	Engine Harness to Body Harness (40 cavities)	-	In the engine compartment, mounted to upper rear of radiator	<ul style="list-style-type: none"> • <u>Engine Harness Routing (LHU)</u> • <u>Engine Harness Routing - Right Front (LUK)</u> 	<ul style="list-style-type: none"> • <u>X115 Engine l</u> <u>Body Harness</u> • <u>X115 Engine l</u>

			support, on left side	<ul style="list-style-type: none"> • <u>Body Harness Routing - Left Front of Vehicle</u> 	<u>Body Harness</u>
X116	Cooling Fan Harness to Forward Lamp Harness (4 cavities)	-	In the engine compartment, mounted to lower rear of radiator support, on left side	<u>Cooling Fan Harness Routing</u>	<u>X116 Cooling Fan F Forward Lamp Har</u>
X117	Cooling Fan Harness to Forward Lamp Harness (5 cavities)	-	In the engine compartment, mounted to lower rear of radiator support, on left side	<u>Cooling Fan Harness Routing</u>	<u>X117 Cooling Fan F Forward Lamp Har</u>
X118	Cooling Fan Harness to Forward Lamp Harness (2 cavities)	LHU	In the engine compartment, mounted to lower rear of radiator support, on left side	<u>Cooling Fan Harness Routing</u>	<u>X118 Cooling Fan F Forward Lamp Har</u>
X120	Forward Lamp Harness to Headlamp - Right Harness (10 cavities)	-	At the front of vehicle, at the back of headlamp - right	-	<u>X120 Forward Lam Right Headlamp Ha</u>
X122	Engine Harness to Body Harness (2 cavities)	NU6	In the engine compartment, left front, forward of the battery	<u>Engine Harness Routing - Right Front (LUK)</u>	<u>X122 Engine Harne Harness (NU6)</u>
X125	Engine Harness to A/C Compressor Harness (2 cavities)	-	In the engine compartment, mounted to A/C compressor, at lower front of engine	-	<u>X125 Engine Harne Compressor Harnes</u>
X130	Forward Lamp Harness to Suspension - Left Front Harness (10 cavities)	F45	Under the vehicle, mounted to the left side of frame, near left front	<u>Left Front Suspension Harness Routing (F45)</u>	<u>X130 Forward Lam Left Suspension Ha</u>

			suspension		
X131	Wheel Speed Sensor, Shock Absorber Actuator, and Vertical Suspension Acceleration Sensor - Left Front to Suspension - Left Front Harness (9 cavities)	F45	Under the vehicle, mounted to front of the left strut	<u>Left Front Suspension Harness Routing (F45)</u>	<u>X131 Left Front Suspension Components to Left Suspension Harness</u>
X140	Forward Lamp Harness to Suspension - Right Front Harness (10 cavities)	F45	Under the vehicle, mounted to the right side of frame, near right front suspension	<u>Right Front Suspension Harness Routing (F45)</u>	<u>X140 Forward Lamp Right Front Suspension (F45)</u>
X141	Wheel Speed Sensor, Shock Absorber Actuator, and Vertical Suspension Acceleration Sensor - Right Front to Suspension - Right Front Harness (9 cavities)	F45	Under the vehicle, mounted to the front of the right strut	<u>Right Front Suspension Harness Routing (F45)</u>	<u>X141 Right Front Suspension Components to Right Suspension Harness</u>
X150	Forward Lamp Harness to Body Harness (40 cavities)	-	In the engine compartment, left rear	-	<u>X150 Forward Lamp Body Harness</u>
X151	Forward Lamp Harness to Body Harness (40 cavities)	F45	In the engine compartment, left rear	-	<u>X151 Forward Lamp Body Harness (F45)</u>
X160	Engine Harness to Fuel Rail Harness (12 cavities)	-	In the engine compartment, mounted to intake manifold at top of engine	<ul style="list-style-type: none"> • <u>Engine Harness Routing (LHU)</u> • <u>Engine Harness Routing - Right Front (LUK)</u> 	<u>X160 Engine Harness Rail Harness LUK/</u>
X190	Forward Lamp Harness to Fuel Composition Sensor Harness (3 cavities)	FHS	In the engine compartment, right rear, attached to fuel composition	-	<u>X190 Forward Lamp Fuel Composition Sensor Harness (FHS)</u>

			sensor bracket		
X205	Instrument Panel Harness to Passenger Instrument Panel Air Bag Harness (5 cavities)	-	In the passenger compartment, behind instrument panel compartment	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	<u>X205 Instrument Panel Harness to Passenger Instrument Panel Air Bag Harness</u>
X210	Instrument Panel Harness to Body Harness (102 cavities)	-	In the passenger compartment, mounted to the base of the left A-pillar	<ul style="list-style-type: none"> • <u>Body Harness Routing - Left Front of Passenger Compartment</u> • <u>Instrument Panel Harness Routing - Behind Instrument Panel</u> 	<u>X210 Instrument Panel Harness to Body Harness</u>
X220	Instrument Panel Harness to Body Harness (102 cavities)	UQA	In the passenger compartment, mounted to the base of the right A-pillar	<u>Body Harness Routing - Right Side of Passenger Compartment</u> <u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	<u>X220 Instrument Panel Harness to Body Harness</u>
X221	Body Harness to Instrument Panel Harness (2 cavities - COAX)	-	In the passenger compartment, at the base of the right A-pillar, mounted to X220	<ul style="list-style-type: none"> • <u>Body Harness Routing - Right Side of Passenger Compartment</u> • <u>Instrument Panel Harness Routing - Behind Instrument Panel</u> 	-
X222	Body Harness to Instrument Panel Harness (2 cavities - COAX)	-	In the passenger compartment, at the base of the right A-pillar, mounted to X220	<ul style="list-style-type: none"> • <u>Body Harness Routing - Right Side of Passenger Compartment</u> • <u>Instrument Panel Harness Routing - Behind Instrument Panel</u> 	-
X300	Floor Console Harness to Instrument Panel Harness (52 cavities)	-	In the passenger compartment, at the base of floor console at front	<u>Floor Console Harness Routing</u>	<u>X300 Floor Console Instrument Panel Harness</u>
X301	Instrument Panel Harness to Floor	-	In the passenger compartment, at	<u>Floor Console Harness</u>	-

	Console Harness (4 cavities - USB)		the base of floor console at front	<u>Routing</u>	
X310	Body Harness to Driver Seat Harness (48 cavities)	-	In the passenger compartment, on floor below driver seat	<ul style="list-style-type: none"> • <u>BODY HARNESS ROUTING - LEFT FRONT OF PASSENGER COMPARTMENT</u> • <u>Driver Seat Harness Routing</u> 	<u>X310 Body Harness Seat Harness</u>
X320	Body Harness to Passenger Seat Harness (48 cavities)	-	In the passenger compartment, on floor below passenger seat	<ul style="list-style-type: none"> • <u>Passenger Seat Harness Routing</u> • <u>Body Harness Routing - Right Side of Passenger Compartment</u> 	<u>X320 Body Harness Seat Harness</u>
X350	Fuel Tank Harness to Body Harness (16 cavities)	-	In the right rear wheel well, mounted to body	-	<u>X350 Fuel Tank Ha Body Harness</u>
X370	Body Harness to Seat Air Bag - Left Rear Harness (5 cavities)	AW7	In the passenger compartment, at back of seat air bag - left rear	-	-
X380	Body Harness to Seat Air Bag - Right Rear Harness (5 cavities)	AW7	In the passenger compartment, at back of seat air bag - right rear	-	-
X400	Headliner Harness to Body Harness (18 cavities)	-	In the passenger compartment, mounted to left C-pillar, above rear seat	<u>Body Harness Routing - Left Rear of Passenger Compartment</u>	<u>X400 Headliner Hai Harness</u>
X410	Body Harness to Tail Lamp Assembly - Left Harness (6 cavities)	-	At rear of vehicle, between tail lamp assembly - left and body	-	<u>X410 Body Harness Lamp Assembly Ha CZ2</u>
X415	Rear Bumper Harness to Body Harness (16 cavities)	UD5 or UD7	At rear of vehicle, between rear bumper cover and body, left of center	<u>Rear Bumper Harness Routing (UD7)</u>	<u>X415 Rear Bumper Body Harness (UD5 without HP6)</u>
	Body Harness to Tail Lamp		At rear of vehicle,		<u>X420 Body Harness</u>

X420	Assembly - Right Harness (6 cavities)	-	between tail lamp assembly - right and body	-	<u>Lamp Assembly Ha CZ2</u>
X430	Suspension - Left Rear Harness to Body Harness (2 cavities)	F45	In the left rear wheel well, mounted to body	-	<u>X430 Left Rear Suspension Harness to Body Harness</u>
X440	Suspension - Right Rear Harness to Body Harness (2 cavities)	F45	In the right rear wheel well, mounted to body	-	<u>X440 Right Rear Suspension Harness to Body Harness</u>
X500	Driver Door Harness to Body Harness (41 cavities)	-	In the passenger compartment, left front, in the left A-pillar	<u>Driver Door Harness Routing</u>	<u>X500 Driver Door Harness to Body Harness</u>
X510	Driver Door Harness to Outside Rearview Mirror - Driver Harness (18 cavities)	-	At side of vehicle, front of driver door, between outside rearview mirror - driver and door frame	<u>Driver Door Harness Routing</u>	<u>X510 Driver Door Harness to Outside Rearview Mirror - Driver Harness</u>
X600	Passenger Door Harness to Body Harness (41 cavities)	-	In the passenger compartment, right front, in the right A-pillar	<u>Passenger Door Harness Routing</u>	<u>X600 Passenger Door Harness to Body Harness</u>
X610	Passenger Door Harness to Outside Rearview Mirror - Passenger Harness (18 cavities)	-	At side of vehicle, front of passenger door, between outside rearview mirror - passenger and door frame	<u>Passenger Door Harness Routing</u>	<u>X610 Passenger Door Harness to Outside Rearview Mirror - Passenger Harness</u>
X700	Left Rear Door Harness to Body Harness (20 cavities)	-	In the passenger compartment, left center, in the left B-pillar	<u>Left Rear Door Harness Routing</u>	<u>X700 Left Rear Door Harness to Body Harness</u>
X800	Right Rear Door Harness to Body Harness (20 cavities)	-	In the passenger compartment, right center in the right B-pillar	<u>Right Rear Door Harness Routing</u>	<u>X800 Right Rear Door Harness to Body Harness</u>
G102	Body Harness	-	In the engine compartment, on the right	<u>G102 and G108</u>	-

			strut tower, nearest to hood hinge		
G103	Battery (-) Harness and Starter - Generator Harness	-	In the engine compartment, on the left side, forward of the battery	<u>G103, G106, and G110</u>	-
G105	Body Harness	T4F	In the engine compartment, on the left strut tower, nearest to hood hinge	<u>G105 and G109</u>	-
G106	Cooling Fan Harness	-	In the engine compartment, on the radiator support, left of radiator, below X115	<u>G103, G106, and G110</u>	-
G108	Body Harness	T4F	In the engine compartment, on the right strut tower, furthest from hood hinge	<u>G102 and G108</u>	-
G109	Body Harness	-	In the engine compartment, on the left strut tower, furthest from hood hinge	<u>G105 and G109</u>	-
G110	Body Harness	-	In the engine compartment, on the radiator support, left of radiator, below X115	<u>G103, G106, and G110</u>	-
G111	Power Steering Harness	NJ1	In the engine compartment, on the left front strut tower	-	-
G112	Body Harness	-	In the engine compartment, left front, on the body under the front of the battery tray	-	-

G120	Engine Harness	LUK	In the engine compartment, above camshaft position sensor - exhaust	<u>G120 (LUK)</u>	-
G121	Engine Harness	LUK	In the engine compartment, on front right of engine block, under generator	<u>G121 (LUK)</u>	-
G122	Engine Harness	-	In the engine compartment, above camshaft position sensor - exhaust	<u>G120, G121, G122, and G140 (LUK)</u>	-
G122	Engine Harness	LHU	In the engine compartment, above camshaft position sensor - exhaust	<u>G122 (LHU)</u>	-
G140	Starter - Generator Harness	-	In the engine compartment, at left side of engine, near top of transmission case	<u>G120, G121, G122, and G140 (LUK)</u>	-
G201	Body Harness and Instrument Panel Harness	-	In the passenger compartment, on floor at left B-pillar, nearest to X210	<u>G201, G205, G302, G303, and G305</u>	-
G203	Instrument Panel Harness	-	In the passenger compartment, on the instrument panel cross bar, left of cluster	<u>G203 and G206</u>	-
G205	Body Harness and Instrument Panel Harness	-	In the passenger compartment, on floor at right B-pillar, nearest to X220	<u>G201, G205, G302, G303, and G305</u>	-
G206	Instrument Panel Harness	-	In the passenger compartment, on the instrument panel cross bar,	<u>G203 and G206</u>	-

			right of cluster		
G302	Body Harness	-	In the passenger compartment, on floor at right B-pillar, furthest from X220	<u>G201, G205, G302, G303, and G305</u>	-
G303	Body Harness and Instrument Panel Harness	-	In the passenger compartment, on floor at front right of driver seat, nearest to console	<u>G201, G205, G302, G303, and G305</u>	-
G305	Body Harness and Instrument Panel Harness	-	In the passenger compartment, on floor at front right of driver seat, furthest from console	<u>G201, G205, G302, G303, and G305</u>	-
G401	Body Harness	-	In the rear compartment, left side on left rear wheel tub	<u>G401</u>	-
G404	Rear Window Defogger Noise Filter - Right	-	In the passenger compartment, on right C-pillar	<u>G404</u>	-
G406	Body Harness	-	In the rear compartment, right side below lid opening	<u>G406</u>	-
J101	Engine Harness	LHU	In the engine compartment, left of center, between breakout to ignition coil 4 and camshaft position sensor - exhaust	<u>Engine Harness Routing (LHU)</u>	-
J105	Engine Harness	LHU	In the engine compartment	<u>Cooling Fan Harness Routing</u>	-
J106	Engine Harness	LHU	In the engine compartment	<u>Cooling Fan Harness Routing</u>	-
J107	Engine Harness	LHU	In the engine compartment	<u>Cooling Fan Harness Routing</u>	-
			In the engine		

J108	Engine Harness	LHU	compartment, left of center, in the main bundle, between breakout to X115, and breakout to front of engine branch	<ul style="list-style-type: none"> • <u>Cooling Fan Harness Routing</u> • <u>Engine Harness Routing (LHU)</u> 	-
J108	Engine Harness	LUK	In the engine compartment, left of center, between breakout to ignition coil 4 and camshaft position sensor - exhaust	<u>Engine Harness Routing - Right Front (LUK)</u>	-
J109	Engine Harness	LHU	In the engine compartment, left of center, between breakout to ignition coil 4 and camshaft position sensor - exhaust	<u>Engine Harness Routing (LHU)</u>	-
J109	Engine Harness	LUK	In the engine compartment, left of center, between breakout to ignition coil 4 and camshaft position sensor - exhaust	<u>Engine Harness Routing - Left Rear (LUK)</u>	-
J110	Headlamp - Left Harness	-	At the left front of vehicle, within the headlamp - left assembly	-	-
J111	Engine Harness	LHU	In the engine compartment	-	-
			In the engine compartment, between fuse		

J112	Engine Harness	LHU	block - underhood X3 and breakout to X115	<u>Engine Harness Routing (LHU)</u>	-
J113	Engine Harness	LUK	-	<u>Engine Harness Routing - Left Rear (LUK)</u>	-
J113	Front Object Sensor Harness	UD5	On the vehicle exterior, behind the front fascia, in the breakout to X100	-	-
J114	Front Object Sensor Harness	UD5	On the vehicle exterior, behind the front fascia, in the breakout to X100	-	-
J115	Cooling Fan Harness	LHU	In the engine compartment, front near center	-	-
J117	Engine Harness Routing - Right Front	LUK	In the engine compartment, near breakout to Body Engine Controller	<u>Engine Harness Routing - Right Front (LUK)</u>	-
J118	Engine Harness	LUK	In the engine compartment	<u>Engine Harness Routing - Left Rear (LUK)</u>	-
J118	Engine Harness	LHU	In the engine compartment, left of center, between breakout to ignition coil 4 and camshaft position sensor - exhaust	<u>Engine Harness Routing (LHU)</u>	-
J119	Engine Harness	LHU	In the engine compartment	-	-
J120	Headlamp - Right Harness	-	At the right front of vehicle, within the headlamp - right assembly	-	-
J121	Engine Harness	LHU	In the engine compartment	-	-
			In the engine		

J121	Engine Harness Routing - Right Front	LUK	compartment, between X115 and rear of engine	<u>Engine Harness Routing - Right Front (LUK)</u>	-
J122	Engine Harness	LHU	In the engine compartment	-	-
J122	Engine Harness Routing - Right Front	LUK	In the engine compartment, between X115 and rear of engine	<u>Engine Harness Routing - Right Front (LUK)</u>	-
J123	Engine Harness Routing - Right Front	LUK	In the engine compartment, between X115 and rear of engine	<u>Engine Harness Routing - Right Front (LUK)</u>	-
J124	Engine Harness Routing - Right Front	LUK	In the engine compartment, between X115 and rear of engine	<u>Engine Harness Routing - Right Front (LUK)</u>	-
J125	Body Harness	-	In the engine compartment, left rear, between breakout to wiper motor, toward breakout to turn signal repeater - left	-	-
J130	Forward Lamp Harness	T4A	At the front of the vehicle, near the left headlamp breakout	-	-
J131	Forward Lamp Harness	T4A	At the front of the vehicle, near the windshield washer pump breakout	-	-
J131	Engine Harness Routing	LUK	In the engine harness, top of engine near battery	<u>Engine Harness Routing - Left Rear (LUK)</u>	-
			In the engine		

J132	Engine Harness Routing	LUK	harness, top of engine near battery	<u>Engine Harness Routing - Left Rear (LUK)</u>	-
J138	Cooling Fan Harness	LHU	In the engine compartment, front near center	-	-
J139	Cooling Fan Harness	LHU	In the engine compartment, front near center	-	-
J140	Cooling Fan Harness	LUK	In the engine compartment, front near center	<u>Engine Harness Routing - Left Rear (LUK)</u>	-
J144	Body Harness	T4F	In the engine compartment	-	-
J147	Engine Harness	LHU	In the engine compartment	-	-
J149	Engine Harness	LHU	In the engine compartment	-	-
J150	Engine Harness	LHU	In the engine compartment, between fuse block - underhood X3 and breakout to X115	<u>Engine Harness Routing (LHU)</u>	-
J151	Engine Harness	LHU	In the engine compartment, left of center, between breakouts to engine control module and breakout to X115	<u>Engine Harness Routing (LHU)</u>	-
J152	Engine Harness	LHU	In the engine compartment, left of center, between breakouts to engine control module and breakout to X115	<u>Engine Harness Routing (LHU)</u>	-

J153	Engine Harness	LHU	In the engine compartment, left of center, in the main bundle, between breakout to X115, and breakout to front of engine branch	<u>Engine Harness Routing (LHU)</u>	-
J154	Engine Harness	LHU	In the engine compartment, left of center, in the main bundle, between breakout to X115, and breakout to front of engine branch	<u>Engine Harness Routing (LHU)</u>	-
J160	Body Harness	-	In the engine compartment, right side, in the main bundle between breakout to X120 and breakout to turn signal repeater lamp - right	-	-
J161	Body Harness	-	In the engine compartment, right side, in the main bundle between breakout to X120 and breakout to turn signal repeater lamp - right	-	-
J162	Body Harness	-	In the engine compartment, left front, in the main bundle between	-	-

			breakout to fuse block - underhood X1 and breakout to G109		
J165	Body Harness	-	In the engine compartment, left rear, approximately 10 cm (4 in) from wiper motor toward breakout to turn signal repeater - left	-	-
J170	Body Harness	-	In the engine compartment, left front, in the main bundle between breakout to X110 and breakout to X116	-	-
J200	Body Harness	-	In the passenger compartment	-	-
J201	Body Harness	-	In the passenger compartment	-	-
J202	Body Harness	T4F	In the passenger compartment	-	-
J204	Instrument Panel Harness	-	In the passenger compartment, near center, in main bundle, behind info display module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J205	Instrument Panel Harness	-	In the passenger compartment, left side, forward of instrument cluster	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
	Instrument Panel		In the passenger compartment, left side, in branch to body control module,	<u>Instrument Panel Harness Routing -</u>	

J206	Harness	-	between main bundle and body control module breakouts	<u>Behind Instrument Panel</u>	-
J207	Instrument Panel Harness	-	In the passenger compartment, left side, in branch to body control module, between main bundle and body control module breakouts	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J209	Instrument Panel Harness	-	In the passenger compartment, left side, in branch to body control module, between main bundle and body control module breakouts	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J213	Instrument Panel Harness	-	In the passenger compartment, left side, in main bundle, between breakout to instrument panel courtesy lamp - left and branch to body control module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J214	Instrument Panel Harness	-	In the passenger compartment, left side, in main bundle, between breakout to instrument panel courtesy lamp - left and branch to body control module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-

J215	Instrument Panel Harness	-	In the passenger compartment, left side, in branch to body control module, between main bundle and body control module breakouts	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J217	Instrument Panel Harness	-	In the passenger compartment, left side, forward of instrument cluster	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J218	Instrument Panel Harness	-	In the passenger compartment, left side, forward of instrument cluster	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J221	Body Harness	-	In the passenger compartment	-	-
J224	Body Harness	-	In the passenger compartment	-	-
J230	Instrument Panel Harness	-	In the passenger compartment, left side, forward of instrument cluster	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J231	Body Harness	-	In the passenger compartment	-	-
J231	HVAC Module Harness	-	In the passenger compartment, mounted to the HVAC module behind instrument panel	-	-
J233	Body Harness	-	In the passenger compartment	-	-
	HVAC Module		In the passenger compartment, mounted to the		

J233	Harness	-	HVAC module behind instrument panel	-	-
J234	Instrument Panel Harness	F45	In the passenger compartment, right of center, in branch to radio, near main bundle	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J235	Instrument Panel Harness	-	In the passenger compartment, left of center, in branch leading to console, left of radio	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J236	Body Harness	-	In the passenger compartment	-	-
J238	Instrument Panel Harness	-	In the passenger compartment, left side, forward of instrument cluster	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J239	Instrument Panel Harness	-	In the passenger compartment, near center, in main bundle, behind info display module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J240	Body Harness	-	In the passenger compartment, about 281 mm (11 inches) from X150/Brake Fluid Level Switch breakout	-	-
J241	Body Harness	-	In the passenger compartment, about 366 mm (14.5 inches) from X150/Brake Fluid Level Switch breakout	-	-
			In the passenger		

J242	Body Harness	-	compartment, between rear of harness branch to X500, forward of breakout to X210	-	-
J243	Instrument Panel Harness	-	In the passenger compartment, left side, forward of instrument cluster	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J245	Instrument Panel Harness	-	In the passenger compartment, near center, in main bundle, behind info display module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J246	Instrument Panel Harness	-	In the passenger compartment, center, in branch to radio, approximately halfway between radio X1 and main bundle	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J247	Instrument Panel Harness	-	In the passenger compartment, center, in branch to radio, approximately halfway between radio X1 and main bundle	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J251	Body Harness	T4F	In the passenger compartment	-	-
J252	Body Harness	-	In the passenger compartment	-	-
J253	Body Harness	-	In the passenger compartment, right side, right front door sill	<u>Body Harness Routing - Right Side of Passenger Compartment</u>	-
			In the passenger compartment,	<u>Instrument Panel</u>	

J255	Instrument Panel Harness	-	left side, forward of instrument cluster	<u>Harness Routing - Behind Instrument Panel</u>	-
J256	Instrument Panel Harness	-	In the passenger compartment, left side, in main bundle, between breakout to instrument panel courtesy lamp - left and branch to body control module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J257	Instrument Panel Harness	-	In the passenger compartment, left side, forward of instrument cluster	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J258	Instrument Panel Harness	-	In the passenger compartment, right side above instrument panel compartment	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J260	Instrument Panel Harness	-	In the passenger compartment, left side, forward of instrument cluster	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J261	Instrument Panel Harness	-	In the passenger compartment, left of center, in branch leading to console, left of radio	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J262	Instrument Panel Harness	-	In the passenger compartment, near center, in main bundle, behind info display module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
			In the passenger compartment,		

J263	Instrument Panel Harness	-	left of center, in branch leading to console, left of telematics communication interface control module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J264	Body Harness	-	In the passenger compartment, left rear, in the main bundle, between breakout to left rear suspension and breakout to X700	-	-
J266	Body Harness	-	In the passenger compartment, left front, in main bundle, between X210 and breakout to X500	-	-
J269	Instrument Panel Harness	-	In the passenger compartment, near center, in main bundle, behind info display module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J270	Instrument Panel Harness	-	In the passenger compartment, near center, in main bundle, behind info display module	<u>Instrument Panel Harness Routing - Behind Instrument Panel</u>	-
J300	Headliner Harness	CF5	In the passenger compartment, above headliner	-	-
J301	Body Harness	F45	In the passenger compartment, in the body harness, about 108 mm (4.25 in.) from left rear seat air bag breakout	-	-
			In the passenger		

J310	Driver Seat Harness	-	compartment, in the driver seat, in the main bundle near breakout to recline motor	<u>Driver Seat Harness Routing</u>	-
J311	Driver Seat Harness	-	In the passenger compartment, in the driver seat, in the main bundle past breakout to anchor pretensioner	<u>Driver Seat Harness Routing</u>	-
J312	Body Harness	-	In the passenger compartment, in the body harness, about 260 mm (10.24 in.) from the main bundle in breakout to parking brake control module, rear vertical body acceleration sensor, and rear compartment keyless entry antenna	-	-
J313	Body Harness	-	In the passenger compartment, in the body harness main bundle, about 175 mm (6.88 in) from breakout for X210	-	-
J314	Body Harness	-	In the passenger compartment, about 110 mm (4.33 in.) from passenger front floor formed conduit, in main	-	-

			bundle		
J316	Body Harness	-	In the passenger compartment, beneath the center console, in the formed conduit	-	-
J317	Body Harness	-	In the passenger compartment, beneath the center console, in the formed conduit	-	-
J318	Body Harness	-	In the passenger compartment, under the carpet, by the driver's seat, in the formed conduit	-	-
J319	Body Harness	-	In the passenger compartment, near center, on left side of tunnel below console	<u>Body Harness Routing - Right Side of Passenger Compartment</u>	-
J320	Passenger Seat Harness	APH	In the passenger compartment, in the passenger seat, in the main bundle near breakout to recline motor	<u>Passenger Seat Harness Routing</u>	-
J321	Passenger Seat Harness	APH	In the passenger compartment, in the passenger seat, in the main bundle past breakout to anchor pretensioner	<u>Passenger Seat Harness Routing</u>	-
J322	Body Harness	-	In the passenger compartment	-	-
J322	Passenger Seat Harness	A6C	In the passenger compartment, in the passenger seat, in the	-	-

			breakout to seat adjuster switch		
J325	Body Harness	-	In the passenger compartment	-	-
J327	Body Harness	-	In the passenger compartment	-	-
J328	Body Harness	-	In the passenger compartment	-	-
J329	Body Harness	-	In the passenger compartment	-	-
J330	Body Harness	-	In the passenger compartment, left side near middle, in formed conduit at outboard side of driver seat, rearward of breakout to X310	-	-
J340	Body Harness	-	In the passenger compartment	-	-
J352	Body Harness	-	In the passenger compartment, near center, on left side of tunnel below console	<u>Body Harness Routing - Right Side of Passenger Compartment</u>	-
J353	Body Harness	-	In the passenger compartment	-	-
J355	Body Harness	F45	In the passenger compartment	-	-
J356	Body Harness	F45	In the passenger compartment	-	-
J361	Body Harness	-	In the rear compartment, in the main bundle, between breakout to left rear suspension, and breakout to rear compartment lid	<u>Body Harness Routing - Right Side of Passenger Compartment</u>	-
			In the passenger		

J394	Body Harness	-	compartment	-	-
J395	Headliner Harness	CF5	In the passenger compartment, above headliner	-	-
J396	Headliner Harness	-	In the passenger compartment, above headliner	-	-
J397	Headliner Harness	-	In the passenger compartment, above headliner	-	-
J415	Rear Bumper Harness	UD7	At rear of vehicle, mounted to rear bumper cover	-	-
J415	Body Harness	without UD7	In the rear compartment, in the main bundle, between breakout to left rear suspension, and breakout to rear compartment lid	-	-
J416	Rear Bumper Harness	UD7	At rear of vehicle, mounted to rear bumper cover	-	-
J416	Body Harness	without UD7	In the rear compartment	-	-
J450	Body Harness	-	In the rear compartment, in the main bundle, between breakout to left rear suspension, and breakout to rear compartment lid	-	-
			In the rear compartment, in the main bundle,		

J451	Body Harness	-	between breakout to left rear suspension, and breakout to rear compartment lid	-	-
J455	Body Harness	-	In the passenger compartment, left rear, in the main bundle, between breakout to left rear suspension and breakout to X700	-	-
J479	Rear Bumper Harness	UD7	At rear of vehicle, mounted to rear bumper cover	-	-
J480	Rear Bumper Harness	UD7	At rear of vehicle, mounted to rear bumper cover	-	-
J501	Driver Door Harness	-	In the driver door, lower middle, between grommet and door courtesy lamp	<u>Driver Door Harness Routing</u>	-
J503	Driver Door Harness	-	In the driver door, lower rear, between door courtesy lamp and door pocket flood lamp breakout	<u>Driver Door Harness Routing</u>	-
J510	Driver Door Harness	-	In the driver door, middle front, between grommet and breakout to outside rearview mirror switch	<u>Driver Door Harness Routing</u>	-
			In the driver		

J511	Driver Door Harness	-	door, lower front, between grommet and breakout to outside rearview mirror switch	<u>Driver Door Harness Routing</u>	-
J550	Driver Door Harness	-	In the driver door, lower middle, between grommet and breakout to outside rearview mirror switch	<u>Driver Door Harness Routing</u>	-
J551	Driver Door Harness	-	In the driver door, lower front, between grommet and breakout to outside rearview mirror switch	<u>Driver Door Harness Routing</u>	-
J603	Passenger Door Harness	-	In the passenger door, lower middle, between grommet and X610	<u>Passenger Door Harness Routing</u>	-
J604	Passenger Door Harness	-	In the passenger door, lower front, between grommet and X610	<u>Passenger Door Harness Routing</u>	-
J610	Passenger Door Harness	-	In the passenger door, middle front, between grommet and X610	<u>Passenger Door Harness Routing</u>	-
J611	Passenger Door Harness	-	In the passenger door, lower front, between grommet and X610	<u>Passenger Door Harness Routing</u>	-
			In the left rear door, in the		

J700	Left Rear Door Harness	-	main bundle between speaker and breakout to grommet	<u>Left Rear Door Harness Routing</u>	-
J710	Left Rear Door Harness	-	In the left rear door, between door latch and breakout to window motor	<u>Left Rear Door Harness Routing</u>	-
J800	Right Rear Door Harness	-	In the right rear door, in the main bundle between speaker and breakout to grommet	<u>Right Rear Door Harness Routing</u>	-
J810	Right Rear Door Harness	-	In the right rear door, between door latch and breakout to window motor	<u>Right Rear Door Harness Routing</u>	-

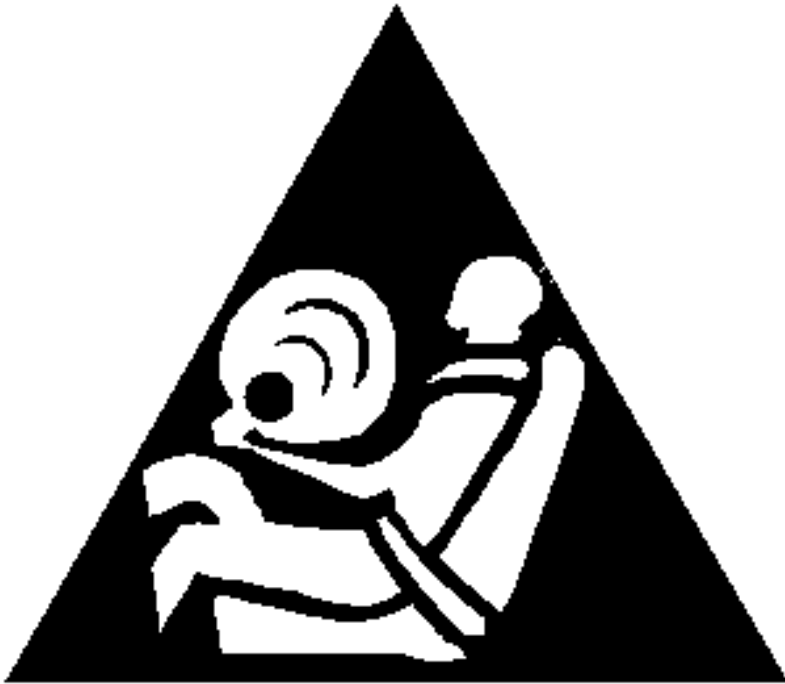
ELECTRICAL

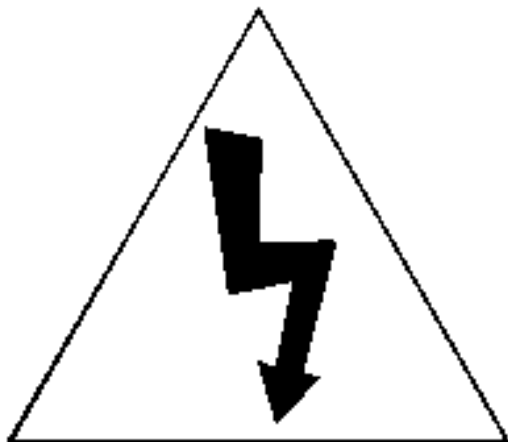
Wiring Systems and Power Management - Schematic Wiring Diagrams - Master Electrical Schematic Icons

SCHEMATIC AND ROUTING DIAGRAMS

MASTER ELECTRICAL SCHEMATIC ICONS

Master Electrical Schematic Icons

Icon	Icon Definition
	<p>WARNING:</p> <p>When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.</p>
	<p>WARNING:</p> <p>The high intensity discharge system produces high voltage and current. To reduce the risk of severe shocks and burns:</p> <ul style="list-style-type: none">• Never open the high intensity discharge system ballast or the arc tube assembly starter.



- Never probe between the high intensity discharge system ballast output connector and the arc tube assembly.

WARNING:

To help avoid personal injury, always treat the accessory power receptacle, accessory DC/AC power inverter module, AC circuit wires, and connectors as if AC high-voltage is present.

NOTE:

Twisted wires provide an effective shield that helps protect sensitive electronic components from electrical interference.

In order to prevent electrical interference from degrading the performance of the connected components, you must maintain the proper specification when making any repairs to the twisted wires shown :

- The wires must be twisted a minimum of 10 turns per 31 cm (12 in) as measured anywhere along the length of the wires.
- The outside diameter of the twisted wires must not exceed 6.0 mm (0.25 in).



NOTE:

This fuse position is used for diagnostic purposes only, vehicle should not be equipped with a fuse in this position

ACCESSORIES & EQUIPMENT

Mirrors

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Inside Rearview Mirror Fastener	2	18 lb in
Outside Rearview Mirror Fastener	9	80 lb in

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Inside Mirror Adhesive Kit	Adhesive	89021329	89020893

SCHEMATIC WIRING DIAGRAMS

INSIDE REARVIEW MIRROR WIRING SCHEMATICS

Inside Rearview Mirror - DD8

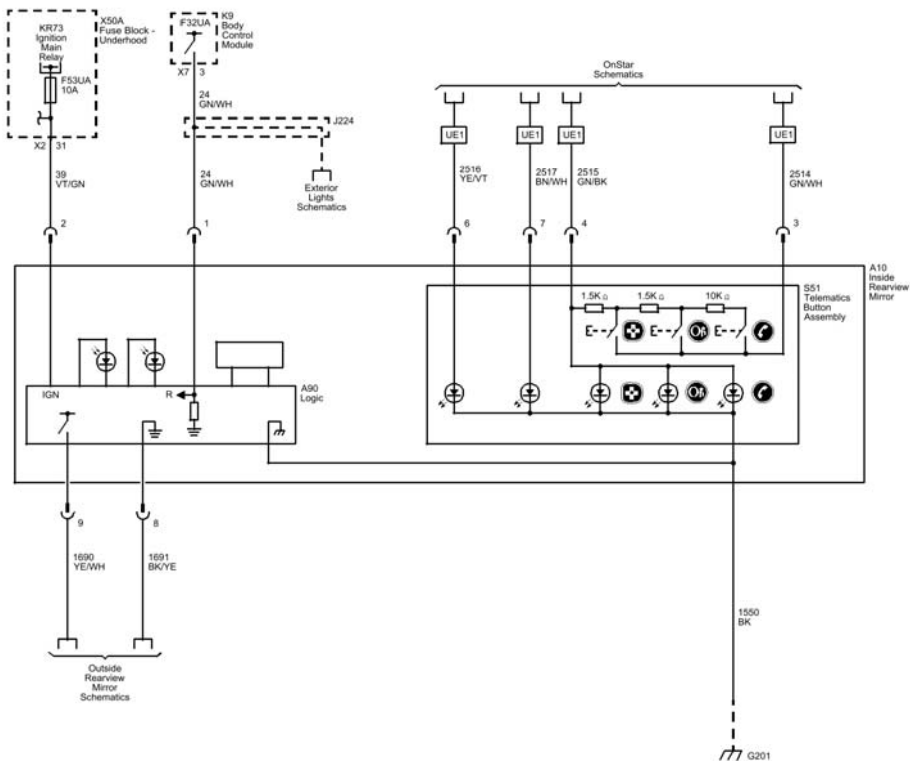


Fig. 1: Inside Rearview Mirror - DD8
Courtesy of GENERAL MOTORS COMPANY

OUTSIDE REARVIEW MIRROR WIRING SCHEMATICS

Controls and Motors (Except CZ2)

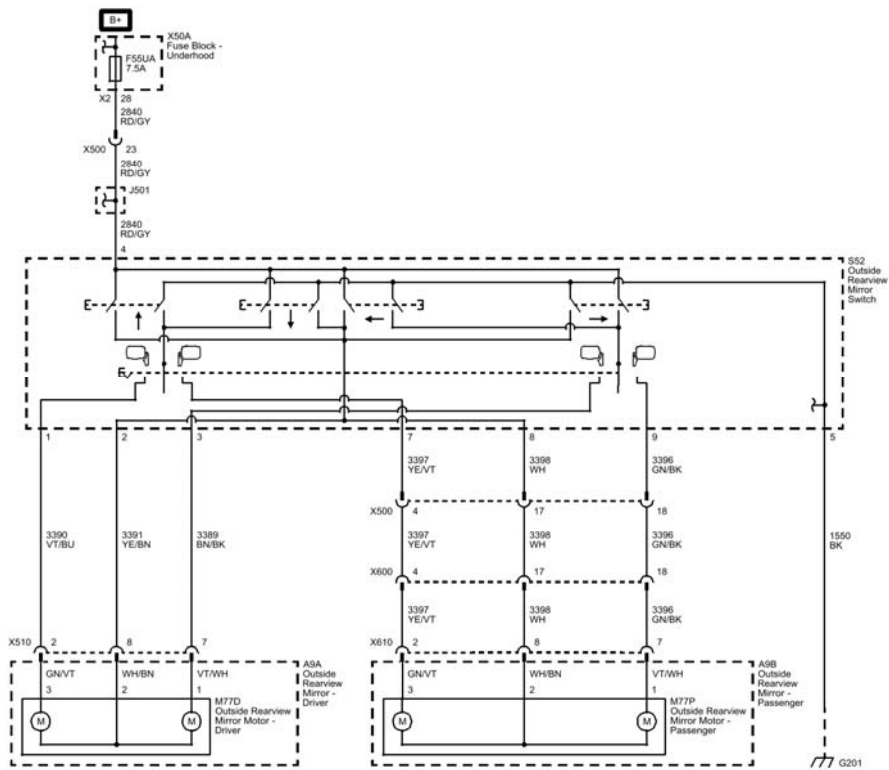


Fig. 2: Controls and Motors (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Driver Controls (A45/CZ2)

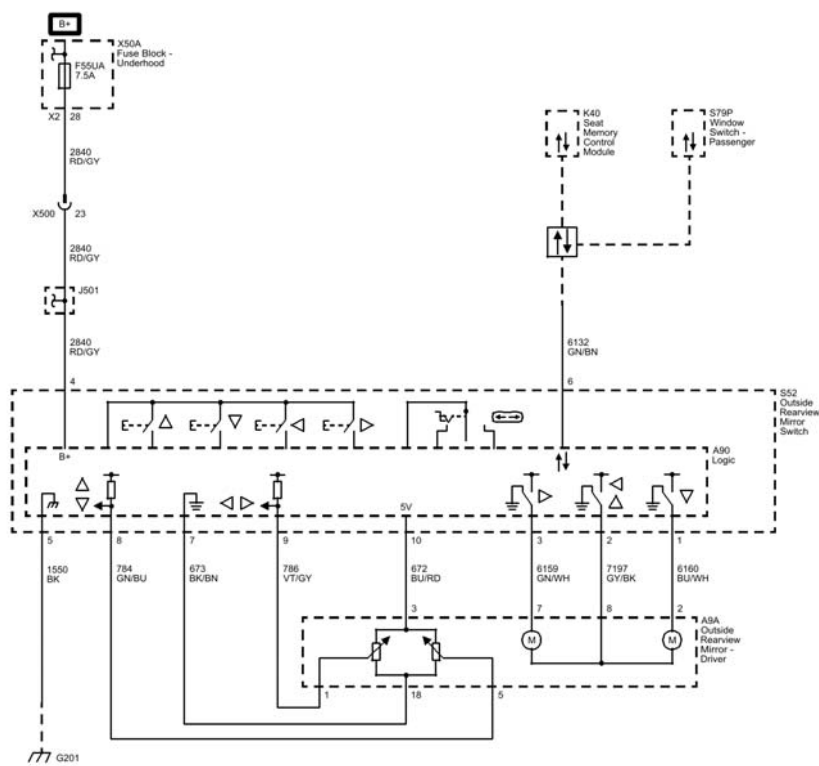
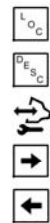


Fig. 3: Driver Controls (A45/CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Passenger Controls (A45/CZ2)



Driver and Passenger Controls (without A45/CZ2)

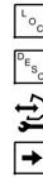
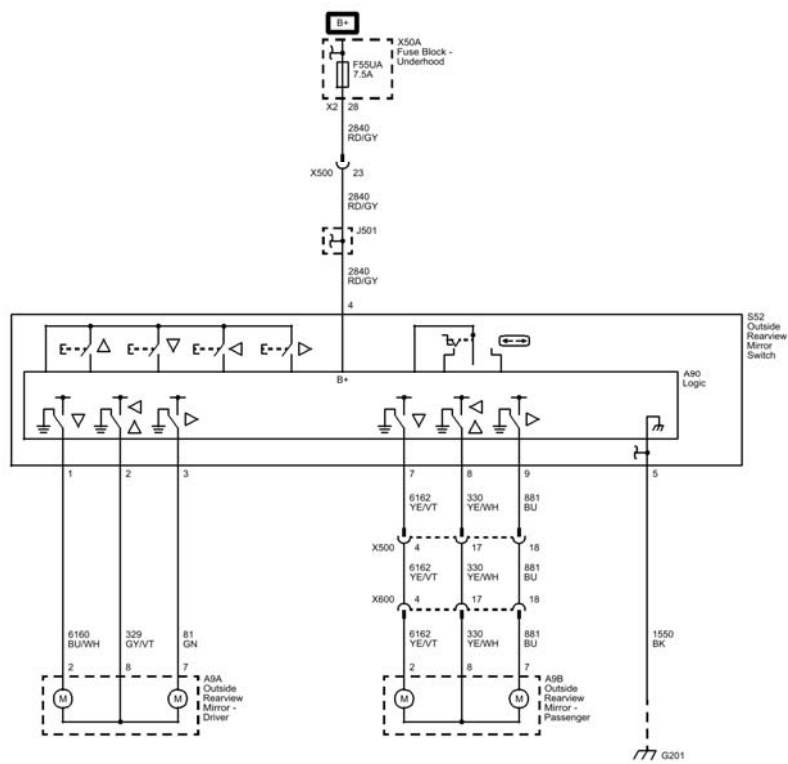


Fig. 5: Driver and Passenger Controls (without A45/CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Folding Mirrors (A45/CZ2)

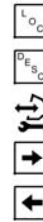
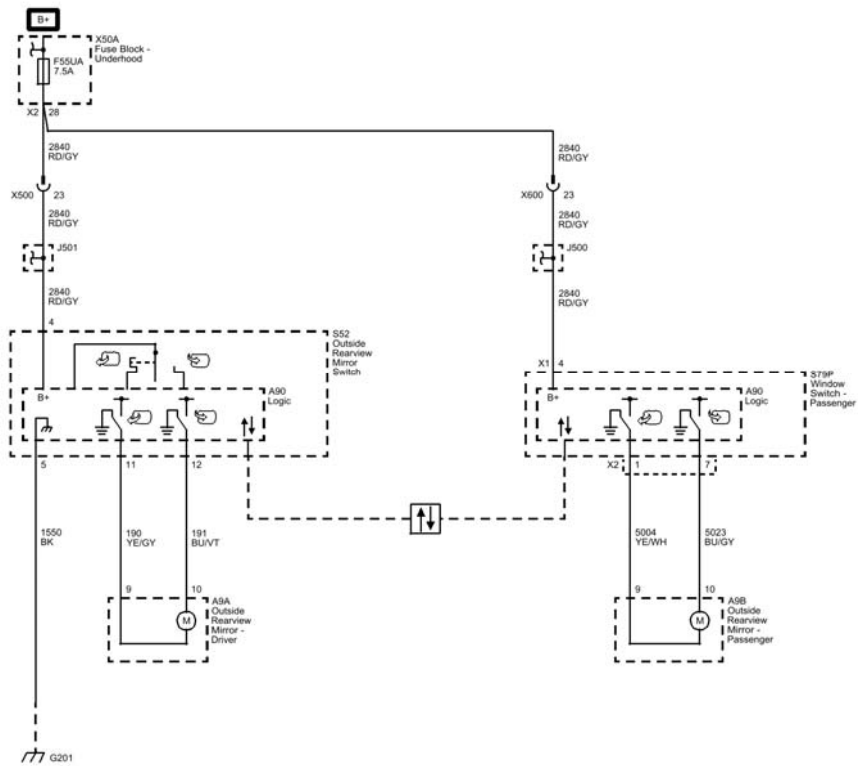


Fig. 6: Folding Mirrors (A45/CZ2)
Courtesy of GENERAL MOTORS COMPANY

Folding Mirrors (without A45/CZ2)

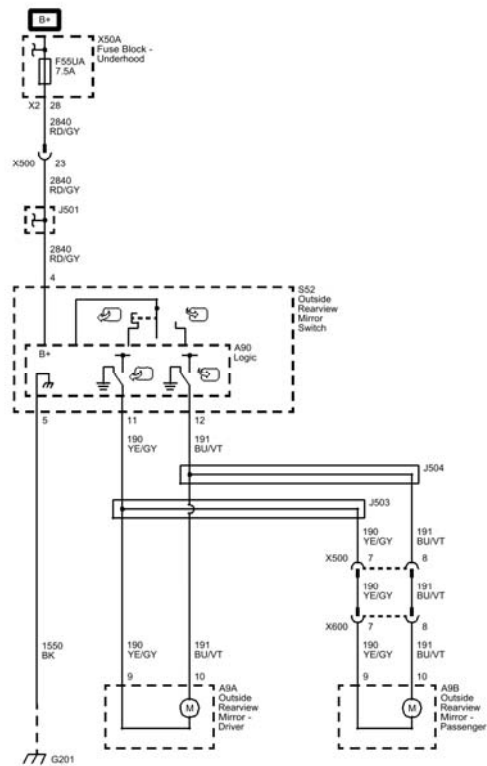


Fig. 7: Folding Mirrors (without A45/CZ2)
Courtesy of GENERAL MOTORS COMPANY

Heated Mirrors or Mirror Dimming

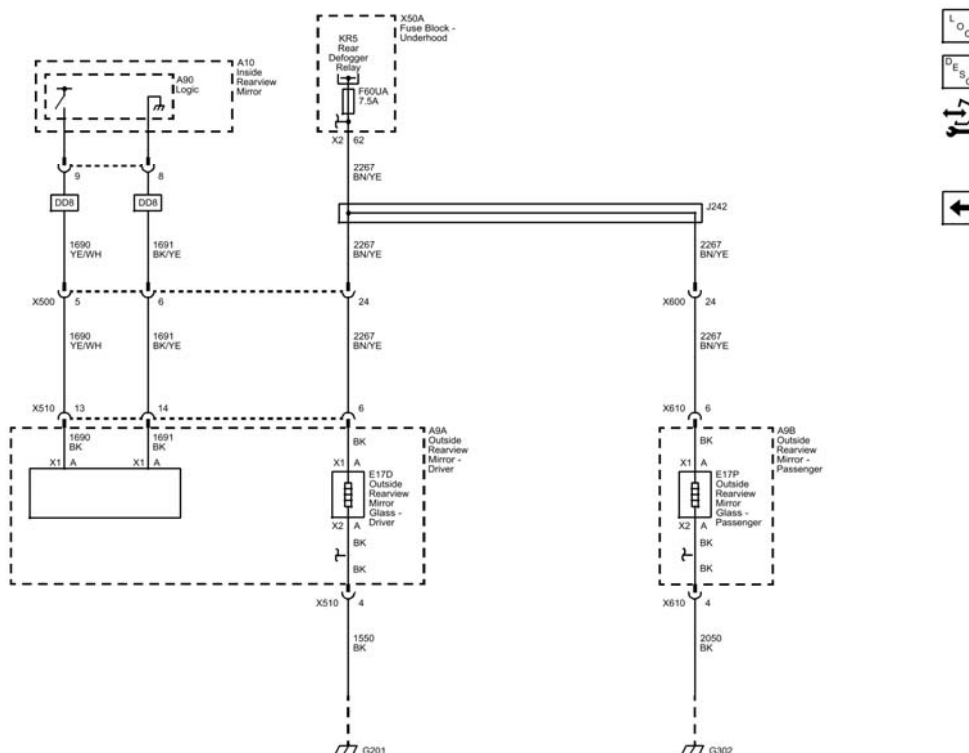


Fig. 8: Heated Mirrors or Mirror Dimming
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B154A or B154B	DTC B154A 39 Driver Mirror Internal Malfunction DTC B154B 39 Passenger Mirror Internal Malfunction

DTC B154A OR B154B: MIRROR INTERNAL MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B154A 39

Driver Mirror Internal Malfunction

DTC B154B 39

Passenger Mirror Internal Malfunction

Circuit/System Description

The outside mirror switch and passenger window switch are on a serial data circuit with the memory seat module as the master. The mirror select and directional control switches are inputs to the memory seat module through the serial data circuit. When the memory seat module receives switch inputs from the outside mirror switch, mirror output commands are sent to the appropriate switch through the serial data circuit. The outside mirror switch and passenger window switch control the left and right outside rear view mirrors through bi-directional motor control circuits. The motor control circuits are floating while in an inactive state and the switches will apply power and ground to the control circuits as necessary to move the mirror in the commanded direction.

Mirror position is determined by both horizontal and vertical position sensors in each of the power mirrors. The outside mirror switch and passenger window switch supply a 5 V reference, low reference, and horizontal and vertical position signal circuits to these sensors. The signal circuits are referenced from 5 V by the switches and the signal circuit voltage levels represent the mirror positions. The mirror positions are sent to the memory seat module through the serial data circuit where they are stored for memory mirror operation. When the memory seat module receives a memory recall command, the memory seat module will send the go to position commands to the outside mirror switch and passenger window switch. The switches will then drive the appropriate mirror motors to the commanded position sensor settings.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B154A 39

An internal malfunction has been detected by the outside rearview mirror switch while commanding the driver outside rearview mirror UP, DOWN, LEFT or RIGHT.

B154B 39

An internal malfunction has been detected by the outside rearview mirror switch while commanding the passenger outside rearview mirror UP, DOWN, LEFT or RIGHT.

Action Taken When the DTC Sets

The affected outside rearview mirror will be inoperative.

Conditions for Clearing the DTC

B154A 39

The driver outside rearview mirror must be replaced before the DTC can be cleared.

B154B 39

The passenger outside rearview mirror must be replaced before the DTC can be cleared.

Reference Information

Schematic Reference

Outside Rearview Mirror Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Outside Mirror Description and Operation (Without A45), Outside Mirror Description and Operation (With A45)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the A9A Outside Rearview Mirror-Driver moves when commanding the Driver Mirror Horizontal Movement Right/Left and Driver Mirror Vertical Movement Up/Down with a scan tool.
 - **If the A9A Outside Rearview Mirror-Driver does not move RIGHT or LEFT or UP or DOWN**

Replace the M77D Outside Rearview Mirror Motor-Driver.

- **If the A9A Outside Rearview Mirror-Driver moves RIGHT, LEFT, UP and DOWN**
3. Verify the A9B Outside Rearview Mirror-Passenger moves when commanding the Passenger Mirror

Horizontal Movement Right/Left and Passenger Mirror Vertical Movement Up/Down with a scan tool.

- If the A9B Outside Rearview Mirror-Passenger does not move RIGHT or LEFT or UP or DOWN

Replace the M77P Outside Rearview Mirror Motor-Passenger.

- If the A9B Outside Rearview Mirror-Passenger moves RIGHT, LEFT, UP and DOWN

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Outside Rearview Mirror Inner Actuator Replacement .

SYMPTOMS - MIRRORS

NOTE: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following system descriptions:
 - **Outside Mirror Description and Operation (Without A45), Outside Mirror Description and Operation (With A45)**
 - **Automatic Day-Night Mirror Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Heated Mirrors Malfunction**
- **Automatic Day-Night Mirrors Malfunction**
- **Power Mirror Malfunction (Without A45), Power Mirror Malfunction (With A45)**

HEATED MIRRORS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Heated Mirror Element Control	1	1	2	-
Ground	-	1	-	-
1. Heated Mirror Inoperative 2. Heated Mirror Always On				

Circuit/System Description

The rear defogger relay supplies voltage to the outside rearview mirror heater elements based on the current state of the rear window defogger. The relay supplies B+ through the driver/passenger mirror heating element control circuit when a request is received.

Reference Information

Schematic Reference

Outside Rearview Mirror Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Outside Mirror Description and Operation (Without A45), Outside Mirror Description and Operation (With A45)

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the E18 Rear Defogger Grid turns ON and OFF when commanding the Rear Defogger On and Off with a scan tool.
 - **If the E18 Rear Defogger Grid does not turn ON and OFF**

Refer to **Rear Window Defogger Malfunction** .

- **If the E18 Rear Defogger Grid turns ON and OFF**
3. Verify the E17D Outside Rearview Mirror Glass-Driver and the E17P Outside Rearview Mirror Glass-Passenger become warm when commanding the Rear Defogger On with a scan tool.
 - **If the E17D Outside Rearview Mirror Glass-Driver and the E17P Outside Rearview Mirror Glass-Passenger do not become warm**

Refer to Circuit/System Testing.

- **If both E17D Outside Rearview Mirror Glass-Driver and the E17P Outside Rearview Mirror Glass-Passenger become warm**
4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 and X2 harness connector at the appropriate E17 Outside Rearview Mirror Glass. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal A X2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal A X1 and ground.
4. Engine running.
5. Verify the test lamp turns ON and OFF when commanding the Rear Defogger On and Off with a scan

tool.

- **If the lamp is always ON**

1. Ignition OFF, disconnect the X2 harness connector at X50A Fuse Block - Underhood, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, refer to **Rear Window Defogger Malfunction** .

- **If the lamp is always OFF**

1. Ignition OFF, disconnect the harness connector at X50A Fuse Block - Underhood, ignition ON.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms refer to **Rear Window Defogger Malfunction** .

- **If the lamp turns on and off**

6. Replace the E17 Outside Rearview Mirror Glass.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Outside Rearview Mirror Glass Replacement

AUTOMATIC DAY-NIGHT MIRRORS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Automatic Day/Night Mirror Signal	2	2	2	-
Backup Lamp Control	B2545 02	1	1	-
Automatic Day/Night Mirror Low Reference	-	2	2	-
Ground	-	1	-	-

- | |
|--|
| <ol style="list-style-type: none">1. Inside and Outside Rearview Mirror Automatic Dimming Malfunction2. Outside Rearview Mirror Automatic Dimming Malfunction |
|--|

Circuit/System Description

The inside rearview mirror uses 2 photocell sensors. One sensor is the rear light sensor, located on the face side of the mirror, facing the rear of the vehicle. The rear light sensor is used to determine light conditions present at the mirror face. The other sensor is the front light sensor, located on the backside of the mirror, facing the front of the vehicle. The front light sensor is used to determine the exterior light conditions at the front of the vehicle. With a low exterior light condition detected by the front light sensor and a high light condition from the rear light sensor, the inside rearview mirror will automatically darken the face of the inside rearview mirror and the driver outside rearview mirror. The inside rearview mirror provides a signal circuit and a low reference circuit to the driver mirror face to darken the mirror when needed.

With the gear selector lever in the REVERSE position and the engine running, backup lamp control voltage is supplied as an input to the inside rearview mirror. The mirror monitors this input to disable the automatic day-night feature. This allows the driver to see objects in the mirror clearly when backing up, regardless of the rear light sensor status.

Reference Information

Schematic Reference

- **Inside Rearview Mirror Schematics**
- **Outside Rearview Mirror Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic Day-Night Mirror Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Cover the windshield with a blanket or other suitable item.
3. Verify the A10 Inside Rearview Mirror face dims when shining a bright light into the rear light sensor
 - **If the A10 Inside Rearview Mirror does not dim**

Refer to Circuit/System Testing - Inside Review Mirror Dimming Inoperative
 - **If the A10 Inside Rearview Mirror dims**
4. Verify the A10 Inside Rearview Mirror face transitions from dim to bright while commanding the Backup Lamps Active and Inactive with a scan tool.
 - **If the A10 Inside Rearview Mirror does not transition between dim and bright.**

Refer to Circuit/System Testing - Day-Night Disable Malfunction
 - **If the A10 Inside Rearview Mirror transitions between bright and dim states**
5. Verify the A9A Outside Rearview Mirror-Driver face dims when shining a bright light into the rear light sensor.
 - **If the A9A Outside Rearview Mirror-Driver does not dim**

Refer to Outside Rearview Mirror Dimming Malfunction.
 - **If the A9A Outside Rearview Mirror-Driver dims**
6. Verify the A9A Outside Rearview Mirror-Driver face transitions from dim to bright while commanding the Backup Lamps Active and Inactive with a scan tool.
 - **If the A9A Outside Rearview Mirror-Driver does not transition between bright and dim states**

Refer to Outside Rearview Mirror Dimming Malfunction.
 - **If the A9A Outside Rearview Mirror-Driver transitions between bright and dim states**
7. All OK.

Circuit/System Testing

Inside Review Mirror Dimming Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A10 Inside Rearview Mirror. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify a test lamp illuminates between the ignition circuit terminal 2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the A10 Inside Rearview Mirror
 - **If the test lamp illuminates**
- 5. Replace the A10 Inside Rearview Mirror.

Day-Night Disable Malfunction

1. Ignition OFF, disconnect the harness connector at the A10 Inside Rearview Mirror. Ignition ON
2. Connect a test lamp between the control circuit terminal 1 and ground
3. Verify the test lamp turns ON and OFF while commanding the Backup Lamps Active and Inactive with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, refer to **Backup Lamps Malfunction (Automatic Transmission)** , **Backup Lamps Malfunction (Manual Transmission)** .
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.

2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, refer to **Backup Lamps Malfunction (Automatic Transmission)** , **Backup Lamps Malfunction (Manual Transmission)**
 - **If the test lamp turns ON and OFF**
4. Replace the A10 Inside Rearview Mirror.

Outside Rearview Mirror Dimming Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A9A Outside Rearview Mirror-Driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 16 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the A10 Inside Rearview Mirror.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the A10 Inside Rearview Mirror.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for less than 1 V between the control circuit terminal 2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the A10 Inside Rearview Mirror, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V replace the A10 Inside Rearview Mirror.
 - **If less than 1 V**
5. Ignition ON, headlamps ON, vehicle in PARK, cover the front light sensor with a towel or other suitable item. Shine a flashlight at the rear light sensor.
6. Test for greater than 1 V between the control circuit terminal 2 and ground.
 - **If 1 V or less**
 1. Ignition OFF, disconnect the harness connector at the A10 Inside Rearview Mirror, ignition ON.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the A10 Inside Rearview Mirror.
 - **If greater than 1 V**
7. Test or replace A9A Outside Rearview Mirror-Driver.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Inside Rearview Mirror Replacement**
- **Outside Rearview Mirror Glass Replacement**

POWER MIRROR MALFUNCTION (WITHOUT A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Outside Rearview Mirror Switch B+	1	1	-	-
Driver Mirror Motor Horizontal Control	1	2	2	-
Driver Mirror Motor Vertical Control	1	2	2	-
Passenger Mirror Motor Horizontal Control	1	3	3	-
Passenger Mirror Motor Vertical Control	1	3	3	-
Outside Rearview Mirror Switch Ground	-	1	-	-
1. Both Outside Power Mirrors Inoperative 2. Driver Outside Power Mirror Malfunction 3. Passenger Outside Power Mirror Malfunction				

Circuit/System Description

The outside rearview mirror switch controls the outside rearview mirrors based on the position of the mirror selector switch and which movement position is selected. The outside rearview mirror switch has four positions: up, down, left, and right. B+ is applied to the switch from the power mirror fuse and when a movement position switch is selected, voltage is sent to the commanded mirror via a mirror control circuit. The opposite mirror control circuit acts as a ground circuit for the bi-directional mirror motor. Ground is the applied through the switch.

Reference Information

Schematic Reference

Outside Rearview Mirror Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Outside Mirror Description and Operation (Without A45)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Verify the mirror glass of the A9A Outside Rearview Mirror-Driver and the A9B Outside Rearview Mirror-Passenger move UP, DOWN, LEFT and RIGHT with the S52 Outside Rearview Mirror Switch.
 - **If both outside mirror glasses do not move**

Refer to Circuit/System Testing - Both Outside Rearview Mirrors Inoperative.
 - **If the driver outside mirror glass does not move UP, DOWN, LEFT or RIGHT**

Refer to Circuit/System Testing - Driver Outside Mirror Movement Malfunction.
 - **If the passenger outside mirror glass does not move UP, DOWN, LEFT or RIGHT**

Refer to Circuit/System Testing - Passenger Outside Mirror Movement Malfunction.
 - **If the mirror glass of the A9A Outside Rearview Mirror-Driver and the A9B Outside Rearview Mirror-Passenger move UP, DOWN, LEFT and RIGHT**
2. All OK.

Circuit/System Testing

Both Outside Rearview Mirrors Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S52 Outside Rearview Mirror Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.

- **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**
- 3. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for infinite resistance between each of the control circuit terminals listed below and ground:
 - Control circuit terminal 1
 - Control circuit terminal 2
 - Control circuit terminal 3
 - Control circuit terminal 7
 - Control circuit terminal 8
 - Control circuit terminal 9
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate M77 Outside Rearview Mirror Motor.
 - **If the test lamp illuminates**
- 4. Test or replace the S52 Outside Rearview Mirror Switch.

Driver Outside Mirror Movement Malfunction

1. Ignition OFF, disconnect the X510 inline harness connector at the A9A Outside Rearview Mirror-Driver. Ignition ON
2. Connect a test lamp between the control circuit terminal 8 and control circuit terminal 2.
3. Verify the test lamp turns ON when commanding the UP and DOWN states with the S52 Outside Rearview Mirror Switch.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.

2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the S52 Outside Rearview Mirror Switch.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
 2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the S52 Outside Rearview Mirror Switch
 - **If the test lamp turns ON during each of the commands**
4. Connect a test lamp between the control circuit terminal 8 and control circuit terminal 7.
5. Verify the test lamp turns ON when commanding the LEFT and RIGHT states with the S52 Outside Rearview Mirror Switch.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the S52 Outside Rearview Mirror Switch.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
 2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the S52 Outside Rearview Mirror Switch
 - **If the test lamp turns ON during each of the commands**
6. Test or replace the M77D Outside Rearview Mirror Motor-Driver.

Passenger Outside Mirror Movement Malfunction

1. Ignition OFF, disconnect the X610 inline harness connector at the A9B Outside Rearview Mirror-Passenger. Ignition ON
2. Connect a test lamp between the control circuit terminal 8 and control circuit terminal 2.

3. Verify the test lamp turns ON when commanding the UP and DOWN states with the S52 Outside Rearview Mirror Switch.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the S52 Outside Rearview Mirror Switch.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
 2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the S52 Outside Rearview Mirror Switch
 - **If the test lamp turns ON during each of the commands**
4. Connect a test lamp between the control circuit terminal 8 and control circuit terminal 7.
5. Verify the test lamp turns ON when commanding the LEFT and RIGHT states with the S52 Outside Rearview Mirror Switch.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the S52 Outside Rearview Mirror Switch.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
 2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the S52 Outside Rearview Mirror Switch
 - **If the test lamp turns ON during each of the commands**
6. Test or replace the M77P Outside Rearview Mirror Motor-Passenger.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Outside Rearview Mirror Inner Actuator Replacement**
- **Outside Rearview Mirror Remote Control Switch Replacement**

POWER MIRROR MALFUNCTION (WITH A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Outside Rearview Mirror Switch B+	U1519 00	U1519 00	-	-
Passenger Window Switch B+	U151B 00	U151B 00	-	-
Position Sensor 5 V Reference	4	4	4	-
Outside Rearview Mirror Switch Left/Right Signal	1	1	1	-
Outside Rearview Mirror Switch Position Signal	1	1	1	-
Left/Right Mirror Horizontal Position Sensor Signal	4	4	4	-
Left/Right Mirror Vertical Position Sensor Signal	4	4	4	-
Left/Right Mirror Motor Horizontal Control	1	1	1	-
Left/Right Mirror Motor Common Control	1	1	1	-
Left/Right Mirror Motor Vertical Control	1	1	1	-
Left/Right Mirror Position Low Reference	-	2	-	-
Outside Rearview Mirror Switch Ground	-	U1519 00	-	-
Passenger Window Switch Ground	-	U151B 00	-	-
1. Outside Rearview Mirror Switch Malfunction 2. Driver Outside Power Mirror Malfunction				

- | |
|---|
| 3. Passenger Outside Power Mirror Malfunction
4. Power Mirror Memory Feature Malfunction |
|---|

Circuit/System Description

The outside mirror switch and passenger window switch are on a serial data circuit with the memory seat module as the master. The mirror select and directional control switches are inputs to the memory seat module through the serial data circuit. When the memory seat module receives switch inputs from the outside mirror switch, mirror output commands are sent to the appropriate switch through the serial data circuit. The outside mirror switch and passenger window switch control the left and right outside rear view mirrors through bi-directional motor control circuits. The motor control circuits are floating while in an inactive state and the switches will apply power and ground to the control circuits as necessary to move the mirror in the commanded direction.

Mirror position is determined by both horizontal and vertical position sensors in each of the power mirrors. The outside mirror switch and passenger window switch supply a 5 V reference, low reference, and horizontal and vertical position signal circuits to these sensors. The signal circuits are referenced from 5 V by the switches and the signal circuit voltage levels represent the mirror positions. The mirror positions are sent to the memory seat module through the serial data circuit where they are stored for memory mirror operation. When the memory seat module receives a memory recall command, the memory seat module will send the go to position commands to the outside mirror switch and passenger window switch. The switches will then drive the appropriate mirror motors to the commanded position sensor settings.

Reference Information

Schematic Reference

Outside Rearview Mirror Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Outside Mirror Description and Operation (With A45)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Mirror Select Switch parameter changes from None to Left and Right when cycling the S52 Outside Rearview Mirror Switch.

- **If the parameter does not change**

Refer to Circuit/System Testing - Outside Rearview Mirror Switch Malfunction.

- **If the parameter changes**

3. Verify the scan tool Mirror Direction Switch parameter changes from Inactive to Up, Down, Right and Left when cycling the S52 Outside Rearview Mirror Switch.

- **If the parameter does not change**

Refer to Circuit/System Testing - Outside Rearview Mirror Switch Malfunction.

- **If the parameter changes**

4. Verify the A9A Outside Rearview Mirror-Driver moves when commanding the Driver Mirror Horizontal Movement Right/Left and Driver Mirror Vertical Movement Up/Down with a scan tool.

- **If the A9A Outside Rearview Mirror-Driver does not move RIGHT or LEFT or UP or DOWN**

Refer to Circuit/System Testing - Driver Outside Mirror Movement Malfunction.

- **If the A9A Outside Rearview Mirror-Driver moves RIGHT, LEFT, UP and DOWN**

5. Verify the scan tool Driver Mirror Vertical Position parameters are between 0.2-4.8 V and change when commanding the Driver Mirror Vertical Movement Up/Down with a scan tool.

- **If not between 0.2-4.8 V or does not change**

Refer to Circuit/System Testing - Driver Mirror Position Sensor Circuit Test.

- **If between 0.2-4.8 V and changes**

6. Verify the scan tool Driver Mirror Horizontal Position parameters are between 0.2-4.8 V and change when commanding the Driver Mirror Horizontal Movement Right/Left with a scan tool.

- **If not between 0.2-4.8 V or does not change**

Refer to Circuit/System Testing - Driver Mirror Position Sensor Circuit Test.

- **If between 0.2-4.8 V and changes**

7. Verify the A9B Outside Rearview Mirror-Passenger moves when commanding the Passenger Mirror Horizontal Movement Right/Left and Passenger Mirror Vertical Movement Up/Down with a scan tool.

- **If the A9B Outside Rearview Mirror-Passenger does not move RIGHT or LEFT or UP or DOWN**

Refer to Circuit/System Testing - Passenger Outside Mirror Movement Malfunction.

- **If the A9B Outside Rearview Mirror-Passenger moves RIGHT, LEFT, UP and DOWN**

8. Verify the scan tool Passenger Mirror Vertical Position parameters are between 0.2-4.8 V and change while commanding the Passenger Mirror Horizontal Movement Right/Left with a scan tool.

- **If not between 0.2-4.8 V or does not change**

Refer to Circuit/System Testing - Passenger Mirror Position Sensor Circuit Test.

- **If between 0.2-4.8 V and changes**

9. Verify the scan tool Passenger Mirror Horizontal Position parameters are between 0.2-4.8 V and change while commanding the Passenger Mirror Vertical Movement Up/Down with a scan tool.

- **If not between 0.2-4.8 V or does not change**

Refer to Circuit/System Testing - Passenger Mirror Position Sensor Circuit Test.

- **If between 0.2-4.8 V and changes**

10. All OK.

Circuit/System Testing

Outside Rearview Mirror Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S52 Outside Rearview Mirror Switch. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp.

2. Test for less than 2 ohms in the ignition circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp.

2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 3. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S52 Outside Rearview Mirror Switch
- **If the test lamp illuminates**
- 4. Test or replace the S52 Outside Rearview Mirror Switch.

Driver Outside Mirror Movement Malfunction

1. Ignition OFF, disconnect the harness connector at the A9A Outside Rearview Mirror-Driver. Ignition ON
2. Connect a test lamp between the control circuit terminal 8 and control circuit terminal 2.
3. Verify the test lamp turns ON when commanding the Up and Down states with a scan tool.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S52 Outside Rearview Mirror Switch.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
 2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S52 Outside Rearview Mirror Switch
 - **If the test lamp turns ON during each of the commands**
4. Connect a test lamp between the control circuit terminal 7 and control circuit terminal 8.
5. Verify the test lamp turns ON when commanding the Left and Right states with a scan tool.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S52 Outside Rearview Mirror Switch.

- **If the test lamp is always ON**
- 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
- 2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S52 Outside Rearview Mirror Switch
- **If the test lamp turns ON during each of the commands**
- 6. Test or replace the M77D Outside Rearview Mirror Motor-Driver.

Driver Mirror Position Sensor Circuit Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A9A Outside Rearview Mirror-Driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 18 and ground.
 - **If 10 ohms or greater**
 - 1. Ignition OFF, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 - 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S52 Outside Rearview Mirror Switch.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 - 1. Ignition OFF, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 - 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S52 Outside Rearview Mirror Switch.
 - **If greater than 5.2 V**
 - 1. Ignition OFF, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
 - 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S52 Outside Rearview Mirror Switch.
 - **If between 4.8-5.2 V**
5. Verify the scan tool Driver Mirror Vertical Position parameter is less than 4.6 V.
 - **If 4.6 V or greater**

1. Ignition OFF, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S52 Outside Rearview Mirror Switch.
- **If less than 4.6 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
7. Verify the scan tool Driver Mirror Vertical Position or the parameter is greater than 0.6 V.
 - **If 0.6 V or less**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S52 Outside Rearview Mirror Switch.
 - **If greater than 0.6 V**
8. Verify the scan tool Driver Mirror Horizontal Position parameter is less than 4.6 V.
 - **If 4.6 V or greater**
 1. Ignition OFF, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S52 Outside Rearview Mirror Switch.
 - **If less than 4.6 V**
9. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the 5 V reference circuit terminal 1.
10. Verify the scan tool Driver Mirror Horizontal Position or the parameter is greater than 0.6 V.
 - **If 0.6 V or less**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S52 Outside Rearview Mirror Switch.

- **If greater than 0.6 V**

11. Test or replace the M77D Outside Rearview Mirror Motor-Driver.

Passenger Outside Mirror Movement Malfunction

1. Ignition OFF, disconnect the harness connector at the A9B Outside Rearview Mirror-Passenger. Ignition ON
2. Connect a test lamp between the control circuit terminal 8 and control circuit terminal 2.
3. Verify the test lamp turns ON when commanding the Up and Down states with a scan tool.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the S79P Window Switch-Passenger.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79P Window Switch-Passenger.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the S79P Window Switch-Passenger, ignition ON.
 2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S79P Window Switch-Passenger
 - **If the test lamp turns ON during each of the commands**
4. Connect a test lamp between the control circuit terminal 7 and control circuit terminal 8.
5. Verify the test lamp turns ON when commanding the Left and Right states with a scan tool.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the S79P Window Switch-Passenger.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79P Window Switch-Passenger.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the S79P Window Switch-Passenger, ignition ON.

2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S79P Window Switch-Passenger
 - **If the test lamp turns ON during each of the commands**
6. Test or replace the M77P Outside Rearview Mirror Motor-Passenger.

Passenger Mirror Position Sensor Circuit Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A9B Outside Rearview Mirror-Passenger. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 18 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the S79P Window Switch-Passenger.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79P Window Switch-Passenger.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X2 harness connector at the S79P Window Switch-Passenger.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79P Window Switch-Passenger.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X2 harness connector at the S79P Window Switch-Passenger, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S79P Window Switch-Passenger.
 - **If between 4.8-5.2 V**
5. Verify the scan tool Passenger Mirror Vertical Position parameter is less than 4.6 V.
 - **If 4.6 V or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the S79P Window Switch-Passenger, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 1 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S79P Window Switch-Passenger.
 - **If less than 4.6 V**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
- 7. Verify the scan tool Passenger Mirror Vertical Position or the parameter is greater than 0.6 V.
 - **If 0.6 V or less**
 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the S79P Window Switch-Passenger.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79P Window Switch-Passenger.
 - **If greater than 0.6 V**
- 8. Verify the scan tool Passenger Mirror Horizontal Position parameter is less than 4.6 V.
 - **If 4.6 V or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the S79P Window Switch-Passenger, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S79P Window Switch-Passenger.
 - **If less than 4.6 V**
- 9. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the 5 V reference circuit terminal 3.
- 10. Verify the scan tool Passenger Mirror Horizontal Position or the parameter is greater than 0.6 V.
 - **If 0.6 V or less**
 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the S79P Window Switch-Passenger.
 2. Test for infinite resistance between the signal circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79P Window Switch-Passenger.
 - **If greater than 0.6 V**
- 11. Test or replace the M77P Outside Rearview Mirror Motor-Passenger.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Outside Rearview Mirror Inner Actuator Replacement**
- **Outside Rearview Mirror Remote Control Switch Replacement**
- **Front Side Door Window Switch Replacement**

POWER MIRROR TILT INOPERATIVE IN REVERSE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The outside mirror switch and passenger window switch are on a serial data circuit with the memory seat module as the master. The mirror select and directional control switches are inputs to the memory seat module through the serial data circuit. When the memory seat module receives switch inputs from the outside mirror switch, mirror output commands are sent to the appropriate switch through the serial data circuit. The outside mirror switch and passenger window switch control the left and right outside rear view mirrors through bi-directional motor control circuits. The motor control circuits are floating while in an inactive state and the switches will apply power and ground to the control circuits as necessary to move the mirror in the commanded direction.

Mirror position is determined by both horizontal and vertical position sensors in each of the power mirrors. The outside mirror switch and passenger window switch supply a 5 V reference, low reference, and horizontal and vertical position signal circuits to these sensors. The signal circuits are referenced from 5 V by the switches and the signal circuit voltage levels represent the mirror positions. The mirror positions are sent to the memory seat module through the serial data circuit where they are stored for memory mirror operation. When the memory seat module receives a memory recall command, the memory seat module will send the go to position commands to the outside mirror switch and passenger window switch. The switches will then drive the appropriate mirror motors to the commanded position sensor settings.

Diagnostic Aids

Not all vehicles have the Park Tilt Mirror feature, verify that the Park Tilt Mirrors option is available in the DIC Vehicle Customization Feature Setting Menu before attempting diagnosis.

Reference Information

Schematic Reference

Outside Rearview Mirror Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Outside Mirror Description and Operation (Without A45), Outside Mirror Description and Operation (With A45)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the park assist option is activated in the driver information center (DIC).
3. Select the driver outside mirror on S52 Outside Rearview Mirror Switch.
4. Verify mirror functions properly when operating the S52 Outside Rearview Mirror Switch in UP/DOWN and LEFT/RIGHT positions.

- **If the mirror does not function properly**

Refer to **Power Mirror Malfunction (Without A45), Power Mirror Malfunction (With A45)**.

- **If the mirror functions properly**

5. Select the passenger outside mirror on S52 Outside Rearview Mirror Switch.
6. Verify mirror functions properly when operating the S52 Outside Rearview Mirror Switch in UP/DOWN and LEFT/RIGHT positions. .

- **If the mirror does not function properly**

Refer to **Power Mirror Malfunction (Without A45), Power Mirror Malfunction (With A45)**.

- **If the mirror functions properly**

7. Operate the memory 1 and 2 recall switches on S47D Seat Memory Switch - Driver.
8. Verify the outside rearview mirrors adjust to the stored memory positions.

- **If the mirrors do not adjust to the stored positions**

Refer to **Power Mirror Malfunction (Without A45)**, **Power Mirror Malfunction (With A45)**.

- **If the mirrors adjust to the stored positions**

9. Park brake on, vehicle running, shift the vehicle in REVERSE.

10. Verify that the outside rearview mirrors tilt.

- **If the driver outside mirror does not tilt**

1. Ignition OFF.

2. Replace the S52 Outside Rearview Mirror Switch.

3. Park brake on, vehicle running, shift the vehicle in REVERSE.

4. Verify the driver mirror tilts.

- If the mirror does not tilt, replace the K40 Memory Seat Module.

- If the mirror tilts

5. All OK.

- **If the passenger outside mirror does not tilt**

1. Ignition OFF.

2. Replace the S79P Passenger Window Switch.

3. Park brake on, vehicle running, shift the vehicle in REVERSE.

4. Verify the driver mirror tilts.

- If the mirror does not tilt, replace the K40 Memory Seat Control Module.

- If the mirror tilts

5. All OK.

- **If the mirrors tilt**

11. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Window Switch Replacement**

REPAIR INSTRUCTIONS

OUTSIDE REARVIEW MIRROR REPLACEMENT

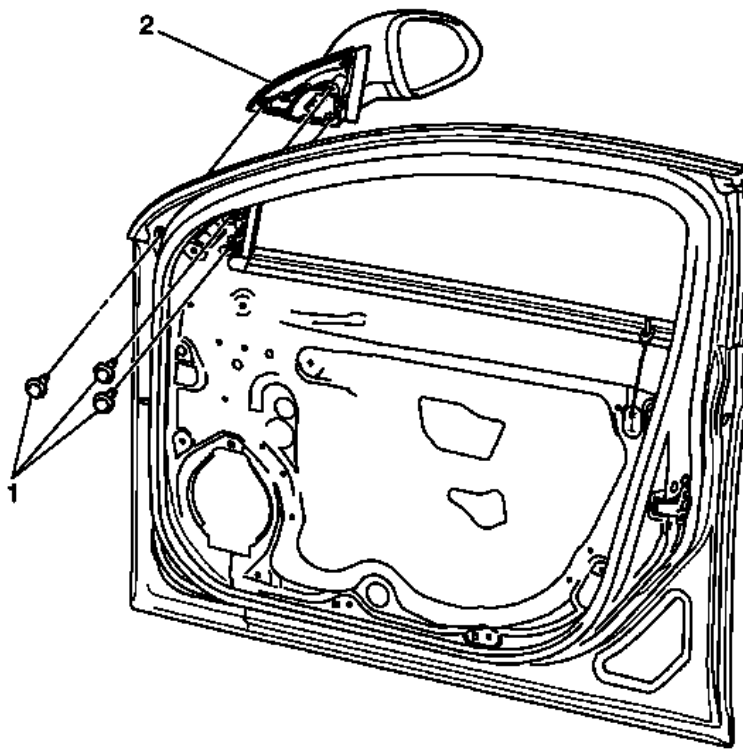


Fig. 9: Outside Rearview Mirror & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Outside Rearview Mirror Replacement

Callout	Component Name
Preliminary Procedure Remove the front side door trim panel. Refer to Front Side Door Trim Panel Replacement .	
1	Outside Rearview Mirror Fastener (Qty: 3) CAUTION: Refer to Fastener Caution . Procedure Disconnect the mirror electrical connector. Tighten 9 N.m (80 lb in)
2	Outside Rearview Mirror Assembly TIP: The mirror assembly must be ordered and assembled prior to being installed to the vehicle.

OUTSIDE REARVIEW MIRROR REMOTE CONTROL SWITCH REPLACEMENT

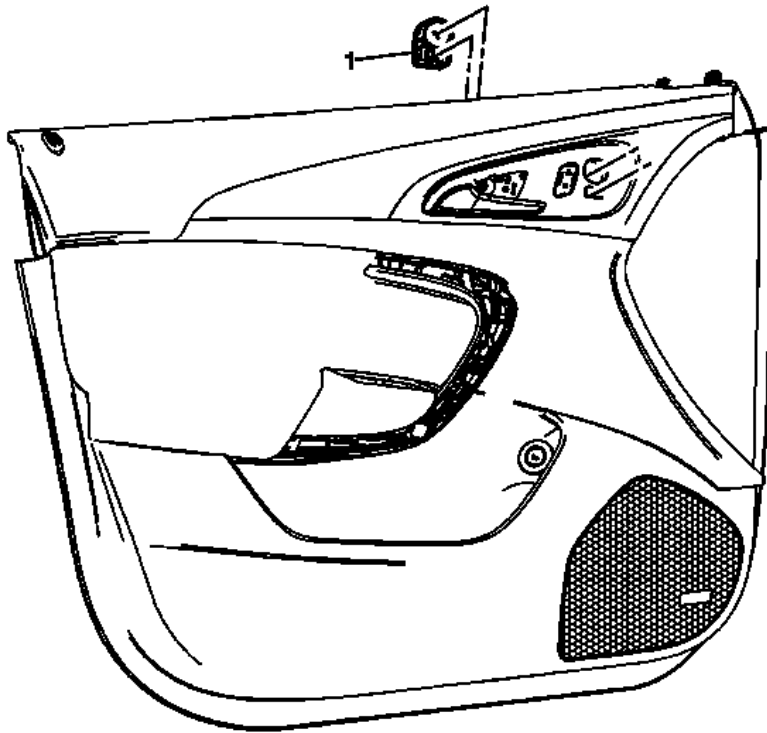


Fig. 10: Outside Rearview Mirror Remote Control Switch
 Courtesy of GENERAL MOTORS COMPANY

Outside Rearview Mirror Remote Control Switch Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front side door trim panel. Refer to <u>Front Side Door Trim Panel Replacement</u> .	
1	Outside Remote Control Rearview Mirror Switch Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Release tabs on switch to remove from the trim panel.

OUTSIDE REARVIEW MIRROR INNER ACTUATOR REPLACEMENT

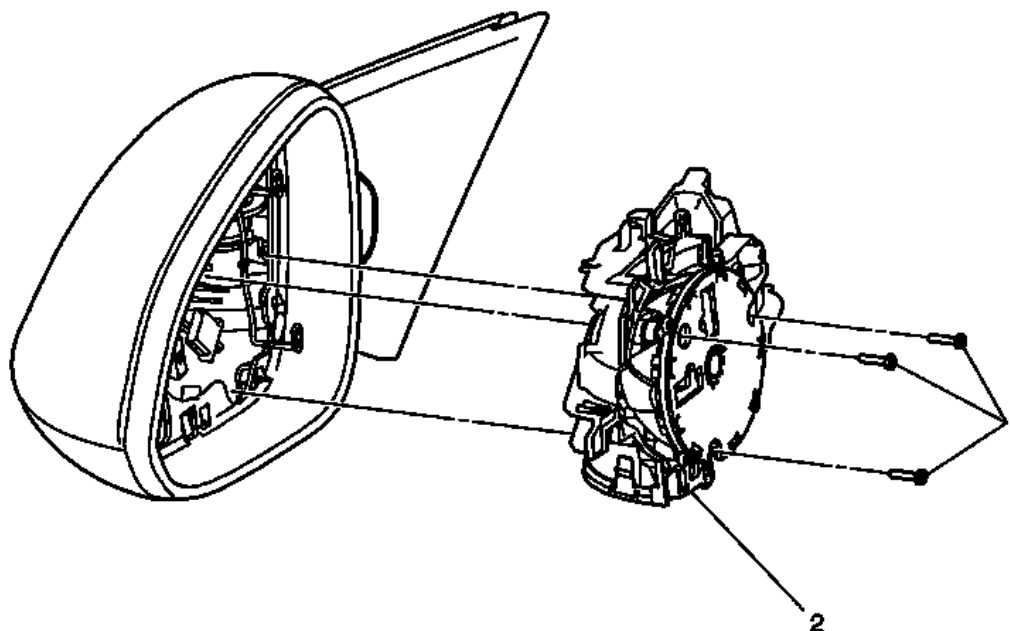


Fig. 11: Outside Rearview Mirror Inner Actuator & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Outside Rearview Mirror Inner Actuator Replacement

Callout	Component Name
Preliminary Procedure	
Remove the outside rearview mirror glass. Refer to <u>Outside Rearview Mirror Glass Replacement</u> .	
1	Outside Rearview Mirror Inner Actuator Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the mirror electrical connector.
2	Outside Rearview Mirror Inner Actuator

OUTSIDE REARVIEW MIRROR GLASS REPLACEMENT

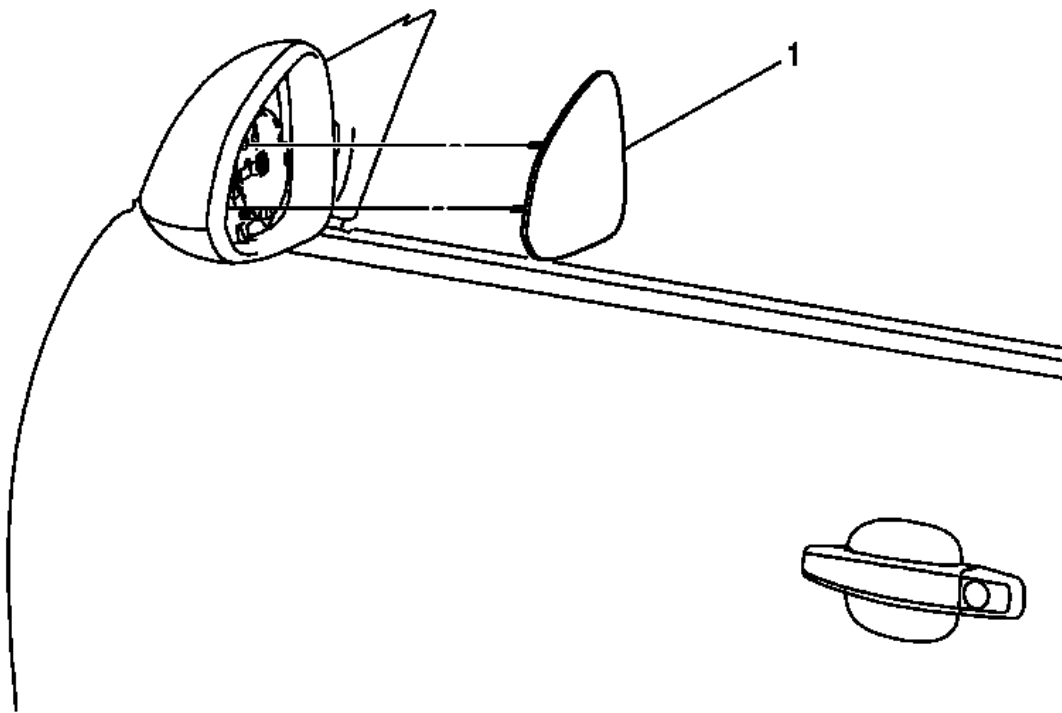


Fig. 12: Outside Rearview Mirror Glass
 Courtesy of GENERAL MOTORS COMPANY

Outside Rearview Mirror Glass Replacement

Callout	Component Name
1	<p>Outside Rearview Mirror Glass</p> <p>WARNING: Refer to <u>Glass and Sheet Metal Handling Warning</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Release the outside rearview mirror glass backing from the mirror housing by releasing the retaining tabs with an appropriate hook tool and pulling outward. 2. Disconnect the power wire harness electrical connector.

OUTSIDE REARVIEW MIRROR HOUSING REPLACEMENT

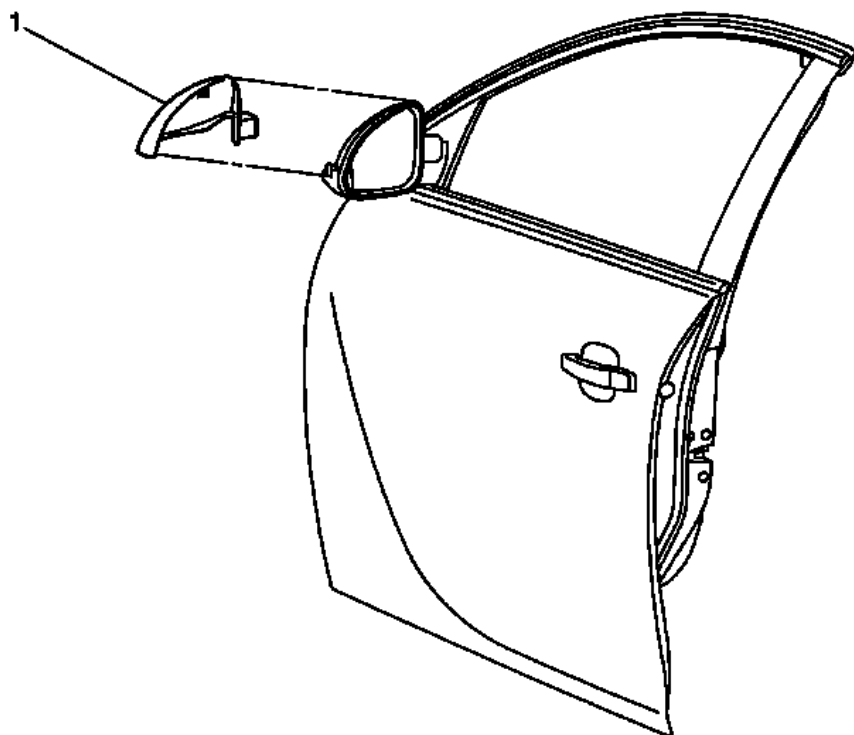


Fig. 13: Outside Rearview Mirror Housing
Courtesy of GENERAL MOTORS COMPANY

Outside Rearview Mirror Housing Replacement

Callout	Component Name
1	Outside Rearview Mirror Housing TIP: Use a small flat-bladed tool to release the outside rearview mirror housing.

INSIDE REARVIEW MIRROR REPLACEMENT

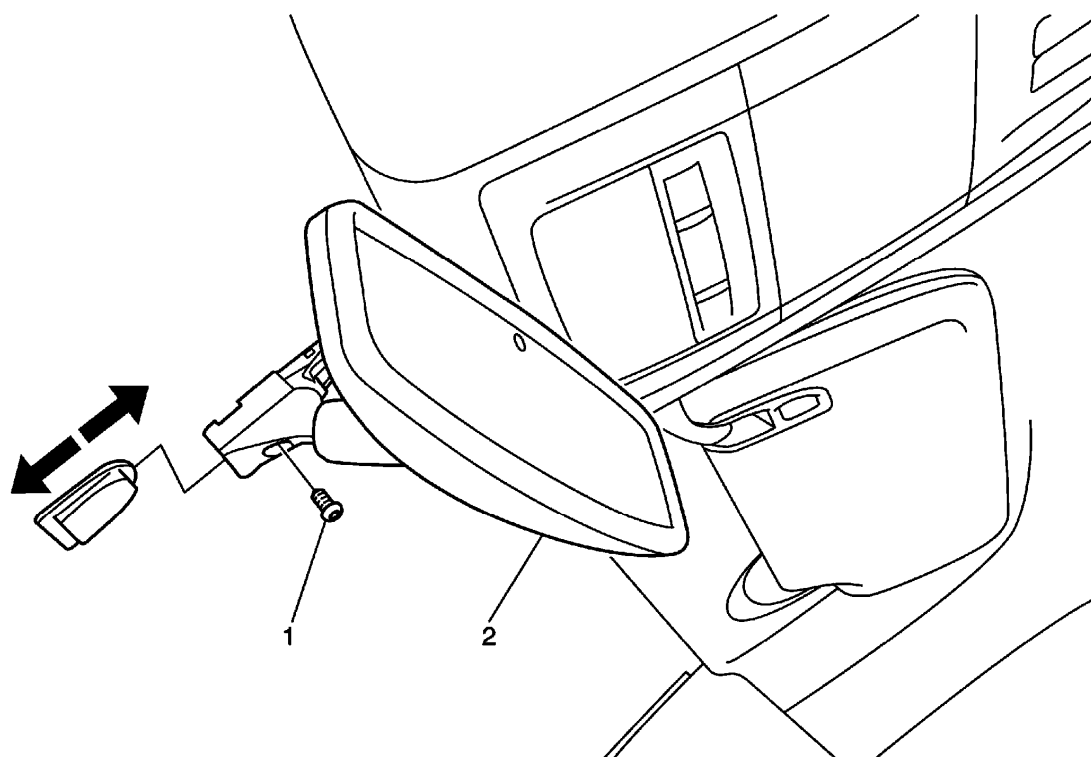


Fig. 14: Inside Rearview Mirror & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Inside Rearview Mirror Replacement

Callout	Component Name
Preliminary Procedure Remove the inside rearview mirror mount plate cover. Refer to <u>Inside Rearview Mirror Mount Plate Cover Replacement</u> .	
1	Inside Rearview Mirror Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2 (18 lb in)
2	Inside Rearview Mirror Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. With both hands on the mirror, rock it from side to side while sliding upward, this will assist in the releasing of the mirror from the mounting tab.

INSIDE REARVIEW MIRROR BRACKET INSTALLATION

NOTE: If the windshield is equipped with a blackout area around the mirror base bracket Care Must be used not to cut or scrape the blackout .

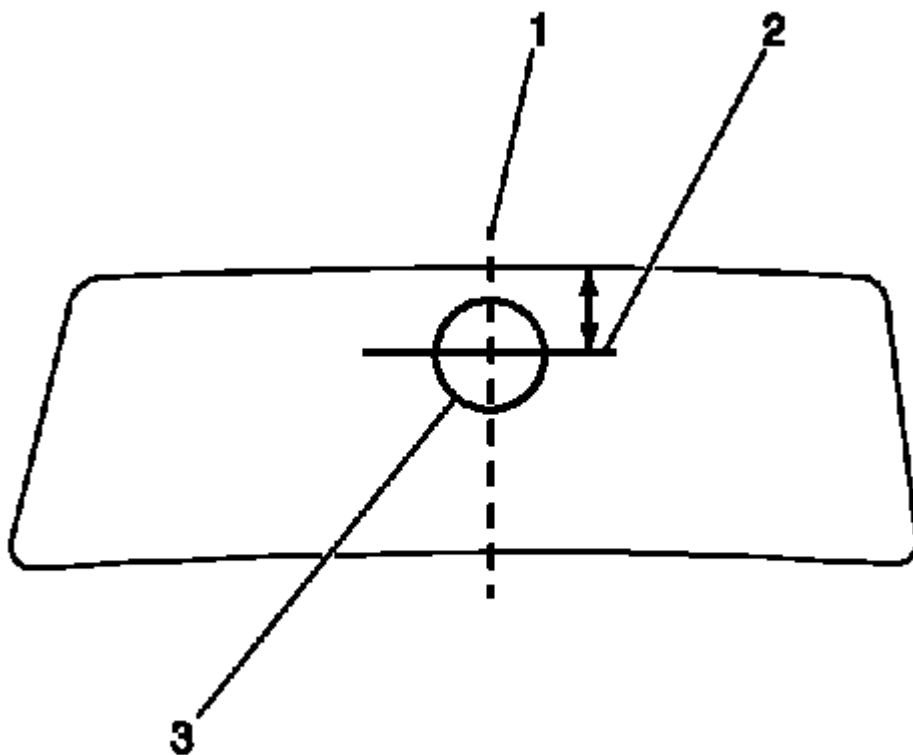


Fig. 15: Identifying Mirror Mounting Base Location
Courtesy of GENERAL MOTORS COMPANY

1. Determine the location of the mirror mounting base by marking the outside/inside of the windshield with a wax pencil where the base was previously located. If it is not clear where the base was located, use the following steps to determine where the base should be installed:
 1. Using a measuring tape, measure the distance between the windshield pillars at the windshield blackout line.
 2. Using a marking pencil, halfway between the windshield pillars, draw a centerline (1) on the windshield from the roof panel to the windshield base.
 3. Draw a perpendicular line intersecting the centerline (2) at that location.

The bottom center of the mirror mounting base will be at the intersection of these lines.

NOTE: Clean the inside windshield glass and the mounting surface of the mirror mounting base thoroughly with a clean cloth saturated with naphtha or a

50/50 mixture by volume of clean water and isopropyl alcohol.

2. Clean the inside windshield glass thoroughly to remove all old adhesive.

NOTE: If reinstalling the original mounting base, place the mirror mounting base in a suitable holding device, such as a vice.

3. Clean mirror mounting base thoroughly to remove all of the old adhesive.

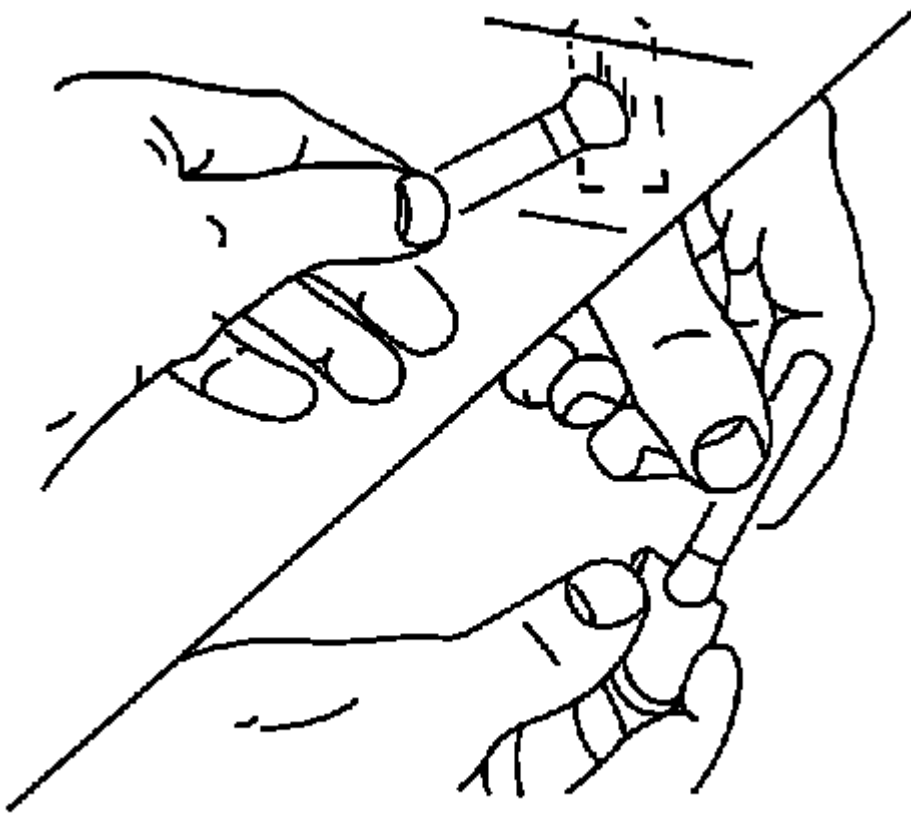


Fig. 16: Applying Adhesive To Mirror Base & Window
Courtesy of GENERAL MOTORS COMPANY

4. Using the Inside Mirror Adhesive Kit , or equivalent to apply a small amount of activator to the mounting surface of the mirror mounting base. Refer to Adhesives, Fluids, Lubricants, and Sealers.
5. Apply a small amount of activator to the windshield where the mounting base is to be installed.
6. Allow the activator to dry 5 minutes.

NOTE: Do not touch the mounting surface of the mirror mounting base or the glass.

7. Apply 1 drop of adhesive to the center of the mirror mounting base.

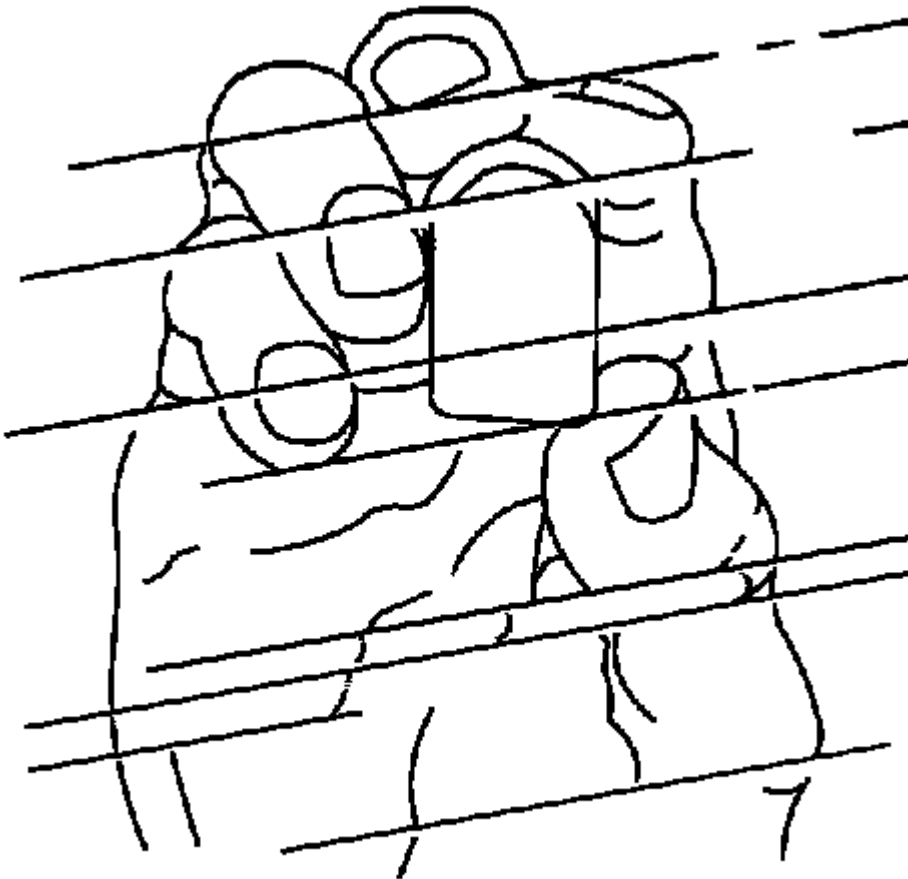


Fig. 17: Installing Mirror Mounting Base
Courtesy of GENERAL MOTORS COMPANY

8. Immediately apply the mounting base to the windshield, ensuring that the mounting base aligns correctly to the marks made on the outside of the windshield.
9. Hold the mounting base firmly in place for 1 minute.
10. Allow the adhesive to set for 15 minutes before installing the rearview mirror.
11. Clean the wax pencil lines from the exterior surface of the glass.
12. Install the mirror to the mirror mounting base. Refer to **Inside Rearview Mirror Replacement**.

DESCRIPTION AND OPERATION

AUTOMATIC DAY-NIGHT MIRROR DESCRIPTION AND OPERATION

Inside Rearview Mirror with the Automatic Day-Night Feature System Operation

The inside rearview mirror uses 2 photocell sensors. One sensor is the headlight sensor, located on the face side

of the mirror. The headlight sensor is used to determine light conditions present at the mirror face. The other sensor is the ambient light sensor, located on the rear of the mirror or windshield side. The ambient light sensor is used to determine the exterior light conditions. With a low exterior light condition detected, and a high light condition from behind the car, at the headlight sensor, the inside rearview mirror will automatically darken the face of the mirror.

In the daytime, the mirror is in a normal state because of the high exterior light condition that is indicated by the ambient light sensor. With the gear selector lever in the REVERSE position and the engine running, backup lamp supply voltage is supplied as an input to the inside rearview mirror. The mirror monitors this input to disable the automatic day-night feature. This allows the driver to see objects in the mirror clearly when backing up, even during the night.

Driver Outside Rearview Mirror with Automatic Day-Night System Operation (If Equipped)

The automatic day-night feature of the driver outside rearview mirror is controlled by the inside rearview mirror. The inside rearview mirror supplies control and low reference to the driver outside rearview mirror. At night, with the automatic day-night feature enabled, the driver outside rearview mirror will automatically darken with the inside rearview mirror to reduce glare from headlamps behind the vehicle.

OUTSIDE MIRROR DESCRIPTION AND OPERATION (WITHOUT A45)

Power Mirror System Components

The power mirror system consists of the following components:

- Mirror direction switch - Controls the left, right, up and down movements of the mirrors
- Mirror select switch - Allows the operator to select the mirror to be moved
- Left outside mirror - Contains both the horizontal and vertical mirror motors
- Right outside mirror - Contains both the horizontal and vertical mirror motors

Each of the outside power mirrors contains 2 motors. The up-down motor operates the vertical directions and the left-right motor operates the horizontal directions. Each of the power mirror motors are internally circuit breaker protected.

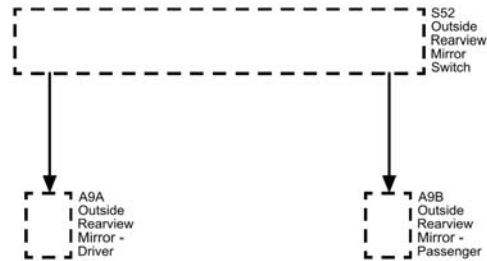


Fig. 18: Power Mirror System Diagram (Without A45)
Courtesy of GENERAL MOTORS COMPANY

Power Mirror System Controls

The outside mirror switch incorporates a mirror select switch and a 4 position mirror direction switch.

The mirror select switch allows the driver to select the mirror to be moved by turning the switch to L position enabling the left outside mirror or turning the switch to R position enabling the right outside mirror.

The mirror direction switch is a 4 position switch that allows the operator to move the selected mirror up, down, left or right.

Power Mirror System Operation

The outside mirror switch receives power through the battery positive voltage circuit from the underhood fuse block. The outside mirror switch also receives a constant ground.

The 4 positions of the direction switch have multiple switch contacts. When not in use, the directional contacts are isolated from any circuit. Each of the contacts are connected to opposing sides of the appropriate mirror motors through the selector switch. The selector switch interrupts or completes these circuits depending on the position of the selector switch, L or R.

If the mirror select switch is placed in the L position and the up switch is pressed, battery voltage will be supplied to the driver outside mirror vertical motor through the driver mirror motor up control circuit and return to the mirror switch through the driver mirror motor left/down control circuit, then to ground and the mirror will

move up. If the down switch is pressed, the driver mirror motor left/down control circuit supplies battery voltage and the driver mirror motor up control circuit completes the path to the mirror switch, then to ground and the mirror will move down.

The remainder of the mirror functions operate in the same manner as described above. Placing the mirror control switch in opposing positions, left/right or up/down, will reverse the voltage polarity to the mirror motor, utilizing the same circuits and the mirror will move accordingly.

Heated Mirrors

The heated mirrors are controlled through the rear defog relay. Whenever the rear window defogger is turned ON, battery voltage is supplied to the mirror heater elements through the left and right mirror heater element control circuits.

OUTSIDE MIRROR DESCRIPTION AND OPERATION (WITH A45)

Power Mirror System Components

The power mirror system consists of the following components:

- Memory Seat Control Module
- Outside Rearview Mirror Switch
- Passenger Window Switch
- Driver Outside Rearview Mirror
- Passenger Outside Rearview Mirror

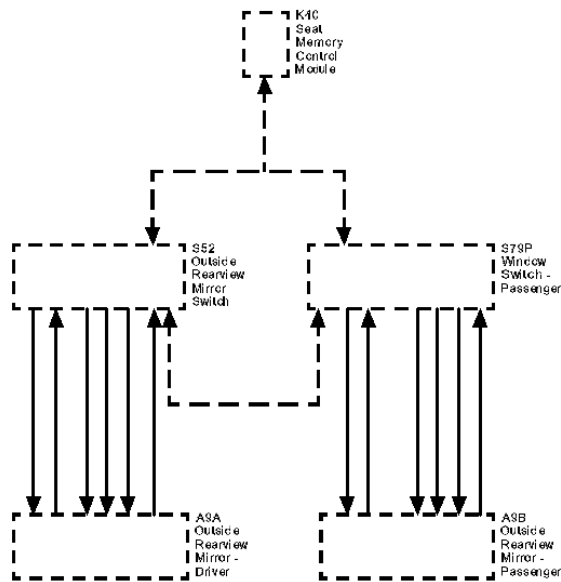


Fig. 19: Power Mirror System Diagram (With A45)
Courtesy of GENERAL MOTORS COMPANY

Power Mirror System Controls

The outside mirror switch and passenger window switch are on a serial data circuit with the memory seat module as the master. The mirror select and directional control switches are inputs to the memory seat module through the serial data circuit. When the memory seat module receives switch inputs from the outside mirror switch, mirror output commands are sent to the appropriate switch through the serial data circuit. The outside mirror switch and passenger window switch control the left and right outside rear view mirrors through bi-directional motor control circuits. The motor control circuits are floating while in an inactive state and the switches will apply power and ground to the control circuits as necessary to move the mirror in the commanded direction.

Mirror position is determined by both horizontal and vertical position sensors in each of the power mirrors. The outside mirror switch and passenger window switch supply a 5 V reference, low reference, and horizontal and vertical position signal circuits to these sensors. The signal circuits are referenced from 5 V by the switches and the signal circuit voltage levels represent the mirror positions. The mirror positions are sent to the memory seat module through the serial data circuit where they are stored for memory mirror operation. When the memory

seat module receives a memory recall command, the memory seat module will send the go to position commands to the outside mirror switch and passenger window switch. The switches will then drive the appropriate mirror motors to the commanded position sensor settings.

Folding Mirrors

The mirror select and fold/unfold switches are inputs to the memory seat module through a serial data circuit. When the memory seat module receives a fold/unfold signal from the outside mirror switch the memory seat module will send a fold/unfold command to the outside mirror switch and passenger window switch. The switches will fold or unfold the mirrors depending on their current state. The outside mirror switch and passenger window switch control the fold/unfold motors through bi-directional control circuits.

This function can also be achieved through the Comfort Open/Close function. If enabled through personalization, the Comfort Open will retract the mirrors and Comfort Close will fold the mirrors.

Heated Mirrors

The heated mirrors are controlled through the rear defog relay. Whenever the rear window defogger is turned on battery voltage is supplied to the mirror heater elements through the left and right mirror heater element control circuits.

ACCESSORIES & EQUIPMENT

Object Detection

SCHEMATIC WIRING DIAGRAMS

OBJECT DETECTION WIRING SCHEMATICS

Power, Ground, On/Off Switch, and Rear Sensors (UD7/Except CZ2)

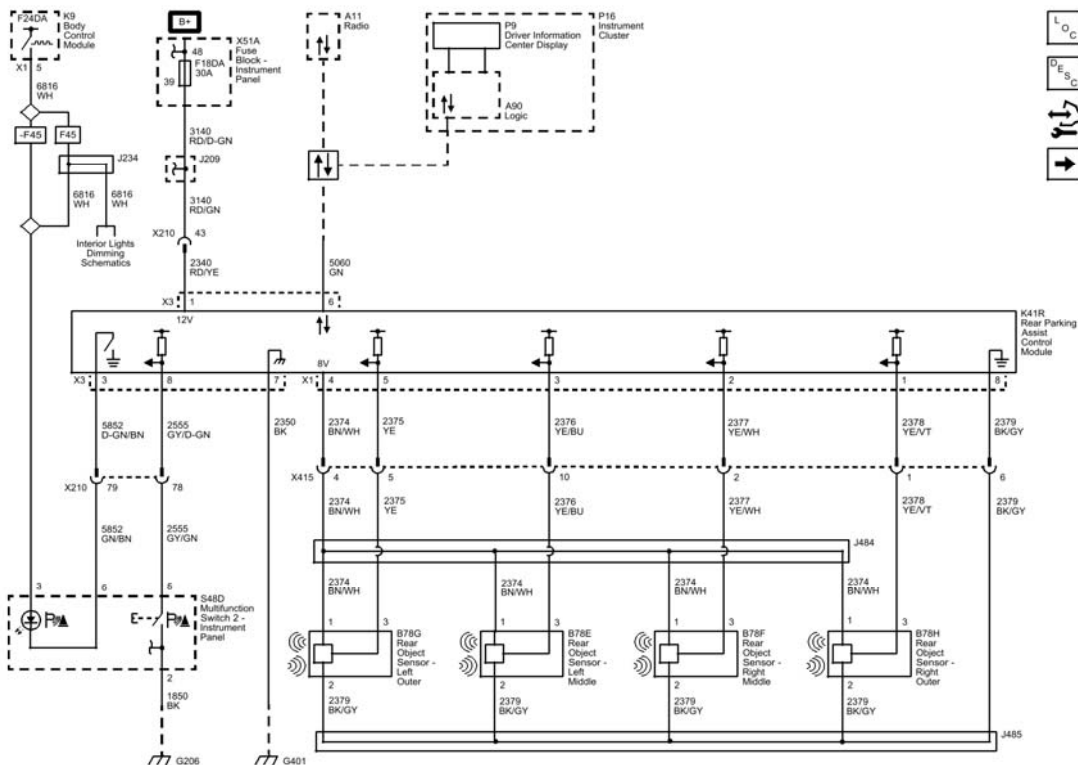


Fig. 1: Power, Ground, On/Off Switch, and Rear Sensors (UD7/Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Power, Ground, On/Off Switch, and Rear Sensors (UD5/Except CZ2)

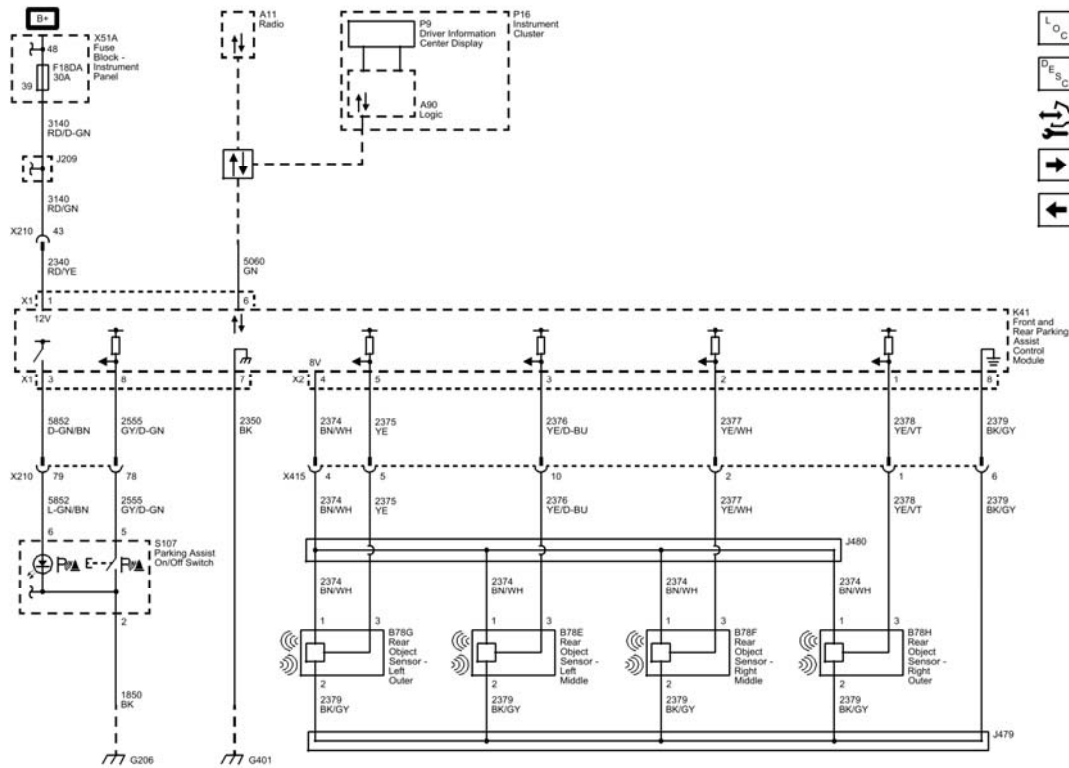


Fig. 2: Power, Ground, On/Off Switch, and Rear Sensors (UD5/Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Front Sensors (UD5/Except CZ2)

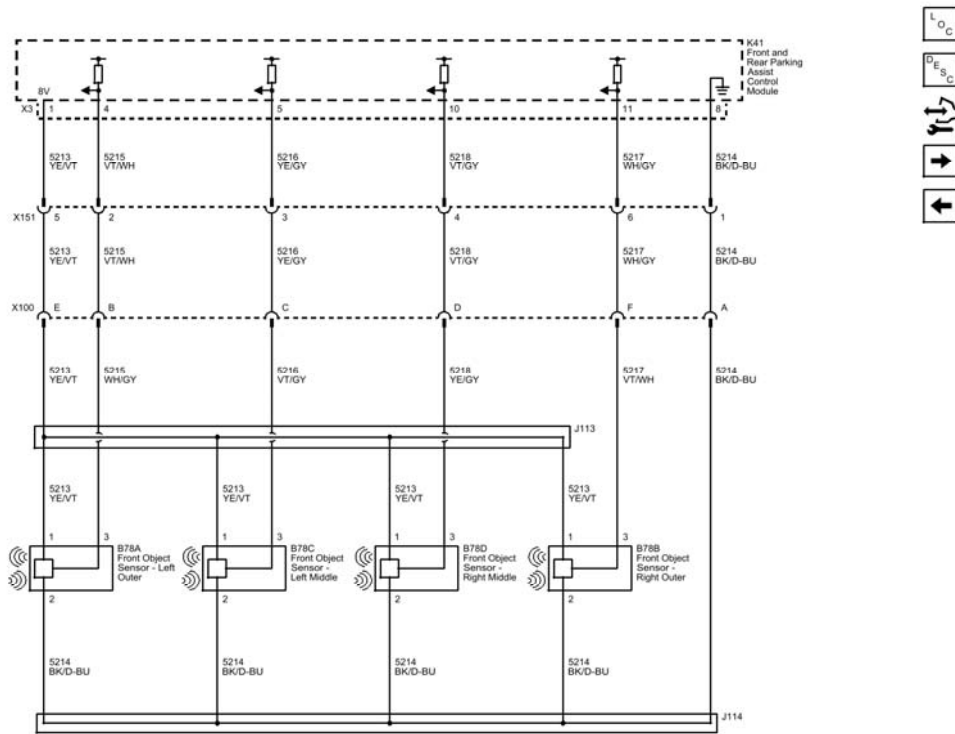


Fig. 3: Front Sensors (UD5/Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Rear Park Assist (CZ2)

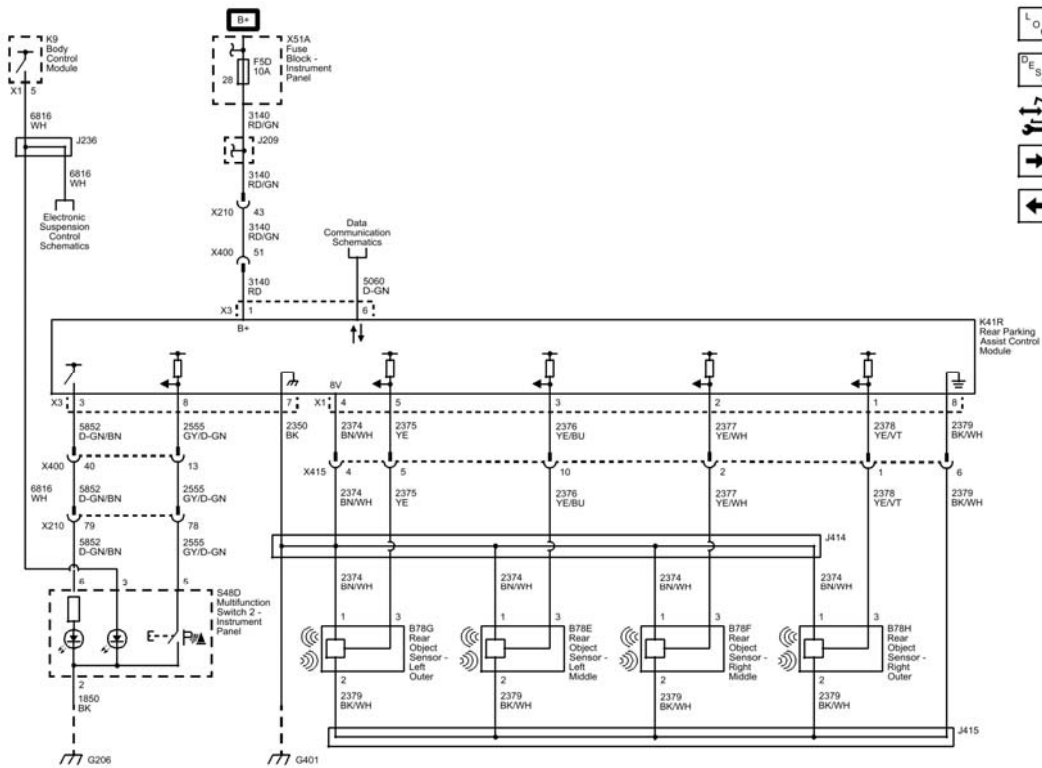


Fig. 4: Rear Park Assist (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Rearview Camera (UVC/CZ2)

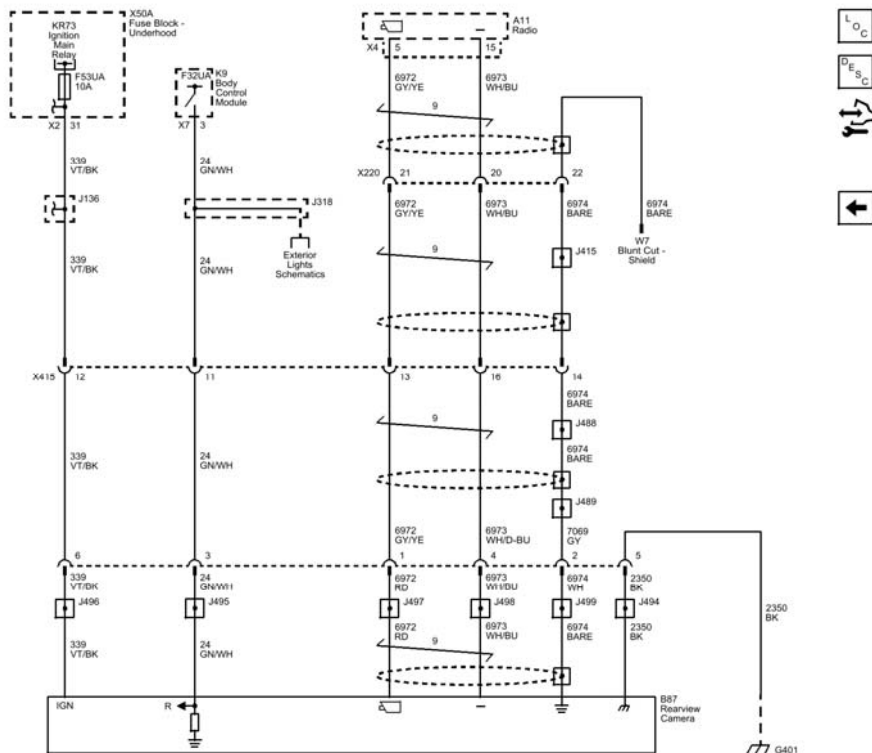


Fig. 5: Rearview Camera (UVC/CZ2)
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B094C	DTC B094C Right Side Object Detection Control Module
DTC B0954, B0955, B0956, or B0957	DTC B0954 01 Parking Assist Front Sensor Right Corner Circuit Short to Battery
	DTC B0954 06 Parking Assist Front Sensor Right Corner Circuit Low Voltage/Open
	DTC B0954 08 Parking Assist Front Sensor Right Corner Circuit Performance - Signal Invalid
	DTC B0954 21 Parking Assist Front Sensor Right Corner Circuit Incorrect Period
	DTC B0954 3A Parking Assist Front Sensor Right Corner Circuit Incorrect Component Installed
	DTC B0955 01 Parking Assist Front Sensor Right Middle Circuit Short to Battery
	DTC B0955 06 Parking Assist Front Sensor Right Middle Circuit Low

	Voltage/Open DTC B0955 08 Parking Assist Front Sensor Right Middle Circuit Performance - Signal Invalid DTC B0955 21 Parking Assist Front Sensor Right Middle Circuit Incorrect Period DTC B0955 3A Parking Assist Front Sensor Right Middle Circuit Incorrect Component Installed DTC B0956 01 Parking Assist Front Sensor Left Middle Circuit Short to Battery DTC B0956 06 Parking Assist Front Sensor Left Middle Circuit Low Voltage/Open DTC B0956 08 Parking Assist Front Sensor Left Middle Circuit Performance - Signal Invalid DTC B0956 21 Parking Assist Front Sensor Left Middle Circuit Incorrect Period DTC B0956 3A Parking Assist Front Sensor Left Middle Circuit Incorrect Component Installed DTC B0957 01 Parking Assist Front Sensor Left Corner Circuit Short to Battery DTC B0957 06 Parking Assist Front Sensor Left Corner Circuit Low Voltage/Open DTC B0957 08 Parking Assist Front Sensor Left Corner Circuit Performance - Signal Invalid DTC B0957 21 Parking Assist Front Sensor Left Corner Circuit Incorrect Period DTC B0957 3A Parking Assist Front Sensor Left Corner Circuit Incorrect Component Installed
<u>DTC B0958, B0959, B0960, or B0961</u>	DTC B0958 Parking Assist Rear Sensor Left Corner Circuit DTC B0959 Parking Assist Rear Sensor Left Middle Circuit DTC B0960 Parking Assist Rear Sensor Right Middle Circuit DTC B0961 Parking Assist Rear Sensor Right Corner Circuit
<u>DTC B0967 or B0968</u>	DTC B0967 02 Parking Assist On/Off Switch Circuit Short to Ground DTC B0968 01 Parking Assist On/Off Switch Indicator Circuit Short to Battery DTC B0968 06 Parking Assist On/Off Switch Indicator Circuit Low Voltage/Open
<u>DTC B0987</u>	DTC B0987 01 Vehicle Direction Camera Indicator Circuit Short to Battery. DTC B0987 06 Vehicle Direction Camera Indicator Circuit Low Voltage/Open
<u>DTC B1011</u>	DTC B1011 00 System Disabled Information Stored Malfunction
<u>DTC B1015</u>	DTC B1015 00 Vehicle Identification Number Information Malfunction
<u>DTC B1405 (with rear park assist)</u>	DTC B1405 02 Control Module Voltage Reference Output 2 Circuit Short to Ground DTC B1405 03 Control Module Voltage Reference Output 2 Circuit Low Voltage DTC B1405 07 Control Module Voltage Reference Output 2 Circuit High Voltage

<u>DTC B1405 (with front and rear park assist)</u>	DTC B1405 02 Control Module Voltage Reference Output 2 Circuit Short to Ground DTC B1405 03 Control Module Voltage Reference Output 2 Circuit Low Voltage DTC B1405 07 Control Module Voltage Reference Output 2 Circuit High Voltage
<u>DTC B356A</u>	DTC B356A 02 Vehicle Direction Warning Switch Circuit Short to Ground DTC B356A 05 Vehicle Direction Warning Switch Circuit Short to Voltage
<u>DTC P15F6</u>	DTC P15F6 Front Object Detection Control Module Torque Request Signal Message Counter Incorrect

DTC B094C: RIGHT SIDE OBJECT DETECTION CONTROL MODULE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B094C

Right Side Object Detection Control Module

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

B218R Side Object Sensor Module - Right communicates on a private communication data bus with the B218L Side Object Sensor Module - Left. The B218L Side Object Sensor Module - Left is the master and can set this code if the B218R Side Object Sensor Module - Right determines it has an internal fault. DTC U18A6 will set if the left module is unable to communicate with the right side module.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The B218R Side Object Sensor Module - Right has detected an internal malfunction.

Action Taken When the DTC Sets

- The side object sensor system is disabled..
- The DIC will display "Service Side Detection System".

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the control module ignition cycle counter reaches the reset threshold of 40, without a repeat of the malfunction.

Diagnostic Aids

- The modules are not identical and cannot be swapped from side to side.
- This DTC may be stored as a history DTC without affecting the operation of the B218R Side Object Sensor Module - Right.
- Do not replace B218R Side Object Sensor Module - Right based only on DTC B094C being set in history.
- If DTC B094C is set as current, replace the B218R Side Object Sensor Module - Right.
- B218R Side Object Sensor Module - Right communicates on a private communication data bus with the B218L Side Object Sensor Module - Left. If programming is needed for module replacement, you must program B218L Side Object Sensor Module - Left which will then in turn program B218R Side Object Sensor Module - Right.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that B094C is not set.
 - **If DTC is set**

Replace the B218R Side Object Sensor Module - Right.

- **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for side object sensor module replacement, programming and setup.

DTC B0954, B0955, B0956, OR B0957: PARKING ASSIST FRONT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0954 01

Parking Assist Front Sensor Right Corner Circuit Short to Battery

DTC B0954 06

Parking Assist Front Sensor Right Corner Circuit Low Voltage/Open

DTC B0954 08

Parking Assist Front Sensor Right Corner Circuit Performance - Signal Invalid

DTC B0954 21

Parking Assist Front Sensor Right Corner Circuit Incorrect Period

DTC B0954 3A

Parking Assist Front Sensor Right Corner Circuit Incorrect Component Installed

DTC B0955 01

Parking Assist Front Sensor Right Middle Circuit Short to Battery

DTC B0955 06

Parking Assist Front Sensor Right Middle Circuit Low Voltage/Open

DTC B0955 08

Parking Assist Front Sensor Right Middle Circuit Performance - Signal Invalid

DTC B0955 21

Parking Assist Front Sensor Right Middle Circuit Incorrect Period

DTC B0955 3A

Parking Assist Front Sensor Right Middle Circuit Incorrect Component Installed

DTC B0956 01

Parking Assist Front Sensor Left Middle Circuit Short to Battery

DTC B0956 06

Parking Assist Front Sensor Left Middle Circuit Low Voltage/Open

DTC B0956 08

Parking Assist Front Sensor Left Middle Circuit Performance - Signal Invalid

DTC B0956 21

Parking Assist Front Sensor Left Middle Circuit Incorrect Period

DTC B0956 3A

Parking Assist Front Sensor Left Middle Circuit Incorrect Component Installed

DTC B0957 01

Parking Assist Front Sensor Left Corner Circuit Short to Battery

DTC B0957 06

Parking Assist Front Sensor Left Corner Circuit Low Voltage/Open

DTC B0957 08

Parking Assist Front Sensor Left Corner Circuit Performance - Signal Invalid

DTC B0957 21

Parking Assist Front Sensor Left Corner Circuit Incorrect Period

DTC B0957 3A

Parking Assist Front Sensor Left Corner Circuit Incorrect Component Installed

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
8 V Reference	B1405 02	B0954 06, B0955 06, B0956 06, B0957 06, B0958 06, B0959 06, B0960 06, B0961 06, B1405 03	B0954 06, B0955 06, B0956 06, B0957 06, B0958 06, B0959 06, B0960 06, B0961 06, B1405 07	-
Right Front Object Sensor Signal	B0954 06	B0954 06	B0954 01	B0954 08, B0954 21
Right Middle Front Object Sensor Signal	B0955 06	B0955 06	B0955 01	B0955 08, B0955 21
Left Middle Front Object Sensor Signal	B0956 06	B0956 06	B0956 01	B0956 08, B0956 21
Left Front Object Sensor Signal	B0957 06	B0957 06	B0957 01	B0957 08, B0957 21
Low Reference	-	B0954 01, B0955 01, B0956 01, B0957 01, B0958 01, B0959 01, B0960 01, B0961 01	-	-

Circuit/System Description

The object sensors are 3-wire sensors that are used to determine the distance between the vehicle and an object

of interest. The front and rear parking assist control module supplies 8 V to the object sensors via the 8 V reference circuit and provides ground via the low reference circuit. The front and rear parking assist control module triggers the sensors in a sequential loop. After each sensor transmits, the front and rear parking assist control module uses the sensor echo received through the signal circuit to calculate the distance and position of an object.

Conditions for Running the DTC

- Ignition ON
- The park assist is activated. The activation takes place through putting in the reverse gear or through operating the park assist switch.

Conditions for Setting the DTC

B0954 01, B0955 01, B0956 01, or B0957 01

The front and rear parking assist control module has detected the voltage at the sensor circuit is greater than 11.5 V or the object sensor is not grounded.

B0954 06, B0955 06, B0956 06, or B0957 06

The front and rear parking assist control module has detected the voltage at the sensor circuit is less than 0.5 V.

B0954 08, B0955 08, B0956 08, or B0957 08

The front and rear parking assist control module has received an invalid signal.

B0954 21, B0955 21, B0956 21, or B0957 21

The object sensor determines no change in the position of an object while the vehicle is in motion.

B0954 3A, B0955 3A, B0956 3A, or B0957 3A

The front and rear parking assist control module determines the wrong sensor type is installed.

Action Taken When the DTC Sets

- The parking assist is disabled.
- The driver information center displays SERVICE PARK ASSIST.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B1405 is not set.
 - **If the DTC is set**

Refer to **DTC B1405 (with rear park assist), DTC B1405 (with front and rear park assist)**

- **If the DTC is not set**
3. Verify that DTC B0954 01, B0955 01, B0956 01, B0957 01 B0954 21, B0955 21, B0956 21 or B0957 21 is not set.
 - **If the DTC is set**
 1. Verify the B78 Front Object Sensors are not contaminated with snow, mud, dirt, slush, or ice.
 - If contaminated, clean sensor.
 - If there is no contamination
 2. Refer to Circuit/System Testing.
 - **If the DTC is not set**

4. Verify that DTC B0954 3A, B0955 3A, B0956 3A or B0957 3A is not set.

- **If the DTC is set**

Replace the B78 Front Object Sensor with the correct sensor type.

- **If the DTC is not set**

5. Ignition ON, transmission in REVERSE.
6. Verify the scan tool Parking Assist System Status parameter displays Enabled.

- **If the Parking Assist System displays Disabled**

Refer to Circuit/System Testing.

- **If the Parking Assist System displays Enabled**

7. All OK.

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, disconnect the harness at the appropriate B78 Front Object Sensor. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.

- **If 10 ohms or greater**

1. Ignition OFF, disconnect the harness connector X3 at the K41 Front and Rear Parking Assist Control Module.

2. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms replace the K41 Front and Rear Parking Assist Control Module.

- **If less than 10 ohms**

3. Ignition ON.

4. Test for 7.5-9.5 V between the 8 V reference circuit terminal 1 and ground.

- **If less than 7.5 V**

1. Ignition OFF, disconnect the harness connector at the K41 Front and Rear Parking Assist Control Module.

2. Test for infinite resistance between the 8 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

3. Test for less than 2 ohms in the 8 V reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K41 Front and Rear Parking Assist Control Module.

- **If greater than 9.5 V**

1. Ignition OFF, disconnect the harness connector at the K41 Front and Rear Parking Assist Control Module, ignition ON.

2. Test for less than 1 V between the 8 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K41 Front and Rear Parking Assist Control Module.
 - **If between 7.5-9.5 V**
5. Ignition OFF, remove appropriate B78 Front Object Sensor and switch locations with another properly operating sensor. Connect harness connector at both sensors. Ignition ON.
6. Verify the DTC is set for the new location in which the malfunctioning sensor is installed.
 - **If DTC set for the new location**

Replace the malfunctioning B78 Front Object Sensor.
 - **If DTC set for the original location**
 - 1. Ignition OFF, disconnect the harness connector at the K41 Front and Rear Parking Assist Control Module, ignition ON.
 - 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Ignition OFF.
 - 4. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 5. Test for less than 2 ohms in the circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K41 Front and Rear Parking Assist Control Module.
 - **If no DTC set**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Parking Assist Alarm Sensor Replacement**
- **Control Module References** for front and rear parking assist control module replacement, programming and setup

DTC B0958, B0959, B0960, OR B0961: PARKING ASSIST REAR SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0958

Parking Assist Rear Sensor Left Corner Circuit

DTC B0959

Parking Assist Rear Sensor Left Middle Circuit

DTC B0960

Parking Assist Rear Sensor Right Middle Circuit

DTC B0961

Parking Assist Rear Sensor Right Corner Circuit

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
8 V Reference	B1405 02	B0958 06, B0959 06, B0960 06, B0961 06, B1405 03	B0958 06, B0959 06, B0960 06, B0961 06, B1405 07	-
Left Rear Object Sensor Signal	B0958 06	B0958 06	B0958 01	B0958 08, B0958 21
Left Middle Rear Object Sensor Signal	B0959 06	B0959 06	B0959 01	B0959 08, B0959 21
Right Middle Rear Object Sensor Signal	B0960 06	B0960 06	B0960 01	B0960 08, B0960 21
Right Rear Object Sensor Signal	B0961 06	B0961 06	B0961 01	B0961 08, B0961 21
Low Reference	-	B0958 01, B0959 01, B0960 01, B0961 01	-	-

Circuit/System Description

The object sensors are 3-wire sensors that are used to determine the distance between the vehicle and an object of interest. The rear parking assist control module supplies 8 V to the object sensors via the 8 V reference circuit and provides ground via the low reference circuit. The rear parking assist control module triggers the sensors in a sequential loop. After each sensor transmits, the rear parking assist control module uses the sensor

echo received through the signal circuit to calculate the distance and position of an object.

Conditions for Running the DTC

- Ignition ON
- The parking assist is activated. The activation takes place through putting in the reverse gear.

Conditions for Setting the DTC

B0958 01, B0959 01, B0960 01, or B0961 01

The rear parking assist control module has detected the voltage at the sensor circuit is greater than 11.5 V or the object sensor is not grounded.

B0958 06, B0959 06, B0960 06, or B0961 06

The rear parking assist control module has detected the voltage at the sensor circuit less than 0.5 V.

B0958 08, B0959 08, B0960 08, or B0961 08

The rear parking assist control module has received an invalid signal.

B0958 21, B0959 21, B0960 21, or B0961 21

The object sensor determines no change in the position of an object while the vehicle is in motion.

B0958 3A, B0959 3A, B0960 3A, or B0961 3A

The rear parking assist control module determines the wrong sensor type is installed.

Action Taken When the DTC Sets

- The parking assist is disabled.
- The driver information center displays SERVICE PARK ASSIST.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

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Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B1405 is not set.
 - **If the DTC is set**

Refer to **DTC B1405 (with rear park assist), DTC B1405 (with front and rear park assist)**

- **If the DTC is not set**
3. Verify that DTC B0958 01, B0959 01, B0960 01 or B0961 01 is not set.
 - **If the DTC is set**

Check the appropriate sensor for contamination with mud. If no contamination is diagnosed, refer to Circuit/System Testing.

- **If the DTC is not set**
4. Verify that DTC B0958 21, B0959 21, B0960 21 or B0961 21 is not set.
 - **If the DTC is set**

Check the appropriate sensor for contamination with mud, ice or snow. If no contamination is diagnosed, replace the sensor.

- **If the DTC is not set**

5. Verify that DTC B0958 3A, B0959 3A, B0960 3A or B0961 3A is not set.

- **If the DTC is set**

Replace the appropriate sensor with a sensor of correct sensor type.

- **If the DTC is not set**

6. Ignition ON, transmission in REVERSE.

7. Verify the scan tool Parking Assist System Status parameter displays Enabled.

- **If the Parking Assist System displays Disabled**

Refer to Circuit/System Testing.

- **If the Parking Assist System displays Enabled**

8. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B78 Rear Object Sensor. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.

- **If 10 ohms or greater**

1. Ignition OFF, disconnect the harness connector X2 at the K41R Rear Parking Assist Control Module.

2. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms replace the K41R Rear Parking Assist Control Module.

- **If less than 10 ohms**

3. Ignition ON.

4. Test for 7.5-9.5 V between the 8 V reference circuit terminal 1 and ground.

- **If less than 7.5 V**

1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module.

2. Test for infinite resistance between the 8 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

3. Test for less than 2 ohms in the 8 V reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K41R Rear Parking Assist Control Module.

- **If greater than 9.5 V**

1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module, ignition ON.

2. Test for less than 1 V between the 8 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K41R Rear Parking Assist Control Module.
 - **If between 7.5-9.5 V**
5. Ignition OFF, remove the appropriate B78 Rear Object Sensor and switch locations with another properly operating sensor. Connect harness connector at both sensors. Ignition ON.
6. Verify the DTC is set for the new location in which the malfunctioning sensor is installed.
 - **If DTC set for the new location**

Replace the malfunctioning B78 Rear Object Sensor.
 - **If DTC set for the original location**
 - 1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module, ignition ON.
 - 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Ignition OFF.
 - 4. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 5. Test for less than 2 ohms in the circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K41R Rear Parking Assist Control Module.
 - **If no DTC set**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

- **Rear Parking Assist Alarm Sensor Replacement**
- **Control Module References** for rear parking assist control module replacement, programming and setup.

DTC B0967 OR B0968: PARKING ASSIST ON/OFF SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B0967 02

Parking Assist On/Off Switch Circuit Short to Ground

DTC B0968 01

Parking Assist On/Off Switch Indicator Circuit Short to Battery

DTC B0968 06

Parking Assist On/Off Switch Indicator Circuit Low Voltage/Open

Circuit/System Description

The parking assist can be activated/deactivated by pressing the parking assist switch. By engaging the reverse gear the parking assist can also be activated. By subsequently pressing the parking assist switch the parking assist can be disabled again.

The indicator in the parking assist switch shows the status of the parking assist. If the lamp is ON, the parking assist is activated.

Conditions for Running the DTC

- Ignition ON
- The parking assist is activated. The activation takes place by putting in the reverse gear or by pressing the parking assist switch.

Conditions for Setting the DTC

B0967 02

The parking assist control module has detected a short to ground.

B0968 01

The parking assist control module has detected a short to battery.

B0968 06

The parking assist control module has detected a short to ground or open.

Action Taken When the DTC Sets

- The parking assist is disabled.
- The driver information center displays SERVICE PARK ASSIST.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

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Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B0967 02 is not set.
 - **If the DTC is set**

Refer to Parking Assist Switch Malfunction.
 - **If the DTC is not set**
3. Verify that B0968 01 or B0968 06 is not set.
 - **If the DTC is set**

Refer to Parking Assist Switch Indicator Malfunction.

- **If the DTC is not set**

4. Activate and deactivate the parking assist switch and verify the scan tool Park Assist Switch parameter changes between Active and Inactive.

- **If the Parking Assist Switch parameter does not change between Active and Inactive**

Refer to Circuit/System Testing.

- **If the Parking Assist Switch parameter changes between Active and Inactive**

5. All OK.

Circuit/System Testing

Parking Assist Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel.
2. Test for less than 10 ohms between the S48D Multifunction Switch 2 - Instrument Panel terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the ground circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 5 and ground circuit terminal 1.
4. Verify the test lamp turns On and Off when commanding the Parking Assist Switch On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K41R Rear Parking Assist Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit

- If less than 1 V, replace the K41R Rear Parking Assist Control Module.
 - **If the test lamp turns ON and OFF**
5. All OK.

Parking Assist Switch Indicator Malfunction

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel.
2. Test for less than 10 ohms between the S48D Multifunction Switch 2 - Instrument Panel terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the voltage circuit terminal 6 and ground circuit terminal 1.
4. Verify the test lamp turns ON and OFF when Commanding the Parking Assist Switch On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module.
 2. Test for infinite resistance between the voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K41R Rear Parking Assist Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module, ignition ON.
 2. Test for less than 1 V between the voltage circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K41R Rear Parking Assist Control Module.
 - **If the test lamp turns ON and OFF**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

- **Rear Object Alarm Control Module Replacement**

- **Control Module References** for parking assist control module replacement, programming and setup.

DTC B0987: VEHICLE DIRECTION CAMERA INDICATOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0987 01

Vehicle Direction Camera Indicator Circuit Short to Battery.

DTC B0987 06

Vehicle Direction Camera Indicator Circuit Low Voltage/Open

Circuit/System Description

The lane departure warning is enabled and disabled through a switch located in the instrument panel. When the switch is pressed once, the vehicle direction camera control module disable or enable the lane departure warning. When the lane departure warning system is enabled the vehicle direction camera control module will illuminate the indicator in the switch.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

B0987 01

The vehicle direction camera control module detects a short to voltage in the control circuit.

B0987 06

The vehicle direction camera control module detects a short to ground or an open/high resistance in the control circuit.

Action Taken When the DTC Sets

Lane departure warning is disabled.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

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Description and Operation

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the DTC B356A is not set.
 - **If the DTC is set**

Refer to **DTC B356A**
 - **If the DTC is not set**
3. Verify the scan tool Vehicle Direction Camera Indicator Status parameter changes between ON and OFF when pressing and releasing the lane departure warning switch.
 - **If the parameter does not change between ON and OFF**

Refer to Circuit/System Testing.

- **If the parameter changes between ON and OFF**

4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel.
2. Test for less than 10 ohms between the ground circuit terminal 1 at the S48D Multifunction Switch 2 - Instrument Panel and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Disconnect the harness connector at the K109 Vehicle Camera Module.
4. Ignition ON, test for less than 1 V between the control circuit terminal 4 at the S48D Multifunction Switch 2 - Instrument Panel and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

5. Ignition OFF.
6. Test for less than 2 ohms in the control circuit end to end.
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 ohms**

7. Test for infinite resistance between the control circuit terminal 4 and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

8. Replace the K109 Vehicle Camera Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

- **Control Module References** for Front View Camera Module replacement, programming and setup.

DTC B1011: SYSTEM DISABLED INFORMATION STORED MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1011 00

System Disabled Information Stored Malfunction

Circuit/System Description

The frontview camera module permanently monitors the serial data bus for error messages. When a malfunction is detected by the frontview camera module, the system will be disabled and an error message will be stored in the frontview camera module disable history buffer which is used to store information about the front camera features that are disabled.

Conditions for Running the DTC

- Ignition ON
- Frontview camera enabled

Conditions for Setting the DTC

The frontview camera module detects a malfunction.

Action Taken When the DTC Sets

- The frontview camera module is disabled.
- The frontview camera module disable history buffer stores information why the system was disabled.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Diagnostic Aids

The frontview camera module disable history buffers are used to store information about the frontview camera module features that are disabled. The buffers will only update if the disable condition changes.

Example: If the data received from the steering wheel angle sensor is Invalid across many ignition cycles then it

will only appear in 1 history buffer and not all history buffers. If this condition is the current reason why the frontview camera module is disabled then it will be set in frontview camera module disable history buffer 1. If a new reason occurs, such as vehicle speed validity is invalid, then the invalid steering wheel angle sensor fault will shift into disable history buffer 2 and vehicle speed validity invalid will be in disable history buffer 1. Since there are only 4 disable history buffers, the invalid steering wheel angle sensor will age out if 4 other disable reasons occur since the last invalid steering wheel angle sensor event occurred. Frontview camera module disable history buffer 1 contains the current reason that one of the frontview camera module features is disabled.

The frontview camera module disable history buffers can display the following values:

- Lane Departure Warning Indicator Malfunction
- Lane Departure Warning Switch Malfunction
- Camera Obstructed
- Accelerator Pedal Position Out of Range
- Driven Wheel Speed Signal Invalid
- Non-Driven Wheel Speed Signal Invalid
- Brake Pedal Moderate Travel Signal Invalid
- Brake Pedal Initial Travel Position Achieved
- Lost Communication with Steering Wheel Angle Sensor Module
- Invalid Data Received From Steering Wheel Angle Sensor Module
- Forward Collision Alert Switch Malfunction
- Clutch Pedal Position (CPP) Sensor Performance
- Clutch Pedal Position (CPP) Sensor Performance
- Transmission Gear Engaged
- Acceleration Sensor Longitudinal Signal
- Invalid Data Received From Yaw Rate Sensor Module
- Power Mode Controlled by Backup Device
- System Power Mode
- Overvoltage
- Undervoltage
- Undefined

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

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Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Do not replace K109 Frontview Camera Module for this DTC. DTC B1011 is an information DTC.

1. Ignition ON.
2. Verify no other DTC is set except for DTC B1011.
 - If any other DTCs are set

Diagnose those first. Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- If no other DTCs are set

NOTE: When referring to Frontview Camera Disable History, some items such as Non-Driven Wheel Speed Signal Invalid and Driven Wheel Speed Signal Invalid may routinely be stored without B1011 being set. If B1011 has not set, disregard any information stored in the buffers as it is not indicative of a problem.

3. Refer to Diagnostic Aids and Frontview Camera Disable History for what caused B1011 to set. Diagnose the system that set the malfunction.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for frontview camera module programming and setup

DTC B1015: VEHICLE IDENTIFICATION NUMBER INFORMATION MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1015 00

Vehicle Identification Number Information Malfunction

Circuit/System Description

When the ignition is turned ON, the parking assist control module and the frontview camera module receives the vehicle identification number (VIN) from the body control module. The modules will compare the VIN received to the VIN stored in memory.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

The stored VIN does not match the received VIN.

Action Taken When the DTC Sets

- The parking assist system or the lane departure warning system is disabled.
- The driver information center displays SERVICE PARK ASSIST or SERVICE FRONT CAMERA.

Conditions for Clearing the DTC

The stored VIN matches the VIN stored in the body control module.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the DTC B1015 is not.
 - **If the DTC B1015 is set**
 1. Program the control module the DTC originally set in.
 2. Verify the DTC does not set.
 - If the DTC is sets, replace the control module the DTC set in.
 - If the DTC does not set
 - 3. All OK
 - **If the DTC B1015 is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

Control Module References for the parking assist control module, frontview camera module replacement, programming and setup.

DTC B1405 (WITH REAR PARK ASSIST): CONTROL MODULE VOLTAGE REFERENCE

OUTPUT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1405 02

Control Module Voltage Reference Output 2 Circuit Short to Ground

DTC B1405 03

Control Module Voltage Reference Output 2 Circuit Low Voltage

DTC B1405 07

Control Module Voltage Reference Output 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Object Sensor Supply Voltage	B1405 02	B0958 06, B0959 06, B0960 06, B0961 06, B1405 03	B0958 06, B0959 06, B0960 06, B0961 06, B1405 07	-
Left Rear Corner Object Sensor Signal	B0958 06	B0958 06	B0958 01	B0958 08, B0958 21
Left Rear Middle Object Sensor Signal	B0959 06	B0959 06	B0959 01	B0959 08, B0959 21
Right Rear Middle Object Sensor Signal	B0960 06	B0960 06	B0960 01	B0960 08, B0960 21
Right Rear Corner Object Sensor Signal	B0961 06	B0961 06	B0961 01	B0961 08, B0961 21
Object Sensor Low Reference	-	B0958 06, B0959 06, B0960 06, B0961 06	-	-

Circuit/System Description

The object sensors are 3-wire sensors that are used to determine the distance between the vehicle and an object

of interest. The parking assist control module supplies 8 V to the object sensors via the object sensor supply voltage circuit and provides ground via the object sensor low reference circuit. The parking assist control module triggers the sensors in a sequential loop. After each sensor transmits, the parking assist control module uses the sensor echo received through the object sensor signal circuit to calculate the distance and position of an object.

Conditions for Running the DTC

- Ignition ON
- Transmission in REVERSE

Conditions for Setting the DTC

B1405 02

The parking assist control module has detected the object sensor supply voltage circuit is shorted to ground.

B1405 03

The parking assist control module has detected the object sensor supply voltage circuit is less than 7.2 V.

B1405 07

The parking assist control module has detected the object sensor supply voltage circuit is greater than 9.2 V.

Action Taken When the DTC Sets

- The parking assist is disabled.
- The driver information center displays SERVICE PARK ASSIST.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection

Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the transmission is in REVERSE.
 - **If the transmission not in REVERSE**

Refer to **DTC B2545**

- **If the transmission is in REVERSE**
3. Verify the scan tool Park Assist Sensor Reference Voltage is between 7.2-9.2 V.
 - **If not between 7.2-9.2 V**

Refer to Circuit/System Testing.

- **If is between 7.2-9.2 V**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at each of the object sensors, ignition On, transmission in REVERSE
2. Test for 7.2-9.2 V between the object sensor reference circuit terminal 1 at all B78 Rear Object Sensor harness connectors and ground.
 - **If less than 7.2 V**
 1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module.
 2. Test for infinite resistance between the 8 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the 8 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K41R Rear Parking Assist Control Module.
 - **If greater than 9.2 V**
- 1. Disconnect the harness connector X 2 at the K41R Rear Parking Assist Control Module, ignition ON.
- 2. Test for less than 1 V between the 8 V supply voltage circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K41R Rear Parking Assist Control Module.
 - **If between 7.2-9.2 V**
- 3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Parking Assist Alarm Sensor Replacement**
- **Control Module References** for parking assist control module replacement, programming and setup

DTC B1405 (WITH FRONT AND REAR PARK ASSIST): CONTROL MODULE VOLTAGE REFERENCE OUTPUT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1405 02

Control Module Voltage Reference Output 2 Circuit Short to Ground

DTC B1405 03

Control Module Voltage Reference Output 2 Circuit Low Voltage

DTC B1405 07

Control Module Voltage Reference Output 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
8 V Reference	B1405 02	B0954 06, B0955 06, B0956 06, B0957 06, B0958 06, B0959 06, B0960 06, B0961 06, B1405 03	B0954 06, B0955 06, B0956 06, B0957 06, B0958 06, B0959 06, B0960 06, B0961 06, B1405 07	-
Left Front Object Sensor Signal	B0954 06	B0954 06	B0954 01	B0954 08, B0954 21
Left Middle Front Object Sensor Signal	B0955 06	B0955 06	B0955 01	B0955 08, B0955 21
Right Middle Front Object Sensor Signal	B0956 06	B0956 06	B0956 01	B0956 08, B0956 21
Right Front Object Sensor Signal	B0957 06	B0957 06	B0957 01	B0957 08, B0957 21
Left Rear Object Sensor Signal	B0958 06	B0958 06	B0958 01	B0958 08, B0958 21
Left Middle Rear Object Sensor Signal	B0959 06	B0959 06	B0959 01	B0959 08, B0959 21
Right Middle Rear Object Sensor Signal	B0960 06	B0960 06	B0960 01	B0960 08, B0960 21
Right Rear Object Sensor Signal	B0961 06	B0961 06	B0961 01	B0961 08, B0961 21
Low Reference	-	B0954 01, B0955 01, B0956 01, B0957 01, B0958 01, B0959 01, B0960 01, B0961 01	-	-

Circuit/System Description

The object sensors are 3-wire sensors that are used to determine the distance between the vehicle and an object of interest. The parking assist control module supplies 8 V to the object sensors via the object sensor supply voltage circuit and provides ground via the object sensor low reference circuit. The parking assist control module triggers the sensors in a sequential loop. After each sensor transmits, the parking assist control module uses the sensor echo received through the object sensor signal circuit to calculate the distance and position of an object.

Conditions for Running the DTC

- Ignition ON
- Transmission in REVERSE

Conditions for Setting the DTC

B1405 02

The parking assist control module has detected the object sensor supply voltage circuit is shorted to ground.

B1405 03

The parking assist control module has detected the object sensor supply voltage circuit is less than 7.2 V.

B1405 07

The parking assist control module has detected the object sensor supply voltage circuit is greater than 9.2 V.

Action Taken When the DTC Sets

- The parking assist is disabled.
- The driver information center displays SERVICE PARK ASSIST.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, engine running, transmission in R.
2. Verify the scan tool Park Assist Sensor Reference Voltage parameter is between 7.2-9.2 V.
 - **If Park Assist Sensor Reference Voltage is not between 7.2-9.2 V**

Refer to Circuit/System Testing

- **If Park Assist Sensor Reference Voltage is between 7.2-9.2V**
- 3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect harness connectors X2 and X3 at the K41 Front and Rear Parking Assist Control Module, ignition ON.
2. Test for less than 1 V between the 8 V reference circuit terminals listed below and ground.
 - Terminal 4 X2
 - Terminal 1 X3
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**
- 3. Ignition OFF.
- 4. Test for infinite resistance between 8V reference circuit terminals listed below and ground.
 - Terminal 4 X2
 - Terminal 1 X3
 - **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**
- 5. Replace the K41 Front and Rear Parking Assist Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Parking Assist Alarm Sensor Replacement**
- **Control Module References** for parking assist control module replacement, programming and setup

DTC B356A: VEHICLE DIRECTION WARNING SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B356A 02

Vehicle Direction Warning Switch Circuit Short to Ground

DTC B356A 05

Vehicle Direction Warning Switch Circuit Short to Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Vehicle Direction Warning Switch Signal Circuit	B356A 02	1	B356A 05	-
Vehicle Direction Warning Switch Ground Circuit	-	1	1	-
1. Vehicle direction warning system inoperative				

Circuit/System Description

The lane departure warning is enabled and disabled through a switch located in the instrument panel. When the switch is pressed once, the vehicle direction camera control module disables or enables the lane departure warning. When the lane departure warning system is enabled the vehicle direction camera control module will illuminate the indicator in the switch.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

DTC B356A 02

The front view camera module has detected a short to ground for more than 10 s.

DTC B356A 05

The front view camera module has detected a short to voltage for more than 10 s.

Action Taken When the DTC Sets

- Lane departure warning is disabled.
- Lane Departure Unavailable is displayed on the driver information center.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Vehicle Direction Warning Switch Status parameter changes between On and Off while cycling the vehicle direction warning switch.

- **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF.
2. Remove the ignition key, open the driver door, disconnect the scan tool, all vehicle systems OFF, this may take up to 2 min.
3. Disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel.
4. Test for less than 10 ohms between the ground circuit terminal 1 and ground.

- **If 10 ohms or greater**

1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

5. Ignition ON.
6. Verify the scan tool Vehicle Direction Warning Switch Status parameter is Off.
 - **If not Off**
 1. Ignition OFF, disconnect the harness connector at the K109 Vehicle Camera Module.
 2. Test for infinite resistance between the signal circuit terminal 4 at the S48D Multifunction Switch 2 - Instrument Panel and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K109 Vehicle Camera Module.
 - **If Off**
7. Disconnect the harness connector at the K109 Vehicle Camera Module.
8. Install a 3 A fused jumper wire between the signal circuit terminal 4 and ground circuit terminal 1.
9. Verify within 10 s the scan tool Vehicle Direction Warning Switch Status parameter is On.
 - **If not On**
 1. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 2. Test for less than 2 ohms in the signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K109 Vehicle Camera Module.
- **If On**

10. Replace the S48D Multifunction Switch 2 - Instrument Panel.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for Front View Camera Module replacement, programming and setup.

DTC P15F6: FRONT OBJECT DETECTION CONTROL MODULE TORQUE REQUEST SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P15F6

Front Object Detection Control Module Torque Request Signal Message Counter Incorrect

Circuit/System Description

The cruise control vehicle distance sensor module is constantly sending a serial data message to the engine control module requesting engine speed or torque reduction. The engine control module sets DTC P15F6 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned. An intermittent fault in the serial data circuits will cause the engine control module to set DTC P15F6.

Conditions for Running the DTC

Engine running.

Conditions for Setting the DTC

The engine control module detects that the engine speed and torque modification messages from the cruise control vehicle distance sensor module are either corrupted or intermittently missing.

Action Taken When the DTC Sets

- The cruise control vehicle distance sensor module sends a serial data message to display the appropriate indicator message

- The cruise control vehicle distance sensor module features are unavailable.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The engine control module clears the history DTC when a current DTC is not detected in 40 consecutive drive cycles.

Diagnostic Aid

This is an informational DTC set by the engine control module. It is set to provide an indication that the cruise control vehicle distance sensor module will not be able to perform as intended. Diagnose any other DTCs first.

NOTE: During normal diagnostic and/or repair verification technicians may find that a "Service Adaptive Cruise Control" message may be displayed by the cruise control vehicle distance sensor module. Do not replace the cruise control vehicle distance sensor module for this condition.

If the Service Driver Assist System message is on with no DTCs set, perform the following steps:

1. Remove the key from the ignition, open and close the driver's door to turn off retained accessory power, and wait 60 seconds.
2. Ignition ON, if the Service Driver Assist message is still present, operate the vehicle at speeds greater than 15 km/h (10 mph) to complete the self test. The cruise control vehicle distance sensor module should request the message to turn OFF.
3. If the telltales remain ON with no DTCs set after the drive cycle, disconnect the battery for at least 60 seconds then reconnect the battery.
4. Operate the vehicle at speeds greater than 40 km/h (25 mph), the cruise control vehicle distance sensor module should request all telltale indicators to turn OFF.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object

Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

- NOTE:**
- **DTC P15F6 is an informational DTC.**
 - **Diagnose all other K20 Engine Control Module DTCs prior to DTC P15F6.**

1. Verify there are no other K20 Engine Control Module or communication DTCs set.
 - **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If a DTC is not set**
2. Complete the diagnosis by looking for an intermittent serial data circuit fault. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** .
 - **If an intermittent serial data circuit fault is found**

Repair as necessary.

- **If an intermittent serial circuit fault is not found**
3. Clear DTCs and operate the vehicle in the conditions that the customer experienced.
 4. Verify DTC P15F6 does not set.
 - **If the DTC sets**

Replace B129 Cruise Control Vehicle Distance Sensor Module

- **If the DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for cruise control vehicle distance sensor module replacement, programming, and setup.

SYMPTOMS - OBJECT DETECTION

NOTE: **The following steps must be completed before using the symptom tables:**

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control module can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Object Detection Description and Operation (with Lane Departure Warning, UFL)**, **Object Detection Description and Operation (with Forward Collision Alert, UEU)**, **Object Detection Description and Operation (with Rearview Camera, UVC)**, **Object Detection Description and Operation (with Side Blind Zone, UFT)**, **Object Detection Description and Operation (with Lane Change Assist, UKC)**, **Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG)**, **Object Detection Description and Operation (with Front and Rear Park Assist, UD5)**, **Object Detection Description and Operation (with Rear Park Assist, UD7)**.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- This system can use various sensors that need to be clean in order to function properly. Make sure to check the following sensors for obstructions:
 - Parking assist sensors located in the rear bumper cover

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

- **Parking Assist System Malfunction**

FORWARD COLLISION ALERT SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Forward Collision Alert Indicators Ignition	-	1	-	-
Forward Collision Alert Switch Signal	P0580, P0592	P0592	P0593	-
Forward Collision Alert Switch Dimming Control	P155A	P0580	-	-
Forward Collision Alert Indicators Control	2	1	1	-
Forward Collision Alert Indicators Ground	-	1	-	-
1. Forward Collision Alert Indicators inoperable 2. Forward Collision Alert Indicators on all the time				

Circuit/System Description

The forward collision alert system is controlled by the frontview camera module mounted on the windshield. The system is designed to detect vehicles directly ahead, within a distance of approximately 60 meters (197 ft). The forward collision alert system operates at speeds above 40 km/h (25 mph). When the system detects a vehicle in the path ahead, the green vehicle ahead alert indicator in the driver information center is illuminated. When approaching another vehicle too rapidly, the collision alert symbol will flash and the radio will beep or the haptic seat will pulse, depending on user configuration. The red collision alert display will stay continuously illuminated if the vehicle ahead remains much too close. These actions are requested by the frontview camera module via serial data. The forward collision alert switch is part of the left steering wheel controls and is used to adjust the timing sensitivity of the front collision alert system.

Diagnostic Aids

Certain factors will affect the operation of the forward collision alert system. Forward collision alert is intended to detect vehicles. It is not intended to warn the driver of any objects that are not detected as a vehicle such as pedestrians, animals, signs, guard rails, bridges, construction barrels or other stationary or slow moving objects. In few cases the camera may inadvertently detect a vehicle that is not in the path ahead, or the system may occasionally provide unrealistic alerts. This could occur with a turning vehicle ahead, guard rails, traffic signs, or other stationary objects. This is normal operation, the vehicle does not need service. When the system is operating properly, the green vehicle ahead alert indicator will illuminate on the vehicle direction display when the system detects a vehicle in the path ahead. This indicates that all of the required operating conditions are met. The green vehicle ahead alert indicator will not appear when the system is having difficulty seeing other vehicles on the road. This can occur if the front view camera is blocked with mud, dirt, snow, ice, slush, if the windshield is damaged, or when weather limits visibility, such as while driving in fog, rain, or snow conditions. This is normal operation, the vehicle does not need service.

Additionally, the Front View Camera Disable History can give useful hints about what affected the operation of the forward collision alert system. For the Front View Camera Disable History, refer to **DTC B1011**.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Refer to Diagnostic Aids before performing Circuit/System Verification.

1. Ignition ON.
2. Verify the scan tool Forward Collision Alert Function Status parameter is not Malfunction.
 - **If the parameter is Malfunction**

Refer to Circuit/System Testing - Frontview Camera Module Malfunction

- **If parameter is not Malfunction**
3. Verify the forward collision alert indicators illuminate momentarily when turning ignition OFF and then

ON.

- **If the indicators do not illuminate**

Refer to Circuit/System Testing - Forward Collision Alert Indicator Malfunction

- **If the indicators illuminate**

4. Verify the driver information center forward collision alert distance indicator toggles between far, medium, near and off.

- **If the setting does not change**

Refer to Circuit/System Testing - Forward Collision Alert Switch Malfunction.

- **If the setting changes**

5. Verify the area of the K109 Frontview Camera Module is not contaminated.

- **If contaminated**

Clean the windshield

- **If not contaminated**

6. All OK.

Circuit/System Testing

NOTE: **Perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

Frontview Camera Module Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K109 Frontview Camera Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Verify a test lamp illuminates between the B+ circuit terminal 3 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
- **If the test lamp does not illuminate and the circuit fuse is open**
- 1. Ignition OFF.
- 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K109 Frontview Camera Module.
- **If the test lamp illuminates**
- 4. Replace the K109 Frontview Camera Module.

Forward Collision Alert Indicator Malfunction

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the P43 Collision Alert Indicators. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 - 1. Ignition OFF.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the P43 Collision Alert Indicators.
 - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 2 and the ignition circuit terminal 1.
6. Verify the test lamp turns ON and OFF when commanding the Instrument Cluster All Indicators ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 - 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
 - 2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V
- 3. Ignition OFF.
- 4. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
 - **If the test lamp is always ON**
- 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
- 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the P16 Instrument Cluster.
 - **If the test lamp turns ON and OFF**
- 7. Test or replace the P43 Collision Alert Indicators.

Forward Collision Alert Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the S70L Steering Wheel Controls Switch - Left, ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 1 and ground.
 - **If test lamp does not illuminate and the circuit fuse is good**
1. Ignition OFF.
2. Test for less than 2 ohms in the Ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
1. Ignition OFF.
2. Test for infinite resistance between the Ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S70L Steering Wheel Controls Switch - Left.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the harness connector at the S70L Steering Wheel Controls Switch - Left, disconnect the X3 harness connector at the K9 Body Control Module, ignition ON.
4. Test for less than 1 V between the signal circuit terminals listed below and ground:
 - Terminal 4
 - Terminal 16
 - **If 1 V or greater**

Repair the short to voltage on the signal circuit.

 - **If less than 1 V**

5. Ignition OFF.

6. Test for infinite resistance between the signal circuit terminals listed below and ground:

- Terminal 4
- Terminal 16
- **If less than infinite resistance**

Repair the short to ground on the signal circuit.

- **If infinite resistance**

7. Disconnect the harness connector at the S70L Steering Wheel Controls Switch - Left.

8. Test for less than 5 ohms between the circuit terminals listed below:

- S70L Steering Wheel Controls Switch - Left terminal 1 and K9 Body Control Module terminal 4.
- S70L Steering Wheel Controls Switch - Left terminal 2 and K9 Body Control Module terminal 16.
- **If greater than 5 ohms**

Repair the open/high resistance in the circuit.

- **If less than 5 ohms**

9. Test or replace the S70L Steering Wheel Controls Switch - Left.

Component Testing

Forward Collision Alert Switch

Static Test

1. Ignition OFF, disconnect the harness connector at the S70L Steering Wheel Controls Switch - Left.
2. Test for 6.1k-7.5k ohms between the control terminal 1 and the signal circuit terminal 2.

- **If not between 6.1k-7.5k ohms**

Replace the S70L Steering Wheel Controls Switch - Left.

- **If between 6.1k-7.5k ohms**

3. Test for 1.6k-2.1k ohms between the control terminal 1 and the signal circuit terminal 2 while pressing the switch.

- **If not between 1.6k-2.1k ohms**

Replace the S70L Steering Wheel Controls Switch - Left.

- **If between 1.6k-2.1k ohms**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Cruise Control Switch Replacement (Grand Sport)** , **Cruise Control Switch Replacement (Except Grand Sport)** - Steering Wheel Controls Switch - Left replacement.
- **Control Module References** for Frontview Camera Module replacement, programming and setup

PARKING ASSIST SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The ultrasonic parking assist system is designed to identify and notify the driver of an object in the vehicle's path when moving reverse at speeds of less than 8 km/h (5 MPH). The distance and location of the object is determined by 4 object sensors, located in the rear bumper. The parking assist system will notify the driver using an audible signal through the radio.

Diagnostic Aids

For Symptom Byte 21 the module only run diagnostic when the vehicle is driven greater than 40 km/h (25 MPH). Therefore, even with clean sensor with no obstruction (i.e. snow or ice melted off) drive the vehicle greater than 40 km/h (25 MPH).

The following is a list of reasons this failure type byte 21 might have set:

- One or more of the sensors may be blocked by snow, mud, ice, or other debris. This might happen after going through a car wash in cold weather.
- Silicone insulator surrounding sensor maybe missing, cut, or twisted.
- Improperly installed sensor, sensor maybe be crooked due to a tight wire harness.
- One or more of the sensors may be scratched or the paint maybe chipped.
- Excessive paint thickness on a sensor may cause an excessive sensor ring time. When replacing or refinishing a sensor, do not apply an excessive amount of paint or clear coat.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Ignition ON.
2. Verify the park assist system is enabled through the parking assist switch.
 - **If the park assist system is manually disabled, enable the system.**

Refer to the vehicle owners manual for instructions on enabling the system.

 - **If the park assist system does not manually change**
3. Verify the scan tool Park Assist Switch parameter while pressing and releasing the parking assist switch. The parameter should change between Active and Inactive.
 - **If the parameter does not change between Active and Inactive**

Refer to Parking Assist Switch Circuit Malfunction.

 - **If the parameter changes between Active and Inactive**
4. Command the Park Assist Switch LED output control On and Off with the scan tool. The parking assist switch indicator should turn On and Off when changing between the commanded states.
 - **If the indicator does not turn ON and OFF**

Refer to Parking Assist Switch Indicator Circuit Malfunction.

 - **If the indicator does turn ON and OFF**
5. Transmission in reverse, verify the Engine Control Module (ECM) scan tool Reverse Position Switch

parameter is Active.

- **If the parameter is not Active**

Refer to **Backup Lamps Malfunction (Automatic Transmission)** , **Backup Lamps Malfunction (Manual Transmission)** .

- **If the parameter is Active**

6. Transmission in REVERSE, verify the scan tool Park Assist System Status parameter displays Enable.

- **If the parameter is not Enabled**

Refer to Diagnostic Aids to determine the cause of the inhibit.

- **If the parameter is Enabled**

7. All OK.

Circuit/System Testing

Parking Assist Switch Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel.

2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.

2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.

4. Verify the scan tool Parking Assist Switch Status parameter is inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module.

2. Test for infinite resistance between the control circuit terminal 5 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K41R Rear Parking Assist Control Module.

- **If Inactive**

5. Test for less than 1 V between the control circuit terminal 5 and ground.

- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

6. Connect a test lamp between the control circuit terminal 5 and the ground circuit terminal 1.

7. Verify that a test lamp turns On and Off when Commanding the Parking Assist Switch On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K41R Rear Parking Assist Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K41R Rear Parking Assist Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K41R Rear Parking Assist Control Module
 - **If the test lamp turns ON and OFF**
8. All OK.

Parking Assist Switch Indicator Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch 2 - Instrument Panel, Ignition ON.
2. Test for greater than 11 V between the terminal 3 and ground.
 - **If less than 11 V**

Test the voltage circuit for a short to ground or an open/high resistance.
 - **If greater than 11 V**
3. Command the Park Assist Switch LED output control ON with the scan tool. Test for greater than 11 V between the ignition circuit terminal 3 and the signal circuit terminal 5.
 - **If less than 11 V**

Test the signal circuit for an open/high resistance.
 - **If greater than 11 V**
4. Command the Park Assist Switch Indicator Off with the scan tool.
5. Test for less than 1 V between the terminal 6 and ground.
 - **If 1 V or greater**

Test the signal circuit for a short to voltage.

6. If all circuits test normal, replace the S48D Multifunction Switch 2 - Instrument Panel.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for parking assist control module replacement, programming, and setup

REAR VISION CAMERA SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

When the transmission is placed into REVERSE, a 12 V signal is sent to the rearview camera indicating that camera operation is requested. Ignition voltage and ground are supplied to the rearview camera. The rearview camera sends video information to the radio through a video signal + and a video signal - circuit. A grounded shielding also wraps the video signal circuits to reduce electronic interference which may degrade the video signal and cause a distorted or otherwise degraded image.

Diagnostic Aids

A poor video image can be caused by ice, snow, and mud build-up on the lens of the rearview camera. Also, extreme lighting conditions can affect performance, such as operating in the dark or with bright sunlight shining on the camera. Extreme high or low temperatures can also affect the image quality. An open in the shield of the video signal circuit can also cause a distorted screen.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object

Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B2545 is not set.
 - **If the DTC is set**
3. Verify the rearview camera there is no debris on the lens and that the bezel or bezel seal is not damaged.
 - **If debris are found on the lens**

Refer to **DTC B2545** .

Clean the lens. If the lens, bezel, or bezel seal are damaged, replace as necessary.

- **If no debris on the lens**
4. Ignition ON, transmission in REVERSE.
 5. Verify the backup lamps are On.
 - **If the backup lamps are not ON**
- Refer to **Backup Lamps Malfunction (Automatic Transmission)** , **Backup Lamps Malfunction (Manual Transmission)** .

- **If the backup lamps are ON**
6. Engine running, transmission in REVERSE.
 7. Verify a clear rear vision image is displayed on the radio.
 - **If a clear image is not displayed**

Refer to Circuit/System Testing.

- **If a clear image is displayed**
8. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before Circuit/System Testing.**

1. Ignition OFF, disconnect the harness connector at the B87 Rearview Camera.
2. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**

Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
 4. Verify a test lamp illuminates between the ignition circuit terminal 6 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the KR74 Ignition Run Relay.
 - **If the test lamp illuminates**
 5. Engine running, park brake applied, transmission in REVERSE.
 6. Test for greater than 11 V between the control circuit terminal 3 and ground.
 - **If less than 11 V**
 1. Ignition OFF, disconnect the X7 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If greater than 11 V**

7. Ignition OFF, disconnect the X4 harness connector at the A11 Radio, ignition ON.

8. Test for less than 1 V between the signal circuit terminal listed below and ground:

- Signal (+) circuit terminal 1 at the B87 Rearview Camera.
- Signal (-) circuit terminal 4 at the B87 Rearview Camera.

- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

9. Test for infinite resistance between the signal circuit terminal listed below and ground:

- Signal (+) circuit terminal 1 at the B87 Rearview Camera.
- Signal (-) circuit terminal 4 at the B87 Rearview Camera.

- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

10. Test for less than 2 ohms in the signal (+) circuit end to end.

- **If 2 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 ohms**

11. Test for less than 2 ohms in the signal (-) circuit end to end.

- **If 2 ohms or greater**

Test the signal circuit for an open/high resistance.

- **If less than 2 ohms**

12. Replace the B87 Rearview Camera.

13. Engine running, transmission in REVERSE, verify a clear rear vision image is displayed on the A11 Radio.

- **If a clear rear vision image is not displayed on the A11 Radio**

Replace the A11 Radio.

- **If a clear rear vision image displayed on the A11 Radio**

14. All Ok.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for body control module or radio replacement, programming and setup.

SIDE BLIND SPOT ALERT SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Side Object Sensor - Left Ground	-	U0232	1	-
Side Object Sensor - Left B+	1	U0232	-	-
Side Object Sensor - Left, Data Communication (terminal 1)	1	U0232	1	-
Side Object Sensor - Left, Data Communication (terminal 4)	U18A6	U18A6	U18A6	-
Side Object Sensor - Left, Data Communication (terminal 5)	-	U18A6	U18A6	-
Side Object Sensor - Left, Control (terminal 3)	U18A6	U18A6	-	-
Side Object Sensor - Right Ground	-	U18A6	U18A6	-
Side Object Sensor - Right B+	U18A6	U18A6	-	-
Side Object Sensor - Right, Left Indicator Control Circuit	B094C 39, 3	1	2	-
Side Object Sensor - Right, Right Indicator Control Circuit	B094C 39, 3	1	2	-
1. Side blind zone alert malfunction 2. Side blind zone alert Indicator on all the time 3. Opposite side blind zone alert indicator flashes rapidly				

Circuit/System Description

The side object sensor modules are located on each side of the vehicle behind the rear fascia and are not directly visible from outside the vehicle. The sensors use radar to determine the presence of objects nearby. The left side object sensor is the master that communicates on serial data. There is a private communication network between the left and right sensors. The scan tool can communicate only with the left sensor.

Side blind zone alert is active when the vehicle is out of park or the parking brake is off on manual transmission vehicles. If a vehicle is detected in the side blind zone, the warning symbols will turn illuminate on the appropriate side. The warning symbols will vary brightness based on the ambient light conditions.

When an object is detected in the left side blind zone, the side object sensor module sends a message to the right sensor through serial data. The right sensor then supplies voltage to illuminate the visual indicator on the left side outside rear view mirror. When an object is detected in the right side blind zone, the right side object sensor will supply a voltage to illuminate the visual indicator on the right side outside rear view mirror. Each sensor is supplied B+ and ground. Ground is provided through the outside rearview mirror harness.

Diagnostic Aids

- When the ignition is turned on, or the engine is started, both outside rearview mirror displays will briefly come on to indicate that the system is operating.
- The conditions for disabling the side blind zone alert system are captured by DTCs. The drivers information center will display Service Side Detection System if one of the sensors has failed.
- The side blind zone system will be disabled if the driver has selected the Off mode through vehicle personalization menus. The selected mode is retained over ignition cycles. A driver information center message stating that the side blind zone system is off shall be displayed and the outside mirror indicators will be OFF.
- The side blind zone may be temporarily unavailable if a blockage condition exists (i.e. mud/snow buildup in front of the sensor). A driver information message "Side Detection System Unavailable" will be displayed. The side blind zone system transitions back to the normal operating state when the blockage is removed. Bumper sticks, fascia damage, labels, and heavy rain storms may also cause this condition. The blockage determination is performed with the vehicle in a drive gear.
- Because the sensors are NOT identical, they must NOT be swapped from one side of the vehicle to the other in an attempt to isolate a concern. Sensors should also NOT be swapped from one vehicle to another.
- The side blind zone system is designed to ignore stationary objects; however, the system may occasionally detect guard rails, signs, trees, shrubs, or other stationary objects as an object in the blind zone. This is normal system operation and does not require service.
- The side blind zone system may indicate an object in the blind zone if a trailer is attached to the vehicle, or a bicycle or object is extending out to either side of the vehicle. This is normal operation and does not require service.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

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Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind

Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool can communicate with the left side object sensor.
 - **If the scan tool can not communicate with the left side object sensor**

Refer to Circuit/System Testing - Left Side Object Sensor Malfunction.

- **If the scan tool can communicate with the left side object sensor**
3. Verify DTC U18A6 is not present
 - **If DTC U18A6 is present**

Diagnose this DTC first. Refer to Diagnostic Trouble Code List.

- **If DTC U18A6 is not present**
4. Ignition OFF, ignition ON.
 5. Verify that both side blind zone alert system indicators located in the outside rearview mirrors briefly turn ON and then turn OFF during the system self test.

- **If both side blind zone alert indicators do not briefly turn ON and OFF**

1. Verify the system is enabled
 - If disabled, refer to diagnostic aids for cause of disable.
 - If enabled, refer to Circuit/System Testing - Side Object Indicator Malfunction.
- **If only one indicator does not briefly illuminate during the self test**

Refer to Circuit/System Testing - Side Object Indicator Malfunction.

- **If both side blind zone alert indicators briefly turn ON and OFF**
6. All OK.

Circuit/System Testing

Left Side Object Sensor Malfunction

1. Ignition OFF and all vehicle systems OFF. Disconnect the harness connector at the B218L Side Object Sensor Module - Left. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between ground circuit terminal 7 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Verify a test lamp illuminates between the B+ circuit terminal 8 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition Off.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the B218L Side Object Sensor Module - Left.
 - **If the test lamp illuminates**
4. Ignition OFF and all vehicle systems OFF. Disconnect the It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 2 ohms between the serial data circuit terminal 1 and the DLC terminal 1.
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.
 - **If less than 2 ohms**
6. Replace B218L Side Object Sensor Module - Left.

Side Object Indicator Malfunction

1. Ignition OFF and all vehicle systems OFF, remove the appropriate outside rearview mirror glass and disconnect the P43 Side Object Detection Indicator connector. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal and ground.

- **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**
- 3. Ignition ON, connect a test lamp between the control circuit terminal and the ground circuit terminal.
- 4. Verify the test lamp turns ON and OFF when commanding the Object Detection Alert Indicators ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the B218R Side Object Sensor Module - Right.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the B218R Side Object Sensor Module - Right.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the B218R Side Object Sensor Module - Right, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the B218R Side Object Sensor Module - Right.
 - **If the test lamp turns ON and OFF**
- 5. Test or replace the appropriate A9 Outside Rearview Mirror Glass.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Outside Rearview Mirror Glass Replacement**
- **Control Module References** for side object sensor module replacement, programming and setup.

LANE DEPARTURE WARNING SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Lane Departure Warning Switch Ignition Circuit	-	2	-	-
Lane Departure Warning Switch Signal Circuit	B356A 02	1	B356A 05	-
Lane Departure Warning Switch Indicator Control Circuit	-	B0987 06	B0987 01	-
Lane Departure Warning Switch Ground Circuit	-	1	1	-
1. Lane Departure Warning Inoperative. 2. Lane Departure Warning Switch Illumination Inoperative.				

Circuit/System Description

The lane departure warning is controlled by the frontview camera module mounted on the windshield. The lane departure warning is enabled and disabled through a switch located at the instrument panel. When enabled, the vehicle direction camera control module will illuminate the indicator located in the switch.

When the system is operating and can detect the lane markings, the vehicle direction camera control module will request via serial data communications that the instrument cluster illuminate the green lane departure ready-to-assist indicator. If the frontview camera module detects that the vehicle has crossed a lane marking without the turn signal being used, the module will request that the instrument cluster flash the yellow lane departure warning indicator. An audible warning will also sound three times when the yellow instrument cluster indicator is flashing.

Diagnostic Aids

Certain factors will affect the operation of the lane departure warning system. When the system is operating properly, the green lane departure indicator will illuminate on the instrument cluster. This indicates that all of the required operating conditions to permit lane departure warning have been met. The green lane departure indicator will not appear when the system is having difficulty seeing the lines on the road or if the view of the camera on the windshield is blocked with mud, dirt, snow, ice, or slush, if the windshield is damaged, or when weather limits visibility, such as while driving in fog, rain, or snow conditions. This is normal operation, the vehicle does not need service. Additionally, lane departure warnings may occasionally occur in a properly operating vehicle due to tar marks, shadows, cracks in the road, or other road imperfections. This is normal system operation and the vehicle does not require service. The driver information center may also display LANE DEPARTURE SYSTEM UNAVAILABLE due to the temporary conditions listed above.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Object Detection Description and Operation (with Lane Departure Warning, UFL), Object Detection Description and Operation (with Forward Collision Alert, UEU), Object Detection Description and Operation (with Rearview Camera, UVC), Object Detection Description and Operation (with Side Blind Zone, UFT), Object Detection Description and Operation (with Lane Change Assist, UKC), Object Detection Description and Operation (with Rear Cross Traffic Alert, UFG), Object Detection Description and Operation (with Front and Rear Park Assist, UD5), Object Detection Description and Operation (with Rear Park Assist, UD7)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC B356A is not set.
 - **If the DTC is set**

Refer to **DTC B356A**.

- **If the DTC is not set**

3. Verify that DTC B0987 is not set.
 - **If the DTC is set**

Refer to **DTC B0987**.

- **If the DTC is not set**

4. Verify the scan tool Frontview Camera System Status parameter is Normal.
 - **If the parameter is Undefined or Malfunction**

Refer to Circuit/System Testing.

- **If the parameter is Normal**

5. Verify the scan tool Lane Departure Warning Switch Status parameter changes between On and Off when pressing the lane departure warning switch.

- **If the parameter does not change between On and Off**

Refer to Lane Departure Warning Switch Circuit Malfunction in Circuit/System Testing.

- **If the parameter changes between On and Off**

6. All OK.

Circuit/System Testing

Lane Departure Warning Switch Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch - Instrument Panel.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the ground circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Lane Departure Warning Switch parameter is Off.
 - **If not Off**
 1. Ignition OFF, disconnect the harness connector at the K109 Vehicle Camera Module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K109 Vehicle Camera Module.
 - **If Off**
5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and ground.
6. Verify the scan tool Lane Departure Warning Switch parameter is On.
 - **If not On**
 1. Ignition OFF, disconnect the harness connector at the K109 Vehicle Camera Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K109 Vehicle Camera Module.

- **If On**

7. Test or replace the S48D Multifunction Switch - Instrument Panel.

Lane Departure Warning Switch Indicator Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the S48D Multifunction Switch - Instrument Panel.
2. Test for less than 10 ohms between the low control circuit terminal 8 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the low control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K109 Vehicle Camera Module.

- **If less than 10 ohms**

3. Ignition ON, test for 4.8-5.2 V between the voltage circuit terminal 3 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the voltage circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.

- **If between 4.8-5.2 V**

4. Test or replace the S48D Multifunction Switch - Instrument Panel.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Frontview Camera Module replacement, programming and setup

REPAIR INSTRUCTIONS

FORWARD RANGE RADAR MODULE REPLACEMENT

Removal Procedure

CAUTION: Always use care when handling the forward range radar module and bracket. Improper handling can cause damage to the module or bracket and affect the functionality of the system.

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .

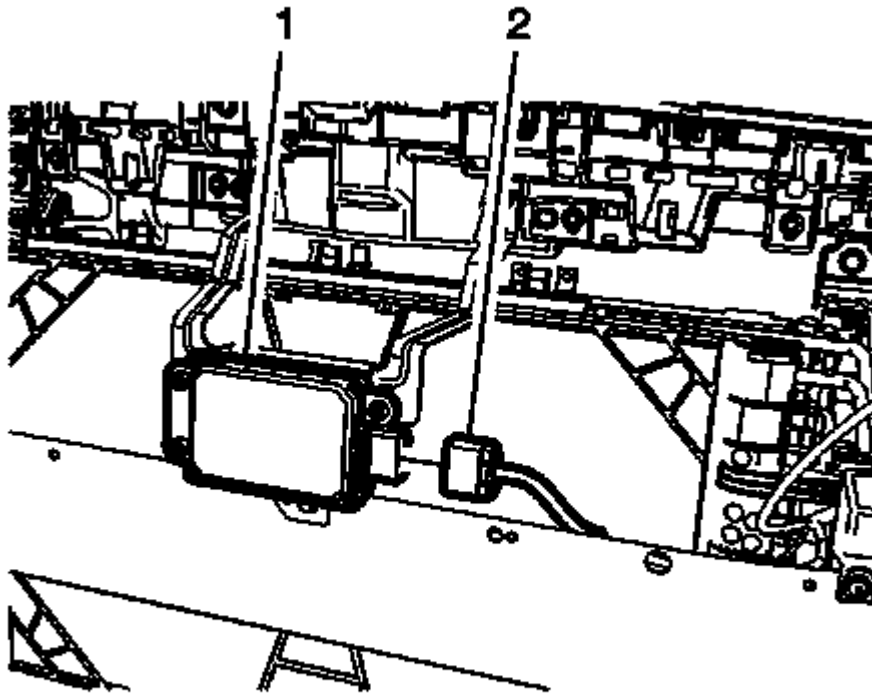


Fig. 6: Forward Range Radar Module
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the forward range radar module wiring harness plug (2) from the forward range radar module (1).

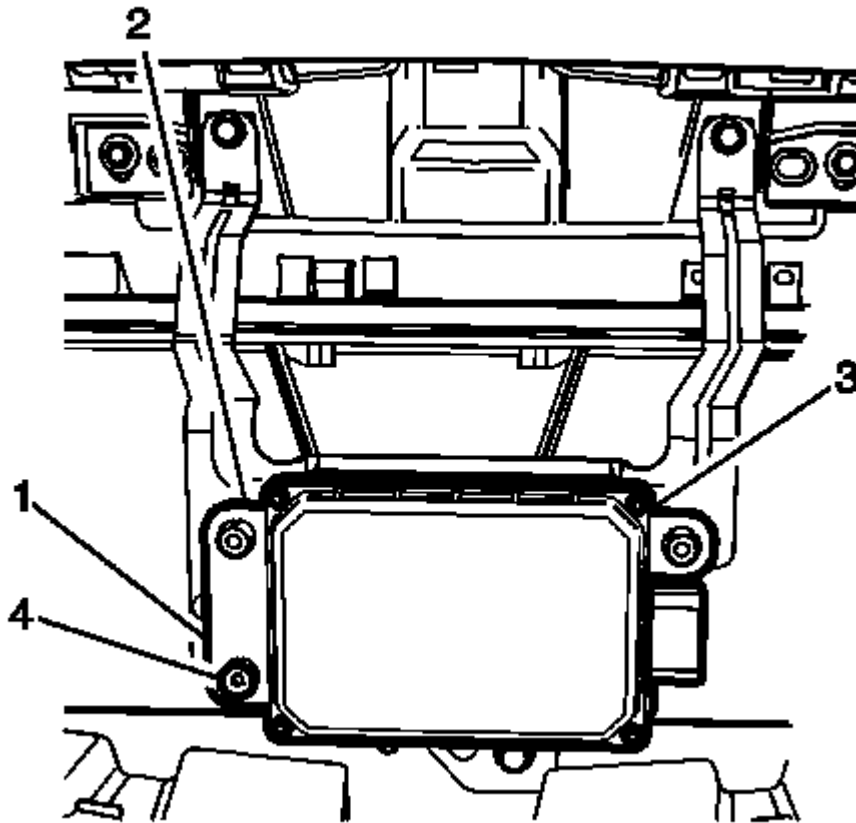


Fig. 7: Lower Ball Socket

Courtesy of GENERAL MOTORS COMPANY

NOTE: Remove the forward range radar module beginning with the lower ball socket (4).

NOTE: ONLY lift at the shown positions.

4. Carefully lift the forward range radar module away from the bracket by using a plastic tool at the positions (1, 2) and (3) successively as shown in the graphic.

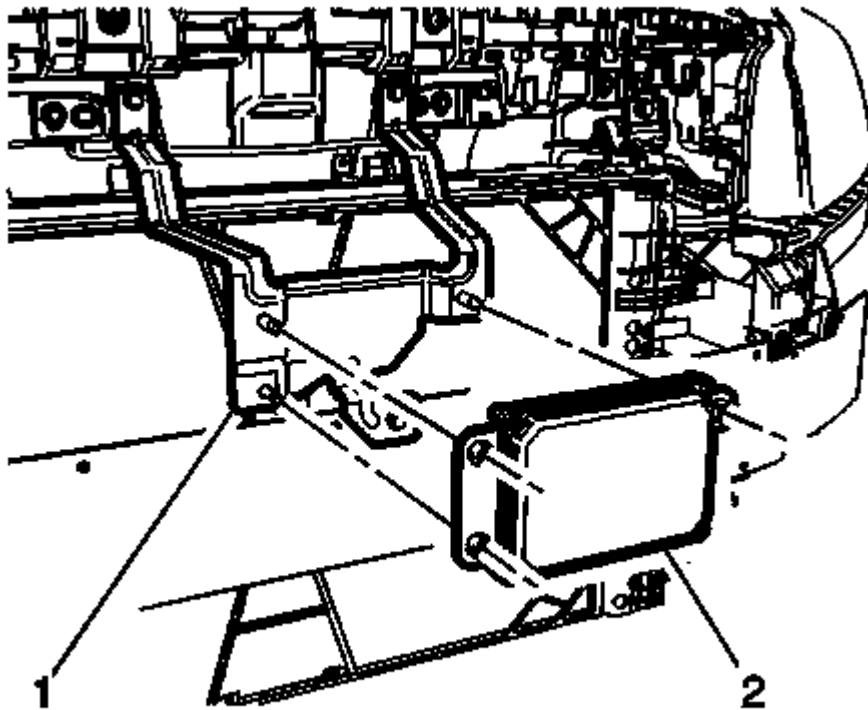


Fig. 8: Forward Range Radar Module And Bracket
Courtesy of GENERAL MOTORS COMPANY

5. Carefully remove the forward range radar module (2) from the forward range radar module bracket (1).

Installation Procedure

1. If the forward range radar bracket is deformed, replace the bracket. Refer to **Forward Range Radar Bracket Replacement**.

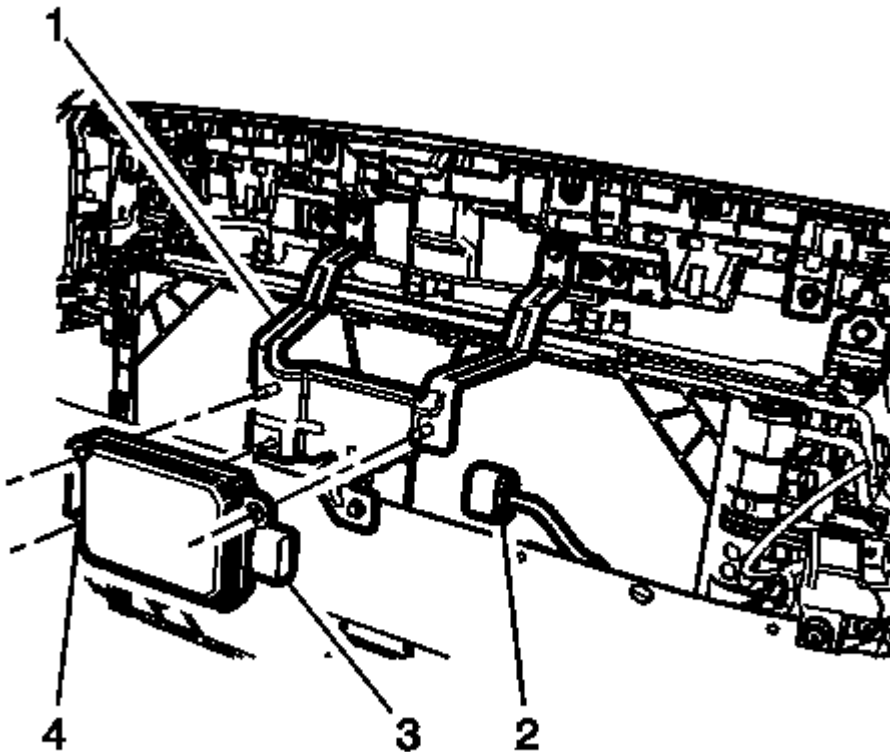


Fig. 9: Forward Range Radar Module
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the forward range radar module beginning with the 2 upper ball sockets and finishing with the ball socket (4). Apply a counterpressure to the opposite side of the bracket to prevent deformation of the bracket.

2. Carefully press the forward range radar module (3) to the forward range radar module bracket (1) and check for proper seat.
3. Connect the forward range radar module wiring harness plug (2).
4. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
5. Execute the vertical alignment of the forward range radar module. Refer to **Forward Range Radar Module Alignment**.
6. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

NOTE: The front bumper fascia must be installed, before continuing with the horizontal alignment.

7. For programming and set up, refer to **Control Module References** .

FORWARD RANGE RADAR MODULE ALIGNMENT

CAUTION: Always use care when handling the forward range radar module and bracket. Improper handling can cause damage to the module or bracket and affect the functionality of the system.

1. Inspect the forward range radar module for damage. Refer to Forward Range Radar Module Inspection.

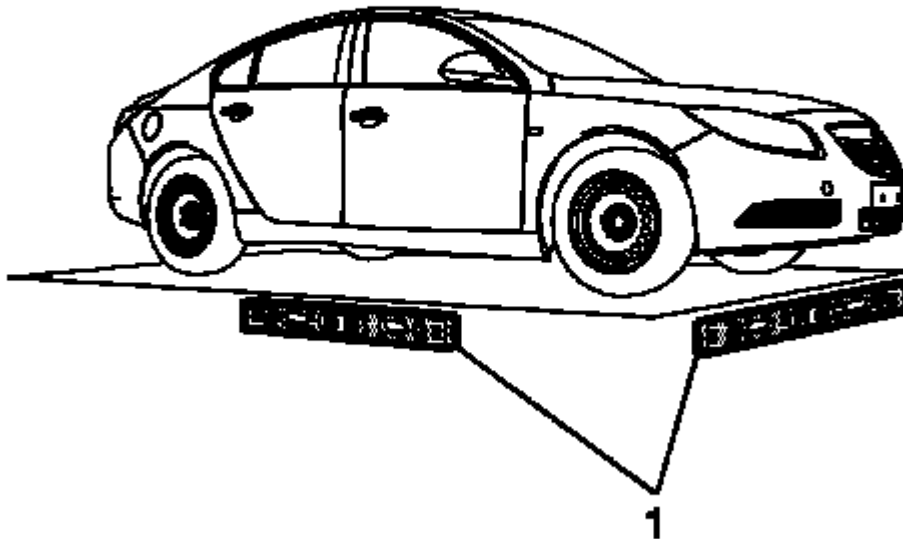


Fig. 10: Verifying Level Surface

Courtesy of GENERAL MOTORS COMPANY

2. The alignment of the forward range radar module is performed under the following vehicle conditions:
 - With an empty vehicle:
 - There shall not be any person in the vehicle
 - Specific equipment can remain in the vehicle
 - Luggage must not exceed 5 kg (11 lb)
 - The vehicle must stand on a flat surface. The level of the ground must not vary by more than $\pm 7\text{mm/m}$. This corresponds to 0.4 degrees, using a water bubble level. (1) as shown in graphic.
 - Vehicle tires must have specified air pressure.

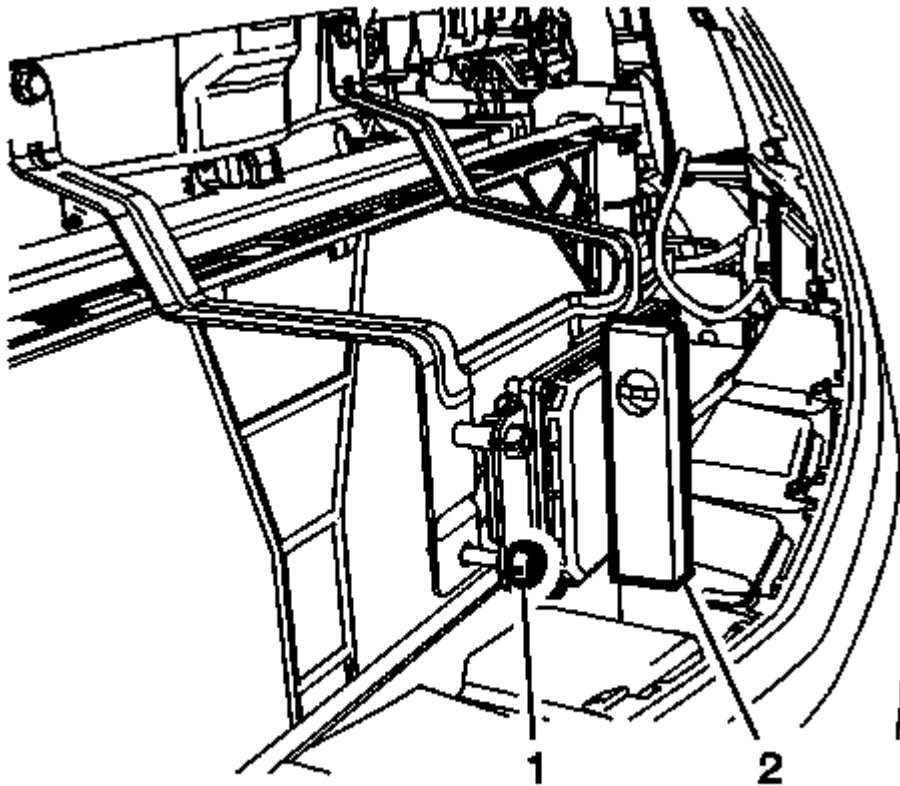


Fig. 11: Aligning Forward Range Radar Module Vertically
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not press the water bubble level too tight against the face of the module.

3. Use a water bubble level (2) to align the forward range radar module vertically as shown in the graphic.

NOTE: The water bubble level must have an accuracy of ± 0.5 degrees (9 mm/m).

NOTE: The vertical position of forward range radar module is 90 degrees.

4. Turn the screw (1) until the water bubble level has a value of 90 degrees.

FORWARD RANGE RADAR MODULE INSPECTION

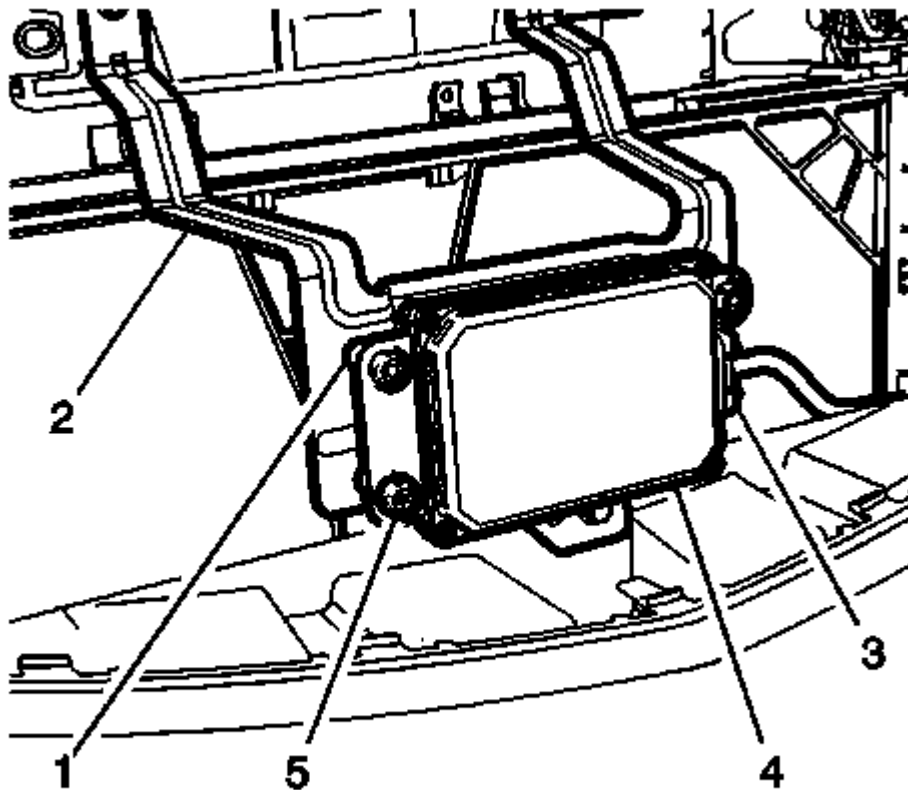


Fig. 12: Forward Range Radar Module
Courtesy of GENERAL MOTORS COMPANY

1. CONTROL MODULE DTC CHECK - Using a scan tool, perform the Vehicle DTC Information function-Verify there are no current control module DTCs set. If any DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Inspect the forward range radar module (4) for vertical alignment. Refer to **Forward Range Radar Module Alignment**.
3. Check the 3 ball sockets (5) for fixed seating. If the ball sockets are damaged replace the ball sockets.
4. Inspect all studs (1) for proper seat. If damaged, replace the bracket. Refer to **Forward Range Radar Bracket Replacement**.
5. Inspect the forward range radar module bracket (2) for paint cracks and deformations. Do NOT repair any cracks or misalignments. If damaged, replace the bracket. Refer to **Forward Range Radar Bracket Replacement**.
6. Inspect the wiring harness plug (3) and the terminal of the forward range radar module for any damage.

FORWARD RANGE RADAR BRACKET REPLACEMENT

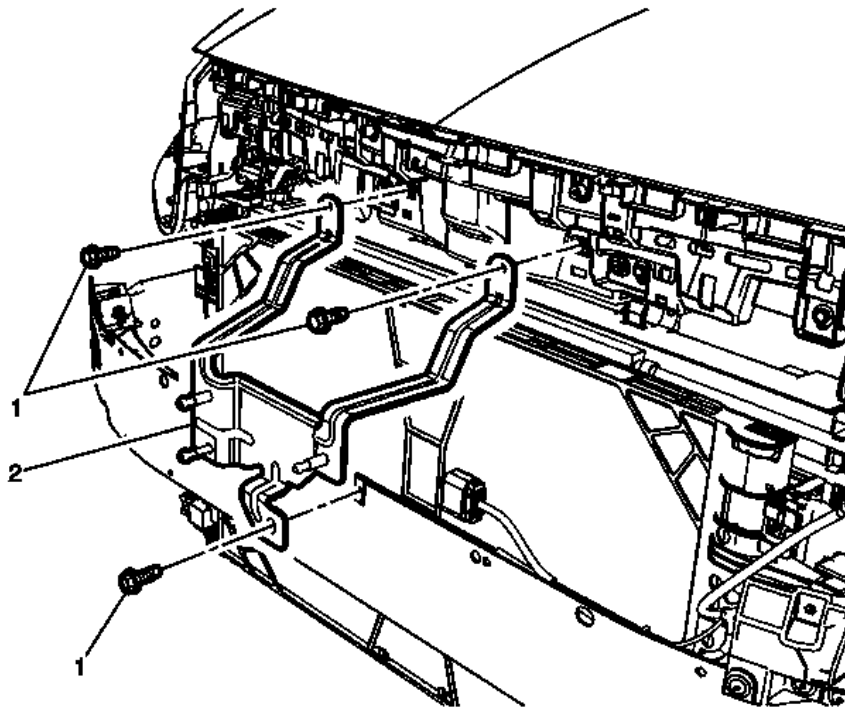


Fig. 13: Forward Range Radar Bracket
 Courtesy of GENERAL MOTORS COMPANY

Forward Range Radar Bracket Replacement

Callout	Component Name
CAUTION: Always use care when handling the forward range radar module and bracket. Improper handling can cause damage to the module or bracket and affect the functionality of the system.	
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the forward range radar module. Refer to <u>Forward Range Radar Module Replacement</u>. 2. Replace the 3 ball sockets from the forward range radar module. 3. Inspect the forward range radar module. Refer to <u>Forward Range Radar Module Inspection</u>. 	
1	Forward Range Radar Bracket Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Forward Range Radar Bracket

REAR OBJECT ALARM CONTROL MODULE REPLACEMENT

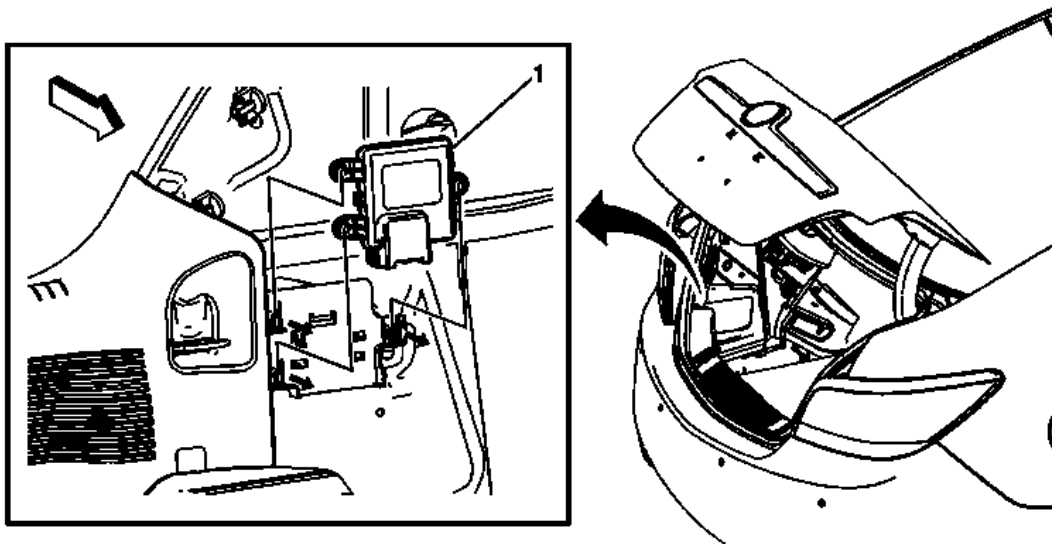


Fig. 14: Rear Object Alarm Module
Courtesy of GENERAL MOTORS COMPANY

Rear Object Alarm Control Module Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment side trim panel. Refer to <u>Rear Compartment Side Trim Panel Replacement (without HP6)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Rear Object Alarm Module Assembly Procedure <ol style="list-style-type: none">1. Disconnect the electrical connectors.2. Release the locking retainer from the front and rear object alarm module bracket.3. For programming and set up, refer to <u>Control Module References</u> .

SIDE OBJECT SENSING ALERT MODULE REPLACEMENT

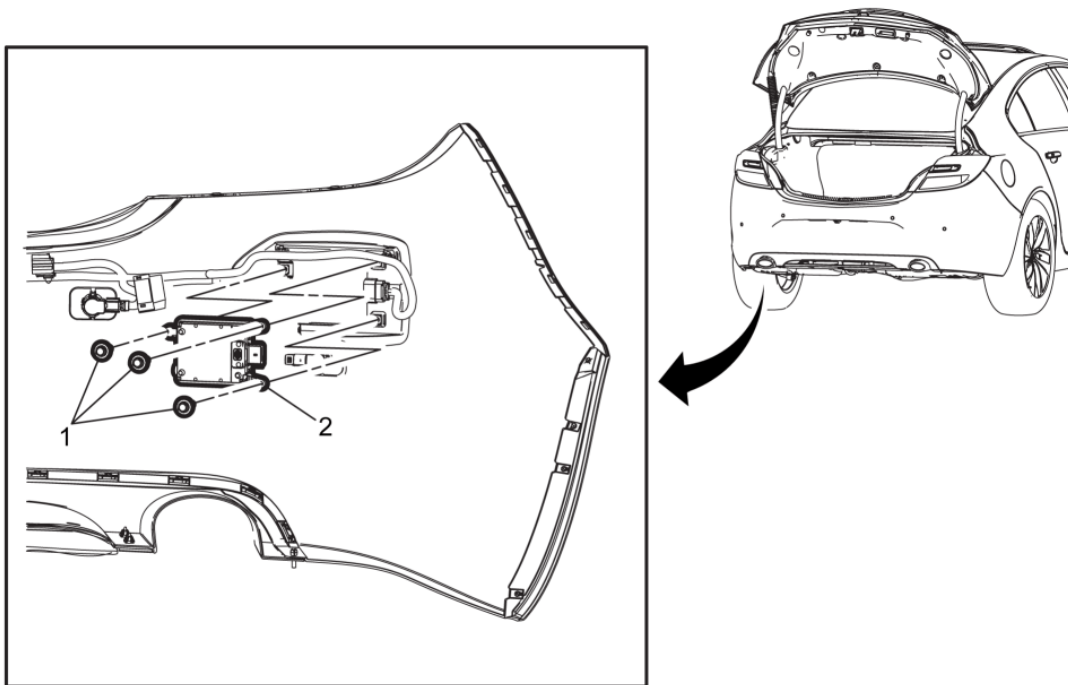


Fig. 15: Side Object Sensing Alert Module
 Courtesy of GENERAL MOTORS COMPANY

Side Object Sensing Alert Module Replacement

Callout	Component Name
Preliminary Procedure Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
1	Side Object Sensing Alert Module Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2.5 (22 lb in)
2	Side Object Sensing Alert Module Procedure Disconnect the side object sensing alert module electrical connector.

REAR PARKING ASSIST ALARM SENSOR REPLACEMENT

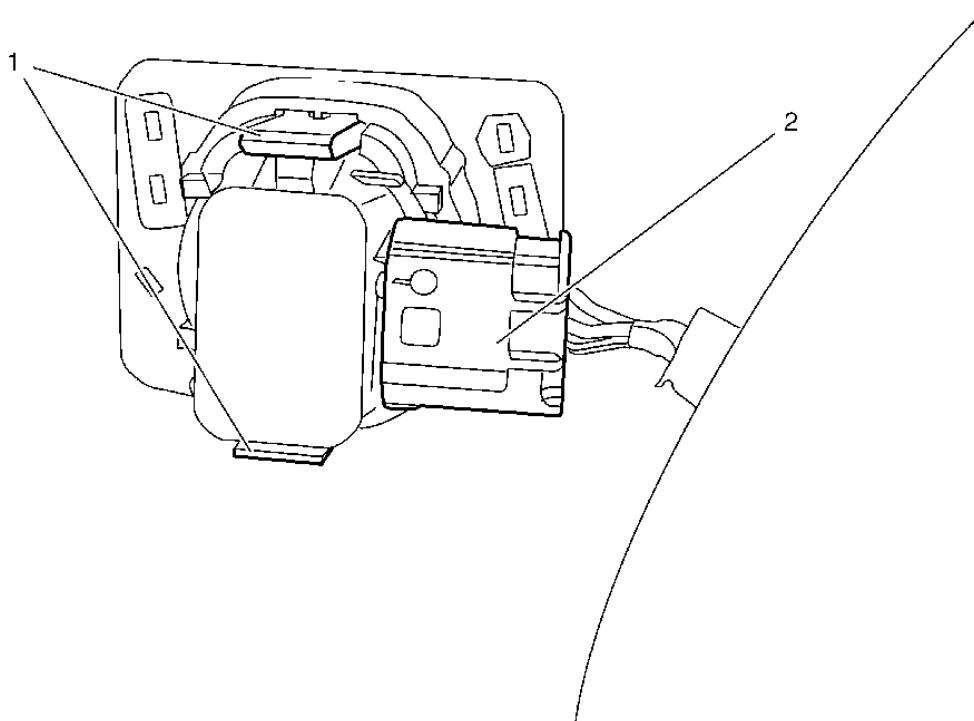


Fig. 16: Rear Object Sensor & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Rear Parking Assist Alarm Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the rear bumper fascia. Refer to <u>Rear Bumper Fascia Replacement</u> .	
1	Rear Object Sensor Retainer (Qty: 2) Procedure <ol style="list-style-type: none"> 1. Disconnect the rear object sensor electrical connector. 2. Release the locking retainer from the rear object sensor support.
2	Rear Object Sensor

FRONT VIEW CAMERA REPLACEMENT

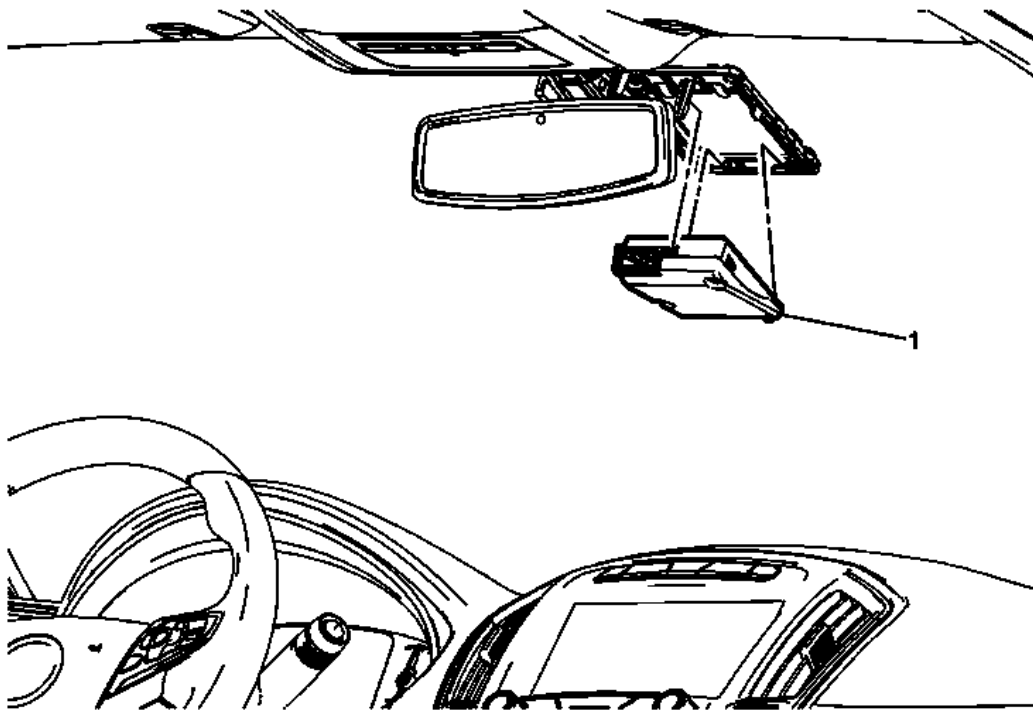


Fig. 17: Front View Camera
 Courtesy of GENERAL MOTORS COMPANY

Front View Camera Replacement

Callout	Component Name
Preliminary Procedure Remove the windshield multifunction sensor mounting bracket cover Refer to <u>Windshield Multifunction Sensor Mount Bracket Cover Replacement</u> .	
1	Front View Camera Procedure <ol style="list-style-type: none"> 1. Gently depress top center tab on bracket to release camera. 2. Disconnect the electrical connector. 3. Program and calibrate the front view camera. For programming and set up, refer to <u>Front View Camera Module Calibration</u>.

FRONT VIEW CAMERA MODULE CALIBRATION

The calibration procedure will start automatically after SPS programming is complete. During this time the Lane Departure Warning amber indicator will illuminate.

Calibration

The calibration process for the front view camera system is necessary when a front view camera module is

replaced by a new one. This process shall not be required when only replacing the windshield and the front view camera module has been mounted again properly. This process shall be completed within 3-5 minutes when the correct driving conditions are met. If conditions are not met correct, the front view camera module shall continuously run the service point calibration until successfully completed. This process shall work across ignition cycles and shall not be required to be re-initialized at start up. If the Lane Departure Warning Switch is pressed during calibration, the indicator will flash momentarily and then stay out - this is normal operation.

To calibrate the front camera, operate the vehicle in the following conditions until the calibration is complete:

- Clean windshield.
- Avoid lane changes.
- Maintain vehicle speeds between 56-90 km/h (35-56 MPH).
- Ensure the road contains visible references (well defined lane markings, curbs, etc.).

Once the procedure is complete, the amber indicator will turn off. Shortly after the green ready to assist light should turn on as long as all conditions are met for normal operation. The system is then ready to assist.

If Slow to Calibrate

One or more of the following conditions may increase the length of time required to complete the self-calibration procedure:

- Heavy traffic
- Stop and go traffic
- Mountain roads
- Curves in roadway
- Poor contrast lane markings
- Botts' Dots type lane markings
- Operating the vehicle speed is greater than 90 km/h (56 MPH)
- Driving through snow or fog, or driving directly into the sun
- Camera not properly installed. Verify it is snapped into tabs and is secure. Refer to **Front View Camera Replacement** .

No Calibration

Conditions that will prevent completion of the self-calibration procedure:

- Dirty windshield glass or obstruction on windshield
- Operating the vehicle with speed less than 56 km/h (35 MPH)
- No visible lane markings
- Severe weather where lane markings cannot be seen
- Camera not properly installed. Verify it is snapped into tabs and is secure. Refer to **Front View Camera Replacement** .

DESCRIPTION AND OPERATION

OBJECT DETECTION DESCRIPTION AND OPERATION (WITH LANE DEPARTURE WARNING, UFL)

The lane departure warning system is a convenience feature of the front view camera that issues a warning when the system detects that the vehicle has unintentionally crossed a lane marking. The front view camera is located behind the windshield, looking out at the road ahead and detecting any lane markings. When the vehicle unintentionally leaves a detected lane, a visual and audible alert is given to the driver.

The lane departure warning system is made up of the following components:

- Front view camera module
- Lane departure warning switch
- Instrument cluster / Vehicle Direction Display
- Radio

Front View Camera Module

The camera detects visual queues such as lane markings. When it is determined that the vehicle has unintentionally moved outside of the lane, a visual and audible warning is given to the driver. The front view camera module receives an input from the lane departure warning switch and controls the lane departure warning switch indicator output. The front view camera module also communicates via serial data with the instrument cluster and radio to request visual and audible alerts.

Lane Departure Warning Switch

The lane departure warning switch provides an input to the front view camera module to turn the lane departure warning system ON and OFF. The front view camera module provides a signal voltage to the normally open momentary switch. When the switch is pressed, the signal circuit is pulled to ground, indicating to the front view camera module that the system has been requested to turn ON or OFF. The lane departure warning switch also contains the lane departure warning switch indicator, which is controlled by the front view camera module to indicate the ON and OFF status of the lane departure warning system. When the system has been enabled by the lane departure warning switch, the front view camera module applies ground to the switch indicator and illuminates the LED. The location of the lane departure warning switch can vary with different vehicles. For the exact location please refer to the user's manual.

Instrument Cluster

The vehicle direction display contains green and amber lane departure warning indicators. These indicate to the driver the current status of the lane departure warning system and are controlled via serial data by the front view camera module. When the vehicle speed is above 56 km/h (35 MPH) and the system has detected the required lane markings and is ready to assist, the green indicator will be illuminated on the vehicle direction display. If the vehicle has unintentionally left the lane, the amber indicator will flash.

Radio

The radio controls the audible alert for the lane departure warning. If the vehicle has unintentionally left the lane, the radio will command three beeps as an audible alert to the driver.

Lane Departure Warning Operation

System operation can be describe by the following modes:

- **Off State:** The system has been turned off by the driver, using the lane departure warning switch. The lane departure warning indicator will not be illuminated.
- **Not Ready To Assist:** The system is enabled and the lane departure warning indicator is illuminated, but not ready to assist when any of the following conditions is true:
 - Vehicle speed is less than 56 km/h (35 MPH). The system is designed to function at speeds greater than 56 km/h (35 MPH).
 - The system cannot detect lane markings. This may be because there are no lane markings, as on a country road or that the lane markings cannot be determined due to snow, rain, or other driving conditions.
 - The windshield area in front of the camera or the camera lens is blocked by fog, dirt, damage to the windshield or other elements that may prevent the camera from detecting lane markings.
- **Ready To Assist:** The system is enabled and ready to warn of the unintentional lane crossing. The system is ready to assist when the green lane departure warning indicator is illuminated on the vehicle direction display.

Lane Crossing Alerts

- When one of the following conditions are met, the system will not give alerts:
 - The correct turn signal is activated. An activated turn signal is interpreted as an intentional lane crossing.
 - The operator makes an intentional steering maneuver.
 - The operator makes an intentional accelerating maneuver.
 - The operator makes an intentional braking maneuver.
- Lane crossing alert consists of the following:
 - Three chimes are activated through the radio.
 - The amber lane departure warning indicator will flash.

Lane Departure Warning System Driver Information Center Messages

The front view camera module can command the driver information center to display the various messages to alert the driver of a system concern or status information. For detailed information about the possible messages please refer to the user's manual.

OBJECT DETECTION DESCRIPTION AND OPERATION (WITH FORWARD COLLISION ALERT, UEU)

The forward collision alert system is a convenience feature of the front view camera that issues a warning to the driver when a potential collision risk exists. The front view camera is located behind the windshield, looking

out at the road ahead and detecting vehicles directly ahead, within a distance of approximately 60 meters (197 ft). The forward collision alert system is always active and operates at speeds above 40 kph (25 mph). When the system detects a vehicle in the path ahead, the green vehicle ahead indicator in the vehicle direction display is illuminated. When approaching another vehicle too rapidly, the collision alert symbol will flash in the vehicle direction display. Simultaneously an audible alert sounds. Forward collision alert does not warn the driver of any objects that are not detected as a vehicle, like e.g. pedestrians, animals, signs, guard rails, bridges, construction barrels or other stationary or slow moving objects. The forward collision alert timing sensitivity to control the distance to the vehicle ahead can be set using the forward collision alert switch in the left steering wheel controls.

In some cases the camera may detect a vehicle that is not in the path ahead, or the system may occasionally provide unrealistic alerts. This could respond to a turning vehicle ahead, guard rails, traffic signs, or other stationary objects. This is normal operation, the vehicle does not need service. Forward collision alert may sometimes set unnecessary alerts to turning vehicles, vehicles in other lanes, objects that are not vehicles, or shadows. These alerts are normal operation and the vehicle does not need service.

The forward collision alert system is made up of the following components:

- Front view camera module
- Forward collision alert switch
- Instrument cluster / Vehicle direction display
- Radio

Front View Camera Module

The camera detects vehicles in front of the host vehicle. The front view camera module requests the green vehicle ahead alert indicator in the vehicle direction display ON via serial data when the front view camera system has detected a vehicle in the driving path ahead. The front view camera module also communicates via serial data with the driver information center and the radio to request visual and audible alerts.

- Lane departure warning system unavailable
- Forward collision alert OFF
- Service front camera

Forward Collision Alert Switch

The forward collision alert switch provides an input to the front view camera module to select the alert timing sensitivity when approaching another vehicle too rapidly. The front view camera module provides a signal voltage to the normally open switch. When the switch is pressed, the signal circuit is pulled to ground, indicating to the front view camera module that the system has been requested to change the alert timing sensitivity. The first button press shows the current alert timing setting on the driver information center. With every button press, the alert timing sensitivity is changed. The current alert timing setting will be maintained until it is changed. The preset alert timing setting is displayed in the top line of the driver information center. The position of the forward collision alert switch can vary with different vehicles. For the exact position please refer to the user's manual.

Instrument Cluster

The Vehicle direction display contains the green vehicle ahead indicator, which indicates to the driver that the Front View Camera system has detected a vehicle in the driving path ahead and is controlled via serial data. When approaching another vehicle too rapidly, the collision alert symbol will flash in the Vehicle direction display. The red Front collision alert display will stay continuously illuminated if the vehicle ahead remains much too close.

Radio

The radio controls the audible alert for the forward collision alert system. If the host vehicle is approaching another vehicle too rapidly, the radio will command an audible alert to the driver.

Forward Collision Alert System Driver Information Center Messages

The front view camera module can command the driver information center to display the various messages to alert the driver of a system concern or status information. For detailed information about the possible messages please refer to the user's manual.

OBJECT DETECTION DESCRIPTION AND OPERATION (WITH REARVIEW CAMERA, UVC)

Rear Vision Camera System Operation

The rear vision camera system consists of a video camera located at the rear of the vehicle and the navigation radio.

When the transmission is placed into REVERSE, a 12 volt signal is sent to the rear vision camera by the body control module (BCM). This signal indicates to the camera that the vehicle is in reverse and image display is requested. The rear vision camera receives ignition voltage and a constant ground to power the camera. Video signal + and video signal - circuits carry the video image from the rear vision camera to the navigation radio. Additionally, the video signal circuits are shielded to prevent any interference which may lead to a loss of video signal resolution and a degraded video image. The shield is provided a ground path by the rear vision camera.

The following conditions may cause a degraded rear vision camera image:

- Ice, snow, or mud has built up on the rear vision camera
- Dark conditions
- Extreme light conditions, such as glare from the sun or the headlights of another vehicle
- Damage to the rear of the vehicle
- Extreme high temperatures or extreme temperature changes

If a malfunction is detected in the system, Service Rear Vision Camera may be displayed on the navigation radio as an indicator to the customer that a problem exists that requires service.

OBJECT DETECTION DESCRIPTION AND OPERATION (WITH SIDE BLIND ZONE, UFT)

Side Blind Alert Block Diagram

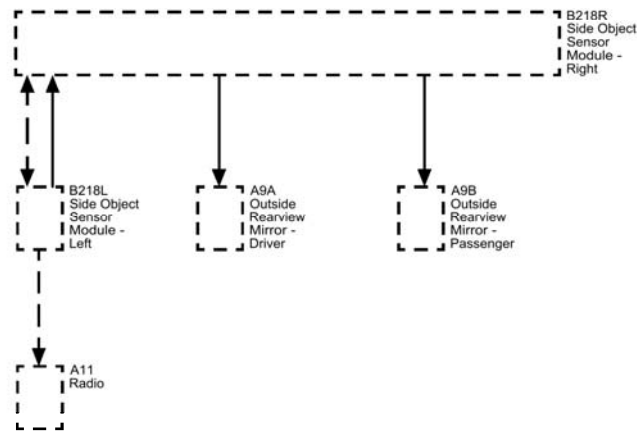


Fig. 18: Side Blind Alert Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DA	Serial Data
HW	Hard-Wired
DB	Serial Data - GMLAN Low Speed
HW	Hard-Wired
HW	Hard-Wired
B218R	B218R Side Object Sensor Module - Right
B218L	B218L Side Object Sensor Module - Left
A11	A11 Radio
A9A	A9A Outside Rearview Mirror - Driver
A9B	A9B Outside Rearview Mirror - Passenger

The side blind zone alert system is a feature that utilizes two side object sensor modules to provide enhanced customer convenience by sensing and reporting to the driver that an object is present in one of the driver's side blind zones. This is communicated to the driver by illuminating an icon on the left or right side view mirror, depending on what side of the vehicle the object is detected. This lane change assist system is radar based system in which the sensors transmit and receives energy that is reflected from external objects and used to determine if that object is an object of interest. Although this system is intended to help drivers avoid lane change crashes, it does not replace driver vision and therefore should be considered a lane change aid.

Side Blind Zone Alert System Components

The side blind zone alert system is made up of the following components:

- Left side object sensor module
- Right side object sensor module
- Driver outside rearview mirror
- Passenger outside rearview mirror

Side Object Sensor Modules

The side object sensor modules are located on each side of the vehicle behind the rear fascia and are not directly visible from outside the vehicle. The sensors use radar to determine the presence of objects nearby. The left side object sensor is the master that communicates on serial data. There is a private communication network between the left and right sensors. The scan tool is able to communicate only with the left sensor.

When an object is detected in the left side blind zone, the side object sensor module sends a message to the right sensor through serial data. The right sensor then supplies voltage to illuminate the visual indicator on the left side outside rear view mirror. When an object is detected in the right side blind zone, the right side object sensor will supply a voltage to illuminate the visual indicator on the right side outside rear view mirror. Each sensor is supplied B+ and ground.

Outside Rearview Mirrors

The outside rearview mirrors contain an icon that is backlit with high intensity, amber-colored LED's located on the mirror surface. The display brightness adapts to day/night conditions. The side blind zone alert indicator icon in the left or right outside rearview mirror is illuminated if the left or right side object sensor module detects a vehicle in the side blind zone to inform the driver that there is a vehicle driving in the blind zone.

Side Blind Zone Alert Operation

The side blind zone alert system shall detect and report "objects of interest" on either side of the vehicle, within a specified "blind spot" zone. The system is designed to alert the driver, with a visual display placed on the side view mirror, to the presence of objects of interest that may not be visible in the inside rearview mirror and outside rear view mirrors. Although this system is intended to help drivers avoid lane change crashes, it does not replace driver vision and therefore should be considered a lane change aid. Even with the side blind zone alert system, the driver must check carefully for objects outside of the reporting zone before changing lanes. In the event that the system senses a malfunction through its diagnostic routines, the system will be disabled and the driver will be visually notified.

When the vehicle is started, both outside mirror displays will briefly come on to indicate that the system is operating. The warning symbols will vary brightness based on the ambient light conditions. Side blind zone alert is active when the vehicle is out of park or the parking brake is off on manual transmission vehicles. When the system detects a vehicle in the side blind zone while driving forward, an amber warning symbol will light up in the appropriate outside mirror. This indicates that it may be unsafe to change lanes. If the driver then activates the turn signal, the amber warning symbol starts flashing as an extra warning not to change lanes.

The system is designed to detect objects of interest as small as a 125cc motorcycle with rider. The detection zone starts at the outside rearview mirror and extends out to 3.5 m (11 ft) at the back corner of the vehicle and

5m (16 ft) behind the vehicle at a height of 0.5 m (1.5 ft) to 2.0 m (6 ft) above the ground. The side blind zone system does not detect stationary objects such as guardrails, posts, curbs, walls, berms, bridges, or parked vehicles.

If the vehicle is towing a trailer or has an object such as a bicycle rack attached to the rear of the vehicle, the side blind zone system may not function properly and the indicators may illuminate intermittently or remain illuminated all the time. The driver information center may display "SIDE DETECTION SYSTEM UNAVAILABLE".

Foul weather may affect the operation of the side blind zone system. Occasional missed alerts can occur under normal circumstances and will increase in wet conditions. The number of missed alerts will increase with increased rainfall or road spray. Heavy rainfall, as well as mud, dirt, snow, ice, or slush build-up on the rear fascia, can completely disable the system. The warning symbols will vary brightness based on the ambient light conditions.

Side Blind Zone Alert Driver Information Center Messages

SIDE BLIND ZONE ALERT OFF

This message indicates that the system has been disabled through the driver information center. Refer to the vehicle owners manual for instructions on how to set personalization options on the driver information center.

SERVICE SIDE DETECTION SYSTEM

This message indicates that the system requires service. When the message is displayed, the indicators may remain illuminated at all times, notifying the driver that the side blind zone system should not be relied upon when changing lanes. Check vehicle for DTCs to determine the cause of this notification.

SIDE DETECTION SYSTEM UNAVAILABLE

This message indicates that the system has been temporarily disabled because the sensor is blocked or can otherwise not accurately detect vehicles or objects. Verify there is no damage to rear fascia or there are any bumper stickers that may interfere with the radar signals. Ask the customer if any of the following circumstances were present when the system became unavailable: towing a trailer, having a bike rack attached, mud, dirt, snow, ice, or slush build-up on the rear fascia, heavy rainfall, or excessive road spray.

OBJECT DETECTION DESCRIPTION AND OPERATION (WITH LANE CHANGE ASSIST, UKC)

Side Blind Alert Block Diagram

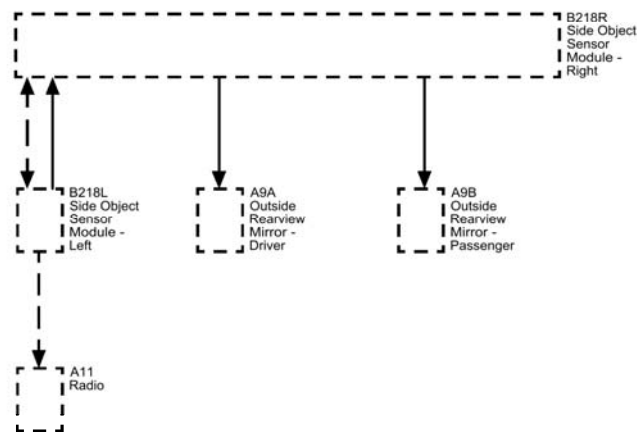


Fig. 19: Side Blind Alert Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DA	Serial Data
HW	Hard-Wired
DB	Serial Data - GMLAN Low Speed
HW	Hard-Wired
HW	Hard-Wired
B218R	B218R Side Object Sensor Module - Right
B218L	B218L Side Object Sensor Module - Left
A11	A11 Radio
A9A	A9A Outside Rearview Mirror - Driver
A9B	A9B Outside Rearview Mirror - Passenger

The lane change alert system is an advanced side blind zone alert feature that utilizes the side object sensor modules that are also used for rear cross traffic alert. The lane change alert system is designed to provide enhanced customer convenience by sensing and reporting to the driver that an object is present in one of the driver's side blind zones, or that a highway licensable vehicle is rapidly approaching the vehicle in one of the adjacent lanes. This is communicated to the driver by illuminating an icon on the left or right side view mirror, depending on what side of the vehicle the object is detected. The lane change alert system is radar based system in which the sensors transmit and receives energy that is reflected from external objects and used to determine if that object is an object of interest. Although this system is intended to help drivers avoid lane change crashes, it does not replace driver vision and therefore should be considered a lane change aid.

Lane Change Alert System Components

The lane change alert system is made up of the following components:

- Side object sensor module - left
- Side object sensor module - right
- Driver outside rearview mirror
- Passenger outside rearview mirror

Side Object Sensor Modules

The side object sensor modules are located on each side of the vehicle behind the rear fascia and are not directly visible from outside the vehicle. The sensors use radar to determine the presence of objects nearby. The left side object sensor is the master that communicates on serial data. There is a private communication network between the left and right sensors. The scan tool is able to communicate only with the left sensor.

When an object is detected in the left side blind zone or approaching in the left side lane change alert zone, the side object sensor module sends a message to the right sensor through serial data. The right sensor then supplies voltage to illuminate the visual indicator on the left side outside rear view mirror. When an object is detected in the right side blind zone or approaching in the right side lane change alert area, the right side object sensor will supply a voltage to illuminate the visual indicator on the right side outside rear view mirror. Each sensor is supplied B+ and ground.

Outside Rearview Mirrors

The outside rearview mirrors contain an icon that is backlit with high intensity, amber-colored LED's located on the mirror surface. The display brightness adapts to day/night conditions. The side blind zone alert indicator icon in the left or right outside rearview mirror is illuminated if the left or right side object sensor module detects a vehicle in the side blind zone or approaching in the lane change alert area to inform the driver that it may not be safe to change lanes.

Lane Change Alert Operation

The lane change alert system shall detect and report "objects of interest" in the driver's blind zone, or approaching on either side of the vehicle, within a specified lane change zone. The system is designed to alert the driver, with a visual display placed on the side view mirror, to the presence of objects of interest that may not be visible in the inside rearview mirror and outside rear view mirrors. Although this system is intended to help drivers avoid lane change crashes, it does not replace driver vision and therefore should be considered a lane change aid. Even with the lane change alert system, the driver must check carefully for objects outside of the reporting zone before changing lanes. In the event that the system senses a malfunction through its diagnostic routines, the system will be disabled and the driver will be visually notified.

When the vehicle is started, both outside mirror displays will briefly come on to indicate that the system is operating. The warning symbols will vary brightness based on the ambient light conditions. Lane change alert is active when the vehicle is out of park or the parking brake is off on manual transmission vehicles. When the system detects a vehicle in the side blind zone or approaching in the lane change alert zone while driving forward, an amber warning symbol will light up in the appropriate outside mirror. This indicates that it may be

unsafe to change lanes. If the driver then activates the turn signal, the amber warning symbol starts flashing as an extra warning not to change lanes.

The system is designed to detect objects of interest as small as a 125cc motorcycle with rider. The detection zone starts at the outside rearview mirror and extends out to 3.5 m (11 ft) at the back corner of the vehicle and 70m (230 ft) behind the vehicle at a height of 0.5 m (1.5 ft) to 2.0 m (6 ft) above the ground. The side blind zone system does not detect stationary objects such as guardrails, posts, curbs, walls, berms, bridges, or parked vehicles.

If the vehicle is towing a trailer or has an object such as a bicycle rack attached to the rear of the vehicle, the lane change alert system may not function properly and the indicators may illuminate intermittently or remain illuminated all the time. The driver information center may display "SIDE DETECTION SYSTEM UNAVAILABLE".

Foul weather may affect the operation of the lane change alert system. Occasional missed alerts can occur under normal circumstances and will increase in wet conditions. The number of missed alerts will increase with increased rainfall or road spray. Heavy rainfall, as well as mud, dirt, snow, ice, or slush build-up on the rear fascia, can completely disable the system. The warning symbols will vary brightness based on the ambient light conditions.

Lane Change Alert Driver Information Center Messages

LANE CHANGE ALERT OFF

This message indicates that the system has been disabled through the driver information center. Refer to the vehicle owners manual for instructions on how to set personalization options on the driver information center.

SERVICE SIDE DETECTION SYSTEM

This message indicates that the system requires service. When the message is displayed, the indicators may remain illuminated at all times, notifying the driver that the side blind zone system should not be relied upon when changing lanes. Check vehicle for DTCs to determine the cause of this notification.

SIDE DETECTION SYSTEM TEMPORARILY UNAVAILABLE

This message indicates that the system has been temporarily disabled because the sensor is blocked or can otherwise not accurately detect vehicles or objects. Verify there is no damage to rear fascia or there are any bumper stickers that may interfere with the radar signals. Ask the customer if any of the following circumstances were present when the system became unavailable: towing a trailer, having a bike rack attached, mud, dirt, snow, ice, or slush build-up on the rear fascia, heavy rainfall, or excessive road spray.

OBJECT DETECTION DESCRIPTION AND OPERATION (WITH REAR CROSS TRAFFIC ALERT, UFG)

Rear Cross Traffic Alert Block Diagram

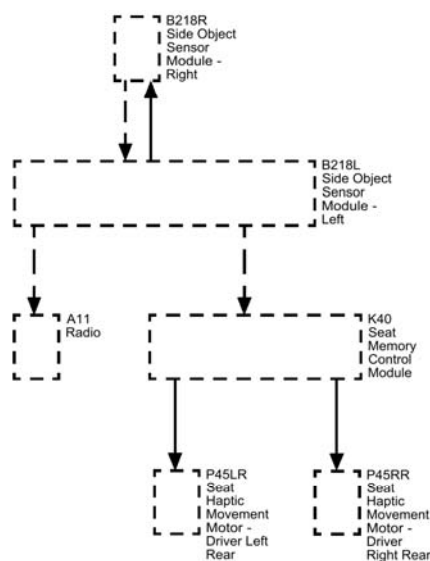


Fig. 20: Rear Cross Traffic Alert Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
DA	Serial Data
DB	Serial Data - GMLAN Low Speed
DB	Serial Data - GMLAN Low Speed
HW	Hard-Wired
HW	Hard-Wired
B218R	B218R Side Object Sensor Module - Right
B218L	B218L Side Object Sensor Module - Left
A11	A11 Radio
K40	K40 Seat Memory Control Module
P45LR	Seat Haptic Movement Motor - Driver Left Rear
P45RR	Seat Haptic Movement Motor - Driver Right Rear

The rear cross traffic alert system is a feature that utilized two side object sensor modules to provide enhanced customer convenience while backing up by sensing and providing warnings to the driver on impending rear cross traffic. The rear cross traffic alert system is designed to detect and track objects of interest within a specified coverage zone behind the vehicle. The system is designed to alert the driver, with a visual display and either an audible sound or a haptic warning, if equipped and enabled, to the presence of objects of interest that may cause a collision with the host vehicle. Although the system is intended to assist drivers in backing up, it

does not replace driver's vision. The driver is responsible to check carefully for objects outside of the coverage zone (e.g., a fast approaching vehicle) for a safe backing maneuver.

Rear Cross Traffic Alert System Components

The side blind zone alert system is made up of the following components:

- Left side object sensor module
- Right side object sensor module
- Visual Display Icons located on the infotainment display screen
- Audio system chime
- Haptic safety seat (if equipped)

Side Object Sensor Modules

The side object sensor modules are located on each side of the vehicle behind the rear fascia and are not directly visible from outside the vehicle. The sensors use radar to determine the presence of objects nearby. The left side object sensor is the master that communicates on serial data. There is a private communication network between the left and right sensors. The scan tool is able to communicate only with the left sensor.

When an object is detected in the left rear cross traffic zone, the side object sensor module sends a serial data message to the human interface module and memory seat module to provide alerts. Each sensor is supplied B+ and ground.

Display Icons

The rear cross traffic alert system visual alert display consists of two visual icons, one on each side of the display screen of the rearview camera display, that are used to alert the driver on rear cross traffic from each side of the host vehicle respectively. In addition to visual indicators, the audio system will beep (if enabled) and the haptic safety seat will vibrate (if equipped and enabled). Refer to owner's manual for vehicle customization.

Audio or Haptic Notification

The alert output type can be driver selected to either audio or haptic. The chime location will be left rear for left rear cross traffic alert and right rear for right rear cross traffic alert. The haptic seat system response will be to generate 3 repetitions of haptic vibration in the left rear area of the seat for left cross traffic alert and right rear area of the seat for right cross traffic alert. If there is a problem with the haptic seats, the audio chime will be substituted.

Rear Cross Traffic Alert Operation

The rear cross traffic alert system is designed to detect objects of interest as small as a 125cc motorcycle with rider. The detection zone extends approximately 30m (99 ft) from the rear corner of the car and covers an area from behind the vehicle to 125 degrees towards the front at a height of 0.45m (1.5 ft) to 2m (6.5 ft) above ground. The system operates when vehicle speed is 10 kph (6 mph) or less and is designed to detect objects moving at speeds up to 36 kph (22 mph).

When the vehicle is backing up, the side object sensors receive energy that is reflected from external objects and determine if the objects are objects of interest or not. The system may at times detect pedestrians, shopping carts, or similar moving objects. This is normal and should not be considered as a false alert or problem with the system. The rear cross traffic alert system will estimate vehicle travel trajectory and use the information in conjunction with object travel trajectory information to determine if there is a potential collision between the vehicle and the object of interest. The rear cross traffic alert function will only alert on objects of interest that pose a potential collision with the host vehicle. The system is not designed to provide an alert to objects that have no potential collision with vehicle. In addition, the system will not alert to stationary objects such as signs, parked cars, etc.

If the vehicle is towing a trailer or has an object such as a bicycle rack attached to the rear of the vehicle, the rear cross traffic alert system may not function properly.

Foul weather may affect the operation of the rear cross traffic alert system. Occasional missed alerts can occur under normal circumstances and will increase in wet conditions. The number of missed alerts will increase with increased rainfall or road spray. Heavy rainfall, as well as mud, dirt, snow, ice, or slush build-up on the rear fascia, can completely disable the system.

Rear Cross Traffic Alert Driver Information Center Messages

REAR CROSS TRAFFIC ALERT OFF

This message indicates that the system has been disabled through the driver information center. Refer to the vehicle owners manual for instructions on how to set personalization options on the driver information center.

SERVICE SIDE DETECTION SYSTEM

This message indicates that the system requires service. Since the side object sensors are also used for side blind zone alert and/or lane change alert, these feature will also be inoperative. Check vehicle for DTCs to determine the cause of this notification.

SIDE DETECTION SYSTEM TEMPORARILY UNAVAILABLE

This message indicates that the system has been temporarily disabled because the sensors are blocked or can otherwise not accurately detect vehicles or objects. Verify there is no damage to rear fascia or there are any bumper stickers that may interfere with the radar signals. Ask the customer if any of the following circumstances that present when the system became unavailable: mud, dirt, snow, ice, or slush build-up on the rear fascia, heavy rainfall, or excessive road spray.

OBJECT DETECTION DESCRIPTION AND OPERATION (WITH FRONT AND REAR PARK ASSIST, UD5)

The parking assist system is designed to identify and notify the driver of an object in the vehicle path when moving forward or reversing at speeds of less than 8 km/h (5 MPH). The distance and location of the object is determined by 8 object sensors: 4 located in the rear bumper and 4 located in the front bumper. The parking assist system will notify the driver using an audible beep signal through the radio.

The parking assist system is made up of the following components:

- Front and rear parking assist control module
- Front object alarm sensors
- Rear object alarm sensors
- Parking assist switch
- Parking assist switch indicator

Front and Rear Parking Assist Control Module

The front and rear parking assist control module provides a reference voltage and a low reference to the 8 object alarm sensors. The front and rear parking assist control module receives individual signals from each of the 8 sensors and determines the location and distance of an object based on these inputs. When an object is detected, the front and rear parking assist control module will send a data message via CAN-Bus to the radio requesting an audible alert.

Object Alarm Sensors

The object alarm sensors are located in the front and rear bumpers of the vehicle. The sensors are used to determine the distance between an object and the bumper. Each sensor emits an ultrasonic frequency which is reflected off any object located in front of or behind the vehicle. These reflections are received by the sensors. The time difference between the emission of the frequency and when the reflection is received is known as sensor echo time, it is used to determine the distance to the object. The sensors report this information to the front and rear parking assist control module.

Parking Assist Switch

The parking assist can be enabled and disabled by pressing the parking assist switch. By engaging the reverse gear the parking assist can also be activated. By subsequently pressing the parking assist switch the parking assist can be disabled again.

Parking Assist Switch Indicator

The indicator in the parking assist switch shows the status of the parking assist. If the lamp is ON, the parking assist is enabled.

Parking Assist Operation

When an object is within the measuring range of the sensor, the ultrasonic pulse is reflected and is received by the sending or a neighboring sensor. The sensor converts this signal into a voltage signal and sends this signal to the parking assist control module. The front and rear parking assist control module evaluates the received sensor signals. As soon as an object is within the measuring range, the front and rear parking assist control module sends a message via CAN-Bus to the radio in order to give out the acoustic distance signal.

The parking assist system can detect objects greater than 7.6 cm (3 in) wide and 25.4 cm (10 in) tall. The system cannot detect objects below the bumper, underneath the vehicle. If an object is detected, one of the following will occur:

- The measuring range of the front object alarm sensors is between 30-120 cm (11.8-47.2 in). From a distance of 120 cm (47.2 in), the acoustic signal is active. The frequency of the beep sound increases with decreasing distance. From a distance less than 30 cm (11.8 in), the sound becomes continuous.
- The measuring range of the rear object alarm sensors is between 30-250 cm (11.8-98.4 in). From a distance of 250 cm (98.4 in), the acoustic signal is active. The frequency of the beep sound increases with decreasing distance. From a distance less than 30 cm (11.8 in), the sound becomes continuous.

The parking assist can be activated and deactivated by pressing the parking assist switch. When REVERSE gear is selected, park assist automatically is engaged for both front and rear sensors. When the vehicle is put into DRIVE from REVERSE the front assist sensors will be active up to speeds of 8 km/h (5 MPH) to assist with parking maneuvers. Once the vehicle is above 8 km/h (5 MPH) the front sensors are disabled and will not be re-enabled until either REVERSE gear is selected or the parking assist switch is pressed to activate the system. Once the parking assist switch is pressed during a key cycle the front sensors become active at speeds under 8 km/h (5 MPH). If the park assist switch is pressed again in the same key cycle the message "Park Assist Off" will be displayed in the driver information center if the vehicle speed is under 8 km/h (5 MPH) and front sensors detect an object within 120 cm (47.2 in). The LED indicator on the parking assist switch provides the ON/OFF state of the system. If the indicator is ON, the system is active and ready to assist.

The front and rear parking assist control module carries out a self test and monitors the sensors for electrical and mechanical faults. Monitored is the power supply of each sensor and the sensor signals, which need to alter when the vehicle moves. If this is not the case, the sensor is acoustically blocked or faulty. Mud, ice and snow may cause obstruction of the function of the sensors. Besides that the front and rear parking assist control module checks whether the correct type of sensor is installed. If any of these tests fails, a DTC with corresponding symptom is set, the parking assist is deactivated and the parking assist indicator in the instrument panel cluster is activated.

Parking Assist System Driver Information Center Messages

SERVICE PARK ASSIST

The driver information center displays SERVICE PARK ASSIST when the front and rear parking assist control module detects a malfunction in the parking assist system and the system is disabled. The driver information center also displays SERVICE PARK ASSIST when a loss of communication occurs with the front and rear parking assist control module.

PARK ASSIST OFF

The PARK ASSIST OFF message is displayed in the driver information center when the parking assist system is disabled due to conditions that disable or inhibit the system. The front and rear parking assist control module requests the driver information center display PARK ASSIST OFF when it detects that one of the following conditions:

- The parking assist system is manually disabled using the parking assist switch.
- An object is attached to the rear of the vehicle, such as a trailer, bicycle rack, trailer hitch receiver, or tow bar. Also, an object extending beyond a lowered tailgate will disable the system.
- The parking assist sensors are covered by snow, mud, dirt, slush, or ice.
- The vehicle bumper is damaged.

- Excessive paint thickness on a replacement parking assist sensor.
- The parking assist sensors are disrupted by vibrations, like those caused by a large nearby vehicle or from heavy equipment such as a jackhammer.

OBJECT DETECTION DESCRIPTION AND OPERATION (WITH REAR PARK ASSIST, UD7)

The ultrasonic parking assist system is designed to identify and notify the driver of an object in the vehicle's path when reversing at speeds of less than 8 km/h (5 MPH). The distance and location of the object is determined by 4 object sensors located in the rear bumper. The parking assist system will notify the driver using an audible beep signal through the radio.

The parking assist system is made up of the following components:

- Parking assist control module
- Rear object alarm sensors
- Parking assist switch
- Parking assist switch indicator

Parking Assist Control Module

The parking assist control module provides an 8 V reference and a low reference to the four object alarm sensors. The parking assist control module receives individual signals from each of the four sensors and determines the location and distance of an object based on these inputs. When an object is detected, the parking assist control module will send a data message via CAN-Bus to the radio requesting an audible alert.

Rear Object Alarm Sensors

The object alarm sensors are located in the rear bumper of the vehicle. The sensors are used to determine the distance between an object and the bumper. Each sensor emits an ultrasonic frequency which is reflected off any object located behind the vehicle. These reflections are received by the sensors. The time difference between the emission of the frequency and when the reflection is received is known as sensor echo time, it is used to determine the distance to the object. The sensors report this information to the parking assist control module.

Parking Assist Switch

The parking assist can be activated and deactivated by pressing the parking assist switch. By engaging the reverse gear the parking assist can also be activated. By subsequently pressing the parking assist switch the parking assist can be disabled again.

Parking Assist Switch Indicator

The indicator in the parking assist switch shows the status of the parking assist. If the lamp is ON, the parking assist is activated.

Rear Parking Assist Operation

When an object is within the measuring range of the sensor, the ultrasonic pulse is reflected and is received by the sending or a neighboring sensor. The sensor converts this signal into a voltage signal and sends this signal to the parking assist control module. The parking assist control module evaluates the received sensor signals. As soon as an object is within the measuring range, the parking assist control module sends a message to the radio in order to give out the acoustic distance signal. If an object is detected within 2.5 m (8 ft) away from the rear bumper, there will be an audible beep out of the speakers. As the vehicle gets closer to an object, the time between the beeps becomes shorter. If the vehicle stops and there is an object within 2.5 m (8 ft) away from the rear bumper the beeping will stop after 5 s. When the distance between the object and the vehicle starts to decrease again the beeping will start again. From a distance less than 30 cm (9.84 in), the sound becomes continuous.

The rear parking assist system can detect objects greater than 7.6 cm (3 in) wide and 25.4 cm (10 in) tall. The system cannot detect objects below the bumper, underneath the vehicle.

The parking assist can be activated and deactivated by pressing the parking assist switch. By engaging the reverse gear the parking assist can also be activated. By subsequently pressing the parking assist switch the parking assist can be disabled again.

The parking assist control module carries out a self test and monitors the sensors for electrical and mechanical faults. Monitored is the power supply of each sensor and the sensor signals, which need to alter when the vehicle moves. If this is not the case, the sensor is acoustically blocked or faulty. Mud, ice and snow may cause obstruction of the function of the sensors. Besides that the parking assist control module checks whether the correct type of sensor is installed. If any of these tests fails, a DTC with corresponding symptom is set, the parking assist is deactivated and the parking assist control module will send a serial data message to display the SERVICE PARK ASSIST message on the driver information center.

Rear Parking Assist System Driver Information Center Messages

SERVICE PARK ASSIST

The driver information center displays SERVICE PARK ASSIST when the parking assist control module detects a malfunction in the rear parking assist system and the system is disabled. The driver information center also displays SERVICE PARK ASSIST when a loss of communication occurs with the parking assist control module.

PARK ASSIST OFF

The PARK ASSIST OFF message is displayed in the driver information center when the parking assist system is disabled due to conditions that disable or inhibit the system. The parking assist control module requests the driver information center display PARK ASSIST OFF when it detects that one of the following conditions:

- The rear parking assist system is manually disabled by the vehicle operator through the parking assist switch or audio system personalization menu.
- An object is attached to the rear of the vehicle, such as a trailer, bicycle rack, trailer hitch receiver, or tow bar. Also, an object extending beyond a lowered endgate will disable the system.
- The parking assist sensors are covered by snow, mud, dirt, slush, or ice.
- The vehicle bumper is damaged.

- Excessive paint thickness on a replacement parking assist sensor.
- The parking assist sensors are disrupted by vibrations, like those caused by a large nearby vehicle or from heavy equipment such as a jackhammer.

ACCESSORIES & EQUIPMENT

Paint and Coatings

SPECIFICATIONS

CLEARCOAT REPAIR SPECIFICATIONS - 3M PRODUCTS

Clearcoat Repair Specifications - 3M Products

Paint Condition	Wet Sanding	Scratch Refinement	Compounding	Rotary Polisher	Dual Action Orbital Polisher	Hand Glazing Polishing
New vehicle prep or fine wheel marks	-	-	-	-	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6-inch Backup Pad P/N 05776 	<ul style="list-style-type: none"> • Perfect-It Wax P/N 39026/395 • Detail Cloth P/N 06016
Swirl marks, water spotting, or light oxidation	-	-	-	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-it Backup Pad P/N 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6-inch 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06066 • Perfect-It 1 Foam DA Pad P/N 05729 • Detail Cloth P/N 06016 • Perfect-It Wax P/N

				05717/18	Backup Pad P/N 05776	39026/395
Overspray or medium oxidation	-	-	<ul style="list-style-type: none"> • Perfect-It III Cleaning Clay P/N 38070 • Perfect-It 3000 Rubbing Compound P/N 06060/62 • Superbuff III Buff Pad P/N 05703/04 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-it Backup Pad P/N 05717/18 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6-inch Backup Pad P/N 05776 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06066 • Perfect-It I Foam DA Pad P/N 05729 • Detail Clo P/N 06016 • Perfect-It Wax P/N 39026/395
Heavy oxidation or minor acid rain pitting	Micro Fine 2000	-	<ul style="list-style-type: none"> • Perfect-It 3000 Rubbing Compound P/N 06060/62 • Superbuff III Buff Pad P/N 05703/04 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-It Backup Pad P/N 05717/18 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6 in Backup Pad P/N 05776 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06066 • Perfect-It I Foam DA Pad P/N 05729 • Detail Clo P/N 06016 • Perfect-It Wax P/N 39026/395
		<ul style="list-style-type: none"> • Trizact Hookit II Foam Disc 6 in 3000 P/N 02075 	<ul style="list-style-type: none"> • Perfect-It 3000 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06066

Dust nibs, minor scratches, or major acid rain pitting	Micro Fine 1500 or 2000	<ul style="list-style-type: none"> • Hookit II Soft Interface Pad 6 in P/N 05274 • Hookit II Painters Disc Pad 6 in P/N 05251 	<ul style="list-style-type: none"> • Rubbing Compound P/N 06060/62 • Superbuff III Buff Pad P/N 05703/04 	<ul style="list-style-type: none"> • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-It Backup Pad P/N 05717/18 	<ul style="list-style-type: none"> • 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6 in Backup Pad P/N 05776 	<ul style="list-style-type: none"> • Perfect-It I Foam DA Pad P/N 05729 • Detail Clo P/N 06016 • Perfect-It Wax P/N 39026/395
Orange peel, paint runs or sags	<ul style="list-style-type: none"> • Hookit II Film Disc 6 in P1200 P/N 00868 • Hookit II Film Disc 6 in P1500 P/N 000850 • Hookit II Painters Disc Pad P/N 05251 	<ul style="list-style-type: none"> • Trizact Hookit II Foam Disc 6 in 3000 P/N 02075 • Hookit II Soft Interface Pad 6 in P/N 05274 • Hookit II Painters Disc Pad 6 in P/N 05251 	<ul style="list-style-type: none"> • Perfect-It 3000 Rubbing Compound P/N 06060/62 • Superbuff III Buff Pad P/N 05703/04 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-It Backup Pad P/N 05717/18 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6 in Backup Pad P/N 05776 	<ul style="list-style-type: none"> • Perfect-It 3000 Swirl Mark Remover P/N 06066 • Perfect-It I Foam DA Pad P/N 05729 • Detail Clo P/N 06016 • Perfect-It Wax P/N 39026/395

INTRODUCTION

BASECOAT/CLEARCOAT PAINT SYSTEMS

WARNING: Exposure to isocyanates during paint preparation and application processes can cause severe breathing problems. Read and follow all of the instructions from the manufacturers of painting materials, equipment, and protective gear.

All paint finish repairs of rigid exterior surfaces must meet GM standards. Refer to the latest revision of the GM

Approved Refinish Materials book to identify the paint systems you may use that have been engineered to meet GM standards. The GM Approved Refinish Materials book supplies all approved products, including volatile organic compound (VOC) compliant regulations recommended by the individual manufacturer, and detailed procedures for materials used in their paint system.

The latest revision of the GM Approved Refinish Materials booklet is located on the Genuine GM Parts website at www.genuinegmparts.com.

ANTI-CORROSION TREATMENT AND REPAIR

WARNING: When applying sound deadeners, or anti-corrosion materials due care and preventative measures must be exercised to prevent any material from being sprayed into door and quarter panel mechanisms such as door locks, window run channels, window regulators and seat belt retractors, as well as any moving or rotating mechanical or suspension parts on the underbody, particularly the parking brake cable. After material application, be sure that all body drain holes are open. Improper application may increase chance of corrosion damage or limit the operation of moving parts, resulting in personal injury.

Any procedure that disturbs these special treatments, such as panel replacement or collision damage repair operations, may leave the metal unprotected and result in corrosion. Proper recoating of these surfaces with service-type anti-corrosion material is essential.

After repair and/or replacement parts are installed, all accessible bare metal surfaces must be treated with metal conditioner and reprimed. Refer to the GM Approved Refinish Materials book which identifies the paint systems you may use.

The latest revision of the GM Approved Refinish Materials booklet is located on the GM Genuine Parts website at www.genuinegmparts.com.

After a collision, some vehicle structure areas such as frame rails, cross-members and rocker panel sections may need to be repaired. In most cases, the anti-corrosion materials need to be removed to perform these repairs. These materials are classified into two types: Closed Cavity coatings and Undercoat coatings. The primary difference is the way the products set up or "dry". Both are intended to protect the surface they are applied to from corrosion caused by water, salt water or Magnesium Chloride blended de-icing compounds used to thaw icy winter roads. They also can provide a measure of sound deadening.

The Closed Cavity coatings remain sticky to the touch and will seep into seams initially and over extended periods of time. Closed Cavity coatings provide the best corrosion protection inside of rocker panel sections, pillar sections, frame rails, cross-members, doors, rear compartment lids and closed areas of hoods - anywhere that is concealed or closed off to exterior surfaces.

The Undercoat coatings are "dry to the touch" and offer the best corrosion protection and sound deadening for floor pans, wheelhouses, inside rear compartment and underhood areas - anywhere the coated surface is exposed.

Below is a listing of Undercoat coatings and Closed Cavity coatings that GM believes to be reliable. While others may exist, we have found these products, or equivalents to them, can be used with satisfactory results. Always use these products according to their manufacturer's recommendations.

Undercoating and Closed Cavity Coatings

The following products are available from *Automotive International/Valugard. Contact them at 1-800-543-7156, or at www.valugard.net

Stock number	Type	Description
VG-104	WAX/SOLVENT BASED UNDERCOAT	Traditional Wax/Solvent based Undercoating available in aerosol or spray gun canister Meets OE specifications for corrosion resistance
VG-076M	HYBRID (SOLV./WATER) UNDERCOAT	Meets OE specifications for corrosion resistance
VG-140	WATER BASED UNDERCOAT	Meets OE specifications for corrosion resistance
VG-101	WAX BASED CLOSED CAVITY COATING	Meets OE specifications for corrosion resistance
VG-UCG	CANISTER UNDERCOATING GUN	High quality undercoating gun uses canister packaging of undercoating
VG-CRG	CANISTER CLOSED CAVITY COATING GUN	High quality closed cavity coating gun uses canister packaging of coating and comes with 30 in inner panel application tube with nozzle

The following products are available through your local *3M® distributor. Information about 3M® product retailers in your area may be obtained at 1-866-364-3577 or at www.mmm.com/automotive.

Stock number	Type	Description
08804	No Cleanup Water-Based Undercoating - Black	Coarse texture SBR rubber and acrylic applied with 3M No-Cleanup Gun 08801
08964	No Cleanup Undercoating - Black	Smooth texture SBR rubber applied with 3M No-Cleanup Gun 08801
08881	16 oz aerosol Undercoating	Calcium Carbonate and asphalt based undercoating
08882	17 oz aerosol Underseal™ Undercoating - Black	Rubber based, paintable undercoating
08883	19.7 oz aerosol Rubberized Undercoating - Black	Synthetic polymer based undercoating
08891	Rust Fighter - 1 Amber Closed Cavity Coating - quart canister	Synthetic Resin remains tacky seeps into crevices; Applied with 3M Applicator Gun 08997 and Application Wand 08998
08892	Rust Fighter - 1 Amber Closed Cavity Coating - 24 oz aerosol	Synthetic Resin remains tacky seeps into crevices; aerosol can
08801	No Cleanup Undercoating Gun	-

The following products are available from *Crest Industries, Inc. at 1-800-822-4100 or www.crestauto.com.

Stock number	Type	Description
AH-C	HONEY COAT/WAX BASED CLOSED CAVITY COATING	16.5 OZ AEROSOL CAN AMBER COLORED SEEPS INTO CREVICES AND REMAINS PLIABLE 36 in spray wand with 360 degree nozzle available (WA-HC)
BZ-BAC BZ-BACB	AMBER COAT/WAX BASED CLOSED CAVITY COATING	GALLON - AMBER COLORED (BZ-BAC) OR BLACK (BZ-BACB) SEEPS INTO CREVICES AND REMAINS PLIABLE APPLIED WITH WZ-GRP GUN AND SIPHON HOSE Flexible spray wand also available (WA-ND)
AC-R	RUBBER COAT/RUBBER BASED UNDERCOATING, PAINTABLE	17.75 OZ AEROSOL
AR-C	SUPER RUBBER COAT/LOW V.O.C. RUBBER BASED UNDERCOATING, PAINTABLE	17.75 OZ AEROSOL
BA-C	AUTO COAT/RUBBER BASED UNDERCOATING, PAINTABLE	28.7 FL OZ CONE-TOP CAN AND GALLON APPLIED WITH GU-C UNDERCOATING GUN
GU-C	UNDERCOATING GUN	ATTACHES TO BA-C CONE-TOP CAN
WZ-GRP	GUN AND SIPHON HOSE	USED WITH BZ-BAC AND BZ-BACB
WA-ND	FLEXIBLE SPRAY WAND	USED WITH WZ-GRP

The following products are available from *Kent Automotive. Contact them at 1-888-YES-KENT (888-937-5368) or at www.kent-automotive.com.

Stock number	Type	Description
P60305	Wax Based Inner Panel Rustproofer - CLOSED CAVITY COATING	24 oz Aerosol (can apply with 36 in wand and 360 degree nozzle kit)
KT14912	Rubber Guard Low VOC Rubber Based Undercoating	24 oz Aerosol (can apply with 36 in wand and 360 degree nozzle kit)
KT14725	Aerosol Extension Wand Kit	36 in wand and 360 degree nozzle
KT14796	Rubber Guard Low VOC Rubber Based Undercoating	QUART - Applied with undercoating gun
P30025	Siphon Feed Gun	-
P86079	360 Degree Wand for siphon feed gun	-

Weld Thru Coating

Part Number	Description
4353	Weld-Through Primer

*We believe these sources and their products to be reliable. There may be additional manufacturers of such material. General Motors does not endorse, indicate any preference for or assume any responsibility for the

products from these firms or for any such items which may be available from other sources.

Seam Sealers

Sealers are intended to prevent water and dust from entering the vehicle and also are anti-corrosion barriers. Sealers are applied to such areas as rear compartment lid hem flanges, wheelhouse, quarter outer, floor, cowl, roof, and various other panel to panel attaching points. The originally sealed joints are obvious and any damage to these sealed locations should be corrected by resealing. Attaching points of new replacement panels should be resealed. Replacement lids and doors will also require sealing in the hem flange areas.

Flanged joints, overlap joints, and seams should be sealed using a quality sealer of medium-bodied consistency. The sealer used must retain its flexible characteristics after curing and be paintable.

Open joints which require bridging of the sealer in order to close a gap should be sealed using a heavy-bodied caulking material. Follow the label directions for the material selected.

Color application may be required in order to restore repaired areas such as hood, fenders, doors, quarters, lid, roof, engine compartment, underbody, and inner panels to original appearance. When this is necessary, conventional refinishing preparation, undercoat buildup, and color application techniques should be followed.

Deadener materials, spray-on type, are used on various metal panels in order to provide corrosion resistance and joint sealing. They control the general noise level inside the passenger area of the vehicle. When deadeners are disturbed because of damage, are removed during repair operations, or a new replacement panel is installed, the deadener material must be replaced by a service equivalent material. The application pattern and location of deadener materials can be determined by observing the original production installation.

Cleaning of the interior and underbody panel surfaces is necessary when original galvanized or other anti-corrosion materials have been burned off during welding or heating operations. Removal of the residue from burning will require additional care in such areas as interior surfaces of box-type construction and when configurations of the metal panels limit access to interior surfaces.

PAINT IDENTIFICATION

WARNING: Exposure to isocyanates during paint preparation and application processes can cause severe breathing problems. Read and follow all of the instructions from the manufacturers of painting materials, equipment, and protective gear.

NOTE: Always refer to the GM Approved Refinish Materials book . This book identifies the paint systems you may use.

The latest revision of the GM Approved Refinish Materials booklet is located on the Goodwrench website at www.gmgoodwrench.com.

Use the service parts identification label to identify the type of paint technology, paint codes, trim level, and any special order paint colors on the vehicle. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .

REPAIR INSTRUCTIONS

CLEARCOAT REPAIR WITHOUT REPAINTING

Repair Procedure

1. Thoroughly wash the repair area with Liquid Wash and Wax GM P/N 1052870 or the equivalent.
2. Environmental damage may be corrected. Refer to **Environmental Fallout (Acid Rain)**, or **Rail Dust Damage Repair**.

IMPORTANT: Follow all of the instructions from the manufacturer of the polishing material.

3. Use a paint gauge before, during, and after sanding and/or polishing, to avoid removing too much clearcoat. Refer to **Paint Gauges**.

ENVIRONMENTAL FALLOUT (ACID RAIN)

CAUTION: Refer to Clearcoat/Ultraviolet Screeners Caution .

NOTE: Always refer to the manufacturer's packaged instructions for the detailed procedures of materials used for compounding and/or polishing.

Since the severity of the condition varies from area to area, proper diagnosis of the contamination extent is critical to the success of the repairs. Perform the diagnosis under high intensity fluorescent lighting on the horizontal surfaces (hood, roof panel, rear compartment lid), after the surfaces have been properly cleaned by washing the vehicle with GM Wash and Wax GM P/N 1237841 (Canadian P/N 10953203), or equivalent.

There are 3 basic types of acid rain damage:

Surface Level Contamination

May be repaired by simply washing the vehicle, cleaning the surface with a silicone wax and grease remover, neutralizing acidic residue, and finesse polishing-Refer to Surface Level Contamination Repair.

Clearcoat Etching

Slight etching is still noticeable after the above washing and finesse polishing procedure. Refer to Slight Clearcoat Damage - Wet Sanding, Finesse Polishing.

Basecoat Etching

Severe etching beyond the clearcoat into the basecoat in the affected areas will require refinishing. Refer to **Basecoat/Clearcoat Paint Systems**.

Surface Level Contamination Repair

1. Thoroughly wash and dry the contaminated area with GM Wash and Wax GM P/N 1237841 (Canadian P/N 10953203), or equivalent.
2. Clean the affected area with silicone, wax and grease remover.
3. Remove and neutralize acidic residue by cleaning the contaminated areas with a mixture of baking soda and water (1 tablespoon of baking soda per 1 liter or 1 quart of water). Rinse thoroughly and dry the panel completely.
4. Apply finesse-type polish with a foam panel. If damage has been repaired, remove any swirl marks with a dual action orbital polisher and foam pad. Refer to **Clearcoat Repair Specifications - 3M Products**.
5. If some damage remains, refer to Slight Clearcoat Damage - Wet Sanding, Finesse Polishing.

Slight Clearcoat Damage - Wet Sanding, Finesse Polishing

1. Select a small contaminated test area.
2. Film thickness should be taken prior to the sanding and polishing. Refer to **Paint Gauges**.
3. Wet sand and finesse polish the contaminated test area. Refer to **Clearcoat Repair Specifications - 3M Products**. If during the polishing you suspect or observe that etching has penetrated into the basecoat, too much clearcoat has been removed during sanding, or base color is transferred to the polishing pad during polishing, then the affected areas will require refinishing. Refer to **Basecoat/Clearcoat Paint Systems**.

PAINT GAUGES

Paint thickness gauges measure the total thickness of the vehicle finish. It is important to accurately measure the thickness of the finish on each vehicle as the thickness of the finish will vary on each vehicle. Use a paint gauge before the sanding process in order to accurately measure how much finish there is to remove before, during, and after the sanding process. Paint gauges range from magnetic pull type to sophisticated electronic types, and are available from a variety of sources. The older magnetic type gauges, at best have a 5 percent accuracy range and are not sensitive enough to detect removal of 0.02 mm 0.5 mil (0.0005 in) clearcoat. The newer type magnetic gauges have improved accuracy ranges. Most gauges are confined to checking either ferrous metal, steel, non-ferrous metal, or aluminum panel. At this time, there are no viable gauges for reading film thickness on composite (SCM doors, RIM fenders) panels. The more sophisticated (ETG) electronic paint thickness gauges digital type gauges are able to read film thickness on both ferrous and non-ferrous metal panel. Digital ETG gauges may have an accuracy range of 1 percent and include thickness standards for recalibration. The following paint thickness gauges are available. Call 1-800-GM-TOOLS for information:

Paint Thickness Gauges

- 147-5437-ETG Standard model
- 147-5437-ETG-P Standard model with print option
- 147-5437-N-ETG-N Non-ferrous model for aluminum panels
- 147-5437-NP-ETG-NP Non-ferrous model with print option
- 147-54437-SD-ETG Steel and aluminum gauge

CLEARCOAT THICKNESS

The clearcoat on the vehicle is typically 0.059-0.078 mm (1.5-2 mils [0.0015-0.0020 in]) thick. The clearcoat contains ultraviolet screeners. Removing more than 0.5 mils (0.019 in) of the clearcoat may result in early paint failure.

RAIL DUST DAMAGE REPAIR

WARNING: Refer to Eye Protection Warning .

NOTE: If rail dust has penetrated into the basecoat, the panel requires refinishing. Ensure all the rail dust has been removed prior to refinishing or the rust spots will return.

Rail dust damage comes from the tiny iron particles produced from the friction between the train wheels and the track. It can also be deposited on vehicles if stored near any operation producing iron dust (i.e., steel ore yards). This dust can either lay on top of, or embed into the paint surface. It is usually diagnosed as bumps in the paint surface or rust colored spots in the paint.

1. Move the vehicle to a cool shaded area and ensure the vehicle surfaces are cool during the removal process.
2. Thoroughly wash the repair area with Liquid Wash and Wax GM P/N 1052870, or equivalent.
3. Wipe the area dry.
4. Clean the affected area with silicone, wax and grease remover.
5. Perform the removal process according to the manufacturer's directions of the type of repair material used (Gel Type Oxalic Acid or Clay Type Non-Acid Based). If, upon inspection, some particles are still present, the process may be repeated. If the damage has been repaired, complete the repair to the entire panel.
6. Polish the entire panel after the removal process. Refer to Clearcoat Repair Specifications - 3M Products. If small pits remain in the clearcoat after all of the damage has been repaired, refer to Clearcoat Repair without Repainting.

GENERAL INFORMATION

Parasitic Load Explanation & Test Procedures

*** PLEASE READ THIS FIRST ***

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

GENERAL INFORMATION

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

The term Parasitic Load refers to electrical devices that continue to use or draw current after the ignition switch is turned to OFF position. This small amount of continuous battery draw is expressed in milliamps (mA). On Chrysler vehicles, a typical Parasitic Load should be no more than 30 milliamps (0.030 amps). On Ford Motor Co. and General Motors vehicles produced after 1980, a typical Parasitic Load should be no more than 50 milliamps (0.050 amps).

Vehicles produced since 1980 have memory devices that draw current with ignition off for as long as 20 minutes before shutting down the Parasitic Drain. When Parasitic Load exceeds normal specifications, the vehicle may exhibit dead battery and no-start condition.

Follow test procedure for checking Parasitic Loads to completion. A brief overview of a suggested test procedure is included along with some typical Parasitic Load specifications. Refer to GENERAL MOTORS PARASITIC LOAD TABLE chart.

TESTING FOR PARASITIC LOAD

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

CAUTION: Always turn ignition off when connecting or disconnecting battery cables, battery chargers or jumper cables. **DO NOT** turn test switch to OFF position (which causes current to run through ammeter or vehicle electrical system).

NOTE: Memory functions of various accessories must be reset after the battery is reconnected.

The battery circuit must be opened to connect test switch (shunt) and ammeter into the circuit. When a battery

cable is removed, timer circuits within the vehicle computer are interrupted and immediately begin to discharge. If in doubt about the condition of the ammeter fuse, test it with an ohmmeter prior to beginning test. An open fuse will show the same reading (00.00) as no parasitic drain. Begin test sequence with the meter installed and on the 10-amp scale. Select lower scale to read parasitic draw.

CHRYSLER IGNITION OFF DRAW (IOD) TEST

To test for excessive IOD, verify that all electrical accessories are OFF. Turn off all lights, remove ignition key, and close all doors and decklid. If the vehicle is equipped with electronic accessories (illuminated entry, automatic load leveler, body computer, or high line radio), allow the system to automatically shut off (time out), up to 3 minutes.

1. Raise the hood and disconnect both battery cables, negative first.

CAUTION: IOD greater than 3 amps may damage milliammeter.

2. Reconnect the negative cable and connect a typical 12-volt test light (low wattage bulb) between the positive cable clamp and the positive battery post. Remove the engine compartment lamp bulb. If the test light does not light, proceed to step 3. If the test light does light, proceed to step 4. The test light will indicate IOD greater than 3 amps. After higher amperage IOD has been corrected, proceed to step 3.
3. With 12-volt test light still connected (not lit), connect an ammeter (milliampere scale) between the positive cable clamp and the positive battery post, disconnect test light, refer to instructions provided with ammeter being used. A reading of 30 milliamperes or less indicates normal electrical draw. If ammeter reads more than 30 milliamperes, excessive IOD must be corrected.
4. Locate the fuse panel and remove fuses or circuit breakers one at a time, and observe ammeter after each fuse or circuit breaker is removed. If test light goes out and the reading drops below 30 milliamperes when a certain fuse or circuit breaker is removed, that circuit may have a defect.
5. If IOD is detected after all fuses and circuit breakers have been removed, disconnect the 60-way connector at the Single Module Engine Control (SMEC), located outboard of the battery.
6. If excessive IOD is detected after all fused circuits and SMEC have been verified, disconnect the B+ terminal from the alternator. If reading drops below 30 milliamperes, reinstall all fuses and circuit breakers, reconnect B+ terminal at alternator, reconnect battery, and perform alternator diagnostics.
7. Install engine compartment lamp bulb.

TEST PROCEDURE USING TEST SWITCH

1. Turn ignition off. Remove negative battery terminal cable. Install Disconnect Tool (J-38758) test switch male end to negative battery cable. Turn test switch knob to OFF position (current through meter). Install negative battery cable to the female end of test switch.
2. Turn test switch knob to ON position (current through switch). Road test vehicle with vehicle accessories on (radio, air conditioner, etc). After road test, turn ignition switch to LOCKED position and remove key. Connect ammeter terminals to test switch terminals. See **Fig. 1**. Select 10-amp scale.
3. Turn off all electrical accessories. Turn off interior lights, underhood lamp, trunk light, illuminated entry, etc. To avoid damaging ammeter or obtaining a false meter reading, all accessories must be off before

turning test switch knob to OFF position.

4. Turn test switch knob to OFF position to allow current to flow through ammeter. If meter reads wrong polarity, turn test switch to ON position and reverse leads. Turn test switch to OFF position. Observe current reading. If reading is less than 2 amps, turn test switch to ON position to keep electrical circuits powered-up.
5. Select low amp scale. Switch lead to the correct meter position. Turn test switch to OFF position and compare results to normal current draw. See **GENERAL MOTORS PARASITIC LOAD TABLE (MILLIAMPS)**. If current draw is unusually high for the vehicle's overall electrical system, remove system fuses one at a time until current draw returns to normal.
6. Turn test switch to ON position each time door is opened or fuse is removed. Turn switch to OFF position to read current draw value through meter. When the cause of excessive current drain has been located and repaired, remove test switch and reconnect negative battery cable to the negative battery terminal.

INTERMITTENT PARASITIC LOAD PROBLEMS

Intermittent parasitic load can occur because of a memory device that does not power down with ignition off. With an intermittent parasitic load, battery draw can be greater than 1.0 amp.

To find an intermittent problem requires that an ammeter and Disconnect Tool (J-38758) test switch be connected and left in the circuit. See **Fig. 1**. Road test vehicle. After road test, turn ignition off and remove key.

Monitor the milliamps scale for 15-20 minutes after ignition is turned off. This allows monitoring memory devices to determine if they time out and stop drawing memory current. The test switch is needed to protect ammeter when the vehicle is started.

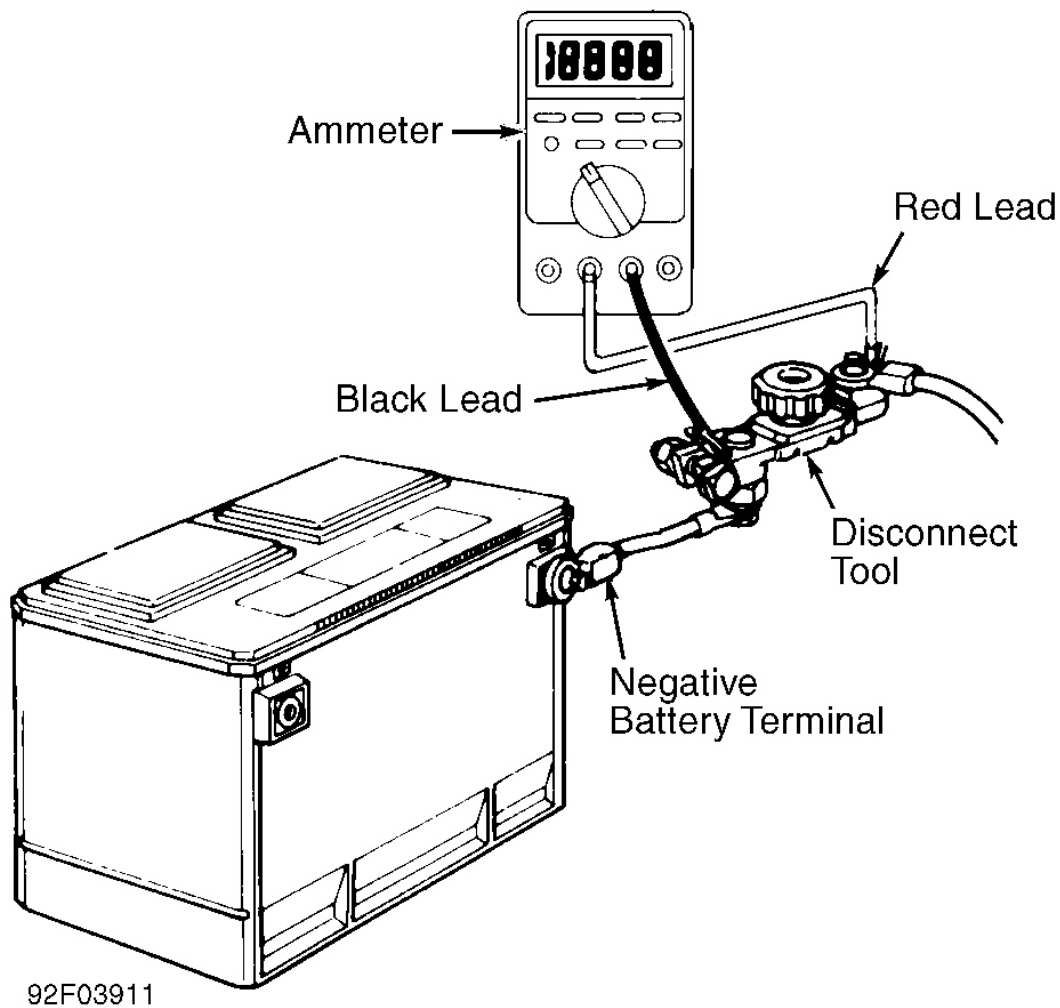


Fig. 1: Connecting Kent-Moore Disconnect Tool (J-38758)
 Courtesy of GENERAL MOTORS CORP.

GENERAL MOTORS PARASITIC LOAD

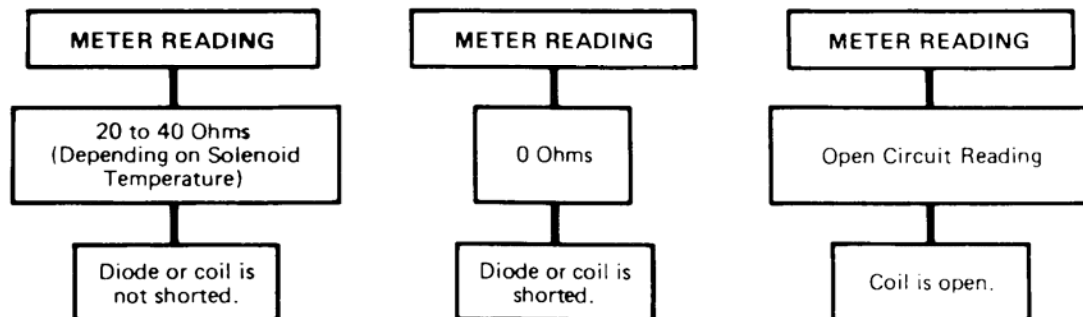
Component	Normal Draw	Maximum Draw	Time-Out (Minutes)
Anti-Theft System	0.4	1.0	.....
Auto Door Lock	1.0	1.0	.....
Body Control Module	3.6	12.4	20
Central Processing System	1.6	2.7	20
Electronic Control Module	5.6	10.0	.....
Electronic Level Control	2.0	3.3	20
Heated Windshield	0.3	0.4	.....

Module			
HVAC Power Module	1.0	1.0	.....
Illuminated Entry	1.0	1.0	1
Light Control Module	0.5	1.0	.....
Oil Level Module	0.1	0.1	.....
Multi-Function Chime	1.0	1.0	.....
Pass Key Decoder Module	0.75	1.0	.....
Power Control Module	5.0	7.0	.....
Retained Accessory Power	3.8	3.8	.....
Radio	7.0	8.0	15
Twilight Sentinel Module	1.0	1.0	.....
Voltage Regulator	1.4	2.0	.....

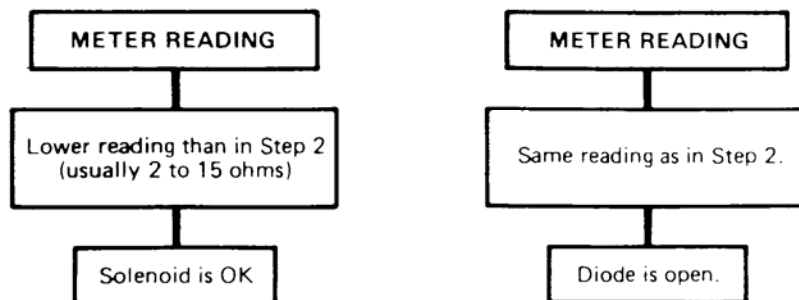
DIODE CHECK & SOLENOID TEST

Step 1) Select the X1 SCALE and zero the needle.

Step 2) Attach the POSITIVE SOLENOID LEAD (Red lead) to the POSITIVE METER LEAD and the NEGATIVE SOLENOID LEAD (Black lead) to the NEGATIVE METER LEAD.



Step 3) Reverse the solenoid lead attachments.



92H03912

Fig. 2: Diode Check & Solenoid Test
Courtesy of GENERAL MOTORS CORP.

QUAD DRIVER TEST

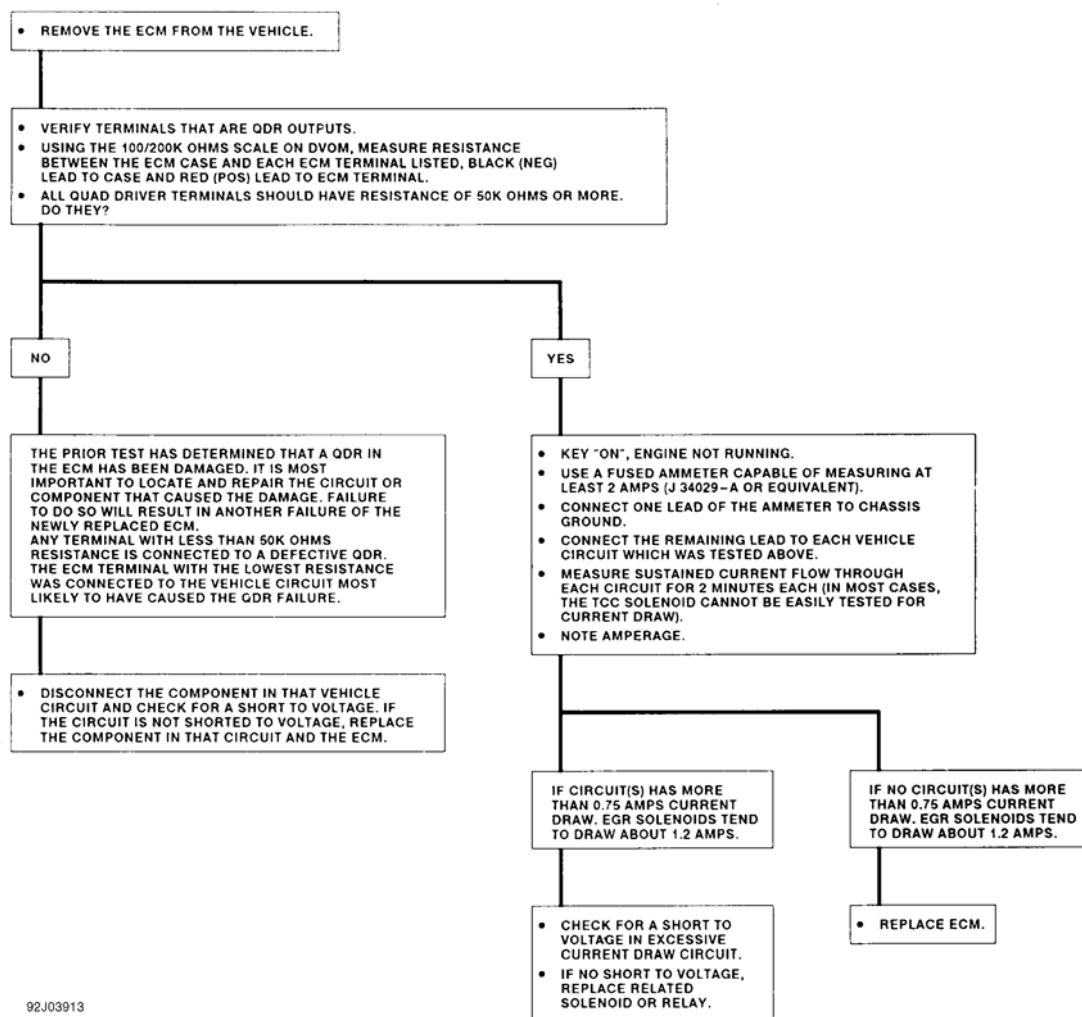


Fig. 3: Quad Driver Test

Courtesy of GENERAL MOTORS CORP.

BRAKES

Parking Brake

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Electronic Parking Brake Control Module Nut	10 N.m	89 lb in
Electronic Parking Brake Rear Cable Nut	6 N.m	53 lb in

SCHEMATIC WIRING DIAGRAMS

PARK BRAKE SYSTEM WIRING SCHEMATICS

Parking Brake

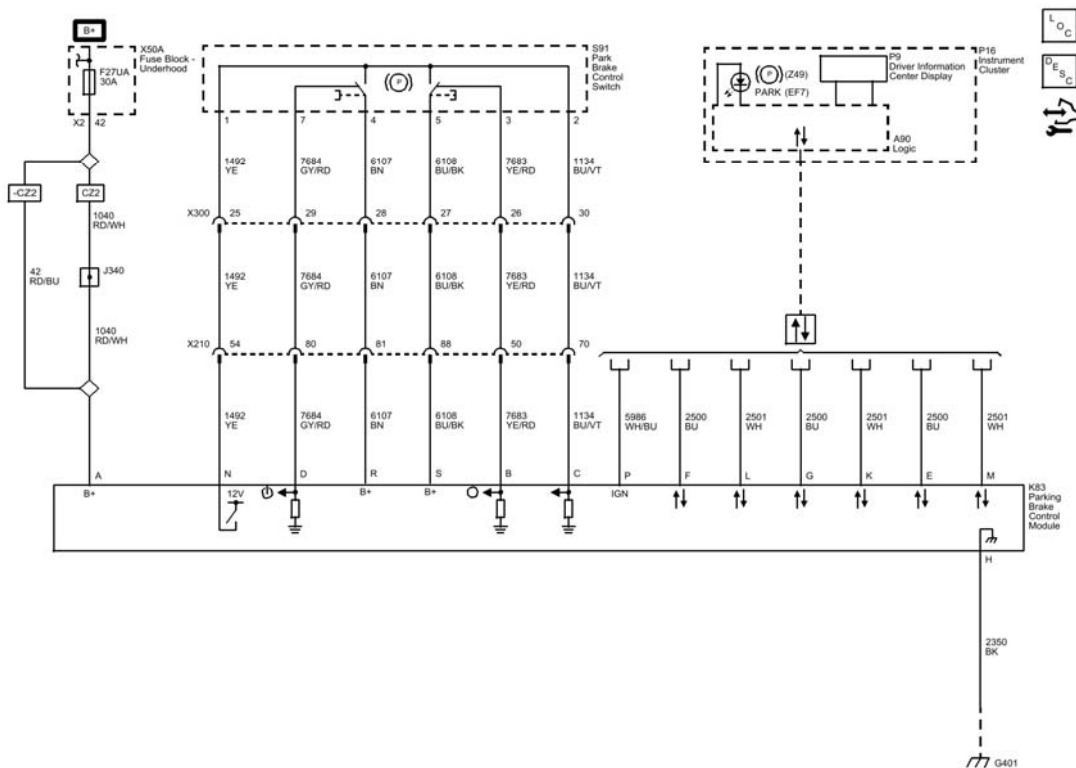


Fig. 1: Parking Brake

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC C028A, C028B, or C028F</u>	DTC C028A 00 Park Brake Motor Circuit Malfunction DTC C028A 01 Park Brake Motor Circuit Short to Battery DTC C028A 02 Park Brake Motor Circuit Short to Ground DTC C028A 04 Park Brake Motor Circuit Open Circuit DTC C028A 05 Park Brake Motor Circuit Short to Battery or Open Circuit DTC C028A 08 Park Brake Motor Circuit Performance - Signal Invalid DTC C028A 28 Park Brake Motor Circuit Performance - Incorrect Frequency DTC C028A 61 Park Brake Motor Circuit Actuator Stuck DTC C028B 08 Park Brake Motor Position Sensor Signal Performance - Signal Invalid DTC C028B 26 Park Brake Motor Position Sensor Signal Low Frequency DTC C028B 29 Park Brake Motor Position Sensor Signal Too Few Pulses DTC C028B 2A Park Brake Motor Position Sensor Signal Too Many Pulses DTC C028F 01 Park Brake Solenoid Actuator Circuit Short to Battery DTC C028F 02 Park Brake Solenoid Actuator Circuit Short to Ground DTC C028F 08 Park Brake Solenoid Actuator Circuit Performance - Signal Invalid
<u>DTC C027D or C028D</u>	DTC C027D 64 Park Brake Slip Detected DTC C028D 00 Replace Park Brake Pad
<u>DTC C0293</u>	DTC C0293 00 Park Brake Switch Malfunction DTC C0293 01 Park Brake Switch Short to Battery DTC C0293 02 Park Brake Switch Short to Ground DTC C0293 04 Park Brake Switch Open DTC C0293 06 Park Brake Switch Low Voltage/Open DTC C0293 08 Park Brake Switch Performance - Signal Invalid
<u>DTC C0298</u>	DTC C0298 00 Park Brake Unlatch Switch Circuit Malfunction DTC C0298 01 Park Brake Unlatch Switch Circuit Short to Battery DTC C0298 02 Park Brake Unlatch Switch Circuit Short to Ground DTC C0298 04 Park Brake Unlatch Switch Circuit Open DTC C0298 08 Park Brake Unlatch Switch Circuit Performance - Signal Invalid
<u>DTC C0558</u>	DTC C0558 55 Calibration Data Too Few Transitions DTC C0558 5A Calibration Data Not Plausible
<u>DTC C0561</u>	DTC C0561 71 System Disabled Information Stored Invalid Data
<u>DTC C056D</u>	DTC C056D 00 Electronic Control Unit Hardware Malfunction DTC C056D 34 Electronic Control Unit Hardware RAM Malfunction DTC C056D 35 Electronic Control Unit Hardware ROM Malfunction DTC C056D 36 Electronic Control Unit Hardware EEPROM Performance/Malfunction DTC C056D 37 Electronic Control Unit Hardware Software Malfunction

	DTC C056D 38 Electronic Control Unit Hardware Supervision Software Malfunction DTC C056D 39 Electronic Control Unit Hardware Internal Malfunction DTC C056D 3B Electronic Control Unit Hardware Internal Self - Test Malfunction DTC C056D 3C Electronic Control Unit Hardware Internal Communication Malfunction
<u>DTC C056E</u>	DTC C056E 41 Electronic Control Unit Software Not Programmed DTC C056E 42 Electronic Control Unit Software Calibration Not Programmed DTC C056E 47 Electronic Control Unit Software VIN Not Programmed DTC C056E 5A Electronic Control Unit Software Not Plausible DTC C056E 71 Electronic Control Unit Software Invalid Data
<u>DTC C0574</u>	DTC C0574 00 Printed Circuit Board Temperature Sensor Malfunction DTC C0574 01 Printed Circuit Board Temperature Sensor Short to Battery DTC C0574 02 Printed Circuit Board Temperature Sensor Short to Ground DTC C0574 54 Printed Circuit Board Temperature Sensor High

DTC C028A, C028B, OR C028F: PARK BRAKE MOTOR/PARK BRAKE SOLENOID ACTUATOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C028A 00

Park Brake Motor Circuit Malfunction

DTC C028A 01

Park Brake Motor Circuit Short to Battery

DTC C028A 02

Park Brake Motor Circuit Short to Ground

DTC C028A 04

Park Brake Motor Circuit Open Circuit

DTC C028A 05

Park Brake Motor Circuit Short to Battery or Open Circuit

DTC C028A 08

Park Brake Motor Circuit Performance - Signal Invalid

DTC C028A 28

Park Brake Motor Circuit Performance - Incorrect Frequency

DTC C028A 61

Park Brake Motor Circuit Actuator Stuck

DTC C028B 08

Park Brake Motor Position Sensor Signal Performance - Signal Invalid

DTC C028B 26

Park Brake Motor Position Sensor Signal Low Frequency

DTC C028B 29

Park Brake Motor Position Sensor Signal Too Few Pulses

DTC C028B 2A

Park Brake Motor Position Sensor Signal Too Many Pulses

DTC C028F 01

Park Brake Solenoid Actuator Circuit Short to Battery

DTC C028F 02

Park Brake Solenoid Actuator Circuit Short to Ground

DTC C028F 08

Park Brake Solenoid Actuator Circuit Performance - Signal Invalid

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the parking brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch, the internal circuit board temperature is checked to verify it is within operating range before the control module performs the requested operation.

The parking brake control module will diagnose the internal park brake motor circuit to verify it is functioning properly. The park brake motor circuit is used to command motor operation, apply and release tension on the parking brake cable, which will apply and release the parking brake. The park brake will self diagnose the internal park brake motor circuit. This circuit is used to drive the motor, which pulls on the park brake cable, ultimately applying and releasing the park brake.

The parking brake control module contains an internal park brake motor position sensor which monitors the park brake motor position. The parking brake control module contains an internal park brake solenoid actuator, and performs diagnostics on the solenoid actuator circuitry to verify it is functioning properly.

Conditions for Running the DTC

- Ignition OFF, ACCESSORY, or RUN mode.
- Battery voltage is between 9 - 16 V

Conditions for Setting the DTC

DTC C028A

The parking brake control module detects an internal motor malfunction.

DTC C028B

The parking brake control module detects an internal motor position sensor signal malfunction.

DTC C028F

The parking brake control module detects an internal park brake solenoid malfunction.

Action Taken When the DTC Sets

DTC C028A

- The parking brake is disabled.
- A message and/or a warning indicator may be displayed.

DTC C028B

- The parking brake is disabled, one release allowed.
- A message and/or a warning indicator may be displayed.

OR

- The parking brake functionality is degraded.
- A message and/or a warning indicator may be displayed.

DTC C028F

- The parking brake is disabled, one release allowed.
- A message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The parking brake control module will clear the DTC after 40 consecutive ignition on/off cycles with at least one test pass in each ignition cycle and no test fail result.
- The condition for the DTC is no longer present.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C028A, C028B, or C028F is not set.
 - **If any of the DTCs are set**
 1. Program the K83 Parking Brake Control Module. Refer to **Electronic Parking Brake Control Module Programming and Setup** .
 2. Ignition ON.
 3. Apply and release the park brake.
 4. Verify the DTC is not set.

- If the DTC is set, replace the K83 Parking Brake Control Module.
- If the DTC is not set
- 5. All OK.
 - **If none of the DTC are set**
- 3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for parking brake control module replacement, programming and setup.

DTC C027D OR C028D: PARK BRAKE SLIP/PARK BRAKE PAD

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C027D 64

Park Brake Slip Detected

DTC C028D 00

Replace Park Brake Pad

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the park brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch, the internal circuit board temperature is checked to verify it is within operating range before the parking brake control module performs the requested operation. The parking brake control module checks for rear wheel speeds after applying the parking brake to check for mechanical faults.

Conditions for Running the DTC

Ignition OFF, ACCESSORY, or RUN mode.

Conditions for Setting the DTC

C027D 64

The parking brake control module has detected wheel speed on the rear wheels with the parking brake applied.

C028D 00

The parking brake control module has an internal counter which keeps track of dynamic applies. When the counter reaches the threshold value this DTC will set.

Action Taken When the DTC Sets

A message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The parking brake control module will clear the DTC after 100 consecutive ignition on/off cycles with at least one test pass in each ignition cycle and no test fail result.
- Adjust or replace the park brake pads.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no additional DTCs are set in other control modules.

- **If additional DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no additional DTCs are set**

3. Verify that DTC C027D or C028D is not set.

- **If the DTC is set**

1. Verify the park brake cable is connected properly. Refer to **Park Brake System Diagnosis**
2. Check park brake pads for excessive wear. Refer to **Disc Brake System Diagnosis**
3. Program the K83 Parking Brake Control Module. Refer to **Electronic Parking Brake Control Module Programming and Setup** .
4. Ignition ON. Apply and release the park brake.
5. Verify the DTC is not set.
 - If the DTC is set, replace the K83 Parking Brake Control Module.
 - If the DTC is not set

6. All OK.

- **If the DTC is not set**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for parking brake control module replacement, programming and setup.

DTC C0293: PARK BRAKE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C0293 00

Park Brake Switch Malfunction

DTC C0293 01

Park Brake Switch Short to Battery

DTC C0293 02

Park Brake Switch Short to Ground

DTC C0293 04

Park Brake Switch Open

DTC C0293 06

Park Brake Switch Low Voltage/Open

DTC C0293 08

Park Brake Switch Performance - Signal Invalid

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Terminal 1	C0293 02 C0293 06	C0293 04 C0293 06	C0293 01	C0293 00 C0293 08
B+ Terminal 4	C0293 02 C0293 06	C0293 04 C0293 06	C0293 01	C0293 00 C0293 08
B+ Terminal 5	C0293 02 C0293 06	C0293 04 C0293 06	C0293 01	C0293 00 C0293 08
Signal Terminal 2	C0293 02 C0293 06	C0293 04 C0293 06	C0293 01	C0293 00 C0293 08
Signal Terminal 3	C0293 02 C0293 06	C0293 04 C0293 06	C0293 01	C0293 00 C0293 08
Signal Terminal 7	C0293 02 C0293 06	C0293 04 C0293 06	C0293 01	C0293 00 C0293 08

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the parking brake when commanded by the park brake control switch. The parking brake control module will perform diagnostics on the park brake control switch and its wiring harness to verify it is functioning properly. When the parking brake control module receives a signal from the switch the internal circuit board temperature is checked to verify it is within operating range before the control module performs the requested operation.

The park brake switch control diagnostic checks for failure conditions in the park brake switch and associated wiring into the parking brake control module.

Conditions for Running the DTC

Ignition OFF, ACCESSORY, or RUN mode.

Conditions for Setting the DTC

The parking brake control module detects a short to battery, short to ground, open circuit, or an internal parking brake switch malfunction. The parking brake control module detects the apply or release button was activated for more than 90 seconds.

Action Taken When the DTC Sets

- The parking brake is disabled.
- A message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The parking brake control module will clear the DTC after 40 consecutive ignition on/off cycles with at least one test pass in each ignition cycle and no test fail result.
- The condition for the DTC is no longer present.
- The park brake control switch button is INACTIVE using the scan tool without the switch being activated.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Park Brake Status parameter changes between Released and Apply while pressing and releasing the S91 park brake control switch.

- **If the parameter does not change**

Refer to Circuit/System Test.

- **If the parameter changes**

3. All OK.

Circuit/System Test

C0293 01, C0293 02, C0293 04 or C0293 06

1. Ignition OFF, disconnect the harness connector at the K83 Parking Brake Control Module.
2. Test for less than 10 ohms between the ground circuit terminal H and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.

4. Verify a test lamp illuminates between the B+ circuit terminal A and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K83 Parking Brake Control Module.

- **If the test lamp illuminates**

5. Verify a test lamp illuminates between the ignition circuit terminal P and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse. Refer to **Power Mode Mismatch**

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K83 Parking Brake Control Module.

- **If the test lamp illuminates**

6. Test for less than 1 V between the circuit terminals listed below and ground;
 - Terminal B
 - Terminal C
 - Terminal D
 - Terminal N
 - Terminal R
 - Terminal S
- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

7. Ignition OFF.
8. Test for infinite resistance between the circuit terminals listed below and ground;
 - Terminal B
 - Terminal C
 - Terminal D
 - Terminal N
 - Terminal R
 - Terminal S
- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

9. Test for less than 5 ohms between the circuit terminal D and the circuit terminal R.
 - **If 5 ohms or greater**
1. Ignition OFF, disconnect the harness connector at the S91 Park Brake Control Switch.
2. Test for less than 2 ohms in the circuits end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S91 Park Brake Control Switch.

- **If less than 5 ohms**
- 10. Test for less than 5 ohms between the circuit terminal B and the circuit terminal S.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the S91 Park Brake Control Switch.
 2. Test for less than 2 ohms in the signal circuit terminal B end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S91 Park Brake Control Switch.
 - **If less than 5 ohms**
- 11. Test for less than 5 ohms between the circuit terminal C and the circuit terminal N.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the S91 Park Brake Control Switch.
 2. Test for less than 2 ohms in the circuits end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S91 Park Brake Control Switch.
 - **If less than 5 ohms**
- 12. Test for less than 5 ohms between the circuit terminal N and the circuit terminal R while closing the switch.
 - **If 5 ohms or greater**

Replace the S91 Park Brake Control Switch.
 - **If less than 5 ohms**
- 13. Test for less than 5 ohms between the circuit terminal N and the circuit terminal S while closing the switch.
 - **If 5 ohms or greater**

Replace the S91 Park Brake Control Switch.
 - **If less than 5 ohms**
- 14. Replace the K83 Parking Brake Control Module.

C0293 00 or C0293 08

1. Ignition ON.
2. Verify no additional DTCs are set in other control modules.
 - **If additional DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no additional DTCs are set**
3. Verify DTC C0293 00 or C0293 08 is not set.

- **If DTC C0293 00 or C0293 08 is set**

1. Ignition OFF, remove the parking brake control module fuse and reinstall, ignition ON.
2. Verify DTC C0293 00 or C0293 08 is not set.

- If the DTC is set,

replace the K83 Parking Brake Control Module.

- If the DTC is not set

3. All OK.

- **If DTC C0293 00 or C0293 08 is not set**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Parking Brake Actuator Switch Replacement**
- **Control Module References** for parking brake control module replacement, programming and setup

DTC C0298: PARK BRAKE UNLATCH SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C0298 00

Park Brake Unlatch Switch Circuit Malfunction

DTC C0298 01

Park Brake Unlatch Switch Circuit Short to Battery

DTC C0298 02

Park Brake Unlatch Switch Circuit Short to Ground

DTC C0298 04

Park Brake Unlatch Switch Circuit Open

DTC C0298 08

Park Brake Unlatch Switch Circuit Performance - Signal Invalid

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Terminal 1	C0298 08	C0298 08	-	C0298 00 C0298 08
B+ Terminal 5	C0298 02	C0298 04	C0298 01	C0298 00 C0298 08
Signal Terminal 2	C0298 08	C0298 08	-	C0298 00 C0298 08
Signal Terminal 3	C0298 02	C0298 04	C0298 01	C0298 00 C0298 08

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the parking brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch, the internal circuit board temperature is checked to verify it is within operating range before the control module performs the requested operation.

Conditions for Running the DTC

Ignition OFF, ACCESSORY, or RUN mode.

Conditions for Setting the DTC

The parking brake control module detects a short to battery, short to ground, open circuit, or an internal parking brake switch malfunction. The parking brake control module detects the apply or release button was activated for more than 90 seconds.

Action Taken When the DTC Sets

A message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The parking brake control module will clear the DTC after 40 consecutive ignition on/off cycles with at least one test pass in each ignition cycle and no test fail result.
- The condition for the DTC is no longer present.
- The park brake control switch button is INACTIVE using the scan tool without the switch being activated.

Diagnostic Aids

Check if the park brake control switch is stuck in the apply or release position which may cause the DTC to set.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Park Brake Status parameter changes between Released and Apply while pressing and releasing the S91 Park Brake Control Switch.
 - **If the parameter does not change**

Refer to Circuit/System Test.
 - **If the parameter changes**
3. All OK.

Circuit/System Test

1. Ignition OFF, disconnect the harness connector at the K83 Parking Brake Control Module.
2. Test for less than 10 ohms between the ground circuit terminal H and ground.
 - **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal A and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K83 Parking Brake Control Module.
 - **If the test lamp illuminates**
 - 5. Verify a test lamp illuminates between the ignition circuit terminal P and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse. Refer to **Power Mode Mismatch**
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K83 Parking Brake Control Module.
 - **If the test lamp illuminates**
 - 6. Test for less than 1 V between the circuit terminals listed below and ground;
 - Terminal B
 - Terminal C
 - Terminal D
 - Terminal N
 - Terminal R
 - Terminal S

- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

7. Ignition OFF.

8. Test for infinite resistance between the circuit terminals listed below and ground;

- Terminal B
- Terminal C
- Terminal D
- Terminal N
- Terminal R
- Terminal S

- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

9. Test for less than 5 ohms between the circuit terminal D and the circuit terminal R.

- **If 5 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the S91 Park Brake Control Switch.
2. Test for less than 2 ohms in the circuits end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S91 Park Brake Control Switch.

- **If less than 5 ohms**

10. Test for less than 5 ohms between the circuit terminal B and the circuit terminal S.

- **If 5 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the S91 Park Brake Control Switch.
2. Test for less than 2 ohms in the signal circuit terminal B end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S91 Park Brake Control Switch.

- **If less than 5 ohms**

11. Test for less than 5 ohms between the circuit terminal C and the circuit terminal N.

- **If 5 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the S91 Park Brake Control Switch.
2. Test for less than 2 ohms in the circuits end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S91 Park Brake Control Switch.

- **If less than 5 ohms**

12. Test for less than 5 ohms between the circuit terminal N and the circuit terminal R while closing the switch.

- **If 5 ohms or greater**

Replace the S91 Park Brake Control Switch.

- **If less than 5 ohms**

13. Test for less than 5 ohms between the circuit terminal N and the circuit terminal S while closing the switch.

- **If 5 ohms or greater**

Replace the S91 Park Brake Control Switch.

- **If less than 5 ohms**

14. Replace the K83 Parking Brake Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Parking Brake Actuator Switch Replacement

DTC C0558: CALIBRATION DATA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C0558 55

Calibration Data Too Few Transitions

DTC C0558 5A

Calibration Data Not Plausible

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the parking brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch, the internal circuit board temperature is checked to verify it is within operating range before

the control module performs the requested operation.

Conditions for Running the DTC

Ignition OFF, ACCESSORY, or RUN mode.

Conditions for Setting the DTC

C0558 55

The parking brake control module detects a calibration malfunction.

C0558 5A

The parking brake control module detects mechanical problems with the parking brake system.

Action Taken When the DTC Sets

C0558 55

- The parking brake is disabled, switch command will not be accepted.
- A message and/or a warning indicator may be displayed.

C0558 5A

- The parking brake is disabled, one release allowed.
- A message and/or a warning indicator may be displayed.

OR

- The parking brake functionality is degraded.
- A message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The parking brake control module will clear the DTC after 40 consecutive ignition on/off cycles with at least one test pass in each ignition cycle and no test fail result.
- Calibrate the parking brake control module after mechanical repairs are made.

Diagnostic Aids

- Verify the parking brake control module software and calibrations are the newest available versions.
- Verify the parking brake cable and related hardware is not broken, seized or pinched.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C0558 55 is not set.
 - **If DTC C0558 55 is set**
 1. Program the K83 Parking Brake Control Module. Refer to **Electronic Parking Brake Control Module Programming and Setup** .
 2. Ignition ON.
 3. Apply and release the park brake.
 4. Verify the DTC is not set.
 - If the DTC is set,

replace the K83 Parking Brake Control Module.
 - If the DTC is not set
 - **If DTC C0558 55 is not set**
3. Verify the scan tool Park Brake Cable Position parameter is less than 1251 counts.
 - **If 1251 counts or greater**
 1. Verify the park brake cable is connected properly. Refer to **Park Brake System Diagnosis**
 2. Check park brake pads for excessive wear. Refer to **Disc Brake System Diagnosis**
 - **If less than 1251 counts**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for parking brake control module replacement, programming and setup

DTC C0561: SYSTEM DISABLED INFORMATION STORED INVALID DATA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C0561 71

System Disabled Information Stored Invalid Data

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the parking brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch, the internal circuit board temperature is checked to verify it is within operating range before the control module performs the requested operation. The parking brake module will verify it has a valid signal from other modules before it performs the requested operation.

Conditions for Running the DTC

- Ignition OFF, ACCESSORY, or RUN mode.
- Battery voltage is between 9-16V.

Conditions for Setting the DTC

The parking brake control module receives an invalid serial data message or does not receive a serial data message from another module.

Action Taken When the DTC Sets

- A message and/or a warning indicator may be displayed.
- The parking brake functionality is degraded.

Conditions for Clearing the DTC

- The parking brake control module will clear the DTC after 40 consecutive ignition on/off cycles with at least one test pass in each ignition cycle and no test fail result.
- The parking brake control module receives valid signals from other modules.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no additional DTCs are set in other control modules.
 - **If additional DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no additional DTCs are set**
3. Verify the scan tool Park Brake Control Module Invalid Signal Identification parameters are all Valid.
 - **If any parameter is Invalid**

Refer to the appropriate subsection in which the failure occurred. Refer to **Symptoms - Vehicle**

- **If all parameters are Valid**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

DTC C056D: ELECTRONIC CONTROL UNIT HARDWARE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C056D 00

Electronic Control Unit Hardware Malfunction

DTC C056D 34

Electronic Control Unit Hardware RAM Malfunction

DTC C056D 35

Electronic Control Unit Hardware ROM Malfunction

DTC C056D 36

Electronic Control Unit Hardware EEPROM Performance/Malfunction

DTC C056D 37

Electronic Control Unit Hardware Software Malfunction

DTC C056D 38

Electronic Control Unit Hardware Supervision Software Malfunction

DTC C056D 39

Electronic Control Unit Hardware Internal Malfunction

DTC C056D 3B

Electronic Control Unit Hardware Internal Self - Test Malfunction

DTC C056D 3C

Electronic Control Unit Hardware Internal Communication Malfunction

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the parking brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch, the internal circuit board temperature is checked to verify it is within operating range before the control module performs the requested operation. The parking brake module will perform diagnostics on the modules internal hardware to verify it is functioning properly

Conditions for Running the DTC

Ignition OFF, ACCESSORY, or RUN mode.

Conditions for Setting the DTC

The parking brake control module detects an internal hardware malfunction.

Action Taken When the DTC Sets

DTC C056D 00, C056D 34, C056D 35, C056D 36, C056D 37, C056D 38, C056D 3B, or C056D 3C

- The parking brake is disabled.
- A message and/or a warning indicator may be displayed.

DTC C056D 39

- The parking brake is disabled, one release allowed.
- A message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The parking brake control module will clear the DTC after 40 consecutive ignition on/off cycles with at least one test pass in each ignition cycle and no test fail result.
- The condition for the DTC is no longer present.
- The latest software and calibrations are programmed into the parking brake control module.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC C056D 36 is not set.
 - **If DTC C056D 36 is set**
 1. Program the K83 Parking Brake Control Module. Refer to **Electronic Parking Brake Control Module Programming and Setup** .
 2. Ignition ON.
 3. Apply and release the park brake.
 4. Verify the DTC is not set.
 - If the DTC is set, replace the K83 Parking Brake Control Module.
 - If the DTC is not set
 5. All OK.
 - **If DTC C056D 36 is not set**
3. Perform the Parking Brake Motor Reset procedure with a scan tool for the Parking Brake Control Module.
4. Verify DTC C056D is not set.
 - **If DTC C056D is set**

Replace the K83 Parking Brake Control Module.
 - **If DTC C056D is not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for parking brake control module replacement, programming and setup.

DTC C056E: ELECTRONIC CONTROL UNIT SOFTWARE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C056E 41

Electronic Control Unit Software Not Programmed

DTC C056E 42

Electronic Control Unit Software Calibration Not Programmed

DTC C056E 47

Electronic Control Unit Software VIN Not Programmed

DTC C056E 5A

Electronic Control Unit Software Not Plausible

DTC C056E 71

Electronic Control Unit Software Invalid Data

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the park brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch, the internal circuit board temperature is checked to verify it is within operating range before the parking brake control module performs the requested operation.

Conditions for Running the DTC

Ignition OFF, ACCESSORY, or RUN mode.

Conditions for Setting the DTC

The parking brake module has detected missing calibration data, calibration procedure not run or completed,

missing VIN, or internal software malfunction.

Actions Taken When DTC Sets

C056E 41 or C056E 5A

- The parking brake is disabled.
- A message and/or a warning indicator may be displayed.

C056E 42

- The parking brake functionality is degraded or disabled.
- A message and/or a warning indicator may be displayed.

C056E 47 or C056E 71

The parking brake will function normally.

Conditions for Clearing the DTC

- The parking brake control module will clear the DTC after 40 consecutive ignition on/off cycles with at least one test pass in each ignition cycle and no test fail result.
- The condition for the DTC is no longer present.
- The latest software and calibrations are programmed into the parking brake control module.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C056E is not set.
 - **If the DTC is set**
 1. Program the K83 Parking Brake Control Module. Refer to **Electronic Parking Brake Control Module Programming and Setup** .
 2. Verify the DTC is not set.
 - If the DTC is set,

replace the K83 Parking Brake Control Module.
 - If the DTC is not set
 - 3. All OK.
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for parking brake control module replacement, programming and setup

DTC C0574: PRINTED CIRCUIT BOARD TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC C0574 00

Printed Circuit Board Temperature Sensor Malfunction

DTC C0574 01

Printed Circuit Board Temperature Sensor Short to Battery

DTC C0574 02

Printed Circuit Board Temperature Sensor Short to Ground

DTC C0574 54

Printed Circuit Board Temperature Sensor High

Circuit/System Description

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the parking brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch, the internal circuit board temperature is checked to verify it is within operating range before the control module performs the requested operation.

Conditions for Running the DTC

Ignition OFF, ACCESSORY, or RUN mode.

Conditions for Setting the DTC

C0574 01 or C0574 02

The parking brake control module detects a short to battery or a short to ground.

C0574 00 or C0574 54

The parking brake control module has detected an internal temperature that is above the allowed value.

Action Taken When the DTC Sets

- A message and/or a warning indicator may be displayed.
- The park brake is disabled, one release allowed.

Conditions for Clearing the DTC

- The parking brake control module clears the history DTC when a current DTC is not detected in 40 ignition cycles.
- The parking brake control module is replaced or the internal temperature drops below the allowed temperature.

Diagnostic Aids

- Check for debris on the parking brake control module which may cause the module to overheat.
- Diagnose all other parking brake control module system related faults before performing this diagnostic. Other faults may cause the circuit board to overheat. Do not attempt to apply the park brake.

Reference Information

Schematic Reference

Park Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Parking Brake Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no additional DTCs are set in other control modules.
 - **If additional DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no additional DTCs are set**
3. Verify that DTC C0574 01 or C0574 02 is not set.
 - **If DTC C0574 01 or C0574 02 is set**
 1. Ignition OFF. Remove the parking brake control module fuse and reinstall. Ignition ON.
 2. Verify DTC C0574 01 or C0574 02 is not set.
 - If the DTC is set, replace the K83 Parking Brake Control Module.
 - If the DTC is not set
 - 3. All OK.
 - **If DTC C0574 01 or C0574 02 is not set**
 4. Allow the K83 Parking Brake Control Module to cool down for 15 minutes.
 5. Verify the scan tool Calculated System Temperature parameter is less than 105° C.

- **If 105° C or greater**

Replace the K83 Parking Brake Control Module.

- **If less than 105° C**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for parking brake control module replacement, programming and setup.

PARK BRAKE WILL NOT HOLD OR RELEASE

Park Brake Will Not Hold or Release

Step	Action	Yes	No
1	Were you sent here from the Park Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
5	Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> . Is the condition still present?	Go to Step 2	System OK

PARK BRAKE SYSTEM DIAGNOSIS

Park Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the mechanical components of the PARK brake system in order to determine if the PARK brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Hydraulic Brake Symptom table?	Go to Step 4	Go to Step 2
2	Were you sent here from a Park Brake Symptom table?	Go to Step 4	Go to Step 3

3	<ol style="list-style-type: none"> 1. Raise and support the vehicle with the rear axle supported by jack stands. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. With the park brake RELEASED, attempt to rotate the rear wheels to check the rear brakes for a significant amount of drag. <p>Do the rear brakes have a significant amount of drag?</p>	Go to Step 7	Go to Step 4
4	<ol style="list-style-type: none"> 1. Apply the park brake. 2. Attempt to rotate the rear wheels to check the rear brakes for a significant amount of drag. <p>Do the rear brakes have a significant amount of drag?</p>	Go to Step 12	Go to Step 5
5	<p>Visually inspect the park brake cable connections and the cables that are accessible on the UNDERSIDE of the vehicle for disconnections and/or damage.</p> <p>Were any of the park brake cables disconnected and/or damaged?</p>	Go to Step 6	Go to Step 7
6	<p>Reconnect or replace the park brake cables as necessary. Refer to <u>Parking Brake Rear Cable Replacement</u>.</p> <p>Did you complete the repair and/or replacement?</p>	Go to Step 12	-
7	<ol style="list-style-type: none"> 1. Disconnect the rear park brake cables from the equalizer and from the brake caliper piston apply levers. Refer to <u>Parking Brake Rear Cable Replacement</u>. 2. Have an assistant apply and maintain the caliper piston apply lever to apply the caliper piston. 3. Attempt to rotate the rear wheels to check the rear brakes for a significant amount of drag. 4. Release the caliper piston apply lever. 5. Repeat steps 2-4 for the opposite caliper piston apply lever. 6. Rotate the rear wheels to check the brake for a significant reduction of drag. <p>Did the brake calipers apply and release properly?</p>	Go to Step 9	Go to Step 8
8	<p>Replace the appropriate rear brake caliper. Refer to <u>Rear Brake Caliper Replacement</u> .</p> <p>Did you complete the replacement?</p>	Go to Step 12	-
9	<p>With the aid of an assistant, apply and release the parking brake while observing the cables for free movement.</p> <p>Did the park brake cables move freely?</p>	Go to Step 11	Go to Step 10

10	Replace any of the park brake cables inspected that do not have free movement. Refer to <u>Parking Brake Rear Cable Replacement</u> . Did you complete the replacement?	Go to Step 12	-
11	Inspect the electronic parking brake control module for proper operation and replace if necessary. Refer to <u>Electronic Parking Brake Control Module Replacement</u> . Did you complete the replacement?	Go to Step 12	-
12	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Park Brake System OK	-

REPAIR INSTRUCTIONS

ELECTRONIC PARKING BRAKE CONTROL MODULE REPLACEMENT

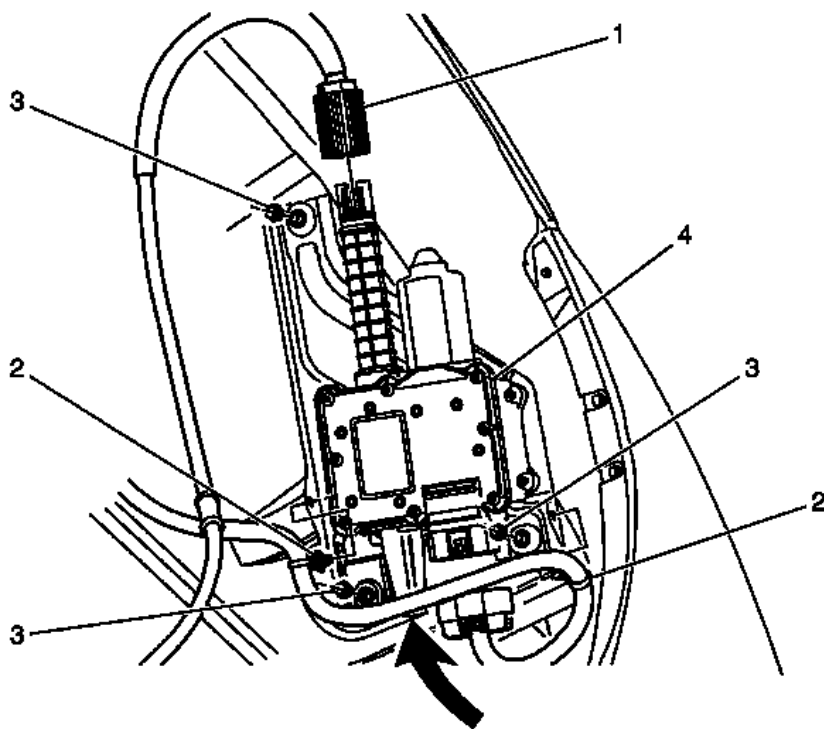


Fig. 2: Electronic Parking Brake Control Module & Components
Courtesy of GENERAL MOTORS COMPANY

Electronic Parking Brake Control Module Replacement

Callout	Component Name
Preliminary Procedures	
1.	Block the drive wheels.

2. Disable the electronic parking brake cable adjuster. Refer to **Parking Brake Cable Adjuster Disabling**.
3. Turn the ignition to the OFF position.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
5. Remove the left rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.
6. Remove the left rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement**.

1	<p>Electronic Parking Brake Rear Cable Nut</p> <p>CAUTION: Refer to <u>Fastener Caution</u>.</p> <p>Tighten 6 N.m (53 lb in)</p>
2	Electronic Parking Brake Rear Cable Clip
3	<p>Electronic Parking Brake Control Module Nut (Qty: 3)</p> <p>Tighten 10 N.m (89 lb in)</p>
4	<p>Electronic Parking Brake Control Module</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connector. <p>NOTE: To ensure proper operation, the electronic parking brake control module must be programmed after replacement.</p> <ol style="list-style-type: none"> 2. After the installation is complete, program the electronic parking brake control module. Refer to <u>Electronic Parking Brake Control Module Programming and Setup</u>. 3. After the installation is complete, enable the electronic parking brake cable adjuster. Refer to <u>Parking Brake Cable Adjuster Enabling</u>.

PARKING BRAKE REAR CABLE REPLACEMENT

Removal Procedure

WARNING: Refer to **Brake Dust Warning**.

1. Disable the parking brake cable adjuster. Refer to **Parking Brake Cable Adjuster Disabling**.
2. Turn the ignition to the OFF position.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove the left rear wheelhouse liner. Refer to Rear Wheelhouse Liner Replacement .

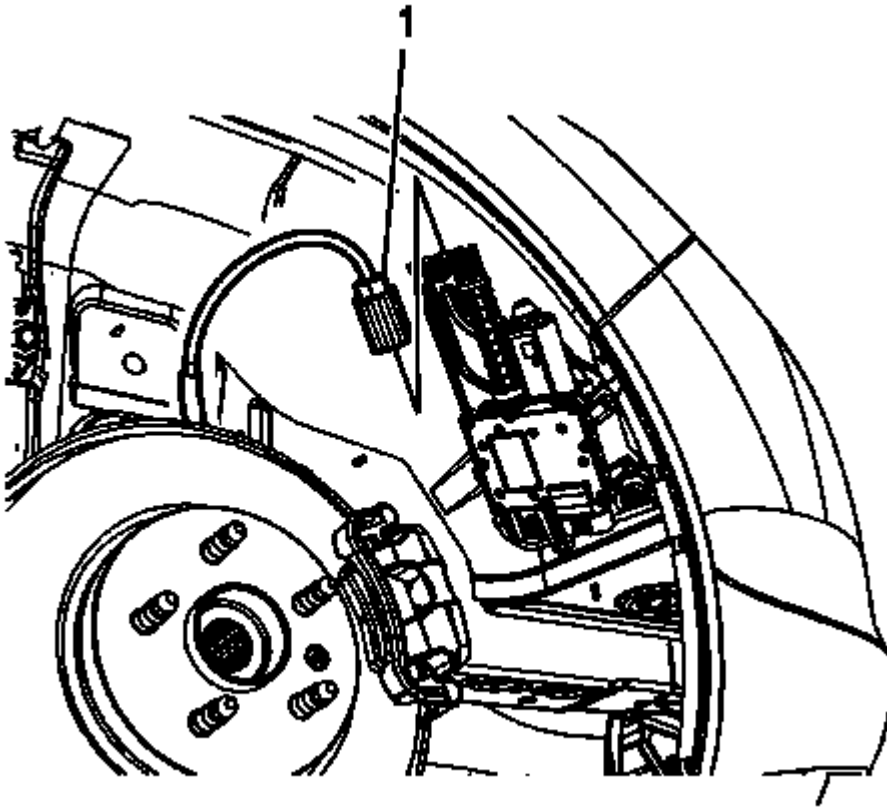


Fig. 3: Rear Parking Brake Cable Nut And Electronic Parking Brake Control Module
Courtesy of GENERAL MOTORS COMPANY

5. Remove the rear parking brake cable nut (1) from the electronic parking brake control module.

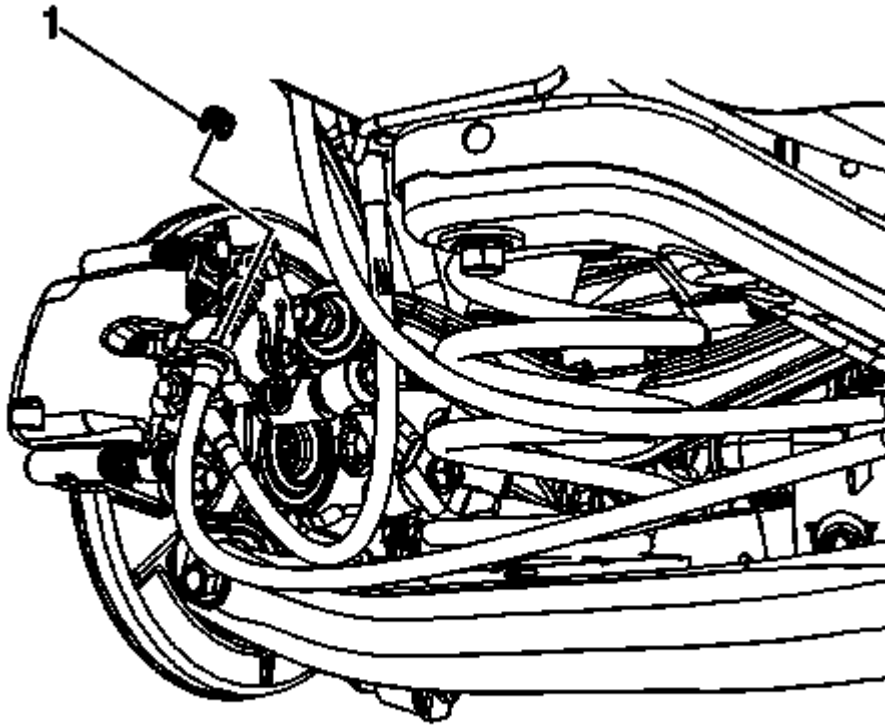


Fig. 4: Left Rear Parking Brake Cable Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove the left rear parking brake cable retainer (1).

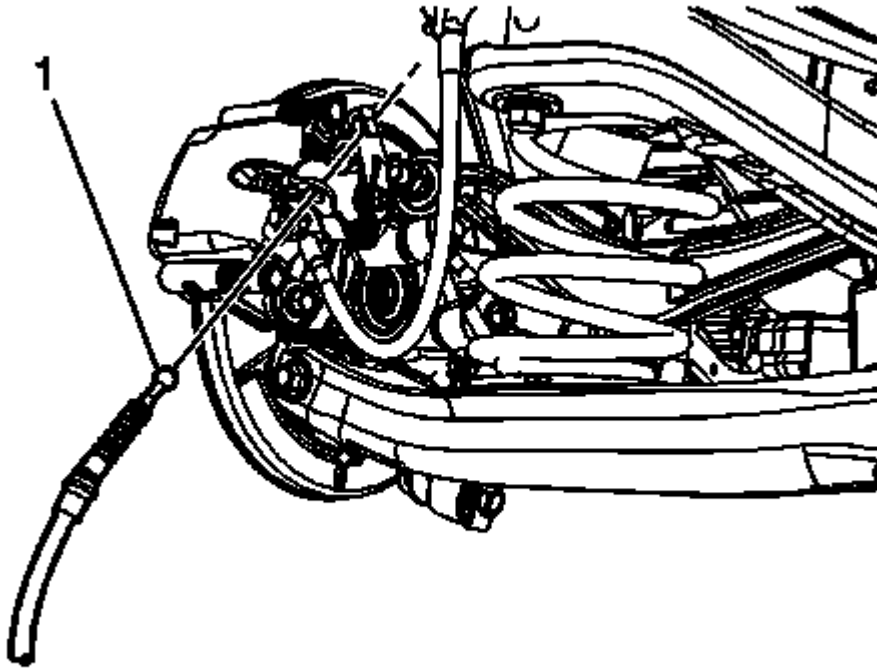


Fig. 5: Rear Parking Brake Cable And Parking Brake Actuator Lever
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the rear parking brake cable (1) from the parking brake actuator lever and remove the cable from the left rear brake caliper.

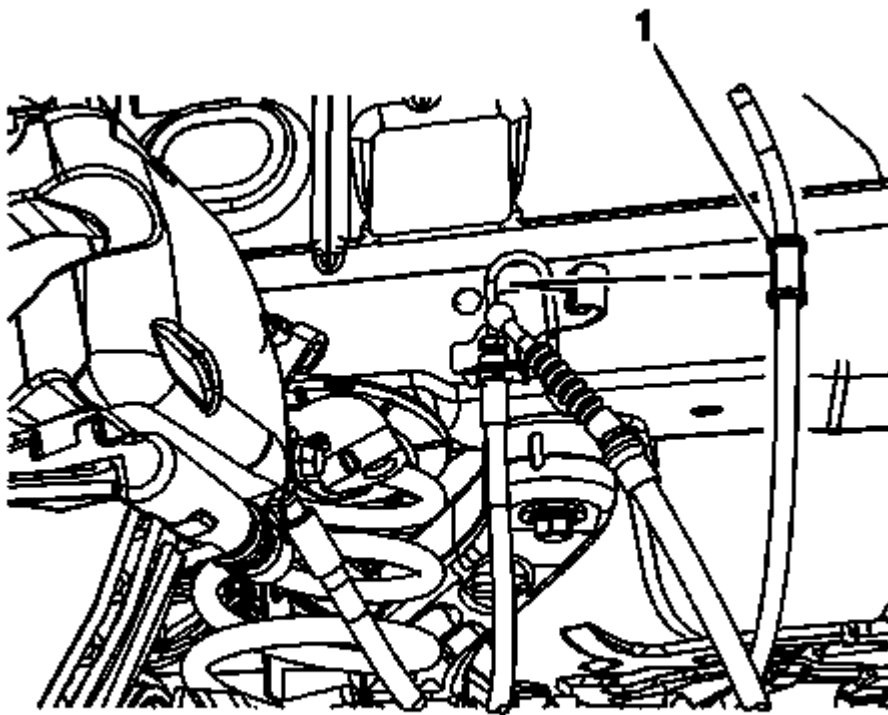


Fig. 6: Rear Parking Brake Cable
Courtesy of GENERAL MOTORS COMPANY

8. Release the rear parking brake cable (1) from the left rear brake hose bracket.

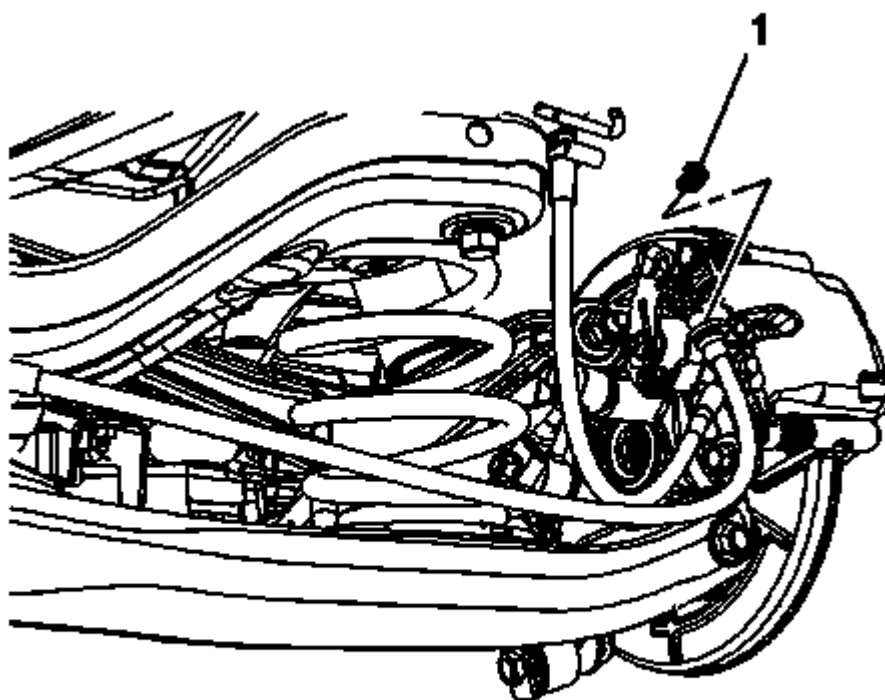


Fig. 7: Right Rear Parking Brake Cable Retainer
Courtesy of GENERAL MOTORS COMPANY

9. Remove the right rear parking brake cable retainer (1).

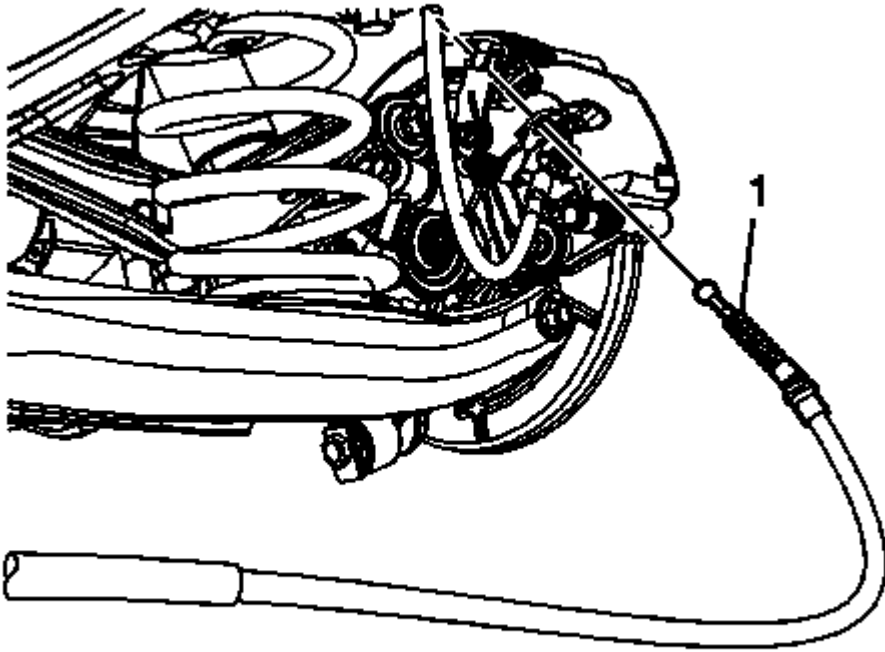


Fig. 8: Rear Parking Brake Cable, Parking Brake Actuator Lever And Right Rear Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the rear parking brake cable (1) from the parking brake actuator lever and remove the cable from the right rear brake caliper.

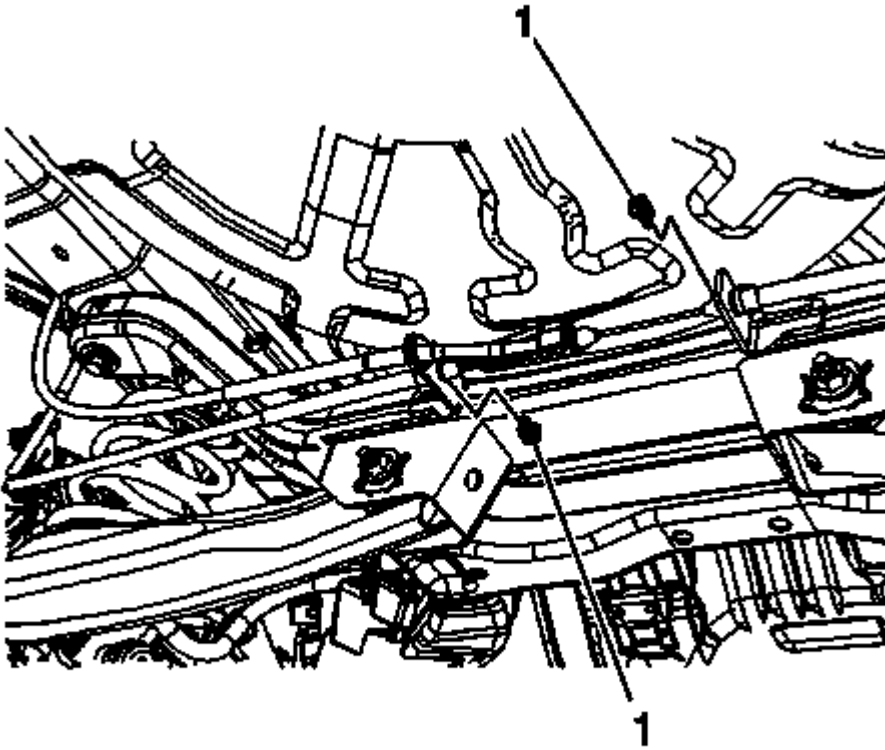


Fig. 9: Rear Parking Brake Cable Retainers And Rear Frame
Courtesy of GENERAL MOTORS COMPANY

11. Remove the rear parking brake cable retainers (1) on the rear frame.

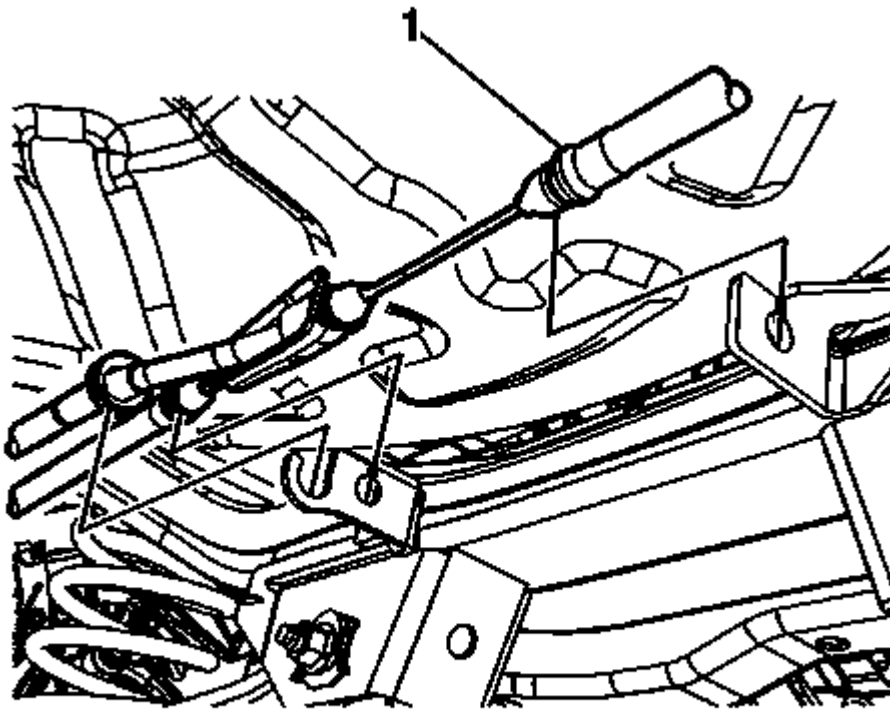


Fig. 10: Rear Parking Brake Cable
Courtesy of GENERAL MOTORS COMPANY

12. Remove the rear parking brake cable (1).

Installation Procedure

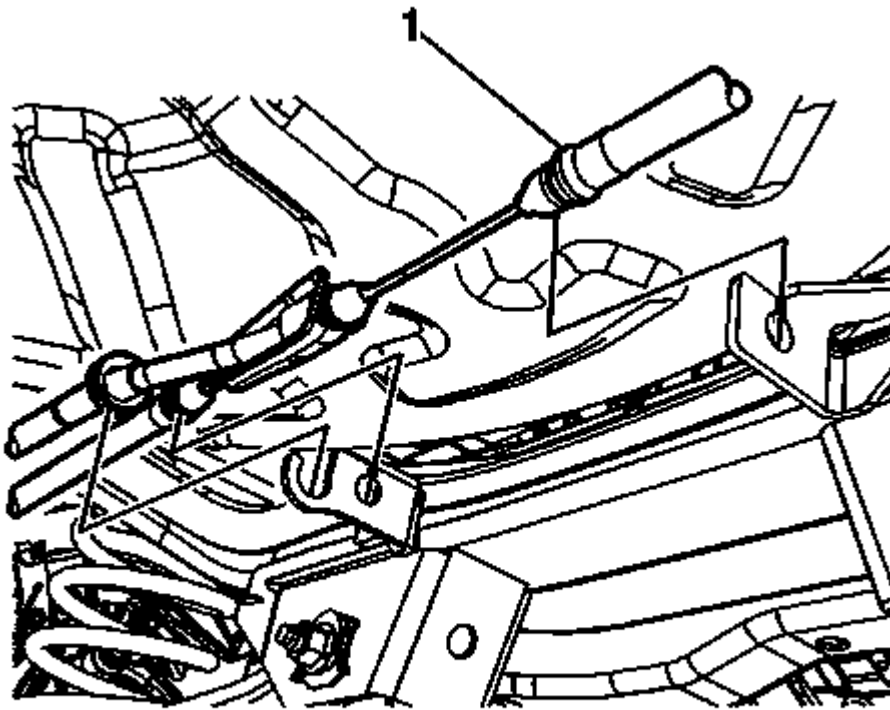


Fig. 11: Rear Parking Brake Cable
Courtesy of GENERAL MOTORS COMPANY

1. Install the rear parking brake cable (1).

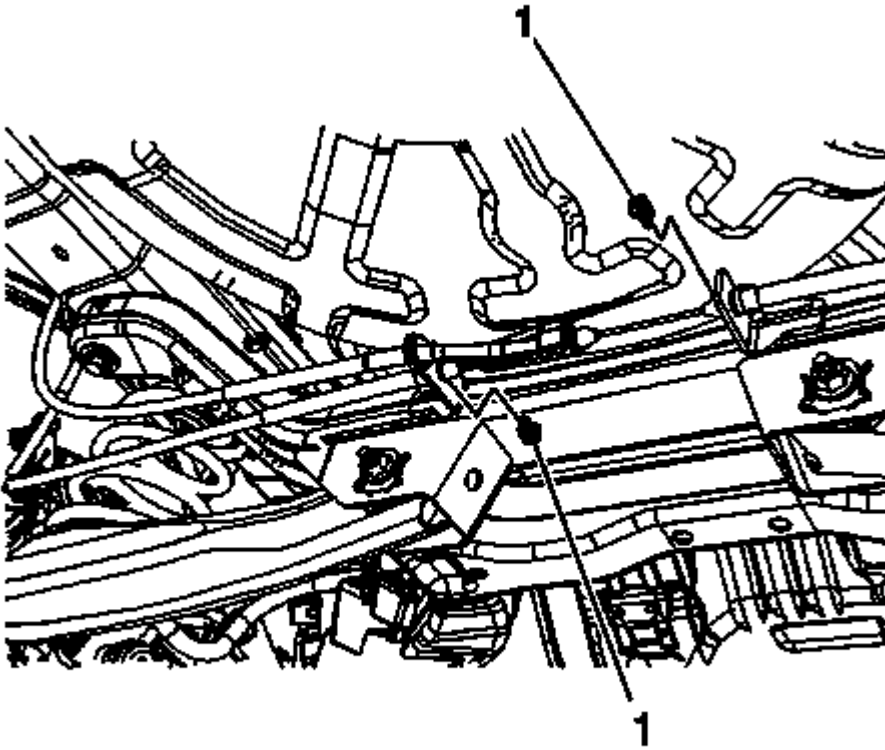


Fig. 12: Rear Parking Brake Cable Retainers And Rear Frame
Courtesy of GENERAL MOTORS COMPANY

2. Install the rear parking brake cable retainers (1) on the rear frame.

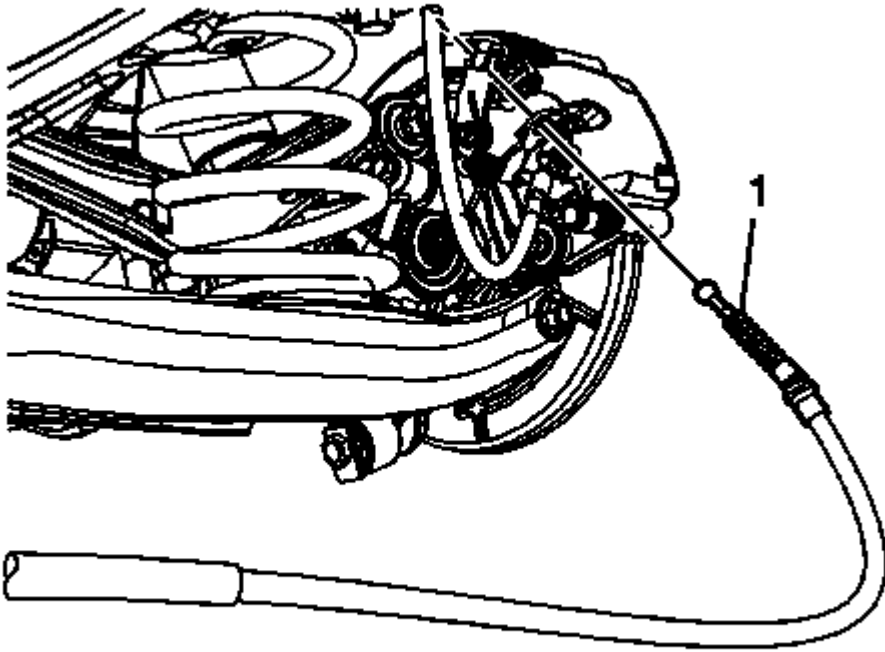


Fig. 13: Rear Parking Brake Cable, Parking Brake Actuator Lever And Right Rear Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

3. Install the rear parking brake cable (1) to the right rear brake caliper and connect the cable to the parking brake actuator lever.

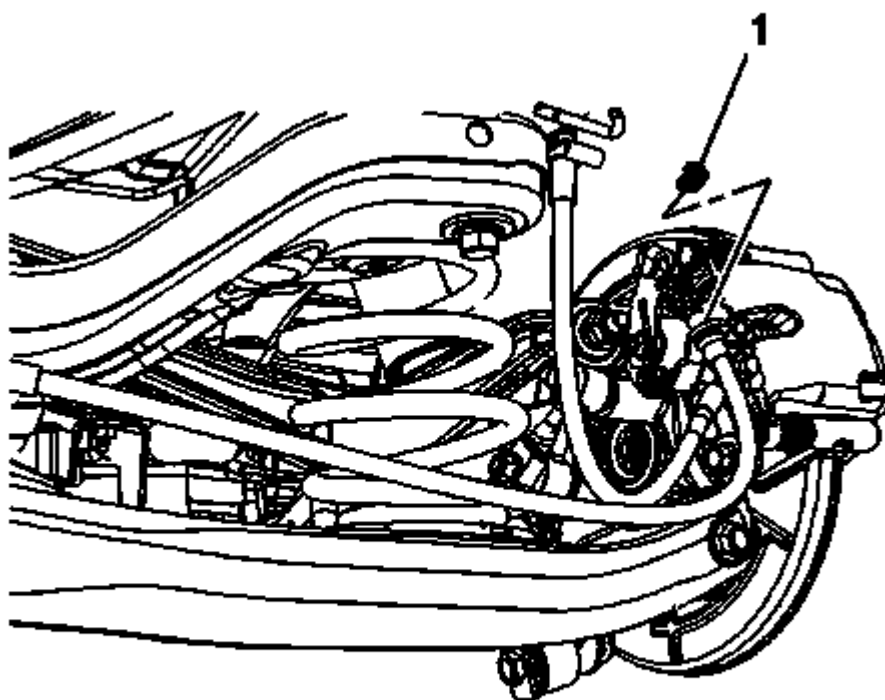


Fig. 14: Right Rear Parking Brake Cable Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install the right rear parking brake cable retainer (1).

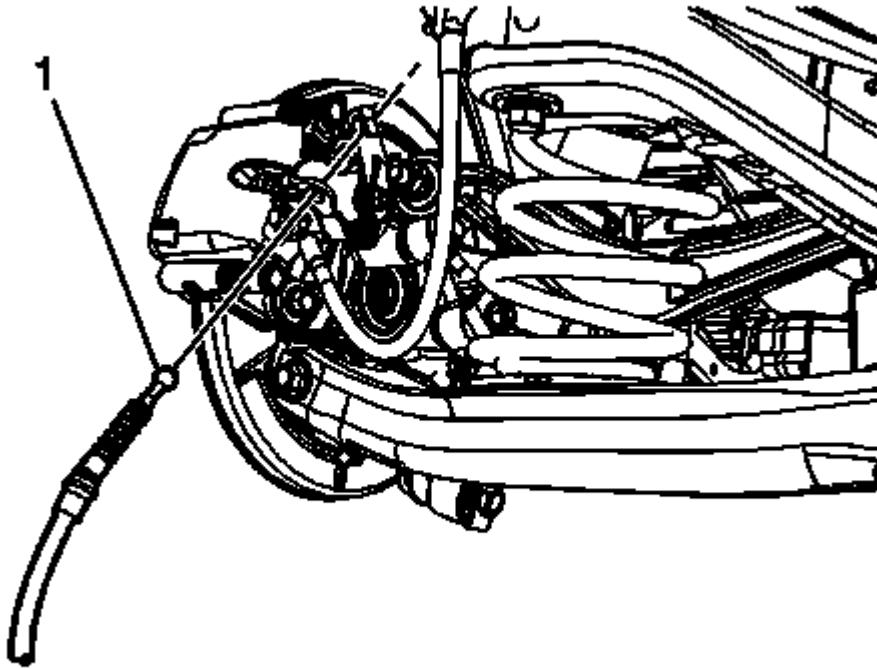


Fig. 15: Rear Parking Brake Cable And Parking Brake Actuator Lever
Courtesy of GENERAL MOTORS COMPANY

5. Install the rear parking brake cable (1) to the left rear brake caliper and connect the cable to the parking brake actuator lever.

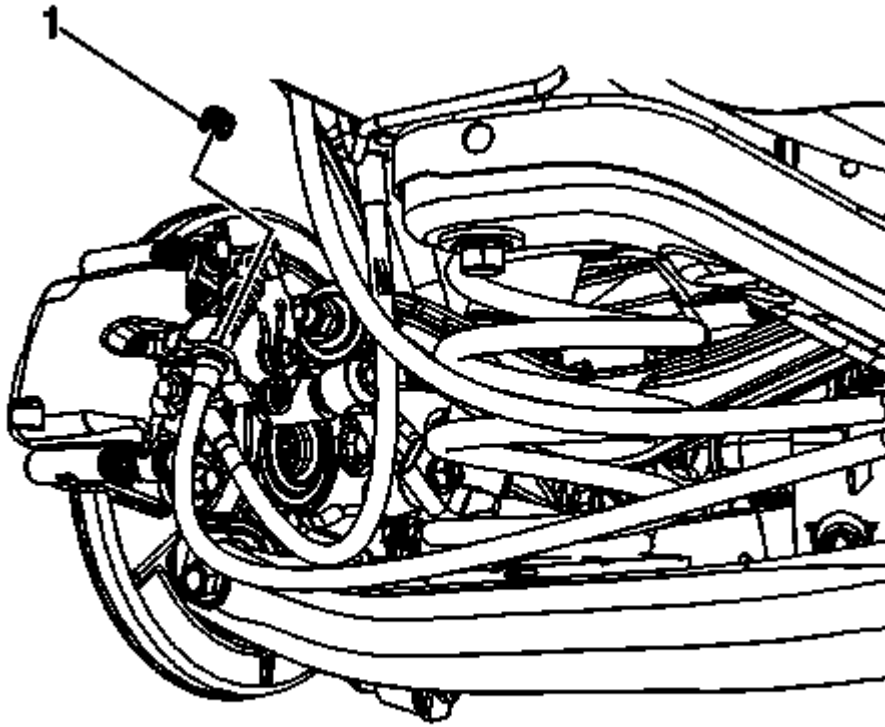


Fig. 16: Left Rear Parking Brake Cable Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Install the left rear parking brake cable retainer (1).

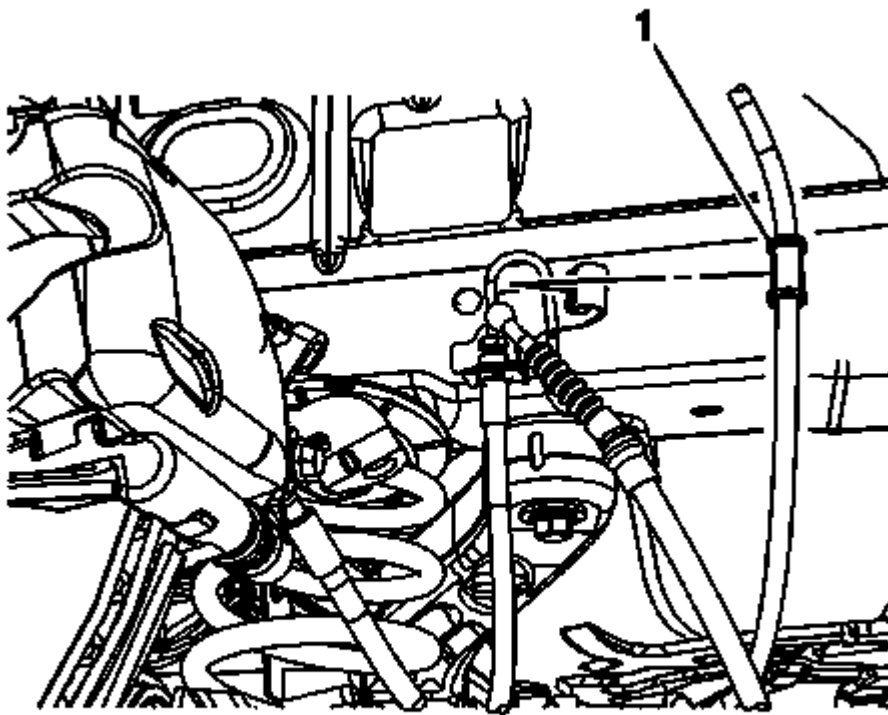


Fig. 17: Rear Parking Brake Cable
Courtesy of GENERAL MOTORS COMPANY

7. Install the rear parking brake cable (1) to the left rear brake hose bracket.

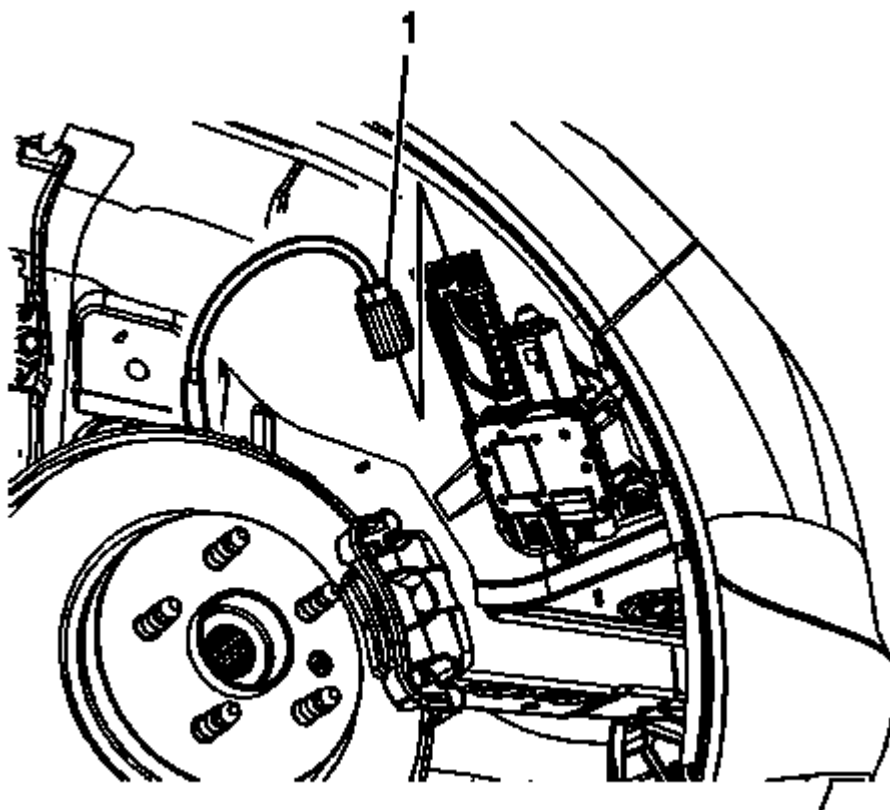


Fig. 18: Rear Parking Brake Cable Nut And Electronic Parking Brake Control Module
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Install the rear parking brake cable nut (1) to the electronic parking brake control module and tighten to 6 N.m (53 lb in).
9. Install the left rear wheelhouse liner. Refer to Rear Wheelhouse Liner Replacement .
10. Enable the parking brake cable adjuster. Refer to Parking Brake Cable Adjuster Enabling.

PARKING BRAKE CABLE ADJUSTER DISABLING

The park brake cable tension is controlled by the electronic park brake (EPB) module. Tension can be fully released from the park brake cables to allow for service of the park brake system. Perform one of the following three methods to fully release cable tension.

Electronic Parking Brake Cable Tension Release

With Scan Tool - Preferred Method

1. Block the drive wheels.
2. Install a scan tool to the vehicle.
3. Turn the ignition switch to the ON/RUN position with the engine OFF.
4. Select Control Functions from the electronic parking brake control module menu.
5. Follow the instructions on the scan tool.

Without Scan Tool - Optional Method

1. Block the drive wheels.
2. Turn the ignition switch to the ON/RUN position with the engine OFF.
3. Place the automatic transmission in PARK or manual transmission in NEUTRAL, as equipped.
4. Apply and hold the brake pedal. The brake pedal must remain applied throughout the park brake cable tension release process.
5. Press and hold down the electronic park brake (EPB) switch approximately 5 seconds.
6. Observe the PARK BRAKE lamp on the instrument cluster.
7. When the PARK BRAKE lamp flashes, release then immediately press and release the EPB switch.

The parking brake cable tension is fully released.

8. Release the brake pedal.

Manual Parking Brake Cable Tension Release

In the event the above methods to release the parking brake cable tension are unsuccessful, the following procedure may be necessary to release the parking brake cable tension.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the left rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .

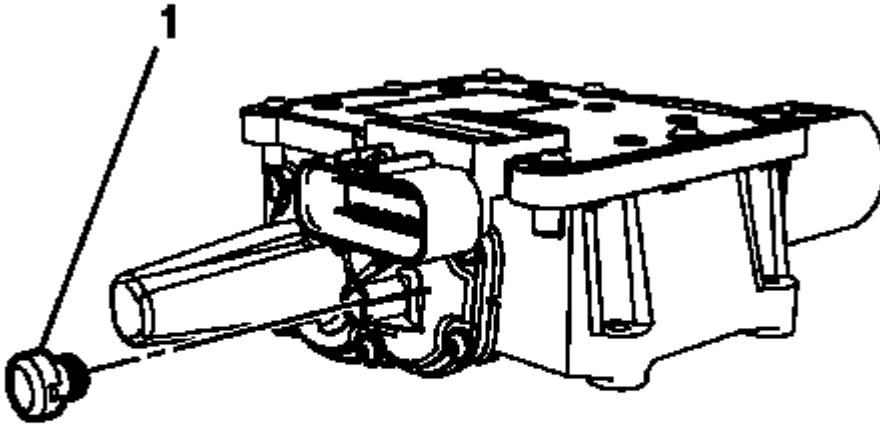


Fig. 19: Protective Plug
Courtesy of GENERAL MOTORS COMPANY

NOTE: The protective plug for the manual release is located near the electrical connector.

4. Remove the protective plug (1) from the EPB manual release.

NOTE: Do NOT use power tools to rotate the manual release mechanism. Use of power tools can damage the EPB module gear drive mechanism.

5. Using an appropriate square-drive tool, rotate the mechanism clockwise until the tension is fully released from the parking brake cables.

Up to 50 cycles may be required until the parking brake cable tension is fully released.

6. Install the protective plug to the EPB module.

PARKING BRAKE CABLE ADJUSTER ENABLING

The park brake cable tension is controlled by the electronic park brake (EPB) module. Cable tension needs to be

set and the EPB module needs to be calibrated following the cable tension disabling procedure. Perform one of the following two methods to fully restore cable tension.

Electronic Parking Brake Cable Tensioning

With Scan Tool - Preferred Method

1. Block the drive wheels.
2. Install a scan tool to the vehicle.
3. Turn the ignition switch to the ON/RUN position with the engine OFF.
4. Select Configuration/Reset Functions from the electronic parking brake control module menu.
5. Perform the Parking Brake Calibration procedure.

Without Scan Tool - Optional Method

1. Block the drive wheels.
2. Turn the ignition switch to the ON/RUN position with the engine OFF.
3. Apply the brake pedal.
4. Place the automatic transmission in PARK or manual transmission in NEUTRAL, as equipped.
5. Momentarily lift then release the EPB switch to apply the EPB.
6. Momentarily press down then release the EPB switch to release the EPB.
7. Repeat step 5 and 6 to cycle the EPB on then off an additional 4 times.
8. The EPB module will be calibrated and proper tension will be applied to the parking brake cables.

PARKING BRAKE ACTUATOR SWITCH REPLACEMENT

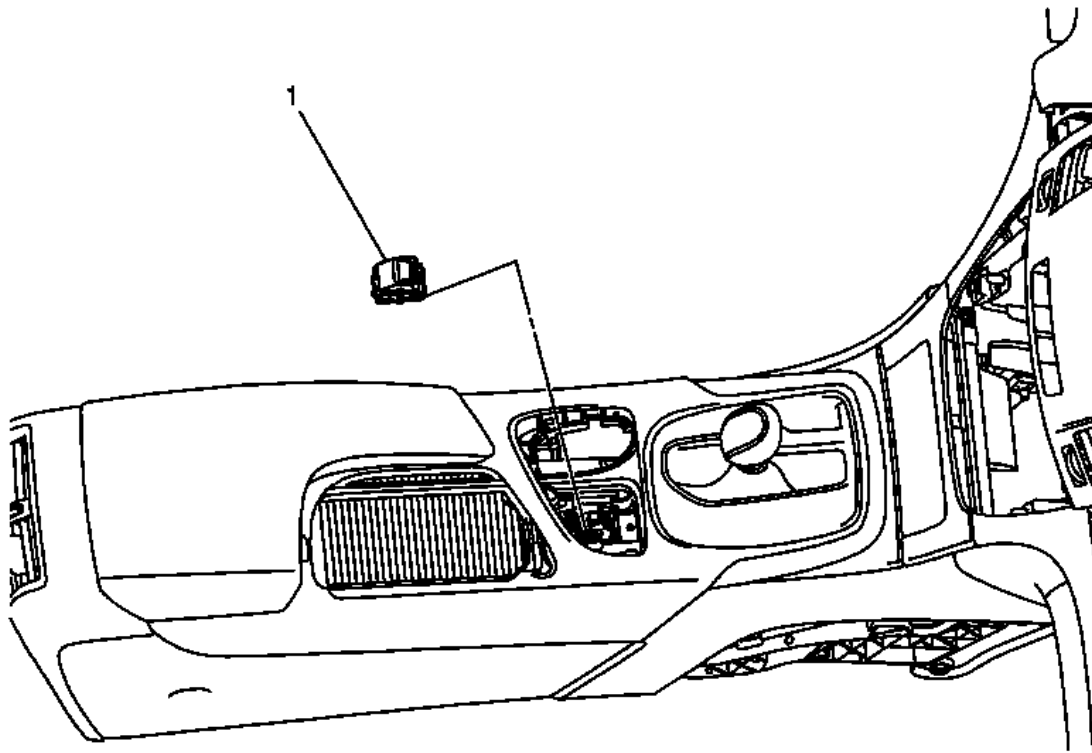


Fig. 20: Parking Brake Actuator Switch
 Courtesy of GENERAL MOTORS COMPANY

Parking Brake Actuator Switch Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front floor console front compartment. Refer to .	
1	Parking Brake Actuator Switch Procedure Disconnect electrical connector.

DESCRIPTION AND OPERATION

ELECTRONIC PARKING BRAKE CONTROL MODULE DESCRIPTION

Vehicles with the electric parking brake have a switch in the center console, which takes the place of the manual parking brake system, the foot pedal and release handle. In case of insufficient electrical power, the electric parking brake cannot be applied or released.

Parking Brake Control Module

The parking brake control module has an internal motor, apply actuator, release actuator, and temperature sensor. The parking brake control module also contains the logic for applying and releasing the parking brake when commanded by the park brake control switch. When the parking brake control module receives a signal from the switch the internal circuit board temperature is checked to verify it is within operating range before the

control module performs the requested operation.

Electric Parking Brake Apply

The electric parking brake can be applied any time the vehicle is stopped or in motion. The electric parking brake is applied by momentarily lifting up on the park brake control switch. The red park brake light will momentarily flash while the parking brake is being applied. Once fully applied, the red park brake light will turn on. If the electric parking brake is applied while the vehicle is in motion, a chime will sound, and the message "Release Park Brake Switch" will be displayed.

If the red park brake light is flashing, the electric parking brake is only partially applied or released, or there is a problem with the electric parking brake. The message "Service Park Brake" will be displayed.

Electric Parking Brake Release

To release the electric parking brake, turn the ignition switch to the ON or RUN position, apply and hold the brake pedal, and push down momentarily on the park brake control switch. When the electric parking brake is released the red park brake light turns off.

The electric parking brake can be used to prevent roll back for vehicles with a manual transmission taking off on a hill. In a situation where no roll back is desired, an applied electric parking brake will allow both feet to be used for the clutch and accelerator pedals in preparation for starting the vehicle moving in the intended direction. In this situation, perform the normal clutch and accelerator actions required to begin moving the vehicle. There is no need to push the switch to release the electric parking brake. To disable this feature lift and hold the park brake control switch while the vehicle is in motion, this will keep the electric parking brake applied.

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Passenger Compartment/Roof Component Views

PASSENGER COMPARTMENT/ROOF COMPONENT VIEWS

LEFT SIDE OF PASSENGER COMPARTMENT COMPONENTS

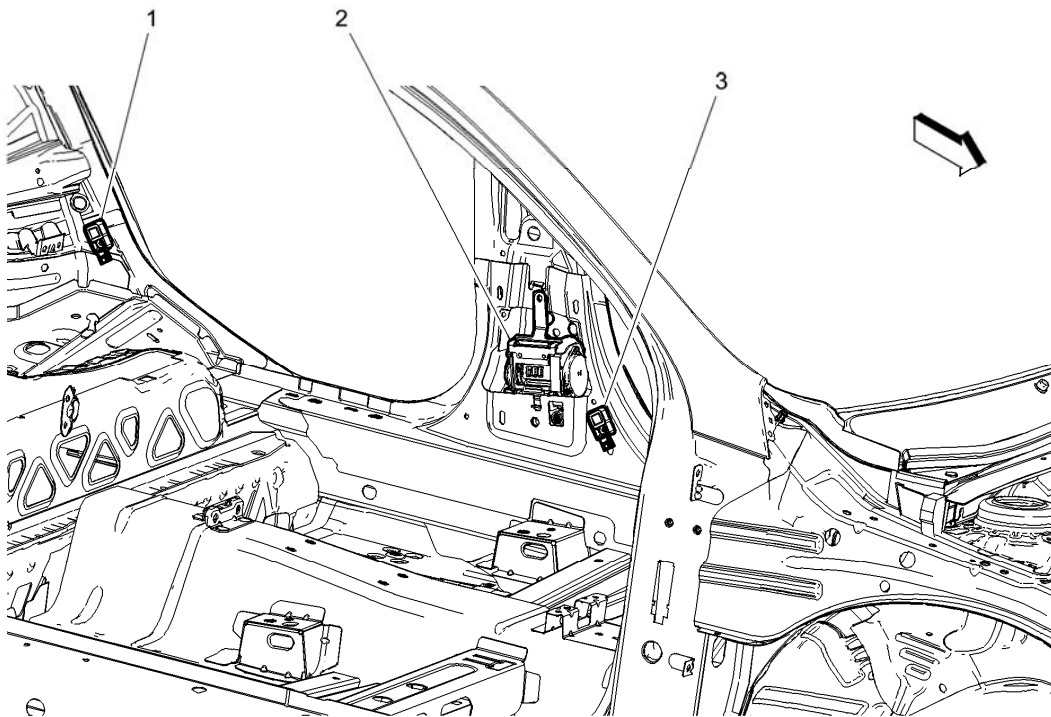


Fig. 1: Left Side of Passenger Compartment Component Locations
Courtesy of GENERAL MOTORS COMPANY

Items

- | | |
|--|---|
| 1: B63LR Side Impact Sensor - Left Rear (AW7) | <u>B63LR Side Impact Sensor - Left Rear (AW7)</u> |
| 2: F112D Seat Belt Retractor Pretensioner - Driver | <u>F112D Seat Belt Retractor Pretensioner - Driver</u> |
| 3: B63LF Side Impact Sensor - Left Front | <u>B63LF Side Impact Sensor - Left Front</u> |

CENTER AND RIGHT SIDE OF PASSENGER COMPARTMENT COMPONENTS

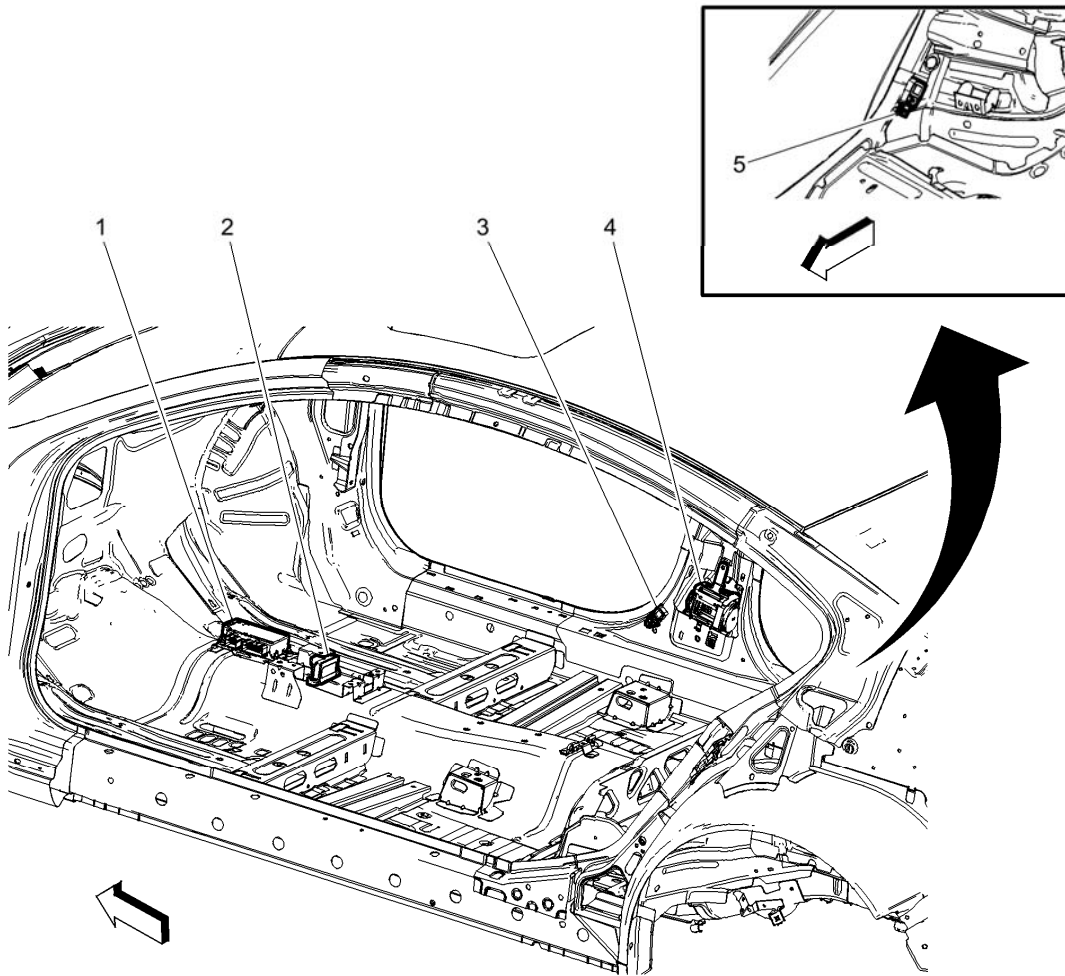


Fig. 2: Center and Right Side of Passenger Compartment Component Locations
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** K36 Inflatable Restraint Sensing and Diagnostic Module **K36 Inflatable Restraint Sensing and Diagnostic Module X1** **K36 Inflatable Restraint Sensing and Diagnostic Module X2 (AW7)** **K36 Inflatable Restraint Sensing and Diagnostic Module X2 (AY0)** **K36 Inflatable Restraint Sensing and Diagnostic Module X2 (CZ2)**
- 2:** B119 Multi-axis Acceleration Sensor **B119 Multi-axis Acceleration Sensor**
- 3:** B63RF Side Impact Sensor - Right Front **B63RF Side Impact Sensor - Right Front**
- 4:** F112P Seat Belt Retractor Pretensioner - Passenger **F112P Seat Belt Retractor Pretensioner - Passenger**
- 5:** B63RR Side Impact Sensor - Right Rear (AW7) **B63RR Side Impact Sensor - Right Rear (AW7)**

LOWER RIGHT SIDE OF THE PASSENGER COMPARTMENT COMPONENTS

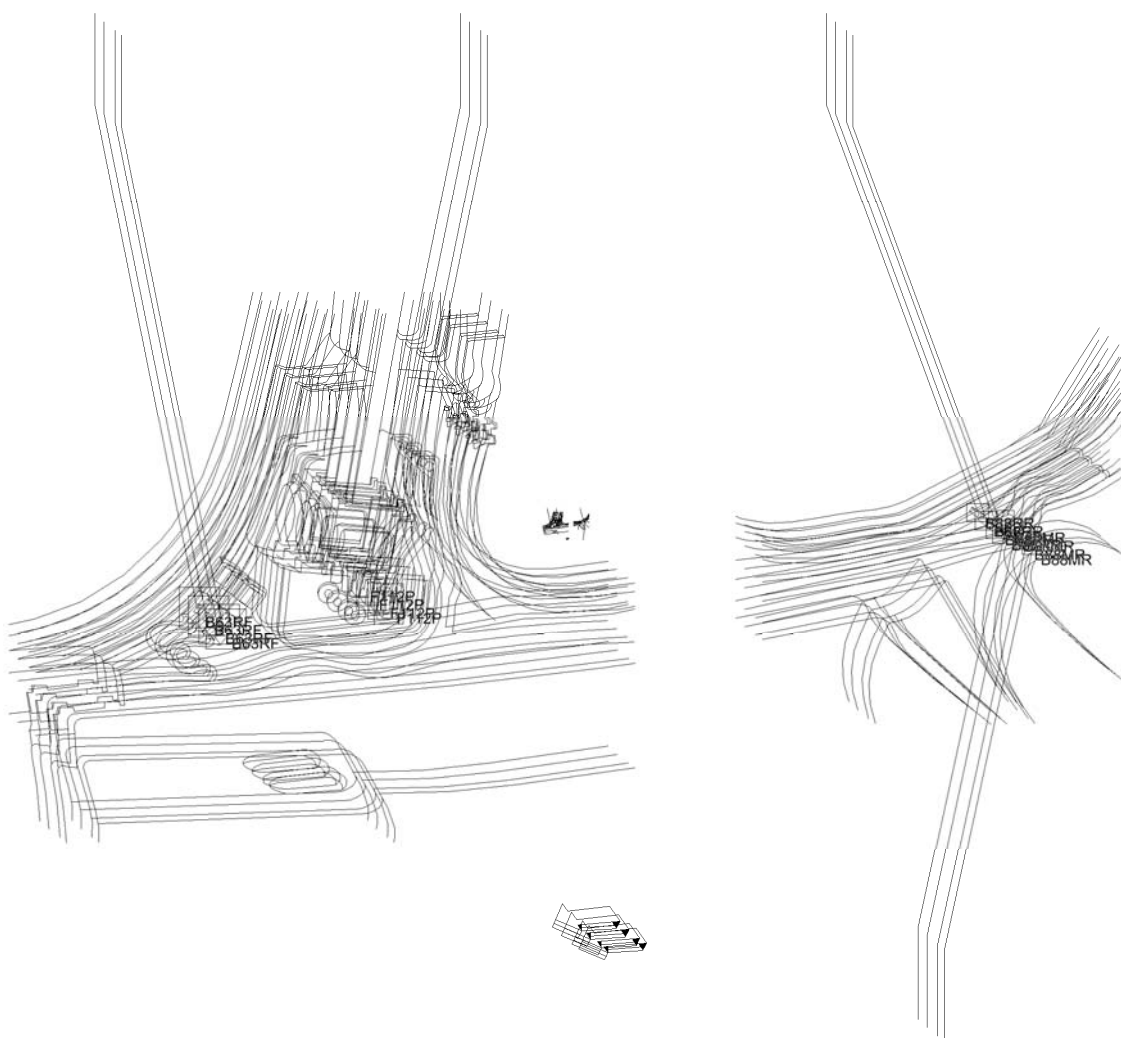


Fig. 3: Lower Right Side of the Passenger Compartment Components
Courtesy of GENERAL MOTORS COMPANY

Items

- | | |
|--|--|
| 1: B63RF Side Impact Sensor - Right Front | <u>B63RF Side Impact Sensor - Right Front</u> |
| 2: F112P Seat Belt Retractor Pretensioner - Passenger | <u>F112P Seat Belt Retractor Pretensioner - Passenger</u> |
| 3: B88RR Seat Belt Switch - Right Rear (CZ2) | <u>B88RR Seat Belt Switch - Right Rear CZ2</u> |
| 4: B88MR Seat Belt Switch - Rear Middle | <u>B88MR Seat Belt Switch - Rear Middle CZ2</u> |

BOTTOM OF DRIVER SEAT COMPONENTS (EXCEPT A45)

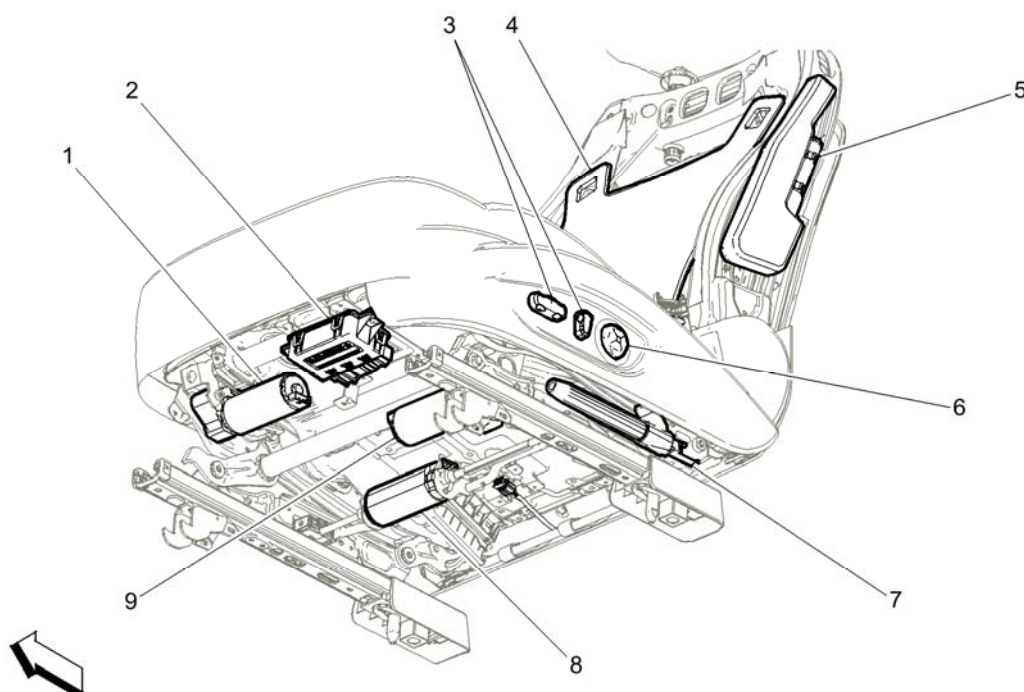


Fig. 4: Bottom of Driver Seat Component Locations (except A45)
 Courtesy of GENERAL MOTORS COMPANY

Items	
1: M50D Seat Front Vertical Motor - Driver	<u>M50D Seat Front Vertical Motor - Driver</u>
2: K29 Seat Heating Control Module (KA1)	<u>K29 Seat Heating Control Module X1 (KA1)</u> <u>K29 Seat Heating Control Module X2 (KA1)</u> <u>K29 Seat Heating Control Module X3 (KA1)</u>
3: S64D Seat Adjuster Switch - Driver	<u>S64D Seat Adjuster Switch - Driver (A6A/CZ2)</u> <u>S64D Seat Adjuster Switch - Driver (AG1/A45/CZ2)</u> <u>S64D Seat Adjuster Switch - Driver (AG1/except CZ2)</u>
4: E14A Seat Heating Element - Driver Back (KA1)	<u>E14A Seat Heating Element - Driver Back (KA1)</u>
5: F106LF Seat Side Air Bag - Left Front	<u>F106LF Seat Air Bag - Left Front CZ2</u> <u>F106LF Seat Air Bag - Left Front except CZ2</u>
6: S65D Seat Lumbar Support Switch - Driver	<u>S65D Seat Lumbar Support Switch - Driver</u>
7: F113D Seat Belt Anchor Pretensioner - Driver	<u>F113D Seat Belt Anchor Pretensioner - Driver</u>
8: M51D Seat Horizontal Motor - Driver	<u>M51D Seat Horizontal Motor - Driver</u>
9: M55D Seat Rear Vertical Motor - Driver	<u>M55D Seat Rear Vertical Motor - Driver</u>

BOTTOM OF THE DRIVER SEAT COMPONENTS (WITH A45)

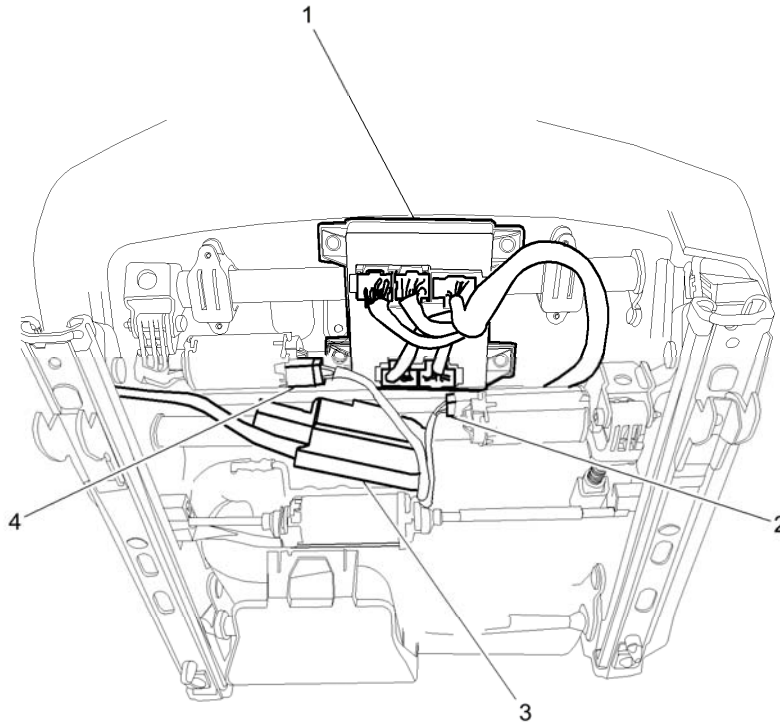


Fig. 5: Bottom of Driver Seat Component Locations (with A45)
 Courtesy of GENERAL MOTORS COMPANY

Items

**1: K40 Seat Memory Control Module (KA1 + A45) K40 Seat Memory Control Module X1 A45/CZ2
K40 Seat Memory Control Module X2 A45/CZ2 K40 Seat Memory Control Module X3 A45/CZ2
KA1 K40 Seat Memory Control Module X4 A45/CZ2 K40 Seat Memory Control Module X5
A45/CZ2**

2: M55D Seat Rear Vertical Motor - Driver M55D Seat Rear Vertical Motor - Driver

3: M51D Seat Horizontal Motor - Driver M51D Seat Horizontal Motor - Driver

4: M50D Seat Front Vertical Motor - Driver M50D Seat Front Vertical Motor - Driver

REAR OF DRIVER SEAT COMPONENTS

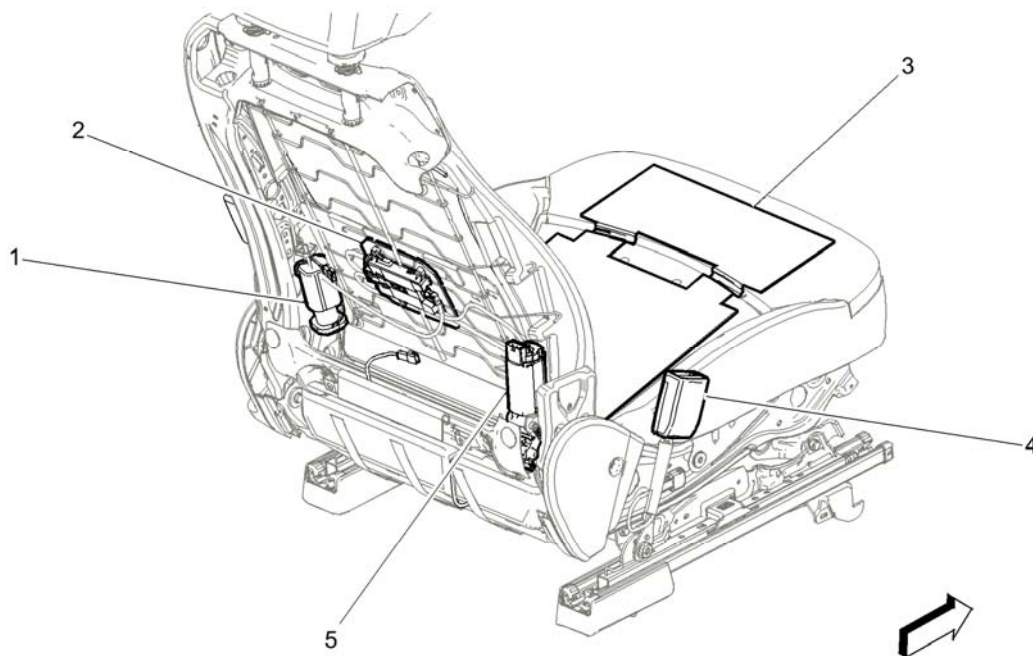


Fig. 6: Rear of Driver Seat Component Locations
 Courtesy of GENERAL MOTORS COMPANY

Items
1: A14D Seat Lumbar Support Pump - Driver (APG) <u>A14D Seat Lumbar Support Pump - Driver (APG)</u>
2: Q51D Seat Lumbar Support Valve Assembly - Driver <u>Q51D Seat Lumbar Support Valve Assembly - Driver</u>
3: E14B Seat Heating Element - Driver Cushion (KA1) <u>E14B Seat Heating Element - Driver Cushion KA1</u>
4: B88D Seat Belt Switch - Driver <u>B88D Seat Belt Switch - Driver</u>
5: M56D Seat Recline Motor - Driver <u>M56D Seat Recline Motor - Driver</u>

BOTTOM OF PASSENGER SEAT COMPONENTS (1 OF 2)

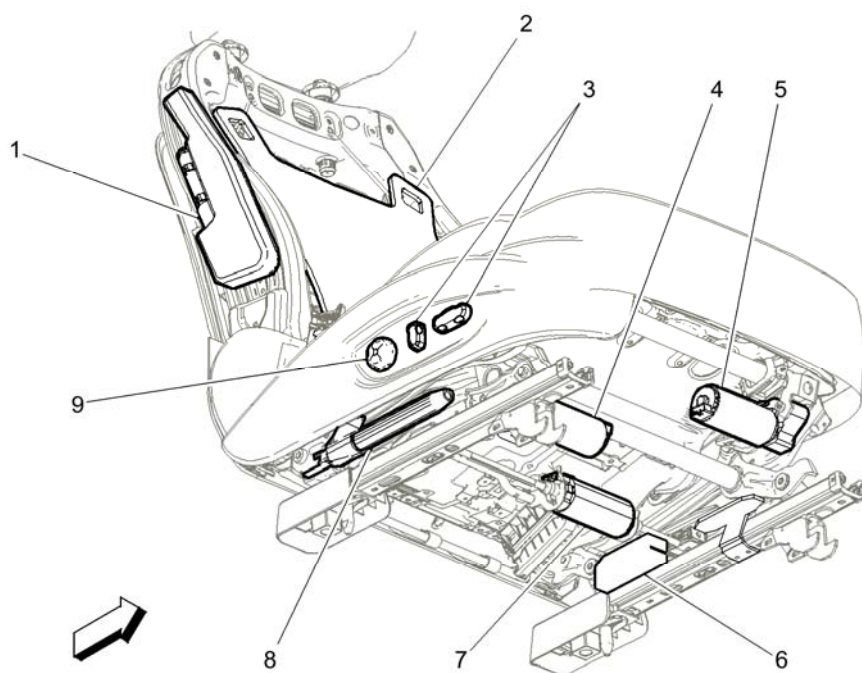


Fig. 7: Bottom of Passenger Seat Component Locations (1 of 2)
 Courtesy of GENERAL MOTORS COMPANY

Items
1: F106RF Seat Side Air Bag - Right Front <u>F106RF Seat Air Bag - Right Front CZ2</u> <u>F106RF Seat Air Bag - Right Front except CZ2</u>
2: E14C Seat Heating Element - Passenger Back (KA1) <u>E14C Seat Heating Element - Passenger Back (KA1)</u>
3: S64P Seat Adjuster Switch - Passenger (A6C or AG2) <u>S64P Seat Adjuster Switch - Passenger (A6C)</u> <u>S64P Seat Adjuster Switch - Passenger (AG2)</u>
4: M51P Seat Horizontal Motor - Passenger (AG2) <u>M51P Seat Horizontal Motor - Passenger (AG2)</u>
5: M50P Seat Front Vertical Motor - Passenger (AG2) <u>M50P Seat Front Vertical Motor - Passenger (AG2)</u>
6: M56P Seat Recline Motor - Passenger (AG2) <u>M56P Seat Recline Motor - Passenger (AG2)</u>
7: M55P Seat Rear Vertical Motor - Passenger (AG2) <u>M55P Seat Rear Vertical Motor - Passenger (AG2)</u>
8: F113P Seat Belt Anchor Pretensioner - Passenger <u>F113P Seat Belt Anchor Pretensioner - Passenger</u>
9: S65P Seat Lumbar Support Switch - Passenger (APH) <u>S65P Seat Lumbar Support Switch - Passenger (APH)</u>

BOTTOM OF THE PASSENGER SEAT COMPONENTS (2 OF 2)

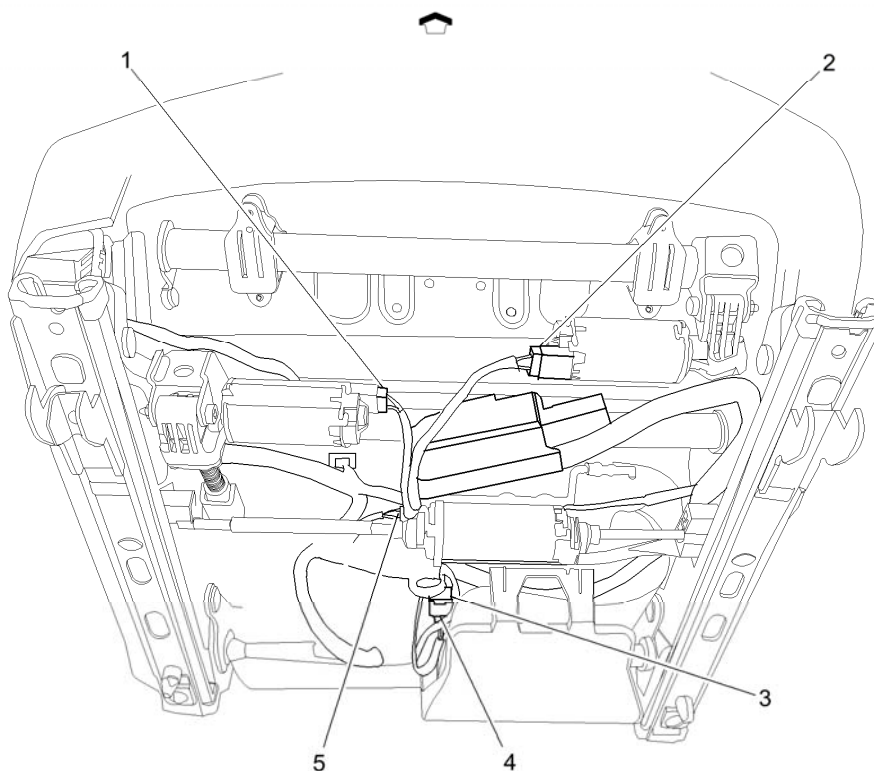


Fig. 8: Bottom of Passenger Seat Component Locations (2 of 2)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** M55P Seat Rear Vertical Motor - Passenger (AG2) **M55P Seat Rear Vertical Motor - Passenger (AG2)**
- 2:** M50P Seat Front Vertical Motor - Passenger (AG2) **M50P Seat Front Vertical Motor - Passenger (AG2)**
- 3:** B60 Passenger Presence Sensor **B60 Passenger Presence Sensor**
- 5:** M51P Seat Horizontal Motor - Passenger (AG2) **M51P Seat Horizontal Motor - Passenger (AG2)**

REAR OF PASSENGER SEAT COMPONENTS

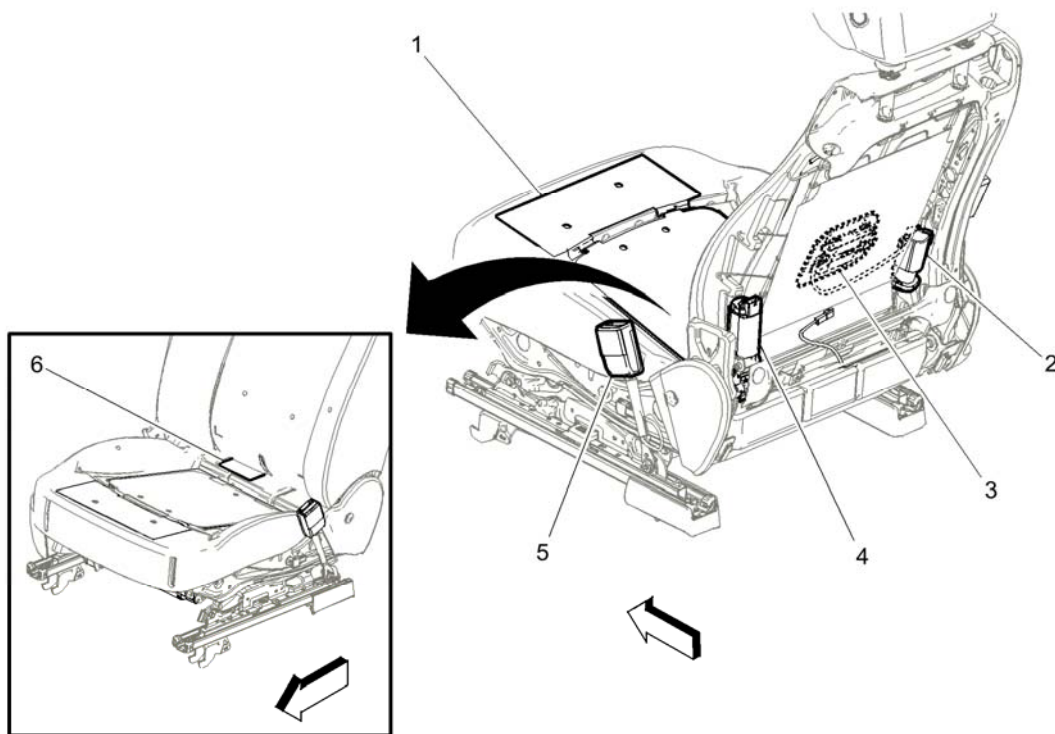


Fig. 9: Rear of Passenger Seat Component Locations
 Courtesy of GENERAL MOTORS COMPANY

Items
2: A14P Seat Lumbar Support Pump - Passenger (APH) <u>A14P Seat Lumbar Support Pump - Passenger (APH)</u>
3: Q51P Seat Lumbar Support Valve Assembly - Passenger (APH) <u>Q51P Seat Lumbar Support Valve Assembly - Passenger (APH)</u>
4: M56P Seat Recline Motor - Passenger (AG2) <u>M56P Seat Recline Motor - Passenger (AG2)</u>
5: B88P Seat Belt Switch - Passenger <u>B88P Seat Belt Switch - Passenger</u>
6: K85 Passenger Presence Module <u>K85 Passenger Presence Module</u>

HEADLINER COMPONENTS

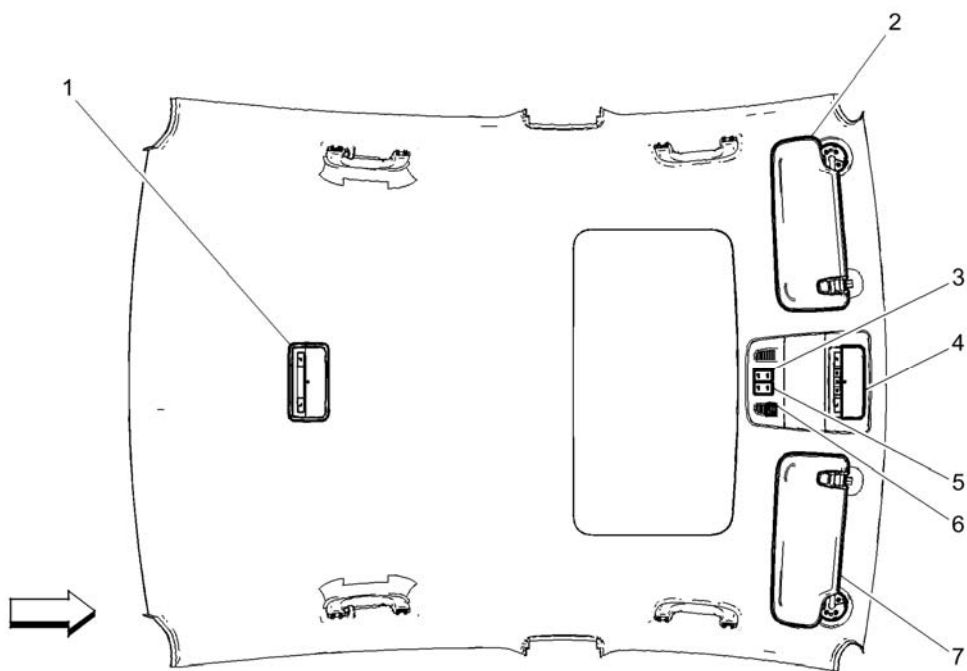


Fig. 10: Headliner Component Locations

Courtesy of GENERAL MOTORS COMPANY

Items

1: E37R Dome/Reading Lamps - Rear E37R Dome/Reading Lamps - Rear

2: A3R Sunshade - Right A3R Sunshade - Right

3: S88 Sunroof Tilt Switch (CF5) S88 Sunroof Tilt Switch (CF5)

5: S72 Sunroof Switch (CF5) S72 Sunroof Switch (CF5)

6: B24 Cellular Phone Microphone (UE1) B24 Cellular Phone Microphone (UPF/UYT) B24 Cellular Phone Microphone UE1

7: A3L Sunshade - Left A3L Sunshade - Left

INSIDE OF ROOF AND WINDSHIELD COMPONENTS

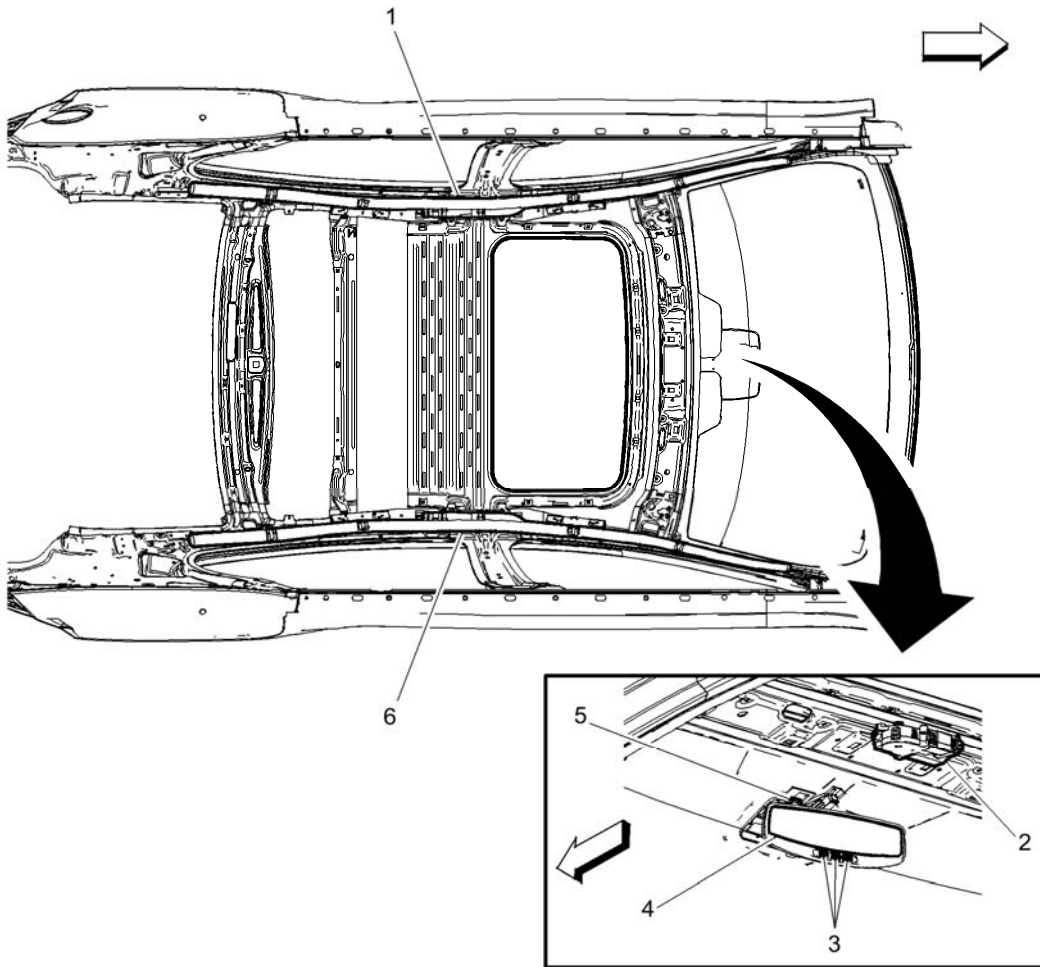


Fig. 11: Inside of Roof and Windshield Component Locations
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: F105L Roof Rail Air Bag - Left F105L Roof Rail Air Bag - Left**
- 2: M69 Sunroof Motor (CF5) M69 Sunroof Motor (CF5)**
- 3: S51 Telematics Button Assembly**
- 4: A10 Inside Rearview Mirror A10 Inside Rearview Mirror**
- 5: B160 Windshield Temperature and Inside Moisture Sensor B160 Windshield Temperature and Inside Moisture Sensor**
- 6: F105R Roof Rail Air Bag - Right F105R Roof Rail Air Bag - Right**

REAR OF PASSENGER COMPARTMENT COMPONENTS

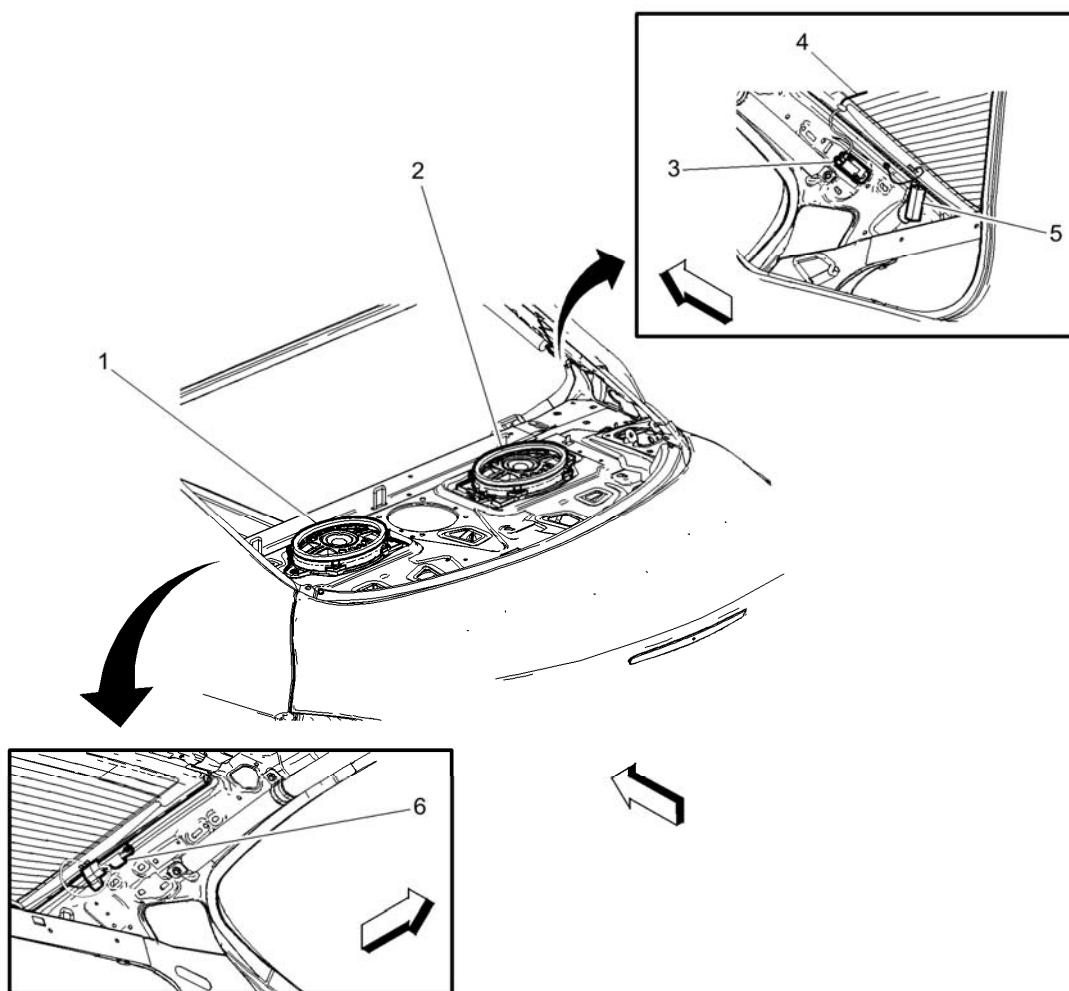


Fig. 12: Rear of Passenger Compartment Component Locations
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: P19N Speaker - Left Subwoofer (UQA) P19N Speaker - Left Subwoofer (UQA/UQS)**
- 2: P19AA Speaker - Right Subwoofer (UQA) P19AA Speaker - Right Subwoofer**
- 3: K46 Radio Antenna Module K46 Radio Antenna Module X1 CZ2**
- 4: T4M Radio Antenna T4M Radio Antenna**
- 5: R14R Rear Window Defogger Noise Filter - Right**
- 6: R14L Rear Window Defogger Noise Filter - Left R14L Rear Window Defogger Noise Filter - Left**

ACCESSORIES & EQUIPMENT

Plastic Panel Information and Repair

SPECIFICATIONS

FLEXIBLE PLASTIC PART REPAIR MATERIALS

Product- 88861039, *88861040, High Strength Plastic Repair 50 ml

Components- 12 cartridges with 2 mixers each

Structural and Cosmetic

Recommended Repair Material

Product	Components	Recommended Repair Material	Work Time 70°F	Handling Strength at 70°F
88861039 *88861040 High Strength Plastic Repair 50 ml	12 cartridges with 2 mixers each	Structural and cosmetic bonding and repairing of all flexible plastics. Requires GM P/N 12378462 on TPO plastics. Will also bond e-coated/primed metals.	90 seconds	10 minutes
* TPO, TEO, (Polyolefin Plastics) require the application of polyolefin adhesive primer before the GM P/N 88861039 repair compound is applied.				

Working Time

Product	Adhesive Sandability at 70°F	Part Paintability at 70°F	Adhesive Full Cure at 70°F	Program
88861039 *88861040 High Strength Plastic Repair 50 ml	20 minutes	30 minutes	24 hours	Bumper covers, emblems, door trims, exterior and interior repairs*
* TPO, TEO, (Polyolefin Plastics) require the application of polyolefin adhesive primer before the GM P/N 88861039 repair compound is applied.				

RIGID PLASTIC PART REPAIR MATERIALS

Rigid Plastic Part Repair Materials

Thermoset Plastic Type	Type of Repair	Recommended Repair Material	Availability
Sheet metal compound		GM Goodwrench® Structural Bonding Epoxy (GM P/N 12345726 or	GM Dealer

(SMC), RIM rigid plastic parts	Cosmetic filling	equivalent)	
		Sikkens Polystop LP™ or equivalent polyester repair putty	Refer to a local paint supplier
Most rigid plastic parts	Cosmetic repair, adhesive bonding	GM Goodwrench® Structural Bonding Epoxy (GM P/N 12345726 or equivalent)	GM Dealer
		Lord Fusor® SMC Body Panel Repair Adhesive or equivalent	Refer to local paint supplier
Most rigid plastic parts	Adhesive bonding	GM Goodwrench® Structural Bonding Epoxy (GM P/N 12345726 or equivalent)	GM Dealer
		Dynatron Dyna-Weld Plio Grip® or equivalent (OE structural adhesive)	Refer to local paint supplier
Most rigid plastic parts	Adhesive structural* bonding	GM Goodwrench® Structural Bonding Epoxy (GM P/N 12345726 or equivalent)	GM Dealer
Most rigid plastic parts	Adhesive bonding Structural bonding	Ashland Pliogrip® 7773B-3-minute Ashland Pliogrip® 7779B-10-minute Ashland Pliogrip® 7770B-35-minute	Supplied by Crest Industries 1-800-822-4100 fax 1-800-344-4461
SRIM most rigid plastic parts	Cosmetic repair, adhesive bonding	GM Goodwrench® SRIM™ repair kit (GM P/N 12378523) or SIA™ Adhesives, INC. SRIM™ repair kit P/N 30208030001 adhesive 200ML TUBES P/N 30208020001 50ML TUBES P/N 30208010001	SIA Adhesives, INC. customer service 1-330-374-2468
* Structural adhesive bonding may require the use of a pneumatic applicator, A8-37479-1A, or equivalent, to speed the application of the GM P/N 12345726 epoxy.			Kent-Moore 1-800-GM-TOOLS

REPAIR INSTRUCTIONS

GENERAL PLASTIC REPAIR

WARNING: In order to reduce the risk of personal injury when exposed to toxic fumes

while grinding, cutting, or applying repair material on any type of sheet molded compound or RIM rigid plastic, observe the following guidelines:

- **Work in a properly ventilated area**
- **Apply protective cream to any exposed skin**
- **Remove any mixture that comes into contact with skin**
- **Wash skin with cold water to remove glass and resin dust**
- **Use a sander with a vacuum attachment**
- **Follow the repair material manufacturer's instructions**

Also, always wear the following:

- **An approved respirator, or air supplied respirator**
- **Eye protection**
- **Rubber gloves**
- **Earplugs**
- **Protective clothing**

The following procedures should be followed when repairing all types of thermoset plastic:

- Follow the manufacturer's application and curing recommendations.
- Do not intermix systems. Use the supplies and the repair materials from the same manufacturer.
- Clean the inner and outer surfaces of the repair area with a soap impregnated scouring pad in order to remove any dirt or mold release agent.
- Clean the area with a wax and grease remover, using only enough of the remover to dampen a cloth. Allow the panel to dry thoroughly.
- Remove the surface finish from the area to be repaired. Adhesives are designed to adhere to the plastic substrate, not the finish.
- Prime a metal surface before applying the repair material.
- Inspect the rear side of the work area before making repairs in order to avoid possible damage to wires, motors, etc.

DESCRIPTION AND OPERATION

HOW TO IDENTIFY PLASTIC PARTS

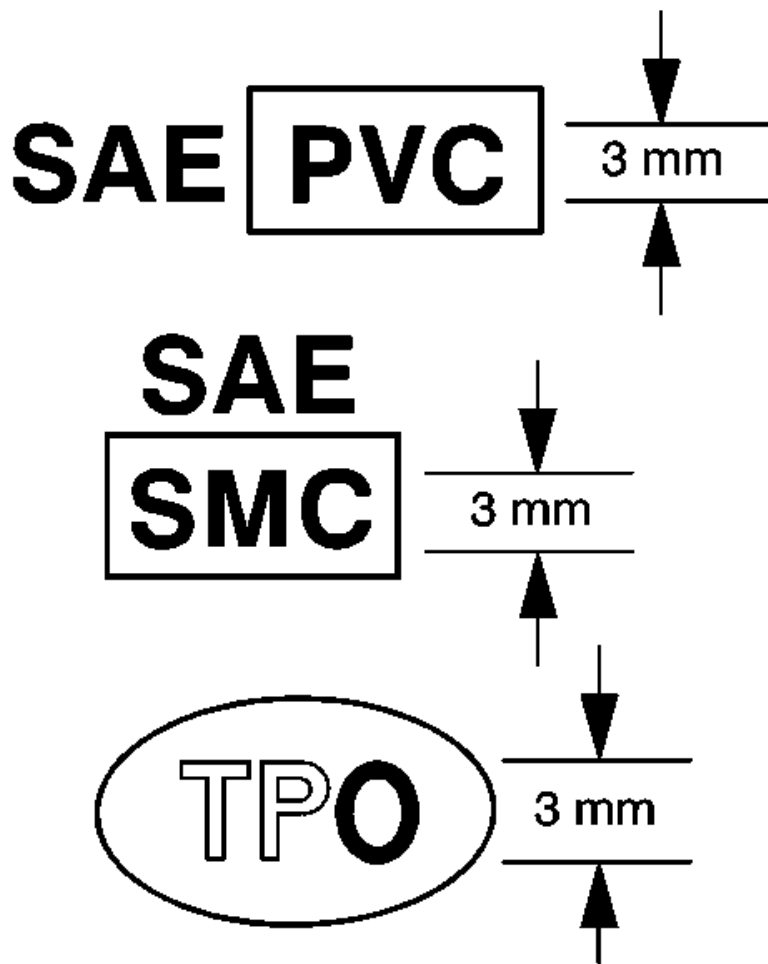


Fig. 1: Identifying SAE Code

Courtesy of GENERAL MOTORS COMPANY

Plastic parts can be identified by the SAE code, which is usually found on the rear of the part, and/or by the characteristics of the plastic. Knowing the type of plastic aids in selecting the proper repair materials and in selecting the proper repair procedure.

Look for the SAE code stamped into the part.

Code Found

Match the code to those in the plastic identification chart to determine whether the plastic is thermoplastic or thermoset plastic, and whether the plastic is rigid or flexible. Refer to **Plastic Identification and Refinishing Systems**.

No Code Found

WARNING: Do NOT use a plastic burn test to distinguish the type of plastic. The burn

test produces vapors which are harmful.

Perform one or both of the following tests to determine if the part is thermoplastic polyolefin or thermoset non-polyolefin.

Float Test

1. Cut a shaving of plastic from the back of the part.

The shaving should be free of mold release agents and paint.

2. Place the shaving in a container of water.
 - Thermoplastic polyolefin floats.
 - Thermoset non-polyolefin sinks.

Abrasion Test

- Sand a spot near the damaged area with Grade 36 Roloc Disc.
- Thermoplastic polyolefin material melts or frays when sanded.
- Thermoset non-polyolefin material sands cleanly.

Thermoplastic and thermoset plastics can be either rigid or flexible. Thermoplastic plastic parts are best repaired with a hot iron plastic material-feed welder, but are usually replaced. Thermoset plastic can be repaired with epoxy or other more rigid 2 package repair material.

- For rigid thermoset repair materials, refer to **Rigid Plastic Part Repair Materials**.
- For flexible thermoset repair materials, refer to **Flexible Plastic Part Repair Materials**.
- For general repair instructions, refer to **General Plastic Repair**.

PLASTIC IDENTIFICATION AND REFINISHING SYSTEMS

Plastic Identification and Refinishing Systems

Identifying Symbol- Old Symbol in ()s	Chemical Composition or Plastic Family Name	Typical Area(s) Where Part is Used	Examples of Common / Trade Names	Type of Plastic
ABS	Acrylonitrile / Butadiene-Styrene	Armrest Support, Console, IPC, Steering Column Bracket / Jacket, Trim Molding	ABS, Absafil, Magnum, Cycolac, Dyel, Kralastic, Lustran	Thermoplastic
ABS + PC	Acrylonitrile / Butadiene-Styrene + Polycarbonate	Instrument Panel, IPC	Bayblend, Cycoloy, KHA, Pulse	Rigid
ABS / PVC	ABS/Vinyl (Soft)	Head Rest Cover, Instrument Panel Pad, Trim	ABS Vinyl	Flexible, Vinyl

		Molding / Panel		
EPDM	Ethylene Propylene Diene Monomer	Body Panel, Bumper Impact Strip	EPDM, Nordel	Rigid
EVA (EVAC)	Ethylene / Vinyl Acetate	Head Rest Cover, Misc Soft Trim	Elvax, Microthane	Flexible
PA	Polyamide	Headlamp Bezels, Quarter Panel Extensions, Exterior Finish Trim Panels	Nylon, Capron, Zytel, Rilsan, Minion, Vydine, Welland	Rigid
PA, PAG, PAGG	Polyamide	Exterior Finish Trim Panel, Headlamp Bezel, Quarter Panel Extension	Capron, Minlon, Nylon, Rilsan, Vydine, Wellamid, Zytel	Rigid, Thermoset
PA + PPE	Polymide + Polyphenylene Ether	Exterior Trim, Fender	GTX	Rigid, Thermoset
PBT + TEEE (PBTP + EEBC)	Polybutylene, Terephthalate + Ether, Ester Block Compound	Fascia, Rocker Panel Molding	Bexloy M	Rigid
PC	Polycarbonate	Interior Rigid / Hard Trim Panel, Valance Panel	Calibre, Lexan, Merlon, Makrolon	Rigid, Thermoset
PC + PETP	Polycarbonate + Polybutylene, Terephthalate	Bumper Fascia	Macroblend, Valox, Xenoy	Flexible, Thermoset
PE	Polyethylene	Fuel Tank Shield, Inner Fender Panel, Interior Trim Panel, Seat Belt Cover, Spoiler, Valance	Alathon, Dylan, Foriflex, Hi-fax, Hosalen, Marlex, Paxon	Rigid, Thermoplastic
PF	Phenol Formaldehyde	Ashtray	Amberol, Bakelite, Durez, Genal, Phenolic, Plyophen, Resinox	Rigid, Thermoset
PP	Polypropylene	Bumper Fascia, Cowl Panel, Deflector Panel, Door Panel, Inner Fender, Interior Molding, Kick Panel, Load Floor, Radiator Shroud, Wheel Cover	Azdel, Daplen, Escorene, Marlex, Novolen, Oleflo, Profax, Tenite	Flexible, Thermoplastic
PPE (PPO)	Polyphenylene Ether	Bezels, Chromed Plastic, Headlamp	Noryl, Oleflo, Prevex	Rigid, Thermoset

		Door, Ornaments		
PS	Polystyrene	Dash Panel, Door Panel	Durathon, Dylan, Lustrex, Polystyrol, Styron	Flexible, Soft
PUR	Polyurethane, Thermoset (Unsaturated)	Bumper Fascia, Filler Panel, Front/Rear Body Panel, Pickup Box	Bayflex, Castethane, RIM, RRIM, SRIM	Thermoset
PVC	Polyvinyl Chloride (Vinyl)	Interior Soft Trim, I/P Skins, Roof Cover	Geon, Pliovic, Unichem, Vinoflex, Vinyl, Vinylite	Flexible, Vinyl
SAN (SA)	Styrene Acrylonitrile	Center Console, Glove Box Door, Interior Trim Panel	Foracryl, Lustran, Tyril	Rigid
TEO (EP, EPM, TPO)	Ethylene / Propylene (Rubber)	Air Dam, Bumper Fascia, Valance Panel	EPI, EPII, TPO, TPR (Thermoplastic Rubber)	Flexible, Thermoplastic
TPO	Thermal Plastic Oletin	Bumper Covers	TPO	Flexible Thermoplastic
TPU (TPUR)	Polyurethane, Polyolefin	Bumper Fascia, Gravel Deflector, Soft Filler Panel, Window Molding	Estane, Pellethane, Roylar, Toxin	Flexible, Thermoplastic
UP	Polyester / Thermoset	Air Scoop, Air Spoiler, Fascia Extension, Hood, Instrument Housing, Rear Compartment Lid, Roof, Ventilation Grid	Fiberglass, Premiglass, Selectron, SMC, Vibrinmat	Rigid, Thermoset
For symbols not listed in this table, contact the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.				

Wiring Systems and Power Management - Schematic Wiring Diagrams - Power Distribution Schematics

SCHEMATIC WIRING DIAGRAMS

POWER DISTRIBUTION WIRING SCHEMATICS

B+ Bus X50D Fuse Block - Battery (except CZ2)

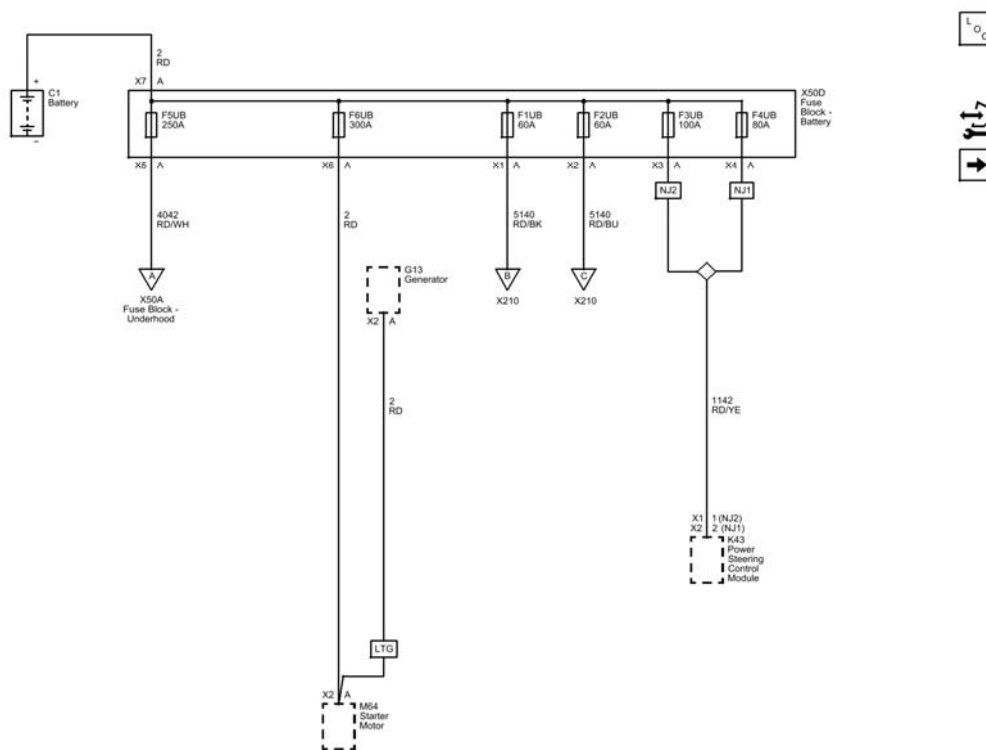


Fig. 1: B+ Bus X50D Fuse Block - Battery (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

B+ Bus X50A Fuse Block - Underhood (1 of 3) (except CZ2)

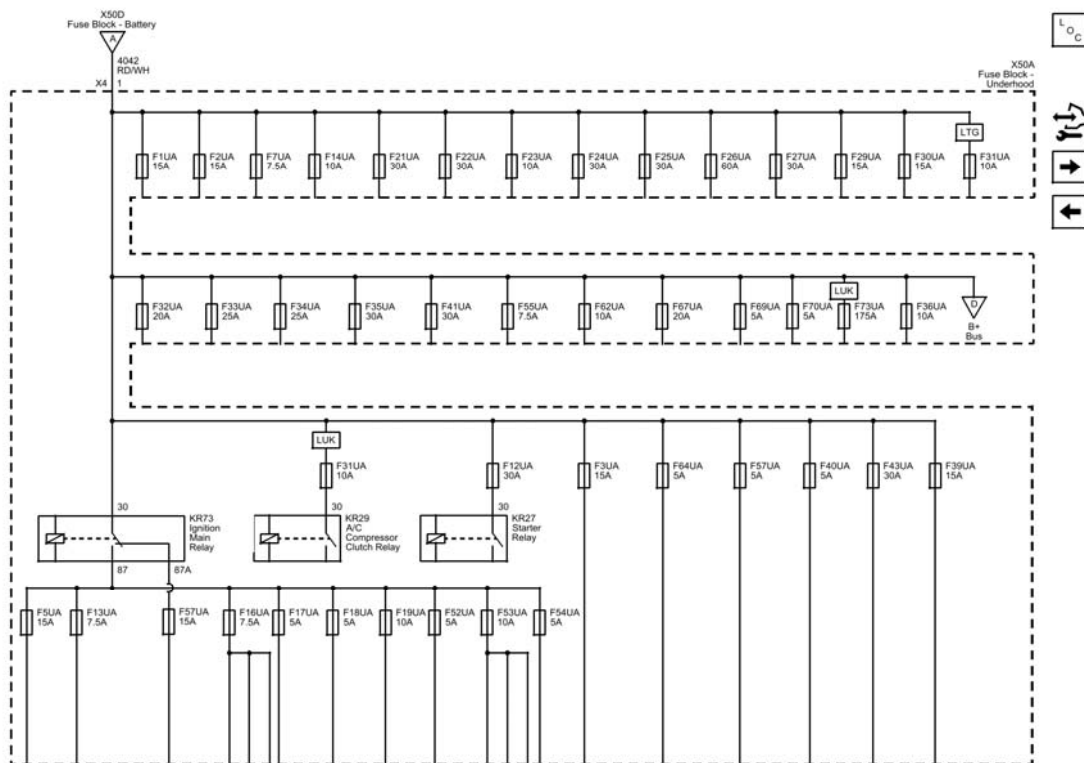


Fig. 2: B+ Bus X50A Fuse Block - Underhood (1 of 3) (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

B+ Bus X50A Fuse Block - Underhood (2 of 3) (except CZ2)

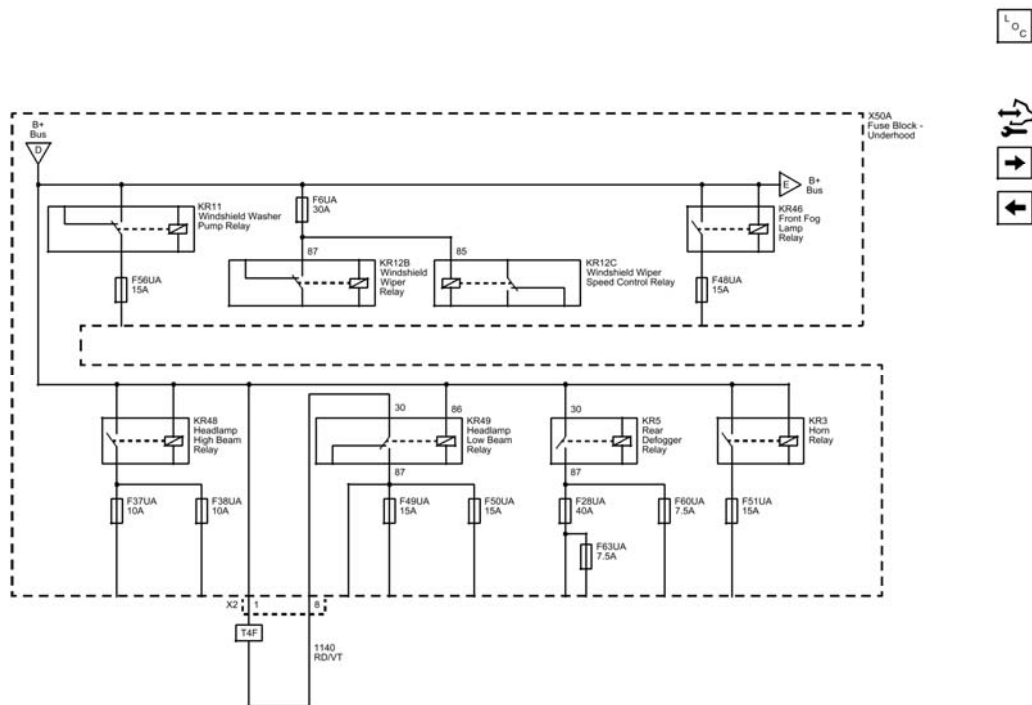


Fig. 3: B+ Bus X50A Fuse Block - Underhood (2 of 3) (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

B+ Bus X50A Fuse Block - Underhood (3 of 3) (except CZ2)

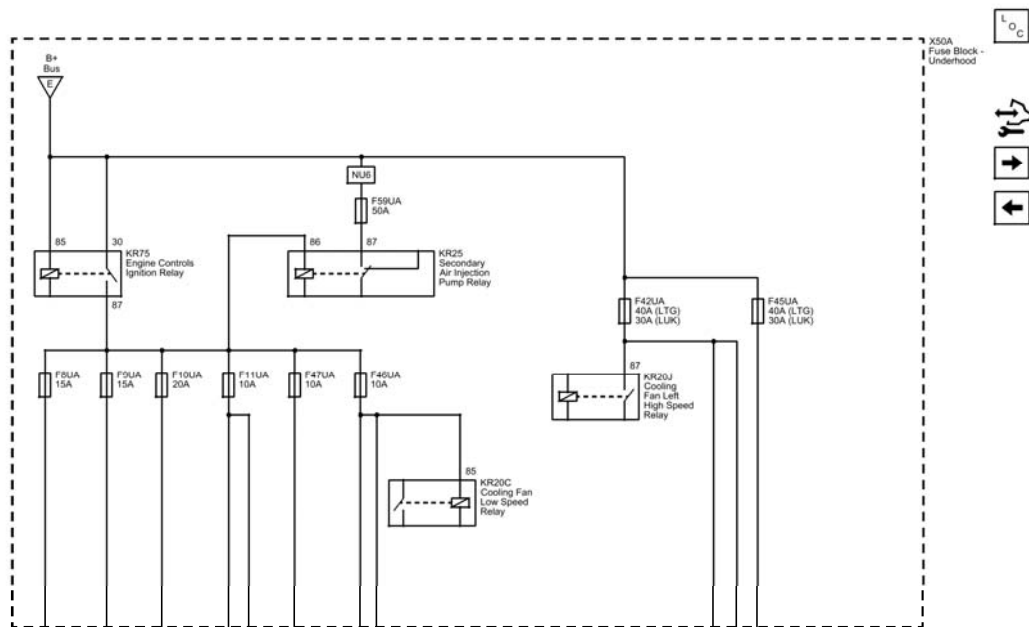


Fig. 4: B+ Bus X50A Fuse Block - Underhood (3 of 3) (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

B+ Bus X50D Fuse Block - Battery (CZ2)

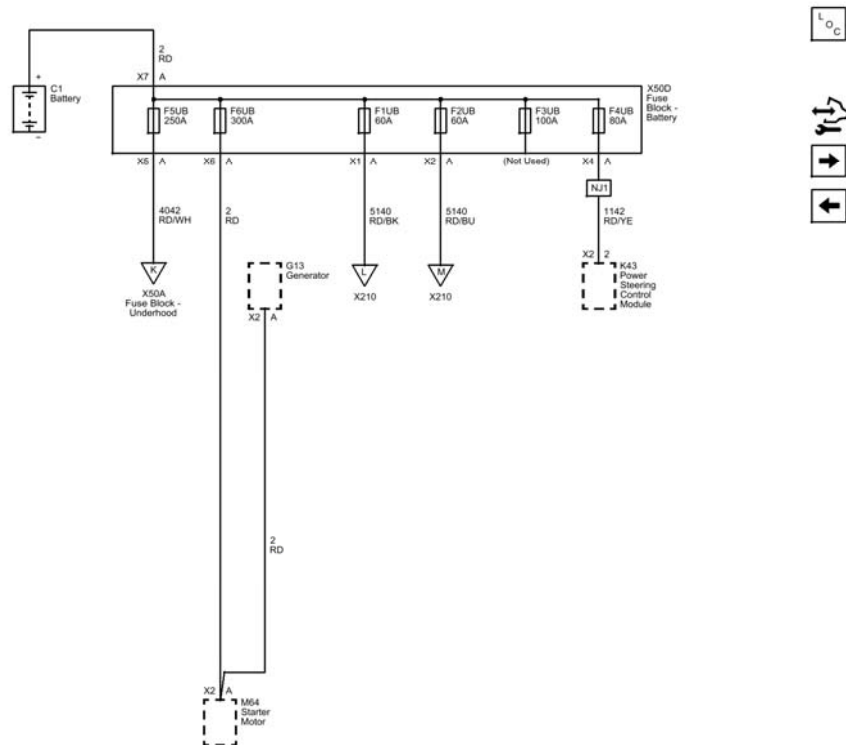


Fig. 5: B+ Bus X50D Fuse Block - Battery (CZ2)
Courtesy of GENERAL MOTORS COMPANY

B+ Bus X50A Fuse Block - Underhood (1 of 3) (CZ2)

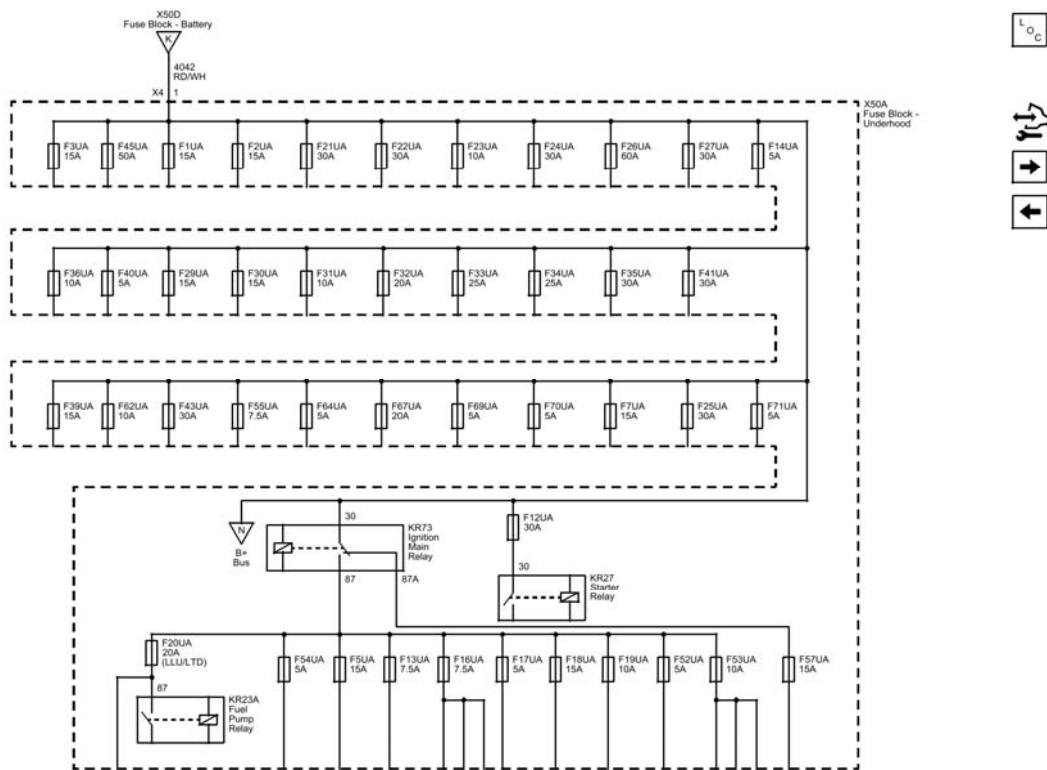


Fig. 6: B+ Bus X50A Fuse Block - Underhood (1 of 3) (CZ2)
Courtesy of GENERAL MOTORS COMPANY

B+ Bus X50A Fuse Block - Underhood (2 of 3) (CZ2)

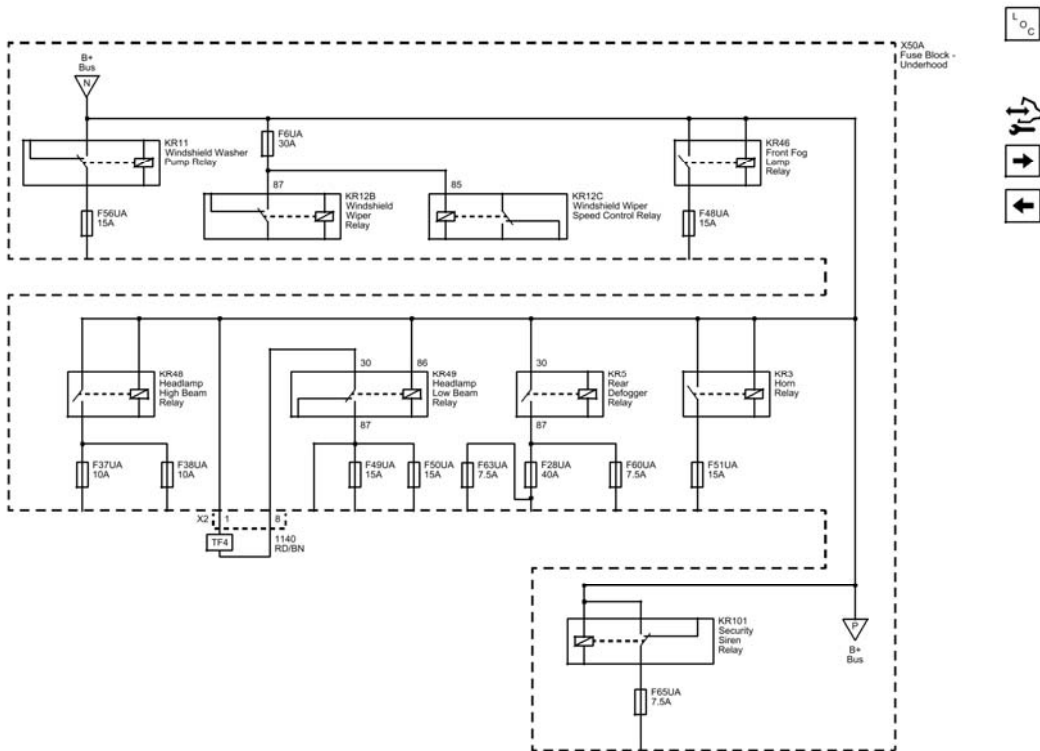


Fig. 7: B+ Bus X50A Fuse Block - Underhood (2 of 3) (CZ2)
Courtesy of GENERAL MOTORS COMPANY

B+ Bus (3 of 3) (CZ2)

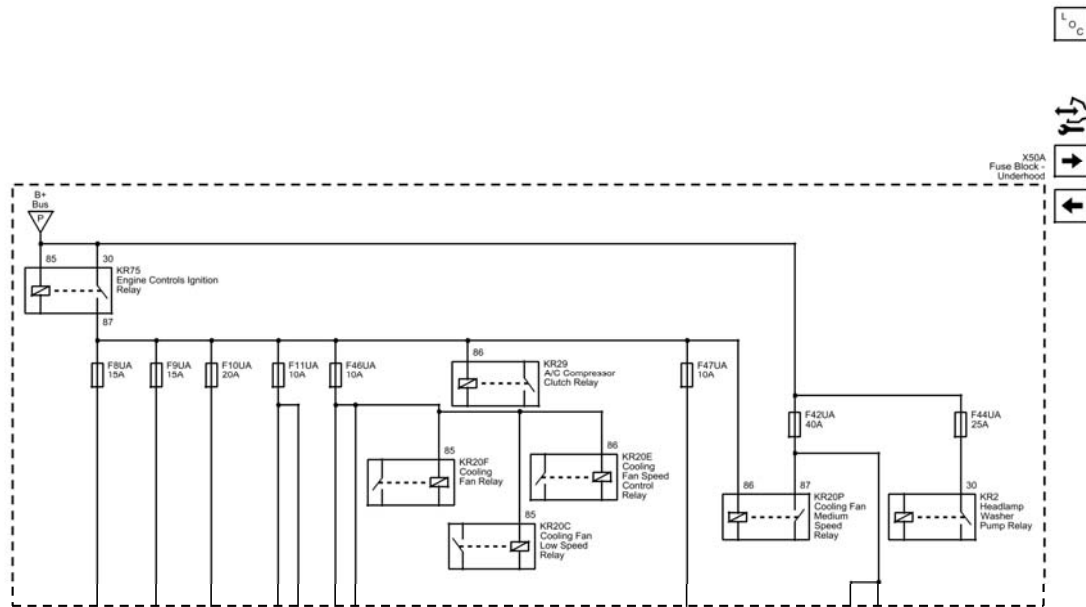


Fig. 8: B+ Bus (3 of 3) (CZ2)

Courtesy of GENERAL MOTORS COMPANY

F1UA, F2UA, F7UA, F14UA, F22UA, F26UA, F29UA, F30UA, and F36UA Fuses (except CZ2)

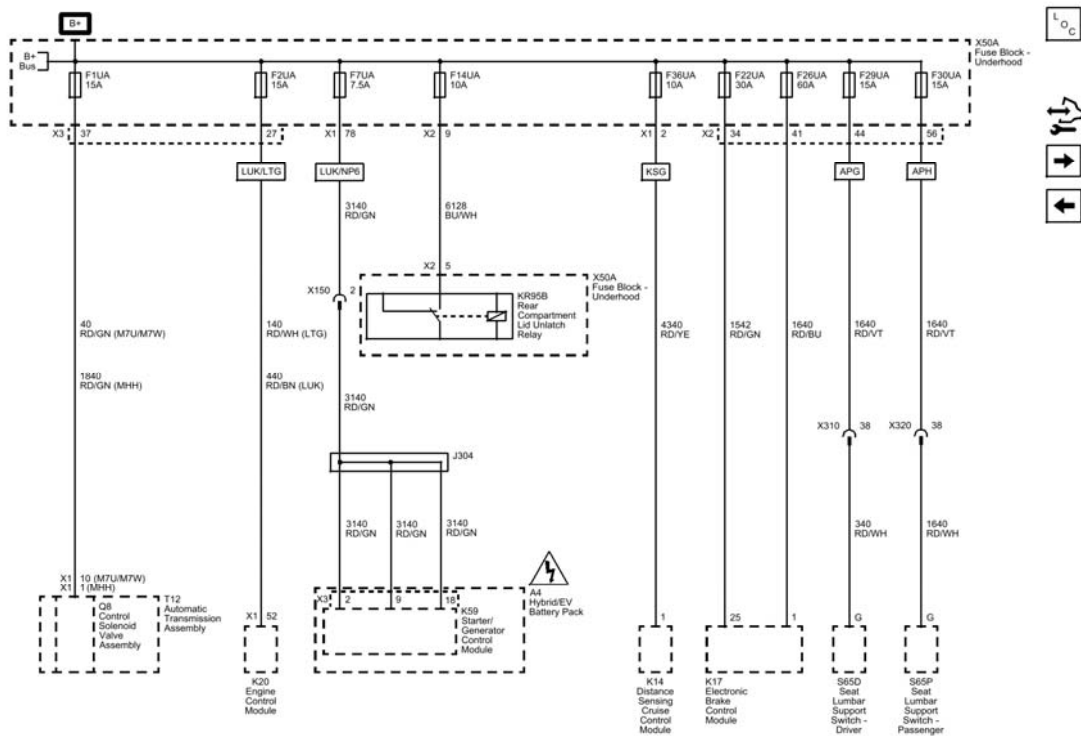


Fig. 9: F1UA, F2UA, F7UA, F14UA, F22UA, F26UA, F29UA, F30UA, and F36UA Fuses (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

F25UA, F27UA, F34UA, F39UA, F40UA, F41UA, F43UA, F55UA, F62UA, F64UA, F67UA, and F71UA Fuses (except CZ2)

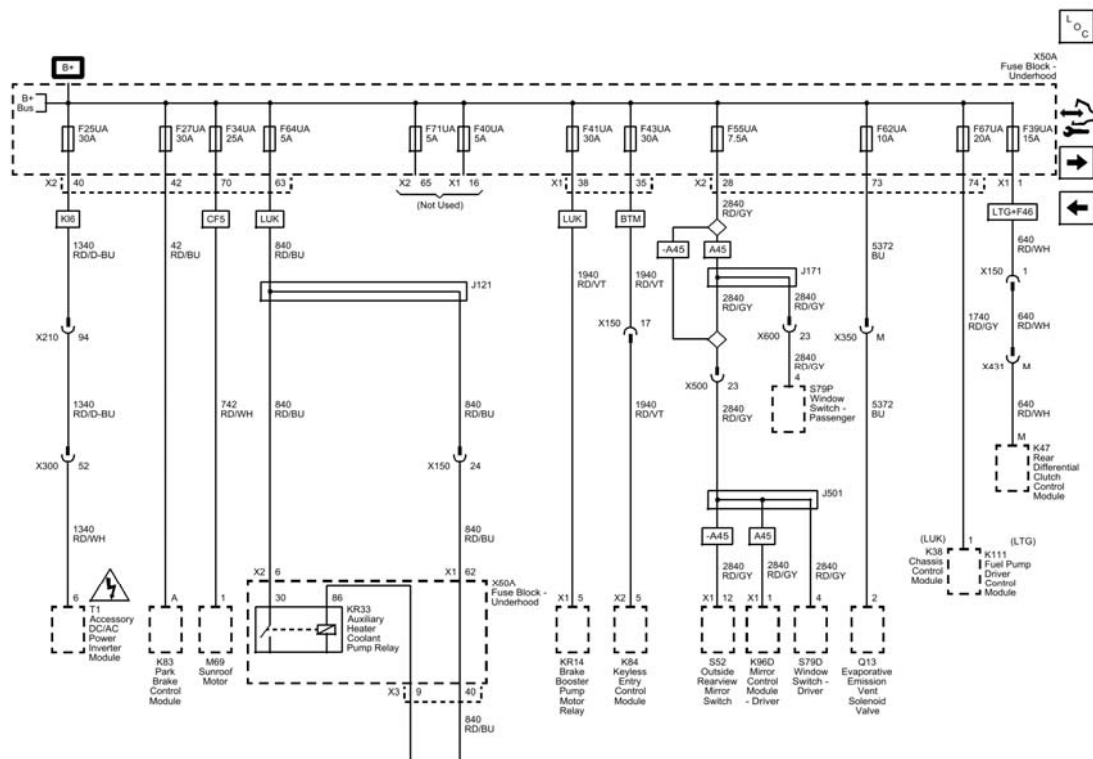


Fig. 10: F25UA, F27UA, F34UA, F39UA, F40UA, F41UA, F43UA, F55UA, F62UA, F64UA, F67UA, and F71UA Fuses (except CZ2)

Courtesy of GENERAL MOTORS COMPANY

F21UA, F24UA, F31UA, F32UA, F33UA, F35UA, and F69UA Fuses (except CZ2)

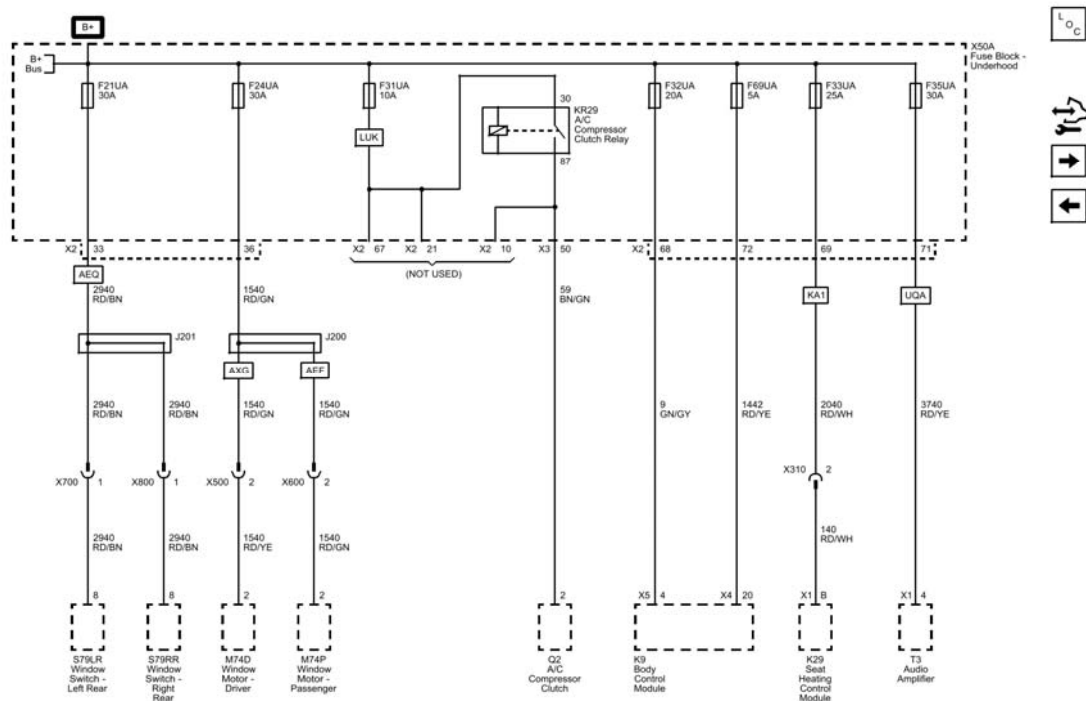


Fig. 11: F21UA, F24UA, F31UA, F32UA, F33UA, F35UA, and F69UA Fuses (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

F8UA, F9UA, F10UA, and F23UA Fuses (except CZ2)

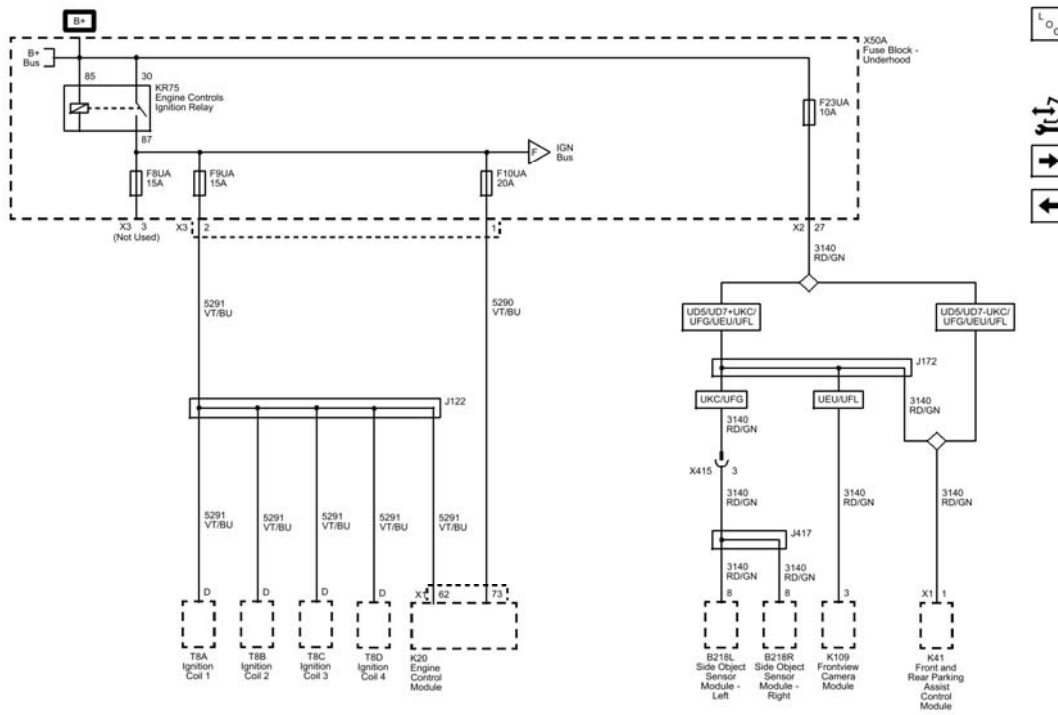


Fig. 12: F8UA, F9UA, F10UA, and F23UA Fuses (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

F46UA and F47UA Fuses (except CZ2)

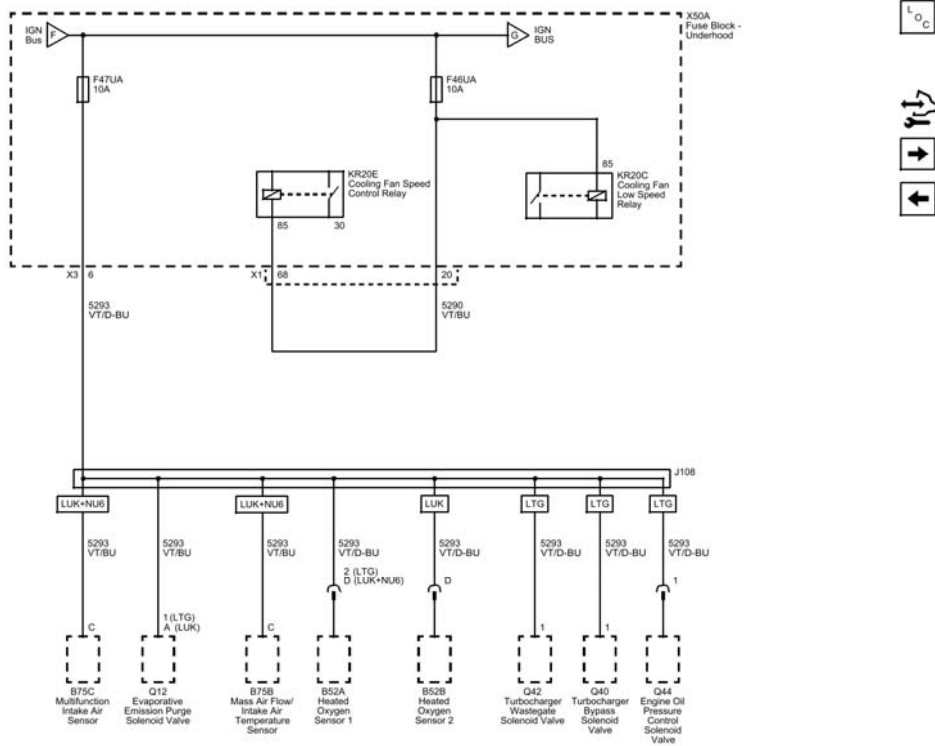


Fig. 13: F46UA and F47UA Fuses (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

F5UA, F13UA, F16UA, F17UA, F18UA, F19UA, F52UA, F53UA, F54UA and F57UA Fuses (except CZ2)

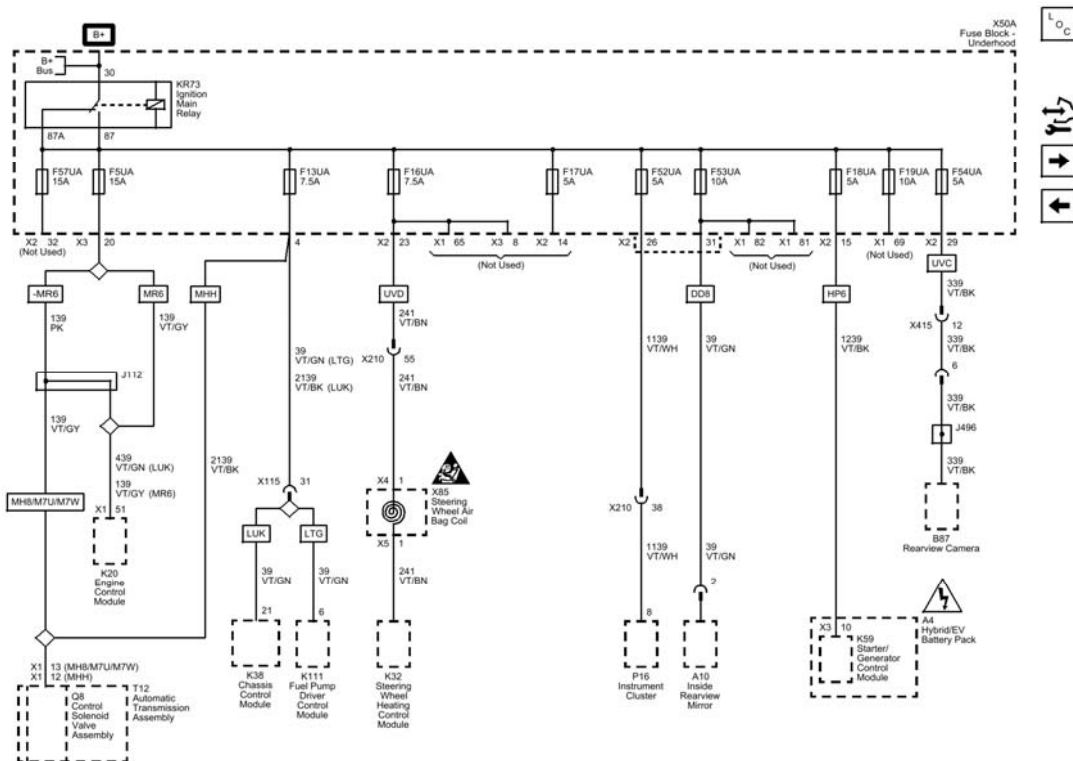


Fig. 14: F5UA, F13UA, F16UA, F17UA, F18UA, F19UA, F52UA, F53UA, F54UA and F57UA Fuses (except CZ2)

Courtesy of GENERAL MOTORS COMPANY

F3UA, F11UA, and F73UA Fuses (except CZ2)

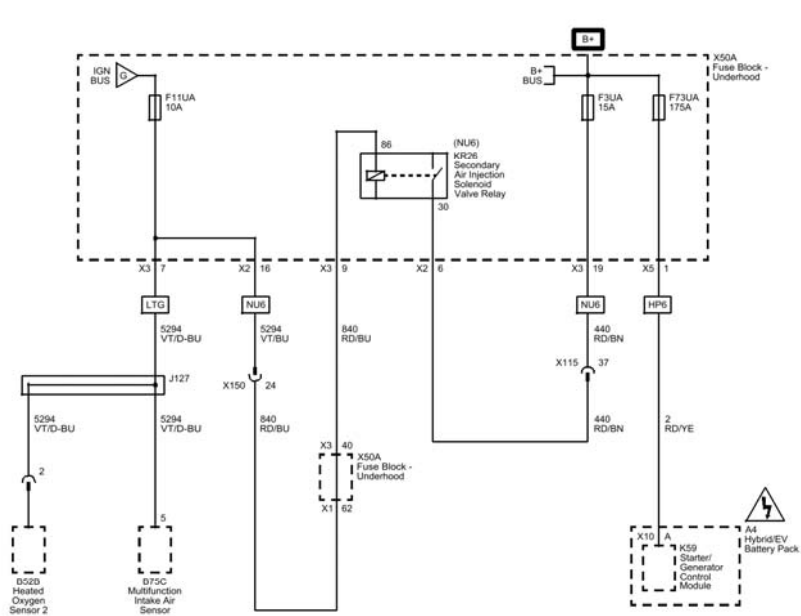


Fig. 15: F3UA, F11UA, and F73UA Fuses (except CZ2)
 Courtesy of GENERAL MOTORS COMPANY

F48UA, F51UA, and F56UA Fuses (except CZ2)

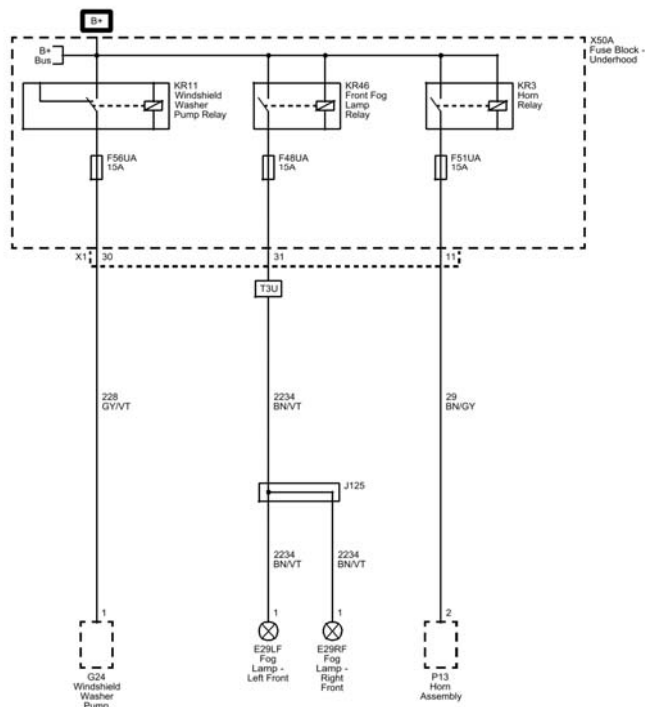


Fig. 16: F48UA, F51UA, and F56UA Fuses (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

F28UA, F42UA, F45UA, F60UA, and F63UA Fuses (except CZ2)

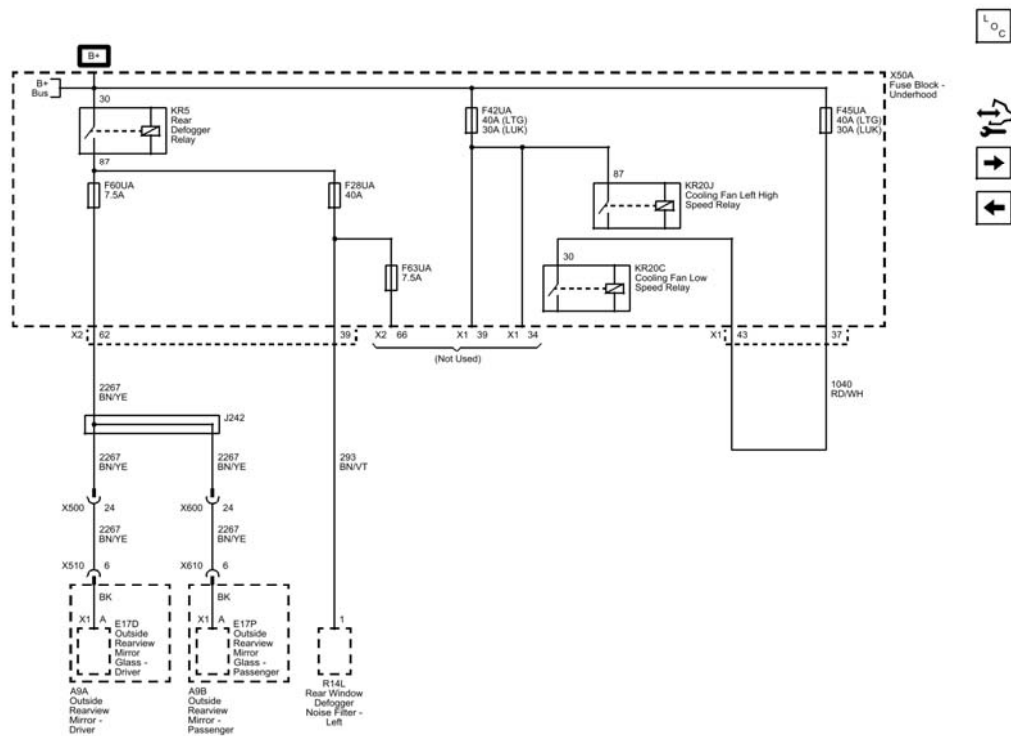


Fig. 17: F28UA, F42UA, F45UA, F60UA, and F63UA Fuses (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

F37UA, F38UA, F49UA, and F50UA Fuses (except CZ2)

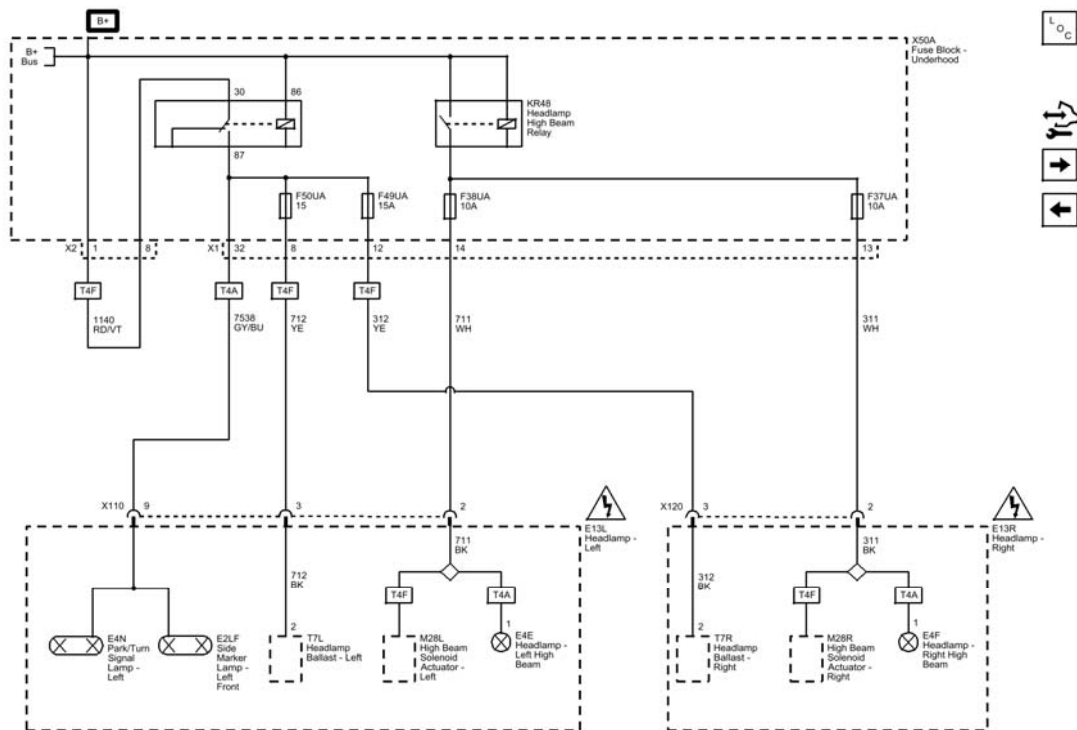


Fig. 18: F37UA, F38UA, F49UA, and F50UA Fuses (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

F14DA, F15DA, F16DA, F17DA, F18DA, F19DA, F20DA, F21DA, F22DA, F23DA, F24DA, F25DA, and F26DA Fuses (except CZ2)

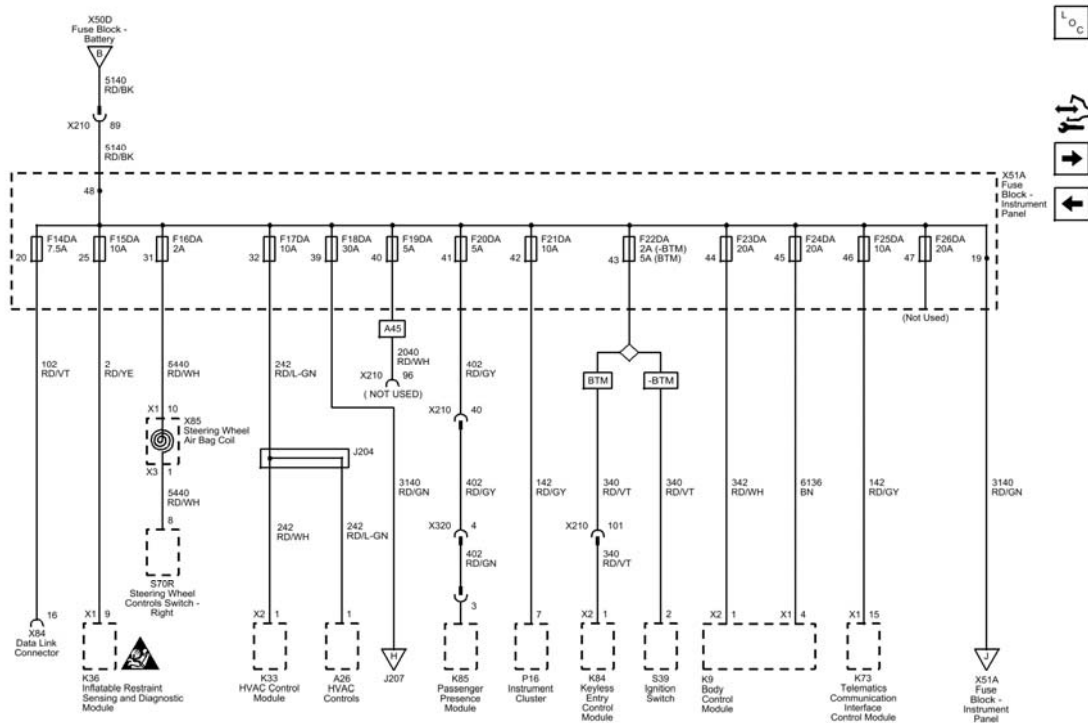


Fig. 19: F14DA, F15DA, F16DA, F17DA, F18DA, F19DA, F20DA, F21DA, F22DA, F23DA, F24DA, F25DA, and F26DA Fuses (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

F1DA, F4DA, F5DA, F6DA, and F7DA Fuses (except CZ2)

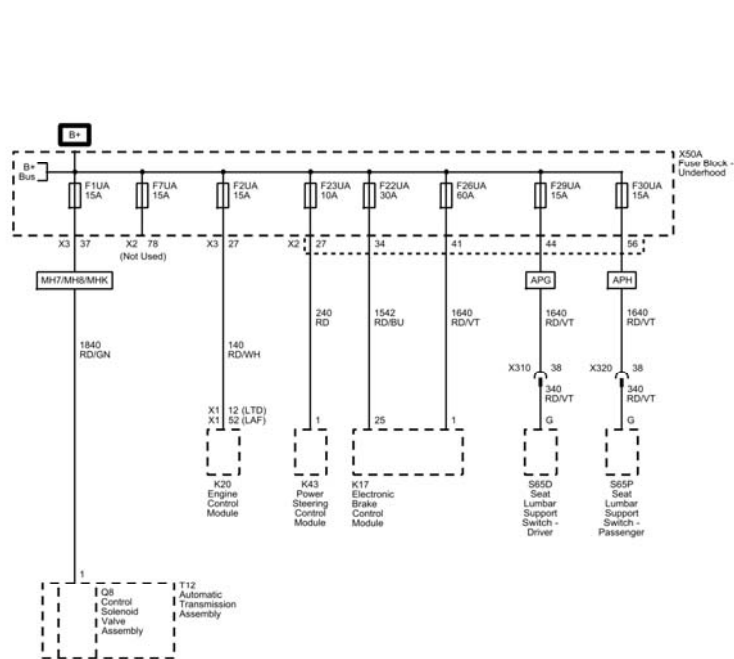


Fig. 22: F1UA, F2UA, F3UA, F4UA, F7UA, F14UA, F22UA, F23UA, F26UA, F29UA, F30UA, and F31UA Fuses (CZ2)

Courtesy of GENERAL MOTORS COMPANY

F25UA, F27UA, F34UA, F36UA, F39UA, F40UA, F41UA, F43UA, F55UA, F62UA, F64UA, F67UA, and F71UA Fuses (CZ2)

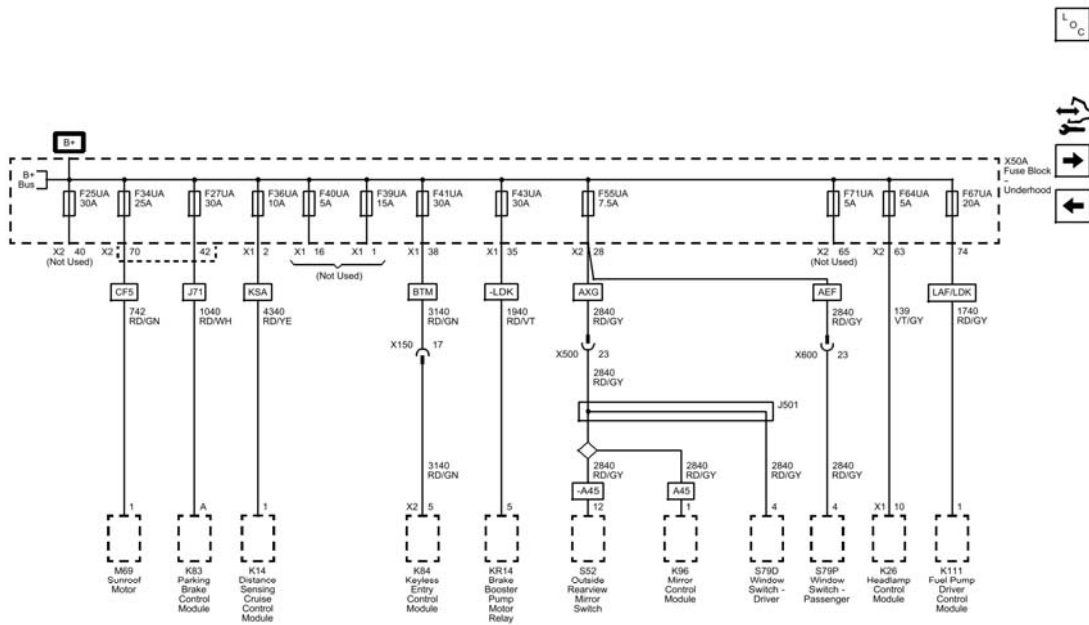


Fig. 23: F25UA, F27UA, F34UA, F36UA, F39UA, F40UA, F41UA, F43UA, F55UA, F62UA, F64UA, F67UA, and F71UA Fuses (CZ2)

Courtesy of GENERAL MOTORS COMPANY

F21UA, F24UA, F32UA, F33UA, F35UA, F69UA, and F70UA Fuses (CZ2)

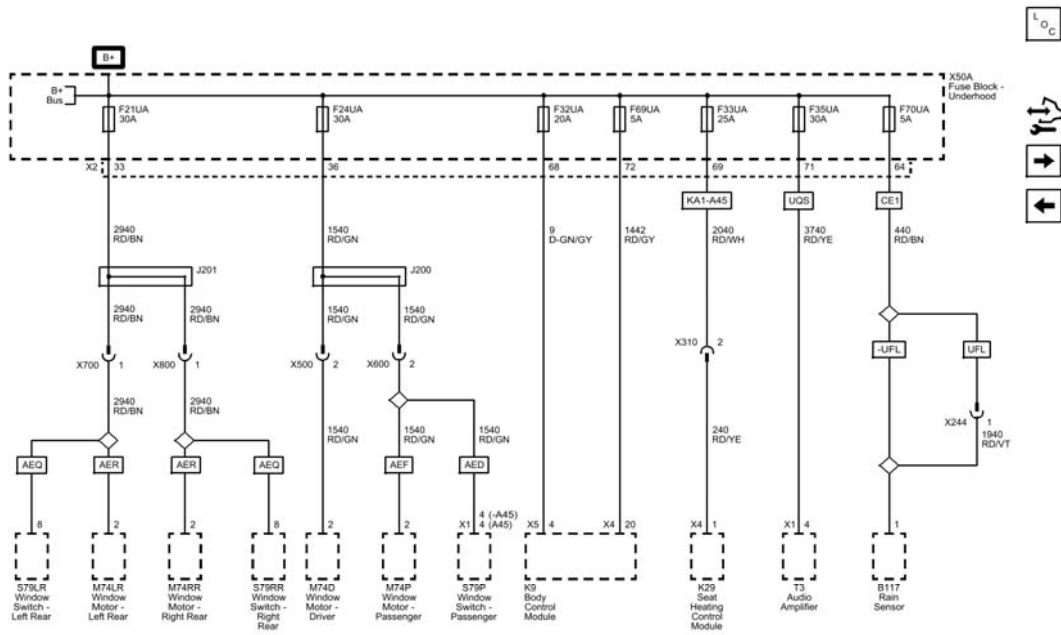


Fig. 24: F21UA, F24UA, F32UA, F33UA, F35UA, F69UA, and F70UA Fuses (CZ2)
Courtesy of GENERAL MOTORS COMPANY

F5UA, F13UA, F16UA, F17UA, F18UA, F19UA, F20UA, F52UA, F53UA, F54UA, and F57UA Fuses (CZ2)

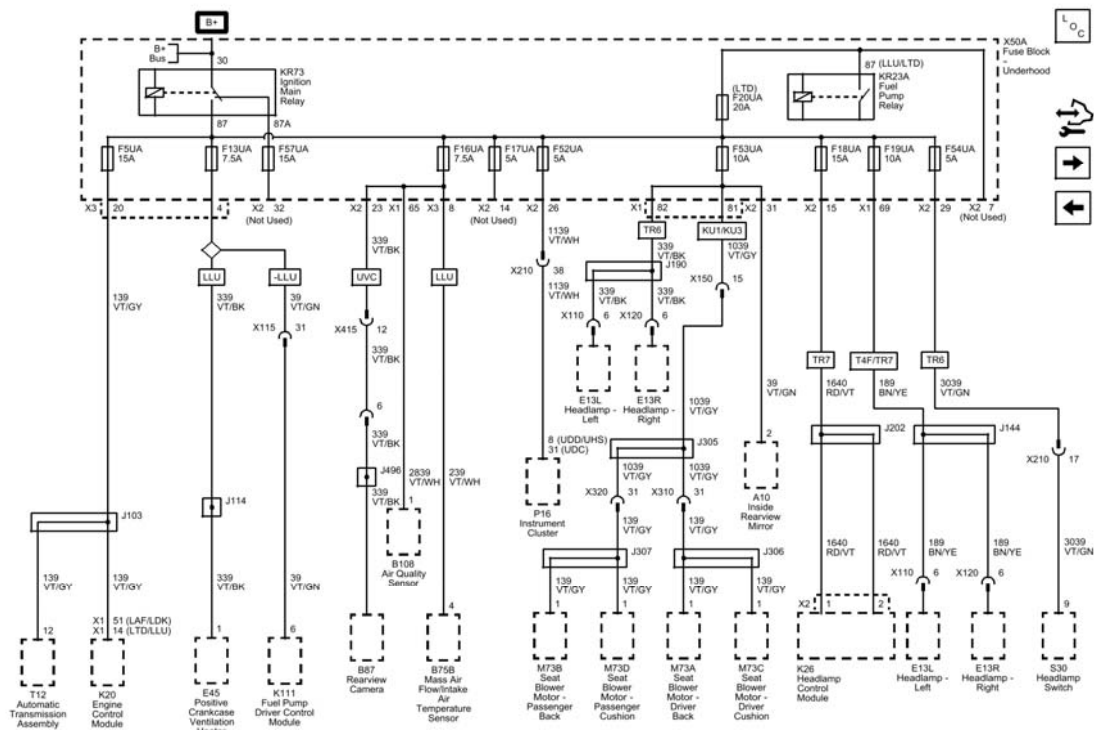


Fig. 25: F5UA, F13UA, F16UA, F17UA, F18UA, F19UA, F20UA, F52UA, F53UA, F54UA, and F57UA Fuses (CZ2)

Courtesy of GENERAL MOTORS COMPANY

F28UA, F42UA, F45UA, F60UA, and F63UA Fuses (CZ2)

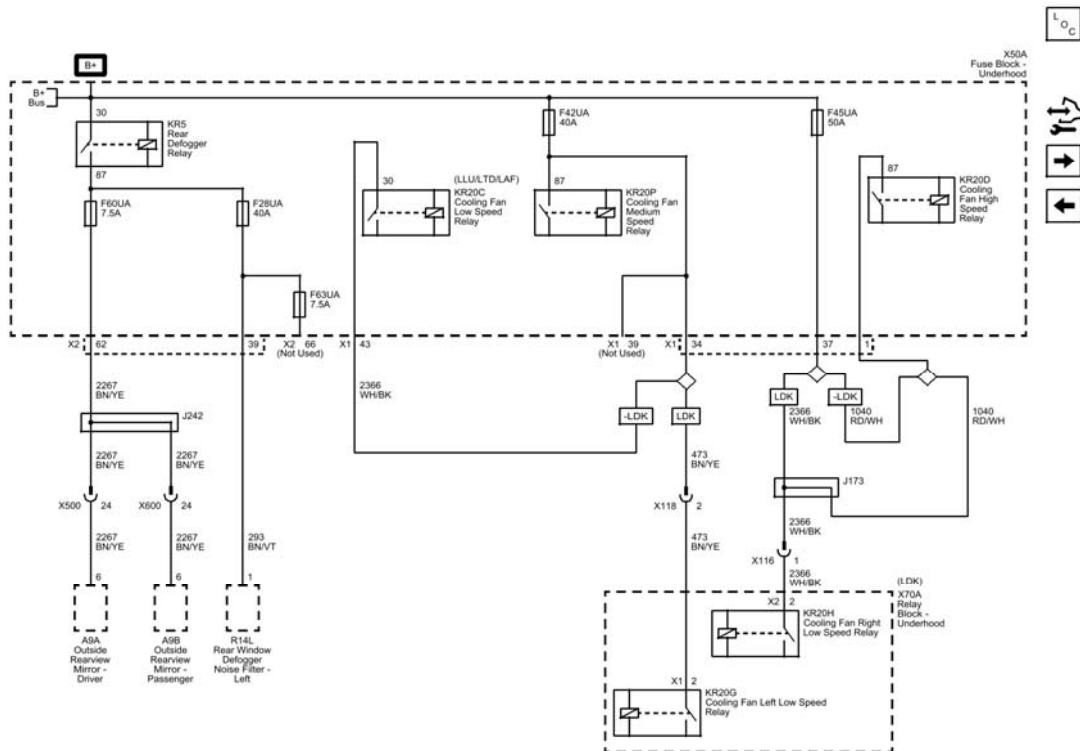


Fig. 26: F28UA, F42UA, F45UA, F60UA, and F63UA Fuses (CZ2)
Courtesy of GENERAL MOTORS COMPANY

F31UA, F48UA, F51UA, F56UA, and F62UA Fuses (CZ2)

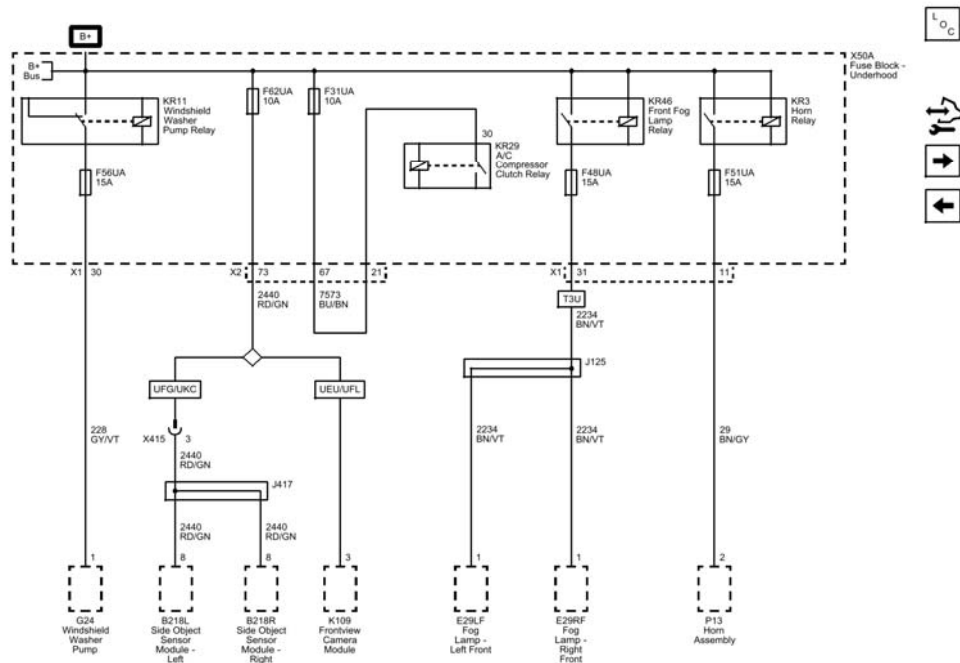


Fig. 27: F31UA, F48UA, F51UA, F56UA, and F62UA Fuses (CZ2)
Courtesy of GENERAL MOTORS COMPANY

F37UA, F38UA, F44UA, F49UA and F50UA Fuses

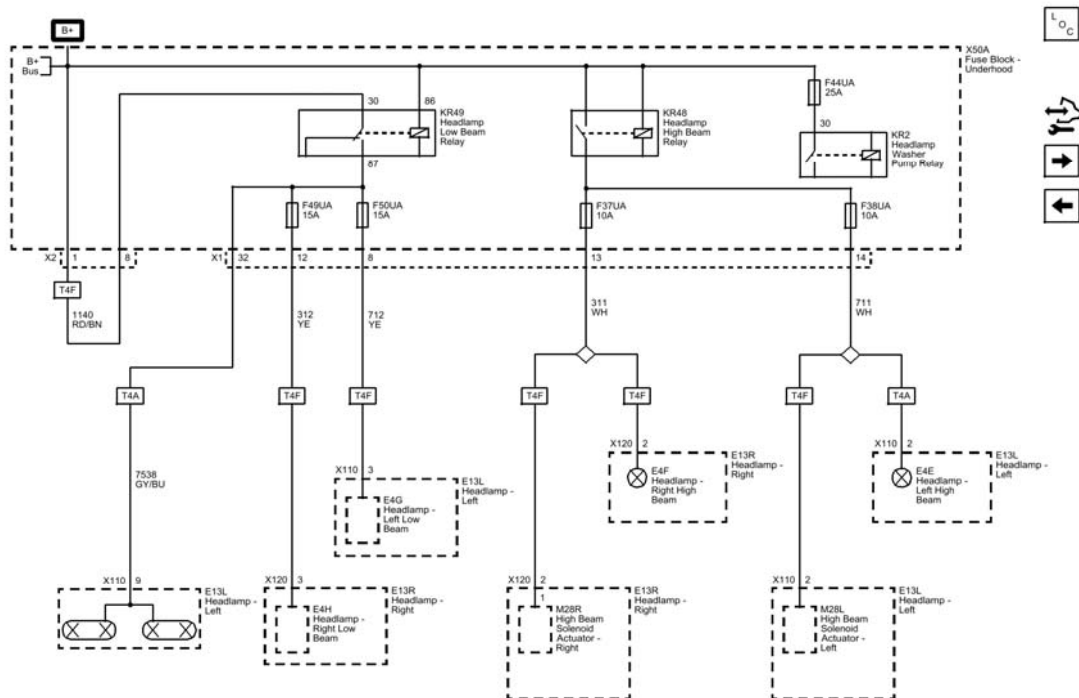


Fig. 28: F37UA, F38UA, F44UA, F49UA and F50UA Fuses
Courtesy of GENERAL MOTORS COMPANY

F8UA, F9UA, F10UA, and F65UA Fuses (CZ2)

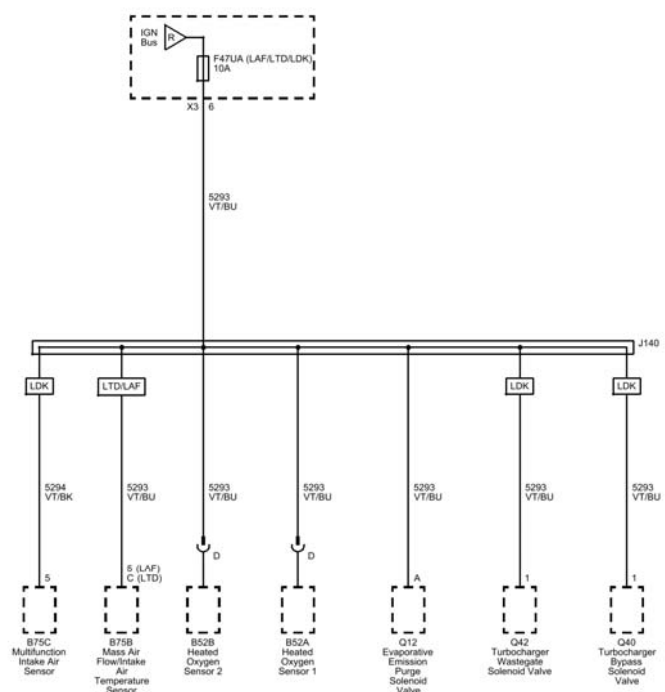


Fig. 31: F47UA Fuse (LAF/LTD/LDK) (CZ2)
Courtesy of GENERAL MOTORS COMPANY

F14DA, F15DA, F17DA, F18DA, F19DA, F20DA, F21DA, F22DA, F23DA, F24DA, F25DA, and F26DA Fuses (CZ2)

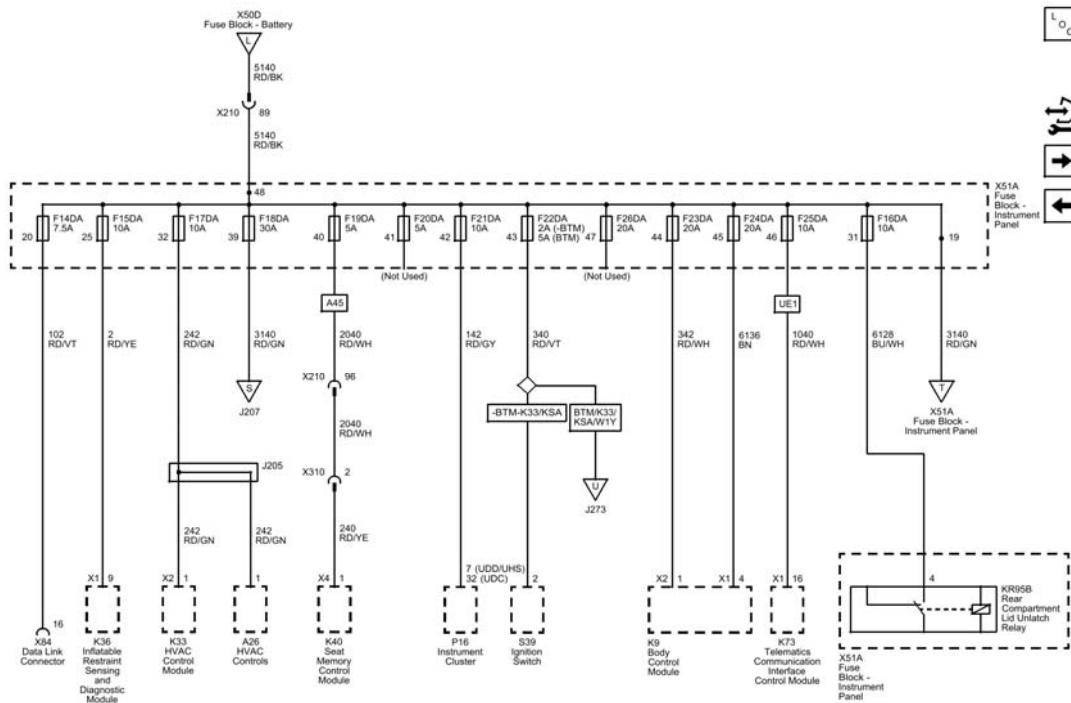


Fig. 32: F14DA, F15DA, F17DA, F18DA, F19DA, F20DA, F21DA, F22DA, F23DA, F24DA, F25DA, and F26DA Fuses (CZ2)

Courtesy of GENERAL MOTORS COMPANY

F1DA, F4DA, F5DA, F6DA, and F7DA Fuses (CZ2)

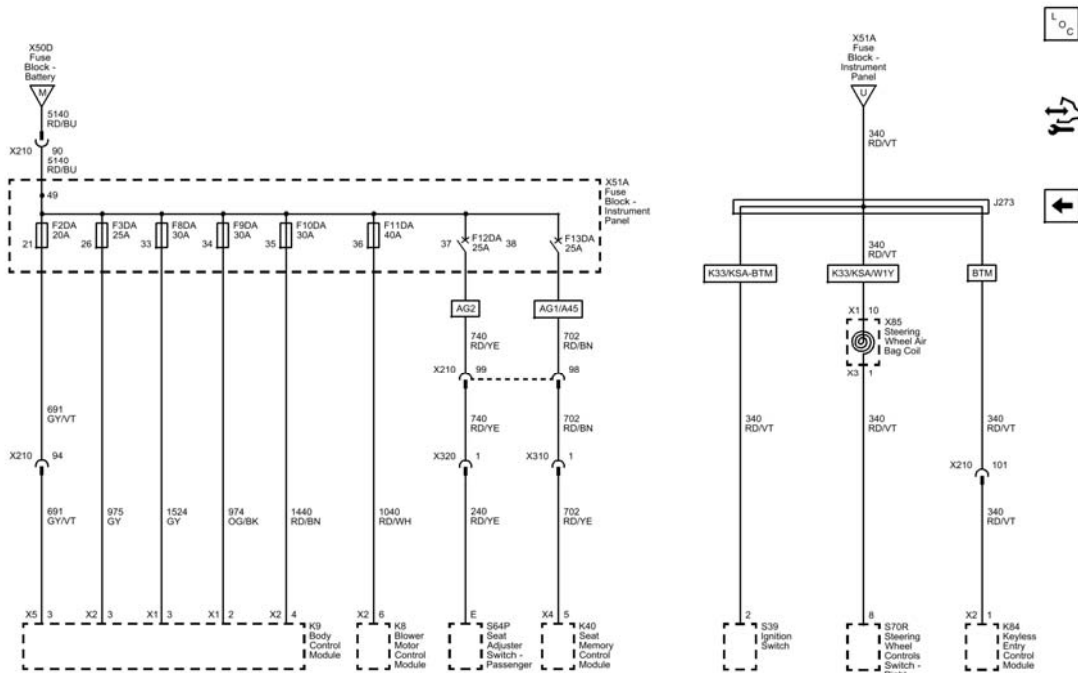


Fig. 34: F2DA, F3DA, F8DA, F9DA, F10DA, and F11DA Fuses, and F12DA, F13DA Circuit Breakers (CZ2)

Courtesy of GENERAL MOTORS COMPANY

ACCESSORIES & EQUIPMENT

Power Outlets

SCHEMATIC AND ROUTING DIAGRAMS

CIGAR LIGHTER/POWER OUTLET SCHEMATICS

12 Volt DC and 110 Volt AC Power Outlets

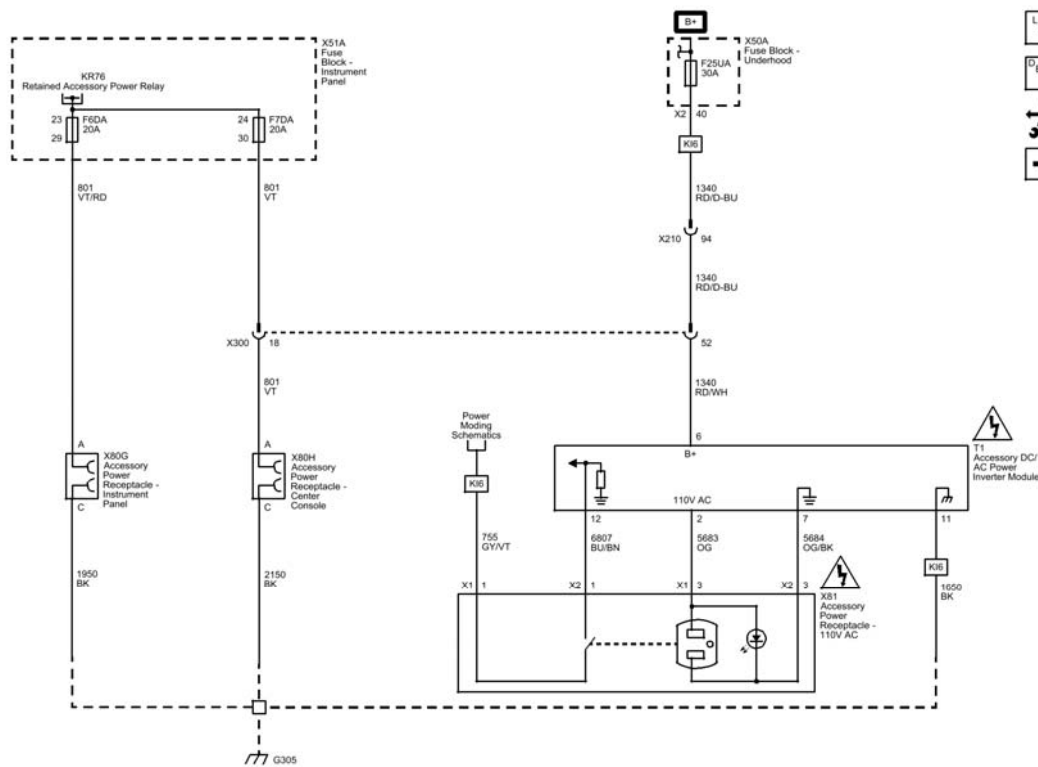


Fig. 1: 12 Volt DC and 110 Volt AC Power Outlets
Courtesy of GENERAL MOTORS COMPANY

Cigar Lighter/Power Outlet CZ2

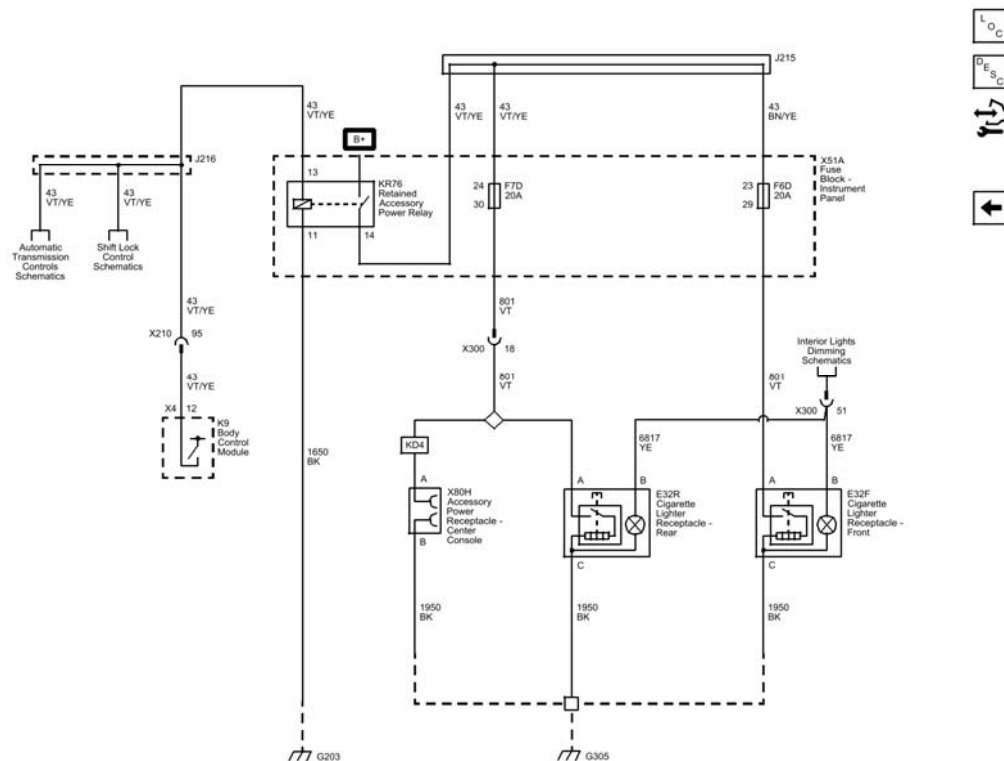


Fig. 2: Cigar Lighter/Power Outlet CZ2
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - POWER OUTLETS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Visual/Physical Inspection

- Inspect for aftermarket devices which can affect the operation of the power outlets. Refer to **Checking Aftermarket Accessories**
- Inspect the accessible system components or the visible system components for obvious damage or for obvious conditions which can cause the symptom.

Intermittent

Electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent**

Conditions and Poor Connections

Symptom List

Refer to **Power Outlet Receptacle Malfunction (110V)**, **Power Outlet Receptacle Malfunction (12V)** in order to diagnose the system.

POWER OUTLET RECEPTACLE MALFUNCTION (110V)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Ignition	1	1	-	-
AC Terminal 2	1	1	1	-
AC Terminal 7	1	1	1	-
Signal	1	1	2	-
Ground	-	1	-	-
1. Accessory DC/AC Power Inverter Module Always OFF				
2. Accessory DC/AC Power Inverter Module Always ON				

Circuit/System Description

The accessory DC/AC power inverter module converts 12 V direct current (DC) battery voltage to 110-120 V alternating current (AC) in order to operate AC powered devices. The accessory DC/AC power inverter module provides up to 150 watts of power. The accessory DC/AC power inverter module is connected to a chassis ground circuit and receives fuse protected battery voltage.

The accessory power receptacle has an internal switch, that detects when an AC powered device is plugged into the receptacle. When the ignition is ON and an AC powered device is plugged into the accessory power receptacle, the normally open switch in the accessory power receptacle, closes. When the accessory DC/AC power inverter module detects the voltage from the accessory power receptacle switch, the inverter module begins to supply 110-120 V AC to the accessory power receptacle - 110V AC after a 1.5 s delay.

Reference Information

Schematic Reference

Cigar Lighter/Power Outlet Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Outlets Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON.
2. Connect an AC powered device to the X81 Accessory Power Receptacle - 110V AC.
3. Verify the T1 Accessory DC/AC Power Inverter Module is turned ON and the device works as expected.
 - **If the device is not powered**

Refer to Circuit/System Testing.

- **If the device is powered**
4. All OK.

Circuit/System Testing

WARNING: To help avoid personal injury, always treat the accessory power receptacle, accessory DC/AC power inverter module, AC circuit wires, and connectors as if AC high-voltage is present.

1. Ignition OFF, scan tool disconnected, ignition key removed. Wait for 2 min. Nothing plugged into the X81 Accessory Power Receptacle - 110V AC, disconnect the harness connector at the T1 Accessory DC/AC Power Inverter Module.
2. Test for less than 10 ohms between the ground circuit terminal 11 and ground.
 - **If greater than 10 ohms**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**

3. Verify that a test lamp illuminates between the B+ circuit terminal 6 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If greater than 2 ohms, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the T1 Accessory DC/AC Power Inverter Module.
 - **If the test lamp illuminates**
4. Test for less than 1 V between the signal circuit terminal 12 and ground.
 - **If greater than 1 V**

Repair the short to voltage in the signal circuit.
 - **If less than 1 V**
5. Test for infinite resistance between the signal circuit terminal 12 and ground.
 - **If less than infinite resistance**

Repair the short to ground in the signal circuit.
 - **If infinite resistance**
6. Test for less than 1 V between the AC circuit terminals listed below and ground.
 - AC Terminal 2
 - AC Terminal 7
 - **If greater than 1 V**

Repair the short to voltage in the AC circuit.
 - **If less than 1 V**
7. Test for infinite resistance between the AC circuit terminals listed below and ground:
 - AC Terminal 2
 - AC Terminal 7
 - **If less than infinite resistance**

Repair the short to ground in the AC circuit.
 - **If infinite resistance**
8. Disconnect X1 and X2 harness connectors at the X81 Accessory Power Receptacle - 110V.

9. Test for less than 2 ohms between the AC circuit terminals listed below:

- X81 Accessory Power Receptacle - 110V AC terminal 3 X1 and the T1 Accessory DC/AC Power Inverter Module terminal 2.
- X81 Accessory Power Receptacle - 110V AC terminal 3 X2 and the T1 Accessory DC/AC Power Inverter Module terminal 7.
- **If greater than 2 ohms**

Repair the open/high resistance in the AC circuit.

- **If less than 2 ohms**

10. Ignition ON.

11. Verify that a test lamp illuminates between the ignition voltage circuit terminal 1 X1 and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit terminal 12 X4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp illuminates**

12. Ignition OFF, connect all harness connectors at the X81 Accessory Power Receptacle - 110V AC. Connect a 110 V extension cord without a connected device to the X81 Accessory Power Receptacle - 110V AC, ignition ON.

13. Verify that a test lamp illuminates between the T1 Accessory DC/AC Power Inverter Module signal circuit terminal 12 and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF.
2. Test for less than 2 ohms in the signal circuit end to end.
 - If greater than 2 ohms, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X81 Accessory Power Receptacle - 110V AC.

- **If the test lamp illuminates**

14. Test or replace the T1 Accessory DC/AC Power Inverter Module.

Component Testing

Accessory Power Outlet 110V AC

1. Ignition OFF, remove the X81 Accessory Power Receptacle - 110V AC.
2. Test for infinite resistance between terminal 3 X2 and terminal 3 X1.
 - **If less than infinite resistance**

Replace X81 Accessory Power Receptacle - 110V AC.

3. Test for less than 2 ohms between the following terminals:

- The terminal 3 X2 and the applicable receptacle terminal
- The terminal 3 X1 and the applicable receptacle terminal
- **If greater than the 2 ohms**

Replace the X81 Accessory Power Receptacle - 110V AC.

4. Test for infinite resistance between terminal 1 X1 and terminal 1 X2.

- **If less than the specified range**

Replace X81 Accessory Power Receptacle - 110V AC.

- **If infinite resistance**

5. Connect a 110 V extension cord without a connected device to the X81 Accessory Power Receptacle - 110V AC.

6. Test for less than 5 ohms between terminal 1 X1 and terminal 1 X2.

- **If greater than the 5 ohms**

Replace the X81 Accessory Power Receptacle - 110V AC.

- **If less than 5 ohms**

7. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Accessory AC and DC Power Control Module Replacement

POWER OUTLET RECEPTACLE MALFUNCTION (12V)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-

Ground	-	1	1	-
1. Accessory Power Receptacle Malfunction				

Circuit/System Description

The vehicle is fitted with a 12 V accessory power receptacle. The accessory power outlets are controlled by an ignition operated relay. The accessory power receptacle is operational when the ignition is turned to either the On or the Accessories positions.

Diagnostic Aids

It may be helpful to discuss with the customer the usage of any device that may have drawn too much current and caused an open fuse.

Reference Information

Schematic Reference

Cigar Lighter/Power Outlet Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Outlets Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON, connect an appropriate device to the X80 Accessory Power Receptacle.
2. Verify the device is powered by the X80 Accessory Power Receptacle.
 - **If the device is not powered**

Refer to Circuit/System Testing

- **If the device is powered**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate X80 Accessory Power Receptacle. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal C and ground.
 - **If greater than 10 ohms**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify that a test lamp illuminates between the control circuit terminal A and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If greater than 2 ohms, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse. Refer to **Retained Accessory Power Malfunction** .
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the control circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate X80 Accessory Power Receptacle.
 - **If the test lamp illuminates**
5. Test or replace the X80 Accessory Power Receptacle.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Accessory Power Receptacle Replacement.

REPAIR INSTRUCTIONS

CIGARETTE LIGHTER RECEPTACLE REPLACEMENT

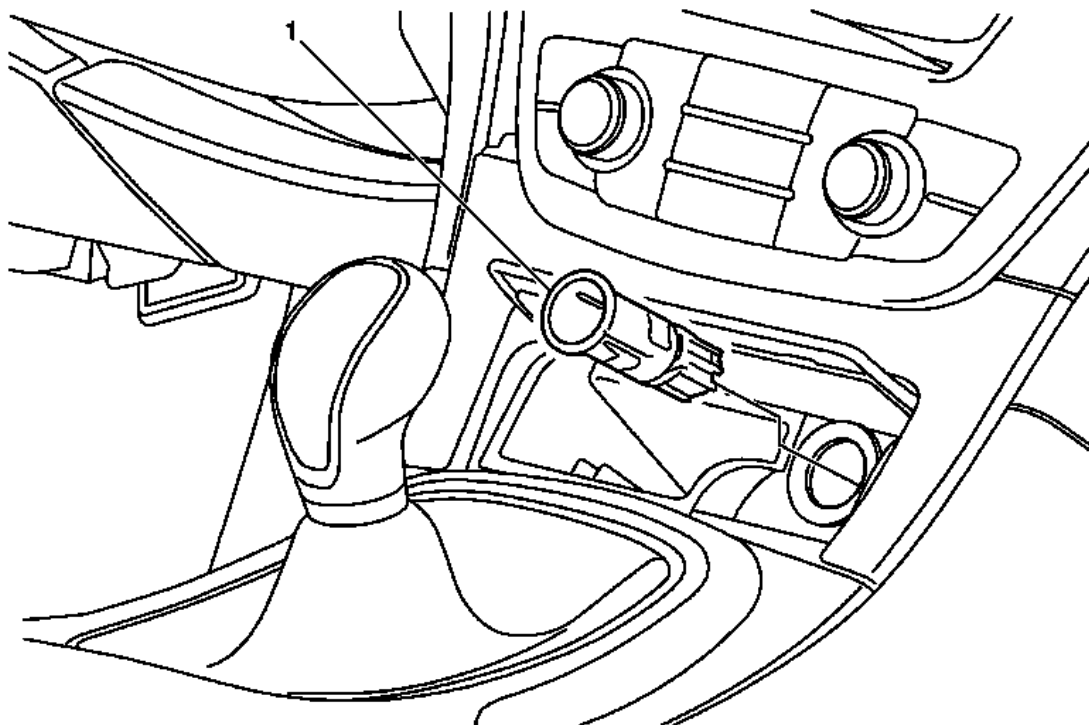


Fig. 3: Cigarette Lighter Receptacle
 Courtesy of GENERAL MOTORS COMPANY

Cigarette Lighter Receptacle Replacement

Callout	Component Name
Preliminary Procedure	
Disconnect battery negative cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
1	Cigarette Lighter Receptacle Procedure Disconnect electrical connectors. Special Tools BO-48871 Cigar Lighter Socket Remover (Side B) For equivalent regional tools, refer to <u>Special Tools</u> .

ACCESSORY AC AND DC POWER CONTROL MODULE REPLACEMENT

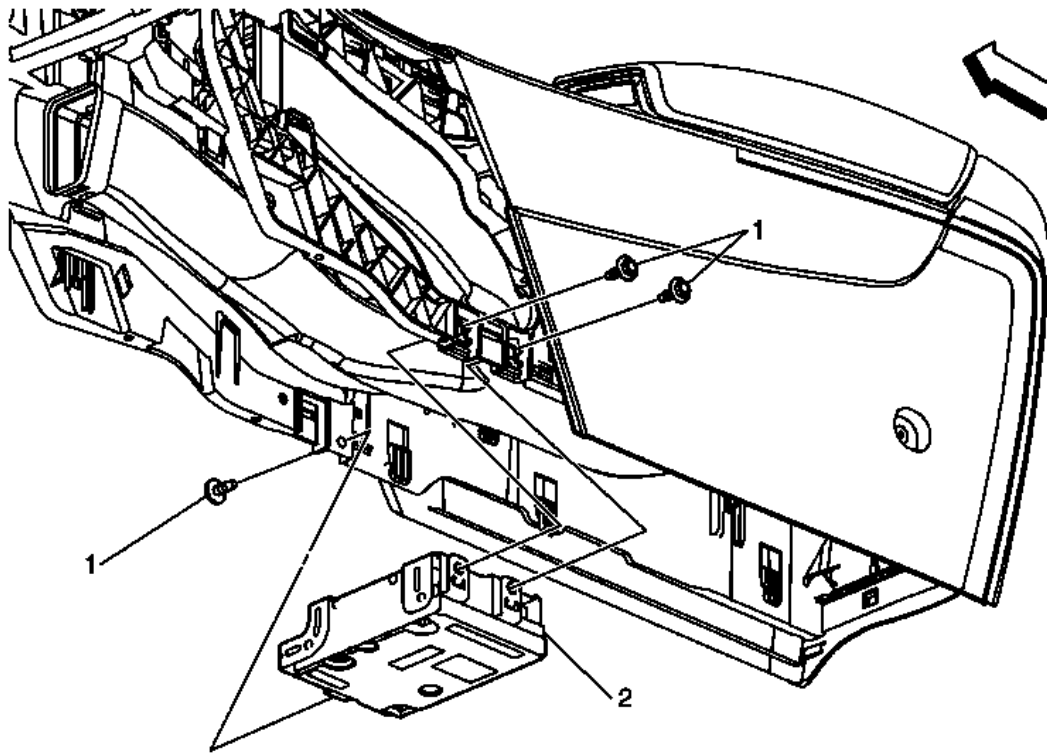


Fig. 4: Accessory AC and DC Power Control Module
 Courtesy of GENERAL MOTORS COMPANY

Accessory AC and DC Power Control Module Replacement

Callout	Component Name
WARNING: The high intensity discharge system produces high voltage and current. In order to reduce the risk of severe shocks and burns, the battery negative cable must be disconnected any time service work is being performed on or around the high intensity discharge system.	
Preliminary Procedures <ol style="list-style-type: none"> 1. Disconnect the battery negative cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the front floor console. Refer to <u>Front Floor Console Replacement</u> . 	
1	Accessory AC and DC Power Control Module Fastener (Qty: 3)
2	Accessory AC and DC Power Control Module Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Transfer any parts as needed. 3. Program the accessory AC and DC power control module. Refer to <u>Control Module References</u> for programming and set up.

120-VOLT ACCESSORY POWER RECEPTACLE REPLACEMENT

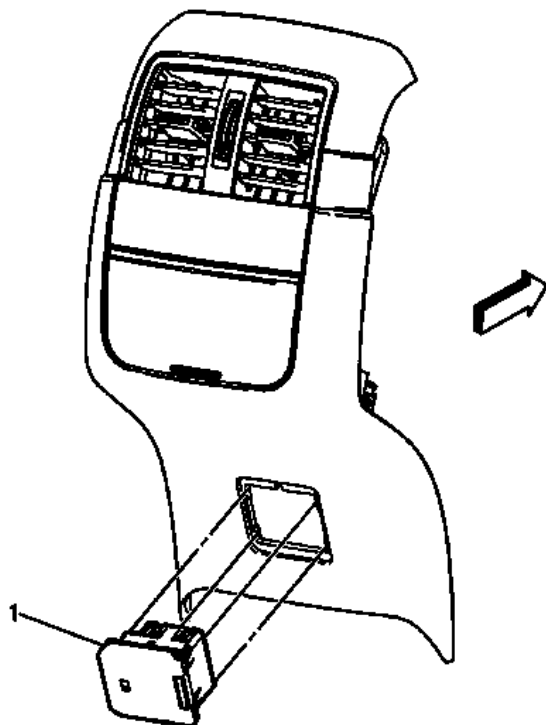


Fig. 5: 120-Volt Accessory Power Receptacle
Courtesy of GENERAL MOTORS COMPANY

120-Volt Accessory Power Receptacle Replacement

Callout	Component Name
Preliminary Procedure Remove the front floor console rear cover panel. Refer to <u>Front Floor Console Rear Cover Replacement</u> .	
1	Accessory Power Receptacle Assembly Procedure Push in the 4 tabs to release the accessory power receptacle from the rear console trim plate.

ACCESSORY POWER RECEPTACLE REPLACEMENT

Special Tools

EL 42059 Cigar Lighter Socket Remover

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

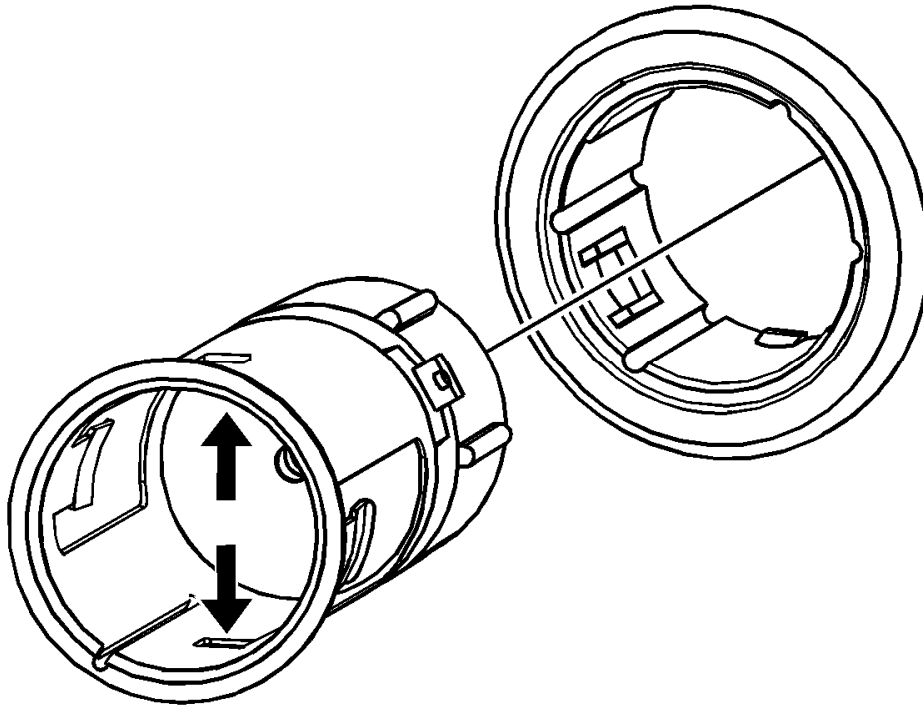


Fig. 6: View Of Cigar Lighter Socket/Accessory Power Outlet
Courtesy of GENERAL MOTORS COMPANY

1. Remove the auxiliary power outlet fuse from the fuse block.
2. Remove the receptacle:
 1. Look into the receptacle. There are two 3 mm (0.11 in) tab windows 12 mm (0.47 in) from the front of the receptacle. The **EL 42059** Remover pushes the plastic latches from these tab windows and the receptacle can be pulled straight out.
 2. Place one side of the "T" portion of the **EL 42059** Remover into the tab window. The **EL 42059** Remover will not fit straight into the receptacle. Angle the **EL 42059** Remover slightly for insertion into the receptacle.
 3. Insert the other side of the "T" into the opposite tab window.

You must move the **EL 42059** Remover handle toward horizontal to engage the other tab window.

4. Use the **EL 42059** Remover to pull the receptacle straight out.

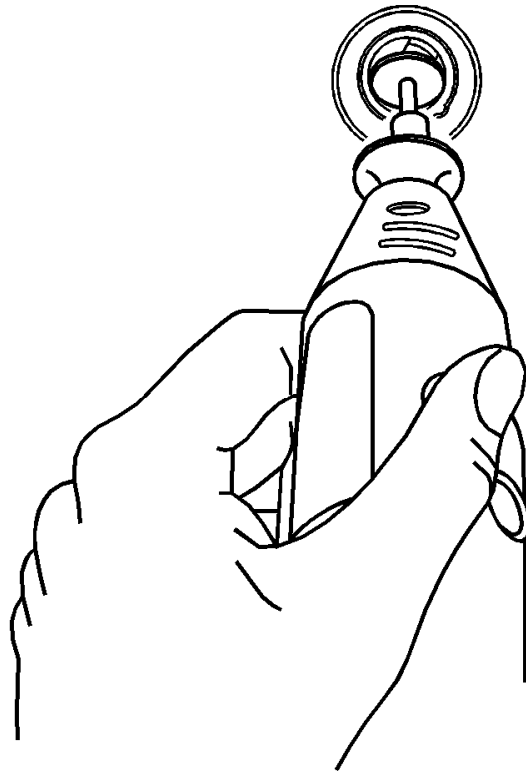


Fig. 7: Removing Cigar Housing Using Grinding Tool
Courtesy of GENERAL MOTORS COMPANY

3. If **EL 42059** Remover tool fails to release the lighter socket from the retainer, perform the following alternate method:
 1. Insert a small grinding tool with a cutoff wheel into the socket.
 2. Remove the plastic latches in the 3 mm (0.11 in) square windows.
 3. Use the **EL 42059** Remover as directed above to remove the socket.

Installation Procedure

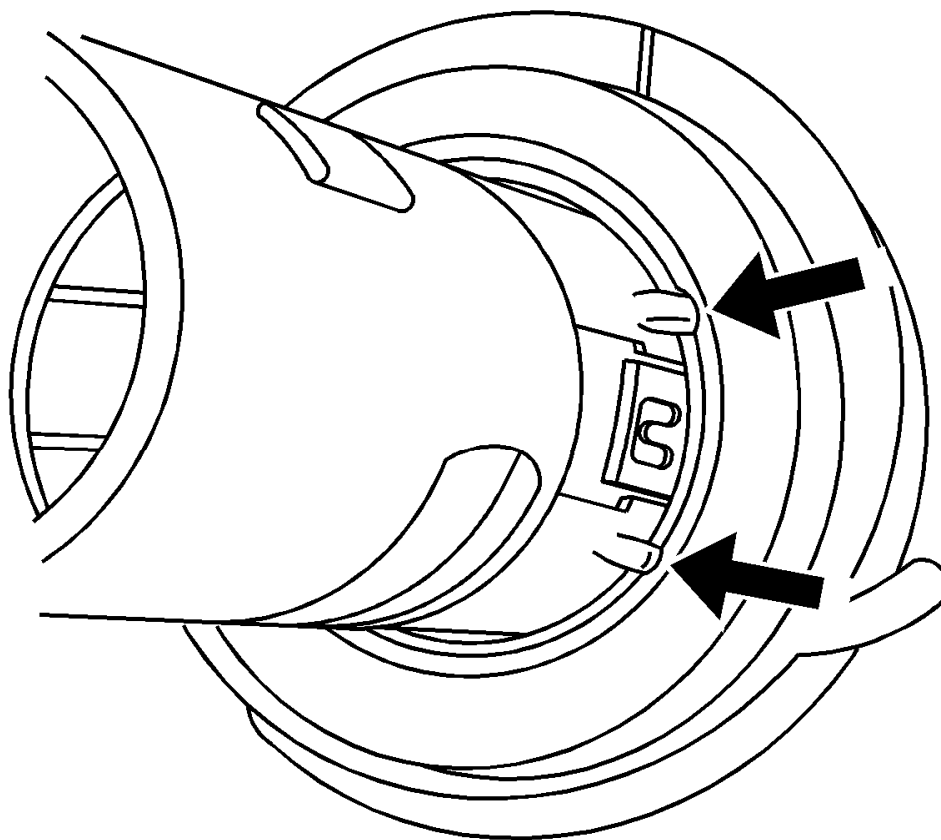


Fig. 8: View Of Receptacle Tabs & Retainer Slots
Courtesy of GENERAL MOTORS COMPANY

1. Route the connector through the retainer. Align the accessory power receptacle retainer to the slot in the opening.
2. Install the retainer by pressing into place fully seated.
3. Connect the electrical connector to the receptacle.
4. Align the tabs on the receptacle to the slots in the retainer. Install the accessory power receptacle by pressing into place until fully seated.
5. Install the accessory power receptacle fuse.

DESCRIPTION AND OPERATION

POWER OUTLETS DESCRIPTION AND OPERATION

12 Volt Power Outlet Receptacle Description and Operation

The 12 V accessory power receptacles are supplied with power by the accessory relay.

The vehicle is fitted with a cigarette lighter and/or with a 12 V accessory power receptacle. The cigarette lighter and accessory power outlets are controlled by an ignition operated relay. The accessory power receptacle and cigarette lighter are operational when the ignition is turned to either the On or the Accessories positions. To operate the cigarette lighter, press in the lighter knob. When the element is hot, the lighter automatically pops out and is ready for use.

110 Volt Power Outlet Receptacle System Description

Power Outlets Block Diagram

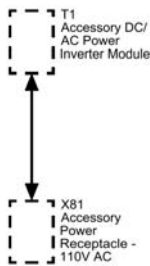


Fig. 9: Power Outlets Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
T1	T1 Accessory DC/AC Power Inverter Module
X81	X81 Accessory Power Receptacle - 110V AC

The alternating current (AC) accessory power outlet system consists of the accessory DC/AC power inverter module and the accessory power receptacle - 110 V AC. The accessory DC/AC power inverter module converts 12 V direct current (DC) battery power to 110 V at 60 Hertz (Hz) AC power to operate AC powered devices. The accessory DC/AC power inverter module provides up to 150 watts of power. The accessory power receptacle - 110 V AC provides the usual connection for AC powered devices.

110 Volt Power Outlet Receptacle System Operation

The accessory DC/AC power inverter module receives fuse protected battery voltage and is connected to the 12 V electrical system ground. The accessory power receptacle - 110 V AC has an internal switch, that detects when an AC powered device is plugged into the outlet. When the ignition is ON, and an AC powered device is plugged into the accessory power receptacle - 110 V AC, the normally open switch in the accessory power receptacle - 110 V AC, closes. When the accessory DC/AC power inverter module detects the voltage from the accessory power receptacle - 110 V AC switch, the inverter module begins to supply 110 V AC to the accessory power receptacle - 110 V AC after a 1.5 s delay. The accessory AC power system is protected against circuit

overload and circuit shorts to ground.

110 Volt Power Outlet Receptacle Isolation Fault Protection

The accessory DC/AC power inverter module contains a ground fault circuit interrupter (GFCI). GFCI monitors the 110 V circuit for a short to vehicle chassis ground. If a 110 V AC short to ground is detected, the accessory DC/AC power inverter module will turn OFF. The module remains OFF, until the AC powered device is unplugged from the outlet, and then plugged into the outlet after a 3 s delay.

110 Volt Power Outlet Receptacle Overload Shutdown

The accessory DC/AC power inverter module will turn OFF if the current in the 110 V circuit is greater than 3.8 A for 1 s , or 2.5 A for 10 s . The module will turn ON again, when the AC powered device is unplugged from the outlet, and then plugged into the outlet after a 3 s delay.

110 Volt Power Outlet Receptacle Internal Shutdown

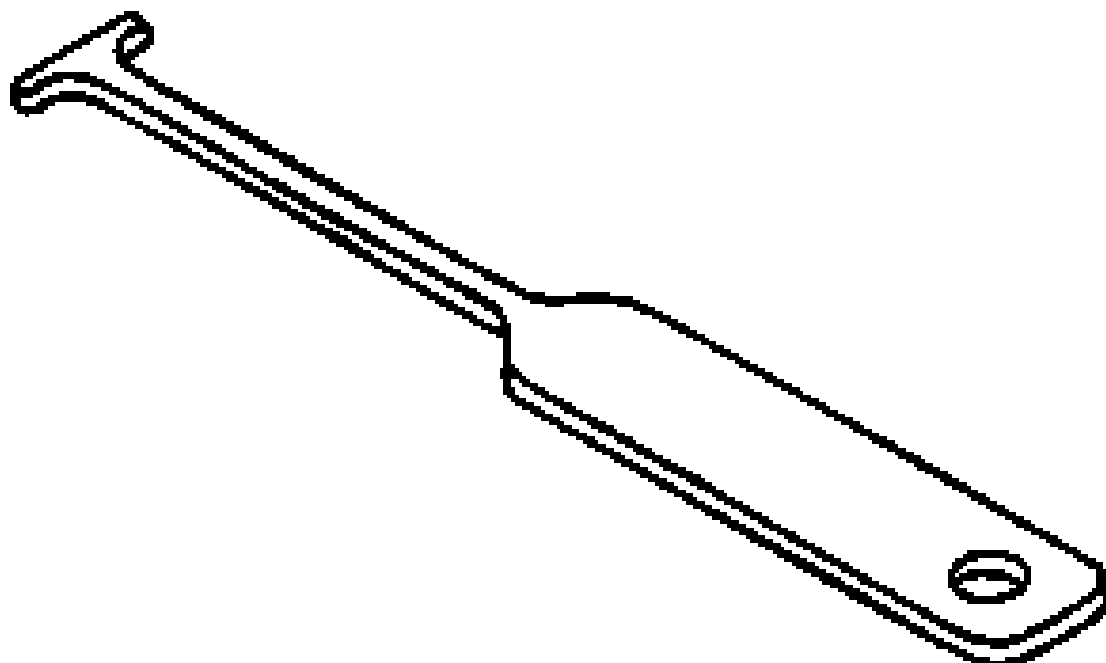
The accessory DC/AC power inverter module will turn OFF if the B+ supply voltage is greater than 16.5 V or less than 11 V. The module will also turn OFF if the device temperature is greater than 85°C (185°F). The module will turn ON again, after the shutdown condition is corrected, and the AC powered device is unplugged from the outlet, and then plugged into the outlet.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	EL 42059 Cigar Lighter

Socket
Remover



ACCESSORIES & EQUIPMENT

Power Seat

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Driver Seat Adjuster Memory Module to Seat Frame	2.5 N.m	22 lb in
Driver or Passenger Seat to Body Side Bolt	20 N.m	15 lb ft
Front Seat Recliner Actuator Motor (Driver or Passenger Seat 8-Way Power) to Backrest Bolt	6 N.m	53 lb in

SCHEMATIC WIRING DIAGRAMS

DRIVER SEAT WIRING SCHEMATICS

Seat Adjuster Switch and Position Motor (except A45)

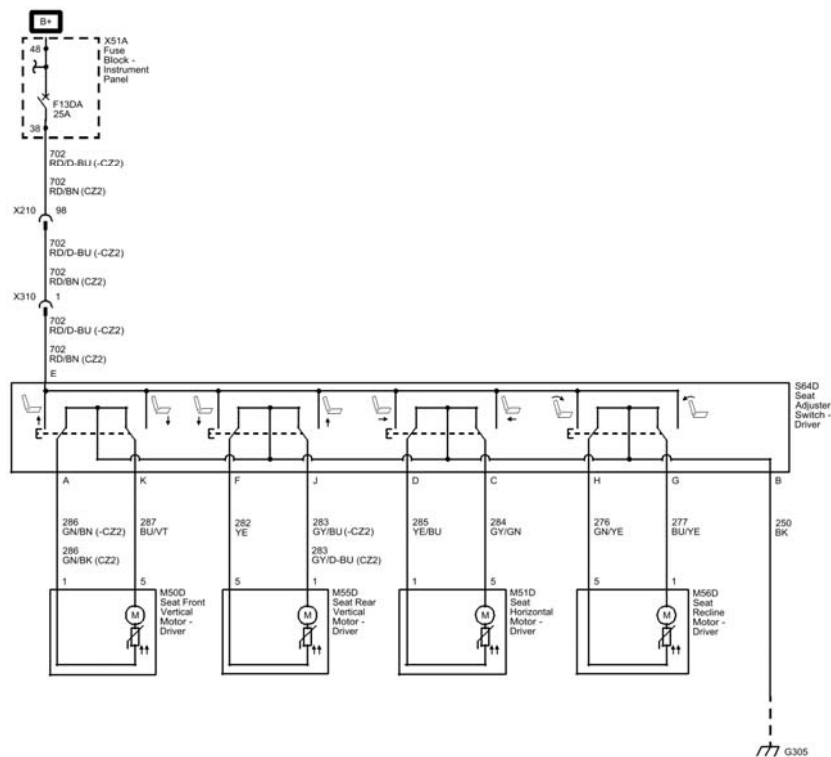


Fig. 1: Seat Adjuster Switch and Position Motor (except A45)
 Courtesy of GENERAL MOTORS COMPANY

Module Power, Ground, Serial Data, and Memory Seat Switch (A45)

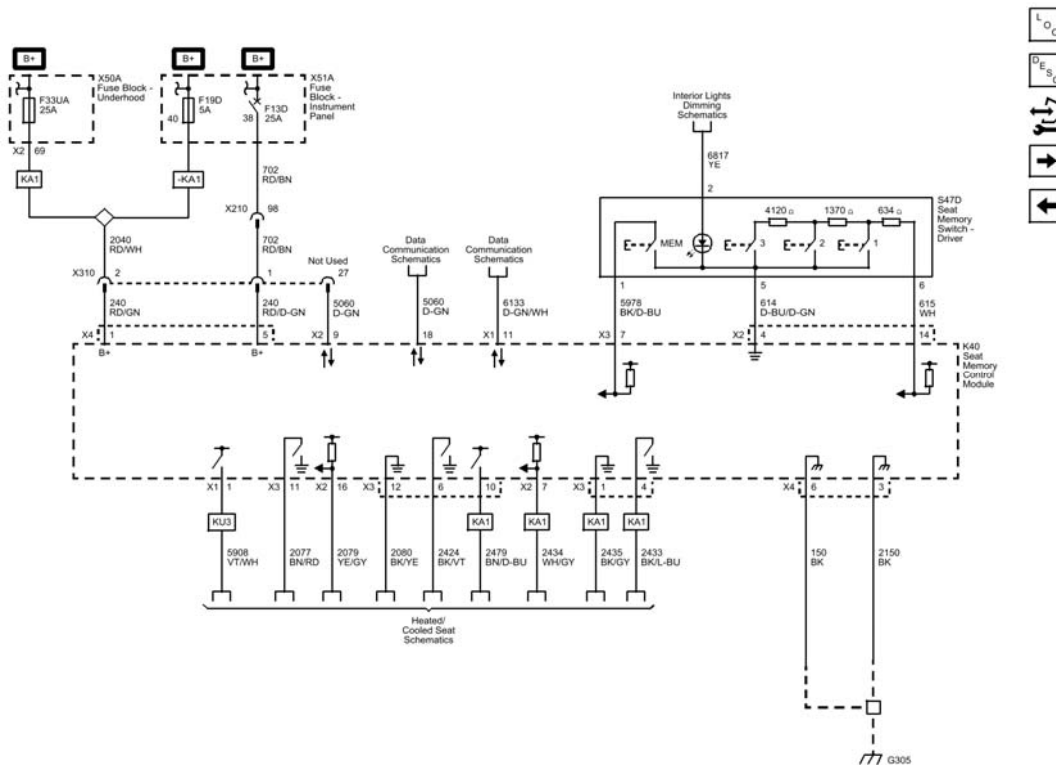


Fig. 2: Module Power, Ground, Serial Data, and Memory Seat Switch (A45)
 Courtesy of GENERAL MOTORS COMPANY

Seat Adjuster Switch and Position Motors (A45/CZ2)

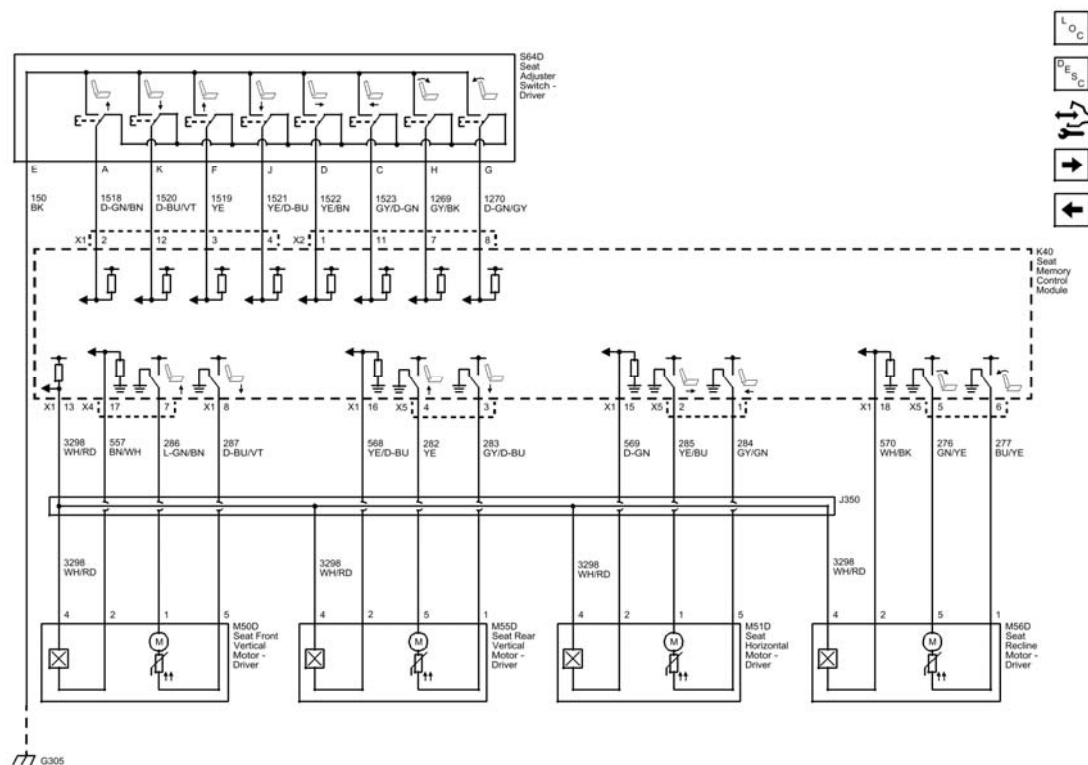


Fig. 3: Seat Adjuster Switch and Position Motors (A45/CZ2)
Courtesy of GENERAL MOTORS COMPANY

Lumbar Support System (APG)

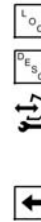
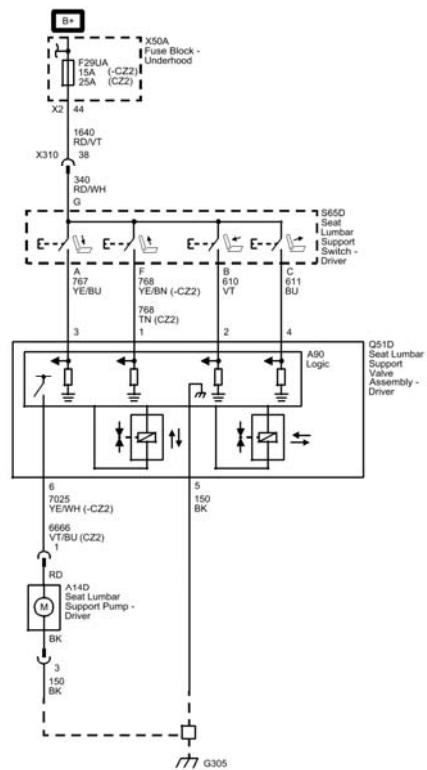


Fig. 4: Lumbar Support System (APG)
 Courtesy of GENERAL MOTORS COMPANY

PASSENGER SEAT WIRING SCHEMATICS

2-Way Adjustable Seat (Except CZ2)

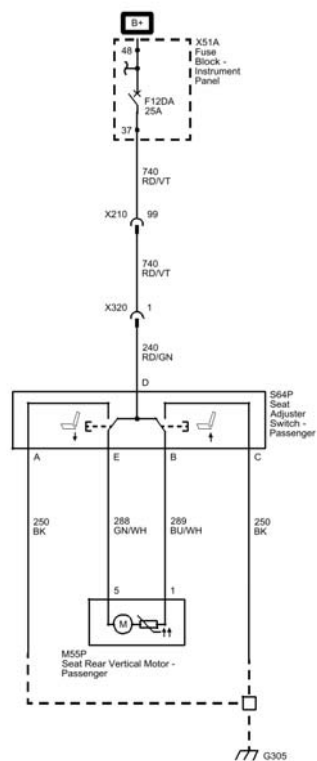


Fig. 5: 2-Way Adjustable Seat (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Seat Adjuster Switch and Position Motor (except A45)

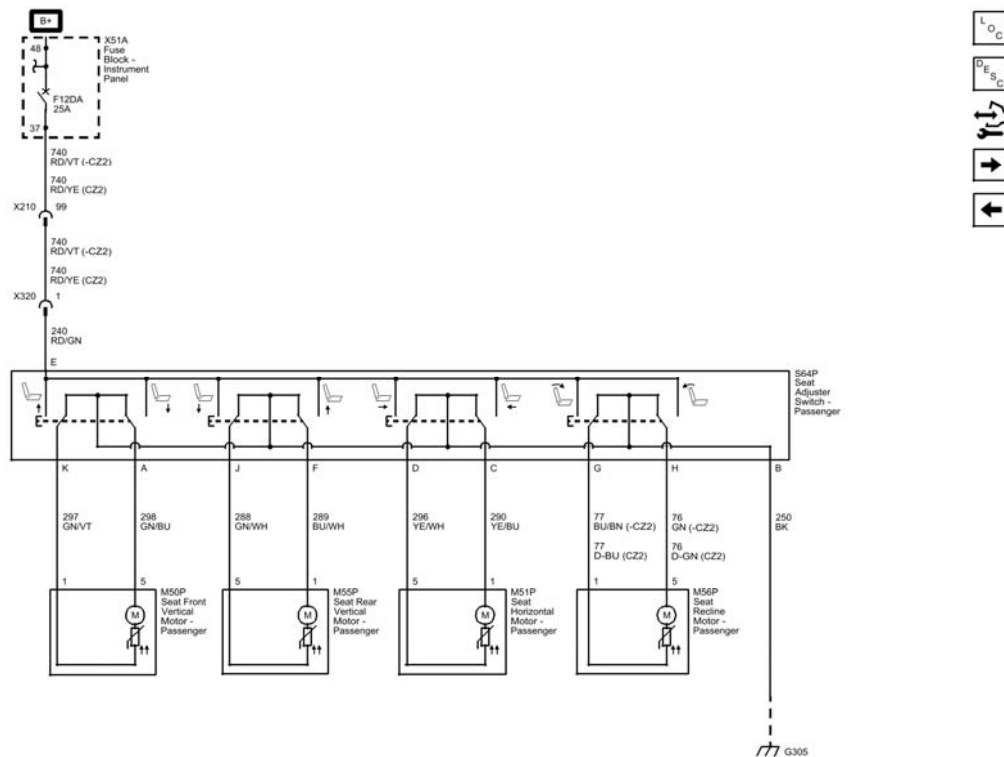


Fig. 6: Seat Adjuster Switch and Position Motor (except A45)
Courtesy of GENERAL MOTORS COMPANY

Lumbar Support System (APH)

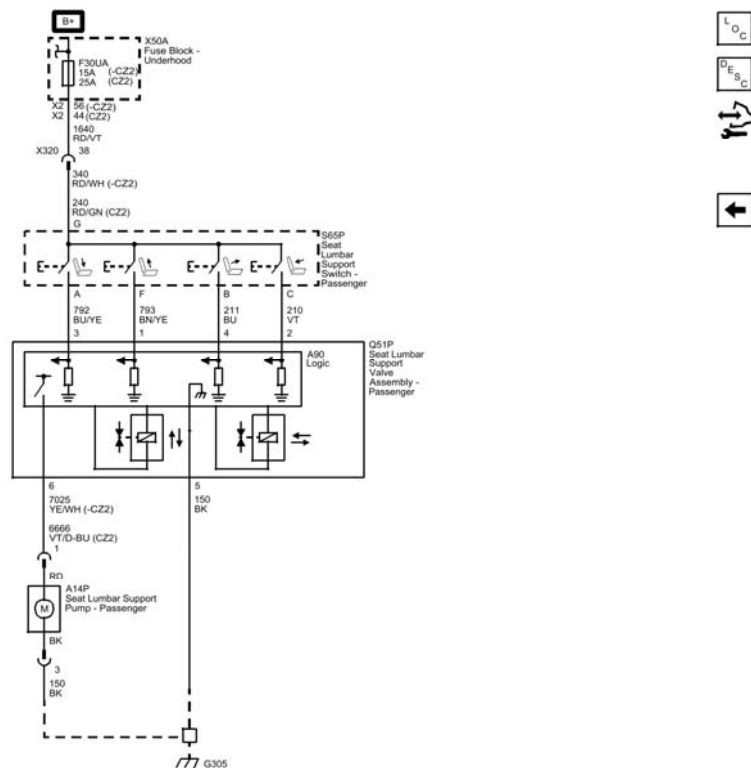


Fig. 7: Lumbar Support System (APH)
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820</u>	DTC B1735 02 Driver Seat Front Up Switch Circuit Short to Ground DTC B1740 02 Driver Seat Front Down Switch Circuit Short to Ground DTC B1745 02 Driver Seat Rear Up Switch Circuit Short to Ground DTC B1750 02 Driver Seat Rear Down Switch Circuit Short to Ground DTC B1755 02 Driver Seat Assembly Forward Switch Circuit Short to Ground DTC B1760 02 Driver Seat Assembly Rearward Switch Circuit Short to Ground DTC B1815 02 Driver Seat Recline Forward Switch Circuit Short to Ground DTC B1820 02 Driver Seat Recline Rearward Switch Circuit Short to Ground
<u>DTC B1825, B2355, B2365,</u>	DTC B1825 01 Driver Seat Recline Position Sensor Circuit Short to

<u>or B2375</u>	Battery DTC B1825 06 Driver Seat Recline Position Sensor Circuit Low Voltage/Open DTC B2355 01 Driver Seat Front Vertical Position Sensor Circuit Short to Battery DTC B2355 06 Driver Seat Front Vertical Position Sensor Circuit Low Voltage/Open DTC B2365 01 Driver Seat Rear Vertical Position Sensor Circuit Short to Battery DTC B2365 06 Driver Seat Rear Vertical Position Sensor Circuit Low Voltage/Open DTC B2375 01 Driver Seat Assembly Horizontal Position Sensor Circuit Short to Battery DTC B2375 06 Driver Seat Assembly Horizontal Position Sensor Circuit Low Voltage/Open
<u>DTC B3920</u>	DTC B3920 00 Driver Seat Motors Group 1 Common Circuit Malfunction DTC B3920 01 Driver Seat Motors Group 1 Common Circuit Short to Battery DTC B3920 02 Driver Seat Motors Group 1 Common Circuit Short to Ground DTC B3920 42 Driver Seat Motors Group 1 Common Circuit Calibration Not Programmed DTC B3920 0B Driver Seat Motors Group 1 Common Circuit High Current

DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, OR B1820: DRIVER SEAT SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1735 02

Driver Seat Front Up Switch Circuit Short to Ground

DTC B1740 02

Driver Seat Front Down Switch Circuit Short to Ground

DTC B1745 02

Driver Seat Rear Up Switch Circuit Short to Ground

DTC B1750 02

Driver Seat Rear Down Switch Circuit Short to Ground

DTC B1755 02

Driver Seat Assembly Forward Switch Circuit Short to Ground

DTC B1760 02

Driver Seat Assembly Rearward Switch Circuit Short to Ground

DTC B1815 02

Driver Seat Recline Forward Switch Circuit Short to Ground

DTC B1820 02

Driver Seat Recline Rearward Switch Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Front Vertical Up Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Front Vertical Down Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Rear Vertical Up Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02,	1	-	-

	B1820 02			
Rear Vertical Down Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Horizontal Forward Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Horizontal Rearward Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Recline Forward Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Recline Rearward Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
1. Power seat inoperative				

Circuit/System Description

The seat memory control module supplies a reference voltage to each signal circuit of the driver seat adjuster switch. When the power seat switches are pressed, the appropriate signal circuit from the seat memory control

module is pulled low through the switch contacts indicating the power seat command. The seat memory control module then commands the driver seat to move in response to the switch signals.

Conditions for Running the DTC

- DTC B1325 must not be present.
- Module battery voltage must be between 9-16 V.

Conditions for Setting the DTC

- If a seat switch circuit is active in one direction and the switch for the opposite direction is pressed, this DTC will set.
- A short to ground on a switch signal circuit.

Action Taken When the DTC Sets

- A motor output driven in response to a switch considered failed, is deactivated for both directions.
- All memory recall commands are ignored.
- The seat memory control module will respond to any other switch signal that has not set a DTC.

Conditions for Clearing the DTC

- The current DTC will clear and set the code to history, when the fault is no longer present and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Diagnostic Aids

- If one of the switch signal circuits is shorted to ground, multiple codes will set.
- If a switch is stuck in one direction and the switch is pressed in the opposite direction, a single code will set.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool seat switch parameters listed below change between Inactive and Forward/Rearward or UP/Down when pressing the appropriate seat directional switch.
 - Driver Seat Cushion Front Vertical Switch
 - Driver Seat Cushion Rear Vertical Switch
 - Driver Seat Horizontal Switch
 - Driver Seat Back Switch
 - **If the parameter does not change**

Refer to Circuit/System Testing.
 - **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S64D Driver Seat Adjuster Switch, Ignition ON.
2. Verify that all scan tool driver seat switch parameters listed below are Inactive:
 - Driver Seat Cushion Front Vertical Switch
 - Driver Seat Cushion Rear Vertical Switch
 - Driver Seat Horizontal Switch
 - Driver Seat Back Switch
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K40 Seat Memory Control Module.
 2. Test for infinite resistance between the appropriate signal circuit terminal listed below and ground:
 - Front vertical upward switch terminal A
 - Front vertical downward switch terminal K
 - Rear vertical upward switch terminal F
 - Rear vertical downward switch terminal J

- Horizontal forward switch terminal D
 - Horizontal rearward switch terminal C
 - Recline forward switch terminal H
 - Recline rearward switch terminal G
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K40 Seat Memory Control Module.
 - **If Inactive**
3. Install a 3 A fused jumper wire between the appropriate signal circuit terminal listed below and the ground circuit terminal E.
 - Front vertical upward switch terminal A
 - Front vertical downward switch terminal K
 - Rear vertical upward switch terminal F
 - Rear vertical downward switch terminal J
 - Horizontal forward switch terminal D
 - Horizontal rearward switch terminal C
 - Recline forward switch terminal H
 - Recline rearward switch terminal G
 4. Verify the scan tool seat switch parameter is Forward/Rearward or UP/Down.
 - **If not Forward/Rearward or UP/Down**
 1. Ignition OFF, disconnect the harness connector at the K40 Seat Memory Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 Seat Memory Control Module.
 - **If Forward/Rearward or UP/Down**
 5. Test or replace the S64D Driver Seat Adjuster Switch.

Component Testing

Seat Adjuster Switch Test

1. Ignition OFF, disconnect the harness connector at the S64D Driver Seat Adjuster Switch.
2. Test for infinite resistance between the ground terminal E and each signal terminal with the switch in the open position.
 - **If less than infinite resistance**

Replace the S64D Driver Seat Adjuster Switch.

- **If infinite resistance**

3. Test for less than 2 ohms between the ground terminal E and each signal terminal with the appropriate switch in the closed position.

- **If 2 ohms or greater**

Replace the S64D Driver Seat Adjuster Switch.

- **If less than 2 ohms**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Adjuster Switch Replacement (Driver/Passenger Seat 4-Way Hybrid)**
- **Control Module References** for K40 Seat Memory Control Module replacement, programming and setup

DTC B1825, B2355, B2365, OR B2375: DRIVER SEAT POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1825 01

Driver Seat Recline Position Sensor Circuit Short to Battery

DTC B1825 06

Driver Seat Recline Position Sensor Circuit Low Voltage/Open

DTC B2355 01

Driver Seat Front Vertical Position Sensor Circuit Short to Battery

DTC B2355 06

Driver Seat Front Vertical Position Sensor Circuit Low Voltage/Open

DTC B2365 01

Driver Seat Rear Vertical Position Sensor Circuit Short to Battery

DTC B2365 06

Driver Seat Rear Vertical Position Sensor Circuit Low Voltage/Open

DTC B2375 01

Driver Seat Assembly Horizontal Position Sensor Circuit Short to Battery

DTC B2375 06

Driver Seat Assembly Horizontal Position Sensor Circuit Low Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V Reference	B1825 06, B2355 06, B2365 06, B2375 06	B1825 06, B2355 06, B2365 06, B2375 06	-	-
Driver Seat Front Vertical Position Sensor Signal	B2355 06	B2355 06	B2355 01	-
Driver Seat Rear Vertical Position Sensor Signal	B2365 06	B2365 06	B2365 01	-
Driver Seat Horizontal Position Sensor Signal	B2375 06	B2375 06	B2375 01	-
Driver Seat Recline Position Sensor Signal	B1825 06	B1825 06	B1825 01	-

Circuit Description

The seat memory control module monitors the position of the seat motors by using hall effect position sensors which are an internal part of each motor. The module supplies each sensor with a 12 V reference circuit and a low side signal circuit. During seat motor operation, the hall effect position sensor provides a determined number of pulse signals for every revolution of the motor shaft. The scan tool displays these pulse signals as counts that range from 0-65,535. The module counts the feedback pulses from each sensor to determine seat position and end of travel limits for each of the seat motors. High scan tool count values indicate forward or upward seat positions while low count values indicate rearward or downward seat positions.

Conditions for Running the DTC

- DTC B1325 must not be present.

- Module battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The seat memory control module does not detect position sensor movement or pulse signals while the adjuster motor is active. The following conditions will set this DTC:

B1825 01, B2355 01, B2365 01, or B2375 01

The seat memory control module detects a voltage greater than 5 V on the sensor signal circuit.

B1825 06, B2355 06, B2365 06, or B2375 06

The seat memory control module detects a short to ground or an open on the sensor signal circuit.

Action Taken When the DTC Sets

- With a short to ground or an open circuit, the seat memory control module disables the memory recall and easy exit/entry action commands of the motor monitored by the sensor. The motor will respond to manual position commands.
- With a short to battery voltage, the seat memory control module disables the memory recall and easy exit/entry action commands for all four seat motors. The motors will respond to manual position commands.

Conditions for Clearing the DTC

- The current DTC clears when the fault is no longer present and the power mode changes to OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate driver seat motor listed below for which the DTC set:
 - M50D Seat Front Vertical Motor
 - M55D Seat Rear Vertical Motor
 - M51D Seat Horizontal Motor
 - M56D Seat Back Recline Motor
2. Ignition ON.
3. Test for greater than 10.8 V between the 12 V reference circuit terminal 4 and ground.
 - **If 10.8 V or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K40 Seat Memory Control Module.
 2. Test for infinite resistance between the 12 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 12 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 Seat Memory Control Module.
 - **If greater than 10.8 V**
4. Test for 0.3-2 V between the signal circuit terminal 2 and ground.
 - **If 0.3 V or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K40 Seat Memory Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 Seat Memory Control Module.
 - **If greater than 2 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K40 Seat Memory Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K40 Seat Memory Control Module.

- **If between 0.3-2 V**

5. Test or replace the seat motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Seat Tilt Adjuster Actuator Replacement (Driver/Passenger Seat 8-Way Power)**
- **Front Seat Adjuster Actuator Replacement (8-Way Power)**
- **Front Seat Recliner Actuator Motor Replacement (Driver or Passenger Seat 8-Way Power)**
- **Control Module References** for K40 Seat Memory Control Module replacement, programming and setup

DTC B3920: DRIVER SEAT MOTORS GROUP 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3920 00

Driver Seat Motors Group 1 Common Circuit Malfunction

DTC B3920 01

Driver Seat Motors Group 1 Common Circuit Short to Battery

DTC B3920 02

Driver Seat Motors Group 1 Common Circuit Short to Ground

DTC B3920 42

Driver Seat Motors Group 1 Common Circuit Calibration Not Programmed

DTC B3920 0B

Driver Seat Motors Group 1 Common Circuit High Current

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Driver Seat Front Vertical Motor Down Control	B3920 02	B3920 0B	1	B3920 01	B3920 42
Driver Seat Front Vertical Motor Up Control	B3920 02	B3920 0B	1	B3920 01	B3920 42
Driver Seat Rear Vertical Motor Down Control	B3920 02	B3920 0B	1	B3920 01	B3920 42
Driver Seat Rear Vertical Motor Up Control	B3920 02	B3920 0B	1	B3920 01	B3920 42
Driver Seat Horizontal Motor Forward Control	B3920 02	B3920 0B	1	B3920 01	B3920 42
Driver Seat Horizontal Motor Rearward Control	B3920 02	B3920 0B	1	B3920 01	B3920 42
Driver Seat Recline Motor Forward Control	B3920 02	B3920 0B	1	B3920 01	B3920 42
Driver Seat Recline Motor Rearward Control	B3920 02	B3920 0B	1	B3920 01	B3920 42
1. Power seat motor inoperative					

Circuit/System Description

The seat memory control module controls the seat motors via half bridges that are connected to power rails internal to the module. The seat memory control module connects all of the motor control circuits on each power rail to a common reference point whenever they are not in operation. This reference point is biased to approximately 2.5 V. The seat memory control module checks to see if this reference voltage is shorted to ground or battery before enabling any seat motor.

When a power seat switch is pressed or when a memory recall is requested, each seat motor receives battery voltage and ground from the seat memory control module via the motor control circuits. All motors are reversible, so the direction the motor rotates depends on which control circuit voltage is applied and which control circuit ground is applied. When the switch is operated in the opposite direction, the module reverses the polarity and applies voltage and ground to the opposite circuits to move the seat in the opposite direction.

Conditions for Running the DTC

- DTC B1325 must not be present.
- Module battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B3920 00

Current out of the module does not match the current returning to the module from 1.5-5 A.

B3920 01

The voltage on any power rail 1 motor control circuit exceeds 2.78 V for 100 ms.

B3920 02

The voltage on any power rail 1 motor control circuit is below 1.47 V for 100 ms.

B3920 42

This DTC will set if the module calibration is not programmed.

B3920 0B

The differential current measured through the high and low side of the power rail is within tolerance of each other, but the absolute current or an over-current has exceeded the maximum value.

Action Taken When the DTC Sets

The seat memory control module will not allow operation of any motor on the power rail for which the DTC was set.

Conditions for Clearing the DTC

- The current DTC clears when the fault is no longer present and the power mode changes to OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B3920 01 or B3920 02

1. Ignition OFF, disconnect the X4 and X5 harness connectors at the K40 Seat Memory Control Module.
2. Test for infinite resistance between the control circuit terminals listed below and ground:

- M50D front vertical motor up control terminal 7 X4
- M50D front vertical motor down control terminal 8 X4
- M55D rear vertical motor up control terminal 4 X5
- M55D rear vertical motor down control terminal 3 X5
- M51D horizontal motor forward control terminal 2 X5
- M51D horizontal motor rearward control terminal 1 X5
- M56D recline motor forward control terminal 5 X5
- M56D recline motor rearward control terminal 6 X5
- **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**

3. Ignition ON.
4. Test for less than 1 V between the control circuit terminals listed below and ground:

- M50D front vertical motor up control terminal 7 X4
- M50D front vertical motor down control terminal 8 X4
- M55D rear vertical motor up control terminal 4 X5
- M55D rear vertical motor down control terminal 3 X5
- M51D horizontal motor forward control terminal 2 X5
- M51D horizontal motor rearward control terminal 1 X5
- M56D recline motor forward control terminal 5 X5
- M56D recline motor rearward control terminal 6 X5
- **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

5. Replace the K40 Seat Memory Control Module.

B3920 00 or B3920 0B

1. Ignition ON.
2. Clear the current and history DTC.
3. Determine which motor set this DTC by operating the driver seat motors listed below one at a time in both directions. Check for the DTC to set between each motor test.
 - M50D Seat Front Vertical Motor
 - M55D Seat Rear Vertical Motor
 - M51D Seat Horizontal Motor
 - M56D Seat Back Recline Motor
4. Ignition OFF, disconnect the harness connector at the seat motor for which the DTC set, ignition ON.
5. Clear the DTC.
6. Verify that DTC B3920 00 or B3920 0B does not set while operating the seat motor adjuster switch in both directions.
 - **If DTC B3920 00 or B3920 0B sets**
 1. Test for infinite resistance between control circuit terminal 1 and control circuit terminal 5.
 - If less than infinite resistance, repair the short between the circuits.
 - If infinite resistance
 2. Test for less than 2 ohms between the control circuit terminals listed below end to end:
 - Terminal 1
 - Terminal 5
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the seat motor.
 - **If DTC B3920 00 or B3920 0B does not set**
7. Replace the seat motor.

B3920 42

1. Ignition ON.
2. Verify the DTC is not set.
 - **If the DTC is set**

Replace the K40 Seat Memory Control Module.

- **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Seat Tilt Adjuster Actuator Replacement (Driver/Passenger Seat 8-Way Power)**
- **Front Seat Adjuster Actuator Replacement (8-Way Power)**
- **Front Seat Recliner Actuator Motor Replacement (Driver or Passenger Seat 8-Way Power)**
- **Control Module References** for K40 Seat Memory Control Module replacement, programming and setup

SYMPTOMS - POWER SEATS

NOTE: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following system descriptions:
 - **Lumbar Support Description and Operation**
 - **Memory Seats Description and Operation**
 - **Power Seats System Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Lumbar Support Malfunction**
- **Memory Seat Feature Malfunction**
- **Power Seat Malfunction (Without Memory A45), Power Seat Malfunction (With Memory A45)**

LUMBAR SUPPORT MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Lumbar Support Switch B+	1	1	-	-
Seat Horizontal Lumbar Deflate Signal	1	2, 3	5	-
Seat Horizontal Lumbar Inflate Signal	1	3	4	-
Seat Vertical Lumbar Deflate Signal	1	2, 3	5	-
Seat Vertical Lumbar Inflate Signal	1	2	4	-
Seat Lumbar Support Pump Control	1	1	4	-
Seat Lumbar Support Pump Ground	-	1	-	-
Seat Lumbar Adjuster Valve Assembly Ground	-	1	-	-
1. The seat lumbar support is inoperative 2. The upper lumbar support is inoperative 3. The lower lumbar support is inoperative 4. The lumbar adjuster pump is always ON 5. The lumbar support will not inflate				

Circuit/System Description

Battery voltage is supplied at all times to the driver and passenger seat lumbar support switches through a 15 A fuse located in the underhood fuse block. When a lumbar switch is pressed to inflate the lumbar support, battery voltage is applied through the switch contacts and the inflate signal circuit to the seat lumbar adjuster valve assembly. In response to this signal, the lumbar adjuster valve assembly energizes its internal inflate solenoid and applies battery voltage through the lumbar support pump control circuit to the pump to inflate the appropriate support bladder until the switch is released. When the switch is pressed to deflate the lumbar support, battery voltage is applied through the switch contacts and the deflate signal circuit to the seat lumbar adjuster valve assembly. The lumbar adjuster valve assembly energizes its internal deflate solenoid and air is released from the bladder until the switch is released.

Reference Information

Schematic Reference

- **Driver Seat Schematics**

- **Passenger Seat Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Lumbar Support Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON.
2. Verify the lumbar support pump turns ON when the lumbar support switch is pressed in the FORWARD direction. The upper and lower lumbar support bladders should inflate until the bladders are 100% inflated or the switch is released.
 - **If the bladders do not inflate**

Refer to Circuit/System Testing

 - **If the bladders inflate**
3. Verify the upper and lower lumbar support bladders deflate when the lumbar REARWARD switch is pressed. The bladders should deflate until the bladders are 100% deflated or the switch is released.
 - **If the bladders do not deflate**

Refer to Circuit/System Testing

 - **If the bladders deflate**
4. Verify the lumbar support pump turns ON and the upper lumbar support bladder starts to inflate when the lumbar switch is pressed in the UP direction. If the lower bladder is inflated it will deflate while the upper bladder inflates until the upper bladder is 100% inflated or switch is released.
 - **If the pump does not turn ON or the upper bladder does not inflate**

Refer to Circuit/System Testing

 - **If the pump turns ON and the upper bladder inflates**
5. Verify the upper lumbar bladder starts to deflate while the lower lumbar bladder starts to inflate while the lumbar switch is pressed in the DOWN direction. The upper bladder should deflate until it is 100%

deflated and the lower bladder should inflate until it is 100% inflated or the switch is released.

- **If the upper bladder does not deflate or the lower bladder does not inflate**

Refer to Circuit/System Testing

- **If the upper bladder deflates and the lower bladder inflates**

6. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate S65 Seat Lumbar Support Switch, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal G and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for greater than 10 ohms between each signal circuit listed below and ground:
 - Lumbar signal circuit terminal A
 - Lumbar signal circuit terminal B
 - Lumbar signal circuit terminal C
 - Lumbar signal circuit terminal F
 - If 10 ohms or less, disconnect the harness connector at the Q51 Seat Lumbar Support Valve Assembly and retest to verify if the short is in the circuit or the component.
 - If greater than 10 ohms, test or replace the S65 Seat Lumbar Support Switch.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the harness connector at the S65 Seat Lumbar Support Switch and disconnect the harness connector at the Q51 Seat Lumbar Support Valve Assembly.
4. Test for less than 10 ohms between the ground circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**
5. Ignition ON.
 6. Verify a test lamp turns ON and OFF between each signal circuit listed below and ground when pressing and releasing the S65 Seat Lumbar Support Switch in the appropriate direction.
 - Lumbar up switch signal terminal 1
 - Lumbar rearward switch signal terminal 2
 - Lumbar down switch signal terminal 3
 - Lumbar forward switch signal terminal 4
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the S65 Seat Lumbar Support Switch.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S65 Seat Lumbar Support Switch.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the S65 Seat Lumbar Support Switch, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the S65 Seat Lumbar Support Switch.
 - **If the test lamp turns ON and OFF**
 - 7. Ignition OFF, connect the harness connector at the Q51 Seat Lumbar Support Valve Assembly and disconnect the harness connector at the A14 Seat Lumbar Support Pump.
 - 8. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance the ground connection.
 - **If less than 10 ohms**
 - 9. Connect a test lamp between the control circuit terminal 1 and ground, ignition ON.
 - 10. Verify the test lamp turns ON and OFF when commanding the A14 Seat Lumbar Support Pump ON and OFF by pressing and releasing the lumbar support switch in either the UP or FORWARD direction.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the Q51 Seat Lumbar Support Valve Assembly.
 2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the Q51 Seat Lumbar Support Valve Assembly.
 - **If the test lamp is always ON**
- 1. Ignition OFF, disconnect the harness connector at the Q51 Seat Lumbar Support Valve Assembly, ignition ON.
- 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the Q51 Seat Lumbar Support Valve Assembly,
 - **If the test lamp turns ON and OFF**
- 11. Test or replace the A14 Seat Lumbar Support Pump.

Component Testing

Lumbar Support Switch

1. Ignition OFF, disconnect the harness connector at the appropriate S65 Seat Lumbar Support Switch.
2. Test for infinite resistance between the B+ terminal G and each signal terminal with the switch in the open position.
 - **If less than infinite resistance**

Replace the S65 Seat Lumbar Support Switch.

 - **If infinite resistance**
3. Test for less than 2 ohms between the B+ terminal G and each signal terminal with the appropriate switch in the closed position.
 - **If 2 ohms or greater**

Replace the S65 Seat Lumbar Support Switch.

 - **If less than 2 ohms**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Lumbar Control Switch Replacement (Driver/Passenger Seat 6-Way Hybrid)**
- **Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Electric Lumbar) , Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Manual Lumbar)**

MEMORY SEAT FEATURE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Memory Set Switch Signal	1	1	-	-
Memory Switch Signal	1	1	1	-
Driver Seat Memory Switch Low Reference	-	1	-	-
1. Memory seat feature inoperative				

Circuit/System Description

Low reference is supplied to the driver seat memory switch from the seat memory control module. When a memory switch is pressed, the signal circuit from the seat memory control module is pulled low through the switch contacts and series of resistors indicating the memory recall request. In response to this signal, the seat memory control module commands the appropriate seat motors to move to the pre-recorded seat positions stored in memory.

Diagnostic Aids

The seat memory control module must be awake when measuring voltage from either one of the memory seat switch signal circuits. Voltage readings of 0.0 V or 5 V are possible if the module is not fully awake and result in misdiagnosing the circuit.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that all manual driver power seat functions operate when being controlled by the power seat adjuster switches.
 - **If any seat function does not operate**

Refer to **Power Seat Malfunction (Without Memory A45)**, **Power Seat Malfunction (With Memory A45)**.

- **If all seat functions operate**
3. Verify that the memory recall personalization option is ON. Refer to the owners manual.
 - **If the memory recall personalization option is not ON**

Turn ON the option, refer to the Owners Manual.

- **If the memory recall personalization option is ON**
4. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S47D Driver Seat Memory Switch.
2. Test for less than 10 ohms between the low reference circuit terminal 5 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K40 Seat Memory Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 Seat Memory Control Module.
 - **If less than 10 ohms**
3. Ignition ON, press a power seat switch in order to wake up the K40 Seat Memory Control Module.
4. Test for 9 V or greater between each signal circuit terminal listed below and ground:
 - Memory set switch signal terminal 1

- Memory switch signal terminal 6
 - **If less than 9 V**
- 1. Ignition OFF, disconnect the X2 harness connector at the K40 Seat Memory Control Module.
- 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 Seat Memory Control Module.
- **If 9 V or greater**
- 5. Ignition OFF, disconnect the X2 harness connector at the K40 Seat Memory Control Module, ignition ON.
- 6. Test for less than 1 V between each signal circuit terminal listed below and ground:
 - Memory set switch signal terminal 1
 - Memory switch signal terminal 6
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

 - **If less than 1 V**
- 7. Test or replace the S47D Driver Seat Memory Switch.

Component Testing

Driver Seat Memory Switch

1. Ignition OFF, disconnect the harness connector at the S47D Driver Seat Memory Switch.
2. Test for infinite resistance between each signal terminal listed below and the low reference terminal 5 with the switch in the open position.
 - Terminal 1
 - Terminal 6
 - **If less than infinite resistance**

Replace the S47D Driver Seat Memory Switch.

 - **If infinite resistance**
3. Test for less than 2 ohms between the signal terminal 1 and the low reference terminal 5 while pressing the memory MEM button.
 - **If 2 ohms or greater**

Replace the S47D Driver Seat Memory Switch.

- **If less than 2 ohms**

4. Test for 570-698 ohms between the signal terminal 6 and the low reference terminal 5 while pressing the memory 1 button.

- **If not between 570-698 ohms**

Replace the S47D Driver Seat Memory Switch.

- **If between 570-698 ohms**

5. Test for 1800-2209 ohms between the signal terminal 6 and the low reference terminal 5 while pressing the memory 2 button.

- **If not between 1800-2209 ohms**

Replace the S47D Driver Seat Memory Switch.

- **If between 1800-2209 ohms**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for K40 Seat Memory Control Module replacement, programming and setup

POWER SEAT MALFUNCTION (WITHOUT MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Front Vertical Motor Down Control	1	1	-	-
Front Vertical Motor Up Control	1	1	-	-
Horizontal Motor Forward Control	1	1	-	-
Horizontal Motor Rearward Control	1	1	-	-

Rear Vertical Motor Down Control	1	1	-	-
Rear Vertical Motor Up Control	1	1	-	-
Recline Motor Forward Control	1	1	-	-
Recline Motor Rearward Control	1	1	-	-
Ground	-	1	-	-
1. Power seat inoperative				

Circuit/System Description

The driver seat without memory and the passenger seat are completely controlled through their respective seat adjuster switches. Battery voltage is supplied at all times to the switch through a circuit breaker located in the instrument panel fuse block. When the seat switches are in an inactive state, the switch contacts are closed to the switch ground circuit.

All seat motors are reversible. For example, when the seat horizontal forward switch is pressed to move the entire seat forward, battery voltage is applied through the switch contacts and the seat horizontal motor forward control circuit to the motor. With the horizontal motor rearward switch contacts closed to the switch ground circuit, the motor runs in order to drive the entire seat forward until the switch is released. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction. All seat motors are powered this way.

Reference Information

Schematic Reference

- **Driver Seat Schematics**
- **Passenger Seat Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Seats System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Verify the appropriate driver or passenger seat directional motors listed below operate while operating the seat switches in both directions.
 - M51 Horizontal Motor
 - M50 Front Vertical Motor
 - M55 Rear Vertical Motor
 - M56 Recline Motor
 - **If all seat motors do not operate**

Refer to Circuit/System Testing - Seat Adjuster Switch Circuit Test.

- **If 1 or more seat motors operate**

Refer to Circuit/System Testing - Seat Motor Circuit Test.

- **If all seat motors operate**

2. All OK.

Circuit/System Testing

Seat Adjuster Switch Circuit Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S64D Driver Seat Adjuster Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal B and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal E and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the circuit breaker is not open and there is voltage at the circuit breaker.
 - **If the test lamp illuminates**
5. Test or replace the S64 Seat Adjuster Switch.

Seat Motor Circuit Test

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor listed below:
 - M50 Front Vertical Motor
 - M55 Rear Vertical Motor
 - M51 Horizontal Motor
 - M56 Recline Motor
2. Connect a test lamp between control circuit terminal 1 and control circuit terminal 5, ignition ON.
3. Verify the test lamp illuminates when commanding the seat motor Up and Down or Forward and Rearward using the S64 Seat Adjuster Switch.
 - **If the test lamp does not illuminate during either of the commands**
 1. Ignition OFF, disconnect the harness connector at the S64 Seat Adjuster Switch.
 2. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the S64 Seat Adjuster Switch
 - **If the test lamp illuminates during each of the commands**
4. Test or replace the seat motor.

Component Testing

Seat Adjuster Switch Test

1. Ignition OFF, disconnect the harness connector at the S64 Seat Adjuster Switch.
2. Test for infinite resistance between the B+ terminal and each control terminal with the switch in the open position.
 - **If less than infinite resistance**

Replace the S64 Seat Adjuster Switch.
 - **If infinite resistance**
3. Test for less than 2 ohms between the B+ terminal and each control terminal with the appropriate switch in the closed position.
 - **If 2 ohms or greater**

Replace the S64 Seat Adjuster Switch.
 - **If less than 2 ohms**
4. Test for less than 2 ohms between the ground terminal and each control terminal with the switch in the open position.
 - **If 2 ohms or greater**

Replace the S64 Seat Adjuster Switch.

- If less than 2 ohms

5. All OK.

Seat Motor

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor listed below:

- M50 Front Vertical Motor
- M55 Rear Vertical Motor
- M51 Horizontal Motor
- M56 Recline Motor

NOTE: When performing the following tests, make sure that the seat is not already in the position the test is attempting to produce.

2. Install a 30 A fused jumper wire between control terminal 1 and 12 V.

3. Momentarily install a jumper wire between control terminal 5 and ground. The seat motor should momentarily perform the appropriate FORWARD/ REARWARD/ UP/ DOWN function.

- If the motor does not perform the FORWARD/ REARWARD/ UP/ DOWN function

Replace the motor.

- If the motor performs the FORWARD/ REARWARD/ UP/ DOWN function

4. Reverse the jumper wires; the motor should perform FORWARD/ REARWARD/ UP/ DOWN function.

- If the motor does not perform the FORWARD/ REARWARD/ UP/ DOWN function

Replace the motor.

- If the motor performs the FORWARD/ REARWARD/ UP/ DOWN function

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Driver or Passenger Seat Adjuster Switch Replacement (Driver/Passenger Seat 4-Way Hybrid)
- Front Seat Adjuster Motor Replacement (Driver or Passenger Seat 8-Way Power)
- Front Seat Recliner Actuator Motor Replacement (Driver or Passenger Seat 8-Way Power)

POWER SEAT MALFUNCTION (WITH MEMORY A45)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Memory Control Module B+ Terminal 1 X4	2	2	-	-
Seat Memory Control Module B+ Terminal 5 X4	B242A 02, B2425 0D, B2430 0D, 1, 3	B242A 02, B2425 0D, B2430 0D, 1, 3	-	-
Front Vertical Up Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Front Vertical Down Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Rear Vertical Up Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Rear Vertical Down Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
	B1735 02, B1740 02,			

Horizontal Forward Switch Signal	B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Horizontal Rearward Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Recline Forward Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Recline Rearward Switch Signal	B1735 02, B1740 02, B1745 02, B1750 02, B1755 02, B1760 02, B1815 02, B1820 02	1	-	-
Driver Seat Front Vertical Motor Down Control	B3920 02	1	B3920 01	B3920 00
Driver Seat Front Vertical Motor Up Control	B3920 02	1	B3920 01	B3920 00
Driver Seat Horizontal Motor Forward Control	B3920 02	1	B3920 01	B3920 00
Driver Seat Horizontal Motor Rearward Control	B3920 02	1	B3920 01	B3920 00
Driver Seat Rear Vertical Motor Down Control	B3920 02	1	B3920 01	B3920 00
Driver Seat Rear Vertical Motor Up Control	B3920 02	1	B3920 01	B3920 00
Driver Seat Recline Motor Forward Control	B3920 02	1	B3920 01	B3920 00
Driver Seat Recline Motor Rearward Control	B3920 02	1	B3920 01	B3920 00

Seat Memory Control Module Ground Terminal 3 X4	-	1, 2	-	-
Seat Memory Control Module Ground Terminal 6 X4	-	1, 2	-	-
1. Power seat and memory functions inoperative 2. Scan Tool Does Not Communicate with Low Speed GMLAN Device 3. Heated seats are inoperative				

Circuit/System Description

Battery voltage is supplied at all times to the seat memory control module through a 25 A fuse located in the I/P fuse block. This voltage is used by the module for logic power. Battery positive voltage is also supplied at all times to the seat memory control module through a 25 A circuit breaker. This voltage is connected to a power rail internal to the seat memory control module and is used to drive the power seat motors and the seat heater elements on vehicles equipped with heated seats. Each seat motor is controlled by the seat memory control module through 2 motor control circuits. The seat memory control module connects all motor control circuits on the power rail to a common reference point whenever they are not in operation. This reference point is biased to approximately 2.5 V. The seat memory control module checks to see if the reference voltage is shorted to ground or battery before enabling any of the seat motors.

All motors are reversible. For example, when the seat switch is operated to move the entire seat forward, the switch signal circuit from the seat memory control module is pulled low indicating the entire seat forward command. In response to this signal, the seat memory control module applies battery voltage through the driver seat horizontal motor forward control circuit and ground through the driver seat horizontal motor rearward control circuit to the motor. The motor runs to drive the entire seat forward until the switch is released. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery positive voltage and ground are applied on the opposite circuits causing the motor to run in the opposite direction.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool seat switch parameters listed below change between Inactive and Forward/Rearward or Up/Down when pressing the appropriate switch.
 - Driver Seat Horizontal Switch
 - Driver Seat Cushion Front Vertical Switch
 - Driver Seat Cushion Rear Vertical Switch
 - Driver Seat Back Switch
 - **If the parameter does not change**

Refer to Circuit/System Testing - Driver Seat Adjuster Switch Circuit Test.

- **If the parameter changes**
3. Verify the seat directional motors listed below operate while operating the appropriate driver seat switches in both directions.
 - M51D Seat Horizontal Motor
 - M50D Seat Front Vertical Motor
 - M55D Seat Rear Vertical Motor
 - M56D Seat Recline Motor
 - **If any seat motor does not operate**

Refer to Circuit/System Testing - Seat Motor Control Circuit Test.

- **If all seat motors operate**
4. All OK.

Circuit/System Testing

Driver Seat Adjuster Switch Circuit Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S64D Driver Seat Adjuster Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal E and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Verify that all scan tool driver seat switch parameters listed below are Inactive:
 - Driver Seat Cushion Front Vertical Switch
 - Driver Seat Cushion Rear Vertical Switch
 - Driver Seat Horizontal Switch
 - Driver Seat Back Switch
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K40 Seat Memory Control Module.
 2. Test for infinite resistance between the appropriate signal circuit terminal listed below and ground:
 - Front vertical upward switch terminal A
 - Front vertical downward switch terminal K
 - Rear vertical upward switch terminal F
 - Rear vertical downward switch terminal J
 - Horizontal forward switch terminal D
 - Horizontal rearward switch terminal C
 - Recline forward switch terminal H
 - Recline rearward switch terminal G
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K40 Seat Memory Control Module.
 - **If Inactive**
 4. Install a 3 A fused jumper wire between the appropriate signal circuit terminal listed below and the ground circuit terminal B.
 - Front vertical upward switch terminal A
 - Front vertical downward switch terminal K
 - Rear vertical upward switch terminal F
 - Rear vertical downward switch terminal J
 - Horizontal forward switch terminal D
 - Horizontal rearward switch terminal C
 - Recline forward switch terminal H
 - Recline rearward switch terminal G
 5. Verify the scan tool seat switch parameter is Forward/Rearward or UP/Down.
 - **If not Forward/Rearward or UP/Down**
 1. Ignition OFF, disconnect the harness connector at the K40 Seat Memory Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V
- 3. Ignition OFF.
- 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 Seat Memory Control Module.
- **If Forward/Rearward or UP/Down**
- 6. Test or replace the S64D Driver Seat Adjuster Switch.

Seat Motor Control Circuit Test

1. Ignition OFF, disconnect the X4 harness connector at the K40 Seat Memory Control Module.
2. Test for less than 10 ohms between each ground circuit terminal listed below and ground:
 - Terminal 3
 - Terminal 6
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate.**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the circuit breaker is OK and there is voltage at the circuit breaker.
 - **If the test lamp illuminates.**
5. Ignition OFF, connect the X4 harness connector at the K40 Seat Memory Control Module and disconnect the harness connector at the appropriate seat motor listed below:
 - M51D Seat Horizontal Motor
 - M50D Seat Front Vertical Motor
 - M55D Seat Rear Vertical Motor
 - M56D Seat Recline Motor
6. Connect a test lamp between control circuit terminal 1 and control circuit terminal 5, ignition ON.

NOTE: **Once a seat motor is commanded On using the scan tool, the seat function may not work using the seat adjuster switch until you back out of the scan tool Control Functions menu.**

7. Verify the test lamp illuminates when commanding the seat motor in the Up/Down or Forward/Rearward states with a scan tool.
 - **If the test lamp does not illuminate during either of the commands**
 1. Ignition OFF, disconnect the X4 harness connector at the K40 Seat Memory Control Module.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 Seat Memory Control Module.
 - **If the test lamp illuminates during each of the commands**
8. Test or replace the seat motor.

Component Testing

Seat Adjuster Switch Test

1. Ignition OFF, disconnect the harness connector at the S64D Driver Seat Adjuster Switch.
2. Test for infinite resistance between the ground terminal B and each signal terminal with the switch in the open position.
 - **If less than infinite resistance**

Replace the S64D Driver Seat Adjuster Switch.
 - **If infinite resistance**
3. Test for less than 2 ohms between the ground terminal B and each signal terminal with the appropriate switch in the closed position.
 - **If 2 ohms or greater**

Replace the S64D Driver Seat Adjuster Switch.
 - **If less than 2 ohms**
4. All OK.

Seat Motor

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor listed below:
 - M51D Seat Horizontal Motor
 - M50D Seat Front Vertical Motor
 - M55D Seat Rear Vertical Motor
 - M56D Seat Recline Motor

NOTE: When performing the following tests, make sure that the seat is not already in the position the test is attempting to produce.

2. Install a 30 A fused jumper wire between control terminal 1 and 12 V.
3. Momentarily install a jumper wire between control terminal 5 and ground. The seat motor should momentarily perform the appropriate FORWARD/ REARWARD/ UP/ DOWN function.
 - **If the motor does not perform the FORWARD/ REARWARD/ UP/ DOWN function**

Replace the motor.
 - **If the motor performs the FORWARD/ REARWARD/ UP/ DOWN function**
4. Reverse the jumper wires; the motor should perform FORWARD/ REARWARD/ UP/ DOWN function.
 - **If the motor does not perform the FORWARD/ REARWARD/ UP/ DOWN function**

Replace the motor.
 - **If the motor performs the FORWARD/ REARWARD/ UP/ DOWN function**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Adjuster Switch Replacement (Driver/Passenger Seat 4-Way Hybrid)**
- **Front Seat Adjuster Motor Replacement (Driver or Passenger Seat 8-Way Power)**
- **Front Seat Recliner Actuator Motor Replacement (Driver or Passenger Seat 8-Way Power)**
- **Control Module References** for K40 Seat Memory Control Module replacement, programming and setup

REPAIR INSTRUCTIONS

DRIVER OR PASSENGER SEAT ADJUSTER SWITCH REPLACEMENT (DRIVER/PASSENGER SEAT 4-WAY HYBRID)

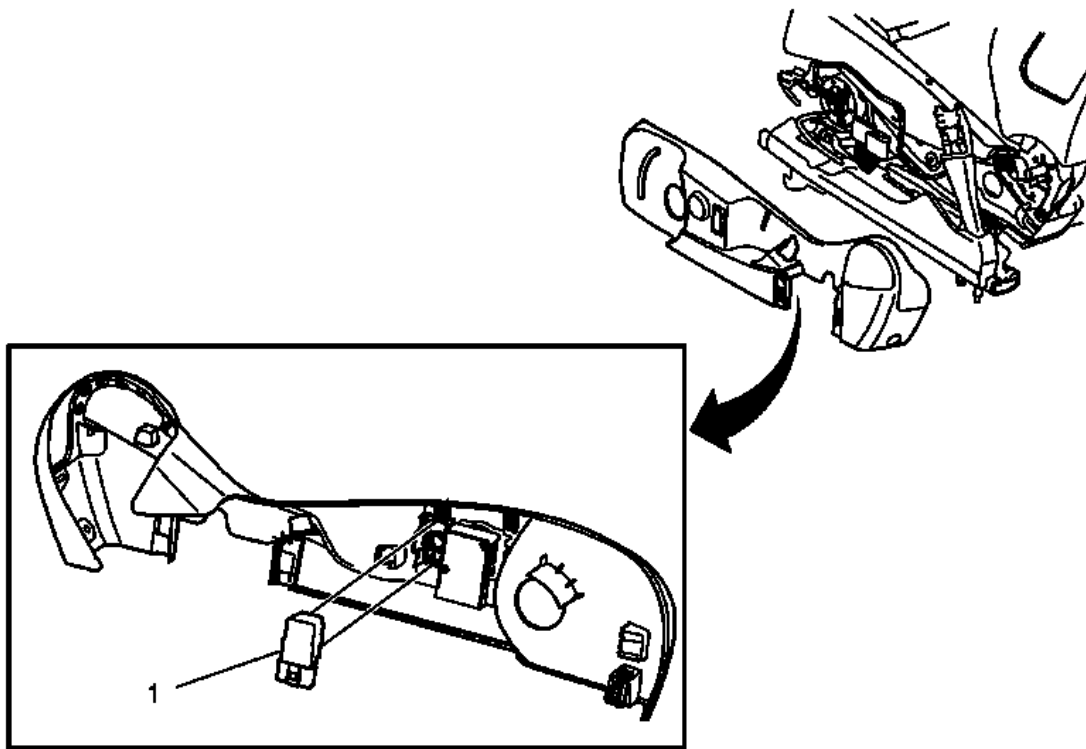


Fig. 8: Driver Or Passenger Seat Adjuster Switch
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Adjuster Switch Replacement (Driver/Passenger Seat 4-Way Hybrid)

Callout	Component Name
Preliminary Procedure	
Remove driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Retainer Replacement (4-Way Hybrid, 6-Way Hybrid Sport)</u> .	
1	Driver or Passenger Seat Adjuster Switch

FRONT SEAT TILT ADJUSTER ACTUATOR REPLACEMENT (DRIVER/PASSENGER SEAT 8-WAY POWER)

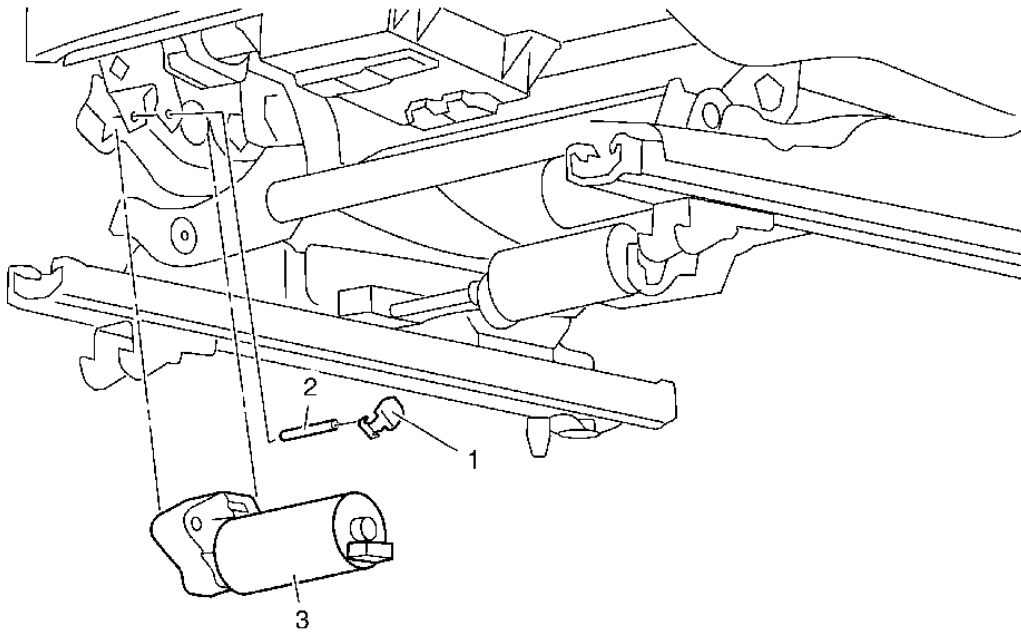


Fig. 9: Front Seat Tilt Adjuster Actuator
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Tilt Adjuster Actuator Replacement (Driver/Passenger Seat 8-Way Power)

Callout	Component Name
Preliminary Procedure	
Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u> .	
1	Securing Clip
2	Roll Pin TIP: Use a hammer and small round tool to tap the roll pin out.
3	Front Seat Tilt Adjuster Actuator Procedure Disconnect the electrical connector.

FRONT SEAT RECLINER ACTUATOR SHAFT REPLACEMENT (LOWER - 8-WAY-POWER)

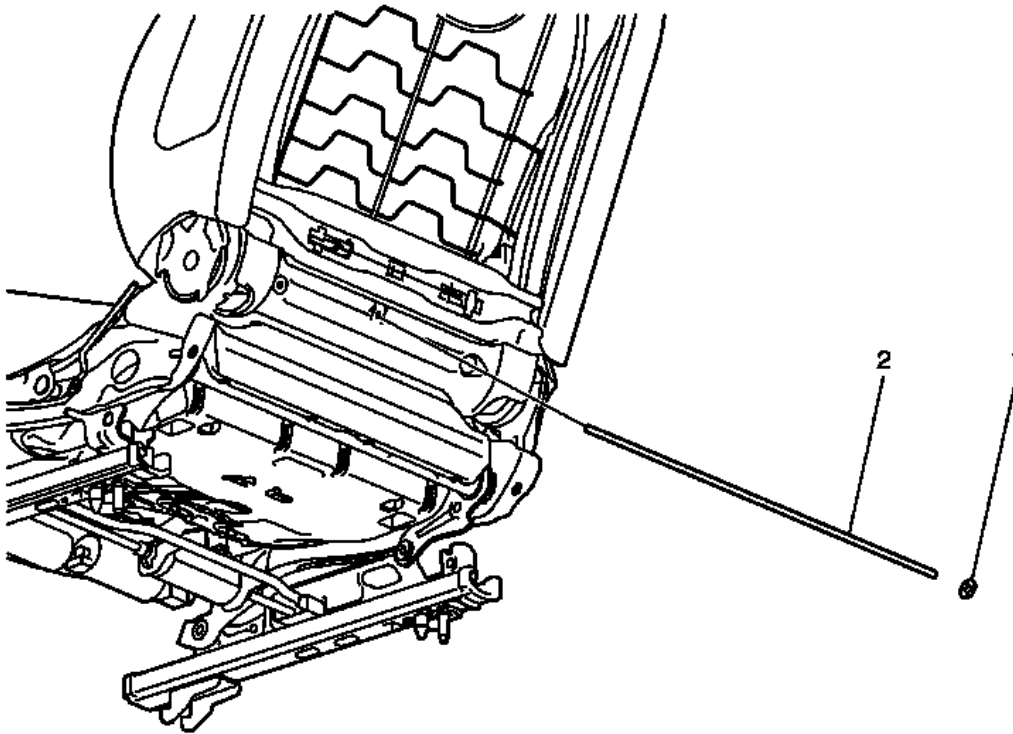


Fig. 10: Front Seat Recliner Actuator Shaft & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Recliner Actuator Shaft Replacement (Lower - 8-Way-Power)

Callout	Component Name
Preliminary Procedure	
1. Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u> . 2. Release the front seat back cushion cover at backrest. 3. Release the front seat recliner actuator.	
1	Front Seat Recliner Actuator Shaft Jam Fastener TIP: Use a new jam fastener.
2	Front Seat Recliner Actuator Shaft

DRIVER OR PASSENGER SEAT VERTICAL ADJUSTER ACTUATOR REPLACEMENT (4/6/8-WAY)

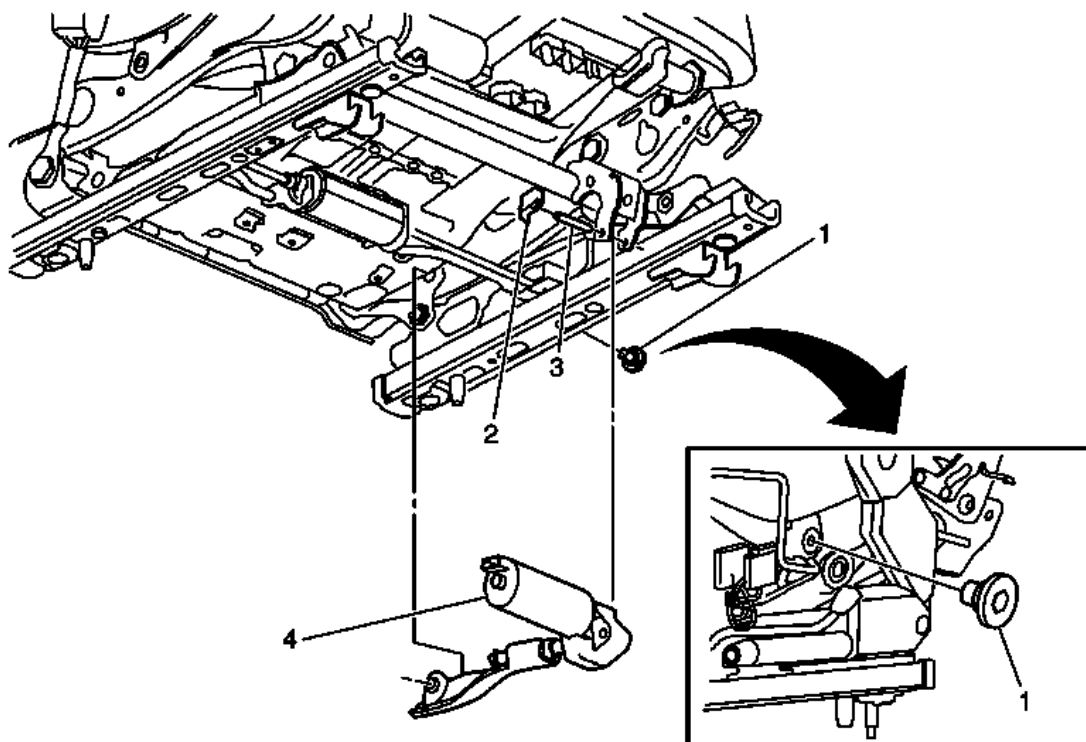


Fig. 11: Driver or Passenger Seat Vertical Adjuster Actuator
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Vertical Adjuster Actuator Replacement (4/6/8-Way)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u> . 3. Remove the driver or passenger seat . Refer to <u>Driver or Passenger Seat Removal and Installation</u> . 4. Remove the front seat adjuster track finish cover. Refer to <u>Front Seat Adjuster Track Finish Cover Replacement</u> . 	
1	Driver or Passenger Seat Adjuster Vertical Actuator Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the electrical connector. Tighten 20 N.m (15 lb ft)

2	Securing Clip
3	Roll Pin
4	Driver or Passenger Seat Adjuster Vertical Actuator

FRONT SEAT ADJUSTER ACTUATOR REPLACEMENT (8-WAY POWER)

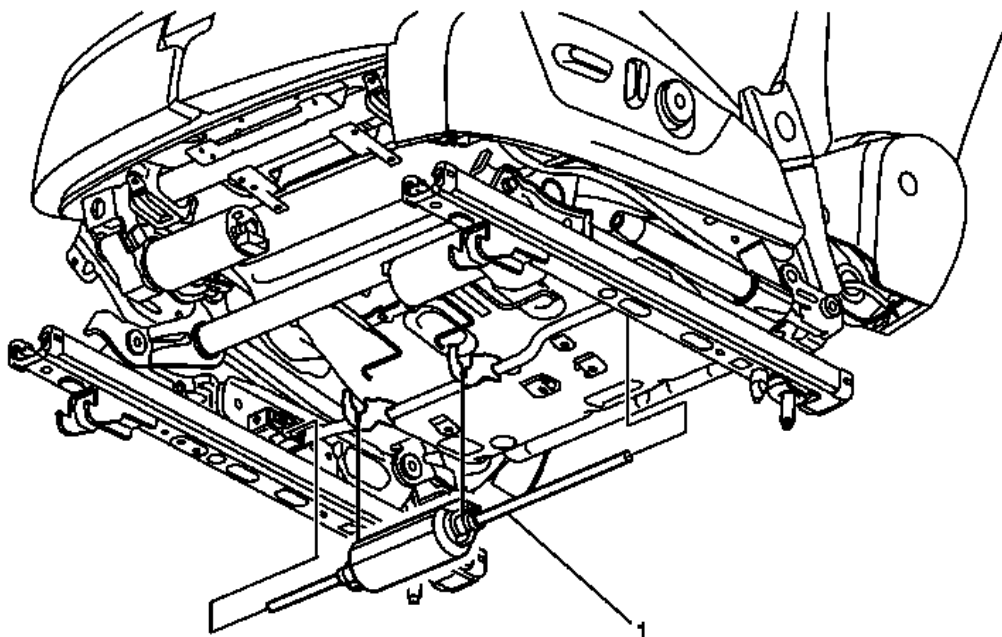


Fig. 12: Front Seat Adjuster Actuator
Courtesy of GENERAL MOTORS COMPANY

Front Seat Adjuster Actuator Replacement (8-Way Power)

Callout	Component Name
Preliminary Procedure Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)</u> .	
1	Front Seat Adjuster Actuator Procedure <ol style="list-style-type: none"> 1. Remove the seat adjuster actuator out of both brackets at seat frame. 2. Disconnect the electrical connector.

FRONT SEAT ADJUSTER MOTOR REPLACEMENT (DRIVER OR PASSENGER SEAT 8-WAY POWER)

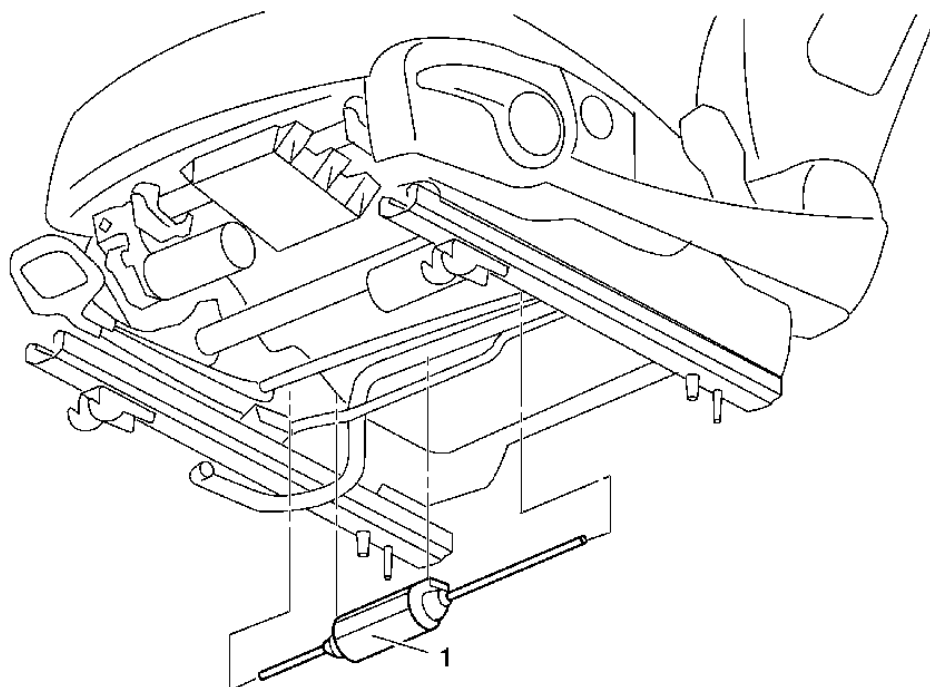


Fig. 13: Front Seat Adjuster Motor
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Adjuster Motor Replacement (Driver or Passenger Seat 8-Way Power)

Callout	Component Name
Preliminary Procedure	
Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u> .	
1	Front Seat Adjuster Motor Procedure <ol style="list-style-type: none"> 1. Remove the seat adjuster motor out of the both brackets at seat frame. 2. Remove the seat adjuster motor cables by pulling the cables out of adjuster. 3. Disconnect the electric connector.

**DRIVER OR PASSENGER SEAT LUMBAR CONTROL SWITCH REPLACEMENT
 (DRIVER/PASSENGER SEAT 6-WAY HYBRID)**

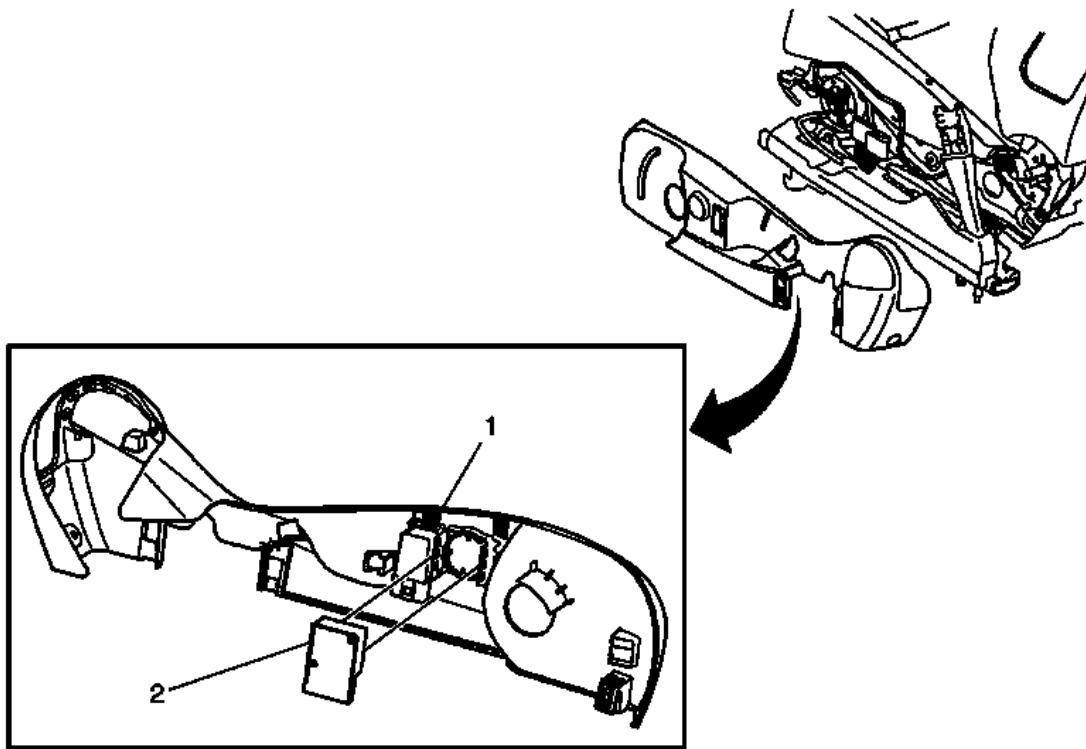


Fig. 14: Driver Or Passenger Seat Lumbar Control Switch
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Lumbar Control Switch Replacement (Driver/Passenger Seat 6-Way Hybrid)

Callout	Component Name
1	Driver or Passenger Seat Adjuster Finish Cover Procedure Remove the driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Retainer Replacement (4-Way Hybrid, 6-Way Hybrid Sport)</u> .
2	Driver or Passenger Seat Lumbar Control Switch

FRONT SEAT RECLINER ACTUATOR MOTOR REPLACEMENT (DRIVER OR PASSENGER SEAT 8-WAY POWER)

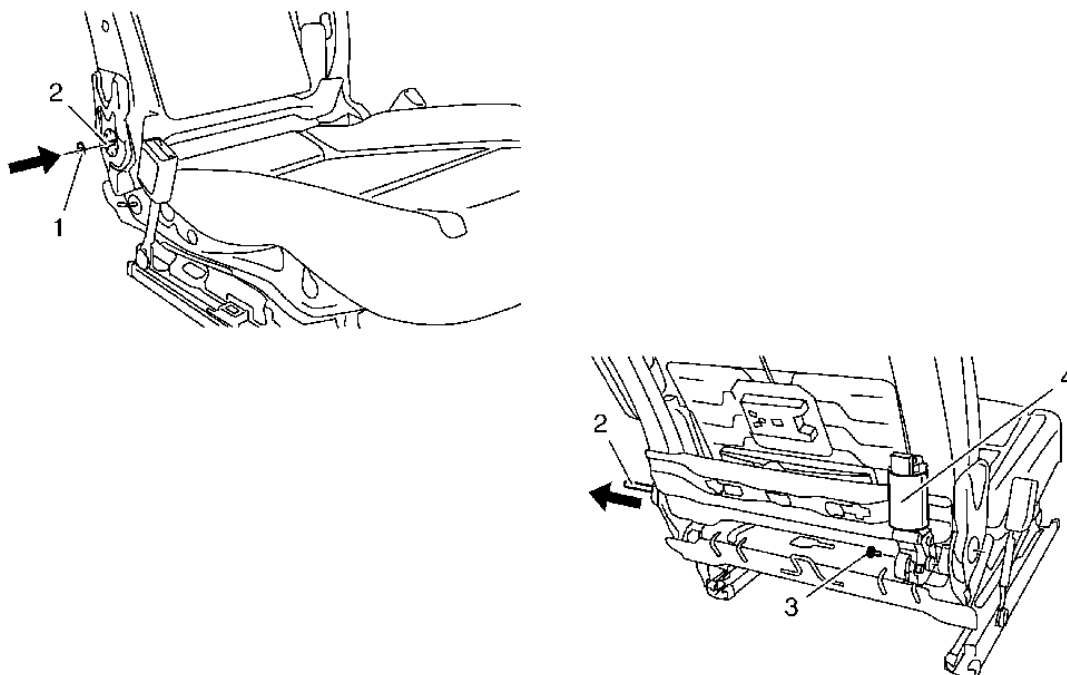


Fig. 15: Seat Recliner Actuator & Components
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Recliner Actuator Motor Replacement (Driver or Passenger Seat 8-Way Power)

Callout	Component Name
Preliminary Procedures	
1.	SIR disabling and enabling. Refer to <u>SIR Disabling and Enabling</u> .
2.	Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .
3.	Remove driver or passenger seat replacement. Refer to <u>Driver or Passenger Seat Removal and Installation</u> .
4.	Remove driver or passenger seat adjuster handle. Refer to <u>Driver or Passenger Seat Adjuster Handle Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u> .
5.	Remove driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)</u> .
6.	Remove driver or passenger seat inner recliner finish cover. Refer to <u>Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u> .
7.	Remove front seat head restraint. Refer to <u>Driver or Passenger Seat Head Restraint Replacement (without AHS)</u> .
8.	Remove front seat head restraint guide bezel. Refer to <u>Front Seat Head Restraint Guide Bezel Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u> , <u>Front Seat Head Restraint Guide Bezel Replacement (8-Way Power)</u> .
9.	Remove front seat back cushion pad. Refer to <u>Front Seat Back Pad Replacement (2/4/6-Way</u>

Hybrid, 6-Way Hybrid Sport) , Front Seat Back Pad Replacement (8-Way Power) .

10. Remove front seat head restraint adjust rod guide. Refer to **Front Seat Head Restraint Guide Replacement** .

1	Front Seat Recliner Rod Jam Nut TIP: Replace with new rod jam nut.
2	Recliner Rod Procedure Gently tap the recliner rod outward until the rod is free of the recliner motor.
3	Front Seat Recliner Actuator Motor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the electric connector. Tighten 6 N.m (53 lb in)
4	Front Seat Recliner Actuator Motor

DESCRIPTION AND OPERATION

LUMBAR SUPPORT DESCRIPTION AND OPERATION

Lumbar Support Components

The driver and front passenger pneumatic lumbar support system each consist of the following components:

- Seat Lumbar support switch
- Seat lumbar adjuster valve assembly
- Seat lumbar support pump

If equipped, the passenger seat block diagram is identical to the driver seat.

Lumbar Block Diagram

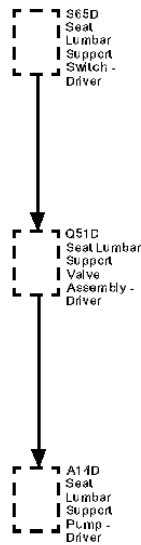


Fig. 16: Lumbar Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
HW	Hard-Wired
S65D	S65D Seat Lumbar Support Switch - Driver
Q51D	Q51D Seat Lumbar Support Valve Assembly - Driver
A14D	A14D Seat Lumbar Support Pump - Driver

Circuit Description

Battery voltage is supplied at all times to the seat lumbar support valve assembly through a 25 A circuit breaker located in the instrument panel fuse block. The lumbar support valve assembly supplies a reference voltage to each signal circuit of the lumbar switch. When a lumbar switch is pressed to inflate the lumbar support, the signal circuit from the lumbar support valve assembly is pulled low through the switch contacts indicating the lumbar support command. The lumbar support valve assembly energizes its internal inflate solenoid and applies ground through the seat lumbar support pump control circuit to the pump. The pump runs to inflate the appropriate lumbar bladder until the switch is released. When the switch is pressed to deflate the lumbar support, the signal circuit is pulled low through the switch contacts and the deflate signal circuit to the lumbar support valve assembly. The lumbar support valve assembly energizes its internal deflate solenoid and air is released from the bladder until the switch is released.

Description of Operation

The following describes the lumbar support operation and how the lumbar adjuster valve assembly responds to each of the lumbar support switch inputs:

- When the lumbar support switch pressed in the FORWARD direction, the lumbar adjuster valve assembly will command the lumbar support pump ON and the upper and lower lumbar support bladders should inflate until the bladders are 100% inflated or the switch is released.
- When pressing the lumbar support switch in the REARWARD direction, the lumbar adjuster valve assembly will slowly deflate the upper and lower lumbar support bladders until the switch is released or both bladders are 100% deflated.
- When the lumbar support switch is pressed in the UP direction, the lumbar adjuster valve assembly will slowly inflate the upper lumbar support bladder until the switch is released or the bladder is 100% inflated.
- When the lumbar support switch is pressed in the DOWN direction, the lumbar adjuster valve assembly will slowly deflate the upper lumbar bladder while it inflates the lower lumbar bladder. The lumbar adjuster valve assembly will continue this operation until the switch is released or the upper lumbar bladder is 100% deflated and the lower lumbar bladder is 100% inflated.

MEMORY SEATS DESCRIPTION AND OPERATION

Memory Seat System Components

The seat memory system consists of the following components:

- Driver seat adjuster switch
- Driver seat memory switch
- Seat memory control module
- Seat horizontal motor/sensor
- Seat front vertical motor/sensor
- Seat rear vertical motor/sensor
- Seat back recline motor/sensor

Memory Seat Block Diagram

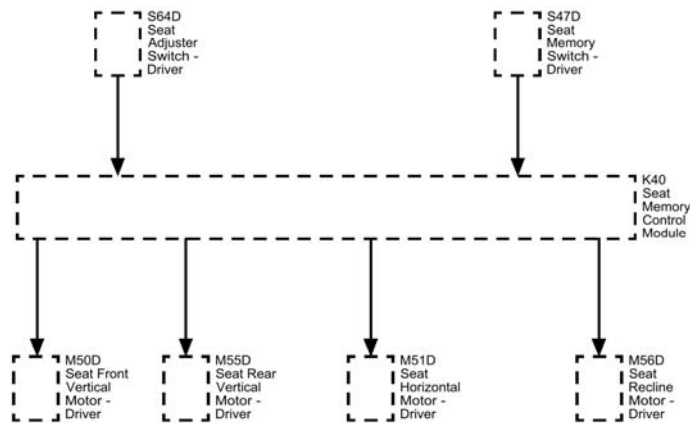


Fig. 17: Memory Seat Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
S64D	S64D Seat Adjuster Switch - Driver
S47D	S47D Seat Memory Switch - Driver
K40	K40 Seat Memory Control Module
M56D	M56D Seat Recline Motor - Driver
M51D	M51D Seat Horizontal Motor - Driver
M55D	M55D Seat Rear Vertical Motor - Driver
M50D	M50D Seat Front Vertical Motor - Driver

Driver Seat Personalization Option

The seat memory control module will not perform remote memory recall and driver seat easy exit functions unless these personalization options are activated in the audio system, refer to Vehicle Personalization in the Owners Manual. The audio system reports the vehicle personalization option settings to the seat memory

control module as well as other receiving modules via GMLAN message each time the ignition switch is cycled to the ON position. The seat memory control module will then store the seat personalization option settings and examine them before making a memory seat adjustment. The seat personalization option settings stored within the seat memory control module will not change until the memory recall option setting in the audio system is changed and the ignition switch is cycled to the ON position.

Driver Seat Adjuster Switch

The seat memory control module supplies a low current voltage to each signal circuit of the seat adjuster switch. When the seat switches are pressed, the appropriate signal circuit from the seat memory control module is pulled low through the switch contacts indicating the power seat command. The seat memory control module then commands the driver seat to move in response to the switch signals.

Seat Motors

There are 4 motors that move the position of the seat. These are the seat horizontal motor, front vertical motor, rear vertical motor and the seat back recline motor. The horizontal motor moves the entire seat forward and rearward. Both vertical motors run simultaneously when the seat switch is operated in order to move the entire seat up and down. Or they can be selected independently to vertically tilt the front or rear of the seat up and down. The recline motor moves the angle of the seat back forward or rearward.

The seat memory control module controls all seat motors via half bridges that are connected to a single power rail internal to the module. The module connects all motor outputs on the power rail to a common reference point whenever they are not in operation. This reference point is biased to approximately 2.5 V. The seat memory control module checks to see if this reference voltage is shorted to ground or battery before enabling any seat motor. All seat motors operate independently of each other. Each motor contains a electronic circuit breaker (PTC), which will reset only after voltage has been removed from the motor.

All seat motors are reversible. For example, when the seat switch is pressed to move the entire seat forward, ground is applied through the switch contacts and seat horizontal forward switch signal circuit to the seat memory control module. In response to this signal, the seat memory control module applies battery voltage through the driver seat horizontal motor forward control circuit and ground through the driver seat horizontal motor rearward control circuit to the motor. The motor runs in order to drive the entire seat forward. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery voltage and ground are applied on the opposite circuits causing the motor to run in the opposite direction. All of the seat motors are powered this way.

Seat Position Sensors

The seat motors are equipped with 2 wire hall effect type position sensors internal to the motor. The sensors are monitored by the seat memory control module and are used to determine seat positions when storing or recalling memory settings. The seat memory control module supplies the sensors with a common 12 V reference circuit and separate signal circuits. During seat motor operation, the hall effect position sensor provides a determined number of pulse signals for every revolution of the motor shaft. These pulse signals (Counts) range from 0 - 65,535. High scan tool count values indicate forward or upward seat positions while low count values indicate rearward or downward seat positions.

Memory Functions

Memory recalls via the memory switch require the driver to press and hold the memory button until the seat reaches its memory position.

Ground from the seat memory control module is supplied at all times through the low reference circuit to the driver seat memory switch. The module also supplies memory set and memory recall signal circuits to the seat memory switch. When a memory recall switch is pressed, the signal circuit from the seat memory control module is pulled low through the switch contacts and a series of resistors indicating the memory recall request. In response to this signal, the seat memory control module commands the appropriate seat motors to move to the pre-recorded seat positions stored in memory.

There are two methods to save and recall memory positions for the driver seat and outside rearview mirrors (also adjustable pedals and power tilt/telescoping steering column if equipped). The first method to save and recall memory positions is by using the memory set buttons, the second method is by using the key fob.

Unique memory positions may be saved for up to 5 drivers. Two unique memory positions can be saved via memory recall switches 1 and 2. To save memory positions for driver 1:

- Adjust the driver seat and the exterior mirrors (also adjustable pedals and power column if equipped) to the desired position.
- Simultaneously press and hold the memory recall switch MEM button and button 1 until a signal chime sounds indicating the memory position is saved for driver 1.

A second seating position for driver 2 may be programmed by repeating the above steps and pressing memory button 2. There is no correlation between fob 1 and memory button 1 or fob 2 and memory button 2. The positions stored for each of the memory recall buttons can be recalled by pressing and holding the memory recall button until the memory controlled devices reach their saved position.

In addition to the two memory recall switch positions, three remote memory recall positions for Drivers 1, 2, and 3 may be saved. Drivers 1 and 2 will each have a unique set of remote memory recall positions saved for key fob ID's 1 and 2. A third unique set of positions for Driver 3 may also be saved for all additional key fobs 3 through 8. Key fob ID's 3 through 8 will be recognized by the Seat Memory Control Module as key fob ID 3. Key fob ID 3 will share the same set of saved positions but will be unique from key fob IDs 1 and 2.

NOTE: The key fob memory recall positions are not tied to the positions stored to the memory seat recall switches.

Key fobs 1, 2 and 3 (up to 3 unique sets of positions) can be saved by:

- Press Unlock on the desired key fob
- Place the ignition in the ON position
- Adjust seat and mirrors to desired positions
- Turn the ignition OFF

Keyless Entry and Memory Recall Personalization

When a keyless entry transmitter is used in order to unlock the vehicle's doors, the body control module

communicates the unlock command and which driver performed the command to the seat memory control module via a serial data message. Vehicle lock/unlock functions and memory recall settings may be personalized. For functional descriptions and personalization instructions, refer to the vehicle owners manual.

POWER SEATS SYSTEM DESCRIPTION AND OPERATION

The driver and passenger 8-way power seat systems each consist of the following components:

- Seat adjuster switch
- Seat horizontal motor
- Seat front vertical motor
- Seat rear vertical motor
- Seat recline motor

The 2-way power seat system consists of a seat adjuster switch and a seat vertical motor.

NOTE: **If equipped, the passenger seat block diagram is identical to the driver seat.**

Power Seat Block Diagram

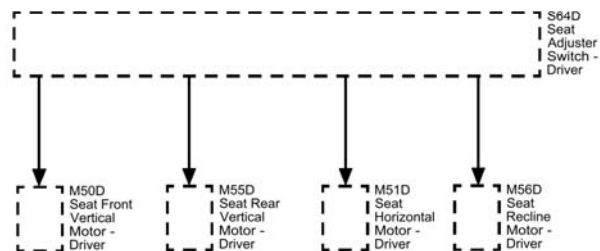


Fig. 18: Power Seat Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
S64D	S64D Seat Adjuster Switch - Driver
M56D	M56D Seat Recline Motor - Driver
M51D	M51D Seat Horizontal Motor - Driver
M55D	M55D Seat Rear Vertical Motor - Driver
M50D	M50D Seat Front Vertical Motor - Driver

Seat Motors

All of the seat motors operate independently of each other. Each motor contains an electronic circuit breaker

(PTC) that opens in the event of a circuit overload and will reset only after voltage has been removed from the circuit. There are four seat position motors and one lumbar motor. These are the horizontal motor, front vertical motor, rear vertical motor, and the seat back recline motor. The seat horizontal motor moves the entire seat forward and rearward. The seat vertical motors may operate independently to tilt the front or rear of the seat cushion up or down. Both motors can also run simultaneously to move the entire seat up or down. The recline motor moves the angle of the seat back forward or rearward.

Seat Operation

The seat switches provide both power and ground to the selected seat motors.

All seat motors are reversible. For example, when the seat horizontal forward switch is pressed to move the entire seat forward, ground is applied through the switch contacts and the seat horizontal motor forward control circuit to the motor. With the horizontal motor rearward switch contacts closed to the switch B+ circuit, the motor runs in order to drive the entire seat forward until the switch is released. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction. All seat motors are powered this way.

STEERING

Power Steering

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Drivetrain and Front Suspension Frame Rear Bolt	160 N.m	118 lb ft
Drivetrain and Front Suspension Frame Reinforcement Bolt		
• First Pass	60 N.m	44 lb ft
• Final Pass	30 Degrees	
Power Steering Assist Motor Bolt (NJ1 Only) (1)	8 N.m	71 lb in
Steering Gear Bolt (1)		
• First Pass	110 N.m	81 lb ft
• Final Pass	150 Degrees	
Steering Gear Heat Shield Fastener	9 N.m	80 lb in
Steering Gear Wiring Harness Bracket Bolt	9 N.m	80 lb in
Steering Linkage Inner Tie Rod	100 N.m	74 lb ft
Steering Linkage Inner Tie Rod Nut	60 N.m	44 lb ft
Steering Linkage Outer Tie Rod Nut (1)		
• First Pass	35 N.m	26 lb ft
• Final Pass	30 Degrees	
1. Use NEW fastener.		

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Steering Gear Boot	Lithium Grease	12377985	88901242

SCHEMATIC WIRING DIAGRAMS

POWER STEERING WIRING SCHEMATICS

Variable Assist (NV7 or NXC)

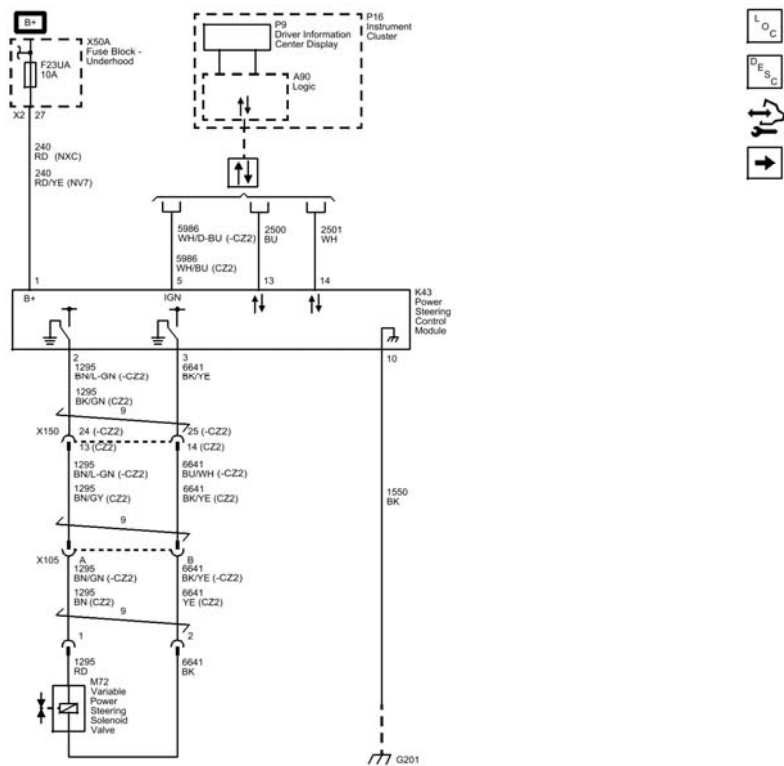


Fig. 1: Variable Assist (NV7 or NXC)
Courtesy of GENERAL MOTORS COMPANY

Electric Power Steering (NJ1)

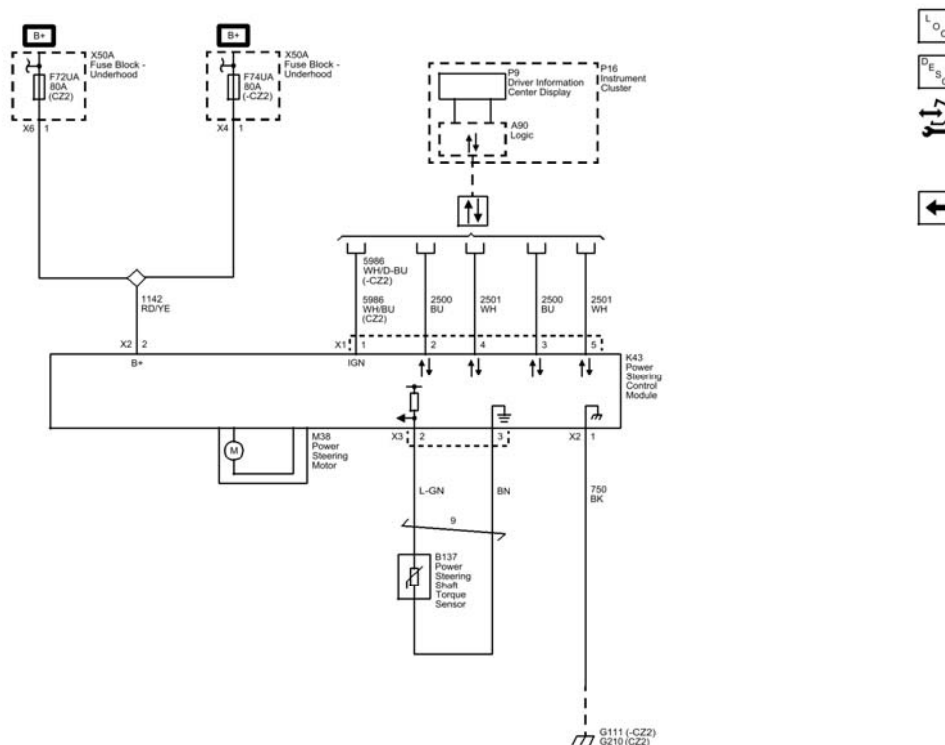


Fig. 2: Electric Power Steering (NJ1)
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC C005B (NJ1)</u>	DTC C005B 00 Power Steering Softstops Learn
<u>DTC C0176 (NJ1)</u>	DTC C0176 54 Control Module Temperature Sensor High Temperature
<u>DTC C044A (NJ1)</u>	DTC C044A 71 Steering System Engine Speed Signal Circuit Invalid Data
<u>DTC C0450 (NV7)</u>	DTC C0450 01 Steering Assist Control Actuator Circuit Short to Battery DTC C0450 02 Steering Assist Control Actuator Circuit Short to Ground DTC C0450 04 Steering Assist Control Actuator Circuit Open
<u>DTC C0456 (NJ1)</u>	DTC C0456 4B Steering Position Sensor Calibration not Learned
<u>DTC C0475 (NJ1)</u>	DTC C0475 00 Electric Steering Motor Circuit Malfunction DTC C0475 59 Electric Steering Motor Circuit Protection Time-Out
<u>DTC C047A (NJ1)</u>	DTC C047A Electric Steering Motor Position Sensor Circuit
<u>DTC C0544 (NJ1)</u>	DTC C0544 5A Steering Wheel Angle Sensor Signal Not Plausible
<u>DTC C0545 (NJ1)</u>	DTC C0545 00 Steering Wheel Torque Sensor Malfunction
<u>DTC C055C (NJ1)</u>	DTC C055C 00 Steering Gear Performance Malfunction

	DTC C055C 64 Steering Gear Performance Slip Detected
DTC C0565 (NJ1)	DTC C0565 5A Vehicle Identification Number Not Plausible
DTC C0569 (NJ1)	DTC C0569 3A System Configuration Incorrect Component Installed
DTC C0710 (NJ1, NJ2, NV7)	DTC C0710 71 Steering Position Signal Invalid Data

DTC C005B: POWER STEERING SOFTSTOPS LEARN (NJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C005B 00

Power Steering Softstops Learn

Circuit/System Description

If the power steering power pack is replaced, the calibration needs to be learned to the new power steering power pack using a scan tool. The power steering control module will set a DTC, if the required parameters are not learned.

Conditions for Running the DTC

Ignition Switch in OFF, ACCESSORY or ON position, power steering control module in communications mode.

Conditions for Setting the DTC

The soft endstop is not learned by the new power steering control module.

Action Taken When the DTC Sets

DTC C005B is stored in memory.

Conditions for Clearing the DTC

The software endstops need to be learned to the new power steering control module using a scan tool, performing the Configuration/Reset functions Power Steering Softstops Reset and Power Steering Softstops Learn.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC C005B is not set.
 - **If DTC C005B is set**

Program the K43 Power Steering Control Module.

- **If DTC C005B is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for power steering control module programming and setup.

DTC C0176: CONTROL MODULE TEMPERATURE SENSOR HIGH TEMPERATURE (NJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0176 54

Control Module Temperature Sensor High Temperature

Circuit/System Description

The power steering control module monitors the temperature of the Power Steering System. The power steering control module uses voltage, current levels and input from an internal temperature sensor to calculate an estimated system temperature. If the power steering control module detects a high system temperature event is occurring, the amount of assist is decreased to reduce system temperature, in effort to prevent thermal damage to the power steering components.

Conditions for Running the DTC

- Ignition ON, engine Running.
- Power steering system voltage is 9-16 volts.
- Repetitive steering input applied.

Conditions for Setting the DTC

The power steering control module detects a high system temperature.

Action Taken When the DTC Sets

- DTC C0176 54 is stored in memory.
- Steering assist is reduced.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Diagnostic Aids

- DTC C0176 54 does not indicate that a malfunction has occurred. Rather that the power steering control module had to limit current to the power steering motor to avoid thermal damage to the power steering system components. Discuss with the customer about driving conditions when the steering assist was reduced.
- Ensure that no steering components down stream of the power steering column assembly, such as ball joints, tie rod ends, universal joints, or the steering gear assembly, are mechanically binding.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the DTC sets outside of the conditions for running and setting. Since most occurrences of this DTC are caused by excessive driver inputs, review with the customer the conditions under which the DTC set.
 - **If the DTC did not set outside of the conditions for running and setting**
 1. Ignition ON.
 2. Operate the vehicle within the conditions that the customer experienced, avoiding excessive inputs, and verify the DTC does not reset.
 - If the DTC is set
 1. Verify that no steering components down stream of the power steering column assembly are mechanically binding. Refer to **Steering Effort Hard or Too Easy in One or Both Directions**
 - If steering components are mechanically binding, replace the mechanically binding steering components.
 - If no steering components are mechanically binding, replace the Steering Gear.
 - If the DTC is not set
3. All OK.
 - **If the DTC set outside of the conditions for running and setting**
2. All OK. The power steering is operating as designed.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1),
Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)**
- **Control Module References** for power steering control module replacement, programming and setup.

DTC C044A: STEERING SYSTEM ENGINE SPEED SIGNAL CIRCUIT INVALID DATA (NJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C044A 71

Steering System Engine Speed Signal Circuit Invalid Data

Circuit/System Description

The power steering control module receives the engine speed signal from the engine control module.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The power steering control module detects a invalid engine speed signal on the CAN Bus.

Action Taken When the DTC Sets

- DTC C044A is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON. Verify that DTC U0401 is not set.
 - **If DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If the DTC is not set**
2. Verify that DTC C044A 71 is not set.
 - **If the DTC is set**

Replace the K43 Power Steering Control Module.

- **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for power steering control module replacement, programming and setup

DTC C0450: STEERING ASSIST CONTROL ACTUATOR (NV7)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0450 01

Steering Assist Control Actuator Circuit Short to Battery

DTC C0450 02

Steering Assist Control Actuator Circuit Short to Ground

DTC C0450 04

Steering Assist Control Actuator Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Variable Effort Steering Actuator Control Circuit 1	C0450 02	C0450 04	C0450 01	-
Variable Effort Steering Actuator Control Circuit 2	C0450 02	C0450 04	C0450 01	-

Circuit/System Description

The actuator is a variable electromagnetic actuator, which consists of one multiple-pole ring-style permanent magnet, with a pole piece, and an electromagnetic coil assembly. By commanding currents between -3 to +3 A through the coils the steering effort will be adapted accordingly.

Conditions for Running the DTC

- System voltage between 9-16 V
- Engine running

Conditions for Setting the DTC

The variable effort steering detects a short to battery, short to ground or an open circuit in the actuator circuits.

C0450 01

If the coil feedback voltage is measured greater than 8 V during the initialization of the module, the DTC will be set.

C0450 02

If the coil feedback voltage is measured less than 3.4 V during the initialization of the module, the DTC will be set.

C0450 04

If the coil current is measured to be less/greater than 1.0 A from the commanded current, the DTC will be set.

Action Taken When the DTC Sets

- DTC C0450 is stored in memory.
- The fault lamp illuminates or the driver information center displays the service power steering message.
- The variable effort steering module goes in to shutdown mode.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present and the DTC is cleared with a scan tool.
- The variable effort steering automatically clears the history DTC when a current DTC is not detected in 40 consecutive communication wake-up enable cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X115 harness connector at the M72 variable power steering solenoid valve.
2. Test for less than 10 ohms between the low reference circuit terminal B and ground.

- **If greater than the specified range**

1. Disconnect the harness connector at the K43 Power Steering Control Module.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K43 Power Steering Control Module.

- **If within the specified range**

3. Test for less than 1 V between the signal circuit terminal A and ground.

- **If greater than the specified range**

Repair the short to voltage on the circuit.

- **If within the specified range**

4. Ignition ON, test for B+ between the signal circuit terminal A and ground.

- **If less than B+**

1. Disconnect the harness connector at the K43 Power Steering Control Module.
2. Test for infinite resistance between the signal circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance

3. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K43 Power Steering Control Module.

- **If B+**

5. Test for 1.6-3.1 ohms between control terminal A and control terminal B of the harness connector at the M72 variable power steering solenoid valve.

- **If not within the specified range**

Replace the M72 variable power steering solenoid valve.

- **If within the specified range**

6. Test for infinite resistance between each terminal and the M72 variable power steering solenoid valve housing case.

- **If less than infinite resistance**

Replace the M72 variable power steering solenoid valve.

- **If infinite resistance**

7. Replace the K43 Power Steering Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Steering Control Module Calibration (NJ1)** for power steering control module replacement
- **Control Module References** for power steering control module replacement, setup and programming

DTC C0456 (NJ1): STEERING ASSIST CONTROL ACTUATOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0456 4B

Steering Position Sensor Calibration not Learned

Circuit/System Description

Steering Angle Sensor Centering and Software Endstop is not learned by the new power steering control module.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The calibration is not learned by the new power steering control module.

Action Taken When the DTC Sets

- DTC C0456 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.
- No steering assist.

Conditions for Clearing the DTC

Steering Angle Sensor Centering and Software Endstop Learning procedure must be completed successfully.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. With a scan tool, verify that DTC C0456 4B is not set.
 - **If the DTC is set**
 1. Perform the Steering Angle Sensor Centering and Software Endstop Learning procedure. Refer to **Power Steering Control Module Calibration (NJ1)**.
 2. Verify the DTC does not reset.
 - If the DTC resets, replace the steering gear.
 - If the DTC does not reset
 3. All OK
 - **If the DTC is not set**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Steering Assist Motor Replacement (NJ1)**, **Power Steering Assist Motor Replacement (NJ2)**
- **Control Module References** for power steering control module programming and setup.

DTC C0475 (NJ1): ELECTRIC STEERING MOTOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0475 00

Electric Steering Motor Circuit Malfunction

DTC C0475 59

Electric Steering Motor Circuit Protection Time-Out

Circuit/System Description

C0475 00

The power steering control module continuously monitors the voltage and current levels being commanded to the 3-phase steering assist motor. The power steering control module compares the desired and actual current levels to detect malfunctions in the internal power steering assist motor circuits.

C0475 59

The power steering control module continuously monitors the thermal cycle counter of the steering gear. If the thermal cycle counter exceeds the maximum allowable limit, the steering gear has reached the end of its predetermined lifecycle and must be replaced.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

C0475 00

The power steering control module detects a short to ground, short to voltage, or an open/high resistance on any of the internal power steering assist motor circuits.

C0475 59

The power steering control module detects the thermal cycle counter has exceeded the maximum allowable limit indicating that the whole steering gear system must be replaced.

Action Taken When the DTC Sets

- The DTC is stored in memory.

- The driver information center displays the SERVICE POWER STEERING warning message.
- No steering assist.

Conditions for Clearing the DTC

C0475 00

- A current DTC will clear on the next malfunction free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction free ignition cycles.

C0475 59

This DTC cannot be cleared. The power steering system must be replaced.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

C0475 00

1. Ignition OFF, disconnect the X2 harness connector at the K43 Power Steering Control Module.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.

- **If greater than the specified range**

Repair the open/high resistance in the ground circuit.

- **If within the specified range**

3. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.

- **If the test lamp does not illuminate**

1. Test for infinite resistance between the B+ circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
2. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K43 Power Steering Control Module.

- **If the test lamp does illuminate**

4. Replace the K43 Power Steering Control Module.

C0475 59

1. Verify that DTC C0475 59 is not set.

- **If the DTC is set**

Replace the M38 Power Steering Motor.

- **If the DTC is not set**

2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Steering Assist Motor Replacement (NJ1), Power Steering Assist Motor Replacement (NJ2)**
- **Control Module References** for power steering control module programming and setup.

DTC C047A (NJ1): ELECTRIC STEERING MOTOR POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C047A

Electric Steering Motor Position Sensor Circuit

Circuit/System Description

The power steering control module continuously monitors the motor position sensor voltage signals. The voltage signals of the motor position sensor and the digital torque sensor index current signal are both processed by the power steering control module to detect and calculate the steering wheel angle.

Conditions for Running the DTC

The vehicle is ON or in SERVICE MODE.

Conditions for Setting the DTC

The power steering control module detects a short to ground, short to voltage, or an open/high resistance on any of the internal motor position sensor circuits, or a plausibility error as a result of a mismatch between the steering angle data from the internal steering angle sensor in the gear versus the external steering angle sensor data on the steering column.

Action Taken When the DTC Sets

- No steering assist.
- The driver information center displays the SERVICE POWER STEERING warning message.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Diagnostics Aids

A communication error between the Electronic Brake Control Module and Power Steering Control Module can cause DTC C047A to set in history and display Service Power Steering warning message. Do not replace the steering gear or power steering control module if DTC C047A is set in history. If DTC C047A is current, follow the Circuit/System Testing for proper diagnosis.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. With a scan tool, verify that DTC C0710 71 is not set.
 - **If DTC C0710 71 is set**

Refer to Anitlock Brake System Diagnostic Information and Procedures.

- **If DTC C0710 71 is not set**
3. With a scan tool verify that DTC C047A is not set.
 - If the DTC is set

Refer to Circuit/System Testing below.

- If the DTC is not set
4. All OK.

Circuit/System Testing

1. Verify that the connector at the B137 Power Steering Shaft Torque Sensor is not damaged or have water intrusion/corrosion.
 - **The B137 Power Steering Shaft Torque Sensor connector is not OK**

Replace the steering gear.

- **The B137 Power Steering Shaft Torque Sensor connector is OK**
2. With a scan tool perform the Power Steering Control Module Calibration procedure Steering Angle Sensor Centering and Software Endstop Learning. Refer to **Power Steering Control Module Calibration (NJ1)**.
 3. Verify that DTC C047A does not set.

- If the DTC does set

Replace the K43 Power Steering Control Module.

- If the DTC does not set

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1),
Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)**
- **Control Module References** for power steering control module replacement, programming and setup

DTC C0544: STEERING WHEEL ANGLE SENSOR (NJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0544 5A

Steering Wheel Angle Sensor Signal Not Plausible

Circuit/System Description

The power steering control module continuously monitors the steering wheel angle sensor. The steering wheel angle sensor indicates the direction in which the driver intends to go.

The power steering control module has a center detection algorithm that compares the reading of the steering angle sensor to the direction based on other vehicle sensors that the vehicle is travelling to determine if the steering angle reading is plausible.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The power steering control module detects a not plausible signal from the steering wheel angle sensor.

The power steering control module detected that the steering angle sensor reading and the direction of the

vehicle exceeds 329 degrees.

Action Taken When the DTC Sets

- DTC C0544 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.

Conditions for Clearing the DTC

A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Ignition ON.
2. Verify that no other DTCs are set except for C0544.
 - **If any other DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no other DTCs are set**

NOTE: Wheel misalignment can cause incorrect Steering Wheel Angle parameter reading.

3. With a scan tool, verify that the Steering Wheel Angle parameter is zero degrees or near zero degrees with the front tire/wheels in the straight ahead position.
 - If the Steering Wheel Angle parameter is not zero degrees or near zero degrees
 1. Perform the Power Steering Control Module Calibration. Refer to **Power Steering Control Module Calibration (NJ1)**
 2. Verify that DTC C0544 is not set.
 - If the DTC is set, replace the K43 Power Steering Control Module.
 - If the DTC is not set
 3. All OK.
 - If the Steering Wheel Angle parameter is zero degrees or near zero degrees
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for power steering control module replacement, programming and setup.

DTC C0545: STEERING WHEEL TORQUE SENSOR (NJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0545 00

Steering Wheel Torque Sensor Malfunction

Circuit/System Description

The power steering control module continuously monitors the digital torque sensor's torque and index current signals. As the steering wheel is turned and torsional twist is applied to the steering shaft, the steering input and output shafts are monitored via the torque signal circuit and then processed by the power steering control module to calculate the steering torque.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The power steering control module detects a short to ground, short to voltage, or an open/high resistance on any of the torque sensor circuits.

Action Taken When the DTC Sets

- DTC C0545 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.
- No steering assist.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC C0545 is not set.
 - **If the DTC is set**

Replace the M38 Power Steering Motor.

- **If the DTC is not set**

2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Steering Assist Motor Replacement (NJ1)**
- **Control Module References** for power steering control module replacement, programming and setup.

DTC C055C: STEERING GEAR PERFORMANCE (NJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C055C 00

Steering Gear Performance Malfunction

DTC C055C 64

Steering Gear Performance Slip Detected

Circuit/System Description

The power steering control module continuously verifies the mechanical friction of the steering gear. If the friction is too high the clutch between motor and rack slips and the internal angle is not longer valid.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The DTC is set when the mechanical friction of the steering gear is too high.

Action Taken When the DTC Sets

- DTC C055C is stored in memory.
- No steering assist.

Conditions for Clearing the DTC

A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Diagnostic Aids

Ensure that no steering components down stream of the power steering column assembly, such as ball joints, tie rod ends, universal joints, or the steering gear assembly, are mechanically binding.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC C055C is not set.
 - **If the DTC is set**
 1. Verify that no steering components down stream of the power steering column assembly are mechanically binding. Refer to Steering Effort Hard or Too Easy in One or Both Directions
 - If steering components are mechanically binding, replace the mechanically binding steering components.
 - If no steering components are mechanically binding, replace the Steering Gear.
 - **If the DTC is not set**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1),
Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)**
- **Control Module References** for Power Steering Control Module replacement, programming and setup.

DTC C0565: VEHICLE IDENTIFICATION NUMBER NOT PLAUSIBLE (NJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0565 5A

Vehicle Identification Number Not Plausible

Circuit/System Description

The vehicle identification number (VIN) is programmed into the power steering control module during initial programming of the module.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

The power steering control module is not properly programmed.

Action Taken When the DTC Sets

- DTC C0565 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction-free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction-free ignition cycles.

Diagnostic Aids

A newly replaced power steering control module can set one or more DTC on its initial ignition ON cycle.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC C0565 is not set.
 - **If the DTC is set**
 1. Program the K43 Power Steering Control Module. Refer to **Power Steering Control Module Programming and Setup** .
 2. Verify the DTC does not reset.
 - If the DTC resets, replace the K43 Power Steering Control Module.
 - If the DTC does not reset
 3. All OK .
 - **If the DTC is not set**
2. All OK .

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for power steering control module replacement, programming and setup

DTC C0569: SYSTEM CONFIGURATION INCORRECT COMPONENT INSTALLED (NJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0569 3A

System Configuration Incorrect Component Installed

Circuit/System Description

The power steering control module continuously monitors the thermal cycle counter of the steering gear. If the power steering control module is replaced, the thermal cycle counter value needs to be transferred from the existing power steering control module over to the new power steering control module using the SPS Electric Power Steering Setup Procedure.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The thermal cycle counter value does not meet the system requirement.

Action Taken When the DTC Sets

- DTC C0569 is stored in memory.
- The driver information center displays the SERVICE POWER STEERING warning message.
- No Steering assist.

Conditions for Clearing the DTC

- A current DTC will clear on the next malfunction free ignition cycle.
- A history DTC will clear after 40 consecutive malfunction free ignition cycles.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Steering System Description and Operation (Electronic Power Steering)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC C0569 3A is not set.
 - **The DTC is set**
 - 1. Program the K43 Power Steering Control Module. Refer to **Power Steering Control Module Programming and Setup** .
 - 2. Verify the DTC does not reset.
 - If the DTC resets, replace the K43 Power Steering Control Module.
 - If the DTC does not reset
 - 3. All OK .
 - **The DTC is not set**
2. All OK .

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for power steering control module replacement, programming and setup.

DTC C0710 (NJ1, NJ2, NV7): STEERING POSITION SIGNAL INVALID DATA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0710 71

Steering Position Signal Invalid Data

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CAN Bus High Serial Data	U0073, U0100, U0101, U0125, U0126, U0140	U0073, U0100, U0101, U0125, U0126, U0140	U0073, U0100, U0101, U0125, U0126, U0140	C0710 5A, C0710 71
CAN Bus Low Serial Data	U0073, U0100, U0101, U0125, U0126, U0140	U0073, U0100, U0101, U0125, U0126, U0140	U0073, U0100, U0101, U0125, U0126, U0140	C0710 5A, C0710 71

Circuit/System Description

The power steering control module monitors the steering angle sensor signal via the GMLAN serial data circuit. The power steering control module utilizes this signal to determine a center point for Active Return and Soft End Stops. Upon detecting an invalid steering angle sensor signal, the power steering control module will disable Active Return and Soft End Stops, then set a DTC.

NOTE: To most drivers the loss of Active Return and Soft End Stops may not be noticeable as there is no visual indicator activated on the instrument cluster or driver information display.

There is no diagnosable cause with the power steering control module when this DTC is set, DO NOT REPLACE POWER STEERING CONTROL MODULE OR STEERING GEAR DUE TO THIS DTC.

For diagnosis of an invalid steering angle sensor signal, refer to **DTC C0460 or C0710** .

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

The power steering control module has received one of the following serial data messages listed below from the external steering angle sensor.

- Steering angle range is exceeded

- Steering angle sensor is not calibrated
- Steering angle sensor is initialized
- Steering angle sensor message: Roll Counter is INVALID
- Steering angle sensor message: Present Bit is FALSE (not common)
- Steering angle sensor message: Error Flag is set to TRUE

Action Taken When the DTC Sets

- The electronic brake control module disables the stability control for the duration of the ignition cycle.
- Active Return and Software End Stops are deactivated.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- When the steering angle sensor signal becomes valid, the fault will set to History and can be cleared with a scan tool.

Diagnostic Aids

The car should not pull in either direction causing the steering wheel to be OFF center while driving straight ahead on a level surface.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. With a scan tool, verify that DTC C0710 71 is not set.
 - **If DTC C0710 71 is set**

Refer to **DTC C0460 or C0710** in Antilock Brake System Diagnostic Information and Procedures.

- **If DTC C0710 71 is not set**
3. All OK.

SYMPTOMS - POWER STEERING SYSTEM

NOTE: Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Power Steering System Description and Operation (Hydraulic Power Steering)**, **Power Steering System Description and Operation (Electronic Power Steering)**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power steering system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Rattle, Clunk, or Shudder Noise from the Power Steering System**
- **Whine or Growl Noise from the Power Steering System**
- **Increase in Effort While Turning Steering Wheel**
- **Poor Return of Steering Wheel**
- **Steering Wheel Surges/Jerks While Turning**
- **Steering Wheel Kickback**
- **Steering Effort Hard or Too Easy in One or Both Directions**

RATTLE, CLUNK, OR SHUDDER NOISE FROM THE POWER STEERING SYSTEM

Rattle, Clunk, or Shudder Noise from the Power Steering System

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Steering Wheel and Column</u>
	Verify a rattle noise is present by driving the vehicle		

2	on a rough road. Verify a clunk noise is present by turning the steering wheel to the left and to the right several times with the key in the ON position. Is a rattle or a clunk noise present?	Go to Step 3	System OK
3	Inspect the steering gear for the proper installation. Is the steering gear installation incorrect?	Go to Step 6	Go to Step 4
4	Inspect the intermediate steering shaft. Is the intermediate steering shaft worn?	Go to Step 8	Go to Step 5
5	Inspect the front suspension. Refer to Noise Diagnosis - Front Suspension . Is the front suspension worn?	Go to Step 7	Go to Step 3
6	Install the steering gear correctly. Refer to Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1) , Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1) , or Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2) , Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2) . Did you complete the repair?	Go to Step 9	-
7	Replace the worn front suspension component that is causing the noise. Did you complete the repair?	Go to Step 9	-
8	Replace the intermediate steering shaft. Refer to Intermediate Steering Shaft Replacement . Did you complete the repair?	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

WHINE OR GROWL NOISE FROM THE POWER STEERING SYSTEM

Special Tools

CH-39570 Chassis Ear

For equivalent regional tools, refer to **Special Tools**.

Whine or Growl Noise from the Power Steering System

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Power Steering System
2	Verify that a whine or growl noise is present. Is a whine or growl noise present?	Go to Step 3	System OK
	Inspect the power steering gear for looseness and/or		

3	worn bushings. Is the steering gear loose or are the bushings worn?	Go to Step 6	Go to Step 4
4	Inspect the power steering motor for a whine or growl noise using the CH-39570 ear. Is the noise present at the power steering motor?	Go to Step 7	Go to Step 5
5	Inspect the power steering gear for a whine or growl noise using the CH-39570 ear. Is the noise present at the power steering gear?	Go to Step 8	Go to Step 3
6	Tighten the power steering gear fasteners or replace the power steering gear due to worn bushings. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u> , <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)</u> , or <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> . Did you complete the repair?	Go to Step 9	-
7	If equipped with an electric dual pinion rack and pinion steering gear, replace the electric power steering assist motor control. Refer to <u>Power Steering Assist Motor Replacement (NJ1)</u> , <u>Power Steering Assist Motor Replacement (NJ2)</u> . If equipped with an electric belt drive rack and pinion steering gear, replace the power steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> . Did you complete the repair?	Go to Step 9	-
8	Replace the power steering gear. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u> , <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)</u> , or <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> . Did you complete the repair?	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

INCREASE IN EFFORT WHILE TURNING STEERING WHEEL

Increase in Effort While Turning Steering Wheel

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Power Steering System</u>
2	Verify that the steering wheel surges or jerks while turning. Does the steering wheel surge or jerk while turning?	Go to Step 3	System OK
3	Inspect the front suspension for worn or binding components. Did you find and correct the condition?	Go to Step 15	Go to Step 4
4	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Inspect the steering linkage outer tie rod for wear or a binding condition. Is the steering linkage outer tie rod worn or binding?	Go to Step 10	Go to Step 5
5	Inspect the intermediate shaft for wear or a binding condition. Is the intermediate shaft worn or binding?	Go to Step 11	Go to Step 6
6	Inspect the steering gear for wear or a binding condition. Is the steering gear worn or binding?	Go to Step 12	Go to Step 7
7	Inspect the steering column for wear or a binding condition. Is the steering column worn or binding?	Go to Step 13	Go to Step 8
8	Inspect the power steering assist motor for an indication of excessive heat. Does the power steering assist motor appear to be overheated?	Go to Step 9	Go to Step 14
9	NOTE: Do not perform excessive parking lot maneuvers during testing. Excessive parking lot maneuvers can cause the power steering motor to heat up. Allow the power steering motor to cool and retest the system.Did you correct the condition?	Go to Step 15	Go to Step 14
10	Replace the steering linkage outer tie rod. Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> . Did you complete the repair?	Go to Step 15	-
11	Replace the intermediate shaft. Refer to <u>Intermediate Steering Shaft Replacement</u> . Did you complete the repair?	Go to Step 15	-
	Replace the steering gear. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear</u>		

12	<u>Replacement (FWD, LUK, MHH, NJ1), Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1), or Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2), Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2).</u> Did you complete the repair?	Go to Step 15	-
13	Replace the steering column. Refer to <u>Steering Column Replacement</u> . Did you complete the repair?	Go to Step 15	-
14	If equipped with an electric dual pinion rack and pinion steering gear, replace the electric power steering assist motor control. Refer to <u>Power Steering Assist Motor Replacement (NJ1), Power Steering Assist Motor Replacement (NJ2).</u> If equipped with an electric belt drive rack and pinion steering gear, replace the power steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2), Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2).</u> Did you complete the repair?	Go to Step 15	-
15	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

POOR RETURN OF STEERING WHEEL

Poor Return of Steering Wheel

Step	Action	Yes	No
DEFINITION: After completing a turn, extra steering input is required for the steering wheel to return to center.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to <u>Power Steering System Description and Operation (Hydraulic Power Steering), Power Steering System Description and Operation (Electronic Power Steering)</u>
2	Verify that poor return of the steering wheel is present.		

	Does the system operate normally?	System OK	Go to Step 3
3	<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Lubricate the tie rod ends and ball joints, if applicable. 3. Inspect the suspension system for worn or damaged components. 4. Repair as necessary. 		
	Did you find and correct the condition?	Go to Step 12	Go to Step 4
4	<ol style="list-style-type: none"> 1. Rotate the steering wheel ONE revolution in both directions. 2. Rotate the steering wheel back to the original position. 		
	Was the steering wheel abnormally difficult to rotate in either direction?	Go to Step 5	Go to Step 10
5	<p>NOTE: Position the wheels straight ahead. Do NOT rotate the steering wheel more than one complete revolution from center.</p> <ol style="list-style-type: none"> 1. Disconnect the intermediate shaft from the steering column. 2. Note the position of the steering wheel and rotate the steering wheel ONE revolution in both directions. 3. Rotate the steering wheel back to the original position. 		
	Was the steering wheel abnormally difficult to rotate in either direction?	Go to Step 11	Go to Step 6
6	<p>Inspect the intermediate shaft for stiff or loose joints. Repair or replace as necessary.</p> <p>Did you find and complete the repair?</p>	Go to Step 12	Go to Step 7
7	<ol style="list-style-type: none"> 1. Remove the front tire and wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> . 2. Disconnect both outer tie rod ends from the steering knuckles. 3. Use your hands in order to move the tie rod end studs. 4. If abnormally difficult to move, replace the tie 		

	rod end. Did you find and complete the repair?	Go to Step 12	Go to Step 8
8	1. Use your hands to rotate the steering knuckle inboard and outboard in order to inspect for a binding strut bearings, ball joints, or axle. 2. Repair or replace any abnormally stiff or loose components. Did you find and complete the repair?	Go to Step 12	Go to Step 9
9	Inspect for binding in the steering gear. If a binding is present repair or replace the steering gear. Did you find and complete the repair?	Go to Step 12	Go to Step 10
10	Inspect the wheel alignment and adjust as necessary. Refer to <u>Wheel Alignment Measurement</u> . Did you find and complete the repair?	Go to Step 12	-
11	Inspect the steering column for a binding. If a binding is present, repair or replace the steering column as necessary. Did you find and complete the repair?	Go to Step 12	-
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

STEERING WHEEL SURGES/JERKS WHILE TURNING

Special Tools

CH-39570 Chassis Ear

For equivalent regional tools, refer to **Special Tools**.

Steering Wheel Surges/Jerks While Turning

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Power Steering System</u>
2	Verify that a whine or growl noise is present. Is a whine or growl noise present?	Go to Step 3	System OK
3	Inspect the power steering gear for looseness and/or worn bushings. Is the steering gear loose or are the bushings worn?	Go to Step 6	Go to Step 4
4	Inspect the power steering motor for a whine or growl noise using the CH-39570 ear. Is the noise present at the power steering motor?	Go to Step 7	Go to Step 5
	Inspect the power steering gear for a whine or growl		

5	noise using the CH-39570 ear. Is the noise present at the power steering gear?	Go to Step 8	Go to Step 3
6	Tighten the power steering gear fasteners or replace the power steering gear due to worn bushings. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u> , <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)</u> , or <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> . Did you complete the repair?	Go to Step 9	-
7	If equipped with an electric dual pinion rack and pinion steering gear, replace the electric power steering assist motor control. Refer to <u>Power Steering Assist Motor Replacement (NJ1)</u> , <u>Power Steering Assist Motor Replacement (NJ2)</u> . If equipped with an electric belt drive rack and pinion steering gear, replace the power steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> . Did you complete the repair?	Go to Step 9	-
8	Replace the power steering gear. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u> , <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)</u> , or <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> . Did you complete the repair?	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

STEERING WHEEL KICKBACK

Steering Wheel Kickback

Condition	Action
The steering column mounting bolts are loose.	Tighten the pivot bolt and the mounting bolts to specification.
The steering gear is loosely mounted.	Tighten the steering gear mounting bolts to

	specification.
The steering linkage tie rods are loose or damaged.	Inspect the steering linkage tie rods. If necessary, replace the steering linkage tie rods. Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> , or to <u>Steering Linkage Inner Tie Rod Replacement (NJ2)</u> , <u>Steering Linkage Inner Tie Rod Replacement (NJ1)</u> .

STEERING EFFORT HARD OR TOO EASY IN ONE OR BOTH DIRECTIONS

Steering Effort Hard or Too Easy in One or Both Directions

Condition	Action
The battery power is low.	Ensure proper battery voltage.
The intermediate shaft dash seal is binding.	Adjust the dash seal or replace the intermediate shaft if necessary. Refer to <u>Intermediate Steering Shaft Replacement</u> .
The intermediate shaft joints are loose or worn.	Inspect the joints and the pinch bolts for damage, and replace the intermediate shaft if necessary. Refer to <u>Intermediate Steering Shaft Replacement</u> .
The steering gear is binding.	If necessary, inspect and replace the steering gear. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u> , <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)</u> , or <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> .
The upper steering shaft is bent.	If necessary, replace the steering column. Refer to <u>Steering Column Replacement</u> .
The connectors to the assist motor are damaged or disconnected.	Verify the connectors are properly connected. Verify the connectors are not damaged. If the connectors are damaged, replace the connectors.
The sensor wire is damaged.	Replace the steering gear. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u> , <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)</u> , or <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> .
The controller is malfunctioning.	Confirm the DTC. If equipped with an electric dual pinion rack and pinion steering gear, replace the electric power

	steering assist motor control. Refer to <u>Power Steering Assist Motor Replacement (NJ1)</u> , <u>Power Steering Assist Motor Replacement (NJ2)</u> . If equipped with an electric belt drive rack and pinion steering gear, replace the power steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> .
The motor shaft is binding.	Confirm the DTC. If equipped with an electric dual pinion rack and pinion steering gear, replace the electric power steering assist motor control. Refer to <u>Power Steering Assist Motor Replacement (NJ1)</u> , <u>Power Steering Assist Motor Replacement (NJ2)</u> . If equipped with an electric belt drive rack and pinion steering gear, replace the power steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> .

REPAIR INSTRUCTIONS

STEERING LINKAGE INNER TIE ROD INSPECTION

Special Tools

GE-8001 Dial Indicator Set

For equivalent regional tools, refer to **Special Tools**.

NOTE: This inspection procedure does not supersede local government required inspections that have more stringent requirements.

1. Turn the ignition key to the ON position with the engine OFF.

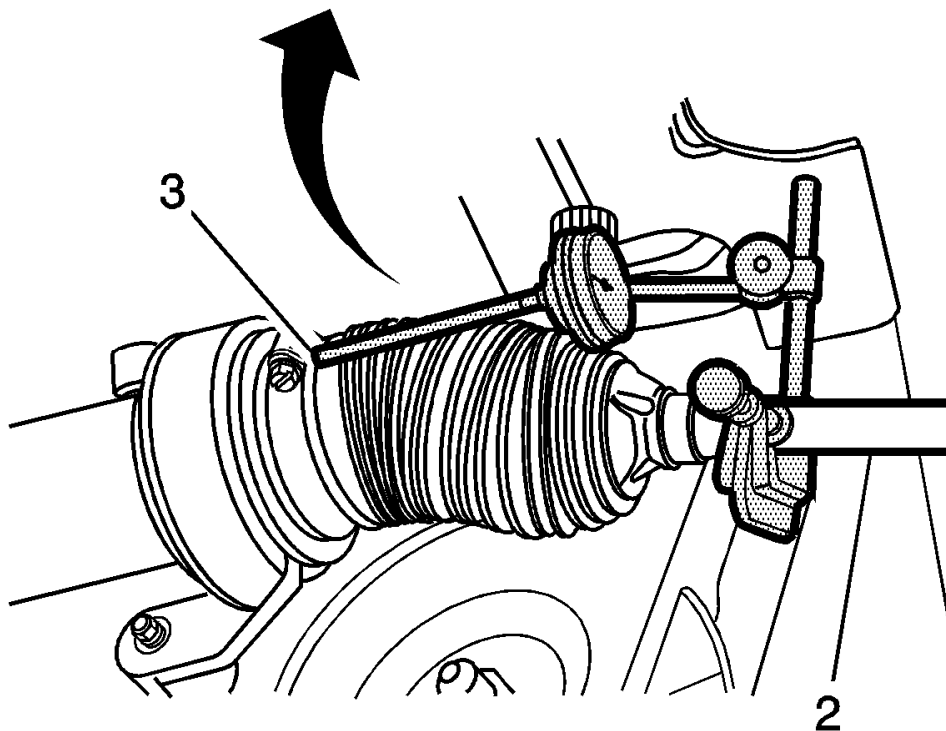
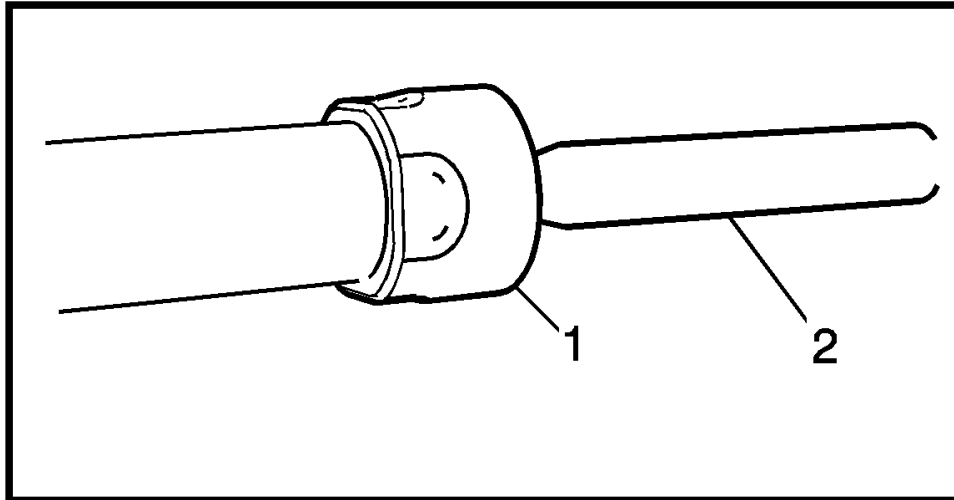


Fig. 3: Measuring Lash Between Inner Tie Rod & Steering Gear Housing
Courtesy of GENERAL MOTORS COMPANY

2. With the aid of an assistant, turn the steering wheel to the full stop position and hold the steering wheel in

that position until the test is complete. Part of the steering linkage inner tie rod (2) being tested should be inside the steering gear housing. The inner tie rod housing (1) being tested should be inside the steering gear housing and seated against the steering stop.

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. If there is not a good location for the **GE-8001** dial indicator pointer at the steering gear housing, install a large worm gear hose clamp (3) to the steering gear housing over the larger steering gear boot clamp and align the clamp so that the screw can be a location for the **GE-8001** dial indicator pointer.
5. Install the **GE-8001** dial indicator between the inner tie rod and the steering gear housing or the worm gear clamp in such a way as to measure the lash between the inner tie rod and the steering gear housing. The lash between the inner tie rod and the steering gear housing is equal to the lash between the inner tie rod and the inner tie rod housing because the inner tie rod housing is inside the steering gear housing during this procedure.

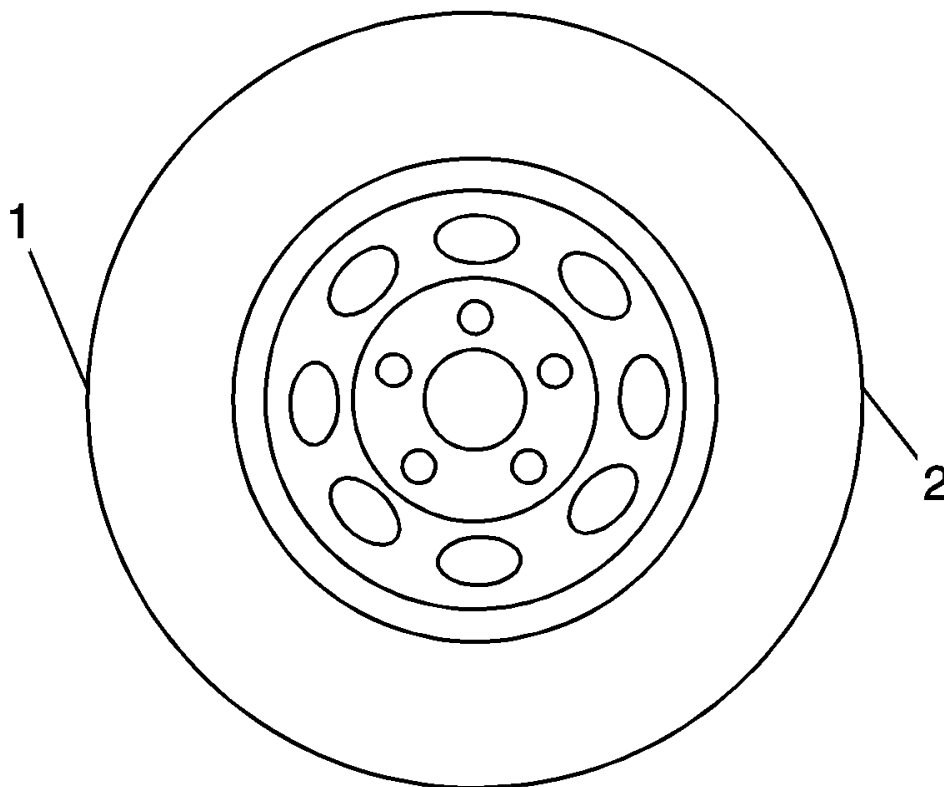


Fig. 4: Identifying Tire Grasping Positions
Courtesy of GENERAL MOTORS COMPANY

NOTE: Only move the tire enough to feel any lash between the inner tie rod and the inner tie rod housing without moving the steering gear rack.

6. Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire in order to remove any lash.
7. Zero the **GE-8001** dial indicator.
8. On the same side of the tire previously pushed in, gently pull out and measure the lash.
9. Record the measurement shown on the **GE-8001** dial indicator.
10. If the measured value exceeds 0.5 mm (0.02 in), replace the inner tie rod. Refer to **Steering Linkage Inner Tie Rod Replacement (NJ2)**, **Steering Linkage Inner Tie Rod Replacement (NJ1)**.
11. Repeat the procedure for the other side.

STEERING LINKAGE OUTER TIE ROD INSPECTION

Special Tools

GE-8001 Dial Indicator Set

For equivalent regional tools, refer to **Special Tools**.

NOTE: **This inspection procedure does not supersede local government required inspections that have more stringent requirements.**

1. Inspect the outer tie rod seal. If the outer tie rod seal is torn, replace the outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.
2. Raise the side of the vehicle being inspected with a floor jack while maintaining contact between the opposite wheel and the shop floor. Support the lower control arm with a floor jack stand as far outboard as possible and remove the floor jack. Refer to **Lifting and Jacking the Vehicle**.

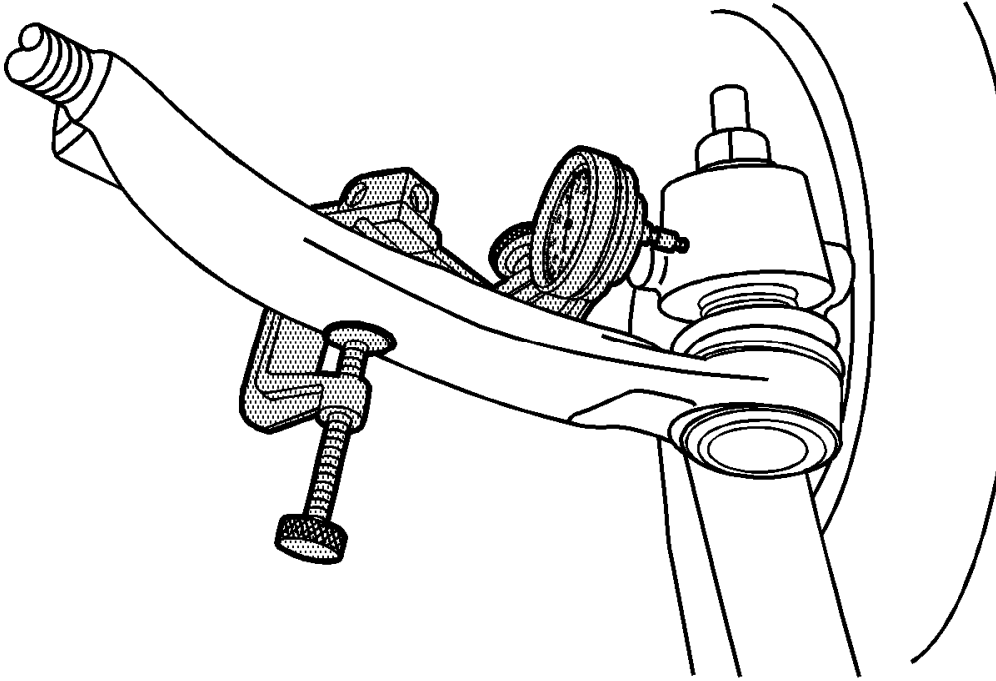


Fig. 5: Measuring Outer Tie Rod Lash
Courtesy of GENERAL MOTORS COMPANY

3. Install the **GE-8001** dial indicator between the outer tie rod and the steering knuckle as shown in the graphic. Note that the tire and wheel assembly is shown removed only for clarification of the **GE-8001** dial indicator position.

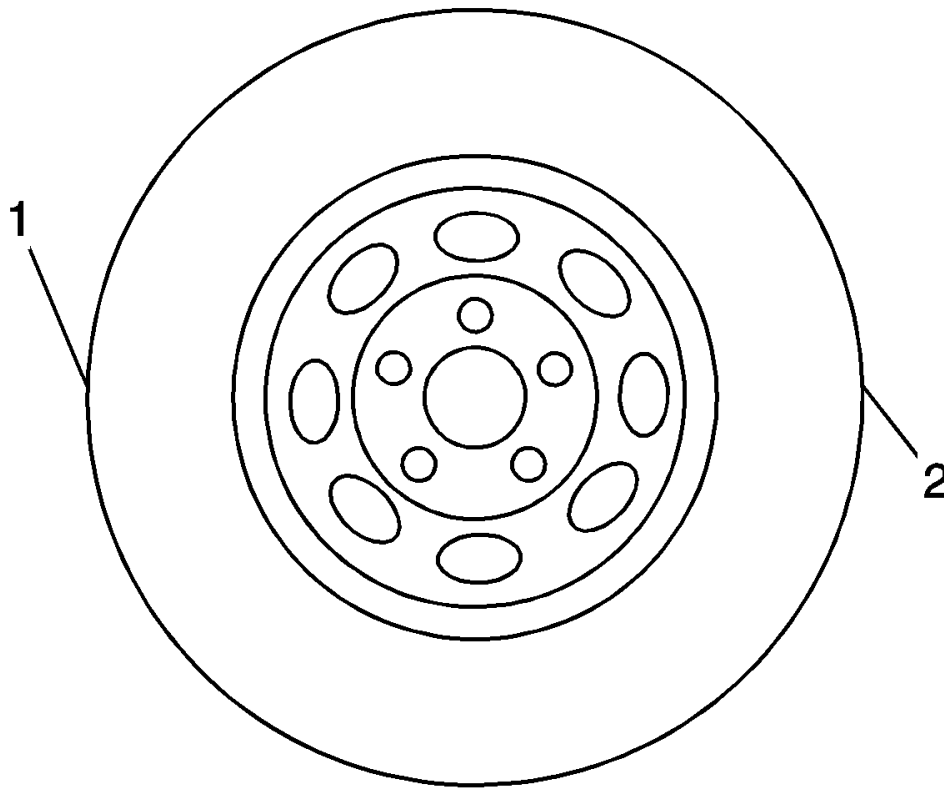


Fig. 6: Identifying Tire Grasping Positions
Courtesy of GENERAL MOTORS COMPANY

4. Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire to remove any lash.
5. Zero the **GE-8001** dial indicator.
6. On the same side of the tire previously pushed inwards, gently pull outwards and measure the lash.
7. Record the measurement shown on the **GE-8001** dial indicator.
8. If the measured value exceeds 0.5 mm (0.02 in), replace the outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.
9. Repeat the procedure for the other side.

STEERING LINKAGE OUTER TIE ROD REPLACEMENT

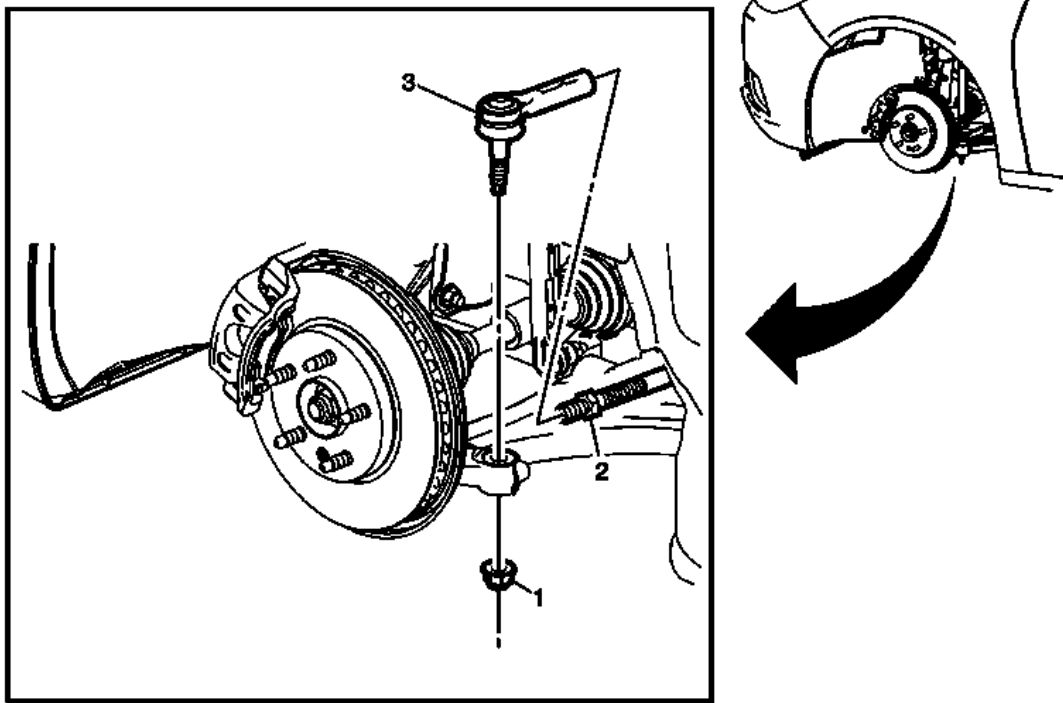


Fig. 7: Steering Linkage Outer Tie Rod And Nuts
 Courtesy of GENERAL MOTORS COMPANY

Steering Linkage Outer Tie Rod Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the front tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 	
1	<p>Steering Linkage Outer Tie Rod Nut</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove the steering linkage outer tie rod nut. Discard the nut. 2. Install a NEW steering linkage outer tie rod nut.

	<p>Tighten 35 N.m (26 lb ft) + 30 degrees</p>
2	<p>Steering Linkage Inner Tie Rod Nut</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Place match marks on the steering linkage inner tie rod nut and the steering linkage inner tie rod. 2. During installation, align the match marks. 3. Do not tighten the nut during installation. Tighten the nut after adjusting the front toe. <p>Tighten 60 N.m (44 lb ft)</p>
3	<p>Steering Linkage Outer Tie Rod</p> <p>CAUTION: Do not free the ball stud by using a pickle fork or a wedge-type tool. Damage to the seal or bushing may result.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Use the CH-161-B puller to disconnect the steering linkage outer tie rod from the steering knuckle. 2. Clean the tapered surface of the steering knuckle. 3. Inspect the steering linkage inner tie rod for bent or damaged threads. Repair or replace the tie rod if needed. Refer to <u>Steering Linkage Inner Tie Rod Replacement (NJ2)</u>, <u>Steering Linkage Inner Tie Rod Replacement (NJ1)</u>. 4. If equipped with electronic power steering, perform the software end stop learning procedure. Refer to <u>Power Steering Control Module Calibration (NJ1)</u>. 5. After the installation is complete, measure and adjust the front toe. Refer to <u>Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment</u> . <p>Special Tools CH-161-B Bearing Puller For equivalent regional tools, refer to <u>Special Tools</u>.</p>

STEERING GEAR BOOT REPLACEMENT (NJ2)

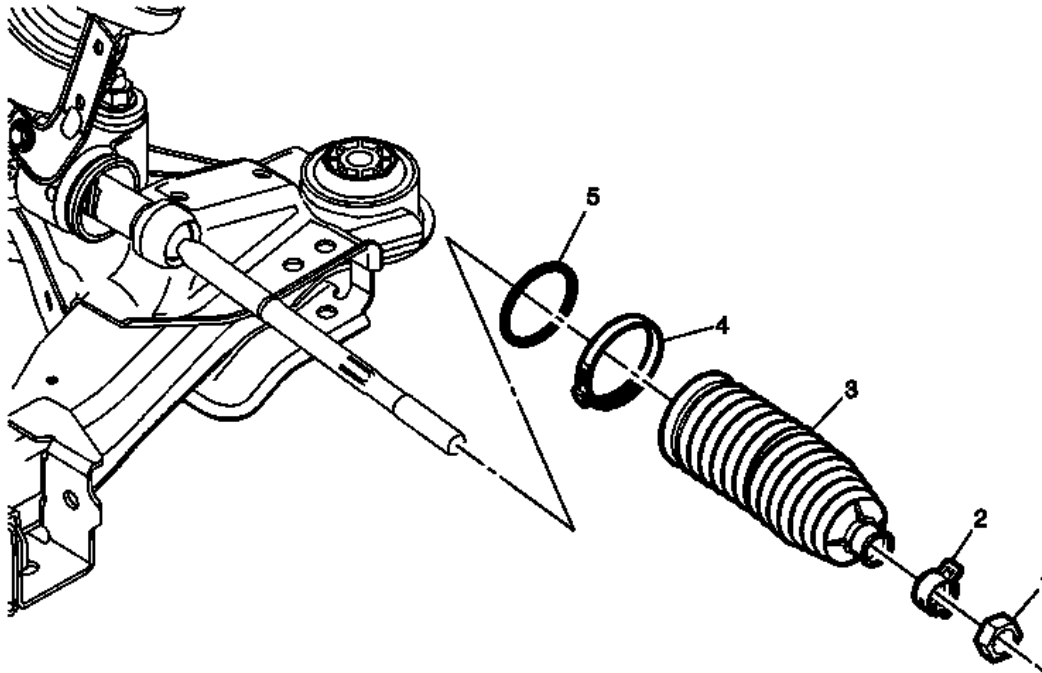


Fig. 8: Steering Gear Boot & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Steering Gear Boot Replacement (NJ2)

Callout	Component Name
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the steering linkage outer tie rod. Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> .	
1	Steering Linkage Inner Tie Rod Nut
2	Steering Gear Boot Outer Clamp
3	Steering Gear Boot Inner Clamp
	Procedure
	1. Cut the steering gear boot inner clamp. Discard the clamp. 2. Use the CH-22610 pliers to install a NEW steering gear boot inner clamp.
	Special Tools CH-22610 Pliers For equivalent regional tools, refer to <u>Special Tools</u> .
	Steering Gear Boot

	Procedure
4	<ol style="list-style-type: none"> 1. After removing the steering gear boot, inspect the steering linkage inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u>, <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u>. 2. Apply a small amount of Lithium Grease or equivalent to the inside of both ends of the steering gear boot. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. 3. Install the steering gear boot and ensure the boot is seated in the assembly groove of the steering gear before installing the steering gear boot clamps.
5	Steering Gear Boot Seal

STEERING GEAR BOOT REPLACEMENT (NJ1)

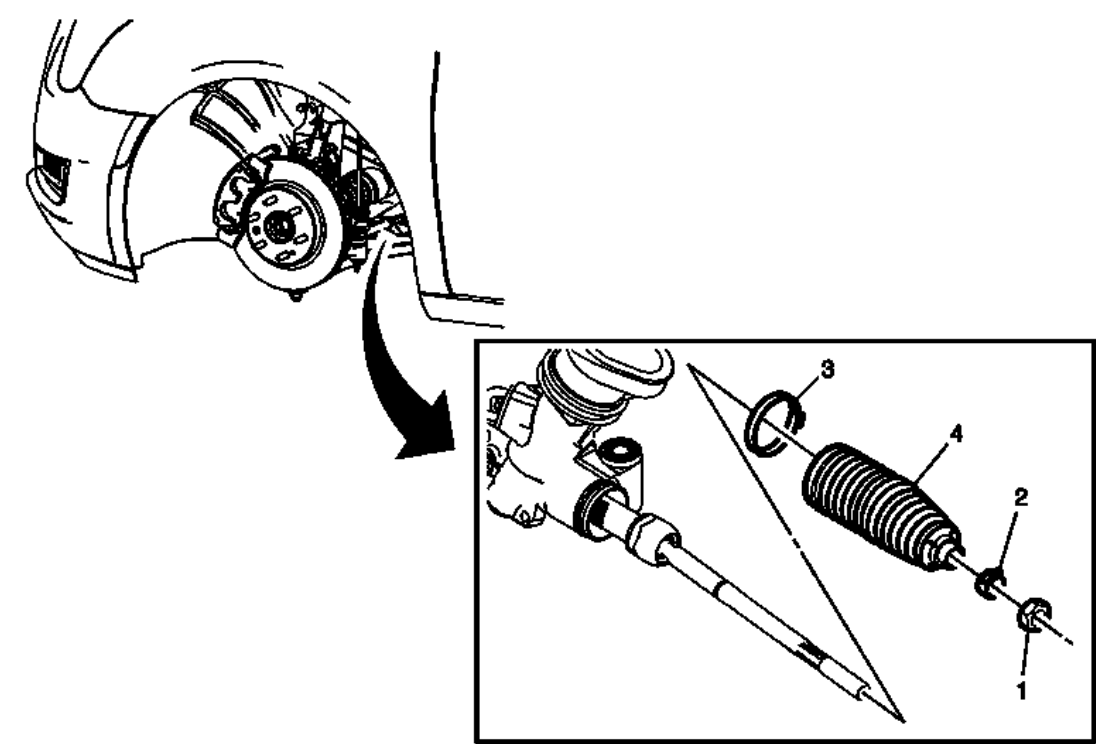


Fig. 9: Steering Gear Boot (NJ1)
 Courtesy of GENERAL MOTORS COMPANY

Steering Gear Boot Replacement (NJ1)

Callout	Component Name
Preliminary Procedures	
1.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .

2. Remove the steering linkage outer tie rod. Refer to <u>Steering Linkage Outer Tie Rod Replacement</u> .	
1	Steering Linkage Inner Tie Rod Nut
2	Steering Gear Boot Outer Clamp
3	<p>Steering Gear Boot Inner Clamp</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Cut the steering gear boot inner clamp. Discard the clamp. 2. Use the DT-35910 pliers to install a NEW steering gear boot inner clamp. <p>Special Tools DT-35910 Drive Axle Boot Clamp Pliers For equivalent regional tools, refer to <u>Special Tools</u>.</p>
4	<p>Steering Gear Boot</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. After removing the steering gear boot, inspect the steering linkage inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u>, <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)</u>. 2. Install the steering gear boot and ensure the boot is seated in the assembly groove of the steering gear before installing the steering gear boot clamps.

STEERING GEAR HEAT SHIELD REPLACEMENT (NJ2)

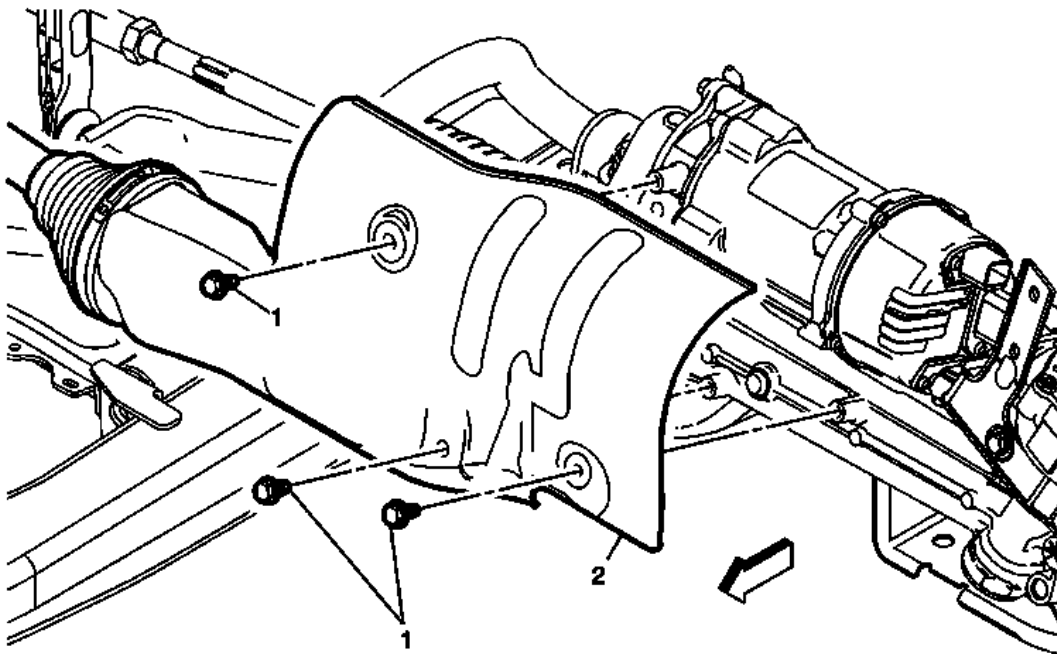


Fig. 10: Steering Gear Heat Shield (NJ2)
 Courtesy of GENERAL MOTORS COMPANY

Steering Gear Heat Shield Replacement (NJ2)

Callout	Component Name
Preliminary Procedure	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Steering Gear Heat Shield Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
2	Steering Gear Heat Shield

STEERING GEAR HEAT SHIELD REPLACEMENT (NJ1)

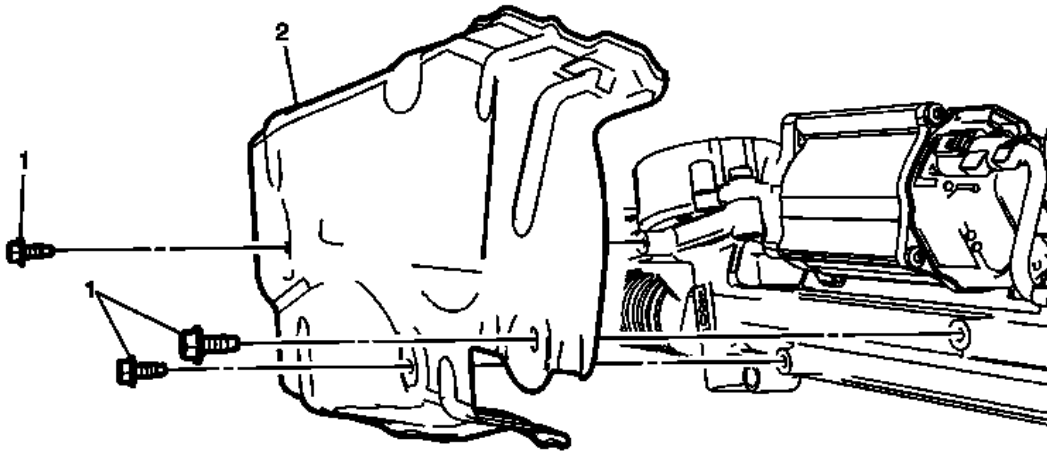


Fig. 11: Steering Gear Heat Shield And Bolts (NJ1)
 Courtesy of GENERAL MOTORS COMPANY

Steering Gear Heat Shield Replacement (NJ1)

Callout	Component Name
Preliminary Procedure	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Steering Gear Heat Shield Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
2	Steering Gear Heat Shield

ELECTRIC BELT DRIVE RACK AND PINION STEERING GEAR REPLACEMENT (FWD, LTG, MR6, NJ2)

Removal Procedure

CAUTION: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components

carefully. Use the following precautions in order to avoid ESD damage:

- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.
- Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.
- Avoid the following actions unless required by the diagnostic procedure:
 - Jumpering or grounding of the components or connectors.
 - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
- Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- The steering column
- The intermediate shaft(s)
- The steering gear

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Lock the steering column in the straight-ahead position.
2. Disconnect the intermediate steering shaft from the steering gear and remove the front dash seal from the steering gear input shaft. Refer to **Intermediate Steering Shaft Replacement** .

3. Install the engine support fixture. Refer to **Engine Support Fixture** .
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Disconnect the steering linkage outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
6. Disconnect the stabilizer shaft links from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA Standard Strut, GNB Performance Struts)** .
7. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA Standard Strut)** , **Lower Control Arm Replacement (GNB Performance Struts)** .
8. Remove the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (NJ2)**.
9. Disconnect the electrical connector on the steering gear and disconnect the wiring harness clip from the steering gear housing.

NOTE: **Wiring harness routing is critical. Note the exact routing of the steering gear wiring harness before repositioning it.**

10. Remove the wiring harness bracket bolts from the steering gear. Leave the bracket attached to the wiring harness and position it out of the way.
11. Remove the through bolts for the front and rear transmission mounts. Refer to **Transmission Front Mount Replacement** , and **Transmission Rear Mount Bracket Replacement** .
12. Position adjustable jackstands underneath the left and right sides of the rear of the drivetrain and front suspension frame.
13. Lower the vehicle until the drivetrain and front suspension frame is resting lightly on the jackstands.
14. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** , **Exhaust Front Pipe Replacement (LUK)** .
15. Loosen the drivetrain and front suspension frame front bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
16. Raise the vehicle while the drivetrain and front suspension frame rests on the jackstands. Do not allow the gap between the body and rear of the frame to exceed a maximum of 50 mm (2 in).
17. Finish removing the stabilizer shaft. Refer to **Stabilizer Shaft Replacement (GNA Standard Strut, GNB Performance Struts)** .

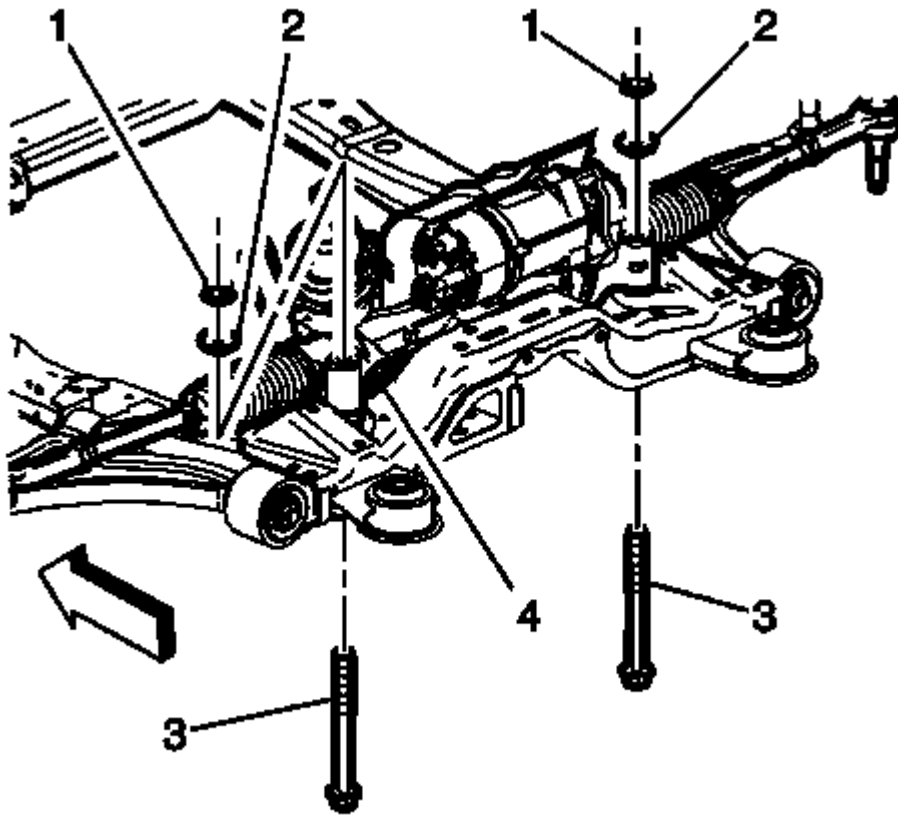


Fig. 12: Steering Gear Nuts, Washers And Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Remove the steering gear nuts (1), washers (2) and bolts (3) from the steering gear (4). Discard the nuts and bolts.
19. Remove the electric belt drive rack and pinion steering gear (4) from the left side of the vehicle.
20. Transfer components as necessary.

Installation Procedure

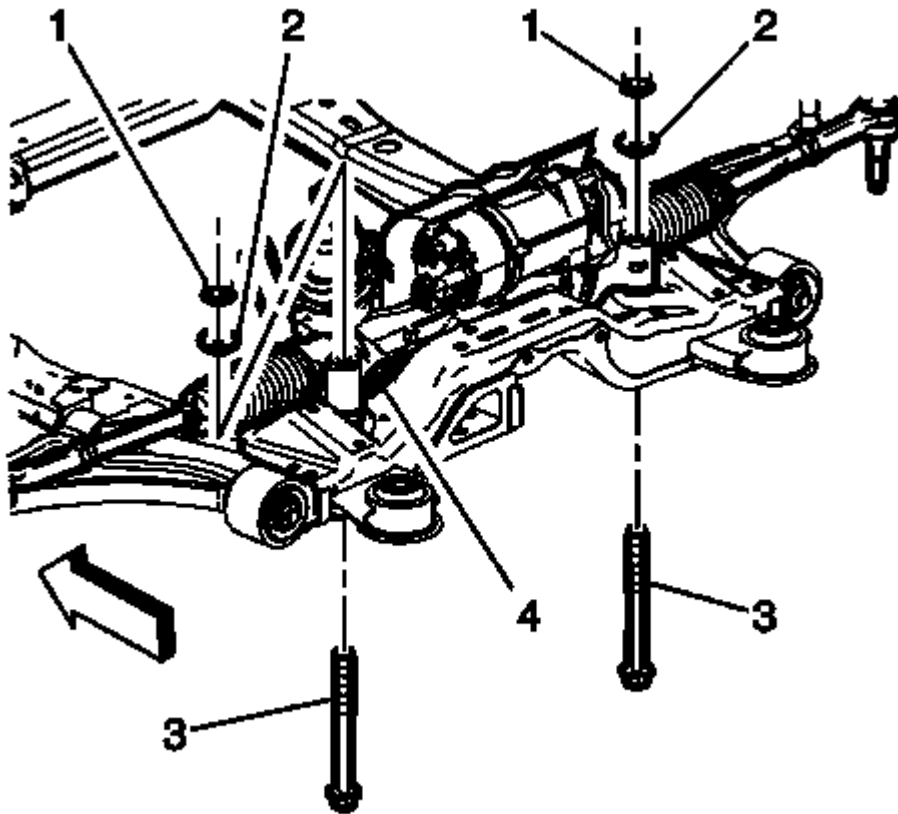


Fig. 13: Steering Gear Nuts, Washers And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the electric belt drive rack and pinion steering gear (4) on the drivetrain and front suspension frame through the left side of the vehicle.

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE: Start all bolts by hand before tightening.

2. Install the NEW steering gear bolts (3), washers (2) and NEW nuts (1) and tighten the bolts (3) to 110 N.m (81 lb ft) + 150 degrees.
3. Install the stabilizer shaft onto the drivetrain and front suspension frame. Refer to Stabilizer Shaft Replacement (GNA Standard Strut, GNB Performance Struts) .

4. Lower the vehicle until the gap between the drivetrain and front suspension frame and body is approximately 12 mm (0.5 in).
5. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** , **Exhaust Front Pipe Replacement (LUK)** .
6. Tighten the drivetrain and front suspension frame front bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
7. Remove the jackstands from underneath the vehicle.
8. Install the through bolts for the front and rear transmission mounts. Refer to **Transmission Front Mount Replacement** , and **Transmission Rear Mount Bracket Replacement** .

NOTE: **Wiring harness routing is critical. When installing, route the wiring harness in the exact same location it was moved from during the removal procedure.**

9. Route the steering gear wiring harness in the position it was in before removal.
10. Tighten the steering gear wiring harness bracket bolts to 9 N.m (80 lb in).
11. Connect the electrical connector on the steering gear and connect the wiring harness clip on the steering gear housing.
12. Install the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (NJ2)**, **Steering Gear Heat Shield Replacement (NJ1)**.
13. Connect the lower control arms to the steering knuckles. Refer to **Lower Control Arm Replacement (GNA Standard Strut)** , **Lower Control Arm Replacement (GNB Performance Struts)** .
14. Connect the stabilizer shaft links to the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB Performance Struts)** .
15. Connect the steering linkage outer tie rods to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
16. Remove the engine support fixture. Refer to **Engine Support Fixture** .
17. Install the front dash seal on the steering gear input shaft and connect the intermediate steering shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
18. Program the power steering control module. Refer to **Power Steering Control Module Programming and Setup** .
19. Measure and adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .

ELECTRIC BELT DRIVE RACK AND PINION STEERING GEAR REPLACEMENT (AWD, LTG, M7U, NJ2)

Removal Procedure

CAUTION: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD

damage:

- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.
- Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.
- Avoid the following actions unless required by the diagnostic procedure:
 - Jumpering or grounding of the components or connectors.
 - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
- Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- The steering column
- The intermediate shaft(s)
- The steering gear

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Lock the steering column in the straight-ahead position.
2. Disconnect the intermediate steering shaft from the steering gear and remove the front dash seal from the steering gear input shaft. Refer to **Intermediate Steering Shaft Replacement** .
3. Install the engine support fixture. Refer to **Engine Support Fixture** .

4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Disconnect the steering linkage outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
6. Disconnect the stabilizer shaft links from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB Performance Struts)** .
7. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB Performance Struts)** .
8. Remove the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (NJ2)**.
9. Disconnect the electrical connector on the steering gear and disconnect the wiring harness clip from the steering gear housing.

NOTE: **Wiring harness routing is critical. Note the exact routing of the steering gear wiring harness before repositioning it.**

10. Remove the wiring harness bracket bolts from the steering gear. Leave the bracket attached to the wiring harness and position it out of the way.
11. Remove the through bolts for the front and rear transmission mounts. Refer to **Transmission Front Mount Replacement** , and **Transmission Rear Mount Replacement (AWD)** , **Transmission Rear Mount Replacement (FWD)** .
12. Remove the propeller shaft. Refer to **Propeller Shaft Replacement** .
13. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LUK)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
14. Position adjustable jackstands underneath the left and right sides of the rear of the drivetrain and front suspension frame.
15. Lower the vehicle until the drivetrain and front suspension frame is resting lightly on the jackstands.

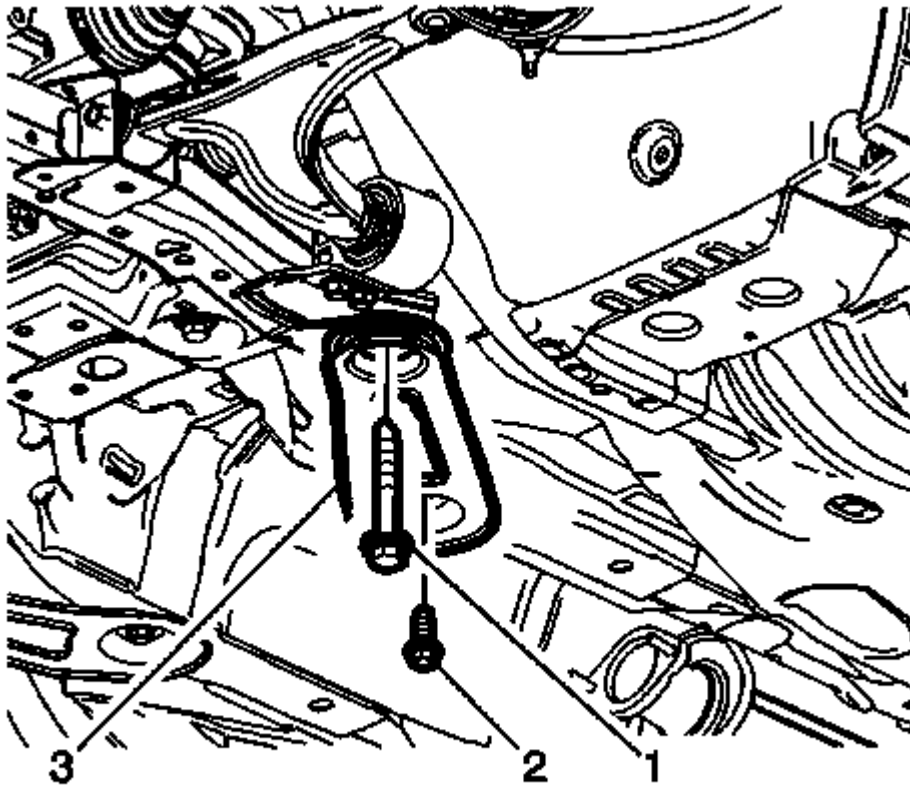


Fig. 14: Front Suspension Frame Rear Bolts, Reinforcements & Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Remove the drivetrain and front suspension frame rear bolts (1), reinforcement bolts (2) and reinforcements (3).
17. Loosen the drivetrain and front suspension frame front bolts. Refer to **Drivetrain and Front Suspension Frame Replacement**.
18. Raise the vehicle while the drivetrain and front suspension frame rests on the jackstands. Do not allow the gap between the body and rear of the frame to exceed a maximum of 50 mm (2 in).
19. Finish removing the stabilizer shaft. Refer to **Stabilizer Shaft Replacement (GNA, GNB Performance Struts)**.

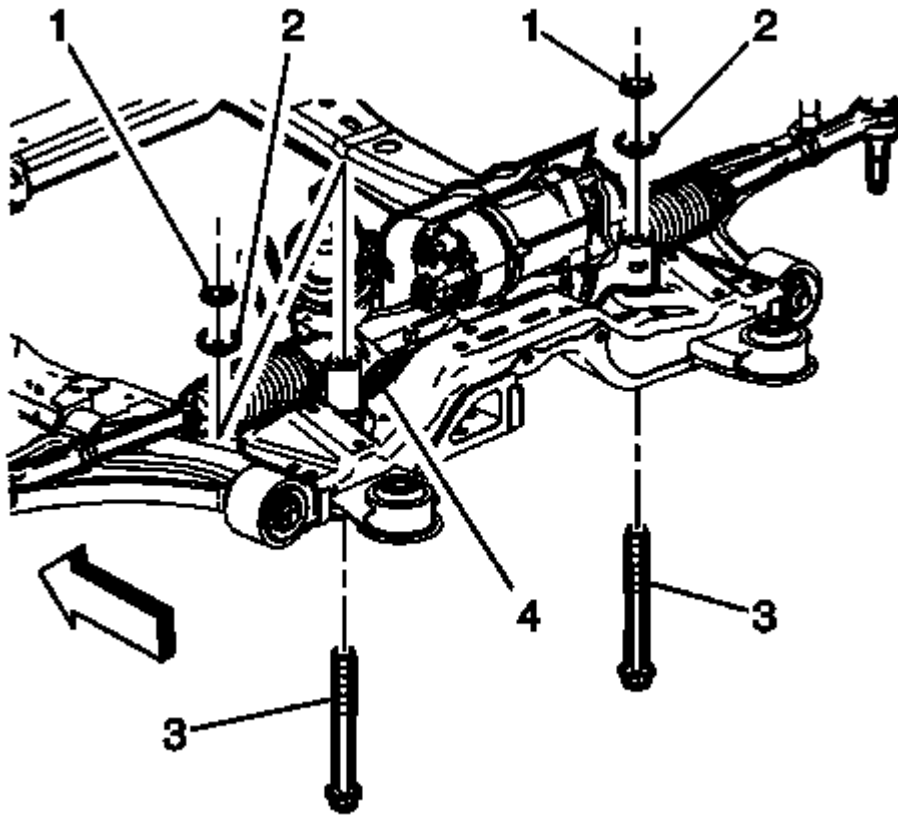


Fig. 15: Steering Gear Nuts, Washers And Bolts
Courtesy of GENERAL MOTORS COMPANY

20. Remove the steering gear nuts (1), washers (2) and bolts (3) from the steering gear (4). Discard the nuts and bolts.
21. Remove the electric belt drive rack and pinion steering gear (4) from the left side of the vehicle.
22. Transfer components as necessary.

Installation Procedure

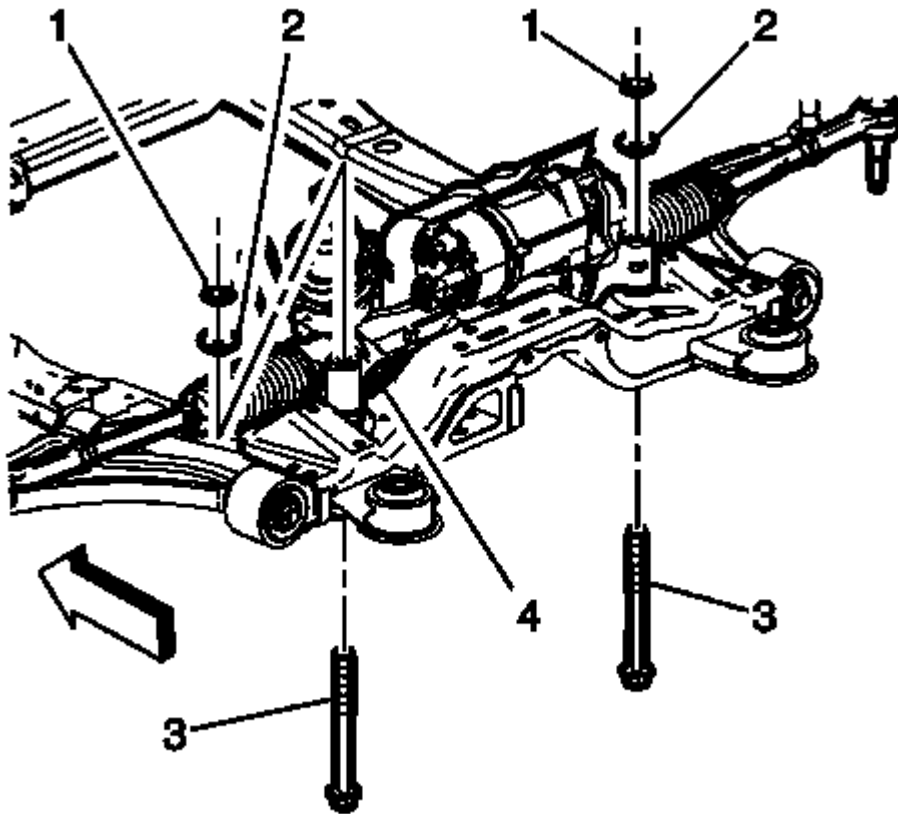


Fig. 16: Steering Gear Nuts, Washers And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the electric belt drive rack and pinion steering gear (4) on the drivetrain and front suspension frame through the left side of the vehicle.

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE: Start all bolts by hand before tightening.

2. Install the NEW steering gear bolts (3), washers (2) and NEW nuts (1) and tighten the bolts (3) to 110 N.m (81 lb ft) + 150 degrees.
3. Install the stabilizer shaft onto the drivetrain and front suspension frame. Refer to Stabilizer Shaft Replacement (GNA, GNB Performance Struts) .

4. Lower the vehicle until the gap between the drivetrain and front suspension frame and body is approximately 12 mm (0.5 in).

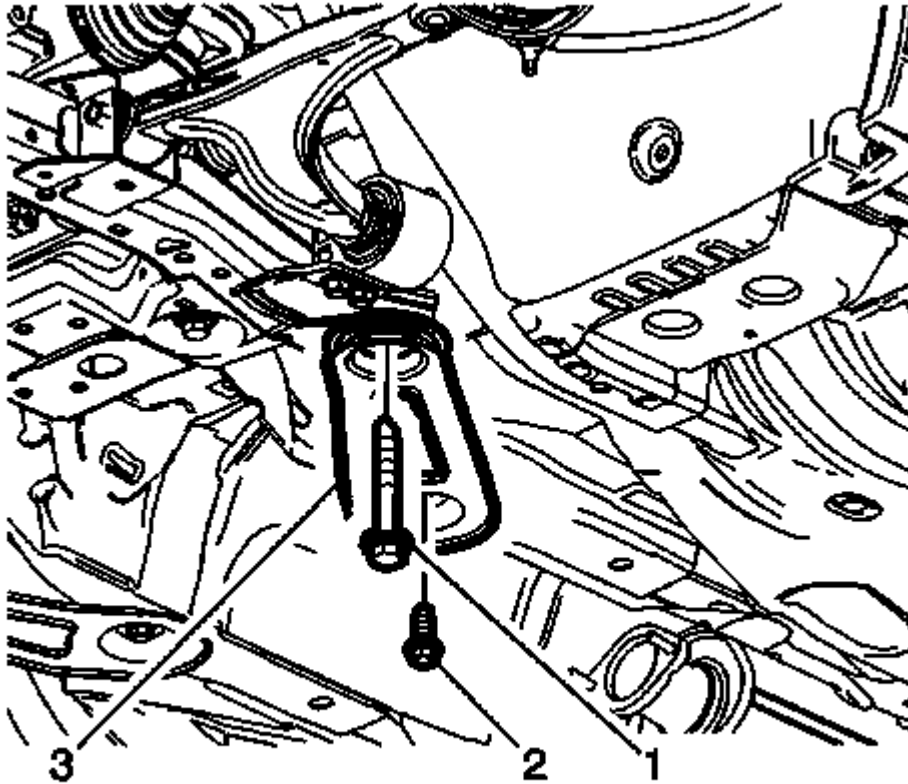


Fig. 17: Front Suspension Frame Rear Bolts, Reinforcements & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the drivetrain and front suspension frame reinforcements (3), reinforcement bolts (2) and rear bolts (1).
6. Tighten the drivetrain and front suspension frame rear bolts (1) to 160 N.m (118 lb ft).
7. Tighten the drivetrain and front suspension frame reinforcement bolts (2) to 60 N.m (44 lb ft) + 30 degrees.
8. Tighten the drivetrain and front suspension frame front bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
9. Remove the jackstands from underneath the vehicle.
10. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LUK)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
11. Install the propeller shaft. Refer to **Propeller Shaft Replacement** .
12. Install the through bolts for the front and rear transmission mounts. Refer to **Transmission Front Mount Replacement** , and **Transmission Rear Mount Replacement (AWD)** .

NOTE: **Wiring harness routing is critical. When installing, route the wiring harness in the exact same location it was moved from during the removal procedure.**

13. Route the steering gear wiring harness in the position it was in before removal.
14. Tighten the steering gear wiring harness bracket bolts to 9 N.m (80 lb in).
15. Connect the electrical connector on the steering gear and connect the wiring harness clip on the steering gear housing.
16. Install the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (NJ2)**.
17. Connect the lower control arms to the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB Performance Struts)** .
18. Connect the stabilizer shaft links to the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB Performance Struts)** .
19. Connect the steering linkage outer tie rods to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
20. Remove the engine support fixture. Refer to **Engine Support Fixture** .
21. Install the front dash seal on the steering gear input shaft and connect the intermediate steering shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
22. Program the power steering control module. Refer to **Power Steering Control Module Programming and Setup** .
23. Measure and adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .

ELECTRIC DUAL PINION RACK AND PINION STEERING GEAR REPLACEMENT (FWD, LUK, MHH, NJ1)

Removal Procedure

CAUTION: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage:

- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.
- Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.

- **Avoid the following actions unless required by the diagnostic procedure:**
 - **Jumpering or grounding of the components or connectors.**
 - **Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.**
- **Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.**

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Lock the steering column in the straight-ahead position.
2. Disconnect the intermediate steering shaft from the steering gear and remove the front dash seal from the steering gear input shaft. Refer to **Intermediate Steering Shaft Replacement** .
3. Install the engine support fixture. Refer to **Engine Support Fixture** .
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Disconnect the steering linkage outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
6. Disconnect the stabilizer shaft links from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA Standard Strut, GNB Performance Struts)** .
7. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA Standard Strut)** , **Lower Control Arm Replacement (GNB Performance Struts)** .
8. Remove the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (NJ1)**.
9. Disconnect the electrical connector on the steering gear and disconnect the wiring harness clip from the

steering gear housing.

NOTE: **Wiring harness routing is critical. Note the exact routing of the steering gear wiring harness before repositioning it.**

10. Remove the wiring harness bracket bolts from the steering gear. Leave the bracket attached to the wiring harness and position it out of the way.
11. Remove the through bolts for the front and rear transmission mounts. Refer to **Transmission Front Mount Replacement** , and **Transmission Rear Mount Replacement** .
12. Position adjustable jackstands underneath the left and right sides of the rear of the drivetrain and front suspension frame.
13. Lower the vehicle until the drivetrain and front suspension frame is resting lightly on the jackstands.
14. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** , **Exhaust Front Pipe Replacement (LUK)** .
15. Loosen the drivetrain and front suspension frame front bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
16. Raise the vehicle while the drivetrain and front suspension frame rests on the jackstands. Do not allow the gap between the body and rear of the frame to exceed a maximum of 50 mm (2 in).
17. Finish removing the stabilizer shaft. Refer to **Stabilizer Shaft Replacement (GNA Standard Strut, GNB Performance Struts)** .

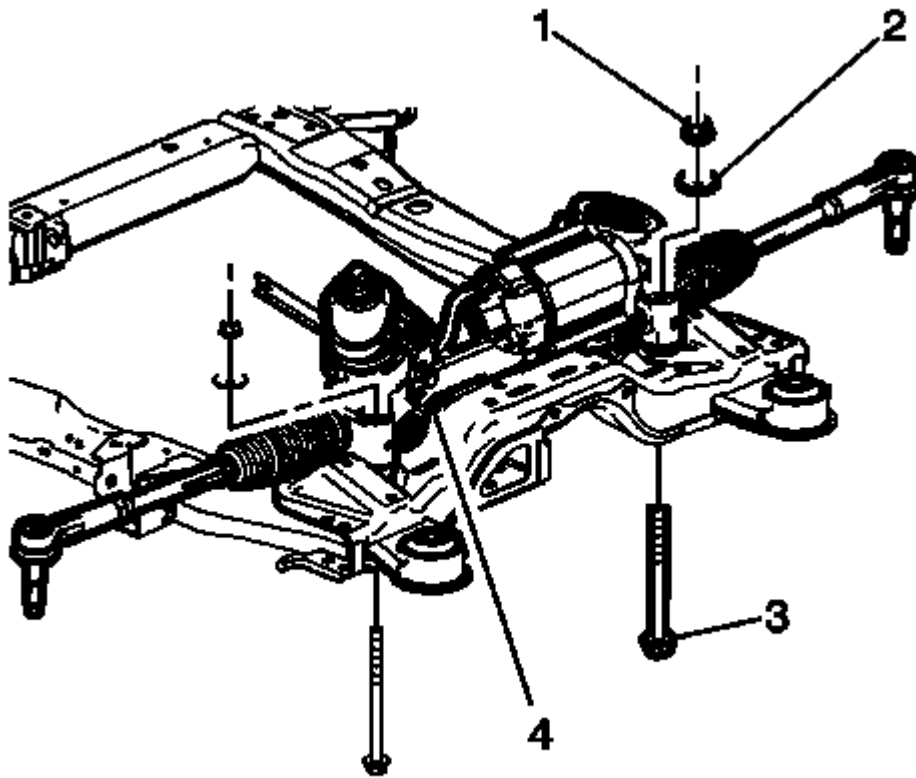


Fig. 18: Power Steering Gear Components
Courtesy of GENERAL MOTORS COMPANY

18. Remove the steering gear nuts (1), washers (2) and bolts (3) from the steering gear (4). Discard the nuts and bolts.
19. Remove the electric dual pinion rack and pinion steering gear (4) from the left side of the vehicle.
20. Transfer components as necessary.

Installation Procedure

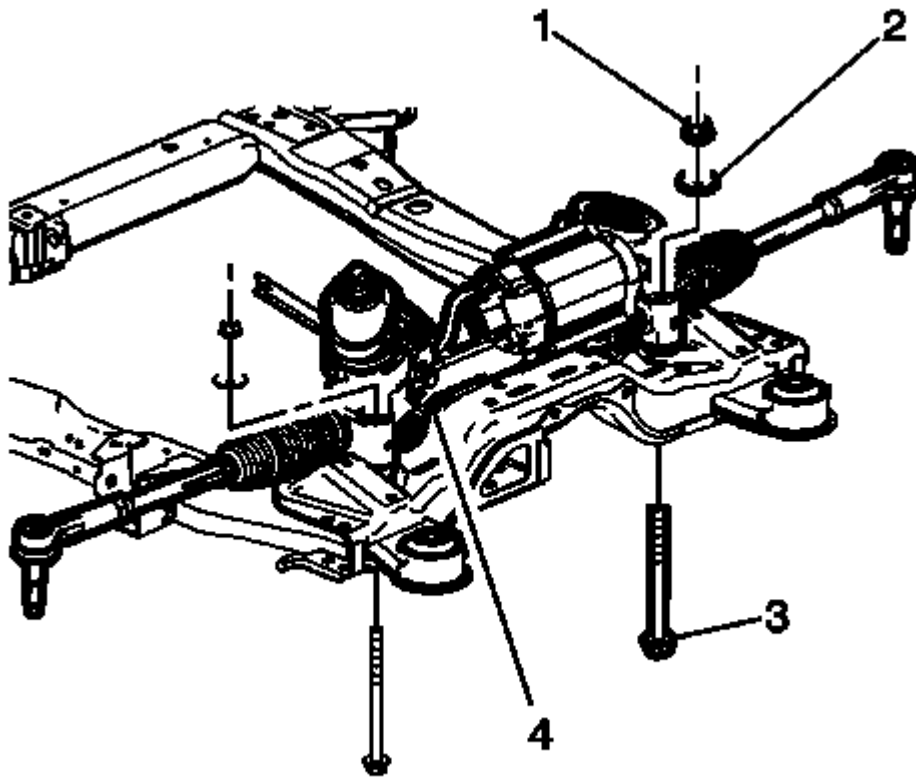


Fig. 19: Power Steering Gear Components
 Courtesy of GENERAL MOTORS COMPANY

1. Position the electric dual pinion rack and pinion steering gear (4) on the front suspension frame through the left side of the vehicle.

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE: Start all bolts by hand before tightening.

2. Install the NEW steering gear bolts (3), washers (2) and NEW nuts (1) and tighten the bolts (3) to 110 N.m (81 lb ft) + 150 degrees.
3. Install the stabilizer shaft onto the drivetrain and front suspension frame. Refer to Stabilizer Shaft Replacement (GNA Standard Strut, GNB Performance Struts) .

4. Lower the vehicle until the gap between the drivetrain and front suspension frame and body is approximately 12 mm (0.5 in).
5. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** , **Exhaust Front Pipe Replacement (LUK)** .
6. Tighten the drivetrain and front suspension frame front bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
7. Remove the jackstands from underneath the vehicle.
8. Install the through bolts for the front and rear transmission mounts. Refer to **Transmission Front Mount Replacement** , and **Transmission Rear Mount Replacement** .

NOTE: **Wiring harness routing is critical. When installing, route the wiring harness in the exact same location it was moved from during the removal procedure.**

9. Route the steering gear wiring harness in the position it was in before removal.
10. Tighten the steering gear wiring harness bracket bolts to 9 N.m (80 lb in).
11. Connect the electrical connector on the steering gear and connect the wiring harness clip on the steering gear housing.
12. Install the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (NJ1)**.
13. Connect the lower control arms to the steering knuckles. Refer to **Lower Control Arm Replacement (GNA Standard Strut)** , **Lower Control Arm Replacement (GNB Performance Struts)** .
14. Connect the stabilizer shaft links to the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA Standard Strut, GNB Performance Struts)** .
15. Connect the steering linkage outer tie rods to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
16. Remove the engine support fixture. Refer to **Engine Support Fixture** .
17. Install the front dash seal on the steering gear input shaft and connect the intermediate steering shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
18. Program the power steering control module. Refer to **Power Steering Control Module Programming and Setup** .
19. Measure and adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .

ELECTRIC DUAL PINION RACK AND PINION STEERING GEAR REPLACEMENT (AWD, LTG, M7U, NJ1)

Removal Procedure

CAUTION: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage:

- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.
- Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.
- Avoid the following actions unless required by the diagnostic procedure:
 - Jumpering or grounding of the components or connectors.
 - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
- Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- The steering column
- The intermediate shaft(s)
- The steering gear

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Lock the steering column in the straight-ahead position.
2. Disconnect the intermediate steering shaft from the steering gear and remove the front dash seal from the steering gear input shaft. Refer to **Intermediate Steering Shaft Replacement** .
3. Install the engine support fixture. Refer to **Engine Support Fixture** .
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

5. Disconnect the steering linkage outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
6. Disconnect the stabilizer shaft links from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA Standard Strut, GNB Performance Struts)** .
7. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA Standard Strut)** , **Lower Control Arm Replacement (GNB Performance Struts)** .
8. Remove the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (NJ2)**, **Steering Gear Heat Shield Replacement (NJ1)**.
9. Disconnect the electrical connector on the steering gear and disconnect the wiring harness clip from the steering gear housing.

NOTE: **Wiring harness routing is critical. Note the exact routing of the steering gear wiring harness before repositioning it.**

10. Remove the wiring harness bracket bolts from the steering gear. Leave the bracket attached to the wiring harness and position it out of the way.
11. Remove the through bolts for the front and rear transmission mounts. Refer to **Transmission Front Mount Replacement** , and **Transmission Rear Mount Replacement (AWD)** .
12. Position adjustable jackstands underneath the left and right sides of the rear of the drivetrain and front suspension frame.
13. Lower the vehicle until the drivetrain and front suspension frame is resting lightly on the jackstands.
14. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LUK)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
15. Loosen the drivetrain and front suspension frame front bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
16. Raise the vehicle while the drivetrain and front suspension frame rests on the jackstands. Do not allow the gap between the body and rear of the frame to exceed a maximum of 50 mm (2 in).
17. Finish removing the stabilizer shaft. Refer to **Stabilizer Shaft Replacement (GNA Standard Strut, GNB Performance Struts)** .

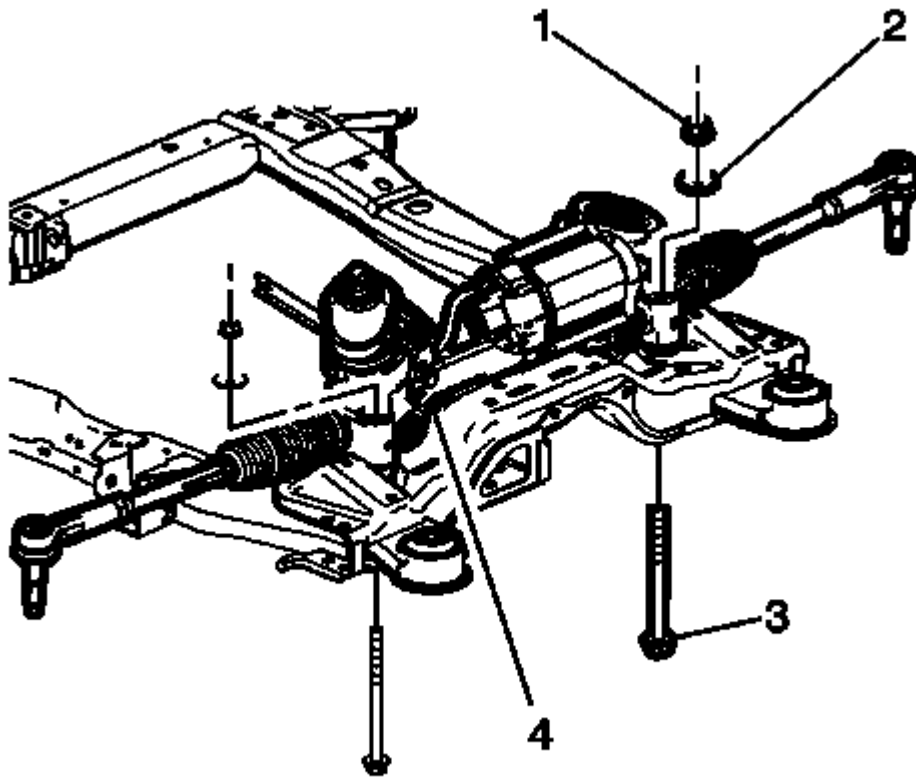


Fig. 20: Power Steering Gear Components
Courtesy of GENERAL MOTORS COMPANY

18. Remove the steering gear nuts (1), washers (2) and bolts (3) from the steering gear (4). Discard the nuts and bolts.
19. Remove the steering gear (4) from the left side of the vehicle.
20. Transfer components as necessary.

Installation Procedure

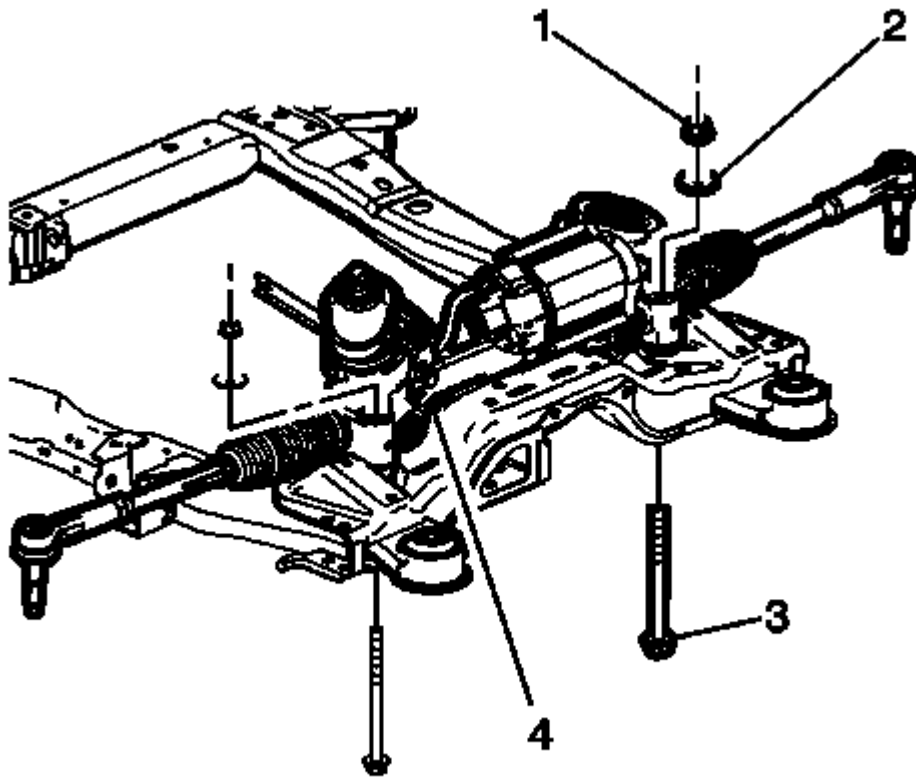


Fig. 21: Power Steering Gear Components
 Courtesy of GENERAL MOTORS COMPANY

1. Position the steering gear (4) on the front suspension frame through the left side of the vehicle.

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE: Start all bolts by hand before tightening.

2. Install the NEW steering gear bolts (3), washers (2) and NEW nuts (1) and tighten the bolts (3) to 110 N.m (81 lb ft) + 150 degrees.
3. Install the stabilizer shaft onto the drivetrain and front suspension frame. Refer to Stabilizer Shaft Replacement (GNA Standard Strut, GNB Performance Struts) .
4. Lower the vehicle until the gap between the drivetrain and front suspension frame and body is

approximately 12 mm (0.5 in).

5. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LUK)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
6. Tighten the drivetrain and front suspension frame front bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
7. Remove the jackstands from underneath the vehicle.
8. Install the through bolts for the front and rear transmission mounts. Refer to **Transmission Front Mount Replacement** , and **Transmission Rear Mount Replacement (AWD)** .

NOTE: **Wiring harness routing is critical. When installing, route the wiring harness in the exact same location it was moved from during the removal procedure.**

9. Route the steering gear wiring harness in the position it was in before removal.
10. Tighten the steering gear wiring harness bracket bolts to 9 N.m (80 lb in).
11. Connect the electrical connector on the steering gear and connect the wiring harness clip on the steering gear housing.
12. Install the steering gear heat shield. Refer to **Steering Gear Heat Shield Replacement (NJ1)**.
13. Connect the lower control arms to the steering knuckles. Refer to **Lower Control Arm Replacement (GNA Standard Strut)** , **Lower Control Arm Replacement (GNB Performance Struts)** .
14. Connect the stabilizer shaft links to the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA Standard Strut, GNB Performance Struts)** .
15. Connect the steering linkage outer tie rods to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
16. Remove the engine support fixture. Refer to **Engine Support Fixture** .
17. Install the front dash seal on the steering gear input shaft and connect the intermediate steering shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
18. Program the power steering control module. Refer to **Power Steering Control Module Programming and Setup** .
19. Measure and adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .

STEERING LINKAGE INNER TIE ROD REPLACEMENT (NJ2)

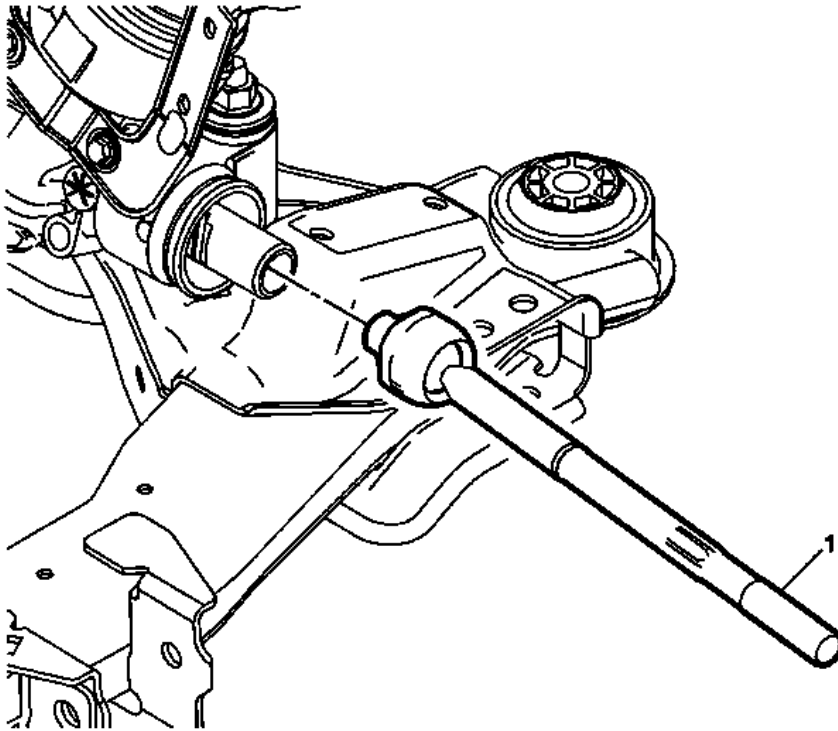


Fig. 22: Steering Linkage Inner Tie Rod (NJ2)

Courtesy of GENERAL MOTORS COMPANY

Steering Linkage Inner Tie Rod Replacement (NJ2)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the steering gear boot. Refer to <u>Steering Gear Boot Replacement (NJ2)</u>. 3. After removing the steering gear boot, inspect the steering linkage inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u>, <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u>. 	
	Steering Linkage Inner Tie Rod CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . NOTE: The appropriate flats on the steering gear rack are only present on the driver side of the vehicle. If the passenger side steering linkage inner tie rod must be replaced then the steering gear boot must be removed from the driver side as well in order to hold the steering gear rack from rotating. Replacing the passenger side steering linkage inner tie rod will require two people, one to hold the steering gear rack and one to install the

steering linkage inner tie rod.

Procedure

1

1. Place a wrench on the flats of the steering linkage inner tie rod housing.
2. Rotate the steering linkage inner tie rod housing counterclockwise to remove the steering linkage inner tie rod from the steering gear rack.
3. Rotate the steering linkage inner tie rod housing clockwise to install the steering linkage inner tie rod to the steering gear rack. Use the **CH-6321** wrench and a torque wrench to tighten the steering linkage inner tie rod to specification.
4. Measure and adjust the front toe. Refer to Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment .

Tighten

100 N.m (74 lb ft)

Special Tools

CH-6321 Tie Rod Wrench

For equivalent regional tools, refer to Special Tools.

STEERING LINKAGE INNER TIE ROD REPLACEMENT (NJ1)

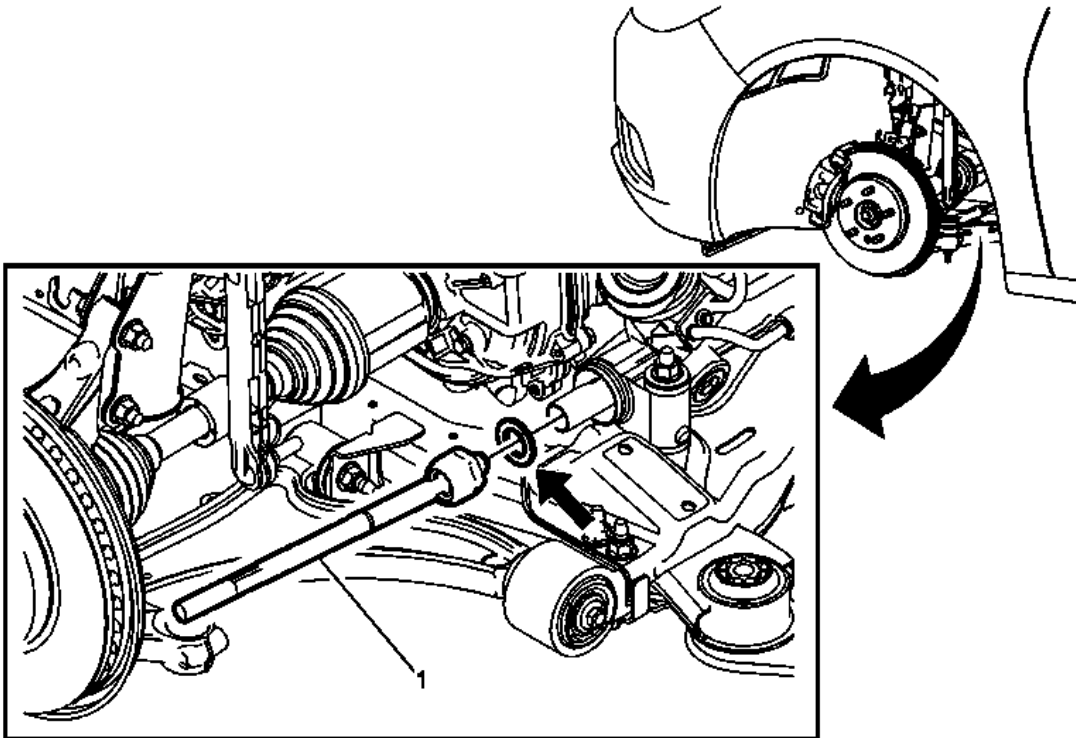


Fig. 23: Steering Linkage Inner Tie Rod (NJ1)
Courtesy of GENERAL MOTORS COMPANY

Steering Linkage Inner Tie Rod Replacement (NJ1)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the steering gear boot. Refer to <u>Steering Gear Boot Replacement (NJ1)</u>. 3. After removing the steering gear boot, inspect the steering linkage inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u>, <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)</u>. 	
1	<p>Steering Linkage Inner Tie Rod</p> <p>CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Place a wrench on the flats of the steering linkage inner tie rod housing. 2. Rotate the steering linkage inner tie rod housing counterclockwise to remove the steering linkage inner tie rod from the steering gear rack. 3. Rotate the steering linkage inner tie rod housing clockwise to install the steering linkage inner tie rod to the steering gear rack. Use the CH-6321 wrench and a torque wrench to tighten the steering linkage inner tie rod to specification. 4. Measure and adjust the front toe. Refer to <u>Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment</u> . <p>NOTE: A 2.5 mm shim is used for vehicles with wheels up to 18 inches and a 5.6 mm shim is used for vehicles with 19 inch and 20 inch wheels.</p> <p>Tighten 100 N.m (74 lb ft)</p> <p>Special Tools CH-6321 Tie Rod Wrench For equivalent regional tools, refer to <u>Special Tools</u>.</p>

STEERING GEAR DRIVE COUPLING REPLACEMENT (NJ1)

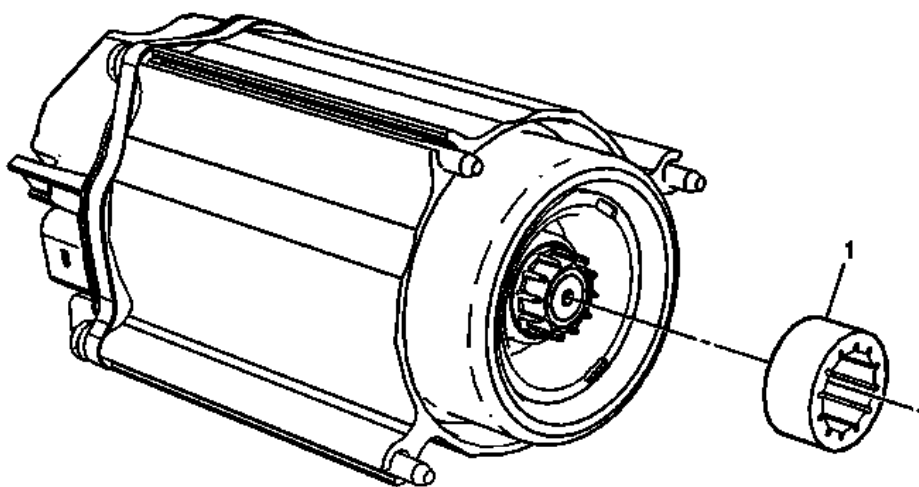


Fig. 24: Steering Gear Drive Coupling
 Courtesy of GENERAL MOTORS COMPANY

Steering Gear Drive Coupling Replacement (NJ1 Only)

Callout	Component Name
Preliminary Procedure	
Remove the power steering assist motor. Refer to <u>Power Steering Assist Motor Replacement (NJ1)</u> .	
1	Steering Gear Drive Coupling NOTE: The steering gear drive coupling connects the power steering assist motor to the steering gear.

POWER STEERING ASSIST MOTOR REPLACEMENT (NJ1)

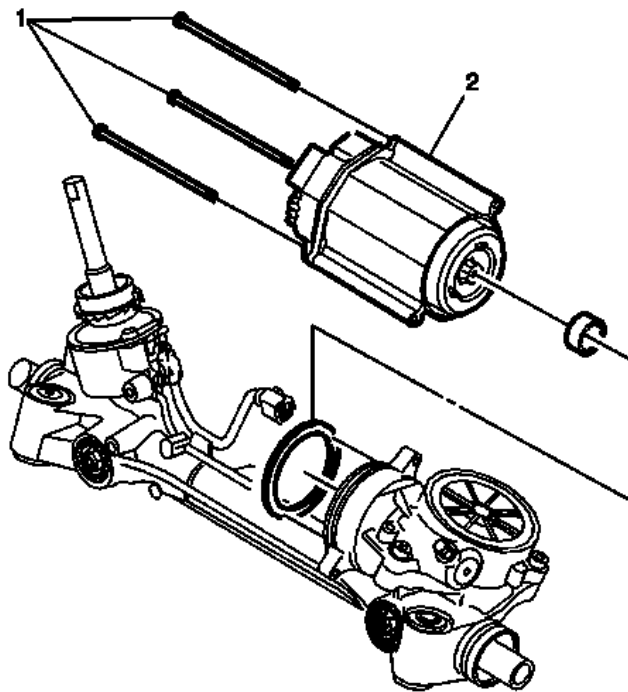


Fig. 25: Power Steering Assist Motor & Bolts (NJ1)
 Courtesy of GENERAL MOTORS COMPANY

Power Steering Assist Motor Replacement (NJ1)

Callout	Component Name
<p>CAUTION: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage:</p> <ul style="list-style-type: none"> • Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat. • Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage. • Do not allow tools to contact exposed terminals when servicing connectors. • Do not remove components from their protective packaging until required to do so. • Avoid the following actions unless required by the diagnostic procedure: <ul style="list-style-type: none"> ○ Jumpering or grounding of the components or connectors. ○ Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes. • Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices. 	
Preliminary Procedures	

1. Perform the strategy based diagnosis. Performing the strategy based diagnostics includes reviewing related bulletins, preliminary information and diagnostics. Refer to **Strategy Based Diagnosis** .
2. Capture the key cycle count from the old steering gear control module. If the key cycle count from the old module is not captured, it will not be possible to flash the new module. Refer to **Power Steering Control Module Programming and Setup** .
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the steering gear. Refer to **Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)**, **Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)**.

1

Power Steering Assist Motor Bolt (Qty: 3)

WARNING:

This component is equipped with torque-to-yield fasteners. Install a NEW torque-to-yield fastener when installing this component. Failure to replace the torque-to-yield fastener could cause bodily injury and damage to the vehicle or component.

CAUTION:

Refer to Fastener Caution .

Procedure

1. Remove the power steering assist motor bolts. DISCARD the bolts.
2. Install the NEW power steering assist motor bolts.

Tighten

8 (71 lb in)

2

Power Steering Assist Motor

Procedure

1. Remove the O-ring from the steering gear housing. DISCARD the O-ring.
2. Inspect the assist motor shaft and inside of the steering gear housing for signs of water intrusion or corrosion. If no signs of water intrusion or corrosion are present proceed to the next step. If signs of water intrusion or corrosion are present then replace the steering gear. Refer to **Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)**, **Electric Dual Pinion Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ1)**.
3. Install a NEW O-ring around the steering gear housing.
4. Install the steering gear drive coupling to the assist motor armature.
5. Align the steering gear drive coupling on the assist motor armature to the steering gear.
6. Align the NEW power steering assist motor bolts to the steering gear while pressing the assist motor over the steering gear housing O-ring.

7. After installation is complete, transfer the key cycle count from the OLD steering gear control module to the NEW steering gear control module. Refer to **Power Steering Control Module Programming and Setup** .

NOTE:

Inspection of the steering gear assist motor shaft and the inside of the steering gear housing is required to ensure there are no signs of water intrusion or corrosion which may cause premature motor failure. If signs of water intrusion or corrosion are present the steering gear must be replaced.

POWER STEERING ASSIST MOTOR REPLACEMENT (NJ2)

Special Tools

GE-50576-A Belt Tension Sonic Gauge

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

CAUTION: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage:

- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.
- Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.
- Avoid the following actions unless required by the diagnostic procedure:
 - Jumpering or grounding of the components or connectors.
 - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
- Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.

CAUTION: During removal and installation, the electric belt drive rack and pinion steering gear is extremely susceptible to damage. Dropping or prying on the electric belt drive motor controller module and/or electric belt drive rack and pinion steering gear may cause damage. If damage occurs, the electric belt drive motor controller module and/or electric belt drive rack and pinion steering gear will need to be replaced.

CAUTION: Care must be taken during removal and installation of the electric belt drive rack and pinion steering gear to not hit or break the electric belt drive motor controller module or module harness connectors. If the module or connectors are damaged, the electric belt drive motor controller module will need to be replaced.

1. Remove the electric belt drive rack and pinion steering gear from the vehicle. Refer to **Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)**, **Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)**.

NOTE: The torque sensor wiring harness is not repairable. Do not attempt to repair the harness under any circumstances. If the harness is damaged then the steering gear must be replaced.

NOTE: When installing the steering gear into a vise and clamping on the barrel of the housing, be careful not to pinch the torque sensor wire harness. If available, use soft jaw vise.

2. Place the steering gear in a vise.

NOTE: After the steering gear has been centered, do not allow the gear to move off the center position.

3. Rotate the input shaft to center the rack in its travel. Measure the outer tie rod to housing to verify the center of travel.
4. Remove the RH inner tie rod. Refer to **Steering Linkage Inner Tie Rod Replacement (NJ2)**.

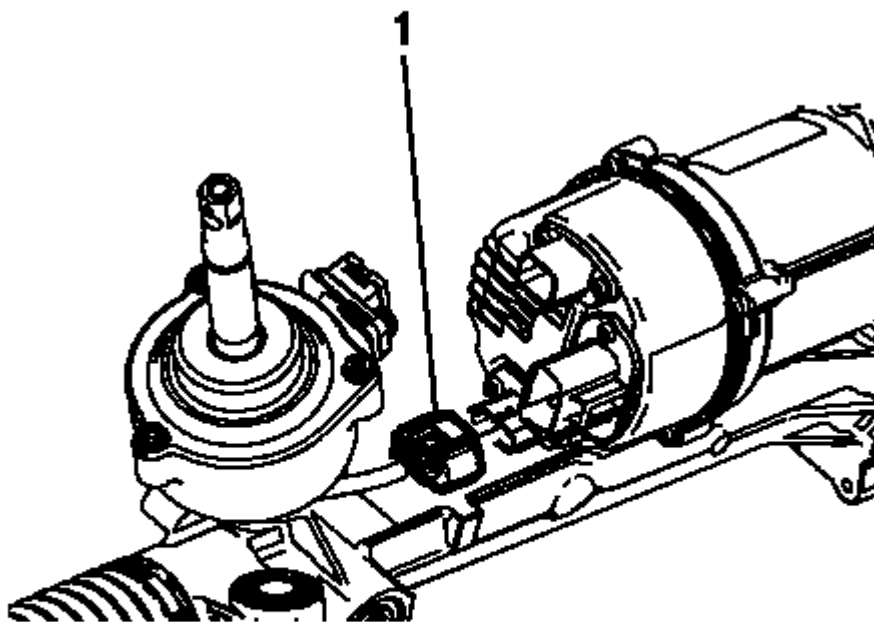


Fig. 26: Torque Sensor Wire Harness Connecto
Courtesy of GENERAL MOTORS COMPANY

5. Clean any dirt from the torque sensor wire harness connector (1) area and disconnect the connector from the power steering assist motor controller module.

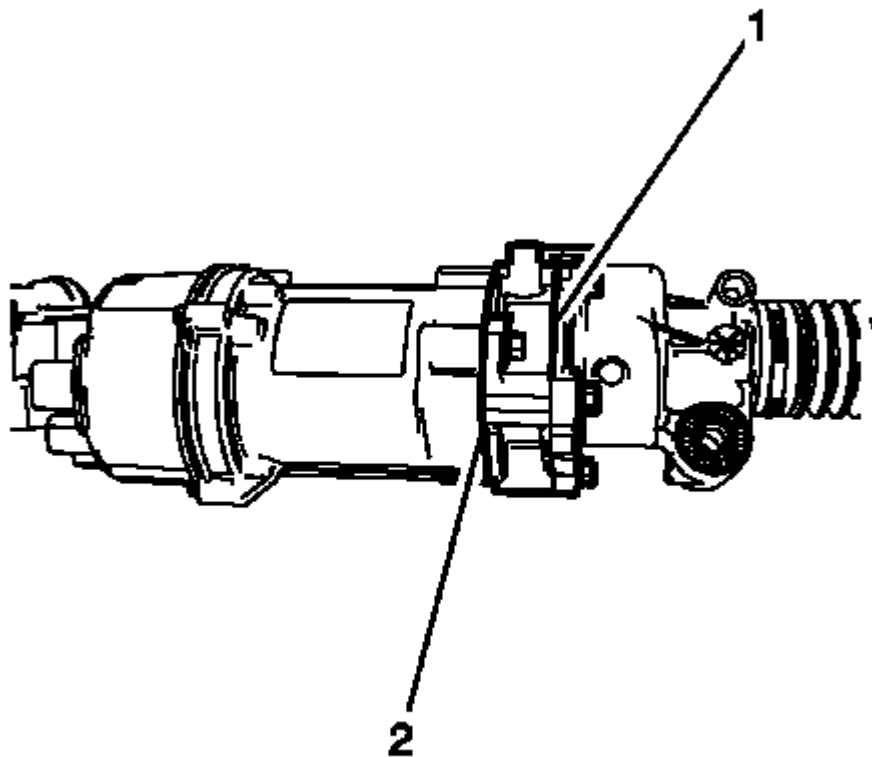


Fig. 27: Steering Gear

Courtesy of GENERAL MOTORS COMPANY

6. Using the appropriate cleaning materials, remove any dirt and debris from the steering gear where the housing will be separated (1) and where the power steering assist motor assembly connects to the steering gear (2). This will ensure that no contaminants enter the steering gear when the housing is separated.

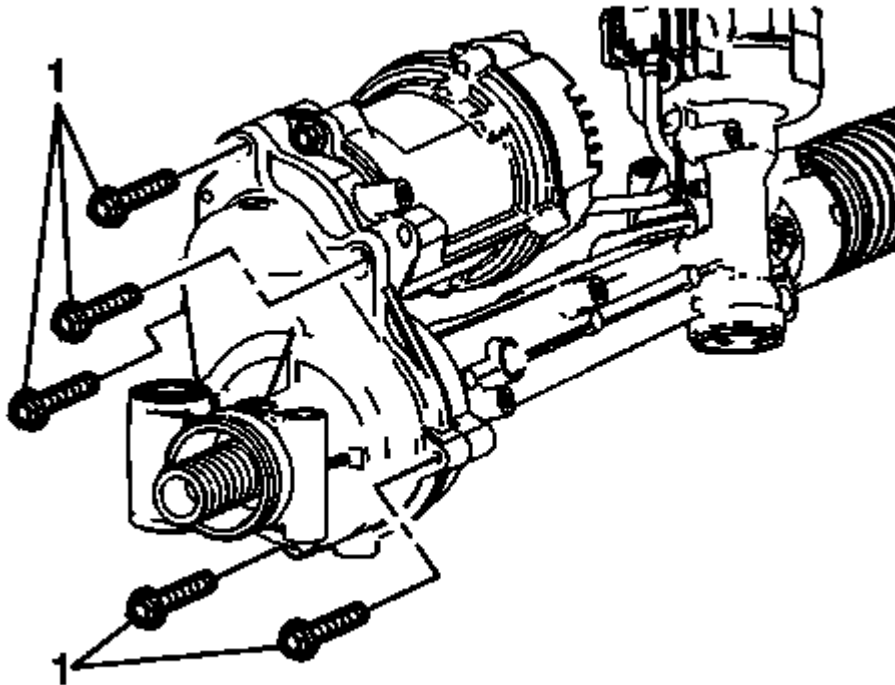


Fig. 28: Steering Gear Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not loosen the belt drive motor controller module pivot bolt at this time.
If bolt is loosened you will not be able to record the belt tension.

7. Remove the steering gear housing bolts (1).

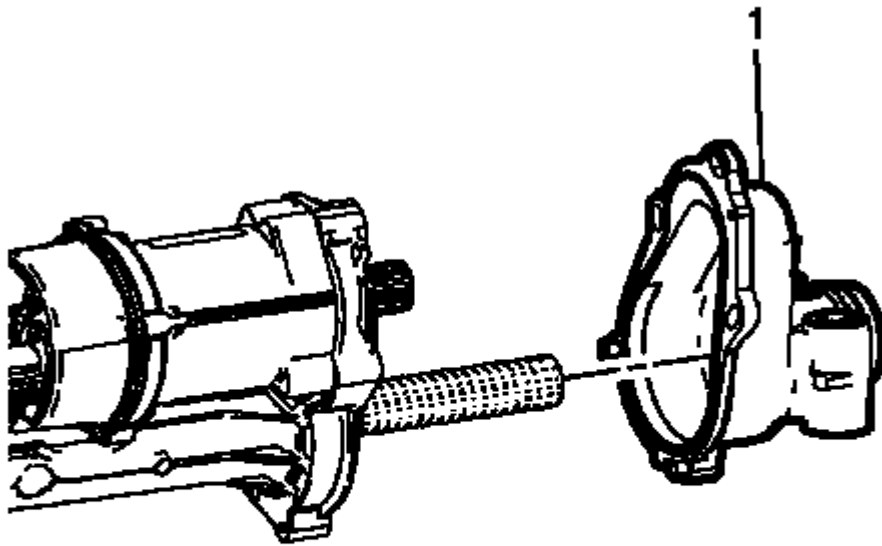


Fig. 29: Outboard Steering Gear Housing
Courtesy of GENERAL MOTORS COMPANY

NOTE: Carefully slide the boot down the inner tie rod, so that the boot does not collapse and roll up.

8. Separate the steering gear housing by using a rubber mallet to tap on the outboard steering gear housing (1) to release the dowel pins and remove the outboard steering gear housing from the steering gear housing.
9. Inspect inside the steering gear housing for contamination and the belt for damage. If there is contamination in the steering gear housing or the belt is damaged, replace the steering gear. Refer to **Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)**, **Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)**.

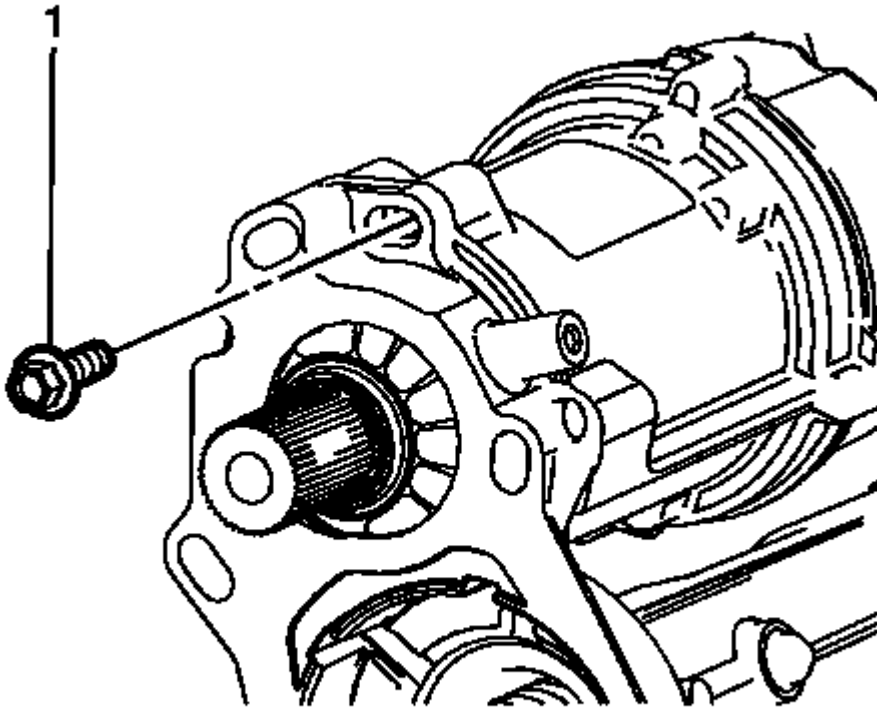


Fig. 30: Power Steering Assist Motor Assembly Pivot Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the power steering assist motor assembly pivot bolt (1).

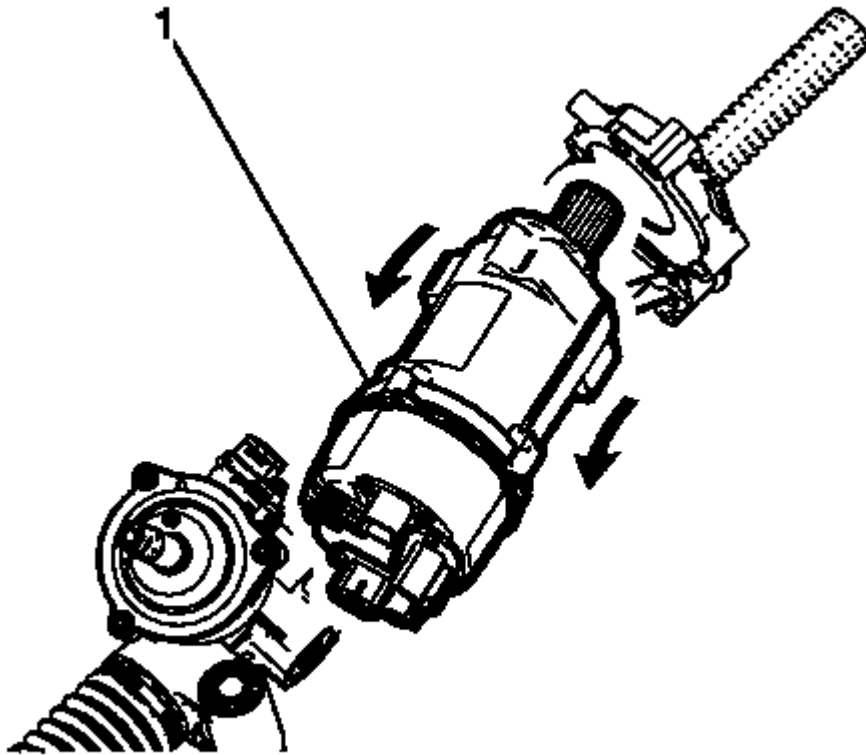


Fig. 31: Power Steering Assist Motor
Courtesy of GENERAL MOTORS COMPANY

11. Rotate the power steering assist motor assembly (1) to remove the belt tension.
12. Pull the power steering assist motor assembly (1) toward the input shaft until it is released from the steering gear housing to release the belt from the pulley and remove the power steering assist motor assembly.
13. Remove the belt from the steering gear and discard.
14. Install a rag over the large rack pulley to prevent dirt and debris from falling into the steering gear housing.

Installation Procedure

1. Use a clean shop rag to clean the power steering assist motor assembly mating surface on the steering gear housing so it is free of old grease or loose particles

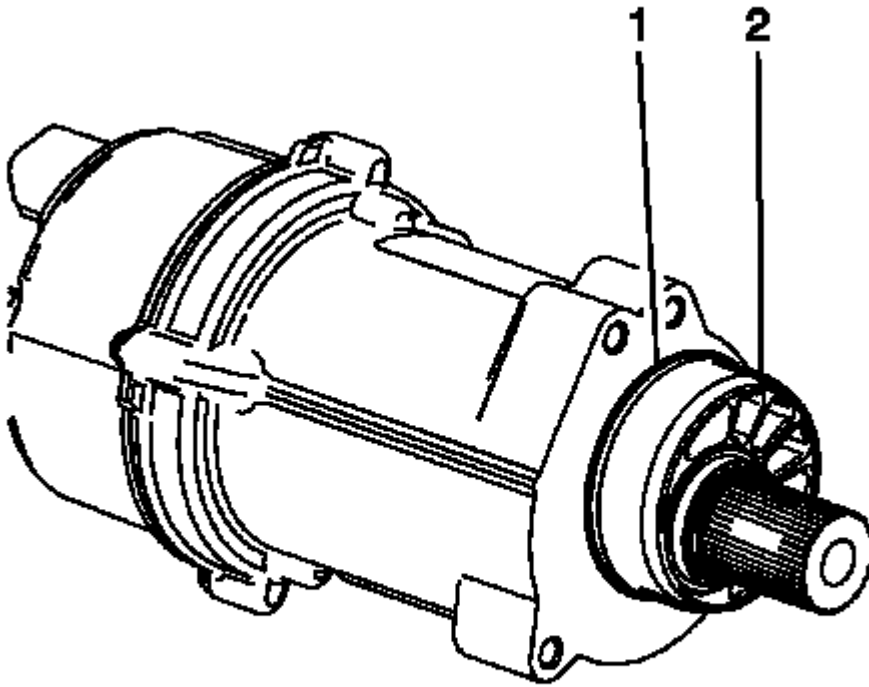


Fig. 32: Power Steering Assist Motor And O Ring
Courtesy of GENERAL MOTORS COMPANY

2. Install the new o-ring seal (1) to the power steering assist motor assembly (2).
3. Add a light film of lithium grease around the nose of the power steering assist motor assembly.
4. Install the NEW belt to the steering gear housing large pulley.

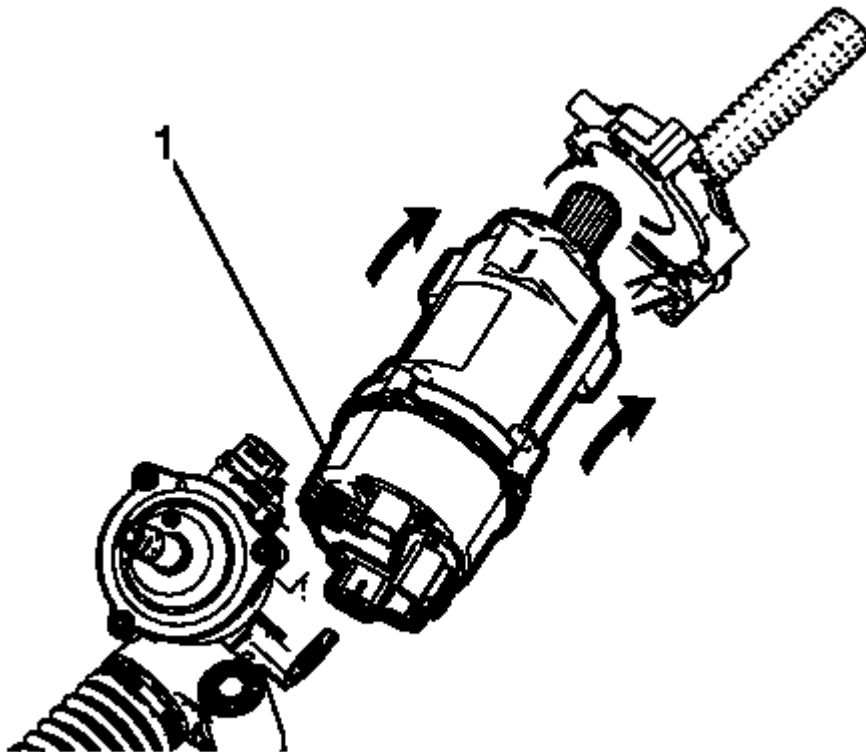


Fig. 33: Power Steering Assist Motor
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that care is taken not to pinch or roll the o-ring while installing power steering assist motor assembly to gear housing.

NOTE: Before adding tension to the belt, ensure that the belt is centered on the large pulley.

5. While being careful not to allow the belt to come into contact with the grease inside of the steering gear housing, install the power steering assist motor assembly (1) to the steering gear housing and place the belt on the power steering assist motor assembly pulley.
6. Rotate the power steering assist motor assembly (1) clockwise in the steering gear housing, while making sure the screw holes and slotted holes are aligned properly.

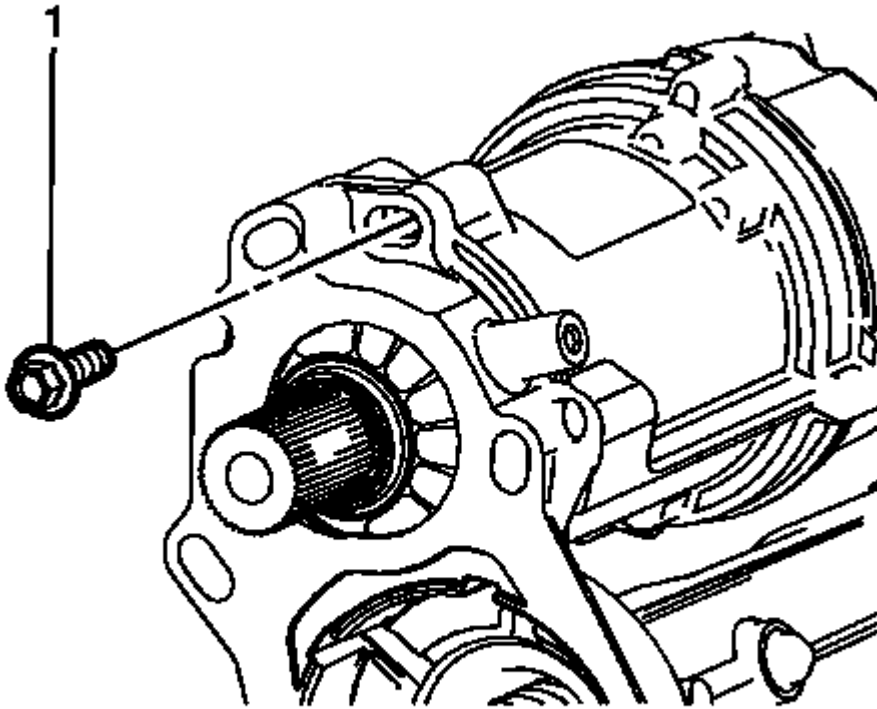


Fig. 34: Power Steering Assist Motor Assembly Pivot Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install the NEW belt pivot bolt (1) and hand tighten, ensuring that the electric power steering motor control module can still rotate.
8. Install wrench to the steering gear input shaft and rotate input shaft 90 degrees in both directions to seat belt. Ensure that the steering gear input shaft is returned to the center position.

NOTE: Care should be taken clamping on the power steering assist motor assembly so as not to damage the power steering assist motor assembly cover or connector headers.

9. Install a suitable clamp or add 5 washers to the lower bolt so the power steering assist motor assembly can be drawn into the gear housing. This will ensure that the power steering assist motor assembly is flush with the steering gear steering gear housing.

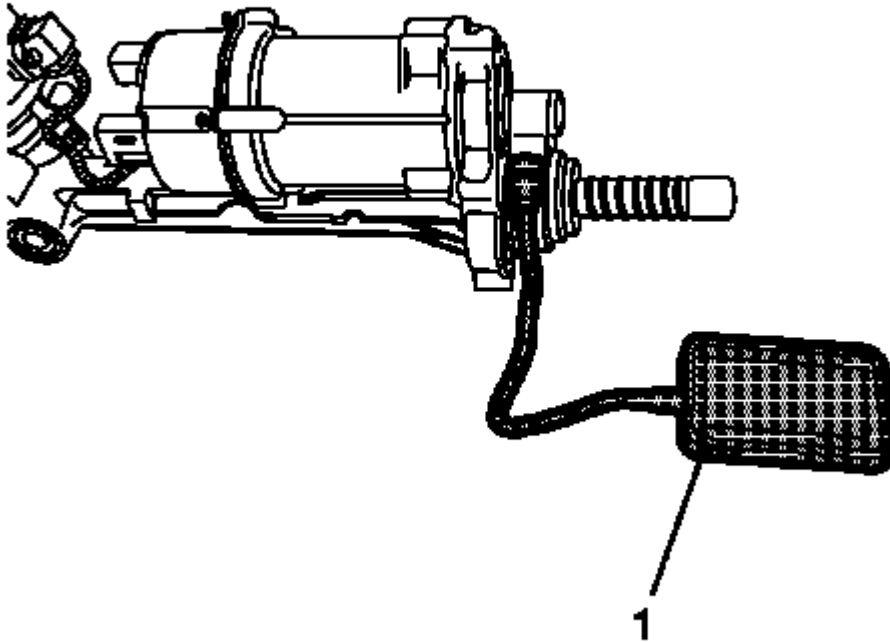


Fig. 35: Belt Tension Sonic Gauge
Courtesy of GENERAL MOTORS COMPANY

10. Tension the belt in the following manner:
 1. Install the **GE-50576-A** gauge (1) on the steering gear housing and position the microphone 1/4 inch away from the edge of the belt.
 2. Using an allen wrench or your finger, strum the belt in the center between the two pulleys and record the measurement. Perform this step 3 times to get an average HZ reading.
 3. If the average reading is at 300 Hz to 330 Hz, continue to next step. If reading is below or above the allowable specification, rotate the power steering assist motor assembly slightly (clockwise to tighten and counter clockwise to loosen) and take another set of readings. Repeat this step until belt is tightened to the specified range and then tighten pivot bolt.
11. Tighten the power steering assist motor assembly pivot bolt to 22 (16 lb ft) and recheck belt tension using **GE-50576-A** gauge. If the reading is not 300 Hz - 330 Hz, loosen the power steering assist motor assembly pivot bolt and readjust the belt tension. Refer to the belt tension steps above. If within range continue to next step.
12. Remove the clamp or bolt and washers holding the power steering assist motor assembly to the steering gear housing.
13. With a clean rag, clean the steering gear housing mating surfaces between the pinion and outboard housings so they are free of loose particles.

14. Remove the rag that you installed to cover the large rack pulley and do not allow any loose particles to fall into the gear housing.

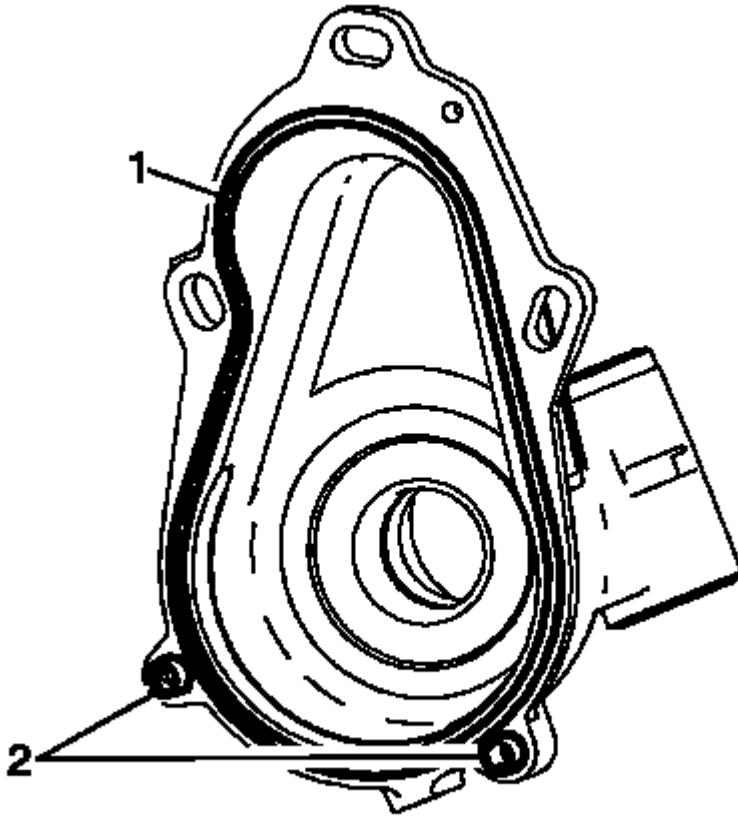


Fig. 36: Outboard Steering Gear Housing Seal
Courtesy of GENERAL MOTORS COMPANY

15. Inspect the outboard steering gear housing seal (1) for damage. If damaged replace the seal.
16. Ensure that the steering gear housing seal is in position and that both the dowel pins (2) are secure.

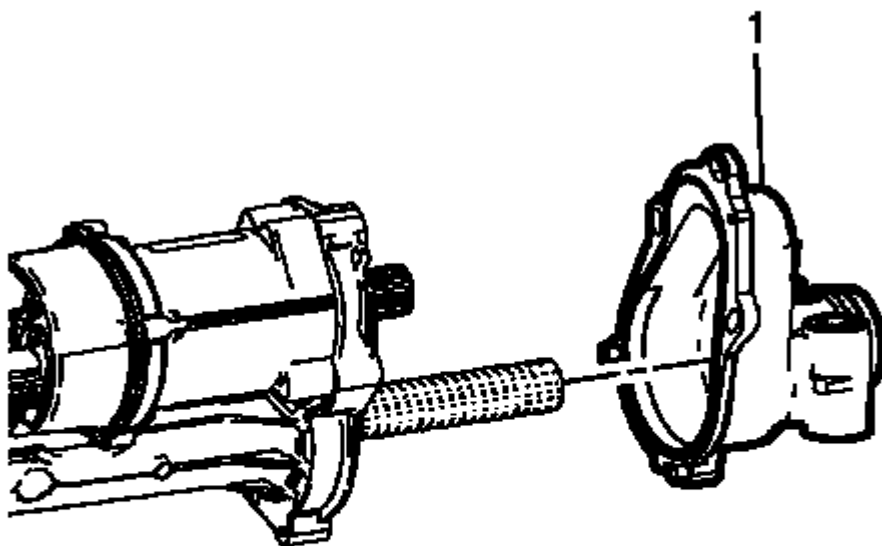


Fig. 37: Steering Gear Housing

Courtesy of GENERAL MOTORS COMPANY

17. Install the steering gear housing (1) to the steering gear assembly.

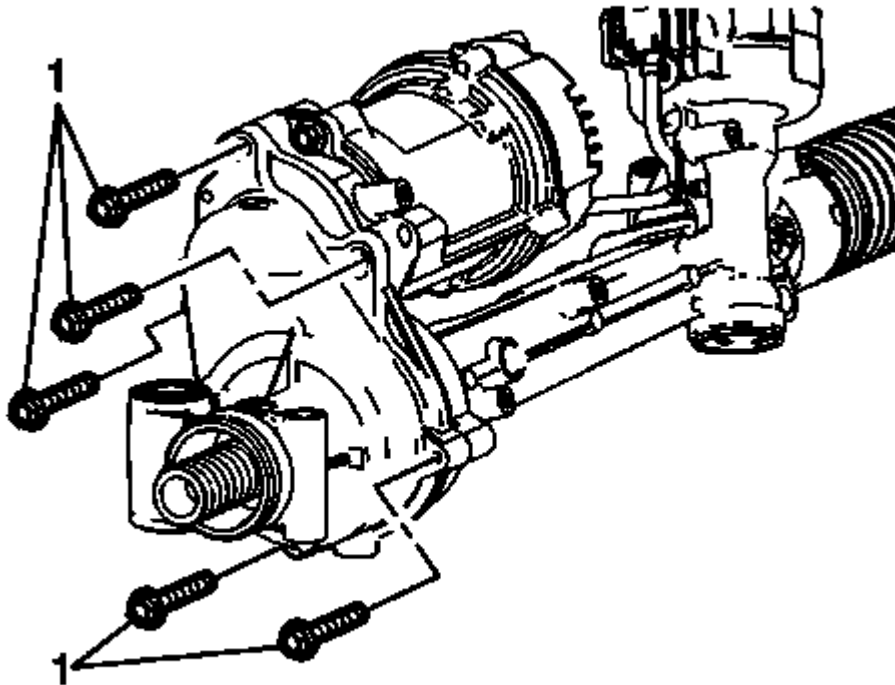


Fig. 38: Steering Gear Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Install the NEW steering gear housing bolts (1) and hand tighten.

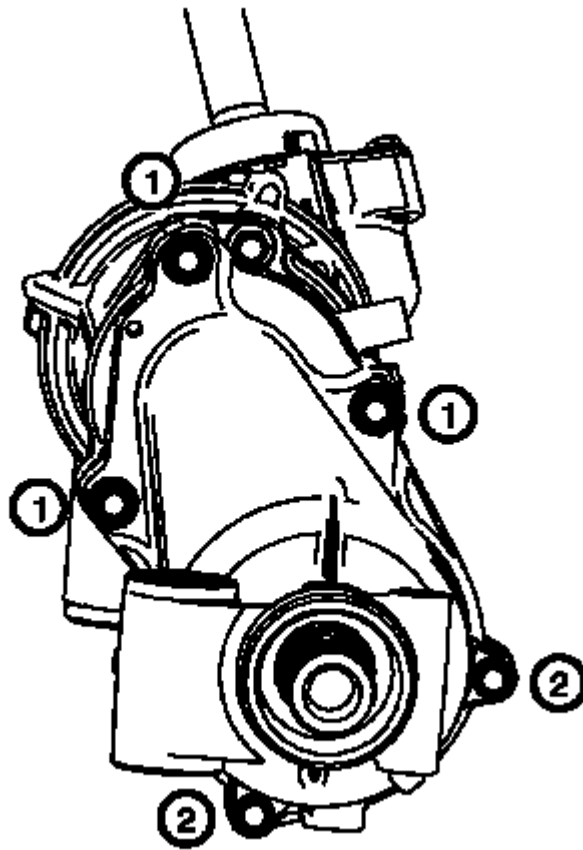


Fig. 39: Steering Gear Housing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

19. Tighten the steering gear housing fasteners in the following sequence:
 1. Tighten M6 bolts (1) to 10 (7 lb ft).
 2. Tighten M8 bolts (2) to 22 (16 lb ft).

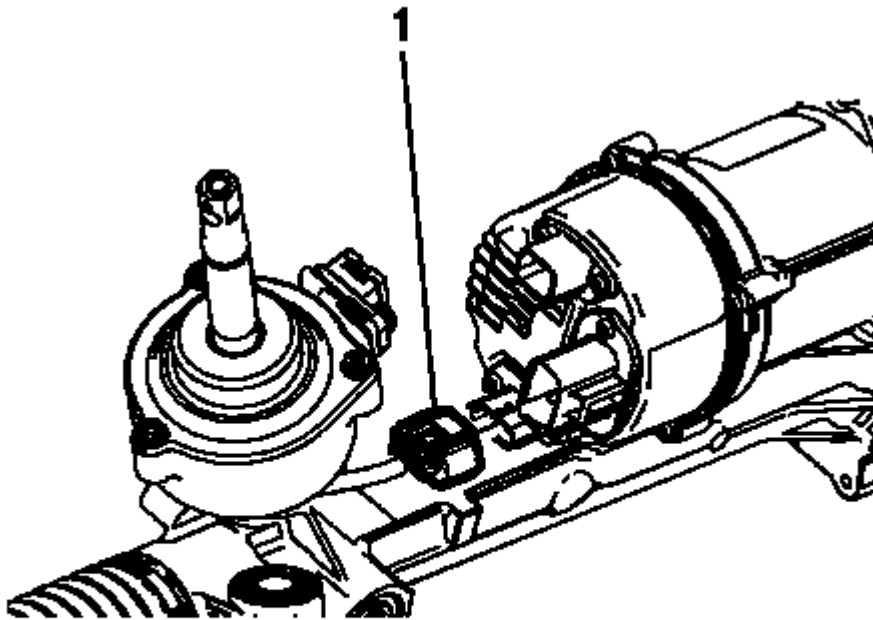


Fig. 40: Torque Sensor Wire Harness Connecto
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure the torque sensor wiring harness is fully connected and seated to the electric power steering motor controller module. If the harness connector is not fully engaged, damage to the module will occur when the key is turned on and replacement of the module will be necessary.

NOTE: The torque sensor wiring harness is not repairable. Do not attempt to repair the harness under any circumstances. If the harness is damaged then the steering gear must be replaced.

20. Install the torque sensor wire connector (1) to the power steering assist motor controller module. Ensure the sensor wire connector lock is engaged.
21. Install the RH inner tie rod. Refer to **Steering Linkage Inner Tie Rod Replacement (NJ2)**.
22. Remove the belt drive rack and pinion steering gear from vise.

CAUTION: During removal and installation, the electric belt drive rack and pinion steering gear is extremely susceptible to damage. Dropping or

prying on the electric belt drive motor controller module and/or electric belt drive rack and pinion steering gear may cause damage. If damage occurs, the electric belt drive motor controller module and/or electric belt drive rack and pinion steering gear will need to be replaced.

CAUTION: Care must be taken during removal and installation of the electric belt drive rack and pinion steering gear to not hit or break the electric belt drive motor controller module or module harness connectors. If the module or connectors are damaged, the electric belt drive motor controller module will need to be replaced.

23. Install the steering gear to the vehicle. Refer to Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2), Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2).
24. Perform the power steering control module setup procedure. Refer to Power Steering Control Module Programming and Setup .

POWER STEERING CONTROL MODULE CALIBRATION (NJ1)

Steering Angle Sensor Centering and Software Endstop Learning

WARNING: An inaccurate or not centered steering angle sensor could limit the operation of the electric power steering (EPS) and result in personal injury.

Centering of the steering angle sensor and software endstop learning might be required after certain service procedures are performed. Some of these procedures are as follows:

- Steering angle sensor replacement
- Steering gear replacement
- Power steering assist motor replacement
- Steering column replacement
- Steering linkage inner tie rod replacement
- Steering linkage outer tie rod replacement

NOTE: It is necessary to perform the steering angle sensor centering BEFORE the software endstop learning.

Steering Angle Sensor Centering

For electronic power steering equipped vehicles WITH electronic stability control program and EXTERNAL Steering Angle Sensor, refer to Steering Angle Sensor Centering .

The centering procedure of the internal steering angle sensor (w/o electronic stability program) can be

completed with the following steps:

Conditions: Front axle measured and set, engine running, vehicle speed 0 km/h (0 MPH), internal steering angle sensor is activated.

1. Using the steering wheel, align the front wheels in the center forward position.
2. Using a scan tool, perform the Configuration/Reset Functions, Steering Wheel Angle Sensor Centering procedure.
3. Steer from the center position slowly 90° to the left.
4. Steer slowly back to the center position and then slowly 90° to the right.
5. Steer slowly back to the center position.
6. Perform the steering movements again.
7. Centering procedure is completed.

Software Endstop Learning

The software endstop learning procedure can be completed with the following steps:

Conditions: Front axle measured and set, vehicle speed 0 km/h (0 MPH), internal steering angle sensor is calibrated or external steering angle sensor sends a valid CAN signal.

1. Using a scan tool, perform the Configuration/Reset Functions, Power Steering Softstops Reset procedure and follow the on-screen instructions.
2. Using a scan tool, perform the Configuration/Reset Functions, Power Steering Softstops Learn procedure and follow the on-screen instructions.
3. Software endstop learning procedure is completed.

DESCRIPTION AND OPERATION

POWER STEERING SYSTEM DESCRIPTION AND OPERATION (HYDRAULIC POWER STEERING)

The hydraulic power steering pump is a constant displacement vane-type pump that provides hydraulic pressure and flow for the power steering gear. The hydraulic power steering pumps are either belt-driven or direct-drive, cam-driven.

The power steering fluid reservoir holds the power steering fluid and may be integral with the power steering pump or remotely located. The following locations are typical locations for the remote reservoir:

- Mounted to the front of the dash panel
- Mounted to the inner fender
- Mounted to a bracket on the engine

The 2 basic types of power steering gears are listed below:

- A recirculating ball system
- A rack and pinion system

In the recirculating ball system, a worm gear converts steering wheel movement to movement of a sector shaft. A pitman arm attached to the bottom of the sector shaft actually moves one tie rod and an intermediate rod move the other tie rod.

In the rack and pinion system, the rack and the pinion are the 2 components that convert steering wheel rotation to lateral movement. The steering shaft is attached to the pinion in the steering gear. The pinion rotates with the steering wheel. Gear teeth on the pinion mesh with the gear teeth on the rack. The rotating pinion moves the rack from side to side. The lateral action of the rack pushes and pulls the tie rods in order to change the direction of the vehicle's front wheels.

The power steering pressure hose connects the power steering pump union fitting to the power steering gear and allows pressurized power steering fluid to flow from the pump to the gear.

The power steering return hose returns fluid from the power steering gear back to the power steering fluid reservoir. The power steering return line may contain an integral fin-type or line-type power steering fluid cooler.

In a typical power steering system, a pump generates hydraulic pressure, causing fluid to flow, via the pressure hose, to the steering gear valve assembly. The steering gear valve assembly regulates the incoming fluid to the right and left chambers in order to assist in right and left turns.

Turning the steering wheel activates the valve assembly, which applies greater fluid pressure and flow to one side of the steering gear piston, and lower pressure and flow to the other side of the piston. The pressure assists the movement of the gear piston. Tie rods transfer this force to the front wheels, which turn the vehicle right or left.

POWER STEERING SYSTEM DESCRIPTION AND OPERATION (ELECTRONIC POWER STEERING)

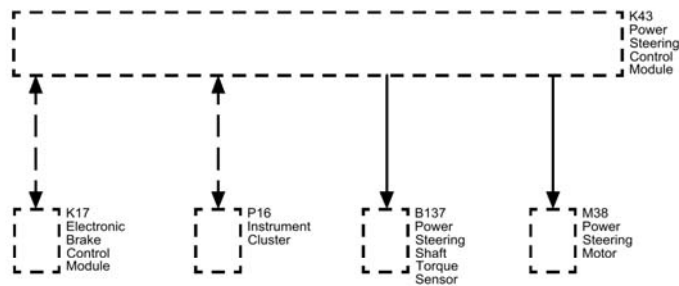


Fig. 41: Power Steering System Diagram

Courtesy of GENERAL MOTORS COMPANY

The power steering system consists of the following components:

- The power steering control module
- The power steering motor
- The power steering motor rotational sensor
- The torque sensor
- The steering gear (rack and dual pinion)

The rack and dual pinion electric power steering system reduces the amount of effort needed to steer the vehicle utilizing the power steering control module to control the power steering motor to maneuver the steering gear. The power steering control module also uses a combination of the torque sensor, motor rotational sensor, battery voltage circuit and GMLAN serial data circuit to perform the system functions. The power steering control module monitors vehicle speed and engine speed from the engine control module via the GMLAN serial data circuit to determine the amount of steering assist needed to steer the vehicle. At low speeds more assist is provided for easy turning during parking maneuvers. At higher speeds less assist is provided for improved road feel and directional stability.

The power steering control module uses a combination of the torque sensor, motor rotational sensor, vehicle speed, and calculated system temperature inputs to determine the amount of assist needed. The power steering control module continuously monitors the digital torque sensor's torque and index current signals. As the steering wheel is turned and torsional twist is applied to the steering shaft, the steering input and output shafts are monitored via the torque signal circuit and then processed by the power steering control module to calculate

the steering torque. The voltage signals of the motor position sensor and the digital torque sensor's index current signal are both processed by the power steering control module to detect and calculate the steering wheel angle.

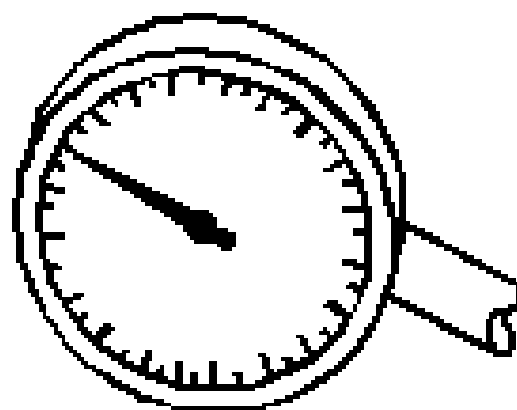
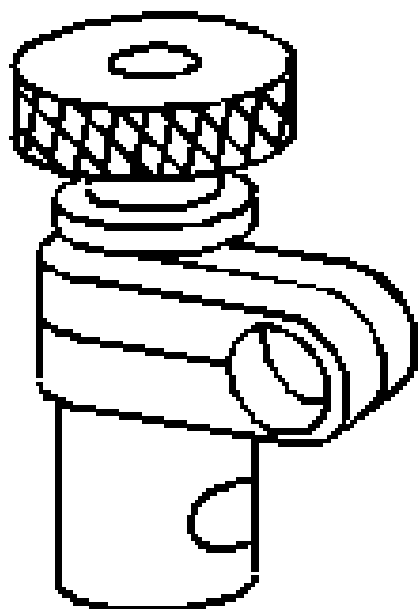
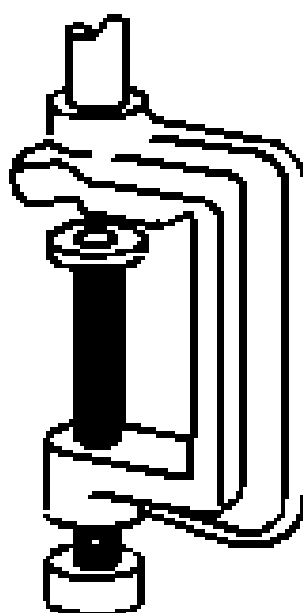
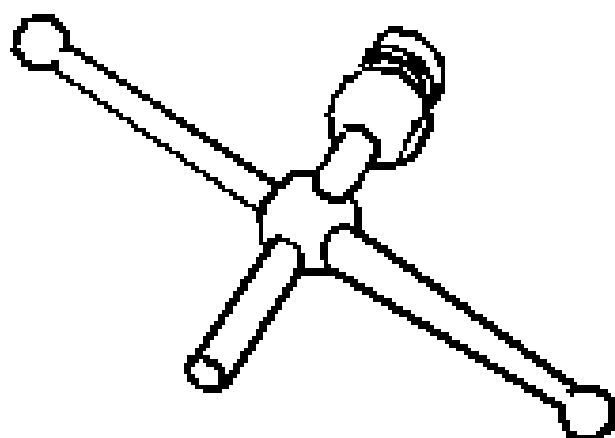
The power steering control module responds to the change in the digital torque sensor signals as well as the motor rotational sensor's voltage signals by commanding current to the power steering motor. The power steering control module controls the pulse width modulated motor drive circuit to drive the 3-phase motor. The power steering control module and motor assembly is attached to the base of the steering gear housing and assists the steering gear pinion to maneuver the rack from left to right according to turning the steering wheel.

The power steering control module has the ability to calculate an internal system temperature to protect the power steering system from damage caused by high temperature. To reduce a high system temperature, the power steering control module will reduce the amount of current commanded to the power steering motor, which reduces the amount of steering assist. The power steering control module has the ability to detect malfunctions within the electric power steering system. Any malfunction detected that disables steering assist will cause the SERVICE POWER STEERING message to be displayed on the driver information center.

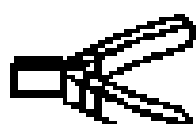
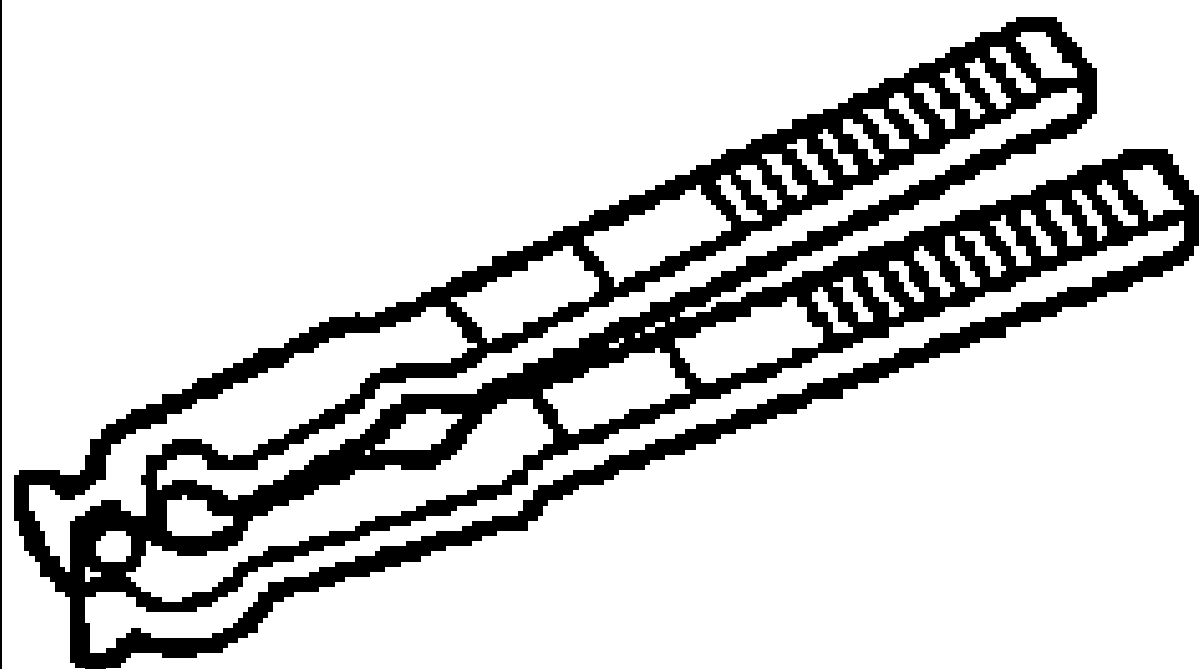
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

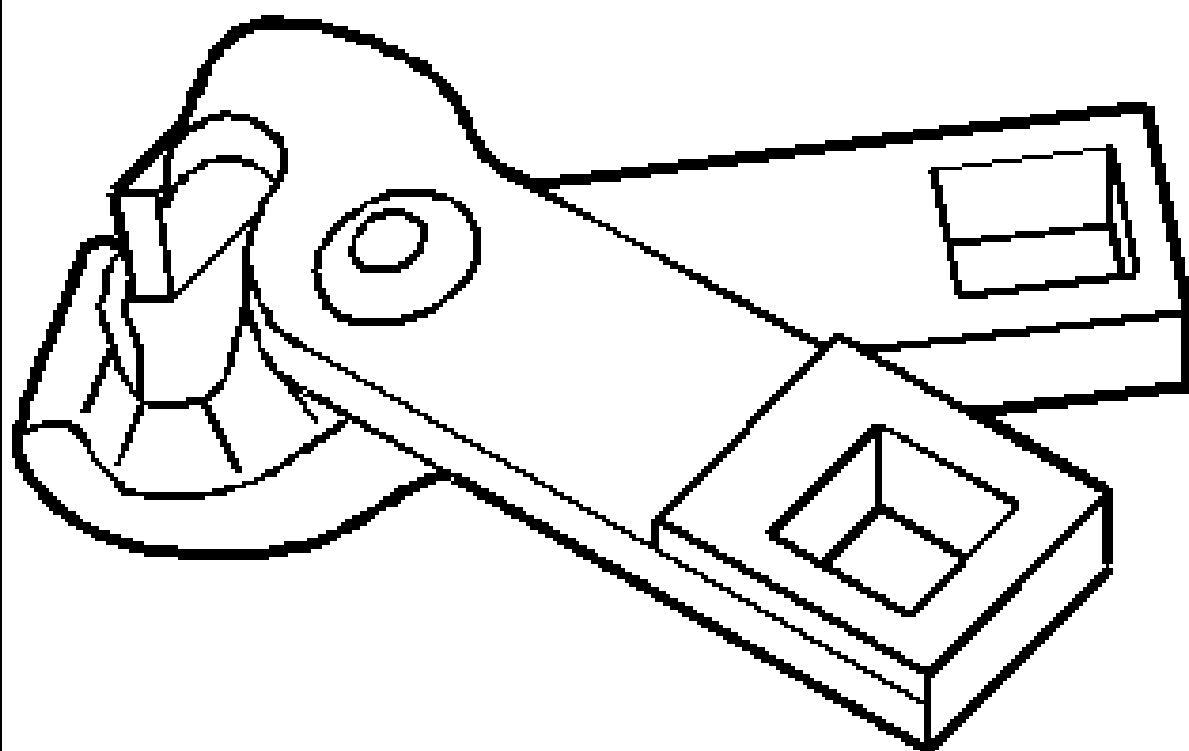
Illustration	Tool Number/ Description
	CH-161-B J-22888-20A KM-161-B Bearing Puller



	CH-6321 J-34028 KM-6321 8997009 Tie Rod Wrench
	CH-22610 J-22610 KM-J- 22610 SA9164C Pliers



	CH-39570 J-39570 Chassis Ear
	DT-35910 J-35910 Drive Axle Boot Clamp Pliers



GE-8001
J-8001
Dial
Indicator
Set

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Powertrain Component Views

POWERTRAIN COMPONENT VIEWS

FRONT OF ENGINE COMPONENTS (LHU)

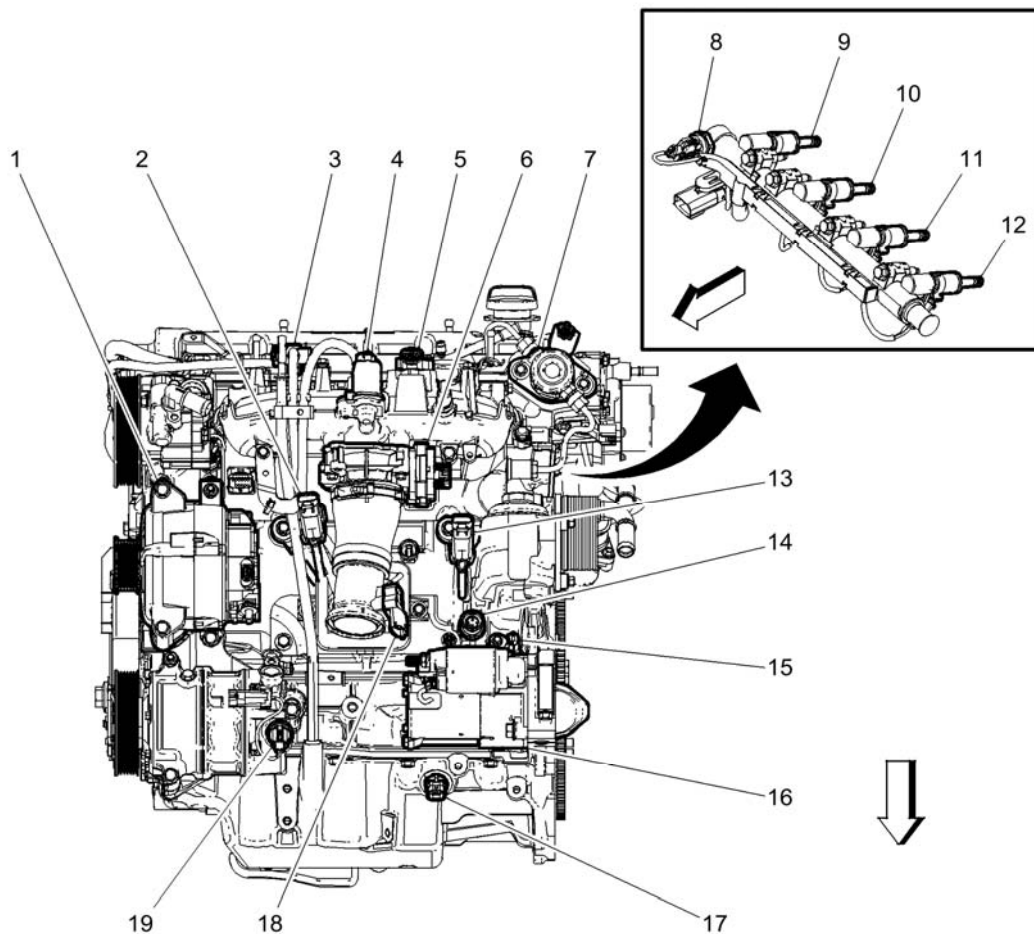


Fig. 1: Front of Engine Component Locations (LHU)

Courtesy of GENERAL MOTORS COMPANY

Items

- 1: G13 Generator G13 Generator X1 LHU/LDK G13 Generator X2
- 2: B68A Knock Sensor 1 (LHU/ LDK) B68A Knock Sensor 1 LHU/LDK
- 3: Q40 Turbocharger Bypass Solenoid Valve (LHU/ LDK/ LLU) Q40 Turbocharger Bypass Solenoid Valve (LHU)

-
- 4: Q12 Evaporative Emission Purge Solenoid Valve Q12 Evaporative Emission Purge Solenoid Valve (LUK/LHU)**
- 5: B74 Manifold Absolute Pressure Sensor B74 Manifold Absolute Pressure Sensor LHU/LDK**
- 6: Q38 Throttle Body Q38 Throttle Body (LHU)**
- 7: G18 High Pressure Fuel Pump G18 High Pressure Fuel Pump**
- 8: B47B Fuel Rail Pressure Sensor B47B Fuel Rail Pressure Sensor LHU/LDK**
- 9: Q17A Fuel Injector 1 Q17A Fuel Injector 1 (LHU/LDK)**
- 10: Q17B Fuel Injector 2 Q17B Fuel Injector 2 (LHU/LDK)**
- 11: Q17C Fuel Injector 3 Q17C Fuel Injector 3 (LHU/LDK)**
- 12: Q17D Fuel Injector 4 Q17D Fuel Injector 4 (LHU/LDK)**
- 13: B68B Knock Sensor 2 (LHU/ LDK) B68B Knock Sensor 2 LHU/LDK**
- 14: B37 Engine Oil Pressure Switch B37 Engine Oil Pressure Switch LUK/LHU/LAF/LDK/LTD**
- 15: B26 Crankshaft Position Sensor B26 Crankshaft Position Sensor LHU**
- 16: M64 Starter Motor M64 Starter Motor X1 M64 Starter Motor X1 M64 Starter Motor X2**
- 17: B35 Engine Oil Level Switch B35 Engine Oil Level Switch LHU/LDK**
- 18: B111B Turbocharger Boost/Intake Air Temperature Sensor (LHU) B111B Turbocharger Boost/Intake Air Temperature Sensor (LHU)**
- 19: Q46 A/C Compressor Solenoid Valve Q46 A/C Compressor Solenoid Valve (LHU/LUK)**

LEFT REAR OF ENGINE COMPONENTS (LHU)

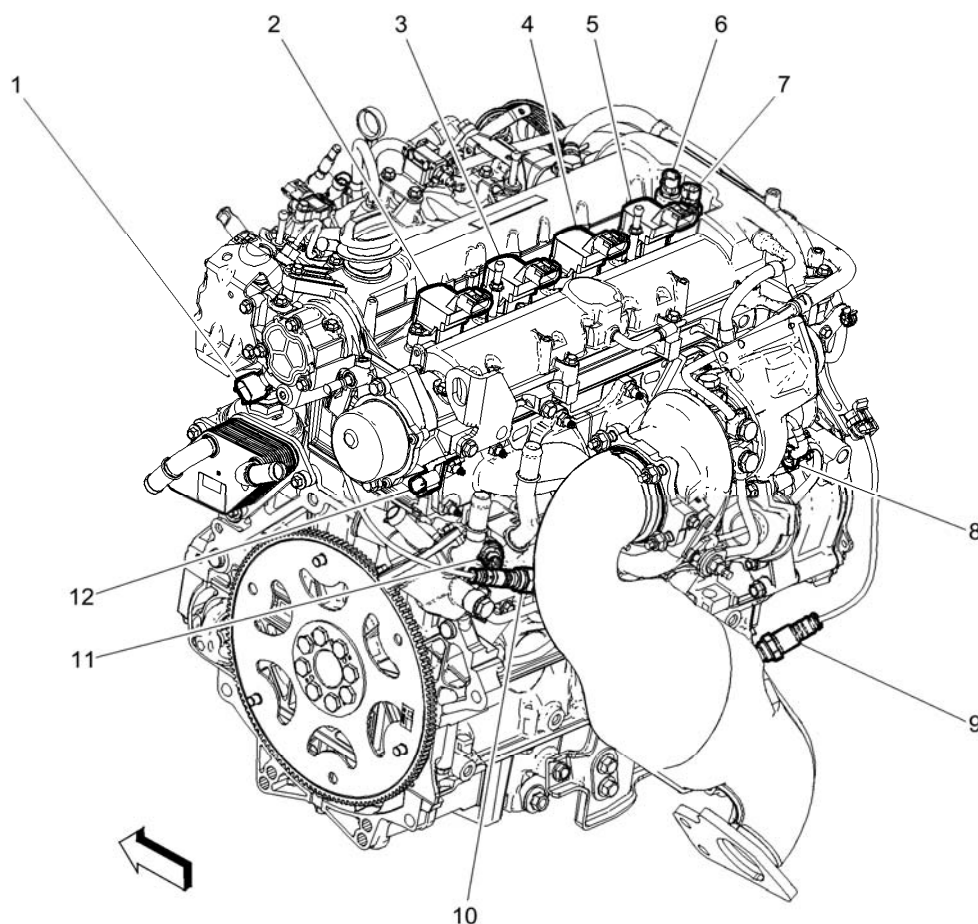


Fig. 2: Left Rear of Engine Component Locations (LHU)
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** B23F Camshaft Position Sensor - Intake **B23F Camshaft Position Sensor - Intake LUK/LHU**
- 2:** T8A Ignition Coil 1 **T8A Ignition Coil 1**
- 3:** T8B Ignition Coil 2 **T8B Ignition Coil 2**
- 4:** T8C Ignition Coil 3 **T8C Ignition Coil 3**
- 5:** T8D Ignition Coil 4 **T8D Ignition Coil 4**
- 6:** Q6F Camshaft Position Actuator Solenoid Valve - Intake **Q6F Camshaft Position Actuator Solenoid Valve - Intake (LUK/LHU)**
- 7:** Q6E Camshaft Position Actuator Solenoid Valve - Exhaust **Q6E Camshaft Position Actuator Solenoid Valve - Exhaust (LUK/LHU)**
- 8:** Q42 Turbocharger Wastegate Solenoid Valve (LHU/ LDK/ LLU) **Q42 Turbocharger Wastegate Solenoid Valve (LHU)**
- 9:** B52B Heated Oxygen Sensor 2 **B52B Heated Oxygen Sensor 2 LUK/LHU/LAF/LDK**
- 10:** B52A Heated Oxygen Sensor 1 **B52A Heated Oxygen Sensor 1 LUK/LHU/LAF/LDK/LTD**

11: B34 Engine Coolant Temperature Sensor **B34A ENGINE COOLANT TEMPERATURE SENSOR 1 (LHU)** **B34B ENGINE COOLANT TEMPERATURE SENSOR 2 (LHU)**
12: B23E Camshaft Position Sensor - Exhaust **B23E Camshaft Position Sensor - Exhaust LUK/LHU**

LEFT FRONT OF ENGINE COMPONENTS (LUK 1 OF 2)

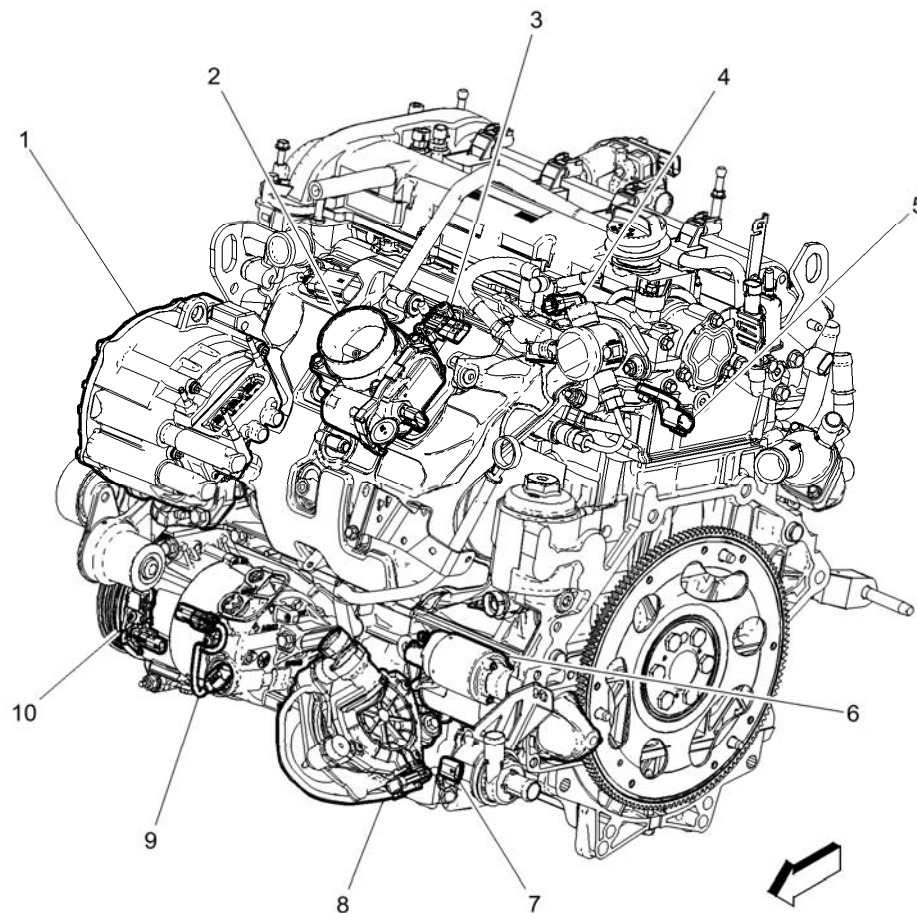


Fig. 3: Left Front of Engine Components (LUK 1 of 2)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: A15 Starter/Generator (HP6)** **A15 Starter/Generator (HP6)**
- 2: Q38 Throttle Body** **Q38 Throttle Body (LUK)**
- 3: B74 Manifold Absolute Pressure Sensor** **B74 Manifold Absolute Pressure Sensor LUK/LTD**
- 4: G18 High Pressure Fuel Pump** **G18 High Pressure Fuel Pump**
- 5: B23F Camshaft Position Sensor - Intake** **B23F Camshaft Position Sensor - Intake LUK/LHU**
- 6: M64 Starter Motor** **M64 Starter Motor X1** **M64 Starter Motor X2**
- 7: G43 Starter/Generator Coolant Pump (HP6)** **G43 Starter/Generator Coolant Pump (HP6)**

8: G21 Secondary Air Injection Pump (NU6) **G21 Secondary Air Injection Pump (NU6)**
9: Q46 A/C Compressor Solenoid Valve **Q46 A/C Compressor Solenoid Valve (LHU/LUK)**
10: Q2 A/C Compressor Clutch **Q2 A/C Compressor Clutch (LUK/LHU)**

LEFT FRONT OF ENGINE COMPONENTS (LUK 2 OF 2)

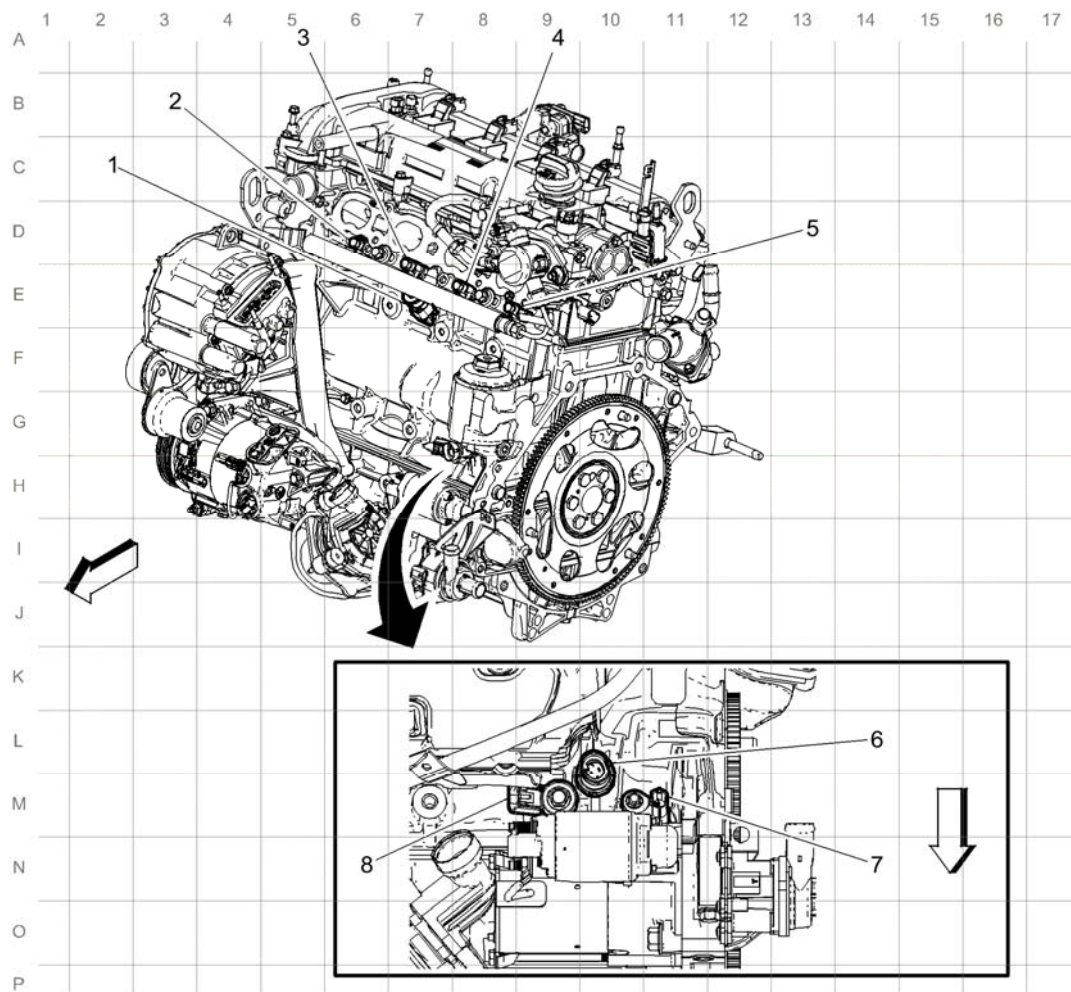


Fig. 4: Left Front of Engine Components (LUK 2 of 2)
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** B47B Fuel Rail Pressure Sensor **B47B Fuel Rail Pressure Sensor (LUK)**
2: Q17A Fuel Injector 1 **Q17A Fuel Injector 1 (LUK/LAF)**
3: Q17B Fuel Injector 2 **Q17B Fuel Injector 2 (LUK/LAF)**
4: Q17C Fuel Injector 3 **Q17C Fuel Injector 3 (LUK/LAF)**
5: Q17D Fuel Injector 4 **Q17D Fuel Injector 4 (LUK/LAF)**
6: B37 Engine Oil Pressure Switch **B37 Engine Oil Pressure Switch LUK/LHU/LAF/LDK/LTD**
7: B26 Crankshaft Position Sensor **B26 Crankshaft Position Sensor LAF/LUK**

8: B68 Knock Sensor B68 Knock Sensor LUK/LAF/LTD

LEFT REAR OF ENGINE COMPONENTS (LUK)

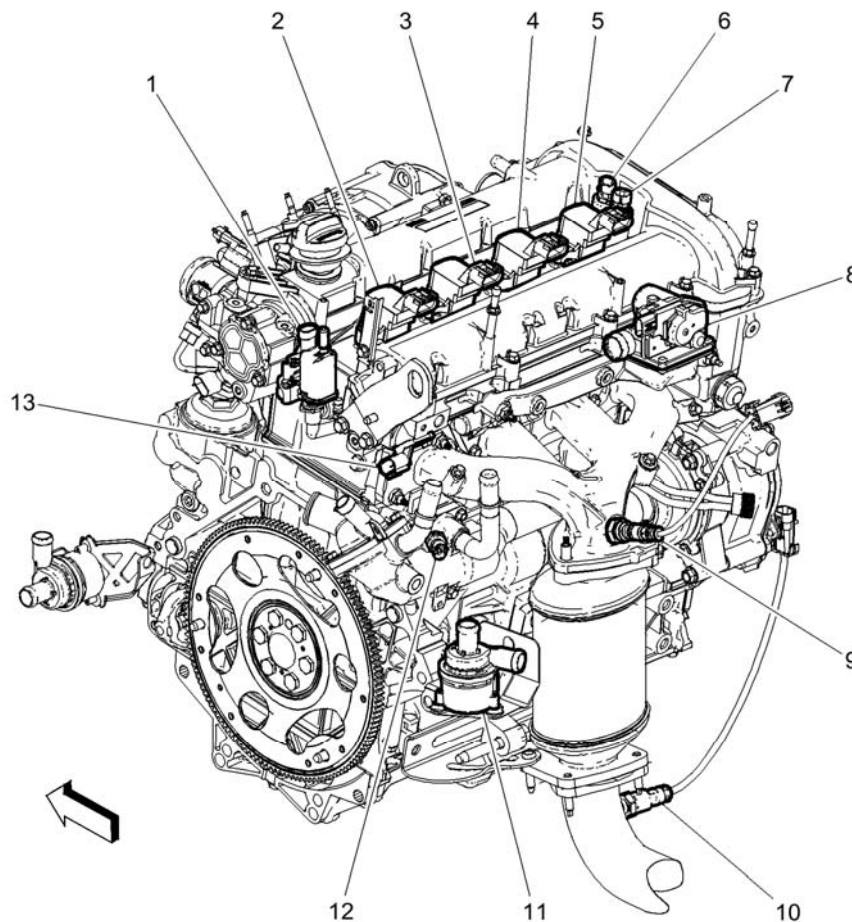


Fig. 5: Left Rear of Engine Components (LUK)

Courtesy of GENERAL MOTORS COMPANY

Items

1: G8 Coolant Pump - Auxiliary (HP6) G8 Coolant Pump - Auxiliary (HP6)

2: T8D Ignition Coil 4 T8D Ignition Coil 4

3: T8C Ignition Coil 3 T8C Ignition Coil 3

4: T8B Ignition Coil 2 T8B Ignition Coil 2

5: T8A Ignition Coil 1 T8A Ignition Coil 1

6: Q6F Camshaft Position Actuator Solenoid Valve - Intake Q6F Camshaft Position Actuator Solenoid Valve - Intake (LUK/LHU)

7: Q6E Camshaft Position Actuator Solenoid Valve - Exhaust Q6E Camshaft Position Actuator Solenoid Valve - Exhaust (LUK/LHU)

8: Q29 Secondary Air Injection Solenoid Valve (NU6) Q29 Secondary Air Injection Solenoid Valve NU6

9: B52A Heated Oxygen Sensor 1 B52A Heated Oxygen Sensor 1 LUK/LHU/LAF/LDK/LTD

10: B52B Heated Oxygen Sensor 2 B52B Heated Oxygen Sensor 2 LUK/LHU/LAF/LDK

11: Q12 Evaporative Emission Purge Solenoid Valve Q12 Evaporative Emission Purge Solenoid Valve (LUK/LHU)

12: B34 Engine Coolant Temperature Sensor B34 Engine Coolant Temperature Sensor LAF/LUK

13: B23E Camshaft Position Sensor - Exhaust B23E Camshaft Position Sensor - Exhaust LUK/LHU

ENGINE COMPONENTS - FRONT (LAF 1 OF 2)

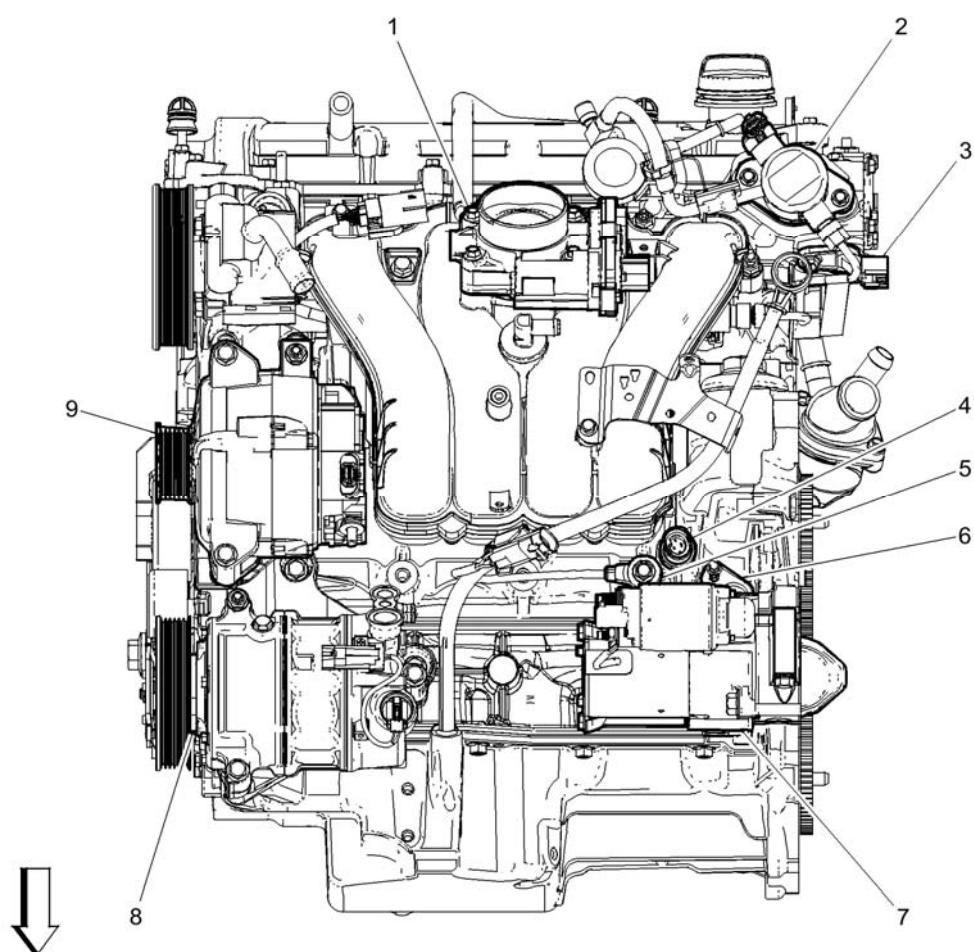


Fig. 6: Front Engine Components (LAF 1 of 2)

Courtesy of GENERAL MOTORS COMPANY

Items

1: Q38 Throttle Body Q38 Throttle Body (LAF/LDK)

2: G18 High Pressure Fuel Pump G18 High Pressure Fuel Pump

- 3: B23F Camshaft Position Sensor - Intake B23F Camshaft Position Sensor - Intake (LAF)
 4: B37 Engine Oil Pressure Switch B37 Engine Oil Pressure Switch LUK/LHU/LAF/LDK/LTD
 5: B68 Knock Sensor B68 Knock Sensor LUK/LAF/LTD
 6: B26 Crankshaft Position Sensor B26 Crankshaft Position Sensor LAF/LUK
 7: M64 Starter Motor M64 Starter Motor X1 M64 Starter Motor X1 M64 Starter Motor X2
(Generator Harness) (LAF) M64 Starter Motor X2 (Positive Battery Cable) (LAF)
 8: Q2 A/C Compressor Clutch Q2 A/C Compressor Clutch (LTD/LAF)
 9: G13 Generator G13 Generator X2

ENGINE COMPONENTS - FRONT (LAF 2 OF 2)

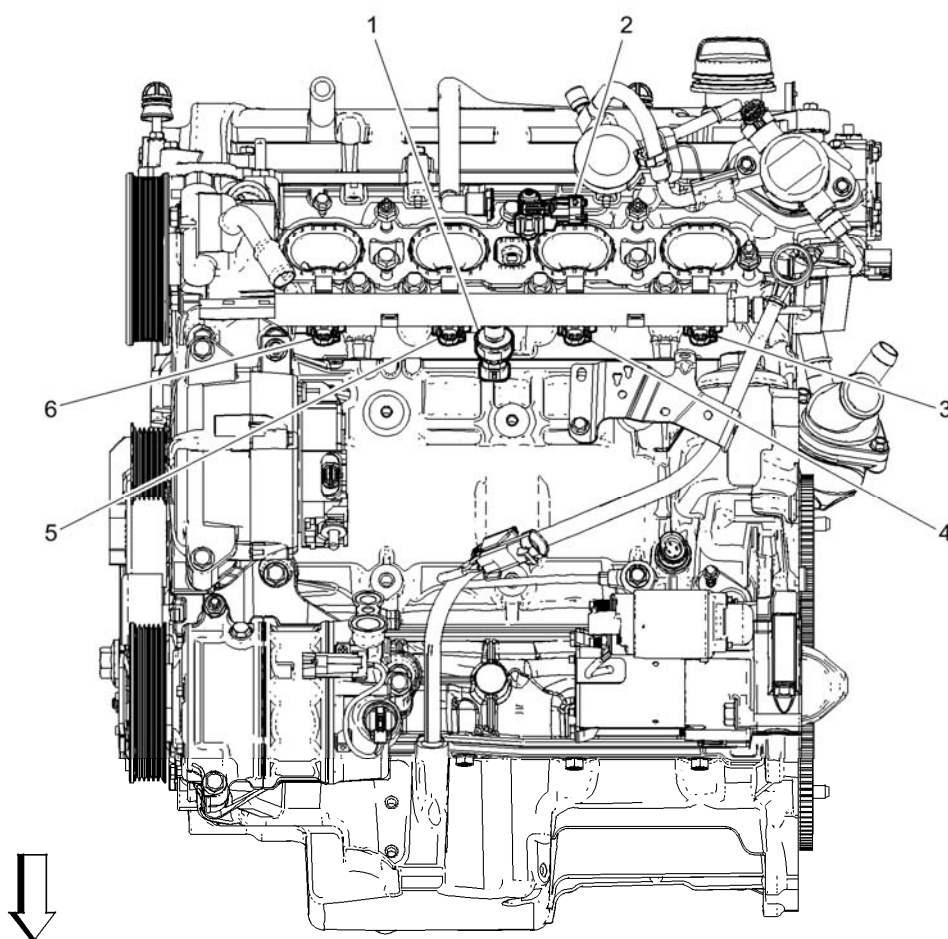


Fig. 7: Front Engine Components (LAF 2 of 2)
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1: B47B Fuel Rail Pressure Sensor
 2: B74 Manifold Absolute Pressure Sensor

3: Q17D Fuel Injector 4 **Q17D Fuel Injector 4 (LUK/LAF)**

4: Q17C Fuel Injector 3 **Q17C Fuel Injector 3 (LUK/LAF)**

5: Q17B Fuel Injector 2 **Q17B Fuel Injector 2 (LUK/LAF)**

6: Q17A Fuel Injector 1 **Q17A Fuel Injector 1 (LUK/LAF)**

ENGINE COMPONENTS - REAR (LAF)

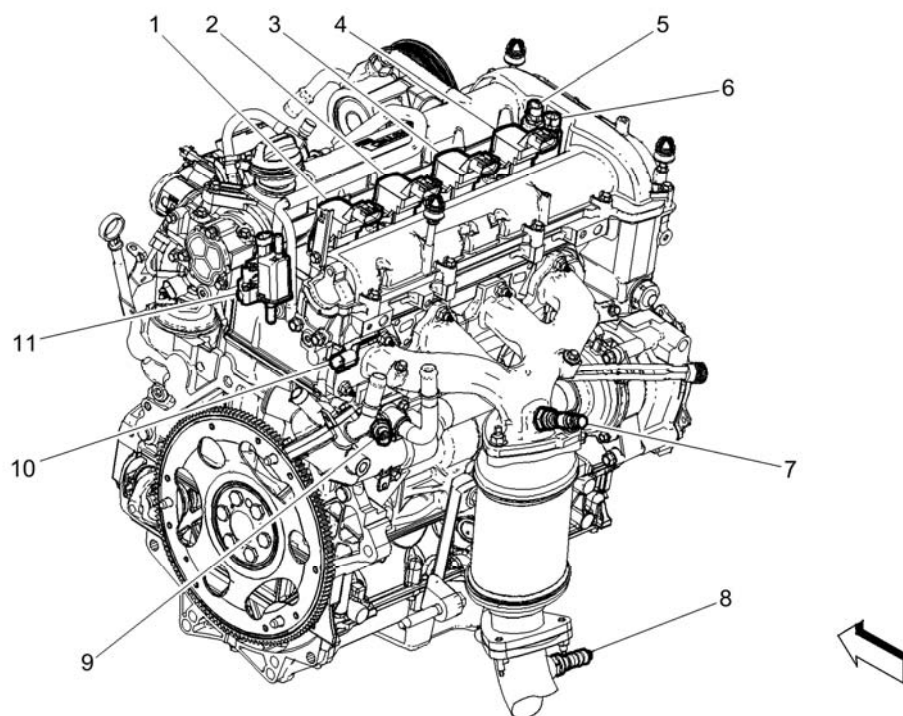


Fig. 8: Left Rear Engine Components (LEA)

Courtesy of GENERAL MOTORS COMPANY

Items

1: T8D Ignition Coil 4 **T8D Ignition Coil 4**

2: T8C Ignition Coil 3 **T8C Ignition Coil 3**

3: T8B Ignition Coil 2 **T8B Ignition Coil 2**

4: T8A Ignition Coil 1 **T8A Ignition Coil 1**

5: Q6F Camshaft Position Actuator Solenoid Valve - Intake **Q6F Camshaft Position Actuator Solenoid Valve - Intake (LAF)**

6: Q6E Camshaft Position Actuator Solenoid Valve - Exhaust **Q6E Camshaft Position Actuator Solenoid Valve - Exhaust (LAF)**

7: B52A Heated Oxygen Sensor 1 **B52A Heated Oxygen Sensor 1 LUK/LHU/LAF/LDK/LTD**

8: B52B Heated Oxygen Sensor 2 **B52B Heated Oxygen Sensor 2 LUK/LHU/LAF/LDK**

9: B34 Engine Coolant Temperature Sensor **B34 Engine Coolant Temperature Sensor LAF/LUK**

10: B23E Camshaft Position Sensor - Exhaust **B23E Camshaft Position Sensor - Exhaust LAF**

11: Q12 Evaporative Emission Purge Solenoid Valve **Q12 Evaporative Emission Purge Solenoid Valve (LAF/LDK/LTD)**

ENGINE COMPONENTS - FRONT (LDK)

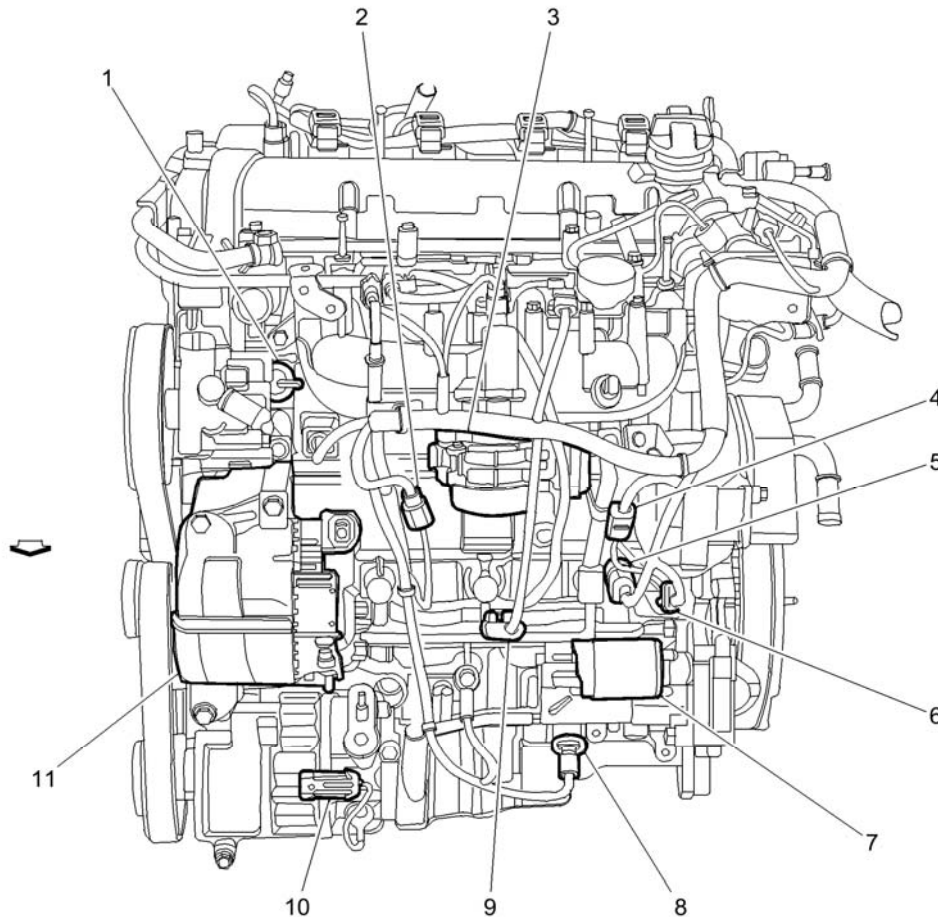


Fig. 9: Engine Components - Front (LDK)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: B47B Fuel Rail Pressure Sensor** **B47B Fuel Rail Pressure Sensor LHU/LDK**
- 2: B68A Knock Sensor 1 (LHU/ LDK)** **B68A Knock Sensor 1 LHU/LDK**
- 3: Q38 Throttle Body** **Q38 Throttle Body (LAF/LDK)**
- 4: B68B Knock Sensor 2 (LHU/ LDK)** **B68B Knock Sensor 2 LHU/LDK**
- 5: B37 Engine Oil Pressure Switch** **B37 Engine Oil Pressure Switch LUK/LHU/LAF/LDK/LTD**
- 6: B26 Crankshaft Position Sensor** **B26 Crankshaft Position Sensor (LDK)**
- 7: M64 Starter Motor** **M64 Starter Motor X1 M64 Starter Motor X1 M64 Starter Motor X2**
- 8: B35 Engine Oil Level Switch** **B35 Engine Oil Level Switch LHU/LDK**

9: B65 Intake Manifold Pressure and Air Temperature Sensor **B65 Intake Manifold Pressure and Air Temperature Sensor (LDK)**

10: Q2 A/C Compressor Clutch **Q2 A/C Compressor Clutch (LDK/LLU)**

11: G13 Generator **G13 Generator X1 LHU/LDK G13 Generator X2**

ENGINE COMPONENTS - TOP (LDK)

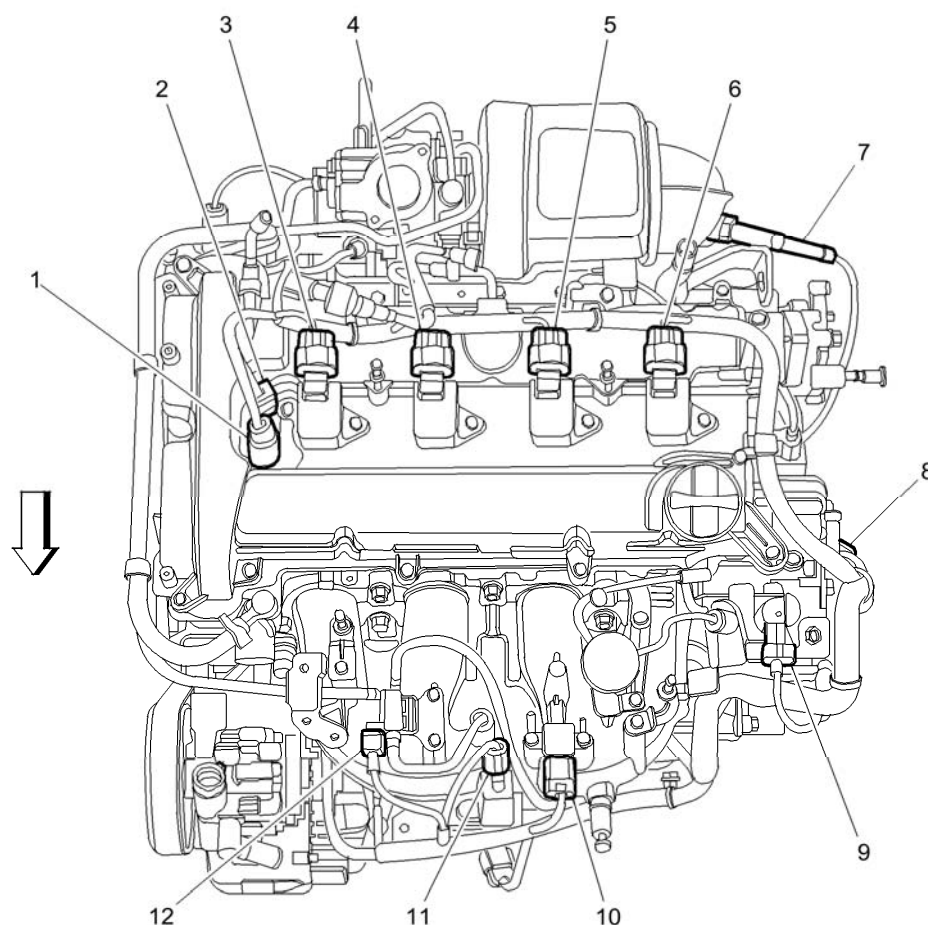


Fig. 10: Engine Components - Top (LDK)

Courtesy of GENERAL MOTORS COMPANY

Items

1: Q6F Camshaft Position Actuator Solenoid Valve - Intake **Q6F Camshaft Position Actuator Solenoid Valve - Intake (LDK) Q6F Camshaft Position Actuator Solenoid Valve - Intake (LDK/LTD)**

2: Q6E Camshaft Position Actuator Solenoid Valve - Exhaust **Q6E Camshaft Position Actuator Solenoid Valve - Exhaust (LDK)**

3: T8A Ignition Coil 1 **T8A Ignition Coil 1**

4: T8B Ignition Coil 2 **T8B Ignition Coil 2**

- 5: T8C Ignition Coil 3 **T8C Ignition Coil 3**
6: T8D Ignition Coil 4 **T8D Ignition Coil 4**
7: B47 Fuel Pressure Sensor **B47 Fuel Pressure Sensor**
8: B74 Manifold Absolute Pressure Sensor **B74 Manifold Absolute Pressure Sensor LHU/LDK**
9: Q12 Evaporative Emission Purge Solenoid Valve **Q12 Evaporative Emission Purge Solenoid Valve (LAF/LDK/LTD)**
10: Q40 Turbocharger Bypass Solenoid Valve (LHU/ LDK/ LLU)
11: B68B Knock Sensor 2 (LHU/ LDK) **B68B Knock Sensor 2 LHU/LDK**
12: B68A Knock Sensor 1 (LHU/ LDK) **B68A Knock Sensor 1 LHU/LDK**

ENGINE COMPONENTS - FRONT (LTD)

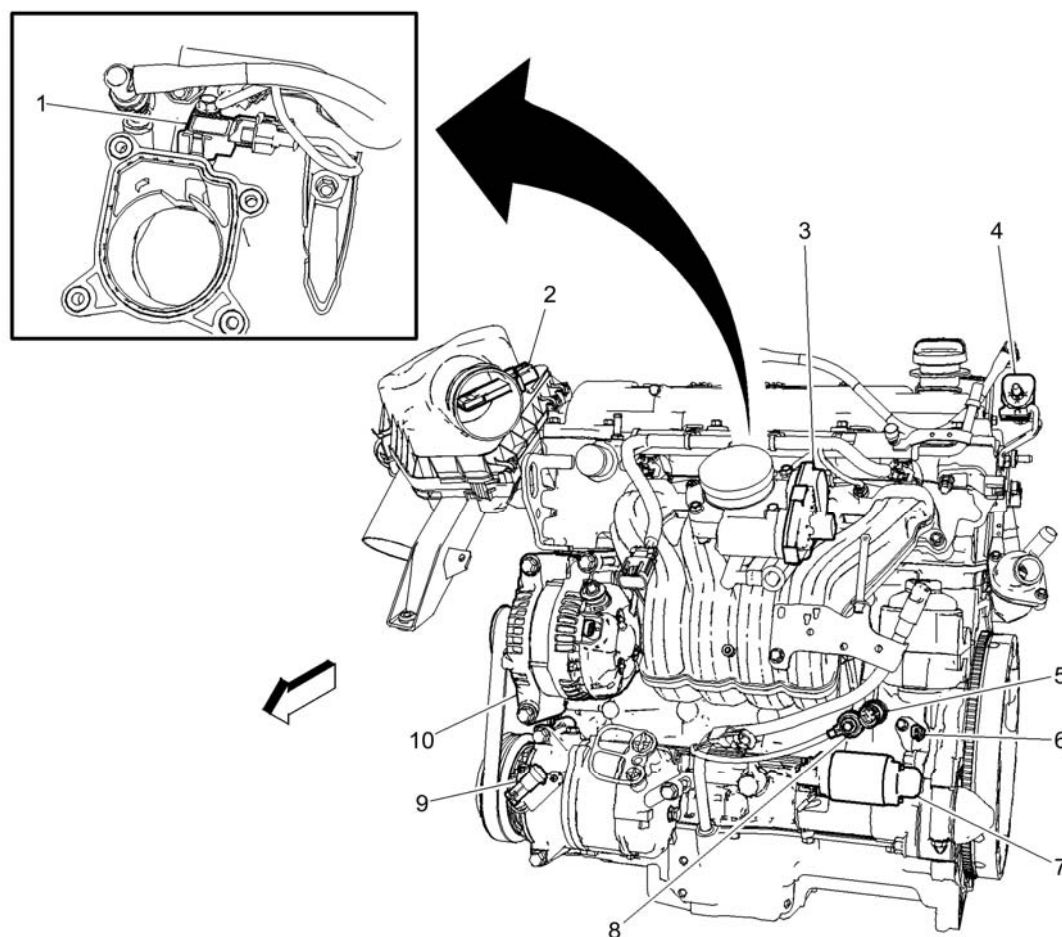


Fig. 11: Engine Components - Front (LTD)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: B74 Manifold Absolute Pressure Sensor **B74 Manifold Absolute Pressure Sensor LUK/LTD**

- 2:** B75B Mass Air Flow/Intake Air Temperature Sensor (LUK/ LTD/ LLU) **B75B Mass Air Flow/Intake Air Temperature Sensor LUK/LTD**
- 3:** Q38 Throttle Body **Q38 Throttle Body (LTD)**
- 4:** Q12 Evaporative Emission Purge Solenoid Valve **Q12 Evaporative Emission Purge Solenoid Valve (LAF/LDK/LTD)**
- 5:** B37 Engine Oil Pressure Switch **B37 Engine Oil Pressure Switch LUK/LHU/LAF/LDK/LTD**
- 6:** B26 Crankshaft Position Sensor **B26 Crankshaft Position Sensor (LTD)**
- 7:** M64 Starter Motor **M64 Starter Motor X1 M64 Starter Motor X1 M64 Starter Motor X2**
- 8:** B68A Knock Sensor 1
- 9:** Q2 A/C Compressor Clutch **Q2 A/C Compressor Clutch (LTD/LAF)**
- 10:** G13 Generator **G13 Generator X1 LTD G13 Generator X2**

ENGINE COMPONENTS - TOP (LTD)

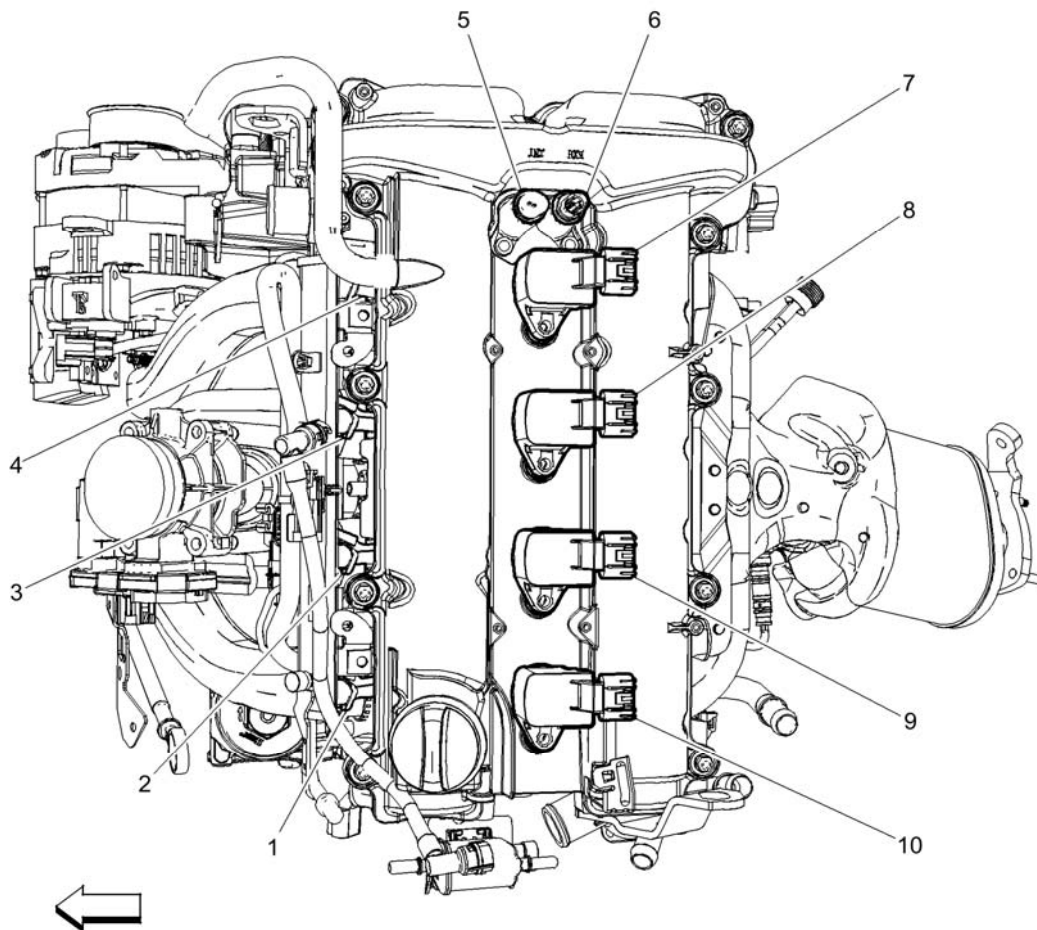


Fig. 12: Engine Components - Top (LTD)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: Q17D Fuel Injector 4 **Q17D Fuel Injector 4 (LTD)**
- 2: Q17C Fuel Injector 3 **Q17C Fuel Injector 3 (LTD)**
- 3: Q17B Fuel Injector 2 **Q17B Fuel Injector 2 (LTD)**
- 4: Q17A Fuel Injector 1 **Q17A Fuel Injector 1 (LTD)**
- 5: Q6F Camshaft Position Actuator Solenoid Valve - Intake **Q6F Camshaft Position Actuator Solenoid Valve - Intake (LDK/LTD)**
- 6: Q6E Camshaft Position Actuator Solenoid Valve - Exhaust **Q6E Camshaft Position Actuator Solenoid Valve - Exhaust (LTD)**
- 7: T8A Ignition Coil 1 **T8A Ignition Coil 1**
- 8: T8B Ignition Coil 2 **T8B Ignition Coil 2**
- 9: T8C Ignition Coil 3 **T8C Ignition Coil 3**
- 10: T8D Ignition Coil 4 **T8D Ignition Coil 4**

ENGINE COMPONENTS - REAR (LTD)

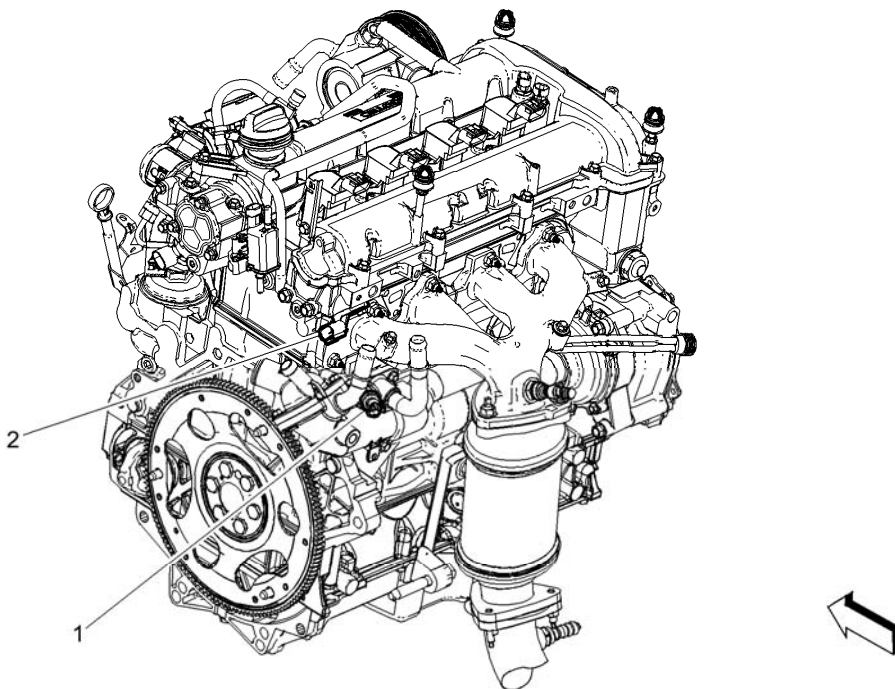


Fig. 13: Engine Components - Rear (LTD)

Courtesy of GENERAL MOTORS COMPANY

Items

- 1: B34 Engine Coolant Temperature Sensor **B34 Engine Coolant Temperature Sensor LTD**
- 2: B23E Camshaft Position Sensor - Exhaust **B23E Camshaft Position Sensor - Exhaust (LTD)**

ENGINE COMPONENTS - FRONT (LLU)

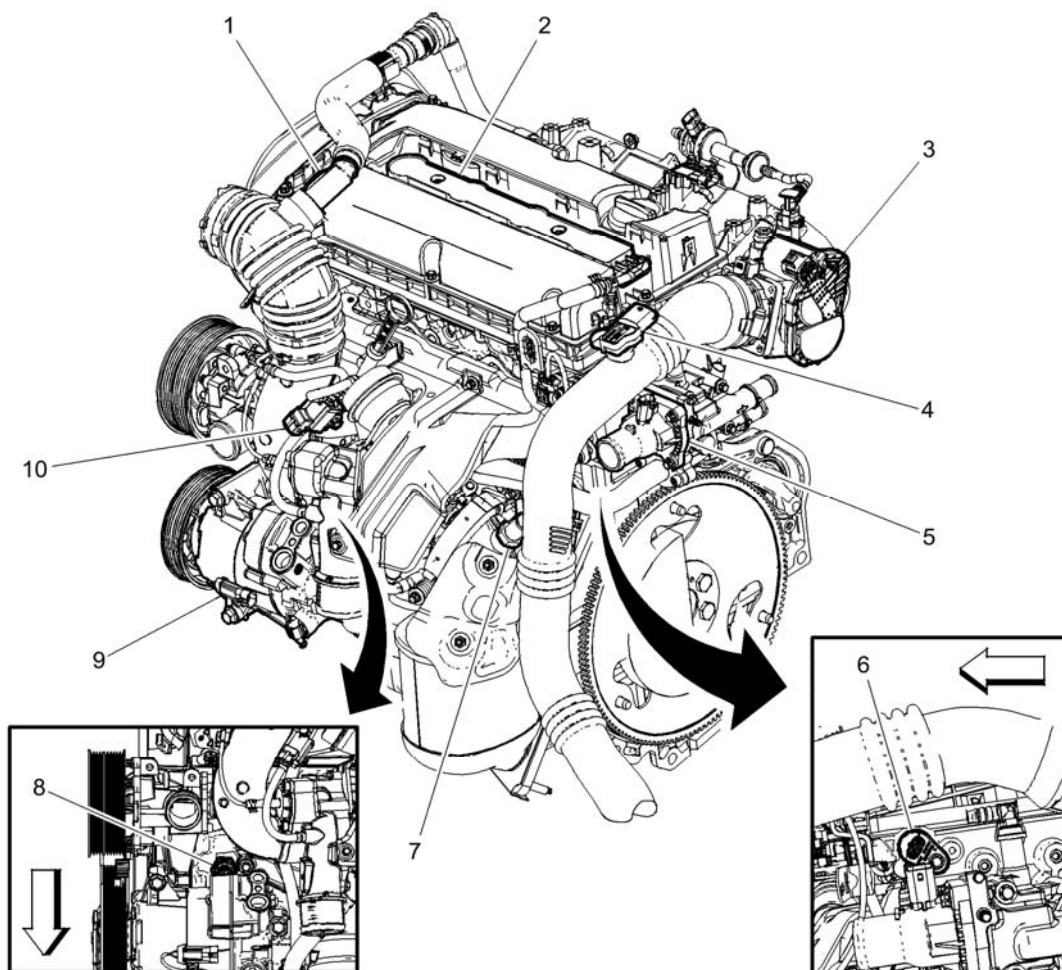


Fig. 14: Engine Components - Front (LLU)
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** E45 Positive Crankcase Ventilation Heater (LLU) **E45 Positive Crankcase Ventilation Heater LLU**
- 2:** K35 Ignition Coil Module (LLU) **K35 Ignition Control Module (LLU)**
- 3:** Q38 Throttle Body **Q38 Throttle Body (LLU)**
- 4:** B111B Turbocharger Boost/Intake Air Temperature Sensor
- 5:** E41 Engine Coolant Thermostat Heater (LLU)
- 6:** B23 Camshaft Position Sensor (LLU) **B23 Camshaft Position Sensor (LLU)**
- 7:** B52A Heated Oxygen Sensor 1 **B52A Heated Oxygen Sensor 1 (LLU)**
- 8:** B37 Engine Oil Pressure Switch **B37 Engine Oil Pressure Switch (LLU)**
- 9:** Q46 A/C Compressor Solenoid Valve
- 10:** Q42 Turbocharger Wastegate Solenoid Valve (LHU/ LDK/ LLU) **Q42 Turbocharger Wastegate Solenoid Valve (LLU)**

ENGINE COMPONENTS - REAR (LLU)

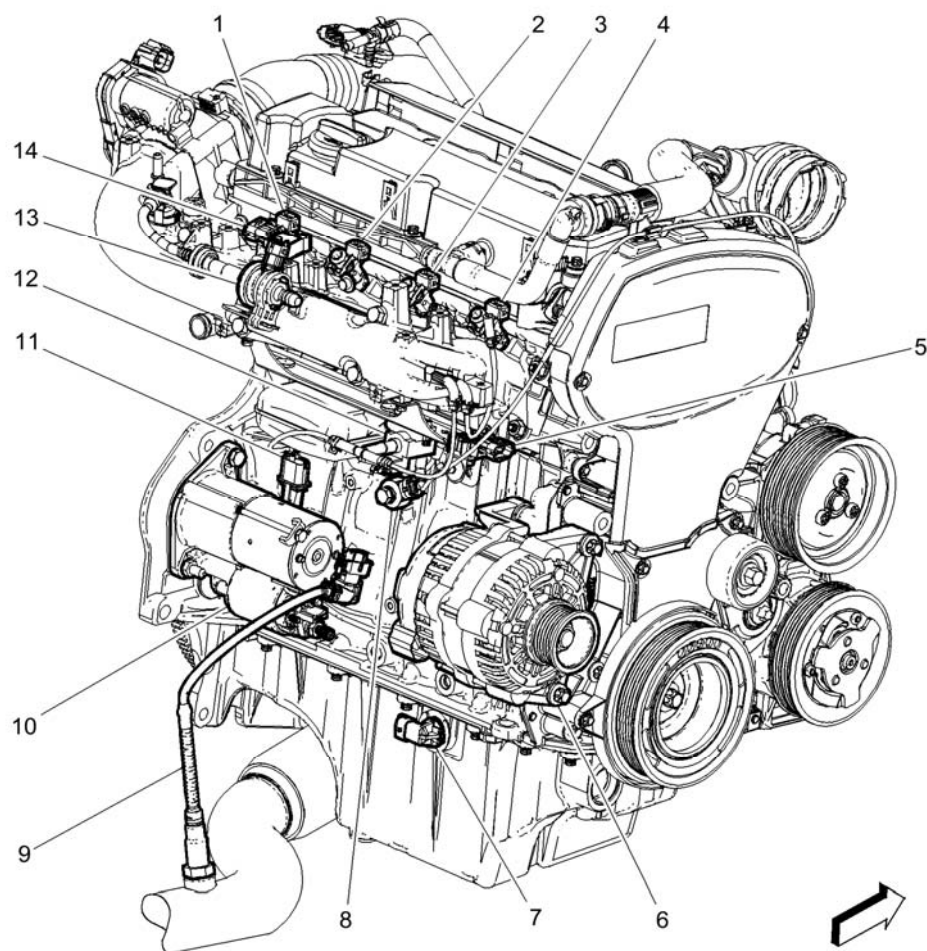


Fig. 15: Engine Components - Rear (LLU)
 Courtesy of GENERAL MOTORS COMPANY

Items
1: Q17D Fuel Injector 4 <u>Q17D Fuel Injector 4 (LLU)</u>
2: Q17C Fuel Injector 3 <u>Q17C Fuel Injector 3 (LLU)</u>
3: Q17B Fuel Injector 2 <u>Q17B Fuel Injector 2 (LLU)</u>
4: Q17A Fuel Injector 1 <u>Q17A Fuel Injector 1 (LLU)</u>
5: B17 Barometric Pressure Sensor <u>B17 Barometric Pressure Sensor (LDK)</u>
6: G13 Generator <u>G13 Generator X1 LLU</u>
7: B35 Engine Oil Level Switch <u>B35 Engine Oil Level Switch (LLU)</u>
8: B68 Knock Sensor <u>B68 Knock Sensor (LLU)</u>
9: B52B Heated Oxygen Sensor 2 <u>B52B Heated Oxygen Sensor 2 (LLU)</u>
10: M64 Starter Motor <u>M64 Starter Motor X1 (LLU)</u> <u>M64 Starter Motor X2</u>
11: B26 Crankshaft Position Sensor <u>B26 Crankshaft Position Sensor (LLU)</u>
12: Q40 Turbocharger Bypass Solenoid Valve (LHU/ LDK/ LLU) <u>Q40 Turbocharger Bypass Solenoid Valve (LLU)</u>

13: Q12 Evaporative Emission Purge Solenoid Valve **Q12 Evaporative Emission Purge Solenoid Valve (LLU)**

14: B74 Manifold Absolute Pressure Sensor

AUTOMATIC TRANSMISSION COMPONENTS (MH8)

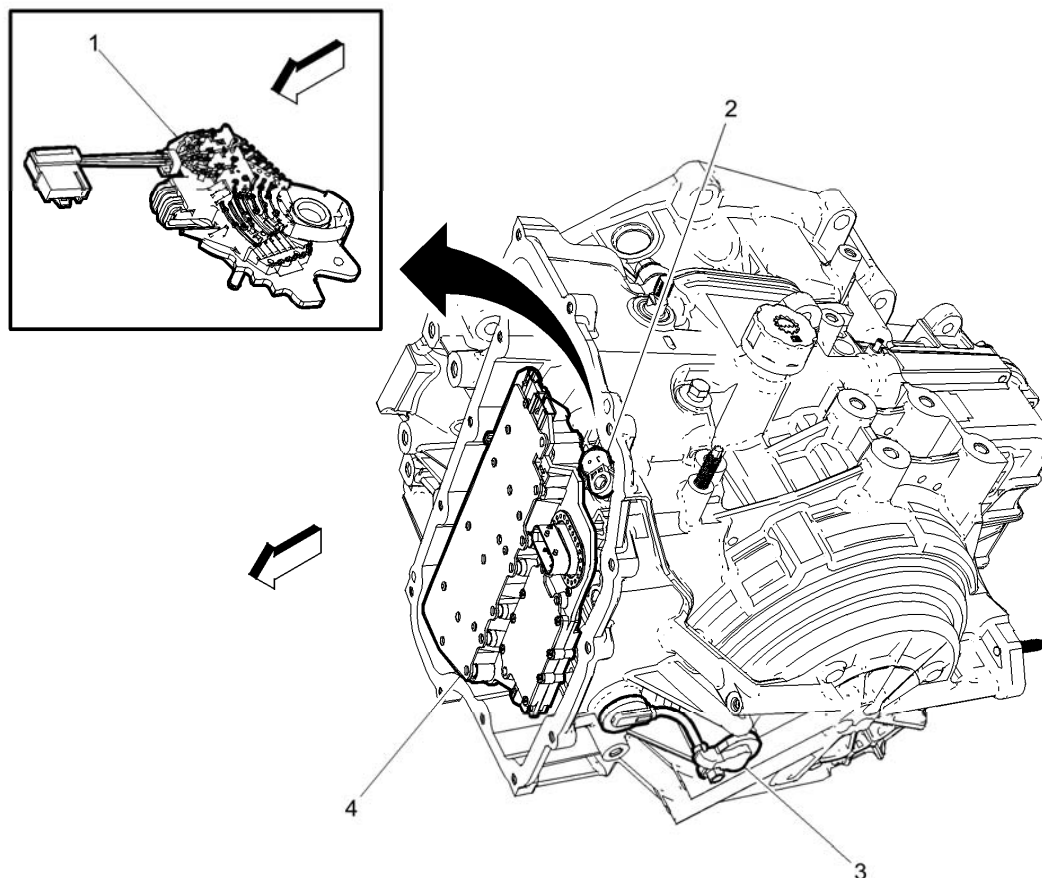


Fig. 16: Automatic Transmission Electronic Components (MH7, MH8 Or MH9)
Courtesy of GENERAL MOTORS COMPANY

Items

1: B15 Transmission Internal Mode Switch (MH8)

2: B14A Transmission Output Shaft Speed Sensor

3: B14C Transmission Input Shaft Speed Sensor

4: Q8 Control Solenoid Valve Assembly (MH8, MHH or MHK) Q8 Control Solenoid Valve Assembly X1 (MH8/MHH/MHK/except CZ2) Q8 Control Solenoid Valve Assembly X1 (MH8/MHK/CZ2) Q8 Control Solenoid Valve Assembly X2 (MH8, MHH or MHK) Q8 Control Solenoid Valve Assembly X2 (MH8/MHK/CZ2) Q8 Control Solenoid Valve Assembly X3 (MH8/MHH/MHK/except CZ2) Q8

Control Solenoid Valve Assembly X3 (MH8/MHK/CZ2) Q8 Control Solenoid Valve Assembly X4 (MH8/MHH/MHK/except CZ2) Q8 Control Solenoid Valve Assembly X4 (MH8/MHK/CZ2)

AUTOMATIC TRANSMISSION COMPONENTS (MDK)

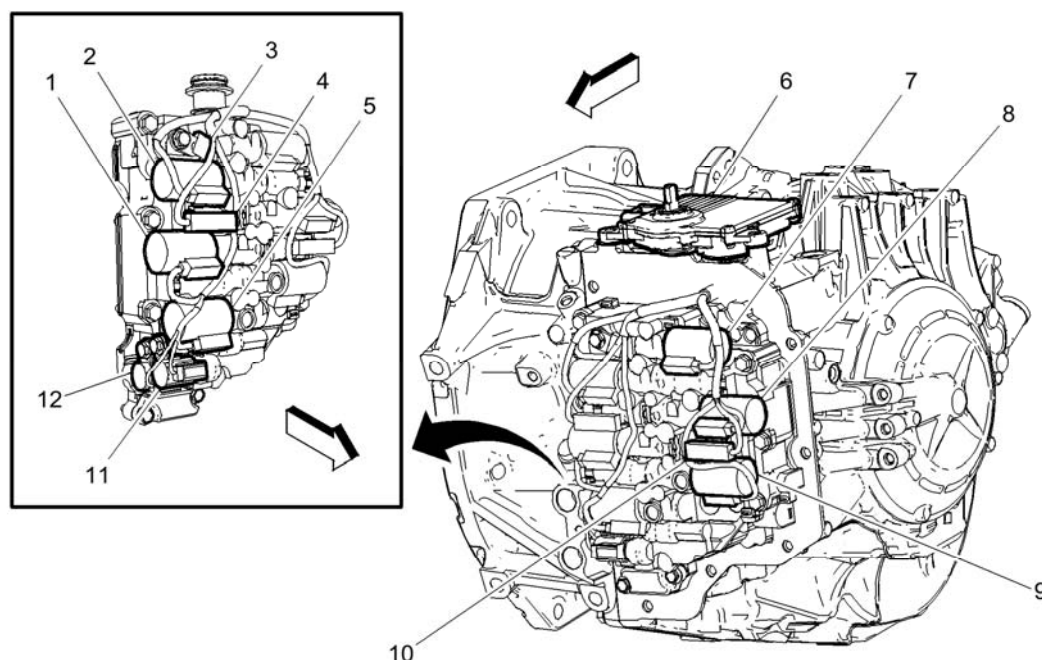


Fig. 17: Automatic Transmission Component Locations (MDK)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** Q27B Pressure Control Solenoid Valve 2
- 2:** Q27A Pressure Control Solenoid Valve 1
- 3:** B13 Transmission Fluid Temperature Sensor
- 4:** B14A Transmission Output Shaft Speed Sensor
- 5:** Q23 Line Pressure Control Solenoid Valve (MDK)
- 6:** Q8 Control Solenoid Valve Assembly (MH8, MHH or MHK) **Q8 Control Solenoid Valve Assembly X1 (MH8/MHH/MHK/except CZ2) Q8 Control Solenoid Valve Assembly X1 (MH8/MHK/CZ2) Q8 Control Solenoid Valve Assembly X2 (MH8, MHH or MHK) Q8 Control Solenoid Valve Assembly X2 (MH8/MHK/CZ2) Q8 Control Solenoid Valve Assembly X3 (MH8/MHH/MHK/except CZ2) Q8 Control Solenoid Valve Assembly X3 (MH8/MHK/CZ2) Q8 Control Solenoid Valve Assembly X4 (MH8/MHH/MHK/except CZ2) Q8 Control Solenoid Valve Assembly X4 (MH8/MHK/CZ2)**
- 7:** Q39A Torque Converter Clutch Pressure Control Solenoid Valve
- 8:** Q27C Pressure Control Solenoid Valve 3
- 9:** Q27D Pressure Control Solenoid Valve 4
- 10:** B14C Transmission Input Shaft Speed Sensor

- 11:** Q32B Shift Solenoid Valve 2
12: Q32A Shift Solenoid Valve 1

MANUAL TRANSMISSION COMPONENTS (MR6)

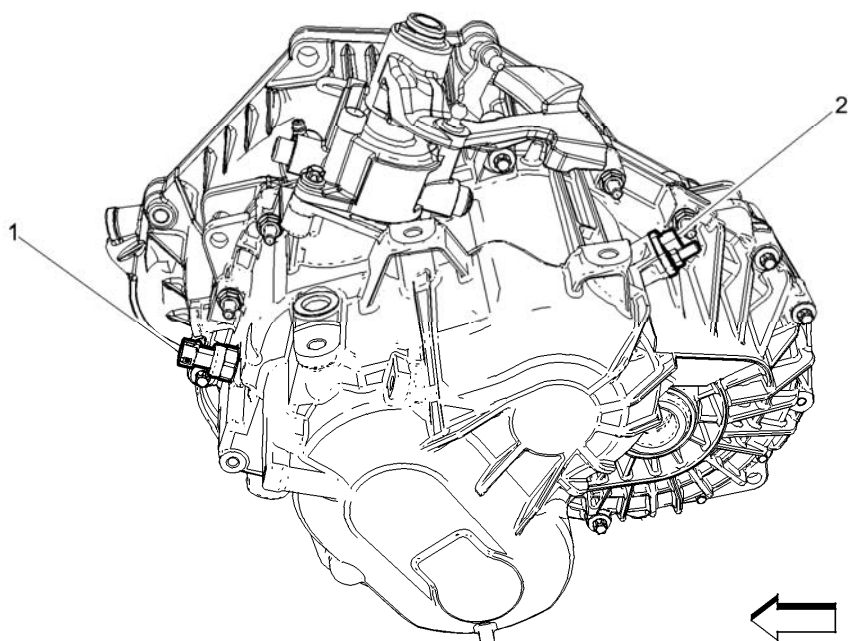


Fig. 18: Manual Transmission Component Locations (MR6)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** B16 Backup Lamp Switch (MR6) **B16 Backup Lamp Switch (MR6)**
2: B115 Vehicle Speed Sensor (MR6) **B115 Vehicle Speed Sensor (MR6)**

GENERAL INFORMATION

Programming and Setup

DIAGNOSTIC INFORMATION AND PROCEDURES

CONTROL MODULE REFERENCES

Reference Information

- Data Link References
- Diagnostic System Check - Vehicle
- Diagnostic Trouble Code (DTC) List - Vehicle
- Symptoms - Vehicle

Control Module References

Code	Control Module/Scan Tool Information	Schematic	Repair Instruction	Program and Set
A11	<u>Radio Scan Tool Information</u>	<u>Radio/Navigation System Schematics</u>	<u>Radio Replacement</u>	<u>Radio Program and Set</u>
A22	Radio Controls	<u>Radio/Navigation System Schematics</u>	-	<u>Radio Program and Set</u>
B218L/R	<u>Side Object Sensing Alert Module Scan Tool Information</u>	<u>Object Detection Schematics</u>	-	<u>Side Object Sensor Program and Set</u>
K9	<u>Body Control Module Scan Tool Information</u>	<u>Body Control System Schematics</u>	<u>Body Control Module Replacement (Left Hand Drive)</u>	<u>Body Control Module Program and Set</u>
K14	<u>Distance Sensing Cruise Control Module Scan Tool Information</u>	<u>Cruise Control Schematics</u>	<ul style="list-style-type: none"> • <u>Forward Range Radar Module Replacement</u> • <u>Forward Range Radar Module Alignment</u> • <u>Forward Range Radar Module Inspection</u> 	<u>Distance Sensing Cruise Control Program and Set</u> or <u>Distance Sensing Cruise Control Learn Procedure</u>
	<u>Battery Energy</u>			<u>Battery</u>

K16	<u>Control Module Scan Tool Information</u>	<u>Hybrid/EV Energy Storage Schematics</u>	<u>Battery Energy Control Module Replacement</u>	<u>Control Module Programming and Set</u>
K17	<u>Electronic Brake Control Module Scan Tool Information</u>	<u>Antilock Brake System Schematics</u>	<u>Electronic Brake Control Module Replacement</u> or <u>Electronic Brake and Traction Control Module with Brake Pressure Modulator Valve Replacement</u>	<u>Electronic Brake Control Module Programming and Set</u>
K19	<u>Electronic Suspension Control Module Scan Tool Information</u>	<u>Electronic Suspension Control Schematics</u>	<u>Electronic Suspension Control Module Replacement</u>	<u>Electronic Suspension Control Module Programming and Set</u>
K20	<u>K20 Engine Control Module: Scan Tool Information</u>	<ul style="list-style-type: none"> • <u>Engine Controls Schematics</u> - 2.0L (LTG) engine • <u>Engine Controls Schematics</u> - 2.2L engine 	<ul style="list-style-type: none"> • <u>Engine Control Module Replacement</u> - 2.0L (LTG) engine • <u>Engine Control Module Replacement</u> - 2.2L engine 	<u>K20 Engine Control Module Programming and Set</u>
K29	<u>Driver Seat and Passenger Seat Heater Control Module Scan Tool Information</u>	<u>Heated/Cooled Seat Schematics</u>	<u>Front Seat Heater Control Module Replacement (Base)</u>	<u>Heated/Cooled Seat Control Module Programming and Set</u>
K33	<u>Heating, Ventilation and Air Conditioning Control Module Scan Tool Information</u>	<u>HVAC Schematics</u>	<u>Heater and Air Conditioning Remote Control Replacement</u>	<u>HVAC Control Module Programming and Set</u>
K36	<u>Inflatable Restraint Sensing and Diagnostic Module Scan Tool Information</u>	<u>SIR Schematics</u>	<u>Inflatable Restraint Control Module Replacement</u>	<u>Inflatable Restraint Sensing and Diagnostic Module Programming and Set</u>
K38	<u>Chassis Control Module Scan Tool Information</u>	<ul style="list-style-type: none"> • <u>Engine Controls Schematics</u> - 2.0L (LTG) engine • <u>Engine Controls Schematics</u> - 2.2L engine 	<ul style="list-style-type: none"> • <u>Fuel Pump Flow Control Module Replacement</u> - 2.0L (LTG) engine • <u>Fuel Pump Flow Control Module Replacement</u> - 2.2L engine 	<u>Chassis Control Module Programming and Set</u>
	<u>Seat Memory</u>	<u>Driver Seat Schematics</u>		<u>Seat Memory Programming and Set</u>

K40	<u>Control Module Scan Tool Information</u>	or <u>Passenger Seat Schematics</u>	-	<u>Control Module Scan Tool Information</u> <u>Program and Set</u>
K41	<u>Front and Rear Parking Assist Control Module Scan Tool Information</u>	<u>Object Detection Schematics</u>	<u>Rear Object Alarm Control Module Replacement</u>	<u>Front and Rear Parking Assist Control Module Scan Tool Information</u> <u>Program and Set</u>
K43	Power Steering Control Module Scan Tool Information (Electronic Power Steering)	<u>Power Steering Schematics</u>	<u>Power Steering Assist Motor Replacement (NJ1) , Power Steering Assist Motor Replacement (NJ2)</u>	<u>Power Steering Control Module Scan Tool Information</u> <u>Program and Set</u>
K43	<u>Power Steering Control Module Scan Tool Information</u> (Variable Effort Steering)	<u>Power Steering Schematics</u>	-	<u>Power Steering Control Module Scan Tool Information</u> <u>Program and Set</u>
K47	<u>Rear Differential Clutch Control Module Scan Tool Information</u>	<u>Rear Axle Schematics</u>	<u>Rear Differential Clutch Control Module Replacement</u>	<u>Rear Differential Clutch Control Module Scan Tool Information</u> <u>Program and Set</u>
K59/K107A	Generator Control Module <ul style="list-style-type: none"> • <u>Hybrid Powertrain Control Module Scan Tool Information</u> • <u>Drive Motor Control Module Scan Tool Information</u> 	<u>Hybrid/EV Controls Schematics</u>	<u>Generator Control Module Replacement</u>	<u>Generator Control Module Scan Tool Information</u> <u>Program and Set</u>
	Control Solenoid Valve and Transmission Control Module Assembly	<ul style="list-style-type: none"> • <u>Automatic Transmission</u> 	<ul style="list-style-type: none"> • <u>Control Solenoid Valve and Transmission Control Module Assembly</u> 	<u>Control Solenoid Valve and Transmission Control Module Assembly</u> <u>Program and Set</u>

K71	<u>Transmission Control Module Scan Tool Information (6T70) , Transmission Control Module Scan Tool Information (6T40)</u>	<u>Controls Schematics - 6T30/6T40/6T41/6T45/6T50 transmission</u> <ul style="list-style-type: none"> • <u>Automatic Transmission Controls Schematics - 6T70/6T75/6T80 transmission</u> 	<u>Replacement - 6T30/6T40/6T41/6T45/6T50 transmission</u> <ul style="list-style-type: none"> • <u>Control Solenoid Valve and Transmission Control Module Assembly Replacement - 6T70/6T75/6T80 transmission</u> 	<u>Program and Set (6T70), Solenoid and Transmission Control Module Assembly Program and Set (6T40)</u>
K73	<u>Communication Interface Module Scan Tool Information</u>	<u>OnStar/Telematics Schematics</u>	<u>Communication Interface Module Replacement</u>	<u>Communication Interface Module Program and Set</u>
K77	Remote Control Door Lock Receiver	<u>Remote Function Schematics</u>	<u>Remote Control Door Lock Receiver Replacement</u>	<u>Remote Control Door Lock Receiver Program and Set</u>
K83	<u>Electronic Parking Brake Control Module Scan Tool Information</u>	<u>Park Brake System Schematics</u>	<u>Electronic Parking Brake Control Module Replacement</u>	<u>Electronic Parking Brake Control Module Program and Set</u>
K84	-	<u>Remote Function Schematics</u>	<u>Keyless Entry Control Module Replacement</u>	<u>Keyless Entry Control Module Program and Set</u>
K85	<u>Inflatable Restraint Passenger Presence System Scan Tool Information</u>	<u>SIR Schematics</u>	<u>Airbag Front Passenger Presence Sensor Replacement</u>	<u>Passenger Presence System Program and Set</u>
K89	Immobilizer Control Module	<u>Immobilizer Schematics</u>	<u>Theft Deterrent Module Replacement (Without BTM) , Theft Deterrent Module Replacement (With BTM)</u>	<u>Immobilizer Control Module Program and Set</u>
K109	<u>Front View Camera Module Scan Tool Information</u>	<u>Object Detection Schematics</u>	<u>Front View Camera Replacement</u>	<u>Front View Camera Module Program and Set</u>
	Fuel Pump Driver Control Module		-	This de

K111	(Refer to ECM for scan tool information)	-	(AKA Fuel Pump Driver Control Module)	not require programming and setup
M69	Sunroof Motor	<u>Sunroof Schematics</u>	<u>Sunroof Window Motor Replacement</u>	<u>Sunroof Control Programming and Setup</u>
P16	<u>Instrument Cluster Scan Tool Information</u>	<u>Instrument Cluster Schematics</u>	<u>Instrument Cluster Replacement</u>	<u>Instrument Cluster Control Programming and Setup</u>
S25	Garage Door Opener	<u>Remote Function Schematics</u>	<u>Garage Door Opener Transmitter Replacement</u>	<u>Garage Door Opener Control Programming and Setup</u>
T1	Accessory AC and DC Power Control Module	<u>Cigar Lighter/Power Outlet Schematics</u>	<u>Accessory AC and DC Power Control Module Replacement</u>	-
T3	Audio Amplifier	<u>Radio/Navigation System Schematics</u>	<u>Radio Speaker Amplifier Replacement</u>	<u>Audio Amplifier Control Programming and Setup</u>

REPAIR INSTRUCTIONS

AUDIO AMPLIFIER PROGRAMMING AND SETUP

NOTE:

- DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.

- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install the **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select T3 Audio Amplifier - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

BATTERY ENERGY CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.

- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Diagnostic Aids

Replace and Program ECU or Reprogram ECU

To program a replacement or an existing ECU, perform the following procedure:

1. Install the **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Battery Energy Control Module - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. **DO NOT** turn the ignition OFF. Ensure that all ECU, DLC and programming tool connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the ECU.
3. If the ECU can still not be programmed, turn the ignition OFF for at least one minute.
4. Turn the ignition ON and attempt to reprogram the ECU. The ECU should program.
 - If the ECU still cannot be programmed, replace the ECU.

BODY CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT** program a control module unless directed to by a service

procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.

- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Reference Information

Special Tools

- **EL-49642** SPS Programming Support Tool
- **EL-46079** Tire Pressure Monitor Diagnostic Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module

To program a replacement K9 Body Control Module (BCM), perform the following procedure:

1. Install **EL-49642** SPS programming support tool.

NOTE: Make sure the vehicle ignition switch state is in appropriate position for the following step.

- For Key Ignition System, begin with the ignition in the RUN position.
- For Push Button Start System, begin with the vehicle in vehicle OFF power mode. The Service Programming System will power mode the vehicle.

2. Access the Service Programming System (SPS) and follow the on-screen instructions.

3. On the SPS Supported Controllers screen, select K9 Body Control Module - Programming and follow the on-screen instructions.
4. Perform the following for the appropriate ignition type prior to proceeding with the next step:
 - Key Ignition System: Key in the ignition and any additional keys must be away from the vehicle at least 3 m.
 - Push Button Start System: Keyless entry transmitter must be in the programming pocket. Refer to the owner manual for the exact pocket location. All additional transmitters must be away from the vehicle at least 3 m.

NOTE: **The following programming step may take between 10-12 min and progress will appear to have stopped during this process. This is a normal security timer response and a restart should not be performed. If the DTC B389A set immediately after programming a replacement BCM, the Immobilizer Learn procedure was not properly completed. The Immobilizer Learn procedure needs to be performed again.**

5. On the SPS Supported Controllers screen, select IMMO Immobilizer Learn - Setup. On the next screen, select Body Control Module IMMO Learn with Existing Transponder or Remote Key and follow the on-screen instructions. When Immobilizer Learn is complete, press the Unlock button on the keyless entry transmitter to allow the keyless entry transmitter to exit the Immobilizer Learn mode.

NOTE: **When performing the Tire Pressure Monitor Sensor Learn during BCM setup, the EL-46079 tire pressure monitor diagnostic tool must be used to activate each tire pressure sensor for vehicles with UJM.**

- **For Key Ignition System, begin with the ignition in the RUN position.**
- **For Push Button Start System, begin with the vehicle in vehicle ON power mode.**

6. On the SPS Supported Controllers screen, select K9 Body Control Module - Setup (or K9 Body Control Module - Configuration & Setup) and follow the on-screen instructions.
7. Check the driver information center display for additional messages regarding further calibration instructions. If there are no additional driver information center instructions present, programming is complete.
8. At the end of programming, choose the "Clear DTCs" function on the SPS screen.
9. If ABS, Traction Control and/or Stabilitrak indicators are ON and DTC C0161 is set in the K17 Electronic Brake Control Module after performing BCM programming and setup, do the following:
 1. Disconnect the scan tool from the X84 Data Link Connector.
 2. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from the vehicle. It may take up to 2 min to power down.
 3. Ignition ON, verify DTC C0161 is in history. If not, repeat the above step to make sure the vehicle is in sleep mode.
 4. Use the scan tool to clear the DTCs.

Reprogram Control Module

To program an existing K9 Body Control Module, perform the following procedure:

1. Install **EL-49642** SPS programming support tool.

NOTE: **Make sure the vehicle ignition switch state is in appropriate position for the following step.**

- **For Key Ignition System, begin with the ignition in the RUN position.**
- **For Push Button Start System, begin with the vehicle in vehicle ON power mode.**

2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select K9 Body Control Module - Programming and follow the on-screen instructions.

NOTE: **When performing the Tire Pressure Monitor Sensor Learn during BCM setup, the EL-46079 tire pressure monitor diagnostic tool must be used to activate each tire pressure sensor for vehicles with UJM.**

4. On the SPS Supported Controllers screen, select K9 Body Control Module - Setup (or K9 Body Control Module - Configuration & Setup) and follow the on-screen instructions.
5. Check the driver information center display for additional messages regarding further calibration instructions. If there are no additional driver information center instructions present, programming is complete.
6. At the end of programming, choose the "Clear DTCs" function on the SPS screen.
7. If ABS, Traction Control and/or Stabilitrak indicators are ON and DTC C0161 is set in the K17 Electronic Brake Control Module after performing BCM programming and setup, do the following:
 1. Disconnect the scan tool from the X84 Data Link Connector.
 2. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 m (9.8 ft) away from the vehicle. It may take up to 2 min to power down.
 3. Ignition ON, verify DTC C0161 is in history. If not, repeat the above step to make sure the vehicle is in sleep mode.
 4. Use the scan tool to clear the DTCs.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**

1. Ignition OFF for one minute, ignition ON.
2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Control Module replacement, programming and setup

CHASSIS CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select K38 Chassis Control Module - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Control Module replacement, programming and setup

COMMUNICATION INTERFACE MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.

- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Diagnostic Aids

- It is critical to use the service replacement Communication Interface Module only in the vehicle for which it was ordered.
- Failure to perform the following procedures will result in a red LED, DTC(s) being set, and limited or incomplete OnStar® services.
- An OnStar® button press to the OnStar® call center is not required to complete the procedure.
- It may take up to 24 hours for OnStar® service to become fully activated after performing the procedures.
- Perform the following procedure only once. Repeat attempts of the procedure may result in a delay of the activation process.
- To fully activate an OnStar® module, both the setup and activation request procedures must be completed on all vehicles with and without an active OnStar® subscription to insure the unit has been setup properly for the vehicle it has been installed into and also to update the OnStar® with the correct unit information.
- To initialize the Turn-by-Turn feature, the vehicle must first be driven In open sky condition at speeds greater than 10 mph (16 kph) or more for a minimum of 5 miles (8 km) , and perform at least 2 left and 2 right 90 degree turns coming to complete stops prior to each turn.
- On vehicles up fitted with TTY capabilities, it is necessary to perform a power cycle of the OnStar® Interface Module (OTIM), and toggle the TTY mode after completing the Communication Interface Module installation and setup procedures.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS programming support tool .
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select ONSU Onstar® Module Setup and Service Activation and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
5. The default language for the new Communication Interface Module is English. To change to an alternate language, access the scan tool.
6. Inform the customer that it may take up to 24 hours for the OnStar® service to become fully activated.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY PROGRAMMING AND SETUP (6T70)

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required, install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**

- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module

To program a replacement transmission control module (TCM), perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Transmission Control Module - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
5. With a scan tool, perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .

Reprogram Control Module

To reprogram an existing TCM, perform the following procedure:

1. Access the Service Programming System (SPS) and follow the on-screen instructions.
2. On the SPS Supported Controllers screen, select Transmission Control Module - Programming and follow the on-screen instructions.
3. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
4. With a scan tool, perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.

- **If the control module cannot be reprogrammed**

1. Ignition OFF for one minute, ignition ON.
2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.

3. All OK.

- **If the control module can be reprogrammed**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for control module replacement, programming, and setup.

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY PROGRAMMING AND SETUP (6T40)

The following service procedures require either a programming or a setup event be performed for a complete repair. The transmission control module (TCM) is part of the control solenoid valve assembly, and is not serviced separately.

Transmission Control Module (TCM) Replacement

If the TCM is replaced, the following procedures must be performed:

1. TCM Reprogramming
2. The Transmission Adaptive Values Learn. Refer to **Transmission Adaptive Values Learn** .

TCM Reprogramming

NOTE:

- **Use a scan tool to view and record the Transmission Control Module - End Model Part Number in the original TCM prior to starting the TCM reprogramming procedure.**
- **In some cases, the TCM and ECM may have to be reprogrammed. When a selection for TCM Transmission Control Module - Programming is not available, select SEQ Programming Sequence ECM/TCM (Automatic Transmission Only).**

1. If the TCM needs to be reprogrammed. Refer to **Service Programming System (SPS)**.
2. Perform the Transmission Adaptive Values Learn. Refer to **Transmission Adaptive Values Learn** .

NOTE: **After programming, perform the following to avoid future misdiagnosis:**

1. Turn the ignition OFF for 30 seconds.
2. Turn the ignition ON with the engine OFF.
3. Use the scan tool in order to retrieve history DTCs from all modules.
4. Clear all history DTCs.

Setup for Component Replacement

The replacement of some components will require a setup procedure for complete repair.

If any of the following components are replaced, the **Transmission Adaptive Values Learn** procedure must be performed:

- Transmission replacement
- Any internal transmission repair
- Any speed sensor

Refer to **Transmission Adaptive Values Learn** .

DISTANCE SENSING CRUISE CONTROL MODULE PROGRAMMING AND SETUP

The following service procedures require either a programming or a setup event performed for a complete repair.

Distance Sensing Cruise Control Module Replacement

If the cruise control vehicle distance sensor module needs to be replaced, the following procedures must be performed:

1. Replace the K14 Distance Sensing Cruise Control Module. Refer to **Forward Range Radar Module Replacement**
2. Align the K14 Distance Sensing Cruise Control Module. Refer to **Forward Range Radar Module Alignment**
3. Connect a scan tool to the vehicle and access SPS. Refer to **Service Programming System (SPS)**.
4. Perform the SPS function Distance Sensing Cruise Control Module - Programming and follow the on-screen instructions.
5. Perform the SPS function Distance Sensing Cruise Control Module - Configuration and follow the on-screen instructions.
6. DTC C056E with failure type byte 4B will set as a result of the programming event.
7. Perform the Distance Sensing Cruise Control Module learn procedure. Refer to **Distance Sensing Cruise Control Module Learn Procedure**
8. Clear DTCs after completing the programming procedure.

Cruise Control Vehicle Distance Sensor Module Reprogramming

Do not reprogram the cruise control vehicle distance sensor module, unless directed by a service procedure, or a service bulletin.

1. Connect a scan tool to the vehicle and access SPS. Refer to **Service Programming System (SPS)**.
2. Perform the SPS function Distance Sensing Cruise Control Module - Programming and follow the on-screen instructions.
3. Perform the SPS function Distance Sensing Cruise Control Module - Configuration and follow the on-screen instructions.
4. DTC C056E with failure type byte 4B will set as a result of the programming event.
5. Perform the Distance Sensing Cruise Control Module learn procedure. Refer to **Distance Sensing Cruise Control Module Learn Procedure**
6. Clear DTCs after completing the programming procedure.

Setup for Bracket Replacement

1. Align the K14 Distance Sensing Cruise Control Module. Refer to **Forward Range Radar Module Alignment**.
2. Perform the Distance Sensing Cruise Control Module learn procedure. Refer to **Distance Sensing Cruise Control Module Learn Procedure**.

ELECTRONIC BRAKE CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Access the Service Programming System (SPS) and follow the on-screen instructions.
2. On the SPS Supported Controllers screen, select K17 Electronic Brake Control Module - Programming and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select K17 Electronic Brake Control Module - Setup and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select K17 Electronic Brake Control Module - Configuration and follow the on-screen instructions.
5. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
6. With a scan tool, perform the Brake Pressure Sensor Calibration. Refer to **Brake Pressure Modulator Valve Pressure Sensor Calibration** .
7. With a scan tool, perform the Steering Wheel Angle Sensor Learn. Refer to **Steering Angle Sensor Centering** .

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Control Module replacement, programming and setup

ELECTRONIC PARKING BRAKE CONTROL MODULE PROGRAMMING AND SETUP

If the electronic parking brake control module is replaced, the following procedures must be performed:

Refer to **Service Programming System (SPS)**.

Calibration with Scan Tool

NOTE: **Verify the rear brakes are clear of any obstacles before starting the calibration procedure. During the procedure the rear brakes will cycle several times, stay clear of all moving parts until the process is complete.**

Perform the Parking Brake Calibration procedure in Module Setup.

Calibration without Scan Tool

1. Ignition ON, apply and hold the brake pedal.
2. Push and hold the electric parking brake switch down for 5-6 seconds.
3. Release the electric parking brake switch.
4. Momentarily push the electric parking brake switch down.
5. Remove the EPB MODULE fuse and reinstall.
6. Apply the electric parking brake.
7. Release the electric parking brake.

ELECTRONIC SUSPENSION CONTROL MODULE PROGRAMMING AND SETUP

The suspension control module must be programmed with the proper calibration software. The module stores and utilizes this information however if it is not properly configured with the correct calibration software, the suspension control module will not control all of the vehicle features properly.

Ensure that the following conditions exist in order to prepare for suspension control module programming:

1. The battery is fully charged.
2. The MDI data link connectors are secure.
3. The scan tool is loaded with the most current software version.
4. All disconnected modules and devices are reconnected securely.
5. This entire procedure has been reviewed before proceeding.

Do not reprogram the suspension control module unless directed by a service procedure or a service bulletin.

Suspension Control Module Programming

To program and setup an existing or new replacement suspension control module, perform the following procedure:

1. With a scan tool, access the Service Programming System (SPS) and follow the on-screen instructions. Refer to **Service Programming System (SPS)**.
2. On the SPS Supported Controllers screen, select ESCM Electronic Suspension Control Module - Programming and follow the on-screen instructions.

If the suspension control module fails to accept the program, verify all scan tool and suspension control module connections are secure.

NOTE: After programming is completed, perform the following to avoid future misdiagnosis:

1. Turn the ignition OFF for 10 seconds.
2. Open and close the door.
3. Connect the scan tool to the data link connector.
4. Ignition ON, engine OFF.
5. With a scan tool, clear all DTCs from all modules.

K20 ENGINE CONTROL MODULE: PROGRAMMING AND SETUP

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.
- Note the engine oil life remaining percentage.

Replace and Program Control Module

To program a replacement K20 Engine Control Module (ECM), perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. Before removing the old control module, perform the SPS function Prepare Control Module for Removal, if available.

NOTE: **The Prepare Control Module for Removal function can only be performed when communication with the old control module is still possible.**

4. Replace the ECM.
5. Perform the SPS function K20 Engine Control Module - Programming and follow the on-screen instructions.
6. Clear the DTCs after completing the Programming procedure.
7. Perform the SPS function Immobilizer Learn and follow the on-screen instructions. Refer to **Immobilizer System Component Programming (with BTM)** , **Immobilizer System Component Programming (without BTM)** .
8. Perform the SPS function K20 Engine Control Module - Configuration & Setup and follow the on-screen instructions.
9. Clear DTCs after completing the Configuration & Setup procedure.

Reprogram Control Module

To reprogram an existing K20 Engine Control Module, perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. Clear DTCs after completing the Programming procedure.
4. Perform the SPS Function Immobilizer Learn and follow the on-screen instructions. Refer to **Immobilizer System Component Programming (with BTM)** , **Immobilizer System Component Programming (without BTM)** .
5. Perform the SPS function Engine Control Module - Configuration & Setup and follow the on-screen instructions, if available.
6. Clear DTCs after completing the Configuration & Setup procedure.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following:

1. Ignition ON. Ensure the control module, DLC, and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**

1. Ignition OFF for one minute, ignition ON.
2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the K20 Engine Control Module.
 - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for ECM replacement, programming and setup.

FRONT AND REAR PARKING ASSIST CONTROL MODULE PROGRAMMING AND SETUP

There is no setup procedure that needs to be performed for the Object Alarm Module on this vehicle.

FRONT VIEW CAMERA MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Replace and Program Control Module or Reprogram Control Module

Do not reprogram the frontview camera module, unless directed by a service procedure, or a service bulletin.

To program a replacement or an existing frontview camera module, perform the following procedure:

1. Access the Service Programming System (SPS) and follow the on-screen instructions.
2. On the SPS Supported Controllers screen, select frontview camera module - Programming and follow the on-screen instructions.
3. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
4. With a scan tool, perform the frontview camera module calibration. Refer to **Front View Camera Module Calibration**.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the frontview camera module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the frontview camera module can be reprogrammed.
 - **If the frontview camera module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the frontview camera module can be reprogrammed.
 - If the frontview camera module cannot be reprogrammed, replace the frontview camera module.
 - If the frontview camera module can be reprogrammed.
 3. All OK.
 - **If the frontview camera module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for frontview camera module replacement, programming and setup.

GARAGE DOOR OPENER PROGRAMMING AND SETUP

Replace and Program ECU or Reprogram ECU

This ECU does not require SPS programming but does require the following setup procedures after a new ECU is installed:

The customer must learn the device they wish to control. This must be done at the device (garage door opener, electric gate, etc.) and cannot be performed at a dealership. Refer to the vehicle owner's manual for programming instructions.

GENERATOR CONTROL MODULE PROGRAMMING AND SETUP

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to Special Tools.

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 SPS programming support tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Replace and Program ECU or Reprogram ECU

To program a replacement or an existing ECU, perform the following procedure:

1. Install the **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Generator Control Module - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. **DO NOT** turn the ignition OFF. Ensure that all ECU, DLC and programming tool connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the ECU.

3. If the ECU can still not be programmed, turn the ignition OFF for at least 1 minute.
4. Turn the ignition ON and attempt to reprogram the ECU. The ECU should program.
 - If the ECU still cannot be programmed, replace the ECU.

HEADLAMP CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Replace and Program Control Module or Reprogram Control Module

This control module does not require SPS programming but does require the following setup procedures after a new control module is installed:

To program a replacement or an existing control module, perform the following procedure:

1. Install a scan tool.
2. Clear all DTC's before proceeding.
3. Select Module Diagnostics.
4. Select Headlamp Control Module.
5. Select Configuration/Reset Functions.
6. Select Headlamp Leveling Sensor Learn and follow the on-screen instructions.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Control Module replacement, programming and setup

HEATED SEAT CONTROL MODULE PROGRAMMING AND SETUP

The seat heating control module must be programmed with the proper calibration software. The module stores and utilizes this information however if it is not properly configured with the correct calibration software, the seat heating control module will not control all of the vehicle features properly.

Ensure that the following conditions exist in order to prepare for seat heating control module programming:

1. The battery is fully charged.
2. The MDI data link connectors are secure.
3. The scan tool is loaded with the most current software version.
4. All disconnected modules and devices are reconnected securely.
5. This entire procedure has been reviewed before proceeding.

Do not reprogram the seat heating control module unless directed by a service procedure or a service bulletin.

Seat Heating Control Module Programming

To program and setup an existing or new replacement seat heating control module, perform the following procedure:

1. Access the Service Programming System (SPS) and follow the on-screen instructions. Refer to **Service Programming System (SPS)**.
2. On the SPS Supported Controllers screen, select HVSMF Front Seat Heating Control Module - Programming and follow the on-screen instructions.

If the HVSMF Front Seat Heating Control Module fails to accept the program, verify all scan tool and seat heating control module connections are secure.

NOTE: After programming is completed, perform the following to avoid future misdiagnosis:

1. Turn the ignition OFF for 10 seconds.
2. Open and close the door.
3. Connect the scan tool to the data link connector.
4. Ignition ON, engine OFF.
5. Clear all DTCs from all modules.

HUMAN MACHINE INTERFACE CONTROL MODULE PROGRAMMING AND SETUP

- NOTE:**
- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
 - Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
 - Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
 - Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
 - During the programming procedure, follow the SPS prompts for the correct ignition switch position.
 - Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Diagnostic Aids

- During programming you may be required to select multiple calibrations dependent upon vehicle equipment. Have the vehicle build/RPO information available during the following procedure to ensure the correct calibrations are selected.
- Dependant upon the current software level of the module, or the release of updates, USB programming may not be required when replacing/reprogramming the control module. If USB files for the application are not available via SPS, or have not been received from General Motors in another manner of

distribution, the USB update process will not need to be performed.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module

To program a replacement control module, perform the following procedure:

NOTE: **The vehicle must remain in PARK during the programming procedure.**

1. Install the **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select K74 Human Machine Interface Control Module - Programming and follow the on-screen instructions.

NOTE: **If using a pre-configured USB drive supplied by General Motors, proceed to step 8.**

4. Connect a USB drive to the computer.
5. Access the Service Programming System (SPS) and follow the on-screen instructions.
6. On the SPS Supported Controllers screen, select K74 Human Machine Interface Control Module - USB File Transfer.

NOTE: **All existing files on the USB drive will be erased when the new files are copied.**

7. Upon completion of the file transfer, remove the USB drive from the computer.
8. Ignition ON, infotainment system ON.
9. Connect the USB drive to the USB port in the vehicle.
10. The infotainment system will recognize that update files are available. Follow the infotainment display on-screen instructions and select Update when prompted. Programming will take several minutes.
11. Upon completion of programming, remove the USB drive. Follow the infotainment display on-screen instructions.
12. At the end of programming, choose the "Clear DTCs" function on the SPS screen.
13. Ignition OFF, Retained Accessory Power (RAP) OFF, remove the key fob from range of the vehicle, and let the vehicle sit for five minutes. Retest system operation to verify the repair.

Reprogram Control Module

To program an existing control module, perform the following procedure:

NOTE: **The vehicle must remain in PARK during the programming procedure.**

1. Install the **EL-49642** SPS Programming Support Tool.

NOTE: **If using a pre-configured USB drive supplied by General Motors, proceed to step 6.**

2. Connect a USB drive to the computer.
3. Access the Service Programming System (SPS) and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select K74 Human Machine Interface Control Module - USB File Transfer.

NOTE:

- **If there are no files available for USB transfer via SPS, proceed to step 10.**
- **All existing files on the USB drive will be erased when the new files are copied.**

5. Upon completion of the file transfer, remove the USB drive from the computer.
6. Ignition ON, infotainment system ON.
7. Connect the USB drive to the USB port in the vehicle.
8. The infotainment system will recognize that update files are available. Follow the infotainment display on-screen instructions and select Update when prompted. Programming will take several minutes.
9. Upon completion of programming, remove the USB drive. Follow the infotainment display on-screen instructions.
10. Access the Service Programming System (SPS) and follow the on-screen instructions.
11. On the SPS Supported Controllers screen, select K74 Human Machine Interface Control Module - Programming and follow the on-screen instructions.
12. At the end of programming, choose the "Clear DTCs" function on the SPS screen.
13. Ignition OFF, Retained Accessory Power (RAP) OFF, remove the key fob from range of the vehicle, and let the vehicle sit for five minutes. Retest system operation to verify the repair.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.

2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.

3. All OK.

- **If the control module can be reprogrammed**

3. All OK.

HVAC SYSTEM CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.

2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select HVAC Control Module - Programming and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select HVAC Control Module - Setup and follow the on-screen instructions.
5. On the SPS Supported Controllers screen, select HVAC Control Module - Configuration and follow the on-screen instructions.
6. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
7. With a scan tool, perform the Actuator Recalibration Function. Refer to **Actuator Recalibration** .

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Control Module replacement, programming and setup

IMMOBILIZER CONTROL MODULE PROGRAMMING AND SETUP

Replace and Program ECU or Reprogram ECU

This ECU does not require SPS programming or any setup procedures.

INFLATABLE RESTRAINT SENSING AND DIAGNOSTIC MODULE PROGRAMMING AND SETUP

The inflatable restraint sensing and diagnostic module (SDM) must be programmed with the proper calibration software. The module stores and utilizes this information however if it is not properly configured with the correct calibration software, the SDM will not control all of the vehicle features properly.

Ensure that the following conditions exist in order to prepare for SDM programming:

1. The battery is fully charged.
2. The MDI data link connectors are secure.
3. The scan tool is loaded with the most current software version.
4. All disconnected modules and devices are reconnected securely.
5. This entire procedure has been reviewed before proceeding.

Do not reprogram the SDM unless directed by a service procedure or a service bulletin.

NOTE:

- **The air bag indicator light may remain ON after the body control module (BCM), or SDM is replaced, and during the programming procedure for the BCM until after the procedure is completed. When installing a new SDM, there may be several DTCs set prior to programming. Once programmed, these DTCs should be in history and can be cleared.**
- **Failure to complete the following Setup procedure may cause DTC B1001 to be set in the SDM.**

The following service procedures require either a programming or a setup event performed for a complete repair:

Sensing and Diagnostic Module Replacement and/or Programming

If the inflatable restraint sensing and diagnostic module needs to be replaced and/or reprogrammed, the following procedures must be performed:

1. Access SPS. Refer to **Service Programming System (SPS)**.
2. Perform the SPS function Inflatable Restraint Sensing and Diagnostic Module Programming and follow the on-screen instructions.
3. Perform the SPS function Inflatable Restraint Sensing and Diagnostic Module Setup and follow the on-screen instructions.
4. Clear DTCs after completing the programming procedure.

If the control module fails to program, proceed as follows:

1. Ensure the DLC and Accessory Power Module connections are good.
2. Inspect the Techline equipment for the latest software version.
3. Attempt to program the SDM. If the SDM still cannot be programmed properly, replace the SDM.

INSTRUMENT CLUSTER PROGRAMMING AND SETUP

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to Special Tools.

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 SPS programming support tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Diagnostic Aids

The programming steps in the Service Programming System (SPS) screens may not be in functional order. Be sure to follow the programming steps in the order listed below.

Replace and Program ECU

To program a replacement or an existing ECU, perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.

NOTE: **The USB File Transfer procedure is performed after the new Instrument Cluster is installed in the vehicle.**

3. On the SPS Supported Controllers screen, select Instrument Cluster - USB File Transfer and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select Instrument Cluster - Programming and follow the on-screen instructions.
5. On the SPS Supported Controllers screen, select Instrument Cluster - Setup and Configuration and follow the on-screen instructions.

6. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Reprogram ECU

To program a replacement or an existing ECU, perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Instrument Cluster - USB File Transfer and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select Instrument Cluster - Programming and follow the on-screen instructions.
5. On the SPS Supported Controllers screen, select Instrument Cluster - Setup and Configuration and follow the on-screen instructions.
6. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. DO NOT turn the ignition OFF. Ensure that all ECU, DLC and programming tool connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the ECU.
3. If the ECU can still not be programmed, turn the ignition OFF for at least one minute.
4. Turn the ignition ON and attempt to reprogram the ECU. The ECU should program.
 - o If the ECU still cannot be programmed, replace the ECU.

KEYLESS ENTRY CONTROL MODULE PROGRAMMING AND SETUP

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install

the **EL-49642 SPS programming support tool** to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.

- Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.
- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Replace and Program ECU or Reprogram ECU

To program a replacement or an existing ECU, perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Keyless Entry Control Module - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. DO NOT turn the ignition OFF. Ensure that all ECU, DLC and programming tool connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the ECU.
3. If the ECU can still not be programmed, turn the ignition OFF for at least one minute.
4. Turn the ignition ON and attempt to reprogram the ECU. The ECU should program.
 - If the ECU still cannot be programmed, replace the ECU.

MEMORY SEAT CONTROL MODULE PROGRAMMING AND SETUP

The seat memory control module must be programmed with the proper calibration software. The module stores and utilizes this information however if it is not properly configured with the correct calibration software, the seat memory control module will not control all of the vehicle features properly.

Ensure that the following conditions exist in order to prepare for seat memory control module programming:

1. The battery is fully charged.
2. The MDI data link connectors are secure.
3. The scan tool is loaded with the most current software version.

4. All disconnected modules and devices are reconnected securely.
5. This entire procedure has been reviewed before proceeding.

Do not reprogram the seat memory control module unless directed by a service procedure or a service bulletin.

Seat Memory Control Module Programming

To program and setup an existing or new replacement seat memory control module, perform the following procedure:

1. With a scan tool, access the Service Programming System (SPS) and follow the on-screen instructions. Refer to **Service Programming System (SPS)**.
2. On the SPS Supported Controllers screen, select MSM Memory Seat Control Module - Programming and follow the on-screen instructions.

If the MSM Memory Seat Module fails to accept the program, verify all scan tool and seat memory control module connections are secure.

NOTE: After programming is completed, perform the following to avoid future misdiagnosis:

1. Turn the ignition OFF for 10 seconds.
2. Open and close the door.
3. Connect the scan tool to the data link connector.
4. Ignition ON, engine OFF.
5. With a scan tool, clear all DTC's from all modules.

MEDIA DISC PLAYER PROGRAMMING AND SETUP

- NOTE:**
- DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
 - Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
 - Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.
 - Turn OFF or disable systems that may put a load on the vehicles battery

such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.

- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Diagnostic Aids

- During programming you may be required to select multiple calibrations dependent upon vehicle equipment. Have the vehicle build/RPO information available during the following procedure to ensure the correct calibrations are selected.
- Dependant upon the current software level of the module, or the release of updates, USB programming may not be required when replacing/reprogramming the control module. If USB files for the application are not available via SPS, or have not been received from General Motors in another manner of distribution, the USB update process will not need to be performed.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

Without Rear Seat Video Entertainment System

This control module does not require SPS programming or any setup procedures.

With Rear Seat Video Entertainment System

1. Install the **EL-49642** SPS Programming Support Tool.
2. Connect a USB drive to the computer.
3. Access the Service Programming System (SPS) and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select Media Disc Player - USB File Transfer and follow the on-screen instructions.
5. Upon completion of the file transfer, remove the USB drive from the computer.
6. Ignition ON, infotainment system ON.
7. Connect the USB drive to the USB port in the vehicle.
8. The infotainment system will recognize that update files are available. Follow the infotainment display on-screen instructions and select Update when prompted. Programming will take several minutes.

9. Upon completion of programming, remove the USB drive. Follow the infotainment display on-screen instructions.
10. On the SPS Supported Controllers screen, select Media Disc Player - Programming and follow the on-screen instructions.
11. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

PASSENGER PRESENCE SYSTEM PROGRAMMING AND SETUP

When the passenger presence system is replaced or serviced, perform the rezeroing procedure for the passenger presence system. Refer to **Passenger Presence System Rezeroing** for the rezeroing procedure.

POWER STEERING CONTROL MODULE PROGRAMMING AND SETUP

The following service procedures require either a programming or a setup event performed for a complete repair.

The electronic power steering control module is part of the power steering assist motor assembly and is electronically paired with the steering gear's sensors.

- If the complete steering gear INCLUDING the assist motor assembly was replaced, or for reprogramming of an existing power steering system WITHOUT replacement, refer to the POWER STEERING CONTROL MODULE REPROGRAMMING instructions in this article.
- If ONLY the Power Steering Assist Motor assembly is replaced, follow the POWER STEERING CONTROL MODULE REPLACEMENT instructions.

Replace and Program Control Module

NOTE: During the procedures listed below, critical data is retrieved from vehicle

components and stored in the scan tool computer's hard drive. This data is needed during the programming and setup sequences.

Ensure the same scan tool is used and capable of reading, storing, and writing the vehicle's system data.

1. Access the Service Programming System (SPS) and follow the on-screen instructions.
2. On the SPS Supported Controllers screen, select Electronic Power Steering - Prepare Control Module for Removal and follow the on-screen instructions.
3. Replace the Power Steering Assist Motor containing the Power Steering Control Module. Refer to **Power Steering Assist Motor Replacement (NJ1)** , **Power Steering Assist Motor Replacement (NJ2)** .
4. With the Power Steering Assist Motor replaced and reconnected, on the SPS Supported Controllers screen, select Electronic Power Steering - Programming and follow the on-screen instructions.
5. On the SPS Supported Controllers screen, select Electronic Power Steering - Configuration and follow the on-screen instructions.
6. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
7. Ignition ON.
8. On the SPS Supported Controllers screen, select Electronic Power Steering - Setup and follow the on-screen instructions.
9. On the SPS Supported Controllers screen, select Electronic Power Steering - Endstop Learning procedure. Refer to **Power Steering Control Module Calibration (NJ1)**
10. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Power Steering Control Module Reprogramming

Do not program or reprogram the electronic power steering control module unless directed by a service procedure or a service bulletin.

NOTE: **This procedure applies to reprogramming of the existing steering gear or the initial programming if the complete steering gear assembly including the assist motor was replaced. If only the power steering control module is replaced, follow the Power Steering Control Module Replacement instructions above.**

1. Access the Service Programming System (SPS) and follow the on-screen instructions.
2. On the SPS Supported Controllers screen, select Electronic Power Steering - Programming and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Electronic Power Steering - Configuration and follow the on-screen instructions.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
5. Ignition ON.
6. On the SPS Supported Controllers screen, select Electronic Power Steering - Setup and follow the on-

screen instructions.

7. On the SPS Supported Controllers screen, select Electronic Power Steering - Endstop Learning procedure. Refer to **Power Steering Control Module Calibration (NJ1)**
8. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Steering Angle Sensor Centering and Software Endstop Learning

For the steering angle sensor centering and software endstop learning, refer to **Power Steering Control Module Calibration (NJ1)** .

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

RADIO CONTROL PROGRAMMING AND SETUP

NOTE:

- **DO NOT** program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.
- Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.
- Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. **DO NOT** connect a battery charger.
- Turn OFF or disable systems that may put a load on the vehicles battery

such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.

- During the programming procedure, follow the SPS prompts for the correct ignition switch position.
- Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace Control Module

The replacement control module is fully programmed by the supplier and does not require SPS programming or any setup procedures.

Reprogram Control Module

To reprogram an existing control module, perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select A22 Radio Controls - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 - 3. All OK.
 - **If the control module can be reprogrammed**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup

RADIO PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Diagnostic Aids

- During radio programming you may be required to select multiple calibrations dependant upon vehicle equipment. Have the vehicle build/RPO information available during the following procedure to ensure the correct calibrations are selected.
- The XM satellite radio (if equipped) is integrated into the radio. If XM was activated in the previous radio, the replacement radio will require no additional activation steps. Customer subscription information is transferred to the replacement radio when a replacement radio is ordered.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select A11 Radio - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
 - **If the control module cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the control module can be reprogrammed.
 - If the control module cannot be reprogrammed, replace the control module.
 - If the control module can be reprogrammed.
 3. All OK.
 - **If the control module can be reprogrammed**
3. All OK.

Valet Mode Reset

1. Verify no DTCs are set.
 - **If any DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If no DTCs are set**
2. Select the Radio control function Erase Valet Mode Code with the scan tool.
 3. Select Clear and confirm the selection to erase the code.

REAR DIFFERENTIAL CLUTCH CONTROL MODULE PROGRAMMING AND SETUP

The following service procedures require either a programming or a setup event performed for a complete repair.

Rear Drive Clutch Control Module Replacement

NOTE: **The transfer case solenoid valve and the rear drive clutch control module must always be replaced together due to calibration reasons.**

If the rear drive clutch control module needs to be replaced, the following procedures must be performed:

1. Connect a scan tool to the vehicle and access SPS. Refer to **Service Programming System (SPS)**.
2. Perform the SPS function Rear Differential Clutch Control Module - Programming and follow the on-screen instructions.
3. Perform the SPS function Rear Differential Clutch Control Module - Configuration & Setup and follow the on-screen instructions. On the screen Control Module - Configuration and Setup Function(s), select both ECU Configuration / Reconfiguration and ECU Setup.
4. Clear DTCs after completing the programming procedure.

Rear Drive Clutch Control Module Reprogramming

Do not reprogram the rear drive clutch control module unless directed by a service procedure or a service bulletin.

1. Connect a scan tool to the vehicle and access SPS. Refer to **Service Programming System (SPS)**.
2. Perform the SPS function Rear Differential Clutch Control Module - Programming and follow the on-screen instructions.
3. Clear DTCs after completing the programming procedure.

Component Replacement

The transfer case solenoid valve and the rear drive clutch control module must always be replaced together due to calibration reasons.

REMOTE CONTROL DOOR LOCK RECEIVER PROGRAMMING AND SETUP

Diagnostic Aids

The remote control door lock receiver only functions as an antenna, receiving the signals sent by the keyless entry transmitter and forwarding them to the body control module (BCM). The keyless entry software is contained wholly within the BCM.

Replace and Program ECU or Reprogram ECU

This ECU does not require SPS programming or any setup procedures.

SERVICE PROGRAMMING SYSTEM (SPS)

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

For step-by-step control module programming instructions, please refer to the techline information system (TIS) terminal.

Review the information below to ensure proper programming protocol.

NOTE:

- **DO NOT program a control module unless you are directed by a service procedure or you are directed by a General Motors service bulletin. Programming a control module at any other time will not permanently correct a customers concern.**
- **It is essential that the TIS terminal, MDI, and/or Scan Tool, is equipped with the latest software before performing service programming.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required, install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Some modules will require additional programming/setup events to be performed before or after programming.**
- **Some vehicles may require the use of a CANDi or MDI module for programming.**
- **Review the appropriate service information for these procedures.**
- **DTCs may set during programming. Clear DTCs after programming is complete.**
- **Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Ensure the following conditions are met before programming a control module:

- **Vehicle system voltage:**
 - There is not a charging system concern. All charging system concerns must be repaired before programming a control module.
 - Battery voltage is greater than 12 volts but less than 16 volts. The battery must be fully charged before programming the control module.
 - Turn OFF or disable any system that may put a load on the vehicles battery, such as the following components:
 - Interior lights
 - Exterior lights including daytime running lights (DRL)-Applying the parking brake, on most vehicles, disables the DRL system

- Heating, ventilation, and air conditioning (HVAC) systems
- Engine cooling fans
- Radio, etc.
- The ignition switch must be in the proper position. SPS prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure, unless instructed to do so.
- Make certain all tool connections are secure, including the following components and circuits:
 - Scan Tool
 - The RS-232 communication cable port
 - The connection at the data link connector (DLC)
 - The voltage supply circuits
 - MDI
 - The USB, Ethernet or Wireless communication port
 - The connection at the data link connector (DLC)
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or control module damage may occur.

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. DO NOT turn the ignition OFF. Ensure that all control module and DLC connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the control module.
3. If the control module can still not be programmed, turn the ignition OFF for at least one minute.
4. Turn the ignition ON and attempt to reprogram the control module. The control module should program.
 - If the control module still cannot be programmed, replace the control module.

After successfully programming the control module, ensure that all post programming procedures are performed; refer to **Control Module References** for the appropriate control module Programming and Setup document for any required procedures.

SIDE OBJECT SENSOR PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a side object sensor - left unless directed to by a service procedure or a service bulletin. If the side object sensor - left is not properly configured with the correct calibration software, the side object sensor - left will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or side object sensor - left damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When**

required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.

- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Diagnostic Aids

The B218R Side Object Sensor Module - Right is not programmable separately. This module is programmed by B218L Side Object Sensor Module - Left after it has been programmed. If a right side module is replaced, follow this procedure to update the module.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing B218L Side Object Sensor Module - Left, perform the following procedure:

1. Access the Service Programming System (SPS) and follow the on-screen instructions.
2. On the SPS Supported Controllers screen, select B218L Side Object Sensor Module - Left - Programming and follow the on-screen instructions.
3. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the B218L Side Object Sensor Module - Left, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the B218L Side Object Sensor Module - Left can be reprogrammed.
 - **If the B218L Side Object Sensor Module - Left cannot be reprogrammed**
 1. Ignition OFF for one minute, ignition ON.
 2. Verify the B218L Side Object Sensor Module - Left can be reprogrammed.
 - If the B218L Side Object Sensor Module - Left cannot be reprogrammed, replace the B218L Side Object Sensor Module - Left.
 - If the B218L Side Object Sensor Module - Left can be reprogrammed.
 3. All OK.
 - **If the B218L Side Object Sensor Module - Left can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for side object sensor module - left replacement, programming and setup.

SUNROOF CONTROL MODULE PROGRAMMING AND SETUP

When replacing the sunroof motor/control module, the sunroof motor/actuator initialization/teach procedure must be followed.

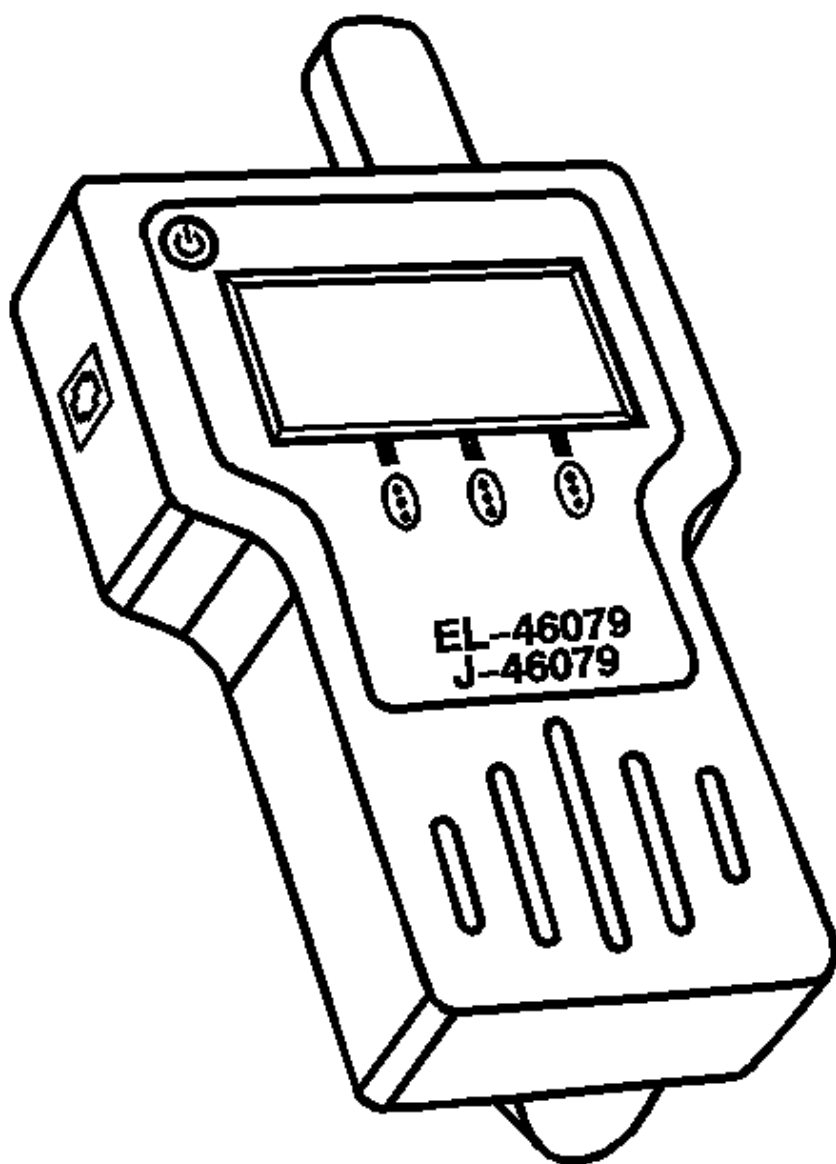
Existing or New Motor

For the sunroof motor/actuator initialization/teach procedure refer to **Sunroof Motor/Actuator Initialization/Teach Process** .

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	EL 46079 J 46079 Tire Pressure Monitor Diagnostic Tool



EL 49642
EL 50113

	Europe- Use recommended equivalent workshop equipment SPS Programming Support Tool
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Driveline/Axle

Propeller Shaft

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Rear Propeller Shaft Bolts	29 N.m	21 lb ft
Support Bearing Mounting Bolts	22 N.m	16 lb ft

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number
Grease	Sealant	Refer to Electronic Parts Catalogue
Locking Agent	Threadlock	Refer to Electronic Parts Catalogue

DIAGNOSTIC INFORMATION AND PROCEDURES

PROPELLER SHAFT DIAGNOSIS

Review the propeller shaft system function. Refer to **Propeller Shaft Description and Operation**.

Inspect for loose or missing propeller shaft-to-flange bolts. Tighten or replace as necessary. Refer to **Propeller Shaft Replacement**.

Inspect for loose bracket bolts and damaged rubber bushings. Tighten or replace as necessary. Refer to **Propeller Shaft Replacement**.

The propeller shaft and the joints are not serviceable.

The joint seals should be inspected for the following:

- Tears
- Cracks
- Contamination of the lubricating grease

Carefully pinch the seal and feel for the presence of grit

- Loose or missing seal clamps
- Leakage of lubricating grease from the seals

The joints should be inspected for the following conditions:

- Binding or impeded motion during axial movement of the front and rear joints
- Binding or impeded motion during lateral movement of the rear joint
- Loose or missing crimped-on end caps
- Leakage of lubricating grease from the end caps

The propeller shaft must be replaced if any of the above conditions exist. This will ensure that the propeller shaft continues to operate as intended, and does not damage the other driveline components.

REPAIR INSTRUCTIONS

PROPELLER SHAFT REPLACEMENT

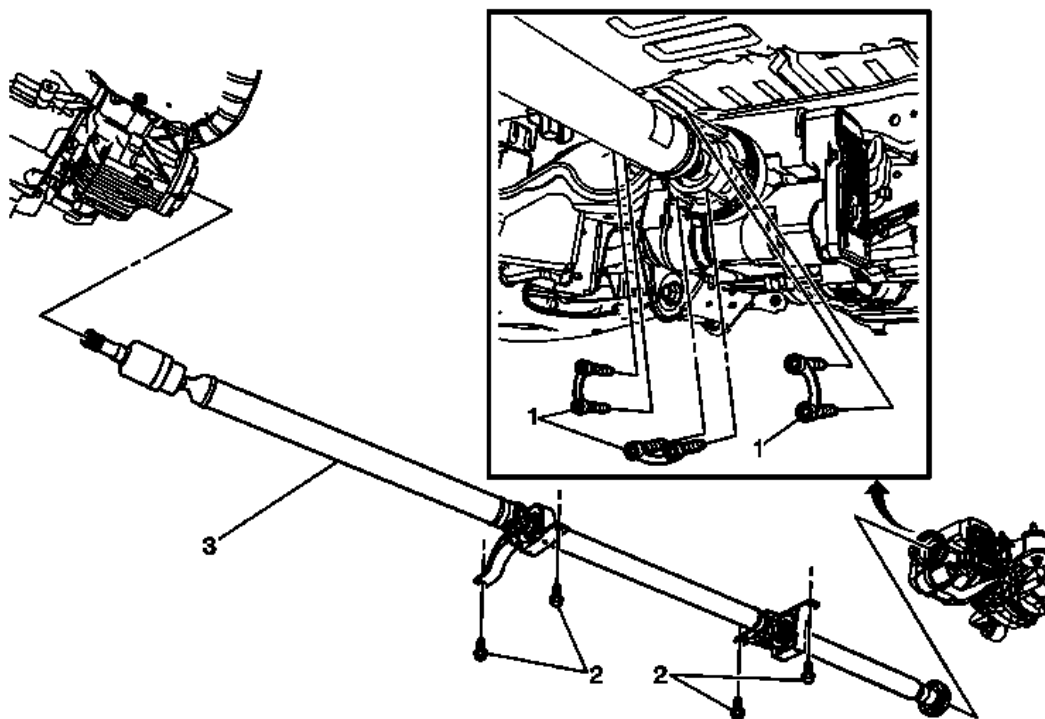


Fig. 1: View Of Propeller Shaft, Mounting Bolts & Retainers
Courtesy of GENERAL MOTORS COMPANY

Propeller Shaft Replacement

Callout	Component Name
Preliminary Procedure	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>	
	Rear Differential Drive Flange Bolts and Retainers (Qty: 3)
	CAUTION:

1	<p>Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Mark a reference point between the propeller shaft and the flange. 2. Using the appropriate tools, remove the flange bolts and the retainers. 3. Use the DT-49064 puller , if needed to remove the propeller shaft. <p>Tighten 29 N.m (21 lb ft)</p> <p>Special Tools DT-49064 Puller</p> <p>For equivalent regional tools, refer to <u>Special Tools</u>.</p>
2	<p>Support Bearing Mounting Bolts (Qty: 4)</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Support the support bearings with jack stands. 2. Clean threads of all residue of the old threader locker. 3. Apply thread locker to the bolts. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. <p>Tighten 22 N.m (16 lb ft)</p>
3	<p>Propeller Shaft</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Using the DT-49030 fork , remove the propeller shaft from the transfer case. 2. It may be necessary to have the help of an assistant to remove the propeller shaft. 3. Apply grease on the spline. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. <p>Special Tools DT-49030 Fork, Cardan Removal</p> <p>For equivalent regional tools, refer to <u>Special Tools</u>.</p>

DESCRIPTION AND OPERATION

PROPELLER SHAFT DESCRIPTION AND OPERATION

The function of the propeller shaft is to transfer power from the transfer case to the differential clutch. It consists of three pipe sections, a front Rzeppa joint, two Polhem joints in the center and a rear Rzeppa joint. The

propeller shaft's support bearings are fitted by the Polhem joints. The bearings are mounted in rubber bushings which are fitted in brackets, and these in turn are bolted to the underside of the vehicle. The position of the brackets is very precisely measured during vehicle manufacture. The propeller shaft does not run in a straight line between the transfer case and the differential clutch but is instead gently curved, and this is to avoid vibration.

Front Drive Shaft

The propeller shaft connects into the transfer case pinion with a splines equipped pin which is part of the front drive shaft universal joint. The function of the joint is to handle the difference in angle between pinion and propeller shaft, as well as to be flexible longitudinally.

Support Bearings

Directly after the Polhem joints are the propeller shaft's support bearings, which are the single-row, permanently-lubricated groove ball bearing type. They are fitted in rubber bushings which in turn are fitted in brackets.

The brackets are bolted to the underside of the vehicle and their position is very precisely measured during vehicle manufacture. If the support bearing brackets are fitted incorrectly then vibration will occur.

Rear Drive Shaft

The propeller shaft connects to the differential clutch driver by means of the rear drive shaft universal joint which is bolted to the driver.

The function of the joint is to handle the difference in angle between differential clutch driver and propeller shaft, as well as to be flexible longitudinally. The rear drive shaft universal joint is also a Rzeppa joint and is friction welded to the rear pipe section and constitutes one unit together with the propeller shaft.

Front/Rear Drive Shaft Universal Joint (Rzeppa Joint)

The Rzeppa joint consists of an outer bearing race, which also constitutes the joint's housing. On its inside are 6 semi-spherical grooves. The inner bearing race consists of a cylindrical section, in the periphery of which are 6 semi-spherical grooves. The inner bearing race is fitted inside the outer one and there are 6 steel balls between the grooves. A ball holder is fitted between the outer and inner bearing races. There are steel balls between the bearing races which transfer the movement between outer and inner bearing races.

Center Joints (Polhem Joint)

There are Polhem joints fitted between front and center pipe sections as well as between center and rear pipe sections. Their function is to handle the angle difference between pipe sections. The joints are angled 45 degrees in relation to each other to avoid vibration.

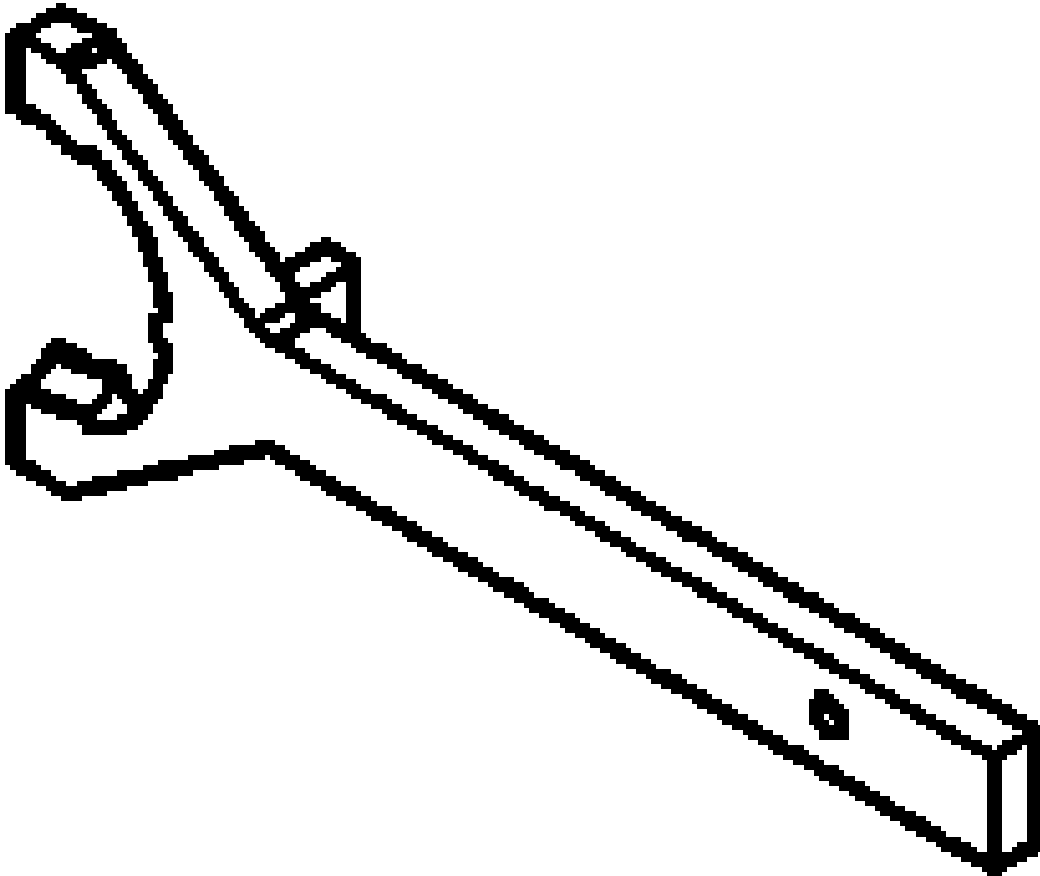
The Polhem joint consists of two forks, produced in forged steel which grip a cross by means of arms. The pins of the cross are mounted in needle bearings in the forks' bearing sleeves. The sleeves are permanently locked in the forks by means of compressive strain.

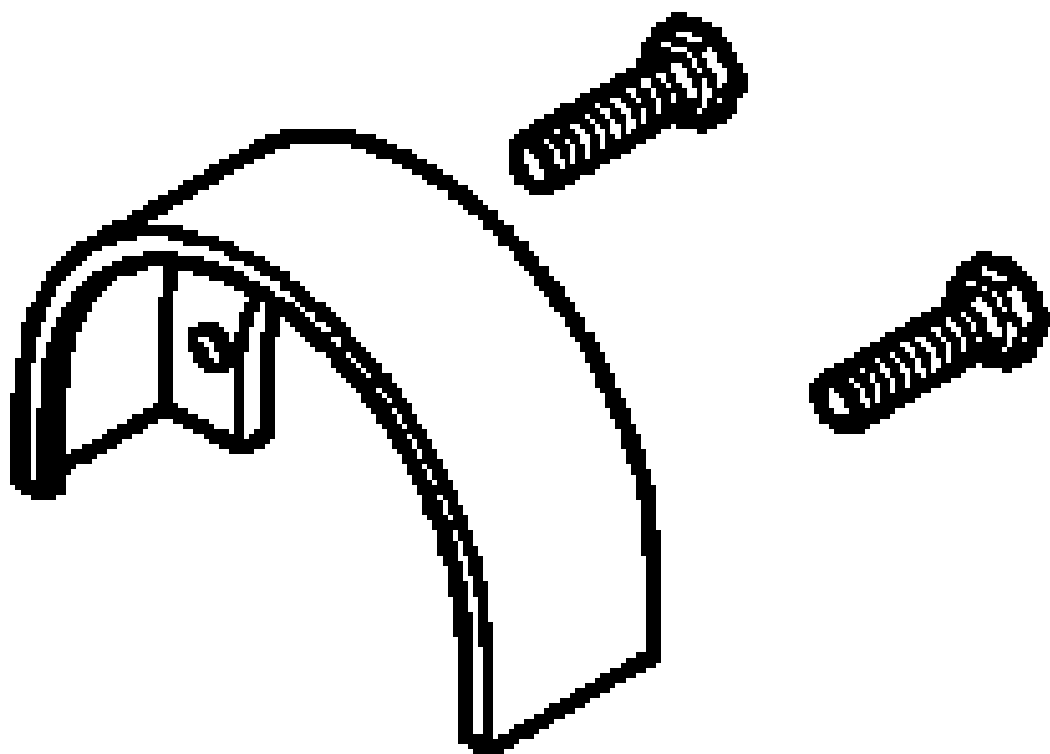
The bearing sleeves are permanently lubricated with synthetic special grease which contains molybdenum disulphide.

The drive shaft universal joint is friction welded to the relevant pipe section and constitutes one unit together with the propeller shaft.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Descrip
	DT-49030 Fork, Cardan Removal Tool



DT-49064
Puller

Driveline/Axle

Rear Drive Axle

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Differential Clutch Bolts	30 N.m	22 lb ft
Differential Clutch Cover Bolts	6 N.m	53 lb in
Differential Clutch Control Module Bolts	6 N.m	53 lb in
Differential Clutch Pipe Connectors	7 N.m	62 lb in
Differential Clutch Bolts	30 N.m	22 lb ft
Differential Clutch Oil Inspection Plug	14 N.m	10 lb ft
Differential Clutch Pump Bolts	6 N.m	53 lb in
Differential Clutch Valve Housing	3 N.m	27 lb in
Lubricant Drain Plug	25 N.m	18 lb ft
Lubricant Fill Plug	25 N.m	18 lb ft
Propeller shaft Flange Nut	100 N.m	74 lb ft
Rear Axle Assembly-Front Bolts	125 N.m	92 lb ft
Rear Axle Assembly- Rear Bolts	90 N.m + 100 degrees	66 lb ft + 100 degrees
Rear Axle Bolts	30 N.m	22 lb ft

LUBRICATION SPECIFICATIONS

Lubrication Specifications

Application	Quantity		GM Part Number	Canadian Part Number
	Metric	US/English		
Differential Clutch	0.56 liters	0.59 quarts	88863349	88863350
Limited Slip Differential	0.65 liters	0.69 quarts	88900401	89021678
Limited Slip Differential (Limited Slip Additive)	0.05 liters	1.69 ounces	88900330	992694

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	Canadian Part Number
Differential Clutch Cover Seal Lubricant	Grease	12377985	88901242

Differential Clutch Fluid	Fluid	88863349	88863350
Differential Rear Axle Fluid	Fluid	88900401	89021678
Rear Differential Assembly Front Mounting Bolts	Threadlock	89021297	10953488
Rear Axle Limited Slip Fluid	Limited Slip Additive	88900330	992694

SCHEMATIC WIRING DIAGRAMS

REAR AXLE WIRING SCHEMATICS

All-Wheel Drive (F46)

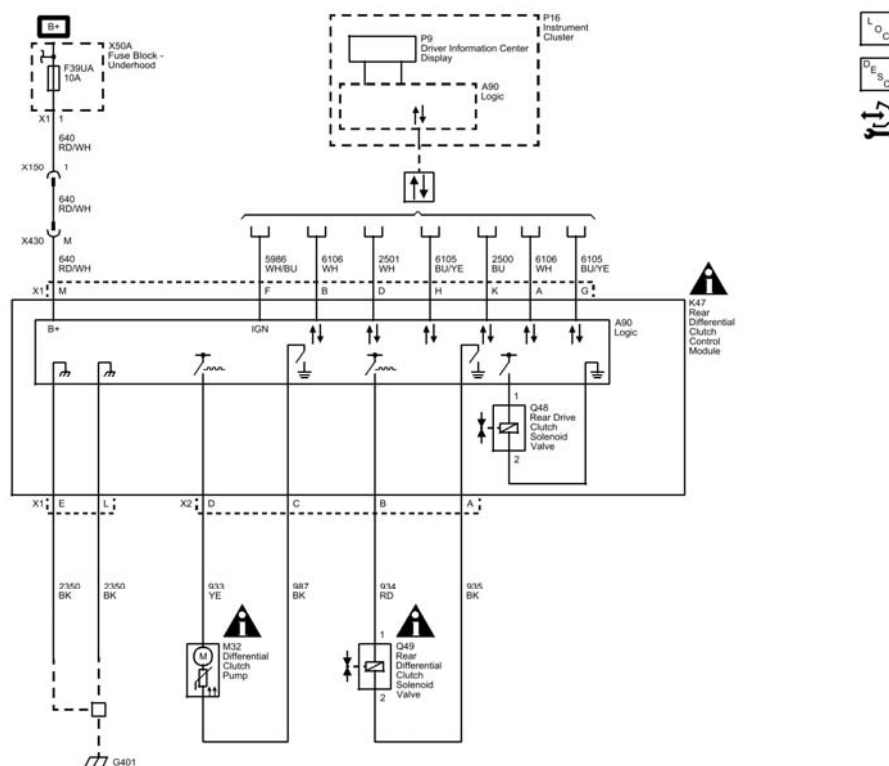


Fig. 1: All-Wheel Drive (F46)
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC C0393	DTC C0393 0B Rear Differential Clutch Solenoid Valve Control Circuit High

	Current
<u>DTC C039F</u>	DTC C039F 00 AWD Torque Signal
<u>DTC C0402</u>	DTC C0402 02 Transfer Case Solenoid Valve Short to Ground DTC C0402 04 Transfer Case Solenoid Valve Open DTC C0402 43 Transfer Case Solenoid Valve EEPROM Incorrect Programming DTC C0402 4B Transfer Case Solenoid Valve Calibration Not Learned DTC C0402 61 Transfer Case Solenoid Valve Stuck
<u>DTC C0403</u>	DTC C0403 62 AWD Oil Filter Reverse Valve Stuck Open
<u>DTC C0406</u>	DTC C0406 0B Transfer Case Solenoid Valve Control Circuit High Current
<u>DTC C0407</u>	DTC C0407 0B Transfer Case Solenoid Valve Control Circuit High Current
<u>DTC C0408</u>	DTC C0408 02 Rear Differential Clutch Solenoid Valve Short to Ground DTC C0408 04 Rear Differential Clutch Solenoid Valve Open DTC C0408 61 Rear Differential Clutch Solenoid Valve Stuck
<u>DTC C0574</u>	DTC C0574 02 Printed Circuit Board Temperature Sensor Short to Ground DTC C0574 04 Printed Circuit Board Temperature Sensor Open DTC C0574 13 Printed Circuit Board Temperature Sensor Low Voltage/High Temperature DTC C0574 14 Printed Circuit Board Temperature Sensor High Voltage/Low Temperature

DTC C0393: REAR DIFFERENTIAL CLUTCH SOLENOID VALVE CONTROL CIRCUIT HIGH CURRENT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0393 0B

Rear Differential Clutch Solenoid Valve Control Circuit High Current

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	C0393 0B	1	1	C0393 0B
1. Differential Lock Malfunction				

Circuit/System Description

The rear differential clutch solenoid valve is installed at the rear halfshaft leading to the rear left wheel. The rear differential clutch control module supplies battery voltage to the control circuit and ground to the low reference circuit of the solenoid valve. The solenoid valve is controlled by a pulse width modulation (PWM) signal. The solenoid valve controls the hydraulic pressure to the clutch package of the limited slip differential. The locking level of the limited slip differential depends on the engagement of the clutch package.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

- The rear differential clutch control module detects a short to ground on the high solenoid valve control circuit.
- or
- The rear differential clutch control module detects a current more than 5.7 A.

Action Taken When the DTC Sets

One or more of the following actions may occur:

- All-wheel drive (AWD) is disabled.
- Service AWD is displayed on the driver information center.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The DTC is not detected in 40 consecutive power cycles.

Reference Information

Schematic Reference

Rear Axle Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

All-Wheel Drive Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool Rear Differential Clutch Status parameter. The reading should be NORMAL when stationary.

Circuit/System Testing

1. Ignition OFF, inspect for damage of the wire, the solenoid or the housing.
 - If a damage is visible, replace the appropriate component.
2. Remove the K47 Rear Differential Clutch Control Module .
3. Test for a infinite resistance between the control circuit terminal B X2 and ground.
 - If not within the specified range, test the control circuit for a short to ground. If the circuit tests normal, replace the Q49 Rear Differential Clutch Solenoid Valve.
4. If the circuit tests normal, replace the K47 Rear Differential Clutch Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Limited Slip Differential Clutch Valve Replacement**
- **Control Module References** for rear differential clutch control module replacement, programming and setup

DTC C039F: AWD TORQUE SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C039F 00

AWD Torque Signal

Circuit/System Description

The rear differential clutch control module monitors the amount of torque transferred through the rear axle. If there is a mechanical malfunction that inhibits the torque transfer process the module will then set DTC C039F.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

A mechanical malfunction exists that inhibits the torque transfer process.

Action Taken When the DTC Sets

One or more of the following actions may occur:

- All-wheel drive (AWD) is disabled.
- Service Rear Axle is displayed on the driver information center.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC is not detected in 40 consecutive ignition cycles.

Reference Information

Schematic Reference

Rear Axle Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

All-Wheel Drive Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, observe the scan tool Rear Drive Clutch Status parameter. The scan tool should display TEMPORARILY LIMITED when stationary.
2. Verify that the following DTCs are not set along with DTC C039F:
 - C0402
 - C0403
 - C0406
 - C0407
 - If any of the DTCs listed are set, diagnose those codes first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Ensure that all differential fluid levels are at the proper levels. Refer to **Rear Axle Lubricant Level Inspection**, and **Differential Clutch Oil Inspection**.
 - If a fluid level is below specifications, inspect the rear differential assembly for leaks and repair as necessary. Refill to the proper level, clear codes, and road test. Verify that DTC C039F is not set. If the DTC resets, proceed to Circuit System Testing.

Circuit/System Testing

NOTE: **The rear drive clutch solenoid valve is calibrated with and is part of the rear differential clutch control module. Both components must be replaced as a matched set.**

Verify DTC C039F is not set.

- If the DTC is set, inspect the rear differential assembly for internal or external mechanical damage and repair as necessary. Clear codes and road test. Verify that DTC C039F is not set. If the DTC resets, replace the K47 Rear Differential Clutch Control Module or Q48 Rear Drive Clutch Solenoid Valve.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for rear differential clutch control module replacement, programming and setup

DTC C0402: TRANSFER CASE SOLENOID VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0402 02

Transfer Case Solenoid Valve Short to Ground

DTC C0402 04

Transfer Case Solenoid Valve Open

DTC C0402 43

Transfer Case Solenoid Valve EEPROM Incorrect Programming

DTC C0402 4B

Transfer Case Solenoid Valve Calibration Not Learned

DTC C0402 61

Transfer Case Solenoid Valve Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	C0402 02, C0402 04	C0402 02	C0402 02	C0402 02

Component	Condition	DTCs
Solenoid Valve	Mechanically Stuck	C0402 61
Solenoid Valve Rear Differential Clutch Control Module	Calibration EEPROM Error	C0402 43
	Calibration not Learned	C0402 4B

Circuit/System Description

The transfer case solenoid valve is installed at the torque transfer device housing . The rear differential clutch control module supplies battery voltage to the control circuit and ground to the low reference circuit of the solenoid valve. The solenoid valve is controlled by a pulse width modulation (PWM) signal. The solenoid valve controls the hydraulic pressure to the clutch package of the torque transfer device. The locking level of the torque transfer device depends on the engagement of the clutch package.

Conditions for Running the DTC

C0402 02, C0402 43 and C0402 4B

- The ignition is ON.
- The circuits are tested during start up of the rear differential clutch control module.

C0402 04

The ignition is ON.

C0402 61

- Engine running.
- Test runs when requested torque is less than 25 N.m (18 lb ft) and the calculated temperature is in the range of 0-90°C (32-194°F).

Conditions for Setting the DTC

C0402 02

A test voltage is applied to the transfer case solenoid valve. An error is detected if the resultant current is greater than the current which corresponds to less than 2 ohms resistance in the solenoid valve.

C0402 04

The measured current diverges from the nominal value with more than 200 mA for more than 100 ms.

C0402 43

The solenoid valve calibration values stored in the rear differential clutch control module EEPROM are invalid or out of bounds.

C0402 4B

There are no solenoid valve calibration values stored in the differential clutch control module EEPROM.

C0402 61

An error is detected if the solenoid valve is not moving fast enough for several times.

Action Taken When the DTC Sets

C0402 02, C0402 04 and C0402 61

One or more of the following actions may occur:

- All-wheel drive (AWD) is disabled.
- Service AWD is displayed on the driver information center.

C0402 43 and C0402 4B

An error record is stored in the rear differential clutch control module. No action will be performed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The DTC is not detected in 40 consecutive power cycles.

Reference Information

Schematic Reference

Rear Axle Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

All-Wheel Drive Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool Rear Drive Clutch Status parameter. The reading should be TEMPORARILY LIMITED when stationary.

Circuit/System Testing

1. Ignition OFF, replace the Q48 Rear Drive Clutch Solenoid Valve.
2. Connect the K47 Rear Differential Clutch Control Module.
3. Ignition ON, verify the DTC does not reset.
 - If the DTC resets, replace the K47 Rear Differential Clutch Control Module.

Repair Instructions

- **Rear Differential Clutch Control Module Replacement**
- **Control Module References** for rear differential clutch control module replacement, programming and setup

DTC C0403: AWD OIL FILTER REVERSE VALVE STUCK OPEN

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0403 62

AWD Oil Filter Reverse Valve Stuck Open

Diagnostic Fault Information

Component	Condition	DTCs
Pump/Oil Filter Reverse Valve	Pump motor is spinning backwards because of clogged filter.	C0403 62

Circuit/System Description

The hydraulic pump delivers both solenoid valves with hydraulic oil pressure, the transfer solenoid valve and if installed the rear differential clutch solenoid valve. The pump is installed in the torque transfer device housing . The pressure of the system is calculated by means of the rear differential clutch control module measuring the motors power consumption. When the pressure reaches approximately 3 200 kPa (464 PSI) the rear differential clutch control module recognizes that the system pressure has been reached. The pump is shut down. If a voltage is detected after the pump is shut down after a certain limit an error is detected. The pump is spinning backwards.

Conditions for Running the DTC

- The ignition is ON.
- Test runs in temperature interval 0-80°C (0-176°F).

Conditions for Setting the DTC

A test voltage is applied to the transfer case solenoid valve. An error is detected if the resultant current is greater than the current which corresponds to less than 2 ohms in the solenoid valve.

Action Taken When the DTC Sets

One or more of the following actions may occur:

- All-wheel drive (AWD) is disabled
- Service AWD is displayed on the driver information center.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The DTC is not detected in 40 consecutive power cycles.

Reference Information

Schematic Reference

Rear Axle Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

All-Wheel Drive Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool Rear Drive Clutch Status parameter. The reading should be TEMPORARILY LIMITED when stationary.

Circuit/System Testing

1. Ignition OFF, replace the oil filter in the torque transfer device housing.
2. Ignition ON, drive the car under normal conditions. Verify the DTC does not reset.
 - If the DTC resets, replace the K47 Rear Differential Clutch Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Differential Clutch Oil Filter Replacement**
- **Control Module References** for rear differential clutch control module replacement, programming and setup

DTC C0406: TRANSFER CASE SOLENOID VALVE CONTROL CIRCUIT HIGH CURRENT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0406 0B

Transfer Case Solenoid Valve Control Circuit High Current

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	C0406 0B	-	-	C0406 0B

Circuit/System Description

The transfer case solenoid valve and the oil pump are installed in the torque transfer device housing of the rear drive module. The rear differential clutch control module supplies battery voltage to the control circuit and ground to the low reference circuit of the solenoid valve and the oil pump motor. The solenoid valve is controlled by a pulse width modulation (PWM) signal. The solenoid valve controls the hydraulic pressure to the clutch package of the torque transfer device. The locking level depends on the engagement of the clutch package. The oil pump motor produces the oil pressure for both oil cycles.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

- The rear differential clutch control module detects a short to ground on the control circuit of the solenoid valve and the oil pump motor.

or

- The rear differential clutch control module detects a current more than 11 A.

Action Taken When the DTC Sets

One or more of the following actions may occur:

- All-wheel drive (AWD) is disabled.
- Service AWD is displayed on the driver information center.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The DTC is not detected in 40 consecutive power cycles.

Reference Information

Schematic Reference

Rear Axle Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

All-Wheel Drive Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool Rear Drive Clutch Status parameter. The reading should be TEMPORARILY LIMITED when stationary.

Circuit/System Testing

1. Ignition OFF, inspect for signs of damage of the K47 Rear Differential Clutch Control Module, the M32 Differential Clutch Pump or the rear drive module housing.
 - If a damage is visible, replace the appropriate component.
2. Remove the K47 Rear Differential Clutch Control Module.
3. Test for infinite resistance between the control circuit terminal C X2 and ground.
 - If less than the specified value, replace the M32 Differential Clutch Pump.
4. Test for infinite resistance between the control terminal 1 X3 at the Q48 Rear Drive Clutch Solenoid Valve and ground.
 - If less than the specified value, replace the Q48 Rear Drive Clutch Solenoid Valve. If the circuits test normal, replace the K47 Rear Differential Clutch Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Rear Differential Clutch Control Module Replacement**
- **Control Module References** for rear differential clutch control module replacement, programming and setup

DTC C0407: AWD OIL PUMP MOTOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0407 02

AWD Oil Pump Motor Short to Ground

DTC C0407 04

AWD Oil Pump Motor Open

DTC C0407 0B

AWD Oil Pump Motor High Current

DTC C0407 64

AWD Oil Pump Motor Slip Detected

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	C0407 02	C0407 04	-	C0407 0B, C0407 64
Low Reference	C0407 02	C0407 04	C0407 04	C0407 02

Component	Condition	DTCs
AWD Oil Pump Motor	Oil leak, oil pump defect	C0407 0B, C0407 64

Circuit/System Description

The oil pump motor is installed in the torque transfer device housing . The rear differential clutch control module supplies battery voltage to the control circuit and ground to the low reference circuit of the oil pump motor. As soon as the engine is started the oil pump motor will be activated. The oil pump is running until the pressure of approximately 3 200 kPa (464 PSI) is reached. The oil pump motor power consumption is the indicator for the oil pressure. The consumption is constant when the full system pressure is reached. The rear differential clutch control module shuts down the pump motor when the full system pressure is reached. Below approximately 2 700 kPa (392 PSI) the pump motor will be restarted.

Conditions for Running the DTC

C0407 02 and C0407 04

- The ignition is ON.
- The oil pump motor voltage is above 4.8 V.

C0407 0B

- The ignition is ON.
- The oil pump motor is running.
- The oil temperature is above 0°C (32°F).

C0407 64

- The ignition is ON.
- The oil pump motor voltage is above 11.5 V.
- The oil temperature is above -20°C (-4°F).

Conditions for Setting the DTC

C0407 02

The oil pump current is more than 9.0 A in 20 consecutive test cycles. The current will be retested every 30 s.

C0407 04

The oil pump current is less than 0.3 A for 30 s.

C0407 0B

The oil pump current is more than 7.0 A for 2 s in 10 consecutive test cycles.

C0407 64

The oil pump current is below a threshold at the end of a pump activation cycle in 30 consecutive test cycles. The measured current is less than 1.5 A from the threshold. The threshold is temperature dependent.

Action Taken When the DTC Sets

C0407 02 and C0407 04

- All-wheel drive (AWD) is disabled.
- Service AWD is displayed on the driver information center.

C0407 0B and C0407 64

An error report entry is stored, no further action is performed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The DTC is not detected in 40 consecutive power cycles.

Reference Information

Schematic Reference

Rear Axle Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

All-Wheel Drive Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool Rear Differential Clutch Pump Motor Current parameter. The reading should be between 2 500-3 500 mA when the pump is ON.

Circuit/System Testing

1. Ignition OFF, inspect for signs of damage of the wire, the oil pump motor and the housing.
 - If a damage is visible, replace the appropriate component.
2. Replace the M32 Differential Clutch Pump.
3. Ignition ON, verify the DTC does not reset.
 - If the DTC resets, replace the K47 Rear Differential Clutch Control Module.

Component Testing

Static Test

1. Ignition OFF, disconnect the X2 harness connector at the K47 Rear Differential Clutch Control Module.
2. Test for 4-7 ohms between the control circuit terminal C and the low reference circuit terminal D.
 - If not in the specified range, replace the M32 Differential Clutch Pump.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Differential Clutch Pump Replacement**
- **Control Module References**

DTC C0408: REAR DIFFERENTIAL CLUTCH SOLENOID VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0408 02

Rear Differential Clutch Solenoid Valve Short to Ground

DTC C0408 04

Rear Differential Clutch Solenoid Valve Open

DTC C0408 61

Rear Differential Clutch Solenoid Valve Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	C0408 02	C0408 04	C0408 04	C0408 04
Low Reference	C0408 02	C0408 04	C0408 04	C0408 04

Component	Condition	DTCs
Solenoid Valve	Mechanically Stuck	C0408 61

Circuit/System Description

The rear differential clutch solenoid valve is installed at the rear halfshaft leading to the rear left wheel. The rear differential clutch control module supplies battery voltage to the control circuit and ground to the low reference circuit of the solenoid valve. The solenoid valve is controlled by a pulse width modulation (PWM) signal. The solenoid valve controls the hydraulic pressure to the clutch package of the limited slip differential. The locking level of the limited slip differential depends on the engagement of the clutch package.

Conditions for Running the DTC

C0408 02

- The ignition is ON.
- Vehicle is equipped with electronic limited slip differential.
- The test runs during start up of the rear differential clutch control module.

C0408 04

- The ignition is ON.
- Vehicle is equipped with electronic limited slip differential.
- The test runs with a frequency of 200 Hz.

C0408 61

- Vehicle is equipped with electronic limited slip differential.
- Engine running.
- Test runs when requested torque is less than 25 N.m (18 lb ft) and the calculated temperature is in the range of 0-120°C (32-248°F).

Conditions for Setting the DTC

C0408 02

A test voltage is applied to the rear differential clutch solenoid valve. An error is detected if the resultant current is greater than the current which corresponds to less than 2.1 ohms resistance in the solenoid valve.

C0408 04

The measured current diverges from the nominal value with more than 200 mA for more than 100 ms.

C0408 61

The valve is subjected to a current spike that should move the needle physically. An error is detected if the solenoid valve is not moving fast enough and an error counter reaches a threshold.

Action Taken When the DTC Sets

One or more of the following actions may occur:

- All-wheel drive (AWD) is disabled.
- Service AWD is displayed on the driver information center.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The DTC is not detected in 40 consecutive power cycles.

Reference Information

Schematic Reference

Rear Axle Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

All-Wheel Drive Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool Rear Drive Clutch Status parameter. The reading should be TEMPORARILY LIMITED when stationary.

Circuit/System Testing

C0408 02 and C0408 04

1. Ignition OFF, inspect for signs of damage of the wire, the solenoid or the housing.
 - If a damage is visible, replace the appropriate component.
2. Remove the K47 Rear Differential Clutch Control Module .
3. Test for infinite resistance between the control circuit terminal B X2 at the Q49 Rear Differential Clutch Solenoid Valve and ground.
 - If not within the specified range, test the control circuit and the low reference circuit for a short to ground. If the circuits test normal, replace the Q49 Rear Differential Clutch Solenoid Valve.
4. If the circuits test normal, replace the K47 Rear Differential Clutch Control Module.

C0408 61

1. Ignition OFF, inspect for signs of damage of the housing.
 - If a damage is visible, replace the appropriate component.
2. Replace the Q49 Rear Differential Clutch Solenoid Valve.
3. Ignition ON, verify the DTC does not reset.
 - If the DTC resets, replace the K47 Rear Differential Clutch Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Limited Slip Differential Clutch Valve Replacement**

- **Control Module References** for rear differential clutch control module replacement, programming and setup

DTC C0574: PRINTED CIRCUIT BOARD TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0574 02

Printed Circuit Board Temperature Sensor Short to Ground

DTC C0574 04

Printed Circuit Board Temperature Sensor Open

DTC C0574 13

Printed Circuit Board Temperature Sensor Low Voltage/High Temperature

DTC C0574 14

Printed Circuit Board Temperature Sensor High Voltage/Low Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	C0574 02	C0574 04	-	C0574 13, C0574 14
Low Reference	C0574 02	C0574 04	-	C0574 13, C0574 14

Circuit/System Description

A temperature sensor is installed on the circuit board of the rear differential clutch control module. The value from this is used for calculating the board temperature and together with information on prevailing driving conditions the temperature of the fluid in the differential clutch is also calculated.

Conditions for Running the DTC

- The ignition is ON.
- The test runs with a frequency of 50 Hz.

Conditions for Setting the DTC

C0574 02

The analog-digital converter circuit is shorted to ground for more than 3 s.

C0574 04

The analog-digital converter circuit is open for more than 3 s.

C0574 13

The board temperature is greater than 115°C (239°F) for more than 3 s.

C0574 14

The board temperature is less than -40°C (-40°F) for more than 3 s.

Action Taken When the DTC Sets

One or more of the following actions may occur:

- All wheel drive (AWD) is disabled.
- Service AWD is displayed on the driver information center.

Conditions for Clearing the DTC

C0574 02 and C0574 04

- The condition for the DTC is no longer present.
- The circuit is not tested unless power is cycled.

C0574 13 and C0574 14

- The temperature is within the limit for more than 30 s.
- The circuit is tested with a frequency of 50 Hz.

Diagnostic Aids

C0574 13 and C0574 14

The DTCs C0574 13 and C0574 14 indicate that the rear differential clutch control module temperature is out of bounds. This is a temporary fault. The rear differential clutch control module is protected against running during

critical temperatures. As soon as the temperature reaches normal values the actual DTC is cleared.

Reference Information

Schematic Reference

Rear Axle Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

All-Wheel Drive Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Rear Differential Clutch Control Module Temperature parameter. The reading should be between -40°C (-40°F) and 115°C (239°F) when stationary.

Circuit/System Testing

C0574 02 and 0574 04

Ignition ON. Verify that DTC C0574 02 or 0574 04 is not set.

- If any of the DTCs are set, replace the K47 Rear Differential Clutch Control Module.

C0574 13 and 0574 14

1. Ignition OFF, wait till the housing and the K47 Rear Differential Clutch Control Module temperatures are adapted to the environment temperature, approximately 0-40°C (32-104°F).
2. Ignition ON, verify that DTC C0574 13 or C0574 14 is not set.

- If any of the DTCs are set, replace the K47 Rear Differential Clutch Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Limited Slip Differential Clutch Valve Replacement**
- **Control Module References**

REPAIR INSTRUCTIONS

REAR DIFFERENTIAL CLUTCH CONTROL MODULE REPLACEMENT

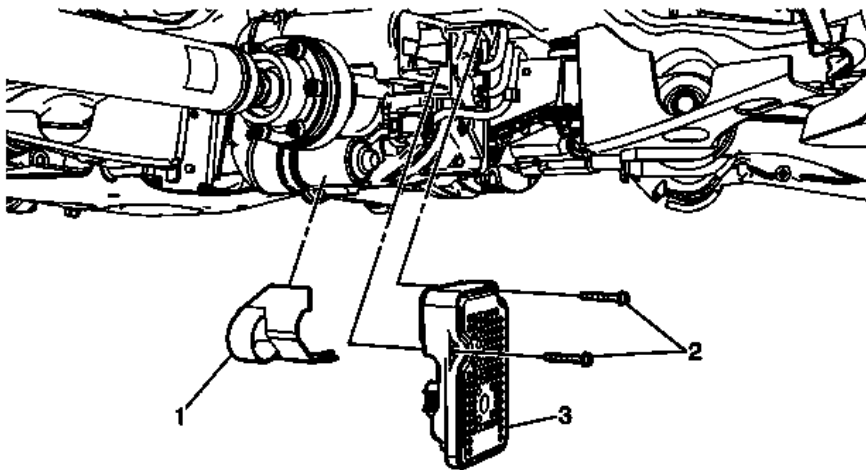


Fig. 2: Rear Differential Clutch Control Module & Components
Courtesy of GENERAL MOTORS COMPANY

Rear Differential Clutch Control Module Replacement

Callout	Component Name
Preliminary Procedures	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>	
1	Protective Cover
2	<p>Differential Clutch Control Module Bolts (Qty: 2)</p> <p>WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch.</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p>

	<p>Procedure DO NOT remove the mounting bolts, leave them attached to the Differential Clutch Control Module.</p> <p>Tighten 6 N.m (53 lb in)</p>
3	<p>Rear Differential Clutch Control Module and Seal</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connector. <p>NOTE: Some oil may leak with the Differential Clutch control Module and valve removed.</p> <ol style="list-style-type: none"> 2. If the Differential Clutch control Module and the valve separate, perform the following: <ol style="list-style-type: none"> 1. Pull the valve straight out of the bore. 2. Assembly the Differential Clutch control Module and the valve prior to the installation of the seal. 3. Install the NEW seal. DO NOT re-use the old seal. 4. Clean the area with a lint free cloth prior to installing the Differential Clutch Control Module and the valve. 3. Program the rear differential clutch control module. Refer to <u>Control Module References</u> .

REAR AXLE LUBRICANT LEVEL INSPECTION

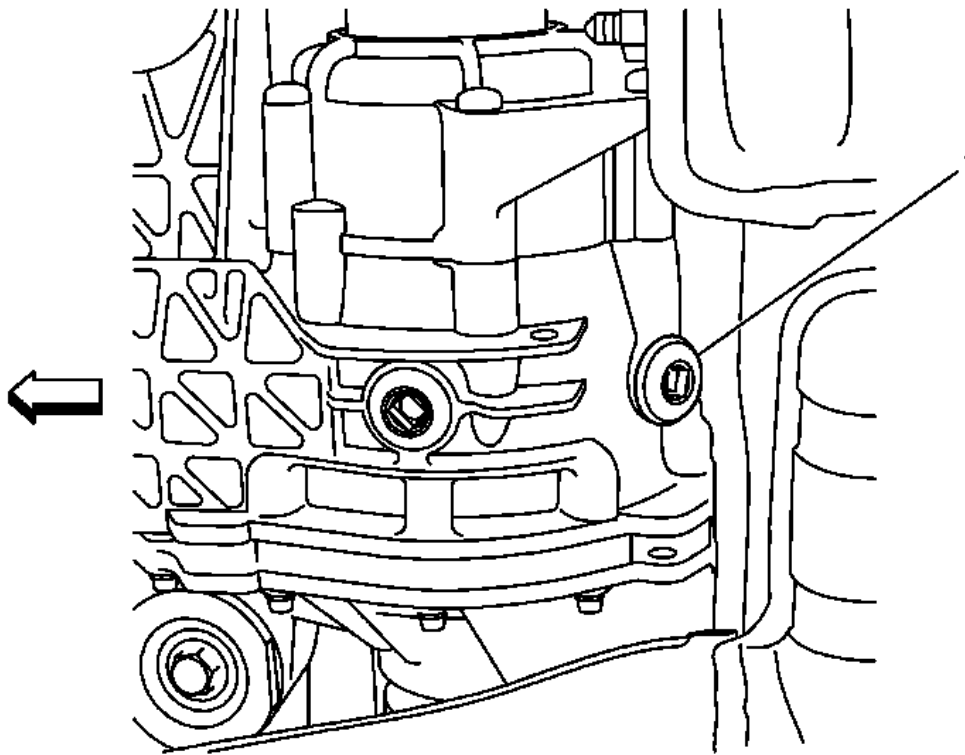


Fig. 3: Rear Axle Lubricant Level
 Courtesy of GENERAL MOTORS COMPANY

Rear Axle Lubricant Level Inspection

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Ensure the vehicle is in level. 3. Inspect the rear axle for leaks. Repair if necessary. 	
1	Lubricant Fill Plug CAUTION: Refer to <u>Fastener Caution</u> . Procedure <ol style="list-style-type: none"> 1. Clean the area around the rear axle fill plug. 2. Add lubricant until the level is even with the bottom edge of the fill plug opening. Use the proper fluid. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. Tighten 25 N.m (18 lb ft)

DIFFERENTIAL CLUTCH OIL INSPECTION

WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch.

NOTE: The following steps must be followed to ensure the proper fluid level for the differential clutch fluid.

1. Run the engine at idling speed for 5 minutes to distribute the fluid.
2. In park, cycle throttle to wide open throttle briefly 5 times to cycle solenoids to purge air.
3. Turn the engine off.

NOTE: Ensure that the vehicle is as level as possible.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

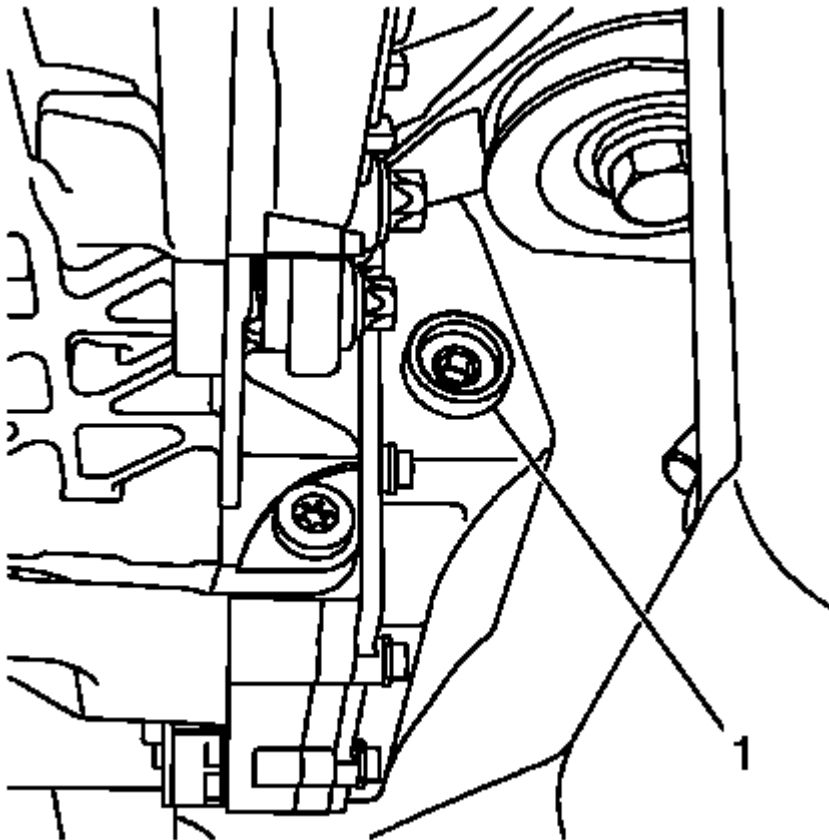


Fig. 4: Identifying Rear Axle Lubricant Fill Plug
Courtesy of GENERAL MOTORS COMPANY

CAUTION: It is very important to observe maximum cleanliness when working

on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.

NOTE: The differential clutch fluid should be level with the top threads of the fill hole.

5. Remove the fill plug (1) and check the differential clutch fluid level.
6. Add the proper differential clutch fluid, if needed. Refer to Adhesives, Fluids, Lubricants, and Sealers, and Differential Clutch Oil Replacement.

CAUTION: Refer to Fastener Caution .

7. Install the fill plug (1) and tighten to 14 (10 lb ft).
8. Install the scan tool.
9. With engine running, observe the scan tool Rear Differential Clutch Pump Motor Current parameter. The parameter display should be between 2500-3500 mA when the pump is on. If the parameter is below 2500 mA, recheck the fluid level.
10. Repeat steps 1-6 to ensure the proper differential clutch fluid level.
11. Remove the supports and lower the vehicle.

DIFFERENTIAL OIL REPLACEMENT

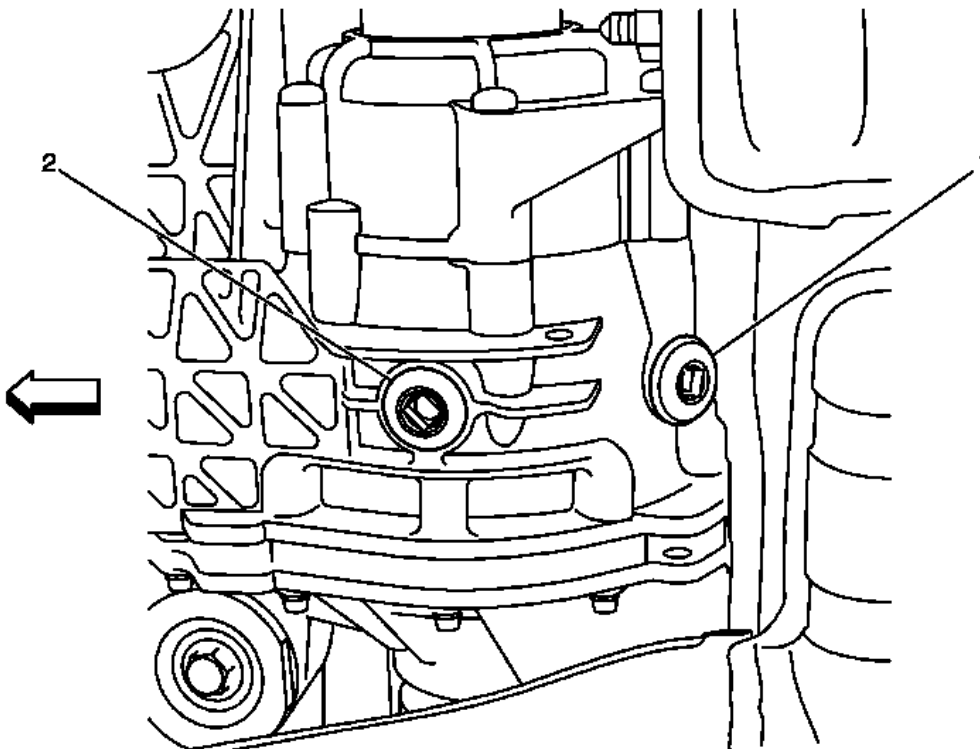


Fig. 5: Rear Axle Lubricant Fill And Drain Plugs
 Courtesy of GENERAL MOTORS COMPANY

Differential Oil Replacement

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Ensure the vehicle is in level. 3. Inspect the rear axle for leaks, repair if necessary. 	
1	Lubricant Fill Plug CAUTION: Refer to <u>Fastener Caution</u> . Procedure <ol style="list-style-type: none"> 1. Clean the area around the rear axle fill plug. 2. Add lubricant until the level is even with the bottom edge of the fill plug opening. Use the proper fluid. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. NOTE: For vehicles with Limited Slip Differentials: Prior to adding the limited slip axle additive, the bottle MUST be shaken vigorously for at least three minutes to mix the additive thoroughly, then immediately poured into the differential. Tighten 25 N.m(18 lb ft)
2	Lubricant Drain Plug Tighten 25 N.m(18 lb ft)

DIFFERENTIAL CLUTCH OIL REPLACEMENT

Removal Procedure

WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch.

NOTE: The vehicle should be as level as possible when performing this procedure.

NOTE: To adjust the differential clutch fluid to the proper level without draining,

go to step 12 of installation.

1. Raise the vehicle and support the vehicle. Refer to Lifting and Jacking the Vehicle .

CAUTION: It is very important to observe maximum cleanliness when working on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.

2. Remove the differential clutch cover to drain the differential clutch.

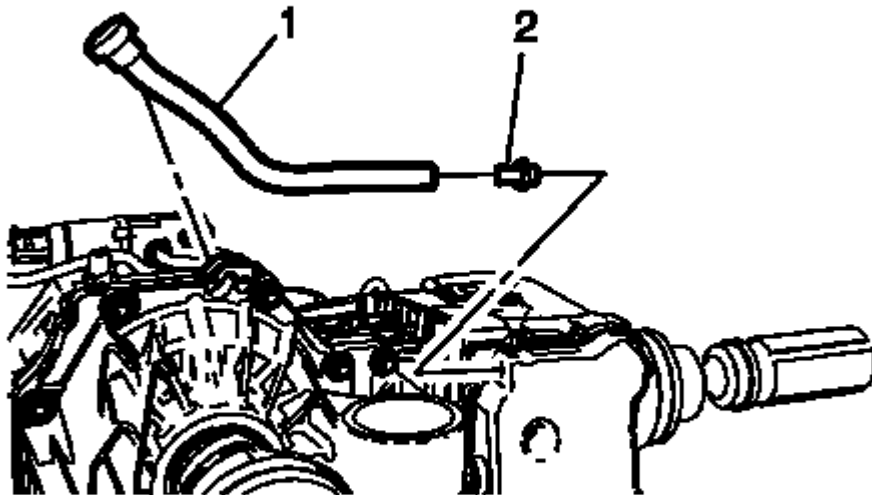


Fig. 6: Differential Clutch Vent Hose And Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Remove the vent hose fitting (2) and the hose (1) from the differential clutch cover.

Installation Procedure

NOTE: Both the fluid level and clutch motor current parameter requirements must be met to ensure the differential is filled to specifications.

1. Install the differential clutch cover.

CAUTION: Refer to Fastener Caution .

NOTE: The following tighten procedure MUST BE PERFORMED TWICE to ensure the proper sealing around the accumulator and the filter.

2. Install the differential cover bolts and tighten to 6 (53 lb in) in a star pattern and repeat this torque sequence twice to ensure proper sealing around the accumulator and the filter.

CAUTION: Fluids for the differential clutch and the rear axle are different. The fluids must never be mixed or interchanged or vehicle damage will result.

3. Fill the differential clutch with 350 ml (12 ounces) of the proper differential fluid through the vent hose fitting hole. Refer to Adhesives, Fluids, Lubricants, and Sealers.
4. Remove the supports and lower the vehicle.
5. To stabilize the oil level, let the vehicle rest for 10 minutes with the ignition off.
6. Start the engine and allow to run for 5 minutes at idle.
7. In park, cycle the throttle to wide open briefly 5 times to cycle solenoids to purge air.
8. Shut the vehicle off.
9. Raise the vehicle.

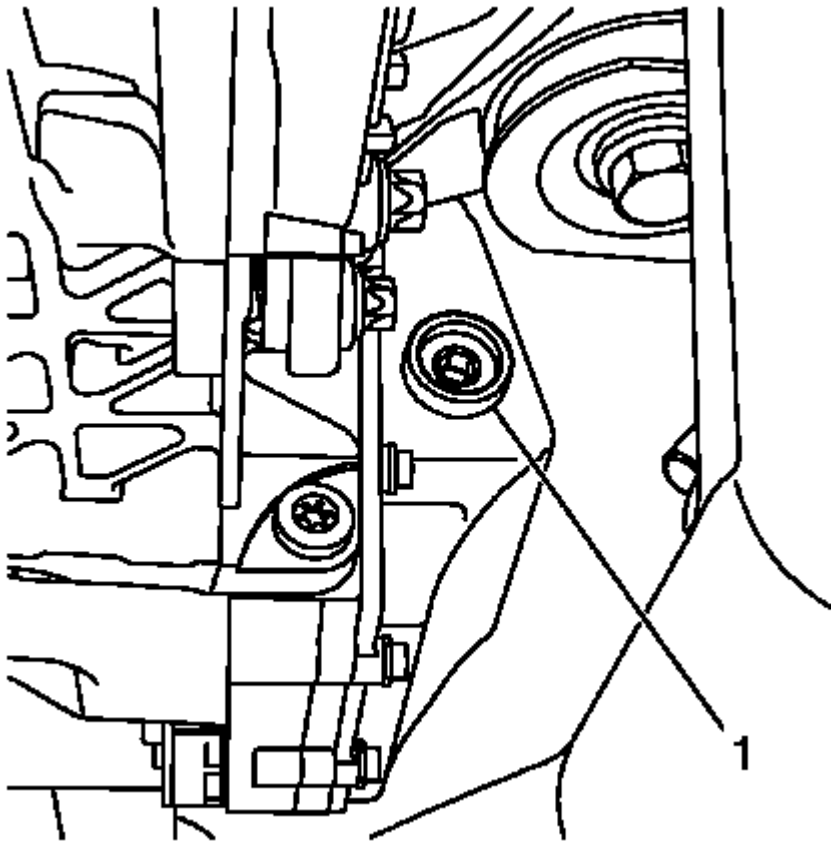


Fig. 7: Identifying Rear Axle Lubricant Fill Plug
Courtesy of GENERAL MOTORS COMPANY

10. Remove the differential clutch level inspection plug (1).
11. The differential clutch fluid should be level with the bottom of the differential clutch fluid level inspection plug hole.
12. If needed, install the differential clutch level inspection plug and add 50 ml (1.7 ounce) through the vent fitting hole. Repeat step 4 through 11.

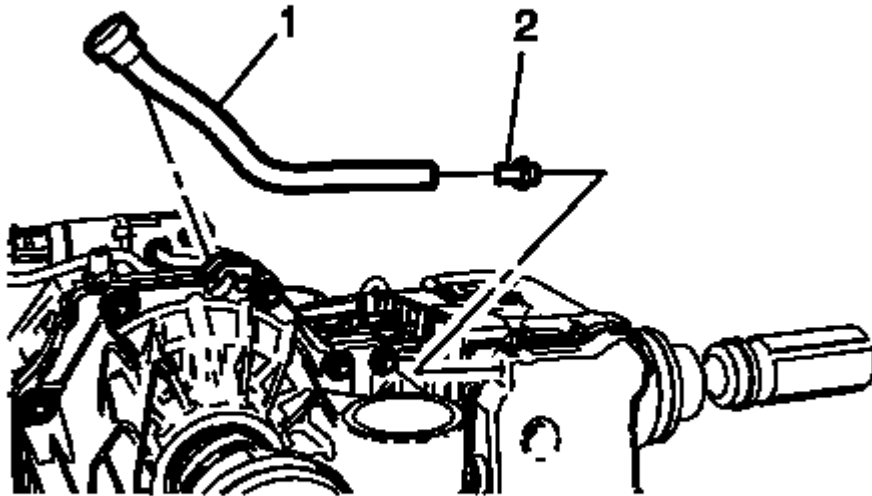


Fig. 8: Differential Clutch Vent Hose And Fitting
Courtesy of GENERAL MOTORS COMPANY

13. Install the vent hose fitting (2) and tighten to 14 (10 lb ft).
14. Install then vent hose (1).
15. Lower the vehicle.
16. Install the scan tool.

NOTE: When the clutch pump motor cycles from OFF to ON the current will also cycle from 0 mA to 2500-3500 mA. DTC C0407 64 is set when the pump current is **CONSTANTLY BELOW 2500 mA**.

17. With engine running, observe the scan tool Rear Differential Clutch Pump Motor Current parameter. The parameter display should be between 2500-3500 mA when the pump is on. If the parameter is below 2500 mA, repeat step 12.
18. Once desired parameter is reached check to ensure proper differential clutch fluid level. Remove fluid level inspection plug and allow any excess fluid to drain level with plug opening.

CAUTION: Refer to **Fastener Caution** .

19. Install the fill plug and tighten to 14 (10 lb ft).

DIFFERENTIAL CARRIER BUSHING REPLACEMENT - FRONT

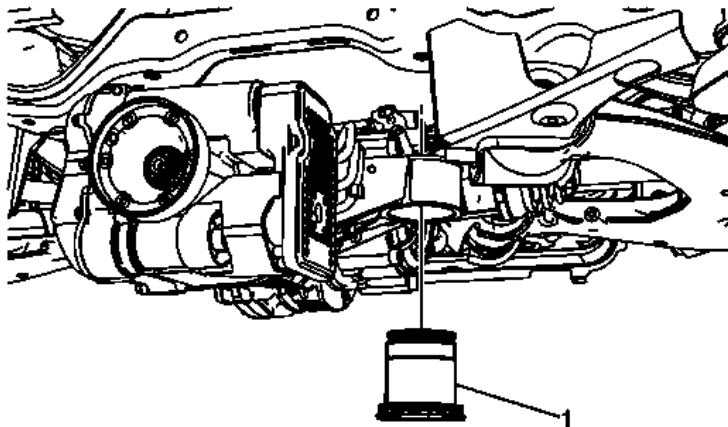


Fig. 9: Identifying Differential Carrier Bushing - Front
Courtesy of GENERAL MOTORS COMPANY

Differential Carrier Bushing Replacement - Front

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none">1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .2. Remove the propeller shaft. Refer to <u>Propeller Shaft Replacement</u> .3. Remove the exhaust system. Refer to <u>Exhaust Muffler Replacement (Dual)</u> , <u>Exhaust Muffler Replacement (Single)</u> .	
1	<p>Differential Carrier Bushing - Front (Qty: 2)</p> <p>Procedure</p> <ol style="list-style-type: none">1. Support the rear differential with a hydraulic transmission jack stand.2. Remove the electrical connector from the rear differential clutch control module. Refer to <u>Rear Differential Clutch Control Module Replacement</u>.3. Remove the front and rear differential mounting bolts. Refer to <u>Differential Carrier Assembly Replacement</u>.4. Lower the rear differential until there is enough room to remove the differential carrier bushings5. Using the DT 49126-1 tool and the DT 49126-10 kit , remove the rear differential bushing.6. Position the NEW rear differential bushing with the beveled edges facing the housing (up).

7. Using the **DT 49126-2** tool and the **DT 49126-10** kit , install the NEW rear differential bushing.

Special Tools

- **DT 49126-1** Press Tool
- **DT 49126-2** Press Tool
- **DT 49126-10** Bushing Replacer Hardware Kit

For equivalent regional tools, refer to **Special Tools**.

DIFFERENTIAL CARRIER BUSHING REPLACEMENT - REAR

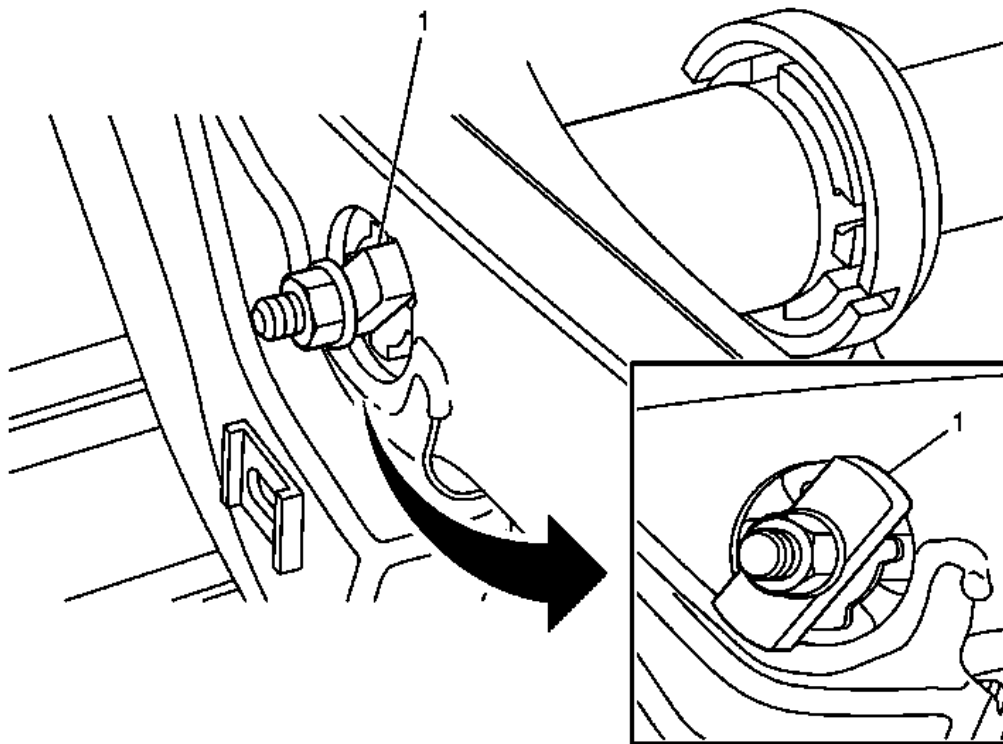


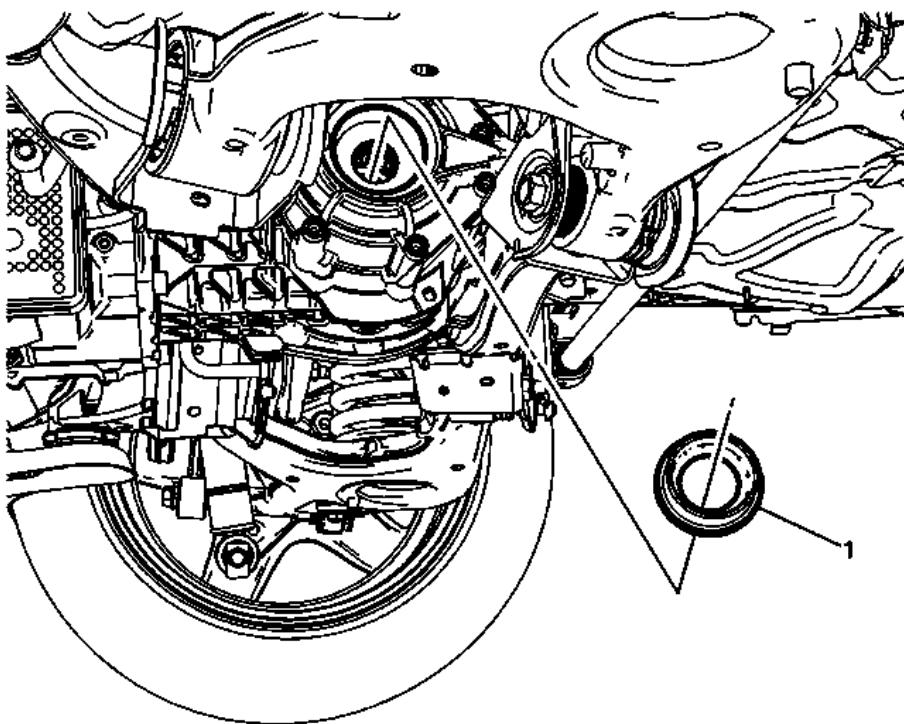
Fig. 10: Differential Carrier Bushing - Rear
Courtesy of GENERAL MOTORS COMPANY

Differential Carrier Bushing Replacement - Rear

Callout	Component Name
Preliminary Procedure	
Remove the differential carrier assembly. Refer to Differential Carrier Assembly Replacement .	
	Differential Carrier Bushing - Rear (Qty: 2)
Procedure	

1

1. Remove any debris from the area around the rear differential carrier bushing prior to removal.
2. Using the **CH-49158-1** tool and **CH-49158-2** tool , remove the rear differential carrier bushing.
3. Remove any residue from the old bushing before installing the new rear differential bushing.
4. Position the rear differential bushing in the rear support.
5. Using the **CH-49158** tool kit , install the rear differential bushings.

Special Tools**CH-49158** Presstool KitFor equivalent regional tools, refer to **Special Tools**.**REAR AXLE SHAFT SEAL REPLACEMENT - LEFT SIDE****Fig. 11: Rear Axle Shaft Seal - Left Side (Yellow Seal)**

Courtesy of GENERAL MOTORS COMPANY

Rear Axle Shaft Seal Replacement - Left Side

Callout	Component Name
Preliminary Procedure	
Remove the left rear wheel drive shaft. Refer to <u>Rear Wheel Drive Shaft Replacement</u>	
	Rear Axle Shaft Seal

Procedure

1. Using the **GE-23907-1** hammer and the **DT-29369-2** puller , remove the rear axle seal.
2. Using the **DT-48077** installer , install the rear axle seal.
3. Apply a small amount of lubricant to the contact area between the seal and axle. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
4. Check lubricant level. Refer to **Rear Axle Lubricant Level Inspection** .

1

NOTE:

Remove excess lubricant from the seal.

Special Tools

- **DT-29369-2** Drive Shaft Seal Puller
- **DT-48077** Seal Installer
- **GE-23907-1** Slide Hammer

For equivalent regional tools, refer to **Special Tools**

REAR AXLE SHAFT SEAL REPLACEMENT - RIGHT SIDE

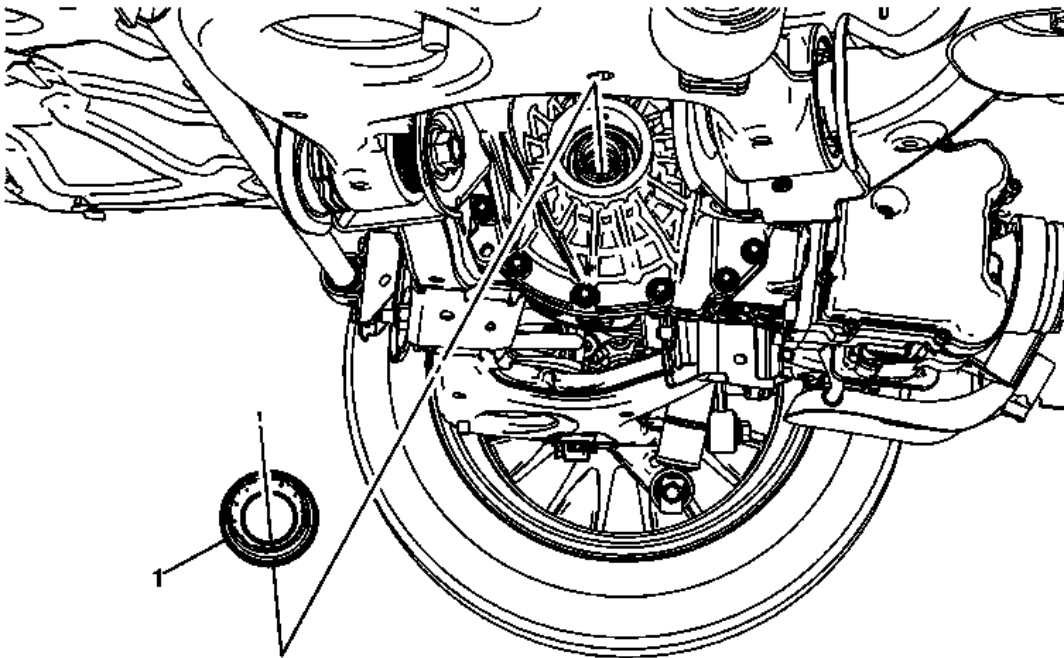


Fig. 12: Rear Axle Shaft Seal - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Rear Axle Shaft Seal Replacement - Right Side

Callout	Component Name
Preliminary Procedure Remove the right rear wheel drive shaft. Refer to <u>Rear Wheel Drive Shaft Replacement</u> .	
1	Rear Axle Shaft Seal Procedure <ol style="list-style-type: none"> Using the GE-23907-1 hammer and the DT-29369-2 puller , remove the rear axle seal. Using the DT-48077 installer , install the rear axle seal. Apply a small amount of lubricant to the contact area between the seal and axle. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. Check lubricant level. Refer to <u>Rear Axle Lubricant Level Inspection</u> NOTE: Remove excess lubricant from the seal. Special Tools <ul style="list-style-type: none"> DT-29369-2 Drive Shaft Seal Puller DT-48077 Seal Installer GE-23907-1 Slide Hammer For equivalent regional tools, refer to <u>Special Tools</u>

DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT

Removal Procedure

- Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
- If replacing the rear differential assembly, drain the rear differential fluid. Refer to **Differential Clutch Oil Replacement**, and **Differential Oil Replacement**.
- Remove the propeller shaft assembly. Refer to **Propeller Shaft Replacement** .
- Remove the exhaust muffler assembly. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
- Remove the parking brake cables. Refer to **Parking Brake Rear Cable Replacement** .
- Remove the wheel drive shaft. Refer to **Rear Wheel Drive Shaft Replacement** .
- Disconnect the electrical connectors from the rear differential assembly to the chassis.

NOTE: Ensure that the rear differential is securely fastened to the hydraulic jack stand.

8. Support the rear differential assembly with a hydraulic transmission jack.

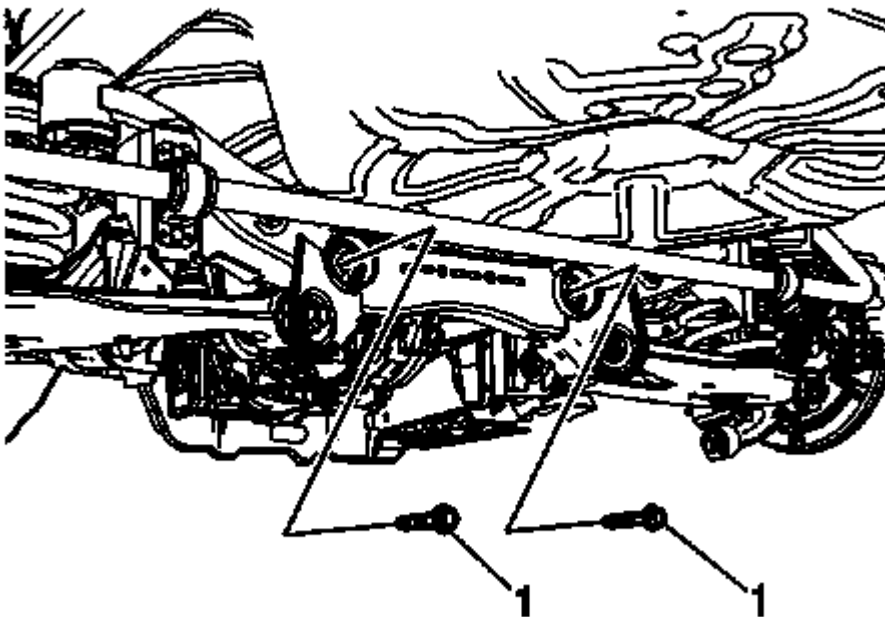


Fig. 13: Rear Differential Assembly Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the rear differential assembly mounting bolts (1).

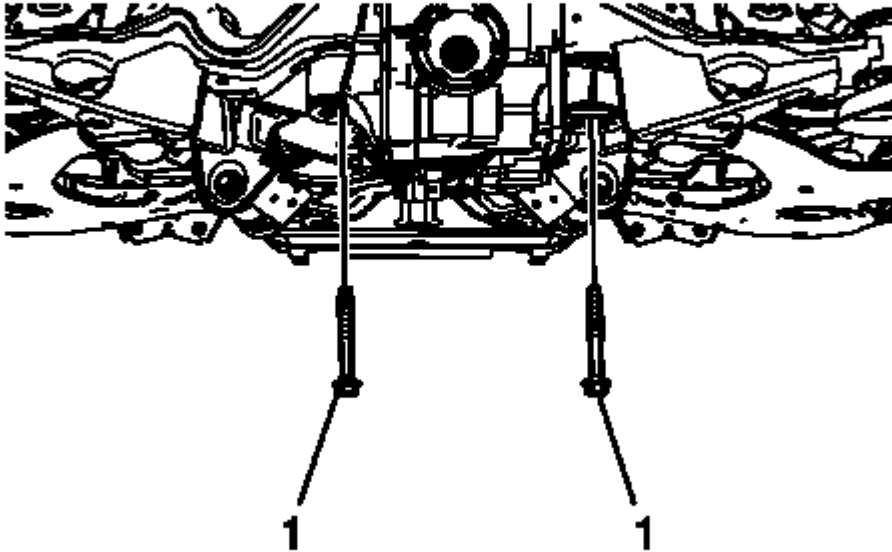


Fig. 14: Identifying Front Differential Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the front differential mounting bolts (1).

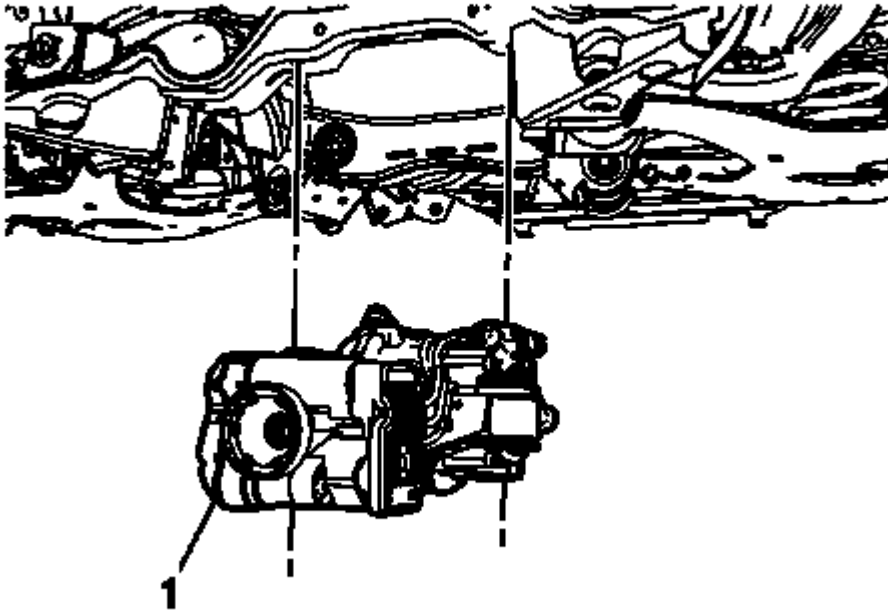


Fig. 15: Rear Differential Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Using the hydraulic jack stand, remove the rear differential assembly (1) from the vehicle.

Installation Procedure

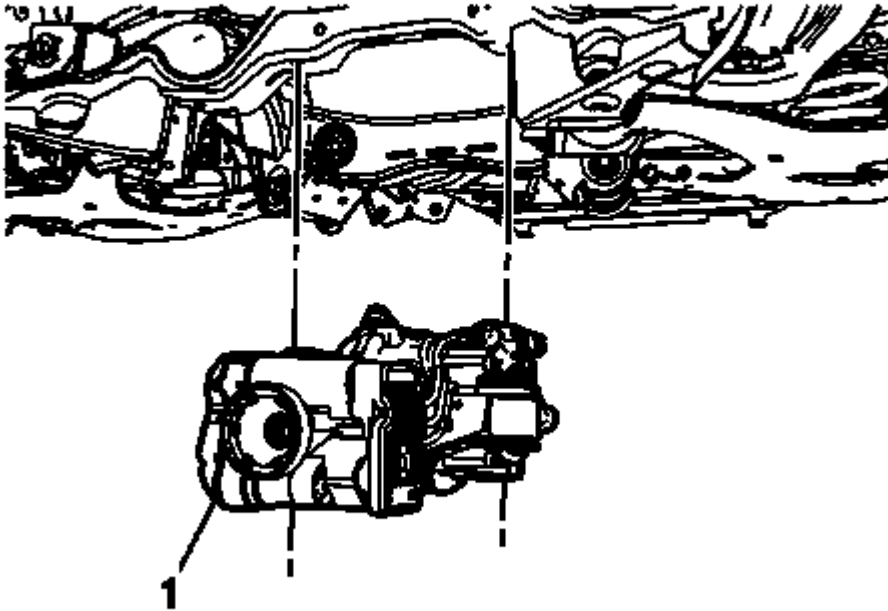


Fig. 16: Rear Differential Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Using the hydraulic jack stand, position the rear differential assembly (1) in the vehicle.

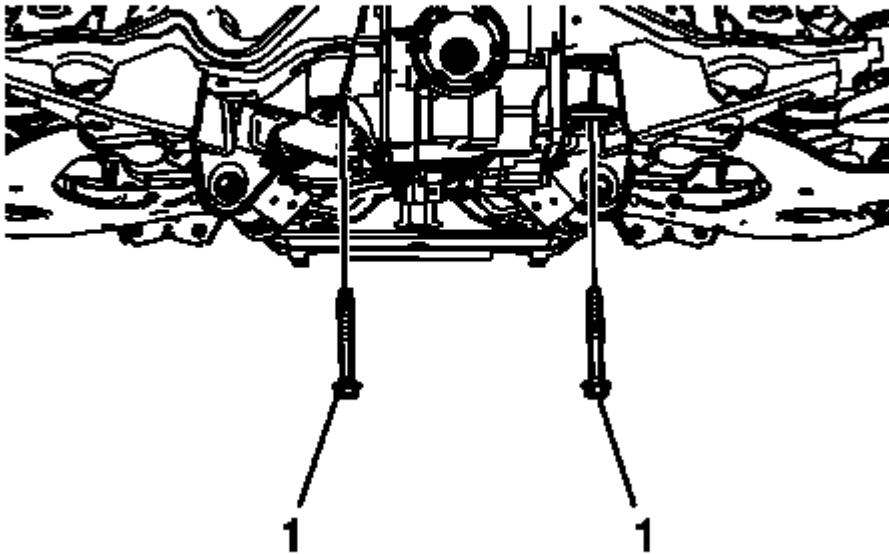


Fig. 17: Identifying Front Differential Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Clean the bolts and apply thread locker on the threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers**

CAUTION: Refer to **Fastener Caution** .

3. Install the front differential mounting bolts (1) and tighten to:
 - First Pass: 90 (66 lb ft)
 - Final Pass: plus 90 to 105 degrees

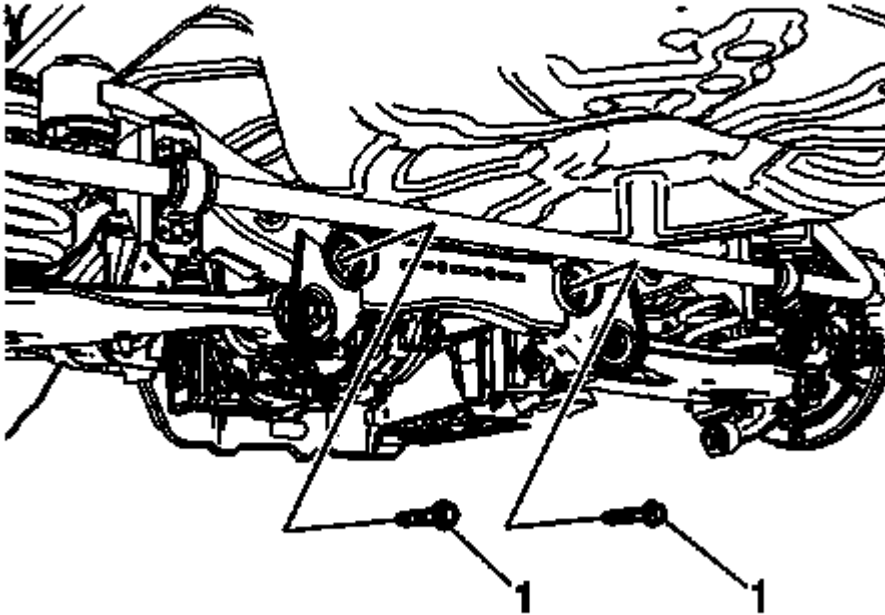


Fig. 18: Rear Differential Assembly Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the rear differential assembly mounting bolts (1) and tighten to:
 - First Pass: 90 (66 lb ft)
 - Final Pass: plus 90 to 105 degrees
5. Remove the hydraulic jack stand.
6. Install the wheel drive shafts. Refer to **Rear Wheel Drive Shaft Replacement** .
7. Install the parking brake cable . Refer to **Parking Brake Rear Cable Replacement** .
8. Reconnect the electrical connectors from the rear differential assembly to the chassis.
9. Install the exhaust muffler assembly. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
10. Install the propeller shaft assembly. Refer to **Propeller Shaft Replacement** .
11. Check the fluid level of the rear differential assembly. Refer to **Differential Clutch Oil Inspection**, and **Rear Axle Lubricant Level Inspection**.
12. If installing a NEW rear differential assembly, fill with the proper fluid. Refer to **Differential Clutch Oil Replacement**, and **Differential Oil Replacement**.
13. Remove the supports and lower the vehicle.
14. Program the rear differential assembly. Refer to **Control Module References** .

PROPELLER SHAFT FLANGE REPLACEMENT

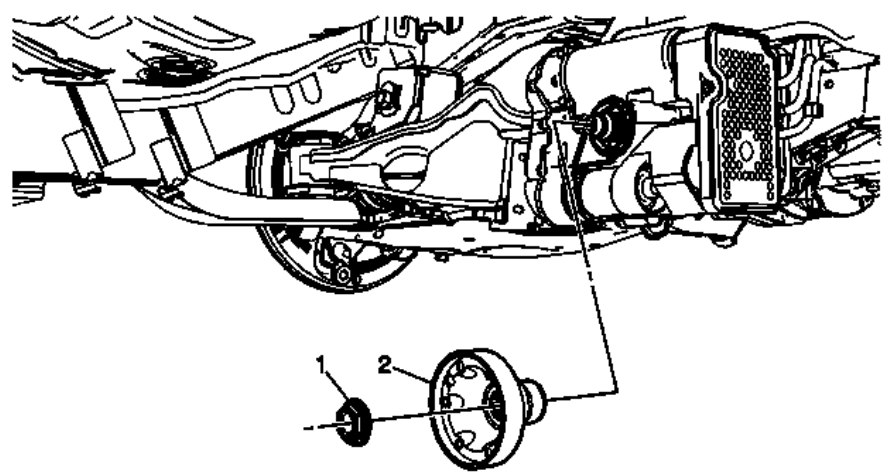


Fig. 19: View Of Propeller Shaft Flange & Nut
Courtesy of GENERAL MOTORS COMPANY

Propeller Shaft Flange Replacement

Callout	Component Name
Preliminary Procedure Remove the propeller shaft. Refer to Propeller Shaft Replacement .	
1	Propeller Shaft Flange Nut CAUTION: Refer to Fastener Caution . Procedure 1. Using the DT 44873-2 holder and the DT 8614-A holder , remove the propeller shaft flange nut. 2. Using the DT 8614-A holder , install the propeller shaft flange nut. Tighten 100 N.m (74 lb ft) Special Tools <ul style="list-style-type: none">• DT 8614-A Pinion Flange Holder• DT 44873-2 Pinion Flange Holder and Remover Bolts For equivalent regional tools, refer to Special Tools .
	Propeller Shaft Flange

2	<p>Procedure</p> <ol style="list-style-type: none"> 1. Replace the Differential Clutch Seal. Refer to <u>Differential Clutch Seal Replacement (Outer)</u>, <u>Differential Clutch Seal Replacement (Inner)</u>. 2. Inspect the oil level. Refer to <u>Differential Clutch Oil Inspection</u>.
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LIMITED SLIP DIFFERENTIAL CLUTCH PIPE CONNECTOR REPLACEMENT

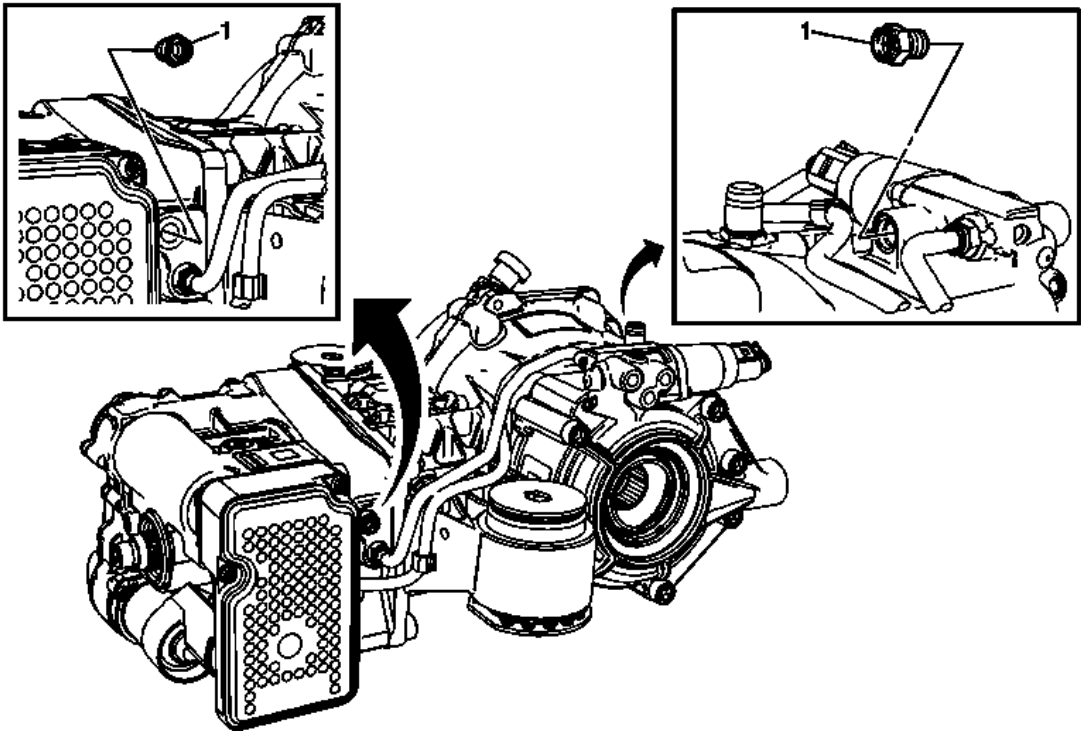


Fig. 20: Limited Slip Differential Clutch Pipe Connectors
 Courtesy of GENERAL MOTORS COMPANY

Limited Slip Differential Clutch Pipe Connector Replacement

Callout	Component Name
<p>CAUTION:</p> <p>It is very important to observe maximum cleanliness when working on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.</p> <p>Preliminary Procedure Remove the rear differential carrier assembly. Refer to <u>Differential Carrier Assembly Replacement</u>.</p>	
	<p>Limited Slip Differential Clutch Pipe Connectors (Qty: 4)</p> <p>WARNING:</p> <p>The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch.</p>

1	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove the limited slip differential clutch low pressure pipe, refer to <u>Limited Slip Differential Clutch Low Pressure Pipe Replacement</u>, or limited slip differential clutch high pressure pipe, refer to <u>Limited Slip Differential Clutch High Pressure Pipe Replacement</u>. 2. Check the fluid level of the rear differential clutch. Refer to <u>Differential Clutch Oil Inspection</u>. <p>Tighten 7 N.m (62 lb in)</p>
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LIMITED SLIP DIFFERENTIAL CLUTCH LOW PRESSURE PIPE REPLACEMENT

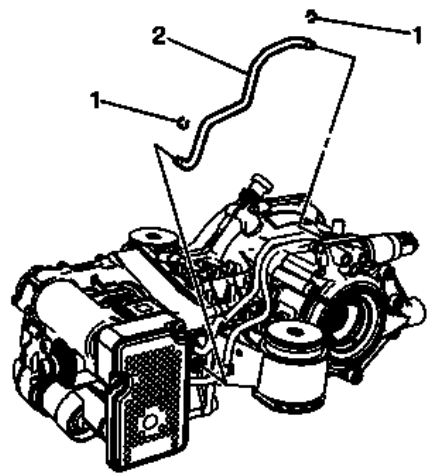


Fig. 21: View Of Limited Slip Differential Clutch Low Pressure Pipe & Springs
 Courtesy of GENERAL MOTORS COMPANY

Limited Slip Differential Clutch Low Pressure Pipe Replacement

Callout	Component Name
<p>CAUTION: It is very important to observe maximum cleanliness when working on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.</p> <p>Preliminary Procedure Remove the differential carrier assembly. Refer to <u>Differential Carrier Assembly Replacement</u>.</p>	
	<p>Limited Slip Differential Clutch Low Pressure Pipe Spring (Qty: 2)</p> <p>Procedure</p>

1	Using a small pick or flat bladed screwdriver, remove and discard the spring from the connector and replace with NEW. TIP: Ensure that the pipe is fully inserted into the connector before installing the spring.
2	Limited Slip Differential Clutch Low Pressure Pipe WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch. Procedure Check the fluid level of the rear differential clutch. Refer to <u>Differential Clutch Oil Inspection.</u>

LIMITED SLIP DIFFERENTIAL CLUTCH HIGH PRESSURE PIPE REPLACEMENT

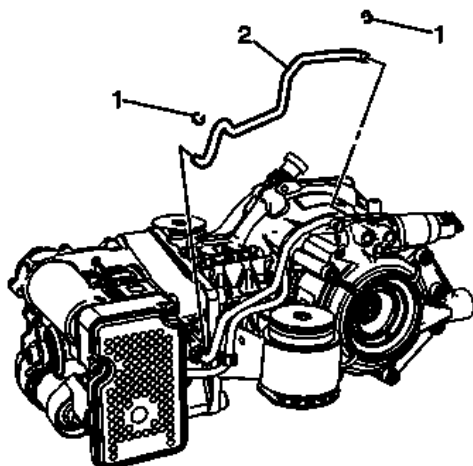


Fig. 22: Limited Slip Differential Clutch High Pressure Pipe & Springs
Courtesy of GENERAL MOTORS COMPANY

Limited Slip Differential Clutch High Pressure Pipe Replacement

Callout	Component Name
CAUTION: It is very important to observe maximum cleanliness when working on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.	
Preliminary Procedure Remove the differential carrier assembly. Refer to <u>Differential Carrier Assembly Replacement.</u>	
1	Limited Slip Differential Clutch High Pressure Pipe Spring (Qty: 2) Procedure Using a small pick or flat bladed screwdriver, remove and discard the spring from the connector and replace with NEW. TIP: Ensure that the pipe is fully inserted into the connector before installing the spring.

2

Limited Slip Differential Clutch High Pressure Pipe

WARNING:

The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch.

Procedure

Check the fluid level of the rear differential clutch. Refer to **Differential Clutch Oil Inspection.**

LIMITED SLIP DIFFERENTIAL CLUTCH VALVE REPLACEMENT

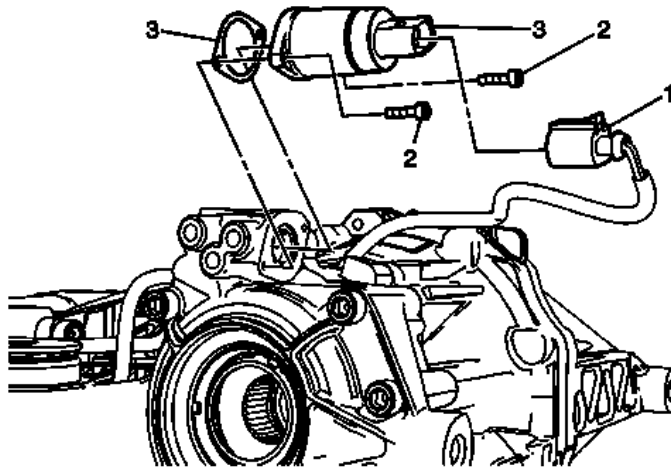


Fig. 23: View Of Limited Slip Differential Clutch Valve, Connector & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Limited Slip Differential Clutch Valve Replacement

Callout	Component Name
CAUTION: It is very important to observe maximum cleanliness when working on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.	
Preliminary Procedure Remove the propeller shaft. Refer to <u>Propeller Shaft Replacement</u> .	
1	Differential Clutch Valve Electrical Connector Procedure Lower the rear axle assembly to gain access to the differential clutch valve. Refer to <u>Differential Carrier Assembly Replacement.</u>
	Differential Clutch Valve Fastener (Qty: 2) WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch.

2	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 3 N.m (27 lb in)
3	Limited Slip Differential Clutch Valve and Gasket Procedure Check the fluid level of the rear differential clutch. Refer to <u>Differential Clutch Oil Inspection</u> . TIP: Preassemble assembly on the bench and use a new gasket. DO NOT reuse the old gasket.

LIMITED SLIP DIFFERENTIAL CLUTCH REPLACEMENT

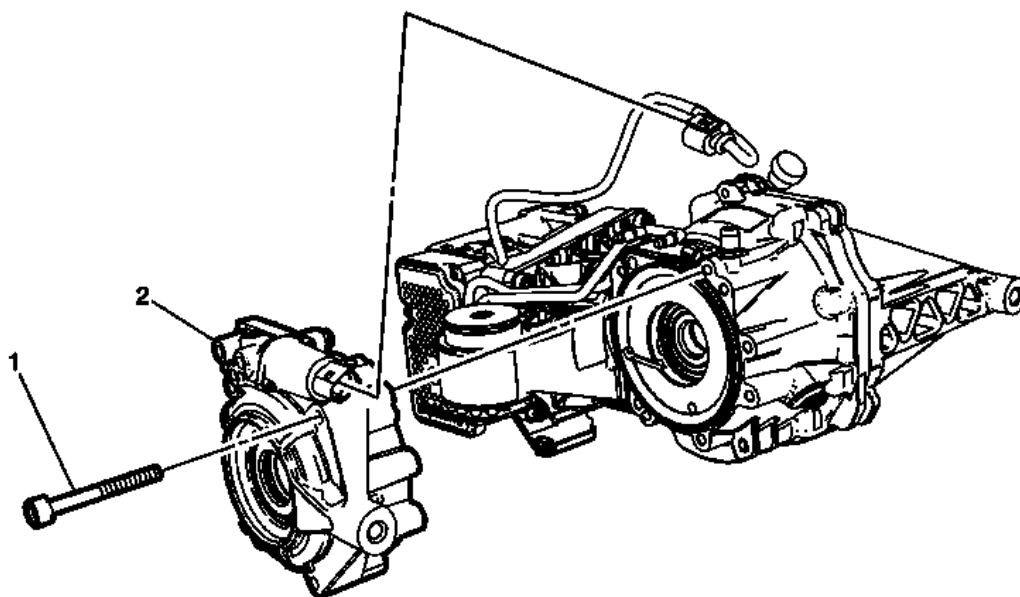


Fig. 24: View Of Limited Slip Differential Clutch & Bolts
Courtesy of GENERAL MOTORS COMPANY

Limited Slip Differential Clutch Replacement

Callout	Component Name
CAUTION: It is very important to observe maximum cleanliness when working on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.	

Preliminary Procedures

1. Remove the differential carrier assembly. Refer to **Differential Carrier Assembly Replacement**.
2. Drain the rear differential fluid. Refer to **Differential Oil Replacement**.
3. Remove the limited slip differential clutch low pressure pipes. Refer to **Limited Slip Differential Clutch Low Pressure Pipe Replacement**.
4. Remove the limited slip differential clutch high pressure pipes. Refer to **Limited Slip Differential Clutch High Pressure Pipe Replacement**.

1	<p>Limited Slip Differential Clutch Bolt (Qty: 6)</p> <p>WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch.</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Remove the electrical connector for the limited slip differential valve. Tighten 30 N.m(22 lb ft)</p>
2	<p>Limited Slip Differential Clutch</p> <p>Procedure</p> <ol style="list-style-type: none">1. Ensure sealing surface is clean and free of any old seal material and new seal is attached to clutch upon installation.2. Check the fluid level of the rear drive axle. Refer to <u>Differential Clutch Oil Inspection</u>, and <u>Differential Oil Replacement</u>.

DIFFERENTIAL SEAL REPLACEMENT

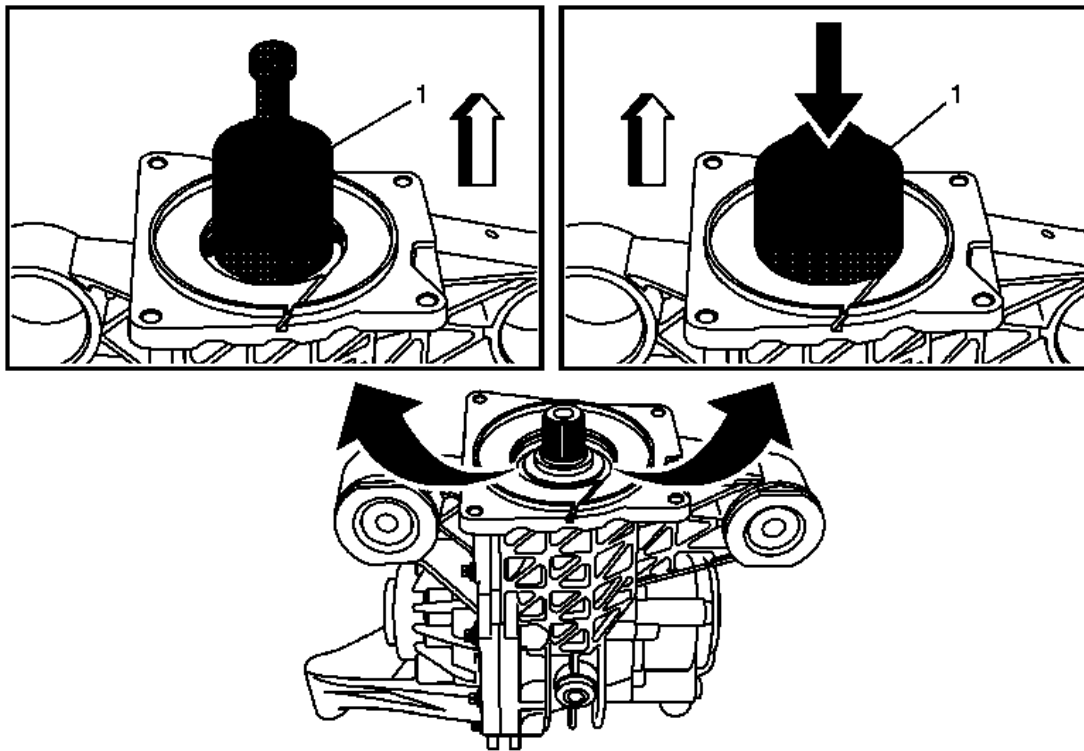


Fig. 25: Differential Seal And Special Tools
 Courtesy of GENERAL MOTORS COMPANY

Differential Seal Replacement

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none"> 1. Remove the differential carrier assembly. Refer to <u>Differential Carrier Assembly Replacement</u>. 2. Drain the rear axle from oil. Refer to <u>Differential Oil Replacement</u>. 	
1	<p>Differential Seal</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Using DT-49231 remover , tighten the puller bolts properly before removing the seal. 2. Using DT-869-4 installer , install the differential seal. 3. Fill the rear axle to the proper level with new fluid. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. <p>Special Tools</p> <ul style="list-style-type: none"> • DT-49231 Seal Remover • DT-869-4 Seal Installer

For equivalent regional tools, refer to **Special Tools**.

DIFFERENTIAL CLUTCH REPLACEMENT

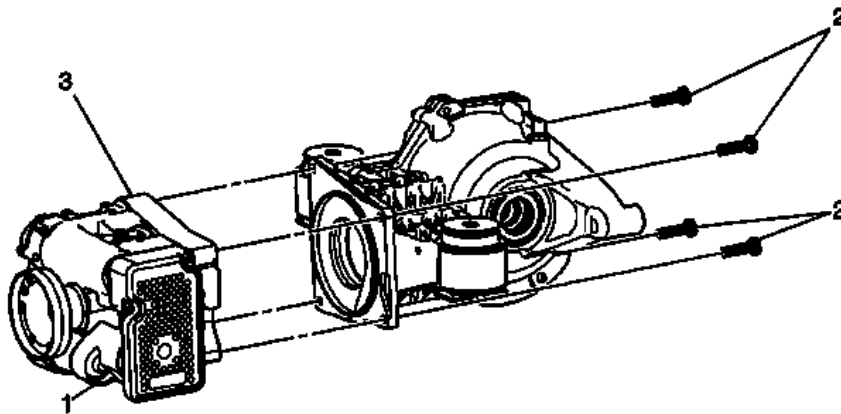


Fig. 26: Identifying Differential Clutch Assembly, Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

Differential Clutch Replacement

Callout	Component Name
CAUTION: It is very important to observe maximum cleanliness when working on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.	
Preliminary Procedure Remove the rear differential assembly from the vehicle. Refer to Differential Carrier Assembly Replacement .	
1	Protective Cover
2	Rear Axle Fastener (Qty: 4) WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch. CAUTION: Refer to Fastener Caution . Tighten 30 N.m (22 lb ft)
	Differential Clutch Procedure

3

1. Remove the limited slip differential clutch pipes, if needed.
 - For the limited slip differential clutch low pressure pipe, refer to **Limited Slip Differential Clutch Low Pressure Pipe Replacement**.
 - For the limited slip differential clutch high pressure pipe, refer to **Limited Slip Differential Clutch High Pressure Pipe Replacement**.
2. Check/fill oil level in the rear differential clutch. Refer to **Differential Clutch Oil Inspection**.
3. Program the rear differential clutch control module. Refer to **Service Programming System (SPS)** .

DIFFERENTIAL CLUTCH PUMP REPLACEMENT

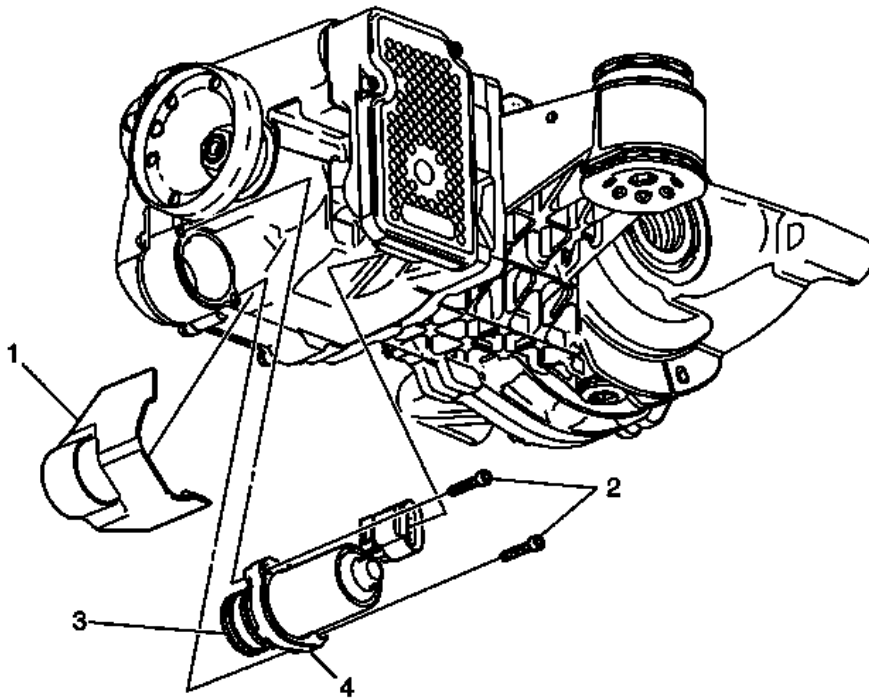


Fig. 27: Identifying Differential Clutch Pump & Components
 Courtesy of GENERAL MOTORS COMPANY

Differential Clutch Pump Replacement

Callout	Component Name
CAUTION: It is very important to observe maximum cleanliness when working on the differential clutch. Dirt particles can seriously damage the function and service life of the differential clutch.	
Preliminary Procedure Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Differential Carrier Splash Guard Shield, If Installed

2	<p>Differential Clutch Pump Bolts</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Clean the threads and apply LOCTITE™. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. Tighten 6 N.m (53 lb in)</p>
3	Differential Clutch Pump O-rings (Qty: 2)
4	<p>Differential Clutch Pump</p> <p>WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove the electrical connector from the differential clutch pump. 2. Check the fluid level of the differential clutch. Refer to <u>Differential Clutch Oil Inspection</u>. <p>TIP: Approximately 80 ml of oil will drain when the pump is removed.</p>

DIFFERENTIAL CLUTCH SEAL REPLACEMENT (OUTER)

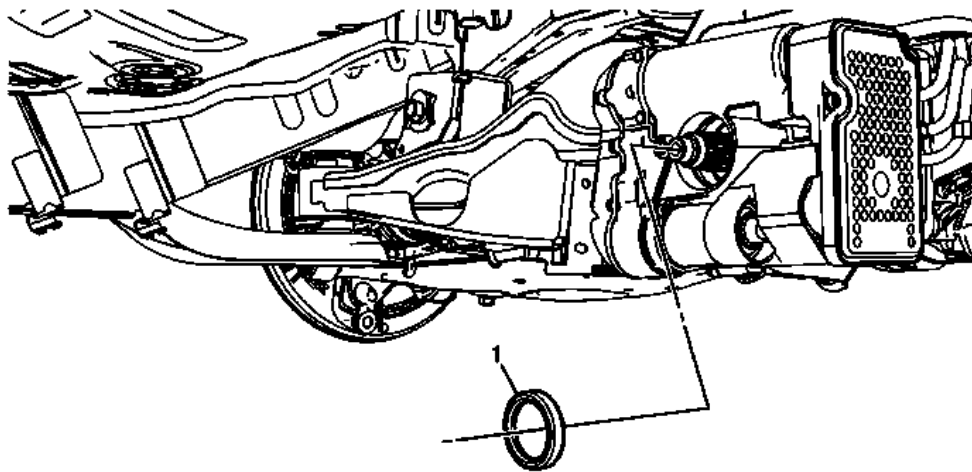


Fig. 28: Identifying Differential Clutch Seal (Outer)
Courtesy of GENERAL MOTORS COMPANY

Differential Clutch Seal Replacement (Outer)

Callous	Component Name
Preliminary Procedure Remove the propeller shaft flange. Refer to Propeller Shaft Flange Replacement .	
1	Differential Clutch Seal
	Procedure 1. Remove the differential clutch seal. 2. Using the DT 49065 installer , install the differential clutch seal. 3. Check lubricant level. Refer to Differential Clutch Oil Inspection .
	Special Tools DT 49065 Seal Installer
	For equivalent regional tools, refer to Special Tools .

DIFFERENTIAL CLUTCH SEAL REPLACEMENT (INNER)

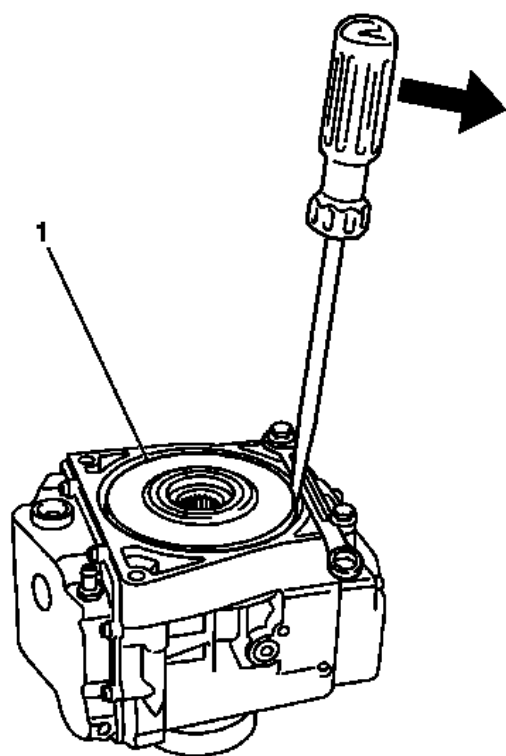


Fig. 29: Locating Differential Seal (Inner)
Courtesy of GENERAL MOTORS COMPANY

Differential Clutch Seal Replacement (Inner)

Callout	Component Name

Preliminary Procedure

Remove the differential clutch. Refer to **Differential Clutch Replacement**.

1	<p>Differential Clutch Seal</p> <p>Procedure</p> <ol style="list-style-type: none">1. Position a wrench cross the differential clutch.2. Using a flat bladed screwdriver, remove the differential clutch seal (1).3. Remove the open end wrench.4. Apply a small amount of lubricant to the seal prior to installing it in the differential clutch. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>.5. Using the DT- 50022 installer and the DT 8092 handle , install the differential clutch seal (1). <p>TIP: The seal shall be flush with the axle.</p> <p>Special Tools</p> <ul style="list-style-type: none">• DT 8092 Universal Handle• DT 50022 Seal Installer <p>For equivalent regional tools, refer to <u>Special Tools</u>.</p>
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DIFFERENTIAL CLUTCH OIL FILTER REPLACEMENT

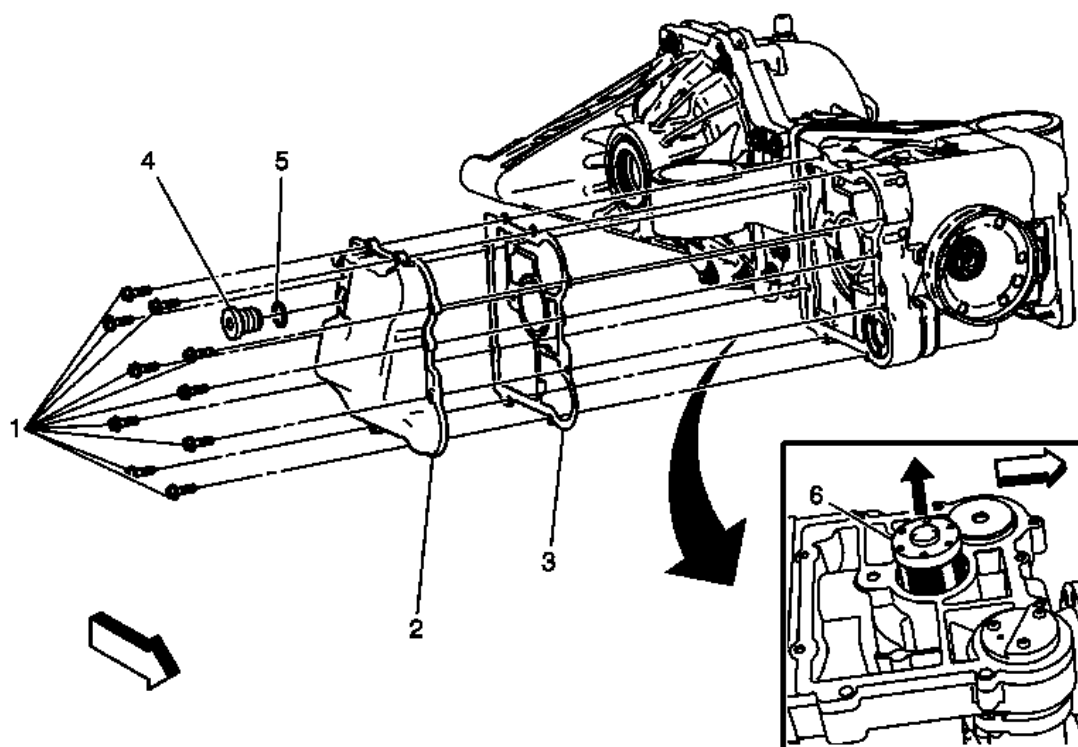


Fig. 30: Differential Clutch Oil Filter & Components
 Courtesy of GENERAL MOTORS COMPANY

Differential Clutch Oil Filter Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the propeller shaft. Refer to <u>Propeller Shaft Replacement</u> . 2. Lower the differential clutch assembly, just enough to reach the cover. Do not damage the drive shaft universal joints. Refer to <u>Rear Differential Clutch Control Module Replacement</u> .	
1	Differential Clutch Cover Bolts (Qty: 10) WARNING: The hydraulic pressure in the differential clutch is very high. To prevent personal injury, wait for at least 10 minutes before removing any parts from the differential clutch. CAUTION: Refer to <u>Fastener Caution</u> . Tighten 6 N.m (53 lb in)
2	Differential Clutch Cover
	Differential Clutch Gasket

3	Procedure Install a new gasket.
4	Differential Clutch Oil Plug Tighten Tighten 14 N.m (10 lb ft)
5	Differential Clutch Oil Plug Sealing Procedure Use a new sealing.
6	Differential Clutch Oil Filter Procedure Fill new fluid in the differential clutch. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> , and <u>Differential Clutch Oil Replacement</u> .

LIMITED SLIP DIFFERENTIAL DISASSEMBLE

CAUTION: Refer to **Fastener Caution** .

1. Drain the oil from the limited slip differential and fit the drain plug with a new seal and tighten to 25 N.m (18.4 lb ft).
2. Remove the complete unit, differential clutch and limited slip differential. Refer to **Differential Carrier Assembly Replacement**
3. Seal the drive shaft holes in the limited slip differential and clean the housing.
4. Place the unit on its side.

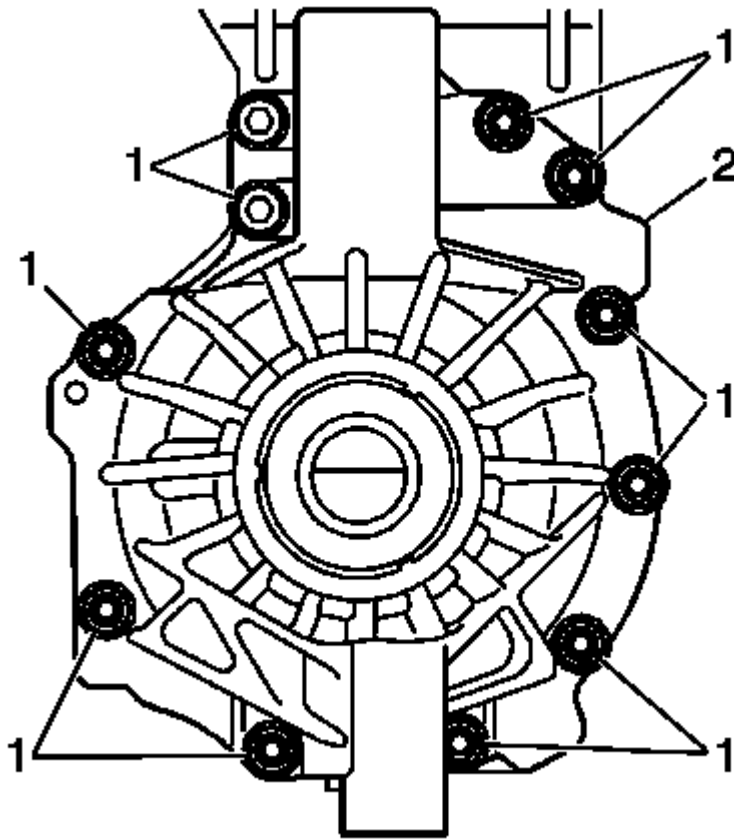


Fig. 31: Identifying Differential Housing Bolts & Right-Hand Limited Slip Differential Housing
Courtesy of GENERAL MOTORS COMPANY

5. Remove the bolts (1).
6. Remove the right-hand limited slip differential housing (2).

LIMITED SLIP DIFFERENTIAL ASSEMBLE

1. Clean sealant from the sealing surfaces and wash with a suitable degreaser. Refer to **Adhesives, Fluids, Lubricants, and Sealers**

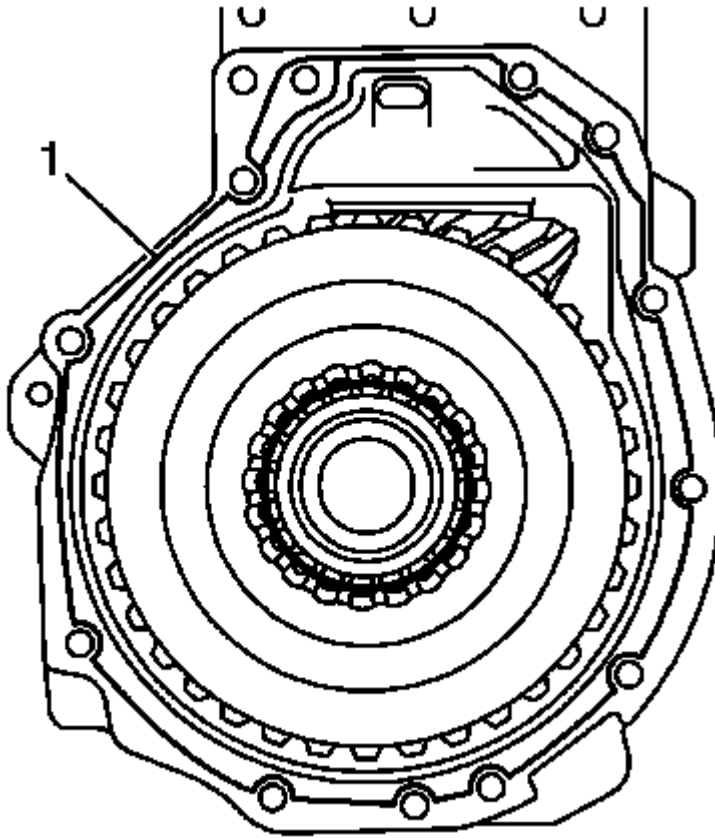


Fig. 32: Sealant Bead Application Area
Courtesy of GENERAL MOTORS COMPANY

2. Apply a bead of (1) Sealing adhesive to one sealing surface Refer to **Adhesives, Fluids, Lubricants, and Sealers**

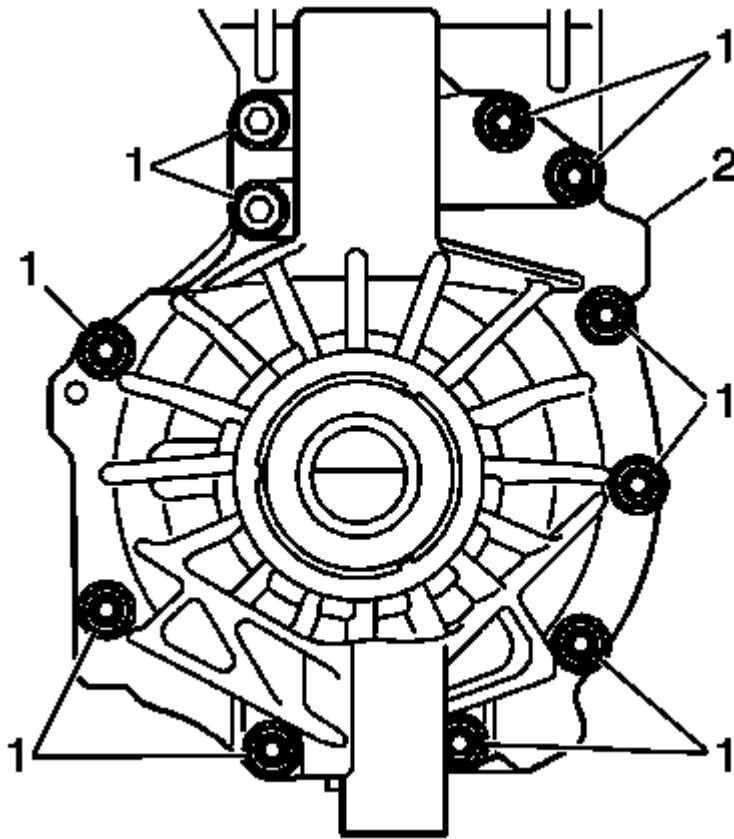


Fig. 33: Identifying Differential Housing Bolts & Right-Hand Limited Slip Differential Housing
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Fit the right-hand limited slip differential housing (2) using new bolts (1) and tighten to 45 N.m (33 lb ft).
4. Fit Complete unit, differential clutch and limited slip differential. Refer to **Differential Carrier Assembly Replacement**
5. Fill the limited slip differential with oil, using a clean funnel and hose. The oil level should be below the hole. For oil type and volume refer to **Adhesives, Fluids, Lubricants, and Sealers**.
6. Fit the level plug with a new sealing washer and tighten to 25 N.m (18.4 lb ft).

DESCRIPTION AND OPERATION

ALL-WHEEL DRIVE DESCRIPTION AND OPERATION

Components

The all-wheel drive system consists of 5 main components:

- Transfer case
- Propeller shaft
- Differential clutch
- Limited slip differential
- Rear differential clutch control module

Transfer Case

The transfer case is located to the right of the gearbox, to which it is bolted. Its function is to take power from the gearbox and transfer it via a hypoid gear and a propeller shaft to the differential clutch.

Differential Clutch

The function of the differential clutch is to control the torque to the rear wheels. It can be varied between 0-100% drive via a hydraulically controlled multi-disc clutch. The differential clutch is bolted to the limited slip differential with 4 bolts.

Propeller Shaft

The function of the propeller shaft is to transfer power from the transfer case to the differential clutch.

Limited Slip Differential

The limited slip differential, also called rear drive module, is located in the subframe and the drive shafts extend from it to each rear wheel. The limited slip differential consists of a hypoid gear and a differential. The limited slip differential is fully mechanical. The limited slip differential clutch, if installed, is bolted with 6 bolts to the left-hand side of the limited slip differential. Its function is to fully or partly lock the left-hand drive shaft to the differential housing. When this takes place the drive torque can be distributed between the rear wheels. The limited slip differential clutch is a disc type, and it is electro-hydraulically controlled by the rear differential clutch control module via a pressure control valve which is fitted on the limited slip differential clutch housing. The rear differential clutch control module calculates drive torque distribution. There are two variants: with and without limited slip differential clutch for the rear wheels.

Hydraulic Pump

The hydraulic pump consists of an electric motor and a pump housing. It is supplied with power from the rear differential clutch control module. The motor drives a five cylinder axial piston pump in the pump housing which produces an operating pressure of 2 700-3 200 kPa (392-464 PSI). The pressure control valve is electrically controlled and its function is to regulate the hydraulic pressure (0-3 000 kPa (435 PSI)) to the operating piston. It is directly connected to the rear differential clutch control module which supplies it with a pulse width modulated voltage. The rear differential control module activates the output to the hydraulic pump as soon as the following conditions are fulfilled: "ignition ON" and "engine started". The output is active until the calculated pressure is approximately 3 200 kPa (464 PSI). The pressure is calculated by means of the rear differential control module measuring the electric motor power consumption. The higher the pressure, the greater the resistance is for the electric motor to drive the pump itself, and the higher the current becomes. When the system pressure is approximately 3 200 kPa (464 PSI) (fully charged accumulator) the accumulator

piston exposes the unloading holes and the pressure does not increase further. The current to the motor does not increase any further but remains constant. The maximum system pressure is reached, the rear differential control module shuts down the pump. Restart takes place when the calculated pressure is below approximately 2 700 kPa (392 PSI).

Rear Differential Clutch Control Module

The rear differential clutch control module is fitted on the housing. The hydraulic pressure is built up by an electrically driven pump, and is controlled by the rear differential clutch control module via a solenoid valve. By using information on the bus the rear differential clutch control module calculates the drive torque distribution between front and rear axles as well as the distribution between the rear wheels for cars with limited slip differential clutch. The rear differential clutch control module is connected to the vehicle communication bus. The bus messages are used to determine the operating/driving conditions for the vehicle, and accordingly how much drive torque should be transferred to the rear wheels. The rear differential clutch control module and the control valve are calibrated together, they must be replaced together without exception.

The rear differential clutch control module has a monitoring for the bus communication, inputs, outputs, certain mechanical faults and internal control module faults. If relevant control module functions are missing or other mechanical or electrical faults are recognized diagnostic trouble codes are generated.

- Internal signals

The control module has a monitoring for internal control module faults.

- Input signals

The control module has an input for an internal temperature sensor. The temperature sensor is fitted on the rear differential control module circuit board and is monitored for electrical faults. The temperature sensor is also used by the rear differential control module to calculate the current fluid and disc pack temperature in the differential clutch.

- Output signals

The control module has pressure control valve outputs for differential clutch and limited slip differential clutch (if fitted) respectively, as well as for the pump motor. These are monitored for electrical faults.

- Mechanical functions

The control module can diagnose clogged pressure control valves and leaking check valves.

DIFFERENTIAL CARRIER ASSEMBLY DESCRIPTION

General

The differential carrier assembly is located in the rear subframe and the drive shafts extend from it to each respective rear wheel. The final drive gear consists of a hypoid gear and a differential. The assembly is bolted to the subframe with 4 bolts.

The splines-equipped pinion shaft for the final drive gear is directly inserted into the disc cage for the differential.

During manufacture the differential carrier assembly is filled with oil, which then does not require changing. The correct type of oil must be used without exception when filling. The incorrect type of oil may destroy the differential. The differential is fully mechanical.

Housing

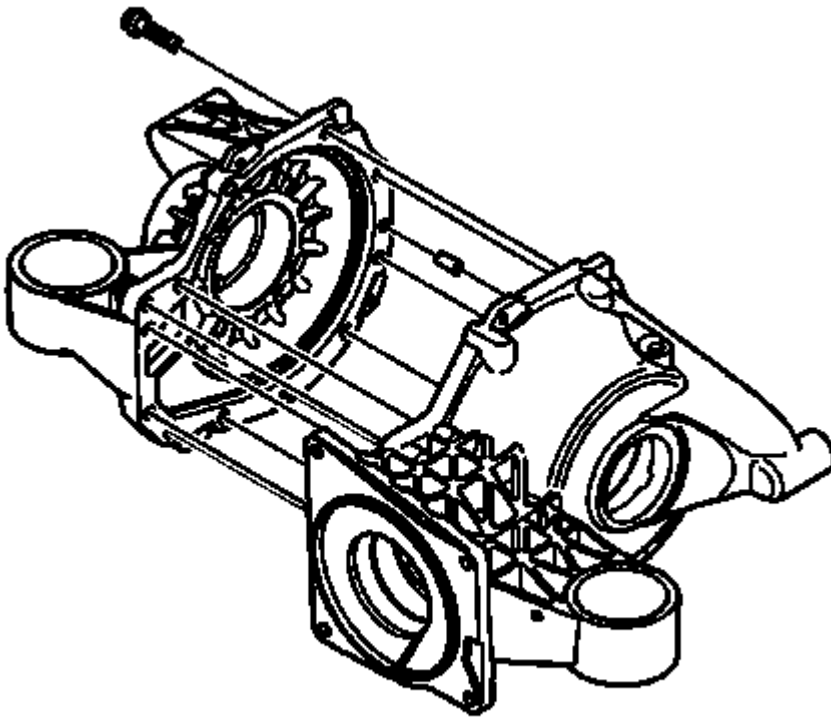


Fig. 34: Identifying Differential Carrier Assembly Housing & Bolts
Courtesy of GENERAL MOTORS COMPANY

The differential carrier assembly housing consists of two halves, a right and left-hand half, bolted to each other with 11 bolts. Their relative position is governed by two guide pins. Housing and cover are produced from a high-pressure cast aluminium alloy. A number of reinforcement ribs are fitted in suitable locations to strengthen the housing and cover. The mating face between them is sealed using sealant.

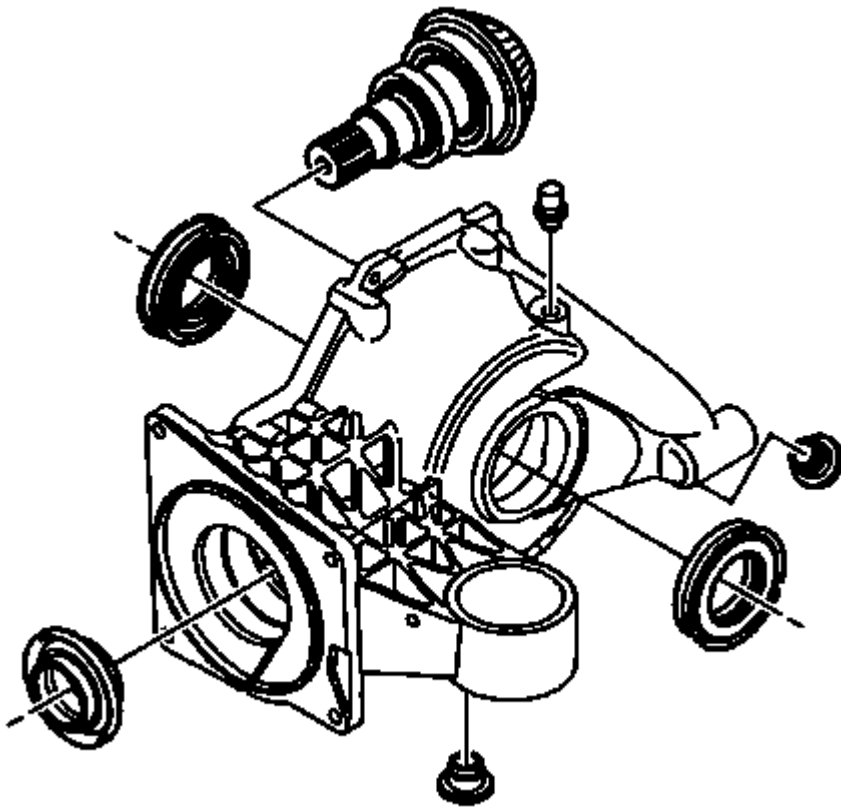


Fig. 35: Locating Differential Carrier Assembly Housing & Seals
Courtesy of GENERAL MOTORS COMPANY

The left-hand half contains pinion, oil level plug, drain plug, air valve, bearing race for the final drive gear's left-hand bearing, stuffing box for sealing at the drive shaft lead-through. If the car is equipped with limited slip differential clutch then it is bolted to the left-hand half of the final drive gear.

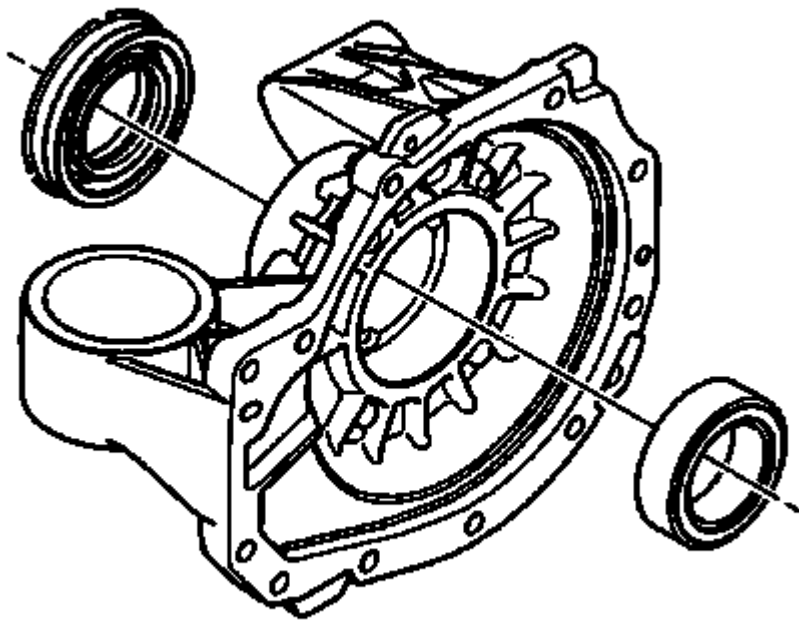


Fig. 36: View Of Final Drive Bearings
Courtesy of GENERAL MOTORS COMPANY

The right-hand half contains bearing race for the final drive gear's right-hand bearing as well as stuffing box for sealing at the drive shaft lead-through.

Pinion

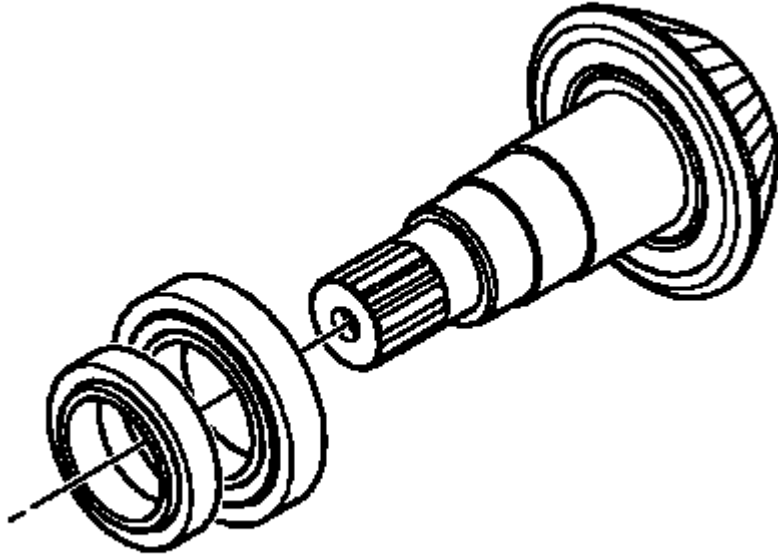


Fig. 37: View Of Pinion Gear & Bearings
Courtesy of GENERAL MOTORS COMPANY

The pinion is fitted in the final drive gear's left-hand housing and cannot be replaced. It is mounted with two conical roller bearings, fitted towards each other. The bearing closest to the pinion gear absorbs forces that attempt to press the pinion gear from the crown wheel, while the farther bearing absorbs the forces that attempt to press the pinion gear into the crown wheel. The bearings have the correct preload by means of a nut fitted on the shaft being tightened until the correct bearing preload is obtained.

The pinion gear's gear contact to the crown wheel is governed by shims. A stuffing box in the front edge of the left-hand housing seals against the pinion shaft.

The pinion is matched together with the crown wheel.

Differential, assembly

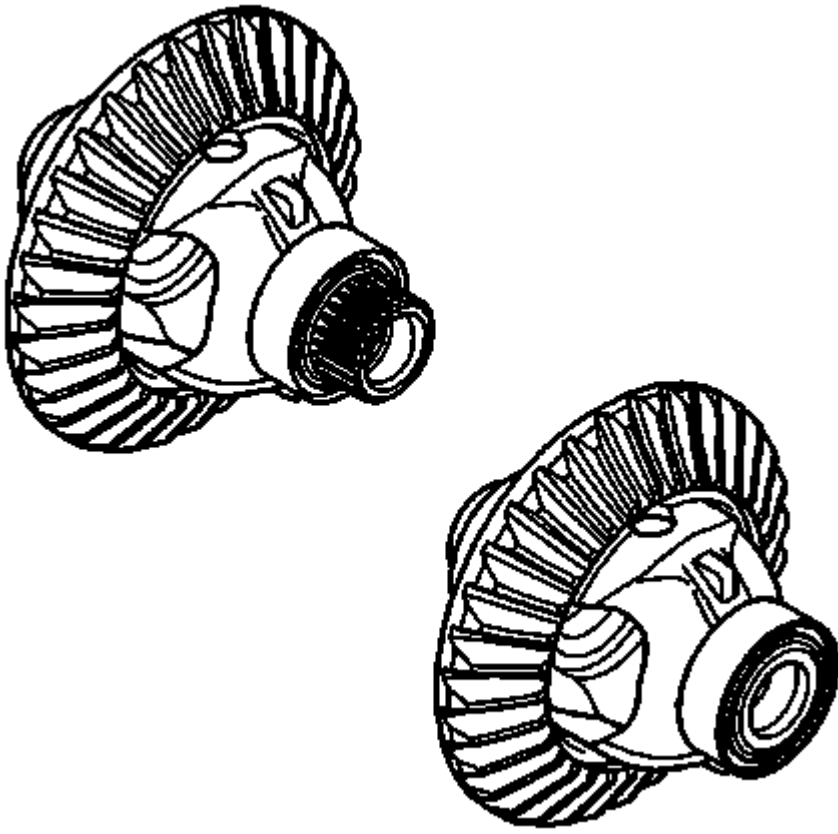


Fig. 38: Identifying Differential, assembly
Courtesy of GENERAL MOTORS COMPANY

The differential consists of a crown wheel and differential housing with associated gears. It is fitted in the left-hand half of the final drive gear housing. The crown wheel is laser welded to the differential housing.

The differential is made up of a forged housing, two differential gears and two drive shaft gears. The differential gears are mounted on a ground and hardened shaft journal, the ends of which are attached into the differential housing and locked by the crown wheel. The drive shaft gears are internally equipped with splines in which the drive shafts fit. Behind the gears, towards the differential housing, there is a spring-loaded thrust washer which provides the drive shaft gears with the correct gear contact to the differential gears. The drive shafts are mounted directly in the differential housing material, the lead-throughs are equipped with lubricating grooves.

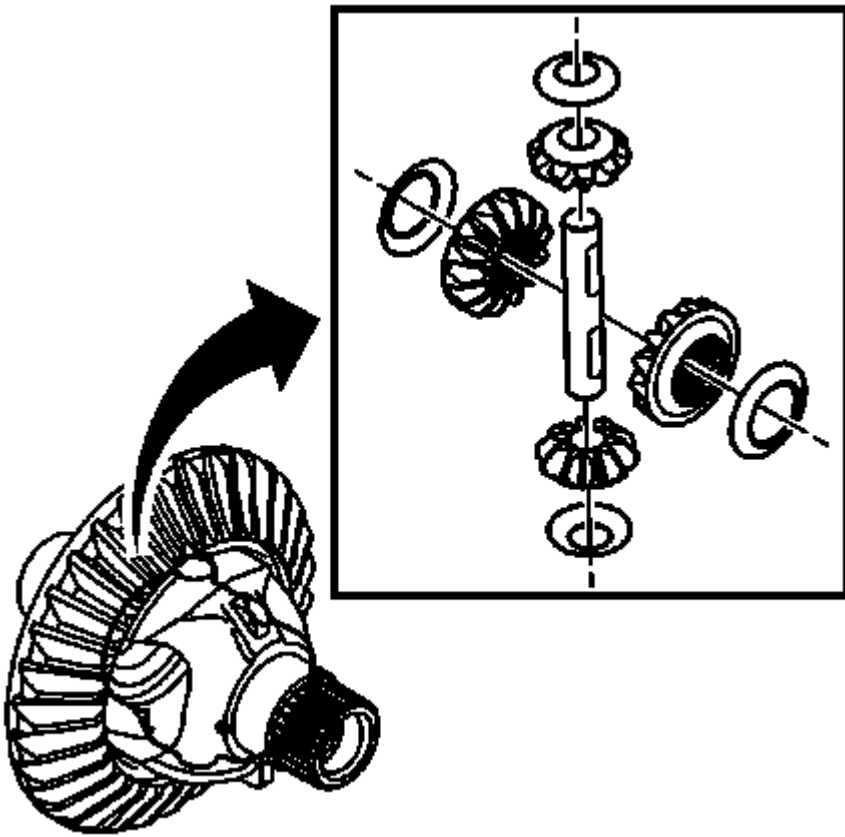


Fig. 39: View Of Differential Unit Components
Courtesy of GENERAL MOTORS COMPANY

The differential unit is mounted in two conical roller bearings. The bearings are given the correct preload at manufacture by means of shims being fitted behind the bearing races in the respective housing.

The function of the differential is to allow the outer wheel to rotate faster than the inner wheel when cornering.

LIMITED SLIP DIFFERENTIAL DESCRIPTION AND OPERATION

The limited slip differential clutch is bolted with 6 bolts to the left-hand side of the differential carrier. Their relative position is governed by 2 guide pins and a flange on the final drive gear.

Its function is to fully or partly lock the left-hand drive shaft to the differential housing. When this takes place wheel torque can be distributed between the rear wheels.

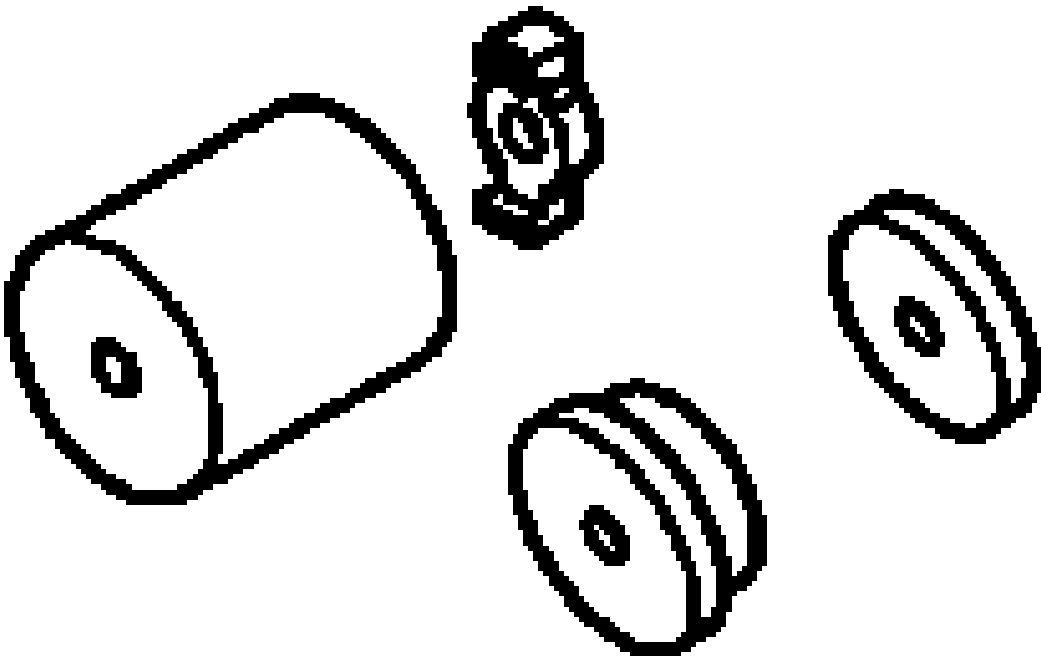
The limited slip differential clutch is a disc type, and it is electro-hydraulically controlled by the rear drive control module (RDCM) via a pressure control valve which is fitted on the limited slip differential clutch housing. The disc pack assembly consists of a hub, smooth steel driven plates with friction material, clutch cage, thrust bearing and journal bearing. The disc pack function is to steplessly distribute the torque between the rear wheels. It consists of 9 driven plates connected to the hub. They are produced in steel and are smooth. Between the smooth steel driven plates are 8 steel discs equipped with friction material.

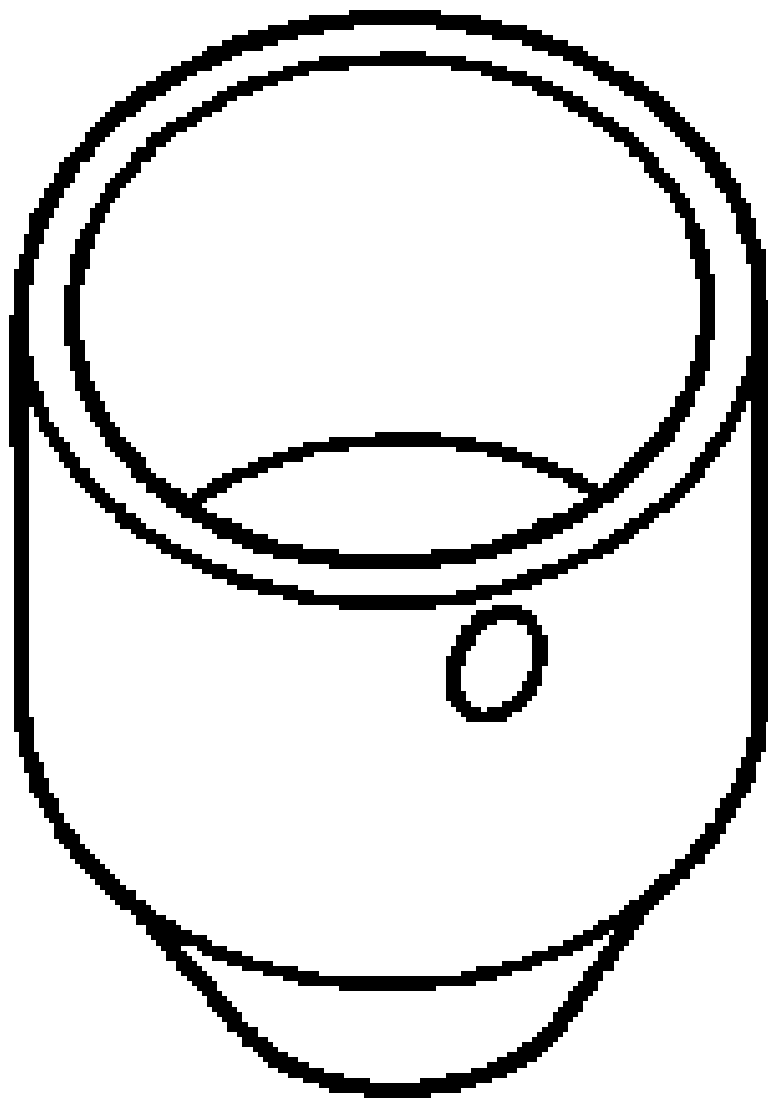
The disc pack is compressed by means of an operating piston. On the rear of the piston a variable oil pressure (0-30 bar, 0-3000 kPa) acts via the pressure control valve which is controlled by the RDCM.

For cooling and lubrication of the disc pack the hub is equipped with 3 longitudinal oil ducts. They are supplied with oil from a chamber in connection with differential carrier. The oil is led through the ducts to the center of the disc pack and is thrown out through the driven plates when they rotate.

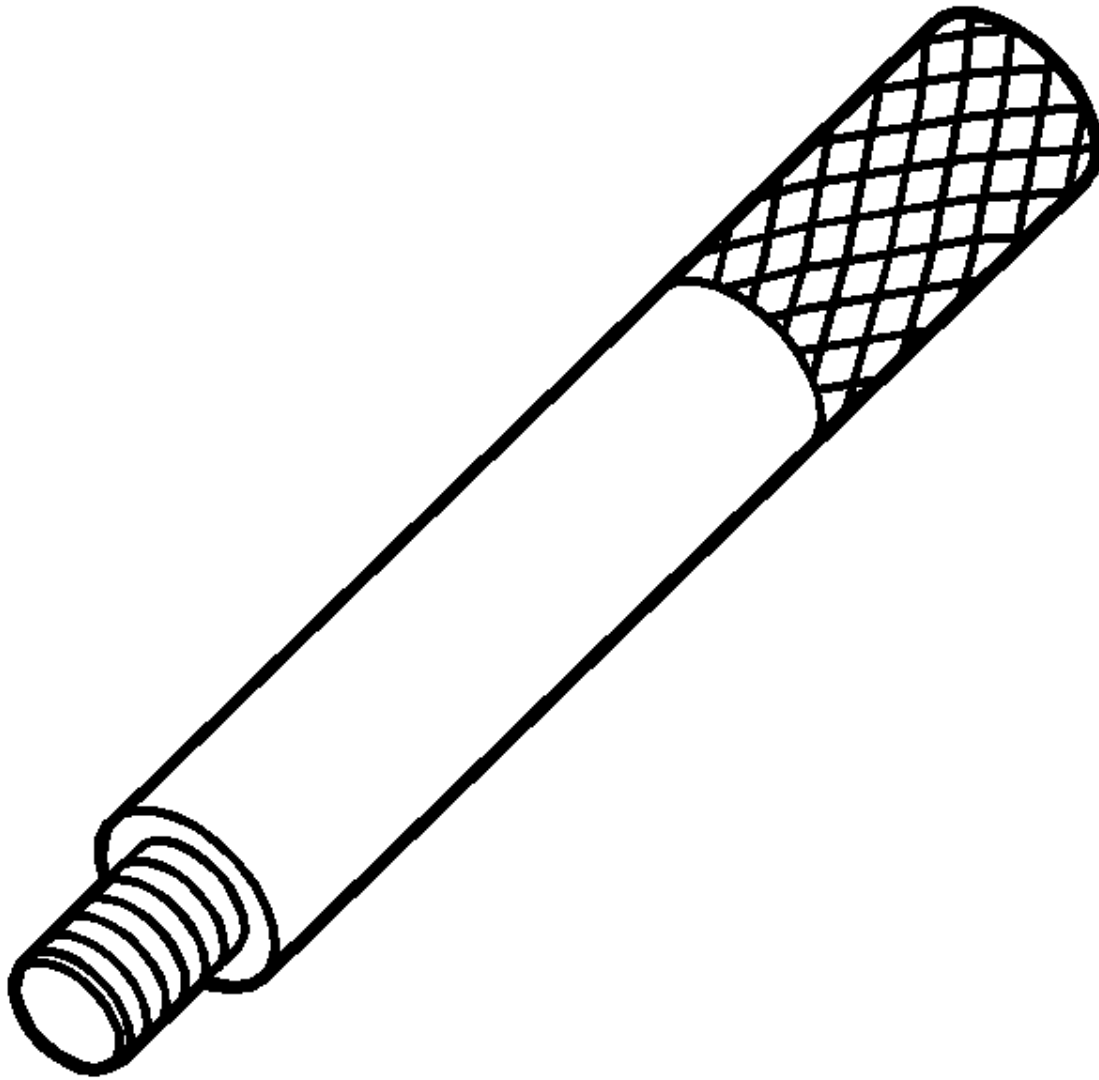
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

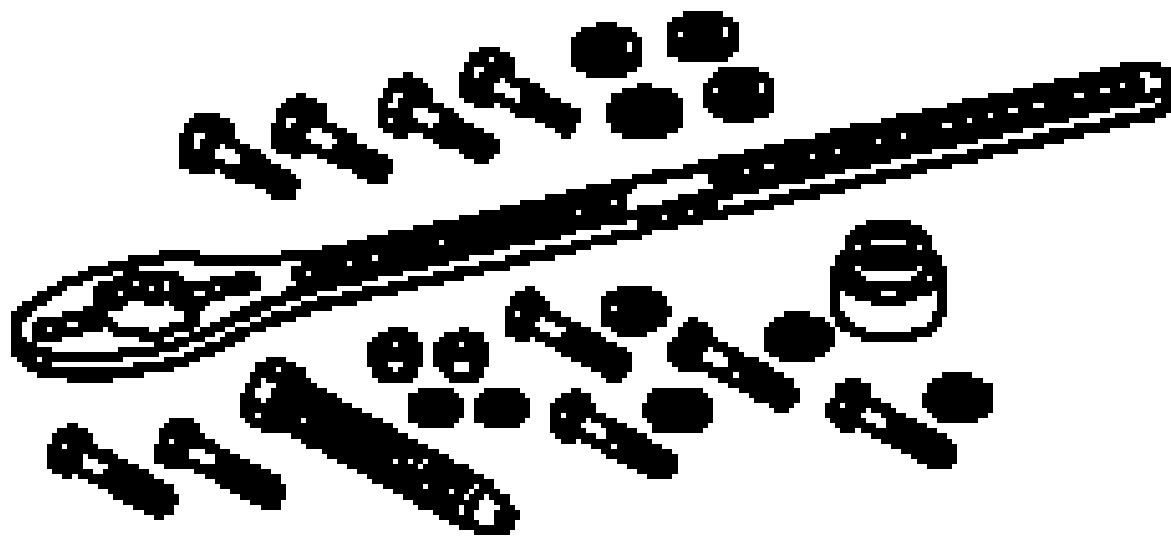
Illustration	Tool Number/Descrip
 A technical line drawing showing a piston on the left and three discs on the right. The piston is a cylinder with a central bore. The three discs are arranged in a triangular pattern to the right of the piston. Each disc has a central hole and a raised outer rim.	CH-49158 Press Tool Kit



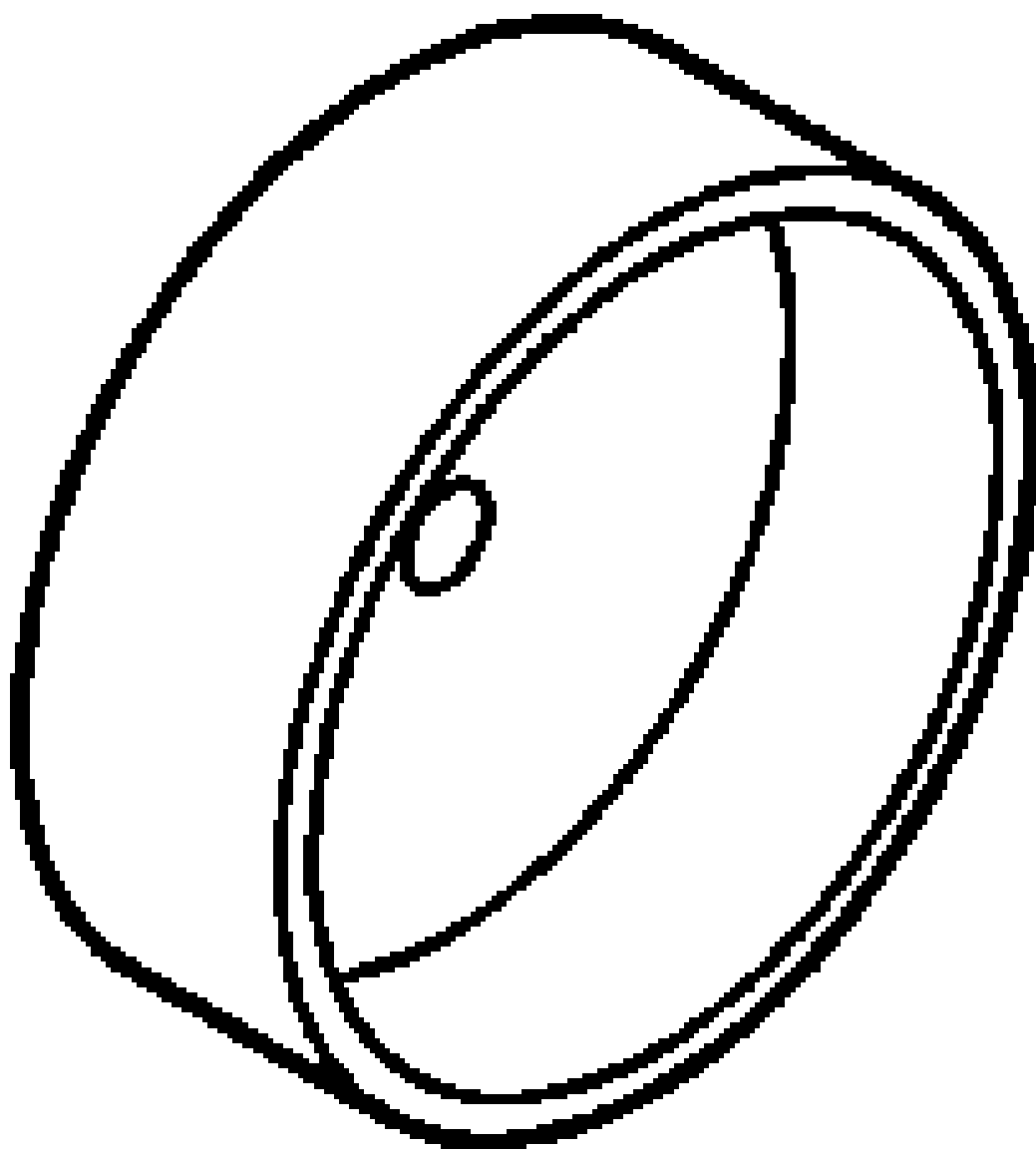
DT-869-4
Seal Installer



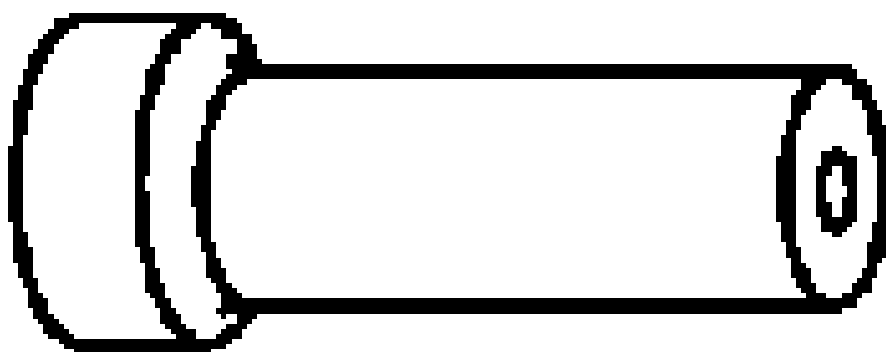
DT-8092
J-8092
Universal Drive
Handle



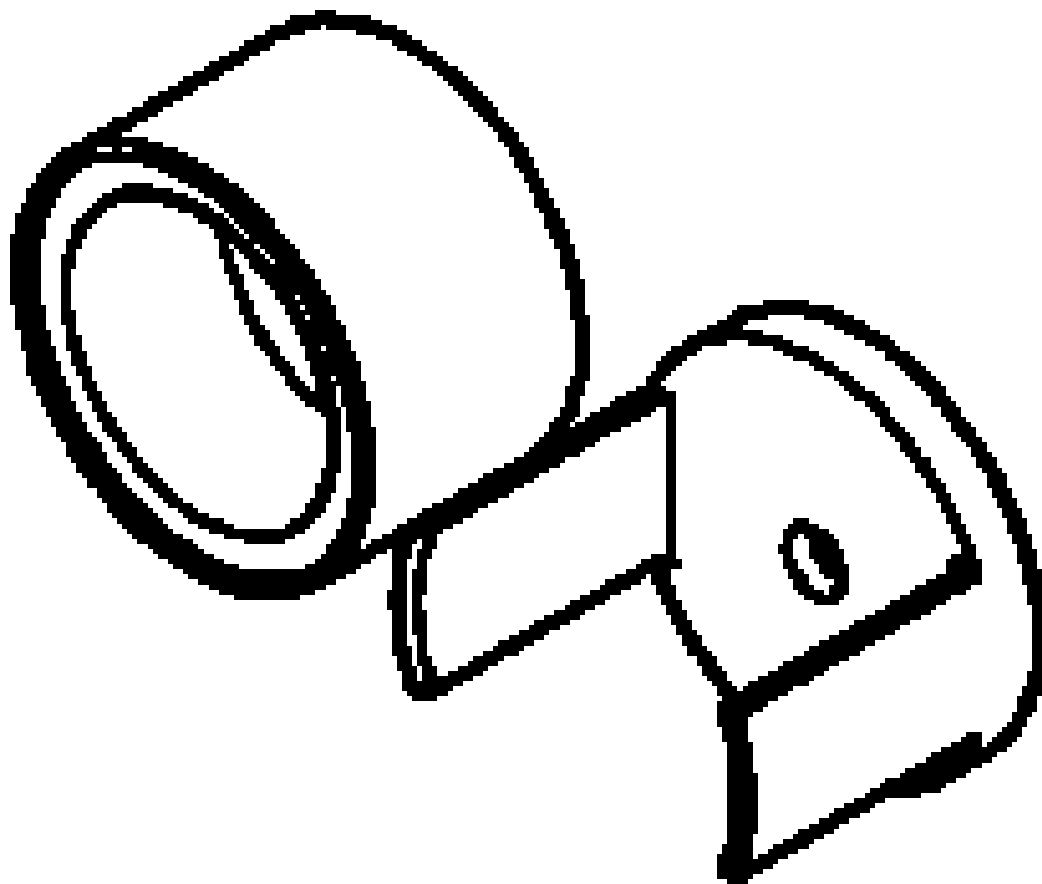
DT-8614-A
J-8614-A
Pinion Flange Ho



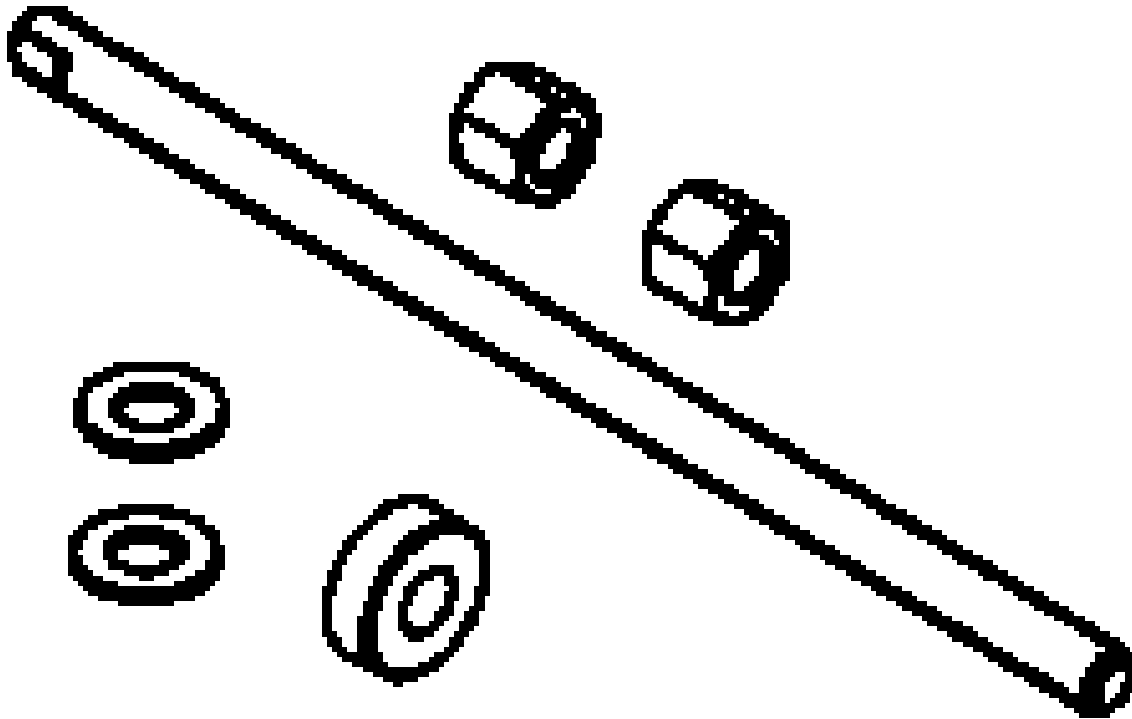
DT-48077
Seal Installer



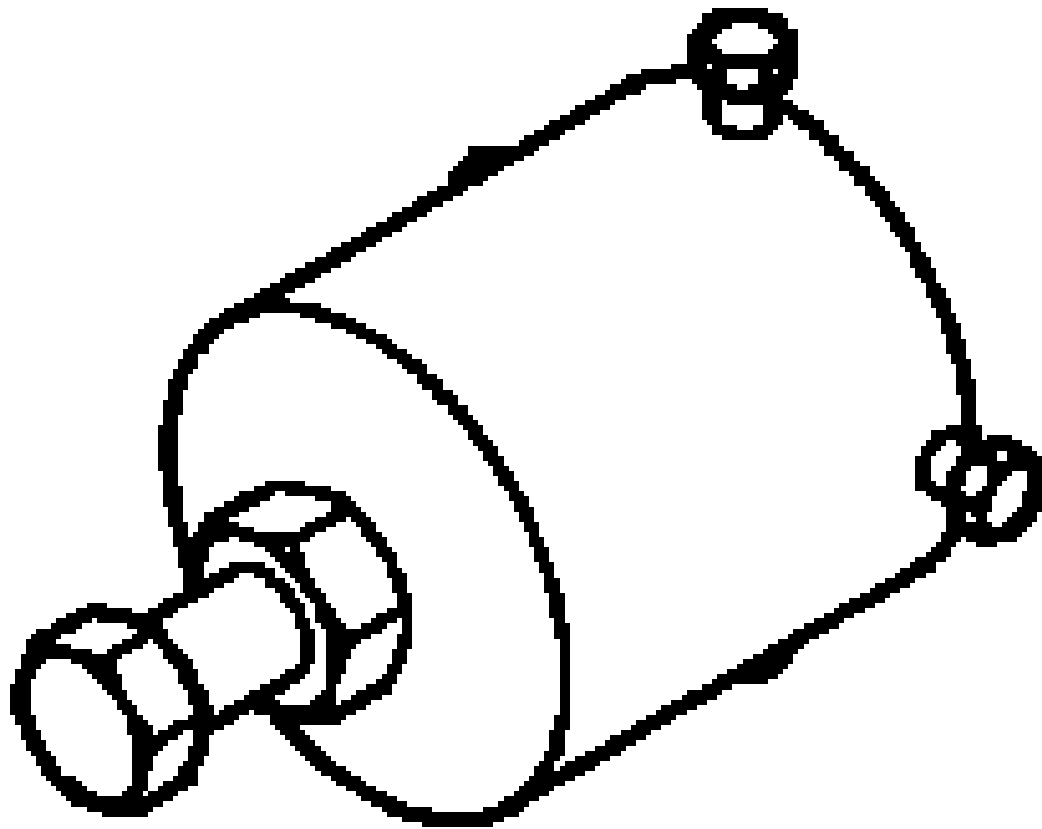
DT-49065
Seal Installer



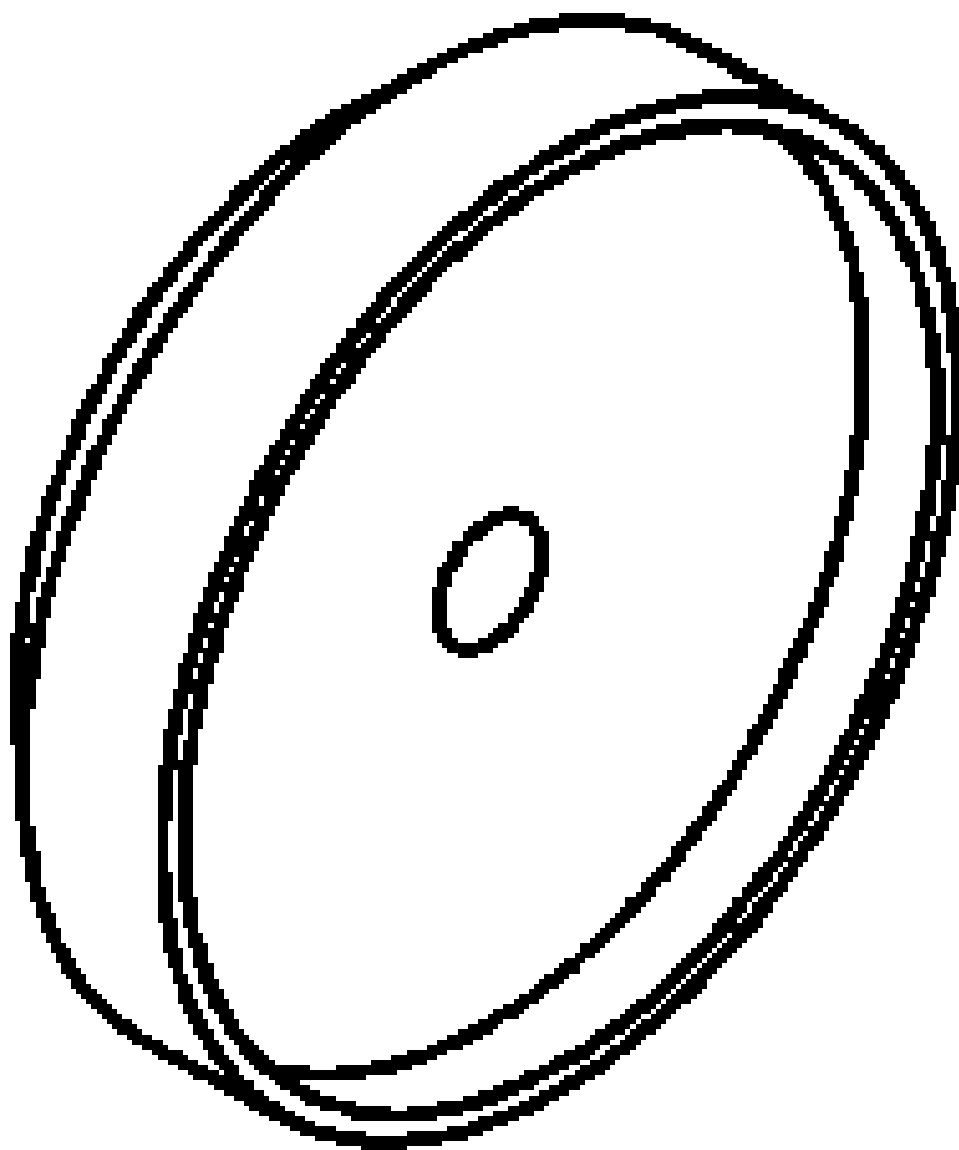
DT-49126
Bushings Replac
Hardware Kit



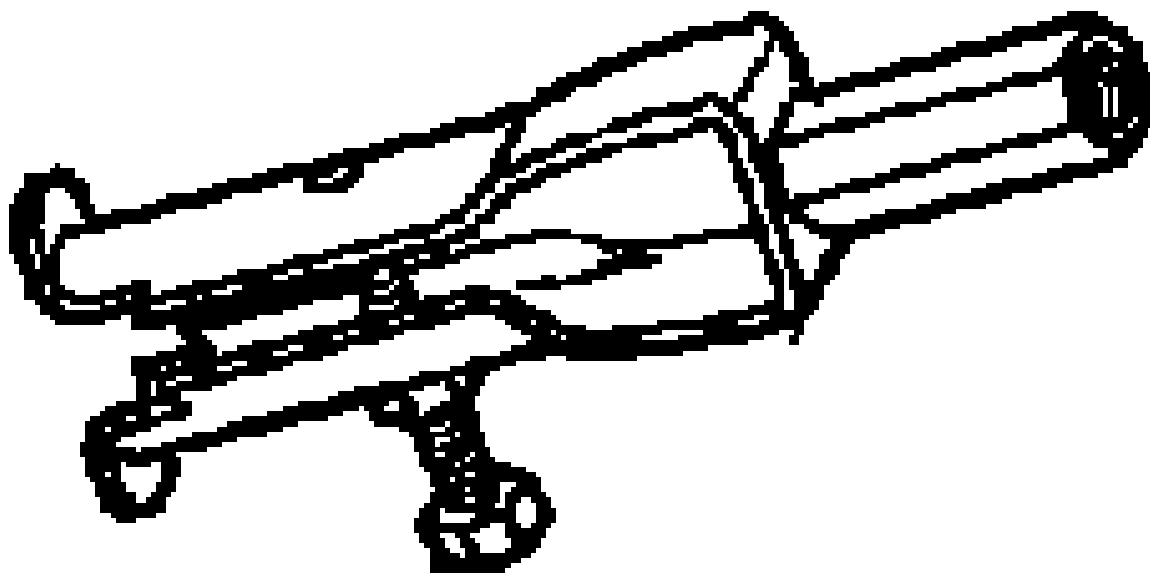
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Press Tool



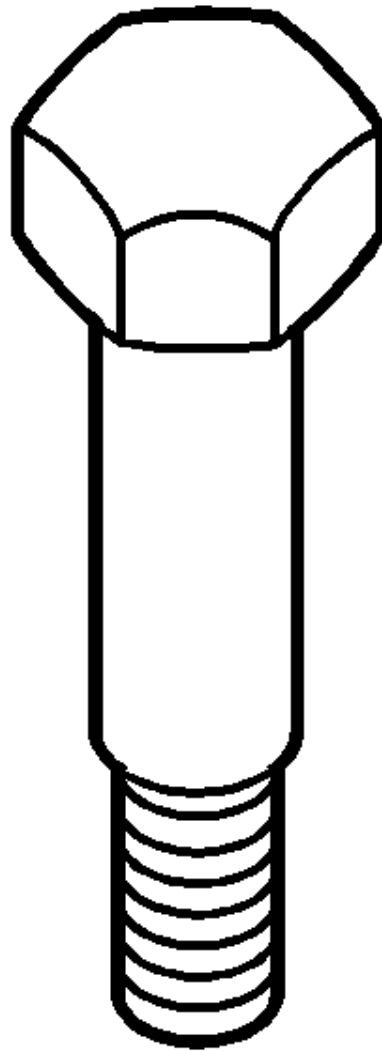
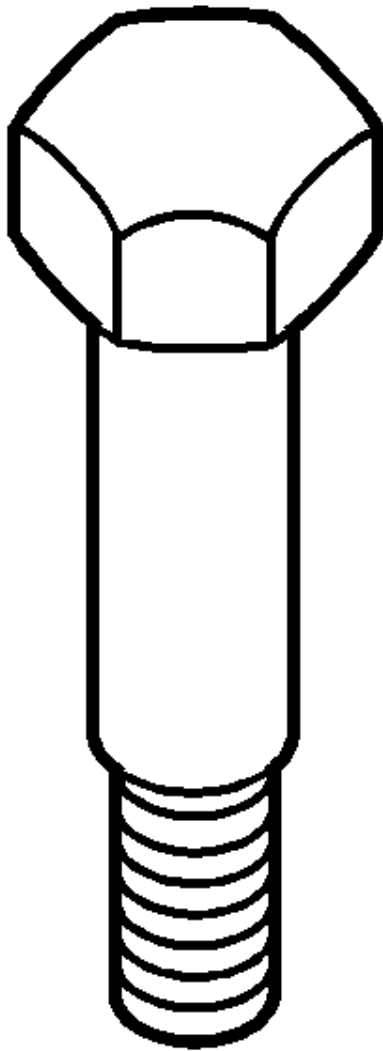
DT-49231
Seal Remover



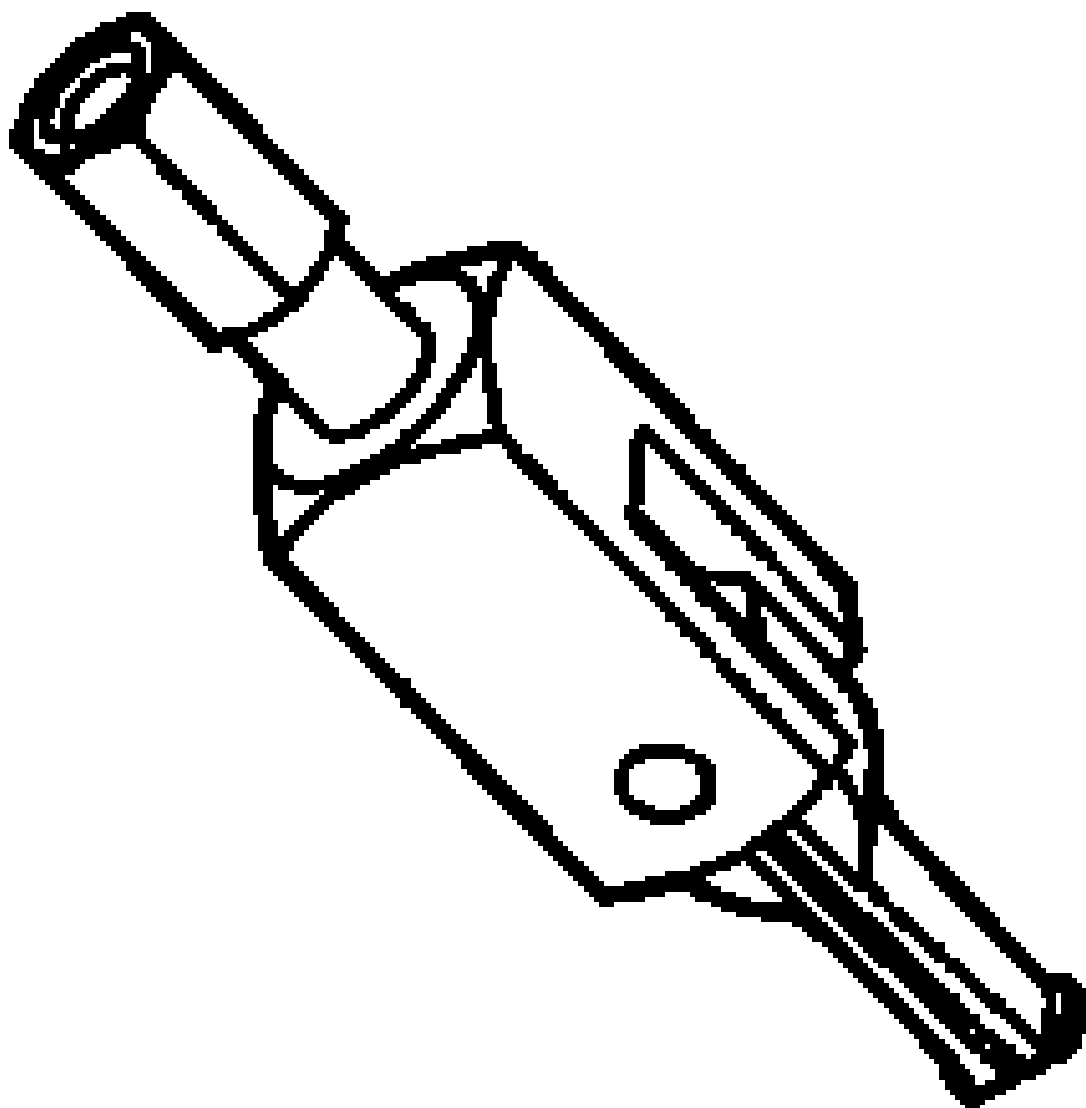
DT-50022
Installer



DT-29369-2
J-29369-2
Slide Hammer



DT-44873-2
J-44873-2
Pinion Flange ho
and Remove Bo



J-23907
GE-239097-1
Slide Hammer

Suspension

Rear Suspension

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Rear Axle Lower Control Arm Inner Fastener (GNC) (1)		
• First Pass	90 N.m	66 lb ft
• Final Pass	plus 60 degrees	
Rear Axle Lower Control Arm Outer Fastener (GNC) (1)		
• First Pass	70 N.m	51 lb ft
• Final Pass	plus 90 degrees	
Rear Axle Lower Control Arm Outer Fastener (GNE) (1)		
• First Pass	115 N.m	85 lb ft
• Second Pass	plus 90 degrees	
• Final Pass	plus 15 degrees	
Rear Axle Upper Control Arm Inner Nut (GNC) (1)		
• First Pass	70 N.m	51 lb ft
• Final Pass	plus 90 degrees	
Rear Axle Upper Control Arm Outer Nut (GNC) (1)		
• First Pass	150 N.m	111 lb ft
• Final Pass	plus 90 degrees	
Rear Axle Upper Control Arm Inner Fastener (GNE) (1)	150 N.m	111 lb ft
Rear Axle Upper Control Arm Outer Fastener (GNE) (1)		
• First Pass	115 N.m	85 lb ft
• Second Pass	plus 90 degrees	
• Final Pass	plus 15 degrees	
Rear Suspension Control Arm Outer Bolts (GNC) (1)		
• First Pass	150 N.m	111 lb ft
• Final Pass	plus 30 degrees	
Rear Suspension Control Arm Inner Bolts (GNC) (1)		
• First Pass	150 N.m	111 lb ft
• Final Pass	plus 30 degrees	

Rear Suspension Link Inner Fastener (GNC) (1)		
• First Pass	90 N.m	66 lb ft
• Final Pass	plus 60 degrees	
Rear Suspension Link Inner Fastener (GNE)	150 N.m	111 lb ft
Rear Suspension Link Outer Fastener (GNE) (1)		
• First Pass	150 N.m	111 lb ft
• Final Pass	plus 60 degrees	
Rear Suspension Link Outer Fastener (GNC) (1)		
• First Pass	115 N.m	85 lb ft
• Final Pass	plus 90 degrees	
Rear Wheel Hub Fastener (1)		
• First Pass	90 N.m	66 lb ft
• Final Pass	plus 75 degrees	
Shock Absorber Bracket Nut	20 N.m	15 lb ft
Shock Absorber Lower Fastener		
• First Pass	150 N.m	111 lb ft
• Final Pass	plus 60 degrees	
Shock Absorber Upper Fastener (GNC)	100 N.m	74 lb ft
Stabilizer Shaft Insulator Fastener		
• First Pass	22 N.m	16 lb ft
• Final Pass	plus 30 degrees	
Stabilizer Shaft Link Fastener	50 N.m	37 lb ft
Support Bolts (GNC) (1)		
• First Pass	90 N.m	66 lb ft
• Second Pass	plus 120 degrees	
• Final Pass	plus 15 degrees	
Support Bolts (GNE) (1)		
• First Pass	150 N.m	111 lb ft
• Second Pass	plus 30 degrees	
• Final Pass	plus 15 degrees	
Trailing Arm Fastener		
• First Pass	150 N.m	111 lb ft
• Final Pass	plus 30 degrees	
Note: (1) indicates a torque to yield fastener. DO NOT re-use, replace with NEW only.		

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number
Rear Shock Absorber Bolts Upper Body	Threadlock	Refer to Electronic Parts Catalog

REPAIR INSTRUCTIONS

REAR WHEEL BEARING AND HUB REPLACEMENT (GNC)

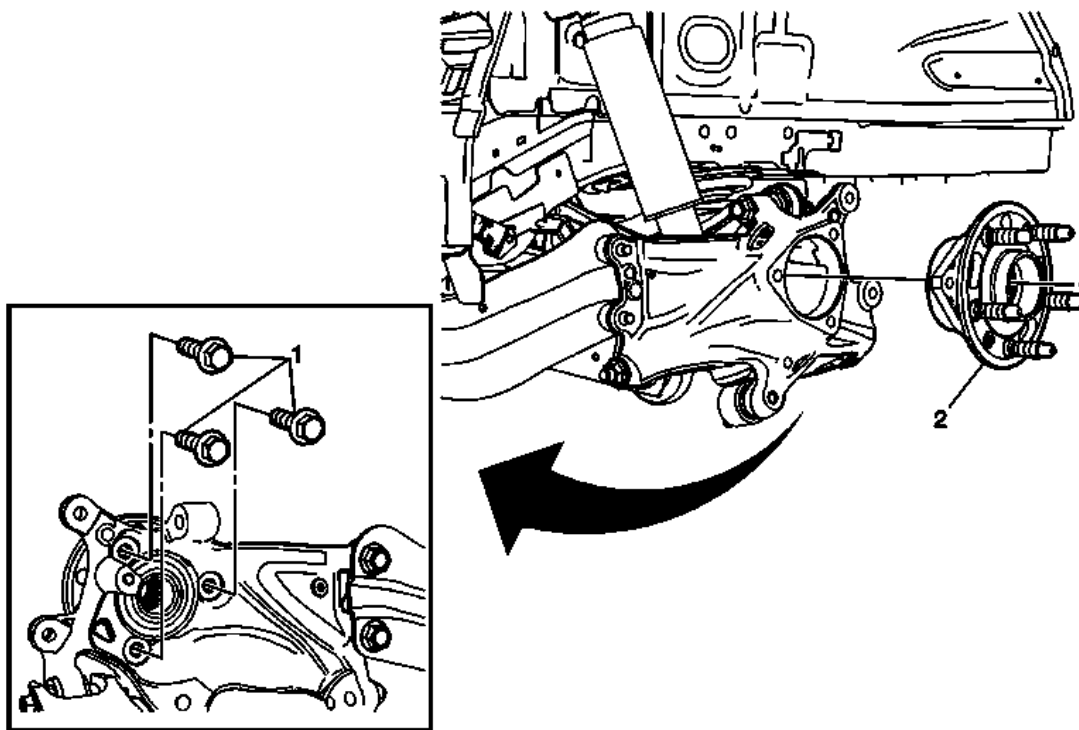


Fig. 1: Rear Wheel Bearing And Hub (GNC)
Courtesy of GENERAL MOTORS COMPANY

Rear Wheel Bearing and Hub Replacement (GNC)

Callout	Component Name
Preliminary Procedure	
1. Remove the rear tire and wheel. Refer to <u>Tire and Wheel Removal and Installation</u> .	
2. Remove the rear wheel speed sensor. Refer to <u>Rear Wheel Speed Sensor Replacement</u>	
3. Remove the rear brake rotor. Refer to <u>Rear Brake Rotor Replacement</u> .	
	Rear Wheel Bearing Bolts (Qty: 3)
	CAUTION: Refer to <u>Fastener Caution</u> .

1	<p>Procedure</p> <ol style="list-style-type: none"> 1. Remove the upper control arm. Refer to <u>Rear Axle Upper Control Arm Replacement (GNC)</u>. 2. Remove and discard the bolts. DO NOT reuse, replace with NEW only. <p>Tighten</p> <ul style="list-style-type: none"> • First Pass: 90 N.m (66 lb ft) • Final Pass: plus 75 degrees
2	<p>Rear Wheel Bearing</p> <p>CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.</p>

REAR WHEEL BEARING AND HUB REPLACEMENT (GNE)

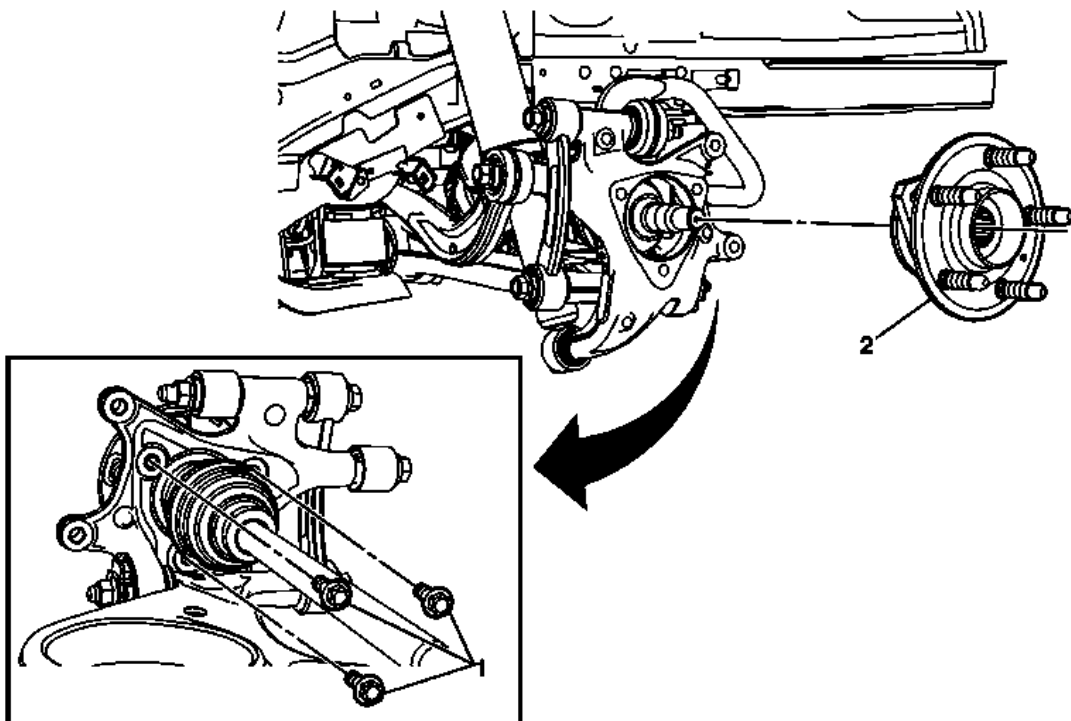


Fig. 2: Rear Wheel Bearing And Hub (GNE)
Courtesy of GENERAL MOTORS COMPANY

Rear Wheel Bearing and Hub Replacement (GNE)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the rear tire and wheel. Refer to <u>Tire and Wheel Removal and Installation</u> . 2. Remove the rear wheel speed sensor. Refer to <u>Rear Wheel Speed Sensor Replacement</u> . 3. Separate the wheel drive shaft from the knuckle. Refer to <u>Rear Wheel Drive Shaft Replacement</u> . 4. Remove the rear brake rotor. Refer to <u>Rear Brake Rotor Replacement</u> . 5. Remove the rear spring. Refer to <u>Rear Spring, Insulator, and Jounce Bumper Replacement</u>. 6. Remove lower control arm bolt and nut from the rear wheel hub bracket. Refer to <u>Rear Suspension Control Arm Replacement</u>. 	
1	Rear Wheel Bearing Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Remove and discard the rear wheel hub bolts and install the NEW bolts. Tighten 90 N.m (66 lb ft)
2	Rear Wheel Bearing CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

REAR WHEEL HUB BRACKET REPLACEMENT

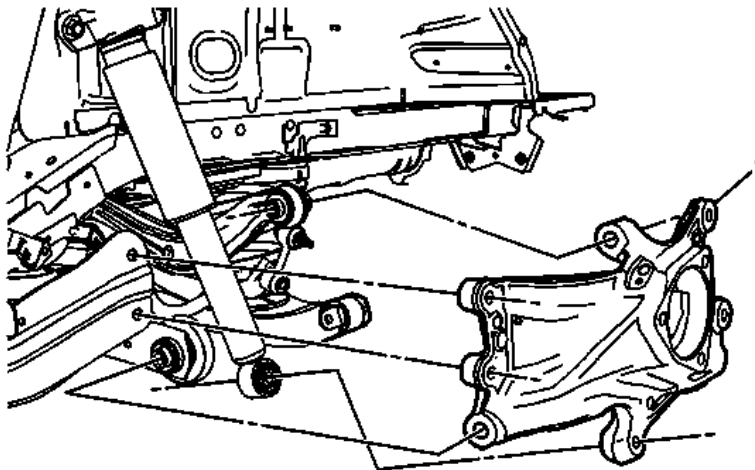


Fig. 3: Rear Wheel Hub Bracket

Courtesy of GENERAL MOTORS COMPANY

Rear Wheel Hub Bracket Replacement

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none">1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> .3. Remove the rear wheel bearing and hub. Refer to <u>Rear Wheel Bearing and Hub Replacement</u>, <u>Rear Wheel Bearing and Hub Replacement (GNE)</u>.	
1	<p>Rear Wheel Hub Bracket</p> <p>Procedure</p> <ol style="list-style-type: none">1. Support the rear lower control arm with a suitable jack stand.2. Remove the bolt from upper control arm to the rear wheel hub bracket. Refer to <u>Rear Axle Upper Control Arm Replacement (GNC)</u>, <u>Rear Axle Upper Control Arm Replacement (GNE)</u>.3. Remove the bolt from the lower shock absorber bolt to the rear wheel hub bracket. Refer to <u>Shock Absorber Replacement (GNC)</u>, <u>Shock Absorber Replacement (GNE)</u>.4. Remove the bolt from the lower control arm to the rear wheel hub bracket. Refer to <u>Rear Axle Lower Control Arm Replacement (GNC)</u>, <u>Rear Axle Lower Control Arm Replacement (GNE)</u>.5. Remove the bolt from the adjust link to the rear wheel hub bracket. Refer to <u>Adjust Link Replacement (GNC)</u>, <u>Adjust Link Replacement (GNE)</u>.6. Remove the bolts from the rear suspension control arm to the rear wheel hub bracket. Refer to <u>Rear Suspension Control Arm Replacement</u>.

REAR AXLE UPPER CONTROL ARM REPLACEMENT (GNC)

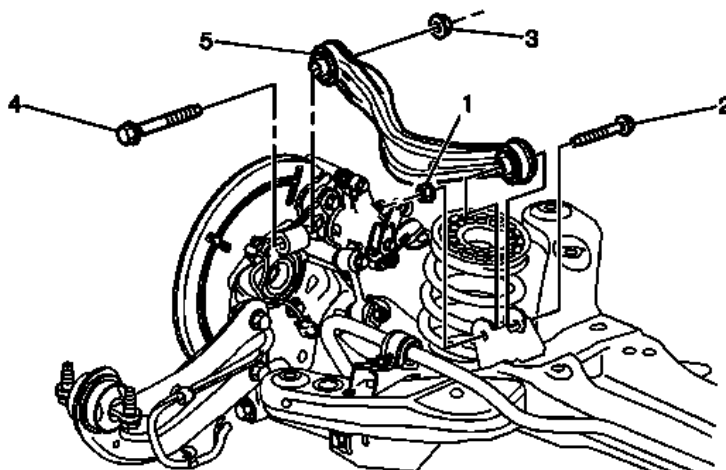


Fig. 4: Upper Control Arm (GNC)

Courtesy of GENERAL MOTORS COMPANY

Rear Axle Upper Control Arm Replacement (GNC)

Callout	Component Name
Preliminary Procedures 1. Raise and suitably support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the rear tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> .	
1	Rear Suspension Upper Control Arm Nut CAUTION: Refer to <u>Fastener Caution</u> . CAUTION: This bolt is designed to permanently stretch when tightened, and therefore MUST be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the components may be damaged. Procedure Remove and discard the nut and the bolt, replace with NEW only. Tighten 70 N.m (52 lb ft) + 60 degrees
2	Rear Suspension Upper Control Arm
3	Rear Suspension Upper Control Arm Nut Procedure Remove and discard the nut and the bolt, replace with NEW only.
4	Rear Suspension Upper Control Arm Bolt Procedure Remove and discard the bolt, replace with NEW only. Tighten <ul style="list-style-type: none">• First Pass: 150 N.m (85 lb ft)• Final Pass: plus 90 degrees
5	Rear Suspension Upper Control Arm

REAR AXLE UPPER CONTROL ARM REPLACEMENT (GNE)

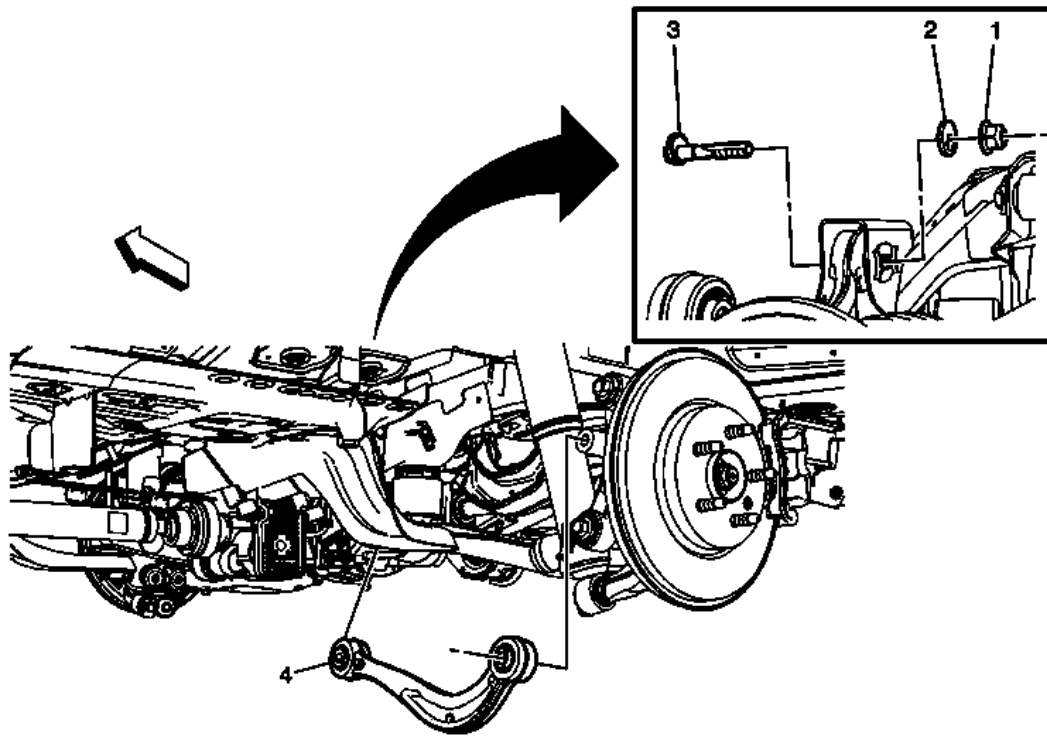


Fig. 5: Upper Control Arm (GNE)
 Courtesy of GENERAL MOTORS COMPANY

Rear Axle Upper Control Arm Replacement (GNE)

Callout	Component Name
Preliminary Procedures	
1. Raise and suitably support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the rear tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> .	
1	Rear Suspension Upper Control Arm Inner Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 150 N.m (111 lb ft)
2	Rear Suspension Upper Control Arm Washer
3	Rear Suspension Upper Control Arm Inner Bolt
4	Rear Axle Upper Control Arm Procedure 1. Use a proper jack stand, support the lower control arm and the rear wheel bracket.

2. Remove the bolt from the upper control to the lower control arm.
3. Remove cable harness clips from control arm.
4. Verify the rear wheel alignment. Refer to Wheel Alignment Measurement .

REAR SUSPENSION CONTROL ARM REPLACEMENT

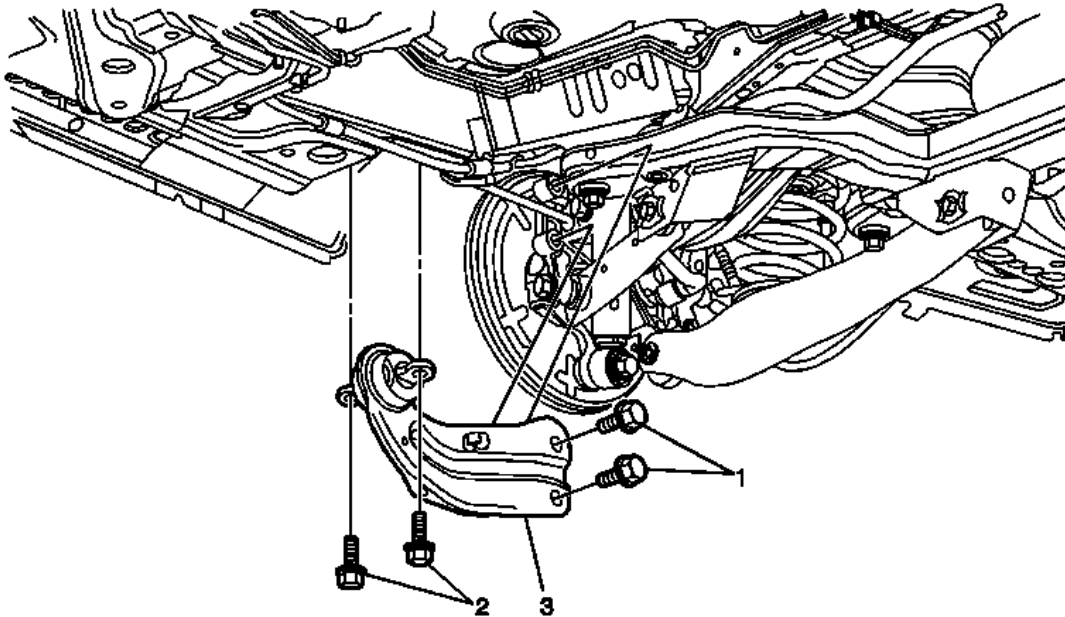


Fig. 6: Rear Suspension Control Arm & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Rear Suspension Control Arm Replacement

Callout	Component Name
Preliminary Procedure	
Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>	
1	<p>Rear Wheel Hub Bracket Bolt (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Remove and discard the bolts. DO NOT reuse, replace with NEW only. Tighten</p> <ul style="list-style-type: none"> First Pass: 150 N.m (111 lb ft)

	<ul style="list-style-type: none"> • Final Pass: plus 30 degrees <p>Special Tools EN-45059 Angle Meter For equivalent regional tools, refer to Special Tools.</p>
2	Rear Suspension Control Arm Bracket Bolt (Qty: 2) Procedure Remove and discard the bolts. DO NOT reuse, replace with NEW only. Tighten <ul style="list-style-type: none"> • First Pass: 150 N.m (111 lb ft) • Final Pass: plus 30 degrees
3	Rear Suspension Control Arm CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component. Procedure Remove the rear speed sensor harness from the rear suspension control arm. Refer to <u>Rear Wheel Speed Sensor Replacement</u> .

REAR SUSPENSION CONTROL ARM BUSHING REPLACEMENT

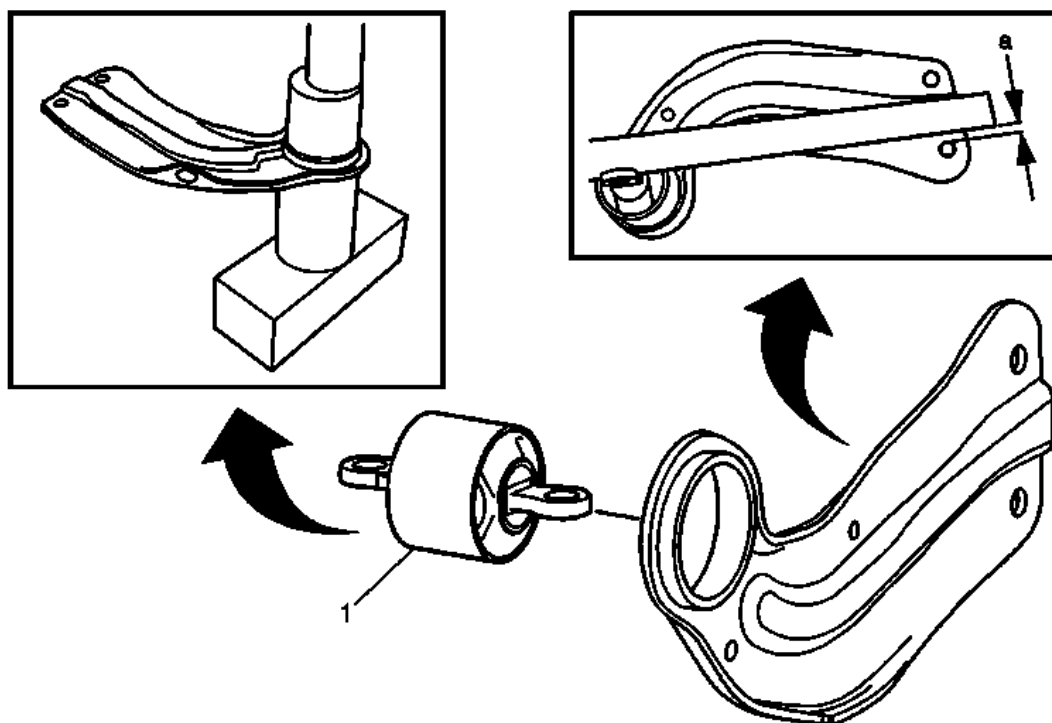


Fig. 7: Rear Suspension Control Arm Bushing
 Courtesy of GENERAL MOTORS COMPANY

Rear Suspension Control Arm Bushing Replacement

Callout	Component Name
Preliminary Procedures	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the rear suspension control arm. Refer to <u>Rear Suspension Control Arm Replacement</u> .	
1	Rear Suspension Control Arm Bushing Procedure <ol style="list-style-type: none"> Using the CH-21474 kit , install the rear suspension control arm bushing. Adjust the rear suspension control arm bushing 18.7 mm from center of hole, when parallel to bushing console with the J-21474 kit. Special Tools CH-21474 Remover/Installer Kit For equivalent regional tools, refer to <u>Special Tools</u> .

REAR AXLE LOWER CONTROL ARM REPLACEMENT (GNC)

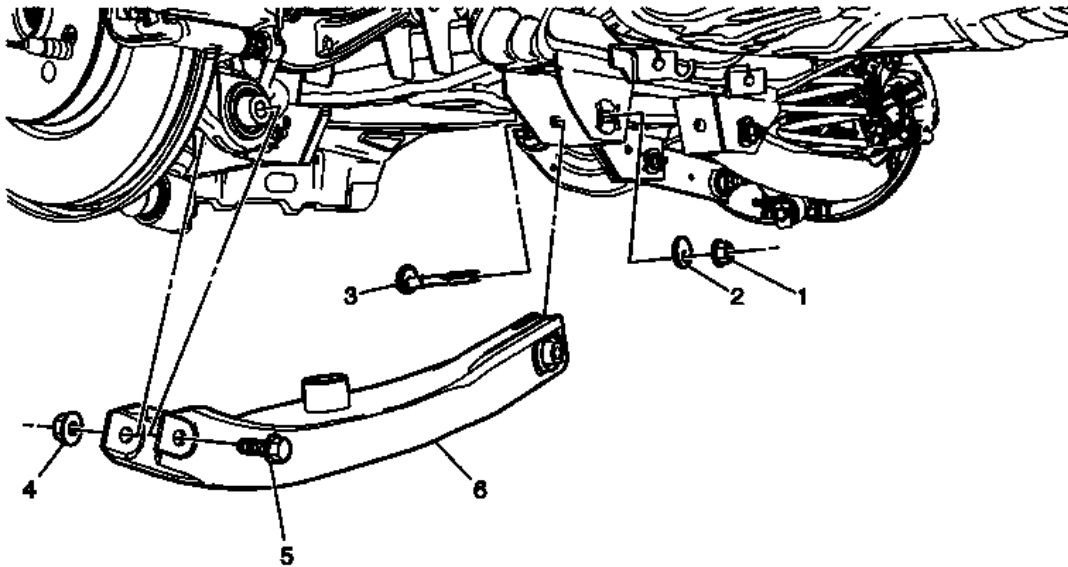


Fig. 8: Rear Axle Lower Control Arm (GNC)
 Courtesy of GENERAL MOTORS COMPANY

Rear Axle Lower Control Arm Replacement (GNC)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Remove the rear spring. Refer to <u>Rear Spring, Insulator, and Jounce Bumper Replacement</u>. 	
1	Rear Suspension Lower Control Arm Inner Nut CAUTION: Refer to <u>Fastener Caution</u> . NOTE: DO NOT torque the nut until all specifications have been checked and/or adjusted. The nut must be tightened at ride height. Tighten <ul style="list-style-type: none"> • First Pass: 90 N.m(66 lb ft) • Final Pass: plus 60 degrees

2	Rear Suspension Lower Control Arm Washer
3	Rear Suspension Lower Control Arm Bolt Procedure Remove and discard the bolt and replace with NEW only.
4	Rear Suspension Lower Control Arm Nut
5	Rear Suspension Lower Control Arm Bolt Tighten 70 N.m(51 lb ft) + 90 degrees
6	Rear Lower Control Arm Procedure Check the rear alignment after installation. Refer to <u>Wheel Alignment Measurement</u> .

REAR AXLE LOWER CONTROL ARM REPLACEMENT (GNE)

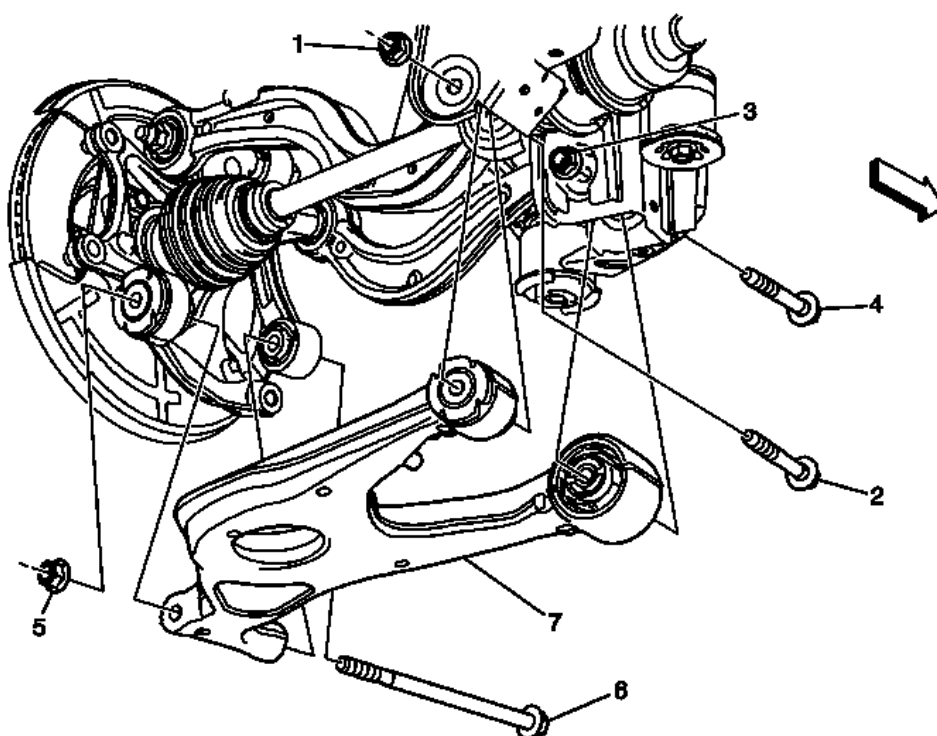


Fig. 9: Rear Axle Lower Control Arm (GNE)
Courtesy of GENERAL MOTORS COMPANY

Rear Axle Lower Control Arm Replacement (GNE)

Callout	Component Name
Preliminary Procedure	
1.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .
2.	Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> .
3.	Remove the rear spring. Refer to <u>Rear Spring, Insulator, and Jounce Bumper Replacement</u> .

4. Remove the shock absorber lower bolt at the rear wheel hub bracket. Refer to **Shock Absorber Replacement (GNE)**.

1	<p>Rear Suspension Lower Control Arm Nut</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten</p> <ul style="list-style-type: none">• First Pass: 150 N.m (111 lb ft)• Final Pass: plus 90 degrees
2	<p>Rear Suspension Lower Control Arm Bolt</p> <p>Procedure Remove and discard the bolt. DO NOT reuse, replace with NEW only.</p>
3	<p>Rear Suspension Lower Control Arm Nut</p> <p>Tighten</p> <ul style="list-style-type: none">• First Pass: 150 N.m (111 lb ft)• Final Pass: plus 90 degrees
4	<p>Rear Suspension Lower Control Arm Bolt</p> <p>Procedure Remove and discard the bolt. DO NOT reuse, replace with NEW only.</p>
5	<p>Rear Suspension Link Lower Nut</p> <p>Tighten</p> <ul style="list-style-type: none">• First Pass: 150 N.m (111 lb ft)• Final Pass: plus 90 degrees
6	<p>Rear Suspension Link Lower Bolt</p> <p>Procedure Remove and discard the bolt. DO NOT reuse, replace with NEW only.</p>
7	<p>Rear Suspension Lower Control Arm</p> <p>CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.</p> <p>Procedure</p> <ol style="list-style-type: none">1. Lower the fuel tank so as to gain enough clearance to remove the lower control arm from the vehicle.<ul style="list-style-type: none">• For those vehicles equipped with the 2.4L, refer to <u>Fuel Tank Replacement</u> .

- | |
|--|
| <ul style="list-style-type: none">• For those vehicles equipped with the 2.0, refer to <u>FUEL TANK REPLACEMENT (AWD)</u> or <u>FUEL TANK REPLACEMENT (FWD)</u> . <ol style="list-style-type: none">2. Use a proper jack stand to load the control arm when tightening the bolts |
|--|

STABILIZER SHAFT REPLACEMENT (GNC)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the rear muffler assembly. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
4. Remove the rear suspension control arm bolts from the body. Refer to **Rear Suspension Control Arm Replacement**.
5. Remove the rear spring. Refer to **Rear Spring, Insulator, and Jounce Bumper Replacement**.
6. Remove the park brake cables from the rear suspension support. Refer to **Parking Brake Rear Cable Replacement** .
7. Without disconnecting the hydraulic brake hose from the caliper, remove and support the brake caliper. Refer to **Rear Brake Caliper Replacement** .
8. Remove the lower shock absorber bolts. Refer to **Shock Absorber Replacement (GNC)**.
9. Support and secure adjustable jack stands to the rear support.
10. Mark up support position to body with spray paint.

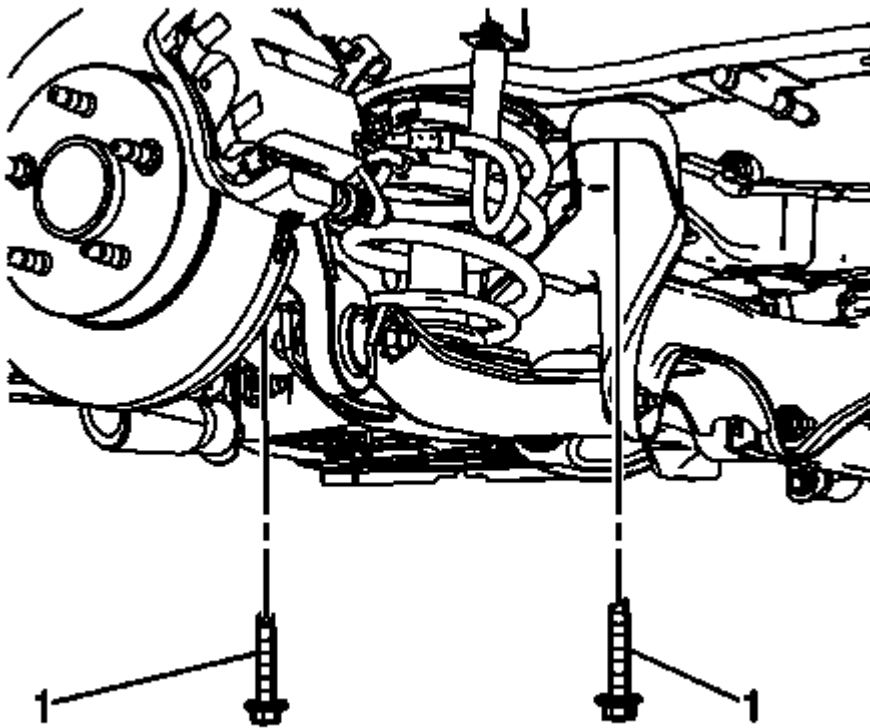


Fig. 10: Identifying Support Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the mounting bolts (1) for the support. Refer to **Rear Suspension Support Replacement (GNC)**.
12. Lower the support enough to gain access to the rear stabilizer shaft insulator clamps mounting bolts.

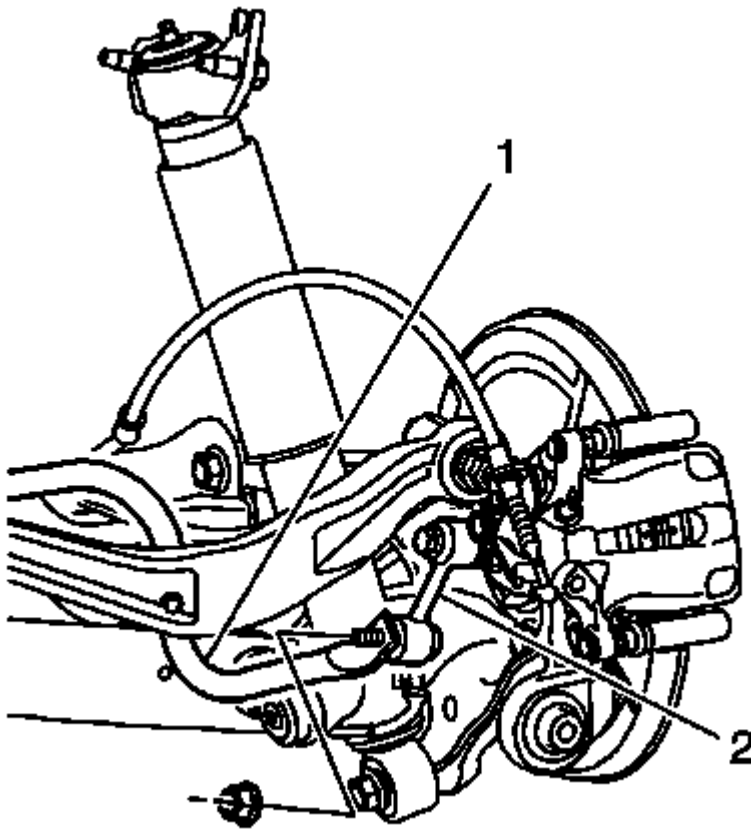


Fig. 11: Stabilizer Shaft & Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

13. Remove the stabilizer shaft (1) from the stabilizer shaft link (2). Refer to **Stabilizer Shaft Link Replacement (GNC)**.

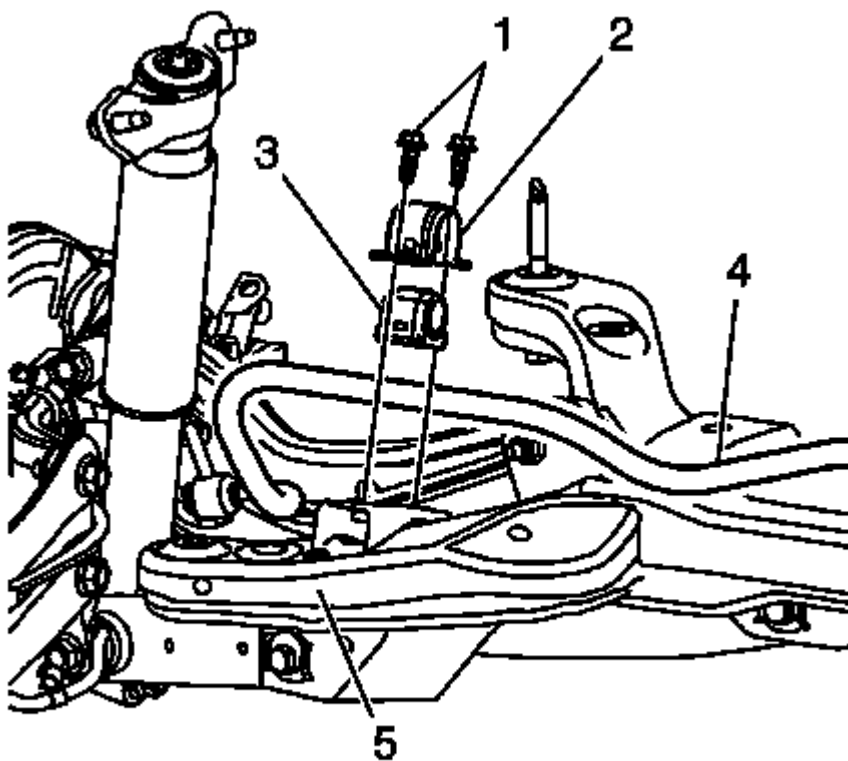


Fig. 12: Stabilizer Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

14. Remove and discard the stabilizer shaft bolts (1). Replace with NEW only.
15. Remove the stabilizer shaft assembly (4) from the support (5).

Installation Procedure

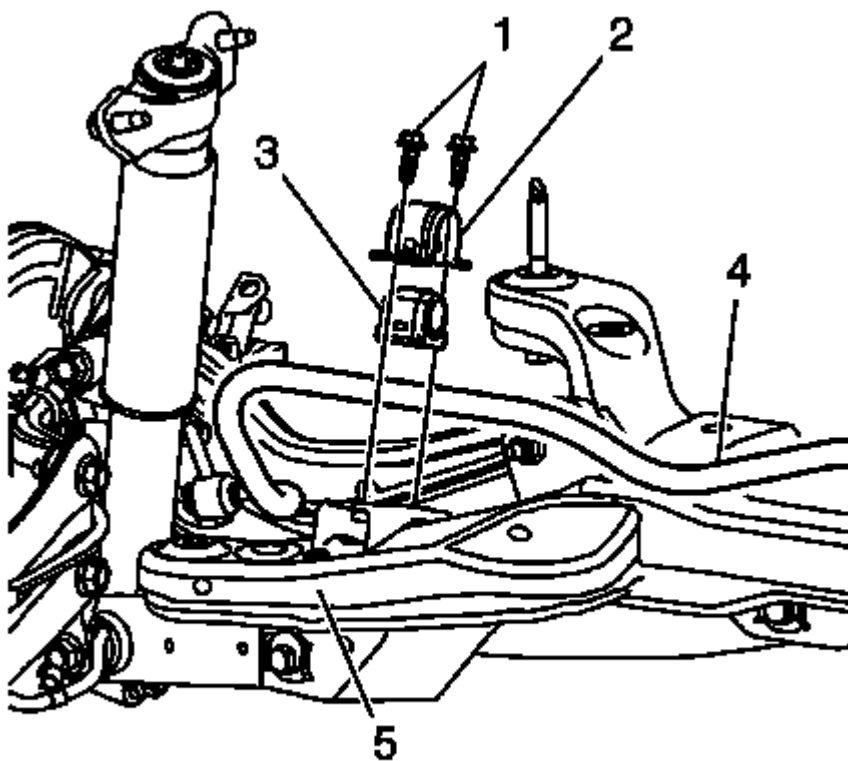


Fig. 13: Stabilizer Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Load the suspension with the proper jack stand before tightening the bolts to specifications.
2. Install the stabilizer shaft (4) on the support (5).

CAUTION: Refer to Fastener Caution .

3. Install NEW clamp bolts (1) and tighten to:

Tighten

- First Pass: 22 N.m (16 lb ft).
- Final Pass: plus 30 degrees.

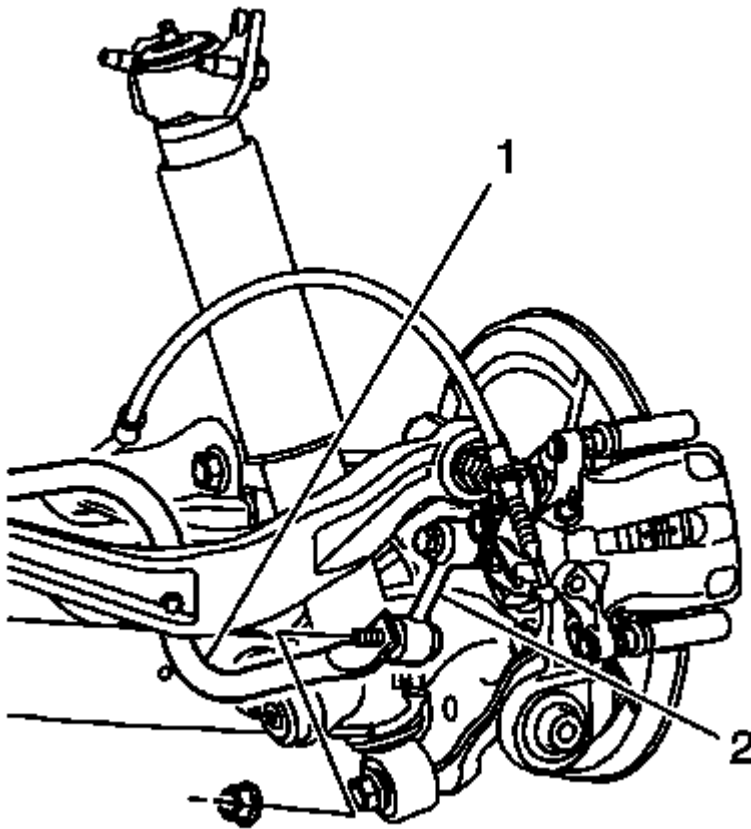


Fig. 14: Stabilizer Shaft & Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

4. Install the stabilizer shaft (1) to stabilizer shaft link (2). Refer to **Stabilizer Shaft Link Replacement (GNC)**.
5. Raise the rear support back into position.

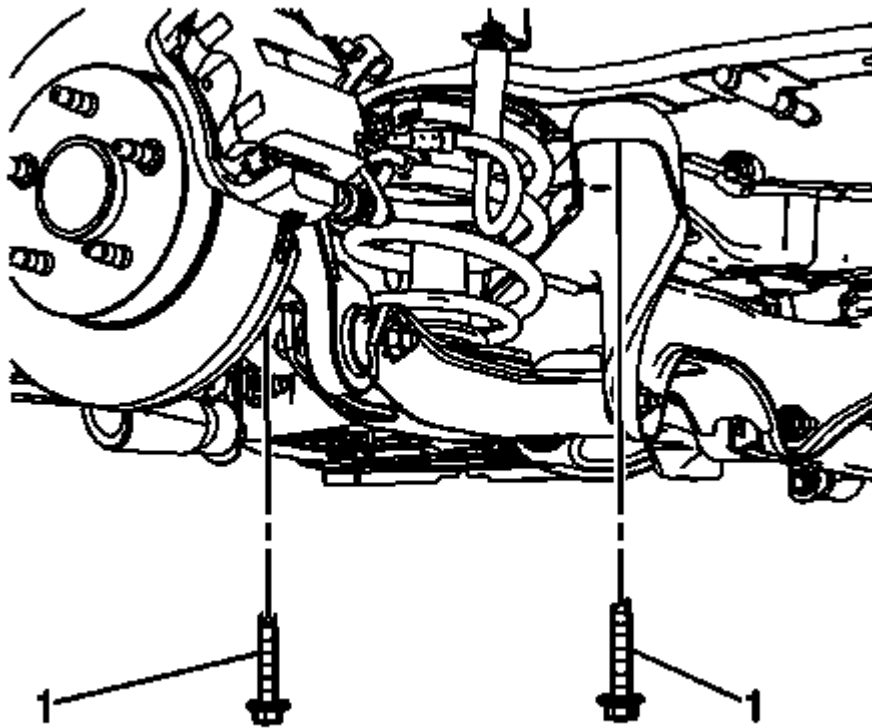


Fig. 15: Identifying Support Mounting Bolts
 Courtesy of GENERAL MOTORS COMPANY

6. Install the rear support bolts (1). Refer to **Rear Suspension Support Replacement (GNC)** .
7. Install the lower shock absorber mounting bolts. Refer to **Shock Absorber Replacement (GNC)**.
8. Install the rear brake calipers. Refer to **Rear Brake Caliper Replacement** .
9. Install the rear suspension control arm bolts to the body. Refer to **Rear Suspension Control Arm Replacement**.
10. Install the rear springs. Refer to **Rear Spring, Insulator, and Jounce Bumper Replacement**.
11. Remove the adjustable jack stands from the rear support.
12. Install the park brake cables on the rear suspension support. Refer to **Parking Brake Rear Cable Replacement** .
13. Install the rear muffler assembly. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
14. Install the tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
15. Lower the vehicle.

STABILIZER SHAFT REPLACEMENT (GNE)

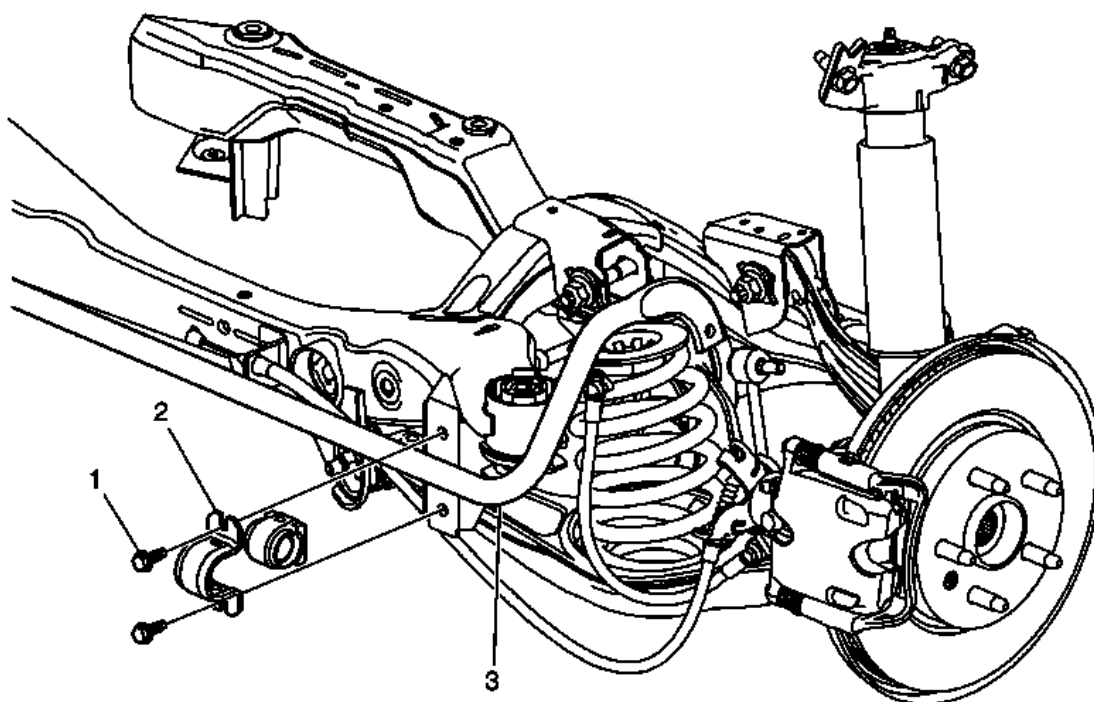


Fig. 16: Stabilizer Shaft (GNE)
 Courtesy of GENERAL MOTORS COMPANY

Stabilizer Shaft Replacement (GNE)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Disconnect the stabilizer links from the stabilizer shaft. Refer to <u>Stabilizer Shaft Link Replacement (GNA, GNB)</u> . 	
1	Stabilizer Shaft Insulator Fastener (Qty: 4) Install NEW clamp bolts. CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft) + 30 degrees
2	Stabilizer Shaft Bracket (Qty 2)
3	Stabilizer Shaft Procedure Replace insulator if necessary.

STABILIZER SHAFT INSULATOR REPLACEMENT (GNC)

Removal Procedure

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
3. Remove the rear muffler assembly. Refer to Exhaust Muffler Replacement (Dual) , Exhaust Muffler Replacement (Single) .
4. Remove the rear suspension control arm bolts from the body. Refer to Rear Suspension Control Arm Replacement.
5. Remove the rear spring. Refer to Rear Spring, Insulator, and Jounce Bumper Replacement.
6. Remove the park brake cables from the rear suspension support. Refer to Parking Brake Rear Cable Replacement .
7. Without disconnecting the hydraulic brake hose from the caliper, remove and support the brake calliper. Refer to Rear Brake Caliper Replacement .
8. Remove the lower shock absorber fasteners. Refer to Shock Absorber Replacement (GNC).
9. Support and secure adjustable jack stands to the rear support.
10. Mark up support position to body with spray paint.

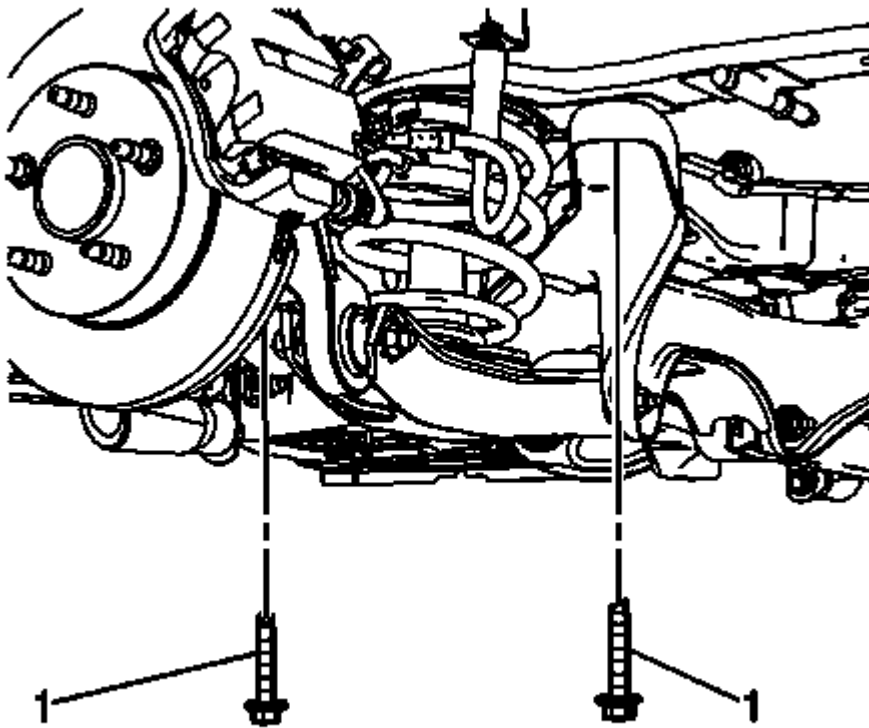


Fig. 17: Identifying Support Mounting Bolts

Courtesy of GENERAL MOTORS COMPANY

11. Remove the mounting bolts (1) for the support. Refer to **Rear Suspension Support Replacement (GNC)**.
12. Lower the support enough to gain access to the rear stabilizer shaft insulator clamps mounting bolts.

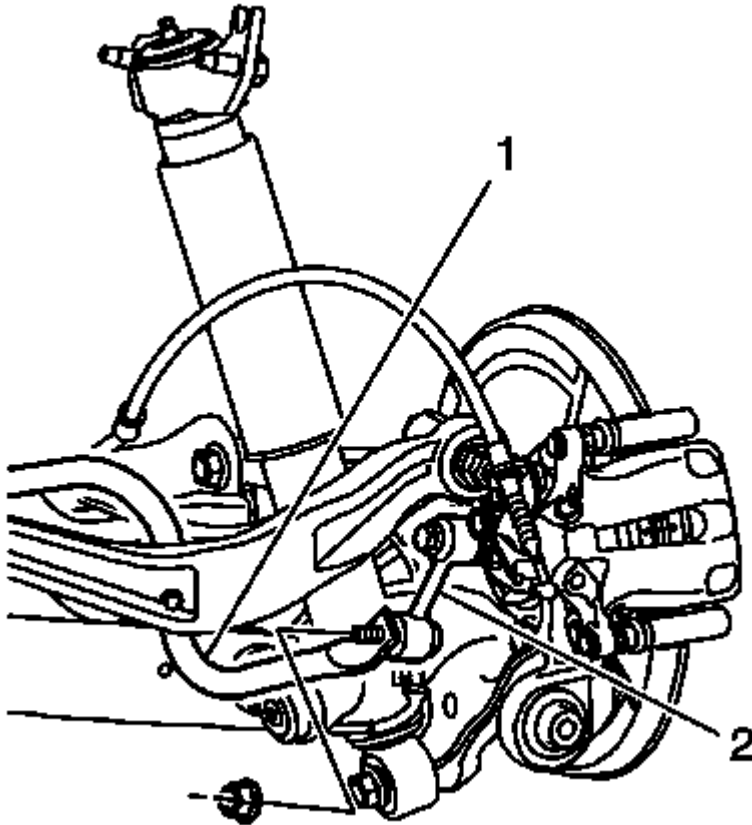


Fig. 18: Stabilizer Shaft & Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

13. Remove the stabilizer shaft (1) from the stabilizer shaft link (2). Refer to **Stabilizer Shaft Link Replacement (GNC)**.

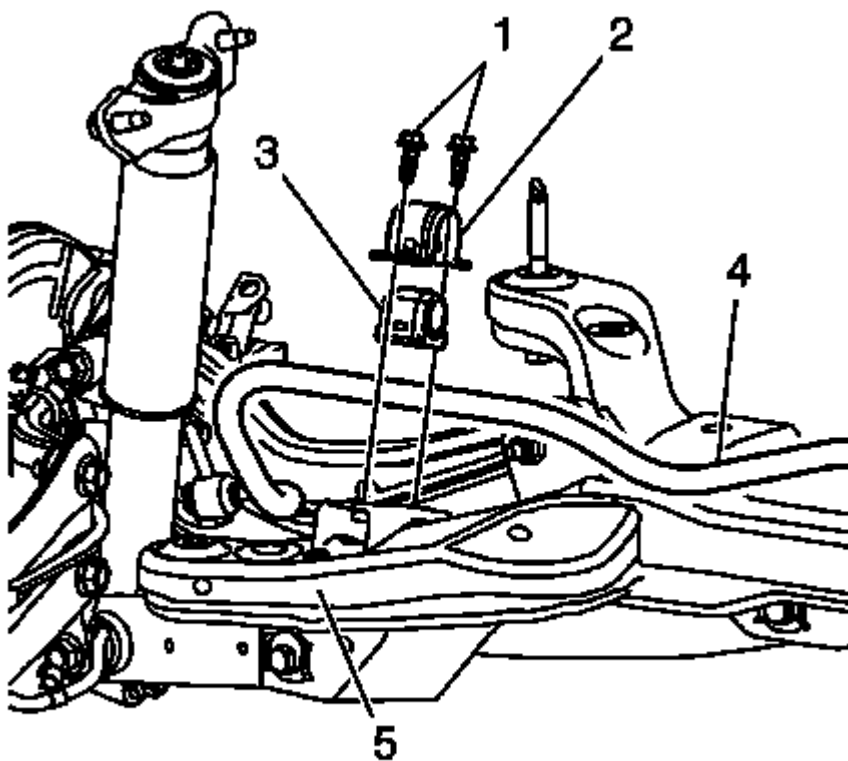


Fig. 19: Stabilizer Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Change one insulator at the time to ensure the right position and angle.
- DO NOT reuse the bracket bolt. Discard and use NEW bolts only.

14. Remove the bracket bolt (1), the bracket (2) and the insulator (3).

Installation Procedure

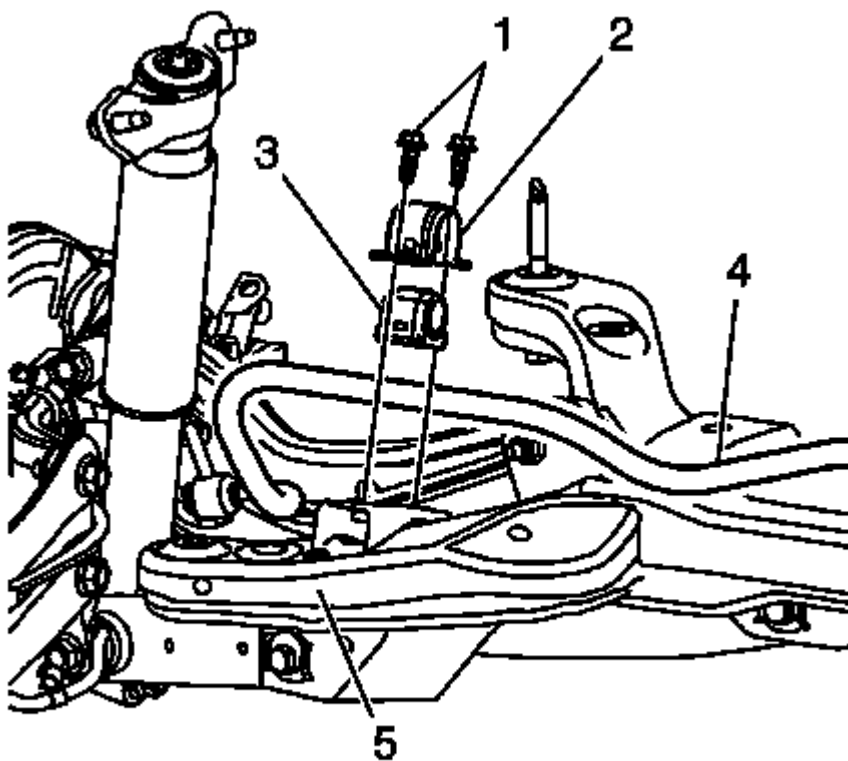


Fig. 20: Stabilizer Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the insulator (3), the bracket (2), on the stabilizer shaft (4).

CAUTION: Refer to Fastener Caution .

2. Install the NEW bolts (1) and tighten to:
 - First Pass: 22 N.m(16 lb ft).
 - Final Pass: plus 30 degrees.

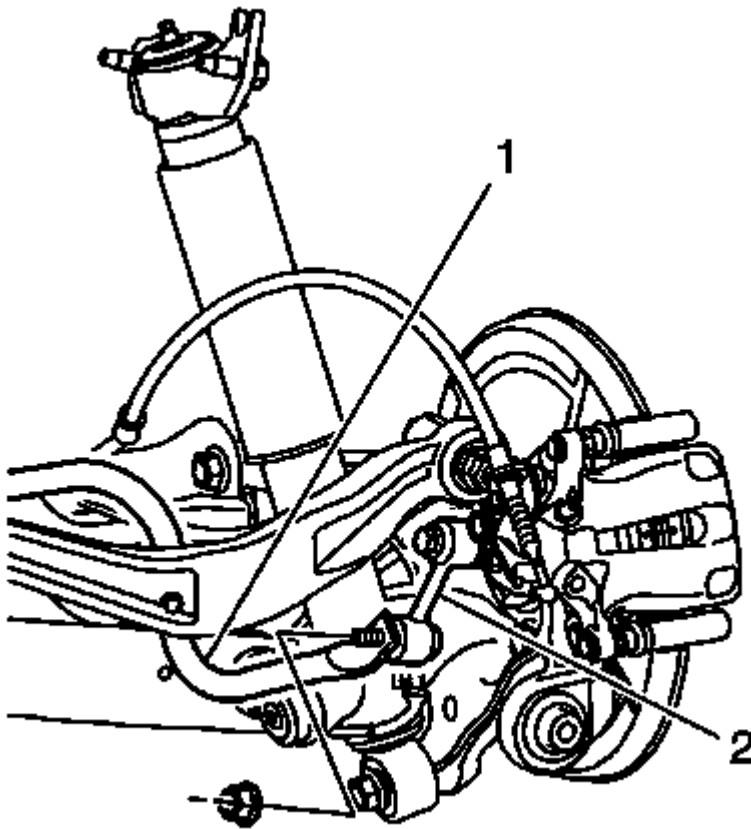


Fig. 21: Stabilizer Shaft & Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

3. Install the stabilizer shaft (1) to stabilizer shaft link (2). Refer to **Stabilizer Shaft Link Replacement (GNC)**.
4. Raise the rear support back into position.

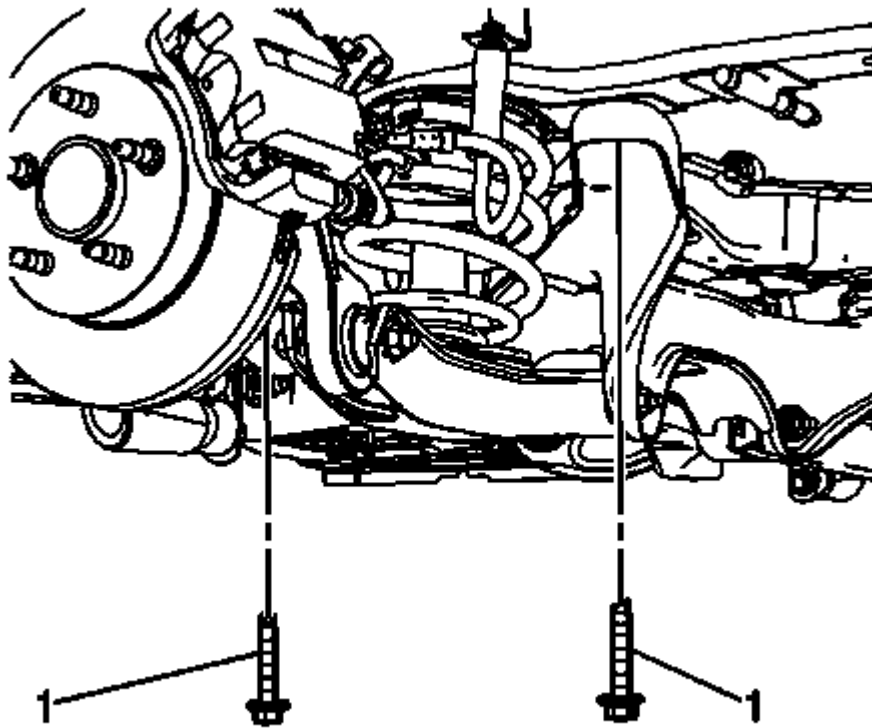


Fig. 22: Identifying Support Mounting Bolts
 Courtesy of GENERAL MOTORS COMPANY

5. Install the rear support bolts (1). Refer to **Rear Suspension Support Replacement (GNC)** .
6. Install the lower shock absorber mounting bolts. Refer to **Shock Absorber Replacement (GNC)**.
7. Install the rear brake callipers. Refer to **Rear Brake Caliper Replacement** .
8. Install the rear suspension control arm bolts to the body. Refer to **Rear Suspension Control Arm Replacement**.
9. Install the rear springs. Refer to **Rear Spring, Insulator, and Jounce Bumper Replacement**.
10. Remove the adjustable jack stands from the rear support.
11. Install the park brake cables on the rear suspension support. Refer to **Parking Brake Rear Cable Replacement** .
12. Install the rear muffler assembly. Refer to **Exhaust Muffler Replacement (Dual)** , **Exhaust Muffler Replacement (Single)** .
13. Install the tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
14. Lower the vehicle.

STABILIZER SHAFT INSULATOR REPLACEMENT (GNE)

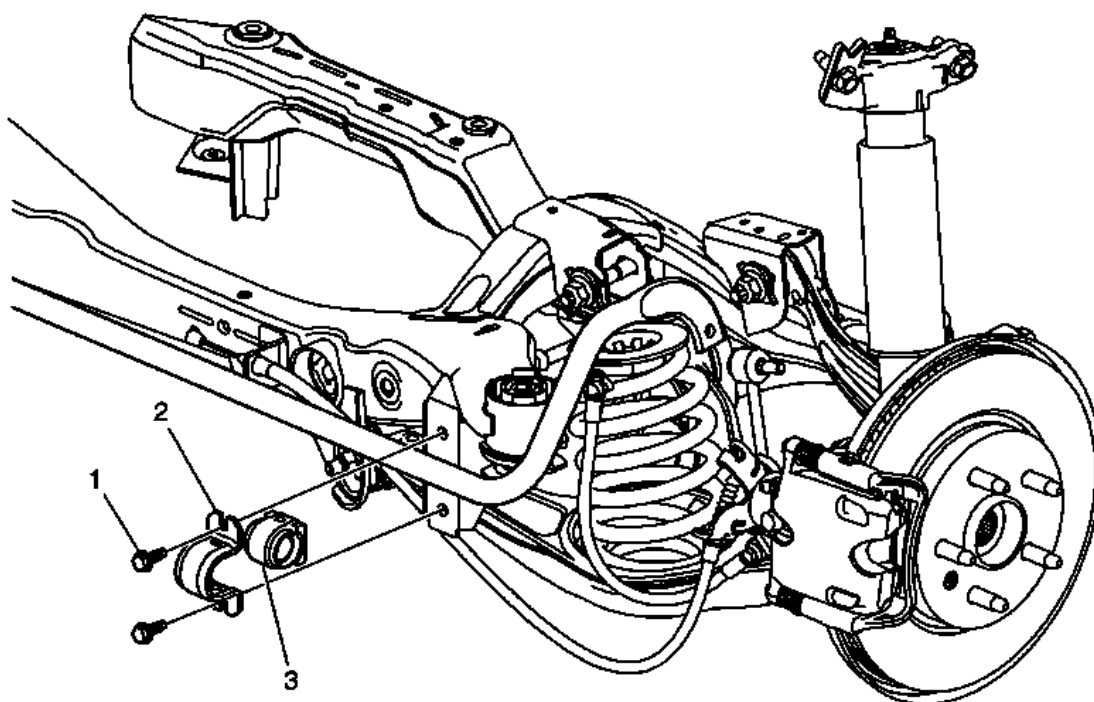


Fig. 23: Stabilizer Shaft Insulator (GNE)
 Courtesy of GENERAL MOTORS COMPANY

Stabilizer Shaft Insulator Replacement (GNE)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise and suitably support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the rear tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Disconnect the stabilizer links from the stabilizer shaft. Refer to <u>Stabilizer Shaft Link Replacement (GNE)</u>. 	
1	Stabilizer Shaft Insulator Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Install NEW bolts. Tighten 22 N.m (16 lb ft) + 30 degrees
2	Stabilizer Shaft Bracket Procedure Replace one insulator at a time to ensure the right position and angle.

STABILIZER SHAFT LINK REPLACEMENT (GNC)

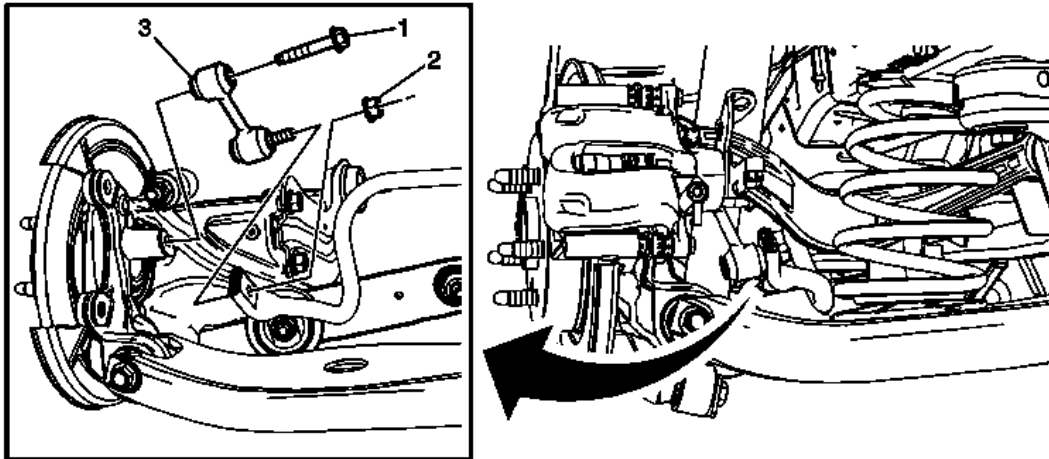


Fig. 24: Stabilizer Shaft Link, Nuts & Bolts (GNC)

Courtesy of GENERAL MOTORS COMPANY

Stabilizer Shaft Link Replacement (GNC)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 	
1	Rear Stabilizer Shaft Link Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 50 N.m(37 lb ft)
2	Rear Stabilizer Shaft Link Nut Tighten 50 N.m(37 lb ft)
3	Stabilizer Shaft Link

STABILIZER SHAFT LINK REPLACEMENT (GNE)

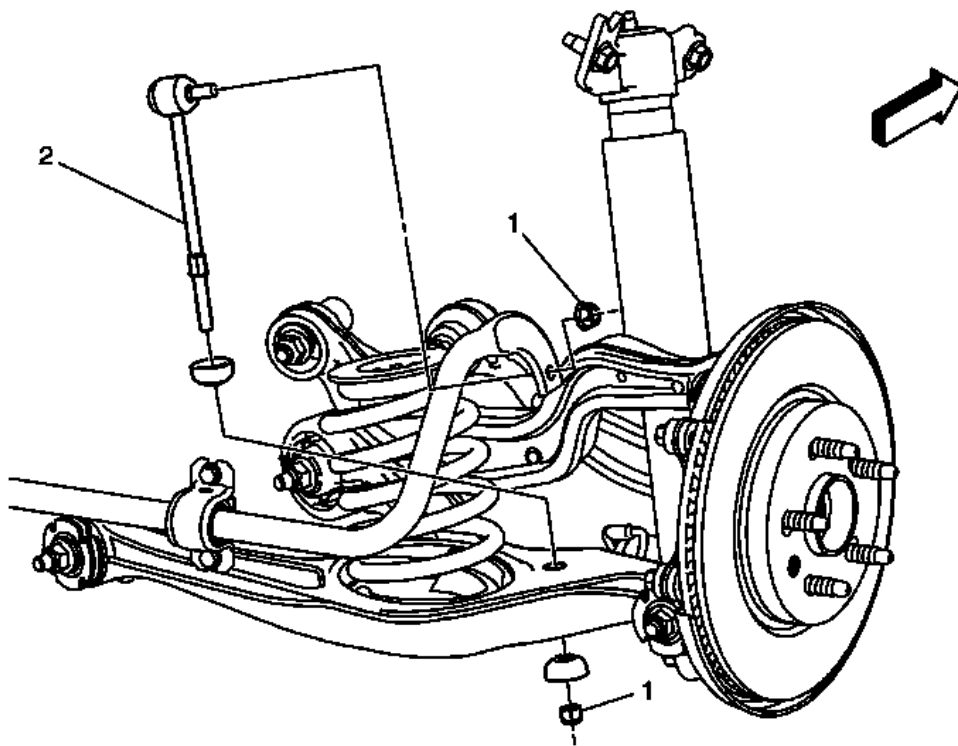


Fig. 25: Stabilizer Shaft Link (GNE)
 Courtesy of GENERAL MOTORS COMPANY

Stabilizer Shaft Link Replacement (GNE)

Callout	Component Name
Preliminary Procedure	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> .	
1	Stabilizer Shaft Link Nut (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 50 N.m(37 lb ft)
2	Stabilizer Shaft Link

STRUT AND SHOCK ABSORBER INSPECTION (SHOCK ABSORBER)

NOTE: The shock absorber assembly **DOES NOT** have to be removed from the vehicle to perform the following inspection procedure.

NOTE: A light film of oil on the top portion of the lower shock absorber tube is normal. DO NOT replace the shock absorber for this condition.

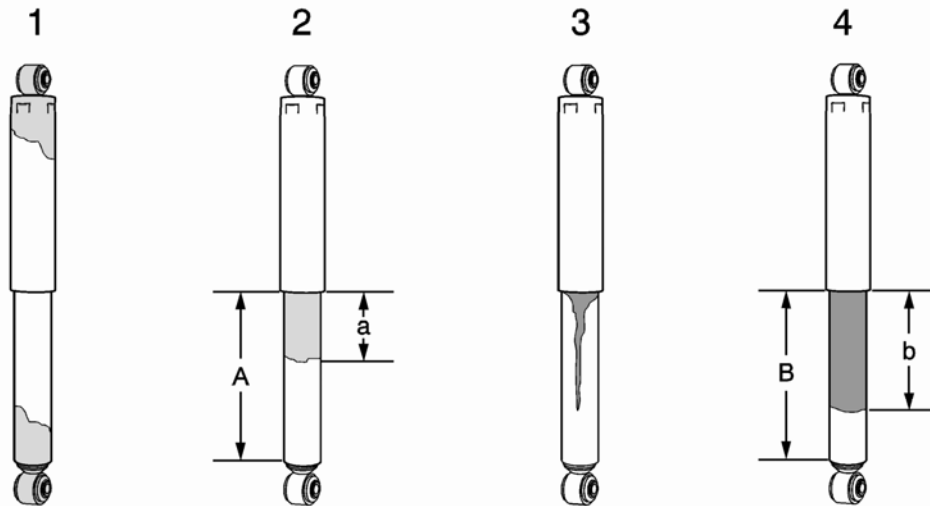


Fig. 26: Identifying Shock Absorber Conditions
Courtesy of GENERAL MOTORS COMPANY

Condition 1

Oil or fluid residue only on the bottom or top of the shock absorber and not originating from the shaft seal, is not a shock absorber related problem. DO NOT replace the shock absorber, look for other external leaks.

Condition 2

Light film/residue on approximately 1/3 (a) or less of the lower shock tube (A) and originating from the shaft seal, is a NORMAL condition. DO NOT replace the shock absorber.

Condition 3

Oil drip or trail down the lower shock tube and originating from the shaft seal, is an ABNORMAL condition. Replace the shock absorber.

Condition 4

An extreme wet film of oil covering more than 1/3 (b) of the lower shock tube and originating from the shaft seal (B), is an ABNORMAL condition. Replace the shock absorber. Refer to **Shock Absorber Replacement (GNC)**, **Shock Absorber Replacement (GNE)**.

Inspection

1. Verify the customer's concern is present. If the concern is present, continue to the next step. If the concern is not present, then the vehicle is operating normally.

NOTE: **The shock absorber assembly DOES NOT have to be removed from the vehicle to perform the following inspection procedure.**

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Visually inspect each of the shock absorbers for external fluid leaks. Refer to the following conditions 1, 2 , 3 , and 4 for visual inspection.
 - If conditions 1 or 2 are found, continue to step 4.
 - If conditions 3 or 4 are found, replace shock absorber. Refer to Shock Absorber Replacement (GNC), Shock Absorber Replacement (GNE).
4. If equipped with electronic suspension control system, ensure that the system is working properly. Refer to Diagnostic Starting Point - Electronic Suspension Control.
5. Use your hands in order to lift up and push down on each corner of the vehicle 3 times. Remove your hands from the vehicle. If the corner motion exceeds 2 cycles, replace the shock absorber. If the shock absorber does not exceed 2 cycles, NO repair is necessary.

SHOCK ABSORBER REPLACEMENT (GNC)

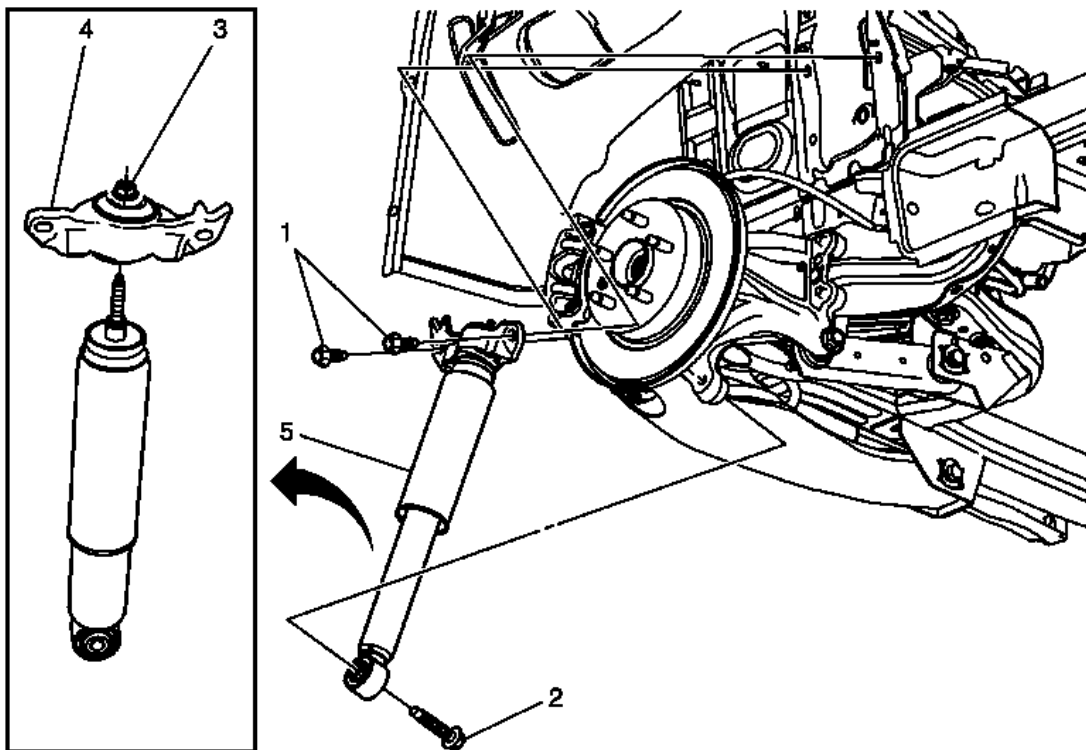


Fig. 27: Shock Absorber Components (GNC)
Courtesy of GENERAL MOTORS COMPANY

Shock Absorber Replacement (GNC)

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the rear tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Remove the rear wheelhouse panel liner from the vehicle. Refer to <u>Rear Wheelhouse Liner Replacement</u> .	
1	Rear Shock Absorber Bolts Upper Body (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Support the lower control arm with a suitable jack stand. Tighten <ul style="list-style-type: none">• First Pass: 100 N.m (74 lb ft)• Second Pass: loosen 120 degrees• Final Pass: 100 N.m (74 lb ft)
2	Rear Shock Absorber Bolt Procedure Remove and discard the bolt. Replace with NEW only. Tighten <ul style="list-style-type: none">• First Pass: 150 N.m (110 lb ft)• Final Pass: plus 60 degrees
3	Shock Absorber Nut CAUTION: Do Not use air tools to remove the upper shock absorber nut. Doing so could damage the shock absorber internally. Tighten 20 N.m (15 lb ft)
4	Rear Shock Absorber Upper Mount Procedure Transfer the upper mount to the new shock absorber.
	Shock Absorber CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW

5

torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

Procedure

Disconnect any electrical connectors, if equipped.

SHOCK ABSORBER REPLACEMENT (GNE)

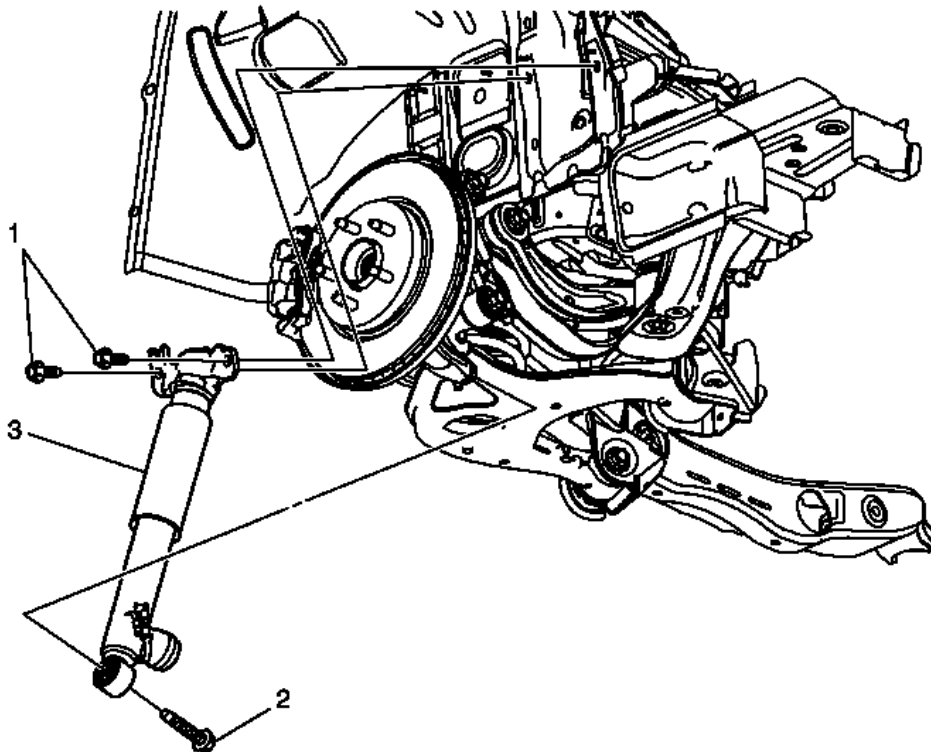


Fig. 28: Shock Absorber (GNE)

Courtesy of GENERAL MOTORS COMPANY

Shock Absorber Replacement (GNE)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the rear tire and wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Remove the rear wheelhouse panel liner from the vehicle. Refer to <u>Rear Wheelhouse Liner Replacement</u> . 	
	Rear Shock Absorber Bolt Upper Body (Qty: 2)
	CAUTION:

1	<p>Refer to <u>Fastener Caution</u> .</p> <p>Procedure Disconnect any electrical connectors if equipped.</p> <p>Tighten 100 N.m (74 lb ft)</p>
2	<p>Rear Shock Absorber Bolt</p> <p>Procedure Remove and discard the bolt. DO NOT reuse, replace with NEW only.</p> <p>Tighten</p> <ul style="list-style-type: none"> • First Pass: 150 N.m (111 lb ft) • Final Pass: plus 60 degrees
3	<p>Shock Absorber</p> <p>CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.</p>

SHOCK ABSORBER DISPOSAL

WARNING: Gas charged shock absorbers contain high pressure gas. Do not remove the snap ring from inside the top of the tube. If the snap ring is removed, the contents of the shock absorber will come out with extreme force which may result in personal injury.

WARNING: To prevent personal injury, wear safety glasses when centerpunching and drilling the shock absorber. Use care not to puncture the shock absorber tube with the centerpunch.

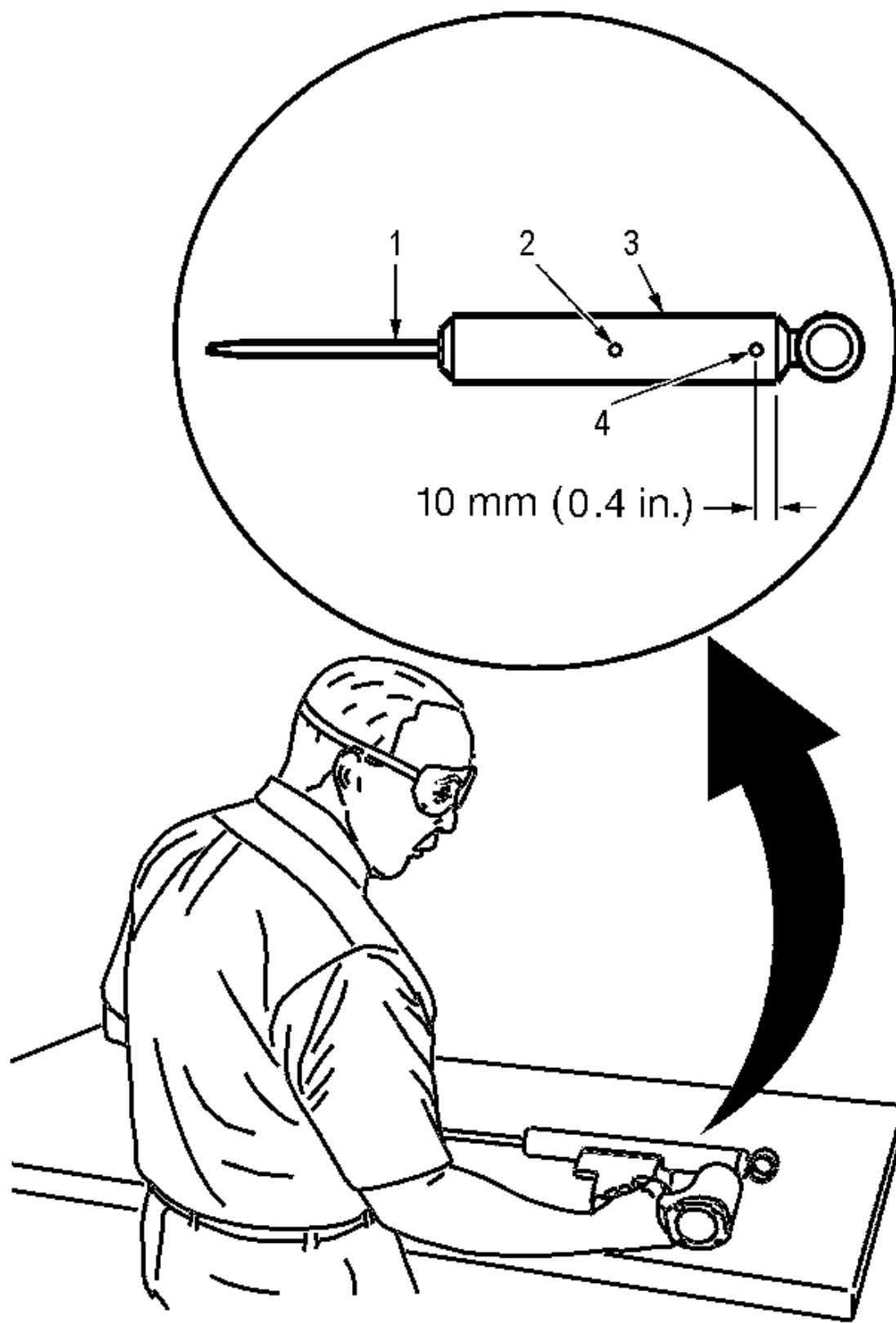


Fig. 29: Drilling Hole In Shock Absorber At Centerpunched Locations

Courtesy of GENERAL MOTORS COMPANY

1. Make an indentation 10 mm (0.4 in) from the bottom of the tube (3) using a centerpunch.
2. Clamp the shock absorber in a vise horizontally with the shock absorber rod (1) completely extended.
3. Drill a hole in the shock absorber at the centerpunch (4) using a 5 mm (3/16 in) drill bit. Gas or a gas/oil mixture will exhaust when the drill bit penetrates the shock absorber. Use shop towels in order to contain the escaping oil.
4. Make an indentation in the middle (2) of the tube (3) with a centerpunch.
5. Drill a second hole in the shock absorber at the centerpunch (2) using a 5 mm (3/16 in) drill bit. Oil will exhaust when the drill bit penetrates the shock absorber. Use shop towels in order to contain the escaping oil.
6. Remove the shock absorber from the vise. Hold the shock absorber over a drain pan horizontally with the holes down. Move the rod (1) in and out of the tube (3) to completely drain the oil from the shock absorber.

REAR SPRING, INSULATOR, AND JOUNCE BUMPER REPLACEMENT

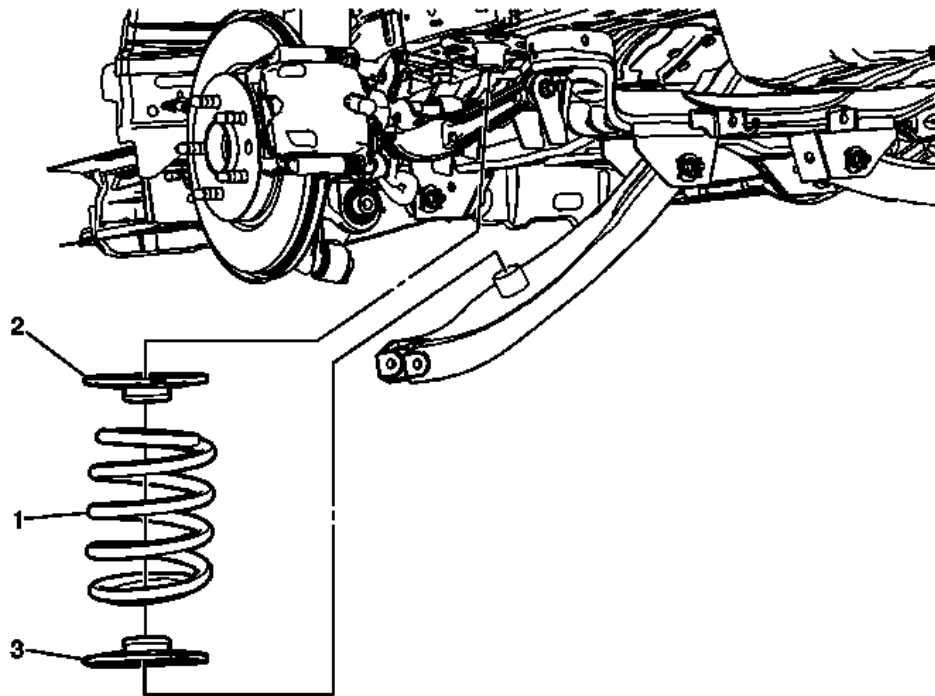


Fig. 30: Rear Spring, Insulator & Jounce Bumper
Courtesy of GENERAL MOTORS COMPANY

Rear Spring, Insulator, and Jounce Bumper Replacement

Callout	Component Name
WARNING: To prevent personal injury and/or component damage, use the proper tools to support the lower	

control arm when removing the coil spring. The coil spring is under extreme pressure and can become a projectile should the spring separate from the lower control arm before all of the tension is relieved.

Preliminary Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the rear tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the rear brake caliper and relocate to the side, if needed. Refer to **Rear Brake Caliper Replacement** .

	Rear Spring
1	Procedure <ol style="list-style-type: none"> 1. Use the proper jack stand to support the lower control arm. 2. Disconnect the lower control arm from the rear wheel hub bracket. Refer to <u>Rear Axle Lower Control Arm Replacement (GNC)</u>, <u>Rear Axle Lower Control Arm Replacement (GNE)</u>.
2	Rear Spring Insulator (Upper)
3	Rear Spring Insulator (Lower)

ADJUST LINK REPLACEMENT (GNC)

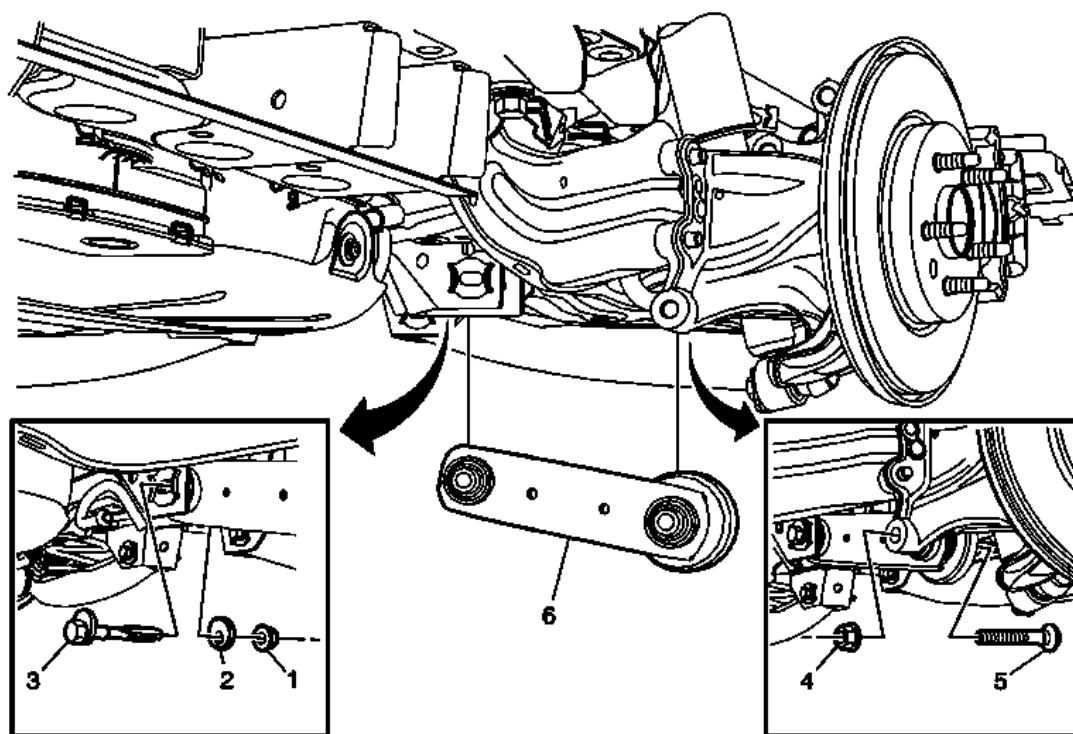


Fig. 31: Adjust Link (GNC)

Courtesy of GENERAL MOTORS COMPANY

Adjust Link Replacement (GNC)

Callout	Component Name
Preliminary Procedure Raise and suitably support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	<p>Rear Suspension Link Inner Nut</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Support the adjust link horizontally with a jack before tightening the nut.</p> <p>NOTE: DO NOT torque the nut until all specifications have been checked and/or adjusted. The nut must be tightened at ride height.</p> <p>Tighten</p> <ul style="list-style-type: none">• First Pass: 90 N.m (66 lb ft)• Final Pass: plus 60 degrees <p>Special Tools EN-45059 Angle Meter For equivalent regional tools, refer to <u>Special Tools</u>.</p>
2	Rear Suspension Washer
3	<p>Rear Suspension Link Bolt (Inner)</p> <p>Procedure Remove and discard the bolt. Replace with NEW only.</p>
4	Rear Suspension Link Nut (Outer)
5	<p>Rear Suspension Link Bolt (Outer)</p> <p>Procedure Remove and discard the rear suspension link bolt. Replace with NEW only.</p> <p>Tighten</p> <ul style="list-style-type: none">• First Pass: 115 N.m (85 lb ft)• Final Pass: plus 90 degrees <p>Special Tools EN-45059 Angle Meter</p>

	For equivalent regional tools, refer to Special Tools .
6	Adjust Link Procedure After installation, check the rear alignment. Refer to Wheel Alignment Measurement .

ADJUST LINK REPLACEMENT (GNE)

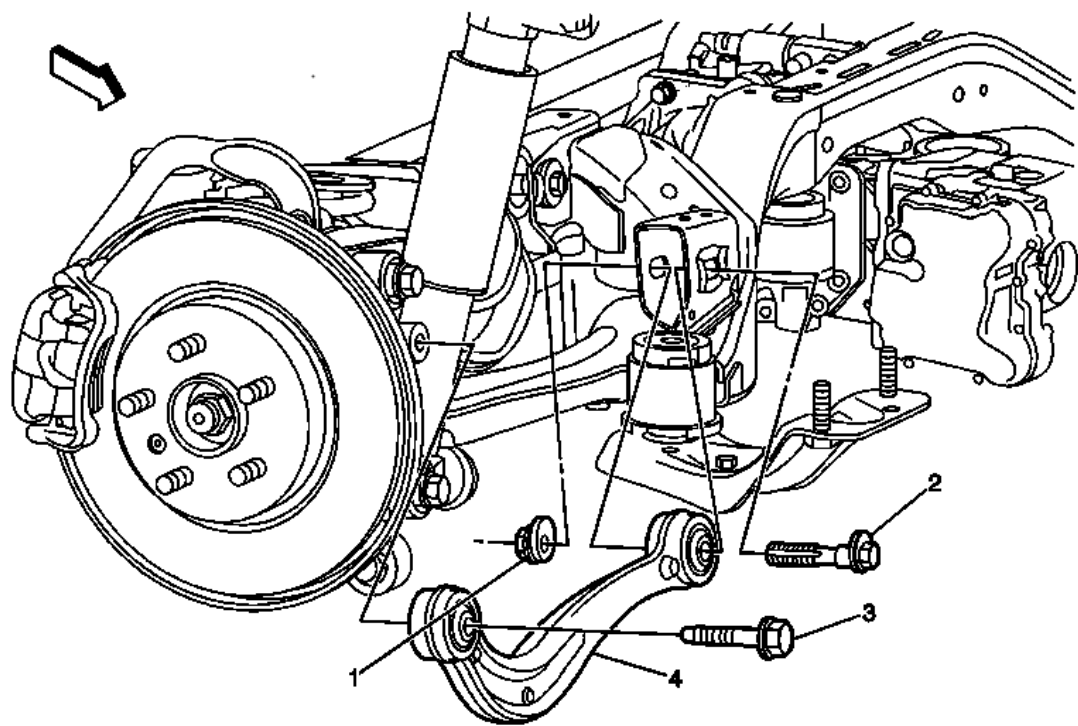


Fig. 32: Adjust Link (GNE)
 Courtesy of GENERAL MOTORS COMPANY

Adjust Link Replacement (GNE)

Callout	Component Name
Preliminary Procedures	
1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the rear tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .	
1	Rear Suspension Adjust Link Nut Procedure Remove the nut. Tighten 150 N.m (111 lb ft)
	Rear Suspension Link Inner Bolt CAUTION:

2	<p>Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Lower the fuel tank, if necessary, to get access to rear suspension adjust link bolt. . 2. Remove the bolt .
3	<p>Rear Suspension Link Outer Bolt</p> <p>CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.</p> <p>Procedure Remove and discard the bolt and nut. DO NOT reuse, replace with NEW only.</p> <p>Tighten</p> <ul style="list-style-type: none"> • First Pass: 150 N.m (111 lb ft) • Final Pass: plus 60 degrees
4	<p>Rear Suspension Adjust Link</p> <p>CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Use a proper jack stand to load the knuckle when tightening the fasteners. 2. After installation, check the rear alignment. Refer to <u>Wheel Alignment Measurement</u> .

WHEEL STUD REPLACEMENT

Special Tools

CH-49455 Ball Joint Remover

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the rear wheel bearing and hub. Refer to **Rear Wheel Bearing and Hub Replacement (GNC)**, **Rear Wheel Bearing and Hub Replacement (GNE)**.

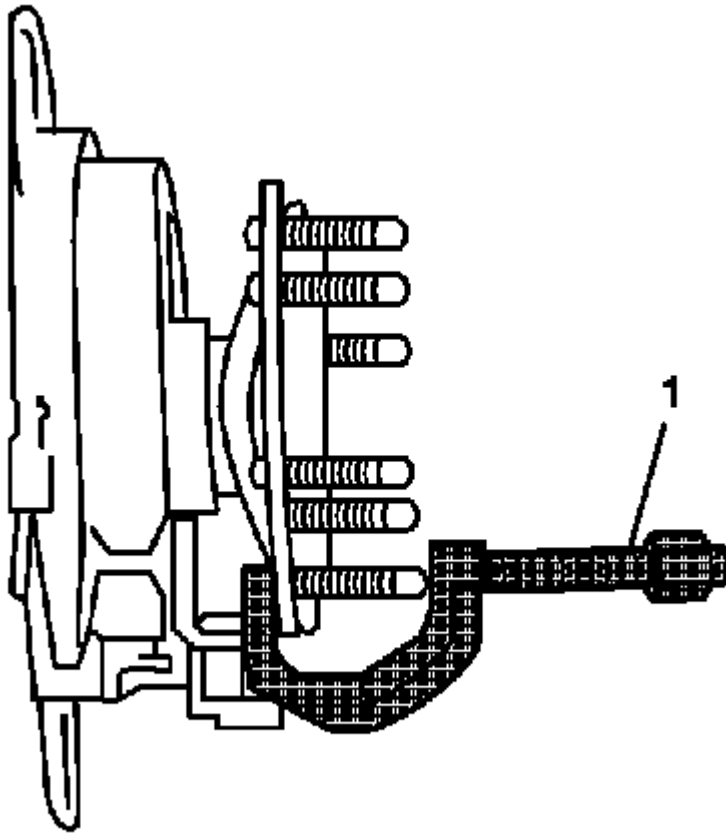


Fig. 33: Removing Wheel Stud From Hub Flange
Courtesy of GENERAL MOTORS COMPANY

4. Use **CH-49455** remover (1) to remove and discard the wheel stud.

Installation Procedure

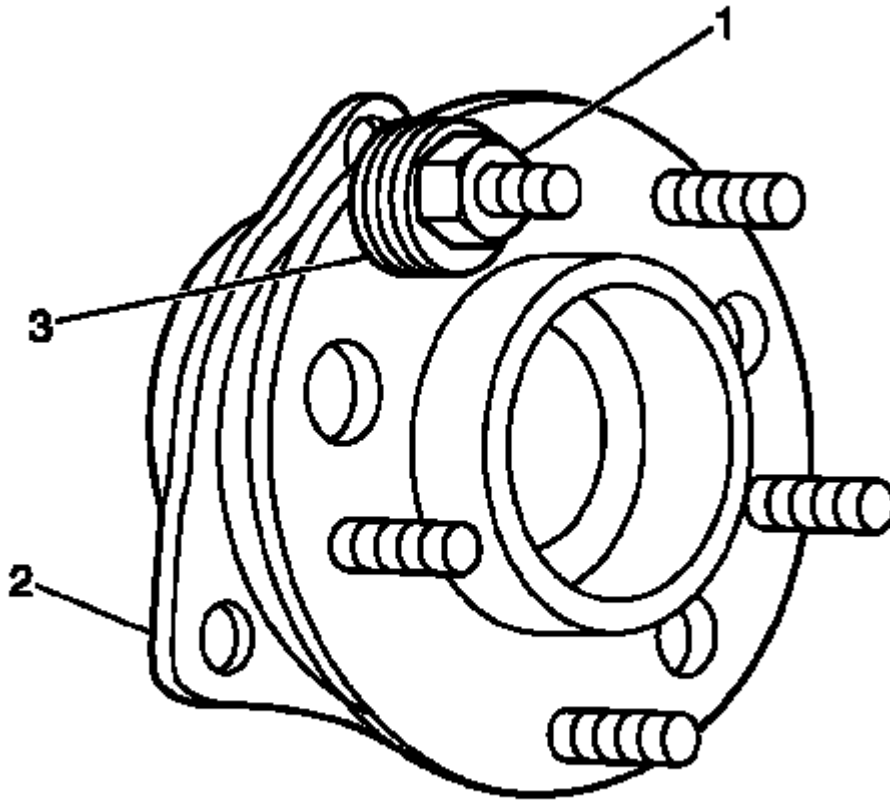


Fig. 34: Installing Wheel Stud

Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW wheel stud into the wheel bearing hub.
2. Add enough washers (3) in order to draw the stud into the hub.
3. Install the wheel nut (1) with the flat side against the washers.
4. Tighten the wheel nut (1) until the head of the wheel stud is fully seated against the back of the bearing hub flange.
5. Remove the wheel nut (1) and the washers (3).
6. Install the rear wheel bearing and hub. Refer to **Rear Wheel Bearing and Hub Replacement (GNC)**, **Rear Wheel Bearing and Hub Replacement (GNE)**.
7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.

DESCRIPTION AND OPERATION

REAR SUSPENSION DESCRIPTION AND OPERATION

The rear suspension system on this vehicle is of the independent link type. Rear suspension adjustment is

achieved through adjustable toe links and lower control arms. The rear coil springs are retained between the body and the lower control arm. Rubber insulators isolate the coil spring at both top and bottom. The rear suspension consists of 2 shock absorbers attached to the knuckle and the reinforced body areas.

The rear suspension system performs the following functions:

- Maintains the relationship of the rear axle to the body
- Controls the torque reaction on acceleration and braking

The suspension system consists of the following components:

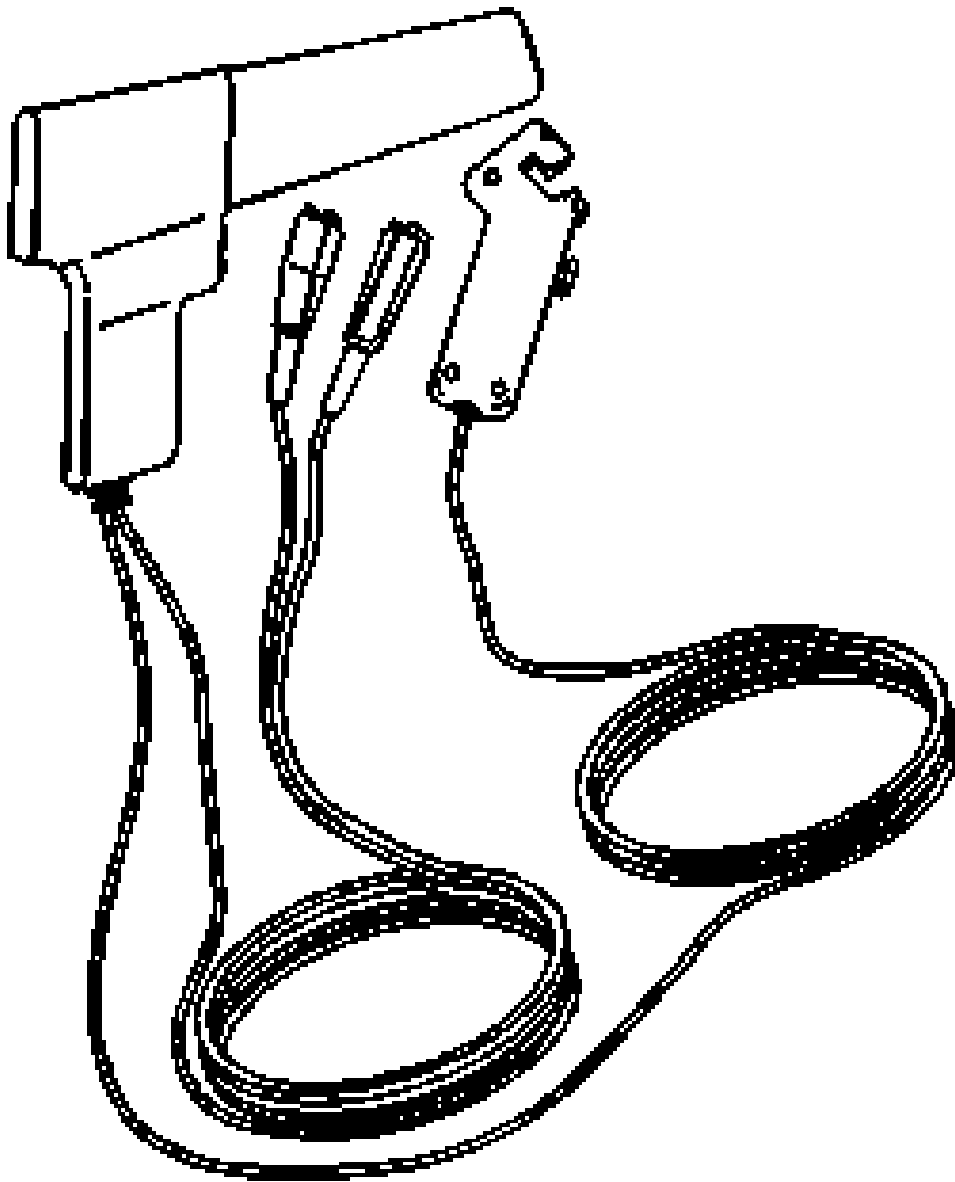
- Support assembly
- Coil springs and insulators
- Stabilizer shaft, insulators and stabilizer links
- Toe links
- Upper control arms
- Lower control arms
- Trailing arms
- Knuckles
- Wheel bearing/hub
- Shock absorbers

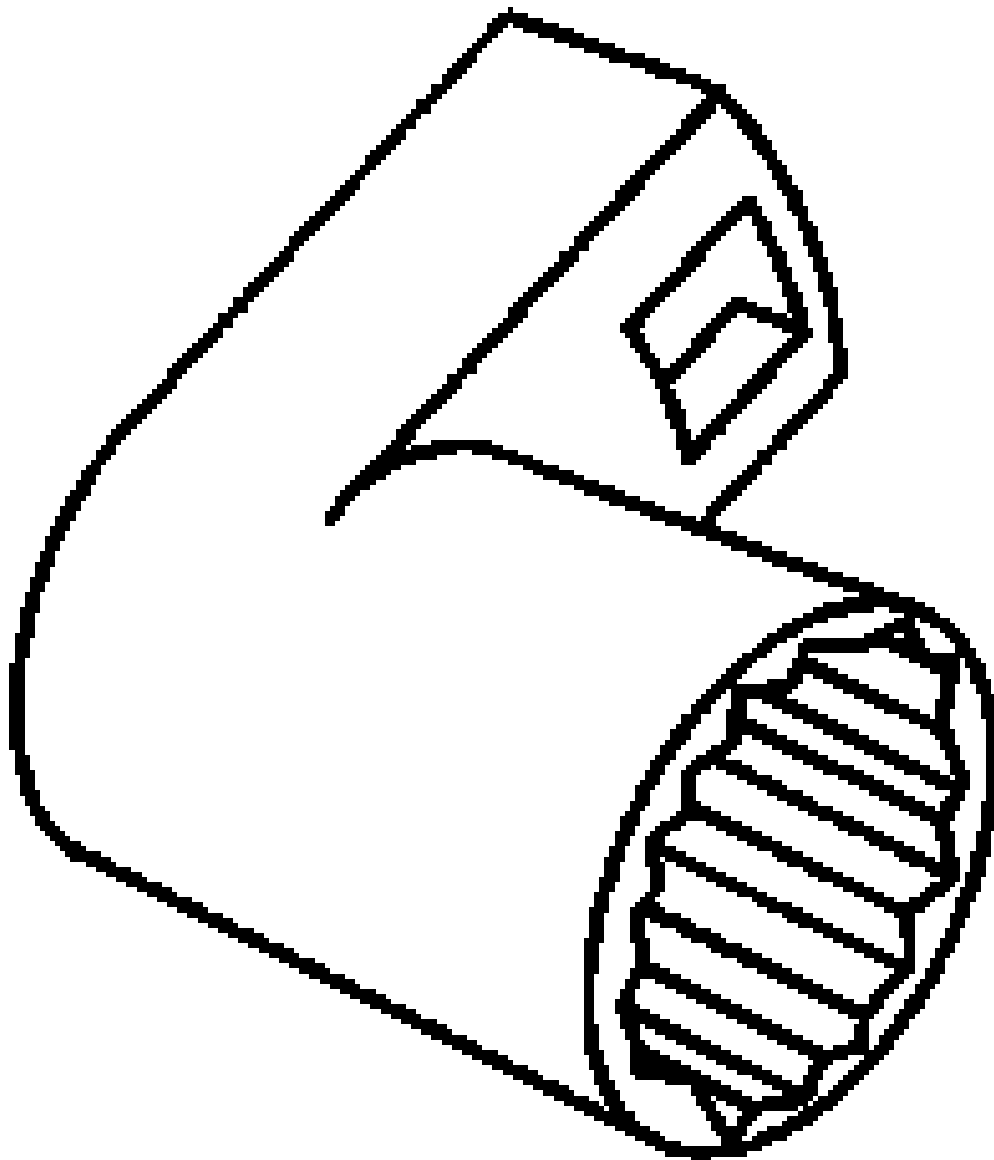
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Descrip
	CH-49455

J-49455
Ball Joint Remo'





J 21474
Control Arm Busl
Kit

ELECTRICAL

Wiring Systems and Power Management - Repair Instructions

REPAIR INSTRUCTIONS

GMLAN AND MEDIA ORIENTED SYSTEMS TRANSPORT (MOST) WIRING REPAIRS

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool
- DuraSeal splice sleeves
- A wire stripping tool

For equivalent regional tools, refer to **Special Tools** .

The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides necessary contact integrity for the sensitive, low energy circuits.

The GM Local Area Network (GMLAN) System requires special wiring repair procedures due to the sensitive nature of the circuitry. Follow the specific procedures and instructions when working on GMLAN connectors and terminals.

GMLAN Repairs

NOTE: **When making a repair to any GMLAN network, the original wire length after the repair must be the same length as before the repair. If the network is a twisted pair, the twist must be maintained after the repair is completed.**

GMLAN has 2 types of networks, low speed and high speed. Low speed GMLAN has a single wire and works at slow speeds. High speed GMLAN has 2 wires in a twisted pair and works at higher speeds. For more information on GMLAN, refer to **Data Link Communications Description and Operation** .

GMLAN Connector Terminal Repair

NOTE: **A terminated lead can be used to replace damaged connector terminals for both high speed and low speed GMLAN systems. When making a connector terminal repair on a GMLAN high speed system with twisted pair wires, do not untwist the wires more than necessary to make the repair.**

If the individual terminals are damaged on any GMLAN connection, use the appropriate connector repair procedure in order to repair the terminal. Refer to **Connector Repairs** for the appropriate connector repair

procedure.

GMLAN Wire Repair

NOTE: Refer to **Wiring Repairs** in the service information connector end views or the vehicle schematics in order to determine the correct wire size for the circuit you are repairing. You must obtain this information in order to ensure circuit integrity.

If any wire except the pigtail is damaged, repair the wire by splicing in a new section of wire of the same gauge size (0.5 mm^2 , 0.8 mm^2 , 1.0 mm^2 etc.). Use the DuraSeal splice sleeves and **EL-38125-10** tool. For wiring repair, refer to **Splicing Copper Wire Using Splice Sleeves**.

ELECTRONIC SUSPENSION POSITION SENSOR FRONT JUMPER HARNESS DISCONNECTION

Removal Procedure

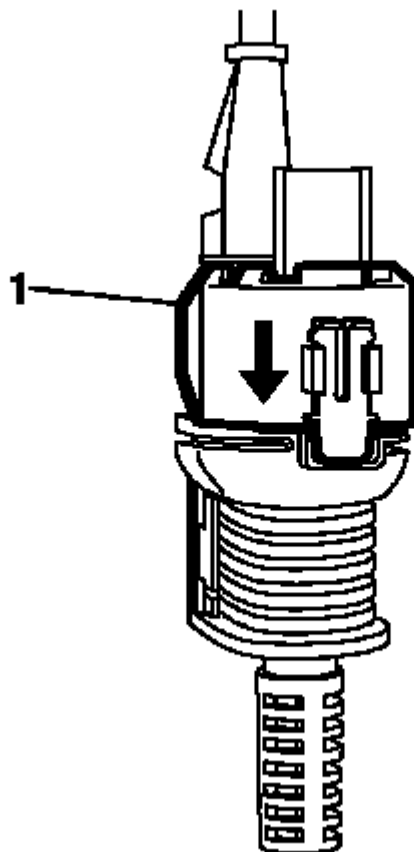


Fig. 1: Connector Position Assurance (CPA) Clip
Courtesy of GENERAL MOTORS COMPANY

1. Locate the connector position assurance (CPA) clip (1), which is in the locked position.

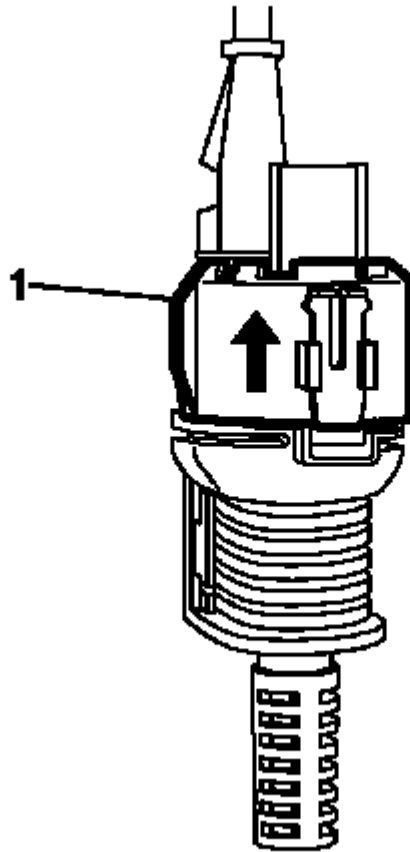


Fig. 2: Unlocking CPA
Courtesy of GENERAL MOTORS COMPANY

2. Unlock the CPA.

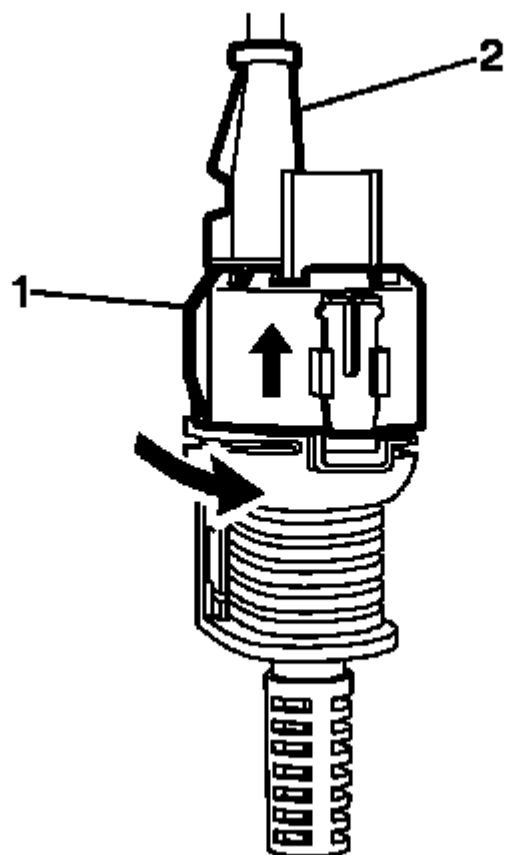


Fig. 3: Locking Part To Right And Disconnect Cable
Courtesy of GENERAL MOTORS COMPANY

3. Twist the locking part to the right and disconnect the cable (2).

Installation Procedure

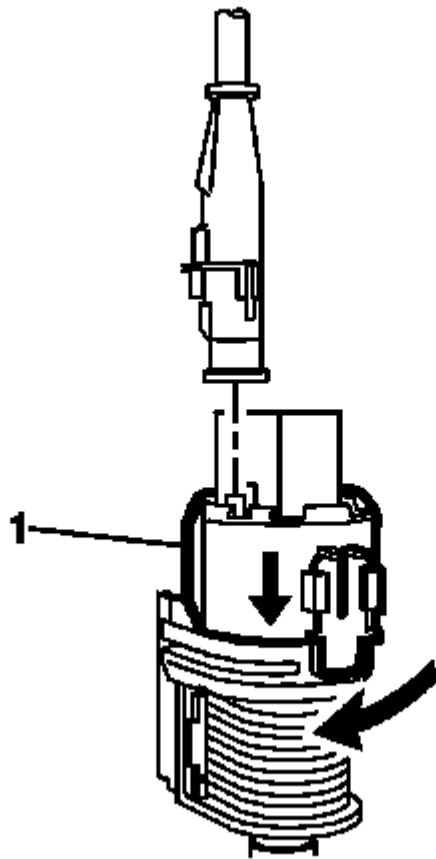


Fig. 4: Twisting Back Locking Part
Courtesy of GENERAL MOTORS COMPANY

1. Twist back the locking part.
2. Place the CPA in the locked position prior to re-connecting the cable.

INSTRUMENT PANEL WIRING HARNESS FUSE BLOCK DISASSEMBLE

NOTE: To remove wires from the top part using terminal release tools, only steps 1, 3, 8, 9, 10, 11, 12 and 13 are required. Use release tool J-38125-38 for cavities 16-18, 20-34, 37-47.

Fuse Block Disassemble Procedure

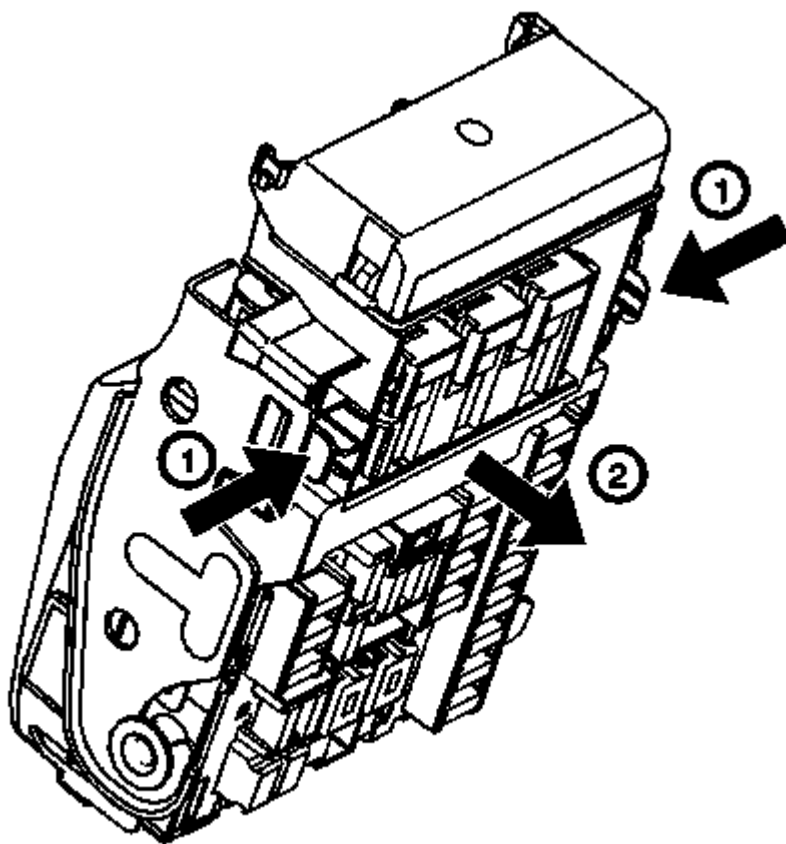


Fig. 5: Fuse Block & Locking Arms

Courtesy of GENERAL MOTORS COMPANY

1. Push the locking arms (1) and unlock the fuse block (2).

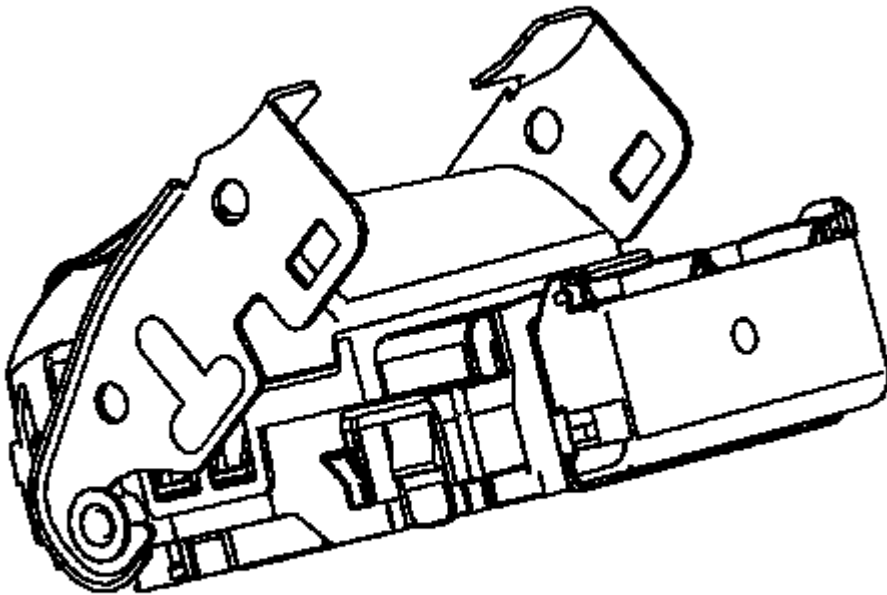


Fig. 6: Fuse Block In Unlocked Position
Courtesy of GENERAL MOTORS COMPANY

2. Fuse block unlocked.

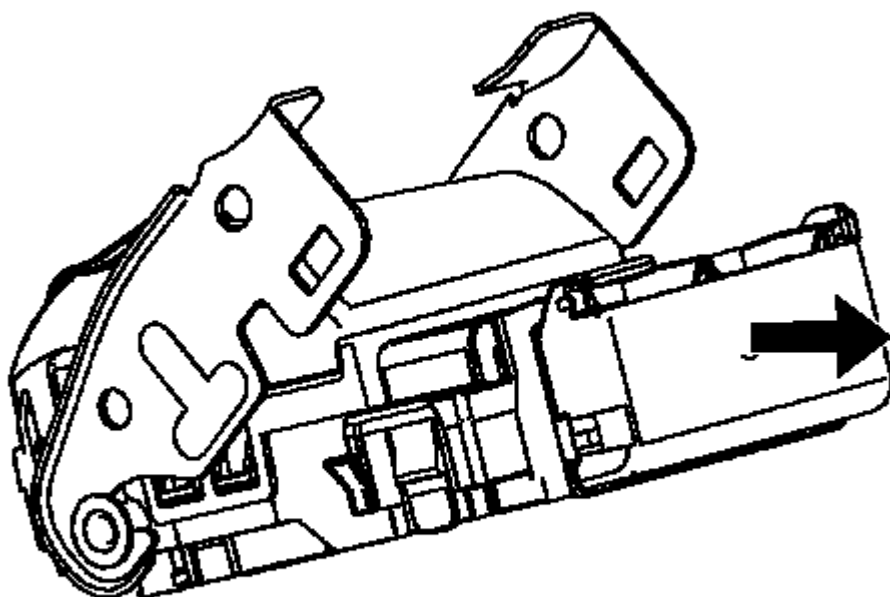


Fig. 7: Fuse Block & Bracket

Courtesy of GENERAL MOTORS COMPANY

3. Pull out and remove the fuse block from bracket.

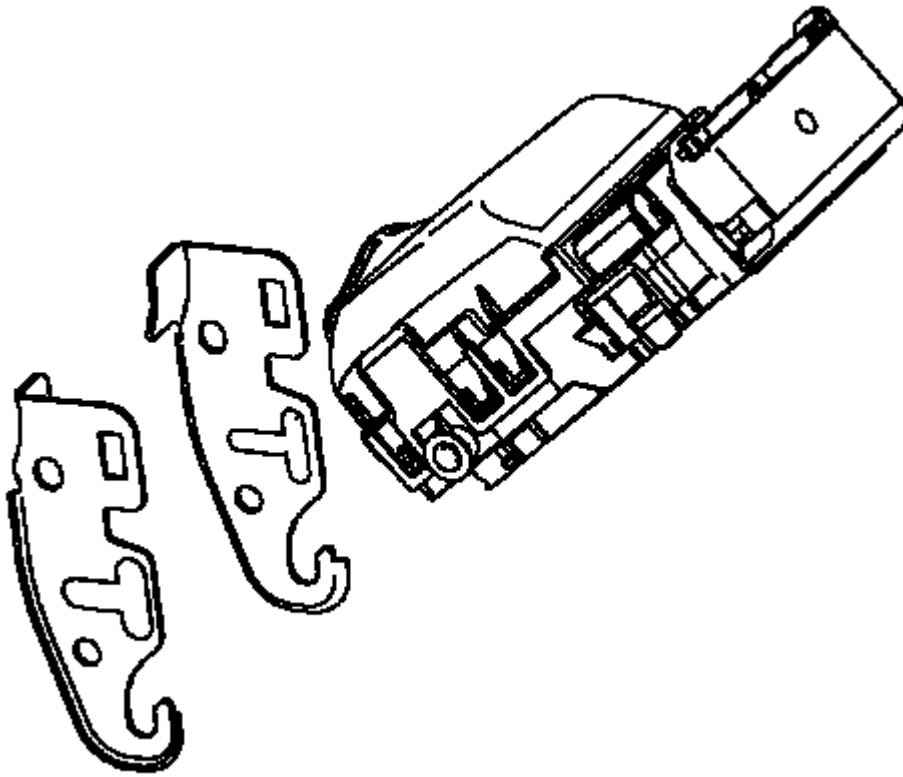


Fig. 8: Fuse Block & Brackets

Courtesy of GENERAL MOTORS COMPANY

4. Fuse block after removed from bracket.

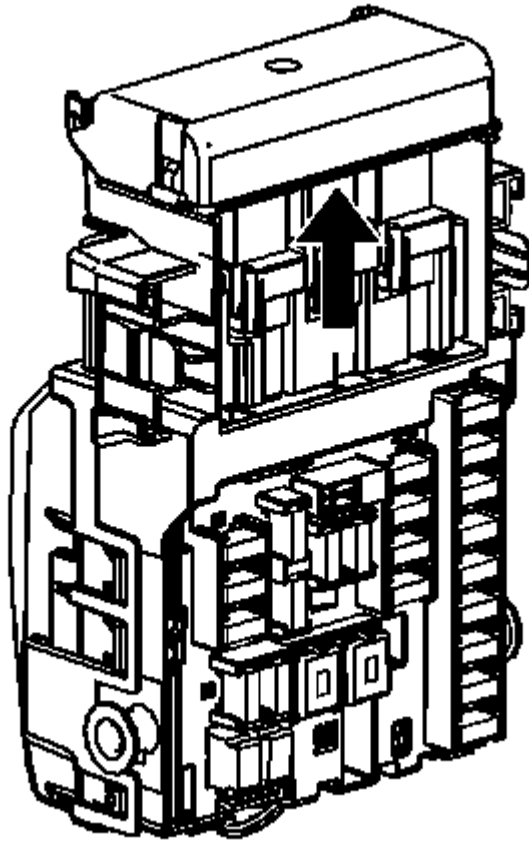


Fig. 9: Fuse Block & Relay Protection Cover
Courtesy of GENERAL MOTORS COMPANY

5. Push and open the relay protection cover.

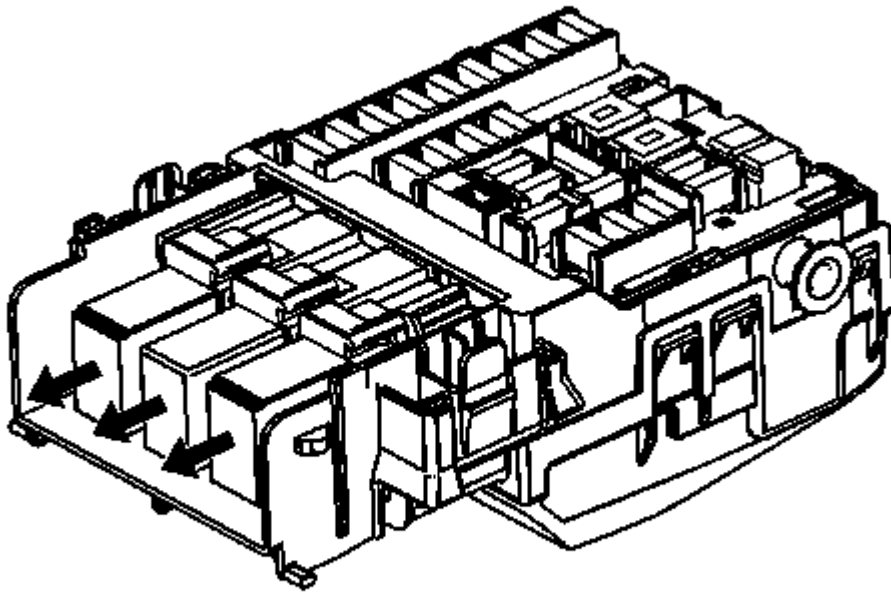


Fig. 10: Fuse Block Micro Relays
Courtesy of GENERAL MOTORS COMPANY

6. Remove micro relays (3x).

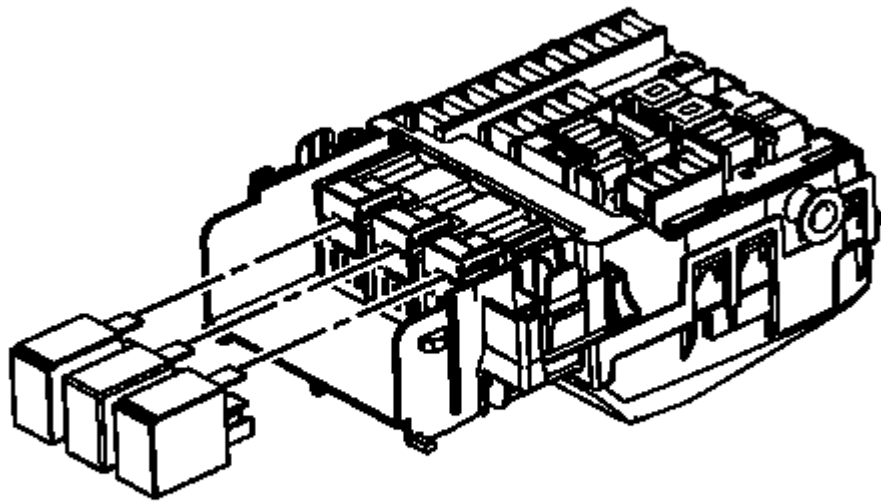


Fig. 11: Micro Relays

Courtesy of GENERAL MOTORS COMPANY

7. Fuse block with relays removed.

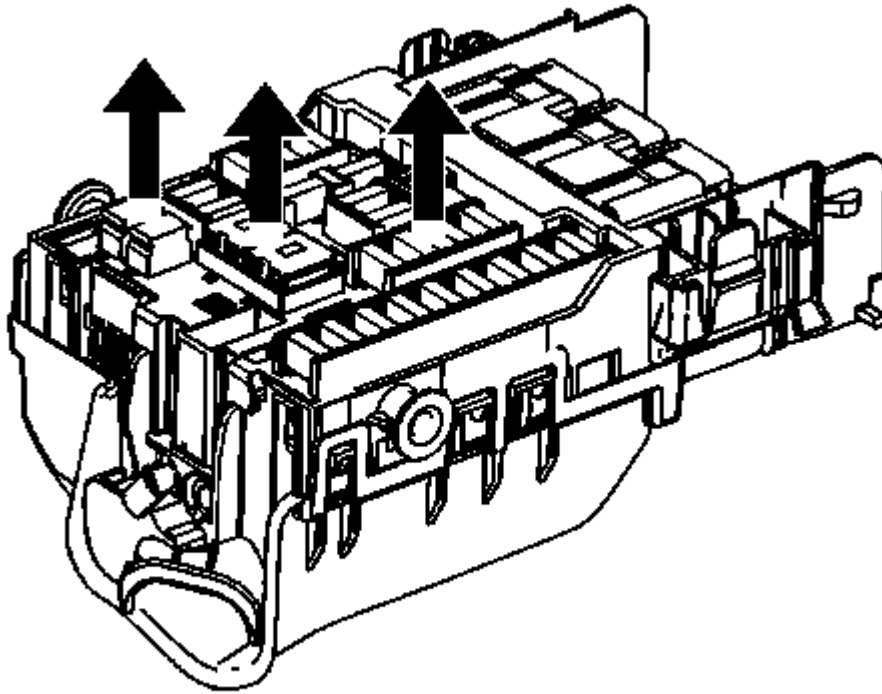


Fig. 12: Fuse Block Components

Courtesy of GENERAL MOTORS COMPANY

8. Remove mini fuses (22x), J-case fuses (2x), and circuit breakers (2x) from fuse block.

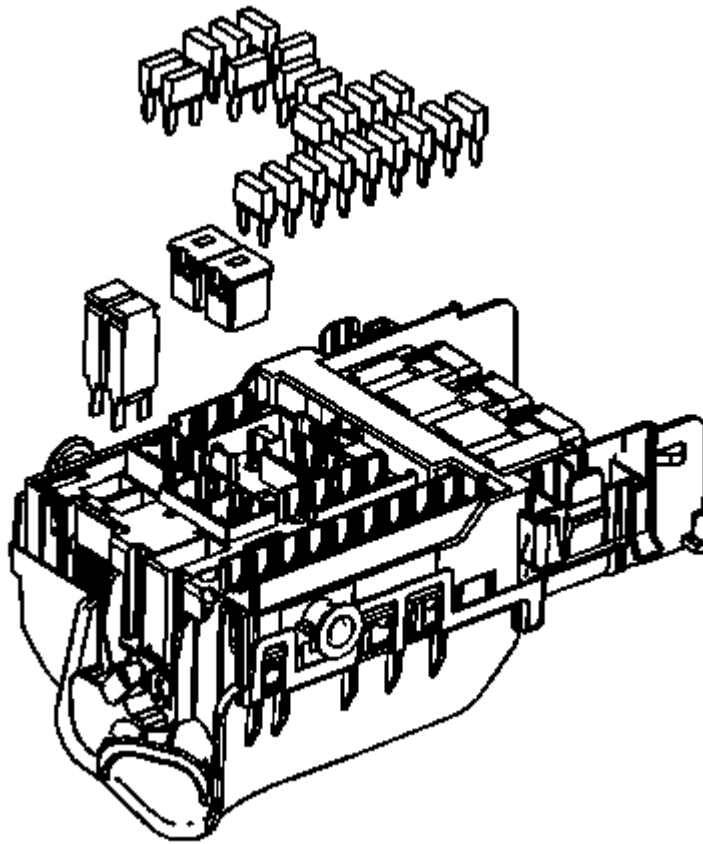


Fig. 13: View Of Fuse Block Components
Courtesy of GENERAL MOTORS COMPANY

9. Fuse block with all fuses and circuit breakers removed.

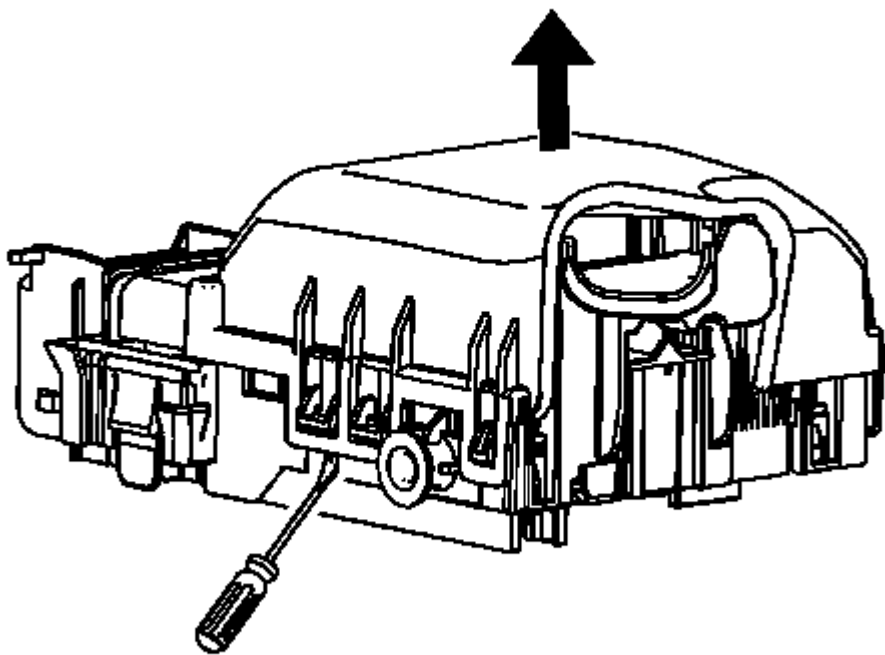


Fig. 14: Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

10. Unlock (6 locking points) and remove bottom protection cover from fuse block.

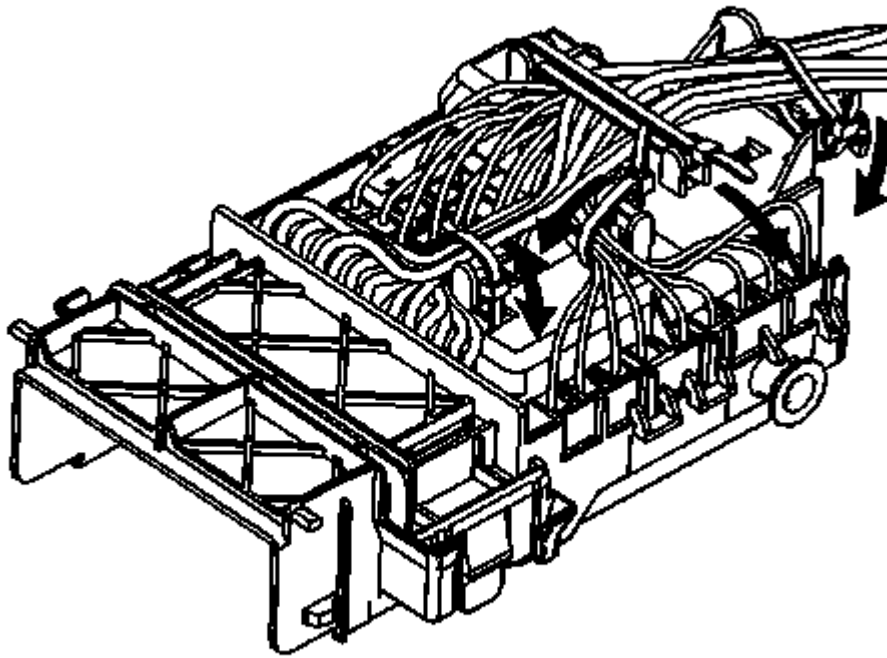


Fig. 15: Fuse Block Wires & Straps
Courtesy of GENERAL MOTORS COMPANY

11. Remove straps (4x) from wires.

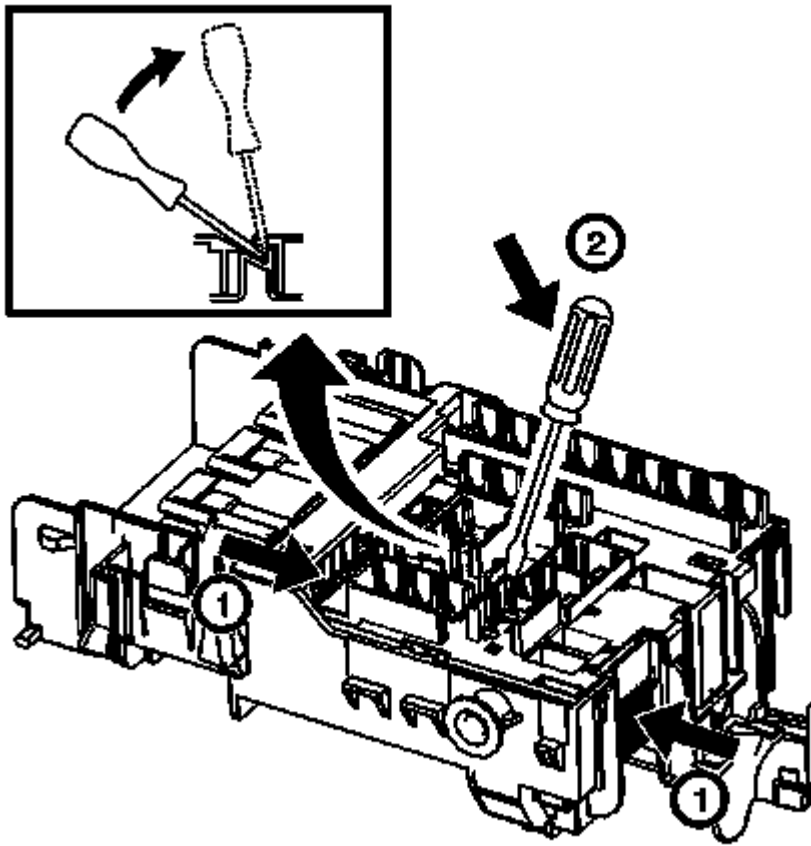


Fig. 16: Fuse Block Locking Arm Components
Courtesy of GENERAL MOTORS COMPANY

12. To place the top part (1) in pre-assembled position, press together locking arms on both sides of the bottom part (2), insert a pry tool into an appropriate hole in the top part and lever the top part upward until it remains in the pre-assembled position. Release the locking arms.

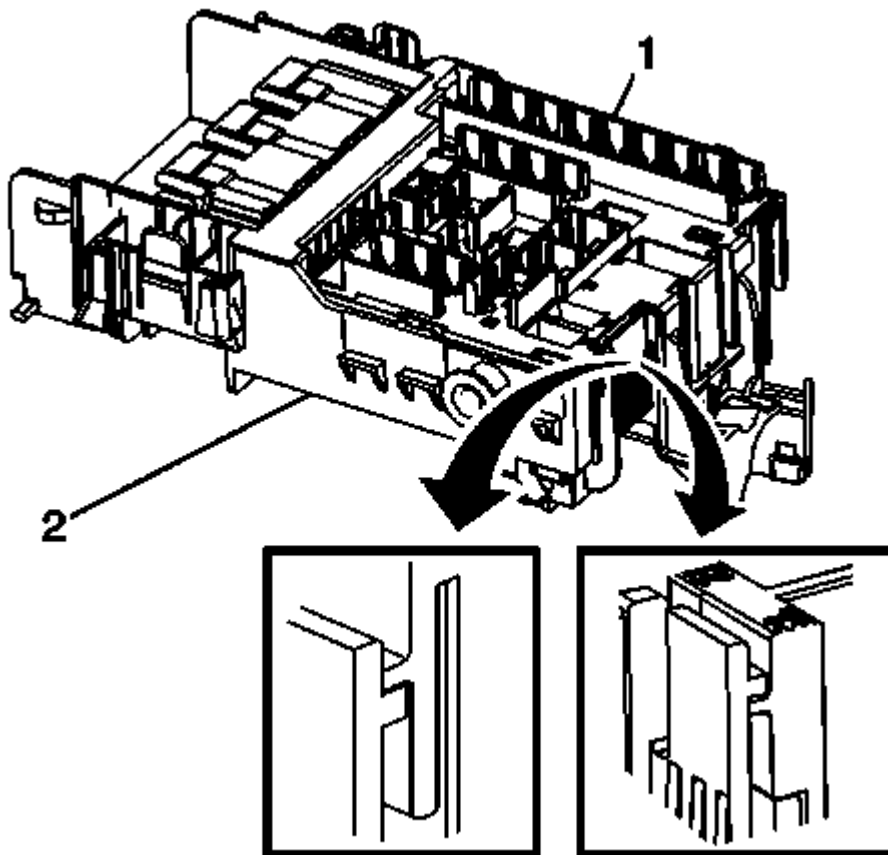


Fig. 17: Fuse Block Tabs

Courtesy of GENERAL MOTORS COMPANY

13. When the top part is in the pre-assembled position (required to release wire terminals), the tabs of the top part are on top of the tabs of the bottom part (left close-up view).

When the top part is in the end-locking position (required after wires are inserted), the tabs of the bottom part are on top of the tabs of the top part (right close-up view).

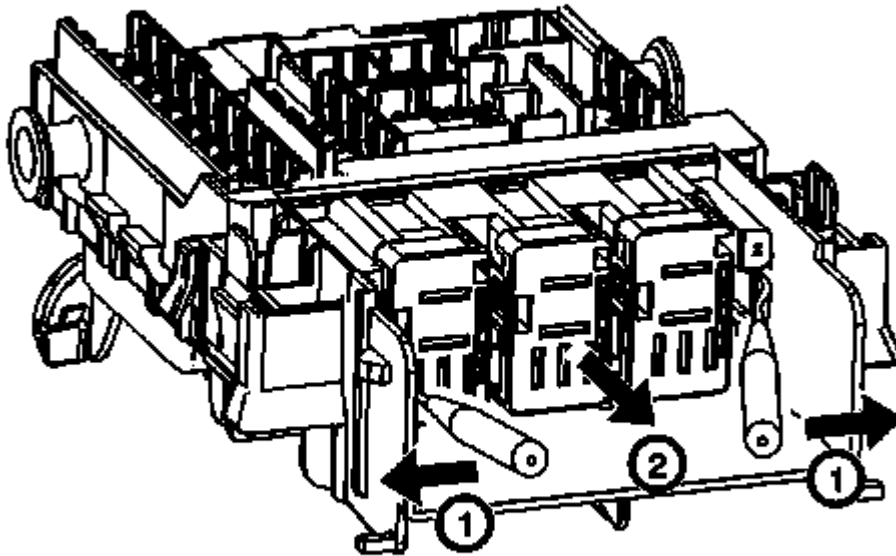


Fig. 18: Fuse Block Relays

Courtesy of GENERAL MOTORS COMPANY

14. Unlock and remove relay socket from fuse block.

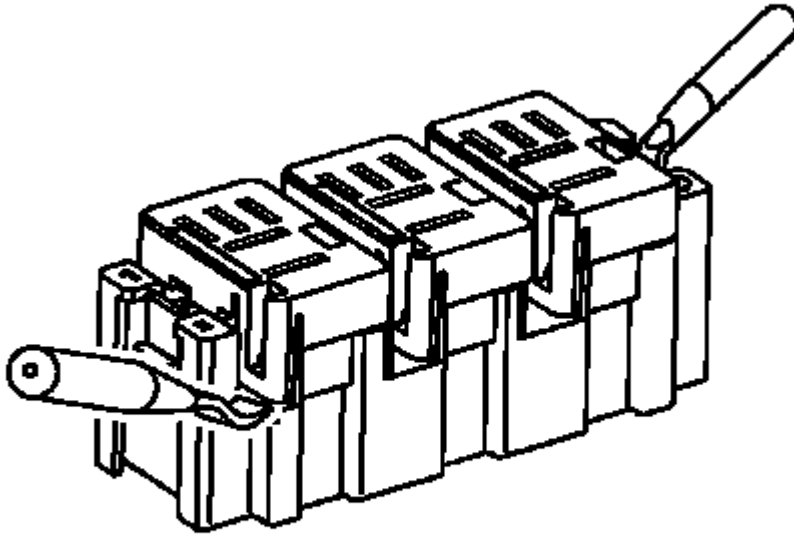


Fig. 19: Fuse Block Relay Socket & Locking Caps
Courtesy of GENERAL MOTORS COMPANY

15. Unlock (6 locking points) and remove locking caps (3x) from relay socket.

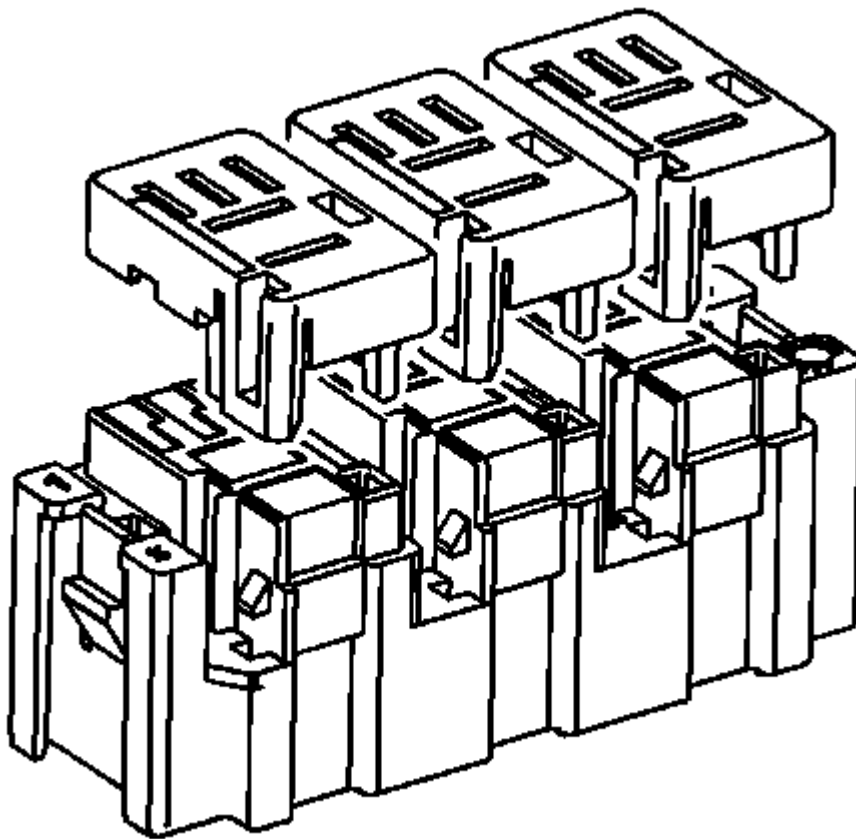


Fig. 20: Relay Socket & Locking Caps
Courtesy of GENERAL MOTORS COMPANY

16. Relay socket with locking caps removed.

RELAY REPLACEMENT (ATTACHED TO WIRE HARNESS)

Removal Procedure

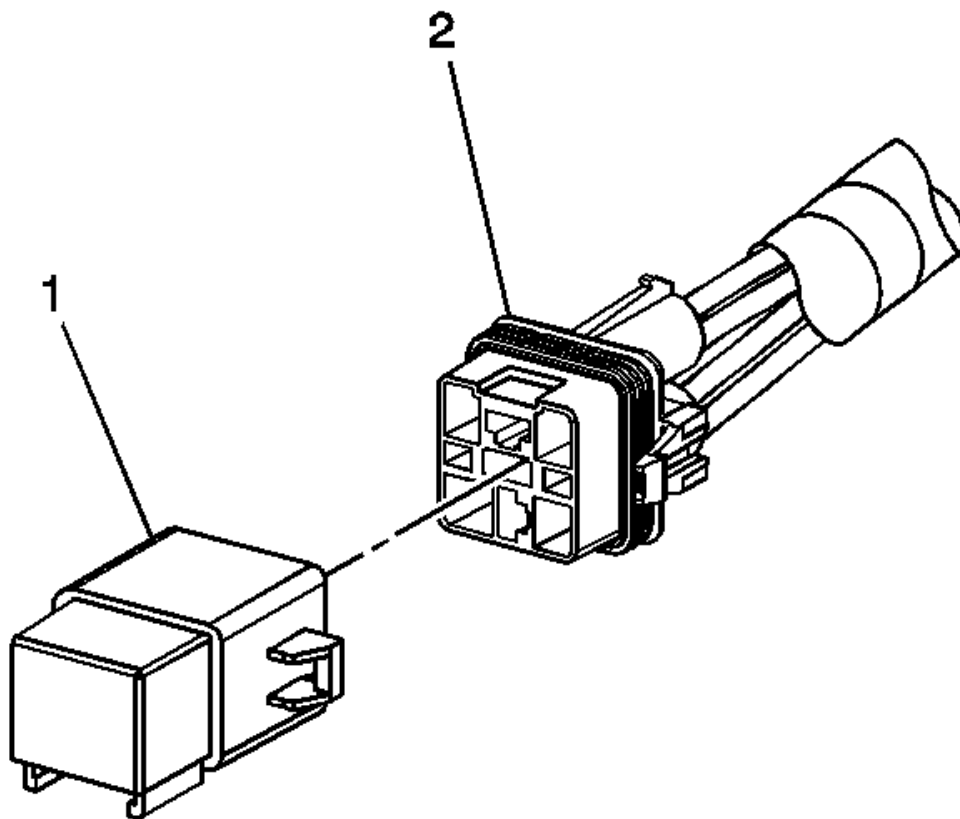


Fig. 21: Identifying Relay & Wire Harness Connector
Courtesy of GENERAL MOTORS COMPANY

1. Locate the relay. Refer to the **Master Electrical Component List** to locate the relay in the vehicle.
2. Remove any fasteners which hold the relay in place.
3. Remove any connector position assurance (CPA) devices or secondary locks.

NOTE: **Use care when removing a relay in a wiring harness when the relay is secured by fasteners or tape.**

4. Separate the relay (1) from the wire harness connector (2).

Installation Procedure

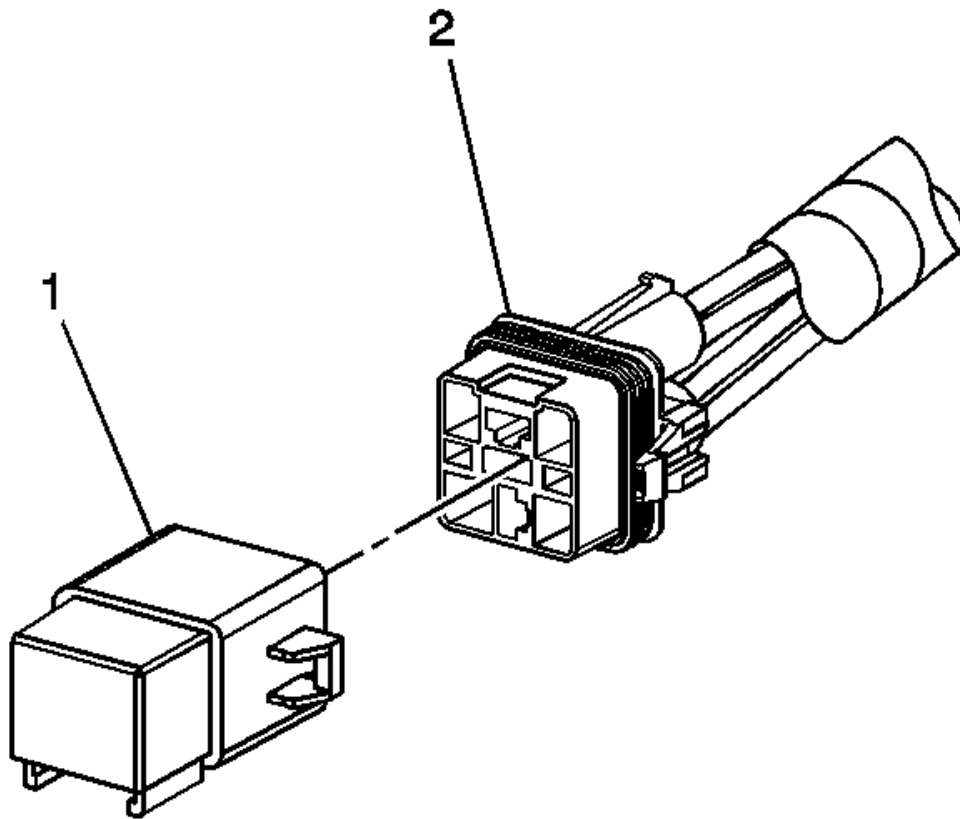


Fig. 22: Identifying Relay & Wire Harness Connector
Courtesy of GENERAL MOTORS COMPANY

1. Connect the relay (1) to the wire harness connector (2).
2. Install any connector position assurance (CPA) devices or secondary locks.
3. Install the relay using any fasteners or tape that originally held the relay in place.

RELAY REPLACEMENT (WITHIN AN ELECTRICAL CENTER)

Special Tools

EL-43244 Relay Puller Pliers

Removal Procedure

1. Remove the electrical center cover.

NOTE:

- Always note the orientation of the relay.

- If equipped with a notch style relay; observe the location of the notch on the old relay to verify the new relay is installed with the notch in the same location.
- Ensure that the electrical center is secure, as not to put added stress on the wires or terminals.

2. Locate the relay. Refer to **Electrical Center Identification Views** to locate the electrical center where the relay exists.

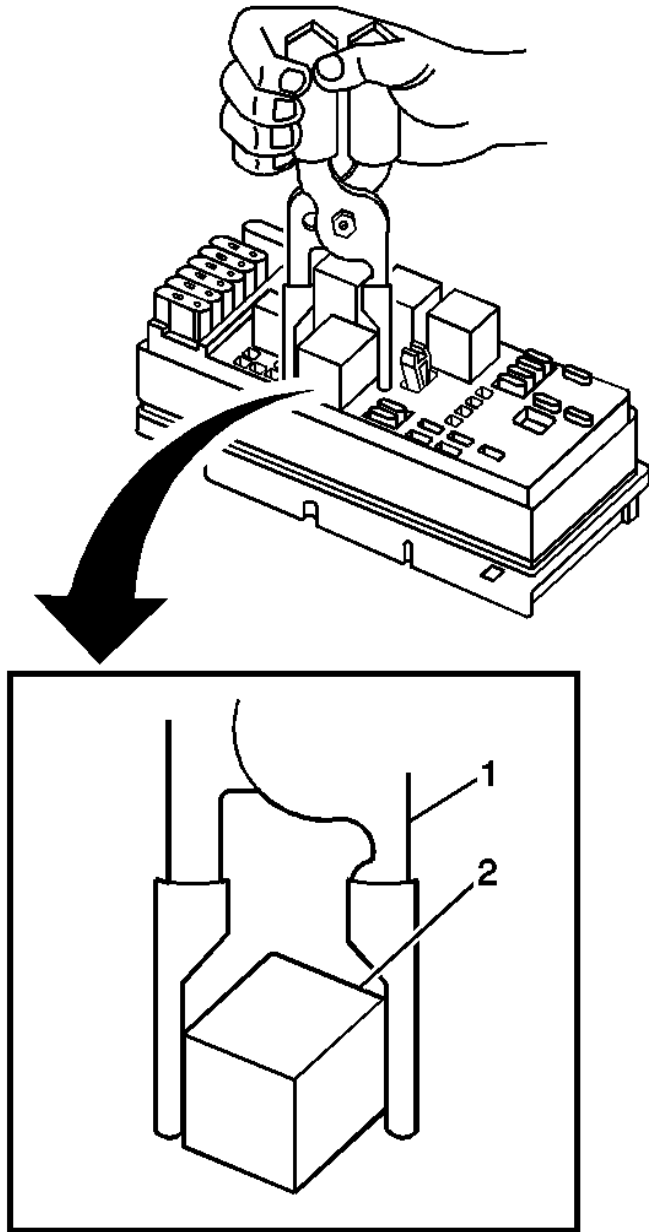


Fig. 23: Removing/Installing Relay
Courtesy of GENERAL MOTORS COMPANY

3. Using the EL-43244 (1) position the tool on opposing corners of the relay (2).

CAUTION: Use EL-43244 to pull the relay straight out from the electrical center terminals. The use of pliers or a flat bladed tool could damage the electrical center.

4. Remove the relay (2) from the electrical center.

Installation Procedure

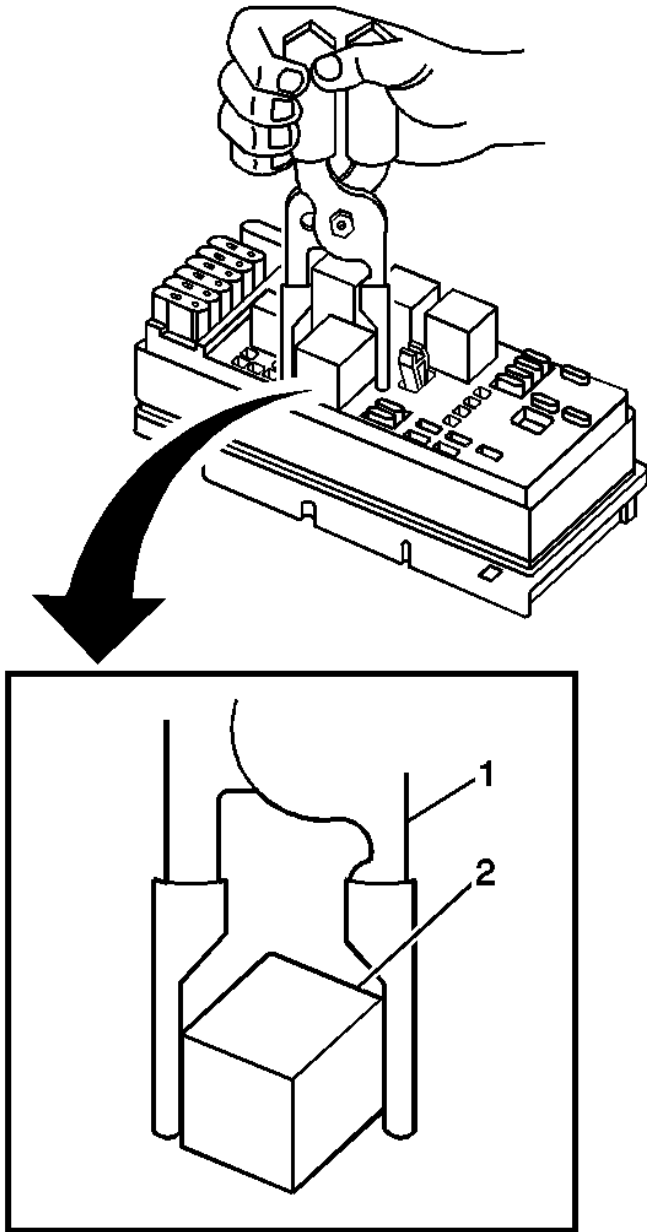


Fig. 24: Removing/Installing Relay
Courtesy of GENERAL MOTORS COMPANY

1. Install the relay (2) in the same position as removed.
2. Install the electrical center cover.

GROUND REPAIR

Electrical Grounds

Proper electrical system function relies on secure, positive, corrosion-free ground connections. Loose, stripped, or corroded connections increase the possibility of improper system function and loss of module communication. These conditions may also lead to unnecessary repairs and component replacements.

In general, electrical ground connections are accomplished using one, or a combination of, three attachment methods:

- Welded M6 stud and nut
- Welded M6 nut and bolt
- Welded M8 nut and bolt

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

Determine which attachment method is used, and carry out the appropriate repair.

M6 Weld Stud Replacement

1. Select a location adjacent the damaged or missing M6 ground stud having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the M6 rivet stud flange.
2. Using GM approved residue-free solvent or equivalent, remove any grease from the repair site and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

3. Drill a 10 mm (0.40 in) diameter hole through the panel.
4. Carefully remove paint and primer from the area surrounding the rivet stud flange until bare metal is visible.

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

5. Select a replacement conductive M6 rivet stud. Refer to GM parts catalog for the correct part number and application.
6. Using a rivet stud installer, install the replacement conductive M6 rivet stud.
7. Ensure the new rivet stud is securely fastened, with no detectable movement.

NOTE: The rivet stud and surrounding panel area must be properly refinished prior to the installation of the ground terminal and nut to maintain positive

electrical grounding.

8. Completely wrap the threads of the rivet stud with painters tape or equivalent.
9. Refinish the repair area using an anti-corrosion primer. Refer to **Anti-Corrosion Treatment and Repair** .
10. Allow the refinished repair area to cure sufficiently before removing the protective material applied to the rivet stud threads.
11. Remove the painters tape or equivalent from the rivet stud threads.
12. Using GM approved residue-free solvent or equivalent, thoroughly clean the rivet stud threads to remove any adhesive and allow to dry.
13. Carefully remove any corrosion from the electrical ground wire terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
14. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new conductive M6 rivet stud threads.
15. Install the ground terminal to the new rivet stud.
16. Select a new, conductive M6 nut. Refer to GM parts catalog for the correct part number and application.

CAUTION: Refer to Fastener Caution .

17. Install the M6 nut and tighten to 8 N.m (71 lb in).
18. Check for proper system operation.

M6 Weld Nut

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M6 weld nut at the electrical ground location is damaged or stripped, a new, conductive self-threading M7 bolt may be used to secure the ground terminal. Refer to GM parts catalog for the correct part number and application.
2. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the weld nut and allow to dry.
3. Remove any loose metal particles from the damaged or stripped weld nut with a stiff brush.
4. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive, self-threading M7 bolt threads.
5. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
6. Install the electrical ground terminal to the new, conductive M7 bolt.

CAUTION: Refer to Fastener Caution .

7. Install the M7 bolt and tighten to 9 N.m (80 lb in).
8. Check for proper system operation.

M6 Weld Nut (Alternative Repair)

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the electrical ground location is accessible from both sides of the panel, a conductive M6 bolt and a conductive M6 nut may be used to secure the electrical ground terminal. Refer to GM parts catalog for the correct part number and application.
2. Select a location adjacent the damaged M6 weld nut having 20 mm (0.79) clearance behind the panel surface and 20 mm (0.79) clearance surrounding the new electrical ground site.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the ground location and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the new ground site until bare metal is visible.
6. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive M6 bolt threads.
7. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
8. Install the electrical ground terminal and new, conductive M6 bolt to the ground location.

CAUTION: Refer to Fastener Caution .

9. Install the conductive M6 nut and tighten to 8 N.m (71 lb in).

NOTE: The repair area must be properly refinished to maintain positive electrical grounding.

10. Refinish the repair area using an anti-corrosion primer. Refer to **Anti-Corrosion Treatment and Repair** .
11. Check for proper system operation.

M8 Weld Nut

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M8 weld nut electrical ground location is accessible from both sides of the panel, a conductive M8 bolt and a conductive M8 nut may be used to secure the ground terminal. Refer to GM parts catalog for the correct part numbers and application.
2. Select a location adjacent to M8 weld nut having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the new electrical ground site.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the ground location and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the new ground site until bare metal is visible.
6. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive M8 bolt threads.
7. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
8. Install the electrical ground terminal and new, conductive M8 bolt to the ground location.

CAUTION: Refer to Fastener Caution .

9. Install the conductive M8 nut and tighten to 22 N.m (16 lb ft).

NOTE: The repair area must be properly refinished to maintain positive electrical grounding.

10. Refinish the repair area using an anti-corrosion primer. Refer to **Anti-Corrosion Treatment and Repair** .
11. Check for proper system operation.

M8 Weld Nut (Alternative Repair)

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M8 weld nut electrical ground location is not accessible from both sides of the panel, a conductive M6 rivet stud and a conductive M6 nut may be used to secure the ground terminal. Refer to GM parts catalog for the correct part numbers and application.

2. Select a location adjacent the damaged M8 weld nut having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the new, conductive M6 rivet stud flange.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the repair site and allow to dry.

NOTE: **Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.**

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the rivet stud flange until bare metal is visible.
6. Using a rivet stud installer, install the replacement conductive M6 rivet stud.
7. Ensure the new rivet stud is securely fastened, with no detectable movement.

NOTE: **The rivet stud and surrounding panel area must be properly refinished prior to the installation of the ground terminal and nut to maintain positive electrical grounding.**

8. Completely wrap the threads of the rivet stud with painters tape or equivalent.
9. Refinish the repair area using an anti-corrosion primer. Refer to **Anti-Corrosion Treatment and Repair**.
10. Allow the refinished repair area to cure sufficiently before removing the protective material applied to the rivet stud threads.
11. Remove the painters tape or equivalent from the rivet stud threads.
12. Using GM approved residue-free solvent or equivalent, thoroughly clean the rivet stud threads to remove any adhesive and allow to dry.
13. Carefully remove any corrosion from the electrical ground wire terminal. Refer to **Testing for Intermittent Conditions and Poor Connections**.
14. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new conductive M6 rivet stud threads.
15. Install the ground terminal to the new, conductive M6 rivet stud.

CAUTION: Refer to **Fastener Caution**.

16. Install the conductive M6 nut and tighten to 8 N.m (71 lb in).
17. Check for proper system operation.

FUSE BLOCK REPLACEMENT

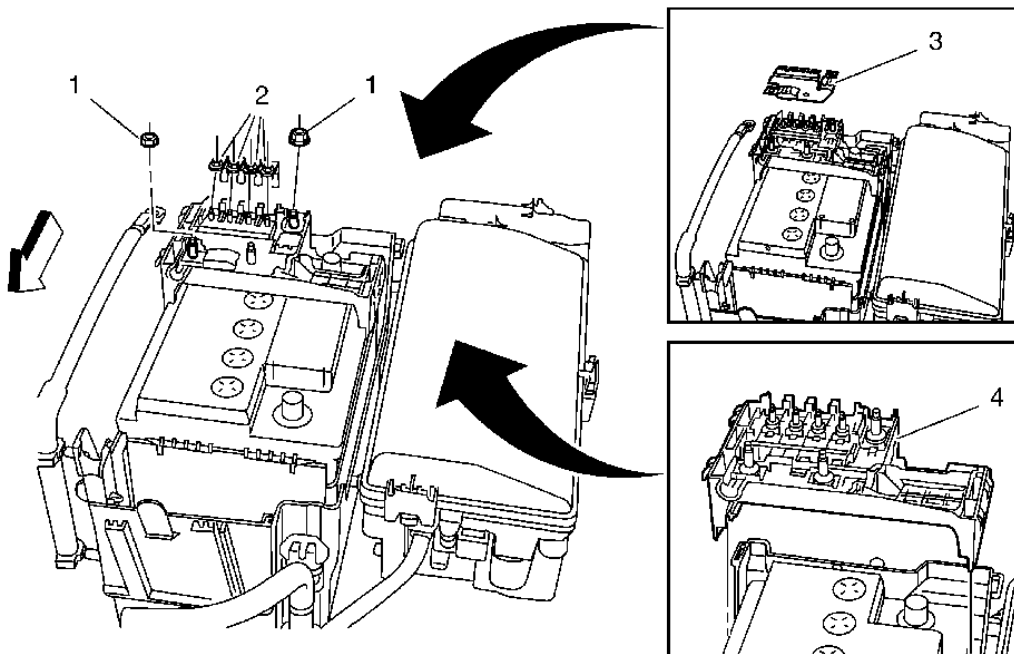


Fig. 25: Fuse Block Components
 Courtesy of GENERAL MOTORS COMPANY

Fuse Block Replacement

Callout	Component Name
Preliminary Procedures	
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Replacement . 2. Disconnect the battery positive cable. Refer to Battery Positive Cable Replacement .	
1	Front Compartment Fuse Block Positive Cable and Engine Power Supply Cable Nut (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 12 (106 lb in)
2	Fuse Block Terminal Wiring Harness (Qty: 2) Tighten 4.7 N.m (3.5 lb in)
3	Master Fuse Fuse Block Procedure Remove the master fuse from the battery positive splitter.

4	Fuse Block Procedure Unclip and remove the battery positive splitter housing from the battery.
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FRONT COMPARTMENT FUSE BLOCK FUSE REPLACEMENT (MIDI-FUSE)

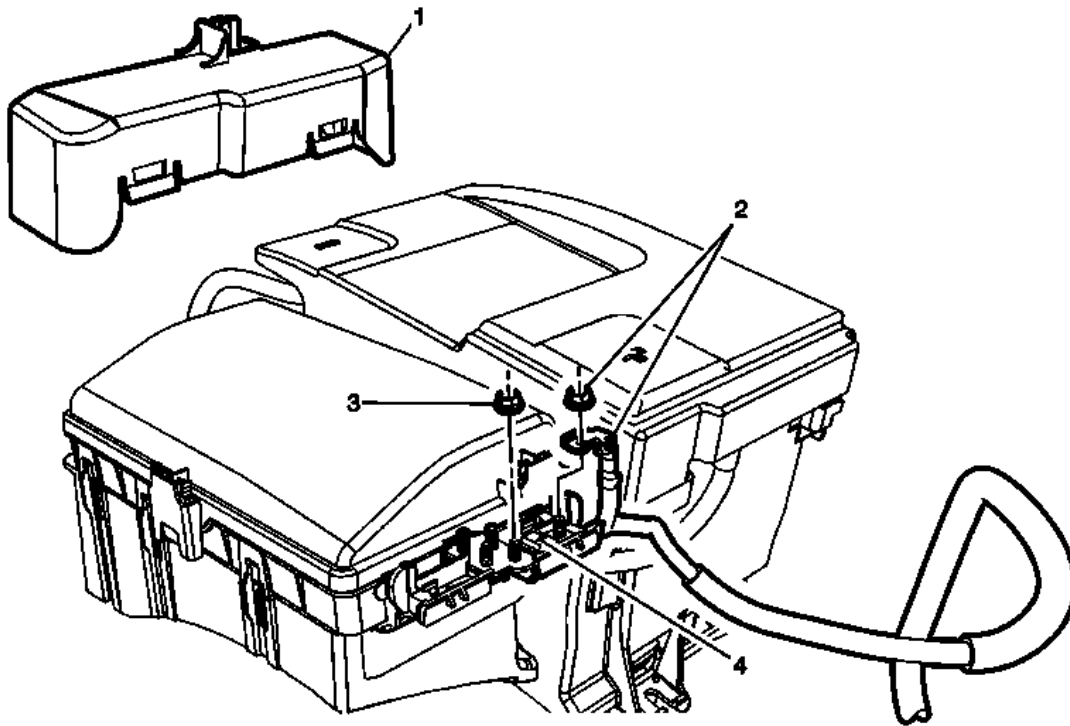


Fig. 26: Front Compartment Fuse Block Fuse Components (MIDI-Fuse)
 Courtesy of GENERAL MOTORS COMPANY

Front Compartment Fuse Block Fuse Replacement (MIDI-Fuse)

Callout	Component Name
Preliminary Procedure Disconnect the battery negative cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
1	Fuse Block Fuse Cover
2	Battery Positive Cable and Nut CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the battery positive cable(s) from the fuse. Tighten 4.7 (42 lb in)

3	Fuse Block Fuse Holder Nut - MIDI-Fuse Tighten 4.7 (42 lb in)
4	Fuse Block Fuse - MIDI-Fuse

FRONT COMPARTMENT FUSE BLOCK HOUSING REPLACEMENT

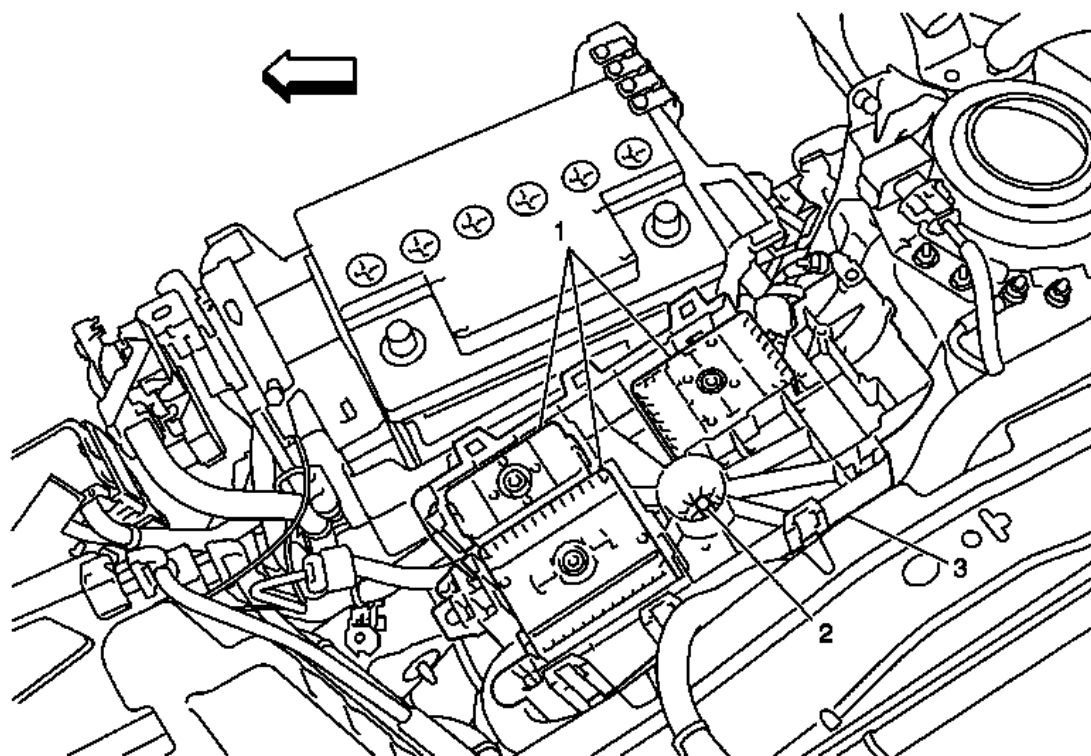


Fig. 27: Front Compartment Fuse Block Housing, Nut & Plugs
Courtesy of GENERAL MOTORS COMPANY

Front Compartment Fuse Block Housing Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the battery ground cable. Refer to Battery Negative Cable Replacement. 2. Disconnect the battery positive and negative cable. Refer to Battery Positive and Negative Cable Replacement (LUK), Battery Positive and Negative Cable Replacement (LTG). 3. Remove the front compartment fuse block housing cover. Refer to Front Compartment Fuse Block Housing Cover Replacement. 4. Remove the underhood electrical center or junction block. Refer to Underhood Electrical Center or Junction Block Replacement. 	
1	Wiring Harness Plug (Qty: 3) Procedure Release the wiring harness plugs.

2	<p>Front Compartment Fuse Block Housing Nut</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 22 N.m (16 lb ft)</p>
3	<p>Front Compartment Fuse Block Housing</p> <p>Procedure Remove the front compartment fuse block housing.</p>

FRONT COMPARTMENT FUSE BLOCK HOUSING COVER REPLACEMENT

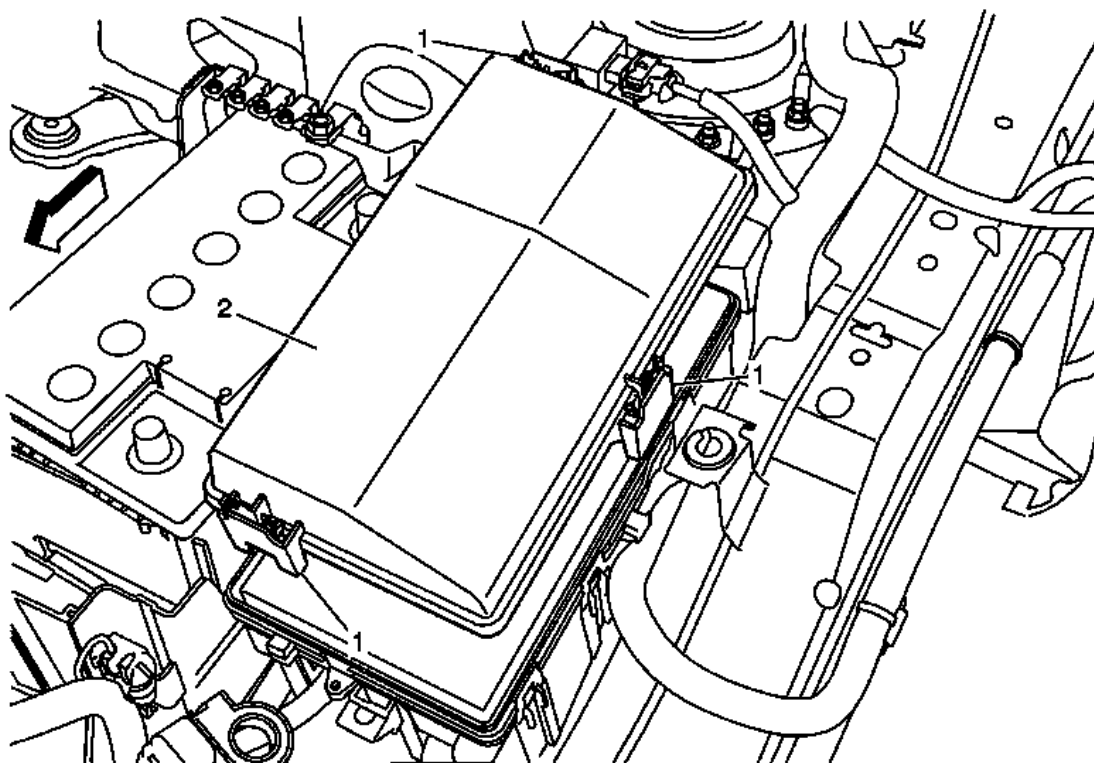


Fig. 28: Front Compartment Fuse Block Housing Cover
Courtesy of GENERAL MOTORS COMPANY

Front Compartment Fuse Block Housing Cover Replacement

Callout	Component Name
1	<p>Front Compartment Fuse Block Housing Cover</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Release the front compartment fuse block housing cover on 3 points.

2. Lift the front compartment fuse block housing cover.

UNDERHOOD ELECTRICAL CENTER OR JUNCTION BLOCK REPLACEMENT

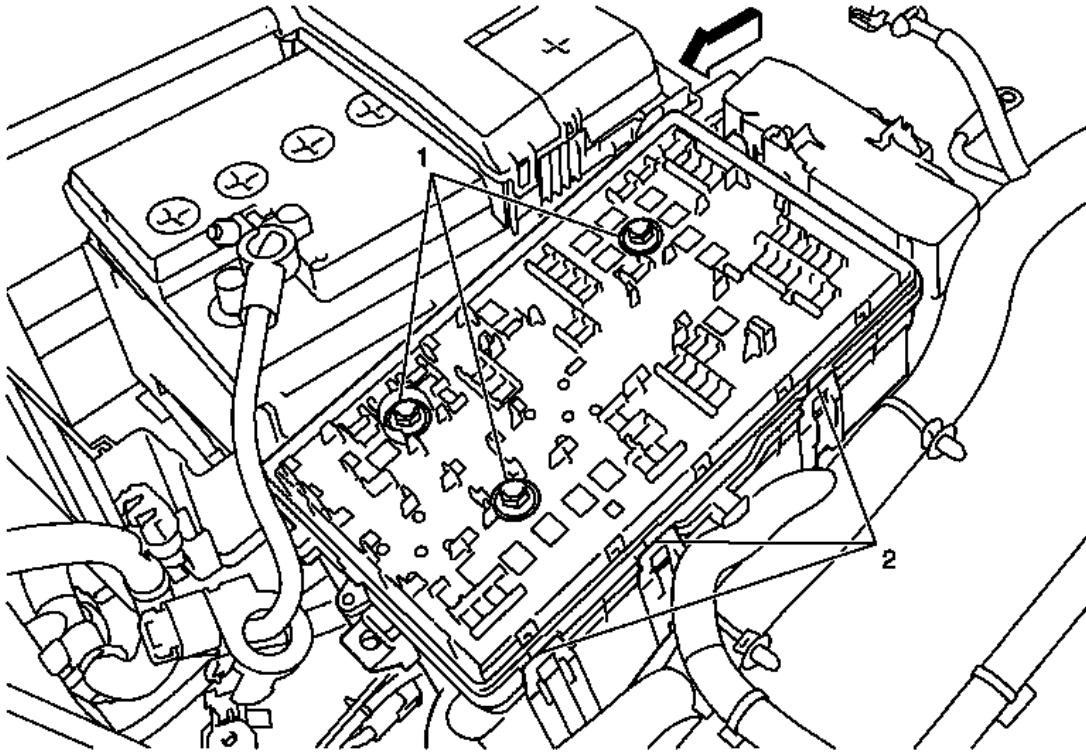


Fig. 29: Underhood Electrical Center or Junction Block & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Underhood Electrical Center or Junction Block Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Disconnect the battery ground cable. Refer to <u>Battery Negative Cable Replacement</u> .2. Disconnect the battery positive and negative cable. Refer to <u>Battery Positive and Negative Cable Replacement (LUK)</u> , <u>Battery Positive and Negative Cable Replacement (LTG)</u> .3. Remove the front compartment fuse block housing cover. Refer to <u>Front Compartment Fuse Block Housing Cover Replacement</u>.	
	Underhood Electrical Center Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure <ol style="list-style-type: none">1. Unscrew the underhood electrical center fasteners.

1	<p>Release the bolts far enough so that the wiring harness plug under the electrical center can drop down.</p> <p>2. After installing and tightening the underhood electrical center fasteners, it is necessary to check, if the green indicator rings under the fasteners be flush with the electrical center.</p> <p>Tighten 7.2 N.m (66 lb in)</p>
2	<p>Underhood Electrical Center</p> <p>Procedure</p> <p>1. Release the underhood electrical center.</p> <p>2. Lift underhood electrical center.</p> <p>TIP: When replacing, transfer fuses and relays.</p>

IGNITION LOCK CYLINDER REPLACEMENT

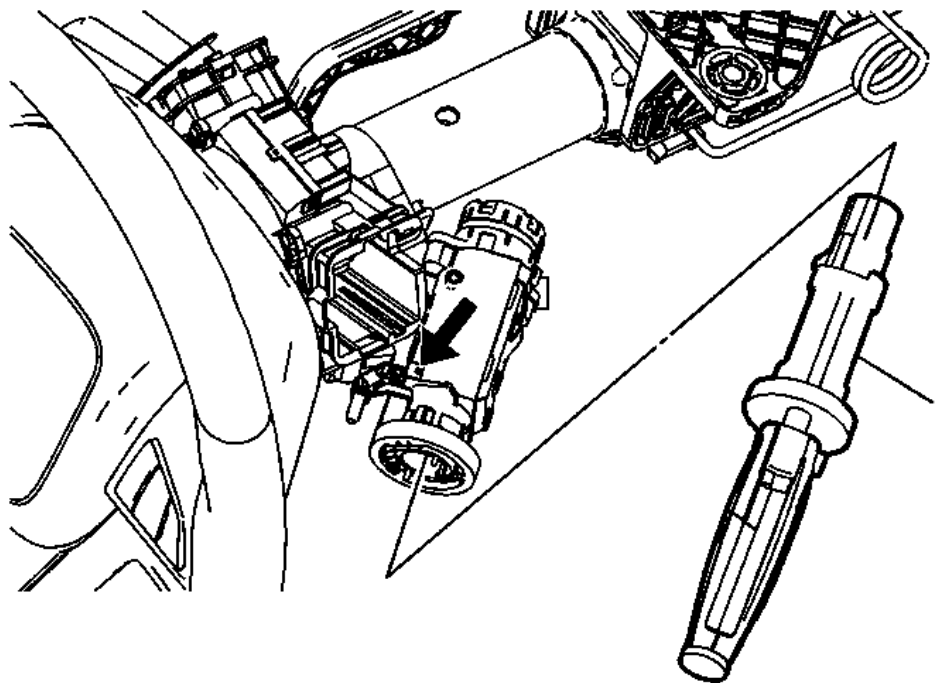


Fig. 30: Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

Ignition Lock Cylinder Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Disconnect the battery negative cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .2. Remove the steering column trim covers. Refer to <u>Steering Column Trim Cover Replacement</u> .	
1	<p>Ignition Lock Cylinder</p> <p>Procedure</p> <ol style="list-style-type: none">1. Turn the ignition lock cylinder to the RUN position.2. Insert a pick-type tool into the proper hole on the ignition and start switch housing and press the lock tab on the ignition lock cylinder down while turning the cylinder to the START position.3. Pull the ignition lock cylinder out of the ignition and start switch housing.4. If installing a new ignition lock cylinder then refer to <u>Lock Cylinder Coding - Ignition</u> .

IGNITION AND START SWITCH REPLACEMENT (WITH BTM)

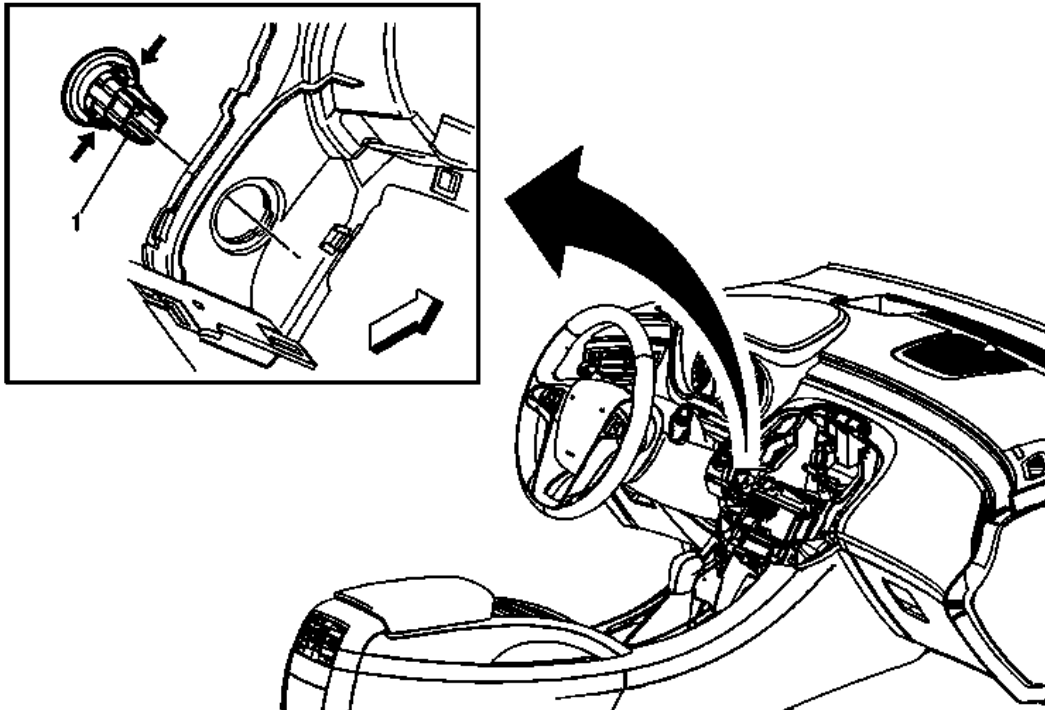


Fig. 31: Ignition And Start Switch (With BTM)

Courtesy of GENERAL MOTORS COMPANY

Ignition and Start Switch Replacement (With BTM)

Callout	Component Name
Preliminary Procedure Remove the instrument panel upper center trim panel. Refer to <u>Instrument Panel Upper Center Trim Panel Replacement</u> .	
1	Ignition and Start Switch 1. Disconnect the electrical connector. 2. Push in the tabs to release the ignition and start switch.

IGNITION AND START SWITCH REPLACEMENT (WITHOUT BTM)

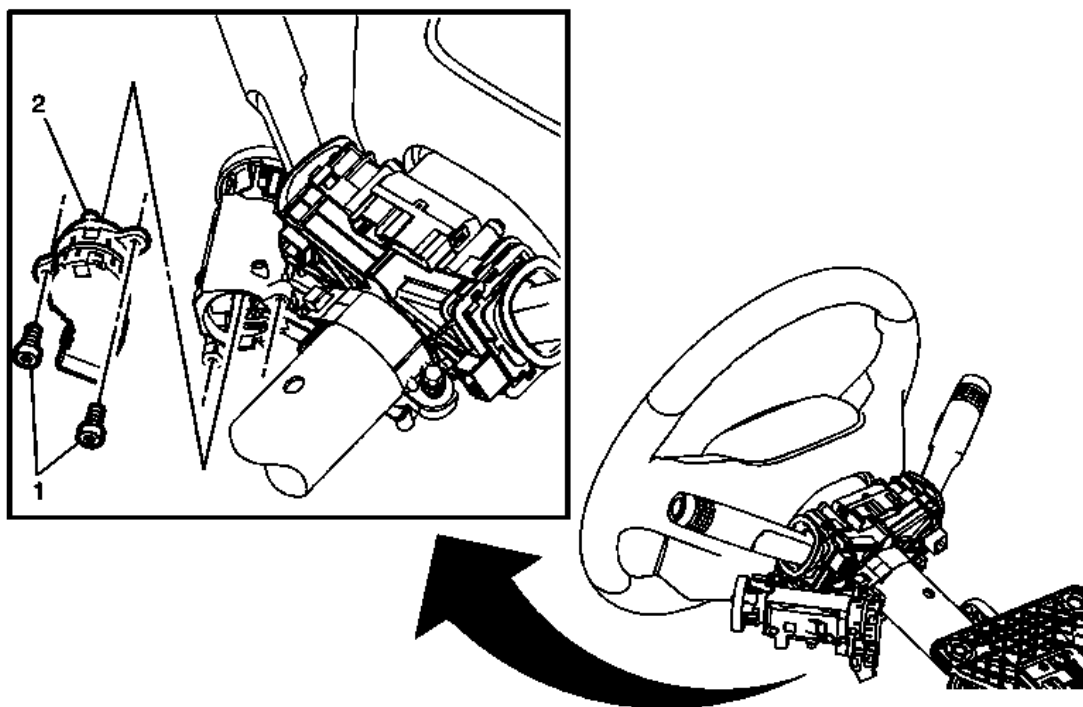


Fig. 32: Ignition And Start Switch (Without BTM)

Courtesy of GENERAL MOTORS COMPANY

Ignition and Start Switch Replacement (Without BTM)

Callout	Component Name
Preliminary Procedure 1. Disconnect the battery negative cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Disable the supplemental inflatable restraint (SIR) system. Refer to <u>SIR Disabling and Enabling</u> . 3. Remove the steering column trim covers. Refer to <u>Steering Column Trim Cover Replacement</u> .	
	Ignition and Start Switch Bolt (Qty: 2)

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 2 N.m (18 lb in)
2	Ignition and Start Switch Procedure Disconnect the ignition and start switch electrical connector.

IGNITION AND START SWITCH HOUSING REPLACEMENT

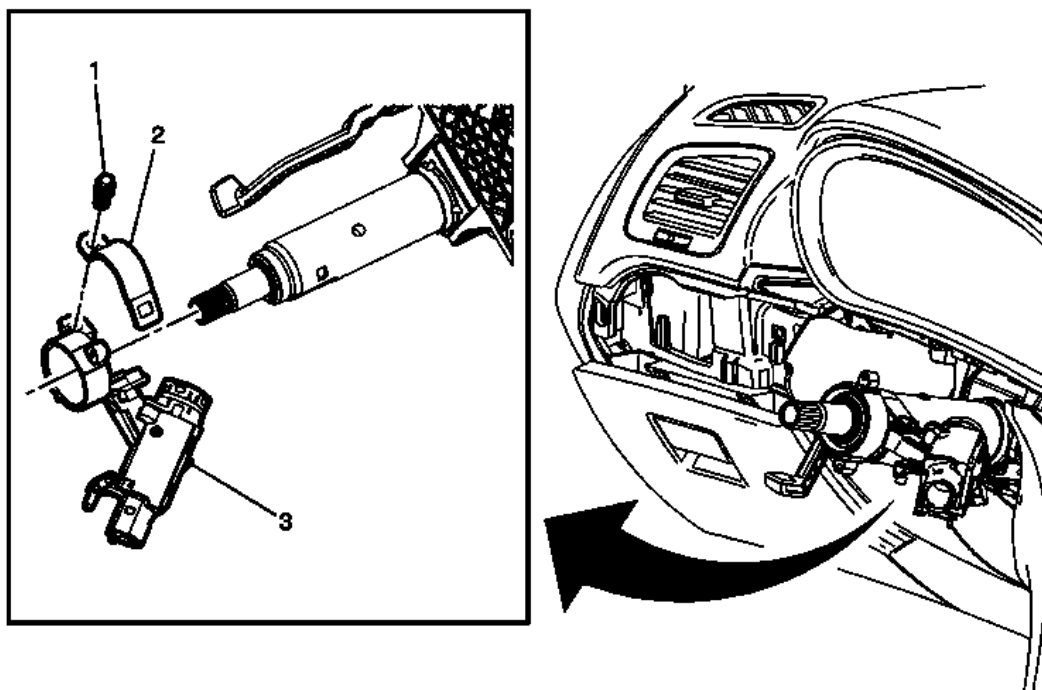


Fig. 33: Ignition and Start Switch Housing
Courtesy of GENERAL MOTORS COMPANY

Ignition and Start Switch Housing Replacement

Callout	Component Name
Preliminary Procedure Remove the turn signal switch bracket. Refer to <u>Turn Signal Switch Bracket Replacement (With BTM)</u> , <u>Turn Signal Switch Bracket Replacement (Without BTM)</u> .	
	Ignition and Start Switch Housing Bolt CAUTION: Refer to <u>Fastener Caution</u> .

1	Procedure <ol style="list-style-type: none"> 1. Discard the old ignition and start switch housing bolt. 2. Install the NEW ignition and start switch housing bolt and tighten until the bolt head breaks off.
2	Ignition and Start Switch Housing Strap
3	Ignition and Start Switch Housing Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Transfer components as necessary.

ELECTRICAL

Wiring Systems and Power Management - Schematic and Routing Diagrams - Schematics RPO Code List

SCHEMATIC AND ROUTING DIAGRAMS

SCHEMATICS RPO CODE LIST

Schematics RPO Code List

RPO	Description	Country Group
A45	MEMORY-SEAT ADJUSTER, MIRROR, POWER, DRIVER, PERSONALIZATION	U.S.A., PR and USVI (MAH)
A6C	ADJUSTER PASS ST-MANUAL, 4 WAY, PWR VERT	U.S.A., PR and USVI (MAH),Canada (MBC)
AEQ	WINDOW-POWER OPERATED, RR DRS, EXPRESS DOWN	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
AER	WINDOW-POWER OPERATED, RR DRS, EXPRESS UP/DOWN	China
AF6	CONTROL-SEAT, MASSAGE, DRIVER	China
AG1	ADJUSTER FRT ST-POWER, MULTI-DIRECTIONAL, DRIVER	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
AG2	ADJUSTER PASS ST-POWER, MULTI-DIRECTIONAL	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
APG	CONTROL-SEAT, POWER LUMBAR, LH	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
APH	CONTROL-SEAT, POWER LUMBAR, RH	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
ASV	EQUIPMENT-SENSOR AIR MOISTURE and W/S TEMP	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
ATH	LOCK CONTROL, ENTRY-REMOTE ENTRY, EXTENDED RANGE, PASSIVE ENTRY, ALL DOORS	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
ATS	Lock Control, Entry - Remote Entry, Standard Range, Passive Entry	China
AW7	RESTRAINT SYSTEM-SEAT, INFLATABLE, DRIVER AND PASS	U.S.A., PR and USVI

	FRT, FRT SEAT SIDE AND RR SEAT SIDE, ROOF SIDE	(MAH),Canada (MBC)
BTM	SWITCH-ENGINE START, KEYLESS	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
C67	HVAC SYSTEM-AIR CONDITIONER FRT, ELECTRONIC CONTROLS	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
CE1	WIPER SYSTEM-WINDSHIELD, PULSE, MOISTURE SENSITIVE	China
CE4	WASHER-HEADLAMP, HIGH PRESSURE	China
CF5	ROOF-SUN, GLASS, SLIDING, ELEC	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
CJ2	HVAC SYSTEM-AIR CONDITIONER FRT, AUTO TEMP CONT, AUX TEMP CONT	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
CZ2	COUNTRY-CHINA	China
DD8	MIRROR I/S R/V-LT SENSITIVE	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
EF7	COUNTRY-UNITED STATES OF AMERICA (USA)	U.S.A., PR and USVI (MAH)
F45	CHASSIS-CONTINUOUSLY VARIABLE REAL TIME DAMPING	U.S.A., PR and USVI (MAH),Canada (MBC)
FHS	VEHICLE FUEL-GASOLINE E85	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
HP6	HYBRID PROPULSION-ELECTRIC, PARALLEL, 14KW CONTINUOUS POWER	U.S.A., PR and USVI (MAH),Canada (MBC)
J71	BRAKE PARKING-POWER OPERATED	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
KA1	HEATER SEAT FRT-DRVR and PASS	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
KD4	RECEPTACLE-ELECTRICAL, FRT CONSOLE	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
KI6	RECEPTACLE-ELECTRICAL, FRT CONSOLE RR 110 VOLT	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
	CONTROL-CONSOLE,	U.S.A., PR and USVI

KRJ	INFOTAINMENT, REDUNDANT CONTROLS, JOYSTICK	(MAH),Canada (MBC),Mexico (MCX)
KTA	AUDIO INTERFACE-	China
KU1	VENTILATED SEAT DRVR-FRONT	U.S.A., PR and USVI (MAH)
KU3	VENTILATED SEAT PASS-FRONT	U.S.A., PR and USVI (MAH)
LAF	ENGINE-GAS, 4 CYL, 2.4L, SIDI,DOHC, VVT, ALUM, GM - DO NOT USE AFTER 2013, USE LEA	China
LDK	ENGINE-GAS, 4 CYL, 2.0L, DI, DOHC, TURBO-HO, VARIABLE CAMSHAFT PHASING - DO NOT USE AFTER 2013, USE LHU	China
LHU	ENGINE-GAS, 2.0L, SIDI, L4, DOHC TURBO, E85 MAX, ALUM	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
LLU	ENGINE-GAS, 4 CYL, 1.6L, MFI, DOHC, TURBO, PT-JV, 132KW	China
LTD	ENGINE-GAS, 4 CYL, 2.0L, MFI, ALUM, DOHC, SGM	China
LUK	ENGINE-GAS, 4 CYL, 2.4L, DI, ALUM, DOHC, BAS, ECOTEC	U.S.A., PR and USVI (MAH),Canada (MBC)
MDK	TRANSMISSION-AUTO 6 SPD, AISIN-WARNER, A6-AF40, ELECTRONIC, GEN2	U.S.A., PR and USVI (MAH),Canada (MBC)
MH8	TRANSMISSION-AUTO 6 SPD, HMD, X23F	U.S.A., PR and USVI (MAH),Canada (MBC)
MHH	TRANSMISSION-AUTO 6 SPD, HMD, GM, BAS+, 6T40, HYBRID, FWD	U.S.A., PR and USVI (MAH),Canada (MBC)
MHK	TRANSMISSION-AUTO 6 SPD, 6T50	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
MR6	TRANSMISSION-MAN 6 SPD, OPEL, 83MM, 3.92 1ST, 0.62 6TH (F40 WR), REDUCE HELIX	U.S.A., PR and USVI (MAH),Canada (MBC)
NJ1	STEERING-POWER, NON-VARIABLE RATIO, ELECTRIC	U.S.A., PR and USVI (MAH),Canada (MBC)
NU6	EMISSION SYSTEM-CALIFORNIA, PZEV	U.S.A., PR and USVI (MAH)
NV7	STEERING-POWER, VARIABLE EFFORT	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
NXC	STEERING-POWER, VARIABLE EFFORT, REDUCED RACK TRAVEL	U.S.A., PR and USVI (MAH),Canada (MBC)
T4A	HEADLAMPS-HALOGEN	U.S.A., PR and USVI (MAH),Canada (MBC)

T4F	HEADLAMPS-HIGH INTENSITY DISCHARGE	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
T83	CONTROL, HEADLAMPS-AUTOMATIC ON-OFF	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
T94	CONTROL, HEADLAMPS-LH RULE OF THE ROAD	China
TR6	CONTROL, HEADLAMPS-LEVELING SYSTEM, MANUAL	China
TR7	CONTROL, HEADLAMPS-LEVELING SYSTEM, AUTOMATIC	China
TT4	Headlamps - Halogen	China
TT6	Headlamps - High Intensity Discharge	China
U2K	DIGITAL AUDIO SYSTEM-S-BAND	U.S.A., PR and USVI (MAH),Canada (MBC)
U39	TBD	TBD
UAG	INFOTAINMENT DISPLAY-GRAPHIC INFO DISPLAY (GID), VAR 1	U.S.A., PR and USVI (MAH), Canada (MBC), China
UCT	RADIO-AM/FM STEREO, SD NAV, DVD-ROM, CAF, USB, RSA, (SGM VERSION)	CHINA
UD5	PARK ASSIST-FRONT AND REAR	U.S.A., PR and USVI (MAH),Canada (MBC)
UD7	PARK ASSIST-REAR	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
UDY	INFOTAINMENT DISPLAY-COLOR INFO DISPLAY (CID) 7", WVGA, TOUCH SCREEN	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
UE1	COMMUNICATION SYSTEM-VEHICLE, ONSTAR	U.S.A., PR and USVI (MAH),Canada (MBC)
UEW	RADIO-AM/FM STEREO, SD NAV, CD-ROM, CAF, USB, RSA (GMNA VERSION)	U.S.A., PR and USVI (MAH),Canada (MBC)
UFU	RADIO-AM/FM STEREO, SINGLE CD, MP3 (AUX IN), USB, GMNA	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
UG1	OPENER-GARAGE DOOR, UNIVERSAL	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
UHQ	RADIO-AM/FM STEREO, SINGLE CD, MP3 (AUX IN), USB, NAVIGATION (GMNA VERSION)	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)

UP9	WIRELESS INTERFACE-SHORT RANGE, VOICE RECOG, MUSIC NAVIGATOR, STREAMING AUDIO	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
UPF	WIRELESS INTERFACE-SHORT RANGE, VOICE REC	U.S.A., PR and USVI (MAH),Canada (MBC)
UQA	SPEAKER SYSTEM-PREMIUM AUDIO BRANDED WITH AMPLIFIER	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
URC	SWITCH-FLEXRIDE MODE SYSTEM	U.S.A., PR and USVI (MAH),Canada (MBC)
UVD	HEATER-STEERING WHEEL	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
UYE	Radio - AM/FM Stereo, CD-ROM, CAF, RSA, Music Navigator (GMNA)	U.S.A., PR and USVI (MAH),Canada (MBC),Mexico (MCX)
UYF	RADIO-AM/FM STEREO, CD-ROM, CAF, RSA, MUSIC NAVIGATOR (CHINA VERSION	China
UYK	TBD	TBD
UYT	RADIO-AM/FM STEREO, NAV, DVD-ROM, CAF, HDD, USB, RSA, RSE, (CHINA VERSION)	China
Z49	COUNTRY-CANADA	Canada (MBC)

ACCESSORIES & EQUIPMENT

Seat Belts

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Driver Seat Belt Buckle Fastener	45 N.m	33 lb ft
Front Seat Shoulder Belt Guide Adjustor Bolt	22 N.m	16 lb ft
Rear Seat Belt Buckle Bracket Fastener	45 N.m	33 lb ft
Rear Seat Belt Retractor Bracket Fastener	45 N.m	33 lb ft
Rear Seat Center Shoulder Belt Buckle Fastener	45 N.m	33 lb ft

SCHEMATIC AND ROUTING DIAGRAMS

SEAT BELT SCHEMATICS

Seat Belt System

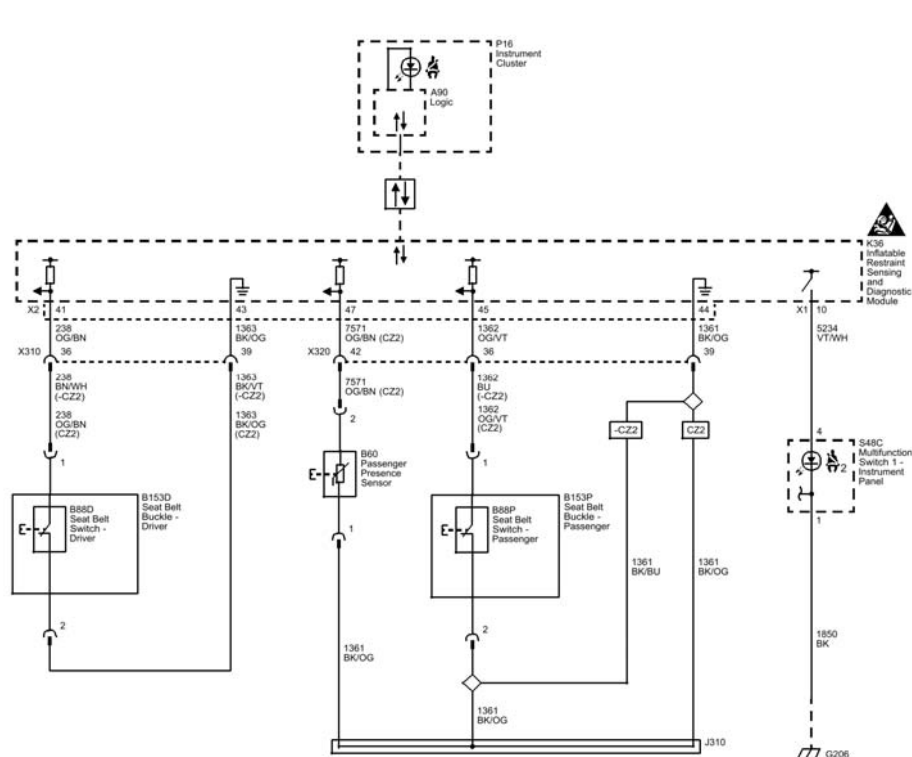


Fig. 1: Seat Belt System

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - SEAT BELTS

NOTE: Review the seat belt system description and operation in order to familiarize yourself with the system and how it functions. Refer to Seat Belt System Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the seat belt system. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to the following symptom diagnostic procedure in order to diagnose the symptom:

- **Seat Belt Indicator Malfunction - Driver**
- **Seat Belt Indicator Malfunction - Passenger**

SEAT BELT INDICATOR MALFUNCTION - DRIVER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Seat Belt Switch Signal	1	2	2	-
Driver Seat Belt Switch Ground	-	2	-	-
1. Seat Belt Indicator Always Illuminated 2. Seat Belt Indicator Inoperative				

Circuit/System Description

The driver seat belt switch is a 2-wire switch wired to the inflatable restraint sensing and diagnostic module (SDM) using a signal circuit and a low reference circuit. When the seat belt is unbuckled the switch is closed, and when the seat belt is buckled the switch is open. The SDM sends the status of the driver seat belt via serial data to the instrument cluster. After receiving the message, the instrument cluster controls the illumination of the driver seat belt indicator.

Reference Information

Schematic Reference

- **Seat Belt Schematics**
- **SIR Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Seat Belt System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Command the instrument cluster all indicators ON and OFF with a scan tool. The driver seat belt indicator should turn ON and OFF as commanded.
 - **If the driver seat belt indicator does not turn ON and OFF as commanded**

Replace the P16 instrument cluster.

 - **If the driver seat belt indicator does turn ON and OFF as commanded**
2. Monitor the scan tool Driver Seat Belt Switch parameter while buckling and unbuckling the seat belt. The parameter should display Buckled and Unbuckled when changing seat belt states.
 - **If the scan tool Driver Seat Belt Switch parameter does not display Buckled and Unbuckled when changing seat belt states**

Refer to Circuit/System Testing.

 - **If the scan tool Driver Seat Belt Switch parameter does display Buckled and Unbuckled when changing seat belt states**
3. All OK.

Circuit/System Testing

NOTE: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- **B88 Seat belt switch**
- **Seat belt switch harness connector**
- **K36 SDM**
- **SDM wiring harness connector**

1. Ignition OFF.
2. Disconnect the harness connector at the B88 seat belt switch.

3. Test for less than 10 ohms between the low reference circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Disconnect the harness connector at the K36 SDM.
 2. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If less than 10 ohms**
4. Ignition ON.
5. Verify the scan tool Driver Seat Belt Status parameter displays Buckled.
 - **If the scan tool Driver Seat Belt Status parameter does not display Buckled**
 1. Disconnect the harness connector at the K36 SDM.
 2. Test for infinite resistance between the seat belt switch signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If the scan tool Driver Seat Belt Status parameter does display Buckled**
6. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1.
7. Verify the scan tool Driver Seat Belt Status parameter displays Unbuckled.
 - **If the scan tool Driver Seat Belt Status parameter does not display Unbuckled**
 1. Disconnect the harness connector at the K36 SDM.
 2. Ignition ON.
 3. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 4. Test for less than 2 ohms in each circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If the scan tool Driver Seat Belt Status parameter does display Unbuckled**
8. Replace the B88 seat belt switch.

Component Testing

1. Ignition OFF.
2. Disconnect the harness connector at the B88 seat belt switch.
3. B88 seat belt switch in the open position.
4. Test for infinite resistance between the signal circuit terminal 2 and the low reference terminal 1 at the B88 seat belt switch.
 - **If there is not infinite resistance**

Replace the B88 seat belt switch.

- **If there is infinite resistance**

5. B88 seat belt switch in the closed position.

6. Test for less than 1 ohms between the signal circuit terminal 2 and the low reference terminal 1 at the B88 seat belt switch.

- **If 1 ohms or greater**

Replace the B88 seat belt switch.

- **If less than 1 ohms**

7. All OK.

Repair Instructions

- Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.
- **Front Seat Belt Buckle Replacement**
- **Control Module References** for SDM and instrument cluster replacement, programming and setup

SEAT BELT INDICATOR MALFUNCTION - PASSENGER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Switch Signal	1	2	2	-
Indicator Control	2	2	1	-
Switch Ground	-	2	-	-
1. Seat Belt Indicator Always Illuminated 2. Seat Belt Indicator Inoperative				

Circuit/System Description

The passenger seat belt switch supplies a ground to the SDM when the passenger seat belt is unbuckled. When a seat belt is buckled, a switch opens removing the ground to the SDM. The SDM will then supply voltage to the seat belt indicator, in the hazard warning switch, which will then cause that indicator to illuminate.

Diagnostic Aids

Objects on the passenger seat can cause the passenger seat belt reminder to be commanded on. Depending on the sensing technology used, a conductive object (computers, MP3 players, cell phones, diagnostic scan tool,

wires, a hand, etc.) placed on the passenger seat may cause the Passenger Presence Detection Module to command the passenger air bag indicator ON and/or command the passenger seat belt indicator ON. The fasten seat belt chime will also sound.

Reference Information

Schematic Reference

Seat Belt Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Seat Belt System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Monitor the scan tool Passenger Seat Belt Status parameter while buckling and unbuckling the passenger seat belt. The value should display Buckled and Unbuckled when changing seat belt states.
 - **If the scan tool Passenger Seat Belt Status parameter does not display Buckled and Unbuckled when changing seat belt states**

Refer to Seat Belt Switch Malfunction.

 - **If the scan tool Passenger Seat Belt Status parameter does display Buckled and Unbuckled when changing seat belt states**
2. Command the Driver Seat Belt Reminder ON and OFF with a scan tool. The seat belt indicator should turn ON and OFF while changing between the commanded states.
 - **If the driver seat belt indicator does not turn ON and OFF as commanded**

Refer to Seat Belt Indicator Malfunction.

- **If the driver seat belt indicator does turn ON and OFF as commanded**
- 3. All OK.

Circuit/System Testing

Seat Belt Switch Malfunction

1. Ignition OFF. Disconnect the harness connector at the B88P seat belt switch-passenger.
2. Test for less than 10 ohms between the low reference circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Disconnect the X2 harness connector at the K36 SDM.
 2. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Passenger Seat Belt Status parameter listed below is Buckled.
 - **If the scan tool Passenger Seat Belt Status parameter does not display Buckled**
 1. Disconnect the X2 harness connector at the K36 SDM.
 2. Test for infinite resistance between the seat belt switch signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If the scan tool Passenger Seat Belt Status parameter does display Buckled**
5. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1.
6. Verify the scan tool Passenger Seat Belt Status parameter is Unbuckled.
 - **If the scan tool Passenger Seat Belt Status parameter does not display Unbuckled**
 1. Disconnect the X2 harness connector at the K36 SDM. Ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 3. Test for less than 2 ohms in each circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If the scan tool Passenger Seat Belt Status parameter does display Unbuckled**
7. Replace the B88P seat belt switch-passenger.

Seat Belt Indicator Malfunction

1. Ignition OFF.
2. Disconnect the harness connector at the S48 multifunction switch 1-instrument panel.

3. Test for less than 10 ohms between the ground circuit terminal 1 and ground.

- **If 10 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 10 ohms**

4. Ignition ON. With a scan tool, command the Passenger Seat Belt Reminder Indicator OFF.

5. Test for less than 11 V between the control circuit terminal 4 and ground.

- **If 11 V or greater**

1. Ignition OFF. Disconnect the X1 harness connector at the K36 SDM. Ignition ON.

2. Test for less than 1 V between the control circuit terminal 4 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K36 SDM.

- **If less than 11 V**

6. With a scan tool, command the Passenger Seat Belt Reminder Indicator ON.

7. Test for greater than 4 V between the control circuit terminal 4 and ground.

- **If 4 V or less**

1. Ignition OFF. Disconnect the X 1 harness connector at the K36 SDM.

2. Test for infinite resistance between the control circuit terminal 4 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

3. Test for less than 2 ohms between the control circuit terminal 4 and ground.

- If 2 ohms or greater repair the open/high resistance in the circuit.

- If less than 2 ohms replace the K36 SDM.

- **If greater than 4 V**

8. Replace the S48 multifunction switch 1-instrument panel.

Component Testing

1. Ignition OFF. Disconnect the harness connector at the B88P seat belt switch-passenger. Buckle the passenger seat belt.

2. Test for infinite resistance between the signal circuit terminal 2 and the low reference terminal 1 at the B88P seat belt switch-passenger.

- **If there is not infinite resistance**

Replace the B88P seat belt switch-passenger.

- **If there is infinite resistance**

3. Unbuckle the passenger seat belt.

4. Test for less than 2 ohms between the signal circuit terminal 2 and the low reference terminal 1 at the B88P seat belt switch-passenger.

- **If 2 ohms or greater**

Replace the B88P seat belt switch-passenger.

- If less than 2 ohms

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Seat Belt Buckle Replacement**
- **Control Module References** for the SDM replacement, programming and setup

REPAIR INSTRUCTIONS

REPAIRS AND INSPECTIONS REQUIRED AFTER A COLLISION

WARNING: Restraint systems can be damaged in a collision. To help avoid injury and ensure that all parts in need of replacement are replaced:

- Replace any seat belt system that was in use during the collision serious enough to deploy any automatic restraint device such as air bags and seat belt pretensioners. This not only includes seat belt systems in use by people of adult size, but seat belt systems used to secure child restraints, infant carriers and booster seats, including LATCH system and top tether anchorages.
- Replace any seat belt system that has torn, worn, or damaged components. This not only includes adult seat belt systems, but built-in child restraints and LATCH system components, if any.
- Replace any seat belt system if you observe the words "REPLACE" or "CAUTION", or if a yellow tag is visible. Do not replace a seat belt if only the child seat caution label is visible.
- Replace any seat belt system if you are doubtful about its condition. This not only includes adult seat belt systems, but built-in child restraints, LATCH system components, and any restraint system used to secure infant carriers, child restraints, and booster seats.

Do NOT replace single seat belt system components in vehicles that have been in a collision as described above. Always replace the entire seat belt system with the buckle, guide and retractor assembly, which includes the latch and webbing material.

After a minor collision where no automatic restraint device was deployed, seat belt system replacement may not be necessary, unless some of the parts are torn, worn, or damaged.

SEAT BELT LATCH STOP INSTALLATION

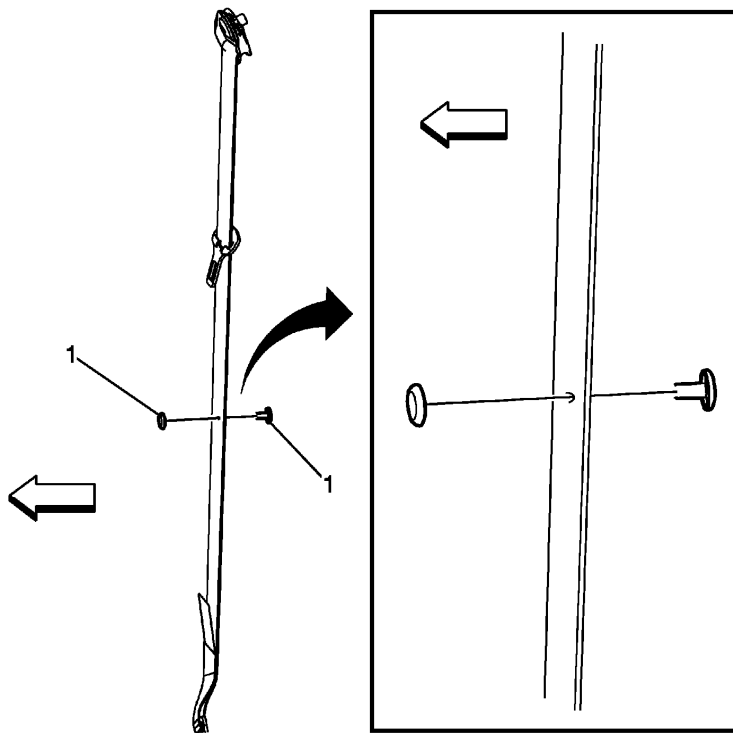


Fig. 2: View Of Seat Belt Latch Stop Components
 Courtesy of GENERAL MOTORS COMPANY

Seat Belt Latch Stop Installation

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none"> 1. Locate the hole in the seat belt webbing where the original seat belt stop button was located. 2. If the original hole in the seat belt webbing is not visible, perform the following: <ul style="list-style-type: none"> • If either the right or left stop button is missing use the opposing seat belt as a reference. • With the opposing seat belt fully stowed, measure the distance between the seat belt lower anchor and the stop button. • Using the measurement obtained above, measure and mark the location of the missing stop button on the center of the seat belt webbing. 3. Ensure the seat belt latch plate is located above the mark or original hole. 	
1	Seat Belt Latch Stop Procedure <ol style="list-style-type: none"> 1. Work the male half of the stop button through the hole in the webbing or at the marked location. 2. Align the female half of the stop button with the male half of the stop button. 3. Snap the two halves together.

- Trim off any excess of the male half of the stop button flush with the female half of the stop button.

TIP: Ensure the male half of the stop button is facing forward in the vehicle in order to ensure the stop button will not snag customers clothing.

FRONT SEAT BELT BUCKLE REPLACEMENT

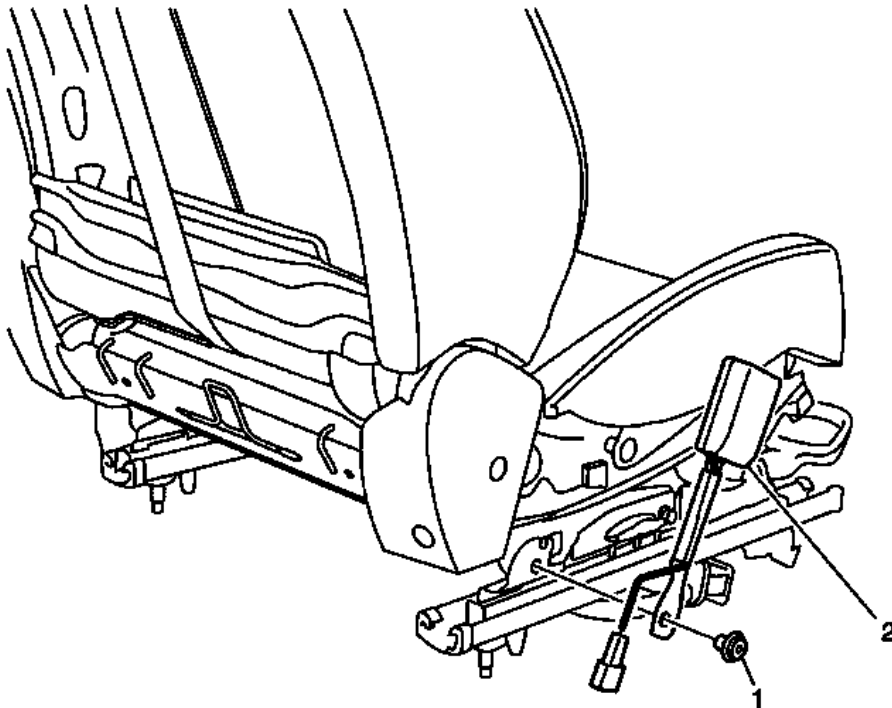


Fig. 3: Driver Or Passenger Seat Belt Buckle & Fastener
Courtesy of GENERAL MOTORS COMPANY

Front Seat Belt Buckle Replacement

Callout	Component Name
Preliminary Procedure Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)</u> .	
1	Driver or Passenger Seat Belt Buckle Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten

	45 N.m (33 lb ft)
2	Driver or Passenger Seat Belt Buckle Procedure Disconnect the electrical connector.

REAR SEAT BUCKLE SIDE BELT REPLACEMENT

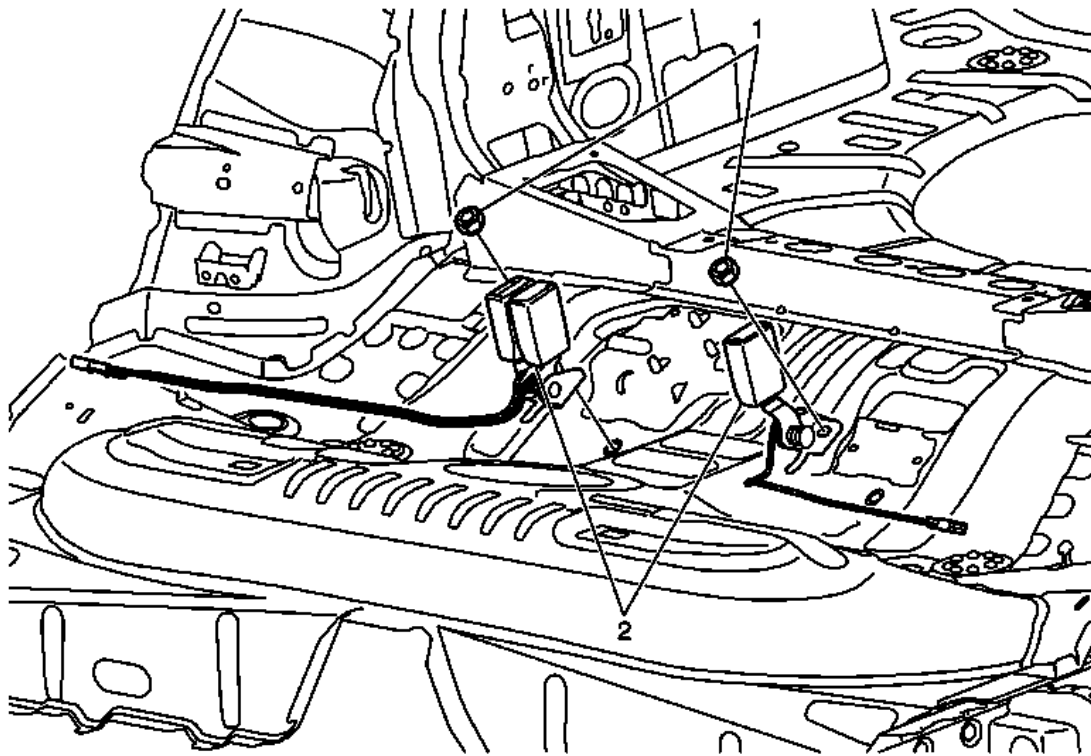


Fig. 4: Rear Seat Center Shoulder Belt Buckle & Fastener
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Buckle Side Belt Replacement

Callout	Component Name
Preliminary Procedure Remove the rear seat cushion. Refer to <u>Rear Seat Cushion Removal and Installation</u> .	
1	Rear Seat Belt Buckle Bracket Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 45 N.m(33 lb ft)
2	Rear Seat Belt Buckle

REAR SEAT CENTER SHOULDER BELT BUCKLE REPLACEMENT

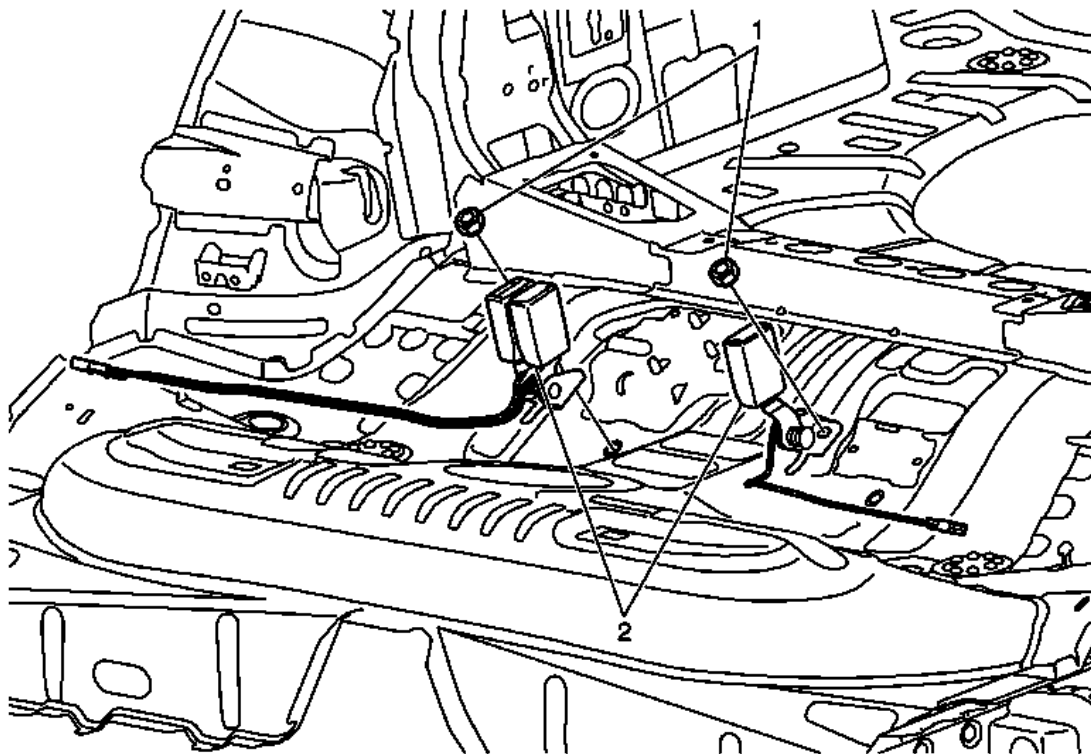


Fig. 5: Rear Seat Center Shoulder Belt Buckle & Fastener
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Center Shoulder Belt Buckle Replacement

Callout	Component Name
Preliminary Procedure Remove the rear seat cushion. Refer to <u>Rear Seat Cushion Removal and Installation</u> .	
1	Rear Seat Center Shoulder Belt Buckle Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 45 N.m (33 lb ft)
2	Rear Seat Center Shoulder Belt Buckle

FRONT SEAT BELT GUIDE ADJUSTER REPLACEMENT

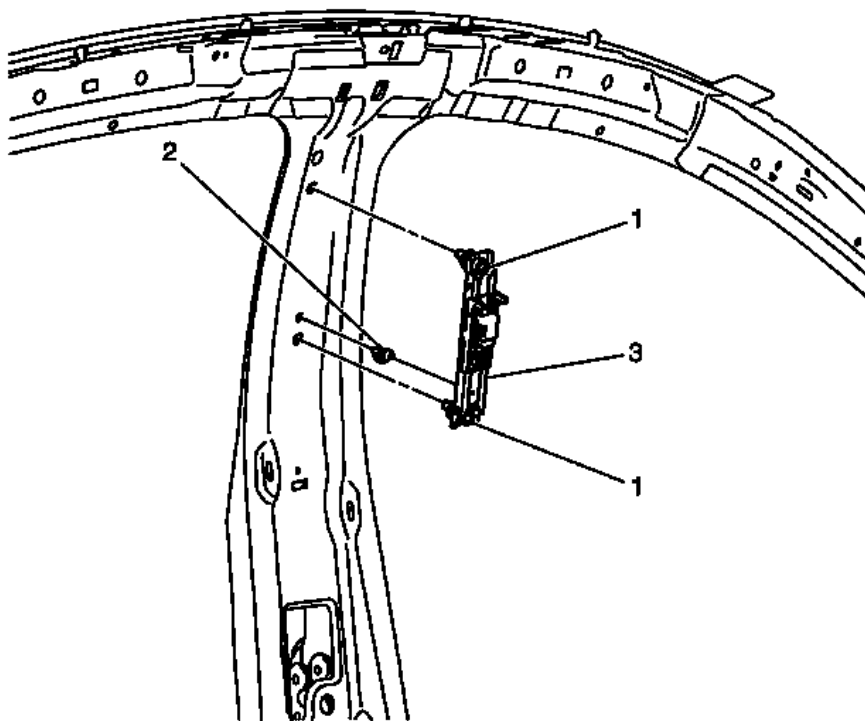


Fig. 6: Driver Or Passenger Seat Shoulder Belt Guide Adjuster & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Belt Guide Adjuster Replacement

Callout	Component Name
Preliminary Procedure Remove the center pillar upper trim panel. Refer to <u>Center Pillar Upper Garnish Molding Replacement</u> .	
1	Driver or Passenger Seat Shoulder Belt Guide Adjuster Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 45 N.m (33 lb ft)
2	Driver or Passenger Seat Shoulder Belt Guide Adjuster Fastener
3	Driver or Passenger Seat Shoulder Belt Guide Adjuster

REAR SEAT BELT RETRACTOR REPLACEMENT

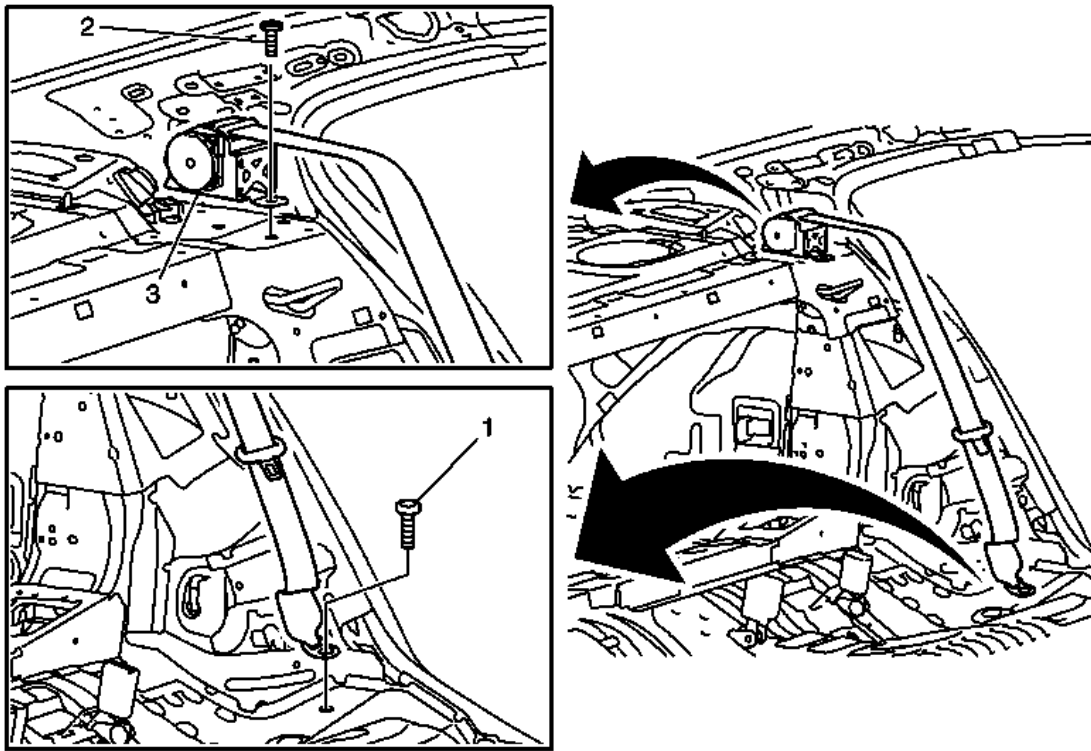


Fig. 7: Rear Seat Retractor Side Belt & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Belt Retractor Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the body lock pillar upper trim panel. Refer to <u>Body Lock Pillar Upper Trim Panel Replacement (Sedan)</u> . 2. Remove the rear seat cushion cover and pad. Refer to <u>Rear Seat Cushion Cover and Pad Replacement</u> .	
1	Rear Seat Belt Retractor Bracket Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 45 N.m (33 lb ft)
2	Rear Seat Belt Retractor Fastener Tighten 45 N.m (33 lb ft)
3	Rear Seat Belt Retractor

REAR SEAT CENTER RETRACTOR SIDE BELT REPLACEMENT

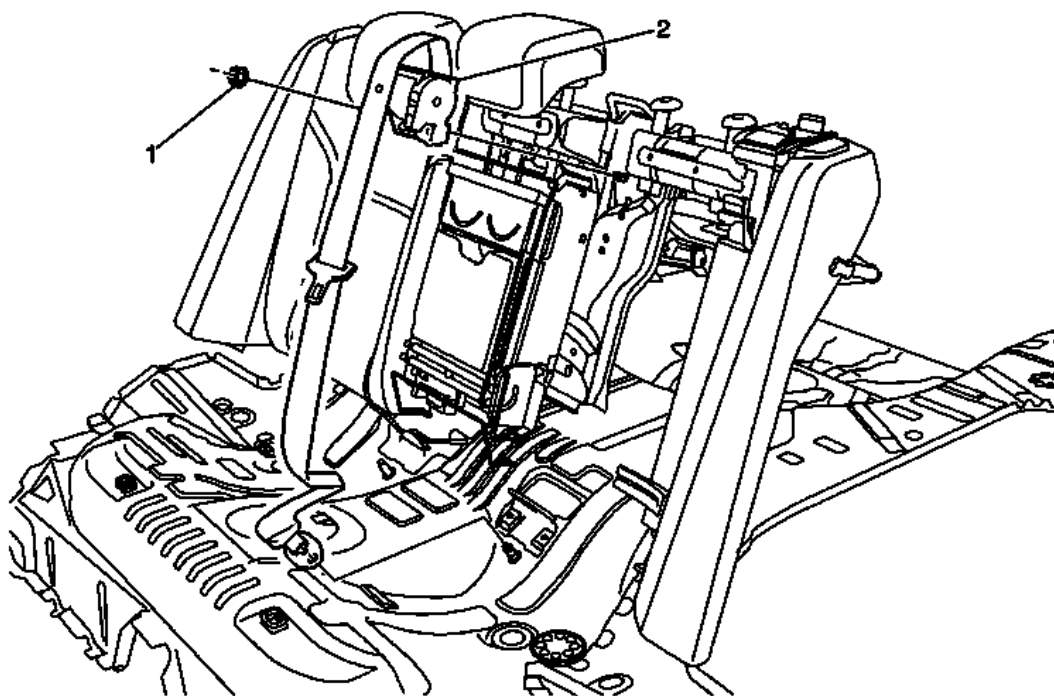


Fig. 8: Rear Seat Center Retractor Side Belt & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Center Retractor Side Belt Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none">1. Remove the rear seat belt buckle. Refer to <u>Rear Seat Buckle Side Belt Replacement</u>.2. Remove the rear seat cushion cover and pad. Refer to <u>Rear Seat Cushion Cover and Pad Replacement</u>.3. Release the rear seat center shoulder belt retractor bracket.	
1	Rear Seat Center Retractor Side Belt Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 45 N.m (33 lb ft)
2	Rear Seat Center Retractor Side Belt

DESCRIPTION AND OPERATION

SEAT BELT SYSTEM DESCRIPTION AND OPERATION

Seat Belts

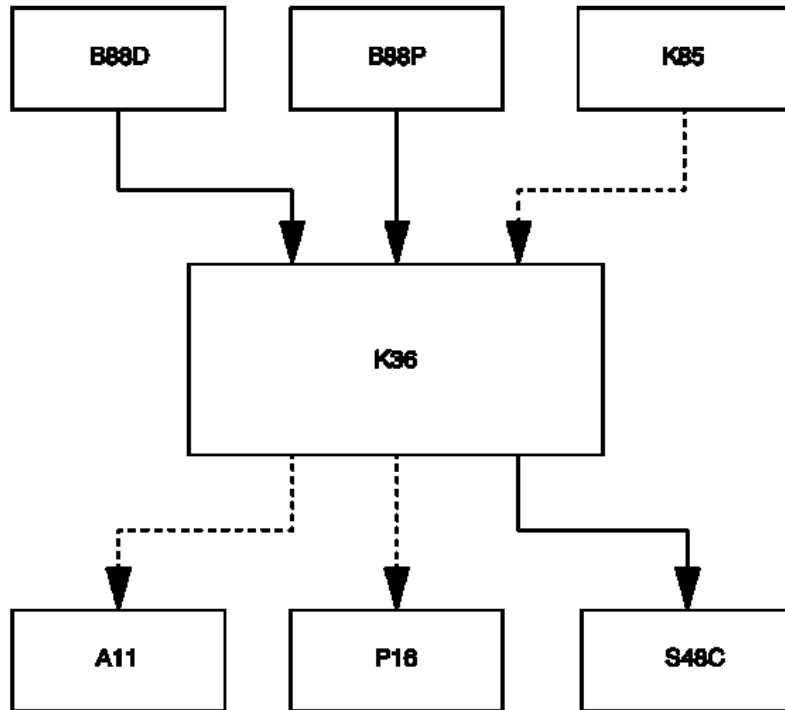


Fig. 9: Seat Belt System Operation Graph
Courtesy of GENERAL MOTORS COMPANY

Solid Line - Hard Wire I/O	
Dash Line - Serial Data	
A11	Radio
B88D	Seat Belt Switch - Driver
B88P	Seat Belt Switch - Passenger
K36	Inflatable Restraint Sensing and Diagnostic Module
K85	Passenger Presence Detection Module
P16	Instrument Cluster
S48C	Multifunction Switch 1 - Instrument Panel

Restraint System

NOTE: If the vehicle has been in a collision, refer to Repairs and Inspections Required After a Collision for additional information.

The vehicle has front and rear seat belts that are the primary means of occupant restraint. Seat belts help to keep the occupants inside the passenger compartment and to gradually reduce the impact forces during the following events:

- Frontal impact type crashes
- Rear impact type crashes
- Side impact type crashes
- Roll-over type crashes

All seat belt retractors have emergency locks. The retractors remain unlocked during normal operation and under normal driving conditions. The retractors remain unlocked during normal conditions in order to allow free movement of the upper body of each occupant. A pendulum locks the seat belt webbing into position. The pendulum causes a locking bar to engage a cog on the spool of the retractor mechanism when the following conditions occur:

- A rapid extraction of the seat belt webbing from the retractor
- An abrupt change in vehicle speed
- An abrupt change in vehicle direction
- Operation of the vehicle on a steep upgrade
- Operation of the vehicle on a downgrade

The seat belts have an automatic locking (cinch) feature. The cinch feature is activated when the seat belt webbing is completely extended from the retractor. The cinch feature prevents the webbing from extending beyond the position from which it is allowed to retract. Use of the cinch feature is recommended for securing a child seat. The cinch feature may be cancelled by allowing the webbing to wind back completely into the retractor. After the cinch feature is cancelled, the webbing is unlocked. After the cinch feature is cancelled, the webbing will extend from the retractor. This vehicle is also equipped with a supplemental inflatable restraint (SIR) system. Refer to **Supplemental Inflatable Restraint System Description and Operation** .

Front Seat Belt System

The front seat belt system includes a driver and passenger seat belt pretensioner anchor and retractor. The front seat belt buckles include a seat belt switch which controls a reminder lamp.

NOTE: **The front passenger seat is equipped with a passenger presence detection sensor, which detects an occupant. If the passenger presence detection sensor detects an empty front passenger seat, then the passenger fasten safety belt indicator will be disabled.**

- When the driver seat belt is buckled and the ignition switch is turned ON, the reminder lamp will not operate.
- When the passenger seat belt is buckled with an occupant sitting in the passenger front seat, then the ignition switch is turned ON, the reminder lamp, which is located within the hazard warning switch, will not be turned ON.
- When the driver seat belt is not buckled and the ignition switch is in the ON position, the fasten safety belt indicator will turn ON until the driver seat belt is buckled.
- When the passenger seat belt is not buckled with an occupant sitting in the passenger front seat, then the ignition switch is turned ON, the passenger fasten safety belt indicator, which is located within the hazard warning switch, will turn ON until the passenger seat belt is buckled.

Rear Seat Belt System

The Rear Seat Belt System includes the following components:

- The rear seat belt retractor is located at the wheelhouse panel and attached to the floor panel by the rear seat shoulder belt retractor bracket.
- The rear seat belt buckles and the center seat belt buckle are attached to each seat.

Child Seat Restraint System

WARNING: A child in a rear-facing child restraint can be seriously injured if the right-front passengers air bag inflates. This is because the back of a rear-facing child restraint would be very close to the inflating air bag. NEVER use a rear-facing child restraint in this vehicle. If a forward-facing child restraint is suitable for your child, ALWAYS move the front passenger seat as far back as it will go and then install the child restraint. Be sure the child restraint position does not conflict with any additional requirements provided by the manufacturer. For more information, refer to the vehicle owners manual and the instruction that came with the child restraint.

The child seat may only be used in a forward facing seating location. The child seat should be installed and secured according to the manufacturer's directions. If the child seat has a top strap, the seat will need to be anchored. Passengers should not be allowed to sit at locations where the seat belts are being used to secure the child seat.

All vehicles are equipped with a dual-mode type retractor with emergency and automatic locking features. The automatic locking feature is for restraint of a child seat. The child seat can be secured by pulling the seat belt all the way out to lock it. Then tighten the seat belt around the child seat.

If a child seat is to be used in the second seat position, a special dealer-installed anchor must be used in order to anchor the child seat top strap. This only applies to the seats designed with the top strap provision and for the vehicles sold in Canada. In order to ensure the correct top strap angle, the child seat is only to be used at the seating position for which the top strap anchor is installed.

Fasten Safety Belt Indicators

There are 2 fasten safety belt indicators for this vehicle. The driver fasten safety belt reminder is monitored on the instrument cluster and the passenger fasten safety belt reminder is located in the hazard warning switch. The fasten safety belt indicators may only be ON during RUN.

The instrument cluster illuminates the driver fasten safety belt indicator under the following conditions:

- During the bulb check (will flash 20 times and then stay on solid until the driver seat belt is buckled).
- The inflatable restraint sensing and diagnostic module (SDM) sends the status of the driver seat belt to the instrument cluster via a serial data.

The hazard warning switch illuminates the passenger fasten safety belt indicator under the following conditions:

Passenger presence recognizes someone is sitting in the front passenger seat. The SDM controls passenger seat belt indicator in the hazard warning switch through a hard wire circuit. The passenger seat belt indicator will remain on until the passenger seat belt is buckled.

ACCESSORIES & EQUIPMENT

Seat Hardware, Trim, and Upholstery

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Adjuster Finish Cover Retainer Screw	5 N.m	44 lb in
Front Seat Adjuster Handle Screw	2 N.m	18 lb in
Front Seat Back Cushion Finish Panel Screw	4 N.m	35 lb in
Front Seat Back Cushion Frame Bolt (8-Way Power Only)	35 N.m	26 lb ft
Front Seat Back Cushion Frame Bolt (6-Way Hybrid and 2/4 Way Power)	20 N.m	15 lb ft
Front Seat Cushion Frame Bolts	35 N.m	26 lb ft
Front Seat Inner Recliner Finish Cover Rear Screw	4 N.m	35 lb in
Front Seat Inner Recliner Finish Cover Side Screw	5 N.m	44 lb in
Front Seat Mounting Bolt - Oshawa Built	45 N.m	33 lb ft
Front Seat Mounting Bolt - Ruesselsheim Built	20 N.m	15 lb ft
Front Seat Outer Recliner Finish Cover Screw	4 N.m	35 lb in
Rear Seat Back Cushion Hinge Nut	43 N.m	32 lb ft
Rear Seat Back Cushion Pivot Support Bolt	20 N.m	15 lb ft
Rear Seat Latch Bolt	45 N.m	33 lb ft

REPAIR INSTRUCTIONS

DRIVER OR PASSENGER SEAT REMOVAL AND INSTALLATION

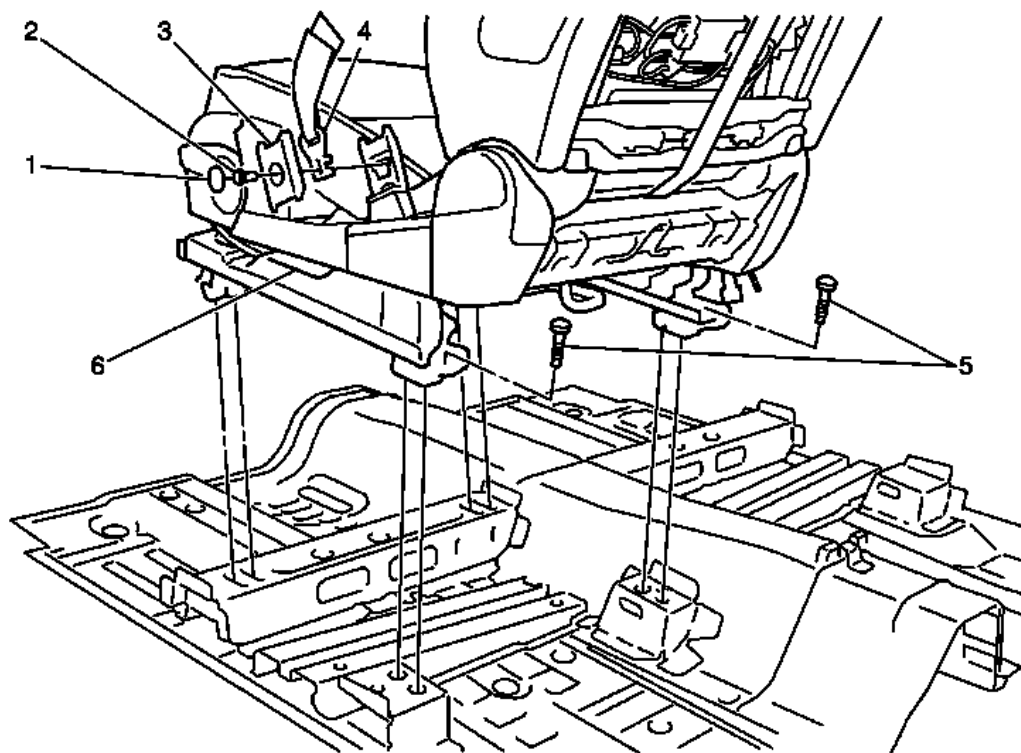


Fig. 1: Driver or Passenger Seat (2/4/6-Way Hybrid, 6-Way Hybrid Sport)
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Removal and Installation

Callout	Component Name
Preliminary Procedure	
1. SIR Disabling and Enabling. Refer to <u>SIR Disabling and Enabling</u> . 2. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
1	Cap
2	Driver or Passenger Seat Belt Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 5 N.m (44 lb in)
3	Seat Belt Tensioner Cover
4	Driver or Passenger Seat Belt
	Driver or Passenger Seat Fastener (Qty: 2)
Procedure	

5	<ol style="list-style-type: none"> 1. Move front seat high adjuster in middle position. 2. Disconnect the battery. 3. Seat belt release at seat belt tensioner. 4. Disconnect the central wiring harness connector at bottom. 5. Unscrew both fasteners at the rail guide. 6. Remove the front seat out of the vehicle with two persons.
	Tighten 45 N.m (30 lb ft)
6	Driver or Passenger Seat

FRONT SEAT ADJUSTER FRONT SPACER REPLACEMENT

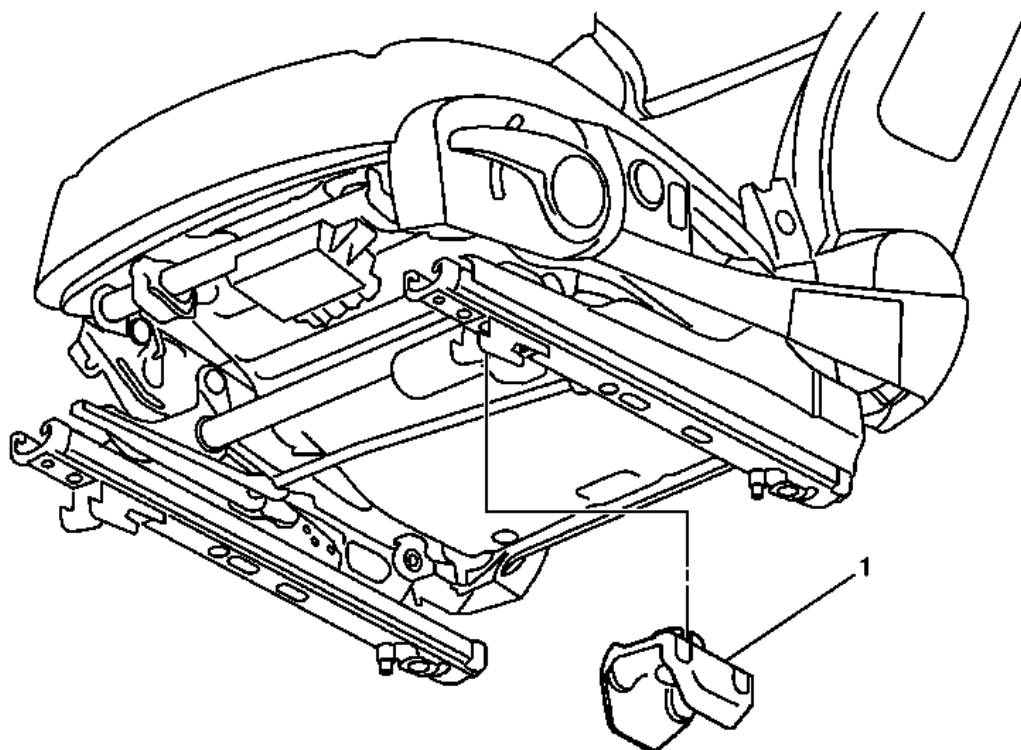


Fig. 2: Front Seat Adjuster Front Spacer
Courtesy of GENERAL MOTORS COMPANY

Front Seat Adjuster Front Spacer Replacement

Callout	Component Name
Preliminary Procedure Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation.</u>	
1	Front Seat Adjuster Front Spacer TIP: Use a small commercial screwdriver for clip out the spacer.

FRONT SEAT ADJUSTER KNOB REPLACEMENT (LOWER - 8-WAY-POWER)

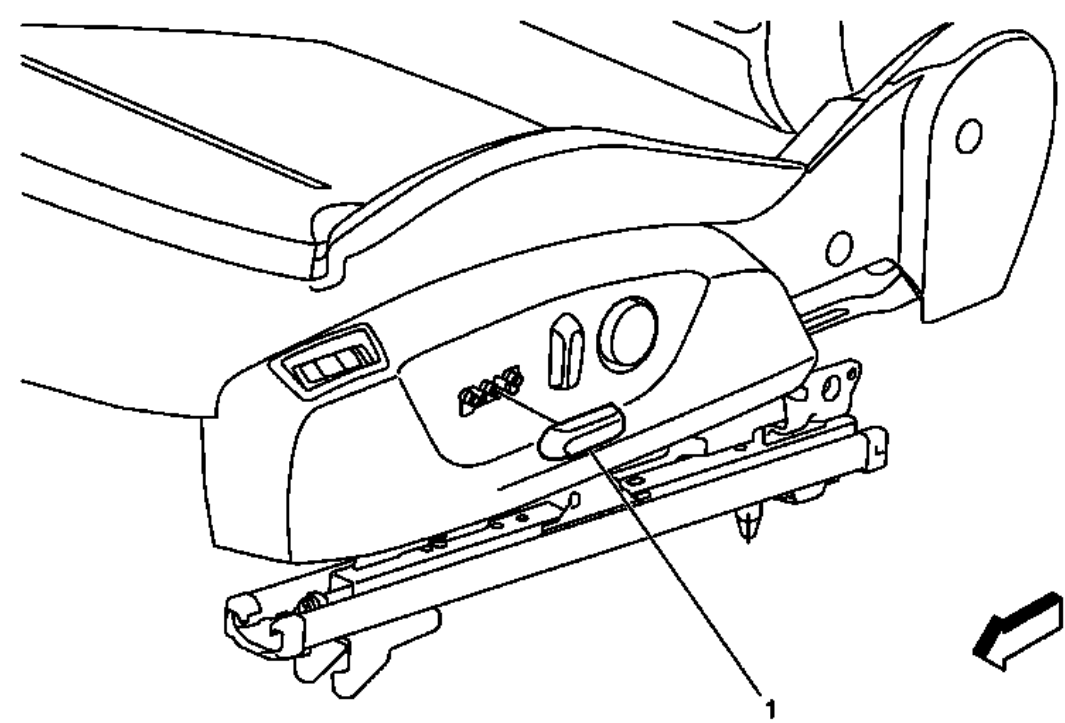


Fig. 3: Front Seat Adjuster Knob (Lower - 8-Way-Power)
Courtesy of GENERAL MOTORS COMPANY

Front Seat Adjuster Knob Replacement (Lower - 8-Way-Power)

Callout	Component Name
1	Front Seat Adjuster Knob TIP: Use a small flat-bladed tool to clip out the knob.

DRIVER OR PASSENGER SEAT ADJUSTER HANDLE REPLACEMENT (2/4/6-WAY HYBRID, 6-WAY HYBRID SPORT)

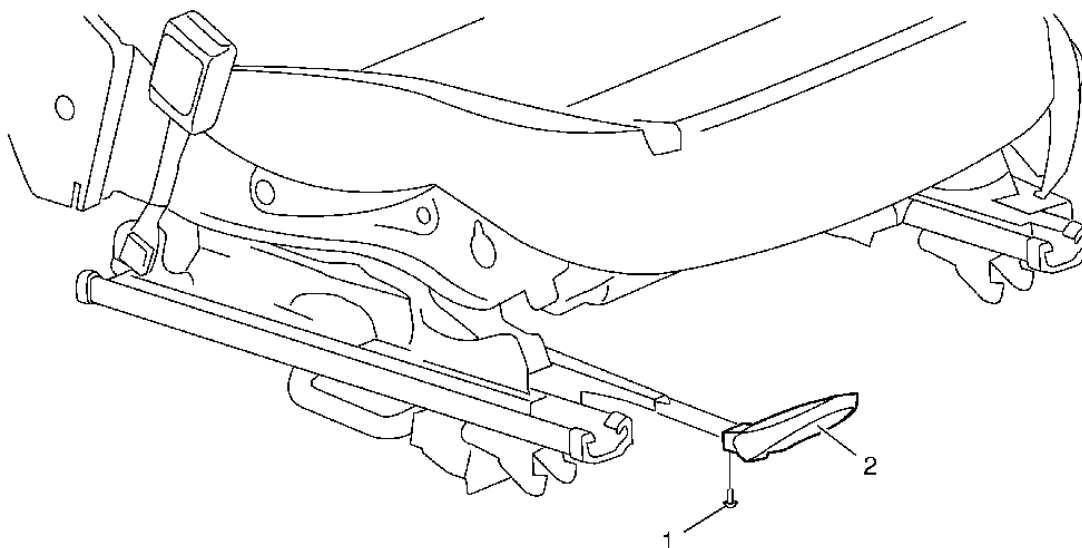


Fig. 4: Driver or Passenger Seat Adjuster Handle
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Adjuster Handle Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)

Callout	Component Name
1	Driver or Passenger Seat Adjuster Handle Fastener CAUTION: Refer to <u>Fastener Caution</u> Procedure For removal of the driver or passenger seat adjuster handle move the front seat full backward. Tighten 3.5 N.m (31 lb in)
2	Driver or Passenger Seat Adjuster Handle

FRONT SEAT ADJUSTER TRACK FINISH COVER REPLACEMENT

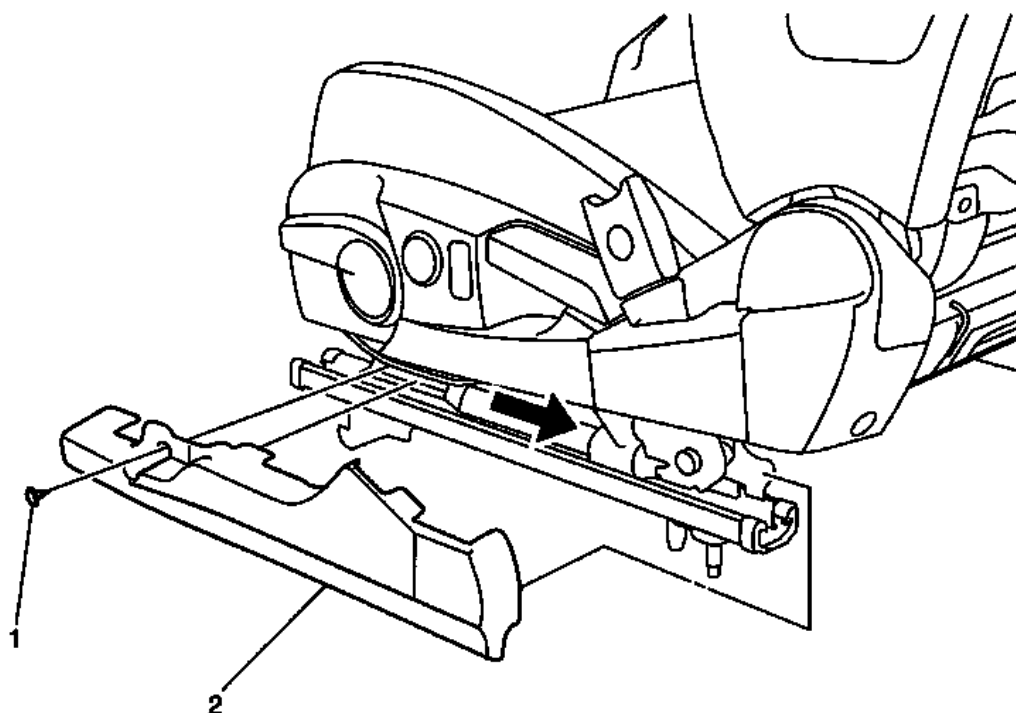


Fig. 5: Front Seat Adjuster Track Finish Cover & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Adjuster Track Finish Cover Replacement

Callout	Component Name
1	<p>Front Seat Adjuster Track Finish Cover Fastener</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 3.5 N.m (31 lb in)</p>
2	<p>Front Seat Adjuster Track Finish Cover</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Move front seat height adjuster into the middle position. 2. Move the driver or passenger seat fully forward. 3. Clip out the front seat adjuster track finish cover at rear. 4. Move the front seat adjuster track finish cover at front. 5. Remove the front seat adjuster track finish cover.

DRIVER OR PASSENGER SEAT HEAD RESTRAINT REPLACEMENT (WITHOUT AHS)

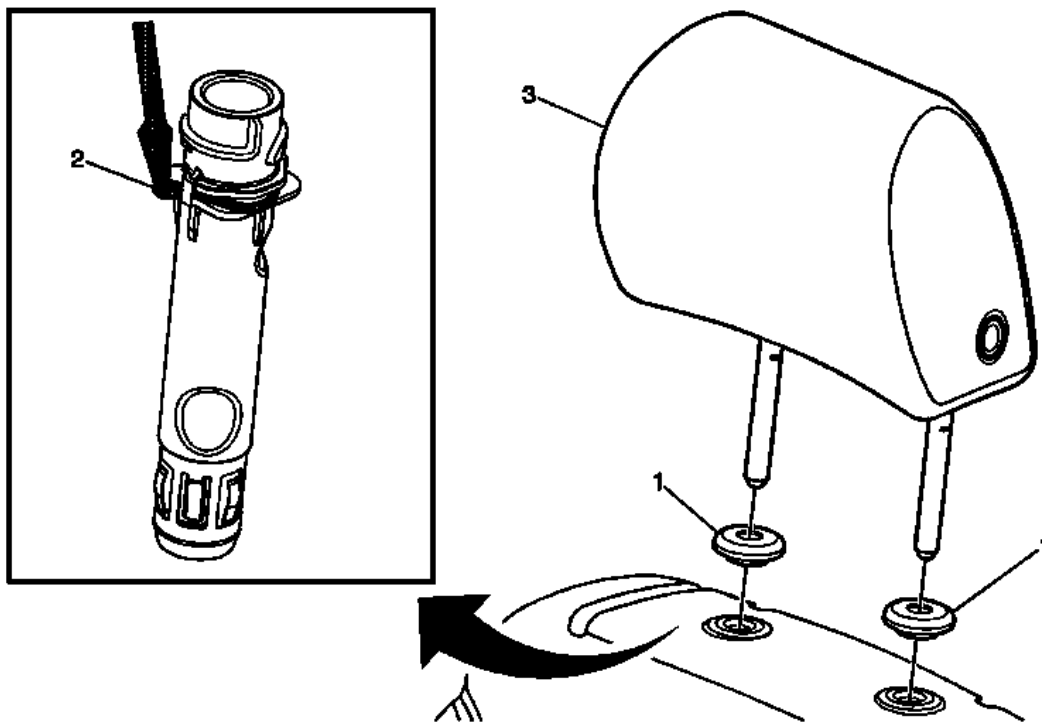


Fig. 6: View Of Driver Or Passenger Seat Head Restraint, Clips & Bezels (Without AHS)
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Head Restraint Replacement (without AHS)

Callout	Component Name
1	Driver or Passenger Seat Head Restraint Bezel (Qty: 2) Procedure 1. Raise the headrest to gain access to the head restraint bezel. 2. Twist the bezel counter clockwise and push the bezel upward on the head restraint shaft.
2	Driver or Passenger Seat Head Restraint Clip (Qty: 2) Procedure Using a suitable pointed or flat bladed tool, push the metal clip forward while pulling upward on the head restraint. TIP: If the clip becomes dislodged, it may be necessary to remove the guides to reset the clips.
3	Driver or Passenger Seat Head Restraint

FRONT SEAT HEAD RESTRAINT GUIDE BEZEL REPLACEMENT (2/4/6-WAY HYBRID, 6-WAY HYBRID SPORT)

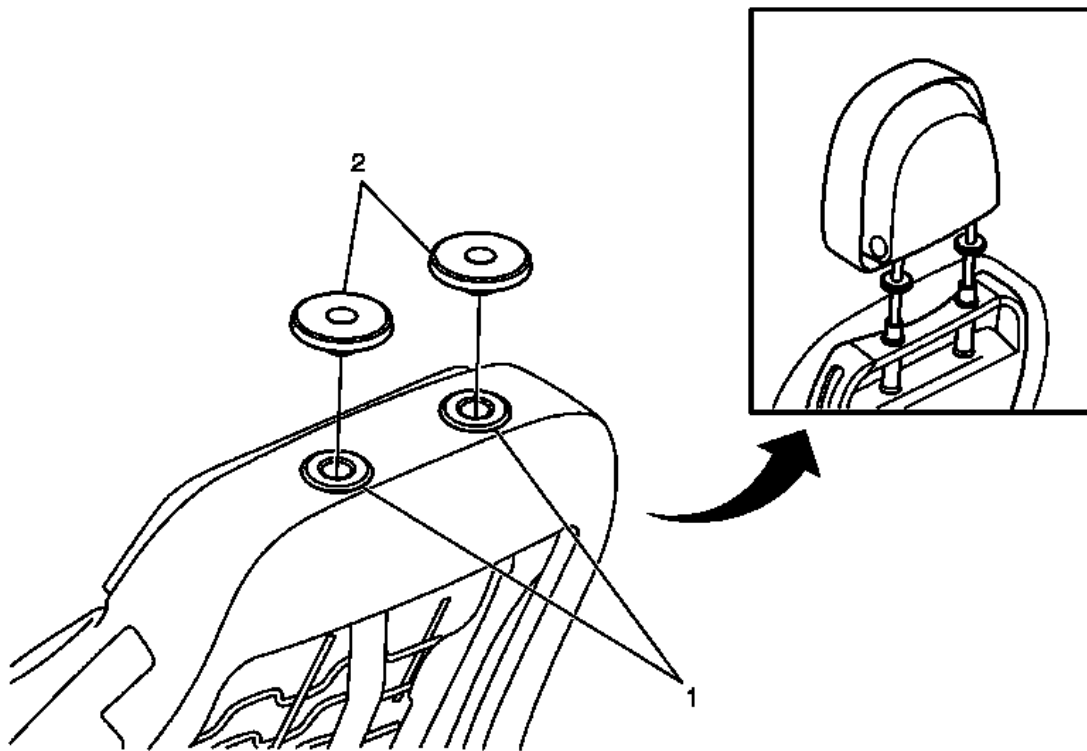


Fig. 7: Front Seat Head Restraint Guide Bezel
Courtesy of GENERAL MOTORS COMPANY

Front Seat Head Restraint Guide Bezel Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove front seat head restraint. Refer to <u>Driver or Passenger Seat Head Restraint Replacement (without AHS)</u>. 2. Remove front seat head restraint adjust rod guide. Refer to <u>Front Seat Head Restraint Guide Replacement</u>. 	
1	Front Seat Head Restraint Adjust Rod Guide
2	Front Seat Head Restraint Guide Bezel Procedure <ol style="list-style-type: none"> 1. Position front seat head restraint guide bezel. 2. Attach front seat head restraint guide bezel at front seat head restraint adjust rod guide. TIP: After removal of head restraint install both head restraint adjust rod guides.

FRONT SEAT HEAD RESTRAINT GUIDE BEZEL REPLACEMENT (8-WAY POWER)

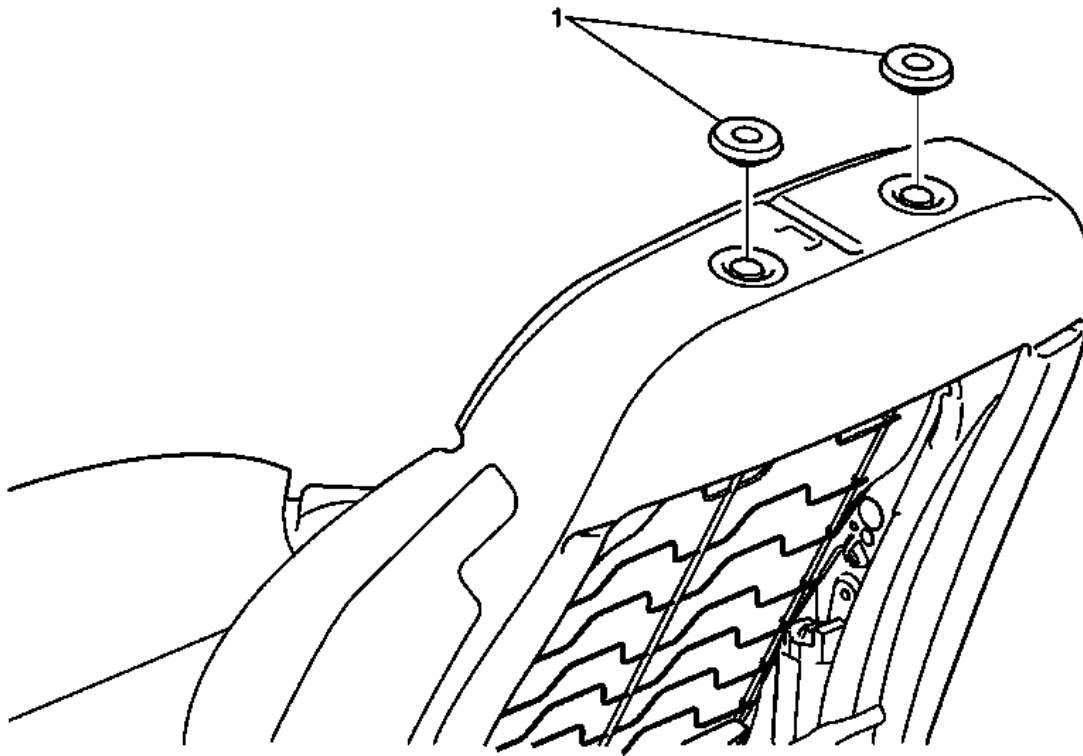


Fig. 8: Front Seat Head Restraint Guide Bezel (8-Way Power)
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Head Restraint Guide Bezel Replacement (8-Way Power)

Callout	Component Name
Preliminary Procedure Remove the driver or passenger seat head restraint. Refer to <u>Driver or Passenger Seat Head Restraint Replacement (without AHS)</u> .	
1	Front Seat Head Restraint Guide Bezel TIP: Twist the bezel to remove.

FRONT SEAT HEAD RESTRAINT GUIDE REPLACEMENT

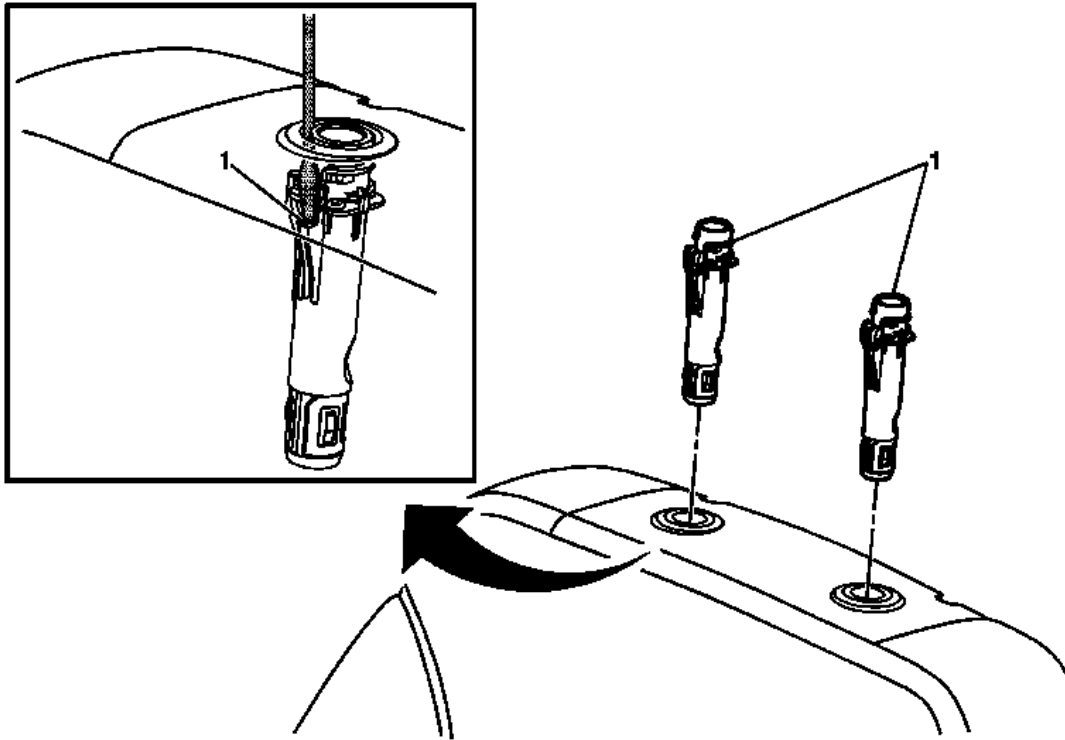


Fig. 9: Identifying Front Seat Head Restraint Adjust Rod Guides
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Head Restraint Guide Replacement

Callout	Component Name
Preliminary Procedure	
Remove the driver or passenger seat head restraint. Refer to <u>Driver or Passenger Seat Head Restraint Replacement (without AHS).</u>	
1	Driver or Passenger Seat Head Restraint Adjust Guide (Qty: 2) Procedure Using a suitable flat-bladed tool, slide the tool on the outside of the guide until it finds the slot. Then push the plastic slot inward and pull up upward to remove the guide from the seat back frame.

DRIVER OR PASSENGER SEAT OUTER ADJUSTER FINISH COVER REPLACEMENT (8-WAY POWER)

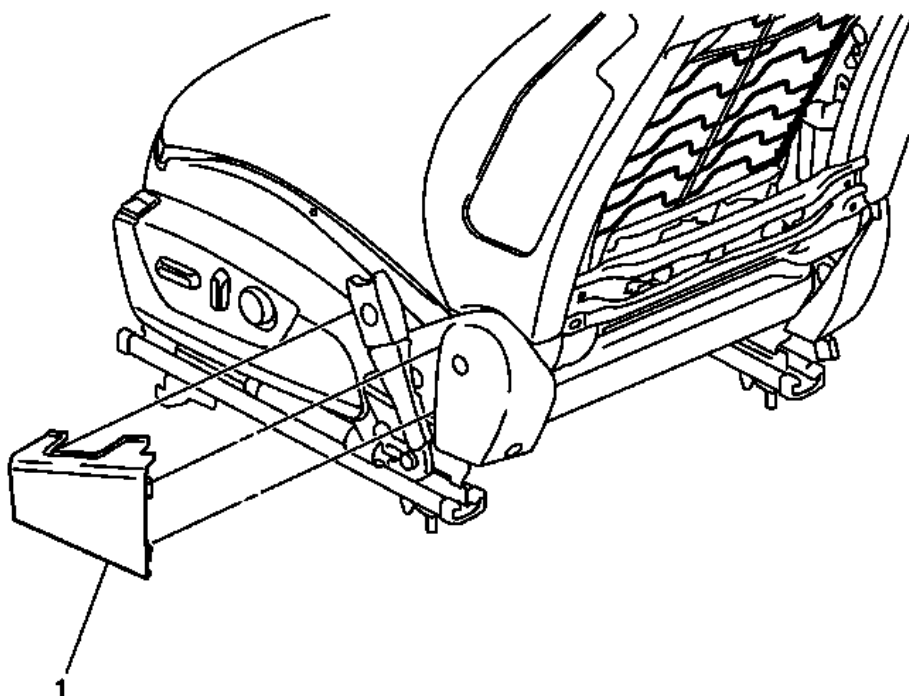


Fig. 10: Driver Or Passenger Seat Outer Adjuster Finish Cover (8-Way Power)
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)

Callout	Component Name
1	Driver or Passenger Seat Outer Adjuster Finish Cover Procedure To remove the driver or passenger seat outer adjuster finish cover move the driver or passenger seat full forward and move the high adjuster in middle position.

DRIVER OR PASSENGER SEAT ADJUSTER FINISH COVER REPLACEMENT (8-WAY-POWER)

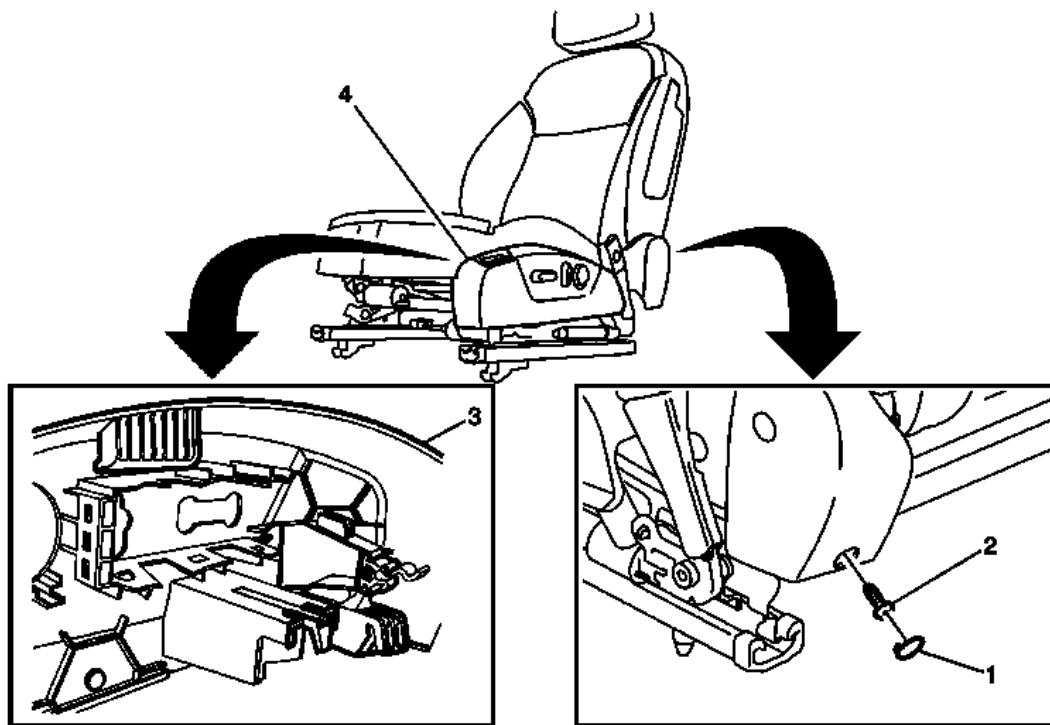


Fig. 11: Driver or Passenger Seat Adjuster Finish Cover (8-Way-Power)
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)

Callout	Component Name
Preliminary Procedures	
1. Open the front door. 2. Release the driver seat retractor side belt. 3. Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u> . 4. Remove the front seat adjuster and recliner knob. Use a small flat-bladed tool to unclip the adjuster and recliner knob.	
1	Front Seat Adjuster Finish Cover Retainer
2	Front Seat Adjuster Finish Cover Fastener
3	Front Seat Adjuster Finish Cover Retainer Procedure 1. Disengage front retainer. 2. Pull up on the front of cover to disengage the front hook. 3. Carefully pull up on the center of the cover to disengage the center hook.
	Front Seat Adjuster Finish Cover

4	Procedure
	<ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Disengage and remove the remainder of the finish cover by pulling the cover upward and outboard away from the seat. <p>NOTE: When reinstalling the finish cover, re-snap the front retainer together around the finish cover retainer rod.</p>

DRIVER OR PASSENGER SEAT ADJUSTER FINISH COVER RETAINER REPLACEMENT (4-WAY HYBRID, 6-WAY HYBRID SPORT)

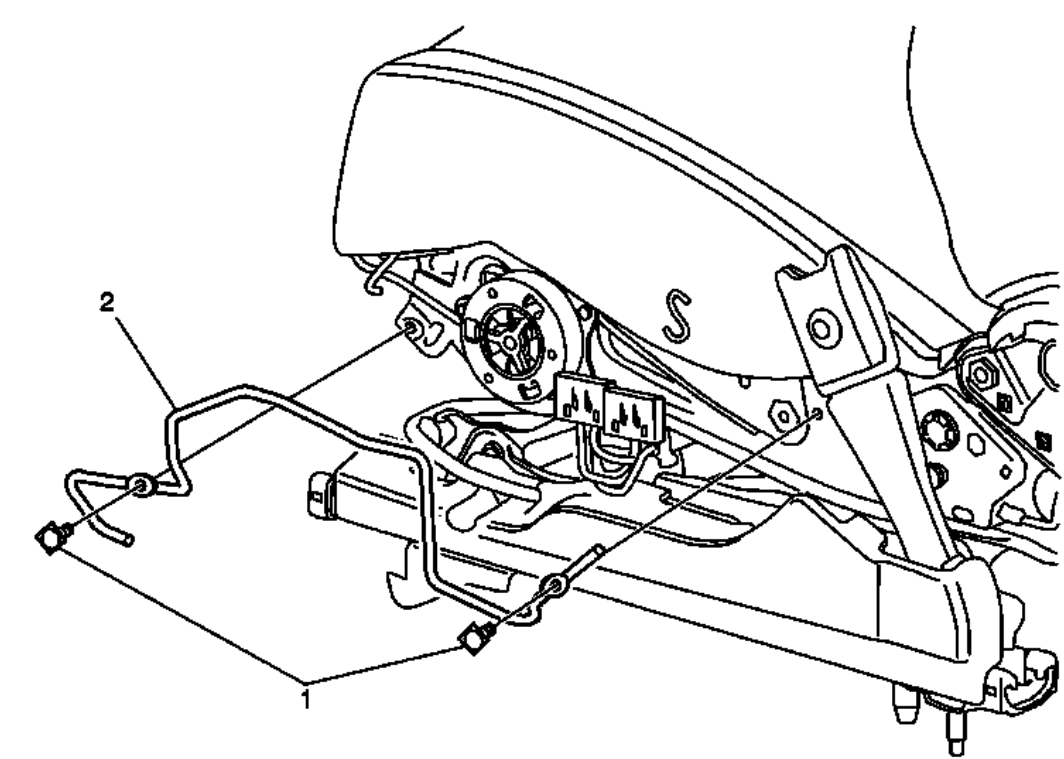


Fig. 12: Driver or Passenger Seat Adjuster Finish Cover Retainer
Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Adjuster Finish Cover Retainer Replacement (4-Way Hybrid, 6-Way Hybrid Sport)

Callout	Component Name
Preliminary Procedure Remove the driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)</u> .	
	Driver and Passenger Seat Adjuster Finish Cover Retainer (Qty: 2)

CAUTION:
Refer to Fastener Caution .

Procedure

1

1. Move the front seat to the highest position.
2. Clip out the cap of adjuster finish cover at finish cover.
3. Unscrew the fastener of adjuster finish cover at the finish cover.
4. Clip off the adjuster finish cover at finish cover retainer.
5. Clip out the wiring harness connector for the lumbar and high adjuster switch.
6. Unscrew the bolts and remove of front seat adjuster finish cover retainer.

Tighten
5 N.m (4 lb ft)

2

Driver and Passenger Seat Adjuster Finish Cover Retainer

DRIVER OR PASSENGER SEAT ADJUSTER FINISH COVER RETAINER REPLACEMENT (8-WAY POWER)

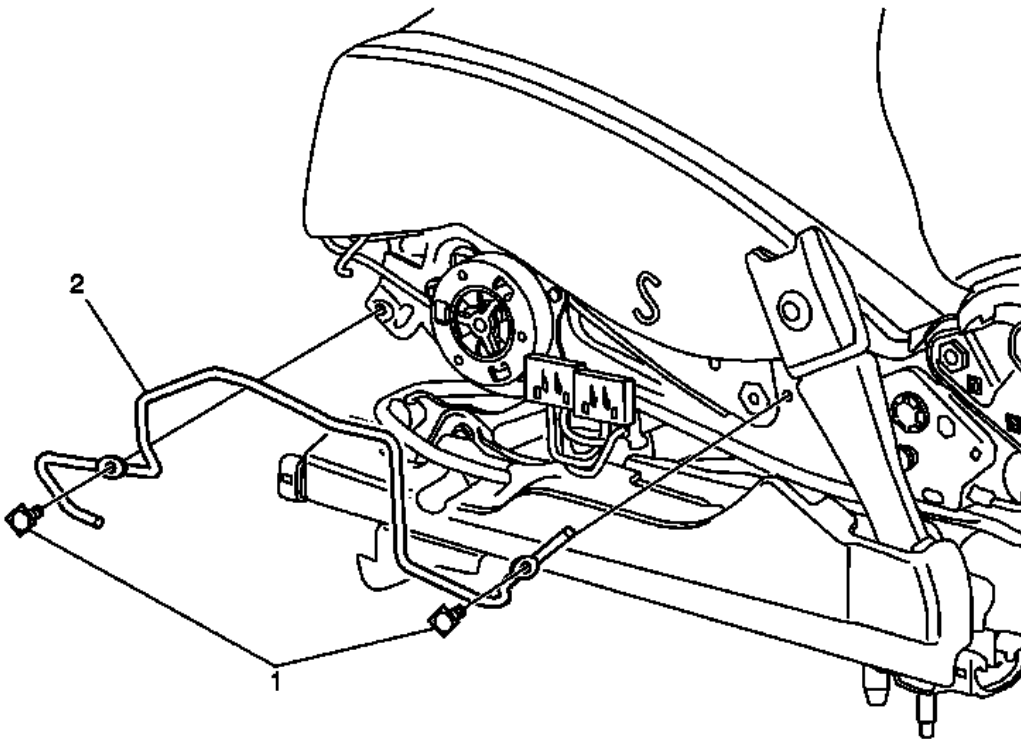


Fig. 13: Driver or Passenger Seat Adjuster Finish Cover (8-Way Power)
Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Adjuster Finish Cover Retainer Replacement (8-Way Power)

Callout	Component Name
Preliminary Procedure Remove the driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)</u> .	
1	Front Seat Adjuster Finish Cover Retainer Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 5 N.m (45 lb in)
2	Front Seat Adjuster Finish Cover Retainer

DRIVER OR PASSENGER SEAT INNER RECLINER FINISH COVER REPLACEMENT (2/4/6-WAY HYBRID, 6-WAY HYBRID SPORT)

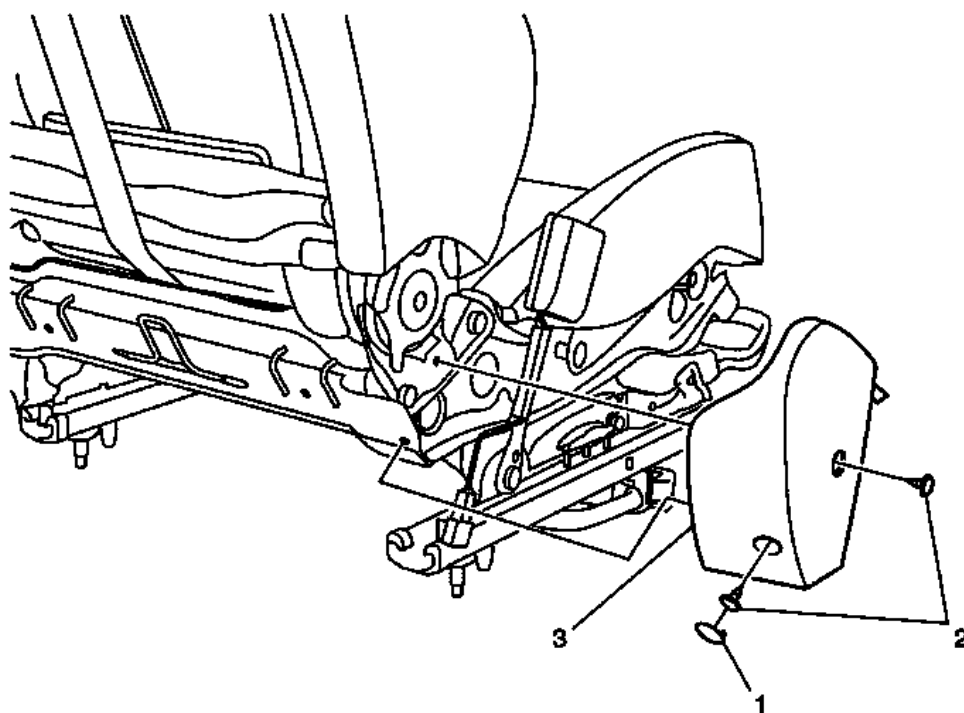


Fig. 14: Driver or Passenger Seat Inner Recliner Finish Cover & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)

Callout	Component Name
Preliminary Procedure	

Remove the driver or passenger seat. Refer to **Driver or Passenger Seat Removal and Installation**.

1	Cap Recliner Cover
2	Driver or Passenger Seat Inner Recliner Finish Cover Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 3.5 N.m (31 lb in)
3	Driver or Passenger Seat Inner Recliner Finish Cover

FRONT SEAT CUSHION COVER REPLACEMENT (DRIVER OR PASSENGER SEAT 6-WAY HYBRID)

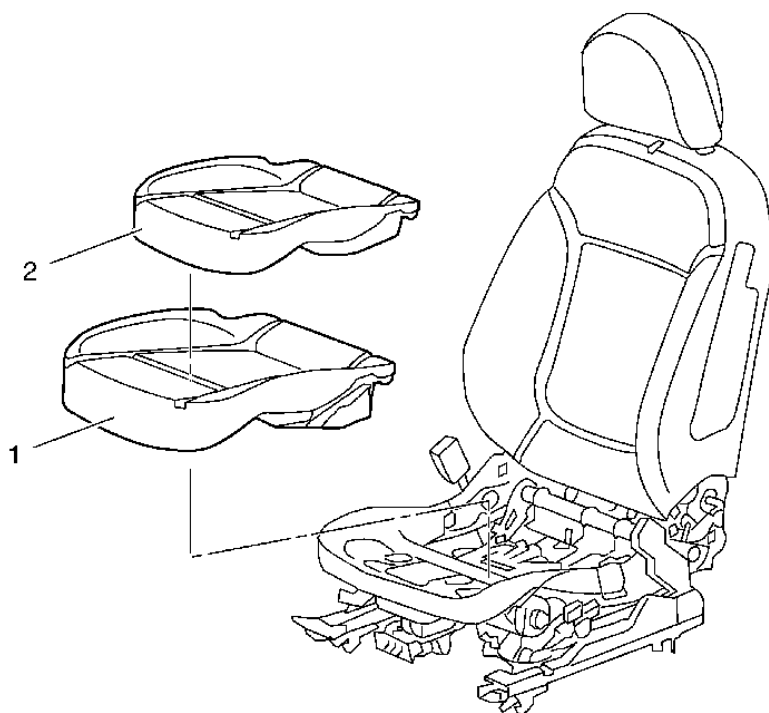


Fig. 15: Front Seat Cushion Cover And Pad
Courtesy of GENERAL MOTORS COMPANY

Front Seat Cushion Cover Replacement (Driver or Passenger Seat 6-Way Hybrid)

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u>	
WARNING:	

To avoid personal injuries, re-zero the passenger presence system whenever you remove or replace the seat cushion or trim. Failure to do so may cause the system to malfunction.

Preliminary Procedures

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the driver or passenger seat. Refer to **Driver or Passenger Seat Removal and Installation**.
3. Remove the driver or passenger seat recliner lever. Refer to **Driver or Passenger Seat Recliner Lever Replacement**.
4. Remove the driver or passenger seat adjuster finish cover. Refer to **Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)**.
5. Remove the driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)**.
6. Remove the front seat outer adjuster finish cover. Refer to **Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)**.
7. When working with the passenger seat re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to **Control Module References**

1	<p>Front Seat Cushion Pad</p> <p>Procedure</p> <ol style="list-style-type: none">1. Clip out the cushion cover at seat frame - rear side.2. Clip out the cushion cover at seat frame - left side.3. Clip out the cushion cover at seat frame - right side.4. Clip out the cushion cover at seat frame - front side.5. Remove the seat cushion pad with the cushion cover.
2	<p>Front Seat Cushion Cover</p> <p>Procedure</p> <ol style="list-style-type: none">1. Remove the hog rings from the under side of the seat cushion.2. Pull the cushion cover off the cushion pad.

FRONT SEAT CUSHION COVER REPLACEMENT (DRIVER OR PASSENGER SEAT 2-WAY, 4-WAY)

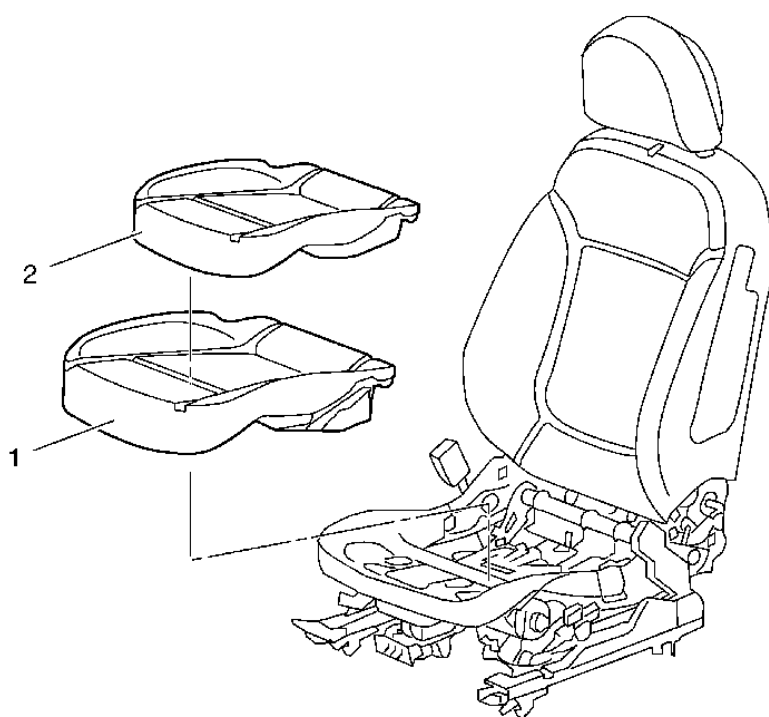


Fig. 16: Front Seat Cushion Cover And Pad
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Cushion Cover Replacement (Driver or Passenger Seat 2-Way, 4-Way)

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u>	
WARNING: To avoid personal injuries, re-zero the passenger presence system whenever you remove or replace the seat cushion or trim. Failure to do so may cause the system to malfunction.	
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u>. 3. Remove the driver or passenger seat recliner lever. Refer to <u>Driver or Passenger Seat Recliner Lever Replacement</u>. 4. Remove the driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)</u>. 5. Remove the driver or passenger seat inner recliner finish cover. Refer to <u>Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u>. 	

6. Remove the front seat outer adjuster finish cover. Refer to **Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)**.
7. When working with the passenger seat re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to **Control Module References**

1	<p>Front Seat Cushion Pad</p> <p>Procedure</p> <ol style="list-style-type: none">1. Clip out the cushion cover at seat frame - rear side.2. Clip out the cushion cover at seat frame - left side.3. Clip out the cushion cover at seat frame - right side.4. Clip out the cushion cover at seat frame - front side.5. Remove the seat cushion pad with the cushion cover.
2	<p>Front Seat Cushion Cover</p> <p>Procedure</p> <ol style="list-style-type: none">1. Remove the hog rings from the under side of the seat cushion.2. Pull the cushion cover off the cushion pad.

FRONT SEAT CUSHION COVER REPLACEMENT (8-WAY POWER)



Fig. 17: Front Seat Cushion Cover (8-Way Power)
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Cushion Cover Replacement (8-Way Power)

Callout	Component Name
<p>WARNING: Refer to <u>SIR Warning</u></p> <p>WARNING: To avoid personal injuries, re-zero the passenger presence system whenever you remove or replace the seat cushion or trim. Failure to do so may cause the system to malfunction.</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u>. 3. Remove the front seat outer adjuster finish cover. Refer to <u>Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)</u>. 4. Remove the driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)</u>. 5. Remove the driver or passenger seat inner recliner finish cover. Refer to <u>Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u>. 6. When working with the passenger seat re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to <u>Control Module References</u> 	
1	<p>Front Seat Cushion Cover</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Clip out cushion cover at seat frame - rear side. 2. Clip out cushion cover at seat frame - left side. 3. Clip out cushion cover at seat frame - right side. 4. Clip out cushion cover at seat frame - front side. 5. Remove seat cushion with cushion pad. 6. Remove the hog rings from the under side of the seat cushion. 7. Pull the cushion cover from the cushion pad.

DRIVER OR PASSENGER SEAT CUSHION FRAME REPLACEMENT

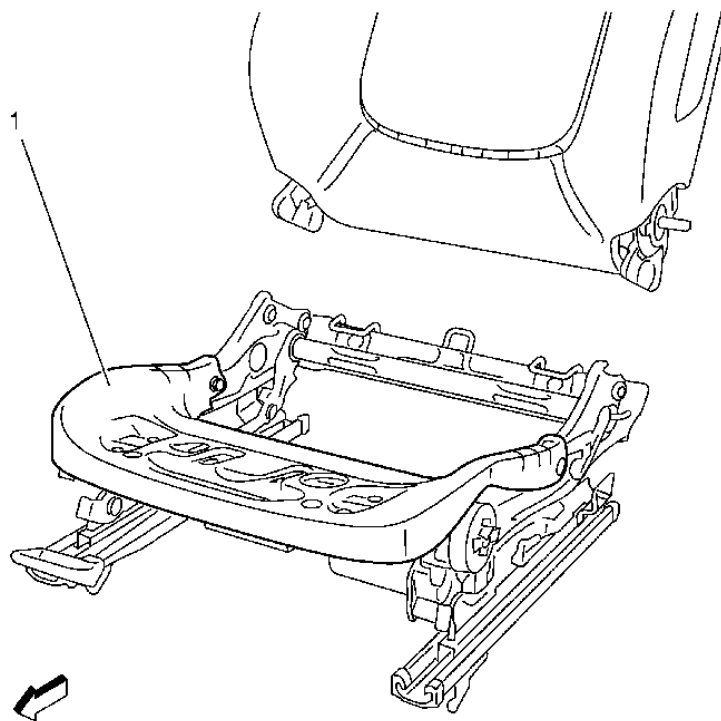


Fig. 18: Driver or Passenger Seat Cushion Frame
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Cushion Frame Replacement

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u>	
WARNING: To avoid personal injuries, re-zero the passenger presence system whenever you remove or replace the seat cushion or trim. Failure to do so may cause the system to malfunction.	
Preliminary Procedures	
1. Remove the driver or passenger seat back cushion frame. Refer to <u>Driver or Passenger Seat Back Cushion Frame Replacement (6-Way Hybrid)</u> , <u>Driver or Passenger Seat Back Cushion Frame Replacement (2/4-Way)</u> , <u>Driver or Passenger Seat Back Cushion Frame Replacement (8-Way Power)</u> .	
2. Remove the driver or passenger seat adjuster vertical actuator. Refer to <u>Driver or Passenger Seat Vertical Adjuster Actuator Replacement (4/6/8-Way)</u> .	
3. Remove the front seat tilt adjuster actuator. Refer to <u>Front Seat Tilt Adjuster Actuator Replacement (Driver/Passenger Seat 8-Way Power)</u> .	
4. Remove the driver or passenger seat adjuster handle. Refer to <u>Driver or Passenger Seat Adjuster Handle Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u> .	

5. Remove the driver or passenger seat cushion pad. Refer to **Front Seat Cushion Cover Replacement (Driver or Passenger Seat 6-Way Hybrid)**, **Front Seat Cushion Cover Replacement (Driver or Passenger Seat 2-Way, 4-Way)**, **Front Seat Cushion Cover Replacement (8-Way Power)**.
6. Remove the front seat cushion cover. Refer to **Driver or Passenger Seat Cushion Pad Replacement (2-Way, 4-Way Hybrid)**, **Driver or Passenger Seat Cushion Pad Replacement (8-Way Power)**.
7. Remove the front seat adjuster memory bracket.
8. Disconnect the electrical connector.
9. When working with the passenger seat re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to **Control Module References**

1	Driver or Passenger Seat Cushion Frame
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DRIVER OR PASSENGER SEAT CUSHION PAD REPLACEMENT (2-WAY, 4-WAY HYBRID)

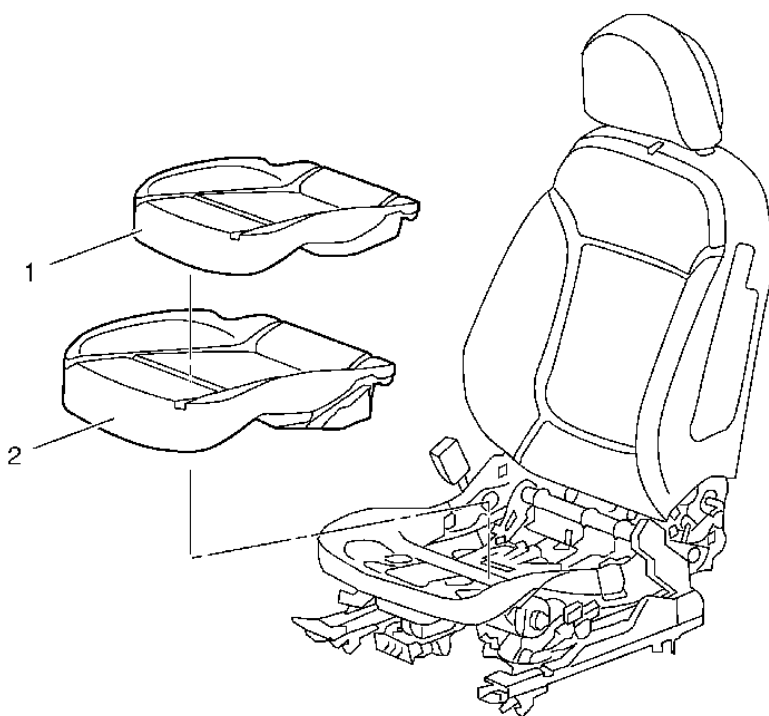


Fig. 19: Driver or Passenger Seat Cushion Pad (2-Way, 4-Way Hybrid)
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Cushion Pad Replacement (2-Way, 4-Way Hybrid)

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u>	

WARNING:

To avoid personal injuries, re-zero the passenger presence system whenever you remove or replace the seat cushion or trim. Failure to do so may cause the system to malfunction.

Preliminary Procedures

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the driver or passenger seat. Refer to **Driver or Passenger Seat Removal and Installation**.
3. Remove the driver or passenger seat recliner lever. Refer to **Driver or Passenger Seat Recliner Lever Replacement**.
4. Remove the driver or passenger seat adjuster finish cover. Refer to **Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)**.
5. Remove the driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)**.
6. Remove the front seat outer adjuster finish cover. Refer to **Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)**.
7. When working with the passenger seat re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to **Control Module References**

1	<p>Front Seat Cushion Cover</p> <p>Procedure</p> <ol style="list-style-type: none">1. Release the cushion cover at seat frame - rear side.2. Release the cushion cover at seat frame - left side.3. Release the cushion cover at seat frame - right side.4. Release the cushion cover at seat frame - front side.5. Remove the seat cushion pad with cushion cover.
2	<p>Driver or Passenger Seat Cushion Pad</p> <p>Procedure</p> <ol style="list-style-type: none">1. Remove the hog rings from the under side of seat cushion.2. Pull the Cushion cover off the cushion pad.

DRIVER OR PASSENGER SEAT CUSHION PAD REPLACEMENT (8-WAY POWER)



Fig. 20: Driver or Passenger Seat Cushion Pad (8-Way Power)
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Cushion Pad Replacement (8-Way Power)

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u>	
WARNING: To avoid personal injuries, re-zero the passenger presence system whenever you remove or replace the seat cushion or trim. Failure to do so may cause the system to malfunction.	
Preliminary Procedure	
1. Remove the front seat cushion cover. Refer to <u>Front Seat Cushion Cover Replacement (Driver or Passenger Seat 6-Way Hybrid)</u> , <u>Front Seat Cushion Cover Replacement (Driver or Passenger Seat 2-Way, 4-Way)</u> , <u>Front Seat Cushion Cover Replacement (8-Way Power)</u>	
2. When working with the passenger seat re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to <u>Control Module References</u>	
1	Driver or Passenger Seat Cushion Pad

DRIVER OR PASSENGER SEAT CUSHION PAD WIRE REPLACEMENT (2-WAY, 4-WAY HYBRID)

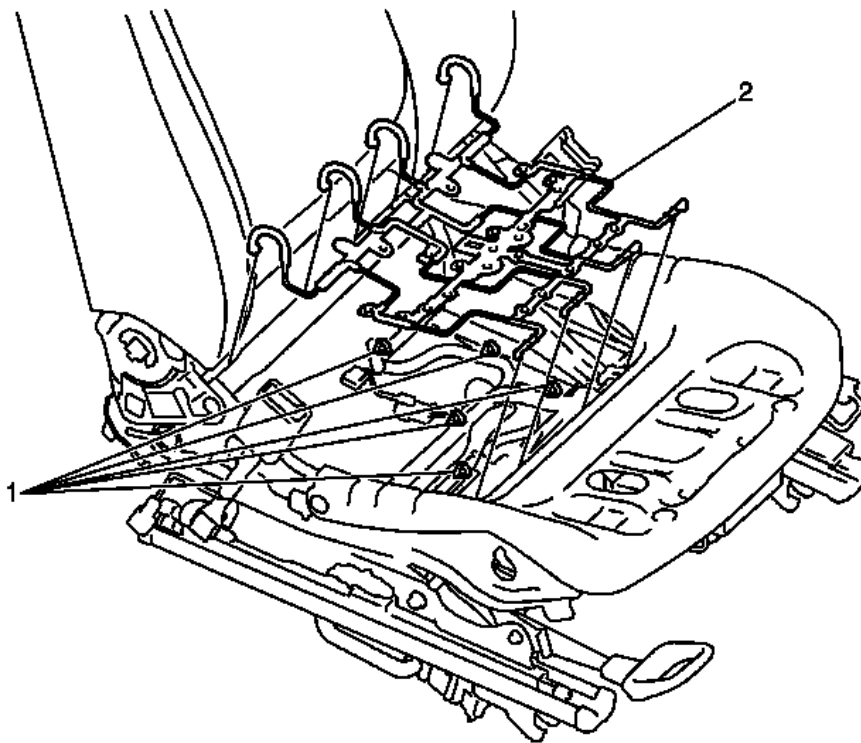


Fig. 21: Driver Or Passenger Seat Cushion Pad Wire & Harness Clips
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Cushion Pad Wire Replacement (2-Way, 4-Way Hybrid)

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u>	
WARNING: To avoid personal injuries, re-zero the passenger presence system whenever you remove or replace the seat cushion or trim. Failure to do so may cause the system to malfunction.	
Preliminary Procedures	
1. Remove the front seat cushion pad. Refer to <u>Driver or Passenger Seat Cushion Pad Replacement (2-Way, 4-Way Hybrid)</u> .	
2. When working with the passenger seat re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to <u>Control Module References</u>	
1	Wiring Harness Clips (Qty: 5)
2	Front Seat Cushion Pad Wire

DRIVER OR PASSENGER SEAT BACK CUSHION COVER REPLACEMENT (8-WAY-POWER)

Removal Procedure

WARNING: Refer to SIR Warning .

WARNING: Do not repair or replace the seat stitching or seams in the seat back trim cover with an internal mounted seat side airbag module. Replace the complete seat back trim cover from the OEM. Non-OEM seat stitching may cause improper airbag deployment which could result in personal injury.

1. Disable the SIR System. Refer to SIR Disabling and Enabling .
2. Remove the driver or passenger seat. Refer to Driver or Passenger Seat Removal and Installation.
3. Remove the front seat outer adjuster finish cover. Refer to Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power).
4. Remove driver or passenger seat adjuster finish cover. Refer to Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power).
5. Remove driver or passenger seat inner recliner finish cover. Refer to Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport).
6. Remove the front seat head restraint guide bezel. Refer to Front Seat Head Restraint Guide Bezel Replacement (8-Way Power).

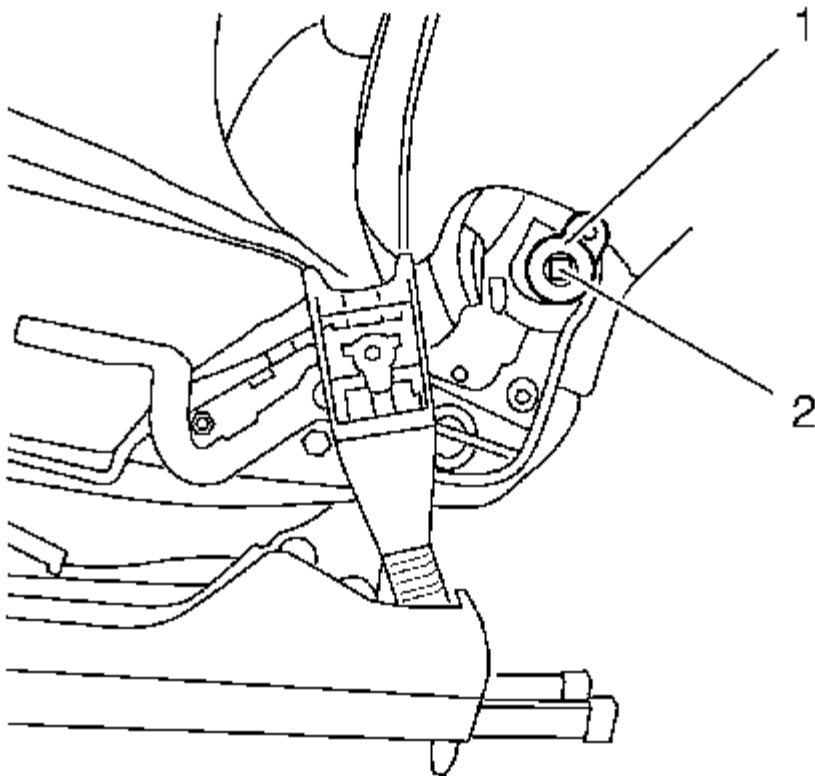


Fig. 22: Recliner Control Shaft And Securing Clip
Courtesy of GENERAL MOTORS COMPANY

7. Clip out retaining ring (1) of recliner control shaft (2).

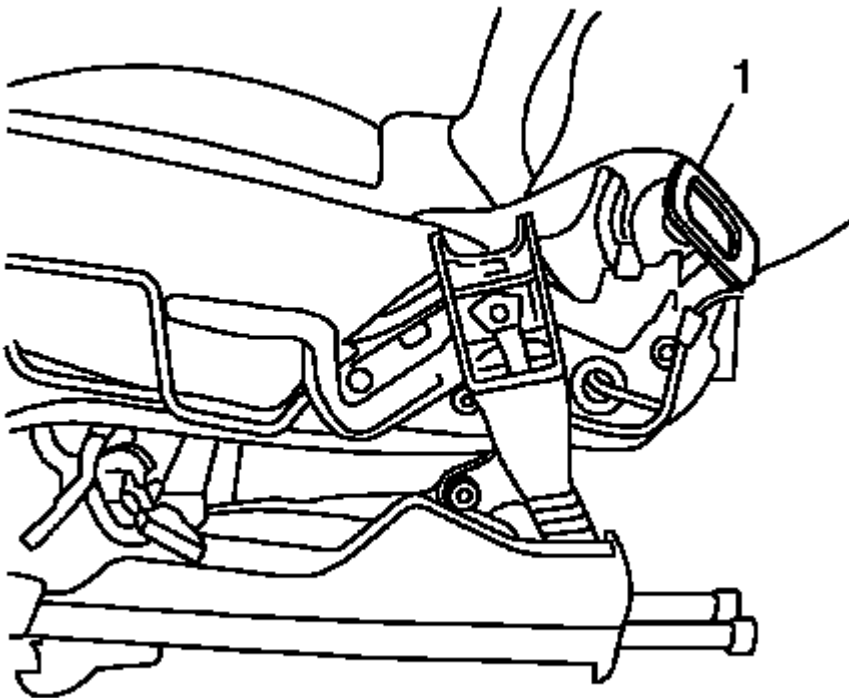


Fig. 23: Cushion Strap And Seat Frame
Courtesy of GENERAL MOTORS COMPANY

8. Unhinge the cushion strap (1) from the seat frame.

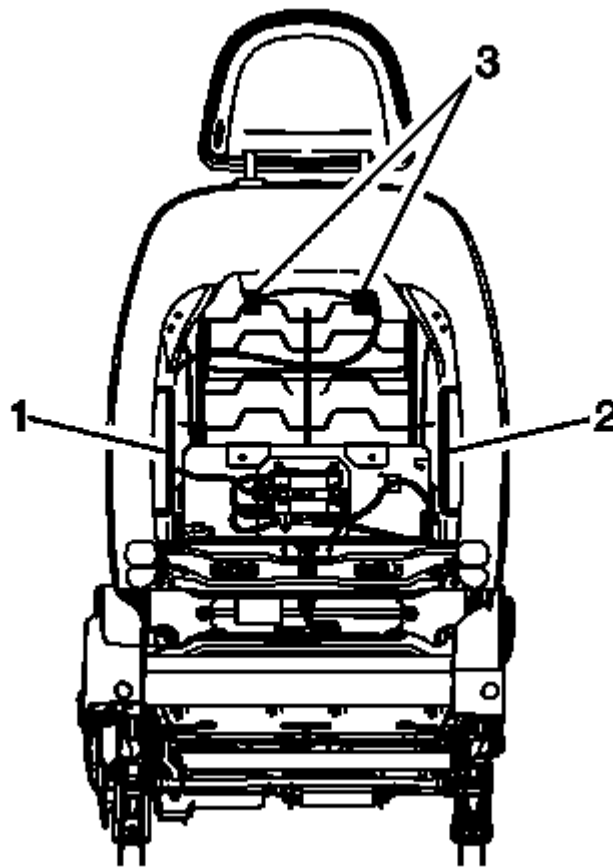


Fig. 24: Front Seat Back Cushion From The Backrest
Courtesy of GENERAL MOTORS COMPANY

9. Release the front seat back cushion from the backrest left side (1) and right side (2).

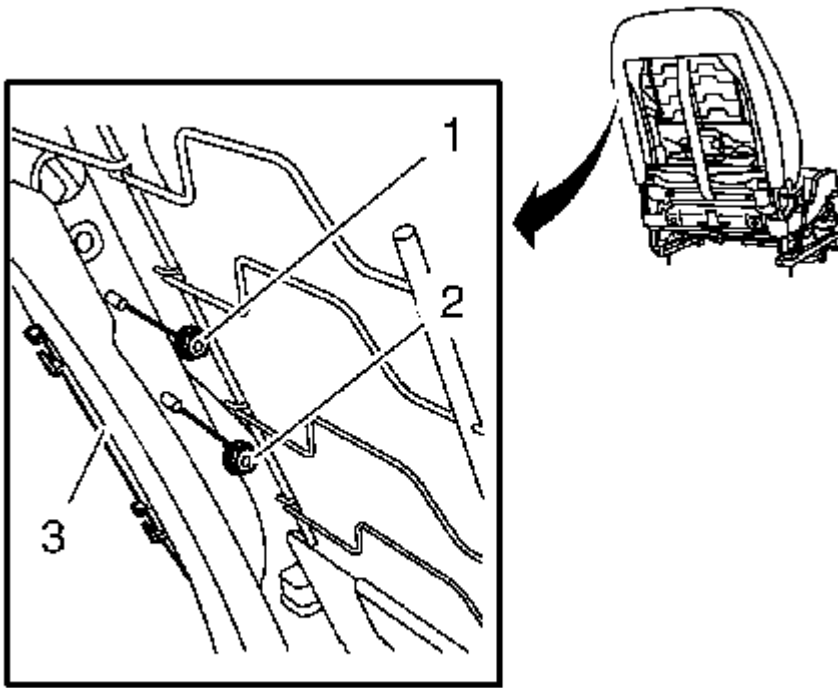


Fig. 25: Seat Side Inflatable Restraint Module And Nuts
Courtesy of GENERAL MOTORS COMPANY

10. Release both fasteners (1, 2) from the seat side inflatable restraint module (3).

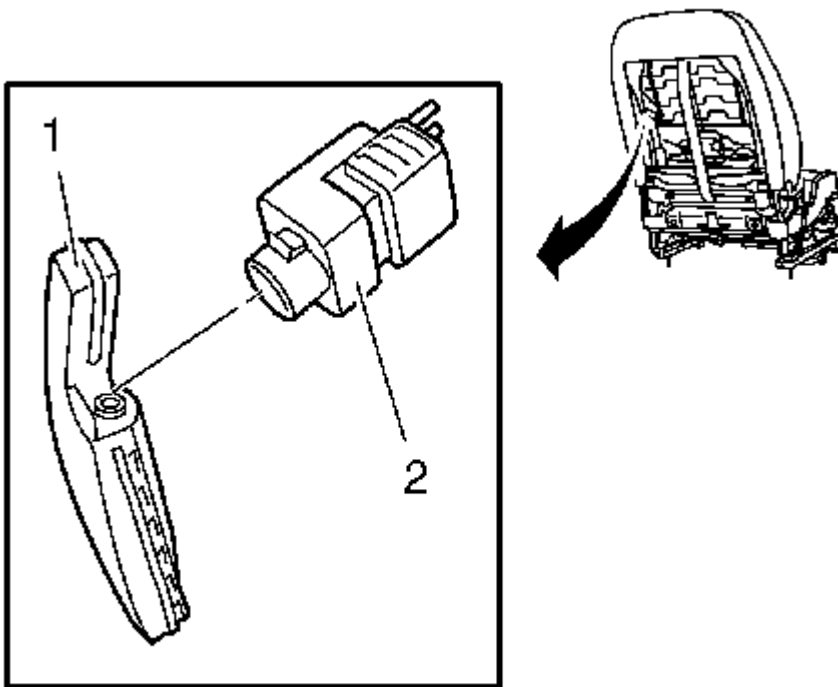


Fig. 26: Wiring Harness Connector And From Seat Side Inflatable Restraint Module
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the wiring harness connector (2) from the seat side inflatable restraint module (1).

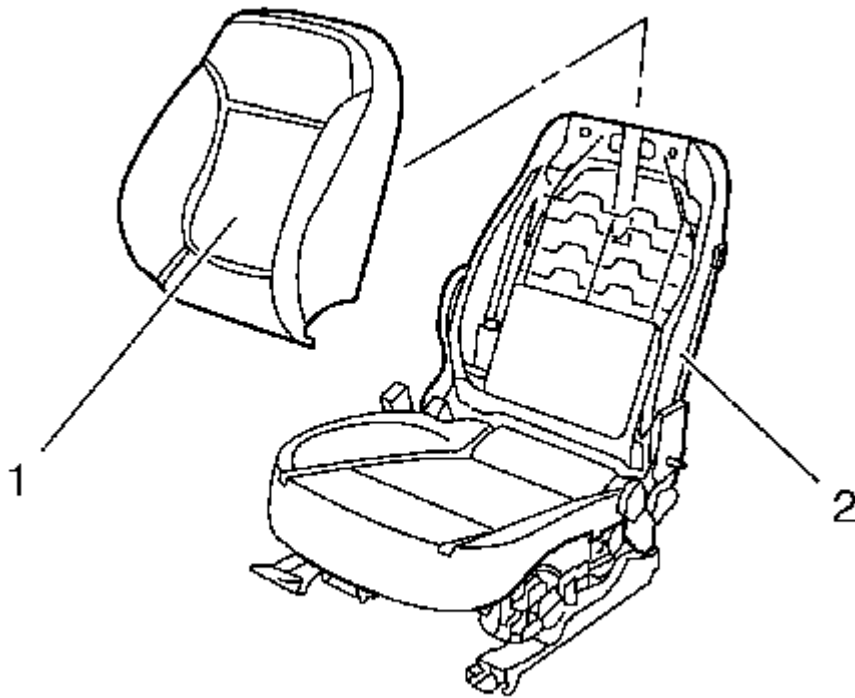


Fig. 27: Front Seat Back Cushion With Cushion Pad And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

12. Remove the front seat back cushion with the cushion pad (1) from the backrest frame (2).

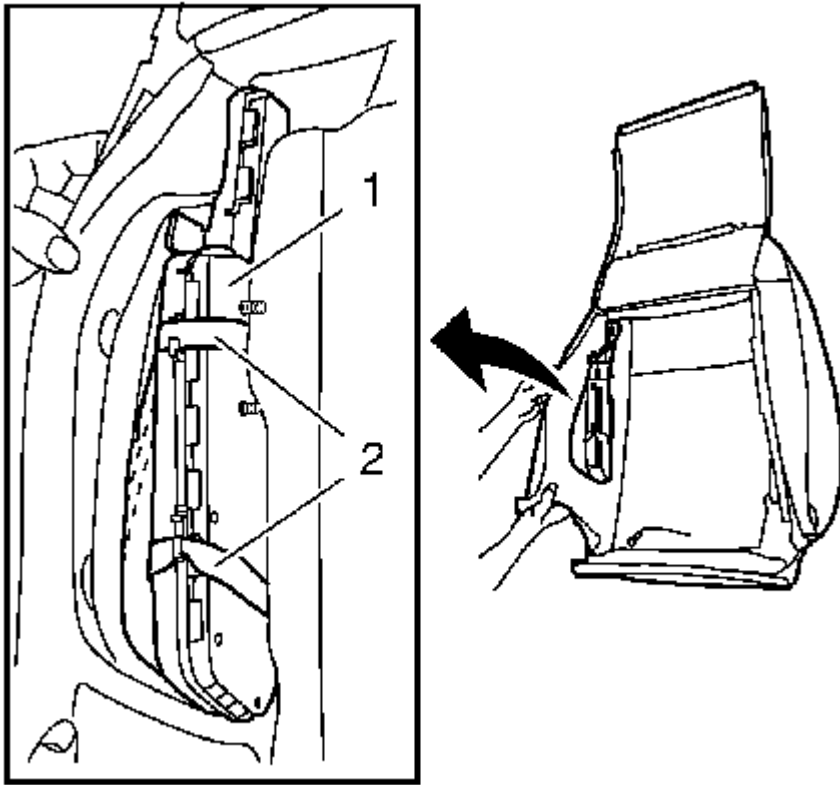


Fig. 28: Seat Side Inflatable Restraint Module And Textile Straps
Courtesy of GENERAL MOTORS COMPANY

13. Remove the seat side inflatable restraint module (1) out of the textile straps (2).

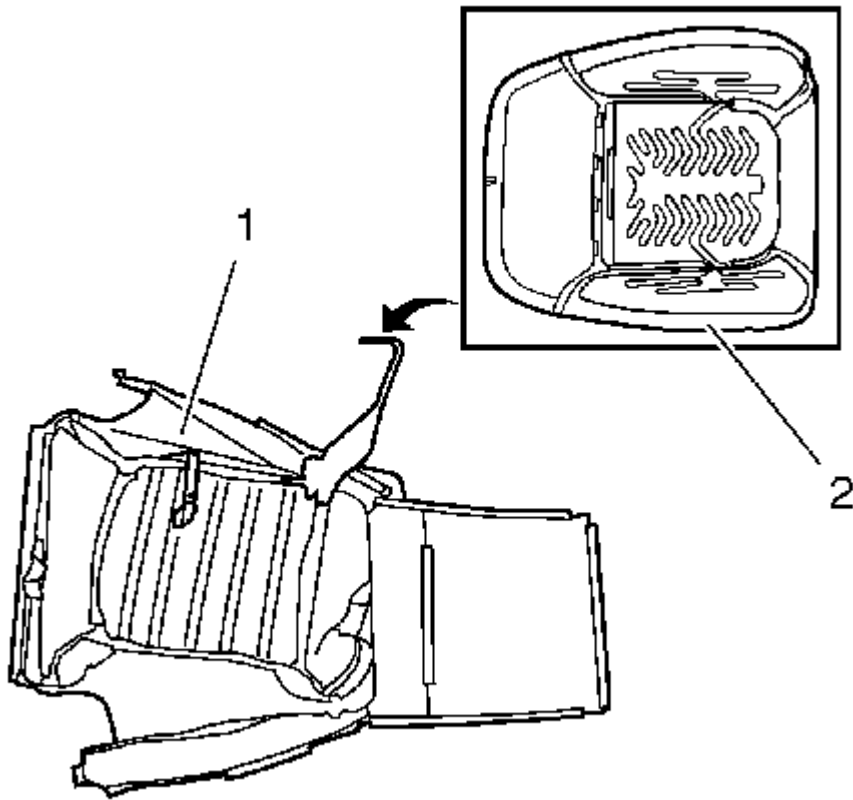


Fig. 29: Under Side Of Seat Cushion
Courtesy of GENERAL MOTORS COMPANY

14. Remove the hog rings from the seat cushion (1), pull the cushion cover from the cushion pad (2).

Installation Procedure

1. Install the front seat cushion cover to the cushion pad with new hog rings.

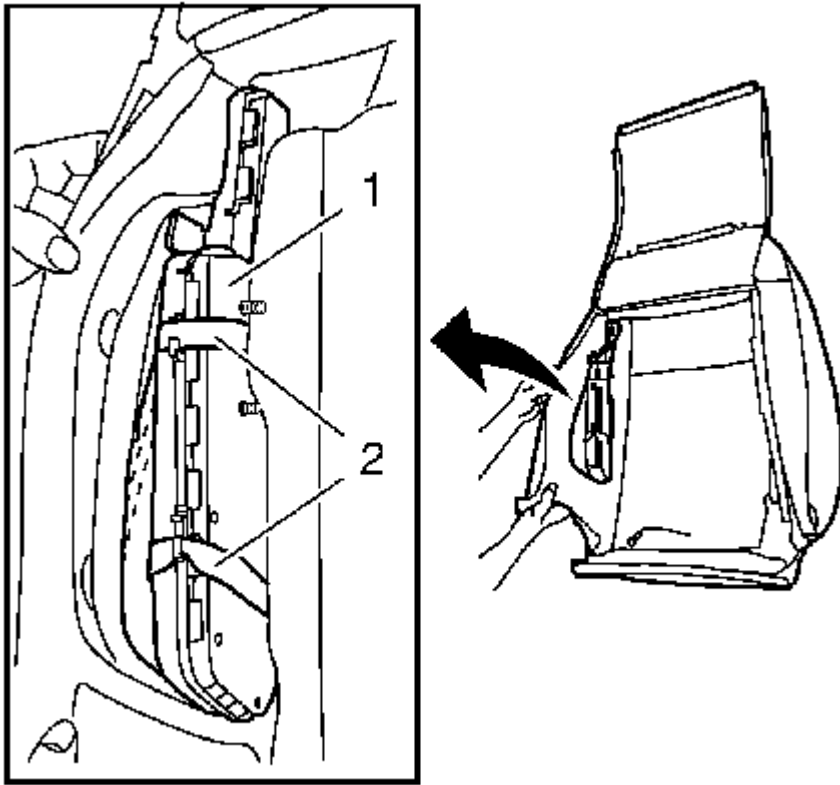


Fig. 30: Seat Side Inflatable Restraint Module And Textile Straps
Courtesy of GENERAL MOTORS COMPANY

2. Install the seat side inflatable restraint module (1) to the cushion cover with the textile straps (2).

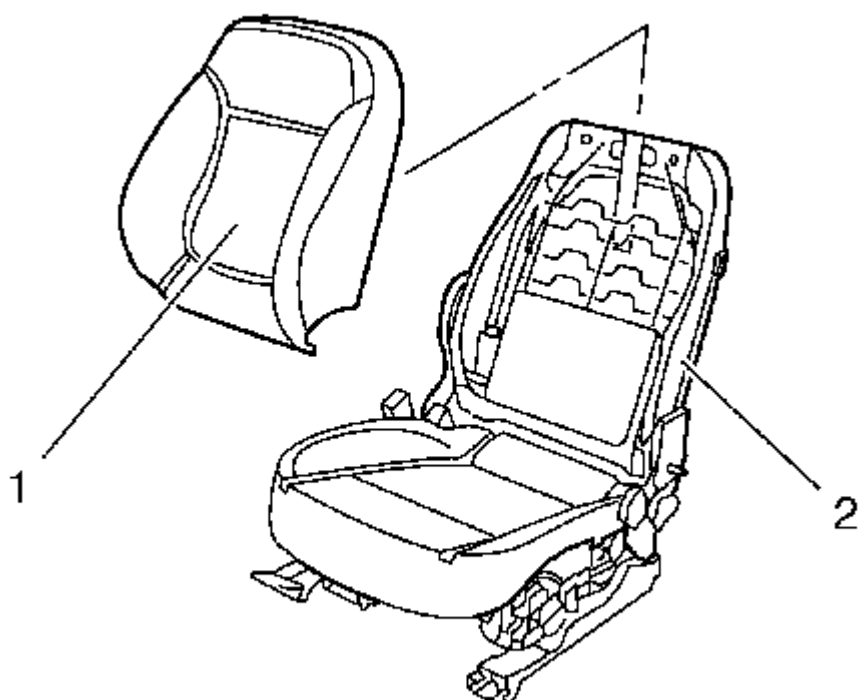


Fig. 31: Front Seat Back Cushion With Cushion Pad And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

3. Install the front seat back cushion with cushion pad (1) to the backrest frame (2).

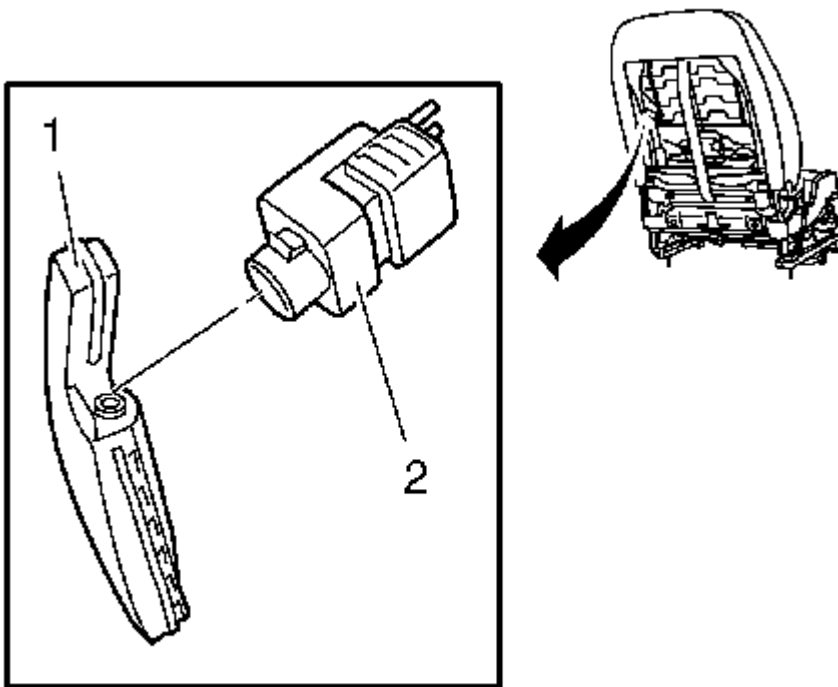


Fig. 32: Wiring Harness Connector And From Seat Side Inflatable Restraint Module
Courtesy of GENERAL MOTORS COMPANY

NOTE: Check the correct locking of wiring harness connector (2).

4. Connect the wiring harness connector (2) to the seat side inflatable restraint module (1).

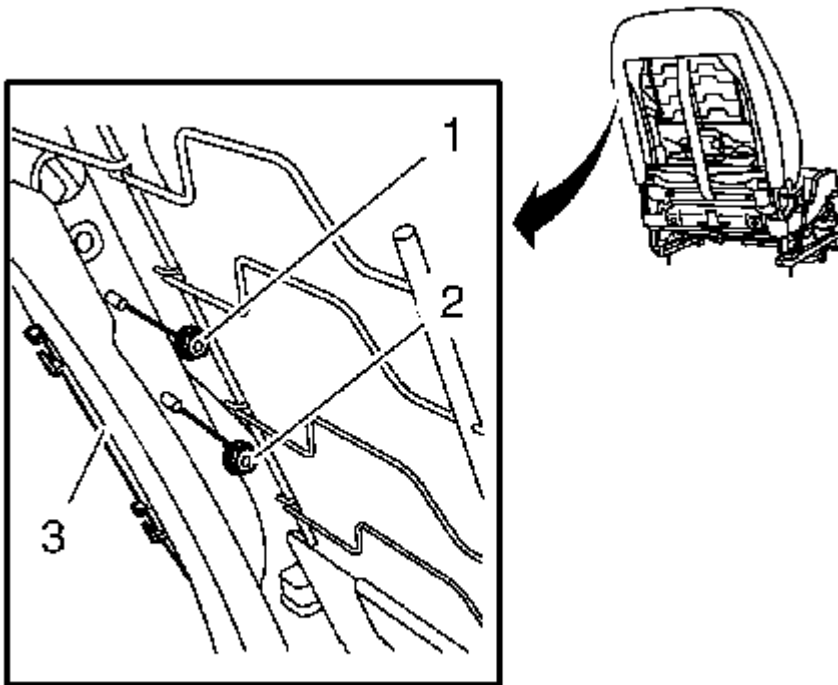


Fig. 33: Seat Side Inflatable Restraint Module And Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Position the seat side inflatable restraint module (3) to the backrest frame. Tighten both fasteners (1, 2) to the seat side inflatable restraint module (3).

Tighten

3.25 N.m (29 lb in)

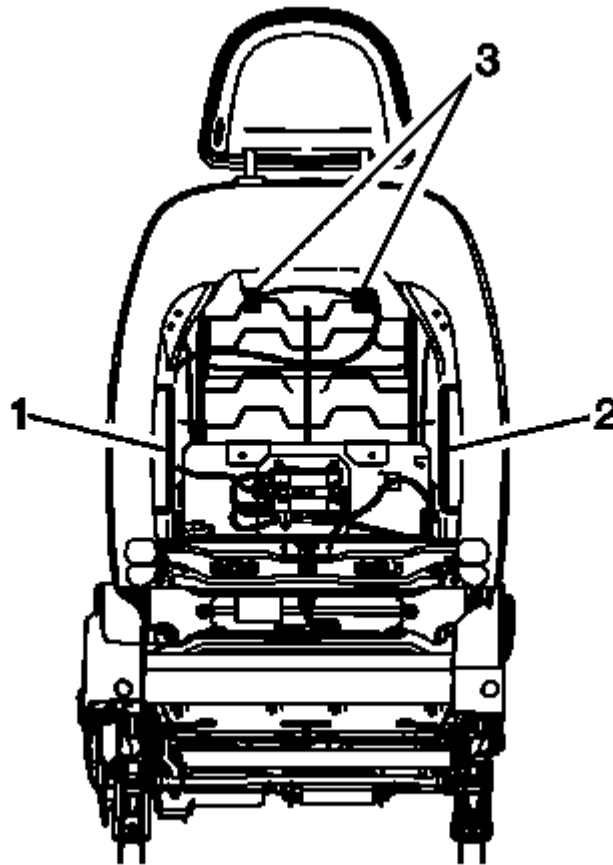


Fig. 34: Front Seat Back Cushion From The Backrest
Courtesy of GENERAL MOTORS COMPANY

6. Install the front seat back cushion to the backrest left side (1) and right side (2).
7. Install the front seat head restraint guide bezel. Refer to **Front Seat Head Restraint Guide Bezel Replacement (8-Way Power)**.
8. Install the front seat head restraint. Refer to **Driver or Passenger Seat Head Restraint Replacement (without AHS)**.
9. Close the cushion at backrest rear side.
10. Install the driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)**.
11. Install the driver or passenger seat adjuster finish cover. Refer to **Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)**.
12. Install the front seat outer adjuster finish cover. Refer to **Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)**.
13. Install driver or passenger seat. Refer to **Driver or Passenger Seat Removal and Installation**.

FRONT SEAT BACK PAD REPLACEMENT (2/4/6-WAY HYBRID, 6-WAY HYBRID SPORT)

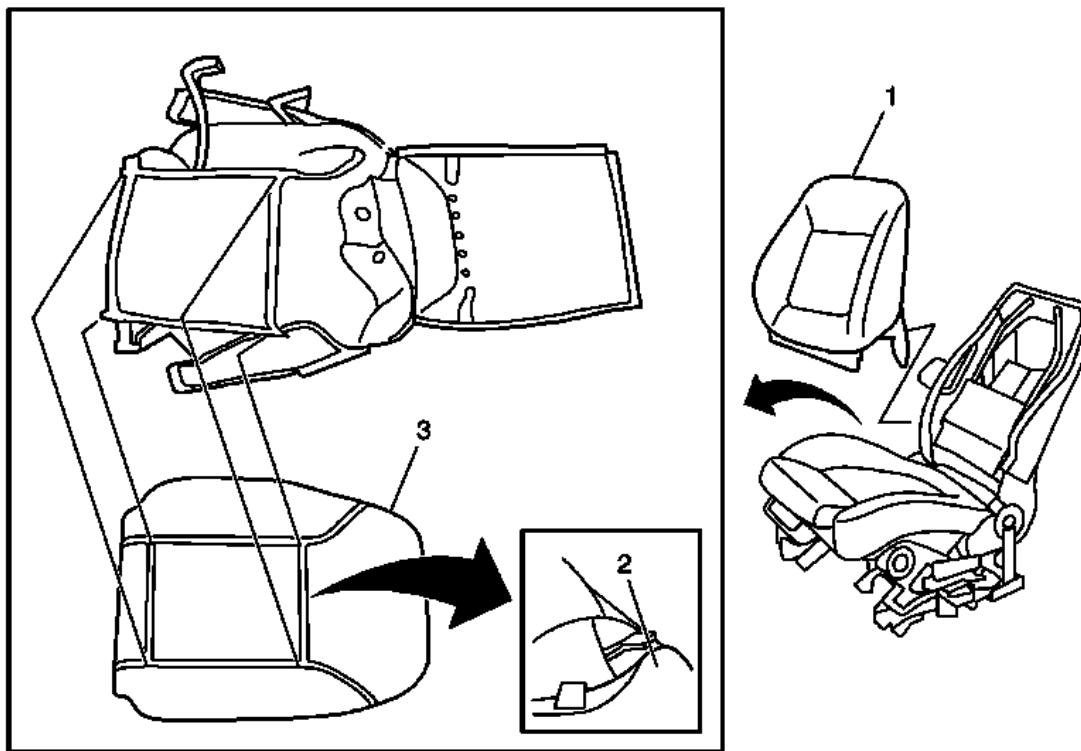


Fig. 35: Front Seat Back Cushion Pad
Courtesy of GENERAL MOTORS COMPANY

Front Seat Back Pad Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none"> 1. Remove driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation.</u> 2. Remove front seat inner recliner finish cover. Refer to <u>Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport).</u> 3. Remove front seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power).</u> 4. Remove front seat head restraint. Refer to <u>Driver or Passenger Seat Head Restraint Replacement (without AHS).</u> 5. Remove seat head restraint adjust rod guide. Refer to <u>Front Seat Head Restraint Guide Replacement.</u> 6. Remove driver or passenger seat side inflatable restraint module. Refer to <u>Front Seat Outboard Seat Back Airbag Replacement .</u> 	
1	Cushion and Cushion Pad Procedure <ol style="list-style-type: none"> 1. Detach cushion from backrest side- left side. 2. Detach cushion from backrest at bottom.

	<ol style="list-style-type: none"> Detach side airbag. Detach cushion at backrest backside- both sides. Remove cushion and cushion pad from backrest frame include airbag. Pull out seat side inflatable restraint module from front seat back cushion pad.
2	<p>Cushion Cover and Cushion Pad</p> <p>Procedure</p> <ol style="list-style-type: none"> Remove cushion from cushion pad- 16 hog rings. Remove seat back cushion heater. Remove back cushion vent mat.
3	Front Seat Back Cushion Pad

FRONT SEAT BACK PAD REPLACEMENT (8-WAY POWER)

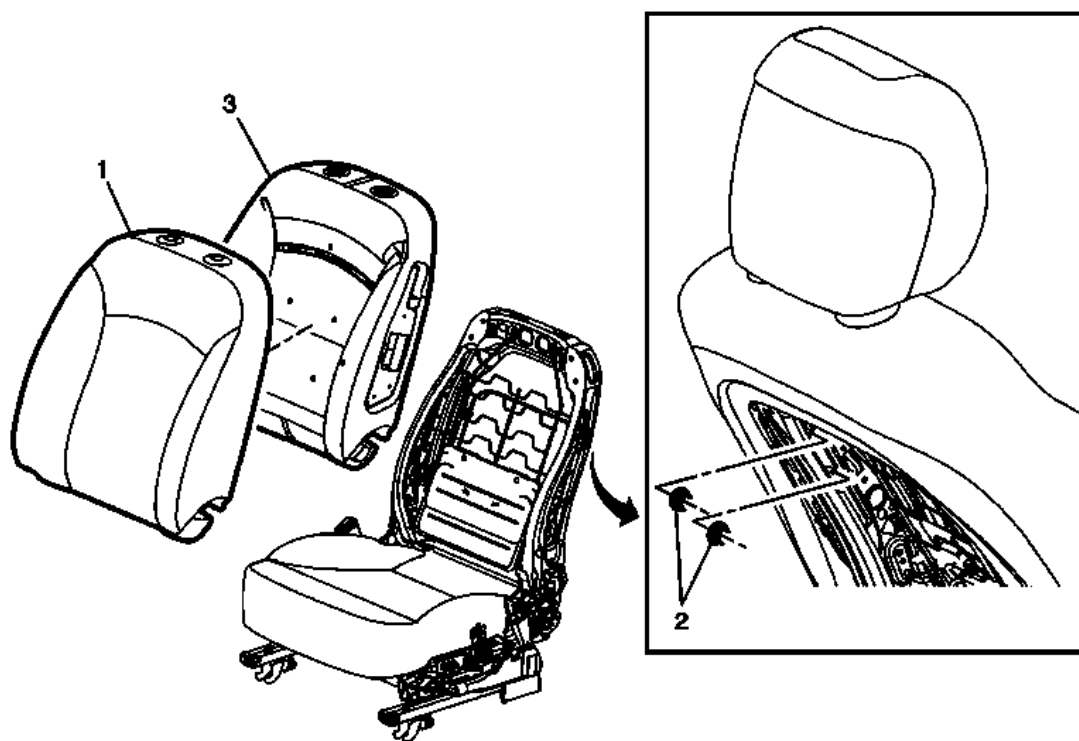


Fig. 36: Driver Or Passenger Seat Back Cushion Cover And Pad
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Back Pad Replacement (8-Way Power)

Callout	Component Name
<p>WARNING: Refer to <u>SIR Warning</u> .</p>	

WARNING:

Do not repair or replace the seat stitching or seams in the seat back trim cover with an internal mounted seat side airbag module. Replace the complete seat back trim cover from the OEM. Non-OEM seat stitching may cause improper airbag deployment which could result in personal injury.

Preliminary Procedures

1. Remove the driver or passenger seat. Refer to **Driver or Passenger Seat Removal and Installation**.
2. Remove the driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)**.
3. Remove the driver or passenger seat adjuster finish cover. Refer to **Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)**.
4. Remove the front seat head restraint guide bezel. Refer to **Front Seat Head Restraint Guide Bezel Replacement (8-Way Power)**.

1	<p>Front Seat Seat Back Cushion Cover</p> <p>Procedure</p> <ol style="list-style-type: none">1. Disengage the j-channel retainers from the seat back cushion frame.2. Remove the connector position assurance (CPA) from the airbag module.3. Disconnect the electrical connector, if equipped.4. Remove the airbag module nuts (2). Note the airbag module and harness routing for re-installation.5. Remove the airbag from the chute. Refer to <u>Front Seat Outboard Seat Back Airbag Replacement</u>6. Remove the seat back cushion cover, pad and airbag from the seat cushion frame as an assembly.7. Remove the side inflatable module from the pocket, inside the trim cover.
2	<p>Driver or Passenger Seat Side Inflatable Restraint Module Nut (Qty: 2)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 5.5 N.m (49 lb in)</p>
3	<p>Front Seat Back Cushion Pad</p> <p>Procedure</p> <ol style="list-style-type: none">1. Remove the hog rings from the seat back pad.2. Pull the cushion cover off of the pad.

DRIVER OR PASSENGER SEAT BACK CUSHION PAD WIRE REPLACEMENT (8-WAY-POWER)

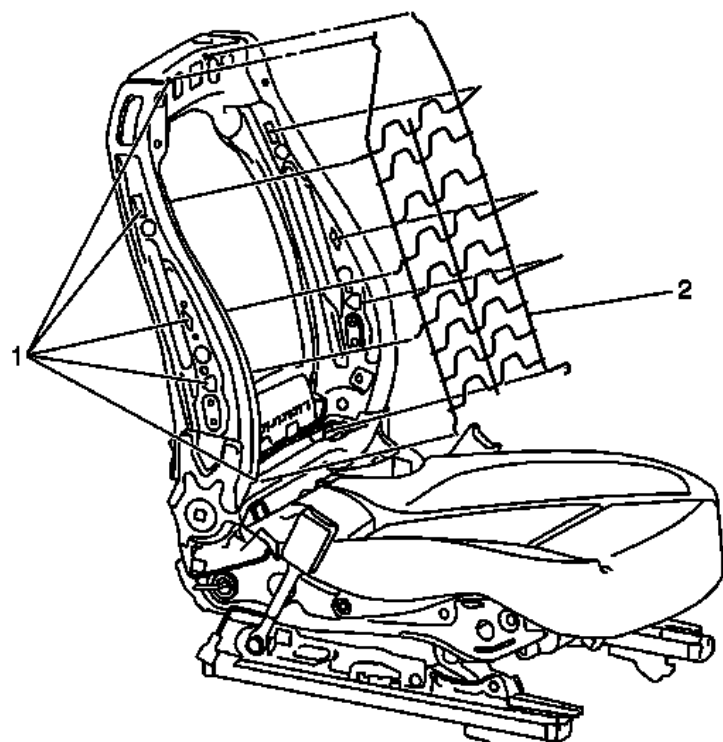


Fig. 37: Driver or Passenger Seat Back Cushion Pad Wire (8-Way-Power)
Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Back Cushion Pad Wire Replacement (8-Way-Power)

Callout	Component Name
Preliminary Procedures	
WARNING: Refer to <u>SIR Warning</u> .	
1. Disable the SIR System.	
2. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
3. Remove the front seat lumbar support. Refer to <u>Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Electric Lumbar)</u> , <u>Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Manual Lumbar)</u> .	
1	Front Seat Back Cushion Pad Wire Retainer (Qty: 10)
2	Front Seat Back Cushion Pad Wire

DRIVER OR PASSENGER SEAT BACK CUSHION FRAME REPLACEMENT (6-WAY HYBRID)

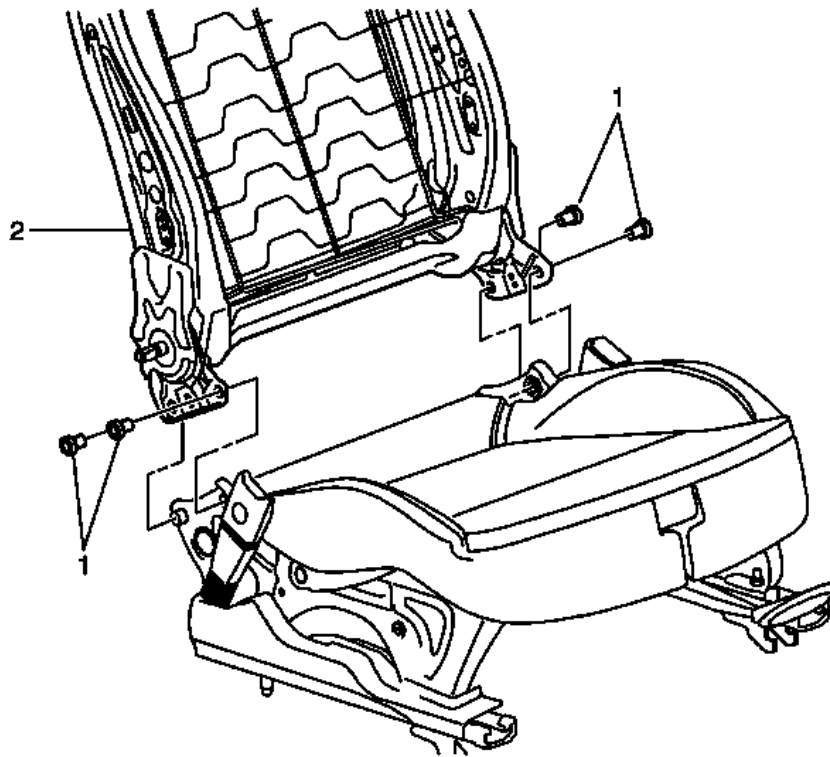


Fig. 38: Driver Or Passenger Seat Back Cushion Frame & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Back Cushion Frame Replacement (6-Way Hybrid)

Callout	Component Name
Preliminary Procedures	
1.	Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .
2.	Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u> .
3.	Remove the front seat recliner lever. Refer to <u>Driver or Passenger Seat Recliner Lever Replacement</u> .
4.	Remove the front seat outer adjuster finish cover. Refer to <u>Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)</u> .
5.	Remove the driver or passenger seat inner recliner finish cover. Refer to <u>Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u> .
6.	Remove the front seat head restraint guide bezel. Refer to <u>Front Seat Head Restraint Guide Bezel Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u> .
7.	Remove the front seat head restraint. Refer to <u>Driver or Passenger Seat Head Restraint Replacement (without AHS)</u> .
8.	Remove the front seat head restraint adjust rod guide. Refer to <u>Front Seat Head Restraint Guide Replacement</u> .

9. Remove the front seat back cushion pad. Refer to <u>Front Seat Back Pad Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)</u> .	
10. Remove the front seat lumbar support. Refer to <u>Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Electric Lumbar)</u> , <u>Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Manual Lumbar)</u> .	
1	Front Seat Back Frame Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 20 N.m (15 lb ft)
2	Driver or Passenger Seat Back Cushion Frame

DRIVER OR PASSENGER SEAT BACK CUSHION FRAME REPLACEMENT (2/4-WAY)

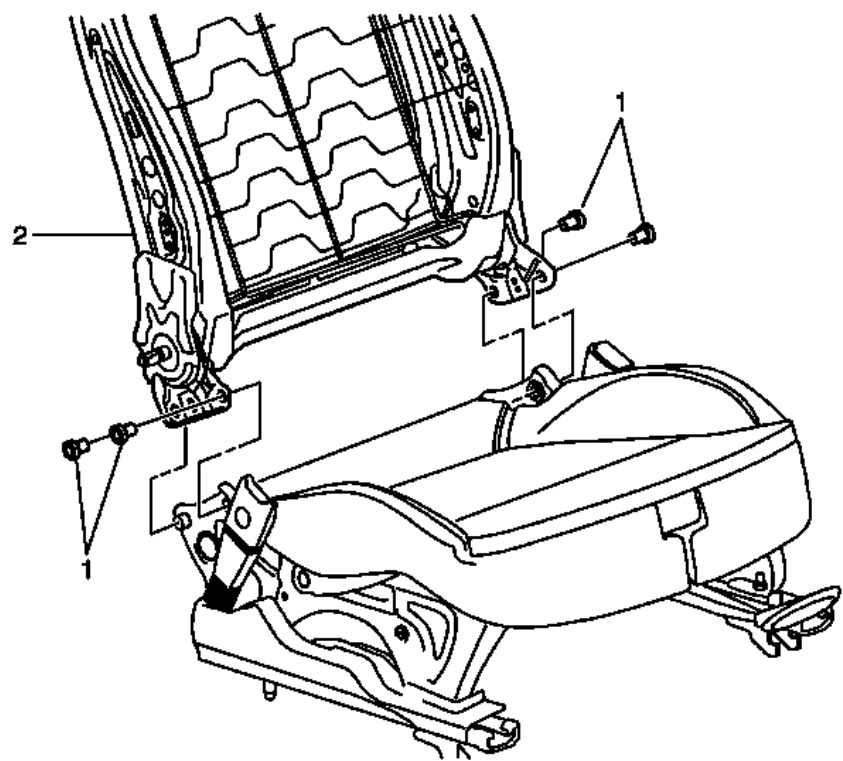


Fig. 39: Driver Or Passenger Seat Back Cushion Frame & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Back Cushion Frame Replacement (2/4-Way)

Callout	Component Name
Preliminary Procedures	

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the driver or passenger seat. Refer to **Driver or Passenger Seat Removal and Installation**.
3. Remove the front seat recliner lever. Refer to **Driver or Passenger Seat Recliner Lever Replacement**.
4. Remove the front seat outer adjuster finish cover. Refer to **Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)**.
5. Remove the driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)**.
6. Remove the front seat head restraint guide bezel. Refer to **Front Seat Head Restraint Guide Bezel Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)**.
7. Remove the front seat head restraint. Refer to **Driver or Passenger Seat Head Restraint Replacement (without AHS)**.
8. Remove the front seat head restraint adjust rod guide. Refer to **Front Seat Head Restraint Guide Replacement**.
9. Remove the front seat back cushion pad. Refer to **Front Seat Back Pad Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)**.
10. Remove front seat lumbar support. Refer to **Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Electric Lumbar)**, **Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Manual Lumbar)**.

1	<p>Front Seat Back Frame Fastener (Qty: 4)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 20 N.m (15 lb ft)</p>
2	Driver or Passenger Seat Back Cushion Frame

DRIVER OR PASSENGER SEAT BACK CUSHION FRAME REPLACEMENT (8-WAY POWER)

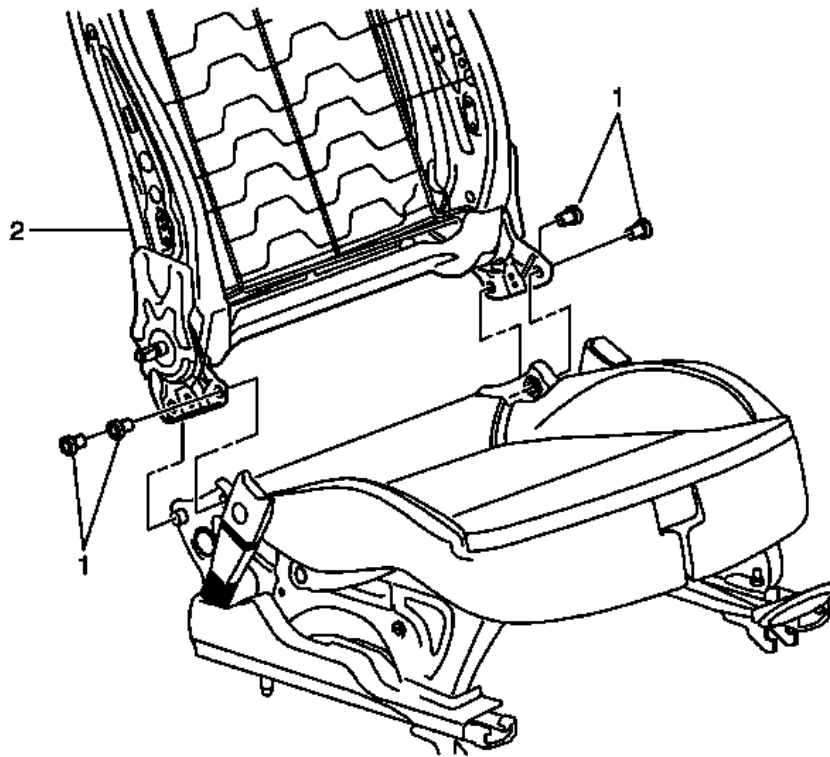
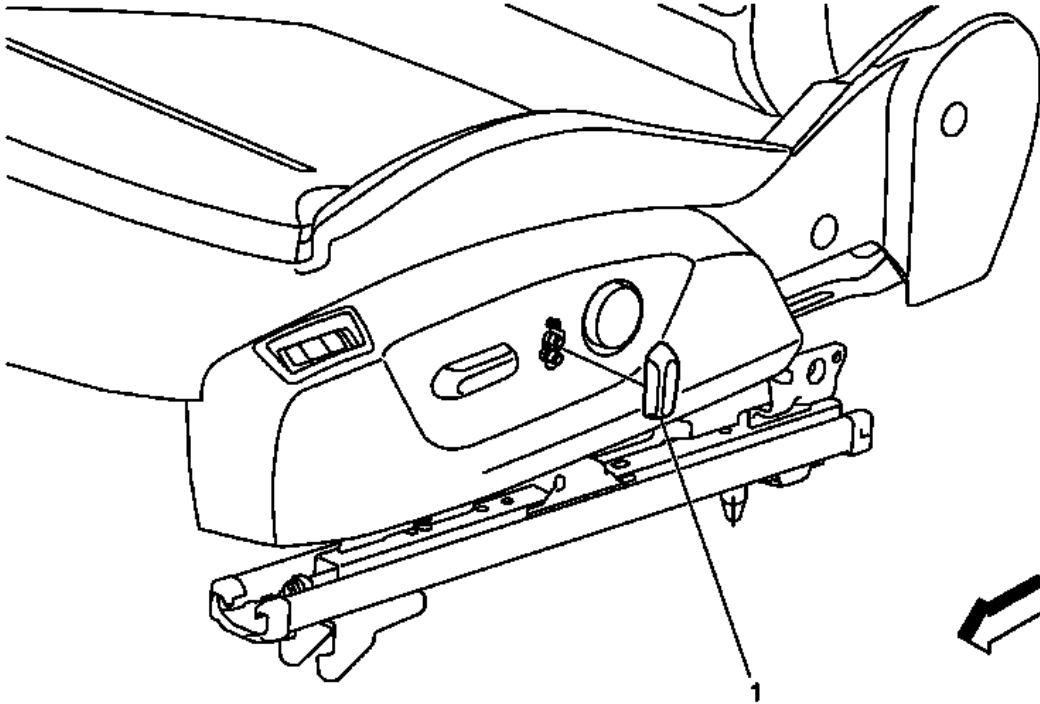


Fig. 40: Driver Or Passenger Seat Back Cushion Frame & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Back Cushion Frame Replacement (8-Way Power)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the front seat back cushion pad. Refer to <u>Front Seat Back Pad Replacement (8-Way Power)</u>. 2. Remove the front seat lumbar support. Refer to <u>Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Electric Lumbar)</u>, <u>Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Manual Lumbar)</u>. 3. Remove the front seat back cushion pad wire. Refer to <u>Driver or Passenger Seat Back Cushion Pad Wire Replacement (8-Way-Power)</u>. 4. Remove the front seat recliner actuator motor. Refer to <u>Front Seat Recliner Actuator Motor Replacement (Driver or Passenger Seat 8-Way Power)</u>. 	
1	Driver or Passenger Seat Back Frame Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 N.m (26 lb ft)

FRONT SEAT RECLINER KNOB REPLACEMENT (8-WAY-POWER - LOWER)**Fig. 41: Front Seat Recliner Knob**

Courtesy of GENERAL MOTORS COMPANY

Front Seat Recliner Knob Replacement (8-Way-Power - Lower)

Callout	Component Name
1	Front Seat Recliner Knob TIP: Use a small flat-bladed tool for clip out the knob.

FRONT SEAT RECLINER CONTROL REPLACEMENT (DRIVER OR PASSENGER SEAT 2 AND 4-WAY)

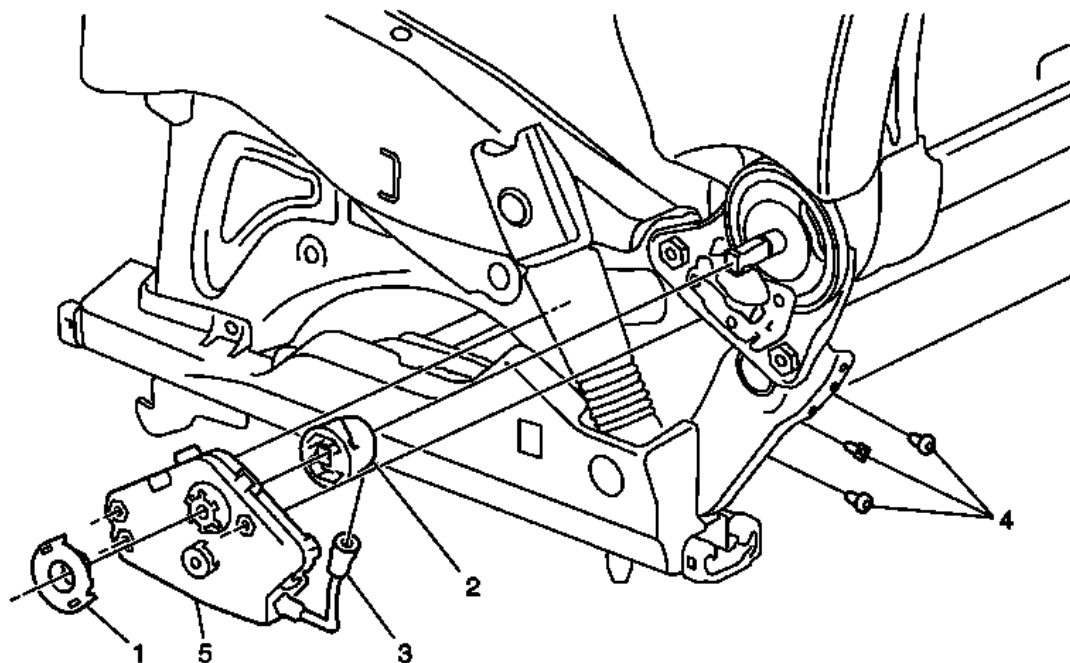


Fig. 42: Front Seat Recliner Control Components (Driver Or Passenger Seat)
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Recliner Control Replacement (Driver or Passenger Seat 2 and 4-Way)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. SIR disabling and enabling. Refer to <u>SIR Disabling and Enabling</u> . 2. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> 3. Remove the driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u>. 4. Remove the driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)</u>. 	
1	Securing Recliner Control Shaft
2	Retainer Recliner Control Shaft
3	Bowden Cable Recliner Control
4	Front Seat Recliner Control Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten

	20 N.m (15 lb ft)
5	Front Seat Recliner Control

DRIVER OR PASSENGER SEAT RECLINER LEVER REPLACEMENT

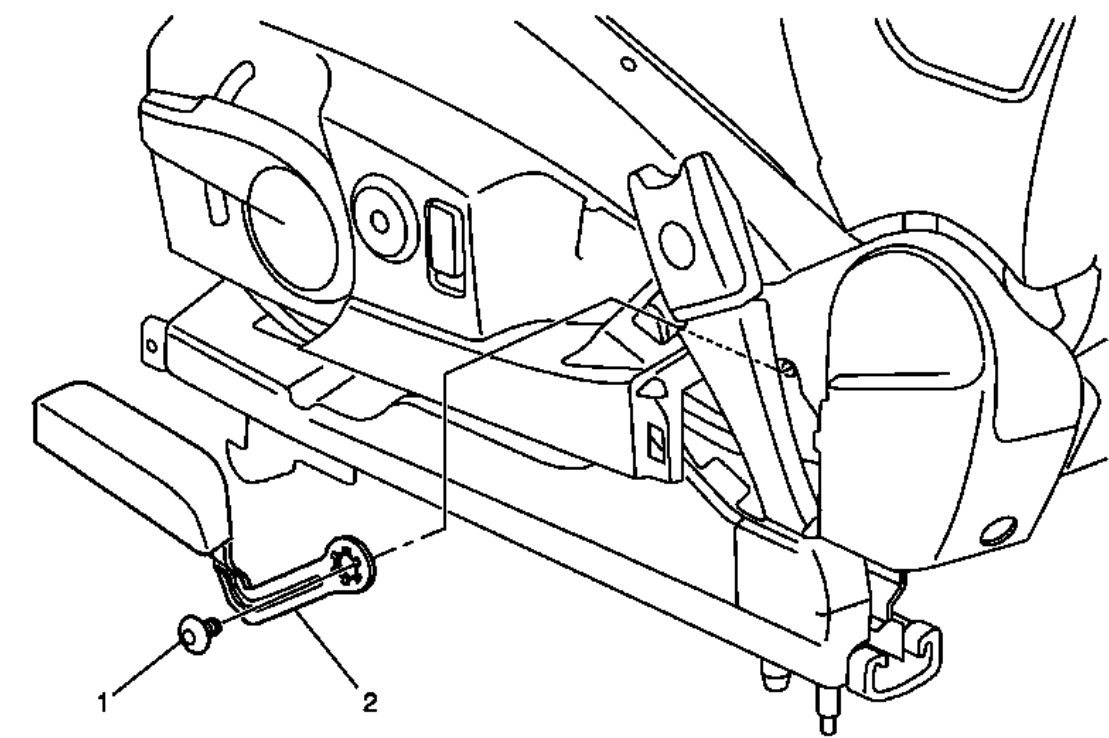


Fig. 43: Driver Or Passenger Seat Recliner Lever & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Recliner Lever Replacement

Callout	Component Name
Preliminary Procedure Remove front seat outer adjuster finish cover. Refer to <u>Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)</u> .	
1	Driver or Passenger Seat Recliner Lever Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 20 N.m (15 lb ft)
2	Driver or Passenger Seat Recliner Lever

DRIVER OR PASSENGER SEAT LUMBAR SUPPORT REPLACEMENT (DRIVER/PASSENGER

SEAT ELECTRIC LUMBAR)

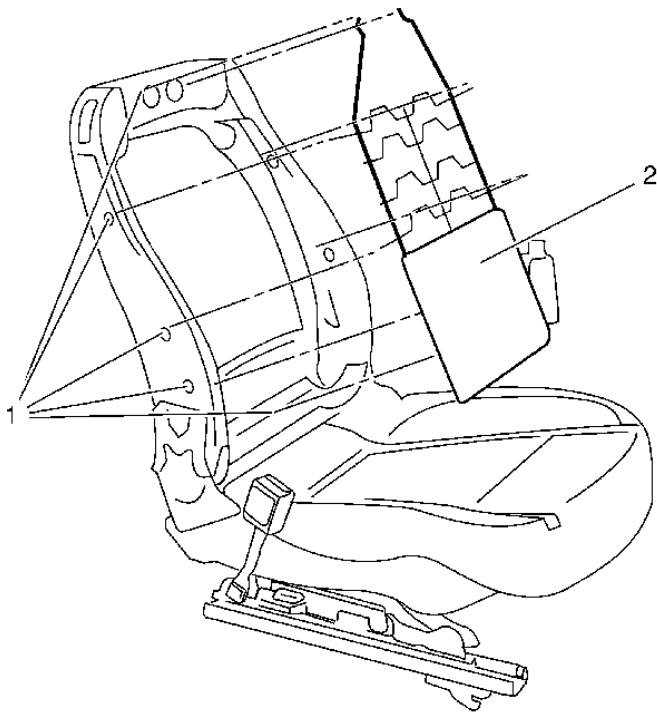


Fig. 44: Driver Or Passenger Seat Lumbar Support (Driver/Passenger Seat Electric Lumbar)
Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Electric Lumbar)

Callout	Component Name
Preliminary Procedures	
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .	
2. Remove driver or passenger seat. Refer to Driver or Passenger Seat Removal and Installation .	
3. Remove the front seat back cushion pad. Refer to Front Seat Back Pad Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport), Front Seat Back Pad Replacement (8-Way Power) .	
	Front Seat Lumbar Support Retainer (Qty: 10)
	Procedure
1	1. Release the lumbar pump. 2. Disconnect the wiring harness connector from the lumbar pump. 3. Disconnect the wiring harness connector from the lumbar distributor. 4. Disconnect the wiring harness connector from the vent fan. 5. Cut cable straps.

	6. Release the lumbar at backrest frame.
	7. Remove lumbar assembly from backrest.
2	Front Seat Lumbar Support

DRIVER OR PASSENGER SEAT LUMBAR SUPPORT REPLACEMENT (DRIVER/PASSENGER SEAT MANUAL LUMBAR)

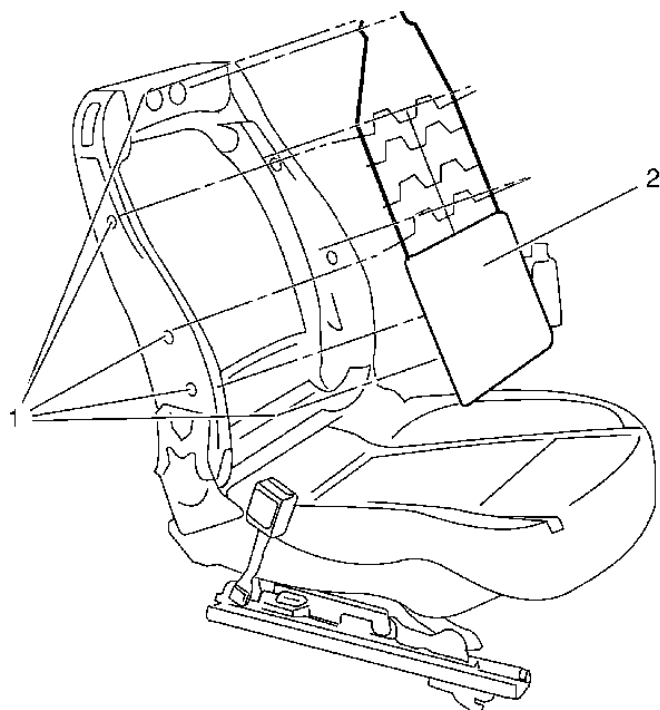


Fig. 45: Driver Or Passenger Seat Lumbar Support (Driver/Passenger Seat Electric Lumbar)
Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Lumbar Support Replacement (Driver/Passenger Seat Manual Lumbar)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Remove driver or passenger seat. Refer to <u>Driver or Passenger Seat Removal and Installation</u>. 3. Remove the front seat back cushion pad. Refer to <u>Front Seat Back Pad Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport), Front Seat Back Pad Replacement (8-Way Power)</u>. 	
	Front Seat Lumbar Support Retainer (Qty: 10)
Procedure	
<ol style="list-style-type: none"> 1. Release the lumbar pump. 	

1	<ol style="list-style-type: none"> 2. Disconnect the wiring harness connector from the lumbar pump. 3. Disconnect the wiring harness connector from the lumbar distributor. 4. Disconnect the wiring harness connector from the vent fan. 5. Cut cable straps. 6. Release the lumbar at backrest frame. 7. Remove lumbar assembly from backrest.
2	Front Seat Lumbar Support

REAR SEAT ARMREST MULTIFUNCTION COMPARTMENT ARMREST REPLACEMENT

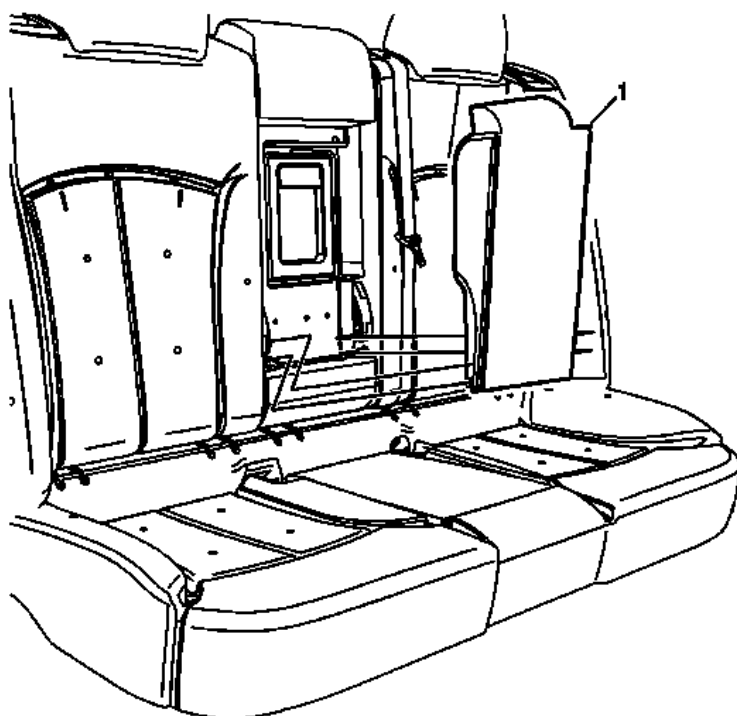


Fig. 46: Rear Seat Armrest Multifunction Compartment Armrest
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Armrest Multifunction Compartment Armrest Replacement

Callout	Component Name
1	<p>Rear Seat Armrest Multifunction Compartment.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disengage the pass through door assembly, if equipped. 2. Remove the armrest hinges from the rear seat back cushion panel.

REAR SEAT HEAD RESTRAINT REPLACEMENT

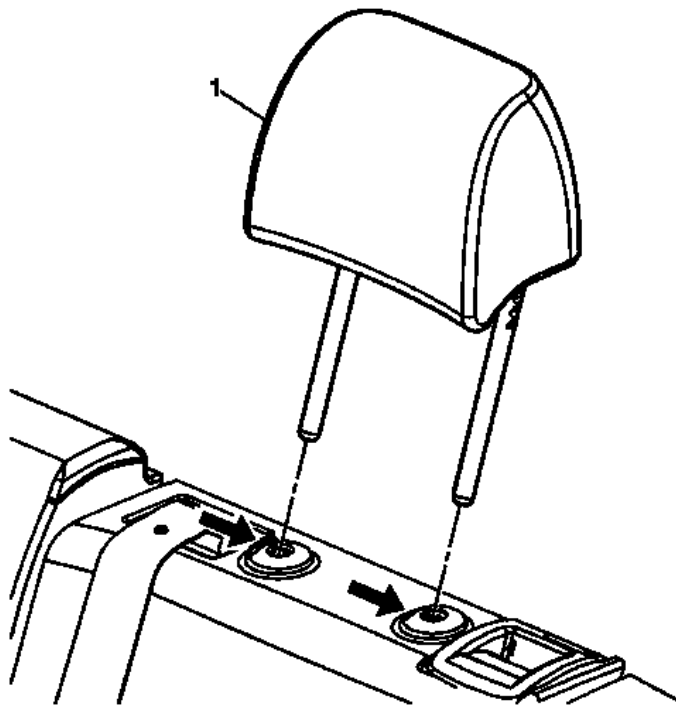


Fig. 47: Rear Seat Head Restraint
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Head Restraint Replacement

Callout	Component Name
1	Rear Seat Head Restraint Procedure <ol style="list-style-type: none"> 1. Tilt the seat forward to gain space between the head restraint and the roof. 2. Depress the large button on the head restraint guide and raise the head restraint to the full up position. 3. Depress the small button on the opposite head restraint guide and pull upward to remove from the seat.

REAR SEAT HEAD RESTRAINT GUIDE REPLACEMENT

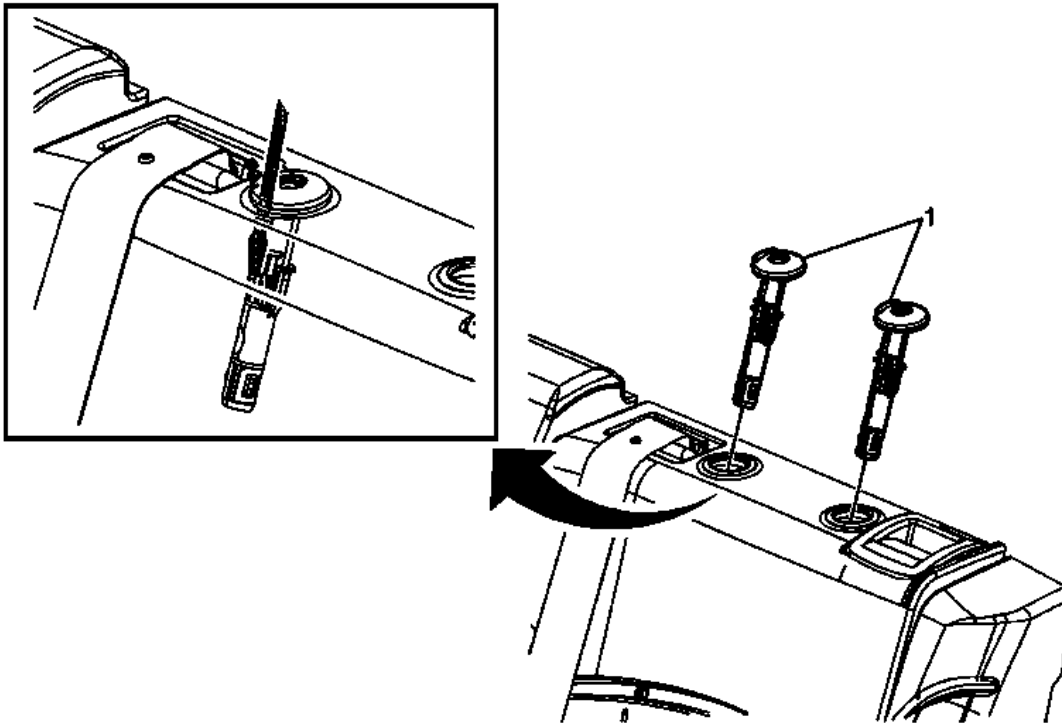


Fig. 48: Rear Seat Head Restraint Guide
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Head Restraint Guide Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear seat head restraint. Refer to <u>Rear Seat Head Restraint Replacement</u>.	
1	Rear Seat Head Restraint Guide Procedure Using a suitable flat-bladed tool, slide the tool between the cushion and the guide until you find the slot on the outboard side of the guide. Push inward on the guide slot tab , while pulling upward to remove the guide from the seat back frame.

REAR SEAT BACK BOLSTER REPLACEMENT

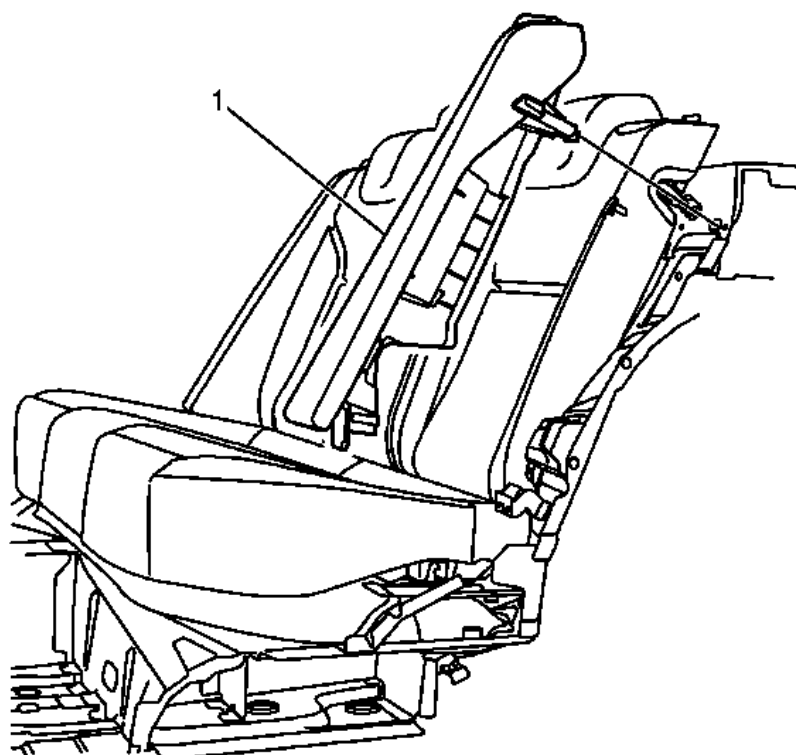


Fig. 49: Rear Seat Back Cushion Bolster
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Bolster Replacement

Callout	Component Name
1	<p>Rear Seat Back Cushion Bolster</p> <p>WARNING: Refer to <u>SIR Warning</u> .</p> <p>WARNING: Do not repair or replace the seat stitching or seams in the seat back trim cover with an internal mounted seat side airbag module. Replace the complete seat back trim cover from the OEM. Non-OEM seat stitching may cause improper airbag deployment which could result in personal injury.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u> 2. Pull the upper seat back cushion bolster forward. <p>NOTE: If equipped, fold rear seat back cushion down to gain better access to back of bolster. Use a flat bladed short screw driver to aid in releasing the retainer from the bolster's retaining bar.</p>

3. Pull the seat back cushion bolster up.
4. Disconnect the electrical connector.
5. Remove rear seat back cushion bolster.
6. Remove the rear seat side inflatable module. Refer to **Rear Seat Outboard Seat Back Airbag Replacement** .

REAR SEAT CUSHION FRAME RETAINER REPLACEMENT

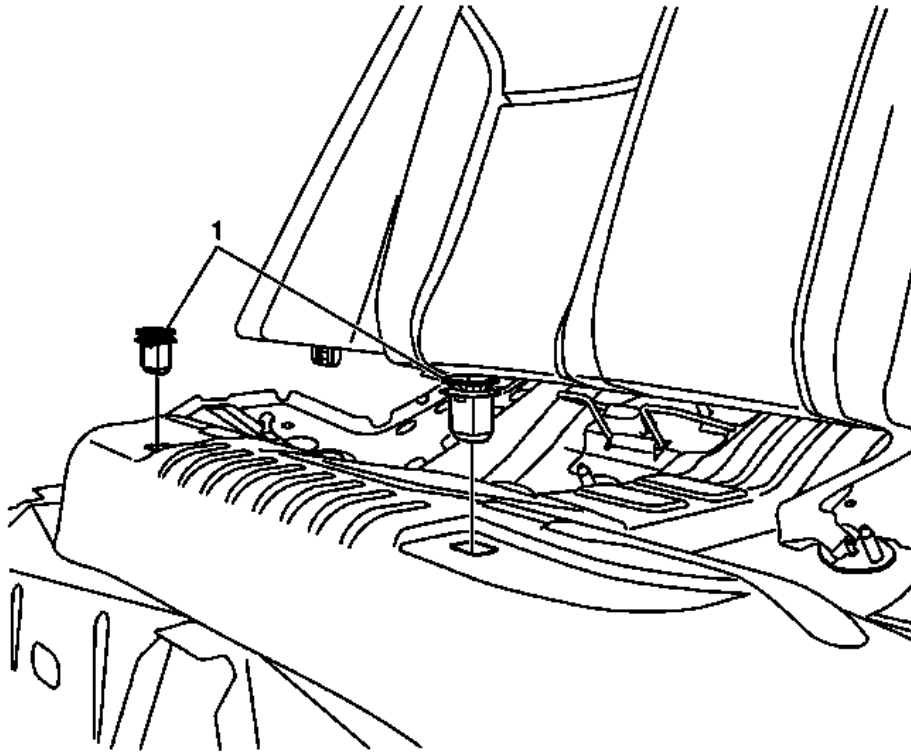


Fig. 50: Rear Seat Cushion Frame Retainers
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Cushion Frame Retainer Replacement

Callout	Component Name
Preliminary Procedure Remove rear seat cushion. Refer to <u>Rear Seat Cushion Removal and Installation</u> .	
1	Rear Seat Cushion Frame Retainer Procedure Using a suitable flat-bladed tool, remove the rear seat cushion frame retainer.

REAR SEAT BACK CUSHION PIVOT SUPPORT REPLACEMENT

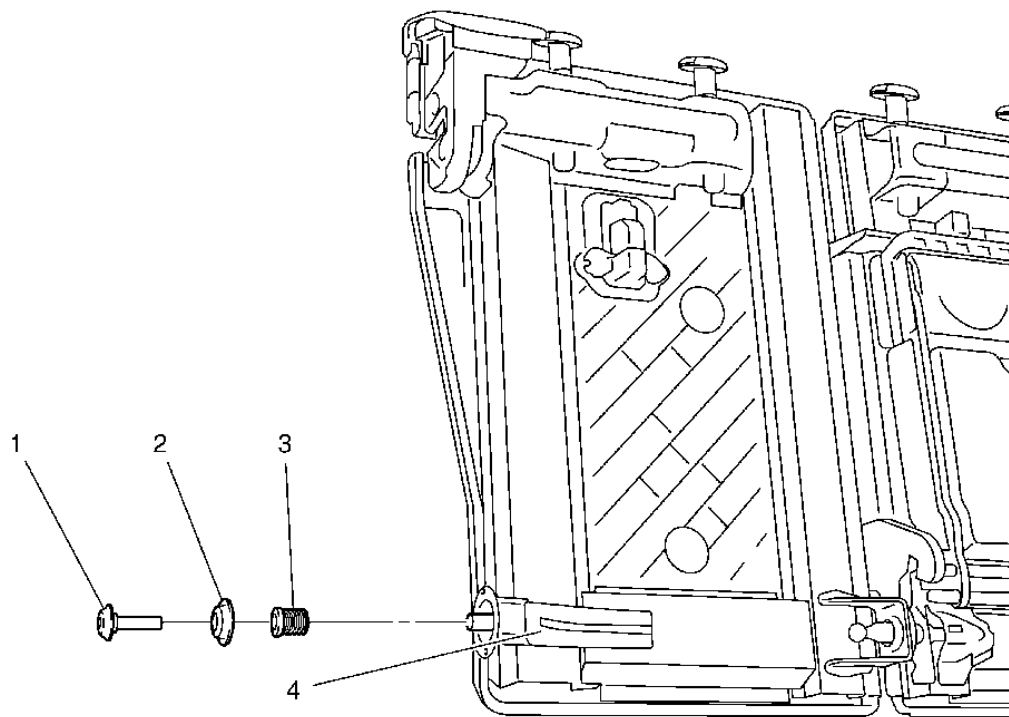


Fig. 51: Rear Seat Back Cushion Pivot Support, Housing, Spring & Bolt
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Pivot Support Replacement

Callout	Component Name
Preliminary Procedure Remove the rear seat back cushion. Refer to <u>Rear Seat Back Cushion Removal and Installation (60% Side)</u> , <u>Rear Seat Back Cushion Removal and Installation (40% Side)</u> .	
1	Rear Seat Back Outer Pivot Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 20 N.m (15 lb ft)
2	Rear Seat Back Cushion Pivot Support
3	Rear Seat Back Cushion Outer Pivot Bolt Spring
4	Rear Seat Back Cushion Pivot Support Housing

REAR SEAT CUSHION COVER AND PAD REPLACEMENT

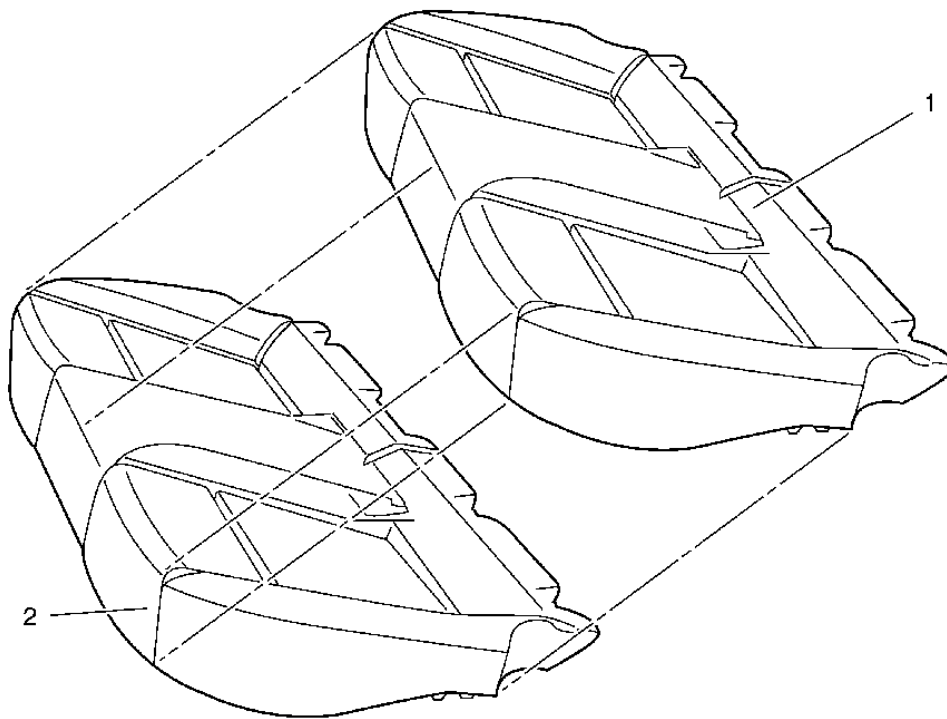


Fig. 52: Rear Seat Cushion Cover And Pad
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Cushion Cover and Pad Replacement

Callout	Component Name
Preliminary Procedure Remove rear seat cushion. Refer to <u>Rear Seat Cushion Removal and Installation.</u>	
1	Rear Seat Cushion Cover Procedure Remove the hog rings that secure the rear seat cushion cover to the pad. TIP: When installing the rear seat cushion cover, pull the cover tightly in all corners to ensure that no creasing occurs.
2	Rear Seat Cushion Pad

REAR SEAT CUSHION REMOVAL AND INSTALLATION

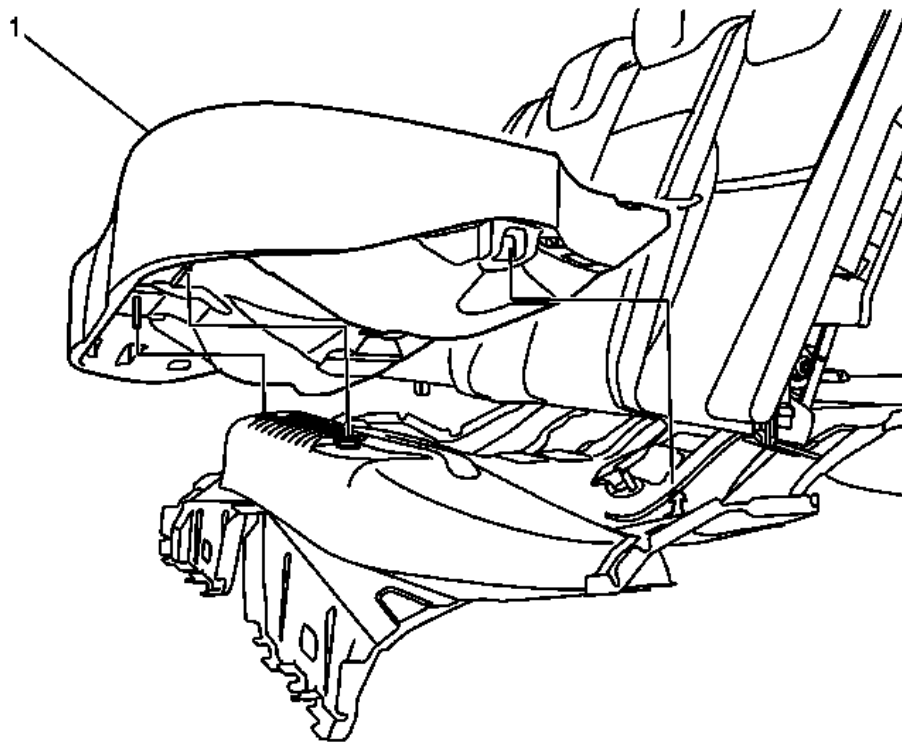


Fig. 53: Rear Seat Cushion

Courtesy of GENERAL MOTORS COMPANY

Rear Seat Cushion Removal and Installation

Callout	Component Name
1	<p>Rear Seat Cushion</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Pull up on the front of the rear seat to disengage the retainers. 2. Pull out the rear seat of the rear retainer. 3. Remove the rear seat center shoulder belt anchor fastener and route the belt through the seat bottom. 4. Remove the rear seat .

REAR SEAT LATCH REPLACEMENT

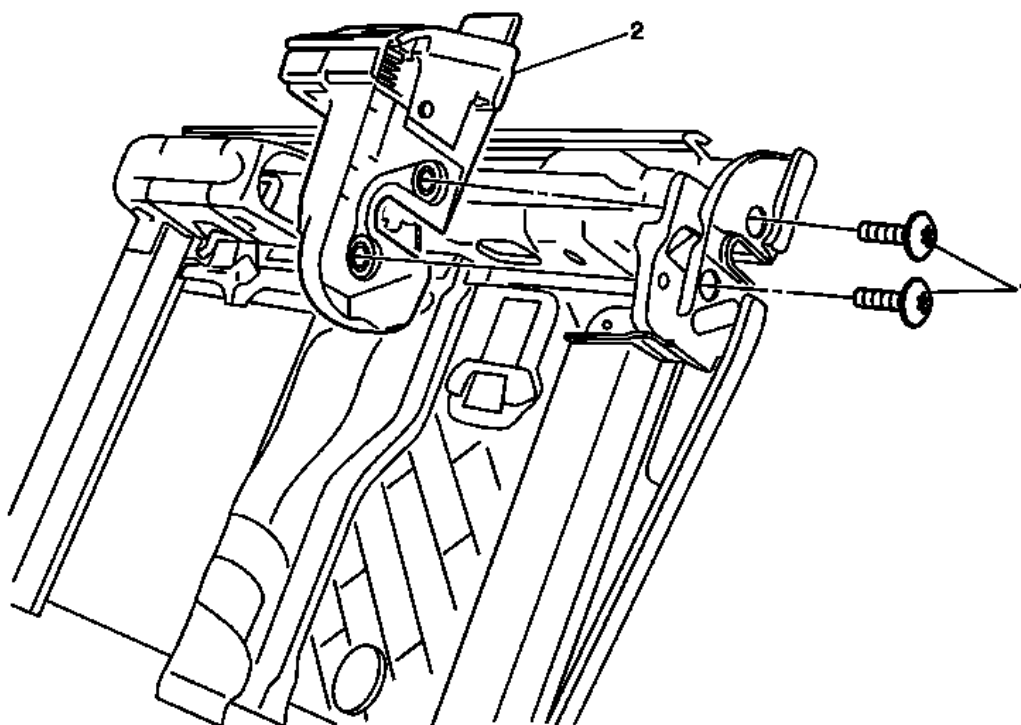


Fig. 54: Rear Seat Latch & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Latch Replacement

Callout	Component Name
Preliminary Procedure Remove the rear seat back cushion cover and pad. Refer to <u>Rear Seat Back Cushion Cover and Pad Replacement (60% Side)</u> , <u>Rear Seat Back Cushion Cover and Pad Replacement (40% Side)</u> .	
1	Rear Seat Latch Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 45 N.m (33 lb ft)
2	Rear Seat Latch

REAR SEAT BACK CUSHION REMOVAL AND INSTALLATION (60% SIDE)

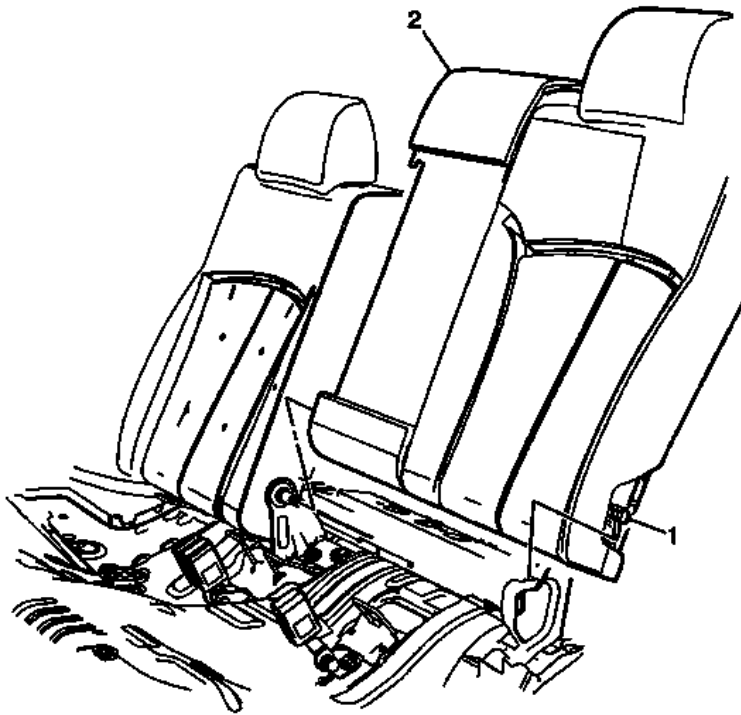


Fig. 55: Rear Seat Back Cushion (60% Side)
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Removal and Installation (60% Side)

Callout	Component Name
Preliminary Procedure	
1. Remove the rear seat cushion. Refer to <u>Rear Seat Cushion Removal and Installation</u> . 2. Remove the rear seat center retractor side belt lower fastener. Refer to <u>Rear Seat Center Retractor Side Belt Replacement</u> .	
1	Rear Seat Back Cushion Pivot Support Procedure <ol style="list-style-type: none"> 1. Pull the rear seat back cushion latch release located on the top of the rear seat back cushion, and fold the rear seat back cushion forward. 2. Push in on the rear seat back cushion pivot support, and release from bracket.
2	Rear Seat Back Cushion Procedure <ol style="list-style-type: none"> 1. Pull up on the outer side of the rear seat back cushion and remove the rear seat back cushion from the bracket and hinge. 2. Transfer components as necessary.

REAR SEAT BACK CUSHION REMOVAL AND INSTALLATION (40% SIDE)

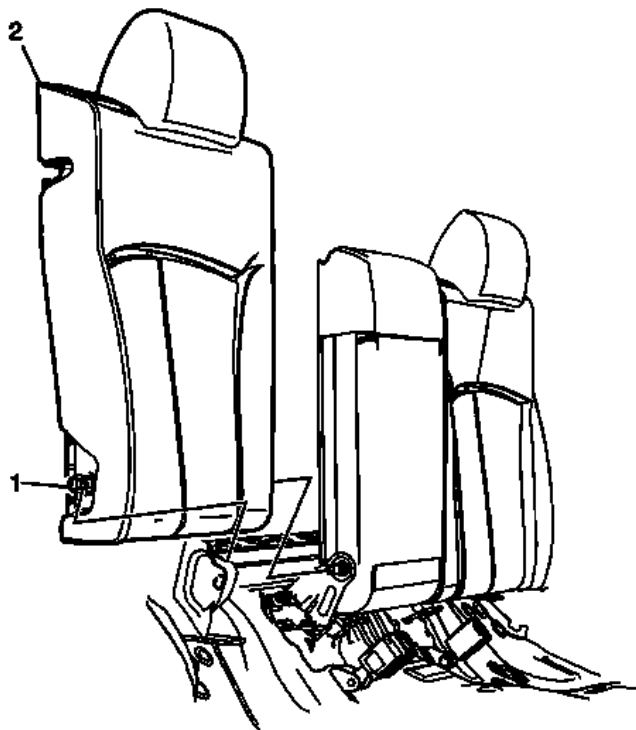


Fig. 56: Rear Seat Back Cushion (40% Side)
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Removal and Installation (40% Side)

Callout	Component Name
1	Rear Seat Back Cushion Pivot Support
	Procedure <ol style="list-style-type: none">1. Pull the rear seat back cushion latch release located on the top of the rear seat back cushion, and fold the rear seat back cushion forward.2. Push in on the rear seat back cushion pivot support, and release from bracket.
2	Rear Seat Back Cushion
	Procedure <ol style="list-style-type: none">1. Pull up on the outer side of the rear seat back cushion and remove the rear seat back cushion from the bracket and hinge.2. Transfer components as necessary.

REAR SEAT BELT OPENING COVER REPLACEMENT

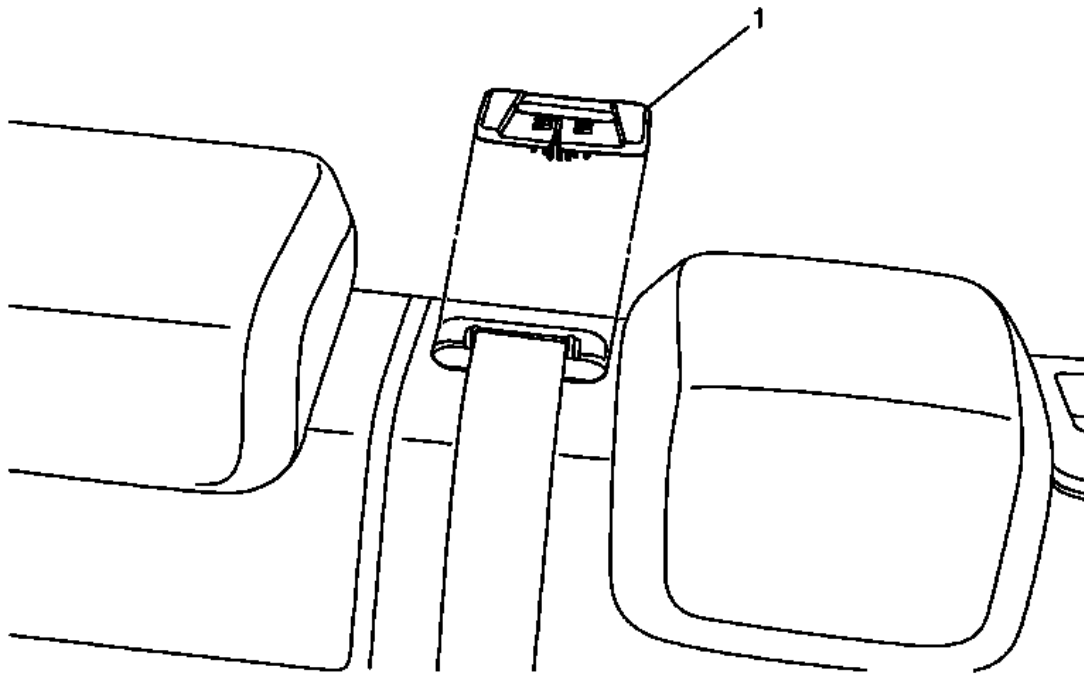


Fig. 57: Rear Seat Shoulder Belt Opening Cover
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Belt Opening Cover Replacement

Callout	Component Name
1	Rear Seat Back Shoulder Belt Opening Cover Procedure Remove the rear seat back shoulder belt opening cover using a suitable flat-bladed tool.

REAR SEAT BELT GUIDE TRIM COVER REPLACEMENT

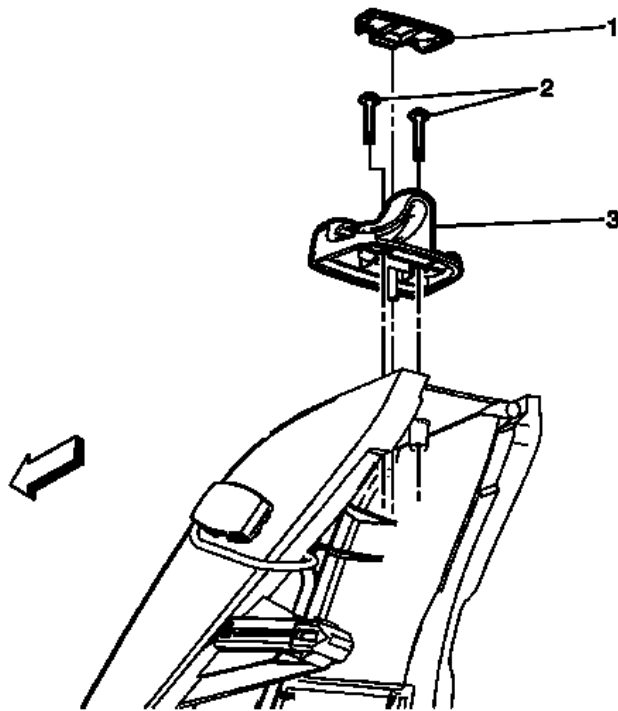


Fig. 58: Rear Seat Belt Guide Trim Cover & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Belt Guide Trim Cover Replacement

Callout	Component Name
1	Rear Seat Belt Guide Trim Cover
2	Rear Seat Belt Guide Trim Cover Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .
3	Rear Seat Belt Guide

REAR SEAT BACK CUSHION PANEL REPLACEMENT (40% SIDE)

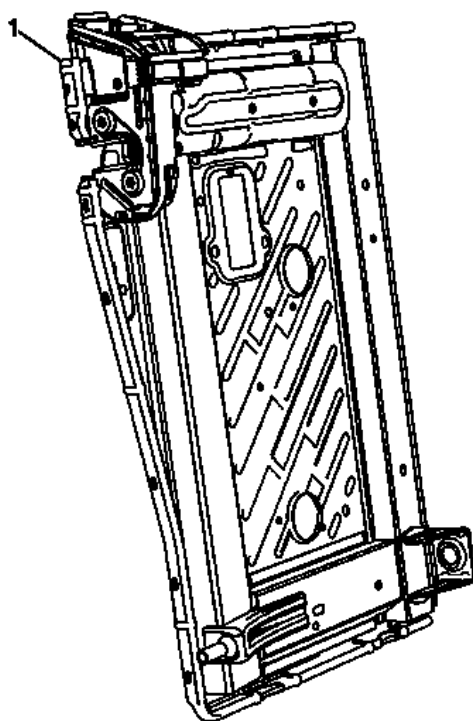


Fig. 59: Rear Seat Back Cushion Panel (40% Side)
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Panel Replacement (40% Side)

Callout	Component Name
Preliminary Procedures	
1. Remove the rear seat back cushion cover and pad. Refer to <u>Rear Seat Back Cushion Cover and Pad Replacement (40% Side)</u> . 2. Remove the rear seat back cushion pivot support. Refer to <u>Rear Seat Back Cushion Pivot Support Replacement</u> . 3. Remove the rear seat latch. Refer to <u>Rear Seat Latch Replacement</u> .	
1	Rear Seat Back Cushion Panel Procedure If replacing the seat back panel, transfer components as necessary.

REAR SEAT BACK CUSHION PANEL REPLACEMENT (60% SIDE)

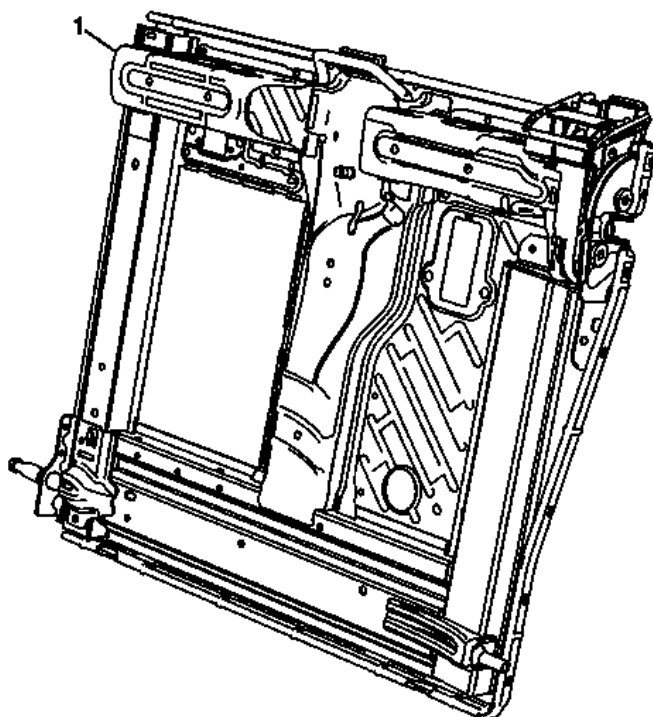


Fig. 60: Rear Seat Back Cushion Panel (60% Side)
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Panel Replacement (60% Side)

Callout	Component Name
Preliminary Procedures	
1. Remove the rear seat armrest multifunction compartment. Refer to <u>Rear Seat Armrest Multifunction Compartment Armrest Replacement</u> . 2. Remove the rear seat back cushion cover and pad. Refer to <u>Rear Seat Back Cushion Cover and Pad Replacement (60% Side)</u> . 3. Remove the rear seat back cushion pivot support. Refer to <u>Rear Seat Back Cushion Pivot Support Replacement</u> . 4. Remove the rear seat center retractor side belt. Refer to <u>Rear Seat Center Retractor Side Belt Replacement</u> . 5. Remove the rear seat latch. Refer to <u>Rear Seat Latch Replacement</u> .	
1	Rear Seat Back Cushion Panel Procedure If replacing the seat back panel, transfer components as necessary.

REAR SEAT BACK CUSHION CARPET REPLACEMENT (60% SIDE)

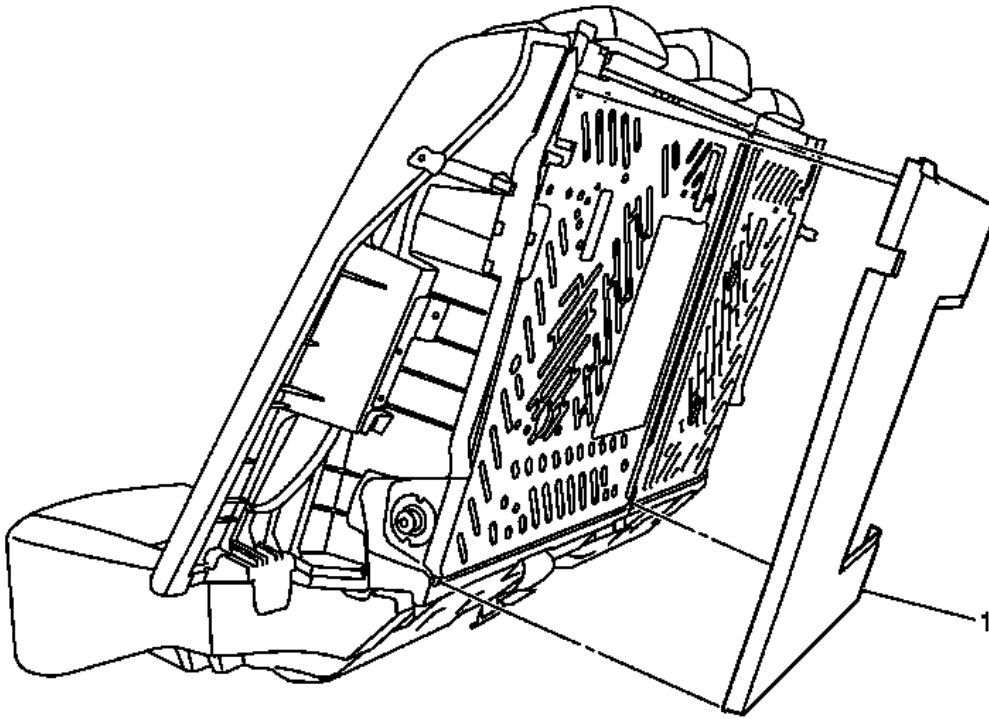


Fig. 61: Rear Seat Back Cushion Carpet (60% Side)
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Carpet Replacement (60% Side)

Callout	Component Name
	Rear Seat Back Cushion Carpet
1	Procedure <ol style="list-style-type: none"> 1. Fold the rear seat back cushion forward. 2. Disengage the j-channel retainers from the seat back cushion frame. 3. Disengage any retainers holding the carpet around the passthrough panel, if equipped. 4. Remove rear seat back cushion carpet.

REAR SEAT BACK CUSHION CARPET REPLACEMENT (40% SIDE)

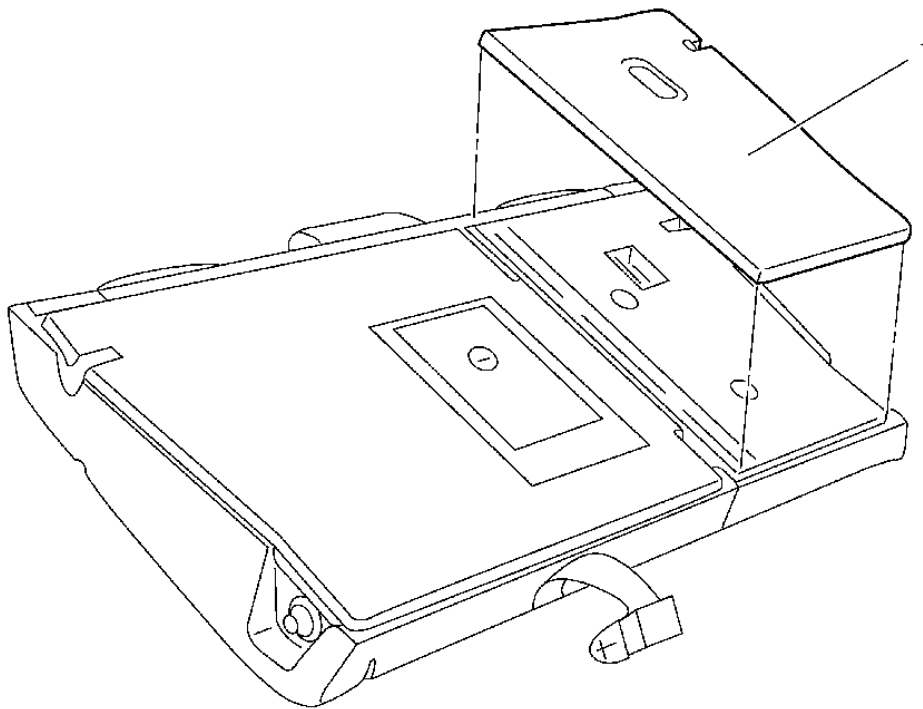


Fig. 62: Rear Seat Back Cushion Carpet (40% Side)
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Carpet Replacement (40% Side)

Callout	Component Name
1	<p>Rear Seat Back Cushion Carpet</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Fold rear seat back cushion forward. 2. Disengage the j-channel retainers from the seat back cushion frame. 3. Disengage any retainers holding the carpet around the passthrough panel, if equipped. 4. Remove rear seat back cushion carpet.

REAR SEAT BACK CUSHION COVER AND PAD REPLACEMENT (60% SIDE)

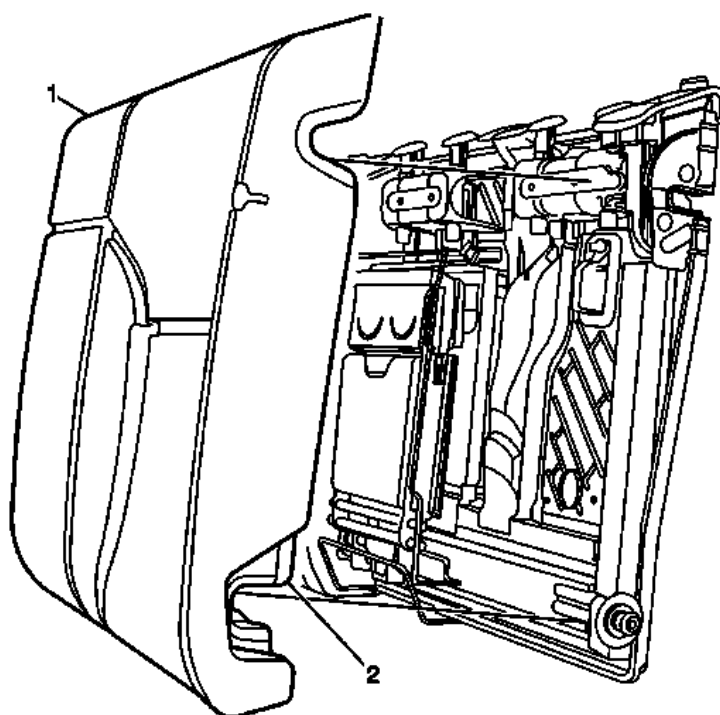


Fig. 63: Rear Seat Back Cushion Cover And Pad (60% Side)

Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Cover and Pad Replacement (60% Side)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the rear seat back cushion. Refer to <u>Rear Seat Back Cushion Removal and Installation (60% Side)</u>. 2. Remove the rear seat back armrest multifunction compartment. Refer to <u>Rear Seat Armrest Multifunction Compartment Armrest Replacement</u> 3. Remove the rear seat back cushion carpet. Refer to <u>Rear Seat Back Cushion Carpet Replacement (60% Side)</u>. 4. Remove the rear seat head restraint guides. Refer to <u>Rear Seat Head Restraint Guide Replacement</u>. 5. Remove the rear seat shoulder belt opening cover. Refer to <u>Rear Seat Belt Opening Cover Replacement</u>. 6. Remove the rear seat back cushion latch release handle. Refer to <u>Rear Seat Back Cushion Latch Release Handle Replacement</u>. 7. Remove the rear seat armrest frame bracket. 8. Remove the rear compartment access door. 	
1	Rear Seat Back Cushion Cover Procedure Remove the hook and loop fasteners that secure the rear seat back cushion cover to the pad.

REAR SEAT BACK CUSHION COVER AND PAD REPLACEMENT (40% SIDE)

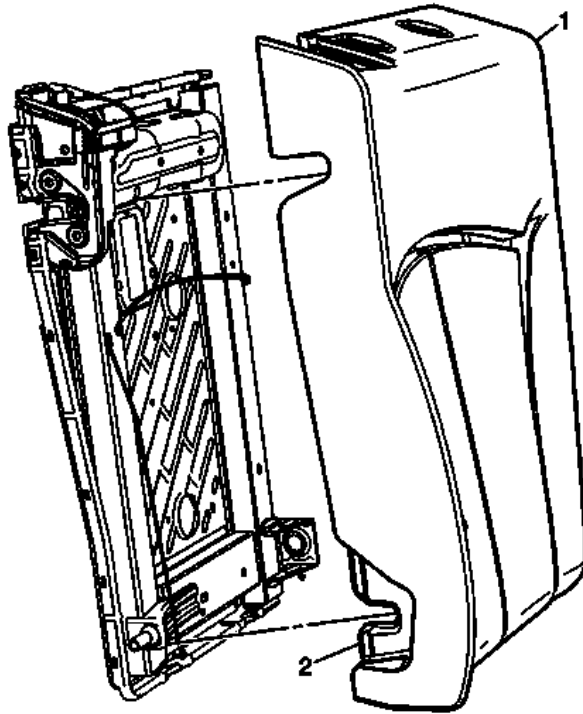


Fig. 64: Rear Seat Back Cushion Cover And Pad (40% Side)

Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Cover and Pad Replacement (40% Side)

Callout	Component Name
Preliminary Procedures	
1.	Remove the rear seat back cushion. Refer to <u>Rear Seat Back Cushion Removal and Installation (40% Side)</u> .
2.	Remove the rear seat back cushion carpet. Refer to <u>Rear Seat Back Cushion Carpet Replacement (40% Side)</u> .
3.	Remove the rear seat head restraint guides. Refer to <u>Rear Seat Head Restraint Guide Replacement</u> .
4.	Remove the rear seat back cushion latch release handle. Refer to <u>Rear Seat Back Cushion Latch Release Handle Replacement</u> .
1	Rear Seat Back Cushion Cover Procedure Remove the hook and loop fasteners that secure the rear seat back cushion cover to the pad.
2	Rear Seat Cushion Pad

REAR SEAT BACK CUSHION HINGE REPLACEMENT

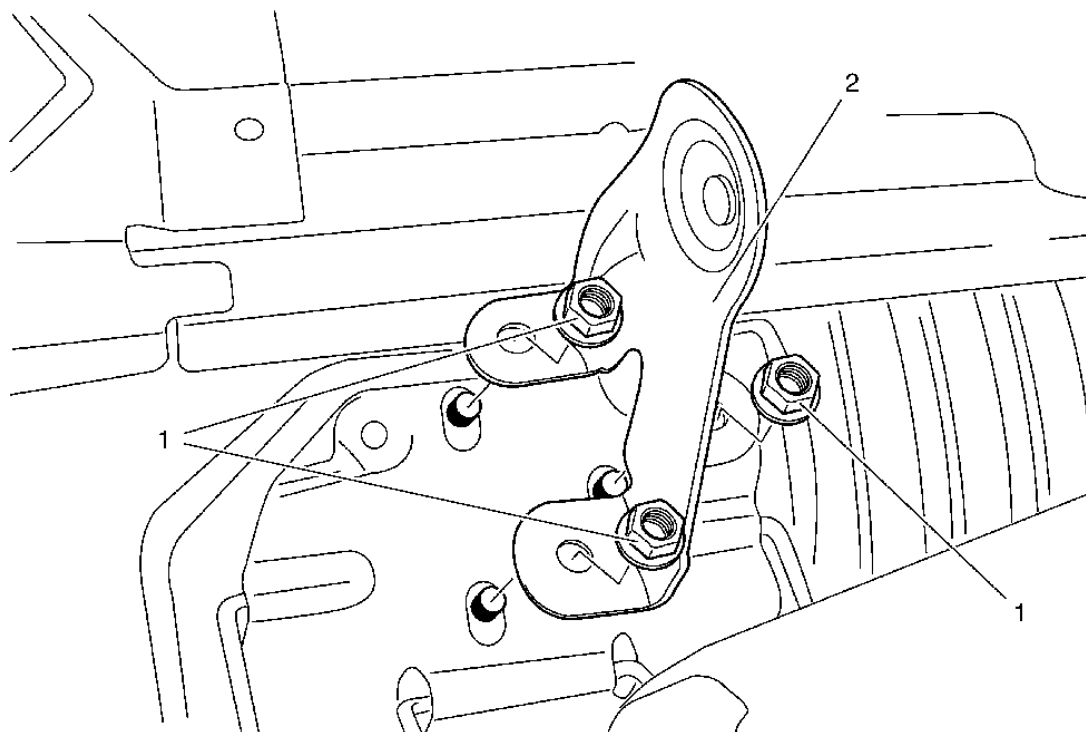


Fig. 65: Rear Seat Back Cushion Hinge & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Hinge Replacement

Callout	Component Name
Preliminary Procedure Remove both rear seat back cushions. Refer to <u>Rear Seat Back Cushion Removal and Installation (60% Side)</u> , <u>Rear Seat Back Cushion Removal and Installation (40% Side)</u> .	
1	Rear Seat Back Cushion Hinge Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 43 N.m (32 lb ft)
2	Rear Seat Back Cushion Hinge Procedure Detach the rear seat back cushion hinge from the guide pin.

REAR SEAT BACK CUSHION LATCH RELEASE HANDLE REPLACEMENT

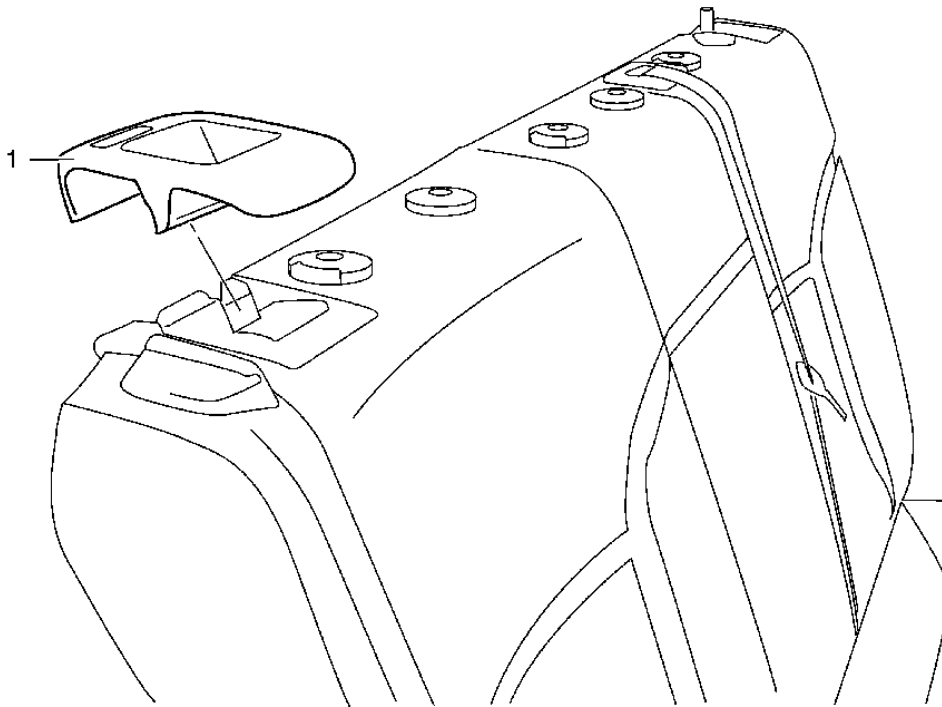


Fig. 66: Rear Seat Back Cushion Latch Release Handle
Courtesy of GENERAL MOTORS COMPANY

Rear Seat Back Cushion Latch Release Handle Replacement

Callout	Component Name
1	Rear Seat Back Cushion Latch Release Handle Procedure Release the rear seat back cushion latch release handle using a suitable flat-bladed tool.

ACCESSORIES & EQUIPMENT

Seat Heating and Seat Cooling

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Seat Heater Control Module to Seat Frame Screw	3.5 N.m	31 lb in

SCHEMATIC WIRING DIAGRAMS

HEATED/COOLED SEAT WIRING SCHEMATICS

Power, Ground, Serial Data and Controls (Except CZ2)

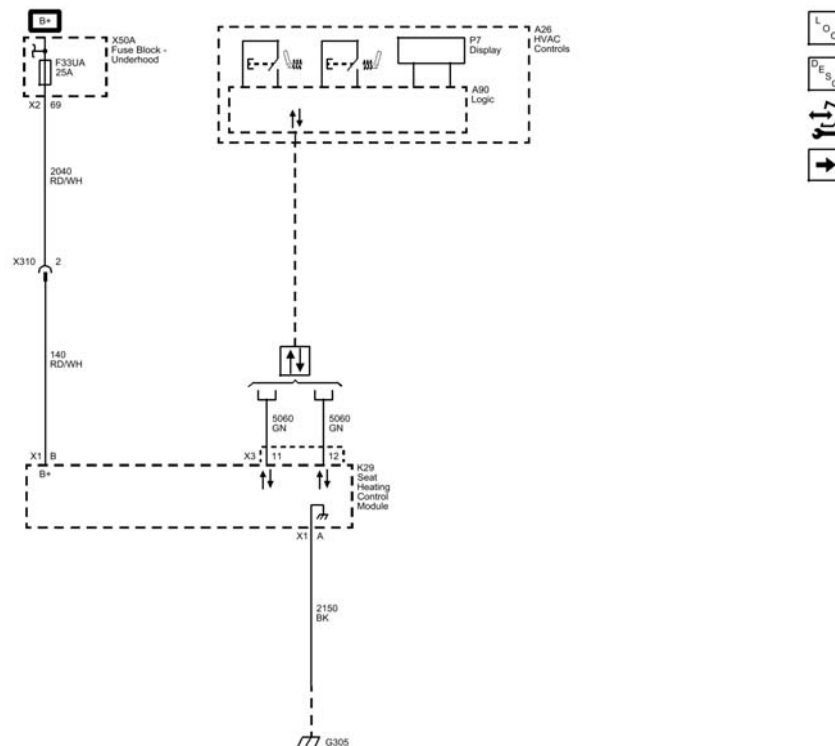


Fig. 1: Power, Ground, Serial Data and Controls (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Heating Elements (Except A45)

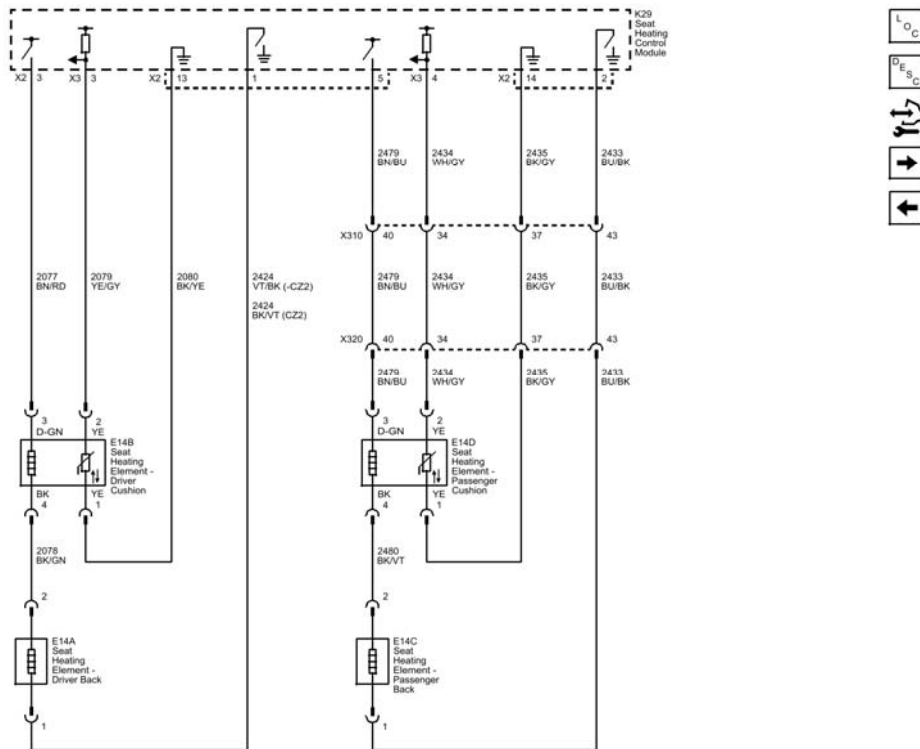


Fig. 2: Heating Elements (Except A45)
 Courtesy of GENERAL MOTORS COMPANY

Power, Ground, Serial Data, and Controls (CZ2)

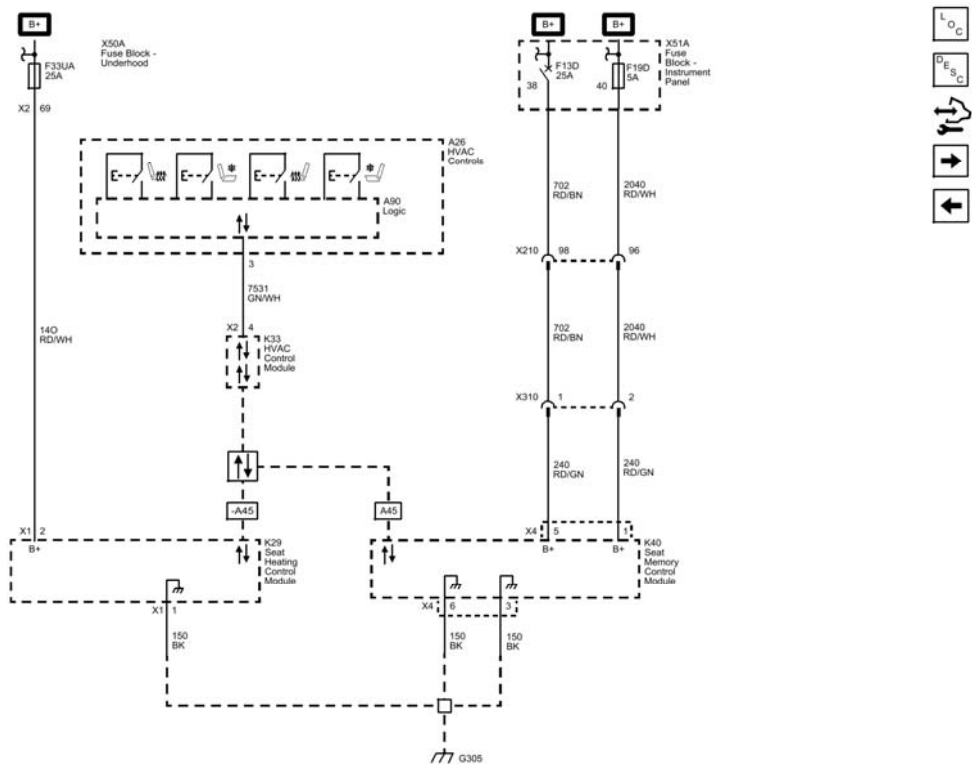


Fig. 3: Power, Ground, Serial Data, and Controls (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Heating Elements and Cooling Modules (A45/CZ2)

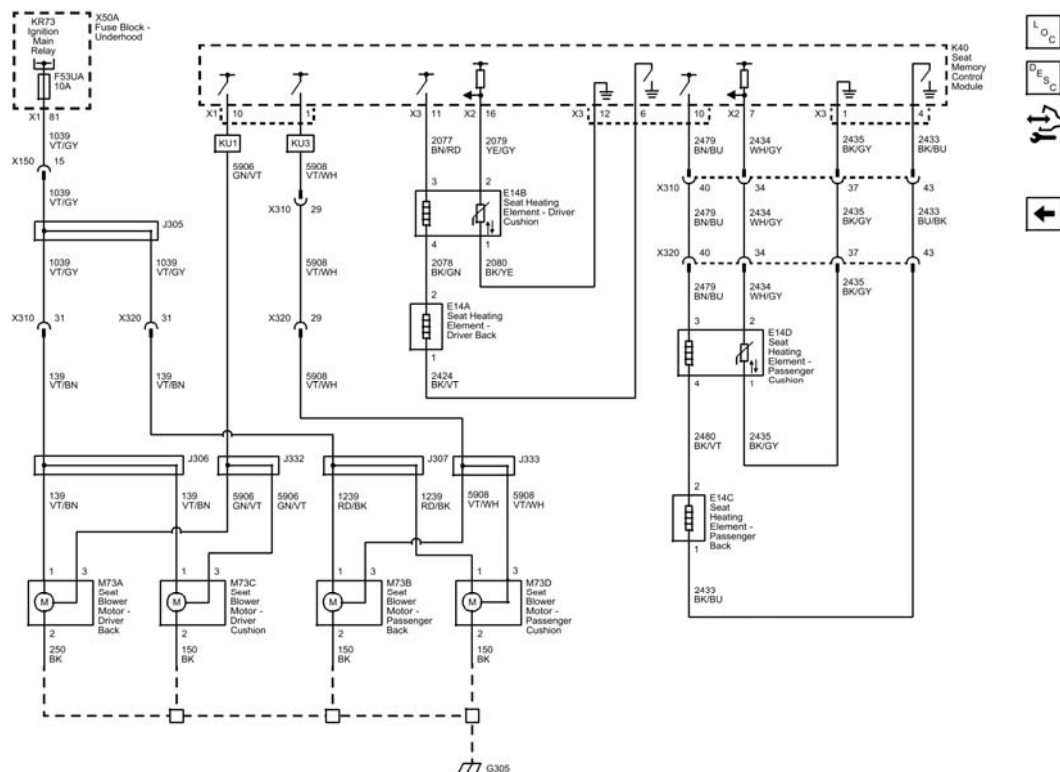


Fig. 4: Heating Elements and Cooling Modules (A45/CZ2)
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B1925 or B2170</u> <u>(With Memory A45)</u>	DTC B1925 02 Driver Seat Cushion Heater Sensor Circuit Short to Ground DTC B1925 05 Driver Seat Cushion Heater Sensor Circuit High Voltage/Open DTC B2170 02 Passenger Seat Cushion Heater Sensor Circuit Short to Ground DTC B2170 05 Passenger Seat Cushion Heater Sensor Circuit High Voltage/Open
<u>DTC B1925 or B2170</u> <u>(Without Memory A45)</u>	DTC B1925 02 Driver Seat Cushion Heater Sensor Circuit Short to Ground DTC B1925 05 Driver Seat Cushion Heater Sensor Circuit High Voltage/Open DTC B2170 02 Passenger Seat Cushion Heater Sensor Circuit Short to Ground DTC B2170 05 Passenger Seat Cushion Heater Sensor Circuit High Voltage/Open

<u>DTC B2345 (With Memory A45)</u>	DTC B2345 13 Seat Heater Disable Circuit Low Voltage High/Temperature
<u>DTC B2345 (Without Memory A45)</u>	DTC B2345 13 Seat Heater Disable Circuit Low Voltage/High Temperature
<u>DTC B2425 or B2430 (With Memory A45)</u>	DTC B2425 0B Driver Seat Cushion Heater Circuit High Current DTC B2425 0D Driver Seat Cushion Heater Circuit High Resistance DTC B2425 0E Driver Seat Cushion Heater Circuit Low Resistance DTC B2430 0B Passenger Seat Cushion Heater Circuit High Current DTC B2430 0D Passenger Seat Cushion Heater Circuit High Resistance DTC B2430 0E Passenger Seat Cushion Heater Circuit Low Resistance
<u>DTC B2425 or B2430 (Without Memory A45)</u>	DTC B2425 0B Driver Seat Cushion Heater Circuit High Current DTC B2425 0D Driver Seat Cushion Heater Circuit High Resistance DTC B2425 0E Driver Seat Cushion Heater Circuit Low Resistance DTC B2430 0B Passenger Seat Cushion Heater Circuit High Current DTC B2430 0D Passenger Seat Cushion Heater Circuit High Resistance DTC B2430 0E Passenger Seat Cushion Heater Circuit Low Resistance
<u>DTC B242A (With Memory A45)</u>	DTC B242A 01 Seat Heaters Common Circuit Short to Battery DTC B242A 02 Seat Heaters Common Circuit Short to Ground
<u>DTC B242A (Without Memory A45)</u>	DTC B242A 01 Seat Heaters Common Circuit Short to Battery DTC B242A 02 Seat Heaters Common Circuit Short to Ground

DTC B1925 OR B2170: SEAT CUSHION HEATER SENSOR (WITH MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1925 02

Driver Seat Cushion Heater Sensor Circuit Short to Ground

DTC B1925 05

Driver Seat Cushion Heater Sensor Circuit High Voltage/Open

DTC B2170 02

Passenger Seat Cushion Heater Sensor Circuit Short to Ground

DTC B2170 05

Passenger Seat Cushion Heater Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Memory Control Module B+ Terminal 5	B242A 02, B2425 0D, B2430 0D, 1, 2	B242A 02, B2425 0D, B2430 0D, 1, 2	-	-
Driver Heated Seat Element Control Terminal 11 X3	B242A 02	B2425 0D	B242A 01	B2425 0E
Driver Heated Seat Element Control Terminal 6 X3	B242A 02	B2425 0D	B242A 01	B2425 0E
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	-
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05	-	-
Passenger Heated Seat Element Control Terminal 10 X3	B242A 02	B2430 0D	B242A 01	B2430 0E
Passenger Heated Seat Element Control Terminal 4 X3	B242A 02	B2430 0D	B242A 01	B2430 0E
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	-
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05	-	-
1. Power seats inoperative 2. Heated seats inoperative				

Circuit/System Description

The heated seat temperature sensor is located in the seat cushion just under the seat cover with the seat heating element. The seat memory control module supplies a 5 V reference voltage through the temperature sensor signal circuit and a ground through the low reference circuit to the sensor. The module monitors the voltage of the sensor signal circuit to determine the temperature of the seat. The temperature sensor varies in resistance based on the temperature of the heating element causing the signal voltage to change. Once the seat reaches the set temperature, the module will then cycle the control circuit of the heating elements ON and OFF in order to maintain the desired seat temperature based on the feedback voltage from the sensor.

Conditions for Running the DTC

- DTC B1325 must not be present.
- The seat memory control module must be powered.

Conditions for Setting the DTC

B1925 02 or B2170 02

The temperature sensor voltage drops below 0.6 V for more than 1 second.

B1925 05 or B2170 05

The temperature sensor voltage is greater than 5 V for more than 1 second.

Action Taken When the DTC Sets

The heated seat function for the affected seat will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set the code to history 3 seconds after the reference voltage returns to normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate E14B or E14D seat cushion heating element. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 1 and ground.

- **If 10 ohms or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K40 seat memory control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 seat memory control module.
- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K40 seat memory control module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 seat memory control module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K29 seat heating control module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K40 seat memory control module.
- **If between 4.8-5.2 V**
- 5. Test or replace the E14 seat cushion heating element.

Component Testing

Seat Cushion Heating Element

1. Ignition OFF, disconnect the harness connector at the appropriate E14B or E14D seat cushion heating element.
2. Test for 500 ohms-300 kohms between the signal circuit terminal 2 and the low reference circuit terminal 1.
 - **If not between 500 ohms-300 kohms**

Replace the E14 seat cushion heating element.
 - **If between 500 ohms-300 kohms**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Cushion Heater Replacement**
- **Control Module References** for K40 seat memory control module replacement, programming and setup

DTC B1925 OR B2170: SEAT CUSHION HEATER SENSOR (WITHOUT MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1925 02

Driver Seat Cushion Heater Sensor Circuit Short to Ground

DTC B1925 05

Driver Seat Cushion Heater Sensor Circuit High Voltage/Open

DTC B2170 02

Passenger Seat Cushion Heater Sensor Circuit Short to Ground

DTC B2170 05

Passenger Seat Cushion Heater Sensor Circuit High Voltage/Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Control Terminal 3 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Element Control Terminal 1 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Cushion Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	B2345 13
Driver Heated Seat Cushion Temperature Sensor Low Reference	-	B1925 05	-	B2345 13
Passenger Heated Seat Element Control Terminal 5 X2	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E

Passenger Heated Seat Element Control Terminal 2 X2	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Cushion Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	B2345 13
Passenger Heated Seat Cushion Temperature Sensor Low Reference	-	B2170 05	-	B2345 13

Circuit/System Description

The heated seat temperature sensor that set this diagnostic trouble code (DTC) is located in the seat cushion just under the seat cover with the seat heating element. The seat heating control module supplies a 5 V reference voltage through the temperature sensor signal circuit and a ground through the low reference circuit to the sensor. The module monitors the voltage of the sensor signal circuit to determine the temperature of the seat. The temperature sensor varies in resistance based on the temperature of the heating element causing the signal voltage to change. Once the seat reaches the set temperature, the module will then cycle the control circuit of the heating elements ON and OFF in order to maintain the desired seat temperature based on the feedback voltage from the sensor.

Conditions for Running the DTC

- DTC B1325 must not be present.
- The seat heating control module must be powered.

Conditions for Setting the DTC

B1925 02 or B2170 02

The temperature sensor voltage drops below 0.6 V for more than 1 second.

B1925 05 or B2170 05

The temperature sensor voltage is greater than 5 V for more than 1 second.

Action Taken When the DTC Sets

The heated seat function for the affected seat will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set the code to history 3 seconds after the reference voltage returns to normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate E14B or E14D seat cushion heating element. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K29 seat heating control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K29 seat heating control module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K29 seat heating control module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K29 seat heating control module.

- **If greater than 5.2 V**
- 1. Ignition OFF, disconnect the X3 harness connector at the K29 seat heating control module, ignition ON.
- 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K29 seat heating control module.
- **If between 4.8-5.2 V**
- 5. Test or replace the E14 seat cushion heating element.

Component Testing

E14B or E14D Seat Cushion Heating Element

1. Ignition OFF, disconnect the harness connector at the appropriate E14B or E14D seat cushion heating element.
2. Test for 500 ohms-300 kohms between the signal circuit terminal 2 and the low reference circuit terminal 1.
 - **If not between 500 ohms-300 kohms**

Replace the E14 seat cushion heating element.
 - **If between 500 ohms-300 kohms**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Cushion Heater Replacement**
- **Control Module References** for seat heating control module replacement, programming setup

DTC B2345: SEAT HEATER DISABLE CIRCUIT LOW VOLTAGE HIGH/TEMPERATURE (WITH MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2345 13

Seat Heater Disable Circuit Low Voltage High/Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Memory Control Module B+ Terminal 5 X4	B242A 02, B2425 0D, B2430 0D, 1, 2	B242A 02, B2425 0D, B2430 0D, 1, 2	-	-
Driver Heated Seat Element Control Terminal 11 X3	B242A 02	B2425 0D	B242A 01	B2425 0E
Driver Heated Seat Element Control Terminal 6 X3	B242A 02	B2425 0D	B242A 01	B2425 0E
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	B2345 13
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05	-	B2345 13
Passenger Heated Seat Element Control Terminal 10 X3	B242A 02	B2430 0D	B242A 01	B2430 0E
Passenger Heated Seat Element Control Terminal 4 X3	B242A 02	B2430 0D	B242A 01	B2430 0E
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	B2345 13
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05	-	B2345 13
1. Power seats inoperative 2. Heated seats inoperative				

Circuit/System Description

The seat memory control module controls seat heating operation for both the driver and front passenger seats. The heating elements are controlled through individual high side and low side control circuits. The low side control circuits for both seats are connected to a common reference point internal to the module. This reference point is biased to approximately 2.5 V. Before the seat memory control module will allow heated seat operation, it checks to see if this biased voltage is shorted to ground or voltage. Once the module verifies that it is not closing to a shorted heating element, it allows for heated seat operation. The module will then continue to monitor the heating elements for a shorted circuit.

Conditions for Running the DTC

The seat memory control module must be powered.

Conditions for Setting the DTC

B2345 13

Any temperature sensor input that remains below 1.5 V for more than 1 second.

Action Taken When the DTC Sets

The heated seat function for both front seats will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set the code to history 3 seconds after the reference voltage returns to the normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 and X3 harness connectors at the K40 seat memory control module.
2. Test for greater than 3.0 kohms between the signal and the low reference circuits listed below:
 - E14B driver seat cushion terminal 16 X2 and terminal 12 X3
 - E14D passenger seat cushion terminal 7 X2 and terminal 1 X3
 - **If less than 3.0 kohms**
1. Ignition OFF, disconnect the harness connector at the appropriate E14B or E14D seat cushion

heating element.

2. Test for Infinite resistance between the signal and low reference circuits.
 - If less than infinite resistance, repair the short between the circuits.
 - If infinite resistance, test or replace the E14 seat cushion heating element.
 - **If greater than 3.0 kohms**
3. Replace the K40 seat memory control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Cushion Heater Replacement**
- **Control Module References** for K40 seat memory control module replacement, programming and setup

DTC B2345: SEAT HEATER DISABLE CIRCUIT LOW VOLTAGE/HIGH TEMPERATURE (WITHOUT MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2345 13

Seat Heater Disable Circuit Low Voltage/High Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Control Terminal 3 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Element Control Terminal 1 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Cushion Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	B2345 13
Driver Heated Seat Cushion Temperature Sensor Low Reference	-	B1925 05	-	B2345 13
Passenger Heated Seat Element Control Terminal 5 X2	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Element				B2430 0B, B2430

Control Terminal 2 X2	B242A 02	B2430 0D	B242A 01	0E
Passenger Heated Seat Cushion Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	B2345 13
Passenger Heated Seat Cushion Temperature Sensor Low Reference	-	B2170 05	-	B2345 13

Circuit/System Description

The seat heating control module controls seat heating operation for the driver and front passenger seats. The heating elements are controlled through individual high side and low side control circuits. The low side control circuits for both seats are connected to a common reference point internal to the module. This reference point is biased to approximately 2.5 V. Before the seat heating control module will allow heated seat operation, it checks to see if this biased voltage is shorted to ground or voltage. Once the module verifies that it is not closing to a shorted heating element, it allows for heated seat operation. The module will then continue to monitor the heating elements for a shorted circuit.

Conditions for Running the DTC

- Engine must be running.
- The seat heating control module must be powered.

Conditions for Setting the DTC

B2345 13

Any temperature sensor input that remains below 1.5 V for more than 1 second.

Action Taken When the DTC Sets

The heated seat function for both seats will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set the code to history 3 seconds after the reference voltage returns to the normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 and X3 harness connectors at the K29 seat heating control module.
2. Test for greater than 3.0 kohms between the signal and the low reference circuit terminals listed below:
 - Driver seat cushion terminal 3 X3 and terminal 13 X2
 - Passenger seat cushion terminal 4 X3 and terminal 14 X2
 - **If less than 3.0 kohms**
 1. Ignition OFF, disconnect the harness connector at the appropriate E14B or E14D seat cushion heating element.
 2. Test for Infinite resistance between the signal and low reference circuits.
 - If less than infinite resistance, repair the short between the circuits.
 - If infinite resistance, test or replace the E14 seat cushion heating element.
 - **If greater than 3.0 kohms**
3. Replace the K29 seat heating control module.

Component Testing

Seat Cushion Heating Element

1. Ignition OFF, disconnect the harness connector at the appropriate E14B or E14D seat cushion heating element.
2. Test for 500 ohms-300 kohms between the signal circuit terminal 4 and the low reference circuit terminal 3.
 - **If not between 500 ohms-300 kohms**

Replace the E14 seat cushion heating element.
 - **If between 500 ohms-300 kohms**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Cushion Heater Replacement**
- **Control Module References** for K29 seat heating control module replacement, programming and setup

DTC B2425 OR B2430: SEAT CUSHION HEATER (WITH MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2425 0B

Driver Seat Cushion Heater Circuit High Current

DTC B2425 0D

Driver Seat Cushion Heater Circuit High Resistance

DTC B2425 0E

Driver Seat Cushion Heater Circuit Low Resistance

DTC B2430 0B

Passenger Seat Cushion Heater Circuit High Current

DTC B2430 0D

Passenger Seat Cushion Heater Circuit High Resistance

DTC B2430 0E

Passenger Seat Cushion Heater Circuit Low Resistance

Diagnostic Fault Information

	Short to	Open/High	Short to	Signal
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Circuit	Ground	Resistance	Voltage	Performance
Seat Memory Control Module B+ Terminal 5 X4	B242A 02, B2425 0D, B2430 0D, 1, 2	B242A 02, B2425 0D, B2430 0D, 1, 2	-	-
Driver Heated Seat Element Control Terminal 11 X3	B242A 02	B2425 0D	B242A 01	B2425 0E
Driver Heated Seat Element Control Terminal 6 X3	B242A 02	B2425 0D	B242A 01	B2425 0E
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	-
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05	-	-
Passenger Heated Seat Element Control Terminal 10 X3	B242A 02	B2430 0D	B242A 01	B2430 0E
Passenger Heated Seat Element Control Terminal 4 X3	B242A 02	B2430 0D	B242A 01	B2430 0E
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	-
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05	-	-
1. Power seats inoperative 2. Heated seats inoperative				

Circuit/System Description

The driver and front passenger heated seats are controlled by the seat memory control module that is located under the driver seat cushion. When the heated seat is active, the module applies power through a common voltage supply circuit to the seat heater elements. The module controls the seat temperature by providing a pulse width modulation (PWM) ground through the seat heater element control circuit to the heater elements. The module then monitors the current flow through the heating elements and the rate of change of the temperature sensor to verify correct heated seat operation.

Conditions for Running the DTC

- DTC B1325 must not be present.
- Engine must be running.
- The seat memory control module must be powered and the heated seat must be enabled.

Conditions for Setting the DTC

B2425 0D or B2430 0D

By measuring current and voltage output to the seat heating elements every 10 seconds, the seat memory control module calculates that the heating element resistance is above the maximum resistance.

B2425 0B, B2425 0E, B2430 0B, or B2430 0E

By measuring current and voltage output to the seat heating elements every 10 seconds, the seat memory control module calculates that the heating element resistance is below the minimum resistance.

Action Taken When the DTC Sets

The heated seat function for the affected seat will be disabled.

Conditions for Clearing the DTC

- The current DTC clears when the malfunction is no longer present, and the power mode changes to OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B2425 0B, B2425 0D, or B2425 0E

1. Ignition OFF, disconnect the X4 harness connector at the K40 seat memory control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.

- **If the test lamp does not illuminate**

1. Ignition OFF.
2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the circuit breaker.

- **If the test lamp illuminates**

3. Ignition OFF, connect the X4 harness connector at the K40 seat memory control module and disconnect the harness connector at the E14A seat back heating element.

NOTE: **Element resistance must be measured twice to ensure that all failure conditions are simulated. First with the seat unoccupied, then with the seat occupied.**

4. Test for 0.5-2 ohms between control circuit terminal 1 and control circuit terminal 2.

- **If not between 0.5-2 ohms**

Replace the E14A seat back heating element.

- **If between 0.5-2 ohms**

5. Connect the harness connector at the E14A seat back heating element and disconnect the X3 harness connector at the K40 seat memory control module.
6. Test for 1-5 ohms between control circuit terminal 11 and control circuit terminal 6.

- **If less than 1 ohms**

1. Ignition OFF, disconnect the harness connector at the E14B seat cushion heating element.
2. Test for infinite resistance between the control circuits.
 - If less than infinite resistance, repair the short between the circuits.
 - If infinite resistance, test or replace the E14B seat cushion heating element

- **If greater than 5 ohms**

1. Ignition OFF, disconnect the harness connector at the E14B seat cushion heating element.
2. Test for less than 2 ohms in the control circuits end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the E14B seat cushion heating element.

- **If between 1-5 ohms**

7. Replace the K40 seat memory control module.

B2430 0B, B2430 0D, or B2430 0E

1. Ignition OFF, disconnect the X4 harness connector at the K40 seat memory control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate**
 - 1. Ignition OFF.

2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the circuit breaker.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X4 harness connector at the K40 seat memory control module and disconnect the harness connector at the E14C seat back heating element.

NOTE: **Element resistance must be measured twice to ensure that all failure conditions are simulated. First with the seat unoccupied, then with the seat occupied.**

4. Test for 0.5-2 ohms between control circuit terminal 1 and control circuit terminal 2.
 - **If not between 0.5-2 ohms**

Replace the E14C seat back heating element.

- **If between 0.5-2 ohms**
5. Connect the harness connector at the E14C seat back heating element and disconnect the X3 harness connector at the K40 seat memory control module.
 6. Test for 1-5 ohms between control circuit terminal 10 and control circuit terminal 4.
 - **If less than 1 ohms**
 1. Ignition OFF, disconnect the harness connector at the E14D seat cushion heating element.
 2. Test for infinite resistance between the control circuits.
 - If less than infinite resistance, repair the short between the circuits.
 - If infinite resistance, test or replace the E14D seat cushion heating element.
 - **If greater than 5 ohms**
 1. Ignition OFF, disconnect the harness connector at the E14D seat cushion heating element.
 2. Test for less than 2 ohms in the control circuits end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the E14D seat cushion heating element.
 - **If between 1-5 ohms**
 7. Replace the K40 seat memory control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Cushion Heater Replacement**
- **Control Module References** for seat memory control module replacement, programming and setup

DTC B2425 OR B2430: SEAT CUSHION HEATER (WITHOUT MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2425 0B

Driver Seat Cushion Heater Circuit High Current

DTC B2425 0D

Driver Seat Cushion Heater Circuit High Resistance

DTC B2425 0E

Driver Seat Cushion Heater Circuit Low Resistance

DTC B2430 0B

Passenger Seat Cushion Heater Circuit High Current

DTC B2430 0D

Passenger Seat Cushion Heater Circuit High Resistance

DTC B2430 0E

Passenger Seat Cushion Heater Circuit Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Control Terminal 3 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Element Control Terminal 1 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Cushion Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	B2345 13
Driver Heated Seat Cushion Temperature Sensor Low Reference	-	B1925 05	-	B2345 13
Passenger Heated Seat Element	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430

Control Terminal 5 X2				0E
Passenger Heated Seat Element Control Terminal 2 X2	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Cushion Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	B2345 13
Passenger Heated Seat Cushion Temperature Sensor Low Reference	-	B2170 05	-	B2345 13

Circuit/System Description

The driver and front passenger heated seats are controlled by the seat heating control module that is located under the driver seat cushion. When the heated seat is active, the module applies power through a common voltage supply circuit to the seat heater elements. The module controls the seat temperature by providing a pulse width modulation (PWM) ground through the seat heater element control circuit to the heater elements. The module then monitors the current flow through the heating elements and the rate of change of the temperature sensor to verify correct heated seat operation.

Conditions for Running the DTC

- DTC B1325 must not be present.
- Engine must be running.
- The seat heating control module must be powered and the heated seat must be enabled.

Conditions for Setting the DTC

B2425 0D or B2430 0D

By measuring current and voltage output to the seat heating elements every 10 seconds, the seat heating control module calculates that the heating element resistance is above the maximum resistance.

B2425 0B, B2425 0E, B2430 0B, or B2430 0E

By measuring current and voltage output to the seat heating elements every 10 seconds, the seat heating control module calculates that the heating element resistance is below the minimum resistance.

Action Taken When the DTC Sets

The heated seat function for the affected seat will be disabled.

Conditions for Clearing the DTC

- The current DTC clears when the malfunction is no longer present, and the power mode changes to OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B2425 0B, B2425 0D, or B2425 0E

1. Ignition OFF, disconnect the harness connector at the E14B driver seat cushion heating element.

NOTE: **Element resistance must be measured twice to ensure that all failure conditions are simulated. First with the seat unoccupied, then with the seat occupied.**

If the resistance is measured with the seat still warm or cool, the resistance values will vary. The following resistance values were determined with the seat heater elements at 23°C (73°F).

2. Test for 0.78-1.57 ohms between control circuit terminal 3 and control circuit terminal 4.
 - **If not between 0.78-1.57 ohms**

Replace the E14B driver seat cushion heating element.
 - **If between 0.78-1.57 ohms**
3. Connect the harness connector at the E14B seat cushion heating element and disconnect the harness connector at the E14A driver seat back heating element.

NOTE: Element resistance must be measured twice to ensure that all failure conditions are simulated. First with the seat unoccupied, then with the seat occupied.

4. Test for 0.54-1.09 ohms between control circuit terminal 1 and control circuit terminal 2.

- **If not between 00.54-1.09 ohms**

Replace the E14A driver seat back heating element.

- **If between 0.54-1.09 ohms ohms**

5. Connect the harness connector at the E14A driver seat back heating element and disconnect the X2 harness connector at the K29 seat heating control module.

NOTE: Element resistance must be measured twice to ensure that all failure conditions are simulated. First with the seat unoccupied, then with the seat occupied.

6. Test for 0.93 - 3.56 ohms between control circuit terminal 1 and control circuit terminal 3.

- **If less than 0.93 ohms**

Repair the short between the circuits.

- **If greater than 3.56 ohms**

Repair the open/high resistance in the circuit.

- **If between 0.93 - 3.56 ohms**

7. Replace the K29 seat heating control module.

B2430 0B, B2430 0D, or B2430 0E

1. Ignition OFF, disconnect the harness connector at the E14D passenger seat cushion heating element.

NOTE: Element resistance must be measured twice to ensure that all failure conditions are simulated. First with the seat unoccupied, then with the seat occupied.

If the resistance is measured with the seat still warm or cool, the resistance values will vary. The following resistance values were determined with the seat heater elements at 23°C (73°F).

2. Test for 0.78-1.57 ohms between control circuit terminal 3 and control circuit terminal 4.

- **If not between 0.78-1.57 ohms**

Replace the E14D passenger seat cushion heating element.

- **If between 0.78-1.57 ohms**

3. Connect the harness connector at the E14D passenger seat cushion heating element and disconnect the harness connector at the E14C passenger seat back heating element.

NOTE: **Element resistance must be measured twice to ensure that all failure conditions are simulated. First with the seat unoccupied, then with the seat occupied.**

4. Test for 0.54-1.09 ohms between control circuit terminal 1 and control circuit terminal 2.

- **If not between 0.54-1.09 ohms**

Replace the E14C passenger seat back heating element.

- **If between 0.54-1.09 ohms**

5. Connect the harness connector at the E14C passenger seat back heating element and disconnect the X2 harness connector at the K29 seat heating control module.

NOTE: **Element resistance must be measured twice to ensure that all failure conditions are simulated. First with the seat unoccupied, then with the seat occupied.**

6. Test for 0.93-3.80 ohms between control circuit terminal 2 and control circuit terminal 5.

- **If less than 0.93 ohms**

Repair the short between the circuits.

- **If greater than 3.80 ohms**

Repair the open/high resistance in the circuit.

- **If between 0.93-3.80 ohms**

7. Replace the K29 seat heating control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Driver or Passenger Seat Cushion Heater Replacement**
- **Control Module References** for K29 seat heating control module replacement, programming and setup

DTC B242A: SEAT HEATERS COMMON CIRCUIT (WITH MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B242A 01

Seat Heaters Common Circuit Short to Battery

DTC B242A 02

Seat Heaters Common Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Memory Control Module B+ Terminal 5 X4	B242A 02, B2425 0D, B2430 0D, 1, 2	B242A 02, B2425 0D, B2430 0D, 1, 2	-	-
Driver Heated Seat Element Control Terminal 11 X3	B242A 02	B2425 0D	B242A 01	B2425 0E
Driver Heated Seat Element Control Terminal 6 X3	B242A 02	B2425 0D	B242A 01	B2425 0E
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	-
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05	-	-
Passenger Heated Seat Element Control Terminal 10 X3	B242A 02	B2430 0D	B242A 01	B2430 0E
Passenger Heated Seat Element Control Terminal 4 X3	B242A 02	B2430 0D	B242A 01	B2430 0E
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	-
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05	-	-
1. Power seats inoperative 2. Heated seats inoperative				

Circuit/System Description

The seat memory control module controls seat heating operation for both the driver and front passenger seats. The module controls the heating elements through individual high side and low side control circuits. The low side control circuits for both seats are connected to a common reference point internal to the module. This reference point is biased to approximately 2.5 V. Before the seat memory control module will allow heated seat

operation, it checks to see if this biased voltage is shorted to ground or voltage. Once the module verifies that it is not closing to a shorted heating element, it allows for heated seat operation. The module will then continue to monitor the heating elements for a shorted circuit.

Conditions for Running the DTC

- DTC B1325 must not be present.
- The seat memory control module must be powered.

Conditions for Setting the DTC

B242A 01

The seat memory control module detects a short to voltage on the heater element control circuits.

B242A 02

The seat memory control module detects a short to ground on the heater element control circuits.

Action Taken When the DTC Sets

The heated seat function for both seats will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set a history code 3 seconds after the reference voltage returns to normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X4 harness connector at the K40 seat memory control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the circuit breaker.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X4 harness connector at the K40 seat memory control module and disconnect the X3 harness connector at the K40 seat memory control module.
4. Test for infinite resistance between the control circuit terminals listed below and ground:
 - Terminal 11
 - Terminal 10
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
5. Ignition ON.
6. Test for less than 1 V between the control circuit terminals listed below and ground:
 - Terminal 11
 - Terminal 10
 - **If 1 V or greater**

Repair the short to voltage on the circuit.
 - **If less than 1 V**
7. Replace the K40 seat memory control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for seat memory control module replacement, programming and setup

DTC B242A: SEAT HEATERS COMMON CIRCUIT (WITHOUT MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B242A 01

Seat Heaters Common Circuit Short to Battery

DTC B242A 02

Seat Heaters Common Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Control Terminal 3 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Element Control Terminal 1 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Cushion Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	B2345 13
Driver Heated Seat Cushion Temperature Sensor Low Reference	-	B1925 05	-	B2345 13
Passenger Heated Seat Element Control Terminal 5 X2	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Element Control Terminal 2 X2	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Cushion Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	B2345 13
Passenger Heated Seat Cushion Temperature Sensor Low Reference	-	B2170 05	-	B2345 13

Circuit/System Description

The seat heating control module controls the seat heating operation for both the driver and front passenger seats.

The module controls the heating elements through individual high side and low side control circuits. The low side control circuits for both seats are connected to a common reference point internal to the module. This reference point is biased to approximately 2.5 V. Before the seat heating control module will allow heated seat operation, it checks to see if this biased voltage is shorted to ground or voltage. Once the module verifies that it is not closing to a shorted heating element, it allows for heated seat operation. The module will then continue to monitor the heating elements for a shorted circuit.

Conditions for Running the DTC

- DTC B1325 must not be present.
- The seat heating control module must be powered.

Conditions for Setting the DTC

B242A 01

The seat heating control module detects a short to voltage on the heater element control circuits.

B242A 02

The seat heating control module detects a short to ground on the heater element control circuits.

Action Taken When the DTC Sets

The heated seat function for both seats will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set a history code 3 seconds after the reference voltage returns to normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 40 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the K29 seat heating control module.
2. Test for infinite resistance between the control circuit terminals listed below and ground:
 - Terminal 3
 - Terminal 5
 - **If less than infinite resistance**

Repair the short to ground on the circuit.

- **If infinite resistance**
3. Ignition ON.
 4. Test for less than 1 V between the control circuit terminals listed below and ground:
 - Terminal 3
 - Terminal 5
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**
5. Replace the K29 seat heating control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for K29 seat heating control module replacement, programming and setup

SYMPTOMS - SEAT HEATING AND COOLING

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:

- There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Refer to the **Heated/Vented Seat Description and Operation** in order to familiarize yourself with the system functions.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power seats. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the seat adjuster track for conditions which may cause binding or objects within the seat adjustment range which obstruct movement or interfere with wiring.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Front Heated Seat Malfunction (With Memory A45), Front Heated Seat Malfunction (Without Memory A45)**
- **Vented Seat Malfunction**

FRONT HEATED SEAT MALFUNCTION (WITH MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Memory Control Module B+ Terminal 5 X4	B242A 02, B2425 0D, B2430 0D, 1, 2	B242A 02, B2425 0D, B2430 0D, 1, 2	-	-
Driver Heated Seat Element Control Terminal 11 X3	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Element	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425

Control Terminal 6 X3				0E
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	-
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05	-	-
Passenger Heated Seat Element Control Terminal 10 X3	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Element Control Terminal 4 X3	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	-
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05	-	-
1. Power seats inoperative 2. Heated seats inoperative				

Circuit/System Description

The driver and passenger heated seats are controlled by separate heated seat switches located in the HVAC controls. When a heated seat switch is pressed, a serial data message is sent from the HVAC controls to the HVAC control module. The HVAC control module serves as a gateway to transmit the message to the seat memory control module via the serial data line indicating the heated seat command. In response to this message, the seat memory control module then applies battery voltage through the element supply voltage circuit to the appropriate seat heating elements. The seat memory control module then sends a serial data message back to the HVAC control module to gateway the information to the HVAC controls to either illuminate or turn off the appropriate temperature indicator.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no heated seat DTCs are set.
 - **If any heated seat DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no heated seat DTCs are set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the X4 harness connector at the K40 seat memory control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp illuminates**
3. Ignition OFF, connect the X4 harness connector at the K40 seat memory control module, ignition ON,
4. Verify the scan tool Seat Memory Control Module Driver Seat Heating/Venting/Cooling Mode parameter changes between Off and Back & Cushion Heat after pressing the driver heated seat switch.
 - **If the parameter does not change**

Replace the A26 HVAC controls.

- **If the parameter changes**
5. Verify the scan tool Passenger Front Seat Heating/Venting/Cooling Mode parameter changes between Off and Back & Cushion Heat after pressing the passenger heated seat switch.
 - **If the parameter does not change**

Replace the A26 HVAC controls.

- **If the parameter changes**

6. Replace the K40 seat memory control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Heater and Air Conditioning Control Replacement**
- **Control Module References** for seat memory control module replacement, programming and setup

FRONT HEATED SEAT MALFUNCTION (WITHOUT MEMORY A45)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Control Terminal 3 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Element Control Terminal 1 X2	B242A 02	B2425 0D	B242A 01	B2425 0B, B2425 0E
Driver Heated Seat Cushion Temperature Sensor Signal	B1925 02	B1925 05	B1925 05	B2345 13
Driver Heated Seat Cushion Temperature Sensor Low Reference	-	B1925 05	-	B2345 13
Passenger Heated Seat Element Control Terminal 5 X2	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Element Control Terminal 2 X2	B242A 02	B2430 0D	B242A 01	B2430 0B, B2430 0E
Passenger Heated Seat Cushion Temperature Sensor Signal	B2170 02	B2170 05	B2170 05	B2345 13
Passenger Heated Seat Cushion Temperature Sensor Low Reference	-	B2170 05	-	B2345 13

Circuit/System Description

The driver and passenger heated seats are controlled by separate heated seat switches that are located in the HVAC control. When a heated seat switch is pressed, a serial data message is sent from the HVAC control to the HVAC control module indicating the heated seat command. The HVAC control module then serves as a

gateway to transmit the message to the seat heating control module via the serial data line. In response to this message, the seat heating control module applies battery positive voltage through the element supply voltage circuit to the appropriate seat heating elements. The seat heating control module then sends a serial data message back to the HVAC control module to gateway the information to the HVAC control to either illuminate or turn off the appropriate temperature indicator.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no heated seat DTCs are set.
 - **If any heated seat DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no heated seat DTCs are set**
3. Engine ON.
4. Verify the scan tool Front Seat Heating Control Module Driver Seat Heating/Venting/Cooling Mode parameter changes between Off and Back & Cushion Heat after pressing the driver heated seat switch.
 - **If the parameter does not change**

Replace the A26 HVAC controls.

- **If the parameter changes**

5. Verify the scan tool Passenger Front Seat Heating/Venting/Cooling Mode Switch parameter changes between Off and Back & Cushion Heat after pressing the passenger heated seat switch.

- **If the parameter does not change**

Replace the A26 HVAC controls.

- **If the parameter changes**

6. Replace the K29 seat heating control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Heater and Air Conditioning Control Replacement**
- **Control Module References** for seat heating control module replacement, programming and setup

VENTED SEAT MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Seat Back Blower Motor Ignition	1, 4	2	-	-
Driver Seat Cushion Blower Motor Ignition	1, 4	3	-	-
Driver Vented Seat Control	1	1	1	-
Driver Seat Back Blower Motor Ground	-	2	-	-
Driver Seat Cushion Blower Motor Ground	-	3	-	-
Passenger Seat Back Blower Motor Ignition	1, 4	5	-	-
Passenger Seat Cushion Blower Motor Ignition	1, 4	6	-	-
Passenger Vented Seat Control	4	4	4	-

Passenger Seat Back Blower Motor Ground	-	5	-	-
Passenger Seat Cushion Blower Motor Ground	-	6	-	-
1. Driver vented seat is inoperative 2. Driver vented seat back is inoperative 3. Driver vented seat cushion is inoperative 4. Passenger vented seat is inoperative 5. Passenger vented seat back is inoperative 6. Passenger vented seat cushion is inoperative				

Circuit/System Description

The driver and passenger vented seats are controlled by separate vented seat switches located in the HVAC controls. Ignition voltage is supplied to the driver and passenger seat blower motors through a 10 A fuse located in the underhood fuse block. When a vented seat switch is pressed, a serial data message is sent from the HVAC controls to the HVAC control module indicating the vented seat command. The HVAC control module serves as a gateway to transmit the message to the seat memory control module via the serial data line. In response to this message, the seat memory control module applies a low side pulse width modulation (PWM) signal through the blower motor control circuits to the seat cushion and seat back blower motors indicating the vented seat command. The logic in the blower motors then sets the blower speed to the switch set point. Both blower motors run drawing cabin air around and away from occupant. The seat memory control module then sends a serial data message back to the HVAC control module to gateway the information back to the HVAC controls to either illuminate or turn off the appropriate switch indicator.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated/Vented Seat Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine ON.
2. Verify each scan tool Seat Memory Control Module parameter listed below changes between Vent/Cool and Off when pressing the appropriate vented seat switch.
 - Driver Seat Heating/Venting/Cooling Mode
 - Passenger Front Seat Heating/Venting/Cooling Mode
 - **If either parameter does not change**

Replace the A26 HVAC controls.

- **If each parameter changes**

3. Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed before proceeding with Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate blower motor listed below. It may take up to 2 minutes for all vehicle systems to power down.
 - M73A seat blower motor - driver back
 - M73C seat blower motor - driver cushion
 - M73B seat blower motor - passenger back
 - M73D seat blower motor - passenger cushion
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 5 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, refer to **Power Mode Mismatch** .
- **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the appropriate component/module listed below.
 - M73A seat blower motor - driver back
 - M73C seat blower motor - driver cushion
 - M73B seat blower motor - passenger back
 - M73D seat blower motor - passenger cushion
 - K50 rear window sunshade module
- **If the test lamp illuminates**
 5. Connect a test lamp between the control circuit terminal 3 and B+.
 6. Verify the test lamp turns ON when pressing the vented seat switch through the high, medium, and low positions then turns OFF when the off position is reached.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 harness connector at the K40 seat memory control module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 1. Ignition OFF.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K40 seat memory control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X1 harness connector at the K40 seat memory control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K40 seat memory control module.
 7. Test or replace the M73 blower motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Heater and Air Conditioning Control Replacement**
- **Control Module References** for seat memory control module replacement, programming and setup

REPAIR INSTRUCTIONS

FRONT SEAT HEATER CONTROL MODULE REPLACEMENT (BASE)

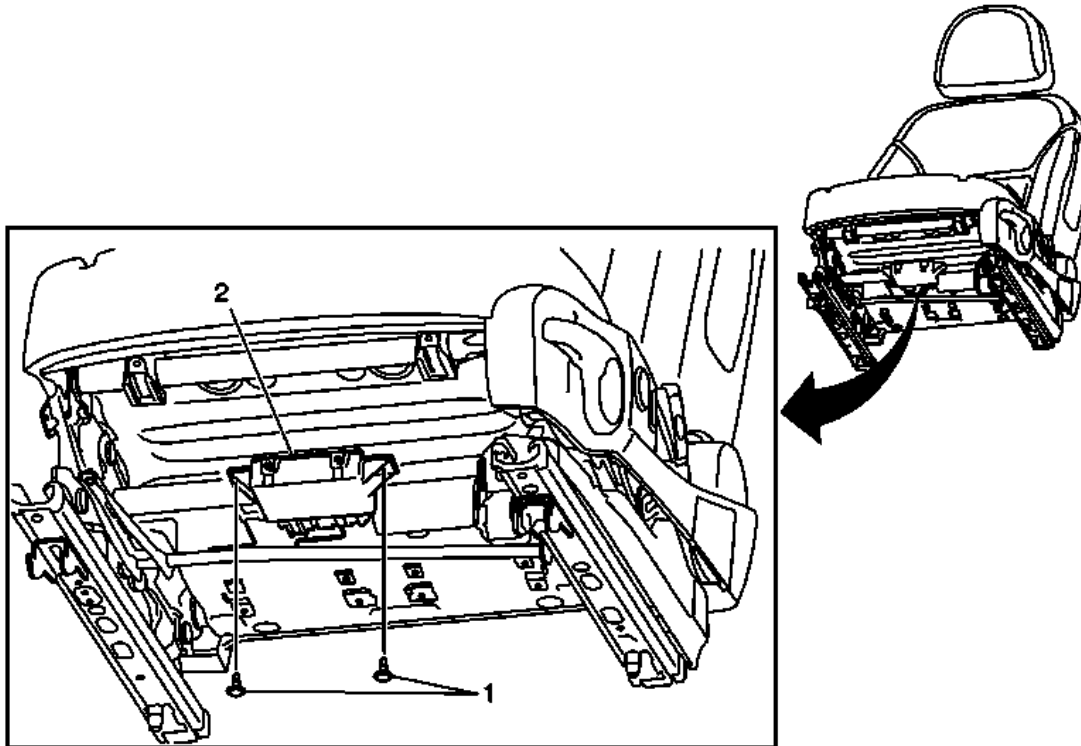


Fig. 5: Front Seat Heater Control Module & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Front Seat Heater Control Module Replacement (Base)

Callout	Component Name
	Front Seat Heater Control Fastener (Qty: 2)
	CAUTION: Refer to <u>Fastener Caution</u> .
	Procedure
1	<ol style="list-style-type: none">1. Move the front seat full backward.2. Move the front seat in upper position.3. Turn Off the ignition.4. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .5. Disconnect wiring harness connectors.

	Tighten 3.5 N.m (31 lb in)
2	Front Seat Heater Control Module

DRIVER OR PASSENGER SEAT BACK CUSHION HEATER REPLACEMENT

Removal Procedure

WARNING: Refer to **SIR Warning** .

1. Disable the SIR System. Refer to **SIR Disabling and Enabling** .
2. Remove the driver or passenger seat. Refer to **Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)** .
3. Remove the front seat outer adjuster finish cover. Refer to **Driver or Passenger Seat Outer Adjuster Finish Cover Replacement (8-Way Power)** .
4. Remove the driver or passenger seat recliner lever, if equipped. Refer to **Driver or Passenger Seat Recliner Lever Replacement** .
5. Remove the driver or passenger seat adjuster finish cover. Refer to **Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)** .
6. Remove the driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)** .
7. Remove the driver or passenger seat head restraint. Refer to **Driver or Passenger Seat Head Restraint Replacement (without AHS)** .
8. Remove the front seat head restraint guide bezel. Refer to **Front Seat Head Restraint Guide Bezel Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)** , **Front Seat Head Restraint Guide Bezel Replacement (8-Way Power)** .
9. Remove the front seat head restraint adjust rod guide. Refer to **Front Seat Head Restraint Guide Replacement** .

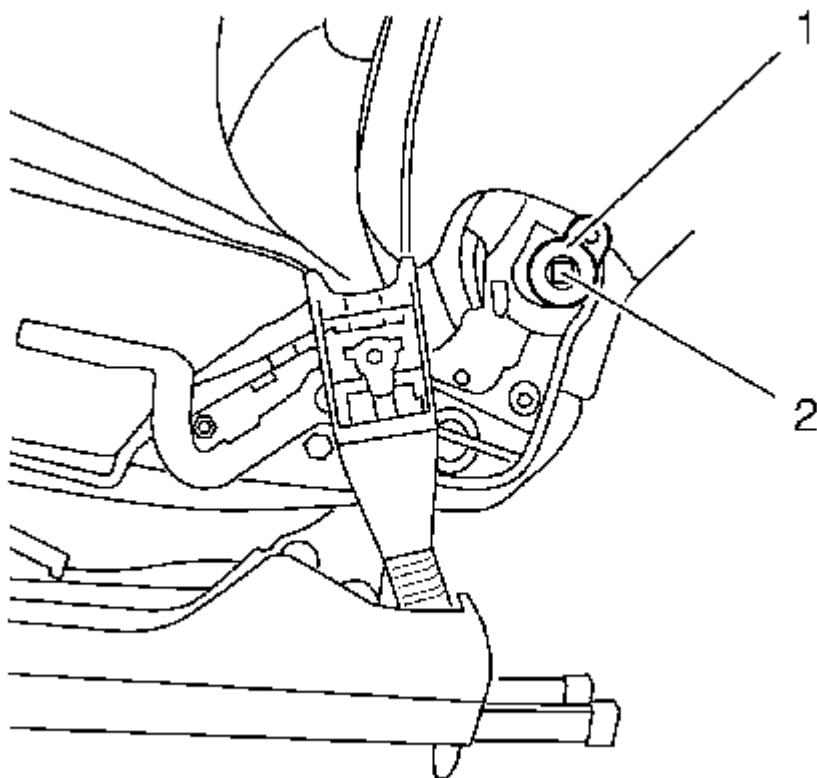


Fig. 6: Recliner Control Shaft And Securing Clip
Courtesy of GENERAL MOTORS COMPANY

10. Clip out securing (1) of recliner control shaft (2).

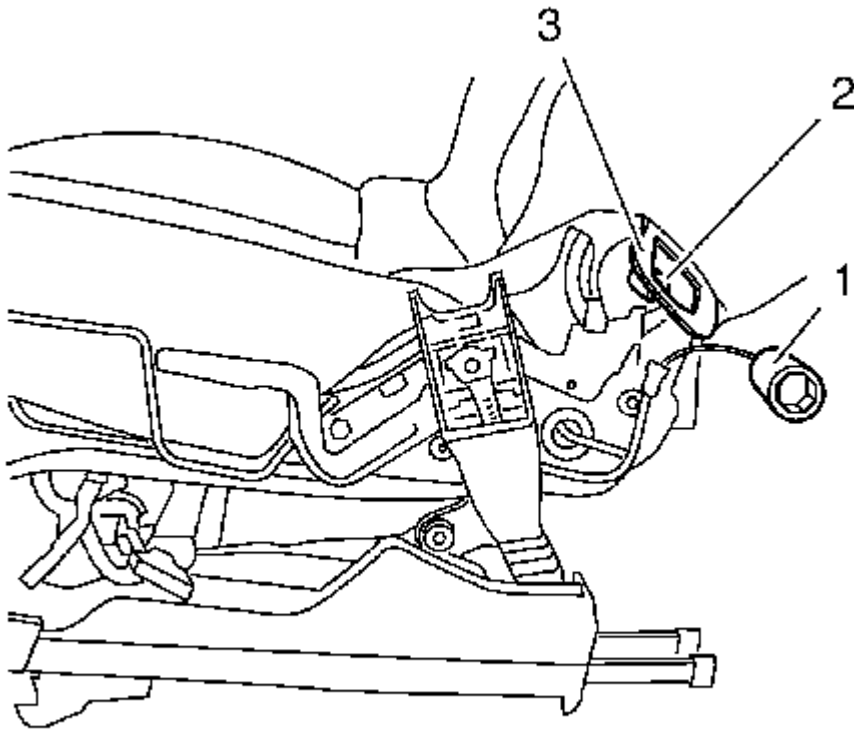


Fig. 7: Recliner Control, Shaft And Cushion Strap
Courtesy of GENERAL MOTORS COMPANY

11. Remove the recliner control (1) from the recliner shaft (2). Unhinge the cushion strap (3) at seat frame.

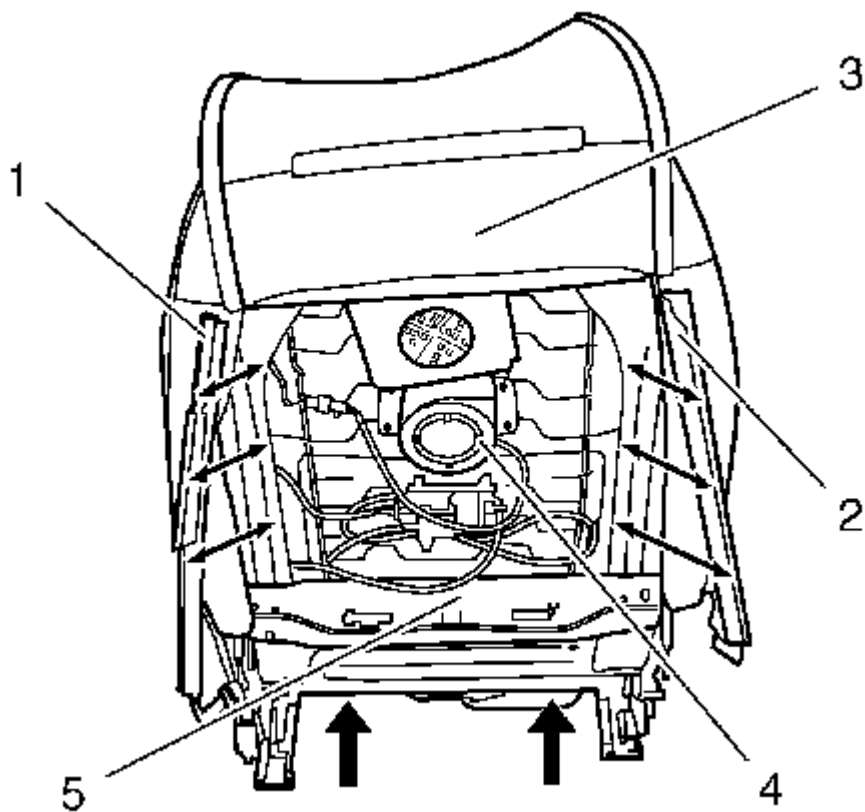


Fig. 8: Front Seat Back Cushion And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

NOTE: For loosening move the cushion upper and pull from backrest frame.

12. Loosen the front seat back cushion at backrest left side (1) and right side (2).
13. Clip out the front seat back cushion vent fan mat (3) of vent fan (4). Pull the cushion (5) in front to surface.

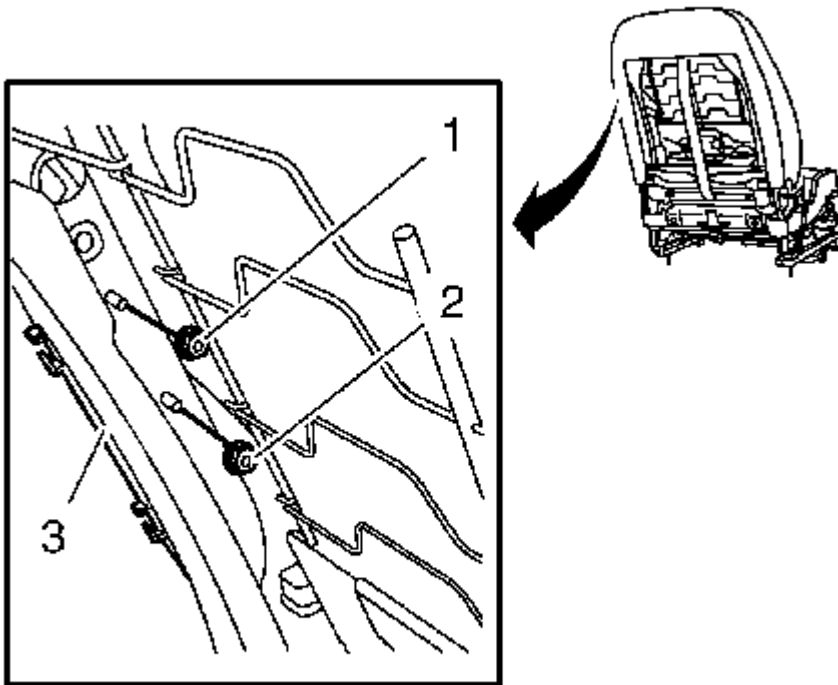


Fig. 9: Seat Side Inflatable Restraint Module And Nuts
Courtesy of GENERAL MOTORS COMPANY

14. Loosen both nuts (1, 2) from the seat side inflatable restraint module (3).

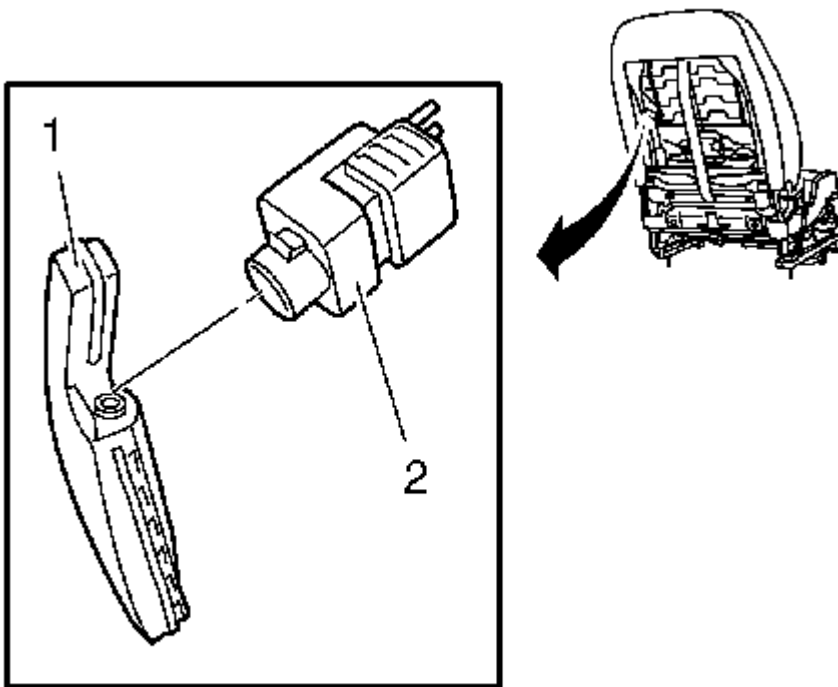


Fig. 10: Wiring Harness Connector And From Seat Side Inflatable Restraint Module
Courtesy of GENERAL MOTORS COMPANY

15. Disconnect the wiring harness connector (2) from the seat side inflatable restraint module (1).

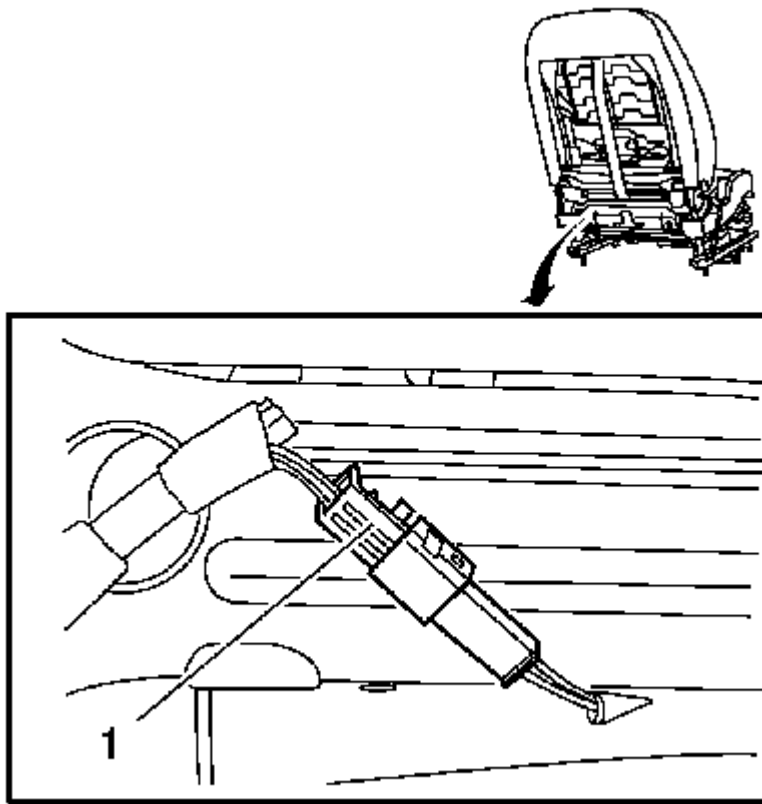


Fig. 11: Wiring Harness Connector And Seat Back Cushion Heater
Courtesy of GENERAL MOTORS COMPANY

16. Disconnect the wiring harness connector (1) of the seat back cushion heater.

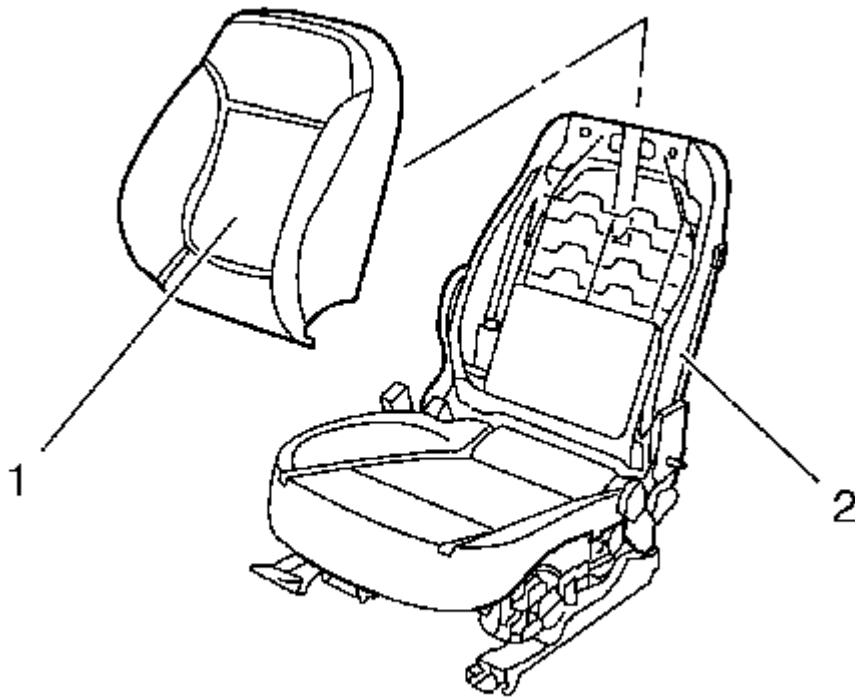


Fig. 12: Front Seat Back Cushion With Cushion Pad And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

17. Remove the front seat back cushion with cushion pad (1) from the backrest frame (2).

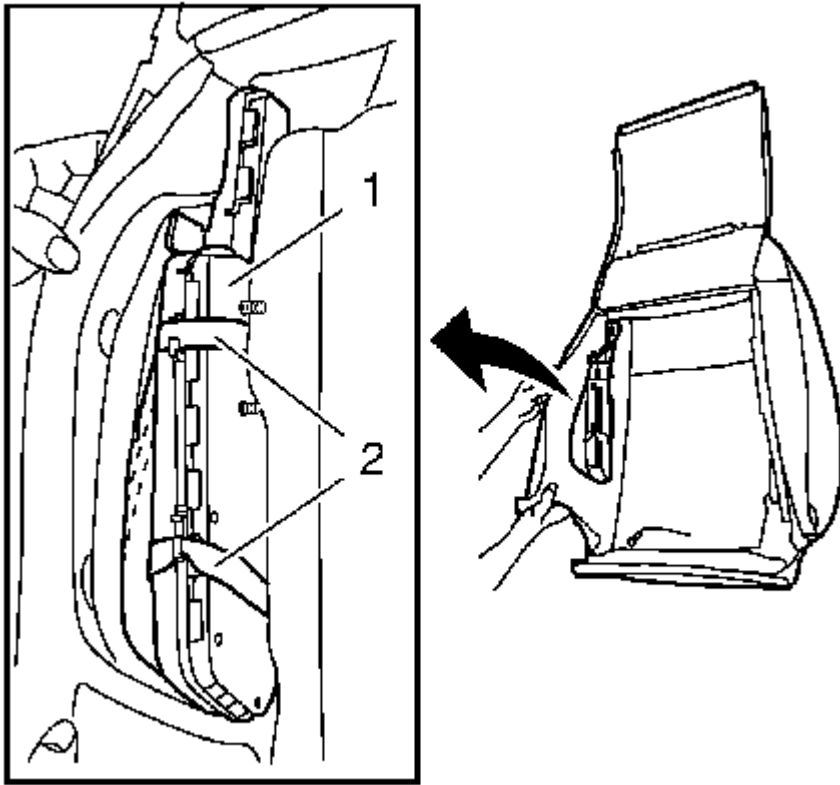


Fig. 13: Seat Side Inflatable Restraint Module And Textile Straps
Courtesy of GENERAL MOTORS COMPANY

18. Remove the seat side inflatable restraint module (1) out of the textile straps (2).

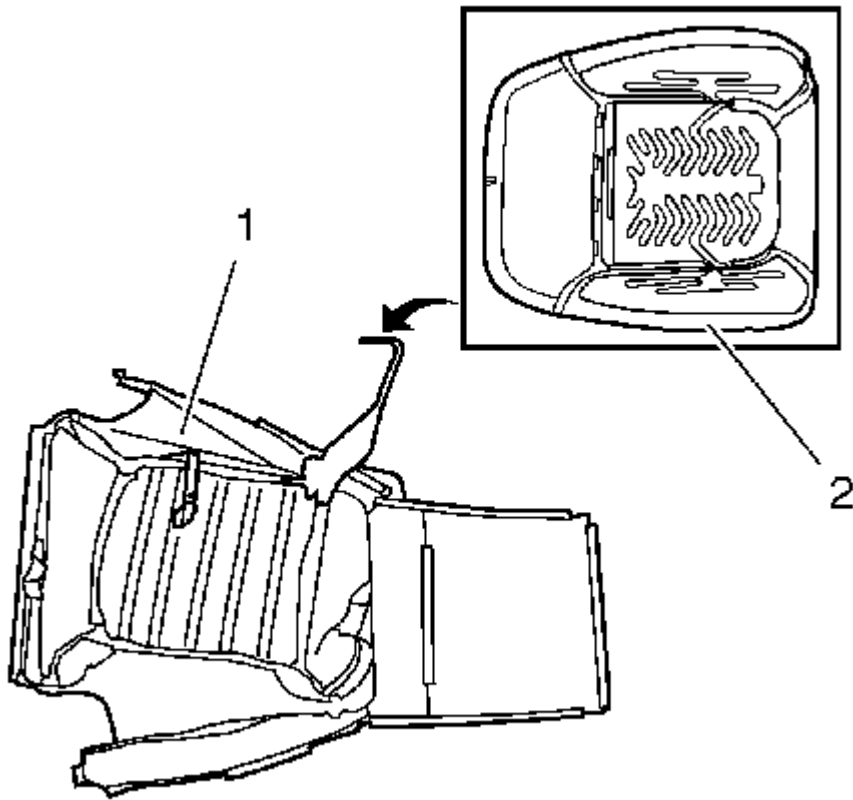


Fig. 14: Under Side Of Seat Cushion

Courtesy of GENERAL MOTORS COMPANY

19. Remove the hog rings from the under side of the seat cushion (1), pull the cushion cover off of the pad (2).

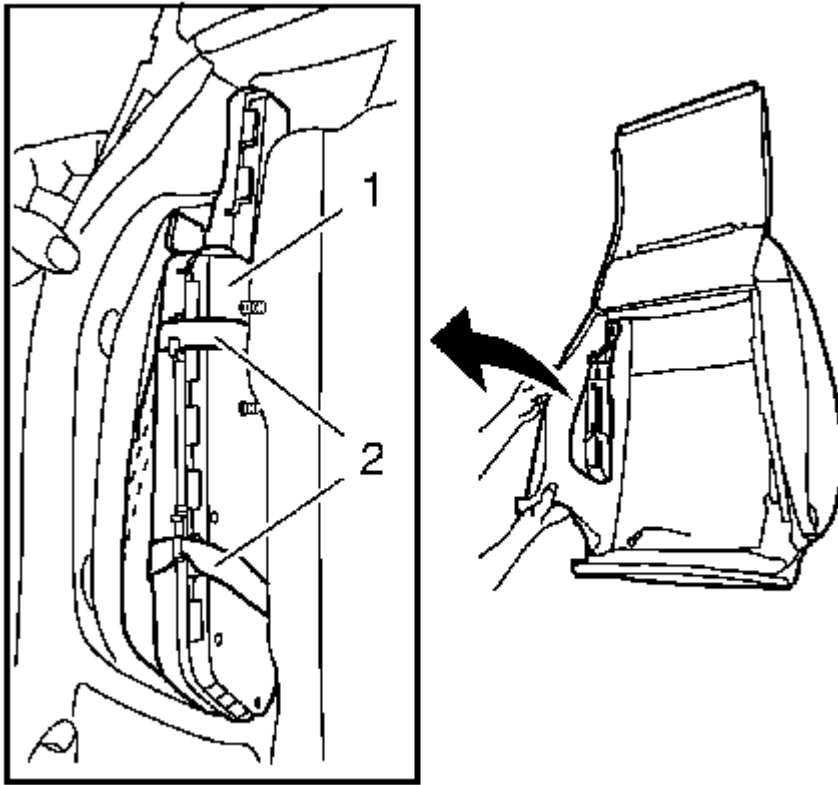


Fig. 15: Seat Side Inflatable Restraint Module And Textile Straps
Courtesy of GENERAL MOTORS COMPANY

20. Install the seat side inflatable restraint module (1) at cushion cover with the textile straps (2).

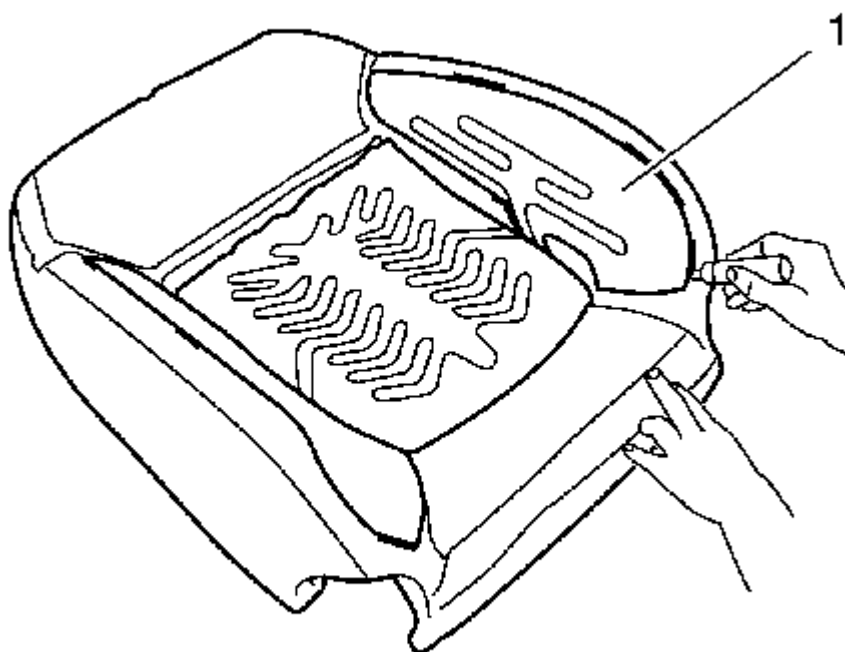


Fig. 16: Marking Position Of Seat Back Cushion Heater
Courtesy of GENERAL MOTORS COMPANY

21. Label the position of the seat back cushion heater (1) with marker.

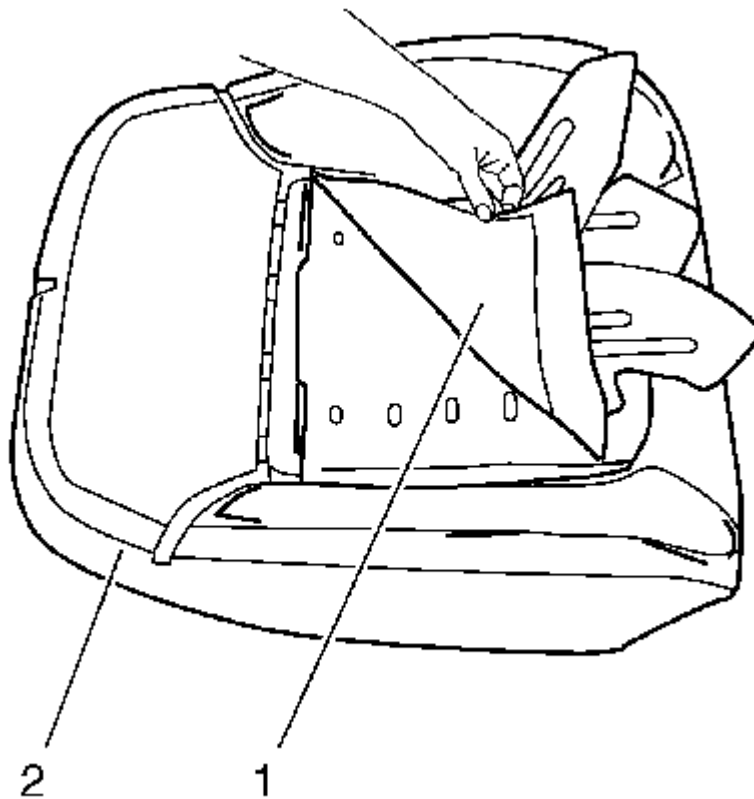


Fig. 17: Heating Mat And Seat Back Cushion Pad
Courtesy of GENERAL MOTORS COMPANY

NOTE: Remove the heating mat careful from seat back cushion pad. If the seat cushion pad is too strongly damaged, this must be replaced.

22. Remove the seat back cushion heater (1) from the seat back cushion pad (2).

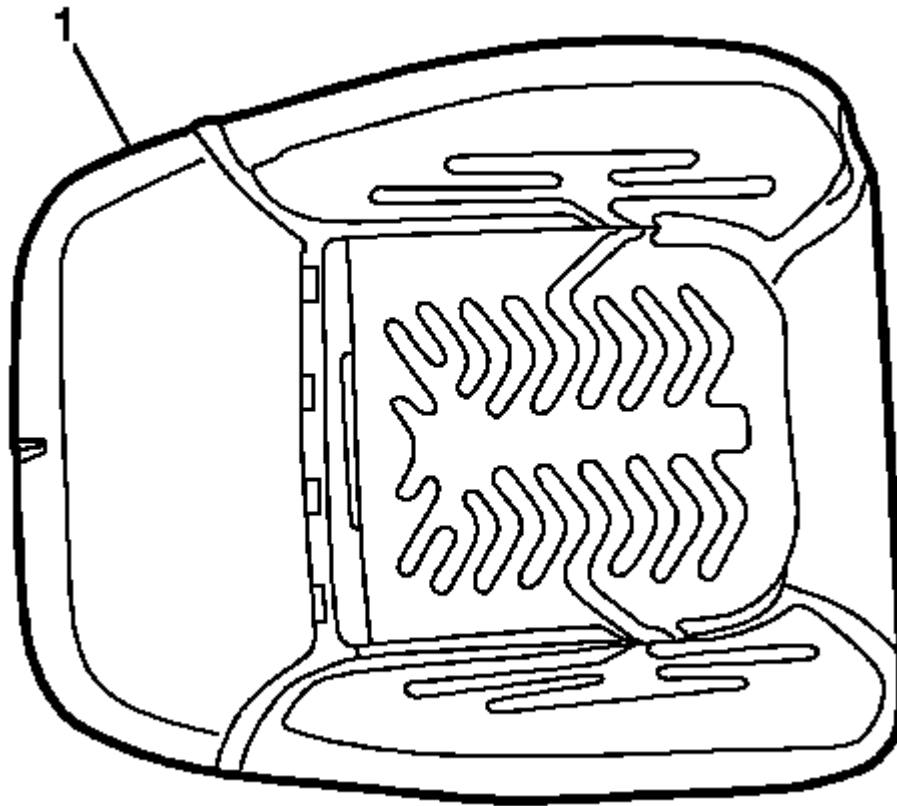


Fig. 18: Seat Back Cushion Heater
Courtesy of GENERAL MOTORS COMPANY

23. Install seat back cushion heater (1) at cushion pad:

Remove the foil from the new seat back cushion heater mat, and install the seat back cushion heater at cushion pad. Proof the correct position and gluing of the seat back cushion heater.

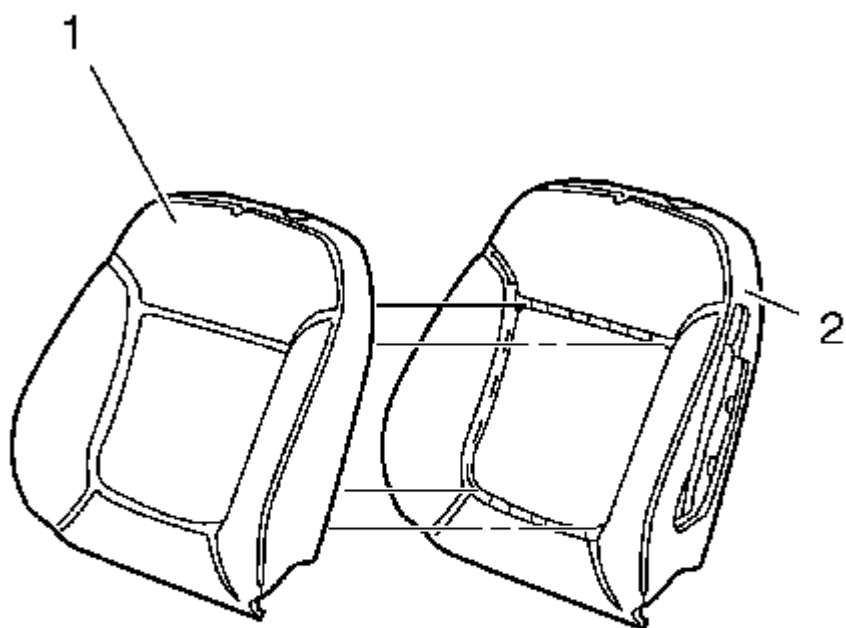


Fig. 19: Front Seat Cushion Cover And Cushion Pad
Courtesy of GENERAL MOTORS COMPANY

24. Install the front seat cushion cover (1) at the cushion pad (2) with hog rings.

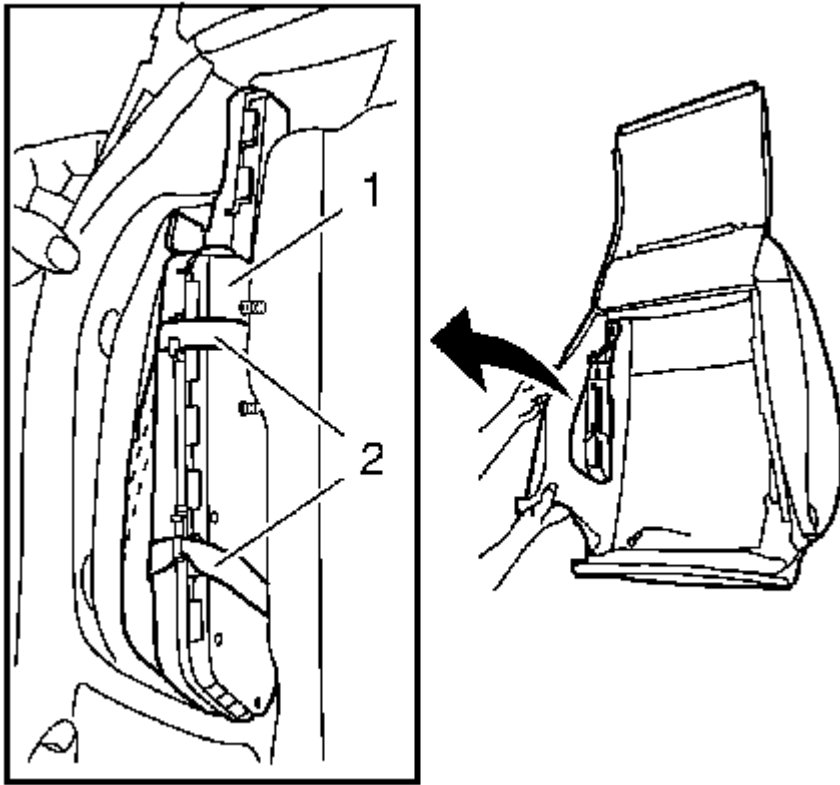


Fig. 20: Seat Side Inflatable Restraint Module And Textile Straps
Courtesy of GENERAL MOTORS COMPANY

25. Install the seat side inflatable restraint module (1) at cushion cover with the textile straps (2).

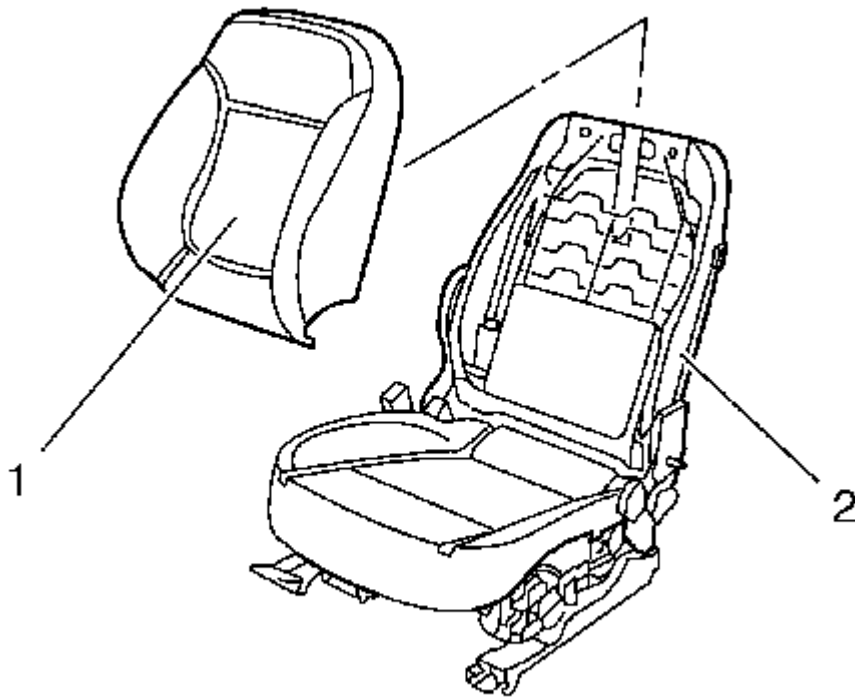


Fig. 21: Front Seat Back Cushion With Cushion Pad And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

26. Install the front seat back cushion with cushion pad (1) at the backrest frame (2).

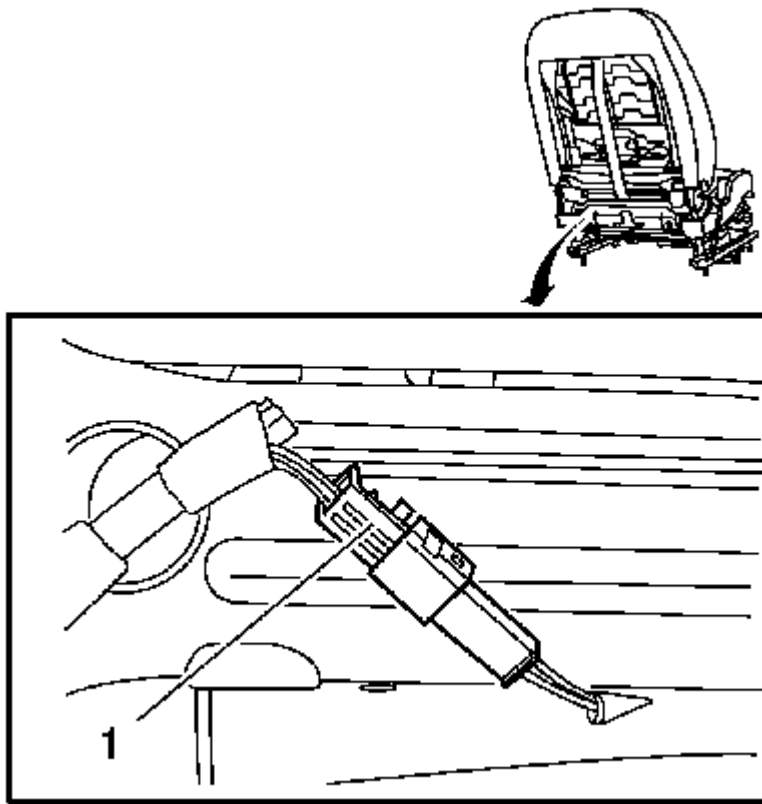


Fig. 22: Wiring Harness Connector And Seat Back Cushion Heater
Courtesy of GENERAL MOTORS COMPANY

27. Connect the wiring harness connector (1) of the seat back cushion heater.

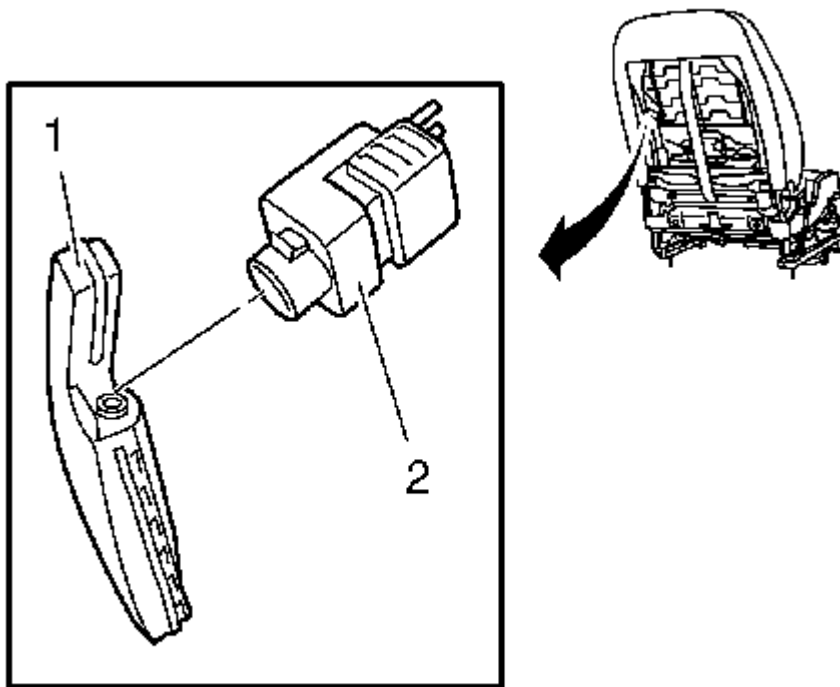


Fig. 23: Wiring Harness Connector And From Seat Side Inflatable Restraint Module
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Proof the correct locking of wiring harness connector (2).**

28. Connect the wiring harness connector (2) from seat side inflatable restraint module (1).

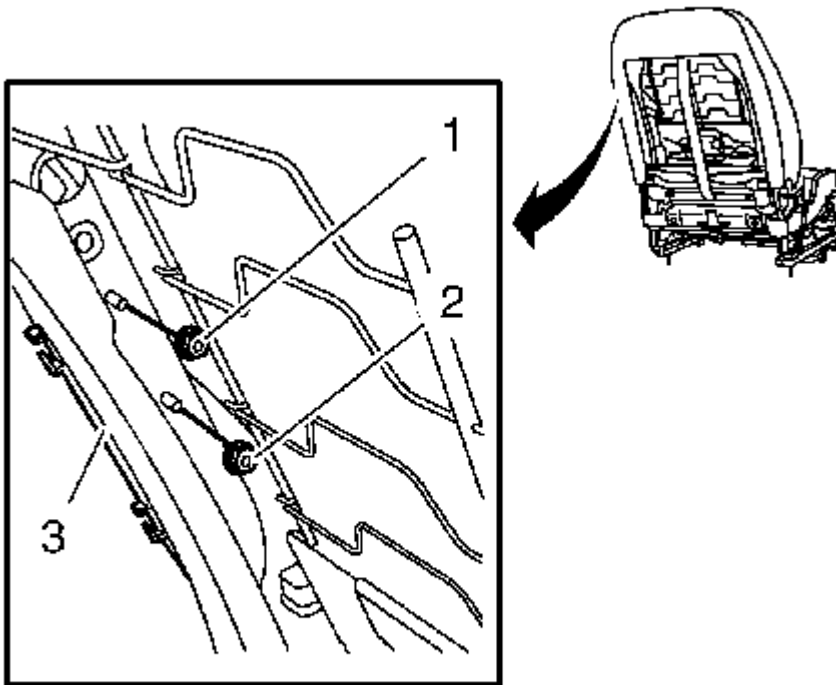


Fig. 24: Seat Side Inflatable Restraint Module And Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

29. Position the seat side inflatable restraint module (3) the backrest frame. Screw both nuts (1, 2) from seat side inflatable restraint module (3) and tighten to 3.25 N.m (29 lb in).

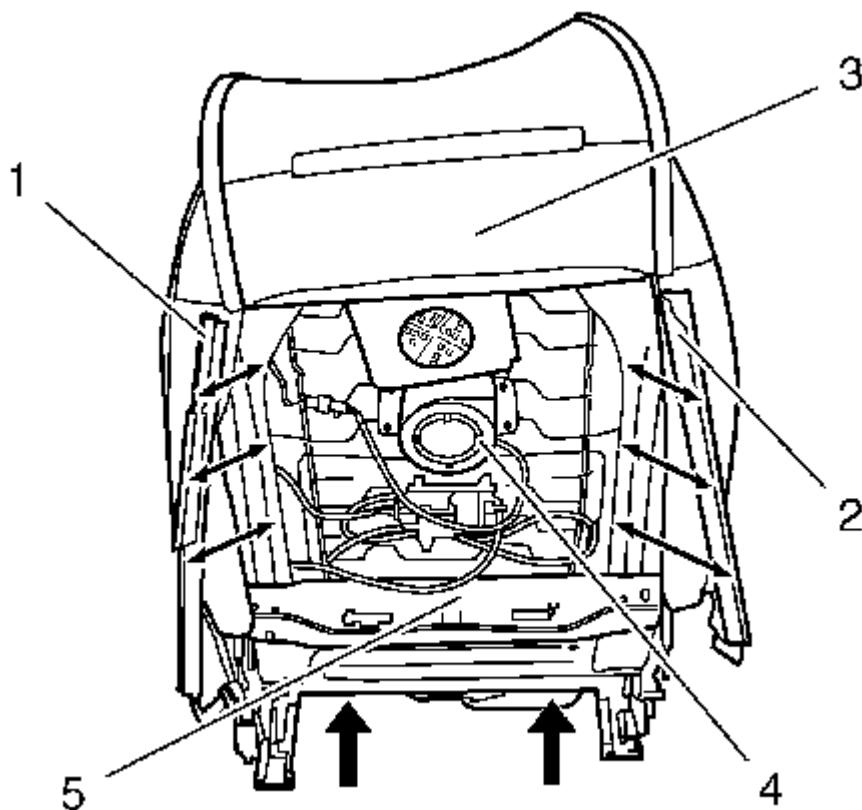


Fig. 25: Front Seat Back Cushion And Backrest Frame
 Courtesy of GENERAL MOTORS COMPANY

30. Clip in the front seat back cushion vent fan mat (3) at the vent fan (4). Position the cushion (5).
31. Install the front seat back cushion at backrest left side (1) and right side (2).
32. Install the front seat head restraint adjust rod guide. Refer to **Front Seat Head Restraint Guide Replacement** .
33. Install the front seat head restraint guide bezel. Refer to **Front Seat Head Restraint Guide Bezel Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)** , **Front Seat Head Restraint Guide Bezel Replacement (8-Way Power)** .
34. Install the front seat head restraint. Refer to **Driver or Passenger Seat Head Restraint Replacement (without AHS)** .
35. Close the cushion at backrest rear side.
36. Install the driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)** .
37. Install the driver or passenger seat adjuster finish cover. Refer to **Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)** .
38. Install the driver or passenger seat recliner lever, if equipped. Refer to **Driver or Passenger Seat Recliner Lever Replacement** .
39. Install the front seat outer adjuster finish cover. Refer to **Driver or Passenger Seat Outer Adjuster**

Finish Cover Replacement (8-Way Power) .

40. Remove the driver or passenger seat. Refer to **Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport) .**

DRIVER OR PASSENGER SEAT CUSHION HEATER REPLACEMENT

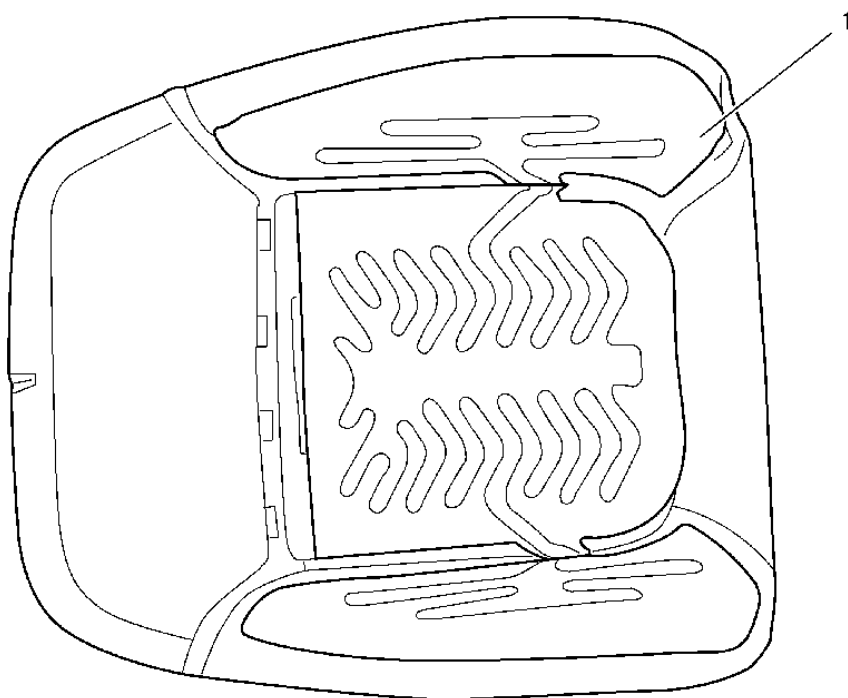


Fig. 26: Driver or Passenger Seat Cushion Heater
Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Cushion Heater Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the front seat. Refer to <u>Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport) .</u>	
2. Remove the driver or passenger seat cushion pad. Refer to <u>Driver or Passenger Seat Cushion Pad Replacement (2-Way, 4-Way Hybrid) , Driver or Passenger Seat Cushion Pad Replacement (8-Way Power) .</u>	
1	Driver Seat Cushion Heater
	Preliminary Procedure
	1. Disconnect the electrical.
	2. Separate the seat cushion from the seat cushion pad.

- | | |
|--|---|
| | 3. Remove the heater element leaving the old adhesive strips intact on the seat cushion cover. The new seat heat adhesive strips will be placed over the old adhesive strips. |
|--|---|

DESCRIPTION AND OPERATION

HEATED/VENTED SEAT DESCRIPTION AND OPERATION

Heated Seat Components

The heated/vented seat system consists of the following components:

- Heated seat switch
- Vented seat switch
- HVAC controls
- Seat memory control module or seat heating control module
- Seat cushion heating element
- Seat back heating element
- Seat cushion temperature sensor
- Seat cushion blower motor
- Seat back blower motor

Heated Seat Operation

NOTE: The passenger seat block diagram is identical to the driver seat.

Heated Seat Block Diagram

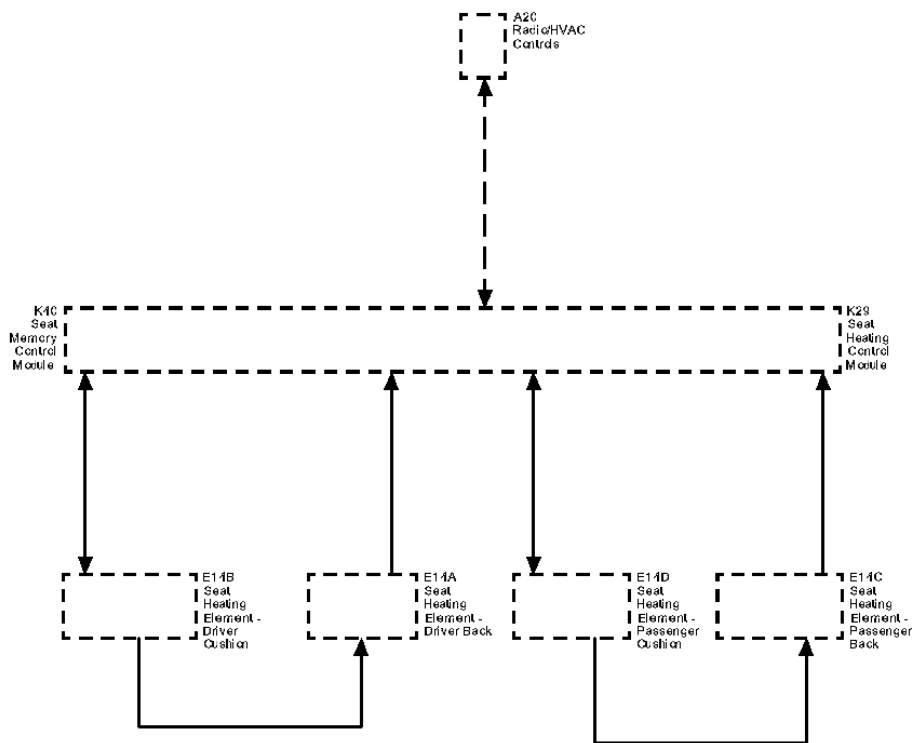


Fig. 27: Heated Seat Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DA	Serial Data
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
A20	A20 Radio/HVAC Controls
K29	K29 Seat Heating Control Module
E14C	E14C Seat Heating Element - Passenger Back
E14D	E14D Seat Heating Element - Passenger Cushion
E14A	E14A Seat Heating Element - Driver Back

E14B	E14B Seat Heating Element - Driver Cushion
K40	K40 Seat Memory Control Module

The driver and passenger heated seats are controlled by separate heated seat switches that are located in the HVAC controls. When a heated seat switch is pressed, a serial data message is sent from the HVAC controls to the HVAC control module indicating the heated seat command. The HVAC control module serves as a gateway to transmit the message to the seat memory control module/seat heating control module via the serial data line. In response to this message, the seat memory control module/seat heating control module applies battery voltage through the element supply voltage circuit of the seat heating elements. The seat memory control module/seat heating control module sends a serial data message back to the HVAC control module to gateway the information to the HVAC controls to either illuminate or turn off the appropriate temperature indicator.

Temperature Regulation

The seat memory control module/seat heating control module monitors the seat temperature through the temperature sensor signal circuit and the temperature sensor (thermistor) located in the seat cushion with the heater element. The temperature sensor is a variable resistor, its resistance varies as the temperature of the seat changes. When the temperature sensor resistance indicates to the seat memory control module/seat heating control module that the seat has reached the desired temperature, the module opens the ground path of the seat heating elements through the heated seat element control circuit. The module will then cycle the element control circuit open and closed in order to maintain the desired temperature.

Vented Seat Operation

NOTE: **The passenger seat block diagram is identical to the driver seat.**

Cooled Seat Block Diagram

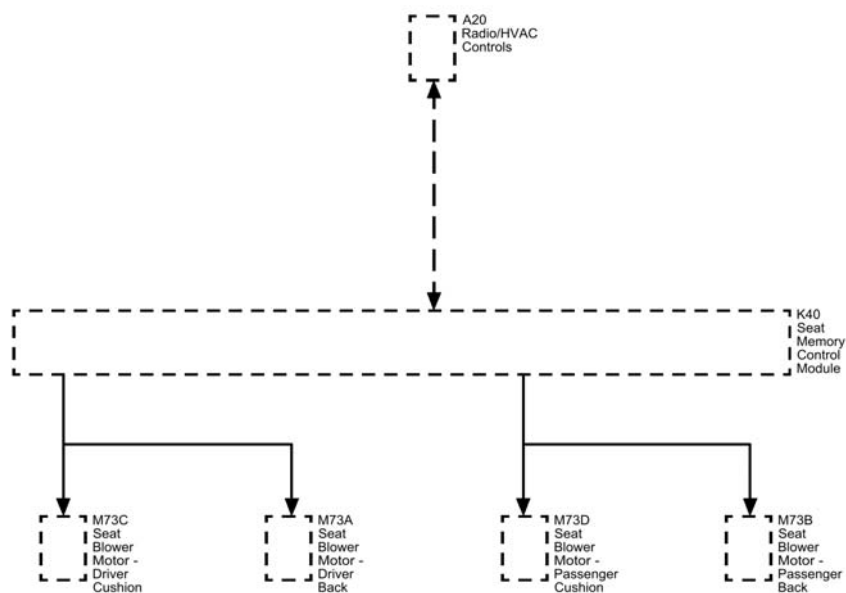


Fig. 28: Cooled Seat Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DA	Serial Data
HW	Hard-Wired
HW	Hard-Wired
A20	A20 Radio/HVAC Controls
K40	K40 Seat Memory Control Module
M73C	M73C Seat Blower Motor - Driver Cushion
M73A	M73A Seat Blower Motor - Driver Back
M73D	M73D Seat Blower Motor - Passenger Cushion
M73B	M73B Seat Blower Motor - Passenger Back

The vented seat operation is designed to draw cabin air around and away from the occupant through small holes in the seat cushion and seat back covers, through channels in the foam pad, and then through the blower motor exhausting the waste air under the seat cushion.

The driver and passenger vented seats are controlled by separate vented seat switches located in the HVAC controls. With the ignition ON, Ignition voltage is supplied to the driver and passenger seat blower motors through a 10 A fuse located in the underdood fuse block. Ground is provided to the driver and passenger seat blower motors from G305. When a vented seat switch is pressed, a serial data message is sent from the HVAC controls to the HVAC control module indicating the vented seat command. The HVAC control module serves as a gateway to transmit the message to the seat memory control module/seat heating control module via the serial data line. In response to this message, the seat memory control module/seat heating control module applies a low side pulse width modulation (PWM) signal through the blower motor control circuits to the seat cushion and seat back blower motors indicating the vented seat command. The logic in the blower motors then sets the blower speed to the switch set point. Both blower motors run drawing cabin air around and away from occupant. The seat memory control module/seat heating control module then sends a serial data message back to the HVAC control module to gateway the information back to the HVAC controls to either illuminate or turn off the appropriate switch indicator.

Load Management

The electrical power management function is designed to monitor the vehicle electrical load and determine when the battery is potentially in a high discharge condition. The heated seat system is one of the vehicle loads that is subject to reduction during a battery discharge condition. For more information on load management refer to **Electrical Power Management Description and Operation** .

DTC	Description
<u>DTC B1295</u>	DTC B1295 07 Steering Wheel Controls Group 2 Signal Circuit High Voltage
<u>DTC B1405</u>	DTC B1405 03 Control Module Voltage Reference Output 2 Circuit Low Voltage

	DTC B1405 07 Control Module Voltage Reference Output 2 Circuit High Voltage
<u>DTC B1529</u>	DTC B1529 03 Control Module Voltage Reference Output 5 Circuit Low Voltage DTC B1529 07 Control Module Voltage Reference Output 5 Circuit High Voltage
<u>DTC B3622</u>	DTC B3622 07 Steering Wheel Controls Signal Circuit High Voltage

DTC B1295: STEERING WHEEL CONTROLS GROUP 2 SIGNAL CIRCUIT HIGH VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1295 07

Steering Wheel Controls Group 2 Signal Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12V Reference	1	1	-	-
Steering Wheel Control Switch Signal	1	1	B1295	-
1. Steering Wheel Controls Inoperative				

Circuit/System Description

The body control module (BCM) supplies voltage to the steering wheel control switches and monitors the return signal. Each switch state is associated to a set resistance value and when pressed a specific voltage drop occurs across the resistor unique to the switch. The BCM identifies the switch selection and activates the feature.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The ignition is ON.

Conditions for Setting the DTC

- The BCM detects a short to voltage on the signal circuit.
- The above condition is present for greater than 30 s.

Action Taken When the DTC Sets

The BCM will ignore switch inputs.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction free ignition cycles have occurred.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the S70R Steering Wheel Controls Switch - Right, ignition ON.
2. Test for 11.8-12.2 V between the reference voltage circuit terminal 1 and ground.
 - **If less than 11.8 V**
 1. Ignition OFF, disconnect the harness connector at the K9 body control module.
 2. Test for infinite resistance between the reference voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the reference voltage circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K9 body control module.
- **If greater than 12.2 V**
- 1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
- 2. Test for less than 1 V between the reference voltage circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
- **If between 11.8-12.2 V**
- 3. Test for 11.8-12.2 V between the reference voltage circuit terminal 1 and signal circuit terminal 2.
 - **If not between 11.8-12.2 V**
 - 1. Ignition OFF, disconnect the harness connector at the K9 body control module.
 - 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms replace the K9 body control module.
 - **If between 11.8-12.2 V**
- 4. Ignition OFF, disconnect the harness connector at the K9 body control module.
- 5. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.

 - **If infinite resistance**
- 6. Test or replace the S70R Steering Wheel Controls Switch - Right.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

DTC B1405: CONTROL MODULE VOLTAGE REFERENCE OUTPUT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1405 03

Control Module Voltage Reference Output 2 Circuit Low Voltage

DTC B1405 07

Control Module Voltage Reference Output 2 Circuit High Voltage

Diagnostic Fault Information

Electrical DTCs

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V Reference	B1529 03, B1405 03	1	B1529 07	B1529 07
Signal	1	1	B3622 07	-
1. Steering Wheel Controls Inoperative				

Circuit/System Description

The body control module (BCM) monitors the system voltage to make sure that the voltage stays within the proper range. Damage to components and/or incorrect operation can occur when the voltage is out of range.

Conditions for Running the DTC

- Battery voltage is between 9-16 V.
- The ignition is ON.

Conditions for Setting the DTC

The BCM detects a low/high voltage on the control circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction free ignition cycles have occurred.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals.
2. Verify the voltage measured at the battery terminals is between 12.6-15.0 V.
 - **If not between 12.6-15.0 V**

Refer to **Charging System Test** .

- **If between 12.6-15.0 V**
3. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ensure a battery charger is not connected to the battery.
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right, ignition ON.
3. Test for 11-12.2 V between the reference voltage circuit terminal 1 and ground.
 - **If less than 11 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the reference voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the reference voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 12.2 V**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the reference voltage circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
- **If between 11-12.2 V**
4. Test for 11-12.2 V between the reference voltage circuit terminal 1 and signal circuit terminal 2.
 - **If not between 11-12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms replace the K9 Body Control Module.
 - **If between 11-12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S70R Steering Wheel Controls Switch - Right.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right.
2. Test the resistance between the signal terminal 2 and the reference voltage terminal 1 while pressing the appropriate steering wheel controls switch button listed below:
 - **If not the specified value**

Replace the S70R Steering Wheel Controls Switch - Right.

- **If the specified value**

3. All OK

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Hang Up-Mute	5.0 kohms	5.5 kohms
Telephone Switch	3.6 kohms	4 kohms
Source Switch	2.8 kohms	3.1 kohms
Arrow Down	2.2 kohms	2.6 kohms
Arrow Up	1.7 kohms	2 kohms
Volume Down	1.4 kohms	1.6 kohms
Volume Up	1.1 kohms	1.3 kohms

No Switch Pressed	Infinite	Infinite
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Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup.

DTC B1529: CONTROL MODULE VOLTAGE REFERENCE OUTPUT 5

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1529 03

Control Module Voltage Reference Output 5 Circuit Low Voltage

DTC B1529 07

Control Module Voltage Reference Output 5 Circuit High Voltage

Diagnostic Fault Information

Electrical DTCs

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V Reference	B1529 03, B1405 03	1	B1529 07	B1529 07
Signal	1	1	B3622 07	-
1. Steering Wheel Controls Inoperative				

Circuit/System Description

The body control module (BCM) supplies voltage to the steering wheel control switches and monitors the return signal. Each switch state is associated to a set resistance value and when pressed a specific voltage drop occurs across the resistor unique to the switch. The BCM identifies the switch selection and activates the feature.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The ignition is ON.

Conditions for Setting the DTC

B1529 03

- The BCM detects a short to ground in the 12 V reference circuit.
- The above condition is present for greater than 30 seconds.

B1529 07

- The BCM detects a short to voltage in the 12 V reference circuit.
- The above condition is present for greater than 30 seconds.

Action Taken When the DTC Sets

The BCM will ignore switch inputs.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction free ignition cycles have occurred.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ensure a battery charger is not connected to the battery.
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right, ignition ON.
3. Test for 11-12.2 V between the reference voltage circuit terminal 1 and ground.
 - **If less than 11 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the reference voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the reference voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the reference voltage circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If between 11-12.2 V**
4. Test for 11-12.2 V between the reference voltage circuit terminal 1 and signal circuit terminal 2.
 - **If not between 11-12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms replace the K9 Body Control Module.
 - **If between 11-12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S70R Steering Wheel Controls Switch - Right.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right.
2. Test the resistance between the signal terminal 2 and the reference voltage terminal 1 while pressing the appropriate steering wheel controls switch button listed below:

- **If not the specified value**

Replace the S70R Steering Wheel Controls Switch - Right.

- **If the specified value**

3. All OK

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Hang Up-Mute	5.0 kohms	5.5 kohms
Telephone Switch	3.6 kohms	4 kohms
Source Switch	2.8 kohms	3.1 kohms
Arrow Down	2.2 kohms	2.6 kohms
Arrow Up	1.7 kohms	2 kohms
Volume Down	1.4 kohms	1.6 kohms
Volume Up	1.1 kohms	1.3 kohms
No Switch Pressed	Infinite	Infinite

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup.

DTC B3622: STEERING WHEEL CONTROLS SIGNAL CIRCUIT HIGH VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3622 07

Steering Wheel Controls Signal Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V Reference	B1529 03, B1405 03	1	B1529 07	B1529 07
Signal	1	1	B3622 07	-

1. Steering Wheel Controls Inoperative

Circuit/System Description

The body control module (BCM) monitors the steering wheel control signal circuit voltage. If the voltage level is too high, damage may result in the system. When a high voltage condition is detected, the BCM will ignore the switch command.

Conditions for Running the DTC

- Battery voltage is between 9-16 V.
- The ignition is ON.

Conditions for Setting the DTC

The BCM detects a short to voltage in the steering wheel control switch signal circuit.

Action Taken When the DTC Sets

The BCM will ignore switch inputs.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction free ignition cycles have occurred.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ensure a battery charger is not connected to the battery.
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right, ignition ON.
3. Test for 11-12.2 V between the reference voltage circuit terminal 1 and ground.
 - **If less than 11 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the reference voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the reference voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the reference voltage circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If between 11-12.2 V**
4. Test for 11-12.2 V between the reference voltage circuit terminal 1 and signal circuit terminal 2.
 - **If not between 11-12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms replace the K9 Body Control Module.
 - **If between 11-12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S70R Steering Wheel Controls Switch - Right.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right.
2. Test the resistance between the signal terminal 2 and the reference voltage terminal 1 while pressing the appropriate steering wheel controls switch button listed below:

- **If not the specified value**

Replace the S70R Steering Wheel Controls Switch - Right.

- **If the specified value**

3. All OK

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Hang Up-Mute	5.0 kohms	5.5 kohms
Telephone Switch	3.6 kohms	4 kohms
Source Switch	2.8 kohms	3.1 kohms
Arrow Down	2.2 kohms	2.6 kohms
Arrow Up	1.7 kohms	2 kohms
Volume Down	1.4 kohms	1.6 kohms
Volume Up	1.1 kohms	1.3 kohms
No Switch Pressed	Infinite	Infinite

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup.

SYMPTOMS - SECONDARY AND CONFIGURABLE CUSTOMER CONTROLS

NOTE: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Steering Wheel Controls Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the steering wheel controls. Refer to **Checking Aftermarket Accessories**.
- Inspect the easily accessible or visible system components, for obvious damage or conditions, which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Refer to **Steering Wheel Controls Malfunction** in order to diagnose the symptom.

STEERING WHEEL CONTROLS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12 V Reference	B1529 03, B1405 03	1	B1529 07	B1529 07
Signal	1	1	B3622 07	-
1. Steering Wheel Controls Inoperative				

Circuit/System Description

The body control module (BCM) supplies voltage to the audio steering wheel control switches and monitors the return signal. Each switch state is associated to a set resistance value and when pressed a specific voltage drop occurs across the resistor unique to the switch. The BCM identifies the switch selection and activates the feature.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the primary controls of the associated component are functioning properly.
 - **If any of the primary controls do not function properly**

Refer to **Symptoms - Entertainment**

- **If all of the primary controls function properly**
3. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ensure a battery charger is not connected to the battery.
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right, ignition ON.
3. Test for 11-12.2 V between the reference voltage circuit terminal 1 and ground.
 - **If less than 11 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the reference voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the reference voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the reference voltage circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K9 Body Control Module.
- **If between 11-12.2 V**
- 4. Test for 11-12.2 V between the reference voltage circuit terminal 1 and signal circuit terminal 2.
 - **If not between 11-12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms replace the K9 Body Control Module.
 - **If between 11-12.2 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S70R Steering Wheel Controls Switch - Right.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S70R Steering Wheel Controls Switch - Right.
2. Test the resistance between the signal terminal 2 and the reference voltage terminal 1 while pressing the appropriate steering wheel controls switch button listed below:
 - **If not the specified value**

Replace the S70R Steering Wheel Controls Switch - Right.

- **If the specified value**
- 3. All OK

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Hang Up-Mute	5.0 kohms	5.5 kohms
Telephone Switch	3.6 kohms	4 kohms
Source Switch	2.8 kohms	3.1 kohms
Arrow Down	2.2 kohms	2.6 kohms
Arrow Up	1.7 kohms	2 kohms
Volume Down	1.4 kohms	1.6 kohms
Volume Up	1.1 kohms	1.3 kohms
No Switch Pressed	Infinite	Infinite

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup.

DESCRIPTION AND OPERATION

STEERING WHEEL CONTROLS DESCRIPTION AND OPERATION

Steering Wheel Controls Block Diagram

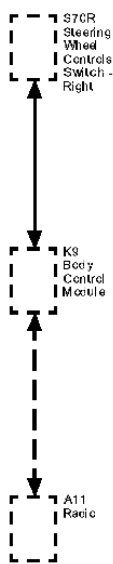


Fig. 2: Steering Wheel Controls Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DA	Serial Data
HW	Hard-Wired
S70R	S70R Steering Wheel Controls Switch - Right
K9	K9 Body Control Module
A11	A11 Radio

The steering wheel control switches duplicate the function of the primary controls of the associated component, through a network of momentary contact switches and a series of resistors. The body control module (BCM) supplies voltage to the switches and monitors the return signal. When a switch is pressed, a specific voltage drops across the resistor unique to that switch. The BCM identifies the switch selected and sends a serial data

message to the component controlled by the switch, activating the feature.

This section is intended to diagnose the circuits between the BCM and the steering wheel control switches. If the primary control for the device is inoperative, refer to the appropriate section for the component the steering wheel control switch is used for.

Transmission

Shift Lock Control

SCHEMATIC WIRING DIAGRAMS

SHIFT LOCK CONTROL WIRING SCHEMATICS

Shift Lock Control System

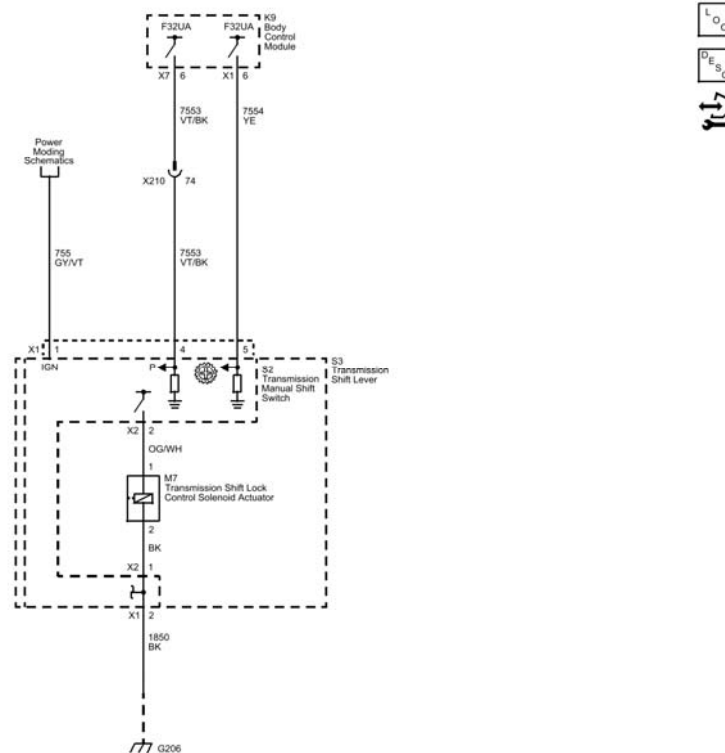


Fig. 1: Shift Lock Control System

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B270A	DTC B270A 01 Park Lock Solenoid Control Circuit Short to Battery DTC B270A 02 Park Lock Solenoid Control Circuit Short to Ground DTC B270A 04 Park Lock Solenoid Control Circuit Open

DTC B270A: PARK LOCK SOLENOID CONTROL CIRCUIT SHORT TO BATTERY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B270A 01

Park Lock Solenoid Control Circuit Short to Battery

DTC B270A 02

Park Lock Solenoid Control Circuit Short to Ground

DTC B270A 04

Park Lock Solenoid Control Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
F24DA (BCM 4) Fuse B+	B270A 02	B270A 04	-	-
Control	B270A 02	B270A 04	B270A 01	-
Ground	-	B270A 04	-	-

Circuit/System Description

The body control module (BCM) controls the transmission shift lock control solenoid actuator by providing a battery positive voltage to the solenoid when the brake pedal is applied. The BCM monitors the voltage and current flow of the control circuit.

Conditions for Running the DTC

- The ignition switch is in the ON position.
- The brake pedal is applied.
- The transmission is in the PARK position.
- The DTC runs continuously once the above conditions are met.

Conditions for Setting the DTC

B270A 01

The body control module detects a short to voltage in the transmission shift lock control solenoid actuator control circuit for 1 second.

B270A 02

The body control module detects a short to ground in the transmission shift lock control solenoid actuator control circuit for 1 second.

B270A 04

The body control module detects an open or short to voltage in the transmission shift lock control solenoid actuator control circuit for 1 second.

Action Taken When the DTC Sets

The body control module will not attempt to enable the voltage supply circuit of the transmission shift lock control solenoid actuator until the next key cycle.

Conditions for Clearing the DTC

- A current DTC B270A will clear when the malfunction is no longer present and the ignition switch is cycled.
- A history DTC will clear after 100 ignition cycles with no current DTC active during the 100 ignition cycles.

Reference Information

Schematic Reference

Shift Lock Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic Transmission Shift Lock Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Brake Transmission Shift Interlock Solenoid Actuator Command parameter changes from Inactive to Active when the brake pedal is applied.

- **If the Brake Transmission Shift Interlock Solenoid Actuator Command does not change**

Refer to **Stop Lamps Malfunction**

- **If the Brake Transmission Shift Interlock Solenoid Actuator Command changes**

3. Verify the S3 transmission shift lever moves out of the PARK position when the brake pedal is applied.

- **If the the S3 transmission shift lever does not move out of the PARK position**

Refer to Circuit/System Testing.

- **If the the S3 transmission shift lever does move out of the PARK position**

All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K9 body control module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.

- **If the test lamp illuminates**

3. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S3 transmission shift lever. It may take up to 2 minutes for all vehicle systems to power down.

4. Test for less than 10 ohms between the ground circuit terminal 2 X1 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**
- 5. Ignition ON, connect a test lamp between the control circuit terminal 4 X1 and the ground circuit terminal 2 X1.
- 6. Verify the test lamp turns ON and OFF when commanding the Brake Transmission Shift Interlock Solenoid Actuator ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
 4. Ignition ON.
 5. Verify a test lamp illuminates between each B+ and ignition circuit terminal at the control module harness connector.
 - If the test lamp does not illuminate, repair the circuit or fuse as necessary.
 - If the test lamp illuminates at each B+ and ignition circuit, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
- 7. Test or replace the S3 transmission shift lever.

Component Testing

Dynamic Test

1. Install a 10 A fused jumper wire between the control terminal 4 X1 and 12 V. Momentarily install a jumper wire between the ground terminal 2 X1 and ground.
2. Verify the solenoid turns on & off/clicks, etc.
 - **If the solenoid does not turn on & off/clicks, etc.**

Replace the S3 transmission shift lever.
 - **If the solenoid does turn on & off/clicks, etc.**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Transmission Control Replacement**
- **Control Module References** for BCM replacement, programming, and setup

SYMPTOMS - AUTOMATIC TRANSMISSION SHIFT LOCK CONTROL

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Automatic Transmission Shift Lock Control Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the automatic transmission shift lock control. Refer to **Checking Aftermarket Accessories**.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**

Symptom List

Refer to a symptom diagnostic procedure in order to diagnose the symptom:

Transmission Control Lever Malfunction

TRANSMISSION CONTROL LEVER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	1	1	2	-
Ground	-	1	-	-
1. Transmission shift control lever will not move from PARK with the brake pedal applied. 2. Transmission shift control lever will move from PARK without the brake pedal applied.				

Circuit/System Description

The body control module (BCM) controls the transmission shift lock control solenoid actuator by providing a battery positive voltage to the solenoid when the brake pedal is applied. The BCM monitors the voltage and current flow of the control circuit.

Reference Information

Schematic Reference

Shift Lock Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic Transmission Shift Lock Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Brake Transmission Shift Interlock Solenoid Actuator Command parameter changes from Inactive to Active when the brake pedal is applied.
 - **If the Brake Transmission Shift Interlock Solenoid Actuator Command does not change**

Refer to **Stop Lamps Malfunction**

- **If the Brake Transmission Shift Interlock Solenoid Actuator Command changes**

3. Verify the S3 transmission shift lever moves out of the PARK position when the brake pedal is applied.

- **If the the S3 transmission shift lever does not move out of the PARK position**

Refer to Circuit/System Testing.

- **If the the S3 transmission shift lever does move out of the PARK position**

All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the S3 transmission shift lever. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON, connect a test lamp between the control circuit terminal 4 X1 and the ground circuit terminal 2 X1.
4. Verify the test lamp turns ON and OFF when commanding the Brake Transmission Shift Interlock Solenoid Actuator ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
 4. Ignition ON.
 5. Verify a test lamp illuminates between each B+ and ignition circuit terminal at the control module harness connector.
 - If the test lamp does not illuminate, repair the circuit or fuse as necessary.
 - If the test lamp illuminates at each B+ and ignition circuit, replace the K9 body control module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.

- **If the test lamp turns ON and OFF**

5. Test or replace the S3 transmission shift lever.

Component Testing

Dynamic Test

1. Install a 10 A fused jumper wire between the control terminal 4 X1 and 12 V. Momentarily install a jumper wire between the ground terminal 2 X1 and ground.
2. Verify the solenoid turns on & off/clicks, etc.
 - **If the solenoid does not turn on & off/clicks, etc.**

Replace the S3 transmission shift lever.

- **If the solenoid does turn on & off/clicks, etc.**

3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Transmission Control Replacement**
- **Control Module References** for BCM replacement, programming, and setup.

DESCRIPTION AND OPERATION

AUTOMATIC TRANSMISSION SHIFT LOCK CONTROL DESCRIPTION AND OPERATION

The automatic transmission park lock control system is a safety device that prevents an inadvertent shift out of PARK. The driver must press the brake pedal before moving the park lever out of the PARK position. The system consists of the following components:

- The automatic transmission park lock solenoid (serviced as the automatic transmission shift lock actuator), is located within the floor shift control assembly.
- The body control module, which controls the voltage supply circuit of the park lock control solenoid.
- The engine control module.

The body control module controls the voltage to the park lock control solenoid through the park lock control solenoid controlled voltage circuit. The following conditions must be met before the body control module will

supply voltage to the park lock solenoid:

- The ignition is in the ON position.
- The engine control module sends an input via GMLAN serial data to the body control module indicating the transmission is in the PARK position.
- The body control module determines the brake pedal is applied according the brake pedal position.

Since the park lock control solenoid is permanently grounded, the body control module supplies voltage to the automatic transmission park lock control solenoid, unlocking the park lever allowing the driver to move the park lever out of the PARK position as the solenoid energizes. When the brake pedal is not applied, the body control module turns the control voltage output of the park lock control solenoid OFF, de-energizing the park lock control solenoid. The de-energized solenoid mechanically locks the park lever in the PARK position.

General Information

Squeaks and Rattles

DIAGNOSTIC INFORMATION AND PROCEDURES

SQUEAKS AND RATTLES

Special Tools

- **CH-39570** Chassis Ear
- **GE-41416** Ultrasonic Leak Detector

For equivalent regional tools, refer to **Special Tools**.

NOTE: Squeaks and rattles are caused by improperly controlled relative motion between vehicle components. There are 4 ways to prevent squeaks and rattles.

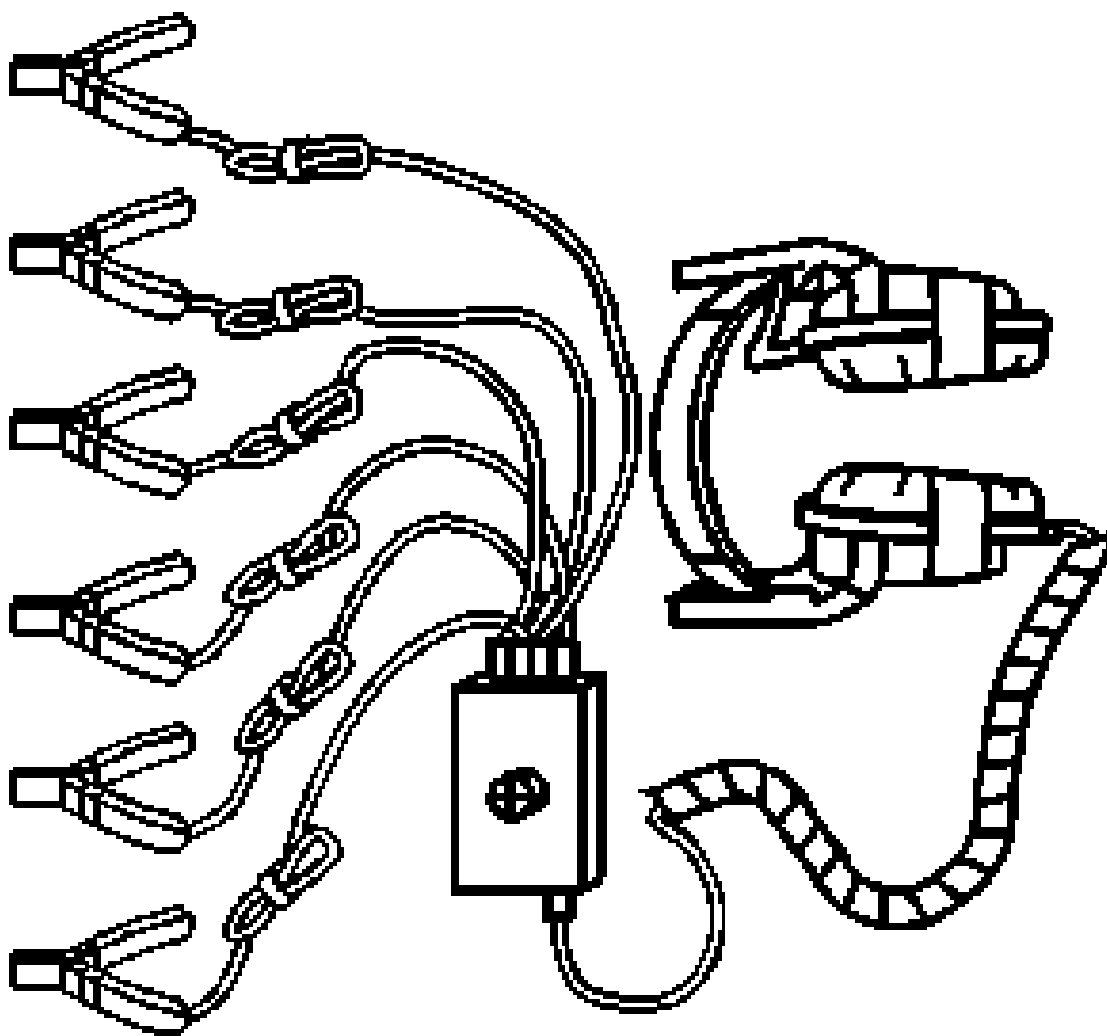
To aid in diagnosing, use CH-39570 ear or GE-41416 detector.

- Attach the component that squeaks or rattles securely.
- Separate the components that squeak or rattle to prevent contact.
- Insulate the components that squeak or rattle.
- Insulate low uniform friction surfaces to eliminate stickslip motion.

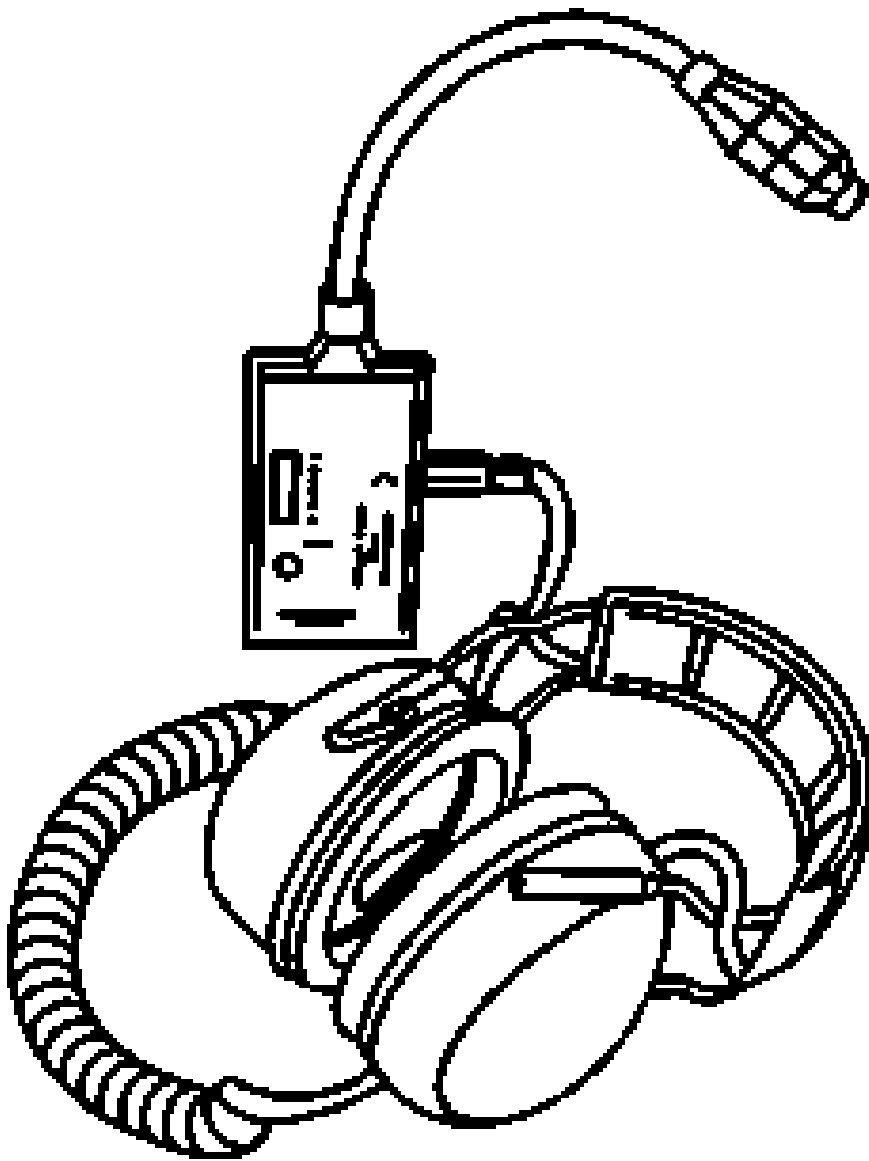
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description



CH-39570
J 39570
Chassis Ear



GE-41416
J 41416
Ultrasonic
Leak
Detector

Charging System (HP6)

	DTC C0895 07 Device Voltage Below Threshold DTC C0899 00 Device Voltage Low DTC C0900 00 Device Voltage High DTC P0560 System Voltage DTC P0562 System Voltage Low Voltage DTC P0563 System Voltage High Voltage
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DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, OR P0563: DEVICE POWER CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1325 03

Device Power Circuit Voltage Below Threshold

DTC B1325 07

Device Power Circuit Voltage Above Threshold

DTC B1330 03

Device Power 2 Circuit Voltage Below Threshold

DTC B1420 00

Device Voltage 1

DTC B1424 00

Device Voltage Low

DTC B1517 03

Battery Voltage Below Threshold

DTC B1517 07

Battery Voltage Above Threshold

DTC B1517 5A

Battery Voltage Plausibility Failure

DTC C12E1 00

Device Voltage Low

DTC C0800 03

Device Power 1 Circuit Voltage Below Threshold

DTC C0800 07

Device Power 1 Circuit Voltage Above Threshold

DTC C0800 11

Device Power 1 Circuit High Input

DTC C0800 0D

Device Power 1 Circuit High Resistance

DTC C0895 03

Device Voltage Below Threshold

DTC C0895 07

Device Voltage Below Threshold

DTC C0899 00

Device Voltage Low

DTC C0900 00

Device Voltage High

DTC P0560

System Voltage

DTC P0562

System Voltage Low Voltage

DTC P0563

System Voltage High Voltage

Circuit/System Description

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The control module or sensor detects a system voltage of less than approximately 9 V or greater than 18 V for approximately 5 seconds.

Action Taken When the DTC Sets

- A driver information center message and/or warning indicator may be displayed.
- The control module may be temporarily disabled.
- For P0562 set in the starter/generator control module, the starter/generator control module is turned off and high voltage contactor opens for remainder of ignition cycle

Conditions for Clearing the DTC

- The system voltage returns to normal operating range.
- For P0562 set in the starter/generator control module, the system voltage is at normal operating range on the next ignition cycle.

Diagnostic Aids

- A high or low voltage DTC set or voltage value in multiple modules/sensors indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

- COMPONENT CONNECTOR END VIEWS - INDEX
- INLINE HARNESS CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **DT 47825-10** Adapter Harness
- **DT 47825-20** Adapter Harness
- **DT 48616-10** Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify The battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.

- **If battery voltage is less than 12.4 V or more than 12.8 V**

Refer to **Battery Inspection/Test** .

- **If battery voltage is between 12.4 and 12.8 V**

3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
 - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or Is greater than 15 V.**

Refer to **Charging System Test** .

- **If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**

5. Verify the appropriate control module scan tool B+ and ignition voltage parameters are within 1 V of the

battery voltage.

- **If not within 1 V of the battery voltage**

Refer to Circuit/System Testing.

- **If within 1 V of the battery voltage**

6. All OK.

Circuit/System Testing

NOTE: Use the schematic to identify the following:

- Control modules the vehicle is equipped with
- The control modules ground, B+, and Ignition circuit terminal IDs and connectors

NOTE: Some control module ground circuits may require up to 20 minutes after the ignition is turned off before achieving a resistance reading of less than 5 ohms. In most cases the readings will drop below 20 ohms between 1 minute indicating the control module is going to sleep.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate control module.

- **If the test lamp illuminates**
- 4. Ignition ON.
- 5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate control module.
 - **If the test lamp illuminates**
- 6. Replace the control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup

SYMPTOMS - ENGINE ELECTRICAL

The following steps must be completed before using the symptom diagnostic procedures:

- Perform the **Diagnostic System Check - Vehicle** before using the symptom diagnostic procedures in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
 - **Battery Description and Operation**
 - **Charging System Description and Operation**
 - **Electrical Power Management Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to **Checking Aftermarket Accessories**.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Battery Inspection/Test**
- **Battery Charging**
- **Battery Electrical Drain/Parasitic Load Test**
- **Charging System Test**

BATTERY INSPECTION/TEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Aids

NOTE: For Warranty repairs -

You must use regionally required battery test equipment for warranty repairs.

For accurate test results the battery must be disconnected from the vehicle and the equipment connected directly to the battery posts. When setting up the equipment, select "Out of Vehicle" and then the correct battery type (Flooded or AGM) and rated CCA (both from the battery label) must be entered.

- **Failure to obtain the correct connections during the test may result in a failed test on a good battery.**
- **Use the Out of Vehicle test (both batteries disconnected with test equipment connected directly to the post) test for each battery when testing a vehicle with dual batteries.**

Follow these instructions in order to avoid an incorrect diagnosis because of connections:

- If testing the vehicle with the battery cables still connected, wiggle the battery tester clips on the terminal. This may cut through any coating or through any oxidation that may be present on the terminal.
- If correct connections to the battery terminals in the vehicle are in doubt, perform the following steps:
 1. Disconnect the negative battery cable.

2. Disconnect the positive battery cable.
3. Follow the instructions for testing a removed battery.
- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
 1. Disconnect the negative battery cable.
 2. Disconnect the positive battery cable.

NOTE: Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. Use the test code from the second, or Out of Vehicle test.

3. Follow the instructions for testing a removed battery.
4. Replace the battery only if the second test shows a REPLACE BATTERY or BAD CELL-REPLACE result.

Use the test code from the second test for any warranty purposes.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 50313 Battery Tester

Circuit/System Testing

WARNING: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Verify the C1 or C1B Battery case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
 - **If there is any apparent damage**

Replace the C1 or C1B Battery.
 - **If there is no damage**
2. Verify the cold cranking amperage and amperage hour rating of the C1 or C1B Battery. Refer to the manufacturer specifications on the battery label.
 - **If the C1 or C1B Battery does not meet specifications**

Replace the C1 or C1B Battery.
 - **If the C1 or C1B Battery meets specifications**
3. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in **Fastener Tightening Specifications**.

- **If the battery cables need to be cleaned or tightened**

Clean as required and tighten as specified.

- **If the battery cables are clean and tight**

4. Install the battery tester and follow directions supplied by the tester.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Replacement

BATTERY CHARGING

NOTE: This procedure pertains to charging the 12V battery only. There is no procedure to charge the Hybrid/EV Battery Pack outside of the vehicle.

Special Tools

EL 42000 Battery Tester

For equivalent regional tools, refer to **Special Tools**

- NOTE:**
- **For best results, use an automatic taper-rate battery charger with a voltage capability of 16 volts.**
 - **The charging area should be well ventilated.**
 - **Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the EL 42000 before charging.**

Battery State of Charge

NOTE: Using voltage to determine the batteries state of charge (SOC) is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery SOC will only be an estimate.

The maintenance-free batteries SOC is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the battery's state of charge:

1. Be sure all electrical loads are turned OFF.

2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
 - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
 - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

NOTE: **The table is accurate to within 10 percent only after the battery has been at rest for 12 hours.**

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the state of charge according to the estimated battery temperature:

Battery Charging

Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)
12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%
12.2 V	65%	45%
12.0 V	40%	20%

Use the state of charge information as follows:

- A battery with a state of charge that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65 percent or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times, or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90 percent, before returning it to service or continuing storage.

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity-The higher the charger's amperage, the less time it will take to charge the battery.
- The SOC of the battery-A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 volts, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may not activate the reversed voltage protection in some chargers. Refer to the manufacturers instructions for operating this circuitry.

- The temperature of the battery-The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

Charging Procedure

WARNING: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

CAUTION: Refer to Fastener Caution .

Use the following procedure to charge the battery:

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.
3. Connect the charger positive lead to the battery positive terminal on the battery or fuse block - underhood.

CAUTION: Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.

4. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative

battery cable is disconnected and a terminal adapter is being used, connect directly to the battery terminal.

5. Turn ON the charger and set to the highest setting for normal charging.
6. Inspect the battery every half hour after starting the battery charger.
 - Charge the battery until the taper-rate charger indicates that the battery is fully charged.
 - Estimate the battery temperature by feeling the side of the battery. If it feels hot to the touch or its temperature is over 45°C (125°F), discontinue charging and allow the battery to cool before resuming charging.
7. After charging, test the battery. Refer to **Battery Inspection/Test** .

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

12 V Battery

The following procedure is for the 12 V battery only.

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

Components most likely to cause a parasitic draw on the vehicles battery are switches, relays, and control modules. After the ignition is turned OFF the control modules will begin to go to sleep shut OFF. All control modules do not go to sleep at the same time, some may take up to 30 min or longer after turning the ignition off before going to sleep. Other modules may periodically wake up then go back to sleep. These are all normal conditions.

Diagnostic Aids

- Rule out any possible aftermarket equipment causing an unacceptable parasitic current drain. Aftermarket accessories installed into the courtesy lamp circuit can cause the inadvertent power timer in the body control module (BCM) to keep resetting. This may cause the BCM to remain awake and cause a current drain on the battery.
- Rule out customer driving habits such as regular short trips that do not allow enough time to properly charge the battery. Refer to **Battery Description and Operation** .
- Verify that the battery and charging system are in proper working order. Refer to **Battery Charging** , and **Charging System Test** .
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStar®, and regulated voltage control, if equipped, are designed to wake up, perform a task, and go back asleep at regular intervals. Refer to **Body Control System Description and Operation** for the system or modules description and operation.
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines

the drive cycle has met the appropriate criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 min. The typical current draw for this is about 1 A.

- Digital OnStar generation 6 and later vehicle communication interface module do not "wake up" every 10 min for the first 48 h as the generation 5 and prior. generation 6 and later vehicle communication interface module current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 h. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the vehicle communication interface module for the first 48 h is normal.
- Some automatic climate control systems can remain in a semi awake state for up to three hours, actual draw amounts vary by vehicle platform but are typically not greater than 50 mA.
- An extremely low mA current level is consumed by the remote keyless entry receiver for monitoring purposes, actual system wake up only occurs when the fobs for the vehicle are used. When other devices on the same remote keyless entry operating frequency are activated, such as the 4 tire pressure monitoring sensors and other vehicle FOBs in the vicinity, the remote keyless entry receiver will have a 100 mA spike. These spikes are normal and occur too briefly to have a significant effect on battery drain. Competing signals may cause remote keyless entry performance issues such as jamming but should not cause excessive battery draw.
- If an excessive current draw is not present during initial testing, continue periodic testing over a 1-2 hour period to see if the current draw increases and stays above an unacceptable level.

NOTE: **The battery specification listed below is a generic specification. Refer to the label on the original battery when testing the battery.**

- The battery run down time will vary depending on the batteries reserve capacity. If the reserve capacity is higher, then the battery run down time may be longer. If the reserve capacity is lower, then the battery run down time may be shorter. The graph below indicates roughly how many days a 690 cold cranking amperage battery with a 110 min reserve capacity starting at 80% state of charge will last with a constant current draw until it reaches 50% state of charge. Differences in battery reserve capacity and temperature will affect the results.

Current Drain	Days
25 mA	33
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 38758 Parasitic Draw Test Switch

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

NOTE:

- **Most vehicle systems will go to sleep within 30 min but it can take up to 2 h before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 s.**
- **Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors closed" mode while allowing vehicle interior access that may be needed to complete the diagnostic steps.**
- **Locking doors will arm the vehicle content theft deterrent system if equipped. Failure to arm the system may cause a theft system fault to not be present during testing.**
- **There are many things that can prevent the vehicle from completely going to sleep and passing the parasitic draw test. Make sure all the conditions listed below are met before performing the parasitic current draw test.**
 - **Ignition OFF**
 - **Key out of the ignition switch - when not equipped with keyless access and start**
 - **Retained Accessory Power OFF - open and close the driver door after ignition OFF**
 - **Scan tool not communicating with a vehicle control module - in some cases it may need to be disconnected from the DLC**

- All access doors closed
- Headlamps OFF - auto headlamps disabled
- Any delay lighting OFF
- If equipped with an under hood lamp disable it
- HVAC after blow OFF
- Any accessory that can work with ignition OFF inactive or OFF
- Wait up to 2 min or longer, after all other listed conditions are met

Using an Inductive Pickup Probe

1. Connect an inductive pickup probe to the negative battery cable that can read down to 1 mA.
2. Ignition OFF, as the vehicle systems shut down test for less than 30 mA of parasitic current drain.
 - If greater than the specified range, refer to Circuit/System Testing.

Using the EL 38758 Parasitic Draw Test Switch

WARNING: Refer to Battery Disconnect Warning .

CAUTION: When a fused jumper wire or digital multimeter is connected to the test switch terminals, always turn the test switch ON before opening any access door, turning the ignition on, or turning any accessory on. This is to prevent damaging the jumper wire or digital multimeter fuse.

NOTE: The switch knob on the EL 38758 switch is marked ON and OFF. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.

1. Ignition OFF, disconnect the battery negative cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Turn the **EL 38758** switch knob to the OFF position.
3. Install the male end of the **EL 38758** switch to the battery ground terminal.
4. Install the battery negative cable to the female end of the **EL 38758** switch.
5. Turn the **EL 38758** switch knob to the ON position.
6. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
7. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
8. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the jumper wire.
9. Check the fuse in the jumper wire. The fuse should be OK.

- Failed: If the jumper wire fuse is blown, refer to Circuit/System Testing.
 - Passed
10. Turn the **EL 38758** switch knob to the ON position. Remove the fused jumper wire.
 11. Connect a DMM set to the 10 A DC scale between the test switch tool terminals.
 12. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the DMM.
 13. As the vehicle systems shut down test for less than 30 mA of parasitic current drain.
 - If greater than the specified range, refer to Circuit/System Testing.

Circuit/System Testing

NOTE:

- Removing or installing a fuse, relay, or connector, to determine the area causing high parasitic draw may wake up control modules. You must wait for the control modules to go back to sleep before retesting. It is best to install any removed or disconnected components after the diagnosis is completed.
- Fuses for power mode master components such as the BCM should be removed last to avoid misdiagnosis.
- If a scan tool is connected to the DLC, either disconnect it or subtract the scan tool current draw from the DMM reading to get the actual vehicle parasitic current draw.

If the vehicle has an unacceptable amount of parasitic current draw, remove each fuse one at a time until the current draw falls to an acceptable level. A drop of more than 10-20 mA, when disabling a single system or circuit, is an indication of an overly high current draw that could be causing the battery drain. Refer to **Power Distribution Schematics** to diagnose exactly which circuit of the suspect system is causing the high parasitic drain. The following is a list of common components that could cause a high current draw:

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup

CHARGING SYSTEM TEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The starter/generator control module supplies the energy that flows between the high voltage (110 volt) direct current (DC) and low voltage (14 volt) DC to charge the 12 volt battery and power accessories. For more information about the starter/generator control module functions, refer to **Drive Motor Battery System Description**.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

Engine running, observe the charge indicator on the instrument cluster or message in the driver information center display. The charge indicator on the instrument cluster should be turned OFF and the driver information center display should not display any charging system message.

Circuit/System Testing

1. Ignition ON, verify that no G13 Generator or B18 battery current sensor DTCs are set that would cause a charging system concern.
 - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle**
2. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.0 V or greater at room temperature.
 - If not within the specified value, refer to **Battery Inspection/Test**

NOTE: **Ensure vehicle accessories are OFF for the next step.**

3. Engine ON, increase engine speed to 2,500 RPM. Verify the battery voltage is between 12.6-15.0 V.

- If not within specified range, replace the K59 Starter/Generator Control Module.
- 4. Engine ON, increase engine speed to 2,500 RPM. Turn ON all vehicle accessories. Verify the battery voltage is between 12.6-15.0 V.
 - If not within specified range, replace the K59 Starter/Generator Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Starter Generator Replacement

DESCRIPTION AND OPERATION

CHARGING SYSTEM DESCRIPTION AND OPERATION

12-V Battery

The following information is for the 12 V battery only.

For information about charging the high voltage drive motor batteries, refer to **Drive Motor Battery System Description** .

Electrical Power Management (EPM) Overview

The electrical power management (EPM) system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems. This EPM system primarily utilizes existing on-board computer capability to maximize the effectiveness of the charging system, manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The EPM system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition off and during ignition on. During ignition off the state-of-charge (SOC) of the battery is determined by measuring the open-circuit voltage. The SOC is a function of the acid concentration and the internal resistance of the battery, and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The SOC can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates SOC based on adjusted net amp hours, battery capacity, initial SOC, and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the EPM function is designed to perform regulated voltage control (RVC) to improve battery SOC, battery life, and fuel economy. This is accomplished by using knowledge of the battery SOC and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

Charging System Components

Starter/Generator Control Module

The starter/generator control module is a serviceable GMLAN device located in the luggage compartment. It is connected to the vehicle's 12 and 110-volt DC power circuits, and it is also joined to the starter/generator by 3-phase AC cables. The starter/generator control module is air-cooled. The hybrid/EV battery pack cooling fan draws air in through ports in the rear package shelf, flows across the Hybrid/EV battery pack and cooling fins of the starter/generator control module, then blows the air out of the vehicle through ports in the luggage compartment. The starter/generator control module performs three main functions:

- As the power inverter for the starter-generator, the starter/generator control module converts 110-volt DC power into 3-phase AC power to drive the starter-generator as a motor.
- The power inverter also rectifies 110-volt AC output power from the starter/generator into the 110-volt DC power used to charge the 110-volt generator battery.
- An auxiliary power module contained within the starter/generator control module converts 110-volt DC power into the 12-volt DC power which is used for 12-volt vehicle loads and to charge the underhood 12-volt battery. A serviceable 200 amp fuse located in the auxiliary fuse block protects the vehicle's 12-volt electrical system from excessive current. The starter/generator control module controls the starter/generator, transmission auxiliary oil pump, hill-hold solenoids, and the auxiliary coolant pump. The pumps and solenoids are driven by 12-volt pulse width modulated (PWM) power through vehicle wiring harnesses.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster (IPC) for electrical power management (EPM) operation. The BCM determines the desired voltage set point and monitors a battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge (SOC).

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to the negative battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-V pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Engine Control Module (ECM)

The ECM receives control decisions based on messages from the BCM.

Instrument Panel Cluster (IPC)

The IPC provides a means of customer notification in case of a failure and a voltmeter. There are 2 means of notification, a charge indicator and a driver information center (DIC) message of SERVICE BATTERY CHARGING SYSTEM.

HP6 Charging System Block Diagram

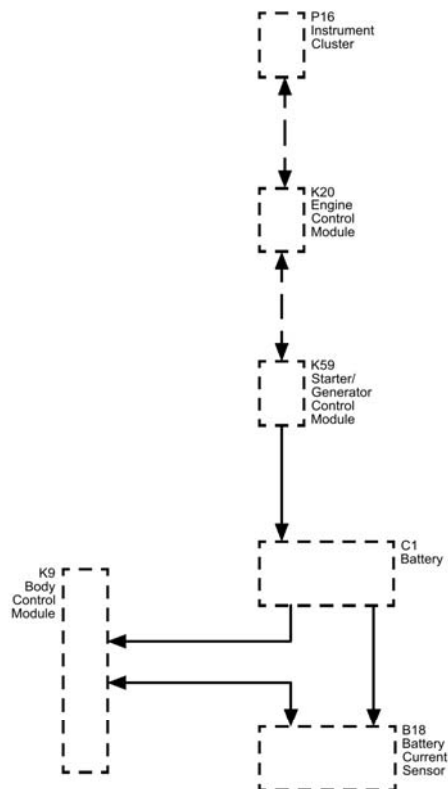


Fig. 3: HP6 Charging System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Normal Mode
- Fuel Economy Mode
- Headlamp Mode

- Voltage Reduction Mode
- Plant Assembly Mode

Battery Sulfation Mode

The BCM will enter this mode when the interpreted charging system voltage is less than 13.2 V for 30 minutes. When this condition exists the BCM will enter Normal Mode for 5 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Normal Mode

The BCM will enter Normal Mode when ever one of the following conditions are met.

- The wipers are ON for more than 3 seconds.
- GMLAN Climate Control Voltage Boost Mode Request is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Vehicle Speed is greater than 145 km/h (90 mph)
- Current Sensor Fault Exists
- System Voltage was determined to be below 12.56 V
- Tow/Haul Mode is enabled

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9-15.5 V, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the ambient air temperature is at least 0°C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is greater than -8 amps but less than 5 amps, and the battery state of charge (SOC) is greater than or equal to 85 percent. Its targeted set-point voltage is the open circuit voltage of the battery and can be between 12.6-13.2 V. The BCM will exit this mode and enter Normal Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the high or low beam headlamps are ON. Voltage will be regulated between 13.9-14.5 V

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated battery temperature is above 0°C (32°F) and the calculated battery current is greater than -7 A but less than 1 A. Its targeted set-point voltage is 12.9-13.2 V. The BCM will exit this mode once the criteria are met for Normal Mode.

Plant Assembly Mode

The BCM will increase charging voltage for the first 500 miles of operation in an effort to ensure that the 12 V battery is fully charged when the vehicle is delivered to the customer.

Instrument Panel Cluster (IPC) Operation

Charge Indicator Operation

The instrument panel cluster (IPC) illuminates the charge indicator and displays a warning message in the driver information center (DIC) when the one or more of the following occurs:

- The engine control module (ECM) detects system voltage less than 11 V or greater than 16 V. The IPC receives a GMLAN message from the ECM requesting illumination.
- The BCM determines that the system voltage is less than 11 V or greater than 16 V.
- The IPC receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.
- The ignition is ON, with the engine OFF.

SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a GMLAN message to the DIC for the SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is displayed whenever the charge indicator is commanded ON due to a failure.

STARTING SYSTEM DESCRIPTION AND OPERATION

12-V Starting System

The following information is for the 12 V starter motor only. The 12 V starter motor is used for initial starting of the engine.

The high voltage starter/generator is used to start the engine once the vehicle is in autostop/autostart mode. For information about charging the high voltage starting system, refer to Starter Generator Description and Operation.

12-V Starting System Components

The starter motors are non-repairable starter motors. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because

battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, the START relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

Circuit Description (Key Start)

When the ignition switch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 V to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

HP6 Starting System Block Diagram

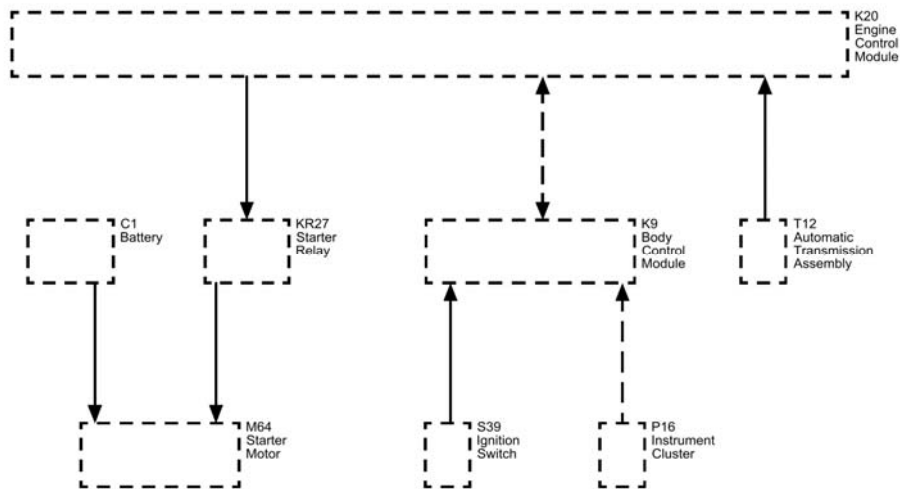


Fig. 4: HP6 Starting System Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

ELECTRICAL

12 V Starting and Charging

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accessory DC Power Control Module Fastener	22 N.m	16 lb ft
Accessory Wiring Junction Block Fastener	10 N.m	89 lb in
Battery Hold Down Retainer Fastener	10 N.m	89 lb in
Battery Hold Down Strap Fastener	12 N.m	106 lb in
Battery Negative Cable Fastener (Battery Post)	4.5 N.m	40 lb in
Battery Negative Cable Ground Fastener (Engine Block)	25 N.m	18 lb ft
Battery Negative Cable Ground Fastener (Frame Rail)	12 N.m	106 lb in
Battery Positive Cable to Engine Wiring Junction Block Fastener	17 N.m	9 lb ft
Battery Positive Cable Fastener (Battery Post)	4.5 N.m	40 lb in
Battery Positive Cable Fastener (Battery Fuse Block)	12 N.m	106 lb in
Battery Positive Cable Fastener at the Starter (V6)	25 N.m	18 lb ft
Battery Tray Fastener	20 N.m	15 lb ft
Body Harness Negative Ground Fastener (Battery Post)	9 N.m	80 lb in
Engine Ground Strap to Engine Block Fastener	22 N.m	16 lb ft
Engine Ground Strap to Wheelhouse Panel Fastener	22 N.m	16 lb ft
Engine Control Module Wiring Harness Ground Cable to Cylinder Head Fastener	12 N.m	106 lb in
Engine Control Module Wiring Harness Ground Cable to Transmission Fastener	9 N.m	80 lb in
Generator BAT Terminal Fastener	20 N.m	15 lb ft
Generator Bracket Fastener	58 N.m	43 lb ft
Generator Fastener (V6)	50 N.m	37 lb ft
Starter Motor Mounting Fastener	53 N.m	39 lb ft
Starter Shield Fastener	7 N.m	62 lb in
Starter Solenoid Fastener	10 N.m	89 lb in

SCHEMATIC WIRING DIAGRAMS

STARTING AND CHARGING WIRING SCHEMATICS

Starting System (Except CZ2)

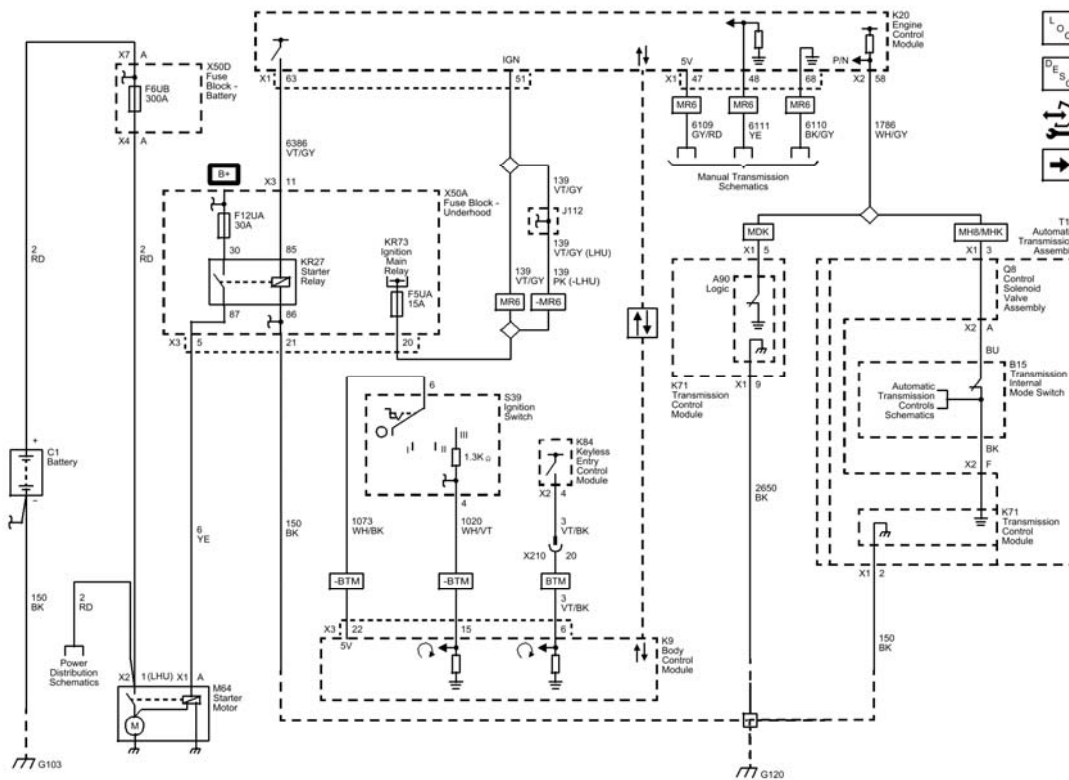


Fig. 1: Starting System (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Charging System (Except CZ2)

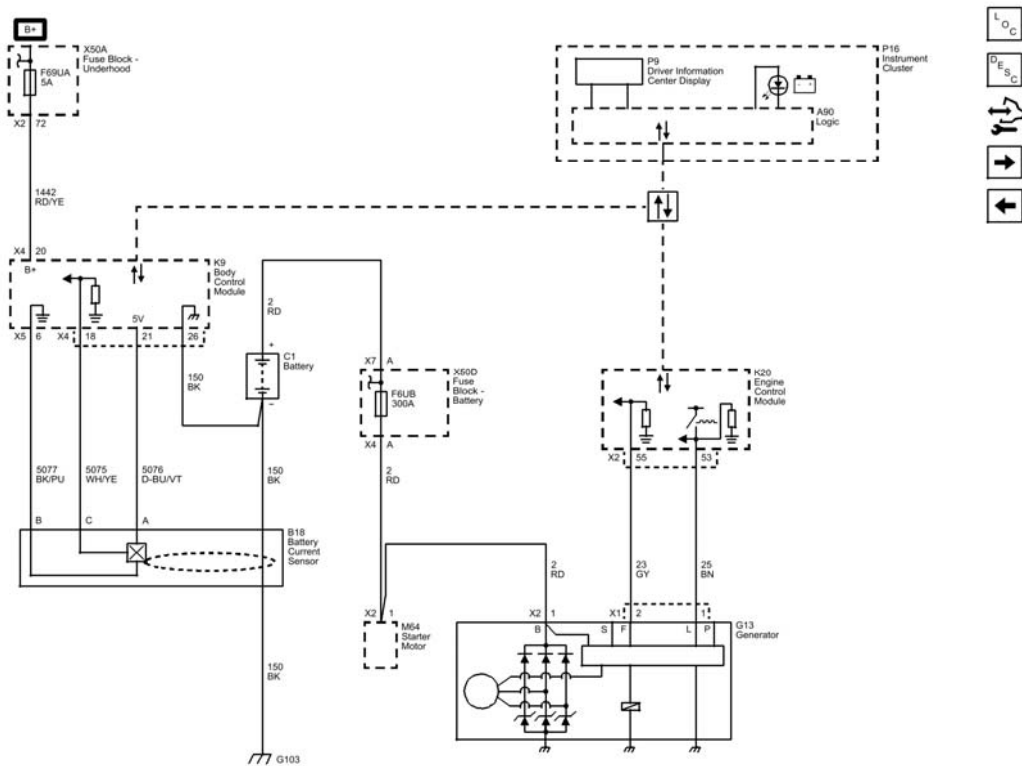


Fig. 2: Charging System (Except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Starting System (CZ2)

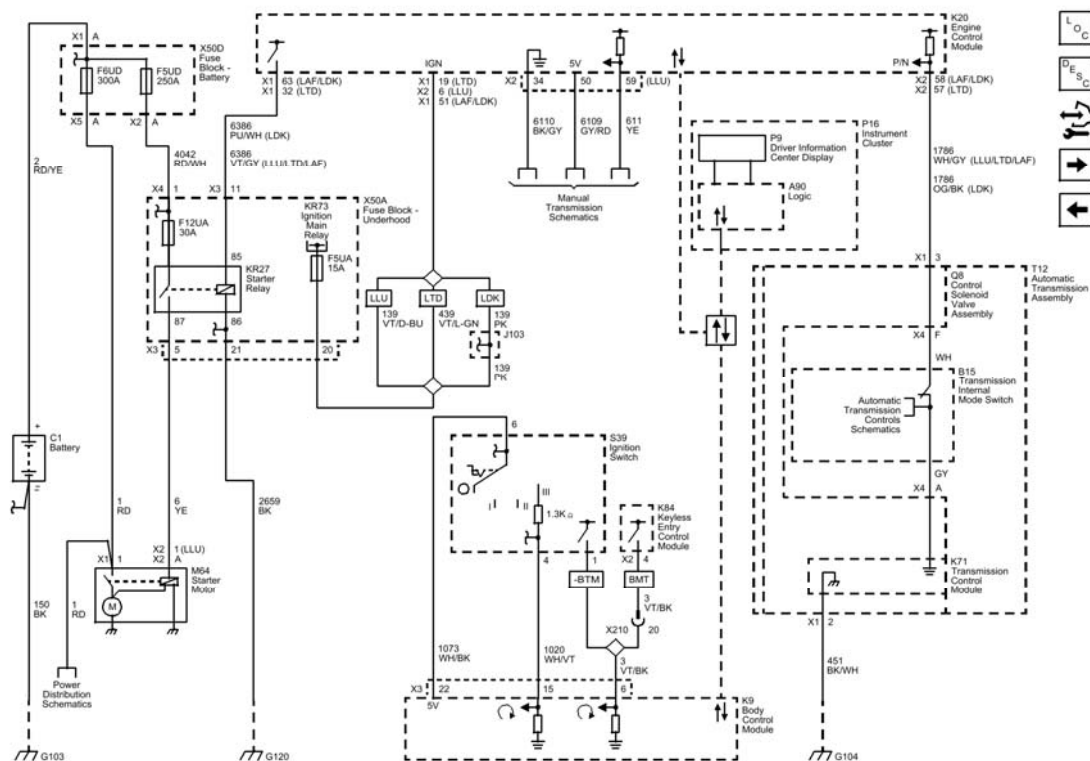


Fig. 3: Starting System (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Charging System (CZ2)

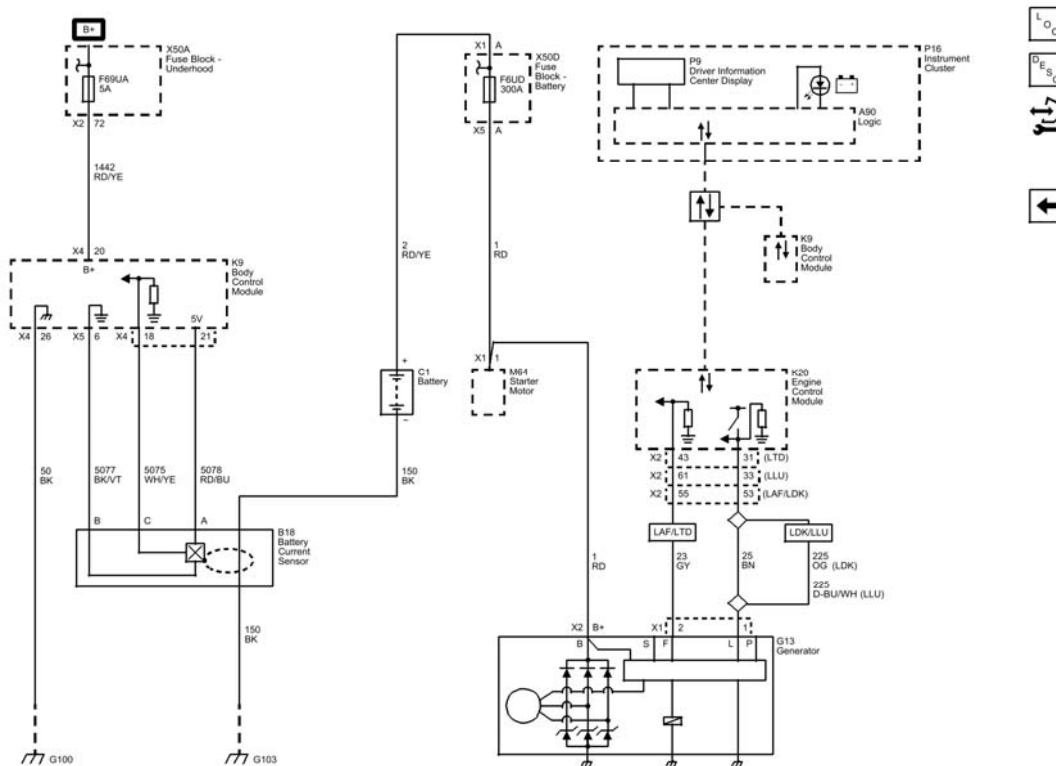


Fig. 4: Charging System (CZ2)
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B1325, B1327, B1328, B1330, B1517, C0800, C0805, C0895, C0899, C0900, P0560, P0562, P0563, P129B, or P129C</u>	<p>DTC B1325 03 Device Power Circuit Voltage Below Threshold</p> <p>DTC B1325 07 Device Power Circuit Voltage Above Threshold</p> <p>DTC B1327 00 Device Voltage Circuit Low</p> <p>DTC B1328 00 Device Voltage Circuit High</p> <p>DTC B1330 03 Device Power 2 Circuit Voltage Below Threshold</p> <p>DTC B1390 00 Control Module Supply Circuit 1 Malfunction</p> <p>DTC B1390 03 Control Module Supply Circuit 1 Low Voltage</p> <p>DTC B1390 07 Control Module Supply Circuit 1 High Voltage</p> <p>DTC B1395 07 Control Module Voltage Reference Output 1 Circuit High Voltage</p> <p>DTC B1395 03 Control Module Voltage Reference Output 1 Circuit Low Voltage</p> <p>DTC B1400 00 Control Module Supply Circuit 2 Malfunction</p> <p>DTC B1400 03 Control Module Supply Circuit 2 Low Voltage</p>

	DTC B1400 07 Control Module Supply Circuit 2 High Voltage DTC B1410 03 Control Module Supply Circuit 3 Low Voltage DTC B1410 07 Control Module Supply Circuit 3 High voltage DTC B1415 02 Control Module Voltage Reference Output 3 Circuit Short to Ground DTC B1424 00 Control Module Power Circuit Low Voltage DTC B1425 00 Control Module Power Circuit High Voltage DTC B1439 00 Intermittent Device Voltage Performance DTC B1517 03 Battery Voltage Below Threshold DTC B1517 07 Battery Voltage Above Threshold DTC B1517 5A Battery Voltage Plausibility Failure DTC C0800 03 Device Power 1 Circuit Voltage Below Threshold DTC C0800 07 Device Power 1 Circuit Voltage Above Threshold DTC C0800 11 Device Power 1 Circuit High Input DTC C0800 0D Device Power 1 Circuit High Resistance DTC C0805 0D Control Module Power 2 Circuit DTC C0870 03 Control Module Voltage Reference Output Circuit Low Voltage DTC C0870 07 Control Module Voltage Reference Output Circuit High Voltage DTC C0895 00 Device Voltage DTC C0899 00 Device Voltage Low DTC C0899 03 Device Voltage Low DTC C0900 00 Device Voltage High DTC P0560 System Voltage Low DTC P0562 System Voltage Low DTC P0563 System Voltage High DTC P0611 Fuel Injector Control Module Performance DTC P129B System Voltage Low DTC P129C System Voltage High DTC P15AE Fuel Injector Control Module System Voltage Low Voltage DTC P15AF Fuel Injector Control Module System Voltage High Voltage
<u>DTC B1516</u>	DTC B1516 08 Battery Current Sensor Performance - Signal Invalid DTC B1516 66 Battery Current Sensor Incorrect Mounting
<u>DTC B151A</u>	DTC B151A 58 Battery Capacity Performance
<u>DTC B1527</u>	DTC B1527 00 Parasitic Load
<u>DTC P0615, P0616, or P0617</u>	DTC P0615 Starter Relay Control Circuit DTC P0616 Starter Relay Control Circuit Low Voltage DTC P0617 Starter Relay Control Circuit High Voltage
<u>DTC P0621</u>	DTC P0621 Generator L-Terminal Circuit
<u>DTC P0622</u>	DTC P0622 Generator F-Terminal Circuit
<u>DTC P0625 or P0626</u>	DTC P0625 Generator F-Terminal Circuit Low Voltage DTC P0626 Generator F-Terminal Circuit High Voltage

DTC B1325, B1327, B1328, B1330, B1517, C0800, C0805, C0895, C0899, C0900, P0560, P0562, P0563, P129B, OR P129C: POWER CIRCUIT VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1325 03

Device Power Circuit Voltage Below Threshold

DTC B1325 07

Device Power Circuit Voltage Above Threshold

DTC B1327 00

Device Voltage Circuit Low

DTC B1328 00

Device Voltage Circuit High

DTC B1330 03

Device Power 2 Circuit Voltage Below Threshold

DTC B1390 00

Control Module Supply Circuit 1 Malfunction

DTC B1390 03

Control Module Supply Circuit 1 Low Voltage

DTC B1390 07

Control Module Supply Circuit 1 High Voltage

DTC B1395 07

Control Module Voltage Reference Output 1 Circuit High Voltage

DTC B1395 03

Control Module Voltage Reference Output 1 Circuit Low Voltage

DTC B1400 00

Control Module Supply Circuit 2 Malfunction

DTC B1400 03

Control Module Supply Circuit 2 Low Voltage

DTC B1400 07

Control Module Supply Circuit 2 High Voltage

DTC B1410 03

Control Module Supply Circuit 3 Low Voltage

DTC B1410 07

Control Module Supply Circuit 3 High voltage

DTC B1415 02

Control Module Voltage Reference Output 3 Circuit Short to Ground

DTC B1424 00

Control Module Power Circuit Low Voltage

DTC B1425 00

Control Module Power Circuit High Voltage

DTC B1439 00

Intermittent Device Voltage Performance

DTC B1517 03

Battery Voltage Below Threshold

DTC B1517 07

Battery Voltage Above Threshold

DTC B1517 5A

Battery Voltage Plausibility Failure

DTC C0800 03

Device Power 1 Circuit Voltage Below Threshold

DTC C0800 07

Device Power 1 Circuit Voltage Above Threshold

DTC C0800 11

Device Power 1 Circuit High Input

DTC C0800 0D

Device Power 1 Circuit High Resistance

DTC C0805 0D

Control Module Power 2 Circuit

DTC C0870 03

Control Module Voltage Reference Output Circuit Low Voltage

DTC C0870 07

Control Module Voltage Reference Output Circuit High Voltage

DTC C0895 00

Device Voltage

DTC C0899 00

Device Voltage Low

DTC C0899 03

Device Voltage Low

DTC C0900 00

Device Voltage High

DTC P0560

System Voltage Low

DTC P0562

System Voltage Low

DTC P0563

System Voltage High

DTC P0611

Fuel Injector Control Module Performance

DTC P129B

System Voltage Low

DTC P129C

System Voltage High

DTC P15AE

Fuel Injector Control Module System Voltage Low Voltage

DTC P15AF

Fuel Injector Control Module System Voltage High Voltage

Circuit/System Description

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The control module or sensor detects a system voltage of less than approximately 9 V for approximately 5 seconds.

Action Taken When the DTC Sets

- A driver information center message and/or warning indicator may be displayed.
- The control module may be temporarily disabled.

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

- A high or low voltage DTC set or voltage value in multiple modules/sensors indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
 - If battery voltage is less than 12.4 V or more than 12.8 V

Refer to **Battery Inspection/Test**.

- **If battery voltage is between 12.4 and 12.8 V**

3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
 - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

Refer to **Charging System Test**.

- **If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**

5. Verify the appropriate control module scan tool battery voltage and ignition voltage parameters are within 1 V of the battery voltage.
 - **If not within 1 V of the battery voltage**

Refer to Circuit/System Testing.

- **If within 1 V of the battery voltage**

6. All OK.

Circuit/System Testing

NOTE: Use the schematic to identify the following:

- **Control modules the vehicle is equipped with**
- **The control module's ground, B+, and Ignition circuit terminal IDs and connectors**

NOTE: Some control module ground circuits may require up to 20 min after the ignition is turned off before achieving a resistance reading of less than 5 ohms. In most cases the readings will drop below 20 ohms within 1 min indicating the control module is going to sleep.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between each ground circuit terminal and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate control module.
 - **If the test lamp illuminates**
- 4. Ignition ON.
- 5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate control module.
 - **If the test lamp illuminates**
- 6. Replace the control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup.

DTC B1516: BATTERY CURRENT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1516 08

Battery Current Sensor Performance - Signal Invalid

DTC B1516 66

Battery Current Sensor Incorrect Mounting

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	B1516 08	B1516 08	B1516 08	-
Signal	B1516 08	B1516 08	B1516 08	B1516 08, B1516 66
Low Reference	-	B1516 08	-	-

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The body control module (BCM) supplies 5 V and ground to the battery current sensor. The battery current sensor measures the amount of current flowing to or from the battery, and supplies a pulse width modulation (PWM) signal to the BCM.

Conditions for Running the DTC

B1516 08

The BCM is awake.

B1516 66

- The BCM is awake.
- The engine is OFF.

Conditions for Setting the DTC

B1516 08

The battery current signal is less than 4% or greater than 96 % duty cycle for 2 min.

B1516 66

The battery current polarity is positive for 2 min.

Action Taken When the DTC Sets

The regulated voltage control is disabled.

Conditions for Clearing the DTC

The DTC passes when the battery current returns to the normal range for 15 s.

Diagnostic Aids

DTC B1516 08 could be set by overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B1516 08

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B18 Battery Current Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 30 ohms between the low reference circuit terminal B and ground.
 - **If 30 ohms or greater**
 1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If less than 30 ohms**
- 3. Ignition ON.
- 4. Test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If between 4.8-5.2 V**
- 5. Test for 4.8-5.2 V between the signal circuit terminal C and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If between 4.8-5.2 V**
- 6. Test or replace the B18 Battery Current Sensor.

B1516 66

1. Verify that the B18 Battery Current Sensor is installed securely around the negative battery cable, with the tape tab pointing away from the negative terminal on the C1 Battery.
 - **If the B18 Battery Current Sensor is not installed correctly**

Remove and reinstall the B18 Battery Current Sensor properly.

- **If the B18 Battery Current Sensor is installed correctly**

2. Replace the B18 Battery Current Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Positive and Negative Cable Replacement (LUK), Battery Positive and Negative Cable Replacement (LTG)**
- **Control Module References** for BCM replacement, programming and setup.

DTC B151A: BATTERY CAPACITY PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B151A 58

Battery Capacity Performance

Circuit/System Description

The body control module (BCM) monitors the battery voltage level during an engine crank event to detect a low battery voltage condition.

Conditions for Running the DTC

The vehicle is ON

Conditions for Setting the DTC

A minimum crank battery voltage is less than the minimum crank battery voltage threshold for 16 consecutive crank events.

Action Taken When the DTC Sets

A driver information center message is displayed.

Conditions for Clearing the DTC

The DTC will clear if the minimum crank voltage is greater than the minimum crank voltage threshold during a crank event.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC P0621 or P0622 is not set.
 - **If DTC P0621 or P0622 is set**

Refer to **DTC P0621**, or **DTC P0622**

- **If DTC P0621 or P0622 is not set**
2. Perform the **Battery Inspection/Test** .

DTC B1527: PARASITIC LOAD

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1527 00

Parasitic Load

Circuit/System Description

The body control module (BCM) monitors the state of charge of the electrical system.

Conditions for Running the DTC

The ignition is in Accessory or Run mode.

Conditions for Setting the DTC

The state of charge at ignition ON is 30% lower than when the engine was running and battery drain is more than 2 A.

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.
- The DTC will clear when run state of charge is greater than or equal to 80%.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Refer to **Battery Electrical Drain/Parasitic Load Test**.

DTC P0615, P0616, OR P0617: STARTER RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0615

Starter Relay Control Circuit

DTC P0616

Starter Relay Control Circuit Low Voltage

DTC P0617

Starter Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+ Terminal 30	1	2	-	-
Relay Coil Ignition Terminal 85	P0616	P0615	P0617	-
Relay Switch Control Terminal 87	2	2	3	-
Relay Coil Ground Terminal 86	-	P0615	-	-
1. Opens fuse, Starter Solenoid does not click. 2. Starter Solenoid does not click. 3. Cranks all the time.				

Circuit/System Description

When the ignition is activated to start the vehicle, a discrete signal is supplied to the body control module (BCM). The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch pedal is pressed or the transmission is in park/neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Conditions for Running the DTC

- The ignition is activated to START.
- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

The ECM detects improper voltage on the control circuit of the starter relay.

Action Taken When the DTC Sets

DTC P0615, P0616, and P0617 are C type DTCs.

Conditions for Clearing the DTC

DTC P0615, P0616, and P0617 are C type DTCs.

Reference Information

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 86 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is good and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance,
 3. Test for infinite resistance between the control circuit terminal 87 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M64 Starter Motor.
 - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.

NOTE: If the Starter Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).

6. Verify the test lamp turns ON and OFF when commanding the Starter Relay ON and OFF with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- **If the test lamp turns ON and OFF**

7. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
8. Verify the M64 Starter Motor is activated.

- **If the M64 Starter Motor does not activate**

1. Ignition OFF, disconnect the harness connector at the M64 Starter Motor.
2. Test for infinite resistance between the control circuit terminal X2 A or X2 1 and ground..
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M64 Starter Motor.

- **If the M64 Starter Motor activates**

9. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.
2. Test for 60-180 ohms between terminals 85 and 86.
 - **If less than 60 or greater than 180 ohms**

Replace the relay.

- **If between 60-180 ohms**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87
- **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 ohms between terminals 30 and 87.
 - **If 2 ohms or greater**

Replace the relay.

- **If less than 2 ohms**

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for ECM replacement, programming, and setup.

DTC P0621: GENERATOR L-TERMINAL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0621

Generator L-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

B+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn ON control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON control circuit. The ECM should detect low voltage on the generator turn on control circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage when the duty cycle voltage is commanded high and a low voltage when the duty cycle voltage is commanded low on the generator turn on control circuit.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s)
- The engine is running for the run test

Conditions for Setting the DTC

- Ignition ON, engine OFF - The ECM detects greater than 3.5 V on the generator control circuit for 5 s
- Engine running - The ECM detects a low voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded high
- Engine running - The ECM detects a high voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded low

Action Taken When the DTC Sets

DTC P0621 is a C type DTC

Conditions for Clearing the DTC

- Ignition ON, engine OFF- Low voltage
- Engine running - A control signal duty cycle is detected

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
2. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
3. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X2, 2 X2 or A X2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
 2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- **If the test lamp illuminates**
- 2. Disconnect the X1 harness connector at the G13 Generator, ignition ON.
- 3. Test for 3.0- 5.5 V between the control circuit terminal 1 X1 and ground.
 - **If less than 3.0 V**
 1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If greater the 2 ohms, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.5 V**
 1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If greater than 1 V, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 3.0-5.5 V**
- 4. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement (LUK), Generator Replacement (LTG)**
- **Control Module References** for Engine Control Module replacement, programming and setup

DTC P0622: GENERATOR F-TERMINAL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0622

Generator F-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is OFF, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5-99%.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s).
- Engine running at less than 3,000 RPM.

Conditions for Setting the DTC

- DTC P0621 is not set.
- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s), the ECM detects a PWM signal that is greater than 65% for 5 s.
- Engine running at less than 3,000 RPM - The ECM detects a PWM signal that is less than 5% for 30 s.

Action Taken When the DTC Sets

DTC P0622 is a C type DTC.

Conditions for Clearing the DTC

- Ignition ON, Engine OFF- Low / no PWM signal detected.
- Engine running - A 5-90% duty cycle is detected.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Do not have a battery charger connected during the generator testing.

1. Engine running.
2. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is between 5-90%.
 - **If not between 5-90%**

Refer to Circuit/System Testing.

- **If between 5-90%**
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter changes when commanding the headlamps ON and OFF.
 - **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X2 or A X2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
 - **If 5% or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 5%**
4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.
 - **If 95% or less**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 95%**

6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement (LUK)**, **Generator Replacement (LTG)**
- **Control Module References** for engine control module replacement, programming and setup

DTC P0625 OR P0626: GENERATOR F-TERMINAL CIRCUIT VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0625

Generator F-Terminal Circuit Low Voltage

DTC P0626

Generator F-Terminal Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0625	-	-
Signal	P0625	P0625	P0626	-
Control	P0621	P0621	P0621	-

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is OFF, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5-99%.

Conditions for Running the DTC

P0625

- The engine is running.
- The engine speed is less than 3000 RPM.

P0626

- The engine is not running.
- The ignition is in the ON position.

Conditions for Setting the DTC

P0625

The ECM detects a PWM signal less than 5% for 15 s.

P0626

The ECM detects a PWM signal greater than 65% for 15 s.

Action Taken When the DTC Sets

DTC P0625 and P0626 are C type DTCs.

Conditions for Clearing the DTC

DTC P0625 and P0626 are C type DTCs.

Reference Information

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Generator F-Terminal Signal Circuit parameter changes between 5 and 99%.
 - **If the parameter does not change**
 Refer to Circuit/System Testing.
 - **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2 or 1 X2, and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the G13 Generator.
 - **If the test lamp illuminates**
2. Ignition OFF, disconnect the X1 harness connector at the G13 Generator.
3. Verify the scan tool ECM Generator F-Terminal Signal parameter is less than 5%.

- **If 5% or greater**
 1. Ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 2 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 5%**
- 4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and B+.
- 5. Verify the scan tool ECM Generator F-Terminal Terminal Signal parameter is greater than 95%.
 - **If 95% or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
 3. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 95%.**
- 6. Replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement (LUK)**, **Generator Replacement (LTG)**
- **Control Module References** for ECM replacement, programming, and setup

SYMPTOMS - ENGINE ELECTRICAL

NOTE: **The following steps must be completed before using the symptom tables.**

- Perform **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
 - **Battery Description and Operation**
 - **Charging System Description and Operation**
 - **Electrical Power Management Description and Operation**
 - **Starting System Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Battery Inspection/Test**
- **Battery Electrical Drain/Parasitic Load Test**
- **Charging System Test**
- **Generator Noise Diagnosis**
- **Starter Solenoid Does Not Click**
- **Starter Solenoid Clicks, Engine Does Not Crank**
- **Engine Cranks Slowly**
- **Starter Noise Diagnosis**

BATTERY INSPECTION/TEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Aids

NOTE: For Warranty repairs -

You must use regionally required battery test equipment for warranty repairs.

For accurate test results the battery must be disconnected from the vehicle and the equipment connected directly to the battery posts. When setting up the equipment, select "Out of Vehicle" and then the correct battery type (Flooded or AGM) and rated CCA (both from the battery label) must be entered.

- Failure to obtain the correct connections during the test may result in a

failed test on a good battery.

- **Use the Out of Vehicle test (both batteries disconnected with test equipment connected directly to the post) test for each battery when testing a vehicle with dual batteries.**

Follow these instructions in order to avoid an incorrect diagnosis because of connections:

- If testing the vehicle with the battery cables still connected, wiggle the battery tester clips on the terminal. This may cut through any coating or through any oxidation that may be present on the terminal.
- If correct connections to the battery terminals in the vehicle are in doubt, perform the following steps:
 1. Disconnect the negative battery cable.
 2. Disconnect the positive battery cable.
 3. Follow the instructions for testing a removed battery.
- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
 1. Disconnect the negative battery cable.
 2. Disconnect the positive battery cable.

NOTE: Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. Use the test code from the second, or Out of Vehicle test.

3. Follow the instructions for testing a removed battery.
4. Replace the battery only if the second test shows a REPLACE BATTERY or BAD CELL-REPLACE result.

Use the test code from the second test for any warranty purposes.

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Schematic Reference

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 50313 Battery Tester

Circuit/System Testing

WARNING: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Verify the C1 or C1B Battery case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
 - **If there is any apparent damage**

Replace the C1 or C1B Battery.

- **If there is no damage**
- 2. Verify the cold cranking amperage and amperage hour rating of the C1 or C1B Battery. Refer to the manufacturer specifications on the battery label.
 - **If the C1 or C1B Battery does not meet specifications**

Replace the C1 or C1B Battery.
 - **If the C1 or C1B Battery meets specifications**
- 3. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in **Fastener Tightening Specifications**.
 - **If the battery cables need to be cleaned or tightened**

Clean as required and tighten as specified.
 - **If the battery cables are clean and tight**
- 4. Install the battery tester and follow directions supplied by the tester.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Replacement

BATTERY CHARGING

Special Tools

EL 50313 Battery Tester

For equivalent regional tools, refer to **Special Tools**.

Diagnostic Aids

- For best results, use an automatic taper-rate battery charger with a voltage capability of 16 V.
- The charging area should be well ventilated.
- Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the EL 50313 before charging.

Battery State of Charge

NOTE: **Using voltage to determine the batteries state of charge is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery state of charge will only be an estimate.**

The maintenance-free batteries state of charge is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the battery's state of charge:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
 - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
 - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

NOTE: **The table is accurate to 10 % only after the battery has been at rest for 12 hours.**

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the state of charge according to the estimated battery temperature:

Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)
12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%
12.2 V	65%	45%
12.0 V	40%	20%

Use the state of charge information as follows:

- A battery with a state of charge that is below 65% must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65% or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times, or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90%, before returning it to service or continuing storage.

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity-The higher the charger amperage, the less time it will take to charge the battery.

- The state of charge of the battery-A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 V, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may not activate the reversed voltage protection in some chargers. Refer to the manufacturer's instructions for operating this circuitry.
- The temperature of the battery-The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

Charging Procedure

CAUTION: Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the ECM/PCM or other electronic components.

CAUTION: Refer to Fastener Caution .

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

Tighten

Tighten the battery side terminal adapters to 15 (11 lb ft).

Use the following procedure to charge the battery:

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.
3. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.

CAUTION: Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.

4. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
5. Turn ON the charger and set to the highest setting for normal charging.
6. Inspect the battery every half hour after starting the battery charger.
 - Charge the battery until the taper-rate charger indicates that the battery is fully charged.

- Estimate the battery temperature by feeling the side of the battery. If it feels hot to the touch or its temperature is over 45°C (125°F), discontinue charging and allow the battery to cool before resuming charging.

7. After charging, test the battery. Refer to **Battery Inspection/Test**.

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

12 V Battery

The following procedure is for the 12 V battery only.

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

Components most likely to cause a parasitic draw on the vehicles battery are switches, relays, and control modules. After the ignition is turned OFF the control modules will begin to go to sleep shut OFF. All control modules do not go to sleep at the same time, some may take up to 30 min or longer after turning the ignition off before going to sleep. Other modules may periodically wake up then go back to sleep. These are all normal conditions.

Diagnostic Aids

- Rule out any possible aftermarket equipment causing an unacceptable parasitic current drain. Aftermarket accessories installed into the courtesy lamp circuit can cause the inadvertent power timer in the body control module (BCM) to keep resetting. This may cause the BCM to remain awake and cause a current drain on the battery.
- Rule out customer driving habits such as regular short trips that do not allow enough time to properly charge the battery. Refer to **Battery Description and Operation**.
- Verify that the battery and charging system are in proper working order. Refer to **Battery Charging**, and **Charging System Test**.
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStar®, and regulated voltage control, if equipped, are designed to wake up, perform a task, and go back asleep at regular intervals. Refer to **Body Control System Description and Operation** for the system or modules description and operation.
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines the drive cycle has met the appropriate criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 min. The typical current draw for this is about 1 A.
- Digital OnStar generation 6 and later vehicle communication interface module do not "wake up" every 10 min for the first 48 h as the generation 5 and prior. generation 6 and later vehicle communication interface

module current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 h. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the vehicle communication interface module for the first 48 h is normal.

- Some automatic climate control systems can remain in a semi awake state for up to three hours, actual draw amounts vary by vehicle platform but are typically not greater than 50 mA.
- An extremely low mA current level is consumed by the remote keyless entry receiver for monitoring purposes, actual system wake up only occurs when the fobs for the vehicle are used. When other devices on the same remote keyless entry operating frequency are activated, such as the 4 tire pressure monitoring sensors and other vehicle FOBs in the vicinity, the remote keyless entry receiver will have a 100 mA spike. These spikes are normal and occur too briefly to have a significant effect on battery drain. Competing signals may cause remote keyless entry performance issues such as jamming but should not cause excessive battery draw.
- If an excessive current draw is not present during initial testing, continue periodic testing over a 1-2 hour period to see if the current draw increases and stays above an unacceptable level.

NOTE: **The battery specification listed below is a generic specification. Refer to the label on the original battery when testing the battery.**

- The battery run down time will vary depending on the batteries reserve capacity. If the reserve capacity is higher, then the battery run down time may be longer. If the reserve capacity is lower, then the battery run down time may be shorter. The graph below indicates roughly how many days a 690 cold cranking amperage battery with a 110 min reserve capacity starting at 80% state of charge will last with a constant current draw until it reaches 50% state of charge. Differences in battery reserve capacity and temperature will affect the results.

Current Drain	Days
25 mA	33
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

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- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 38758 Parasitic Draw Test Switch

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

NOTE:

- **Most vehicle systems will go to sleep within 30 min but it can take up to 2 h before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 s.**
- **Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors closed" mode while allowing vehicle interior access that may be needed to complete the diagnostic steps.**
- **Locking doors will arm the vehicle content theft deterrent system if equipped. Failure to arm the system may cause a theft system fault to not be present during testing.**
- **There are many things that can prevent the vehicle from completely going to sleep and passing the parasitic draw test. Make sure all the conditions listed below are met before performing the parasitic current draw test.**
 - **Ignition OFF**
 - **Key out of the ignition switch - when not equipped with keyless access and start**
 - **Retained Accessory Power OFF - open and close the driver door after ignition OFF**
 - **Scan tool not communicating with a vehicle control module - in some cases it may need to be disconnected from the DLC**
 - **All access doors closed**
 - **Headlamps OFF - auto headlamps disabled**
 - **Any delay lighting OFF**

- If equipped with an under hood lamp disable it
- HVAC after blow OFF
- Any accessory that can work with ignition OFF inactive or OFF
- Wait up to 2 min or longer, after all other listed conditions are met

Using an Inductive Pickup Probe

1. Connect an inductive pickup probe to the negative battery cable that can read down to 1 mA.
2. Ignition OFF, as the vehicle systems shut down test for less than 30 mA of parasitic current drain.
 - If greater than the specified range, refer to Circuit/System Testing.

Using the EL 38758 Parasitic Draw Test Switch

WARNING: Refer to Battery Disconnect Warning .

CAUTION: When a fused jumper wire or digital multimeter is connected to the test switch terminals, always turn the test switch ON before opening any access door, turning the ignition on, or turning any accessory on. This is to prevent damaging the jumper wire or digital multimeter fuse.

NOTE: The switch knob on the EL 38758 switch is marked ON and OFF. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.

1. Ignition OFF, disconnect the battery negative cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Turn the **EL 38758** switch knob to the OFF position.
3. Install the male end of the **EL 38758** switch to the battery ground terminal.
4. Install the battery negative cable to the female end of the **EL 38758** switch.
5. Turn the **EL 38758** switch knob to the ON position.
6. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
7. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
8. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the jumper wire.
9. Check the fuse in the jumper wire. The fuse should be OK.
 - Failed: If the jumper wire fuse is blown, refer to Circuit/System Testing.
 - Passed
10. Turn the **EL 38758** switch knob to the ON position. Remove the fused jumper wire.

11. Connect a DMM set to the 10 A DC scale between the test switch tool terminals.
12. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the DMM.
13. As the vehicle systems shut down test for less than 30 mA of parasitic current drain.
 - If greater than the specified range, refer to Circuit/System Testing.

Circuit/System Testing

NOTE:

- Removing or installing a fuse, relay, or connector, to determine the area causing high parasitic draw may wake up control modules. You must wait for the control modules to go back to sleep before retesting. It is best to install any removed or disconnected components after the diagnosis is completed.
- Fuses for power mode master components such as the BCM should be removed last to avoid misdiagnosis.
- If a scan tool is connected to the DLC, either disconnect it or subtract the scan tool current draw from the DMM reading to get the actual vehicle parasitic current draw.

If the vehicle has an unacceptable amount of parasitic current draw, remove each fuse one at a time until the current draw falls to an acceptable level. A drop of more than 10-20 mA, when disabling a single system or circuit, is an indication of an overly high current draw that could be causing the battery drain. Refer to **Power Distribution Schematics** to diagnose exactly which circuit of the suspect system is causing the high parasitic drain. The following is a list of common components that could cause a high current draw:

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup

CHARGING SYSTEM TEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn ON control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON control circuit. The ECM should detect low voltage on the generator turn on control circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage when the duty cycle voltage is commanded high and a low voltage when the duty cycle voltage is commanded low on the generator turn on control circuit.

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings on and off. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is off, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5-99%.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

NOTE: Do not have a battery charger connected during the generator testing.

1. Ignition ON.
2. Verify that no G13 Generator or B18 Battery Current Sensor DTCs are set that would cause a charging system concern.
 - **If DTCs are set**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- **If no DTCs are set**
3. Verify the scan tool Body Control Module Battery Voltage parameter is 12 V or greater.
 - **If less than 12 V**

Refer to Battery Inspection/Test.

- **If 12 V or greater**
4. Engine running, all accessories OFF.
 5. Verify the scan tool Body Control Module Battery Voltage parameter continually increases when controlling the Body Control Module Generator Regulator Setpoint from 10% to 80% with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each setpoint change.
 - **If the battery voltage does not continually increase**

Refer to Circuit/System Testing.

- **If the battery voltage continually increases**
6. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X2, 2 X2 or A X2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+

cable.

2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the G13 Generator.
 - **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
 - **If 5% or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the G13 Generator signal circuit terminal 2 X1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 5%**
4. Install a 3 A fused jumper wire between the signal circuit terminal 1 X1 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.
 - **If 95% or less**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 95%**
6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Generator Replacement (LUK), Generator Replacement (LTG)

GENERATOR NOISE DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Aids

Noise from a generator may be due to electrical or mechanical noise. Electrical noise or magnetic whine usually varies with the electrical load placed on the generator and is a normal operating characteristic of all generators. When diagnosing a noisy generator, it is important to remember that loose or misaligned components around the generator may transmit the noise into the passenger compartment and that replacing the generator may not solve the problem.

Circuit/System Testing

1. Start the engine. Verify the noise can be heard. Compare the concern to a similar vehicle.
2. Perform a charging system test. Verify that the generator is charging properly.
3. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines, or other accessory equipment that may be misrouted or be the cause of noise being transmitted into the passenger compartment.
4. Ignition OFF, remove the engine drive belt. Verify the generator, A/C compressor, water pump pulley, power steering pump, idler pulley, and tensioner pulley spin freely.
 - If any of the pulleys do not spin freely, replace the affected component.
5. Start the engine, with the drive belt removed. Verify that the noise goes away. Operate the engine for no longer than 30-40 seconds.
 - If the noise is still present, the generator is not the cause of the noise.
6. Loosen all generator mounting bolts and ensure the generator is properly aligned. Tighten the mounting bolts to specification, refer to **Generator Replacement (LUK)**, **Generator Replacement (LTG)**.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Drive Belt Replacement (LEA)** , **Drive Belt Replacement (LUK)** for the 2.4L engines
- **Drive Belt Tensioner Replacement (LUK)** , **Drive Belt Tensioner Replacement (LEA)** for the 2.4L engines
- **Generator Replacement (LUK)**, **Generator Replacement (LTG)**

STARTER SOLENOID DOES NOT CLICK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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B+	1	1	-	-
Signal	2	1	-	-
Relay Coil Control Terminal 85	-	1	3	-
Starter Control Terminal 87	1	1	3	-
Ground	-	1	-	-
1. Starter Solenoid Does Not Click 2. Cranks In Any Gear 3. Cranks All The Time				

Circuit/System Description

When the ignition mode switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a serial data message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch is fully depressed or the automatic transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Reference Information

Schematic Reference

- **Starting and Charging Schematics**
- **Automatic Transmission Controls Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that no ignition, starter relay, brake pedal position sensor, immobilizer, or automatic transmission DTCs are set that would cause the ECM to disable engine starting.
 - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, observe the scan tool BCM 5 V Ignition Switch parameter. Place the ignition switch in the crank position, the parameter should display Crank Request.
 - If not the specified value, refer to **Power Mode Mismatch** .
3. Transmission range selector in park , verify the scan tool TCM Internal Mode Switch parameters display Park.
 - If the TCM Internal Mode Switch parameter does not indicate Park. Refer to **Transmission Internal Mode Switch Logic** ..
4. Transmission in park or neutral, attempt to start the vehicle. The crank relay should click and the engine should begin cranking.
 - If the KR27 Starter Relay does not click or the engine does not crank, refer to Circuit/System Testing.
5. Ignition ON, observe the scan tool ECM Crankshaft Position Sensor Active Counter is not incrementing.
 - If the Crankshaft Position Sensor Active Counter is incrementing, replace the Crankshaft Position Sensor.

Circuit/System Testing

1. Ignition ON, with a scan tool verify the ECM Ignition 1 Signal parameter is greater than 10 V.
 - If less than the specified range, test the ECM ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
2. Ignition OFF, disconnect the KR27 Starter Relay.
3. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5.0 ohms between the relay ground circuit terminal 86 and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse or starter fuse is open, test the control circuit terminal 87 for a short to ground.
5. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.
 - If the test lamp illuminates, test the control circuit terminal 87 for a short to voltage.
6. Ensure the parking brake is applied and the T12 Transmission is in PARK. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the M64 Starter Motor is activated.
 - If the M64 starter motor does not activate, test the control circuit for an open/high resistance. If the circuit tests normal, test or replace the M64 Starter Motor.
7. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
8. Transmission in park/neutral, command the starter relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

- If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 Engine Control Module.
 - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 Engine Control Module.
9. If all circuits test normal, test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.
2. Test for 60-180 ohms between terminals 85 and 86.
 - If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - If not the specified value, replace the relay.
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
 - If greater than specified range, replace the KR27 Starter Relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Crankshaft Position Sensor Replacement** for the 2.4L engine
- **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**
- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for ECM replacement, setup, and programming

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 Battery. The voltage should be between 12.0-15.0 V.
 - If not within the specified range, refer to **Battery Inspection/Test**.
2. Remove the drive belts. Refer to **Drive Belt Tensioner Replacement (LUK)** , **Drive Belt Tensioner Replacement (LEA)** , or **Drive Belt Replacement (LEA)** , **Drive Belt Replacement (LUK)** .
3. Using the appropriate tools, rotate the crankshaft by hand and verify the crankshaft rotates.
 - If the crankshaft does not rotate, refer to **Engine Will Not Crank - Crankshaft Will Not Rotate** .
4. Ignition Start, verify the engine does not crank.
 - If the engine cranks, inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.
5. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal A X2 and ground.
 - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
6. Test for less than 0.5 V between the positive battery cable and terminal A X2 at the M64 Starter Motor as ignition is switched to start position.
 - If greater than the specified value, replace the positive battery cable.
7. Test for less than 0.5 V between the negative battery cable and the M64 Starter Motor case as ignition is switched to start position.
 - If greater than the specified value, replace the negative battery cable.
8. If all circuits test normal, replace the M64 Starter Motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Positive and Negative Cable Replacement (LUK), Battery Positive and Negative Cable Replacement (LTG)**
- **Starter Replacement (LUK), Starter Replacement (LTG)**

ENGINE CRANKS SLOWLY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 Battery. The voltage should be between 12.0-15.0 V.
 - If not within the specified range, refer to **Battery Inspection/Test**.

2. Remove the drive belts. Refer to **Drive Belt Tensioner Replacement (LUK)** , **Drive Belt Tensioner Replacement (LEA)** , or **Drive Belt Replacement (LEA)** , **Drive Belt Replacement (LUK)** .
3. Ignition Start, verify the engine does not crank normal.
 - If the engine cranks normal, inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.
4. Verify that a test lamp illuminates between the M64 starter motor B+ terminal A X2 and ground.
 - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. Test for less than 0.5 V between the positive battery cable and terminal A X2 at the M64 starter motor as ignition is switched to start position.
 - If greater than the specified value, replace the positive battery cable.
6. Test for less than 0.5 V between the negative battery cable and the M64 starter motor case as ignition is switched to start position.
 - If greater than the specified value, replace the negative battery cable.
7. If all circuits test normal, replace the M64 starter motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Positive and Negative Cable Replacement (LUK)**, **Battery Positive and Negative Cable Replacement (LTG)**
- **Starter Replacement (LUK)**, **Starter Replacement (LTG)**

STARTER NOISE DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The PG starter motors are non-repairable. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

Reference Information

Description and Operation

Starting System Description and Operation

Circuit/System Verification

Start the engine. Listen to the starter noise while the engine is cranking. Compare the concern to a similar vehicle.

Circuit/System Testing

1. Remove the flywheel inspection cover.
2. Inspect the flywheel for the following:
 - Loose flywheel bolts
 - Chipped gear teeth
 - Missing gear teeth
 - Bent flywheel
 - Debris in the bell housing
 - If not within specifications, remove the debris, tighten the flywheel bolts, or repair or replace the flywheel.
3. If all inspections were within specification, replace the starter motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fastener Tightening Specifications**
- **Engine Flywheel Replacement**
- **Starter Replacement (LUK), Starter Replacement (LTG)**

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION

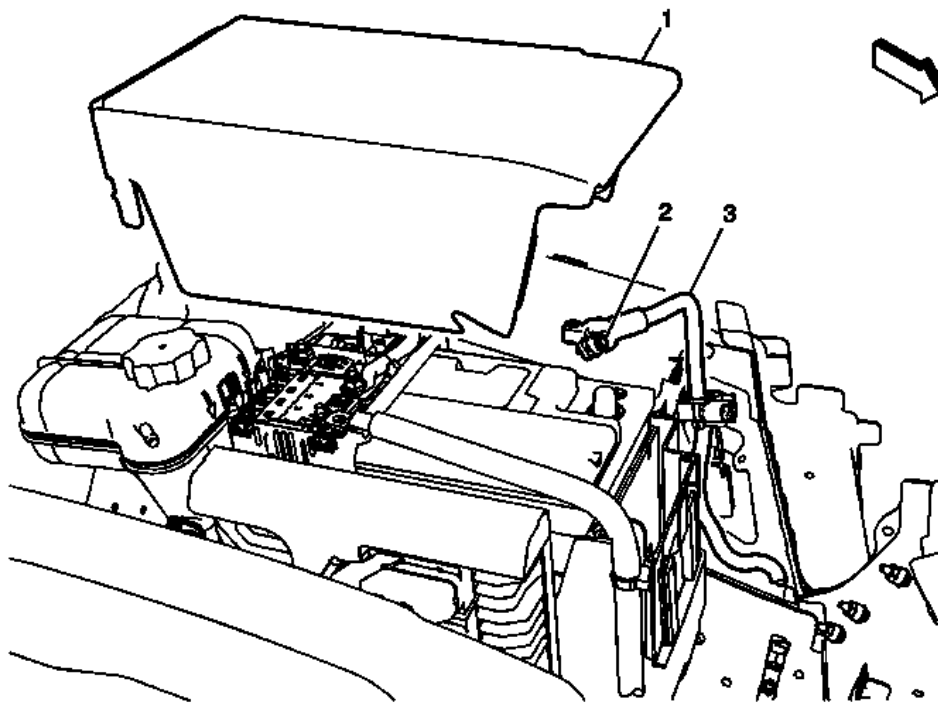


Fig. 5: View Of Battery Negative Cable & Cover
 Courtesy of GENERAL MOTORS COMPANY

Battery Negative Cable Disconnection and Connection

Callout	Component Name
Preliminary Procedures 1. Turn the ignition OFF. 2. Record radio and engine oil life resets.	
1	Battery Cover
2	Battery Negative Cable Fastener WARNING: Refer to <u>Battery Disconnect Warning</u> . CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4.5 N.m (40 lb in)
3	Battery Negative Cable

BATTERY CURRENT SENSOR REPLACEMENT

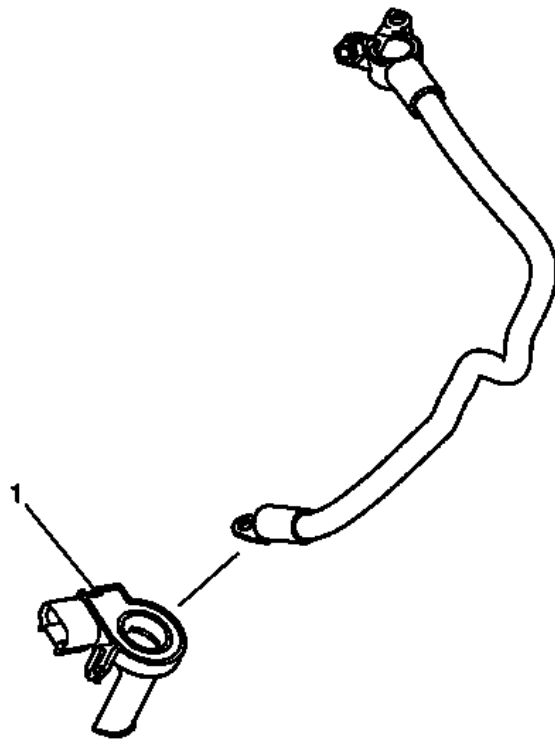


Fig. 6: Battery Current Sensor
 Courtesy of GENERAL MOTORS COMPANY

Battery Current Sensor Replacement

Callout	Component Name
Preliminary Procedure	
Remove the battery negative cable fastener from the frame strut.	
1	Battery Current Sensor Procedure <ol style="list-style-type: none"> 1. Detach the electrical connector. 2. Ensure that the location measurement of the battery current sensor is recorded for reference during installation. 3. Cut and remove the tape securing the sensor to the negative battery cable. 4. Remove the sensor from the cable.

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT (LUK)

Removal Procedure

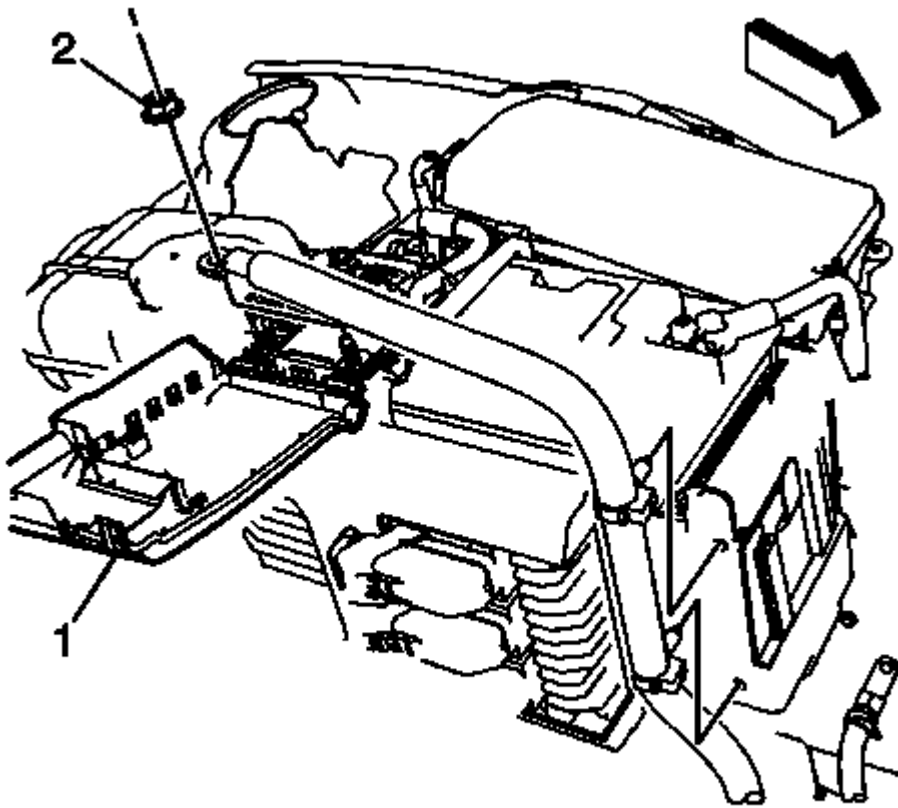


Fig. 7: Positive Battery Cable Terminal, Nut And Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection.**
2. Open the battery fuse block cover (1).
3. Remove the battery positive fastener (2) from battery fuse block and detach retainers from the battery tray.

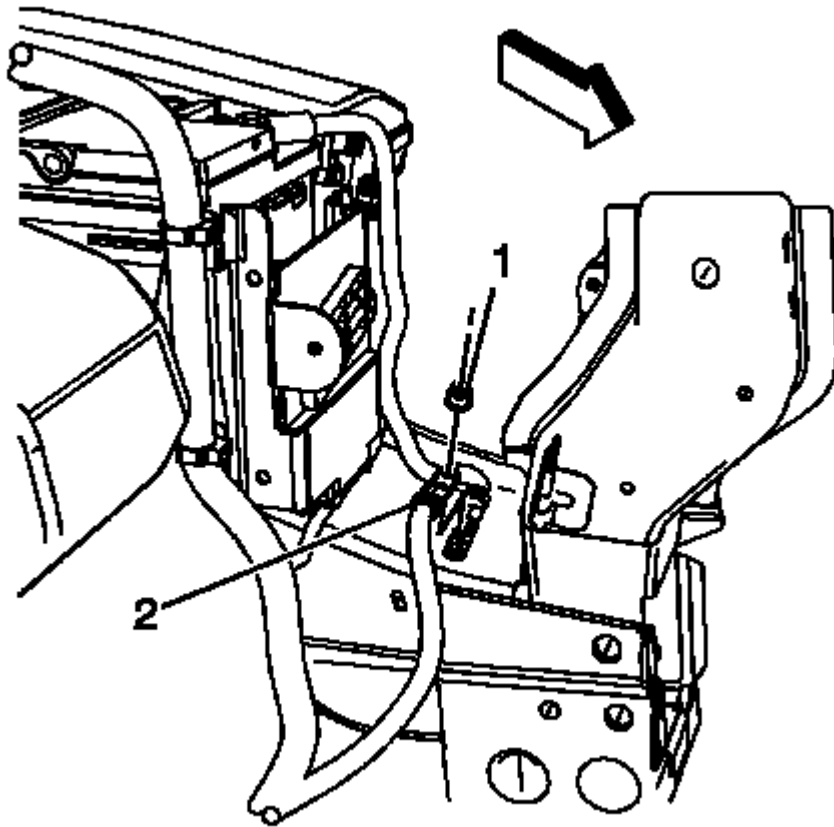


Fig. 8: Battery Negative Nut & Terminal
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery negative fastener (1) and terminal (2) from the left front frame rail.

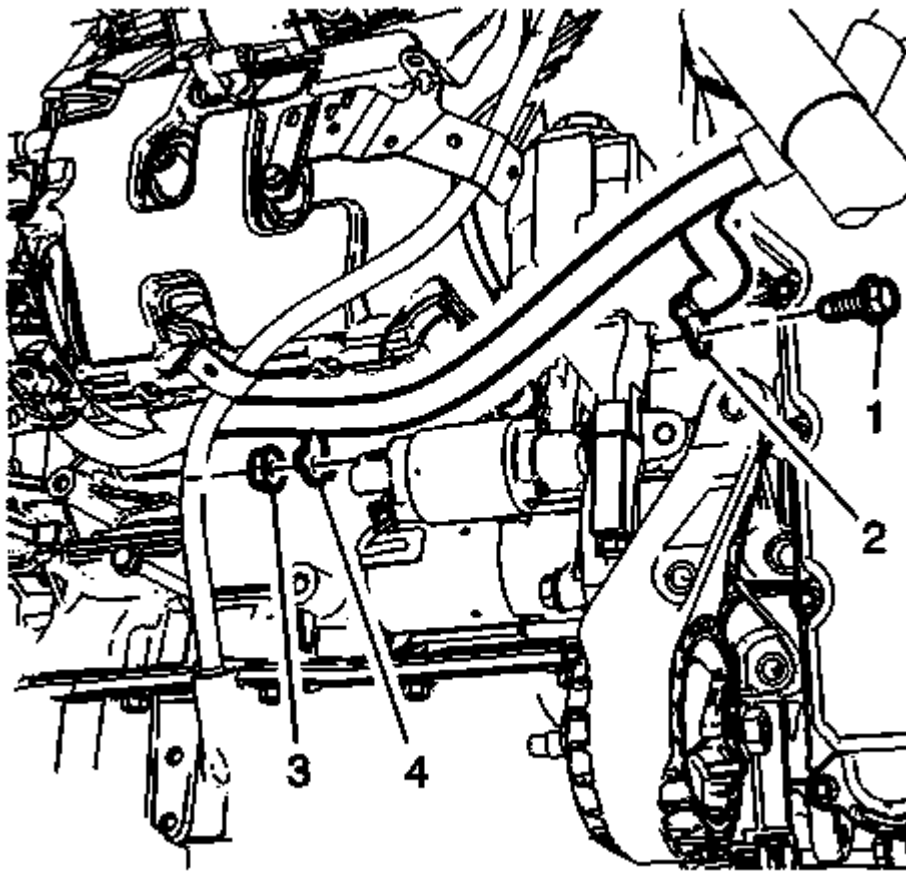


Fig. 9: Battery Positive Cable Terminal And Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Remove the battery negative ground fastener (1) and remove the battery negative terminal (2).
6. Remove the starter solenoid fastener (3) and battery positive cable terminal (4) from the starter solenoid.

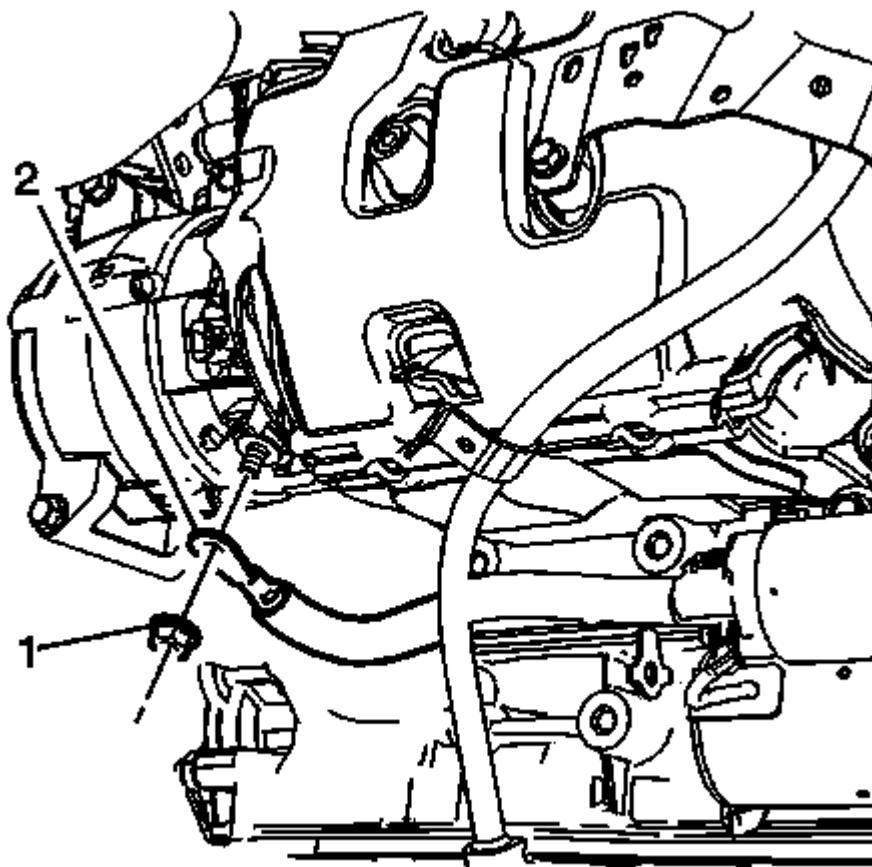


Fig. 10: Generator Fastener And Battery Positive Terminal
Courtesy of GENERAL MOTORS COMPANY

7. Remove the generator fastener (1) and the battery positive terminal (2) from the generator.

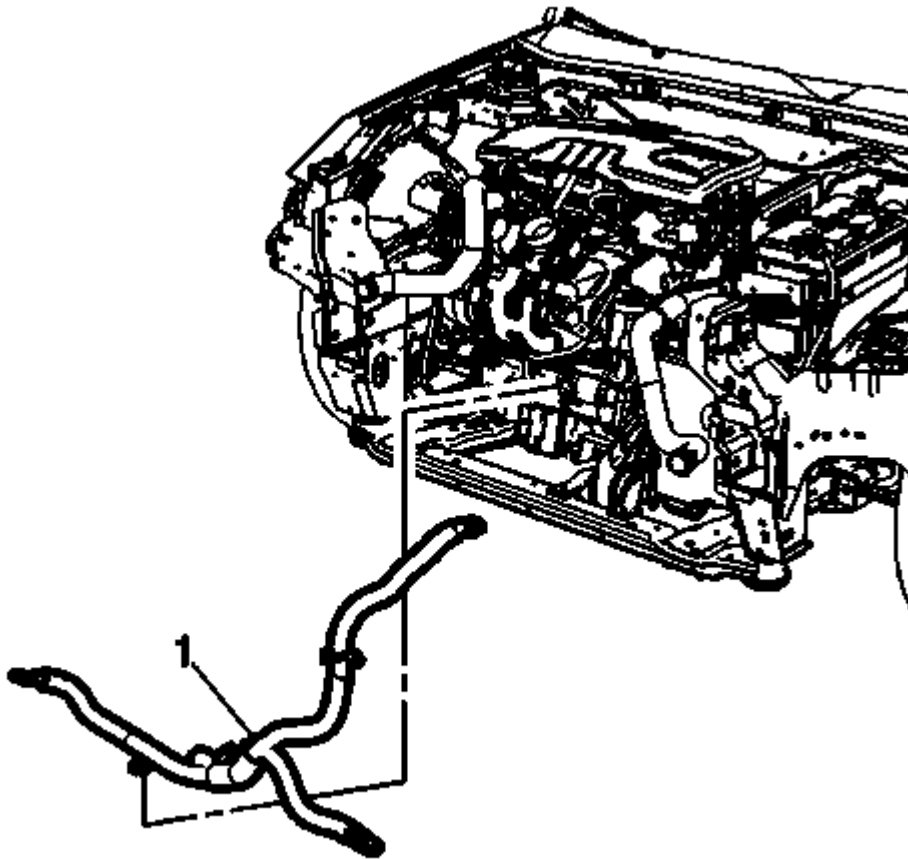


Fig. 11: Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: Observe how the battery positive and negative cable was routed within the engine compartment.

8. Remove the battery positive and negative cable (1) from the engine compartment.

Installation Procedure

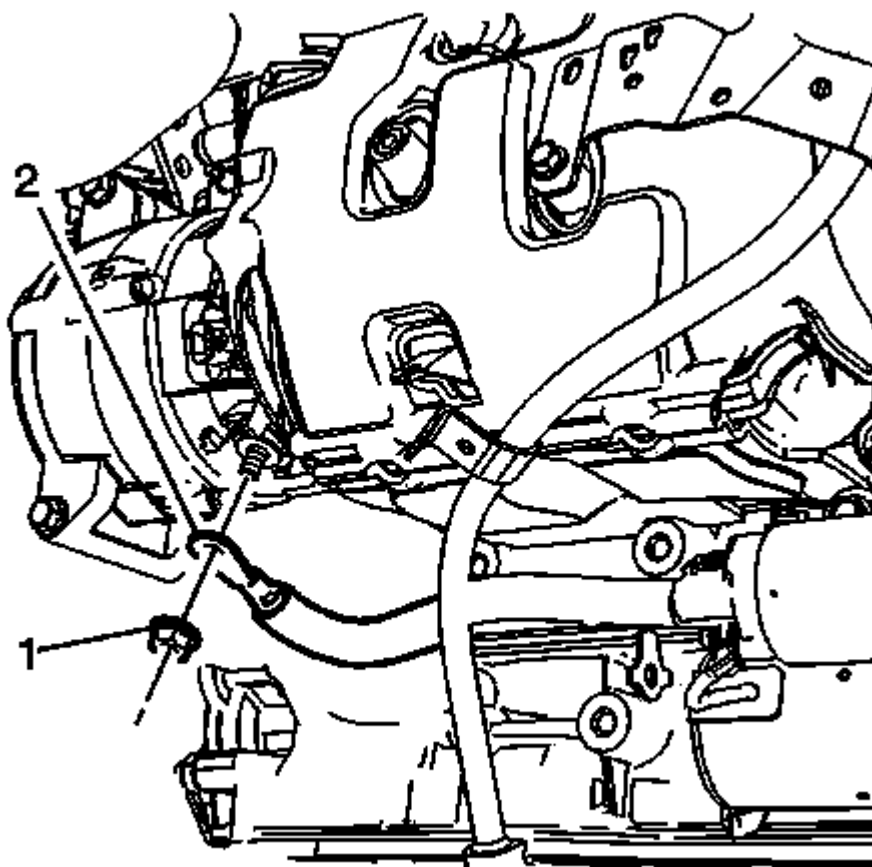


Fig. 12: Generator Fastener And Battery Positive Terminal
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the battery positive cable terminal (2) and fastener (1) to the back of the generator. Tighten to 15 N.m (11 lb ft).

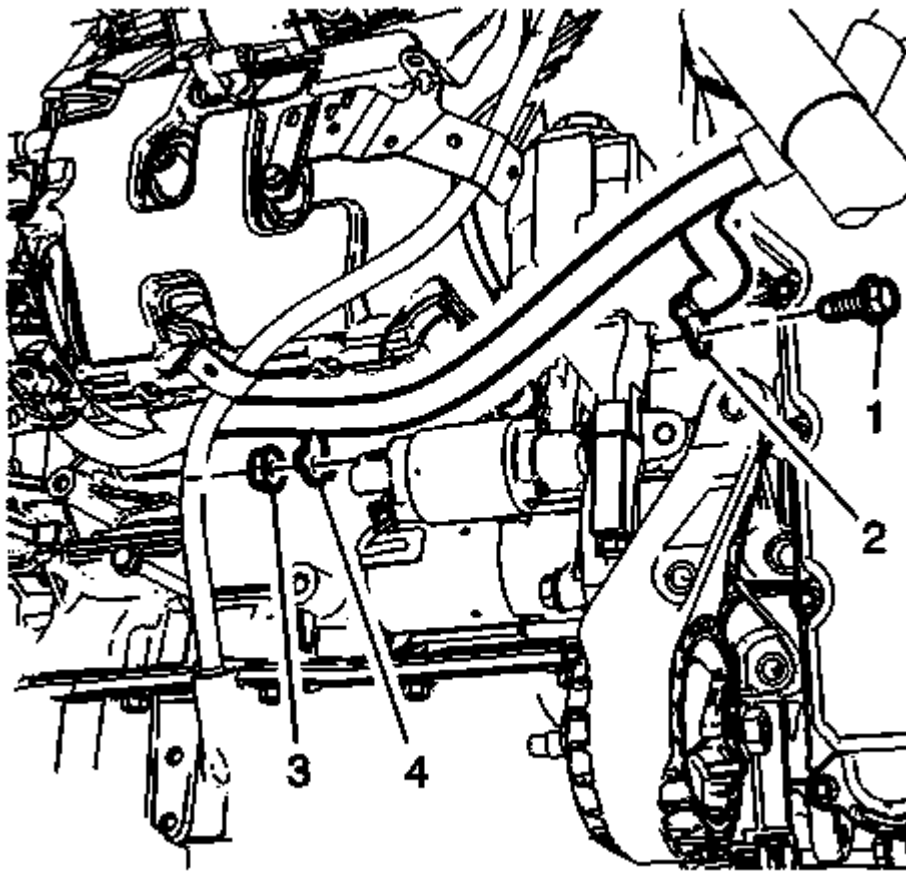


Fig. 13: Battery Positive Cable Terminal And Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Install the battery positive cable terminal (4) and fastener (3) to the starter solenoid. Tighten to 10 N.m (88 lb in).
3. Install the battery negative ground terminal (2) to the engine block and tighten the fastener (1) to 25 N.m (18 lb ft).

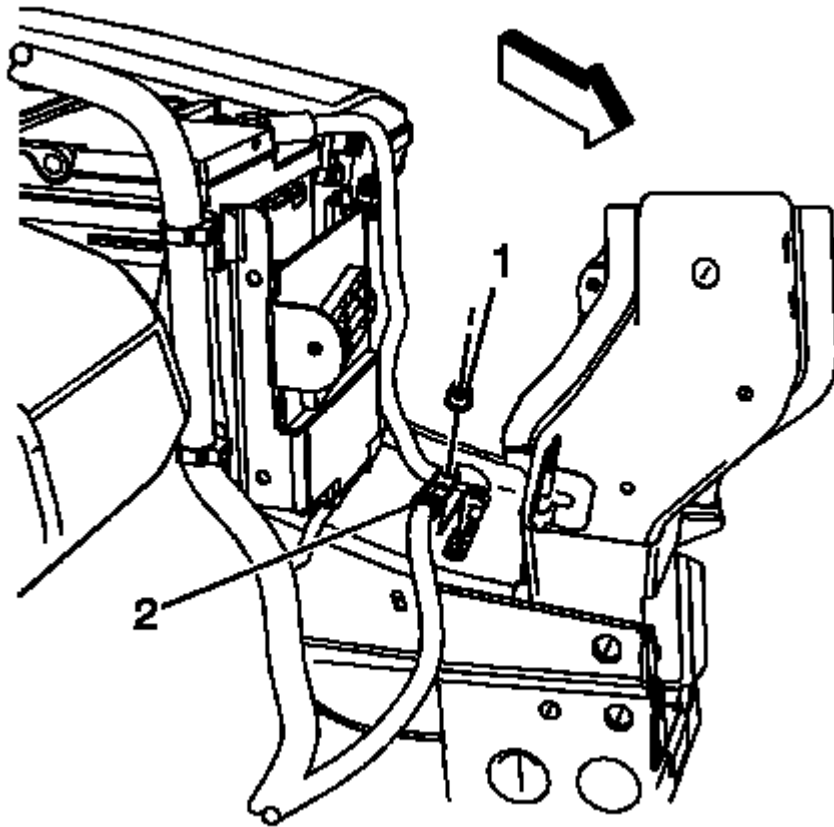


Fig. 14: Battery Negative Nut & Terminal
Courtesy of GENERAL MOTORS COMPANY

4. Install the battery negative cable terminal (2) and fastener (1) to the left front frame rail. Tighten to 25 N.m (18 lb ft).

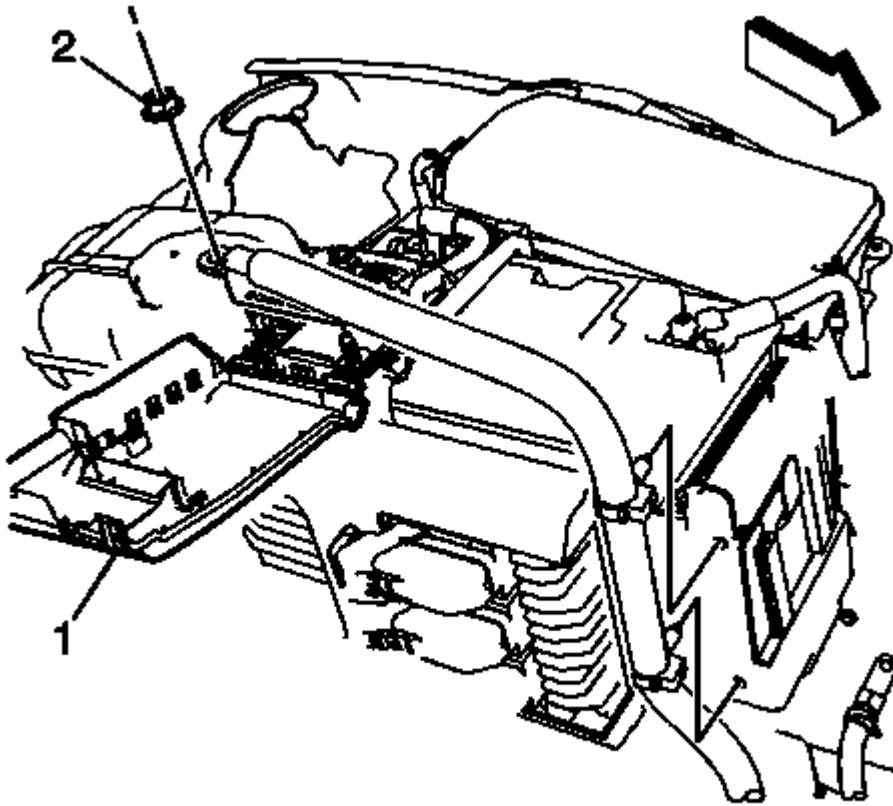


Fig. 15: Positive Battery Cable Terminal, Nut And Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

5. Install the positive battery cable terminal and fastener (2) to the battery fuse block. Tighten to 12 N.m (106 lb in).
6. Close battery fuse block cover (1) and install battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

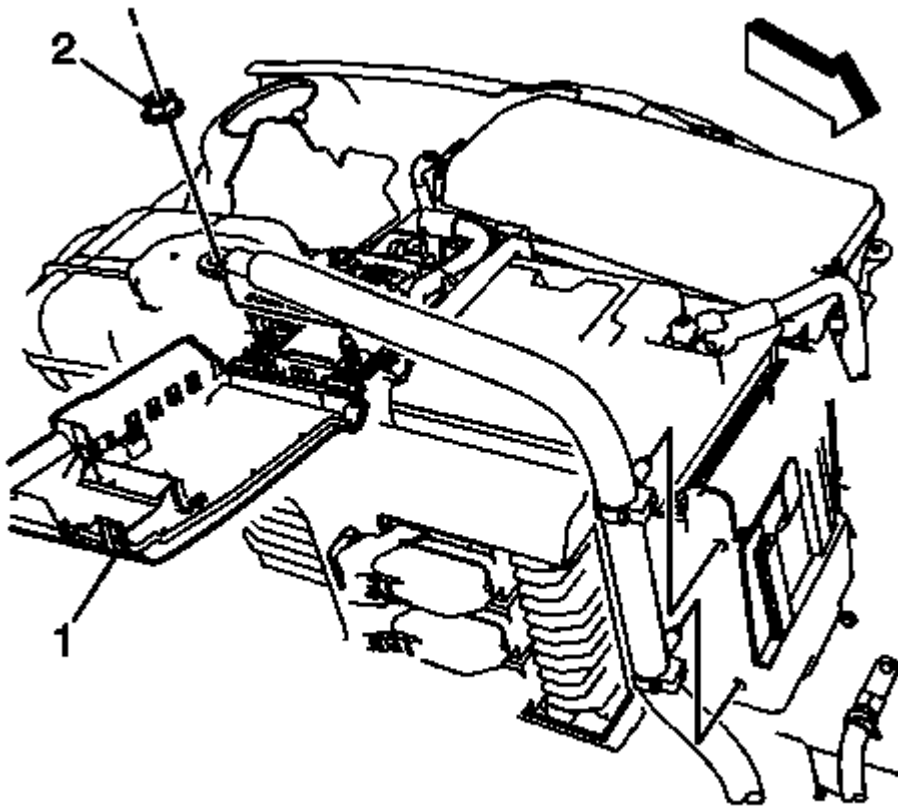


Fig. 16: Positive Battery Cable Terminal, Nut And Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open the battery fuse block cover (1).
3. Remove the battery positive fastener (2) from battery fuse block and detach the battery positive cable retainers from the battery tray.

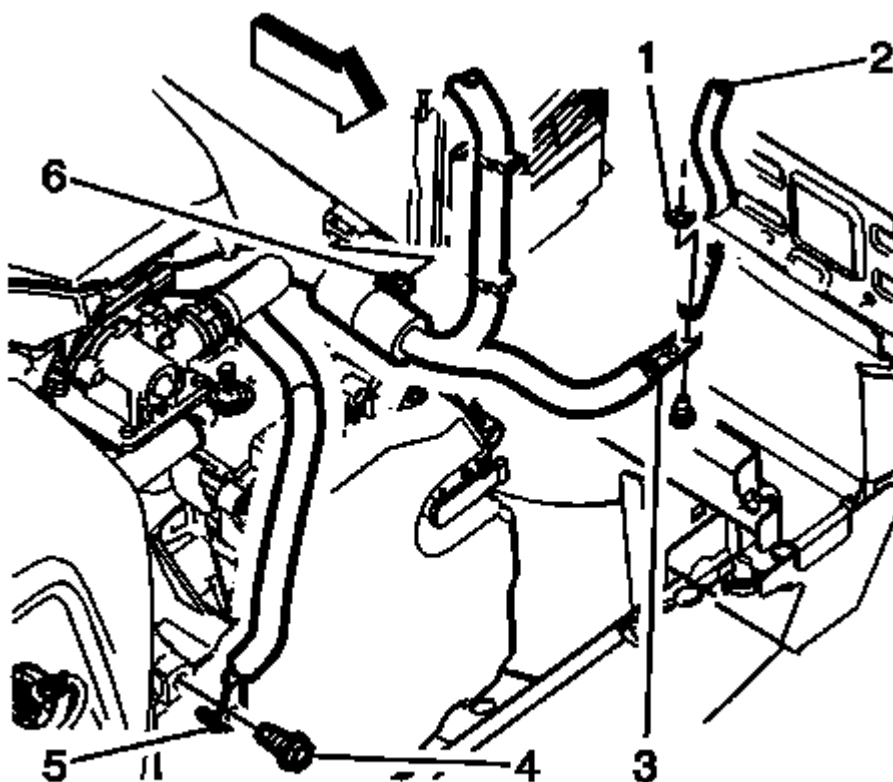


Fig. 17: Battery Negative Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery negative fastener (1) and the battery negative cable (2), from the left front frame rail.
5. Remove the battery positive and negative cable (3) from the left front frame rail.
6. Remove the battery negative cable ground fastener (4) and remove the battery negative cable (5).
7. Detach the battery positive and negative cable retainer (6), from the battery tray.

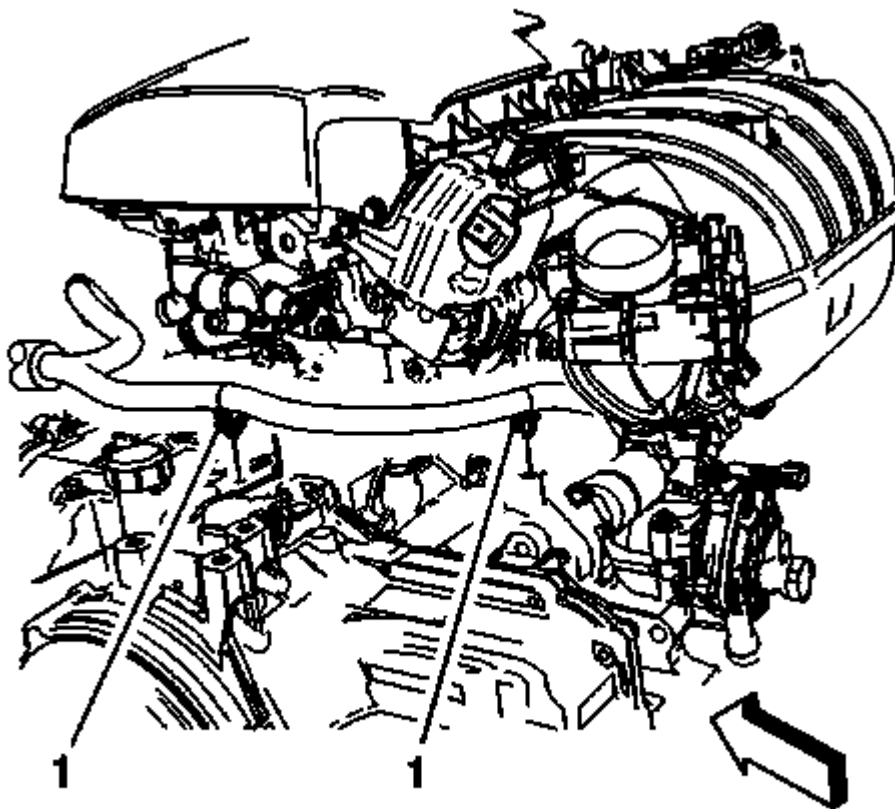


Fig. 18: Battery Positive And Negative Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Detach the battery positive and negative cable retainers (1).
9. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

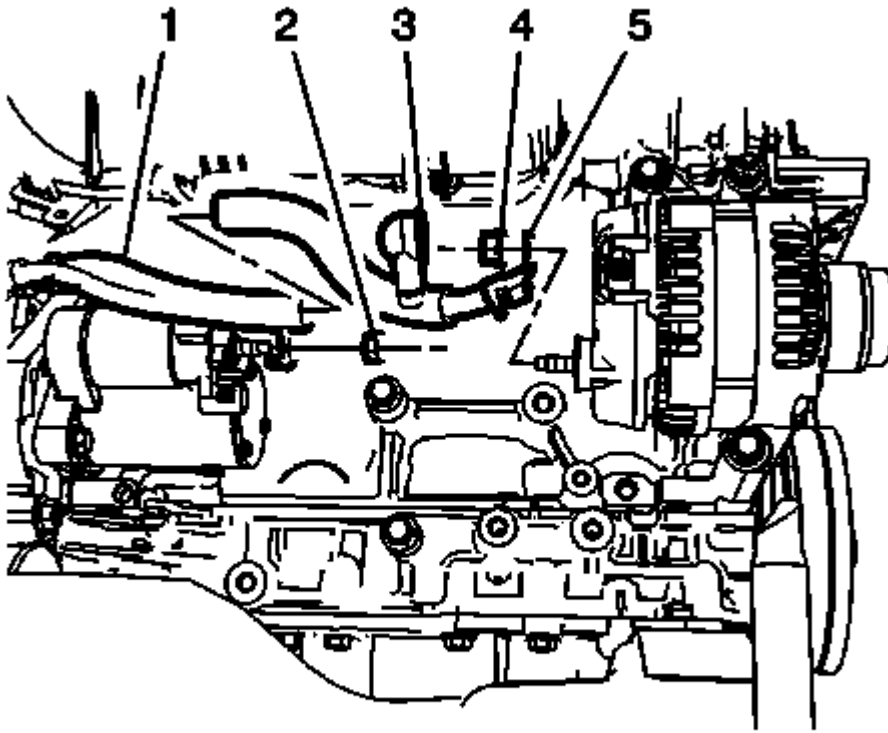


Fig. 19: Starter Solenoid Fastener
Courtesy of GENERAL MOTORS COMPANY

10. Remove the starter solenoid fastener (2) and remove the battery positive cable (1) from the starter solenoid.
11. Remove the protective boot (3) and the generator battery positive cable fastener (4).
12. Remove the battery positive cable (5) from the generator.

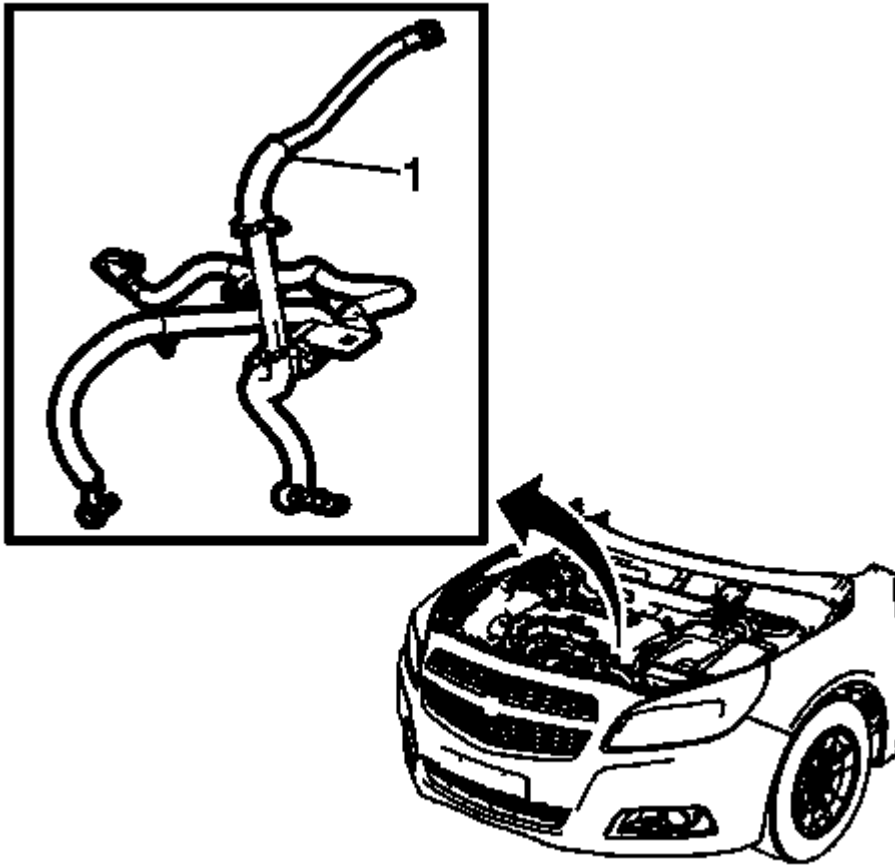


Fig. 20: Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: Observe how the battery positive and negative cable was routed within the engine compartment.

13. Remove the battery positive and negative cable (1) from the engine compartment.

Installation Procedure

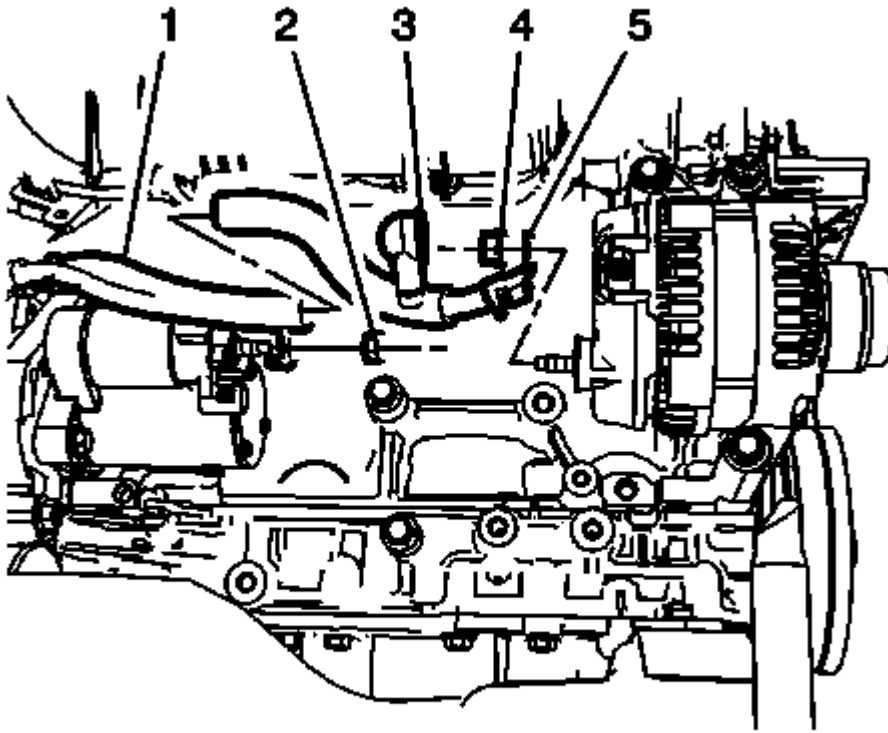


Fig. 21: Starter Solenoid Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the battery positive cable terminal (5) and fastener (4) to the back of the generator. Tighten to 15 (11 lb ft).
2. Install the battery positive cable (1) to the starter solenoid and tighten the fastener (2) to 10 (89 lb in).

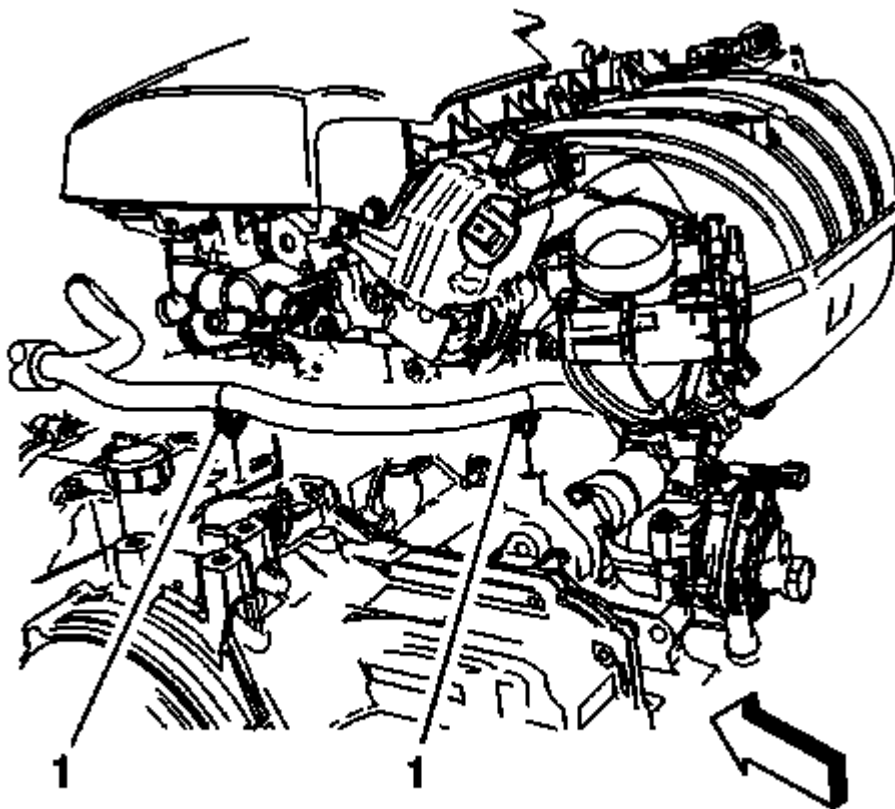


Fig. 22: Battery Positive And Negative Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install the battery positive and negative cable retainers (1), to the engine and transmission shift cable bracket.

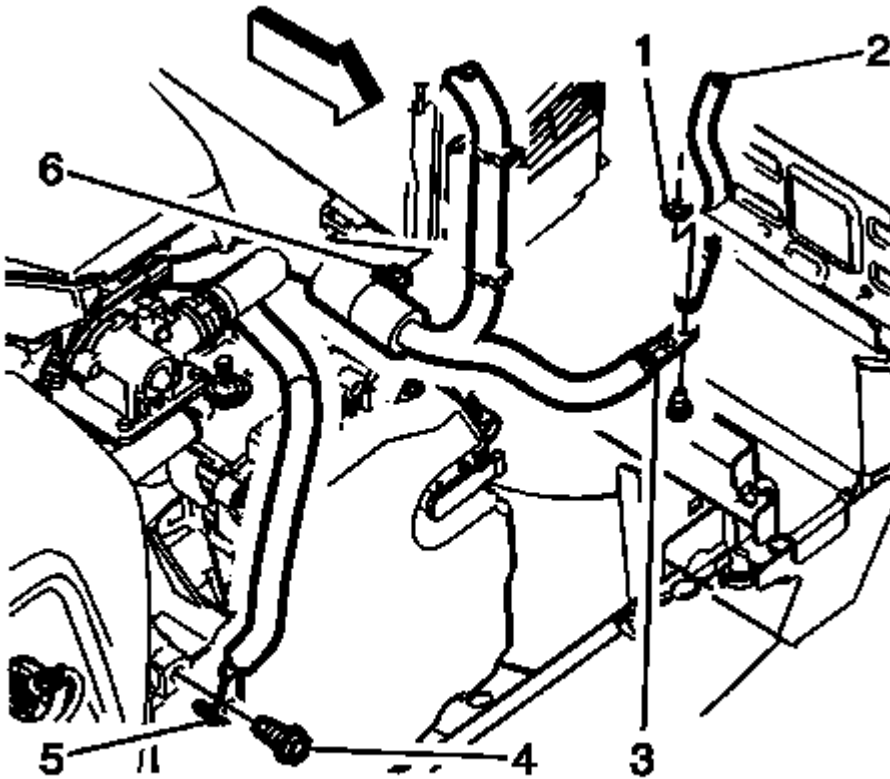


Fig. 23: Battery Negative Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Install the battery negative cable terminal (5), to the transmission, and tighten the fastener (4) to 25 (18 lb ft).
5. Install the battery positive and negative cable ground terminal (3) and the battery negative cable (2) to the frame stud. Tighten the fastener (1) to 25 (18 lb ft).
6. Install the battery positive and negative cable retainer (6), to the battery tray bracket.

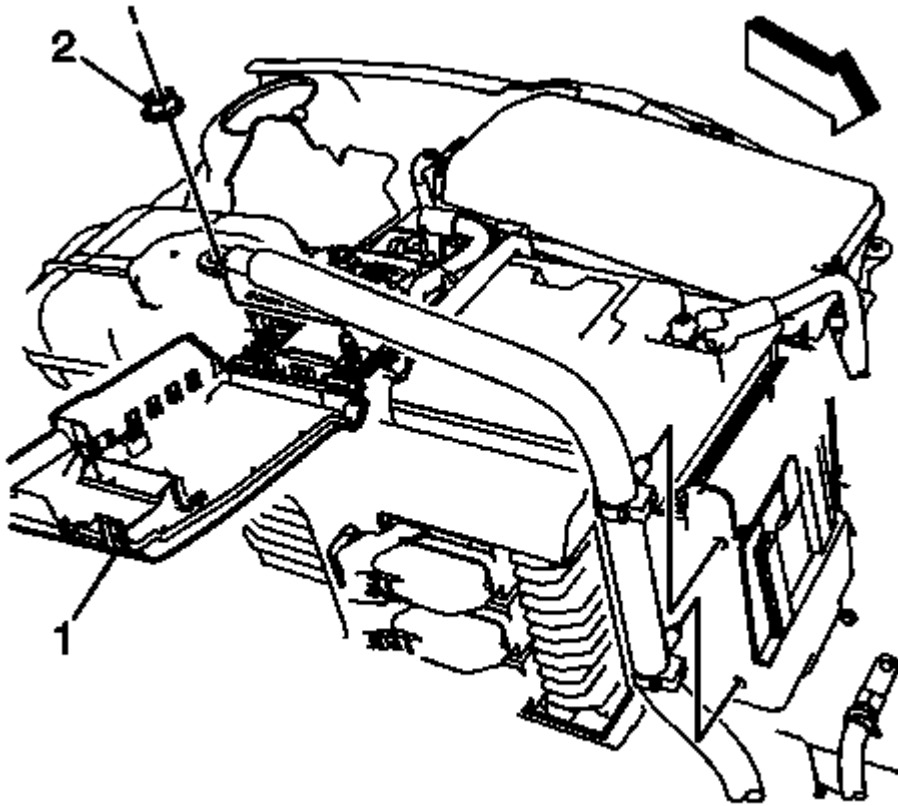


Fig. 24: Positive Battery Cable Terminal, Nut And Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

7. Install the battery positive cable terminal and fastener (2), to the battery fuse block. Tighten to 12 N.m (106 lb in).
8. Close the battery fuse block cover (1).
9. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection.**

BATTERY NEGATIVE CABLE REPLACEMENT

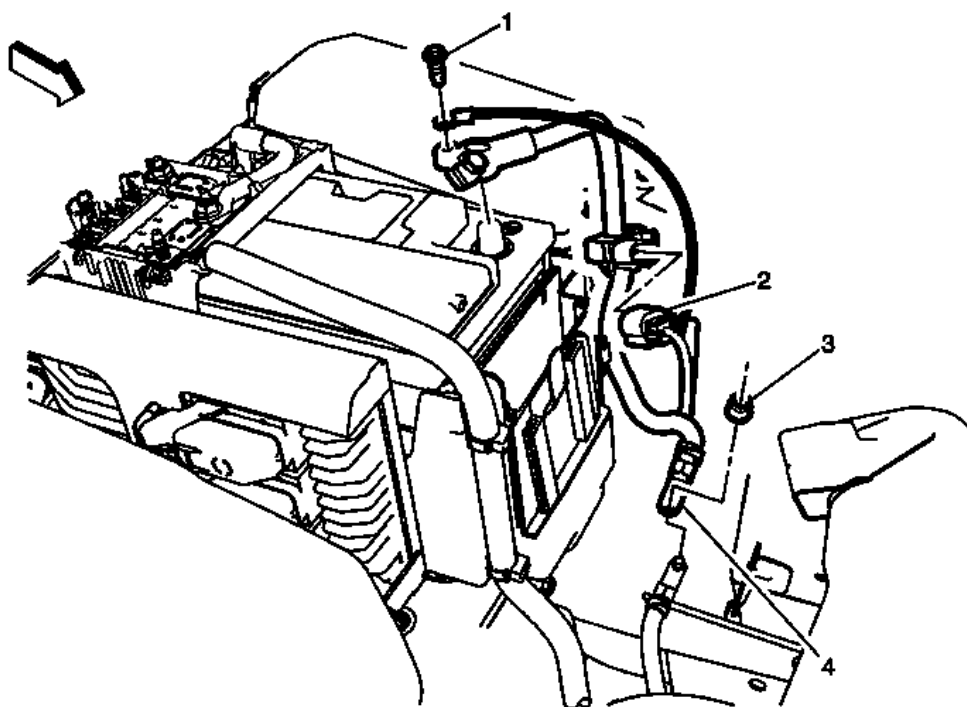


Fig. 25: Battery Negative Cable
 Courtesy of GENERAL MOTORS COMPANY

Battery Negative Cable Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Turn the ignition OFF. 2. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u>. 	
1	Body Harness Ground Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Battery Current Sensor Connector
3	Battery Negative Cable Frame Ground Nut Tighten 25 (18 lb ft)
	Battery Negative Cable

4	<p>Procedure</p> <ol style="list-style-type: none"> 1. Note the location of the current sensor. 2. Cut the tape retaining the battery current sensor to the battery negative cable. 3. Slide negative battery cable through current sensor. 4. Transfer the current sensor to the NEW battery negative cable, in the same location.
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BATTERY POSITIVE CABLE REPLACEMENT

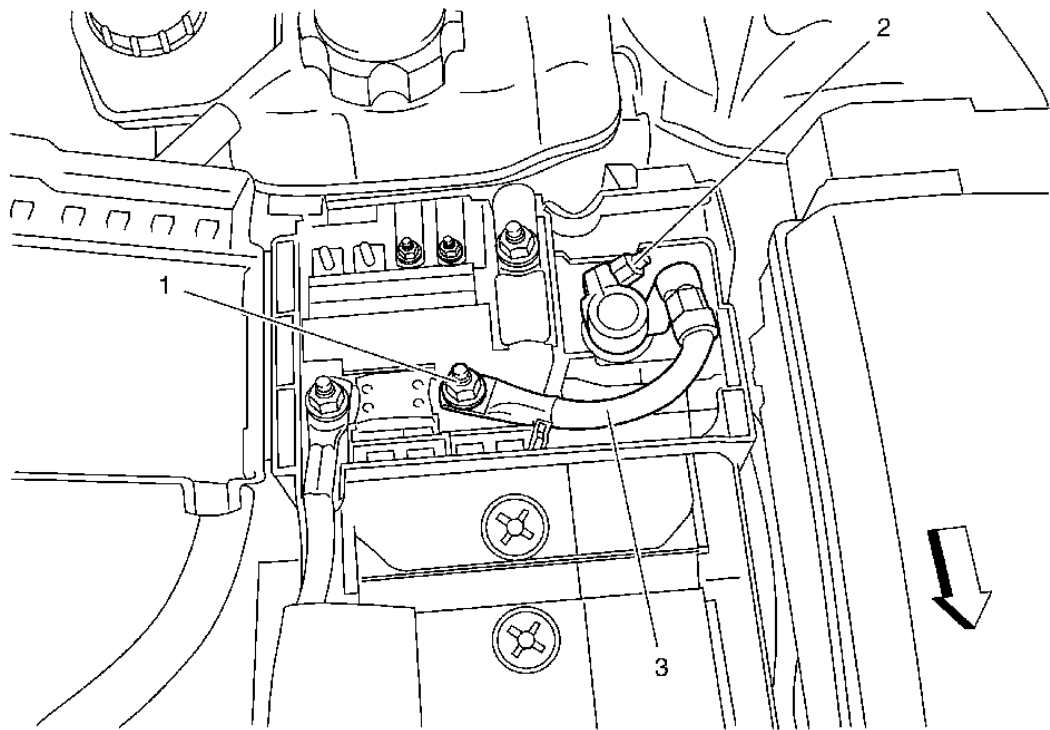


Fig. 26: Battery Positive Cable
 Courtesy of GENERAL MOTORS COMPANY

Battery Positive Cable Replacement

Callout	Component Name
<p>Preliminary Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the battery negative cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u>. 2. Open the battery fuse block cover. 	
1	<p>Battery Positive Cable Fastener</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p>

	Tighten 20 (15 lb ft)
2	Battery Positive Cable Fastener Tighten 4.5 (40 lb in)
3	Battery Positive Cable

BATTERY REPLACEMENT

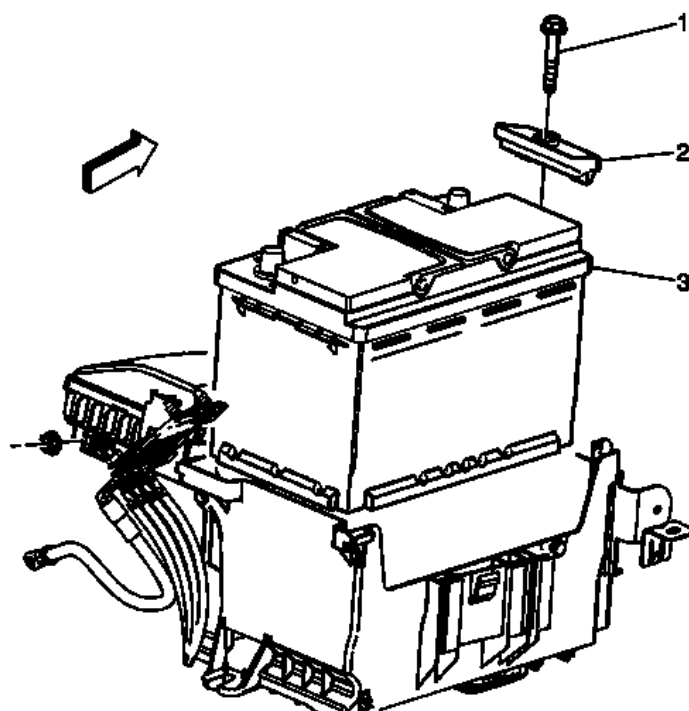


Fig. 27: View Of Battery, Retainer Bracket & Fastener
Courtesy of GENERAL MOTORS COMPANY

Battery Replacement

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none"> 1. Remove the battery cover. 2. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u>. 3. Remove the fuse block. Refer to <u>Fuse Block Replacement</u>. 	
	Battery Retainer Fastener
	CAUTION:

1	Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Battery Retainer Bracket
3	Battery

BATTERY TRAY REPLACEMENT

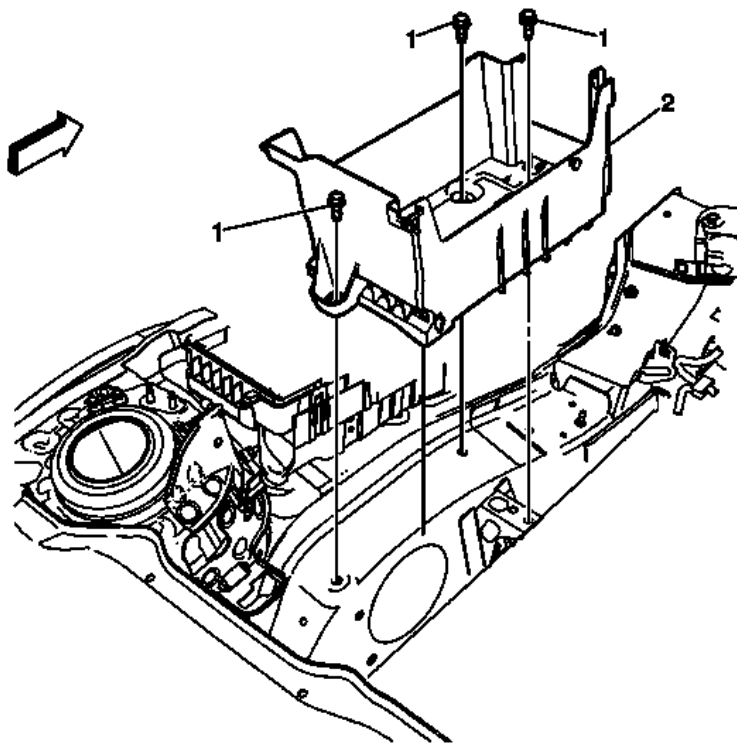


Fig. 28: Battery Tray & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Battery Tray Replacement

Callout	L Component Name
Preliminary Procedure	
1. Remove the battery. Refer to <u>Battery Replacement</u> . 2. Remove the engine control module. Refer to <u>ENGINE CONTROL MODULE REPLACEMENT</u> , for the 2.0L engine or <u>Engine Control Module Replacement</u> for the 2.4L engine .	
	Battery Tray Bolt (Qty: 3)

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 20 N.m (15 lb ft)
2	Battery Tray TIP: Unclip harnesses as necessary.

STARTER REPLACEMENT (LUK)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

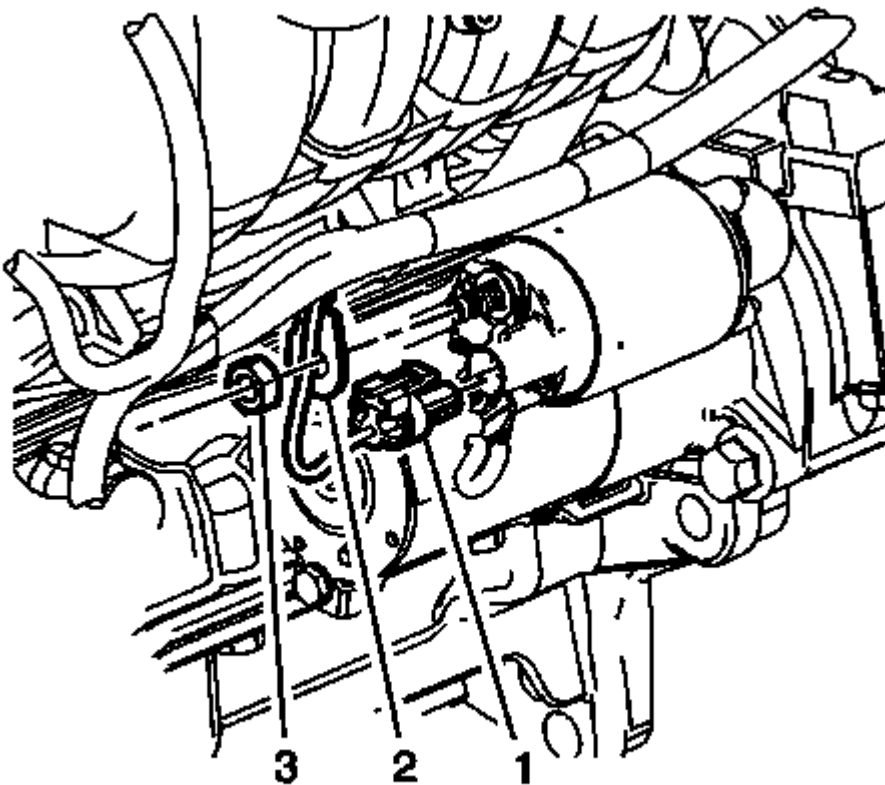


Fig. 29: Engine Harness Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the engine harness connector (1) from the starter.
4. Remove the starter solenoid fastener (3) and the battery positive terminal (2) from the starter.

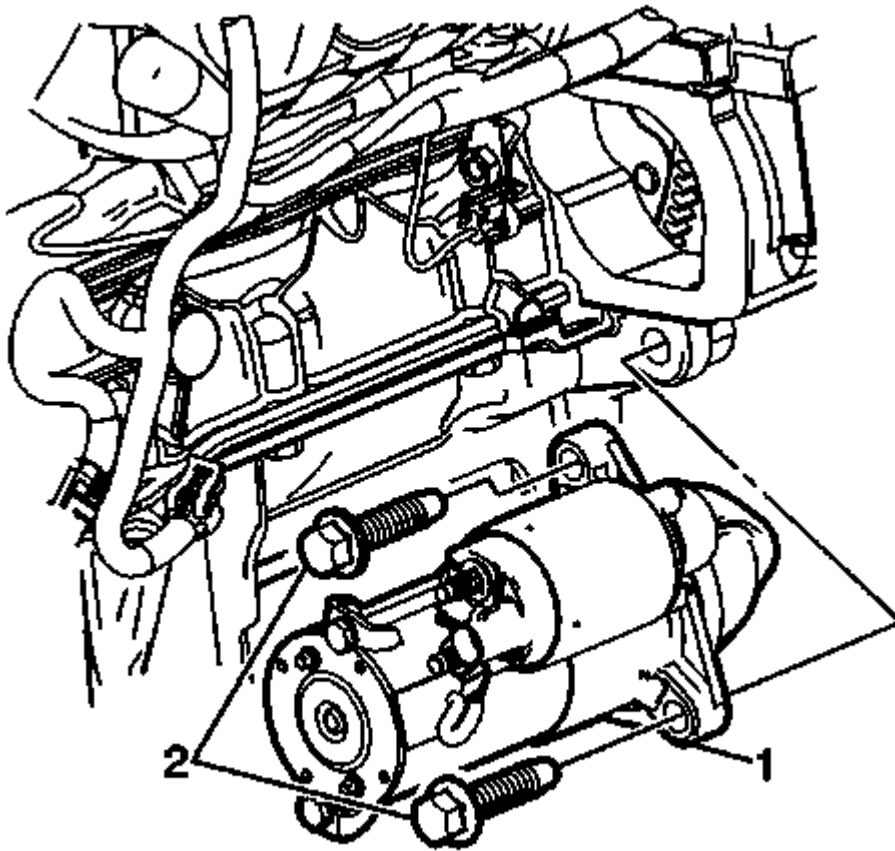


Fig. 30: View Of Starter Motor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the starter fasteners (2).
6. Remove the starter (1).

Installation Procedure

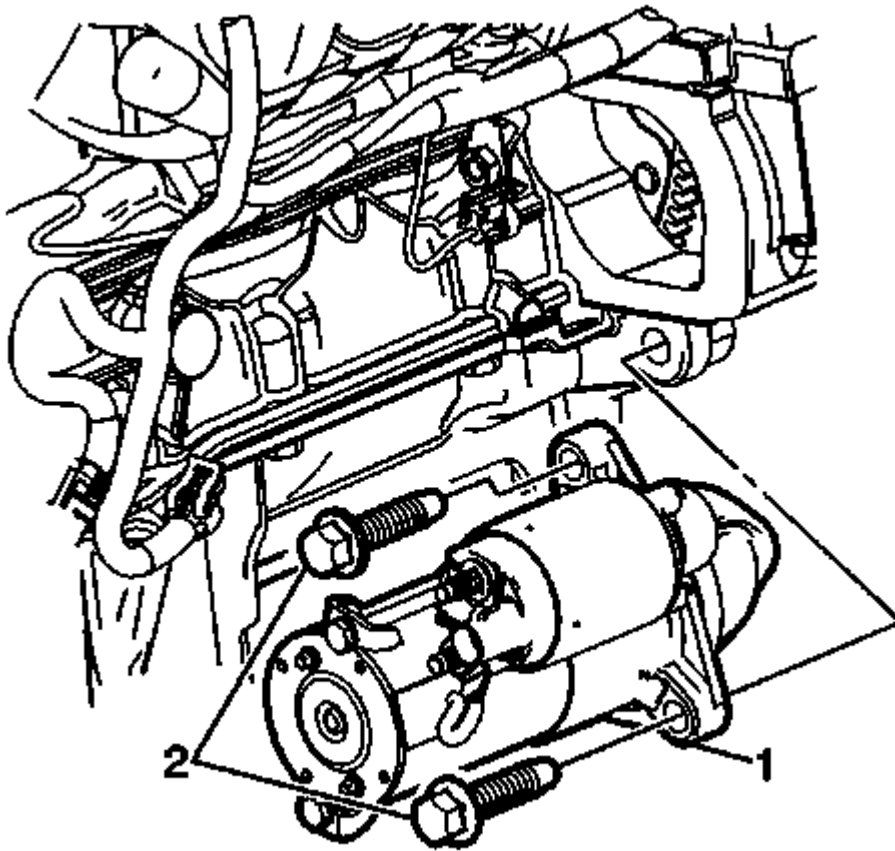


Fig. 31: View Of Starter Motor
Courtesy of GENERAL MOTORS COMPANY

1. Position the starter (1) to the engine.

CAUTION: Refer to Fastener Caution .

2. Install the starter mounting fasteners (2) and tighten to 58 N.m (43 lb ft).

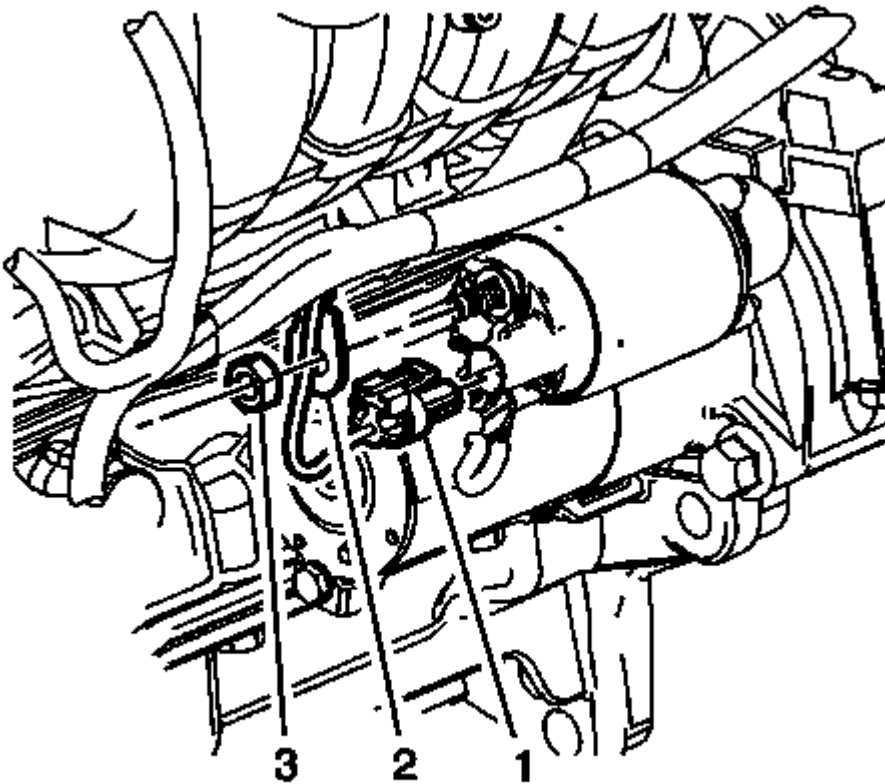


Fig. 32: Engine Harness Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the positive battery cable terminal (2) to the starter. Ensure that the anti-rotational tab is correctly located into the indexing slot.
4. Install the starter solenoid terminal fastener (3) and tighten to 11 N.m (8 lb ft).
5. Connect the engine harness connector (1) to the starter.
6. Lower the vehicle.
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection.**

STARTER REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection.**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle .**
3. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG) , Exhaust Front Pipe Replacement (LTG AWD) .**

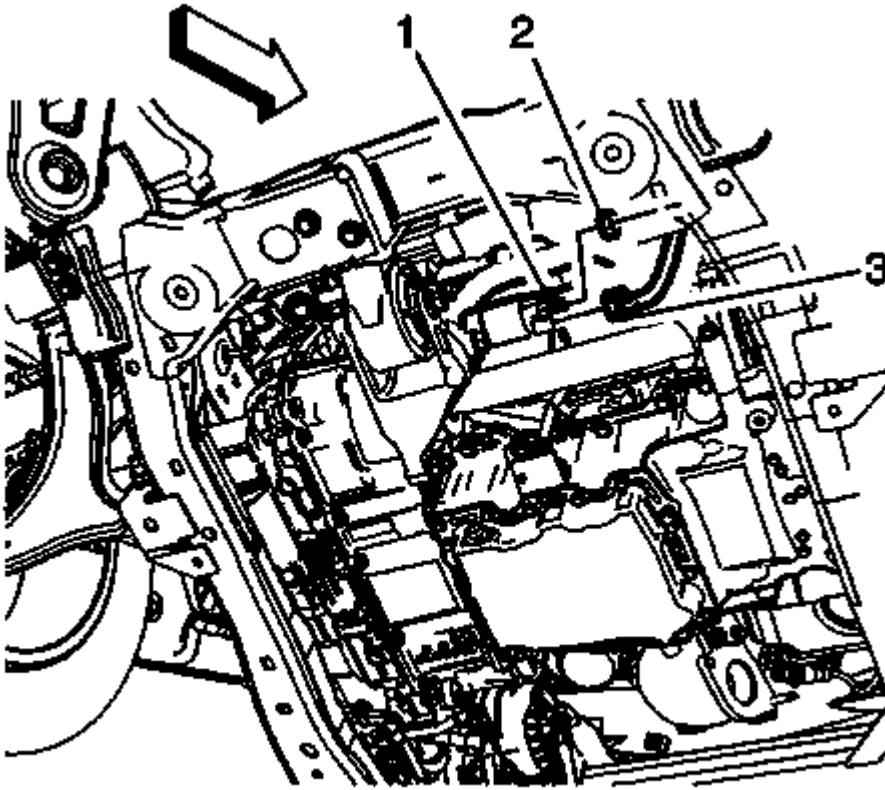


Fig. 33: Battery Positive Cable Terminal And Engine Harness Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the engine harness connector (3) from the starter solenoid.
5. Remove the battery positive cable fastener (2) and remove the battery positive cable terminal (1), from the starter solenoid.

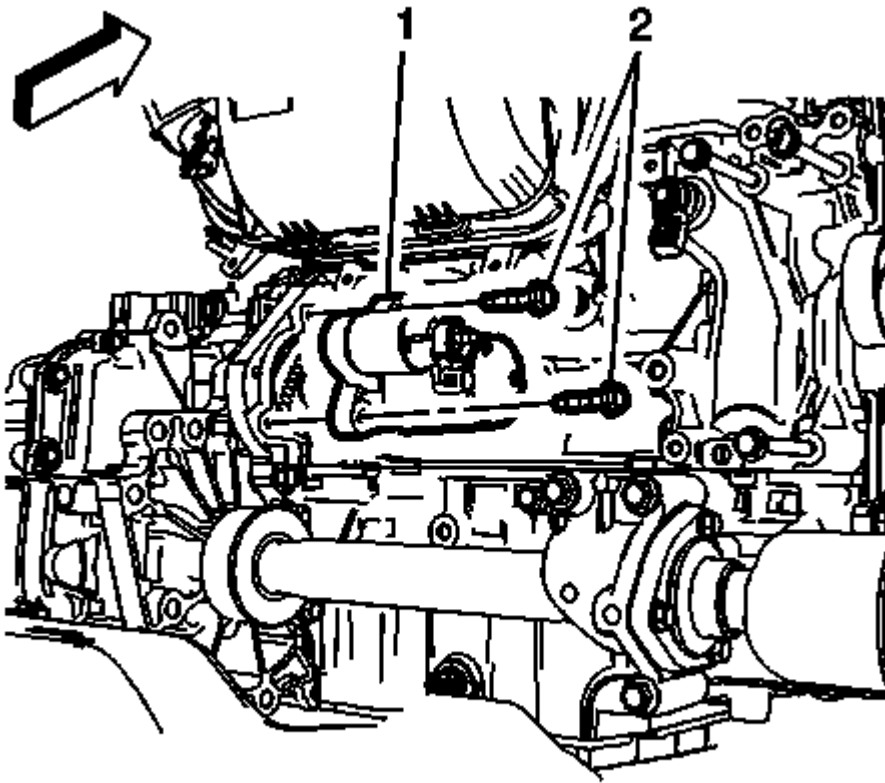


Fig. 34: Starter Mounting Fasteners And Starter
Courtesy of GENERAL MOTORS COMPANY

6. Remove the starter mounting fasteners (2) and remove the starter (1).

Installation Procedure

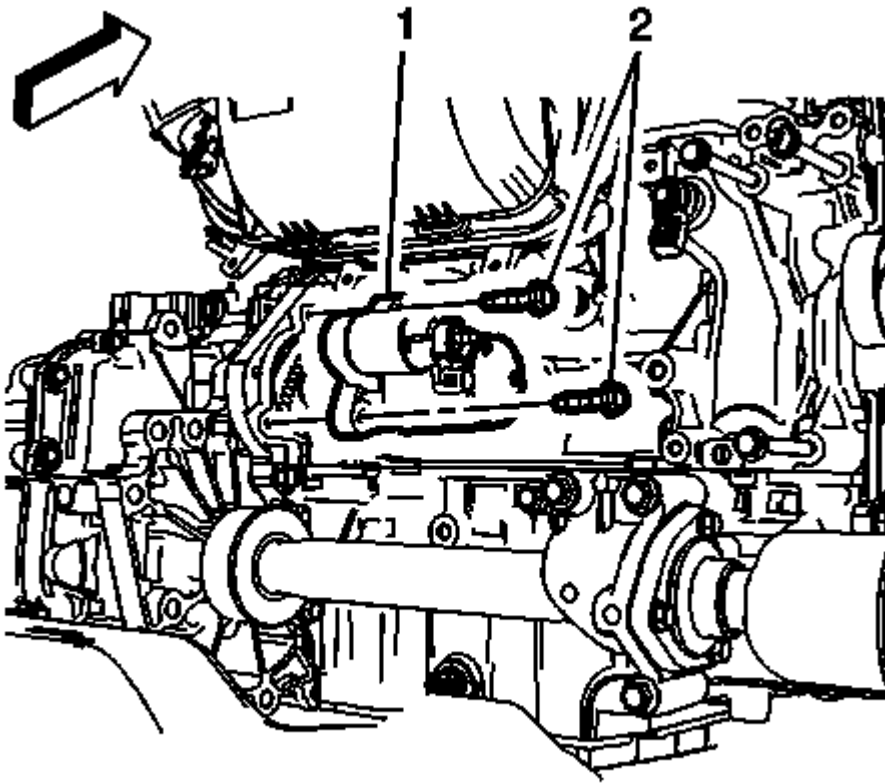


Fig. 35: Starter Mounting Fasteners And Starter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the starter (1) and tighten the fasteners (2) to 22 (16 lb ft).

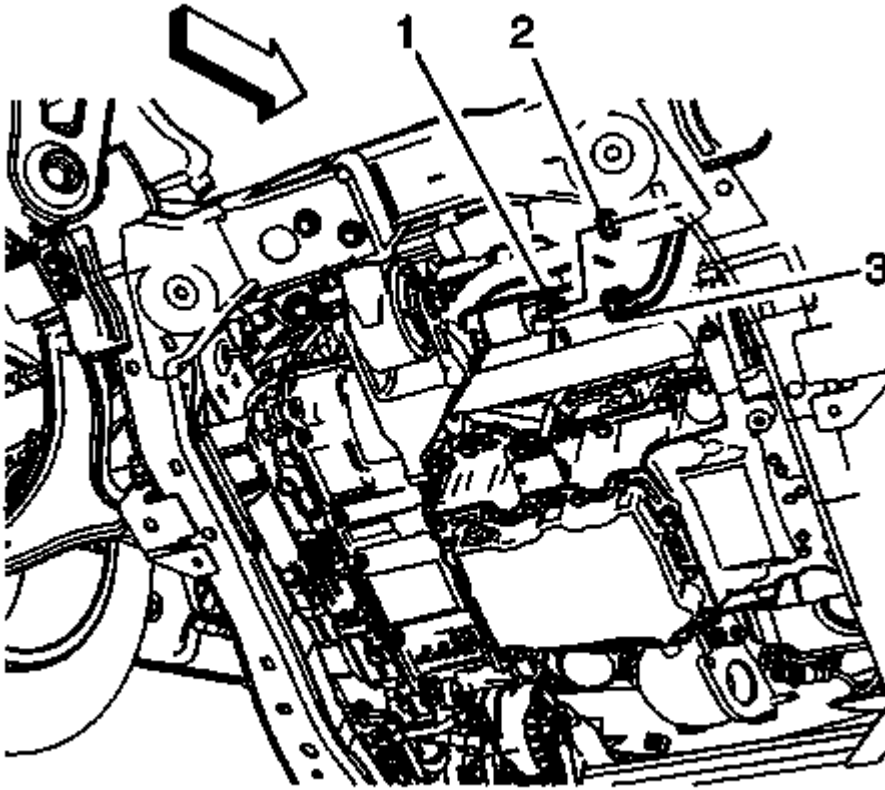


Fig. 36: Battery Positive Cable Terminal And Engine Harness Connector
Courtesy of GENERAL MOTORS COMPANY

2. Install the battery positive cable terminal (1) to the starter solenoid and tighten the fastener (2) to 10 (89 lb in).
3. Install the engine wiring harness connector (3) to the starter solenoid.
4. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection.**

GENERATOR BRACKET REPLACEMENT

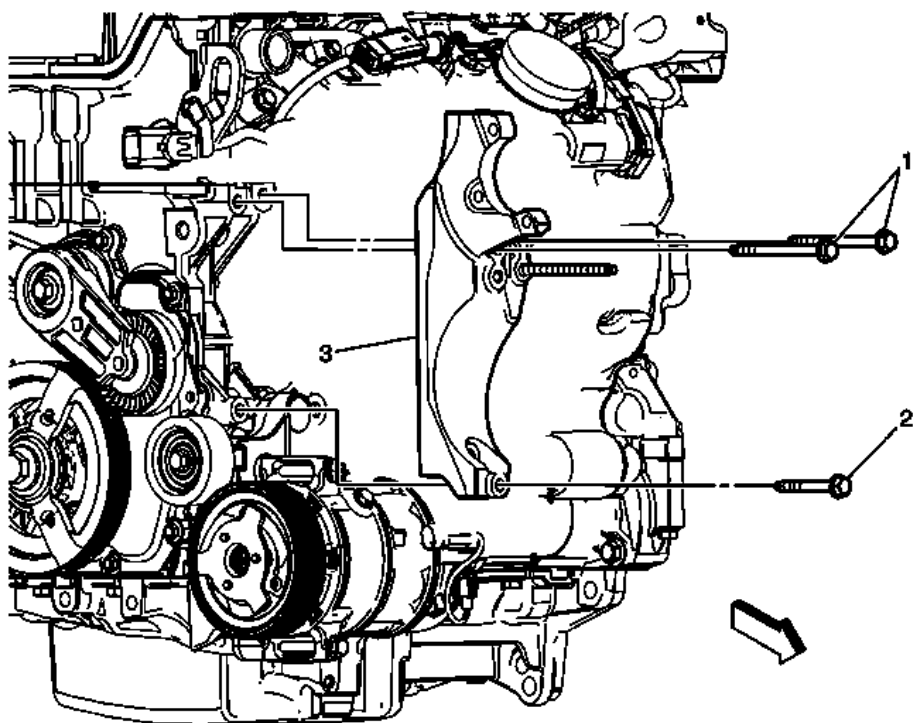


Fig. 37: Generator Bracket Replacement
 Courtesy of GENERAL MOTORS COMPANY

Generator Bracket Replacement (L4)

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Disconnect the battery negative cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u>. 2. Remove the drive belt. Refer to <u>Drive Belt Replacement (LEA)</u> , <u>Drive Belt Replacement (LUK)</u> 3. Remove the power steering pump. 	
1	Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the generator electrical connector. Tighten 22 N.m (16 lb ft)
2	Bolt (Qty: 1) Tighten 22 N.m (16 lb ft)

GENERATOR REPLACEMENT (LUK)

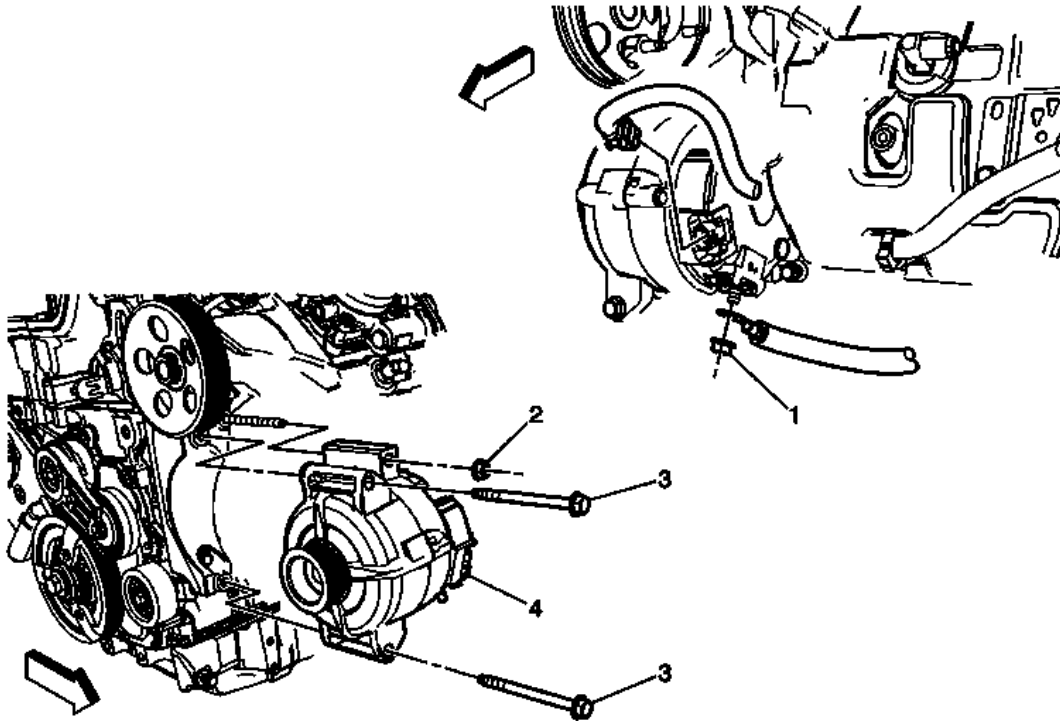


Fig. 38: Generator

Courtesy of GENERAL MOTORS COMPANY

Generator Replacement (LUK)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u>. 2. Remove the drive belt. Refer to <u>Drive Belt Replacement (LUK)</u> . 3. Disconnect the engine harness generator connector. 	
1	Generator Battery Positive Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 20 N.m (15 lb ft)
	Generator Nut (Qty: 1)

2	Tighten 22 N.m (16 lb ft)
3	Generator Bolt (Qty: 2) Tighten 22 N.m (16 lb ft)
4	Generator

GENERATOR REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection.**
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement .**
3. Remove the drive belt. Refer to **Drive Belt Replacement .**
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle .**

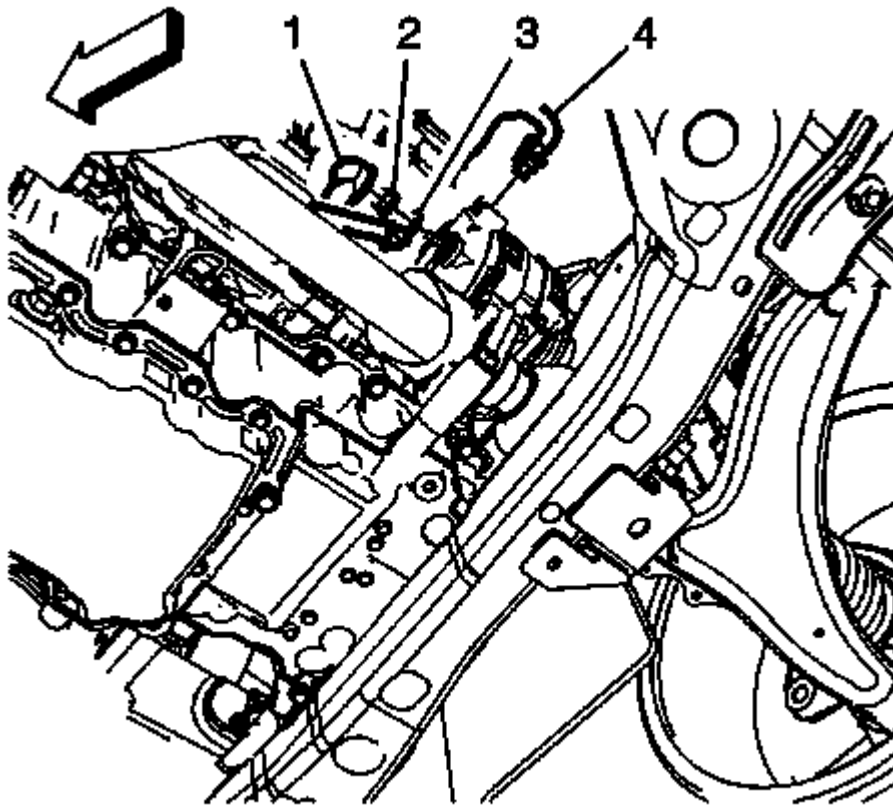


Fig. 39: Protective Boot And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Remove the protective boot (1) and the battery positive cable fastener (2).

6. Remove the battery positive cable terminal (3) and the engine harness connector (4) .

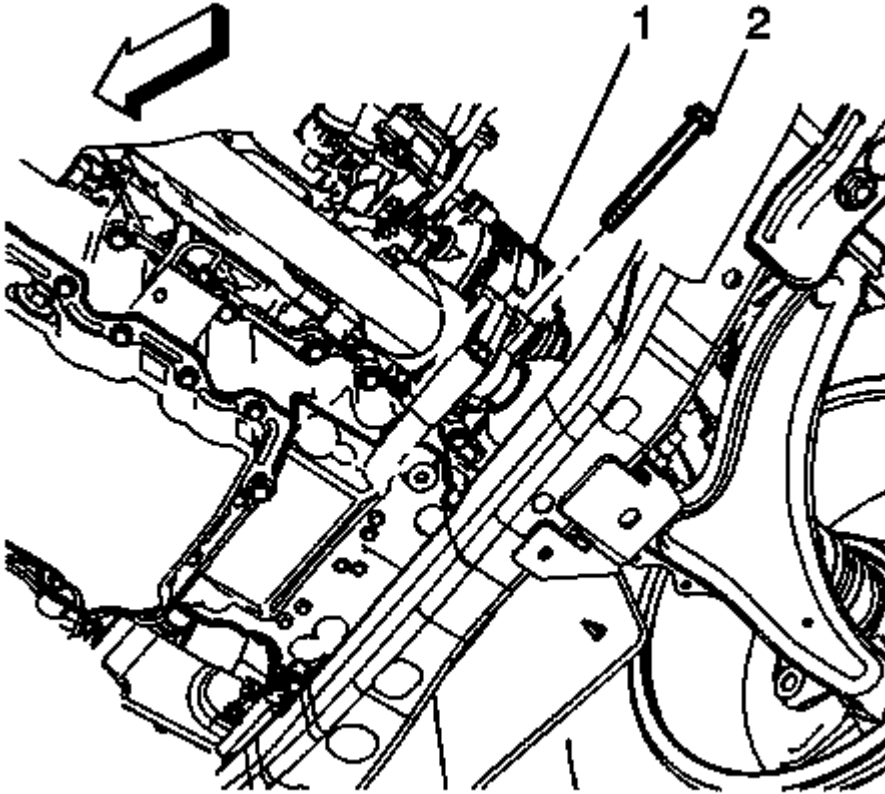


Fig. 40: Lower Generator Mounting Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Remove the lower generator mounting fastener (2).

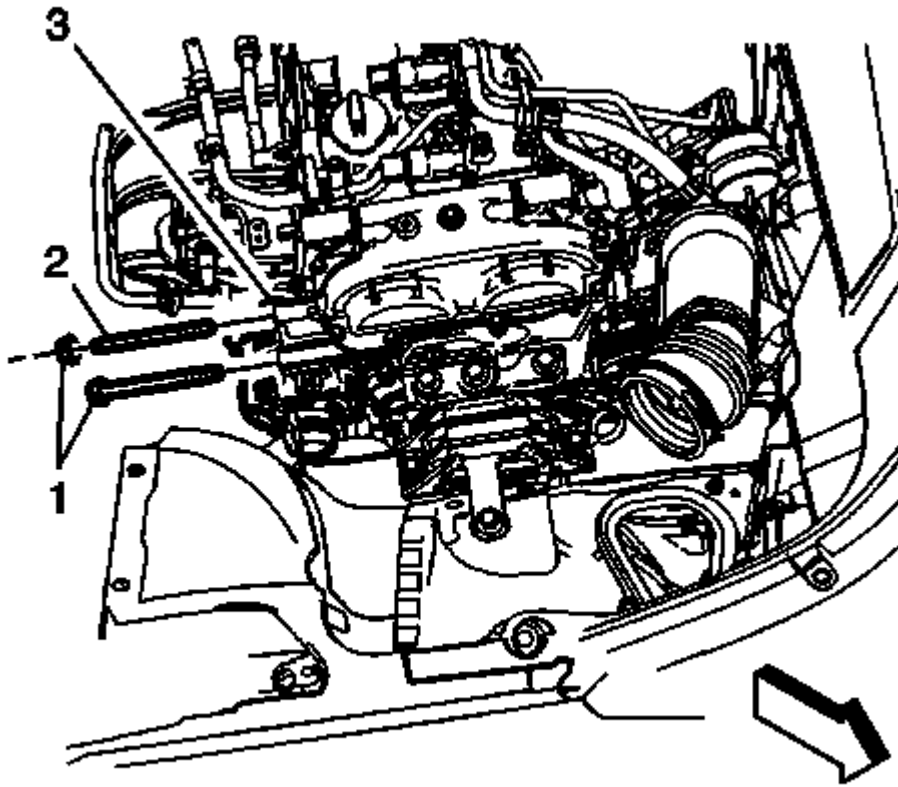


Fig. 41: Generator Mounting Fasteners, Generator Mounting Stud And Generator
Courtesy of GENERAL MOTORS COMPANY

8. Remove the upper generator mounting fasteners (1) and the generator mounting stud (2), from the generator (3).

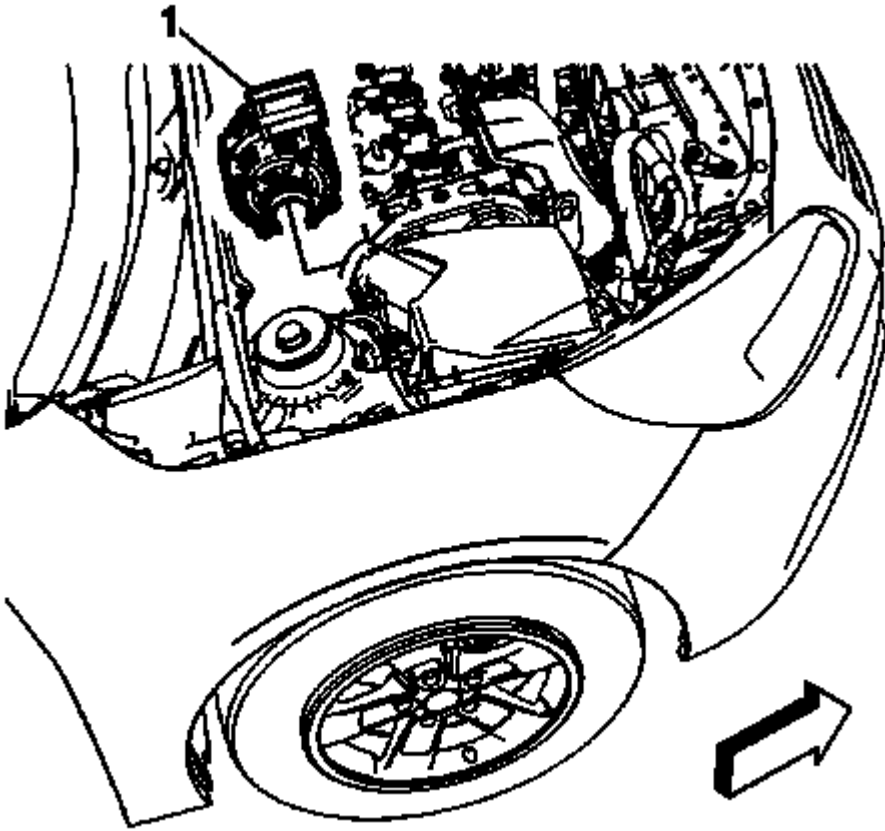


Fig. 42: Generator

Courtesy of GENERAL MOTORS COMPANY

9. Remove the generator (1) from the engine compartment.

Installation Procedure

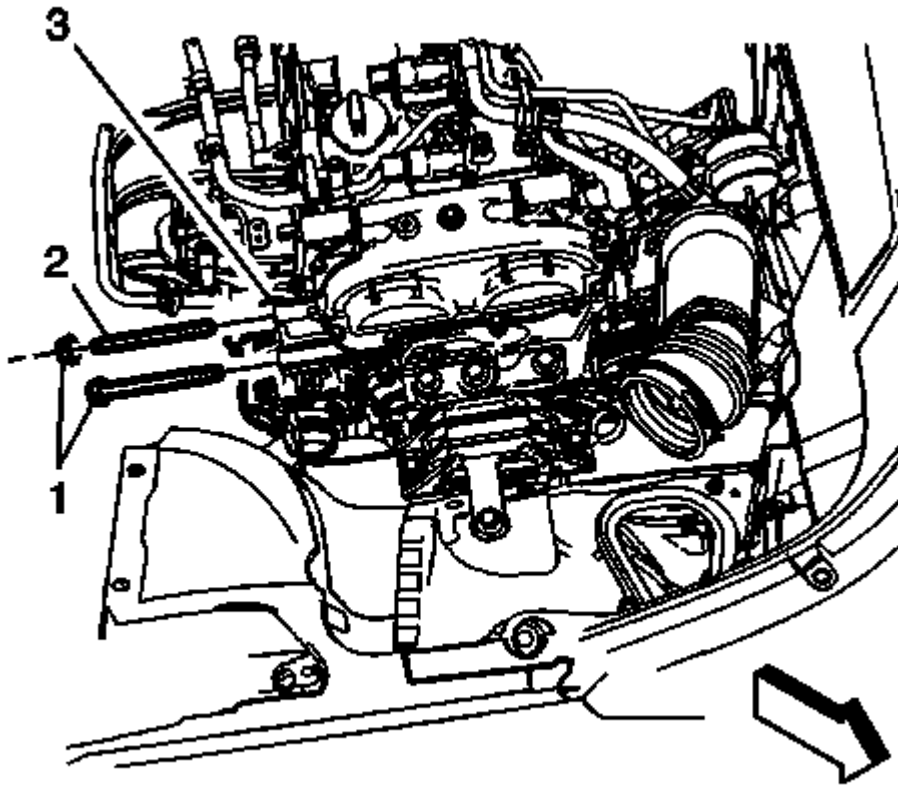


Fig. 43: Generator Mounting Fasteners, Generator Mounting Stud And Generator
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the generator mounting stud (2) to the cylinder head and tighten to 9 (80 lb in).
2. Install the generator (3) into position and tighten the fasteners (1) to 22 (16 lb ft).

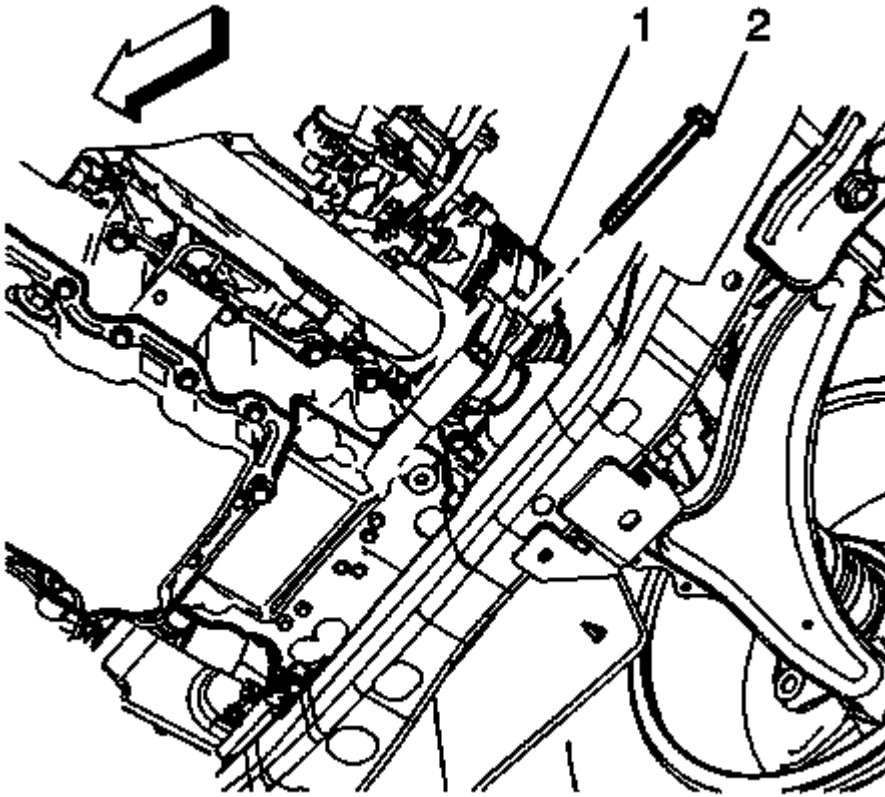


Fig. 44: Lower Generator Mounting Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Install the generator lower mounting fastener (2) and tighten to 22 (16 lb ft).
4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

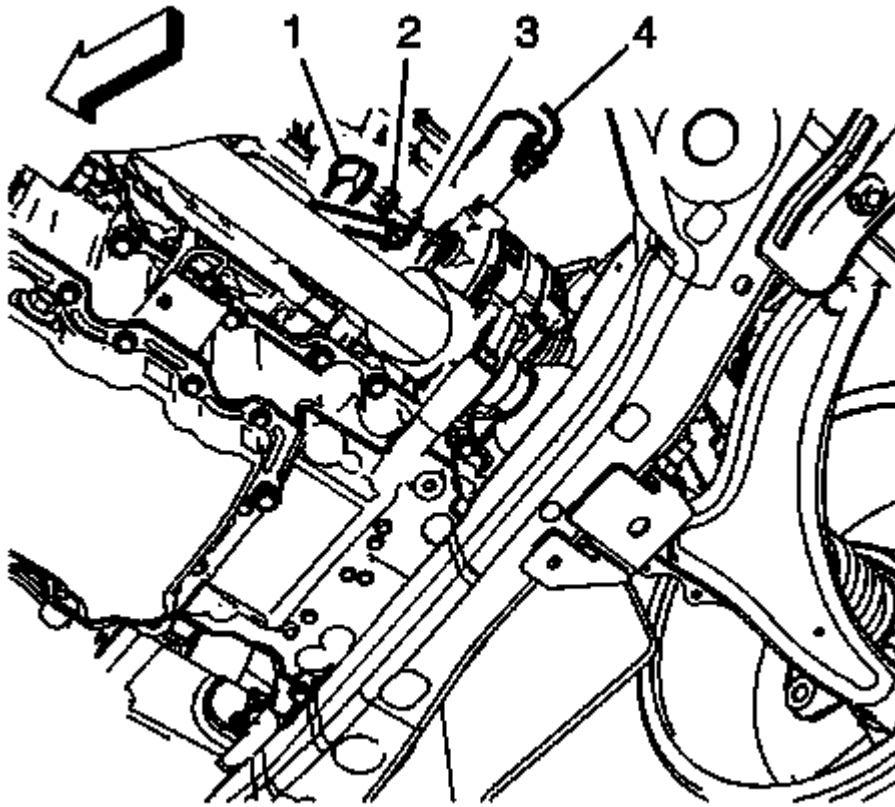


Fig. 45: Protective Boot And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Install the battery positive cable (3) to the back of the generator and tighten the fastener (2) to 15 (11 lb ft).
6. Install the protective boot (1) and connect the engine wiring harness connector (4).
7. Install the drive belt. Refer to **Drive Belt Replacement** .

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

WARNING: Batteries produce explosive gases, contain corrosive acid, and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- Always shield your eyes and avoid leaning over the battery whenever possible.
- Do not expose the battery to open flames or sparks.
- Do not allow the battery electrolyte to contact the eyes or the skin.

Flush immediately and thoroughly any contacted areas with water and get medical help.

- **Follow each step of the jump starting procedure in order.**
- **Treat both the booster and the discharged batteries carefully when using the jumper cables.**

NOTE: Because of the materials used in the manufacture of automotive lead acid batteries, dealers and service shops that handle them are subject to various regulations issued by OSHA, EPA, DOT, and various state or local agencies. Other regulations may also apply in other locations. Always know and follow these regulations when handling batteries.

Batteries that are no longer wanted must be disposed of by an approved battery recycler and must never be thrown in the trash or sent to a landfill.

Batteries that are not part of the vehicle itself, not the battery under the hood, must only be transported on public streets for business purposes via approved hazardous material transportation procedures.

Battery storage, charging and testing facilities in repair shops must meet various requirements for ventilation, safety equipment, material segregation, etc.

The maintenance free battery is standard. There are no vent plugs in the cover. The battery is completely sealed except for 2 small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has 3 functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with generator overload

Battery Low Start Vehicle Message

The body control module (BCM) monitors battery positive voltage to determine battery state of charge. If one or more of the BCM battery positive voltage terminals measure less than approximately 11.6V compared to the BCM ground circuits, this message will display and four chimes may sound. Start the vehicle immediately. If the vehicle is not started and the battery continues to discharge, the climate controls, heated seats, and audio systems will shut off and the vehicle may require a jump start. These systems will function again after the vehicle is started.

Battery Ratings

A battery has 2 ratings:

- Cold cranking amperage
- Amperage hours

When a battery is replaced use a battery with similar ratings. See battery specification label on the original battery.

Amperage Hours

The amperage hour rating tells you how much amperage is available when discharged evenly over a 20 hour period. The amperage hour rating is cumulative, so in order to know how many constant amperage the battery will output for 20 h, you have to divide the amperage hour rating by 20. Example: If a battery has an amperage hour rating of 74, dividing by 20 = 3.75. Such a battery can carry a 3.75 A load for 20 hours before dropping to 10.5 V. (10.5 V is the fully discharged level, at which point the battery needs to be recharged.) A battery with an amperage hour rating of 55 will carry a 2.75 A load for 20 hours before dropping to 10.5 V.

Cold Cranking Amperage

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18°C (0°F) while maintaining at least 7.2 V. See battery label for the cold cranking amperage rating of this battery.

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management Overview

The electrical power management system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds, and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge of the battery is determined by measuring the open-circuit voltage. The state-of-charge is a function of the acid concentration and the internal resistance of the battery, and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The state-of-charge can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the electrical power management function is designed to perform regulated voltage control to improve battery state-of-charge, battery life, and fuel economy. This is accomplished by using knowledge of the

battery state-of-charge and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 sections. The first section describes the charging system components and their integration into the electrical power management. The second section describes charging system operation. The third section describes the instrument panel cluster operation of the charge indicator, driver information center messages, and voltmeter operation.

Charging System Components

Generator

The generator is a serviceable component. If there is a diagnosed failure of the generator it must be replaced as an assembly. The engine drive belt drives the generator. When the rotor is spun it induces an alternating current (AC) into the stator windings. The AC voltage is then sent through a series of diodes for rectification. The rectified voltage has been converted into a direct current (DC) for use by the vehicles electrical system to maintain electrical loads and the battery charge. The voltage regulator integral to the generator controls the output of the generator. It is not serviceable. The voltage regulator controls the amount of current provided to the rotor. If the generator has field control circuit failure, the generator defaults to an output voltage of 13.8 V.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster for electrical power management (electrical power management) operation. The BCM determines the output of the generator and sends the information to the ECM for control of the generator turn on signal circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM for control of the generator. It monitors a battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge. The BCM performs idle boost.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to either the negative or positive battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Engine Control Module (ECM)

When the engine is running, the generator turn-on signal is sent to the generator from the ECM, turning on the regulator. The generator's voltage regulator controls current to the rotor, thereby controlling the output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. When the engine is started, the regulator senses generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the regulator varies the field current by controlling the pulse width. This regulates the generator output voltage for proper battery charging and electrical system operation. The generator field duty terminal is connected internally to the voltage regulator and externally to the ECM. When the voltage regulator detects a charging system problem, it grounds this circuit to signal the ECM that a problem exists. The ECM monitors the generator field duty cycle signal circuit, and receives control decisions based on information

from the BCM.

Instrument Panel Cluster

The instrument panel cluster provides the customer notification in case a concern with the charging system. There are 2 means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM if equipped.

HP6 Charging System Block Diagram

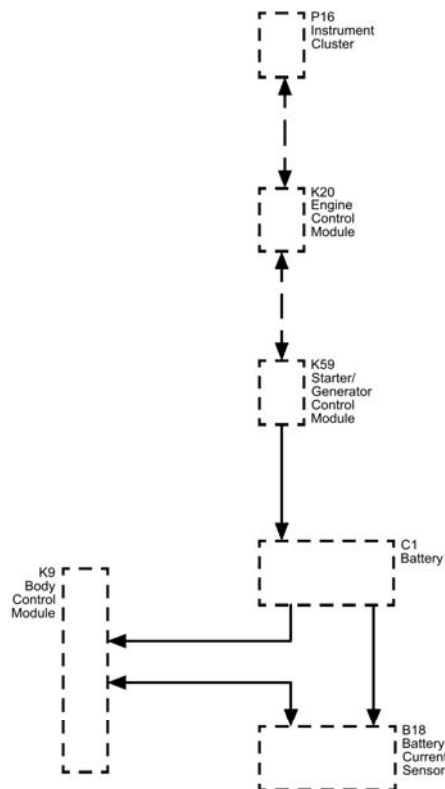


Fig. 46: HP6 Charging System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode

- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator turn ON signal circuit. The ECM monitors the generator performance through the generator field duty cycle signal circuit. The signal is a pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the generator:

Commanded Duty Cycle	Generator Output Voltage
10%	11 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 V for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2-3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for more than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Battery State of Charge is less than 80 percent.

- Vehicle speed is greater than 145 km/h (90 mph)
- Current sensor fault exists.
- System voltage was determined to be below 12.56 V

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9-15.5 V, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0°C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is less than 15 amperes and greater than -8 amperes, and the battery state-of-charge is greater than or equal to 80 percent. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5-13.1 V. The BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9-14.5 V.

Start Up Mode

When the engine is started the BCM sets a targeted generator output voltage of 14.5 V for 30 seconds.

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0°C (32°F). The calculated battery current is less than 1 ampere and greater than -7 amperes, and the generator field duty cycle is less than 99 percent. Its targeted generator output voltage is 12.9 V. The BCM will exit this mode once the criteria are met for Charge Mode.

Instrument Panel Cluster Operation

Charge Indicator Operation

The instrument panel cluster illuminates the charge indicator and displays a warning message in the driver information center if equipped, when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 V or greater than 16 V. The instrument panel cluster receives a GMLAN message from the ECM requesting illumination.
- The instrument panel cluster determines that the system voltage is less than 11 V or greater than 16 V for more than 30 seconds. The instrument panel cluster receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The instrument panel cluster performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

Display Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE

BATTERY CHARGING SYSTEM

The BCM and the ECM will send a serial data message to the driver information center for the BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

The electrical power management is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The electrical power management system makes the most efficient use of the generator output, improves the battery state-of-charge, extends battery life, and manages system electrical loads.

The load shed operation is a means of reducing electrical loads during a low voltage or low battery state-of-charge condition.

The idle boost operation is a means of improving generator performance during a low voltage or low battery state-of-charge condition.

Each electrical power management function, either idle boost or load shed, is discrete. No two functions are active at the same time. Idle boost is activated in incremental steps, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate electrical power management are outlined below:

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C (5°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 Ah	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 10.9 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -15°C (5°F)	Greater Than -12 V	Battery has a net loss less than 0.2 Ah	First level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 Ah	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 20% of their cycle
				Rear Defrost, Heated Mirrors,

Load Shed 1 Start	-	Less Than 10.9 V	-	Heated Seats cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12 V	Battery has a net loss of less than 2 Ah	Clear Load Shed 1
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 10.9 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 Ah	Second level Idle boost request cancelled
Idle Boost 3 Start	-	-	Battery has a net loss of 10 Ah	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 10.9 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6.0 Ah	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 10 V	Battery has a net loss greater than 12 Ah	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	-	Less Than 10.9 V	-	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.6 V	Battery has a net loss of less than 10.5 Ah	Clear Load Shed 2
			Battery has a net	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 100% of

Load Shed 3 Start	-	Less Than 11.9 V	loss greater than 20 Ah	their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.6 V	Battery has a net loss of less than 15 Ah	Clear Load Shed 3

STARTING SYSTEM DESCRIPTION AND OPERATION

The starter motors are non-repairable starter motors. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, the START relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

Circuit Description (Key Start)

When the ignition switch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 V to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

Starting System Block Diagram

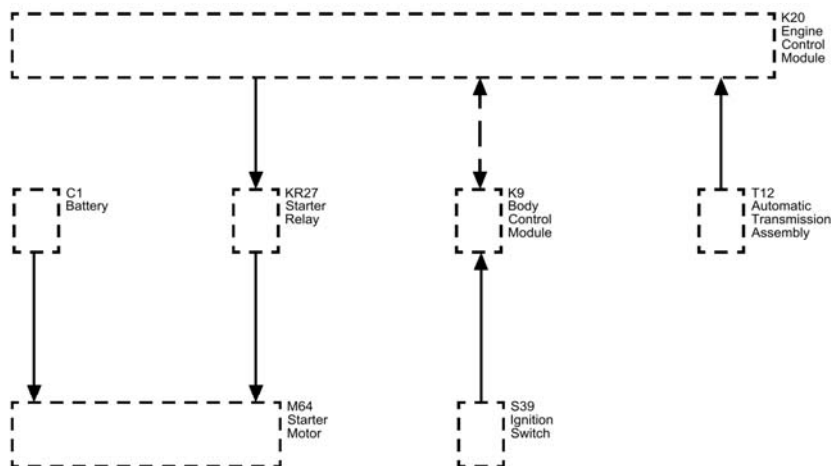


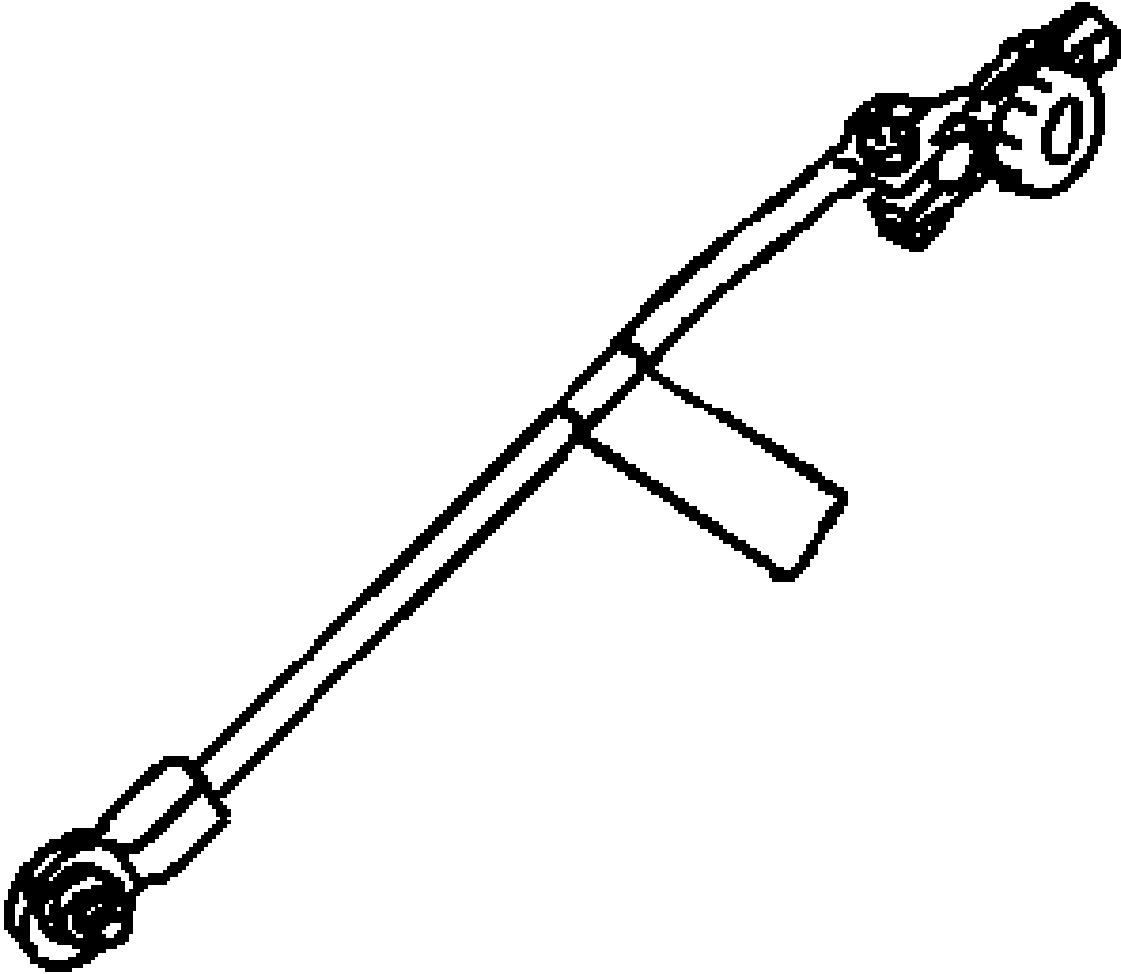
Fig. 47: Starting System Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

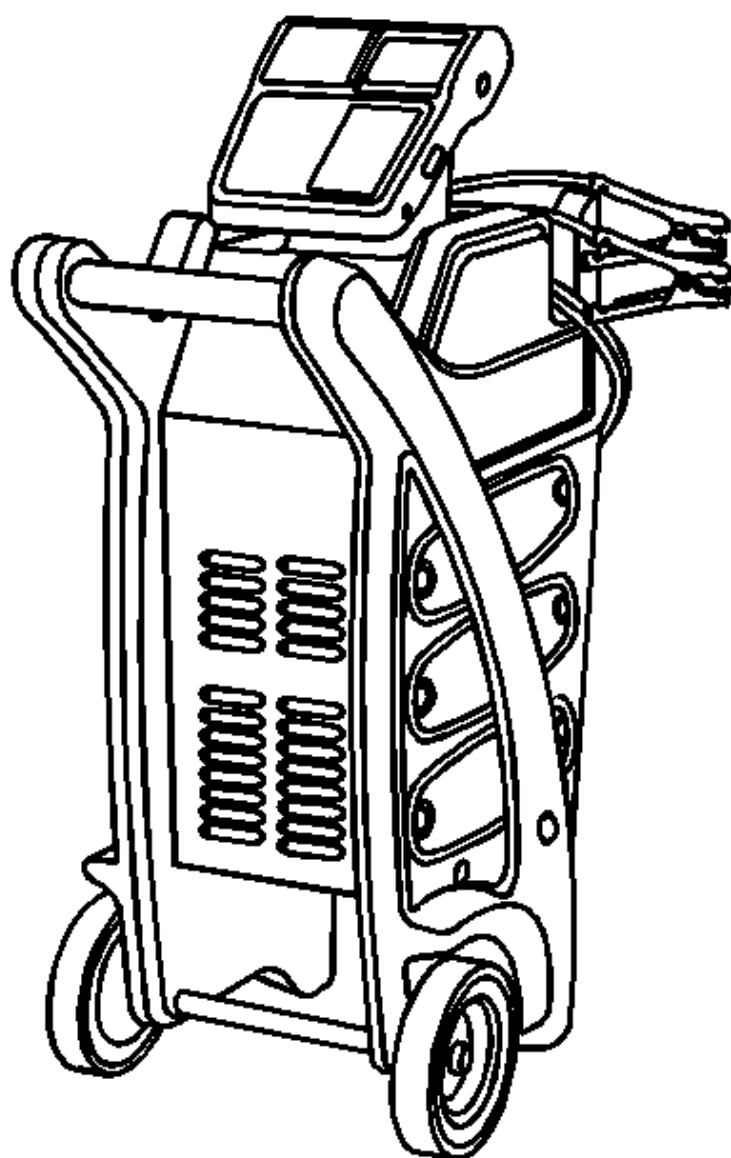
Callout	Component Name
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
HW	Hard-Wired
DD	Serial Data - GMLAN High Speed
HW	Hard-Wired
K20	K20 Engine Control Module
C1	C1 Battery
KR27	KR27 Starter Relay
K9	K9 Body Control Module
T12	T12 Automatic Transmission Assembly
M64	M64 Starter Motor
S39	S39 Ignition Switch

SPECIAL TOOLS AND EQUIPMENT

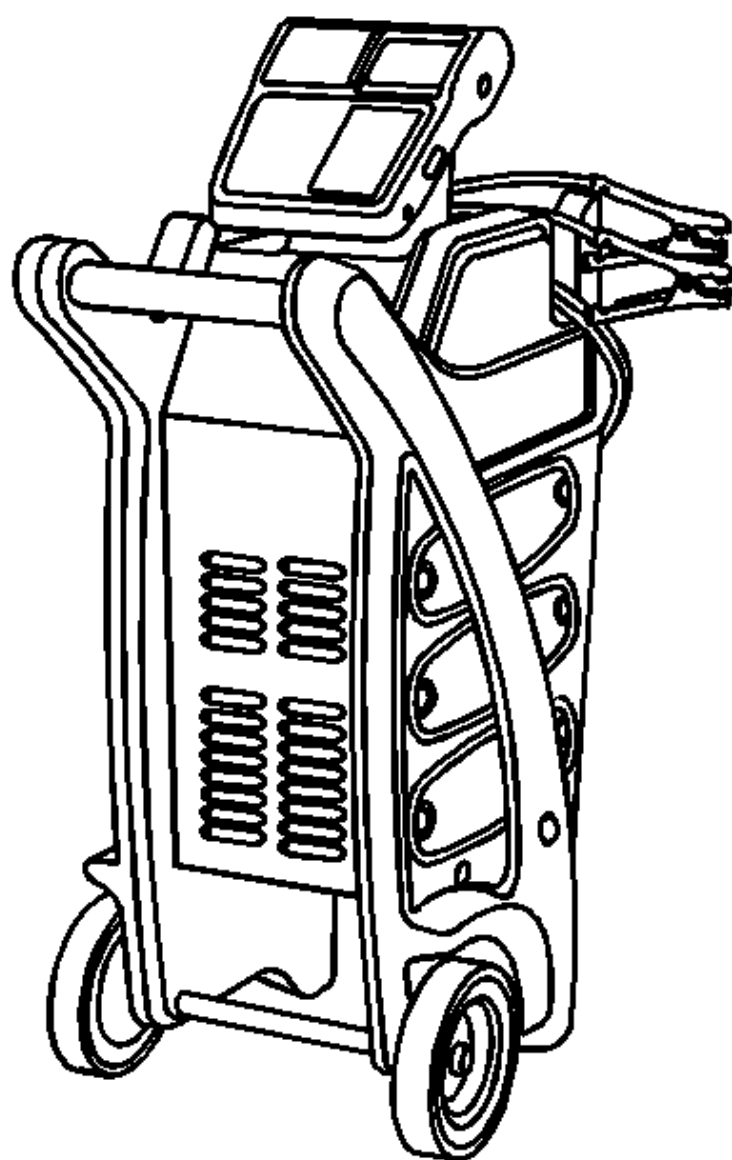
SPECIAL TOOLS

	Tool
--	------

Illustration	Number/Descrip
	<p>EL 38758 EL 50074 J 38758 Parasitic Draw T Switch</p>



EL 50313
EL 42000
EL 50076
J 42000
Battery Tester



Steering

Steering Wheel and Column

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Instrument Panel Steering Column Lower Trim Cover Fastener	2.5 N.m	22 lb in
Instrument Panel Steering Column Upper Trim Cover Fastener	2.5 N.m	22 lb in
Intermediate Steering Shaft Lower Bolt	34 N.m	25 lb ft
Intermediate Steering Shaft Upper Bolt		
• First Pass	25 N.m	18 lb ft
• Final Pass	180 Degrees	
Steering Column Nut	22 N.m	16 lb ft
Steering Wheel Bolt	30 N.m	22 lb ft
Turn Signal Switch Bracket Fastener	15 N.m	11 lb ft

SCHEMATIC WIRING DIAGRAMS

STEERING WHEEL WIRING SCHEMATICS

Heated Steering Wheel (UVD/Except CZ2)

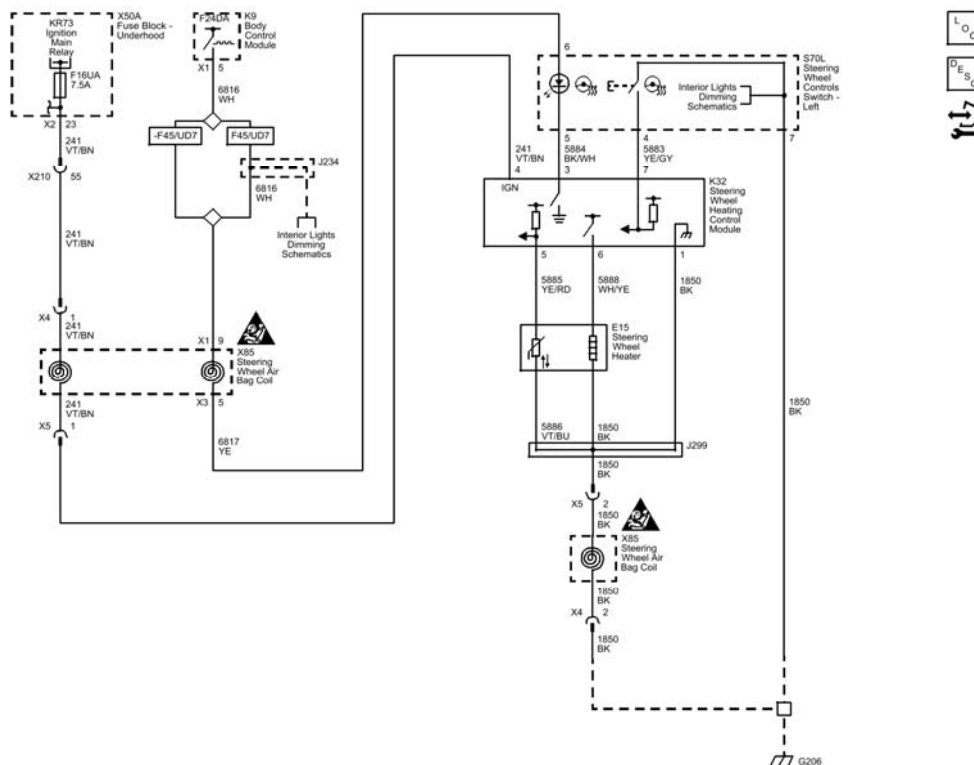


Fig. 1: Heated Steering Wheel (UVD/Except CZ2)
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - STEERING WHEEL AND COLUMN

Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Steering Wheel and Column Description and Operation.**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the steering wheel and column.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Steering Column Tilt Function Inoperative**
- **High Telescoping Effort**
- **Noise While Driver Adjusting Column**

- **Noise in Steering Column**
- **Looseness in Steering Column**

HEATED STEERING WHEEL INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Switch Signal	2	1	-	-
LED Control	3	3	4	-
Switch and LED Ground	-	1	-	-
Module Ground	-	1	-	-
1. Heated Steering Wheel System Inoperative 2. Heated Steering Wheel Always ON 3. LED Inoperative 4. LED Always ON				

Circuit/System Description

The heated steering wheel control module controls the heated steering wheel and the heated steering wheel ON indicator based on an input from the heated steering wheel switch. When the heated steering wheel switch is pressed, the switch signal circuit is pulled to ground. This indicates to the heating steering wheel control module that steering wheel heat is requested. When the request is seen, the heated steering module supplies voltage to the indicator lamp and supplies voltage to the heating elements, which are internal to the steering wheel.

Reference Information

Schematic Reference

Steering Wheel Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel and Column Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON.
2. Verify the S70L Steering Wheel Controls Switch - Left is OFF. The steering wheel heater indicator should not be illuminated and the left and right sides of the steering wheel should not be warm.
 - **The steering wheel is always warm**

Refer to **Heated Steering Wheel Malfunction**

- **The steering wheel does not become warm and the heater indicator is illuminated**

Refer to Circuit/System Testing

- **The steering wheel does not become warm and the heater indicator is not illuminated**

3. Press and release the S70L Steering Wheel Controls Switch - Left. The steering wheel heater indicator should illuminate and the left and right sides of the steering wheel should become warm.
 - **The steering wheel does not become warm**

Refer to **Heated Steering Wheel Malfunction**

- **The steering wheel becomes warm and the heater indicator does not illuminate**

Refer to Circuit/System Testing

- **The steering wheel becomes warm and the heater indicator illuminates**

4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X5 in-line harness connector at the K32 Heated Steering Wheel Control Module.
2. Test for less than 10 ohms between the ground terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify a test lamp illuminates between the B+ terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse. Refer to **Power Mode Mismatch**.
 - If 2 ohms or greater
 3. Verify the in-line fuse is OK and there is voltage at the fuse.
 - If the in-line fuse is blown, replace the K32 Steering Wheel Heating Control Module.
 - If the in-line fuse is OK, repair the open/high resistance in the circuit.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K32 Steering Wheel Heating Control Module.
 - **If the test lamp illuminates**
- 5. Ignition OFF, disconnect the harness connector at the S70L Steering Wheel Controls Switch - Left. Ignition ON.
- 6. Test for 4.8-5.2 V between the signal circuit terminal 6 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If 5.2 V or greater**
 1. Ignition OFF, disconnect the in-line connector at the S70L Steering Wheel Controls Switch - Left. Ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K32 Steering Wheel Heating Control Module.
 - **If with in 4.8-5.2 V**
- 7. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 4 and ground circuit terminal 7 at the S70L Steering Wheel Controls Switch - Left. Ignition ON.

8. Test for less than 2 ohms between the control circuit terminal 5 and ground.
 - **If 2 ohms or greater**

Replace the K32 Steering Wheel Heating Control Module.

- **If less than 2 ohms**

9. Replace the S70L Steering Wheel Controls Switch - Left.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

- **Heated Steering Wheel Indicator Malfunction**
- **Control Module References** for steering wheel heating control module, body control module replacement, programming, and setup

HEATED STEERING WHEEL MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Switch Signal	2	1	-	-
Switch and LED Ground	-	1	-	-
Temperature Sensor Signal	3	3	3	-
Temperature Sensor Ground	-	3	-	-
Heater Element Control	3	3	2	-
Heater Element Ground	-	3	-	-
Module Ground	-	1	-	-
1. Heated Steering Wheel System Inoperative 2. Heated Steering Wheel Always ON 3. Heated Steering Wheel Inoperative				

Circuit/System Description

The heated steering wheel control module controls the heated steering wheel and the heated steering wheel ON indicator based on an input from the heated steering wheel switch. When the heated steering wheel switch is pressed, the switch signal circuit is pulled to ground. This indicates to the heating steering wheel control module

that steering wheel heat is requested. When the request is seen, the heated steering wheel control module supplies voltage to the indicator lamp and supplies voltage to the heating elements, which are internal to the steering wheel.

Reference Information

Schematic Reference

Steering Wheel Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel and Column Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON.
2. Verify the S70L Steering Wheel Controls Switch - Left is OFF. The steering wheel heater indicator should not be illuminated and the left and right sides of the steering wheel should not be warm.
 - **The steering wheel is always warm**

Refer to Circuit/System Testing
 - **The steering wheel does not become warm and the heater indicator is illuminated**

Refer to **Heated Steering Wheel Indicator Malfunction**
 - **The steering wheel does not become warm and the heater indicator is not illuminated**
3. Press and release the S70L Steering Wheel Controls Switch - Left. The steering wheel heater indicator should illuminate and the left and right sides of the steering wheel should become warm.
 - **The steering wheel does not become warm**

Refer to Circuit/System Testing
 - **The steering wheel becomes warm and the heater indicator does not illuminate**

Refer to **Heated Steering Wheel Indicator Malfunction**

- **The steering wheel becomes warm and the heater indicator illuminates**
- 4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X5 in-line harness connector at the K32 Steering Wheel Heating Control Module.
2. Test for less than 10 ohms between the ground terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If less than 2 ohms, verify the fuse is OK and there is voltage at the fuse. Refer to **Power Mode Mismatch**.
 - If 2 ohms or greater
 - 3. Verify the in-line fuse is OK and there is voltage at the fuse.
 - If the in-line fuse is blown, replace the K32 Steering Wheel Heating Control Module.
 - If the in-line fuse is OK, repair the open/high resistance in the circuit.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K32 Steering Wheel Heating Control Module.
 - **If the test lamp illuminates**
5. Ignition OFF, reconnect the in-line harness connector X5. Disconnect the harness connector at the S70L Steering Wheel Controls Switch - Left.
6. Test for less than 10 ohms between the ground circuit terminal 7 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
7. Ignition ON.
 8. Test for 4.5-5.5 V between the signal circuit terminal 4 and ground.
 - **If less than 4.5 V**
 1. Ignition OFF, disconnect the in-line connector at the S70L Steering Wheel Controls Switch - Left.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K32 Steering Wheel Heating Control Module.
 - **If 5.5 V or greater**
 1. Ignition OFF, disconnect the in-line connector at the S70L Steering Wheel Controls Switch - Left. Ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K32 Steering Wheel Heating Control Module.
 - **If with in 4.5-5.5 V**
 9. Place the S70L Steering Wheel Controls Switch - Left in the OFF position.
 10. Test for infinite resistance between terminal 4 and terminal 7 at the S70L Steering Wheel Controls Switch - Left.
 - **If less than infinite resistance**

Replace the S70L Steering Wheel Controls Switch - Left
 - **If infinite resistance**
 11. Place the S70L Steering Wheel Controls Switch - Left in the ON position.
 12. Test for less than 2 ohms between terminal 4 and terminal 7.
 - **If 2 ohms or greater**

Replace the S70L Steering Wheel Controls Switch - Left
 - **If less than 2 ohms**
 13. Ignition OFF, disconnect the in-line harness connector at the E15 Steering Wheel Heater.
 14. Test for less than 10 ohms between the ground circuit terminal A at the K32 Steering Wheel Heating Control Module and ground.
 - **If 10 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 10 ohms**

15. Test for 1.8-2.24 ohms between the control circuit terminal B and the ground circuit terminal A at the E15 Steering Wheel Heater.

- **If not within the specified range**

Replace the E15 Steering Wheel Heater.

- **If within the specified range**

16. Test for 5700-70600 ohms between the 5 V reference circuit terminal D and the low reference circuit terminal C at the E15 Steering Wheel Heater.

- **If not within the specified range**

Replace the E15 Steering Wheel Heater.

- **If within the specified range**

17. Replace the K32 Steering Wheel Heating Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

- **Cruise Control Switch Replacement (Grand Sport)** , **Cruise Control Switch Replacement (Except Grand Sport)**
- **Steering Wheel Replacement**
- **Control Module References** for steering wheel heating control module replacement, programming, and setup

STEERING COLUMN TILT FUNCTION INOPERATIVE

Steering Column Tilt Function Inoperative

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Steering Wheel and Column</u>
2	Verify that the steering column tilt function is inoperative. Does the steering column tilt function operate normally?	System OK	Go to Step 3
3	If equipped, verify that the following components are not seized or corroded: <ul style="list-style-type: none"> • Tilt pivot pins • Tilt head lock shoes 		

	Are the components seized or corroded?	Go to Step 7	Go to Step 4
4	Inspect the tilt pivot pins for binding. Are the tilt pivot pins binding?	Go to Step 8	Go to Step 5
5	Inspect for a weak or broken steering column tilt spring. Is the steering column tilt spring weak or broken?	Go to Step 9	Go to Step 6
6	Inspect the steering column wiring harness routing for tightness. Was the steering column wiring harness routed correctly?	Go to Step 11	Go to Step 10
7	Replace the steering column. Refer to <u>Steering Column Replacement</u> . Did you complete the repair?	Go to Step 11	-
8	If serviceable, replace the pivot pins. If not serviceable replace the steering column. Refer to <u>Steering Column Replacement</u> . Did you complete the repair?	Go to Step 11	-
9	If serviceable, replace the tilt spring. Did you complete the repair?	Go to Step 11	-
10	Route the steering column wiring harness to the correct location. Did you correctly route the wiring harness?	Go to Step 11	-
11	Operate the steering column tilt function in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

HIGH TELESCOPING EFFORT

High Telescoping Effort

Checks	Action
The steering shaft assembly is bent or damaged.	If necessary, replace the steering column. Refer to <u>Steering Column Replacement</u> .

NOISE WHILE DRIVER ADJUSTING COLUMN

Noise While Driver Adjusting Column

Checks	Action
Interference occurs in the column assembly pivot path.	Inspect the column jacket for wear patterns. Ensure that the mounting and the pivot bolts are properly installed and that the column is properly aligned in the vehicle.

NOISE IN STEERING COLUMN

Noise in Steering Column

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Steering Wheel and Column
2	Verify that noise is present in the steering column during operation. Is noise present in the steering column during operation?	Go to Step 3	System OK
3	Inspect the steering column mounting features for the following conditions: <ul style="list-style-type: none"> • The steering column mounting fasteners are loose. • The steering column mounting features are sheared. Are the steering column mounting features loose?	Go to Step 9	Go to Step 4
4	Inspect the SIR/SRS coil for noise. Is the SIR/SRS coil noisy?	Go to Step 10	Go to Step 5
5	If equipped, inspect the lock plate retaining ring for correct installation. Is the lock plate retaining ring installed incorrectly?	Go to Step 11	Go to Step 6
6	Inspect the steering column upper and lower bearings for the following conditions: <ul style="list-style-type: none"> • Damage • Lubrication • Wear • Proper seating Are the bearings in need of repair or replacement?	Go to Step 12	Go to Step 7
7	Does the tilt joint need to be lubricated?	Go to Step 13	Go to Step 8
8	NOTE: Inspect the intermediate shaft for noise while driving the vehicle, turning the steering wheel, and applying the brakes. Inspect the intermediate shaft for noise. Is the intermediate shaft noisy?	Go to Step 14	Go to Step 15
	NOTE: If the steering column mounting feature is damaged or sheared, replace the steering column.		

9	Refer to <u>Steering Column Replacement</u> . Tighten the steering column mounting fastener to specifications. Refer to <u>Fastener Tightening Specifications</u> . Did you complete the repair?	Go to Step 15	-
10	Replace the SIR/SRS coil. Refer to <u>Steering Wheel Airbag Coil Replacement</u> . Did you complete the repair?	Go to Step 15	-
11	Install the lock plate retaining ring correctly. Did you complete the repair?	Go to Step 15	-
12	NOTE: If the steering column upper and/or lower bearings are not serviceable, replace the steering column. Refer to <u>Steering Column Replacement</u>. Replace the upper and/or lower bearings, if serviceable. Did you complete the replacement?	Go to Step 15	-
13	Lubricate the tilt joint. Did you complete the repair?	Go to Step 15	-
14	Replace the appropriate steering intermediate shaft component. Did you complete the repair?	Go to Step 15	-
15	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

LOOSENESS IN STEERING COLUMN

Looseness in Steering Column

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Steering Wheel and Column</u>
2	Verify that the steering column is loose. Is the steering column loose?	Go to Step 3	System OK
3	Inspect the steering column mounting features for the following conditions. <ul style="list-style-type: none"> The steering column mounting fasteners are loose. The steering column mounting features are sheared. Are the steering column mounting features loose?	Go to Step 5	Go to Step 4
	Inspect the upper and/or lower bearings for looseness.		

4	Are any of the bearings worn or loose?	Go to Step 6	Go to Step 7
5	<p>NOTE: If the steering column mounting feature is damaged or sheared, replace the steering column. Refer to <u>Steering Column Replacement</u>.</p> <p>Tighten the steering column mounting fastener to specifications. Refer to <u>Fastener Tightening Specifications</u>. Did you complete the repair?</p>	Go to Step 7	-
6	<p>NOTE: If the steering column upper and/or lower bearings are not serviceable, replace the steering column. Refer to <u>Steering Column Replacement</u>.</p> <p>Replace the upper and/or lower bearings, if serviceable. Did you complete the repair?</p>	Go to Step 7	-
7	<p>Operate the steering column in order to verify the repair.</p> <p>Did you correct the condition?</p>	System OK	Go to Step 3

REPAIR INSTRUCTIONS

INTERMEDIATE STEERING SHAFT REPLACEMENT

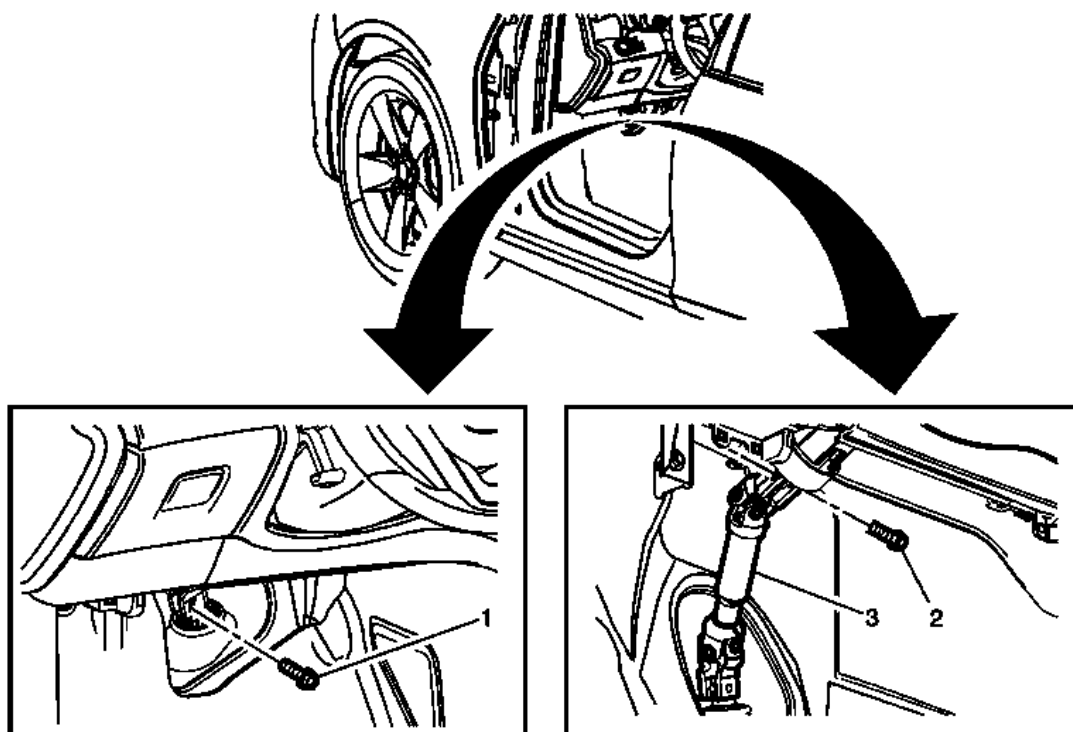


Fig. 2: Intermediate Steering Shaft & Bolts

Courtesy of GENERAL MOTORS COMPANY

Intermediate Steering Shaft Replacement

Callout	Component Name
<p>CAUTION:</p> <p>With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:</p> <ul style="list-style-type: none">• The steering column• The intermediate shaft(s)• The steering gear <p>After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none">1. With the wheels of the vehicle in the straight ahead position, LOCK the steering column.2. Remove the instrument panel lower trim panel insulator. Refer to <u>Instrument Panel Lower Trim Panel Insulator Replacement</u> .3. Place match marks on the steering gear pinion shaft and the intermediate steering shaft.4. Place match marks on the steering column shaft and the intermediate steering shaft.	
1	<p>Intermediate Steering Shaft Lower Bolt</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Apply thread locking adhesive to the bolt. Tighten 34 N.m (25 lb ft)</p>
2	<p>Intermediate Steering Shaft Upper Bolt</p> <p>Procedure Apply thread locking adhesive to the bolt. Tighten 25 N.m (18 lb ft) + 180 degrees</p>
3	<p>Intermediate Steering Shaft</p> <p>Procedure If replacing the intermediate steering shaft, copy the match marks from the old intermediate steering shaft to the new intermediate steering shaft.</p>

NOTE:

Ensure the steering column dash inner and outer seals are positioned properly on the dash panel.

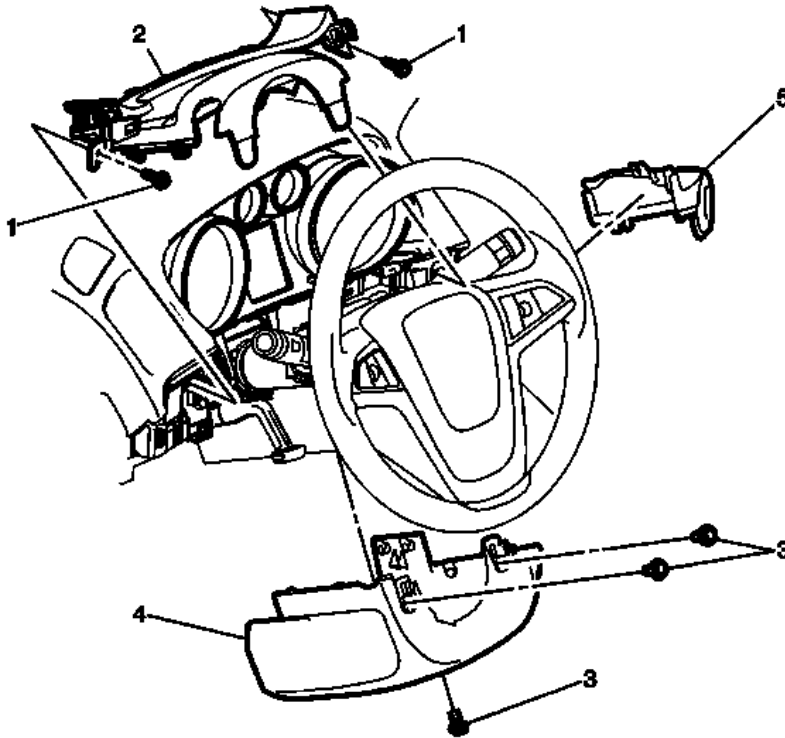
STEERING COLUMN TRIM COVER REPLACEMENT

Fig. 3: Steering Column Trim Cover & Components
Courtesy of GENERAL MOTORS COMPANY

Steering Column Trim Cover Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the driver side instrument panel center upper molding. Refer to <u>Instrument Panel Center Upper Molding Replacement (Driver Side)</u> , <u>Instrument Panel Center Upper Molding Replacement (Passenger Side)</u> .	
2. Remove the headlamp switch molding. Refer to <u>Headlamp Switch Molding Replacement</u> .	
1	Instrument Panel Steering Column Upper Trim Cover Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten

	2.5 (22 lb in)
2	Instrument Panel Steering Column Upper Trim Cover Procedure 1. Telescope the steering column to its most extended position. 2. Turn the steering wheel for access.
3	Instrument Panel Steering Column Lower Trim Cover Fastener (Qty: 3) Procedure Turn the steering wheel to access the upper fasteners, Tighten 2.5 (22 lb in)
4	Instrument Panel Steering Column Lower Trim Cover
5	Ignition Lock Cylinder Bezel

TURN SIGNAL SWITCH REPLACEMENT

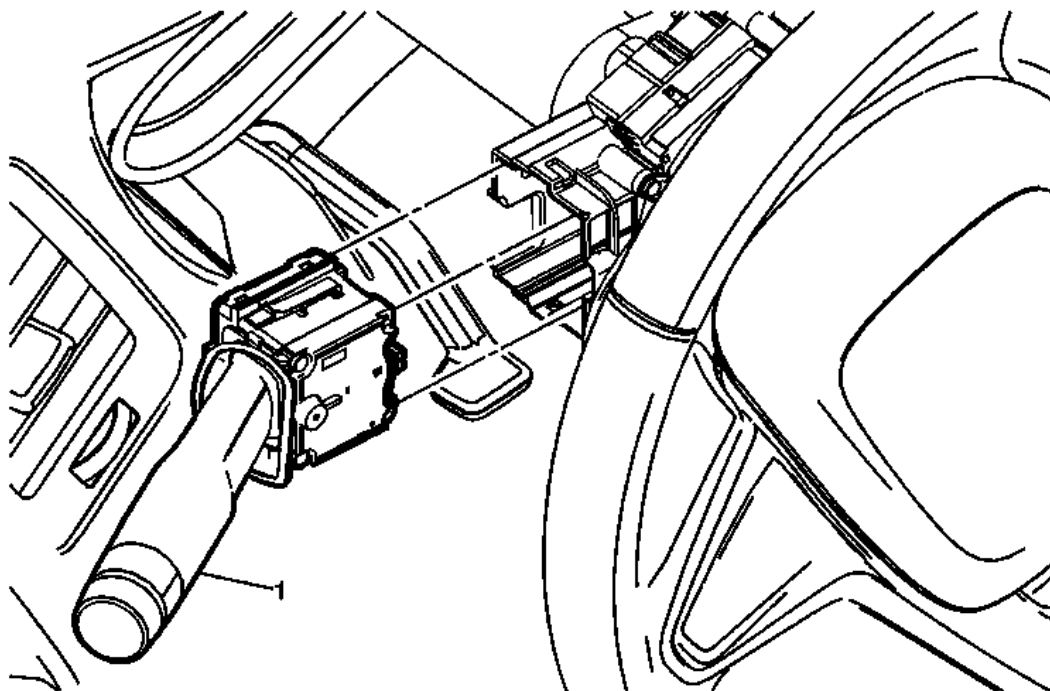


Fig. 4: Turn Signal Switch

Courtesy of GENERAL MOTORS COMPANY

Turn Signal Switch Replacement

Callout	Component Name
Preliminary Procedure	
Remove the steering column trim covers. Refer to <u>Steering Column Trim Cover Replacement</u> .	

1	Turn Signal Switch Procedure 1. Disconnect the electrical connector. 2. Release the retaining tabs and remove the turn signal switch from the turn signal switch bracket.
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TURN SIGNAL SWITCH BRACKET REPLACEMENT (WITH BTM)

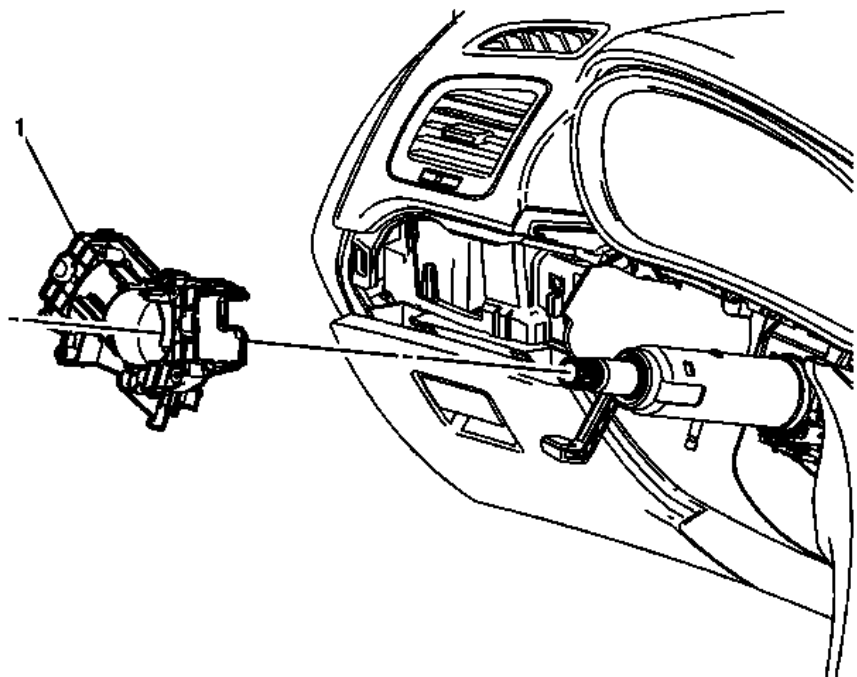
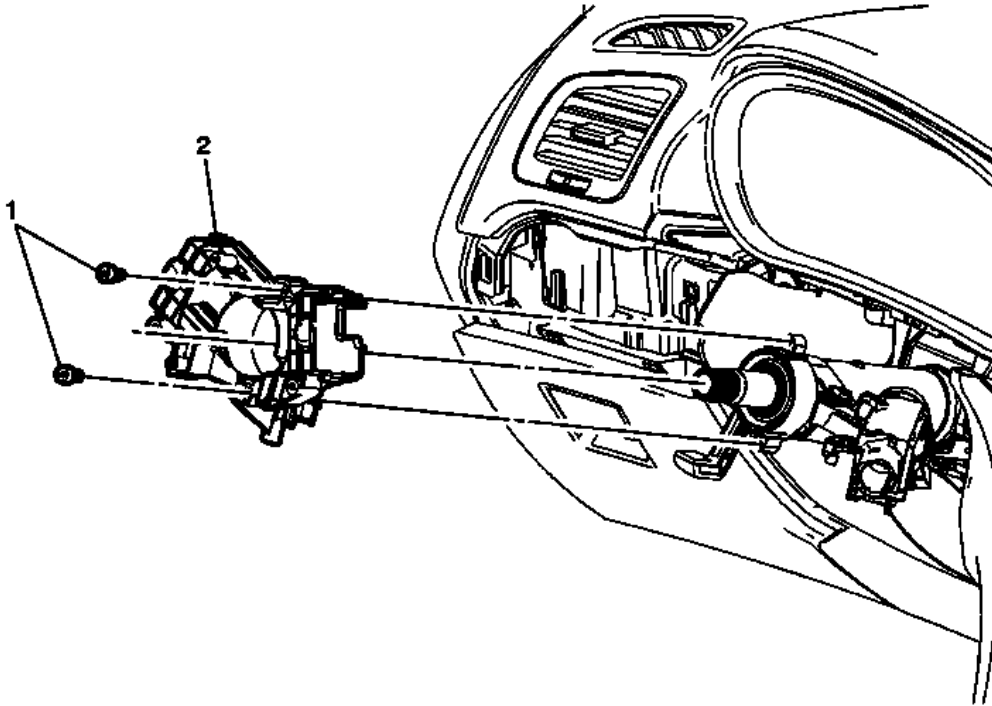


Fig. 5: Turn Signal Switch Bracket (With BTM)
 Courtesy of GENERAL MOTORS COMPANY

Turn Signal Switch Bracket Replacement (With BTM)

Callout	Component Name
Preliminary Procedure 1. Remove the steering wheel airbag coil. Refer to <u>Steering Wheel Airbag Coil Replacement</u> . 2. Remove the turn signal switch. Refer to <u>Turn Signal Switch Replacement</u> . 3. Remove the windshield wiper and washer switch. Refer to <u>Windshield Wiper and Washer Switch Replacement</u> .	
1	Turn Signal Switch Bracket Procedure Release the retaining tabs and remove the turn signal switch bracket from the steering

TURN SIGNAL SWITCH BRACKET REPLACEMENT (WITHOUT BTM)**Fig. 6: Turn Signal Switch Bracket (Without BTM)**

Courtesy of GENERAL MOTORS COMPANY

Turn Signal Switch Bracket Replacement (Without BTM)

Callout	Component Name
Preliminary Procedure	
1. Remove the steering wheel airbag coil. Refer to <u>Steering Wheel Airbag Coil Replacement</u> .	
2. Remove the turn signal switch. Refer to <u>Turn Signal Switch Replacement</u> .	
3. Remove the windshield wiper and washer switch. Refer to <u>Windshield Wiper and Washer Switch Replacement</u> .	
1	Turn Signal Switch Bracket Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 15 N.m (11 lb ft)
2	Turn Signal Switch Bracket

STEERING WHEEL HEAT CONTROL MODULE REPLACEMENT

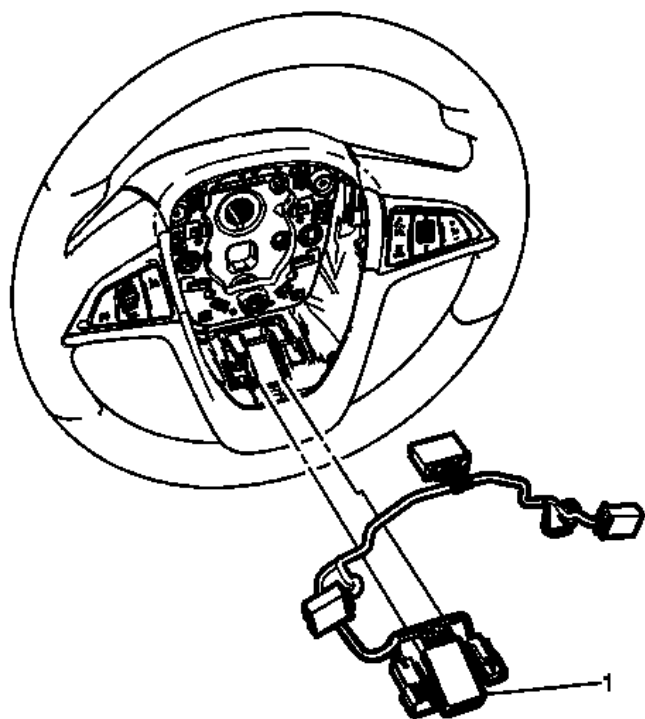


Fig. 7: Steering Wheel Heat Control Module
Courtesy of GENERAL MOTORS COMPANY

Steering Wheel Heat Control Module Replacement

Callout	Component Name
WARNING: When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.	
Preliminary Procedures Remove the inflatable restraint steering wheel module. Refer to <u>Airbag Steering Wheel Module Replacement</u> .	
1	Steering Wheel Heat Control Module Procedure 1. Disconnect the electrical connectors. 2. Slide the module out of the slot.

STEERING WHEEL REPLACEMENT

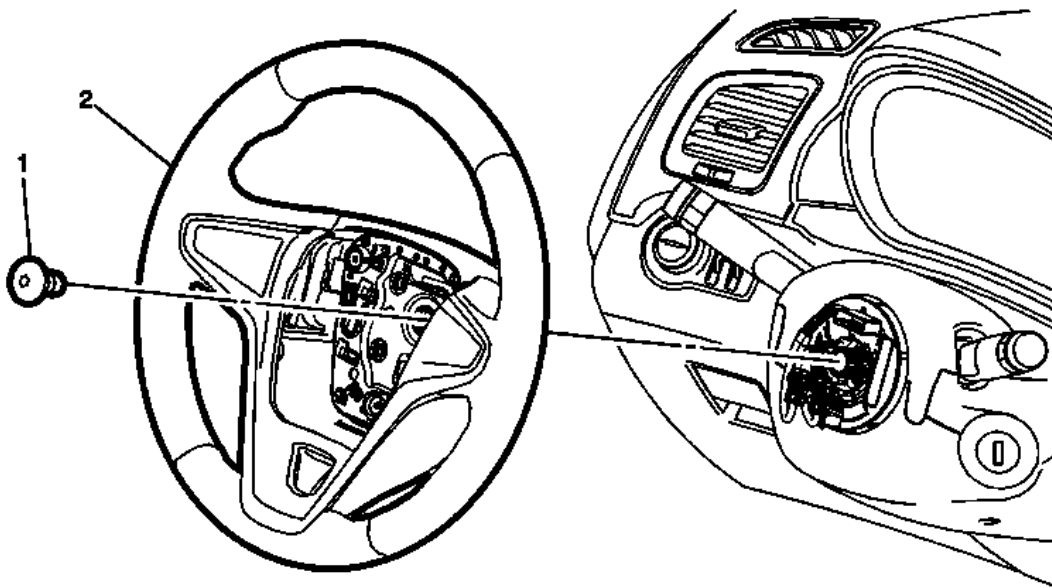


Fig. 8: Steering Wheel
 Courtesy of GENERAL MOTORS COMPANY

Steering Wheel Replacement

Callout	Component Name
WARNING: When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.	
Preliminary Procedures Remove the airbag steering wheel module. Refer to <u>Airbag Steering Wheel Module Replacement</u> .	
1	Steering Wheel Bolt CAUTION: Refer to <u>Fastener Caution</u> . Procedure Clean the bolt threads and apply new locking agent. Tighten 30 N.m (22 lb ft)
	Steering Wheel Procedure

- | | |
|---|---|
| 2 | <ol style="list-style-type: none"> 1. Disconnect the electrical connectors. 2. Loosen the steering wheel bolt until 2 to 3 threads are left engaged. 3. Wiggle the steering wheel until the steering wheel disengages completely. 4. Remove the steering wheel. 5. Transfer components as necessary. |
|---|---|

STEERING WHEEL SPOKE LOWER COVER REPLACEMENT (GRAND SPORT)

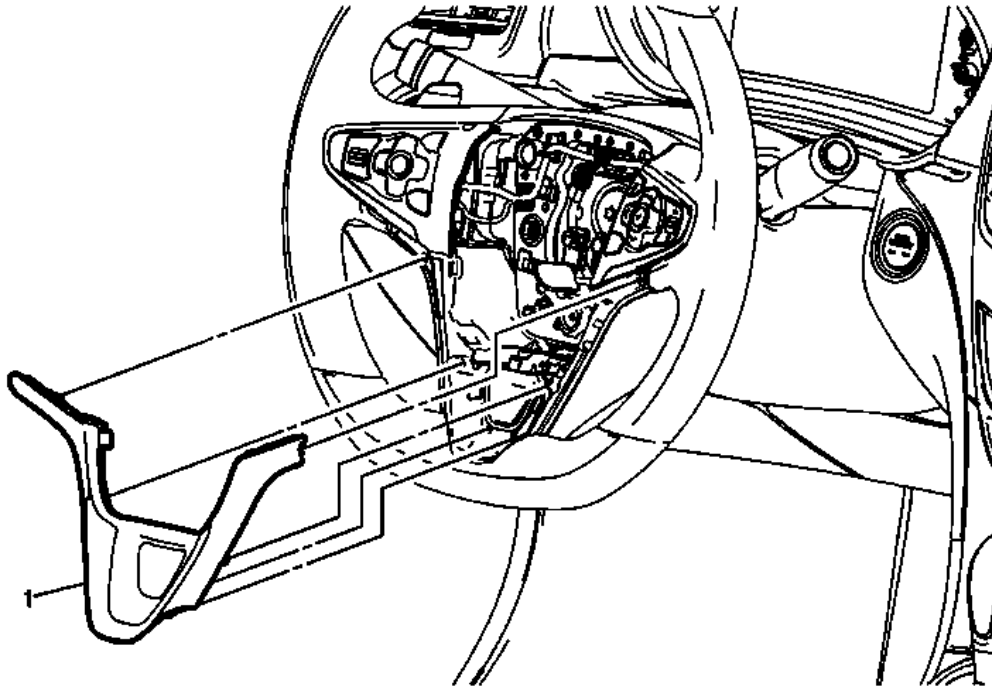


Fig. 9: Steering Wheel Spoke Lower Cover (Grand Sport)
 Courtesy of GENERAL MOTORS COMPANY

Steering Wheel Spoke Lower Cover Replacement (Grand Sport)

Callout	Component Name
Preliminary Procedure	
Remove the airbag steering wheel module. Refer to Airbag Steering Wheel Module Replacement .	
1	Steering Wheel Spoke Lower Cover Procedure Use the appropriate tool to gently release the retaining tabs on the cover. NOTE: Gently release tabs one by one, using care to avoid snapping the tab off.

STEERING WHEEL SPOKE LOWER COVER REPLACEMENT (EXCEPT GRAND SPORT)

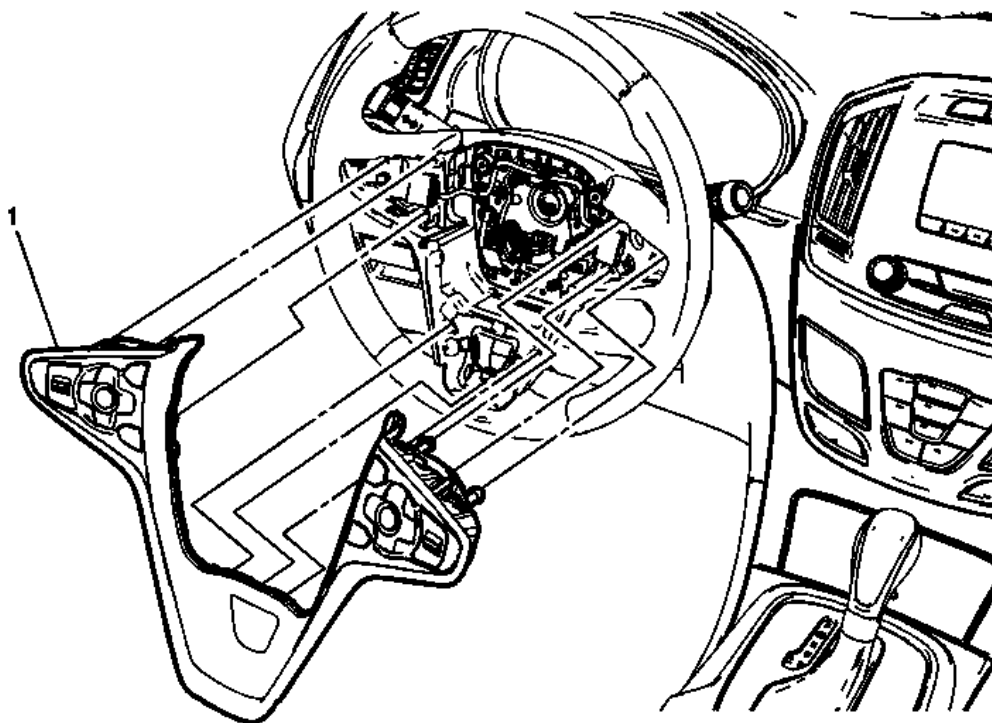


Fig. 10: Steering Wheel Spoke Lower Cover (Except Grand Sport)

Courtesy of GENERAL MOTORS COMPANY

Steering Wheel Spoke Lower Cover Replacement (Except Grand Sport)

Callout	Component Name
Preliminary Procedure	
Remove the airbag steering wheel module. Refer to <u>Airbag Steering Wheel Module Replacement</u> .	
1	<p>Steering Wheel Spoke Lower Cover</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Use the appropriate tool to gently release the retaining tabs on the cover. 2. Disconnect the electrical connections. <p>NOTE: Gently release tabs one by one, using care to avoid snapping the tab off.</p>

STEERING COLUMN REPLACEMENT

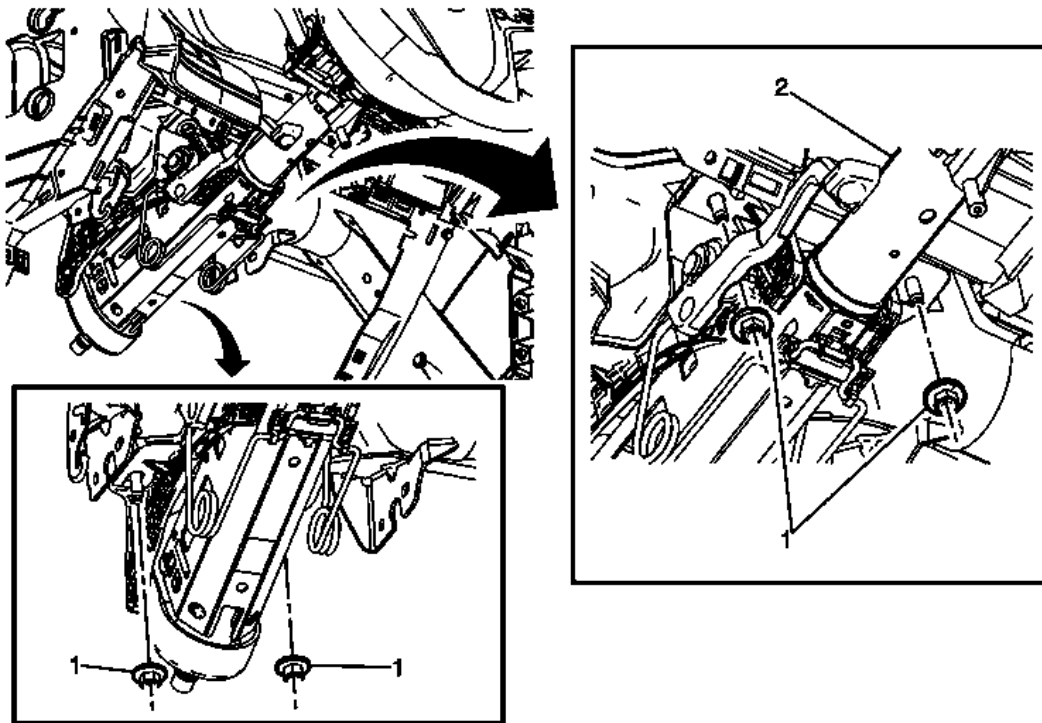


Fig. 11: Steering Column

Courtesy of GENERAL MOTORS COMPANY

Steering Column Replacement

Callout	Component Name
<p>WARNING: Refer to <u>SIR Inflator Module Handling and Storage Warning</u> .</p> <p>WARNING: Refer to <u>SIR Warning</u> .</p> <p>CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:</p> <ul style="list-style-type: none"> • The steering column • The steering shaft coupling • The intermediate shaft(s) <p>After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.</p>	

Preliminary Procedures

1. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling** .
2. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.
3. Remove the left side instrument panel lower trim panel. Refer to **Instrument Panel Lower Trim Panel Replacement - Left Side** .
4. If replacing the steering column, verify the front wheels are in the straight ahead position and LOCK the steering column using the lock pin from the new steering column.
5. If removing and reinstalling the steering column, verify the front wheels are in the straight ahead position and SECURE the steering column as best as possible to prevent any rotation of the steering column shaft and steering wheel.
6. Place match marks on the steering column shaft and the intermediate steering shaft and disconnect the intermediate steering shaft from the steering column. Refer to **Intermediate Steering Shaft Replacement**.

1	<p>Steering Column Nut (Qty: 4)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 22 N.m (16 lb ft)</p>
2	<p>Steering Column</p> <p>CAUTION: Once the steering column is removed from the vehicle, the column is extremely susceptible to damage. Dropping the column assembly on the end could collapse the steering shaft or loosen the plastic injections, which maintain column rigidity. Leaning on the column assembly could cause the jacket to bend or deform. Any of the above damage could impair the columns collapsible design. Do NOT hammer on the end of the shaft, because hammering could loosen the plastic injections, which maintain column rigidity. If you need to remove the steering wheel, refer to the Steering Wheel Replacement procedure in this section.</p> <p>Procedure</p> <ol style="list-style-type: none">1. Disconnect any electrical connectors.2. If replacing the steering column, copy the match marks from the old steering column to the new steering column.3. If replacing the steering column, transfer components as necessary.4. After installation is complete, center the steering angle sensor. Refer to <u>Steering Angle Sensor Centering</u> .

STEERING COLUMN DASH INNER SEAL REPLACEMENT

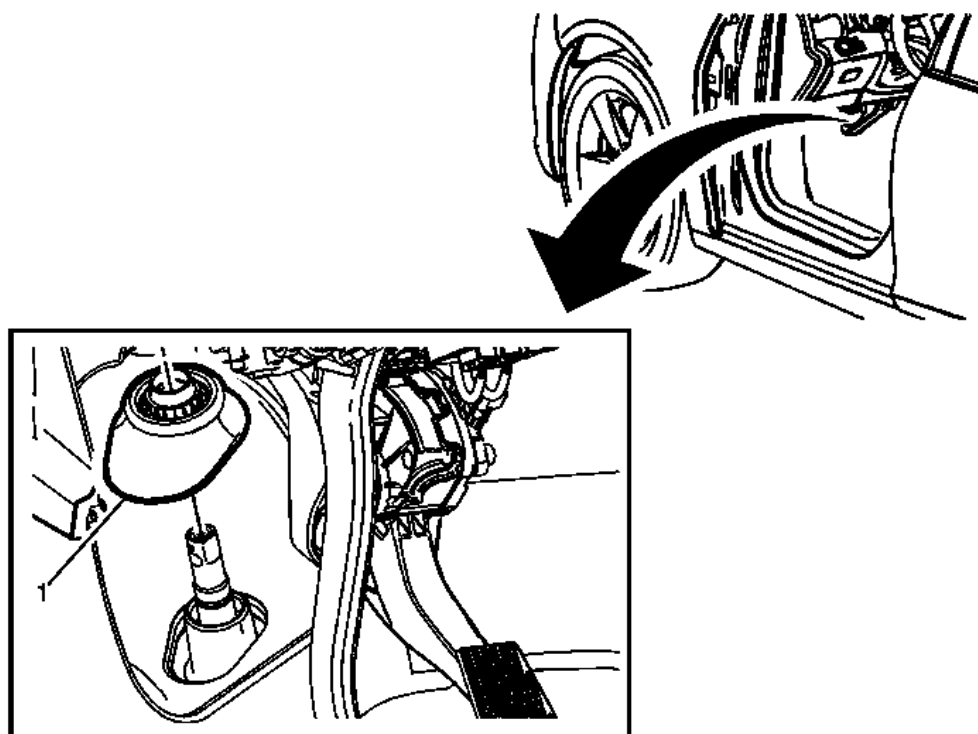


Fig. 12: Steering Column Dash Inner Seal
 Courtesy of GENERAL MOTORS COMPANY

Steering Column Dash Inner Seal Replacement

Callout	Component Name
Preliminary Procedure Disconnect the intermediate steering shaft from the steering gear. Refer to <u>Intermediate Steering Shaft Replacement</u> .	
1	Steering Column Dash Inner Seal Procedure Position the steering column dash inner seal over the steering gear and on the dash panel. Ensure the lip on the seal is positioned correctly.

STEERING COLUMN DASH OUTER SEAL REPLACEMENT (NJ2)

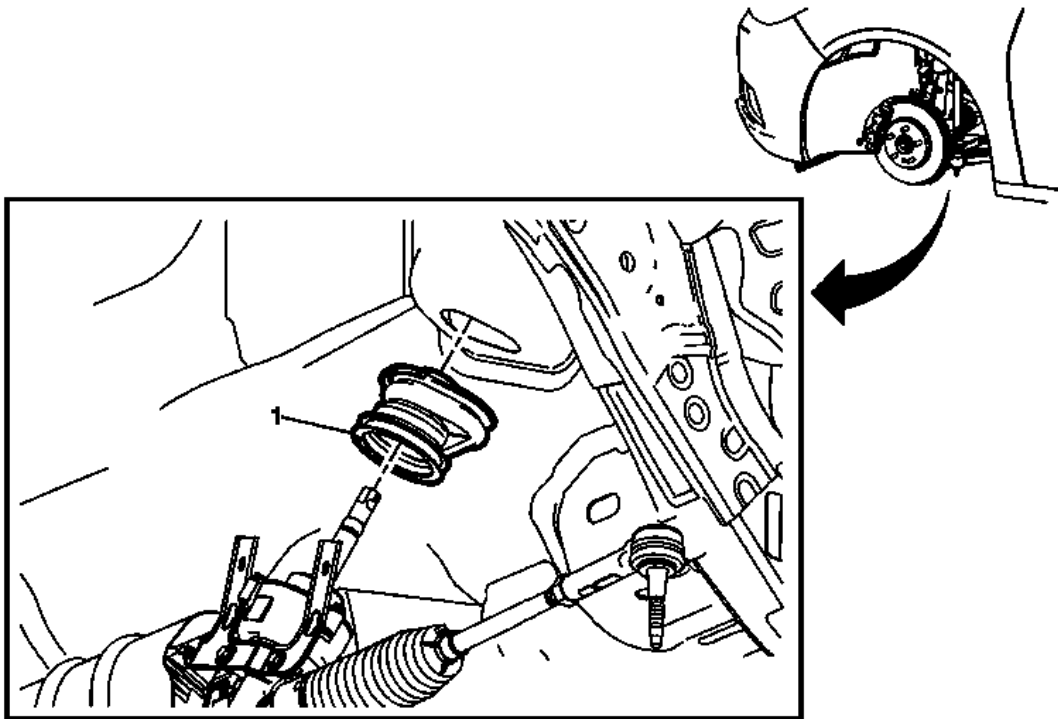


Fig. 13: Steering Column Dash Outer Seal (NJ2)
 Courtesy of GENERAL MOTORS COMPANY

Steering Column Dash Outer Seal Replacement (NJ2)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the steering column dash inner seal. Refer to <u>Steering Column Dash Inner Seal Replacement</u>. 2. Lower the steering gear as needed to provide the clearance necessary to remove the steering column dash outer seal. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (FWD, LTG, MR6, NJ2)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD, LTG, M7U, NJ2)</u> . 	
1	Steering Column Dash Outer Seal Procedure Position the steering column dash outer seal over the steering gear and on the dash panel. Ensure the seal is aligned with the steering gear and dash panel correctly.

STEERING COLUMN DASH OUTER SEAL REPLACEMENT (NJ1)

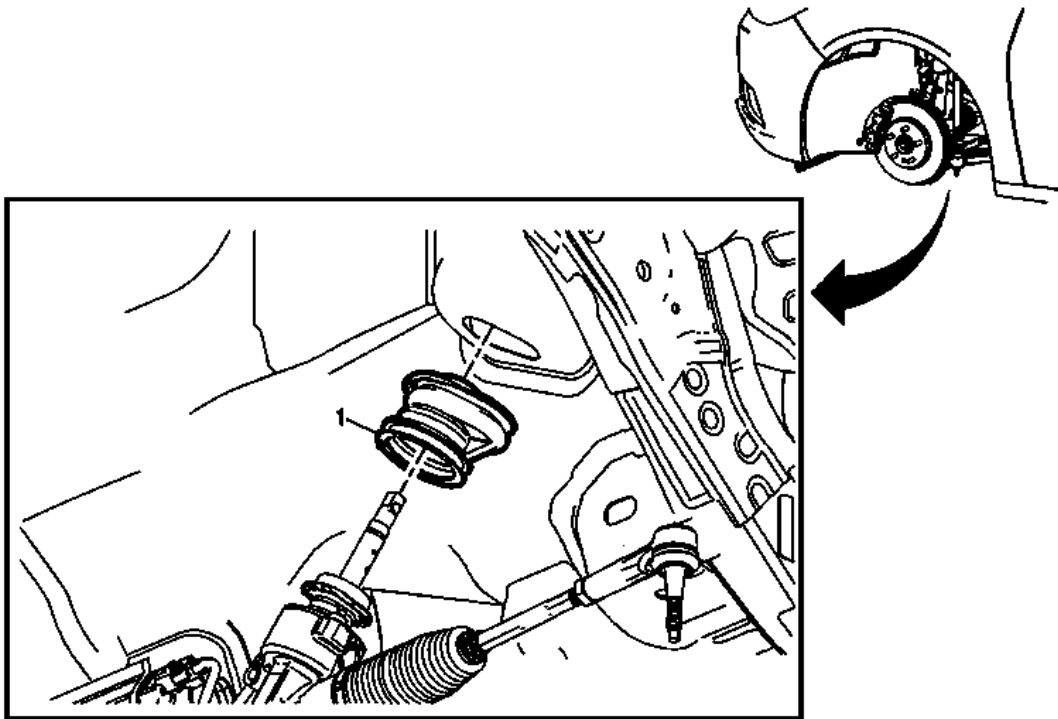


Fig. 14: Steering Column Dash Outer Seal (NJ1)
 Courtesy of GENERAL MOTORS COMPANY

Steering Column Dash Outer Seal Replacement (NJ1)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the steering column dash inner seal. Refer to <u>Steering Column Dash Inner Seal Replacement</u>. 2. Lower the steering gear as needed to provide the clearance necessary to remove the steering column dash outer seal. Refer to <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LUK, MHH, NJ1)</u> , <u>Electric Dual Pinion Rack and Pinion Steering Gear Replacement (FWD, LTG, M7U, NJ1)</u> . 	
1	Steering Column Dash Outer Seal Procedure Position the steering column dash outer seal over the steering gear and on the dash panel. Ensure the seal is aligned with the steering gear and dash panel correctly.

DESCRIPTION AND OPERATION

STEERING WHEEL AND COLUMN DESCRIPTION AND OPERATION

The steering wheel and column has 4 primary functions:

- Vehicle steering

- Vehicle security
- Driver convenience
- Driver safety

Vehicle Steering

The steering wheel is the first link between the driver and the vehicle. The steering wheel is fastened to a steering shaft within the column. At the lower end of the column, the intermediate shaft connects the column to the steering gear.

Vehicle Security, Found on Some Vehicle Models

Theft deterrent components are mounted and designed into the steering column. The following components allow the column to be locked in order to minimize theft:

- The ignition switch-location varies
- The steering column lock-content varies
- The ignition cylinder-location varies
- The theft deterrent module-location varies

Driver Convenience

The steering wheel and column may also have driver controls attached for convenience and comfort. The following controls may be mounted on or near the steering wheel or column.

- The turn signal switch
- The hazard switch
- The headlamp dimmer switch
- The wiper/washer switch
- The horn pad/cruise control switch
- The redundant radio/entertainment system controls
- The manual/power tilt or tilt/telescoping functions
- The power pedal adjustment control switch
- The navigation/OnStar® features
- The HVAC controls

Driver Safety

The steering wheel and column has safety features to protect the driver. The following components may be mounted on or near the steering column:

Energy-Absorbing Steering Column

The energy-absorbing steering column compresses in the event of a front-end collision, which reduces the

chance of injury to the driver. The energy-absorbing feature, collapsible steering shaft, and break away mounting features help reduce the injury in the event of an accident. In addition to these features, the following driver safety features may be on the steering column.

Electronic Park Lock (EPL)/Ignition Lock Cylinder Control Actuator

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an ignition lock cylinder control actuator system in the steering column. The ignition lock cylinder control actuator purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The column ignition lock system consists of an ignition lock cylinder control actuator, and a park position switch that is located in the automatic transmission shift lock control switch. The ignition lock cylinder control actuator contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

Linear Shift Assembly

If the vehicle is equipped with a column mounted gear shift, it has a linear shift assembly on the steering column. The linear shift assembly has a cable that runs from the linear shift assembly to the ignition lock cylinder case. The purpose of this cable is to prevent the ignition key from being turned to the OFF position when the transmission is in gear and the vehicle may still be moving. The linear shift assembly cable contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

SIR Coil and Module

For additional information on the operation of the SIR coil and module, refer to **Supplemental Inflatable Restraint System Description and Operation** .

Automatic Transmission Shift Lock Actuator

The automatic transmission shift lock control system is a safety device that prevents an inadvertent shift out of PARK when the engine is running. The driver must press the brake pedal before moving the shift lever out of the PARK position. The system consists of the following components: the automatic transmission shift lock control solenoid, the automatic transmission shift lock control switch, the body control module (BCM), the powertrain control module (PCM)/engine control module (ECM). With the ignition in the ON position, voltage is supplied to automatic transmission shift lock control switch. Voltage flows through the normally closed contacts of the automatic transmission shift lock control switch to the automatic transmission shift lock control solenoid. When the BCM receives a class 2 message from the PCM/ECM indicating the transmission is in the park position the BCM then grounds the automatic transmission shift lock solenoid control circuit . This energizes the automatic transmission shift lock control solenoid causing the transmission shift lever to be physically locked in the PARK position. When the brake pedal is pressed the contacts in the automatic transmission shift lock control switch open, de-energizing the automatic transmission shift lock control solenoid. This allows the shift

lever to be move out of the PARK position.

Steering Wheel Angle Sensor or Steering Wheel Position Sensor

The steering wheel position sensor is located somewhere along the steering shaft assembly. The sensor measures the position of the steering wheel and the speed at which it is rotated. A signal representing this measurement is provided to the vehicle stability enhancement system (VSES) module. The VSES module uses this signal, along with several others representing different vehicle conditions, to monitor the driving behavior of the vehicle and ensure that it stays in control. If the VSES module determines that the vehicle is out of control it provides signals to the powertrain control module (PCM) and the ABS module. These output signals are used to modulate the transmission torque and brake pressure of each of the vehicles wheels in order to regain control of the vehicle.

Heated Steering Wheel

The heated steering wheel system consists of a heated steering wheel, a heated steering wheel switch, and a steering wheel heat module. The heated steering wheel includes non-serviceable heating elements and a temperature sensor. The heating elements and sensor are located in the left and right sides of the rim of the steering wheel. The heated steering wheel switch is located in the left steering wheel control switch assembly. The steering wheel heat control module is located at the bottom of the steering wheel center hub. When the switch is pressed, the switch signal circuit is grounded and the heat module turns the heated steering wheel on. The system then remains on until the customer turns it off. The wheels normal operating temperature is 32°C (89.6°F). The wheel takes approximately 3 to 4 minutes to reach the normal operating temperature. The wheel will take longer to heat up if the vehicle temperature is below -21°C (-5.8°F). The built-in temperature sensor provides input to the controller to limit the temperature to the normal operating temperature. The wheel will not operate if the vehicle temperature is at or above 32°C (89.6°F).

ACCESSORIES & EQUIPMENT

Sunroof

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Sunroof Air Deflector Fastener	4 N.m	35 lb in
Sunroof Housing Bolts	9 N.m	80 lb in
Sunroof Motor Fastener	4 N.m	35 lb in
Sunroof Sunshade Motor Screws	4 N.m	35 lb in
Sunroof Window Front Screws	4 N.m	35 lb in
Sunroof Window Rear Screws	4 N.m	35 lb in

SCHEMATIC WIRING DIAGRAMS

SUNROOF WIRING SCHEMATICS

CF5

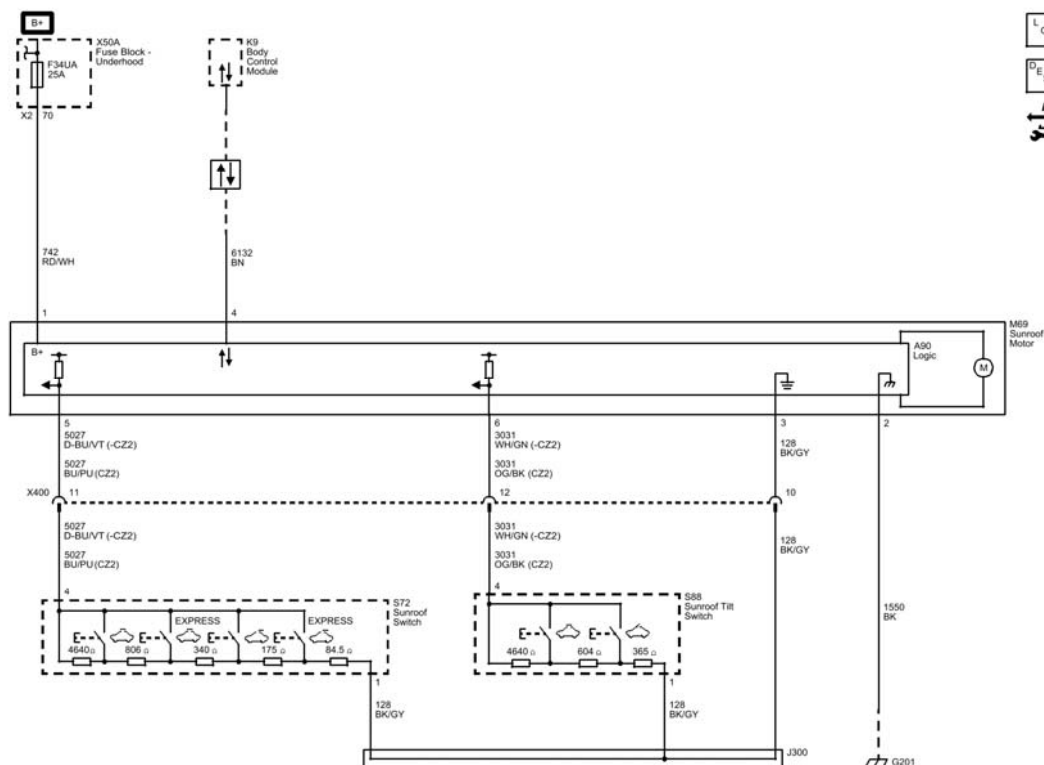


Fig. 1: CF5

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B3664	<p>DTC B3664 02 Sunroof Position Select Switch High Signal Circuit Short to Ground</p> <p>DTC B3664 05 Sunroof Position Select Switch High Signal Circuit High Voltage/Open</p> <p>DTC B3664 59 Sunroof Position Select Switch High Signal Circuit Protection Time-Out</p>
DTC B3697	DTC B3697 Sunroof Actuator Malfunction
DTC B369C	<p>DTC B369C 02 Sunroof Tilt Position Select Switch Circuit Short to Ground</p> <p>DTC B369C 05 Sunroof Tilt Position Select Switch Circuit High Voltage/Open</p> <p>DTC B369C 59 Sunroof Tilt Position Select Switch Circuit Protection Time-Out</p>

DTC B3664: SUNROOF POSITION SELECT SWITCH HIGH SIGNAL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3664 02

Sunroof Position Select Switch High Signal Circuit Short to Ground

DTC B3664 05

Sunroof Position Select Switch High Signal Circuit High Voltage/Open

DTC B3664 59

Sunroof Position Select Switch High Signal Circuit Protection Time-Out

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Sunroof Position Select Switch Signal	B3664 02	B3664 05	B3664 05	-
Sunroof Position Select Switch Low Reference	-	1	1	-
1. Power Sunroof Malfunction				

Circuit/System Description

The sunroof position select switch is connected directly to the controller. The sliding glass switch provide detent positions for open, express open, off, close, and express close. The sunroof position select switch completes the circuit provided by the sunroof motor module, a reference ground input and a pull-up voltage provided by an analog to digital switch input. The control switch places a different resistor ladder network in the circuit depending on the function selected.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

B3664 02

The sunroof motor module has detected and reported via serial data that the sunroof position select switch high signal circuit is shorted to ground.

B3664 05

The sunroof motor module has detected and reported via serial data that the sunroof position select switch high signal circuit is open or shorted to voltage.

B3664 59

The sunroof motor module has detected and reported via serial data that the sunroof position select switch high signal has been the same active position for 20 s after the glass has stopped moving in the requested direction due to reaching the end of the allowable motion.

Action Taken When the DTC Sets

DTC B3664 is stored in the body control module (BCM) memory.

Conditions for Clearing the DTC

The BCM no longer detects a malfunction in the sunroof position select switch high signal circuit.

Reference Information

Schematic Reference

Sunroof Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Sunroof Description and Operation (Tilt and Slide System)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: Because of the accessibility of the sunroof switch, perform the component testing before beginning the Circuit/System Testing.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S72 Sunroof Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the M69 Sunroof Motor.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the M69 Sunroof Motor.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Slide Switch parameter is Short to Battery.
 - **If not Short to Battery**
 1. Ignition Off, disconnect the harness connector at the M69 Sunroof Motor.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M69 Sunroof Motor.
 - **If Short to Battery**
5. Install a 5 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 1.
6. Verify the scan tool Slide Switch parameter is Short to Ground.
 - **If not Short to Ground**
 1. Ignition OFF, disconnect the harness connector at the M69 Sunroof Motor.
 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M69 Sunroof Motor.
 - **If Short to Ground**
7. All OK.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the S72 Sunroof Switch.
2. Test for 5.4-6.6k ohms between the control terminal 4 and the low reference terminal 1.
 - **If not between 5.4-6.6k ohms**

Replace the S72 Sunroof Switch.
 - **If between 5.4-6.6k ohms**
3. Test for 234-286 ohms between the control terminal 4 and the low reference terminal 1 while pressing the open switch while pressing the open switch.
 - **If not between 234-286 ohms**

Replace the S72 Sunroof Switch.
 - **If between 234-286 ohms**
4. Test for 76-93 ohms between the control terminal 4 and the low reference terminal 1 while pressing the express open switch.
 - **If not between 76-93 ohms**

Replace the S72 Sunroof Switch.
 - **If between 76-93 ohms**
5. Test for 1.3-1.5k ohms between the control terminal 4 and the low reference terminal 1 while pressing the close switch.
 - **If not between 1.3-1.5k ohms**

Replace the S72 Sunroof Switch.
 - **If between 1.3-1.5k ohms**
6. Test for 540-660 ohms between the control terminal 4 and the low reference terminal 1 while pressing the express close switch.
 - **If not between 540-660 ohms**

Replace the S72 Sunroof Switch.
 - **If between 540-660 ohms**
7. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Sunroof Switch Replacement**
- **Control Module References** for sunroof motor/actuator replacement, programming and setup

DTC B3697: SUNROOF ACTUATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3697

Sunroof Actuator Malfunction

For symptom byte information refer to **Symptom Byte List** .

Circuit/System Description

The sunroof glass is controlled by its own integrated motor/controller containing the necessary electronics, motor, hall effect position sensors, as well as the interface to the driver control switches. The motor/controller is capable of controlling motion based on control switch activation and serial data message commands from the body control module (BCM).

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

B3697 00

The sunroof motor has detected and reported via serial data that the sunroof actuator has a malfunction.

B3697 39

The sunroof motor has detected and reported via serial data that the sunroof actuator has an internal malfunction.

B3697 42

The sunroof motor has detected and reported via serial data that the sunroof actuator is not programmed.

B3697 4B

The sunroof motor has detected and reported via serial data that the sunroof actuator calibration is not learned.

Action Taken When the DTC Sets

DTC B3697 is stored in the BCM memory.

Conditions for Clearing the DTC

The BCM no longer detects a malfunction in the sunroof actuator.

Reference Information

Schematic Reference

Sunroof Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Sunroof Description and Operation (Tilt and Slide System)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B3697 42 or DTC B3697 4B is not set.
 - **If DTC B3697 42 or DTC B3697 4B is set**
 1. Calibrate the M69 Sunroof Motor. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.
 2. Verify DTC B3697 42 or DTC B3697 4B does not set while operating the sunroof.
 - **If DTC B3697 42 or DTC B3697 4B sets**

Replace the M69 Sunroof Motor.

 - **If DTC B3697 42 or DTC B3697 4B does not set**
3. All OK.

- If DTC B3697 42 or DTC B3697 4B is not set
- 3. Verify DTC B3697 00 or DTC B3697 39 is not set
 - If DTC B3697 00 or DTC B3697 39 is set

Replace the M69 Sunroof Motor.

- If DTC B3697 00 or DTC B3697 39 is not set
- 4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Sunroof Window Motor Replacement

DTC B369C: SUNROOF TILT POSITION SELECT SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B369C 02

Sunroof Tilt Position Select Switch Circuit Short to Ground

DTC B369C 05

Sunroof Tilt Position Select Switch Circuit High Voltage/Open

DTC B369C 59

Sunroof Tilt Position Select Switch Circuit Protection Time-Out

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Sunroof Ventilation Position Select Switch Signal	B369C 02	B369C 05	B369C 05	-
Sunroof Ventilation Position Select Switch Low Reference	-	1	1	-

1. Power Sunroof/Sunshade Malfunction

Circuit/System Description

The sunroof tilt position select switch is connected directly to the controller and provide detent positions for open, off and close. The control switch completes the circuit provided by the sunroof motor module, a reference ground Input and a pull-up voltage provided by the analog to digital switch input. The control switch places a different resistor ladder network in the circuit depending on the function selected. The controllers analog to digital switch input reads the resulting voltage range and determines the function.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

B369C 02

The sunroof module has detected and reported via serial data that the sunroof tilt position select switch circuit is shorted to ground.

B369C 05

The sunroof module has detected and reported via serial data that the sunroof tilt position select switch circuit is open or shorted to voltage.

B369C 59

The sunroof module has detected and reported via serial data that the sunroof tilt position select switch has been the same active position for 20 s after the glass has stopped moving in the requested direction due to reaching the end of the allowable motion.

Action Taken When the DTC Sets

DTC B369C is stored in the body control module (BCM) memory.

Conditions for Clearing the DTC

The BCM no longer detects a malfunction in the sunroof tilt position select switch circuit.

Reference Information

Schematic Reference

Sunroof Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Sunroof Description and Operation (Tilt and Slide System)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S88 Sunroof Tilt Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the M69 Sunroof Motor.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms , test or replace the M69 Sunroof Motor.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Sunroof Tilt Switch parameter is Short to Battery.
 - **If not Short to Battery**
 1. Ignition OFF, disconnect the harness connector at the M69 Sunroof Motor.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M69 Sunroof Motor.
 - **If Short to Battery**
5. Install a 5 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 1.
6. Verify the scan tool Sunroof Tilt Switch parameter is Short to Ground.
 - **If not Short to Ground**
 1. Ignition OFF, disconnect the harness connector at the M69 Sunroof Motor.

2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M69 Sunroof Motor.
 - **If Short to Ground**

7. All OK.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the S88 Sunroof Tilt Switch.
2. Test for 5.0-6.2k ohms between the control terminal 4 and the low reference terminal 1.
 - **If not between 5.0-6.2k ohms**

Replace the S88 Sunroof Tilt Switch.
 - **If between 5.0-6.2k ohms**
3. Test for 329-402 ohms between the control terminal 4 and the low reference terminal 1 while pressing the open switch.
 - **If not between 329-402 ohms**

Replace the S88 Sunroof Tilt Switch.
 - **If between 329-402 ohms**
4. Test for 872-1065 ohms between the control terminal 4 and the ground terminal 1 while pressing the close switch.
 - **If not between 872-1065 ohms**

Replace the S88 Sunroof Tilt Switch.
 - **If between 872-1065 ohms**
5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Sunroof Switch Replacement**
- **Control Module References** for sunroof motor/actuator replacement, programming and setup

SYMPTOMS - ROOF

NOTE: Complete the following procedures before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** in order to verify that all of the following conditions are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system description and operation in order to learn the system functions. Refer to **Sunroof Description and Operation (Tilt and Slide System)**.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the power sunroof system. Refer to **Checking Aftermarket Accessories**.
- Inspect the accessible system components for obvious damage or for conditions which can cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Symptom List

Power Sunroof/Sunshade Malfunction

POWER SUNROOF/SUNSHADE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Sunroof Switch Close Signal	B3664 02	B3664 05	B3664 05	-
Sunroof Switch Open Signal	B3664 02	B3664 05	B3664 05	-
Sunroof Tilt Switch Open Signal	B369C 02	B369C 05	B369C 05	-
Sunroof Tilt Switch Close Signal	B369C 02	B369C 05	B369C 05	-
Sunroof Switch Ground	-	1	-	-

Sunroof Motor Ground	-	1	-	-
1. Power Sunroof Malfunction				

Circuit/System Description

The sunroof electrical system uses a master/slave configuration utilizing a serial data based system for communication. The body control module (BCM) is designated as the master, while the sunroof motor module is configured as the slave.

As the system master, the BCM uses serial data communication bus to enable or disable sunroof operation, communicate vehicle information to the sunroof motor, and request sunroof movement. The sunroof controller provide system status and diagnostic information to the BCM for diagnostic reporting and operational purposes. The control switches places a different resistor ladder network in the circuit depending on the function selected. The sunroof motor analog to digital switch input reads the resulting voltage range and determines the function.

Reference Information

Schematic Reference

Sunroof Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the sunroof opens and closes when pressing the open and close sunroof switch.
 - **If the sunroof does not open or close**

Refer to Circuit/System Testing.

- **If the sunroof opens and closes**

3. Verify the sunroof opens and closes to the vent position when pressing the open and close sunroof vent switch.

- **If the sunroof does not open or close to the vent position**

Refer to Circuit/System Testing.

- **If the sunroof opens and closes to the vent position**

4. All OK.

Circuit/System Testing

NOTE: **Because of the accessibility of the switches, perform the switch component testing before beginning the circuit/system testing.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M69 Sunroof Motor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the M69 Sunroof Motor.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M69 Sunroof Motor.
 - **If the test lamp illuminates**
4. Ignition ON.
5. Test for less than 1 V between the signal circuit terminals listed below and ground:
 - Terminal 3 - M69 Sunroof Motor

- Terminal 5 - M69 Sunroof Motor
- Terminal 6 - M69 Sunroof Motor
- **If 1 V or greater**

Repair the short to voltage on the signal circuit.

- **If less than 1 V**

6. Ignition OFF.

7. Test for infinite resistance between the signal circuit terminals listed below and ground:

- Terminal 3 - M69 Sunroof Motor
- Terminal 5 - M69 Sunroof Motor
- Terminal 6 - M69 Sunroof Motor
- **If less than infinite resistance**

Repair the short to ground on the signal circuit

- **If infinite resistance**

8. Disconnect the harness connector at the S72 Sunroof Switch and the S88 Sunroof Tilt Switch.

9. Test for less than 5 ohms between the circuit terminals listed below:

- S72 Sunroof Switch terminal 1 and M69 Sunroof Motor terminal 3
- S72 Sunroof Switch terminal 4 and M69 Sunroof Motor terminal 5
- S88 Sunroof Tilt Switch terminal 1 and M69 Sunroof Motor terminal 3
- S88 Sunroof Tilt Switch terminal 4 and M69 Sunroof Motor terminal 6
- **If greater than 5 ohms**

Repair the open/high resistance in the circuit.

- **If less than 5 ohms**

10. Test or replace the M69 Sunroof Motor.

Component Testing

Sunroof Switch

Static Test

1. Ignition OFF, disconnect the harness connector at the S72 Sunroof Switch.
2. Test for 5.4-6.6k ohms between the control terminal 4 and the low reference terminal 1.
 - **If not between 5.4-6.6k ohms**

Replace the S72 Sunroof Switch.

- **If between 5.4-6.6k ohms**

3. Test for 234-286 ohms between the control terminal 4 and the low reference terminal 1 while pressing the open switch while pressing the open switch.

- **If not between 234-286 ohms**

Replace the S72 Sunroof Switch.

- **If between 234-286 ohms**

4. Test for 76-93 ohms between the control terminal 4 and the low reference terminal 1 while pressing the express open switch.

- **If not between 76-93 ohms**

Replace the S72 Sunroof Switch.

- **If between 76-93 ohms**

5. Test for 1.3-1.5k ohms between the control terminal 4 and the low reference terminal 1 while pressing the close switch.

- **If not between 1.3-1.5k ohms**

Replace the S72 Sunroof Switch.

- **If between 1.3-1.5k ohms**

6. Test for 540-660 ohms between the control terminal 4 and the low reference terminal 1 while pressing the express close switch.

- **If not between 540-660 ohms**

Replace the S72 Sunroof Switch.

- **If between 540-660 ohms**

7. All OK

Sunroof Tilt Switch

Static Test

1. Ignition OFF, disconnect the harness connector at the S88 Sunroof Tilt Switch.

2. Test for 5.0-6.2k ohms between the control terminal 4 and the low reference terminal 1.

- **If not between 5.0-6.2k ohms**

Replace the S88 Sunroof Tilt Switch.

- **If between 5.0-6.2k ohms**

3. Test for 329-402 ohms between the control terminal 4 and the low reference terminal 1 while pressing the open switch.

- **If not between 329-402 ohms**

Replace the S88 Sunroof Tilt Switch.

- **If between 329-402 ohms**

4. Test for 872-1065 ohms between the control terminal 4 and the ground terminal 1 while pressing the close switch.

- **If not between 872-1065 ohms**

Replace the S88 Sunroof Tilt Switch.

- **If between 872-1065 ohms**

5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Sunroof Switch Replacement**
- **Control Module References** for sunroof actuator replacement, programming and setup

REPAIR INSTRUCTIONS

SUNROOF ACTUATOR TRIM PLATE REPLACEMENT

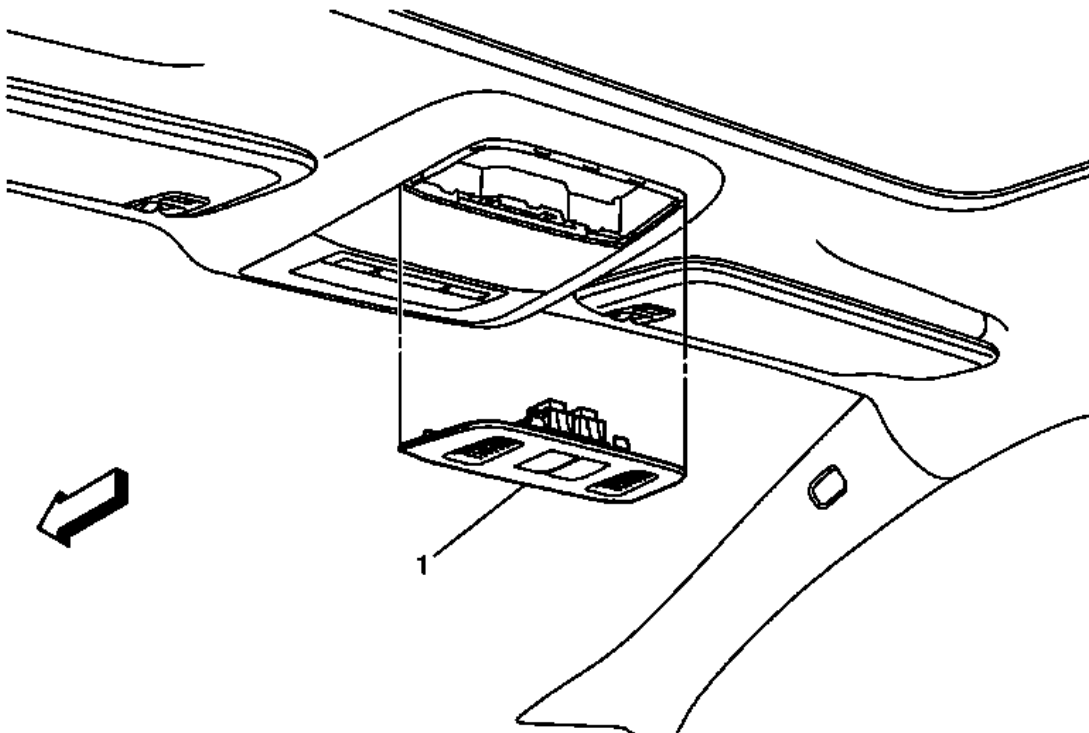


Fig. 2: Sunroof Actuator Trim Cover
 Courtesy of GENERAL MOTORS COMPANY

Sunroof Actuator Trim Plate Replacement

Callout	Component Name
1	Sunroof Actuator Trim Cover Procedure Disconnect the electrical connector. TIP: Carefully use a flat-bladed tool to release the retainer from the sunroof actuator trim cover to the roof console.

SUNROOF AIR DEFLECTOR REPLACEMENT

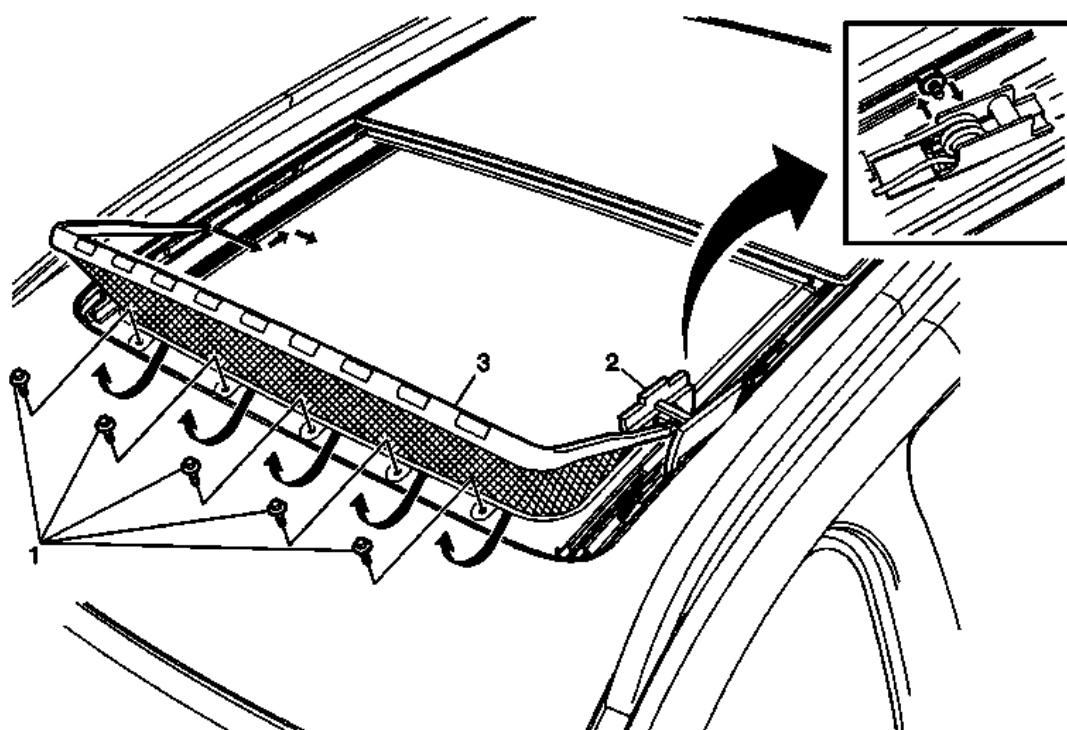


Fig. 3: Sunroof Air Deflector, Brackets & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Sunroof Air Deflector Replacement

Callout	Component Name
1	Sunroof Deflector Fastener (Qty: 5) CAUTION: Refer to <u>Fastener Caution</u> . Procedure

	<p>Open the front sunroof window.</p> <p>Tighten 4 N.m (35 lb in)</p>
2	<p>Sunroof Deflector Rear Bracket (Qty: 2)</p> <p>Procedure Position the deflector over and rearward. Lift up on the front tab of the bracket and slide forward to remove from frame. After the front fasteners are removed, the deflector must be rolled rearward in order to access the brackets.</p>
3	<p>Sunroof Deflector</p> <p>Procedure Install the deflector rear brackets on each side first. Then install the front part of the deflector and fasteners.</p> <p>NOTE: Verify the operation of the sunroof window to the deflector to ensure no binding.</p>

SUNROOF AIR DEFLECTOR COVER REPLACEMENT

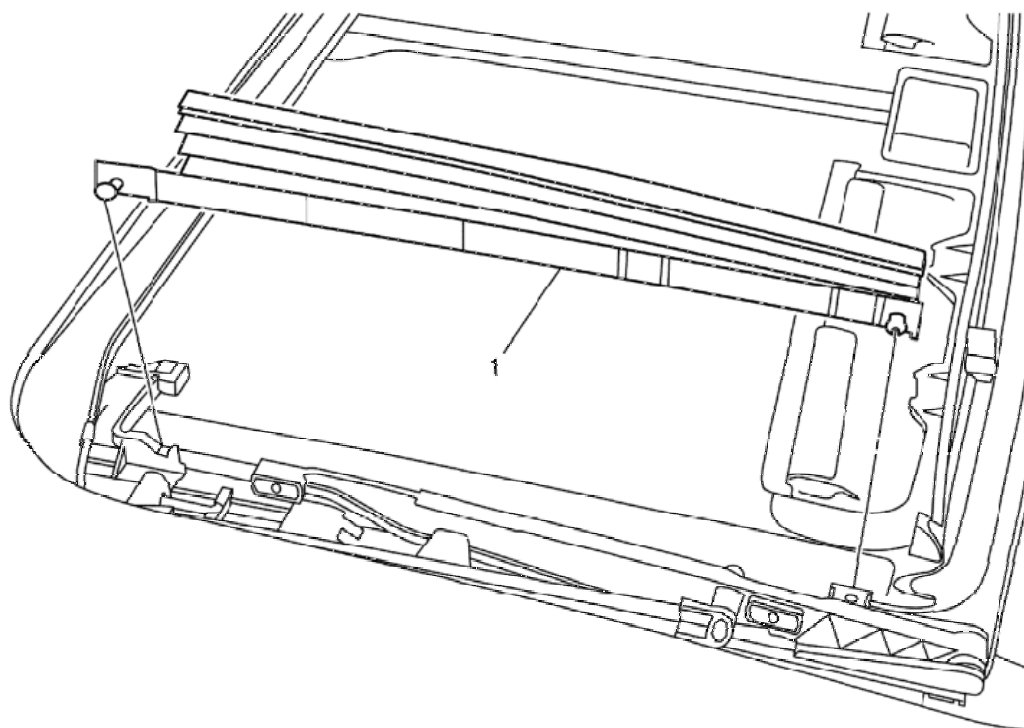


Fig. 4: Sunroof Air Deflector Cover
Courtesy of GENERAL MOTORS COMPANY

Sunroof Air Deflector Cover Replacement

Callout	Component Name
	Sunroof Air Deflector Cover

	Procedure
1	<ol style="list-style-type: none"> 1. Place the sunroof window in the vent position. 2. Move the sunshade to the maximum rear position. 3. Unclip the sunroof air deflector cover in front. 4. Unclip the sunroof air deflector cover in rear. 5. Remove the air deflector.

SUNROOF DRAIN INSPECTION AND CLEANING

Drain Hose Routing

NOTE: If the headliner is wet **DO NOT** remove any interior trim. Do the **Plugged Drain Hose test first**.

A drain trough encircles the sunroof window panel and water is drained off by the drain hoses located at each corner of the housing. A drain channel spans across the sunroof module at the rear of the window panel and directs water into the trough.

1. The front drain hoses are routed down the windshield pillars and out the front of the pillar into the wheelhouse area of through the for cowl panel by the wipers. The front hoses are installed in a rubber grommet and retained by clips located in the side of the windshield pillar.
2. The rear drain hoses are routed either through the side pillars and out of the body side outer panel extension or through the rear quarter lower panel. The rear hoses are installed in a rubber grommet and retained by clips.

Plugged Drain Hose

In some vehicle it may be necessary to clean the sunroof drain hose by applying air from the lower end of the drain hose outlet instead of the upper drain hose outlet.

If a water leak has occurred check for a plugged sunroof module drain hose at each corner of drainage system by doing the following:

1. Open the sunroof window.
2. Locate each sunroof module drain hose outlet area.
3. With a visual look, ensure that all the hoses are attached to the sunroof module drain outlet.
4. Cover all of the interior before air is apply to the drain hose.
5. To test for blockage, pour a small container of water into the module housing drain trough. Check each corner to confirm the drain hose is draining water if not go to step number 7.

WARNING: Wear safety glasses in order to avoid eye damage.

6. Use compressed air, 241 kPa (35 psi) or less to blow out any drain hose that is plugged.
7. Test the system again.
8. If remain plugged remove the blockage using the following steps.
 1. Push mechanics wire through the hose to remove the obstruction.
 2. Use compressed air in order to blow out any remaining material.
9. If the hose remains plugged, check to see it is properly routed and does not have a kink. Refer to **Sunroof Housing Front Drain Hose Replacement**, or **Sunroof Housing Rear Drain Hose Replacement**.

Disconnected Drain Hose

Inspect the drainage system for disconnected drain hoses. Complete the following steps in order to obtain partial access to drain hoses and check for a disconnected hose.

1. Open the sunroof window panel.
2. Lower the headliner as needed. Refer to **Headlining Trim Panel Replacement (With Sunroof)** .
3. Connect any disconnected hoses. If tie straps are required, connect the hose and apply tie strap.
4. Ensure that the rear drain hoses are properly routed in the metal roof slot and taped in place.

SUNROOF HOUSING DRAIN GUTTER REPLACEMENT

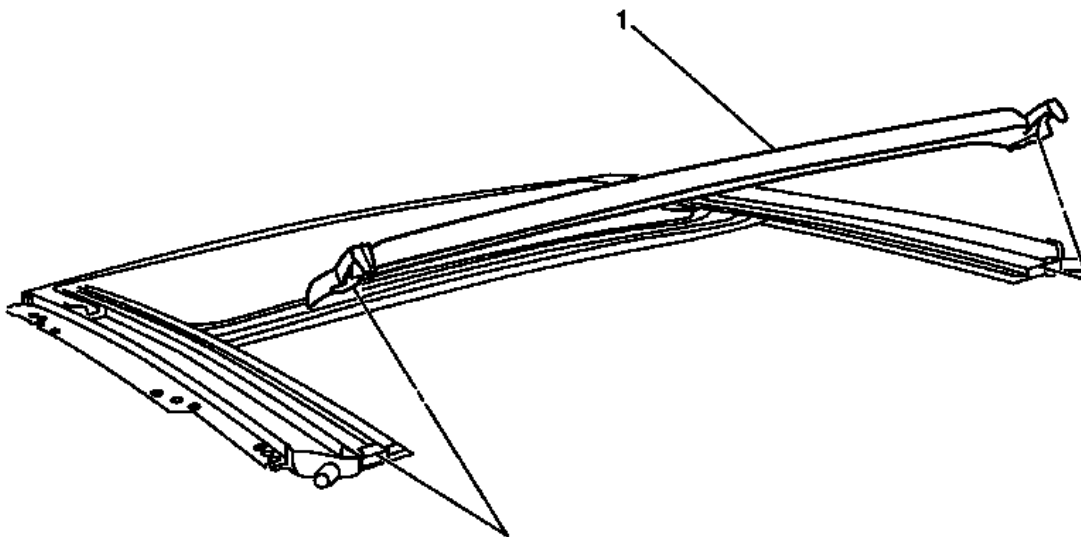


Fig. 5: Sunroof Housing Drain Gutter
Courtesy of GENERAL MOTORS COMPANY

Sunroof Housing Drain Gutter Replacement

Callout	Component Name
Preliminary Procedure Remove sunroof housing assembly. Refer to <u>Sunroof Housing Replacement</u> .	
1	Sunroof Housing Drain Gutter Procedure <ol style="list-style-type: none"> 1. Do not remove the motor or sunshades. 2. Remove clips from the sunroof housing drain gutter bracket on the left and right side. 3. Verify sunroof window height and opening fit adjustment. Refer to <u>Sunroof Window Height and Opening Fit Adjustment</u>.

SUNROOF HOUSING REPLACEMENT

Removal Procedure

1. Remove the sunroof windows front and rear. Refer to **Sunroof Window Replacement - Front**, and **Sunroof Window Replacement - Rear**.
2. It is only necessary to lower the headliner. Only perform the steps in the headliner replacement procedure that will lower the headliner enough to gain access to the part. Refer to **Headlining Trim Panel Replacement (With Sunroof)** .

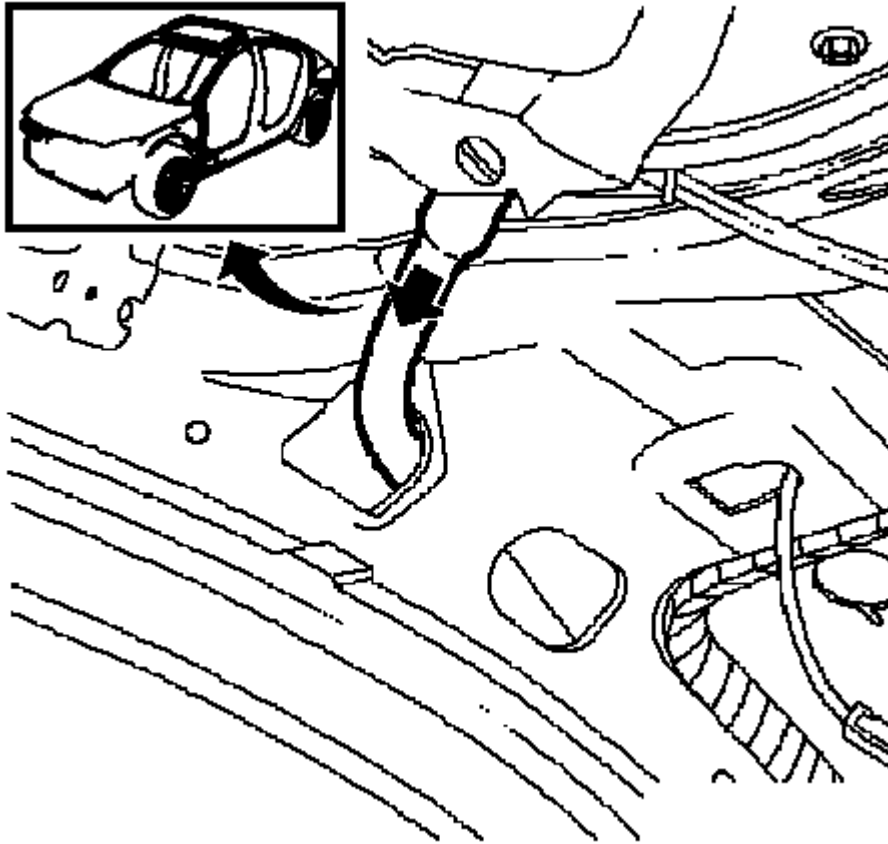


Fig. 6: Identifying Front Water Drain Hose Actuation Unit
Courtesy of GENERAL MOTORS COMPANY

3. Remove the both front water drain hoses from the sunroof frame spigot.

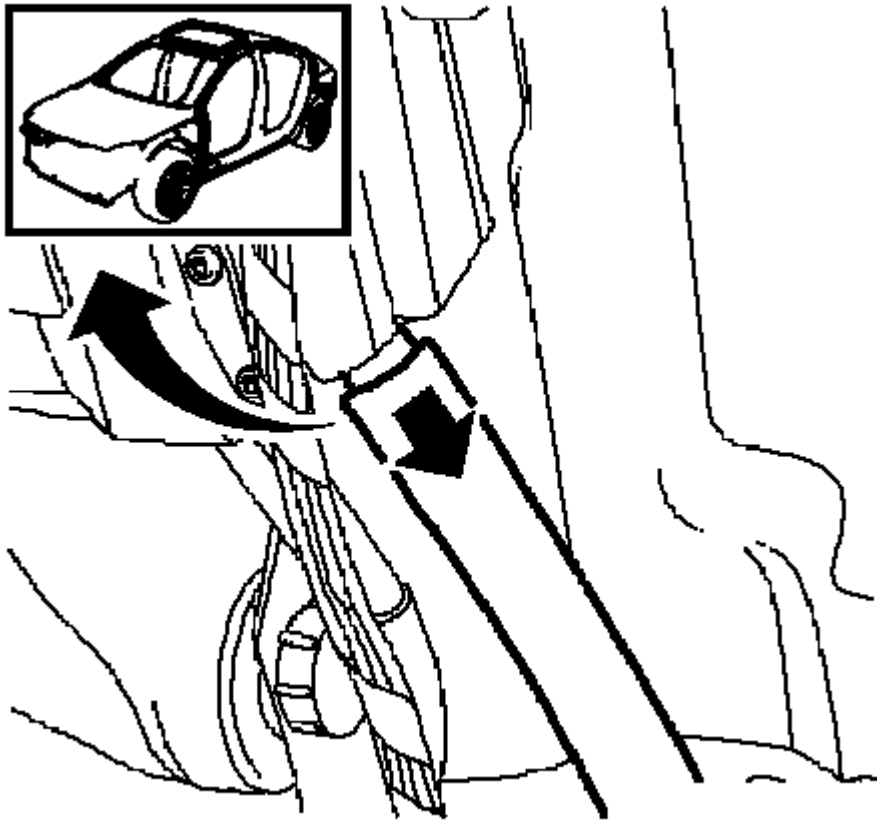


Fig. 7: View Of Rear Water Drain Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove the both rear water drain hoses from the sunroof frame spigot.
5. Disconnect the sunroof window and sunshade motor electrical connectors.

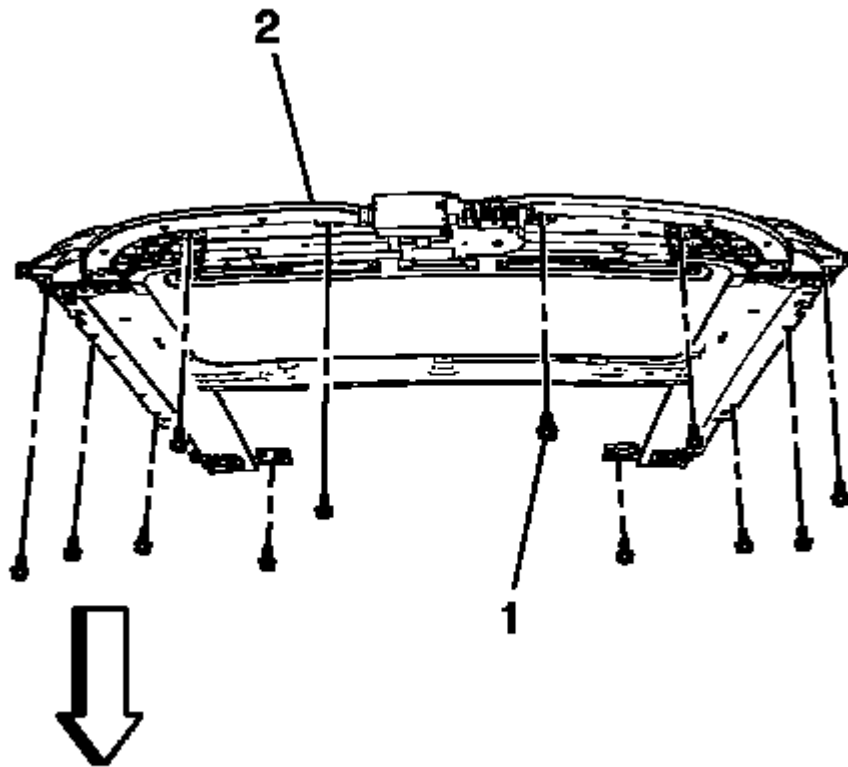


Fig. 8: Sunroof Housing And Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the sunroof housing fasteners (1).
7. Remove the sunroof housing (2) assembly from the vehicle.

Installation Procedure

1. Transfers all parts as necessary.

CAUTION: Refer to Fastener Caution .

2. Insert the sunroof housing assembly to the gauge pin location in the opening.

Tighten the three fasteners.

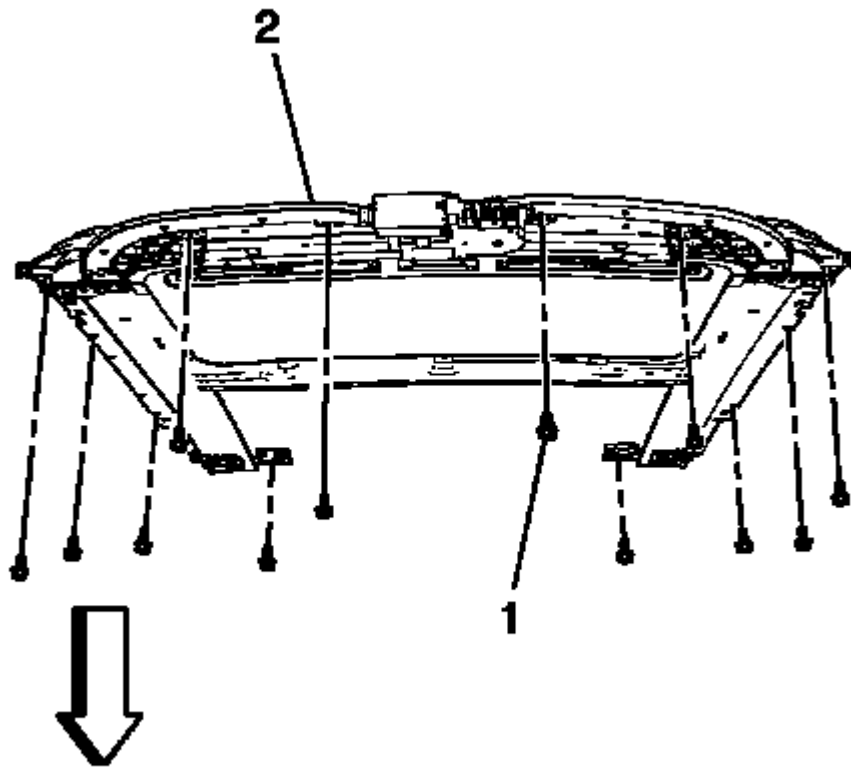


Fig. 9: Sunroof Housing And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

3. Install the sunroof housing (2) assembly with the remaining fasteners and tighten to 9 (80 lb in).
4. Connect the sunroof window motor electrical connector.
5. Install the both rear water drain hoses to the sunroof frame spigot and tie straps, if required.

Connect the 2 hoses and apply tie straps if required.

6. Install the both front water drain hoses to the sunroof frame spigot and tie straps, if required.
7. Install the sunroof windows front and rear. **Sunroof Window Replacement - Front**, and **Sunroof Window Replacement - Rear**.
8. Verify the operation of the sunroof.
9. Water test the vehicle before installing the headliner.
10. Install the headlining. Refer to **Headlining Trim Panel Replacement (With Sunroof)** .

SUNROOF HOUSING FRONT DRAIN HOSE REPLACEMENT

Removal Procedure

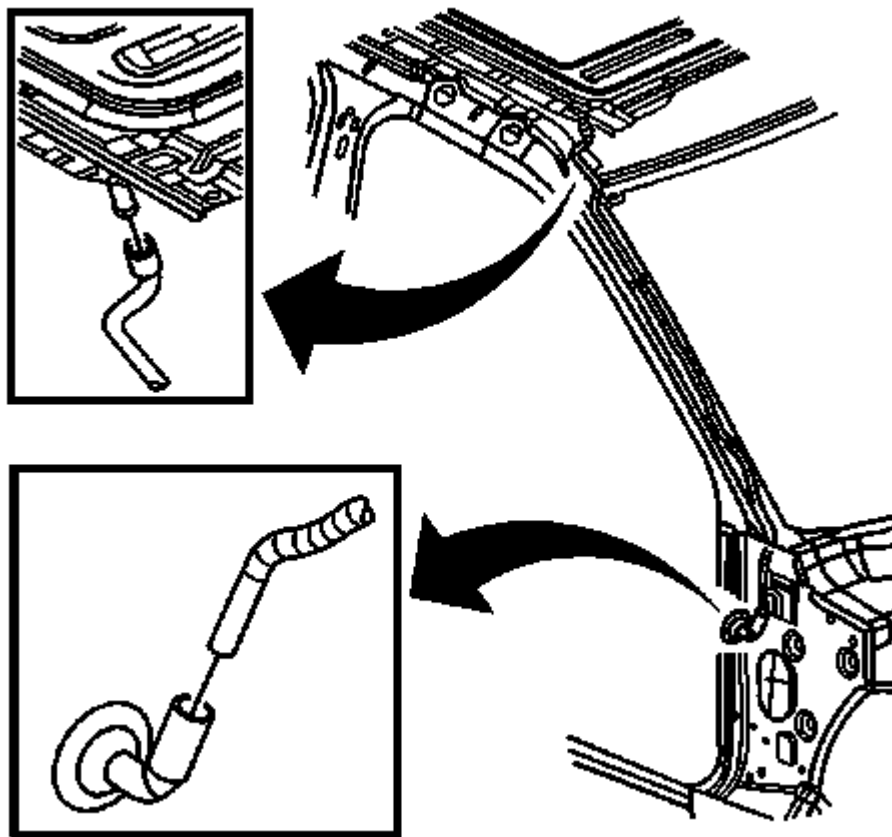


Fig. 10: Identifying Front Sunroof Drain Hose Connections
Courtesy of GENERAL MOTORS COMPANY

1. It is only necessary to lower the headliner. Only do those step in headliner replacement that will lower the headliner enough to gain access to the part.
2. Disconnect the front sunroof drain hose from the sunroof drain spigot.
3. Disengage the sunroof drain hose from the attachment points on the windshield pillar.

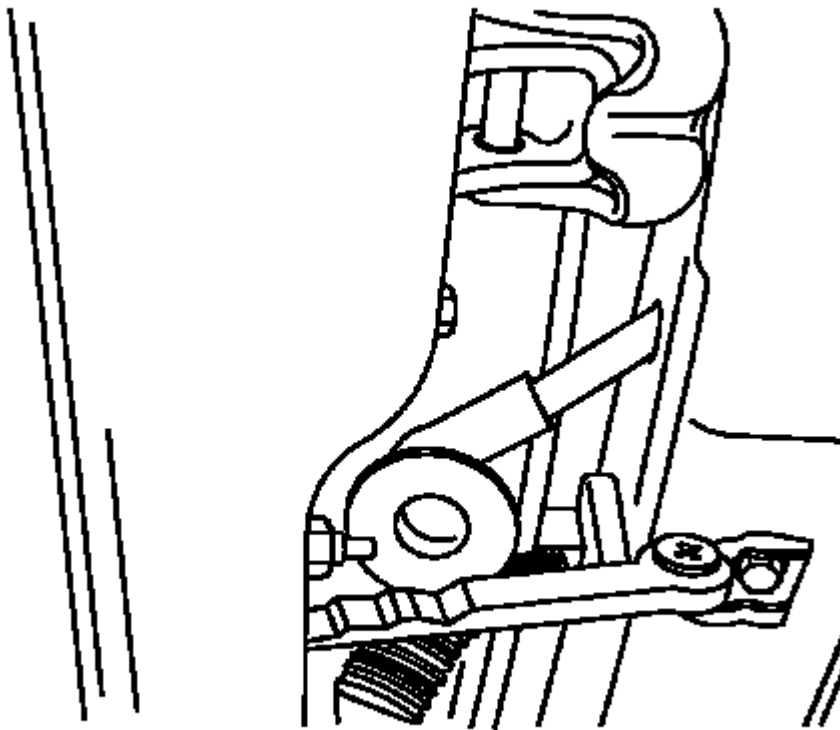


Fig. 11: Identifying Front Sunroof Drain Hose Grommet
Courtesy of GENERAL MOTORS COMPANY

4. Pull the grommet and a short length of the front drain hose out of the front hinge pillar.
5. Disconnect the grommet from the drain hose.
6. Remove the hose from the vehicle

Installation Procedure

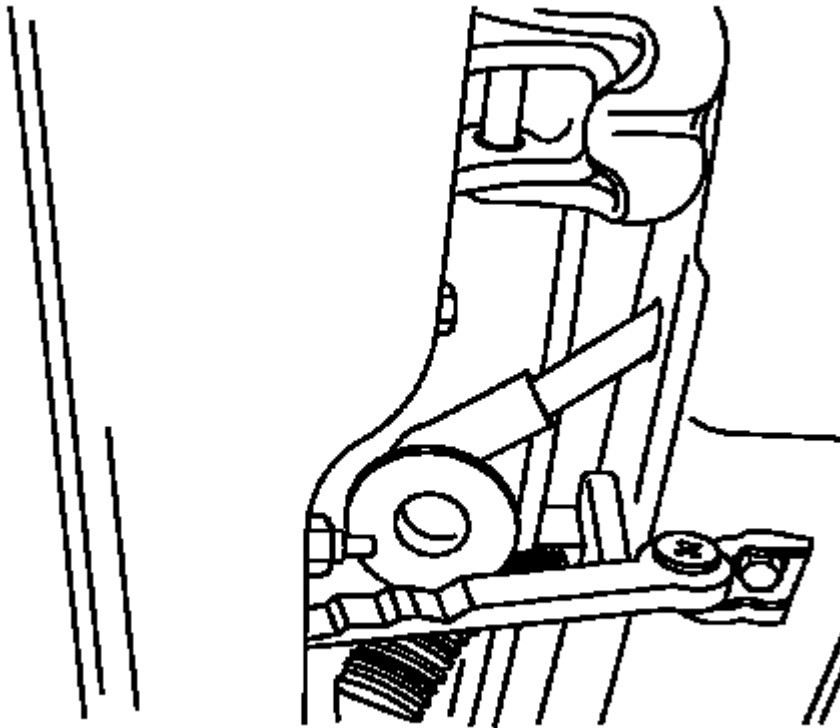


Fig. 12: Identifying Front Sunroof Drain Hose Grommet
Courtesy of GENERAL MOTORS COMPANY

1. Install the hose to the vehicle
2. Pull the hose out through the hole in the front hinge pillar.
3. Install the grommet onto the end of the hose.
4. Install the grommet into the hole in the front hinge pillar.

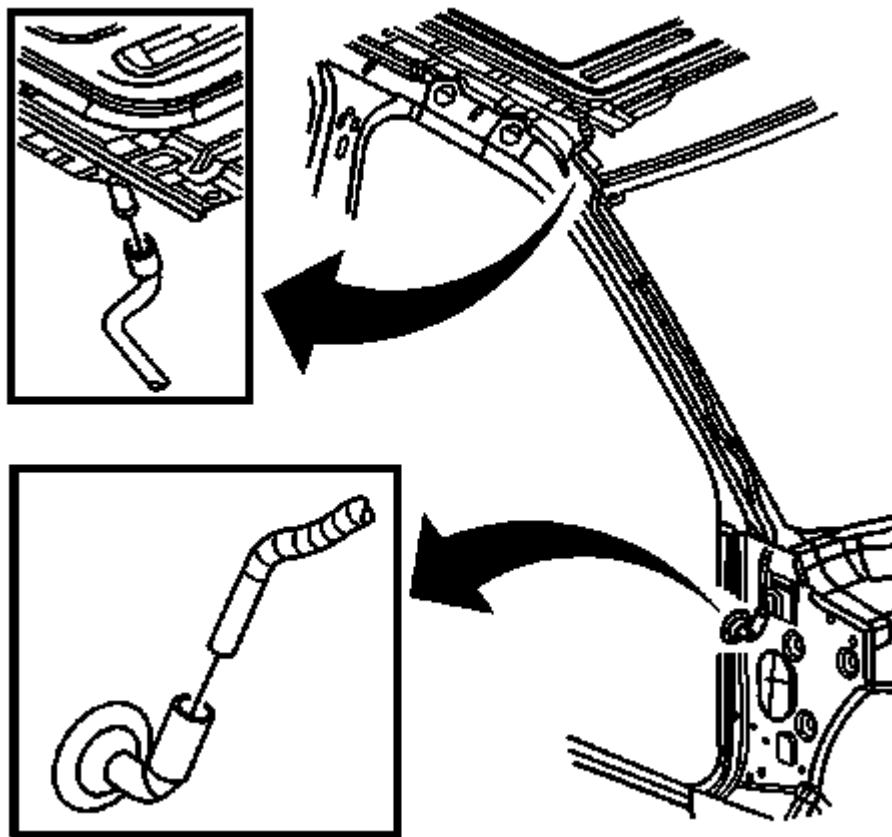


Fig. 13: Identifying Front Sunroof Drain Hose Connections
Courtesy of GENERAL MOTORS COMPANY

5. Connect the hose to the attachments on the windshield pillar.
6. Connect the front sunroof drain hose to the sunroof drain spigot.
7. Install the headliner.
8. Inspect sunroof for proper operation.

SUNROOF HOUSING REAR DRAIN HOSE REPLACEMENT

Removal Procedure

1. Open the rear compartment
2. It is only necessary to lower the headliner. Only do those step in headliner replacement that will lower the headliner enough to gain access to the part.
3. Remove the rear compartment trim panel.

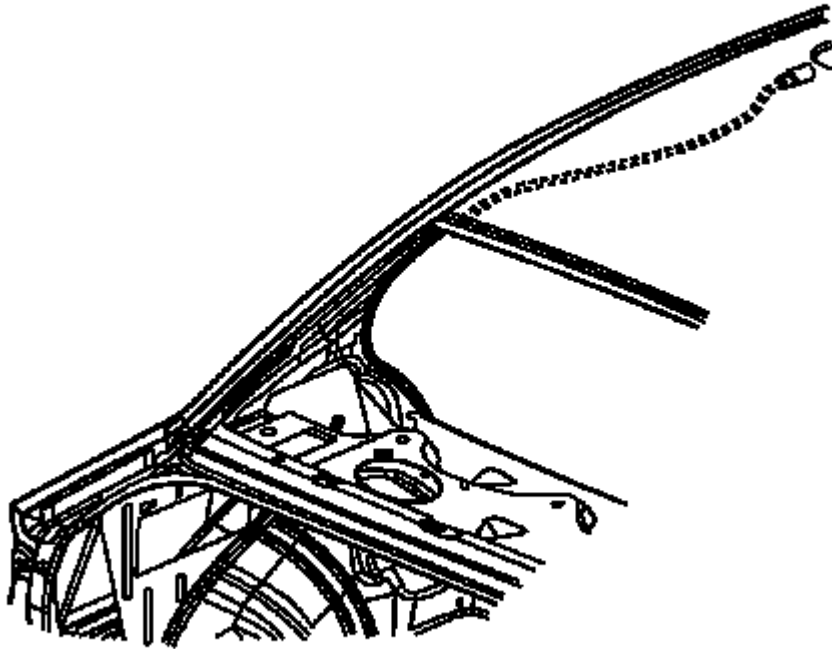


Fig. 14: View Of Rear Sunroof Drain Hose
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the rear sunroof drain hose from the sunroof drain spigot.
5. Disengage the sunroof drain hose from the attachment clips on the roof rail, the C-pillar, and the rear compartment.

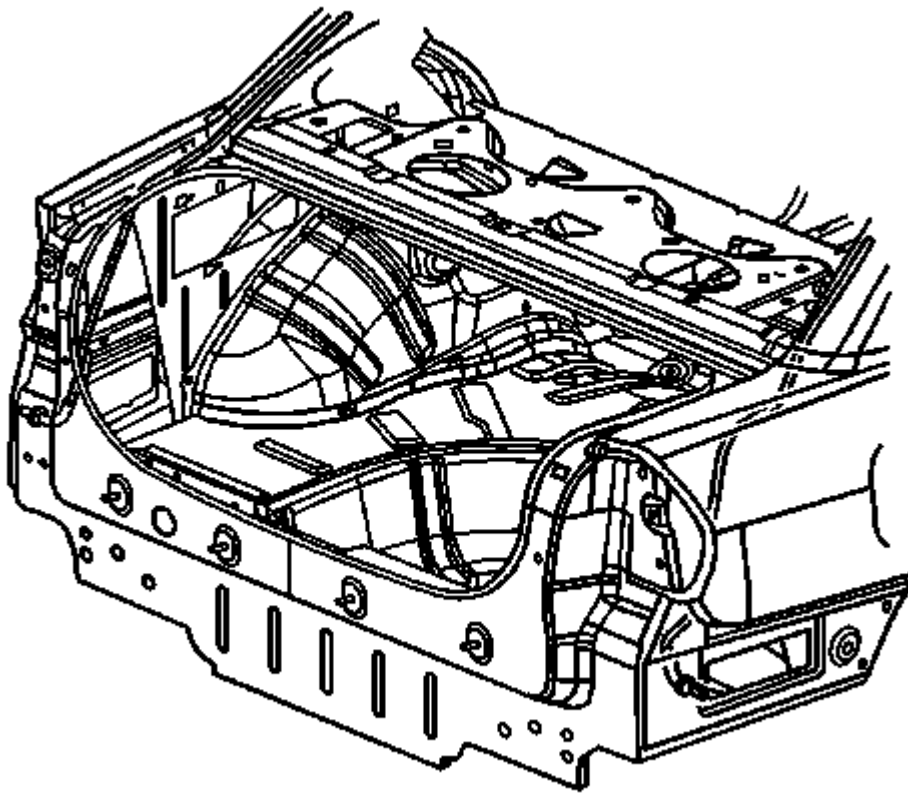


Fig. 15: Identifying Rear Sunroof Drain Hose Grommet
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the drain hose from the grommet seated in the rear lower quarter panel.
7. Remove the drain hose into the passenger compartment by pulling the hose through the access hole in the rear package shelf.
8. If necessary, pull the grommet into the rear compartment to remove.

Installation Procedure

1. Feed the rear sunroof drain hose down the C-pillar through the outboard access hole in the rear package shelf and into the rear compartment.

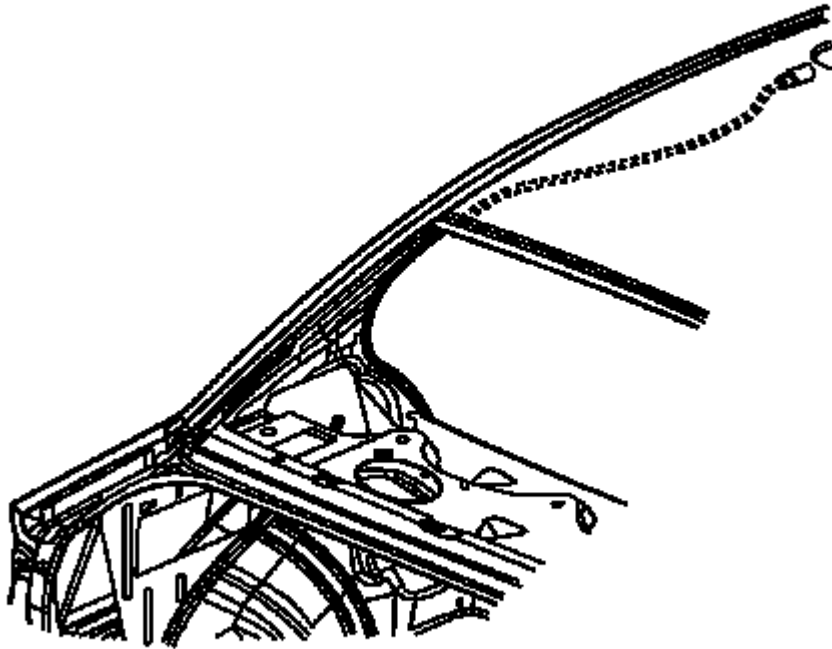


Fig. 16: View Of Rear Sunroof Drain Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect the rear sunroof drain hose to the sunroof drain spigot.
3. Connect the drain hose to the attachment clips on the roof rail, the C-pillar, and the rear compartment.

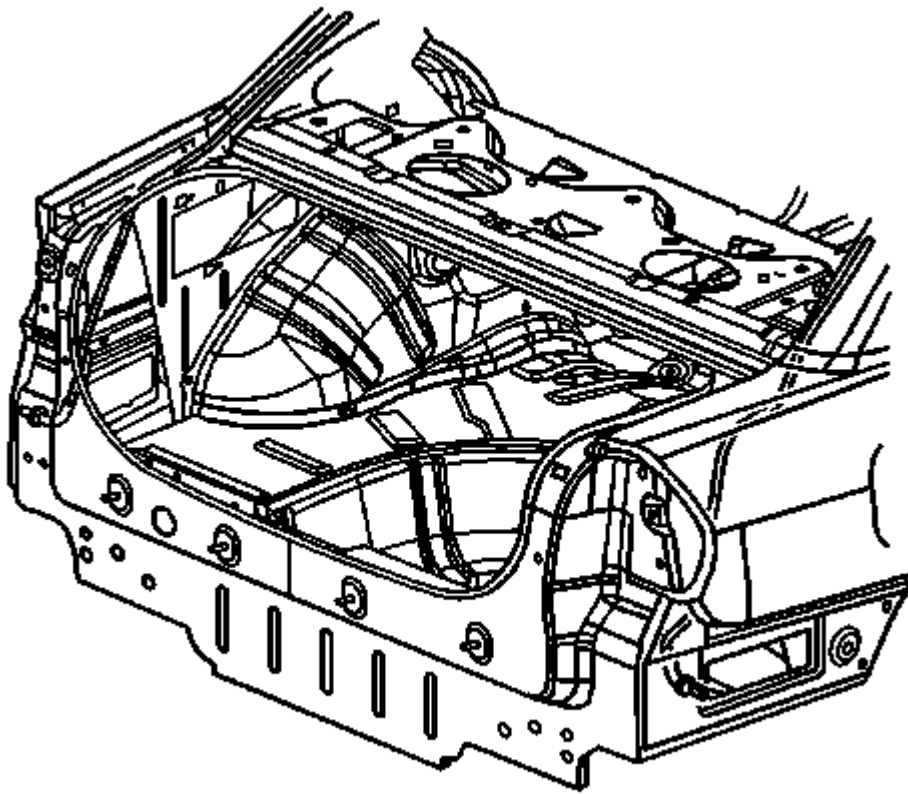


Fig. 17: Identifying Rear Sunroof Drain Hose Grommet
Courtesy of GENERAL MOTORS COMPANY

4. Install the grommet into the opening in the rear lower quarter panel, if necessary. Ensure that the grommet is fully seated.
5. Connect the end of the drain hose to the grommet.
6. Install the rear compartment trim panel.
7. Install the headliner.
8. Close the rear compartment.

SUNROOF WINDOW MOTOR REPLACEMENT

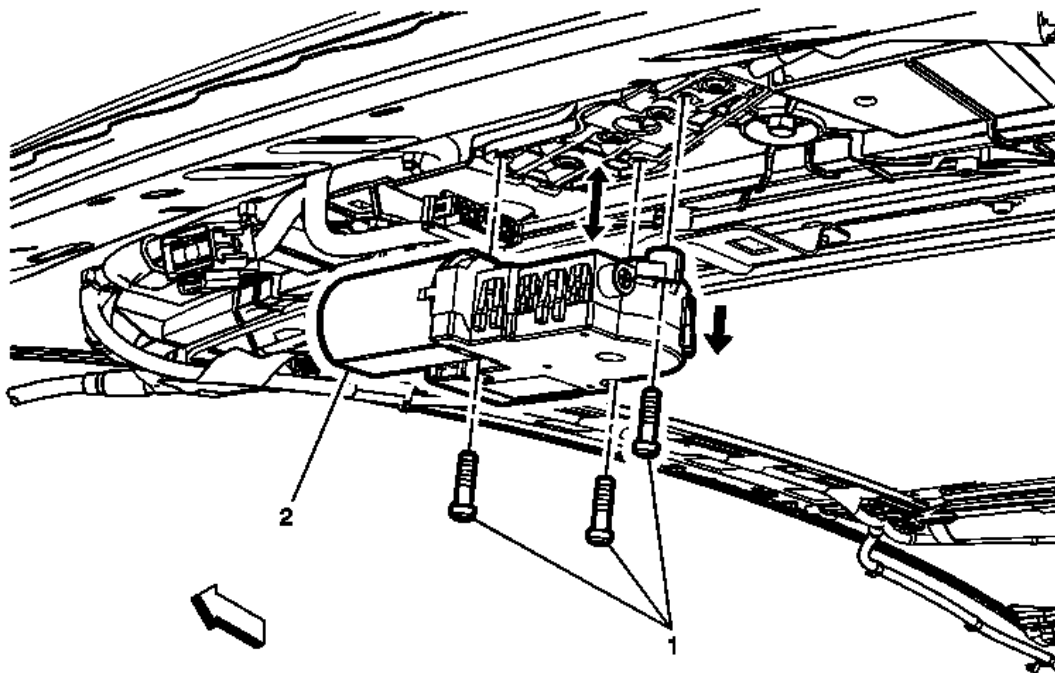


Fig. 18: Sunroof Window Motor & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Sunroof Window Motor Replacement

Callout	Component Name
Preliminary Procedure Remove the roof console. Refer to <u>Roof Console Replacement</u> .	
1	Sunroof Window Motor Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the electrical wiring harness connector. Tighten 4 (35 lb in)
2	Sunroof Window Motor Procedure <ol style="list-style-type: none"> When replacing the sunroof motor, refer to <u>Sunroof Motor/Actuator Initialization/Teach Process</u>. Verify the operation of the sunroof before installing the headliner trim.

SUNROOF MOTOR/ACTUATOR INITIALIZATION/TEACH PROCESS

Perform the Initialization/Teach Process any time a sunroof window motor actuator is installed in the vehicle.

Use only the slide button for the these steps.

"Manual" indicates the first switch detent.

"Express" indicates the second switch detent.

1. Ensure that the electrical harness on the headliner is connected to the sunroof motor.
2. Put the ignition in the RUN position. (CAL file will be automatically downloaded by Body Control housing, BCM).
3. Ensure that the sunroof window is in the fully closed position. This is Not required for a new motor.
4. Press and hold the "Manual Close Switch. After 10 seconds the sunroof window will move to the vent and then slightly back. Do not release the switch until the sunroof window stops moving. A 10 second delay is not required for a new motor.
5. Learn Process:
 1. Open the sunroof window using the express or manual open switch to the full open position then release the switch.
 2. Press and hold "Manual Open Switch. After 10 seconds, the window will move to the close position, vent and then close. Do not release the switch during the movement until the window stops in the fully closed position.

NOTE: The Initialization/Teach Process is not complete if any of the following actions take place before the initialization cycle is done.

6. Verify the operation of the sunroof window.
 1. The slide button is not held as instructed.
 2. The ignition and/or battery power has been removed.
 3. The window panel has not reached the closed position.

The Initialization/Teach Process must be restarted if the procedure is not carried out completely.

SUNROOF SUNSHADE REPLACEMENT

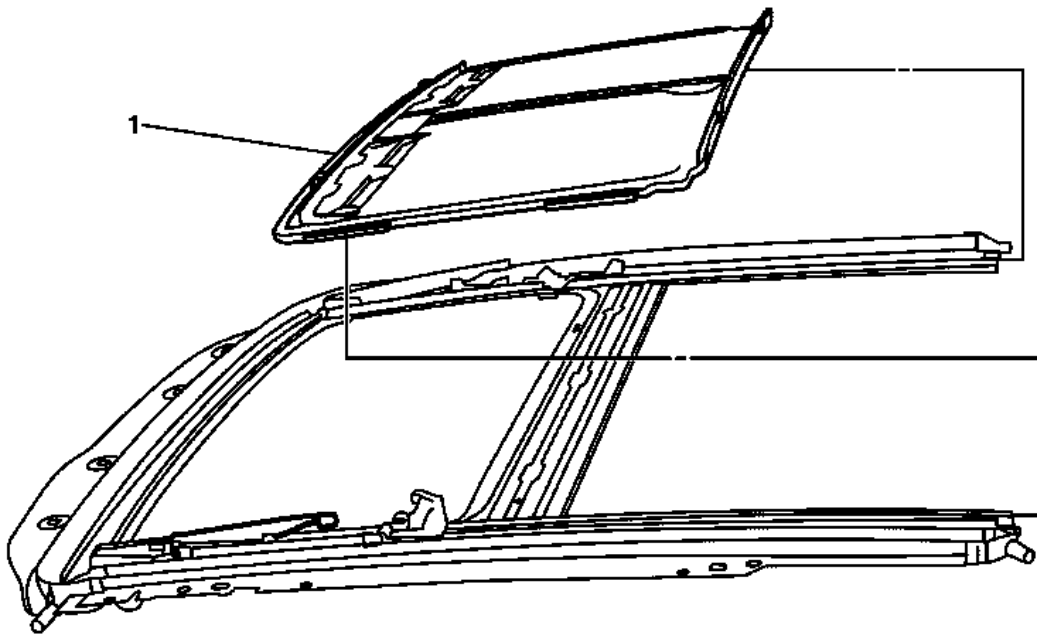


Fig. 19: Sunroof Sunshade
 Courtesy of GENERAL MOTORS COMPANY

Sunroof Sunshade Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the front sunroof window. Refer to <u>Sunroof Window Replacement - Front.</u> 2. Remove the sunroof housing assembly. Refer to <u>Sunroof Housing Replacement.</u>	
1	Sunroof Sunshade Procedure <ol style="list-style-type: none"> 1. Remove the 2 rear sunroof housing assembly brackets. 2. Move the sunroof sunshade rearward out of the sliding rail.

SUNROOF WINDOW SEAL REPLACEMENT - OUTER

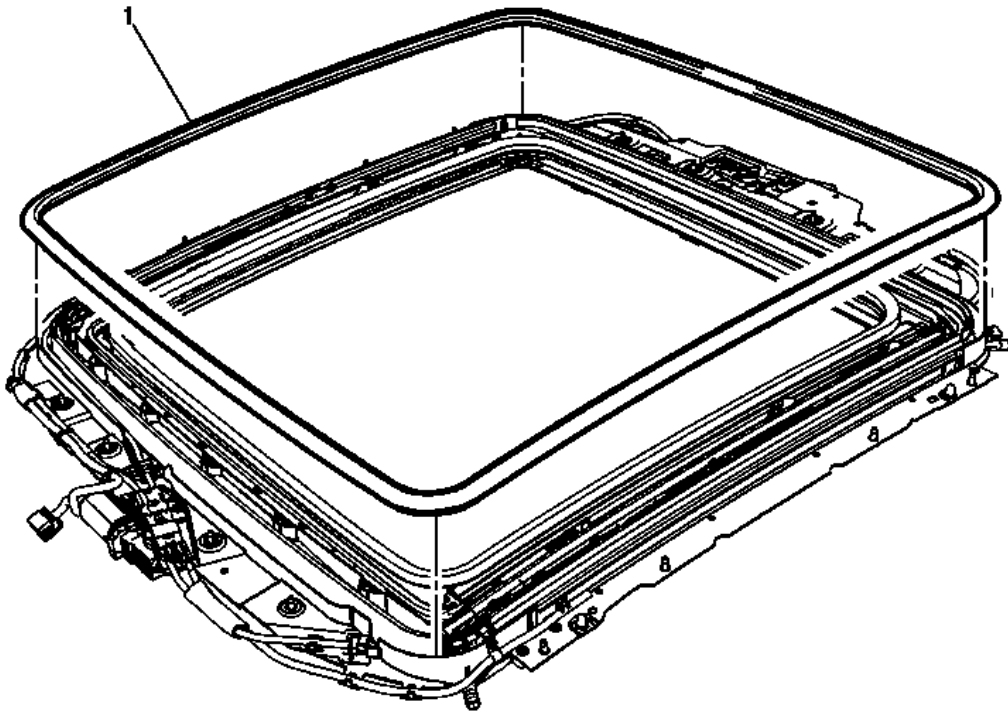


Fig. 20: Sunroof Window Seal - Outer
 Courtesy of GENERAL MOTORS COMPANY

Sunroof Window Seal Replacement - Outer

Callout	Component Name
Preliminary Procedure	
Remove the sunroof housing assembly. Refer to <u>Sunroof Housing Replacement</u> .	
1	Sunroof Window Outer Seal NOTE: Ensure that the outer seal is fitted around the edge of the housing to prevent water leaks.

SUNROOF WINDOW SEAL REPLACEMENT - INNER

Removal Procedure

1. Remove the front sunroof window. Refer to **Sunroof Window Replacement - Front**, and rear sunroof window **Sunroof Window Replacement - Rear**.

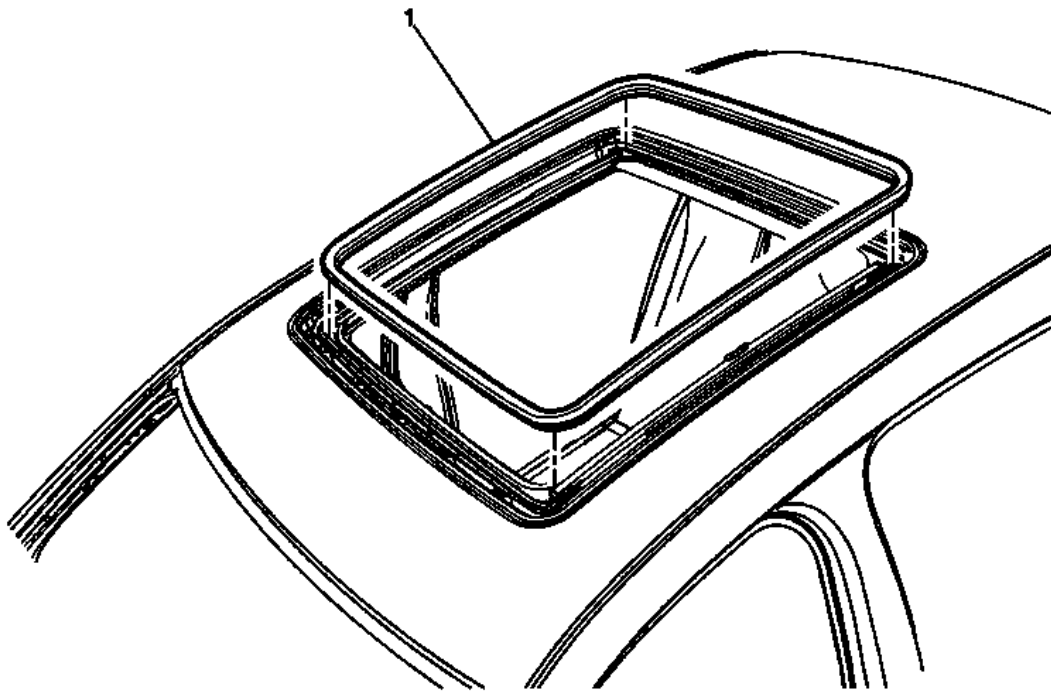


Fig. 21: Sunroof Window Seal - Inner
Courtesy of GENERAL MOTORS COMPANY

2. Start in the front of the vehicle, lift the weatherstrip (1) off the inside edge of the sunroof.
3. Remove the seal from the sunroof housing track.

Installation Procedure

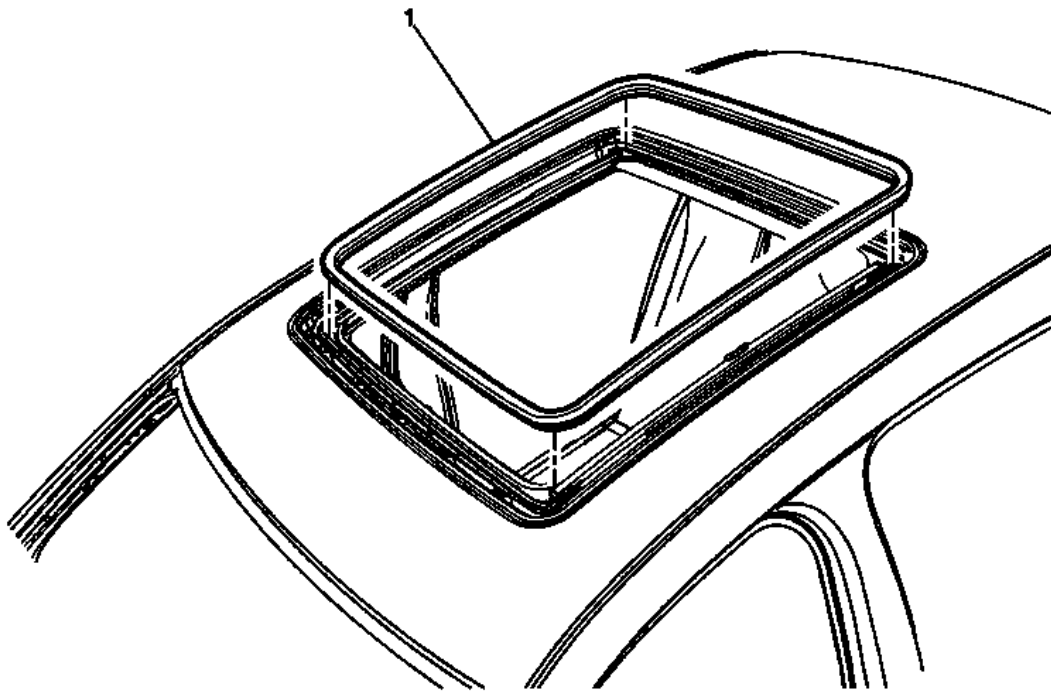


Fig. 22: Sunroof Window Seal - Inner
Courtesy of GENERAL MOTORS COMPANY

1. Install the seal (1) to the sunroof housing track.
2. Using a suitable tool, seat the weatherstrip on the inner edge of the sunroof.
3. Install the front sunroof window. Refer to **Sunroof Window Replacement - Front**, and rear sunroof window **Sunroof Window Replacement - Rear**.
4. Water test to verify no leaks.

SUNROOF WINDOW REAR SEAL REPLACEMENT - REAR WINDOW SIDE

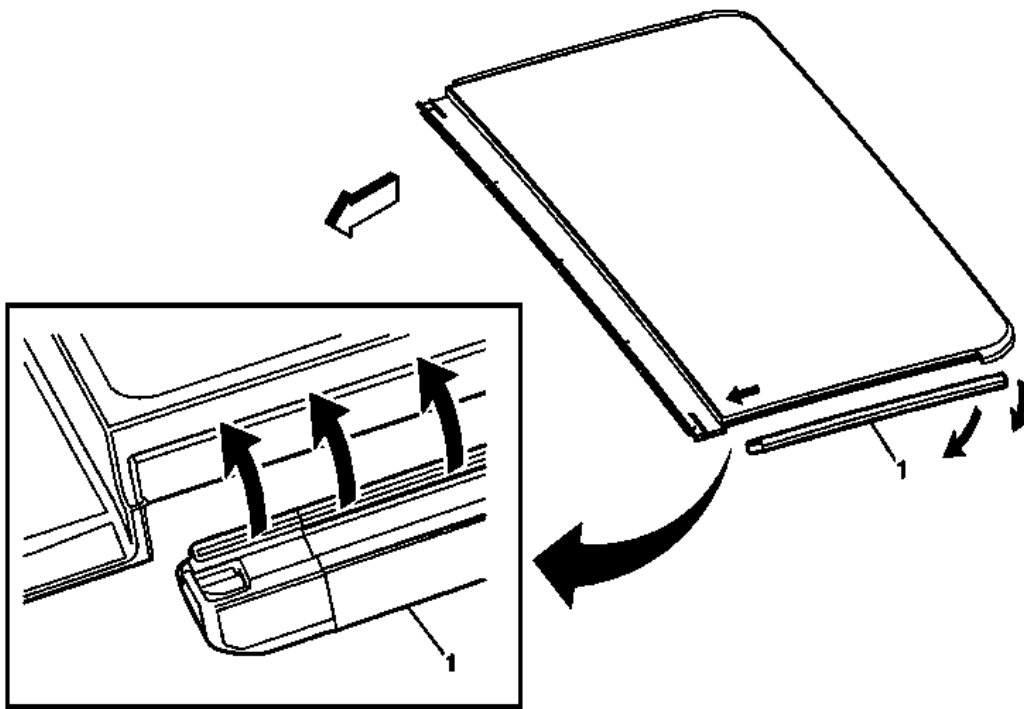


Fig. 23: Sunroof Window Rear Seal - Rear Window Side
 Courtesy of GENERAL MOTORS COMPANY

Sunroof Window Rear Seal Replacement - Rear Window Side

Callout	Component Name
WARNING: Refer to <u>Glass and Sheet Metal Handling Warning</u> .	
Preliminary Procedures Remove the sunroof window rear. Refer to <u>Sunroof Window Replacement - Rear</u> .	
1	Sunroof Window Rear Seal Side Procedures <ol style="list-style-type: none"> 1. Before removing the sunroof window, apply a double layer of masking tape around the perimeter of the painted surfaces. 2. Remove the sunroof window weatherstrip by grasping the edge, pull downward to release it from the retainer. 3. Clean around the inside surface of the window weatherstrip retainer with a 50/50 mixture of isopropyl alcohol and water by volume on a dampened lint free cloth. 4. Position the sunroof window rear seal side in the center of the window retainer, working outward the entire length. 5. Ensure the window height. Refer to <u>Sunroof Window Height and Opening Fit Adjustment</u>.

6. Inspect sunroof for proper operation and water test to ensure no leaks.

SUNROOF WINDOW FRONT SEAL REPLACEMENT - FRONT WINDOW REAR

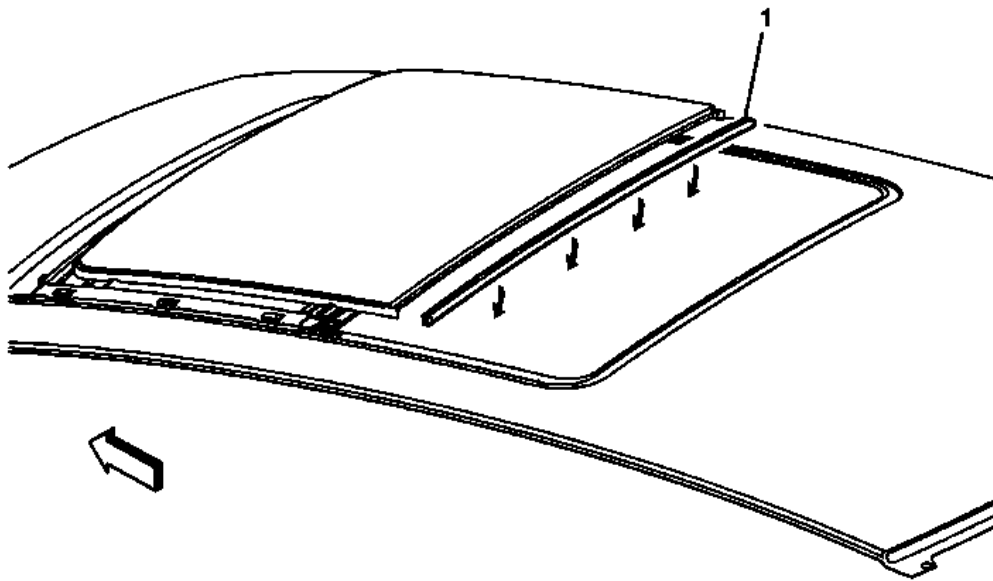


Fig. 24: Sunroof Window Front Seal - Front Window Rear
Courtesy of GENERAL MOTORS COMPANY

Sunroof Window Front Seal Replacement - Front Window Rear

Callout	Component Name
WARNING: Refer to <u>Glass and Sheet Metal Handling Warning</u> .	
Preliminary Procedures Remove the sunroof window front. Refer to <u>Sunroof Window Replacement - Front</u> .	
1	<p>Sunroof Window Front Seal Rear</p> <p>Procedures</p> <ol style="list-style-type: none">1. Before removing the sunroof window, apply a double layer of masking tape around the perimeter of the painted surfaces.2. Remove the sunroof window weatherstrip by grasping the edge, pull downward to release it from the retainer.3. Clean around the inside surface of the window weatherstrip retainer with a 50/50 mixture of isopropyl alcohol and water by volume on a dampened lint free cloth.

4. Position the sunroof window front seal rear in the center of the window retainer working outward the entire length.
5. Ensure the window height. Refer to **Sunroof Window Height and Opening Fit Adjustment**.
6. Inspect sunroof for proper operation and water test to ensure no leaks.

SUNROOF SUNSHADE SWITCH REPLACEMENT

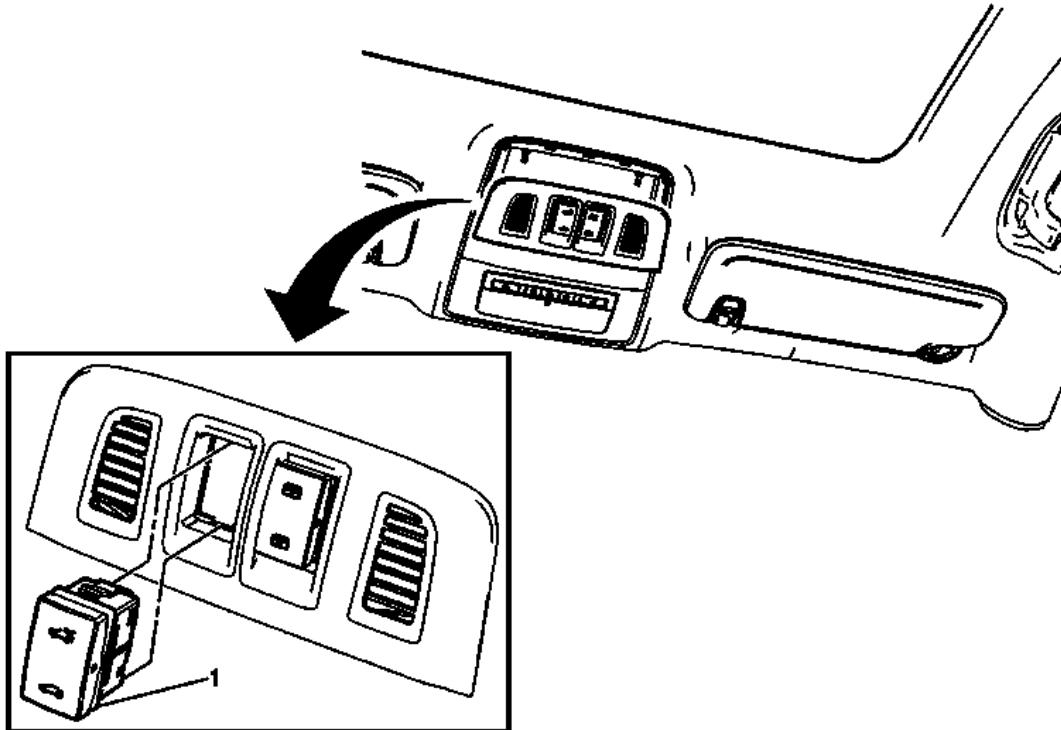


Fig. 25: Sunroof Sunshade Switch
Courtesy of GENERAL MOTORS COMPANY

Sunroof Sunshade Switch Replacement

Callout	Component Name
Preliminary Procedure	
Remove the sunroof actuator trim cover. Refer to <u>Sunroof Actuator Trim Plate Replacement</u> .	
1	Sunroof Sunshade Switch Procedure Unsnap the switch from the trim cover.

SUNROOF SWITCH REPLACEMENT

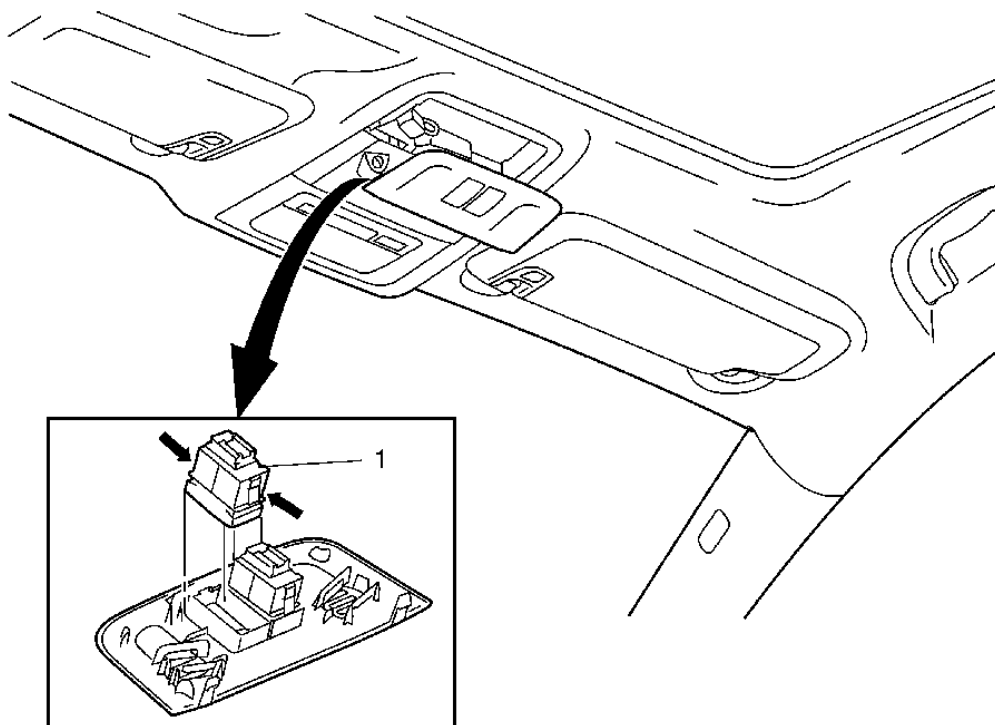


Fig. 26: Sunroof Switch

Courtesy of GENERAL MOTORS COMPANY

Sunroof Switch Replacement

Callout	Component Name
Preliminary Procedure	
Remove the sunroof actuator trim cover. Refer to <u>Sunroof Actuator Trim Plate Replacement</u> .	
1	Sunroof Switch Procedure Unsnap the switch from the console.

SUNROOF WINDOW HEIGHT AND OPENING FIT ADJUSTMENT

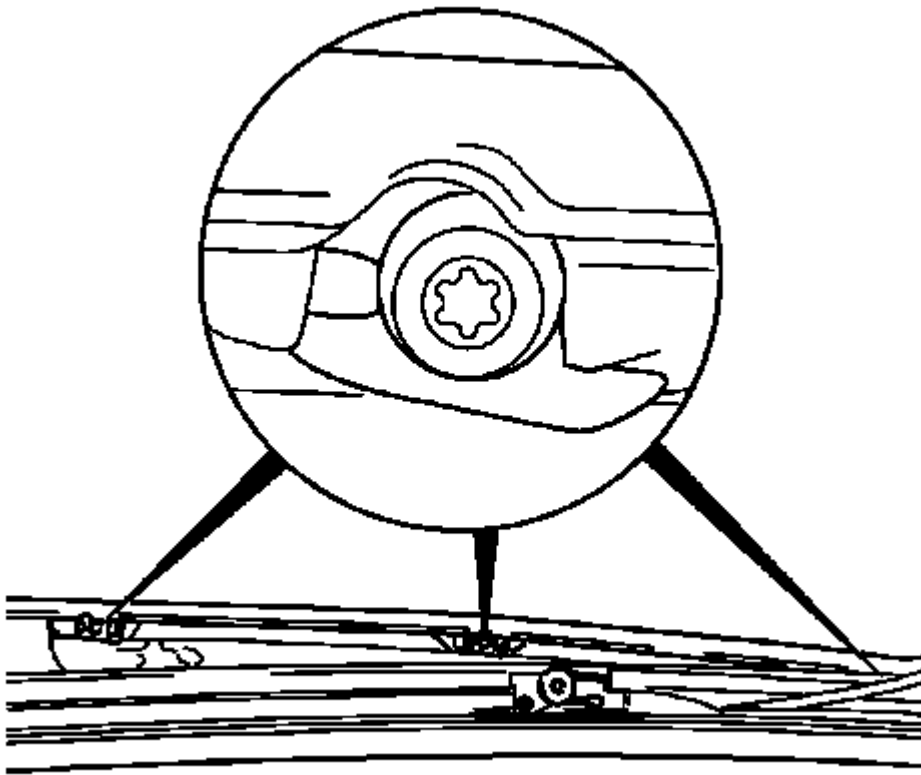


Fig. 27: View Of Front Window Screws
Courtesy of GENERAL MOTORS COMPANY

1. Open the front sunroof window to the vent position.
2. Remove the front sunroof side cover to expose the screws. If equipped.
3. Loosen the front sunroof window rear fasteners, left and right side.
4. Open the front sunroof to the half open position.
5. Loosen the front and middle sunroof window fasteners, left and right side.
6. Close the front sunroof.

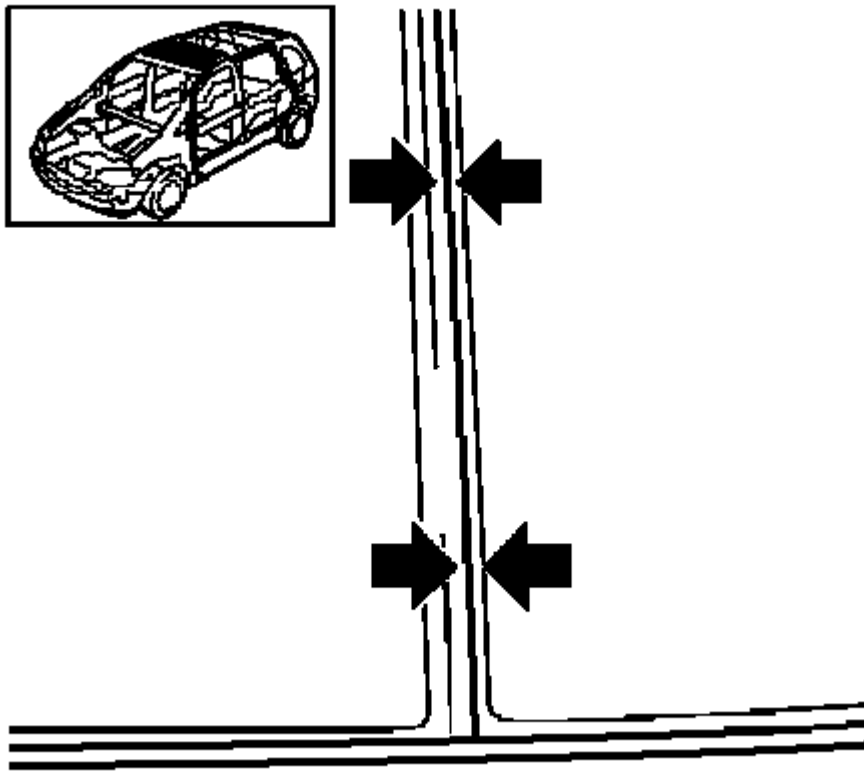


Fig. 28: Window Gap

Courtesy of GENERAL MOTORS COMPANY

NOTE: Tighten the sunroof window in the upper position.

7. Adjust the window to the following specs, gap 11.0 + or -0.3 mm (0.43 in) between the front rear and rear front edges.

CAUTION: Refer to Fastener Caution .

8. Tighten the front sunroof window rear fasteners to 4 (35 lb in).
9. Open the front sunroof window until the rear part is in the vent position.
10. Tighten the front and middle sunroof window fasteners to 4 (35 lb in).
11. Install the front sunroof side covers, if removed.
12. Close the front sunroof.

SUNROOF WINDOW REPLACEMENT - FRONT

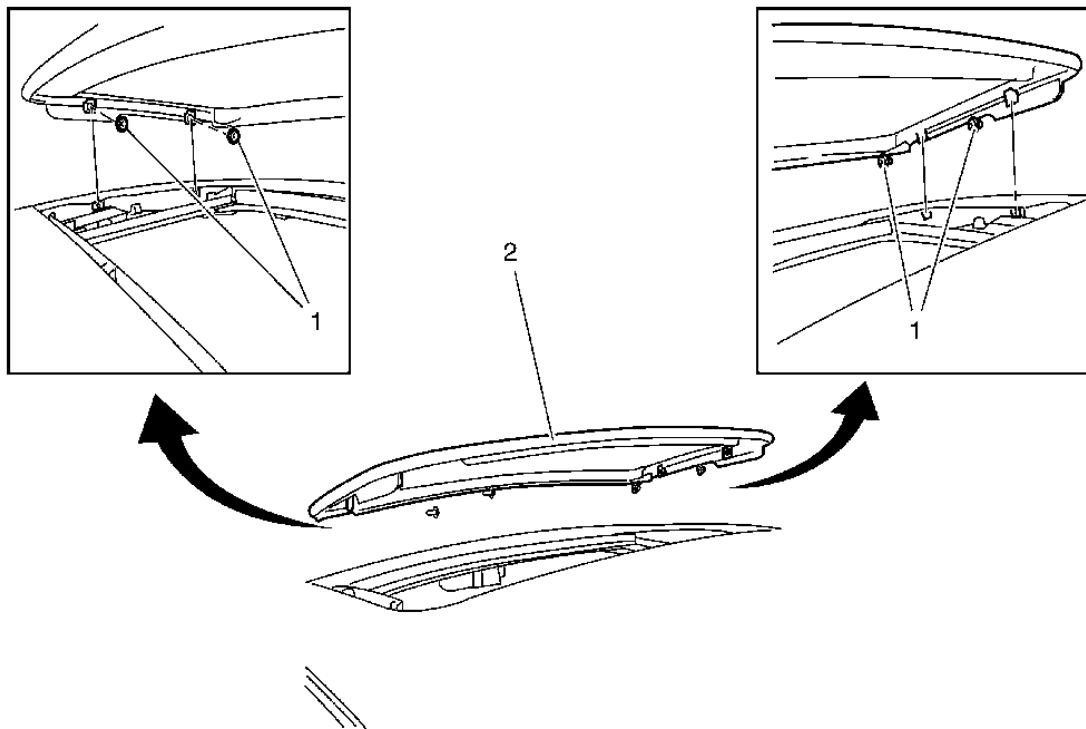


Fig. 29: Sunroof Window - Front
 Courtesy of GENERAL MOTORS COMPANY

Sunroof Window Replacement - Front

Callout	Component Name
Preliminary Procedure Remove sunroof air deflector cover. Refer to <u>Sunroof Air Deflector Cover Replacement</u> .	
1	Sunroof Window Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> Procedure <ol style="list-style-type: none"> 1. Turn the ignition on. 2. Lift up the sunroof window to the vent position. 3. Slide the sunshade to the full rearward position. Tighten 4 N.m (35 lb in)
2	Sunroof Window Procedure After the installation adjust the sunroof window. Refer to <u>Sunroof Window Height and</u>

SUNROOF WINDOW REPLACEMENT - REAR

Removal Procedure

1. Open the sunshade.
2. Place the sunroof window in the vent position.

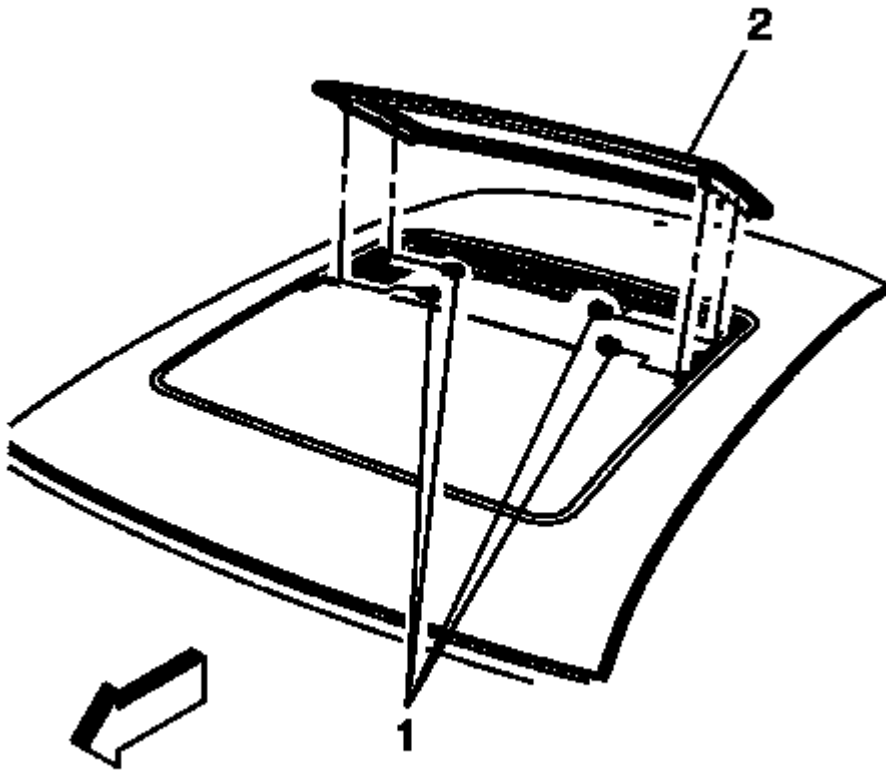


Fig. 30: Sunroof Window And Screws - Rear
Courtesy of GENERAL MOTORS COMPANY

3. Remove the rear window (2).
 1. Push down on the inner seal/weatherstrip to access the screws.
 2. Remove the 4 screws (1).
4. Remove the rear window from the vehicle.

Installation Procedure

1. Align the side window brackets with the holes on left and right side of the frame.

CAUTION: Refer to Fastener Caution .

2. Install the rear sunroof window screws (1), two on left and right side, tighten to 4 N.m (35 lb in).

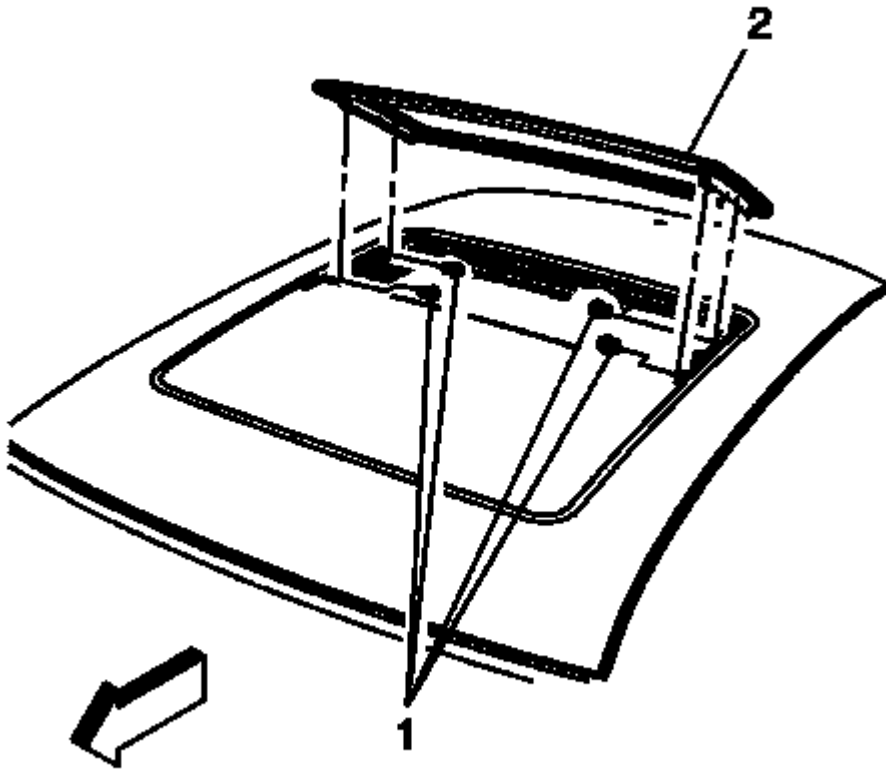


Fig. 31: Sunroof Window And Screws - Rear
Courtesy of GENERAL MOTORS COMPANY

3. Close the sunroof.

Inspect the gap between the window and roof. Refer to Sunroof Window Height and Opening Fit Adjustment.

4. Close the sunroof.
5. Inspect sunroof for proper operation and water test to ensure no leaks.

DESCRIPTION AND OPERATION

SUNROOF DESCRIPTION AND OPERATION (TILT AND SLIDE SYSTEM)

The tilt/slide sunroof consists of a moving glass panel and a manual sunshade. In the tilt/slide sunroof system the rear of the glass tilts up for venting and slides between the head liner and roof panel as it slides open. The glass is controlled by an integrated motor/controller. The sunshade has a mechanical connection to the glass causing it to open with the glass and keeping it from closing more than the glass.

The electrical portion of the tilt/slide sunroof system consists of:

- Body control module (BCM)
- Sunroof glass motor module
- Sunroof control switch assembly
- Tilt control switch assembly
- Local interconnected network (LIN-Bus)

The sunroof electrical system uses a master/slave configuration utilizing a LIN-Bus based system for communication. The BCM is designated as the master, while the sunroof motor module is configured as the slave.

As the system master, the BCM uses the LIN-Bus communication bus to enable or disable sunroof operation, communicate vehicle information to the sunroof motor, and request sunroof movement. The sunroof motor provides system status and diagnostic information to the BCM for diagnostic reporting and operational purposes.

The sunroof glass is controlled by a integrated motor/controller containing the necessary electronics, motor, hall effect position sensors, as well as the interface to the driver control switches. The motor/controller is capable of controlling motion based on control switch activation and LIN-Bus message commands from the system master.

The operational calibrations for the sunroof integrated motor/controller are loaded over the LIN-Bus communication bus by the sunroof system master, the BCM.

Sunroof Glass and Sunshade Control Switches

The sunroof control switches are connected directly to the controller. The sliding glass switches provide detent positions for open, express open, off, close, and express close. The tilt switches provide detent positions for open, off, and close. The control switch completes the circuit between two signals provided by the sunroof motor module, a reference ground input and a pull-up voltage provided by an analog to digital switch input. The control switches place a different resistor ladder network in the circuit depending on the function selected. The controller's analog to digital switch input reads the resulting voltage range and determines the function as indicated in the included charts.

System Protection Functions

Normal operation of the sunroof system may be altered by one of the following events.

Obstacle or Blockage Detection

When enabled, obstacle detection is active only while the sunroof opening is approximately 4-200 mm (0.16-7.87 in) when moving in the closing direction. When an obstacle is detected in this range, the motion in the

closing direction will stop and the sunroof will reverse direction for a short distance. The reversal shall complete regardless of operating Mode. If the travel is outside the range defined above, the sunroof will try to continue closing until it detects a motor stall condition or the system is at one of its defined stops.

Motor Stall

If the sunroof is moving in the open or close direction and stops moving for 350 ms while the switch or LIN-Bus command is active, and no obstacle has been detected, the motor shall be turned off to prevent overheating.

Sunroof System Thermal Protection

The sunroof controllers have a thermal protection algorithm to protect the sunroof controller and motor from damage due to overheating conditions resulting from immoderately switch actuations. The thermal protection algorithm will cause any new sunroof open commands to be ignored until the motor is allowed to cool. A number of close requests during an over temperature condition will be allowed. If the thermal protection is triggered during an obstacle detection event, the sunroof reversal shall be finished.

Sunroof Operation

Open to Vent Position

When the sunroof is closed or in a partial vent position and the sunroof tilt open switch becomes active, the sunroof shall begin to express open to the vent position. Sunroof motion shall cease when the sunroof reaches the vent position or if the sunroof sliding glass switch becomes active.

Close from Vent

When the sunroof is in the vent position and the sunroof tilt switch enters the Close state, the sunroof will begin to express close the sunroof. Motion will continue until the sunroof has reached its fully closed position or if the sunroof sliding glass switch becomes active.

Normal Open (Non-Express)

When the sunroof is not in a vent position and the sunroof sliding glass switch is held in the Open position, the sunroof will begin opening. Motion will continue until the switch returns to the Off state or the tilt switch transitions to any active state.

Sunroof Express Open

When the sunroof control switch transitions to the Express Open state and the sunroof is not in a vent position, the sunroof will express open until the controller determines the sunroof has reached the comfort stop position or the fully Open position, the switch transitions to another state after first returning to the Off position, or the tilt switch transitions to an active state.

Normal Close (Non-Express)

When the sunroof switch is in the Close state and the sunroof is not in the vent position, the controller will begin moving the sunroof in the close direction. If the tilt switch becomes active the motor will be turned off.

Sunroof Express Close

When the sunroof switch is in the Express Close state and the sunroof is not in a vent position, the sunroof will express close until the controller determines the sunroof has reached the fully closed position, or the switch transitions to another state after first returning to the Off position. The sunroof motion will cease if the switch transitions back to the Close or Express Close state after returning to the Off position first or the vent switch transitions to any active state.

RESTRAINTS

Supplemental Inflatable Restraints

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

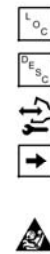
Fastener Tightening Specifications

Application	Specification	
	Metric	English
Driver or Passenger Seat Belt Tensioner Fastener	45	33 lb ft
Instrument Panel Inflatable Restraint Module Fastener	5	44 lb in
Instrument Panel Tie Bar Brace Fastener	22	16 lb ft
Inflatable Restraint Control Module Fastener	10	89 lb in
Seat Side Inflatable Restraint Module Screws	3.25	29 lb in
Steering Wheel Airbag Coil Bolt	3	27 lb in

SCHEMATIC WIRING DIAGRAMS

SIR WIRING SCHEMATICS

Power, Ground, Serial Data, Indicators, Passenger Presence, and Subsystem References



Front Impact Sensors, Air Bags, and Pretensioners

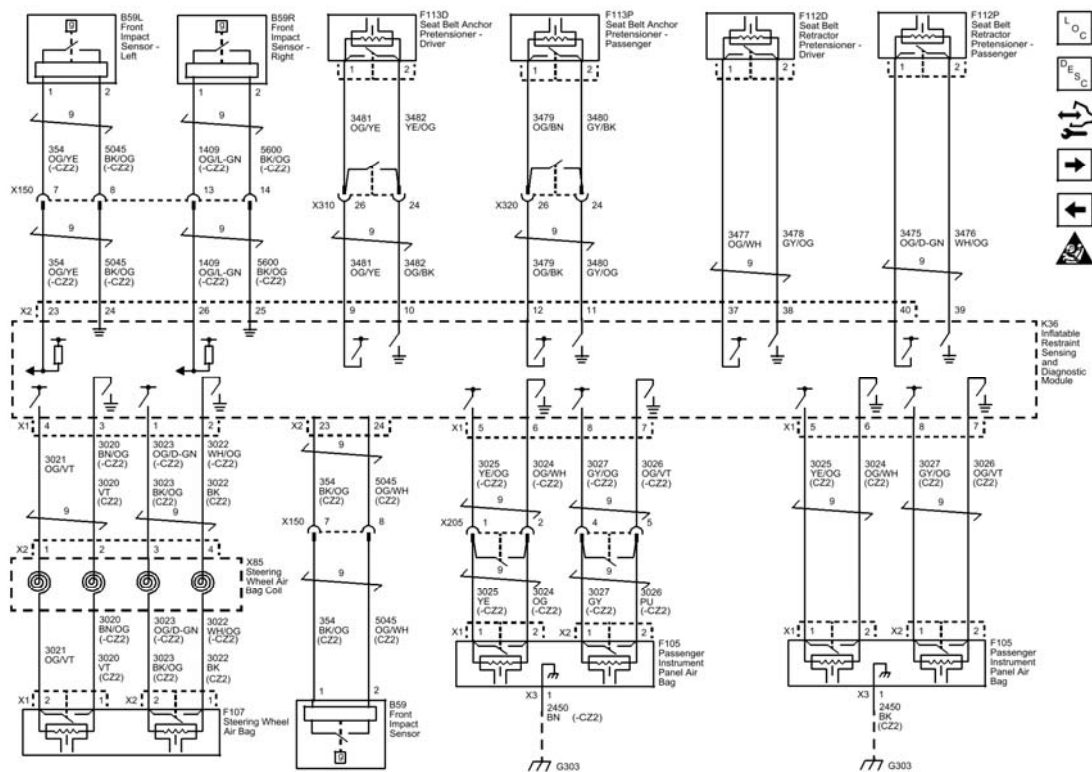


Fig. 2: Front Impact Sensors, Air Bags, and Pretensioners
Courtesy of GENERAL MOTORS COMPANY

Side Impact Sensors, Seat and Roof Rail Air Bags

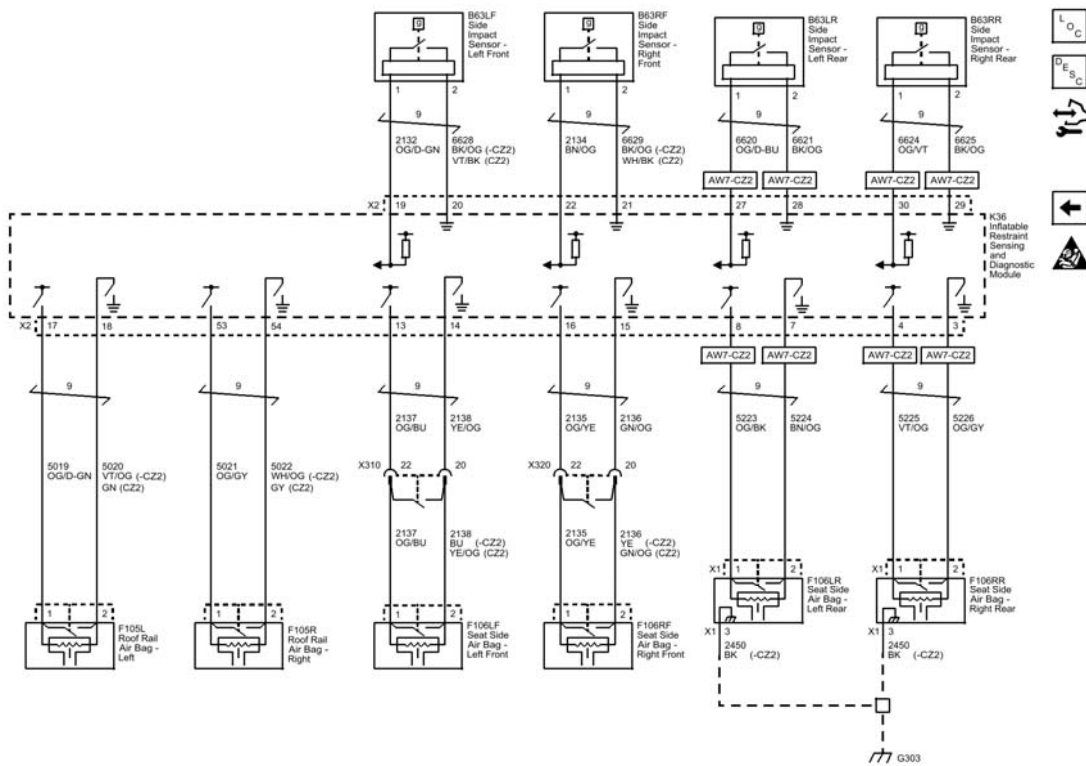


Fig. 3: Side Impact Sensors, Seat and Roof Rail Air Bags
 Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

SIR IDENTIFICATION VIEWS

The SIR Identification Views shown below illustrate the approximate location of all SIR components available for the vehicle. This will assist in determining the appropriate SIR Disabling and Enabling for a given service procedure, refer to **SIR Disabling and Enabling**.

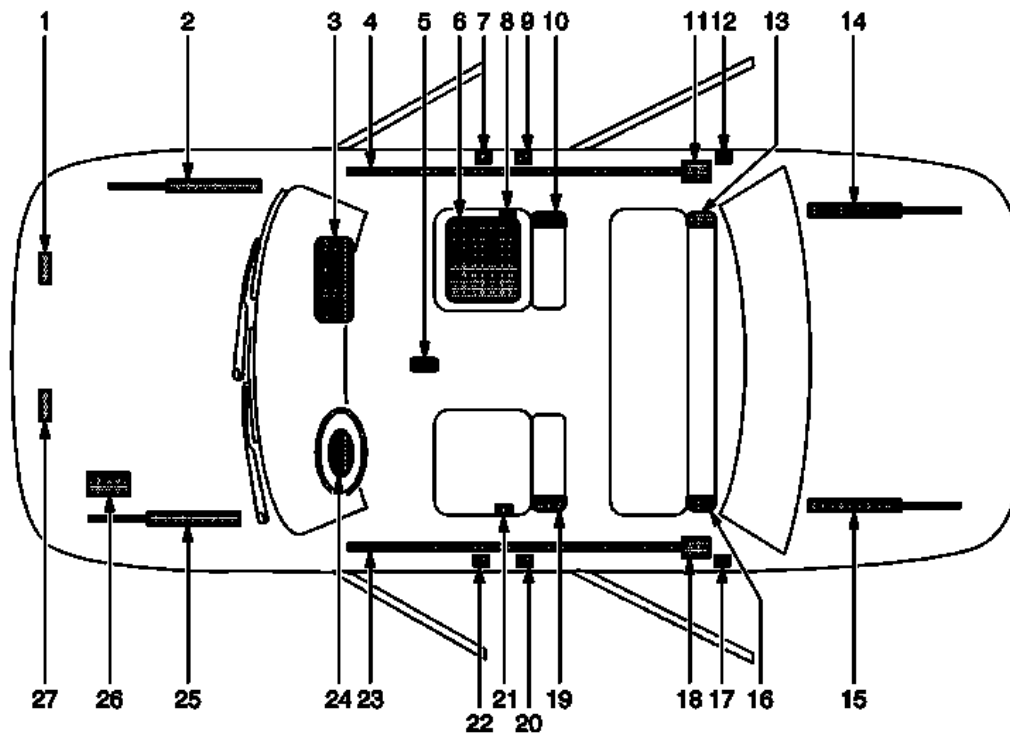


Fig. 4: Locating SIR Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Right Front Impact Sensor-Located under the hood at the front right side of the vehicle
2	Front Hood Assist Rod-A gas shock located under the front hood on the passenger side
3	Passenger Instrument Panel Air Bag-Located at the top right under the instrument panel
4	Right Roof Rail Air Bag-Located under the headliner, extending from the passenger front windshield pillar to the passenger rear windshield pillar
5	Inflatable Restraint Sensing and Diagnostic Module (SDM)-Located underneath the center console
6	Passenger Presence System-Located on the passenger front seat underneath the seat bottom trim
7	Right Front Side Impact Sensor-Located at the B-pillar underneath the door sill
8	Passenger Seat Belt Anchor Pretensioner-Located on the outboard side of the passenger seat
9	Passenger Seat Belt Retractor Pretensioner-Located under the trim near the bottom of the center pillar on the passenger side of vehicle
10	Passenger Seat Side Air Bag-Located on the seat back of the passenger seat
11	Inflator Module for Right Roof Rail Air Bag-Located behind the headliner above the C-pillar

12	Right Rear Side Impact Sensor-Located at the C-pillar underneath the door sill
13	Right Rear Seat Side Air Bag-Located on the seat back bolster of the rear passenger seat (not on the folding part of the seat)
14	Rear Hood Assist Rod-A gas shock located under the rear truck lid on the passenger side
15	Rear Hood Assist Rod-A gas shock located under the rear truck lid on the driver side
16	Left Rear Seat Side Air Bag-Located on the seat back of the rear passenger seat (not on the folding part of the seat)
17	Left Rear Side Impact Sensor-Located at the C-pillar underneath the door sill
18	Inflator Module for Left Roof Rail Air Bag-Located behind the headliner above the C-pillar
19	Driver Seat Side Air Bag-Located on the seat back of the driver seat
20	Driver Seat Belt Retractor Pretensioner-Located under the trim near the bottom of the center pillar on the driver side of vehicle
21	Driver Seat Belt Anchor Pretensioner-Located on the outboard side of the driver seat
22	Left Front Side Impact Sensor-Located at the B-pillar underneath the door sill
23	Leftt Roof Rail Air Bag-Located under the headliner, extending from the driver front windshield pillar to the driver rear windshield pillar
24	Driver Steering Wheel Air Bag-Located on the steering wheel
25	Front Hood Assist Rod-A gas shock located under the front hood on the driver side
26	Vehicle Battery-Located under the hood on the left side
27	Left Front Impact Sensor-Located under the hood at the front left side of the vehicle

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B0012 or B0013</u>	DTC B0012 Driver Steering Wheel Air Bag Deployment Loop Stage 1 DTC B0013 Driver Steering Wheel Air Bag Deployment Loop Stage 2
<u>DTC B0014, B0021, B0031, or B0038</u>	DTC B0014 01 Driver Seat Side Air Bag Deployment Loop Short to Battery DTC B0014 02 Driver Seat Side Air Bag Deployment Loop Short to Ground DTC B0014 04 Driver Seat Side Air Bag Deployment Loop Open DTC B0014 0D Driver Seat Side Air Bag Deployment Loop High Resistance DTC B0014 0E Driver Seat Side Air Bag Deployment Loop Low Resistance DTC B0021 01 Passenger Seat Side Air Bag Deployment Loop Short to Battery

	<p>DTC B0021 02 Passenger Seat Side Air Bag Deployment Loop Short to Ground</p> <p>DTC B0021 04 Passenger Seat Side Air Bag Deployment Loop Open</p> <p>DTC B0021 0D Passenger Seat Side Air Bag Deployment Loop High Resistance</p> <p>DTC B0021 0E Passenger Seat Side Air Bag Deployment Loop Low Resistance</p> <p>DTC B0031 01 Left Rear Seat Side Air Bag Deployment Loop Short to Battery</p> <p>DTC B0031 02 Left Rear Seat Side Air Bag Deployment Loop Short to Ground</p> <p>DTC B0031 04 Left Rear Seat Side Air Bag Deployment Loop Open</p> <p>DTC B0031 0D Left Rear Seat Side Air Bag Deployment Loop High Resistance</p> <p>DTC B0031 0E Left Rear Seat Side Air Bag Deployment Loop Low Resistance</p> <p>DTC B0038 01 Right Rear Seat Side Air Bag Deployment Loop Short to Battery</p> <p>DTC B0038 02 Right Rear Seat Side Air Bag Deployment Loop Short to Ground</p> <p>DTC B0038 04 Right Rear Seat Side Air Bag Deployment Loop Open</p> <p>DTC B0038 0D Right Rear Seat Side Air Bag Deployment Loop High Resistance</p> <p>DTC B0038 0E Right Rear Seat Side Air Bag Deployment Loop Low Resistance</p>
<u>DTC B0015, B001A, B001B, or B0022</u>	<p>DTC B0015 01 Driver Seat Belt Retractor Pretensioner Deployment Loop Short to Battery</p> <p>DTC B0015 02 Driver Seat Belt Retractor Pretensioner Deployment Loop Short to Ground</p> <p>DTC B0015 04 Driver Seat Belt Retractor Pretensioner Deployment Loop Open</p> <p>DTC B0015 0D Driver Seat Belt Retractor Pretensioner Deployment Loop High Resistance</p> <p>DTC B0015 0E Driver Seat Belt Retractor Pretensioner Deployment Loop Low Resistance</p> <p>DTC B001A 01 Driver Seat Belt Anchor Pretensioner Deployment Loop Short to Battery</p> <p>DTC B001A 02 Driver Seat Belt Anchor Pretensioner Deployment Loop Short to Ground</p> <p>DTC B001A 04 Driver Seat Belt Anchor Pretensioner Deployment Loop Open</p> <p>DTC B001A 0D Driver Seat Belt Anchor Pretensioner Deployment Loop High Resistance</p> <p>DTC B001A 0E Driver Seat Belt Anchor Pretensioner Deployment Loop Low Resistance</p> <p>DTC B001B 01 Passenger Seat Belt Anchor Pretensioner Deployment Loop Short to Battery</p> <p>DTC B001B 02 Passenger Seat Belt Anchor Pretensioner Deployment</p>

	<p>Loop Short to Ground</p> <p>DTC B001B 04 Passenger Seat Belt Anchor Pretensioner Deployment Loop Open</p> <p>DTC B001B 0D Passenger Seat Belt Anchor Pretensioner Deployment Loop High Resistance</p> <p>DTC B001B 0E Passenger Seat Belt Anchor Pretensioner Deployment Loop Low Resistance</p> <p>DTC B0022 01 Passenger Seat Belt Retractor Pretensioner Deployment Loop Short to Battery</p> <p>DTC B0022 02 Passenger Seat Belt Retractor Pretensioner Deployment Loop Short to Ground</p> <p>DTC B0022 04 Passenger Seat Belt Retractor Pretensioner Deployment Loop Open Circuit</p> <p>DTC B0022 0D Passenger Seat Belt Retractor Pretensioner Deployment Loop High Resistance</p> <p>DTC B0022 0E Passenger Seat Belt Retractor Pretensioner Deployment Loop Low Resistance</p>
<u>DTC B0016, B0018, B0023, or B0025</u>	<p>DTC B0016 01 Left Roof Rail Air Bag Deployment Loop Short to Battery</p> <p>DTC B0016 02 Left Roof Rail Air Bag Deployment Loop Short to Ground</p> <p>DTC B0016 04 Left Roof Rail Air Bag Deployment Loop Open</p> <p>DTC B0016 0D Left Roof Rail Air Bag Deployment Loop High Resistance</p> <p>DTC B0016 0E Left Roof Rail Air Bag Deployment Loop Low Resistance</p> <p>DTC B0023 01 Right Roof Rail Air Bag Deployment Loop Short to Battery</p> <p>DTC B0023 02 Right Roof Rail Air Bag Deployment Loop Short to Ground</p> <p>DTC B0023 04 Right Roof Rail Air Bag Deployment Loop Open</p> <p>DTC B0023 0D Right Roof Rail Air Bag Deployment Loop High Resistance</p> <p>DTC B0023 0E Right Roof Rail Air Bag Deployment Loop Low Resistance</p>
<u>DTC B0019 or B0020</u>	<p>DTC B0019 01 Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Short to Battery</p> <p>DTC B0019 02 Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Short to Ground</p> <p>DTC B0019 04 Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Open</p> <p>DTC B0019 0D Passenger Instrument Panel Air Bag Deployment Loop Stage 1 High Resistance</p> <p>DTC B0019 0E Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Low Resistance</p> <p>DTC B0020 01 Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Short to Battery</p> <p>DTC B0020 02 Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Short to Ground</p> <p>DTC B0020 04 Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Open</p> <p>DTC B0020 0D Passenger Instrument Panel Air Bag Deployment Loop Stage 2 High Resistance</p>

	DTC B0020 0E Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Low Resistance
<u>DTC B0052</u>	DTC B0052 00 Deployment Commanded DTC B0052 56 Deployment Commanded Too Many Transitions
<u>DTC B0074</u>	DTC B0074 01 Passenger Presence Sensor Short to Battery DTC B0074 02 Passenger Presence Sensor Short to Ground DTC B0074 08 Passenger Presence Sensor Performance - Signal Invalid DTC B0074 11 Passenger Presence Sensor High Input
<u>DTC B0081 (SDM)</u>	DTC B0081 00 Passenger Presence Module Malfunction DTC B0081 3A Passenger Presence Module Incorrect Component Installed
<u>DTC B0081 (Passenger Presence Module)</u>	DTC B0081 11 Passenger Presence Module High Input DTC B0081 4B Passenger Presence Module Calibration Not Learned
<u>DTC B0083 or B0084</u>	DTC B0083 02 Left Front Impact Sensor Short to Ground DTC B0083 05 Left Front Impact Sensor High Voltage/Open DTC B0083 39 Left Front Impact Sensor Internal Electronic Failure DTC B0083 3A Left Front Impact Sensor Incorrect Component Installed DTC B0083 71 Left Front Impact Sensor Invalid Serial Data Received DTC B0084 02 Right Front Impact Sensor Short to Ground DTC B0084 05 Right Front Impact Sensor High Voltage/Open DTC B0084 39 Right Front Impact Sensor Internal Electronic Failure DTC B0084 3A Right Front Impact Sensor Incorrect Component Installed DTC B0084 71 Right Front Impact Sensor Invalid Serial Data Received
<u>DTC B0085 or B0088</u>	DTC B0085 01 Left Front Side Impact Sensor Short to Voltage DTC B0085 02 Left Front Side Impact Sensor Short to Ground DTC B0085 04 Left Front Side Impact Sensor Open DTC B0085 39 Left Front Side Impact Sensor Internal Malfunction DTC B0085 3A Left Front Side Impact Sensor Incorrect Component Installed DTC B0088 01 Right Rear Side Impact Sensor Short to Voltage DTC B0088 02 Right Rear Side Impact Sensor Short to Ground DTC B0088 04 Right Rear Side Impact Sensor Open DTC B0088 39 Right Rear Side Impact Sensor Internal Malfunction DTC B0088 3A Right Rear Side Impact Sensor Incorrect Component Installed
<u>DTC B0086 or B0087</u>	DTC B0086 01 Right Front Side Impact Sensor Short to Voltage DTC B0086 02 Right Front Side Impact Sensor Short to Ground DTC B0086 04 Right Front Side Impact Sensor Open DTC B0086 39 Right Front Side Impact Sensor Internal Malfunction DTC B0086 3A Right Front Side Impact Sensor Incorrect Component Installed DTC B0087 01 Left Rear Side Impact Sensor Short to Voltage DTC B0087 02 Left Rear Side Impact Sensor Short to Ground DTC B0087 04 Left Rear Side Impact Sensor Open DTC B0087 39 Left Rear Side Impact Sensor Internal Malfunction DTC B0087 3A Left Rear Side Impact Sensor Incorrect Component Installed
<u>DTC B067F or B0680</u>	DTC B067F 01 Passenger Air Bag On Indicator Circuit Short to Battery

	DTC B067F 02 Passenger Air Bag On Indicator Circuit Short to Ground DTC B067F 04 Passenger Air Bag On Indicator Circuit Open DTC B0680 01 Passenger Air Bag Off Indicator Circuit Short to Battery DTC B0680 02 Passenger Air Bag Off Indicator Circuit Short to Ground DTC B0680 04 Passenger Air Bag Off Indicator Circuit Open
<u>DTC B1001 (Inflatable Restraint Sensing and Diagnostic Module)</u>	DTC B1001 00 Option Configuration
<u>DTC B1001 (Passenger Presence System)</u>	DTC B1001 00 Option Configuration Error
<u>DTC B1019</u>	DTC B1019 00 System Configuration Error

DTC B0012 OR B0013: DRIVER STEERING WHEEL AIR BAG DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

DTC Descriptors

DTC B0012

Driver Steering Wheel Air Bag Deployment Loop Stage 1

DTC B0013

Driver Steering Wheel Air Bag Deployment Loop Stage 2

For symptom byte information refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Steering Wheel Air Bag Stage 1 High Control	B0012 02, B0012 0E	B0012 0D	B0012 04, B0012 0D	B0012 01	-
Steering Wheel Air Bag Stage 1 Low Control	B0012 02, B0012 0E	B0012 0D	B0012 04, B0012 0D	B0012 01	-
Steering Wheel Air Bag Stage 2 High Control	B0013 02, B0013 0E	B0013 0D	B0013 04, B0013 0D	B0013 01	-
Steering Wheel Air Bag Stage 2 Low Control	B0013 02, B0013 0E	B0013 0D	B0013 04, B0013 0D	B0013 01	-

Circuit/System Description

During a frontal crash of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the steering wheel air bag. The SDM performs continuous diagnostic tests on the deployment loops to check for proper circuit continuity and for shorts to ground or voltage. There are 2 shorting bars used within the steering wheel air bag coil connector which will short together both steering wheel air bag stage 1 high control circuit and steering wheel air bag stage 1 low control circuit and both steering wheel air bag stage 2 high control circuit and steering wheel air bag stage 2 low control circuit when the connector is disconnected. This will help to prevent unwanted deployment of the steering wheel air bag during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0012 01 stage 1 or B0013 01 stage 2

The steering wheel air bag deployment loop is shorted to voltage for 2 s.

B0012 02 stage 1 or B0013 02 stage 2

The steering wheel air bag deployment loop is shorted to ground for 2 s.

B0012 04 stage 1 or B0013 04 stage 2

The steering wheel air bag deployment loop is open for 2 s.

B0012 0D stage 1 or B0013 0D stage 2

The steering wheel air bag deployment loop resistance is greater than 4.4 ohms for 2 s.

B0012 0E stage 1 or B0013 0E stage 2

The steering wheel air bag deployment loop resistance is less than 1.7 ohms for 2 s.

Action Taken When the DTC Sets

- The inflatable restraint sensing and diagnostic module requests the instrument cluster to illuminate the AIR BAG indicator.
- The inflatable restraint sensing and diagnostic module will store a DTC, however if an event occurs the system will still attempt deployment.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: The following diagnostic aids apply for both current and history DTCs.

A worn steering wheel air bag coil can cause a repeated history DTC to set. To verify this condition, turn the steering wheel 360 degrees in one direction then back 360 degrees in the other direction, multiple times, while viewing the scan tool Deployment Loop Resistance parameters.

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Steering wheel air bag assembly
- Steering wheel air bag coil assembly
- Inline harness connectors
- Harness side of the inflatable restraint sensing and diagnostic module connector

Terminal fretting or incorrectly seated connector can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Verification

NOTE:

- Refer to **SIR Service Precautions**.
- Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.
 - Steering wheel air bag
 - Steering wheel air bag coil
 - Inflatable restraint sensing and diagnostic module
 - Air bag wiring harness connector
 - Inflatable restraint sensing and diagnostic module wiring harness connector
- The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly. Replace any CPA that is damaged or missing.
- If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.

1. Verify the appropriate scan tool Deployment Loop Resistance parameters stay consistently between 2.1-4.0 ohms without any spikes or dropouts while turning the steering wheel 360 degrees in one direction then back 360 degrees in the other direction.

- If less than 2.1 ohms or greater than 4.0 ohms

Refer to Circuit/System Testing.

- If there are spikes or dropouts

Replace the X85 Steering Wheel Air Bag Coil.

- If between 2.1-4.0 ohms without any spikes or dropouts

2. Verify DTC B0012 or B0013 is only set as a history DTC.

- If the DTC is set as current

Refer to Circuit/System Testing.

- If the DTC is set as history

3. Verify the scan tool Deployment Loop Resistance parameters stay consistently between 2.1-4.0 ohms without any drop outs or spikes while moving the harness near each connector listed below.
 - X85 Steering Wheel Air Bag Coil
 - F107 Steering Wheel Air Bag
 - Any inline harness connector
 - K36 Inflatable Restraint Sensing and Diagnostic Module
 - **If the reading is erratic while moving the harness, perform the following**
 - Inspect each connector terminal for damage or corrosion and repair as necessary.
 - Apply dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to each connector terminal.
 - Ensure each connector and CPA is correctly seated.
 - **If between 2.1-4.0 ohms without any spikes or dropouts**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the scan tool and disconnect the appropriate harness connector listed below at the F107 Steering Wheel Air Bag.
 - DTC B0012 connector X1
 - DTC B0013 connector X2
2. Test for greater than 25 ohms between the control circuit terminal 1 and the control circuit terminal 2 at the harness connector.
 - **If 25 ohms or less**
 - 1. Disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.

NOTE: Some connectors may be equipped with shorting bars as a safety component to prevent accidental deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.

2. Test for infinite resistance between the two control circuits.
 - If less than infinite resistance, repair the short between the two circuits.
 - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If greater than 25 ohms**
3. Ignition ON.
4. Test for less than 11 V between each control circuit terminal listed below and ground:
 - Control circuit terminal 1

- Control circuit terminal 2
- **If 11 V or greater**
- 1. Ignition OFF, disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module, ignition ON.
- 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
- **If less than 11 V**
- 5. Ignition OFF.
- 6. Test for greater than 25 ohms between each control circuit terminal listed below and ground:
 - Control circuit terminal 1
 - Control circuit terminal 2
 - **If 25 ohms or less**
 - 1. Disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.

NOTE: Some connectors may be equipped with shorting bars as a safety component to prevent accidental deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.

- 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If greater than 25 ohms**
- 7. Install a 3 A fused jumper wire between the control circuit terminal 1 and the control circuit terminal 2, ignition ON.
- 8. Verify the appropriate scan tool Deployment Loop Resistance parameter is consistently less than 2 ohms while turning the steering wheel 360 degrees in one direction then back 360 degrees in the other direction.
 - **If the reading is erratic while turning the steering wheel**

Replace the X85 Steering Wheel Air Bag Coil.

- **If 2 ohms or greater**
- 1. Ignition OFF, disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
- 2. Test for less than 2 ohms in the X85 Steering Wheel Air Bag Coil and each control circuit end to end.

- If 2 ohms or greater, replace the X85 Steering Wheel Air Bag Coil or repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 2 ohms**
9. Ignition OFF, connect the harness connector at the F107 Steering Wheel Air Bag, press in the CPA (if equipped) until an audible and/or tactile click is heard.
 10. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
 11. Verify DTC B0012 or B0013 is not set.
 - **If DTC B0012 or B0013 is set**

Replace the F107 Steering Wheel Air Bag.

 - **If DTC B0012 or B0013 is not set**
 12. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Steering Wheel Airbag Coil Replacement**
- **Airbag Steering Wheel Module Replacement**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for inflatable restraint sensing and diagnostic module replacement, programming and setup

DTC B0014, B0021, B0031, OR B0038: SEAT SIDE AIR BAG DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0014 01

Driver Seat Side Air Bag Deployment Loop Short to Battery

DTC B0014 02

Driver Seat Side Air Bag Deployment Loop Short to Ground

DTC B0014 04

Driver Seat Side Air Bag Deployment Loop Open

DTC B0014 0D

Driver Seat Side Air Bag Deployment Loop High Resistance

DTC B0014 0E

Driver Seat Side Air Bag Deployment Loop Low Resistance

DTC B0021 01

Passenger Seat Side Air Bag Deployment Loop Short to Battery

DTC B0021 02

Passenger Seat Side Air Bag Deployment Loop Short to Ground

DTC B0021 04

Passenger Seat Side Air Bag Deployment Loop Open

DTC B0021 0D

Passenger Seat Side Air Bag Deployment Loop High Resistance

DTC B0021 0E

Passenger Seat Side Air Bag Deployment Loop Low Resistance

DTC B0031 01

Left Rear Seat Side Air Bag Deployment Loop Short to Battery

DTC B0031 02

Left Rear Seat Side Air Bag Deployment Loop Short to Ground

DTC B0031 04

Left Rear Seat Side Air Bag Deployment Loop Open

DTC B0031 0D

Left Rear Seat Side Air Bag Deployment Loop High Resistance

DTC B0031 0E

Left Rear Seat Side Air Bag Deployment Loop Low Resistance

DTC B0038 01

Right Rear Seat Side Air Bag Deployment Loop Short to Battery

DTC B0038 02

Right Rear Seat Side Air Bag Deployment Loop Short to Ground

DTC B0038 04

Right Rear Seat Side Air Bag Deployment Loop Open

DTC B0038 0D

Right Rear Seat Side Air Bag Deployment Loop High Resistance

DTC B0038 0E

Right Rear Seat Side Air Bag Deployment Loop Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Left Front Seat Side Air Bag High Control	B0014 02, B0014 0E	B0014 0D	B0014 04, B0014 0D	B0014 01	-
Left Front Seat Side Air Bag Low Control	B0014 02, B0014 0E	B0014 0D	B0014 04, B0014 0D	B0014 01	-
Right Front Seat Side Air Bag High Control	B0021 02, B0021 0E	B0021 0D	B0021 04, B0021 0D	B0021 01	-
Right Front Seat Side Air Bag Low Control	B0021 02, B0021 0E	B0021 0D	B0021 04, B0021 0D	B0021 01	-
Left Rear Seat Side Air Bag High Control	B0031 02, B0031 0E	B0031 0D	B0031 04, B0031 0D	B0031 01	-
Left Rear Seat Side Air Bag Low Control	B0031 02, B0031 0E	B0031 0D	B0031 04, B0031 0D	B0031 01	-
Right Rear Seat Side Air Bag High Control	B0038 02, B0038 0E	B0038 0D	B0038 04, B0038 0D	B0038 01	-
Right Rear Seat Side Air Bag Low Control	B0038 02, B0038 0E	B0038 0D	B0038 04, B0038 0D	B0038 01	-

Circuit/System Description

During a side or frontal crash of sufficient force, the inflatable restraint sensing and diagnostic module (SDM)

will allow current to flow through the deployment loop in order to deploy an air bag. There are 2 shorting bars used within the connector that will short the control circuits together when the connector is disconnected. This will help to prevent unwanted deployment of the air bag or retractor pretensioner during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0014 01, B0021 01, B0031 01, B0038 01

The air bag control circuit is shorted to voltage for 2 seconds.

B0014 02, B0021 02, B0031 02, B0038 02

The air bag control circuit is shorted to ground for 2 seconds.

B0014 04, B0021 04, B0031 04, B0038 04

The air bag control circuit is open for 2 seconds.

B0014 0D, B0021 0D, B0031 0D, B0038 0D

The air bag deployment loop resistance is greater than 4.2 ohms for 2 seconds.

B0014 0E, B0021 0E, B0031 0E, B0038 0E

The air bag deployment loop resistance is less than 1.4 ohms for 2 seconds.

Action Taken When the DTC Sets

- The inflatable restraint sensing and diagnostic module requests the instrument cluster to illuminate the AIR BAG indicator.
- The inflatable restraint sensing and diagnostic module will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: **The following diagnostic aids apply for both current and history DTCs.**

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a

shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Front and rear seat side air bags
- Left and right roof rail air bags
- Inline harness connectors
- Harness side of the inflatable restraint sensing and diagnostic module connector

Terminal fretting or incorrectly seated connector can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set. DTCs of deployment loops which are in the seat can occur because of stress or damage to the harness due to seat movement. Move the seat to the full extent of travel while using the scan tool to observe deployment type loop parameters.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Verification

NOTE:

- Refer to **SIR Service Precautions.**
- **Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.**
 - **Seat side air bag**
 - **Inflatable restraint sensing and diagnostic module**
 - **All wiring harness connectors**
 - **Inflatable restraint sensing and diagnostic module wiring harness connector**
- **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.**
- **If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease/lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.**

1. Verify the appropriate scan tool Deployment Loop Resistance parameters stay consistently between 2.1-4.0 ohms without any spikes or dropouts while moving the harness near each connector.
 - F106 Seat Side Air Bag
 - Any inline harness connector
 - K36 Inflatable Restraint Sensing and Diagnostic Module
 - **If less than 2.1 ohms or greater than 4.0 ohms**

Refer to Circuit/System Testing.

- **If there are spikes or dropouts, perform the following:**
 - Inspect each connector terminal and harness for damage or corrosion and repair as necessary.
 - Apply dielectric grease/lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to each connector terminal.
 - Ensure each connector and CPA is correctly seated.
 - **If between 2.1-4.0 ohms without any spikes or dropouts**

2. All OK

Circuit/System Testing

1. Ignition OFF, scan tool disconnected, disconnect the harness connector at the appropriate F106 Seat Side Air Bag.
2. Test for greater than 25 ohms between the control circuit terminals 1 and 2.
 - **If 25 ohms or less**
 1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic

Module.

NOTE: Some connectors may be equipped with shorting bars as a safety component to prevent accidental deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.

2. Test for infinite resistance between the 2 control circuits.
 - If less than infinite resistance, repair the short between the 2 circuits.
 - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If greater than 25 ohms**
3. Ignition ON.
4. Test for less than 11 V between each control circuit terminal listed below and ground:
 - Control circuit terminal 1
 - Control circuit terminal 2
 - **If 11 V or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 11 V**
5. Ignition OFF.
6. Test for greater than 25 ohms between each control circuit terminal listed below and ground:
 - Control circuit terminal 1
 - Control circuit terminal 2
 - **If 25 ohms or less**
 1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If greater than 25 ohms**
7. Install a 3 A fused jumper wire between the control circuit terminals 1 and 2, ignition ON.
8. Verify the appropriate scan tool Deployment Loop Resistance parameter is less than 2 ohms.
 - **If 2 ohms or greater**

1. Ignition OFF, disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
2. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 2 ohms**
9. Ignition OFF, connect the harness connector at the F106 Seat Side Air Bag, press in the CPA (if equipped) until an audible and/or tactile click is heard.
10. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
11. Verify DTC B0014, B0021, B0031, or B0038 is not set.
 - **If DTC B0014, B0021, B0031, or B0038 is set**

Test or replace the F106 Seat Side Air Bag.

○ **If DTC B0014, B0021, B0031, or B0038 is not set**
12. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Seat Outboard Seat Back Airbag Replacement**
- **Rear Seat Outboard Seat Back Airbag Replacement**
- **Control Module References** for inflatable restraint sensing and diagnostic module replacement, programming, and setup

DTC B0015, B001A, B001B, OR B0022: SEAT BELT RETRACTOR PRETENSIONER DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0015 01

Driver Seat Belt Retractor Pretensioner Deployment Loop Short to Battery

DTC B0015 02

Driver Seat Belt Retractor Pretensioner Deployment Loop Short to Ground

DTC B0015 04

Driver Seat Belt Retractor Pretensioner Deployment Loop Open

DTC B0015 0D

Driver Seat Belt Retractor Pretensioner Deployment Loop High Resistance

DTC B0015 0E

Driver Seat Belt Retractor Pretensioner Deployment Loop Low Resistance

DTC B001A 01

Driver Seat Belt Anchor Pretensioner Deployment Loop Short to Battery

DTC B001A 02

Driver Seat Belt Anchor Pretensioner Deployment Loop Short to Ground

DTC B001A 04

Driver Seat Belt Anchor Pretensioner Deployment Loop Open

DTC B001A 0D

Driver Seat Belt Anchor Pretensioner Deployment Loop High Resistance

DTC B001A 0E

Driver Seat Belt Anchor Pretensioner Deployment Loop Low Resistance

DTC B001B 01

Passenger Seat Belt Anchor Pretensioner Deployment Loop Short to Battery

DTC B001B 02

Passenger Seat Belt Anchor Pretensioner Deployment Loop Short to Ground

DTC B001B 04

Passenger Seat Belt Anchor Pretensioner Deployment Loop Open

DTC B001B 0D

Passenger Seat Belt Anchor Pretensioner Deployment Loop High Resistance

DTC B001B 0E

Passenger Seat Belt Anchor Pretensioner Deployment Loop Low Resistance

DTC B0022 01

Passenger Seat Belt Retractor Pretensioner Deployment Loop Short to Battery

DTC B0022 02

Passenger Seat Belt Retractor Pretensioner Deployment Loop Short to Ground

DTC B0022 04

Passenger Seat Belt Retractor Pretensioner Deployment Loop Open Circuit

DTC B0022 0D

Passenger Seat Belt Retractor Pretensioner Deployment Loop High Resistance

DTC B0022 0E

Passenger Seat Belt Retractor Pretensioner Deployment Loop Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Driver Seat Belt Retractor Pretensioner High Control	B0015 02, B0015 0E	B0015 0D	B0015 04, B0015 0D	B0015 01	-
Driver Seat Belt Retractor Pretensioner Low Control	B0015 02, B0015 0E	B0015 0D	B0015 04, B0015 0D	B0015 01	-
Driver Seat Belt Anchor Pretensioner Low Control	B001A 02, B001A 0E	B001A 0D	B001A 04	B001A 01	-
Driver Seat Belt Anchor Pretensioner High Control	B001A 02, B001A 0E	B001A 0D	B001A 04	B001A 01	-
Passenger Seat Belt Anchor Pretensioner Low Control	B001B 02, B001B 0E	B001B 0D	B001B 04	B001B 01	-
Passenger Seat Belt Anchor Pretensioner High Control	B001B 02, B001B 0E	B001B 0D	B001B 04	B001B 01	-
Passenger Seat Belt Retractor Pretensioner High Control	B0022 02, B0022 0E	B0022 0D	B0022 04, B0022 0D	B0022 01	-
Passenger Seat Belt Retractor Pretensioner Low Control	B0022 02, B0022 0E	B0022 0D	B0022 04, B0022 0D	B0022 01	-

Circuit/System Description

During a side or frontal crash of sufficient force the Inflatable Restraint Sensing and Diagnostic Module will allow current to flow through the deployment loop in order to deploy an air bag or pretensioner. There are 2 shorting bars which will short together control circuits, when the connector is disconnected. This will help to prevent unwanted deployment of the air bag or pretensioner during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0015 01, B001A 01, B001B 01, B0022 01

The pretensioner control circuit is shorted to voltage for 2 seconds.

B0015 02, B001A 02, B001B 02, B0022 02

The pretensioner control circuit is shorted to ground for 2 seconds.

B0015 04, B001A 04, B001B 04, B0022 04

The pretensioner control circuit is open for 2 seconds.

B0015 0D, B001A 0D, B001B 0D, B0022 0D

The pretensioner deployment loop resistance is greater than 4.2 ohms for 2 seconds.

B0015 0E, B001A 0E, B001B 0E, B0022 0E

The pretensioner deployment loop resistance is less than 1.4 ohms for 2 seconds.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the Instrument Cluster to illuminate the AIR BAG indicator.
- The Inflatable Restraint Sensing and Diagnostic Module will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: **The following diagnostic aids apply for both current and history DTCs.**

An incorrectly installed CPA or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Driver and passenger anchor or retractor pretensioners
- Inline connectors - on the side of the harness connector
- Harness side of the inflatable restraint sensing and diagnostic module connector

Terminal fretting or incorrectly seated connectors can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set. DTCs of deployment loops which are in the seat can occur because of stress or damage to the harness due to seat movement. Move the seat to the full extend of travel while using the scan tool to observe deployment type loop parameters.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Verification

NOTE:

- **Refer to SIR Service Precautions.**
- **Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.**
 - **Seat belt retractor pretensioner**
 - **Seat belt retractor pretensioner wiring harness connector**
 - **Seat belt anchor pretensioner**
 - **Seat belt anchor pretensioner wiring harness connector**
 - **Inflatable Restraint Sensing and Diagnostic Module**
 - **Inflatable Restraint Sensing and Diagnostic Module wiring harness connector**
- **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.**
- **If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.**

1. Verify the scan tool Deployment Loop Resistance parameters stay consistently between 2.1 and 4.0 ohms without any spikes or dropouts while moving the harness near each connector listed below:

- F112 Seat Belt Retractor Pretensioner
- F113 Seat Belt Anchor Pretensioner
- Any inline harness
- K36 Inflatable Restraint Sensing and Diagnostic Module
- **If less than 2.1 or greater than 4.0 ohms**

Refer to Circuit/System Testing.

- **If there are spikes or dropouts, perform the following**
- Inspect each connector terminal and harness for damage or corrosion and repair as necessary.
- Apply dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to each connector terminal.
- Ensure each connector and CPA is correctly seated.
- **If within 2.1 and 4.0 ohms without any spikes or dropouts**

2. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the scan tool. It may take up to 2 minutes for all vehicle systems to power down. Disconnect the appropriate harness connector listed below:
 - F112 Seat Belt Retractor Pretensioner
 - F113 Seat Belt Anchor Pretensioner
2. Test for greater than 25 ohms between the appropriate control circuit terminals listed below:
 - F112 Seat Belt Retractor Pretensioner terminals 1 and 2
 - F113 Seat Belt Anchor Pretensioner terminals 1 and 2
 - **If 25 ohms or less**
1. Disconnect the harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.

NOTE: Some connectors may be equipped with shorting bars as a safety component to prevent accidental inflator deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.

2. Test for infinite resistance between the 2 control circuits.
 - If less than infinite resistance, repair the short between the two circuits.
 - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If greater than 25 ohms**
3. Ignition ON.
4. Test for less than 11 V between the control circuit terminals listed below and ground:
 - F112 Seat Belt Retractor Pretensioner terminal 1
 - F112 Seat Belt Retractor Pretensioner terminal 2
 - F113 Seat Belt Anchor Pretensioner terminal 1
 - F113 Seat Belt Anchor Pretensioner terminal 2
 - **If 11 V or greater**
1. Ignition OFF, disconnect the harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module, ignition ON.
2. Test for less than 1 V between each control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 11 V**
5. Ignition OFF. It may take up to 2 minutes for all vehicle systems to power down.
6. Test for greater than 25 ohms between the control circuit terminals listed below and ground:
 - F112 Seat Belt Retractor Pretensioner terminal 1

- F112 Seat Belt Retractor Pretensioner terminal 2
- F113 Seat Belt Anchor Pretensioner terminal 1
- F113 Seat Belt Anchor Pretensioner terminal 2
- **If 25 ohms or less**
- 1. Disconnect the harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
- 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
- **If greater than 25 ohms**
- 7. Install a 3 A fused jumper wire between the appropriate control circuit terminals listed below:
 - F112 Seat Belt Retractor Pretensioner terminals 1 and 2
 - F113 Seat Belt Anchor Pretensioner terminals 1 and 2
- 8. Ignition ON.
- 9. Verify the scan tool Deployment Loop Resistance parameter is less than 2 ohms.
 - **If 2 ohms or greater**
 - 1. Ignition OFF.
 - 2. Disconnect the harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 2 ohms**
- 10. Ignition OFF, connect the harness connector at the F112 Seat Belt Retractor Pretensioner or F113 Seat Belt Anchor Pretensioner, press in the CPA (if equipped) until an audible and/or tactile click is heard.
- 11. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
- 12. Verify DTC B0015, B001A, B001B, or B0022 is not set.
 - **If B0015, B001A, B001B, or B0022 is set**
 - Replace the appropriate F112 Seat Belt Retractor Pretensioner or F113 Seat Belt Anchor Pretensioner.
 - **If DTC B0015, B001A, B001B, or B0022 is not set**
- 13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Seat Belt Anchor Plate Tensioner Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)**
- **Driver or Passenger Seat Retractor Side Belt Replacement**
- **SIR/SRS Wiring Repairs**

- **Control Module References** for Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0016, B0018, B0023, OR B0025: ROOF RAIL AIR BAG DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0016 01

Left Roof Rail Air Bag Deployment Loop Short to Battery

DTC B0016 02

Left Roof Rail Air Bag Deployment Loop Short to Ground

DTC B0016 04

Left Roof Rail Air Bag Deployment Loop Open

DTC B0016 0D

Left Roof Rail Air Bag Deployment Loop High Resistance

DTC B0016 0E

Left Roof Rail Air Bag Deployment Loop Low Resistance

DTC B0023 01

Right Roof Rail Air Bag Deployment Loop Short to Battery

DTC B0023 02

Right Roof Rail Air Bag Deployment Loop Short to Ground

DTC B0023 04

Right Roof Rail Air Bag Deployment Loop Open

DTC B0023 0D

Right Roof Rail Air Bag Deployment Loop High Resistance

DTC B0023 0E

Right Roof Rail Air Bag Deployment Loop Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Left Roof Rail Air Bag High Control	B0016 02, B0016 0E	B0016 0D	B0016 04, B0016 0D	B0016 01	-
Left Roof Rail Air Bag Low Control	B0016 02, B0016 0E	B0016 0D	B0016 04, B0016 0D	B0016 01	-
Right Roof Rail Air Bag High Control	B0023 02, B0023 0E	B0023 0D	B0023 04, B0023 0D	B0023 01	-
Right Roof Rail Air Bag Low Control	B0023 02, B0023 0E	B0023 0D	B0023 04, B0023 0D	B0023 01	-

Circuit/System Description

During a side or frontal crash of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy an air bag or pretensioner. There are 2 shorting bars which will short together control circuits, when the connector is disconnected. This will help to prevent unwanted deployment of the air bag or pretensioner during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0016 01, B0023 01

The air bag control circuit is shorted to voltage for 2 seconds.

B0016 02, B0023 02

The air bag control circuit is shorted to ground for 2 seconds.

B0016 04, B0023 04

The air bag control circuit is open for 2 seconds.

B0016 0D, B0023 0D

The air bag deployment loop resistance is greater than 4.2 ohms for 2 seconds.

B0016 0E, B0023 0E

The air bag deployment loop resistance is less than 1.4 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument cluster to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: **The following diagnostic aids apply for both current and history DTCs.**

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Passenger instrument panel air bag
- Driver and passenger seat side air bags
- Left and right roof rail air bags
- Driver and passenger retractor pretensioners
- Inline harness connectors
- Harness side of the SDM connector

Terminal fretting or incorrectly seated connectors can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set. DTCs of deployment loops which are in the seat DTC can occur because of stress or damage to the harness due to seat movement. Move the seat to the full extent of travel while using the scan tool to observe deployment type loop parameters.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Verification

NOTE: Refer to **SIR Service Precautions**.

Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- Seat belt retractor pretensioner
- Passenger instrument panel air bag
- Seat side air bag
- Roof rail air bag
- SDM
- Seat belt retractor pretensioner wiring harness connector
- Passenger instrument panel air bag wiring harness connector
- Seat side air bag wiring harness connector
- Roof rail air bag wiring harness connector
- SDM wiring harness connector

NOTE: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.

If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.

1. Verify the appropriate scan tool Deployment Loop Resistance parameters stay consistently between 2.1 and 4.0 ohms without any spikes or dropouts while moving the harness near each connector listed below:
 - F105L Roof rail air bag - left
 - F105R Roof rail air bag - right
 - Any inline harness connector
 - K36 SDM
 - **If less than 2.1 or greater than 4.0 ohms**

Refer to Circuit/System Testing.

- **If there are spikes or dropouts, perform the following**
 - Inspect each connector terminal and harness for damage or corrosion and repair as necessary
 - Apply dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to each connector terminal
 - Insure each connector and CPA is correctly seated.
 - **If within 2.1 and 4.0 ohms without any spikes or dropouts**
2. All OK

Circuit/System Testing

1. Ignition OFF. Scan tool disconnected. It may take up to 2 minutes for all vehicle systems to power down. Disconnect the appropriate harness connector at the roof rail air bag listed below:
 - DTC B0016 - F105L Roof rail air bag - left
 - DTC B0023 - F105R Roof rail air bag - right
2. Test for greater than 25 ohms between the control circuit terminals 1 and 2.
 - **If 25 ohms or less**
 1. Disconnect the X2 harness connector at the K36 SDM.

NOTE: Some connectors may be equipped with shorting bars as a safety component to prevent accidental inflator deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.

2. Test for infinite resistance between the two control circuits.
 - If less than infinite resistance, repair the short between the two circuits.
 - If infinite resistance, replace the K36 SDM.
 - **If greater than 25 ohms**
3. Ignition ON.
4. Test for less than 11 V between the control circuit terminals listed below and ground:
 - Control circuit terminal 1
 - Control circuit terminal 2
 - **If 11 V or greater**
 1. Ignition OFF. Disconnect the X2 harness connector at the K36 SDM. Ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K36 SDM.
 - **If less than 11 V**
5. Ignition OFF.
6. Test for greater than 25 ohms between the control circuit terminals listed below and ground:
 - Control circuit terminal 1
 - Control circuit terminal 2
 - **If 25 ohms or less**
 1. Disconnect the X2 harness connector at the K36 SDM.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K36 SDM.
 - **If greater than 25 ohms**
7. Ignition OFF. Install a 3 A fused jumper wire between the appropriate control circuit terminals 1 and 2. Ignition ON.
8. Verify the scan tool Deployment Loop Resistance parameter is less than 2 ohms.
 - **If 2 ohms or greater**
 1. Ignition OFF. Disconnect the X2 harness connector at the K36 SDM.
 2. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If less than 2 ohms**
9. Ignition OFF, connect the harness connector at the F105L roof rail air bag - left or F015R roof rail air bag - right, press in the CPA (if equipped) until an audible and/or tactile click is heard.
10. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
11. Verify DTC B0016, B0018, B0023, or B0025 is not set.
 - **If DTC B0016, B0018, B0023, or B0025 is set**

Replace the appropriate F105L roof rail air bag - left or F015R roof rail air bag - right.

- **If DTC B0016, B0018, B0023, or B0025 is not set**

12. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Inflatable Restraint Roof Side Rail Module Replacement - Left Side**
- **Inflatable Restraint Roof Side Rail Module Replacement - Right Side**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for SDM replacement, programming and setup

DTC B0019 OR B0020: PASSENGER INSTRUMENT PANEL AIR BAG DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0019 01

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Short to Battery

DTC B0019 02

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Short to Ground

DTC B0019 04

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Open

DTC B0019 0D

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 High Resistance

DTC B0019 0E

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Low Resistance

DTC B0020 01

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Short to Battery

DTC B0020 02

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Short to Ground

DTC B0020 04

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Open

DTC B0020 0D

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 High Resistance

DTC B0020 0E

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Passenger Instrument Panel Air Bag Stage 1 High Control	B0019 02, B0019 0E	B0019 0D	B0019 04, B0019 0D	B0019 01	-
Passenger Instrument Panel Air Bag Stage 1 Low Control	B0019 02, B0019 0E	B0019 0D	B0019 04, B0019 0D	B0019 01	-
Passenger Instrument Panel Air Bag Stage 2 High Control	B0020 02, B0020 0E	B0020 0D	B0020 04, B0020 0D	B0020 01	-
Passenger Instrument Panel Air Bag Stage 2 Low Control	B0020 02, B0020 0E	B0020 0D	B0020 04, B0020 0D	B0020 01	-

Circuit/System Description

During a side or frontal crash of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy an air bag or pretensioner. There are 2 shorting bars which will short together control circuits, when the connector is disconnected. This will help to prevent unwanted deployment of the air bag or pretensioner during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0019 01, B0020 01

The air bag control circuit is shorted to voltage for 2 seconds.

B0019 02, B0020 02

The air bag control circuit is shorted to ground for 2 seconds.

B0019 04, B0020 04

The air bag control circuit is open for 2 seconds.

B0019 0D, B0020 0D

The air bag deployment loop resistance is greater than 4.2 ohms for 2 seconds.

B0019 0E, B0020 0E

The air bag deployment loop resistance is less than 1.4 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument cluster to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: **The following diagnostic aids apply for both current and history DTCs.**

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Passenger instrument panel air bag
- Inline harness connectors
- Harness side of the SDM connector

Terminal fretting or incorrectly seated connectors can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set. DTCs of deployment loops which are in the seat can occur because of stress or damage to the harness due to seat

movement. Move the seat to the full extent of travel while using the scan tool to observe deployment type loop parameters.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Verification

NOTE: Refer to **SIR Service Precautions**.

Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- **Seat belt retractor pretensioner**
- **Passenger instrument panel air bag**
- **Knee air bag**
- **Seat air bag**
- **Roof rail air bag**

- **SDM**
- **Seat belt retractor pretensioner wiring harness connector**
- **Passenger instrument panel air bag wiring harness connector**
- **Seat side air bag wiring harness connector**
- **Roof rail air bag wiring harness connector**
- **SDM wiring harness connector**

NOTE: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.

If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.

1. Verify the scan tool Deployment Loop Resistance parameters stay consistently between 2.1 and 4.0 ohms without any spikes or dropouts while moving the harness near each connector listed below:
 - F105 Passenger instrument panel air bag
 - Any inline harness connector
 - K36 SDM
 - **If less than 2.1 or greater than 4.0 ohms**

Refer to Circuit/System Testing.

- **If there are spikes or dropouts, perform the following**
 - Inspect each connector terminal and harness for damage or corrosion and repair as necessary
 - Apply dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to each connector terminal
 - Insure each connector and CPA is correctly seated.
 - **If within 2.1 and 4.0 ohms without any spikes or dropouts**

2. All OK

Circuit/System Testing

1. Ignition OFF. Scan tool disconnected. Disconnect the F105 passenger instrument panel air bag inline harness connector X205. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for greater than 25 ohms between the appropriate control circuit terminals listed below on the K36 SDM side of the connector:
 - F105 Passenger instrument panel air bag stage 1 X205 terminal 1 and 2
 - F105 Passenger instrument panel air bag stage 2 X205 terminal 4 and 5

- **If 25 ohms or less**

1. Disconnect the X1 harness connector at the K36 SDM.

NOTE: Some connectors may be equipped with shorting bars as a safety component to prevent accidental inflator deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.

2. Test for infinite resistance between the two control circuits.
 - If less than infinite resistance, repair the short between the two circuits.
 - If infinite resistance, replace the K36 SDM.

- **If greater than 25 ohms**

3. Ignition ON.

4. Test for less than 11 V between the control circuit terminals listed below and ground:

- X205 control circuit terminal 1
- X205 control circuit terminal 2
- X205 control circuit terminal 4
- X205 control circuit terminal 5

- **If 11 V or greater**

1. Ignition OFF. Disconnect the X1 harness connector at the K36 SDM. Ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K36 SDM.

- **If less than 11 V**

5. Ignition OFF.

6. Test for greater than 25 ohms between the control circuit terminals listed below and ground:

- X205 control circuit terminal 1
- X205 control circuit terminal 2
- X205 control circuit terminal 4
- X205 control circuit terminal 5

- **If 25 ohms or less**

1. Disconnect the X1 harness connector at the K36 SDM.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K36 SDM.

- **If greater than 25 ohms**
- 7. Install a 3 A fused jumper wire between the control circuit terminals listed below:
 - F105 Passenger instrument panel air bag stage 1 X205 terminal 1 and 2
 - F105 Passenger instrument panel air bag stage 2 X205 terminal 4 and 5
- 8. Ignition ON.
- 9. Verify the scan tool Deployment Loop Resistance parameter is less than 2 ohms.
 - **If 2 ohms or greater**
 1. Ignition OFF. Disconnect the X1 harness connector at the K36 SDM.
 2. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If less than 2 ohms**
- 10. Ignition OFF. Reconnect the inline harness connector X205. Disconnect the appropriate F105 Passenger instrument panel air bag harness connector X1 (DTC B0019) or X2 (DTC B0020). Ignition ON.
- 11. Test for less than 11 V between the control circuit terminals listed below and ground:
 - F105 passenger instrument panel air bag control circuit terminal 1 X1
 - F105 passenger instrument panel air bag control circuit terminal 2 X1
 - F105 passenger instrument panel air bag control circuit terminal 1 X2
 - F105 passenger instrument panel air bag control circuit terminal 2 X2
 - **If 11 V or greater**

Repair the short to voltage on the circuit.

- **If less than 11 V**
- 12. Ignition OFF.
- 13. Test for greater than 25 ohms between the control circuit terminals listed below and ground:
 - F105 passenger instrument panel air bag control circuit terminal 1 X1
 - F105 passenger instrument panel air bag control circuit terminal 2 X1
 - F105 passenger instrument panel air bag control circuit terminal 1 X2
 - F105 passenger instrument panel air bag control circuit terminal 2 X2
 - **If 25 ohms or less**

Repair the short to ground on the circuit.

- **If greater than 25 ohms**
- 14. Install a 3 A fused jumper wire between the control circuit terminals listed below:
 - F105 Passenger instrument panel air bag stage 1 control circuit terminal 1 X1 and 2 X1
 - F105 Passenger instrument panel air bag stage 2 control circuit terminal 1 X2 and 2 X2
- 15. Ignition ON.

16. Verify the scan tool Deployment Loop Resistance parameter is less than 2 ohms.

- **If 2 ohms or greater**

1. Ignition OFF. Disconnect the X1 harness connector at the K36 SDM.
2. Test for less than 2 ohms in each control circuit end to end.

- **If greater than 2 ohms**

Repair the open/high resistance in the circuit between the F105 passenger instrument panel air bag connector and the X205 inline harness connector.

- **If less than 2 ohms**

17. Ignition OFF, connect the harness connector at the F105 passenger instrument panel air bag, press in the CPA (if equipped) until an audible and/or tactile click is heard.

18. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.

19. Verify DTC B0019 or B0020 is not set.

- **If DTC B0019 or B0020 is set**

Replace the F105 passenger instrument panel air bag.

- **If DTC B0019 or B0020 is not set**

20. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Airbag Instrument Panel Module Replacement**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for SDM control module replacement, programming and setup

DTC B0052: DEPLOYMENT COMMANDED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using the diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0052 00

Deployment Commanded

DTC B0052 56

Deployment Commanded Too Many Transitions

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) senses vehicle impacts and provides deployment signals to the air bags and anchor and/or retractor pretensioners when warranted. The inflatable restraint sensing and diagnostic module sets DTC B0052 after each command for deployment. DTC B0052 will latch and not clear after 3 commanded deployments by the inflatable restraint sensing and diagnostic module. Therefore the inflatable restraint sensing and diagnostic module has to be replaced.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

- The inflatable restraint sensing and diagnostic module detects a frontal impact of sufficient force to warrant deployment of the frontal air bags.
- The inflatable restraint sensing and diagnostic module detects a side impact or rollover (if equipped) of sufficient force to warrant deployment of a seat air bag and/or roof rail air bag.

Action Taken When the DTC Sets

The inflatable restraint sensing and diagnostic module requests the instrument cluster to illuminate the AIR BAG indicator.

Conditions for Clearing the DTC

- DTC B0052 00 is a DTC that may be cleared with a scan tool without replacing the inflatable restraint sensing and diagnostic module. This DTC will not clear if deployment has been commanded more than two times, and the inflatable restraint sensing and diagnostic module would have to be replaced.
- DTC B0052 56 is a latched DTC. The DTC cannot be cleared with the scan tool. Replacement of the inflatable restraint sensing and diagnostic module is required.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC B0052 00 is not set.
 - **If DTC B0052 00 is set**

Clear the DTC. If the DTC will not clear, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If DTC B0052 00 is not set**

2. Verify that DTC B0052 56 is not set.
 - **If DTC B0052 56 is set**

Replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If DTC B0052 56 is not set**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for inflatable restraint sensing and diagnostic module replacement, programming and setup

DTC B0074: PASSENGER PRESENCE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0074 01

Passenger Presence Sensor Short to Battery

DTC B0074 02

Passenger Presence Sensor Short to Ground

DTC B0074 08

Passenger Presence Sensor Performance - Signal Invalid

DTC B0074 11

Passenger Presence Sensor High Input

Circuit/System Description

The passenger presence module monitors the sensor status continually. Whenever the sensor mat has an internal malfunction, the passenger presence module will set DTC B0074.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0074 01

The passenger presence module has detected a short to voltage.

B0074 02

The passenger presence module has detected a short to ground.

B0074 08

The passenger presence module has detected an invalid signal.

B0074 11

The passenger presence module has detected a short to voltage.

Action Taken When the DTC Sets

The SDM requests the instrument panel cluster to illuminate the AIR BAG indicator.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aids

If either the inflatable restraint sensing and diagnostic module or passenger presence module were replaced verify that the correct part numbers were used for the vehicle application.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: This system is serviced as a kit (module and sensing mat). Perform **Passenger Presence System Programming and Setup** procedure whenever a component is replaced. Inspect the following component connectors for damage or corrosion. Repair or replace the affected component/connector:

- Passenger presence module harness connector
- Seat wiring harness to vehicle harness connector

The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click.

1. Confirm that all passenger presence module and sensor connectors are fully seated.
2. Verify DTC B0074 is not set.
 - **If DTC B0074 is set**

Replace the K85 passenger presence module.

- **If DTC B0074 does not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for passenger presence system and inflatable restraint sensing and diagnostic module replacement, programming and setup

DTC B0081: PASSENGER PRESENCE MODULE (SDM)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0081 00

Passenger Presence Module Malfunction

DTC B0081 3A

Passenger Presence Module Incorrect Component Installed

Circuit/System Description

When the ignition is turned ON, the Inflatable Restraint Sensing and Diagnostic Module and the Passenger Presence Module perform tests to diagnose critical malfunctions. Upon a successful power-up mode the Inflatable Restraint Sensing and Diagnostic Module will illuminate both PASSENGER AIRBAG ON/OFF indicators. If the Inflatable Restraint Sensing and Diagnostic Module detects a fault in the Passenger Presence Module, it may disable the passenger instrument panel air bag deployment loop, set DTC B0081 00 or DTC B0081 3A and illuminate the AIRBAG indicator.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0081 00

The Inflatable Restraint Sensing and Diagnostic Module has received a fault present message from the Passenger Presence Module.

B0081 3A

The Inflatable Restraint Sensing and Diagnostic Module has received a message from the Passenger Presence Module indicating a vehicle and Passenger Presence Module mismatch.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the instrument cluster to illuminate the AIR BAG indicator.
- The passenger instrument panel air bag deployment loop will be disabled.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aids

- If either the Inflatable Restraint Sensing and Diagnostic Module or Passenger Presence Module were replaced verify that the correct part numbers were used for the vehicle application.
- If this DTC is set as either current or history it may have been caused by an electronic device. If an electronic device (Computers, MP3 Players, Cell Phones, Diagnostic Scan Tool, Power Inverter, etc.) was placed on the passenger seat the Passenger Presence Module may command the passenger air bag indicator to turn on and/or command the passenger seat belt indicator to turn on. Make sure there are no objects on the passenger seat and clear the DTCs. If this DTC resets then perform this diagnostic. If the DTC does not reset there is no further work needed on the passenger presence system.
- If this DTC is set as either current or history it may have been caused by an aftermarket seat heater. The aftermarket seat heater may command the passenger air bag indicator to turn on and/or command the passenger seat belt indicator to turn on. Remove the aftermarket seat heater from the passenger seat and clear the DTCs. If this DTC resets then perform this diagnostic. If the DTC does not reset there is no further work needed on the passenger presence system.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- This system is serviced as a kit (seat foam, module and/or sensing mat). Perform a Passenger Presence System Preload procedure whenever a component is replaced. Refer to **Passenger Presence System Programming and Setup** .
- Both Inflatable Restraint Sensing and Diagnostic Module and Passenger Presence Module set DTC B0081 but with different symptom bytes. Therefore it is important to identify which module has set the DTC B0081. Use the symptom bytes as a way of identify the correct module to diagnose.

1. Verify that DTC B1001 is not set in the Inflatable Restraint Sensing and Diagnostic Module.
 - If DTC B1001 is set in the Inflatable Restraint Sensing and Diagnostic Module

Refer to **DTC B1001 (Inflatable Restraint Sensing and Diagnostic Module)**, **DTC B1001 (Passenger Presence System)**.

- If DTC B1001 is not set in the Inflatable Restraint Sensing and Diagnostic Module

2. Verify that DTC B0074, B101D, or B101E is not set in the Passenger Presence Module.

- If any of these DTCs are set in the Passenger Presence Module

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- If none of these DTCs are set in the Passenger Presence Module

NOTE: The Inflatable Restraint Sensing and Diagnostic Module sets a redundant B0081 00 DTC when the Passenger Presence Module sets a DTC B0081 11

or B0081 4B.

3. Verify that DTC B0081 00 is not set in the Inflatable Restraint Sensing and Diagnostic Module

- **If DTC B0081 00 is set in the Inflatable Restraint Sensing and Diagnostic Module**

The Passenger Presence Module has set B0081 11 or a B0081 4B. Refer to B0081 (Passenger Presence Module) for diagnosis.

- **If DTC B0081 00 is not set in the Inflatable Restraint Sensing and Diagnostic Module**

NOTE: The Inflatable Restraint Sensing and Diagnostic Module sets a B0081 3A when an incorrect Passenger Presence Module is installed.

4. Verify that DTC B0081 3A is not set in the Inflatable Restraint Sensing and Diagnostic Module.

- **If DTC B0081 3A is set in the Inflatable Restraint Sensing and Diagnostic Module**

Replace the K85 Passenger Presence Module.

- **If DTC B0081 3A is not set in the Inflatable Restraint Sensing and Diagnostic Module**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Passenger Presence Module and Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0081: PASSENGER PRESENCE MODULE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0081 11

Passenger Presence Module High Input

DTC B0081 4B

Passenger Presence Module Calibration Not Learned

Circuit/System Description

When the ignition is turned ON, the Inflatable Restraint Sensing and Diagnostic Module and the Passenger Presence Module perform tests to diagnose critical malfunctions. Upon a successful power-up mode the Inflatable Restraint Sensing and Diagnostic Module will illuminate both PASSENGER AIRBAG ON/OFF indicators. If the Inflatable Restraint Sensing and Diagnostic Module detects a fault in the Passenger Presence Module, it may disable the passenger instrument panel air bag deployment loop, set DTC B0081 and illuminate the AIRBAG indicator.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

Any of the following conditions must exist for 5 seconds.

B0081 11

The Passenger Presence Module has failed the preload procedure.

B0081 4B

The Passenger Presence Module is not calibrated.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the instrument cluster to illuminate the AIR BAG indicator.
- The passenger instrument panel air bag deployment loop will be disabled.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aids

- If either the Inflatable Restraint Sensing and Diagnostic Module or passenger presence system were replaced verify that the correct part numbers were used for the vehicle application.
- An aftermarket seat heater may command the passenger air bag indicator to turn on and/or command the passenger seat belt indicator to turn on. Remove the aftermarket seat heater from the passenger seat and clear the DTCs. If this DTC resets then perform this diagnostic. If the DTC does not reset there is no further work needed on the passenger presence system.
- If this DTC is set as either current or history it may have been caused by:
 - An aftermarket seat heater
 - A scan tool, laptop, or other electronic device is in the seat

- The seat is damp or wet
- An object is in the seat

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Use the table below in identifying specific module DTC B0081 application and symptom byte that sets with it.

DTC	Symptom Bytes	
B0081 - Inflatable Restraint Sensing and Diagnostic Module	00	3A
B0081 - Passenger Presence Module	11	4B

NOTE:

- This system is serviced as a kit (seat foam, module and sensing mat). Perform a passenger presence system preload procedure whenever a component is replaced. Refer to Passenger Presence System Programming and Setup .
- Both Inflatable Restraint Sensing and Diagnostic Module and Passenger Presence Module set DTC B0081 but with different symptoms bytes. Therefore it is important to identify which module has set the DTC B0081. Use the symptom bytes as a way of identify the correct module to diagnose.
- The Inflatable Restraint Sensing and Diagnostic Module sets a B0081 3A when an incorrect Passenger Presence Module is installed.

1. Verify that DTC B0081 3A is not set in the Inflatable Restraint Sensing and Diagnostic Module.

- If DTC B0081 3A is set in the Inflatable Restraint Sensing and Diagnostic Module

Replace the K85 Passenger Presence Module.

- If DTC B0081 3A is not set in the Inflatable Restraint Sensing and Diagnostic Module

NOTE:

The Inflatable Restraint Sensing and Diagnostic Module sets a B0081 00 DTC when the Passenger Presence Module sets a DTC B0081 11 or B0081 4B.

2. Verify that DTC B0081 11 or DTC B0081 4B is not set in the Passenger Presence Module.

- **If DTC B0081 11 or DTC B0081 4B is set in the Passenger Presence Module**

Perform the passenger presence system rezero procedure. Refer to **Passenger Presence System Programming and Setup** .

- **If DTC B0081 11 or DTC B0081 4B is not set in the Passenger Presence Module**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Passenger Presence Module or Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0083 OR B0084: FRONT IMPACT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0083 02

Left Front Impact Sensor Short to Ground

DTC B0083 05

Left Front Impact Sensor High Voltage/Open

DTC B0083 39

Left Front Impact Sensor Internal Electronic Failure

DTC B0083 3A

Left Front Impact Sensor Incorrect Component Installed

DTC B0083 71

Left Front Impact Sensor Invalid Serial Data Received

DTC B0084 02

Right Front Impact Sensor Short to Ground

DTC B0084 05

Right Front Impact Sensor High Voltage/Open

DTC B0084 39

Right Front Impact Sensor Internal Electronic Failure

DTC B0084 3A

Right Front Impact Sensor Incorrect Component Installed

DTC B0084 71

Right Front Impact Sensor Invalid Serial Data Received

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Impact Sensor High Signal	B0083 02	B0083 05	B0083 05	B0083 3A
Left Front Impact Sensor Low Reference	B0083 02	B0083 05	B0083 05	B0083 3A
Right Front Impact Sensor High Signal	B0084 02	B0084 05	B0084 05	B0084 3A
Right Front Impact Sensor Low Signal	B0084 02	B0084 05	B0084 05	B0084 3A

Circuit/System Description

The impact sensors are electronic and are not part of the deployment loops, but instead provide inputs to the inflatable restraint sensing and diagnostic module (SDM). The impact sensors can assist in determining the severity of some frontal and side collisions. The inflatable restraint sensing and diagnostic module uses the input from the impact sensors to assist in determining the severity of a collision further supporting air bag deployment. If the inflatable restraint sensing and diagnostic module determines a deployment is warranted, the inflatable restraint sensing and diagnostic module will cause current to flow through the deployment loops deploying the air bags.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

Any of the following conditions exist for 10 seconds:

B0083 02, B0084 02

- The sensor has been shorted to ground.
- The sensor current is greater than 23 mA for greater than 5 ms.

B0083 05, B0084 05

- The sensor circuit is open.
- The inflatable restraint sensing and diagnostic module has not received a message from the sensor for greater than 375 milliseconds.

B0083 39, B0084 39

- The inflatable restraint sensing and diagnostic module has received a Not OK message from the sensor.
- The inflatable restraint sensing and diagnostic module has not received a message.

B0083 3A, B0084 3A

- The inflatable restraint sensing and diagnostic module has received identification message from the sensor, which does not match the identification stored in the inflatable restraint sensing and diagnostic module memory.
- The inflatable restraint sensing and diagnostic module has reset the impact sensor twice without detecting the correct identification message.

B0083 71, B0084 71

The inflatable restraint sensing and diagnostic module has received invalid serial data from the sensor.

Action Taken When the DTC Sets

The inflatable restraint sensing and diagnostic module requests the instrument cluster to illuminate the air bag indicator.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.
- An ignition cycle is required for the DTC to go from current to history.

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SIR Schematics

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **SIR Service Precautions**
- **Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.**
 - **Impact sensor**
 - **inflatable restraint sensing and diagnostic module**
 - **inflatable restraint sensing and diagnostic module wiring harness connector**
- **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.**

1. Ignition ON.
2. Verify that DTC B0083 or B0084 symptom byte 39 or 71 is not set as current.
 - **If DTC B0083 or B0084 symptom byte 39 or 71 is set as current**

Replace the appropriate B59 Front Impact Sensor.

- **If DTC B0083 or B0084 symptom byte 39 or 71 is not set as current**
3. Verify that DTC B0083 or B0084 symptom byte 3A is not set as current.

- **If DTC B0083 or B0084 symptom byte 3A is set as current**

Replace the incorrect B59 Front Impact Sensor

- **If DTC B0083 or B0084 symptom byte 3A is not set as current**

4. Verify that DTC B0083 or B0084 symptom byte 02 or 05 is not set as current.

- **If DTC B0083 or B0084 symptom byte 02 or 05 is set as current**

Refer to Circuit/System Testing.

- **If DTC B0083 or B0084 symptom byte 02 or 05 is not set as current**

5. All OK.

Circuit/System Testing

1. Ignition OFF. Disconnect the harness connector at the appropriate B59 Front Impact Sensor. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.

- **If 10 ohms or greater**

1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.

2. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If less than 10 ohms**

3. Ignition ON.

4. Test for less than 1 V between the signal circuit terminal 1 and ground.

- **If 1 V or greater**

1. Ignition OFF. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. Ignition ON.

2. Test for less than 1 V between the signal circuit terminal 1 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If less than 1 V**

5. Ignition OFF.

6. Test for greater than 50k ohms between the signal circuit terminal 1 and ground.

- **If 50k ohms or less**

1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.

2. Test for infinite resistance between the signal circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
- **If greater than 50k ohms**
- 7. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
- 8. Test for less than 2 ohms between the B59 Front Impact Sensor signal circuit terminal 1 and the appropriate K36 Inflatable Restraint Sensing and Diagnostic Module signal circuit terminal listed below:
 - Right front impact sensor terminal 26 X2
 - Left front impact sensor terminal 23 X2
- **If 2 ohms or greater**

Repair the short to voltage or an open/high resistance in the circuit.

- **If less than 2 ohms**
- 9. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile click is heard.
- 10. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
- 11. Verify DTC B0083 or B0084 does not set.
 - **If the DTC sets**
 1. Replace the B59 Front Impact Sensor.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - If the DTC does not set.
 3. All OK.
 - **If the DTC does not set**
- 12. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front End Inflatable Restraint Discriminating Sensor Replacement**
- **Control Module References** for inflatable restraint sensing and diagnostic module control module replacement, programming and setup

DTC B0085 OR B0088: FRONT SIDE IMPACT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0085 01

Left Front Side Impact Sensor Short to Voltage

DTC B0085 02

Left Front Side Impact Sensor Short to Ground

DTC B0085 04

Left Front Side Impact Sensor Open

DTC B0085 39

Left Front Side Impact Sensor Internal Malfunction

DTC B0085 3A

Left Front Side Impact Sensor Incorrect Component Installed

DTC B0088 01

Right Rear Side Impact Sensor Short to Voltage

DTC B0088 02

Right Rear Side Impact Sensor Short to Ground

DTC B0088 04

Right Rear Side Impact Sensor Open

DTC B0088 39

Right Rear Side Impact Sensor Internal Malfunction

DTC B0088 3A

Right Rear Side Impact Sensor Incorrect Component Installed

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Side Impact Sensor High Signal	B0085 02, B0088 02	B0085 04	B0085 01, B0088 01	B0085 39
Left Front Side Impact Sensor	B0085 02,		B0085 01,	

Low Reference	B0088 02	B0085 04	B0088 01	B0085 39
Right Rear Side Impact Sensor High Signal	B0085 02, B0088 02	B0088 04	B0085 01, B0088 01	B0088 39
Right Rear Side Impact Sensor Low Reference	B0085 02, B0088 02	B0088 04	B0085 01, B0088 01	B0088 39

Circuit/System Description

The impact sensors are electronic and are not part of the deployment loops, but instead provide inputs to the Inflatable Restraint Sensing and Diagnostic Module (SDM). The impact sensors can assist in determining the severity of some frontal and side collisions. The Inflatable Restraint Sensing and Diagnostic Module uses the input from the impact sensors to assist in determining the severity of a collision further supporting air bag deployment. If the Inflatable Restraint Sensing and Diagnostic Module determines a deployment is warranted, the Inflatable Restraint Sensing and Diagnostic Module will cause current to flow through the deployment loops deploying the air bags.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

Any of the following conditions exist for 10 seconds:

B0085 01, B0088 01

The impact sensor has been shorted to voltage.

B0085 02, B0088 02

- The sensor has been shorted to ground.
- The sensor current is greater than 23 mA for greater than 5 ms.

B0085 04, B0088 04

- The impact sensor has an open or high resistance.
- The Inflatable Restraint Sensing and Diagnostic Module has not received a message from the sensor for greater than 375 ms.

B0085 39, B0088 39

- The Inflatable Restraint Sensing and Diagnostic Module has received a Not OK message from the sensor.
- The Inflatable Restraint Sensing and Diagnostic Module has not received a message.

B0085 3A, B0088 3A

- The Inflatable Restraint Sensing and Diagnostic Module has received identification message from the sensor, which does not match the identification stored in the Inflatable Restraint Sensing and Diagnostic Module memory.
- The Inflatable Restraint Sensing and Diagnostic Module has reset the impact sensor twice without detecting the correct identification message.

Action Taken When the DTC Sets

The Inflatable Restraint Sensing and Diagnostic Module requests the instrument panel cluster to illuminate the AIR BAG indicator.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.
- An ignition cycle is required for the DTC to go from current to history.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: • Refer to **SIR Service Precautions**.

- **Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.**
 - **Side Impact Sensor**
 - **Inflatable Restraint Sensing and Diagnostic Module**
 - **Front impact sensor wiring harness connector**
 - **Side Impact Sensor wiring harness connector**
 - **Inflatable Restraint Sensing and Diagnostic Module wiring harness connector**
- **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly. Replace any CPA that is damaged or missing.**
- **If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.**

1. Verify that DTC B0085 or B0088 symptom byte 39 is not set as current.

- **If DTC B0085 or B0088 symptom byte 39 is set as current**

Replace the sensor listed below:

- B0085 - B63LF Side Impact Sensor-Left Front
- B0088 - B63RR Side Impact Sensor-Right Rear
- **If DTC B0085 or B0088 symptom byte 39 is not set as current**

2. Verify that DTC B0085 or B0088 symptom byte 3A is not set as current.

- **If DTC B0085 or B0088 symptom byte 3A is set as current**

Replace the incorrect B63 Side Impact Sensor

- **If DTC B0085 or B0088 symptom byte 3A is not set as current**

3. Verify that DTC B0085 or B0088 symptom byte 02 or 05 is set as current.

- **If only DTC B0085 symptom byte 01, 02 or 04 is set as current**

Refer to Circuit/System Testing - Only DTC B0085 or B0088 is set.

- **If only DTC B0088 symptom byte 01, 02 or 04 is set as current**

Refer to Circuit/System Testing - Only DTC B0085 or B0088 is set.

- **If both DTC B0085 or B0088 symptom byte 01 or 02 is set as current**

Refer to Circuit/System Testing - Both DTC B0085 and B0088 are set.

- **If DTC B0085 or B0088 symptom byte 01 or 02 is not set as current**

4. All OK.

Circuit/System Testing

NOTE: The signal circuit is shared at the K36 Inflatable Restraint Sensing and Diagnostic Module between the B63LF Side Impact Sensor - Left Front and the B63RR Side Impact Sensor - Right Rear (DTC B0085 and DTC B0088). Therefore a short to ground or short to voltage in either of these signal circuits can set a DTC for both circuits, and an open in either circuit will only set its corresponding DTC.

Only DTC B0085 or B0088 is set

1. Ignition OFF, disconnect the harness connector at the appropriate B63 Side Impact Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - **If 1 V or greater**
 1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 1 V**
5. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
6. Test for less than 2 ohms between the B63 Side Impact Sensor signal circuit terminal 1 and the K36 Inflatable Restraint Sensing and Diagnostic Module terminal listed below:
 - Left front signal terminal 19 X2
 - Right rear signal terminal 30 X2
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 2 ohms**

7. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile click is heard.
8. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
9. Verify the DTC does not set.

- **If the DTC sets**

1. Replace the B63 Side Impact Sensor.
2. Verify the DTC does not set.
 - If the DTC sets, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - If the DTC does not set.
3. All OK.

- **If the DTC does not set**

10. All OK

Both DTC B0085 and B0088 are set

1. Ignition OFF. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for greater than 50k ohms between each signal circuit listed below and ground:
 - Left front signal circuit - terminal 19 X2
 - Right rear signal circuit - terminal 30 X2
 - **If 50k ohms or less**
 1. Ignition OFF. Disconnect the harness connector at the B63 Side Impact Sensor that failed the test. Ignition ON.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the B63 Side Impact Sensor.
 - **If greater than 50k ohms**
3. Ignition ON.
4. Test for less than 1 V between the signal circuit terminals listed below and ground:
 - Left front signal circuit - terminal 19 X2
 - Right rear signal circuit - terminal 30 X2
 - **If 1 V or greater**
 1. Disconnect the harness connector at the B63 Side Impact Sensor that failed the test.
 2. Test for less than 1 V between signal circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the B63 Side Impact Sensor.
 - **If less than 1 V**

5. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile click is heard.
6. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
7. Verify the DTC does not set.

- **If the DTC sets**

Replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If the DTC does not set**

8. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Airbag Side Impact Sensor Replacement**
- **Airbag Side Impact Rear Sensor Replacement**
- **Control Module References** for Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0086 OR B0087: SIDE IMPACT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0086 01

Right Front Side Impact Sensor Short to Voltage

DTC B0086 02

Right Front Side Impact Sensor Short to Ground

DTC B0086 04

Right Front Side Impact Sensor Open

DTC B0086 39

Right Front Side Impact Sensor Internal Malfunction

DTC B0086 3A

Right Front Side Impact Sensor Incorrect Component Installed

DTC B0087 01

Left Rear Side Impact Sensor Short to Voltage

DTC B0087 02

Left Rear Side Impact Sensor Short to Ground

DTC B0087 04

Left Rear Side Impact Sensor Open

DTC B0087 39

Left Rear Side Impact Sensor Internal Malfunction

DTC B0087 3A

Left Rear Side Impact Sensor Incorrect Component Installed

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Right Front Side Impact Sensor High Signal	B0086 02, B0087 02	B0086 04	B0086 01, B0087 01	B0086 39
Right Front Side Impact Sensor Low Reference	B0086 02, B0087 02	B0086 04	B0086 01, B0087 01	B0086 39
Left Rear Side Impact Sensor High Signal	B0086 02, B0087 02	B0087 04	B0086 01, B0087 01	B0087 39
Left Rear Side Impact Sensor Low Reference	B0086 02, B0087 02	B0087 04	B0086 01, B0087 01	B0087 39

Circuit/System Description

The impact sensors are electronic and are not part of the deployment loops, but instead provide inputs to the Inflatable Restraint Sensing and Diagnostic Module (SDM). The impact sensors can assist in determining the severity of some frontal and side collisions. The Inflatable Restraint Sensing and Diagnostic Module uses the input from the impact sensors to assist in determining the severity of a collision further supporting air bag deployment. If the Inflatable Restraint Sensing and Diagnostic Module determines a deployment is warranted, the Inflatable Restraint Sensing and Diagnostic Module will cause current to flow through the deployment loops deploying the air bags.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

Any of the following conditions exist for 10 seconds:

B0086 01, B0087 01

The impact sensor has been shorted to voltage.

B0086 02, B0087 02

- The sensor has been shorted to ground.
- The sensor current is greater than 23 mA for greater than 5 ms.

B0086 04, B0087 04

- The sensor circuit is open.
- The Inflatable Restraint Sensing and Diagnostic Module has not received a message from the sensor for greater than 375 ms.

B0086 39, B0087 39

- The Inflatable Restraint Sensing and Diagnostic Module has received a Not OK message from the sensor.
- The Inflatable Restraint Sensing and Diagnostic Module has not received a message.

B0086 3A, B0087 3A

- The Inflatable Restraint Sensing and Diagnostic Module has received identification message from the sensor, which does not match the identification stored in the Inflatable Restraint Sensing and Diagnostic Module memory.
- The Inflatable Restraint Sensing and Diagnostic Module has reset the impact sensor twice without detecting the correct identification message.

Action Taken When the DTC Sets

The Inflatable Restraint Sensing and Diagnostic Module requests the instrument panel cluster to illuminate the AIR BAG indicator.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.
- An ignition cycle is required for the DTC to go from current to history.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Connector Repairs
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Refer to SIR Service Precautions.

Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- Side Impact Sensor
- Inflatable Restraint Sensing and Diagnostic Module
- Front impact sensor wiring harness connector
- Side Impact Sensor wiring harness connector
- Inflatable Restraint Sensing and Diagnostic Module wiring harness connector

NOTE: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly. Replace any CPA that is damaged or missing.

If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.

1. Verify that DTC B0086 or B0087 symptom byte 39 is not set as current.
 - **If DTC B0086 or B0087 symptom byte 39 is set as current**

Replace the sensor listed below:

- B0086 - B63LF Side Impact Sensor-Right Front
- B0087 - B63RR Side Impact Sensor-Left Rear
- **If DTC B0086 or B0087 symptom byte 39 is not set as current**

2. Verify that DTC B0086 or B0087 symptom byte 3A is not set as current.
 - **If DTC B0086 or B0087 symptom byte 3A is set as current**

Replace the incorrect B63 Side Impact Sensor

- **If DTC B0086 or B0087 symptom byte 3A is not set as current**

3. Verify that DTC B0086 or B0087 symptom byte 02 or 05 is set as current.
 - **If only DTC B0086 symptom byte 01, 02 or 04 is set as current**

Refer to Circuit/System Testing - Only DTC B0086 or B0087 is set.

- **If only DTC B0087 symptom byte 01, 02 or 04 is set as current**

Refer to Circuit/System Testing - Only DTC B0086 or B0087 is set.

- **If both DTC B0086 or B0087 symptom byte 01, 02 or 04 is set as current**

Refer to Circuit/System Testing - Both DTC B0086 and B0087 are set.

- **If DTC B0086 or B0087 symptom byte 01, 02 or 04 is not set as current**

4. All OK.

Circuit/System Testing

NOTE: The signal circuit is shared at the K36 Inflatable Restraint Sensing and Diagnostic Module between the B63RF Side Impact Sensor right front and the B63LR Side Impact Sensor left rear (DTC B0086 and DTC B0087). Therefore a short to ground or short to voltage in either of these signal circuits can set a DTC for both circuits, and an open in either circuit should only set its corresponding DTC.

Only DTC B0086 or B0087 is set

1. Ignition OFF, disconnect the harness connector at the appropriate B63 Side Impact Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 10 ohms**
3. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
4. Test for less than 2 ohms between the B63 Side Impact Sensor signal circuit terminal 1 and the K36 Inflatable Restraint Sensing and Diagnostic Module terminal listed below:
 - Right front signal terminal 22 X2
 - Left rear signal terminal 27 X2
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.
 - **If less than 2 ohms**
5. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile click is heard.
6. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
7. Verify the DTC does not set.
 - **If the DTC sets**
 1. Replace the B63 Side Impact Sensor.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - If the DTC does not set.
 3. All OK.
 - **If the DTC does not set**
8. All OK.

Both DTC B0086 and B0087 are set

1. Ignition OFF. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for greater than 50k ohms between each signal circuit listed below and ground:
 - Right front signal circuit - terminal 22 X2

- Left rear signal circuit - terminal 27 X2
 - **If 50k ohms or less**
 1. Disconnect the harness connector at the B63 Side Impact Sensor that failed the test.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the B63 Side Impact Sensor.
 - **If greater than 50k ohms**
- 3. Ignition ON.
- 4. Test for less than 1 V between the signal circuit terminals listed below and ground:
 - Right front signal circuit - terminal 22 X2
 - Left rear signal circuit - terminal 27 X2
 - **If 1 V or greater**
 1. Ignition OFF. Disconnect the harness connector at the B63 Side Impact Sensor that failed the test. Ignition ON.
 2. Test for less than 1 V between signal circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the B63 Side Impact Sensor.
 - **If less than 1 V**
- 5. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile click is heard.
- 6. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
- 7. Verify the DTC does not set.
 - **If the DTC sets**
 1. Replace the B63 Side Impact Sensor.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - If the DTC does not set.
 - 3. All OK.
 - **If the DTC does not set**
- 8. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Airbag Side Impact Sensor Replacement**
- **Airbag Side Impact Rear Sensor Replacement**
- **Control Module References** for Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B067F OR B0680: PASSENGER AIR BAG ON INDICATOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B067F 01

Passenger Air Bag On Indicator Circuit Short to Battery

DTC B067F 02

Passenger Air Bag On Indicator Circuit Short to Ground

DTC B067F 04

Passenger Air Bag On Indicator Circuit Open

DTC B0680 01

Passenger Air Bag Off Indicator Circuit Short to Battery

DTC B0680 02

Passenger Air Bag Off Indicator Circuit Short to Ground

DTC B0680 04

Passenger Air Bag Off Indicator Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Passenger Air Bag OFF Indicator Control	B0680 02	B0680 04	B0680 01	-
Passenger Air Bag ON Indicator Control	B067F 02	B067F 04	B067F 01	-
Passenger Air Bag Disable Indicator Ground	-	B067F 04, B0680 04	-	-

Circuit/System Description

The passenger air bag ON/OFF indicators are used to notify the driver when the passenger presence system has enabled or disabled the passenger instrument panel air bag. When the ignition is turned ON, the ignition voltage is supplied to the passenger presence module. When the Inflatable Restraint Sensing and Diagnostic Module (SDM) receives the appropriate serial data message from the passenger presence module the SDM will then provide voltage to the appropriate indicator.

Conditions for Running the DTC

Ignition Voltage is between 9-16 V

Conditions for Setting the DTC

The SDM detects improper voltage on the control circuit of the passenger air bag ON or OFF indicator.

Actions Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the instrument cluster to illuminate the AIR BAG indicator.
- Passenger air bag ON and OFF indicators are disabled.

Conditions for Clearing the DTC

The condition for setting the DTC no longer exists.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other Inflatable Restraint Sensing and Diagnostic Module DTCs are set.
 - **If other Inflatable Restraint Sensing and Diagnostic Module DTCs are set**

Diagnose those DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no other Inflatable Restraint Sensing and Diagnostic Module DTCs are set**
3. Verify the passenger air bag ON indicator and passenger air bag OFF indicators turn ON and OFF when commanded ON and OFF with a scan tool.
 - **If the passenger air bag indicators do not change**

Refer to Circuit/System Testing

- **If the passenger air bag indicators change**
4. All OK.

Circuit/System Testing

NOTE: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.

- **Passenger air bag disable on/off indicator.**
- **Passenger air bag disable on/off indicator wiring harness.**

1. Ignition OFF, disconnect the harness connector at the P14 Passenger Air Bag Disable Indicator.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON, command the passenger air bag OFF indicator OFF with a scan tool.
4. Test for less than 11 V between the control circuit terminal 3 and ground.
 - **If 11 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. Ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 11 V**
- 5. Command the passenger air bag OFF indicator ON with a scan tool.
- 6. Test for greater than 4 V between the control circuit terminal 3 and ground.
 - **If 4 V or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If greater than 4 V**
- 7. Command the passenger air bag ON indicator OFF with a scan tool.
- 8. Test for less than 11 V between the control circuit terminal 1 and ground.
 - **If 11 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. Ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If less than 11 V**
- 9. Command the passenger air bag ON indicator ON with a scan tool.
- 10. Test for greater than 4 V between the control circuit terminal 1 and ground.
 - **If 4 V or less**
 1. Ignition OFF, disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - **If greater than 4 V**
- 11. Replace the P14 Passenger Air Bag Disable Indicator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Instrument Panel Airbag Arming Status Display Replacement**
- **Control Module References** for K36 Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B1001: OPTION CONFIGURATION (INFLATABLE RESTRAINT SENSING AND DIAGNOSTIC MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

DTC Descriptor

DTC B1001 00

Option Configuration

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) stores a primary data key, which is a 4-digit number. When the ignition is turned ON, the inflatable restraint sensing and diagnostic module compares this information to the information stored in the Body Control Module (BCM) via serial data. If there is a mismatch between the information stored in the inflatable restraint sensing and diagnostic module and Body Control Module, DTC B1001 will set.

Conditions for Running the DTC

System voltage is between 9-16 V.

Conditions for Setting the DTC

The 4-digit Primary Data Key stored in the inflatable restraint sensing and diagnostic module does not match the 4 digits stored in the Body Control Module.

Action Taken When the DTC Sets

- The inflatable restraint sensing and diagnostic module requests the instrument cluster to illuminate the AIR BAG indicator.
- The inflatable restraint sensing and diagnostic module disables all deployments.

Conditions for Clearing the DTC

The last 4-digit Primary Data Key in the inflatable restraint sensing and diagnostic module matches the last 4 digits stored in the Body Control Module.

Diagnostic Aids

- This DTC is an indication that an incorrect inflatable restraint sensing and diagnostic module is installed in the vehicle, or that the inflatable restraint sensing and diagnostic module and/or the Body Control Module was replaced without reprogramming the Body Control Module with the new information.
- If the inflatable restraint sensing and diagnostic module was previously programmed and DTC B1001 is now set, the setup portion of program was not completed. Proceed to the inflatable restraint sensing and diagnostic module Setup portion of the **Inflatable Restraint Sensing and Diagnostic Module Programming and Setup**

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the scan tool K36 Inflatable Restraint Sensing and Diagnostic Module Primary Key Status parameter is Valid.
 - **If the K36 Inflatable Restraint Sensing and Diagnostic Module Primary Key Status parameter is Invalid**

Perform the K36 Inflatable Restraint Sensing and Diagnostic Module setup. Refer to **Inflatable Restraint Sensing and Diagnostic Module Programming and Setup** .

- **If the K36 Inflatable Restraint Sensing and Diagnostic Module Primary Key Status**

parameter is Valid

2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **SIR/SRS Wiring Repairs**
- **Control Module References** for K36 Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B1001: OPTION CONFIGURATION ERROR (PASSENGER PRESENCE SYSTEM)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1001 00

Option Configuration Error

Circuit/System Description

The Inflatable Restraint Sensing and Diagnostic Module (SDM) stores a 4-digit primary key for the Passenger Presence Module. The Inflatable Restraint Sensing and Diagnostic Module sends the Passenger Presence Module the primary key. If the Passenger Presence Module determines that it is the wrong primary key, the Passenger Presence Module will set DTC B1001 and send the Inflatable Restraint Sensing and Diagnostic Module a vehicle mismatch message. The Inflatable Restraint Sensing and Diagnostic Module then will set DTC B0081 and illuminate the SIR warning indicator. The Passenger Presence Module does not use a secondary key.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

The 4-digit primary key stored in the Inflatable Restraint Sensing and Diagnostic Module does not match the 4-digit key stored in the Passenger Presence Module.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the instrument panel cluster to

illuminate the AIR BAG indicator.

- The passenger instrument panel air bag deployment is disabled.

Conditions for Clearing the DTC

The 4-digit Primary Key in the Inflatable Restraint Sensing and Diagnostic Module and in the Passenger Presence Module match.

Diagnostic Aids

This DTC is an indication that the passenger presence system module was not set-up correctly, is not the correct part number or that the Passenger Presence Module is defective.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **SIR/SRS Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.

- Passenger Presence Module
- Passenger Presence Module wiring harness

1. Verify the correct K85 Passenger Presence Module part number has been installed
 - **If the K85 Passenger Presence Module installed has an incorrect part number, replace the K85 Passenger Presence Module**
 - **If the K85 Passenger Presence Module installed has a correct part number**
2. Verify that DTC B1001 is not set as current in the K85 Passenger Presence Module.
 - **If DTC is set as current, . If Inflatable Restraint Sensing and Diagnostic Module part number is correct**
 1. Verify the Inflatable Restraint Sensing and Diagnostic Module part number is correct.
 - If the K36 Inflatable Restraint Sensing and Diagnostic Module part number is incorrect, replace the K36 Inflatable Restraint Sensing and Diagnostic Module
 - If the K36 Inflatable Restraint Sensing and Diagnostic Module part number is correct
 2. Replace the K85 Passenger Presence Module
 - **If the DTC is no set as current**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for K85 Passenger Presence Module and K36 Inflatable Restraint Sensing and Diagnostic Module replacement, setup, and programming

DTC B1019: SYSTEM CONFIGURATION ERROR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1019 00

System Configuration Error

Circuit/System Description

The inflatable restraint sensing and diagnostic module monitors the number of safety components installed on the vehicle. When the ignition is turned ON, the inflatable restraint sensing and diagnostic module evaluates the number of safety components installed and compares it to the number of components the inflatable restraint sensing and diagnostic module expects to see on the vehicle with its current calibration. If there is a mismatch between detected components and the components programmed with the inflatable restraint sensing and diagnostic module calibration, DTC B1019 will set. The components (if equipped) that the inflatable restraint sensing and diagnostic module will detect include inflatable restraint deployment loops, impact sensors,

passenger presence system components, seat position sensors, disable switches, and seat belt switches.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

The setup for the inflatable restraint sensing and diagnostic module has not been completed and the inflatable restraint sensing and diagnostic module does not detect the passenger presence system (if equipped), the correct number of sensors, or deployment loops, that is expected with this calibration.

Action Taken When the DTC Sets

- The inflatable restraint sensing and diagnostic module requests the instrument cluster to illuminate the AIR BAG warning indicator.
- The DTC must be cleared before running the setup inflatable restraint sensing and diagnostic module.
- Air bag indicator will continue to flash until inflatable restraint sensing and diagnostic module setup procedure is complete.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aids

The inflatable restraint sensing and diagnostic module scan tool deployment loop, impact sensor, and passenger presence (if equipped) data will match what the inflatable restraint sensing and diagnostic module has been programmed to expect to see on the vehicle. B1019 DTC will set if a deployment loop or impact sensor is added or removed from the system, or if the passenger presence is not detected.

DTC B1019 will set when an open/high resistance DTC sets for a deployment loop or impact sensor. This causes mismatch between the learned and actual components connected to the inflatable restraint sensing and diagnostic module.

DTC B1019 can set with no other DTCs if an unused deployment loop or impact sensor circuit is shorted to ground. This causes a mismatch between the learned and actual components connected to the inflatable restraint sensing and diagnostic module.

Reference Information

Schematic Reference

- **Seat Belt Schematics**
- **SIR Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Seat Belt System Description and Operation**
- **Supplemental Inflatable Restraint System Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: DTC B1019 can set after the inflatable restraint sensing and diagnostic module has been replaced and/or reprogrammed before the setup procedure is completed. The setup procedure cannot be completed if DTC B1019 is set as current or history. If a short or open is detected in a deployment circuit prior to the setup procedure being performed, the inflatable restraint sensing and diagnostic module will set DTC B1019.

1. Ignition ON.
2. Verify no other K36 Inflatable Restraint Sensing and Diagnostic Module DTCs are set.
 - **If other K36 Inflatable Restraint Sensing and Diagnostic Module DTCs are set**

Diagnose those DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no other K36 Inflatable Restraint Sensing and Diagnostic Module DTCs are set**
3. Verify the enabled impact sensors identified in the scan tool data list match the number of actual impact sensors installed on the vehicle.
 - **If the number of enabled impact sensors do not match**
 1. Verify the correct K36 Inflatable Restraint Sensing and Diagnostic Module calibration file is loaded in the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - If the K36 Inflatable Restraint Sensing and Diagnostic Module calibration file is correct and the vehicle contains an incorrect number of sensors, identify which sensors are missing to make the vehicle match the K36 Inflatable Restraint Sensing and Diagnostic Module impact sensor calibration scan tool data list.

- If the calibration file is incorrect
- 2. Reprogram the K36 Inflatable Restraint Sensing and Diagnostic Module. Refer to **Inflatable Restraint Sensing and Diagnostic Module Programming and Setup**
 - **If the number of enabled impact sensors match**
- 4. Verify the enabled deployment loops identified in the scan tool data list match the deployment loops installed on the vehicle.
 - **If the number of enabled deployment loops do not match**
 1. Verify the correct K36 Inflatable Restraint Sensing and Diagnostic Module calibration file is loaded in the K36 Inflatable Restraint Sensing and Diagnostic Module.
 - If the K36 Inflatable Restraint Sensing and Diagnostic Module calibration file is correct and the vehicle contains an incorrect number of loops, identify which deployment loops are missing to make the vehicle match the K36 Inflatable Restraint Sensing and Diagnostic Module impact sensor calibration scan tool data list.
 - If the calibration file is incorrect
 2. Program the K36 Inflatable Restraint Sensing and Diagnostic Module. Refer to **Inflatable Restraint Sensing and Diagnostic Module Programming and Setup**
 - **If the number of enabled deployment loops match**
- 5. Verify a passenger presence system is equipped on the vehicle.
 - **If a passenger presence system is not equipped on the vehicle**

Replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

 - **If a passenger presence system is equipped on the vehicle**
- 6. Verify the Passenger Presence System Enable Status parameter identified in the scan tool data list is Enabled.
 - **If the Passenger Presence System Enable Status parameter is not Enabled**

Refer to **Inflatable Restraint Sensing and Diagnostic Module Programming and Setup**

 - **If the Passenger Presence System parameter is Enabled**
- 7. Verify the Passenger Presence System Learn Status parameter identified in the scan tool data list is Learned.
 - **If the Passenger Presence System Learn Status parameter is not Learned**
 1. Verify the scan tool can communicate with the passenger presence system.
 - If the scan tool will not communicate with the passenger presence system, refer to **Scan Tool Does Not Communicate with Low Speed GMLAN Device**
 - If the scan tool communicates
 2. Ignition OFF, disconnect the scan tool, wait 2 min.
 3. Ignition ON, connect the scan tool, verify DTC B1019 is not set as current.
 - If the DTC is set as current, refer to **Inflatable Restraint Sensing and Diagnostic Module Programming and Setup**
 - If the DTC is not set as current

4. All OK.

- **If the Passenger Presence System Learn status is Learned**

8. Replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **SIR/SRS Wiring Repairs**
- **Control Module References** for inflatable restraint sensing and diagnostic module replacement, programming and setup

PASSENGER PRESENCE SYSTEM REZEROING

Introduction

The inflatable restraints passenger presence system is a calibrated system that requires re-zeroing or a zero check anytime the seat cushion trim attachments have been removed or the passenger presence system has been replaced. The procedures below are designed to assist in the re-zeroing of the passenger presence system. Before you start, read these procedures carefully and completely. For further information regarding the passenger presence system refer to **Supplemental Inflatable Restraint System Description and Operation**.

NOTE: **The following procedures must be followed:**

1. Read this procedure carefully and completely.
2. The passenger presence system will not function properly if the passenger presence system re-zeroing procedure is not performed.
3. Perform the **Diagnostic Repair Verification** after successfully completing the re-zeroing procedure to ensure the system is functioning properly.

Passenger Presence System Re-zeroing Procedure

NOTE:

- **Before the passenger presence system can be re-zeroed the front passenger seat must be completely empty of all items. The presence of any liquid or items on the front passenger seat will affect the calibration and operation of the passenger presence system.**
- **DTC B0081 will set if the re-zero system test is performed with:**
 - **An aftermarket seat heater located too close to the sensor mat**
 - **A scan tool, laptop, or other electronic device is in the seat**
 - **The seat is damp or wet**
 - **An object or person is in the seat**

1. Verify that the temperature is between 32°F to 100°F before running a re-zero procedure.
2. Verify the seat is completely dry.

3. Empty the front outboard passenger seat.
4. Verify that all SIR and passenger presence system components, connectors, and connector position assurances are properly connected and mounted.
5. Install a scan tool.
6. Turn ON the ignition, with the engine OFF.

NOTE: **The presence of current DTCs, except DTC B0081 11 or B0081 4B, will prevent the passenger presence system from re-zeroing and may set additional DTCs.**

7. With a scan tool, perform the Passenger Presence Sensor Learn procedure.
8. If the test fails, confirm that the seat is empty and completely dry. Perform the Passenger Presence Sensor Learn test again. If the test fails again, verify DTC B0081 is not set as current, if the DTC is set refer to **Diagnostic Trouble Code (DTC) List - Vehicle** . If the test successfully completed, cycle the ignition OFF.
9. After the passenger presence system has been successfully re-zeroed, perform the **Diagnostic Repair Verification** .

SYMPTOMS - SIR

NOTE: **Complete the following steps before using the symptom tables:**

1. Perform **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The inflatable restraint sensing and diagnostic module (SDM) can communicate via the serial data link.
2. Review the SIR system description and operation in order to familiarize yourself with the system functions. Refer to **Supplemental Inflatable Restraint System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the SIR system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to **Airbag Indicator Malfunction (Passenger)**, **Airbag Indicator Malfunction (Driver)** in order to diagnose the symptom.

AIRBAG INDICATOR MALFUNCTION (DRIVER)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

When the ignition is turned ON the driver air bag indicator will illuminate, and then turn OFF after the bulb check is complete. The inflatable restraint sensing and diagnostic module (SDM) performs diagnostic tests on the SIR system during the bulb check. If any malfunction exists the inflatable restraint sensing and diagnostic module will request the instrument cluster to illuminate the air bag indicator steady, via serial data. If a preexisting malfunction exists, the air bag indicator will illuminate steady immediately after the ignition is turned ON. If the ignition 1 voltage is outside of the normal operating voltage range of 9-16 V, the inflatable restraint sensing and diagnostic module will command the instrument cluster to illuminate the air bag indicator ON, even with no DTCs present, and then disable all deployment loops.

Diagnostic Aids

- A DTC B1370 may set if the ignition 1 circuit is outside the 9-16 V range.
- A flashing driver air bag indicator is displayed if the inflatable restraint sensing and diagnostic module was programmed but did not fully complete the programming. For a flashing driver airbag indicator, refer to **Inflatable Restraint Sensing and Diagnostic Module Programming and Setup** .

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**

- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the air bag indicator turns ON and OFF when commanding the All Indicators ON and OFF with a scan tool.
 - **If the air bag indicator does not turn ON or OFF**

Replace the P16 Instrument Cluster.

- **If the air bag indicator does turn ON or OFF**

2. Replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **SIR/SRS Wiring Repairs**
- **Control Module References** for instrument cluster or inflatable restraint sensing and diagnostic module replacement, programming and setup

AIRBAG INDICATOR MALFUNCTION (PASSENGER)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Passenger Air Bag OFF Indicator Control	2	2*	4	-
Passenger Air Bag ON Indicator Control	3	3*	5	-
Passenger Air Bag Disable Indicator Ground	-	1	1	-
1. Both indicators always OFF				

2. The OFF indicator will not illuminate
 3. The ON indicator will not illuminate
 4. The OFF indicator always ON
 5. The ON indicator always ON
- * High resistance may cause the appropriate indicator to illuminate less bright than normal

Circuit/System Description

The passenger air bag ON/OFF indicators are used to notify the driver when the passenger presence system has enabled or disabled the passenger instrument panel air bag. When the ignition is turned ON, the ignition voltage is supplied to the passenger presence module. When the inflatable restraint sensing and diagnostic module (SDM) receives the appropriate serial data message from the passenger presence module the SDM will then provide voltage to the appropriate indicator.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: The passenger air bag ON and OFF indicators may not operate as expected if there are supplemental inflatable restraint (SIR) DTCs. Repair all SIR DTCs before proceeding with this diagnostic.

1. Ignition ON.

2. With a scan tool command the passenger air bag ON indicator and passenger air bag OFF indicator ON and OFF. The respective indicators should turn ON and OFF as commanded.

Circuit/System Testing

NOTE: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected:

- Passenger air bag disable on/off indicator.
- Passenger air bag disable on/off indicator wiring harness.

1. Ignition OFF.
2. Disconnect the harness connector at the P14 passenger air bag disable indicator.
3. Test for less than 10 ohms between the ground circuit terminal 4 and ground.

- **If 10 ohms or greater**

Repair the open/high resistance in the circuit.

- **If less than 10 ohms**

4. Ignition ON.
5. With a scan tool, command the passenger air bag OFF indicator OFF.
6. Test for less than 11 V between the control circuit terminal 5 and ground.

- **If 11 V or greater**

1. Ignition OFF.
2. Disconnect the harness connector at the K36 SDM.
3. Ignition ON.
4. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K36 SDM.

- **If less than 11 V**

7. With a scan tool, command the passenger air bag OFF indicator ON.
8. Test for greater than 11 V between the control circuit terminal 5 and ground.

- **If 11 V or less**

1. Disconnect the harness connector at the K36 SDM.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 SDM.

- **If greater than 11 V**

9. With a scan tool, command the passenger air bag ON indicator OFF.
10. Test for less than 11 V between the control circuit terminal 2 and ground.
 - **If 11 V or greater**
 1. Ignition OFF.
 2. Disconnect the harness connector at the K36 SDM.
 3. Ignition ON.
 4. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K36 SDM.
 - **If less than 11 V**
11. With a scan tool, command the passenger air bag ON indicator ON.
12. Test for greater than 11 V between the control circuit terminal 2 and ground.
 - **If 11 V or less**
 1. Disconnect the harness connector at the K36 SDM.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K36 SDM.
 - **If greater than 11 V**
13. Replace the P14 passenger air bag disable indicator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for SDM replacement, programming and setup

SIR DISABLING AND ENABLING

SIR component location affects how a vehicle should be serviced. There are parts of the SIR system installed in various locations around a vehicle. To find the location of the SIR components refer to **Supplemental Inflatable Restraint System Description and Operation**.

There are several reasons for disabling the SIR system, such as repairs to the SIR system or servicing a component near or attached to an SIR component. There are several ways to disable the SIR system depending on what type of service is being performed. The following information covers the proper procedures for disabling/enabling the SIR system.

Condition	Action
If the vehicle was involved in an accident with an air	Disconnect the negative battery cable(s) *. Refer to <u>Repairs and Inspections Required After a</u>

bag deployment.	<u>Collision.</u>
When performing SIR diagnostics.	Follow the appropriate SIR service manual diagnostic procedure(s) *
When moving, removing or replacing an SIR component or a component attached to an SIR component. (Anytime you remove fasteners.)	Disconnect the negative battery cable(s) *
If the vehicle is suspected of having shorted electrical wires.	Disconnect the negative battery cable(s) *
When performing electrical diagnosis on components other than the SIR system.	Remove the SIR/Airbag fuse(s) when indicated by the diagnostic procedure to disable the SIR system
* DTCs will be lost when the negative battery cable is disconnected.	

SIR Service Precautions

WARNING: When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Failure to observe the correct procedure could cause deployment of the SIR components. Serious injury can occur. Failure to observe the correct procedure could also result in unnecessary SIR system repairs.

The Inflatable Restraint Sensing and Diagnostic Module (SDM) maintains a reserved energy supply. The reserved energy supply provides deployment power for the air bags if the Inflatable Restraint Sensing and Diagnostic Module loses battery power during a collision. Deployment power is available for as much as 2 minutes after disconnecting the vehicle power. Waiting 2 minutes before working on the system after disabling the SIR system prevents deployment of the air bags from the reserved energy supply.

General Service Instructions

The following are general service instructions which must be followed in order to properly repair the vehicle and return it to its original integrity:

- Do not expose air bags to temperatures above 65°C (149°F).
- Verify the correct replacement part number. Do not substitute a component from a different vehicle.
- Use only original GM replacement parts available from your authorized GM dealer. Do not use salvaged parts for repairs to the SIR system.

Discard any of the following components if it has been dropped from a height of 92 cm (3 feet) or greater:

- Inflatable Restraint Sensing and Diagnostic Module (SDM)
- Any air bag
- Driver steering wheel air bag coil
- Any impact sensor
- Seat belt anchor and/or retractor pretensioners
- Passenger presence module and/or occupant sensor

Disabling Procedure - Air Bag Fuse

1. Turn the steering wheel so that the vehicles wheels are pointing straight ahead.
2. Place the ignition in the OFF position.

WARNING: The SDM may have more than one fused power input. To ensure there is no unwanted SIR deployment, personal injury, or unnecessary SIR system repairs, remove all fuses supplying power to the SDM. With all SDM fuses removed and the ignition switch in the ON position, the AIR BAG warning indicator illuminates. This is normal operation, and does not indicate a SIR system malfunction.

3. Locate and remove the fuse(s) supplying power to the Inflatable Restraint Sensing and Diagnostic Module. Refer to **SIR Schematics**, or **Electrical Center Identification Views** .
4. Wait 2 minutes before working on the system.

Enabling Procedure - Air Bag Fuse

1. Place the ignition in the OFF position.
2. Install the fuse(s) supplying power to the Inflatable Restraint Sensing and Diagnostic Module. Refer to **SIR Schematics**, or **Electrical Center Identification Views** .
3. Turn the ignition switch to the ON position. The AIR BAG indicator will illuminate or flash then turn OFF.
4. Perform the Diagnostic System Check - Vehicle if the AIR BAG warning indicator does not operate as described. Refer to **Diagnostic System Check - Vehicle** .

Disabling Procedure - Negative Battery Cable

1. Turn the steering wheel so that the vehicles wheels are pointing straight ahead.
2. Place the ignition in the OFF position.
3. Disconnect the negative battery cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Wait 2 minutes before working on system.

Enabling Procedure - Negative Battery Cable

1. Place the ignition in the OFF position.
2. Connect the negative battery cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Turn the ignition switch to the ON position. The AIR BAG indicator will illuminate or flash then turn OFF.
4. Perform the Diagnostic System Check - Vehicle if the AIR BAG warning indicator does not operate as described. Refer to **Diagnostic System Check - Vehicle** .

REPAIR INSTRUCTIONS

SIR SERVICE PRECAUTIONS

General Service Instructions

WARNING: When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.

NOTE: The Inflatable Restraint Sensing and Diagnostic Module (SDM) maintains a reserved energy supply. The reserved energy supply provides deployment power for the SIR air bags. Deployment power may be available for up to 2 minutes after disconnecting the vehicle power. Disabling the SIR system prevents deployment of the SIR air bags from the reserved energy supply.

NOTE: The following are general service instructions which must be followed in order to properly repair the vehicle and return it to its original integrity:

- Do not expose air bags to temperatures above 85 °C (185 °F)
- Verify the correct replacement part number. Do not substitute a component from a different vehicle
- Use only original GM replacement parts available from your authorized GM dealer. Do not use salvaged parts for repairs to the SIR system

NOTE: Discard any of the following components if it has been dropped from a height of 80 cm (15.75 in) or greater:

- Inflatable Restraint Sensing and Diagnostic Module
- Passenger instrument panel air bag
- Driver steering wheel air bag
- Driver steering wheel air bag coil
- Roof rail air bags
- Front and /or side impact sensors
- Seat belt anchor and/or retractor pretensioners
- Front seat side air bag
- Knee air bag

FRONT END INFLATABLE RESTRAINT DISCRIMINATING SENSOR REPLACEMENT

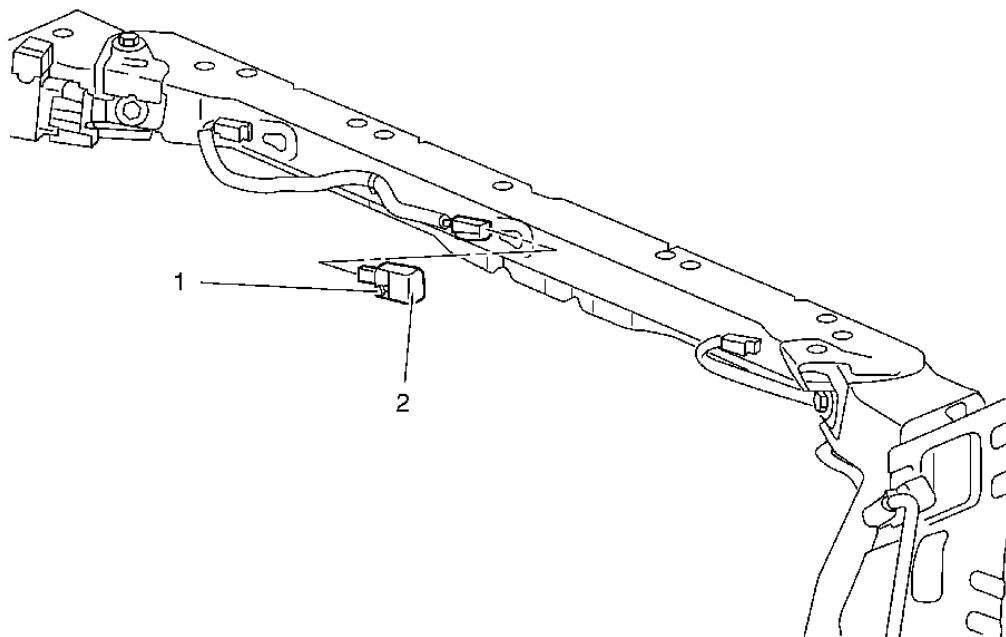


Fig. 5: Front End Inflatable Restraint Discriminating Sensor
 Courtesy of GENERAL MOTORS COMPANY

Front End Inflatable Restraint Discriminating Sensor Replacement

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u> .	
Preliminary Procedure Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u> .	
1	Front End Inflatable Restraint Discriminating Sensor Fastener Procedure <ol style="list-style-type: none"> 1. Release the fastener from the front end inflatable restraint discriminating sensor. 2. Disconnect the electrical connector.
2	Front End Inflatable Restraint Discriminating Sensor Procedure Push the front end inflatable restraint discriminating sensor to the left and pull it out from the front end upper tie bar.

AIRBAG SIDE IMPACT SENSOR REPLACEMENT

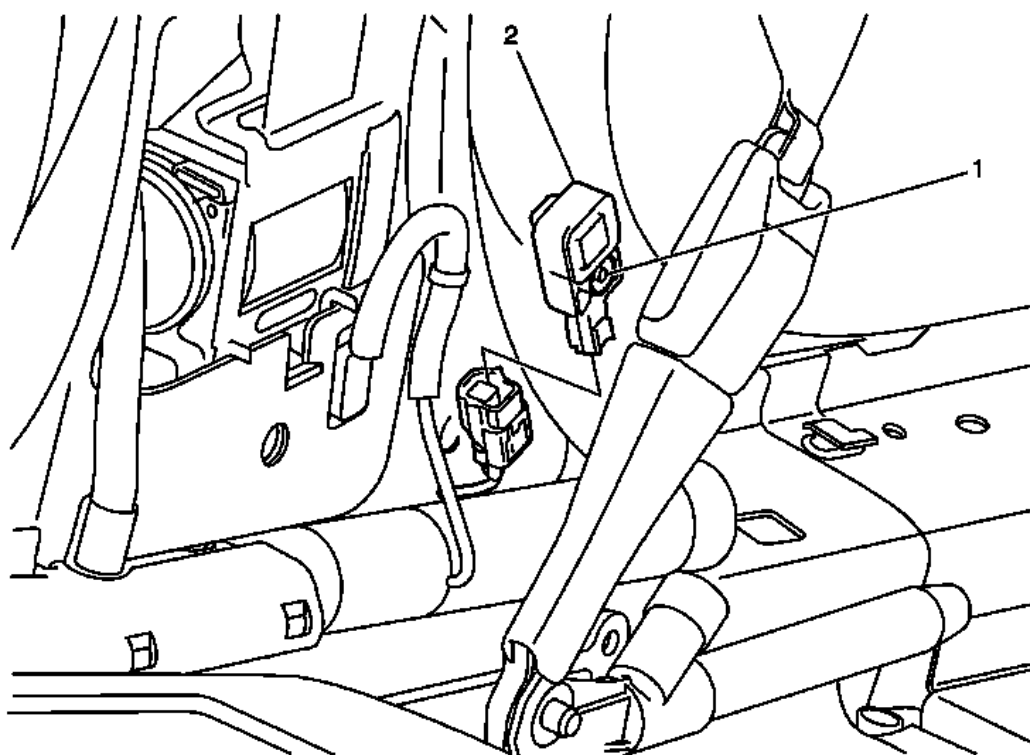


Fig. 6: Inflatable Restraint Side Impact Sensor
Courtesy of GENERAL MOTORS COMPANY

Airbag Side Impact Sensor Replacement

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u> .	
Preliminary Procedures <ol style="list-style-type: none"> 1. Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u>. 2. Remove the front and rear side door sill trim plate. Refer to <u>Front and Rear Side Door Sill Trim Plate Replacement</u> . 	
1	Inflatable Restraint Side Impact Sensor Fastener Procedure <ol style="list-style-type: none"> 1. Loosen the fasteners and slide the sensor out of the keyhole slots. 2. The bolts are integral to the sensor assembly, DO NOT remove separately. 3. Disconnect the electrical connector.
2	Inflatable Restraint Side Impact Sensor Procedure Push the inflatable restraint side impact sensor upwards and pull it from the C-pillar.

AIRBAG STEERING WHEEL MODULE REPLACEMENT

Removal Procedure

WARNING: After installation of the steering wheel airbag module to the steering wheel, slightly pull the module outward. If there is no give on the airbag module then it is secured correctly. If the airbag module is not fully attached personal injury could result.

WARNING: Refer to SIR Inflator Module Handling and Storage Warning .

WARNING: Refer to SIR Warning .

1. Disable the supplemental inflatable restraint (SIR) system. Refer to SIR Disabling and Enabling.

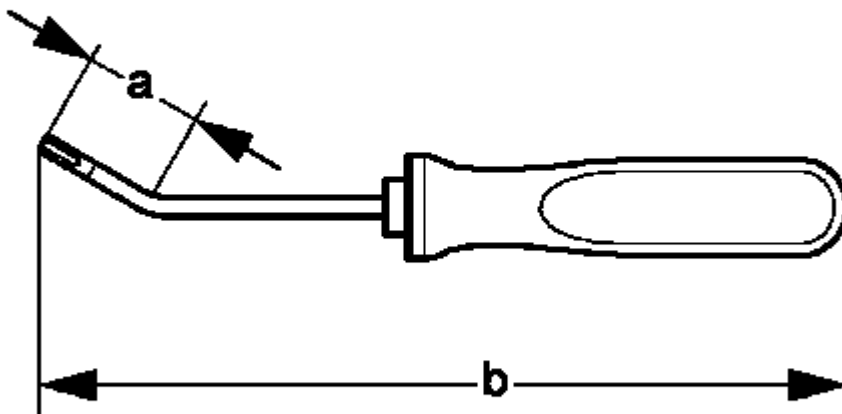


Fig. 7: Special Tool Length And Diameter
Courtesy of GENERAL MOTORS COMPANY

NOTE: Produce a special tool for airbag removal, the tool can be reused.

2. Use a screwdriver or equivalent tool with total length of (b) 180 mm (7.1 in) and a diameter of 3-4 mm (0.1-0.15 in). Bend the tip (a) at 30 mm (1.2 in) by approx. 30 degrees.
3. Lower the steering column and move to the maximum rear end position.
4. Turn the steering wheel to a 3 o'clock and 9 o'clock position so that the holes are at the top.

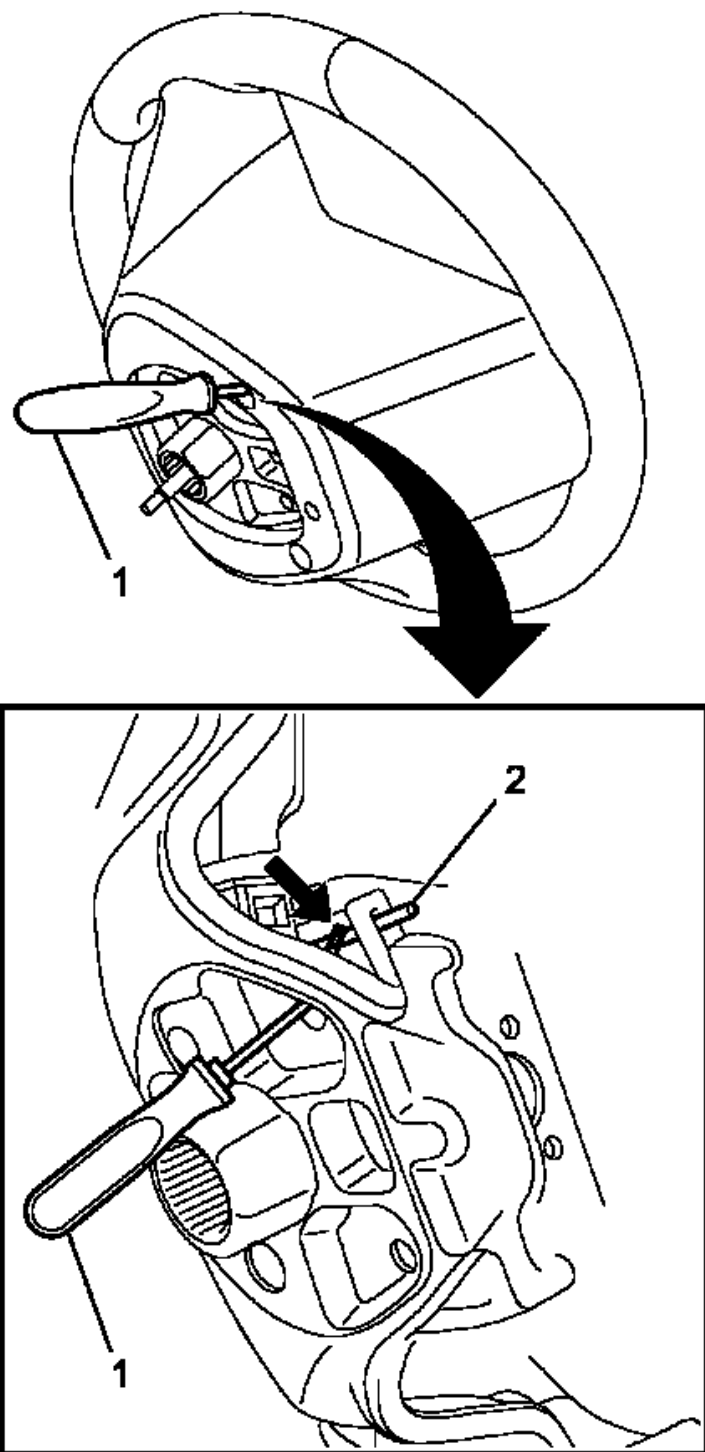


Fig. 8: Inserting Special Tool Through Access Openings
Courtesy of GENERAL MOTORS COMPANY

5. Insert the screw driver (1) through both access openings and push the spring fastener (2) inward to release the steering wheel inflator from the steering wheel.

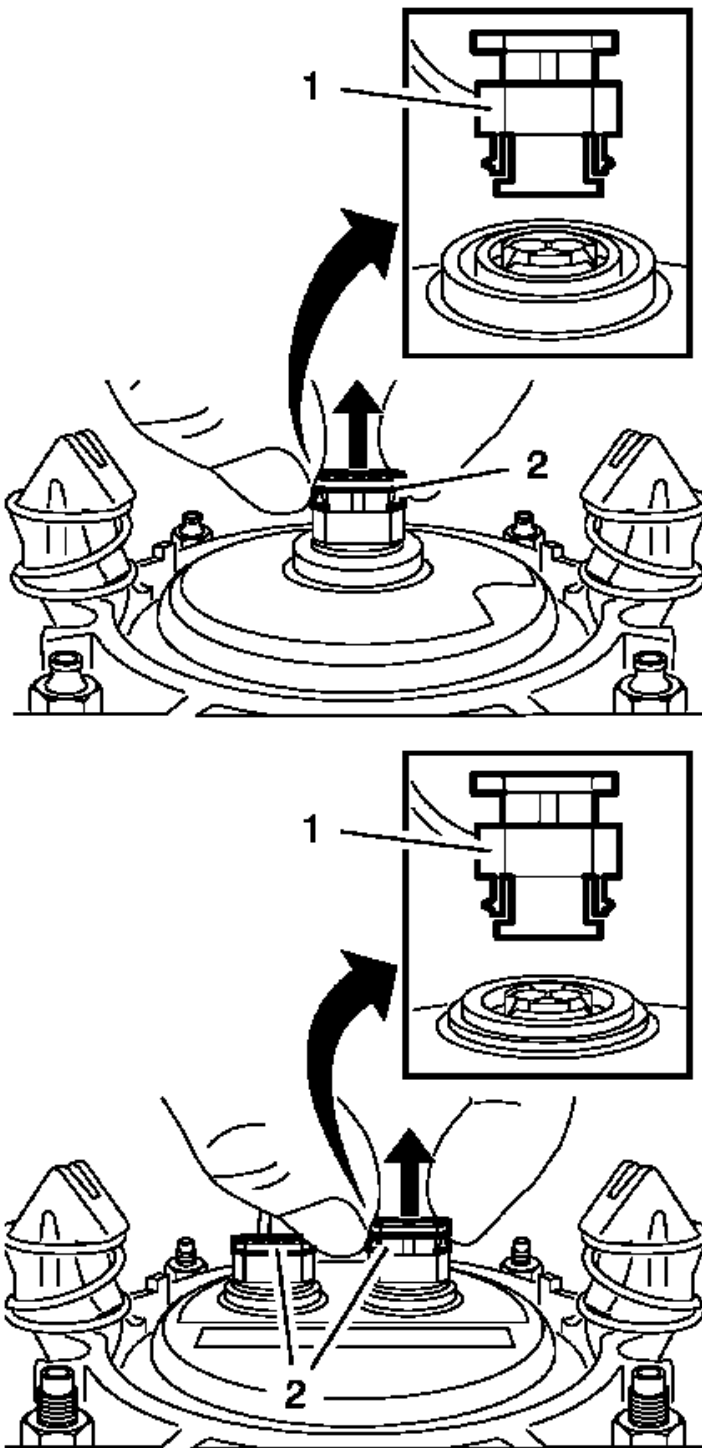


Fig. 9: Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

6. Open secondary locking (2).
7. Disconnect the electrical connectors (1).

8. Remove the steering wheel inflatable restraint module (2).

Installation Procedure

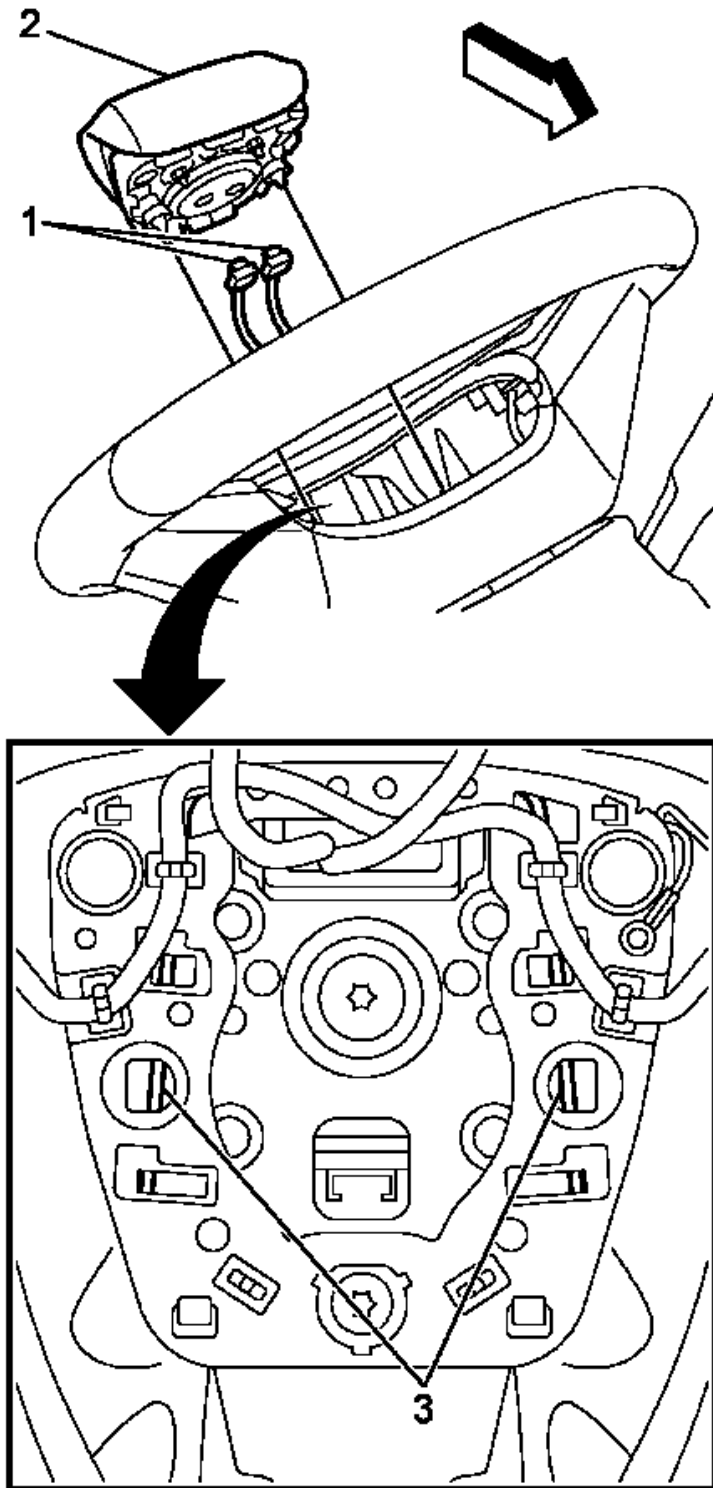


Fig. 10: Aligning Inflatable Restraint Module Fasteners

Courtesy of GENERAL MOTORS COMPANY

1. Connect the electrical connectors (1).
2. Close secondary locking.
3. Align the inflatable restraint module fasteners to the steering wheel spring fastener (3).
4. Push the inflatable restraint module (2) firmly into the steering wheel in order to engage the spring fastener (3).
5. Enable the SIR system. Refer to SIR Disabling and Enabling.
6. Refer to Inflatable Restraint Module Handling and Scrapping.

STEERING WHEEL AIRBAG COIL REPLACEMENT

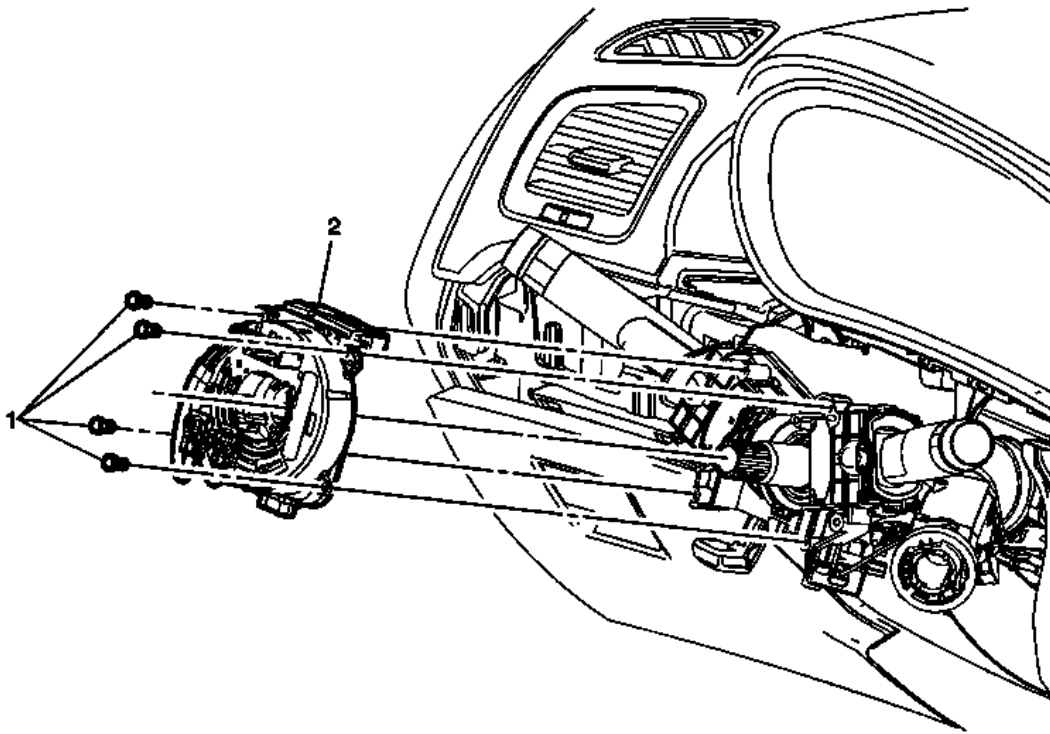


Fig. 11: Steering Wheel Airbag Coil
Courtesy of GENERAL MOTORS COMPANY

Steering Wheel Airbag Coil Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the steering wheel. Refer to <u>Steering Wheel Replacement</u> .	
2. Remove the steering column trim covers. Refer to <u>Steering Column Trim Cover Replacement</u> .	
	Steering Wheel Airbag Coil Fastener (Qty: 4)
	CAUTION:

1	<p>Refer to <u>Fastener Caution</u> .</p> <p>Tighten 3 N.m (27 lb in)</p>
2	<p>Steering Wheel Airbag Coil</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connectors. 2. Transfer the steering angle sensor. Refer to <u>Steering Angle Sensor Replacement</u> . 3. Ensure the coil is centered during installation. If installing a NEW coil, remove the centering tab AFTER the coil is on the steering column. Refer to <u>Airbag Steering Wheel Module Coil Centering</u>.

AIRBAG STEERING WHEEL MODULE COIL CENTERING

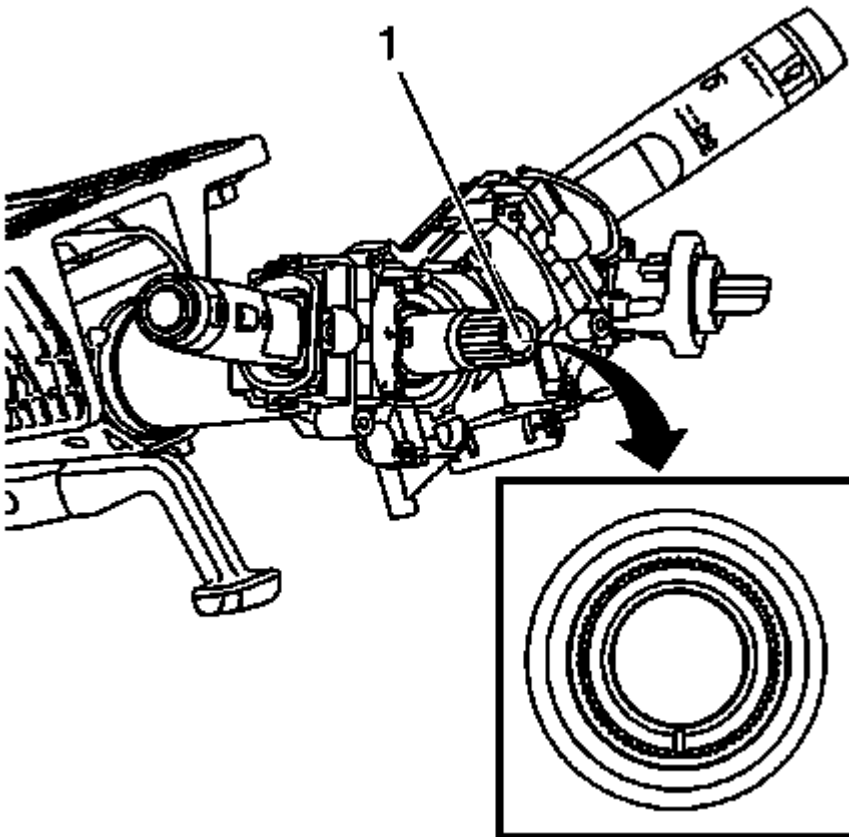


Fig. 12: Steering Shaft Centering Mark
Courtesy of GENERAL MOTORS COMPANY

CAUTION: The new SIR coil assembly will be centered. Improper alignment of

the SIR coil assembly may damage the unit, causing an inflatable restraint malfunction.

1. Verify the following conditions before centering the supplemental inflatable restraint (SIR) steering wheel module coil:
 - The wheels on the vehicle are straight ahead.
 - The centering mark (1) of the steering shaft is in the 6 o'clock position.
2. Turn the lobe of the coil clockwise until the coil ribbon stops. Do not force.
3. Turn the lobe of the coil counterclockwise approximately 3 turns to the neutral position.

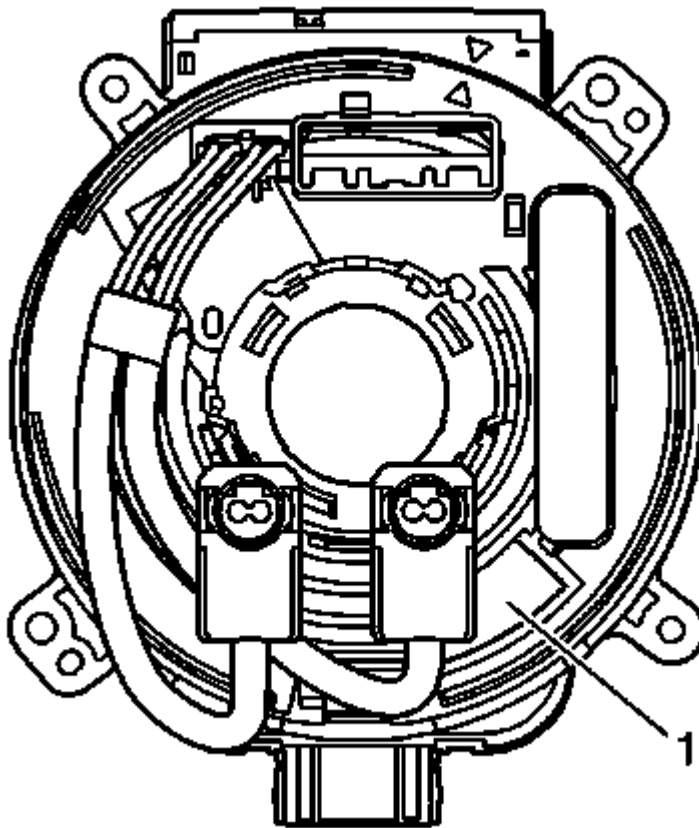


Fig. 13: Locating Centering Window
Courtesy of GENERAL MOTORS COMPANY

NOTE: The quantity of electrical connectors may vary depending upon the content of the vehicle.

4. Properly align the coil until the centering window turns yellow (1). This indicates the CENTER position of the coil.

AIRBAG INSTRUMENT PANEL MODULE REPLACEMENT

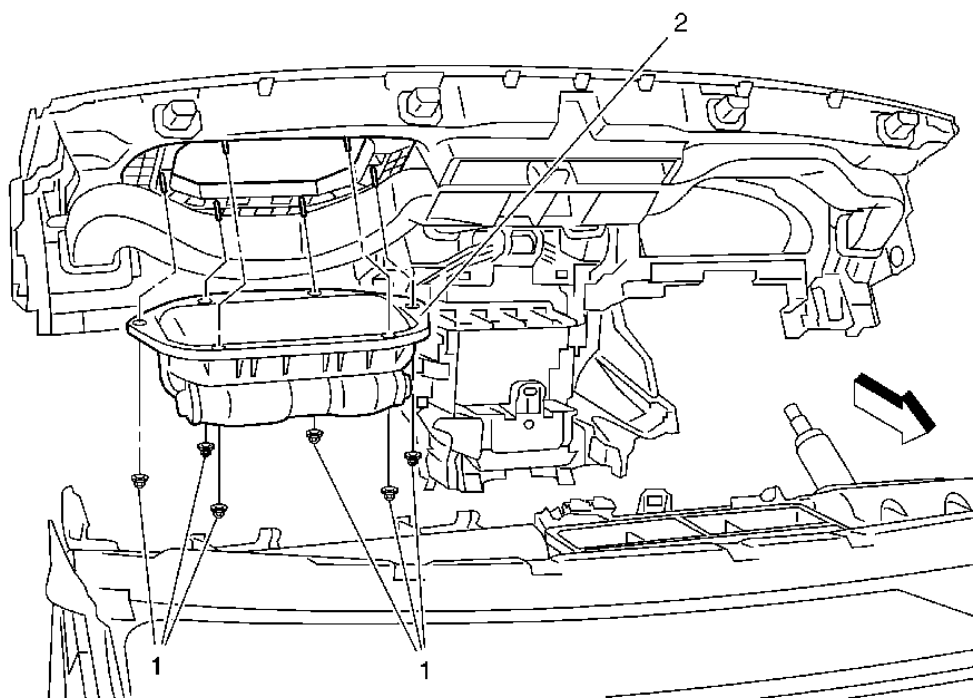


Fig. 14: Instrument Panel Inflatable Restraint Module & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Airbag Instrument Panel Module Replacement

Callout	Component Name
WARNING: Refer to <u>SIR Inflator Module Handling and Storage Warning</u> . WARNING: Refer to <u>SIR Warning</u> .	
Preliminary Procedures 1. Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u> . 2. Remove the instrument panel assembly. Refer to <u>Instrument Panel Assembly Replacement</u> .	
1	Instrument Panel Inflatable Restraint Module Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 5 (44 lb in)
	Instrument Panel Inflatable Restraint Module

2	Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connectors. 2. Refer to <u>Inflatable Restraint Module Handling and Scrapping</u>. <p>NOTE: Replace the accessory wiring harness retainer (passenger airbag retainer), if necessary.</p>

AIRBAG FRONT PASSENGER PRESENCE SENSOR REPLACEMENT

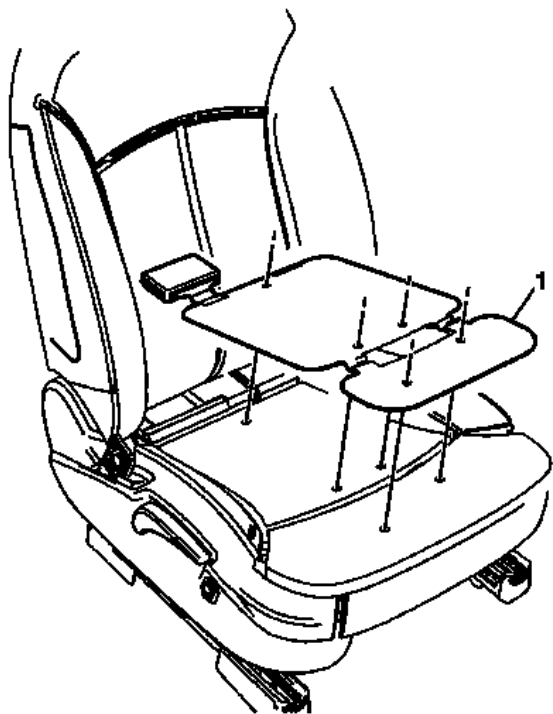


Fig. 15: Inflatable Restraint Front Passenger Presence Sensor
Courtesy of GENERAL MOTORS COMPANY

Airbag Front Passenger Presence Sensor Replacement

Callout	Component Name
<p>WARNING: Refer to <u>SIR Warning</u> .</p> <p>WARNING: Replace the passenger presence system as a complete assembly to prevent possible injury to the occupant. All the components in the service kit are assembled and calibrated as a unit. Using only some of the components in the service kit will cause the passenger presence system to operate improperly.</p>	

WARNING:

To avoid personal injury, perform a preload test on the passenger presence system whenever you remove or replace the seat cushion trim. Failure to do so may cause the system to malfunction.

Preliminary Procedure

1. Disable the SIR system. Refer to. **SIR Disabling and Enabling**
2. Remove the driver or passenger seat. Refer to. **Driver or Passenger Seat Removal and Installation (Oshawa 2/4/6-Way Hybrid, 6-Way Sport)**
3. Remove the front seat cushion cover. Refer to **Front Seat Cushion Cover Replacement (Driver or Passenger Seat 6-Way Hybrid)** , **Front Seat Cushion Cover Replacement (Driver or Passenger Seat 2-Way, 4-Way)** , **Front Seat Cushion Cover Replacement (8-Way Power)** .
4. Remove the front seat cushion pad. Refer to **Driver or Passenger Seat Cushion Pad Replacement (2-Way, 4-Way Hybrid)** , **Driver or Passenger Seat Cushion Pad Replacement (8-Way Power)** .

Inflatable Restraint Front Passenger Presence Sensor

Procedure

- | | |
|---|---|
| 1 | <ol style="list-style-type: none">1. Disconnect the electrical connectors.2. Preload Test the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. <u>Control Module References</u>3. Program the inflatable restraint passenger presence system after replacement. Refer to. <u>Control Module References</u><ul style="list-style-type: none">• The passenger presence system is an integral part of the pad on the passenger seat cushion.• Note the routing of the wiring harness and connector location for installation. |
|---|---|

FRONT SEAT OUTBOARD SEAT BACK AIRBAG REPLACEMENT

Removal Procedures

WARNING: Refer to **SIR Warning** .

1. Disable the SIR system. Refer to **SIR Disabling and Enabling**.
2. Remove driver or passenger seat adjuster finish cover. Refer to **Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)** .
3. Remove driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)** .
4. Remove front seat head restraint. Refer to **Driver or Passenger Seat Head Restraint Replacement (without AHS)** .

5. Remove front seat head restraint guide bezel. Refer to **Front Seat Head Restraint Guide Bezel Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport) , Front Seat Head Restraint Guide Bezel Replacement (8-Way Power)** .
6. Remove the front seat head restraint adjust rod guide. Refer to **Front Seat Head Restraint Guide Replacement** .

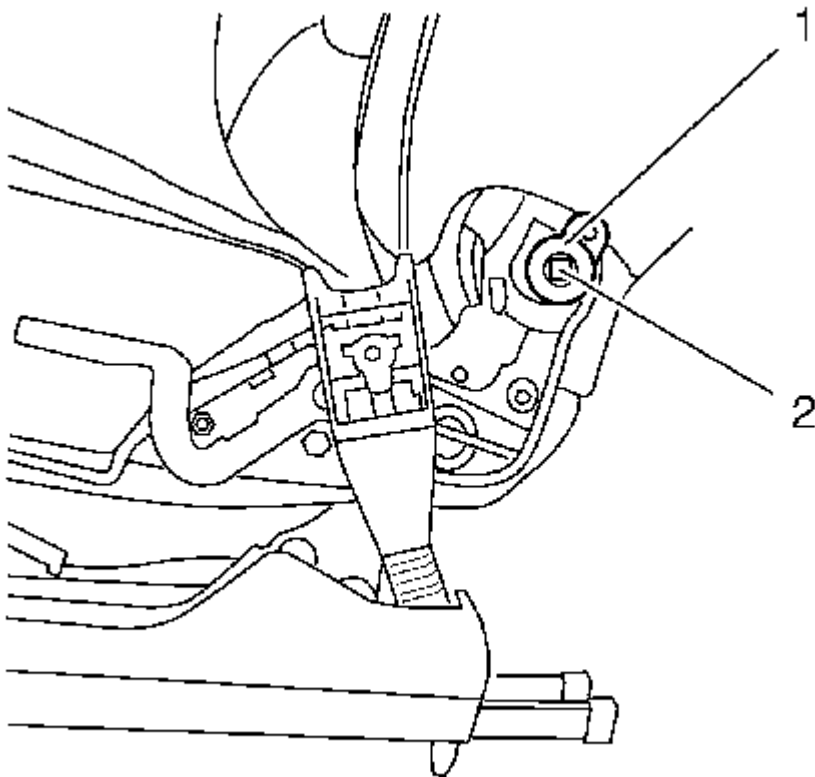


Fig. 16: Recliner Control Shaft And Securing Clip
Courtesy of GENERAL MOTORS COMPANY

7. Clip out securing (1) of recliner control shaft (2).

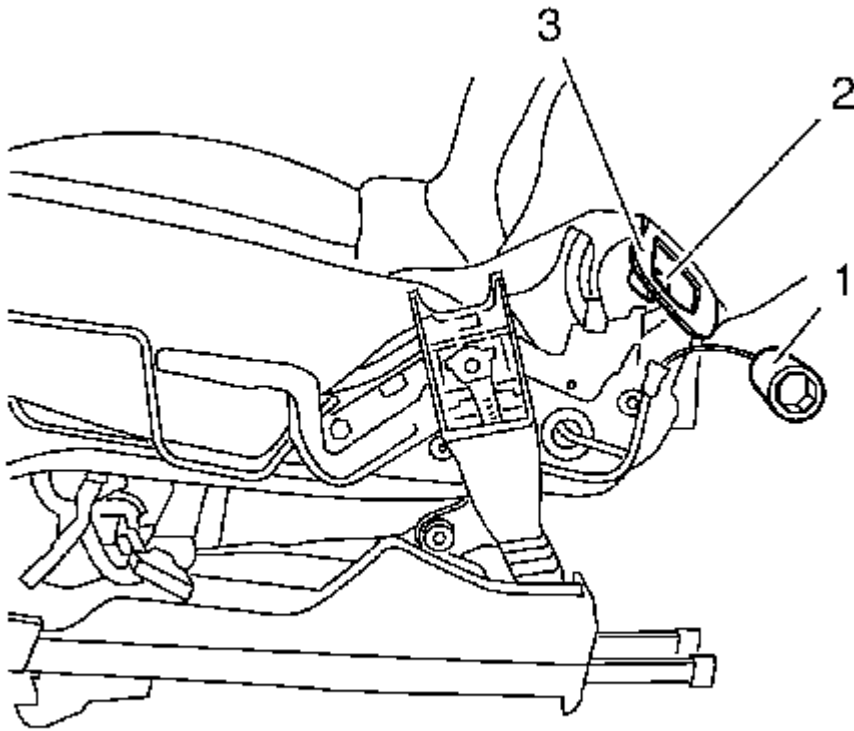


Fig. 17: Recliner Control, Shaft And Cushion Strap
Courtesy of GENERAL MOTORS COMPANY

8. Remove recliner control (1) from recliner shaft (2). Unhinge the cushion strap (3) at seat frame.

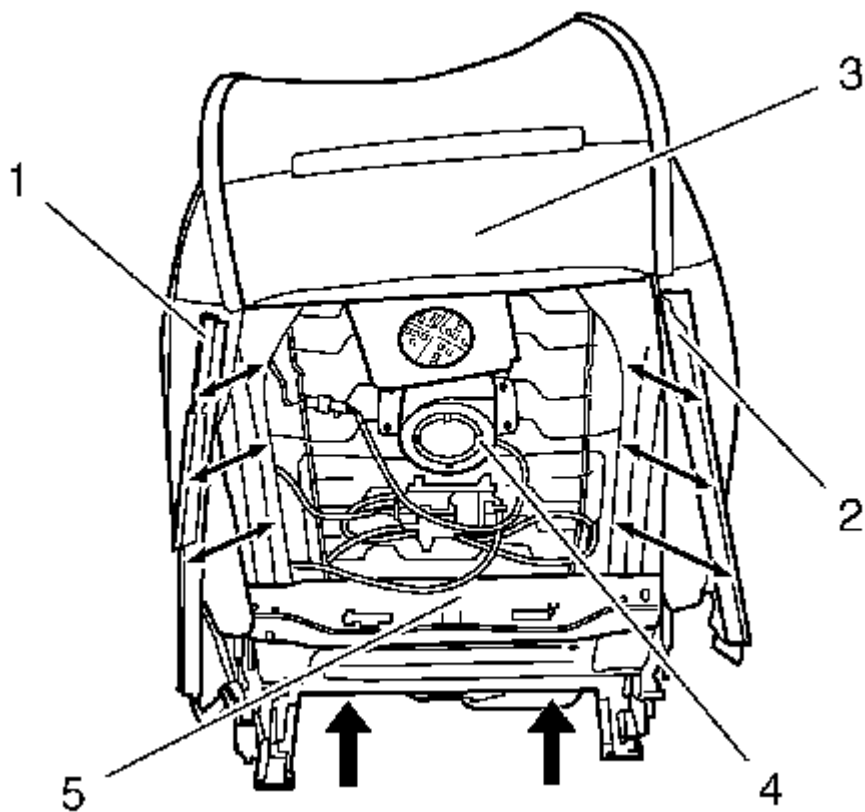


Fig. 18: Front Seat Back Cushion And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

NOTE: For loosening move the cushion upper and pull from backrest frame.

9. Loose the front seat back cushion at backrest left side (1) and right side (2).
10. Clip out the front seat back cushion vent fan mat (3) of vent fan (4). Pull the cushion (5) in front to surface.

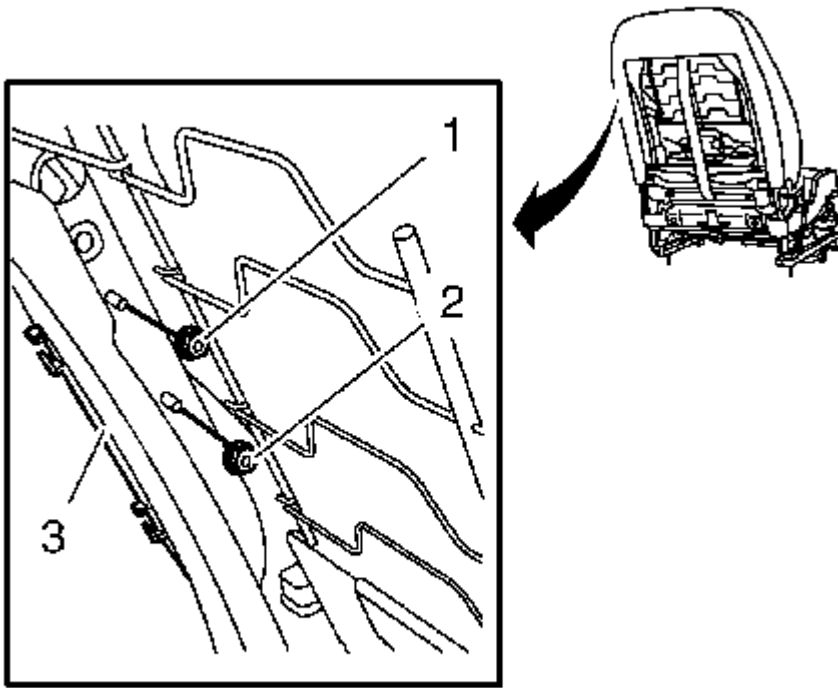


Fig. 19: Seat Side Inflatable Restraint Module And Nuts
Courtesy of GENERAL MOTORS COMPANY

11. Loosen both nuts (1, 2) from seat side inflatable restraint module (3).

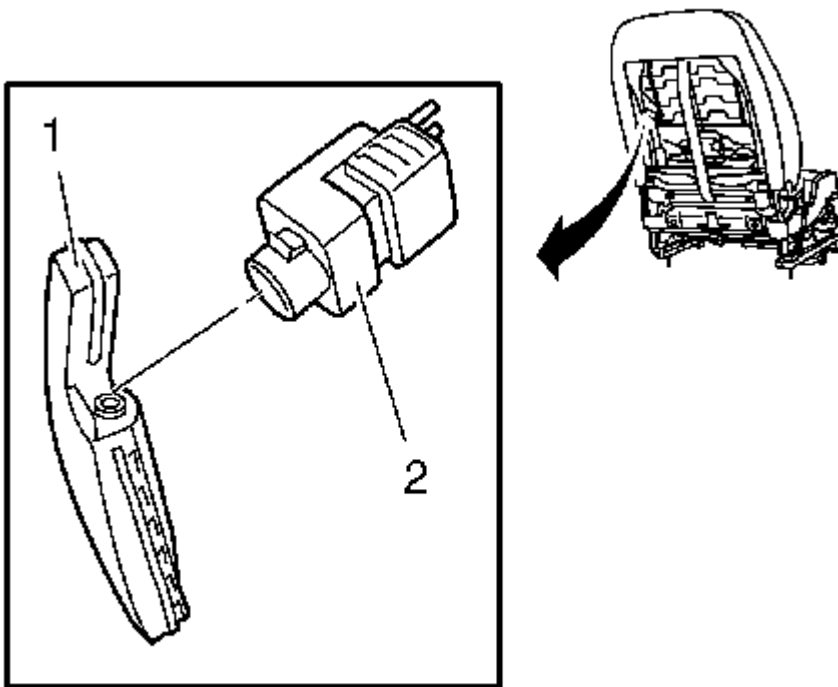


Fig. 20: Wiring Harness Connector And From Seat Side Inflatable Restraint Module
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the wiring harness connector (2) from seat side inflatable restraint module (1).

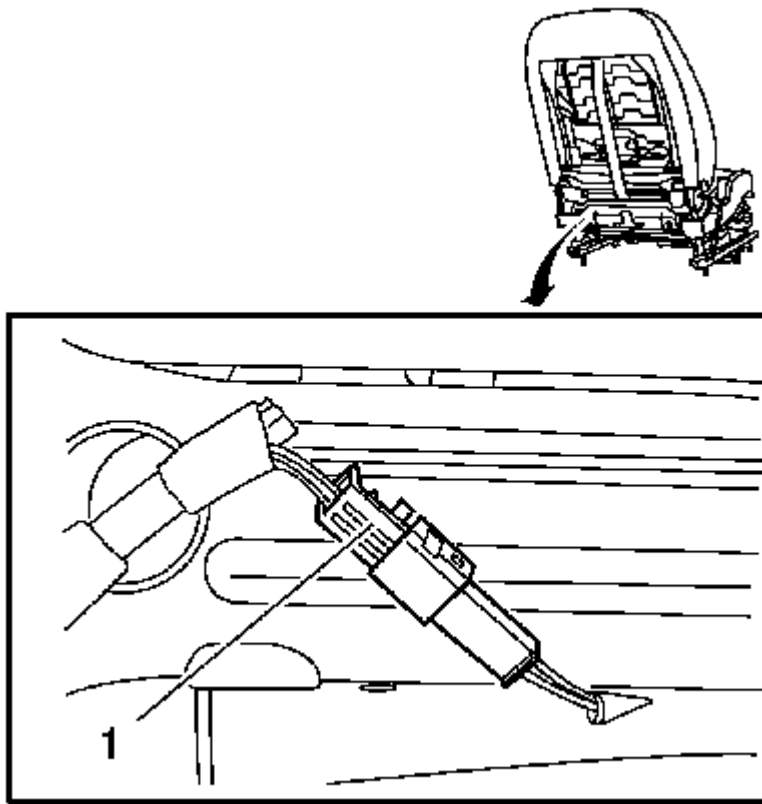


Fig. 21: Wiring Harness Connector And Seat Back Cushion Heater
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect wiring harness connector (1) of the seat back cushion heater.

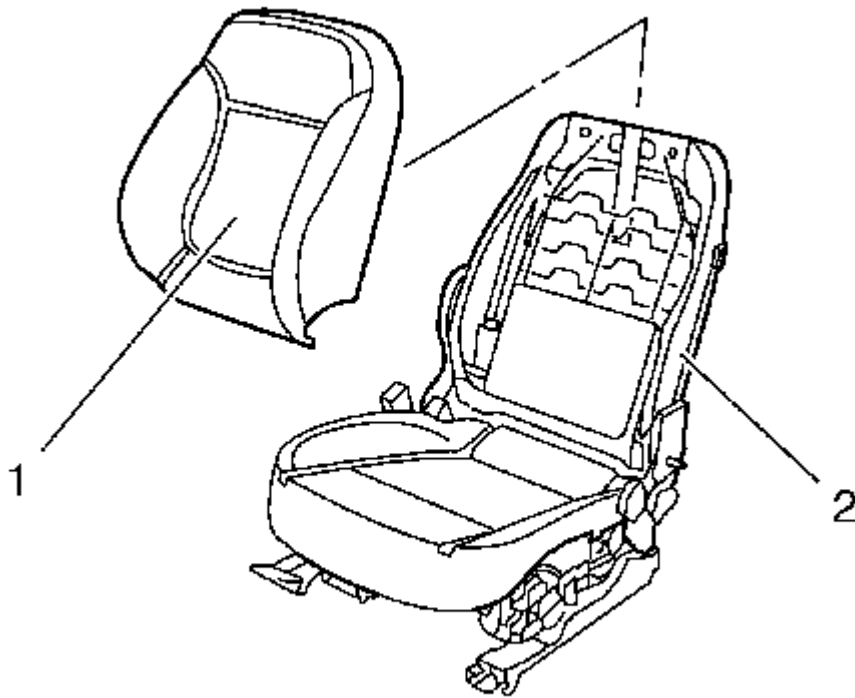


Fig. 22: Front Seat Back Cushion With Cushion Pad And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

14. Remove front seat back cushion with cushion Pad (1) from backrest frame (2).

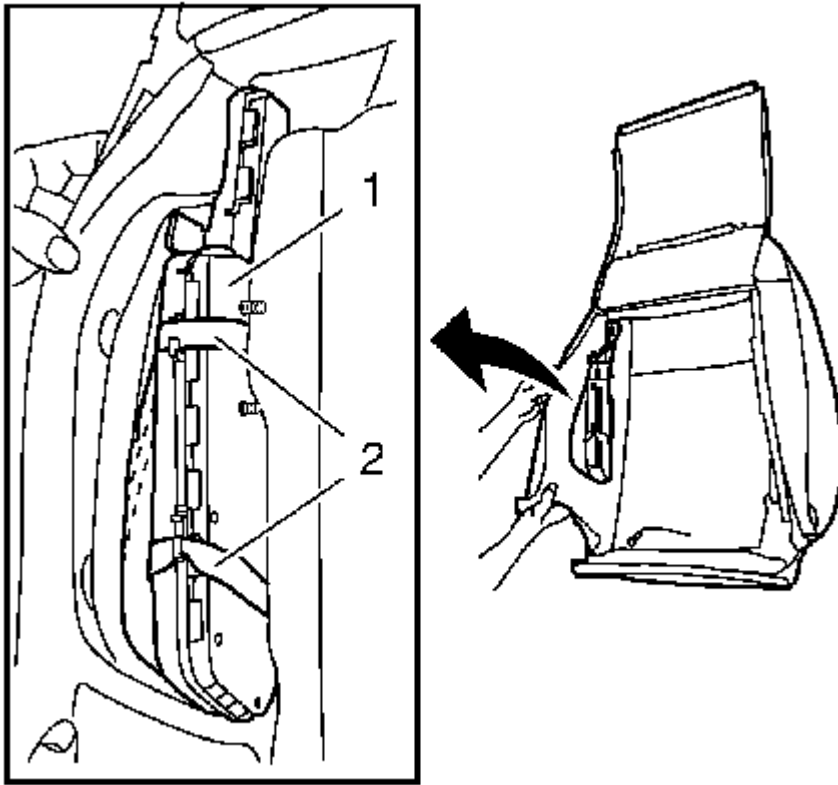


Fig. 23: Seat Side Inflatable Restraint Module And Textile Straps
Courtesy of GENERAL MOTORS COMPANY

15. Remove seat side inflatable restraint module (1) out of the textile straps (2).

Installation Procedures

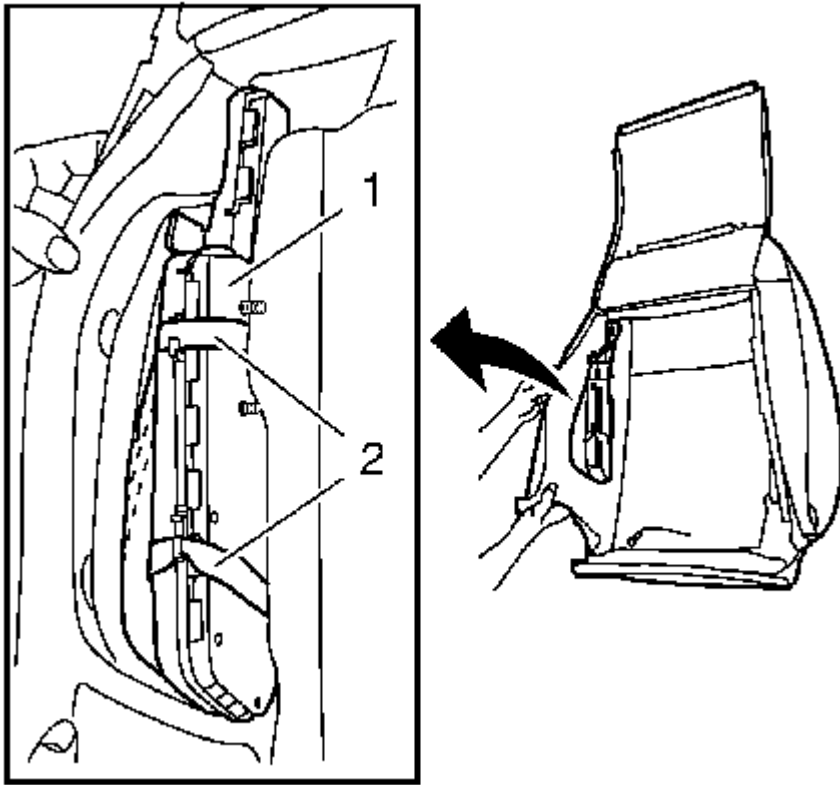


Fig. 24: Seat Side Inflatable Restraint Module And Textile Straps
Courtesy of GENERAL MOTORS COMPANY

1. Install seat side inflatable restraint module (1) at cushion cover with the textile straps (2).

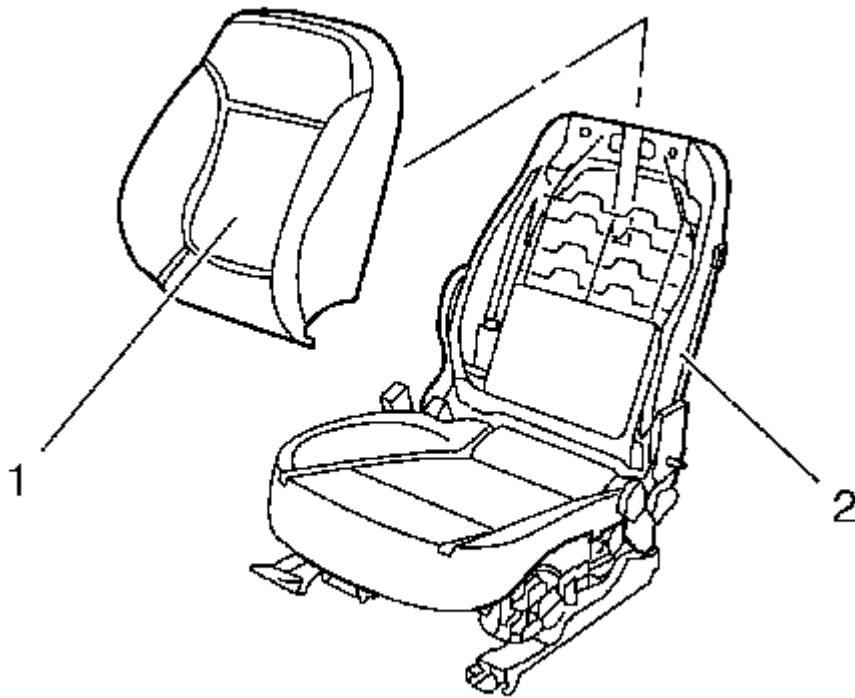


Fig. 25: Front Seat Back Cushion With Cushion Pad And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

2. Install front seat back cushion with cushion pad (1) at the backrest frame (2).

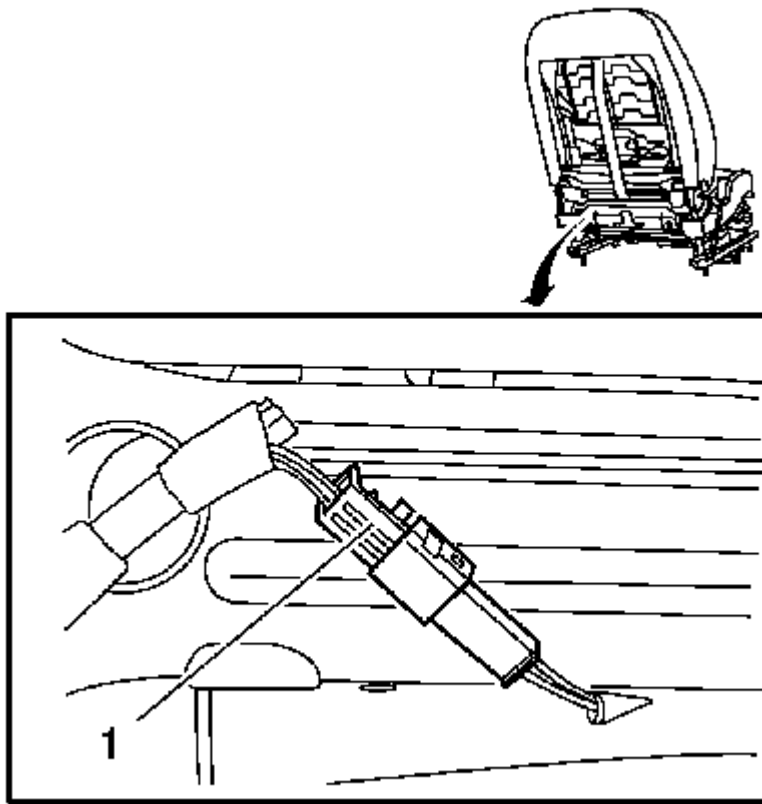


Fig. 26: Wiring Harness Connector And Seat Back Cushion Heater
Courtesy of GENERAL MOTORS COMPANY

3. Connect the wiring harness connector (1) of the seat back cushion heater.

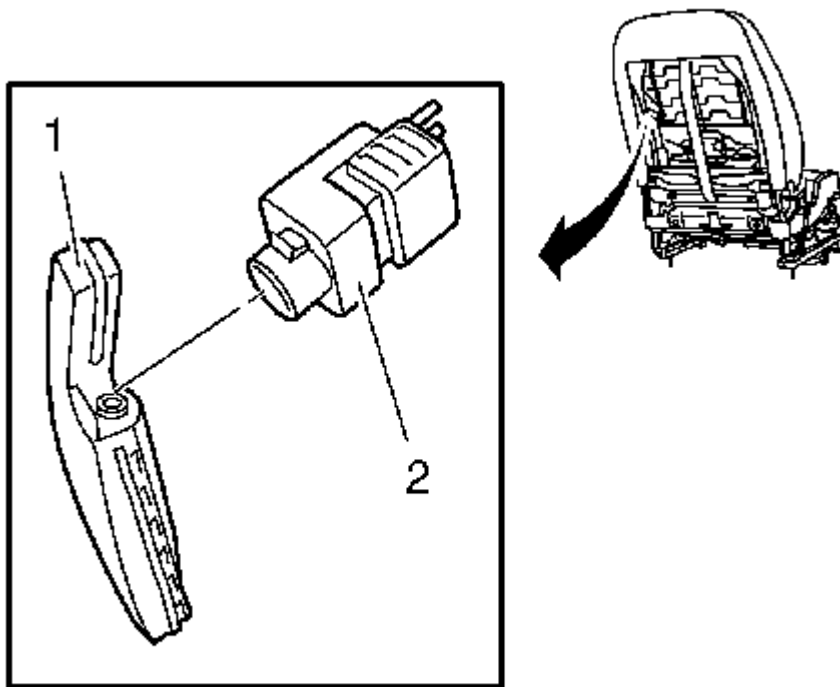


Fig. 27: Wiring Harness Connector And From Seat Side Inflatable Restraint Module
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Proof the correct locking of wiring harness connector (2).**

4. Connect the wiring harness connector (2) from seat side inflatable restraint module (1).

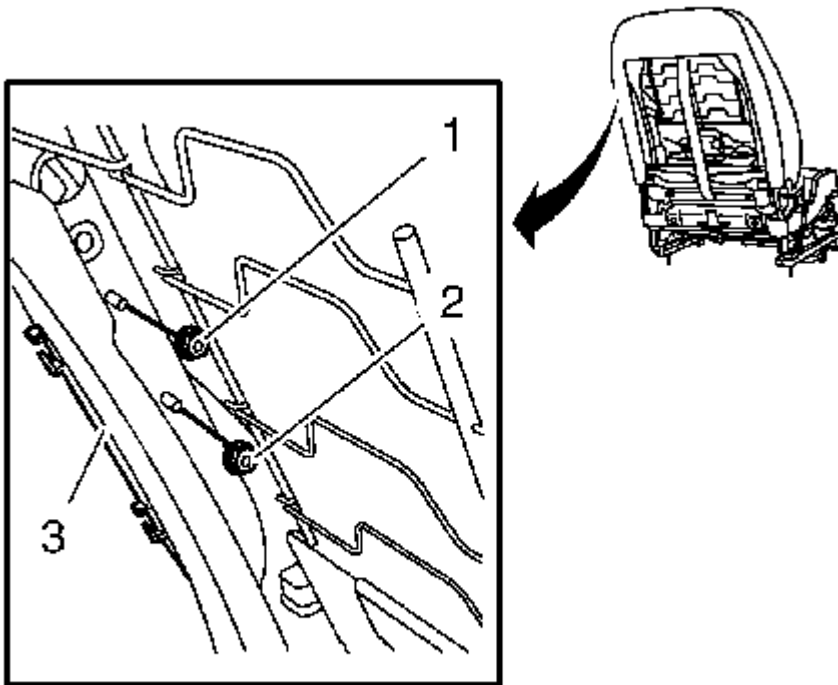


Fig. 28: Seat Side Inflatable Restraint Module And Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Position seat side inflatable restraint module (3) the backrest frame. Screw both nuts (1, 2) from seat side inflatable restraint module (3) and tighten to 3.25 N.m (29 lb in).

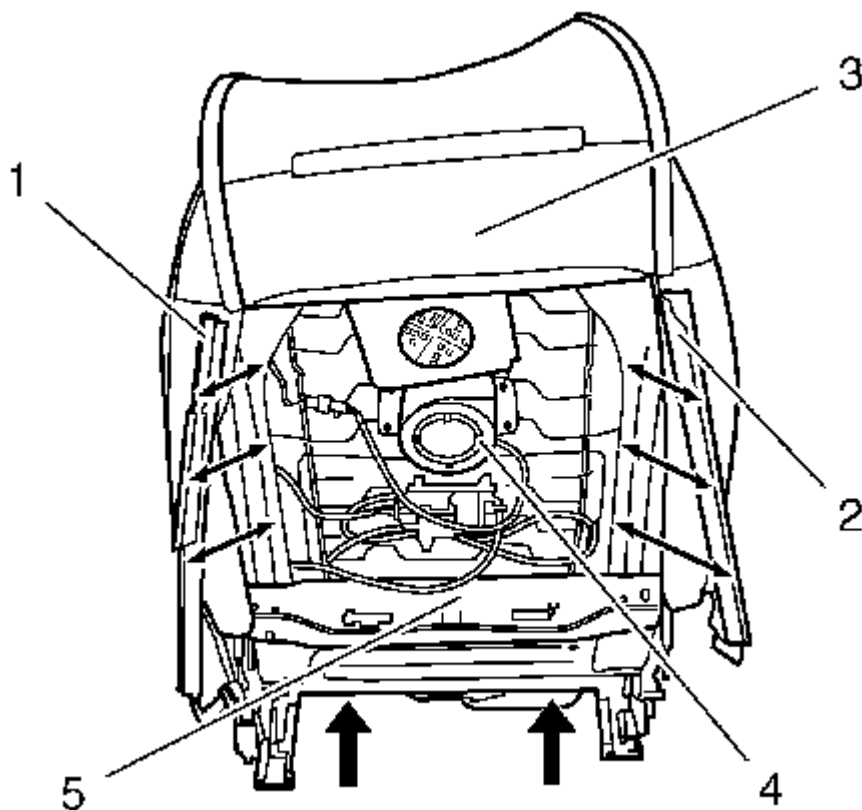


Fig. 29: Front Seat Back Cushion And Backrest Frame
Courtesy of GENERAL MOTORS COMPANY

6. Clip in the front seat back cushion vent fan mat (3) at the vent fan (4). Position the cushion (5).
7. Install front seat back cushion at backrest left side (1) and right side (2).
8. Install the front seat head restraint adjust rod guide. Refer to **Front Seat Head Restraint Guide Replacement** .
9. Install the front seat head restraint guide bezel. Refer to **Front Seat Head Restraint Guide Bezel Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)** , **Front Seat Head Restraint Guide Bezel Replacement (8-Way Power)** .
10. Install the front seat head restraint. Refer to **Driver or Passenger Seat Head Restraint Replacement (without AHS)** .
11. Close the cushion at backrest rear side.
12. Install the driver or passenger seat inner recliner finish cover. Refer to **Driver or Passenger Seat Inner Recliner Finish Cover Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)** .
13. Install the driver or passenger seat adjuster finish cover. Refer to **Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)** .

REAR SEAT OUTBOARD SEAT BACK AIRBAG REPLACEMENT

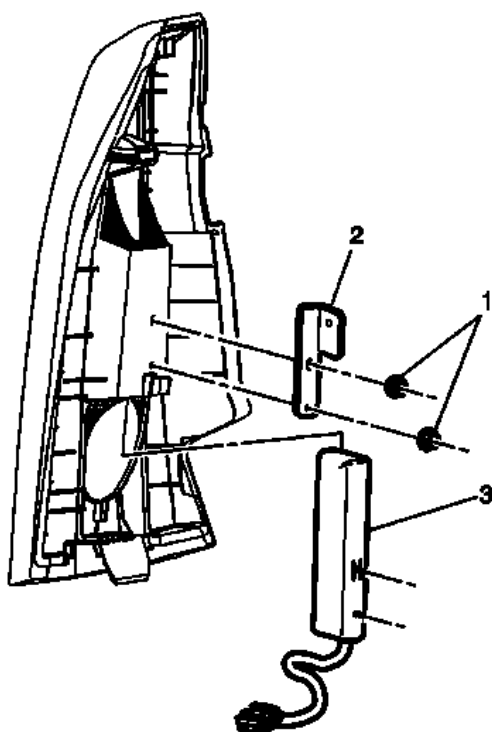


Fig. 30: Rear Seat Outboard Seat Back Airbag
 Courtesy of GENERAL MOTORS COMPANY

Rear Seat Outboard Seat Back Airbag Replacement

Callout	Component Name
WARNING: Following the deployment of a rear seat side air bag, inspect the following parts for damage. Replace these parts if necessary: <ul style="list-style-type: none"> • The rear seat side bolster, attachments, brackets and wiring • The rear seat back frame, cushion and cover • The rear seat cushion frame, cushion and cover Failure to do so may cause future personal injury.	
Preliminary Procedure <ol style="list-style-type: none"> 1. Disable the SIR system, if equipped. Refer to <u>SIR Disabling and Enabling</u>. 2. Remove the rear seat back cushion bolster. Refer to <u>Rear Seat Back Bolster Replacement</u>. 	
1	Rear Seat Side Inflatable Restraint Module Nut (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 3.5 (31 lb in)
2	Rear Seat Side Inflatable Restraint Module Bracket
3	Rear Seat Side Inflatable Restraint Module Procedure <ol style="list-style-type: none"> 1. Remove the connector position assurance (CPA) from the module electrical connector. 2. Disconnect the electrical connector. 3. Slide airbag out of airbag chute. 4. Install seat side airbag into airbag chute with connector facing down. Airbag mounting studs must fit through airbag chute holes and then into the module bracket. 5. Refer to <u>Inflatable Restraint Module Handling and Scrapping</u>.

AIRBAG SIDE IMPACT REAR SENSOR REPLACEMENT

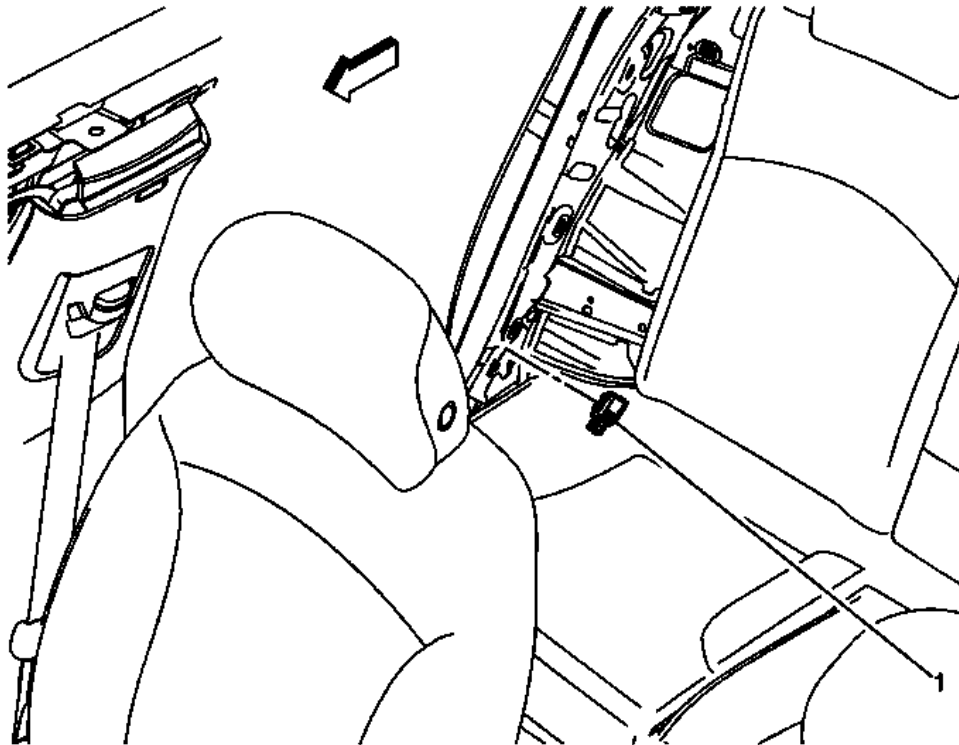


Fig. 31: Airbag Side Impact Rear Sensor
Courtesy of GENERAL MOTORS COMPANY

Airbag Side Impact Rear Sensor Replacement

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u> .	

WARNING:

Refer to SIR Inflator Module Handling and Storage Warning .

WARNING:

Following the deployment of a side impact air bag, inspect the following parts for damage. Replace these parts if necessary:

- The seat cushion frame
- The seat recliner, if equipped
- The seat adjuster
- The seat back frame

Failure to do so may cause future personal injury.

Preliminary Procedures

1. Disable the SIR system. Refer to SIR Disabling and Enabling.
2. Remove the rear seat back cushion bolster. Refer to Rear Seat Back Bolster Replacement .

1	<p>Inflatable Restraint Rear Side Door Side Impact Sensor Assembly</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none">1. Disconnect the electrical connector.2. Loosen the fastener and slide the sensor out of the keyhole slot.3. The bolt is integral to the sensor assembly, DO NOT remove separately. <p>Tighten 7.5 (66 lb in)</p>
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INFLATABLE RESTRAINT CONTROL MODULE REPLACEMENT

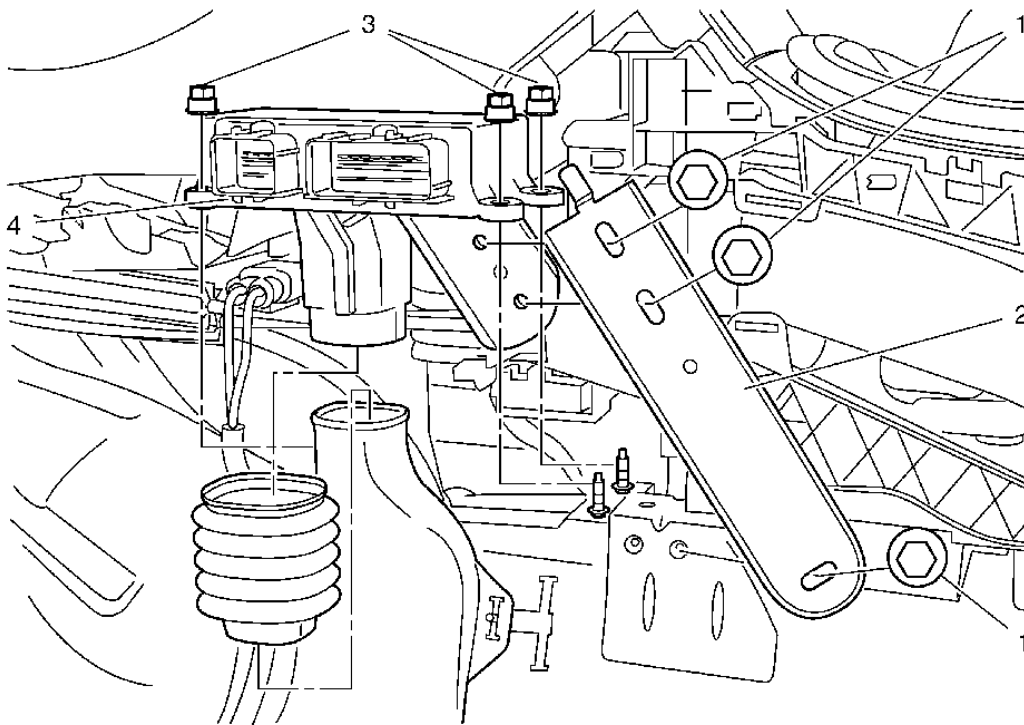


Fig. 32: Inflatable Restraint Control Module
 Courtesy of GENERAL MOTORS COMPANY

Inflatable Restraint Control Module Replacement

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u> .	
Preliminary Procedures	
1. Disable the SIR system. Refer to <u>SIR Disabling and Enabling</u> . 2. Remove the front floor console extension panel. Refer to <u>Front Floor Console Extension Panel Replacement</u> .	
1	Instrument Panel Tie Bar Brace Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Move the front floor carpet left side in the area of the front floor console. Tighten 22 N.m (16 lb ft)
2	Instrument Panel Tie Bar Brace

3	<p>Inflatable Restraint Control Module Fastener (Qty: 3)</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Remove the adapter from the floor rear air outlet duct left side. 2. Disconnect the electrical connectors. <p>Tighten 10 N.m (89 lb in)</p>
4	<p>Inflatable Restraint Control Module</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Tighten down the inflatable restraint control module by all three fasteners. 2. Connect the electrical connectors. 3. Program the inflatable restraint control module after replacement. Refer to <u>Control Module References</u> .

INSTRUMENT PANEL AIRBAG ARMING STATUS DISPLAY REPLACEMENT

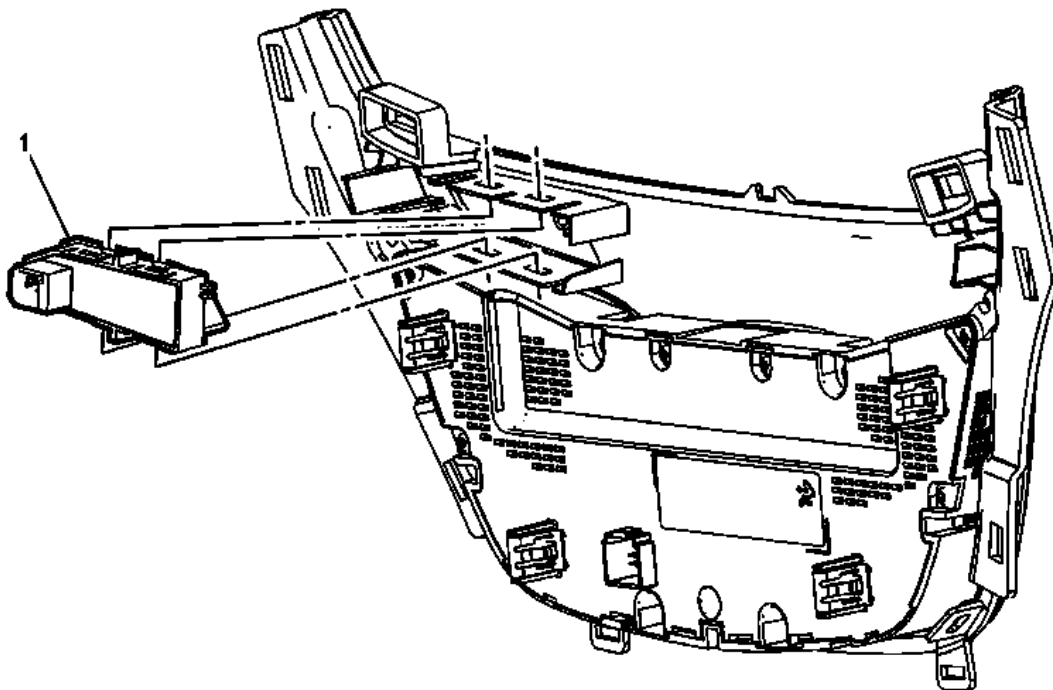


Fig. 33: Instrument Panel Airbag Arming Status Display
Courtesy of GENERAL MOTORS COMPANY

Instrument Panel Airbag Arming Status Display Replacement

Callout	Component Name
Preliminary Procedure Remove the instrument panel accessory trim plate. Refer to <u>Instrument Panel Accessory Trim Plate Replacement</u> .	
1	Instrument Panel Airbag Arming Status Display Assembly Procedure Depress the tabs to release from the instrument panel accessory trim plate.

INFLATABLE RESTRAINT ROOF SIDE RAIL MODULE REPLACEMENT - LEFT SIDE

Removal Procedure

WARNING: Refer to **SIR Inflator Module Handling and Storage Warning** .

WARNING: Refer to **SIR Warning** .

NOTE: The inflatable restraint roof side rail module cannot be removed without destroying it must be replaced.

1. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling**.
2. Remove the headlining trim panel. Refer to **Headlining Trim Panel Replacement (With Sunroof)** , **Headlining Trim Panel Replacement (Without Sunroof)** .
3. Remove the windshield side garnish molding. Refer to **Windshield Side Garnish Molding Replacement** .

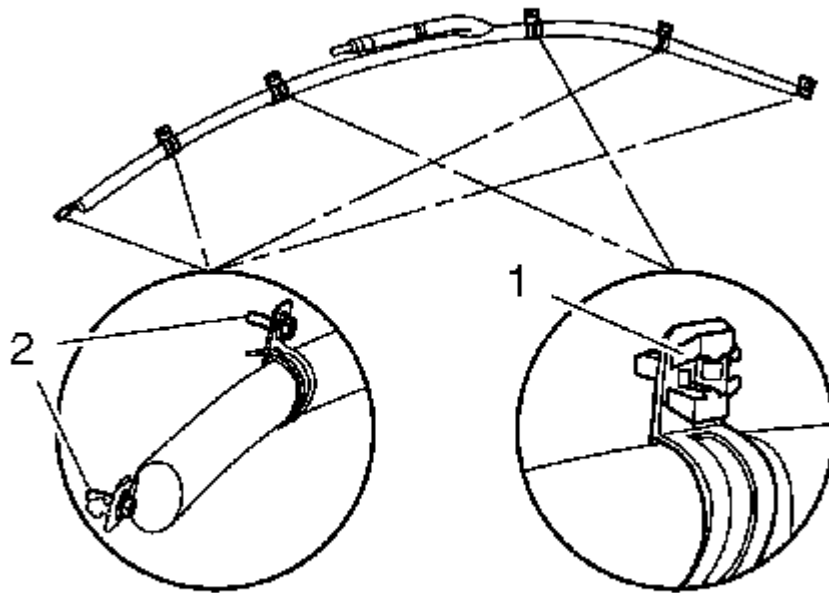


Fig. 34: Side Rail Module Security Clips And Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the 2 security clips (1), and remove the 5 fasteners (2).

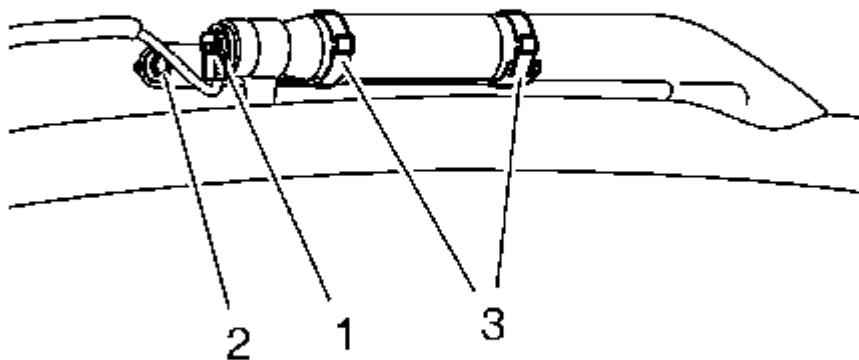


Fig. 35: Wiring Harness Plug

Courtesy of GENERAL MOTORS COMPANY

5. Release and disconnect the wiring harness plug (1).
6. Unscrew the fastener from the inflatable restraint roof side rail module (2).
7. Open the metal clip (3) and remove it.

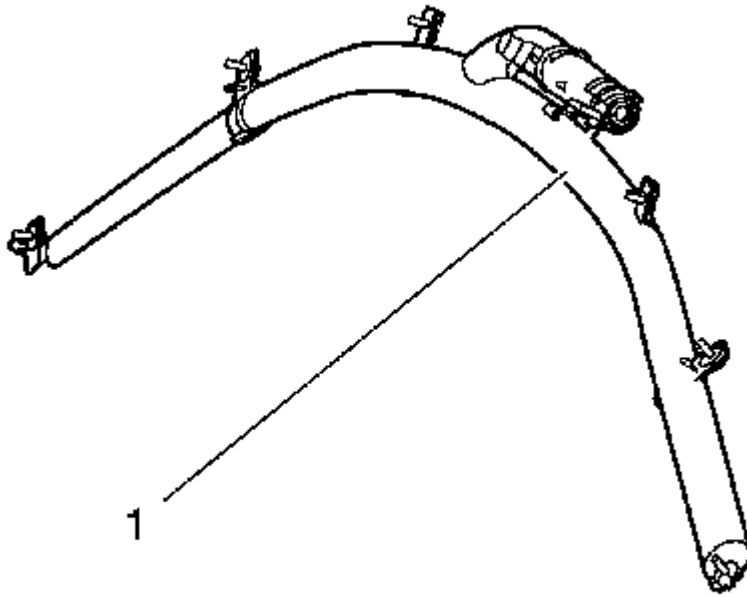


Fig. 36: Inflatable Restraint Roof Side Rail Module
Courtesy of GENERAL MOTORS COMPANY

8. Remove the inflatable restraint roof side rail module (1) from the vehicle.

Installation Procedure

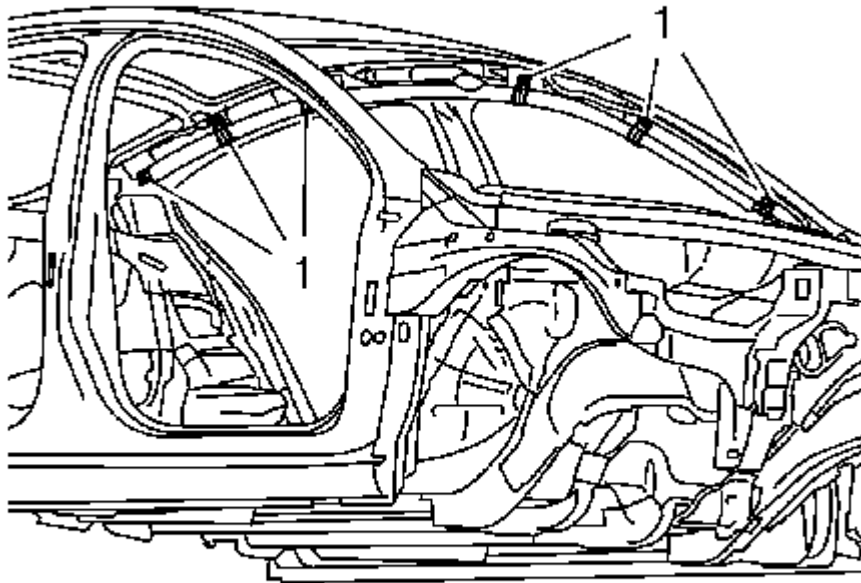


Fig. 37: Positioning And Aligning Inflatable Restraint Roof Side Rail Module
Courtesy of GENERAL MOTORS COMPANY

1. Position and align the inflatable restraint roof side rail module on in the vehicle (1).

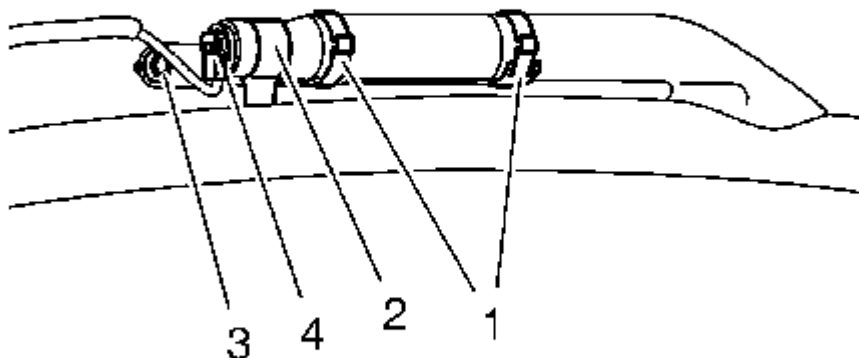


Fig. 38: Inflatable Restraint Roof Side Rail Module And Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: After ignition ON, the airbag system readiness indicator illuminates for 4 seconds and then goes out.

2. Attach the inflatable restraint roof side rail module with new metal clip (1) to the bracket (2).
3. Insert the inflatable restraint roof side rail module fastener (3).
4. Connect the wiring harness plug (4).
5. Install the headlining trim panel. Refer to **Headlining Trim Panel Replacement (With Sunroof)** , **Headlining Trim Panel Replacement (Without Sunroof)** .
6. Install the windshield side garnish molding. Refer to **Windshield Side Garnish Molding Replacement** .

INFLATABLE RESTRAINT ROOF SIDE RAIL MODULE REPLACEMENT - RIGHT SIDE

Removal Procedure

WARNING: Refer to **SIR Inflator Module Handling and Storage Warning** .

WARNING: Refer to SIR Warning .

NOTE: The inflatable restraint roof side rail module cannot be removed without destroying it must be replaced.

1. Disable the supplemental inflatable restraint (SIR) system. Refer to SIR Disabling and Enabling.
2. Remove the headlining trim panel. Refer to Headlining Trim Panel Replacement (With Sunroof) , Headlining Trim Panel Replacement (Without Sunroof) .
3. Remove the windshield side garnish molding. Refer to Windshield Side Garnish Molding Replacement .

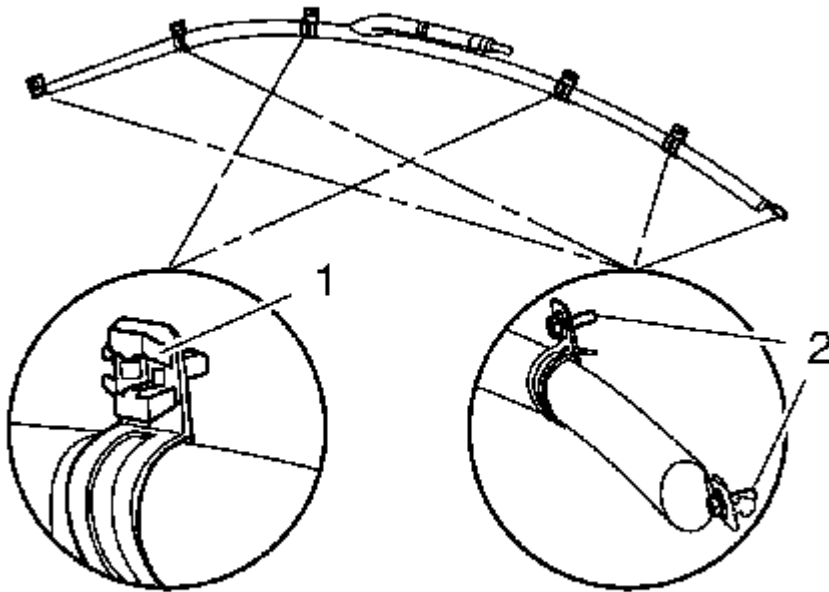


Fig. 39: Locating Security Clips And Remove Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the 2 security clips (1), and remove the 5 fasteners (2).

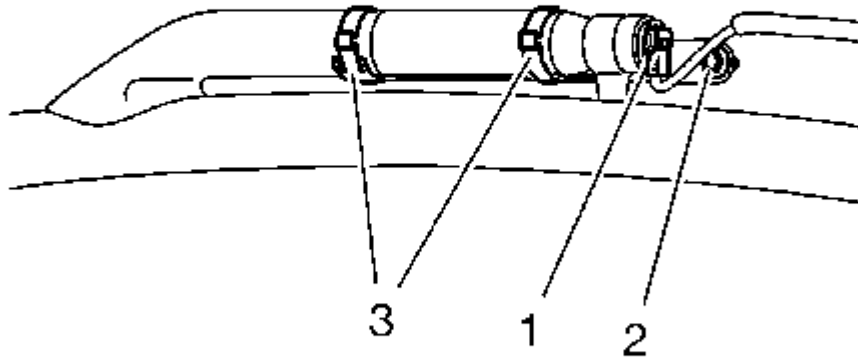


Fig. 40: Location Of Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

5. Release and disconnect the wiring harness plug (1).
6. Unscrew the fastener from the inflatable restraint roof side rail module (2).
7. Open the metal clip (3) and remove it.

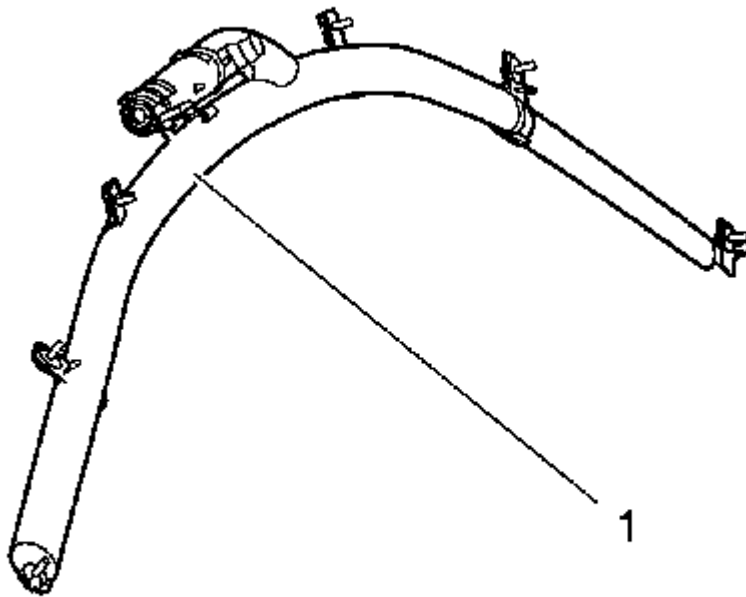


Fig. 41: Inflatable Restraint Roof Side Rail Module
Courtesy of GENERAL MOTORS COMPANY

8. Remove the inflatable restraint roof side rail module (1) from the vehicle.

Installation Procedure

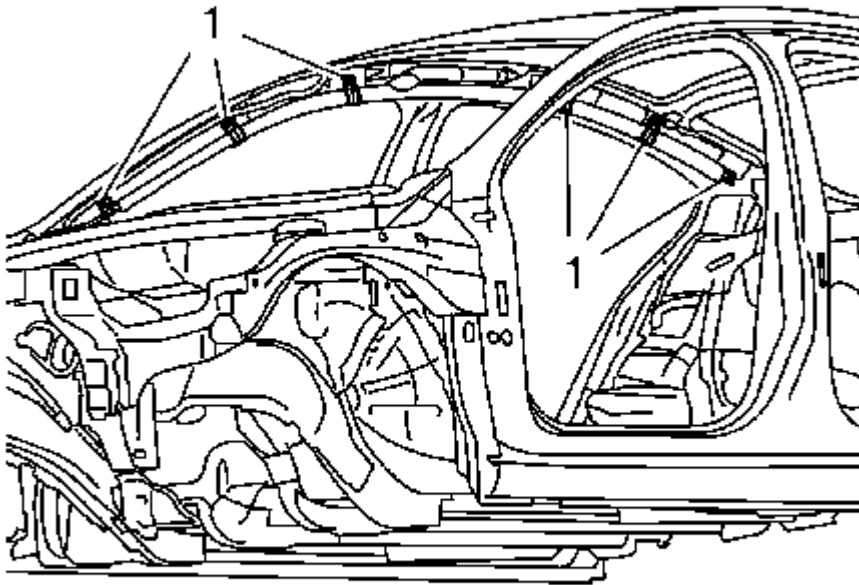


Fig. 42: Positioning Inflatable Restraint Roof Side Rail Module
Courtesy of GENERAL MOTORS COMPANY

1. Position and align the inflatable restraint roof side rail module on in the vehicle (1).

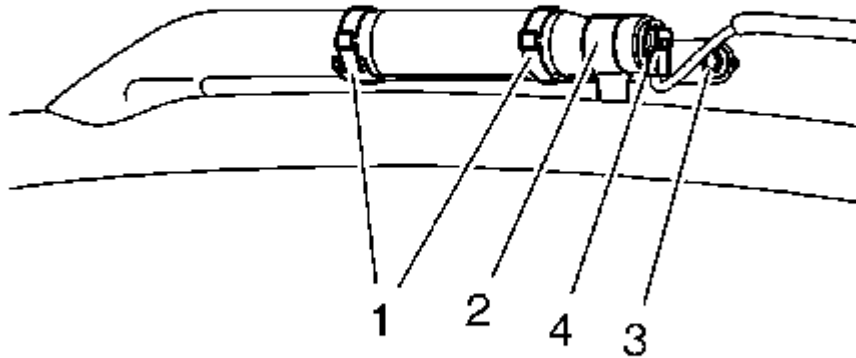


Fig. 43: Location Of Wiring Harness Plug, Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: After ignition ON, the airbag system readiness indicator illuminates for 4 seconds and then goes out.

2. Attach the inflatable restraint roof side rail module with new metal clip (1) to the bracket (2).
3. Insert the inflatable restraint roof side rail module fastener (3).
4. Connect the wiring harness plug (4).
5. Install the headlining trim panel. Refer to **Headlining Trim Panel Replacement (With Sunroof)** , **Headlining Trim Panel Replacement (Without Sunroof)** .
6. Install the windshield side garnish molding. Refer to **Windshield Side Garnish Molding Replacement** .

FRONT SEAT BELT ANCHOR PLATE TENSIONER REPLACEMENT (2/4/6-WAY HYBRID, 6-WAY HYBRID SPORT)

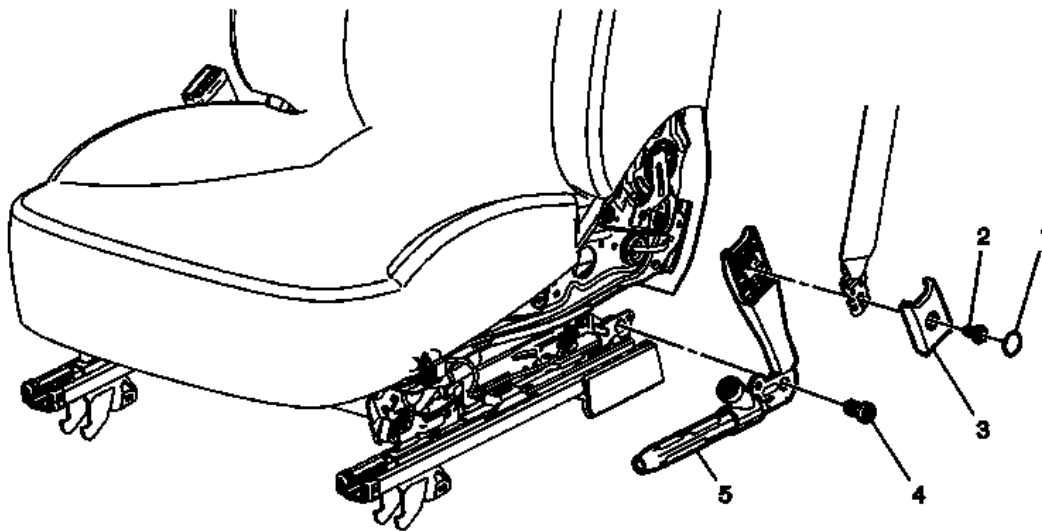


Fig. 44: Front Seat Belt Anchor Plate Tensioner (2/4/6-Way Hybrid, 6-Way Hybrid Sport)
 Courtesy of GENERAL MOTORS COMPANY

Front Seat Belt Anchor Plate Tensioner Replacement (2/4/6-Way Hybrid, 6-Way Hybrid Sport)

Callout	Component Name
<p>WARNING: Refer to <u>SIR Warning</u> .</p> <p>WARNING: In order to prevent accidental deployment and the risk of personal injury, do not dispose of an undeployed inflatable restraint seat belt pretensioner as normal shop waste. Undeployed seat belt pretensioners contain substances that could cause severe illness or personal injury if their sealed containers are damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed seat belt pretensioner. Failure to observe the following disposal methods may be a violation of federal, state, or local laws.</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none"> 1. Move the front seat to the full forward and full up position. 2. Disable the SIR. Refer to <u>SIR Disabling and Enabling</u>. 3. Remove the front seat adjuster track finish cover. Refer to <u>Front Seat Adjuster Track Finish Cover Replacement</u> . 4. Remove the driver or passenger seat adjuster finish cover. Refer to <u>Driver or Passenger Seat Adjuster Finish Cover Replacement (8-Way-Power)</u> . 5. For pretensioner handling and scrapping, refer to <u>Pretensioner Handling and Scrapping</u>. 	

1	Driver or Passenger Seat Belt Tensioner Cover Bolt (Retractor Side) Cover
2	Driver or Passenger Seat Belt Tensioner Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 5 (44 lb in)
3	Driver or Passenger Seat Belt Tensioner Cover Assembly
4	Driver or Passenger Seat Belt Tensioner Assembly Fastener Tighten 45 (33 lb ft)
5	Driver or Passenger Seat Belt Tensioner Assembly Procedure 1. Disconnect the electrical connector. 2. Refer to <u>Pretensioner Handling and Scrapping</u> .

DRIVER OR PASSENGER SEAT RETRACTOR SIDE BELT REPLACEMENT

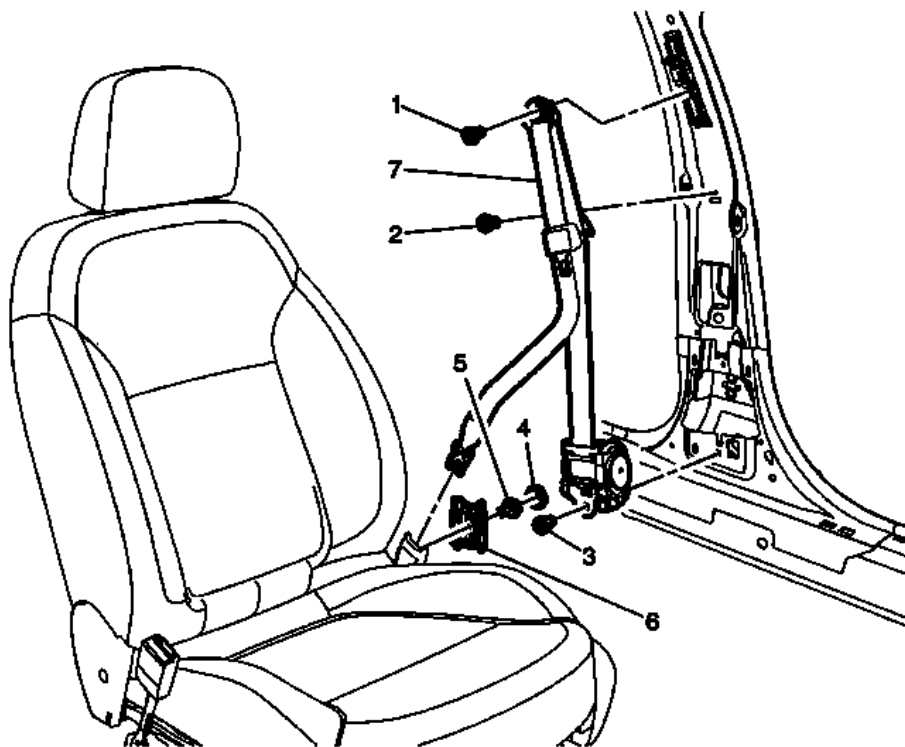


Fig. 45: Driver or Passenger Seat Retractor Side Belt
Courtesy of GENERAL MOTORS COMPANY

Driver or Passenger Seat Retractor Side Belt Replacement

Callout	Component Name
WARNING: Refer to <u>SIR Warning</u> .	
WARNING: In order to prevent accidental deployment and the risk of personal injury, do not dispose of an undeployed inflator module as normal shop waste. Undeployed inflator modules contain substances that could cause severe illness or personal injury if their sealed containers are damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed inflator module. Failure to observe the following disposal methods may be a violation of federal, state, or local laws.	
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disable the SIR. Refer to <u>SIR Disabling and Enabling</u>. 2. Remove the front and rear side door sill trim plate. Refer to <u>Front and Rear Side Door Sill Trim Plate Replacement</u> . 3. Remove the center pillar lower trim panel. Refer to <u>Center Pillar Lower Trim Panel Replacement</u> . 4. Remove the center pillar upper trim panel. Refer to <u>Center Pillar Upper Garnish Molding Replacement</u> . 	
1	Front Seat Belt Retractor Guide Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 45 N.m (33 lb ft)
2	Front Seat Belt Retractor Guide Retainer
3	Front Seat Belt Retractor Fastener Procedure Disconnect the electrical connector. Tighten 45 N.m (33 lb ft)
4	Front Seat Belt Tensioner Cover Bolt Cover
5	Front Seat Belt Tensioner Cover Bolt Tighten 5 N.m (44 lb in)
6	Front Seat Belt Tensioner Cover
7	Front Seat Belt Retractor

REPAIRS AND INSPECTIONS REQUIRED AFTER A COLLISION

Accident With or Without Air Bag Deployment - Component Inspections

WARNING: Proper operation of the Supplemental Inflatable Restraint (SIR) sensing system requires that any repairs to the vehicle structure return the vehicle structure to the original production configuration. Not properly repairing the vehicle structure could cause non-deployment of the air bag(s) in a frontal collision or deployment of the air bag(s) for conditions less severe than intended.

After any collision, inspect the following components as indicated. If you detect any damage, replace the component. If you detect any damage to the mounting points or mounting hardware, repair the component or replace the hardware as needed.

- The steering column-Inspect the steering column for bending, twisting, buckling or any type of damage.
- The instrument panel knee bolsters and mounting points-Inspect the knee bolsters for bending, twisting, buckling, or any other type of damage.
- The instrument panel brackets, braces, etc.-Inspect for bending, twisting, buckling, or any other type of damage.
- The seat belts-Perform the seat belt operational and functional checks. Refer to **Repairs and Inspections Required After a Collision** .
- The instrument panel cross car beam-Inspect for bending, twisting, buckling, or any other type of damage.
- The instrument panel mounting points and brackets-Inspect for bending, twisting, buckling, or any other type of damage.
- The seats and seat mounting points-Inspect for bending, twisting, buckling, or any other type of damage.
- The roof and headliner mounting points.
- The brake pedal --Inspect the brake pedal for bending, twisting, buckling or any type of damage.

Accident With Frontal Air Bag Deployment - Component Replacement and Inspections

After a collision involving air bag deployment, replace the following components.

- Driver Steering Wheel Air Bag
- Passenger instrument panel air bag, if deployed
- Inflatable Restraint Sensing and Diagnostic Module (SDM), if the Inflatable Restraint Sensing and Diagnostic Module has set DTC B0052 and will not clear
- Front and/or Side Impact Sensors
- Driver/Passenger Seat Side Air Bag, if deployed
- Seat back cover if Side Seat Air Bag is deployed
- Driver/Passenger Seat Belt Anchor and/or Retractor Pretensioners

Perform additional inspections on the following components.

- Steering wheel air bag coil and the coil wiring pigtail-Inspect for melting, scorching, or other damage due

to excessive heat.

- Mounting points or mounting hardware for the passenger instrument panel air bag, steering wheel air bag, Inflatable Restraint Sensing and Diagnostic Module, seat side air bag (if deployed) and seat belt anchor and/or retractor pretensioners-Inspect for any damage and repair or replace each component as needed.

Accident With Side Seat Air Bag Deployment - Component Replacement and Inspections

After a collision involving driver/passenger side seat air bag deployment, replace the following components.

- Left/right side impact sensors on the side of the impact.
- Left/right roof rail air bag on the side of the impact.
- Inflatable Restraint Sensing and Diagnostic Module (SDM), if the Inflatable Restraint Sensing and Diagnostic Module has set DTC B0052 and will not clear.
- Inflatable Restraint Seat Belt Anchor and/or Retractor Pretensioner.
- Driver or passenger seat back cushion cover replacement.

WARNING: Do not repair or replace the seat stitching or seams in the seat back trim cover with an internal mounted seat side airbag module. Replace the complete seat back trim cover from the OEM. Non-OEM seat stitching may cause improper airbag deployment which could result in personal injury.

Perform additional inspections on the following components.

- Mounting points or mounting hardware for the side impact sensors, and driver/passenger side seat air bags on the side of impact-Inspect for any damage and repair or replace each component as needed.
- Mounting points, mounting hardware, headliner and trim pieces for the left/right roof rail air bag on the side of impact-Inspect for any damage and repair or replace each component as needed.
- Mounting points or mounting hardware for the Inflatable Restraint Sensing and Diagnostic Module and seat belt anchor and/or retractor pretensioners-Inspect for any damage and repair or replace each component as needed.
- The seat cushion frame
- The seat recliner and cover, if equipped
- The seat adjuster
- The seat back frame
- Door trim assembly
- Impacted seat cushion side covers and switches

Accident With Seat Belt Pretensioner Deployment Only - Component Replacement and Inspections

After a collision involving driver/passenger Seat Belt Retractor or Anchor Pretensioner deployment, replace the following components.

- Driver and Passenger Inflatable restraint seat belt anchor pretensioner and/or retractor pretensioner
- Inflatable Restraint Sensing and Diagnostic Module (SDM), if the Inflatable Restraint Sensing and

Diagnostic Module has set DTC B0052 and will not clear

Perform additional inspections for any damage and repair or replace each component as needed on the following components.

- Mounting points or mounting hardware for the Inflatable Restraint Sensing and Diagnostic Module
- Mounting points or mounting hardware for the Seat Belt Anchor Pretensioners
- Mounting points or mounting hardware for the Seat Belt Retractor Pretensioners

Impact Sensor Replacement Guidelines

The impact sensor replacement policy requires replacing sensors in the area of the accident damage. The area of accident damage is defined as the portion of the vehicle which is crushed, bent, or damaged due to a collision. An example of this would be a moderate collision where the front of the vehicle impacts a object. If the vehicle has an impact sensor mounted forward of the radiator, it must be replaced.

- Replace the impact sensor whether or not the air bags have deployed.
- Replace the impact sensor even if it appears to be undamaged.

Impact sensor damage which is not visible, such as slight bending of the mounting bracket or cuts in the wire insulation, can cause improper operation of the SIR system. Do not try to determine whether the impact sensor is undamaged, replace the impact sensor. Also, if you follow a diagnostic trouble code (DTC) procedure and a malfunctioning impact sensor is indicated, replace the impact sensor.

INFLATABLE RESTRAINT MODULE HANDLING AND SCRAPPING

Special Tools

- **EL-38826** SIR Deployment Harness
- **EL-39401-B** SIR Deployment Fixture

For equivalent regional tools, refer to **Special Tools**.

Live and Undeployed Air Bag

WARNING: Refer to SIR Inflator Module Handling and Storage Warning .

Take special care when handling or storing an undeployed air bag. An air bag deployment produces a rapid generation of gas. This may cause the air bag, or an object in front of the air bag, to project through the air in the event of an unlikely deployment.

Dual Stage Air Bags

Dual stage air bags have two deployment stages. If stage 1 was used to deploy a dual stage air bag, stage 2 may still be active. Therefore, a deployed dual stage air bag must be treated as an active air bag. If disposal of a dual

stage air bag is required, both deployment loops must be energized to deploy the air bag.

Scrapping Procedure

During the course of a vehicle's useful life, certain situations may arise which will require the disposal of a live and undeployed air bag. Do NOT dispose a live and undeployed air bag through normal disposal channels until the air bag has been deployed.

Do not deploy the air bag in the following situations:

- After replacement of an air bag under warranty-the air bag may need to be returned undeployed to the manufacturer.
- If the vehicle is the subject of a product liability claim, related to the SIR system and is subject to a preliminary investigation - do NOT alter the SIR system in any manner.
- If the vehicle is involved in a campaign affecting the air bags - follow the instructions in the campaign service bulletin for proper SIR handling procedures.

Deployment Procedures

NOTE: **Some countries, states or localities may not allow service deployment of air bags without special permission or training. Local laws regarding deploying and scrapping of air bags/devices with pyrotechnics must be followed.**

You can deploy the air bag either inside or outside of the vehicle. The method used depends upon the final disposition of the vehicle. Review the following procedures in order to determine which will work best in a given situation:

Deployment Outside Vehicle - Steering Wheel Air Bag, Instrument Panel Air Bag, and Roof Rail Air Bag

Deploy the air bag outside of the vehicle when the vehicle will be returned to service. Situations that require deployment outside of the vehicle include the following:

- Using the SIR diagnostics, you determine that the air bag is malfunctioning.
- The air bag is cosmetically damaged, scratched, or ripped.
- The air bag pigtail is damaged.
- The air bag connector is damaged.
- The air bag connector terminals are damaged.

Deployment and disposal of a malfunctioning air bag is subject to any required retention period.

WARNING: Refer to SIR Inflator Module Disposal Warning .

1. Turn OFF the ignition.

WARNING: Refer to SIR Inflator Module Handling and Storage Warning .

2. Remove the air bag.

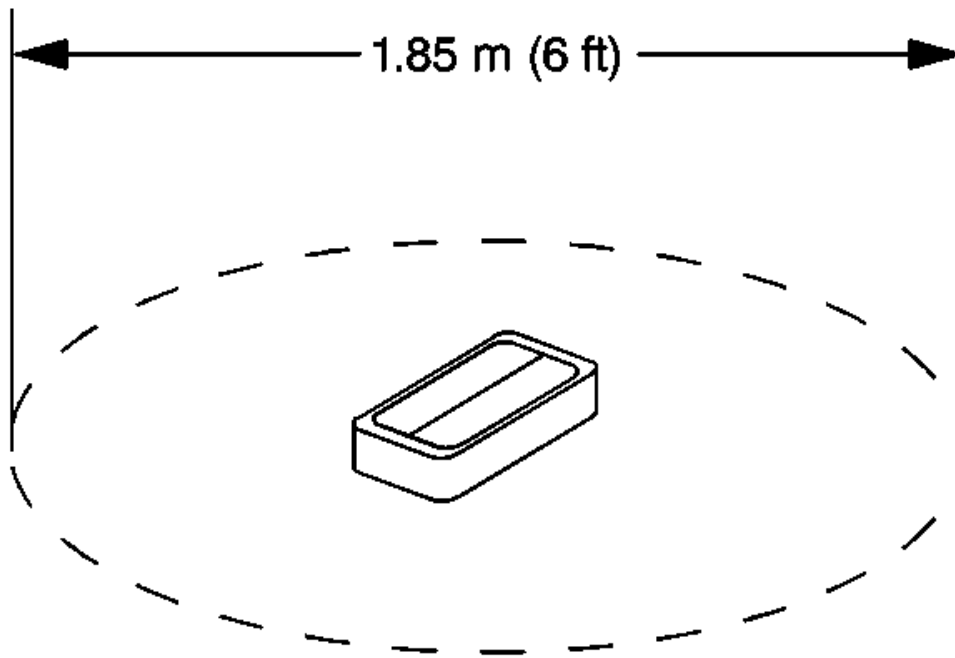


Fig. 46: Identifying Clearance For Deployment Of Inflator Module
Courtesy of GENERAL MOTORS COMPANY

3. Clear a space on the ground about 1.85 m (6 ft) in diameter for deployment of the air bag or deployment fixture. If possible, use a paved, outdoor location free of activity. Otherwise, use a space free of activity on the shop floor. Ensure you have sufficient ventilation.
4. Clear the area of loose or flammable objects.

NOTE: Dual stage deployments are only used in steering wheel and instrument panel air bags. If stage 1 was used to deploy a dual stage air bag, stage 2 may still be active. If disposal of a dual stage air bag is required, both deployment loops must be energized to deploy the air bag.

5. If you are deploying a steering wheel air bag, place the air bag in the center of the space with the vinyl trim cover facing up and away from the surface.

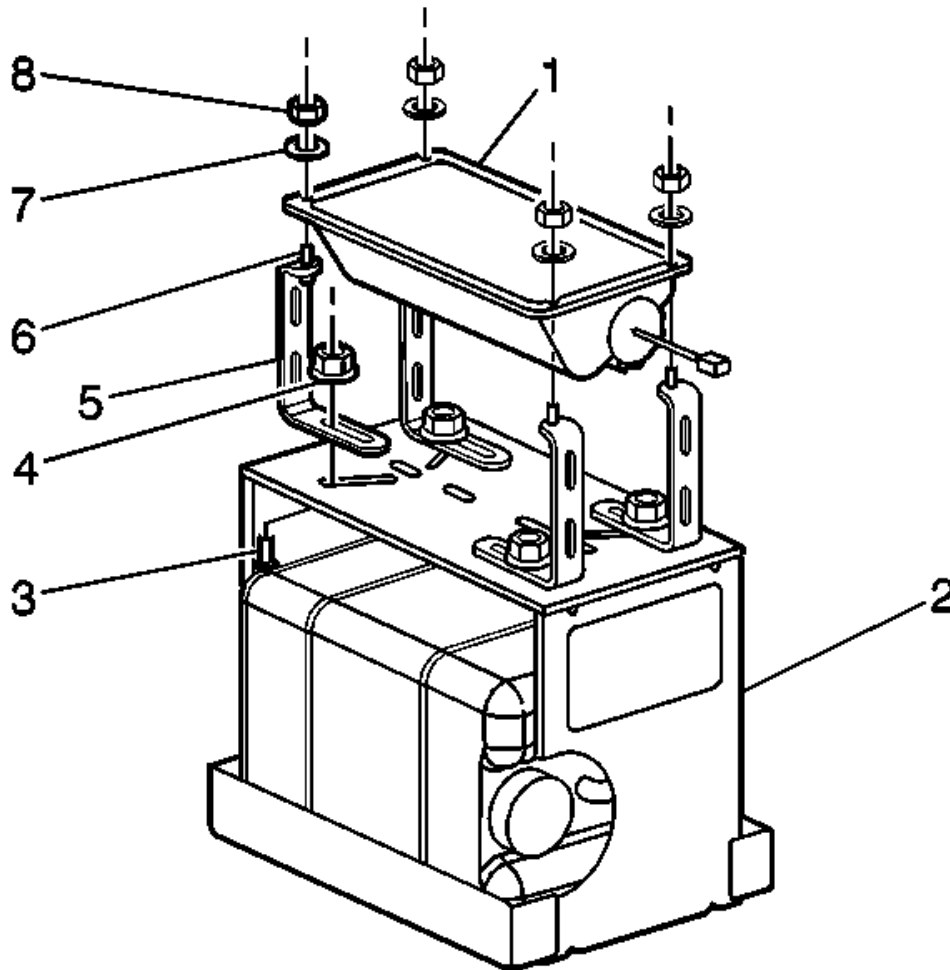


Fig. 47: Identifying I/P Module Components
Courtesy of GENERAL MOTORS COMPANY

6. When deploying an instrument panel air bag, perform the following instructions:
 1. Place the **EL-39401-B** fixture in the center of the cleared area.
 2. Fill the deployment fixture with water or sand.
 3. Using the proper nuts and bolts, mount the instrument panel air bag (1) to the deployment fixture (2), with the vinyl trim facing up.
 4. Securely tighten all fasteners that hold the instrument panel air bag (1) to the deployment fixture (2).

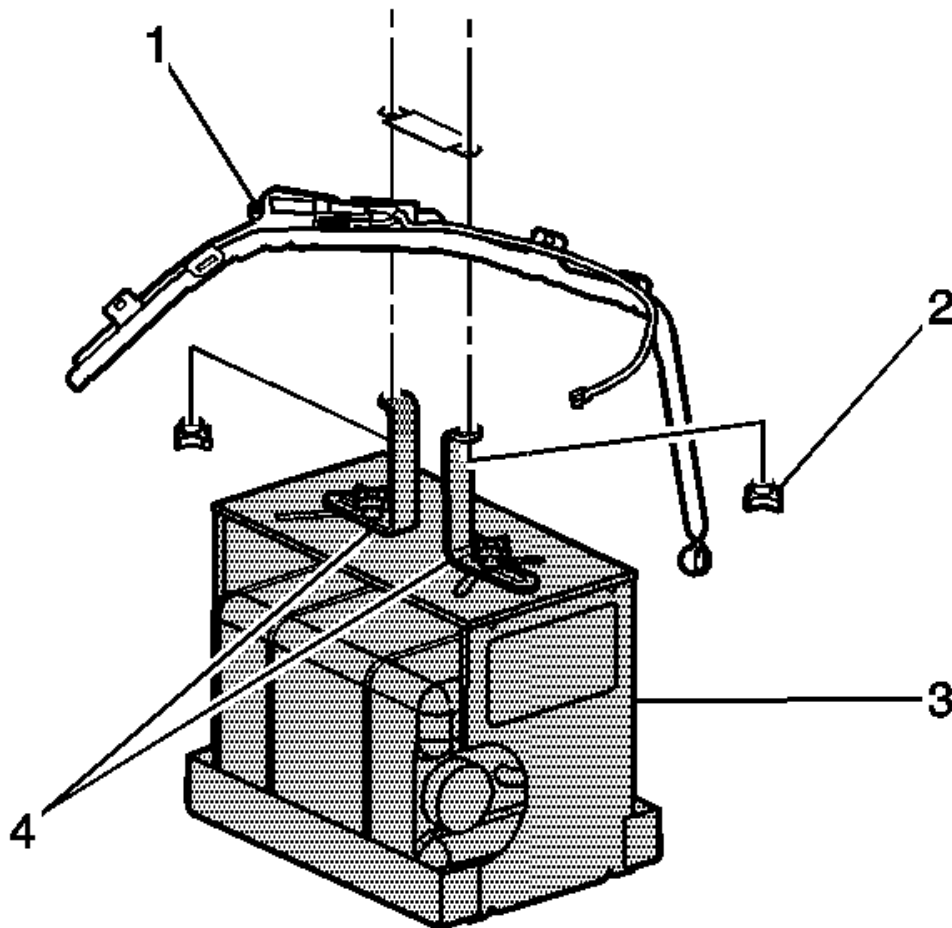


Fig. 48: Identifying Fasteners Holding Side Impact Module To Deployment Fixture
Courtesy of GENERAL MOTORS COMPANY

7. When deploying a roof rail air bag, perform the following instructions:
 1. Place the **EL-39401-B** fixture (3) in the center of the cleared area.
 2. Fill the deployment fixture with water or sand to provide sufficient stabilization of fixture during deployment.
 3. Adjust and secure the fixture arms (4) to the deployment fixture (3), using the proper nuts and bolts.
 4. Attach the roof rail air bag in the deployment fixture and securely tighten all fasteners.

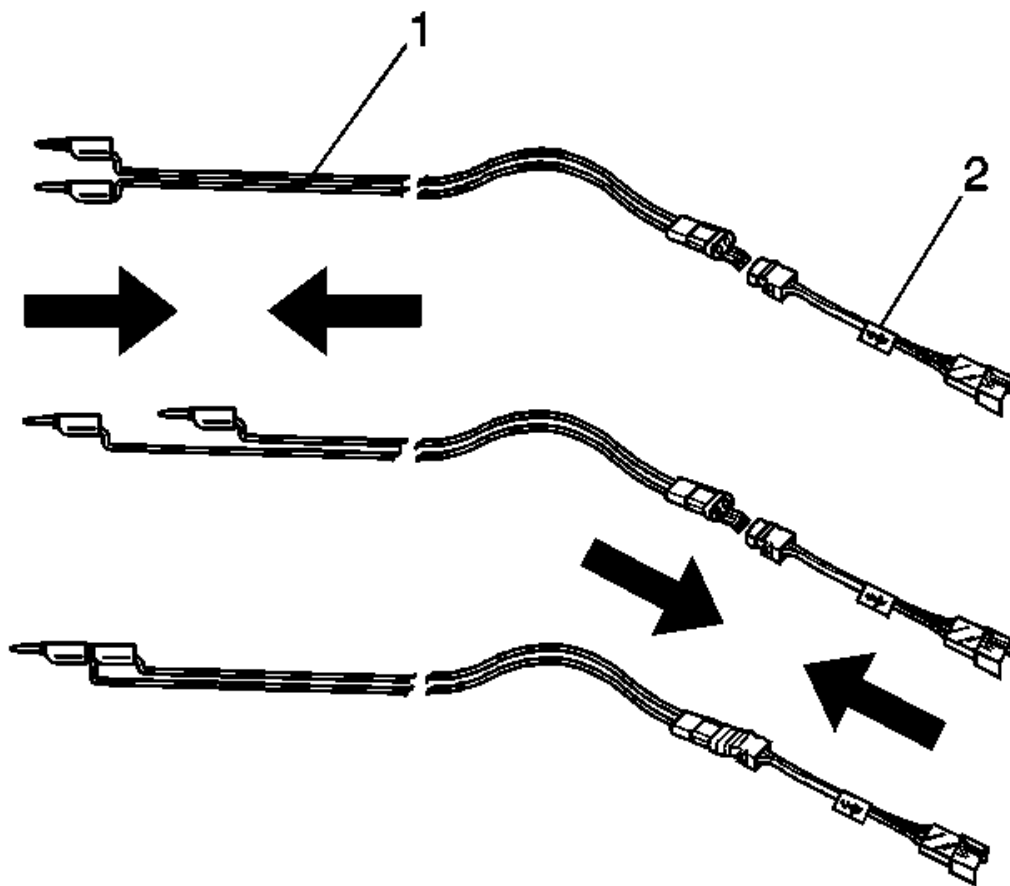


Fig. 49: Identifying SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

8. Inspect the **EL-38826** harness and the appropriate pigtail adapter (2) for damage. Replace as needed.
9. Short the 2 SIR deployment harness leads (1) together using one banana plug seated into the other.
10. Connect the appropriate pigtail adapter (2) to the SIR deployment harness (1).

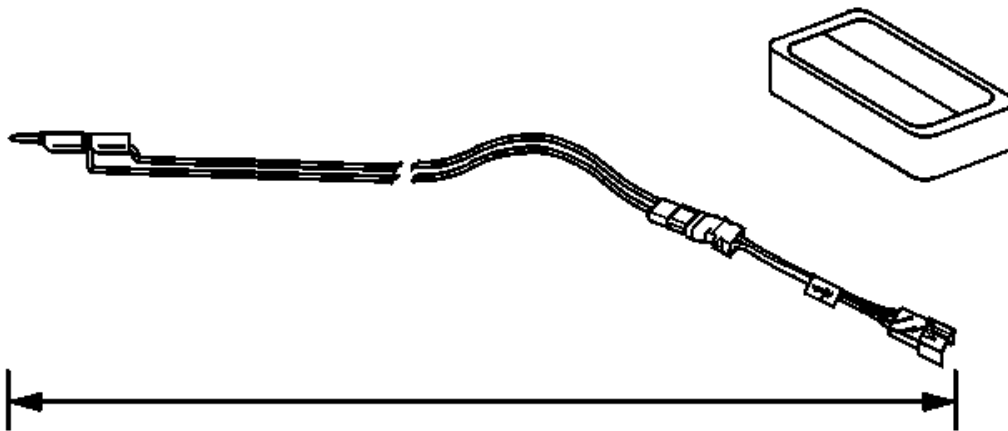


Fig. 50: Extending SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

11. Extend the SIR deployment harness and adapter to the full length from the deployment fixture or area.

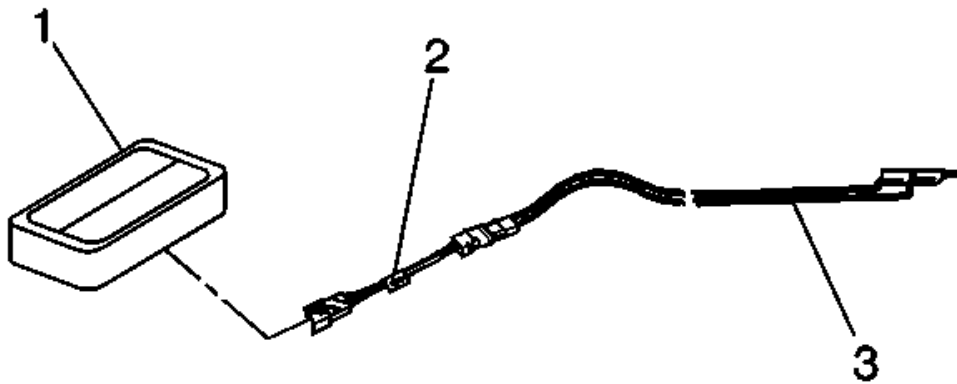


Fig. 51: Identifying Inflator Module, SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

NOTE: On a dual stage air bag, both connectors must be attached to the deployment harness adapter. This will ensure that both stage 1 and stage 2 of the deployment loops are energized, regardless of the deployment state.

12. Connect the air bag (1) to the adapter (2) on the SIR deployment harness (3).

NOTE:

- The rapid expansion of gas involved with deploying an air bag is very loud. Notify all the people in the immediate area that you intend to deploy the air bag.
- When the air bag deploys, the deployment fixture may jump about 30 cm (1 ft) vertically. This is a normal reaction of the air bag due to the force of the rapid expansion of gas inside the air bag.

- If you are deploying a dual stage air bag with stage 1 already deployed, the fixture may not move and the noise may have been reduced.

13. Clear the area of people.

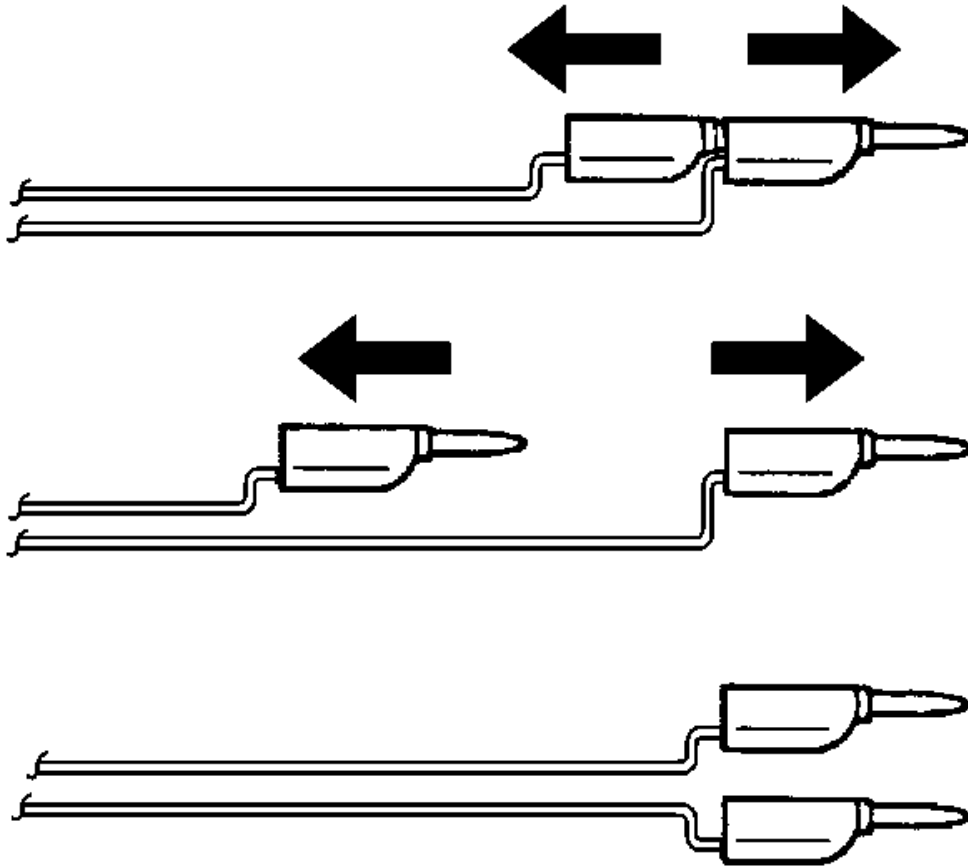


Fig. 52: Separating Banana Plugs

Courtesy of GENERAL MOTORS COMPANY

14. Separate the 2 banana plugs on the SIR deployment harness that were shorted together earlier in the procedure.

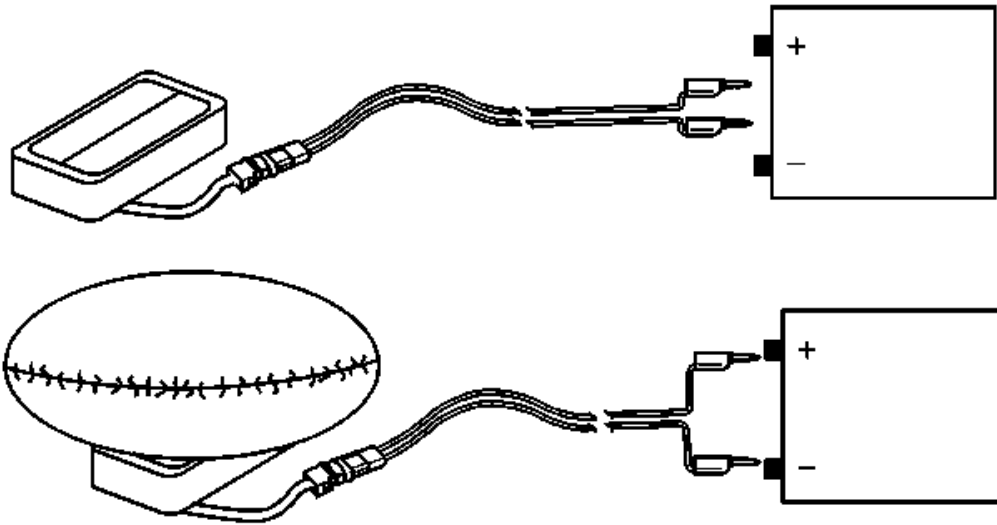


Fig. 53: Connecting SIR Deployment Harness Wires To Power Source
Courtesy of GENERAL MOTORS COMPANY

15. Place a 12 V minimum/2A minimum power source, such as a vehicle battery, near the shorted end of the harness.
16. Connect the SIR deployment harness wires to the power source. Deployment of the air bag will occur when contact is made.

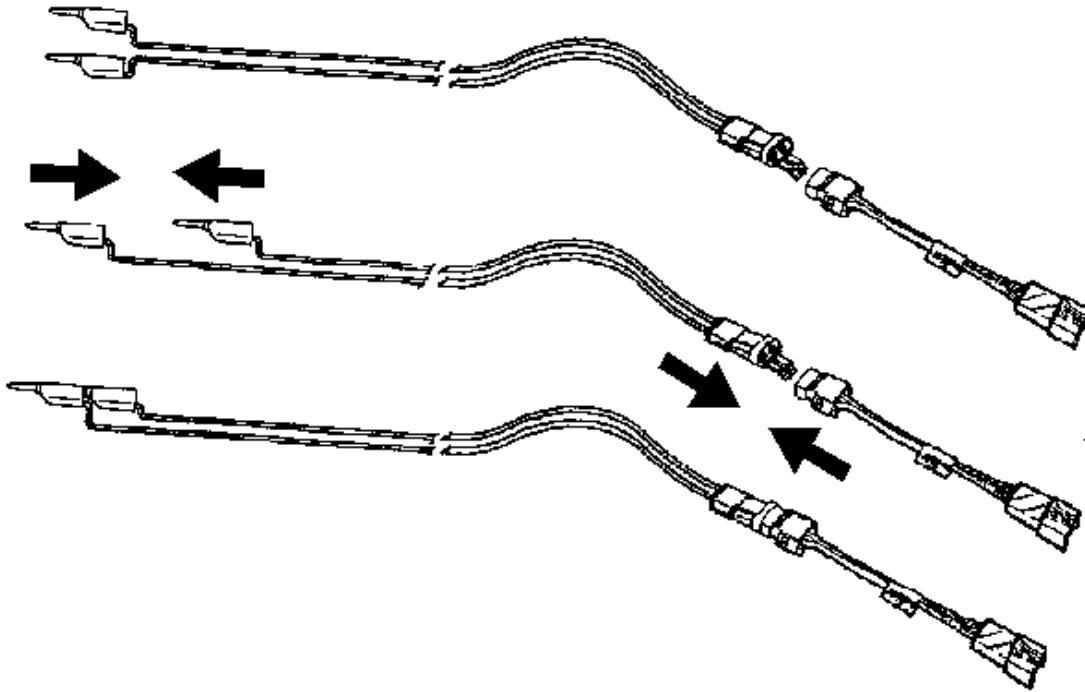


Fig. 54: View Of Deployment Harness Leads
Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the SIR deployment harness from the power source after the air bag deploys.
18. If the air bag did not deploy, disconnect the adapter and discontinue the procedure and contact the Technical Assistance Group.

If deployment was successful, proceed to the following steps.

WARNING: Refer to SIR Deployed Inflator Modules Are Hot Warning .

19. Seat one banana plug into the other in order to short the deployment harness leads.
20. Put on a pair of shop gloves.

21. Disconnect the pigtail adapter from the air bag as soon as possible.
22. Inspect the pigtail adapter and the SIR deployment harness. Replace as needed.
23. Dispose of the deployed air bag through normal refuse channels.
24. Wash your hands with a mild soap.

Deployment Inside Vehicle - Vehicle Scrapping Procedure

Deploy the air bags inside of the vehicle when destroying the vehicle or when salvaging the vehicle for parts. This includes, but is not limited to, the following situations:

- The vehicle has completed all useful life.
- Irreparable damage occurred to the vehicle in a non-deployment type accident.
- Irreparable damage occurred to the vehicle during a theft.
- The vehicle is being salvaged for parts to be used on a vehicle with a different VIN, as opposed to rebuilding as the same VIN.

WARNING: Refer to SIR Inflatable Module Deployment Outside Vehicle Warning .

1. Lower the driver and passenger windows.
2. Turn the ignition switch to the OFF position and remove the ignition key.
3. Check that all air bags which will be deployed are mounted securely.
4. Remove all loose objects from the front seats.

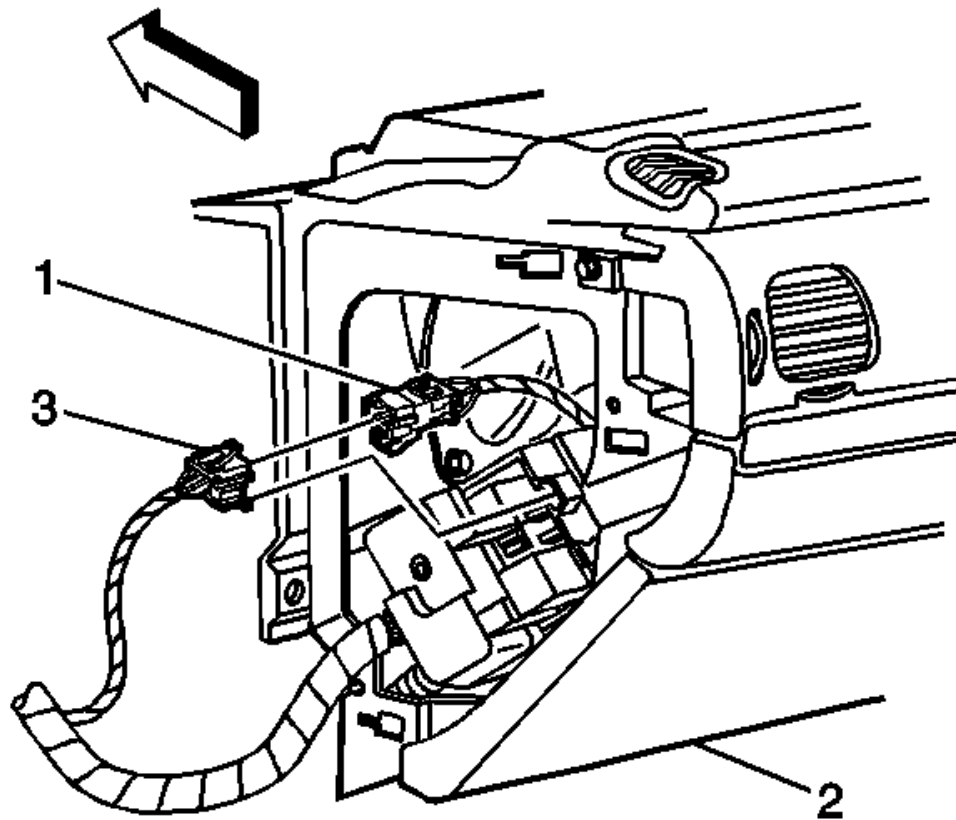


Fig. 55: Identifying I/P Module Connector To Vehicle Harness Connector (LH Side I/P)
Courtesy of GENERAL MOTORS COMPANY

WARNING: A deployed dual stage inflator module will look the same whether one or both stages were used. Always assume a deployed dual stage inflator module has an active stage 2. Improper handling or servicing can activate the inflator module and cause personal injury.

5. Disconnect the steering wheel air bag yellow connector (1) from vehicle harness yellow connector (3).

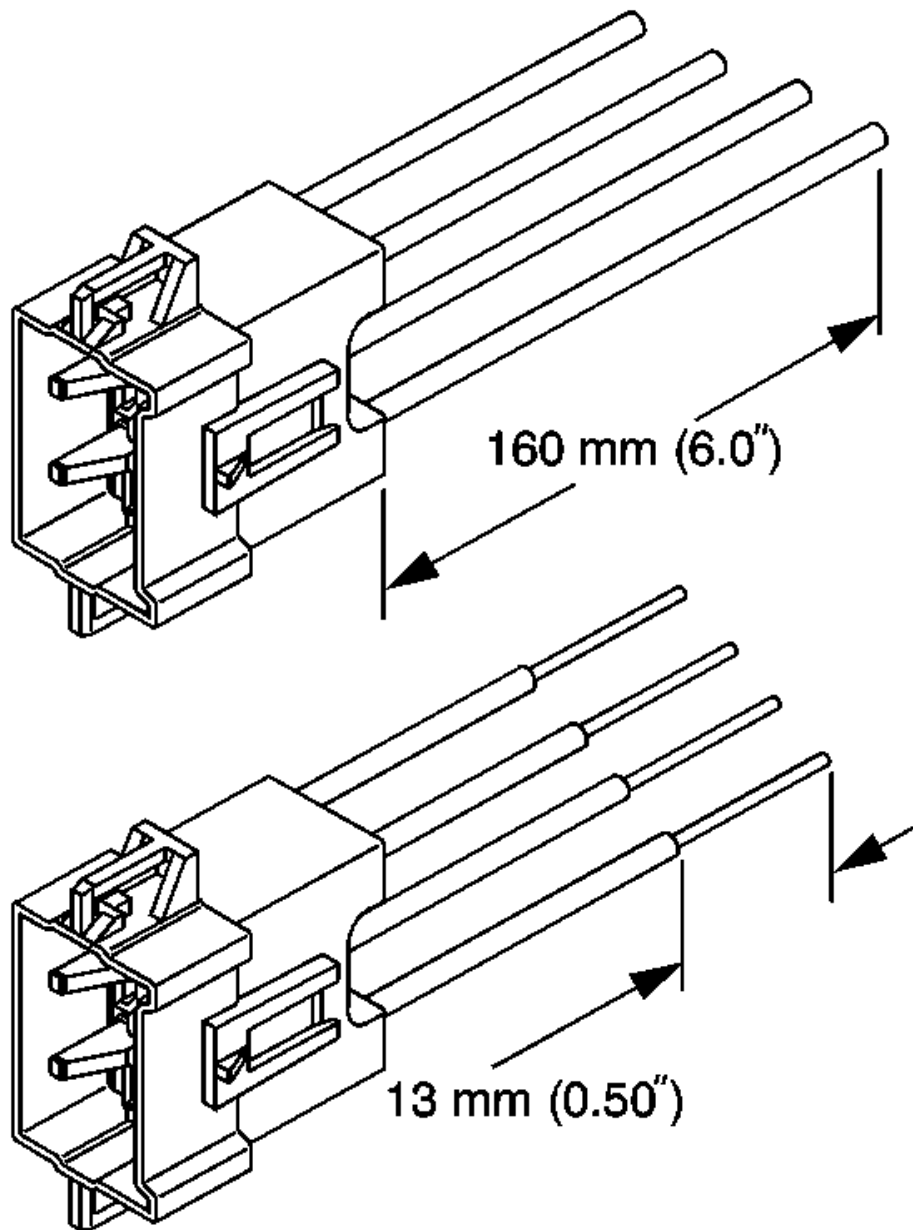


Fig. 56: Stripping SIR Wires

Courtesy of GENERAL MOTORS COMPANY

NOTE: If the vehicle is equipped with dual stage air bags the steering wheel air

bag and instrument panel air bag will each have 4 wires. Refer to Component Connector End Views for determining high and low circuits.

6. Cut the yellow harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
7. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.

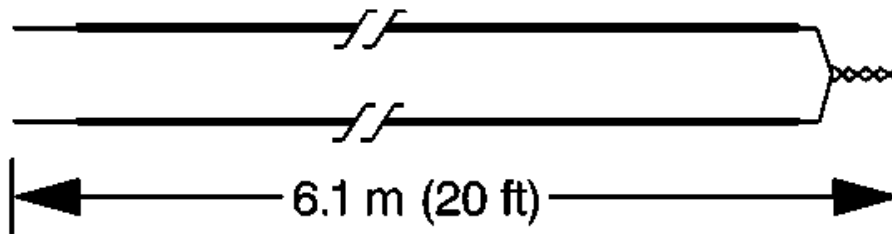


Fig. 57: Fabricating 20 Ft. Deployment Harness
Courtesy of GENERAL MOTORS COMPANY

8. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gauge) or thicker multi-strand wire. Use these wires to fabricate the driver deployment harness.
9. Strip 13 mm (0.5 in) of insulation from both ends of the wires.
10. Twist together one end from each of the wires in order to short the wires. Deployment wires shall remain shorted, and not connected to a power source until you are ready to deploy the air bag.

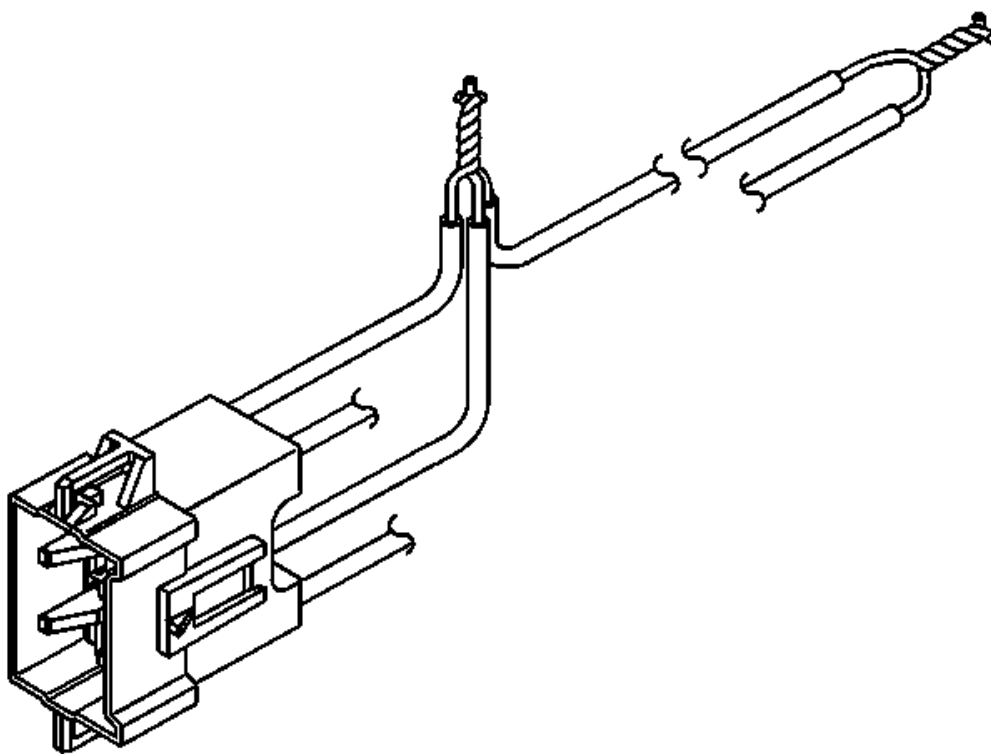


Fig. 58: Twisting Connector Wire Leads (High Circuits) To Deployment Harness Wire
Courtesy of GENERAL MOTORS COMPANY

11. Twist together the 2 connector wire leads from the high circuits from both stages of the steering wheel air bag, to one set of deployment wires. Refer to **Component Connector End Views** in order to determine the correct circuits.
12. Inspect that the 3-wire connection is secure.
13. Secure and insulate the 3-wire connection to the deployment harness using electrical tape.

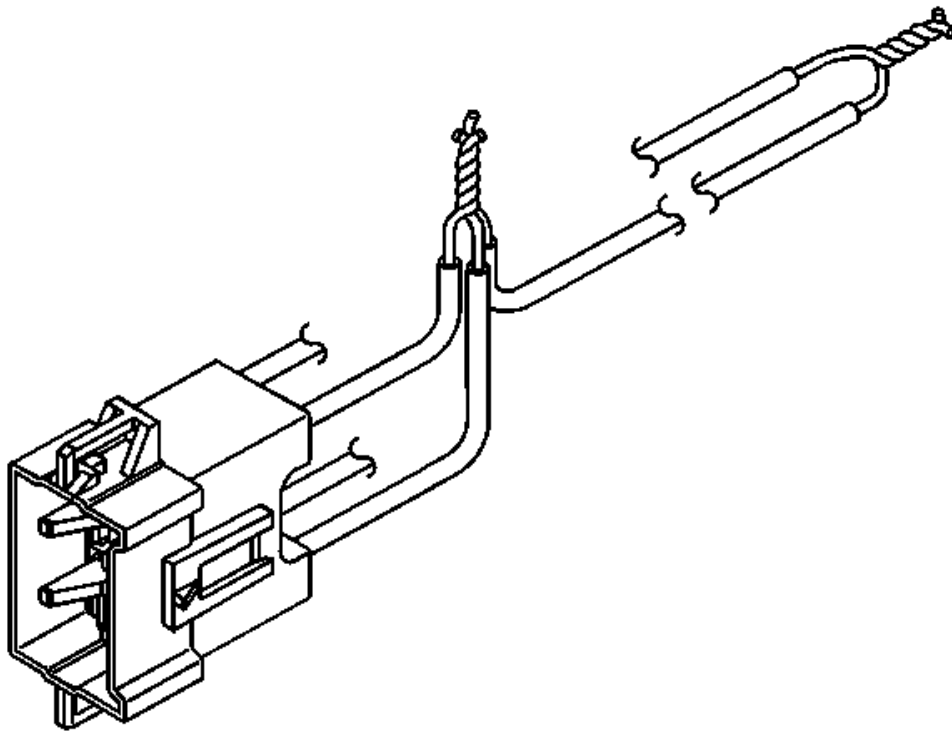


Fig. 59: Twisting Connector Wire Leads (Low Circuits) To Deployment Harness Wire
Courtesy of GENERAL MOTORS COMPANY

14. Twist together the 2 connector wire leads from the low circuits from both stages of the steering wheel air bag, to one set of deployment wires. Refer to **Component Connector End Views** in order to determine the correct circuits.
15. Inspect that the 3-wire connection is secure.
16. Secure and insulate the 3-wire connection to the deployment harness using electrical tape.
17. Connect the deployment harness to the connector on the steering wheel air bag.
18. Route the deployment harness out of the driver side of the vehicle.
19. Disconnect the yellow left roof rail harness connector from the vehicle harness connector.
20. Cut the harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
21. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.
22. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gauge) or thicker multi-strand wire. These wires will be used to fabricate the roof rail air bag deployment harness.
23. Strip 13 mm (0.5 in) of insulation from both ends of the wires.

24. Twist together one end from each of the wires in order to short the wires.
25. Twist together one connector wire lead to one deployment wire.
26. Secure and insulate the connection using electrical tape.
27. Twist together and tape the remaining connector wire lead to the remaining deployment wire.
28. Connect the deployment harness to the yellow connector of the roof rail air bag.
29. Route the deployment harness out of the driver side of the vehicle.

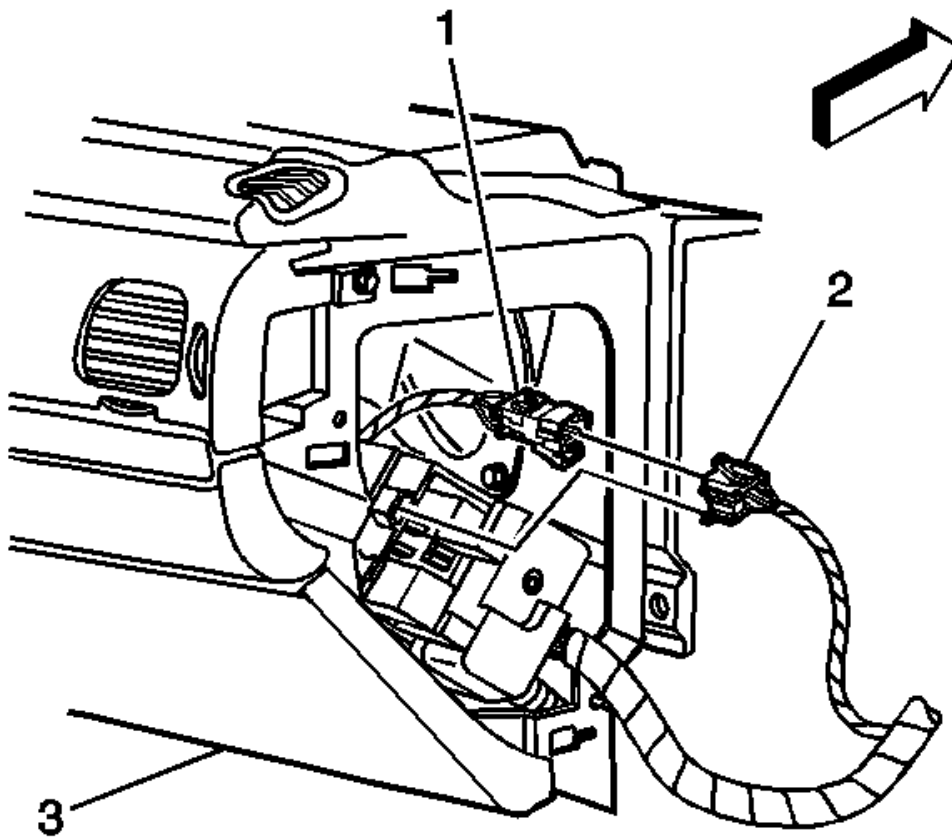


Fig. 60: Identifying I/P Module Connector To Vehicle Harness Connector
Courtesy of GENERAL MOTORS COMPANY

30. Disconnect the instrument panel air bag yellow harness connector (1) from the vehicle harness connector (2).

NOTE: If the vehicle is equipped with dual stage air bags the steering wheel air bag and instrument panel air bag will each have 4 wires. Refer to Component Connector End Views for determining high and low circuits.

31. Cut the yellow harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
32. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.
33. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gauge) or thicker multi-strand wire. These wires will be used to fabricate the passenger deployment harness.
34. Strip 13 mm (0.5 in) of insulation from both ends of the wires.
35. Twist together one end from each of the wires in order to short the wires.
36. Twist together the 2 connector wire leads from the high circuits from both stages of the instrument panel air bag to one set of deployment wires. Refer to **Component Connector End Views** in order to determine the correct circuits.
37. Inspect that the 3-wire connection is secure.
38. Secure and insulate the 3-wire connection to the deployment harness using electrical tape.
39. Twist together the 2 connector wire leads from the low circuits from both stages of the instrument panel air bag to one set of deployment wires. Refer to **Component Connector End Views** in order to determine the correct circuits.
40. Inspect that the 3-wire connection is secure.
41. Secure and insulate the 3-wire connection to the deployment harness using electrical tape.
42. Connect the deployment harness to the instrument panel air bag in-line connector.
43. Route the deployment harness out of the passenger side of the vehicle.
44. Disconnect the yellow harness connector to the right roof rail air bag from the vehicle harness connector.
45. Cut the harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
46. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.
47. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gauge) or thicker multi-strand wire. These wires will be used to fabricate the roof rail air bag deployment harness.
48. Strip 13 mm (0.5 in) of insulation from both ends of the wires.
49. Twist together one end from each of the wires in order to short the wires.
50. Twist together one connector wire lead to one deployment wire.
51. Secure and insulate the connection using electrical tape.
52. Twist together and tape the remaining connector wire lead to the remaining deployment wire.
53. Connect the deployment harness to the roof rail air bag yellow connector.
54. Route the deployment harness out of the passenger side of the vehicle.
55. Completely cover the windshield and the front door window openings with a drop cloth.
56. Stretch to the full length all of the deployment harness wires on the right side of the vehicle.
57. Deploy each deployment loop one at a time.
58. Place a power source, 12 V minimum/2A minimum, such as a vehicle battery, near the shorted end of the harnesses.
59. Separate one set of wires and touch the wire ends to the power source in order to deploy the selected air bag.
60. Disconnect the deployment harness from the power source and twist the wire ends together.
61. Continue the same process with the remaining deployment harnesses.

62. Disconnect all harnesses from the vehicle.
63. Discard the harnesses.
64. Scrap the vehicle in the same manner as a non-SIR equipped vehicle.
65. If one or all of the air bags did not deploy, remove the undeployed air bags from the vehicle.

PRETENSIONER HANDLING AND SCRAPPING

Scrapping Procedure

During the course of a vehicle's useful life, certain situations may arise which will necessitate the disposal of a live (undeployed) pretensioner. The following information covers the proper procedures for the disposing of a live (undeployed) pretensioner. Deploy the pretensioner before disposal. Do not dispose of a live (undeployed) pretensioner through normal disposal channels until the pretensioner has been deployed. The following information covers the proper procedures for the disposing of a live (undeployed) pretensioner.

- After replacement of a pretensioner under warranty. The pretensioner may need to be returned undeployed to the original manufacturer of pretensioner.
- If the vehicle is the subject of a Product Liability report related to the SIR system and is subject to a Preliminary Investigation (GM-1241). Do not alter the SIR system in any manner.
- If the vehicle is involved in a campaign affecting the pretensioners. Follow the instructions in the Campaign Service Bulletin for proper SIR handling procedures.

Deployment Procedures

NOTE: **Some countries, states or localities may not allow service deployment of air bags without special permission or training. Local laws regarding deploying and scrapping of air bags/devices with pyrotechnics must be followed.**

The pretensioner can be deployed inside or outside of the vehicle. The method used depends upon the final disposition of the vehicle. Review the following procedures in order to determine which will work best in a given situation.

Deployment Inside the Vehicle

Refer to **Inflatable Restraint Module Handling and Scrapping** for deploying the pretensioner inside vehicle under Vehicle Scrapping Procedure.

Deployment Outside Vehicle for Seat Belt Pretensioners

Deploy the seat belt pretensioners outside of the vehicle when the vehicle will be returned to service. Situations that require deployment outside of the vehicle include the following:

- Using the SIR diagnostics, you determine that the seat belt pretensioner is malfunctioning.
- The pretensioner pigtail (if equipped) is damaged.
- The pretensioner connector is damaged.

- The pretensioner connector terminal is damaged.

Deployment and disposal of a malfunctioning seat belt pretensioner is subject to any required retention period.

WARNING: In order to prevent accidental deployment of the pretensioner which could cause personal injury, do not dispose of an undeployed pretensioner as normal shop waste. The undeployed pretensioner contains substances that could cause severe illness or personal injury if the sealed container is damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed pretensioner. Failure to dispose of a pretensioner as instructed may be a violation of federal, state, or local laws.

WARNING: When you are deploying a pretensioner for disposal, perform the deployment procedures in the order listed. Failure to follow the procedures in the order listed may result in personal injury.

Special Tools

- **EL-39401-B** SIR Deployment Fixture
- **EL-38826** SIR Deployment Harness

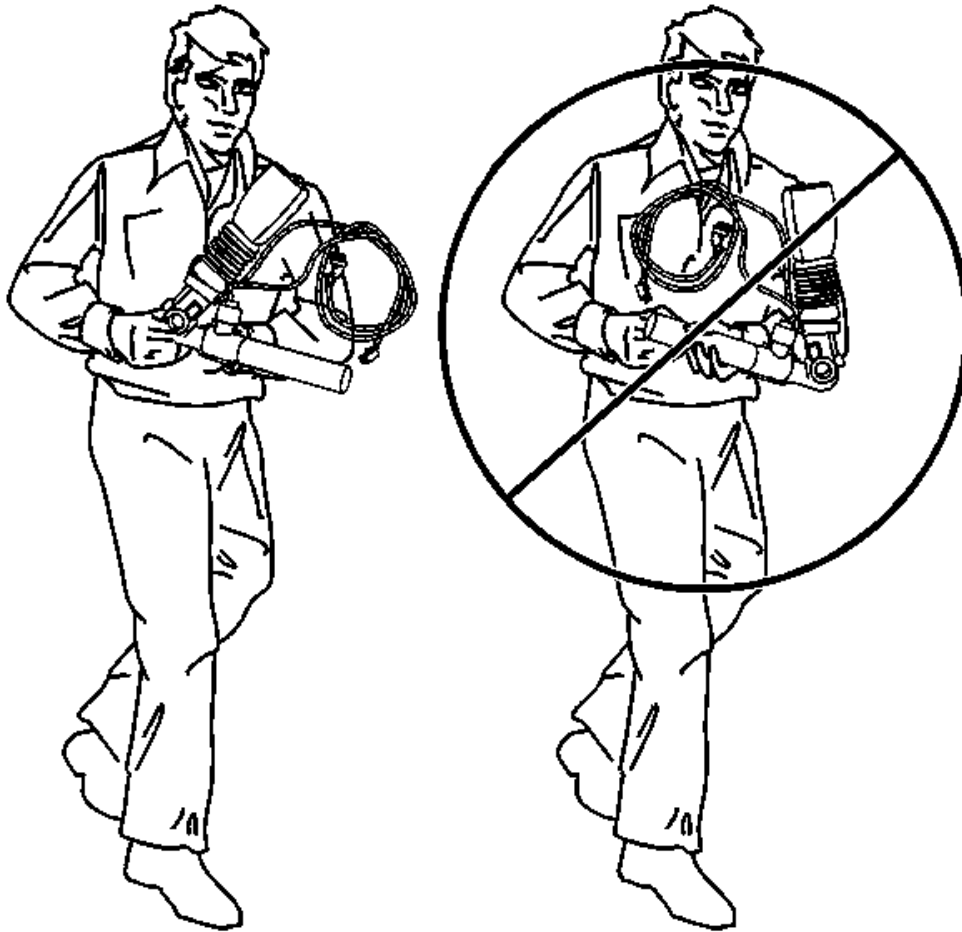


Fig. 61: Proper Pretensioner Carrying
Courtesy of GENERAL MOTORS COMPANY

1. Turn the ignition switch to the OFF position.
2. Remove the ignition key.
3. Put on safety glasses.
4. Remove the seat belt pretensioner from the vehicle.
5. When carrying a pretensioner to the deployment area keep the open end of pretensioner pointed away from the body.

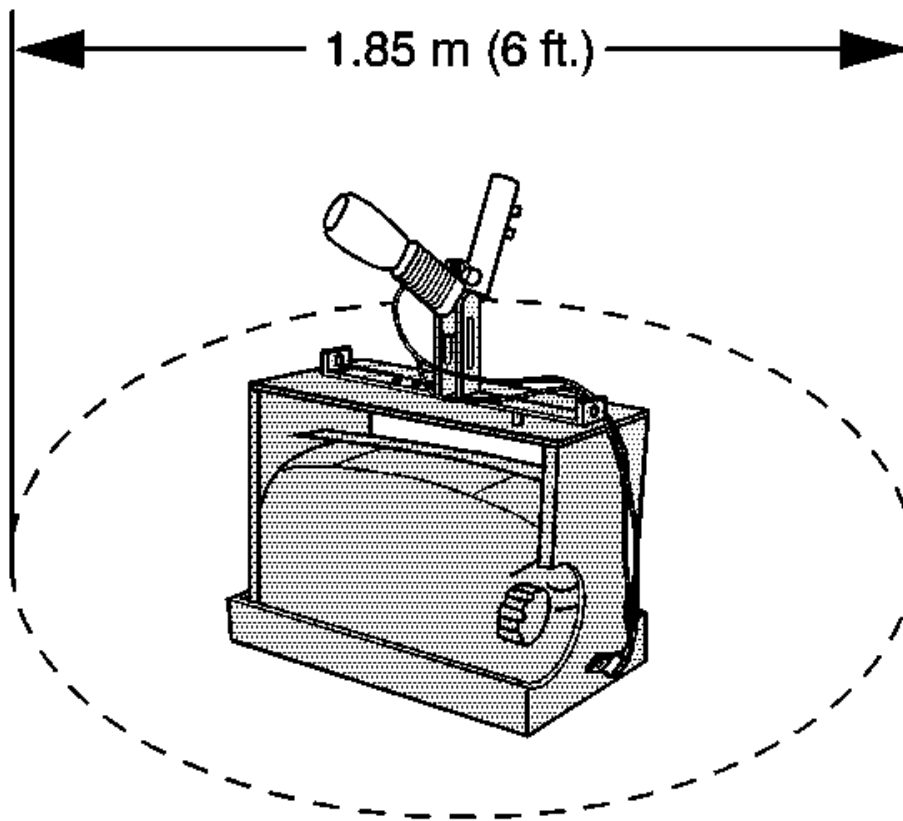


Fig. 62: Pretensioner Deployment Area
Courtesy of GENERAL MOTORS COMPANY

6. Clear a space on the ground about 1.85 M (6 ft) in diameter for deployment of the pretensioner. If possible, use a paved, outdoor location free of activity. Otherwise, use a space free of activity on the shop floor. Make sure you have sufficient ventilation.
7. Make sure no loose or flammable objects are in the area.
8. Place the **EL-39401-B** SIR deployment fixture in the center of the cleared area.
9. Fill the fixture plastic reservoir with water or sand.

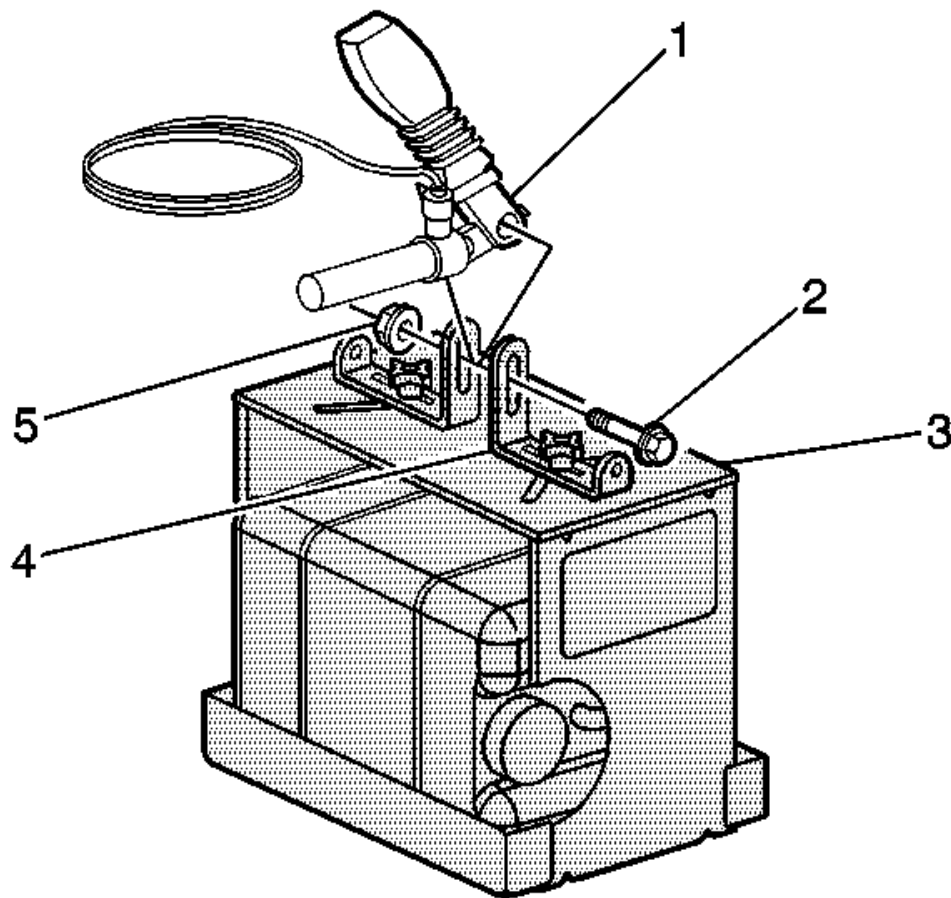


Fig. 63: Mounting Pretensioner In SIR Deployment Fixture
Courtesy of GENERAL MOTORS COMPANY

10. Mount the pretensioner (1) in the SIR deployment fixture (3) with the open end facing up using the following mounting method.
 1. Adjust and secure the EL-39401-B arms (4) to the deployment fixture (3).
 2. To mount, use the proper size bolt (2) and nut (5) with washers in order to secure the pretensioner (1) to the deployment fixture brackets (4).
 3. Securely tighten all fasteners prior to deployment.

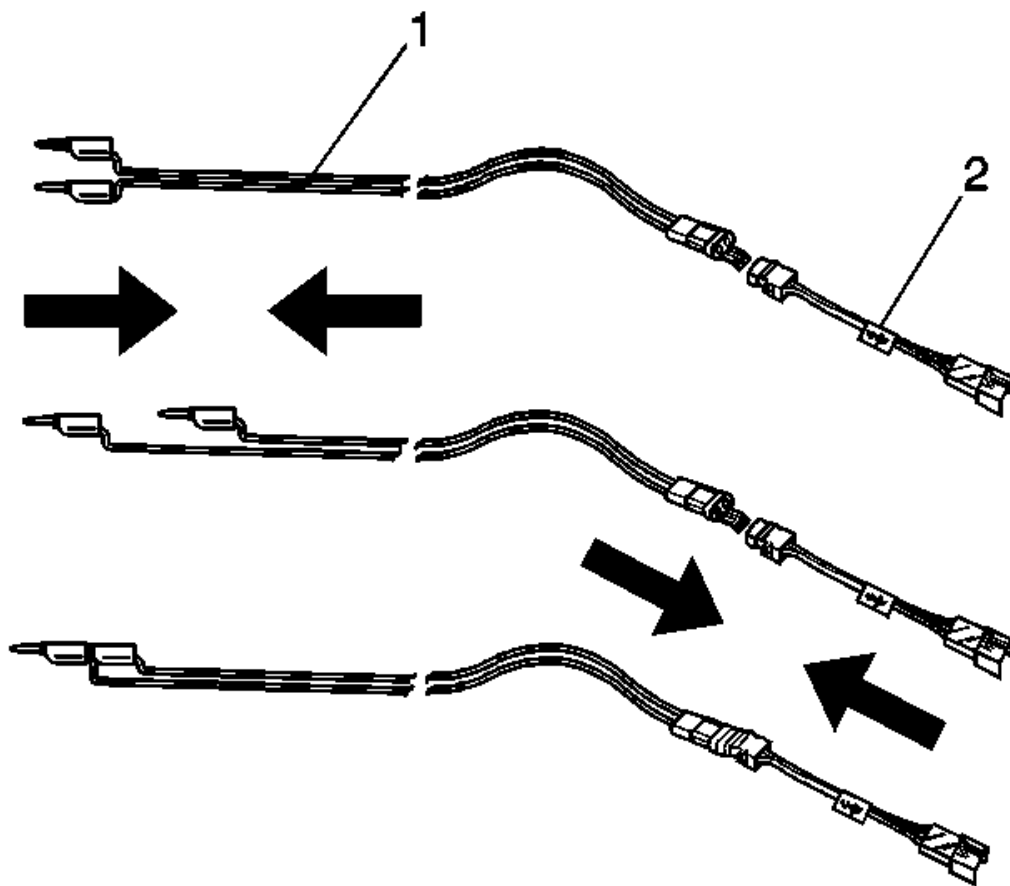


Fig. 64: Identifying SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the **EL-38826** SIR deployment harness and the appropriate pigtail adapter for damage. Replace as needed.
12. Short the 2 SIR deployment harness (1) leads together using one banana plug seated into the other.
13. Connect the appropriate pigtail adapter (2) to the SIR deployment harness (1).

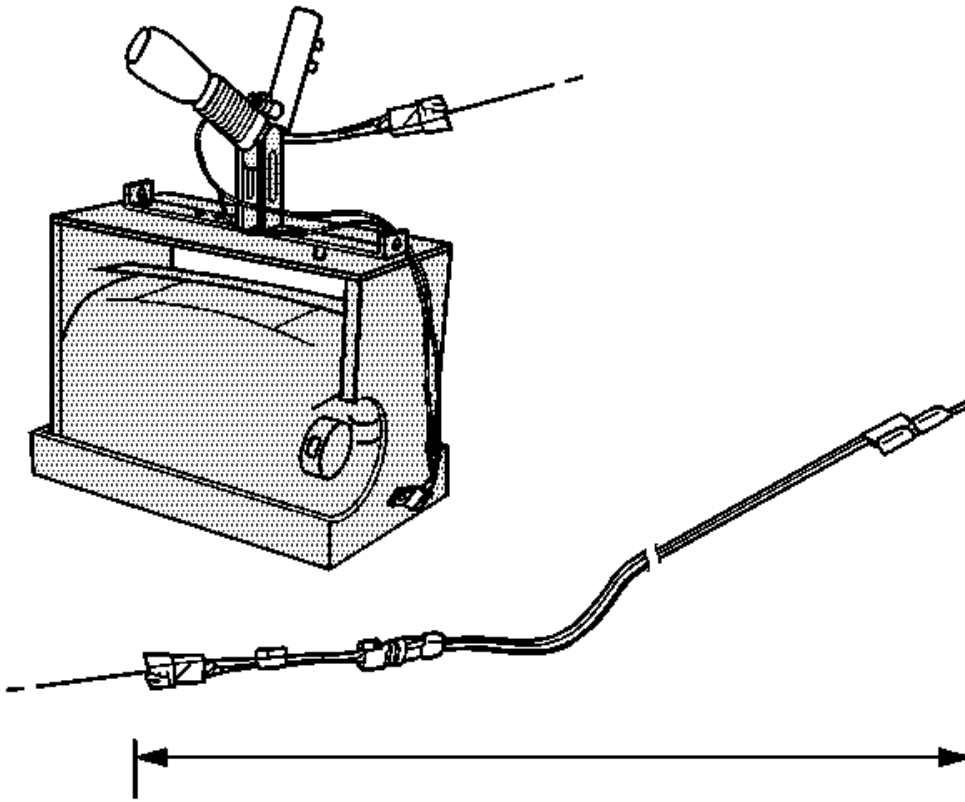


Fig. 65: Extending SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

14. Extend the SIR deployment harness and adapter to full length from the deployment fixture.

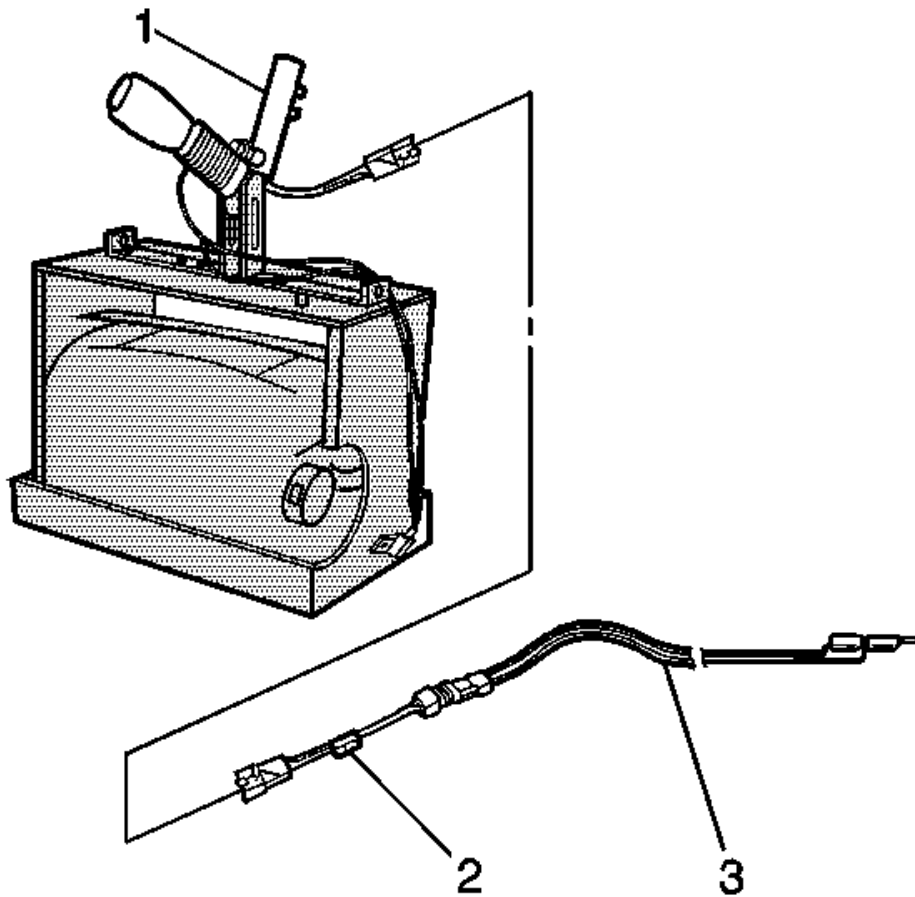


Fig. 66: Connecting Pretensioner To Adapter
Courtesy of GENERAL MOTORS COMPANY

15. Connect the pretensioner (1) to the adapter (2) on the deployment harness (3).

NOTE: The rapid gas expansion involved with deploying a pretensioner is very loud. Notify all the people in the immediate area that you intend to deploy the seat belt pretensioner.

16. Clear the area of people.

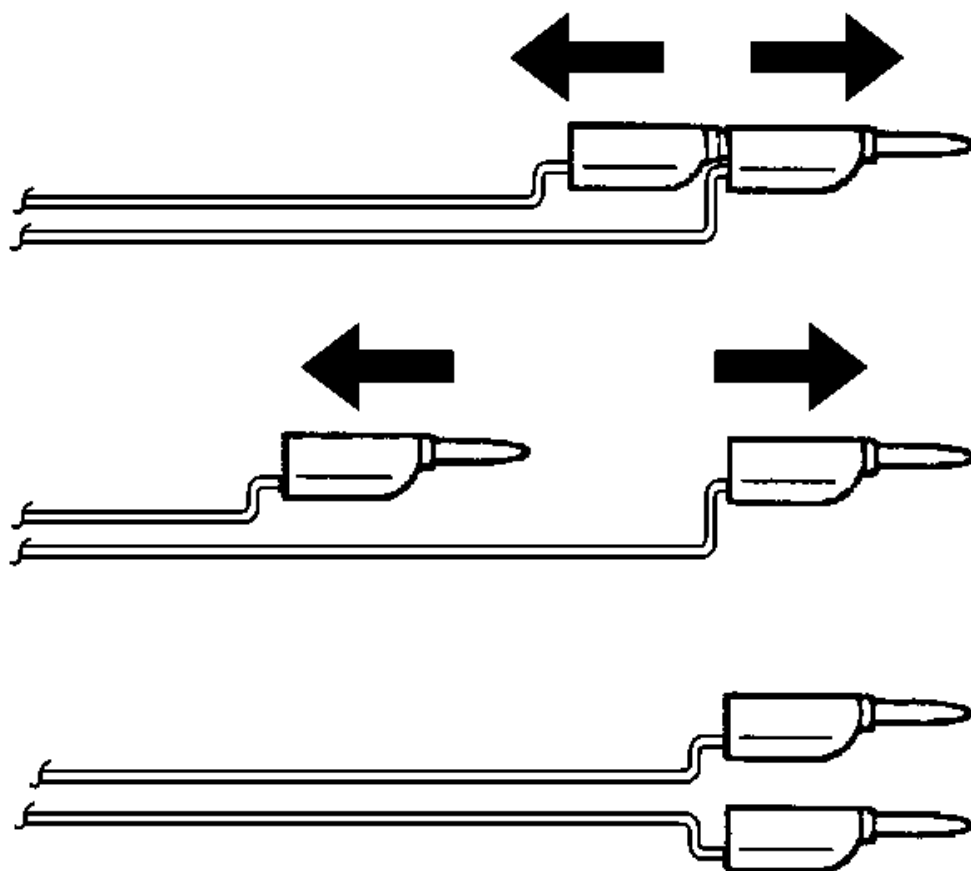


Fig. 67: Separating Banana Plugs
Courtesy of GENERAL MOTORS COMPANY

WARNING: When you are deploying a pretensioner for disposal, perform the deployment procedures in the order listed. Failure to follow the procedures in the order listed may result in personal injury.

17. Separate the 2 banana plugs on the SIR deployment harness.

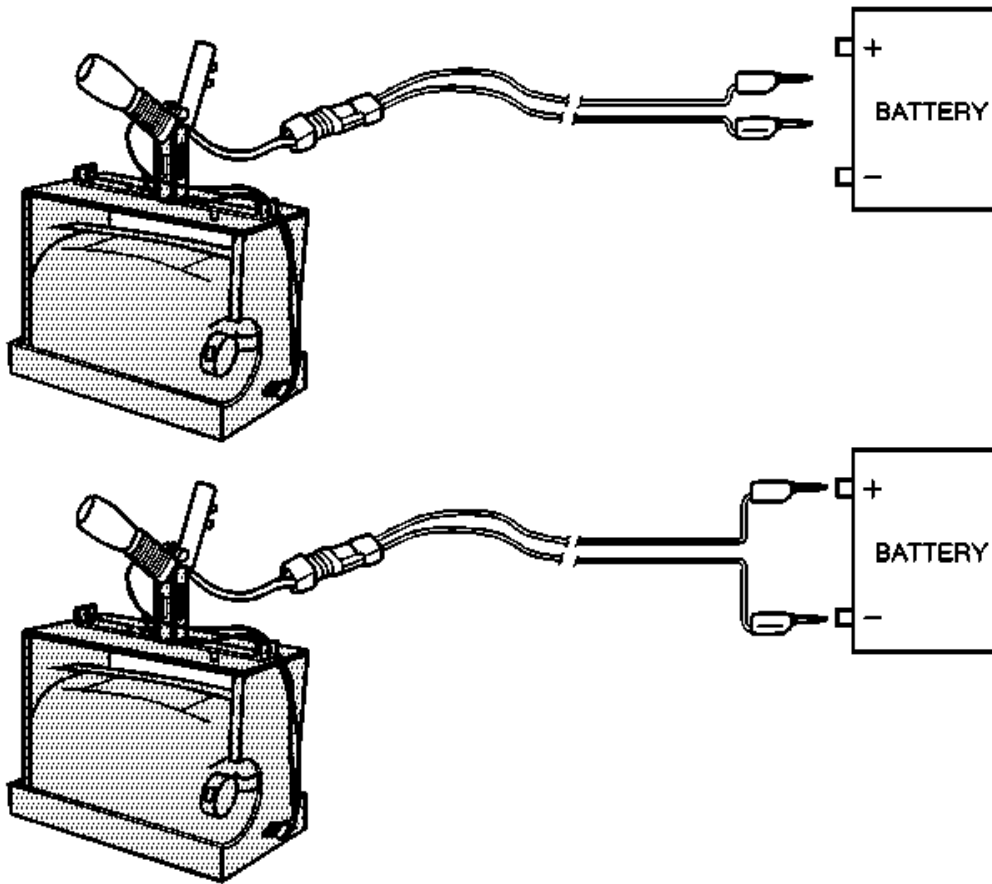


Fig. 68: Deploying Pretensioner

Courtesy of GENERAL MOTORS COMPANY

NOTE: When the seat belt pretensioner deploys, the deployment fixture may jump about 30 cm (1 ft) vertically. This is a normal reaction of the seat belt pretensioner due to the force of the rapid expansion of gas inside the pretensioner.

18. Place a 12 V minimum/2 A minimum power source (i.e., vehicle battery) near the shorted end of the harness.
19. Connect the SIR deployment harness wires to the power source. Pretensioner deployment will occur when contact is made.
20. Disconnect the SIR deployment harness from the power source after the pretensioner deploys.

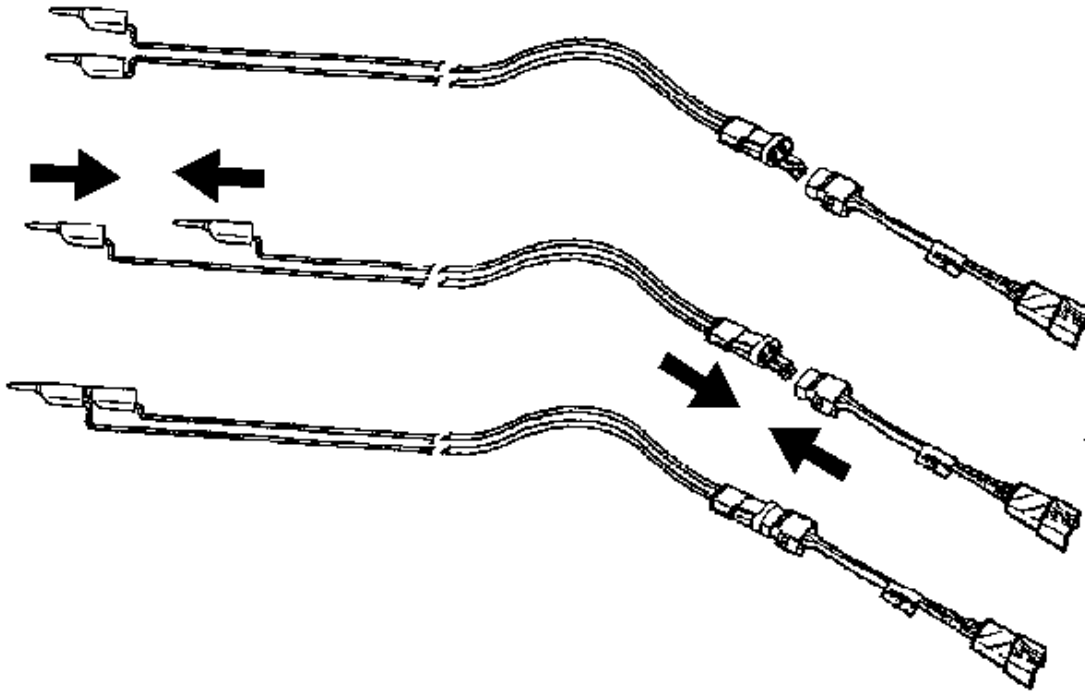


Fig. 69: View Of Deployment Harness Leads
Courtesy of GENERAL MOTORS COMPANY

21. Seat one banana plug into the other in order to short the deployment harness leads.
22. If the pretensioner did not deploy, disconnect the adapter and discontinue the procedure. Contact the Technical Assistance Group. Otherwise, proceed to the following steps.
23. Put on a pair of shop gloves.
24. Disconnect the pigtail adapter from the pretensioner as soon as possible.
25. Inspect the pigtail adapter and the SIR deployment harness. Replace as needed.
26. Dispose of the deployed pretensioner through normal refuse channels.
27. Wash hands with a mild soap.

DESCRIPTION AND OPERATION

SUPPLEMENTAL INFLATABLE RESTRAINT SYSTEM DESCRIPTION AND OPERATION

SIR System Overview

The supplemental inflatable restraint (SIR) system supplements the protection offered by the seat belts. The SIR system contains an inflatable restraint sensing and diagnostic module (SDM), air bags, seat belt pretensioners (anchor and retractor), and impact sensors. The inflatable restraint sensing and diagnostic module determines the severity of a collision with the assistance of impact sensors located at strategic points on the vehicle. When the inflatable restraint sensing and diagnostic module detects a collision, the inflatable restraint sensing and diagnostic module will process the information provided by the sensors to further support air bag or pretensioner deployment. The inflatable restraint sensing and diagnostic module will deploy the air bags and pretensioners if it detects a collision of sufficient force. If the force of the impact is not sufficient to warrant air bag deployment, the inflatable restraint sensing and diagnostic module may still deploy the seat belt pretensioners. The inflatable restraint sensing and diagnostic module contains a sensing device that converts vehicle velocity changes to an electrical signal. The inflatable restraint sensing and diagnostic module compares these signals to values stored in memory. If the signals exceed a stored value, the inflatable restraint sensing and diagnostic module will determine the severity of the impact and either cause current to flow through the frontal deployment loops deploying the frontal air bags and pretensioners, or it will deploy the pretensioners only. The inflatable restraint sensing and diagnostic module continuously monitors the deployment loops for malfunctions and illuminates the SIR system AIR BAG indicator if a fault is detected. The inflatable restraint sensing and diagnostic module performs continuous diagnostic monitoring of the SIR system electrical components. Upon detection of a circuit malfunction, the inflatable restraint sensing and diagnostic module will set a DTC and inform the driver by illuminating the SIR system AIR BAG indicator. The steering column and knee bolsters are designed to absorb energy and compress during frontal collisions in order to limit leg movement and decrease the chance of injury to the driver and passenger.

SIR System AIR BAG Indicator

The SIR system AIR BAG indicator, located in the instrument cluster, is used to notify the driver of SIR system malfunctions and to verify that the inflatable restraint sensing and diagnostic module is communicating with the instrument cluster. When the ignition is turned ON, the inflatable restraint sensing and diagnostic module is supplied with ignition positive voltage. The instrument cluster will momentarily turn on the SIR system AIR BAG indicator. While the indicator is on, the inflatable restraint sensing and diagnostic module conducts tests on all SIR system components and circuits. If no malfunctions are detected the inflatable restraint sensing and diagnostic module will communicate with the instrument cluster through the serial data circuit and command the SIR system AIR BAG indicator OFF. The inflatable restraint sensing and diagnostic module provides continuous monitoring of the air bag circuits by conducting a sequence of checks. If a malfunction is detected the inflatable restraint sensing and diagnostic module will store a diagnostic trouble code (DTC) and command the instrument cluster to illuminate the SIR system AIR BAG indicator via serial data. The presence of a SIR system malfunction could result in non-deployment of the air bags or deployment in conditions less severe than intended. The SIR system AIR BAG indicator will remain ON until the malfunction has been repaired.

Inflatable Restraint Sensing and Diagnostic Module (SDM)

The inflatable restraint sensing and diagnostic module (SDM) is a microprocessor and the control center for the supplemental inflatable restraint (SIR) system. The inflatable restraint sensing and diagnostic module contains internal sensors along with external impact sensors, mounted at strategic locations on the vehicle. In the event of a collision, the inflatable restraint sensing and diagnostic module compares the signals from the internal and

external impact sensors to a value stored in memory. When the generated signals exceed the stored value, the inflatable restraint sensing and diagnostic module will cause current to flow through the appropriate deployment loops to deploy the air bags. The inflatable restraint sensing and diagnostic module records the SIR system status when a deployment occurs and illuminates the SIR system AIR BAG indicator located in the instrument cluster. The inflatable restraint sensing and diagnostic module performs continuous diagnostic monitoring of the SIR system electrical components and circuitry when the ignition is turned ON. If the inflatable restraint sensing and diagnostic module detects a malfunction, a DTC will be stored and the inflatable restraint sensing and diagnostic module will request the instrument cluster to illuminate the SIR system AIR BAG indicator, notifying the driver that a malfunction exists. In the event that ignition positive voltage is lost during a collision, the inflatable restraint sensing and diagnostic module maintains a 23-volt loop reserve for deployment of the air bags. It is important when disabling the SIR system for servicing or rescue operations to allow the 23-volt loop reserve to dissipate, which could take up to 1 minute.

Air Bags

This vehicle contains 8 air bags. The 8 air bags are located in the steering wheel (dual air bags), instrument panel (passenger side) (dual air bags), driver seat side (B-pillar), passenger seat side (B-pillar), left roof rail, right roof rail, left rear seat side (C-pillar), and the right rear seat side (C-pillar). To view the locations of the air bags refer to **SIR Identification Views**. Air bags contain a housing, inflatable air bag, two initiating devices (if dual air bags), canister of gas generating material and, in some cases, stored compressed gas. The deployment loops supply current to deploy the air bags. The driver steering wheel and passenger instrument panel air bags have two stages of deployment, which varies the amount of restraint to the occupant according to the collision severity. For moderate frontal collisions the air bags deploy at less than full deployment which consists of stage 1 of the air bag. For more severe frontal collisions a full deployment is initiated which consists of stage 1 and stage 2 of the air bag. The current passing through the air bags ignites the material in the canister producing a rapid generation of gas and in some cases, the release of compressed gas. The gas produced from this reaction rapidly inflates the air bag. Once the air bag is inflated it quickly deflates through the air bag vent holes and/or the bag fabric. A shorting bar (if equipped) is located in the connector.

Seat Belt Pretensioners (Anchor and Retractor)

The seat belt pretensioners (driver and passenger) consist of a housing, seat belt retractor (located in the B-pillar), seat belt anchor (located on the floor), seat belt webbing, an initiator, and a canister of gas generating materials. To view the locations of the seat belt pretensioners refer to **SIR Identification Views**. The initiator is part of the seat belt pretensioner deployment loop. When the vehicle is involved in a collision of sufficient force, the inflatable restraint sensing and diagnostic module causes current to flow through the seat belt deployment loops to the initiator. Current passing through the initiator ignites the material in the canister producing a rapid generation of gas. The gas produced from this reaction deploys the seat belt pretensioners which removes all of the slack in the seat belts. Depending on the severity of the collision, the seat belt pretensioners may deploy without the frontal air bags deploying, or they will deploy immediately before the frontal air bags deploy. A shorting bar (if equipped) is located in the connector.

Impact Sensors

This vehicle contains 6 impact sensors. There are 6 impact sensors which are located in the front of the vehicle (2, left and right), and the 4 doors. To view the locations of the impact sensors refer to **SIR Identification Views**. The impact sensors contain a sensing device which monitors vehicle acceleration and velocity changes to detect side collisions that are severe enough to warrant air bag deployment. The impact sensors are not part of

the deployment loop, but instead provide input to the inflatable restraint sensing and diagnostic module. The inflatable restraint sensing and diagnostic module contains a microprocessor that performs calculations using the measured accelerations and compares these calculations to a value stored in memory. When the generated calculations exceed the stored value, the inflatable restraint sensing and diagnostic module will cause current to flow through the deployment loops deploying the appropriate air bags.

Passenger Presence Detection System and Passenger Air Bag Indicator

NOTE: **The passenger presence system (PPS) is a calibrated unit. When replacing the assembly all parts in the service kit must remain together. Do not mix any of the old parts with the new parts. After repairing or replacing the passenger presence system, the preload test must be performed in order to function properly.**

The passenger presence detection system (PPS) is used to monitor the type of occupant that is sitting in the front passenger seat and communicate the status to the inflatable restraint sensing and diagnostic module (SDM). The inflatable restraint sensing and diagnostic module then uses this information to determine whether to enable or suppress the deployment of the passenger instrument panel air bag. The passenger presence detection system consists of an electronic control module, a sensor mat in the seat, a harness, and PASSENGER AIR BAG ON/OFF indicators. The passenger presence detection system transmits and receives a low-level electric field. The measured capacitance value of this field is used to determine the type of occupant sitting in the front passenger seat. If the measured capacitance is less than a calibrated value, then the passenger presence module will send a hard wire signal to the inflatable restraint sensing and diagnostic module to disable the passenger instrument panel air bag. If the measured capacitance is greater than a calibrated value, then the passenger presence module will send a serial data signal to the inflatable restraint sensing and diagnostic module to enable the passenger instrument panel air bag. The passenger presence detection system module will notify the customer of the enable/disable status by illuminating one of the PASSENGER AIR BAG ON/OFF indicator. The passenger presence detection system monitors itself for faults and will displays diagnostic trouble codes (DTCs) on the scan tool. When a fault is detected, the passenger presence module sends out a message to the inflatable restraint sensing and diagnostic module. The inflatable restraint sensing and diagnostic module responds by sending a command message to the instrument panel cluster to illuminate the SIR system AIR BAG indicator.

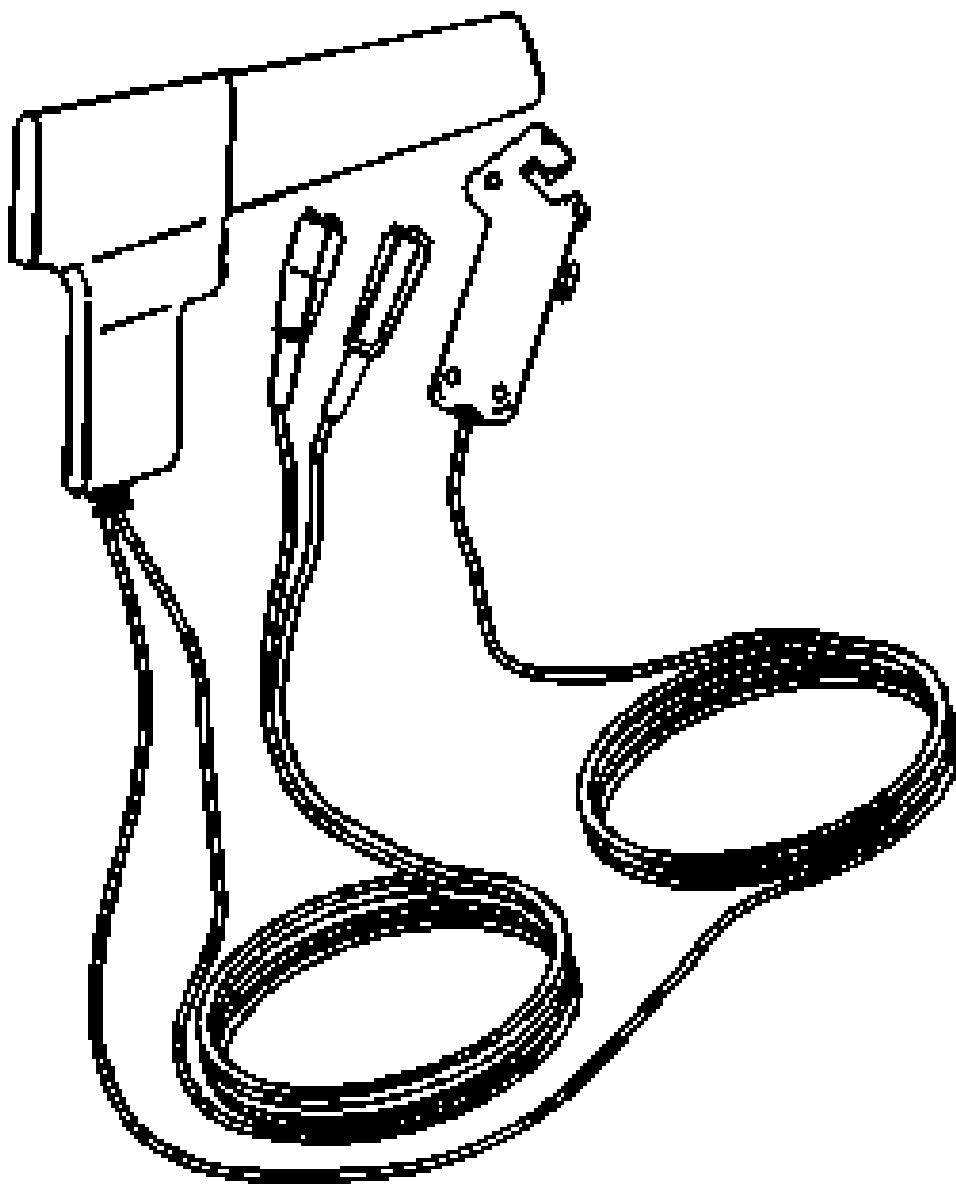
Seat Belt Indicators

The seat belt indicators are controlled through the inflatable restraint sensing and diagnostic module (SDM). For further information on seat belt indicators refer to **Seat Belt System Description and Operation** .

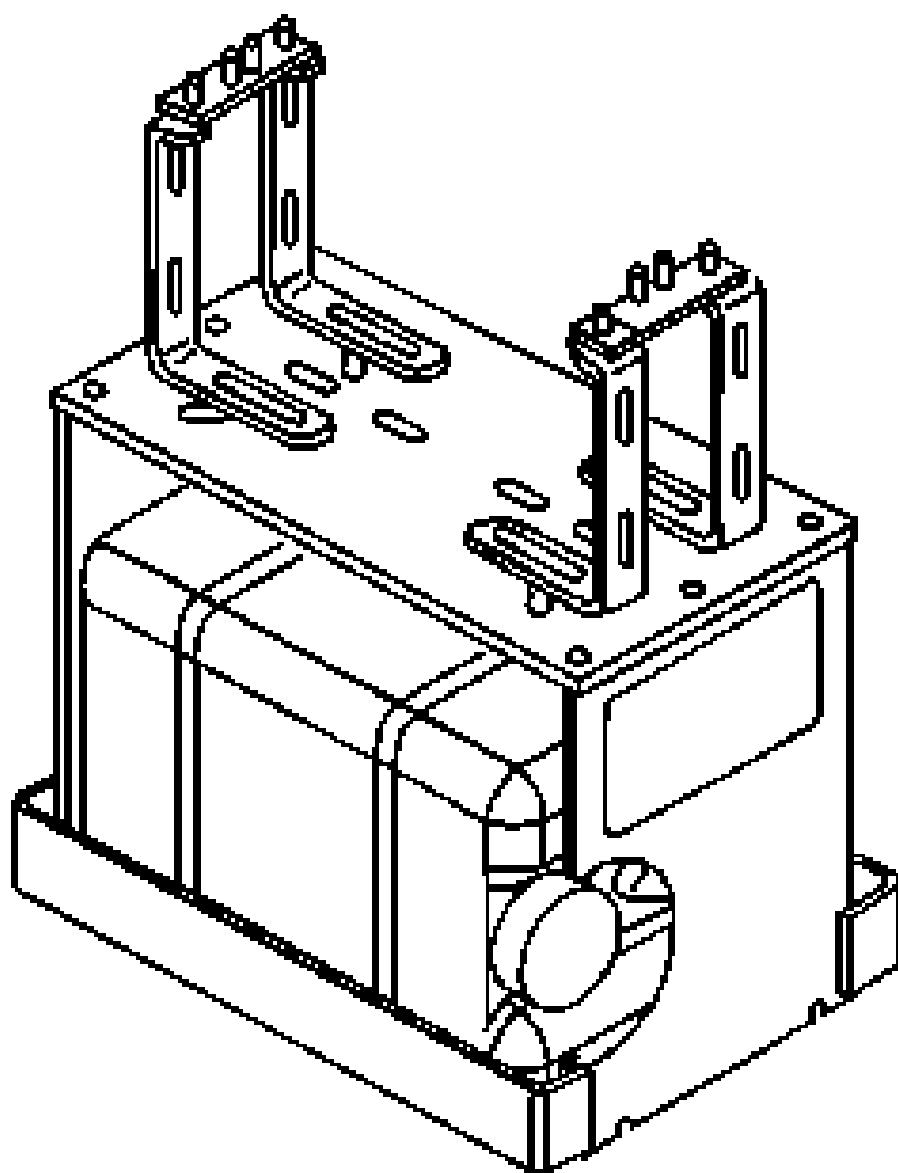
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description



EL 38826
J 38826
KM 799-3
SIR
Deployment
Harness



EL 39401-
B
J 39401-B
SIR
Deployment
Fixture

Suspension

Suspension General Diagnosis

SPECIFICATIONS

TRIM HEIGHT SPECIFICATIONS

Trim Height Specifications

Model	Option	Z	D	P	R
4GL69, 4GK69, 4GP69, 4GR69, 4GS69	GNA, GNC, QKE	-13 mm (-0.5 in)	40 mm (1.6 in)	734 mm (28.9 in)	739 mm (29.1 in)
4GL69, 4GK69, 4GP69, 4GR69, 4GS69	GNA, GNC, RP2	-13 mm (-0.5 in)	40 mm (1.6 in)	731 mm (28.8 in)	735 mm (28.9 in)
4GP69, 4GR69	GNA, GNC, QRU	-13 mm (-0.5 in)	40 mm (1.6 in)	726 mm (28.6 in)	731 mm (28.8 in)
4GR69	GNA, GNC, RAF, HP6	-13 mm (-0.5 in)	40 mm (1.6 in)	723 mm (28.5 in)	728 mm (28.7 in)
4GS69	GNB, GNC, RP2	-20 mm (-0.8 in)	33 mm (1.3 in)	726 mm (28.6 in)	728 mm (28.7 in)
4GS69	GNB, GNC, Q19	-20 mm (-0.8 in)	33 mm (1.3 in)	732 mm (28.8 in)	734 mm (28.9 in)
All measurements taken with a full tank of gas. All measurements have a tolerance of +/- 10 mm (0.39 in).					

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - SUSPENSION GENERAL DIAGNOSIS

NOTE: The following step must be completed before using the symptom tables.

Review the system description and operation in order to familiarize yourself with the system functions. Refer to the appropriate description and operation:

- **General Description (GNB)** , **General Description (GNA)** for the front suspension
- **General Description** for tires and wheels

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of any of the suspension subsystems.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for proper tire size and inflation pressure.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Ride Diagnosis**
- **Vehicle Leads/Pulls**
- **Suspension Bottoms**
- **Torque Steer**
- **Memory Steer**

RIDE DIAGNOSIS

Ride Diagnosis

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Suspension General Diagnosis</u>
2	IMPORTANT: Verify the vehicle suspension package RPO. Verify that the ride is too soft or too hard.Does the vehicle ride normally?	System OK	Go to Step 3
3	Check the tire inflation and adjust to specifications. Refer to <u>Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label</u> . Did you adjust the tire pressure?	Go to Step 6	Go to Step 4
4	Inspect the vehicle trim height. Refer to <u>Trim Height Inspection (GNA), Trim Height Inspection (GNB).</u> Did you find and correct the condition?	Go to Step 6	Go to Step 5
5	Inspect the following suspension components for wear or damage: <ul style="list-style-type: none">• Shock Absorbers-Refer to <u>Suspension Strut and Shock Absorber Testing - On Vehicle.</u>• Springs Did you find and correct the condition?	Go to Step 6	-
6	Drive the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

VEHICLE LEADS/PULLS

Vehicle Leads/Pulls

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Step	Action	Yes	No
DEFINITION: At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle straight path.			
1	Did you review the General Description and perform the visual/physical inspections?	Go to Step 2	Go to <u>Symptoms - Suspension General Diagnosis</u>
2	Road test the vehicle in order to verify the complaint. Does the vehicle operate normally?	System OK	Go to Step 3
3	Inspect the tire/wheel assemblies for the following: <ul style="list-style-type: none"> • Correct tire pressure-Refer to the tire placard. • Correct tire size-Refer to the tire placard. • Abnormal tire wear or damage Did you find and correct the condition?	Go to Step 9	Go to Step 4
4	Perform the <u>Radial Tire Lead/Pull Correction</u> . Did you find and correct the condition?	Go to Step 9	Go to Step 5
5	Inspect and correct/adjust the suspension and steering systems for the following: <ul style="list-style-type: none"> • Vehicle trim height-Refer to <u>Trim Height Specifications</u>. • Excessively worn, loose, or damaged components Did you find and correct the condition?	Go to Step 9	Go to Step 6
6	Inspect the brake system for brake drag. With the vehicle suspended on a hoist, brake drag can be identified by rotating each wheel several times and observing whether more force is needed to rotate the left wheel or the right wheel. Did you find and correct the condition?	Go to Step 9	Go to Step 7
7	Inspect the wheel alignment and adjust as necessary. Refer to <u>Wheel Alignment Measurement</u> . Did you correct the condition?	Go to Step 9	Go to Step 8
8	Inspect the steering gear for unequal effort. The vehicle must be suspended on a hoist, the engine running, and the transmission in park or neutral. Grasp the tire assembly and manually simulate a turn from the left of center and the right of center observing whether more force is needed to turn to the left or to the right. If this condition exists, replace the steering gear.		

	Did you correct the condition?	System OK	Go to Step 3
9	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

BODY LEANS OR SWAYS IN CORNERS

Body Leans or Sways in Corners

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis
2	Verify the vehicle leans or sways in corners. Does the vehicle operate normally?	System OK	Go to Step 3
3	Inspect the following components for wear or damage: <ul style="list-style-type: none"> • Rear coil springs • Front coil springs Are the components worn or damaged?	Go to Step 5	Go to Step 4
4	1. Inspect the stabilizer shaft link for wear or damage. 2. Repair as necessary. Did you find and correct the condition?	Go to Step 6	Go to Step 2
5	Replace the springs as necessary. Did you complete the repair?	Go to Step 6	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

SUSPENSION BOTTOMS

Suspension Bottoms

Step	Action	Yes	No
DEFINITION: A loud bang or thump that can usually be felt and/or heard when the vehicle is driven over bumps. This condition is commonly noticed when the vehicle trim height is too low.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis
2	Verify that the suspension bottoms. Does the vehicle operate normally?	System OK	Go to Step 3
	Inspect for vehicle overloading and correct the overloading condition as necessary. Refer to Vehicle		

3	<u>Certification, Tire Placard, Anti-Theft, and Service Parts ID Label</u> for specifications. Did you find and correct the condition?	Go to Step 6	Go to Step 4
4	Inspect the following components: <ul style="list-style-type: none"> Inspect the shock absorbers. Refer to <u>Suspension Strut and Shock Absorber Testing - On Vehicle</u> Inspect for damaged coil springs, torsion bar or leaf springs and replace as necessary. Did you find and correct the condition?	Go to Step 6	Go to Step 5
5	Inspect the vehicle trim height. Refer to <u>Trim Height Inspection (GNA), Trim Height Inspection (GNB)</u> . Did you complete the trim height inspection procedure?	Go to Step 6	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

TORQUE STEER

Torque Steer

Step	Action	Yes	No
DEFINITION: On a dry, smooth, flat road, the vehicle has a left or right steering force only during acceleration.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Suspension General Diagnosis</u>
2	<ol style="list-style-type: none"> Drive the vehicle on a straight, smooth, flat road. Press the accelerator and determine if any additional steering input is required to maintain a straight ahead direction. Repeat this test with the vehicle traveling in the opposite direction in order to eliminate crosswind effects. Lead/pull caused by unlevel roads and crosswinds are considered normal. Does the vehicle exhibit torque steer when the accelerator is pressed?	Go to Step 3	System OK
	<ol style="list-style-type: none"> Drive the vehicle on a straight, smooth, flat road at 64-97 km/h (40-60 mph). 		

3	<ol style="list-style-type: none"> Remove your foot from the accelerator. Shift the transmission into NEUTRAL in order to allow the vehicle to coast. Is any additional steering input required to maintain a straight ahead direction. Repeat this test with the vehicle traveling in the opposite direction in order to eliminate crosswind effects. Lead/pull caused by unlevel roads and crosswinds are considered normal. 		
	Does the vehicle direction change when the steering wheel is momentarily released?	Go to <u>Vehicle Leads/Pulls</u>	Go to Step 4
4	Inspect the front suspension and powertrain mounts for worn or damaged components and repair as necessary. Did you find and correct the condition?	Go to Step 6	Go to Step 5
5	Inspect the vehicle trim height. Refer to <u>Trim Height Inspection (GNA)</u> , <u>Trim Height Inspection (GNB)</u> . Did you find and correct the condition?	Go to Step 6	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	-

MEMORY STEER

Memory Steer

Step	Action	Yes	No
DEFINITION: A lead or pull in the direction the driver previously turned the vehicle. Additionally, after turning in the opposite direction, the vehicle will want to lead or pull in that direction.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Suspension General Diagnosis</u>
2	Verify that memory steer is present. Does the system operate normally?	System OK	Go to Step 3
3	<ol style="list-style-type: none"> Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>. Lubricate the tie rod ends and the ball joints if applicable. Inspect the suspension system for worn or damaged components. Repair as necessary. 		
	Did you find and correct the condition?	Go to Step 7	Go to Step 4

4	<p>Inspect for binding strut bearings.</p> <ol style="list-style-type: none"> 1. Disconnect the strut from the steering knuckle. 2. If the strut is abnormally difficult to rotate, repair or replace the upper bearing mount. <p>Did you find and complete the repair?</p>	Go to Step 7	Go to Step 5
5	<p>Inspect for binding in the lower ball joints. If joint is binding, replace the joint.</p> <p>Did you find and complete the repair?</p>	Go to Step 7	Go to Step 6
6	<p>Inspect the wheel alignment and adjust as necessary. Refer to <u>Wheel Alignment Measurement</u> .</p> <p>Did you complete the wheel alignment?</p>	Go to Step 7	-
7	<p>Operate the vehicle in order to verify the repair.</p> <p>Did you correct the condition?</p>	System OK	-

NOISE DIAGNOSIS - FRONT SUSPENSION

Noise Diagnosis - Front Suspension

Step	Action	Yes	No
DEFINITION: Any noise emitted from the front of the vehicle that is induced by VEHICLE SPEED or DRIVING TERRAIN as related to the front suspension.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Suspension General Diagnosis</u>
2	<p>Attempt to duplicate the condition. Road test the vehicle.</p> <p>Did you duplicate the condition?</p>	Go to Step 3	System OK
3	Is the noise reactive to vehicle load or speed?	Go to Step 4	Go to Step 7
4	<p>Inspect the tires for the following condition:</p> <ul style="list-style-type: none"> • Proper tire inflation and adjust as necessary- Refer to <u>Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label</u> . • Unusual tire wear-Refer to <u>Vibration Analysis - Tire and Wheel</u> . • Inspect the wheel nuts for looseness and tighten as necessary. Refer to <u>Fastener Tightening Specifications</u> . <p>Did you find and correct the condition?</p>	Go to Step 14	Go to Step 5
5	Inspect the front wheel bearings. Refer to <u>Wheel Bearings Diagnosis</u> .		

	Did you find and correct the condition?	Go to Step 14	Go to Step 6
6	Inspect for front axle or transaxle noises. Refer to Noise and Vibration Analysis . Did you find and correct the condition?	Go to Step 14	Go to Step 7
7	Bounce the front of the vehicle in order to duplicate the noise. Did you duplicate the noise?	Go to Step 8	Go to Step 9
8	<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Inspect the front suspension components for looseness. Refer to Fastener Tightening Specifications . 3. Inspect the front suspension components for damage and repair as necessary. Did you find and correct the condition?	Go to Step 14	Go to Step 9
9	<ol style="list-style-type: none"> 1. Install a listening device, if existing. 2. Bounce the front of the vehicle, preferably by using a listening device, in order to locate the source of the noise. If necessary road test the vehicle. 3. Repair or replace any damaged components as necessary. Did you find and correct the condition?	Go to Step 14	Go to Step 10
10	Inspect the ball joints and steering components for the following conditions: <ul style="list-style-type: none"> • Lack of lubrication where applicable • Looseness in the ball joints-Refer to Ball Joint Inspection. • Looseness in the tie rods-Refer to Steering Linkage Outer Tie Rod Replacement . Did you find and correct the condition?	Go to Step 14	Go to Step 11
11	Inspect for damaged shock absorbers. Refer to Suspension Strut and Shock Absorber Testing - On Vehicle . Did you find and correct the condition?	Go to Step 14	Go to Step 12
12	Inspect the front stabilizer shaft and stabilizer shaft links for damage and repair as necessary. Refer to Stabilizer Shaft Replacement (GNA, GNB) , or Stabilizer Shaft Link Replacement (GNA, GNB) .		

	Did you find and correct the condition?	Go to Step 14	Go to Step 13
13	Inspect for control arm damage and repair as necessary. Refer to <u>Lower Control Arm Replacement (GNA)</u> , <u>Lower Control Arm Replacement (GNB)</u> . Did you find and correct the condition?	Go to Step 14	-
14	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

NOISE DIAGNOSIS - REAR SUSPENSION

Noise Diagnosis - Rear Suspension

Step	Action	Yes	No
DEFINITION: Any noise emitted from the rear of the vehicle that is induced by VEHICLE SPEED or DRIVING TERRAIN as related to the rear suspension.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Suspension General Diagnosis</u>
2	Attempt to duplicate the condition. Road test the vehicle. Did you duplicate the condition?	Go to Step 3	System OK
3	Is the noise reactive to vehicle load or speed?	Go to Step 4	Go to Step 6
4	Perform the following inspections: <ul style="list-style-type: none"> Inspect and adjust the tire inflation. Refer to <u>Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label</u> . Inspect for unusual tire wear. Refer to <u>Vibration Analysis - Tire and Wheel</u> . Inspect the wheel nuts for looseness. Refer to <u>Fastener Tightening Specifications</u> . Did you find and correct the condition?	Go to Step 10	Go to Step 5
5	Inspect the rear wheel bearings. Refer to <u>Wheel Bearings Diagnosis</u> . Did you find and correct the condition?	Go to Step 10	Go to Step 6
6	Bounce the rear of the vehicle in order to duplicate the noise. Did you duplicate the noise?	Go to Step 7	Go to Step 9
7	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Inspect the rear suspension components for looseness. Refer to <u>Fastener Tightening Specifications</u> .		

	3. Inspect the rear suspension components for damage and repair as necessary.		
	Did you find and correct the condition?	Go to Step 10	Go to Step 8
8	Inspect the rear shock absorber. Refer to <u>Suspension Strut and Shock Absorber Testing - On Vehicle.</u> Did you find and correct the condition?	Go to Step 10	Go to Step 9
9	1. Install a listening device, if existing. 2. Bounce the rear of the vehicle, preferably by using a listening device, in order to locate the source of the noise. If necessary, road test the vehicle. 3. Repair or replace any defective component, as necessary.		
	Did you find and correct the condition?	Go to Step 10	System OK
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

BALL JOINT INSPECTION

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Clean and inspect the ball joint seal for cuts or tears. If the ball joint seal is damaged, replace the lower control arm. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .

SUSPENSION STRUT AND SHOCK ABSORBER TESTING - ON VEHICLE

Suspension Strut and Shock Absorber Testing - On Vehicle

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Suspension General Diagnosis</u>
2	Verify that the customer's concern is present. Does the vehicle operate normally?	System OK	Go to Step 3
3	IMPORTANT: A light film of oil on the top portion of the shock reservoir is normal. Inspect each strut or shock absorber for external fluid leakage. Is a strut or shock absorber leaking?	Go to Step 5	Go to Step 4
	1. Use your hands in order to lift up and push down each corner of the vehicle 3 times. 2. Remove your hands from the vehicle.		

4	3. Locate a shock or strut that exceeds 2 cycles. Did you locate shock or strut that exceeds 2 cycles?	Go to Step 5	Go to Step 6
5	IMPORTANT: Inspect the vehicle trim height in order to correct any possible causes of shock/strut failures. Refer to <u>Trim Height Inspection (GNA)</u>, <u>Trim Height Inspection (GNB)</u>. Replace the strut or shock absorber. Refer to <u>Strut, Strut Component, or Spring Replacement (GNA, GNB)</u> , or <u>Shock Absorber Replacement (GNC)</u> , <u>Shock Absorber Replacement (GNE)</u> .Did you complete the repair?	Go to Step 6	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

WHEEL BEARINGS DIAGNOSIS

Wheel Bearings Diagnosis

Step	Action	Values	Yes	No
1	Did you review the General Description and perform the necessary inspections?	-	Go to Step 2	Go to <u>Symptoms - Suspension General Diagnosis</u>
2	Road test the vehicle in order to verify the customer's complaint. Does the vehicle operate normally?	-	System OK	Go to Step 3
3	1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Inspect for tire or wheel damage. Did you find and correct the condition?	-	Go to Step 6	Go to Step 4
4	Road test the vehicle to verify the location of the wheel bearing noise. Did you locate the source of the wheel bearing noise?	-	Go to Step 5	Go to Step 2
5	Replace the wheel bearing. Refer to <u>Front Wheel Bearing and Hub Replacement (GNB)</u> , <u>Front Wheel Bearing and Hub Replacement (GNA)</u> , or <u>Rear Wheel Bearing and Hub Replacement , Rear Wheel Bearing and Hub Replacement (GNE)</u> . Did this complete the repair?	-	Go to Step 6	-

6	Road test the vehicle to verify the repair. Does the vehicle operate normally?	-	System OK	Go to Step 3
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TRIM HEIGHT INSPECTION (GNA)

Trim Height Measurement

Trim height is a predetermined measurement relating to vehicle ride height. Incorrect trim heights can cause the vehicle to bottom out over bumps, damage to the suspension components and symptoms similar to wheel alignment problems. Check the trim heights when diagnosing suspension concerns and before checking the wheel alignment.

Perform the following before measuring the trim heights:

- Set the tire pressure to the specifications shown on the certification label. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .
- Check the fuel level. Add additional weight if necessary to simulate a full tank.
- Make sure the passenger and rear compartments are empty, except for the spare tire.
- Make sure the vehicle is on a flat and level surface, such as an alignment rack.
- Check that all the vehicle doors are securely closed.
- Check that the vehicle hood and rear deck lids are securely closed.
- Check for installed after market accessories or modifications that could affect trim height measurement:
 - Larger or Smaller than production wheels and tires.
 - Lifting or Lowering Kits
 - Wheel Opening Flares or Ground Affects

Measuring the P and R Dimension

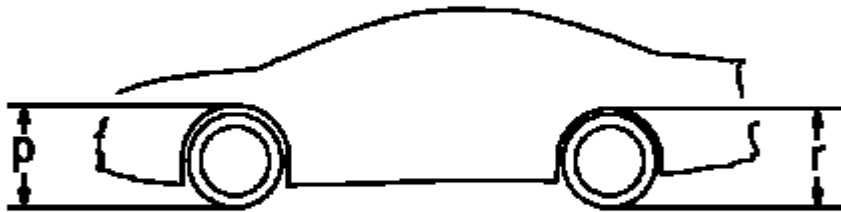


Fig. 1: P and R Dimension

Courtesy of GENERAL MOTORS COMPANY

Measurement Definitions

P Height: The vertical distance from the ground to the top of the wheel opening through the center line of the front wheel.

R Height: The vertical distance from the ground to the top of the wheel opening through the center line of the rear wheel.

Use the following procedures to measure the P and R dimensions:

NOTE: **The left and right P and R height differences should be no more than 12 mm (47 in).**

1. Push the front bumper down a minimum of 25 mm (1 in), and release. Perform this step three times.
2. Measure and record the trim height per the "Measurement Definitions" above.
3. Lift the bumper up a minimum of 25 mm (1 in), and release. Perform this step three times.
4. Measure and record the trim height per the "Measurement Definitions" above.

5. The true P height measurement is the average of the measurements taken in step 2 & 4. Refer to **Trim Height Specifications**
6. Repeat the above steps at the rear of the vehicle for the R heights.
7. If the P & R heights are outside of the specifications, measure the Z & D heights.

Measuring the Z Dimension

Measurement Definitions

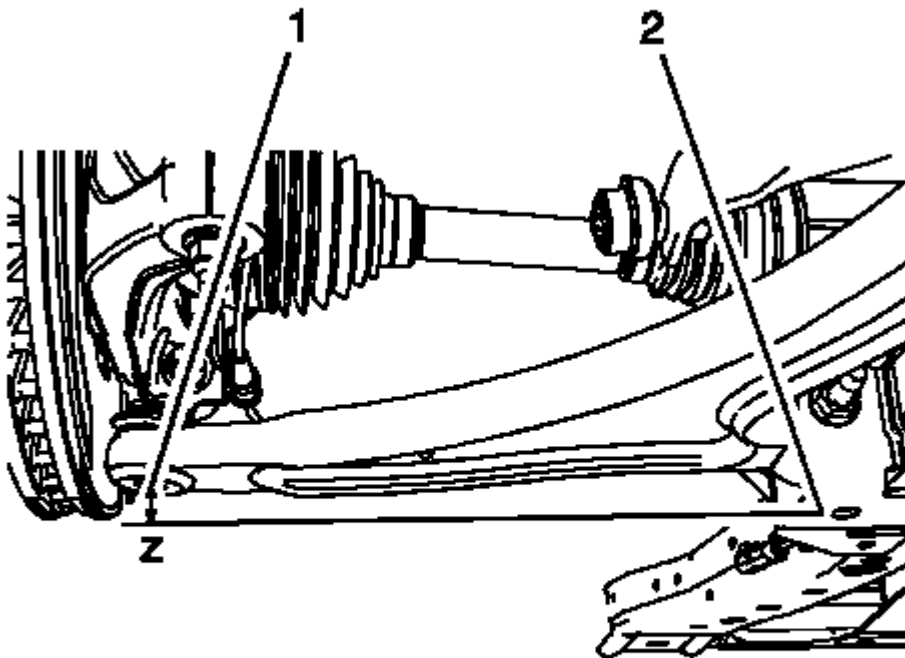


Fig. 2: Z Dimension

Courtesy of GENERAL MOTORS COMPANY

Z Height: The vertical distance between the bottom surface of the cradle bracket (2) in line with the ball joint and center point of the ball joint cup (1).

Use the following procedures to measure the Z dimensions:

NOTE: The left and right Z height differences should be no more than 10 mm (.39 in).

1. Push the front bumper down a minimum of 25 mm (1 in). Perform this step three times.

2. Measure and record the trim height per the "Measurement Definitions" above.
3. Lift the front bumper a minimum of 25 mm (1 in). Perform this step three times.
4. Measure and record the trim height per the "Measurement Definitions" above.
5. The true Z height dimension is the average of the measurements taken in steps 2 & 4. Refer to **Trim Height Specifications**.
6. If these measurements are out of specifications, inspect for the following conditions:
 - Worn or damaged suspension components
 - Collision damage

D Height Measurement

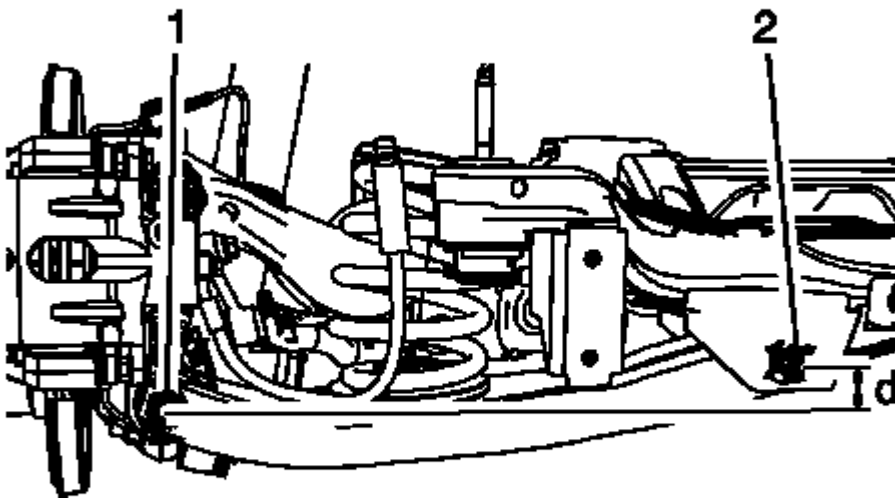


Fig. 3: D Height Measurement
Courtesy of GENERAL MOTORS COMPANY

Measurement Definitions

D Height GNC: The vertical distance between the center of the outer lower control arm bolt (1) to the center of the inner lower control arm bolt (2).

Use the following procedure to check the D dimension:

NOTE: **The left and right D height difference should be no more than 10 mm (.39 in).**

1. Push the rear bumper down a minimum of 25 mm (1 in). Perform this step three times.
2. Measure and record the trim height per the "Measurement Definitions" above.
3. Lift the rear bumper up a minimum of 25 mm (1 in), and release. Perform this step three times.
4. Measure and record the trim height per the "Measurement Definitions" above.
5. The true D height is the average of the measurements taken in steps 2 & 4. Refer to **Trim Height Specifications**.
6. If these measurements are out of specifications, inspect for the following conditions:
 - Worn or damaged suspension components
 - Collision damage

TRIM HEIGHT INSPECTION (GNB)

Trim Height Measurement

Trim height is a predetermined measurement relating to vehicle ride height. Incorrect trim heights can cause the vehicle to bottom out over bumps, damage to the suspension components and symptoms similar to wheel alignment problems. Check the trim heights when diagnosing suspension concerns and before checking the wheel alignment.

Perform the following before measuring the trim heights:

- Set the tire pressure to the specifications shown on the certification label. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .
- Check the fuel level. Add additional weight if necessary to simulate a full tank.
- Make sure the passenger and rear compartments are empty, except for the spare tire.
- Make sure the vehicle is on a flat and level surface, such as an alignment rack.
- Check that all the vehicle doors are securely closed.
- Check that the vehicle hood and rear deck lids are securely closed.
- Check for installed after market accessories or modifications that could affect trim height measurement:
 - Larger or Smaller than production wheels and tires.
 - Lifting or Lowering Kits
 - Wheel Opening Flares or Ground Affects

Measuring the P and R Dimension

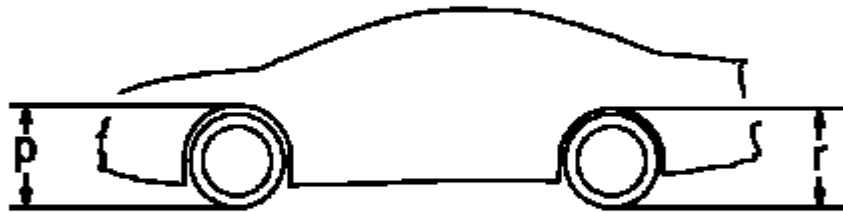


Fig. 4: P and R Dimension

Courtesy of GENERAL MOTORS COMPANY

Measurement Definitions

P Height: The vertical distance from the ground to the top of the wheel opening through the center line of the front wheel.

R Height: The vertical distance from the ground to the top of the wheel opening through the center line of the rear wheel.

Use the following procedures to measure the P and R dimensions:

NOTE: **The left and right P and R height differences should be no more than 12 mm (47 in).**

1. Push the front bumper down a minimum of 25 mm (1 in), and release. Perform this step three times.
2. Measure and record the trim height per the "Measurement Definitions" above.
3. Lift the bumper up a minimum of 25 mm (1 in), and release. Perform this step three times.
4. Measure and record the trim height per the "Measurement Definitions" above.

5. The true P height measurement is the average of the measurements taken in step 2 & 4. Refer to **Trim Height Specifications**
6. Repeat the above steps at the rear of the vehicle for the R heights.
7. If the P & R heights are outside of the specifications, measure the Z & D heights.

Measuring the Z Dimension

Measurement Definitions

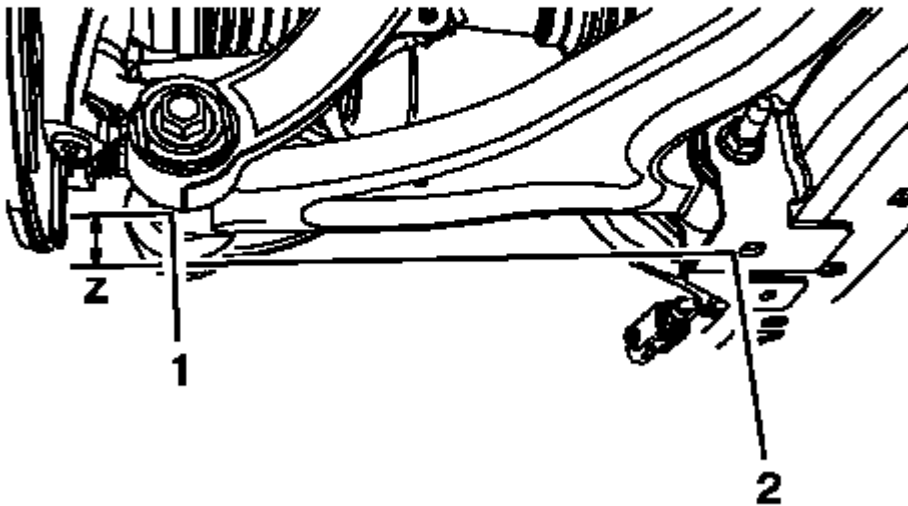


Fig. 5: Z Dimension

Courtesy of GENERAL MOTORS COMPANY

Z Height: The vertical distance between the bottom surface of the cradle bracket (2) in line with the outer measurement and the lowest point on the surface of the lower control arm at the knuckle (1).

Use the following procedures to measure the Z dimensions:

NOTE: The left and right Z height differences should be no more than 10 mm (.39 in).

1. Push the front bumper down a minimum of 25 mm (1 in). Perform this step three times.

2. Measure and record the trim height per the "Measurement Definitions" above.
3. Lift the front bumper a minimum of 25 mm (1 in). Perform this step three times.
4. Measure and record the trim height per the "Measurement Definitions" above.
5. The true Z height dimension is the average of the measurements taken in steps 2 & 4. Refer to **Trim Height Specifications**.
6. If these measurements are out of specifications, inspect for the following conditions:
 - Worn or damaged suspension components
 - Collision damage

D Height Measurement

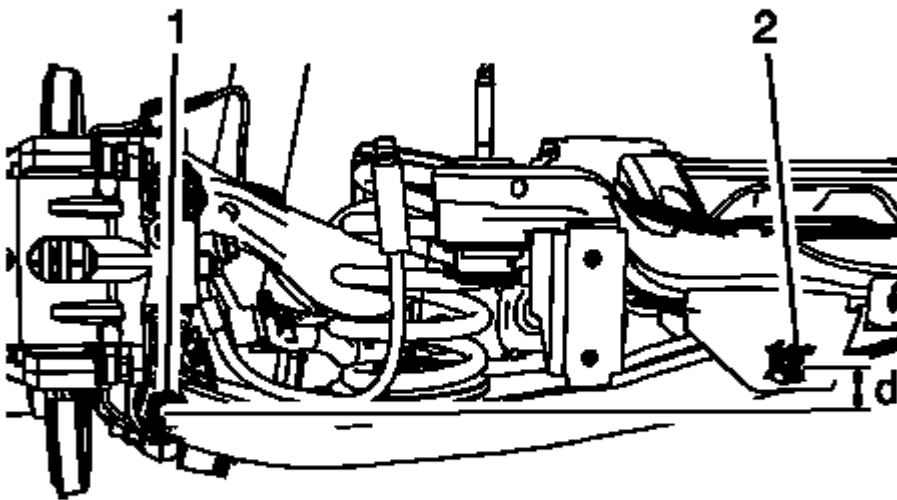


Fig. 6: D Height Measurement
Courtesy of GENERAL MOTORS COMPANY

Measurement Definitions

D Height GNC: The vertical distance between the center of the outer lower control arm bolt (1) to the center of the inner lower control arm bolt (2).

Use the following procedure to check the D dimension:

NOTE: **The left and right D height difference should be no more than 10 mm (.39 in).**

1. Push the rear bumper down a minimum of 25 mm (1 in). Perform this step three times.
2. Measure and record the trim height per the "Measurement Definitions" above.
3. Lift the rear bumper up a minimum of 25 mm (1 in), and release. Perform this step three times.
4. Measure and record the trim height per the "Measurement Definitions" above.
5. The true D height is the average of the measurements taken in steps 2 & 4. Refer to **Trim Height Specifications**.
6. If these measurements are out of specifications, inspect for the following conditions:
 - Worn or damaged suspension components
 - Collision damage

AIR CONDITIONING

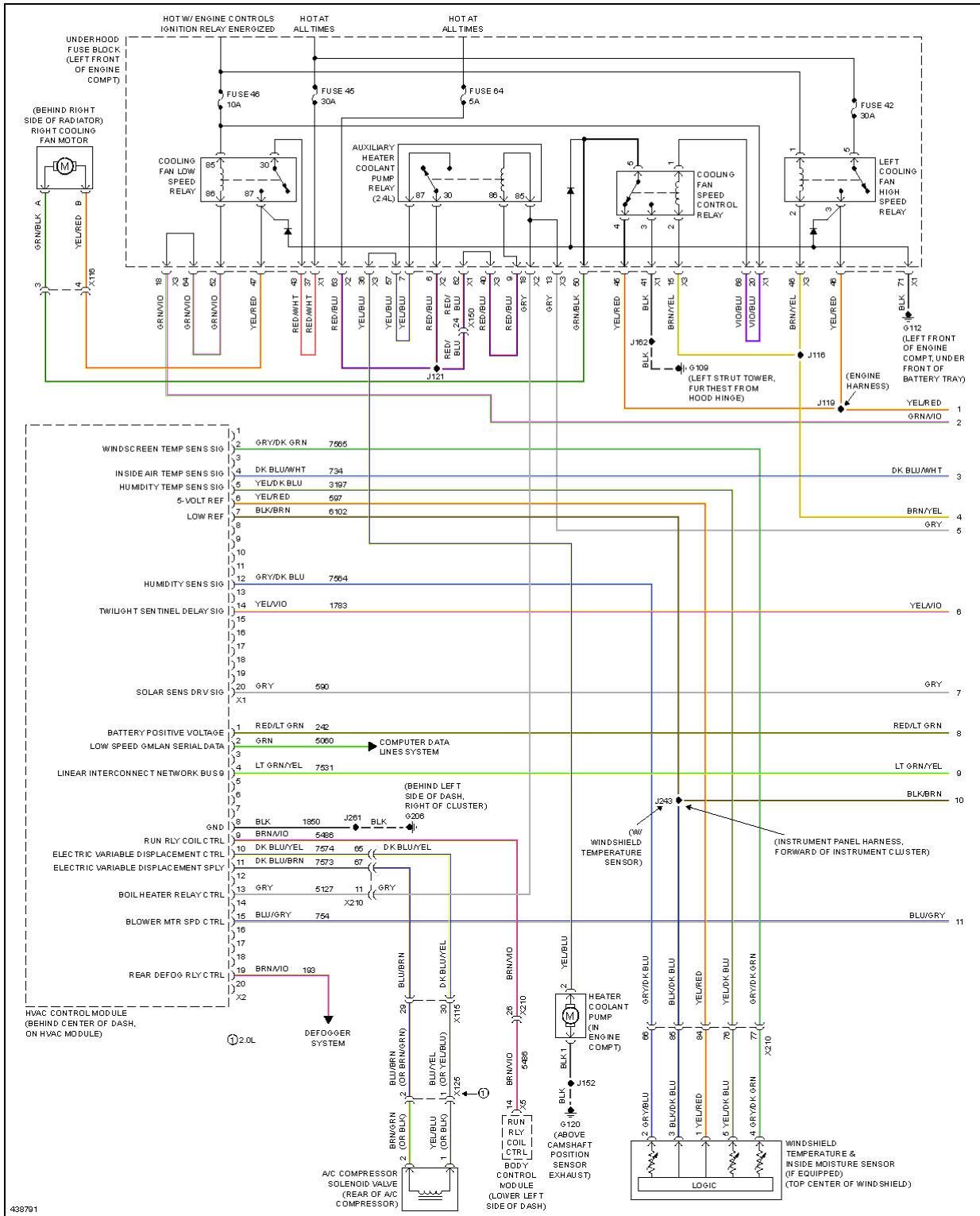


Fig. 1: Automatic A/C Circuit (1 of 4)

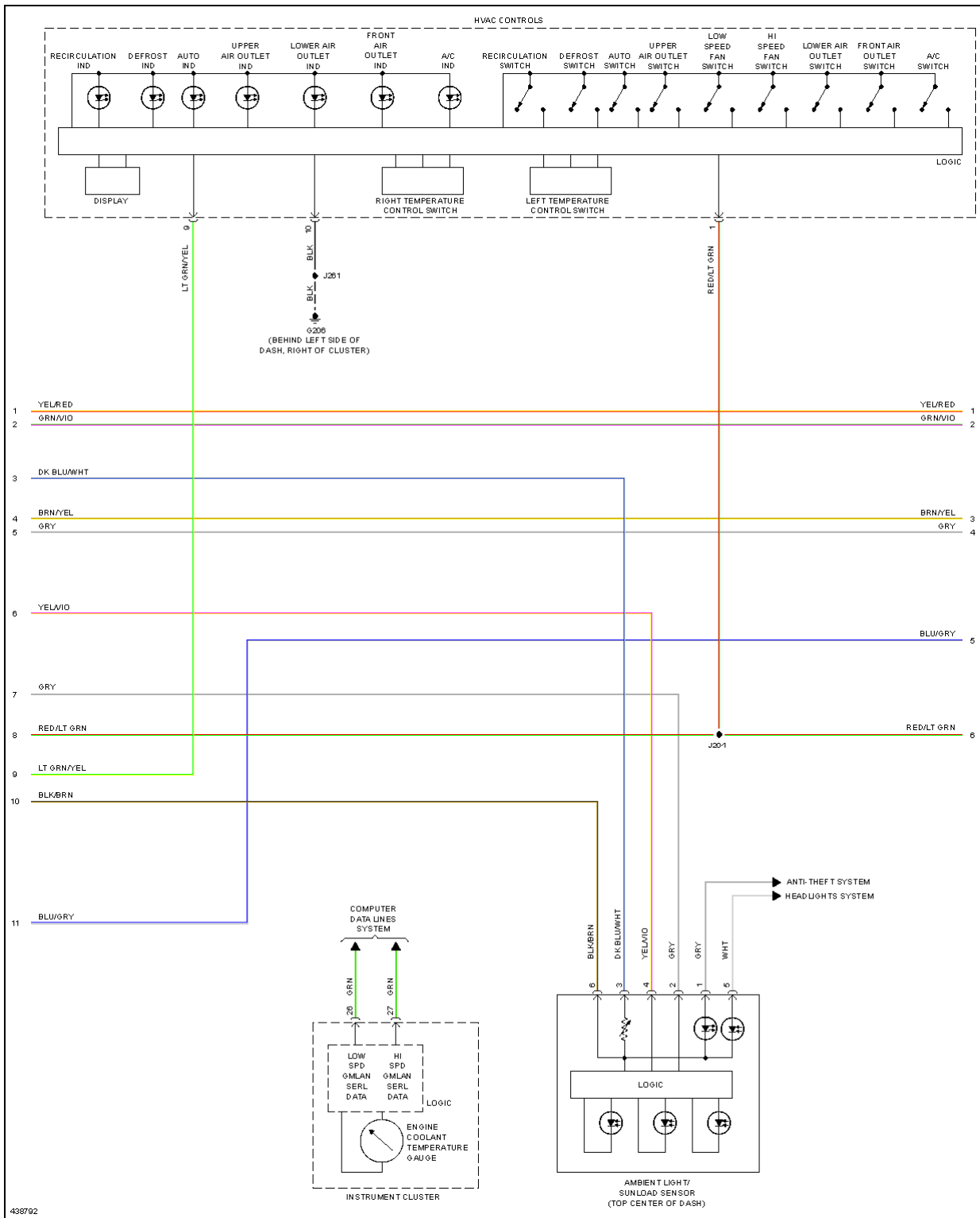


Fig. 2: Automatic A/C Circuit (2 of 4)

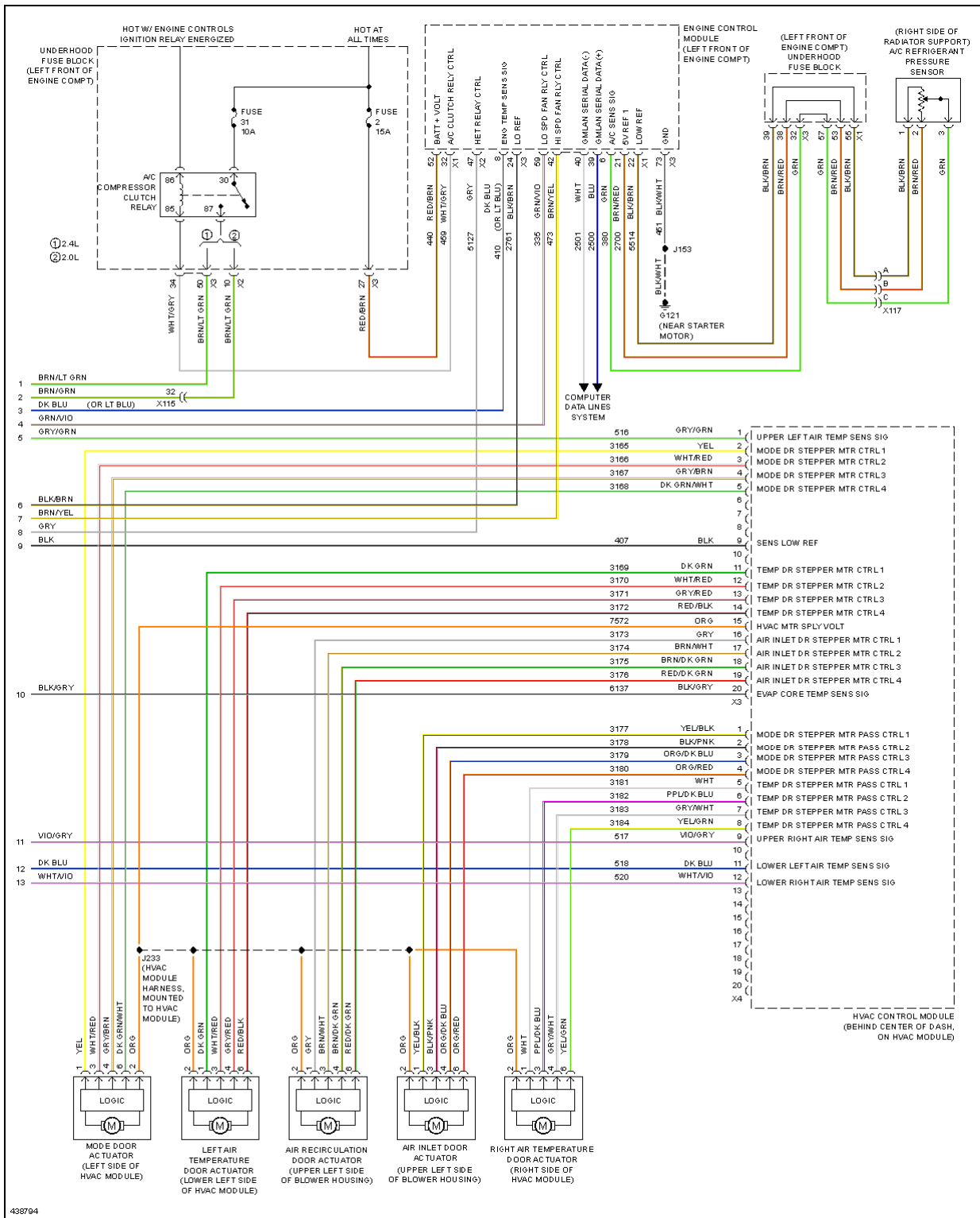


Fig. 4: Automatic A/C Circuit (4 of 4)

ANTI-LOCK BRAKES

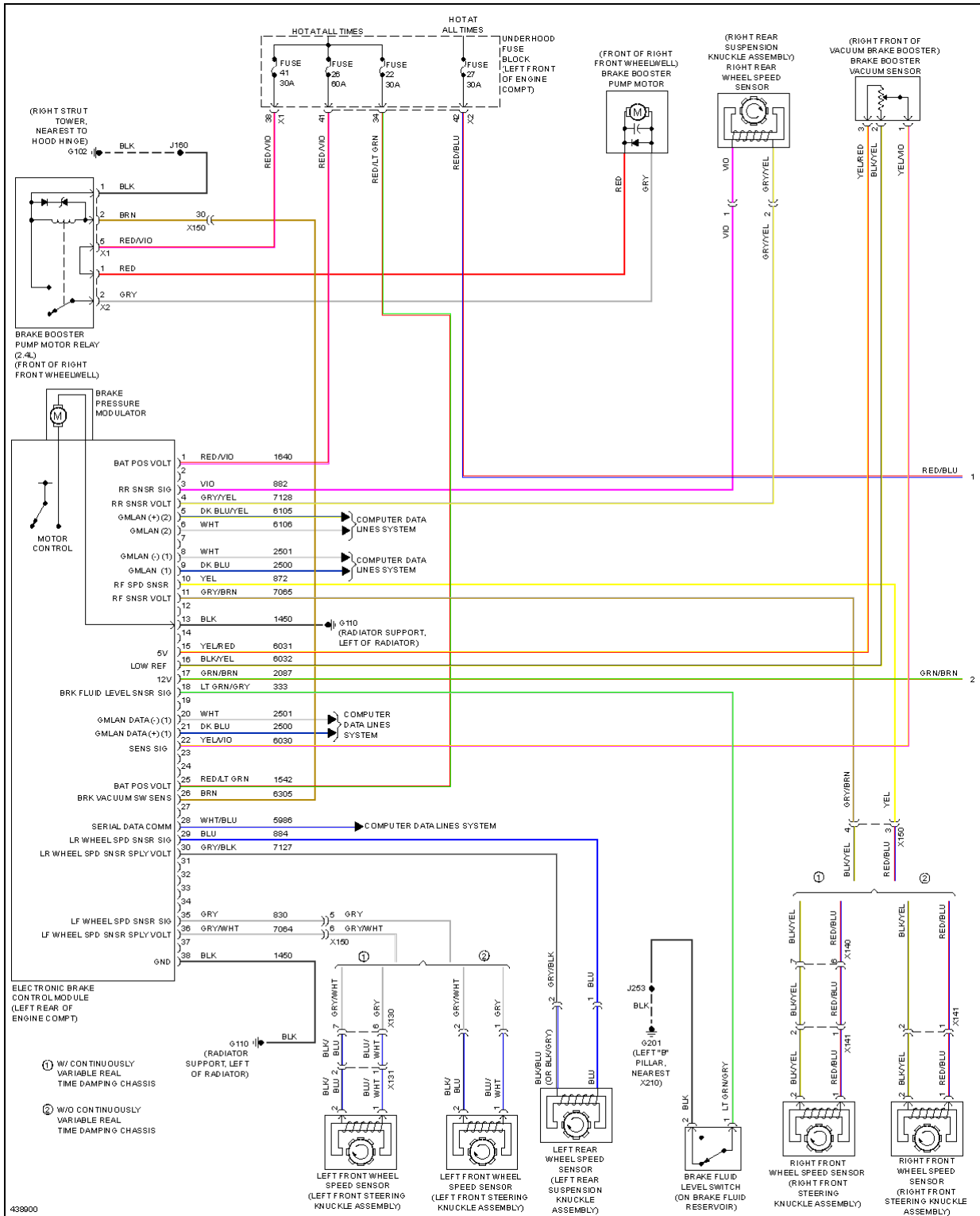


Fig. 5: Anti-lock Brakes Circuit (1 of 2)

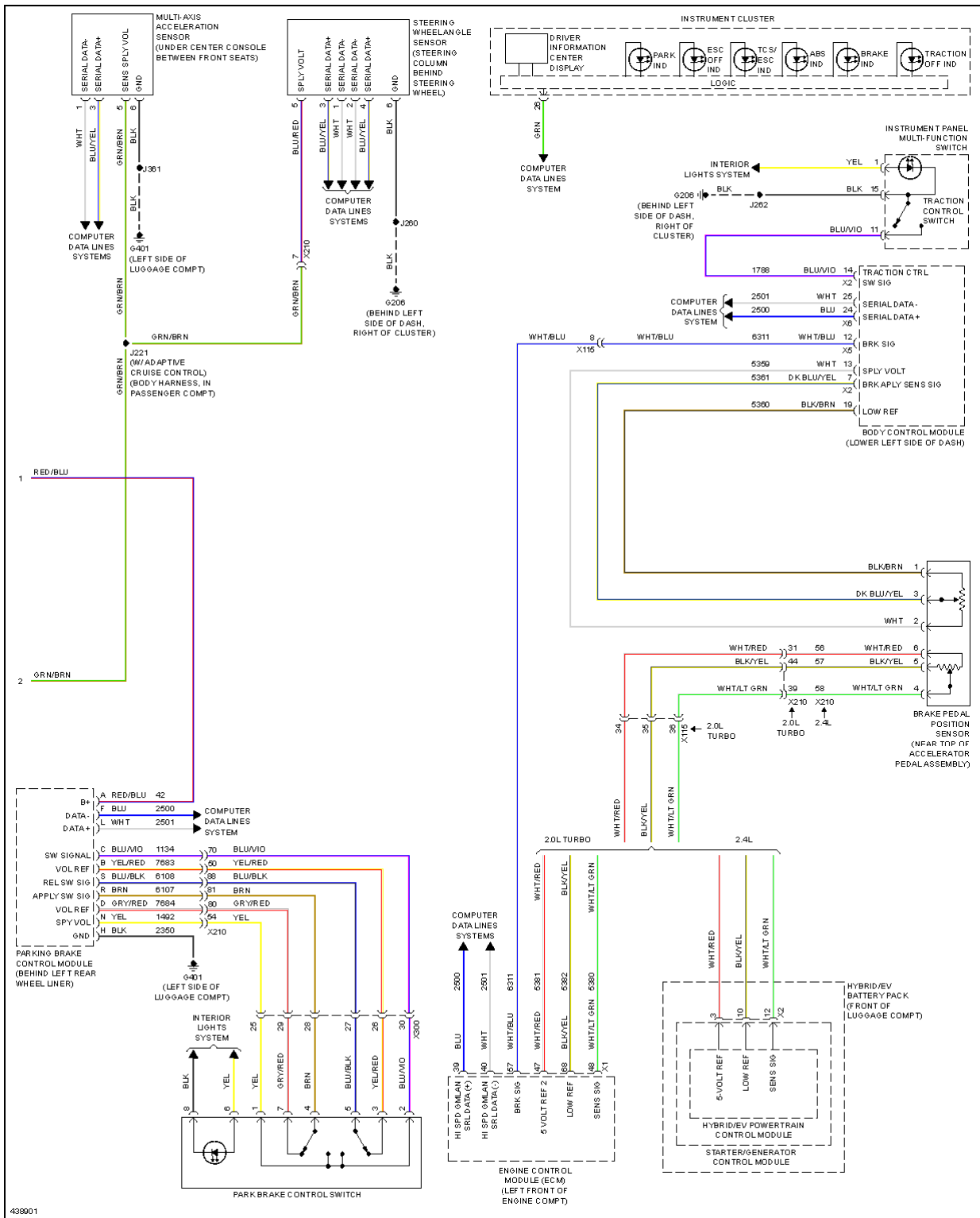


Fig. 6: Anti-lock Brakes Circuit (2 of 2)

ANTI-THEFT



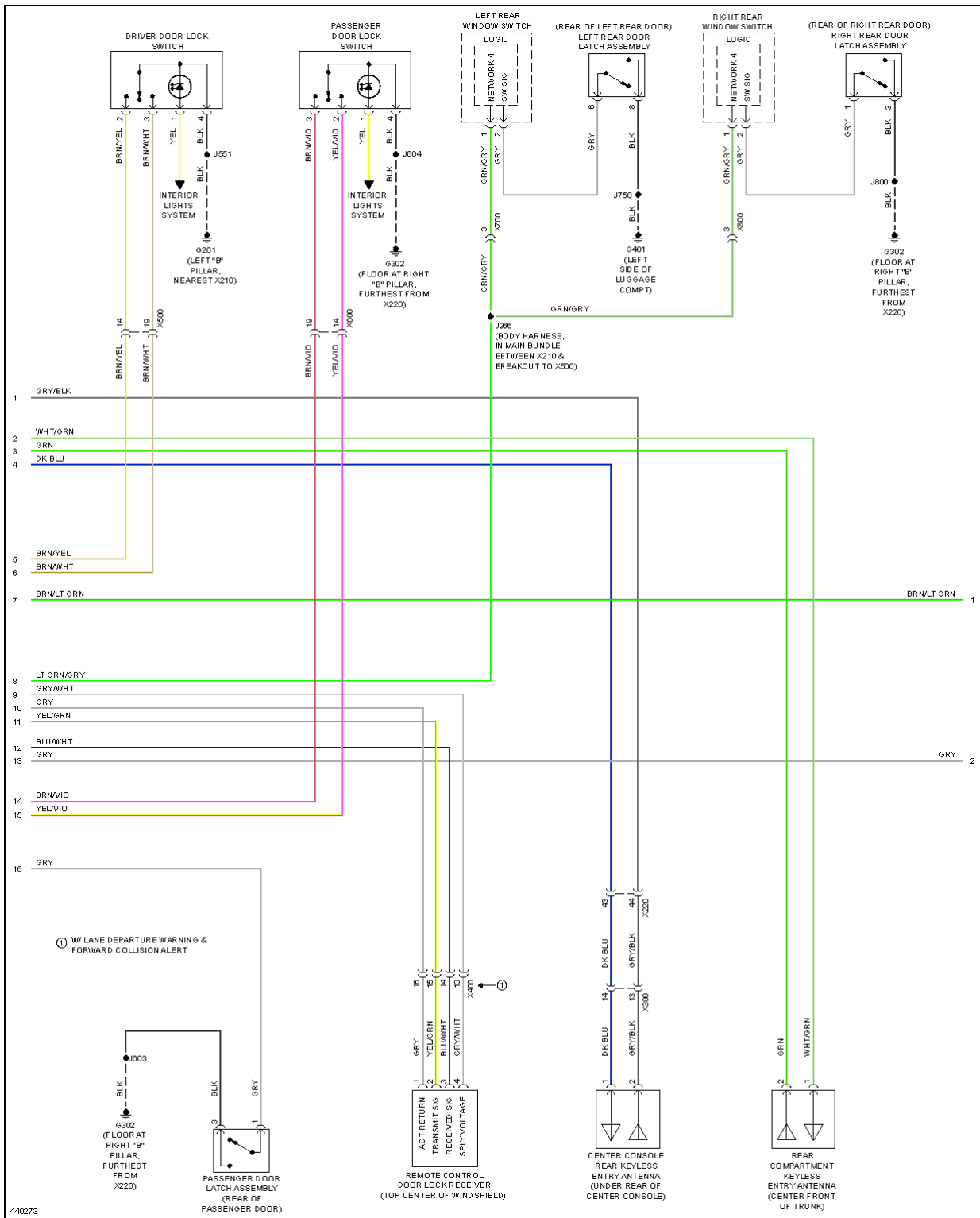


Fig. 8: Forced Entry Circuit, W/ Passive Keyless Entry (2 of 3)



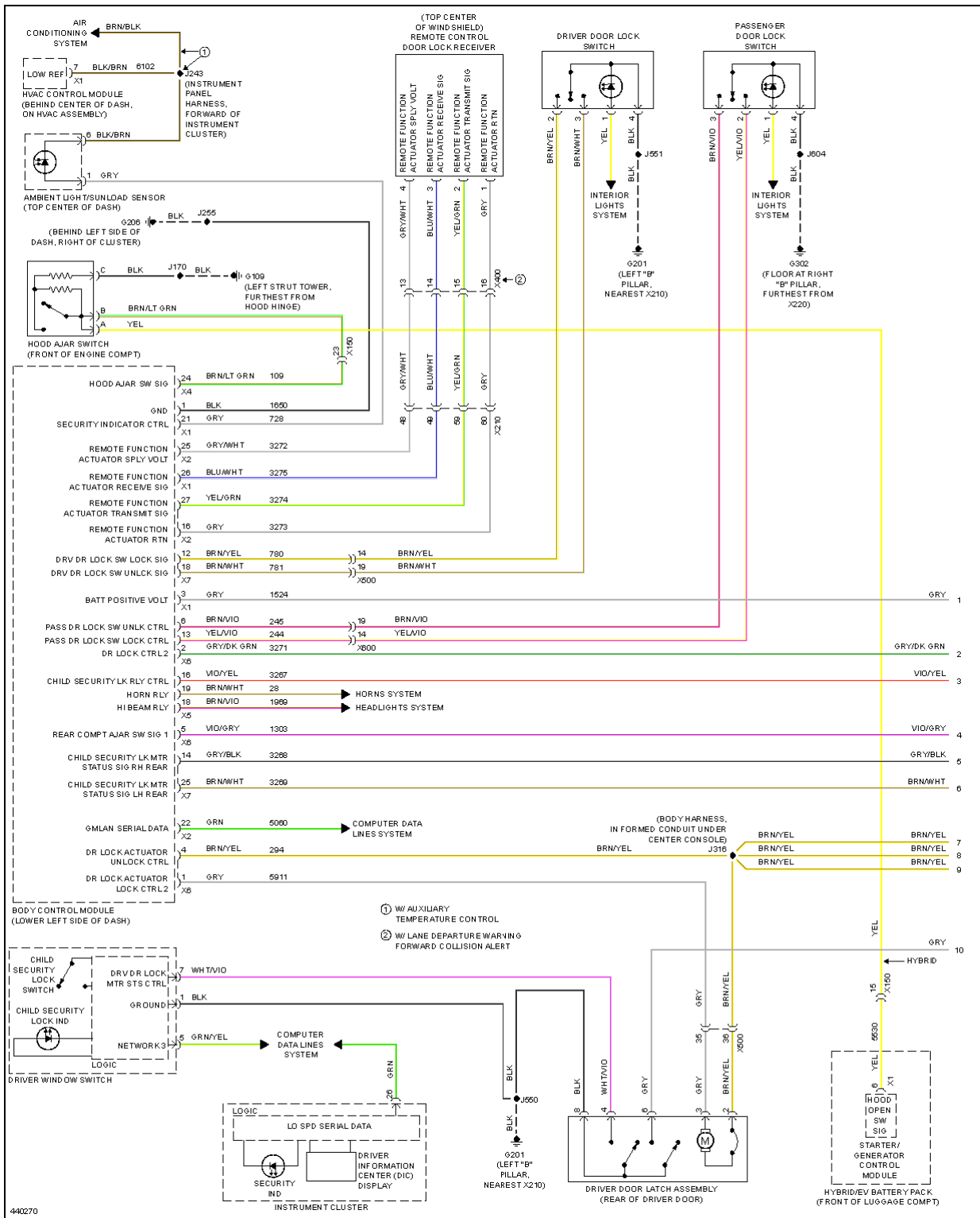


Fig. 10: Forced Entry Circuit, W/O Passive Keyless Entry (1 of 2)

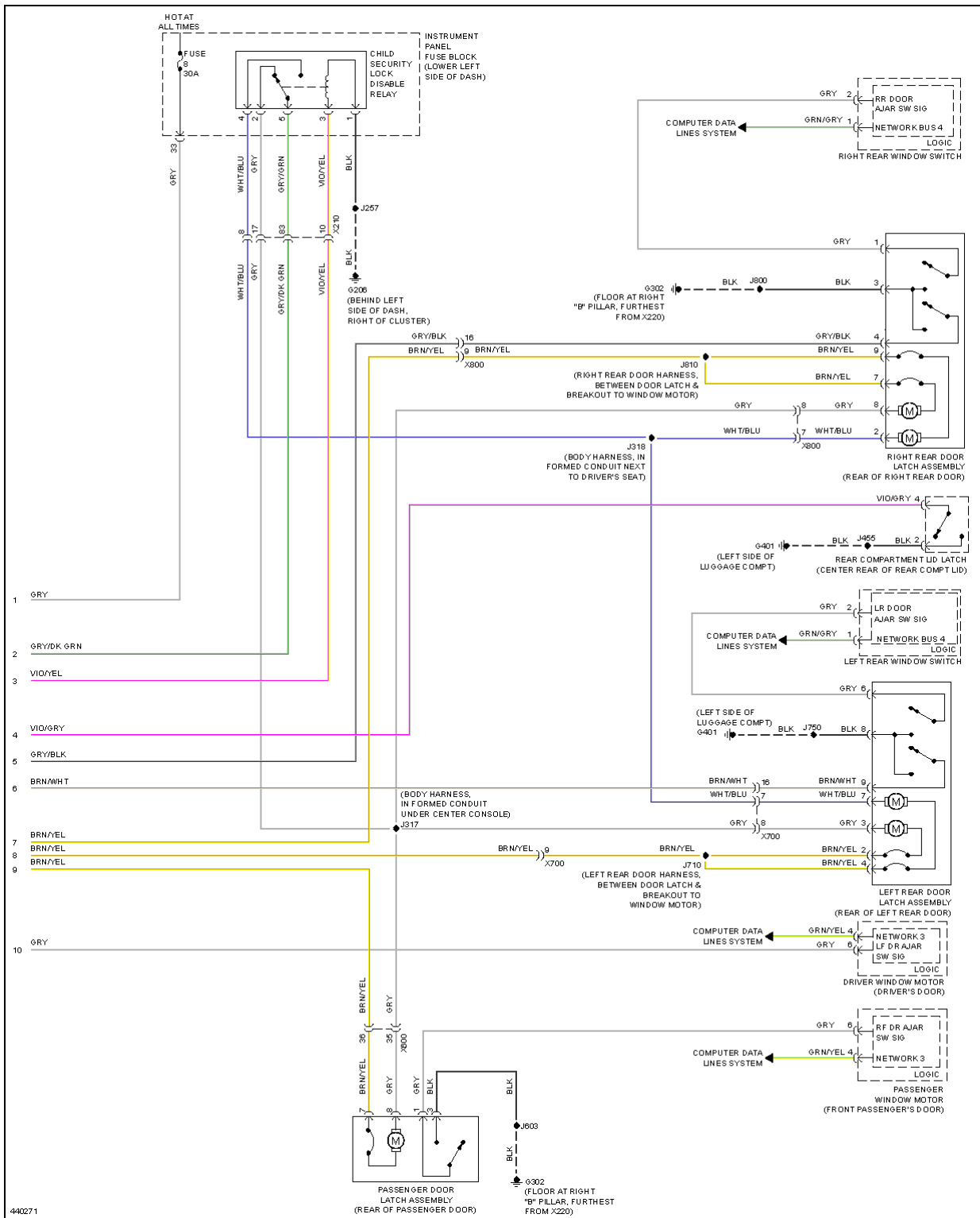


Fig. 11: Forced Entry Circuit, W/O Passive Keyless Entry (2 of 2)

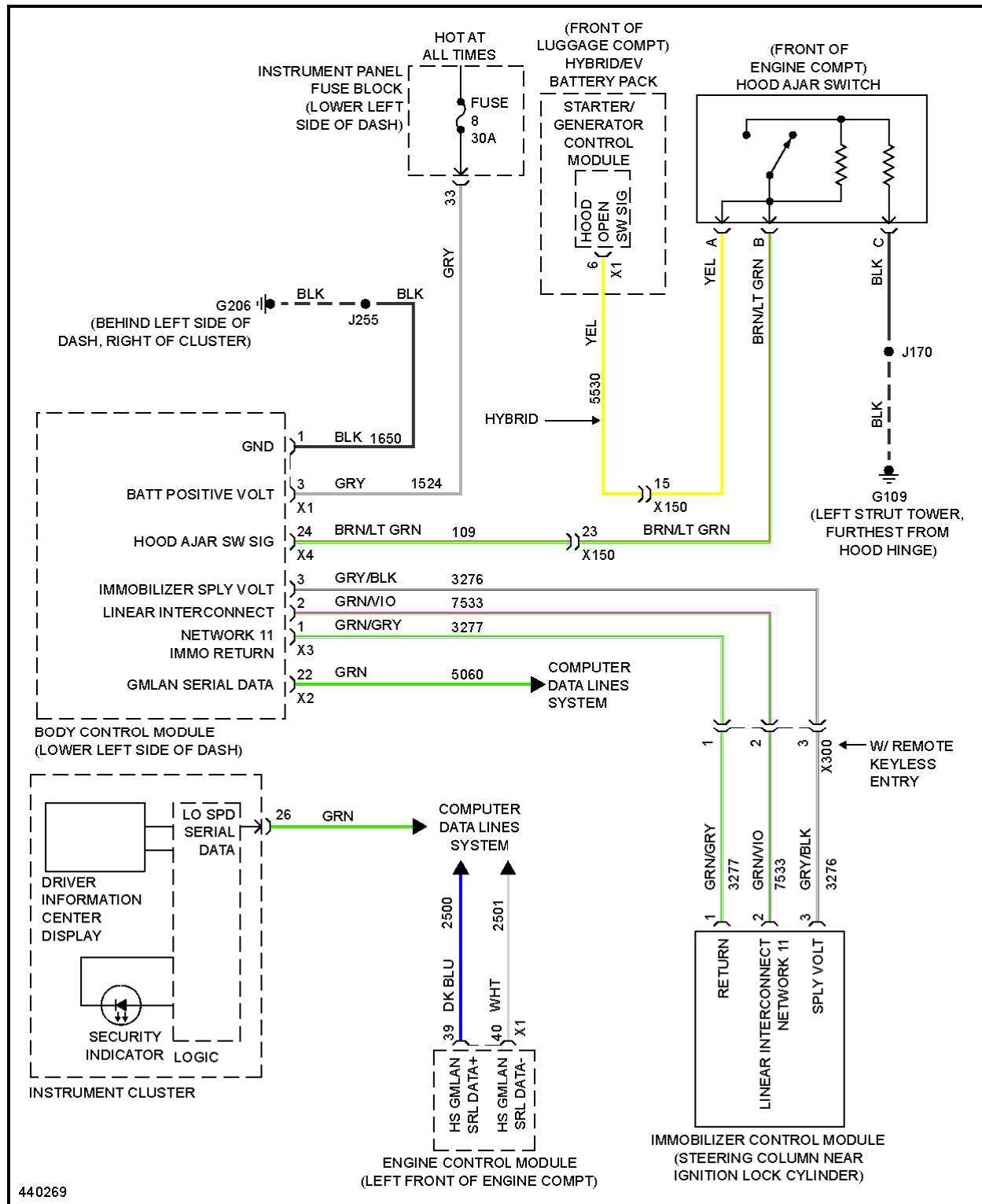


Fig. 12: Pass-Key Circuit

BODY CONTROL MODULES

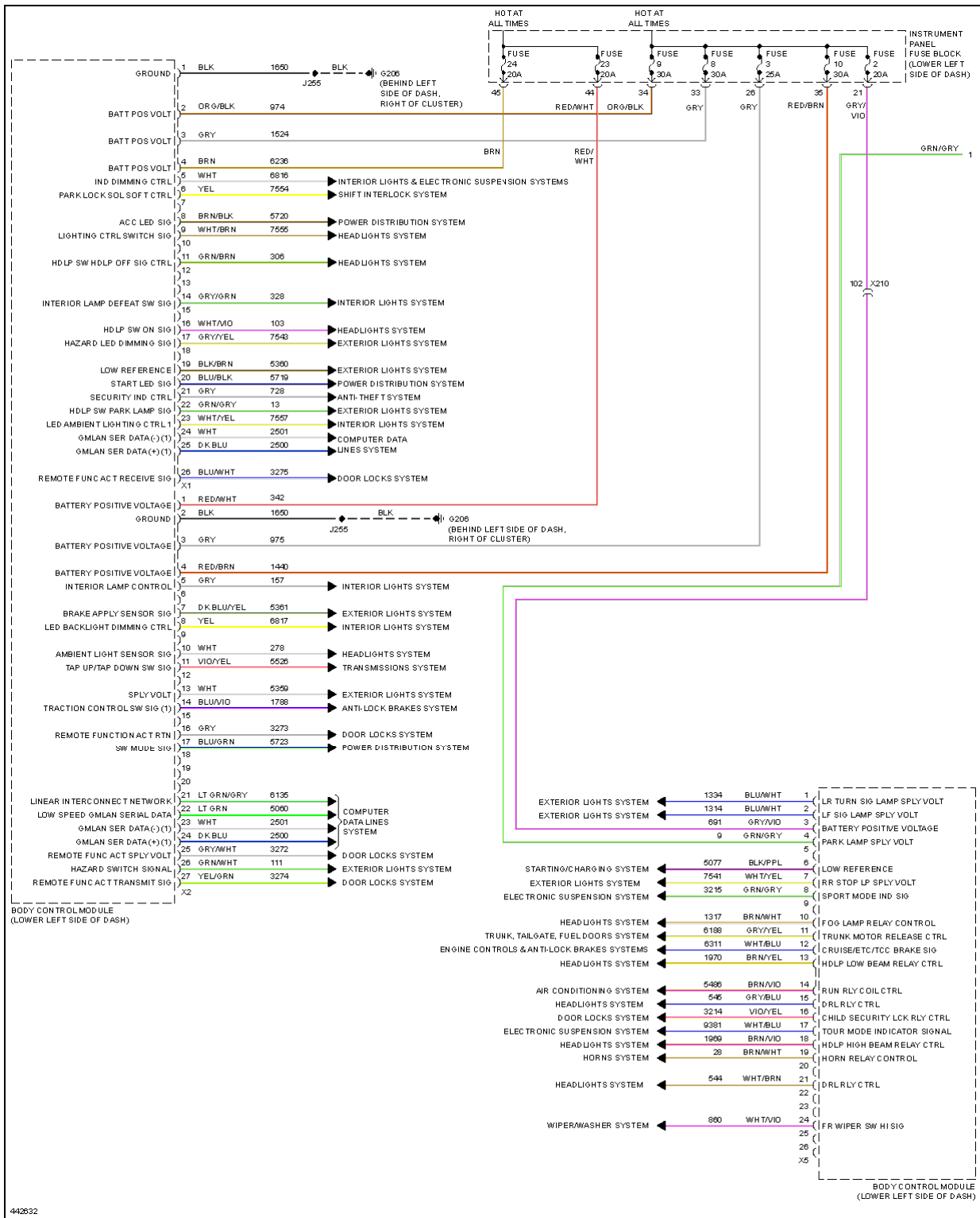


Fig. 13: Body Control Modules Circuit (1 of 2)



COMPUTER DATA LINES

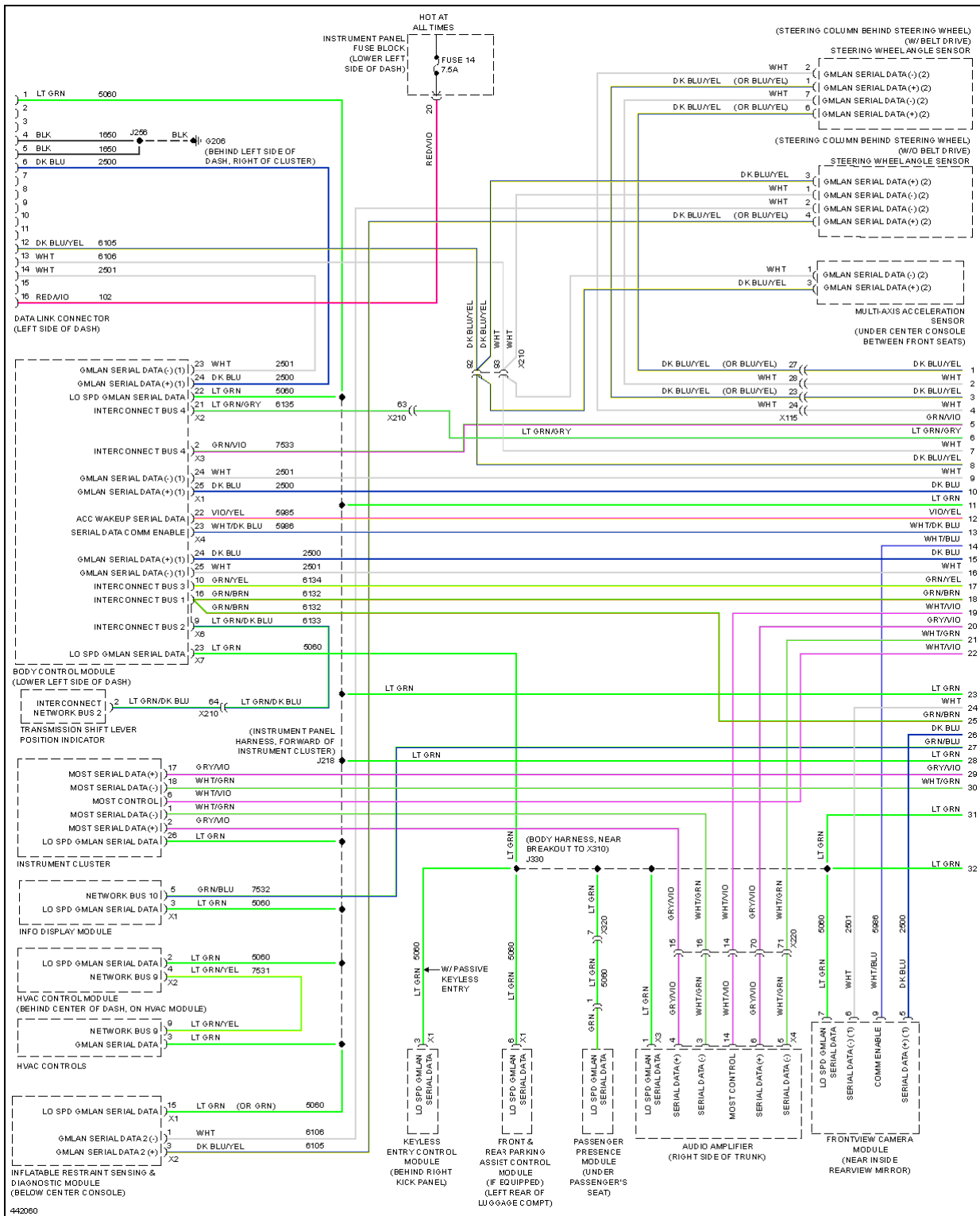


Fig. 15: Computer Data Lines Circuit (1 of 4)



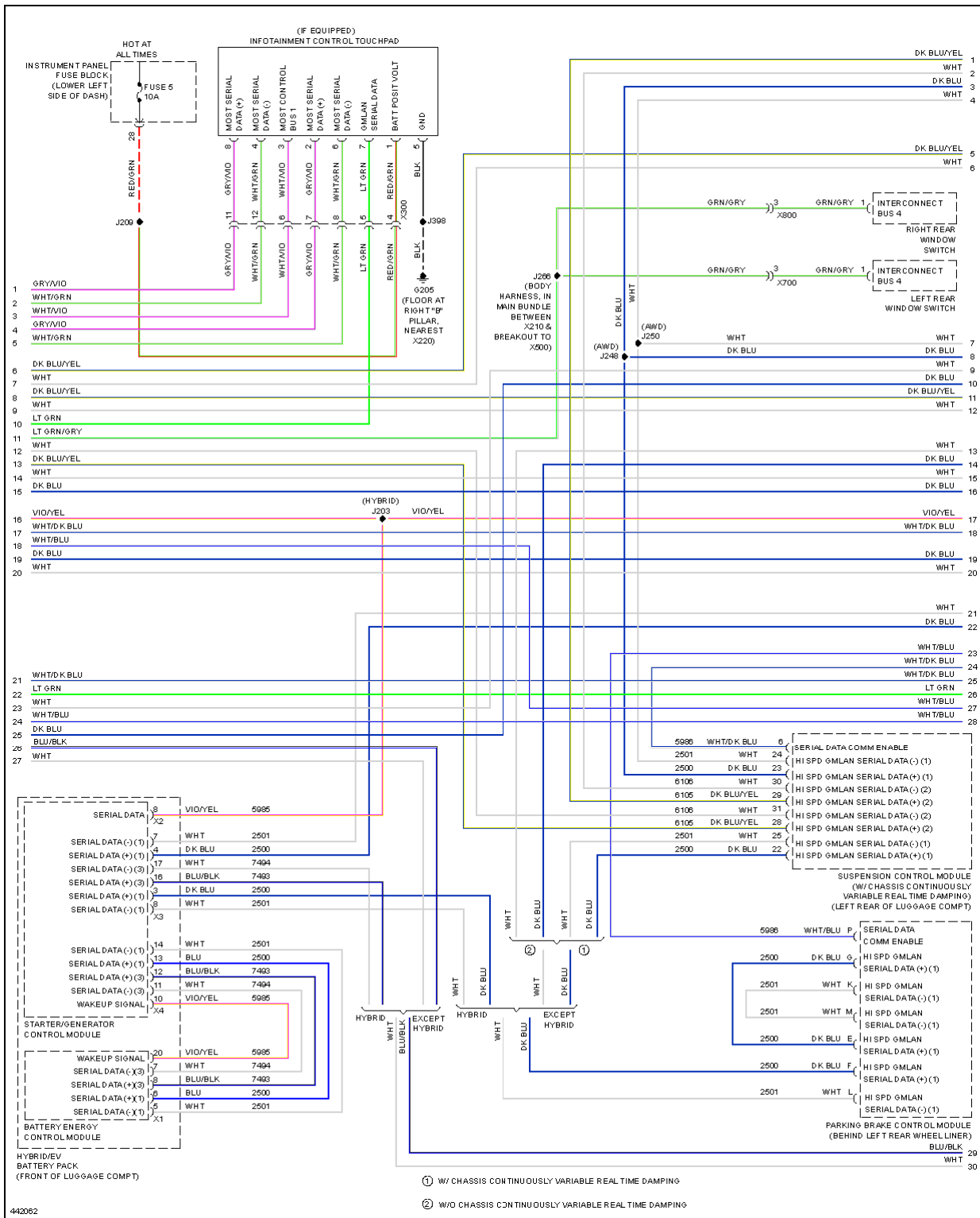


Fig. 17: Computer Data Lines Circuit (3 of 4)

COOLING FAN





Fig. 20: Hybrid Cooling Fan Circuit

CRUISE CONTROL

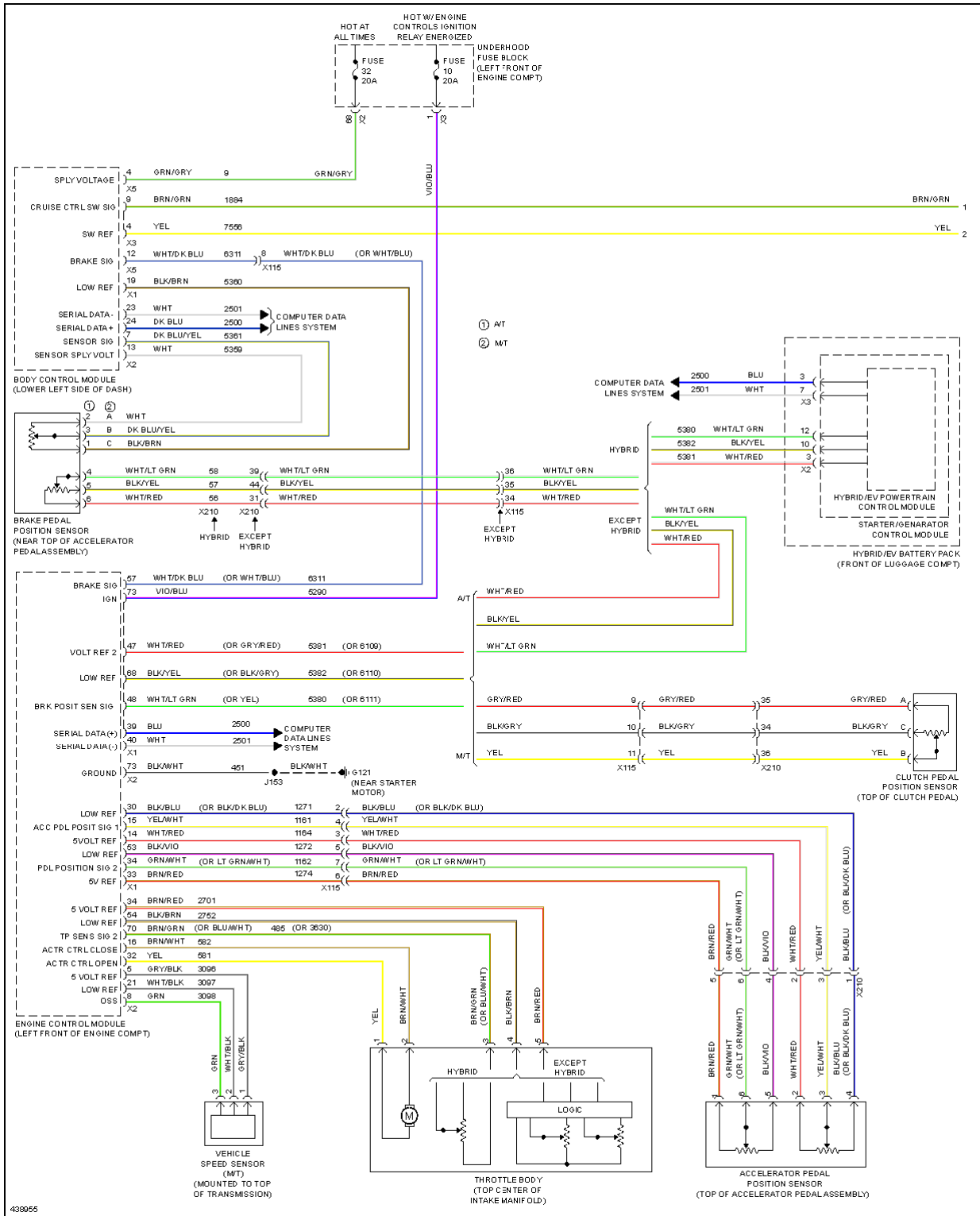


Fig. 21: Cruise Control Circuit (1 of 2)

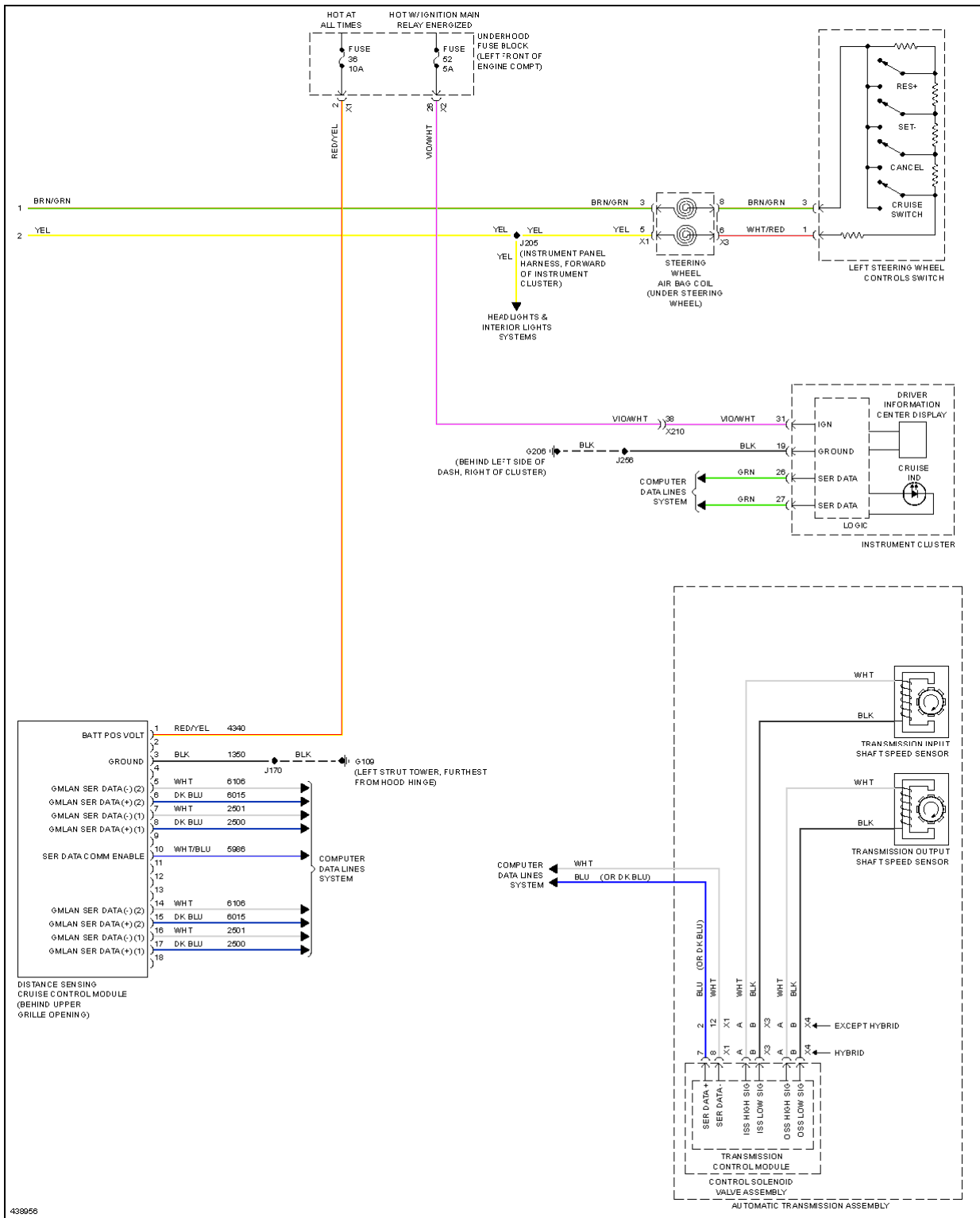


Fig. 22: Cruise Control Circuit (2 of 2)

DEFOGGERS

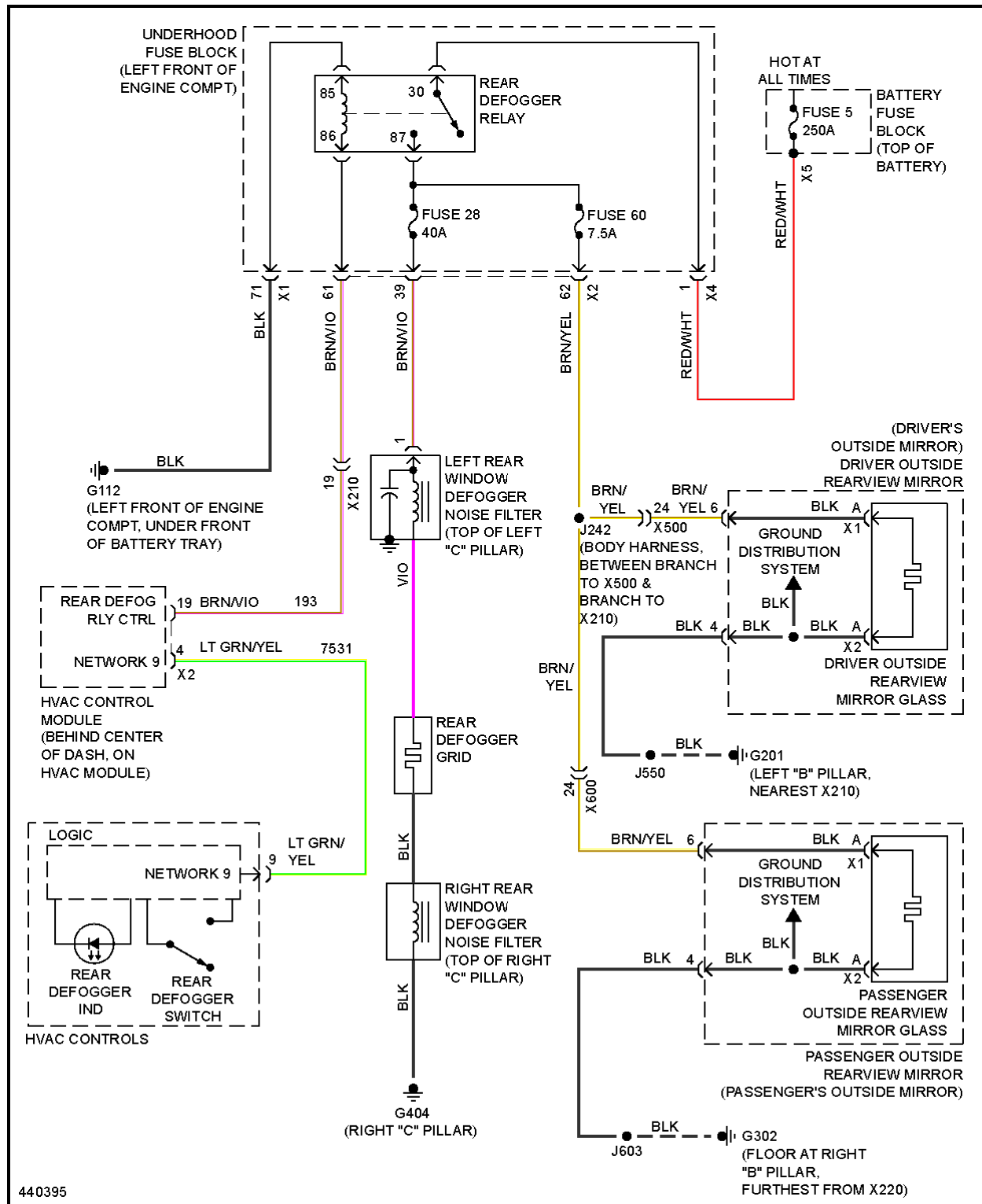


Fig. 23: Defoggers Circuit

ELECTRONIC POWER STEERING

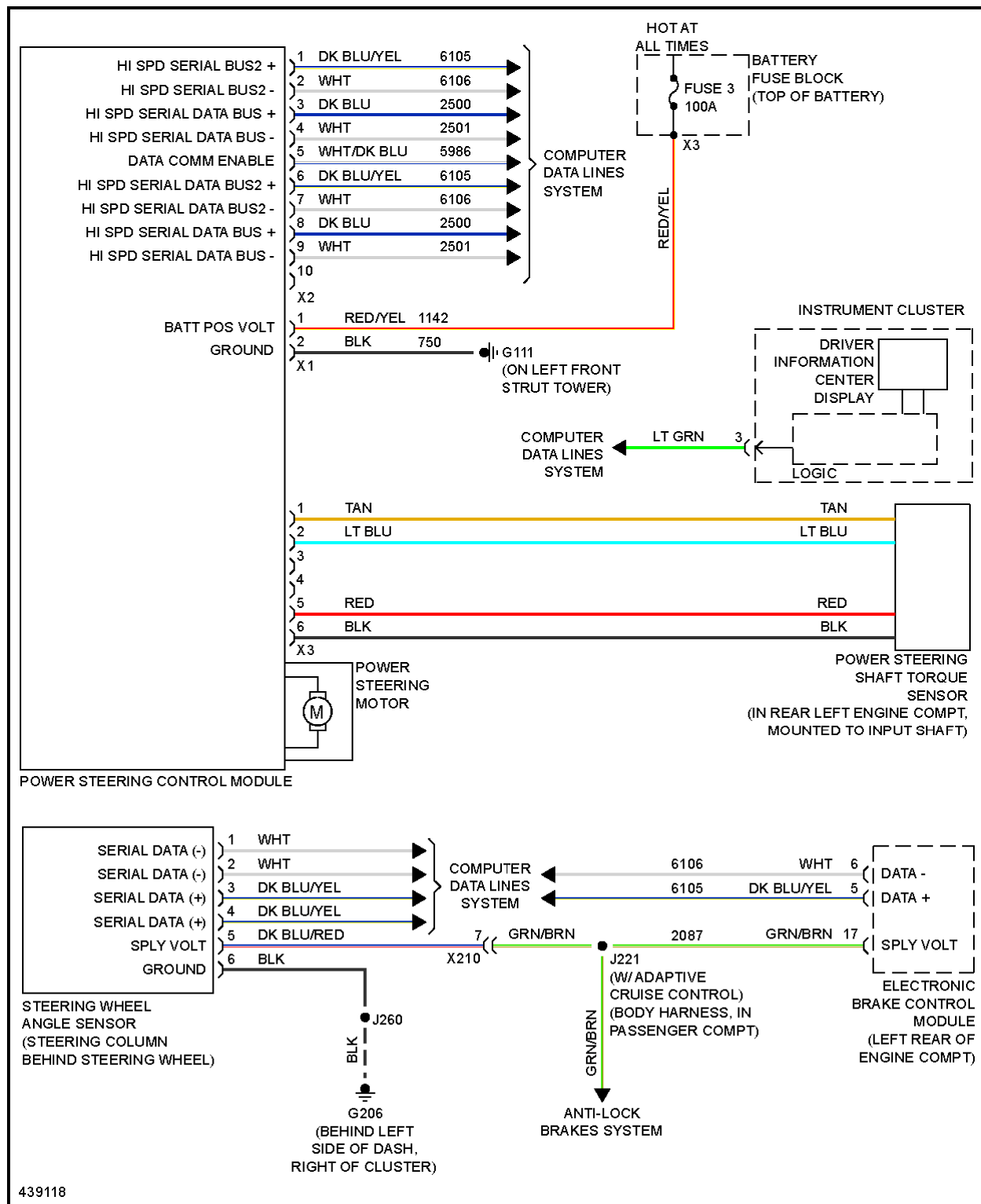


Fig. 24: Electronic Power Steering Circuit, W/ Belt Drive

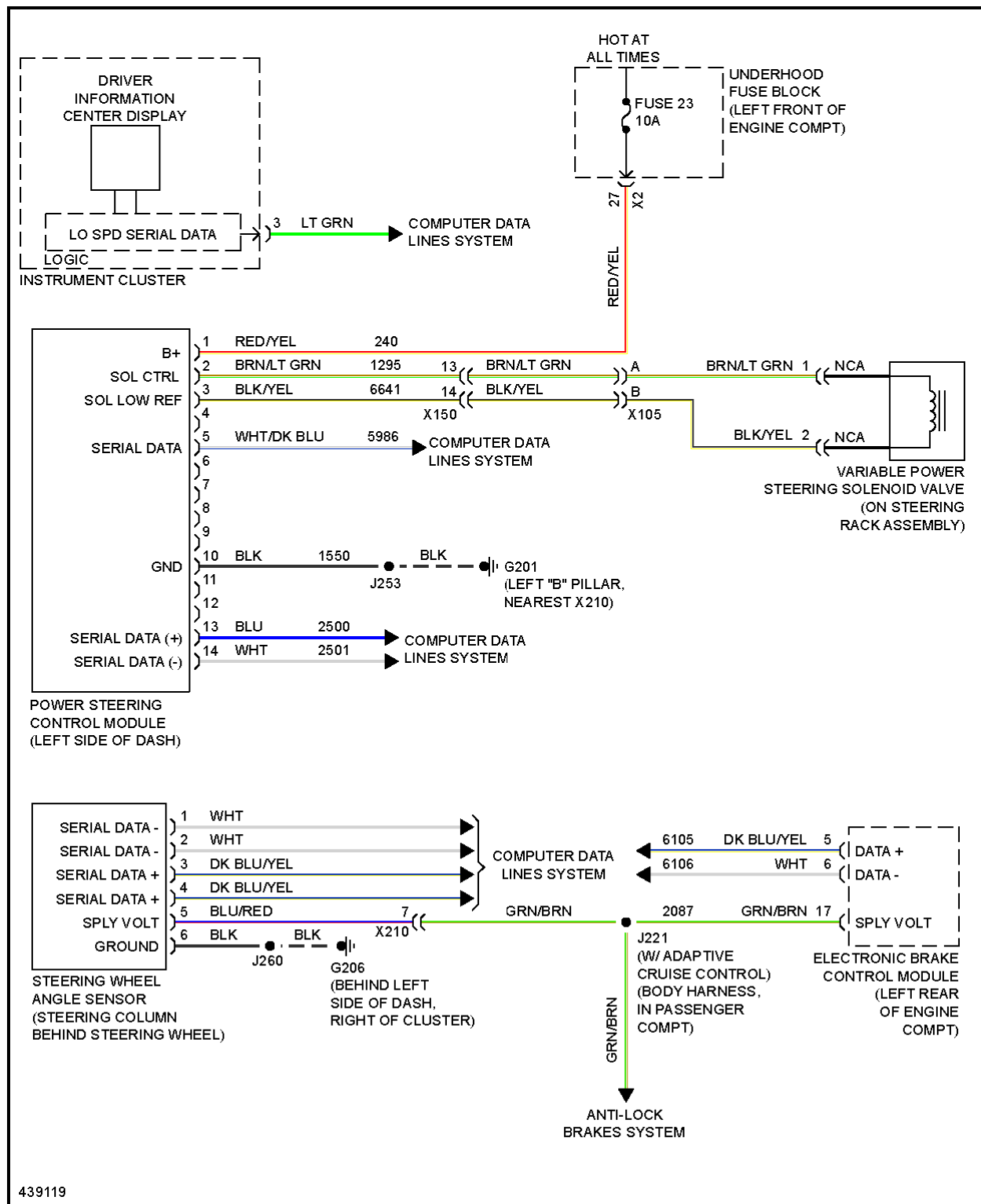


Fig. 25: Electronic Power Steering Circuit, W/ Variable Assist

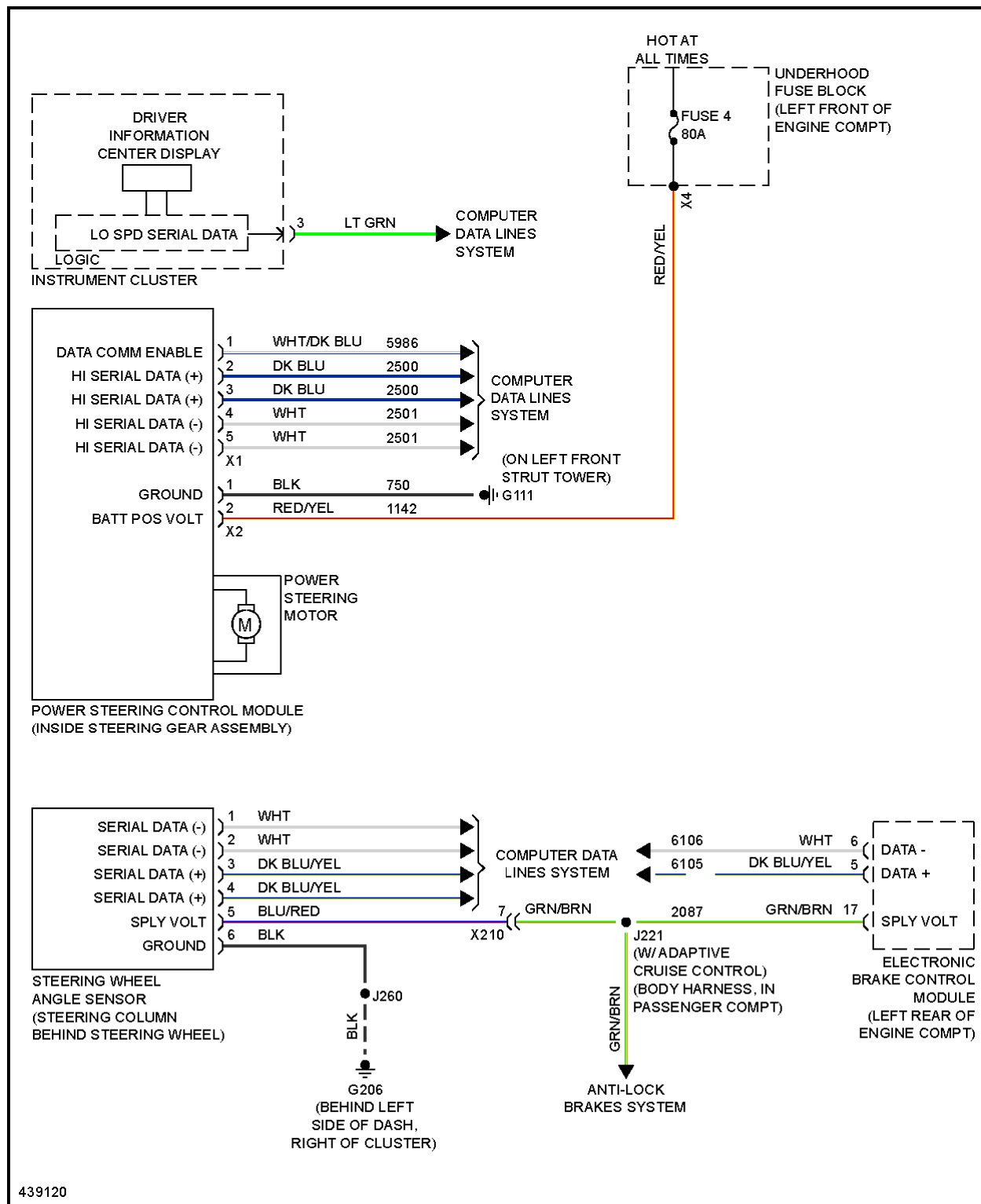


Fig. 26: Electronic Power Steering Circuit, W/O Variable Assist

ELECTRONIC SUSPENSION

ENGINE PERFORMANCE

2.0L VIN X



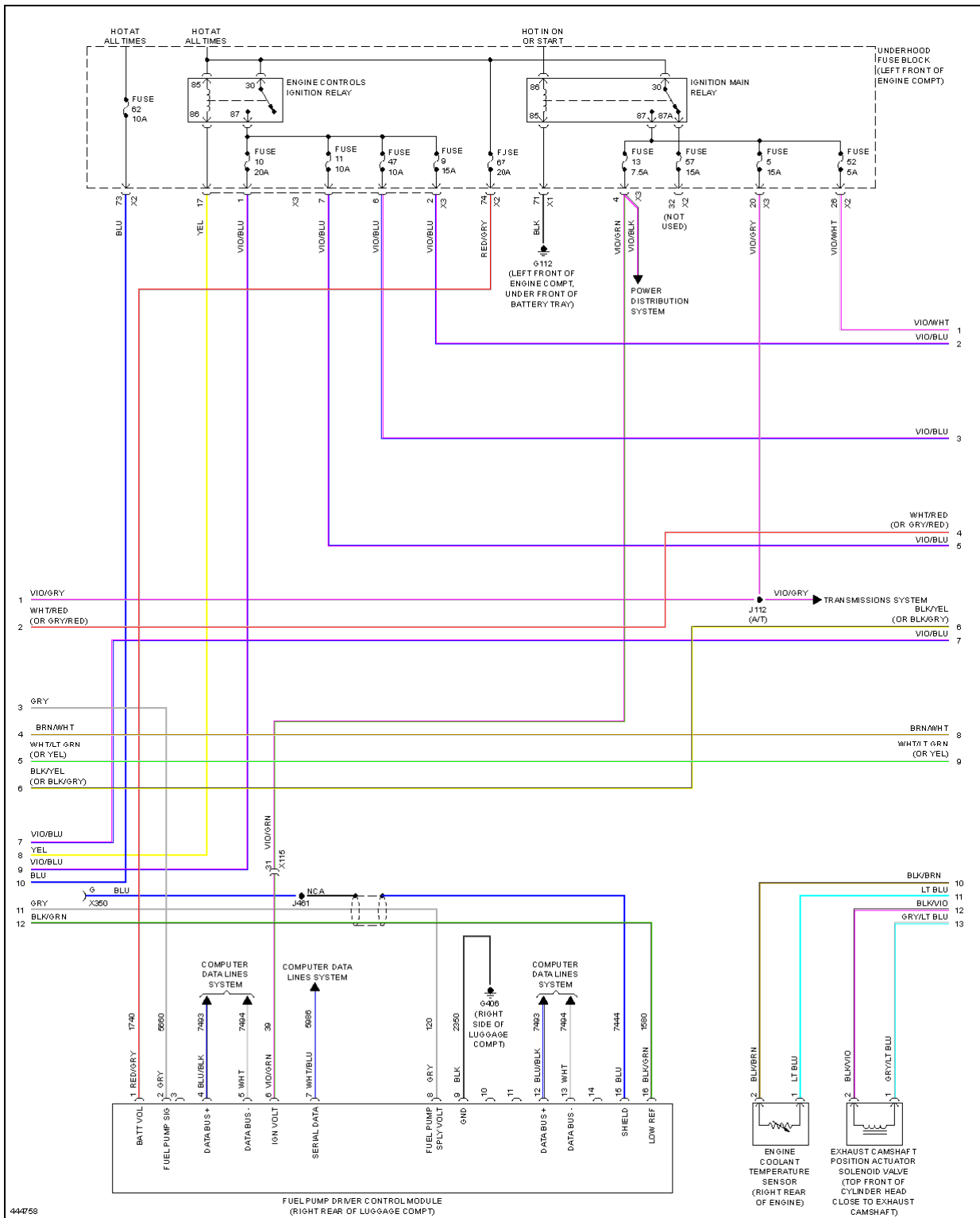


Fig. 29: 2.0L VIN X, Engine Performance Circuit (2 of 5)

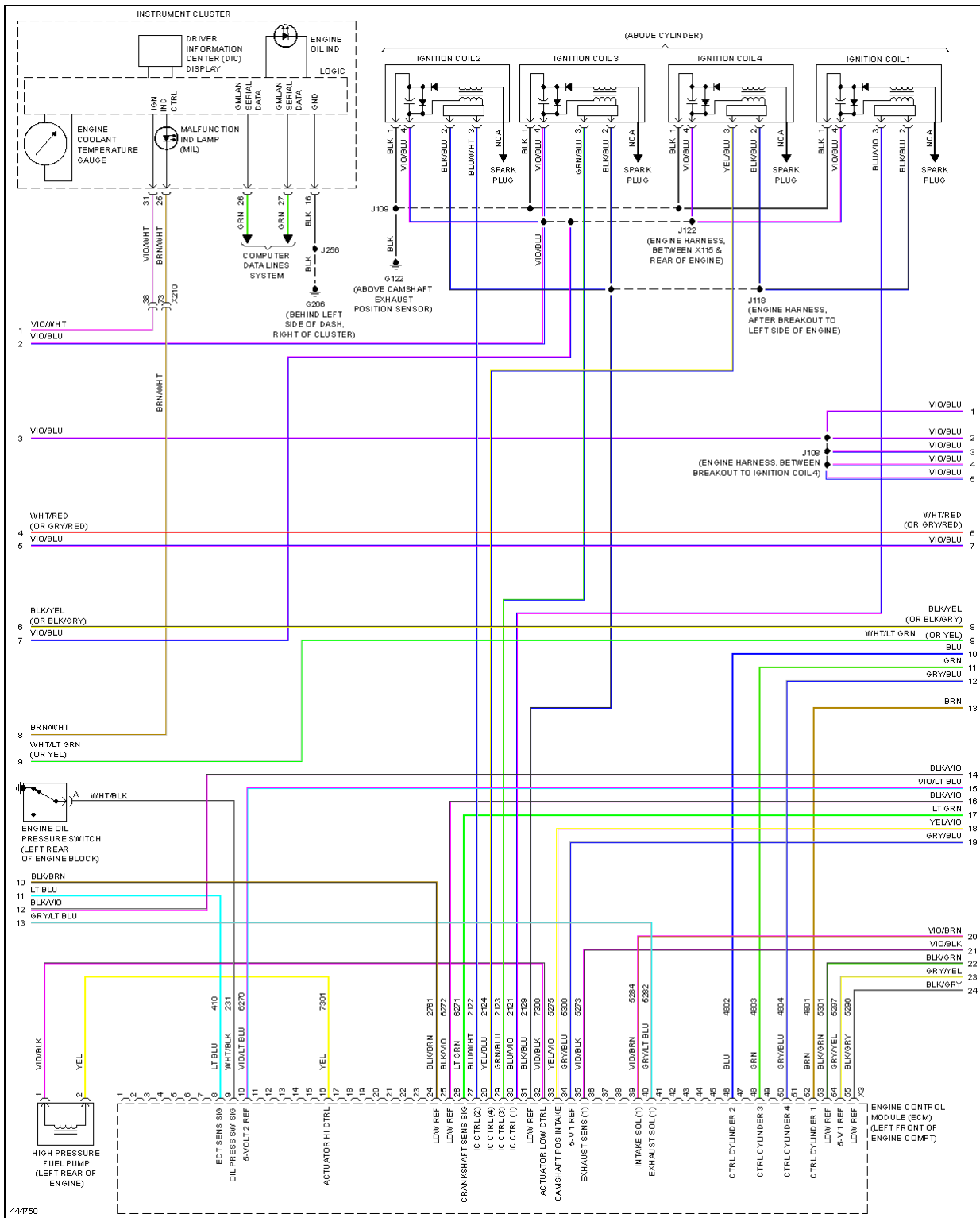


Fig. 30: 2.0L VIN X, Engine Performance Circuit (3 of 5)

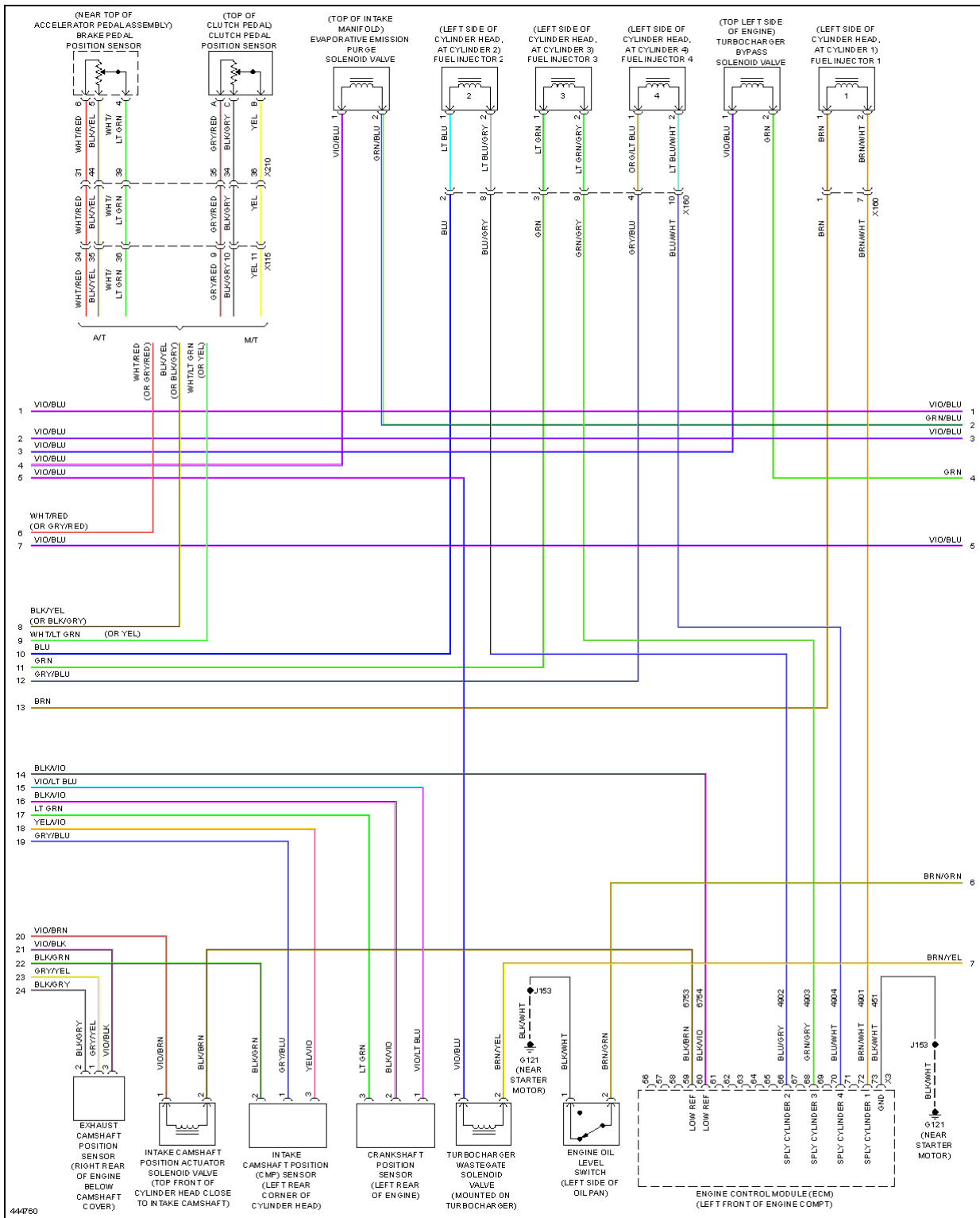


Fig. 31: 2.0L VIN X, Engine Performance Circuit (4 of 5)

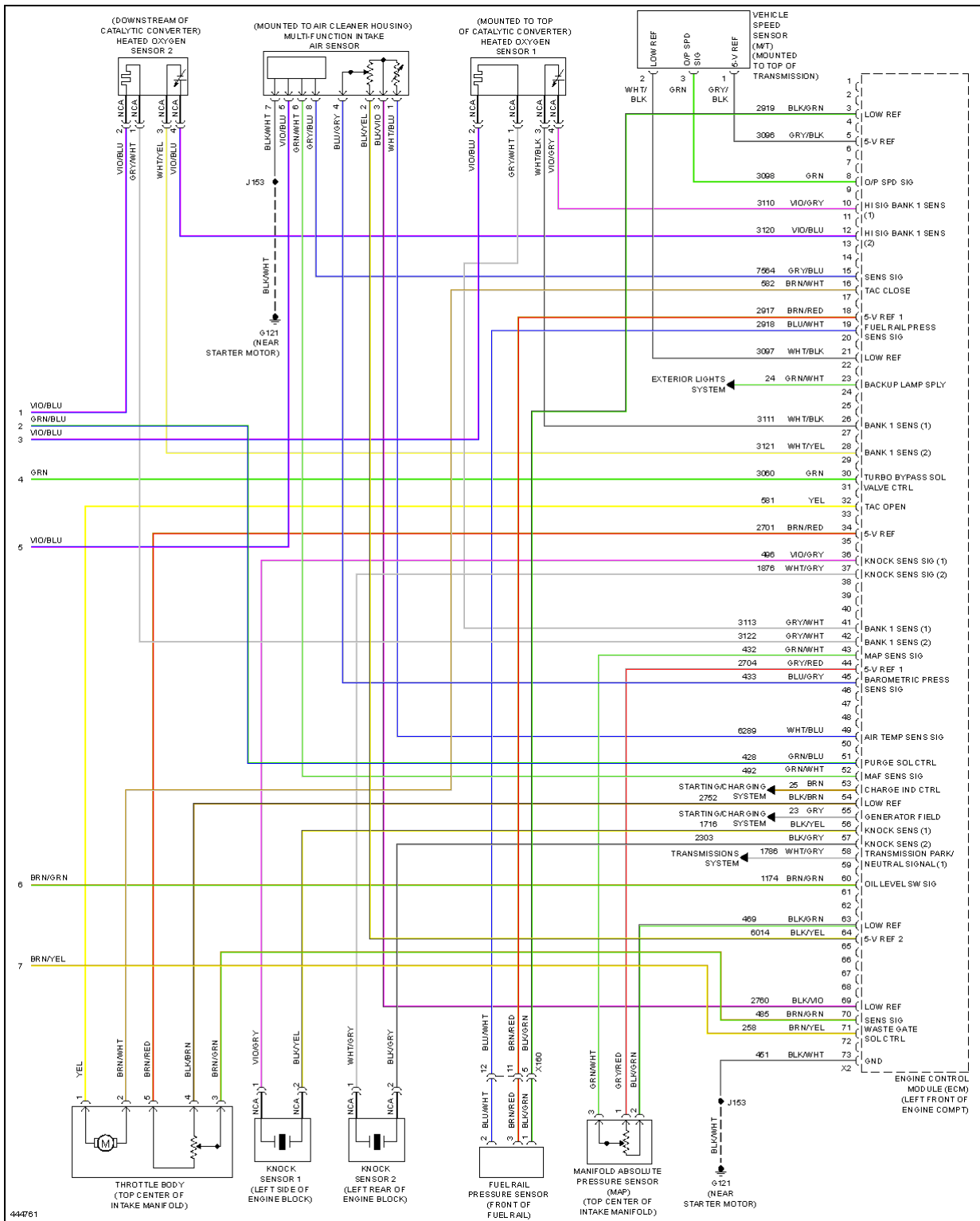


Fig. 32: 2.0L VIN X, Engine Performance Circuit (5 of 5)

2.4L VIN R



Fig. 33: 2.4L VIN R, Engine Controls Circuit (1 of 6)

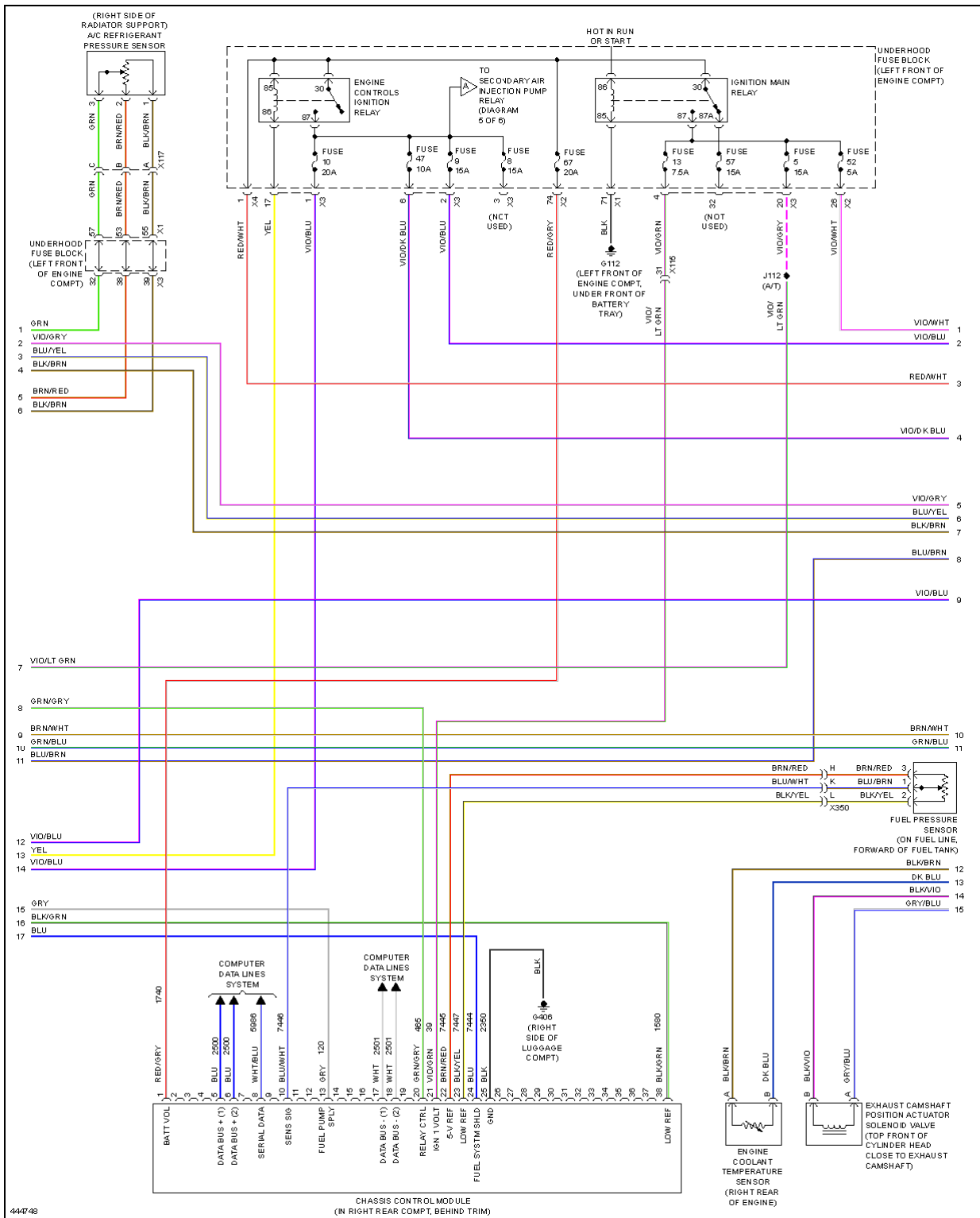


Fig. 34: 2.4L VIN R, Engine Controls Circuit (2 of 6)

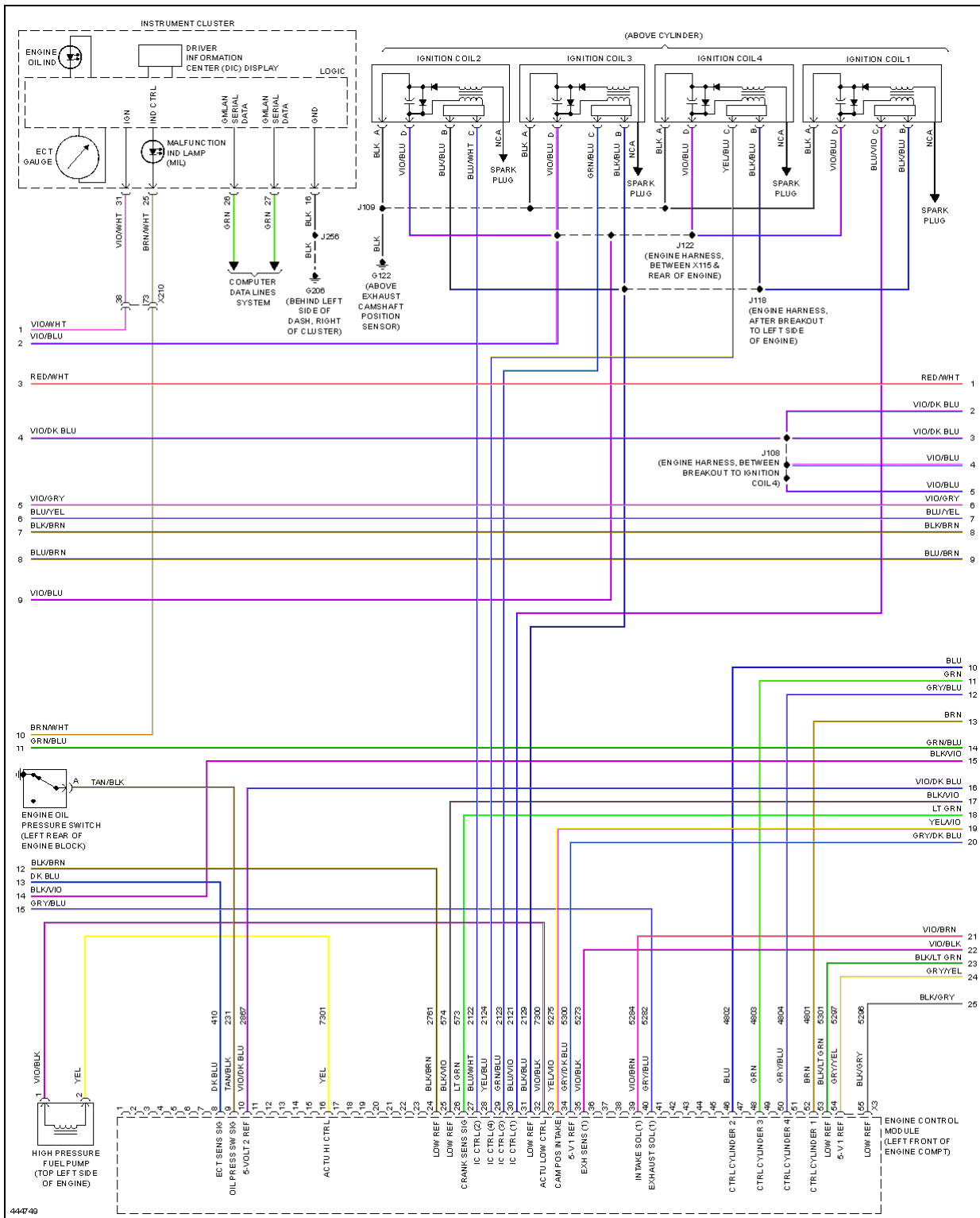


Fig. 35: 2.4L VIN R, Engine Controls Circuit (3 of 6)

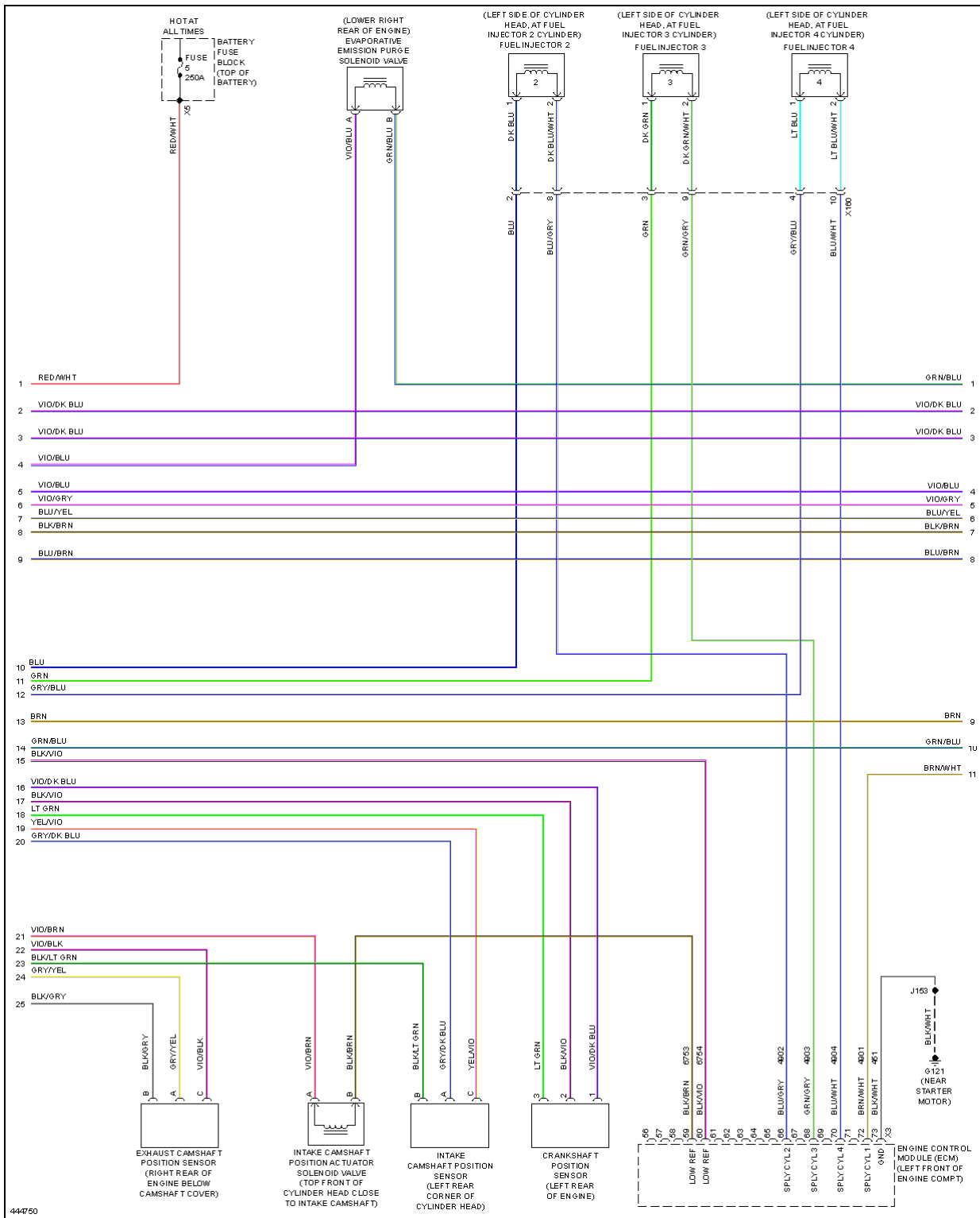


Fig. 36: 2.4L VIN R, Engine Controls Circuit (4 of 6)



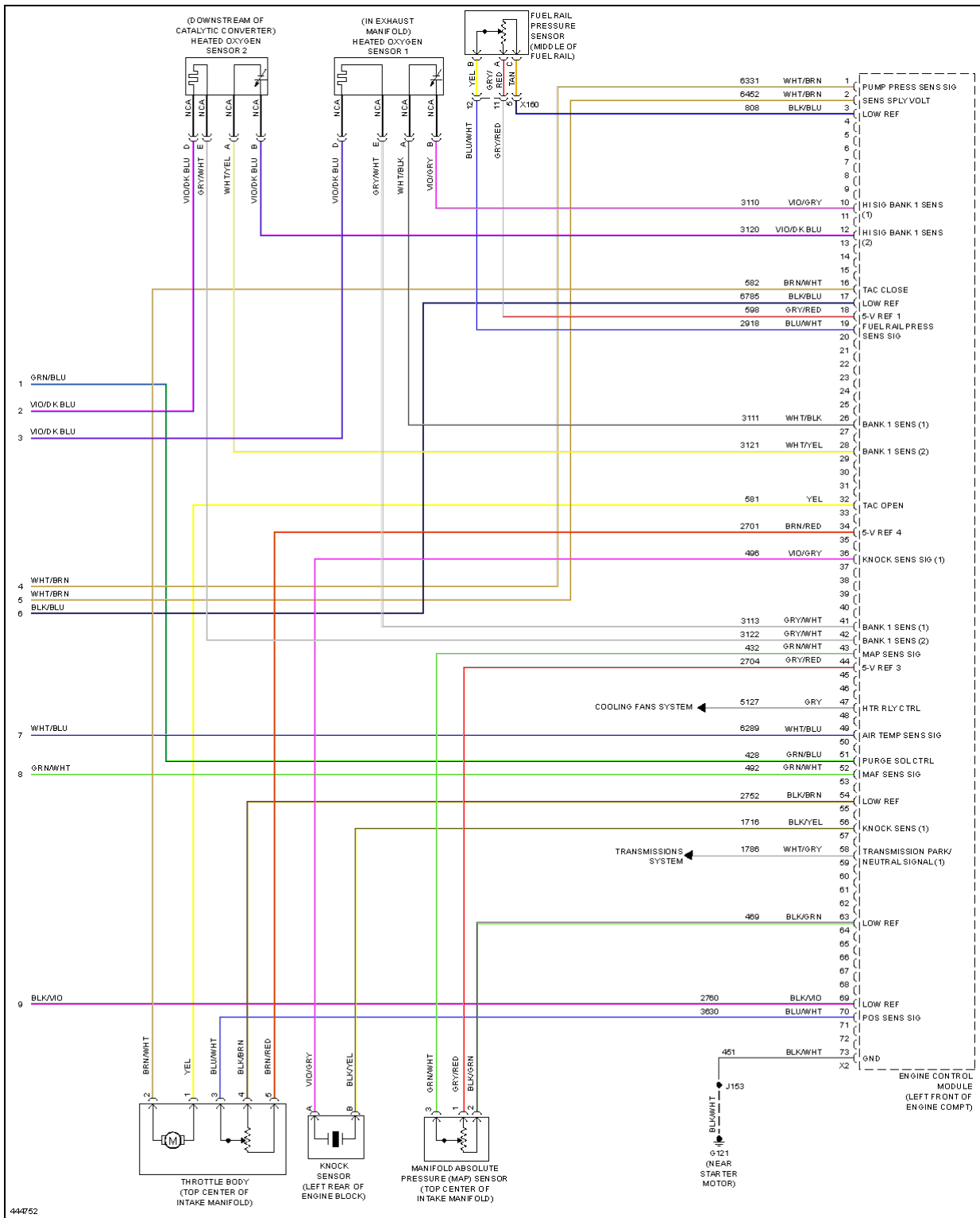


Fig. 38: 2.4L VIN R, Engine Controls Circuit (6 of 6)

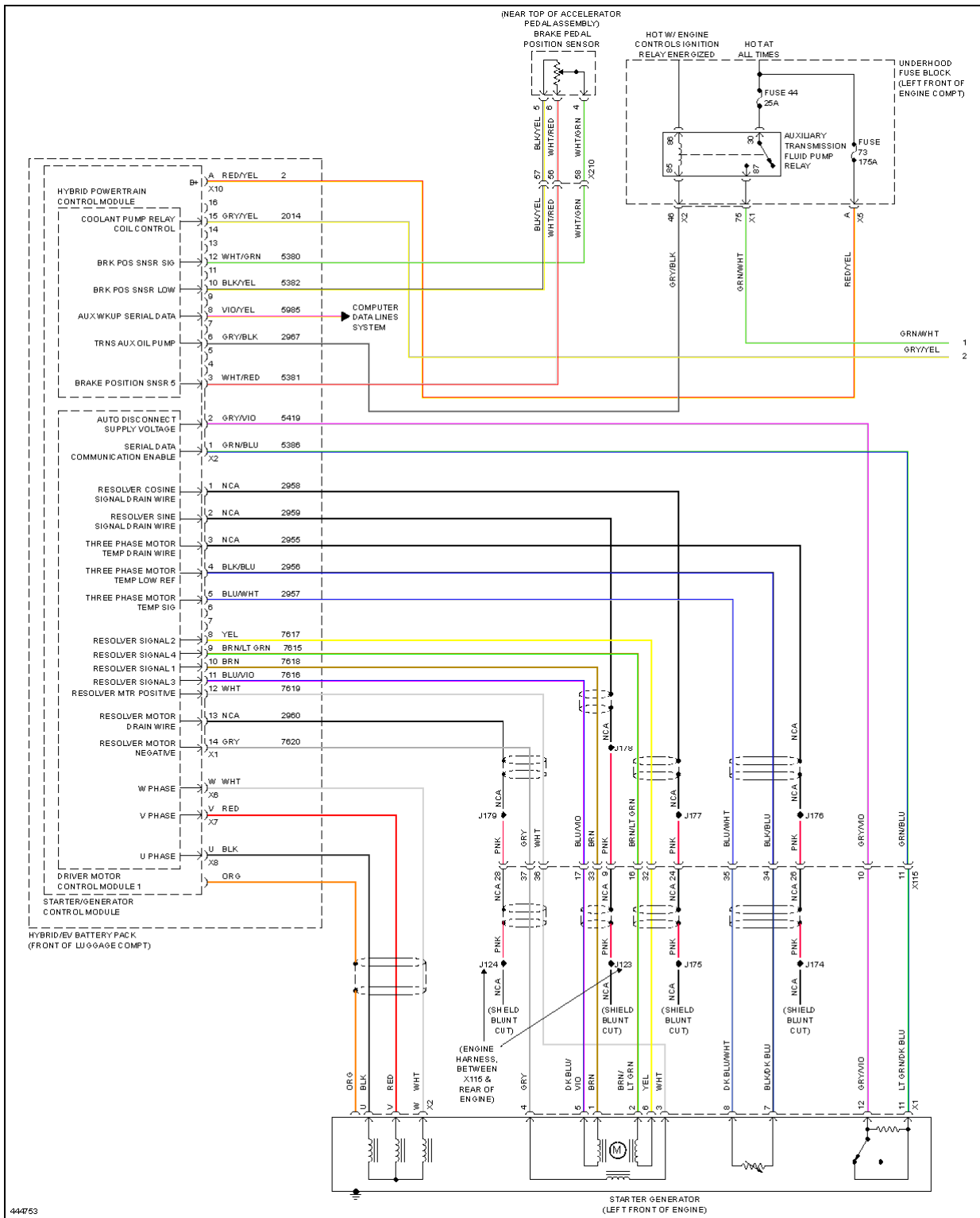


Fig. 39: 2.4L VIN R, Hybrid System Circuit (1 of 4)

EXTERIOR LIGHTS



Fig. 43: Backup Lamps Circuit

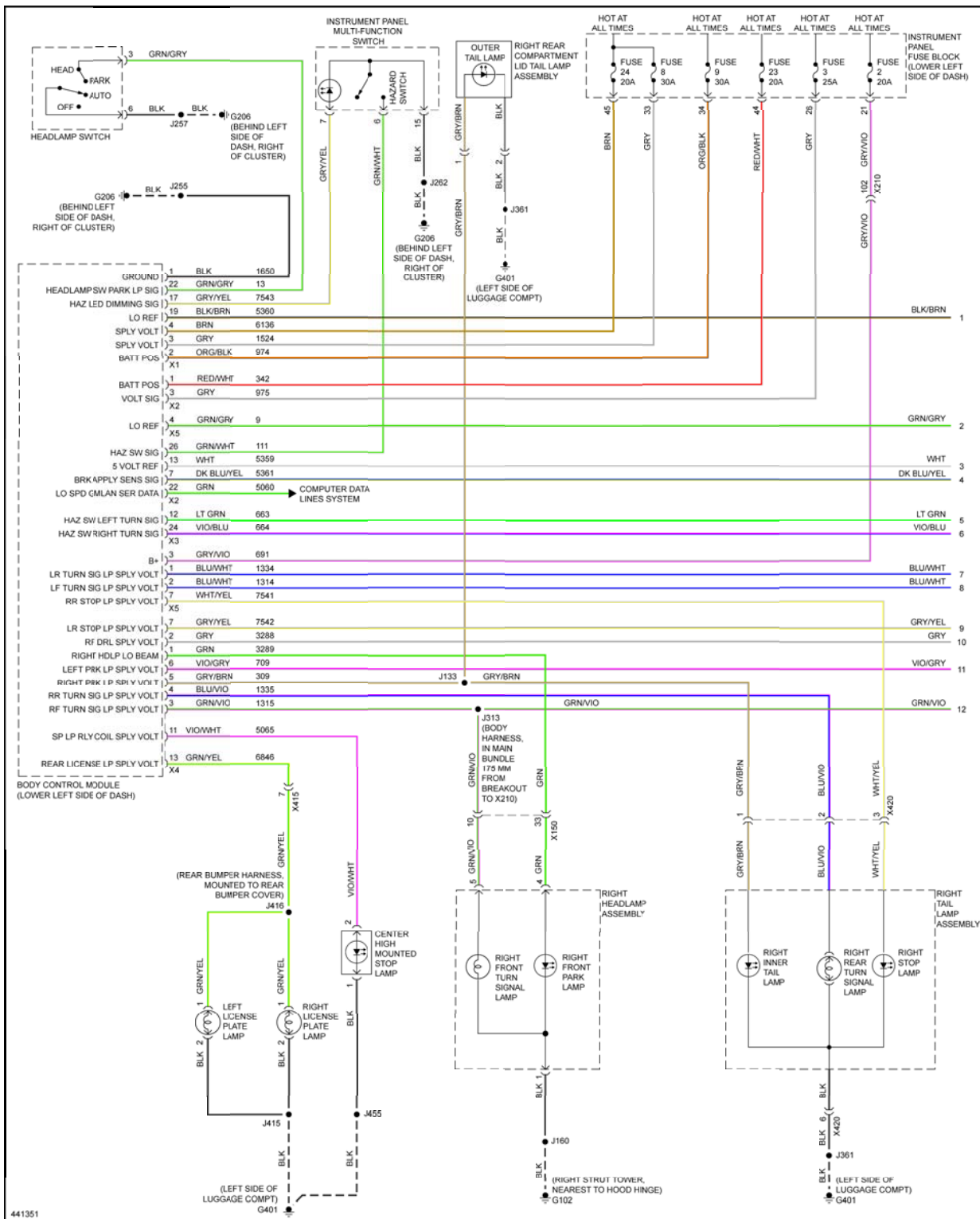


Fig. 44: Exterior Lamps Circuit, W/ HID Headlamps (1 of 2)

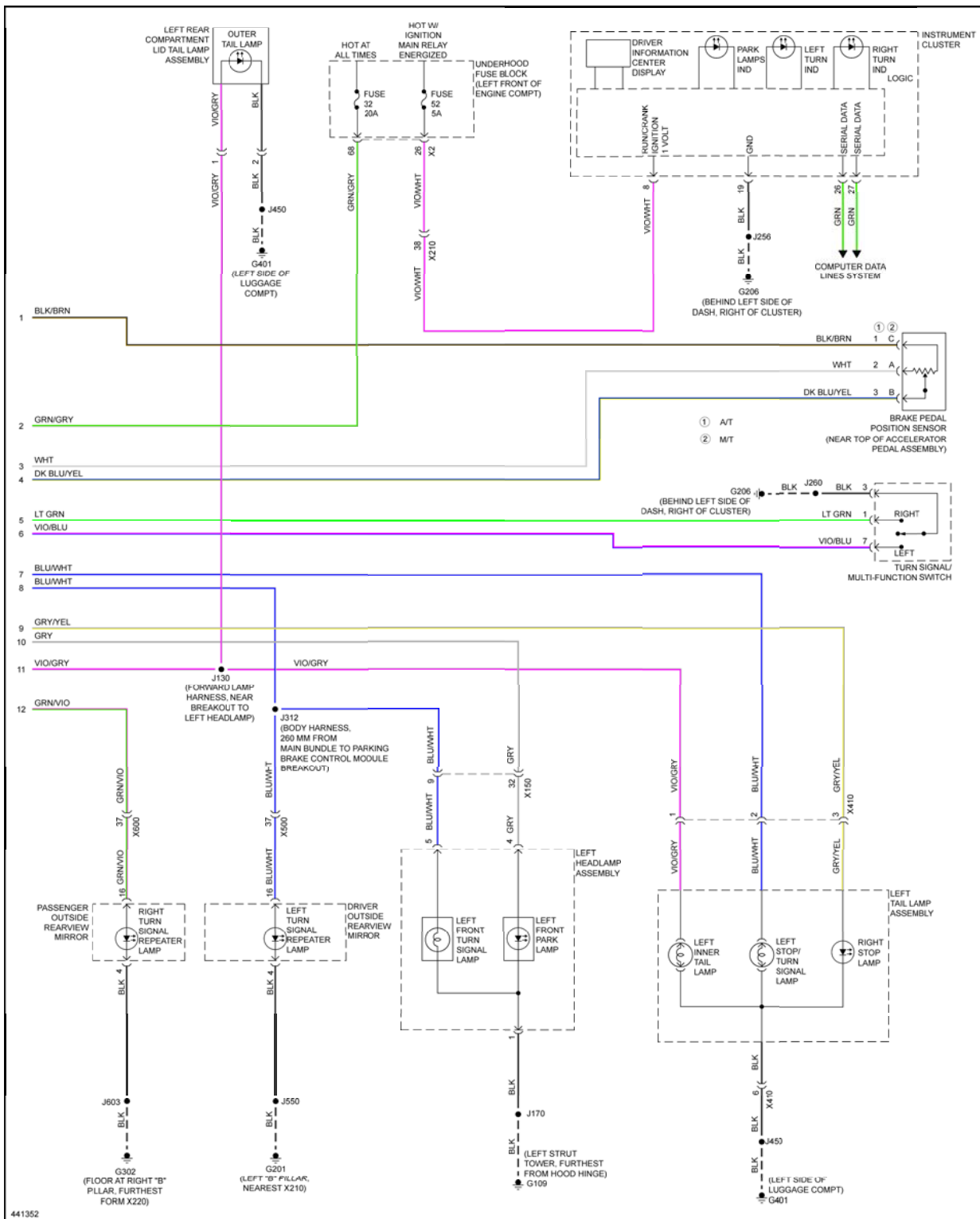


Fig. 45: Exterior Lamps Circuit, W/ HID Headlamps (2 of 2)

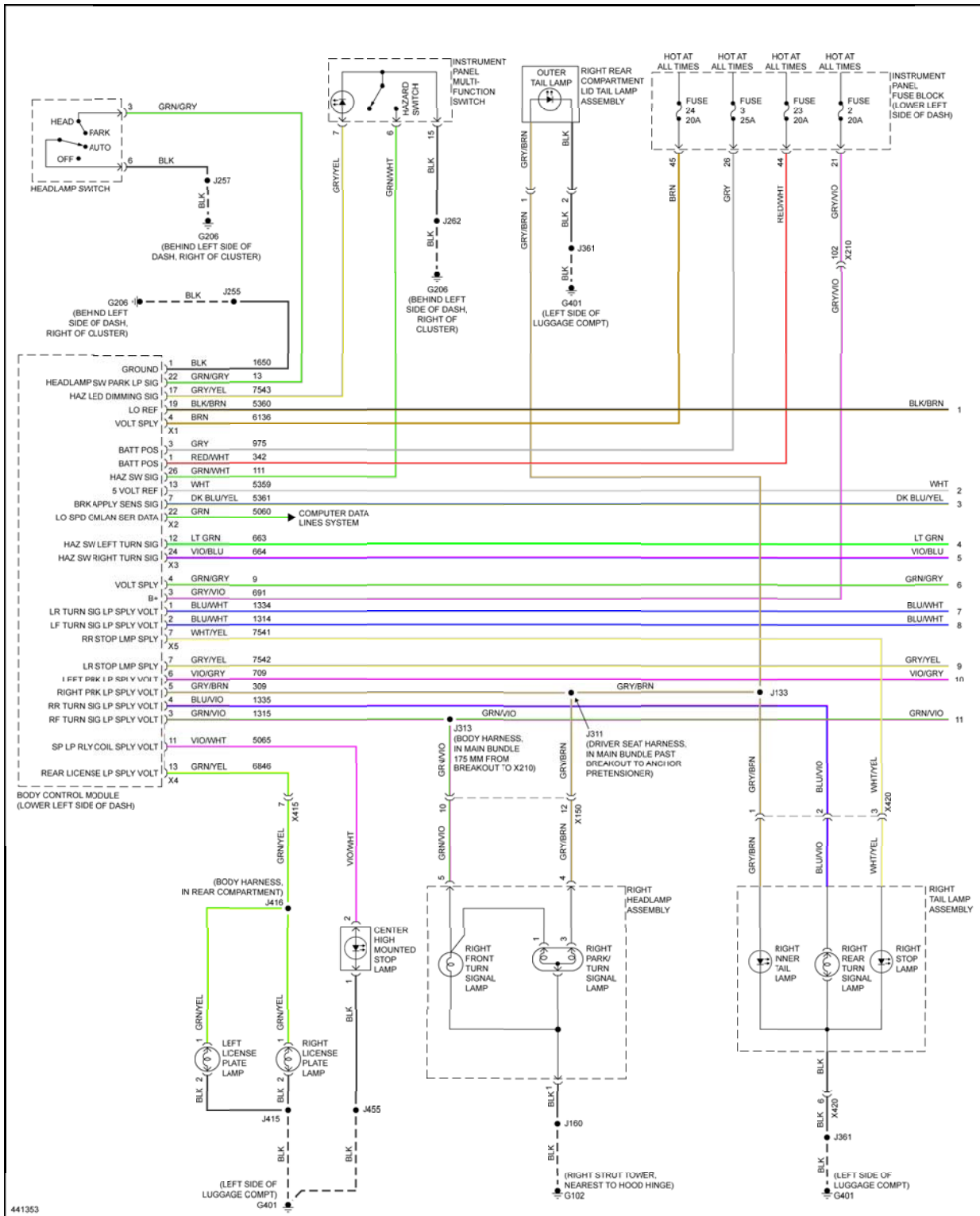
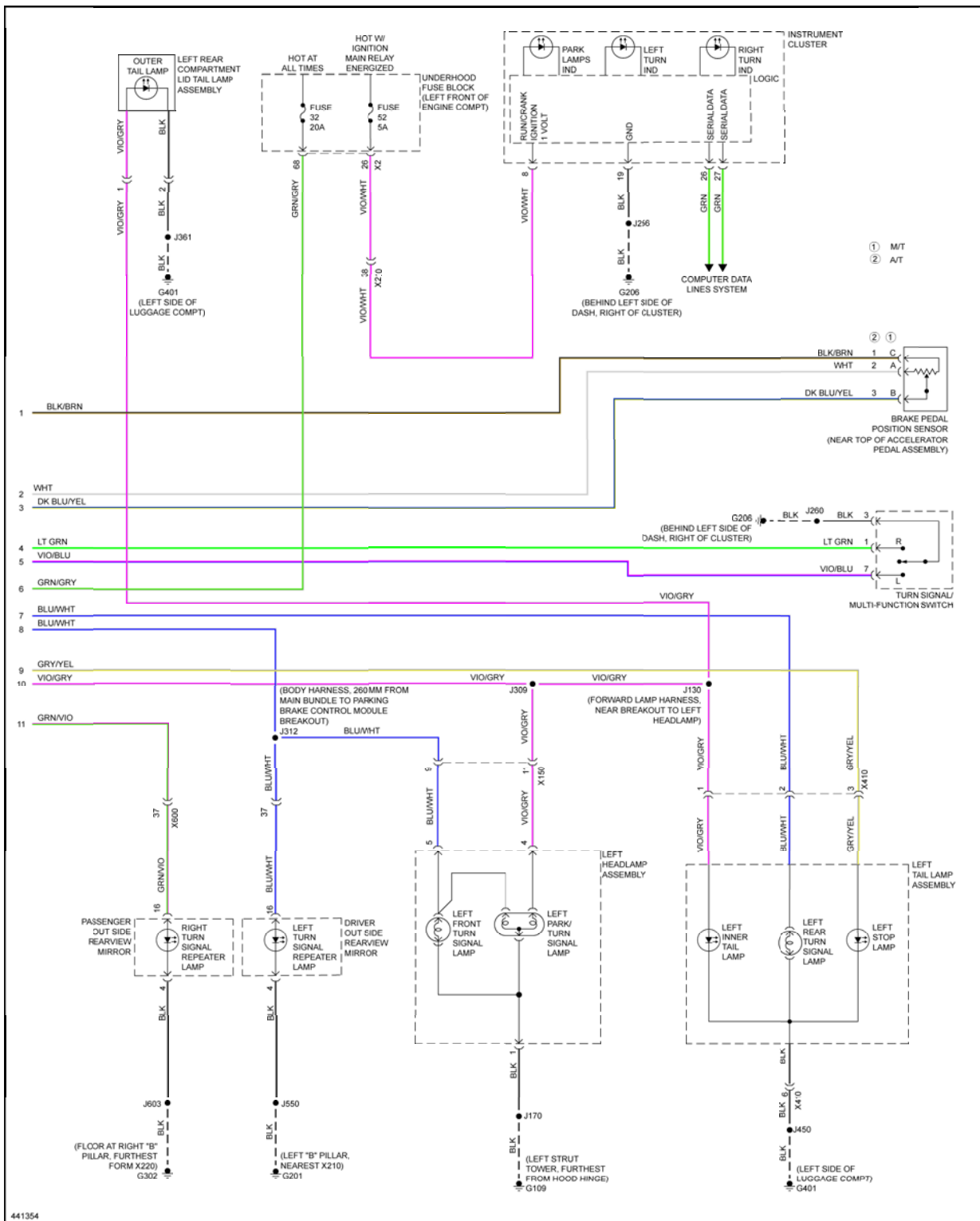


Fig. 46: Exterior Lamps Circuit, W/O HID Headlamps (1 of 2)



GROUND DISTRIBUTION

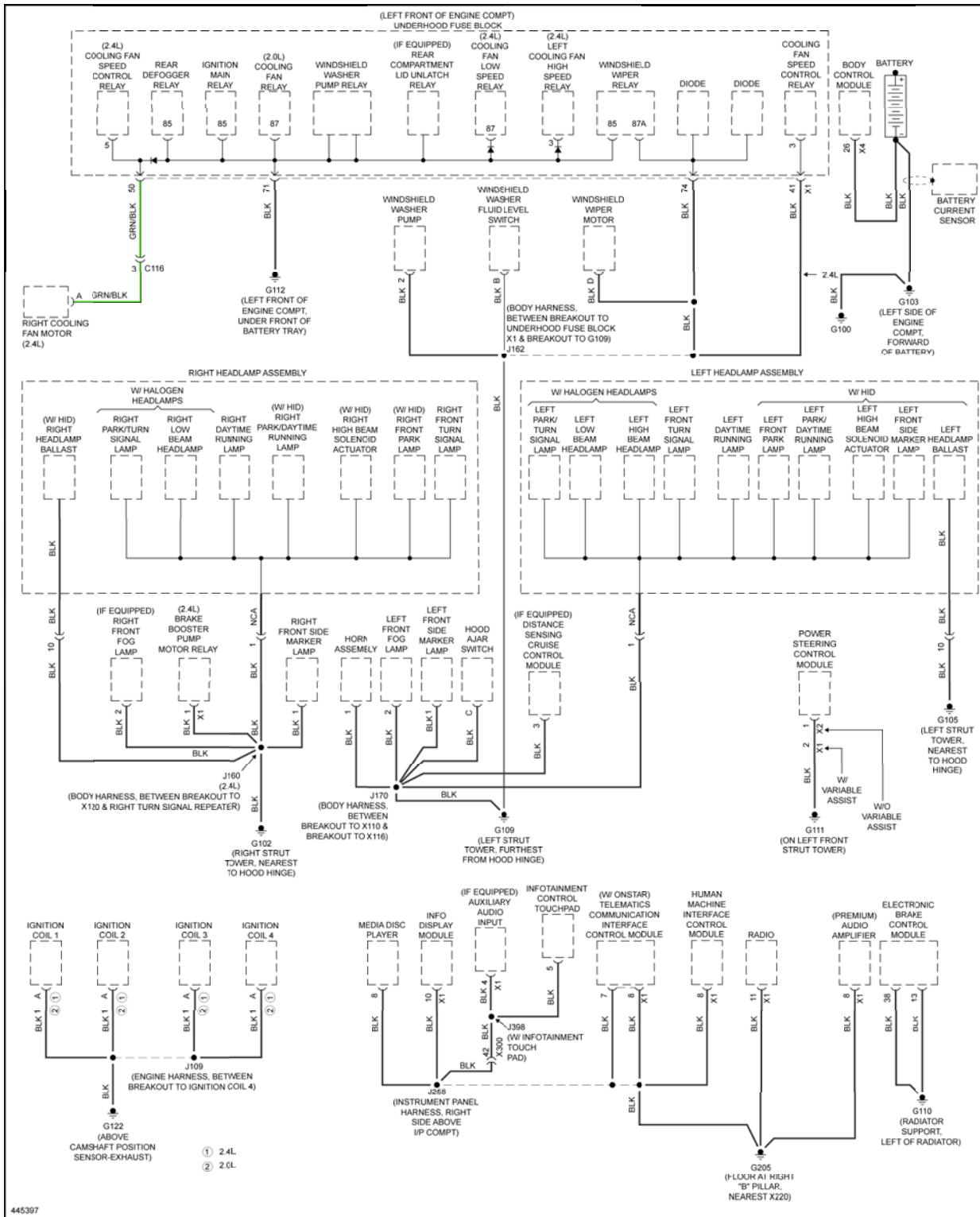


Fig. 48: Ground Distribution Circuit (1 of 4)

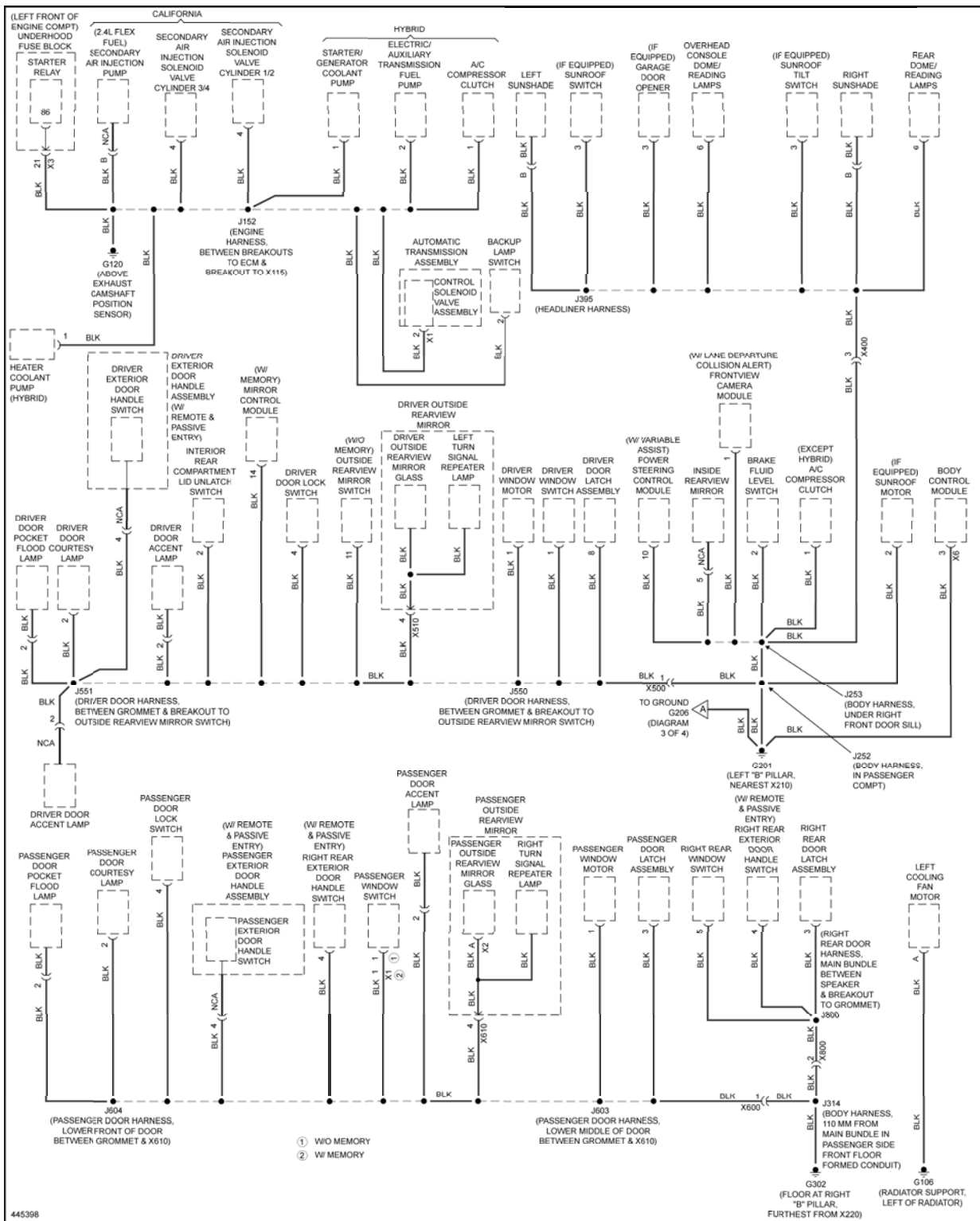


Fig. 49: Ground Distribution Circuit (2 of 4)





Fig. 51: Ground Distribution Circuit (4 of 4)

HEADLIGHTS

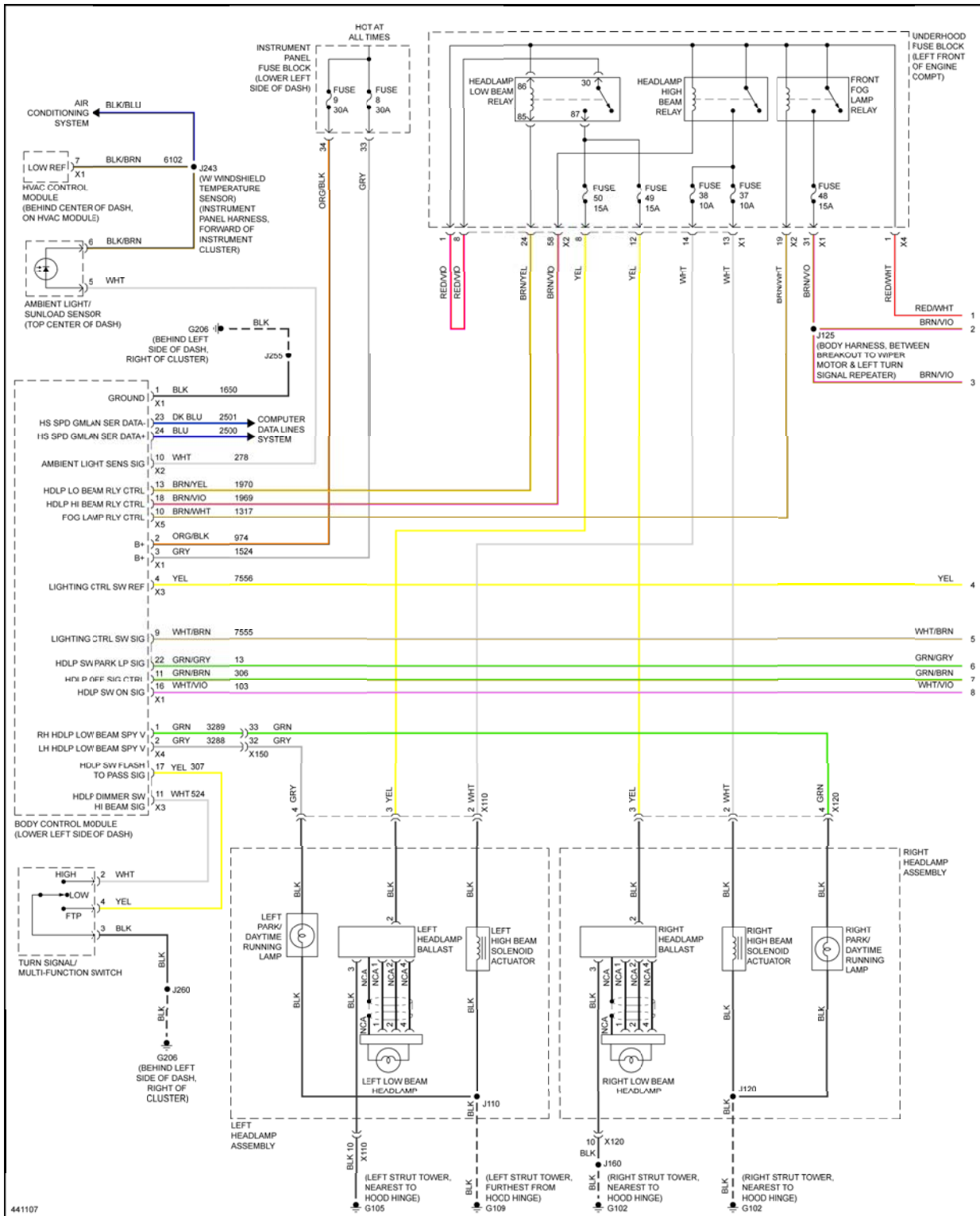


Fig. 52: Headlights Circuit, W/ HID Headlamps (1 of 2)

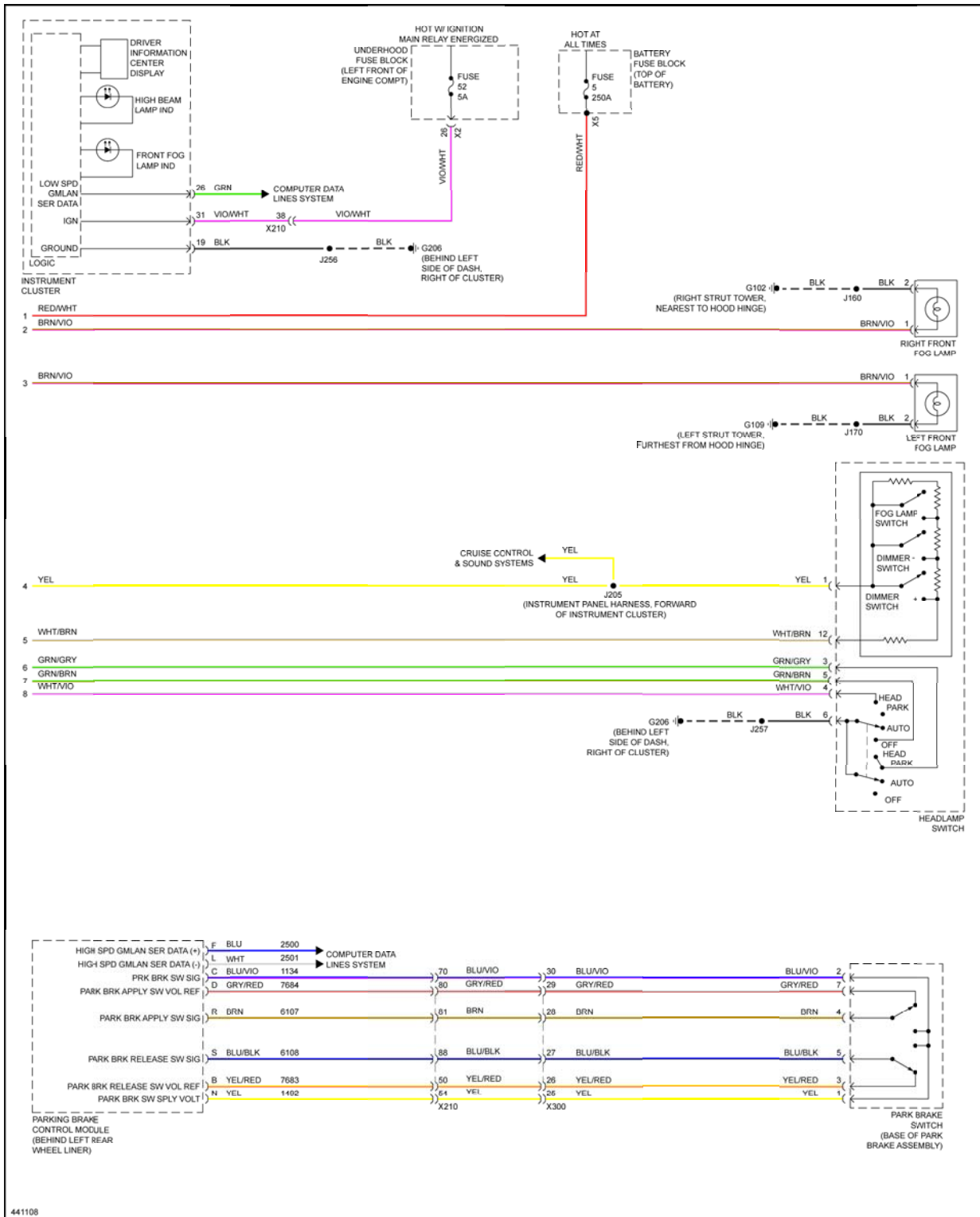


Fig. 53: Headlights Circuit, W/ HID Headlamps (2 of 2)

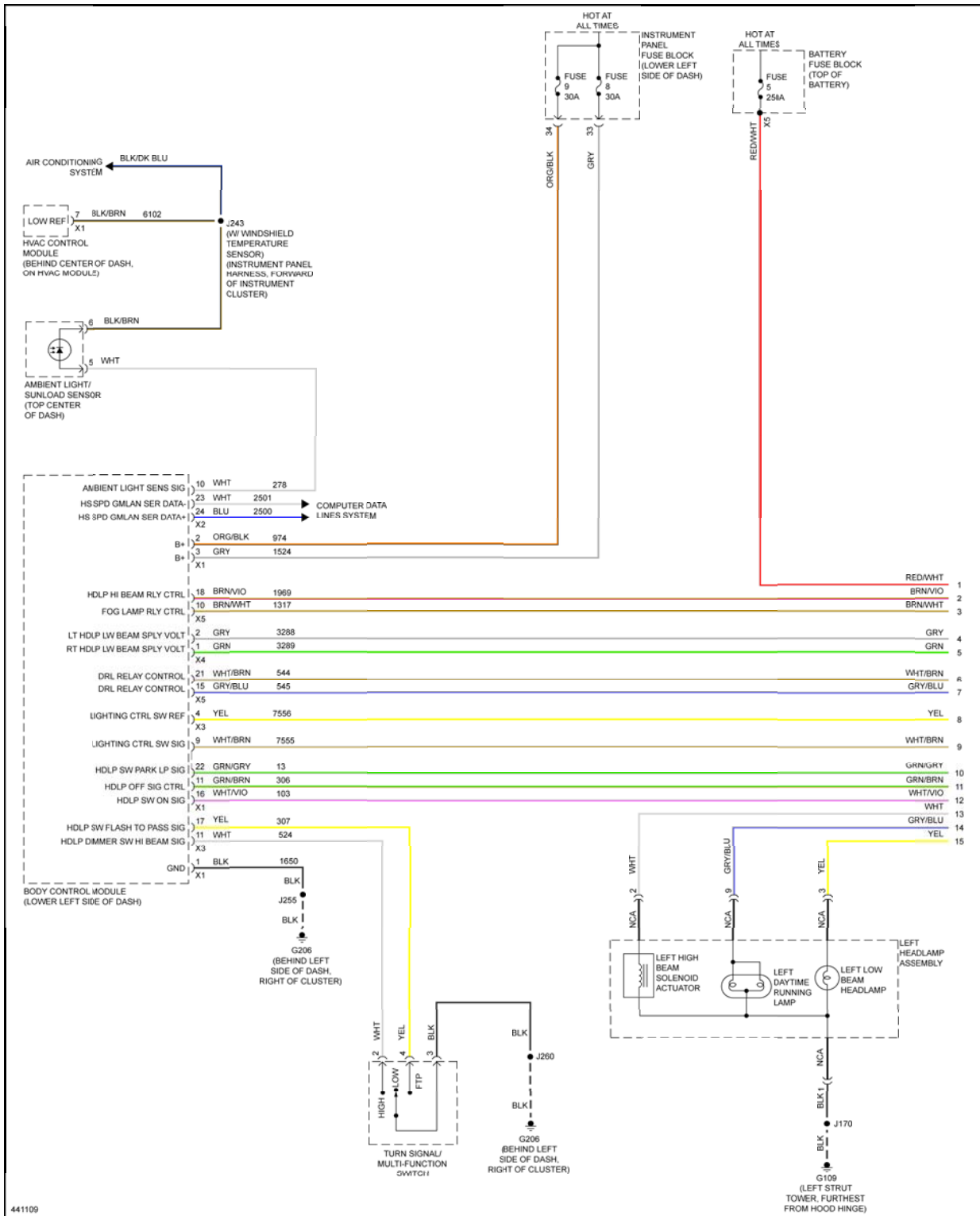


Fig. 54: Headlights Circuit, W/O HID Headlamps (1 of 3)

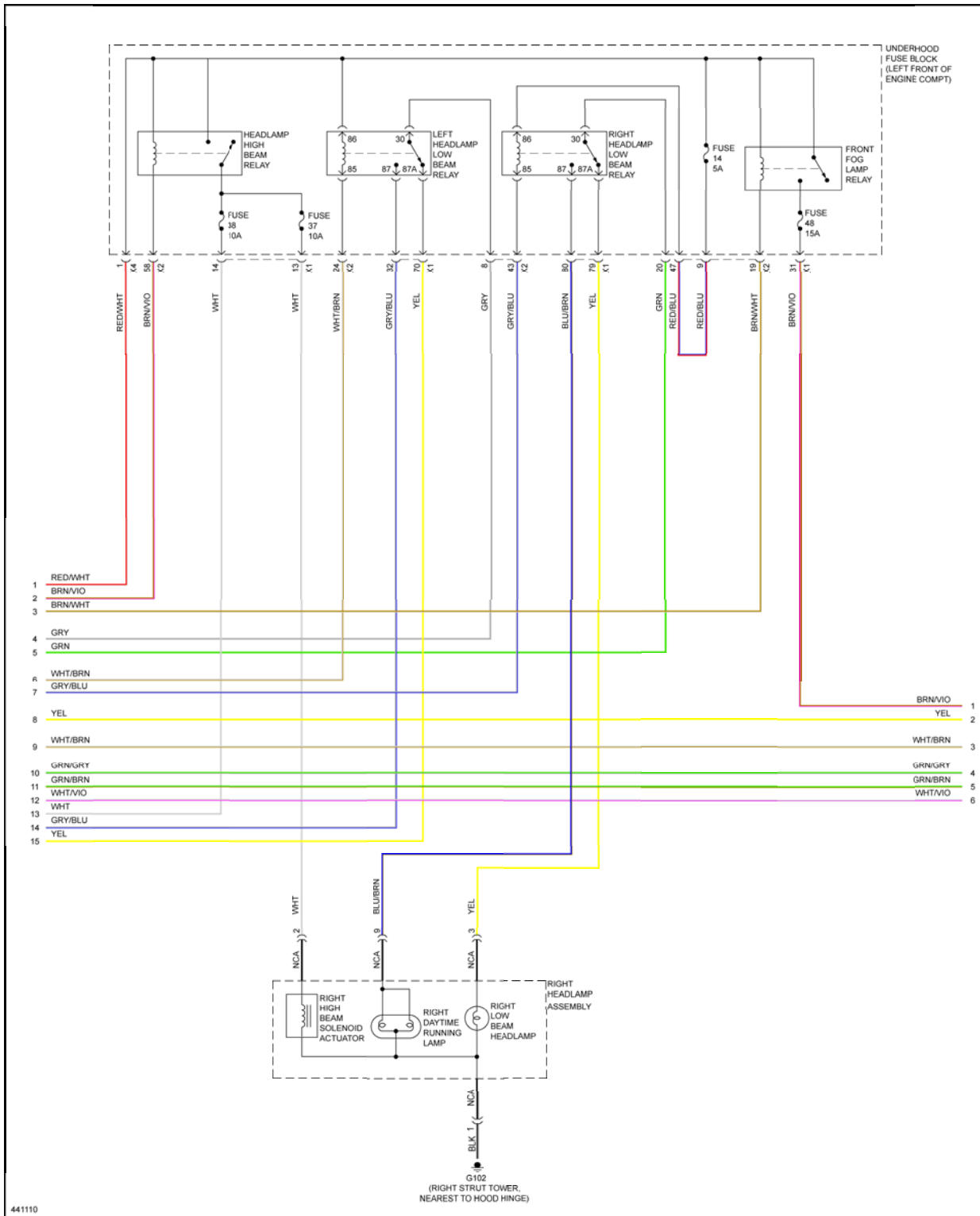


Fig. 55: Headlights Circuit, W/O HID Headlamps (2 of 3)

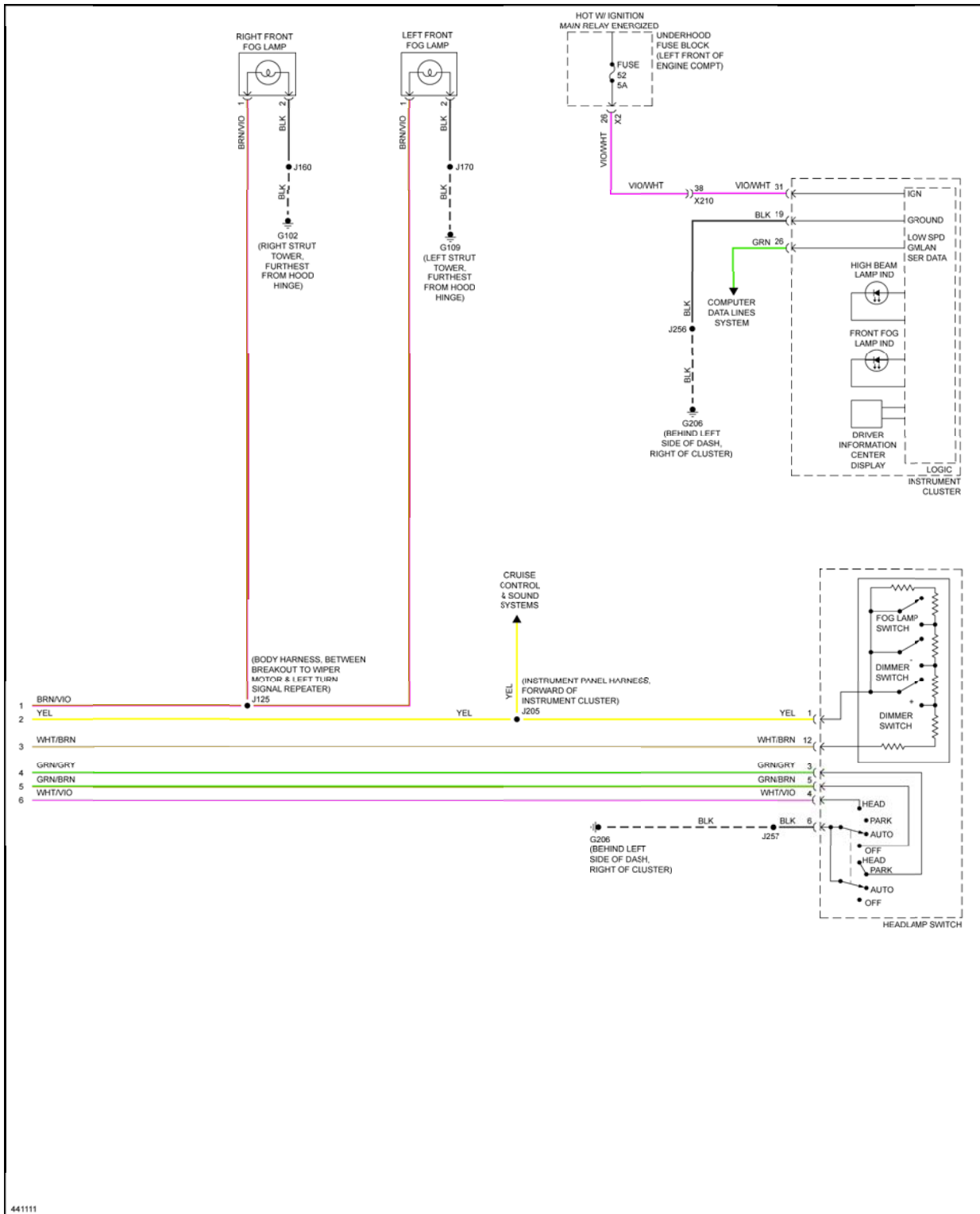


Fig. 56: Headlights Circuit, W/O HID Headlamps (3 of 3)

HORN

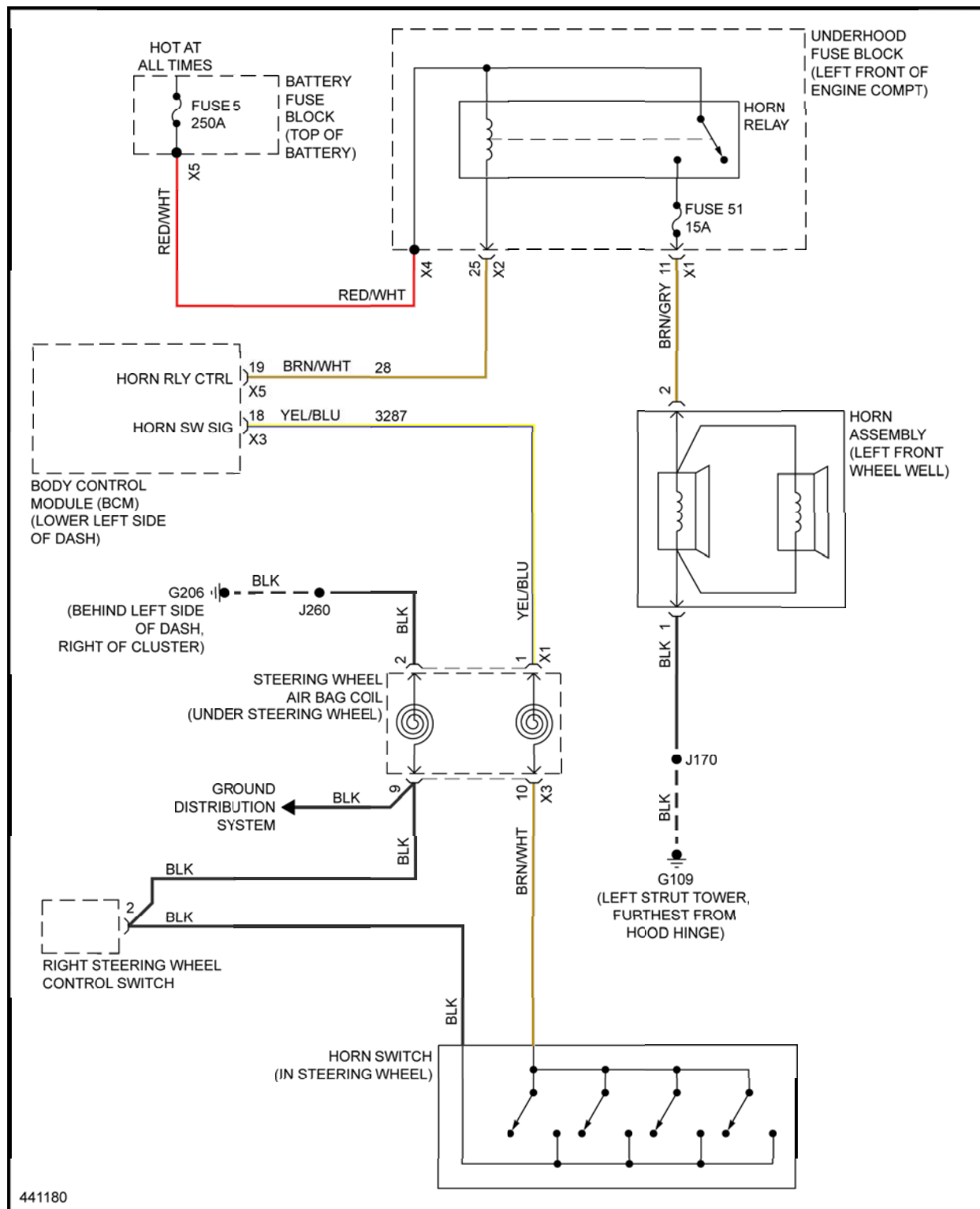


Fig. 57: Horn Circuit

INSTRUMENT CLUSTER

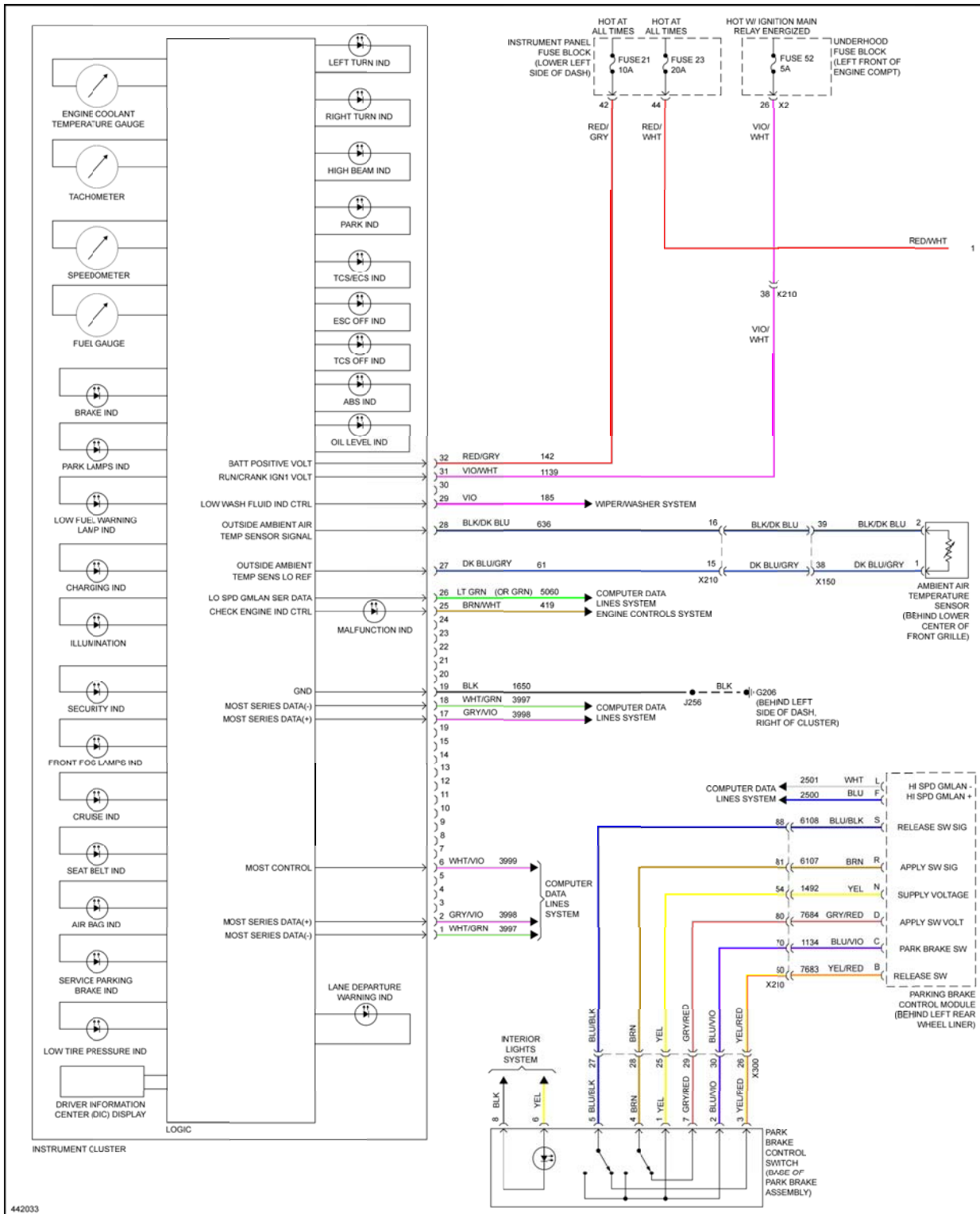


Fig. 58: Instrument Cluster Circuit (1 of 2)

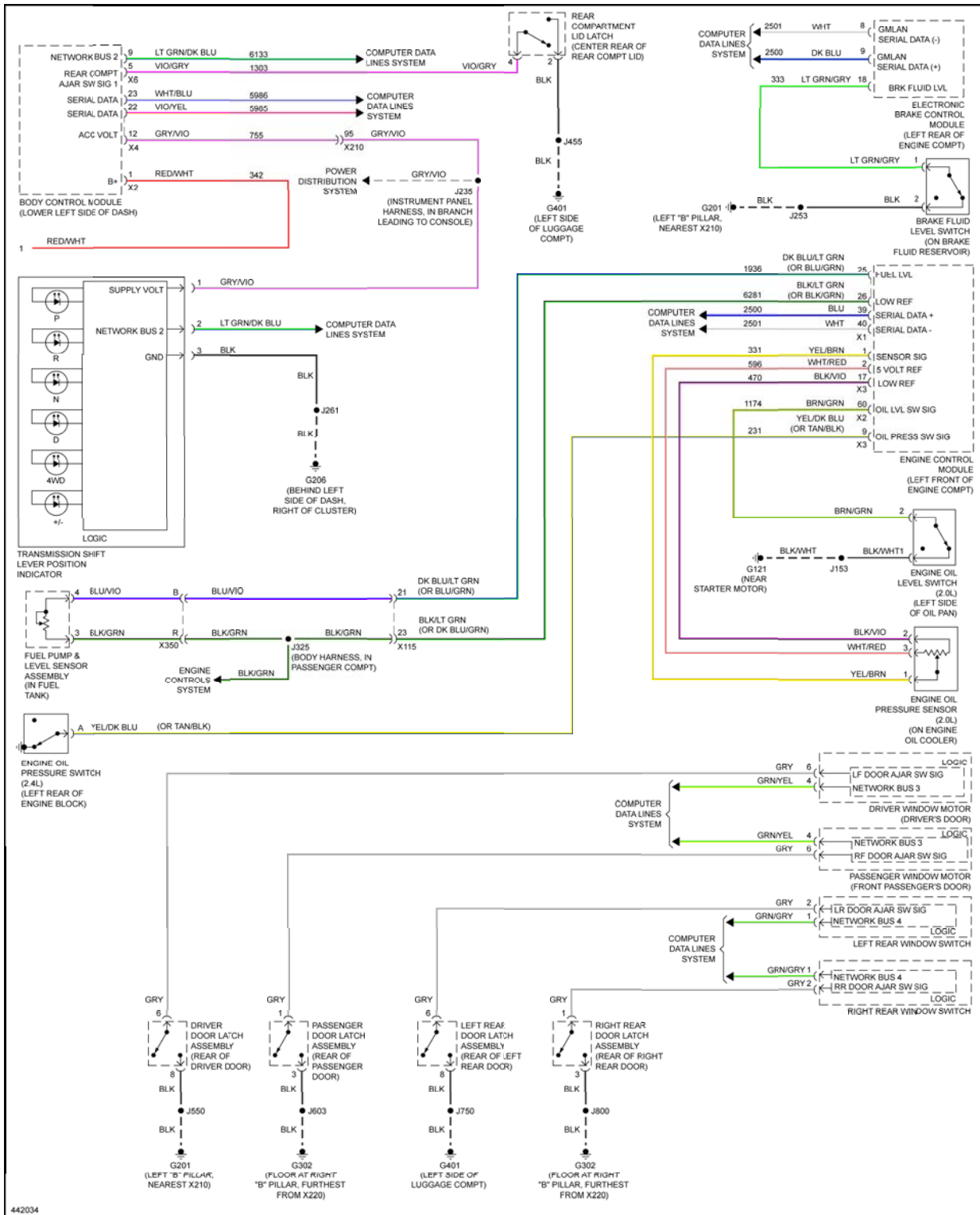


Fig. 59: Instrument Cluster Circuit (2 of 2)

INTERIOR LIGHTS



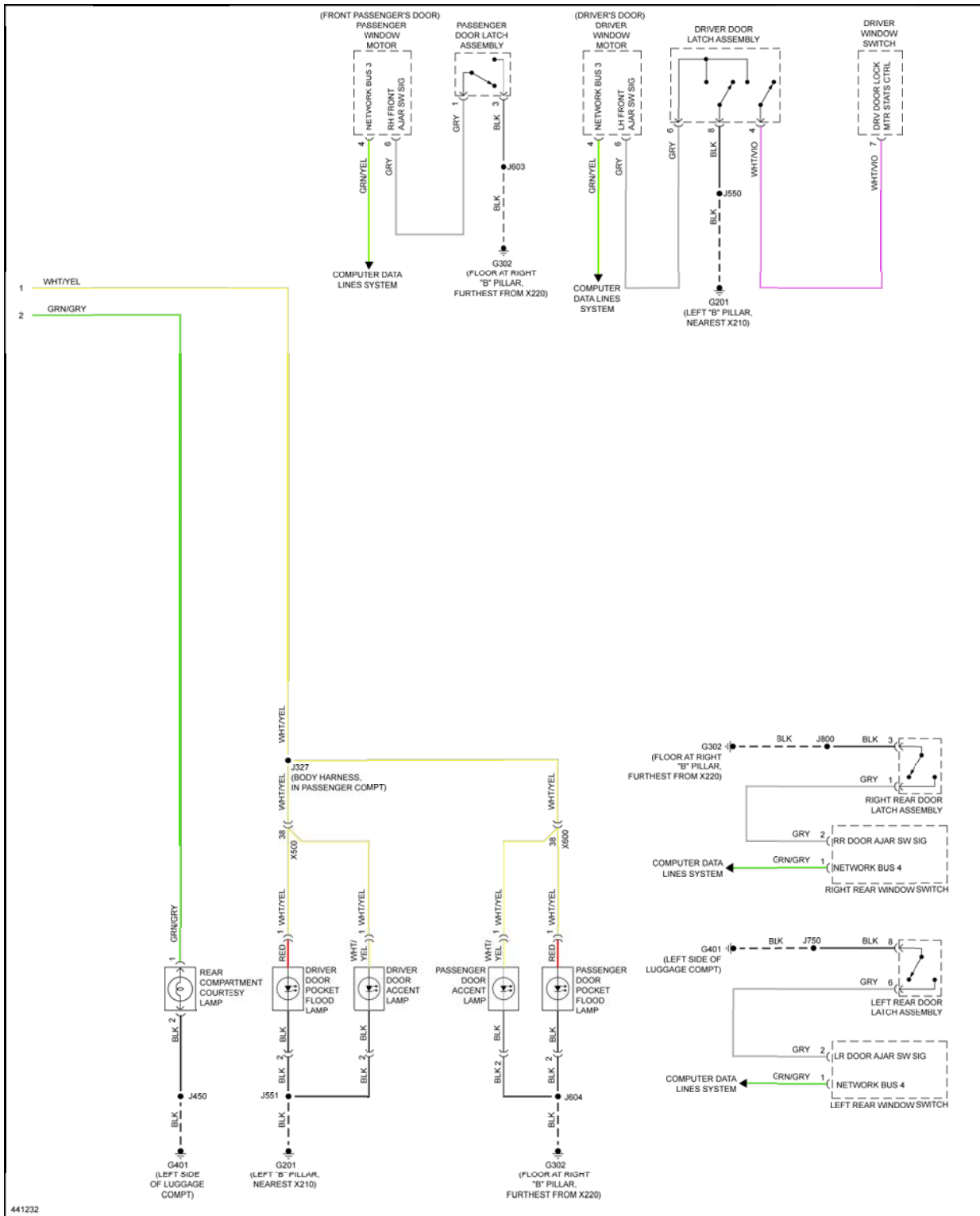


Fig. 61: Courtesy Lamps Circuit (2 of 2)

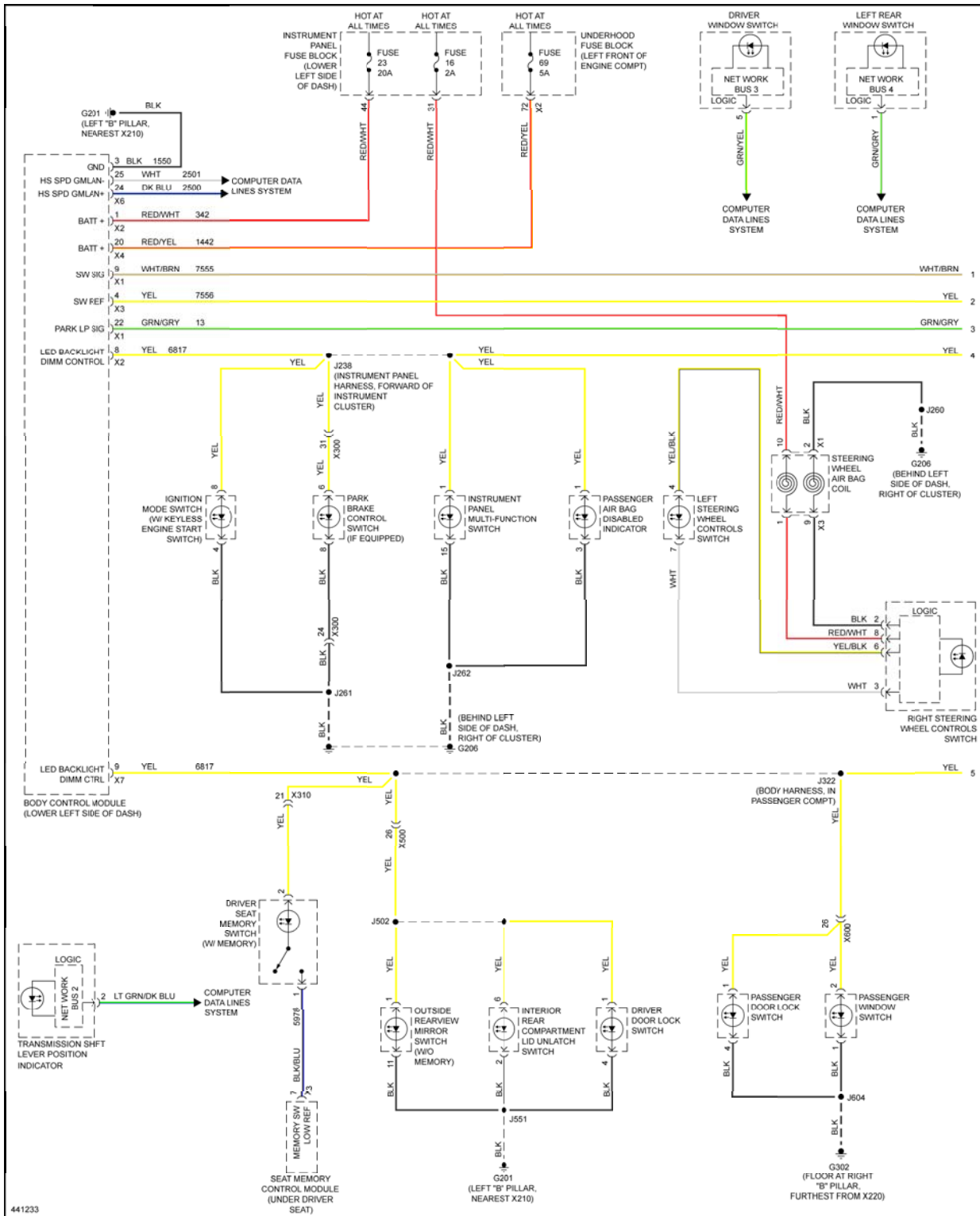


Fig. 62: Instrument Illumination Circuit (1 of 2)

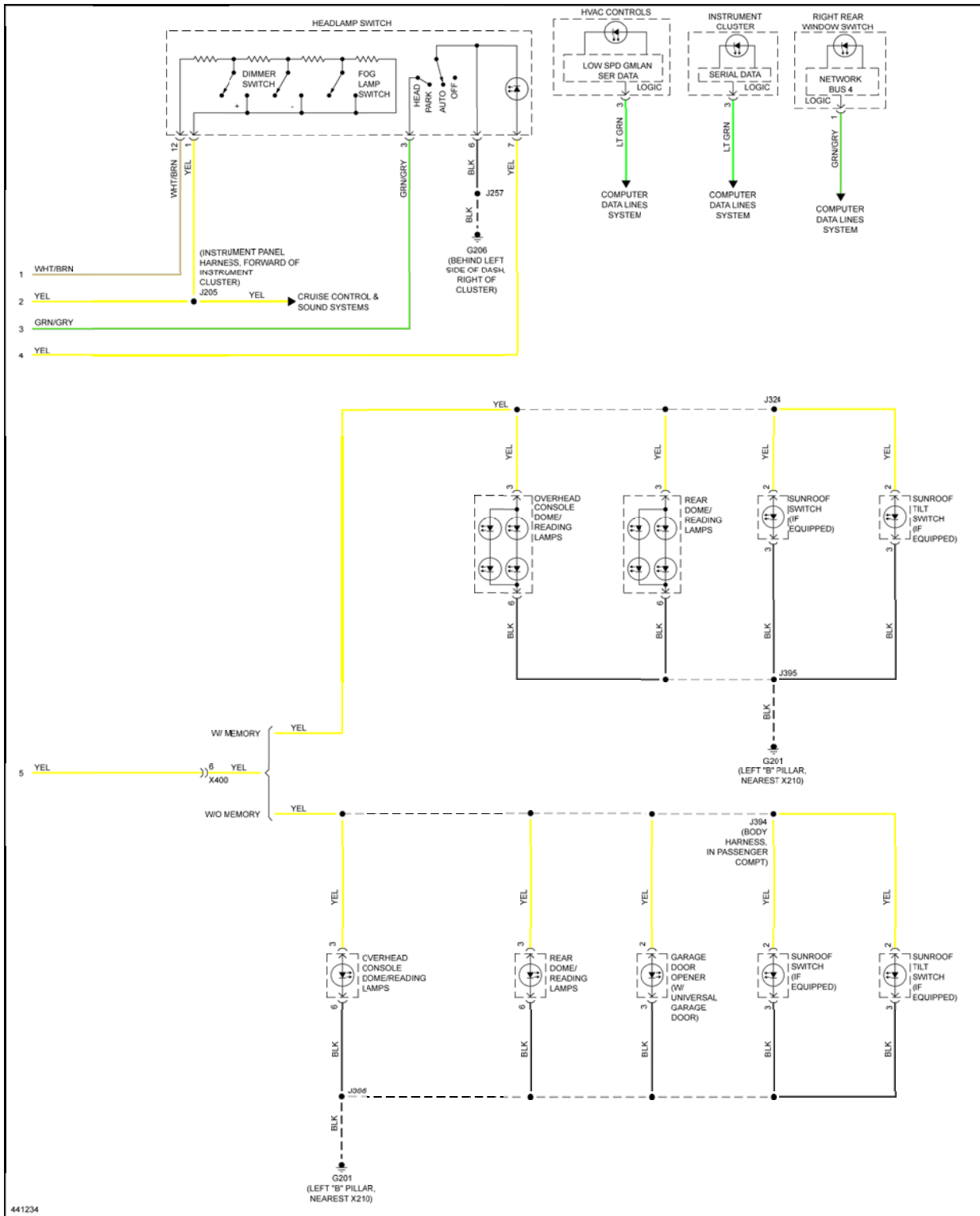


Fig. 63: Instrument Illumination Circuit (2 of 2)

MEMORY SYSTEMS

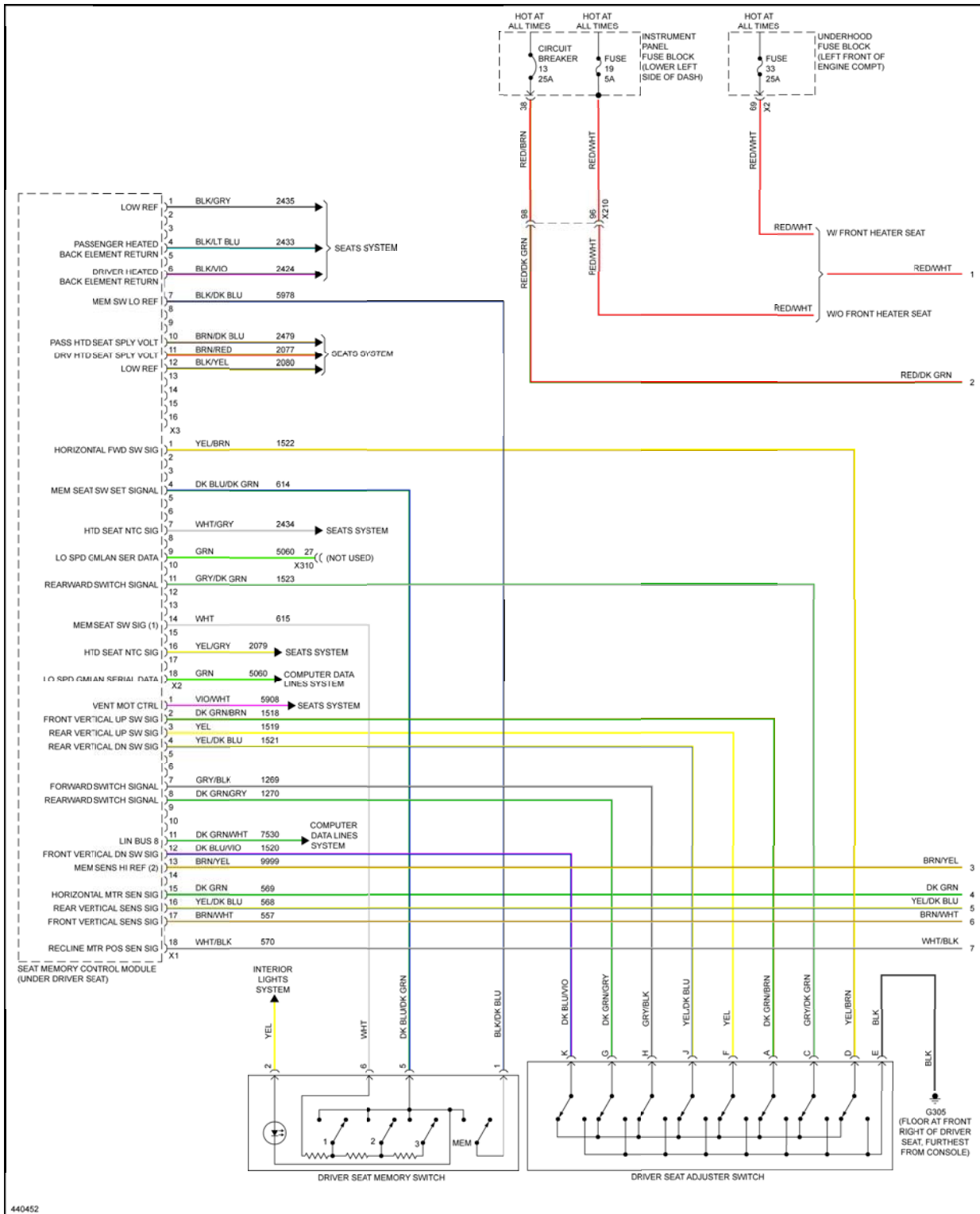


Fig. 64: Driver's Memory Seat Circuit (1 of 2)

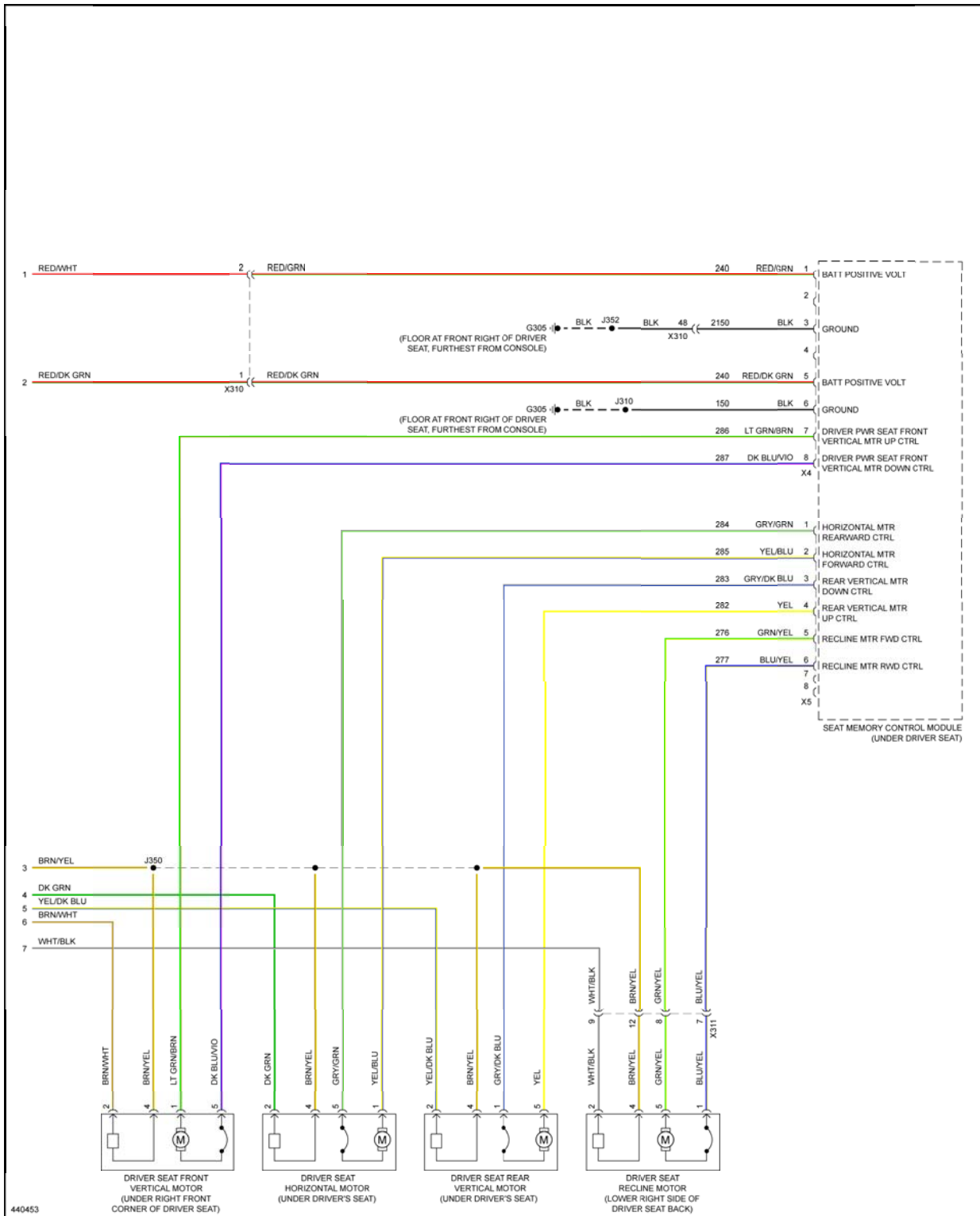


Fig. 65: Driver's Memory Seat Circuit (2 of 2)

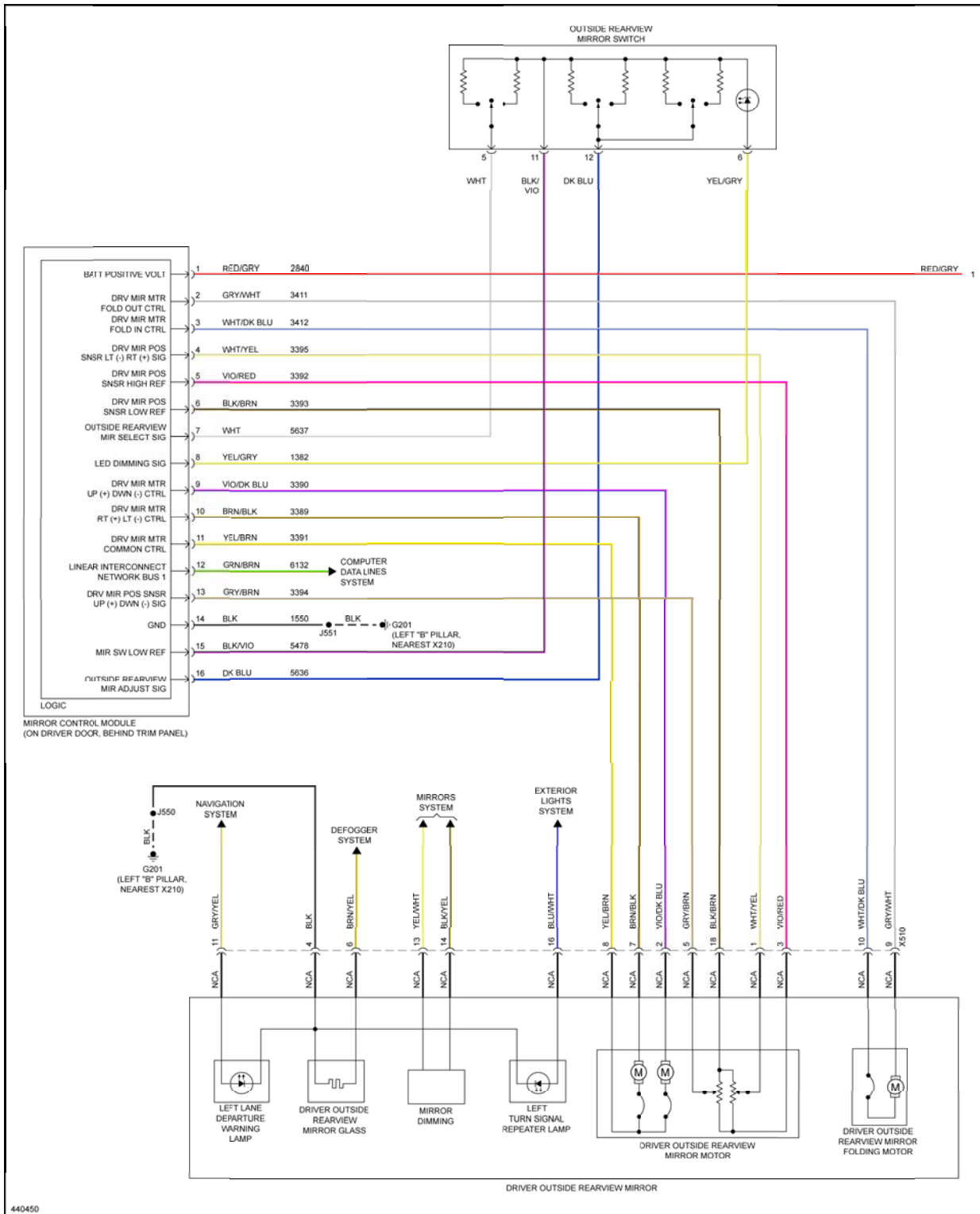


Fig. 66: Memory Mirrors Circuit (1 of 2)

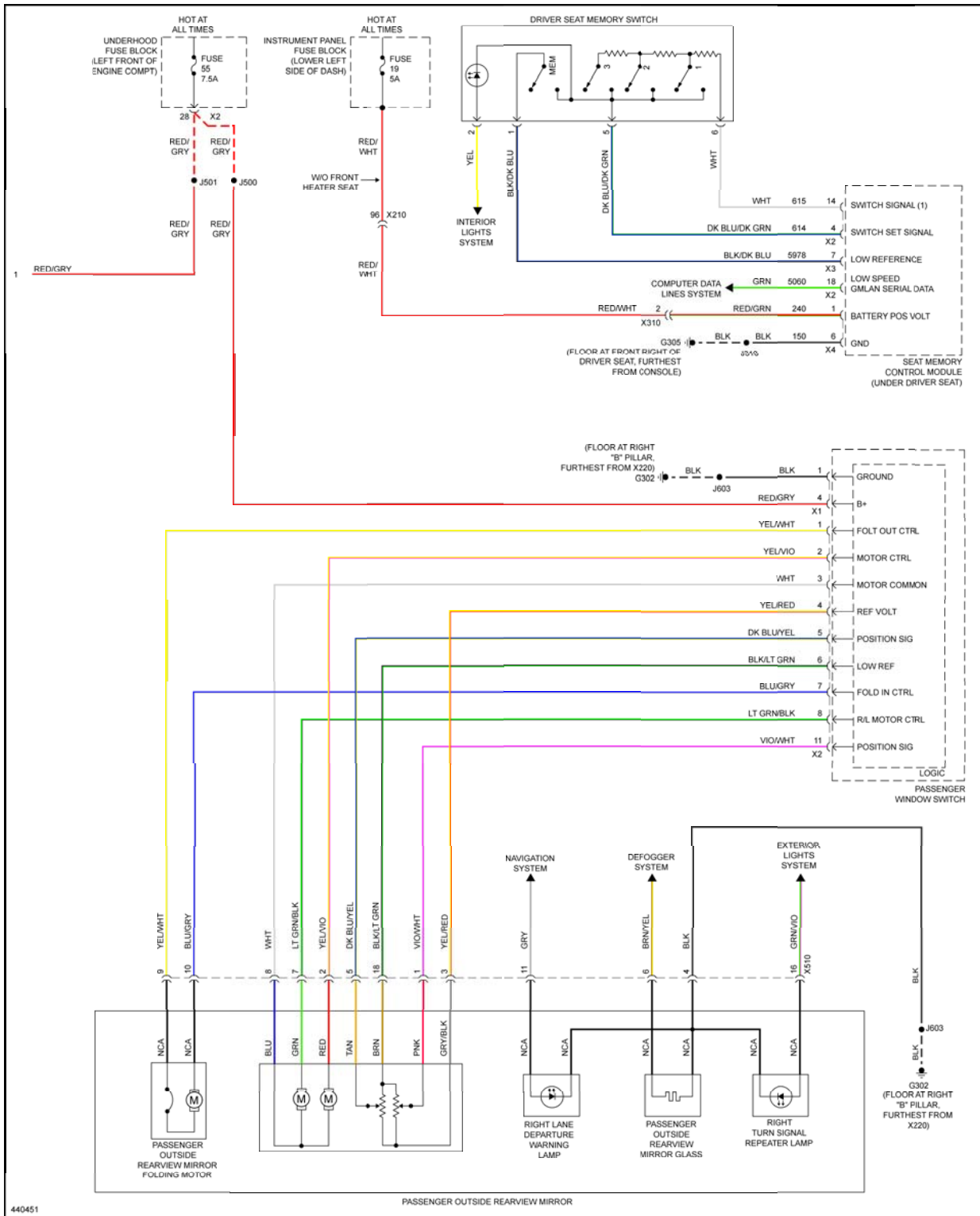


Fig. 67: Memory Mirrors Circuit (2 of 2)

NAVIGATION

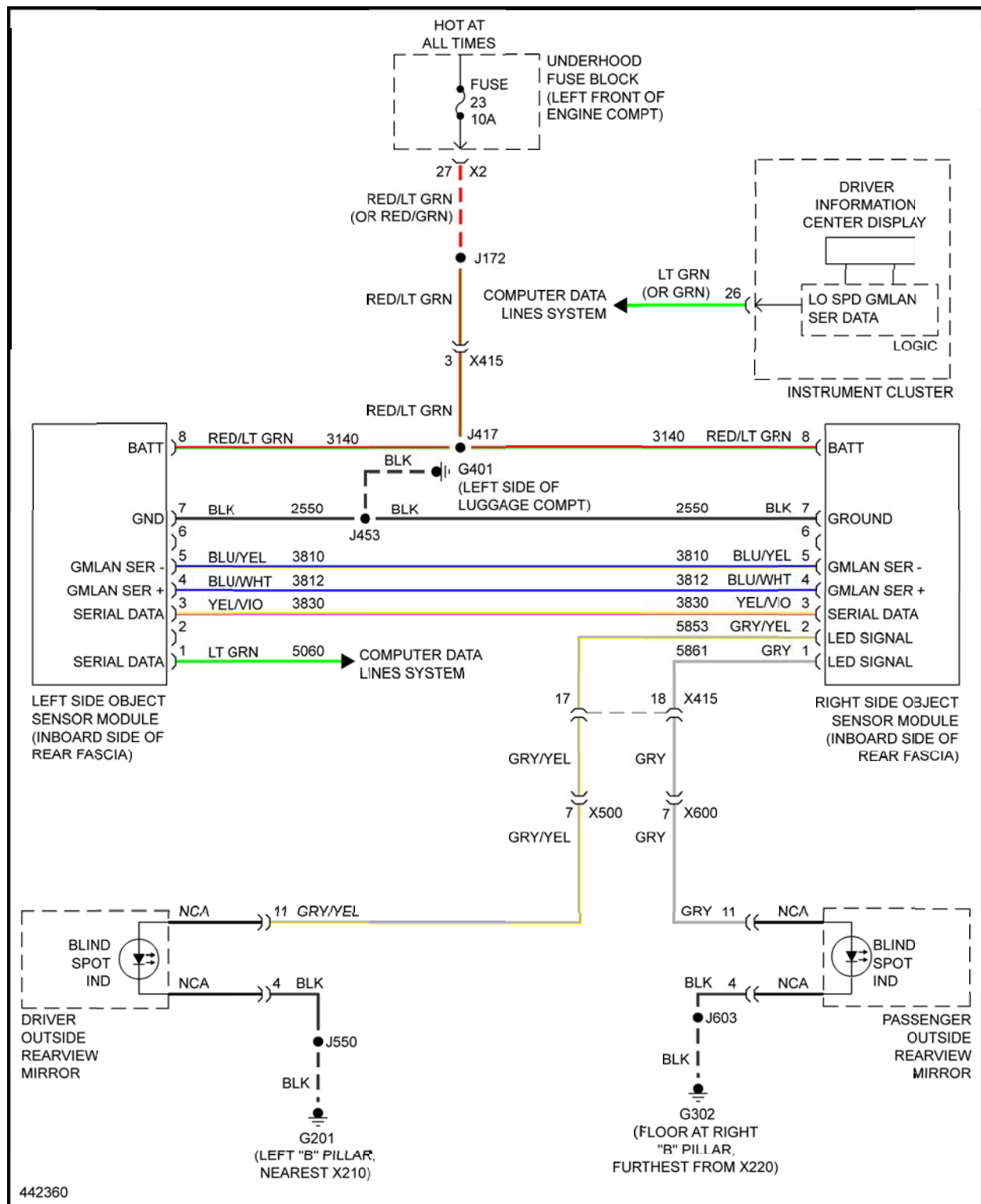


Fig. 68: Blind Spot Monitoring Circuit

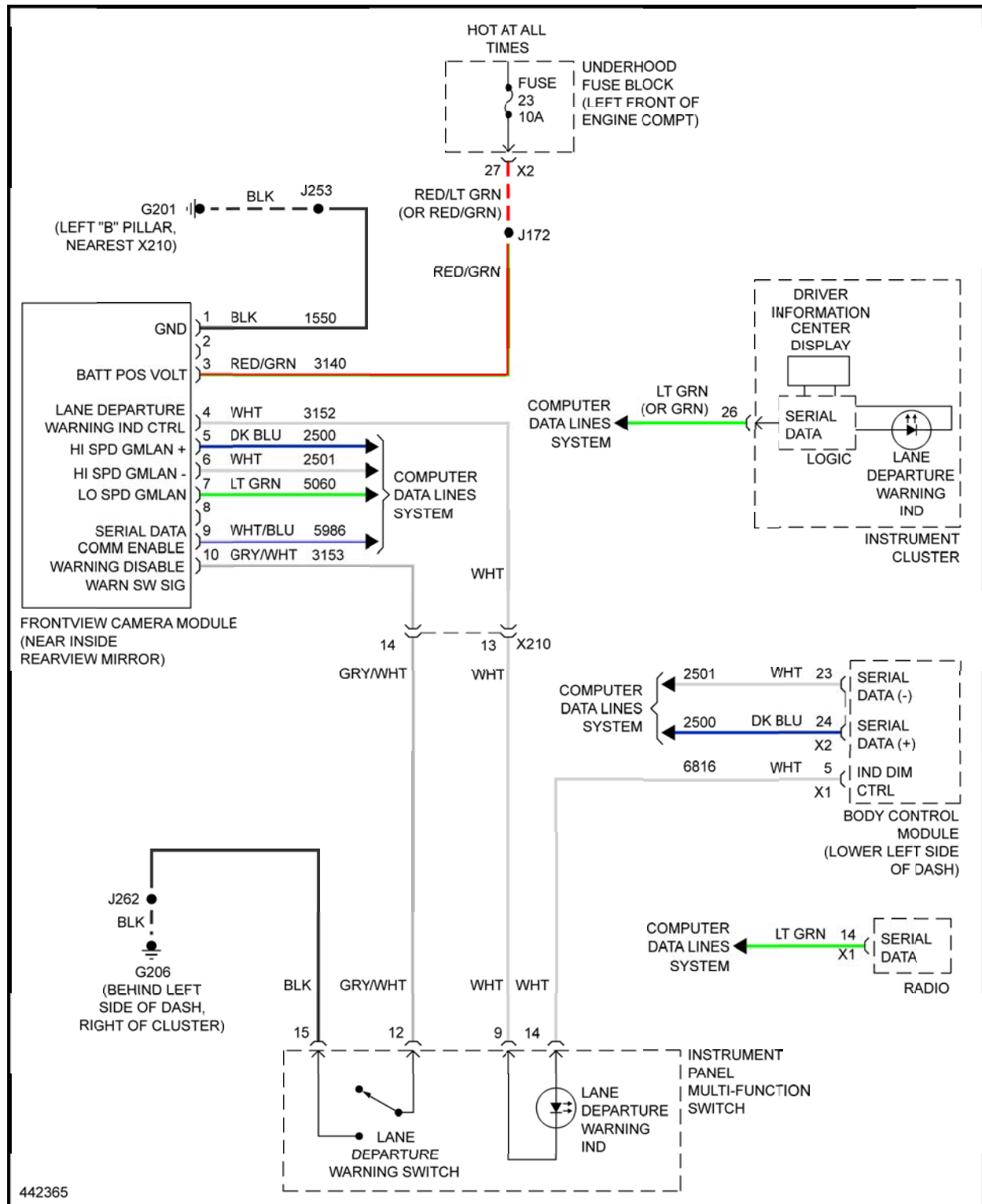


Fig. 69: Lane Departure Warning Circuit

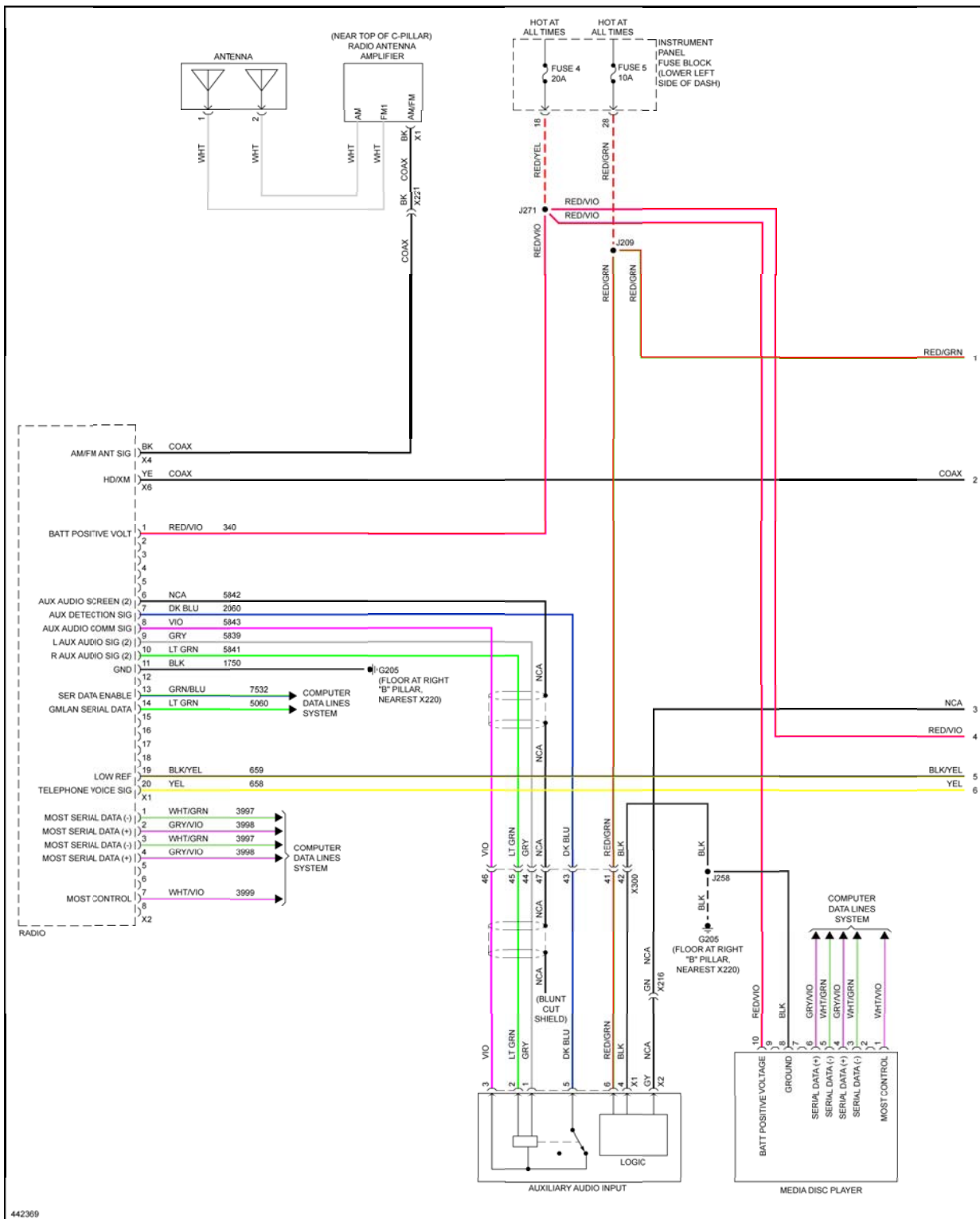


Fig. 70: Navigation Circuit, W/ Amplifier (1 of 4)

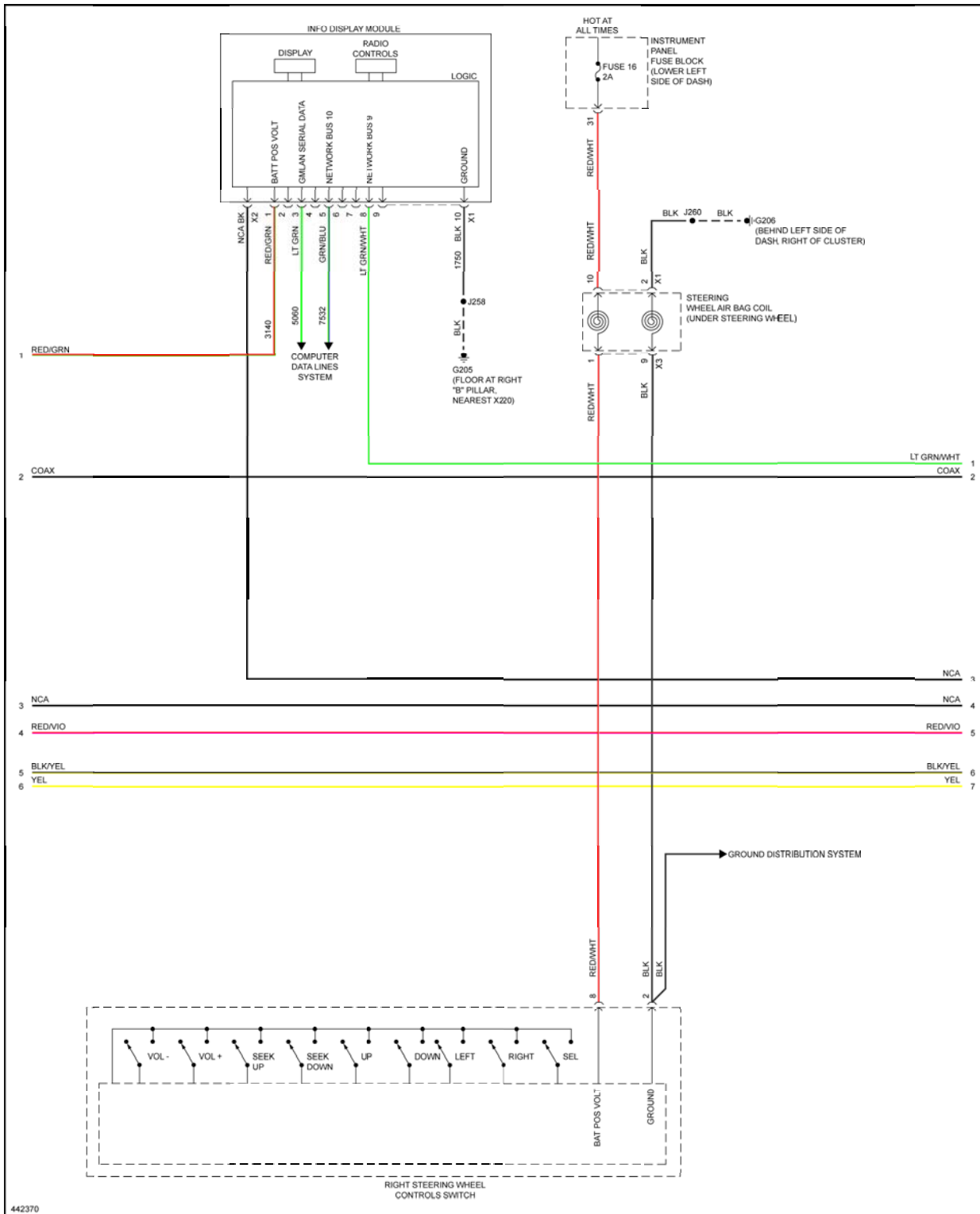


Fig. 71: Navigation Circuit, W/ Amplifier (2 of 4)



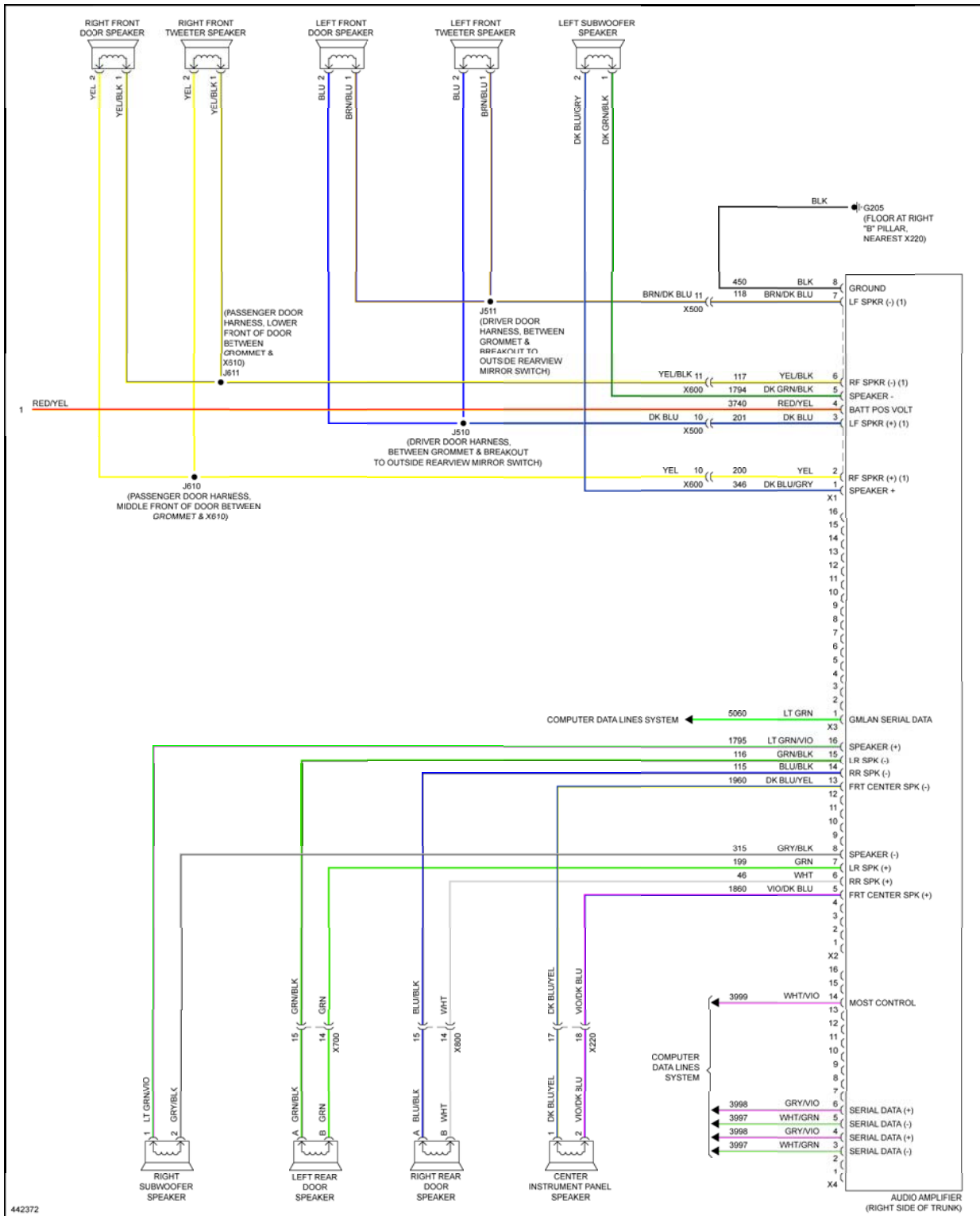


Fig. 73: Navigation Circuit, W/ Amplifier (4 of 4)

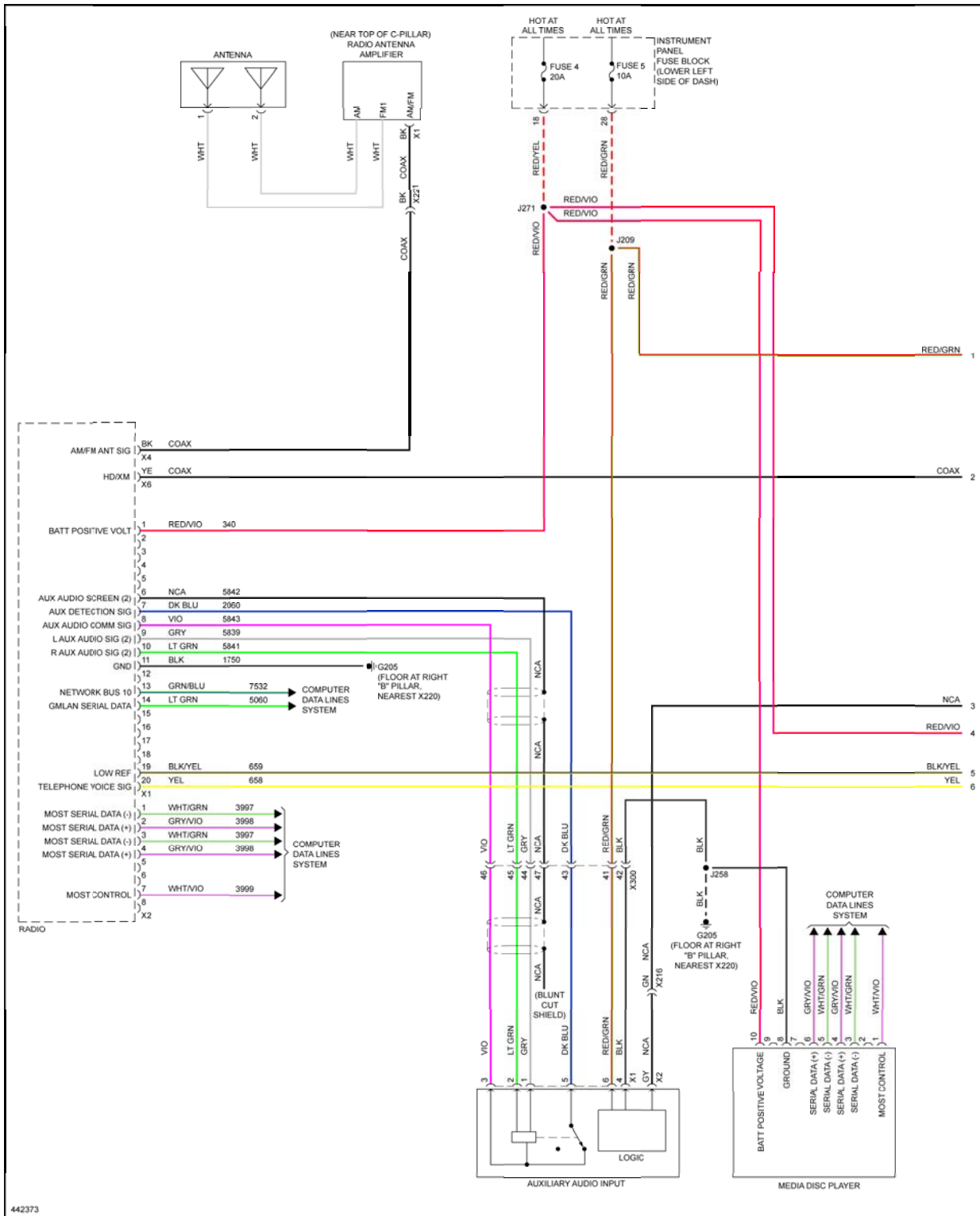


Fig. 74: Navigation Circuit, W/O Amplifier (1 of 4)

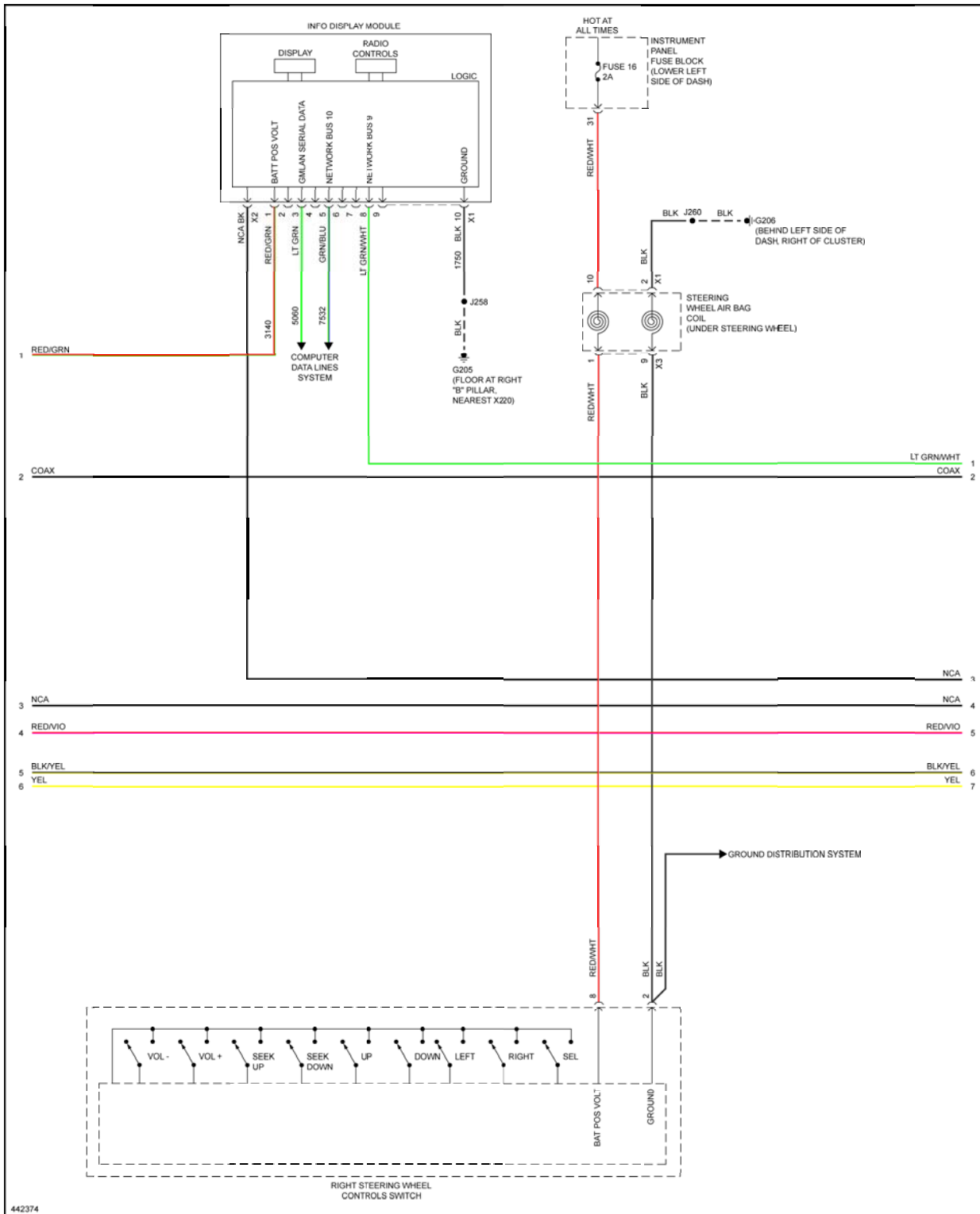


Fig. 75: Navigation Circuit, W/O Amplifier (2 of 4)



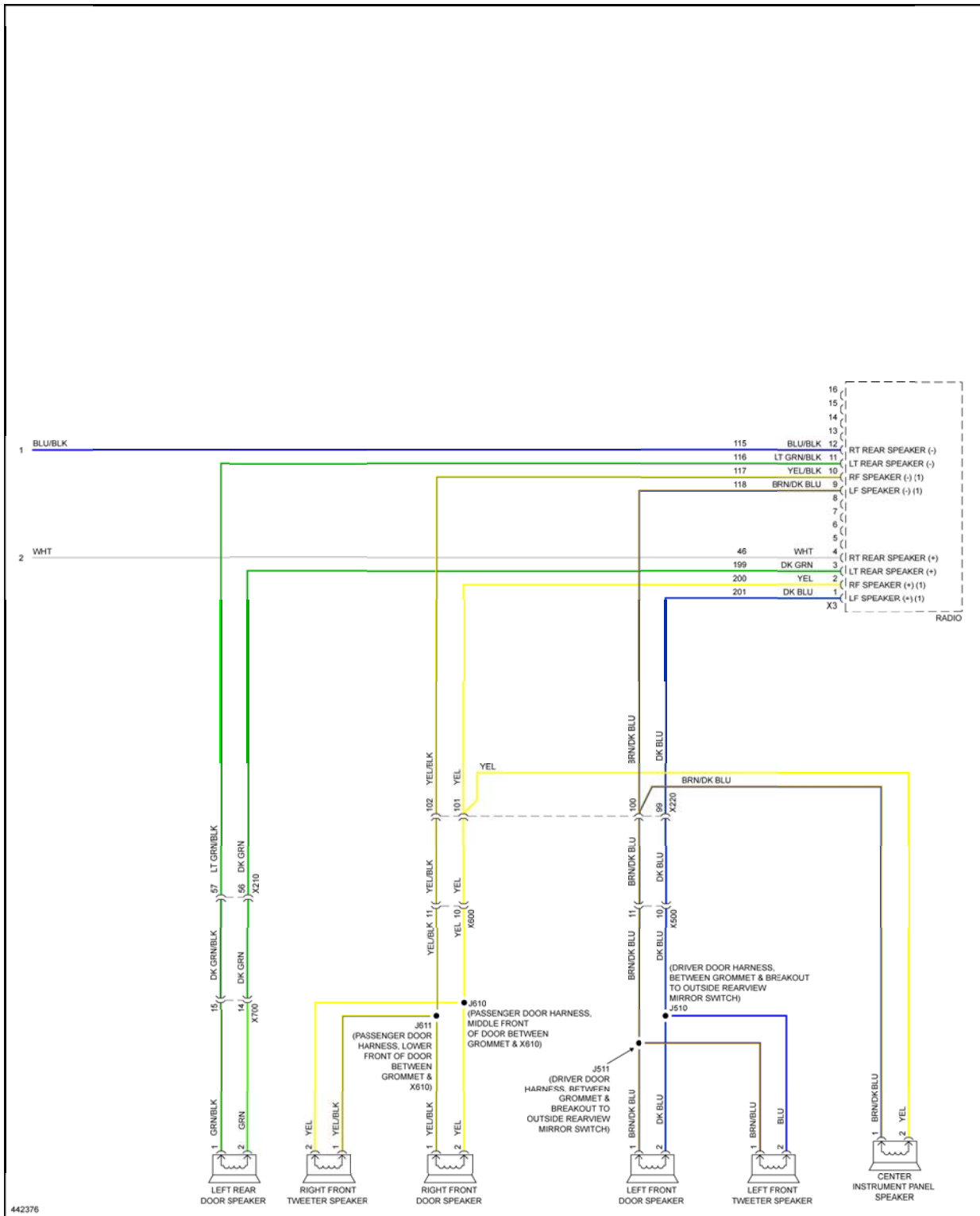


Fig. 77: Navigation Circuit, W/O Amplifier (4 of 4)

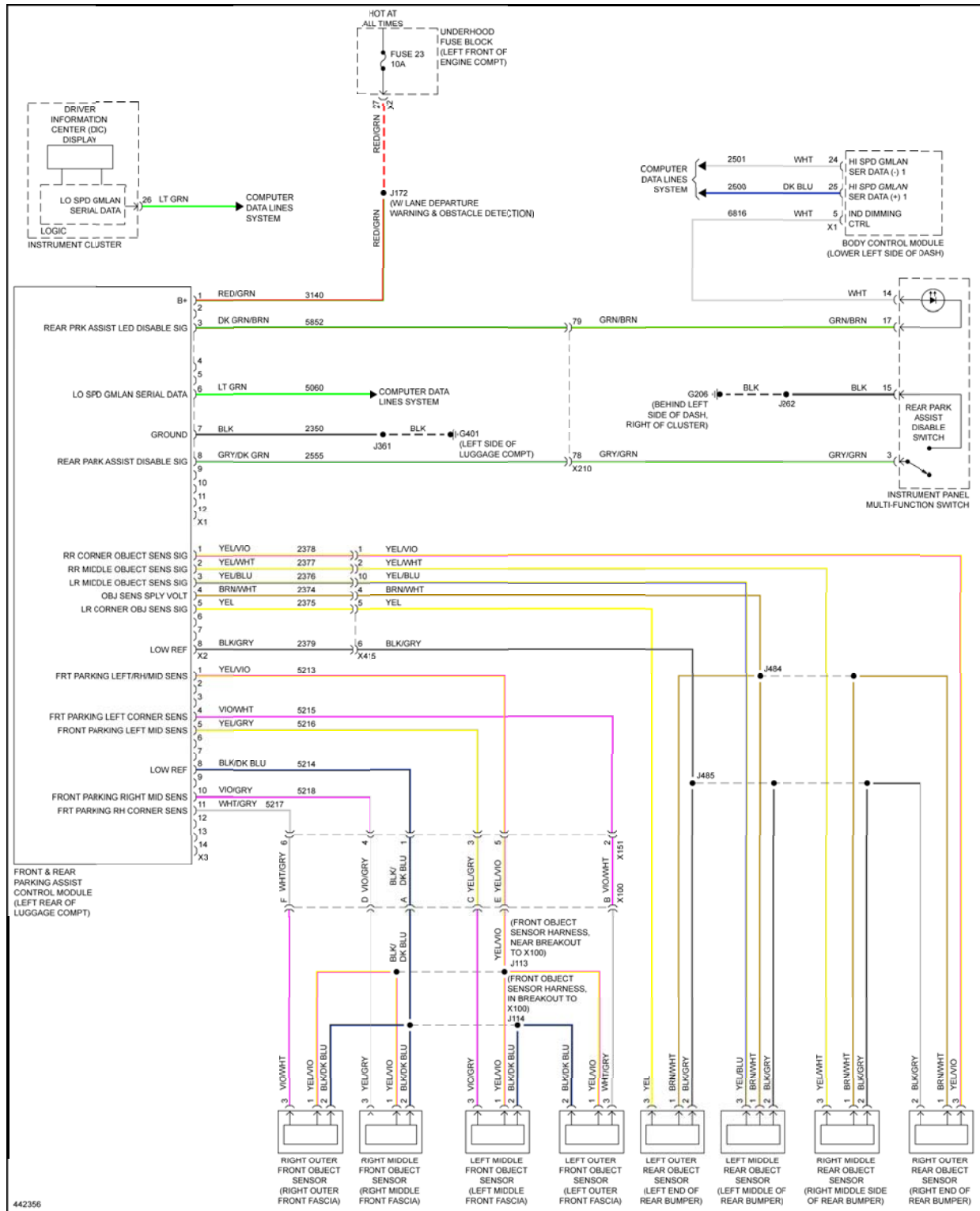
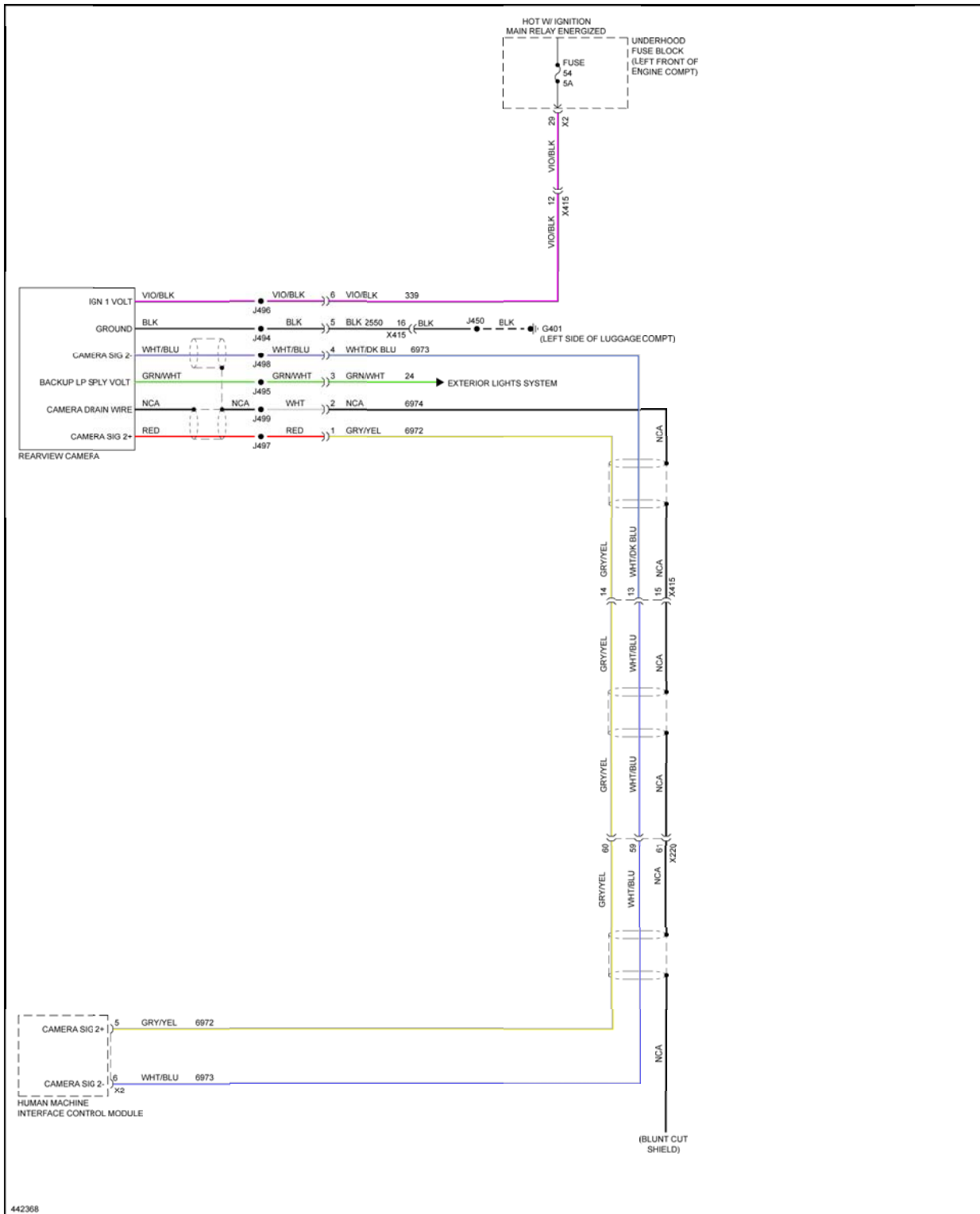


Fig. 78: Parking Assistant Circuit



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Fig. 79: Rear View Camera Circuit

POWER DISTRIBUTION



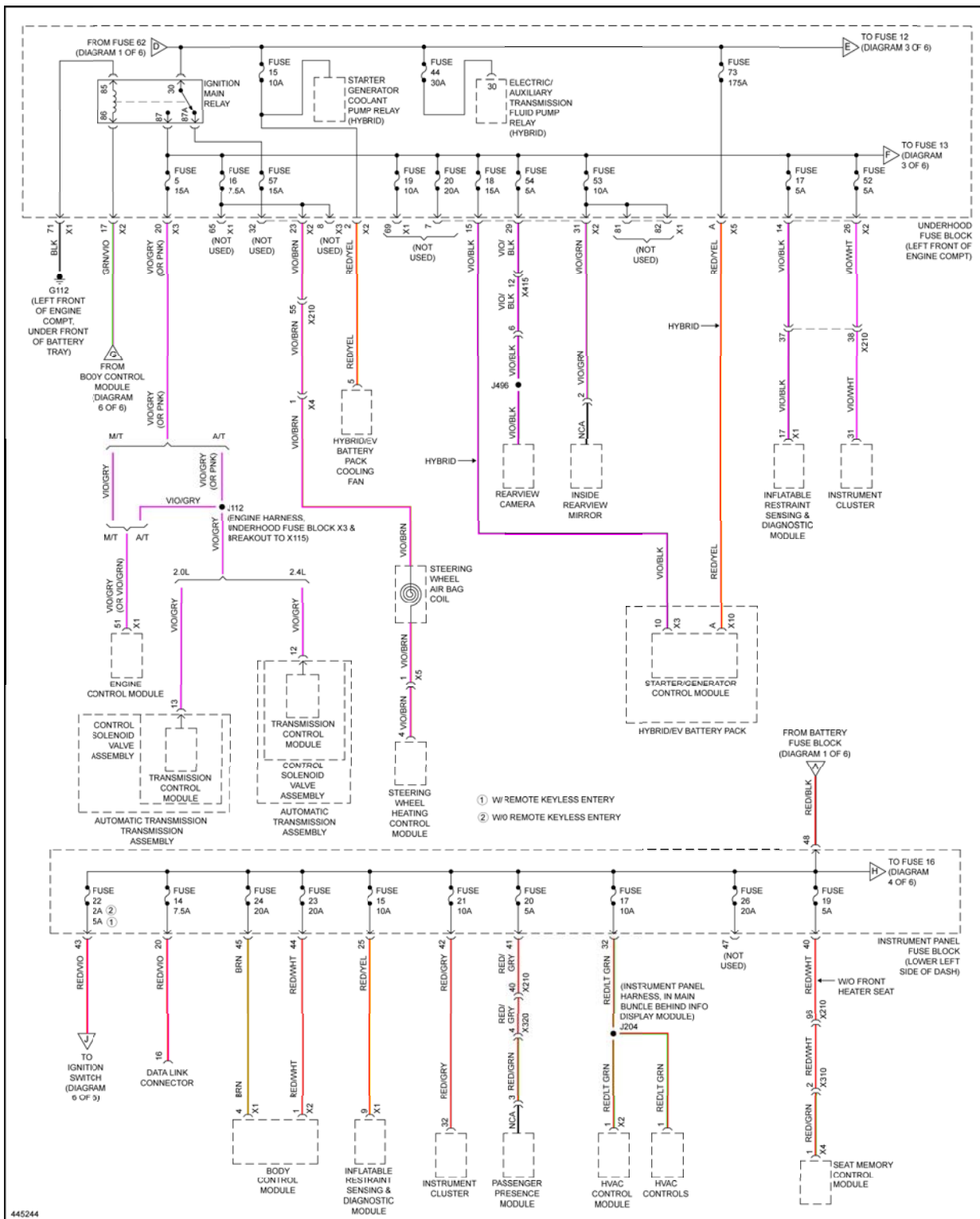


Fig. 81: Power Distribution Circuit (2 of 6)

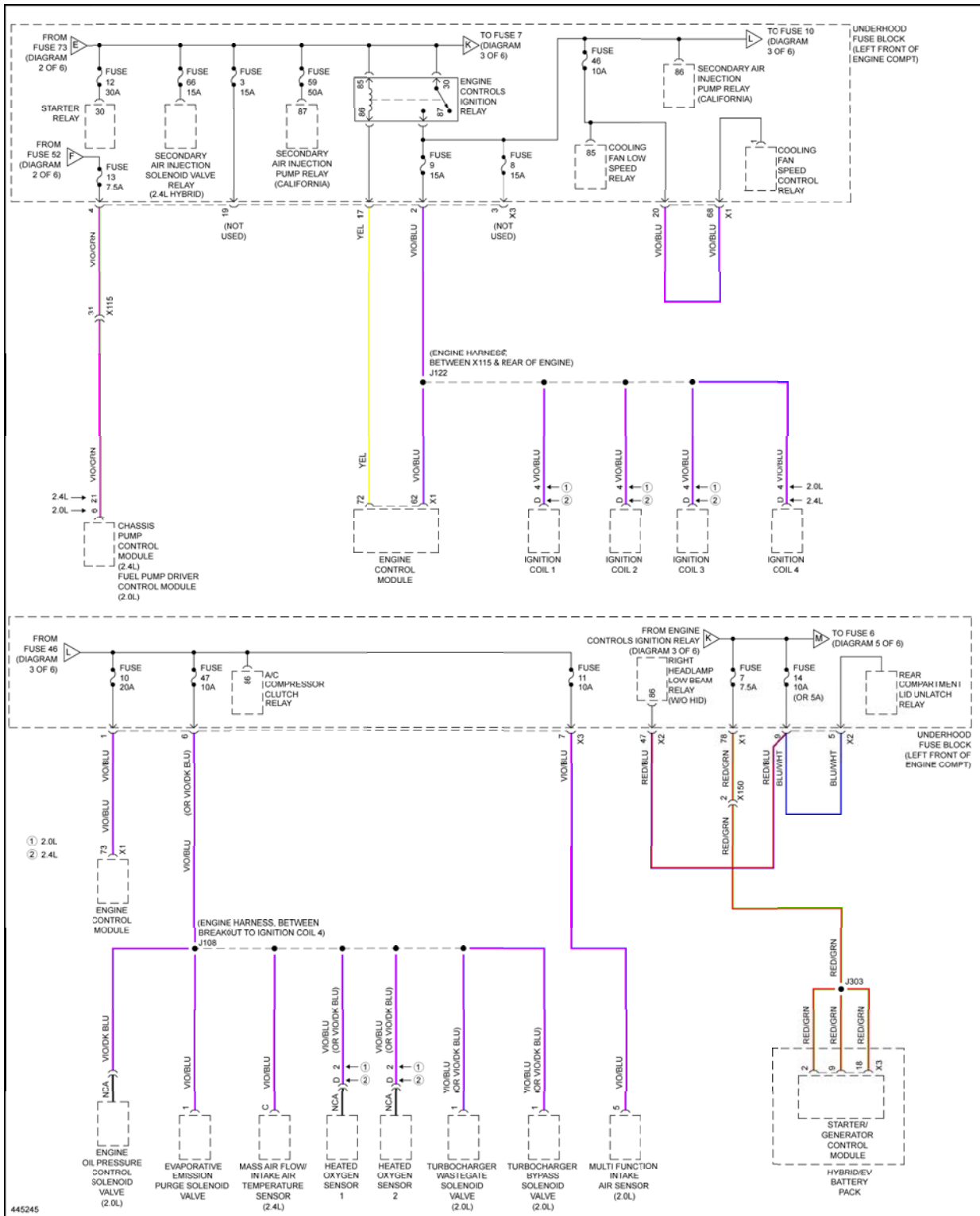


Fig. 82: Power Distribution Circuit (3 of 6)





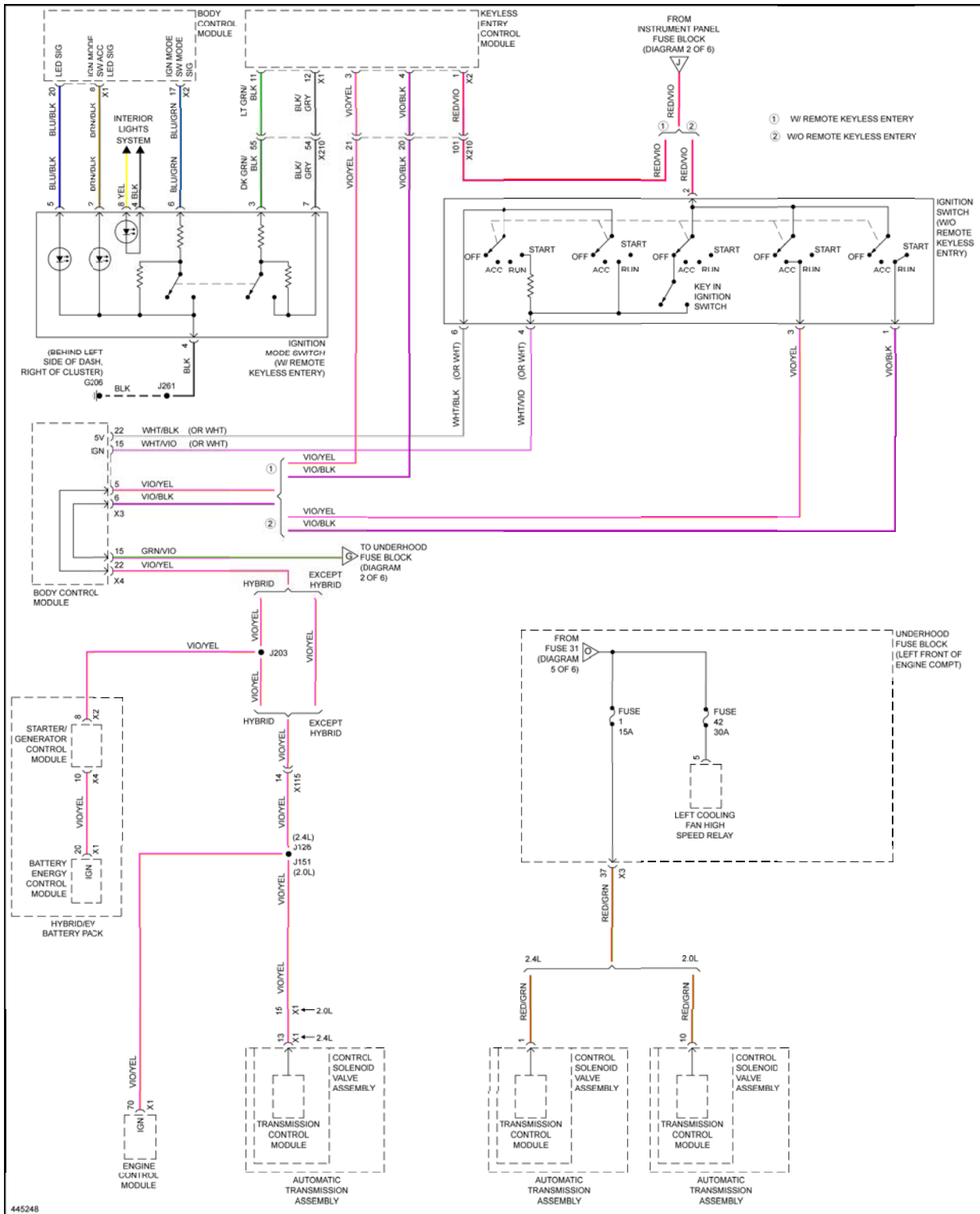
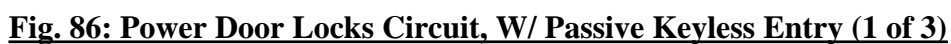


Fig. 85: Power Distribution Circuit (6 of 6)

POWER DOOR LOCKS



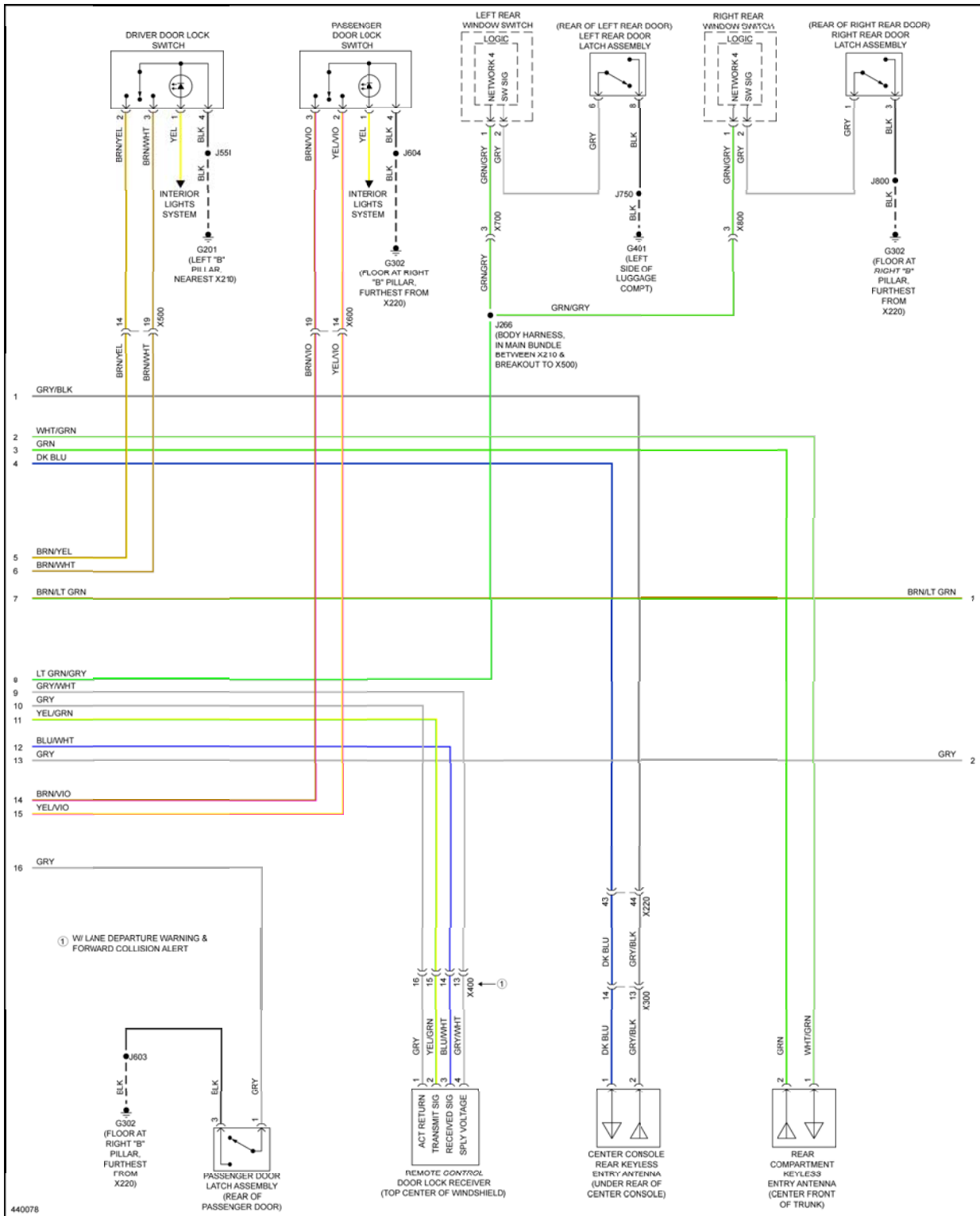
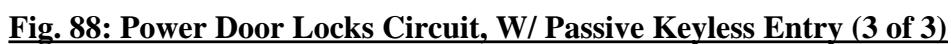


Fig. 87: Power Door Locks Circuit, W/ Passive Keyless Entry (2 of 3)



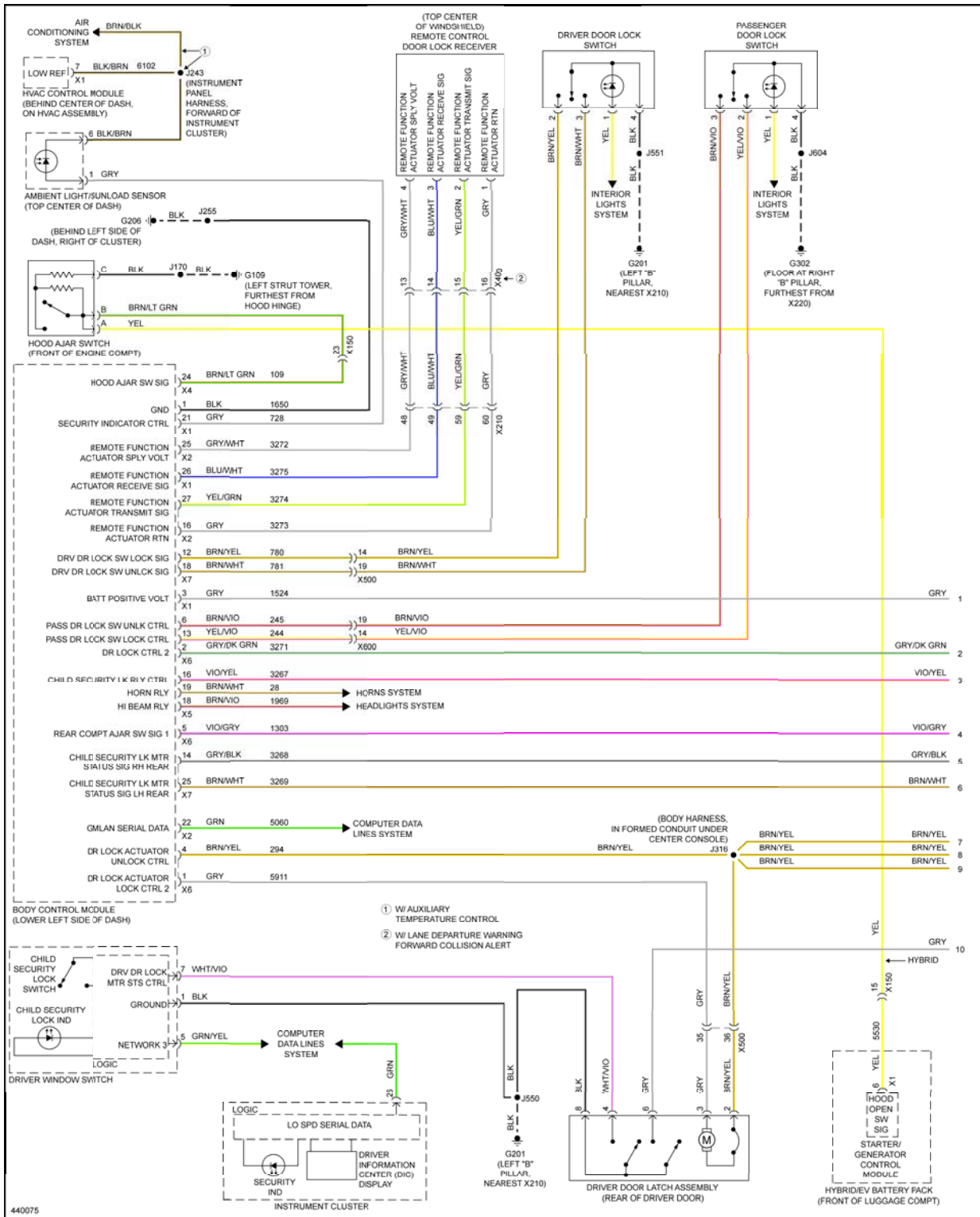


Fig. 89: Power Door Locks Circuit, W/O Passive Keyless Entry (1 of 2)

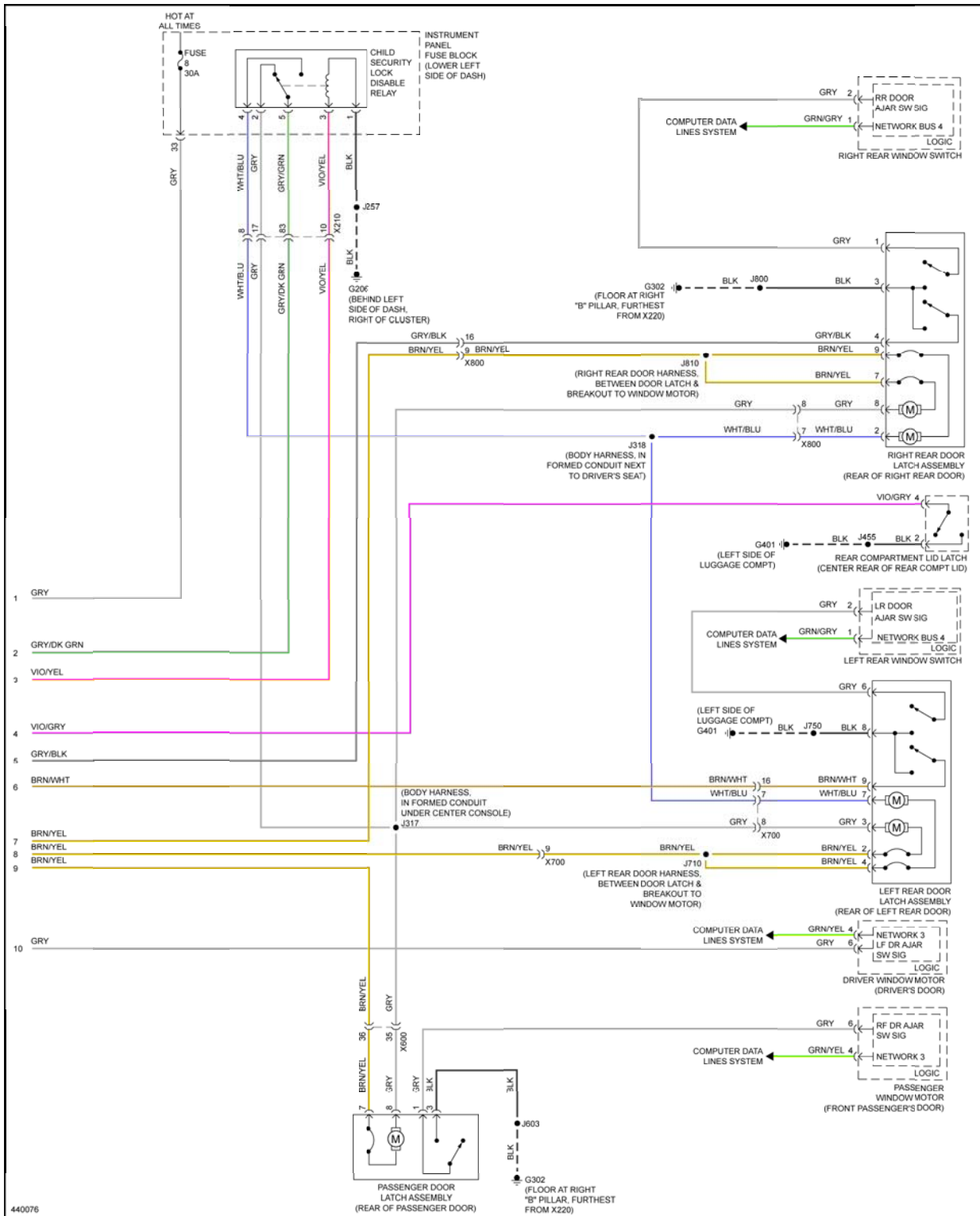


Fig. 90: Power Door Locks Circuit, W/O Passive Keyless Entry (2 of 2)

POWER MIRRORS

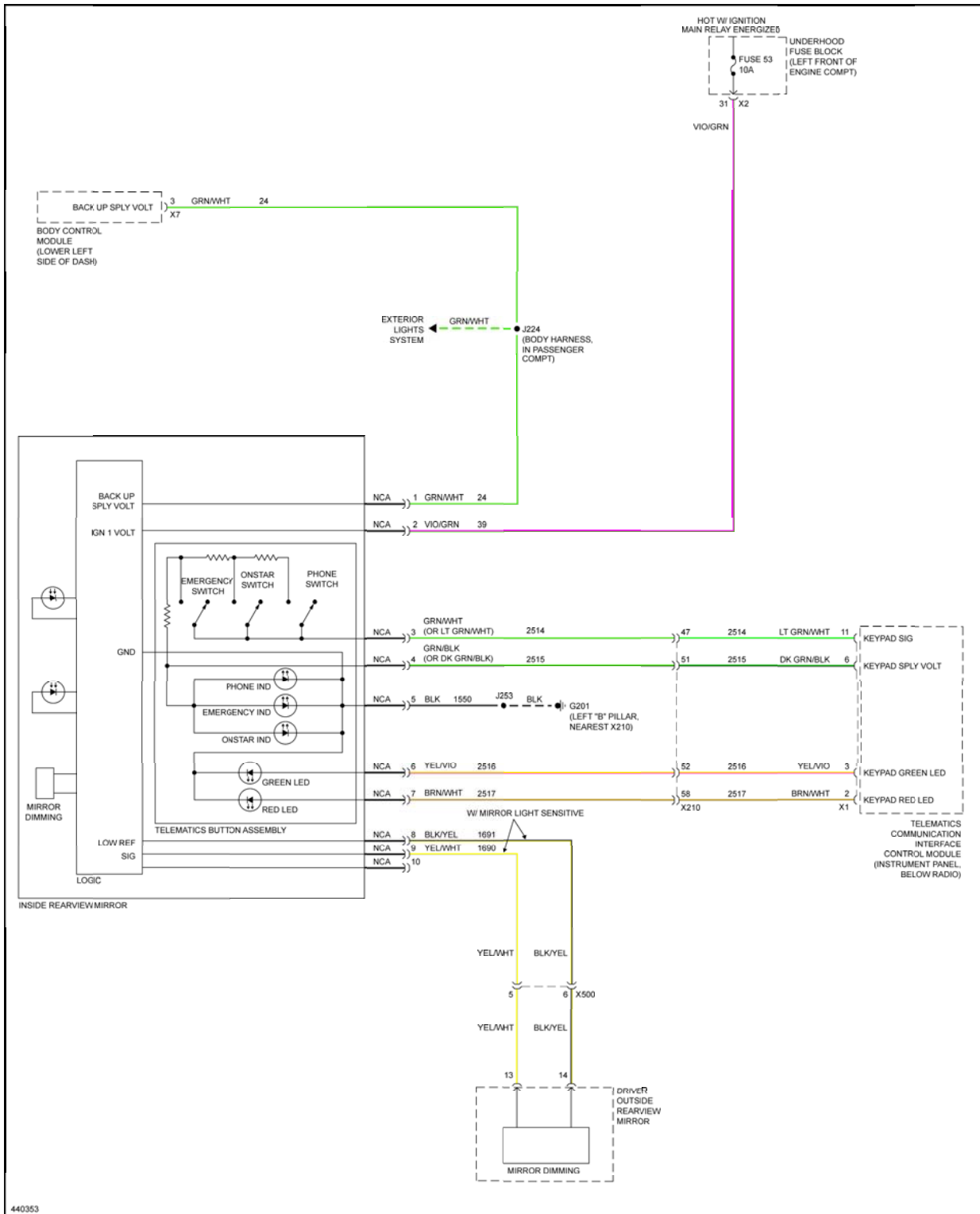


Fig. 91: Electrochromic Mirror Circuit

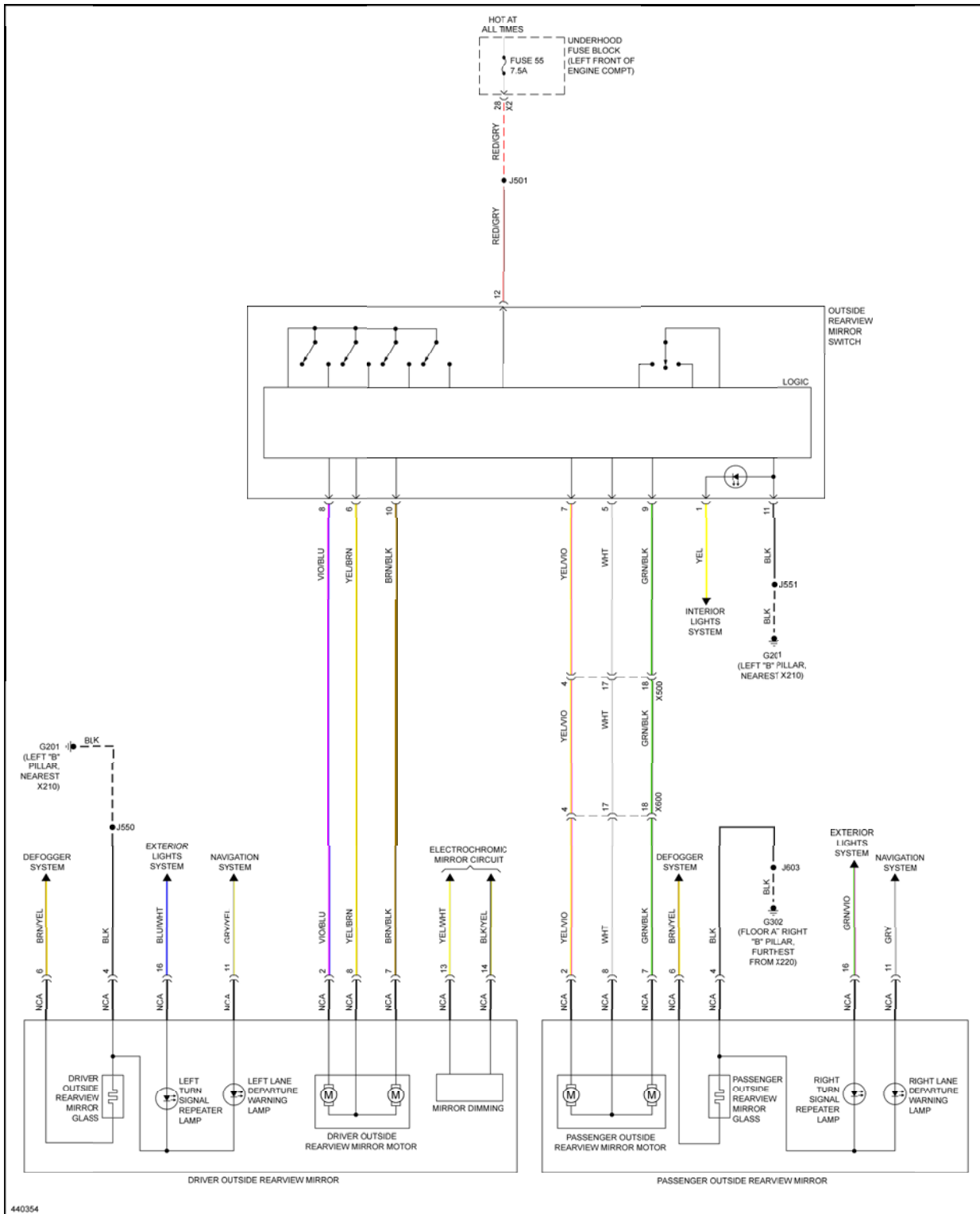


Fig. 92: Power Mirrors Circuit

POWER SEATS

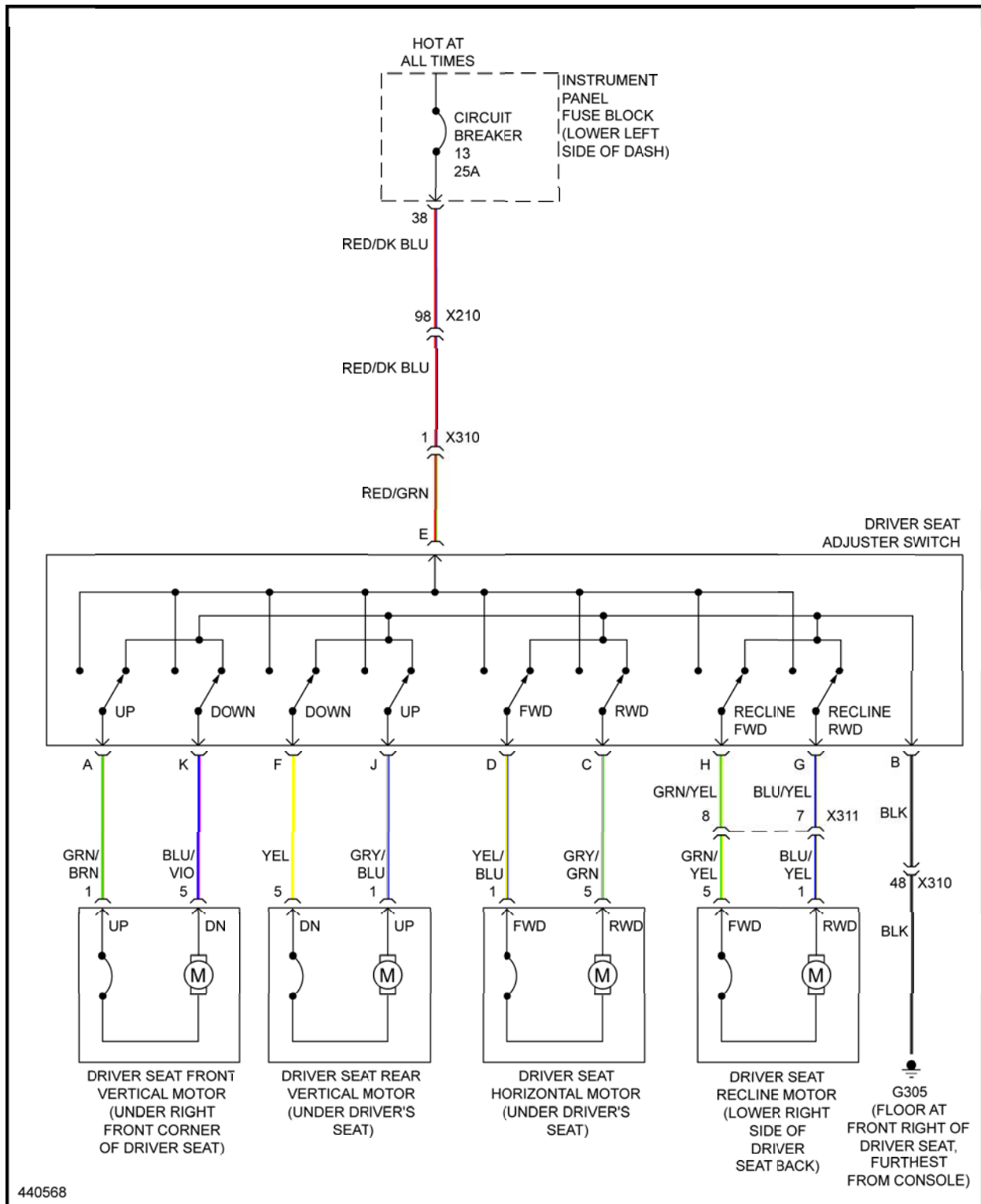


Fig. 93: Driver Power Seat Circuit

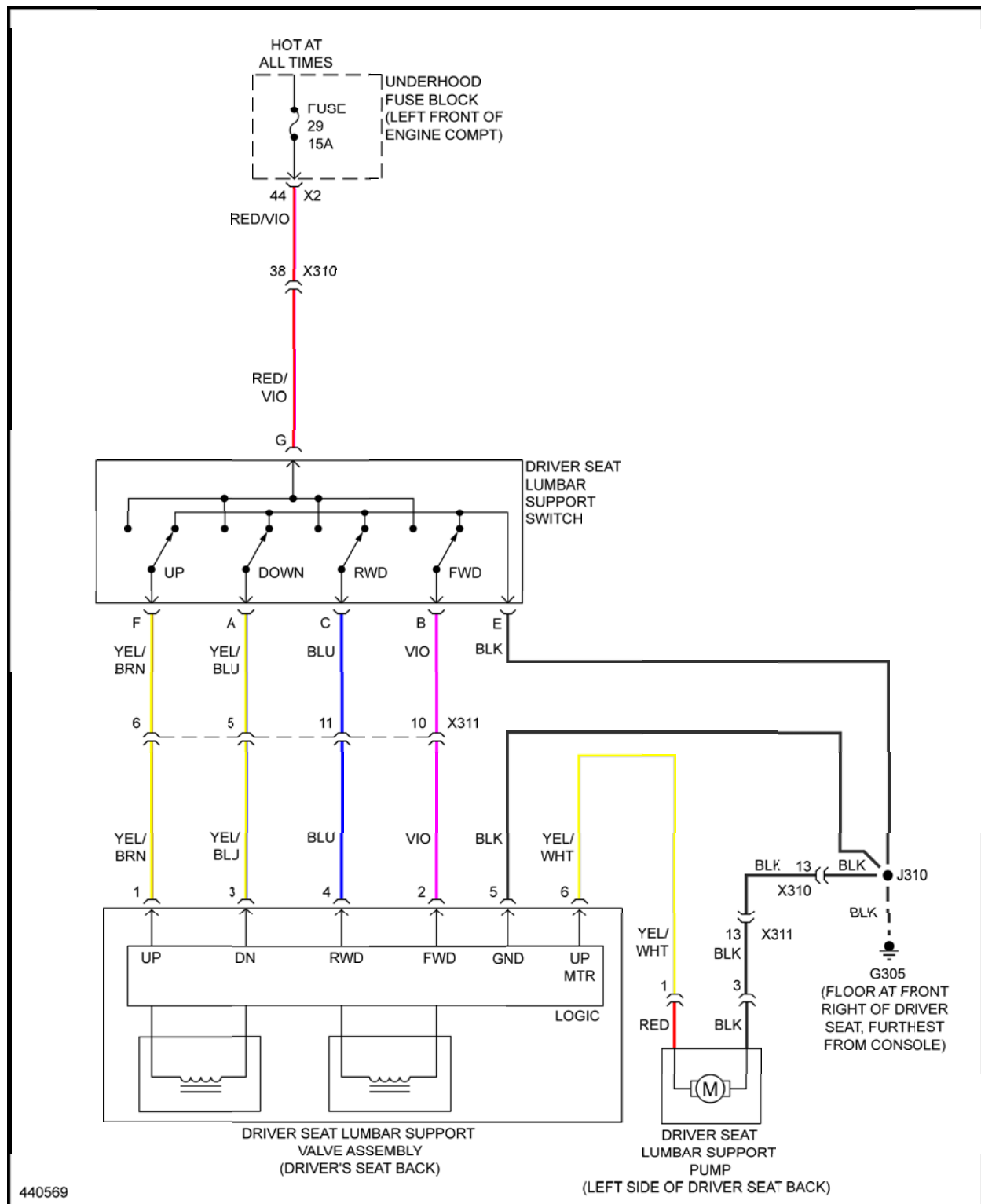


Fig. 94: Driver's Lumbar Circuit

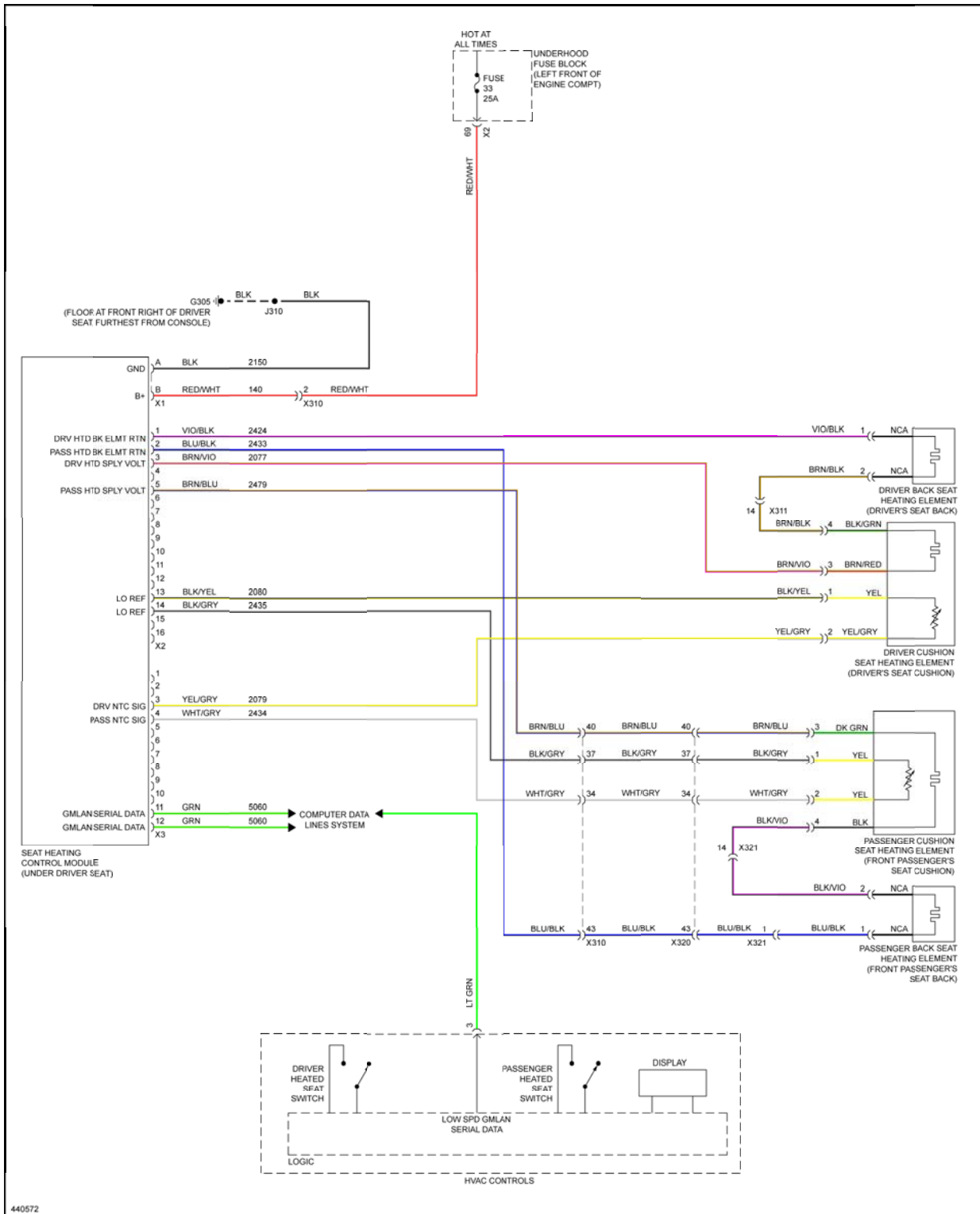


Fig. 95: Heated Seats Circuit

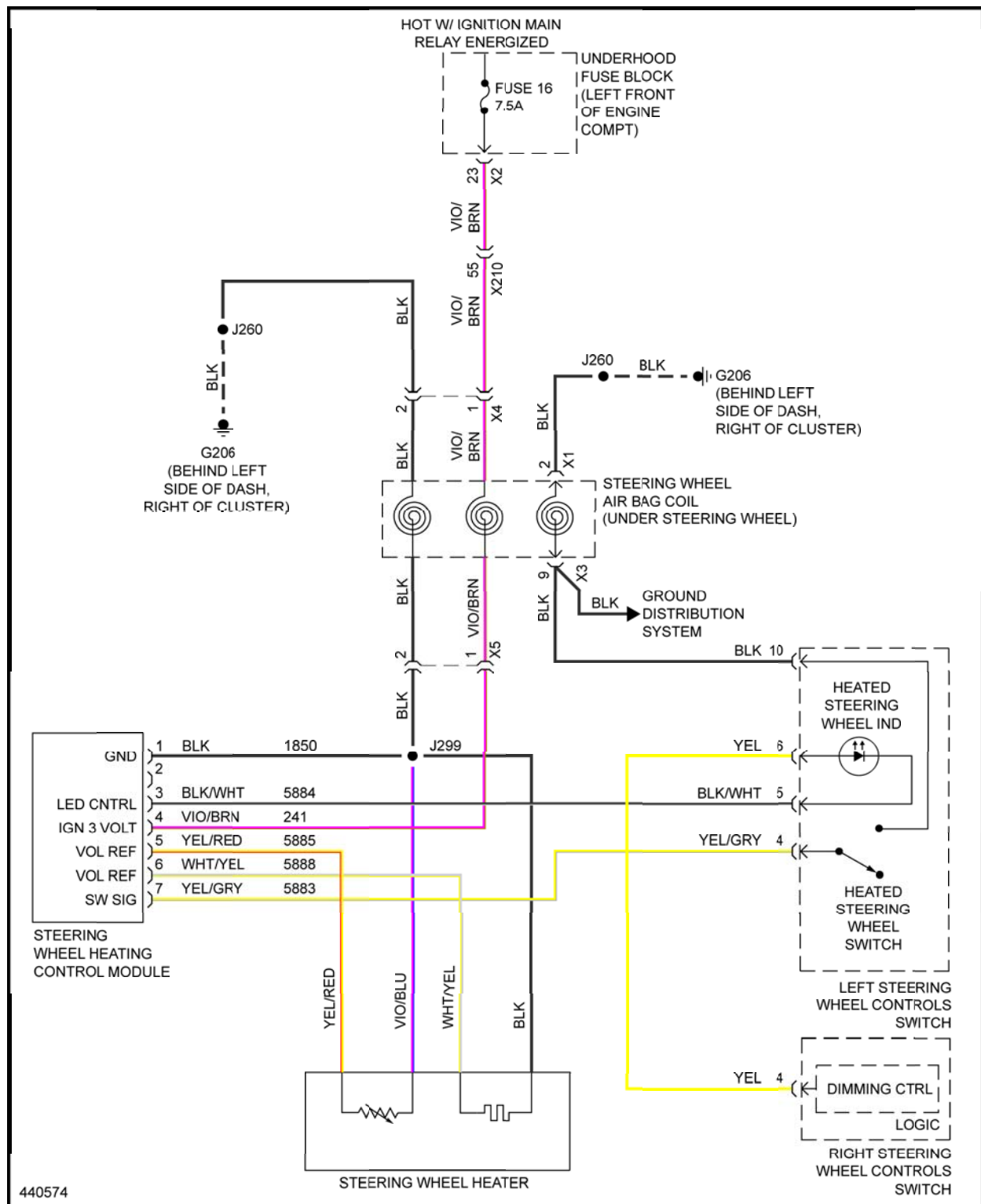


Fig. 96: Heated Steering Wheel Circuit

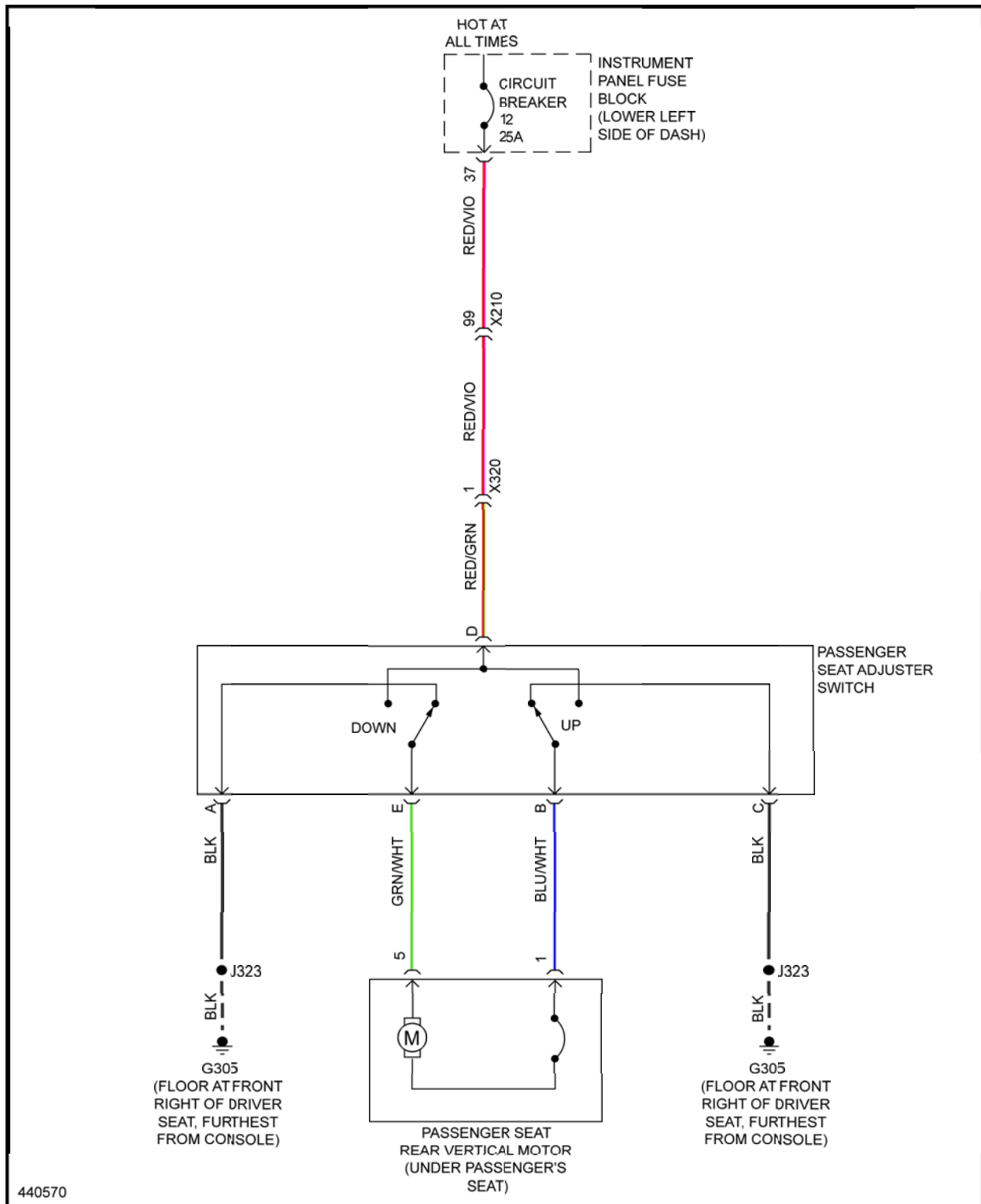


Fig. 97: Passenger Power Seat Circuit, 2-Way Power Seat

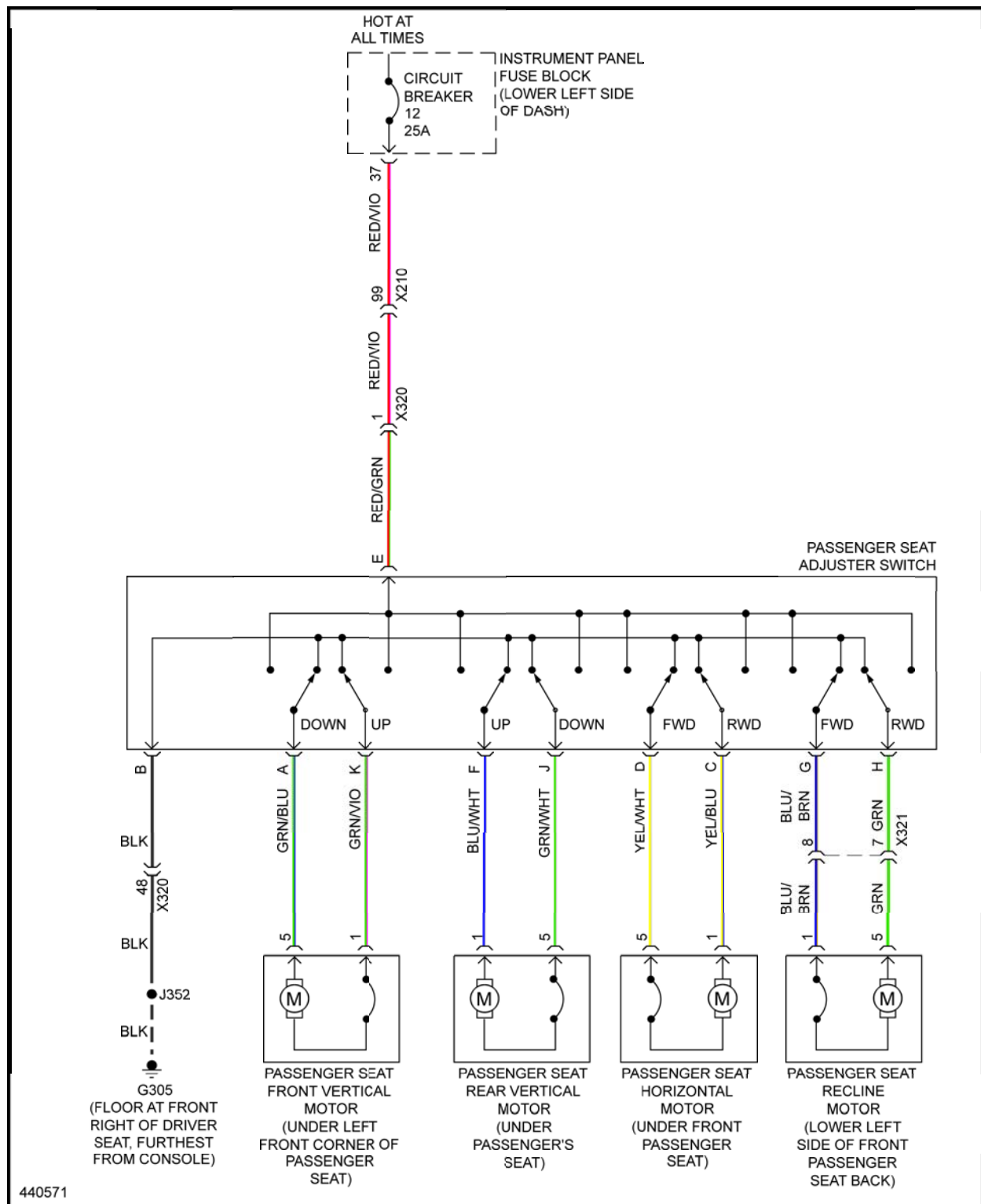


Fig. 98: Passenger Power Seat Circuit, 8-Way Power Seat

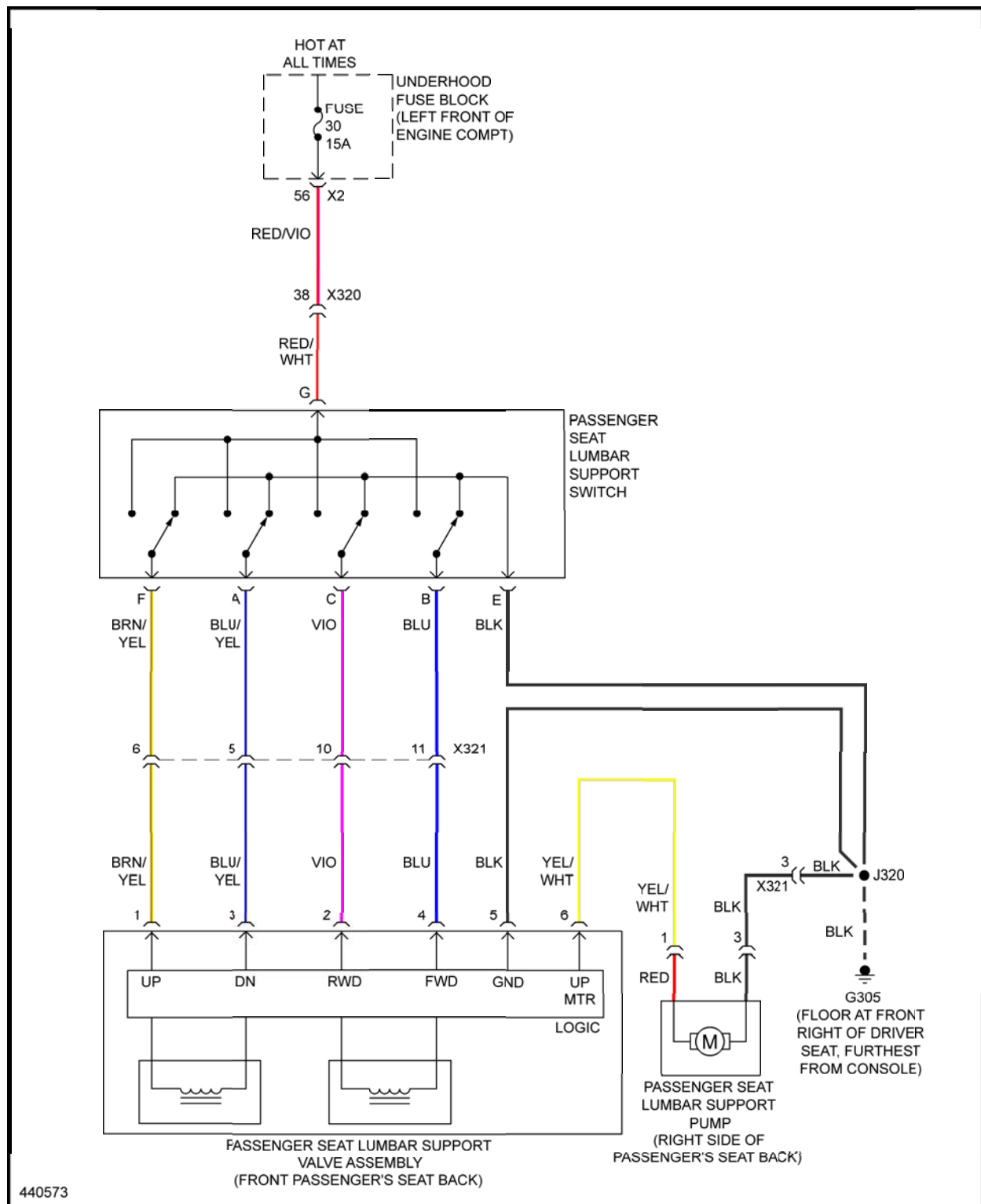


Fig. 99: Passenger's Lumbar Circuit

POWER TOP/SUNROOF

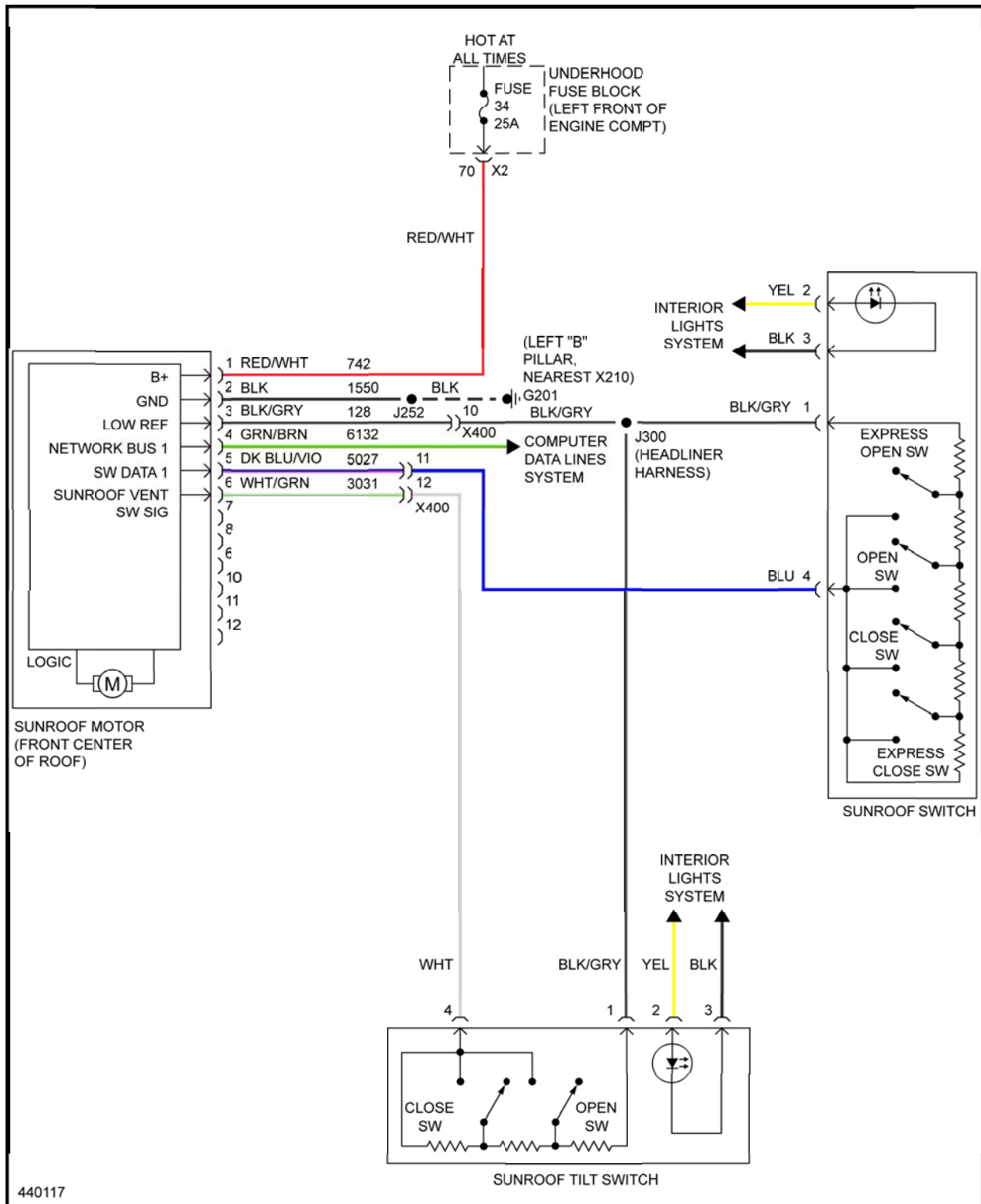


Fig. 100: Power Top/Sunroof Circuit

POWER WINDOWS

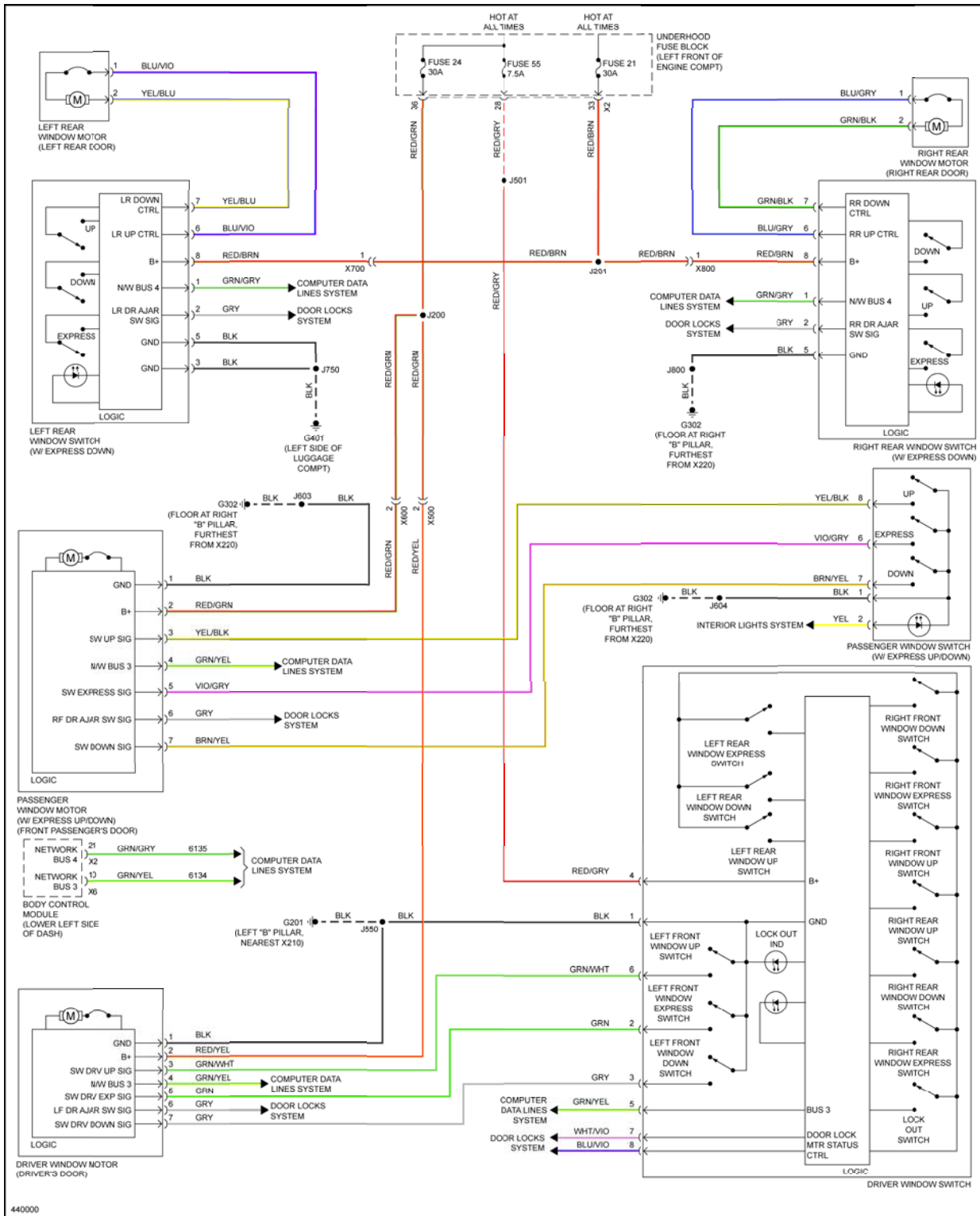


Fig. 101: Power Windows Circuit

RADIO

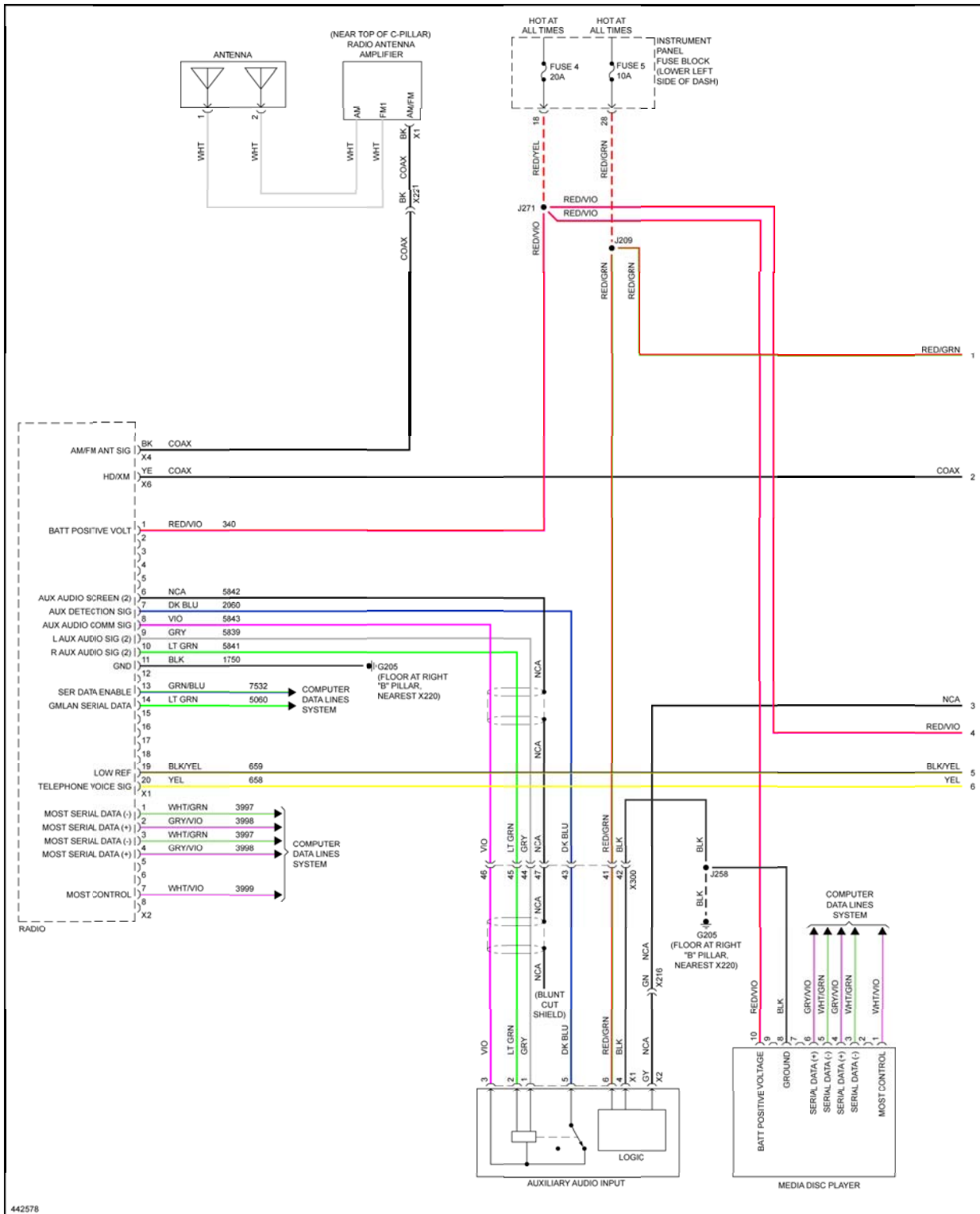


Fig. 102: Radio Circuit, W/ Amplifier (1 of 4)

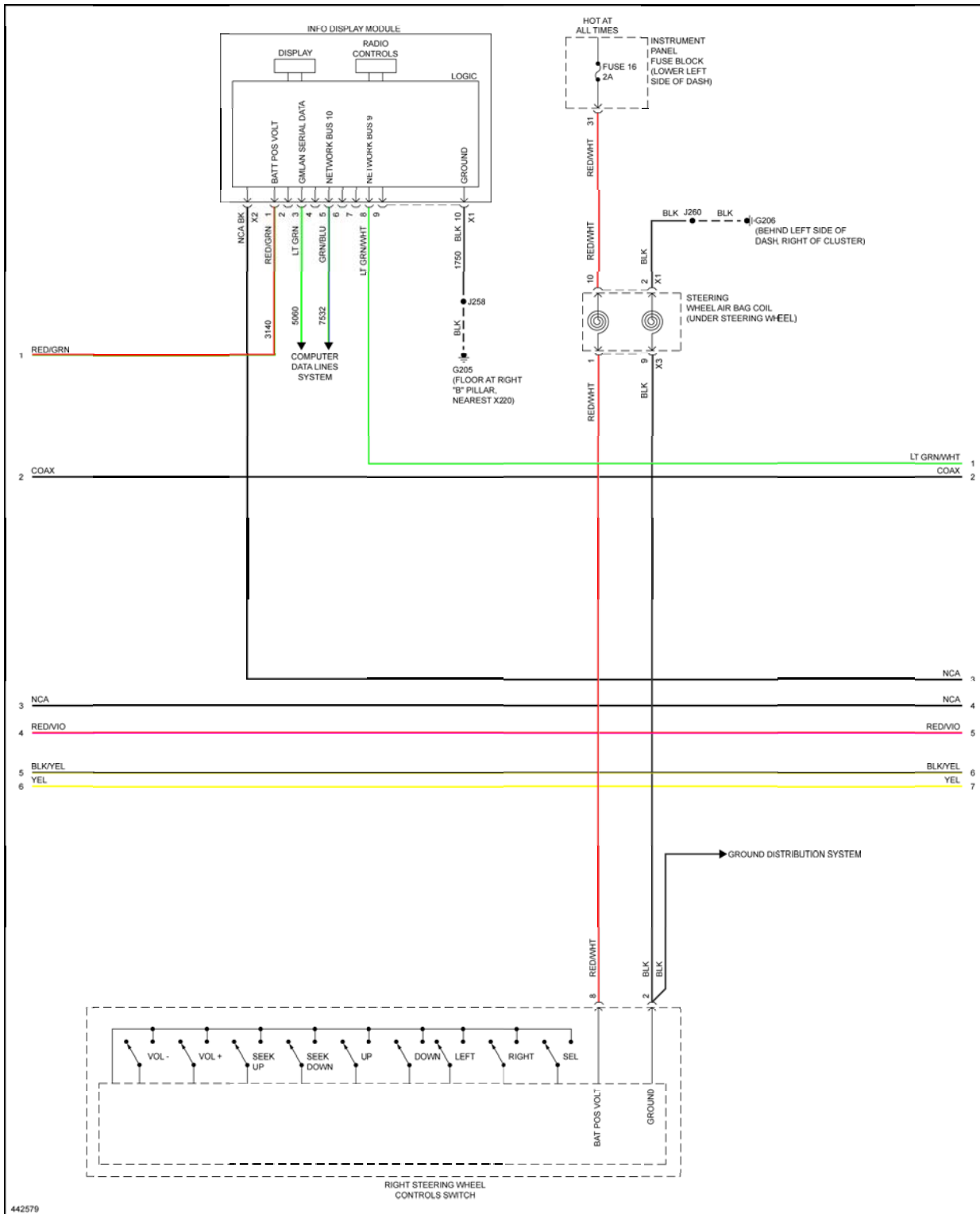
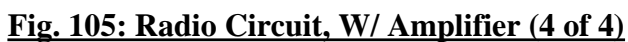


Fig. 103: Radio Circuit, W/ Amplifier (2 of 4)







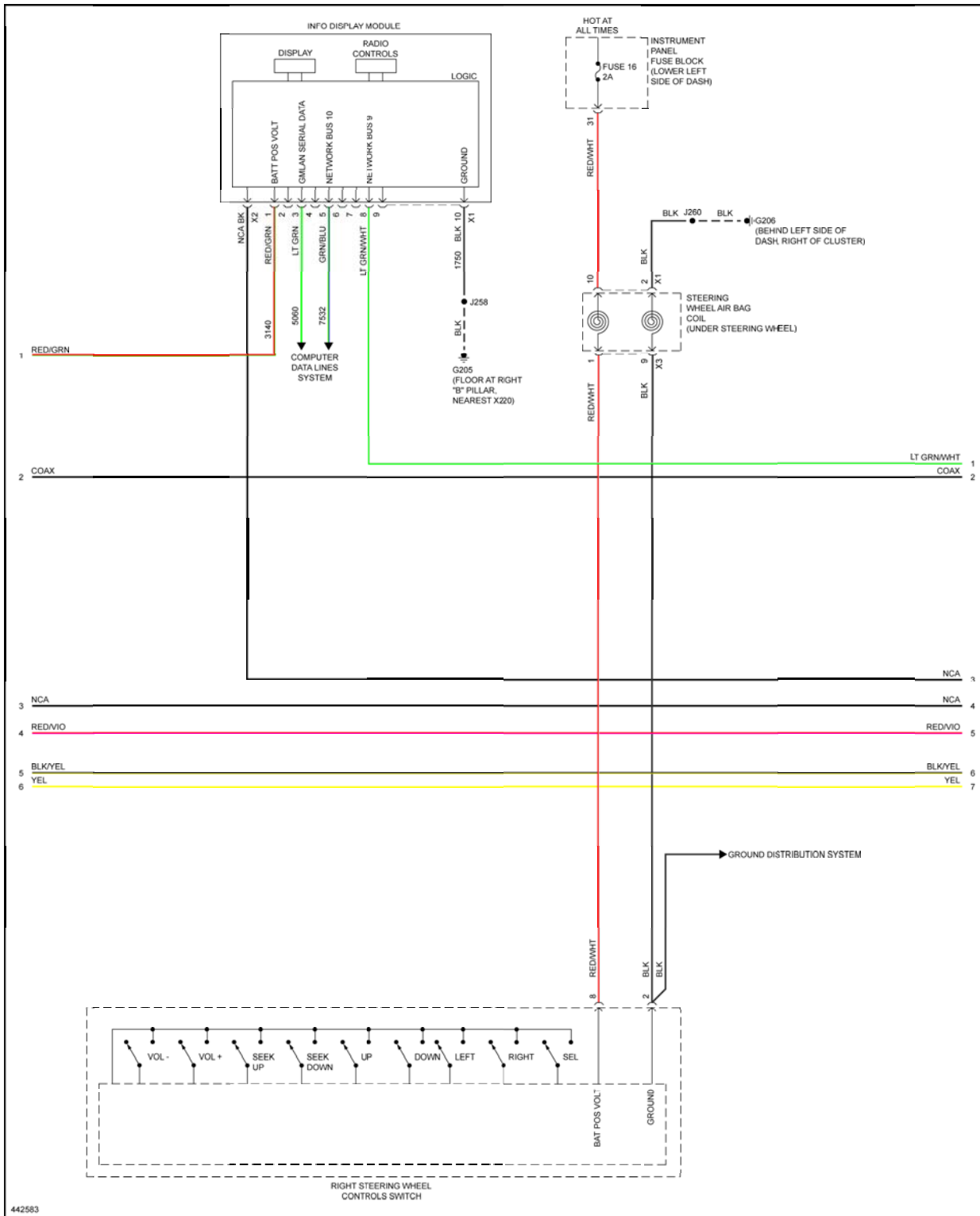


Fig. 107: Radio Circuit, W/O Amplifier (2 of 4)

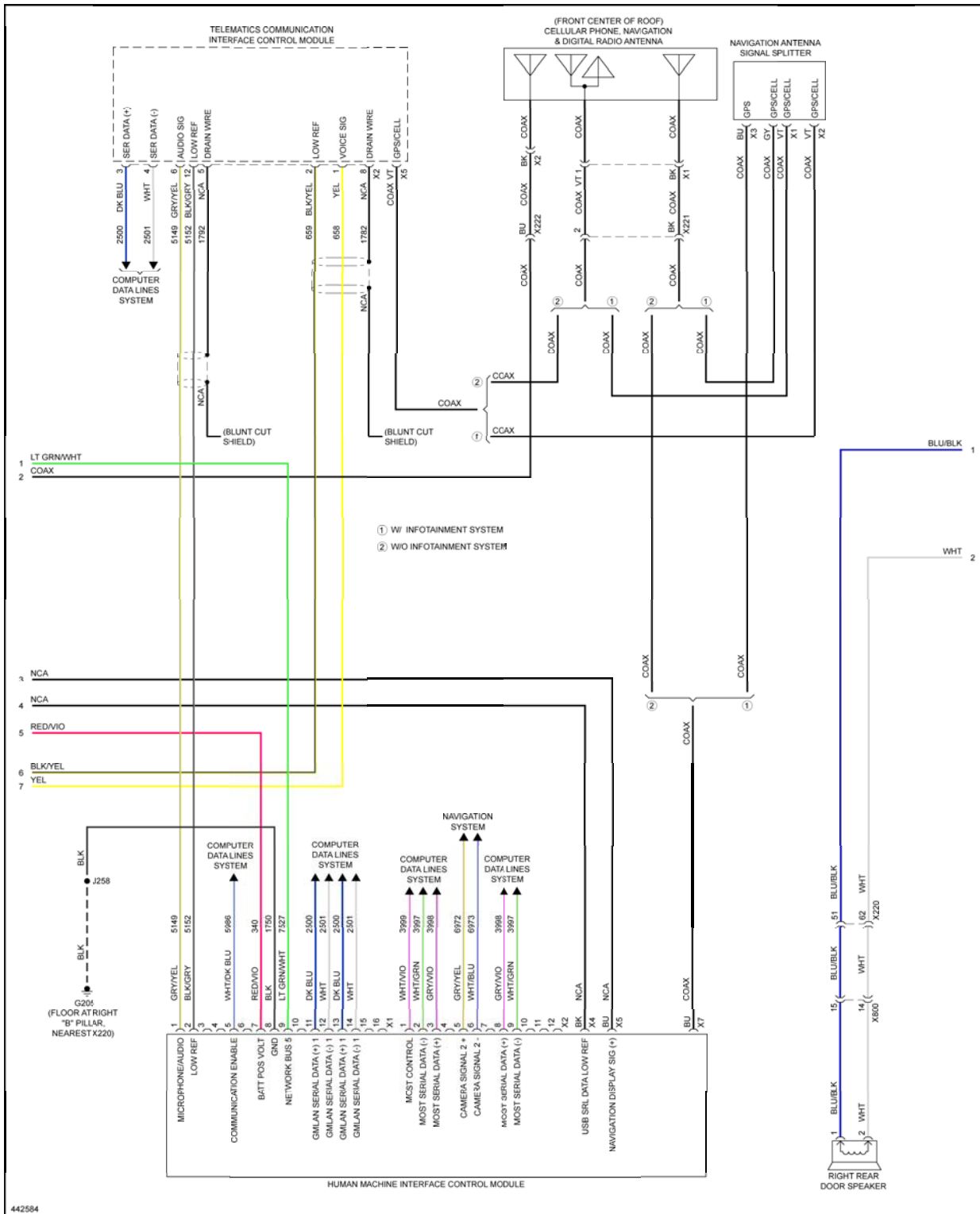


Fig. 108: Radio Circuit, W/O Amplifier (3 of 4)

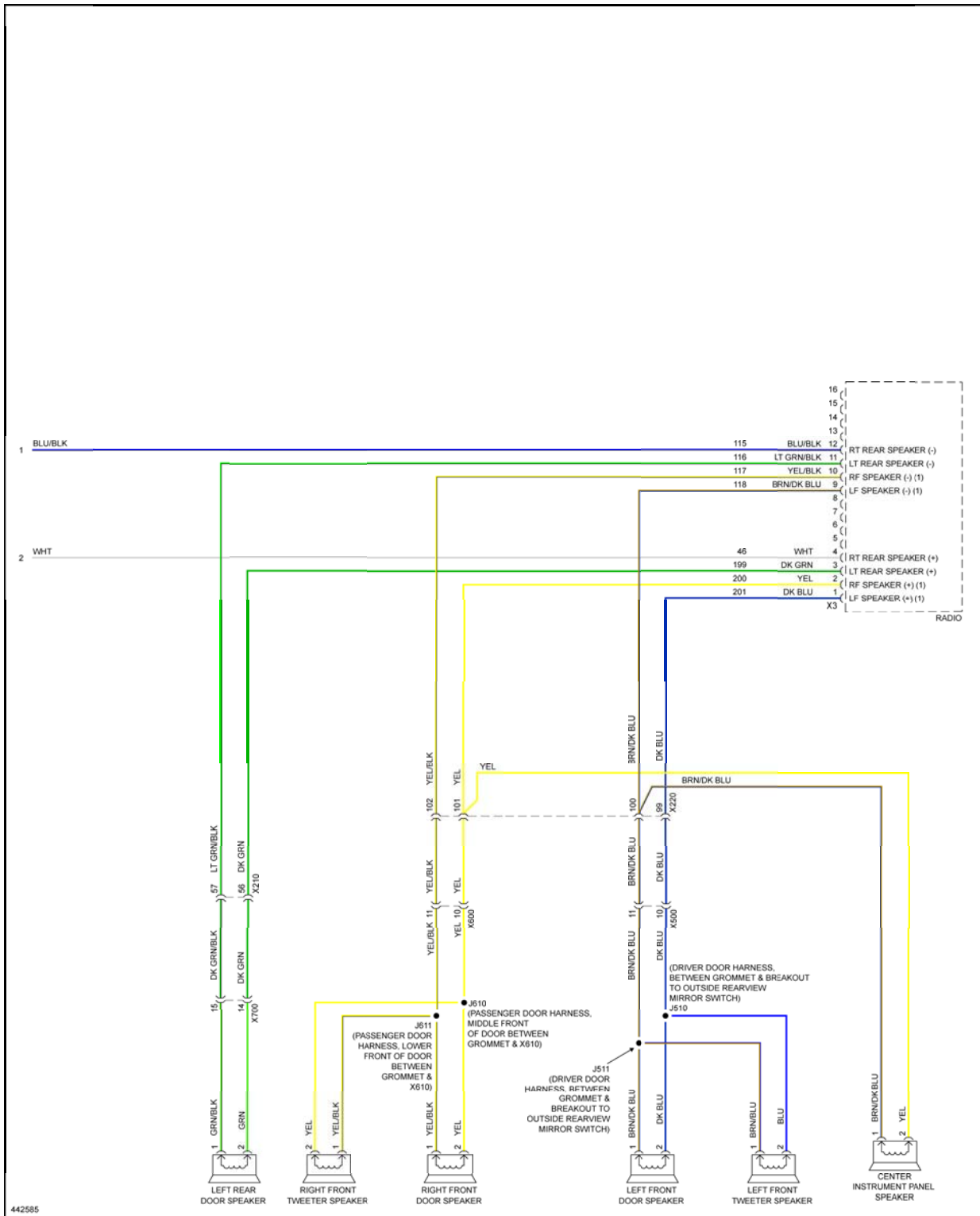


Fig. 109: Radio Circuit, W/O Amplifier (4 of 4)

SHIFT INTERLOCK



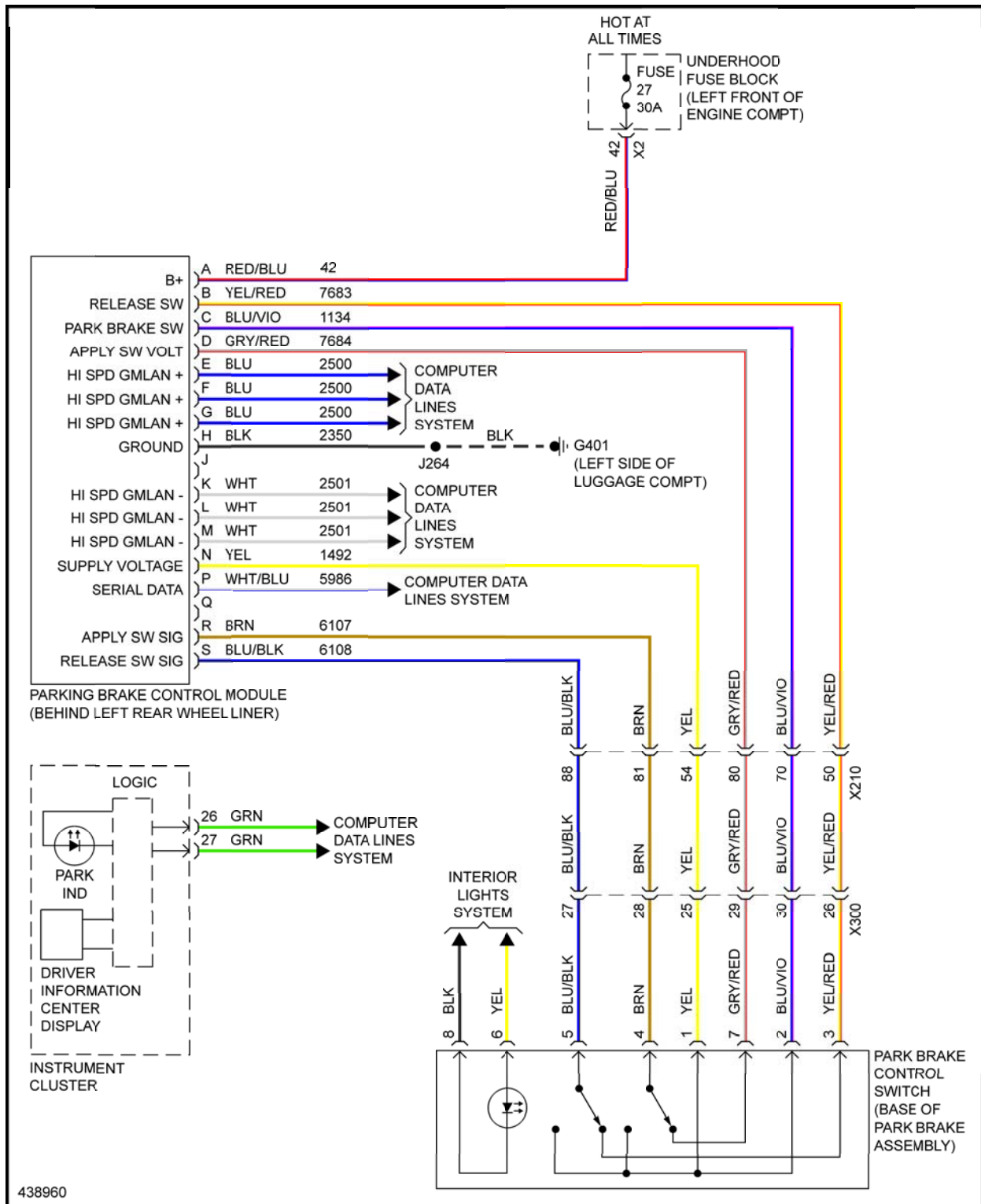


Fig. 111: Park Brake System Circuit

STARTING/CHARGING

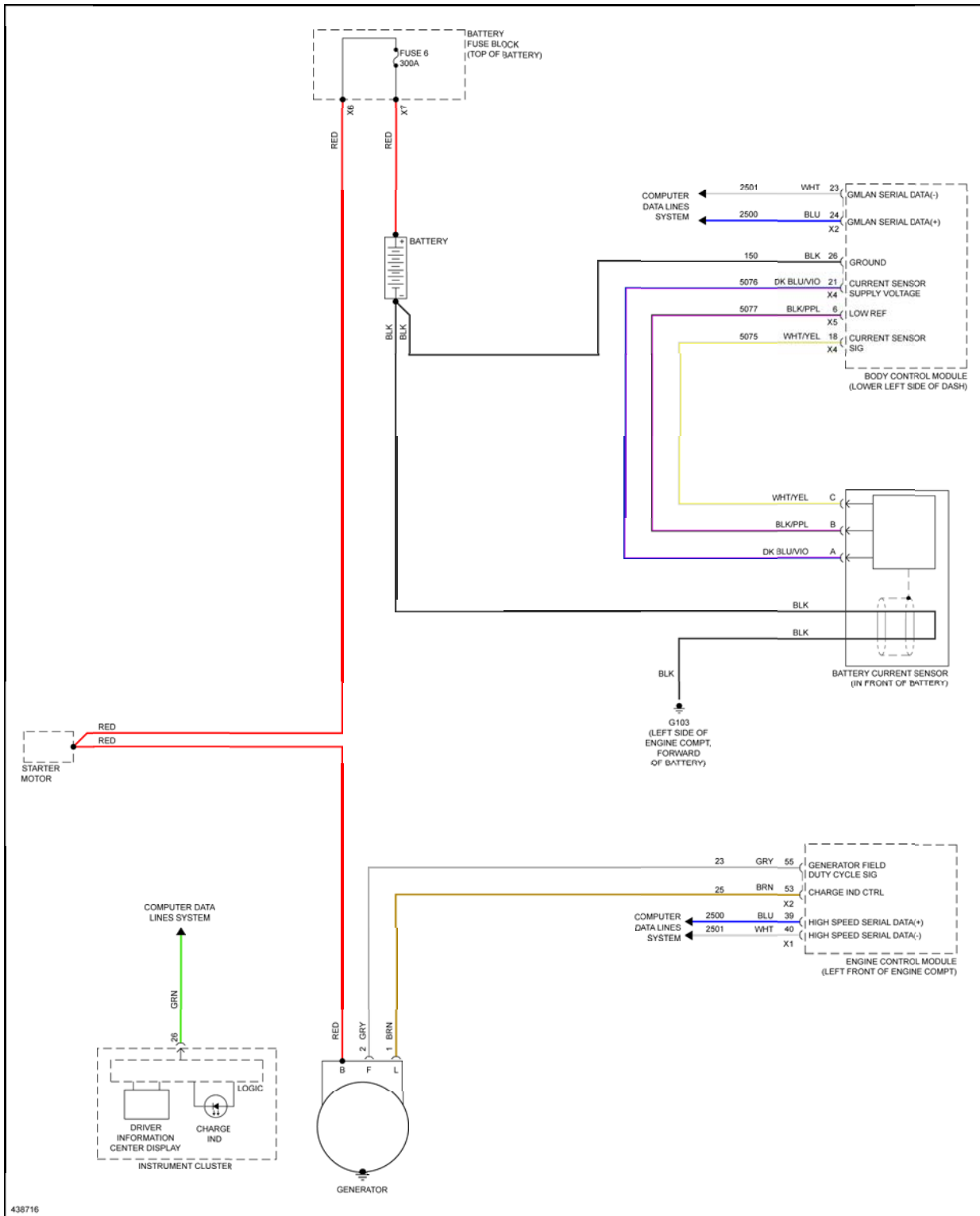


Fig. 113: Charging Circuit

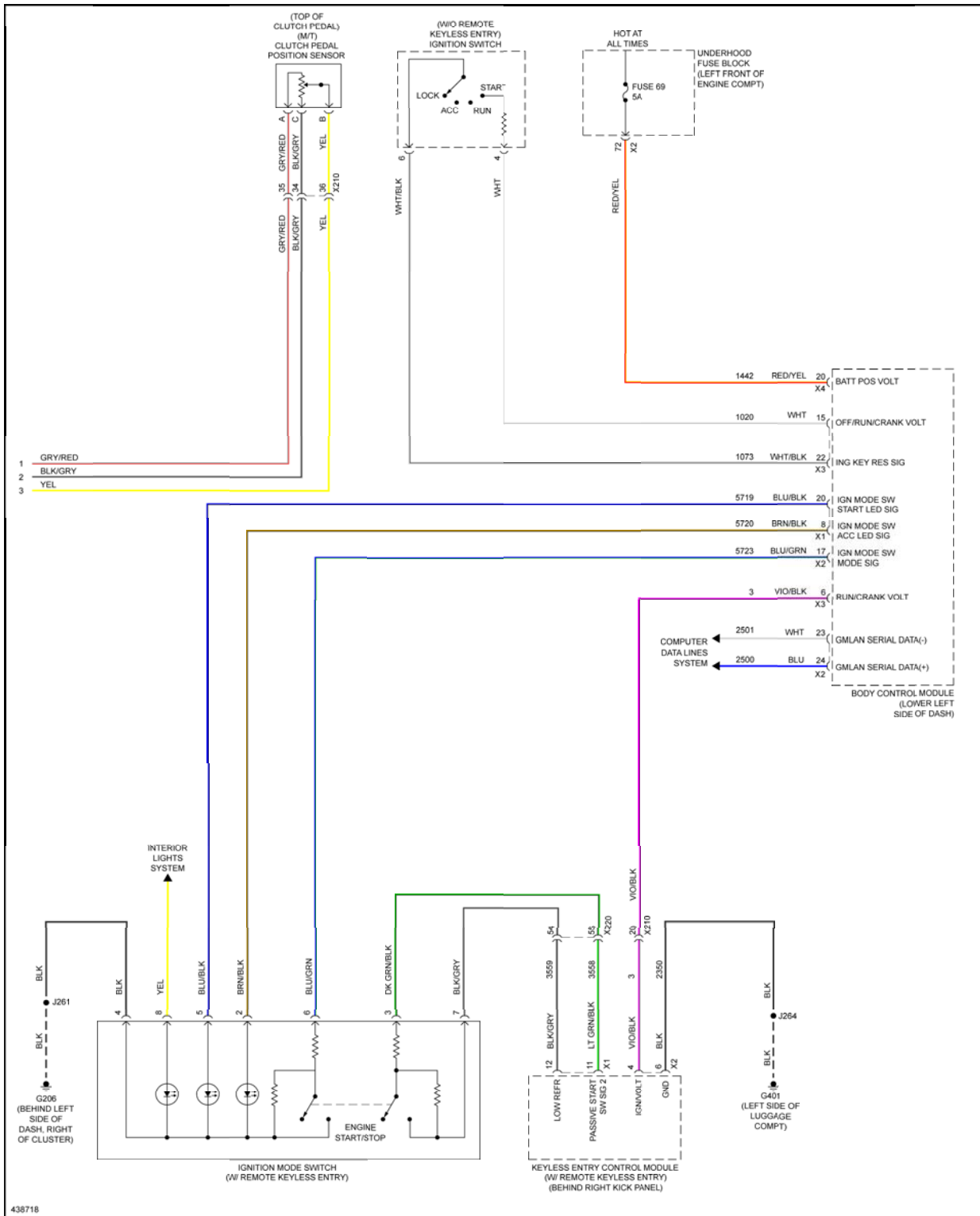


Fig. 115: Starting Circuit (2 of 2)

SUPPLEMENTAL RESTRAINTS

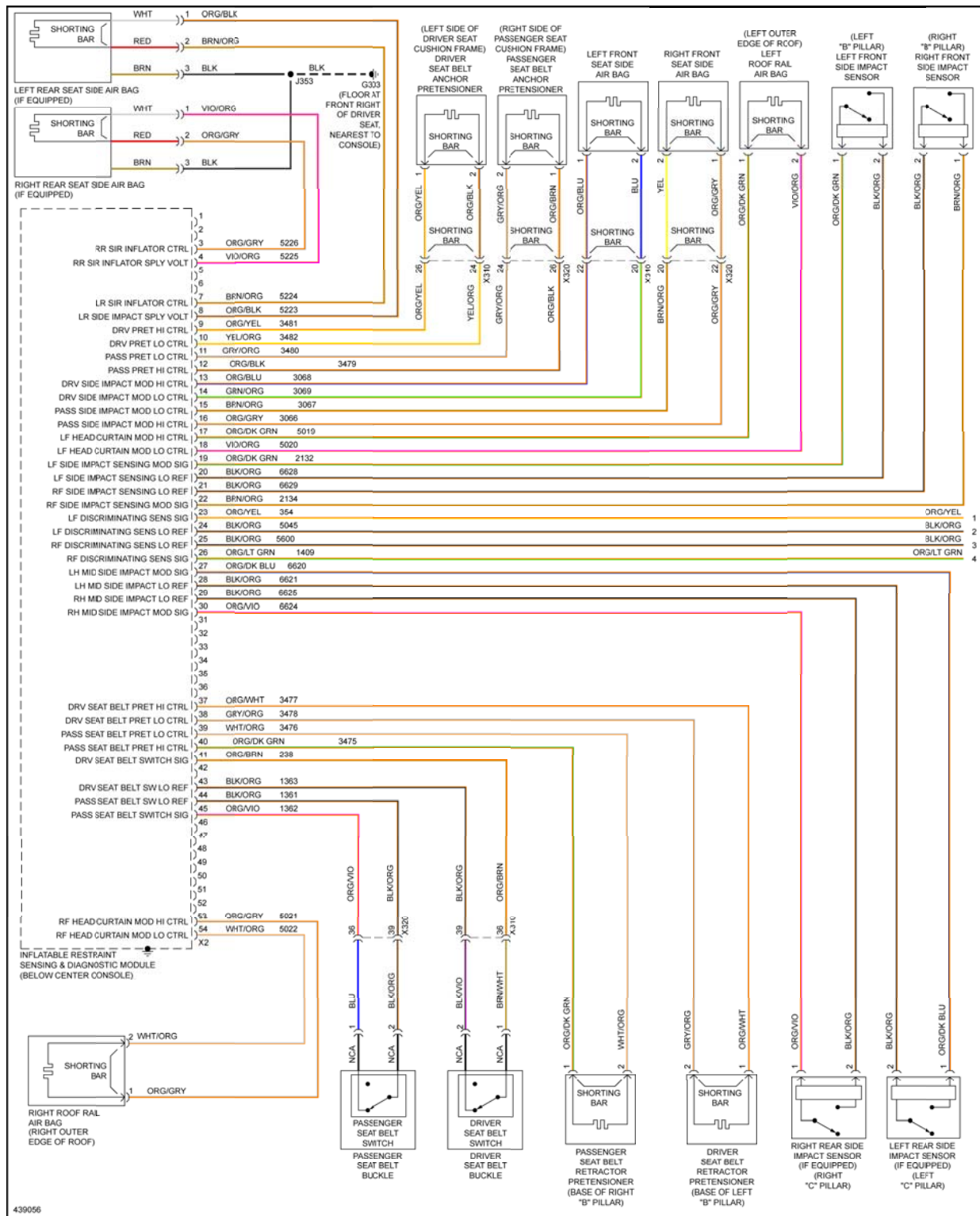


Fig. 116: Supplemental Restraints Circuit (1 of 2)



TRANSMISSION

2.0L VIN X

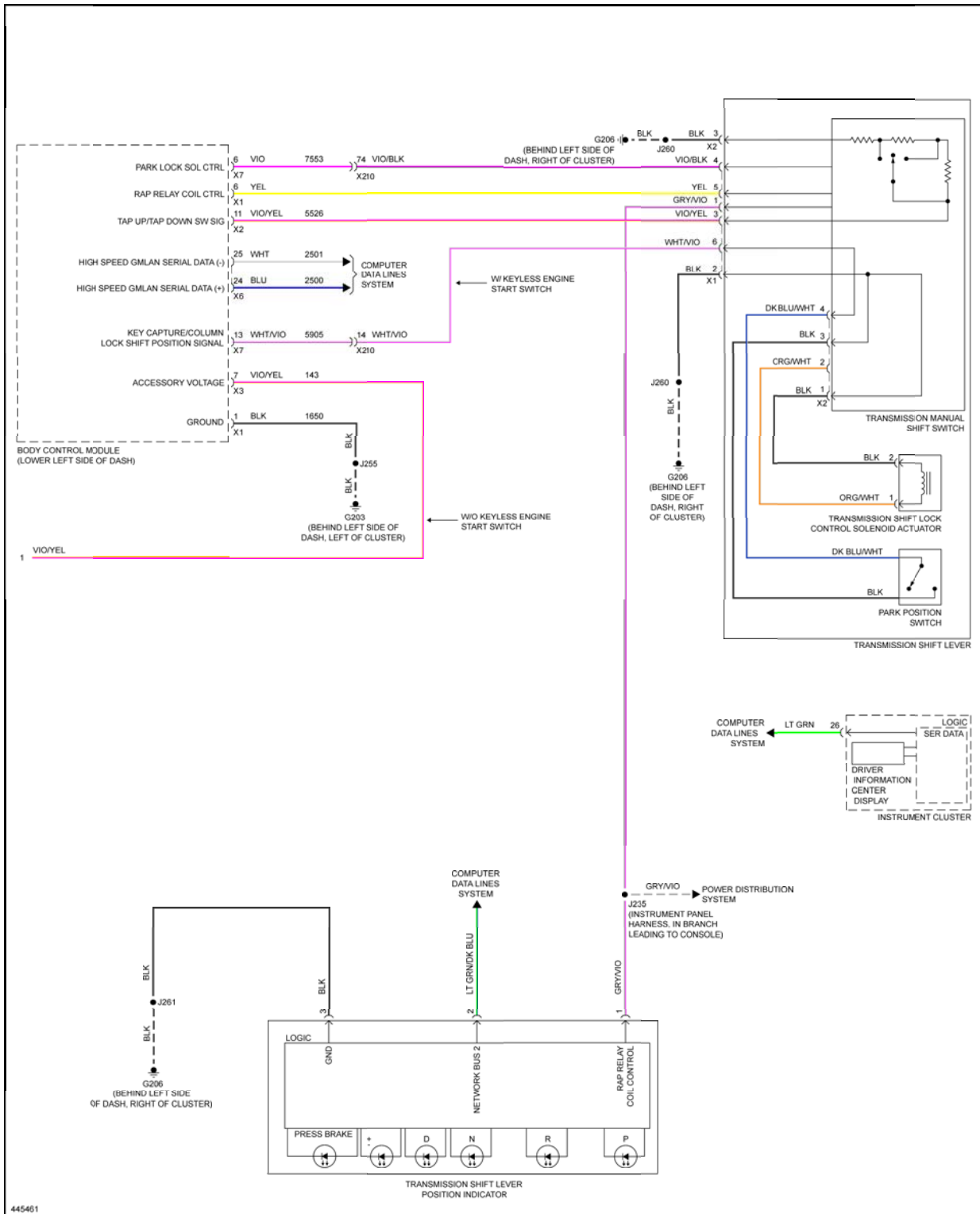


Fig. 119: 2.0L VIN X, A/T Circuit (2 of 2)

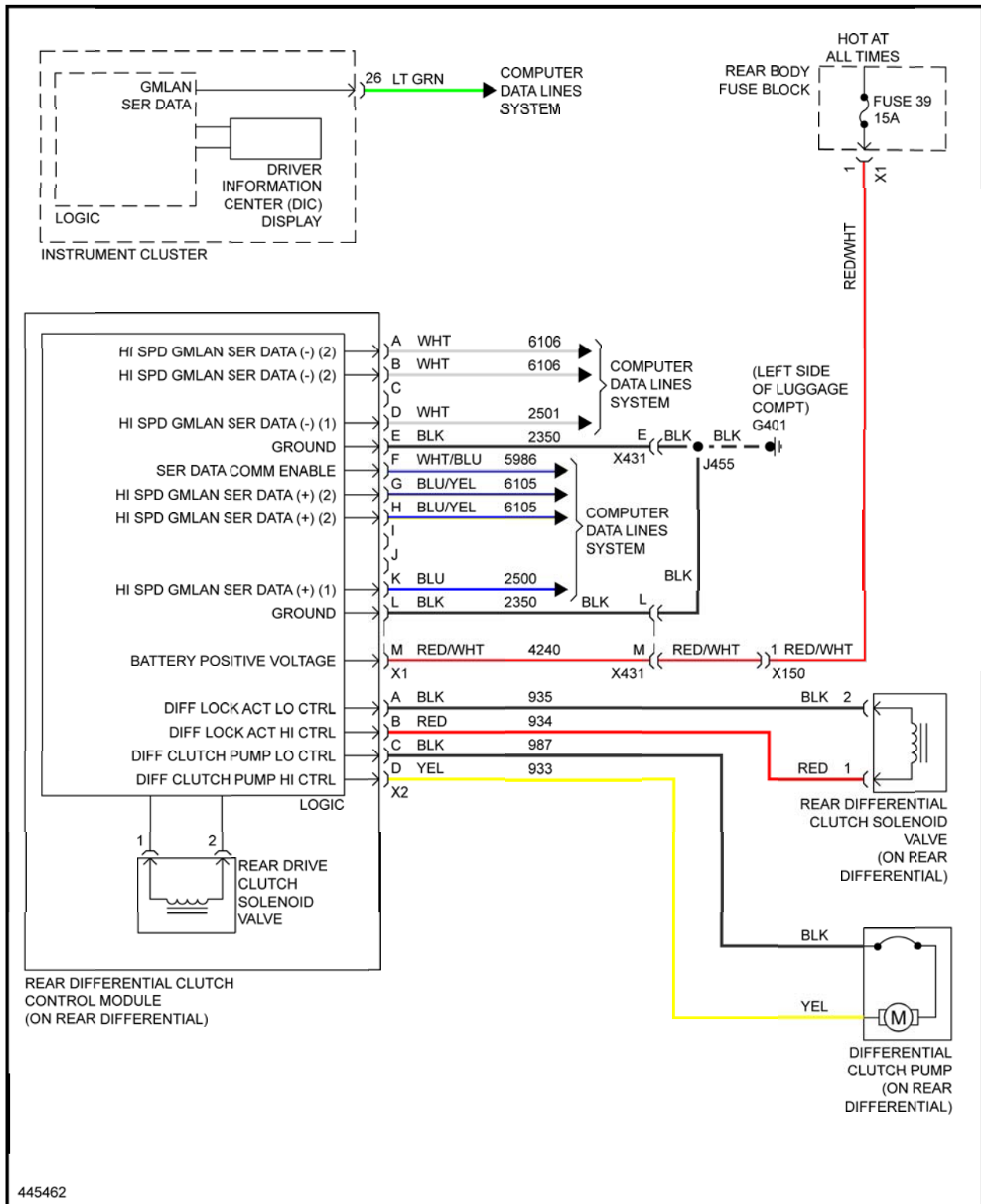


Fig. 120: 2.0L VIN X, Rear Differential Lock Circuit

2.4L VIN R

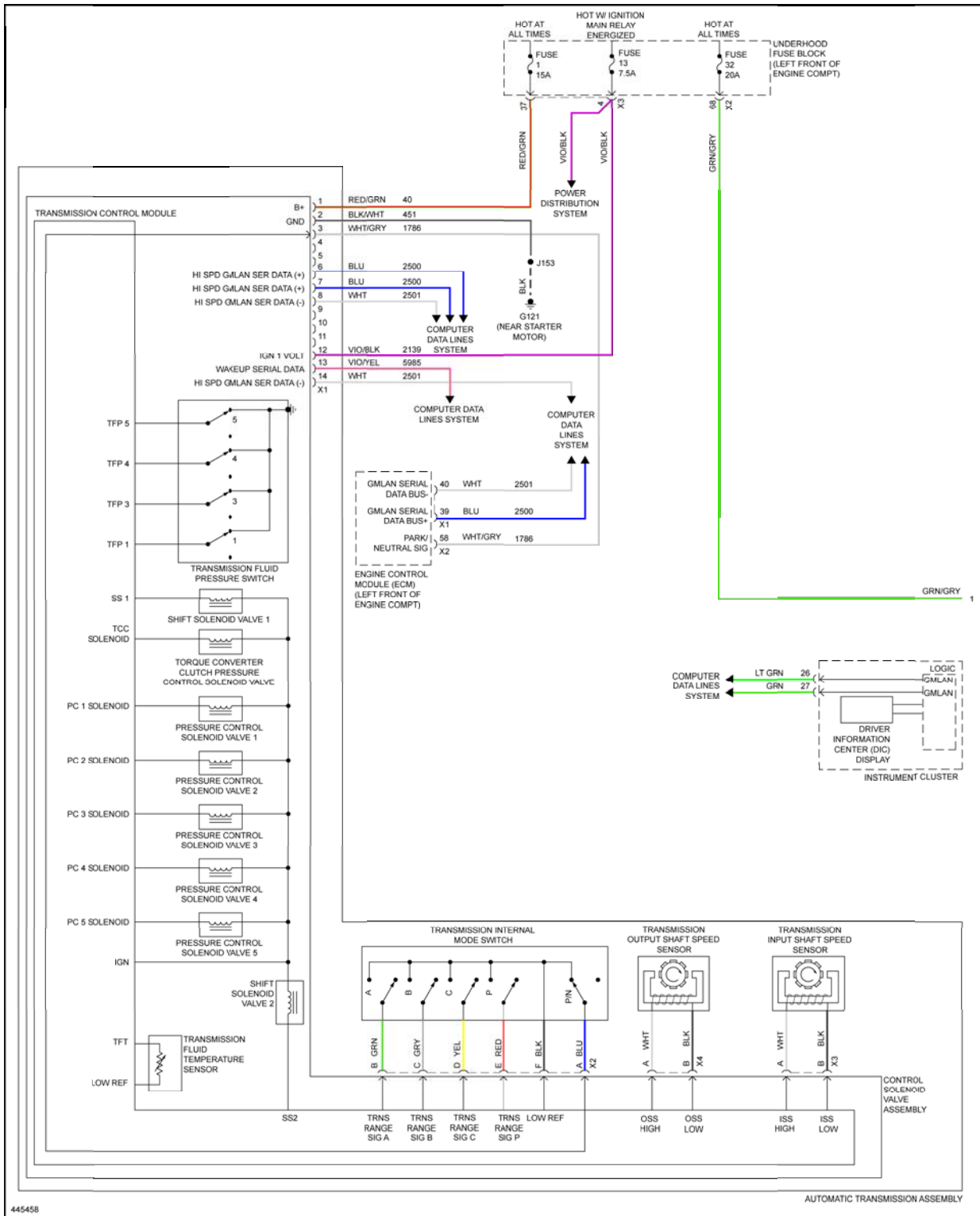


Fig. 121: 2.4L VIN R, A/T Circuit (1 of 2)

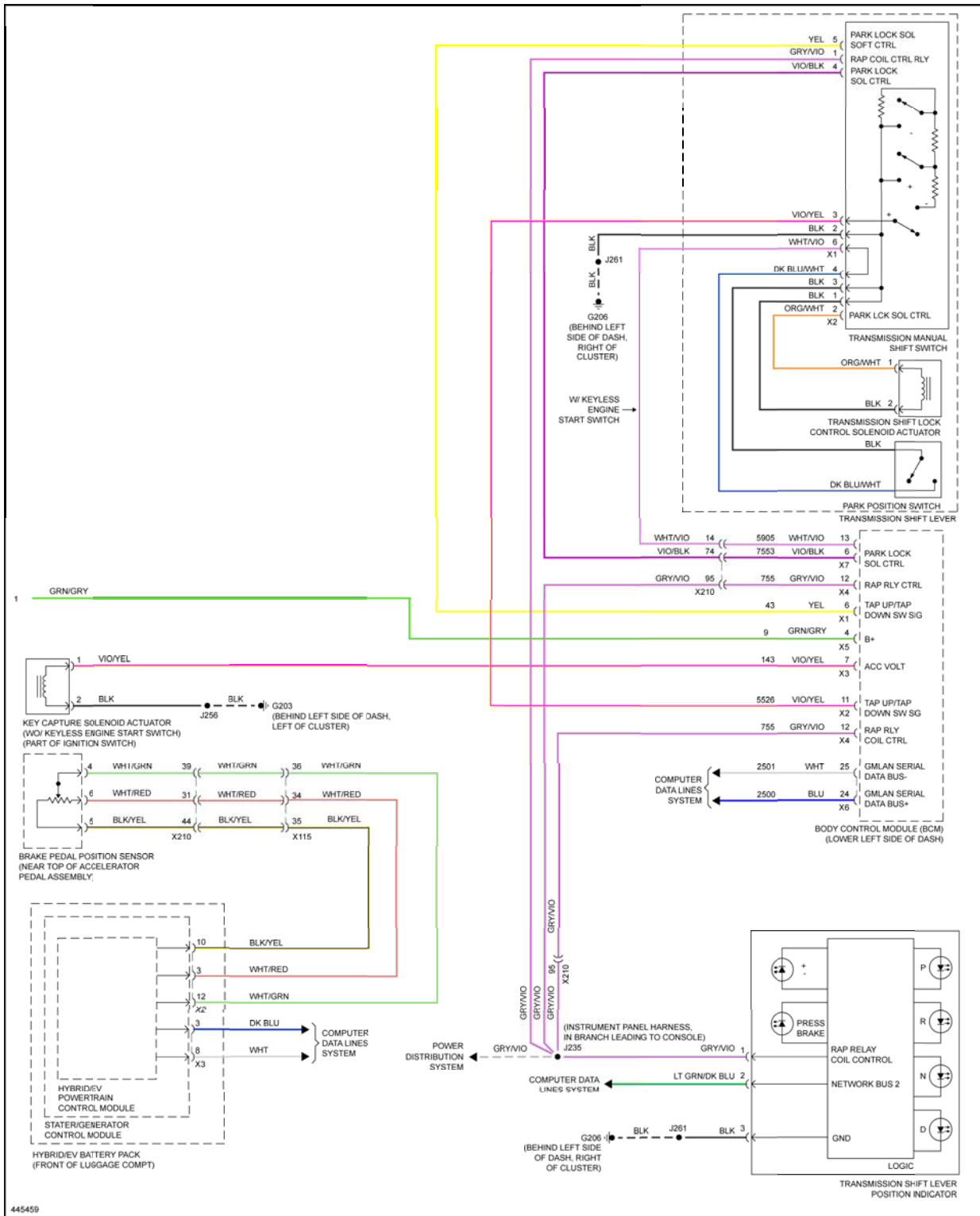


Fig. 122: 2.4L VIN R, A/T Circuit (2 of 2)

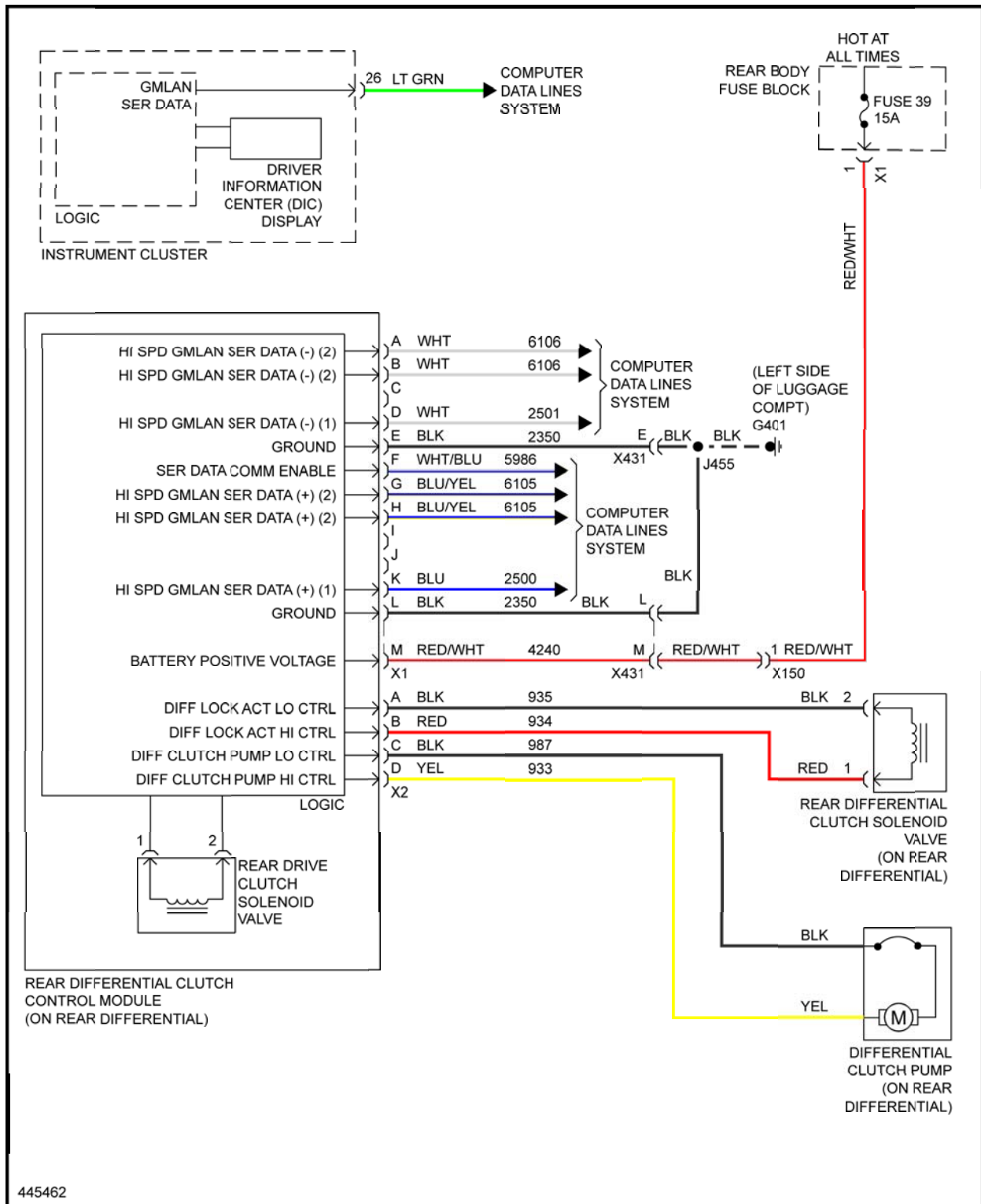


Fig. 123: 2.4L VIN R, Rear Differential Lock Circuit

TRUNK, TAILGATE, FUEL DOOR

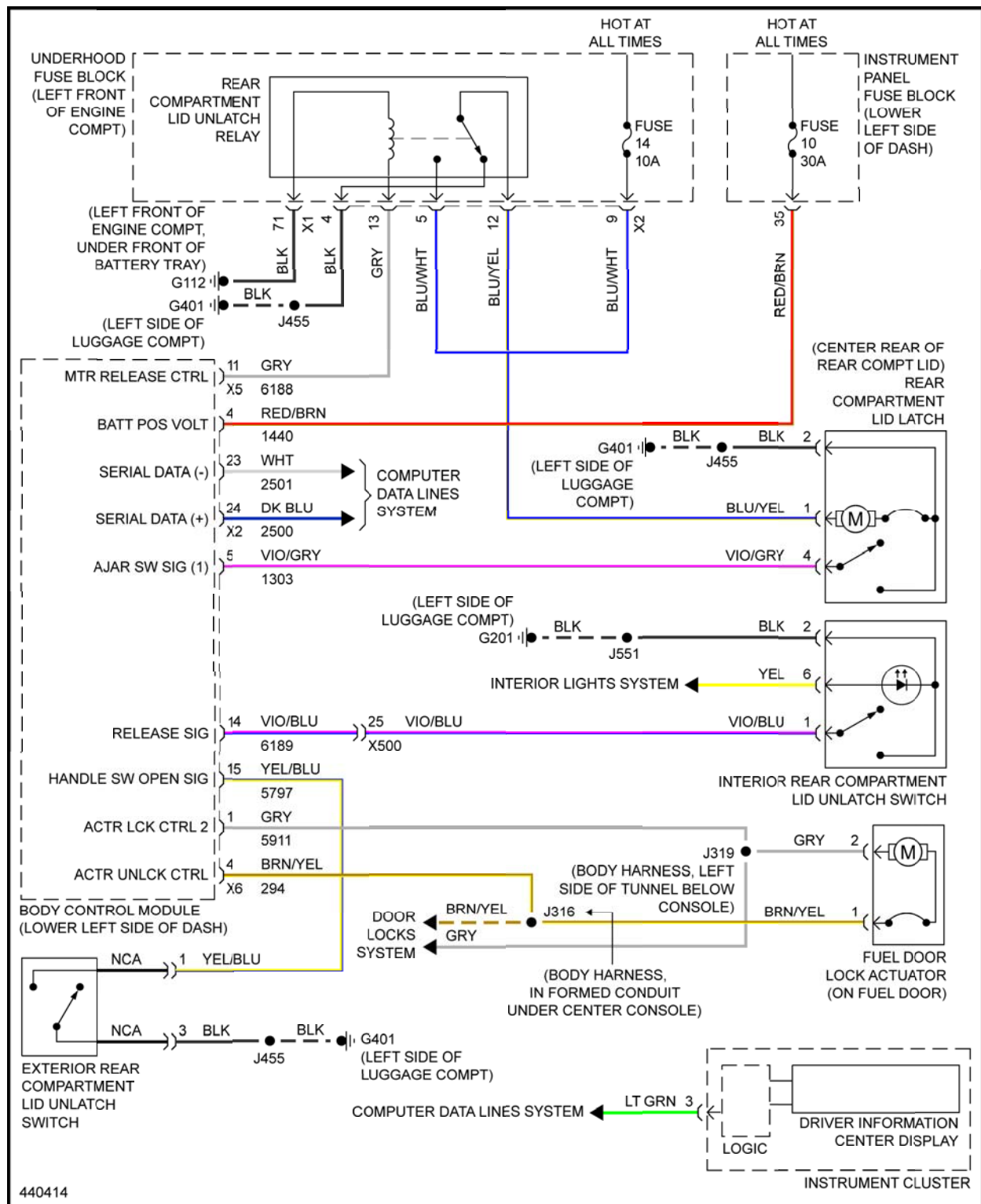


Fig. 124: Trunk & Fuel Door Release Circuit

WARNING SYSTEMS

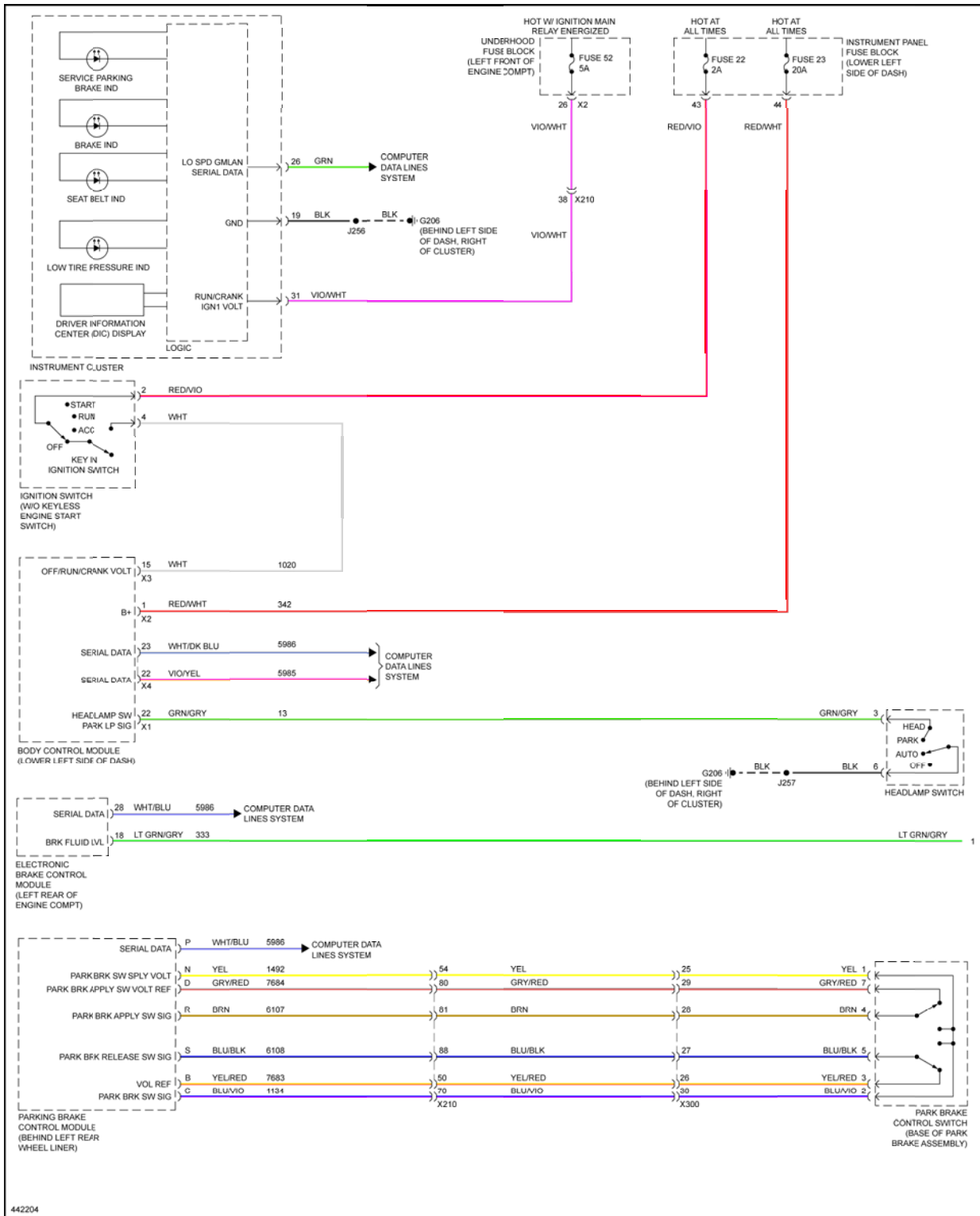


Fig. 125: Warning Systems Circuit (1 of 2)

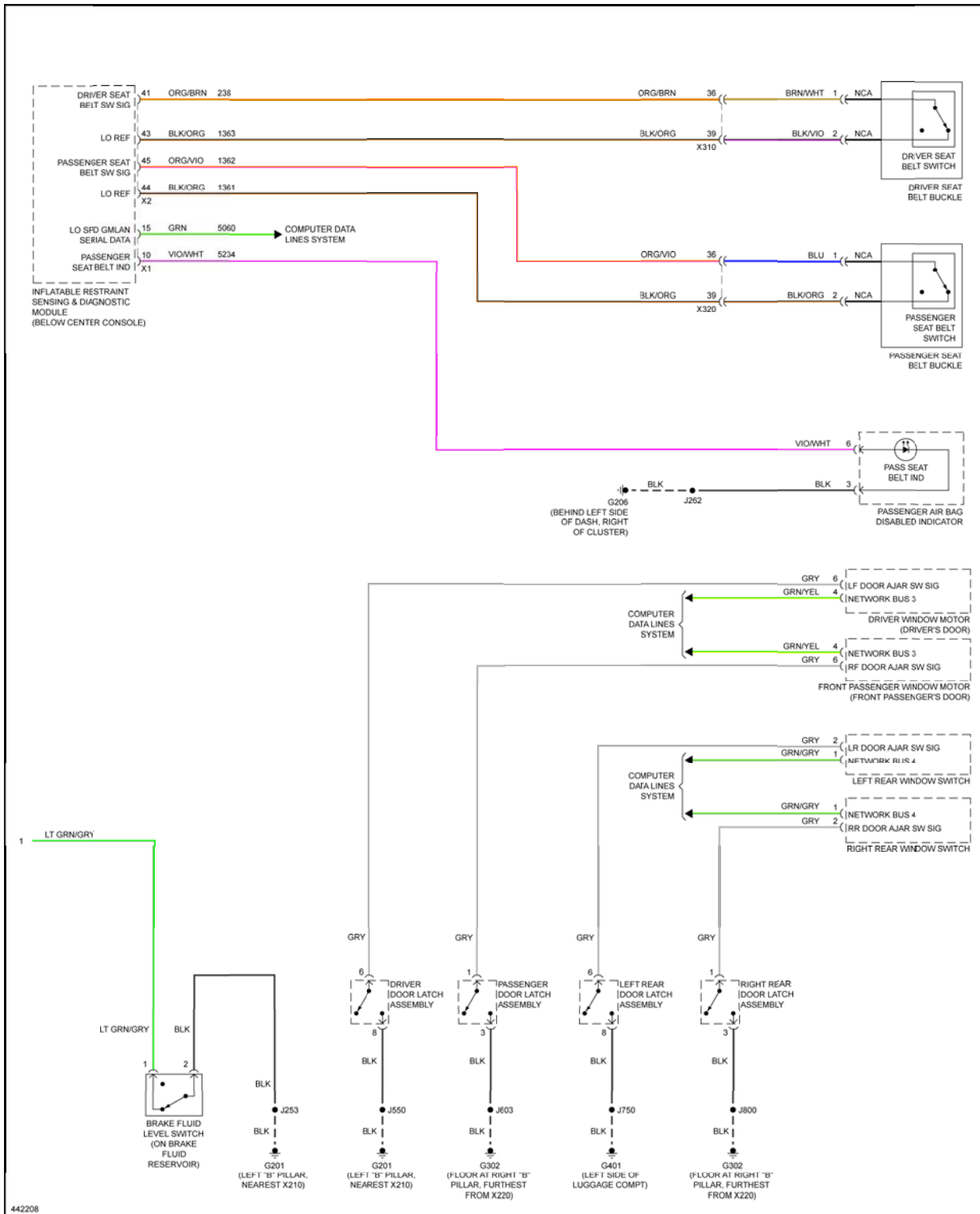


Fig. 126: Warning Systems Circuit (2 of 2)

WIPER/WASHER



Theft Deterrent

THEFT DETERRENT SYSTEM SCHEMATICS

Door Lock/Indicator Schematics

745 GY

6

A90 Logic

M74D Window Motor - Driver

746 GY

6

A90 Logic

M74P Window Motor - Passenger

747 GY

2

A90 Logic

M74R Window Switch - Left Rear

748 GY

2

A90 Logic

M74R Window Switch - Right Rear

747 GY

6

A90 Logic

M74L Window Motor - Left Rear

748 GY

6

A90 Logic

M74R Window Motor - Right Rear

Headlights/Daytime Running Lights (DRL) Schematics

1069 BN/VT

18

K9 Body Control Module

28 BN/WH

19

Hom Schematics

X5

1

F23DA

X1

21

728 GY

1

B108 Ambient Light/Sunload Sensor

6

HVAC Schematics

CJ2

CR7

HVAC Schematics

X1

7

K33 HVAC Control Module

6102 BK/BN

CJ2

CR7

J243

7566 BN/BK

6102 BK/BN

2350 BK (-CZ2)

650 BK (CZ2)

1303 VT/GY

X5

5

M40 Rear Compartment Lid Latch

3

4

P16 Instrument Cluster

P16 Driver Information Center Display

A90 Logic

745 GY

6

A90 Logic

M74D Window Motor - Driver

746 GY

6

A90 Logic

M74P Window Motor - Passenger

747 GY

2

A90 Logic

M74R Window Switch - Left Rear

748 GY

2

A90 Logic

M74R Window Switch - Right Rear

747 GY

6

A90 Logic

M74L Window Motor - Left Rear

748 GY

6

A90 Logic

M74R Window Motor - Right Rear

Headlights/Daytime Running Lights (DRL) Schematics

1069 BN/VT

18

K9 Body Control Module

28 BN/WH

19

Hom Schematics

X5

1

F23DA

X1

21

728 GY

1

B108 Ambient Light/Sunload Sensor

6

HVAC Schematics

CJ2

CR7

HVAC Schematics

X1

7

K33 HVAC Control Module

6102 BK/BN

CJ2

CR7

J243

7566 BN/BK

6102 BK/BN

2350 BK (-CZ2)

650 BK (CZ2)

1303 VT/GY

X5

5

M40 Rear Compartment Lid Latch

3

4

P16 Instrument Cluster

P16 Driver Information Center Display

A90 Logic

Courtesy of GENERAL MOTORS COMPANY

SYMPTOMS - THEFT DETERRENT

1. Perform **Diagnostic System Check - Vehicle** in order to verify that all of the following are true:

- There are no DTCs set.
- The control modules can communicate via the serial data link.

2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following **Theft Systems Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Theft Deterrent System. Refer to **Checking Aftermarket Accessories**.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Content Theft Deterrent Malfunction**
- **Security Indicator Malfunction**

CONTENT THEFT DETERRENT MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The content theft deterrent system is a software based system in which the body control module (BCM) actively monitors certain inputs to determine if unauthorized vehicle access is being attempted. Based on inputs such as the door ajar switches, the rear compartment ajar switch, and the hood ajar switch, the BCM determines whether a content theft deterrent alarm is warranted. If unauthorized access is being detected, the BCM will pulse the vehicle horn and flash the exterior lamps as a means of theft deterrence. If equipped, the BCM will also activate a siren as an additional theft deterrence.

Diagnostic Aids

The scan tool Content Theft Deterrent Trigger History 1, 2, and 3 parameters can be used to help isolate an intermittent unwanted content theft deterrent alarm. These parameters are a rolling history of the previous three causes of a theft deterrent alarm. If all three parameters are indicating the same alarm trigger, the indicated input should be the starting point when diagnosing an intermittent concern.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Theft Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify each indicator/message transitions between the ajar and closed state while opening and closing each vehicle door, hood, and rear compartment.
 - **If any indicator/message does not change**

Refer to **Hood Ajar Indicator/Message Malfunction** , **Door Ajar Indicator Malfunction** , or **Trunk Ajar Indicator Malfunction** .

- **If each indicator/message changes**
3. Completely lower the driver door window and close all vehicle doors, ignition OFF.
 4. Arm the content theft deterrent system by locking the doors with the keyless entry transmitter.
 5. Verify the scan tool Content Theft Deterrent Alarm Status parameter is Armed.
 - **If not Armed**

Refer to **Keyless Entry System Malfunction (Active)** , **Keyless Entry System Malfunction (Passive)** .

- **If Armed**
6. Without disarming the system, reach in through the open driver window and open the driver door.

7. Verify the scan tool Content Theft Deterrent Alarm Status parameter is Alarm.

○ **If not Alarm**

Replace the K9 Body Control Module.

○ **If Alarm**

8. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for body control module replacement, programming, and setup.

SECURITY INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	2	2	1	-
Low Reference	-	2	-	-
1. Security LED always ON 2. Security LED inoperative				

Circuit/System Description

The security LED is controlled by the Body Control Module (BCM) based on commands from the content theft deterrent system. The security LED is located in the instrument panel as part of the ambient light sensor and is supplied ground at all times. When the content theft deterrent system requests the LED be illuminated, the BCM applies voltage to the control circuit, illuminating the LED.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Theft Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Arm the content theft deterrent system.
2. Verify the security LED illuminates or flashes during the arming sequence.
 - **If the security LED does not illuminate or flash**

Refer to Circuit/System Testing.

- **If the security LED illuminates or flashes**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B10B Ambient Light/Sunload Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 30 ohms between the low reference circuit terminal 6 and ground.
 - **If 30 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K33 HVAC Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K33 HVAC Control Module.
 - **If less than 10 ohms**
3. Ignition ON, connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 6.
4. Verify the test lamp turns ON and OFF when commanding the Security Indicator On and Off with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.

- **If the test lamp turns ON and OFF**

5. Test or replace the B10B Ambient Light/Sunload Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Headlamp Automatic Control Ambient Light Sensor Replacement**
- **Control Module References** for Body Control Module or HVAC Control Module replacement, programming, and setup

DESCRIPTION AND OPERATION

THEFT SYSTEMS DESCRIPTION AND OPERATION

When armed, the content theft deterrent system is designed to deter vehicle content theft by pulsing the horns and exterior lamps for approximately 30 seconds when an unauthorized vehicle entry is detected. If equipped, a siren will also be activated. However, the content theft deterrent system does not affect engine starting.

An unauthorized entry can be any of the following with the content theft deterrent system armed:

- Unauthorized entry into the underhood area
- Unauthorized entry into the rear compartment
- When any door is opened without receiving a valid unlock command
- After a battery reconnect, if the battery was disconnected with the content theft deterrent system armed

The components of the content theft deterrent system are:

- Body Control Module (BCM)

- Keyless Entry Control Module (RPO ATH)
- Remote Control Door Lock Receiver
- Security LED
- Door ajar switches
- Rear compartment ajar switch
- Hood ajar switch
- External siren, if equipped

Arming the Content Theft Deterrent System

Use the following procedure in order to arm the system:

1. Place the shift lever in P (park).
2. Turn OFF the ignition.
3. Open any door.
4. Lock the doors with the power door lock switch, locking the door manually using the door lock rod, or by pressing the LOCK button on the transmitter.
5. The system will begin the arm sequence immediately after the last door is closed. If the keyless entry transmitter is used to arm the system after the vehicle doors are closed, the arm sequence will begin as soon as the LOCK command is received from the transmitter.
6. Pressing the LOCK button on the keyless entry transmitter a second time will bypass the delayed arming function and force the system to arm.

Locking the Vehicle Without Arming the Content Theft Deterrent System

Locking the vehicle may be accomplished without arming the content theft deterrent system. Use of the exterior door lock cylinder will lock the vehicle, but will not arm the content theft deterrent system.

Disarming an Armed System/Silencing an Alarm

If system arming has been requested, it must be disarmed before the vehicle is opened again.

NOTE: **Disconnecting the battery or removing fuses does not disable the arm or alarm modes, since the BCM stores the content theft deterrent mode status in memory.**

- To disarm the content theft deterrent system in standby mode, perform one of the following:
 - Press the UNLOCK button on the keyless entry transmitter.
 - Approach the vehicle with a valid keyless entry transmitter and press the exterior door handle button (RPO ATH).
 - Insert a valid key into the ignition and switch to the ON position.
- To disarm the content theft deterrent system in the armed mode (non-event) or when activated (during an alarm event):

- Press the UNLOCK button on the keyless entry transmitter.
- Insert a valid key into the ignition and switch to the ON position

Content Theft Deterrent Circuit Description

The following is a description of each component used in the content theft deterrent system:

Body Control Module

The content theft deterrent system is an internal function of the BCM which utilizes serial data and various switch inputs information to perform content theft deterrent functions. When the BCM detects an unauthorized entry, it activates the horns and exterior lamps. If equipped, a siren will also be activated. The BCM has 4 basic modes (disarmed, standby, armed, and alarm) for operating the content theft deterrent system. The different modes are described below.

1. The BCM has the content theft deterrent system in a disarmed mode until the following conditions are detected:
 - Ignition key turned to the OFF position.
 - Doors locked using the power door lock switch, the door lock rod, or the LOCK button on the transmitter.
2. The BCM enters the standby mode when the above conditions are detected. If a door was already opened when the arm mode was requested, the standby mode does not start the timer until the last door is closed.
3. When the last door is closed, a 15 second timer is activated. Once the timer has expired, the BCM enters the armed mode. After this delay, any unauthorized entry will activate the alarm mode.
4. When the BCM detects an unauthorized entry, the BCM enters the alarm mode. The BCM activates the horns and exterior lamps for 30 seconds. If equipped, a siren will also be activated. This is followed by a three minute time-out with the horn no longer active. If no new intrusions are detected after the time-out, the horn is not active. The system must be disarmed or the intrusion condition removed after the time-out for the system to exit alarm mode.

Keyless Entry Control Module (RPO ATH)

The passive keyless entry system can arm and disarm the content theft deterrent system. When a valid keyless entry transmitter is detected while attempting to passively access the vehicle, the keyless entry module will send a message via serial data to disarm the content theft deterrent system.

Remote Control Door Lock Receiver

The keyless entry system can arm and disarm the content theft deterrent system. When the remote control door lock receiver receives a door lock or unlock signal from the transmitter, the remote control door lock receiver sends a message to the BCM via serial data to perform the appropriate arm/disarm functions.

Security LED

The security LED is illuminated on the instrument panel by the BCM. The content theft deterrent system uses the security LED to inform the driver of system status prior to arming.

Door Ajar Switches

The content theft deterrent system uses the door ajar switches as a status indicator to activate the alarm. The door ajar switches are monitored by the body control module via a discrete input from each door ajar switch. If the BCM receives a signal indicating a door is opened when the content theft deterrent system is armed, the BCM activates the alarm.

Hood Ajar Switch

The content theft deterrent system uses the hood ajar switch as a status indicator to activate the alarm. The BCM monitors the hood ajar switch via a discrete input from the switch. If the BCM receives a signal indicating the hood has been opened when the content theft deterrent system is armed, the BCM activates the alarm.

Rear Compartment Ajar Switch

The content theft deterrent system uses the rear compartment ajar switch as a status indicator to activate the alarm. The BCM monitors the rear compartment ajar switch via a discrete input from the switch. If the BCM receives a signal indicating the rear compartment has been opened when content theft deterrent system is armed, the BCM activates the alarm.

Inputs

The BCM monitors the following inputs for content theft deterrent:

- The door ajar switches
- The keyless entry transmitter LOCK/UNLOCK buttons; a message from the remote control door lock receiver
- The immobilizer status - The BCM uses the immobilizer status for disarming the system or silencing an alarm when the correct vehicle key is used to start the vehicle
- The rear compartment ajar switch
- The hood ajar switch

Outputs

The BCM controls the following for content theft deterrent:

- The horn relay
- The exterior lamps
- If equipped, an external siren.

SUSPENSION

Tire Pressure Monitoring

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Tire Pressure Indicator Receiver Fastener (Qty: 2)	4 N.m	35 lb in
Tire Pressure Indicator Sensor Fastener	10 N.m	7.4 lb ft

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC C0569</u>	DTC C0569 00 System Configuration Malfunction
<u>DTC C0750, C0755, C0760, or C0765</u>	DTC C0750 03 Left Front Tire Pressure Sensor Low Voltage DTC C0750 29 Left Front Tire Pressure Sensor Too Few Pulses DTC C0750 39 Left Front Tire Pressure Sensor Internal Malfunction DTC C0755 03 Right Front Tire Pressure Sensor Low Voltage DTC C0755 29 Right Front Tire Pressure Sensor Too Few Pulses DTC C0755 39 Right Front Tire Pressure Sensor Internal Malfunction DTC C0760 03 Left Rear Tire Pressure Sensor Low Voltage DTC C0760 29 Left Rear Tire Pressure Sensor Too Few Pulses DTC C0760 39 Left Rear Tire Pressure Sensor Internal Malfunction DTC C0765 03 Right Rear Tire Pressure Sensor Low Voltage DTC C0765 29 Right Rear Tire Pressure Sensor Too Few Pulses DTC C0765 39 Right Rear Tire Pressure Sensor Internal Malfunction
<u>DTC C0775</u>	DTC C0775 00 Tire Pressure Monitoring System Sensors Malfunction

DTC C0569: SYSTEM CONFIGURATION MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0569 00

System Configuration Malfunction

Circuit/System Description

If the tire type and pressure information is not entered during the body control module (BCM) setup, the tire pressure monitor system indicator icon on the instrument cluster will flash for 1 min and then remain illuminated after the ignition is cycled ON and the instrument cluster bulb check is complete. If equipped, the driver information center will also display a service tire monitor type message. Under these circumstances, DTC C0569 will be set and the tire type and pressure information will need to be entered for the system to function correctly.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The tire type and pressure information is not entered into the BCM during programming and setup.

Action Taken When the DTC Sets

- The tire pressure monitor system indicator icon on the instrument cluster flashes for 1 min and then remains illuminated after the ignition switch is cycled ON and the instrument cluster bulb check is complete.
- If equipped, the driver information center displays a service tire monitor type message.

Conditions for Clearing the DTC

A current DTC will clear when the BCM has undergone the tire type and pressure selection setup procedure and one ignition cycle has occurred.

Diagnostic Aids

A newly replaced BCM will set DTC C0569 after programming on it's initial ignition ON cycle if the module setup information has not been entered.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Enter the tire type and pressure information into the K9 Body Control Module with a scan tool. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .
3. Ignition OFF, then Ignition ON.
4. Verify DTC C0569 is not set.
 - **If the DTC is set**

Replace the K9 Body Control Module.
 - **If the DTC is not set.**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming, and setup.

DTC C0750, C0755, C0760, OR C0765: TIRE PRESSURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0750 03

Left Front Tire Pressure Sensor Low Voltage

DTC C0750 29

Left Front Tire Pressure Sensor Too Few Pulses

DTC C0750 39

Left Front Tire Pressure Sensor Internal Malfunction

DTC C0755 03

Right Front Tire Pressure Sensor Low Voltage

DTC C0755 29

Right Front Tire Pressure Sensor Too Few Pulses

DTC C0755 39

Right Front Tire Pressure Sensor Internal Malfunction

DTC C0760 03

Left Rear Tire Pressure Sensor Low Voltage

DTC C0760 29

Left Rear Tire Pressure Sensor Too Few Pulses

DTC C0760 39

Left Rear Tire Pressure Sensor Internal Malfunction

DTC C0765 03

Right Rear Tire Pressure Sensor Low Voltage

DTC C0765 29

Right Rear Tire Pressure Sensor Too Few Pulses

DTC C0765 39

Right Rear Tire Pressure Sensor Internal Malfunction

Circuit/System Description

The tire pressure monitor system has a radio frequency (RF) transmitting pressure sensor in each wheel/tire assembly. As vehicle speed increases, centrifugal force closes the sensors internal roll switch, which puts the sensor into Drive mode. The body control module (BCM) receives and translates the data contained in the tire pressure sensor RF transmissions into sensor presence, sensor mode, and tire pressure. Once vehicle speed is greater than 40 km/h (25 MPH), the BCM waits for the first sensor to go into Drive mode, then checks if all sensors have gone into Drive mode. If one or more sensors does not go into these modes, or does not transmit at all, the BCM will set DTC C0750, C0755, C0760, or C0765 respectively.

Conditions for Running the DTC

Vehicle speed is greater than 40 km/h (25 MPH).

Conditions for Setting the DTC

- A sensor does not transmit or transmits invalid data to the BCM.
- A sensor low battery condition.

Action Taken When the DTC Sets

- The tire pressure monitor system indicator icon on the instrument cluster flashes for 1 min and then remains illuminated after the ignition switch is cycled ON and the instrument cluster bulb check is complete.
- If equipped, the driver information center displays a service tire monitor type message.

Conditions for Clearing the DTC

A current DTC will clear when the malfunction is no longer present and one ignition cycle occurs.

Diagnostic Aids

- Some aftermarket wheel valve stem holes are located further from the wheel rim than original equipment wheels. When using the tire pressure monitor special tool to activate a sensor, ensure the tool is placed along the tire sidewall and no further than 15 cm (6 in) from the sensor and the antenna is aiming upward.
- Aftermarket wheel valve system locations can cause a sensor to not function correctly.
- A sensor may have been damaged due to a previous wheel/tire service or flat tire event.
- The use of other than GM approved tire sealants can obstruct the sensor pressure sensing port and cause inaccurate tire pressure readings. If this condition is verified, remove the sealer from the tire and replace the sensor. Refer to **Tire Pressure Indicator Sensor Replacement**.
- Occasionally sensor transmissions are not received by the BCM due to vehicle level radio frequency interference from items such as but not limited to aftermarket ignition systems, DVD players, CB radios, or metallic type window tinting.
- The sensor activation procedure may have to be repeated up to 3 times before determining a sensor is malfunctioning. In the event a particular sensor information is displayed on the special tool upon activation but the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the RF signal being blocked by another component.
- Occasionally sensors can become mislocated due to previous tire rotations where the sensor learn procedure was not performed. Always learn the sensors to ensure the DTC set is for that actual physical corner of the vehicle. Refer to **Tire Pressure Indicator Sensor Learn**.
- A sensor low battery condition will set a sensor DTC but will not illuminate the low tire pressure indicator or display a message on the driver information center, if equipped. The sensor battery condition can be verified in the scan tool BCM data list. If a sensor low battery condition is indicated on the scan tool, the sensor will need to be replaced. Refer to **Tire Pressure Indicator Sensor Replacement**.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify there are no communication DTCs set along with DTC C0750, C0755, C0760, and C0765.
 - **If a communication DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If a communication DTC is not set**
2. Perform the **Tire Pressure Indicator Sensor Learn**.
 3. Verify the scan tool Tire Pressure Sensor Mode parameters change to Drive while driving the vehicle above 40 km/h (25 mph) for greater than 2 min.
 - **If a Tire Pressure Sensor Mode parameter does not change to Drive**
 1. Replace the appropriate B2 Tire Pressure Sensor.
 2. Perform the **Tire Pressure Indicator Sensor Learn**.
 - **If the Tire Pressure Sensor Mode parameter changes to Drive**
 4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Tire Pressure Indicator Sensor Replacement**
- **Tire Pressure Indicator Sensor Learn**

DTC C0775: TIRE PRESSURE MONITORING SYSTEM SENSORS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0775 00

Tire Pressure Monitoring System Sensors Malfunction

Circuit/System Description

If the body control module (BCM) has been reprogrammed or replaced and the tire pressure sensor learn

procedure has not been performed, the tire pressure monitor system indicator icon on the instrument cluster will flash for 1 min and then remain illuminated after the power switch is cycled ON and the instrument cluster bulb check is complete. If equipped, the driver information center will also display a service tire monitor type message. Under these circumstances, DTC C0775 will be set in the BCM and the tire pressure sensor learn procedure will need to be performed for the system to function correctly.

Conditions for Running the DTC

Vehicle ON or Vehicle in Service Mode.

Conditions for Setting the DTC

The body control module (BCM) has not learned tire pressure sensor ID and location information from the tire pressure sensors.

Action Taken When the DTC Sets

- The tire pressure monitor system indicator icon on the instrument cluster will flash for 1 min and then remain illuminated after the power switch is cycled ON and the instrument cluster bulb check is complete.
- If equipped, the driver information center displays a service tire monitor type warning message.

Conditions for Clearing the DTC

A current DTC will clear when the BCM has received tire pressure sensor ID and location information from the tire pressure indicator module and at least 1 power switch cycle has occurred.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Perform the **Tire Pressure Indicator Sensor Learn**.
2. Verify DTC C0775 is not set.
 - **If the DTC is set**

Replace the K9 Body Control Module.
 - **If the DTC is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming, and setup.

SYMPTOMS - TIRE PRESSURE MONITORING

1. Perform the **Diagnostic System Check - Vehicle** , before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Tire Pressure Monitor Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Tire Pressure Monitoring (TPM) System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to **Low Tire Pressure Indicator Malfunction** in order to diagnose the symptom.

LOW TIRE PRESSURE INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The tire pressure monitor system has a radio frequency transmitting pressure sensor in each wheel/tire assembly. As vehicle speed increases, centrifugal force closes the sensors internal roll switch, which puts the sensor into Drive mode. The sensors send the tire pressure data to the body control module (BCM). The BCM translates the data contained in the tire pressure sensor radio frequency transmissions into sensor presence, sensor mode, and tire pressure. Once vehicle speed is greater than 40 km/h (25 MPH), the BCM waits for the sensors to go into Drive mode.

Each sensor has its own unique identification (ID) code, which it transmits as part of each RF message, that must be learned into the BCM memory. Once all 4 IDs have been learned and vehicle speed is greater than 40 km/h (25 mph), the BCM continuously compares IDs and pressure data in the received transmissions to the learned IDs and pressures to determine if all 4 sensors are present and if one or more tires are low. If the BCM detects a low tire pressure condition or a malfunction in the system, it will send a serial data message to the instrument cluster requesting the appropriate tire pressure monitor indicator illumination and also to display the appropriate data message on the driver information center, if equipped.

Diagnostic Aids

- If unsure about the condition, cycle the ignition and observe the tire pressure monitor indicator icon. If the tire pressure monitor indicator icon is continuously illuminated after the instrument cluster bulb check is completed, a low tire pressure condition is present. Check the tires for damage or leaks and inflate to the tire placard specifications. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** , . If the tire pressure monitor indicator icon flashes for 1 min after the instrument cluster bulb check is completed and then remains illuminated, a tire pressure monitor system DTC is set. Perform the **Diagnostic System Check - Vehicle** to proceed with the proper diagnosis.
- Temperature can greatly effect tire pressures. Low tire pressure on a cold morning may cause the tire pressure monitor indicator icon to turn ON. The air pressure in the tire increases as the ambient temperature rises or as the tire warms up while the vehicle is driven. The pressure may increase enough to exceed the predetermined low pressure threshold which will turn OFF the tire pressure monitor indicator icon .
- Some aftermarket wheel valve stem holes are located further from the wheel rim than original equipment wheels. When using the tire pressure monitor special tool to activate a sensor, ensure the tool antenna is no further than 15 cm (6 in) from the sensor and is aiming upward.
- Aftermarket wheel value stem locations can cause a sensor to not function correctly.
- A sensor may have been damaged due to a previous wheel/tire service or flat tire event.
- The use of other than GM approved tire sealants can obstruct the sensor pressure sensing port and cause inaccurate tire pressure readings. If this condition is verified, remove the sealer from the tire and replace the sensor. Refer to **Tire Pressure Indicator Sensor Replacement**.
- The sensor activation procedure may have to be repeated up to 3 times before determining a sensor is malfunctioning. In the event a particular sensor's information is displayed on the special tool upon activation but the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the RF signal is being blocked by another component.
- Occasionally sensor transmissions are not received by the BCM due to vehicle level RF interference from items such as but not limited to aftermarket ignition systems, DVD players, CB radios, or metallic type window tinting.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Low tire pressure in one or more tires is indicated by a continuously illuminated tire pressure monitor indicator icon after the instrument cluster bulb check is completed. If equipped with a driver information center, a check tire pressure type message will also be displayed.

When a tire pressure monitor DTC is set, the tire pressure monitor indicator icon will flash for 1 min after the instrument cluster bulb check is completed and then remains illuminated. If equipped with a driver information center, a service tire monitor type message will also be displayed.

1. Adjust all tire pressures to the correct pressure. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .
2. Drive the vehicle over 40 km/h (25 mph) for greater than 2 min.
3. Verify the low tire pressure indicator is OFF.
 - **If the low tire pressure indicator is ON**
 1. Perform the **Tire Pressure Indicator Sensor Learn**.
 2. Record all 4 Tire Pressure Parameters values from the scan tool.
 3. Check and record the tire pressures with a known accurate hand held tire pressure gauge.
 4. Verify that the scan tool Tire Pressure parameters do not differ more than 27.6 kPa (4 psi) from the actual tire pressure readings.
 - If the scan tool Tire Pressure parameters differ more than 27.6 kPa (4 psi), replace the appropriate B2 Tire Pressure Sensor then perform the **Tire Pressure Indicator Sensor Learn**.
 - If the scan tool Tire Pressure parameters do not differ more than 27.6 kPa (4 psi)
5. Verify the BCM Tire Type and Pressure selections are setup correctly with a scan tool. Refer to the **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .
 - If the BCM Tire Type and Pressure selections are incorrect, input the proper placard values for the vehicle with the scan tool then drive the vehicle over 40 km/h (25 mph) for greater than 2 min.
 - If the BCM Tire Type and Pressure selections are correct
6. Ignition ON.
7. Verify the low tire pressure monitor indicator icon turns ON and OFF when commanding All Indicators ON and OFF with a scan tool.
 - If the low tire pressure monitor icon does not turn ON and OFF, replace the P16 Instrument Cluster.
 - If the low tire pressure monitor icon turns ON and OFF
8. All OK
 - **If the tire pressure indicator is OFF**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Tire Pressure Indicator Sensor Replacement**
- **Tire Pressure Indicator Sensor Learn**
- **Control Module References** for instrument cluster or BCM replacement, programming, and setup.

REPAIR INSTRUCTIONS

TIRE PRESSURE INDICATOR RECEIVER REPLACEMENT

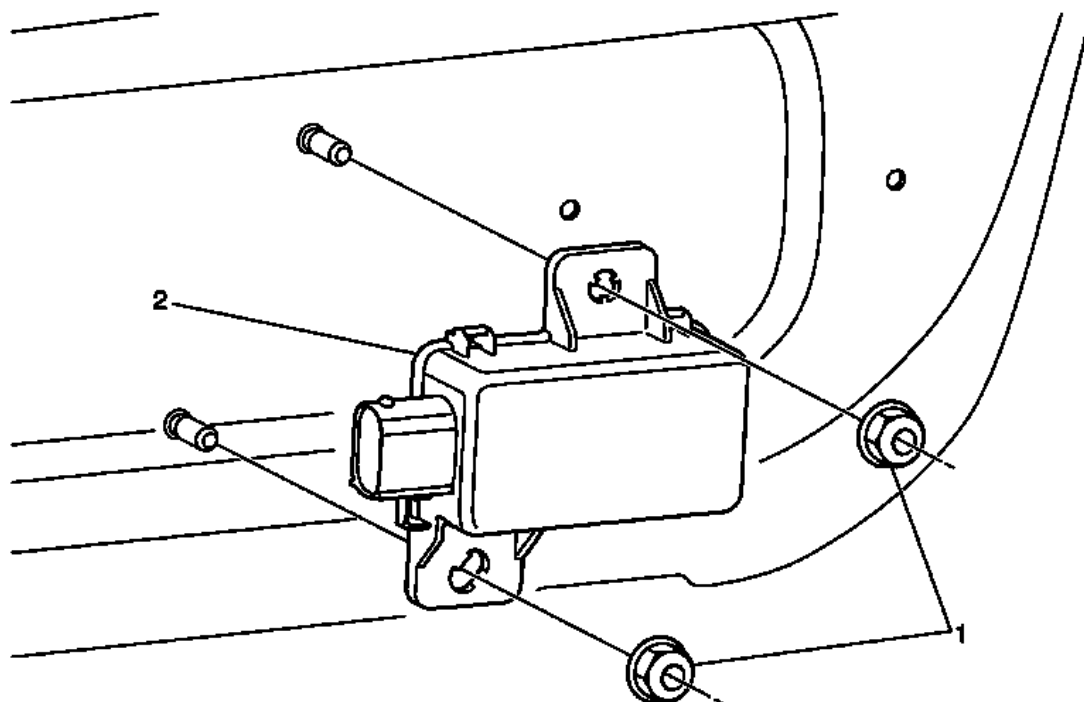


Fig. 1: Tire Pressure Indicator Receiver & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Tire Pressure Indicator Receiver Replacement

Callout	Component Name
Preliminary Procedure Remove the 2 center clips on the lower part of the rear bumper. Refer to <u>Rear Bumper Fascia Replacement</u> .	
	Tire Pressure Indicator Receiver Fastener (Qty: 2)

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 N.m (35 lb in)
2	Tire Pressure Indicator Receiver Procedure <ol style="list-style-type: none"> 1. Disconnect any electrical connectors as needed. 2. After repairs, program the tire pressure monitoring system. Refer to <u>Control Module References</u> .

TIRE PRESSURE INDICATOR SENSOR REPLACEMENT

Removal Procedure

1. Raise the vehicle on a suitable support. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly from the vehicle. Refer to **Tire and Wheel Removal and Installation** .
3. Dismount the tire from the rim.

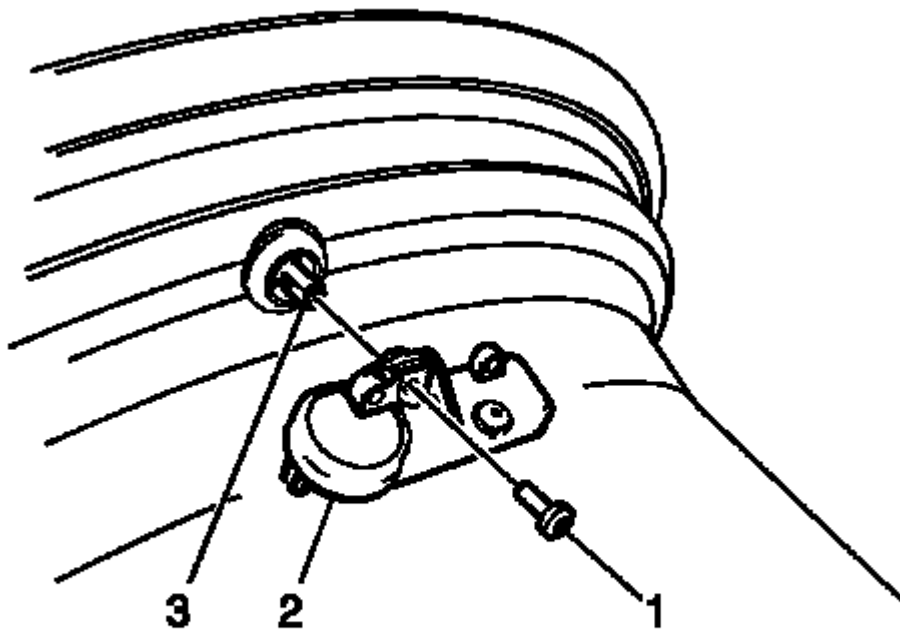


Fig. 2: View Of Tire Pressure Indicator Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not scratch or damage the clear coating on aluminum wheels with the tire changing equipment. Scratching the clear coating could cause the aluminum wheel to corrode and the clear coating to peel from the wheel.

NOTE: When servicing the tire pressure sensor always use a new tire pressure monitor (TPM) and a new TORX screw during installation.

4. Remove the TORX screw (1) from the tire pressure sensor (2) and pull it straight off the tire pressure valve stem (3).
5. Remove the tire pressure valve stem by pulling it through the rim.

Installation Procedure

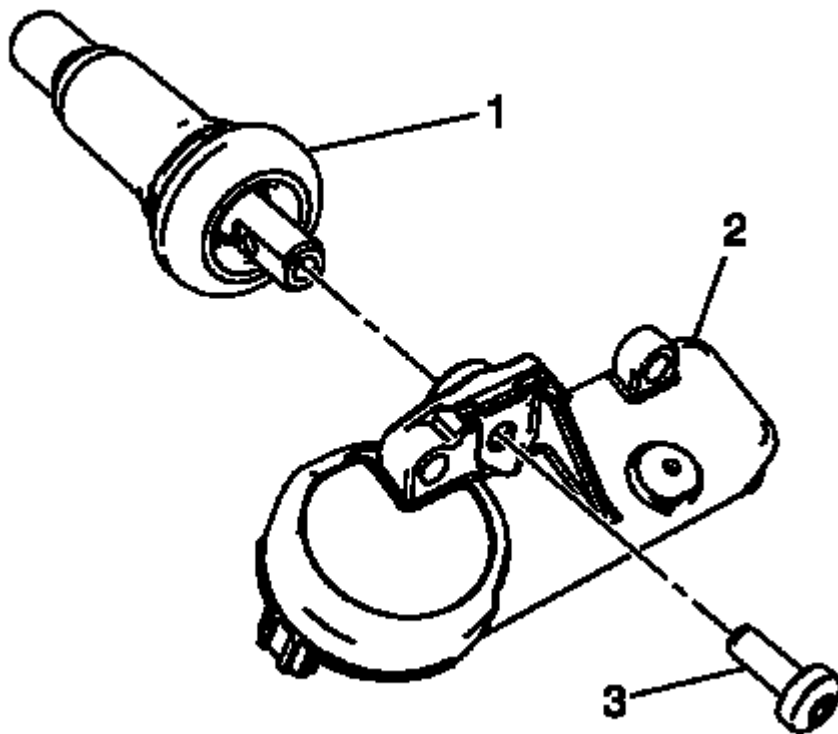


Fig. 3: View Of Tire Pressure Indicator Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution

NOTE: Ensure the flat of the valve, lines up with the flats of the snap in the enclosure.

1. Assemble the tire pressure sensor (2) to the valve stem and install the NEW TORX screw (3). Tire Pressure Monitor (TPM) valves and TORX screws are one-time use only.

CAUTION: When mounting the tires, use an approved tire mounting lubricant. **DO NOT** use silicon or corrosive base compounds to lubricate the tire bead and the wheel rim. A silicon base compound can cause the tire to slip on the rim. A corrosive type compound can cause tire or rim deterioration.

2. Apply tire soap to the rubber portion of the valve stem (1).

NOTE: Snap Fit TPM sensors are still shipped in the OFF mode. However, the TPM no longer needs to be spun to remove it from the OFF mode. The sensor will exit its OFF state when the tire is inflated. The technician can then program the vehicle as normal.

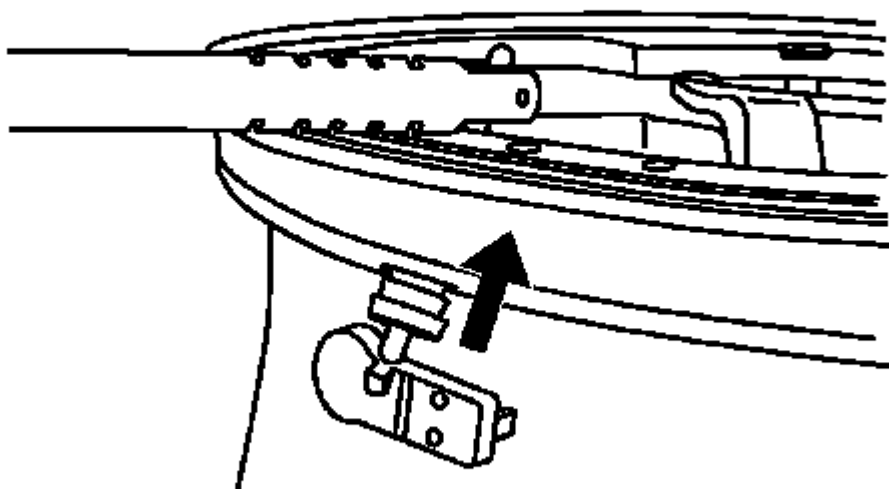


Fig. 4: View Of Tire Valve Stem Mounting Tool
Courtesy of GENERAL MOTORS COMPANY

3. Using a tire valve stem mounting tool, pull the valve stem through in a direction parallel to the valve hole on the rim.
4. Mount the tire to the rim.
5. Install the tire and wheel assembly on the vehicle. Refer to **Tire and Wheel Removal and Installation** .
6. Lower the vehicle.
7. Program the tire pressure sensors. Refer to **Tire Pressure Indicator Sensor Learn**.

TIRE PRESSURE INDICATOR SENSOR LEARN

Special Tools

- **EL-46079** Tire Pressure Monitor Diagnostic Tool

- **EL-50448** Tire Pressure Monitor Sensor Activation Tool

For equivalent regional tools, refer to **Special Tools**.

Learn Mode Description

The tire pressure monitor system uses the instrument cluster, body control module (BCM), 4 radio frequency transmitting pressure sensors, and the serial data circuit to perform the tire pressure monitor learn mode functions. The sensor learn procedure must be performed after every tire rotation, BCM replacement, or sensor replacement. Once the Learn mode has been enabled, each of the sensors unique identification codes can be learned into the BCM memory. When a sensor ID has been learned, the BCM sounds a horn chirp indicating the sensor has transmitted its ID and the BCM has received and learned it. The BCM must learn the sensor IDs in the proper sequence to determine correct sensor location. The first learned ID is assigned to the left front location, the second to right front, the third to right rear and the fourth to left rear. The turn signals will individually illuminate indicating which location is to be learned in the proper sequence.

Sensor Functions Using EL-46079, EL-50448, or Equivalent

Each sensor has an internal low frequency coil. When the tire pressure monitor special tool is used in activate mode, it produces a low frequency transmission that activates the sensor. The sensor responds to a low frequency activation by transmitting in Learn Mode-Remotely Triggered. When the BCM receives a learn mode transmission while in Learn mode, it will assign that sensors ID to the location on the vehicle relative to the order in which it was learned.

Learn Mode Cancellation

The Learn mode will cancel if the ignition is cycled to OFF or if more than 2 minutes has elapsed for any sensor that has not been learned. If the relearn mode is cancelled before the first sensor is learned, the original sensor IDs will be maintained. If the relearn mode is canceled after the first sensor is learned, the following will occur:

- All stored sensor IDs will be invalidated in the BCM memory.
- If equipped, the driver information center will display dashes instead of tire pressures.
- DTC C0775 will be set.

These conditions will now require the Learn procedure to be repeated for the system to function properly.

Tire Pressure Monitor Learn Procedure

NOTE: In the event when a particular sensor is activated and the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.

1. Apply park brake (manual transmission only).
2. Ignition ON, using a scan tool or driver information center buttons (refer to owners manual), initiate the Tire Pressure Sensors Learn mode. A double horn chirp will sound indicating the Learn mode has been enabled. The left front turn signal will also be illuminated.

3. Starting with the left front tire, active the sensor by holding the antenna of the tire pressure monitor special tool aimed upward against the tire sidewall close to the wheel rim at the valve stem location. Press and release the activate button. Ensure that the transmit indicator on the special tool indicates that the sensor activation signal is being transmitted. Wait for a horn chirp. If the horn does not chirp, repeat the sensor activation sequence with the tool. Once the horn chirp has sounded, the sensor information is learned and the turn signal in the next location to be learned will illuminate.
4. After the horn chirp has sounded and the right front turn signal is illuminated, repeat step 3 for the remaining 3 sensors in the following order:
 1. Right front
 2. Right rear
 3. Left rear
5. When the left rear sensor has been learned and a double horn chirp has sounded, the learn process is complete and the BCM exits the Learn mode.

DESCRIPTION AND OPERATION

TIRE PRESSURE MONITOR DESCRIPTION AND OPERATION

Tire Pressure Monitoring Block Diagram

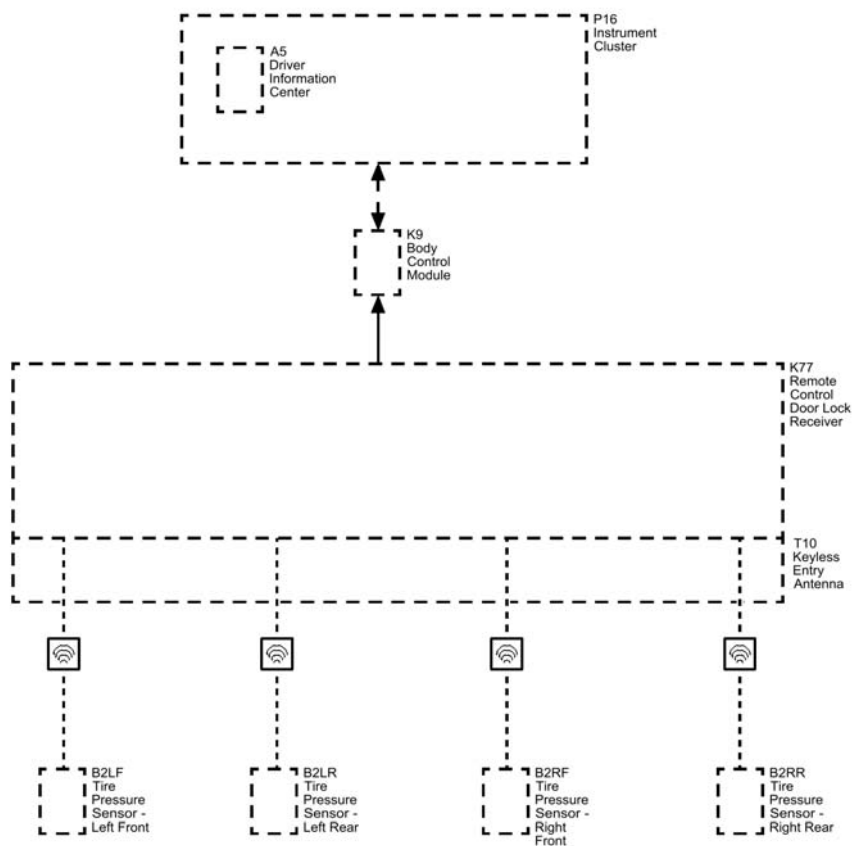


Fig. 5: Tire Pressure Monitoring System Wiring Schematic
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DA	Serial Data
HW	Hard-Wired
WL	Wireless
WL	Wireless
WL	Wireless
WL	Wireless
P16	P16 Instrument Cluster
P9	P9 Driver Information Center Display
K9	K9 Body Control Module
K77	K77 Remote Control Door Lock Receiver
T10	T10 Keyless Entry Antenna
B2LF	B2LF Tire Pressure Sensor - Left Front

B2LR	B2LR Tire Pressure Sensor - Left Rear
B2RF	B2RF Tire Pressure Sensor - Right Front
B2RR	B2RR Tire Pressure Sensor - Right Rear

Special Tools

- **EL-46079/J-46079** Tire Pressure Monitor Diagnostic Tool
- **EL-50448** Tire Pressure Monitor Sensor Activation Tool

For equivalent regional tools, refer to **Special Tools**.

The tire pressure monitor system warns the driver when a significant loss, or gain of tire pressure occurs in any of the 4 tires and allows the driver to display the individual tire pressures and their locations on the driver information center.

The system uses the body control module (BCM), driver information center, instrument cluster, a radio frequency (RF) transmitting pressure sensor in each wheel/tire assembly, and the serial data circuit to perform the system functions. Each sensor has an internal power supply with an approximate 10 year service life.

When the vehicle is stationary, the sensor's internal accelerometer is inactive, which puts the sensors into a Stationary state. In this state the sensors sample tire pressure once every 30 seconds and do not transmit at all if the tire pressure does not change. As vehicle speed increases, centrifugal force activates the sensors internal accelerometer causing the sensors to go into Wake and then Drive mode. In Drive mode, the sensors sample tire pressure once every 30 seconds and transmit in Drive mode once every 60 seconds. The BCM receives and translates the data contained in each sensors RF transmission into sensor presence, sensor mode, and tire pressure. The BCM sends the tire pressure and tire location data to the driver information center via the serial data circuit where they are displayed.

The sensors continuously compare their last pressure sample to their current pressure sample and will transmit in Learn Mode-Pressure Triggered if a 8.3 kPa (1.2 psi) change in tire pressure has been detected in either a Stationary or Drive state. When the tire pressure monitor system detects a significant loss, or gain of tire pressure, the tire pressure monitor indicator icon is illuminated on the instrument cluster and if equipped, a check tire pressure type message is displayed on the driver information center. Both the indicator icon and driver information center message can be cleared by adjusting the tire pressures to the recommended pressures and driving the vehicle above 40 km/h (25 mph) for at least 2 minutes.

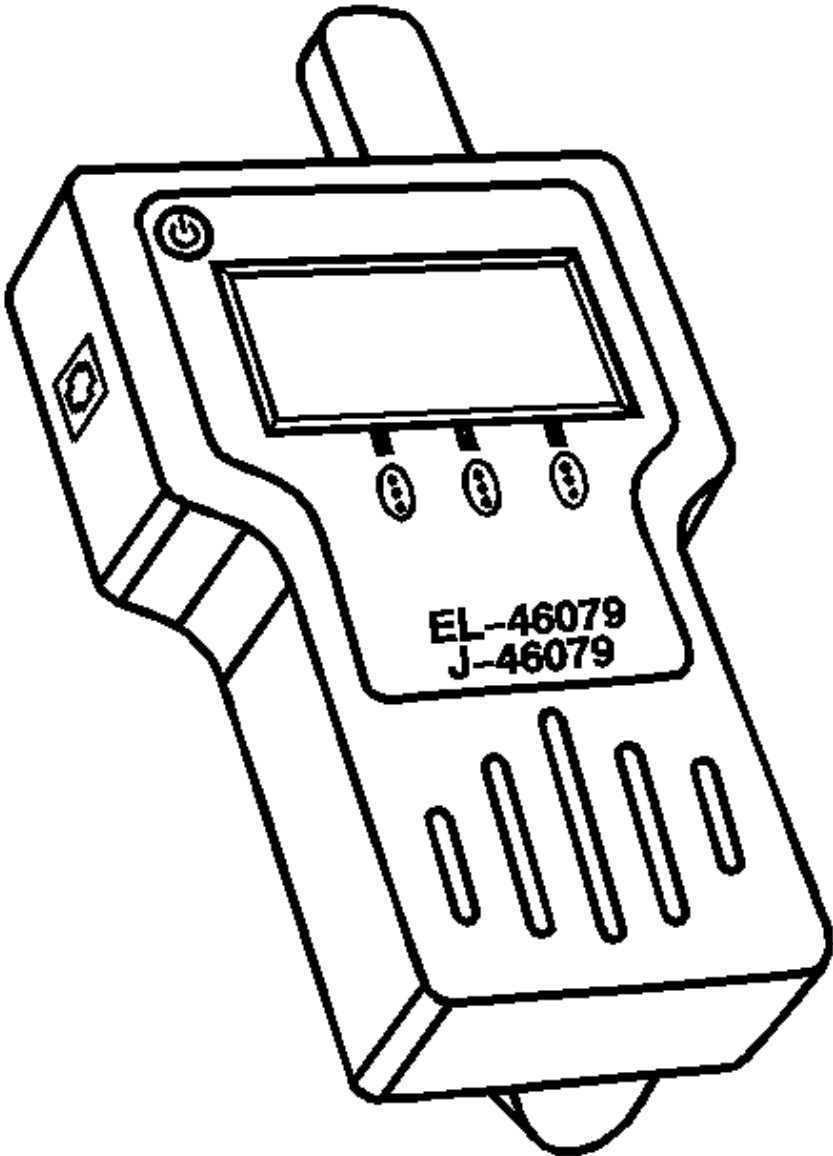
If power is disconnected from the BCM or if the vehicle battery is disconnected, each tire pressure monitor sensor ID is retained but all of the tire pressure information is lost. Under these circumstances the BCM cannot assume that the tire pressures were maintained over an unknown period of time. If equipped, the driver information center will display all dashes and the scan tool will indicate a default tire pressure value of 1020 kPa (148 psi) for each tire. Driving the vehicle above 40 km/h (25 mph) for at least 2 minutes will activate the sensors causing the driver information center to display the current tire pressures. The **EL-46079/J-46079** tire pressure monitor diagnostic tool , **EL-50448** tire pressure monitor sensor activation tool , or equivalent may also be used to activate the sensors as well.

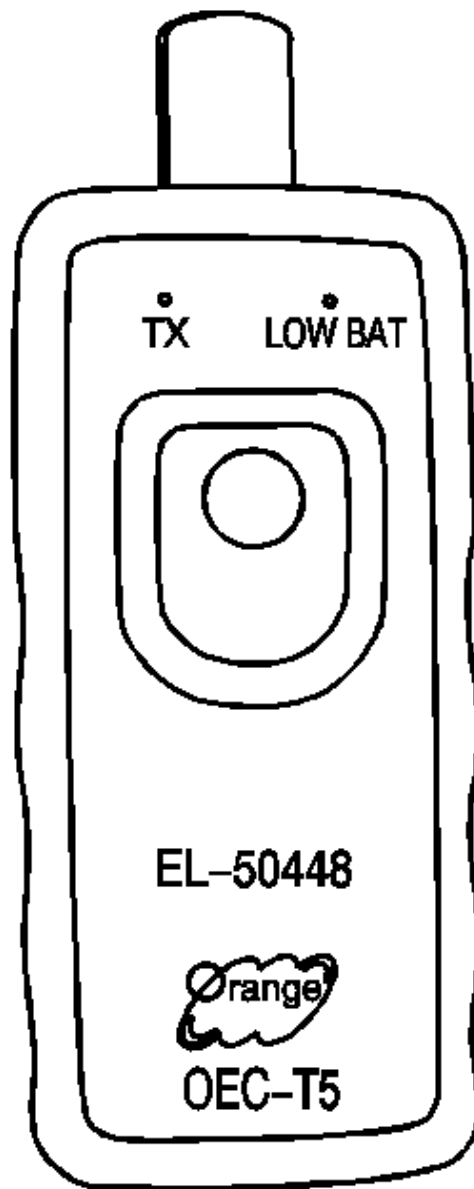
The BCM has the ability to detect malfunctions within the tire pressure monitor system. In the event a DTC is set, the tire pressure monitor indicator icon on the instrument cluster will flash for 1 minute and then remain

illuminated after the ignition is turned ON and the instrument cluster bulb check has been completed. Any malfunction detected will cause the driver information center to display a service tire monitor system type message. For more information on other functions of the BCM, refer to Keyless Entry System Description and Operation (without BTM) , Keyless Entry System Description and Operation (with BTM) .

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Descrip
	EL 46079 Tire Pressure Monitor Diagnos Tool



EL 50448
Tire Pressure
Monitor Senso
Activation Toc

Suspension

Tires and Wheels

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
• Wheel Nut Torque	165 N.m	122 lb ft

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	Canadian Part Number
Aluminum Wheel	Adhesive/Sealant	12378478	88900041
Wheel	Mounting Lubricant	12345884	88863415
Wheel to Hub	Lubricant	1051344	993037

DIAGNOSTIC INFORMATION AND PROCEDURES

TIRE DIAGNOSIS - IRREGULAR OR PREMATURE WEAR

Tire Wear

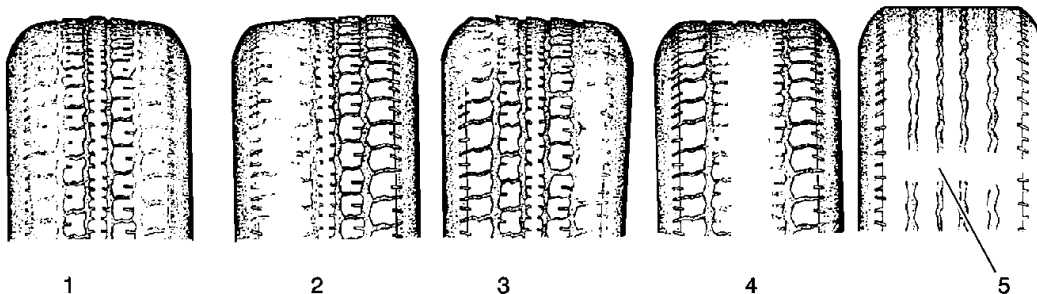


Fig. 1: Identifying Types Of Tire Wear
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Under-Inflation, Hard Cornering, Lack of Regular Rotation
2	Incorrect Wheel Alignment, Hard Cornering, Lack of Regular Rotation
3	Incorrect Wheel Alignment
4	Over-Inflation, Heavy Acceleration, Lack of Regular Rotation
5	Normal Wear to the Wear Indicator

Inspection Procedure

1. Inspect the front tire wear.
2. Inspect the rear tire wear.
3. Rotate the tires if any of the following conditions exist:
 - The amount of time or mileage since the last tire rotation matches the maintenance schedule.
 - The outer tread blocks are worn more than the middle tread blocks (1).
 - The outer tread blocks are worn more than the inner tread blocks (2).
 - The middle tread blocks are worn more than the outer tread blocks (4).
4. Measure the wheel alignment if any of the following conditions exist:
 - The tread blocks have feathered edges (3).
 - The outer tread blocks are worn more than the inner tread blocks (2).
 - The inner tread blocks are worn more than the outer tread blocks (2).
5. Inspect the struts or the shock absorbers if the tire tread exhibits a cupped appearance (3).

TIRE DIAGNOSIS - WADDLE COMPLAINT

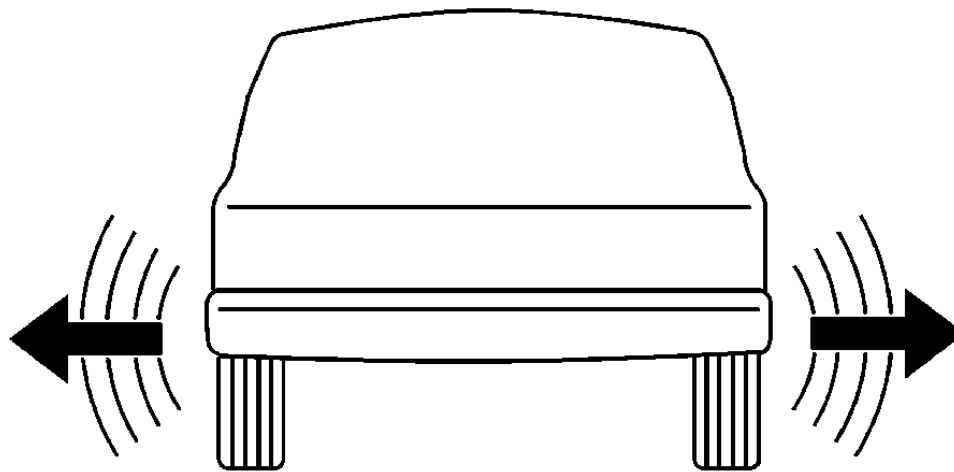


Fig. 2: Identifying Tire Wobble/Waddle
Courtesy of GENERAL MOTORS COMPANY

Tire waddle is a side to side movement at the front of the vehicle and/or the rear of the vehicle. Tire waddle can be caused by the following conditions:

- A steel belt not being straight within the tire
- Excessive lateral runout of the tire
- Excessive lateral runout of the wheel

The tire waddle is most noticeable at a low speed of about 8-48 km/h (5-30 mph). Tire waddle may appear as ride roughness at 80-113 km/h (50-70 mph). Tire waddle may appear as a vibration at 80-113 km/h (50-70 mph).

Inspection Procedure

1. Raise and support the vehicle with safety stands. Refer to **Lifting and Jacking the Vehicle** .

WARNING: Wear gloves when inspecting the tires in order to prevent personal injury from steel belts sticking through the tire.

2. Perform the following preliminary inspection:
 1. Mark the tire with a crayon in order to note the start and the stop position.
 2. Rotate each tire and wheel by hand.
 3. Inspect the tire for bulges or bent wheels. Replace as necessary.
3. Use tire substitution in order to identify the faulty tire. Perform the following steps for a tire substitution check:
 1. Use a comparable tire in order to replace each tire, one at a time.
 2. Test drive the vehicle.
 3. If the problem is tire or wheel related, you will eliminate the problem when you remove the faulty tire from the vehicle.

WHEEL MOUNTING SURFACE CHECK

Replace any wheels that are bent or dented, or have excessive lateral or radial runout. Wheels with runout greater than specified may cause objectionable vibrations.

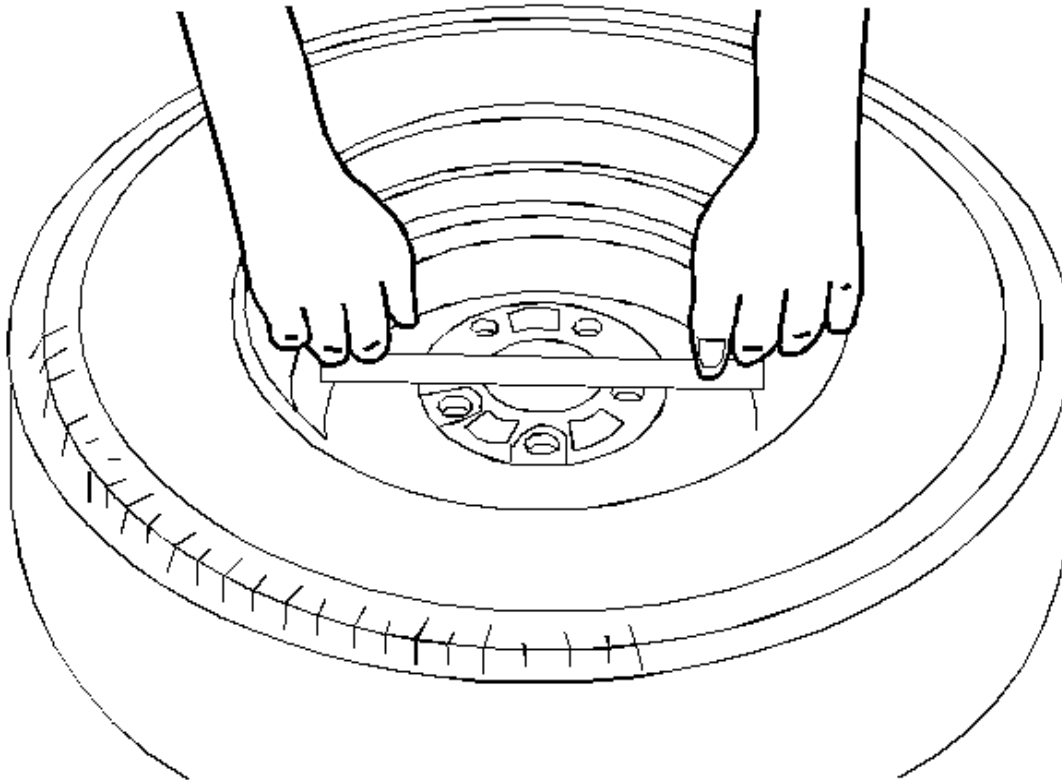


Fig. 3: Checking Wheel Mounting Surface
Courtesy of GENERAL MOTORS COMPANY

1. Thoroughly clean the wheel mounting surface with a clean shop towel and denatured alcohol, or equivalent.
2. Use a straight edge 203-229 mm (8-9 in) long. Place the straight edge on the wheel inboard mounting surface. Try to rock the straight edge up and down within the mounting surface.
3. For aluminum flat-mount wheels, repeat the procedure in step 2 on at least 3-4 different positions on the inboard mounting surface.

If you can rock the straight edge, the mounting surface is bent and you must replace the wheel.

4. Inspect the mounting wheel/nut holes for damage caused from over-torquing the wheel/nuts. Inspect for collapsed wheel/nut bosses. Inspect for cracked wheel bosses.

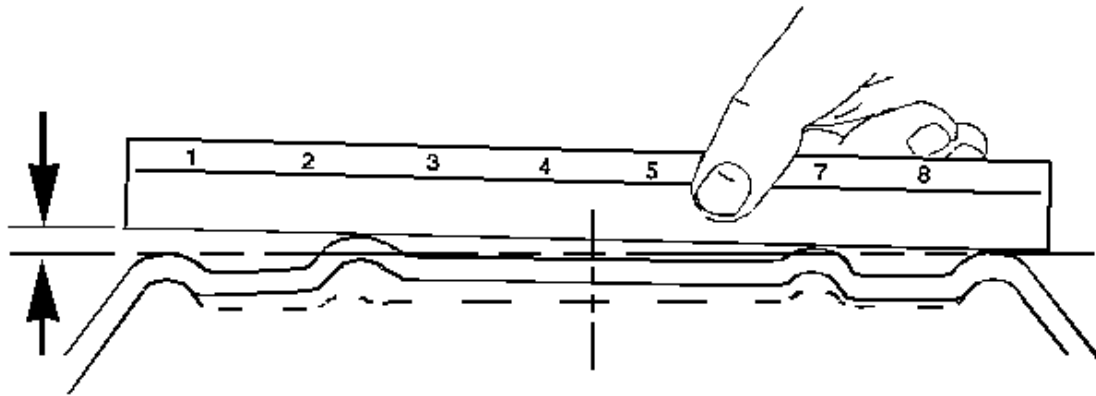


Fig. 4: Inspecting Wheel Inboard Mounting Surface
Courtesy of GENERAL MOTORS COMPANY

5. For steel wheels, repeat the procedure in step 2 on at least 3-4 different positions on the inboard mounting surface.
 - The outer mounting ring is designed to be raised slightly above the inner mounting ring.
 - If you can rock the straight edge, the mounting surface is bent and you must replace the wheel.

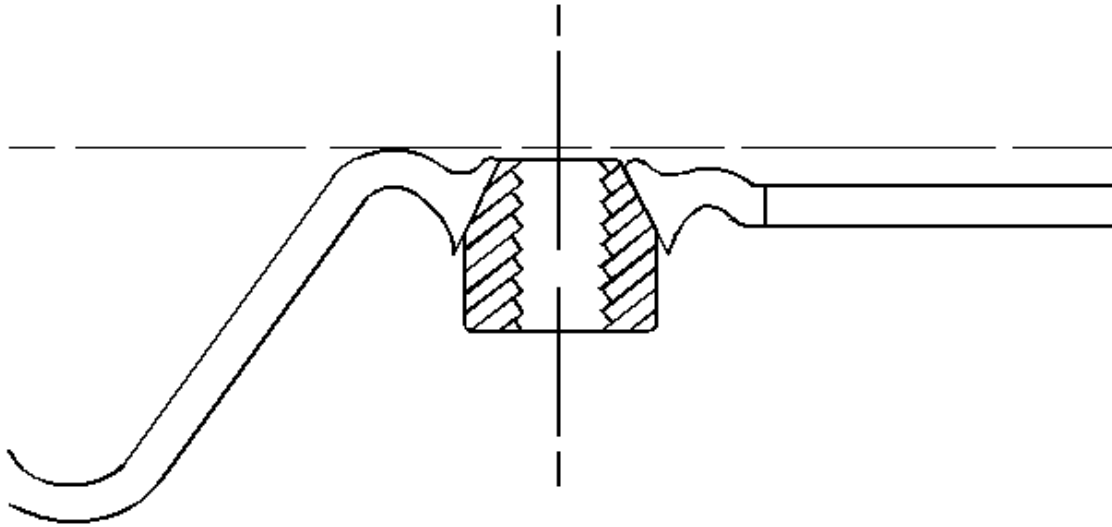


Fig. 5: Inspecting Mounting Wheel/Nut Holes For Damage Caused From Over-Torquing The Wheel/Nuts

Courtesy of GENERAL MOTORS COMPANY

6. Inspect the mounting wheel/nut holes for damage caused from over-torquing the wheel/nuts. Inspect for collapsed wheel/nut bosses. Inspect for cracked wheel bosses.

CAUTION: The use of non-GM original equipment wheels may cause:

- Damage to the wheel bearing, the wheel fasteners and the wheel
- Tire damage caused by the modified clearance to the adjacent vehicle components
- Adverse vehicle steering stability caused by the modified scrub radius
- Damage to the vehicle caused by the modified ground clearance

- **Speedometer and odometer inaccuracy**

NOTE:

- **Replacement wheels must be equivalent to the original equipment wheels in the following ways:**
 - **The load capacity**
 - **The wheel diameter**
 - **The rim width**
 - **The wheel offset**
 - **The mounting configuration**
- **A wheel of the incorrect size or type may affect the following conditions:**
 - **Wheel and hub-bearing life**
 - **Brake cooling**
 - **Speedometer/odometer calibration**
 - **Vehicle ground clearance**
 - **Tire clearance to the body and the chassis**

7. Replace the wheel if the wheel is bent.

8. Replace the wheel if the wheel/nut boss area is cracked.

Identify steel wheels with a 2 or 3-letter code stamped into the rim near the valve stem. Aluminum wheels have the code, the part number, and the manufacturer identification cast into the back side of the wheel.

RADIAL TIRE LEAD/PULL CORRECTION

Radial Tire Lead/Pull Correction

Step	Action	Yes	No
DEFINITION: Lead/pull is the deviation of the vehicle from a straight path on a level road with no pressure on the steering wheel.			
1	Did you perform the Vehicle Leads/Pull diagnostic table?	Go to Step 2	Go to <u>Vehicle Leads/Pulls</u>
2	Road test the vehicle to verify the complaint. Select a smooth level surface to perform the test. Does the condition exist?	Go to Step 3	System OK
3	1. Cross-switch the front tire/wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> . 2. Road test the vehicle on a smooth level surface. Does the vehicle still lead/pull?	Go to Step 4	System OK

4	Does the vehicle lead/pull in the opposite direction?	Go to Step 5	Go to <u>Wheel Alignment Measurement</u>
5	<ol style="list-style-type: none"> 1. Cross-switch the left front tire/wheel assembly with the left rear tire/wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u>. 2. Road test the vehicle on a smooth level surface. <p>Does the vehicle still lead/pull?</p>	Go to Step 6	Go to Step 7
6	<ol style="list-style-type: none"> 1. Cross-switch the right front tire/wheel assembly with the right rear tire/wheel assembly. Refer to <u>Tire and Wheel Removal and Installation</u>. 2. Road test the vehicle on a smooth level surface. <p>Does the vehicle still lead/pull?</p>	Go to <u>Wheel Alignment Measurement</u>	Go to Step 8
7	Replace the left rear tire. Is the repair complete?	Go to Step 9	-
8	Replace the right rear tire. Is the repair complete?	Go to Step 9	-
9	Verify proper vehicle operation. Does the original condition still exist?	Go to Step 1	System OK

REPAIR INSTRUCTIONS

TIRE AND WHEEL REMOVAL AND INSTALLATION

Special Tools

- **CH-41013** Rotor Resurfacing Kit
- **CH-42450-A** Wheel Hub Resurfacing Kit

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

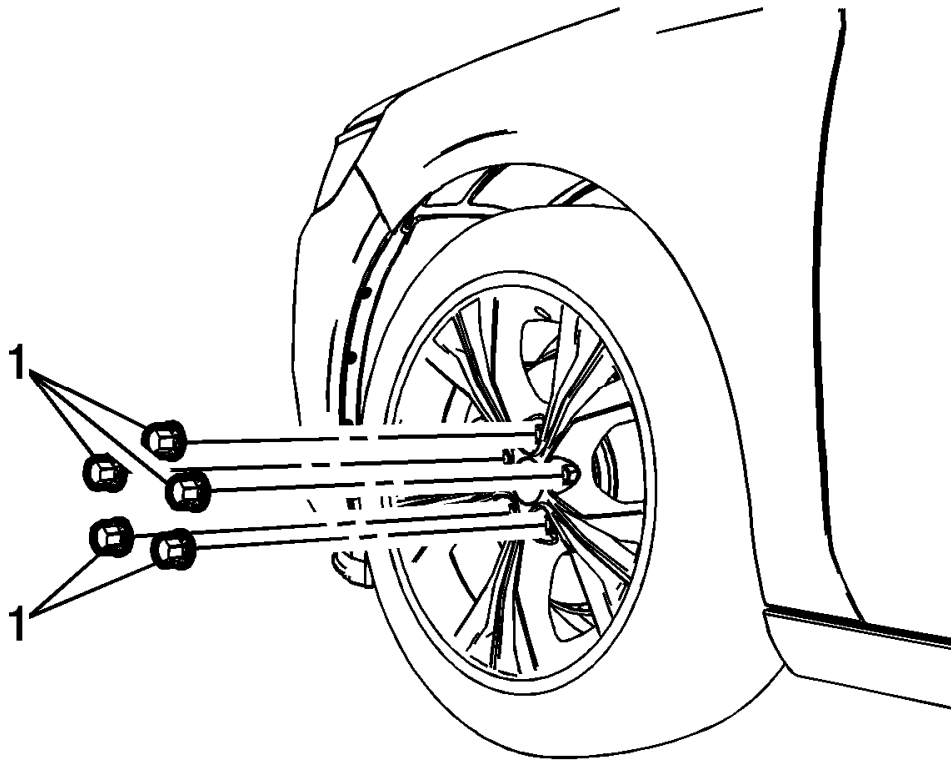


Fig. 6: Wheel Nut Caps

Courtesy of GENERAL MOTORS COMPANY

2. Remove the wheel nut caps (1), if equipped.

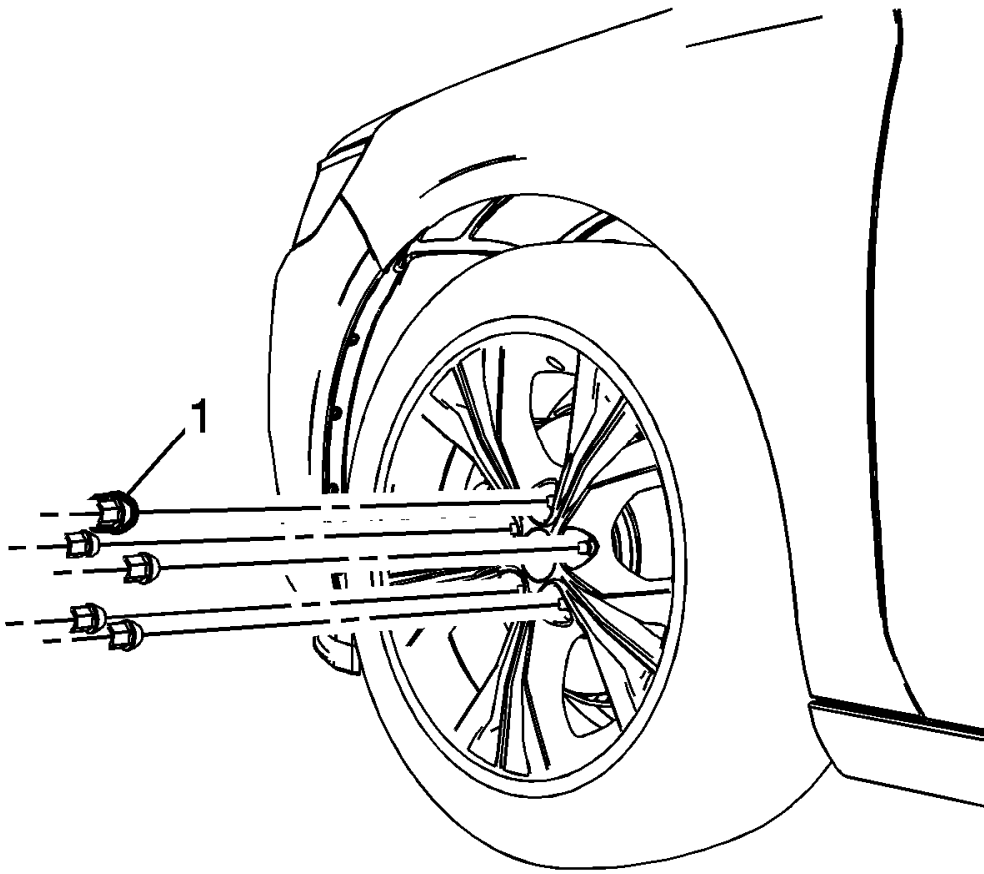


Fig. 7: Wheel Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the wheel nuts (1).

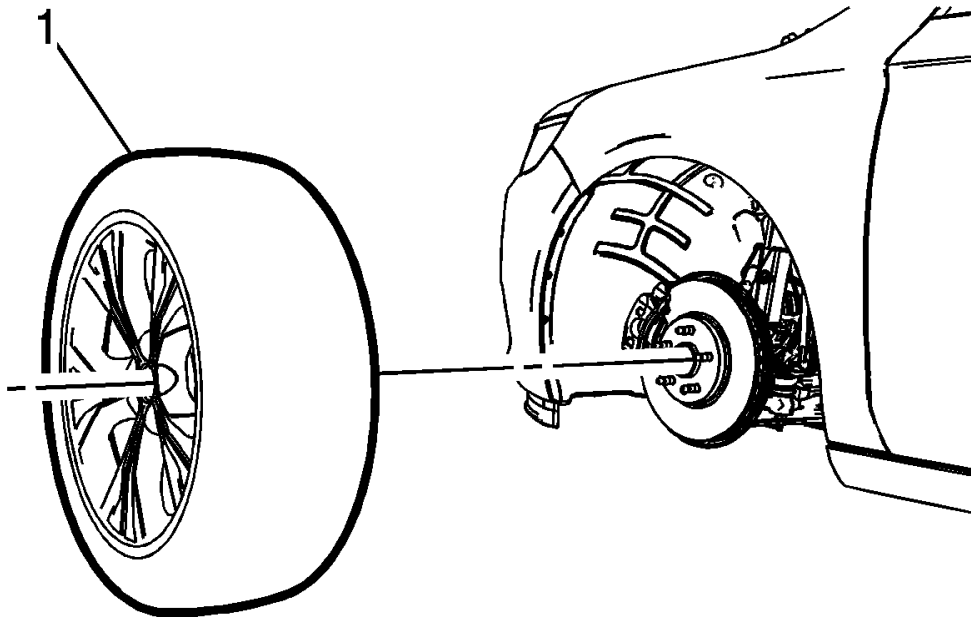


Fig. 8: Tire And Wheel Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Remove the tire and wheel assembly (1).

WARNING: If penetrating oil gets on the vertical surfaces between the wheel and the rotor or drum it could cause the wheel to work loose as the vehicle is driven, resulting in loss of control and an injury accident.

CAUTION: Removing the wheel may be difficult because of foreign materials or a tight fit between the wheel and the hub/rotor. Slightly tap the tire side wall with a rubber mallet in order to remove the wheel. Failure to follow these instructions may result in damage to the wheel.

CAUTION: Never use heat to loosen a tight wheel bolt or nut. This can shorten the life of wheel and damage wheel bearings.

5. If the tire and wheel assembly is difficult to remove or cannot be removed, perform the following steps:

- Hand install the wheel nuts.
 - Loosen the wheel nuts 2 complete turns.
 - Lower the vehicle.
 - Rock the vehicle from side to side.
 - Repeat the procedure if necessary.
6. When the tire and wheel assembly loosens, raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
 7. Remove the wheel nuts.
 8. Remove the tire and wheel assembly.
 9. Remove the wheel center cap, if equipped.

Installation Procedure

WARNING: Before installing the wheels, remove any buildup of corrosion on the wheel mounting surface and brake drum or disc mounting surface. Installing wheels with poor metal-to-metal contact at the mounting surfaces can cause wheel nuts to loosen. This can cause a wheel to come off when the vehicle is moving, causing loss of control and possibly personal injury.

NOTE: Do not use power grinding tools to clean the brake rotor or drum to wheel mating surfaces.

1. Using a wire brush or wire wheel, clean the wheel to brake rotor or drum mating surface.
2. Using the **CH-41013** Rotor Resurfacing Kit , clean the rotor or drum to wheel contact area.
3. Using the **CH-42450-A** Wheel Hub Resurfacing Kit , clean the surfaces around the wheel studs.
4. Clean the threads of the wheel studs.
5. If the threads of the wheel stud are damaged, replace the wheel stud. Refer to **Wheel Stud Replacement** , or **Wheel Stud Replacement** .
6. After cleaning all of the wheel and brake rotor or drum contact areas, use brake cleaner or denatured alcohol to remove any dirt and debris from the wheel nuts and the brake rotor or drum.
7. Inspect and clean the contact areas of the wheel. Refer to **Wheel Mounting Surface Check**.

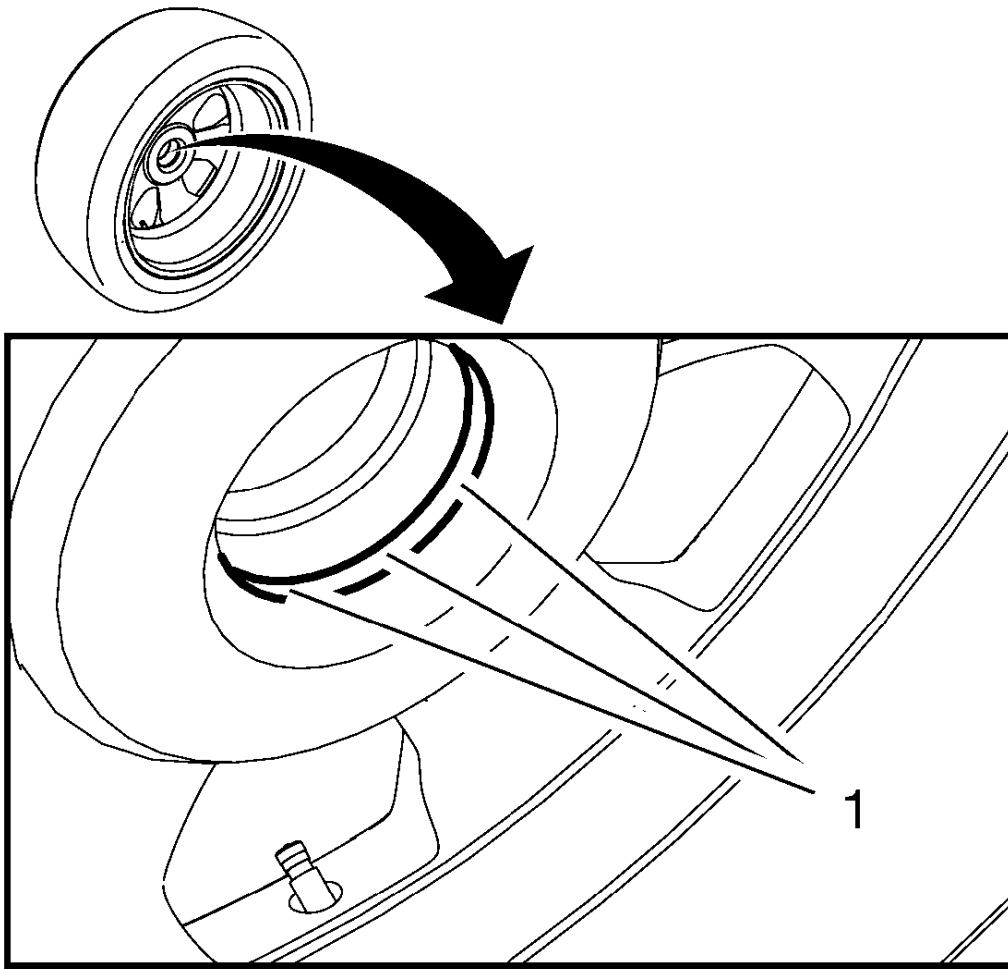


Fig. 9: Rim Inner Center Seat

Courtesy of GENERAL MOTORS COMPANY

8. Apply a small amount of lubricant to the inner diameter of the wheel hub pilot hole (1) where it contacts the wheel hub flange. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

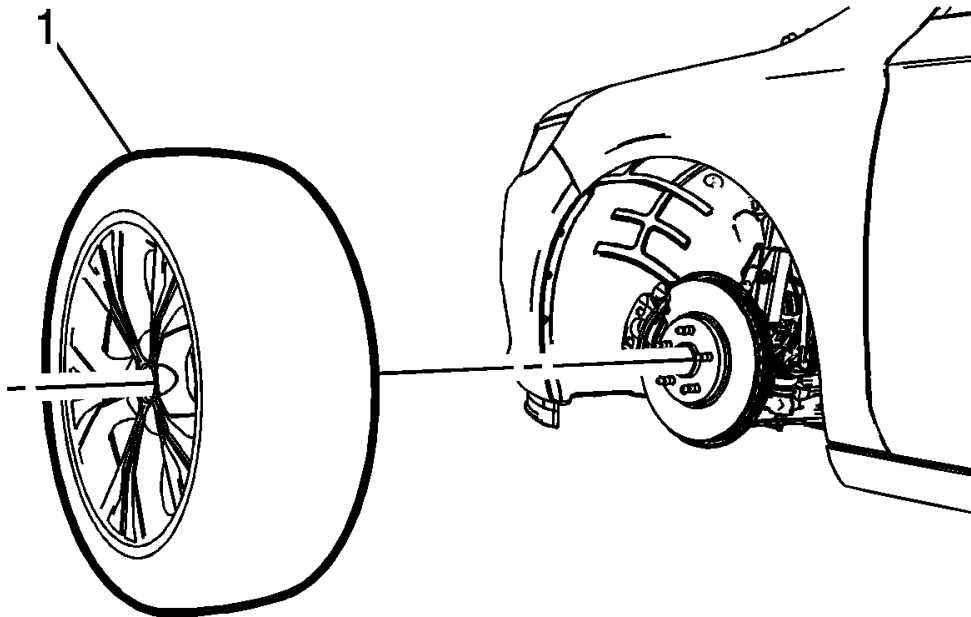


Fig. 10: Tire And Wheel Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Install the tire and wheel assembly (1).

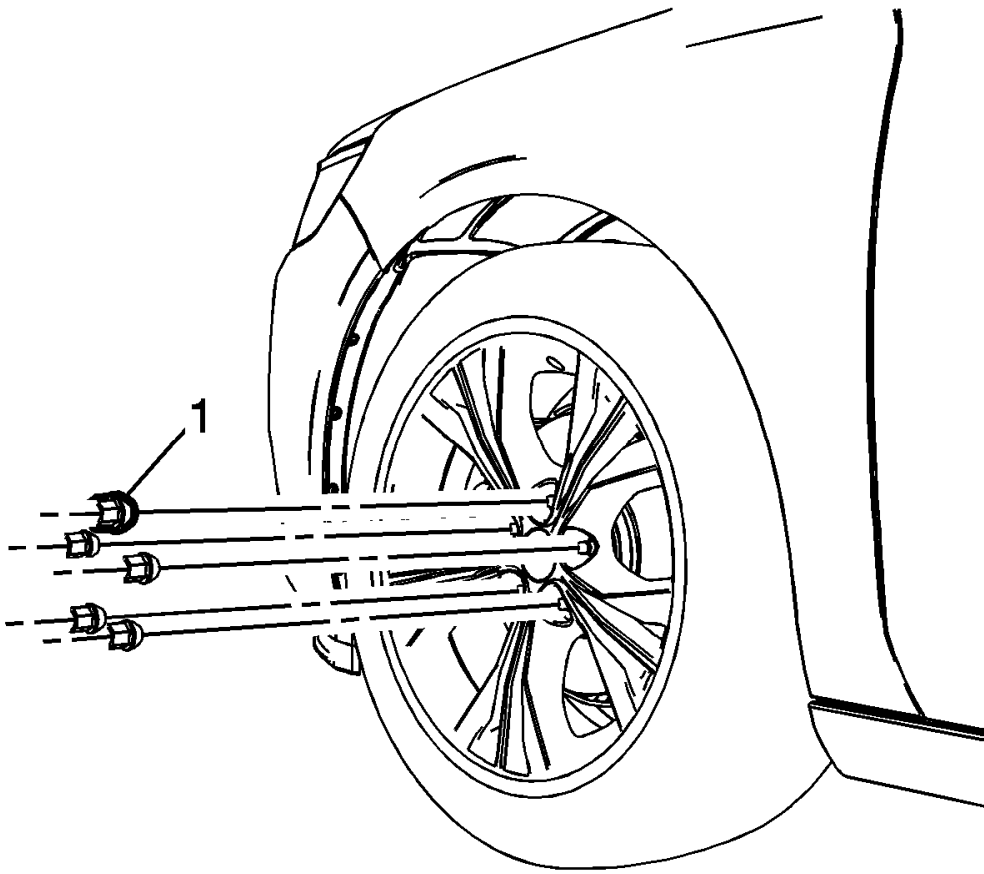


Fig. 11: Wheel Nuts

Courtesy of GENERAL MOTORS COMPANY

WARNING: Never grease or lubricate wheel nuts, studs and mounting surfaces. Wheel nuts, studs, and mounting surfaces must be clean and dry. Tightening the lubricated parts can cause damage to the wheel studs. This can cause a wheel to come off when the vehicle is moving, causing loss of control and possibly personal injury.

10. Hand install the wheel nuts (1).

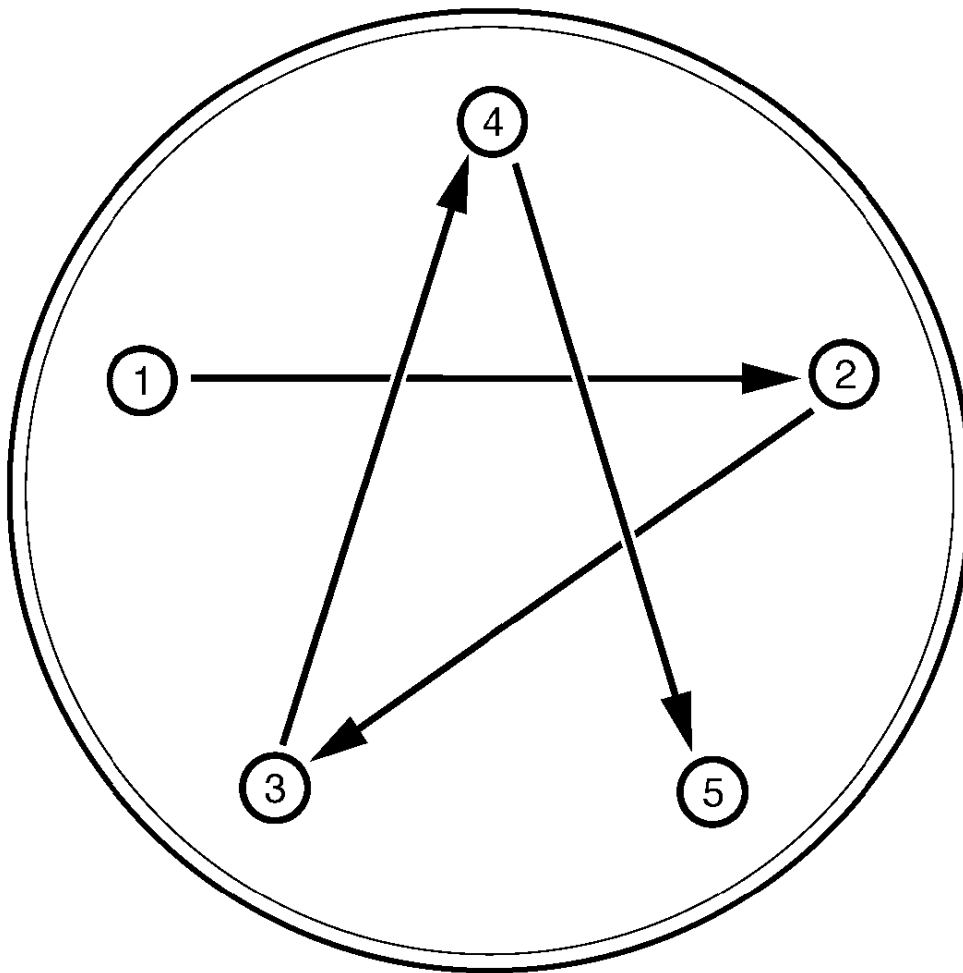


Fig. 12: Wheel Nut Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Improperly tightened wheel bolts or nuts can lead to brake pulsation and rotor damage. In order to avoid expensive brake repairs, evenly tighten the wheel bolts or nuts to the proper torque specification.

CAUTION: Refer to Fastener Caution .

11. Using a torque wrench and the appropriate socket, alternately and evenly tighten the wheel nuts to 165 (122 lb ft) in the sequence illustrated.

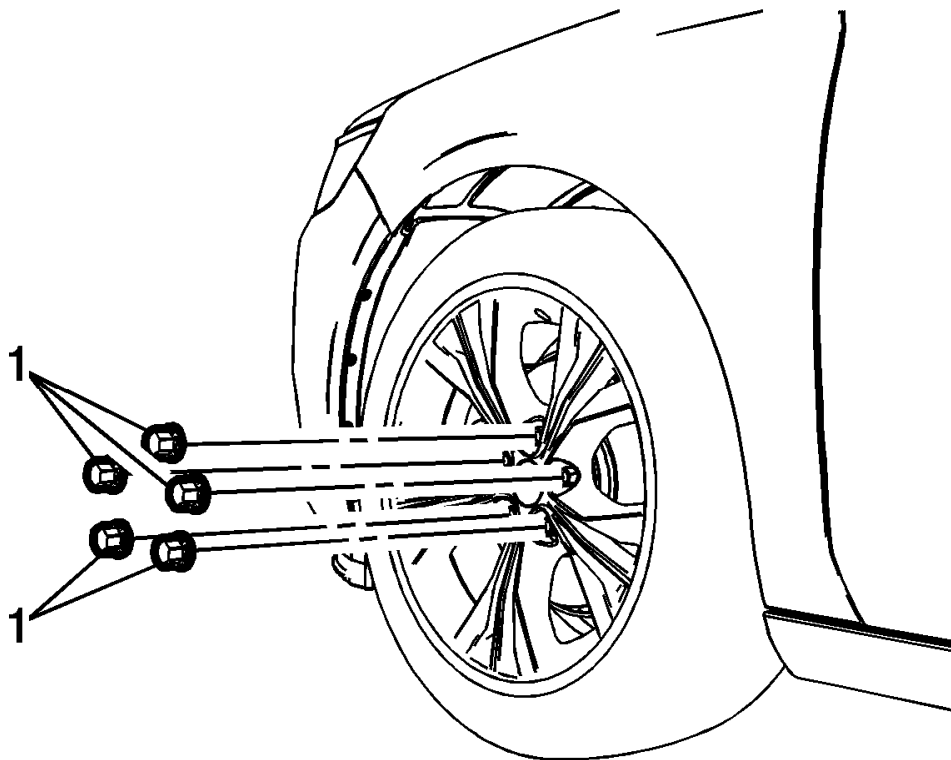


Fig. 13: Wheel Nut Caps

Courtesy of GENERAL MOTORS COMPANY

12. Install the wheel nut caps (1), if equipped.
13. Install the wheel center cap, if equipped.

WHEEL TRIM COVER HUB CAP REPLACEMENT

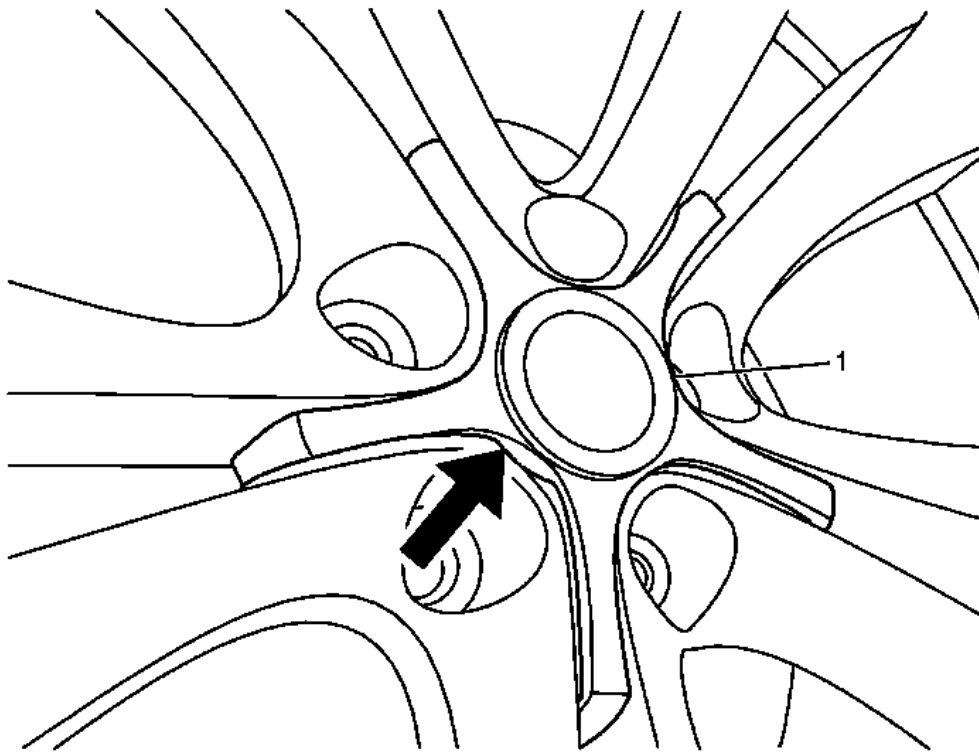


Fig. 14: Wheel Trim Cover Hub Cap
 Courtesy of GENERAL MOTORS COMPANY

Wheel Trim Cover Hub Cap Replacement

Callout	Component Name
1	Wheel Trim Cover Hub Cap Procedure <ol style="list-style-type: none"> 1. Orientate the wheel cap depending on the positioning leg. 2. Press softly by hand, in the center of the wheel cap. 3. Clip the arms of the wheel cap to the wheel, one by one.

TIRE DISMOUNTING AND MOUNTING

CAUTION: Use a tire changing machine in order to dismount tires. Do not use hand tools or tire irons alone in order to remove the tire from the wheel. Damage to the tire beads or the wheel rim could result.

CAUTION: Do not scratch or damage the clear coating on aluminum wheels with the tire changing equipment. Scratching the clear coating could cause the aluminum wheel to corrode and the clear coating to peel from the wheel.

CAUTION: Damage to either the tire bead or the wheel mounting holes can

result from the use of improper wheel attachment or tire mounting procedures. It takes up to 70 seconds for all of the air to completely exhaust from a large tire. Failure to follow the proper procedures could cause the tire changer to put enough force on the tire to bend the wheel at the mounting surface. Such damage may result in vibration and/or shimmy, and under severe usage lead to wheel cracking.

1. Remove the valve core from the valve stem.
2. Deflate the tire completely.

NOTE: Rim-clamp European-type tire changers are recommended.

3. Use the tire changer in order to remove the tire from the wheel. Follow steps 4-7 to remove the tire from the wheel.

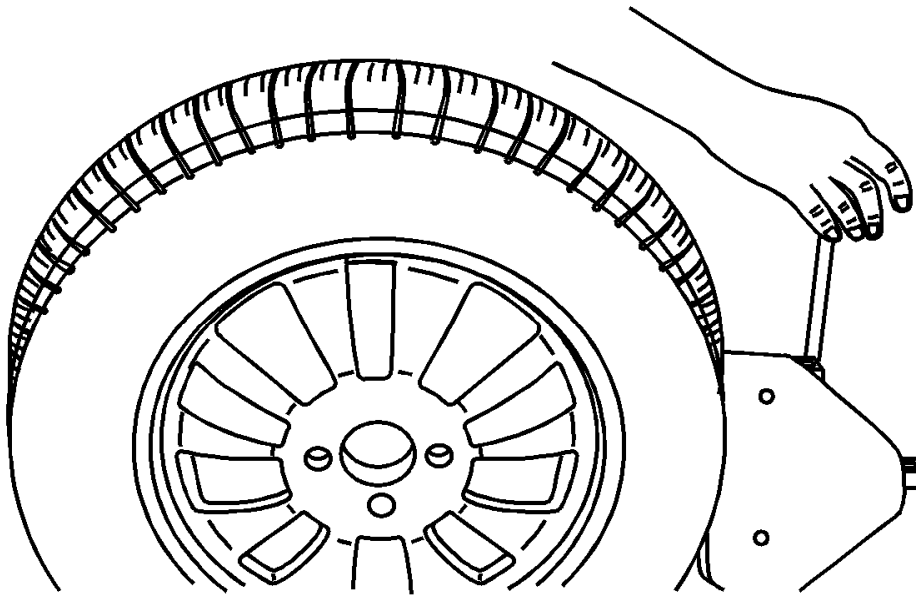


Fig. 15: Using Tire Changer to Remove Tire
Courtesy of GENERAL MOTORS COMPANY

4. When separating the tire bead from the wheel, position the bead breaking fixture 90, 180 and 270 degrees from the valve stem.

CAUTION: Failure to position valve stem in proper position while dismounting and mounting the tire may result in the TPM sensor to become damaged.

5. Position the wheel and tire so the valve stem is at the 7 o'clock position relative to the head. Apply tire bead lubricant to the pry bar to prevent damage to the tire bead. The tire iron or pry bar can be inserted when prying the outer tire bead up and over the mounting/dismounting head.

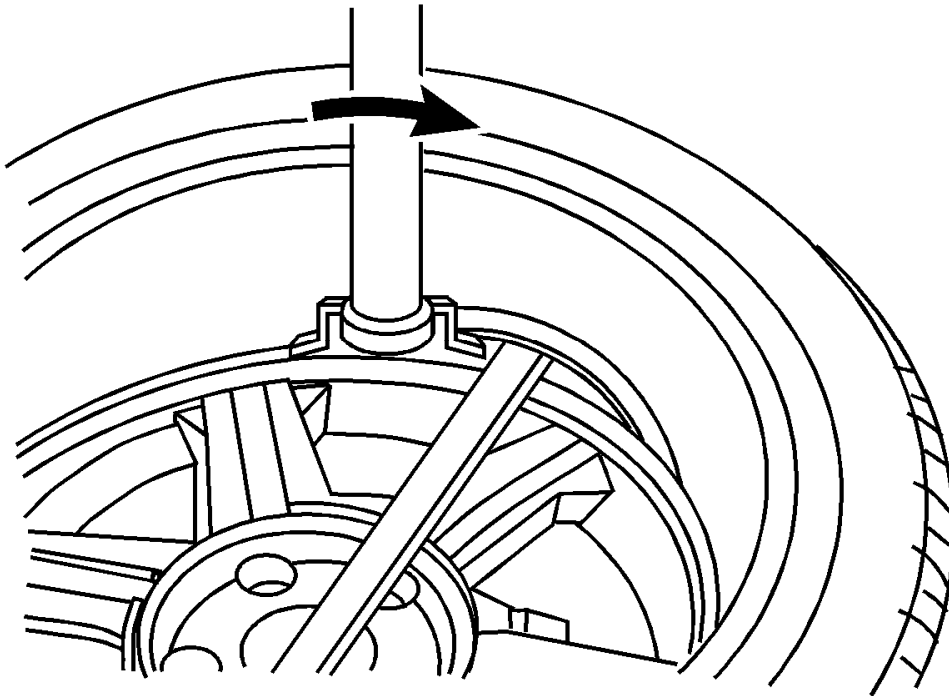


Fig. 16: Separating Tire Bead from Wheel
Courtesy of GENERAL MOTORS COMPANY

6. Position the wheel and tire so the valve stem is again at the 7 o'clock position relative to the head. The tire iron or pry bar can be inserted when prying the inner tire bead up and over the mounting/dismounting head.
7. Remove all residual liquid sealant from the inside of the tire and wheel surfaces. If any tire sealant is

noted upon tire dismounting on vehicles equipped with TPM, replace the tire pressure sensor. Refer to **Tire Pressure Indicator Sensor Replacement** .

8. Use medium coarseness steel wool in order to remove any rubber, light rust or corrosion from the wheel bead seats.

CAUTION: When mounting the tires, use an approved tire mounting lubricant. **DO NOT** use silicon or corrosive base compounds to lubricate the tire bead and the wheel rim. A silicon base compound can cause the tire to slip on the rim. A corrosive type compound can cause tire or rim deterioration.

9. Apply mounting lubricant to the tire bead and the wheel rim. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

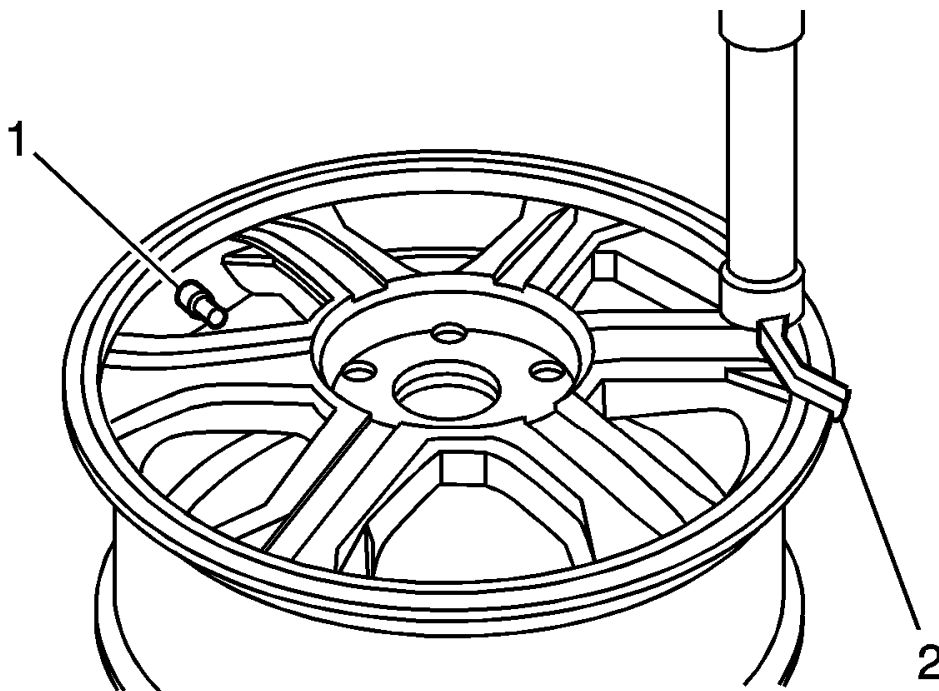


Fig. 17: Position Rim So Valve Stem Is At 7 O'clock Position Relative To Head
Courtesy of GENERAL MOTORS COMPANY

10. Position the rim so the valve stem (1) is at the 7 o'clock position relative to the head (2). This will protect

the sensor when the bottom bead seats.

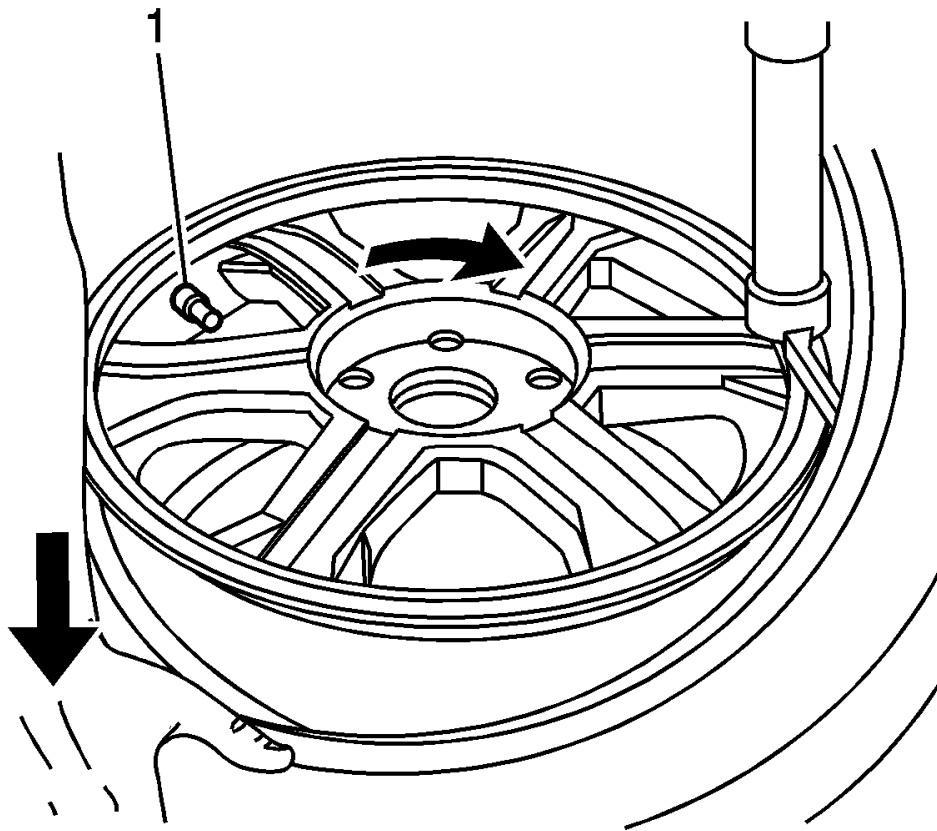


Fig. 18: Ensure Valve Stem Is At 7 O'clock Position
Courtesy of GENERAL MOTORS COMPANY

11. Using the tire machine, rotate the tire/wheel assembly clockwise when transferring the tire bead to the inside of the wheel rim. Ensure that the valve stem (1) is at the 7 o'clock position.

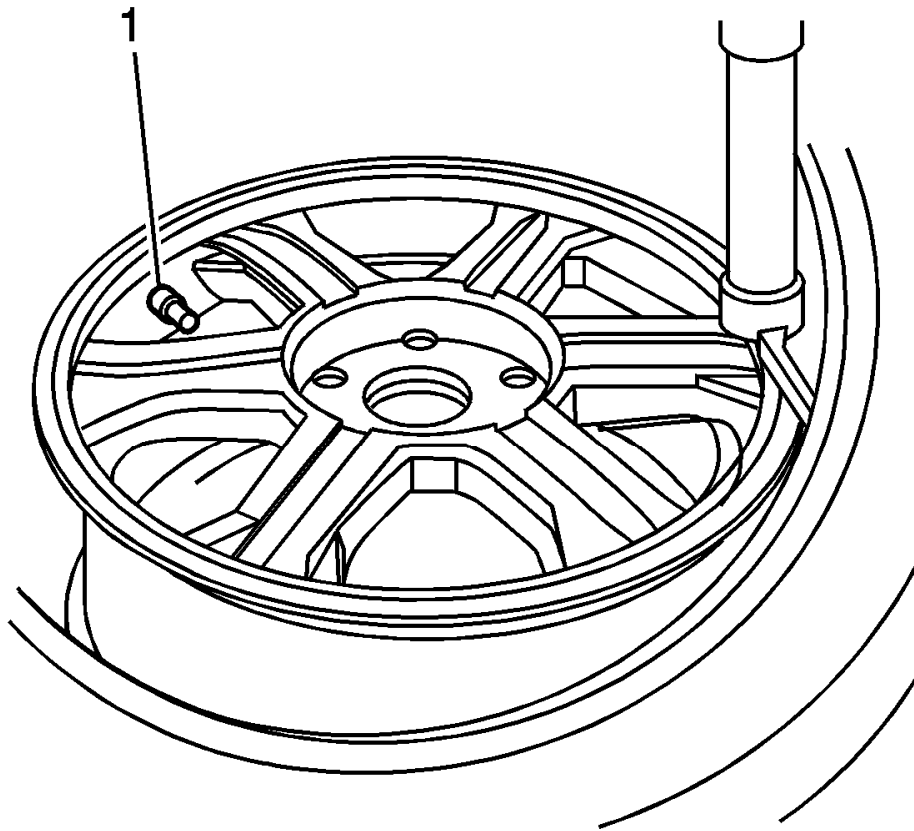


Fig. 19: Reposition Wheel And Tire So Valve Stem Is At 7 O'clock Position Relative To Head
Courtesy of GENERAL MOTORS COMPANY

12. After the bottom bead is on the wheel, reposition the wheel and tire so that the valve stem (1) is at the 7 o'clock position relative to the head. This will protect the sensor while mounting the tire bead to the outside of the wheel.

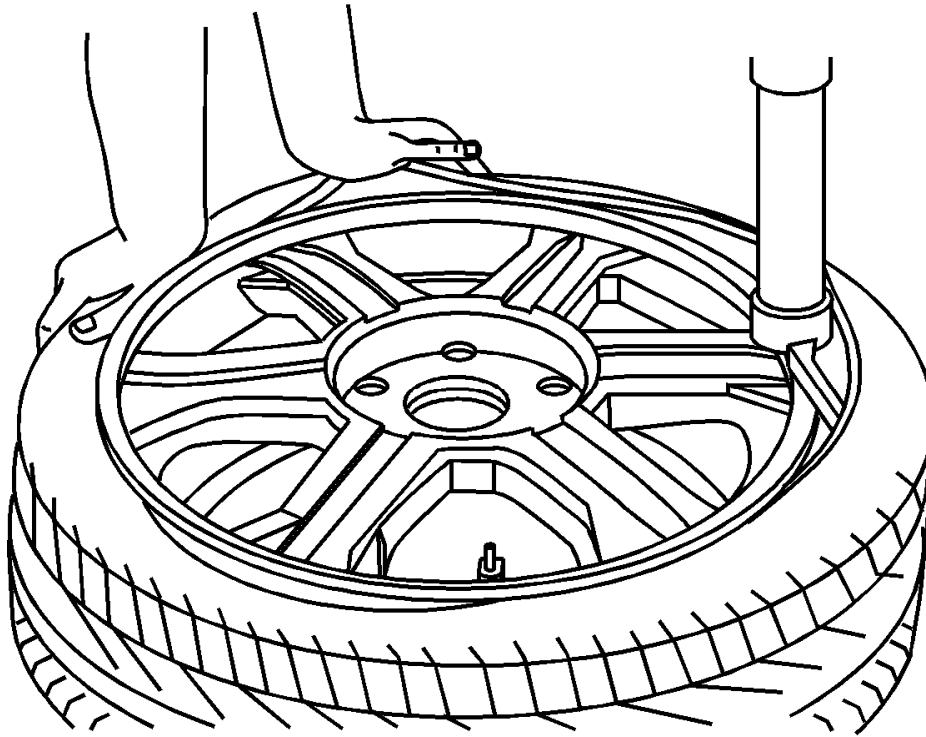


Fig. 20: Transferring Tire Bead
Courtesy of GENERAL MOTORS COMPANY

13. Use the tire changer in order to install the tire to the wheel.

WARNING: To avoid serious personal injury, do not stand over tire when inflating. The bead may break when the bead snaps over the safety hump. Do not exceed 275 kPa (40 psi) pressure when inflating any tire if beads are not seated. If 275 kPa (40 psi) pressure will not seat the beads, deflate, relubricate the beads and reinflate. Overinflation may cause the bead to break and cause serious personal injury.

14. Inflate the tire until it passes the bead humps. Be sure that the valve core is not installed at this time.
15. Install the valve core to the valve core stem.
16. Inflate the tire to the proper air pressure.
17. Ensure that the locating rings are visible on both sides of the tire in order to verify that the tire bead is fully seated on the wheel.

TIRE ROTATION

Rotate the tires and wheels at frequent intervals to equalize wear. Refer to **Maintenance Schedule** . In addition to scheduled rotation, rotate the tire and wheel whenever uneven tire wear is noticed.

Radial tires tend to wear faster in the shoulder area, particularly in front positions. Radial tires in non-drive locations may develop an irregular wear pattern that may increase tire noise. This makes regular rotation especially necessary.

Refer to **Tire and Wheel Removal and Installation**.

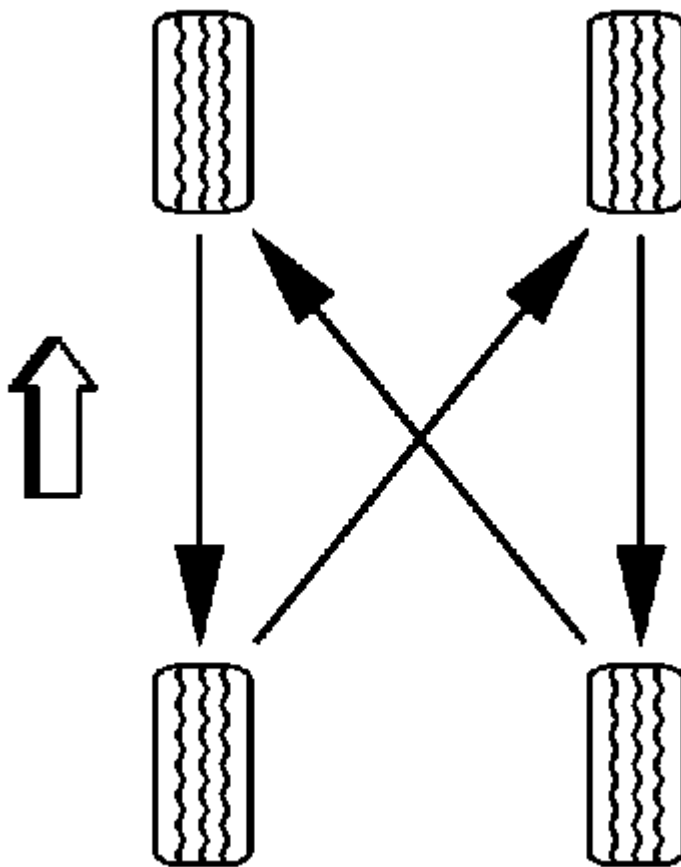


Fig. 21: Identifying Tire Rotation Pattern
Courtesy of GENERAL MOTORS COMPANY

Always use a 4-wheel rotation. After rotation, check the wheel nuts for specified torque. Then, set the tire pressure.

After the tires have been rotated, the tire pressure sensors must be reset, if applicable. Refer to Refer to Tire Pressure Indicator Sensor Learn.

DESCRIPTION AND OPERATION

ALL SEASONS TIRES DESCRIPTION

Steel belted all-season radial tires qualify as snow tires, with a higher than average rating for snow traction than the non-all season radial tires previously used. Other performance areas, such as wet traction, rolling resistance, tread life, and air retention, are also improved. This is done by improvements in both tread design and tread compounds. These tires are identified by an M + S molded in the tire side wall after the tire size. The suffix MS is also molded in the tire side wall after the TPC specification number.

GENERAL DESCRIPTION

This vehicle has been engineered to operate up to the stated load capacity with wheel and tire assemblies of the type, size, construction, and configuration as originally installed. Maintenance of the tire inflation pressures is critical to the continued satisfactory performance, handling, and operating economy of the vehicle. Operation with incorrectly or improperly inflated tires can adversely affect vehicle performance and may contribute to the following:

- Reduced fuel economy
- Tire overloading
- Shortened tire life
- Excessive tire wear
- Uneven tire wear
- Vehicle handling concerns

Inspect the tire pressures when the vehicle has not been driven for at least 3 hours or not more than 1.6 km (1 mi) and when the tires are cool to the touch.

Tire inflation pressures should be inspected monthly and before an extended trip and adjusted to meet the specifications listed for the particular vehicle. Replace any missing or damaged tire valve stem extensions and/or caps to prevent the intrusion of water and contaminants.

One pound per square inch (psi) equals 6.9 kilopascals (kPa). The following table illustrates the conversion of kilopascals to pounds per square inch:

Inflation Pressure Conversion (Kilopascals to PSI)

kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40

185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60
Conversion: 6.9 kPa = 1 psi			

For the correct inflation pressures refer to the vehicle Tire Placard.

Tires inflated to a higher than recommended pressure can contribute to the following conditions:

- A hard ride
- Tire bruising
- Rapid tread wear at the center of the tire

Tires inflated to a lower than recommended pressure can contribute to the following conditions:

- Tire squeal on turns
- Hard steering
- Rapid and/or uneven wear on the outer edges of the tread
- Tire rim bruises and tire rim rupture
- Tire cord breakage
- High tire temperatures
- Sluggish vehicle handling
- Higher fuel consumption

Unequal pressure on the same axle can cause the following conditions:

- Uneven braking action
- Steering lead
- Imprecise vehicle handling

METRIC WHEEL NUTS AND BOLTS DESCRIPTION

Metric wheel/nuts and bolts are identified in the following way:

- The wheel/nut has the word Metric stamped on the face.
- The letter M is stamped on the end of the wheel bolt.

The thread sizes of metric wheel/nuts and the bolts are indicated by the following example: M12 x 1.5.

- M = Metric
- 12 = Diameter in millimeters
- 1.5 = Millimeters gap per thread

P-METRIC SIZED TIRES DESCRIPTION

Tire Designation

The dimensions of a P-metric sized tire are described in its designation as per the following table.

Example: 205/65 R 15 94V

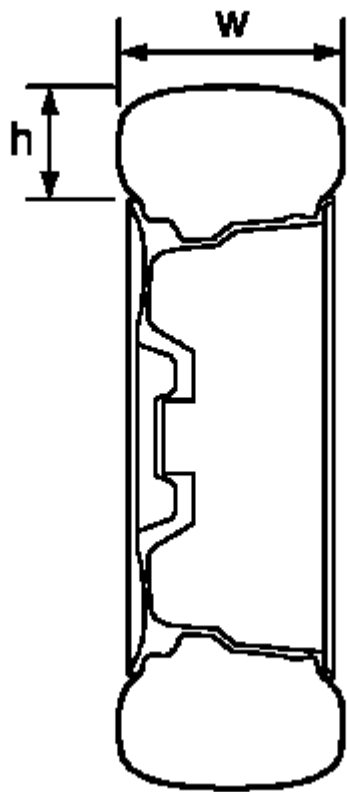


Fig. 22: View Of Tire Width & Height
Courtesy of GENERAL MOTORS COMPANY

Designation	Explanation
205	Tire width in mm
65	Aspect ratio height (h)/width (w) %
R	Construction type, see table below
16	Rim diameter in inches
94	Load index, see table below
V	Speed rating, see table below

Construction Type

Designation	Explanation

R	Radial
B	Bias-belted
D	Diagonal (Bias)

Load Index

Code	Max Load kg	Max Load lb
91	615	1353
93	650	1430
94	670	1474
95	690	1518

Speed Rating

Code	Max Speed km/h	Max Speed mph
Q	160	99
S	180	112
T	190	118
H	210	130
V	240	149
W	270	168
Y	300	186

The marking of the tire in the example means:

- 205 - Tire width is 205 mm
- 65 - Aspect Ratio is 65% (height is 65% of width)
- 205 - Tire width is 205 mm
- 16 - The tire is for 16 inch rim
- 94 - Max load is 670 kg (1,474 lb)
- V - Max speed is 240 km/h (149 mph)

There may sometimes be an added marking showing that the tire can handle more load:

- RF - Reinforced
- XL - Extra Load

Winter tires have an extra marking M+S.

Week of Manufacture

The week and year of manufacture is indicated on the tire.

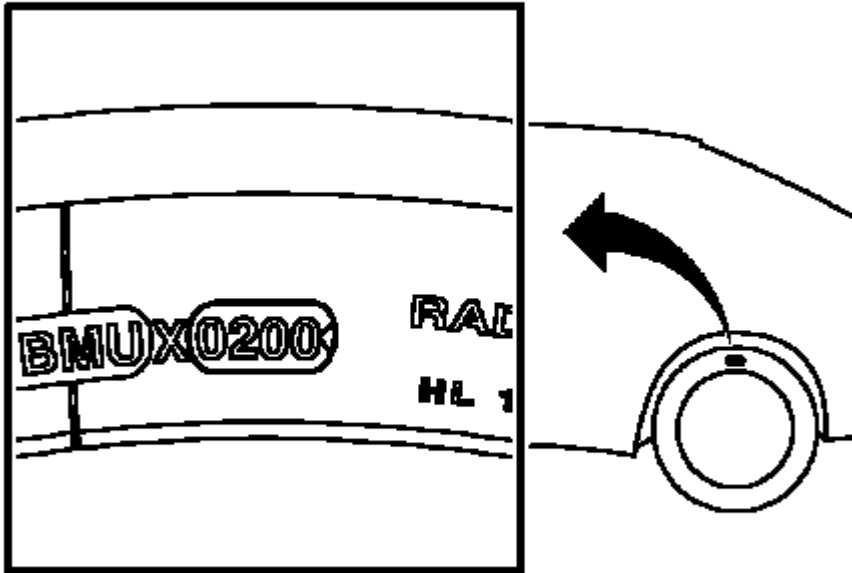


Fig. 23: Week Of Manufacture
Courtesy of GENERAL MOTORS COMPANY

The 2 first digits states the production week and the 2 last digits states the year. The symbol "<" points to the year. The code 0200< means that the tire is manufactured week 02 year 2000.

Replacing Tires

When replacing wheels/tires/rims using other dimensions always use the diagnostic tool to program the new values to avoid inaccuracy for e.g. speedometer, odometer and TPMS.

Most P-metric tire sizes do not have exact corresponding alphanumeric tire sizes. Replacement tires should be of the same tire performance criteria TPC specification number including the same size, the same load range, and the same construction as those originally installed on the vehicle.

REPLACEMENT WHEELS DESCRIPTION

Replace the wheel if any of the following conditions exist:

- The wheel exhibits excessive runout.
- The wheel is bent.
- The wheel is cracked.

- The wheel is severely corroded.
- The wheel leaks air.

WARNING: If you are replacing the wheel(s), the wheel stud(s), the wheel nut(s) or the wheel bolt(s), install only new GM original equipment parts. Installation of used parts or non-GM original equipment parts may cause the wheel to loosen, loss of tire air pressure, poor vehicle handling and loss of vehicle control resulting in personal injury.

CAUTION: The use of non-GM original equipment wheels may cause:

- Damage to the wheel bearing, the wheel fasteners and the wheel
- Tire damage caused by the modified clearance to the adjacent vehicle components
- Adverse vehicle steering stability caused by the modified scrub radius
- Damage to the vehicle caused by the modified ground clearance
- Speedometer and odometer inaccuracy

Replace the wheel, the wheel studs and the wheel/nuts, or the wheel bolts if applicable, if any of the following conditions exist:

- The wheel has elongated bolt holes.
- The wheel/nuts, or bolts if applicable, loosen repeatedly.

Aluminum wheel identification is cast into the inboard side of the wheel.

When replacing wheels/tires/rims using other dimensions always use the diagnostic tool to program the new values to avoid inaccuracy for e.g. speedometer, odometer and TPMS.

TIRE INFLATION DESCRIPTION

The factory installed tires are designed to operate satisfactorily with loads up to and including the full rated load capacity when these tires are inflated to the recommended pressures.

The following factors have an important influence on tire life:

- Correct tire pressures
- Correct wheel alignment
- Proper driving techniques
- Tire rotation

The following factors increase tire wear:

- Heavy cornering
- Excessively rapid acceleration
- Heavy braking

TREAD WEAR INDICATORS DESCRIPTION

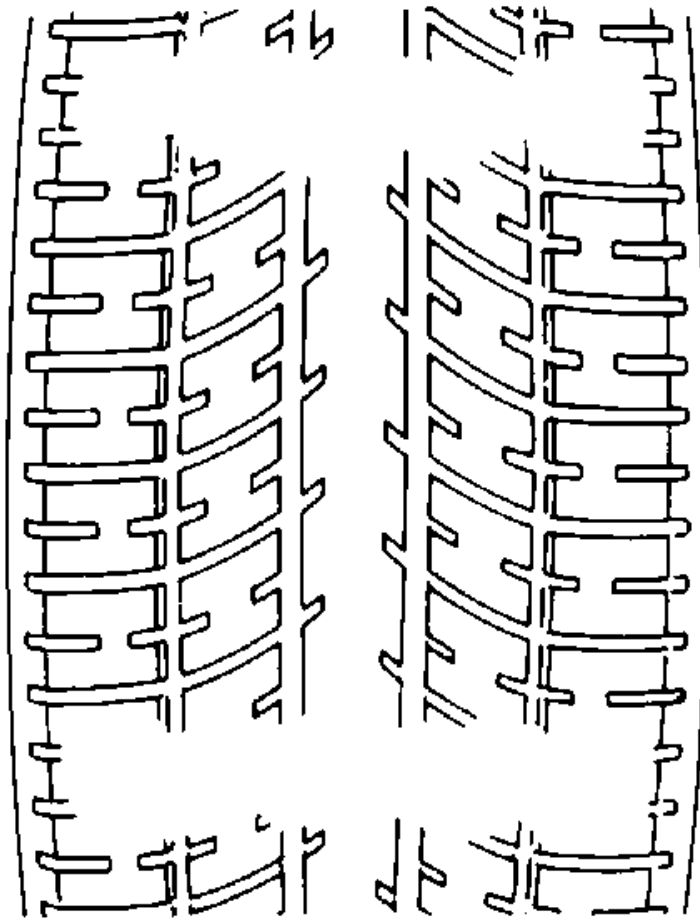


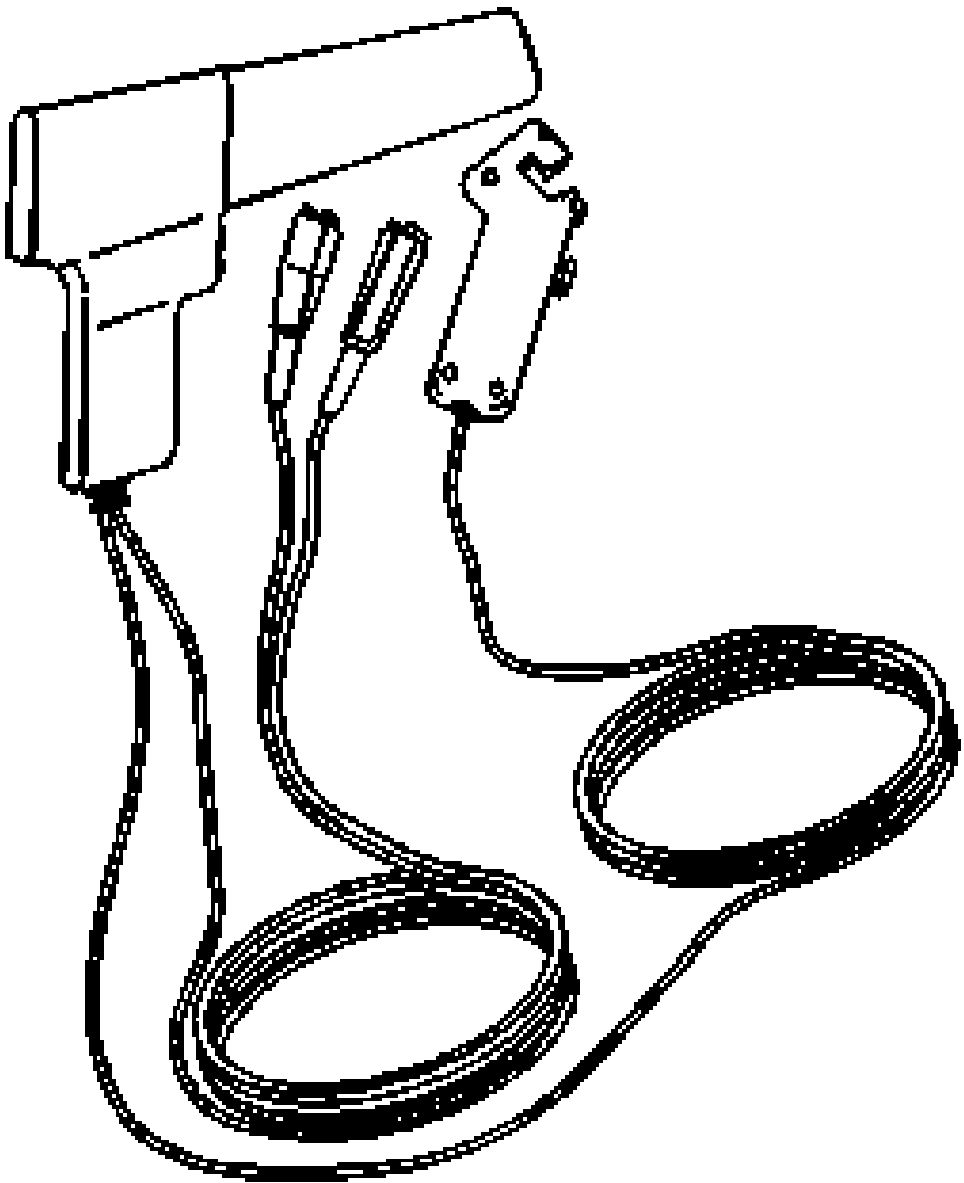
Fig. 24: View Of Tread Wear Indicators
 Courtesy of GENERAL MOTORS COMPANY

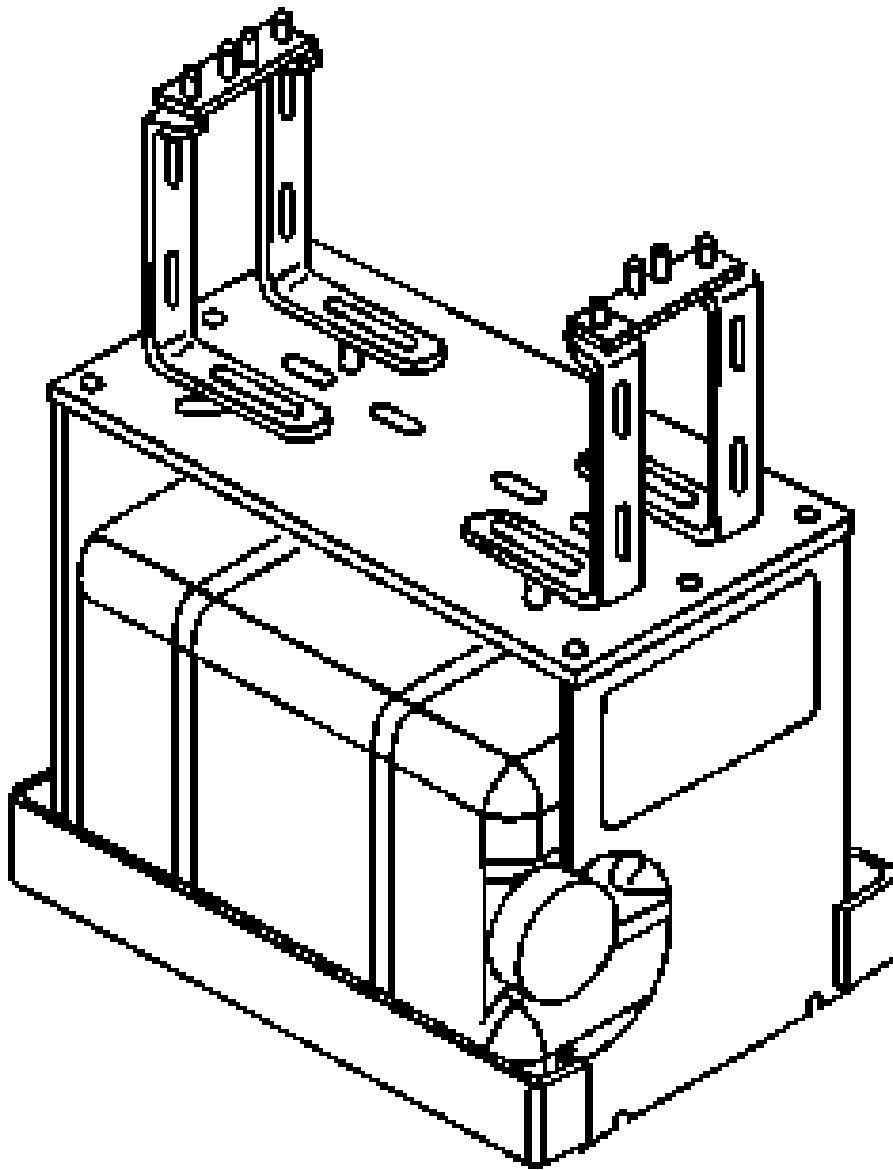
The original equipment tires have tread wear indicators that show when you should replace the tires.

The location of these indicators are at 60 degree intervals around the outer diameter of the tire. The indicators appear as a 6 mm (0.25 in) wide band when the tire tread depth becomes 1.6 mm (2/32 in).

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	CH 41013 J 41013 Rotor Resurfacing kit



CH 42450-
A
J 42450-A
Wheel Hub
Resurfacing
Kit

Transmission

Transfer Case - AAM

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Transfer Case Bracket-to-Engine Bolts	22 N.m	16 lb ft
Transfer Case Bracket-to-Rear Extension Housing Bolts	58 N.m	43 lb ft
Transfer Case-to-Transmission Bolts	110 N.m	81 lb ft
Transfer Case-to-Transmission Bolts- RPO MXE		
• First pass	100 N.m	74 lb ft
• Second pass	60 degrees	
Transfer Case Housing-to-Rear Extension Housing Bolts		
• First pass	25 N.m	18 lb ft
• Second pass	130 degrees	
Transfer Case Oil Fill Plug	40 N.m	30 lb ft
Transfer Case Oil Drain Plug	40 N.m	30 lb ft
Transfer Case Rear Output Shaft Flange Bolts	35 N.m	25 lb ft
Transfer Case Vent	25 N.m	18 lb ft

APPROXIMATE FLUID CAPACITIES

Approximate Fluid Capacities

Application	Specification	
	Metric	English
Transfer Case Oil GM P/N 19256084 (Canadian P/N 19256085)	0.65 L	0.69 qt

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Transfer Case Oil	Lubricant	19256084	19256085
Intermediate Shaft Output Splines	Lubricant	1051344	00993037
Transfer Case Rear	Threadlocker	89021297	10953488

Extension Housing Bolts			
Transfer Case Rear Extension Housing Bolt Holes	Cleaner	88862650	88901247
Vent Hose Connector Threads	Sealant	12346004	10953480

COMPONENT LOCATOR

TRANSFER CASE DISASSEMBLED VIEW

Transfer Case Components

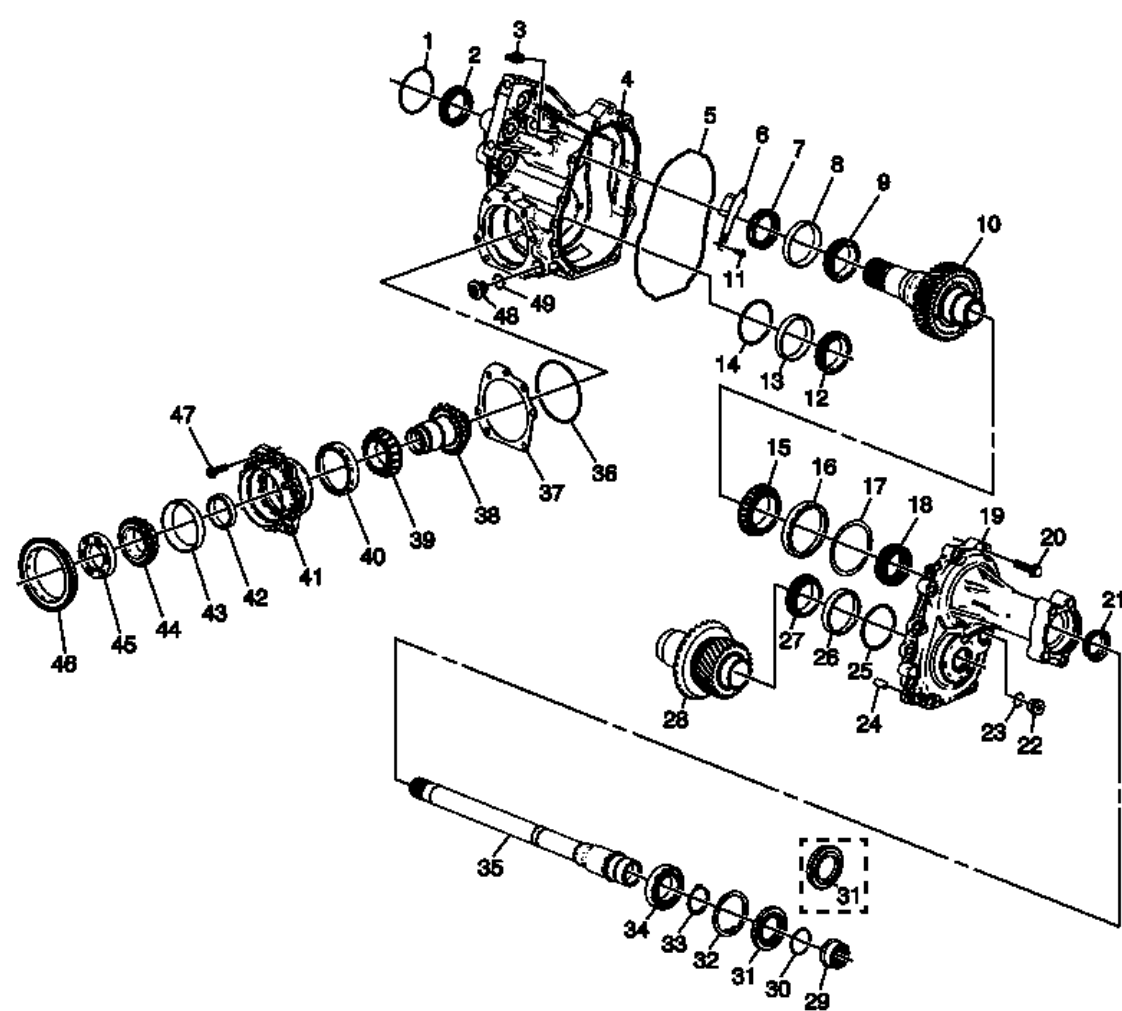


Fig. 1: Transfer Case Components (MH4)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Transmission-to-Transfer Case O-ring Seal

2	Input Shaft Front (outer) Seal
3	Transfer Case Vent Hose Connector
4	Transfer Case Housing
5	Transfer Case Rear Extension Housing-to-Transfer Case Seal
6	Transfer Case Vent Baffle
7	Input Shaft Front (inner) Seal
8	Input Shaft Front Bearing Race
9	Input Shaft Front Bearing
10	Input Shaft
11	Transfer Case Vent Baffle Bolt
12	Idler Shaft Front Bearing
13	Idler Shaft Front Bearing Race
14	Idler Shaft Front Bearing Shim
15	Input Shaft Rear Bearing
16	Input Shaft Rear Bearing Race
17	Input Shaft Rear Bearing Shim
18	Input Shaft Bearing Retainer Rear Seal
19	Rear Extension Housing
20	Transfer Case-to-Rear Extension Housing Bolt
21	Intermediate Shaft Seal
22	Transfer Case Fill Plug
23	Transfer Case Fill Plug Sealing Washer
24	Transfer Case-to-Rear Extension Housing Locating Pin
25	Idler Shaft Rear Bearing Shim
26	Idler Shaft Rear Bearing Race
27	Idler Shaft Rear Bearing
28	Idler Shaft
29	Transfer Case Seal
30	Intermediate Shaft O-ring Seal - Second Design
31	Intermediate Shaft Dirt Deflector - Model Dependent
32	Intermediate Shaft Assembly Retaining Ring
33	Intermediate Shaft Bearing Retaining Ring
34	Intermediate Shaft Bearing
35	Intermediate Shaft
36	Rear Output Shaft Housing O-ring Seal
37	Rear Output Shaft Shim
38	Rear Output Shaft
39	Rear Output Shaft Bearing
40	Rear Output Shaft Bearing Race
41	Rear Output Shaft Housing
42	Rear Output Shaft Bearing Spacer

	Rear Output Shaft Bearing Race
44	Rear Output Shaft Bearing
45	Rear Output Drive Gear Nut
46	Rear Output Shaft Seal
47	Rear Output Shaft Housing Bolt
48	Transfer Case Drain Plug
49	Transfer Case Drain Plug Sealing Washer

Transfer Case Seal View

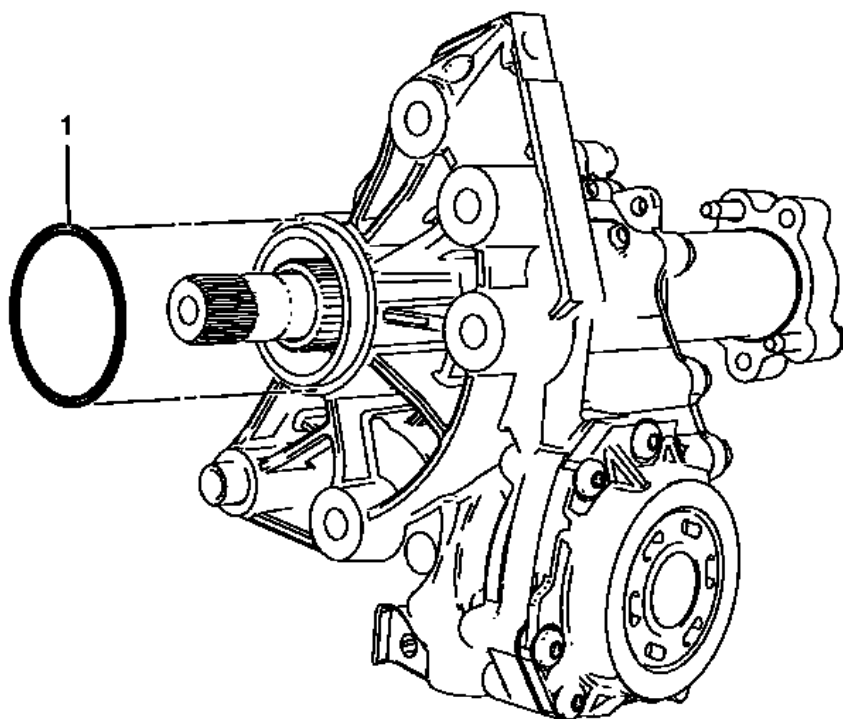


Fig. 2: Transfer Case Seal View

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Transfer Case-to-Transmission Seal

Transfer Case Mounting

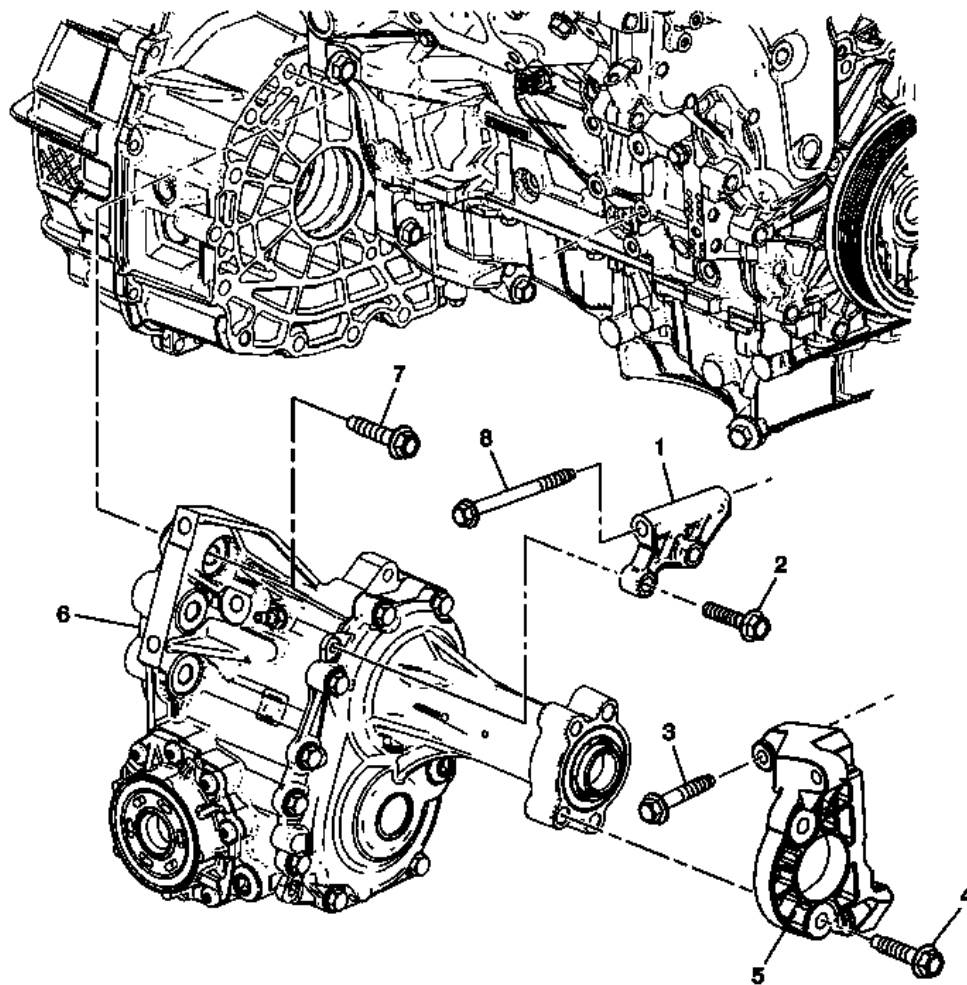


Fig. 3: Transfer Case Mounting Components (MH4)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Transaxle Brace
2	Transaxle Brace Bolt
3	Transfer Case Bracket-to-Engine Bolt
4	Transfer Case Bracket Bolt
5	Transfer Case Bracket
6	Transfer Case
7	Transfer Case-to-Transmission Bolt
8	Transaxle Brace-to-Engine Bolt

Vent Hose Assembly

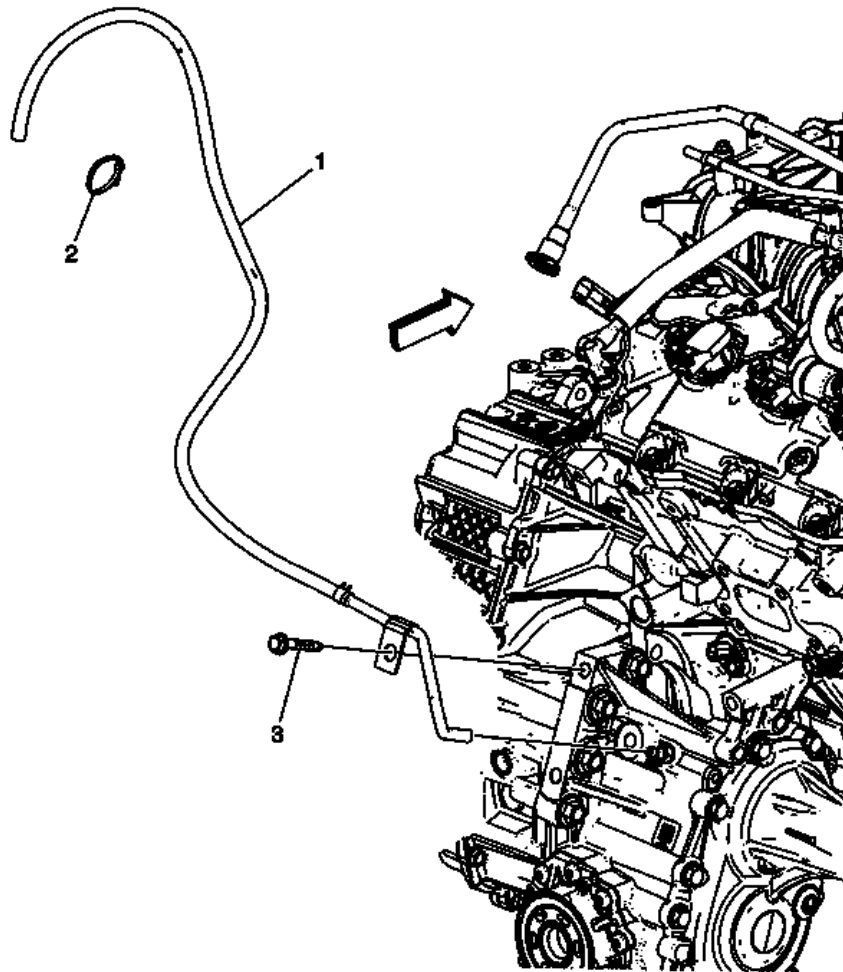


Fig. 4: Vent Hose Assembly Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Vent Hose Assembly
2	Strap
3	Bolt

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - TRANSFER CASE

Strategy Based Diagnostics

Review the system operations in order to familiarize yourself with the system functions. Refer to **Transfer Case Disassembled View**, **Transfer Case Description and Operation**, and **DESCRIPTION AND OPERATION** . All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed

explanation, refer to **Strategy Based Diagnosis** .

Visual/Physical Inspection

- Inspect for aftermarket devices, which could affect the operation of the vehicle. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions, which could cause the symptom.
- Inspect for the correct lubricant levels and the proper viscosities.
- Verify the exact operating conditions under which the concern exists. Note factors such as vehicle speed, road conditions, ambient temperature, and other specifics.
- Compare the driving characteristics or sounds, if applicable, to a known good vehicle and ensure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Diagnostic System Check - Vehicle**
- **Noisy in Drive**
- **Noisy When Coasting**
- **Intermittent Noise**
- **Constant Noise**
- **Transfer Case Leak Diagnosis**

NOISY IN DRIVE

Noisy in Drive

Cause	Correction
Inspect for the proper transaxle and gear oil levels prior to performing system diagnosis.	
Low gear oil level	Inspect the transfer case for leaks, repair as required. Refer to <u>Transfer Case Leak Diagnosis</u> , and <u>Adhesives, Fluids, Lubricants, and Sealers</u> .
Incorrect gear oil in the transfer case	Replace the gear oil. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .
Water or contamination within the lubricant	Replace the lubricant and flush the transfer case of the contaminated fluid.
Worn propeller shaft constant velocity joints	Replace propeller shaft assembly. Refer to <u>Propeller Shaft Replacement</u> .

Worn or noisy wheel bearings	Replace the wheel bearings as required.
Worn axle shaft constant velocity joints	Replace the constant velocity joints, as required.
Worn bearing in the differential assembly	Repair or replace the assembly.
Bearing noise within the transfer case <ul style="list-style-type: none"> • A grinding noise that occurs at a specific engine speed, regardless of transmission gear, is not within the transfer case. • A grinding noise that changes as a transmission shift occurs is not within the transfer case. • A grinding noise that changes as vehicle speed changes may be also caused by worn wheel bearings. • A grinding noise that changes as the vehicle turns may also be caused by worn wheel bearings and/or tires. 	<ol style="list-style-type: none"> 1. Inspect for the proper fluid level. Fill, as required. 2. Identify the location of the noise using the J 39570 Chassis Ears. 3. If the noise continues, repair or replace components, as required.
Gear set whine noise within the transfer case <ul style="list-style-type: none"> • A whine noise that occurs at a specific engine speed, regardless of transmission gear, is not within the transfer case. • A whine noise that changes as a transmission shift occurs is not within the transfer case. • A whine noise that changes as vehicle speed changes may be also caused by worn wheel bearings. • A whine noise that changes as the vehicle turns may also be caused by worn wheel bearings and/or tires. 	<ol style="list-style-type: none"> 1. Inspect for the proper fluid level. Fill, as required. 2. Identify the location of the noise using the J 39570 Chassis Ears. 3. If the noise continues, repair or replace components, as required.

NOISY WHEN COASTING

Noisy When Coasting

Cause	Correction
Inspect for the proper transaxle and gear oil levels prior to performing system diagnosis.	
Low gear oil level	Inspect the transfer case for leaks, repair as required. Refer to <u>Transfer Case Leak Diagnosis</u> , and <u>Adhesives, Fluids, Lubricants, and Sealers</u> .
Incorrect gear oil in the transfer case.	Replace the gear oil. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .
Worn propeller shaft constant velocity joints	Replace the propeller shaft assembly. Refer to <u>Propeller Shaft Replacement</u>
Worn axle shaft constant velocity joints	Replace the constant velocity joints, as required.

Worn bearing in the differential assembly	Repair or replace the assembly as required.
Bearing noise within the transfer case <ul style="list-style-type: none"> • A grinding noise that occurs at a specific engine speed, regardless of transmission gear, is not within the transfer case. • A grinding noise that changes as a transmission shift occurs is not within the transfer case. • A grinding noise that changes as vehicle speed changes may be also caused by worn wheel bearings. • A grinding noise that changes as the vehicle turns may also be caused by worn wheel bearings and/or tires. 	<ol style="list-style-type: none"> 1. Inspect for the proper fluid level. Fill, as required. 2. Identify the location of the noise using the J 39570 Chassis Ears. 3. If the noise continues, repair or replace components, as required.
Gear set whine noise within the transfer case <ul style="list-style-type: none"> • A whine noise that occurs at a specific engine speed, regardless of transmission gear, is not within the transfer case. • A whine noise that changes as a transmission shift occurs is not within the transfer case. • A whine noise that changes as vehicle speed changes may be also caused by worn wheel bearings. • A whine noise that changes as the vehicle turns may also be caused by worn wheel bearings and/or tires. 	<ol style="list-style-type: none"> 1. Inspect for the proper fluid level. Fill, as required. 2. Identify the location of the noise using the J 39570 Chassis Ears. 3. If the noise continues, repair or replace components, as required

INTERMITTENT NOISE

Intermittent Noise

Cause	Correction
Inspect for the proper transaxle and gear oil levels prior to performing system diagnosis.	
Incorrect gear oil in the transfer case.	Replace the gear oil. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .
Transfer case bearing or rear drive axle clutch module. A chatter or racheting type noise during hard acceleration on tight turns.	Confirm noise is coming from the transfer case or the rear drive axle clutch module. Repair as required.

CONSTANT NOISE

Constant Noise

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Cause	Correction
Inspect for the proper transaxle and gear oil levels prior to performing system diagnosis.	
Low gear oil level	Inspect the transfer case for leaks, repair as required. Refer to <u>Transfer Case Leak Diagnosis</u> , and <u>Adhesives, Fluids, Lubricants, and Sealers</u> .
Incorrect gear oil in the transfer case	Replace the gear oil. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .
Worn propeller shaft constant velocity joints	Replace the propeller shaft assembly. Refer to <u>Propeller Shaft Replacement</u> .
Worn bearing in the differential assembly	Repair or replace the assembly as required.
Bearing noise within the transfer case <ul style="list-style-type: none"> • A grinding noise that occurs at a specific engine speed, regardless of transmission gear, is not within the transfer case. • A grinding noise that changes as a transmission shift occurs is not within the transfer case. • A grinding noise that changes as vehicle speed changes may be also caused by worn wheel bearings. • A grinding noise that changes as the vehicle turns may also be caused by worn wheel bearings and/or tires. 	<ol style="list-style-type: none"> 1. Inspect for the proper fluid level. Fill, as required. 2. Identify the location of the noise using the J 39570 Chassis Ears. 3. If the noise continues, repair or replace components, as required.
Gear set whine noise within the transfer case <ul style="list-style-type: none"> • A whine noise that occurs at a specific engine speed, regardless of transmission gear, is not within the transfer case. • A whine noise that changes as a transmission shift occurs is not within the transfer case. • A whine noise that changes as vehicle speed changes may be also caused by worn wheel bearings. • A whine noise that changes as the vehicle turns may also be caused by worn wheel bearings and/or tires. 	<ol style="list-style-type: none"> 1. Inspect for the proper fluid level. Fill, as required. 2. Identify the location of the noise using the J 39570 Chassis Ears. 3. If the noise continues, repair or replace components, as required.

TRANSFER CASE LEAK DIAGNOSIS

Transfer Case Leak Diagnosis

Cause	Correction
DEFINITION: A visible indication of an external fluid leak from the transfer case. Review the <u>Symptoms - Transfer Case</u> and perform the necessary inspections. See below for suggested	

diagnostic method(s).

Special Tools

- **GE 28431-6** Fluorescent Oil Dye
- **GE 28428-E** High Intensity Black Light Kit

For equivalent regional tools, refer to **Special Tools**.

Fluorescent Dye Method

1. Add **GE 28431-6** Fluorescent dye to the transmission or transfer case to determine the source of the leak.
2. Operate the vehicle.
3. Inspect for the presence of dye within the oil leak using the **GE 28428-E** High Intensity Black Light Kit. A presence or non-presence of dye within the oil leak will indicate which component is the source of the leak.

Powder Method

CAUTION:

Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

1. Thoroughly clean the suspected leak area using a rag.
2. Apply an aerosol type leak tracing powder to the suspected leak area.

NOTE:

Do not drive the vehicle on the freeway as this will splatter oil inhibiting leak diagnosis.

3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Shut OFF the engine.
5. Inspect the suspected leak area.
6. Trace the leak path through the powder in order to find the source of the leak.

Drain plug or fill plug leak

1. Inspect for dirty, worn, scored sealing surfaces, or missing drain and/or fill plug sealing washers.
2. Replace as required.

Restricted or damaged ventilation hose assembly

Replace the ventilation hose assembly, as required.

Leaking at the transfer case left side weep hole

Replace components as required.

- A transmission oil leak at the transfer case weep hole area is caused by the transmission right side drive shaft seal.

If the leak is transmission or O-ring related, do not replace the transfer case input shaft seals.

<ul style="list-style-type: none"> • A gear oil leak at the transfer case weep hole area is caused by the transfer case input shaft front (inner) seal. 	
Leaking at the transfer case right side weep hole A transmission or gear oil leak at the transfer case right side weep hole is caused by the input shaft seal located in the rear extension housing.	Replace the input shaft seal.
Leaking ATF at the right side axle shaft-to-intermediate shaft bearing location	Replace the intermediate shaft seal located in the rear extension housing.
Leaking at rear output shaft area A leak at rear output shaft area is caused by either the rear output shaft seal or the rear output shaft housing O-ring seal.	Inspect and replace the rear output shaft seal as required. The O-ring is not serviceable on AAM transfer case.
Leaking at transaxle assembly-to-transfer case interface <ul style="list-style-type: none"> • A transmission oil leak at the transmission-to-transfer case interface may be caused by the transmission-to-transfer case o-ring seal. • A transmission oil leak at the transfer case weep hole area is caused by the transmission right side drive shaft seal. • A gear oil leak at the transfer case weep hole area is caused by the transfer case input shaft front (inner) seal. 	<p>NOTE: If the leak is transmission or O-ring related, do not replace the transfer case input shaft seals.</p> <ol style="list-style-type: none"> 1. Identify the type of oil leak. 2. Replace components as required.
Case half seam leak AAM	Disassemble and replace the transfer case-to-rear extension housing O-ring seal.
Leaking through case	<ul style="list-style-type: none"> • Inspect for a cracked case. • Inspect for case porosity.

REPAIR INSTRUCTIONS - ON VEHICLE

TRANSFER CASE FLUID REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

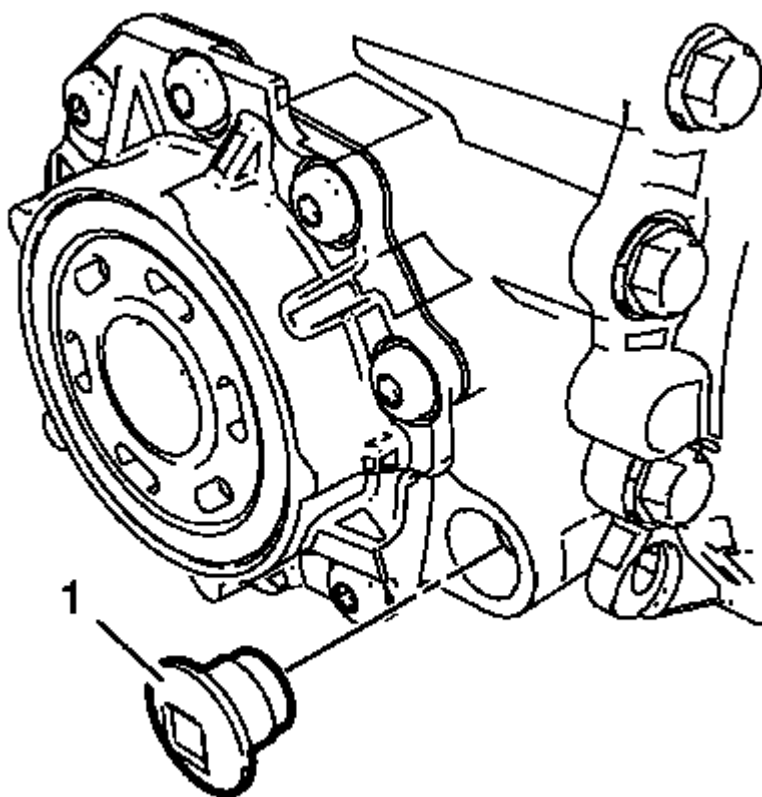


Fig. 5: View Of Transfer Case Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- When performing the following procedure, use only hand tools to remove and install the drain and fill plugs.
- Ensure that an approved drain pan is used when draining the transfer case.

2. Remove and DISCARD the oil drain plug (1) and seal.

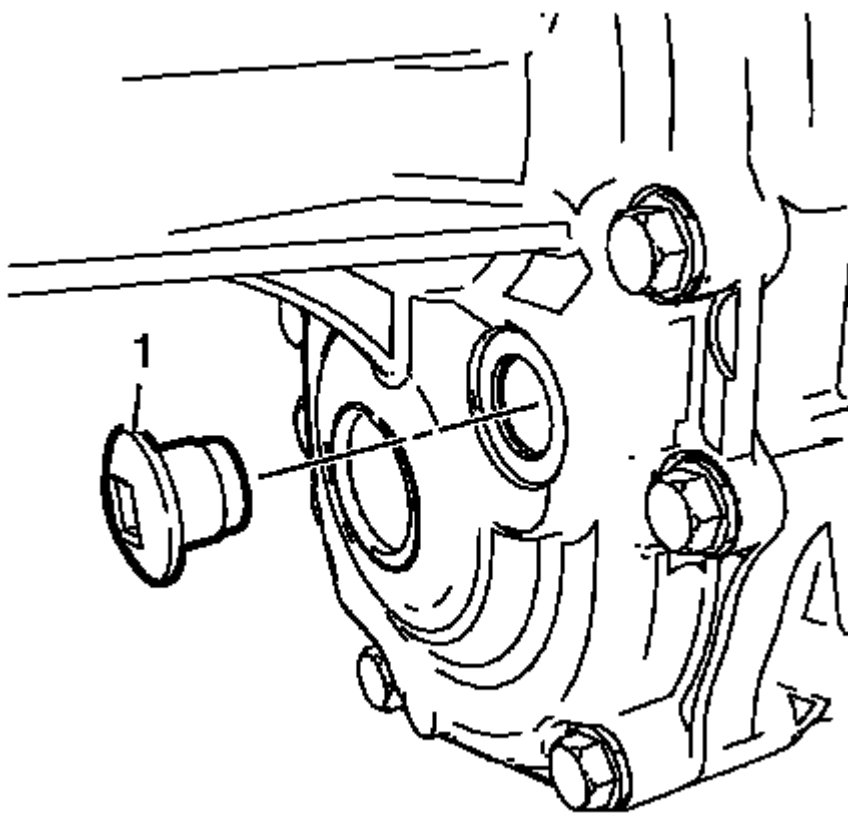


Fig. 6: Identifying Transfer Case Fill Plug
Courtesy of GENERAL MOTORS COMPANY

3. Remove and DISCARD the fill plug (1) and seal.
4. Allow the transfer case to drain completely.

Installation Procedure

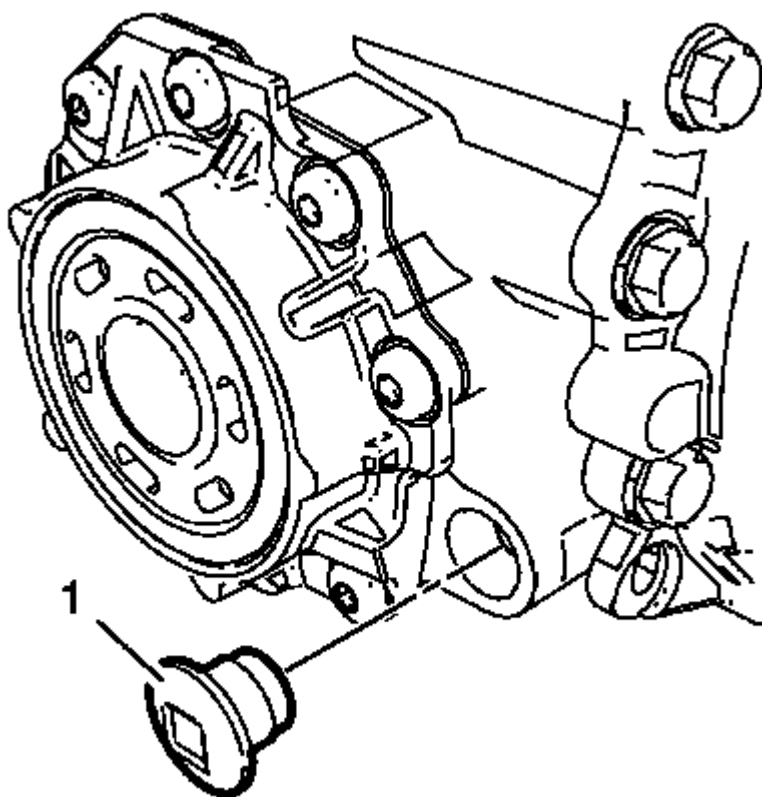


Fig. 7: View Of Transfer Case Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install a NEW drain plug (1) and seal and tighten to 50 (37 lb ft).
2. Fill the transfer case to the bottom of the fill plug hole with the recommended fluid.

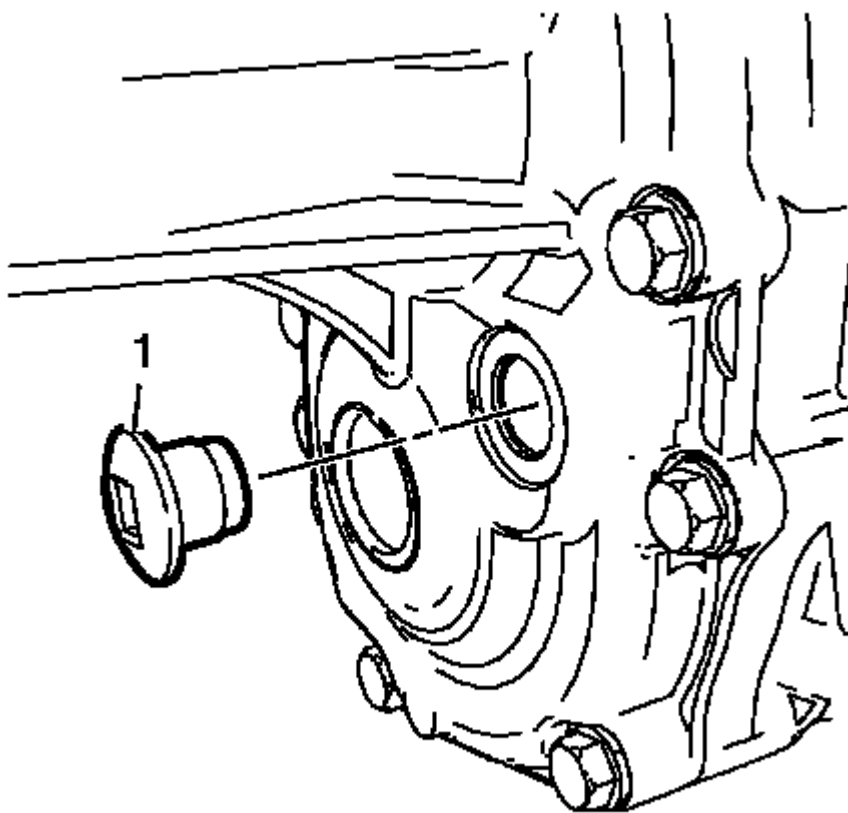


Fig. 8: Identifying Transfer Case Fill Plug
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW fill plug (1) and seal and tighten to 50 (37 lb ft).

DRAIN PLUG REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

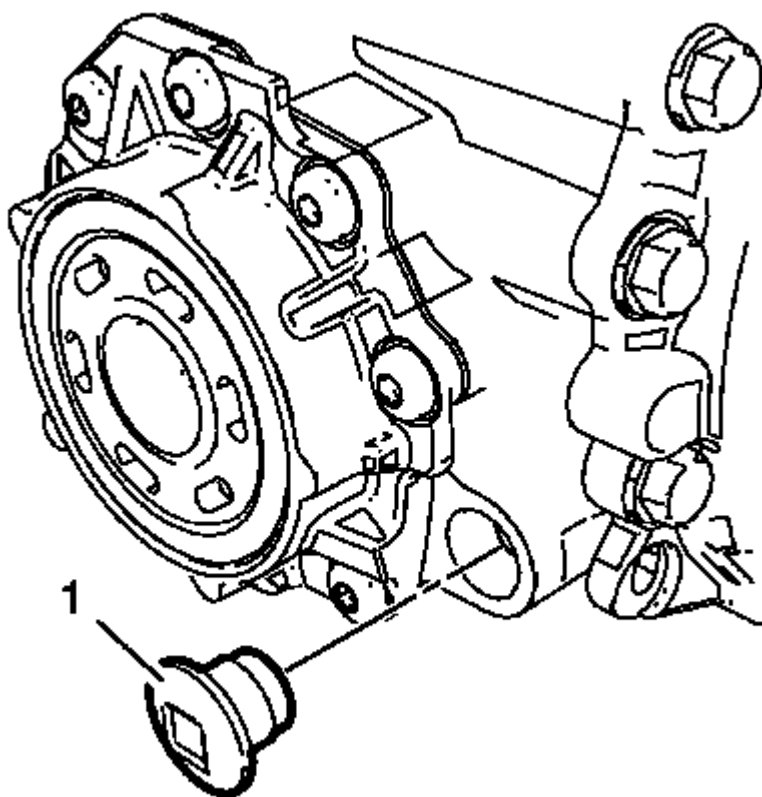


Fig. 9: View Of Transfer Case Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- When performing the following procedure, use only hand tools to remove and install the drain and fill plugs.
- Ensure that an approved drain pan is used when draining the transfer case.

2. Remove and DISCARD the oil drain plug (1) and seal.

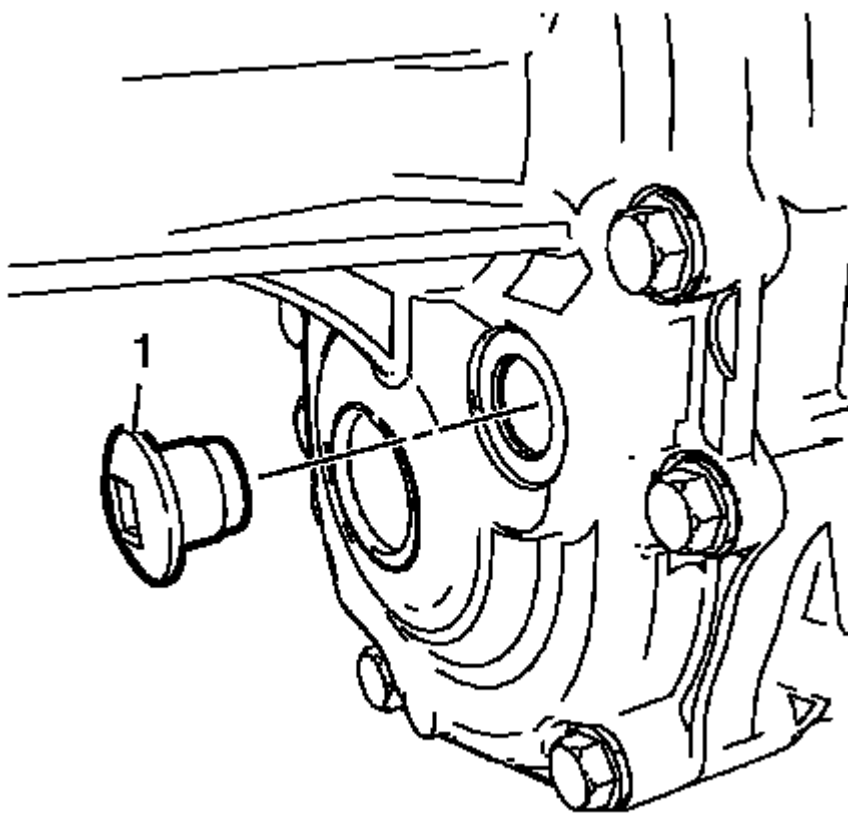


Fig. 10: Identifying Transfer Case Fill Plug
Courtesy of GENERAL MOTORS COMPANY

3. Remove and DISCARD the fill plug (1) and seal.
4. Allow the transfer case to drain completely.

Installation Procedure

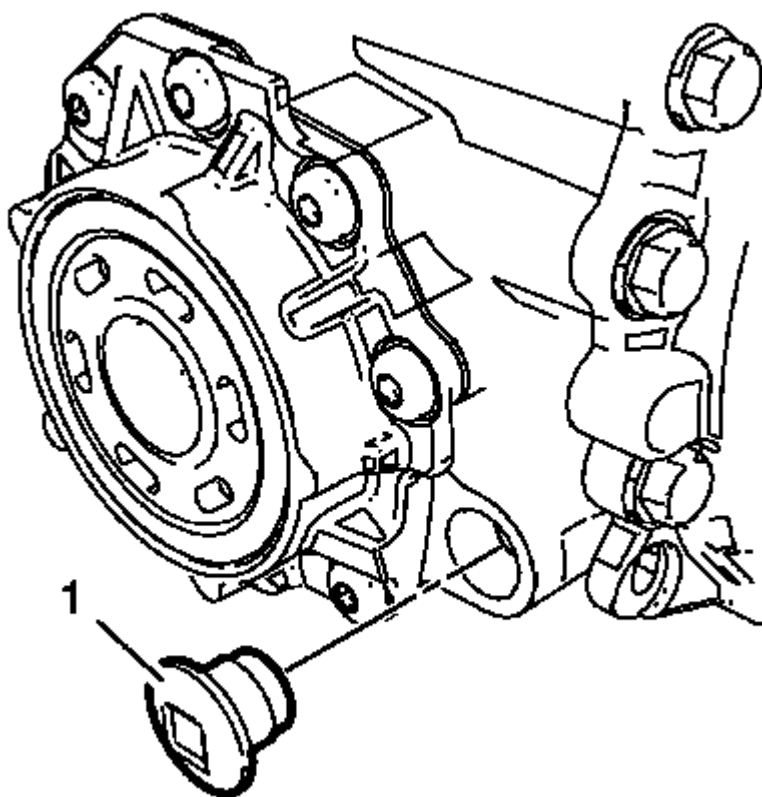


Fig. 11: View Of Transfer Case Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install a NEW drain plug (1) and seal and tighten to 50 (37 lb ft).
2. Fill the transfer case to the bottom of the fill plug hole with the recommended fluid.

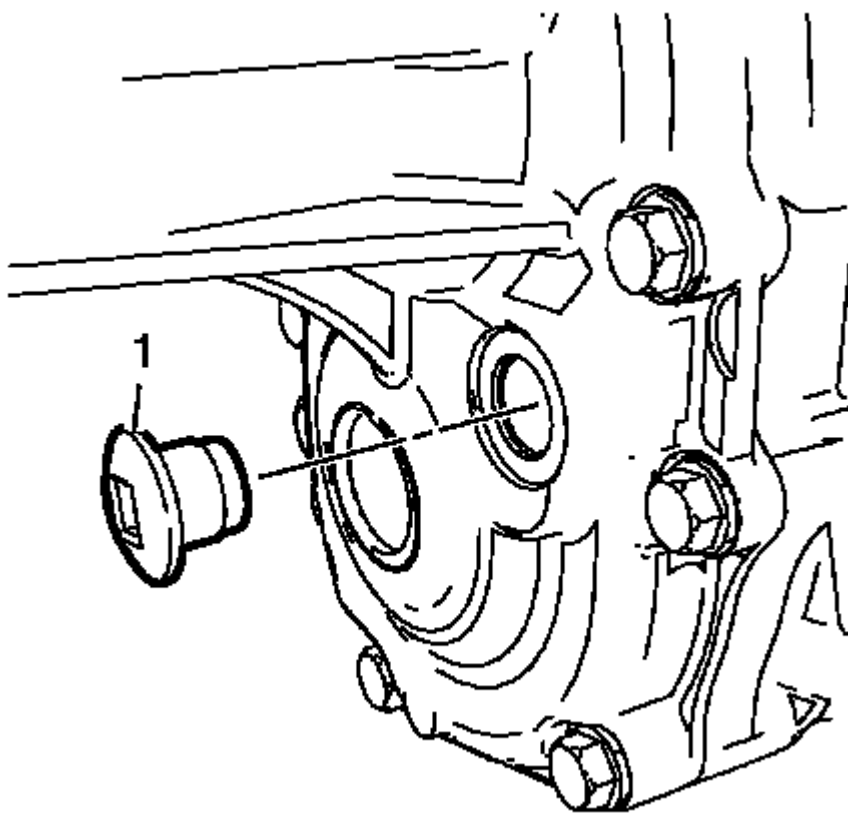


Fig. 12: Identifying Transfer Case Fill Plug
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW fill plug (1) and seal and tighten to 50 (37 lb ft).

FILL PLUG REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

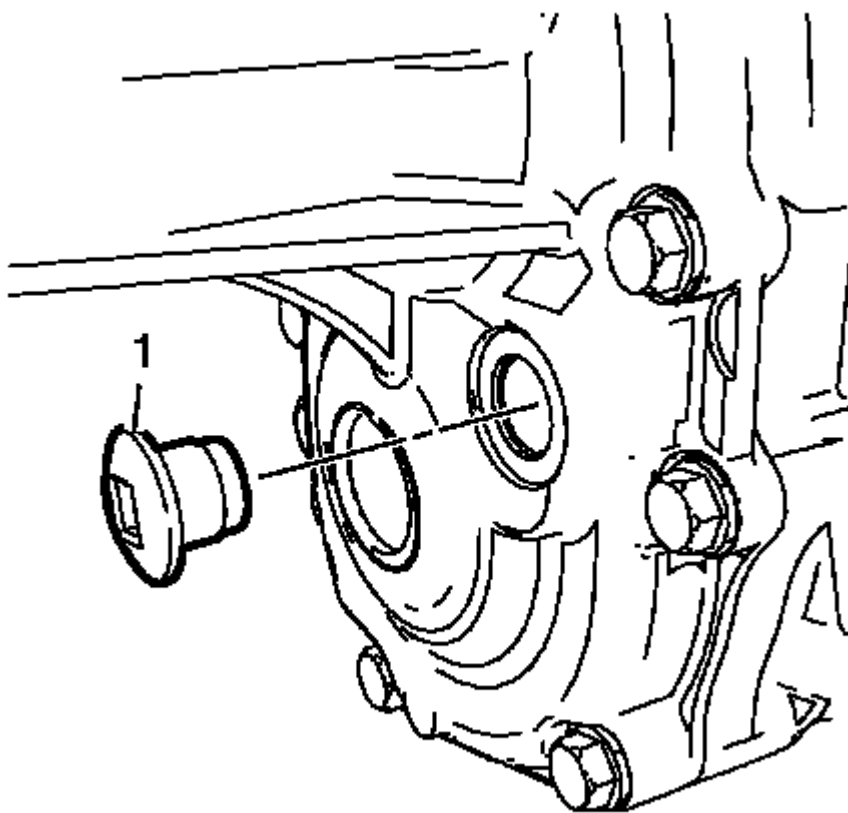


Fig. 13: Identifying Transfer Case Fill Plug
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD the fill plug (1) and seal.

Installation Procedure

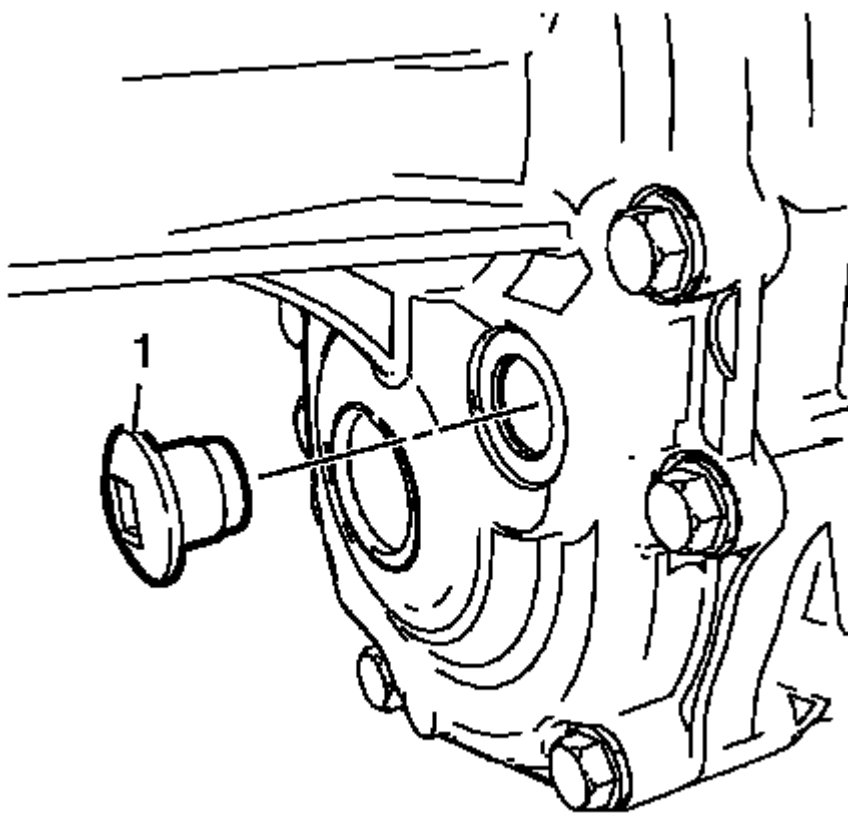


Fig. 14: Identifying Transfer Case Fill Plug
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install a NEW fill plug (1) and seal and tighten to 50 (37 lb ft).
2. Lower the vehicle.

FRONT OUTPUT SHAFT SEAL REPLACEMENT

Special Tools

- **DT-50768** Seal Installer
- **J-8092** Driver Handle

For equivalent regional tools, refer to Special Tools.

Removal Procedure

1. Remove the right wheel drive shaft. Refer to Front Wheel Drive Shaft Replacement - Right Side .

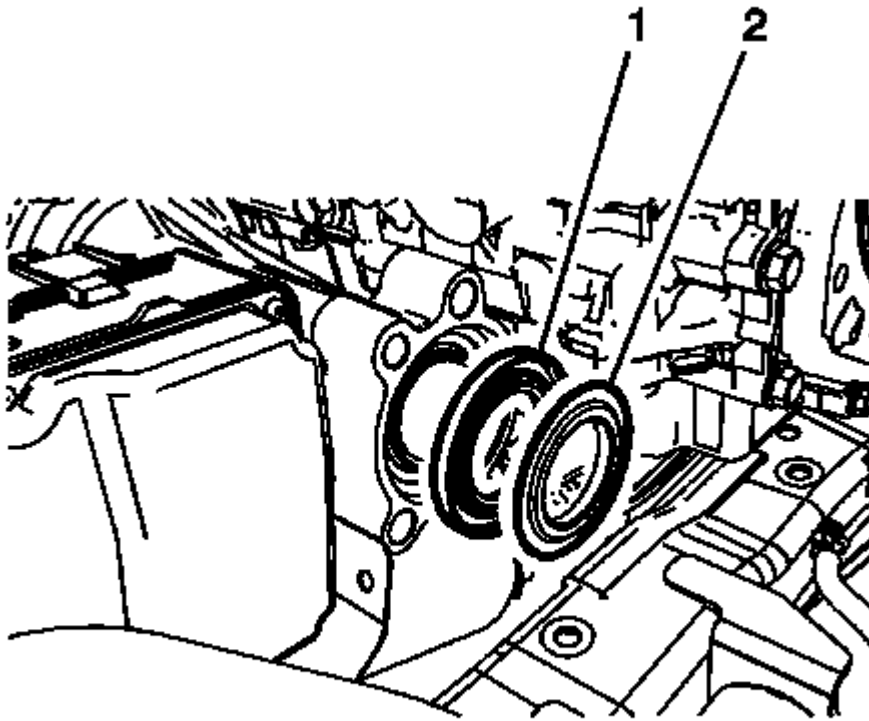


Fig. 15: Wheel Drive Shaft Seal And Dust Deflector
Courtesy of GENERAL MOTORS COMPANY

2. Remove the dust deflector (1) first using a prying type tool and then remove the seal (2) by installing a sheet metal screw into surface and removing with suitable pliers.
3. Discard the seal assembly (1,2).

Installation Procedure

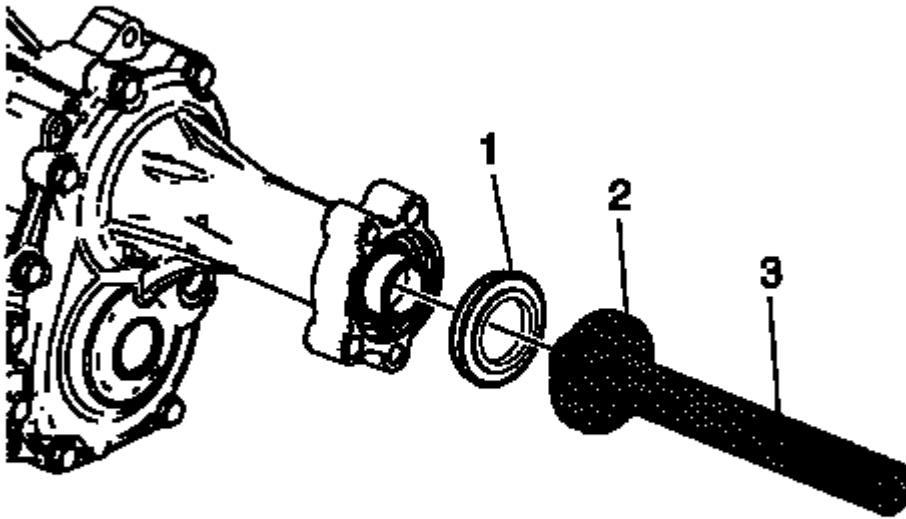


Fig. 16: Seal And Special Installer Tool
Courtesy of GENERAL MOTORS COMPANY

1. Install the New seal assembly (1) using the **DT-50768** seal installer (2) and **J-8092** driver handle (3).
2. Install the right wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .

FRONT WHEEL DRIVE INTERMEDIATE SHAFT REPLACEMENT

Special Tools

- **DT-113-2-A** Holder
- **DT-622-A** Transmission Bracket
- **DT-49104** Protective Collar
- **DT-50768** Seal Installer
- **J-8092** Driver Handle

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the transfer case from the vehicle. Refer to **Transfer Case Replacement**.

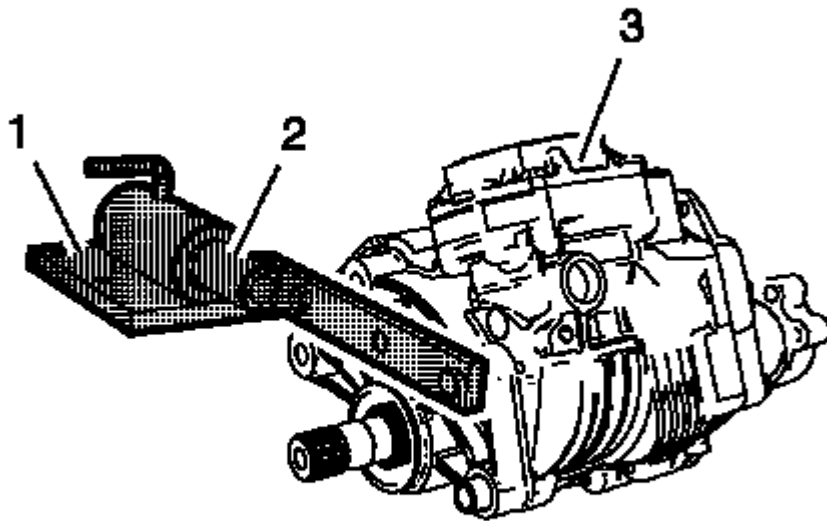


Fig. 17: Transmission Bracket, Transfer Case And Holder
Courtesy of GENERAL MOTORS COMPANY

2. Secure the transfer case (3) in **DT-113-2-A** holder (1), using the **DT-622-A** bracket (2).

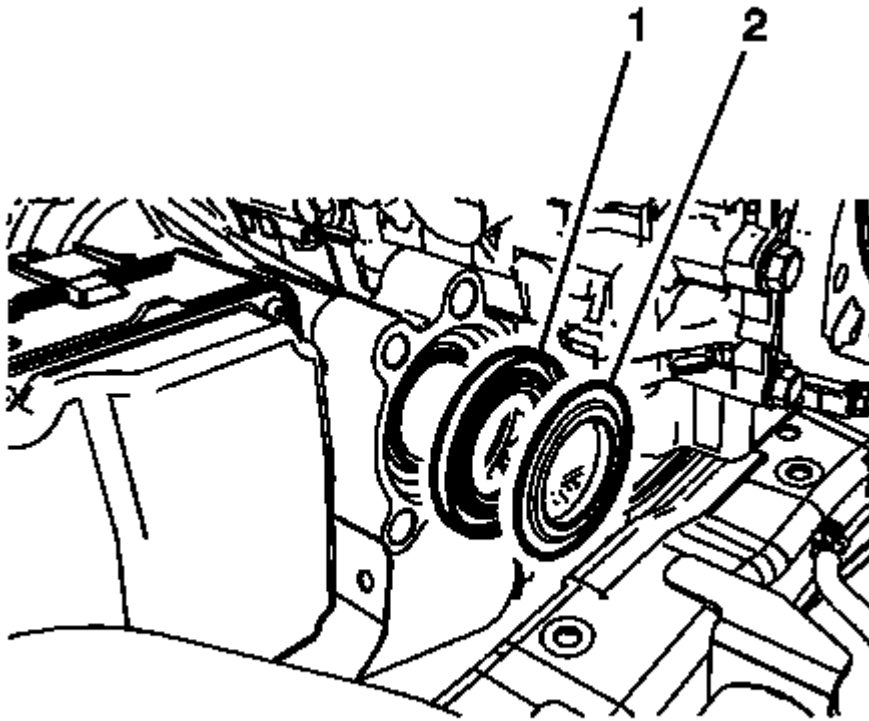


Fig. 18: Wheel Drive Shaft Seal And Dust Deflector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the dust deflector (1) first using a prying type tool and then remove the seal (2) by installing a sheet metal screw into surface and removing with suitable pliers.
4. Discard the seal assembly (1,2).

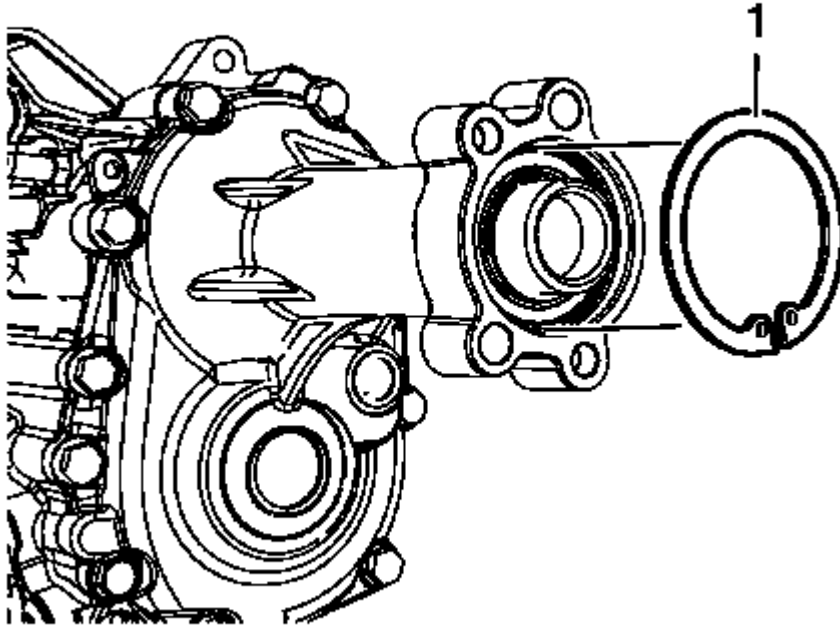


Fig. 19: Intermediate Shaft Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

5. Remove the transfer case intermediate shaft retaining ring (1), using suitable snap ring pliers.

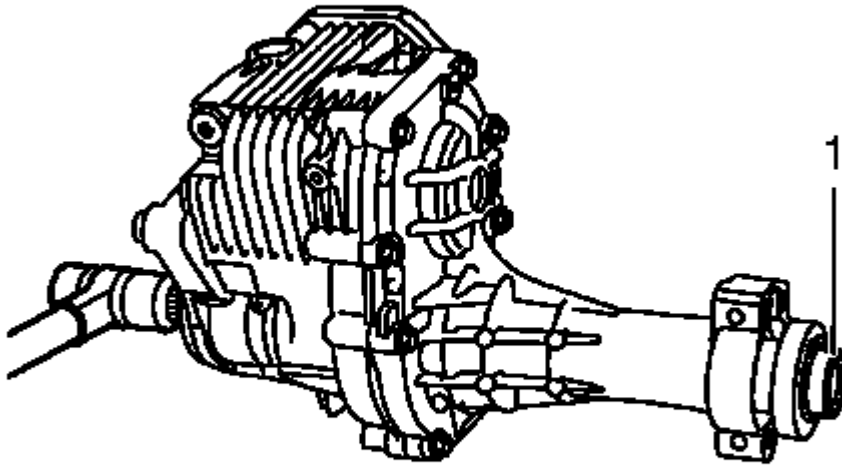


Fig. 20: Transfer Case Intermediate Shaft
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transfer case intermediate shaft (1), with bearing, using a rubber mallet.
7. Remove the bearing, if necessary. Refer to front wheel drive intermediate shaft in **Transfer Case Disassemble**.

Installation Procedure

1. Install the bearing, if removed. Refer to front wheel drive intermediate shaft in **Transfer Case Assemble**.

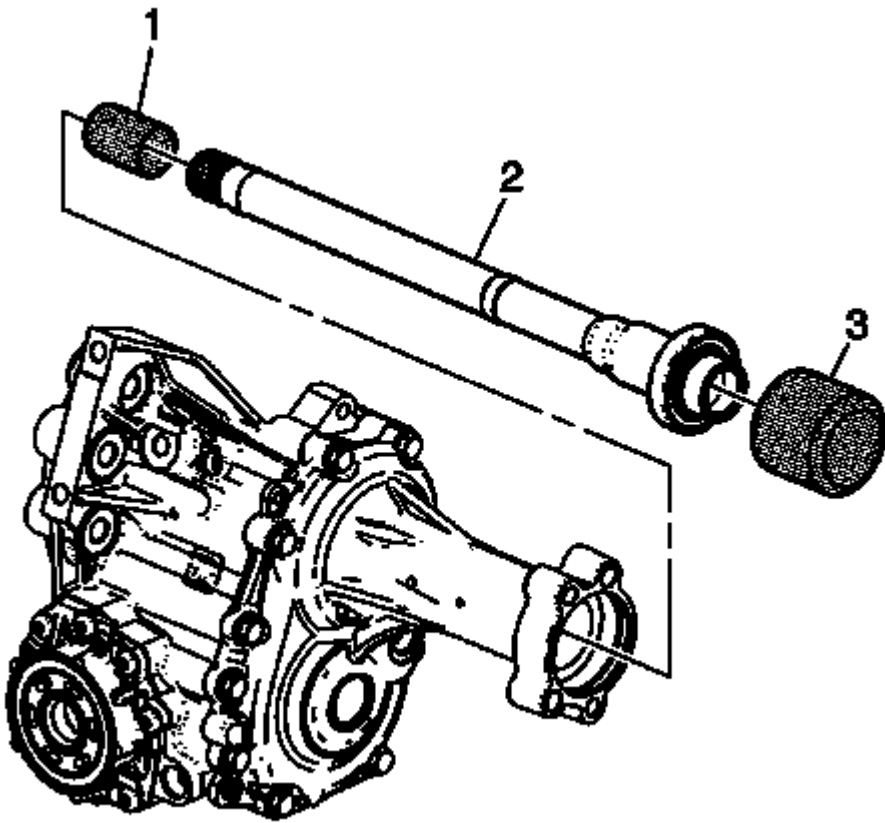


Fig. 21: View Of Installing Intermediate Shaft
Courtesy of GENERAL MOTORS COMPANY

2. Install the **DT-49104** protective collar (1) to the intermediate shaft (2), and tap in the intermediate shaft using the **DT-48076** installer (3) and a rubber mallet.
3. Remove the **DT-49104** protective collar (1).

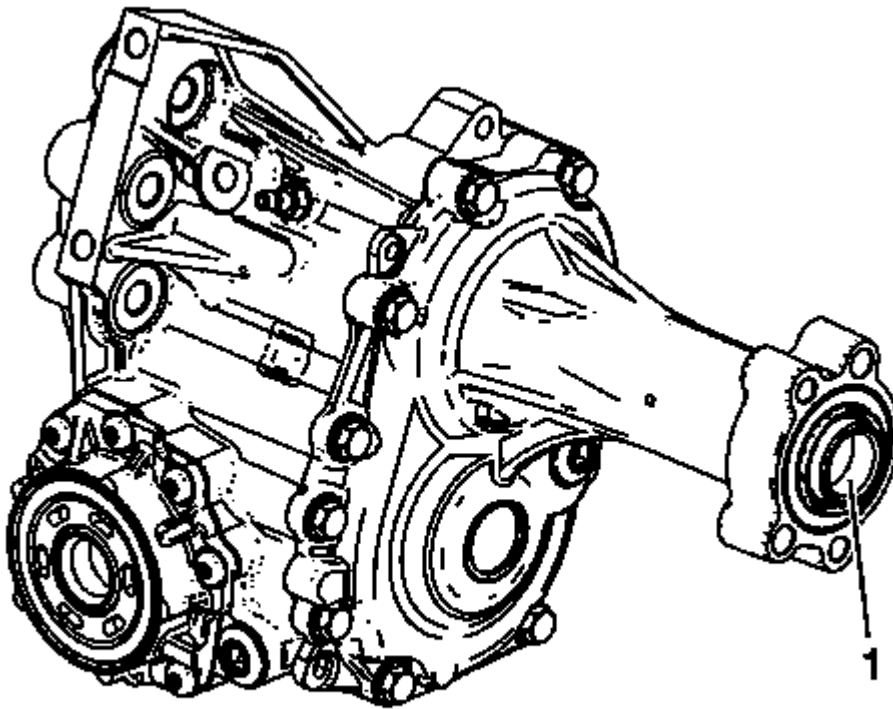


Fig. 22: Intermediate Shaft Output Splines
Courtesy of GENERAL MOTORS COMPANY

4. Apply grease to the output splines (1) of the intermediate shaft.

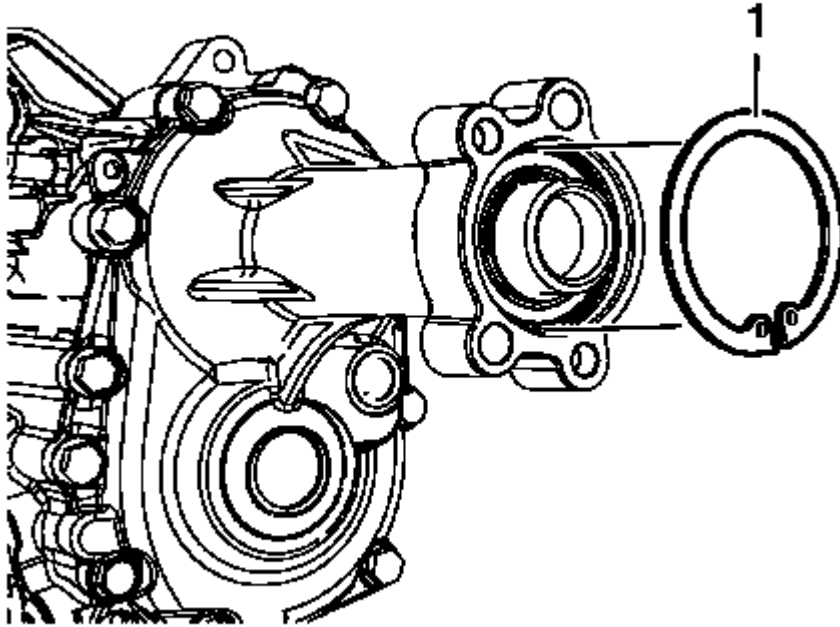


Fig. 23: Intermediate Shaft Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the transfer case intermediate shaft retaining ring (1), using suitable snap ring pliers.

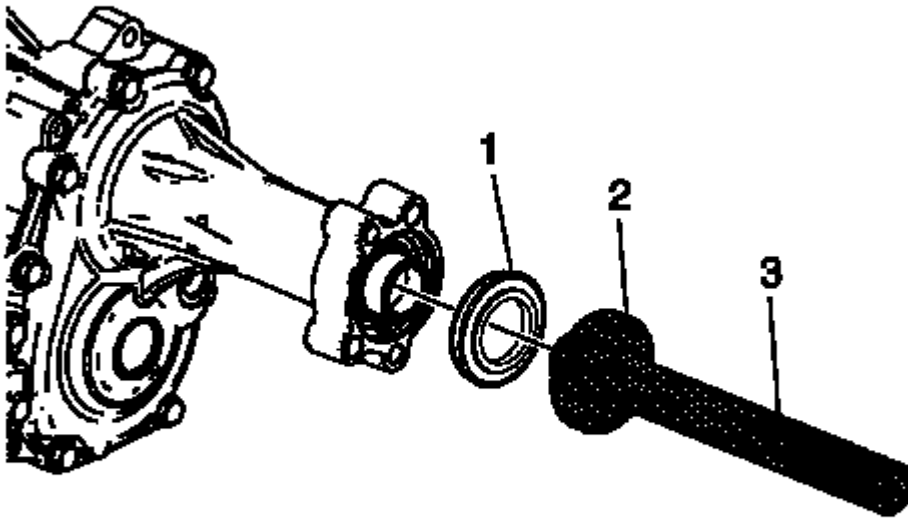


Fig. 24: Seal And Special Installer Tool
Courtesy of GENERAL MOTORS COMPANY

6. Install the New seal assembly (1) using the **DT-50768** seal installer (2) and **J-8092** driver handle (3).
7. Install the transfer case in the vehicle. Refer to **Transfer Case Replacement**.

REAR OUTPUT SHAFT SEAL REPLACEMENT

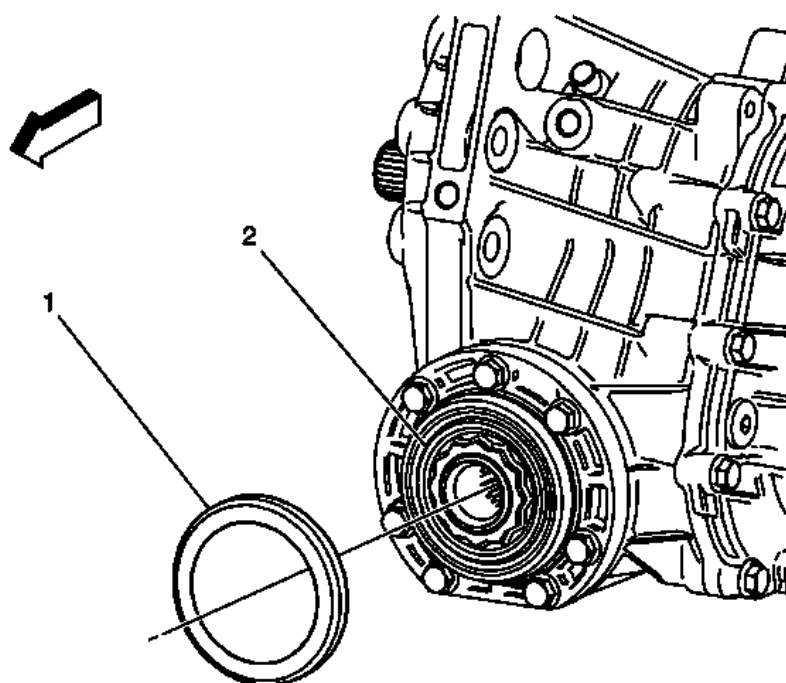


Fig. 25: Rear Output Shaft Seal
 Courtesy of GENERAL MOTORS COMPANY

Rear Output Shaft Seal Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the propeller shaft. Refer to <u>Propeller Shaft Replacement</u> . 2. Drain the transfer case fluid. Refer to <u>Transfer Case Fluid Replacement</u>. 	
1	Dust Shield Procedure Install the dust shield using DT-49095 installer. Special Tools DT-49095 Seal Installer For equivalent regional tools, refer to <u>Special Tools</u> .
2	Rear Output Shaft Seal Procedure Install the shaft seal using DT-49097 installer and DT-49061 cone. Special Tools <ul style="list-style-type: none"> • DT-49061 Entry Cone • DT-49097 Seal Installer

For equivalent regional tools, refer to **Special Tools**.

INTERMEDIATE DRIVE SHAFT DIRT DEFLECTOR REPLACEMENT

Special Tools

- **DT-50768** Seal Installer
- **J-8092** Driver Handle

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the right wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .

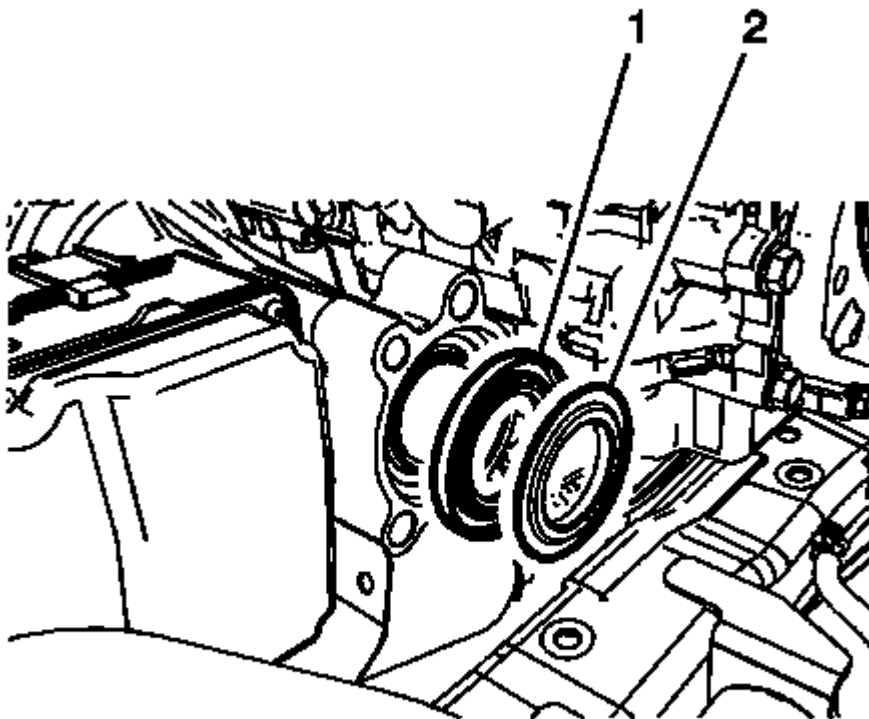


Fig. 26: Wheel Drive Shaft Seal And Dust Deflector
Courtesy of GENERAL MOTORS COMPANY

2. Remove the dust deflector (1) first using a prying type tool and then remove the seal (2) by installing a sheet metal screw into surface and removing with suitable pliers.
3. Discard the seal assembly (1,2).

Installation Procedure

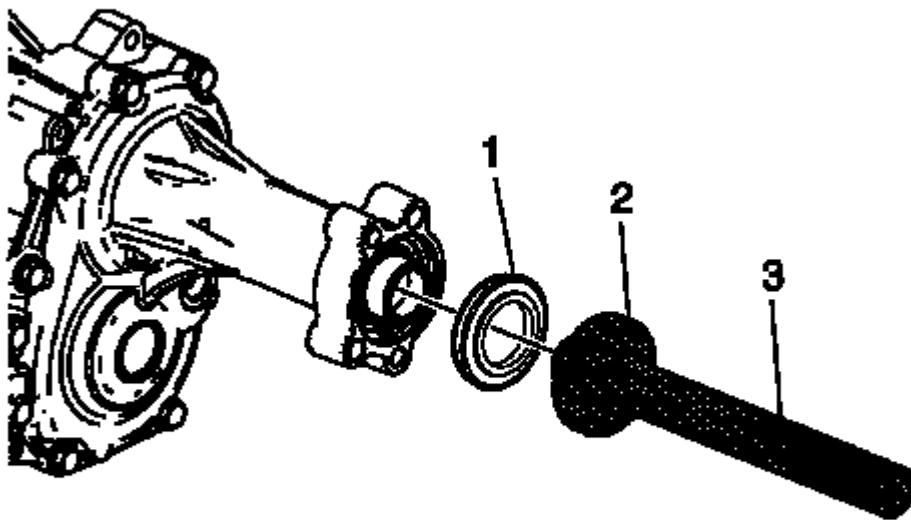


Fig. 27: Seal And Special Installer Tool
Courtesy of GENERAL MOTORS COMPANY

1. Install the New seal assembly (1) using the **DT-50768** seal installer (2) and **J-8092** driver handle (3).
2. Install the right wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - CASE SIDE

Removal Procedure

1. Remove the right wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .

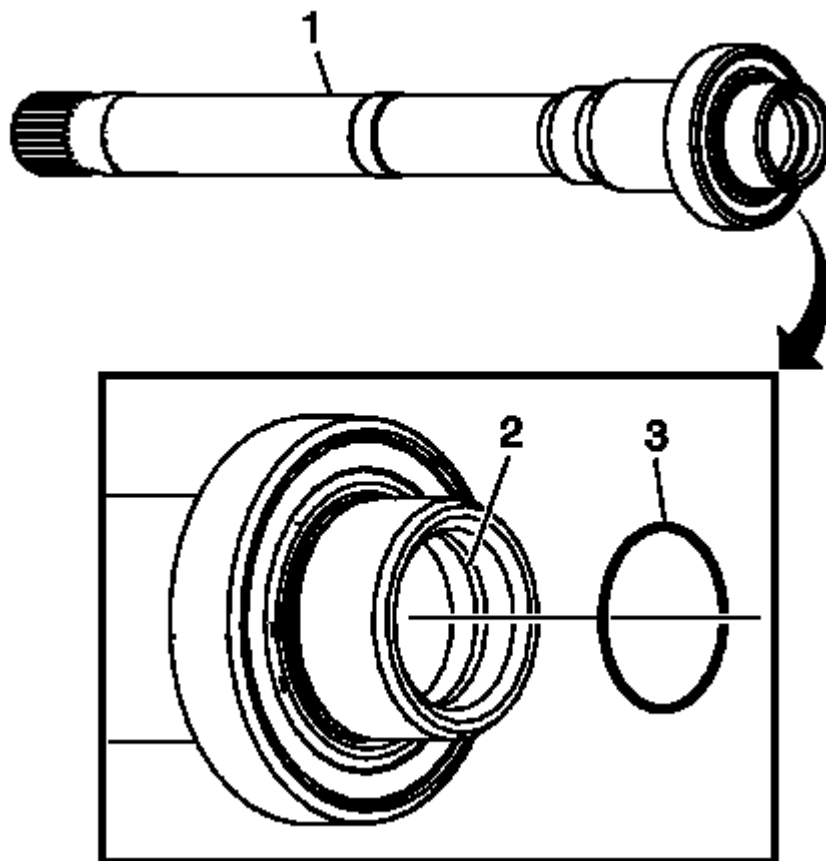


Fig. 28: Intermediate Shaft O-Ring (Second Design)
Courtesy of GENERAL MOTORS COMPANY

2. Remove the second design intermediate shaft O-ring (3), as required.

Installation Procedure

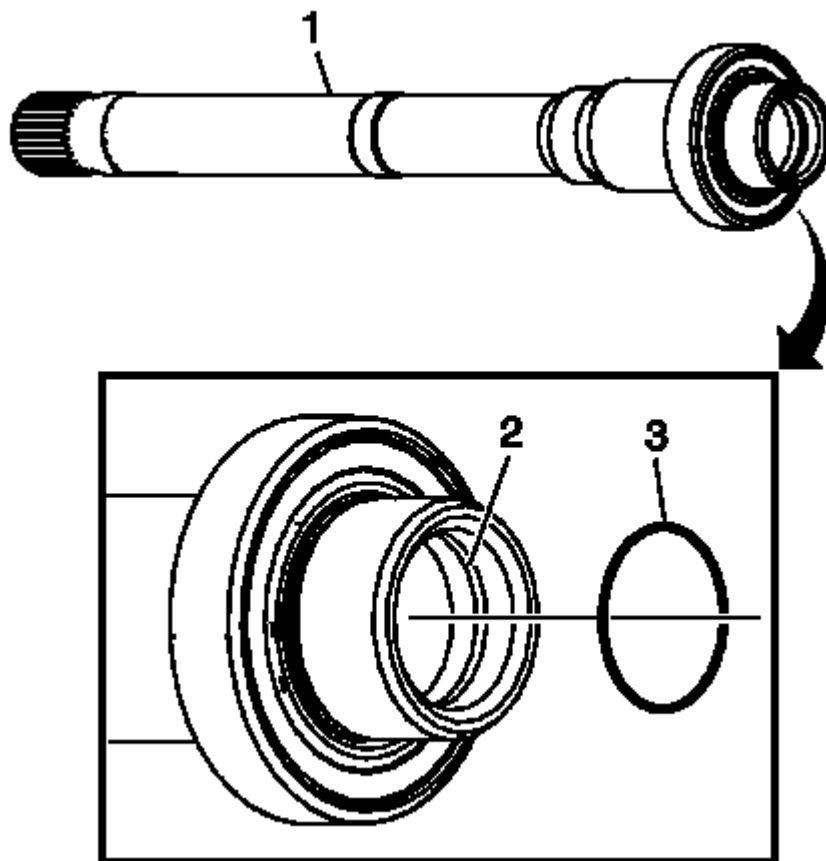


Fig. 29: Intermediate Shaft O-Ring (Second Design)
Courtesy of GENERAL MOTORS COMPANY

1. Install the second design intermediate shaft O-ring (3), as required.
2. Install the right wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .

FRONT WHEEL DRIVE INTERMEDIATE SHAFT BEARING REPLACEMENT

Special Tools

- **DT-113-2-A** Holder
- **DT-622-A** Transmission Bracket
- **DT-49104** Protective Collar
- **DT-50768** Seal Installer
- **J-8092** Driver Handle

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the transfer case from the vehicle. Refer to **Transfer Case Replacement**.

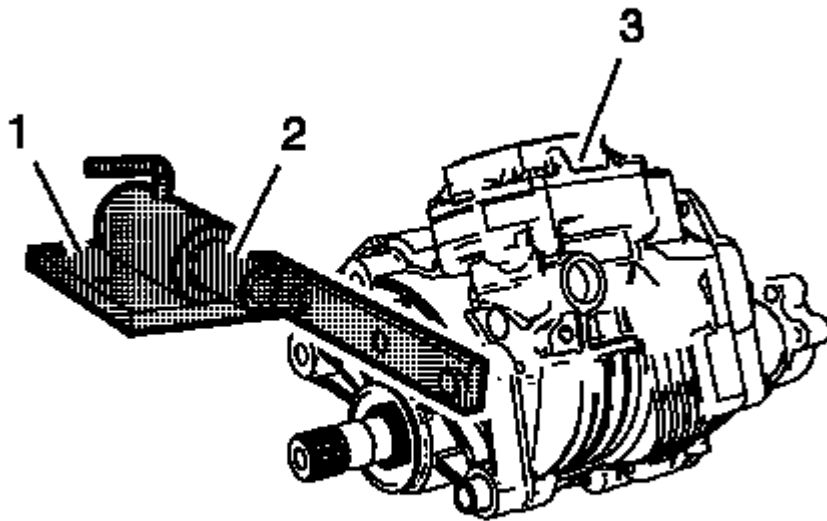


Fig. 30: Transmission Bracket, Transfer Case And Holder
Courtesy of GENERAL MOTORS COMPANY

2. Secure the transfer case (3) in **DT-113-2-A** holder (1) , using the **DT-622-A** bracket (2) .

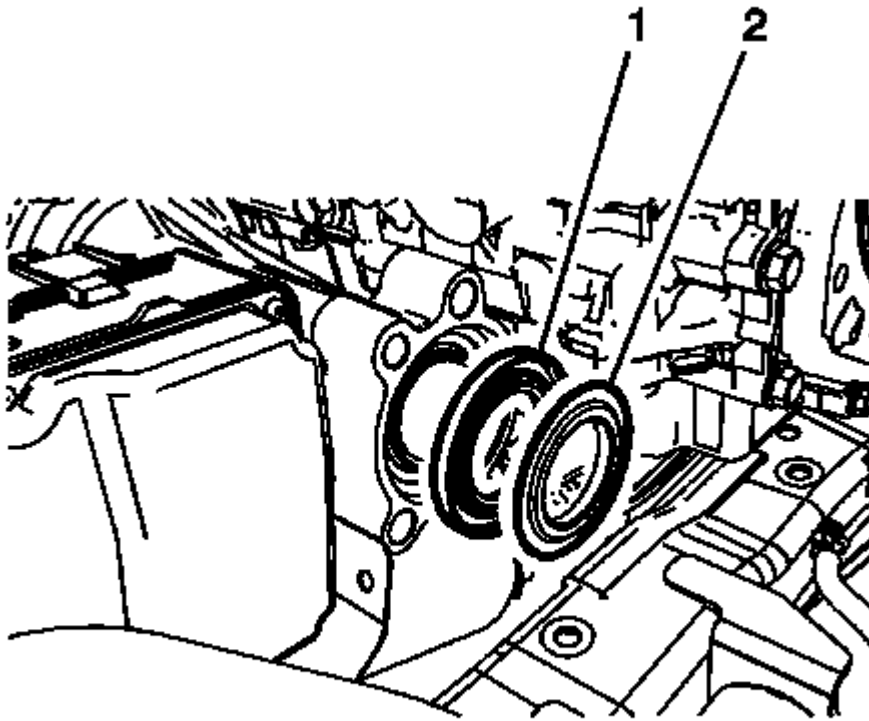


Fig. 31: Wheel Drive Shaft Seal And Dust Deflector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the dust deflector (1) first using a prying type tool and then remove the seal (2) by installing a sheet metal screw into surface and removing with suitable pliers.
4. Discard the seal assembly (1,2).

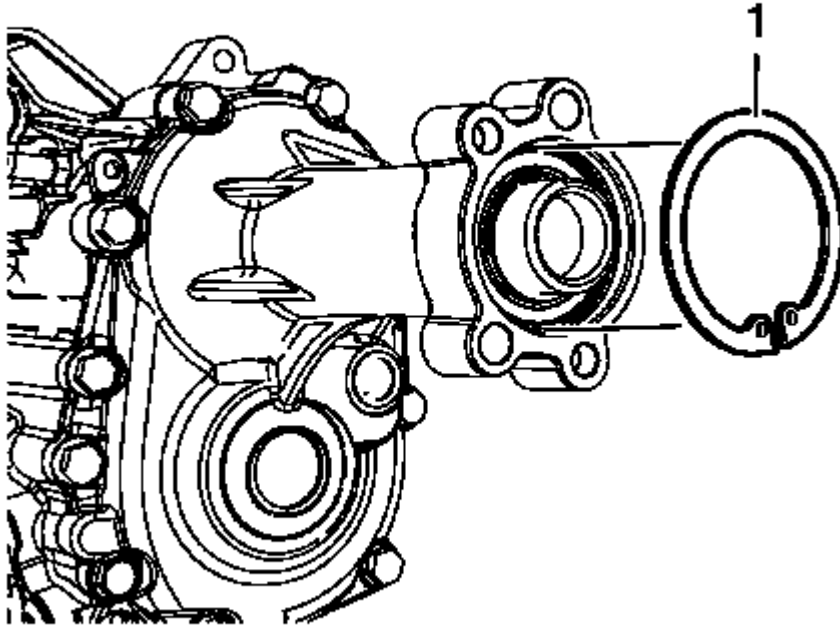


Fig. 32: Intermediate Shaft Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

5. Remove the transfer case intermediate shaft retaining ring (1), using suitable snap ring pliers.

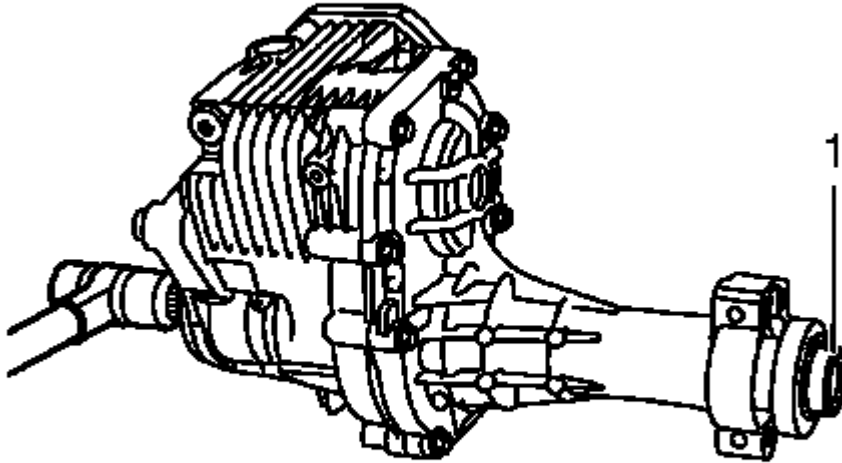


Fig. 33: Transfer Case Intermediate Shaft
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transfer case intermediate shaft (1), with bearing, using a rubber mallet.
7. Remove the bearing, if necessary. Refer to front wheel drive intermediate shaft in **Transfer Case Disassemble**.

Installation Procedure

1. Install the bearing, if removed. Refer to front wheel drive intermediate shaft in **Transfer Case Assemble**.

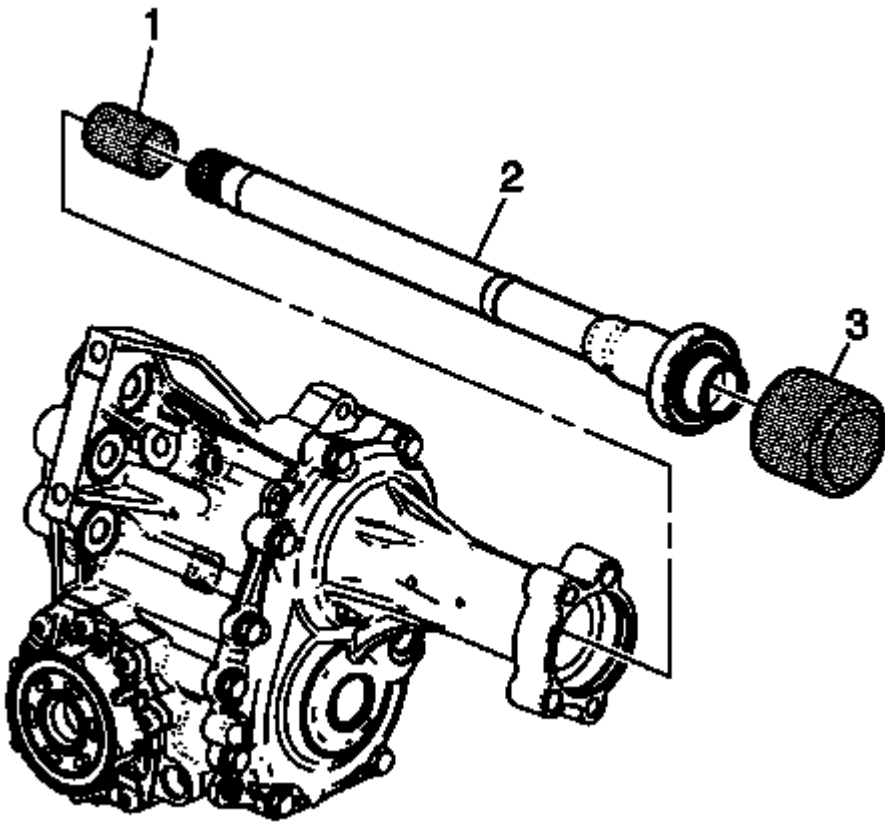


Fig. 34: View Of Installing Intermediate Shaft
Courtesy of GENERAL MOTORS COMPANY

2. Install the **DT-49104** protective collar (1) to the intermediate shaft (2), and tap in the intermediate shaft using the **DT-48076** installer (3) and a rubber mallet.
3. Remove the **DT-49104** protective collar (1).

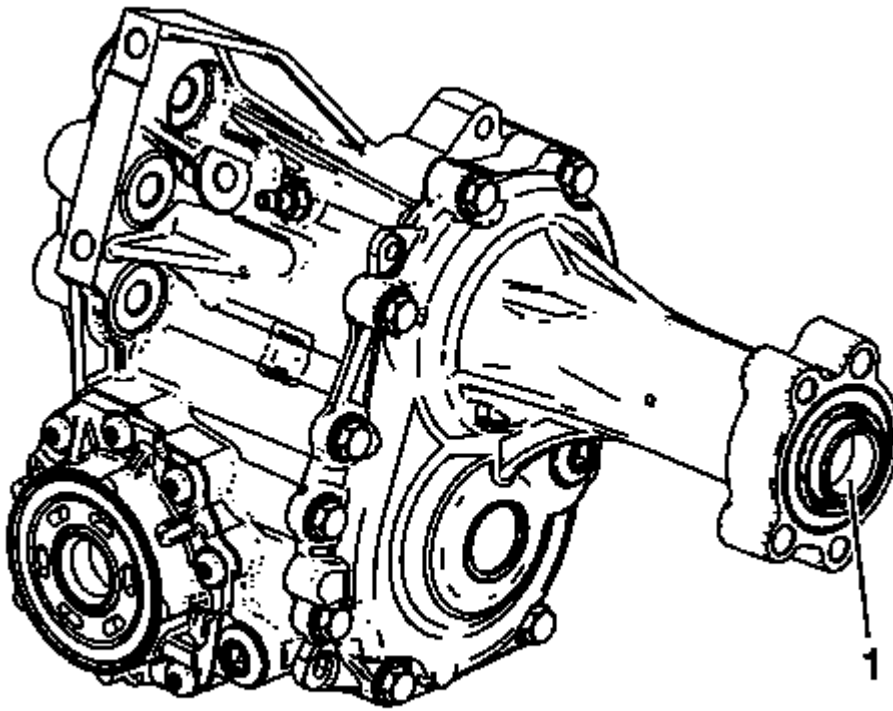


Fig. 35: Intermediate Shaft Output Splines
Courtesy of GENERAL MOTORS COMPANY

4. Apply grease to the output splines (1) of the intermediate shaft.

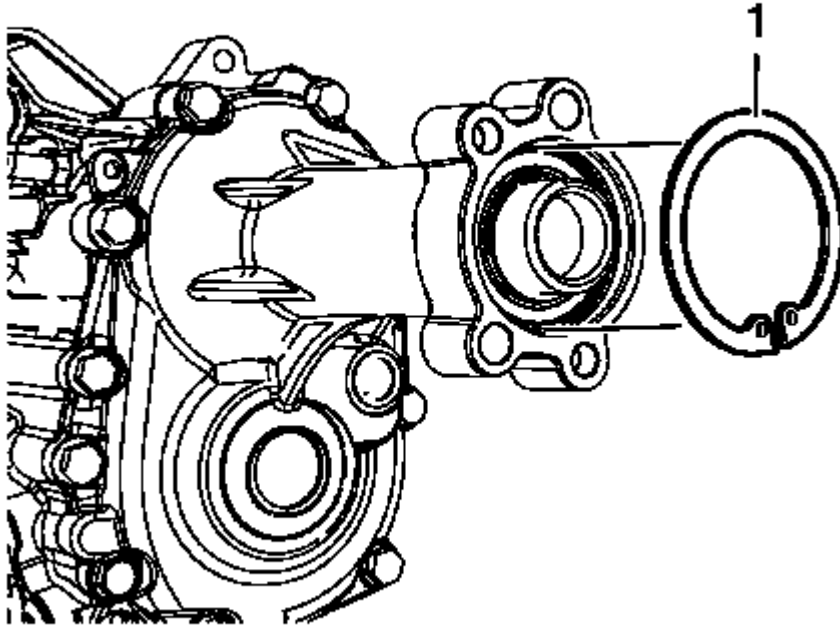


Fig. 36: Intermediate Shaft Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the transfer case intermediate shaft retaining ring (1), using suitable snap ring pliers.

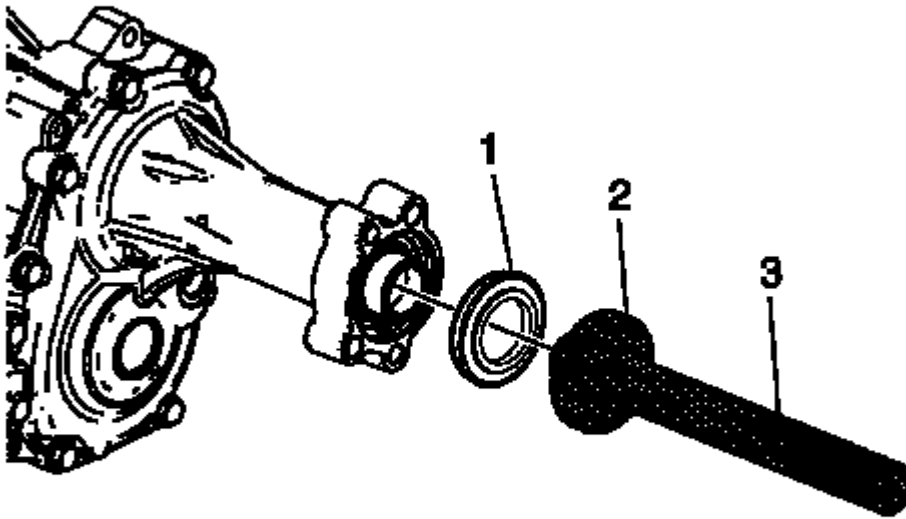


Fig. 37: Seal And Special Installer Tool
Courtesy of GENERAL MOTORS COMPANY

6. Install the New seal assembly (1) using the **DT-50768** seal installer (2) and **J-8092** driver handle (3).
7. Install the transfer case in the vehicle. Refer to **Transfer Case Replacement**.

TRANSFER CASE REPLACEMENT

Removal Procedure

1. Remove the propeller shaft. Refer to **Propeller Shaft Replacement** .
2. Drain the oil from the transmission. Refer to **Transmission Fluid Drain and Fill** .
3. Remove the right drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .
4. Remove the exhaust front pipe. Refer to , **Exhaust Front Pipe Replacement (LUK)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
5. Remove the transmission rear mount bracket. Refer to **Transmission Rear Mount Replacement (AWD)** .

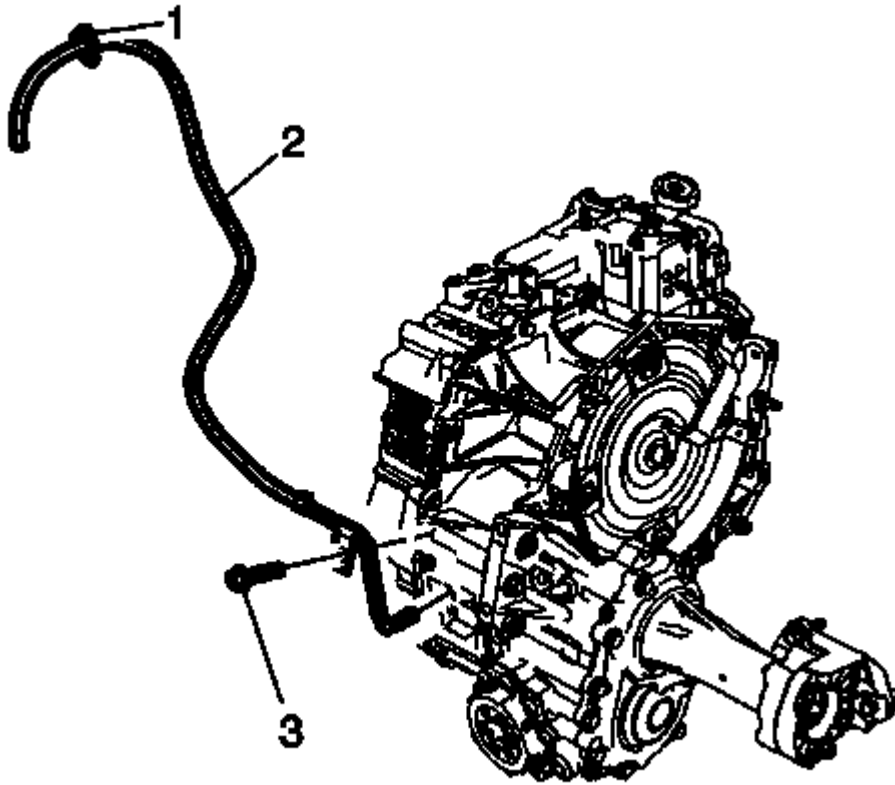


Fig. 38: Transfer Case Vent Hose, Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transfer case vent hose strap (1), bolt (3), and hose (2).

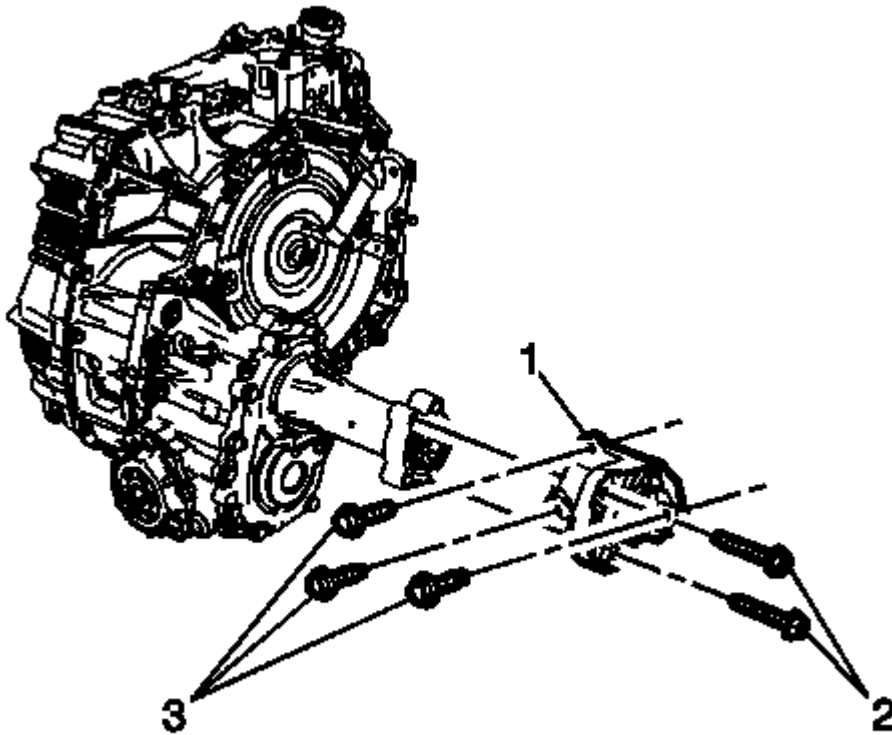


Fig. 39: Transfer Case Support Bracket-To-Transfer Case Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the transfer case support bracket-to-transfer case bolts (2).
8. Remove the transfer case support bracket-to-engine bolts (3).
9. Remove the support bracket (1).
10. Support the transfer case with a suitable jack, and secure with suitable straps.

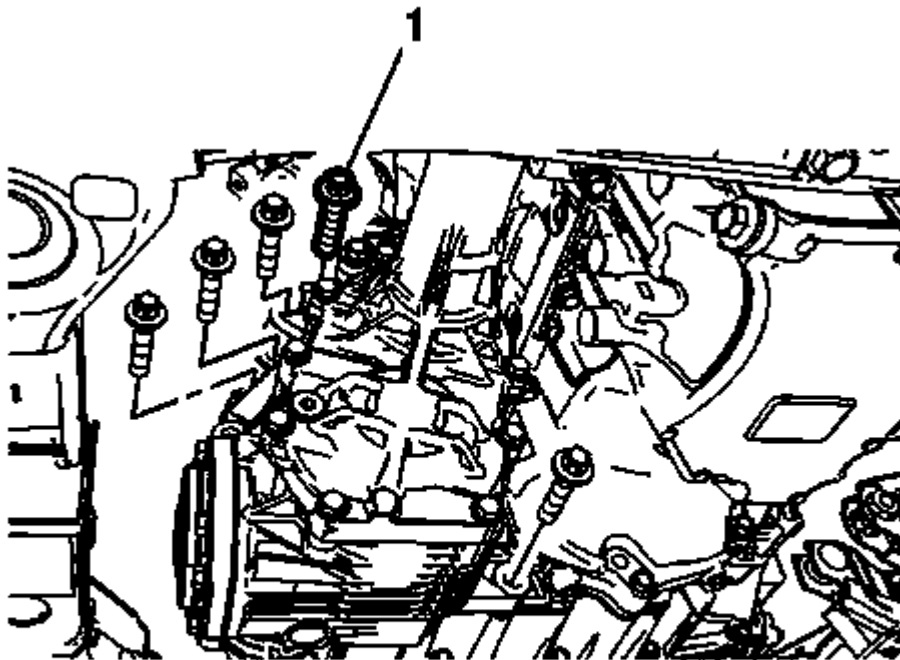


Fig. 40: Transfer Case-To-Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the remaining five transfer case-to-transmission bolts (1).
12. Separate the transfer case from the transmission and remove the transfer case.

Installation Procedure

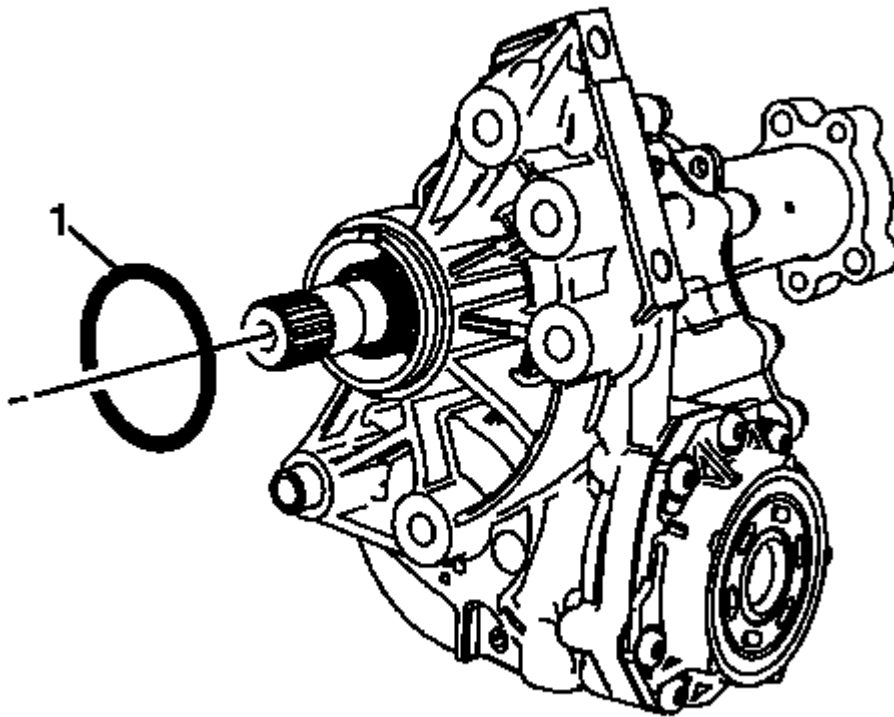


Fig. 41: Identifying Transfer Case-To-Transmission O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Clean the contact surfaces between the transfer case and the transmission. Install a new transfer case-to-transmission O-ring (1).

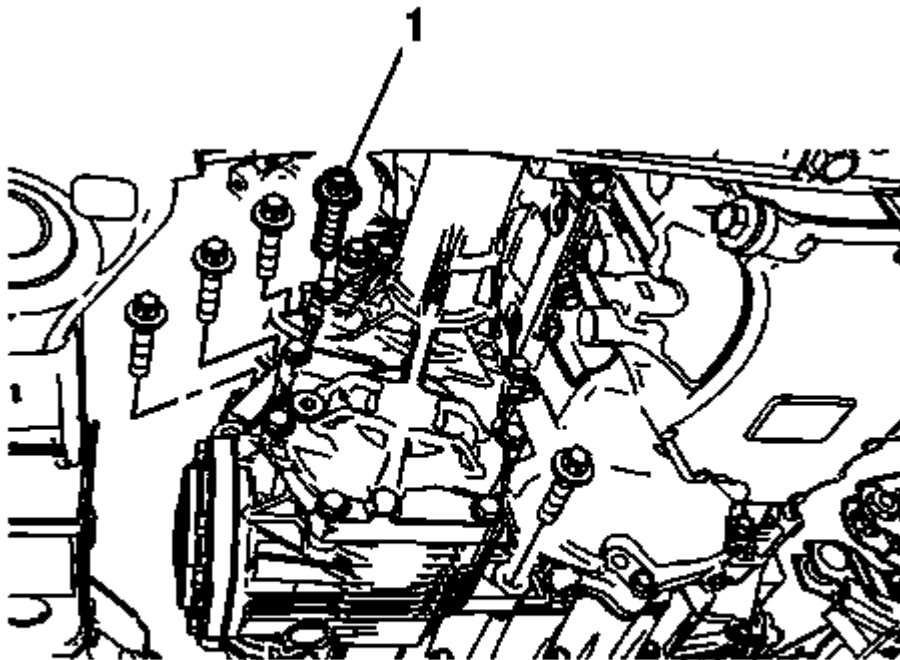


Fig. 42: Transfer Case-To-Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Support the transfer case with a suitable jack, and secure with suitable straps.
3. Raise and align the transfer case in the correct position in relation to the transmission.
4. Install the transfer case to the transmission.

CAUTION: Refer to Fastener Caution .

5. Install the five transfer case-to-transmission bolts (1), then tighten the bolts to 110 (81 lb ft).

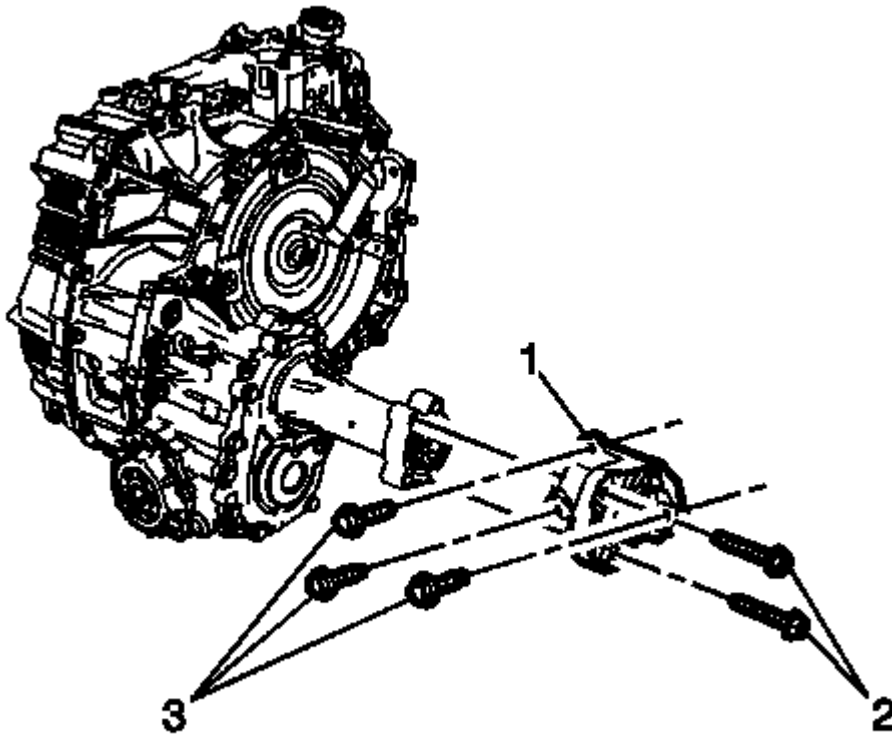


Fig. 43: Transfer Case Support Bracket-To-Transfer Case Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the support bracket (1).
7. Install the transfer case support bracket-to-transfer case bolts (2).
8. Install the transfer case support bracket-to-engine bolts (3).
9. Install the support bracket between the transfer case and the engine carefully in three steps to avoid breakage.
 1. Tighten the support bracket-to-transfer case bolts (2) the first time to 5 (44 lb in).
 2. Tighten the support bracket-to-engine bolts (3) to 60 (44 lb ft).
 3. Tighten the support bracket-to-transfer case bolts (2) the second time to 60 (44 lb ft).
10. Install the transmission rear mount bracket. Refer to **Transmission Rear Mount Replacement (AWD)**.

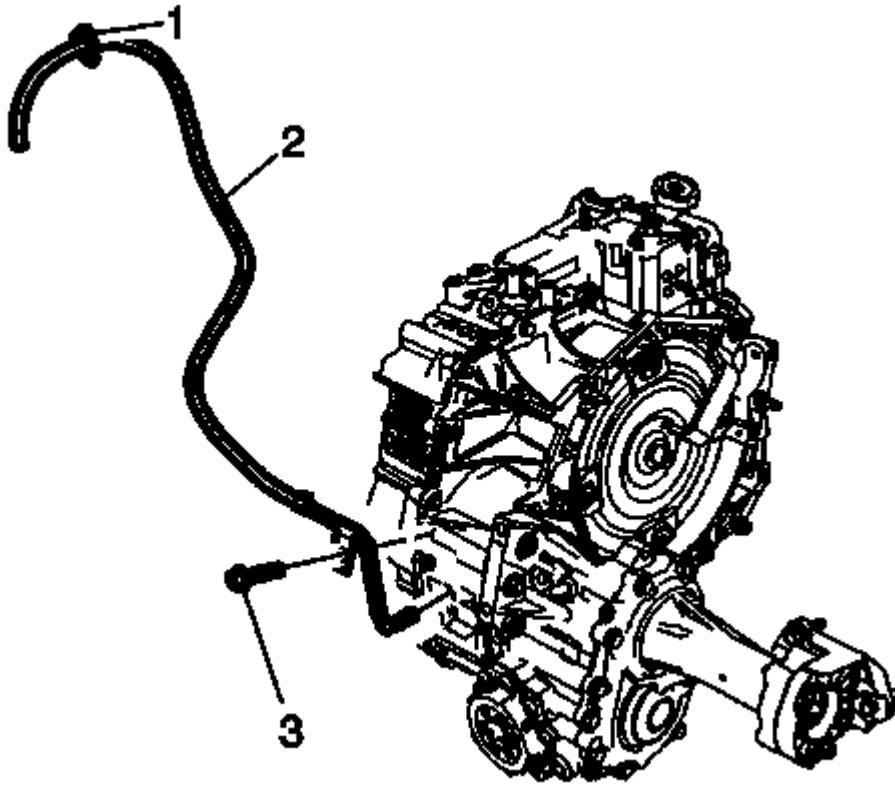


Fig. 44: Transfer Case Vent Hose, Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Install the transfer case vent hose (2), strap (1), and bolt (3).
12. Tighten the transfer case vent hose bolt, if equipped, to 22 (17 lb ft).
13. Install the right drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Right Side** .
14. Install the propeller shaft. Refer to **Propeller Shaft Replacement** .
15. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LUK)** , **Exhaust Front Pipe Replacement (LTG AWD)** .
16. Check the fluid level in the transfer case. Refer to **Transfer Case Fluid Replacement**.
17. Fill the transmission with oil. Refer to **Transmission Fluid Drain and Fill** .
18. Fill the transfer case fluid. Refer to **Transfer Case Fluid Replacement**.

INPUT SHAFT SEAL REPLACEMENT

Removal Procedure

1. Remove the transfer case from the vehicle. Refer to **Transfer Case Replacement**.

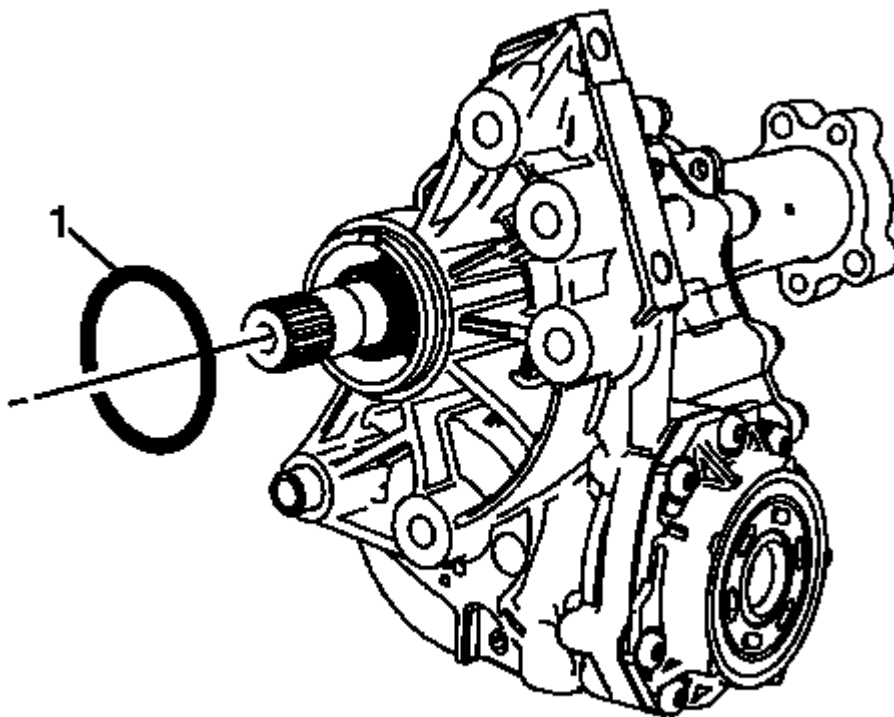


Fig. 45: Identifying Transfer Case-To-Transmission O-Ring
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD the transfer case-to-transmission seal (1).

Installation Procedure

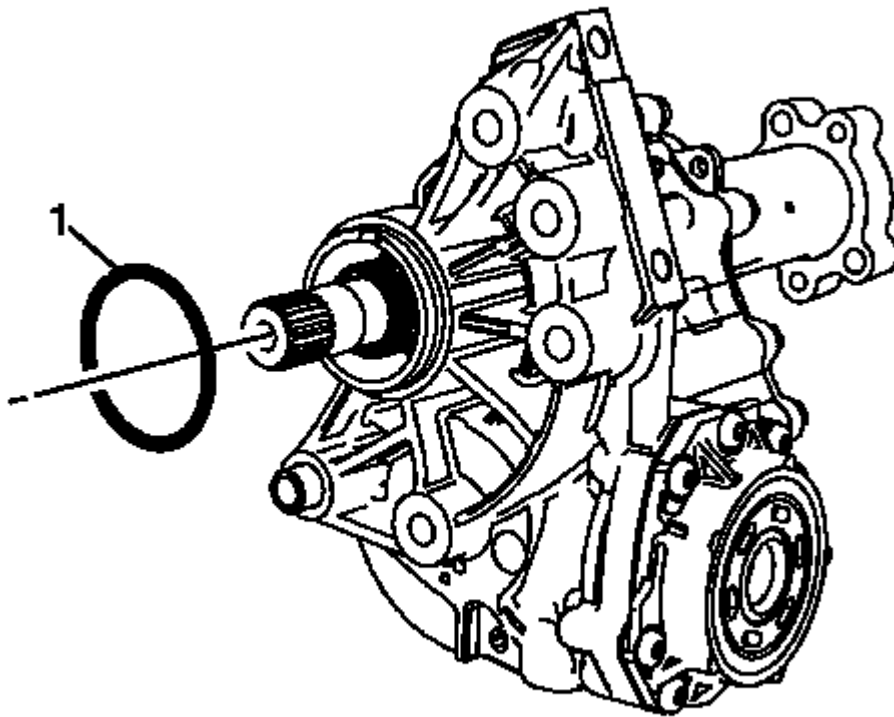


Fig. 46: Identifying Transfer Case-To-Transmission O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW transfer case-to-transmission seal (1).
2. Install the transfer case in the vehicle. refer to Transfer Case Replacement.

REPAIR INSTRUCTIONS - OFF VEHICLE

TRANSFER CASE DISASSEMBLE

Oil Drain Plug Removal

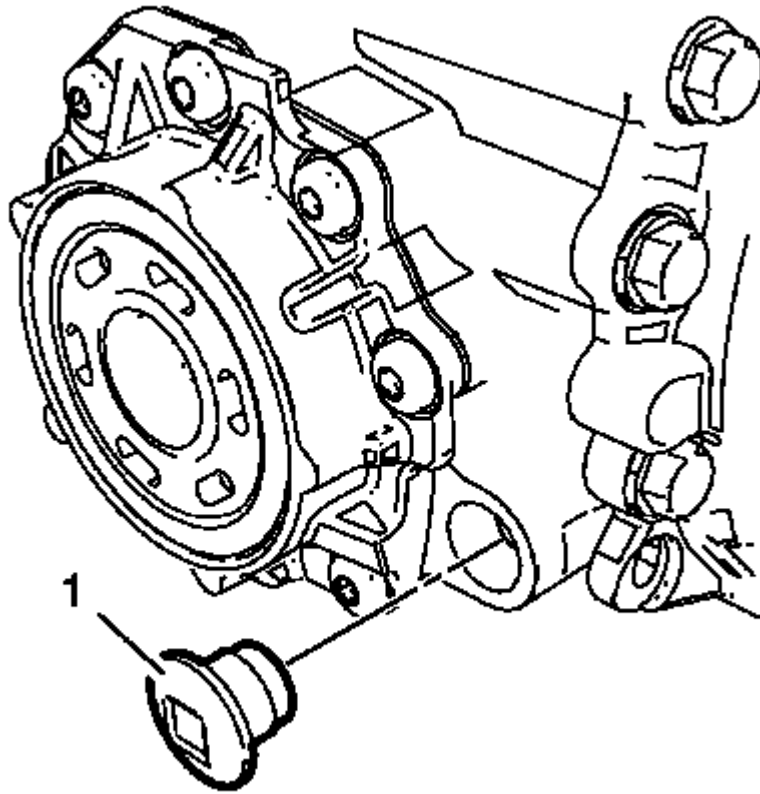


Fig. 47: View Of Transfer Case Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

Remove and discard the oil drain plug (1) and seal.

Oil Fill Plug Removal

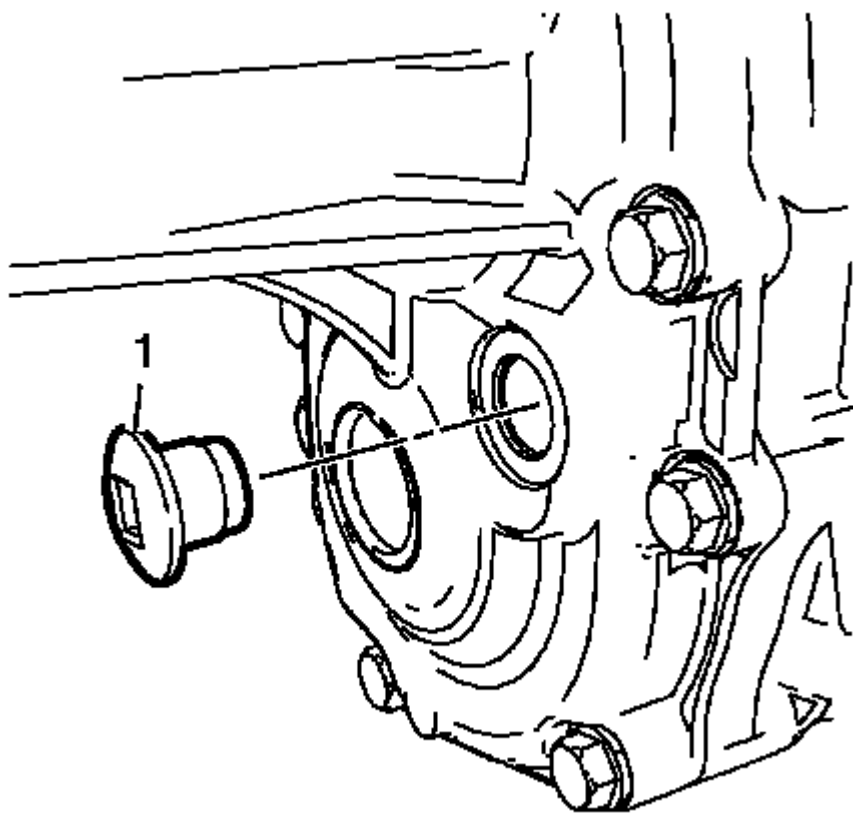


Fig. 48: Identifying Transfer Case Fill Plug
Courtesy of GENERAL MOTORS COMPANY

Remove and discard the oil fill plug (1) and seal.

Transfer Case Vent Removal

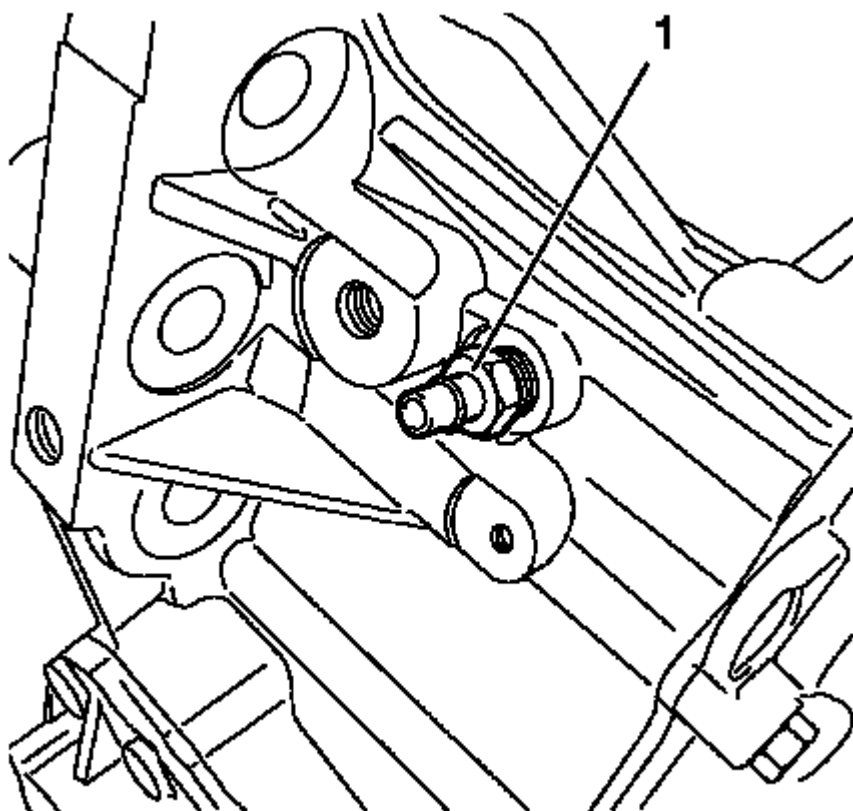


Fig. 49: View Of Transfer Case Vent
Courtesy of GENERAL MOTORS COMPANY

Remove the transfer case vent hose connector (1), as required.

Transfer Case-to-Transmission Seal Removal

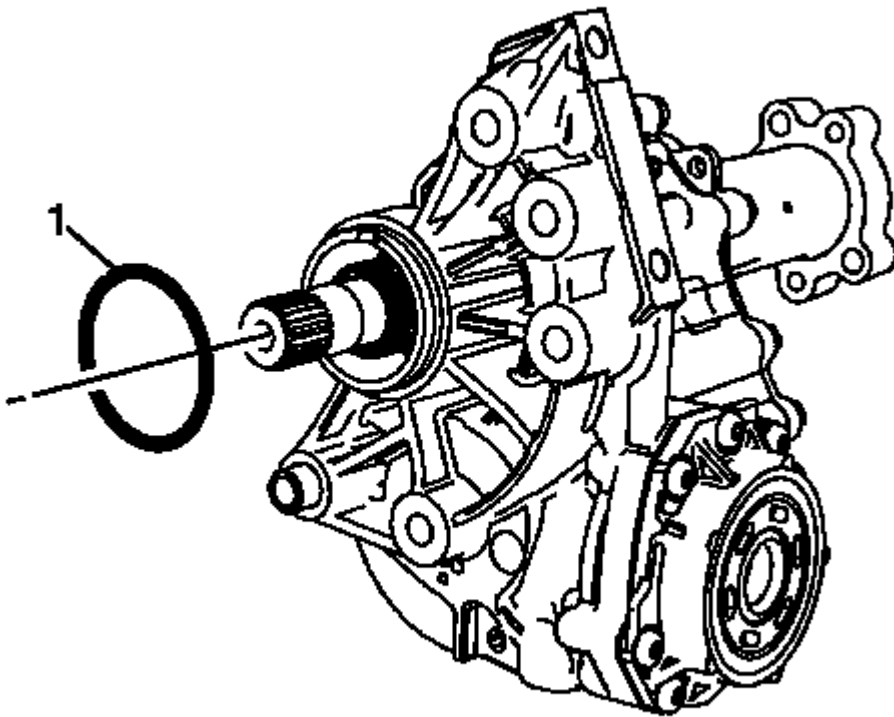


Fig. 50: Identifying Transfer Case-To-Transmission O-Ring
Courtesy of GENERAL MOTORS COMPANY

Remove and discard the transfer case-to-transmission seal (1).

Locating Bushing Removal

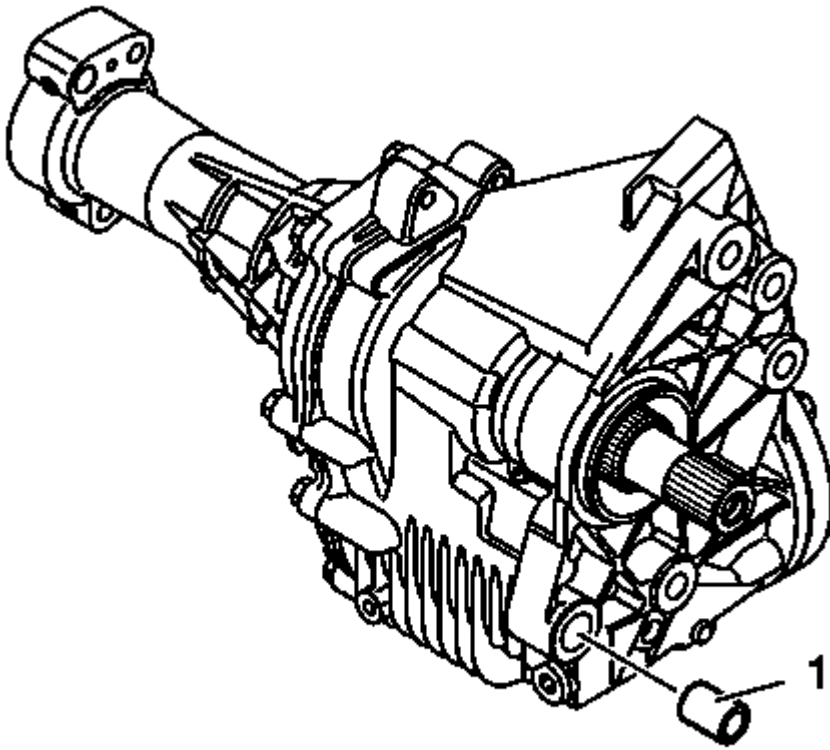


Fig. 51: View Of Transfer Case Location Bushing
Courtesy of GENERAL MOTORS COMPANY

Remove the transfer case locating bushing (1), using multi-grip pliers as required - Model Dependent.

Front Wheel Drive Intermediate Shaft Removal

Special Tools

- **DT-113-2-A** Holder
- **DT-622-A** Transmission Bracket

For equivalent regional tools, refer to **Special Tools**.

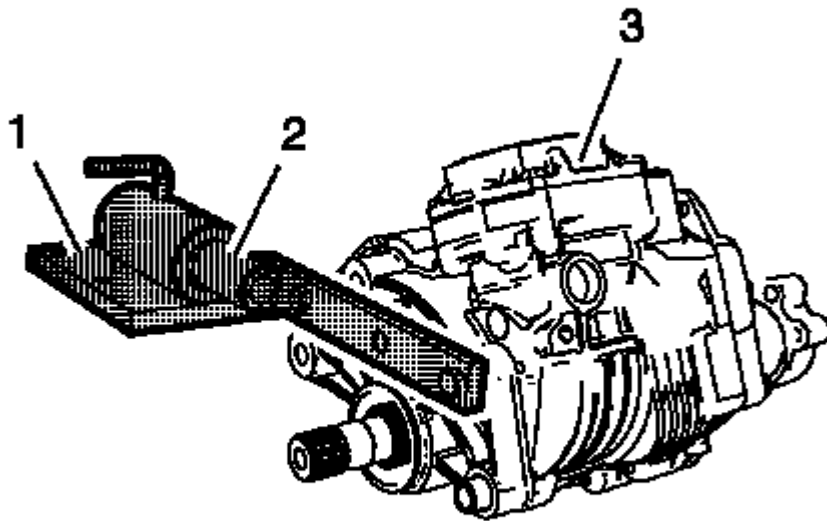


Fig. 52: Transmission Bracket, Transfer Case And Holder
Courtesy of GENERAL MOTORS COMPANY

1. Secure the transfer case (3) in **DT-113-2-A** holder (1) , using the **DT-622-A** bracket (2) .

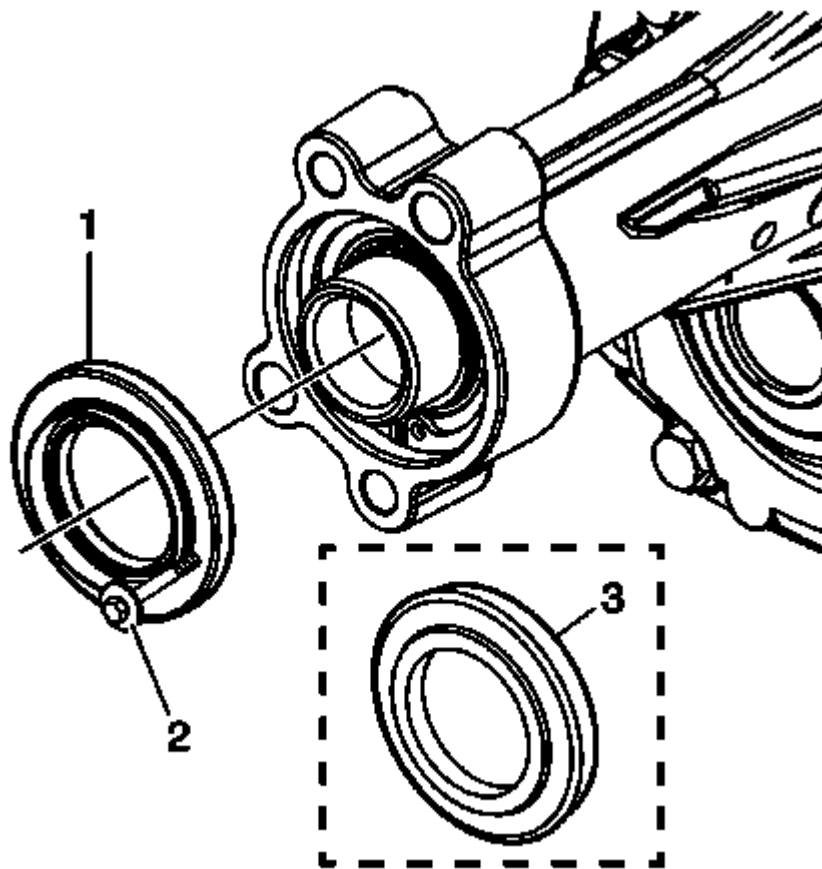


Fig. 53: View Of Shaft Dirt Deflector & Grease Seal Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Remove the first design dirt deflector (1). Install a sheet metal screw (2) into the outer surface of the dirt deflector and remove with suitable pliers.
3. Remove the second design dirt deflector (3). Remove the inner metal portion first using a prying type tool and then remove the outer portion by installing a sheet metal screw into surface and removing with suitable pliers.
4. Discard the seal assembly (1).

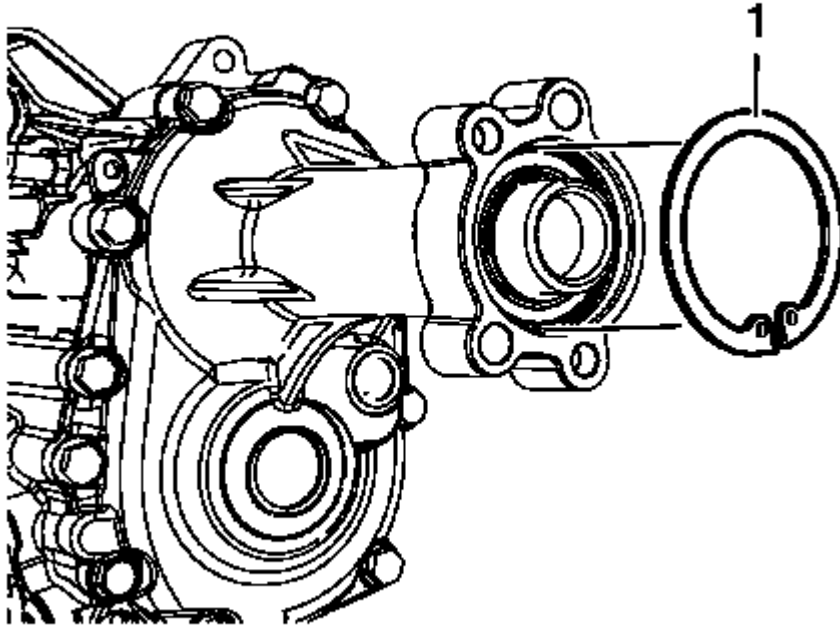


Fig. 54: Intermediate Shaft Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

5. Remove the transfer case intermediate shaft retaining ring (1), using suitable snap ring pliers.

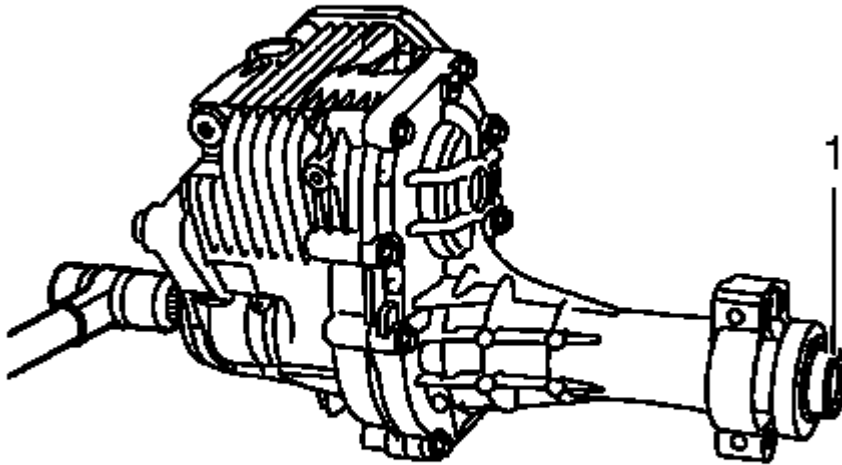


Fig. 55: Transfer Case Intermediate Shaft
Courtesy of GENERAL MOTORS COMPANY

6. Remove the transfer case intermediate shaft (1), with bearing, using a rubber mallet.

Front Wheel Drive Intermediate Shaft Bearing Removal

Special Tools

DT-307-B Remover Plate

For equivalent regional tools, refer to **Special Tools**.

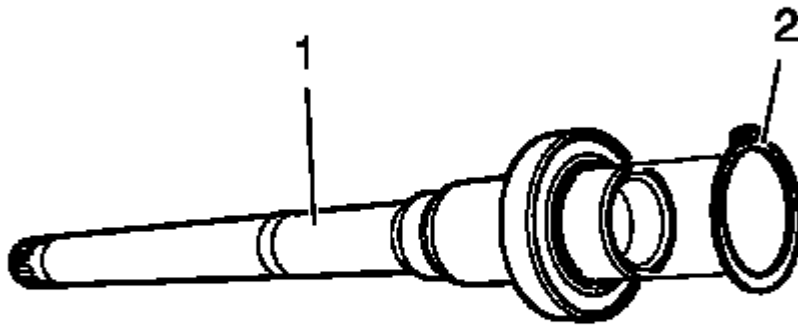


Fig. 56: Identifying Intermediate Shaft Bearing Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

1. Remove the transfer case intermediate shaft bearing retaining ring (2) from intermediate shaft (1), using suitable pliers.

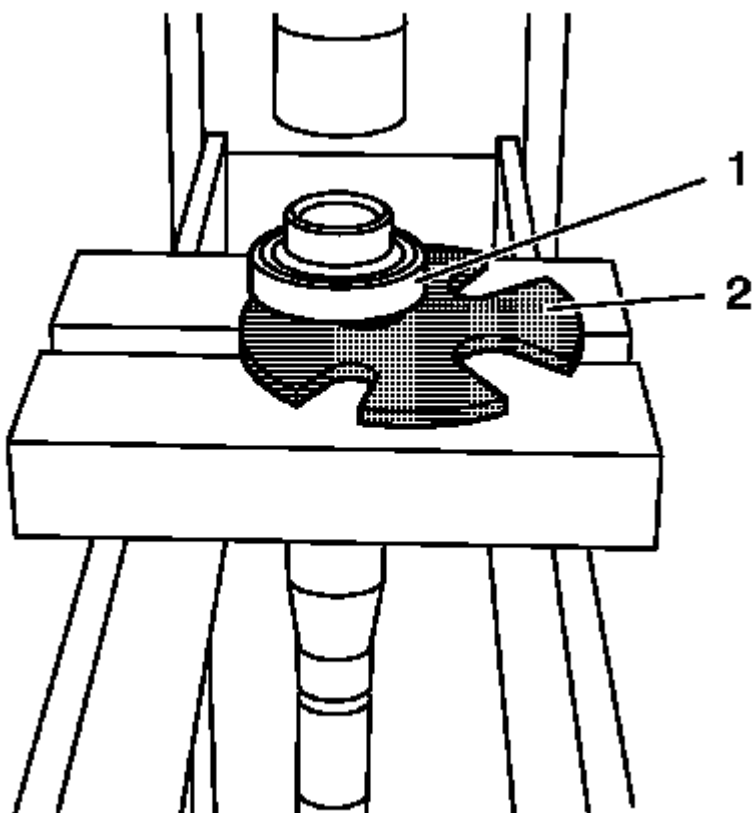


Fig. 57: View Of Transfer Case Intermediate Shaft Bearing Removal
Courtesy of GENERAL MOTORS COMPANY

2. Remove the transfer case intermediate shaft bearing (1), using the **DT-307-B** remover plate and a hydraulic press.

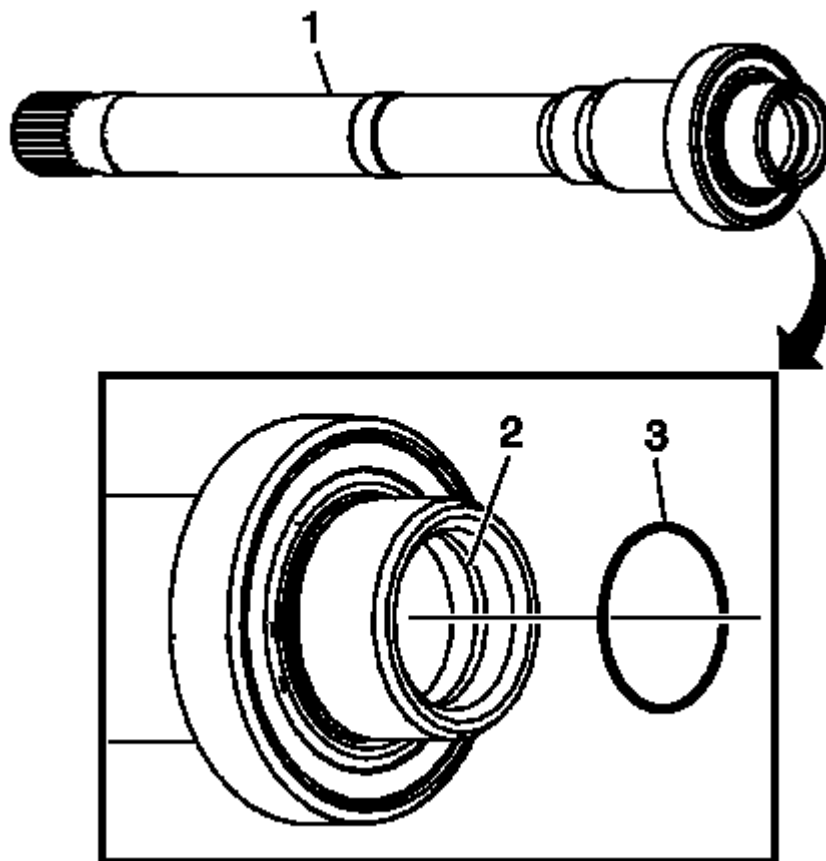


Fig. 58: Intermediate Shaft O-Ring (Second Design)
Courtesy of GENERAL MOTORS COMPANY

3. Remove the intermediate shaft O-ring (3), as required.

Rear Output Shaft Seal Removal

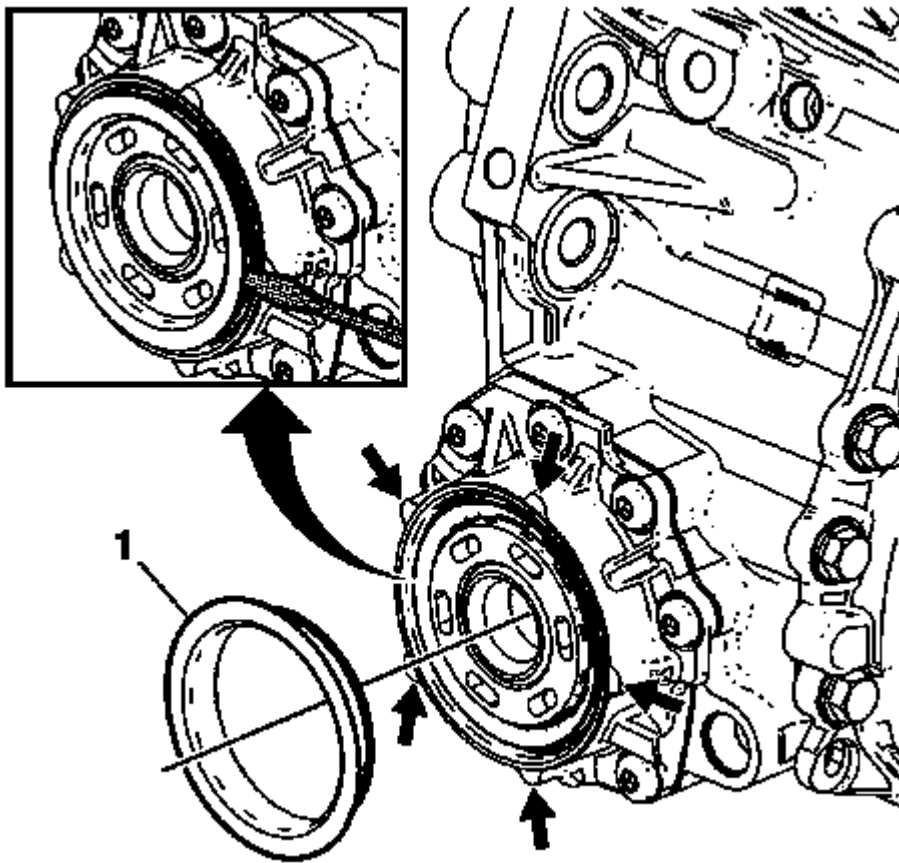


Fig. 59: View Of Rear Output Shaft Seal Sleeve
Courtesy of GENERAL MOTORS COMPANY

NOTE: Be sure to only pry against the five flat bosses on the rear output shaft housing.

1. Remove the inner metal sleeve (1) from the seal by working a screwdriver around the perimeter of the sleeve, prying only against the flat bosses of the output shaft housing.

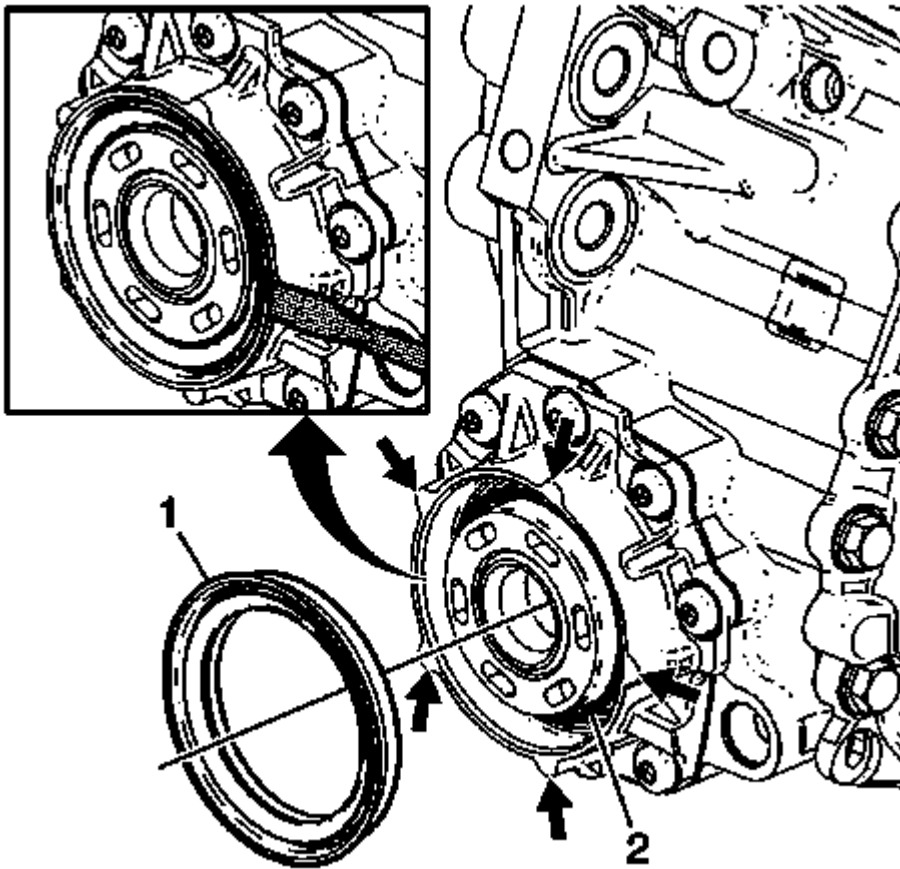


Fig. 60: View Of Rear Output Shaft Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Be sure to only pry against the five flat bosses on the rear output shaft housing.
- The seal tension spring (2) may fall off as the seal is removed.

2. Remove the rear output shaft seal (1) by working a sharpened chisel around the perimeter of the seal, prying only against the flat bosses of the output shaft housing.
3. Ensure the seal tension spring (2) is removed from the bore.

Rear Output Shaft Housing Removal

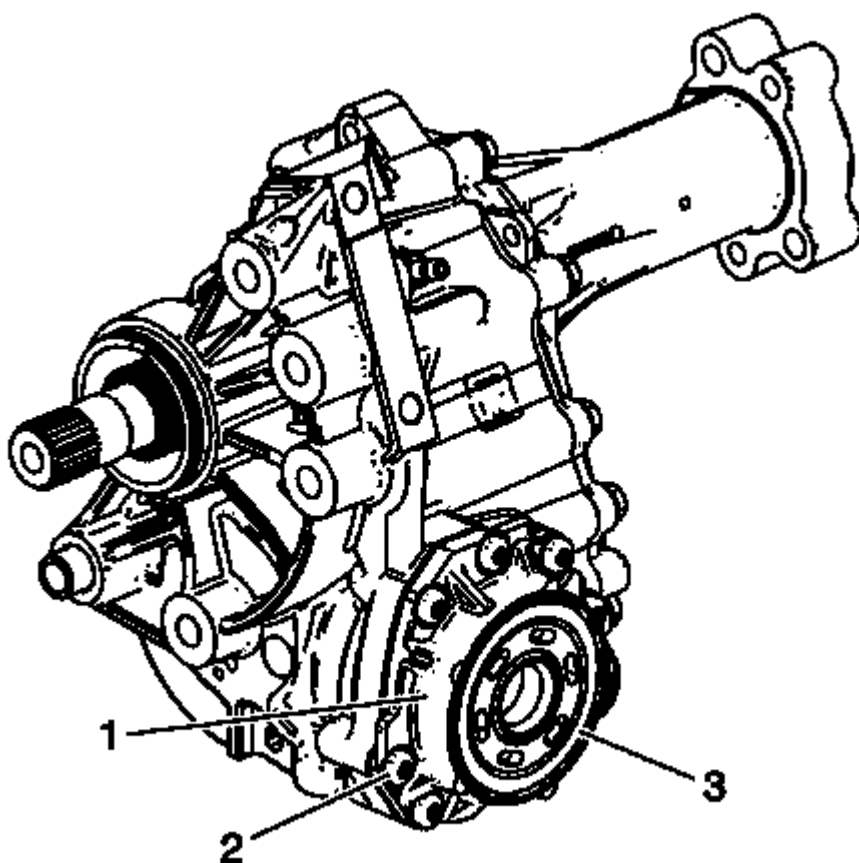


Fig. 61: Output Shaft Housing And Output Shaft Housing Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Do not attempt to remove the rear output shaft housing (1) or bolts (2) from the transfer case assembly.
- The rear output shaft, shaft bearings, housing (1) and housing O-ring seal are not serviceable components.

1.

The rear output shaft seal (3) is a serviceable component. Refer to Rear Output Shaft Seal Removal and Rear Output Shaft Seal Installation.

Rear Extension Housing Removal

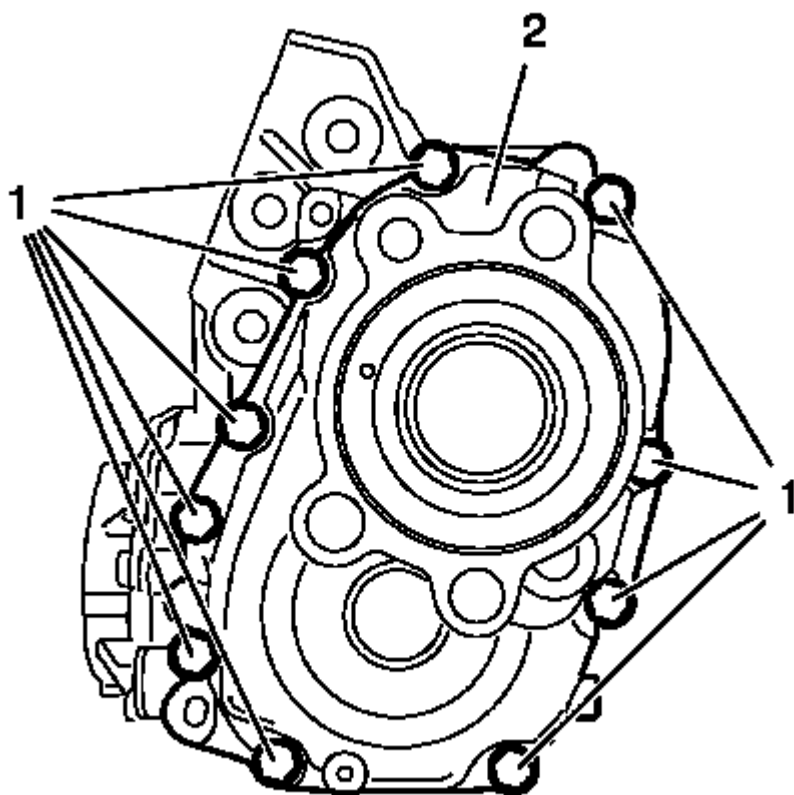


Fig. 62: Locating Transfer Case Rear Extension Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the transfer case rear extension housing bolts (1) from the rear extension housing (2).

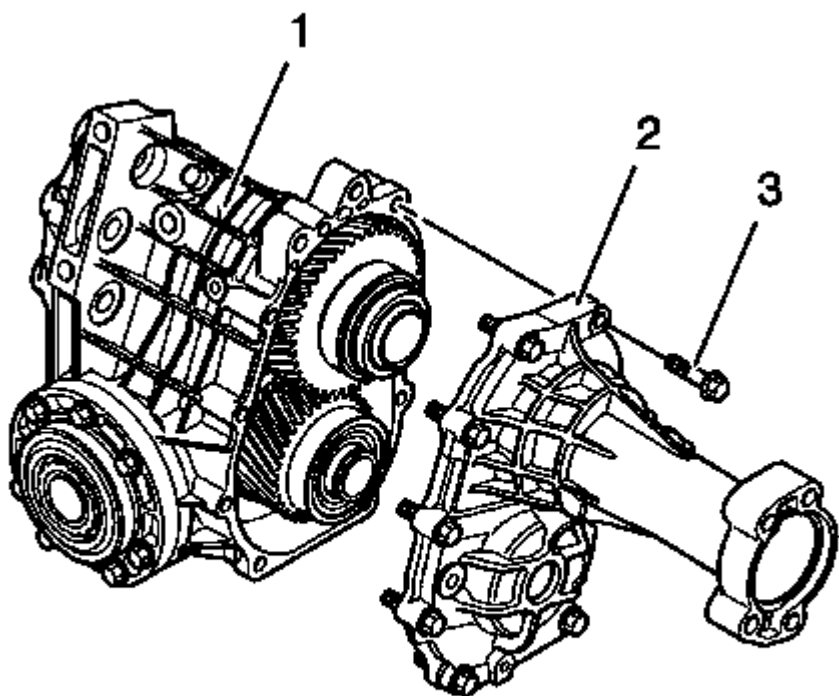


Fig. 63: View Of Transfer Case Housing & Rear Extension Housing
Courtesy of GENERAL MOTORS COMPANY

2. Remove the rear extension housing (2) and bolts (3).

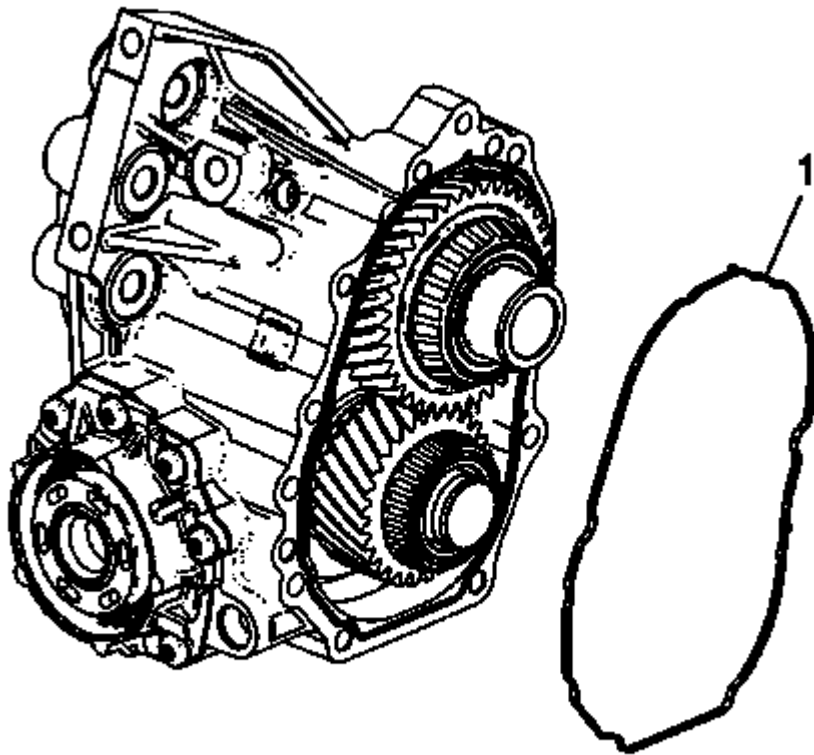


Fig. 64: Rear Extension Housing-To-Transfer Case Seal
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the rear extension housing-to-transfer case seal (1).

Input Shaft and Idler Shaft Removal

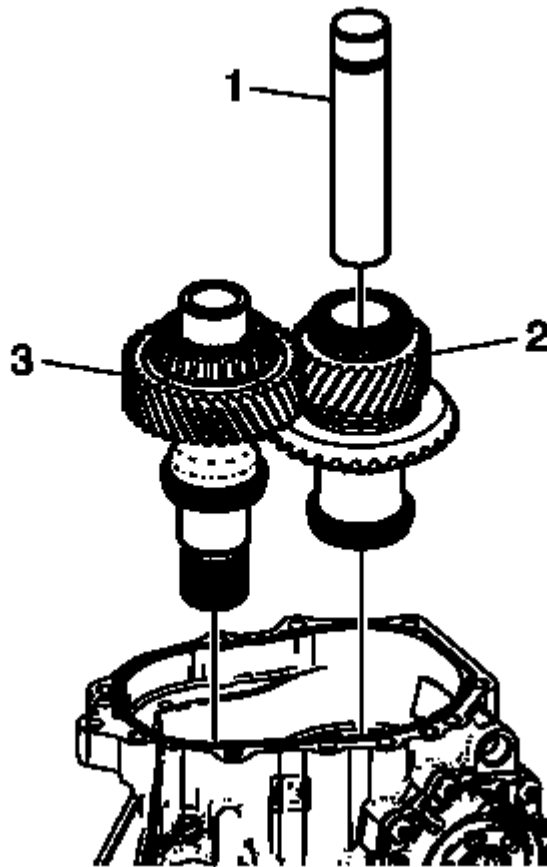


Fig. 65: Identifying Idler Gear Shaft, Input Shaft & Idler Gear
Courtesy of GENERAL MOTORS COMPANY

1. Remove the input shaft (3)
2. Remove the idler gear (2).
3. Remove the idler gear shaft (1) - Model Dependent.

Input Shaft Bearing Retainer Front Seals Removal

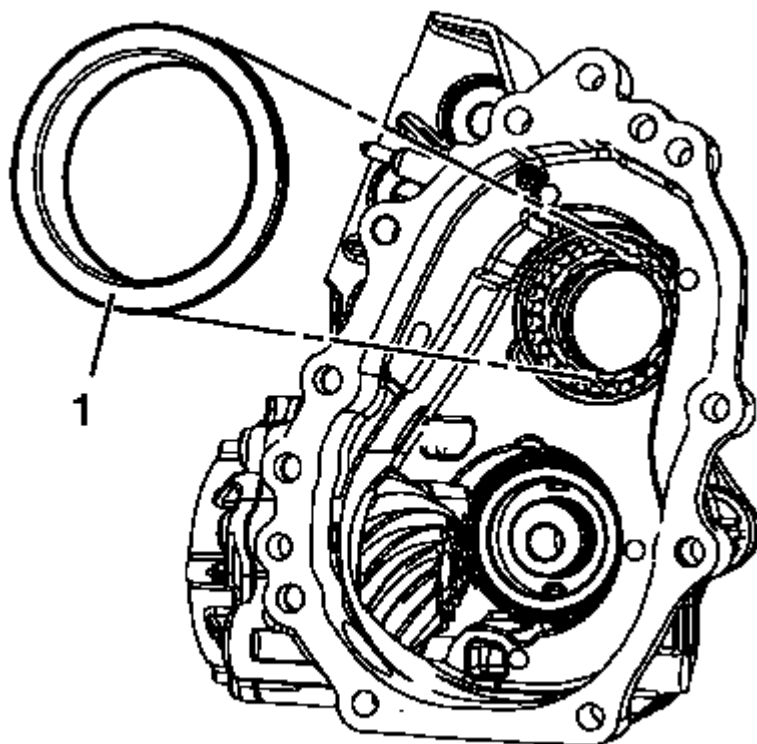


Fig. 66: Transfer Case Input Shaft Rear Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are two input shaft front seals located in the transfer case housing.

1. Remove the transfer case input shaft front (inner) seal (1) using a suitable screw driver.

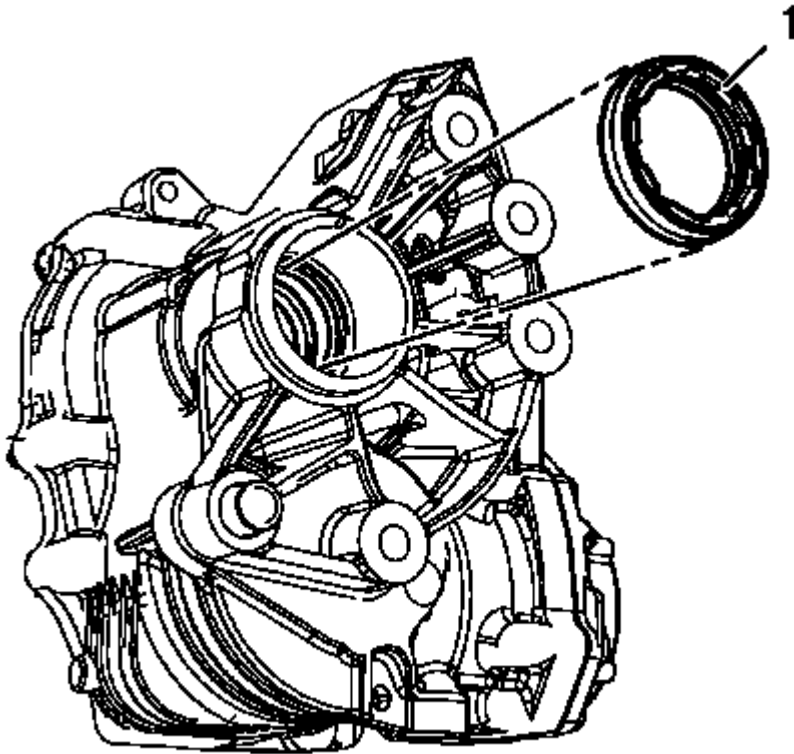


Fig. 67: Identifying Input Shaft Front Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are two input shaft front seals located in the transfer case housing.

2. Remove the transfer case input shaft front (outer) seal (1) using a suitable screw driver.

Idler Gear Shaft Front Seal Removal

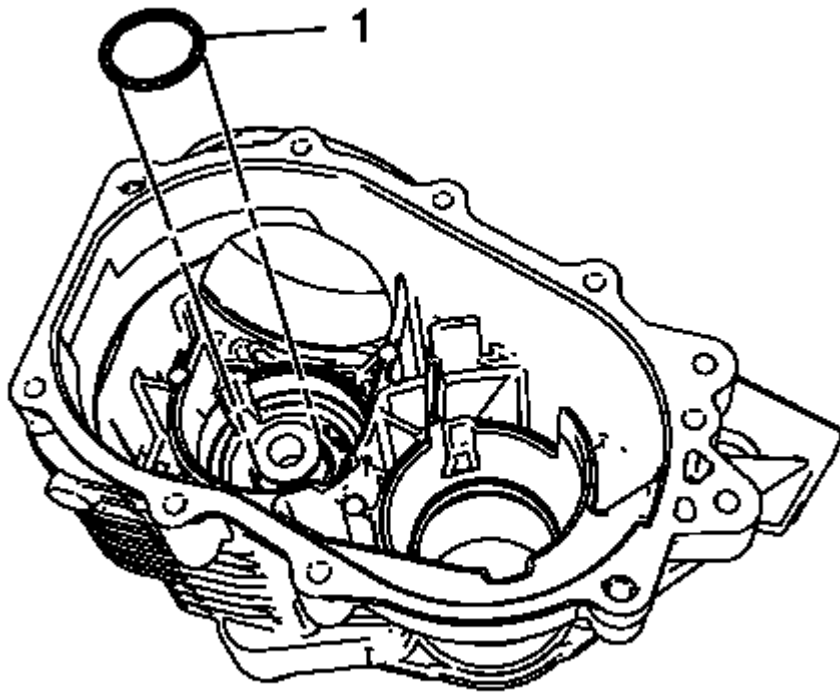


Fig. 68: Transfer Case Idler Gear Shaft Front Seal
Courtesy of GENERAL MOTORS COMPANY

Remove the transfer case idler gear shaft front seal (1) from transfer case - Model Dependent.

Idler Gear Shaft Rear Seal Removal

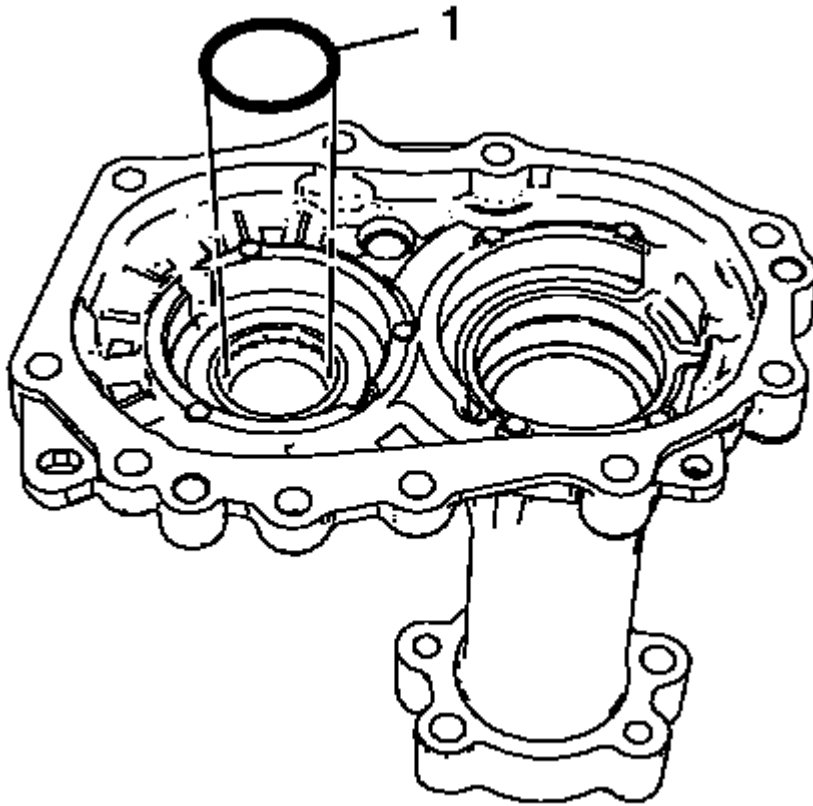


Fig. 69: Identifying Idler Gear Shaft Rear Seal
Courtesy of GENERAL MOTORS COMPANY

Remove the transfer case idler gear shaft rear seal (1) from the rear extension housing - Model Dependent.

Input Shaft Bearing Retainer Rear Seal Removal

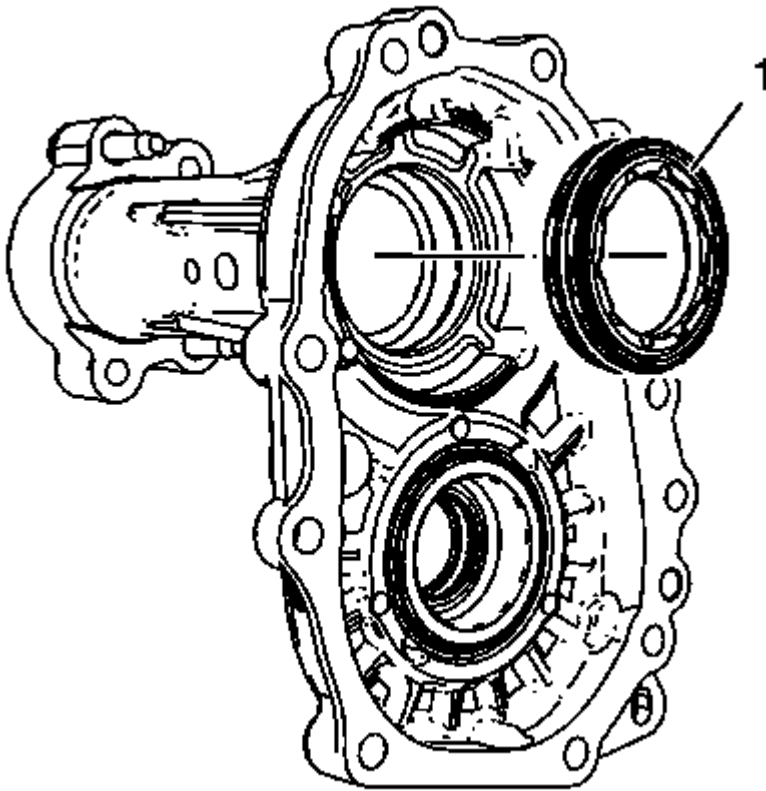


Fig. 70: Identifying Transfer Case Input Shaft Rear Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: To avoid damage to the housing, use a brass punch to remove the seal.

Remove the transfer case input shaft rear seal (1) from the rear extension housing.

Front Wheel Drive Intermediate Shaft Seal Removal

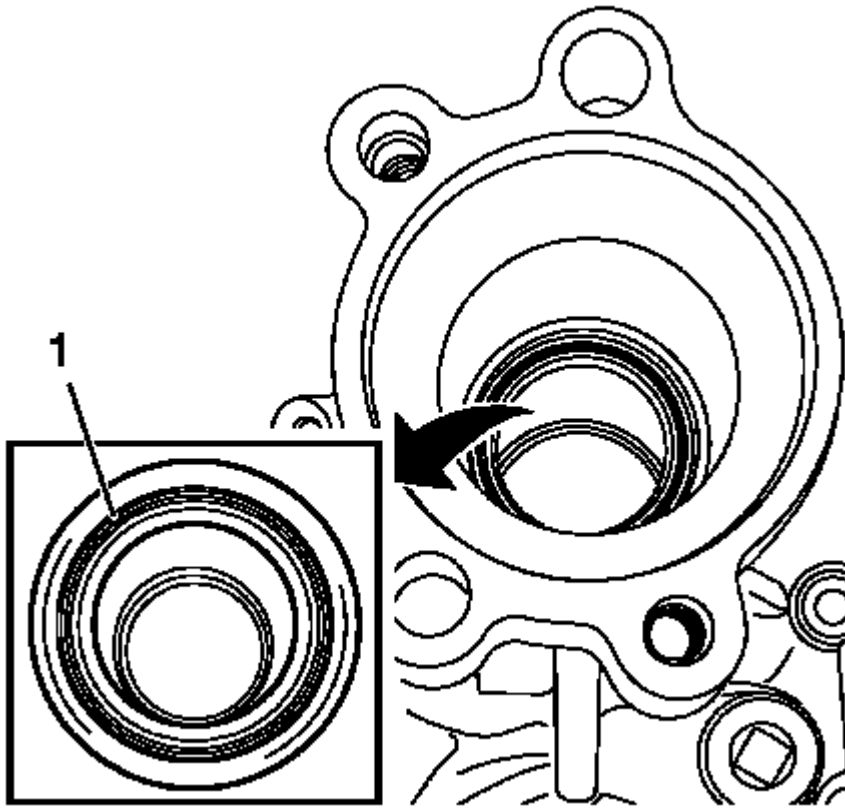


Fig. 71: Identifying Front Wheel Drive Intermediate Shaft Seal
Courtesy of GENERAL MOTORS COMPANY

Remove the intermediate shaft seal (1) from the rear extension housing using a suitable screw driver.

TRANSFER CASE CLEANING AND INSPECTION

Transfer Case Housing

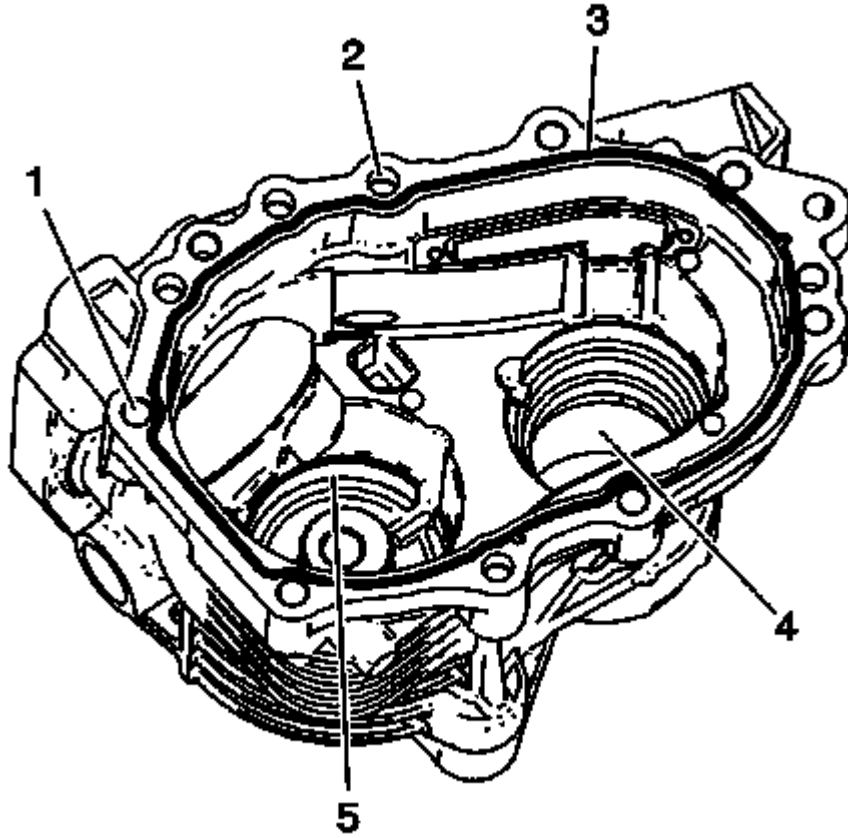


Fig. 72: Transfer Case Housing Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The bearings, shafts, gears, and housings are not serviceable components. If damage to any of those components is present, the transfer case must be replaced as an assembly.

1. Clean the front case half in cleaning solvent and air dry.
2. Inspect the housing for the following:
 - Damage to threaded bolt holes (1 and 2)
 - Damaged sealing surfaces (3)
 - Bearing races (5) with wear or pitting
 - Porosity
 - External Damage

Rear Extension Housing

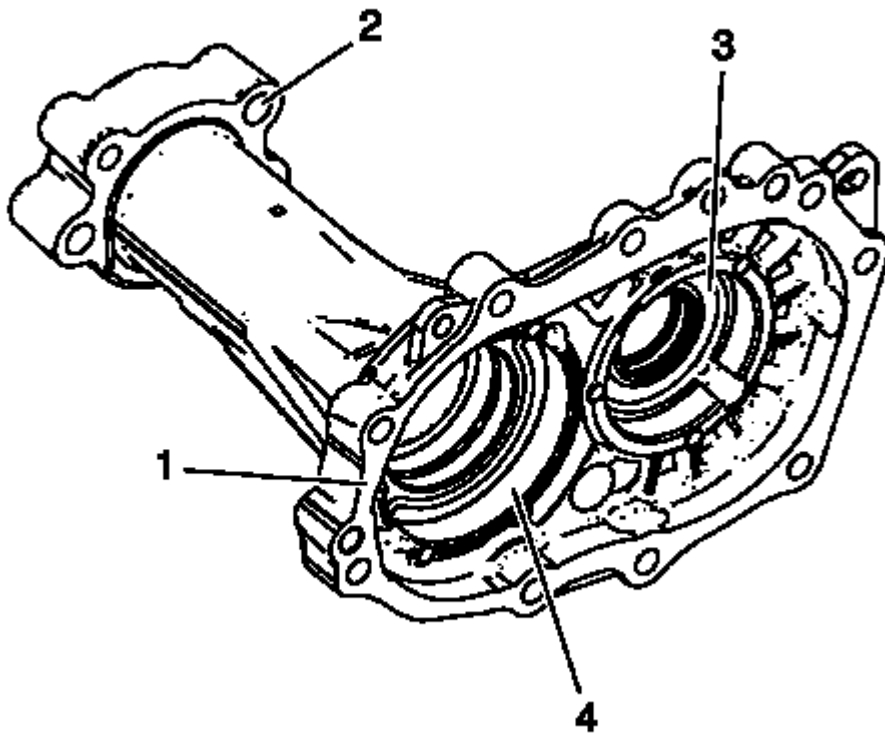


Fig. 73: Rear Extension Housing Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The bearings, shafts, gears, and housings are not serviceable components. If damage to any of those components is present, the transfer case must be replaced as an assembly

1. Clean the rear case half in cleaning solvent and air dry.

CAUTION: Do not nick, scratch or damage the sealing surface. The sealing surface is a machined surface. Damage to the machined surface can cause leakage. 2. Inspect the housing for the following:

2. Inspect the housing for the following:
 - Damages sealing surfaces (1)
 - Damage to threaded bolt holes (2)
 - Bearing races (3) with wear or pitting
 - Porosity
 - External Damage

Input Shaft

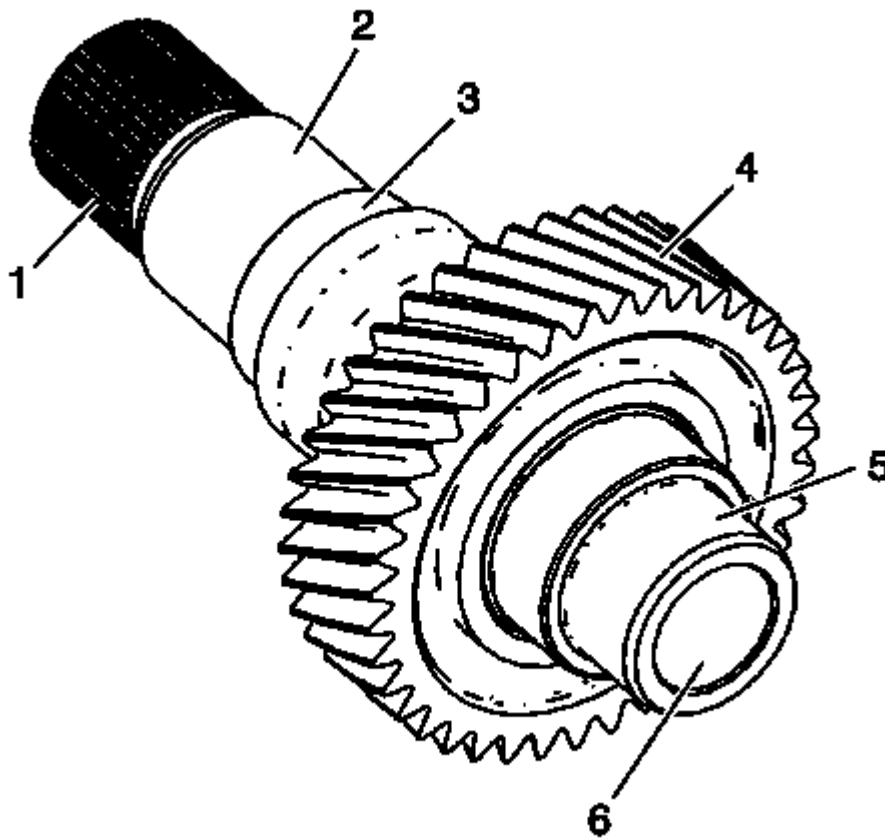


Fig. 74: Input Shaft Inspection Points
Courtesy of GENERAL MOTORS COMPANY

NOTE: The bearings, shafts, gears, and housings are not serviceable components. If damage to any of those components is present, the transfer case must be replaced as an assembly

1. Clean the input shaft in cleaning solvent.
2. Inspect the input shaft splines (1) for excessive wear or damage.
3. Inspect the input shaft seal surfaces (2 and 5) for excessive grooves, rust, pitting or other damage.
4. Inspect the input shaft gear teeth (4) for excessive wear or damage.

Idler Gear and Idler Shaft

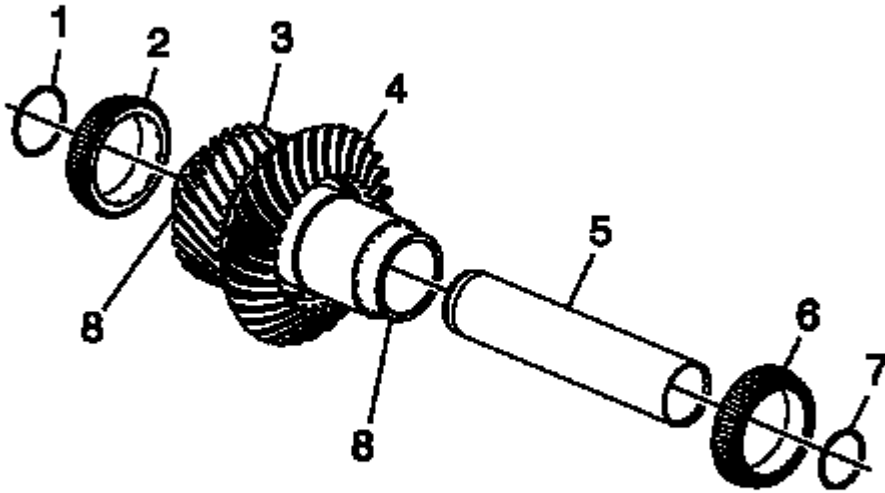


Fig. 75: Idler Gear and Idler Shaft Inspection Areas
 Courtesy of GENERAL MOTORS COMPANY

NOTE: **The bearings, shafts, gears, and housings are not serviceable components. If damage to any of those components is present, the transfer case must be replaced as an assembly**

1. Clean the idler shaft in cleaning solvent.
2. Inspect the idler shaft seal surfaces (8) for excessive grooves, rust, pitting or other damage. - Model Dependent
3. Inspect the sealing surfaces of the idler gear shaft (5) for excessive grooves, rust, pitting or other damage. - Model Dependent
4. Inspect the idler shaft gear teeth (3 and 4) for excessive wear or damage
5. Inspect the bearings (2 and 6) for pitting, wear or other damage.

TRANSFER CASE ASSEMBLE

Front Wheel Drive Intermediate Shaft Seal Installation

Special Tools

- **DT-305-1/KM-305-1** Remover/Installer
- **DT-49953** Seal Installer

For equivalent regional tools, refer to **Special Tools**.

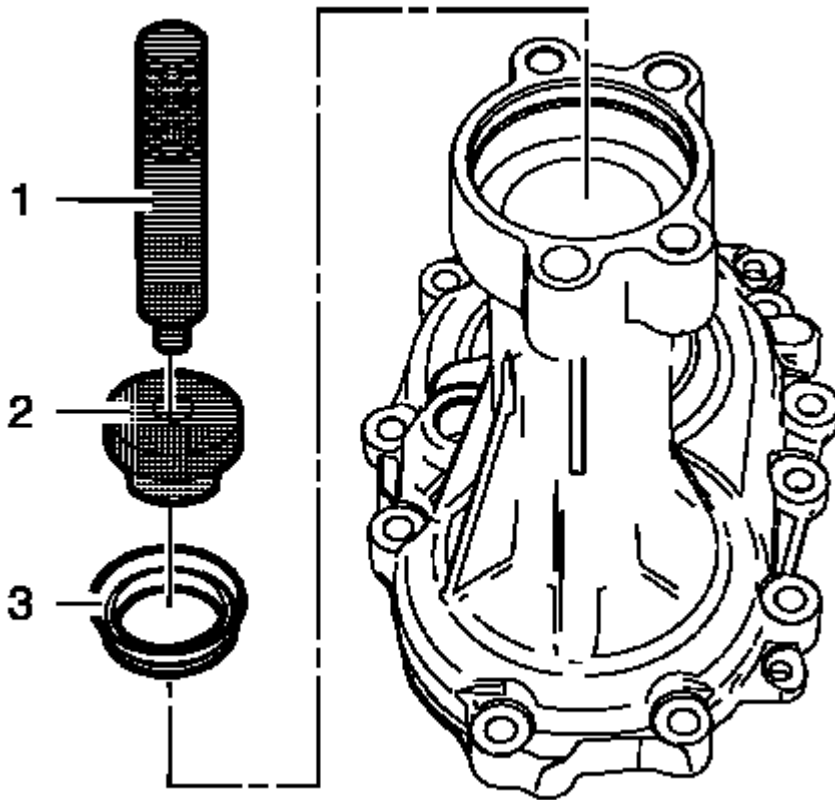


Fig. 76: Intermediate Shaft Seal Installer

Courtesy of **GENERAL MOTORS COMPANY**

Install the intermediate shaft seal (3), to the rear extension housing using the **DT-49953** installer (2) with **DT-305-1/KM-305-1** remover/installer (1) .

Input Shaft Bearing Retainer Rear Seal Installation

Special Tools

- **DT-305-1/KM-305-1** Remover/Installer
- **DT-49951** Seal Installer

For equivalent regional tools, refer to **Special Tools**

1. Clean the transfer case rear extension housing threaded bolt holes. A thread repair tool may be used to clean the threads of old threadlocking material.

2. Spray thread cleaner into the holes. Refer to Adhesives, Fluids, Lubricants, and Sealers.

WARNING: Wear safety glasses when using compressed air in order to prevent eye injury.

3. Clean the transfer case housing and rear extension housing bolt holes with compressed air.

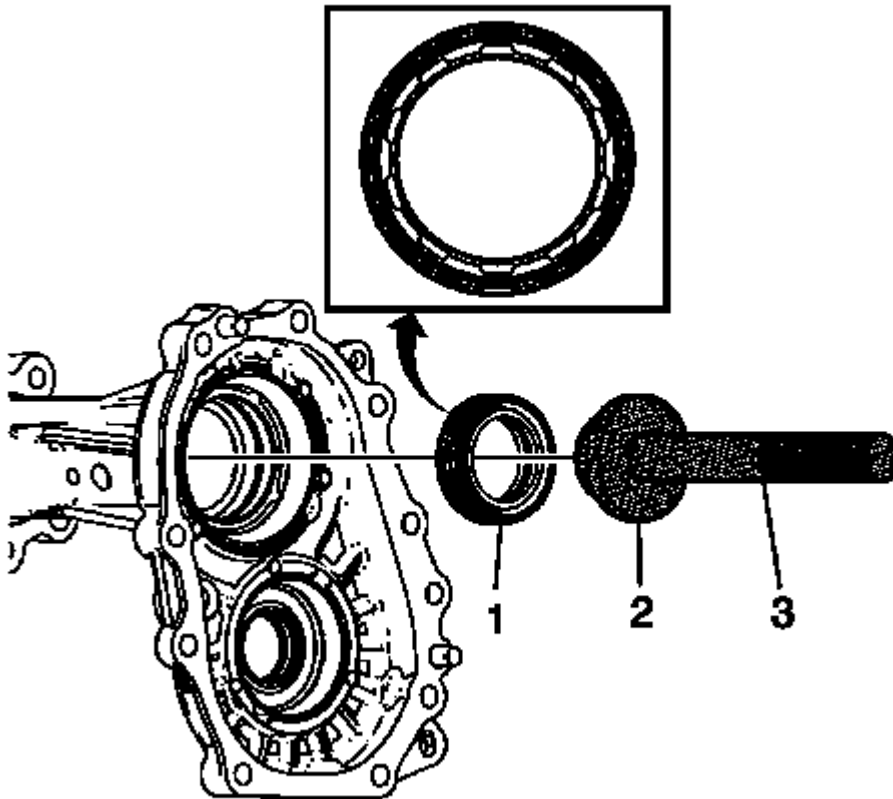


Fig. 77: Installing Input Shaft Bearing Retainer Rear Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the NEW seal with the notched surface of the seal facing away from the installer tool.

4. Install the NEW input shaft rear seal (1) to the rear extension housing using the **DT-49951** installer (2) and **DT-305-1/KM-305-1** remover/installer (3).

Idler Gear Shaft Rear Seal Installation

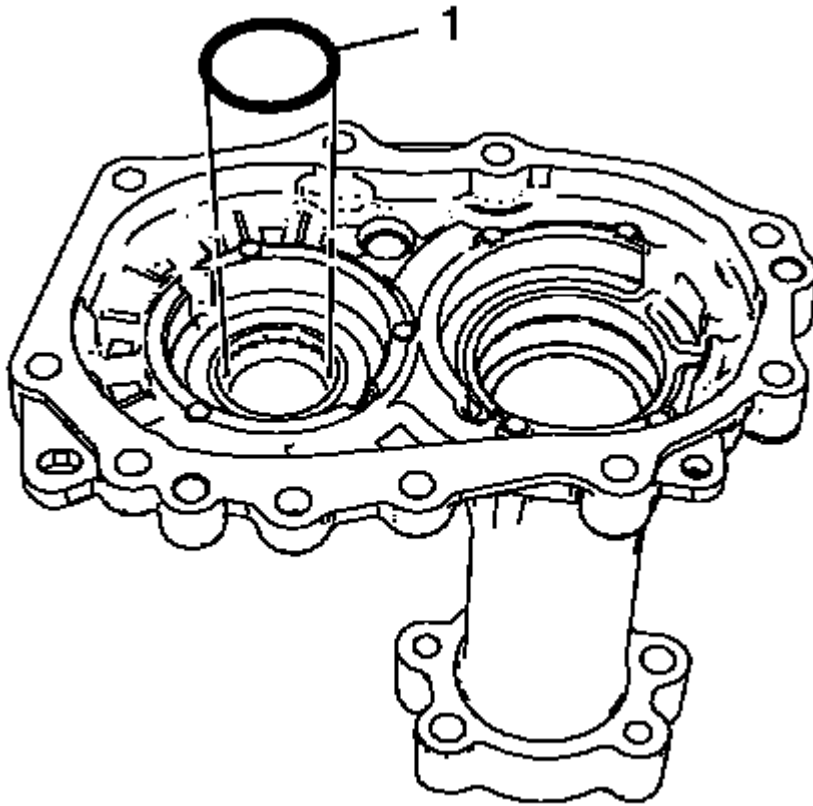


Fig. 78: Identifying Idler Gear Shaft Rear Seal
Courtesy of GENERAL MOTORS COMPANY

Install a NEW idler gear shaft rear seal (1) to the rear extension housing - Model Dependent.

Idler Gear Shaft Front Seal Installation

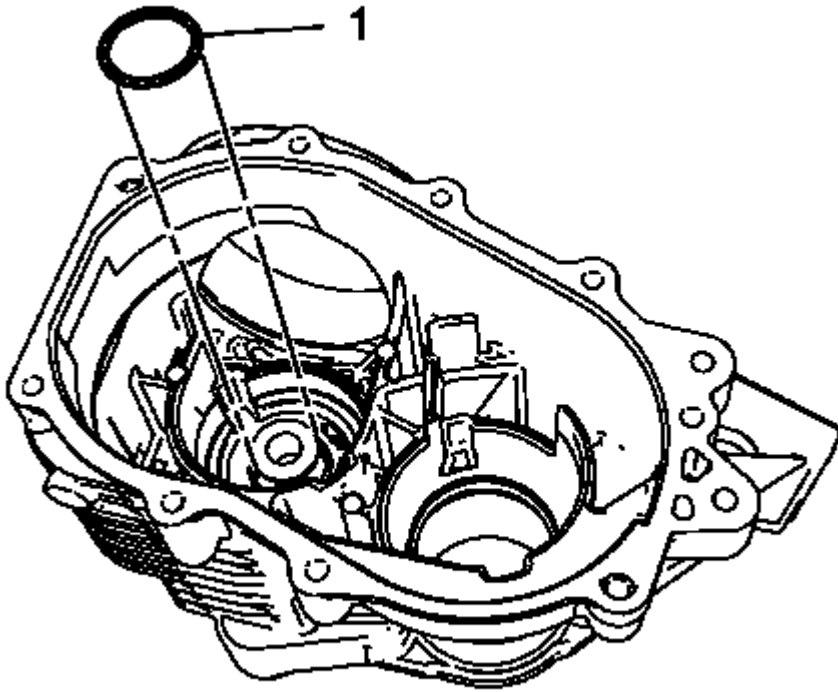


Fig. 79: Transfer Case Idler Gear Shaft Front Seal
Courtesy of GENERAL MOTORS COMPANY

Install a NEW transfer case idler gear shaft front seal (1) to transfer case - Model Dependent.

Input Shaft Bearing Retainer Front Seals Installation

Special Tools

- **DT-305-1/KM-305-1** Remover/Installer
- **DT-49952** Installer

For equivalent regional tools, refer to **Special Tools**.

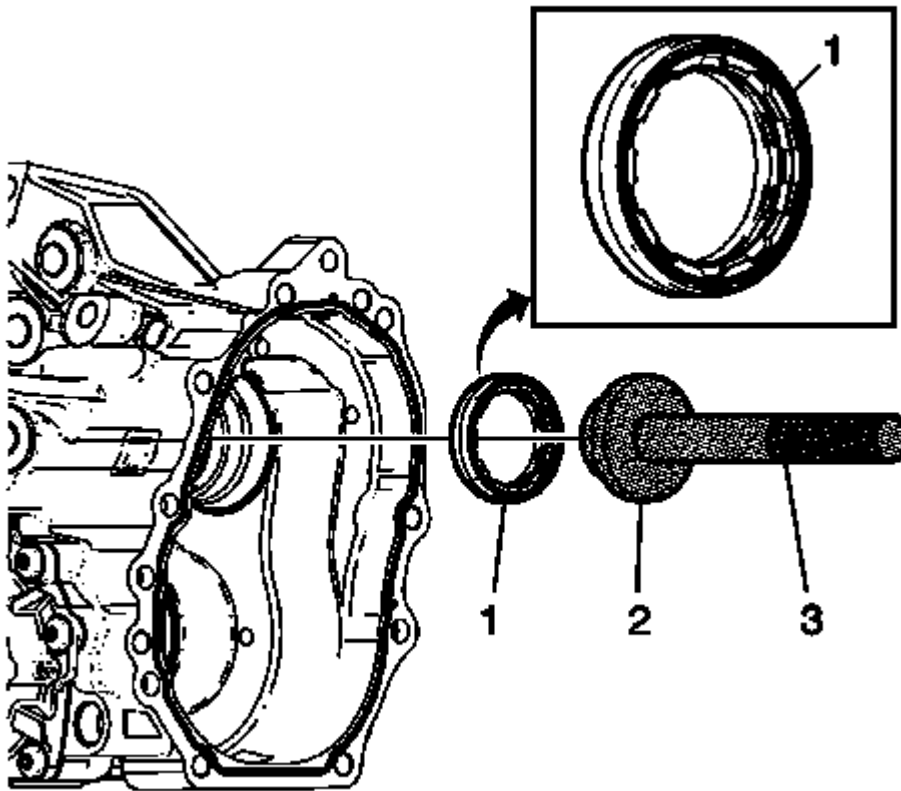


Fig. 80: Identifying Input Shaft Bearing Retainer Front Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the NEW seal with the notched surface of the seal facing the installer tool.

1. Install the input shaft front (inner) seal (1), to the transfer case using the **DT-49952** installer (2) and **DT-305-1/KM-305-1** remover/installer (3) .

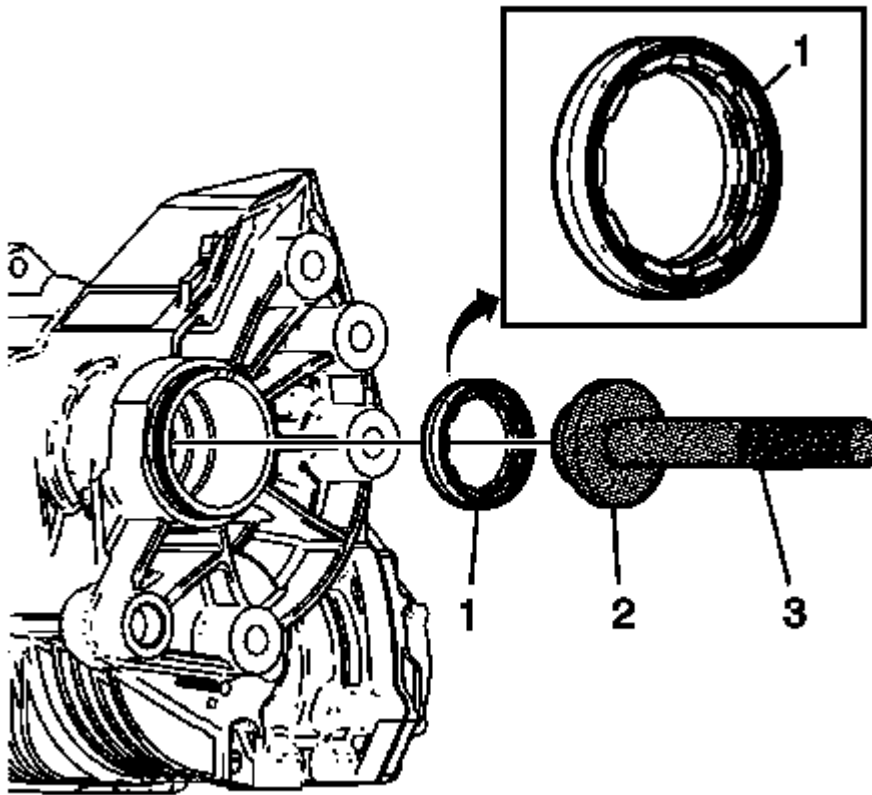


Fig. 81: Installing Input Shaft Front Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the NEW seal with the notched surface of the seal facing the installer tool.

2. Install the input shaft front (outer) seal (1), to the transfer case using the **DT-49952** installer (2) and **DT-305-1/KM-305-1** remover/installer (3) .

Input Shaft and Idler Gear Installation

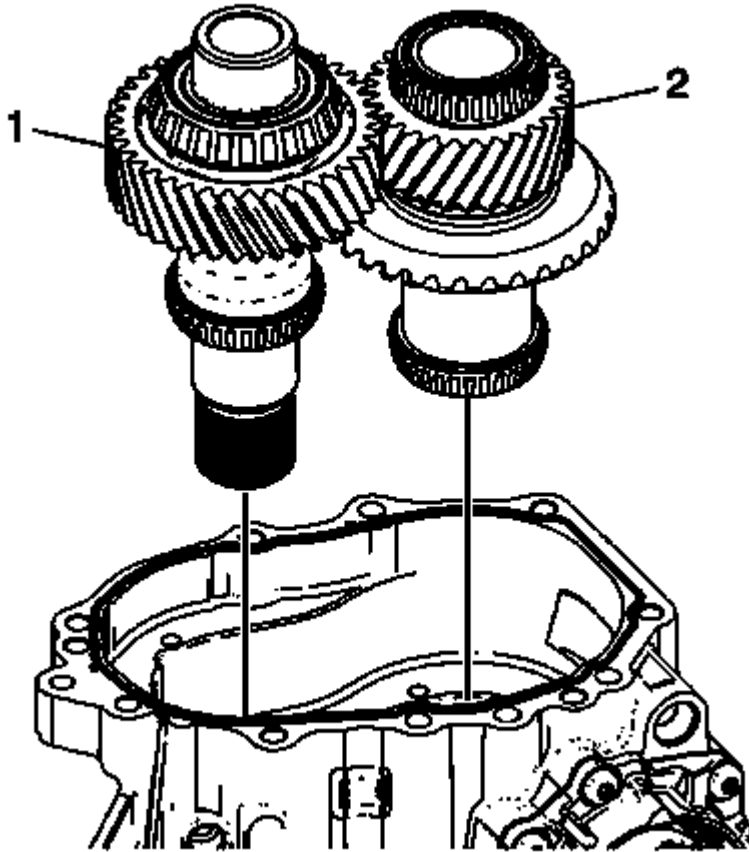


Fig. 82: Input Shaft And Idler Gear
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Cover the splines of the input shaft to prevent damage to the input shaft oil seals during installation.

Install input shaft (1) and idler gear (2).

Rear Extension Housing Installation - Model Dependent

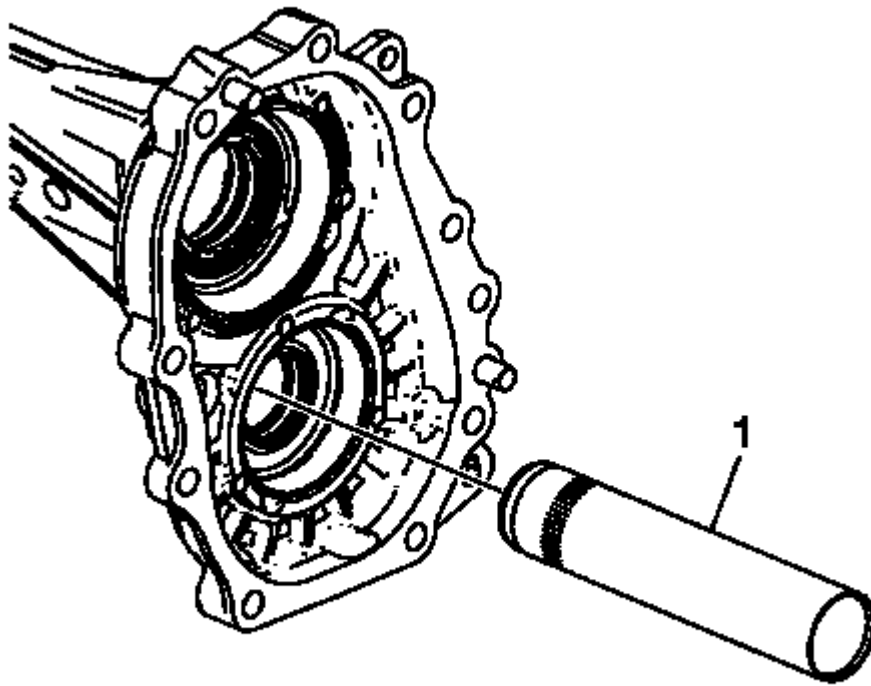


Fig. 83: Idler Gear Shaft

Courtesy of GENERAL MOTORS COMPANY

1. Install the idler gear shaft (1) to the rear extension housing - Model Dependent.

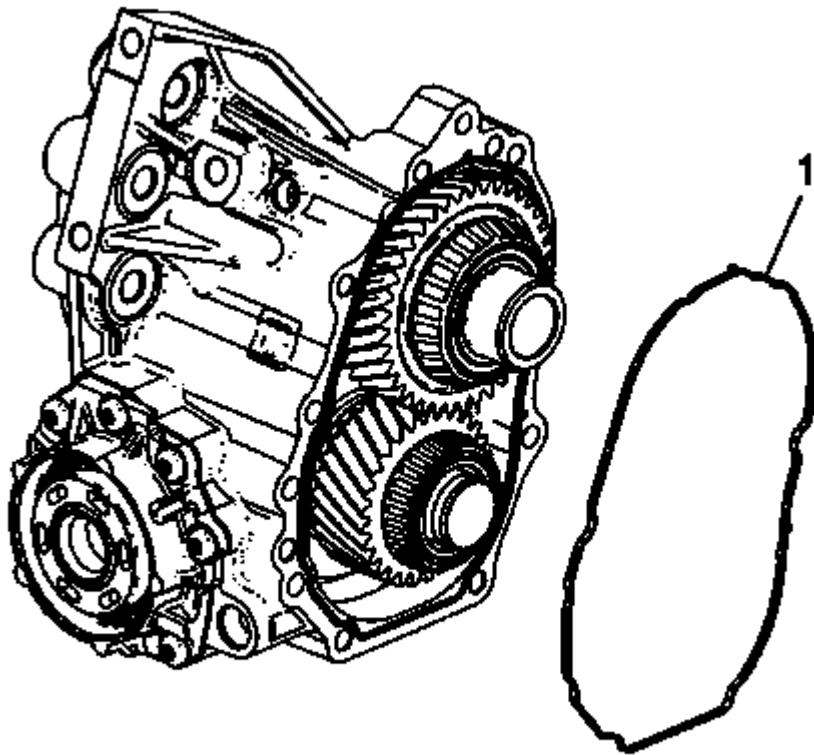


Fig. 84: Rear Extension Housing-To-Transfer Case Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW rear extension housing-to-transfer case seal (1).

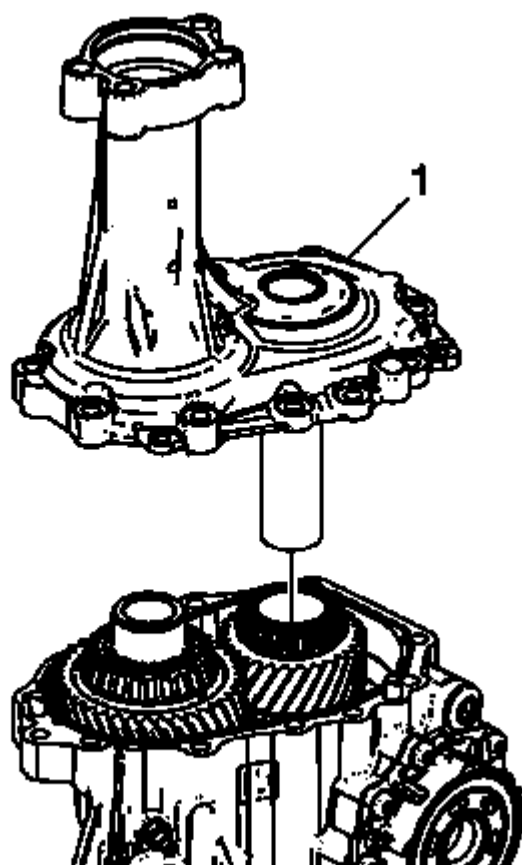


Fig. 85: Transfer Case Rear Extension Housing
Courtesy of GENERAL MOTORS COMPANY

3. Install the rear extension housing (1) and idler gear shaft to the transfer case housing. Position the idler gear shaft into the center opening of the idler gear.

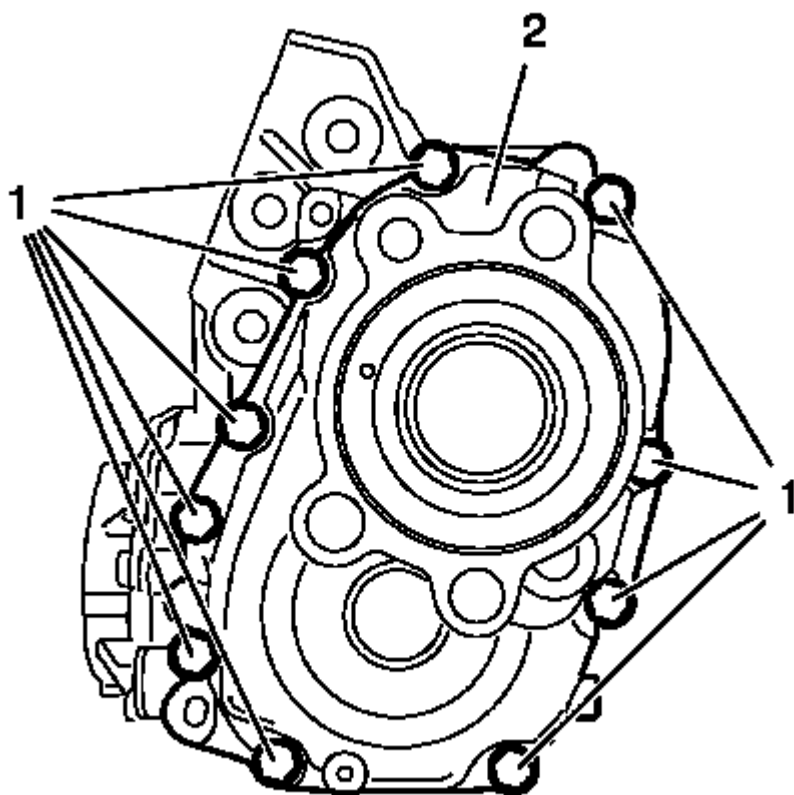


Fig. 86: Locating Transfer Case Rear Extension Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Apply threadlock to the threads of the NEW transfer case-to-rear extension housing bolts (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
5. Install the NEW transfer case-to-rear extension housing bolts (1).
 1. Tighten the 10 transfer case-to-rear extension housing bolts (1) a first pass to 25 N.m (18 lb ft).
 2. Tighten the 10 transfer case-to-rear extension housing bolts (1) a second pass 130 degrees.

Rear Extension Housing Installation - RPO MH4

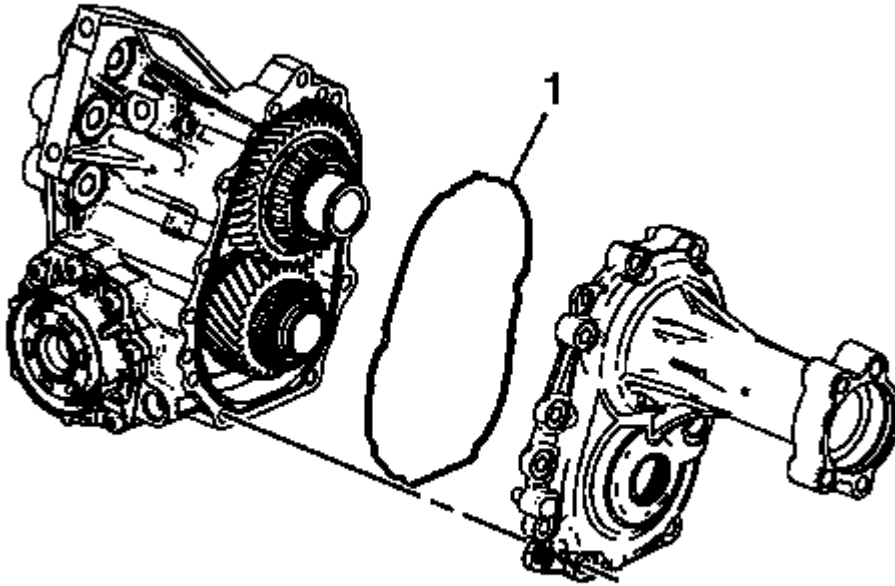


Fig. 87: View Of Rear Extension Housing-To-Transfer Case Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW rear extension housing-to-transfer case seal (1).
2. Install the rear extension housing onto the transfer case housing .

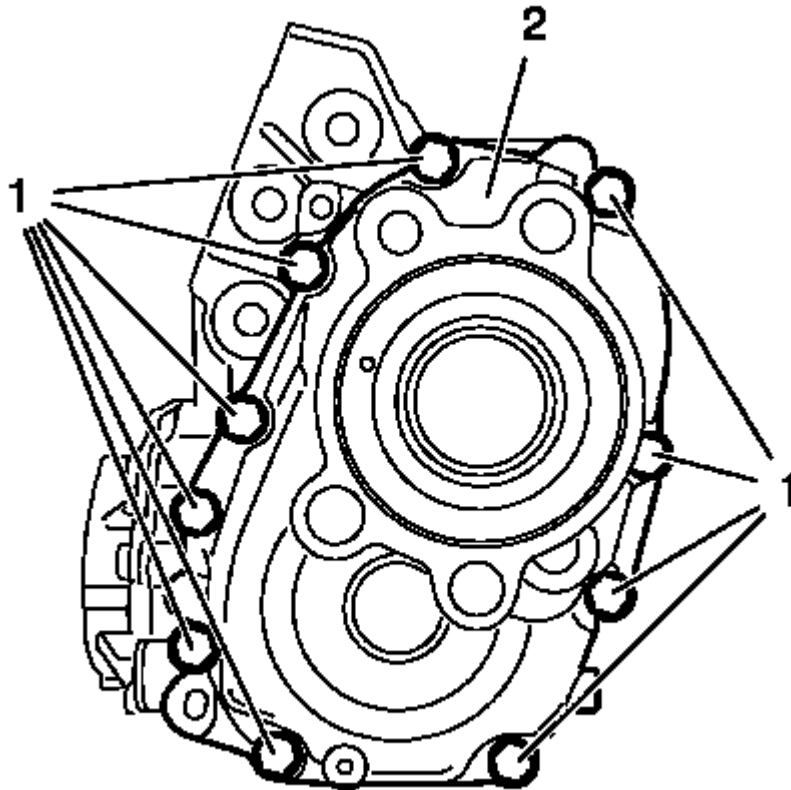


Fig. 88: Locating Transfer Case Rear Extension Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Apply threadlock to the threads of the NEW transfer case-to-rear extension housing bolts. Refer to Adhesives, Fluids, Lubricants, and Sealers.
4. Install the NEW transfer case-to-rear extension housing bolts (1).
 1. Tighten the 10 transfer case-to-rear extension housing bolts (1) a first pass to 25 N.m (18 lb ft).
 2. Tighten the 10 transfer case-to-rear extension housing bolts (1) a second pass to 130 degrees.

Rear Output Shaft Seal Installation

Special Tools

- **DT-305-1/KM-305-1** Remover/Installer
- **DT-49954-A** Seal Installer

For equivalent regional special tools, refer to Special Tools.

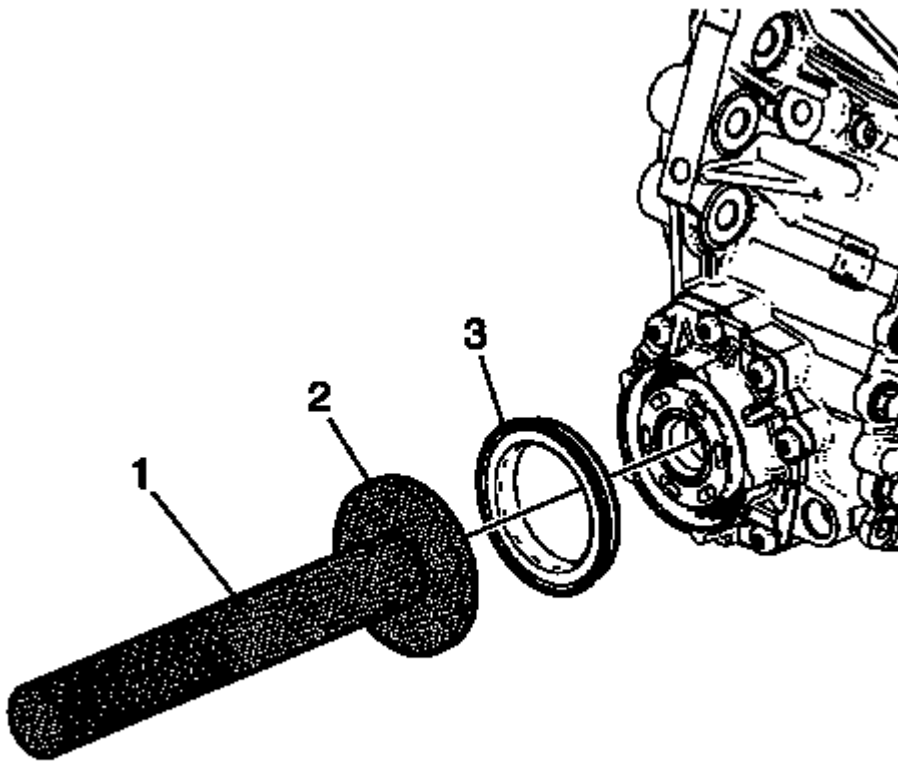


Fig. 89: View Of Rear Output Shaft Seal
Courtesy of GENERAL MOTORS COMPANY

Install the rear output shaft seal (3), using the **DT-49954-A** installer (2) and **DT-305-1/KM-305-1** remover/installer (1).

Front Wheel Drive Intermediate Shaft Bearing Installation

Special Tools

DT-48076 Bearing Installer

For equivalent regional tools, refer to **Special Tools**.

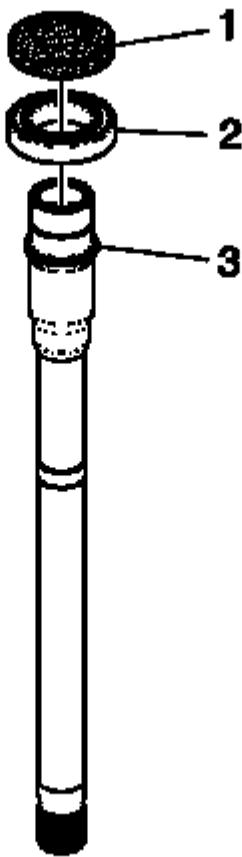


Fig. 90: View Of Intermediate Shaft Bearing And Bearing Installer
Courtesy of GENERAL MOTORS COMPANY

1. Press on the intermediate shaft bearing (2) onto the intermediate shaft (3), using **DT-48076** installer (1) and a hydraulic press.

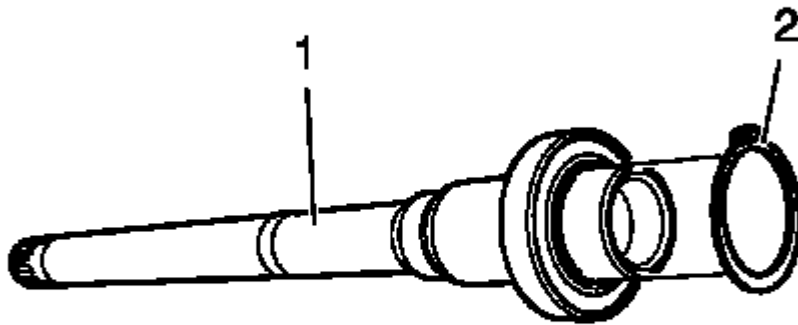


Fig. 91: Identifying Intermediate Shaft Bearing Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

2. Install the transfer case intermediate shaft bearing retaining ring (2) to intermediate shaft (1), using suitable pliers.

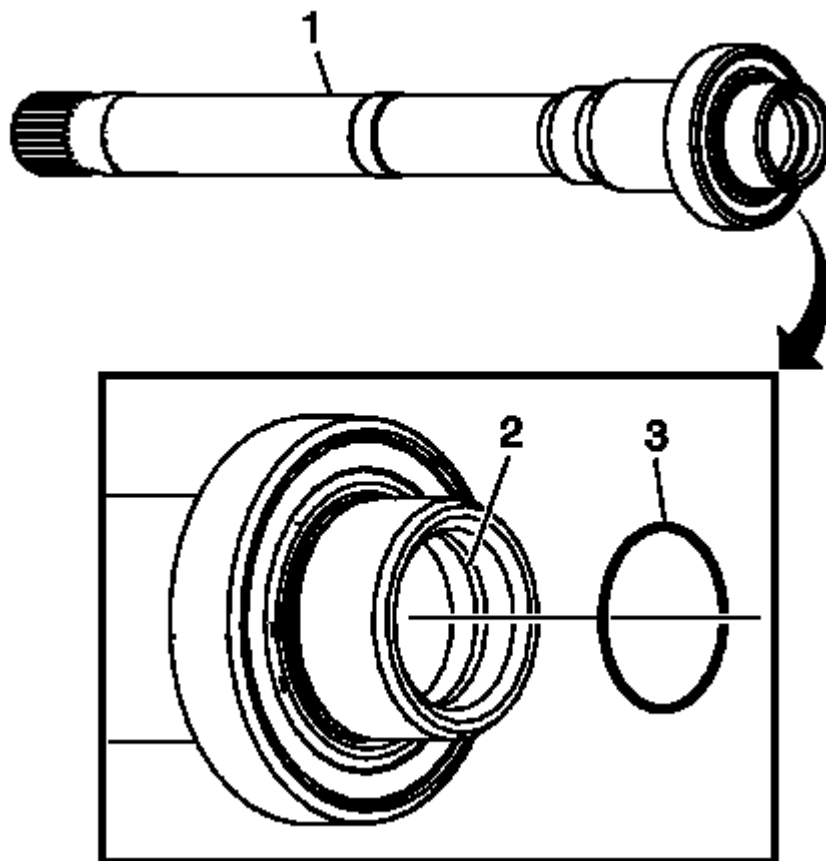


Fig. 92: Intermediate Shaft O-Ring (Second Design)
Courtesy of GENERAL MOTORS COMPANY

3. Install intermediate shaft O-ring (3), as required.

Front Wheel Drive Intermediate Shaft Installation

Special Tools

- **DT-113-2-A** Holder
- **DT-622-A** Transmission Bracket
- **DT-48076** Bearing Installer
- **DT-49104** Protective Collar

For equivalent regional tools, refer to **Special Tools**.

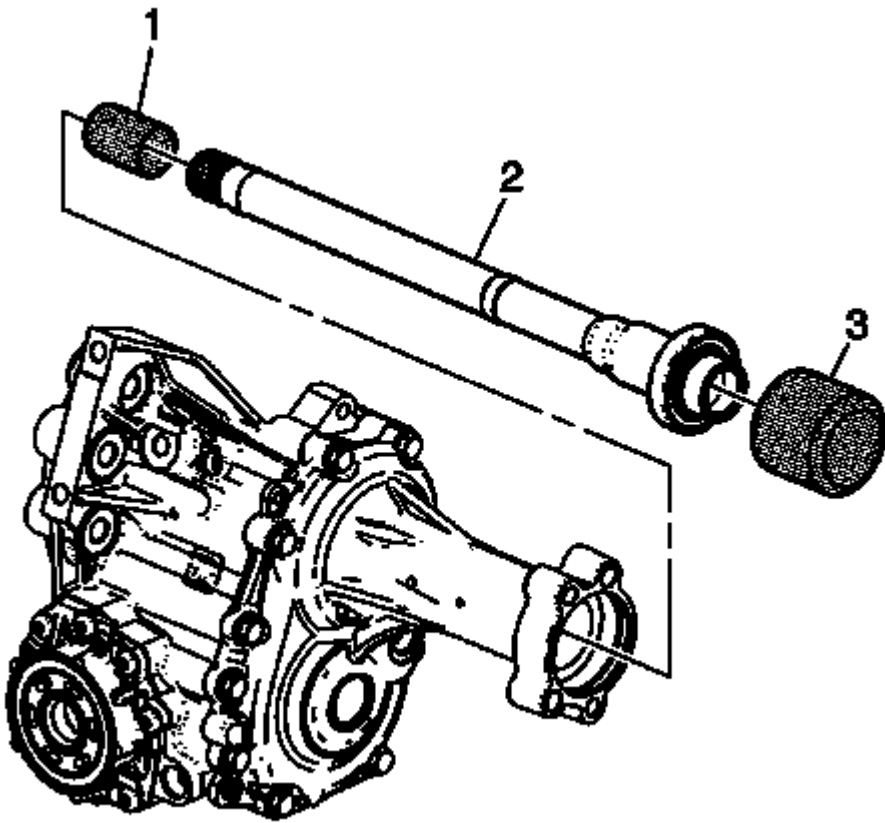


Fig. 93: View Of Installing Intermediate Shaft
Courtesy of GENERAL MOTORS COMPANY

1. Install the **DT-49104** protective collar (1) to the intermediate shaft (2), and tap in the intermediate shaft using the **DT-48076** installer (3) and a rubber mallet.
2. Remove the **DT-49104** protective collar (1).

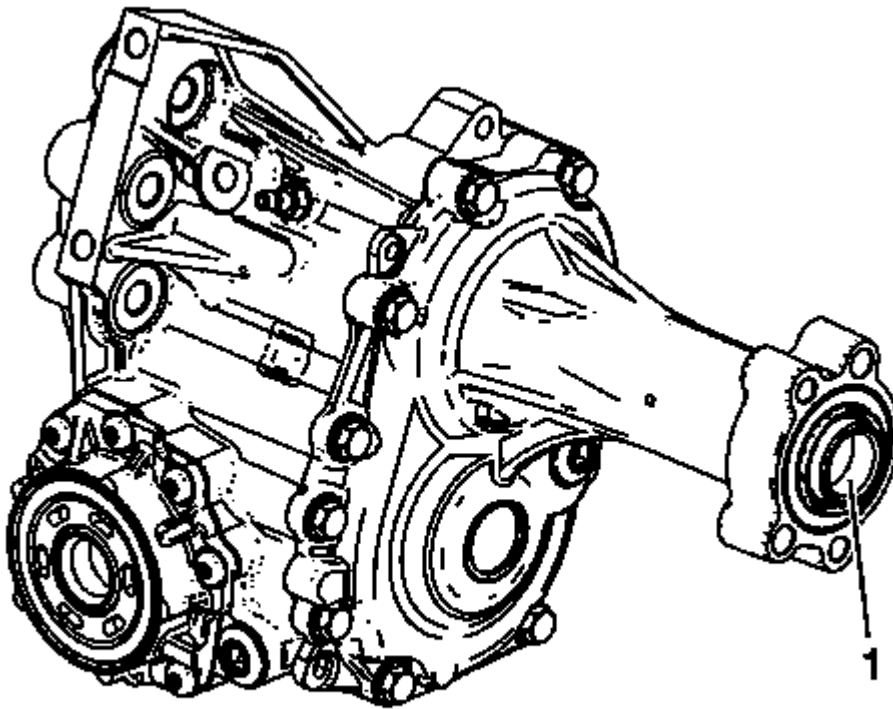


Fig. 94: Intermediate Shaft Output Splines
Courtesy of GENERAL MOTORS COMPANY

3. Apply grease to the output splines (1) of the intermediate shaft. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

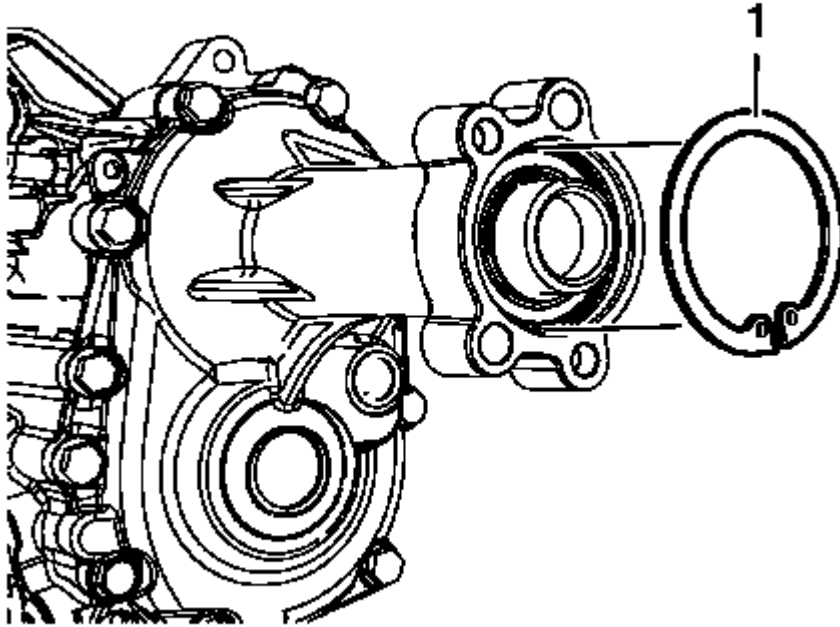


Fig. 95: Intermediate Shaft Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the transfer case intermediate shaft retaining ring (1), using suitable snap ring pliers.

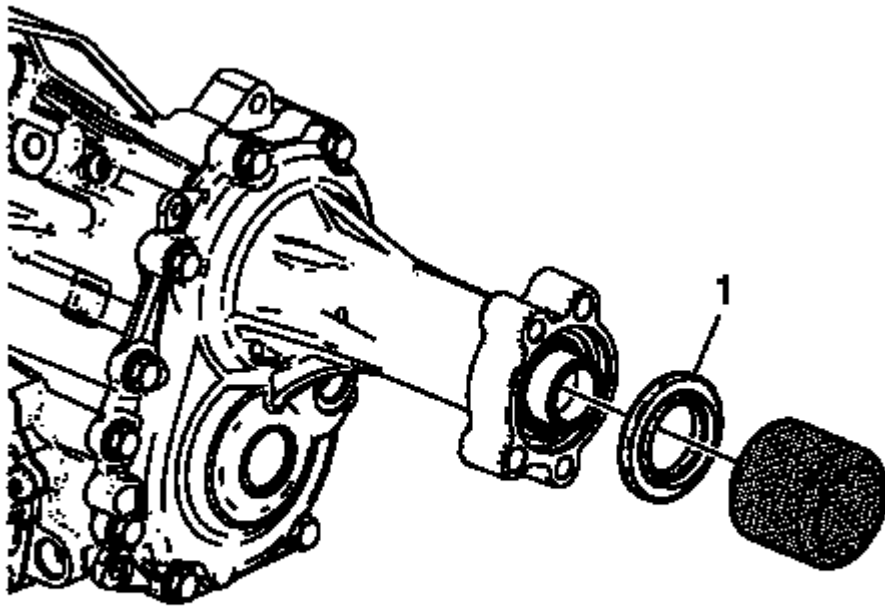


Fig. 96: Shaft Dirt Deflector And Grease Seal
Courtesy of GENERAL MOTORS COMPANY

5. Install the dirt deflector (1) using the **DT-48076** installer.

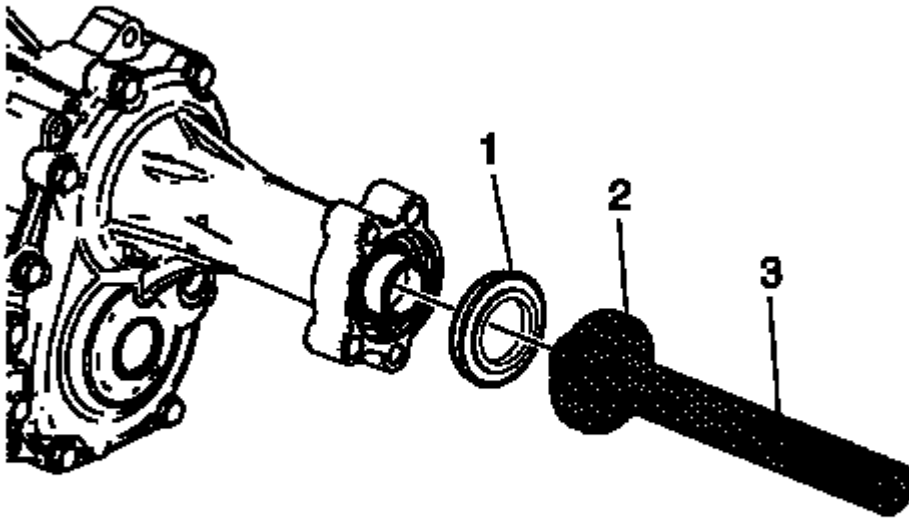


Fig. 97: Seal And Special Installer Tool
Courtesy of GENERAL MOTORS COMPANY

6. Install the front wheel drive intermediate shaft dirt deflector (1) - model dependant using the **DT 50768** seal installer (2) and **J 8092** driver handle (3).

Locating Bushing Installation

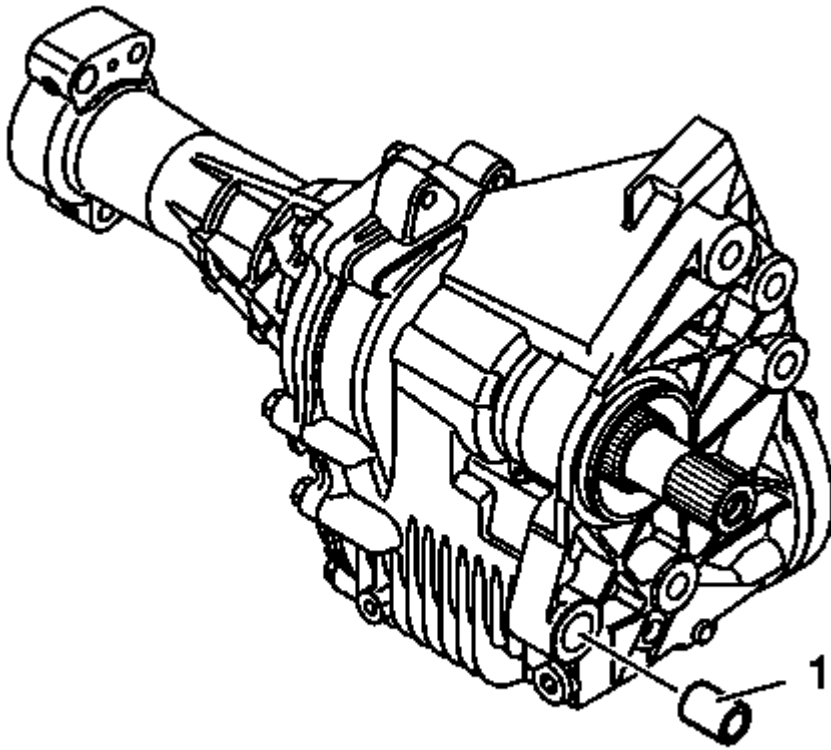


Fig. 98: View Of Transfer Case Location Bushing
Courtesy of GENERAL MOTORS COMPANY

Install the transfer case locating bushing (1) as required using a rubber mallet - Model Dependent.

Transfer Case-to-Transmission Seal Installation

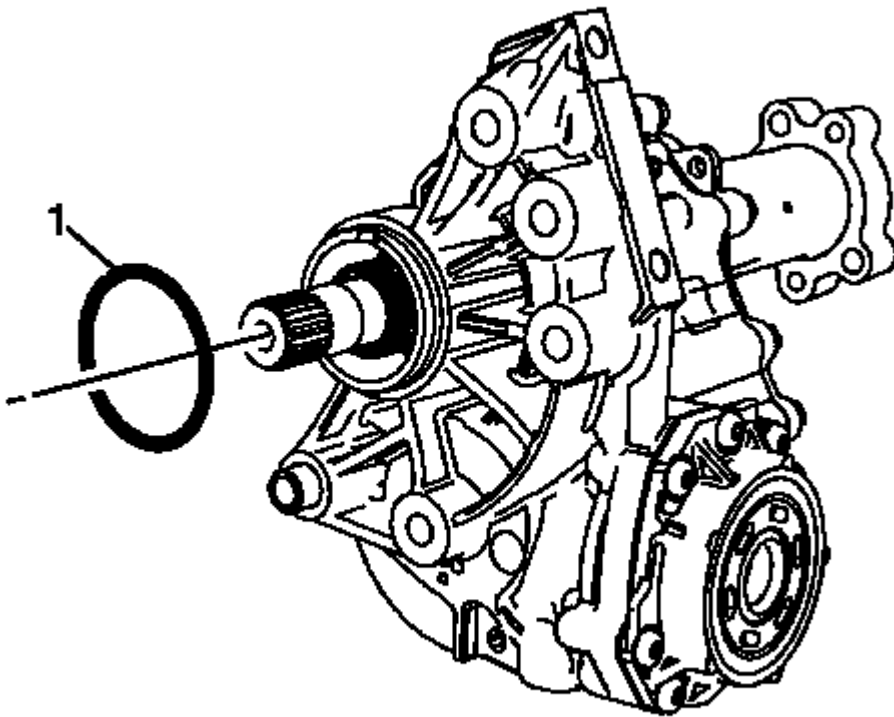


Fig. 99: Identifying Transfer Case-To-Transmission O-Ring
Courtesy of GENERAL MOTORS COMPANY

Install the NEW transfer case-to-transmission seal (1).

Transfer Case Vent Installation

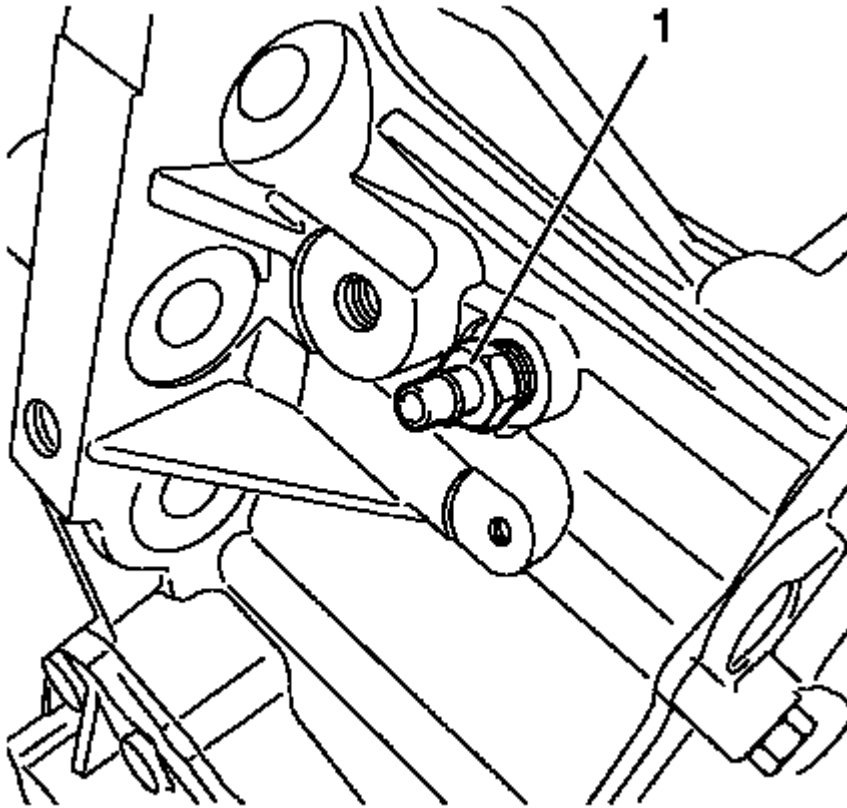


Fig. 100: View Of Transfer Case Vent
Courtesy of GENERAL MOTORS COMPANY

1. Apply sealant to the threads of the vent hose connector. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
2. Install the transfer case vent hose connector (1) and tighten to 25 N.m (18 lb ft).

Oil Drain Plug Installation

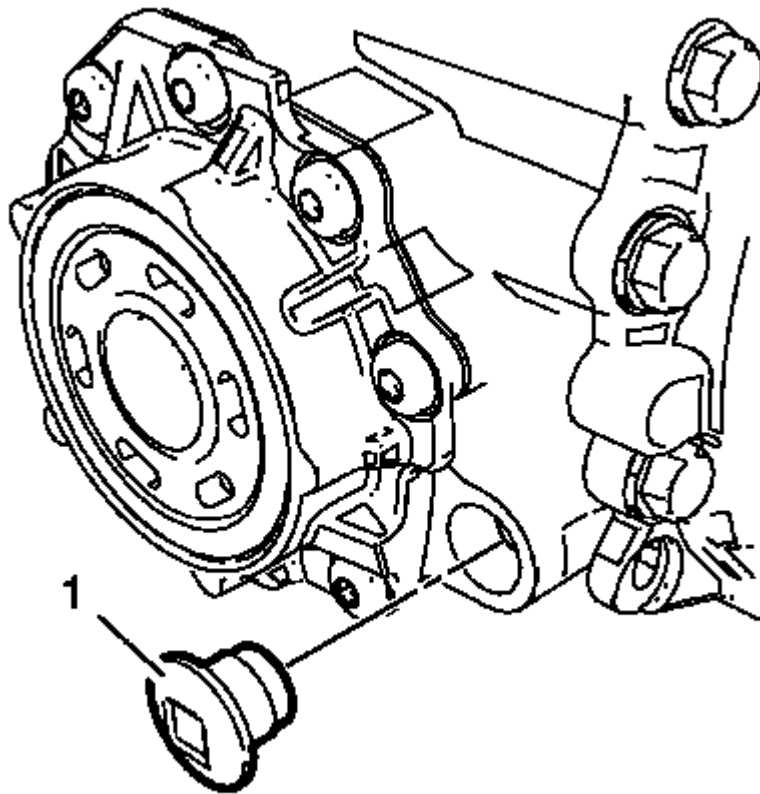


Fig. 101: View Of Transfer Case Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Install a NEW oil drain plug (1) and tighten to 40 N.m (30 lb ft).

Oil Fill Plug Installation

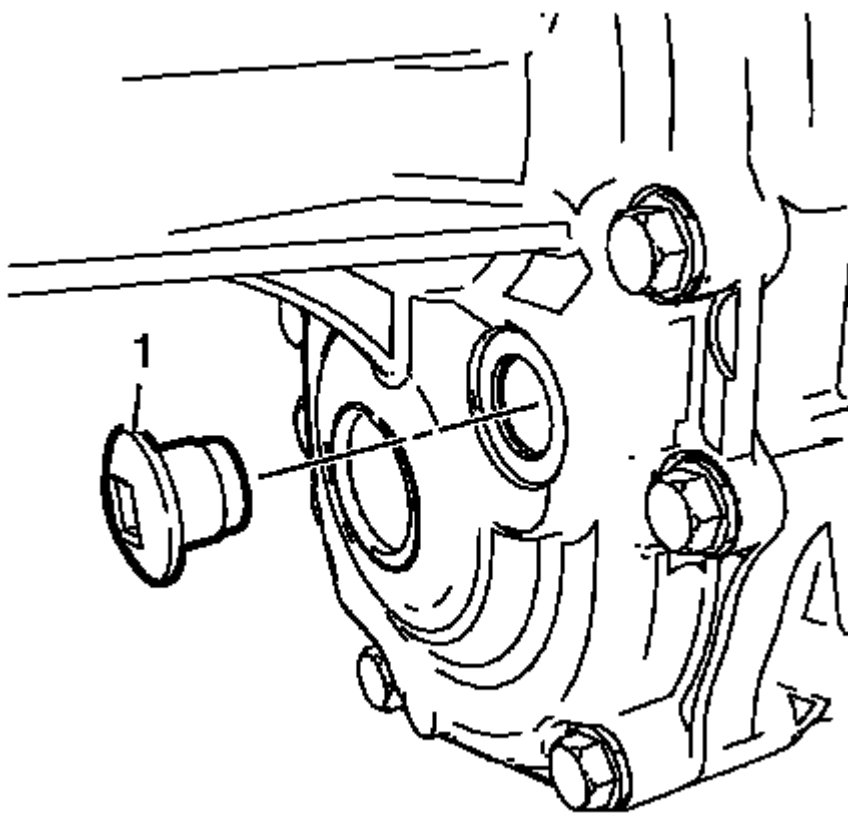


Fig. 102: Identifying Transfer Case Fill Plug
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW transfer case oil fill plug (1).
2. Once the transfer case has been filled with oil, tighten the oil fill plug to 40 N.m (30 lb ft).

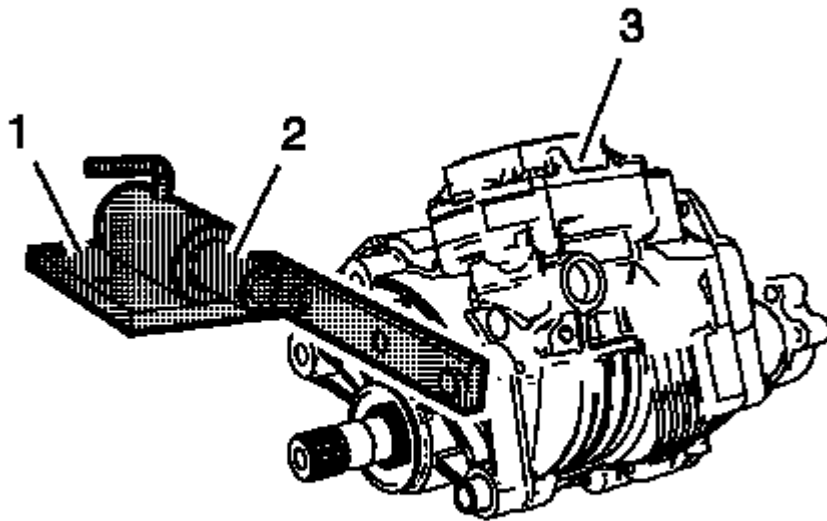


Fig. 103: Transmission Bracket, Transfer Case And Holder
Courtesy of GENERAL MOTORS COMPANY

3. Remove the transfer case (3) from **DT-622-A** bracket (2) and **DT-113-2-A** holder (1) .

DESCRIPTION AND OPERATION

TRANSFER CASE IDENTIFICATION

AAM First Design Label Location

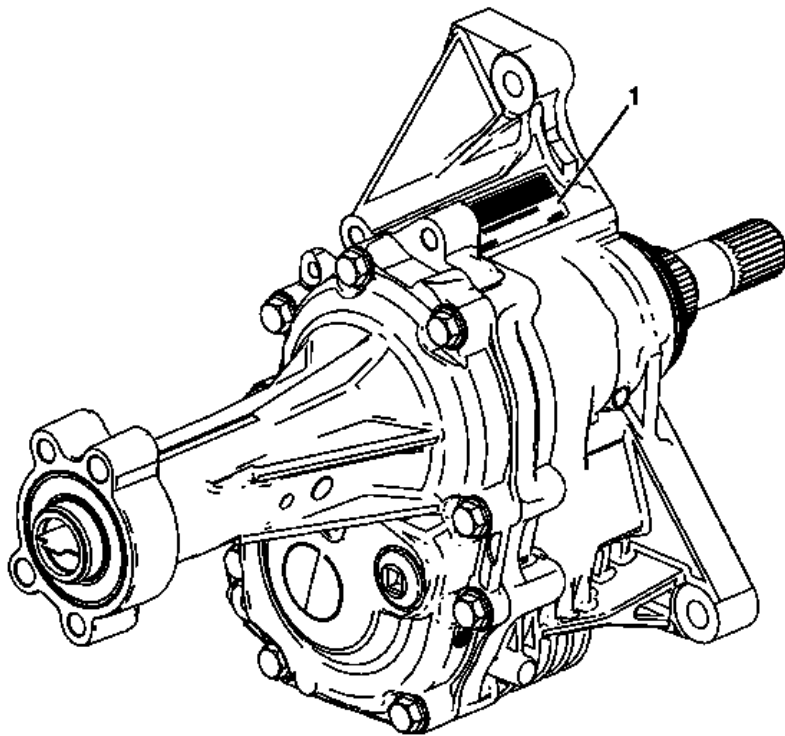


Fig. 104: AAM First Design Label Location
 Courtesy of GENERAL MOTORS COMPANY

The transfer case identification label (1) is located on the top of the front case half.

AAM First Design Label

Bar Code

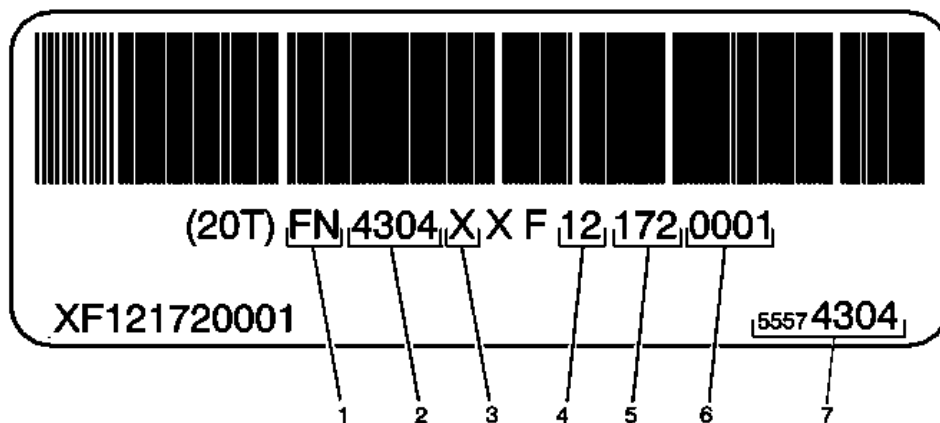


Fig. 105: Bar Code Information Identification
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

1	GM Assigned Component Identification
2	Last 4 digits of GM Part Number
3	Supplier Identification
4	Calendar Year Produced
5	Julian Date
6	Supplier Serial Number
7	GM Part Number

AAM Second Design Label Location

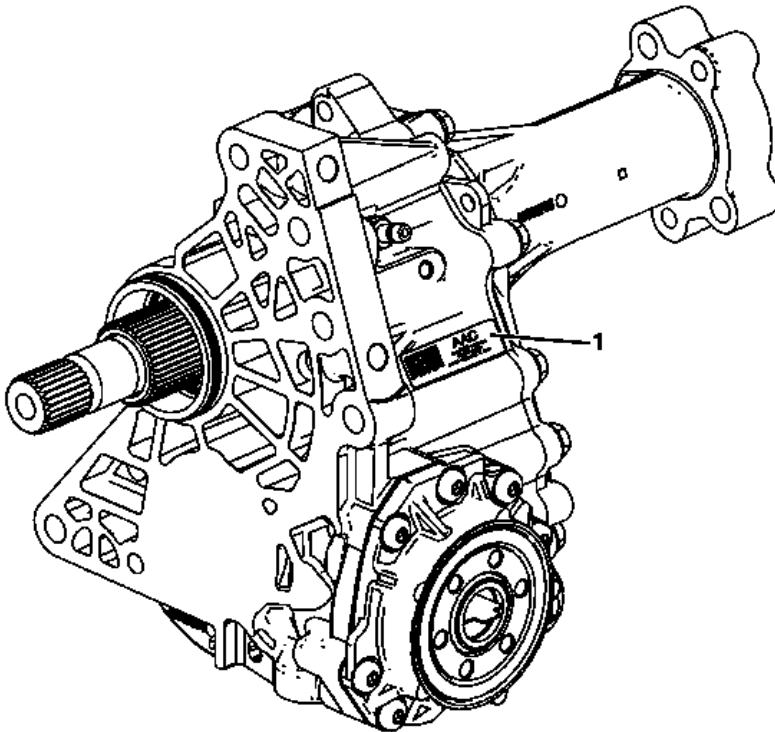


Fig. 106: AAM Second Design Label Location
Courtesy of GENERAL MOTORS COMPANY

The transfer case identification label (1) is located on the side of the front case half.

AAM Second Design Label

Bar Code

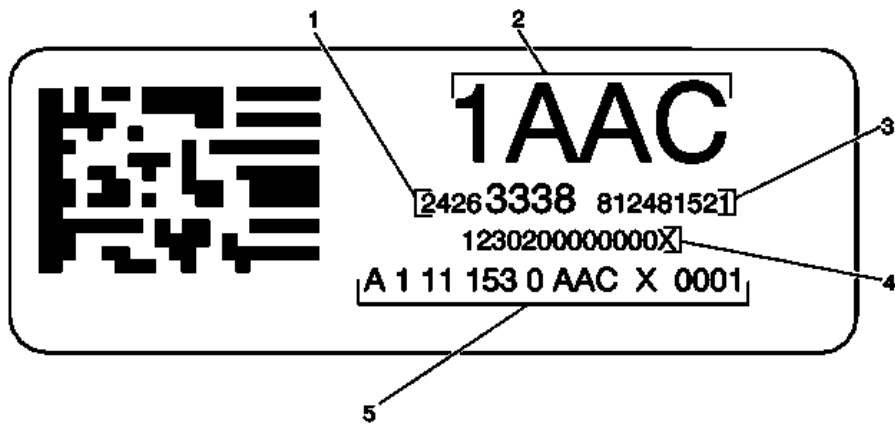


Fig. 107: Bar Code Information Identification
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	GM Full Part Number
2	Broadcast Code
3	Supplier DUNs
4	VPPS Code
5	Supplier Trace Code

TRANSFER CASE DESCRIPTION AND OPERATION

Transfer Case Identification

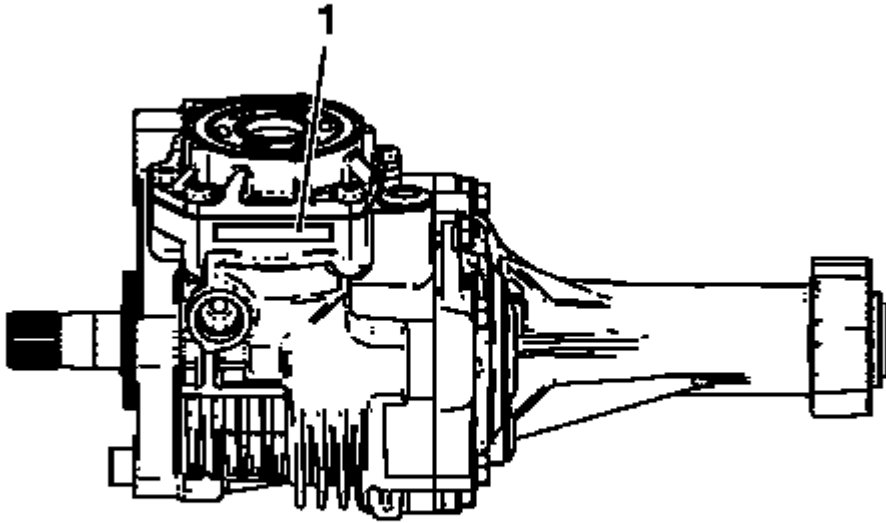


Fig. 108: Locating Transfer Case Assembly Part Number
Courtesy of GENERAL MOTORS COMPANY

The build variation of transfer case can be identified by the assembly part number (1) located on the bottom of the transfer case.

General

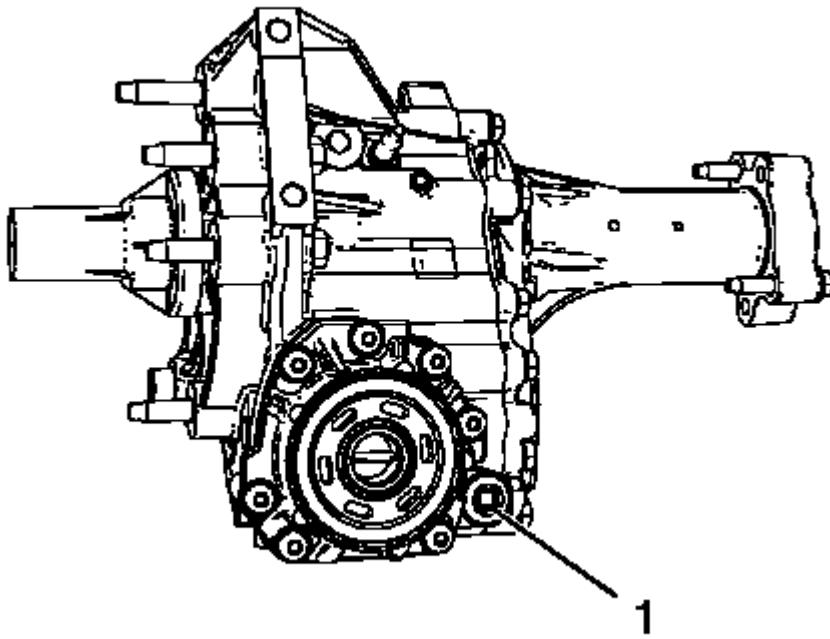


Fig. 109: Identifying Transfer Case Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

The transfer case oil drain plug (1) is located at the bottom of the assembly to the right side of the rear output shaft.

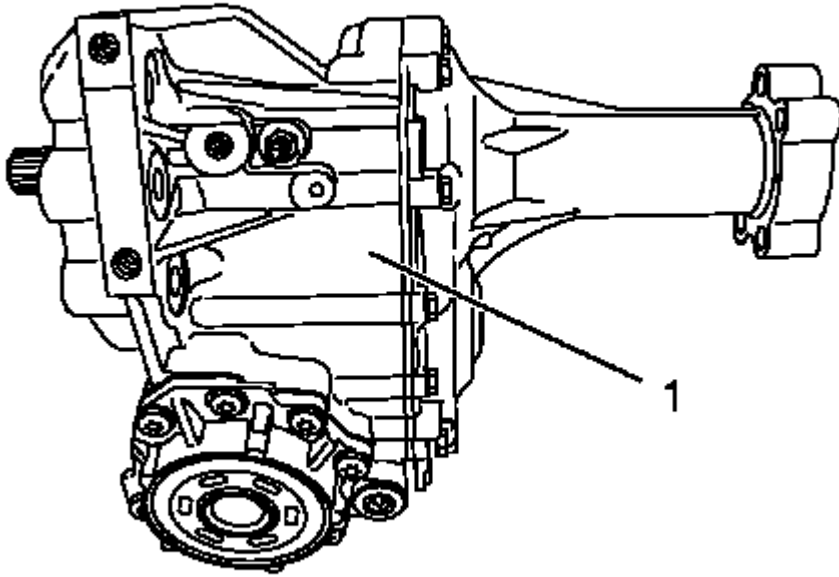


Fig. 110: View Of Transfer Case
Courtesy of GENERAL MOTORS COMPANY

The transfer case (1) is positioned in the right side of the vehicle and bolted to the transmission. Its primary function is to receive power from the transmission and transfer it using helical and hypoid gear sets to the rear differential via the propeller shaft. The internal intermediate shaft transfers power to the right-side front wheel.

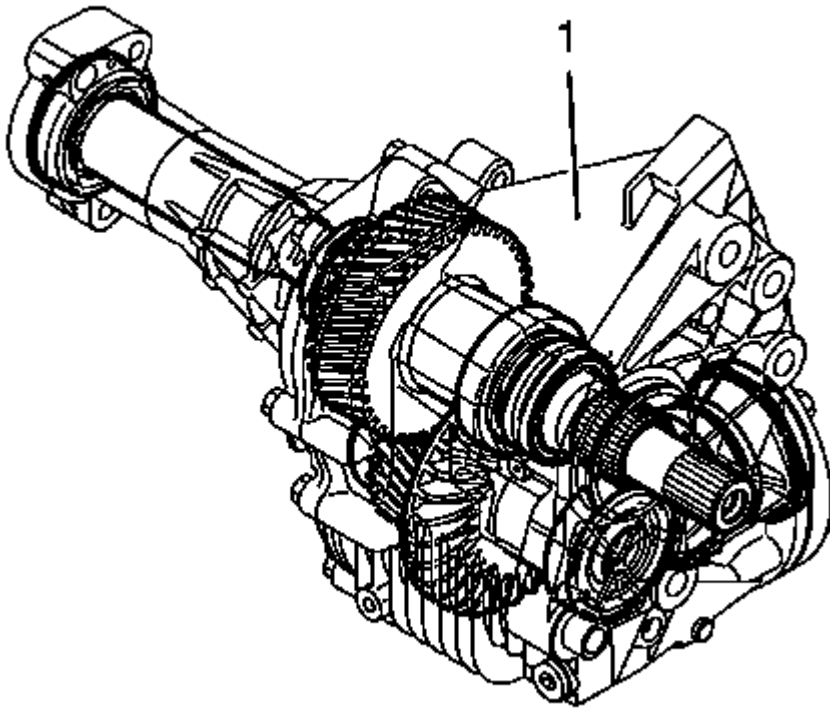


Fig. 111: Cutaway View Of Transfer Case
Courtesy of GENERAL MOTORS COMPANY

The transfer case (1) is fully mechanical with no internal or external electronic controls or sensors.

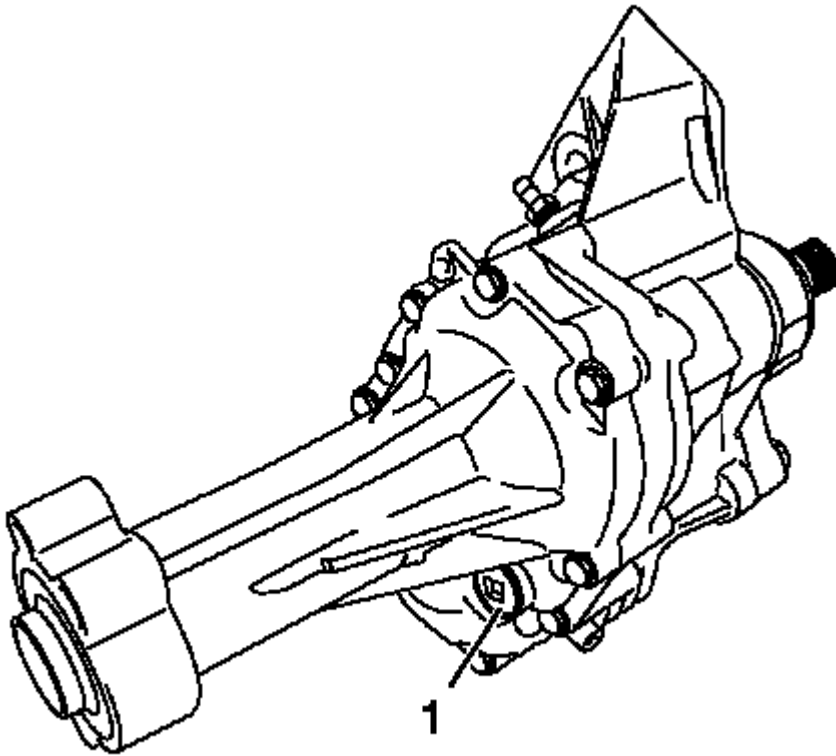


Fig. 112: Identifying Fill Plug
Courtesy of GENERAL MOTORS COMPANY

During assembly the transfer case (1) is filled with oil, which then does not require service interval replacement. The correct type of oil must be used when filling. The incorrect type of oil could lead to transfer case damage. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

Housing and Cover

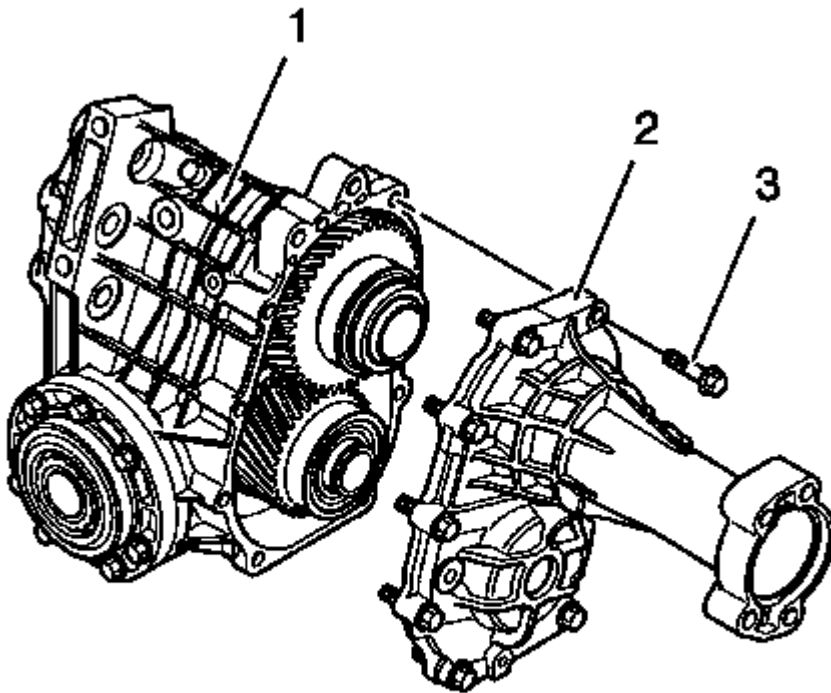


Fig. 113: View Of Transfer Case Housing & Rear Extension Housing
Courtesy of GENERAL MOTORS COMPANY

The transfer case housing (1) and rear extension housing (2) are produced from a high-pressure cast aluminium alloy. A number of reinforcement ribs are fitted in suitable locations to strengthen the transfer case assembly. These reinforcement ribs constitute a vital part of the cooling for the transfer case. The transfer case rear extension housing is retained to the transfer case housing with bolts (3). Two dowel pins locate the extension housing to the transfer case housing. The mating surfaces of transfer case housing and rear extension housing are sealed by a press-in-place serviceable seal.

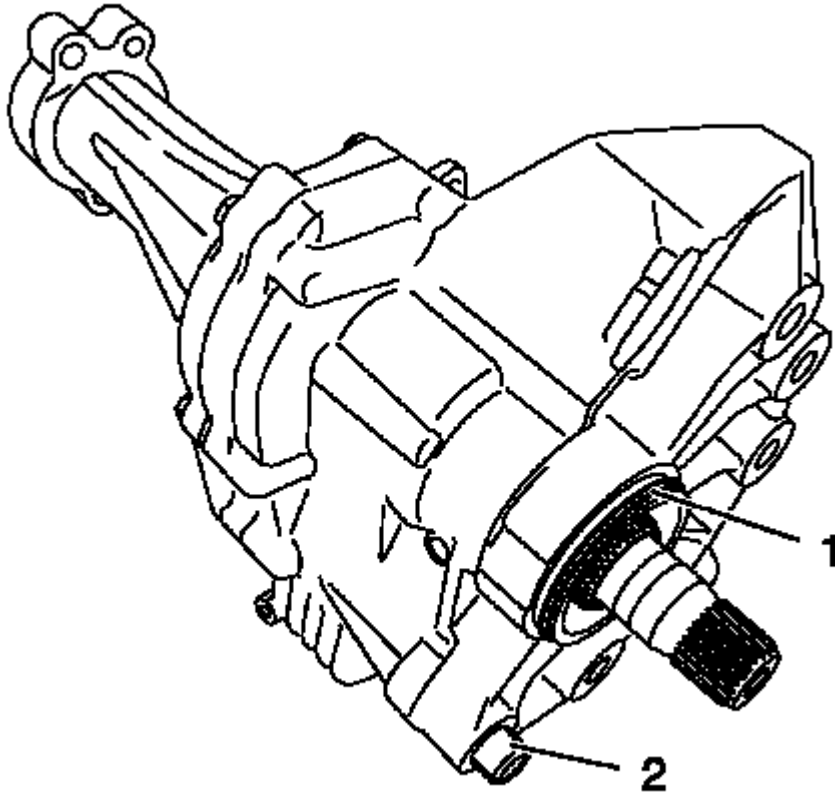


Fig. 114: Transfer Case Locating Bushing
Courtesy of GENERAL MOTORS COMPANY

The transfer case assembly is bolted to the transmission with four or five transfer case bolts. The sealing area between the transfer case housing and the transmission is sealed with serviceable O-ring (1). Two opposite radial seals seal the input shaft and prevent transmission and transfer case oil from mixing. If an input shaft seal failure occurs, the transmission and transfer case fluids will not mix as there is a weep hole in the transfer case housing between the two radial seals.

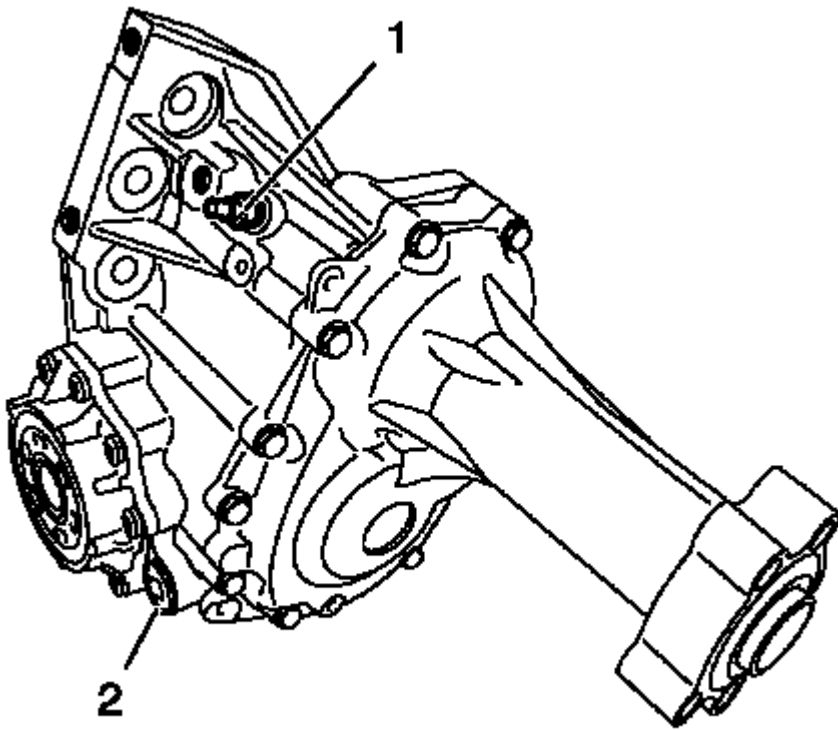


Fig. 115: Identifying Transfer Case Vent & Drain Plug
Courtesy of GENERAL MOTORS COMPANY

A transfer case vent (1) is located on the top area of the transfer case housing. The vent is mated to a remote vent hose assembly that is routed into the engine compartment. The oil drain plug (2) is magnetic. A mounting bracket retains the output end of the rear extension housing to the engine assembly.

Bearings and Races

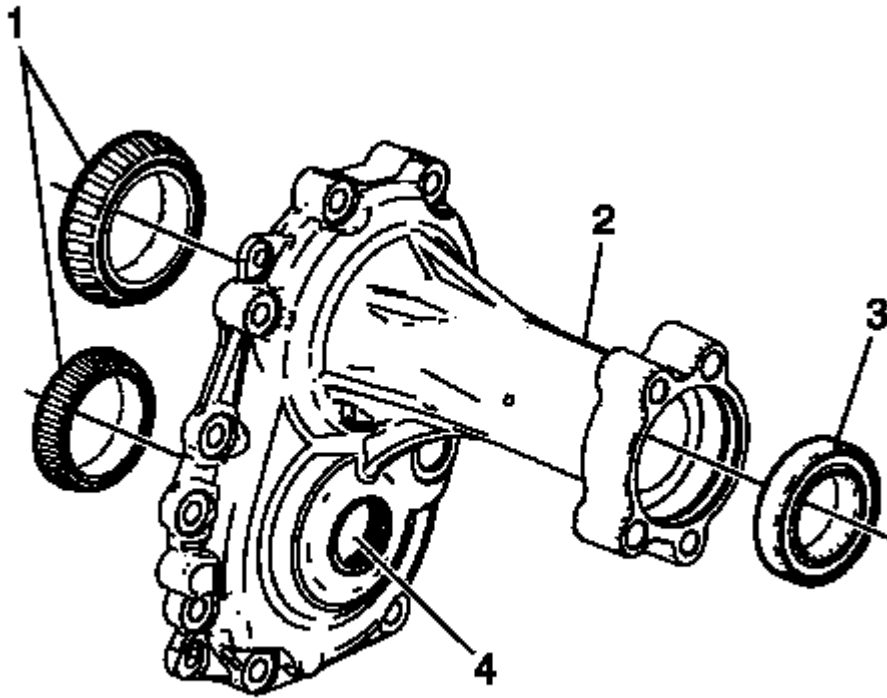


Fig. 116: Transfer Case Bearings
Courtesy of GENERAL MOTORS COMPANY

There are tapered bearing races (1) in the transfer case housing and rear extension housing (2) for the input shaft and idler shaft. Gear tooth clearances and bearing preloads are maintained by shims located behind the bearing races. There is a sealed ball bearing type intermediate shaft bearing (3) located in the rear extension housing. For some models, the transfer case rear extension housing has an opening (4) through which one of the transmission-to-transfer case attaching bolts is accessed.

Input Shaft

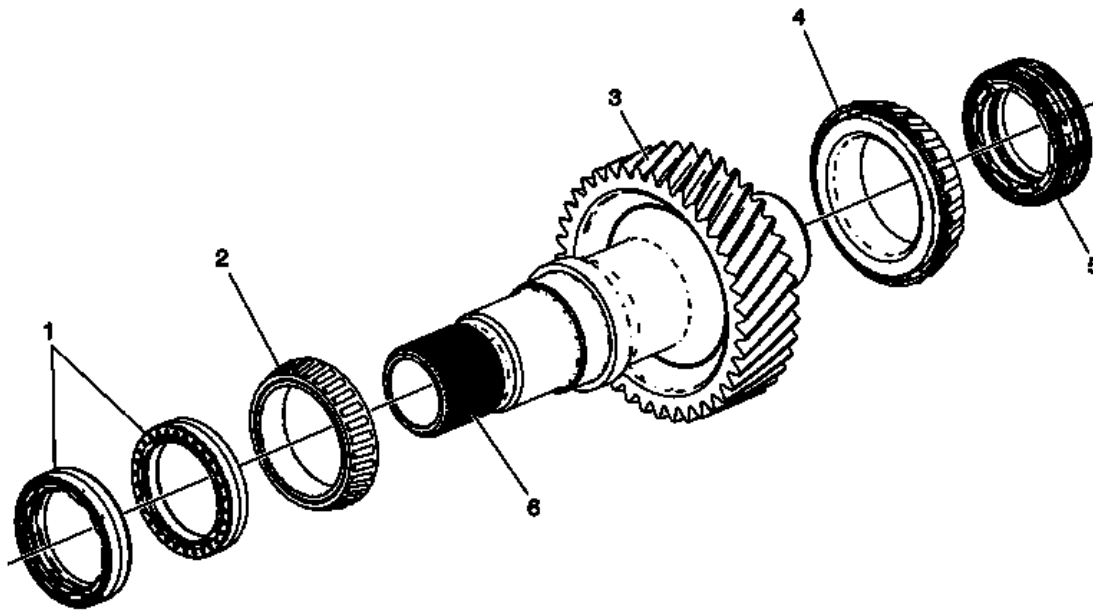


Fig. 117: View Of Input Shaft & Components
Courtesy of GENERAL MOTORS COMPANY

The input shaft splines (6) are mated to and driven by the transmission differential housing. The rotational speed of the input shaft is the same as the transmission output. Installed into the transfer case housing are two opposing input shaft front seals (1). The two input shaft front seals are designed to restrict transmission oil from entering the transfer case as well as restrict transfer case oil from entering the transmission. The opposite or rear end of the input shaft is sealed by a double-lip intermediate shaft seal (5). The intermediate shaft seal (5) is installed into the output end of the rear extension housing and is designed to restrict oil, dirt, and debris from entering the transfer case. The helical gear teeth of the input shaft (3) are engaged to the helical gear teeth of the idler shaft. The input shaft is mounted in two tapered roller bearings (2,4). The bearings are given the correct preload during assembly by means of shims being fitted behind the bearing races in the housing and cover.

Idler Gear

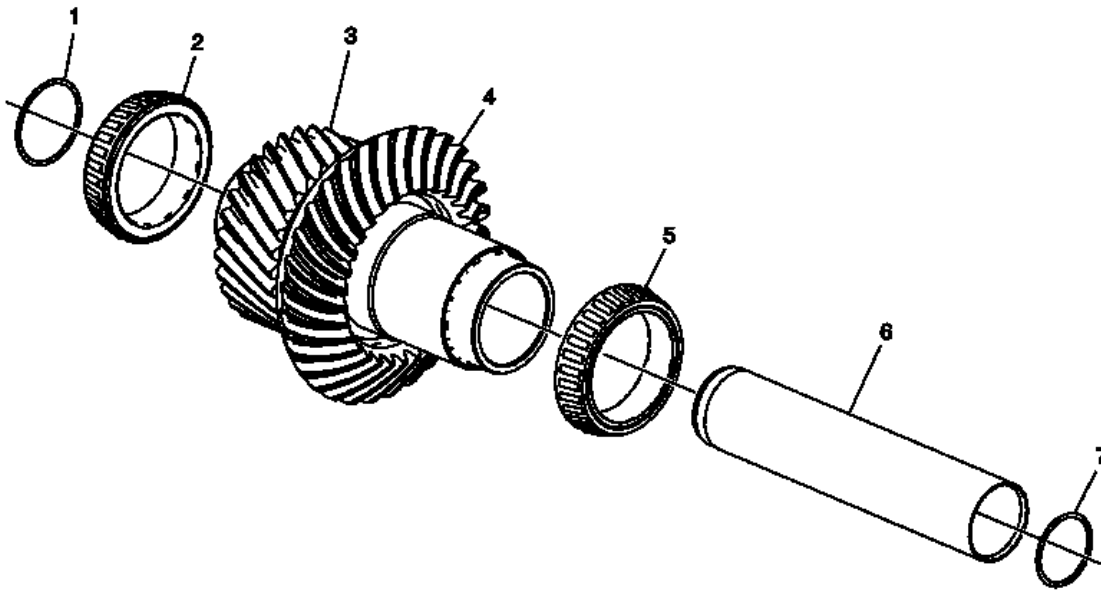


Fig. 118: View Of Idler Shaft
Courtesy of GENERAL MOTORS COMPANY

The idler gear consists of a helical gear (3) and a hypoid gear (4), has a hollow center, and is driven by the helical gear on the input shaft.

The idler hypoid gear (4) mates to and drives the hypoid gear on the rear output shaft. The input shaft, idler gear, and rear output shaft gear sets are precision machined and are not serviceable.

The idler gear is mounted in two tapered roller bearings (2 and 5). The bearings are given the correct preload and gears proper clearance during assembly by means of shims being fitted behind the bearing races in the housing and cover. If the shims are removed for any reason, the shims need to be reinstalled to their original locations.

For some models, there is an additional idler gear shaft (6) located inside and running through the idler gear. The idler shaft is sealed at each end by O-ring seals (1 and 7) within the transfer case and rear extension housings.

Rear Output Shaft Housing

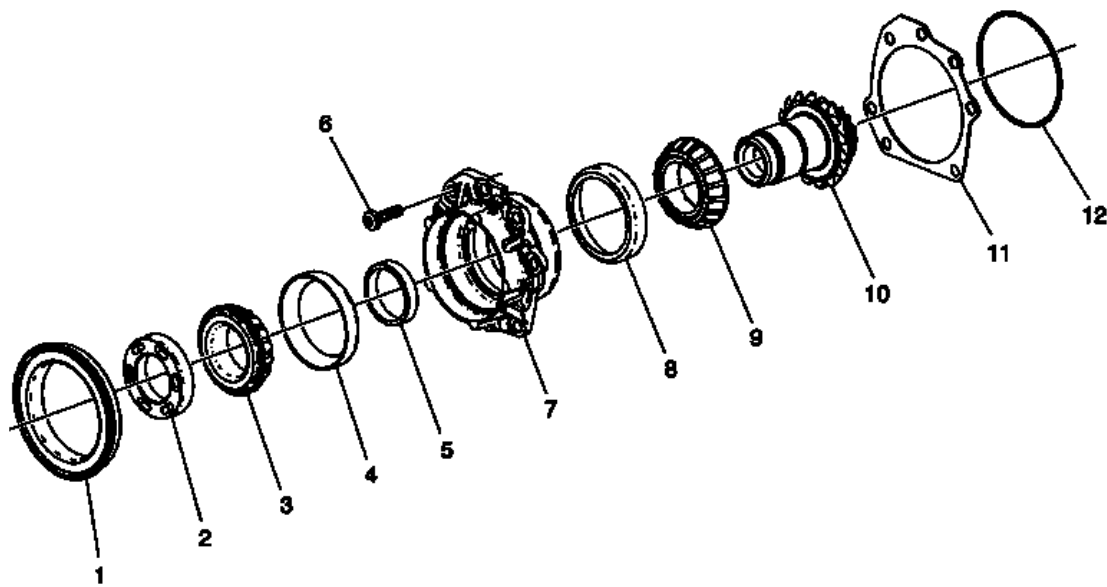


Fig. 119: Exploded View Of Rear Output Shaft Housing
 Courtesy of GENERAL MOTORS COMPANY

The rear output shaft housing assembly includes an output shaft (10), 2 tapered roller bearings (3 and 9), a rear output shaft seal (1), shaft retaining nut (2), housing (7) and housing seal (12).

The hypoid gear of the rear output shaft is mated to the hypoid gear of the idler shaft. A shim (11) maintains the proper gear contact.

The housing is retained to the transfer case by 7 bolts (6). The only serviceable component within the rear output shaft and housing assembly is the rear output shaft seal (1).

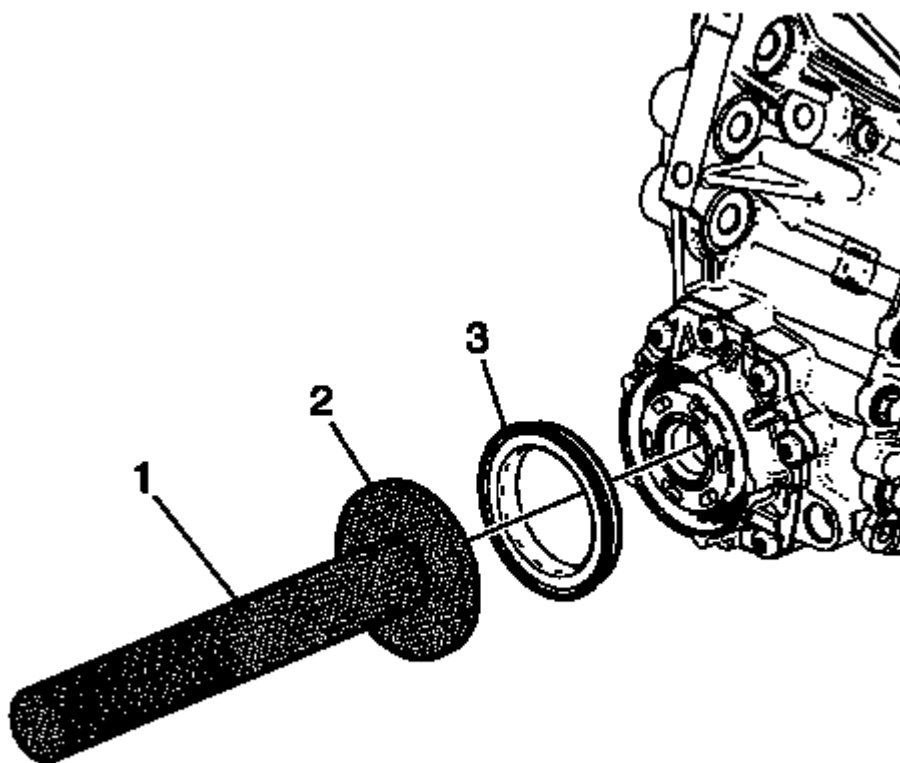


Fig. 120: View Of Rear Output Shaft Seal
 Courtesy of GENERAL MOTORS COMPANY

The only serviceable component within the rear output shaft and housing assembly is the rear output shaft seal (3).

The seal is a unitized/cassette type design to include inner and outer metal sleeves and internal sealing rings.

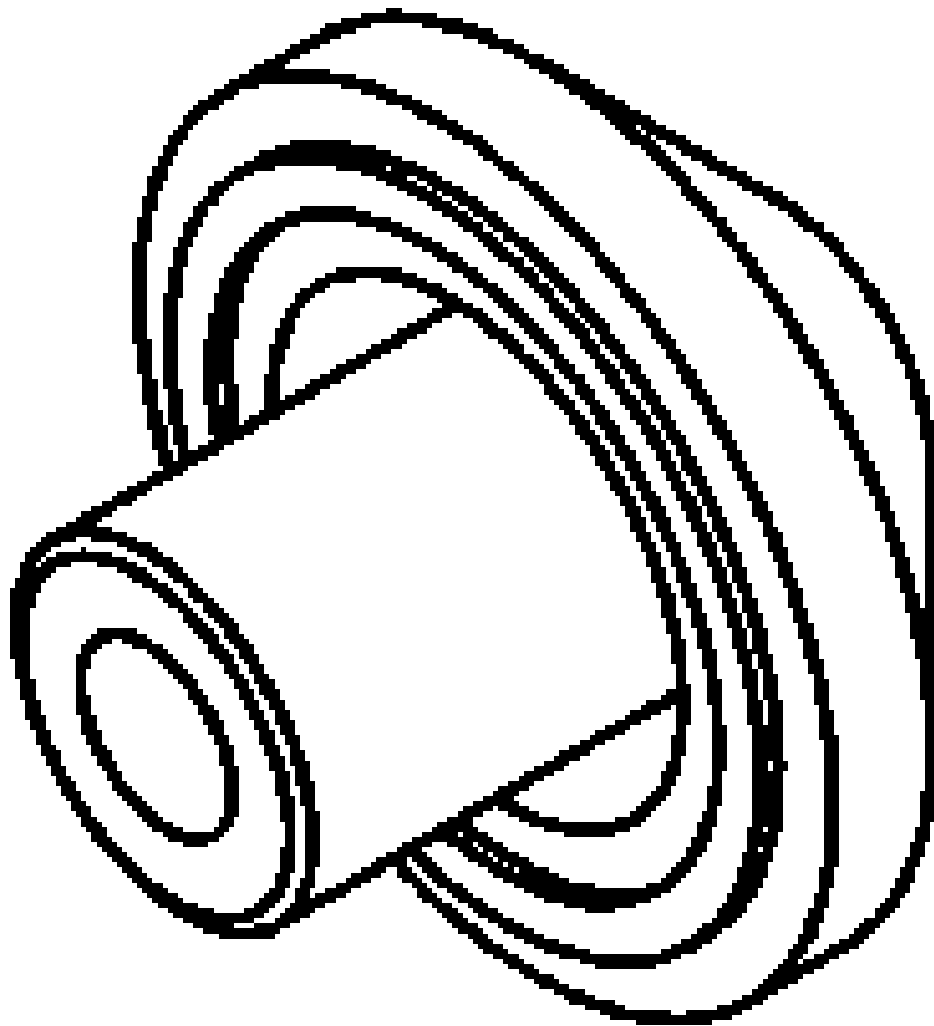
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

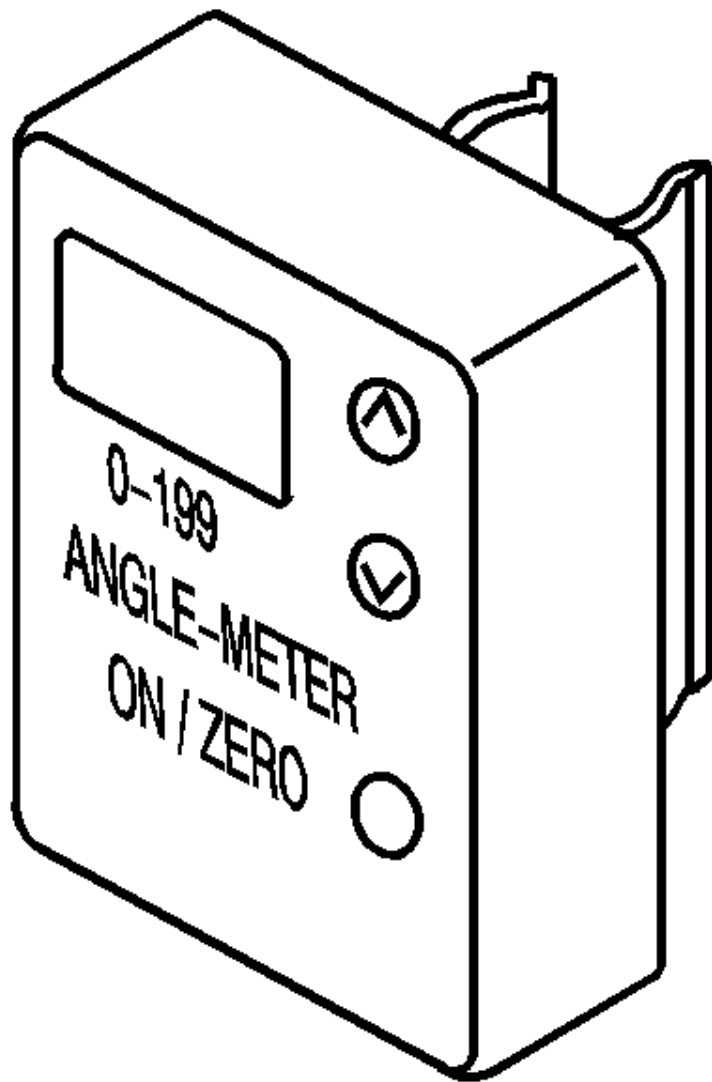
Illustration	Tool Number/ Description



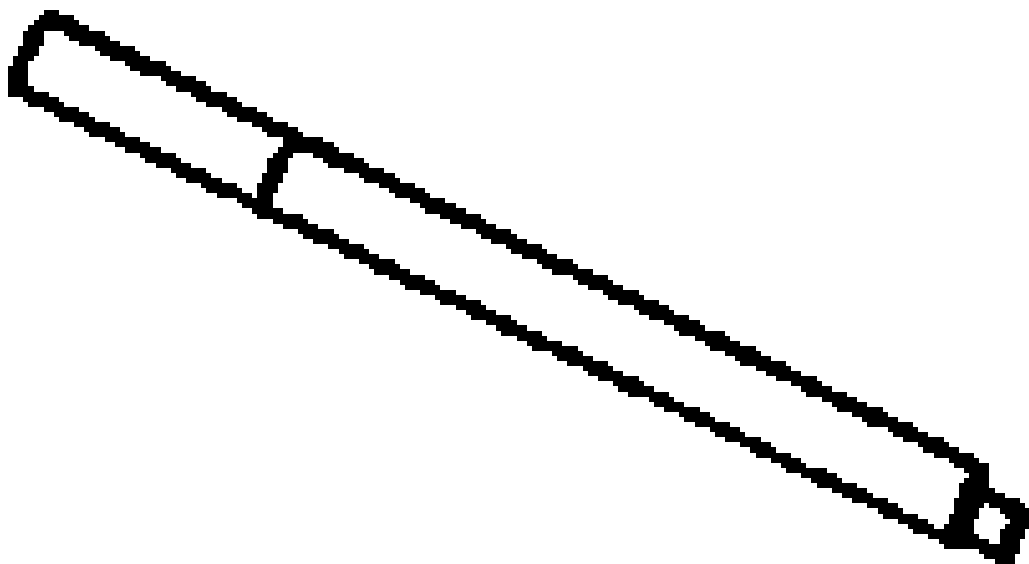
GE 8092
6-9606332
M-840911-A
J-8092
Driver
Handle



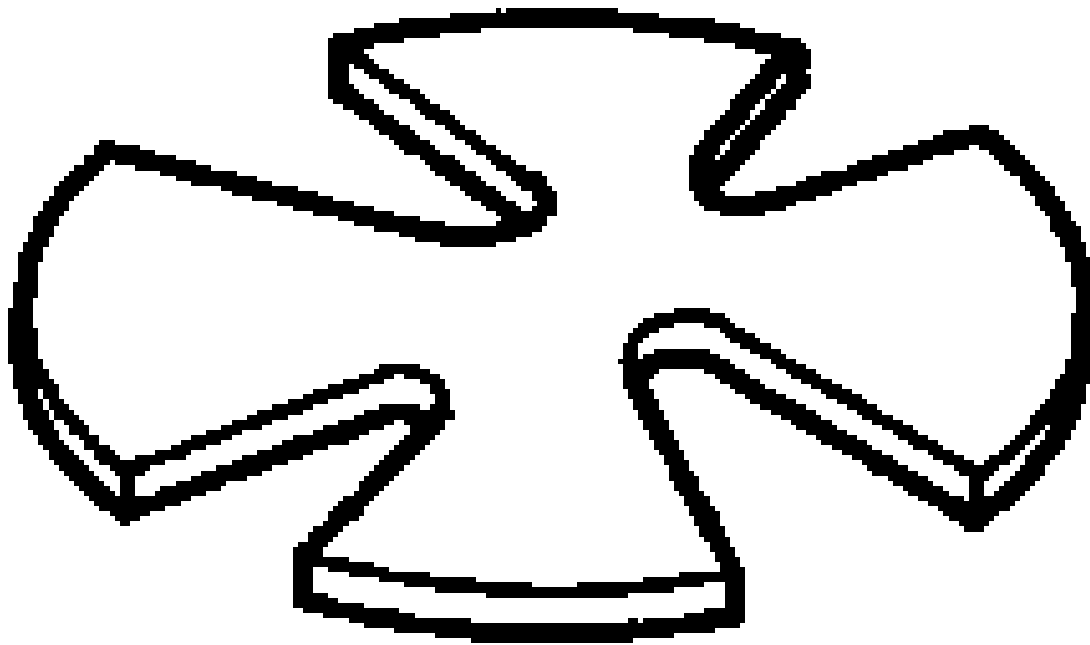
DT-50768
Seal Installer



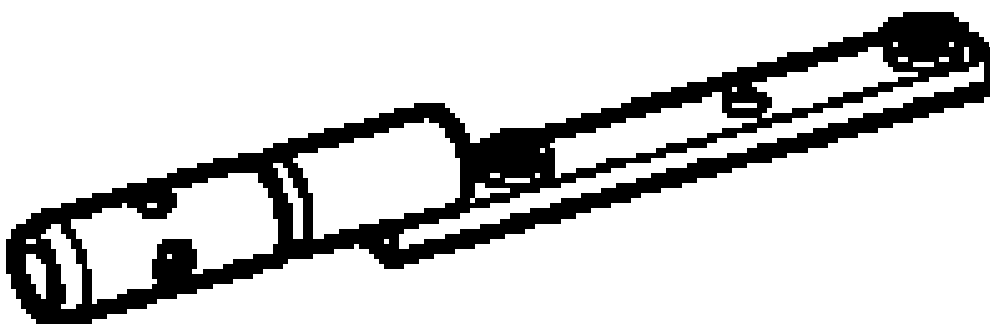
DT-113-2-A
J-03289-20
KM-113-2
Bracket



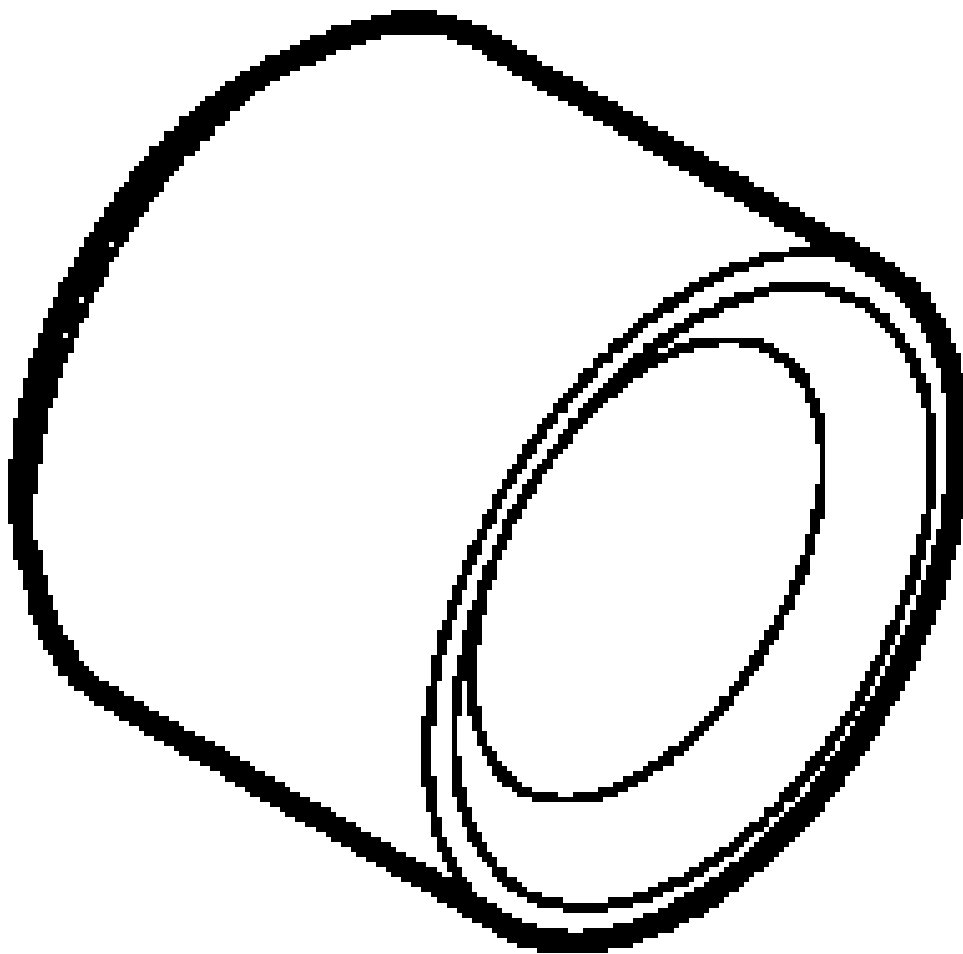
DT-305-1
J-42176
KM-305-1
Driver
Handle



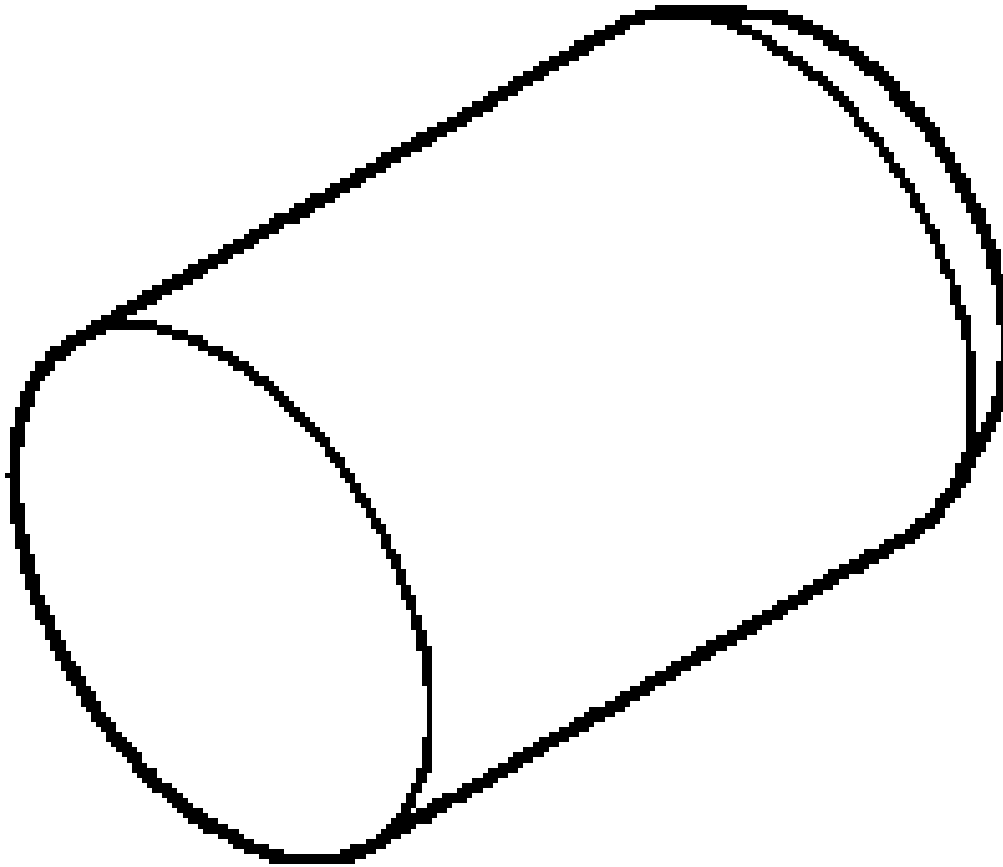
DT-307 B
J-22912-B
KM-307-B
Remover
Plate



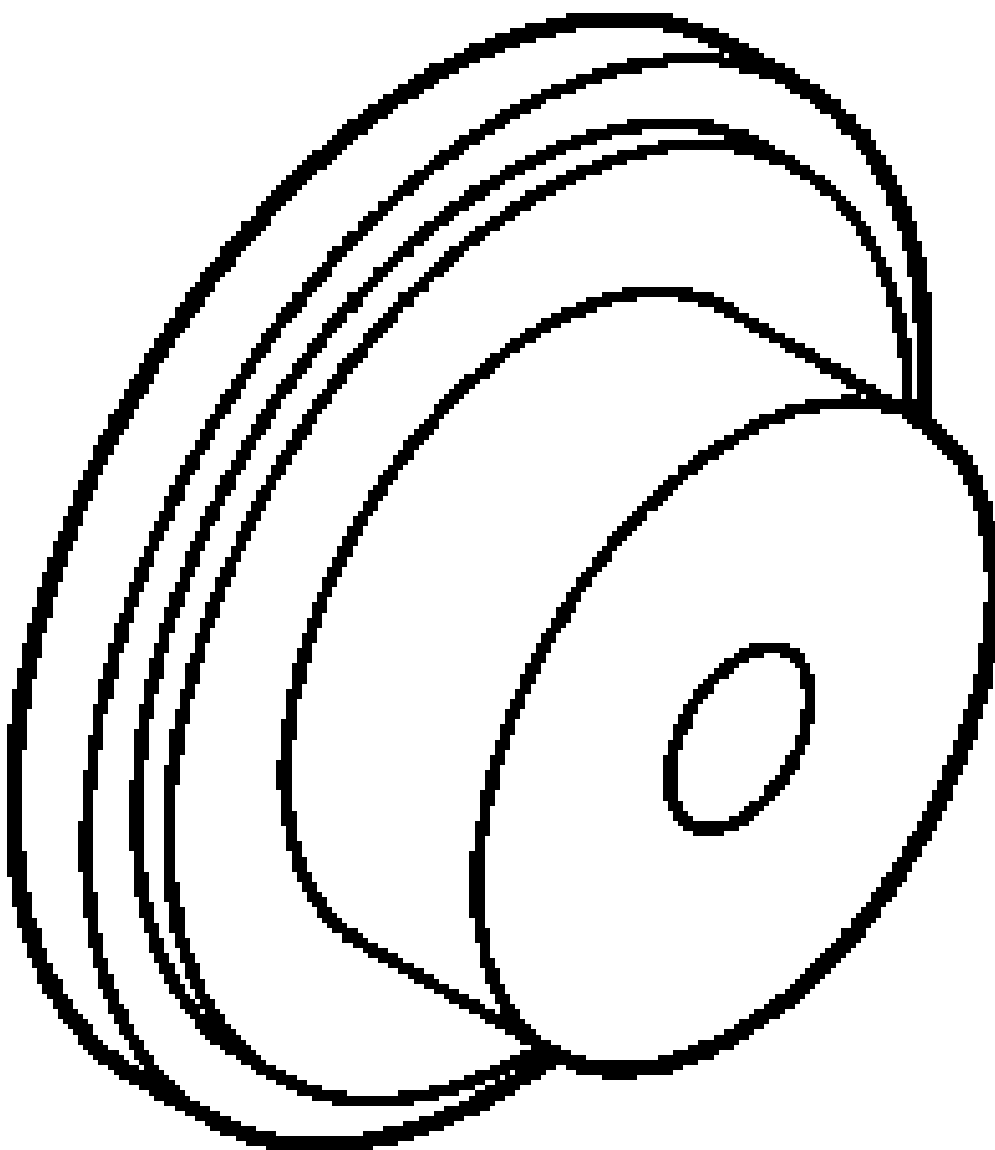
DT-622-A
J-36842
KM-622-A
Transmission
Bracket



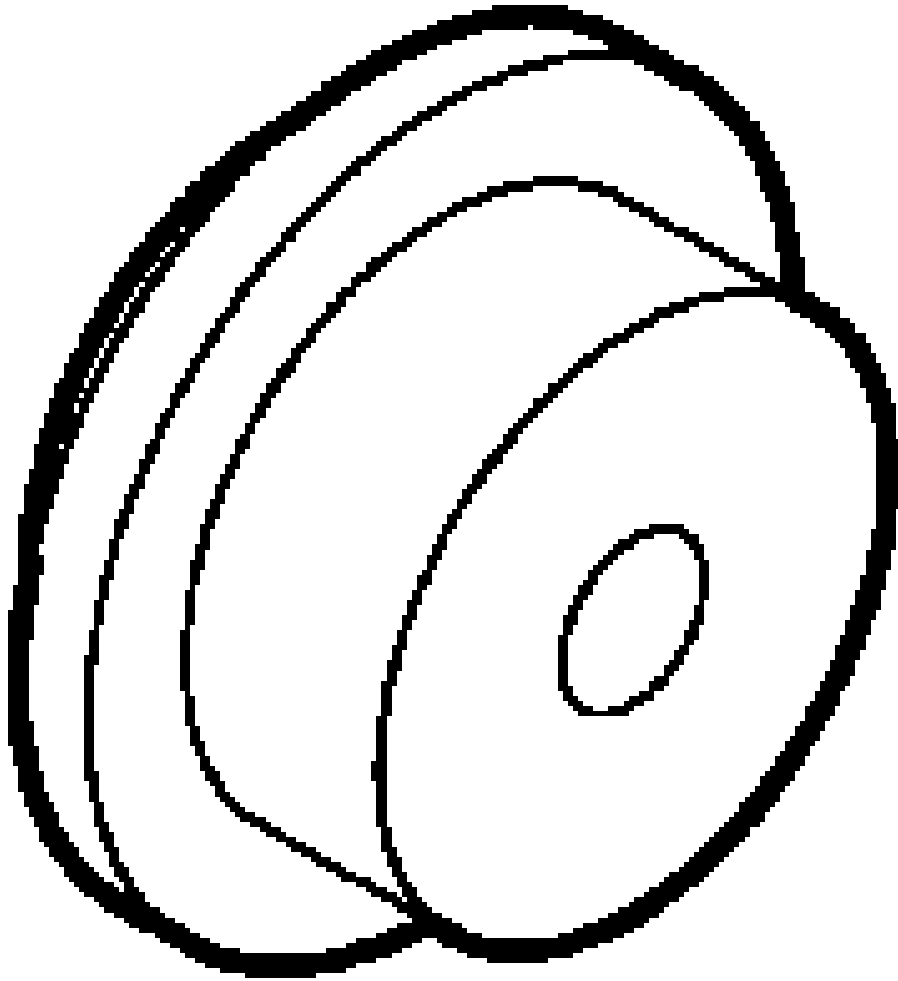
DT-48076
Bearing
Installer



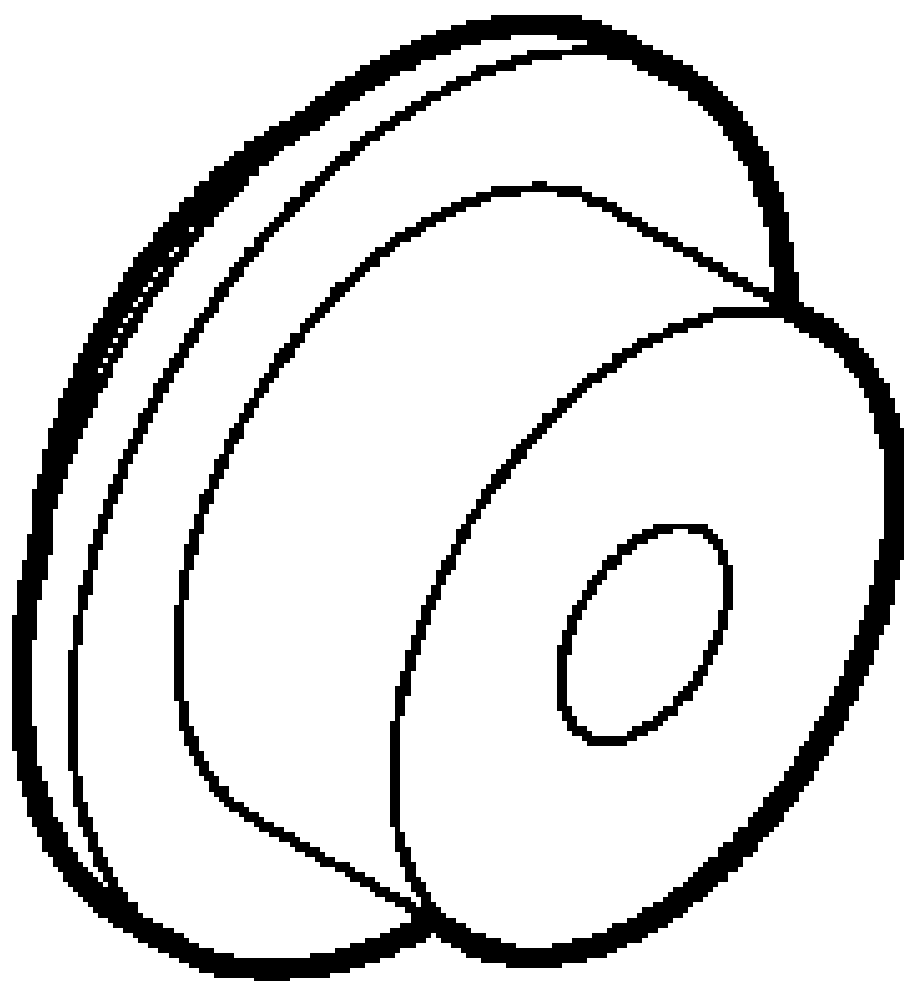
DT-49104
Protective
Collar



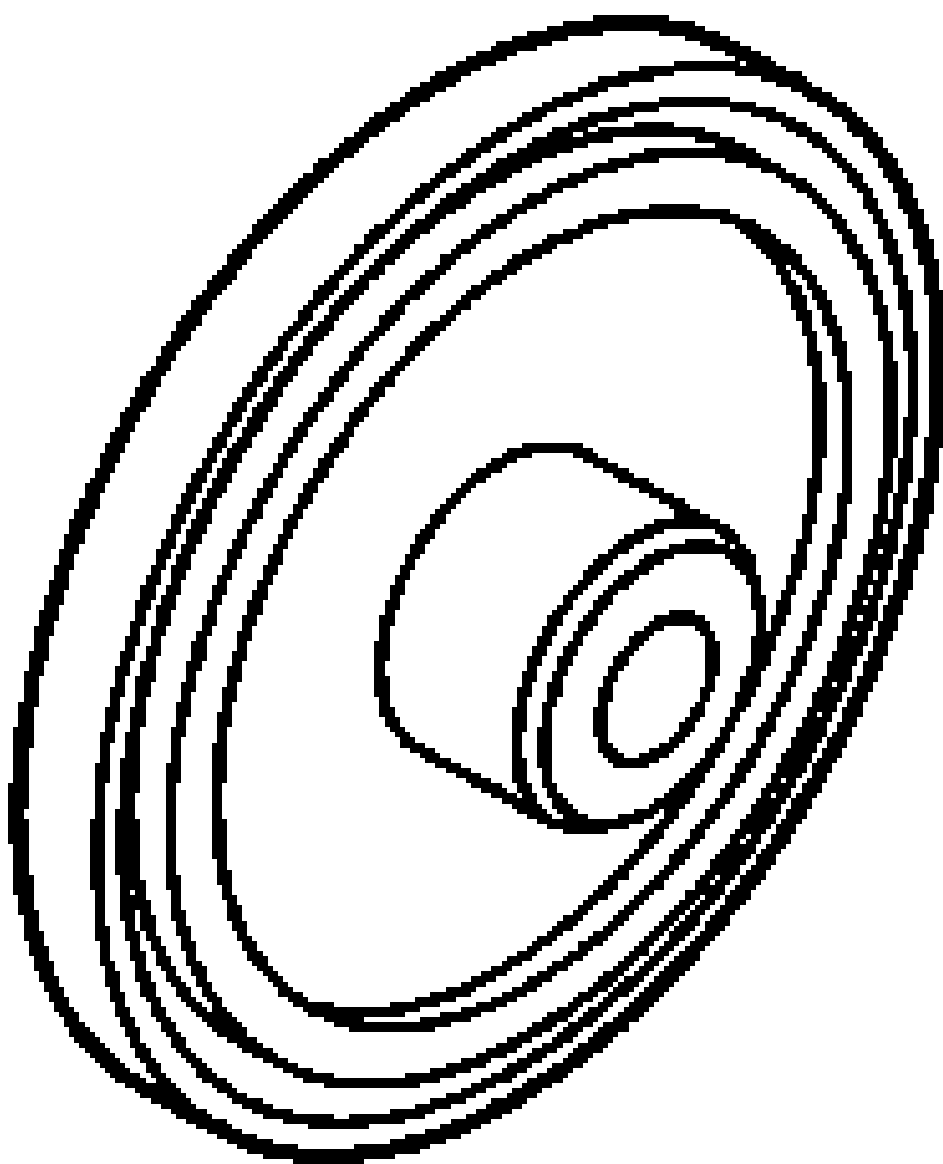
DT-49951
Seal Installer



DT-49952
Seal Installer



DT-49953
Seal Installer



DT-49954-A
Seal Installer

Transmission

Transmission Cooling

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Transaxle Oil Cooler Line Assembly Nut	9 N.m	80 lb in
Transmission Fluid Cooler Inlet Pipe Nut-M7U	22 N.m	16 lb ft
Transmission Fluid Cooler Outlet Hose Nut-MHH	22 N.m	16 lb ft
Transmission Fluid Cooler Outlet Pipe Nut-M7U	22 N.m	16 lb ft
Transmission Oil Cooler Fitting	24 N.m	18 lb ft
Transmission Fluid Cooler Pipe Bracket Nut-MHH	10 N.m	89 lb in

DIAGNOSTIC INFORMATION AND PROCEDURES

TRANSMISSION FLUID COOLER FLUSHING AND FLOW TEST (6T40)

GM studies indicate that plugged or restricted transmission oil coolers and pipes cause insufficient transmission lubrication and elevated operating temperatures which can lead to premature transmission failure. Many repeat repair cases could have been prevented by following published procedures for transmission oil cooler flushing and flow checking. This procedure includes flow checking and flushing the auxiliary transmission oil cooler, if equipped.

NOTE: Use the DT-45096 flush and flow test tool or equivalent to flush and flow test the transmission oil cooler and the oil cooler pipes after the transaxle is removed for repairs.

Only GM Goodwrench DEXRON®VI automatic transmission fluid should be used when doing a repair on a GM transmission.

Time allowance for performing the cooler flow checking and flushing procedure has been included in the appropriate labor time guide operations since the 1987 model year. The service procedure steps for oil cooler flushing and flow testing are as follows:

Cooler Flow Check and Flushing Steps

1. Machine Set-up
2. Determine Minimum Flow Rate
3. Back Flush

4. Forward Flush
5. Flow Test
6. Code Recording Procedure
7. Clean-up

Special Tools

- **DT-45096** Transmission Oil Cooling System Flush and Flow Test Tool
- **DT-45096-50** Transmission Cooler Flush Adapter
- Shop air supply with water/oil filters, regulator and pressure gauge - minimum 90 psi
- Eye protection
- Rubber gloves

For equivalent regional tools, refer to **Special Tools** .

Machine Set-up

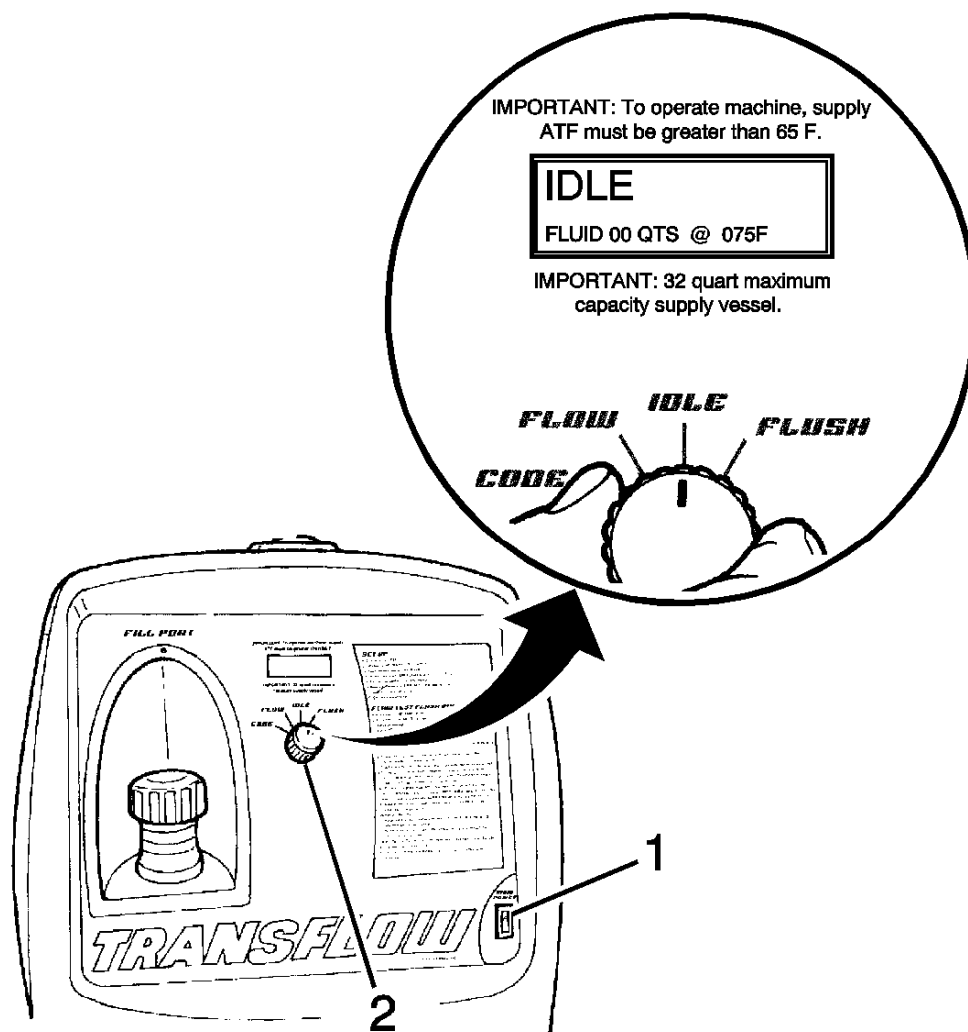


Fig. 1: View Of Main Power Switch & Main Function Switch
Courtesy of GENERAL MOTORS COMPANY

1. Verify that the main power switch (1) is in the OFF position.
2. Place the main function switch (2) in the IDLE position.

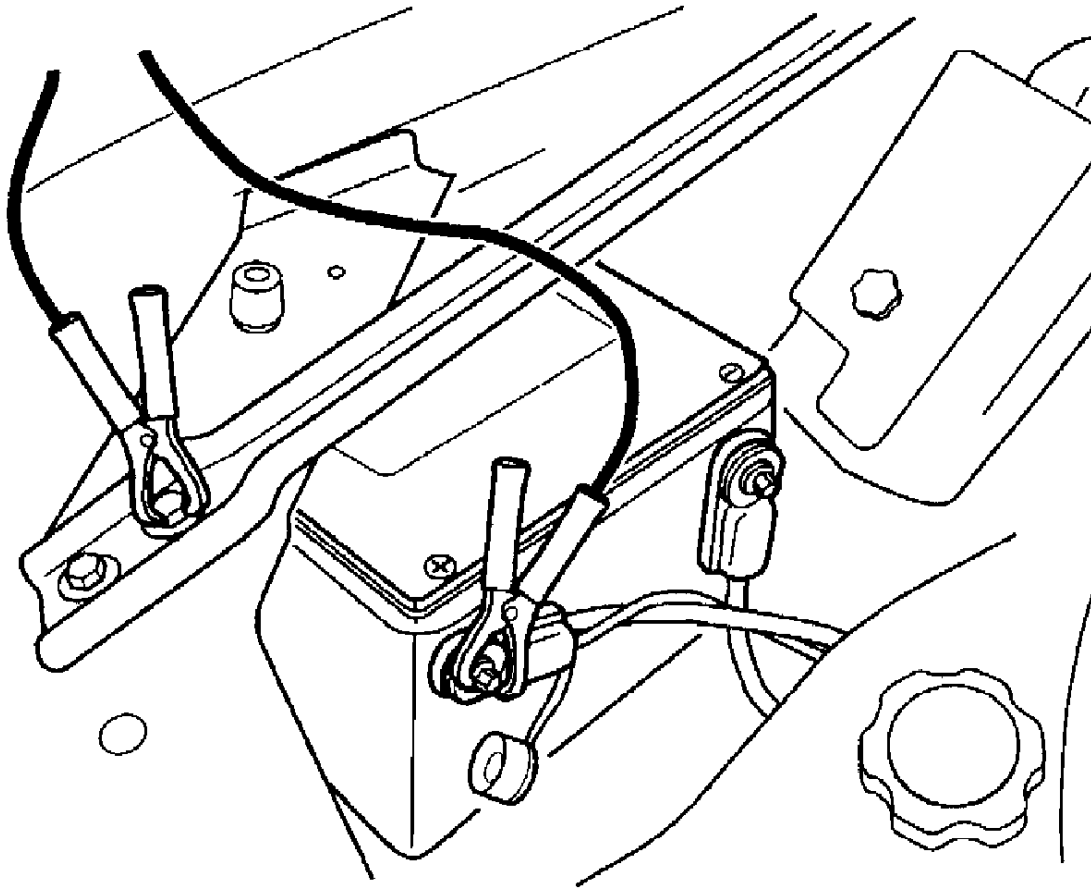


Fig. 2: Connecting To 12V DC Power Source
Courtesy of GENERAL MOTORS COMPANY

3. Connect **DT-45096** flush and flow test tool to the vehicle 12V DC power source by connecting the red battery clip to the positive, +, battery post on the vehicle and connect the negative lead to a known good chassis ground.
4. Turn the main power switch to the ON position.

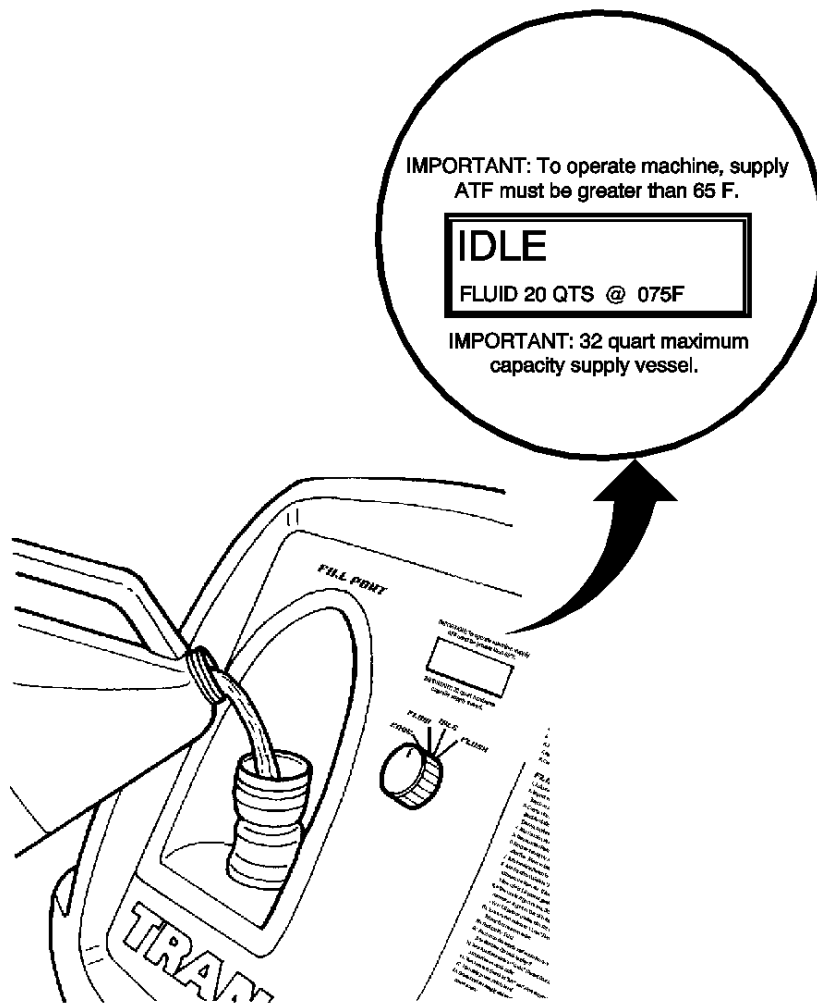


Fig. 3: Filling Supply Tank With Transmission Fluid
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not overfill the supply vessel. Damage to the unit may result. To verify the fluid level, view the LCD screen display while filling the unit, to ensure the fluid level does not exceed 30 L (32 qt).

5. Fill the supply tank with Dexron®VI through the fill port.
6. Reinstall and tighten the fill cap.

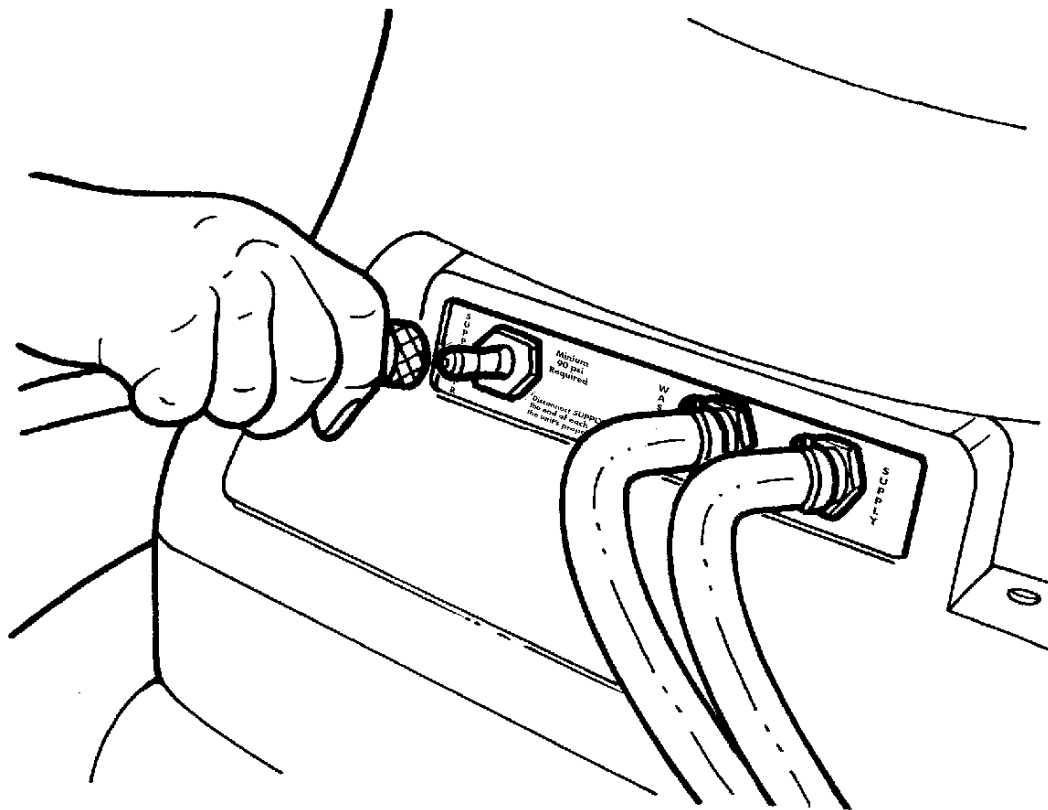


Fig. 4: Applying Shop Air Supply Hose To Quick-Disconnect
Courtesy of GENERAL MOTORS COMPANY

7. Connect a shop air supply hose to the quick-disconnect on the rear panel marked SUPPLY AIR.

Determine Minimum Flow Rate

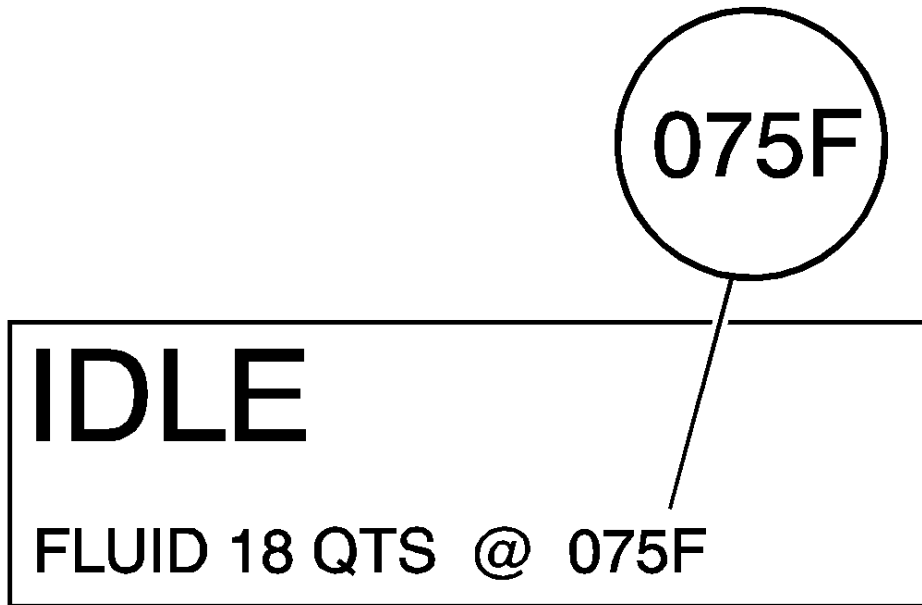


Fig. 5: Identifying Machine Display Of Automatic Transmission Fluid Temperature
Courtesy of GENERAL MOTORS COMPANY

1. From the machine display, identify the temperature of the automatic transmission fluid that is stored in the supply vessel of **DT-45096** flush and flow test tool.

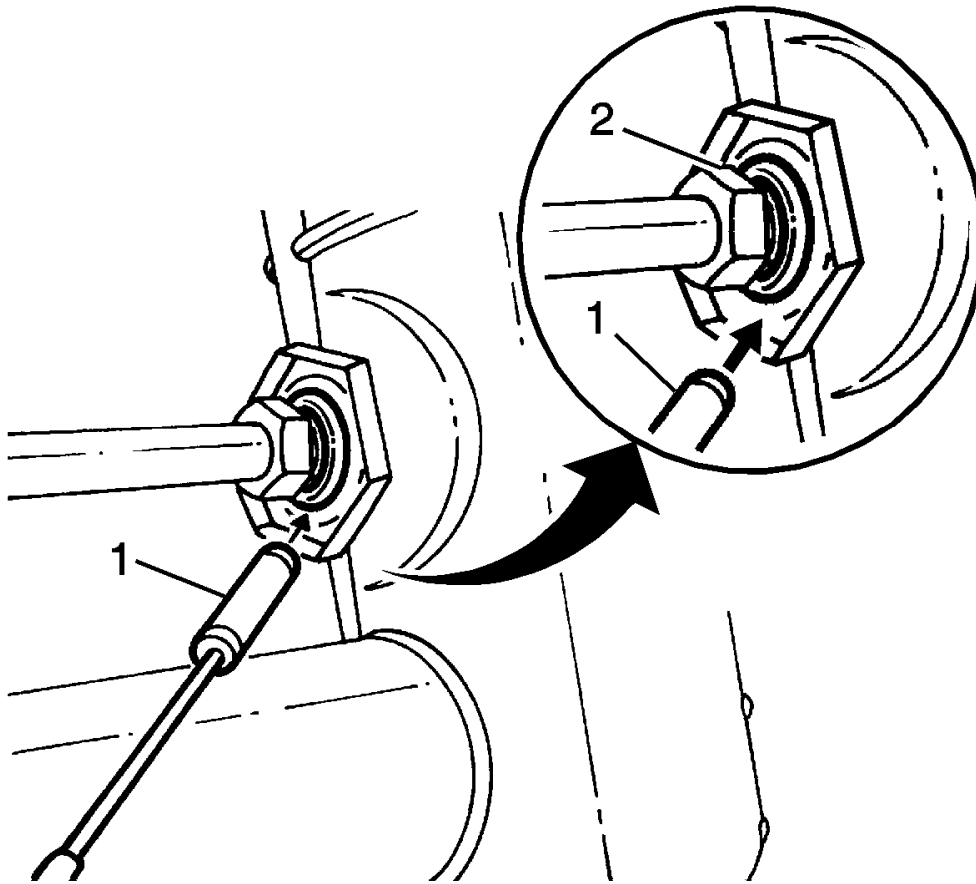


Fig. 6: Identifying Transmission Oil Cooler Metal Composition
Courtesy of GENERAL MOTORS COMPANY

2. Determine whether the transmission oil cooler is steel or aluminum by using a magnet (1) at the cooler flange (2) at the radiator.
3. Refer to the table below. Using the temperature from step 1, locate on either the Steel MINIMUM Flow Rate table or the Aluminum MINIMUM Flow Rate table the minimum flow rate in gallons per minutes (GPM). Record the minimum flow rate in GPMs and the supply fluid temperature for further reference.

Example

- Fluid temperature: 75°F
- Cooler type: Steel

The MINIMUM flow rate for this example would be 0.8 GPM.

4. Inspect transmission oil cooler lines for damage or kinks that could cause restricted oil flow. Repair as needed and refer to the appropriate GM service manual procedures.

Minimum Flow Rate in Gallons Per Minute (gpm)

Temperature Range	Steel	Aluminum
65 - 66°F	0.6 gpm	0.5 gpm
67 - 70°F	0.7 gpm	0.6 gpm
71 - 75°F	0.8 gpm	0.7 gpm
76 - 80°F	0.9 gpm	0.8 gpm
81 - 84°F	1.0 gpm	0.9 gpm
85 - 89°F	1.1 gpm	1.0 gpm
90 - 94°F	1.2 gpm	1.1 gpm
95 - 98°F	1.3 gpm	1.2 gpm
99 - 103°F	1.4 gpm	1.3 gpm
104 - 108°F	1.5 gpm	1.4 gpm
109 - 112°F	1.6 gpm	1.5 gpm
113 - 117°F	1.7 gpm	1.6 gpm
118 - 120°F	1.8 gpm	1.7 gpm

Back Flush Procedure

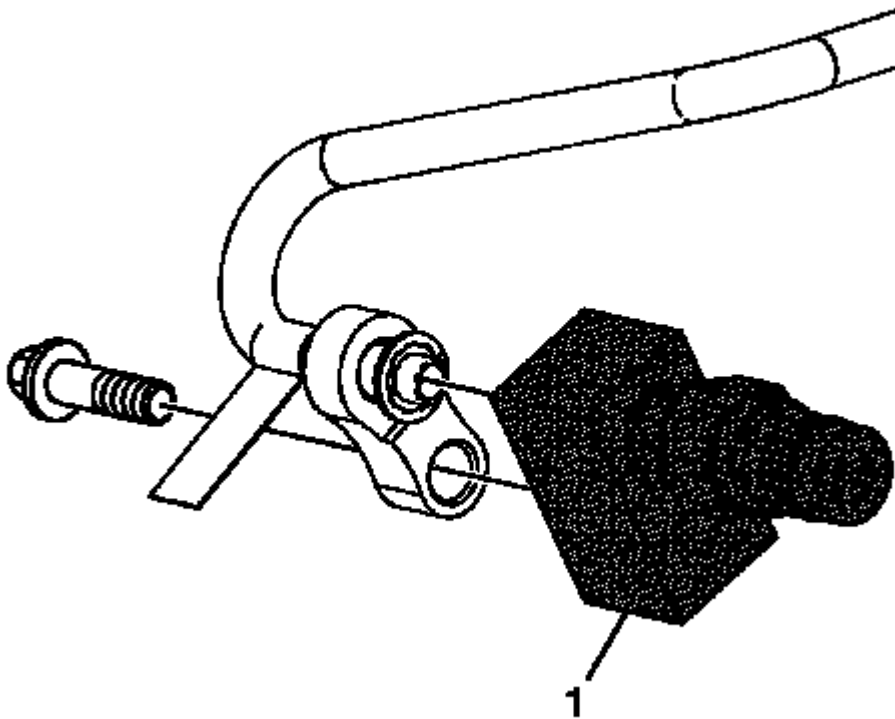


Fig. 7: Identifying Cooler Flush Adapter
Courtesy of GENERAL MOTORS COMPANY

1. Connect the **DT-45096-50** cooler flush adapter (1) to the vehicle transmission oil cooler supply and return lines at the transmission.

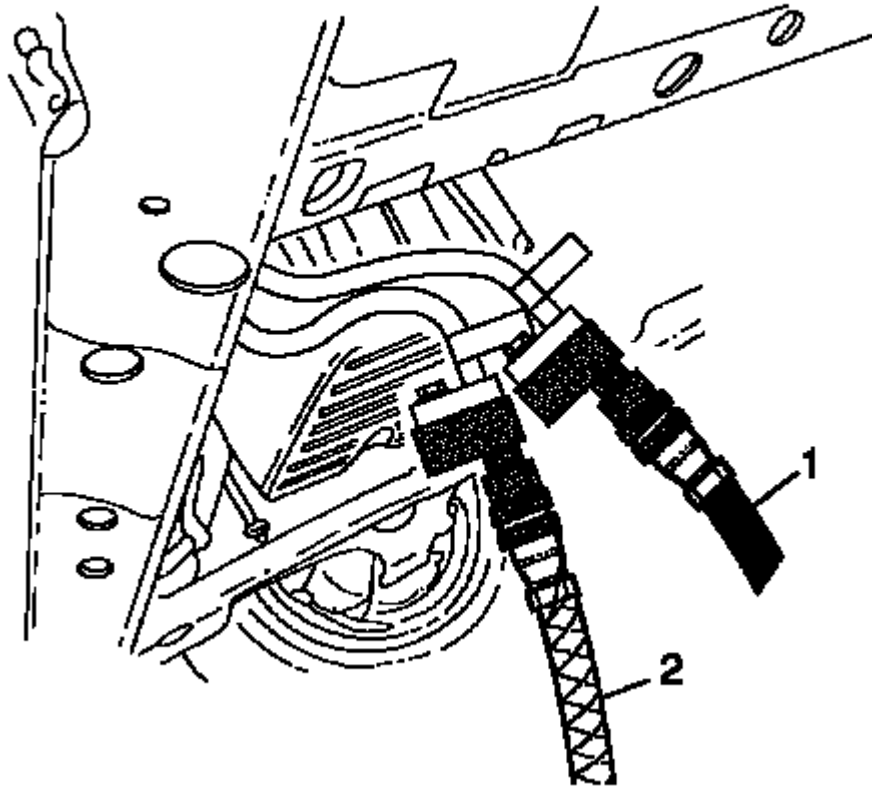


Fig. 8: View Of Black Supply Hose And Clear Waste Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect the black supply hose (1) to the return line, top connector of the transmission, and the clear waste hose (2) to the feed line, bottom connector of the transmission, to the vehicle cooler lines. This is the reverse flow - backflush direction.

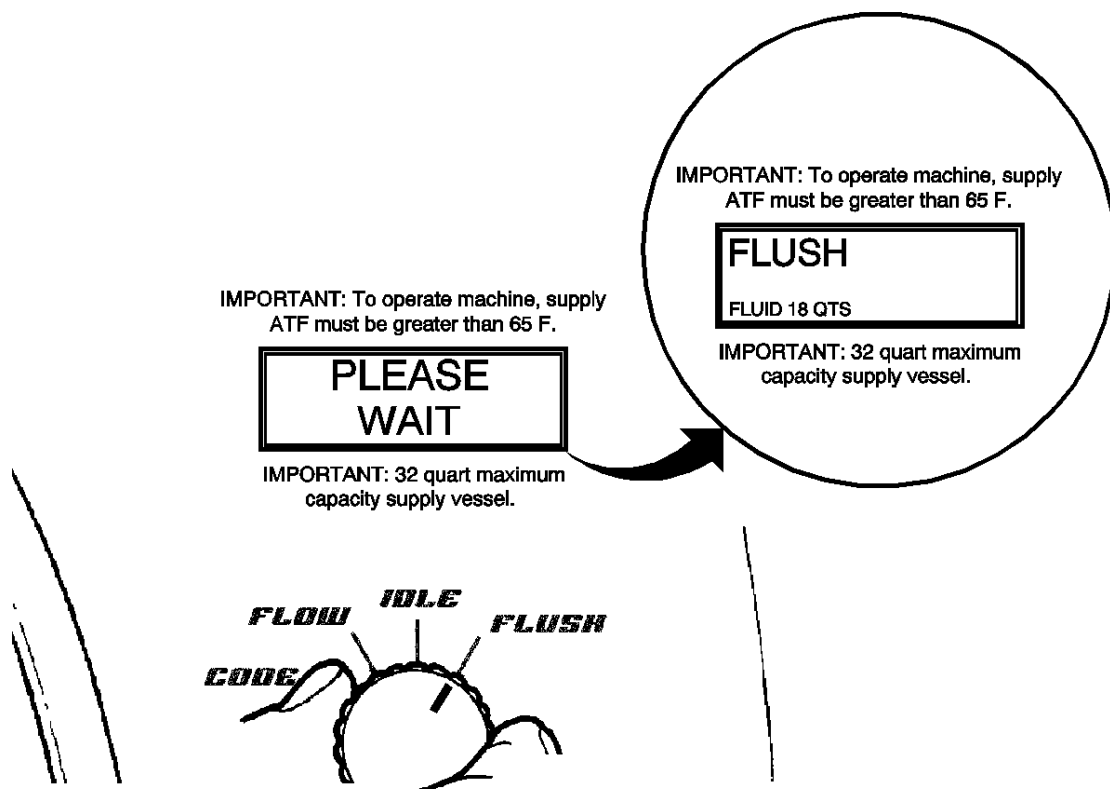


Fig. 9: View Of Main Function Switch FLUSH Position
Courtesy of GENERAL MOTORS COMPANY

3. Turn the main function switch to the FLUSH position. Allow the machine to operate for 30 seconds.

IMPORTANT: To operate machine, supply
ATF must be greater than 65 F.

IDLE

FLUID 16 QTS @ 075F

IMPORTANT: 32 quart maximum
capacity supply vessel.

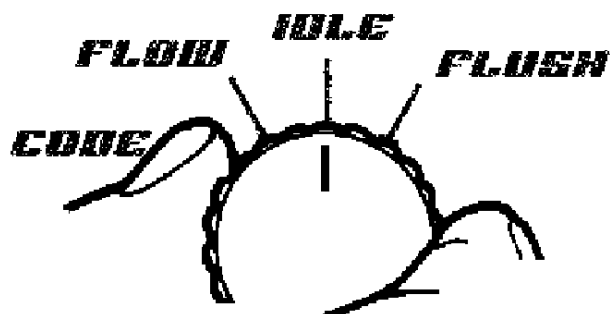


Fig. 10: View Of Main Function Switch IDLE Position
Courtesy of GENERAL MOTORS COMPANY

4. Turn the main function switch to the IDLE position and allow the supply vessel pressure to dissipate.

Forward Flush

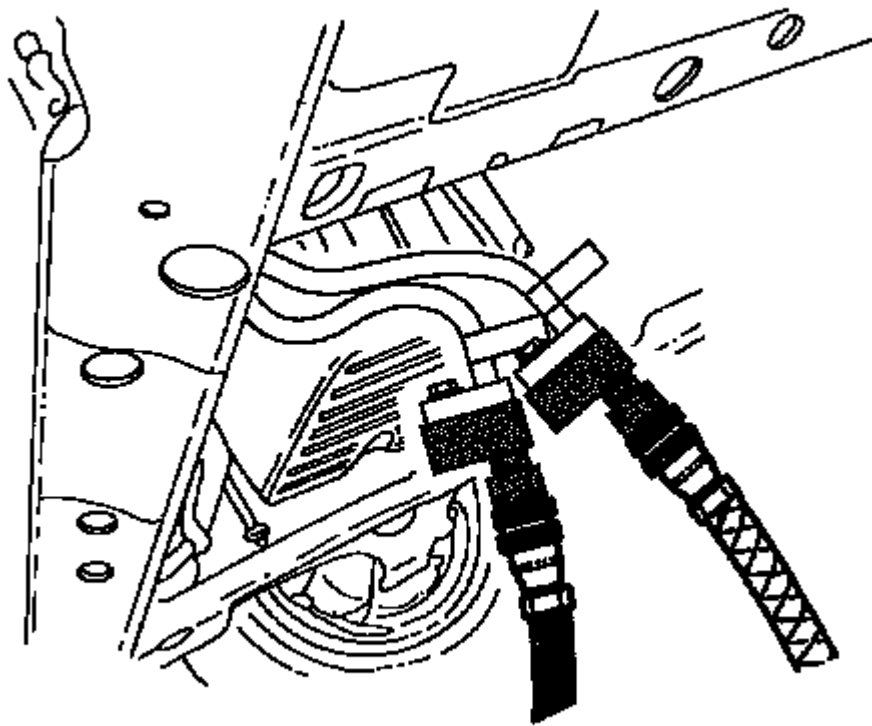


Fig. 11: Identifying Supply And Waste Hoses
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the supply and waste hoses from the vehicle cooler lines. Reverse the supply and waste hoses to provide a normal flow direction.

IMPORTANT: To operate machine, supply
ATF must be greater than 65 F.

FLUSH

FLUID 18 QTS

IMPORTANT: 32 quart maximum
capacity supply vessel.



Fig. 12: View Of Main Function Switch FLUSH Position
Courtesy of GENERAL MOTORS COMPANY

2. Turn the main function switch to the FLUSH position and allow machine to operate for 30 seconds.

Flow Test

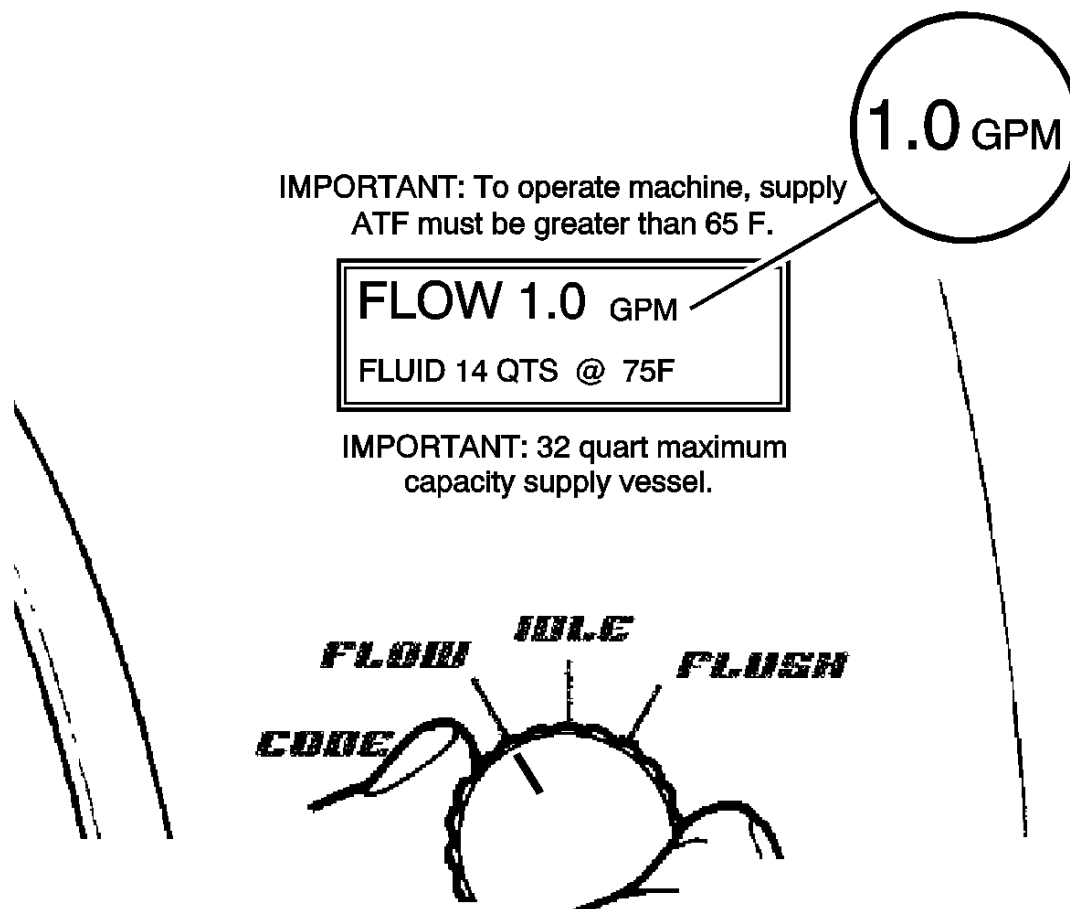


Fig. 13: View Of Main Function Switch FLOW Position
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the flow rate is less than 0.5 gpm, the LCD displays an error message. Refer to the Troubleshooting section of the operation manual.

1. Turn the main function switch to the FLOW position and allow the oil to flow for 15 seconds. Observe and note the flow rate; this is the TESTED flow rate.
2. Compare the TESTED flow rate to the MINIMUM flow rate information previously recorded.
 - If the TESTED flow rate is equal to or greater than the MINIMUM flow rate recorded, the oil cooling system is functioning properly. Perform Code Recording Procedure.
 - If the TESTED flow rate is less than the MINIMUM flow rate previously recorded, repeat the back flush and forward flush procedures.
3. If the TESTED flow rate is less than the MINIMUM flow rate after the second test, perform Code Recording Procedure.

1. Replace the transmission oil cooler.
2. Reconnect supply and waste hoses to the cooler lines in the normal flow direction. Perform Flow Test.
3. Perform Code Recording Procedure.

Code Recording Procedure

IMPORTANT: To operate machine, supply
ATF must be greater than 65 F.

FLOW 1.0 @ 75F CYCLE 6
A10DFB2

IMPORTANT: 32 quart maximum
capacity supply vessel.

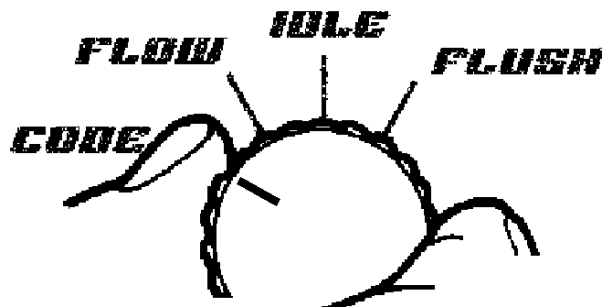


Fig. 14: View Of Main Function Switch CODE Position
Courtesy of GENERAL MOTORS COMPANY

1. Turn the main function switch to the CODE position.

NOTE:

- If power is interrupted prior to the recording of the seven-character code, the code will be lost and the flow rate test will need to be repeated.

- The flow test must run for a minimum of 8-10 seconds and be above 0.5 GPM for a code to be generated.

2. Record TESTED flow rate, temperature, cycle and seven-character flow code information on repair order.

Clean-up

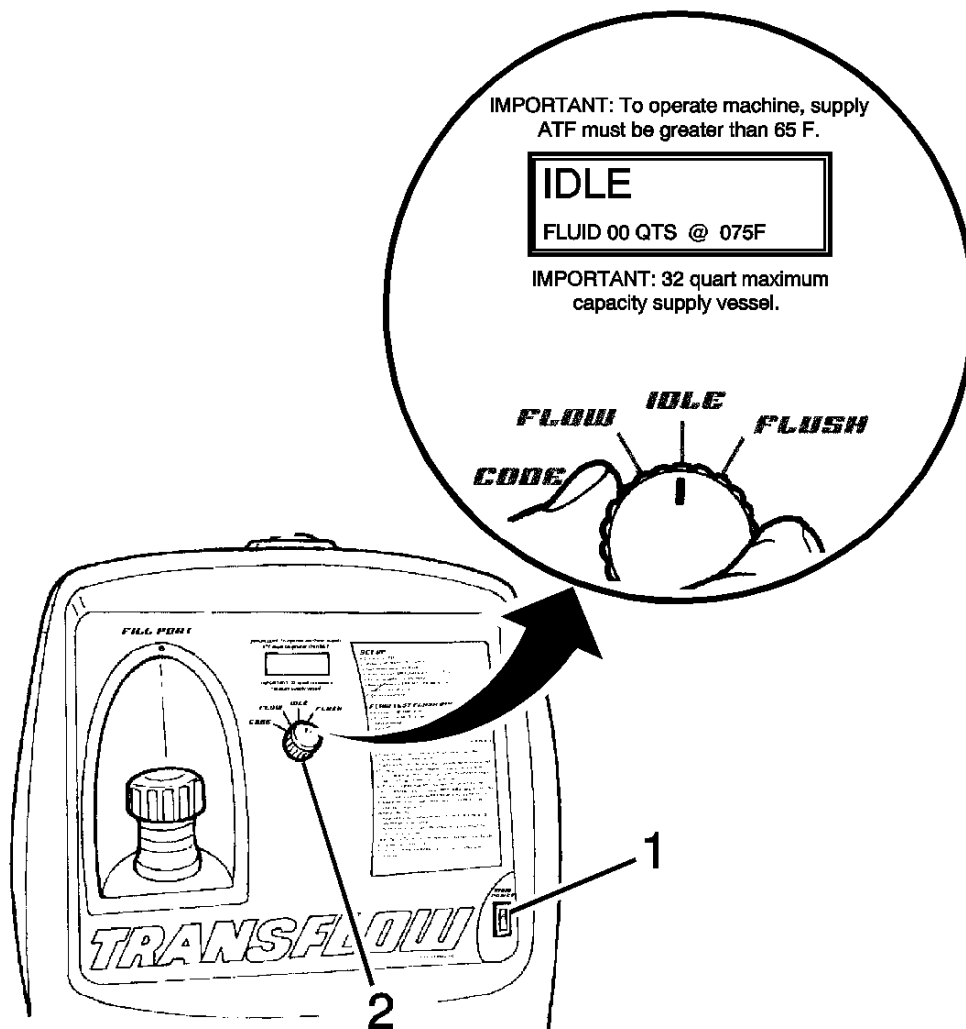


Fig. 15: View Of Main Power Switch & Main Function Switch
Courtesy of GENERAL MOTORS COMPANY

1. Turn the main function switch (2) to the IDLE position and allow the supply vessel pressure to dissipate.
2. Turn the main power switch (1) to the OFF position.

NOTE: A small amount of water may drain from the bottom of the unit when the air supply is disconnected. This is a normal operation of the built-in water

separator.

3. Disconnect the supply and waste hoses and the 12-volt power source from the vehicle.

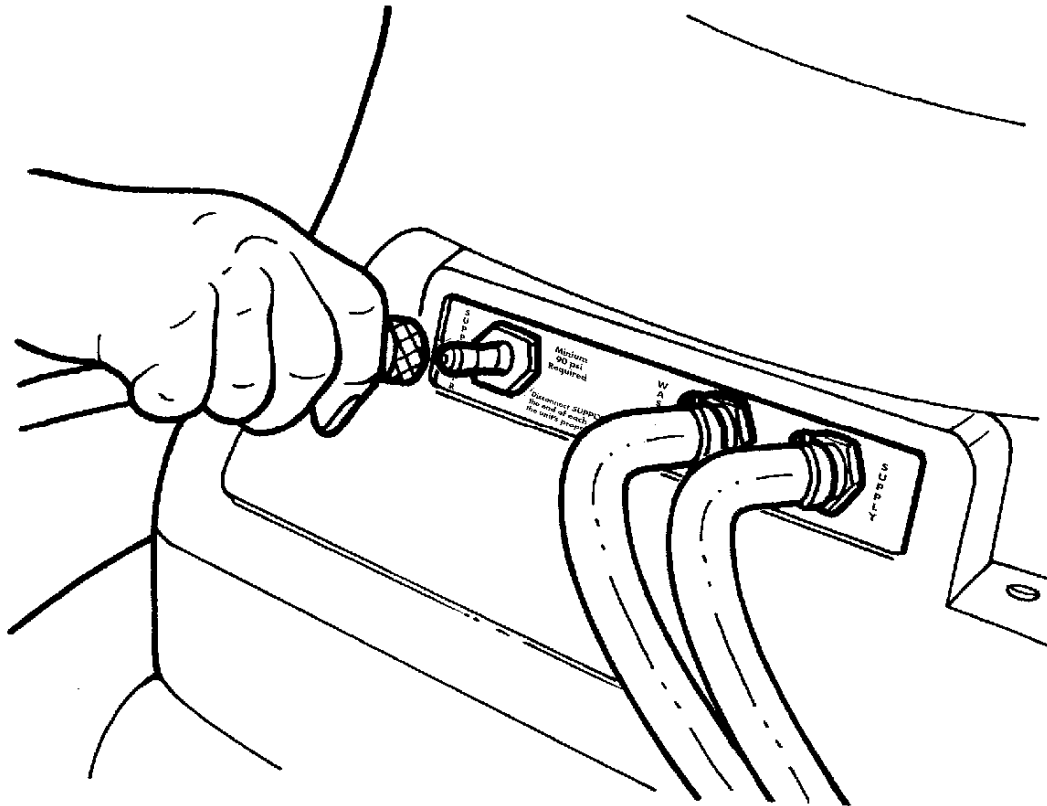


Fig. 16: Applying Shop Air Supply Hose To Quick-Disconnect
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the air supply hose from **DT-45096** flush and flow test tool.
5. Dispose of the waste ATF in accordance with all applicable federal, state, and local requirements.

TRANSMISSION FLUID COOLER FLUSHING AND FLOW TEST (6T70)

GM studies indicate that plugged or restricted transmission oil coolers and pipes cause insufficient transmission lubrication and elevated operating temperatures which can lead to premature transmission failure. Many repeat repair cases could have been prevented by following published procedures for transmission oil cooler flushing and flow checking. This procedure includes flow checking and flushing the auxiliary transmission oil cooler, if

equipped.

NOTE: Use the DT 45096 transmission oil cooling system flush and flow test tool or equivalent to flush and flow test the transmission oil cooler and the oil cooler pipes after the transaxle is removed for repairs.

Only GM Goodwrench DEXRON®VI automatic transmission fluid should be used when doing a repair on a GM transmission.

Time allowance for performing the cooler flow checking and flushing procedure has been included in the appropriate labor time guide operations since the 1987 model year. The service procedure steps for oil cooler flushing and flow testing are as follows:

Cooler Flow Check and Flushing Steps

1. Machine Set-up
2. Determine Minimum Flow Rate
3. Back Flush
4. Forward Flush
5. Flow Test
6. Code Recording Procedure
7. Clean-up

Special Tools

- **DT 45096** Transmission Oil Cooling System Flush and Flow Test Tool
- **DT 45096-50** Transmission Cooler Flush Adapter
- Shop air supply with water/oil filters, regulator and pressure gauge - minimum 90 psi
- Eye protection
- Rubber gloves

For equivalent regional tools, refer to **Special Tools** .

Machine Set-up

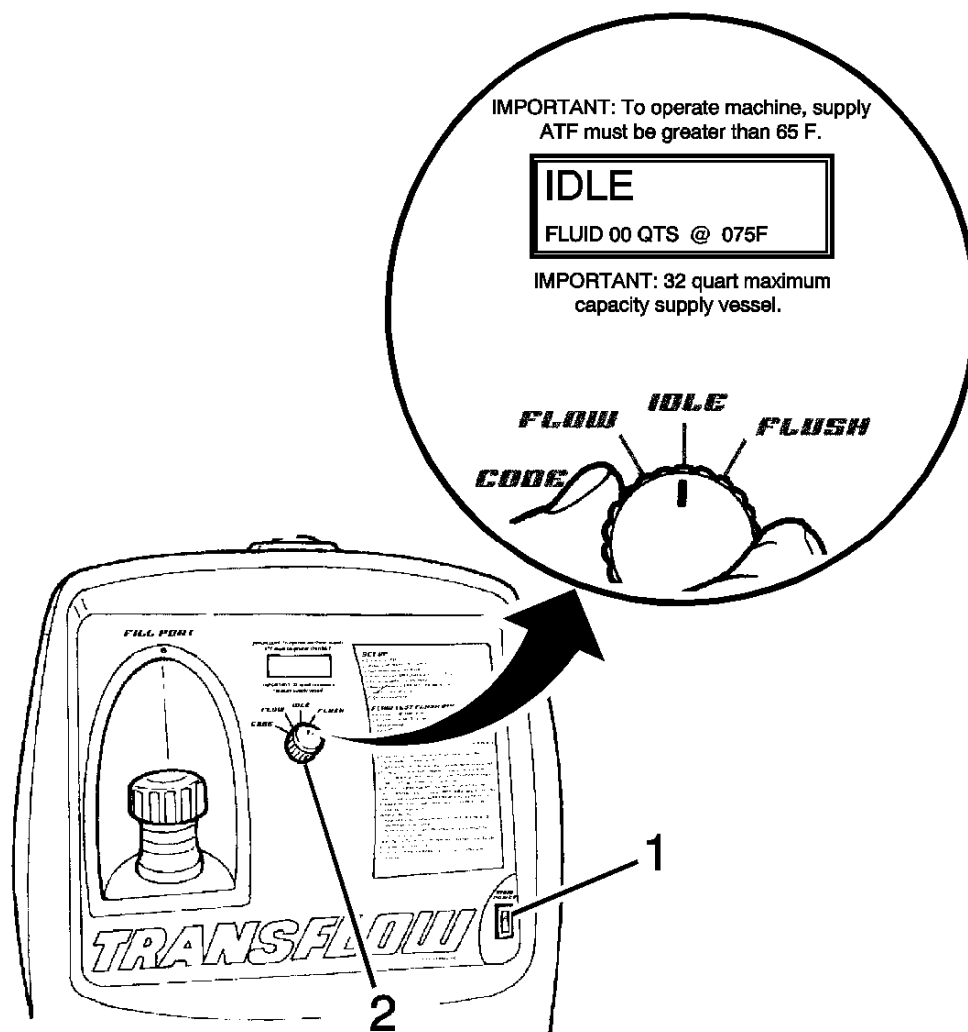


Fig. 17: View Of Main Power Switch & Main Function Switch
Courtesy of GENERAL MOTORS COMPANY

1. Verify that the main power switch (1) is in the OFF position.
2. Place the main function switch (2) in the IDLE position.

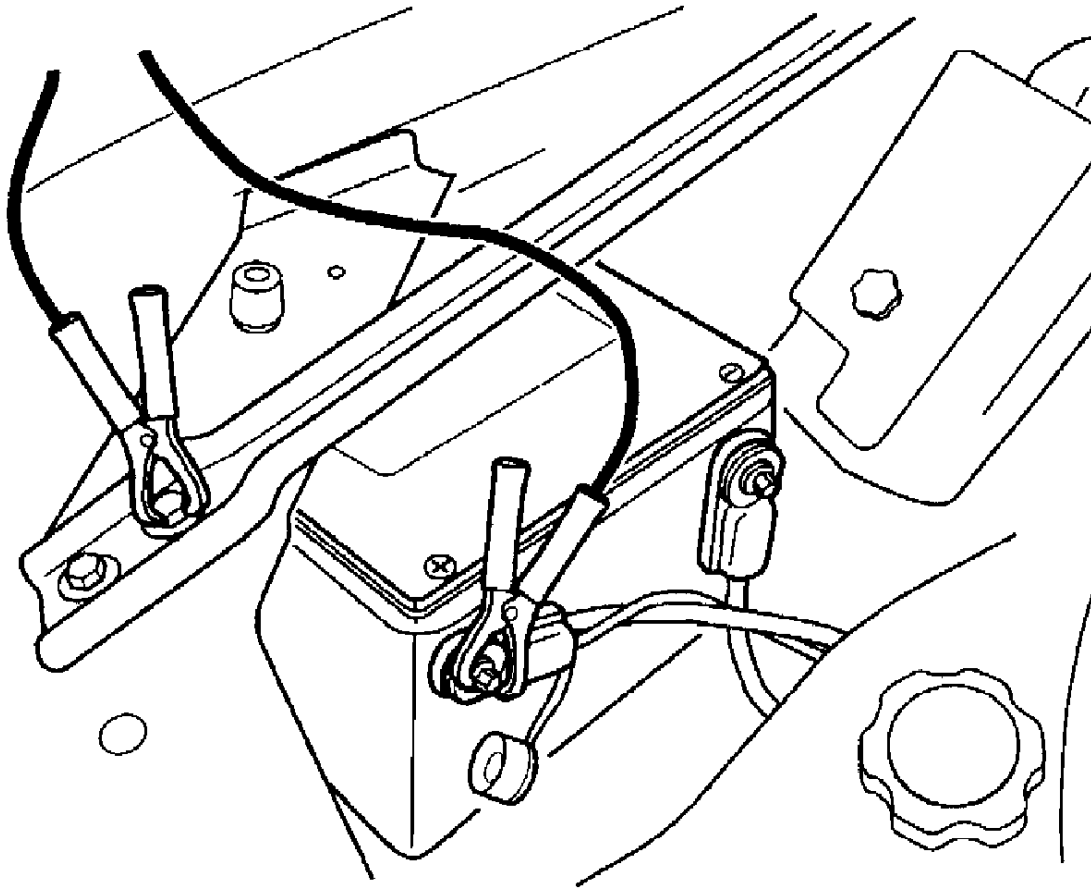


Fig. 18: Connecting To 12V DC Power Source
Courtesy of GENERAL MOTORS COMPANY

3. Connect **DT 45096** flush and flow test tool to the vehicle 12V DC power source by connecting the red battery clip to the positive, +, battery post on the vehicle and connect the negative lead to a known good chassis ground.
4. Turn the main power switch to the ON position.

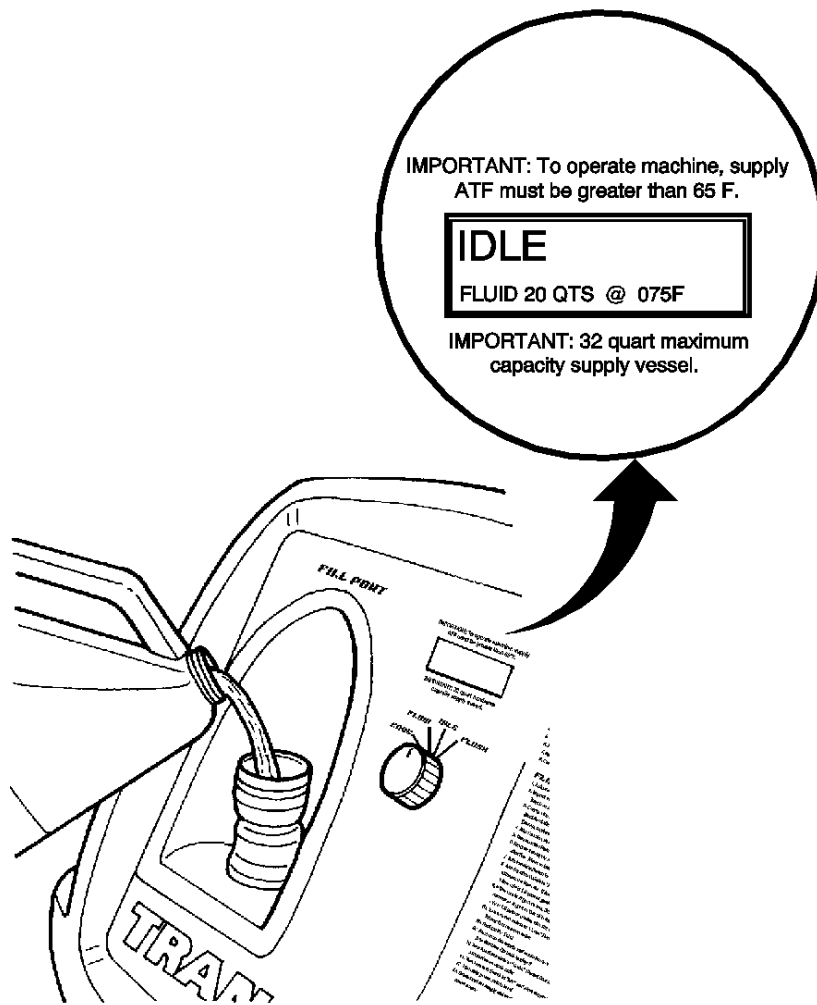


Fig. 19: Filling Supply Tank With Transmission Fluid
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not overfill the supply vessel. Damage to the unit may result. To verify the fluid level, view the LCD screen display while filling the unit, to ensure the fluid level does not exceed 30 L (32 qt).

5. Fill the supply tank with Dexron®VI through the fill port.
6. Reinstall and tighten the fill cap.

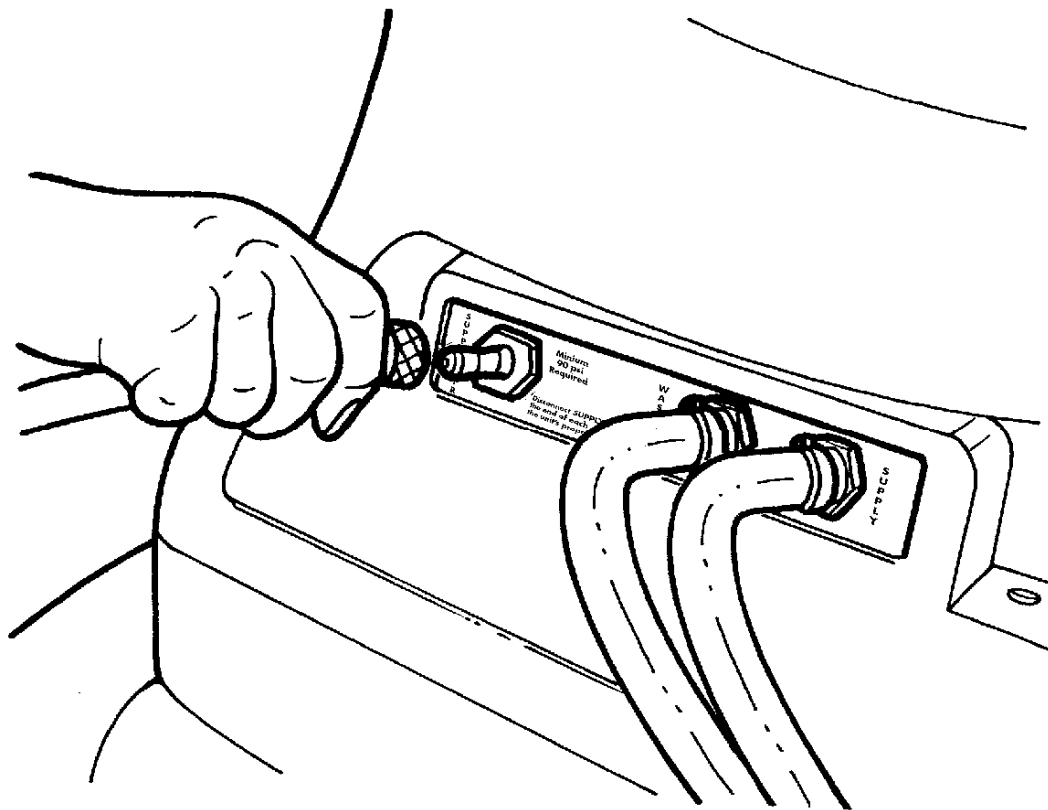


Fig. 20: Applying Shop Air Supply Hose To Quick-Disconnect
Courtesy of GENERAL MOTORS COMPANY

7. Connect a shop air supply hose to the quick-disconnect on the rear panel marked SUPPLY AIR.

Determine Minimum Flow Rate

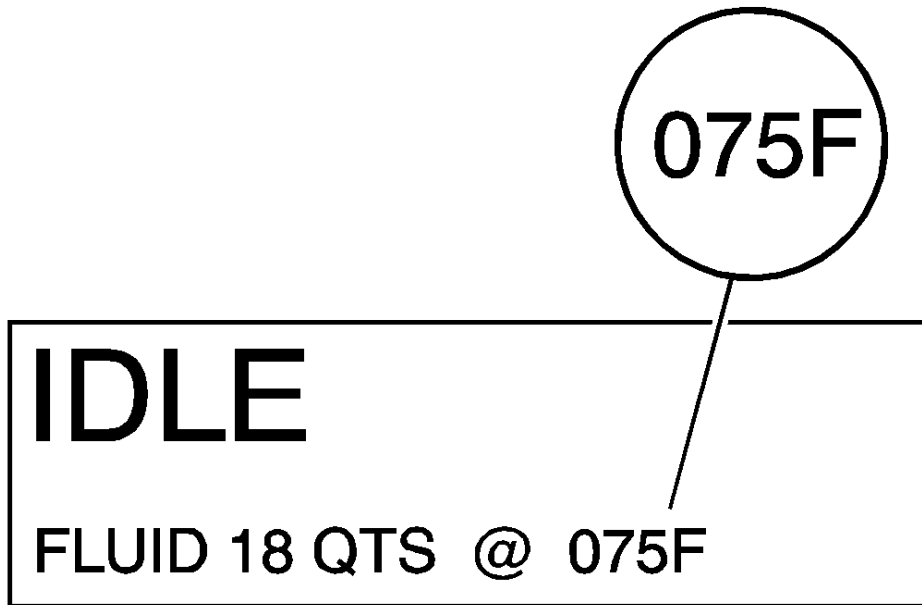


Fig. 21: Identifying Machine Display Of Automatic Transmission Fluid Temperature
Courtesy of GENERAL MOTORS COMPANY

1. From the machine display, identify the temperature of the automatic transmission fluid that is stored in the supply vessel of **DT 45096** flush and flow test tool.

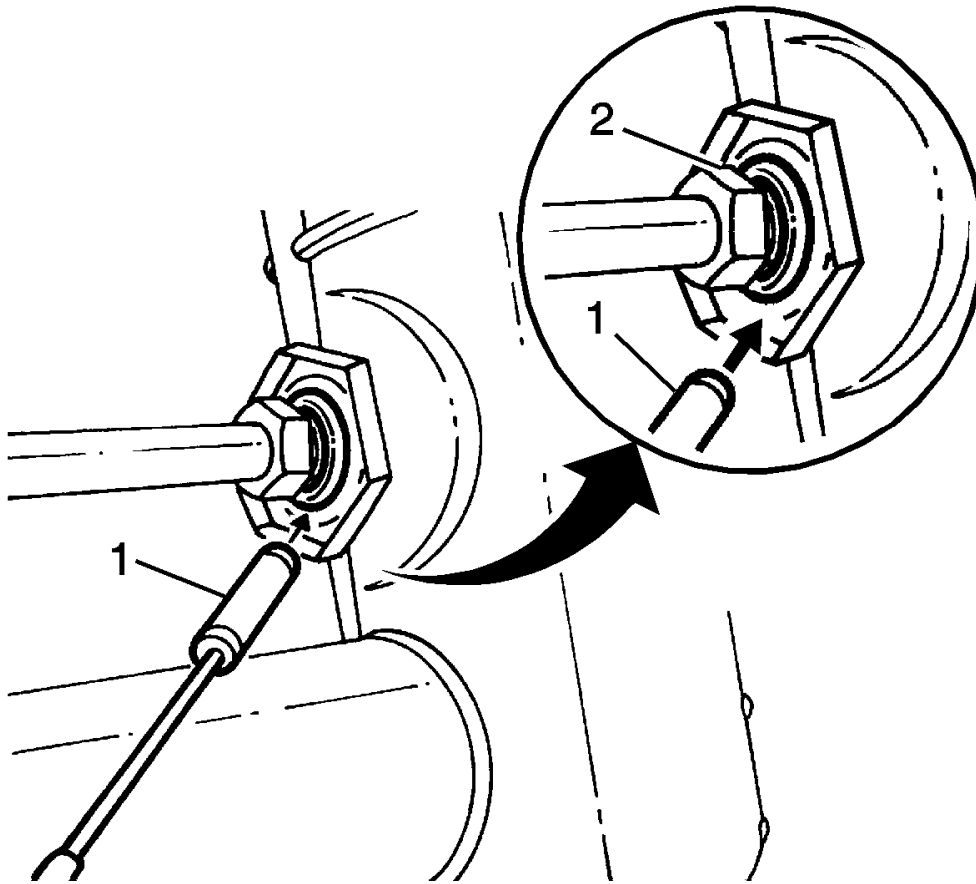


Fig. 22: Identifying Transmission Oil Cooler Metal Composition
Courtesy of GENERAL MOTORS COMPANY

2. Determine whether the transmission oil cooler is steel or aluminum by using a magnet (1) at the cooler flange (2) at the radiator.
3. Refer to the table below. Using the temperature from step 1, locate on either the Steel MINIMUM Flow Rate table or the Aluminum MINIMUM Flow Rate table the minimum flow rate in gallons per minutes (GPM). Record the minimum flow rate in GPMs and the supply fluid temperature for further reference.

Example

- Fluid temperature: 75°F
- Cooler type: Steel

The MINIMUM flow rate for this example would be 0.8 GPM.

4. Inspect transmission oil cooler lines for damage or kinks that could cause restricted oil flow. Repair as needed and refer to the appropriate GM service manual procedures.

Minimum Flow Rate in Gallons Per Minute (gpm)

Temperature Range	Steel	Aluminum
65 - 66°F	0.6 gpm	0.5 gpm
67 - 70°F	0.7 gpm	0.6 gpm
71 - 75°F	0.8 gpm	0.7 gpm
76 - 80°F	0.9 gpm	0.8 gpm
81 - 84°F	1.0 gpm	0.9 gpm
85 - 89°F	1.1 gpm	1.0 gpm
90 - 94°F	1.2 gpm	1.1 gpm
95 - 98°F	1.3 gpm	1.2 gpm
99 - 103°F	1.4 gpm	1.3 gpm
104 - 108°F	1.5 gpm	1.4 gpm
109 - 112°F	1.6 gpm	1.5 gpm
113 - 117°F	1.7 gpm	1.6 gpm
118 - 120°F	1.8 gpm	1.7 gpm

Back Flush Procedure

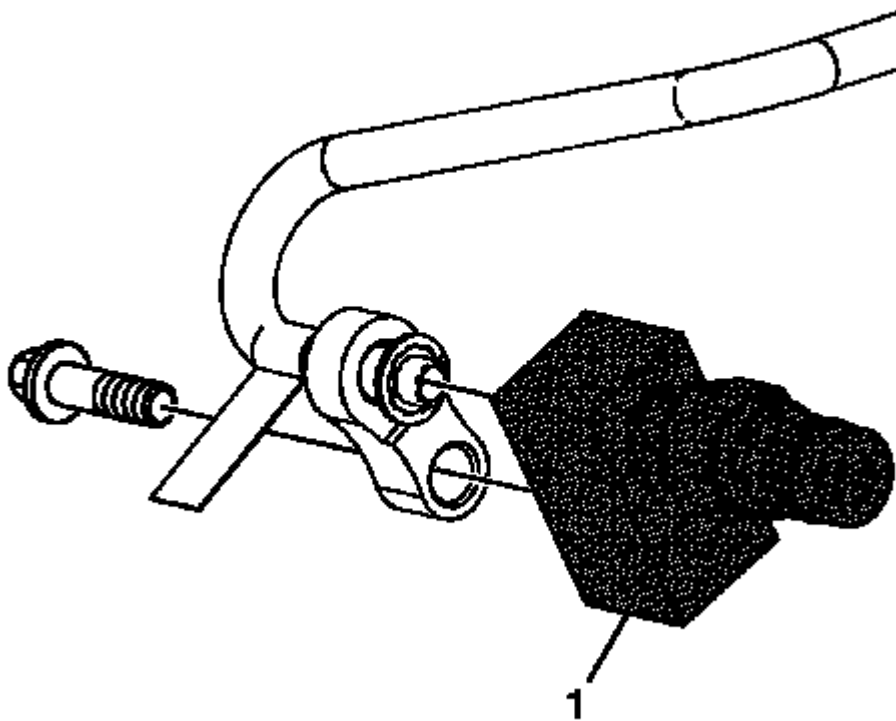


Fig. 23: Identifying Cooler Flush Adapter
Courtesy of GENERAL MOTORS COMPANY

1. Connect the **DT 45096-50** cooler flush adapter (1) to the vehicle transmission oil cooler supply and return lines at the transmission.

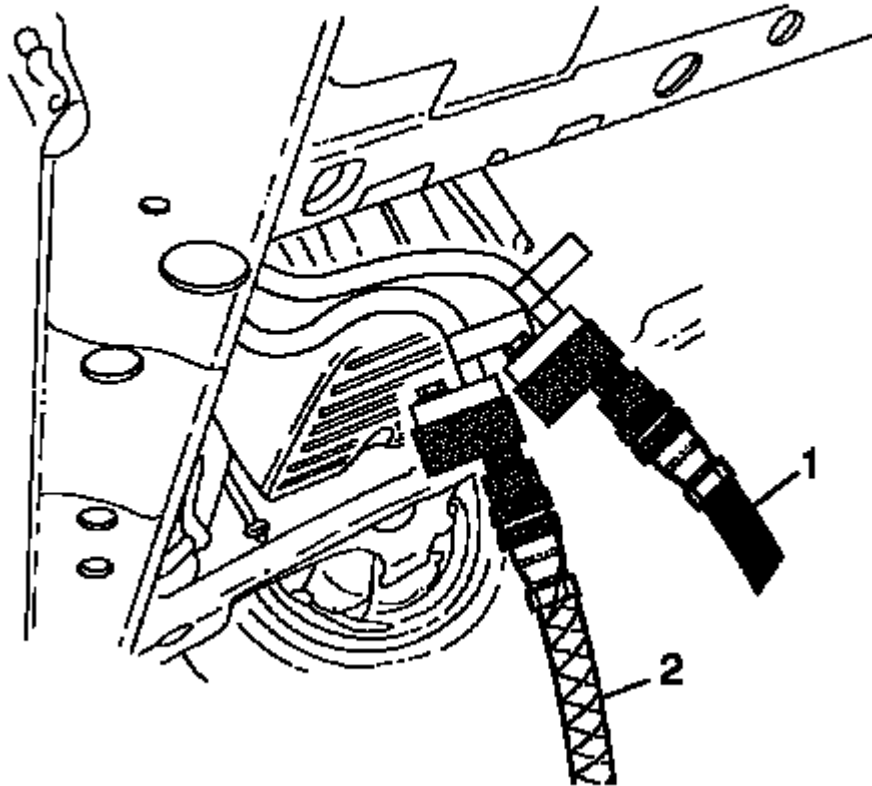


Fig. 24: View Of Black Supply Hose And Clear Waste Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect the black supply hose (1) to the return line, top connector of the transmission, and the clear waste hose (2) to the feed line, bottom connector of the transmission, to the vehicle cooler lines. This is the reverse flow - backflush direction.

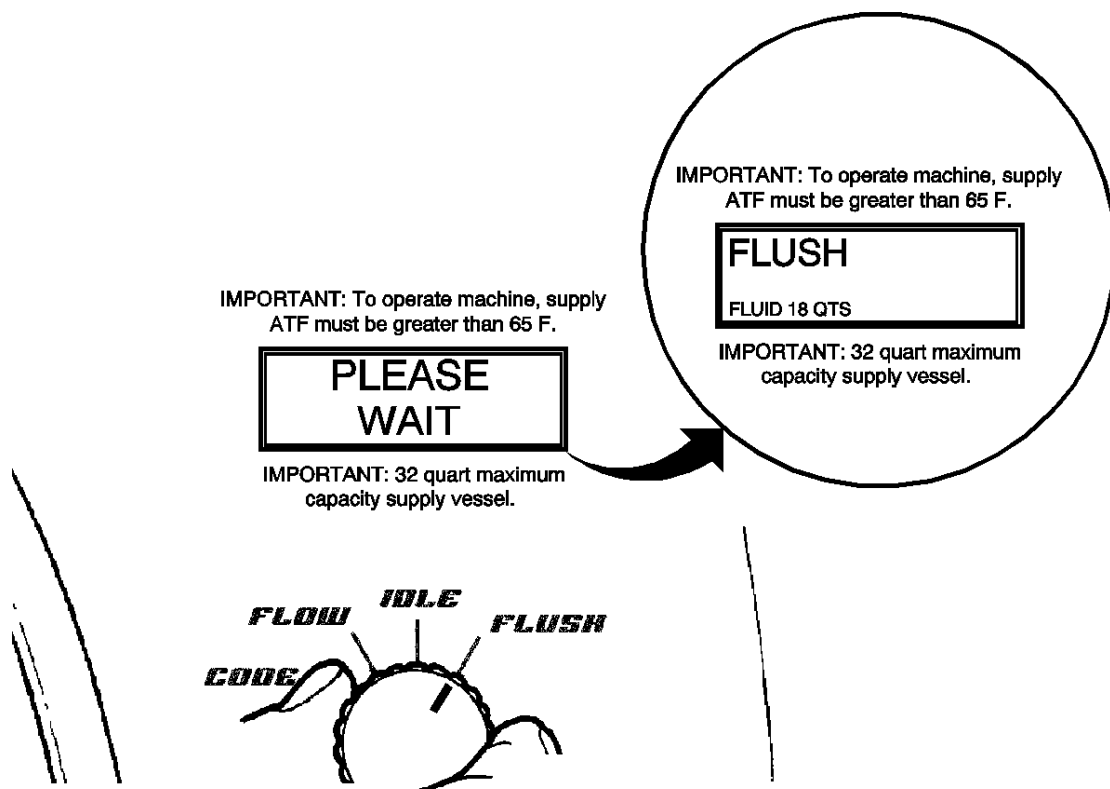


Fig. 25: View Of Main Function Switch FLUSH Position
Courtesy of GENERAL MOTORS COMPANY

3. Turn the main function switch to the FLUSH position. Allow the machine to operate for 30 seconds.

IMPORTANT: To operate machine, supply
ATF must be greater than 65 F.

IDLE

FLUID 16 QTS @ 075F

IMPORTANT: 32 quart maximum
capacity supply vessel.

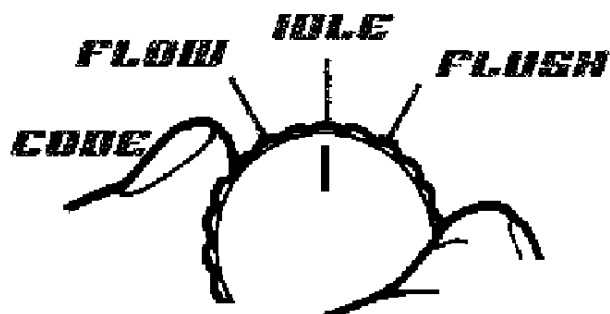


Fig. 26: View Of Main Function Switch IDLE Position
Courtesy of GENERAL MOTORS COMPANY

4. Turn the main function switch to the IDLE position and allow the supply vessel pressure to dissipate.

Forward Flush

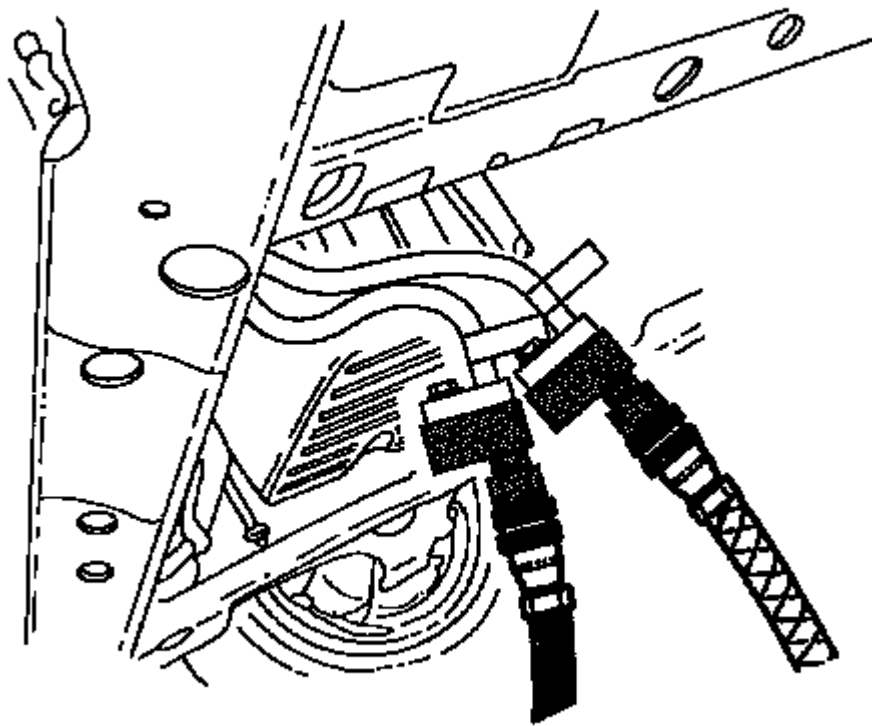


Fig. 27: Identifying Supply And Waste Hoses
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the supply and waste hoses from the vehicle cooler lines. Reverse the supply and waste hoses to provide a normal flow direction.

IMPORTANT: To operate machine, supply
ATF must be greater than 65 F.

FLUSH

FLUID 18 QTS

IMPORTANT: 32 quart maximum
capacity supply vessel.

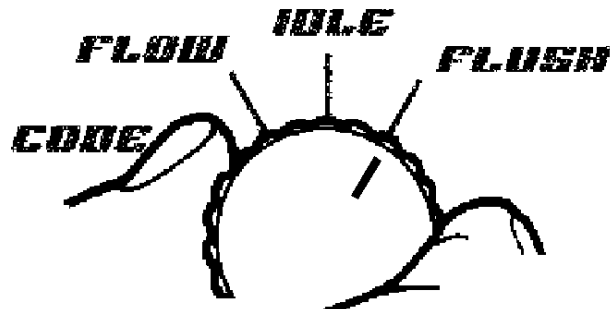


Fig. 28: View Of Main Function Switch FLUSH Position
Courtesy of GENERAL MOTORS COMPANY

2. Turn the main function switch to the FLUSH position and allow machine to operate for 30 seconds.

Flow Test

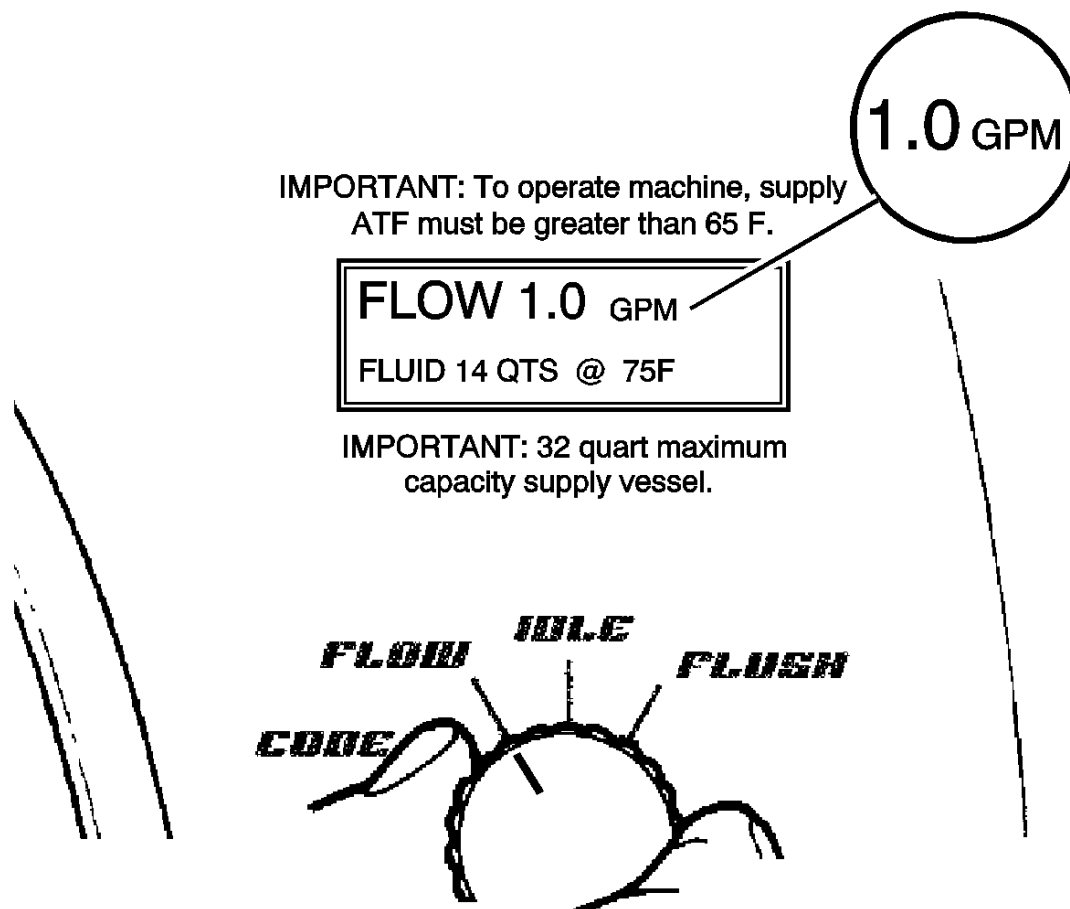


Fig. 29: View Of Main Function Switch FLOW Position
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the flow rate is less than 0.5 gpm, the LCD displays an error message. Refer to the Troubleshooting section of the operation manual.

1. Turn the main function switch to the FLOW position and allow the oil to flow for 15 seconds. Observe and note the flow rate; this is the TESTED flow rate.
2. Compare the TESTED flow rate to the MINIMUM flow rate information previously recorded.
 - If the TESTED flow rate is equal to or greater than the MINIMUM flow rate recorded, the oil cooling system is functioning properly. Perform Code Recording Procedure.
 - If the TESTED flow rate is less than the MINIMUM flow rate previously recorded, repeat the back flush and forward flush procedures.
3. If the TESTED flow rate is less than the MINIMUM flow rate after the second test, perform Code Recording Procedure.

1. Replace the transmission oil cooler.
2. Reconnect supply and waste hoses to the cooler lines in the normal flow direction. Perform Flow Test.
3. Perform Code Recording Procedure.

Code Recording Procedure

IMPORTANT: To operate machine, supply
ATF must be greater than 65 F.

FLOW 1.0 @ 75F CYCLE 6
A10DFB2

IMPORTANT: 32 quart maximum
capacity supply vessel.

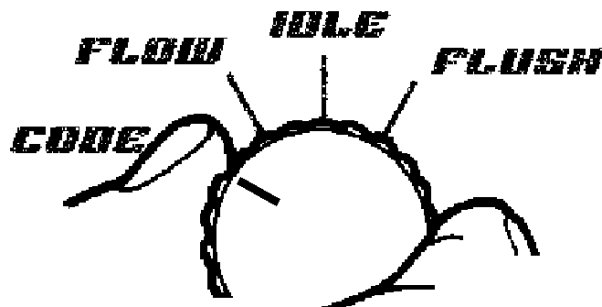


Fig. 30: View Of Main Function Switch CODE Position
Courtesy of GENERAL MOTORS COMPANY

1. Turn the main function switch to the CODE position.

NOTE:

- If power is interrupted prior to the recording of the seven-character code, the code will be lost and the flow rate test will need to be repeated.

- The flow test must run for a minimum of 8-10 seconds and be above 0.5 GPM for a code to be generated.

2. Record TESTED flow rate, temperature, cycle and seven-character flow code information on repair order.

Clean-up

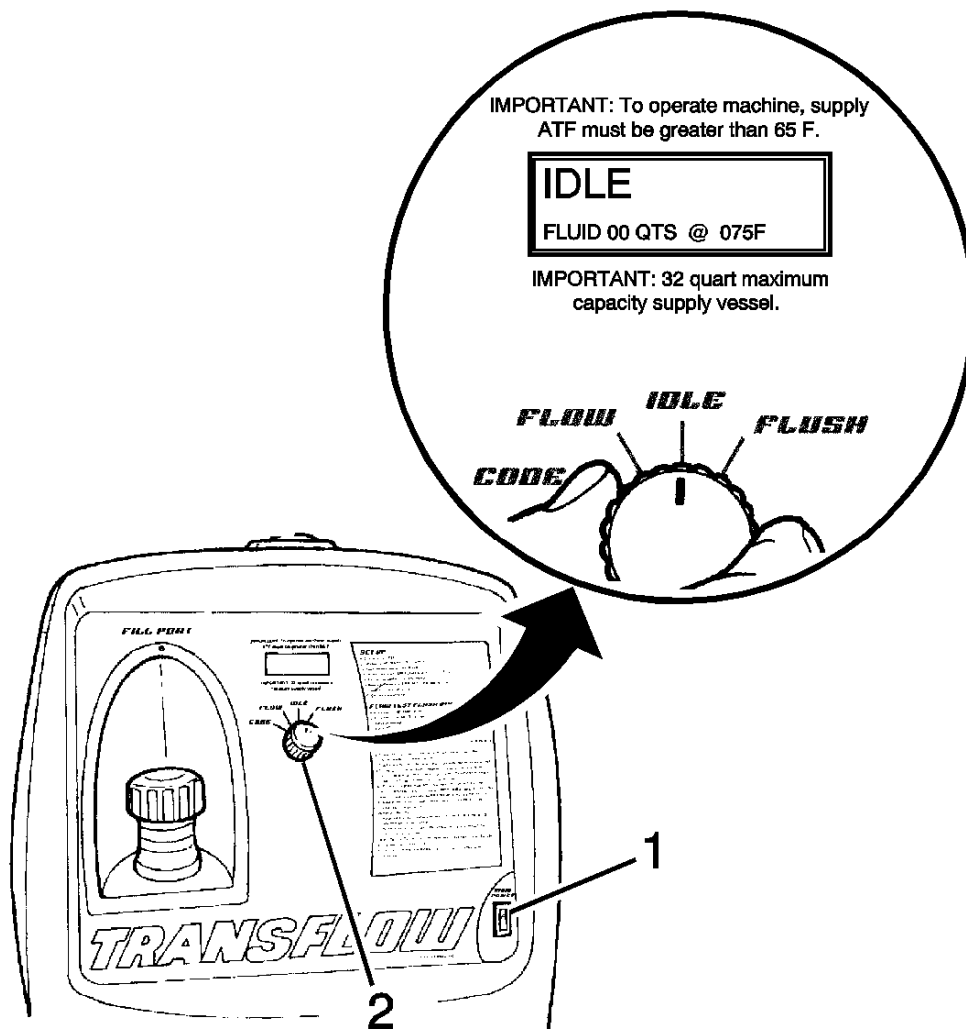


Fig. 31: View Of Main Power Switch & Main Function Switch
Courtesy of GENERAL MOTORS COMPANY

1. Turn the main function switch (2) to the IDLE position and allow the supply vessel pressure to dissipate.
2. Turn the main power switch (1) to the OFF position.

NOTE: A small amount of water may drain from the bottom of the unit when the air supply is disconnected. This is a normal operation of the built-in water

separator.

3. Disconnect the supply and waste hoses and the 12-volt power source from the vehicle.

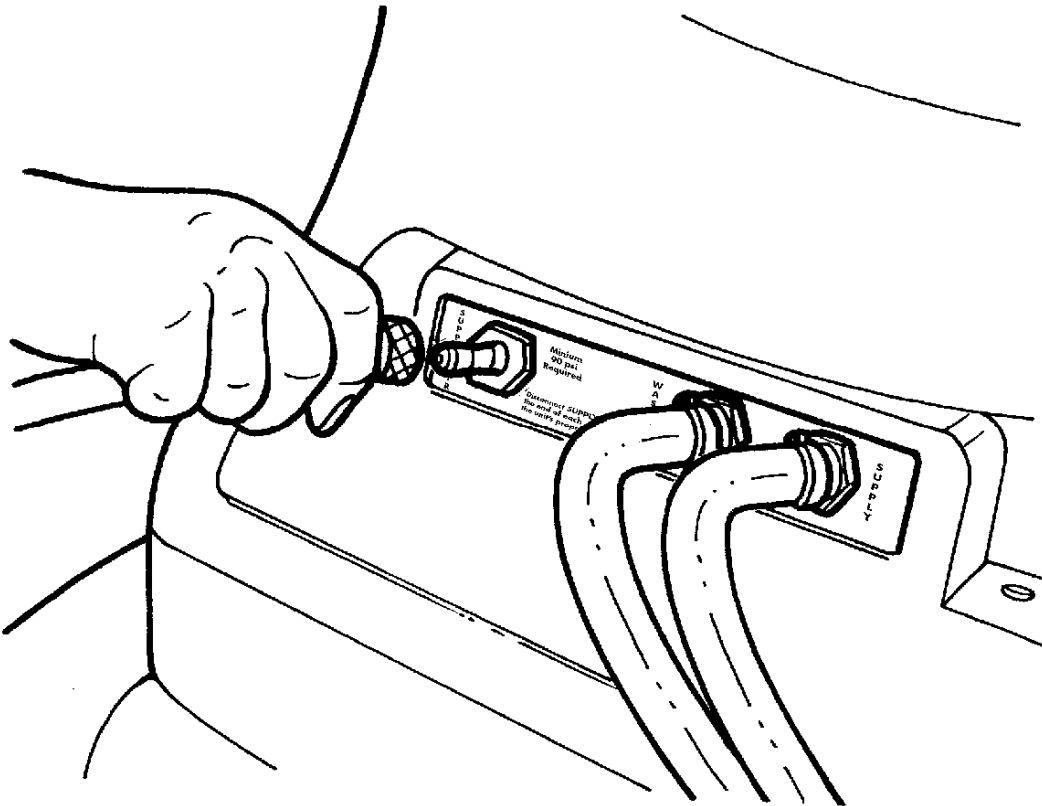


Fig. 32: Applying Shop Air Supply Hose To Quick-Disconnect
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the air supply hose from **DT 45096** flush and flow test tool.
5. Dispose of the waste ATF in accordance with all applicable federal, state, and local requirements.

REPAIR INSTRUCTIONS

TRANSMISSION FLUID COOLER PIPE SEAL REPLACEMENT

Special Tools

- **DT-41239-1A** Cooler Line Seal Installer
- **DT-45201** Cooler Line Seal Remover

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place a drain pan or suitable container under the vehicle.

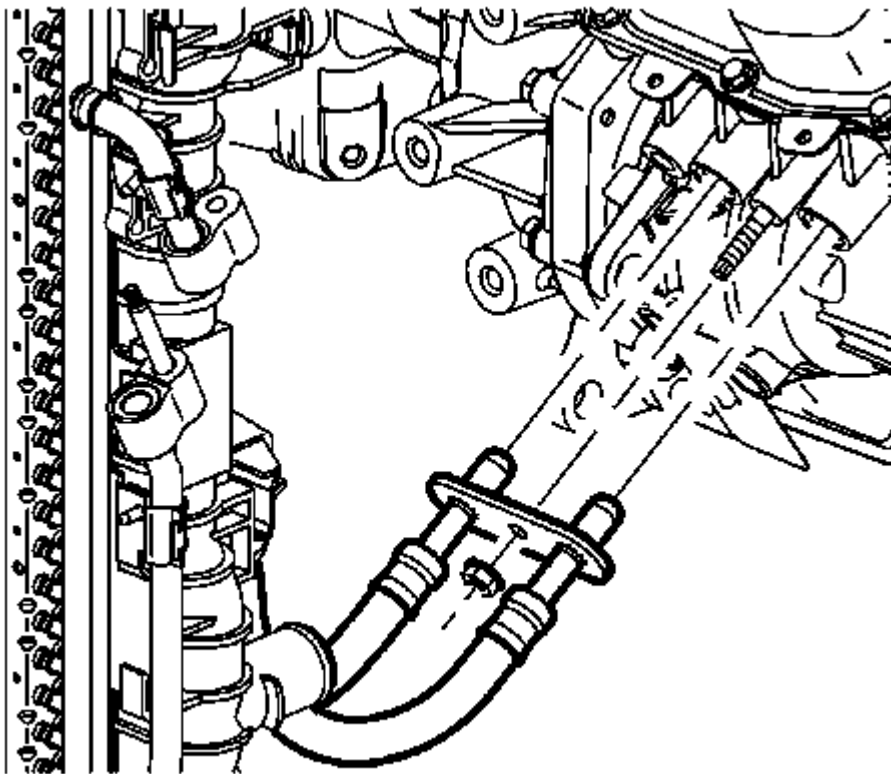


Fig. 33: View Of Transaxle Oil Cooler Line Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Remove the transaxle oil cooler line assembly nut from the transaxle.
4. Disconnect the transaxle oil cooler lines from the vehicle.

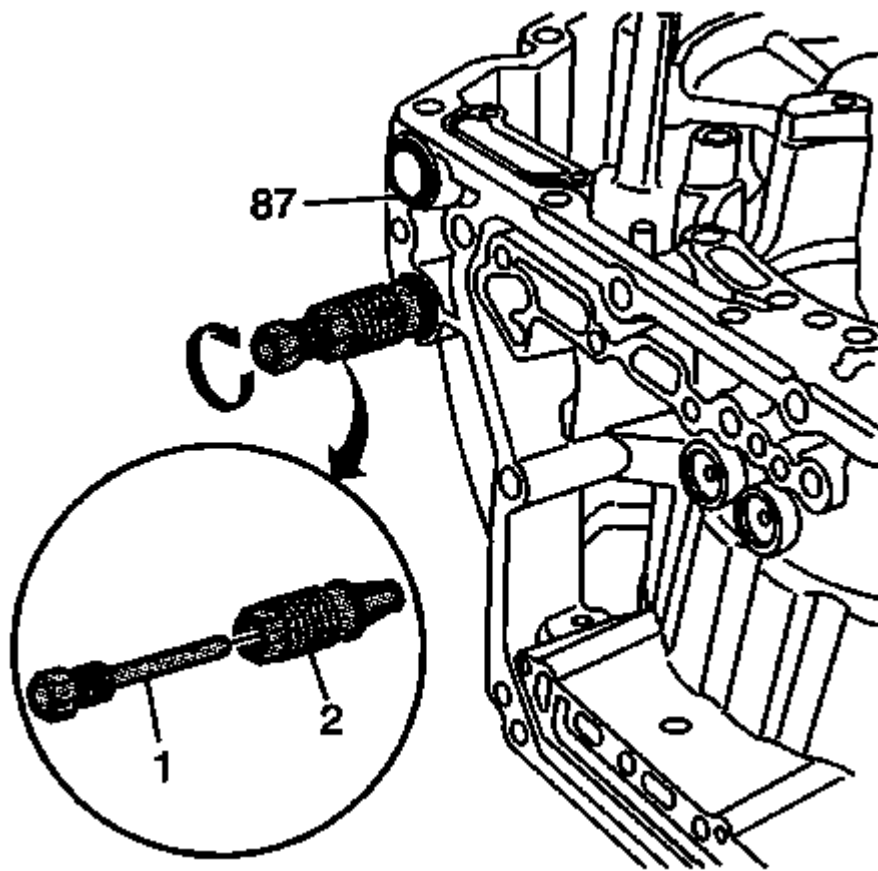


Fig. 34: View Of Cooler Line Seal Remover
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the J 45201 is fully seated into the transaxle seal bore.

5. Insert the collet piece (2) of the **DT-45201** Cooler Line Seal Remover into the cooler line seal.
6. Insert the forcing screw piece (1) of the **DT-45201** Cooler Line Seal Remover into the collet (2).
7. Tighten the forcing screw (1) until snug.

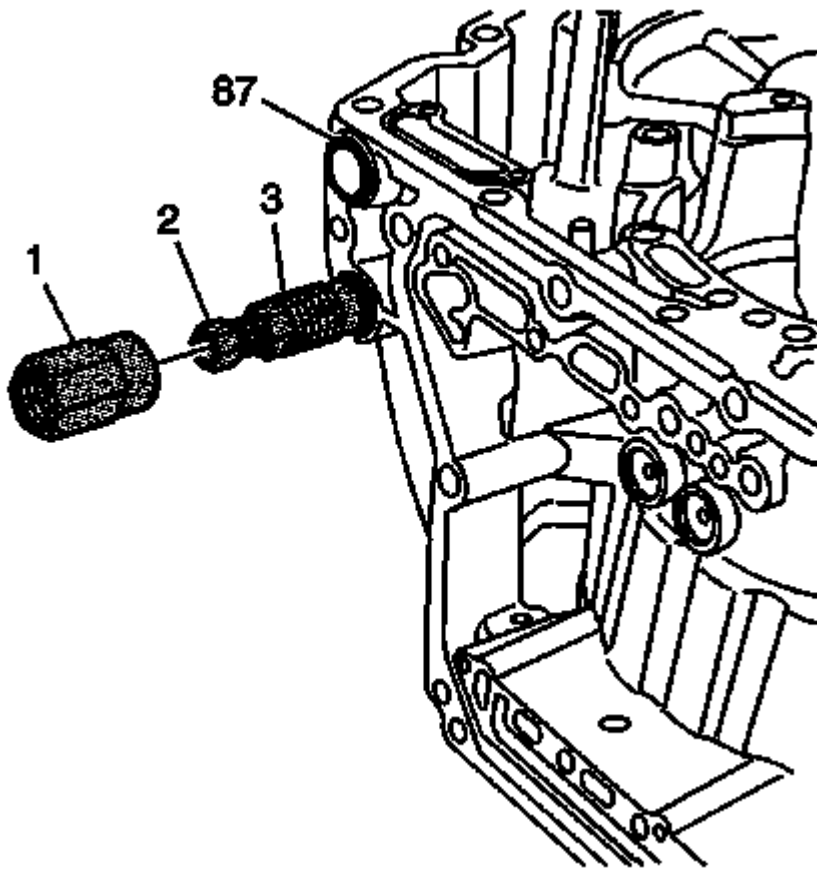


Fig. 35: Identifying Collar & Collet
Courtesy of GENERAL MOTORS COMPANY

8. Thread the collar piece (1) of the **DT-45201** Cooler Line Seal Remover onto the collet (3) until snug.

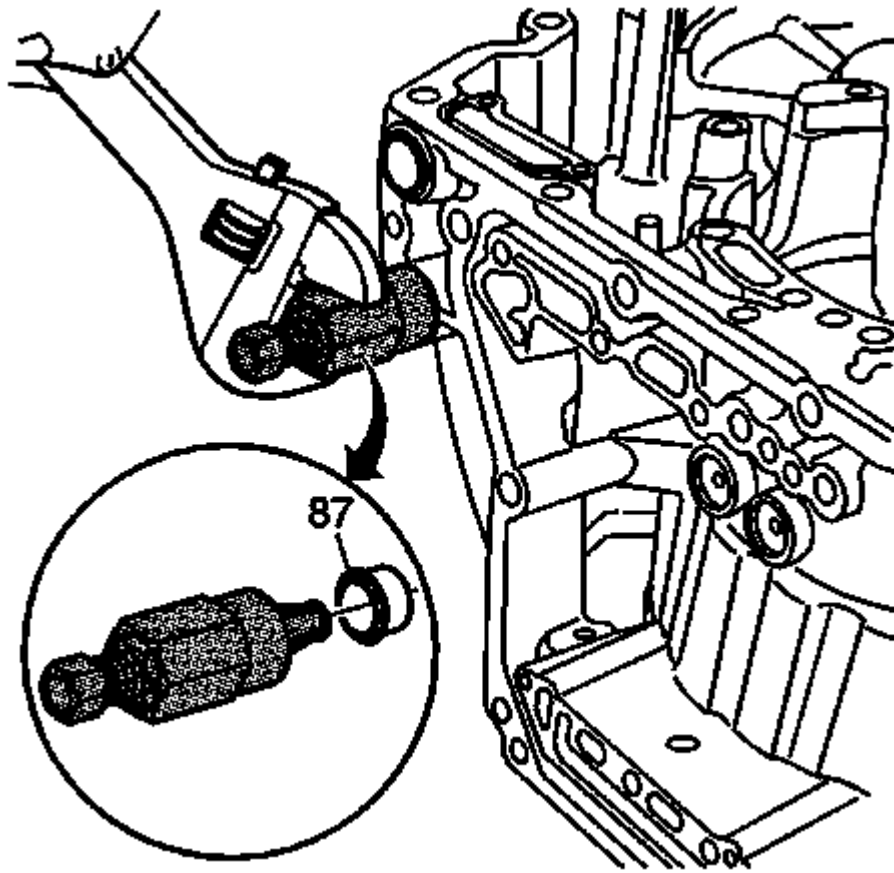


Fig. 36: Removing Fluid Cooler Pipe Fitting Seal
Courtesy of GENERAL MOTORS COMPANY

9. Turn the collar clockwise in order to remove the cooler line seal (87).
10. Discard the seal (87).
11. Clean the case bores for the cooler line seals.

Installation Procedure

1. Insert a new transaxle cooler line seal into the case bore.

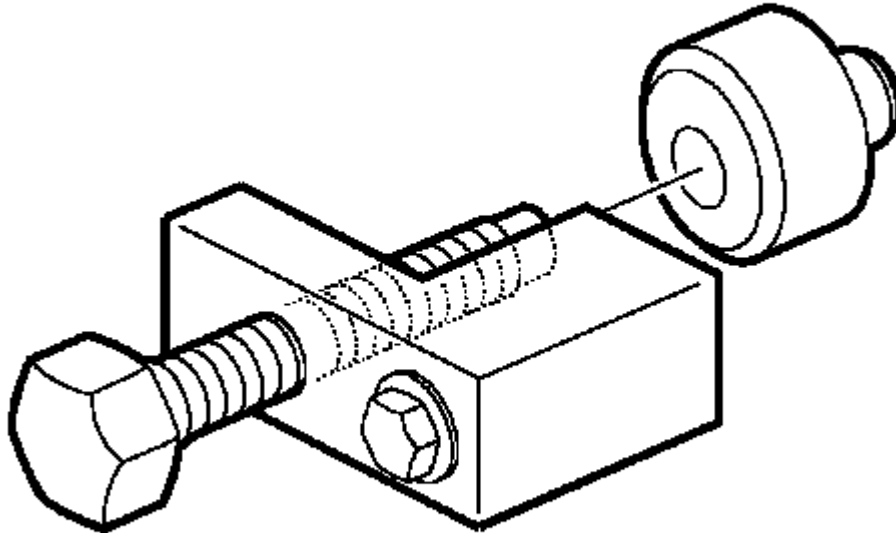


Fig. 37: View Of Nub & Cooler Line Seal Installer
Courtesy of GENERAL MOTORS COMPANY

2. Remove the nub from the **DT-41239-1A** Cooler Line Seal Installer.

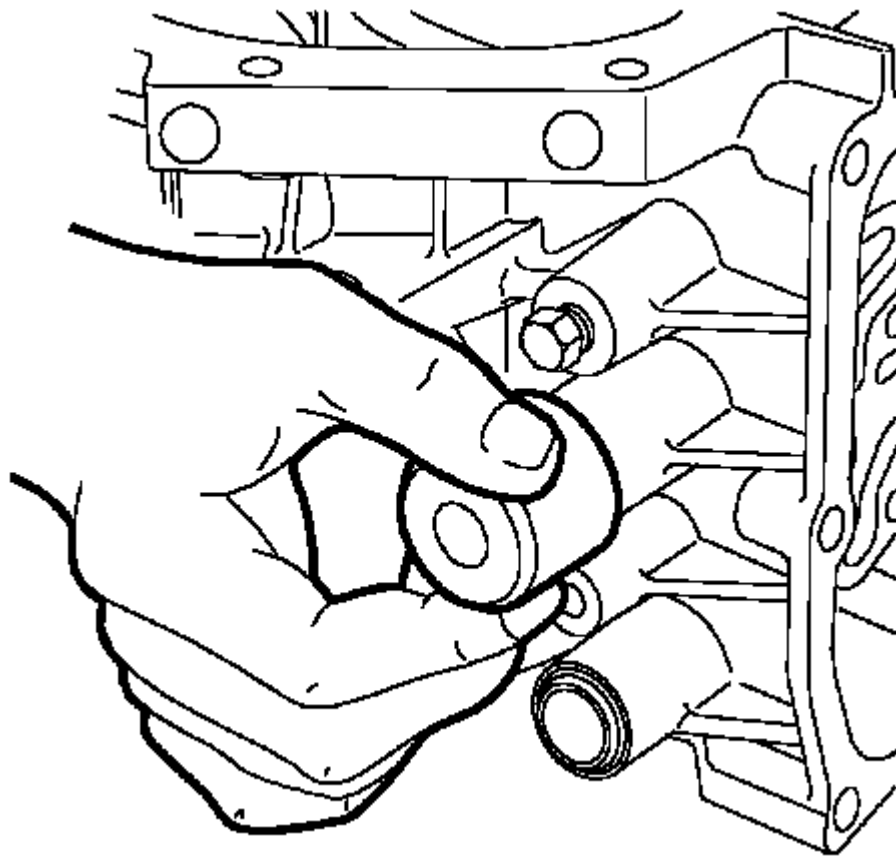


Fig. 38: View Of Nub Of Cooler Line Seal Installer & Transaxle Cooler Line Seal
Courtesy of GENERAL MOTORS COMPANY

3. Install the nub of the **DT-41239-1A** Cooler Line Seal Installer on the transaxle cooler line seal.
4. Tap the new transaxle cooler line seal into the case bore.

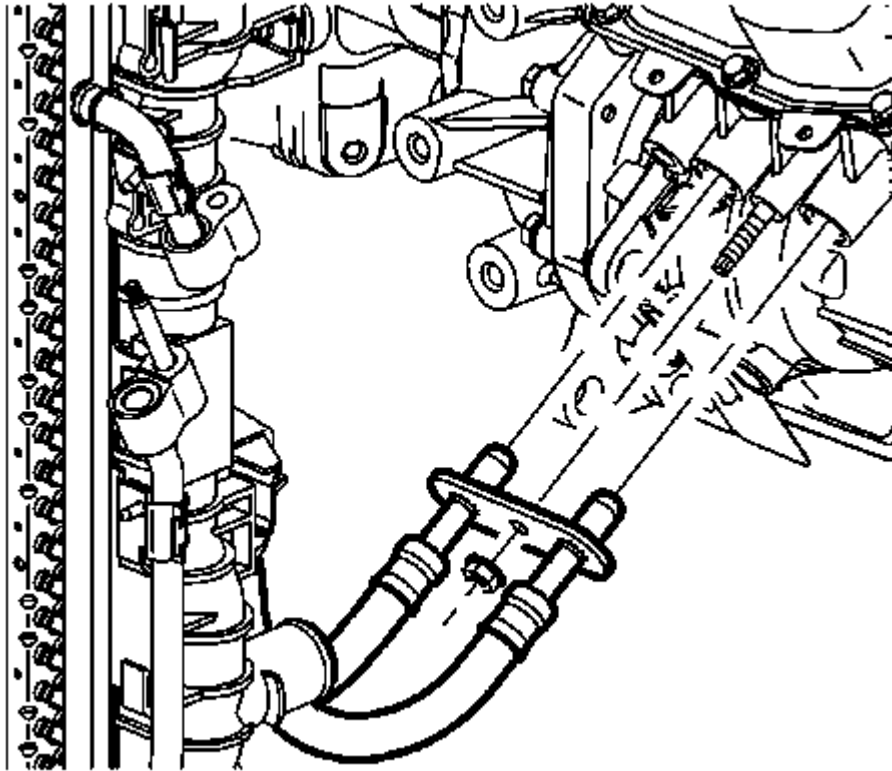


Fig. 39: View Of Transaxle Oil Cooler Line Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Install the transaxle oil cooler line assembly to the transaxle.

CAUTION: Refer to Fastener Caution .

6. Install the transaxle oil cooler line assembly nut and tighten to 9 N.m (80 lb in).
7. Lower the vehicle.
8. Add fluid to the transaxle. Refer to Adhesives, Fluids, Lubricants, and Sealers , for the MH8/MHH, or Adhesives, Fluids, Lubricants, and Sealers for the M7U/M7W.
9. Start the engine and check for leaks.

TRANSMISSION FLUID COOLER PIPE CONNECTOR REPLACEMENT - RADIATOR

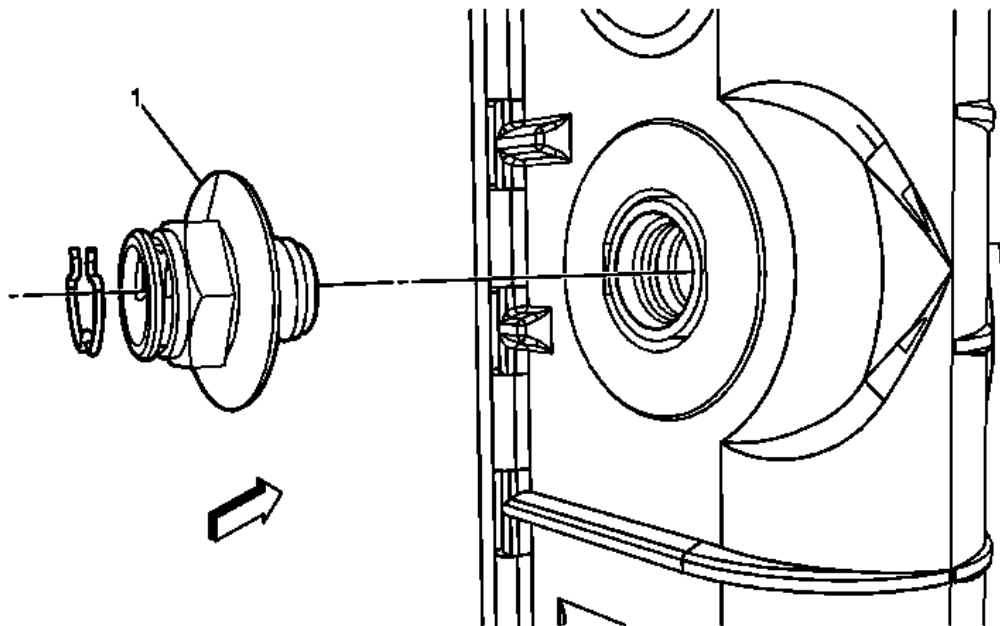


Fig. 40: View Of Transmission Fluid Cooler Hose/Pipe Connector
 Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Cooler Pipe Connector Replacement - Radiator

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static Fill)</u> , <u>Cooling System Draining and Filling (GE 47716)</u> . 2. Remove the transaxle oil cooler pipe from the oil cooler fittings on the radiator. Refer to <u>Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MHH, MHK)</u> , <u>Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MDK)</u> . 	
1	<p>Transmission Oil Cooler Fitting</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Remove the plastic caps from the quick connect fittings by pulling the caps back along the pipe before installation.</p> <p>NOTE: Do not remove the upper and lower transaxle oil cooler fittings from the radiator at the</p>

same time other wise the transaxle oil cooler may fall inside the radiator end tank.

NOTE:

The correct thread engagement is critical. Cross-threaded fittings can achieve proper tightness and still leak.

Tighten

24 N.m (18 lb ft)

TRANSMISSION FLUID COOLER HOSE/PIPE QUICK-CONNECT FITTING DISCONNECTION AND CONNECTION (MHH, MHK)

Special Tools

- **DT-28585** Universal Snap Ring Remover for the 5/8 inch Line
- **DT-41623-B** 3/8 inch Line Quick Release Tool

Removal Procedure

1. Remove the plastic caps from the quick connect fittings by pulling the caps back along the pipe before installation.

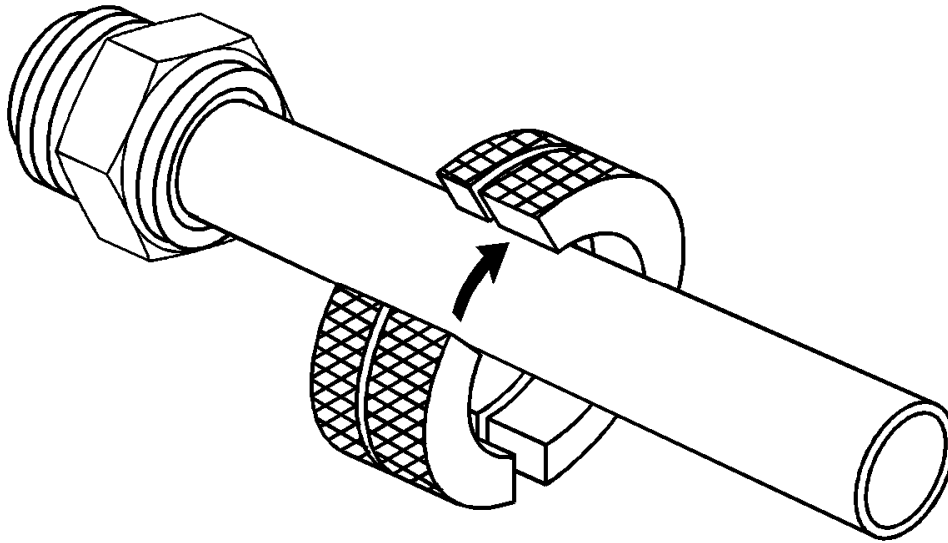


Fig. 41: View Of Quick Release Tool & Generator Cooling Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install the **DT-41623-B** 3/8 inch line quick release tool onto the transmission oil cooler (TOC) pipe, or use the **DT-28585** universal snap ring remover for the 5/8 inch line.

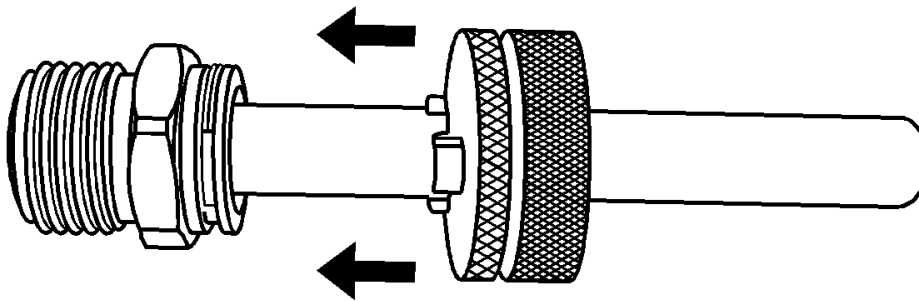


Fig. 42: Sliding Quick Release Tool Toward Generator Cooling Inlet Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Slide the **DT-41623-B** 3/8 inch line quick release tool toward the TOC pipe fitting, or use the **DT-28585** universal snap ring remover for the 5/8 inch line.

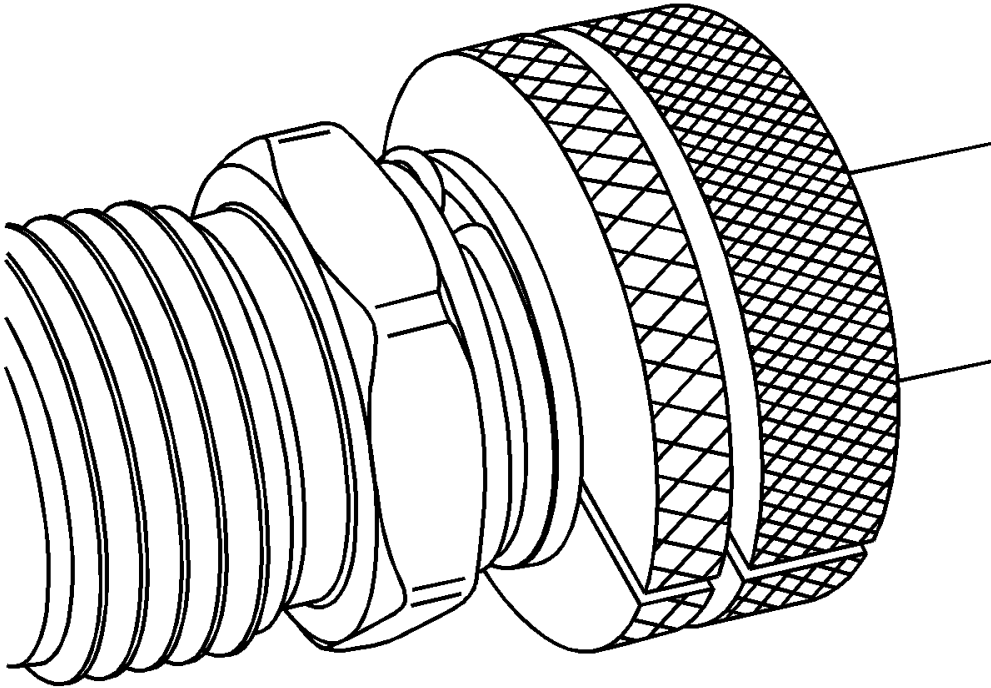


Fig. 43: Rotating Quick-Connect On Coolant Pipe
Courtesy of GENERAL MOTORS COMPANY

NOTE: Rotate the DT-41623-B 3/8 inch line quick release tool to engage the TOC pipe fitting's retainer slots.

The DT-41623-B 3/8 inch line quick release tool should be nearly flush with the fitting.

4. Connect the **DT-41623-B** 3/8 inch line quick release tool onto the TOC pipe fitting.

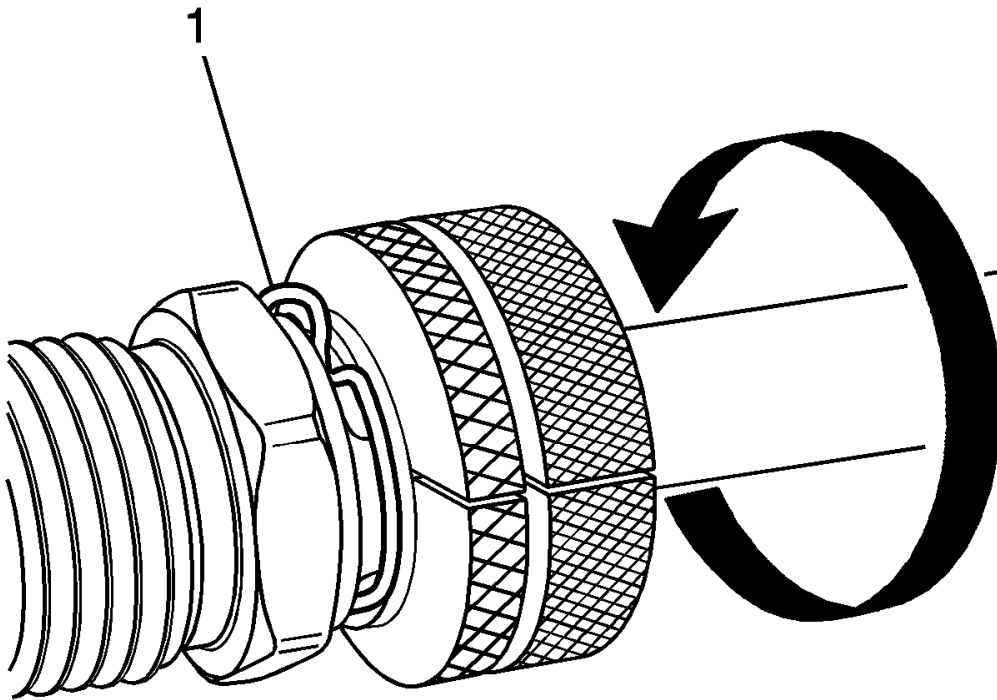


Fig. 44: Rotating Quick-Connect Until Retainer Clip Rises Above Fitting Retainer Seat
Courtesy of GENERAL MOTORS COMPANY

5. Rotate the **DT-41623-B** 3/8 inch line quick release tool or use the **DT-28585** universal snap ring remover for the 5/8 inch line until the retainer clip (1) rises above the fitting retainer seat.

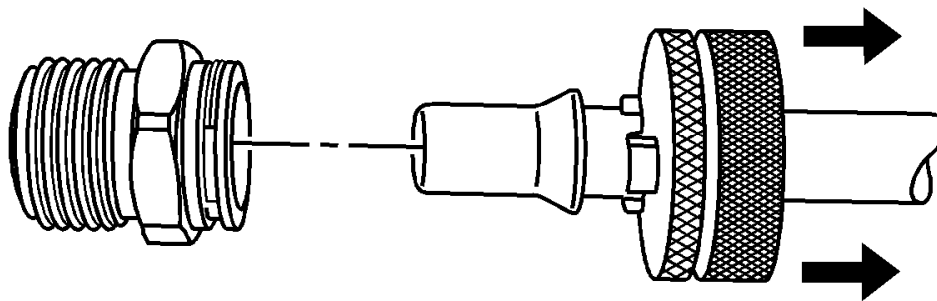


Fig. 45: View Of Quick Release Tool & Generator Cooling Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Pull back on the TOC pipe to disengage the pipe from the TOC pipe fitting.
7. Remove the **DT-41623-B** 3/8 inch line quick release tool or the **DT-28585** universal snap ring remover for the 5/8 inch line from the TOC pipe.

Installation Procedure

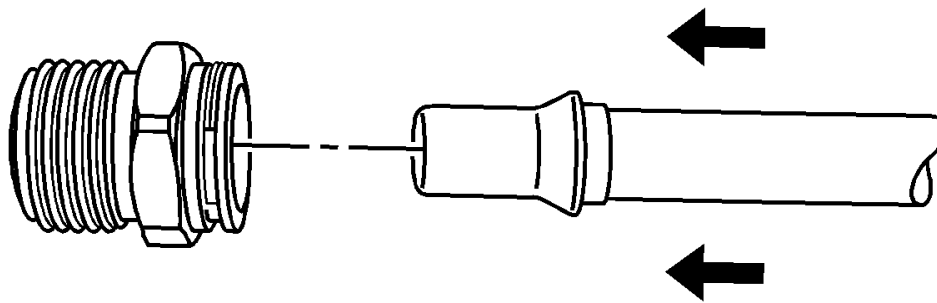


Fig. 46: View Of Generator Cooling Inlet Pipe & Generator Cooling Inlet Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

NOTE: Discard the TOC retaining clip and install a new retaining clip.

1. Install the TOC pipe into the TOC pipe fitting.

A distinct snap should be heard or felt when assembling the TOC pipe to the fitting.

2. To ensure the cooler line is properly installed, give the cooler pipe a gentle pull.

**TRANSMISSION FLUID COOLER HOSE/PIPE QUICK-CONNECT FITTING DISCONNECTION
AND CONNECTION (MDK)**

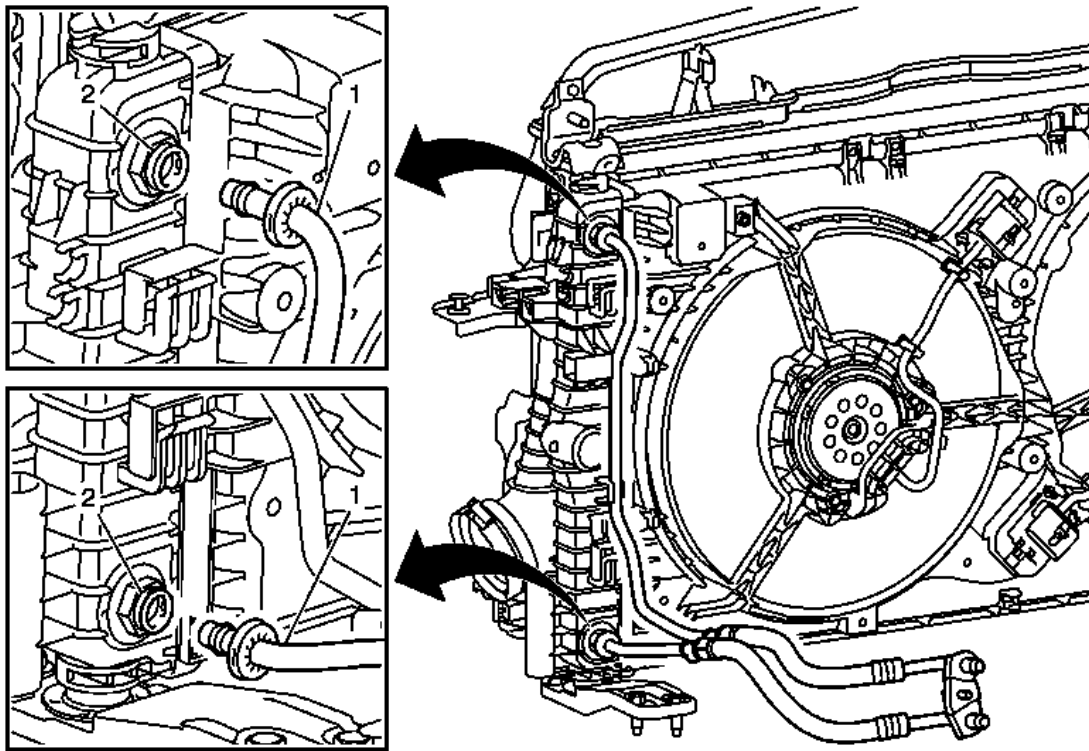


Fig. 47: Transmission Fluid Cooler Hose/Pipe Quick-Connect Fittings (MDK)
 Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MDK)

Callout	Component Name
1	Transmission Fluid Cooler Hose Cover (Qty: 2)
2	Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting (Qty: 2) Procedure Mount the release tool round the pipe, press it in to the quick connector and turn for removal using DT-49662 disconnect tool. Special Tools DT-49662 Disconnect Tool 3/8". For equivalent regional tools, refer to Special Tools .

TRANSMISSION FLUID COOLER HOSE REPLACEMENT (MHH)

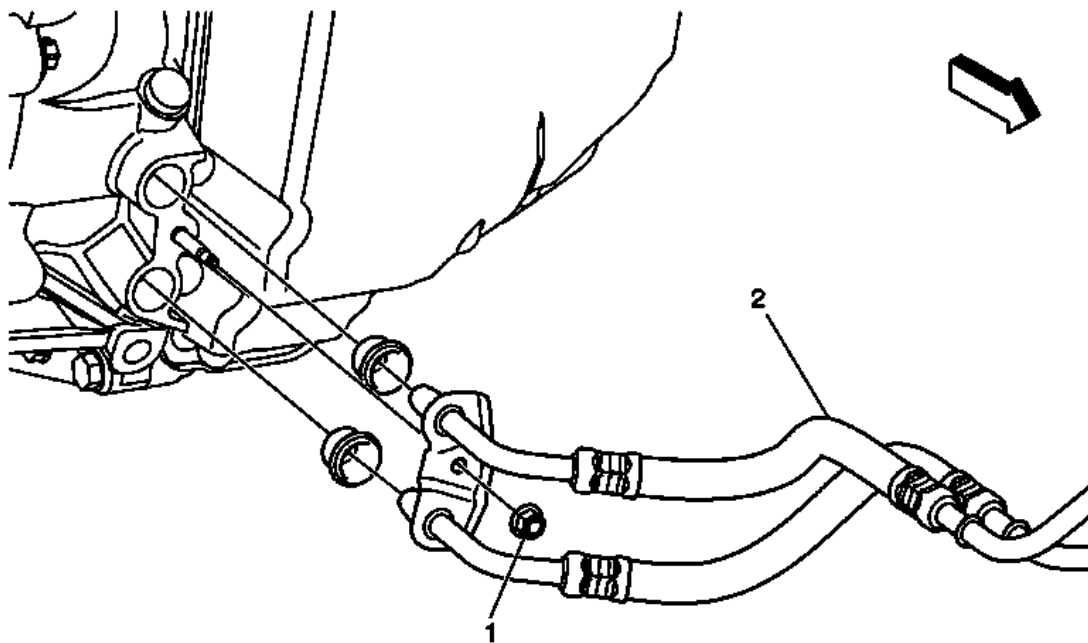


Fig. 48: Transmission Fluid Cooler Hose (MHH)
 Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Cooler Hose Replacement (MHH)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Remove the engine shield. Refer to Engine Shield Replacement. 2. Disconnect the transmission lines from the radiator. Refer to <u>Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MHH, MHK)</u>. 	
1	Transmission Fluid Cooler Pipe Bracket Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Transmission Fluid Cooler Hose Procedure Discard the hose and install NEW seals prior to installation of the pipe.

TRANSMISSION FLUID COOLER INLET PIPE REPLACEMENT (M7U)

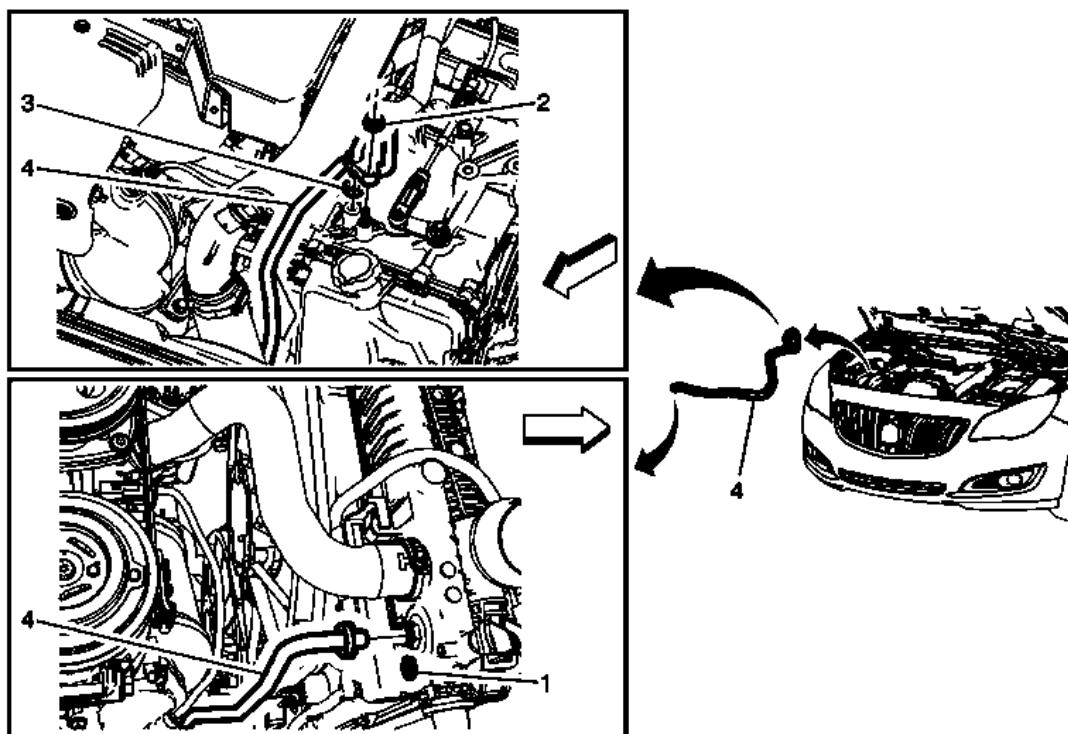


Fig. 49: Transmission Fluid Cooler Inlet Pipe (M7U)

Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Cooler Inlet Pipe Replacement (M7U)

Callout	Component Name
Preliminary Procedures	
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Reposition the engine control module. Refer to <u>Engine Control Module Replacement</u> . 2. Reposition the engine wiring harness to gain access to the transmission fluid cooler inlet pipe nut. 3. Cap the fittings and plug the holes when removing the transmission fluid cooler inlet pipe. 	
1	Transmission Fluid Cooler Inlet Pipe Quick Disconnect Retaining Clip Refer to <u>Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MHH, MHK)</u> , <u>Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MDK)</u> . Procedure Remove the transmission fluid cooler inlet pipe from the retaining clip on the engine coolant fan shroud.
2	Transmission Fluid Cooler Inlet Pipe Nut CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 22 (16 lb ft)
3	Transmission Fluid Cooler Inlet Pipe Seal Procedure Remove and discard the sealing washers and replace with a NEW sealing washer.
4	Transmission Fluid Cooler Inlet Pipe Procedures <ol style="list-style-type: none"> 1. Note the routing of the transmission line to ensure proper installation. 2. Remove the transmission fluid cooler inlet pipe from the retaining clip on the transmission. 3. Adjust the transmission fluid level. Refer to <u>Transmission Fluid Level and Condition Check</u> . 4. Inspect for fluid leaks.

TRANSMISSION FLUID COOLER OUTLET PIPE REPLACEMENT (M7U)

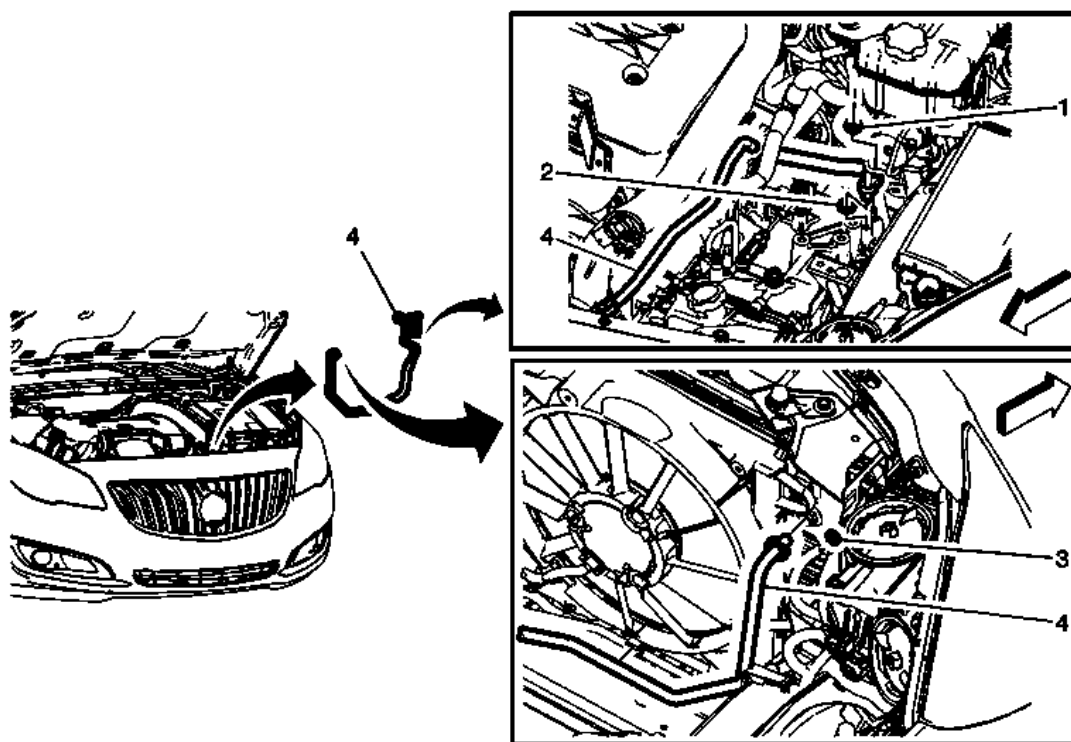


Fig. 50: Transmission Fluid Cooler Outlet Pipe (M7U)
Courtesy of GENERAL MOTORS COMPANY

Transmission Fluid Cooler Outlet Pipe Replacement (M7U)

Callout	Component Name

1. Remove the battery tray. Refer to <u>Battery Tray Replacement</u> . 2. Cap the fittings and plug the holes when removing the transmission fluid cooler outlet pipe.	
1	Transmission Fluid Cooler Outlet Pipe Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 (16 lb ft)
2	Transmission Fluid Cooler Outlet Pipe Seal Procedure Remove and discard the sealing washers and replace with a NEW sealing washer.
3	Transmission Fluid Cooler Outlet Pipe Quick Disconnect Retaining Clip Refer to <u>Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MHH, MHK), Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MDK)</u> . Procedure Remove the transmission fluid cooler outlet pipe from the retaining clip on the engine coolant fan shroud.
4	Transmission Fluid Cooler Outlet Pipe Procedures <ol style="list-style-type: none"> 1. Note the routing of the transmission fluid cooler outlet pipe to ensure proper installation. 2. Remove the transmission fluid cooler outlet pipe from the retaining clip on the transmission. 3. Adjust the transmission fluid level. Refer to <u>Transmission Fluid Level and Condition Check</u> . 4. Inspect for fluid leaks.

FLUID COOLER INLET HOSE REPLACEMENT (MHH)

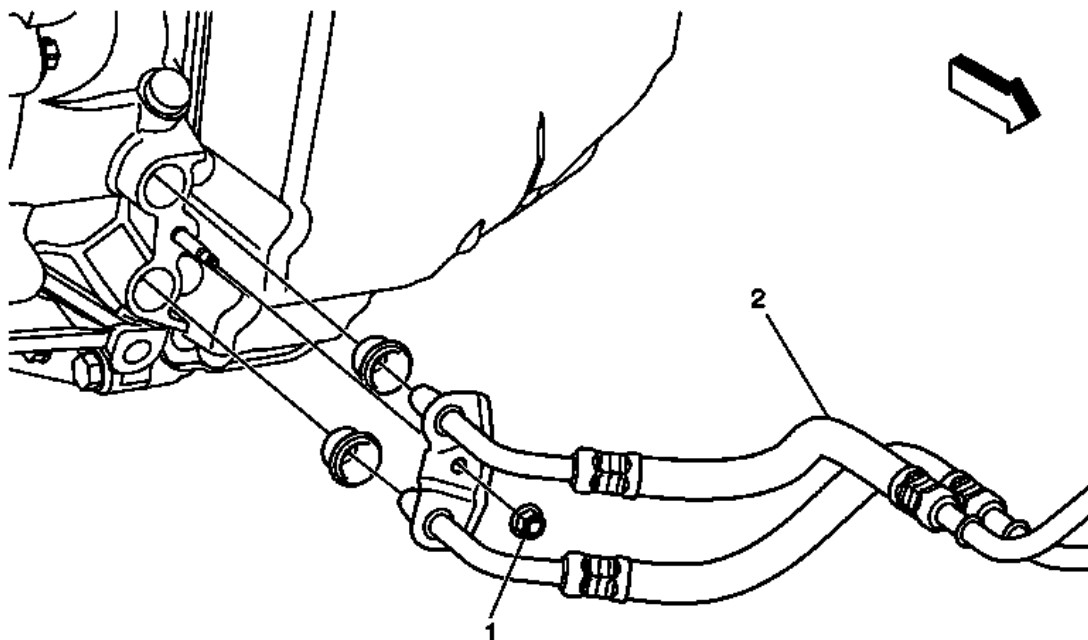


Fig. 51: Transmission Fluid Cooler Hose (MHH)
 Courtesy of GENERAL MOTORS COMPANY

Fluid Cooler Inlet Hose Replacement (MHH)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Remove the engine shield. Refer to Engine Shield Replacement. 2. Disconnect the transmission lines from the radiator. Refer to <u>Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MHH, MHK)</u>. 	
1	Transmission Fluid Cooler Pipe Bracket Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Transmission Fluid Cooler Hose Procedure Discard the hose and install NEW seals prior to installation of the pipe.

FLUID COOLER OUTLET HOSE REPLACEMENT (MHH)

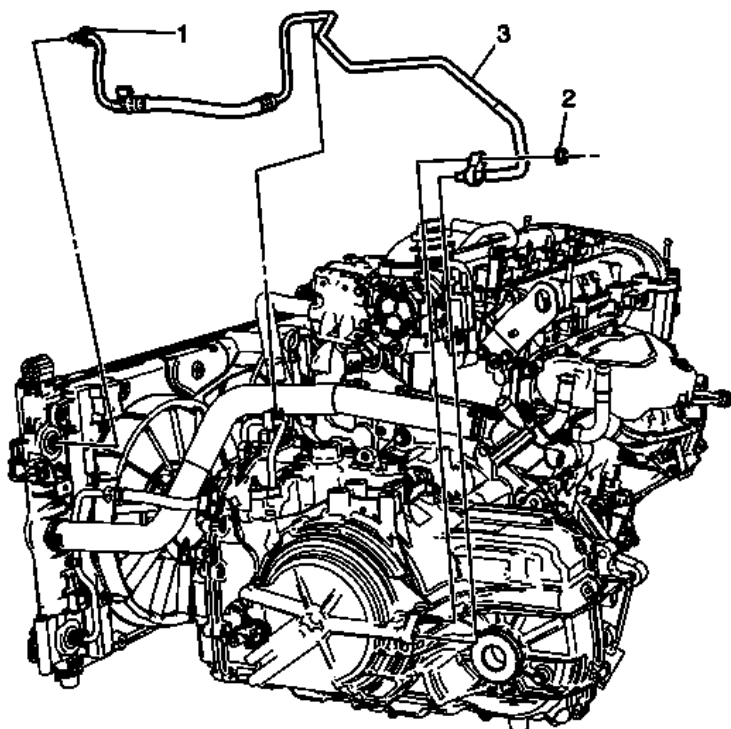


Fig. 52: Transmission Fluid Cooler Outlet Pipe & Components (MHH)
 Courtesy of GENERAL MOTORS COMPANY

Fluid Cooler Outlet Hose Replacement (MHH)

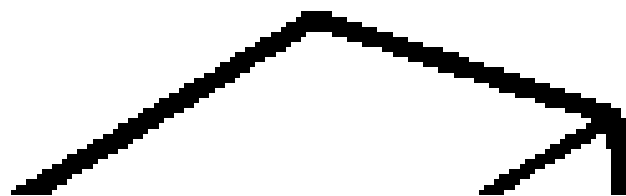
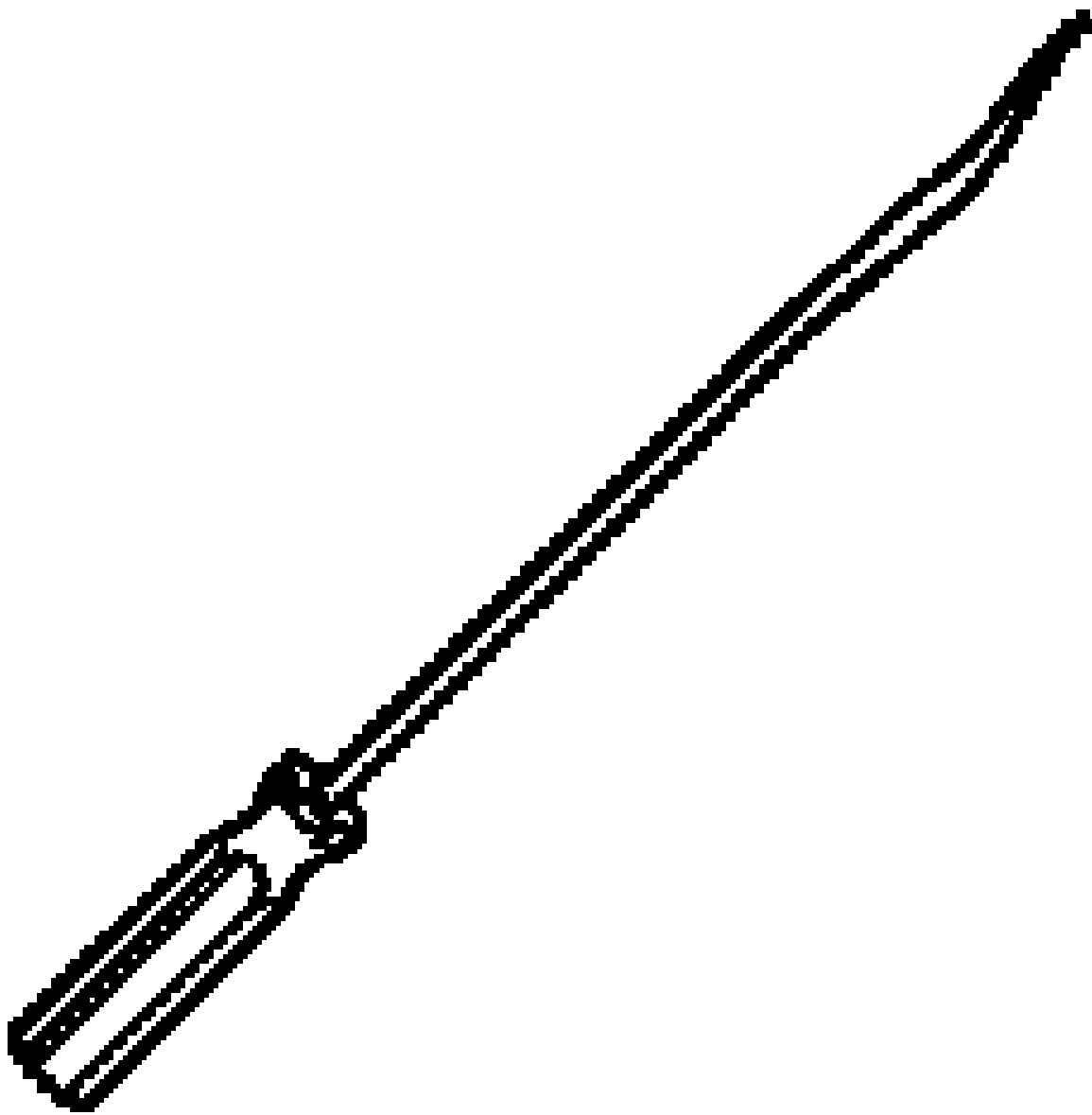
Callout	Component Name
Preliminary Procedures Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>	
1	Transmission Fluid Cooler Outlet Hose Nut CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
2	Transmission Fluid Cooler Outlet Hose Quick Disconnect Procedure Remove and discard the sealing washer. Refer to <u>Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection (MHH, MHK)</u> .
3	Transmission Fluid Cooler Outlet Hose Procedure 1. Note the routing of the transmission line to ensure proper installation.

2. Remove the transmission line from the clips securing the line to the transmission and fan shroud.
3. Inspect the transmission fluid level. Refer to **Transmission Fluid Level and Condition Check**

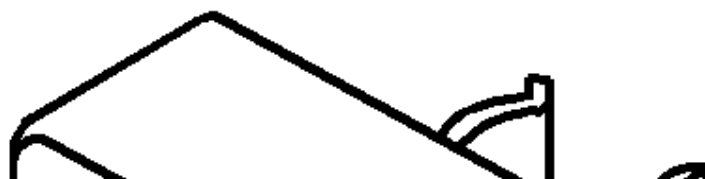
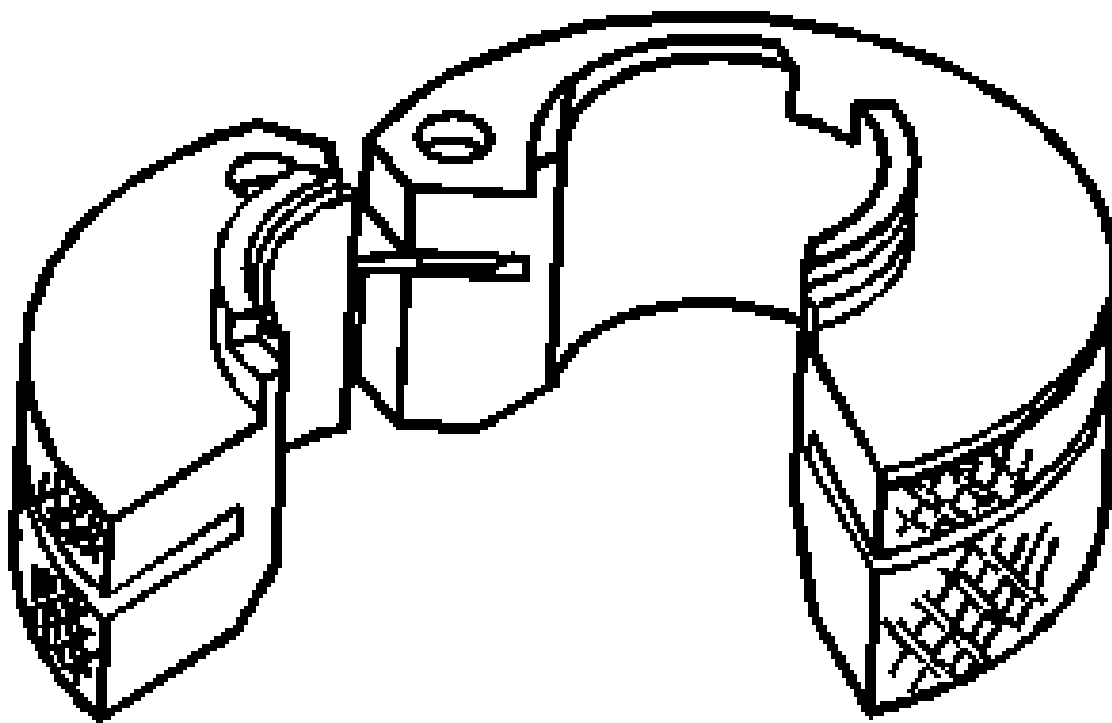
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

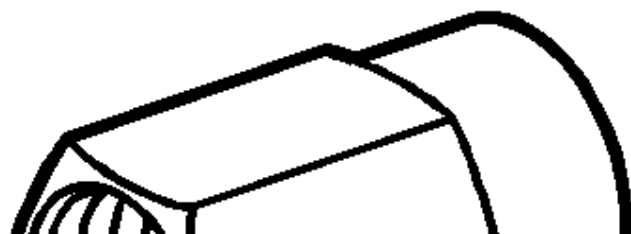
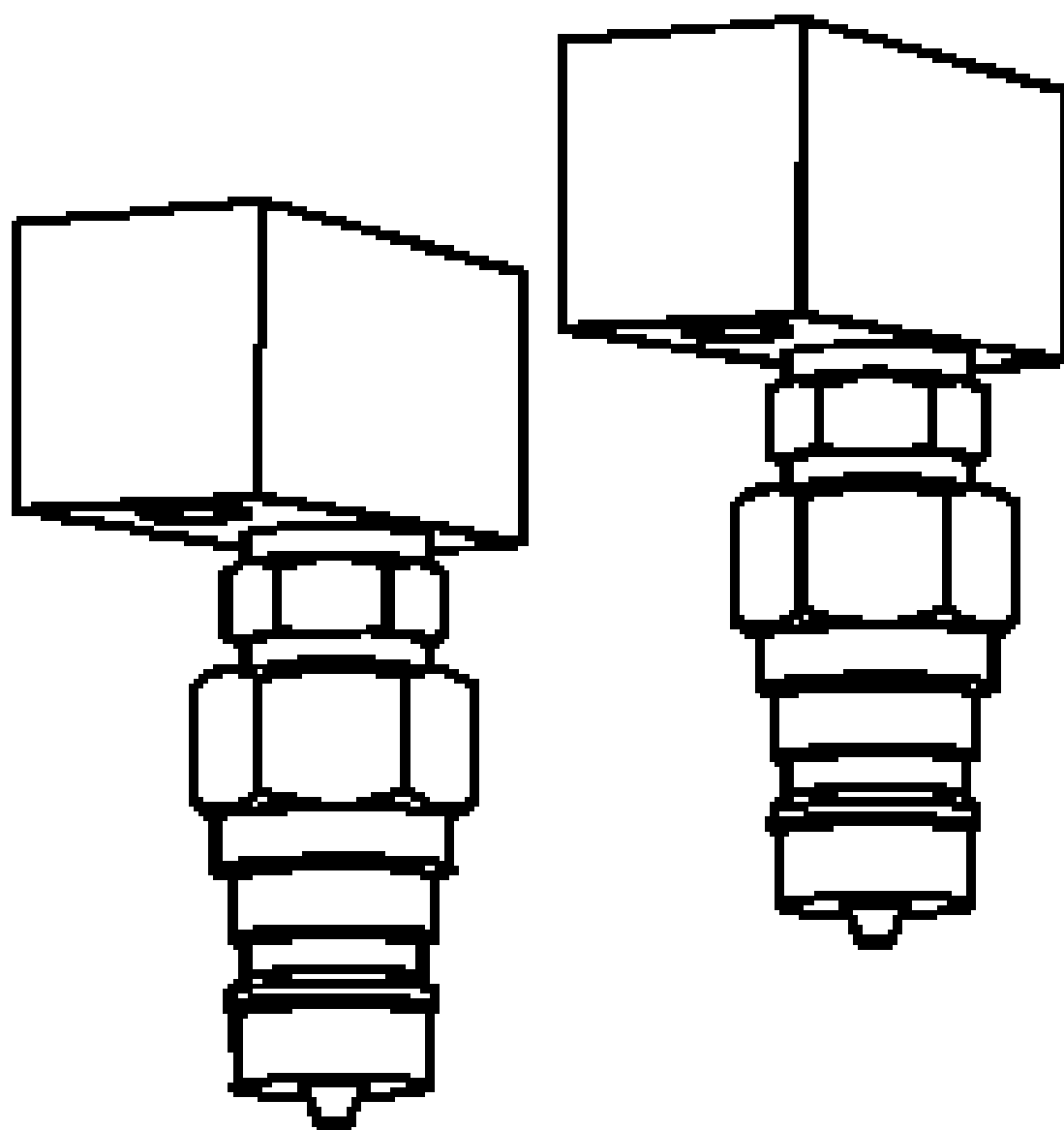
Illustration	Tool Number/ Description
	DT 28585 J 28585 Snap Ring Remover



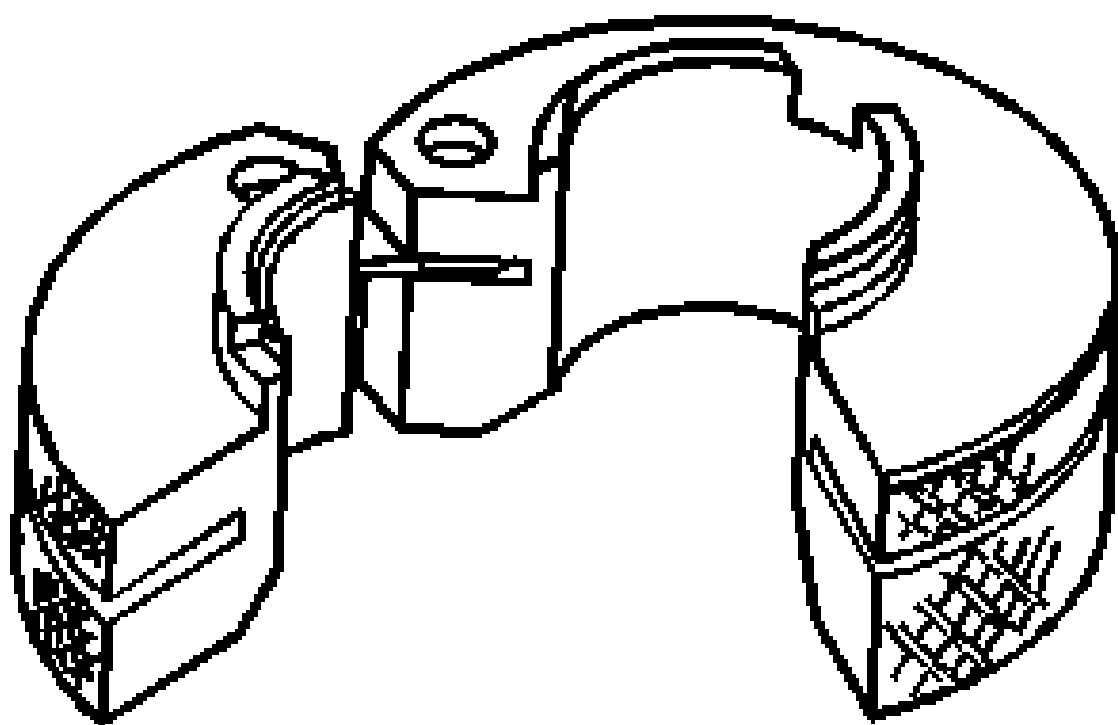
	DT 41239-1A J 41239-1A Cooler Line Seal Installer
	DT 41623-B J 41623-B Cooler Line Seal Installer



	J 45096 Transmission Oil Cooling System Flush and Flow Test Tool
	DT 45096- 50 J 45096-50 Transmission Cooler Flush Adapter



	DT 45201 DT 48203 J 45201 Cooler Line Seal Remover
	DT 49662 Disconnect Tool



ACCESSORIES & EQUIPMENT

Vehicle Access

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Side Door Inside Door Handle Screw	3 N.m	27 lb in
Front Side Door Lock Screws	9 N.m	80 lb in
Front Side Door Striker Screws	24 N.m	18 lb ft
Front Outside Door Handle Bolts	10 N.m	89 lb in
Rear Compartment Lid Latch Bolts	10 N.m	89 lb in
Rear Compartment Lid Latch Striker	9 N.m	80 lb in
Rear Outside Door Handle Bolts	10 N.m	89 lb in
Rear Side Door Lock Screws	9 N.m	80 lb in
Rear Side Door Striker Screws	24 N.m	18 lb ft
Rear Side Door Inside Door Handle Screw	3 N.m	27 lb in

SCHEMATIC WIRING DIAGRAMS

DOOR LOCK/INDICATOR WIRING SCHEMATICS

Indicators and Switches (except CZ2)

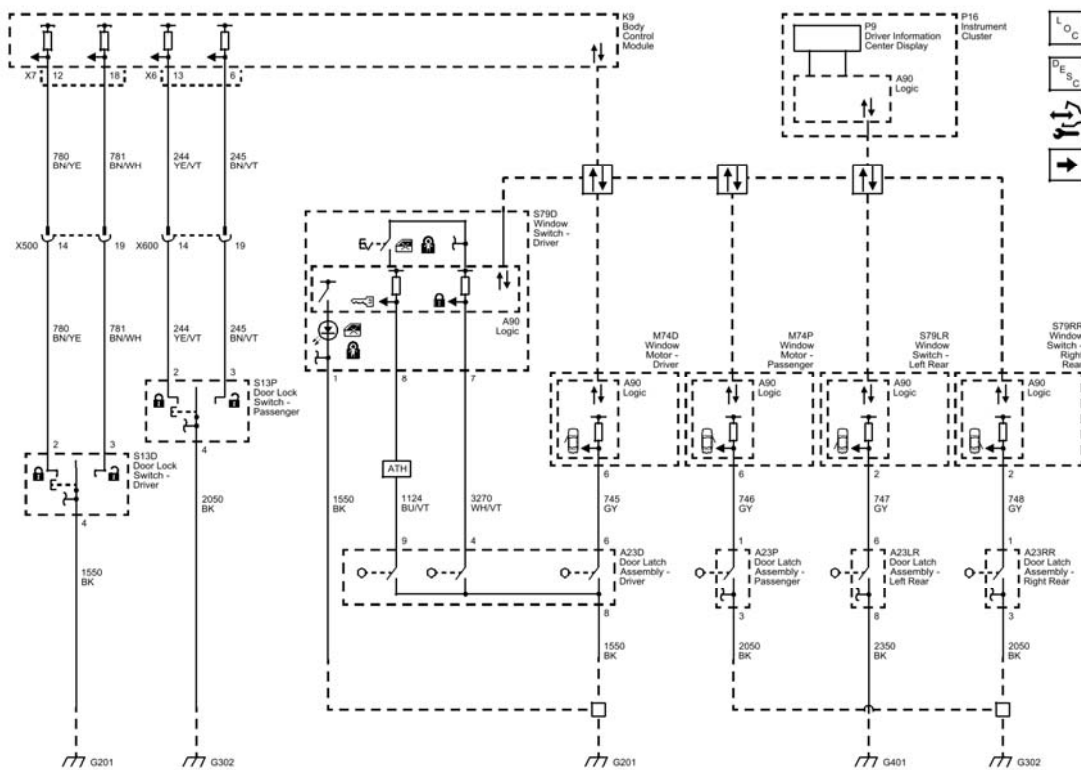
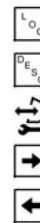


Fig. 1: Indicators and Switches (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Actuators (without ATH)



Door Lock Switches and References (ATH with BTM)

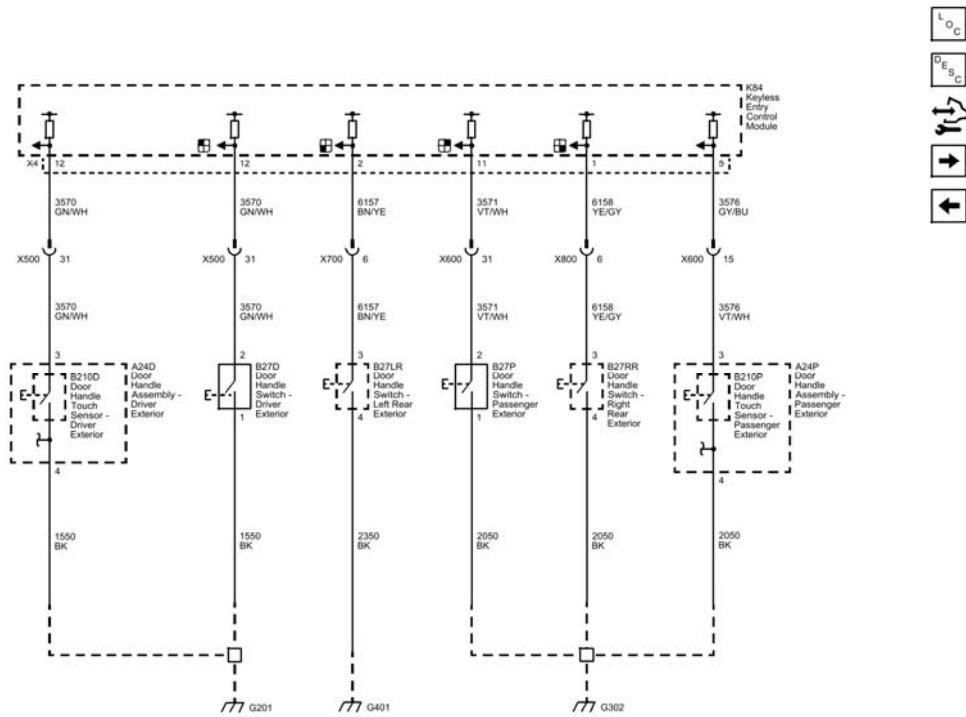


Fig. 3: Door Lock Switches and References (ATH with BTM)
Courtesy of GENERAL MOTORS COMPANY

Indicators and Switches (CZ2)

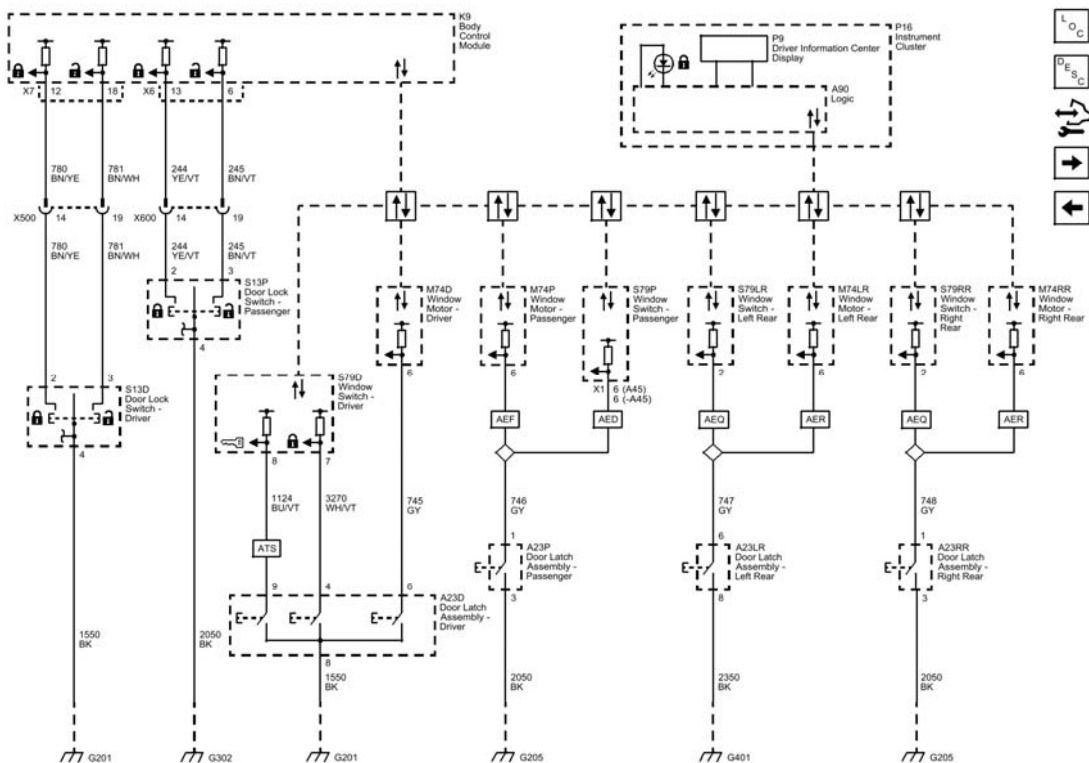


Fig. 4: Indicators and Switches (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Door Lock Actuators (without ATS)

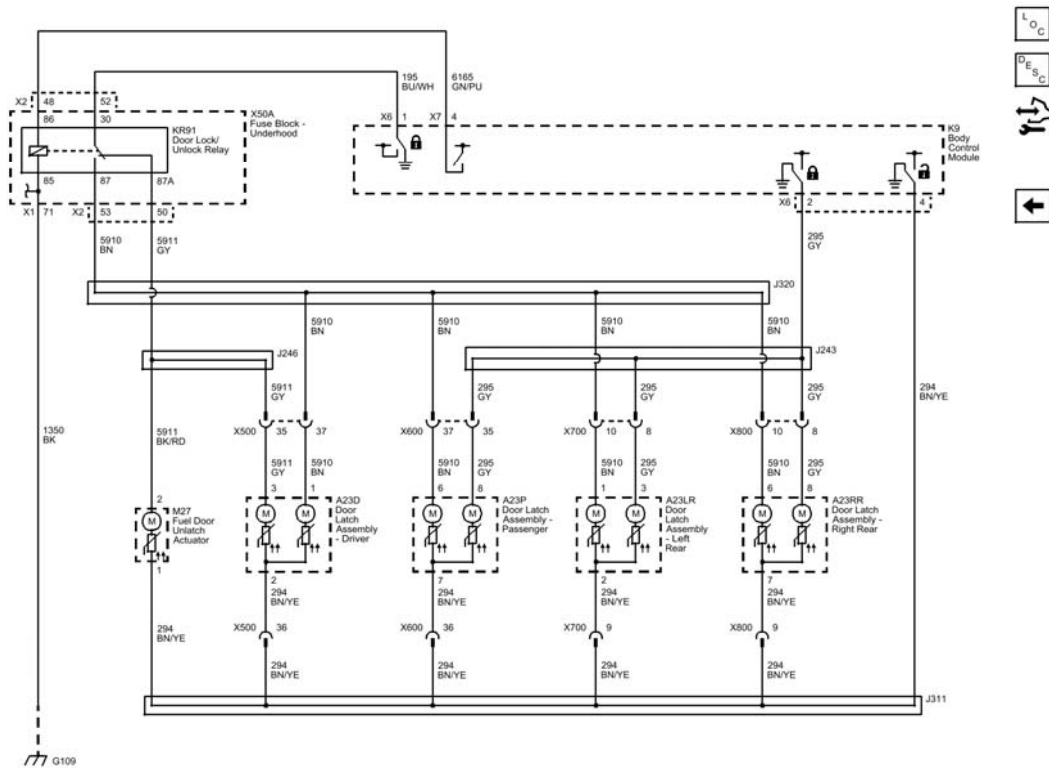


Fig. 5: Door Lock Actuators (without ATS)
 Courtesy of GENERAL MOTORS COMPANY

RELEASE SYSTEMS WIRING SCHEMATICS

Rear Compartment (except CZ2)

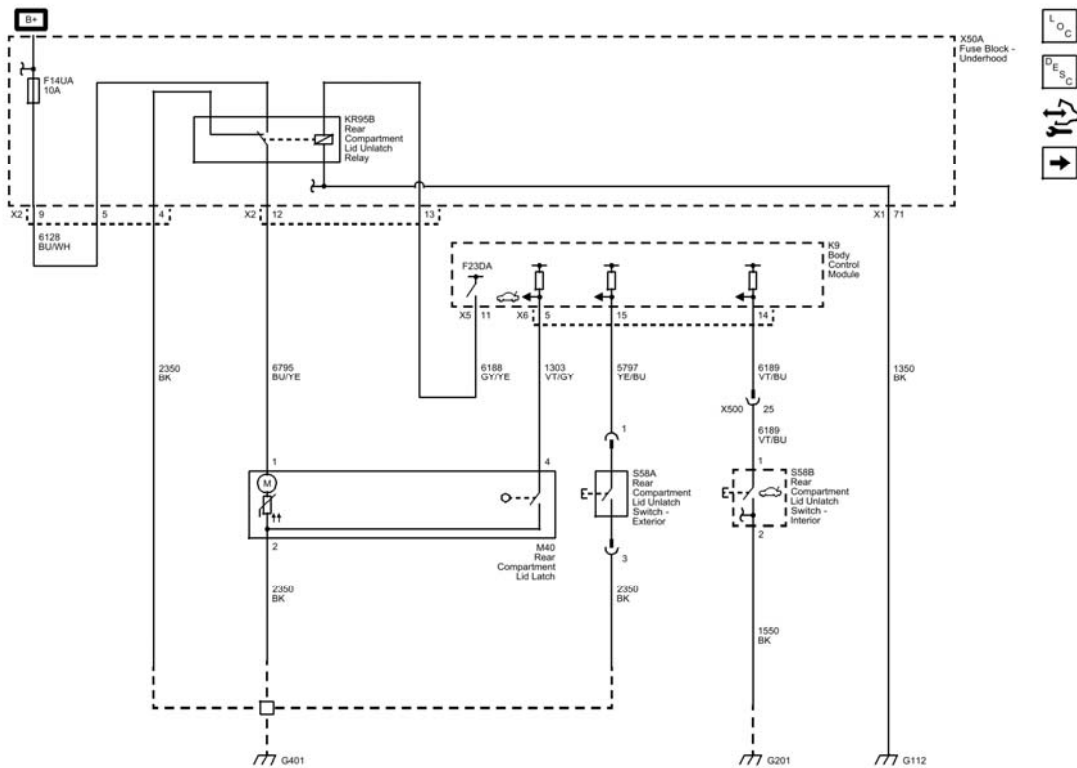


Fig. 6: Rear Compartment (except CZ2)
Courtesy of GENERAL MOTORS COMPANY

Rear Compartment (CZ2)

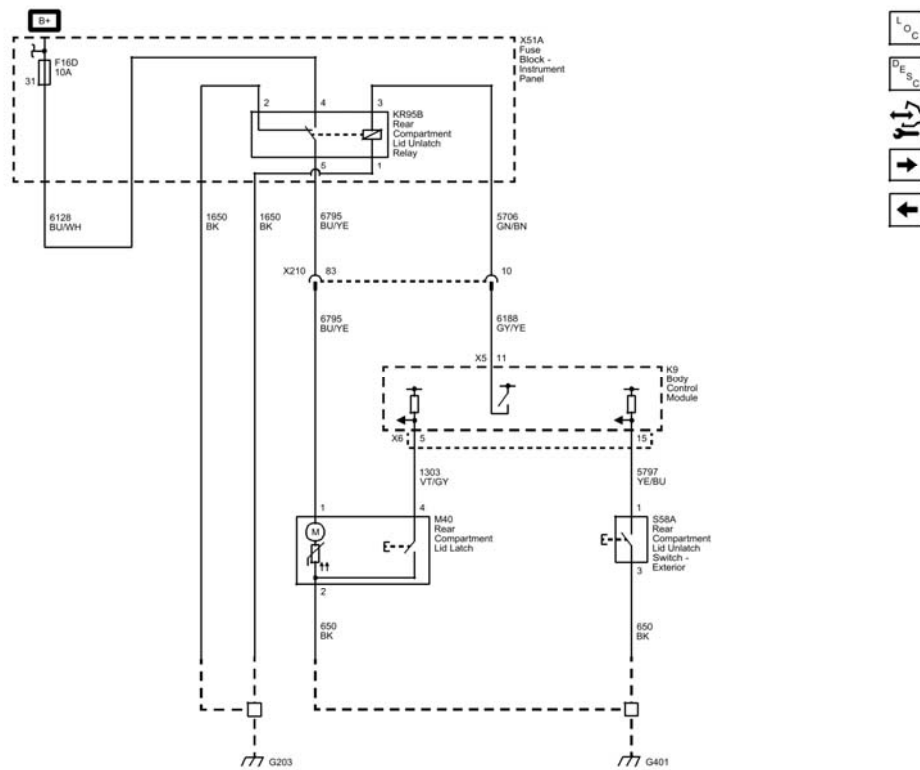


Fig. 7: Rear Compartment (CZ2)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Door (except CZ2)

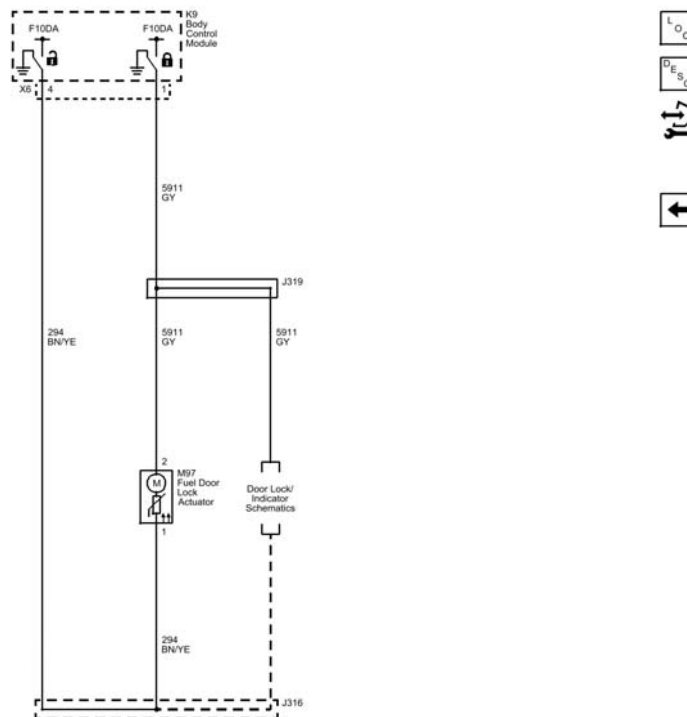


Fig. 8: Fuel Door (except CZ2)

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B1474 or B3849</u>	DTC B1474 02 Passenger Exterior Door Handle Switch Circuit Short to Ground DTC B3849 02 Driver Exterior Door Handle Switch Circuit Short to Ground
<u>DTC B1534 or B1535</u>	DTC B1534 02 Left Rear Door Handle Switch Circuit Short to Ground DTC B1535 02 Right Rear Door Handle Switch Circuit Short to Ground
<u>DTC B2494</u>	DTC B2494 02 Liftgate Handle Switch Circuit Short to Ground
<u>DTC B2730</u>	DTC B2730 00 Interior Trunk Lid Unlatch Switch Circuit Malfunction
<u>DTC B297B or B297C</u>	DTC B297B 5A Driver Door Open Switch Circuit Not Plausible DTC B297C 5A Passenger Door Open Switch Circuit Not Plausible
<u>DTC B3125, B3130, or B3135</u>	DTC B3125 Driver Door Only Unlock Circuit DTC B3130 All Doors Unlock Circuit DTC B3135 All Doors Lock Circuit

<u>DTC B3140, B3145, B3150, or B3155</u>	DTC B3140 00 Driver Door Unlock Switch Circuit DTC B3145 00 Passenger Door Unlock Switch Circuit DTC B3150 00 Driver Front Door Lock Switch Circuit DTC B3155 00 Passenger Front Door Lock Switch Circuit
<u>DTC B3265</u>	DTC B3265 02 Trunk Lid Unlatch Output Circuit Short to Ground
<u>DTC B3618</u>	DTC B3618 00 Exterior Liftgate Unlatch Switch Circuit Malfunction
<u>DTC B3930</u>	DTC B3930 02 Child Security Lock Motors Circuit Short to Ground

DTC B1474 OR B384: EXTERIOR DOOR HANDLE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1474 02

Passenger Exterior Door Handle Switch Circuit Short to Ground

DTC B3849 02

Driver Exterior Door Handle Switch Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Handle Switch Signal	B3849 02	1	1	-
Driver Door Handle Switch Ground	-	1	-	-
Passenger Door Handle Switch Signal	B1474 02	2	2	-
Passenger Door Handle Switch Ground	-	2	-	-
1. Driver Door Handle Switch Malfunction 2. Passenger Door Handle Switch Malfunction				

Circuit/System Description

The exterior door handle switch signal circuits provide inputs to the keyless entry control module when the exterior door handle switches are activated. These inputs allow the keyless entry control module to detect a door lock or a door unlock request. The keyless entry control module provides a 12 V signal to each exterior door

handle switch via the door handle switch signal circuits. When a door handle switch is pressed, the switch closes and the voltage signals from the keyless entry control module are pulled to ground.

Conditions for Running the DTC

Battery voltage is between 9-16 V.

Conditions for Setting the DTC

B1474 02

The keyless entry control module detects the passenger exterior door handle switch signal circuit is shorted to ground or closed for greater than 180 seconds.

B3849 02

The keyless entry control module detects the driver exterior door handle switch signal circuit is shorted to ground or closed for more than 180 seconds.

Action Taken When the DTC Sets

The keyless entry control module will ignore input from the affected door switch and the doors will not lock or unlock when the affected door handle switch is pressed.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 40 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Exterior Driver Door Handle Switch or the Exterior Passenger Door Handle Switch parameters changes between Active and Inactive when pressing and releasing the B27D Door Handle Switch-Driver Exterior or the B27P Door Handle Switch-Passenger Exterior.
 - **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B27 Door Handle Switch-Exterior. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Exterior Door Handle Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K84 Keyless Entry Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 4.
6. Verify the scan tool Exterior Door Handle Switch parameter is Active.

- **If not Active**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.

- **If Active**

7. Test or replace the B27 Door Handle Switch-Exterior.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B27 Door Handle Switch-Exterior.
2. Test for infinite resistance between the signal terminal 3 and the ground terminal 4 with the switch in the open position.

- **If less than infinite resistance**

Replace the B27 Door Handle Switch-Exterior.

- **If infinite resistance**

3. Test for less than 5 ohms between the signal terminal 3 and the ground terminal 4 with the switch in the closed position.

- **If 5 ohms or greater**

Replace the B27 Door Handle Switch-Exterior.

- **If less than 5 ohms**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Outside Handle Replacement (Passive Entry ATH), Front Side Door Outside Handle Replacement (Base)**
- **Control Module References** for keyless entry control module replacement, programming and setup

DTC B1534 OR B1535: REAR DOOR HANDLE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1534 02

Left Rear Door Handle Switch Circuit Short to Ground

DTC B1535 02

Right Rear Door Handle Switch Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Rear Door Handle Switch Signal	B1534 02	1	1	-
Left Rear Door Handle Switch Ground	-	1	-	-
Right Rear Door Handle Switch Signal	B1535 02	2	2	-
Right Rear Door Handle Switch Ground	-	2	-	-
1. Left Rear Door Handle Switch Malfunction 2. Right Rear Door Handle Switch Malfunction				

Circuit/System Description

The exterior door handle switch signal circuits provide inputs to the keyless entry control module when the exterior door handle switches are activated. These inputs allow the keyless entry control module to detect a door lock or a door unlock request. The keyless entry control module provides a 12 V signal to each exterior door handle switch via the door handle switch signal circuits. When a door handle switch is pressed, the switch closes and the voltage signals from the keyless entry control module are pulled to ground.

Conditions for Running the DTC

Battery voltage is between 9-16 V.

Conditions for Setting the DTC

B1534 02

The keyless entry control module detects the left rear exterior door handle switch signal circuit is shorted to

ground or closed for greater than 180 seconds.

B1535 02

The keyless entry control module detects the right rear exterior door handle switch signal circuit is shorted to ground or closed for greater than 180 seconds.

Action Taken When the DTC Sets

The keyless entry control module will ignore input from the affected door switch and the doors will not lock or unlock when the affected door handle switch is pressed.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 40 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

2. Verify the scan tool Exterior Left Rear Door Handle Switch or the Exterior Right Rear Door Handle Switch parameters changes between Active and Inactive when pressing and releasing B27LR Door Handle Switch-Left Rear Exterior or the B27RR Door Handle Switch-Right Rear Exterior.

- **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B27 Door Handle Switch-Rear Exterior. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.

4. Verify the scan tool Exterior Door Handle Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K84 Keyless Entry Control Module.

- **If Inactive**

5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 4.
6. Verify the scan tool Exterior Door Handle Switch parameter is Active.

- **If not Active**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.

- **If Active**

7. Test or replace the B27 Door Handle Switch-Rear Exterior.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B27 Door Handle Switch-Rear Exterior.
2. Test for infinite resistance between the signal terminal 3 and the ground terminal 4 with the switch in the open position.

- **If less than infinite resistance**

Replace the B27 Door Handle Switch-Rear Exterior.

- **If infinite resistance**

3. Test for less than 5 ohms between the signal terminal 3 and the ground terminal 4 with the switch in the closed position.

- **If 5 ohms or greater**

Replace the B27 Door Handle Switch-Rear Exterior.

- **If less than 5 ohms**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Side Door Outside Handle Replacement**
- **Control Module References** for keyless entry control module replacement, programming and setup

DTC B2494: LIFTGATE HANDLE SWITCH CIRCUIT SHORT TO GROUND

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2494 02

Liftgate Handle Switch Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B2494 02	1	1	-
Ground	-	1	-	-
1. Trunk Lid Release Malfunction				

Circuit/System Description

The exterior rear compartment lid release switch receives a signal from the body control module (BCM). When the exterior rear compartment lid release switch is activated the signal circuit is pulled to ground. The BCM applies battery positive voltage to the trunk release relay control circuit which energizes the relay. The trunk release relay is grounded at all times. With the relay coil energized, the relay switch contacts close allowing battery voltage to flow to the rear compartment lid release actuator causing the rear compartment lid to release.

Conditions for Running the DTC

Battery voltage is between 9-16 V.

Conditions for Setting the DTC

The BCM detects the exterior rear compartment lid release switch signal circuit is shorted to ground or closed for greater than 180 s.

Action Taken When the DTC Sets

The BCM ignores inputs from the exterior rear compartment lid release switch.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter changes between Inactive to Active when pressing the S58A Rear Compartment Lid Unlatch Switch-Exterior.
 - **If the parameter does not change**

Refer to Circuit/System Testing.
 - **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S58A Rear Compartment Lid Unlatch Switch-Exterior. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.

- **If Inactive**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 3.
6. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
7. Test or replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S58A Rear Compartment Lid Unlatch Switch-Exterior.
2. Test for infinite resistance between the signal terminal 1 and the ground terminal 3 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.
 - **If infinite resistance**
3. Test for less than 3 ohms between the signal terminal 1 and the ground terminal 3 with the switch in the closed position.
 - **If 3 ohms or greater**

Replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.
 - **If less than 3 ohms**
4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Compartment Lid Release Switch Replacement (Interior), Rear Compartment Lid Release Switch Replacement (Exterior)**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2730: INTERIOR TRUNK LID UNLATCH SWITCH CIRCUIT MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2730 00

Interior Trunk Lid Unlatch Switch Circuit Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B2730 00	1	1	-
Ground	-	1	-	-
1. Interior Rear Compartment Lid Release Switch Inoperative				

Circuit/System Description

When the ignition is ON, the Body Control Module supplies a 12 V signal to the rear compartment lid unlatch switch through the trunk release switch signal circuit. When the interior rear compartment lid release switch is pressed, the voltage within the signal circuit is pulled low and in response, the Body Control Module will energize the trunk release relay.

Conditions for Running the DTC

The system voltage is 9-16 V.

Conditions for Setting the DTC

The Body Control Module detects a short to ground in the interior rear compartment lid release switch signal circuit for greater than 60 seconds

Action Taken When the DTC Sets

The Body Control Module ignores the input from the interior rear compartment lid unlatch switch.

Conditions for Clearing the DTC

- This DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.

- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Interior Trunk Lid/Liftgate Window Unlatch Switch parameter changes between Inactive and Active when pressing the S58B Rear Compartment Lid Unlatch Switch-Interior.

- **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S58B Rear Compartment Lid Unlatch Switch-Interior. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.

- **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the scan tool Interior Trunk Lid/Liftgate Window Unlatch Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 2.
- 6. Verify the scan tool Interior Trunk Lid/Liftgate Window Unlatch Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
- 7. Test or replace the S58B Rear Compartment Lid Unlatch Switch-Interior.

Component Testing

1. Ignition OFF, disconnect the harness connector at the S58B Rear Compartment Lid Unlatch Switch-Interior.
2. Test for infinite resistance between the signal terminal 1 and the ground terminal 2 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S58B Rear Compartment Lid Unlatch Switch-Interior.
 - **If infinite resistance**
3. Test for less than 3 ohms between the signal terminal 1 and the ground terminal 2 with the switch in the

closed position.

- **If 3 ohms or greater**

Replace the S58B Rear Compartment Lid Unlatch Switch-Interior.

- **If less than 3 ohms**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Compartment Lid Release Switch Replacement (Interior), Rear Compartment Lid Release Switch Replacement (Exterior)**
- **Control Module References** for Body Control Module replacement, programming and setup

DTC B297B OR B297C: DOOR OPEN SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B297B 5A

Driver Door Open Switch Circuit Not Plausible

DTC B297C 5A

Passenger Door Open Switch Circuit Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Open Switch Signal	B297B 5A	B297B 5A	B297B 5A	-
Passenger Door Open Switch Signal	B297C 5A	B297C 5A	B297C 5A	-
Driver Door Latch Ground	-	1	-	-
Passenger Door Latch Ground	-	1	-	-
1. Ajar Indicator Malfunction				

Circuit/System Description

The keyless entry control module provides a 12V signal to the driver and passenger door open switch signal circuits. The driver window motor provides a 12V signal to the driver door ajar switch signal circuit. The passenger window switch provides a 12V signal to the passenger door ajar switch signal circuit. The door open switches and the door ajar switches are integral to each door latch assembly.

The door open switch and the door ajar switch contacts will be open with the door is fully closed, the door switches within the door latch are designed so that the when the door is ajar, the contact in the door ajar switch closes, the voltage is pulled low and the window motor will then send a serial data message to the BCM indicating that the door is ajar. When the door is opened further, the contact in the door open switch will then close providing a ground for the door open signal circuit, the keyless entry control module will then detect that the door is open.

Conditions for Running the DTC

Battery voltage is between 9-16 V.

Conditions for Setting the DTC

B297B 5A

- The keyless entry control module detects the driver door open switch is Active while receiving a serial data message from the BCM that the driver door ajar switch is Inactive.
- The condition must be present for greater than 30 seconds

B297C 5A

- The keyless entry control module detects the passenger door open switch is Active while receiving a serial data message from the BCM that the passenger door ajar switch is Inactive.
- The condition must be present for greater than 30 seconds.

Action Taken When the DTC Sets

B297B 5A or B297C 5A

The driver information center will display the message: Service Steering Column Lock.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the keyless entry control module receives a serial data message from the BCM that the door is ajar before the keyless entry control module detects the door open switch is active, then the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Schematic Wiring Diagrams

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel and Column Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Body Control Module Driver Door Ajar Switch parameter changes between Inactive and Active when opening and closing the driver door.
 - **If the parameter does not change**

Refer to **Door Ajar Indicator Malfunction**

- **If the parameter changes**
3. Verify the scan tool Keyless Entry Control Module Driver Door Ajar Switch parameter changes between Inactive and Active when opening and closing the driver door.
 - **If the parameter does not change**

Refer to Circuit/System Testing

- **If the parameter changes**
4. Verify the scan tool Body Control Module Passenger Door Ajar Switch parameter changes between Inactive and Active when opening and closing the passenger door.
 - **If the parameter does not change**

Refer to **Door Ajar Indicator Malfunction**

- **If the parameter changes**

5. Verify the scan tool Keyless Entry Control Module Passenger Door Ajar Switch parameter changes between Inactive and Active when opening and closing the passenger door.

- **If the parameter does not change**

Refer to Circuit/System Testing

- **If the parameter changes**

6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate A23 Door Latch Assembly. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 10 ohms between the ground circuit terminal listed below and ground:

- A23D Door Latch Assembly-Driver - ground circuit terminal 8
- A23P Door Latch Assembly-Passenger - ground circuit terminal 3

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.
4. Verify the scan tool Door Ajar Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
2. Test for infinite resistance between the signal circuit terminal listed below and ground.

- A23D Door Latch Assembly-Driver - signal circuit terminal 7
- A23P Door Latch Assembly-Passenger - signal circuit terminal 2
- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K84 Keyless Entry Control Module.

- **If Inactive**

5. Install a 3 A fused jumper wire between the circuit terminals listed below and ground .
 - A23D Door Latch Assembly-Driver - signal circuit terminal 7
 - A23P Door Latch Assembly-Passenger - signal circuit terminal 2
6. Verify the scan tool Door Ajar Switch parameter is Active.

- **If not Active**

1. Ignition OFF, remove the fused jumper wire, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.

2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
- **If Active**

7. Test or replace the A23 Door Latch Assembly.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the appropriate A23 Door Latch Assembly.
2. With the door in the closed position, test for infinite resistance between the signal and the ground terminals listed below:
 - A23D Door Latch Assembly-Driver - signal terminal 7 and ground terminal 8
 - A23P Door Latch Assembly-Passenger - signal terminal 2 and ground terminal 3
 - If not the specified value, replace the A23 Door Latch Assembly.
3. With the door in the open position, test for less than 5 ohms between the signal and the ground terminals listed below:
 - A23D Door Latch Assembly-Driver - signal terminal 7 and ground terminal 8
 - A23P Door Latch Assembly-Passenger - signal terminal 2 and ground terminal 3
 - If greater than the specified range, replace the A23 Door Latch Assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Lock Replacement**
- **Control Module References** for keyless entry control module replacement, programming and setup

DTC B3125, B3130, OR B3135: DRIVER DOOR ONLY UNLOCK/ALL DOORS LOCK AND UNLOCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3125

Driver Door Only Unlock Circuit

DTC B3130

All Doors Unlock Circuit

DTC B3135

All Doors Lock Circuit

For symptom byte information refer to: Symptom Byte List

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+	B3125 02, B3130 02, B3135 02	B3125 02, B3130 02, B3135 02	-	-
Door Lock/Unlock Control	B3125 02, B3130 02, B3135 02	2, 3, 4	B3125 01, B3130 01, B3135 01	-
Door Lock Control	B3125 02, B3130 02, B3135 02	1	B3125 01, B3130 01, B3135 01	-
Driver Door Latch Unlock Control	B3125 02, B3130 02, B3135 02	1	B3125 01, B3130 01, B3135 01	-
Left Rear Door Latch Lock Control	B3125 02, B3130 02, B3135 02	3	B3125 01, B3130 01, B3135 01	-
Left Rear Door Latch Unlock Control	B3125 02, B3130 02, B3135 02	3	B3125 01, B3130 01, B3135 01	-
Passenger Door Latch Lock Control	B3125 02, B3130 02, B3135 02	2	B3125 01, B3130 01, B3135 01	-
Passenger Door Latch Unlock Control	B3125 02, B3130 02, B3135 02	2	B3125 01, B3130 01, B3135 01	-
Right Rear Door Latch Lock Control	B3125 02, B3130 02, B3135 02	4	B3125 01, B3130 01, B3135 01	-
	B3125 02,		B3125 01,	

Right Rear Door Latch Unlock Control	B3130 02, B3135 02	4	B3130 01, B3135 01	-
1. Driver Door Lock Malfunction 2. Passenger Door Lock Malfunction 3. Left Rear Door Lock Malfunction 4. Right Rear Door Lock Malfunction				

Circuit/System Description

The body control module (BCM) powers the reversible door latch assemblies by providing battery positive voltage and ground to the appropriate lock and unlock control circuits of the door latch assemblies. The lock and unlock control circuits of the rear doors and passenger door latch assemblies are all connected together. When the door latch assemblies are not active, all actuator lock and unlock control circuits are supplied a floating voltage door driver by the BCM. Transitioning of the lock actuators to the lock or unlocked position depends upon which control circuits receive voltage and which control circuits receive ground.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

B3125 01, B3130 01, B3135 01

The BCM detects a short to battery on a door latch control circuit

B3125 02, B3130 02 and B3135 02

- A short to ground or an open/high resistance in the BCM B+ circuit.
- The BCM detects a short to ground on a door latch control circuit.

Action Taken When the DTC Sets

All the power door locks will be inoperative.

Conditions for Clearing the DTC

- This DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Diagnostic Aids

Verify the smooth and consistent mechanical operation of each part of the door latch system prior to performing extensive electrical diagnostics

Any door that does not function smoothly or consistently, refer to **Door Will Not Open/Close, Door Binding,**

or Locks, Handles, or Cylinders Do Not Function.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify all vehicle doors LOCK and UNLOCK when commanding the All Doors Lock/Unlock with a scan tool.
 - **If only the driver door LOCK or UNLOCK functions do not work**
Refer to Circuit/System Testing - Driver Door Lock Malfunction.
 - **If one or more, but not all, passenger door LOCK or UNLOCK functions do not work**
Refer to Circuit/System Testing - Passenger Door Lock Malfunction.
 - **If all door LOCK and UNLOCK functions do not work**
Refer to Circuit/System Testing - All Door Lock Inoperative.
 - **If the LOCK and UNLOCK function for all doors works**
3. All OK.

Circuit/System Testing

Driver Door Lock Malfunction

1. Ignition OFF, disconnect the harness connector at the A23D Door Latch Assembly-Driver. Ignition ON.

NOTE: Leaving the DMM connected between a control circuit and ground for greater than 20 seconds will cause the K9 Body Control Module to interpret the test as a system fault and will cause the voltage on the control circuit to drop to 0 V. If the voltage drops to 0 V, operate the door locks using the door lock switch to restore the voltage for testing.

2. Test for greater than 7 V between the control circuit terminal 3 and ground.
 - **If 7 V or less**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 7 V**

NOTE: Leaving the DMM connected between a control circuit and ground for greater than 20 seconds will cause the K9 Body Control Module to interpret the test as a system fault and will cause the voltage on the control circuit to drop to 0 V. If the voltage drops to 0 V, operate the door locks using the door lock switch to restore the voltage for testing.

3. Test for greater than 7 V between the control circuit terminal 2 and ground.
 - **If 7 V or less**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 7 V**
4. Test or replace the A23D Door Latch Assembly-Driver.

Passenger Door Lock Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate passenger or rear A23 Door Latch Assembly. Ignition ON.

NOTE: Leaving the DMM connected between a control circuit and ground for greater than 20 seconds will cause the K9 Body Control Module to interpret the test as a system fault and will cause the voltage on the control circuit to drop to 0 V. If the voltage drops to 0 V, operate the door locks using the door lock switch to restore the voltage for testing.

2. Test for greater than 7 V between the control circuit terminal listed below and ground:
 - A23P Door Latch Assembly-Passenger - control circuit terminal 7
 - A23P Door Latch Assembly-Passenger - control circuit terminal 8
 - A23RR Door Latch Assembly-Right Rear - control circuit terminal 7
 - A23RR Door Latch Assembly-Right Rear - control circuit terminal 8
 - A23LR Door Latch Assembly-Left Rear - control circuit terminal 2
 - A23LR Door Latch Assembly-Left Rear - control circuit terminal 3
 - **If 7 V or less**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 7 V**
3. Test or replace the A23 Door Latch Assembly.

All Door Locks Inoperative

1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module, ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 3. Disconnect the harness connector at each A23 Door Latch Assembly.
- 4. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate A23 Door Latch Assembly.
 - **If the test lamp illuminates**
- 3. Ignition OFF, connect the X2 harness connector at the K9 Body Control Module. Disconnect the harness connector at the A23D Door Latch Assembly-Driver, ignition ON.

NOTE: Leaving the DMM connected between a control circuit and ground for greater than 20 seconds will cause the K9 Body Control Module to interpret the test as a system fault and will cause the voltage on the control circuit to drop to 0 V. If the voltage drops to 0 V, operate the door locks using the door lock switch to restore the voltage for testing.

- 4. Test for greater than 7 V between the control circuit terminal 2 and ground.
 - **If 7 V or less**
 - 1. Ignition OFF, disconnect the KR113 Child Security Lock Disable Relay.
 - 2. Disconnect the X6 harness connector at the K9 Body Control Module.
 - 3. Test for infinite resistance between the control circuit terminal listed below and ground:
 - KR113 Child Security Lock Disable Relay - control circuit terminal 2
 - KR113 Child Security Lock Disable Relay - control circuit terminal 3
 - K9 Body Control Module - control circuit terminal 1 X6
 - K9 Body Control Module - control circuit terminal 4 X6
 - If less than infinite resistance, repair the short to ground on the circuit.
 - 1. Ignition OFF, connect the KR113 Child Security Lock Disable Relay.
 - 2. Test for infinite resistance between the K9 Body Control Module control circuit terminal 2 X6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the KR113 Child Security Lock Disable Relay.
 - **If greater than 7 V**
- 5. Replace the K9 Body Control Module.

Component Testing

Door Latch Test

- 1. Ignition OFF, disconnect the harness connector at the appropriate A23 Door Latch Assembly.
- 2. Install a 25 A fused jumper wire between one of the control terminals and 12 V. Momentarily install a jumper wire between the other control terminal and ground. Reverse the jumper wires at least two times, the A23 Door Latch Assembly should perform the LOCK and UNLOCK function.

- **If the actuator does not perform the LOCK and UNLOCK function**

Replace the A23 Door Latch Assembly.

- **If the actuator performs the LOCK and UNLOCK function**

3. All OK

Relay Test

1. Ignition OFF, disconnect the KR113 Child Security Lock Disable Relay.

2. Test for 60-200 ohms between terminals 1 and 3.

- **If less than 60 ohms or greater than 200 ohms**

Replace the KR113 Child Security Lock Disable Relay.

- **If between 60-200 ohms**

3. Test for infinite resistance between the terminals listed below:

- 4 and 3
- 4 and 5
- 4 and 1
- 5 and 1

- **If less than infinite resistance**

Replace the KR113 Child Security Lock Disable Relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal 3 and 12 V. Install a jumper wire between relay terminal 1 and ground.

5. Test for less than 2 ohms between terminals 4 and 5.

- **If 2 ohms or greater**

Replace the KR113 Child Security Lock Disable Relay.

- **If less than 2 ohms**

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Lock Replacement**
- **Rear Side Door Lock Replacement**
- **Relay Replacement (Within an Electrical Center) , Relay Replacement (Attached to Wire Harness)**

- **Control Module References** for BCM replacement, programming and setup

DTC B3140, B3145, B3150, OR B3155: FRONT DOOR LOCK/UNLOCK SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3140 00

Driver Door Unlock Switch Circuit

DTC B3145 00

Passenger Door Unlock Switch Circuit

DTC B3150 00

Driver Front Door Lock Switch Circuit

DTC B3155 00

Passenger Front Door Lock Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Lock Switch Lock Signal	B3150 00	3	3	-
Driver Door Lock Switch Unlock Signal	B3140 00	2	2	-
Driver Door Lock Switch Ground	-	1	-	-
Passenger Door Lock Switch Lock Signal	B3155 00	4	4	-
Passenger Door Lock Switch Unlock Signal	B3145 00	5	5	-
Passenger Door Lock Switch Ground	-	6	-	-
1. Driver Door Lock Switch Inoperative 2. Driver Door Lock Switch Lock Inoperative				

- | |
|---|
| <ul style="list-style-type: none">3. Driver Door Lock Switch Unlock Inoperative4. Passenger Door Lock Switch Lock Inoperative5. Passenger Door Lock Switch Unlock Inoperative6. Passenger Door Lock Switch Inoperative |
|---|

Circuit/System Description

The body control module (BCM) supplies a 12 V signal to each of the door lock and door unlock signal circuits. When the door lock switches are in the open position, the voltage level in the signal circuit will be near 12 V. When any door lock switch is pressed to the lock or unlock position, the voltage level in the appropriate signal circuit will drop to 0 V and the BCM will detect the voltage drop and command the door latches to perform the requested lock or unlock command.

Conditions for Running the DTC

The system voltage is 9-16 V.

Conditions for Setting the DTC

B3140 00

The BCM detects short to ground in the driver unlock signal circuit for greater than 30 seconds.

B3145 00

The BCM detects short to ground in the passenger unlock signal circuit for greater than 30 seconds.

B3150 00

The BCM detects a short to ground in the driver lock signal circuit for greater than 30 seconds.

B3155 00

The BCM detects a short to ground in the passenger lock signal circuit for greater than 30 seconds.

Action Taken When the DTC Sets

B3140 00

The BCM will ignore the unlock signal and the doors will not unlock when using the driver door unlock switch.

B3145 00

The BCM will ignore the unlock signal and the doors will not unlock when using the passenger door unlock switch.

B3150 00

The BCM will ignore the lock signal and the doors will not lock when using the driver door lock switch.

B3155 00

The BCM will ignore the lock signal and the doors will not lock when using the passenger door lock switch.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Driver Door Lock Switch parameter changes from Inactive to Lock and Unlock when pushing the appropriate switch on the S13D Door Lock Switch - Driver.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Driver Door Lock Switch Malfunction.

- **If the parameter changes**
- 3. Verify the scan tool Passenger Door Lock Switch parameter changes from Inactive to Lock and Unlock when pushing the appropriate switch on the S13P Door Lock Switch - Passenger.

- **If the parameter does not change**

Refer to Circuit/System Testing - Passenger Door Lock Switch Malfunction.

- **If the parameter changes**
- 4. All OK.

Circuit/System Testing

Driver Door Lock Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S13D Door Lock Switch - Driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Driver Door Lock Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 3. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 4.
6. Verify the scan tool Driver Door Lock Switch parameter is Lock.
 - **If not Lock**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
- **If Lock**
- 7. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 4.
- 8. Verify the scan tool Driver Door Lock Switch parameter is Unlock.
 - **If not Unlock**
 1. Ignition OFF, 3 A fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Unlock**
- 9. Test or replace the S13D Door Lock Switch - Driver.

Passenger Door Lock Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S13P Door Lock Switch - Passenger. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Passenger Door Lock Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 3. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.

- **If Inactive**

5. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 4.
6. Verify the scan tool Passenger Door Lock Switch parameter is Lock.

- **If not Lock**

1. Ignition OFF, 3 A fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If Lock**

7. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 4.
8. Verify the scan tool Passenger Door Lock Switch parameter is Unlock.

- **If not Unlock**

1. Ignition OFF, 3 A fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If Unlock**

9. Test or replace the S13P Door Lock Switch - Passenger.

Component Testing

Door Lock Switch

1. Ignition OFF, disconnect the harness connector at the appropriate S13 Door Lock Switch.
2. Test for infinite resistance between the signal terminal 2 and the ground terminal 4 with the switch in the center position.
 - **If less than infinite resistance**

Replace the S13 Door Lock Switch.
 - **If infinite resistance**
3. Test for infinite resistance between the signal terminal 3 and the ground terminal 4 with the switch in the center position.

- **If less than infinite resistance**

Replace the S13 Door Lock Switch

- **If infinite resistance**

4. Test for less than 2 ohms between the signal terminal 2 and the ground terminal 4 with the switch in the Lock position.

- **If 2 ohms or greater**

Replace the S13 Door Lock Switch.

- **If less than 2 ohms**

5. Test for less than 2 ohms between the signal terminal 3 and the ground terminal 4 with the switch in the Unlock position.

- **If 2 ohms or greater**

Replace the S13 Door Lock Switch.

- **If less than 2 ohms**

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup

DTC B3265: TRUNK LID UNLATCH OUTPUT CIRCUIT SHORT TO GROUND

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3265 02

Trunk Lid Unlatch Output Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Control	B3265 02	1	1	-
Ground	-	1	-	-
1. Rear Compartment Lid Release Inoperative				

Circuit/System Description

When the rear compartment lid unlatch switch is pressed, the rear compartment lid release signal circuit to the body control module is grounded. When the rear compartment lid release signal circuit is grounded, the body control module grounds the coil side of the rear compartment lid unlatch relay through the relay control circuit. With ground applied to the coil side of the rear compartment lid unlatch relay, voltage is applied to the rear compartment lid latch, opening the rear compartment.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The body control module detects a short to ground in the rear compartment lid unlatch relay control circuit.

Action Taken When the DTC Sets

The rear compartment lid latch will be inoperative.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the M40 Rear Compartment Lid Latch activates when commanding the Trunk Lid Unlatch with a scan tool.

- **If the M40 Rear Compartment Lid Latch does not UNLATCH**

Refer to Circuit/System Testing.

- **If the M40 Rear Compartment Lid Latch does UNLATCH**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the X50A Fuse Block-Underhood. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 71 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition OFF, connect the X1 harness connector at the X50A Fuse Block-Underhood. Disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
4. Verify the M40 Rear Compartment Lid Latch is not activated.
 - **If the M40 Rear Compartment Lid Latch is activated**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block-Underhood.
 2. Test for less than 1 V between the K9 Body Control Module control circuit terminal 11 X5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the X50A Fuse Block-Underhood.
 - **If the M40 Rear Compartment Lid Latch is not activated**
5. Connect a 3A fused jumper wire between the control circuit terminal 11 and B+.

6. Verify the M40 Rear Compartment Lid Latch activates.
 - **If the M40 Rear Compartment Lid Latch does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the X50A Fuse Block-Underhood, ignition ON.
 2. Test for infinite resistance between the K9 Body Control Module control circuit terminal 11 X5 and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A Fuse Block-Underhood.
 - **If the M40 Rear Compartment Lid Latch activates**
7. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Underhood Electrical Center or Junction Block Replacement**
- **Control Module References** for body control module replacement, programming and setup

DTC B3618: EXTERIOR LIFTGATE UNLATCH SWITCH CIRCUIT MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3618 00

Exterior Liftgate Unlatch Switch Circuit Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B3618 00	1	1	-
Ground	-	1	-	-
1. Exterior Rear Compartment Lid Release Switch Malfunction				

Circuit/System Description

When the ignition is ON, the body control module (BCM) supplies a 12V signal to the rear compartment lid unlatch switch through the trunk release switch signal circuit. When the exterior rear compartment lid release switch is pressed, the voltage within the signal circuit is pulled low and in response, the BCM will energize the trunk release relay.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The BCM detects a short to ground in the rear compartment lid release switch signal circuit for greater than 60 seconds

Action Taken When the DTC Sets

The BCM ignores the input from the rear compartment lid unlatch switch.

Conditions for Clearing the DTC

- This DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter changes between Active and Inactive when pressing and releasing the S58A Rear Compartment Lid Unlatch Switch-Exterior.

- **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S58A Rear Compartment Lid Unlatch Switch-Exterior. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 3.
6. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
- **If Active**
- 7. Test or replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.

Component Testing

Trunk Release Switch

1. Ignition OFF, disconnect the harness connector at the S58A Rear Compartment Lid Unlatch Switch-Exterior.
2. Test for infinite resistance between the signal circuit terminal 1 and the ground circuit terminal 3 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.
 - **If infinite resistance**
3. Test for less than 3 ohms between the signal circuit terminal 1 and the ground circuit terminal 3 with the switch in the closed position.
 - **If 3 ohms or greater**

Replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.
 - **If less than 3 ohms**
4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Compartment Lid Release Switch Replacement (Interior), Rear Compartment Lid Release Switch Replacement (Exterior)**
- **Control Module References** for BCM replacement, setup, and programming

DTC B3930: EXTERIOR LIFTGATE UNLATCH SWITCH CIRCUIT MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3930 02

Child Security Lock Motors Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	B3930 02	1	1	-
Ground	-	1	-	-
1. Child Security Door Lock Malfunction				

Circuit/System Description

The child door lockout switch is on the driver door lock/window switch and controls the child locks on the rear doors as well as the rear window switches. When the BCM receives a command from the window lockout switch, it will apply voltage to the door lock security relay coil, this will energize the relay and the contact within the relay will then direct the voltage to lock the left rear and right rear child locks and then isolate them from the normal door lock system to prevent the rear doors from being opened by using the interior rear door handles.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

The BCM detects a short to ground in the child security lock relay circuit.

Action Taken When the DTC Sets

- The interior rear door handles will always be disabled or will not lockout depending upon the latch states when the fault occurred
- The BCM will command the lockout indicator to flash ON and OFF for 30 seconds when the lockout switch is pressed to indicate a fault in the system.

Conditions for Clearing the DTC

- This DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

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Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the operation of both interior rear door handles do not open the rear doors when commanding the Child Security Lock Motors ON with a scan tool.
 - **If both interior door handles open the rear doors**

Refer to Circuit/System Testing.

- **If both interior door handles do not open the rear doors**
3. Verify the operation of both interior rear door handles will open the rear doors when commanding the Child Security Lock Motors OFF with a scan tool.
 - **If both interior door handles do not open the rear doors**

Refer to Circuit/System Testing.

- **If both interior door handles open the rear doors**
4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR113 child security lock disable relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 3 and the ground circuit terminal 1.
4. Verify the test lamp turns ON and OFF when commanding the Child Security Lock Motors ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K9 body control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 body control module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the KR113 child security lock disable relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR113 child security lock disable relay.
2. Test for 60-200 ohms between terminals 1 and 3.
 - **If less than 60 ohms or greater than 200 ohms**

Replace the KR113 child security lock disable relay.
 - **If between 60-200 ohms**
3. Test for infinite resistance between the terminals listed below:

- 4 and 3
- 4 and 5
- 4 and 1
- 5 and 1
- **If less than infinite resistance**

Replace the KR113 child security lock disable relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal 3 and 12 V. Install a jumper wire between relay terminal 1 and ground.
5. Test for less than 2 ohms between terminals 4 and 5.
 - **If 2 ohms or greater**

Replace the KR113 child security lock disable relay.

- **If less than 2 ohms**

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for BCM replacement, programming and setup

SYMPTOMS - VEHICLE ACCESS

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** , before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set
 - The control modules can communicate via the serial data link
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following systems description:
 - **Door Ajar Indicator Description and Operation**
 - **Luggage Compartment Description and Operation**
 - **Power Door Locks Description and Operation**
 - **Fuel Fill Door Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Fuel Filler Door Release Malfunction**
- **Power Door Child Lock Malfunction**
- **Door Ajar Indicator Malfunction**
- **Power Door Locks Malfunction**
- **Trunk Release Malfunction**
- **Trunk Ajar Indicator Malfunction**
- **Door Will Not Open/Close, Door Binding, or Locks, Handles, or Cylinders Do Not Function**
- **Exterior Door Handle Switch Malfunction**

EXTERIOR DOOR HANDLE SWITCH MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1474 02

Passenger Exterior Door Handle Switch Circuit Short to Ground

DTC B1534 02

Left Rear Door Handle Switch Circuit Short to Ground

DTC B1535 02

Right Rear Door Handle Switch Circuit Short to Ground

DTC B3849 02

Driver Exterior Door Handle Switch Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Handle Switch Signal	B3849 02	1	1	-
Driver Door Handle Switch Ground	-	1	-	-
Passenger Door Handle Switch Signal	B1474 02	2	2	-
Passenger Door Handle Switch Ground	-	2	-	-
Left Rear Door Handle Switch Signal	B1534 02	3	3	-
Left Rear Door Handle Switch Ground	-	3	-	-
Right Rear Door Handle Switch Signal	B1535 02	4	4	-
Right Rear Door Handle Switch Ground	-	4	-	-
1. Driver Door Handle Switch Malfunction 2. Passenger Door Handle Switch Malfunction 3. Left Rear Door Handle Switch Malfunction 4. Right Rear Door Handle Switch Malfunction				

Circuit/System Description

The exterior door handle switch signal circuits provide inputs to the keyless entry control module when the exterior door handle switches are activated. These inputs allow the keyless entry control module to detect a door lock or a door unlock request. The keyless entry control module provides a 12 V signal to each exterior door handle switch via the door handle switch signal circuits. When a door handle switch is pressed, the switch closes and the voltage signals from the keyless entry control module are pulled to ground.

Conditions for Running the DTC

Battery voltage is between 9-16 V.

Conditions for Setting the DTC

B1474 02

The keyless entry control module detects the passenger exterior door handle switch signal circuit is shorted to

ground or closed for greater than 180 seconds.

B1534 02

The keyless entry control module detects the left rear exterior door handle switch signal circuit is shorted to ground or closed for more than 180 seconds.

B1535 02

The keyless entry control module detects the right rear exterior door handle switch signal circuit is shorted to ground or closed for more than 180 seconds.

B3849 02

The keyless entry control module detects the driver exterior door handle switch signal circuit is shorted to ground or closed for more than 180 seconds.

Action Taken When the DTC Sets

The keyless entry control module will ignore input from the affected door switch and the doors will not lock or unlock when the affected door handle switch is pressed.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 40 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Exterior Driver Door Handle Switch, Exterior Passenger Door Handle Switch, Exterior Left Rear Door Handle Switch and Exterior Right Rear Door Handle Switch parameters changes between Active and Inactive when pressing and releasing each B27 Door Handle Switch-Exterior.
 - **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B27 Door Handle Switch-Exterior. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Exterior Door Handle Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K84 Keyless Entry Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K84 Keyless Entry Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 4.
6. Verify the scan tool Exterior Door Handle Switch parameter is Active.
 - **If not Active**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K84 Keyless Entry Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K84 Keyless Entry Control Module.
 - **If Active**
7. Test or replace the B27 Door Handle Switch-Exterior.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B27 Door Handle Switch-Exterior.
2. Test for infinite resistance between the signal terminal 3 and the ground terminal 4 with the switch in the open position.
 - **If less than infinite resistance**

Replace the B27 Door Handle Switch-Exterior.
 - **If infinite resistance**
3. Test for less than 5 ohms between the signal terminal 3 and the ground terminal 4 with the switch in the closed position.
 - **If 5 ohms or greater**

Replace the B27 Door Handle Switch-Exterior.
 - **If less than 5 ohms**
4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Outside Handle Replacement (Passive Entry ATH), Front Side Door Outside Handle Replacement (Base)**
- **Rear Side Door Outside Handle Replacement**
- **Control Module References** for keyless entry control module replacement, programming and setup

FUEL FILLER DOOR RELEASE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Door Actuator Control	B3125 02. B3130 02, B3135 02	1	1	-
1. Fuel Door Release Malfunction				

Circuit/System Description

The locking and unlocking of the fuel door is a function of the power door lock system. The fuel door unlatch actuator shares the circuit with the door latch unlock control circuit. The body control module (BCM), upon receipt of a lock switch lock or unlock signal, will switch the appropriate door latch, as well as a fuel filler door unlatch actuator control circuits to B+ voltage. The opposing side of the door latch and fuel filler door unlatch actuator is connected to ground provided by the BCM through the other the door latch control circuits, along with the fuel filler door unlatch actuator, will lock or unlock as commanded.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel Fill Door Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the operation of the fuel door lock actuator does not release the fuel filler door when commanding the All Doors Lock/Unlock to Lock with a scan tool.
 - **If the fuel door lock actuator releases the fuel filler door**

Refer to Circuit/System Testing.

- **If the fuel door lock actuator does not release the fuel filler door**
3. Verify the operation of the fuel door unlatch actuator releases the fuel filler door when commanding the All Doors Lock/Unlock to Unlock with a scan tool.
 - **If the fuel door lock actuator does not release the fuel filler door**

Refer to Circuit/System Testing.

- **If the fuel door lock actuator releases the fuel filler door**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the M97 fuel door lock actuator.
2. Connect a test lamp between control circuit terminal 1 and control circuit terminal 2, ignition ON.
3. Verify the test lamp turns ON when commanding the All Doors Lock/Unlock to Lock and Unlock with a scan tool.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, disconnect the harness connector at the K9 body control module.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 body control module.
 3. Test for less than 2 ohms in each control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 body control module.
 - **If the test lamp turns ON during each of the commands**
4. Test or replace the M97 fuel door lock actuator.

Component Testing

Fuel Door Latch

1. Ignition OFF, disconnect the harness connector at the M97 fuel door lock actuator.

2. Install a 25 A fused jumper wire between one of the control terminals and 12 V. Momentarily install a jumper wire between the other control terminal and ground. Reverse the jumper wires at least two times, the M97 fuel door lock actuator should perform the LOCK and UNLOCK function.

- **If the actuator does not perform the LOCK and UNLOCK function**

Replace the M97 fuel door lock actuator.

- **If the actuator performs the LOCK and UNLOCK function**

3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Fuel Tank Filler Pipe Housing Replacement

DOOR AJAR INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Ajar Switch Signal	1	2	2	-
Left Rear Door Ajar Switch Signal	1	4	4	-
Right Front Door Ajar Switch Signal	1	3	3	-
Right Rear Door Ajar Switch Signal	1	5	5	-
Driver Door Latch Ground	-	2	-	-
Passenger Door Latch Ground	-	3	-	-
Left Rear Door Latch Ground	-	4	-	-
Right Rear Door Latch Ground	-	5	-	-
1. Ajar indicator always illuminated 2. Ajar indicator inoperative when driver door is open 3. Ajar indicator inoperative when passenger door is open 4. Ajar indicator inoperative when left rear door is open 5. Ajar indicator inoperative when right rear door is open				

Circuit/System Description

Depending upon the vehicle power window options, the window motors or the window switches will provide the ajar switches with a 12V signal. With the door ajar switch closed, ground is provided to the door ajar switch signal circuit, the window motor and/or window switch will detect the voltage drop and will send a serial data message to the BCM and the BCM will send serial data message to the instrument panel cluster to display the door ajar icon.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Door Ajar Indicator Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Driver Door Ajar Switch parameter changes between Inactive and Active when opening and closing the driver door.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Driver Door Ajar Switch Malfunction.
 - **If the parameter changes**
3. Verify the scan tool Passenger Door Ajar Switch parameter changes between Inactive and Active when opening and closing the passenger door.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Passenger Door Ajar Switch Malfunction.

- **If the parameter changes**

4. Verify the scan tool Left Rear Door Ajar Switch parameter changes between Inactive and Active when opening and closing the left rear door.

- **If the parameter does not change**

Refer to Circuit/System Testing - Left Rear Door Ajar Switch Malfunction.

- **If the parameter changes**

5. Verify the scan tool Right Rear Door Ajar Switch parameter changes between Inactive and Active when opening and closing the right rear door.

- **If the parameter does not change**

Refer to Circuit/System Testing - Right Rear Door Ajar Switch Malfunction.

- **If the parameter changes**

6. All OK.

Circuit/System Testing

Driver Door Ajar Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A23D door latch assembly - driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 8 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Driver Door Ajar Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the M74D window motor - driver.
 2. Test for infinite resistance between the signal circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74D window motor - driver.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 6 and the ground circuit terminal 8.
6. Verify the scan tool Driver Door Ajar Switch parameter is Active.

- **If not Active**

1. Ignition OFF, disconnect the harness connector at the M74D window motor - driver, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the M74D window motor - driver.

- **If Active**

7. Test or replace the A23D door latch assembly - driver.

Passenger Door Ajar Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A23P door latch assembly - passenger. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.
4. Verify the scan tool Passenger Door Ajar Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the M74P window motor - passenger.
2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M74P window motor - passenger.

- **If Inactive**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 3.
6. Verify the scan tool Passenger Door Ajar Switch parameter is Active.

- **If not Active**

1. Ignition OFF, disconnect the harness connector at the M74P window motor - passenger, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the M74P window motor - passenger.

- **If Active**

7. Test or replace the A23P door latch assembly - passenger.

Left Rear Door Ajar Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A23LR door latch assembly - left rear. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 8 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Left Rear Door Ajar Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the S79LR window switch - left rear.
 2. Test for infinite resistance between the signal circuit terminal 6 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S79LR window switch - left rear.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 6 and the ground circuit terminal 8.
6. Verify the scan tool Left Rear Door Ajar Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the harness connector at the S79LR window switch - left rear, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79LR window switch - left rear.
 - **If Active**
7. Test or replace the A23LR door latch assembly - left rear.

Right Rear Door Ajar Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A23RR door latch assembly - right rear. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Right Rear Door Ajar Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the S79RR window switch - right rear.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the S79RR window switch - right rear.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 3.
6. Verify the scan tool Right Door Ajar Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the harness connector at the S79RR window switch - right rear, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the S79RR window switch - right rear.
 - **If Active**
7. Test or replace the A23RR door latch assembly - right rear.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate A23 door latch assembly.
2. Test for infinite resistance between the terminals listed below with the switch in the open position.
 - Driver door latch signal terminal 6 and ground terminal 8
 - Left rear door latch signal terminal 6 and ground terminal 8
 - Right rear door latch signal terminal 1 and ground terminal 3
 - Passenger door latch signal terminal 1 and ground terminal 3

- **If less than infinite resistance**

Replace the A23 door latch assembly.

- **If infinite resistance**

3. Test for less than 5 ohms between the terminals listed below with the switch in the closed position.

- Driver door latch signal terminal 6 and ground terminal 8
- Left rear door latch signal terminal 6 and ground terminal 8
- Right rear door latch signal terminal 1 and ground terminal 3
- Passenger door latch signal terminal 1 and ground terminal 3

- **If 5 ohms or greater**

Replace the A23 door latch assembly.

- **If less than 5 ohms**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Front Side Door Lock Replacement**
- **Rear Side Door Lock Replacement**
- **Rear Side Door Window Switch Replacement**
- **Front Side Door Window Regulator Motor Replacement**

POWER DOOR CHILD LOCK MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Rear Door Latch Lock Status Signal	-	4	4	-
Left Rear Door Latch Child Lock Control	B3125 02, B3130 02, B3135 02	2	2	-

Left Rear Door Latch Ground	-	4	-	-
Right Rear Door Latch Lock Status Signal	-	4	4	-
Right Rear Door Latch Child Lock Control	B3125 02, B3130 02, B3135 02	3	3	-
Right Rear Door Latch Ground	-	4	-	-
Child Lock Security Relay Control	B3930 02	1	1	-
Child Lock Security Relay Ground	-	1	-	-
1. Both Child Door Lockouts Inoperative 2. Left Rear Child Door Lockout Inoperative 3. Right Rear Child Door Lockout Inoperative 4. Rear Windows Always Function From Local Rear Window Switches				

Circuit/System Description

The child door lockout switch is on the driver door lock/window switch and controls the child locks on the rear doors as well as the rear window switches. When the BCM receives a command from the window lockout switch, it will apply voltage to the door lock security relay coil, this will energize the relay and the contact within the relay will then direct the voltage to lock the left rear and right rear child locks and then isolate them from the normal door lock system to prevent the rear doors from being opened by using the interior rear door handles. The BCM will also send a serial data message to the rear window switches which will disable the functions of the rear windows from the local rear window switches

The BCM monitors the voltage level of the rear lock status signal circuits to determine if the rear door latches have been locked out. A switch within the rear door latch will be open or closed depending upon the lockout status of the rear latch. If the rear latches are locked out, the switch will be open and the BCM will disable the functions of the rear window switches. If the latches have not been lockout, the switch will be closed, pulling the voltage within the signal circuit to 0 volts and the BCM will permit normal rear window switch functions.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify both interior rear door handles do not open the rear doors when commanding the Child Security Lock Motors ON with a scan tool.
 - **If both interior rear door handles open the rear doors**

Refer to Circuit/System Testing - Security Lockout Inoperative.
 - **If a single interior rear door handle opens the rear door**

Refer to Circuit/System Testing - Single Door Security Lockout Malfunction.
 - **If both interior door handles do not open the rear doors**
3. Verify both interior rear door handles will open the rear doors when commanding the Child Security Lock Motors OFF with a scan tool.
 - **If both interior rear door handles do not open the rear doors**

Refer to Circuit/System Testing - Security Lockout Inoperative.
 - **If a single interior rear door handle does not open the rear door**

Refer to Circuit/System Testing - Single Door Security Lockout Malfunction.
 - **If both interior door handles open the rear doors**
4. Verify both rear window switches do not open the rear windows when commanding the Child Security Lock Motors ON with a scan tool.
 - **If a rear window switch continues to function**

Refer to Circuit/System Testing - Rear Window Lockout Inoperative.
 - **If the rear window switch is inoperative**
5. Verify the scan tool Window Lockout Switch parameter changes between On and Off when pressing the lockout switch on the S79D Window Switch-Driver.
 - **If the parameter does not change**

Replace the S79D Window Switch-Driver.

- **If the parameter changes**

6. All OK.

Circuit/System Testing

Security Lockout Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the KR113 Child Security Lock Disable Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 3 and the ground circuit terminal 1.
4. Verify the test lamp turns ON and OFF when commanding the Child Security Lock Motors ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
5. Test or replace the KR113 Child Security Lock Disable Relay.

Single Door Security Lockout Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate A23 Door Latch Assembly-Rear. Ignition ON.
2. Connect a test lamp between control circuit terminals listed below:
 - A23LR Door Latch Assembly-Left Rear - control circuit terminal 4 and control circuit terminal 7
 - A23RR Door Latch Assembly-Right Rear - control circuit terminal 2 and control circuit terminal 9
3. Verify the test lamp turns ON and OFF when commanding the Child Security Lock Motors ON and OFF with a scan tool.
 - **If the test lamp remains OFF during either of the commands**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp turns ON during each of the commands**
4. Test or replace the A23 Door Latch Assembly-Rear.

Rear Window Lockout Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate A23 Door Latch Assembly-Rear. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal listed below and ground:
 - A23RR Door Latch Assembly-Right Rear - ground terminal 3
 - A23LR Door Latch Assembly-Left Rear - ground terminal 8
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for greater than 10 V between the signal circuit terminal listed below and ground:
 - A23RR Door Latch Assembly-Right Rear - signal terminal 4
 - A23LR Door Latch Assembly-Left Rear - signal terminal 9
 - **If less than 10 V**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance on the circuit.
- If less than 2 ohms, replace the K9 Body Control Module.

- **If greater than 10 V**

5. Test or replace the A23 Door Latch Assembly-Rear.

Component Testing

Door Latch Test

1. Ignition OFF, disconnect the harness connector at the appropriate A23 Door Latch Assembly-Rear.
2. Install a 30 A fused jumper wire between one of the control terminals and 12 V. Momentarily install a jumper wire between the other control terminal and ground. Reverse the jumper wires at least two times, the A23 Door Latch Assembly-Rear should perform the LOCK and UNLOCK functions.

- **If the function does not perform the LOCK and UNLOCK function**

Replace the A23 Door Latch Assembly-Rear.

- **If the function performs the LOCK and UNLOCK function**

3. All OK

Relay Test

1. Ignition OFF, disconnect the KR113 Child Security Lock Disable Relay.
2. Test for 60-200 ohms between terminals 1 and 3.

- **If less than 60 ohms or greater than 200 ohms**

Replace the KR113 Child Security Lock Disable Relay.

- **If between 60-200 ohms**

3. Test for infinite resistance between the terminals listed below:

- 4 and 3
- 4 and 5
- 4 and 1
- 5 and 1

- **If less than infinite resistance**

Replace the KR113 Child Security Lock Disable Relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal 3 and 12 V. Install a jumper wire between relay terminal 1 and ground.
5. Test for less than 2 ohms between terminals 4 and 5.
 - **If 2 ohms or greater**

Replace the KR113 Child Security Lock Disable Relay.

- If less than 2 ohms

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Side Door Lock Replacement**
- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Front Side Door Window Switch Replacement**
- **Control Module References** for BCM replacement, programming and setup

POWER DOOR LOCK KEY CYLINDER SWITCHES MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	1	1	1	-
Ground	-	1	-	-
1. Key Cylinder Switch Inoperative				

Circuit/System Description

The driver window switch monitors the voltage level of the key switch unlock signal circuit. When the key is inserted into the driver door key cylinder and turned to the Unlock position, a switch within the driver door latch closes causing the voltage to drop within the key switch unlock signal circuit. The driver window switch will detect the drop in voltage and will send a serial data message to the BCM commanding all the doors to unlock.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON
2. Command all doors to LOCK with a scan tool.
3. Verify the passenger and rear doors UNLOCK when inserting the key into the door lock key cylinder and turning the key to the unlock position.
 - **If the passenger and rear doors does not UNLOCK**

Refer to Circuit/System Testing.

- **If the passenger and rear doors UNLOCKS**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the A23D Door Latch Assembly-Driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 8 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for greater than 10 V between the signal circuit terminal 9 and ground.
 - **If 10 V or less**
 1. Ignition OFF, disconnect the harness connector at the S79D Window Switch-Driver.
 2. Test for infinite resistance between the signal circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the S79D Window Switch-Driver.
 - **If greater than 10 V**
- 5. Test or replace the A23D Door Latch Assembly-Driver.

Component Testing

1. Ignition OFF, disconnect the harness connector at the A23D Door Latch Assembly-Driver.
2. Test for infinite resistance between the signal terminal 9 and the ground terminal 8 with the switch in the open position:
 - **If less than infinite resistance**

Replace the A23D Door Latch Assembly-Driver.

- **If infinite resistance**
- 3. Test for less than 2 ohms between the signal terminal 9 and the ground terminal 8 with the switch in the closed position:
 - **If 2 ohms or greater**

Replace the A23D Door Latch Assembly-Driver.

- **If less than 2 ohms**
- 4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Window Switch Replacement**
- **Front Side Door Lock Replacement**

POWER DOOR LOCKS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+	B3125 02, B3130 02, B3135 02	B3125 02, B3130 02, B3135 02	-	-
BCM Ground	-	7	-	-
Driver Door Lock Switch Lock Signal	B3150 00	3	3	-
Driver Door Lock Switch Unlock Signal	B3140 00	2	2	-
Driver Door Lock Switch Ground	-	1	-	-
Passenger Door Lock Switch Lock Signal	B3155 00	4	4	-
Passenger Door Lock Switch Unlock Signal	B3145 00	5	5	-
Passenger Door Lock Switch Ground	-	6	-	-
Driver Door Unlock Control	B3125 02, B3130 02, B3135 02	B3125 04, B3130 04, B3135 04	B3125 01, B3130 01, B3135 01	-
Doors Lock Control	B3125 02, B3130 02, B3135 02	B3125 04, B3130 04, B3135 04	B3125 01, B3130 01, B3135 01	-
Passenger Doors Unlock Control	B3125 02, B3130 02, B3135 02	B3125 04, B3130 04, B3135 04	B3125 01, B3130 01, B3135 01	-
1. Driver Door Lock Switch Inoperative 2. Driver Door Lock Switch Lock Inoperative 3. Driver Door Lock Switch Unlock Inoperative 4. Passenger Door Lock Switch Lock Inoperative 5. Passenger Door Lock Switch Unlock Inoperative 6. Passenger Door Lock Switch Inoperative 7. All Door Latches Inoperative				

Circuit/System Description

The body control module powers the reversible door latch assemblies by providing battery positive voltage and ground to the appropriate lock and unlock control circuits of the door latch assemblies. The lock and unlock control circuits of the rear doors and passenger door latch assemblies are all connected together. When the door latch assemblies are not active, all actuator lock and unlock control circuits are supplied a floating voltage door driver by the body control module. Transitioning of the lock actuators to the lock or unlocked position depends upon which control circuits receive voltage and which control circuits receive ground.

The body control module supplies a 12 V signal to each of the door lock and door unlock signal circuits. When the door lock switches are in the open position, the voltage level in the signal circuit will be near 12 V. When

any door lock switch is pressed to the lock or unlock position, the voltage level in the appropriate signal circuit will drop to 0 V and the body control module will detect the voltage drop and command the door latches to perform the requested lock or unlock command.

Diagnostic Aids

Verify the smooth and consistent mechanical operation of each part of the door latch system prior to performing extensive electrical diagnostics

Any door that does not function smoothly or consistently, refer to **Door Will Not Open/Close, Door Binding, or Locks, Handles, or Cylinders Do Not Function.**

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Driver Door Lock Switch parameter changes from Inactive to Lock and Unlock when pushing the appropriate switch on the S13D Door Lock Switch-Driver.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Driver Door Lock Switch Malfunction.

- **If the parameter changes**

3. Verify the scan tool Passenger Door Lock Switch parameter changes from Inactive to Lock and Unlock when pushing the appropriate switch on the S13P Door Lock Switch-Passenger.

- **If the parameter does not change**

Refer to Circuit/System Testing - Passenger Door Lock Switch Malfunction.

- **If the parameter changes**

4. Verify all vehicle doors LOCK and UNLOCK when commanding the All Doors Lock/Unlock to Lock and Unlock with a scan tool.

- **If only the driver door LOCK or UNLOCK functions do not work**

Refer to Circuit/System Testing - Driver Door Lock Malfunction.

- **If one or more, but not all, passenger door LOCK or UNLOCK functions do not work**

Refer to Circuit/System Testing - Passenger Door Lock Malfunction.

- **If all door LOCK and UNLOCK functions do not work**

Refer to Circuit/System Testing - All Door Lock Inoperative.

- **If the LOCK and UNLOCK function for all doors works**

5. Command all doors to UNLOCK with a scan tool.
6. Verify all doors to LOCK when pressing the driver door lock plunger down flush with the driver door panel.

- **If the door LOCK function for all doors do not work**

Refer to Circuit/System Testing - Driver Door Lock Plunger Malfunction.

- **If the LOCK function for all doors works**

7. Command all doors to UNLOCK with a scan tool.
8. Verify all doors to LOCK when pressing the driver door lock plunger down flush with the driver door panel.

- **If the door LOCK function for all doors do not work**

Refer to Circuit/System Testing - Driver Door Lock Plunger Malfunction.

- **If the LOCK function for all doors works**

9. All OK.

Circuit/System Testing

Driver Door Lock Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S13D Door Lock Switch-Driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Driver Door Lock Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 3. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 4.
6. Verify the scan tool Driver Door Lock Switch parameter is Unlock.
 - **If not Unlock**
 1. Ignition OFF, remove the fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Unlock**
7. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 4.
8. Verify the scan tool Driver Door Lock Switch parameter is Lock.
 - **If not Lock**
 1. Ignition OFF, remove the fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
- **If Lock**
- 9. Test or replace the S13D Door Lock Switch-Driver.

Passenger Door Lock Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S13P Door Lock Switch-Passenger. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Passenger Door Lock Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 3. Test for infinite resistance between the signal circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ground circuit terminal 4.
6. Verify the scan tool Passenger Door Lock Switch parameter is Unlock.
 - **If not Unlock**
 1. Ignition OFF, remove the fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If Unlock**

7. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 4.
8. Verify the scan tool Passenger Door Lock Switch parameter is Lock.

- **If not Lock**

1. Ignition OFF, remove the fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If Lock**

9. Test or replace the S13P Door Lock Switch-Passenger.

Driver Door Lock Malfunction

1. Ignition OFF, disconnect the harness connector at the A23D Door Latch Assembly-Driver. Ignition ON.

NOTE: Leaving the DMM connected between a control circuit and ground for greater than 20 seconds will cause the K9 Body Control Module to interpret the test as a system fault and will cause the voltage on the control circuit to drop to 0 V. If the voltage drops to 0 V, operate the door locks using the S13D Door Lock Switch-Driver to restore the voltage for testing.

2. Test for greater than 6 V between the control circuit terminal 7 and ground.
 - **If 6 V or less**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 6 V**

NOTE: Leaving the DMM connected between a control circuit and ground for greater than 20 seconds will cause the K9 Body Control Module to interpret the test as a system fault and will cause the voltage on the control circuit to drop to 0 V. If the voltage drops to 0 V, operate the door

locks using the S13D Door Lock Switch-Driver to restore the voltage for testing.

3. Test for greater than 6 V between the control circuit terminal 8 and ground.
 - **If 6 V or less**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 6 V**
4. Test or replace the A23D Door Latch Assembly-Driver.

Passenger Door Lock Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate passenger or rear A23 Door Latch Assembly. Ignition ON.

NOTE: **Leaving the DMM connected between a control circuit and ground for greater than 20 seconds will cause the K9 Body Control Module to interpret the test as a system fault and will cause the voltage on the control circuit to drop to 0 V. If the voltage drops to 0 V, operate the door locks using the door lock switch to restore the voltage for testing.**

2. Test for greater than 7 V between the control circuit terminal listed below and ground:
 - A23P Door Latch Assembly-Passenger - control circuit terminal 7
 - A23P Door Latch Assembly-Passenger - control circuit terminal 8
 - A23RR Door Latch Assembly-Right Rear - control circuit terminal 7
 - A23RR Door Latch Assembly-Right Rear - control circuit terminal 8
 - A23LR Door Latch Assembly-Left Rear - control circuit terminal 2
 - A23LR Door Latch Assembly-Left Rear - control circuit terminal 3
- **If 7 V or less**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance on the circuit.

- If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 7 V**
3. Test or replace the A23 Door Latch Assembly.

All Door Locks Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the X6 harness connector at the K9 Body Control Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Disconnect the X2 harness connector at the K9 Body Control Module, ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 4 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 - 3. Ignition OFF.
 - 4. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 5. Disconnect the harness connector at each of the A23 Door Latch Assemblies.
 - 6. Test for infinite resistance between each control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate A23 Door Latch Assembly.
 - **If the test lamp illuminates**
5. Ignition OFF, connect the X2 and X6 harness connectors at the K9 Body Control Module. Disconnect the harness connector at the A23D Door Latch Assembly-Driver, ignition ON.

NOTE: Leaving the DMM connected between a control circuit and ground for greater than 20 seconds will cause the K9 Body Control Module to interpret the test as a system fault and will cause the voltage on the control circuit to drop to 0 V. If the voltage drops to 0 V, operate the door locks using the S13D Door Lock Switch-Driver to restore the voltage for

testing.

6. Test for greater than 6 V between the control circuit terminal 7 and ground.
 - **If 6 V or less**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit terminal listed below and ground:
 - Control circuit terminal 1 X6
 - Control circuit terminal 2 X6
 - Control circuit terminal 4 X6
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If greater than 6 V**
7. Replace the K9 Body Control Module.

Driver Door Lock Plunger Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A23D Door Latch Assembly-Driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for greater than 10 V between the signal circuit terminal 4 and ground.
 - **If 10 V or less**
 1. Ignition OFF, disconnect the harness connector at the S79D Window Switch-Driver, ignition ON.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module or the S79D Window Switch-Driver.
 - **If greater than 10 V**
5. Test or replace the A23D Door Latch Assembly-Driver.

Component Testing

Driver Door Lock Switch

1. Ignition OFF, disconnect the harness connector at the S13D Door Lock Switch-Driver.
2. Test for infinite resistance between the signal terminal 2 and the ground terminal 4 with the switch in the open position.

- **If less than infinite resistance**

Replace the S13D Door Lock Switch-Driver.

- **If infinite resistance**

3. Test for infinite resistance between the signal terminal 3 and the ground terminal 4 with the switch in the open position.

- **If less than infinite resistance**

Replace the S13D Door Lock Switch-Driver

- **If infinite resistance**

4. Test for less than 2 ohms between the signal terminal 2 and the ground terminal 4 with the switch in the Lock position.

- **If 2 ohms or greater**

Replace the S13D Door Lock Switch-Driver.

- **If less than 2 ohms**

5. Test for less than 2 ohms between the signal terminal 3 and the ground terminal 4 with the switch in the Unlock position.

- **If 2 ohms or greater**

Replace the S13D Door Lock Switch-Driver.

- **If less than 2 ohms**

6. All OK

Passenger Door Lock Switch

1. Ignition OFF, disconnect the harness connector at the S13P Door Lock Switch-Passenger.
2. Test for infinite resistance between the signal terminal 2 and the ground terminal 4 with the switch in the open position.

- **If less than infinite resistance**

Replace the S13P Door Lock Switch-Passenger.

- **If infinite resistance**

3. Test for infinite resistance between the signal terminal 3 and the ground terminal 4 with the switch in the

open position.

- **If less than infinite resistance**

Replace the S13P Door Lock Switch-Passenger

- **If infinite resistance**

4. Test for less than 2 ohms between the signal terminal 2 and the ground terminal 4 with the switch in the Lock position.

- **If 2 ohms or greater**

Replace the S13P Door Lock Switch-Passenger.

- **If less than 2 ohms**

5. Test for less than 2 ohms between the signal terminal 3 and the ground terminal 4 with the switch in the Unlock position.

- **If 2 ohms or greater**

Replace the S13P Door Lock Switch-Passenger

- **If less than 2 ohms**

6. All OK

Door Latch Test

1. Ignition OFF, disconnect the harness connector at the appropriate A23 Door Latch Assembly.
2. Install a 25 A fused jumper wire between one of the control terminals and 12 V. Momentarily install a jumper wire between the other control terminal and ground. Reverse the jumper wires at least two times, the A23 Door Latch Assembly should perform the LOCK and UNLOCK function.

- **If the actuator does not perform the LOCK and UNLOCK function**

Replace the A23 Door Latch Assembly.

- **If the actuator performs the LOCK and UNLOCK function**

3. All OK

Relay Test

1. Ignition OFF, disconnect the KR113 Child Security Lock Disable Relay.
2. Test for 60-200 ohms between terminals 1 and 3.

- **If less than 60 ohms or greater than 200 ohms**

Replace the KR113 Child Security Lock Disable Relay.

- **If between 60-200 ohms**

3. Test for infinite resistance between the terminals listed below:

- 4 and 3
- 4 and 5
- 4 and 1
- 5 and 1
- **If less than infinite resistance**

Replace the KR113 Child Security Lock Disable Relay.

- **If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal 3 and 12 V. Install a jumper wire between relay terminal 1 and ground.

5. Test for less than 2 ohms between terminals 4 and 5.

- **If 2 ohms or greater**

Replace the KR113 Child Security Lock Disable Relay.

- **If less than 2 ohms**

6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Lock Replacement**
- **Rear Side Door Lock Replacement**
- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for body control module replacement, programming and setup

TRUNK RELEASE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Rear Compartment Lid Unlatch Relay B+	3	3	-	-

Rear Compartment Lid Unlatch Relay Control	B3265 02	3	3	-
Underhood Fuse Block Ground	-	3	-	-
Exterior Rear Compartment Lid Unlatch Switch Signal	B3618 00	1	1	-
Interior Rear Compartment Lid Unlatch Switch Ground	-	1	-	-
Interior Rear Compartment Lid Unlatch Switch Signal	B2730 00	2	2	-
Exterior Rear Compartment Lid Unlatch Switch Ground	-	2	-	-
Rear Compartment Lid Latch Control	2	3	2	-
Rear Compartment Lid Latch Ground	-	3	-	-
1. Exterior Rear Compartment Lid Release Switch Inoperative 2. Interior Rear Compartment Lid Release Switch Inoperative 3. Rear Compartment Lid Release Inoperative				

Circuit/System Description

The body control module supplies a 12 V reference voltage to the rear compartment lid unlatch switch through the release switch signal circuit. When the rear compartment lid unlatch switch is pressed, the release switch signal circuit is grounded through the rear compartment lid unlatch switch ground circuit and the reference voltage is pulled low within the body control module. In response, the body control module applies battery positive voltage to the compartment lid release relay control circuit, which energizes the coil side of the relay. The switch side of the compartment lid release relay then closes, supplying battery positive voltage through the relay and the rear compartment lid latch control circuit activating the latch so that the trunk lid may be manually raised to an open position.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter changes between Active and Inactive when pressing and releasing the S58A Rear Compartment Lid Unlatch Switch-Exterior.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Exterior Trunk Release Switch Inoperative
 - **If the parameter changes**
3. Verify the scan tool Interior Liftgate/Liftgate Window Unlatch Switch parameter changes between Active and Inactive when pressing and releasing the S58B Rear Compartment Lid Unlatch Switch-Interior.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Interior Trunk Release Switch Inoperative
 - **If the parameter changes**
4. Verify the operation of the M40 Rear Compartment Lid Latch when commanding the Trunk Lid Unlatch with a scan tool.
 - **If the M40 Rear Compartment Lid Latch does not Unlatch**

Refer to Circuit/System Testing - Release Actuator Inoperative
 - **If the M40 Rear Compartment Lid Latch does Unlatch**
5. All OK.

Circuit/System Testing

Exterior Trunk Release Switch Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S58A Rear Compartment Lid Unlatch Switch-Exterior. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.

- **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 3.
- 6. Verify the scan tool Trunk Lid/Liftgate Window Exterior Unlatch Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
- 7. Test or replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.

Interior Trunk Release Switch Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S58B Rear Compartment Lid Unlatch Switch-Interior. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the scan tool Interior Liftgate/Liftgate Window Unlatch Switch parameter is Inactive.
 - **If not Inactive**
 - 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 - 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 2.
- 6. Verify the scan tool Interior Liftgate/Liftgate Window Unlatch Switch parameter is Active.
 - **If not Active**
 - 1. Ignition OFF, remove the 3 A fused jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 - 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
- 7. Test or replace the S58B Rear Compartment Lid Unlatch Switch-Interior.

Release Actuator Inoperative

- 1. Ignition OFF, and all vehicle systems OFF. Disconnect the harness connector at the M40 Rear Compartment Lid Latch. It may take up to 2 minutes for all vehicle systems to power down.
- 2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
- 3. Connect a test lamp between the control circuit terminal 1 and ground, ignition ON.
- 4. Verify the test lamp does not turn ON and OFF when commanding the Trunk Lid Unlatch with a scan tool.
 - **If the test lamp turns ON and OFF**

Test or replace the M40 Rear Compartment Lid Latch.

- **If the test lamp does not turn ON and OFF**

5. Ignition OFF, connect the harness connector at the M40 Rear Compartment Lid Latch. Disconnect the X2 harness connector at the X50A Fuse Block-Underhood, ignition ON.
6. Verify the M40 Rear Compartment Lid Latch is not activated.
 - **If the M40 Rear Compartment Lid Latch is activated**
 1. Ignition OFF, disconnect the harness connector at the M40 Rear Compartment Lid Latch, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the M40 Rear Compartment Lid Latch.
 - **If the M40 Rear Compartment Lid Latch is not activated**
7. Connect a 10 A fused jumper wire between the control circuit terminal 12 and B+.
8. Verify the M40 Rear Compartment Lid Latch activates.
 - **If the M40 Rear Compartment Lid Latch does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the M40 Rear Compartment Lid Latch, ignition ON.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the M40 Rear Compartment Lid Latch.
 - **If the M40 Rear Compartment Lid Latch activates**
9. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the X50A Fuse Block-Underhood. It may take up to 2 minutes for all vehicle systems to power down.
10. Test for less than 10 ohms between the ground circuit terminal 71 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
11. Ignition OFF, connect the X1 and X2 harness connector at the X50A Fuse Block-Underhood. Disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
12. Verify the M40 Rear Compartment Lid Latch is not activated.
 - **If the M40 Rear Compartment Lid Latch is activated**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block-Underhood.

2. Test for less than 1 V between the K9 Body Control Module control circuit terminal 11 X5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the X50A Fuse Block-Underhood.
 - **If the M40 Rear Compartment Lid Latch is not activated**
13. Connect a 3A fused jumper wire between the control circuit terminal 11 and B+.
14. Verify the M40 Rear Compartment Lid Latch activates.
 - **If the M40 Rear Compartment Lid Latch does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the X50A Fuse Block-Underhood, ignition ON.
 2. Test for infinite resistance between the K9 Body Control Module control circuit terminal 11 X5 and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the X50A Fuse Block-Underhood.
 - **If the M40 Rear Compartment Lid Latch activates**
 - 15. Replace the K9 Body Control Module.

Component Testing

Rear Compartment Lid Latch

1. Ignition OFF, disconnect the harness connector at the M40 Rear Compartment Lid Latch.
2. Install a 10 A fused jumper wire between the control terminal 1 and 12 V. Install a jumper wire between the ground terminal 2 and ground.
3. Verify the M40 Rear Compartment Lid Latch activates
 - **If the M40 Rear Compartment Lid Latch does not activate.**

Replace the M40 Rear Compartment Lid Latch.
 - **If the M40 Rear Compartment Lid Latch does activate.**
4. All OK

Exterior Trunk Release Switch

1. Ignition OFF, disconnect the harness connector at the S58A Rear Compartment Lid Unlatch Switch-Exterior.
2. Test for infinite resistance between the signal terminal 1 and the ground terminal 3 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.

- **If infinite resistance**

3. Test for less than 3 ohms between the signal terminal 1 and the ground terminal 3 with the switch in the closed position.

- **If 3 ohms or greater**

Replace the S58A Rear Compartment Lid Unlatch Switch-Exterior.

- **If less than 3 ohms**

4. All OK

Interior Trunk Release Switch

1. Ignition OFF, disconnect the harness connector at the S58B Rear Compartment Lid Unlatch Switch-Interior.
2. Test for infinite resistance between the signal terminal 1 and the ground terminal 2 with the switch in the open position.

- **If less than infinite resistance**

Replace the S58B Rear Compartment Lid Unlatch Switch-Interior.

- **If infinite resistance**

3. Test for less than 3 ohms between the signal terminal 1 and the ground terminal 2 with the switch in the closed position.

- **If 3 ohms or greater**

Replace the S58B Rear Compartment Lid Unlatch Switch-Interior.

- **If less than 3 ohms**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Compartment Lid Latch Replacement**
- **Rear Compartment Lid Release Switch Replacement (Interior), Rear Compartment Lid Release Switch Replacement (Exterior)**
- **Underhood Electrical Center or Junction Block Replacement**
- **Control Module References** for body control module replacement, programming and setup

TRUNK AJAR INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	1	2	2	-
Ground	-	3	-	-
1. Trunk Ajar Message Always Illuminated 2. Trunk Ajar Message Inoperative 3. Trunk Release Inoperative				

Circuit/System Description

The Body Control Module (BCM) supplies a 12 V signal to the rear compartment lid ajar switch signal circuit. When the Rear Compartment Lid Latch releases the rear compartment lid, the rear compartment lid ajar switch, which is internal to the Rear Compartment Lid Latch, is supplied with ground which causes the trunk ajar switch signal circuit to be pulled low. The BCM interprets this and communicates via serial data to the driver information center which will display the Trunk Open message.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Door Ajar Indicator Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Rear Closure Ajar Switch parameter changes between Inactive and Active when opening and closing the trunk.

- **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M40 Rear Compartment Lid Latch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.
4. Verify the scan tool Rear Closure Ajar Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.

- **If Inactive**

5. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the ground circuit terminal 2.
6. Verify the scan tool Rear Closure Ajar Switch parameter is Active.

- **If not Active**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K9 Body Control Module.

○ **If Active**

7. Test or replace the M40 Rear Compartment Lid Latch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the M40 Rear Compartment Lid Latch.
2. Test for infinite resistance between the signal terminal 4 and the ground terminal 2 with the switch in the open position.

○ **If less than infinite resistance**

Replace the M40 Rear Compartment Lid Latch.

○ **If infinite resistance**

3. Test for less than 3 ohms between the signal terminal 4 and the ground terminal 2 with the switch in the closed position.

○ **If 3 ohms or greater**

Replace the M40 Rear Compartment Lid Latch.

○ **If less than 3 ohms**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Compartment Lid Latch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DOOR WILL NOT OPEN/CLOSE, DOOR BINDING, OR LOCKS, HANDLES, OR CYLINDERS DO NOT FUNCTION

Door Will Not Open/Close, Door Binding, or Locks, Handles, or Cylinders Do Not Function

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to address the mechanical diagnosis of the door latching system, which could include the inside and outside handles, latch rods/cables, latches, or latch cylinders.			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	Were you sent here from a Vehicle Access Symptom Table?	Go to Step 3	Go to <u>Symptoms - Vehicle Access</u>
3	Does the door open with the outside handle?	Go to Step 4	Go to Step 10

4	Does the door open with the inside handle?	Go to Step 5	Go to Step 11
5	Does the manual latch knob latch and unlatch the latch smoothly without binding?	Go to Step 6	Go to Step 12
6	Does the door latch switch and/or the keyless entry transmitter latch and unlatch the door latch or door latches?	Go to Step 7	Go to Step 14
7	Is the outside key cylinder loose or does it rattle or fall out? (if equipped)	Go to Step 15	Go to Step 8
8	Does the outside key cylinder latch and unlatch the latch and function smoothly without binding? (if equipped)	Go to Step 9	Go to Step 16
9	Does the door bind, does it take excessive effort to open, or is it misaligned?	Go to Step 17	Go to Step 18
10	<p>If the door will not open with the outside handle, or the handle is obstructed or loose, check the following:</p> <ul style="list-style-type: none"> • For cold weather freezing, thaw as necessary. • Check the handle for foreign material. Remove material as necessary. • Check the handle grab bar for looseness or damage. Repair as necessary. • Check the handle for full travel. <p>If the issue is not resolved, remove the trim panel as necessary to gain access to door hardware and check the following:</p> <ul style="list-style-type: none"> • Check the handle chassis for loose fasteners, broken chassis inserts, loose or missing spring, or a loose, missing or bent rod lever. • Check for bent rod to the outside handle. • Check that the handle grab bar engages the rod lever properly. • Check for interference of rod and handle to other components in the door. • Check that handle rod is securely attached at both latch and handle. • Check if rod is positioned properly in the clip on the latch. At rest position, the handle should be fully against the down stop and the latch lever should be at the bottom of its travel. Correct by opening clip, repositioning rod in clip and closing clip till it snaps, as necessary. 		

	Did you find and correct the condition?	Go to Step 18	Go to Step 11
11	<p>Door will not open with the inside handle:</p> <ul style="list-style-type: none"> • Check the inside handle for foreign material. Remove material as necessary. • Check that the handle is secure. Correct as necessary. • If rear door, verify child security is not engaged. • Remove the trim panel as necessary to and check the inside handle rod/cable attachments at both the latch and handle. If the cable is kinked or pinched, correct as necessary. 		
	Did you find and correct the condition?	Go to Step 18	Go to Step 12
12	<p>The door will not or is difficult to unlatch with the inside manual latch knob:</p> <ul style="list-style-type: none"> • For cold weather freezing, thaw as necessary • Check the latch knob for a loose condition. Repair or replace as necessary. <p>Check the latch knob for binding or dragging using the following procedure:</p> <ol style="list-style-type: none"> 1. Remove the latch knob. 2. If condition goes away, check for drag/interference of the latch knob against the inner belt seal, or the trim panel. Correct as required. <p>If further action is required, remove the trim panel and check the latch rod and latch knob for interference with the following:</p> <ul style="list-style-type: none"> • Water deflector/paper • Side impact foam • Rod grommet in sheet metal • Glass run channel • Other rods or cables • Trim panel 		

	Did you find and correct the condition?	Go to Step 18	Go to Step 13
13	<p>With a manual lock, if the latch will not function properly do the following:</p> <ol style="list-style-type: none"> 1. Function the lock/unlatch lever on the latch to unlatch the latch. Check for high internal resistance. 2. With the door open, manually close the latch with a screwdriver. 3. Check the latch for internal binding by actuating the latch with the inside door handle lever. 4. Manually close the latch with a screwdriver again. 5. Check the latch for internal binding by actuating the latch with the outside door handle lever. 		
	Did you find and correct the condition?	Go to Step 18	Go to Step 14
14	<p>If power locks are included in vehicle options and do not function with either the keyless entry transmitter or switch:</p> <ol style="list-style-type: none"> 1. For cold weather freezing, thaw as necessary. 2. Remove trim pad as required and check the following: <ul style="list-style-type: none"> • Verify door harness has appropriate power connectors for switches and latch. • Check harness connector pins for corrosion. • Assure wire harness connectors are seated and locked properly at latch and switch. Remove and re-seat if required. • Check door harness for cuts/chafing/corrosion. Correct/replace as required. • Check for 12V at latch and door switch. Correct/proceed accordingly. • Check BCM for trouble codes. Correct/proceed accordingly. 3. If power locks still do not function do the following: <ol style="list-style-type: none"> 1. Remove latch from door cavity. 2. Connect latch to electrical connector outside the door. 3. Function power lock/unlatch switch in both latch and unlatch directions. Watch for 		

	<p>lock/unlatch lever on latch to move completely from one position to the other.</p> <ol style="list-style-type: none"> If lever does not move, remove connector from old latch and attach to new latch outside of door cavity. Verify new latch is functional, if so, attach rods and install new latch in door. 		
	Did you find and correct the condition?	Go to Step 18	Go to Step 15
15	<p>If the key cylinder is loose do the following:</p> <ul style="list-style-type: none"> Remove the trim if necessary. Check that the retaining clip is properly seated. (if equipped) Check that the fastener is properly torqued. (if equipped) 		
	Did you find and correct the condition?	Go to Step 18	Go to Step 16
16	<p>The outside key cylinder will not latch and unlatch the latch and function smoothly without binding:</p> <ol style="list-style-type: none"> For cold weather freezing, thaw as necessary Remove trim if required. Check that the key cylinder rod is securely attached both to the key cylinder pawl and the latch. Check that key cylinder lever, rod and latch lever are free of interferences. Remove interferences as required. Check that latch cylinder rod is routed properly. Re-route as required. Remove rod from latch cylinder and actuate cylinder. Check for internal resistance. Lubricate latch cylinder as required Verify Cylinder rotates with vehicle key. If not, code and replace cylinder to match vehicle key. See latch cylinder coding and replacing. 		
	Did you find and correct the condition?	Go to Step 18	Go to Step 17
	<p>The door is difficult to open:</p> <ul style="list-style-type: none"> Check for interference with the fender, adjacent 		

17	<p>door, body opening or door striker and adjust as necessary.</p> <ul style="list-style-type: none"> • Check for binding door hinges. Lubricate or align/adjust as necessary. • Check the door check link for binding. Lubricate as necessary. • Adjust the door as necessary. 		<p>Go to <u>Front Side Door Adjustment</u> or Go to <u>Rear Side Door Adjustment</u></p>
	Did you find and correct the condition?	Go to Step 18	
18	<p>Verify proper operation of the door closing system.</p> <ul style="list-style-type: none"> • Outside handle • Inside handle • Manual lock/unlatch <ul style="list-style-type: none"> ○ Outside key cylinder ○ Inside latch knob ○ Double pull handle • Power lock/unlatch <ul style="list-style-type: none"> ○ Key fob ○ Door switches • Door opening/closing effort 		
	Is the condition still present?	Go to Step 1	System OK

REPAIR INSTRUCTIONS

FRONT SIDE DOOR INSIDE HANDLE CABLE REPLACEMENT

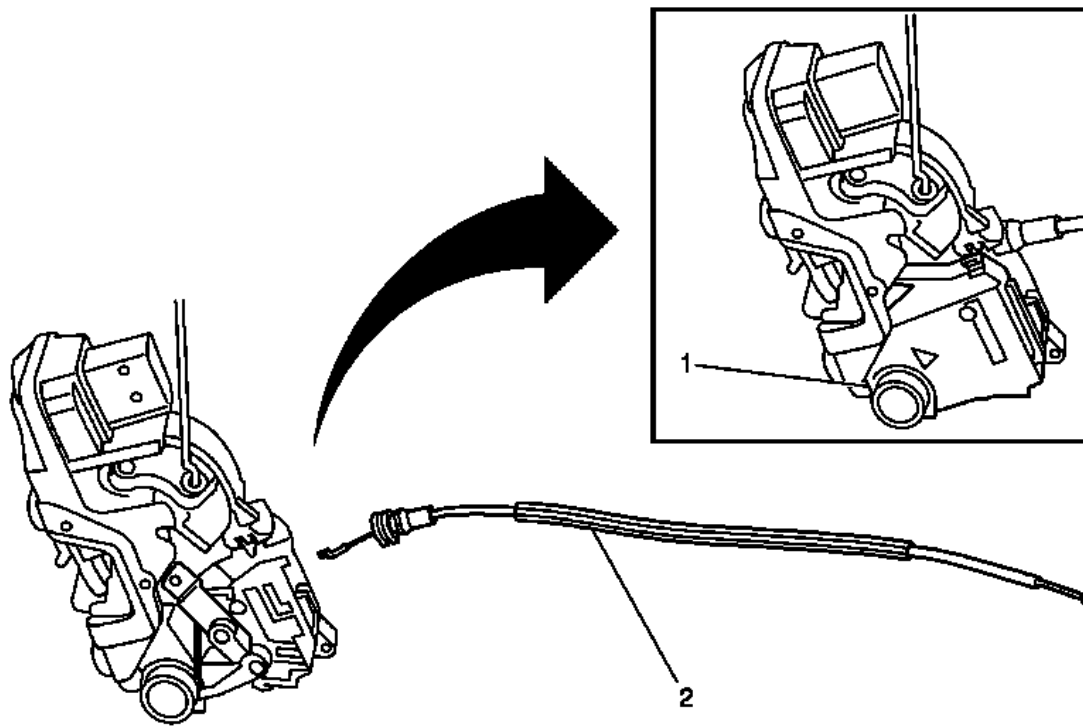


Fig. 9: Rear Side Door Inside Handle Cable & Cover
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Inside Handle Cable Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front side door lock. Refer to <u>Front Side Door Lock Replacement</u> .	
1	Front Side Door Inside Handle Cable Cover TIP: Open the front side door inside handle cable cover to access and release the front side door inside handle cable.
2	Front Side Door Inside Handle Cable

REAR SIDE DOOR INSIDE HANDLE CABLE REPLACEMENT

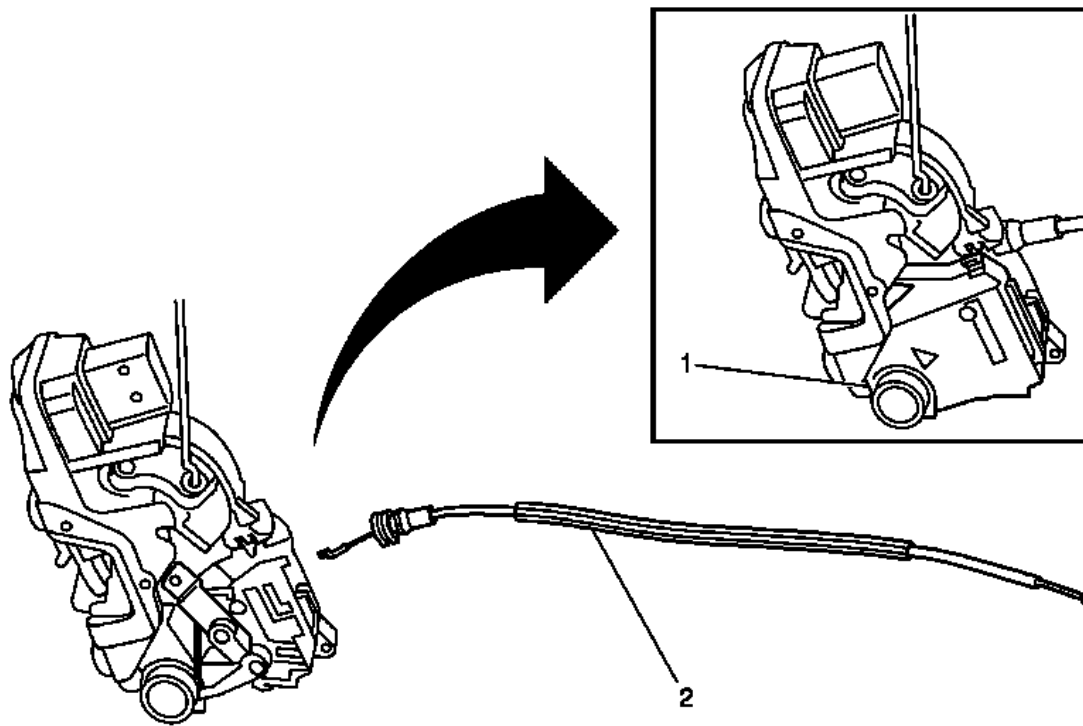


Fig. 10: Rear Side Door Inside Handle Cable & Cover
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Inside Handle Cable Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear side door lock. Refer to <u>Rear Side Door Lock Replacement</u> .	
1	Rear Side Door Inside Handle Cable Cover TIP: Open the rear side door inside handle cable cover to access and release the rear side door inside handle cable.
2	Rear Side Door Inside Handle Cable

FRONT SIDE DOOR LOCK CYLINDER REPLACEMENT

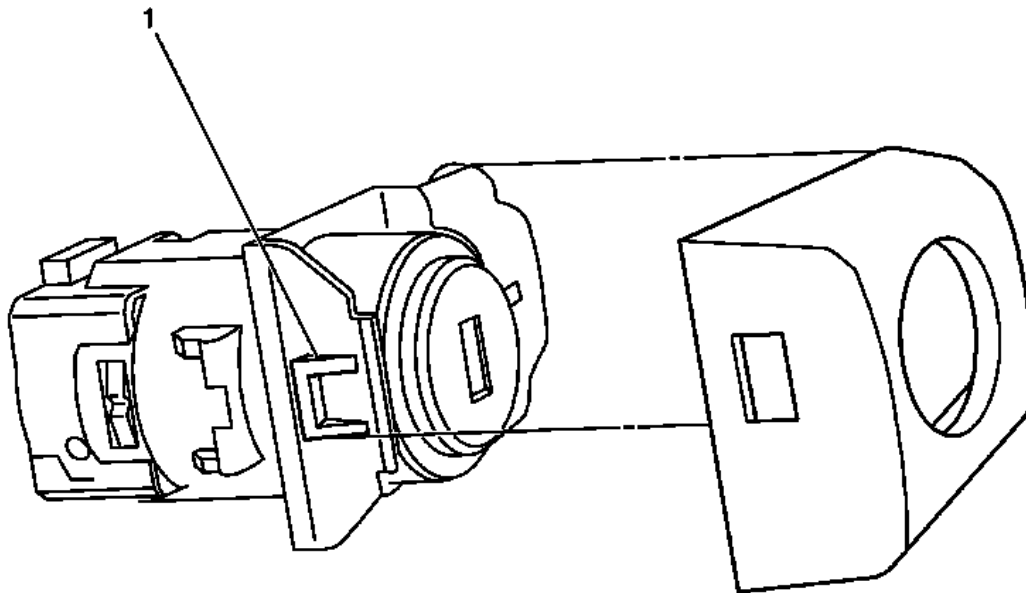


Fig. 11: Front Side Door Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Lock Cylinder Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the front side door outside handle. Refer to <u>Front Side Door Outside Handle Replacement (Passive Entry ATH)</u> , <u>Front Side Door Outside Handle Replacement (Base)</u> . 2. Remove the front door lock cylinder bezel. Refer to <u>Front Side Door Lock Cylinder Bezel Replacement</u> .	
1	Front Side Door Lock Cylinder

FRONT SIDE DOOR OUTSIDE HANDLE REPLACEMENT (BASE)

Removal Procedure

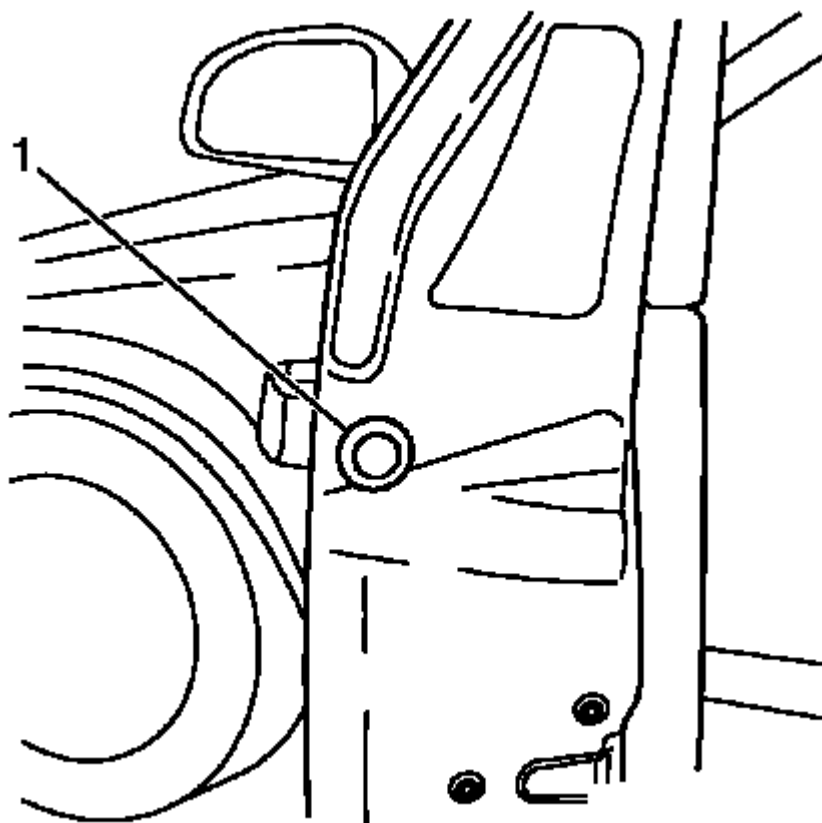


Fig. 12: Cover Cap

Courtesy of GENERAL MOTORS COMPANY

NOTE: **USE HAND TOOL ONLY.** Using a battery operated gun or power tool can **BREAK** the door handle bracket.

1. Remove the cover cap that conceals the screw (1) from the inside edge of the door.

Using a small flat-bladed tool, release the cover cap from the door.

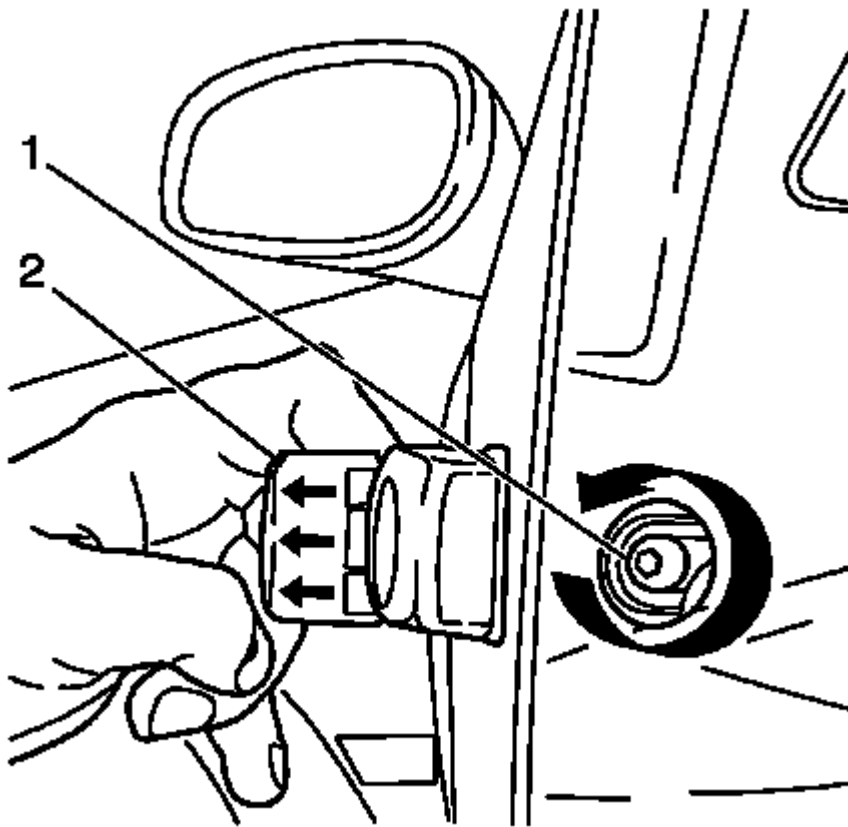


Fig. 13: Securing Door Outside Handle In Pulled Position
Courtesy of GENERAL MOTORS COMPANY

NOTE: The door outside handle (2) must now be secured in the pulled position.

2. Remove the door handle from the door.
 1. Pull the door handle (2) outwards and hold.

NOTE: USE HAND TOOL ONLY. DO NOT TURN THE SCREW PAST 12.5 ROTATIONS TOTAL, this will break the door handle bracket.

2. While holding handle (2) in the full open position, using a manual screwdriver loosen the screw (1) TEN full turns. The handle (2) will stay in the full open position without being held.



Fig. 14: Handle Cover

Courtesy of GENERAL MOTORS COMPANY

3. Remove the bezel with cylinder / cover and blank cylinder (1) from the door. If unable to remove the bezel, complete one full turn of the screw at a time until bezel can be released. DO NOT TURN MORE THAN 2.5 ROTATIONS.

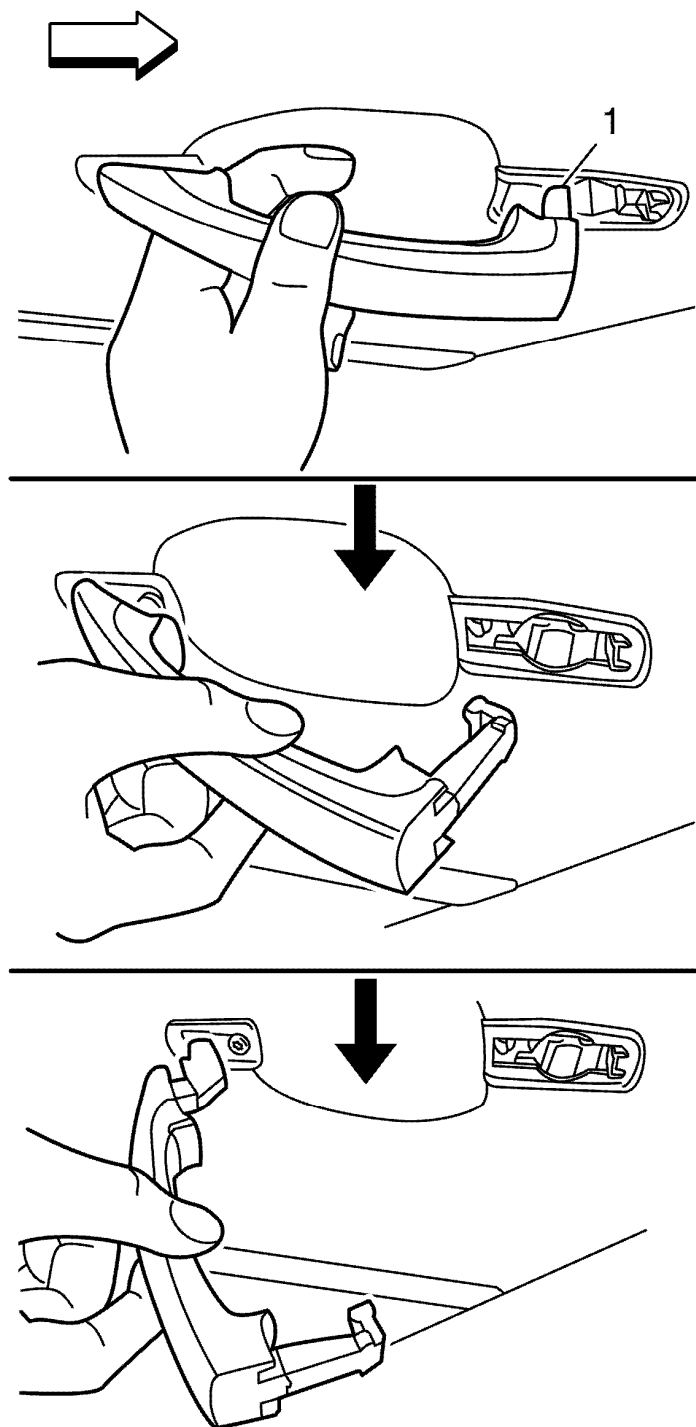


Fig. 15: Pulling Side Door Outside Handle To Rear
Courtesy of GENERAL MOTORS COMPANY

3. Remove the door handle (1) from the door as follows:
 1. Slide the door handle rearward releasing it from the door handle bracket.

2. Open the door handle fully.
3. Remove the door handle from the door.

Installation Procedure

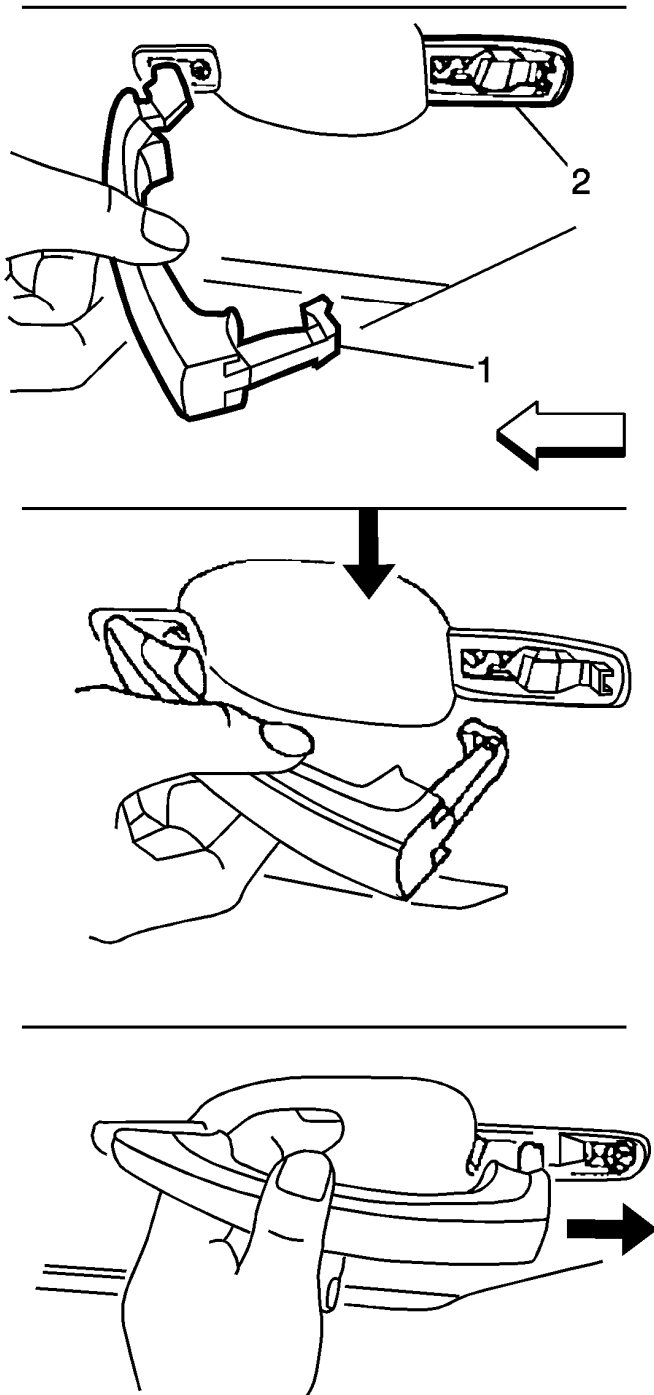


Fig. 16: Door Handle

Courtesy of GENERAL MOTORS COMPANY

1. Install the door handle (1) to the door (2) as follows:
 1. Insert the door handle into the door handle pocket.
 2. Slide the door handle forward securing it into the door handle bracket.

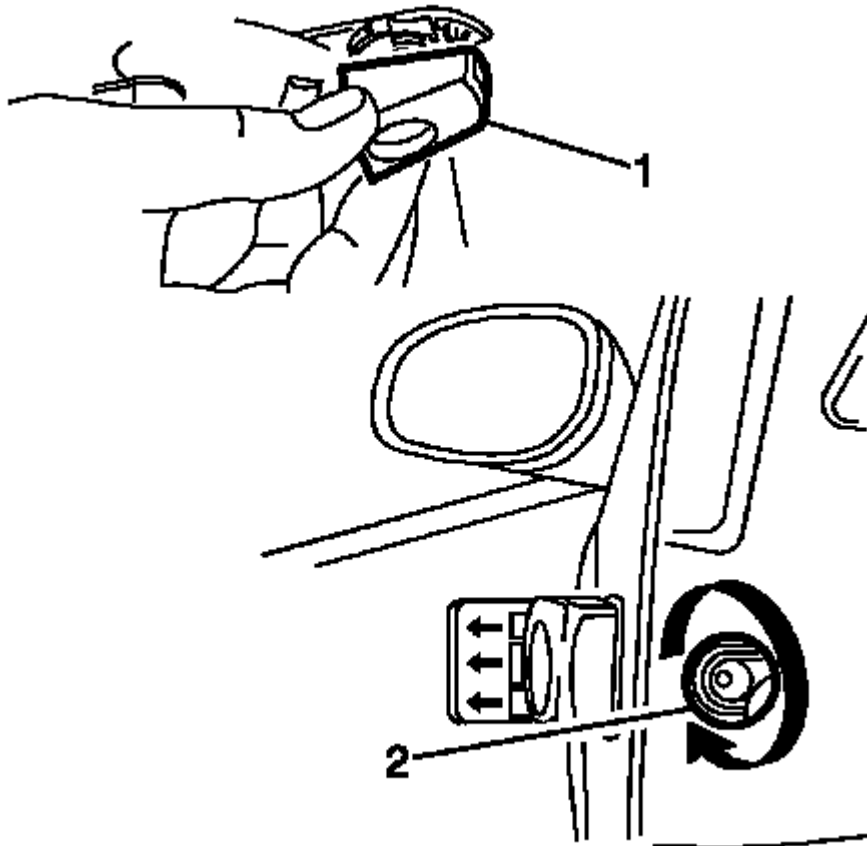


Fig. 17: Side Door Outside Handle

Courtesy of GENERAL MOTORS COMPANY

NOTE: Handle will snap back to flush condition, continue to turn the fastener in the clockwise (right) direction until proper torque is reached.

2. Install the bezel with cylinder / cover and blank cylinder (1) in the door.

Hold the bezel or cover flush to the door sheet metal and turn the cylinder clamp screw (2) until proper torque is reached.

3. Tighten the screw to 6 (53 lb in).

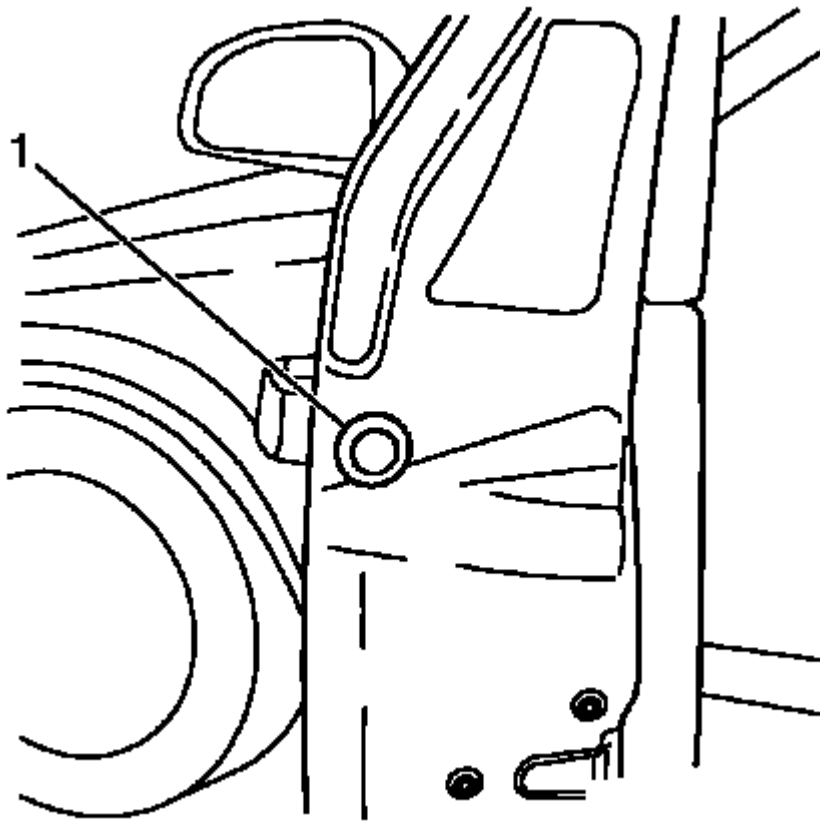


Fig. 18: Cover Cap

Courtesy of GENERAL MOTORS COMPANY

4. Install the cover cap that conceals the screw (1) to the inside edge of the door.
5. Ensure that the door lock system operates properly.

FRONT SIDE DOOR OUTSIDE HANDLE REPLACEMENT (PASSIVE ENTRY ATH)

Removal Procedure

1. Remove the front side door trim panel. Refer to **Front Side Door Trim Panel Replacement** .
2. Remove the door water deflector.
3. Move the window to the full up position.
4. Disconnect the electrical connector from the door handle for the pass key entry (ATH).

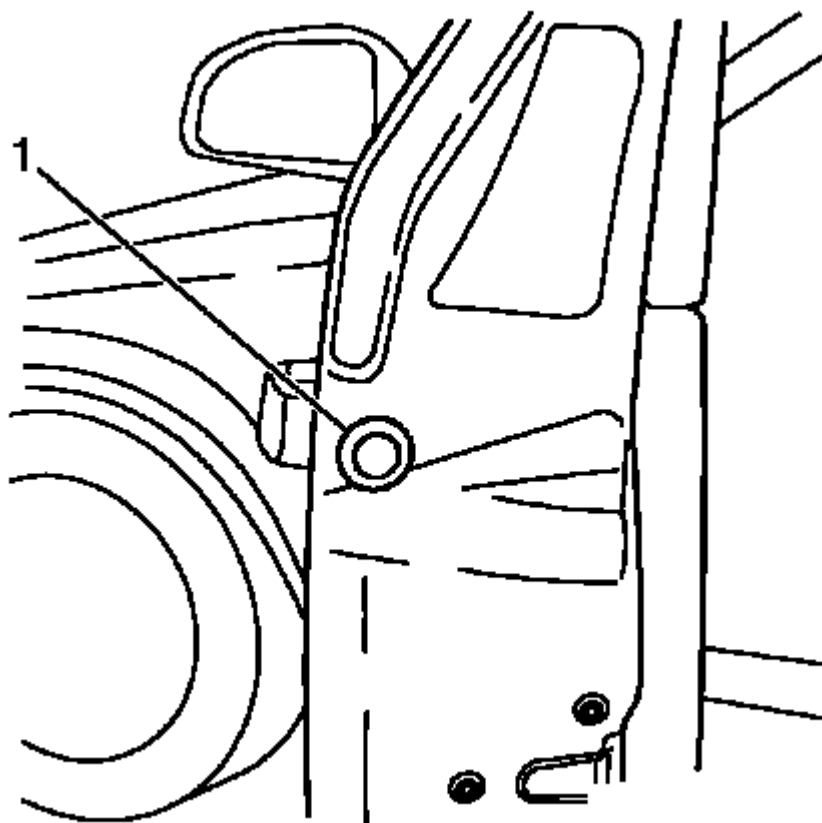


Fig. 19: Cover Cap

Courtesy of GENERAL MOTORS COMPANY

5. Remove the cover cap that conceals the screw (1) from the inside edge of the door.

Using a small flat-bladed tool, release the cover cap from the door.

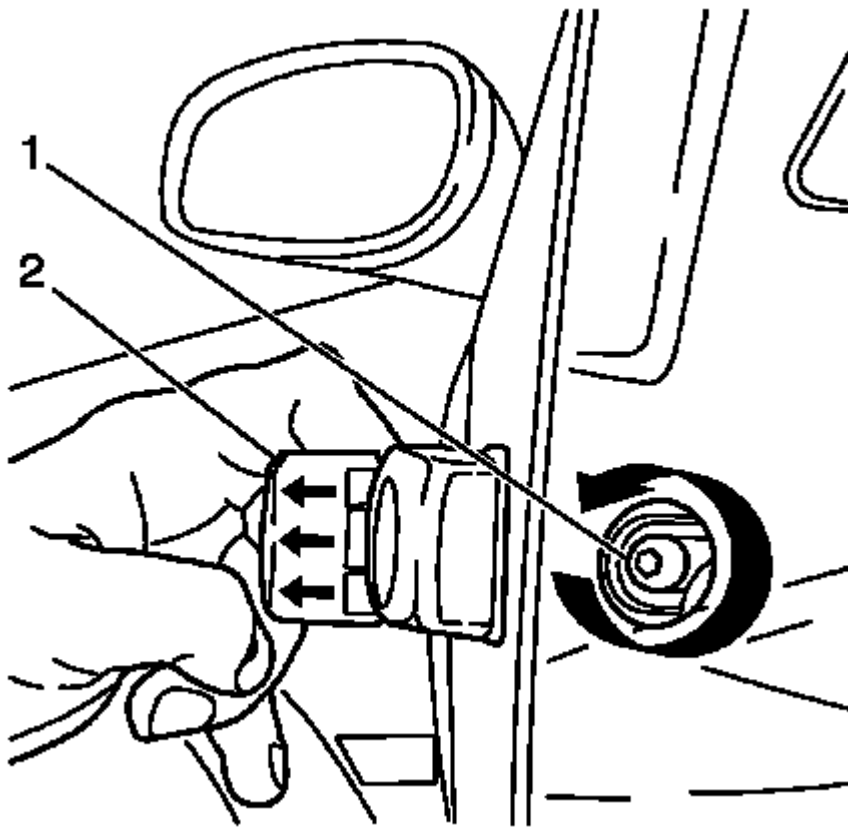


Fig. 20: Securing Door Outside Handle In Pulled Position
Courtesy of GENERAL MOTORS COMPANY

NOTE: The door outside handle (2) must now be secured in the pulled position.

6. Remove the outside door handle from the door.
 1. Pull the outside door handle (2) outwards and hold.
 2. Turn the fastener (1) counterclockwise (left) to the mechanical hard stop.



Fig. 21: Handle Cover

Courtesy of GENERAL MOTORS COMPANY

7. Remove the bezel with cylinder/cover with blank cylinder (1) from the door.
8. While still holding the outside handle in the open position, turn the fastener clockwise to the mechanical hard stop. The handle should be relaxed with no spring tension which will now allow the handle to clear the bracket mechanism.

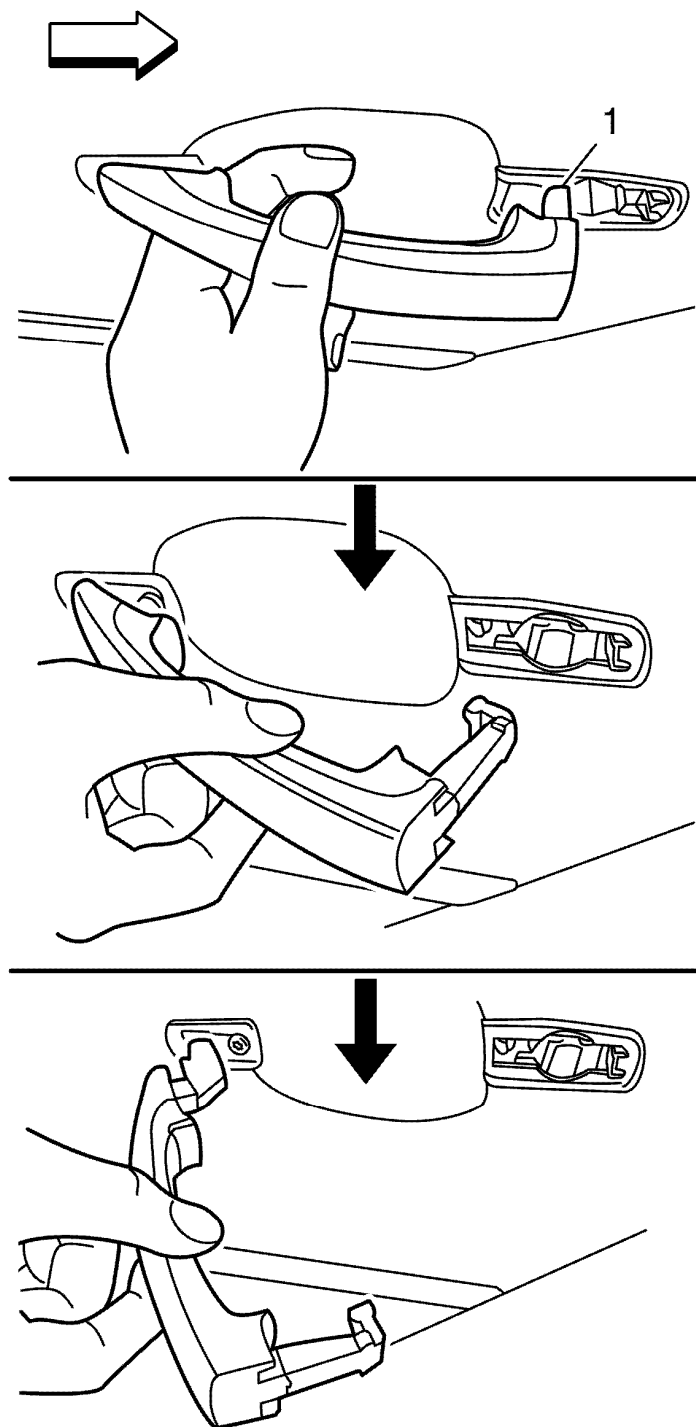


Fig. 22: Pulling Side Door Outside Handle To Rear
Courtesy of GENERAL MOTORS COMPANY

9. Remove the door handle (1) from the door as follows:
 1. Slide the door handle rearward releasing it from the door handle bracket.

2. Open the door handle fully.
3. Remove the door handle from the door.

Installation Procedure

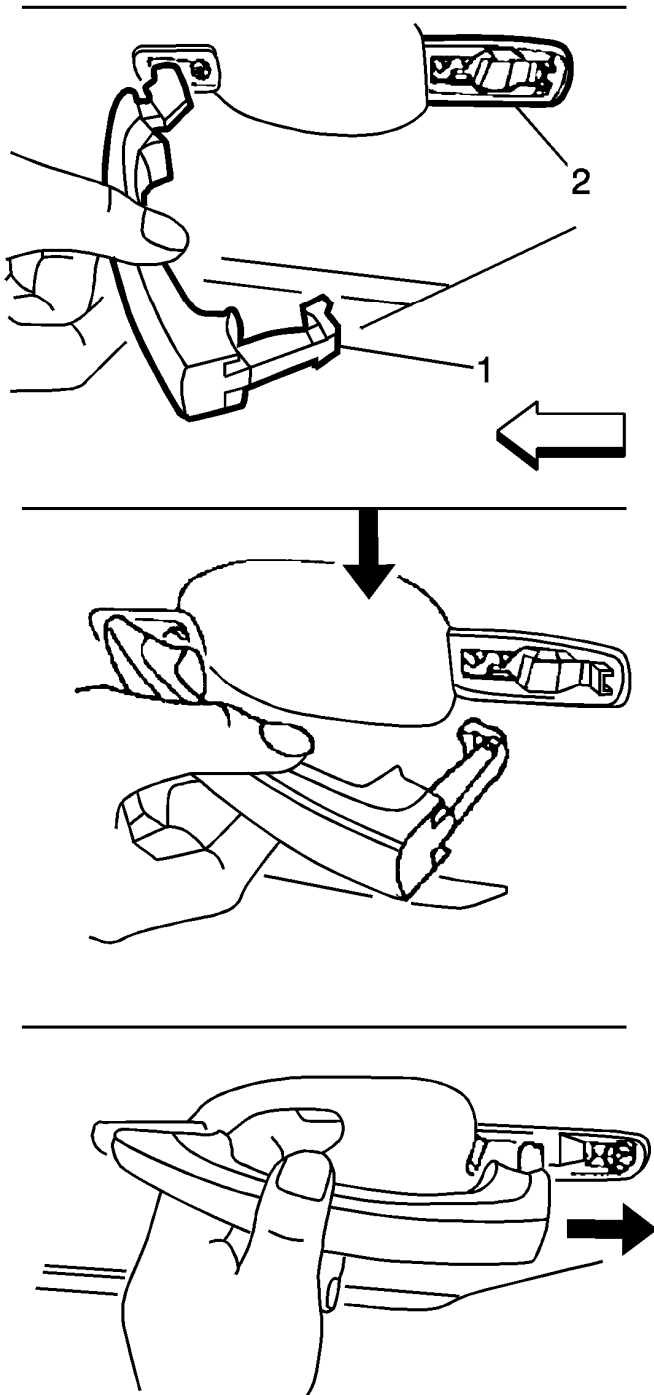


Fig. 23: Door Handle

Courtesy of GENERAL MOTORS COMPANY

1. Install the door handle (1) to the door (2) as follows:
 1. Insert the door handle into the door handle pocket.
 2. Slide the door handle forward securing it into the door handle bracket.



Fig. 24: Side Door Outside Handle

Courtesy of GENERAL MOTORS COMPANY

NOTE: The door handle will snap back to a flush condition, continue to turn the fastener in a clockwise (right) direction to the mechanical stop.

2. Install the bezel with cylinder/cover with blank cylinder (1) in the door.

Hold the bezel or cover flush to the door sheet and turn the cylinder clamp screw (2) to a mechanical hard stop.

3. Connect the electrical connector to the door handle for the pass key entry (ATH).

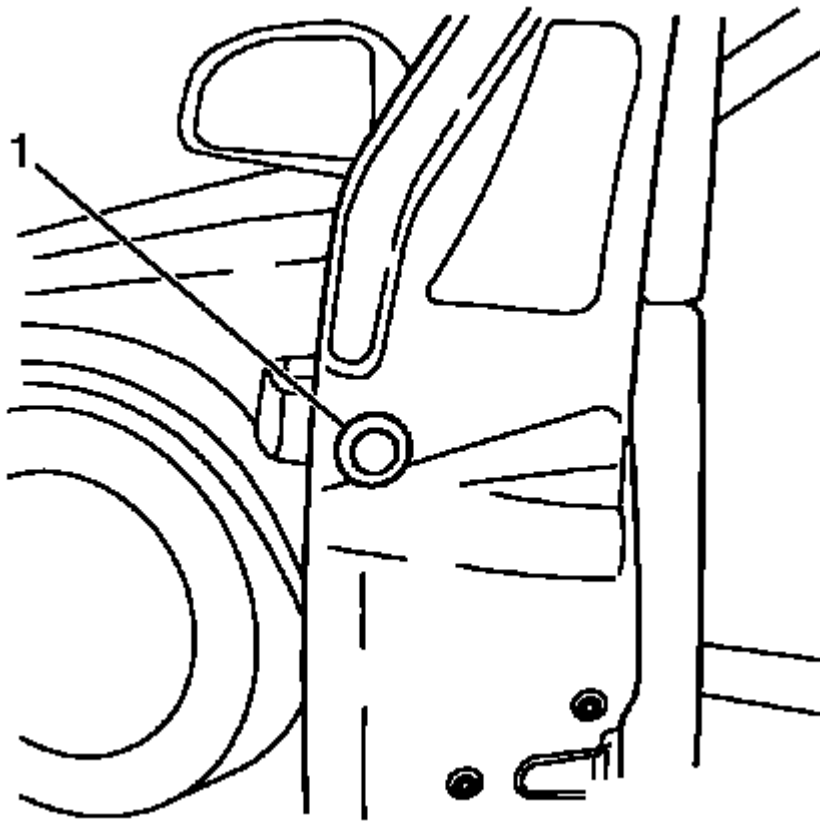


Fig. 25: Cover Cap

Courtesy of GENERAL MOTORS COMPANY

4. Install the cover cap that conceals the screw (1) to the inside edge of the door.
5. Vehicle with passive entry/passive start do the following:
 1. Close all doors on the vehicle.
 2. With the key fob, lock all the doors.
 3. Put key fob in pocket.
 4. Walk up to every door and open (Note: Each door should open, if door does not open then further diagnostic needs to be completed.
6. Install the door water deflector.
7. Install the front side door trim panel. Refer to **Front Side Door Trim Panel Replacement** .

FRONT AND REAR SIDE DOOR OUTSIDE HANDLE ROD CLIP REPLACEMENT

Removal Procedure

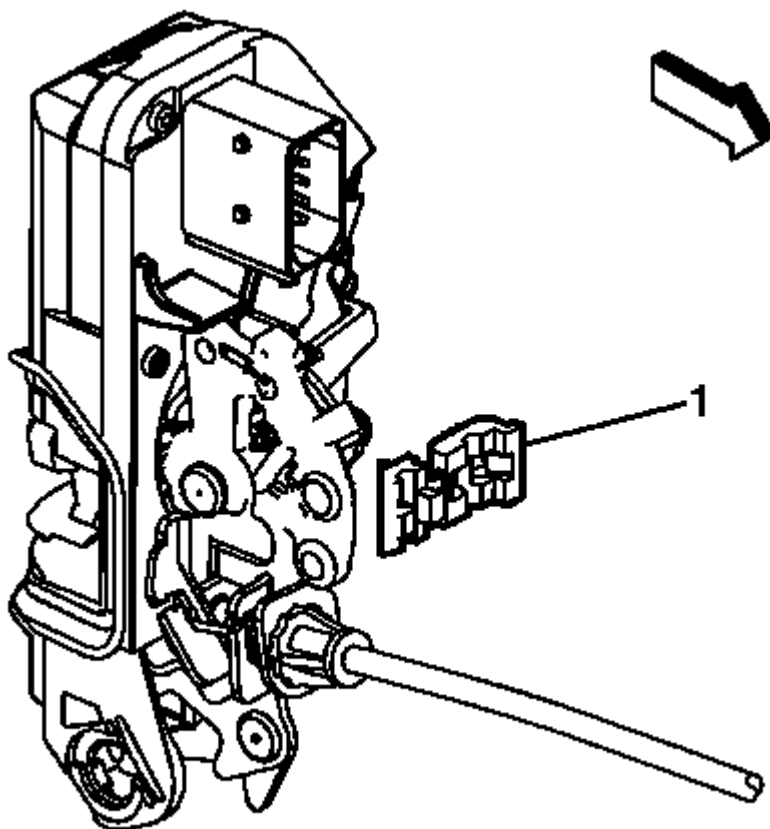


Fig. 26: Outside Door Handle Rod Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: It maybe necessary to remove the front or rear side door latch from some of the vehicles to access the rod clip, refer to the appropriate procedure in this sub-section.

1. Using the appropriate tool, open the outside door handle rod clip (1) on the latch.

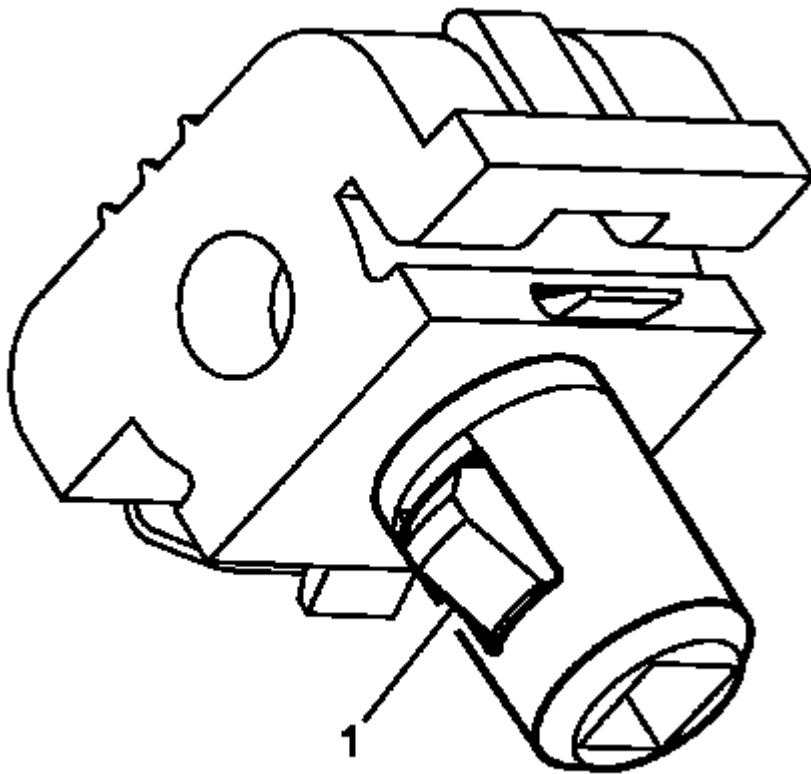


Fig. 27: Retaining Tabs

Courtesy of GENERAL MOTORS COMPANY

NOTE: The clip for the outside door handle rod is designed for one use only, a new clip Must be installed to the door latch to retain the outside handle rod.

NOTE: Use the appropriate tool to push in on the retaining tabs (1) located on each side of the old clip to remove.

2. Remove the old outside door handle rod clip from the door latch.

Installation Procedure

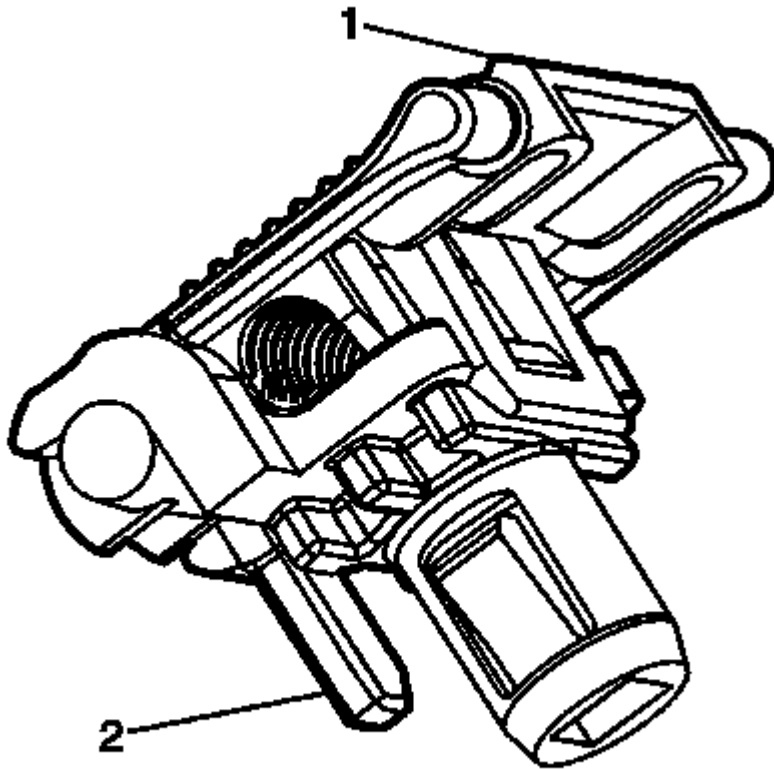


Fig. 28: Outside Door Handle Rod Clip
Courtesy of GENERAL MOTORS COMPANY

- NOTE:** When replacing the old designed outside door handle rod clip with the new designed clip (1) the anti rotation tab (2) will need to be removed.
- NOTE:** When installing the outside door handle rod to latch in order to prevent outside handle lever pre-load, the outside handle shall be fully secured to the door prior to securing integral latch clip to outside handle release rod. Push upward at the bottom the rod clip.

1. Install the new outside door handle rod clip (1) to the latch.
2. Verify the outside door handle will release the door latch.

FRONT SIDE DOOR OUTSIDE HANDLE BRACKET REPLACEMENT (BASE)

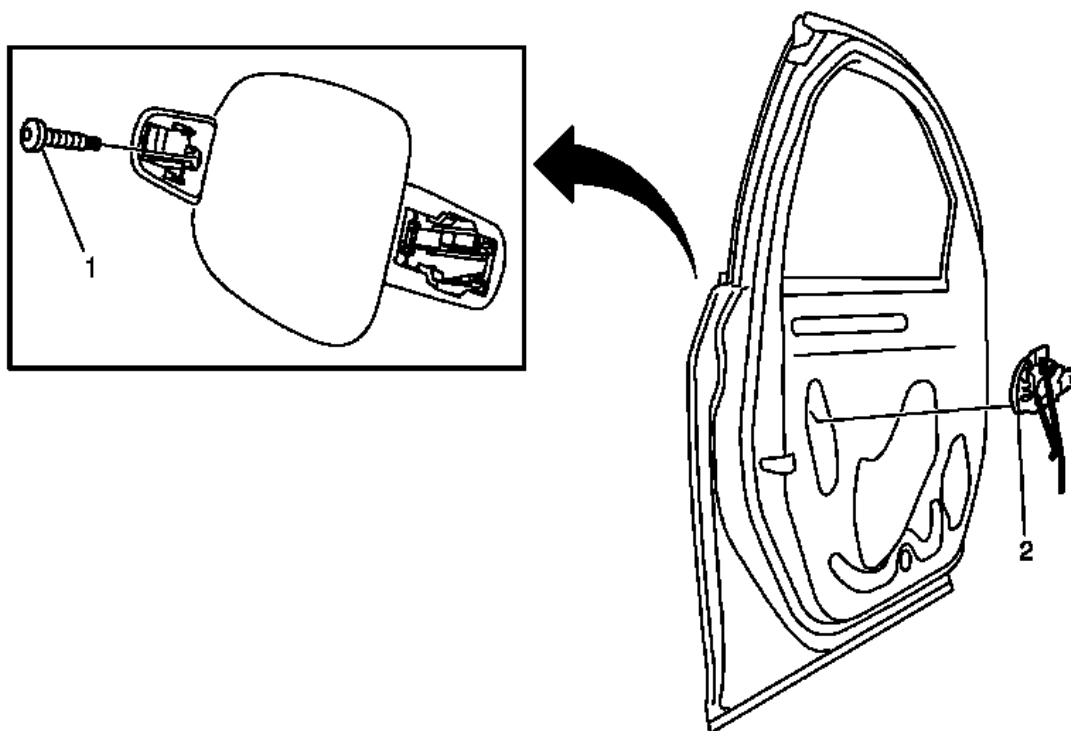


Fig. 29: Front Side Door Outside Handle Bracket (Base)
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Outside Handle Bracket Replacement (Base)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the front side door water deflector. Refer to <u>Front Side Door Water Deflector Replacement</u> . 2. Remove the front side door outside handle. Refer to <u>Front Side Door Outside Handle Replacement (Base)</u>. 	
1	Front Side Door Outside Handle Bracket Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 5 N.m (44 lb in)
2	Front Side Door Outside Handle Bracket Procedure <ol style="list-style-type: none"> 1. Release front side door outside handle rod mechanism at shift linkage lever - clip.

2. Release the front side door lock cylinder rod from the door lock.
3. Transfer components as necessary.

REAR SIDE DOOR OUTSIDE HANDLE BRACKET REPLACEMENT (PASSIVE ENTRY PASSIVE)

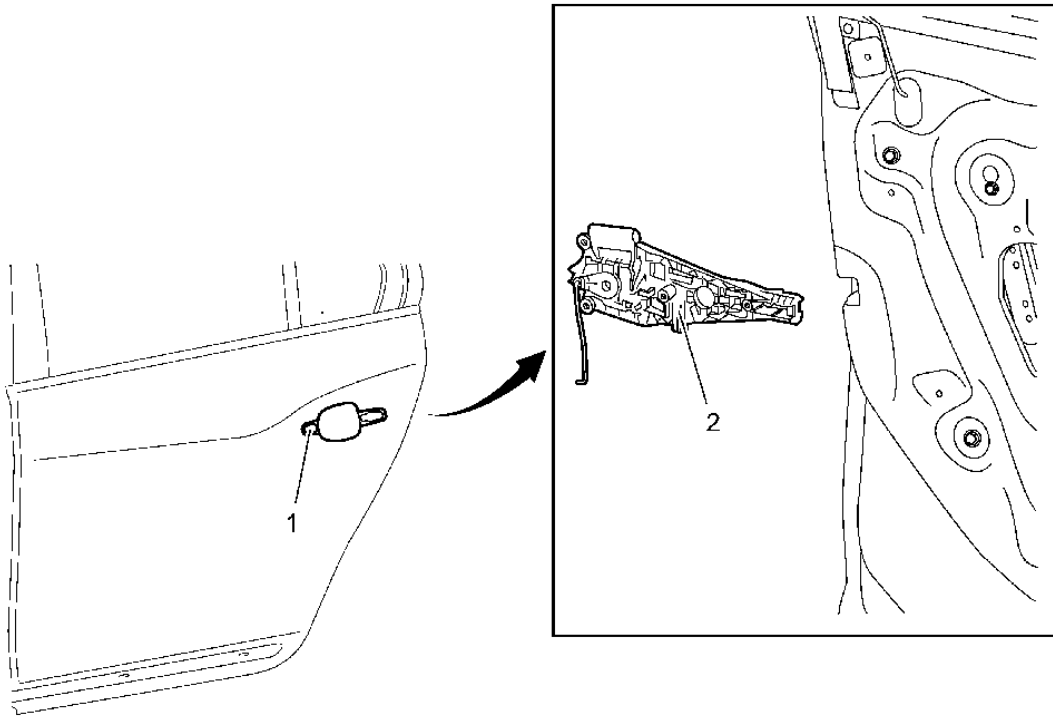


Fig. 30: Rear Side Door Outside Handle Bracket (Passive Entry Passive Start)
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Outside Handle Bracket Replacement (Passive Entry Passive)

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Remove the rear side door water deflector. Refer to <u>Rear Side Door Water Deflector Replacement</u> . 2. Remove the rear side door outside handle. Refer to <u>Rear Side Door Outside Handle Replacement</u>. 	
1	Release Rear Side Door Outside Handle Bracket Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 5 N.m (44 lb in)

Rear Side Door Outside Handle Bracket

Procedure

2

1. Remove the shift linkage lever clip.
2. Disconnect the passive entry passive start sensor electrical connector.
3. Transfer components as necessary.

REAR SIDE DOOR OUTSIDE HANDLE REPLACEMENT

Removal Procedure

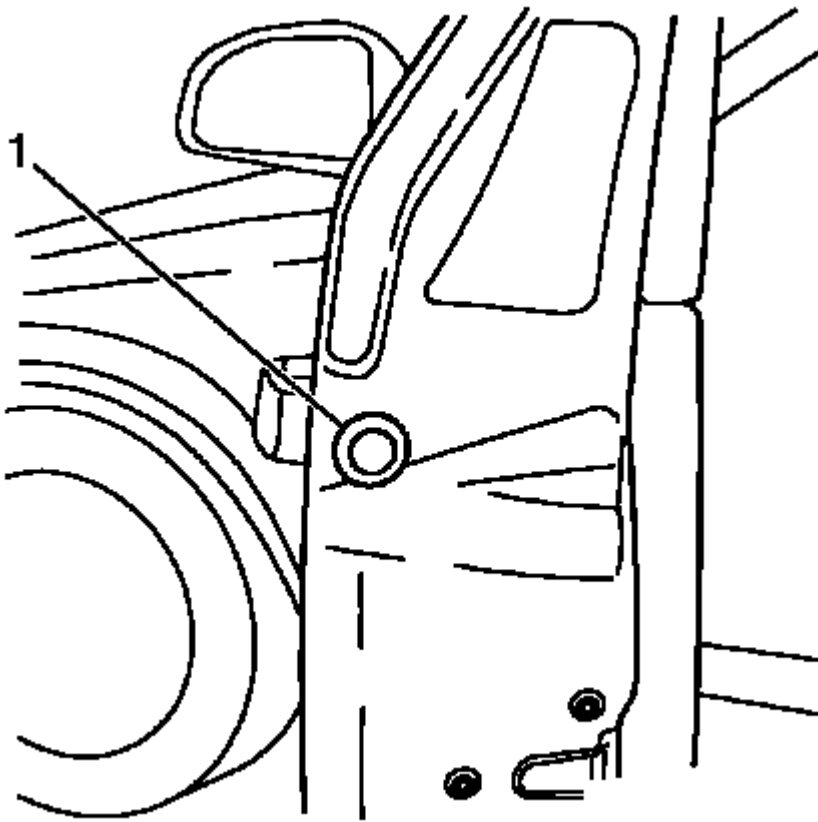


Fig. 31: Cover Cap

Courtesy of GENERAL MOTORS COMPANY

1. Remove cover cap (1) from the rear side door.

Using a small flat-bladed tool, release the cover cap from the rear side door.

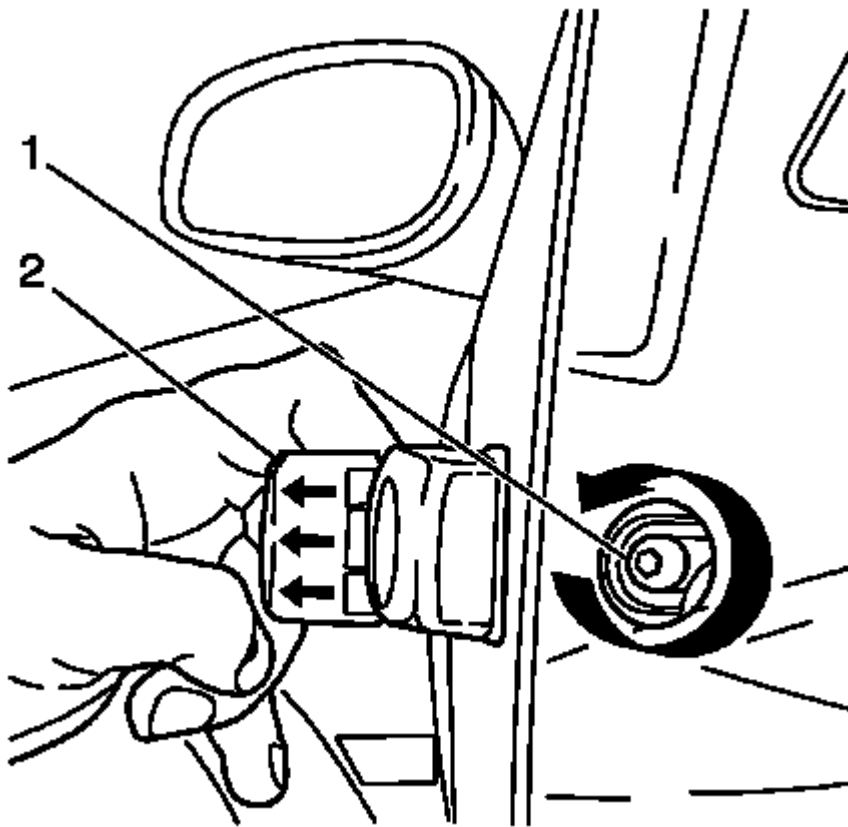


Fig. 32: Securing Door Outside Handle In Pulled Position
Courtesy of GENERAL MOTORS COMPANY

NOTE: Rear side door outside handle (2) must now be secured in pulled position.

2. Remove the rear side door outside handle from the rear side door.
 1. Pull the rear side door outside handle (2) outwards and hold.
 2. Turn fastener (1) to the left and to the mechanical stop.



Fig. 33: Handle Cover
Courtesy of GENERAL MOTORS COMPANY

3. Remove fixed rear handle part (1).

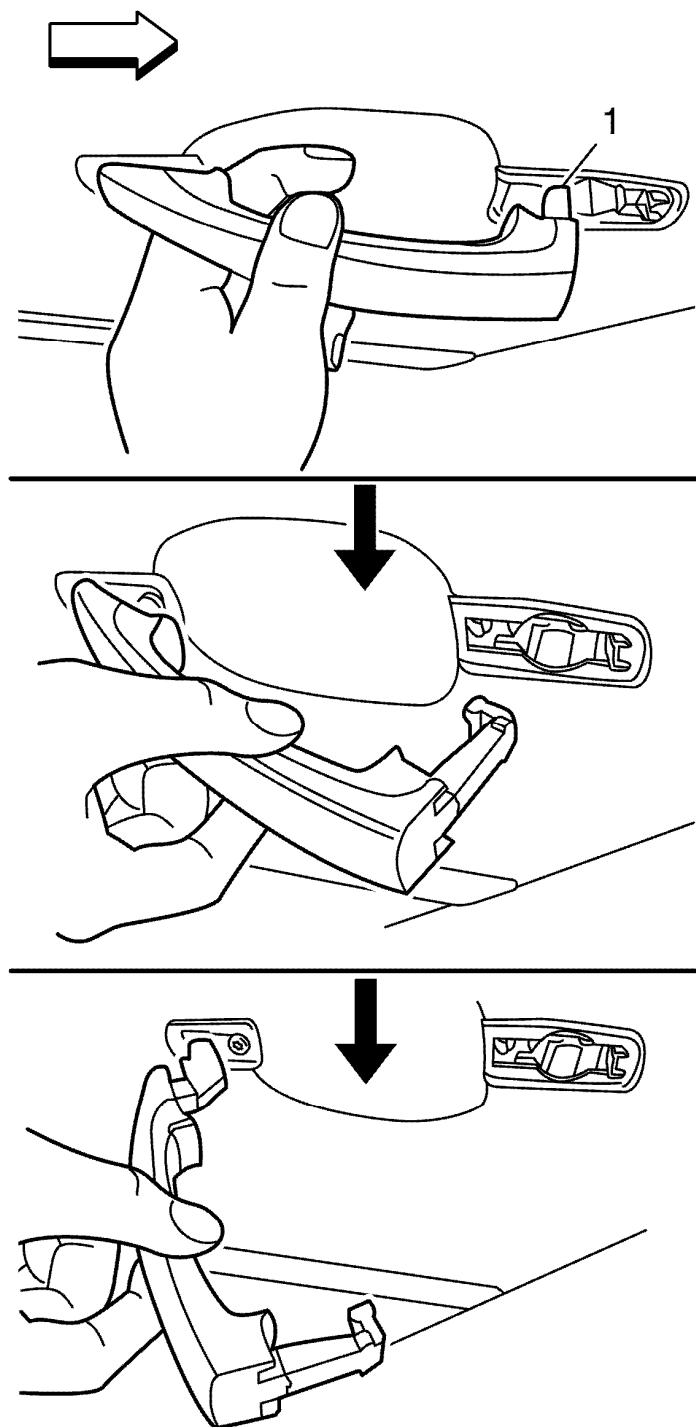


Fig. 34: Pulling Side Door Outside Handle To Rear
Courtesy of GENERAL MOTORS COMPANY

4. Pull the rear side door outside handle (1) to the rear and remove.

Installation Procedure



Fig. 35: Side Door Outside Handle
Courtesy of GENERAL MOTORS COMPANY

NOTE: Hold the rear side door outside handle taut while screwing and lightly counterhold fixed handle part.

1. Install the rear side door outside handle.
 - Guide rear side door outside handle (1) into rear side door panel and latch door handle cage.
 - Insert fixed rear handle part.
 - Turn fastener (2) to the right and to the mechanical stop.

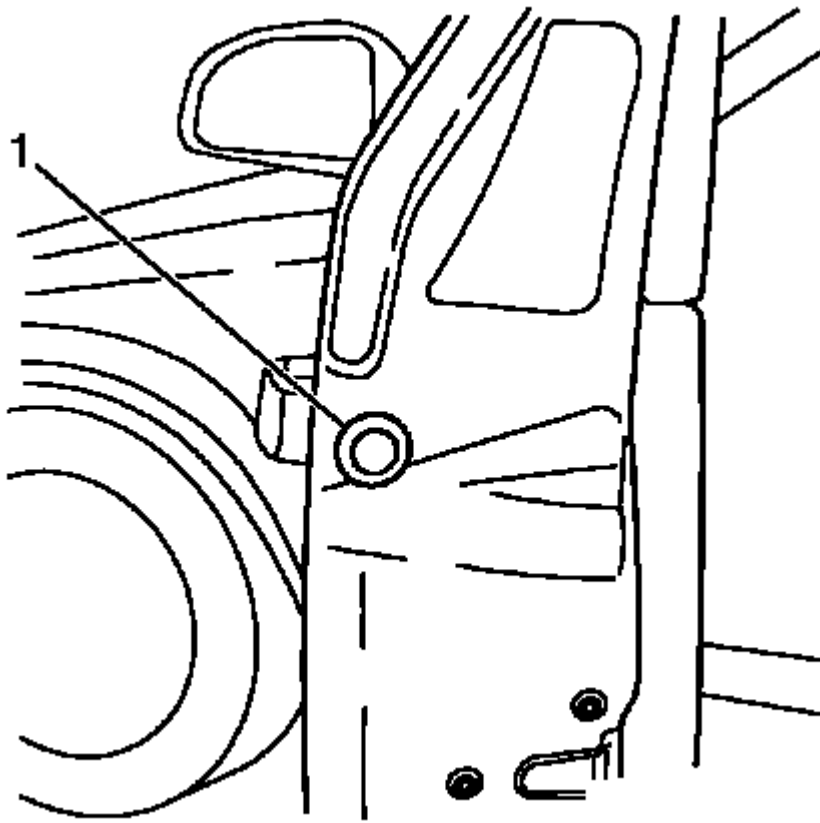


Fig. 36: Cover Cap

Courtesy of GENERAL MOTORS COMPANY

2. Install the cover cap (1) into the rear side door.

REAR COMPARTMENT LID LATCH REPLACEMENT

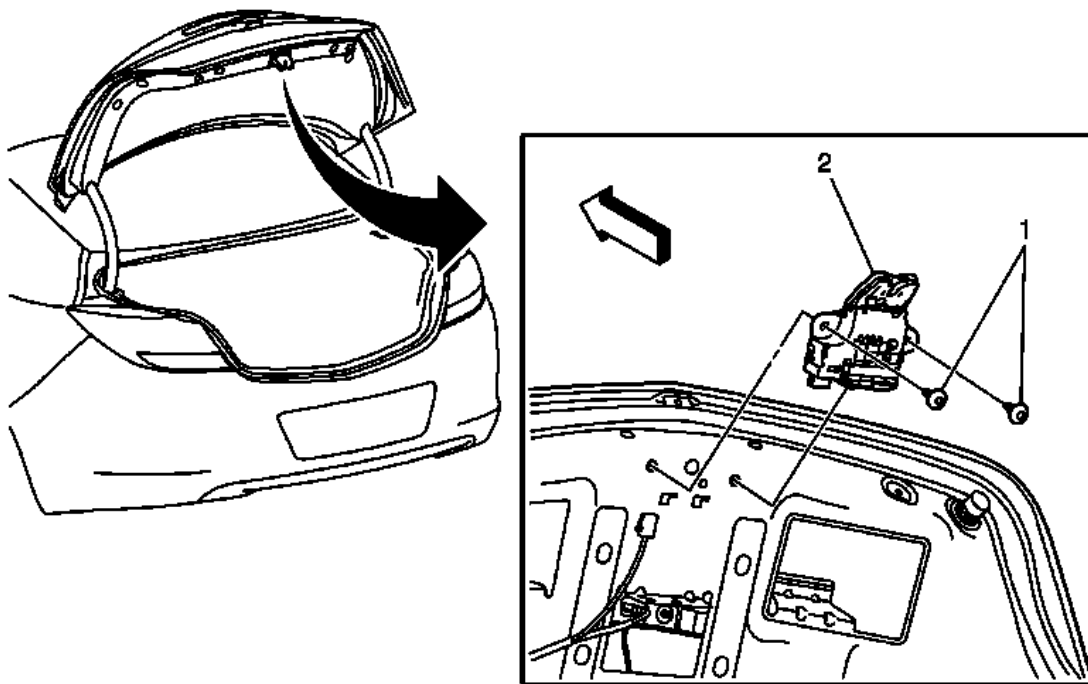


Fig. 37: Rear Compartment Lid Latch & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Latch Replacement

Callout	Component Name
Preliminary Procedure Remove the rear compartment lid inner panel trim. Refer to <u>Rear Compartment Lid Inner Panel Trim Replacement</u> .	
1	Rear Compartment Lid Latch Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
2	Rear Compartment Lid Latch Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Push the lid latch to the left side and then forward. 3. Pull out the lid latch. 4. Disconnect the latch cable.

FRONT SIDE DOOR LOCK CYLINDER BEZEL REPLACEMENT

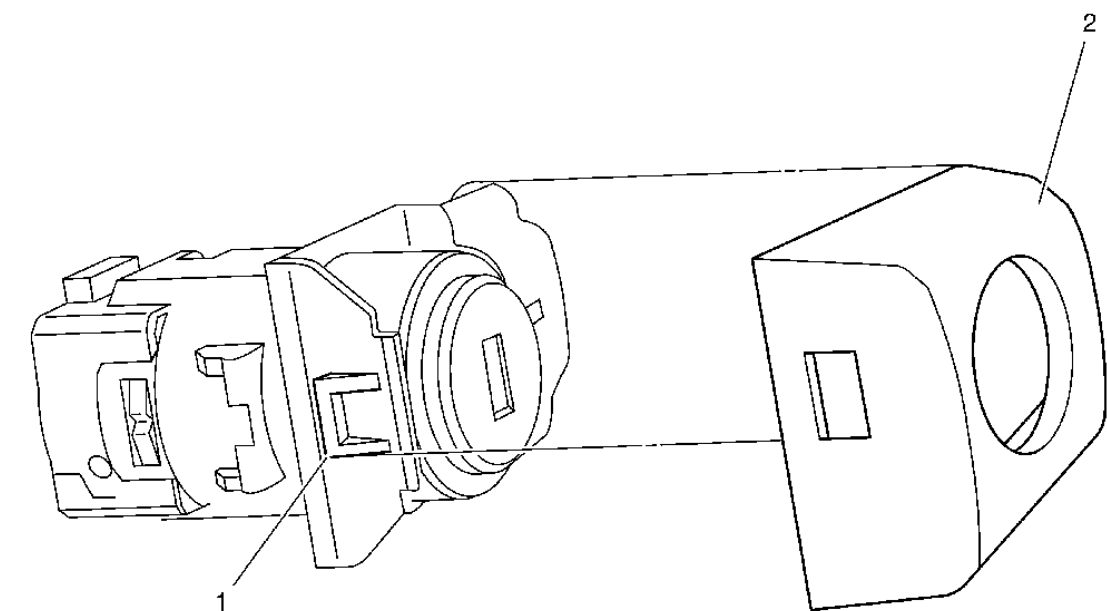


Fig. 38: Front Side Door Lock Cylinder Opening Cover Bezel
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Lock Cylinder Bezel Replacement

Callout	Component Name
Preliminary Procedure Remove the front side door outside handle. Refer to <u>Front Side Door Outside Handle Replacement (Passive Entry ATH)</u> , <u>Front Side Door Outside Handle Replacement (Base)</u> .	
1	Front Side Door Lock Cylinder Bezel Retainer Procedure Use a small flat-bladed tool to release the front side door lock cylinder bezel.
2	Front Side Door Lock Cylinder Bezel

FRONT SIDE DOOR LOCK REPLACEMENT

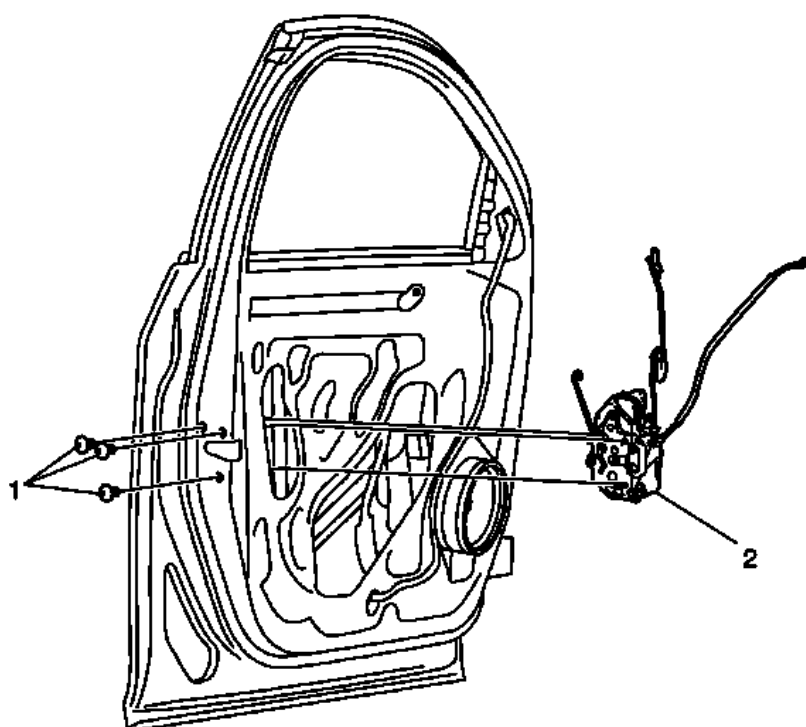


Fig. 39: Front Side Door Lock & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Lock Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Raise the window to the full up position. 2. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement . 3. Disconnect both linkage lever clip and lock cylinder rod. 	
1	Front Side Door Lock Fastener (Qty: 3) CAUTION: Refer to Fastener Caution . Procedure Remove the water deflector. Tighten 9 (80 lb in)
	Front Side Door Lock Procedure

1. Disconnect the door lock electrical connector.
2. Install the front side door outside handle rod. Refer to **Front Side Door Outside Handle Rod Adjustment**

2

NOTE:

In order to prevent outside handle lever pre-load, latch, outside handle, handle bracket and cover/cap shall be fully secured to the door prior to securing integral latch clip to outside handle rod. Integral latch clip shall be in the full up position while securing to outside handle rod.

REAR SIDE DOOR LOCK REPLACEMENT

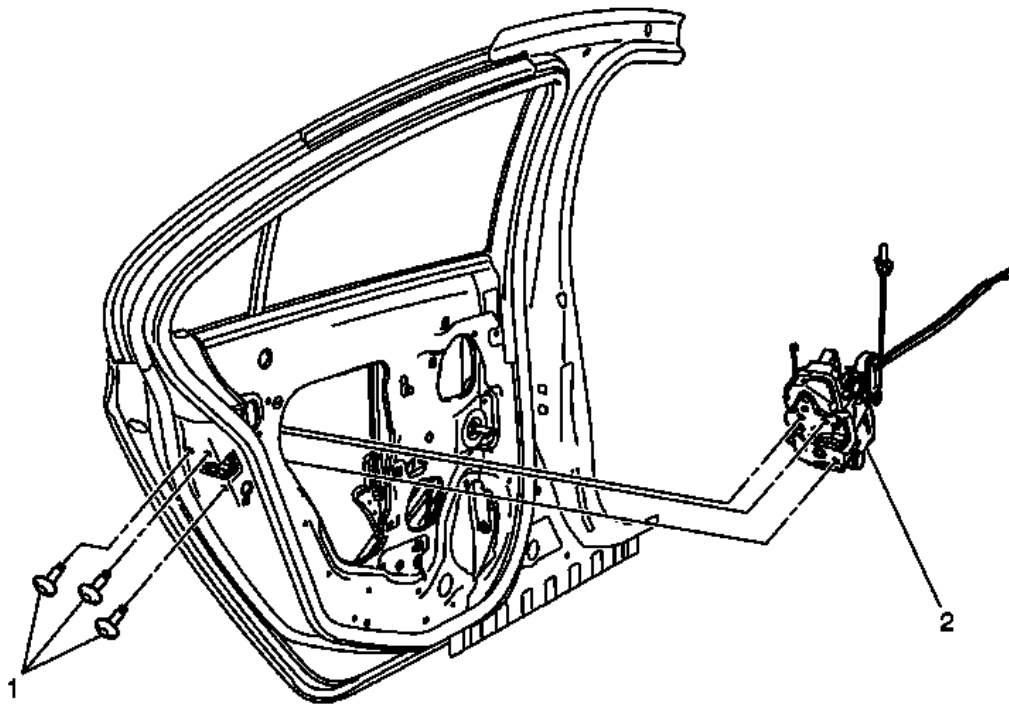


Fig. 40: Rear Side Door Lock & Fasteners

Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Lock Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear side door water deflector. Refer to <u>Rear Side Door Water Deflector Replacement</u> .	
1	Rear Side Door Lock Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .

	<p>Tighten 9 N.m (80 lb in)</p>
2	<p>Rear Side Door Lock</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Release the shift linkage lever clip. 2. Disconnect the door lock electrical connector. <p>TIP: In order to prevent outside handle lever pre-load, latch, outside handle, handle bracket and cover/cap shall be fully secured to the door prior to securing integral latch clip to outside handle rod. Integral latch clip shall be in the full up position while securing to outside handle rod.</p>

FRONT SIDE DOOR LOCKING ROD REPLACEMENT

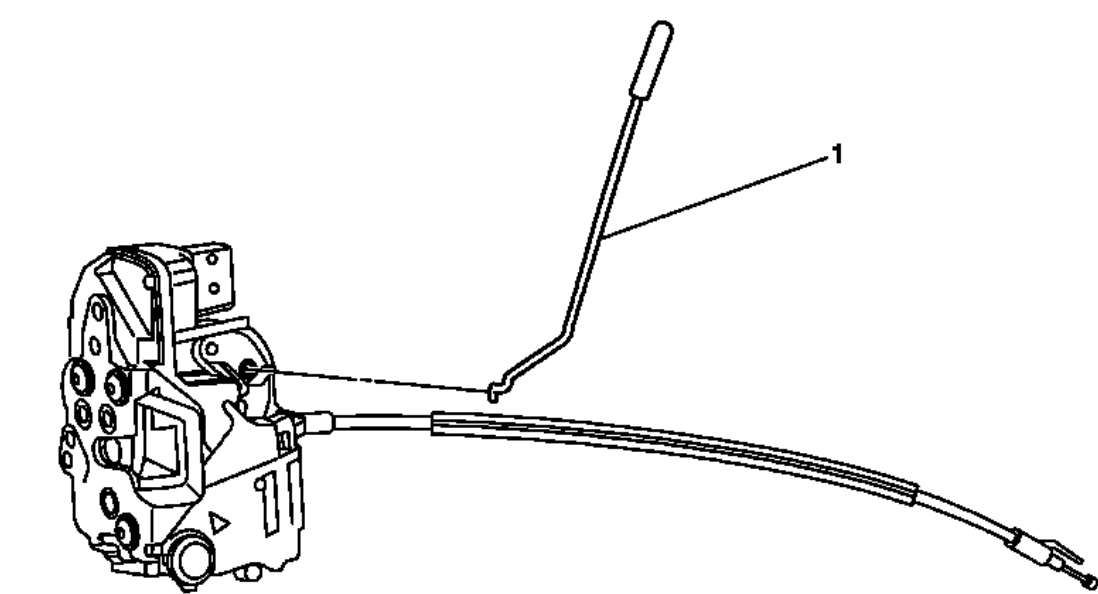


Fig. 41: Rear Side Door Locking Rod
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Locking Rod Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front side door lock. Refer to Front Side Door Lock Replacement .	

FRONT SIDE DOOR LOCK CYLINDER ROD REPLACEMENT

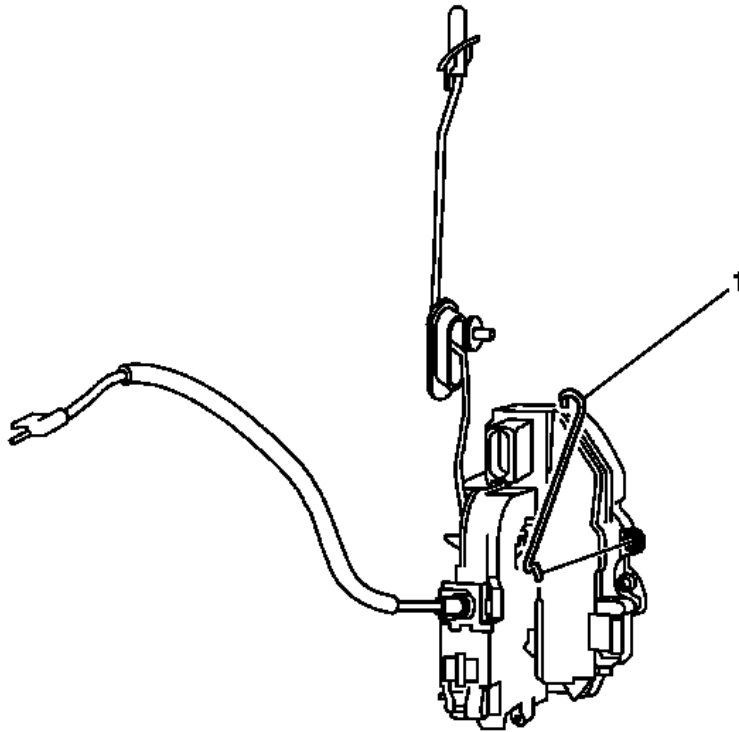


Fig. 42: Rear Side Door Outside Handle Rod
Courtesy of GENERAL MOTORS COMPANY

Front Side Door Lock Cylinder Rod Replacement

Callout	Component Name
Preliminary Procedure Remove the front side door lock. Refer to Front Side Door Lock Replacement .	
1	Front Side Door Lock Cylinder Rod

FRONT SIDE DOOR OUTSIDE HANDLE ROD ADJUSTMENT

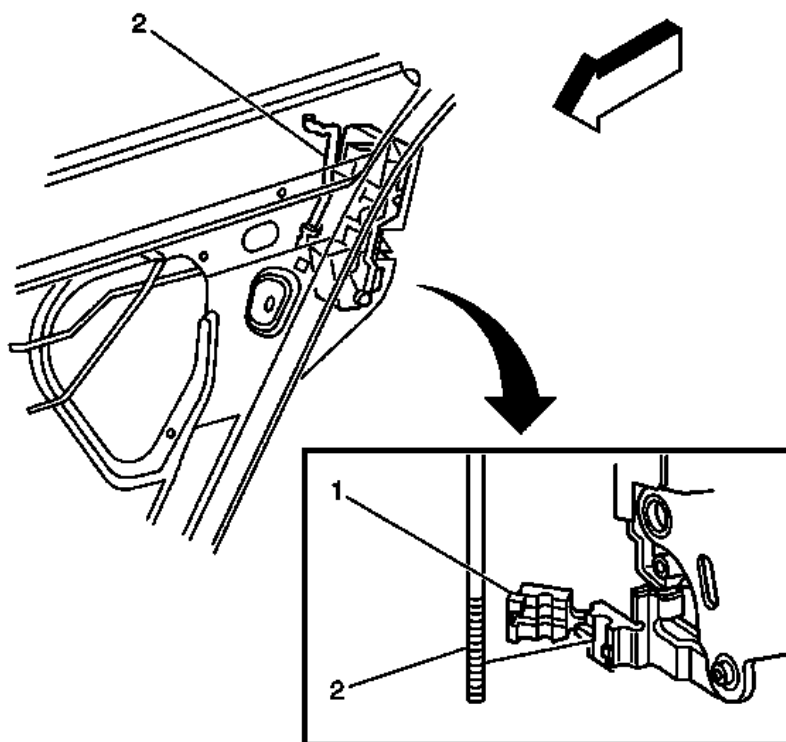


Fig. 43: Rear Side Door Outside Handle Rod & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Outside Handle Rod Adjustment

Callout	Component Name
Preliminary Procedures	
Remove the water deflector. Refer to <u>Front Side Door Water Deflector Replacement</u>	
1	Front Side Door Outside Handle Rod Retainer TIP: Use a flat-head tool to open the retainer from the threaded rod connecting the lock to the outside handle.
2	Front Side Door Outside Handle Rod Procedure <ol style="list-style-type: none"> 1. Position the front side door outside handle rod in the retainer in order to eliminate any free play in the outside door handle. 2. Adjust the travel of the handle by removing the threaded rod from the retainer. 3. Install the retainer cover closed over the threaded front side door outside handle rod. 4. Inspect the door lock system for proper operation.

FRONT SIDE DOOR OUTSIDE HANDLE ROD REPLACEMENT

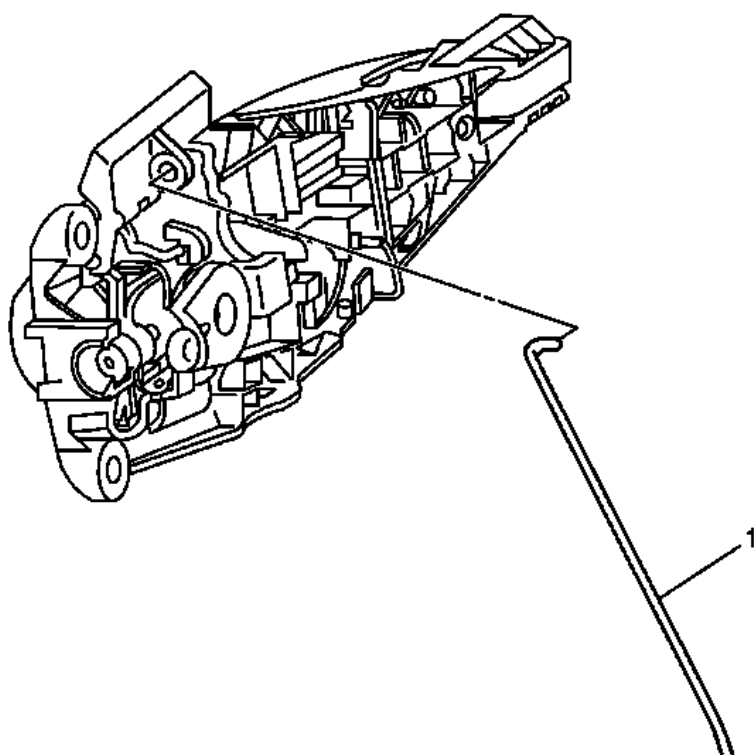


Fig. 44: Front Side Door Outside Handle Rod
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Outside Handle Rod Replacement

Callout	Component Name
Preliminary Procedure Remove the front side door outside handle bracket. Refer to <u>Front Side Door Outside Handle Bracket Replacement (Base)</u> .	
1	Front Side Door Outside Handle Rod Procedure Open the mechanism by releasing the clip at the shift linkage lever.

REAR SIDE DOOR LOCKING ROD REPLACEMENT

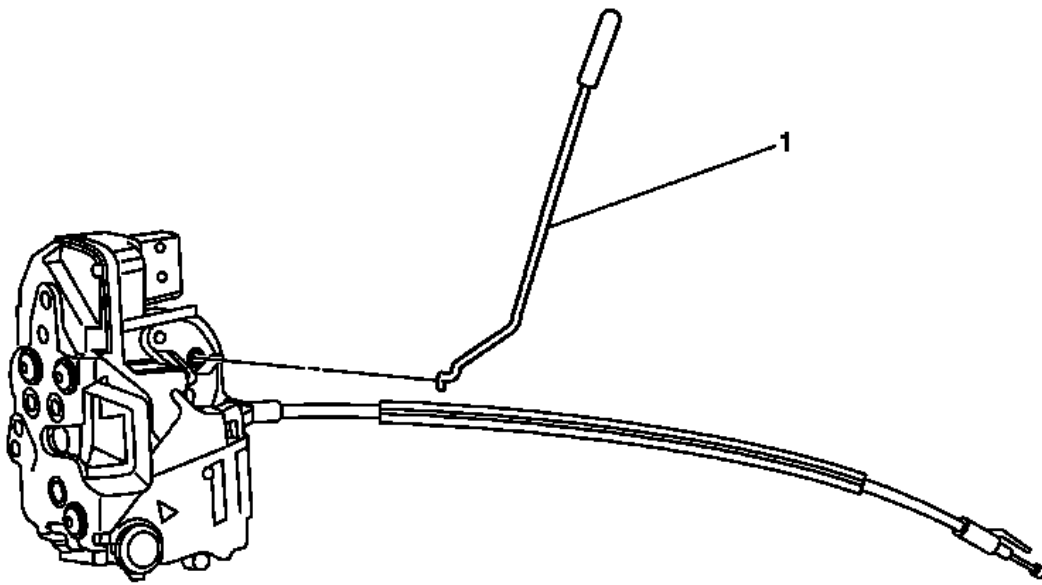


Fig. 45: Rear Side Door Locking Rod
Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Locking Rod Replacement

Callout	Component Name
Preliminary Procedure	
Remove the rear side door lock. Refer to <u>Rear Side Door Lock Replacement.</u>	
1	Rear Side Door Locking Rod

REAR COMPARTMENT LID HINGE SPRING REPLACEMENT

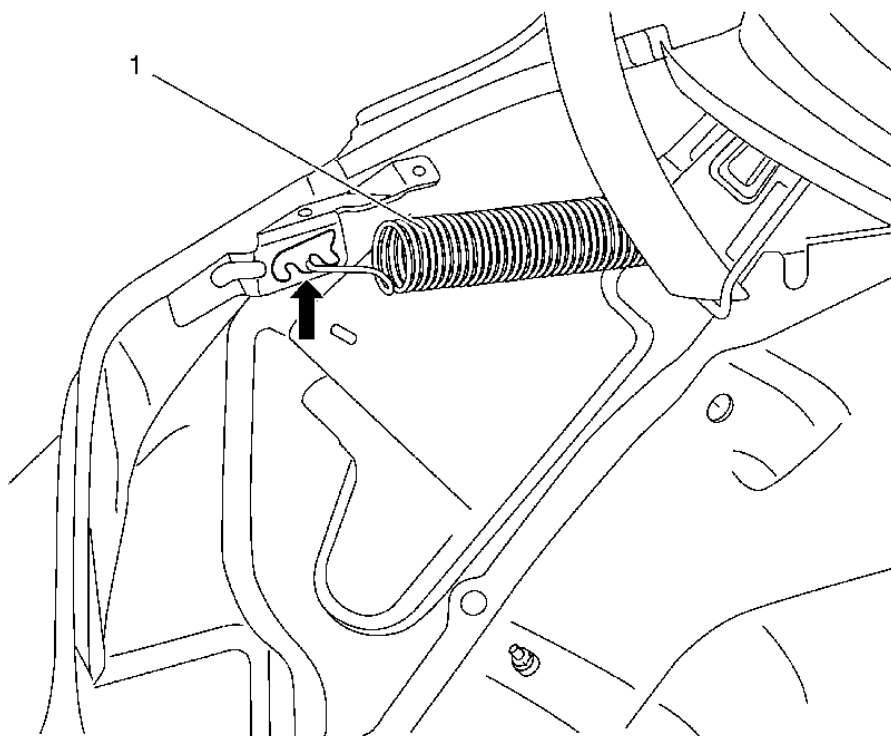


Fig. 46: Rear Compartment Lid Hinge Spring
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Hinge Spring Replacement

Callout	Component Name
WARNING: When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.	
WARNING: Refer to <u>Eye Protection Warning</u> .	
Preliminary Procedure Remove the rear compartment side trim panel. Refer to <u>Rear Compartment Side Trim Panel Replacement (without HP6)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Rear Compartment Lid Spring Procedure Pull the rear compartment lid spring backwards and unhook the rear compartment lid spring from the rear compartment lid hinge spring bracket.

FRONT SIDE DOOR LOCK STRIKER ADJUSTMENT

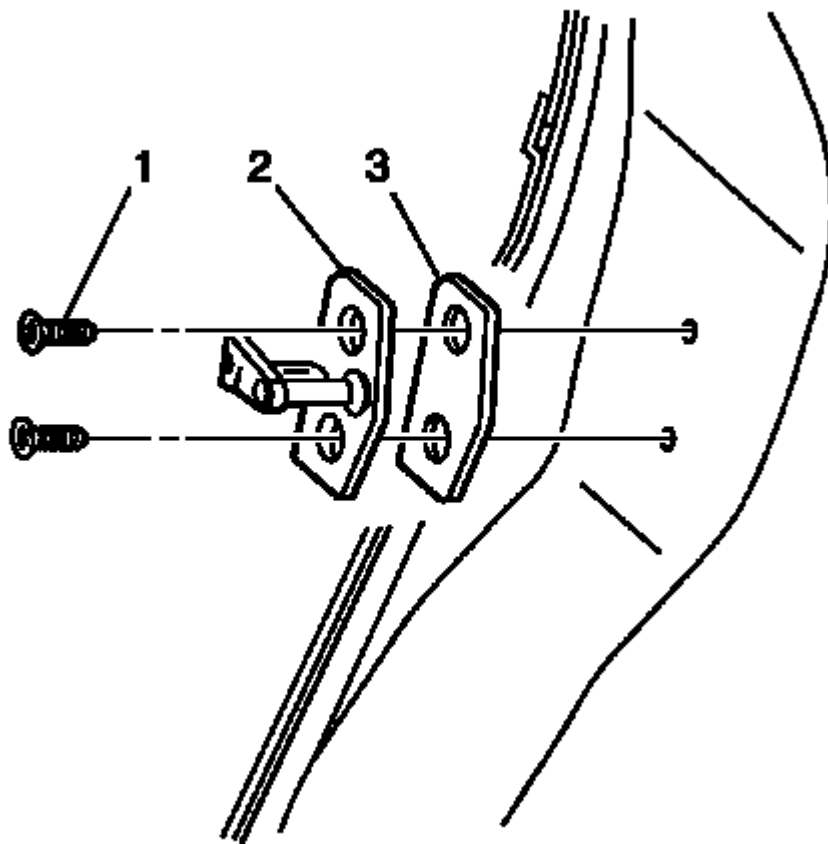


Fig. 47: Striker & Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: To determine if the striker adjustment is required, proceed as follows.

1. Ensure that the door is properly aligned with the door opening before proceeding with the striker adjustment.
2. Open and close the door on the striker (2). Note if the door drags on the striker causing the door to move upward or downward upon contact with the striker. Also note the closing effort to fully engage the latch.

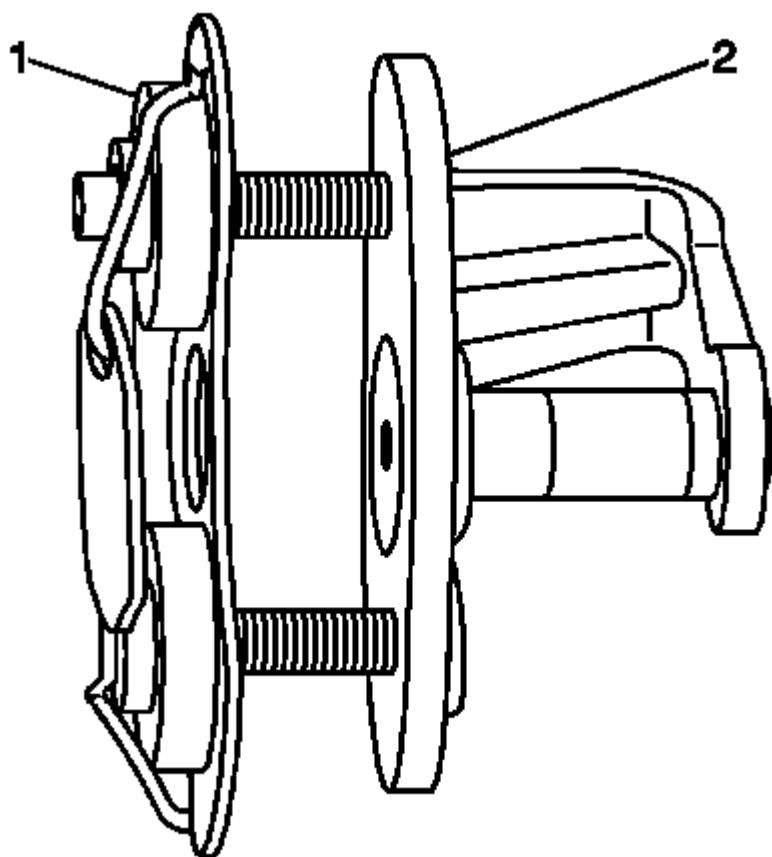


Fig. 48: Door Striker & Door Opening
Courtesy of GENERAL MOTORS COMPANY

NOTE: When the striker bolts have been removed, the striker anchor plate (1) will slip down in the door pillar or quarter panel and the trim will need to be removed to gain access.

3. Using a soft marker, mark around the striker (2) for reference of the original position. Loosen the striker screws just enough to allow the movement of the door striker and shims if equipped.

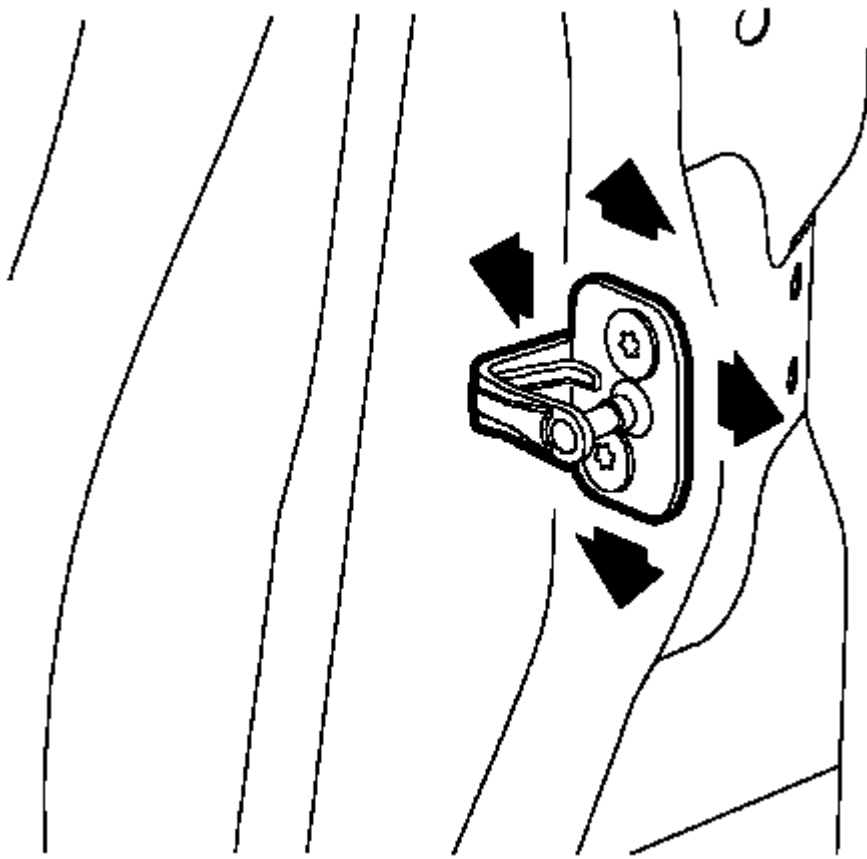


Fig. 49: View Of Door Striker

Courtesy of GENERAL MOTORS COMPANY

4. Adjust the door striker up or down and inboard or outboard as required.
5. Move the striker to eliminate drag on the striker and door latch and to achieve proper door position within door opening. Start with up/down position, then position the striker to achieve proper alignment to the door opening. Set the in/out adjustment for proper door seal engagement ensuring that the door closing efforts are correct.

CAUTION: Refer to Fastener Caution .

6. Adjust the striker and add spacers as required.

Tighten

Tighten the screws to 24 N.m (18 lb ft).

7. Inspect the door for proper operation.
8. Close the door.

FRONT SIDE DOOR LOCK STRIKER REPLACEMENT

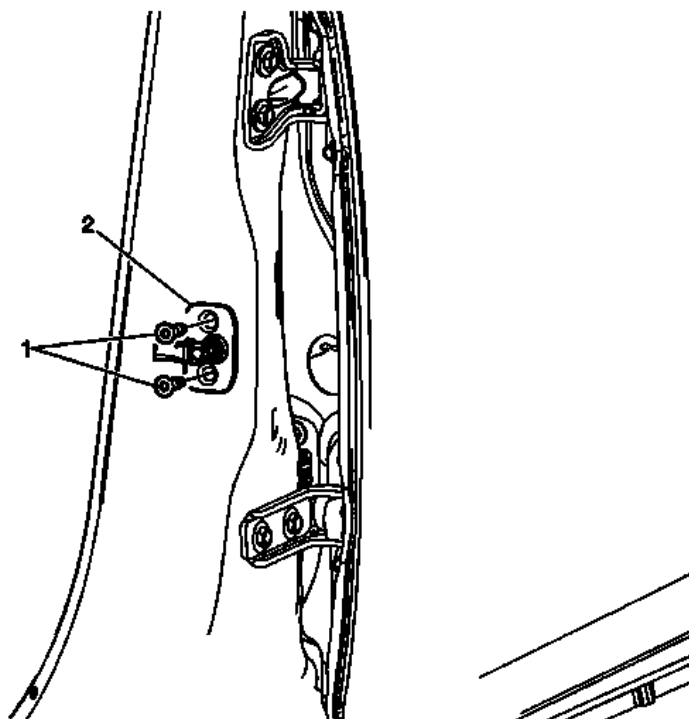


Fig. 50: Identifying Door Striker
 Courtesy of GENERAL MOTORS COMPANY

Front Side Door Lock Striker Replacement

Callout	Component Name
1	Front Door Lock Striker Screws (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 24 N.m (18 lb ft)
2	Front Door Lock Striker Procedure Ensure the alignment of the striker. Refer to <u>Front Side Door Lock Striker Adjustment</u> .

REAR COMPARTMENT LID LATCH STRIKER REPLACEMENT

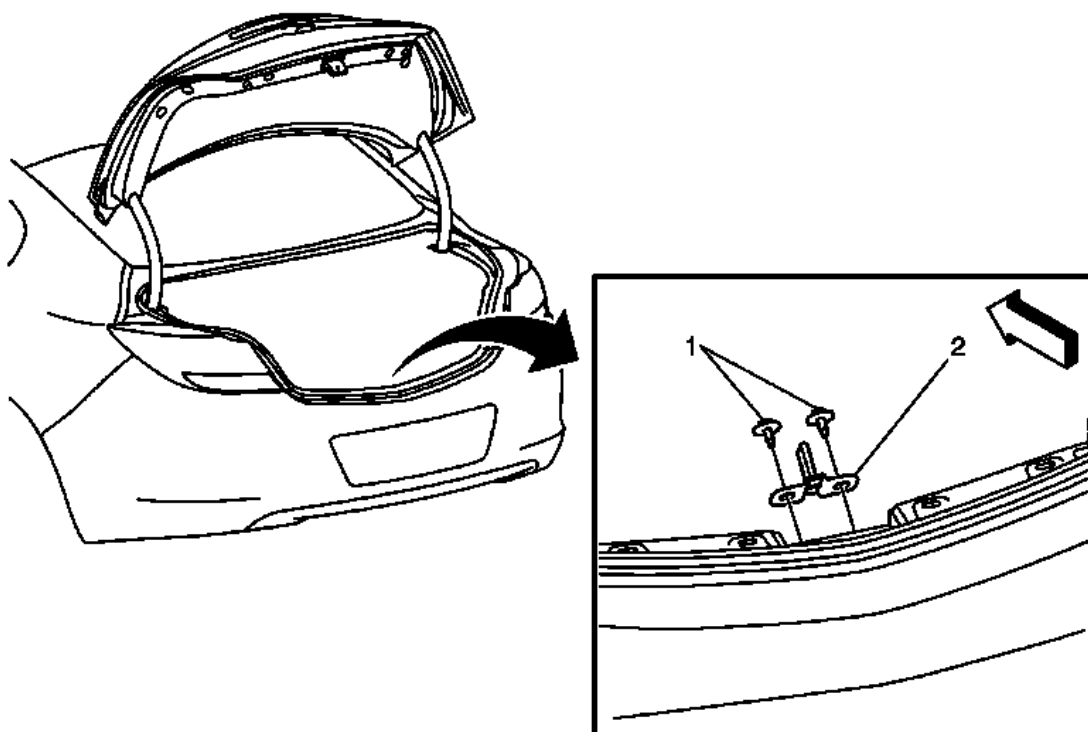


Fig. 51: Rear Compartment Lid Latch Striker
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Latch Striker Replacement

Callout	Component Name
Preliminary Procedure Remove the rear end trim finish panel. Refer to <u>Rear End Trim Finish Panel Replacement</u> .	
1	Rear Compartment Lid Latch Striker Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Procedure Use a grease pencil to outline the striker before removing the fasteners. Tighten 9 N.m (80 lb in)
2	Rear Compartment Lid Latch Striker TIP: Adjust the rear compartment lid latch striker after replacing, if needed.

REAR SIDE DOOR LOCK STRIKER ADJUSTMENT

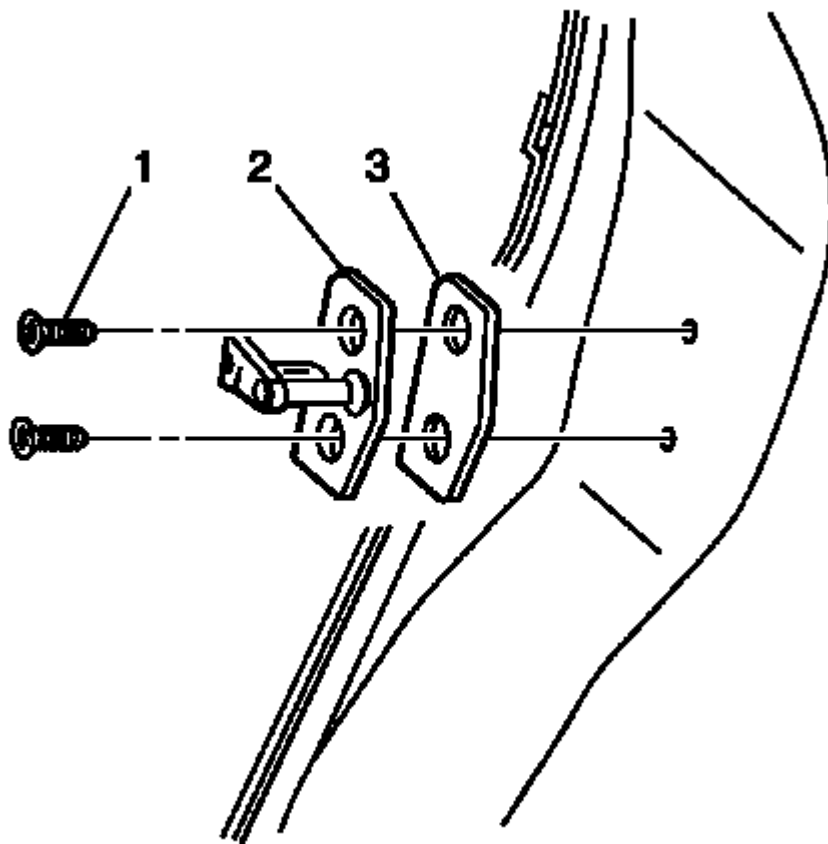


Fig. 52: Striker & Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: To determine if the striker adjustment is required, proceed as follows.

1. Ensure that the door is properly aligned with the door opening before proceeding with the striker adjustment.
2. Open and close the door on the striker (2). Note if the door drags on the striker causing the door to move upward or downward upon contact with the striker. Also note the closing effort to fully engage the latch.

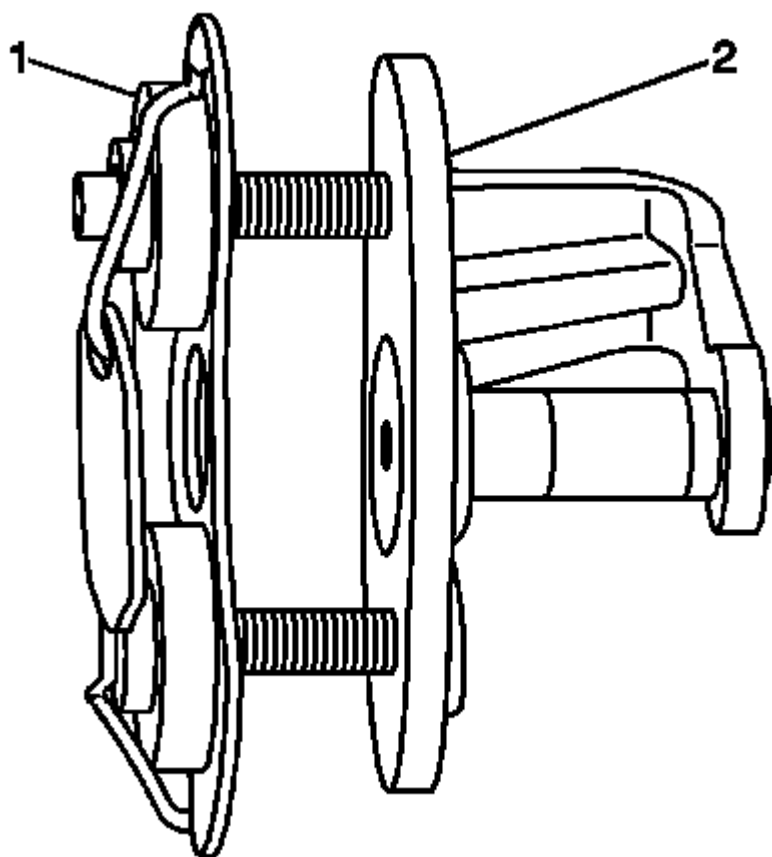


Fig. 53: Door Striker & Door Opening
Courtesy of GENERAL MOTORS COMPANY

NOTE: When the striker bolts have been removed, the striker anchor plate (1) will slip down in the door pillar or quarter panel and the trim will need to be removed to gain access.

3. Using a soft marker, mark around the striker (2) for reference of the original position. Loosen the striker screws just enough to allow the movement of the door striker and shims if equipped.

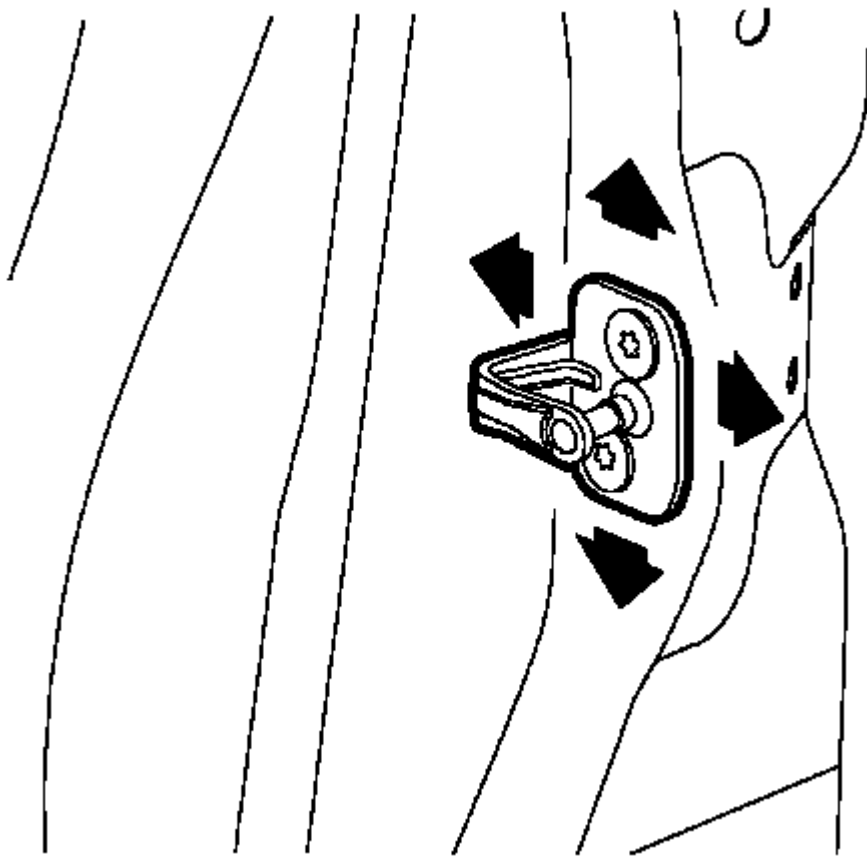


Fig. 54: View Of Door Striker

Courtesy of GENERAL MOTORS COMPANY

4. Adjust the door striker up or down and inboard or outboard as required.
5. Move the striker to eliminate drag on the striker and door latch and to achieve proper door position within door opening. Start with up/down position, then position the striker to achieve proper alignment to the door opening. Set the in/out adjustment for proper door seal engagement ensuring that the door closing efforts are correct.

CAUTION: Refer to Fastener Caution .

6. Adjust the striker and add spacers as required.

Tighten

Tighten the screws to 24 N.m (18 lb ft).

7. Inspect the door for proper operation.
8. Close the door.

REAR SIDE DOOR LOCK STRIKER REPLACEMENT

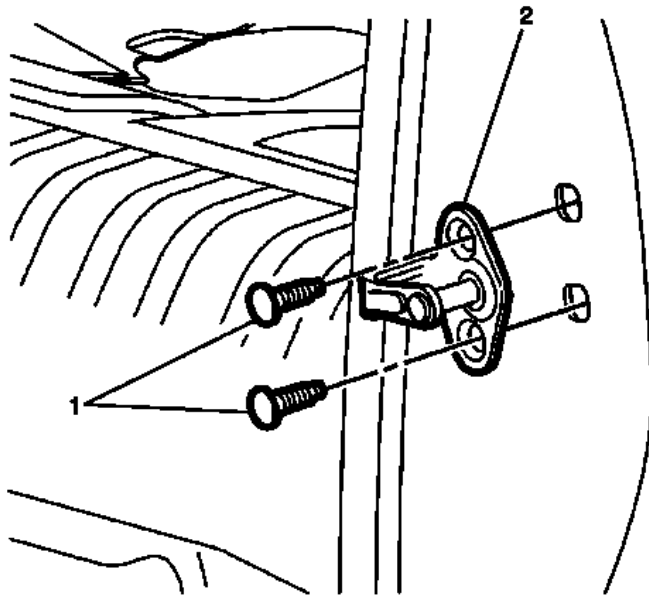


Fig. 55: Rear Side Door Lock Striker & Screws
 Courtesy of GENERAL MOTORS COMPANY

Rear Side Door Lock Striker Replacement

Callout	Component Name
1	Rear Side Door Lock Striker Screws (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 24 N.m (18 lb ft)
2	Rear Side Door Lock Striker Procedure Ensure the alignment of the striker. Refer to <u>Rear Side Door Lock Striker Adjustment</u> .

DOOR LOCK SWITCH REPLACEMENT - FRONT

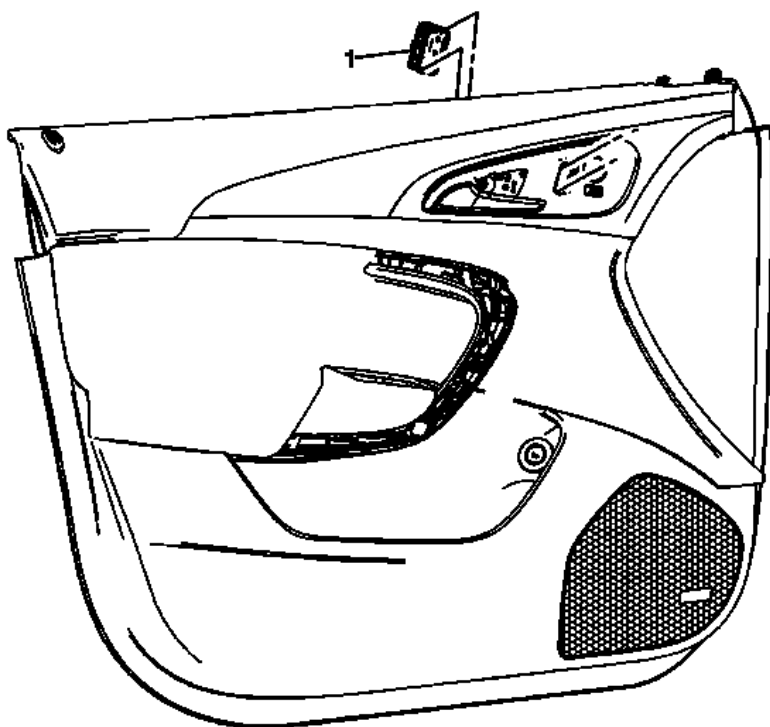


Fig. 56: Door Lock Switch - Front
 Courtesy of GENERAL MOTORS COMPANY

Door Lock Switch Replacement - Front

Callout	Component Name
Preliminary Procedure	
Remove the front side door trim. Refer to <u>Front Side Door Trim Panel Replacement</u> .	
1	Door Lock Switch Assembly
	Procedure
	1. Using a plastic pry tool, gently pry on the sides to release the switch.
	2. Disconnect the electrical connector.
	3. Refer to <u>Control Module References</u> for programming and set up procedures.

REAR COMPARTMENT LID RELEASE SWITCH REPLACEMENT (INTERIOR)

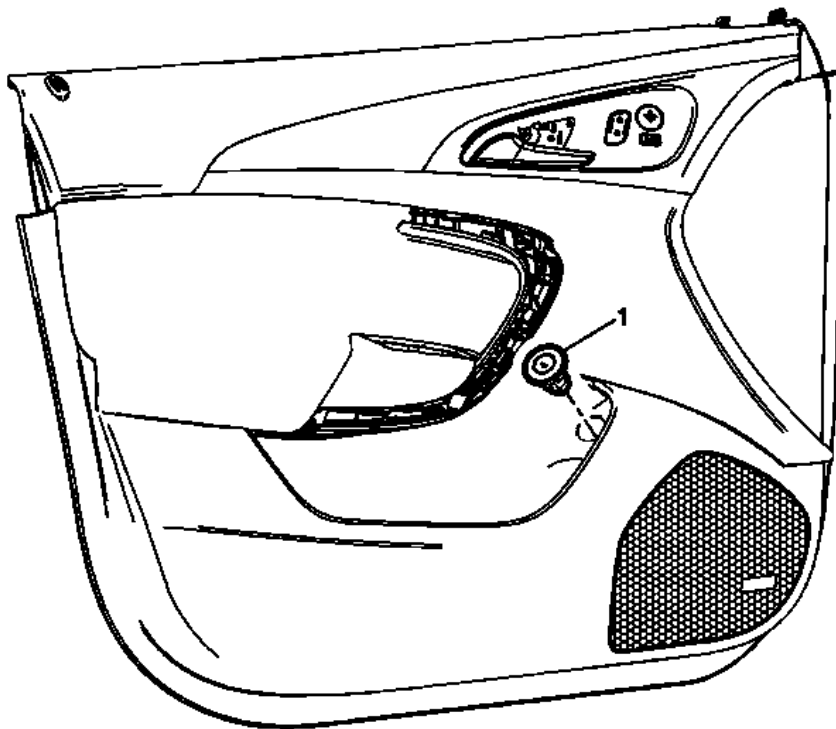


Fig. 57: Rear Compartment Lid Release Switch (Interior)
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Release Switch Replacement (Interior)

Callout	Component Name
Preliminary Procedure	
Remove the front side door trim. Refer to <u>Front Side Door Trim Panel Replacement</u> .	
1	Rear Compartment Lid Release Switch Assembly Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Push the 2 tabs in to release the switch from the front side door trim.

REAR COMPARTMENT LID RELEASE SWITCH REPLACEMENT (EXTERIOR)

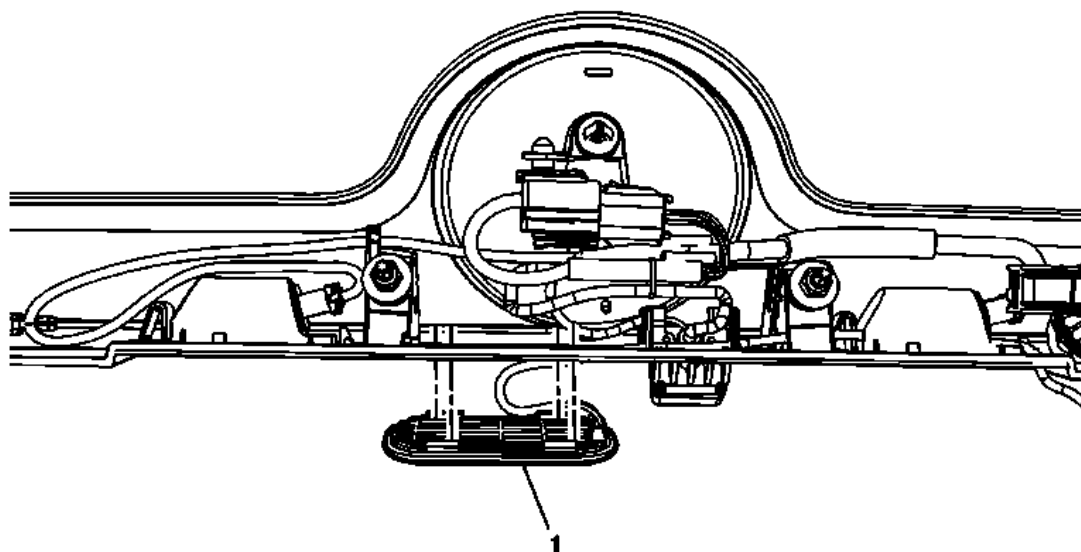


Fig. 58: Rear Compartment Lid Release Switch (Exterior)
 Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Release Switch Replacement (Exterior)

Callout	Component Name
Preliminary Procedure	
Remove the rear closure center applique. Refer to <u>Rear Closure Center Applique Replacement</u> .	
1	Rear Compartment Lid Release Switch Procedure Use a small flat-bladed tool on the 4 retainers, 2 on each side, to release the rear compartment lid release switch.

DESCRIPTION AND OPERATION

DOOR AJAR INDICATOR DESCRIPTION AND OPERATION

Door Ajar Indicator System Components

The door ajar indicator system consists of the following components:

- Body control module (BCM)
- Instrument cluster
- Driver door latch
- Passenger door latch

- Left rear door latch
- Right rear door latch
- Driver window motor
- Passenger window motor
- Left rear window switch
- Right rear window switch

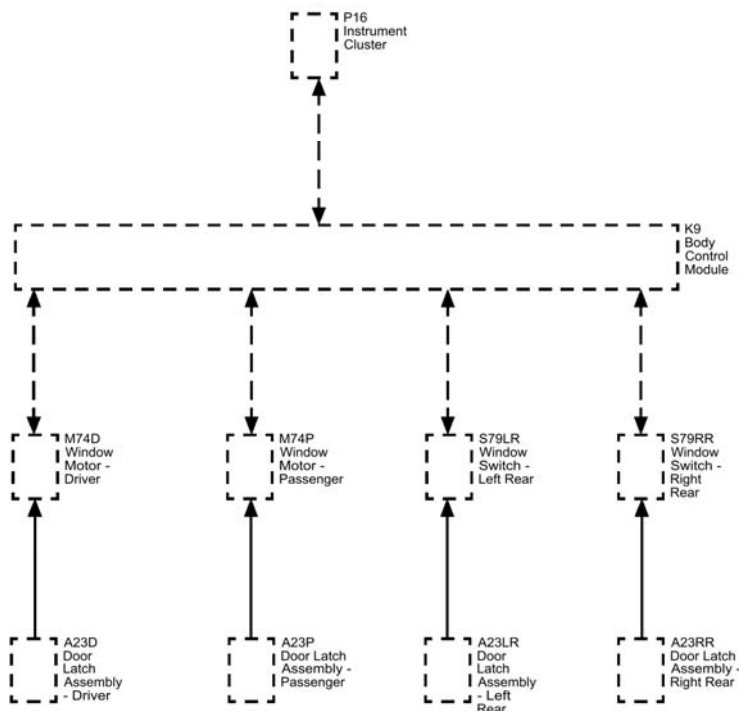


Fig. 59: Door Ajar Indicator Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Driver and Passenger Door Ajar

The window motor supplies a 12 V signal to the door ajar switch within the door latch, when a door is open the door ajar switch closes pulling the 12 V signal low. When the window motor detects the drop in the 12 V signal circuit, it will then communicate this status to the BCM via local interconnect network (LIN) bus. The BCM communicates with the instrument cluster via serial data message. The instrument cluster, upon receipt of this serial data message, will illuminate the door ajar indicator and also send a serial data message to the radio to

activate the door ajar audible warning when the vehicle speed is greater than 8 km/h (5 mph).

Rear Doors Ajar

The rear window switches each provide a 12 V signal to their respective door ajar switch signal circuits. The rear door ajar switches are integral to each rear door latch assembly. When a rear door is opened, the normally open door ajar switch closes. With the door ajar switch closed, ground is provided to the door ajar switch signal circuit and the voltage within the signal circuit drops. The rear window switch will detect the voltage drop and will send a serial data message to the body control module which will then send a message to the instrument cluster to command the door ajar message

FUEL FILL DOOR DESCRIPTION AND OPERATION

Fuel Door Release System Components

- Body control module (BCM)
- Fuel door release actuator

The locking and unlocking of the fuel door is a function of the power door lock system. The fuel door release actuator is supplied by the door lock control circuit and the driver door unlock control circuit. The BCM, upon receipt of a lock switch lock or unlock signal, will supply battery voltage to the door lock actuator lock or unlock control circuits. Since the opposite side of the lock actuator is connected to ground through the other lock actuator control circuit, the driver door latch assembly and the fuel door release actuator will then lock or unlock as commanded.

LUGGAGE COMPARTMENT DESCRIPTION AND OPERATION

Rear Compartment Lid Release System Components

- Body control module (BCM)
- Exterior rear compartment lid unlatch switch
- Interior rear compartment lid unlatch switch
- Rear compartment lid latch
- Trunk ajar switch (Part of the rear compartment lid latch)
- Underhood fuse block (Contains rear compartment lid unlatch PCB relay)

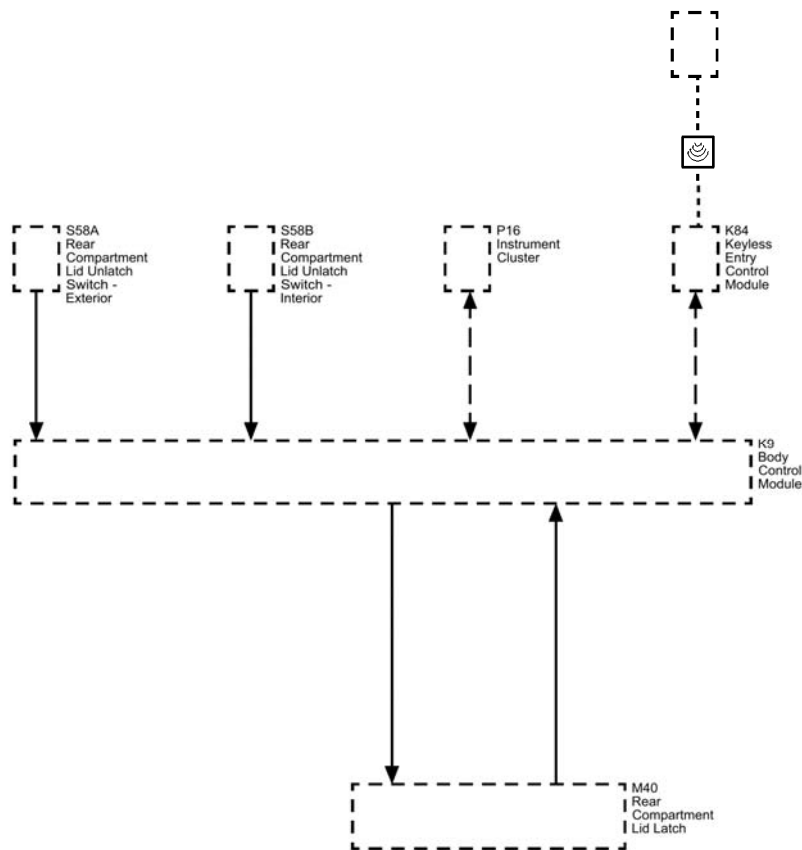


Fig. 60: Luggage Compartment Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Rear Compartment Lid Release Operation

Rear Compartment Lid Unlatch Switch

The BCM monitors a voltage signal to the interior and exterior rear compartment lid unlatch switch so that when either switch is pressed, the voltage within the signal circuit is pulled low and in response, the BCM will detect the voltage drop and check the status of the door lock system. If the vehicle doors are locked, the BCM will ignore the switches, if the vehicle doors have been unlocked, the BCM will recognize the request and will provide voltage to the rear compartment lid unlatch PCB relay.

Rear Compartment Lid Latch

When BCM receives a rear compartment lid release command from the exterior rear compartment lid unlatch switch, the BCM applies brief pulse of voltage to the rear compartment lid unlatch PCB relay control circuit, which energizes the coil side of the relay. The switch side of the rear compartment lid unlatch PCB relay then

momentarily closes, supplying a brief pulse of battery positive voltage to the rear compartment lid latch. The rear compartment lid latch is continuously grounded and when it receives the voltage pulse, it will become energized and the latch will activate releasing the trunk lid so that the trunk lid may be manually raised to an open position.

Keyless Entry Transmitter

The BCM may also get a rear compartment lid release command from the remote keyless entry module. When the trunk button is pressed on the keyless entry transmitter, a rear compartment lid release request is sent to the remote keyless entry module, the remote keyless entry module will then send a serial data message to the BCM to command the release of the rear compartment lid.

Trunk Open Message

The body control module (BCM) monitors the voltage level of the trunk ajar signal circuit which is normally at the system voltage when the trunk lid is closed. When the trunk lid is ajar or open, a switch within the latch assembly closes providing a path to ground for the trunk ajar signal circuit. The voltage within the signal circuit will then drop to 0 volts, the BCM will then detect the voltage drop and will send a serial data message to the instrument panel. The instrument panel will then display the Trunk Open message.

POWER DOOR LOCKS DESCRIPTION AND OPERATION

Door Lock System Components

The power door lock system consists of the following components:

- Driver door lock switch
- Passenger door lock switch
- Rear window/door lockout switch, located on the driver window switch
- Body control module (BCM)
- Driver door latch
- Passenger door latch
- Left rear door latch
- Right rear door latch
- Door lock security PCB relay
- Exterior door handle switches
- Keyless entry control module

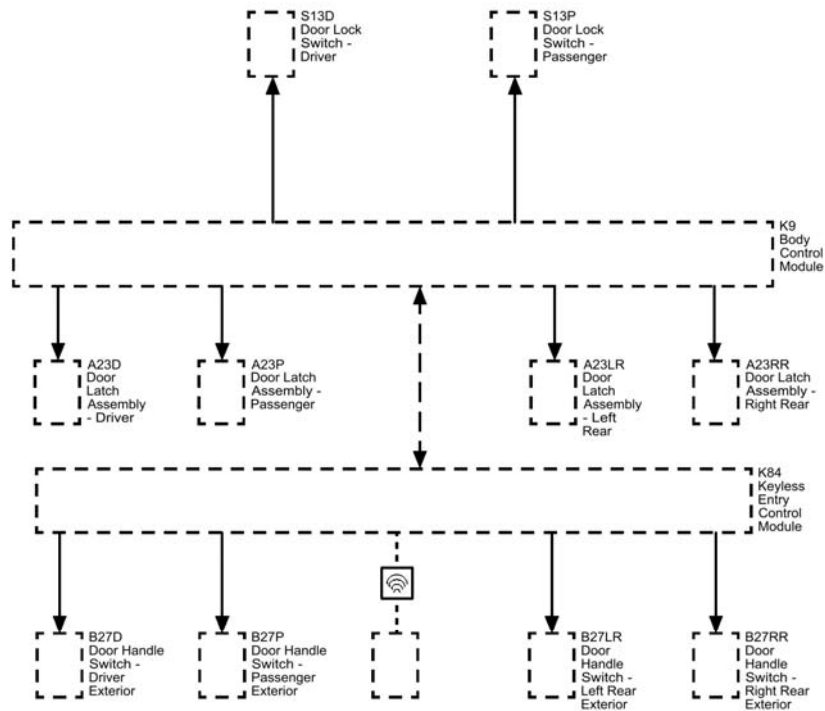


Fig. 61: Power Door Locks Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Door Lock and Unlock Operation

When a door lock switch is activated in the lock or unlock position, the BCM will receive a ground signal on either the door lock switch lock or unlock signal circuits.

The BCM, upon receipt of a lock switch lock or unlock signal, will supply battery voltage to the door lock actuator lock or unlock control circuits. Since the opposite side of the lock actuator is connected to ground through the other lock actuator control circuit, the doors will then lock or unlock as commanded.

The following three circuits are used to operate the lock:

- Driver door unlock
- Passenger door unlock
- All door lock

The driver door lock actuator is isolated so it can be unlocked by itself using the keyless entry transmitter.

Passive Door Lock/Unlock Operation

The exterior door handle switch signal circuits provide inputs to the keyless entry control module when the exterior door handle switches are activated. These inputs allow the keyless entry control module to detect a door lock or a door unlock request. The keyless entry control module provides a 12 V signal to each exterior door handle switch via the door handle switch signal circuits. When a door handle switch is pressed, the switch closes and the voltage signal within the signal circuit is pulled to ground. The keyless entry control module will detect the voltage drop and a low frequency antenna will transmit a challenge to the keyless entry transmitter. If the challenge is met, the keyless entry transmitter will respond, and the keyless entry control module will send a serial data message to the body control module to command the door(s) to be locked or unlocked

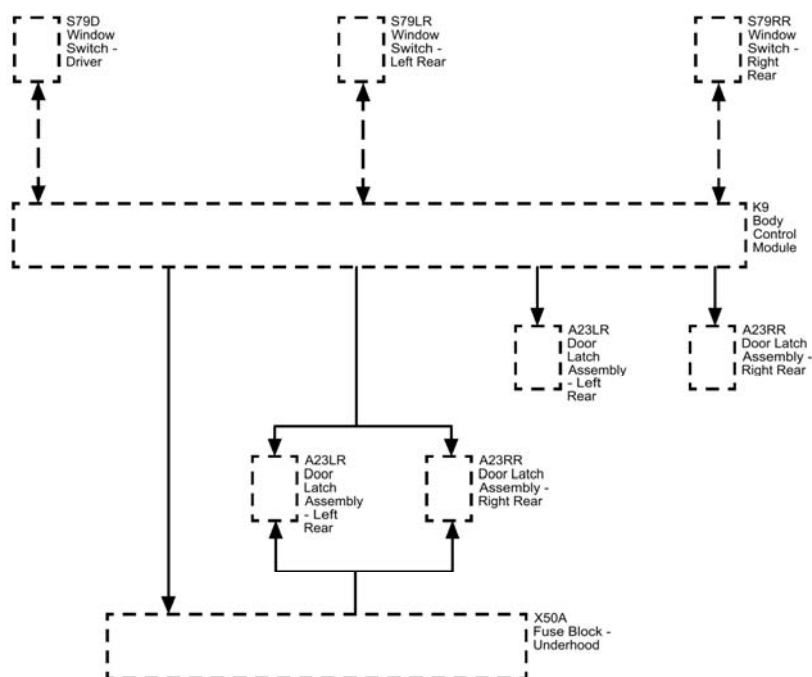


Fig. 62: Power Door Child Lock Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Rear Window and Rear Door Lockout Operation

The operator has the option to disable the interior rear door handles to prevent the unauthorized opening of the rear door doors while still retaining normal driver and passenger door handle functions. The driver door window switch has a lockout switch that will disable the interior rear door handles and the local rear window switches. When the lockout switch is pressed, the BCM will command the child lockout latches and will also send a disable command to the local rear window switches. The driver and passenger doors will still function normally by pressing a door lock switch which will unlock the doors but the child lockout latches will continue to disable the interior rear door handles.

Pressing the lockout switch again will signal a command to the BCM to unlatch the rear doors, restore normal interior rear door handle functions and restore normal function of the rear window switches

If the lockout indicator flashes while commanding the lockout system, indicates that the BCM has detected a fault in the system and that one or both interior rear door handles are not locked out and/or the local rear window switches are not locked out.

GENERAL INFORMATION

Vehicle Diagnostic Information - Specifications

SPECIFICATIONS

AUDIO AMPLIFIER SCAN TOOL INFORMATION

Amplifier Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Power Mode	Run	The scan tool displays Off, Accessory, Run or Crank Request. This is the vehicle power mode status as received via serial data.
Active Noise Cancellation	On	The scan tool displays On or Off. This indicates if the Active Noise Cancellation feature is available and capable of operating.
Engine Speed Signal	Normal	The scan tool displays Normal or Malfunction. This is the status of the dedicated engine speed signal circuit.
Battery Voltage	Varies	The scan tool displays volts. This is the voltage at the input to the amplifier.
Vehicle Speed	0 km/h	The scan tool displays the vehicle speed received by the amplifier in km/h or mph.
Engine Speed	0 RPM	The scan tool displays the current engine speed received by the amplifier in RPM .
Calculated System Temperature	Varies	The scan tool displays the calculated temperature of the amplifier in °C or °F.
Active Noise Cancellation Speaker Output	OK	The scan tool displays OK or Malfunction. This is the status of the amplifier speaker outputs.
Cylinder Deactivation System Command	Varies	The scan tool displays 8 Cylinder Active, Transitioning from 8 to 4, 4 Cylinder Active, Transitioning from 4 to 8, or Malfunction. This is the status of the cylinder deactivation mode as received via serial data. Malfunction is displayed when this data is not being received, or when the engine is not running.
Microphone Status	Normal	The scan tool displays Normal, Clipped, or Malfunction.
Microphone 1 Input Level	Varies	The scan tool displays counts from 0 to 65,535. This is the sound level currently being received by the microphone 1, with higher numbers indicating louder sounds.
Microphone 2 Input Level	Varies	The scan tool displays counts from 0 to 65,535. This is the sound level currently being received by the microphone 2, with higher numbers indicating louder sounds.

Microphone 3 Input Level	Varies	The scan tool displays counts from 0 to 65,535. This is the sound level currently being received by the microphone 3, with higher numbers indicating louder sounds.
Door Status	Varies	The scan tool displays All Closed or One or More Open. This is the current status of the vehicle access door latches as received via serial data.
Folding Top Status	Varies	The scan tool displays Closed, Open, Malfunction, or Normal. This is the current position of the vehicle folding top (if equipped) as received via serial data.
Calibration Part Number 1	Varies	The scan tool displays the software calibration part number 1.
Calibration Part Number 2	Varies	The scan tool displays the software calibration part number 2.
Calibration Part Number 3	Varies	The scan tool displays the software calibration part number 3.
Calibration Part Number 4	Varies	The scan tool displays the software calibration part number 4.
Calibration Part Number 5	Varies	The scan tool displays the software calibration part number 5.
Calibration Part Number 6	Varies	The scan tool displays the software calibration part number 6.
Calibration Part Number 7	Varies	The scan tool displays the software calibration part number 7.
Calibration Part Number 8	Varies	The scan tool displays the software calibration part number 8.
Calibration Part Number 9	Varies	The scan tool displays the software calibration part number 9.
Calibration Part Number 10	Varies	The scan tool displays the software calibration part number 10.
End Model Part Number	Varies	The scan tool displays the end software module part number.
Diagnostic Data Identifier	Varies	Identifies a supplier and system specific data stream used by diagnostic testers to interpret a diagnostic data stream.

BODY CONTROL MODULE SCAN TOOL INFORMATION

Body Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions: Ignition ON, Vehicle in Park, All Doors Closed			
5 V Ignition Switch	-	Accessory / Key Out	The scan tool displays Off, Accessory, Run, or Crank. This parameter displays the ignition switch mode.
			This parameter displays the interior

Accent Lighting 1 Command	-	Varies	lighting ambient 1 command as a percentage.
Accent Lighting 2 Command	-	Varies	This parameter displays the interior lighting ambient 2 command as a percentage.
Accessory	-	Active	The scan tool displays Active or Inactive.
Accessory Power Mode Indicator Command	-	Varies	This parameter displays ignition switch accessory LED PWM command as a percentage.
Accessory Relay Command	-	Active	The scan tool displays Active or Inactive.
Accessory/Retained Accessory Power Relay Command	-	Active	The scan tool displays Active or Inactive. This parameter displays the retained accessory power relay status.
All Doors Lock Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the door lock status.
Ambient Light Sensor	-	Varies	The scan tool displays volts. This parameter displays the ambient light sensor signal voltage.
Ambient Light Status	-	Night	The scan tool displays Unknown, Night, or Day. This parameter displays the ambient light level status.
Automatic Headlamps Disable Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the headlamp disable switch status.
Automatic Transmission Manual Shift Switch	-	Off	The scan tool displays Off or On. This parameter displays the transmission tap up tap down switch status.
Backup Lamps Relay Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the backup lamps relay status.
Battery Current Sensor	-	Varies	The scan tool displays the battery current in amperes.
Battery Low at Start	-	Inactive	The scan tool displays Active or Inactive. This parameter displays Active when the battery level is low when the vehicle starts.
Battery Reconnect Detected	-	No	The scan tool displays No or Yes when a battery disconnect/reconnect event has been detected.
Battery Voltage	-	Varies	The scan tool displays the current battery voltage.
BCM-Controlled Charging Voltage	-	Active	The scan tool displays Active or Inactive.
			The scan tool displays Active or Inactive.

BCM-Requested Charging Voltage Reduction	-	Inactive	This parameter displays Active when the BCM has detected a low battery voltage condition.
Boot Software Part Number	-	Varies	The scan tool displays the boot software part number.
Brake Lamp Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the brake lamp command status.
Brake Pedal Applied	-	Inactive	The scan tool displays Active or Inactive.
Brake Pedal Initial Travel Position Achieved	-	No	The scan tool displays No or Yes.
Brake Pedal Position Sensor	-	Varies	This displays Counts. This numeric value is the current brake pedal position.
Brake Pedal Position Sensor High Voltage During Learn	-	No	The scan tool displays No or Yes.
Brake Pedal Position Sensor Learn	-	No	The scan tool displays No or Yes. This parameter displays Yes when the brake pedal position sensor has learned.
Brake Pedal Position Sensor Learned Home Position	-	Yes	The scan tool displays No or Yes. This parameter displays Yes when the brake pedal position sensor has learned the home position.
Brake Pedal Position Sensor Learned Released Position	-	Yes	The scan tool displays No or Yes. This parameter displays Yes when the brake pedal position sensor has learned the released position.
Brake Pedal Position Sensor Learned Released Position	-	Varies	The scan tool displays volts.
Brake Pedal Position Sensor Learned Released Position	-	Varies	The scan tool displays percentage.
Brake Pedal Position Sensor Low Voltage During Learn	-	No	The scan tool displays No or Yes.
Brake Pedal Position Sensor Move During Learn	-	No	The scan tool displays No or Yes. This parameter displays the brake pedal sensor learn status.
Brake Pedal Position Sensor Pulled Up from Home Position	-	No	The scan tool displays No or Yes.
Brake Pedal Position Sensor Reference	-	Varies	The scan tool displays the brake pedal position as voltage value. This parameter displays the current brake pedal position sensor reference.
Brake Pedal Pulled Up from Home Position	-	No	The scan tool displays No or Yes.
Brake Pedal Pulled Up from	-	No	The scan tool displays No or Yes.

Released Position			
Brake Transmission Shift Interlock Solenoid Actuator	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the remote start diagnostic status history.
Brake Transmission Shift Interlock Solenoid Actuator Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the last remote start diagnostic status history.
Calculated Brake Pedal Position	-	Varies	The scan tool displays volts.
Calculated Brake Pedal Position	-	Varies	The scan tool displays percentage.
Calibration Part Number 1-20	-	Varies	The scan tool displays the software module calibration part number.
Center Brake Lamp Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the center brake lamp status.
Center Stop Lamp Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the center stop lamp status.
Central Door Lock Switch on Center Console/Passenger Door Lock Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the driver door lock switch status.
Child Security Lock Indicator Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the child security lock indicator command status.
Child Security Lock Motors Command	-	Inactive	The scan tool displays Active or Inactive.
Child Security Lock/Window Lockout Switch	-	Inactive	The scan tool displays Active or Inactive.
Child Security Lock/Window Lockout Switch Indicator Command	-	Inactive	The scan tool displays Active or Inactive.
Content Theft Deterrent Alarm Status	-	Disarmed	The scan tool displays Off, Armed, or Disarmed. This parameter displays the content theft alarm status.
Content Theft Deterrent Disarmed Until Vehicle Closed	-	No	The scan tool displays No or Yes. This parameter displays the content theft deterrent system status.
Content Theft Deterrent Mode	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history.
			The scan tool displays None, Driver door, Passenger door, Left rear door, Right rear door, Rear closure, Midgate, Tonneau

Content Theft Deterrent Trigger History 1-3	-	None	Cover, Hood, Ignition Voltage, Intrusion, Inclination, Telematics enhanced service alarm, Battery reconnect detected, Unauthorized PWM change, Security Indicates Tamper, or Glass Breakage. This parameter displays the content theft deterrent trigger history status.
Courtesy Lamps Duty Cycle Command	-	Varies	This parameter displays the interior lights dimming command as a percentage.
Crank Abort	-	Inactive	This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history.
Cruise Charging Set Level	-	Varies	This parameter displays cruise charging set level.
Cruise Control Switch Status	-	OFF	The scan tool displays CANCEL, OFF, ON, RESUME, SET or ERROR. This parameter displays the cruise control switch status.
Current Content Theft Deterrent Trigger	-	None	The scan tool displays None, Driver door, Passenger door, Left rear door, Right rear door, Rear closure, Midgate, Tonneau Cover, Hood, Ignition Voltage, Intrusion, Inclination, Telematics enhanced service alarm, Battery reconnect detected, Unauthorized PWM change, Security Indicates Tamper, Glass Breakage. This parameter displays the content theft deterrent current alarm trigger.
Current Driver	-	1-8	This parameter displays the current driver in vehicle.
Disable Battery Saver Relay Command	-	Inactive	The scan tool displays Active or Inactive.
Dome Lamp Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the dome lamp switch status.
Door Lock Switch	-	Inactive	The scan tool displays Active or Inactive.
Driver Door Ajar Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the driver door Ajar switch status.
Driver Door Key Unlock Switch	-	Inactive	The scan tool displays Active or Inactive.
Driver Door Lock Switch	-	Inactive	The scan tool displays Active or Inactive.
Driver Door Unlatch Command	-	Inactive	The scan tool displays Active or Inactive.
Driver Door Unlock	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the driver door

Command			unlock command status.
Driver Seat Heating Switch	-	Inactive	The scan tool displays Active or Inactive.
Driver Seat Heating/Venting/Cooling Mode	-	Off	The scan tool displays On or Off.
Driver Seat Ventilation Switch	-	Inactive	The scan tool displays Active or Inactive.
Driver Window Learned	-	Yes	The scan tool displays No or Yes.
Driver Window Main Control Down Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the driver window main control down switch input status.
Driver Window Main Control Express Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the driver window switch express input status.
Driver Window Main Control Up Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the driver window switch UP input status.
Driver Window Motor Mode	-	Local Switch Overridden	The scan tool displays Down, Express Down, Express, Up, Error, Inhibit, or Local Switch Overridden. This parameter displays the driver window motor mode status.
Driver Window Motor Reversing Status	-	No	The scan tool displays No or Yes.
Driver Window Motor Sensing System Fault Status	-	No	The scan tool displays No or Yes.
Driver Window Motor Undervoltage Status	-	No	The scan tool displays No or Yes.
Enable Battery Saver Relay Command	-	Inactive	The scan tool displays Active or Inactive.
End Model Part Number	-	Varies	This parameter displays the end model part number.
Engine Stalled	-	Inactive	This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history.
Environment Identification	-	Unknown	The parameter displays the vehicle environment identification successful status.
Front Fog Lamps Relay Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the front fog lamp relay status.
Front Fog Lamps Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the front fog lamp switch status.

Front Passenger Window Main Control Down Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the front passenger window down switch status.
Front Passenger Window Main Control Express Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the passenger window switch express input status.
Front Passenger Window Main Control Up Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the passenger window switch UP input status.
Front Tire Pressure on Placard	-	Varies	The scan tool displays kPa or PSI. This parameter displays the specified tire pressure placard information programmed in the BCM for tire pressure monitoring.
Fuel Economy Mode Inhibited - Low Charging Voltage	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the fuel economy mode status.
Generator Regulator Setpoint	-	Varies	The scan tool displays percentage.
Glove Box Unlatch Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the instrument panel compartment release switch status.
Hazard Lamps Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the hazard lamps switch status.
Hazard Lamps Switch Backlight Command	-	Varies	The scan tool displays percentage. This parameter displays hazard switch backlight level PWM command status.
Headlamps On Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the headlamp on switch status.
Headlamps Flash Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the headlamps flash to pass switch status.
Headlamp Washer Relay Command	-	Inactive	The scan tool displays Active or Inactive.
High Beam Select Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the high beam switch status.
High Beam Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the high beam command status.
Hood Ajar Switch	-	Inactive	This parameter display the remote start diagnostic status history or the last remote start diagnostic status history.
Hood Ajar Switch Signal 1	-	Inactive	This parameter display the remote start diagnostic status history or the last remote

			start diagnostic status history.
Hood Position	-	CLOSED	The scan tool displays CLOSED, AJAR, or OPENED. This parameter displays the hood position.
Horn Relay Command	-	Inactive	The scan tool displays Active or Inactive.
Horn Switch	-	Inactive	The scan tool displays Active or Inactive.
Idle Boost Level 2-3 Counter	-	Varies	This parameter displays the state of the idle boost level as counts.
Idle Charging Set Level	-	Varies	This parameter displays idle charging set level.
Ignition Mode Switch Dimming Command	-	Varies	The scan tool displays percentage.
Ignition Switch Reference	-	Varies	This parameter displays the ignition switch voltage reference.
Ignition Switch Signal Voltage	-	Varies	This parameter displays the ignition switch signal voltage.
Ignition Switch Status	-	Inactive	This parameter displays the ignition switch status.
Immobilizer Allows Engine To Start	-	Unknown	The scan tool displays Unknown, Incorrect, Not Allowed, or Valid. This parameter displays the immobilizer status.
Immobilizer Automatic Learn Timer	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the automatic learn timer status.
Immobilizer Environment Device 1-4	-	Unknown	The scan tool displays Incorrect, Correct, Not Received, Not Programmed or Unknown. This parameter displays the immobilizer source status.
Immobilizer Password Learn	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the password learn status.
Immobilizer Password Learn Scan Tool Delay	-	Varies	This parameter displays the auto learn timer status.
Immobilizer Security Code Accepted	-	No	The scan tool displays No or Yes.
Immobilizer Security Code Lockout	-	No	The scan tool displays No or Yes.
Immobilizer Security Code Programmed	-	Yes	The scan tool displays No or Yes.
In Park Switch Status	-	On	The scan tool displays On or Off. This parameter displays the park switch status.
Inadvertent Load Command	-	Active	The scan tool displays Active or Inactive.
Indicator Dimming Duty Cycle Command	-	Varies	The scan tool displays percentage. This parameter displays indicator lighting PWM command status.

Interior/Courtesy Lighting Master Switch	-	Door	The scan tool displays Door or other lighting switch status.
Interior Trunk Lid/Liftgate Window Unlatch Switch	-	Inactive	The scan tool displays Active or Inactive.
Key Capture Solenoid Actuator	-	Active	The scan tool display Active or Inactive. This parameter displays column lock input status.
Key Fob 1-4 Battery Status	-	OK	The scan tool displays OK or other key fob battery status. This parameter displays the key fob battery status.
Key Fob 1-4 Function	-	Undefined	The scan tool displays Inactive, Lock, Unlock Driver Door, All Door Unlock, Release Rear Closure, Actuate Left Sliding Door, Actuate Right Sliding door, Panic Alarm, Release Fuel door, Actuate Power Windows, Actuate Folding Top, Start Engine, Stop Engine, Programmed, Locator Alarm, Close Liftgate, Open Liftgate, Stop Liftgate While Closing, Stop Liftgate While opening, Deadlock All Doors, Stop Liftgate Motion, Start Liftgate Motion, Stop Left Sliding Door Motion, Stop Right Sliding Door Motion, Comfort open, or Comfort close. This parameter displays the key fob function status.
Key Fob in Vehicle	-	Inactive	This parameter displays the current key fob in the vehicle.
Key In Cylinder Switch	-	Active	The scan tool displays Active or Inactive.
Key In Cylinder Switch/Key Fob in Vehicle	-	Yes	The scan tool displays No or Yes.
Key in Ignition Status	-	Inactive	The scan tool displays Key Out or Key In. This parameter displays the key in ignition status.
Key Part Number	-	Varies	This parameter displays the key part number.
Key Type	-	Master Key	The scan tool displays Unknown, Master Key, Valet Key, Fleet Key, or Unconfigured. This parameter displays the key type.
Last Door Lock Function	-	All Doors Lock	The scan tool displays NO Action, PC UNDB Lock, PC Unlock, Unlock, Unlock Driver, Unlock Passenger, Unlock Left Rear, Unlock Right Rear, Unlock Cargo Liftgate, Unlock Driver Side, Unlock Passenger Side, Unlock Non Driver,

			Unlock All, Lock All, DBL Lock, or UNDBL Lock.
LED Backlight Dimming Command	-	Varies	The scan tool displays as a percentage. This parameter displays LED backlight dimming PWM command status.
Left Brake Lamp Command	-	Varies	The scan tool displays percentage. This parameter displays left brake lamp command status.
Left Dedicated Daytime Running Lamp Command	-	Varies	The scan tool displays percentage. This parameter displays left dedicated daytime running lamp command status.
Left Front Tire Pressure	-	Varies	This parameter displays left front tire pressure in PSI.
Left Front Tire Pressure Sensor Identification	-	Varies	This parameter displays left front tire pressure sensor ID.
Left Front Tire Pressure Sensor Location Learned	-	Yes	The scan tool displays No or Yes. This parameter display tire pressure monitor system learned status.
Left Front Tire Pressure Sensor Mode	-	Learn Mode - Pressure Triggered	The scan tool parameter displays Learn Mode, Undefined, Remeasure Data Mode, Rolling Mode, Enter Off Mode, Exit Off Mode, or Learn Mode Pressure Triggered.
Left Front Tire Pressure Status	-	Normal	The scan tool displays Unknown, Normal, Very Low Pressure, Low, Weak Signal, or High.
Left Front Turn Signal Bulb Out Feedback	-	Inactive	The scan tool displays Active or Inactive.
Left Front Turn Signal/Hazard Lamp Command	-	Inactive	The scan tool displays Active or Inactive.
Left Low Beam/Daytime Running Lamp Command	-	Varies	The scan tool displays percentage. This parameter displays left low beam/daytime running lamp status.
Left Park Lamps Command	-	Varies	The scan tool displays percentage. This parameter displays rear exterior lighting status.
Left Rear Child Security Lock Switch	-	Inactive	This parameter displays Active or Inactive.
Left Rear Door Ajar Switch	-	Inactive	This parameter displays Active or Inactive. This parameter displays the left rear door ajar switch status.
Left Rear Tire Pressure	-	Varies	This parameter displays left rear tire pressure in PSI.
Left Rear Tire Pressure	-	Varies	This parameter displays left rear tire

Sensor Identification			pressure sensor ID.
Left Rear Tire Pressure Sensor Location Learned	-	Yes	The scan tool displays No or Yes. This parameter displays tire pressure monitor system learned status.
Left Rear Tire Pressure Sensor Mode	-	Stationary	The scan tool displays Learn Mode, Undefined, Remeasure Data Mode, Rolling Mode, Enter Off Mode, Exit Off Mode, or Learn Mode Pressure Triggered.
Left Rear Tire Pressure Status	-	Normal	The scan tool displays Unknown, Normal, Very Low Pressure, Low, Weak Signal, or High.
Left Rear Turn Signal Bulb Out Feedback	-	Inactive	The scan tool displays Active or Inactive. The parameter displays turn lamp outage status.
Left Rear Turn Signal/Hazard Lamp Command	-	Inactive	The scan tool displays Active or Inactive.
Left Rear Window Learned	-	Yes	The scan tool displays No or Yes.
Left Rear Window Main Control Down Switch	-	Inactive	The scan tool display Active or Inactive. This parameter displays driver window switch inputs.
Left Rear Window Main Control Express Switch	-	Inactive	The scan tool display Active or Inactive. This parameter displays driver window switch inputs.
Left Rear Window Main Control Up Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays driver window switch inputs.
Left Rear Window Motor Mode	-	Local Switch Overridden	The scan tool displays Down, Express, Up, Inhibit, or Local Switch Overridden.
Left Rear Window Switch at Door	-	Inactive	The scan tool displays Active or Inactive.
Left Stop Lamp Command	-	Varies	The scan tool display percentage.
Left Turn Signal Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the left turn signal switch status.
License Plate Lamps Command	-	Inactive	The scan tool displays Active or Inactive.
Load Reduction Level 2-3 Counter	-	Varies	The scan tool display as counts.
Low Beam Relay Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the headlamp low beam relay status.
Manufacturers Enable Counter	-	Varies	This parameter tool displays various counter values.
Master Keys Learned	-	Varies	This parameter displays the total number of master keys learned.

Module Diagnostic Address	-	Varies	This parameter displays module diagnostic address.
Number of Key Fobs In Vehicle	-	1	This parameter displays the number of fobs located in the vehicle.
Odometer	-	Varies	This parameter displays the vehicle mileage.
Outside Rear View Mirror Courtesy Lamp Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays front exterior lighting status.
Park Brake Switch	-	Active	The scan tool displays Active or Inactive. This parameter displays front exterior lighting status.
Park Lamps Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays Active when the parklamp switch is activated.
Passenger Door Ajar Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the passenger door ajar switch status.
Passenger Door Lock Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the passenger door lock switch status.
Passenger Door Unlock Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the passenger door unlock switch status.
Passenger Door(s) Unlatch Command	-	Inactive	The scan tool displays Active or Inactive.
Passenger Door(s) Unlock Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the passenger door unlock status.
Passenger Seat Heating Switch	-	Inactive	The scan tool displays Active or Inactive.
Passenger Seat Heating/Venting/Cooling Mode	-	Off	The scan tool displays On or Off.
Passenger Seat Ventilation Switch	-	Inactive	The scan tool displays Active or Inactive.
Passenger Window Learned	-	Yes	The scan tool displays No or Yes. This parameter displays the passenger window learned status.
Passenger Window Motor Mode	-	Local Switch Overridden	The scan tool displays Down, Express, Up, Inhibit, or Local Switch Overridden.
Passenger Window Switch at Door	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the passenger window switch status.
Pickup Bed Cargo Lamp			The scan tool displays percentage. This

Command	-	Varies	parameter displays pickup bed cargo lamp command status.
Previous Key Type	-	Unknown	This parameter displays previous driver identification device type.
Primary Key Status	-	Yes	The scan tool displays No or Yes.
Push Button Ignition Switch	-	Inactive	The scan tool displays Active or Inactive.
Push Button Ignition Switch Voltage	-	Varies	This parameter displays the push button ignition switch voltage.
Rain Sensor	-	Inactive	The scan tool displays Active or Inactive.
Rear Closure Ajar Switch	-	Active	The scan tool displays Active or Inactive.
Rear Closure Cylinder Lock Switch	-	Inactive	The scan tool displays Active or Inactive.
Rear Closure Cylinder Unlock Switch	-	Inactive	The scan tool displays Active or Inactive.
Rear Tire Pressure on Placard	-	Varies	This parameter displays the rear tire pressure in kPa or PSI. This parameter displays the specified tire pressure placard information programmed in the BCM for tire pressure monitoring.
Regulated Voltage Control Mode	-	Voltage	The scan tool displays voltage.
Remote Vehicle Start Attempts Exhausted	-	Varies	This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history or remaining start attempts.
Remote Vehicle Start Crank Time	-	Inactive	This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history.
Remote Vehicle Start Disabled by Driver	-	Inactive	This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history.
Remote Vehicle Start Source	-	Ignition Switch Start	The scan tool displays Ignition Switch Start or Remote Vehicle Start.
Remote Vehicle Starts Exhausted	-	Varies	This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history or remaining remote starts.
Right Brake Lamp Command	-	Varies	The scan tool display percentage. This parameter displays right brake lamp PWM command status.
Right Dedicated Daytime Running Lamp Command	-	Varies	The scan tool display percentage. This parameter displays right dedicated DRL PWM command status.
Right Front Tire Pressure	-	Varies	This parameter displays right front tire pressure in PSI.

Right Front Tire Pressure Sensor Identification	-	Varies	This parameter displays right front tire pressure sensor ID.
Right Front Tire Pressure Sensor Location Learned	-	Yes	The scan tool displays No or Yes.
Right Front Tire Pressure Sensor Mode	-	Stationary	The scan tool displays Learn Mode, Undefined, Remeasure Data Mode, Rolling Mode, Enter Off Mode, Exit Off Mode or Learn Mode Pressure Triggered.
Right Front Tire Pressure Status	-	Normal	The scan tool displays Unknown, Normal, Very Low Pressure, Low, Weak Signal, or High.
Right Front Turn Signal Bulb Out Feedback	-	Inactive	The scan tool displays Active or Inactive.
Right Front Turn Signal/Hazard Lamp Command	-	Inactive	The scan tool displays Active or Inactive.
Right Low Beam/Daytime Running Lamp Command	-	Varies	The scan tool displays percentage. This parameter displays right low beam/daytime running lamp status.
Right Park Lamps Command	-	Varies	The scan tool displays percentage. This parameter displays rear exterior lighting status.
Right Rear Child Security Lock Switch	-	Inactive	The scan tool displays Active or Inactive.
Right Rear Door Ajar Switch	-	Inactive	The scan tool displays Active or Inactive.
Right Rear Tire Pressure	-	Varies	This parameter displays right rear tire pressure in PSI.
Right Rear Tire Pressure Sensor Identification	-	Varies	This parameter displays right rear tire pressure sensor ID.
Right Rear Tire Pressure Sensor Location Learned	-	Yes	The scan tool displays No or Yes.
Right Rear Tire Pressure Sensor Mode	-	Learn Mode - Pressure Triggered	The scan tool displays Learn Mode, Undefined, Remeasure Data Mode, Rolling Mode, Enter Off Mode, Exit Off Mode, or Learn Mode Pressure Triggered. This parameter displays the pressure sensor mode status.
Right Rear Tire Pressure Status	-	Normal	The scan tool displays Unknown, Normal, Very Low Pressure, Low, Weak Signal or High. This parameter displays the right rear tire pressure status.
Right Rear Turn Signal Bulb Out Feedback	-	Inactive	The scan tool displays Active or Inactive.
Right Rear Turn Signal/Hazard Lamp	-	Inactive	The scan tool displays Active or Inactive.

Command			
Right Rear Window Main Control Down Switch	-	Inactive	The scan tool displays Active or Inactive.
Right Rear Window Main Control Express Switch	-	Inactive	The scan tool displays Active or Inactive.
Right Rear Window Main Control Up Switch	-	Inactive	The scan tool displays Active or Inactive.
Right Rear Window Motor Mode	-	Local Switch Overridden	The scan tool displays Down, Express, Up, Inhibit, or Local Switch Overridden.
Right Rear Window Switch at Door	-	Inactive	The scan tool displays Active or Inactive.
Right Stop Lamp Command	-	Varies	The scan tool displays percentage.
Right Turn Signal Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the right turn signal switch status.
Run Abort	-	Inactive	This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history.
Run Relay Command	-	Active	The scan tool displays Active or Inactive.
Run/Crank	-	Inactive	The scan tool displays Active or Inactive.
Run/Crank Relay Command	-	Active	The scan tool displays Active or Inactive.
Run/Crank Power Mode Indicator Command	-	Varies	The scan tool displays percentage. This parameter displays ignition switch run LED PWM command status.
Secondary Key Status	-	No	The scan tool displays No or Yes.
Security Indicator Command	-	Varies	The scan tool displays percentage. This parameter displays security LED PWM command status.
Selected Front Tire Type	-	Standard Load	The scan tool displays No Tire Type, Metric Standard Load, Metric Extra Load, Load Range C, Load Range D, or Load Range E. This parameter displays the front tire type.
Selected Rear Tire Type	-	Standard Load	The scan tool displays No Tire Type, Metric Standard Load, Metric Extra Load, Load Range C, Load Range D, or Load Range E. This parameter displays the rear tire type.
Start-Up State of Charge	-	Varies	The scan tool displays percentage. This parameter displays startup state of charge status.
State of Charge	-	Varies	The scan tool displays percentage. This parameter displays state of charge status.
Sunroof Enabled	-	Active	The scan tool displays Active or Inactive.
Sunroof Motor			

Overtemperature	-	Inactive	The scan tool displays Active or Inactive.
Sunroof Not Learned	-	Inactive	The scan tool displays Active or Inactive.
Sunroof Position	-	Closed	The scan tool displays Closed, Open, Venting, Comfort Open, Closing, Opening. This parameter displays the current sunroof position.
Sunroof Remote Command	-	Inactive	The scan tool displays Sunroof Secure Close, Venting, Close, or Open. This parameter displays the last sunroof remote command.
Sunroof Slide Switch	-	Inactive	The scan tool displays Inactive, Express Open, Open, Express Close, Close, Short to Ground, Short to Battery, or Stuck. This parameter displays the sunroof slide switch status.
Sunroof Tilt Switch	-	Inactive	The scan tool displays Inactive, Open, Close, Short to Ground, Short to Battery or Stuck. This parameter displays the sunroof tilt switch status. When the switch experiences a malfunction Short to Ground, Short to Battery or Stuck will be displayed.
Sunroof/Sunshade Motor Overtemperature	-	Inactive	The scan tool displays Active or Inactive.
Sunroof/Sunshade Switch	-	Inactive	The scan tool displays Inactive, Express Open, Open, Express Close, Close, Short to Ground, Short to Battery, or Stuck. This parameter displays the sunroof or sunshade switch status.
Sunshade Enabled	-	Active	The scan tool displays Active or Inactive.
Sunshade Not Learned	-	Inactive	The scan tool displays Active or Inactive.
Sunshade Position	-	Closed	The scan tool displays Ajar, Closed, Opened, Closing, or Opening. This parameter displays the sunshade position status.
Sunshade Remote Command	-	Inactive	The scan tool displays Close or Open. This parameter displays the last sunshade remote command.
Tamper Status	-	No	The scan tool displays No or Yes.
Telematics Enhanced Service Override Active	-	No	The scan tool displays No or Yes. This parameter displays vehicle theft deterrent system status.
Total Keys Learned	-	Varies	This parameter displays the number of keys learned.
			The scan tool displays Active or Inactive.

Traction Control Switch	-	Inactive	This parameter displays Active when the traction control switch is active.
Transponder Authentication	-	Initializing	The scan tool displays Inactive, Initializing, ID Received, Password Received, Data Reception Complete, or Data Transmission Complete. This parameter displays the transponder key communication status.
Transponder Key Status	-	OK	The scan tool displays OK, LIN Bus Initialization Malfunction, Antenna Initialization Malfunction, Password Error, No Valid Key Detected, LIN Bus Communication Malfunction, or Antenna Malfunction. This parameter displays the transponder key communication error status.
Trunk Lamp Command	-	Varies	The scan tool displays as percentage.
Trunk Lid/Liftgate Window Exterior Unlatch Switch	-	Inactive	The scan tool displays Active or Inactive.
Trunk Lid/Liftgate Window Unlatch Command	-	Inactive	The scan tool displays Active or Inactive.
Valet Keys Learned	-	Varies	This parameter displays the number of valet keys learned.
Valet Mode Status	-	Inactive	This parameter displays the remote start diagnostic status history or the last remote start diagnostic status history.
Valet switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays Active when the valet switch is on.
Vehicle Identification Number (VIN)	-	Varies	This parameter displays the vehicle identification number.
Window Lockout Switch	-	Inactive	The scan tool displays Active or Inactive.
Window Lockout Switch Indicator Command	-	Inactive	The scan tool displays Active or Inactive.
Windshield Washer Relay Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the windshield washer relay status.
Windshield Washer Switch	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the windshield washer switch status.
Windshield Wiper Park Switch	-	Active	The scan tool displays Active or Inactive.
Windshield Wiper High Speed Relay Command	-	Inactive	The scan tool displays Active or Inactive.
Windshield Wiper High	-	Inactive	The scan tool displays Active or Inactive.

Speed Switch			
Windshield Wiper Motor Relay Command	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the windshield wiper relay status.
Windshield Wiper Stalled During Sweep	-	Inactive	The scan tool displays Active or Inactive.
Windshield Wiper Stalled in Park Position	-	Inactive	The scan tool displays Active or Inactive. This parameter displays the windshield wiper stalled status.
Windshield Wiper Switch	-	Off	The scan tool displays Off, Delay 1, Delay 2, Delay 3, Delay 4, Delay 5, or Low. This parameter displays the windshield wiper switch status.

Body Control Module Scan Tool Output Controls

Scan Tool Output Control	Description
Accent Lighting 1	The BCM activates the accent lighting when you select On. The value should be 100%. All accent lighting should illuminate until commanded Off.
Accent Lighting 2	The BCM activates the accent lighting when you select On. The value should be 100%. All accent lighting should illuminate until commanded Off.
Accessory Power Mode Indicator	The BCM activates the accessory indicator when you select On. The value should be 100%. The yellow LED accessory indicator on start button should illuminate until commanded Off.
Accessory Power Relay	The BCM actuates the accessory power relay when you select On. The accessory power relay should turn on allowing specific vehicle functions to operate.
Accessory/Retained Accessory Power Relay	The BCM actuates the retained accessory power relay when you select On. The retained accessory power relay should turn on allowing specific vehicle functions to operate.
All Doors Lock	The BCM activates all doors lock when you select Lock. All doors should lock.
All Doors Lock/Unlock	The BCM activates all doors lock/unlock when you select Lock/Unlock.
Auxiliary Ignition Run Relay	The BCM controls the Ignition Run Coil Control circuit to turn it On and Off.
Backup Lamps	The BCM actuates the backup lamps relay when you select On. The backup lamps should illuminate until commanded Off. Engine must be running.
Battery Saver Relay	The BCM activates the battery saver relay when you select Enable. This command sets the low power mode relay in the state in which it does not supply power to the non-essential parts of the vehicle. This is used to prevent the battery from being depleted when the vehicle is not used for a long period of time.
Brake Pedal Position Sensor Learn	The BCM activates the brake pedal position sensor learn when you select Learn. The brake pedal position sensor learn procedure should start.
Brake Transmission Shift Interlock Solenoid Actuator	The BCM activates the transmission shift interlock solenoid actuator when you select On.
Brake Transmission	The BCM activates the transmission range indicator when you select On. The

Shift Interlock Indicator	transmission range indicator at the shifter should illuminate until commanded Off.
Center Brake Lamp	The BCM activates the center brake lamp when you select On. The center brake lamp should illuminate until commanded Off.
Center Stop Lamp	The BCM activates the center stop lamp when you select On. The center stop lamp should illuminate until commanded Off.
Child Security Lock Indicator	The BCM activates the child security lock indicator when you select On. The child security lock indicator should illuminate until commanded Off.
Child Security Lock Motors	The BCM actuates the child security door motor when you select Lock. The child security doors should lock.
Child Security Lock/Window Lockout Switch Indicator	The BCM activates the child security lock/window lockout switch indicator when you select On. The child security lock/window lockout switch indicator should illuminate until commanded Off.
Clear Driver Window Learned Values	When you select Clear the clear driver window learn procedure should start.
Clear Passenger Window Learned Values	When you select Clear the clear left rear window learn procedure should start.
Courtesy Lamps	The BCM activates the courtesy lamps when you select On. The value should be 100%. The courtesy lamps should illuminate until commanded Off.
Driver Door Unlatch	The BCM activates the output circuit to unlatch the driver door with a passive entry passive start when you select Unlatch. There is NO door handle on this type of vehicle to open the door. Instead, there is a pad that you press to unlatch the door.
Driver Door Unlock	The BCM pulses the driver door unlock motor when you select Unlock. The driver door should unlock.
Driver Window Motor	The BCM activates the driver window motor when you select Up/Down/Stop/Express Up/Express Down. The driver window should follow the appropriate command.
Driver Window Motor Mode	The BCM activates the driver window motor when you select Up/Down/Stop/Express Up/Express Down. The driver window should follow the appropriate command.
Front Fog Lamps	The BCM actuates the front fog lamps relay when you select On. The front fog lamps relay should turn on.
Generator Regulator Setpoint	The BCM changes the output of the generator.
Hazard Lamps Switch Backlight	The BCM activates the hazard lamps switch when you select On. The value should be 100%. The hazard lamps switch backlight should illuminate until commanded Off.
High Beams	The BCM activates the high beam command when you select On. The high beam lights should illuminate. The headlamps have to be on.
Horn Relay	The BCM activates the horn when you select On. The horn should sound.
Inadvertent Load	The BCM activates the inadvertent load command when you select On. (It is an electronic request to shut down an electrical or electronic device that is drawing power from the battery at a time when there should be no activity, usually after

	the key has been removed from the ignition for a period of time.)
Incandescent Dimming	The BCM activates the incandescent light dimming when you select On. The values should be 100%. The incandescent light dimming should illuminate until commanded Off.
Indicator Dimming	The BCM activates the indicator dimming when you select On. The values should be 100%. The indicator should illuminate until commanded Off.
LED Backlight Dimming	The BCM activates the LED backlight dimming when you select On. The values should be 100%. The LED backlight dimming for control switches should illuminate until commanded Off.
Left Brake Lamp	The BCM activates the left brake lamp when you select On. The values should be 100%. The left brake lamp should illuminate until commanded Off.
Left Dedicated Daytime Running Lamp	The BCM activates the left dedicated daytime running lamp when you select ON. The value changes to 100%. The left daytime running lamp should illuminate.
Left Front Park Lamp	The BCM activates the left front park lamp when you select ON with a value of 100%. The left front park lamp should illuminate.
Left Front Park Lamp/Daytime Running Lamp	The BCM activates the left front park lamp/daytime running lamp when you select ON with a value of 100%. The left front park lamp/daytime running lamp should illuminate.
Left Front Turn Signal Lamp	The BCM activates the left front turn signal lamp when you select On. The left front turn signal lamp should illuminate until commanded Off.
Left Headlamp Lamp Low Beam	The BCM activates the left headlamp low beam when you select On. The values should be 100%. The left headlamp low beam should illuminate until commanded Off.
Left Park Lamps	The BCM activates the left park lamps when you select ON with a value of 100%. The left park lamps should illuminate.
Left Rear Park Lamp	The BCM activates the left rear park lamp when you select ON with a value of 100%. The left rear park lamp should illuminate.
Left Rear Stop/Park Lamp	The BCM activates the left rear stop/park lamp when you select ON with a value of 100%. The left rear stop/park lamp should illuminate.
Left Rear Turn Signal Lamp	The BCM activates the left rear turn signal lamp when you select On. The left rear turn signal lamp should illuminate until commanded Off.
Left Rear Turn Signal/Stop Lamp	The BCM activates the left rear turn signal/stop lamp when you select On. The left rear turn signal/stop lamp should illuminate until commanded Off.
Left Rear Window Motor	The BCM activates the left rear window motor when you select Up/Down/Stop/Express Down. The left rear window should follow the appropriate command.
Left Stop Lamp	The BCM activates the left stop lamp when you select ON with a value of 100%. The left stop lamp should illuminate.
Left Trailer Turn Signal Lamp	The BCM activates the left trailer turn signal lamp when you select ON with a value of 100%. The left trailer turn signal lamp should illuminate.
License Plate Lamps	The BCM activates the license plate lamps when you select On. The license plate lights should turn on until commanded Off.
Liftgate Unlatch	The BCM actuates the rear compartment lid release actuator when you select Unlatch. The trunk or liftgate should open.

LIN Bus Device Identification Data	When you select Update the LIN Bus Device part number and calibration part number should be updated.
Low Beam Lamps	The BCM activates the low beam lamps when you select On. The low beam lamps should turn on.
Low Beam Relay	The BCM activates the low beams when you select On. The low beam lights should turn on.
Outside Rear View Mirror Courtesy Lamp	The BCM activates the outside rear view mirror courtesy lamp when you select On. The outside rear view mirror courtesy lamp (at the bottom) should illuminate.
Passenger Door(s) Unlatch	The BCM activates the output circuit to unlatch the passenger door with a passive entry passive start when you select Unlatch. There is NO door handle on this type of vehicle to open the door. Instead, there is a pad that you press to unlatch the door.
Passenger Door(s) Unlock	The BCM pulses the passenger door unlock motor when you select Unlock. The passenger door should unlock.
Passenger Window Motor	The BCM activates the passenger window motor when you select Up/Down/Stop/Express Up/Express Down. The passenger window should follow the appropriate command.
Pickup Bed Cargo Lamp	The BCM activates the pickup bed cargo lamp when you select On. The values should be 100%. The pickup bed cargo lamp should illuminate until commanded Off.
Rear Fog Lamp(s) Relay	The BCM activates the rear fog lamps when you select On. The rear fog lamps should turn on.
Right Brake Lamp	The BCM activates the right brake lamp when you select On. The value should be 100%. The right brake lamp should illuminate until commanded Off.
Right Dedicated Daytime Running Lamp	The BCM activates the right dedicated daytime running lamp when you select On. The value should be 100%. The right daytime running lamp should illuminate.
Right Front Park Lamp	The BCM activates the right front park lamp when you select ON with a value of 100%. The right front park lamp should illuminate.
Right Front Park Lamp/Daytime Running Lamp	The BCM activates the right front park lamp/daytime running lamp when you select ON with a value of 100%. The right front park lamp/daytime running lamp should illuminate.
Right Front Turn Signal Lamp	The BCM activates the right front turn signal lamp when you select On. The right front turn signal/hazard lamp should illuminate.
Right Headlamp Low Beam	The BCM activates the right headlamp low beam when you select On. The right headlamp low beam should illuminate.
Right Park Lamps	The BCM activates the right park lamps when you select ON with a value of 100%. The right park lamps should illuminate.
Right Rear Park Lamp	The BCM activates the right rear park lamp when you select ON with a value of 100%. The right rear park lamp should illuminate.
Right Rear Stop/Park Lamp	The BCM activates the right rear stop/park lamp when you select ON with a value of 100%. The right rear stop/park lamp should illuminate.
Right Rear Turn Signal Lamp	The BCM activates the right rear turn signal/hazard lamp when you select On. The right rear turn signal lamp should illuminate until commanded Off.

Right Rear Turn Signal/Stop Lamp	The BCM activates the right rear turn signal/stop lamp when you select On. The right rear turn signal/stop lamp should illuminate until commanded Off.
Right Rear Window Motor	The BCM activates the right rear window motor when you select Up/Down/Stop/Express Down. The right rear window should follow the appropriate command.
Right Stop Lamp	The BCM activates the right stop lamp when you select ON with a value of 100%. The right stop lamp should illuminate.
Right Trailer Turn Signal Lamp	The BCM activates the right trailer turn signal lamp when you select ON with a value of 100%. The right trailer turn signal lamp should illuminate.
Run Relay	The BCM actuates the run relay when you select On. The run relay should turn on.
Run/Crank Relay	The BCM actuates the run/crank relay when you select On. The run/crank relay should turn on.
Run/Start Power Mode Indicator	The BCM activates the run/start lamp when you select On. The value should be 100%. The green LED on engine start/stop button should illuminate until commanded Off.
Security Indicator	The BCM activates the security indicator command when you select On. The security indicator at center of dash (or at DRL sensor) should illuminate until commanded Off.
Stop Lamps	The BCM activates the stop lamps when you select ON with a value of 100%. The stop lamps should illuminate.
Tire Pressure Sensors Learn	The BCM activates the tire pressure sensor learn procedure when you select Learn.
Tire Type/Pressure Selection	When you select OK, you can change tire type and load range.
Trailer Backup Lamps	The BCM activates the trailer backup lamps when you select ON with a value of 100%. The trailer backup lamps should illuminate.
Trailer Park Lamps	The BCM activates the trailer park lamps when you select ON with a value of 100%. The trailer park lamps should illuminate.
Transmission Range Indicator	The BCM activates the transmission range indicator when you select On. The transmission range indicator at the shifter should illuminate until commanded Off.
Trunk Lamp	The BCM activates the trunk lamp when you select On. The value should be 100%. The trunk lamp should illuminate until commanded Off.
Trunk Lid Unlatch	The BCM activates the trunk lid unlatch when you select On. The trunk lid should unlatch.
Window Lockout Switch Indicator	The BCM activates the window lockout switch indicator when you select On. The window lockout switch indicator should illuminate until commanded Off.
Windshield Washer Relay	The BCM actuates the windshield washer relay when you select On. The windshield washer relay should turn on.
Windshield Wiper High Speed Relay	The BCM actuates the windshield wiper high speed relay when you select On. The windshield wiper high speed relay should turn on.
Windshield Wiper Motor Relay	The BCM actuates the windshield wiper motor relay when you select On. The windshield wiper motor relay should turn on.

CHASSIS CONTROL MODULE SCAN TOOL INFORMATION

Chassis Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature/Vehicle is in Park or Neutral			
Desired Fuel Pressure	-	306.8 kPa (44.5 psi)	This displays kPa (psi). This is the desired fuel pressure.
Fuel Pump Command	-	On	The scan tool displays On or Off. This is the current state of the fuel pump command.
Fuel Pump Signal Command	-	Varies	This displays %. This is the commanded fuel pump signal measured in percentage.
Fuel Pressure Sensor	-	296.4-310.3 kPa (43-45 psi)	This displays kPa (psi). This is the current pressure at the fuel pressure sensor.
Fuel Pressure Sensor	-	4.90-5.01 Volts	This displays Volts. This is the fuel pressure sensor voltage.
Ignition 1 Signal	-	Varies	This displays Volts. This is the current ignition 1 signal.
LT Fuel Pump Trim	-	Varies	This displays a numeric value. This is the long term (LT) fuel pump trim.
ST Fuel Pump Trim	-	Varies	This displays a numeric value. This is the short term (ST) fuel pump trim.

Chassis Control Module Scan Tool Output Controls

Output Control	Description
Fuel Pressure Control	This output control is used to control the fuel pressure.
Fuel Pump	This output control is used to command the fuel pump ON and OFF.
Fuel Pump Trim Reset	This output control is used to reset the fuel pump trim.

Active Grille Air Shutter Scan Tool Data Parameters (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature / Vehicle is in Park or Neutral			
Active Grille Air Shutter			This displays %. This is the

Position Command (Single Shutter System)	-	Varies	commanded active grille air shutter position.
Active Grille Air Shutter Position (Single Shutter System)	-	Varies	This displays %. This is the actual active grille air shutter position.
Active Grille Air Shutter 1 Position Command (Dual Shutter System)	-	Varies	This displays %. This is the commanded active grille air shutter position.
Active Grille Air Shutter 1 Position (Dual Shutter System)	-	Varies	This displays %. This is the actual active grille air shutter position.
Active Grille Air Shutter 2 Position Command (Dual Shutter System)	-	Varies	This displays %. This is the commanded active grille air shutter position.
Active Grille Air Shutter 2 Position (Dual Shutter System)	-	Varies	This displays %. This is the actual active grille air shutter position.

Active Grille Air Shutter Scan Tool Output Controls (If Equipped)

Output Control	Description
Active Grille Air Shutter System (Single Shutter System)	This output control is used to perform the Active Grille Air Shutter Actuator test. It is used to cycle the active grille air shutter open and closed. The test result will display pass or fail based on the ability of the louvers to cycle open and closed.
Active Grille Air Shutter 1 (Dual Shutter System)	This output control is used to perform the Active Grille Air Shutter Actuator test. It is used to cycle the active grille air shutter open and closed. The test result will display pass or fail based on the ability of the louvers to cycle open and closed.
Active Grille Air Shutter 2 (Dual Shutter System)	This output control is used to perform the Active Grille Air Shutter Actuator test. It is used to cycle the active grille air shutter open and closed. The test result will display pass or fail based on the ability of the louvers to cycle open and closed.

Exhaust Flow Control Valve Scan Tool Data Parameters (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature / Vehicle is in Park or Neutral			
Exhaust Flow Control Valve Command	-	Open/Closed	Exhaust Flow Valve Commanded State
Exhaust Flow Control Valve Command	-	%	Exhaust Flow Valve Commanded Duty Cycle (0%-100%)
Exhaust Flow Control Valve Performance Mode	-	Active/Inactive	Exhaust Flow Valve Control Status
Exhaust Flow Control Valve Rumble Mode	-	Active/Inactive	Exhaust Flow Valve Control Status
Exhaust Flow Control			Exhaust Flow Valve

Valve	-	Active/Inactive	Control Status
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Exhaust Flow Control Valve Scan Tool Output Controls (If Equipped)

Output Control	Description
Exhaust Flow Control Valve Command	This output control is used to cycle the exhaust flow control valve open and closed.

CCM Scan Tool Parameters for Trailer Brake Control System (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature / Vehicle is in Park or Neutral			
ABS Active Signal	-	OK	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the ABS Active Signal serial data message from the electronic brake control module to the chassis control module.
Antilock Braking System	-	Inactive	The scan tool displays Active/Inactive. The scan tool displays Inactive when the ABS system is not functioning.
Automatic Brake Control Gain Request From EBCM	-	0-100%	The scan tool displays a number between 0-100%.
Automatic Brake Request From EBCM	-	No	The scan tool displays Yes/No. This is a request from the EBCM to apply the trailer brakes.
Automatic-Brake Torque	-		The scan tool displays a numerical value.
Automatic-Brake Torque Signal	-	Ok	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the Automatic Brake Torque Signal serial data message to the chassis control module.
Automatic Braking Active Signal	-	Ok	The scan tool displays Ok/Not OK. The scan tool displays OK when no problems are found with the Automatic Braking Active Signal serial data message to the chassis control module.
Automatic Braking Event	-	Not Detected	The scan tool displays Detected/Not Detected. This parameter represents a command to apply the trailer

			brakes from the adaptive cruise control system.
Brake Master Cylinder Pressure Sensor	-	Varies	The scan tool will display brake fluid pressure in the master cylinder. The scan tool will display a kPa or psi signal received from the chassis control module.
Brake Pressure Signal	-	OK	The scan tool will display Ok/Not Ok. The scan tool will display a serial data message received from the chassis control module.
Brake Request from EBCM	-	Ok	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the Brake Request signal serial data message from the electronic brake control module to the chassis control module.
Desired Trailer Brake Control Duty Cycle	-	0-100%	The scan tool displays a number between 0-100%. This number represents a duty cycle request signal from the chassis control module to the trailer brake power module.
Deviation Between Manual Trailer Brake Apply Request Signal 1 and 2	-	Varies	The scan tools displays a percentage difference between the Apply Request Signal 2 and Redundant Request Signal 1.
Driver Initiated Brake Event	-	Not Detected	The scan tool displays Detected/Not Detected. The scan tool detects when the driver has applied the trailer brakes.
Induced Voltage by Trailer Brake Coil	-	0-20 V	The scan tool displays a voltage. This number represents the actual voltage supplied by the trailer brake power module to the trailer brakes.
Manual Trailer Brake Apply Request Signal 1	-	Varies	The scan tool displays a percentage. This represents a brake apply signal between the chassis control module and the trailer brake power module.
Manual Trailer Brake Apply Request Signal 2	-	Varies	The scan tool displays a percentage. This represents a brake apply signal between the chassis control module and the trailer brake power module.
Stop Lamp Signal	-	Not Requested	The scan tool displays Requested/Not Requested. This is the brake pedal position sensor

			signal from the BCM to the chassis control module.
Trailer Brake Automatic Control State	-	Normal	The scan tool displays Normal/Active/Temporarily Inhibited/Temporarily Limited/Permanently Failed/Communication Failed/Disabled by Calibration. This represents the operational state of the chassis control module.
Trailer Brake Control Duty Cycle	-	0-100%	The scan tool displays a percentage. This is the pulse width modulated output signal from the trailer brake power module to the trailer brakes.
Trailer Brake Control Output Circuit	-	Okay	The scan tool displays Unknown/Short to Battery/Short to Ground/Okay. This represents the state of health of the output circuit from the trailer brake power module to the trailer brakes.
Trailer Brake Control Output Circuit	-	0-20 V	The scan tool displays a voltage. This represents the voltage supplied by the trailer brake power module to the trailer brakes.
Trailer Brake Power Control Module	-	De-Energized	The scan tool displays Energized/De-Energized. This represents the state of the trailer brake power module.
Trailer Brake Power Control Module Battery Voltage	-	Varies	The scan tool displays a voltage. This represents the battery voltage supplied to the trailer brake power module.
Trailer Brake Type	-	Undefined	The scan tool displays Undefined when a trailer is not connected to the vehicle. The scan tool displays Electromagnetic Brakes or Electrohydraulic Brakes when a trailer is connected to the vehicle. The type displayed is based on what is detected by the chassis control module.
Trailer Brake User Gain	-	Varies	The scan tool displays percent of full gain setting. The scan tool displays 0-100%. Each full gain setting represents an increment of approximately 10 percent of full gain setting. Approximately 40% will be

			indicated with a gain setting of 4.0, 65% will be indicated with a gain setting of 6.5, etc.
Trailer Brake User Gain Switch	-	Varies	The scan tool displays percent of full gain setting. The scan tool displays 0-100%. Each full gain setting represents an increment of approximately 10 percent of full gain setting. Approximately 40% will be indicated with a gain setting of 4.0, 65% will be indicated with a gain setting of 6.5, etc.
Vehicle Speed	-	Varies	The scan tool displays 0-327 km/h (0-204 mph). The scan tool displays 0 km/h (0 mph) when the vehicle is not moving. This is the vehicle speed serial data message from the ECM.
Vehicle Stability Enhancement System Signal	-	Ok	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the Vehicle Stability Enhancement System signal to the chassis control module.
Wheel Speed Signal	-	Ok	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the Wheel Speed signal from the EBCM to the chassis control module.

COMMUNICATION INTERFACE MODULE SCAN TOOL INFORMATION

Telematics Communication Interface Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
GPS Data			
• Dead Reckoning Calibration Status	-	Calibrated or Not Calibrated	Indicates the dead reckoning calibration status.
• Position Calibration Method	-	Varies	Indicates the method used to determine current location. (0) GPS, (1) Wheel Speed Dead Reckoning only, (2) Combined Wheel Speed and GPS, (3) Gyro only, (4) Combined Gyro and GPS, (5) No Fix
• Month	-	MM	This displays the current month.
• Day	-	DD	This displays the current day of the month.

• Year	-	YY	This displays the current year.
• Hour	-	HH	This displays the GPS current hour (24 hour format - GMT).
• Minute	-	MM	This displays the GPS current minute.
• Second	-	SS	This displays the GPS current second.
• GPS Signal	-	Varies	The scan tool displays Yes or No. Yes is displayed if there is a GPS signal received by the telematics communication interface control module.
Signal Strength Data			
• Current Transceiver Identifier	-	Varies	The scan tool displays a 2-5 digit value. This is the transceiver identification number.
• GSM Signal Strength	-	Varies	The scan tool displays 0-127. This is the telematics communication interface control module signal strength.
• Signal Type	-	Digital	This is the signal type received by the telematics communication interface control module.
Bluetooth Data			
• Bluetooth	-	Enabled	Indicates if the Bluetooth system is enabled or disabled.
• Bluetooth Link Status	-	Varies	Indicates the current link status. (0) Unconnected, (1) Connected / Idle, (2) Call active, (3) 3-way calling active
• Bluetooth Link Quality	-	Varies	The scan tool displays a decimal value between 0 and 255.
• Bluetooth Phone to Telematics Communication Interface Control Module Authentication Status	-	Active or Inactive	Displays the bluetooth phone to telematics communication interface control module authentication status.
• Bluetooth Phone to Telematics Communication Interface Control Module Communication Status	-	Active or Inactive	Displays the bluetooth phone to telematics communication interface control module status.
• Bluetooth Phone Voice Recognition Status	-	Active or Inactive	Displays the bluetooth phone to voice recognition status.

Telematics Communication Interface Control Module Scan Tool Output Controls

Output Control	Description

B1000 Information	This shows the data recorded when DTC B1000 was set in the telematics communication interface control module.
Green Indicator	The telematics communication interface control module illuminates the green LED when ON is selected.
Phone Call Test	When ON is selected, telematics communication interface control module commands OnStar to connect to the OnStar Center.
Red Indicator	The telematics communication interface control module illuminates the red LED when ON is selected.
Preferred Roaming List Update	The telematics communication interface control module performs a preferred roaming list (PRL) update when this is selected.
Remote Vehicle Speed Limiting Reset	This function resets the speed limiting feature.

DISTANCE SENSING CRUISE CONTROL MODULE SCAN TOOL INFORMATION

Cruise Control Vehicle Distance Sensor Module Scan Tool Data Parameters

-	System State	Expected Value	Description
Operating Conditions: Engine Running/Cruise Control ON			
Automatic Alignment Learn Progress	-	Varies	The scan tool displays %. This is the current status of the alignment progress.
Automatic Alignment Learn Status	-	Learn Successful	The scan tool displays Off, Ready, Learn Failed, Learn Successful or Busy. This is the learn state of the automatic alignment.
Brake Pedal Position Sensor	-	Varies	The scan tool displays Released or Applied depending on the state of the brake pedal
Cruise Control Disengage History 1-4	-	Varies	This is the state of the ACC disable history. see TAB enm_ACCDisengageHist (1 Byte)
Cruise Control Driver Memory	-	-	Driver 1 / Driver 2
Cruise Control Inhibit Data	-	-	see TAB enm_ACCDisengageHist (1 Byte)
Cruise Control On/Off Switch Status	-	On	The scan tool displays On or Off. This is the state of the cruise on/off switch.
Cruise Control Throttle Override By Driver	-	Varies	The scan tool displays Active or Inactive. This is the state of the throttle override.
Cruise Control Throttle Override By Driver Indicator Message	-	-	Active/Inactive
Distance Sensing Cruise Control Status	-	-	Active/Inactive
Distance Sensing Cruise Control Type	-	-	Full Speed Range / Limited Speed Range
Following Distance Setting	-	Varies	The scan tool displays Stage 1, Stage 2 or Stage 3. This is the selected following

			distance.
Horizontal Alignment Angle	-	-	°
Ignition Voltage Signal	-	11-14 V	The scan tool displays V. This is the current ignition voltage signal.
Radar Needs Cleaning	-	No	The scan tool displays Yes or No. Yes/No
Radar Temporarily Unavailable Indicator Message	-	-	Active/Inactive
Service Radar Display Message	-	Inactive	The scan tool displays Active or Inactive. Active will be displayed when the cruise control vehicle distance sensor module detects a malfunction in the ACC system.
System Voltage	-	11-14 V	The scan tool displays V. This is the current battery voltage.
Vertical Alignment Angle	-	-	° degrees

Cruise Control Vehicle Distance Sensor Module Scan Tool Output Controls

Output Control	Description
Distance Sensing Cruise Control Service Alignment	The cruise control vehicle distance sensor module will activate the alignment/calibration procedure when selected.

DRIVE MOTOR CONTROL MODULE SCAN TOOL INFORMATION

The drive motor control module is a non-serviceable module within the generator control module. The Drive Motor Control Module Scan Tool Data Parameters list contains hybrid controls-related parameters. The list is arranged in alphabetical order.

Use the Drive Motor Control Module Scan Tool Data Parameters list only after the following is determined:

- The **Diagnostic System Check - Vehicle** is completed.
- No diagnostic trouble codes (DTCs)
- On-board diagnostics are functioning properly

The scan tool values from a properly running vehicle may be used for comparison with the vehicle you are diagnosing. The Drive Motor Control Module Scan Tool Data Parameters list represents values that would be seen on a normally running vehicle.

NOTE: **A scan tool that displays faulty data should not be used. The scan tool concern should be reported to the manufacturer. Use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.**

Only the parameters listed below are referenced in this service manual for use in diagnosis. If all values are within the typical range described below, refer to **Symptoms - Hybrid Controls** for diagnosis.

Drive Motor Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Closed Throttle/Park or Neutral/Accessories OFF, unless otherwise noted			
Brake Pedal Position Circuit Signal	Released / Applied	Released	This parameter displays the undefaulted state of brake pedal travel beyond a top of travel threshold. This signal is based upon the state of the redundant brake switch.
Calculated Drive Motor Rotor Temperature	°C (°F)	Varies	This parameter displays the calculated/modeled rotor temperature for the drive motor.
Calculated Throttle Position	%	0	This parameter displays the accelerator effective position, which represents the driver's intended request for torque or acceleration. It is determined from the maximum of the driver requests to open the throttle (e.g., accelerator pedal, cruise control, PTO, etc.) and is normalized to 0 to 100%, where 0% represents an idle or coast request and 100% represents a request for wide open throttle (WOT). It is the primary indication of accelerator position / throttle position used by transmission control algorithms and, thus, is often referred to as transmission throttle position. In the event that the engine is operating in a forced idle mode due to an accelerator pedal position fault, the accelerator effective position will have a value of 0%, corresponding to an idle request.
Drive Motor Control Module Negative Supply Isolation Voltage	Volts	56	This parameter displays the high voltage negative to chassis voltage as measured for the drive motor. This value will vary based on hybrid battery voltage level.
Drive Motor Control Module Positive Supply Isolation Voltage	Volts	58	This parameter displays the high voltage positive to chassis voltage as measured for the drive motor. This value will vary based on hybrid battery voltage level.
Drive Motor Control Module Temperature	°C (°F)	Varies	This parameter displays the drive motor control module Insulated Gate Bipolar Transistor temperature 1 as

Sensor 1			measured by a sensor.
Drive Motor Control Module Temperature Sensor 2	°C (°F)	Varies	This parameter displays the drive motor control module Insulated Gate Bipolar Transistor temperature 2 as measured by a sensor.
Drive Motor Control Module Temperature Sensor 3	°C (°F)	Varies	This parameter displays the drive motor control module Insulated Gate Bipolar Transistor temperature 3 as measured by a sensor.
Drive Motor Current	Amps	Varies	This parameter displays the DC current consumed by the drive motor. This could display a negative or positive value. A negative value equals charging.
Drive Motor Inverter Status	Power Stage Inactive; Power Stage Active; Power Stage On: Shutdown Pending; Power Stage On: Active Discharge; Reserved; High Voltage Required	Active	This parameter displays the state of the Drive Motor Inverter.
Drive Motor Inverter Supply Voltage Circuit	Volts	114	This parameter displays the voltage on the DC bus at the inverter for the drive motor. This value will vary based on hybrid battery voltage level.
Drive Motor Phase U Current	Amps	Varies	This parameter displays the current flow to phase U of the drive motor.
Drive Motor Phase V Current	Amps	Varies	This parameter displays the calculated current flow to phase V of the drive motor.
Drive Motor Phase W Current	Amps	Varies	This parameter displays the current flow to phase W of the drive motor.
Drive Motor Position Sensor Offset Learn Status	Not Run This Power Cycle; Successful Learn This Power Cycle; Failure for Electric Motor Speed Not Zero; Failure for High Voltage Too Low; Failure for Incorrect Motor Current	Not Run	This parameter displays the current status of the resolver offset learn (ROL) for the drive motor. This parameter will update based on any ROL, whether performed automatically as part of normal vehicle operation or as the result of a device control.
			This parameter displays the speed, in revolutions per minute, of the drive

Drive Motor Speed	RPM	1800	motor as determined from the resolver. This value changes with motor speed.
Drive Motor Temperature	°C (°F)	Varies	This parameter displays the temperature for the drive motor.
Drive Motor Torque	Y (lb ft)	Varies	This parameter displays the torque value for the drive motor.
Drive Motor Torque Command	Y (lb ft)	Varies	This parameter displays the commanded torque value requested by the drive motor control module.
ECT Sensor	°C (°F)	Varies	This parameter displays the undefaulted engine coolant temperature measured by a sensor.
Engine Speed	RPM	Varies	This parameter displays the undefaulted engine speed determined from the low resolution (LORES) period of the crank position sensor.
Hybrid/EV Battery Pack Charge Remaining	%	Varies	This parameter displays the remaining charge for the Hybrid Battery Pack.
Hybrid Powertrain Control Module High Voltage Circuit	Volts	114	This parameter displays the high voltage circuit voltage as detected by the hybrid powertrain control module. This value will vary based on hybrid battery voltage level.
Ignition 1 Signal	Volts	14.5	Run/Crank Voltage
Power Mode	Off; Accessory; Run; Crank Request	Run	This parameter displays system power mode status as determined by ignition switch inputs to the power mode master. System power mode status should match the ignition switch position.
Torque Delivered Signal	Y (lb ft)	Varies	Engine Actual Steady State Torque

SEAT MEMORY CONTROL MODULE SCAN TOOL INFORMATION

Seat Position Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Driver Seat Back Switch	Inactive	The scan tool displays Inactive, Forward, or Rearward. When the seat recline switch is pressed, the scan tool displays the state of the seat recline switch.
		The scan tool displays Inactive, Forward, or

Driver Seat Back Direction Command	Inactive	Rearward. When the seat recline switch is pressed or when a memory recall occurs, the scan tool displays the direction the memory control module is commanding the seat recline motor.
Driver Seat Back Position	Varies	The scan tool displays 0-65,535 counts. The hall effect sensor provides a determined number of pulse signals with each rotation of the motor that the scan tool displays as counts. High count values indicate that the seat back is in the forward position, while low count values indicate that the seat back is in the rearward position.
Driver Seat Cushion Front Vertical Direction Command	Inactive	The scan tool displays Inactive, Up or Down. When the seat front vertical switch is pressed or when a memory recall occurs, the scan tool displays the direction the memory control module is commanding the seat front vertical motor.
Driver Seat Cushion Front Vertical Position	Varies	The scan tool displays 0-65,535 counts. The hall effect sensor provides a determined number of pulse signals with each rotation of the motor that the scan tool displays as counts. High count values indicate that the seat front vertical is in the up position, while low count values indicate that the seat front vertical is in the down position.
Driver Seat Cushion Front Vertical Switch	Inactive	The scan tool displays Inactive, Up or Down. This is the state of the seat front vertical switch.
Driver Seat Cushion Rear Vertical Direction Command	Inactive	The scan tool displays Inactive, Up or Down. When the seat rear vertical switch is pressed or when a memory recall occurs, the scan tool displays the direction the memory control module is commanding the seat rear vertical motor.
Driver Seat Cushion Rear Vertical Position	Varies	The scan tool displays 0-65,535 counts. The hall effect sensor provides a determined number of pulse signals with each rotation of the motor that the scan tool displays as counts. High count values indicate that the seat rear vertical is in the up position, while low count values indicate that the seat rear vertical is in the down position.
Driver Seat Cushion Rear Vertical Switch	Inactive	The scan tool displays Inactive, Up or Down. This is the state of the rear vertical downward switch.
Driver Seat Horizontal Direction Command	Inactive	The scan tool displays Inactive, Forward, or Rearward. When the seat horizontal switch is pressed or when a memory recall occurs, the scan tool displays the direction the memory control module is commanding the seat horizontal motor.
		The scan tool displays 0-65,535 counts. The hall effect sensor provides a determined number of

Driver Seat Horizontal Position	Varies	pulse signals with each rotation of the motor that the scan tool displays as counts. High count values indicate that the seat horizontal position is forward, while low count values indicate that the seat horizontal position is rearward.
Driver Seat Horizontal Switch	Inactive	The scan tool displays Inactive, Forward, or Rearward. This is the state of the seat horizontal switch.
Memory Recall Switches	Idle	The scan tool displays Idle, Memory 1, Memory 2, or Memory 3. When a memory function switch is pressed, the scan tool will momentarily display the function selected.

Mirror Memory Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Driver Mirror Direction Command	Inactive	The scan tool displays Inactive/Up/Down/Left/Right/Folding/Extending. When the power mirror switch is being used or when a memory recall occurs, the scan tool displays the direction the memory control module is commanding the driver mirror motors.
Driver Mirror Horizontal Position	Varies	The scan tool displays 0-5 V. The voltage displayed represents the position of the driver horizontal motor.
Driver Mirror Vertical Position	Varies	The scan tool displays 0-5 V. The voltage displayed represents the position of the driver vertical motor.
Mirror Direction Switch	Inactive	The scan tool displays Inactive/Up/Down/Left/Right/Folding/Extending. The scan tool displays the current state of the power mirror switch.
Mirror Select Switch	None	The scan tool displays None/Left/Right. The scan tool displays the current state of the mirror select switch.
Passenger Mirror Direction Command	Inactive	The scan tool displays Inactive/Up/Down/Left/Right/Folding/Extending. When the power mirror switch is being used or when a memory recall occurs, the scan tool displays the direction the memory control module is commanding the passenger mirror motors.
Passenger Mirror Horizontal Position	Varies	The scan tool displays 0-5 V. The voltage displayed represents the position of the passenger horizontal motor.
Passenger Mirror Vertical Position	Varies	The scan tool displays 0-5 V. The voltage displayed represents the position of the passenger vertical motor.

Left Front Seat Heating/Venting/Cooling Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
		The scan tool displays 0-100 %. The value displayed is a PWM signal from the heated

Driver Seat Blower Duty Cycle	Varies	seat module to the logic terminal of the seat blower motor. Higher values indicate higher blower motor speeds while lower values indicate lower blower motor speeds.
Driver Seat Cushion Heating Command	Inactive	The scan tool displays Inactive or Active. This parameter displays the commanded output from the heated seat module to the seat heater elements.
Driver Seat Cushion Temperature Sensor	Varies	The scan tool displays 0-5 V. The voltage displayed is an input to the heated seat module from the seat cushion temperature sensor. Higher voltage readings indicate cooler seat temperatures while lower voltage readings indicate warmer seat temperatures.
Driver Seat Heating/Venting/Cooling Level	Off	The scan tool displays Off, Low Medium, or High. When the heated seat is active, this parameter displays the selected temperature setting.
Driver Seat Heating/Venting/Cooling Mode	Off	The scan tool displays Off, Back & Cushion Heat, or Vent. This parameter indicates the heated or vented seat mode of operation.

Right Front Seat Heating/Venting/Cooling Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Passenger Seat Blower Duty Cycle	Varies	The scan tool displays 0-100 %. The value displayed is a PWM signal from the heated seat module to the logic terminal of the seat blower motor. Higher values indicate higher blower motor speeds while lower values indicate lower blower motor speeds.
Passenger Seat Cushion Heating Command	Inactive	The scan tool displays Inactive or Active. This parameter displays the commanded output from the heated seat module to the seat heater elements.
Passenger Seat Cushion Temperature Sensor	Varies	The scan tool displays 0-5 V. The voltage displayed is an input to the heated seat module from the seat cushion temperature sensor. Higher voltage readings indicate cooler seat temperatures while lower voltage readings indicate warmer seat temperatures.
Passenger Seat Heating/Venting/Cooling Level	Off	The scan tool displays Off, Low Medium, or High. When the heated seat is active, this parameter displays the selected temperature setting.
		The scan tool displays Off, Back & Cushion

Passenger Seat Heating/Venting/Cooling Mode	Off	Heat, or Vent. This parameter indicates the heated or vented seat mode of operation.
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Seat Memory Control Module Scan Tool Output Controls

Control Functions	Description
Driver Mirror Fold	This output control is used to command the driver mirror to fold and unfold.
Driver Mirror Horizontal Movement	This output control is used to command the driver mirror left and right.
Driver Mirror Vertical Movement	This output control is used to command the driver mirror up and down.
Driver Seat Back Horizontal Movement	This output control is used to command the driver seat back Forward and Rearward.
Driver Seat Cushion Front Vertical Movement	This output control is used to command the driver seat cushion front vertical motor Up and Down.
Driver Seat Cushion Rear Vertical Movement	This output control is used to command the driver seat cushion rear vertical motor Up and Down.
Driver Seat Horizontal Movement	This output control is used to command the driver seat Forward and Rearward.
Driver Seat Cushion Heating	This output control is used to command the driver seat heater elements On.
Driver Seat Blower	This output control is used to command the driver seat blower motor On.
Passenger Mirror Fold	This output control is used to command the passenger mirror to fold and unfold.
Passenger Mirror Horizontal Movement	This output control is used to command the passenger mirror left and right.
Passenger Mirror Vertical Movement	This output control is used to command the passenger mirror up and down.
Passenger Seat Cushion Heating	This output control is used to command the passenger seat heater elements On.
Passenger Seat Blower	This output control is used to command the passenger seat blower motor On.

DRIVER SEAT AND PASSENGER SEAT HEATER CONTROL MODULE SCAN TOOL INFORMATION

Front Seat Heating Control Module Scan Tool Data Parameters

Parameter	Expected Value	Description
Operating Conditions: Engine Running		
Driver Seat Blower Duty Cycle	Varies	The scan tool displays 0-100 %. The value displayed is a PWM signal from the seat heating control module to the logic terminal of the seat blower motor. Higher values indicate higher blower motor speeds while lower values indicate lower blower motor speeds.

Driver Seat Cushion Heating Command	Inactive	The scan tool displays Inactive or Active. This parameter displays the commanded output from the seat heating control module to the seat heater elements.
Driver Seat Cushion Temperature Sensor	Varies	The scan tool displays 0-5 V. The voltage displayed is an input to the seat heating control module from the seat cushion temperature sensor. Higher voltage readings indicate cooler seat temperatures while lower voltage readings indicate warmer seat temperatures.
Driver Seat Heating/Venting/Cooling Level	Off	The scan tool displays Off, Low Medium, or High. When the heated or vented seat is active, this parameter displays the selected temperature setting.
Driver Seat Heating/Venting/Cooling Mode	Off	The scan tool displays Off, Back& Cushion Heat, or Vent. This parameter indicates the heated or vented seat mode of operation.
Passenger Seat Blower Duty Cycle	Varies	The scan tool displays 0-100 %. The value displayed is a PWM signal from the seat heating control module to the logic terminal of the seat blower motor. Higher values indicate higher blower motor speeds while lower values indicate lower blower motor speeds.
Passenger Seat Cushion Heating Command	Inactive	The scan tool displays Inactive or Active. This parameter displays the commanded output from the seat heating control module to the seat heater elements.
Passenger Seat Cushion Temperature Sensor	Varies	The scan tool displays 0-5 V. The voltage displayed is an input to the seat heating control module from the seat cushion temperature sensor. Higher voltage readings indicate cooler seat temperatures while lower voltage readings indicate warmer seat temperatures.
Passenger Seat Heating/Venting/Cooling Level	Off	The scan tool displays Off, Low Medium, or High. When the heated or vented seat is active, this parameter displays the selected temperature setting.
Passenger Seat Heating/Venting/Cooling Mode	Off	The scan tool displays Off, Back& Cushion Heat, or Vent. This parameter indicates the heated or vented seat mode of operation.

Front Seat Heating Control Module Scan Tool Output Controls

Control Functions	Description
Operating Conditions: Engine Running	
Driver Seat Blower	This output control is used to command the driver seat blower motors On.
Driver Seat Cushion Heating	This output control is used to command the driver seat heater elements On.

Passenger Seat Blower	This output control is used to command the passenger seat blower motors On.
Passenger Seat Cushion Heating	This output control is used to command the passenger seat heater elements On.

ELECTRONIC BRAKE CONTROL MODULE SCAN TOOL INFORMATION

The Electronic Brake Control Module (EBCM) scan tool data parameters list contains all ABS related parameters that are available on the scan tool. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists.

Electronic Brake Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
ABS Pump Motor Voltage	-	0 V	The scan tool displays the commanded pump motor voltage.
Acceleration Sensor Longitudinal Signal	-	Varies	The scan tool displays 0-5 V depending on the vehicle's longitudinal acceleration.
Antilock Braking System	-	OK	The scan tool displays OK or Malfunction. Malfunction is displayed if there is an ABS malfunction.
Brake Booster Vacuum Sensor	-	Varies	The scan tool displays kPa (psi) This is the current vacuum.
Brake Booster Vacuum Sensor Supply	-	0 V	The scan tool displays 0-5 V depending on the brake booster vacuum sensor supply voltage.
Brake Fluid Level Sensor	-	OK	The scan tool displays OK when the brake fluid is at correct level and Low when the brake fluid is low.
Brake Pedal Position Sensor	Brake pedal released	Inactive	The scan tool displays Inactive or Active depending on the state of the brake pedal.
	Brake pedal applied	Active	
Brake Pressure Sensor	Brake pedal released	0-1 V	The scan tool displays 0-5 V depending on the applied hydraulic brake pressure.
	Brake pedal applied	1-5 V	
Delivered Torque	-	Varies	The scan tool displays 0-100% depending on the how much torque the engine is delivering.
Dynamic Rear Proportioning Status	-	OK	The scan tool displays OK or Malfunction. Malfunction is displayed if the EBCM disables the dynamic rear proportioning due to a fault.
			The scan tool displays 0-5 V depending

Lateral Acceleration Signal	-	Varies	on the vehicle's lateral acceleration.
Left Front Inlet Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the left front inlet solenoid valve is commanded ON.
Left Front Outlet Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the left front outlet solenoid valve is commanded ON.
Left Front Wheel Speed Sensor	-	0 km/h (0 MPH)	The scan tool displays km/h (MPH) depending on the current speed of the left front wheel speed sensor.
Left Rear Inlet Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the left rear inlet solenoid valve is commanded ON.
Left Rear Outlet Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the left rear outlet solenoid valve is commanded ON.
Left Rear Wheel Speed Sensor	-	0 km/h (0 MPH)	The scan tool displays km/h (MPH) depending on the current speed of the left rear wheel speed sensor.
Panic Brake Assist Status	-	OK	The scan tool displays OK or Malfunction. Malfunction is displayed if the EBCM disables the panic brake assist due to a fault.
Pump Motor Relay Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the pump motor is commanded ON.
Primary Isolation Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the isolation solenoid valve is commanded ON.
Primary Prime Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the prime solenoid valve is commanded ON.
Requested Torque	-	Varies	The scan tool displays 0-100% depending on the how much torque is requested.
Right Front Inlet Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the right front inlet solenoid valve is commanded ON.
Right Front Outlet Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the right front outlet solenoid valve is commanded ON.
Right Front Wheel Speed Sensor	-	0 km/h (0 MPH)	The scan tool displays km/h (MPH) depending on the current speed of the right front wheel speed sensor.
Right Rear Inlet Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the right rear

			inlet solenoid valve is commanded ON.
Right Rear Outlet Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the right rear outlet solenoid valve is commanded ON.
Right Rear Wheel Speed Sensor	-	0 km/h (0 MPH)	The scan tool displays km/h (MPH) depending on the current speed of the right rear wheel speed sensor.
Secondary Isolation Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the isolation solenoid valve is commanded ON.
Secondary Prime Solenoid Valve Feedback	-	Inactive	The scan tool displays Inactive or Active. Active is displayed when the prime solenoid valve is commanded ON.
Steering Column Position	Steering wheel in straight position	-5 to +5°	The scan tool displays °. This is the current position of the steering angle sensor.
	Steering wheel turned left until stop	450-550°	
	Steering wheel turned right until stop	-550 to -450°	
System Voltage	-	11-14 V	The scan tool displays V. This is the current battery voltage.
Traction Control Switch	Traction control switch released	Inactive	The scan tool displays Inactive or Active depending on the traction control switch status.
	Traction control switch pressed	Active	
Traction Control System	-	OK	The scan tool displays OK or Malfunction. Malfunction is displayed if there is a traction control malfunction.
Vehicle Stability System	-	OK	The scan tool displays OK or Malfunction. Malfunction is displayed if there is a stability control malfunction.
Vehicle Stability Enhancement System Relay Feedback	-	Active	The scan tool displays Inactive or Active. Inactive is displayed when stability control is disabled.
Vehicle Stability Enhancement System Switch	Traction control switch released	Inactive	The scan tool displays Inactive or Active depending on the traction control switch status.
	Traction control switch pressed	Active	

Yaw Rate Signal	-	Varies	The scan tool displays 0-5 V depending on the vehicle's yaw rate.
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Electronic Brake Control Module Scan Tool Output Controls

Output Control	Description
ABS Left Front Solenoid Valves	Commands the solenoid valves ON or OFF.
ABS Left Rear Solenoid Valves	Commands the solenoid valves ON or OFF.
ABS Pump Motor	Commands the ABS pump motor Increase or Decrease.
ABS Right Front Solenoid Valves	Commands the solenoid valves ON or OFF.
ABS Right Rear Solenoid Valves	Commands the solenoid valves ON or OFF.
Automated Brake Bleed	This is used in order to bleed ABS hydraulics.
Brake Booster Electric Vacuum Pump	Commands the brake booster electric vacuum pump motor ON or OFF.
Traction Control Left Front Solenoid Valves	Commands the solenoid valves ON or OFF.
Traction Control Left Rear Solenoid Valves	Commands the solenoid valves ON or OFF.
Traction Control Right Front Solenoid Valves	Commands the solenoid valves ON or OFF.
Traction Control Right Rear Solenoid Valves	Commands the solenoid valves ON or OFF.

ELECTRONIC PARKING BRAKE CONTROL MODULE SCAN TOOL INFORMATION

Parking Brake Control Module Scan Tool Data Parameters

Parameter	Expected Value	Description
Operating Conditions: Ignition ON, Parking Brake Off		
Base Hardware	Varies	The scan tool displays the base hardware number.
BCM Brake Pedal Signal	Valid	The scan tool displays Valid or Invalid. This parameter displays the signal status received by the body control module brake pedal as valid or invalid. If the signal received is invalid the parking brake control module will deactivate.
Calculated System Temperature	Varies	The scan tool displays the parking brake control module temperature in degrees Celsius.
Calibrations	Varies	The scan tool displays the calibration number.
EBCM Emergency Park Brake Enable Signal	Valid	The scan tool displays Valid or Invalid. This parameter displays the signal status received by the electronic brake control module emergency park brake enable signal as valid

		or invalid. If the signal received is invalid the parking brake control module will deactivate.
ECM Accelerator Pedal Position Signal	Valid	The scan tool displays Valid or Invalid. This parameter displays the signal status received by the engine control module accelerator pedal position signal as valid or invalid. If the signal received is invalid the parking brake control module will deactivate.
ECM Clutch Pedal Position Signal	Valid	The scan tool displays Valid or Invalid. This parameter displays the signal status received by the engine control module clutch pedal position signal as valid or invalid. If the signal received is invalid the parking brake control module will deactivate.
ECM Vehicle Speed Signal	Valid	The scan tool displays Valid or Invalid. This parameter displays the signal status received by the engine control module vehicle speed signal as valid or invalid. If the signal received is invalid the parking brake control module will deactivate.
End Model	Varies	The scan tool displays the end model number.
OS/Software	Varies	The scan tool displays the software number.
Park Brake Calibration Status	Passed	The scan tool displays Passed or Failed. This parameter displays if the park brake calibration is properly programmed into the parking brake control module.
Park Brake Cable Position	Varies	The scan tool displays the current park brake position in counts. When the park brake is fully released the value will be 0 counts which will allow cable disassembly. The park brake cable position counts will display in range of 0-700 counts when released and 701-1300 counts when applied.
Park Brake Motor Command	Off	The scan tool displays On or Off. This parameter displays the status of the park brake motor.
Park Brake Motor Direction	Inactive	The scan tool displays Apply, Release or Inactive. This parameter displays the status of the park brake motor direction.
Park Brake Motor Duty Cycle Command	Varies	The scan tool displays the pulse width modulated cycle as a percentage.
Park Brake Release Reason	None	The scan tool displays None, Ign. Cycled, Spd. Threshold, or Brake Applied. This parameter displays the reason the parking brake was released.
Park Brake Status	Released	The scan tool displays Applied, Released, Malfunction or Invalid. This parameter displays the current status of the parking brake.
Park Brake Switch	Inactive	The scan tool displays Applied, Released, Inactive, or Invalid. This parameter displays the current status of the parking brake switch.
TCM Current Gear Signal	Valid	The scan tool displays Valid or Invalid. This parameter displays the signal status received by the transmission control module current gear signal as valid or invalid. If the

		signal received is invalid the parking brake control module will deactivate.
VIN	Varies	The scan tool displays the vehicle identification number.

Parking Brake Control Module Scan Tool Output Controls

Output Control	Description
Parking Brake Shoe Service Reset	The electric parking brake module will reset the dynamic brake counter. When selected the EPB counter will be set to zero.
Parking Brake Calibration	The electric parking brake module will activate the park brake calibration learn procedure when selected. During the learn procedure the rear brakes will cycle several times.
Parking Brake Cable Apply	The electric parking brake module will apply the parking brake cable tension to diagnose a possible EPB switch failure.
Parking Brake Cable Release	The electric parking brake module will release the parking brake cable to diagnose a possible EPB switch failure.
Parking Brake Cable Replacement	The electric parking brake module will unwind the parking brake cable for replacement or service when selected.
Parking Brake Actuator DTC Reset	The electric parking brake module will reset the park brake actuator when commanded.
Parking Brake Switch Procedure	The electric parking brake module will test the parking brake switch signals to verify they are working properly or if there is an open circuit.

ELECTRONIC SUSPENSION CONTROL MODULE SCAN TOOL INFORMATION

The electronic suspension control module scan tool data parameters list contains all suspension control related parameters that are available on the scan tool. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists.

Electronic Suspension Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
Battery Voltage	-	11-14 V	The scan tool displays V. This is the current battery voltage.
Front Steering Position Sensor Circuit	-	varies	The scan tool displays degrees. This is the current rotational position of the steering wheel.
Left Front Damper Actuator Command	-	varies	The scan tool displays mA. This is the current applied to the left front damper actuator.
Left Front Vertical Body Acceleration	-	0 m/s ²	The scan tool displays m/s ² . This is the signal from the left front body acceleration sensor.
Left Front Vertical Wheel			The scan tool displays m/s ² . This is the

Acceleration	-	0 m/s ²	signal from the left front wheel acceleration sensor.
Left Rear Damper Actuator Command	-	varies	The scan tool displays mA. This is the current applied to the left rear damper actuator.
Rear Vertical Body Acceleration	-	0 m/s ²	The scan tool displays m/s ² . This is the signal from the rear body acceleration sensor.
Right Front Damper Actuator Command	-	varies	The scan tool displays mA. This is the current applied to the right front damper actuator.
Right Front Vertical Body Acceleration	-	0 m/s ²	The scan tool displays m/s ² . This is the signal from the right front body acceleration sensor.
Right Front Vertical Wheel Acceleration	-	0 m/s ²	The scan tool displays m/s ² . This is the signal from the right front wheel acceleration sensor.
Right Rear Damper Actuator Command	-	varies	The scan tool displays mA. This is the current applied to the right rear damper actuator.
Suspension Position Sensor 5 V Reference	-	4.8-5.2 V	The scan tool displays V. This is the wheel and body acceleration sensors supply voltage.
Suspension System Mode	-	Normal	The scan tool displays Normal, Comfort or Sport Mode depending on the selected mode.
	Tour mode switch pressed	Comfort	
	Sport mode switch pressed	Sport Mode	
Vehicle Speed	-	0 km/h (0 MPH)	The scan tool displays km/h (MPH) depending on the current speed of the vehicle.

Electronic Suspension Control Module Scan Tool Output Controls

Output Control	Description
Left Front Damper Actuator	Commands the current applied to the left front damper actuator Increase or Decrease.
Left Rear Damper Actuator	Commands the current applied to the left rear damper actuator Increase or Decrease.
Right Front Damper Actuator	Commands the current applied to the right front damper actuator Increase or Decrease.
Right Rear Damper Actuator	Commands the current applied to the right rear damper actuator Increase or Decrease.

GENERAL INFORMATION

Vehicle Diagnostic Information - Scan Tool Information

SPECIFICATIONS

K20 ENGINE CONTROL MODULE: SCAN TOOL INFORMATION

Engine Control Module Scan Tool Data

Parameter	System State	Expected Value	Description
This is a comprehensive list. Not all parameters listed are available for all applications. Base Operating Conditions: Engine Idling/Radiator Hose Hot/Park or Neutral/Closed Loop			
5 V Reference 1, 2, 3 or 4	Engine Idling	5 Volts	This parameter displays the voltage sensed on the 5 V reference circuits at the control module. The scan tool will display a higher value at higher voltage. The scan tool will display a lower value at lower voltage.
5 V Reference 1, 2, 3 or 4 Circuit Status	Engine Idling	OK	This parameter will display OK if the circuit is good or Malfunction if a short to ground, short to B+ is present.
A/C Compressor Clutch Relay Command	Engine Idling	Off	This parameter displays when the A/C Compressor Clutch relay is commanded ON or OFF.
A/C Compressor Clutch Relay Control Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the status of the relay control circuit. It can display OK, Malfunction or Not Run.
A/C Compressor Clutch Relay Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the status of the relay control circuit. It can display OK, Malfunction or Not Run.
A/C Compressor Clutch Relay Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the status of the relay control circuit. It can display OK, Malfunction or Not Run.
A/C Disabled - A/C Pressure Out of Range	A/C ON	No	This parameter displays whether the A/C pressure is out of range for normal operation as determined by the control module.
			The parameter displays reason

A/C Disengage 1-8 History	A/C ON	Reason for A/C Disengagement	for the last 8 air conditioning (A/C) compressor disengagements in order from 1 to 8 with 8 being the most recent. There are 8 possible causes for the A/C compressor to disengage.
A/C High Side Pressure Sensor	A/C OFF	0.75-1.5 Volts*	This parameter displays the voltage signal from the A/C high side pressure sensor input to the control module. * Varies with temperature, humidity, and altitude.
	A/C ON	1.3-2.5 Volts*	
A/C High Side Pressure Sensor	A/C OFF	450-827 kPa (65-120 psi) *	This parameter displays the pressure from the A/C high side pressure sensor signal circuit to the control module. * Varies with temperature, humidity, and altitude.
	A/C ON	827-2,350 kPa (120-341 psi)*	
A/C OFF for WOT	A/C ON	No	This parameter displays whether the control module is commanding the A/C compressor clutch relay OFF for wide open throttle (WOT).
A/C Request Signal	A/C ON	No	This parameter displays the state of the A/C request input to the control module from the heating, ventilation, and air conditioning (HVAC) controls.
Accelerator Pedal Position	Engine Idling	0-100 %	This parameter displays the angle of the accelerator pedal position (APP) as calculated by the control module using the signals from the APP sensors.
Accelerator Pedal Position When Engine Overspeed Detected	Engine Idling	%	This parameter displays the accelerator pedal position (APP) observed upon initial detection of an overspeed condition. This value will be updated upon each overspeed condition.
Air/Fuel Equivalence Ratio Command	Engine Idling	Varies:1	This parameter should display 1.0 when in Closed Loop fuel control.
			This parameter displays an 'undefaulted' fuel rail pressure relative to manifold vacuum.

Alternative Fuel Rail Pressure Sensor	Ignition ON	kPa	This is intended for gaseous fuel injection alternative fuel applications (CNG/LPG Mono-Fuel and Bi-Fuel).
Ambient Air Temperature	Engine Idling	Varies	This parameter displays temperature from the input of the Intake Air Temperature Sensor.
Ambient Air Temperature	Ignition ON	°C (°F) Varies	This parameter displays the outside air temperature as calculated by the control module.
Ambient Air Temperature When Recommended Maximum Fuel Alcohol Content Exceeded	-	°C (°F)	This parameter displays the ambient air temperature when the recommended maximum fuel alcohol content was exceeded.
Ambient Humidity	Ignition ON	%	This parameter displays the current ambient humidity level.
APP Sensor 1	Accelerator pedal not actuated	0.98 Volts	This parameter displays the actual voltage on the accelerator pedal position (APP) sensor 1 signal circuit as measured by the control module.
	Accelerator pedal fully actuated	4.25 Volts	
APP Sensor 1 and 2	Ignition ON	Agree	This parameter displays Disagree if the control module detects the signal voltage from APP sensor 1 is not in correct relationship to APP sensor 2. The scan tool displays Agree under the normal operating conditions.
APP Sensor 1 Circuit Status	Engine Idling	OK	APP Sensor 1 Out of Range indicates that the sensed accelerator pedal position 1 sensor value is currently out of range or that a Malfunction has been detected based upon the sensed accelerator pedal position 1 sensor value being out of range
APP Sensor 1 Learned			This parameter contains the learned maximum (fully applied) accelerator pedal position relating to absolute accelerator pedal position (no

Applied Position	Ignition ON	78 %	correction or normalization based upon learned minimum or maximum positions) from accelerator pedal position sensor 1.
APP Sensor 1 Learned Released Position	Ignition ON	0.98 Volts	This parameter indicates the accelerator pedal sensor 1 signal at its minimum learned position (pedal released) as a percentage of its reference voltage. (The minimum learned position is automatically updated periodically as determined by the calibration.
APP Sensor 1 Position	Pedal Released	0 %	This parameter contains the displacement determined from accelerator pedal position sensor 1 (corrected and normalized based upon its learned minimum and maximum positions).
	Pedal Fully Applied	99 %	
APP Sensor 2	Ignition ON	Volts	This parameter contains the accelerator pedal position sensor 2 analog input as a percentage of its reference voltage
APP Sensor 2	Accelerator pedal not actuated	0.49 Volts	This parameter displays the actual voltage on the accelerator pedal position (APP) sensor 2 signal circuit as measured by the control module.
	Accelerator pedal fully actuated	2.14 Volts	
APP Sensor 2 Circuit Status	Ignition ON	OK	APP Sensor 2 Out of Range indicates that the sensed accelerator pedal position 2 sensor value is currently out of range or that a malfunction has been detected (and latched) based upon the sensed accelerator pedal position 2 sensor value being out of range
APP Sensor 2 Learned Applied Position	Ignition ON	78 %	This parameter contains the learned maximum (fully applied) accelerator pedal position relating to absolute accelerator pedal position (no correction or normalization

			based upon learned minimum or maximum positions) from accelerator pedal position sensor 2.
APP Sensor 2 Learned Released Position	Ignition ON	0.49 Volts	This parameter indicates the accelerator pedal sensor 2 signal at its minimum learned position (pedal released) as a percentage of its reference voltage. (The minimum learned position is automatically updated periodically as determined by the engine control module.
APP Sensor 2 Position	Pedal Released	0 %	This parameter contains the displacement determined from accelerator pedal position sensor 2 (corrected and normalized based upon its learned minimum and maximum positions).
	Pedal Fully Applied	100 %	
APP Sensors	Pedal Released	0 %	This parameter contains the accelerator pedal position resulting directly from the settling of differences of the accelerator pedal position sensors (prior to any compensation to determine driver intent).
	Pedal Fully Applied	99 %	
Autostart/Autostop Disable Mode	-	Active	This parameter displays "Active" when all conditions for allowing the autostart/autostop mode are present (no inhibit conditions exist), this parameter displays "Inactive" when all conditions for allowing the autostart/autostop mode are not present.
Autostart Inhibit Reason Autostart/Autostop Malfunction	Engine Idling	No	This parameter displays that a immediate stop was commanded due to a Autostart/Autostop malfunction.
			The scan tool displays Yes if one of the following Autostart Inhibit Reason is detected.

Autostart Inhibit Reason	Engine Idling	No	Control Function Active, Crank Abort, Driver Exited Vehicle, ECM Malfunction, ECM Request, Engine Coolant Temperature Out of Range, Hood Ajar, Hybrid/EV Power Conditions, Hybrid/EV Battery Pack Contactor Open, Hybrid/EV Battery Pack Power Low, Hybrid/EV Battery Pack State of Charge Low, Hybrid/EV Battery Pack Voltage Low, Hybrid/EV Propulsion System Inactive, Not Commanded, Run/Crank Not Active, System Malfunction, Transmission Range.
Autostart Reason	Engine Idling	No	This parameter displays Yes if one of the following Autostart Reason is detected. A/C Request, Acceleration Request, Accelerator Pedal Pressed, Auxiliary Transmission Fluid Pump Not Available, Brake Booster Weak Vacuum, Brake Pedal Released, Clutch Pedal Applied, Control Function Active, Drive Motor Inverter Temperature High, Drive Motor Temperature High, Driver Exited Vehicle, ECM Request, Engine Coolant Temperature Out of Range, Hood Ajar, Hybrid/EV Battery Module Voltage Low, Hybrid/EV Battery Pack Power Low, Hybrid/EV Battery Pack State of Charge Low, Hybrid/EV Battery Pack Temperature, Hybrid/EV Battery Pack Voltage Low, Hybrid/EV Propulsion System Inactive, Ignition Switch Start, Inclination, Invalid Data Received, Low Voltage Battery Discharge Current High, Low Voltage Battery State of

			Function Low, Low Voltage Battery State of Health Low, Low Voltage Battery Voltage Low, Maximum Autostop Time Exceeded, Minimum Engine Run Time Not met, Reduced Engine Power Active, Remote Vehicle Start Request, Stop/Start Select Switch, System Malfunction, System Optimization, System Voltage Low, TCM Demand, Tow/Haul Mode Switch ON, Transmission Fluid Temperature Out of Range, Transmission In Reverse, Transmission Range, Vehicle Speed Too High.
Autostop Disable Reason	Engine Idling	No	The scan tool displays Yes if one of the following Autostop Disable Reason is detected. 12 V Start Counter Exceeded, A/C Request, Acceleration Request, Accelerator Pedal Pressed, Auxiliary Transmission Fluid Pump Not Available, Brake Booster Weak Vacuum, Brake Pedal Released, Clutch Pedal Applied, Control Function Active, Drive Motor Inverter Temperature High, Drive Motor Temperature High, ECM Request, Engine Coolant Temperature Out of range, Engine Speed High, Generator Load High, Hood Ajar Hybrid/EV Battery Module Voltage Low, Hybrid/EV Battery Pack Power Low, Hybrid/EV Battery Pack State of Charge Low, Hybrid/EV Battery Pack Temperature, Hybrid/EV Battery Pack Voltage Low, Hybrid/EV Propulsion System Inactive, Idle Boost Mode Active, Ignition Switch Start, Intake Manifold Weak Vacuum,

			Invalid Data Received, Low Voltage Battery Discharge Current High, Low Voltage Battery State of Charge Low, Low Voltage Battery State of Function Low, Low Voltage Battery State of Health Low, Low Voltage Battery Temperature Out of Range, Low Voltage Battery Voltage Low, Maximum Vehicle Stop Time Exceeded, Minimum Engine Run Time Not Met, Reduced Engine Power Active, Remote Vehicle Start Request, Run/Crank Not Active, Stop/Start Select Switch, System Optimization, System Voltage Low, TCM Request, Tow/Haul Mode Switch ON, Transmission Fluid Temperature Out of Range, Transmission in Reverse, Transmission Range, Vehicle Inclination, Vehicle Speed Threshold Not Reached, Vehicle Speed Too High, Wheel Slip Detected.
Axle Torque	Engine Idling		This parameter displays the Axle Torque value sent from the hybrid control processor (HCP) to the ECM and anti-lock brake system (ABS) module.
BARO	Engine Idling	65-104 kPa (8-16 psi)	This parameter displays the barometric pressure. The control module uses the barometric pressure sensor input for fuel control to compensate for altitude differences.
BARO Sensor	Engine Idling	2.5-4.0 Volts	This parameter displays the barometric pressure sensor voltage.
Boost Pressure	Engine Idling	kPa	This parameter shows the Turbocharger boost pressure in kPa.

Boost Pressure Sensor	Engine Idling	kPa	This parameter shows the Turbocharger boost pressure in kPa.
Boost Pressure Sensor	-	Volts	This parameter displays the turbocharger boost pressure sensor in voltage.
Brake Booster Pressure Sensor	Engine Idling	Volts	This parameter displays the brake booster vacuum pressure analog input as a percentage of its reference voltage.
Brake Booster Pressure Sensor	Engine Idling	kPa	This parameter displays the undefaulted, unfiltered brake booster vacuum pressure measured by a sensor.
Brake Pedal Position Circuit Signal	Ignition ON	Closed	This parameter displays the serial data message of the brake signal from the electronic brake and traction control module (EBTCM).
Brake Pedal Position Circuit Signal	-	Released	This parameter displays the displacement of the brake pedal.
Brake Pedal Position Sensor	Ignition ON	%	This parameter displays the displacement of the brake pedal, where 0% corresponds to the brake pedal being released and 100% corresponds to the brake pedal being fully applied.
Brake Pedal Position Sensor	Ignition ON	Volts	This parameter displays the brake pedal position as indicated by the analog sensor as a percentage of its reference voltage.
Brake Pedal Position Sensor Fully Released Learn Status	Ignition ON	Complete	This parameter displays the brake pedal fully released learn position status.
Brake Pedal Position Sensor Learned Released Position	Ignition ON	Volts	This parameter displays the position learned for the brake pedal position sensor when the brake pedal is fully released.
Brake Pedal Position Sensor Signal	Ignition ON	Released	This parameter displays the serial data message of the brake position sensor signal from the electronic brake and traction control module (EBTCM).
			This parameter contains the

Calculated Air Flow	Engine Idling	G/S	mass airflow determined from the speed density (MAP based) calculation of air mass per cylinder.
Calculated BARO	Engine Idling	kPa/psi 97.2 kPa/14.1 psi at idle	This parameter contains an estimate of barometric pressure, used to correlate with sensed ambient air pressure in the Barometric Pressure Correlation Diagnostic.
Calculated Catalyst Temperature Bank 1 or Bank 2	Engine Idling	Approximately 552°C (1026°F)	This parameter contains the estimated catalyst temperature for bank 1 sensor 1 (as a function of engine speed, engine airflow, and fuel ethanol percentage) for use in the oxygen sensor and catalyst monitor diagnostic algorithms.
Calculated Engine Oil Temperature	Engine Idling	105°C (221°F)	This parameter displays the estimated engine oil temperature (as a function of engine coolant temperature and other parameters).
Calibration History Buffer	Ignition ON	Unlocked	This parameter displays locked when the buffer has been locked against further updates due to detection of a non-production calibration.
Calibration Verification Number History 1-10	Ignition ON	#	This parameter displays the history entries for the primary calibration part in the controller.
Camshaft Position Active Counter	Ignition ON	Counts	This parameter displays a rolling count of the number of primary cam position sensor pulses.
Camshaft Position Sensor	Engine Idling	0 RPM	This parameter displays the speed of the engine as calculated by the signal from a camshaft position (CMP) sensor. This parameter will always display 0 unless a condition with the CKP sensor or CKP reluctor exists. If a CKP condition exists the control module will use a valid CMP sensor signal to determine

			engine speed and crank/camshaft position.
Camshaft Position Signal Output Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the Camshaft Position Signal Output Circuit. The parameter displays Malfunction if the Camshaft Position Signal Output Circuit is shorted to voltage.
Camshaft Position Signal Output Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the Camshaft Position Signal Output Circuit. The parameter displays Malfunction if the Camshaft Position Signal Output Circuit is shorted to ground.
Camshaft Position Signal Output Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the Camshaft Position Signal Output Circuit. The parameter displays Malfunction if the Camshaft Position Signal Output Circuit is open.
Catalyst Monitor Complete	Engine Idling	Yes/No	This parameter indicates the status of the Catalyst. The scan tool displays YES when the diagnostic is complete. And NO if the diagnostic has not run, or a malfunction is detected in the catalyst.
Catalyst Monitor Complete This Ignition Cycle	Engine Idling	Yes/No	This parameter indicates the status of the catalyst monitor diagnostic. Catalyst Monitor Test Running indicates yes or no when the catalyst monitor diagnostic is actively running a test.
Catalyst Monitor Enabled	Engine Idling	Yes/No	The scan tool displays YES when the Catalyst Monitor is Enabled. If the scan tool displays NO this could indicate a malfunction in the Catalyst Monitor circuit.
Catalyst Monitor Enabled this Ignition Cycle	Engine Idling	Yes-No	This parameter displays the monitor enable status during the current driving/monitoring cycle.
			This parameter indicates the

Catalyst Monitor Not At Idle Test Conditions Met	Engine Idling	Yes/No	status of the catalyst monitor diagnostic. Catalyst Monitor Test Running indicates yes or no when the catalyst monitor diagnostic is actively running a test.
Catalyst Monitor Test Counter Bank 1 or 2	Engine Idling	Counts	This parameter contains the number of repeated results of the catalyst monitor diagnostic test that have been performed since a code clear for bank 1 or bank 2 (used to determine if a sufficient number of tests have run to report a passing condition).
Catalyst Monitor Test Result Bank 1 or 2	Engine Idling	No Decision/Failed/Passed	This parameter indicates the status of the catalyst monitor diagnostic for bank 1 or bank 2. Multiple tests may run before the diagnostic reports a "Pass" or "Fail" and will be tracked by Catalyst Monitor Diagnostic Test Counter Bank 1 or bank 2. When this Parameter reports a "Pass" or "Fail", the diagnostic is complete for the current trip and will not attempt any further tests on bank 1 or bank 2.
Catalyst Monitor Test State	Engine Idling	Active/Inactive	This parameter indicates the status of the catalyst monitor diagnostic by displaying active or inactive. This test will only run with the engine at idle.
Change Engine Oil Indicator Command	Ignition ON	Off	This parameter sends a signal through the serial communication to inform the driver to change the engine oil. It is based on a calibrated amount of time.
Charge Air Cooler Coolant Pump Relay Command	Ignition ON	Off	This parameter displays the commanded state of the intercooler pump relay command.
Charge Air Cooler Coolant Pump Relay Control	Ignition ON	OK	This parameter displays the state of the charge air cooler coolant pump control circuit. The parameter displays

Circuit High Voltage Test Status			Malfunction if the charge air cooler coolant pump control circuit is shorted to voltage.
Charge Air Cooler Coolant Pump Relay Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the charge air cooler coolant pump control circuit. The parameter displays Malfunction if the charge air cooler coolant pump control circuit is shorted to ground.
Charge Air Cooler Coolant Pump Relay Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the charge air cooler coolant pump control circuit. The parameter displays Malfunction if the charge air cooler coolant pump control circuit is open.
Clutch Pedal Starter Inhibit Switch (If Equipped)	Engine Idling	On	This parameter displays ON when the clutch pedal is released.
Clutch Pedal Switch (If Equipped)	Engine Idling	Released	This parameter displays the state of the clutch pedal as determined by the control module from the clutch pedal switch.
Cold Startup	Ignition ON	No	This parameter displays whether the engine meets the conditions for a cold startup during the present ignition cycle. The scan tool displays Yes when the conditions for a cold startup are met during the ignition cycle. The scan tool displays No when the conditions for a cold startup are not met during the present ignition cycle. Conditions for a cold startup require the coolant temperature and the intake air temperature to be below a predetermined temperature and within a certain range of each other. These conditions must occur after the engine was warmed up to a specific temperature during the previous ignition cycle.

Component Monitor Complete	Ignition ON	Yes/No	This parameter displays Yes when the Component Monitor is Complete. The engine control module looks at many input and output components to make this determination. If a malfunction is detected the scan tool will display No.
Component Monitor Enabled	Ignition ON	Yes/No	This parameter displays Yes when Component Monitor is Enabled. And No when it is not Enabled.
Cooling Fan Command	-	%	This parameter displays the amount of fan power commanded as a percentage of the total fan power available.
Cooling Fan Motor Command	-	%	This parameter displays the commanded duty cycle for the cooling fan.
Cooling Fan Relay 1 Command	Ignition ON	On	This parameter displays the commanded state of the fan relay 1 control circuit. The cooling fan relay 1 should be ON when the scan tool indicates the FC Relay 1 Command is ON. The cooling fan relay 1 should be OFF when the scan tool indicates the FC Relay 1` Command is OFF.
Cooling Fan Relays 2 and 3 Command	Ignition ON	On	This parameter displays the commanded state of the fan relay 2 output.
Cooling Fan Relay 1 Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the cooling fan relay control circuit. The parameter displays Malfunction if the cooling fan relay control circuit is open.
Cooling Fan Relay 1, or 2 and 3 Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the cooling fan relay control circuit. The parameter displays Malfunction if the cooling fan relay control circuit is shorted to voltage.
Cooling Fan Relay 1, or 2			This parameter displays the state of the cooling fan relay control circuit. The parameter

and 3 Control Circuit Low Voltage Test Status	Ignition ON	OK	displays Malfunction if the cooling fan relay control circuit is shorted to ground.
Cooling Fan Speed	Ignition ON	Varies	This parameter displays the current state of the cooling fan speed. (For example OFF, Low, Medium, or High) rather than rotational speed.
CPP Learn Status	Ignition ON	Learned	This parameter displays the status of the procedure used to learn the clutch pedal fully applied position.
CPP Learned Apply Position	Ignition ON	Volts	This parameter displays the position learned for the clutch pedal position sensor when the clutch pedal is fully applied during the associated learn procedure.
CPP Learned Release Position	Ignition ON	Volts	This parameter displays the position learned for the clutch pedal position sensor when the clutch pedal is released.
CPP Sensor	Ignition ON	Volts	This parameter displays the clutch pedal position sensor analog input as a percentage of its reference voltage.
CPP Sensor	Ignition ON	%	This parameter displays the position learned for the clutch pedal position sensor when the clutch pedal is fully applied during the associated learn procedure.
Crank Request Signal	Ignition switch not in the crank position	No	This parameter displays whether the ignition switch has been cycled to the crank position requesting the control module to activate the starter relay.
	Ignition switch in the crank position	Yes	
Crankshaft Position Active Counter	Engine Idling	0-255 Counts	This parameter displays an incrementing counter when the control module receives a signal from the crankshaft position sensor (CKP).
Crankshaft Position	Ignition ON	Volts	This parameter displays the position learned for the clutch pedal position (CPP) sensor

Learned Apply Position			when the clutch pedal is fully applied during the associated learn procedure.
Crankshaft Position Learned Release Position	Ignition ON	Volts	This parameter displays the position learned for the clutch pedal position sensor when the clutch pedal is released.
Crankshaft Position Resync Counter	Engine Idling	0 Counts	This parameter displays the number of times the control module has to resynchronize with the CKP sensor. The parameter will begin to increment if the control module does not detect a CKP reference pulse. The parameter will reset to 0 after the ignition is switched OFF.
Crankshaft Position Sensor	Engine Idling	RPM	This parameter displays engine speed.
Crankshaft Position Sensor	Ignition ON	Volts	This parameter displays the displacement of the clutch pedal (corrected and normalized based upon its learned released and fully applied positions), where 0% corresponds to the clutch pedal being released and 100% corresponds to the clutch pedal being fully applied.
Crankshaft Position Sensor	Ignition ON	%	This parameter displays the clutch pedal position sensor analog input as a percentage of its reference voltage.
Crankshaft Position Signal Output Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the crankshaft position signal output circuit. The parameter displays Malfunction if the crankshaft position signal output circuit is shorted to voltage.
Crankshaft Position Signal Output Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the crankshaft position signal output circuit. The parameter displays Malfunction if the crankshaft position signal output circuit is shorted to ground.
			This parameter displays the

Crankshaft Position Signal Output Circuit Open Test Status	Ignition ON	OK	state of the crankshaft position signal output circuit. The parameter displays Malfunction if the crankshaft position signal output circuit is open.
Crankshaft Position Variation Learn	Ignition ON	Not Learned	This parameter displays if the crank angle learned this key cycle.
Crankshaft Position Variation Learn Crank Pulse to Cylinder Count	Ignition ON	Counts	This parameter displays the number of attempts to learn the crank angle sensing error (CASE) during the current key cycle.
Crankshaft Position Variation Learn Crank Pulse to Cylinder Count	Ignition ON	Agree	This parameters displays the number of crank pulses observed over an engine cycle did not equal the number of cylinders for the engine at some point during the CASE learn cycle.
Crankshaft Position Variation Learn Required Engine Speed	Ignition ON	In Range	This parameter displays that the engine speed required to complete the CASE learn process has not been achieved.
Crankshaft Position Variation Learn Status	Ignition ON	Complete	This parameter displays the status of the crank angle sensing error (CASE) learn algorithm.
Cruise Control	Cruise ON	Active	This parameter displays the status of the cruise control system as determined by the control module.
Cruise Control Cancel Switch	Cruise ON	Inactive	This parameter displays the status of the cruise control cancel switch.
Cruise Control Disengage 1-8 History	Cruise ON	Reason for Cruise Disengagement	The parameter displays the last 8 cruise control disengages in order from 1 to 8, with 8 being the most recent. There are approximately 30 possible causes for the cruise control to disengage.
Cruise Control Inhibit Reason	Cruise OFF	Off	The parameter displays the reason the cruise control system cannot engage.
	Cruise ON	Park/Neutral	
			The engine control module

Cruise Control ON/OFF Switch	Cruise ON	On	(ECM) monitors the signal circuit of the cruise control switch. A closed switch is displayed as ON.
Cruise Control Resume/Accelerator Switch	Cruise ON	On	The scan tool displays ON, when the cruise ON/OFF switch is ON and the resume/accel (+) button is pressed, the ECM detects a predetermined voltage value for the resume/accel. switch.
Cruise Control Set/Coast Switch	Cruise ON	On	The scan tool displays ON, when the cruise ON/OFF switch is ON and the ECM detects a predetermined voltage value for the set/coast (-) switch.
Cruise Control Switch	Cruise ON	Inactive	The engine control module (ECM) monitors the signal circuit of the cruise control switch. A closed switch is displayed as Active.
Current Gear	Transmission in Park/Neutral	P/N	This parameter displays the transmission gear commanded by the transmission control module.
	Transmission not in Park/Neutral	Reverse/1st-5th	
Current Gear When Engine Overspeed Detected	Engine Idling	Varies	This parameter displays the transmission actual gear observed upon initial detection of an overspeed condition.
Cycles of Misfire Data	Engine Running	0-3,000 counts	This parameter displays the number of cylinder firing events recorded by the control module.
Cylinder 1,2,3,4,5,6,7,8 Current Misfire Counter	Engine Idling	Counts	The scan tool displays a range of 0-255 counts. This parameter displays the number of misfires that have been detected during the last 255 cylinder firing events. The counters may normally display some activity, but the activity should be nearly equal for all of the cylinders, and in low numbers.
			The scan tool displays a range of 0-65,535 counts. The misfire

Cylinder 1,2,3,4,5,6,7, or 8 History Misfire Counter	Engine Running	Counts	history counters display the total level of misfire that has been detected on each cylinder. The misfire history counters will not update or show any activity until a misfire DTC P0300 has become active. The misfire history counters will update every 255 cylinder firing events.
Cylinder 1, 2, 3, 4, 5, 6, 7 or 8 Injector Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the injector control circuit. The parameter displays Malfunction if the injector control circuit is shorted to voltage.
Cylinder 1, 2, 3, 4, 5, 6, 7 or 8 Injector Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the injector control circuit. The parameter displays Malfunction if the injector control circuit is shorted to ground.
Cylinder 1, 2, 3, 4, 5, 6, 7 or 8 Injector Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the injector control circuit. The parameter displays Malfunction if the injector control circuit is open.
Cylinder 1, 2, 3, 4, 5, 6, 7 or 8 Injector Flow Identifier	Ignition ON	OK	This parameter displays the End of Line Injector Adjustment (EIA) for the fuel injector. This value shall be used by the ECM for adjustment to actual fuel injected quantity compared to nominal for the injector.
Cylinder 1-6 Injector Control Circuit Status	Engine Idling	OK	This parameter displays the state of the fuel injector control circuit.
Cylinder 1-6 Injector Disabled Misfire Detected	Engine Idling	No	This parameter displays the injector that has been disabled by the misfire catalyst converter protection calibration.
Cylinder 1-6 Knock Detected	Engine Idling	No	This parameter displays yes if a knock has been detected in an individual cylinder.
			This parameter displays the status of the operating mode of the control module used to turn

Deceleration Fuel Cut-Off	Engine Idling	Inactive	OFF the fuel injectors and the EVAP canister purge valve during certain deceleration conditions.
Desired Boost Pressure	-	kPa	This parameter displays the desired turbocharger boost pressure.
Desired ECT	Ignition ON	°C (°F)	This parameter displays the desired engine coolant temperature in degrees.
Desired Exhaust Camshaft Position Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays the desired exhaust camshaft angle as commanded by the control module.
	Engine speed at 2000 RPM	10 Degrees	
Desired Fuel Rail Pressure	Engine Idling	Varies 3.4 mPa to 5.5 mPa (500 to 800 psi)	This parameter displays the desired Fuel Rail Pressure commanded by the control module.
Desired Idle Speed	Engine Idling	Approximately 650 RPM	This parameter displays the desired engine idle speed as commanded by the control module. The desired idle speed varies depending on engine load.
Desired Intake Camshaft Position Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays the desired intake camshaft angle as commanded by the control module.
	Engine speed at 2000 RPM	10 Degrees	
Desired Throttle Position	Engine Idling	%	Commanded Throttle Actuator Control.
Distance Since DTC Cleared	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance traveled since a DTC was cleared.
Distance Since First Malfunction	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance traveled since a Malfunction occurred.
Distance Since Last Malfunction	Engine Idling	0 Km/mi	This parameter displays the distance accumulated since last malfunction was captured. This parameter is only meaningful within the context of a failure record or freeze frame.
Distance Since Last Oil	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance

Level Warning			traveled since the last oil level warning Malfunction occurred.
Distance Since Last Oil Pressure Warning	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance traveled since the last oil pressure warning Malfunction occurred.
Distance Since Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance Since Recommended Maximum Fuel Alcohol Content Exceeded.
Distance This Driving Cycle	Ignition ON	km / miles	This parameter displays the distance a vehicle has traveled in the current driving cycle.
Distance with MIL On	Ignition ON	km / miles	This parameter displays the accumulated distance driven with the malfunction indicator lamp (MIL) on.
Drag Control Status	Vehicle Moving	Active/Inactive	EDC Active (Drag Active) control mode is indicated when the requested torque signal is above the driver requested value while the traction control system signal input is active.
Driver Requested Axle Torque	Engine Idling		This parameter displays a (desired) output value after comparing engine load as an input to the hybrid control processor and engine control module.
Drop-Throttle Detected while Traction Control Active	Engine Idling	No	This parameter displays if the Drop Throttle Control Mode is active while the Traction Control System Data Control Signal input is active.
Drop-Throttle Status	Engine Idling	Inactive	This parameter displays the Drop Throttle Control Mode is active when the Requested Torque Signal indicates greater than 90 percent duty cycle while the Traction Control System Data Control Signal input is active.
			ECM Authentication Status indicates the result of the

ECM Authentication Status	Ignition ON	Valid	comparison between the last received immobilizer response and the expected response calculated into the ECM.
ECM Challenge Status	Ignition ON	Valid	This parameter displays the immobilizer system status of the ECM challenge. This indicates whether the currently calculated ECM challenge is valid.
ECM in Immobilizer Fail Enable Mode	Ignition ON	Yes / No	This parameter displays that a serial communication failure has been detected after the receipt of the correct VTD password.
ECM Response Source	Ignition ON	Ignition Switch Start	ECM Response Source indicates the source used to calculate the ECM response.
Economy Mode Indicator Command	Ignition ON	Off	This parameter indicates the status of the serial data signal used to illuminate the economy mode indicator lamp.
ECT Sensor	Ignition ON	88 to 105°C (190 to 221° F)	This parameter displays the temperature of the engine coolant based on input to the control module from the engine coolant temperature (ECT) sensor.
ECT vs. IAT Sensor Temperature at Last ECT vs. RCT Malfunction Detection	Ignition ON	Agree	This parameter displays that the temperature values of the ECT and IAT sensors did not agree at the time of the most recent failure of the ECT/RCT rationality diagnostic.
EGR/Camshaft Position Monitor Complete	Ignition ON	Yes/No	This parameter displays the status of the EGR/Camshaft Position Monitor. The parameter will display Yes when the EGR/Camshaft Position Monitor is complete.
EGR/Camshaft Position Monitor Complete This Ignition Cycle	Engine Idling	Yes/No	This parameter displays Yes or No of the completion status during the current driving/monitoring cycle of emission related monitors.
			This parameter displays the

EGR/Camshaft Position Monitor Enabled	Ignition ON	Yes/No	status of the EGR/Camshaft Position Monitor. The parameter will display Yes when the EGR/Camshaft Position Monitor is Enabled.
EGR/Camshaft Position Monitor Enabled This Ignition Cycle	Engine Idling	Yes/No	This parameter displays Yes or No of the completion status during the current driving/monitoring cycle of emission related monitors.
Electric Power Management Inhibit Reason	Engine Idling	None	<p>This parameter displays the reason for the source of the Regulated Voltage Control (RVC) override command. RVC lowers system operating voltage to reduce system electrical load and improve fuel economy performance. The following is a list of possible reasons:</p> <ul style="list-style-type: none"> • None • Control Function • Active/Fuel System • On-board Diagnostic System • Air Flow Measurement System • Cylinder Deactivation System • System Transmission Control Module
Engine Autostopped	-	No	This parameter displays the status of the internal combustion engine (ICE) in vehicles incorporating ICE autostart/stop functionality.
Engine Calibration Part Number History 1-10	Ignition ON	#	This parameter displays the engine calibration part number history.
Engine Controls Ignition Relay Command	Ignition ON	Off	This parameter displays the state of the control circuit for control module power relay as commanded by the control module.

Engine Controls Ignition Relay Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the Engine Controls Ignition Relay control circuit. The parameter displays Malfunction if the Engine Controls Ignition Relay control circuit is shorted to voltage.
Engine Controls Ignition Relay Controls Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the Engine Controls Ignition Relay control circuit. The parameter displays Malfunction if the Engine Controls Ignition Relay control circuit is shorted to ground.
Engine Controls Ignition Relay Controls Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the Engine Controls Ignition Relay control circuit. The parameter displays Malfunction if the Engine Controls Ignition Relay control circuit is open.
Engine Controls Ignition Relay Feedback Signal	Ignition ON	12.0-14.9 Volts	This parameter displays the voltage available at the engine controls ignition relay terminal of the engine control module.
Engine Coolant Thermostat Heater Command	Ignition ON	%	This parameter displays the commanded duty cycle for the engine coolant thermostat.
Engine Coolant Thermostat Heater Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the engine coolant thermostat heater control circuit. The parameter displays Malfunction if the engine coolant thermostat heater control circuit is shorted to voltage.
Engine Coolant Thermostat Heater Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the engine coolant thermostat heater control circuit. The parameter displays Malfunction if the engine coolant thermostat heater control circuit is shorted to ground.
Engine Coolant			This parameter displays the state of the engine coolant thermostat heater control

Thermostat Heater Control Circuit Open Test Status	Ignition ON	OK	circuit. The parameter displays Malfunction if the engine coolant thermostat heater control circuit is open.
Engine Load	Engine Idling	25-45 %	This parameter displays the calculated engine load in percent based on inputs to the control module from various engine sensors.
	Engine speed at 2,500 RPM	40-60 %	
Engine Load During Misfire History 1-10	Ignition ON	%	This parameter displays the engine load during the last misfire event.
Engine Off	-	No	This parameter displays the status of the internal combustion engine (ICE) in vehicles incorporating ICE autostart/stop functionality.
Engine OFF Time	Engine Idling	0:00:00 Seconds - Varies	This parameter displays the amount of time that has elapsed since the engine was last cycled OFF.
Engine Oil Absolute Pressure Sensor	Engine Idling	kPa/PSI	This parameter displays the defaulted, unfiltered measured engine oil pressure read by an oil absolute pressure sensor.
Engine Oil Level Switch	Engine Idling	OK	This parameter displays the status of the engine oil level switch as determined by the control module. The control module uses this information to turn on the low engine oil lamp if the engine oil level remains approximately 1 quart low for a sufficient amount of time. The scan tool will display Low when the engine oil level is low. The scan tool will display OK when the engine oil level is correct.
Engine Oil Life Remaining	Engine Idling	0-100 %	This parameter displays the percent of engine oil life remaining. The controller calculates the engine oil life by monitoring engine load, coolant temperature, and engine speed.
			This parameter displays the

Engine Oil Pressure	Engine Idling	kPa/PSI	actual engine oil pressure measured by a sensor.
Engine Oil Pressure Control Solenoid Valve Command	Ignition ON	High Pressure/Low Pressure	This parameter displays the commanded state of the variable displacement oil pump output.
Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the engine oil pressure control solenoid valve control circuit. The parameter displays Malfunction if the engine oil pressure control solenoid valve control circuit is shorted to voltage.
Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the engine oil pressure control solenoid valve control circuit. The parameter displays Malfunction if the c engine oil pressure control solenoid valve control circuit is shorted to ground.
Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the engine oil pressure control solenoid valve control circuit. The parameter displays Malfunction if the engine oil pressure control solenoid valve control circuit is open.
Engine Oil Pressure Sensor	Engine Idling	OK	This parameter displays the engine oil pressure as determined by engine oil pressure sensor.
Engine Oil Temperature Sensor	Ignition ON	C° (°F)	This parameter displays engine oil temperature as measured by a sensor connected to the ECM.
Engine Oil Temperature When Engine Overspeed Detected	Engine Idling	Temperature	This parameter displays the temperature of the engine oil as determined by the control module.
Engine Overspeed	Engine Idling	Not Present	This parameter displays if an Engine Overspeed is Present or Not Present.
Engine Overspeed Counter	Ignition ON	Counts	This parameter displays the accumulated number of engine overspeed detection events.

Engine Run Time	Engine Idling	0:00:00 Increments when the engine is operating	This parameter displays the time elapsed since the engine was started.
Engine Running	-	No	This parameter displays the status of the internal combustion engine (ICE) in vehicles incorporating ICE autostart/stop functionality.
Engine Serial Number	Ignition ON	#	This parameter displays the engine serial number.
Engine Shutdown Counter - Excessive Idle Time	Ignition ON	Counts	This parameter displays the count of engine shutdowns due to excessive idle time.
Engine Shutdown Counter - High Coolant Temperature	Ignition ON	Counts	This parameter displays the count of engine shutdowns due to high coolant temperature.
Engine Shutdown Counter - Low Coolant Level	Ignition ON	Counts	This parameter displays the count of engine shutdowns due to low coolant level.
Engine Shutdown Counter - Low Oil Level	Ignition ON	Counts	This parameter displays the count of engine shutdowns due to low oil level.
Engine Speed	Engine Cranking	Greater than 60 RPM	This parameter displays the speed of the engine crankshaft rotation from information received from the crankshaft position (CKP) sensor. If there is a CKP sensor DTC, the ECM calculates the engine speed from one of the camshaft position (CMP) sensors.
	Engine Idling	550-700 RPM	
Engine Speed During Misfire History 1-5	Ignition ON	RPM	This parameter displays the last 5 engine speeds during misfire events.
Engine Speed When Engine Overspeed Detected	Engine Idling	RPM	This parameter displays the engine speed observed upon initial detection of an overspeed condition. This value will be updated after each overspeed condition.
Engine Stalled	Ignition ON	No	This parameter displays that the internal combustion engine has stopped running unintentionally.
Engine Starting	Ignition ON	No	This parameter displays that the internal combustion engine is

			being started (in transition from engine OFF to engine running).
Engine Stopping	Ignition ON	No	Engine Stopping indicates that the internal combustion engine is stopping (in transition from engine running to engine off, OR in transition from engine running to engine failed).
Engine Torque Command	Engine Idling		This parameter displays the commanded predicted engine torque value, which is the torque request for the slow response air path (control of the throttle).
EVAP Malfunction History	Engine Running	None	<p>This parameter displays the result of the evaporative emission (EVAP) system as determined by the control module. The scan tool will display the following:</p> <ul style="list-style-type: none"> • None • Excess Vacuum • Purge Valve Leak • Small Leak • Weak Vacuum • No Test Result
EVAP Monitor Complete	Engine Running	Yes/No	This parameter displays if the most recent evaporative emissions diagnostic test is complete.
EVAP Monitor Complete This Ignition Cycle	Engine Running	Yes/No	This parameter displays the diagnostic monitor completion status during the current driving/monitoring cycle.
EVAP Monitor Enabled	Engine Running	Yes/No	This parameter displays if the evaporative emissions diagnostic test is enabled.
EVAP Monitor Enabled This Ignition Cycle	Engine Running	Yes/No	This parameter displays the diagnostic monitor enable status during the current driving/monitoring cycle.
EVAP Purge Solenoid Valve Command	Engine Idling	%	This parameter displays the commanded duty cycle for the canister purge output.

EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the evaporative emission (EVAP) purge solenoid control circuit. The parameter displays Malfunction if the EVAP purge solenoid control circuit is shorted to voltage.
EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the evaporative emission (EVAP) purge solenoid control circuit. The parameter displays Malfunction if the EVAP purge solenoid control circuit is shorted to ground.
EVAP Purge Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the evaporative emission (EVAP) purge solenoid control circuit. The parameter displays Malfunction if the EVAP purge solenoid control circuit is open.
EVAP Vent Solenoid Command	Engine Idling	Not Venting	This parameter displays the state of the control circuit for evaporative emission (EVAP) vent solenoid as commanded by the control module.
EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the EVAP vent solenoid control circuit. The parameter displays Malfunction if the EVAP vent solenoid control circuit is shorted to voltage. This parameter may not change if the scan tool is used to command the EVAP vent solenoid ON.
EVAP Vent Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the EVAP vent solenoid control circuit. The parameter displays Malfunction if the EVAP vent solenoid control circuit is shorted to ground. This parameter may not change if the scan tool is used to command the EVAP vent

			solenoid ON.
EVAP Vent Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the EVAP vent solenoid control circuit. The parameter displays Malfunction if the EVAP vent solenoid control circuit is open. This parameter may not change if the scan tool is used to command the EVAP vent solenoid ON.
Exhaust Camshaft Position	Engine Idling	°	This parameter displays the position of the exhaust camshaft for bank 1 in terms of degrees of camshaft rotation (retard) from the park position (a value of zero represents the park position).
Exhaust Camshaft Position Active Counter Bank 1 or 2	Engine Idling	0-255	This parameter displays an incrementing counter when the control module receives a signal from the exhaust camshaft position (CMP) sensor.
Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the exhaust camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is shorted to voltage.
Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the exhaust camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is shorted to ground.
Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the exhaust camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is open.
Exhaust Camshaft Position Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays the actual exhaust camshaft position in degrees.
	Engine speed at 2000 RPM	10 Degrees	

Exhaust Camshaft Position Command Bank 1 or 2	Engine Idling	20 %	This parameter displays the on-time or duty cycle of the exhaust camshaft position (CMP) actuator solenoid valve as commanded by the control module.
	Engine speed at 2000 RPM	50 %	
Exhaust Camshaft Position Variance Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays in degrees, the difference between the desired exhaust camshaft position and the actual exhaust camshaft position.
	Engine speed at 2000 RPM	0 Degrees	
Extended Travel Brake Pedal Position Signal	Engine Idling	Released	This parameter displays the status of the Extended Travel Brake Pedal Position sensor.
Extended Travel Brake Pedal Switch	Ignition ON	Released	This parameter displays the undebounced / undefaulted state of the extended travel brake switch input to the ECM
Freeze Frame DTC	Ignition ON	#	This parameter displays the diagnostic trouble code (DTC) that caused the freeze frame to be stored.
Fuel Alcohol Content	Engine Idling	%	This parameter displays the percentage of alcohol in the fuel. The value is calculated by the ECM using the fuel composition sensor input.
Fuel Alcohol Content When Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	%	This parameter displays a percentage of Fuel Alcohol Content When Recommended Maximum Fuel Alcohol Content Exceeded.
Fuel Composition Learn	Engine Idling	Inactive	This parameter displays Active or Inactive. Active will be displayed if the ECM is learning the alcohol content of the fuel.
Fuel Composition Sensor	Engine Idling	Hz	This parameter displays the frequency of the fuel composition sensor input. This value can be used to determine fuel composition or sensor malfunction.
Fuel Consumed Since Recommended Maximum Fuel Alcohol Content	Engine Idling	Liters	This parameter displays in Liters the Fuel Consumed Since Recommended Maximum Fuel

Exceeded			Alcohol Content Exceeded.
Fuel Control Loop Status	Engine Idling	Closed	Fuel Closed Loop Active indicates that oxygen sensor 1 of each bank is being used as feedback to adjust the amount of fuel delivered to the engine.
Fuel Economy	Engine Idling	Liters per Hour	This parameter displays the instant fuel consumption rate of the engine in liters per hour.
Fuel Economy Mode	Ignition ON	Inactive	This parameter indicates if the economy mode algorithm has activated economy mode.
Fuel Economy Mode Request	Ignition ON	Off	This parameter indicates if the driver of the vehicle has requested economy mode by pressing the economy mode switch.
Fuel Economy Mode Switch	Ignition ON	Volts	This parameter displays the economy mode switch reference voltage.
Fuel Enrichment-Hot Catalyst	Engine Running	Inactive	Fuel Enrichment Catalyst Protection Active indicates fuel is being added to cool the catalytic converter.
Fuel Enrichment-Hot Coolant	Engine Running	Inactive	Hot Coolant Enrichment Active indicates that the conditions to enable hot coolant enrichment are active and that a richer than stoichiometric air/fuel ratio is being commanded in order to help cool the engine when a system malfunction is causing the engine to run at extreme temperatures.
Fuel Injector Driver Supply Voltage	Ignition ON	Volts	This parameter displays the injector driver circuit boost supply voltage.
Fuel Level Sensor	Ignition ON	Volts	This parameter displays the unfiltered fuel level sensor analog input for the primary fuel tank as a percentage of its reference voltage.
Fuel Level Sensor Left Tank (If Equipped)	Ignition ON	0-5 Volts	This parameter displays the voltage signal received by the control module from the secondary fuel level sensor in

			the left side of the fuel tank.
Fuel Level Sensor Reference Command	Engine Idling	%	This parameter displays the percentage of time that the power supply for the fuel level sensor is on. This percentage is minimized when the fuel has high ethanol content and is maximized when the fuel has low ethanol content.
Fuel Level Sensor Right Tank (If Equipped)	Ignition ON	0-5 Volts	This parameter displays the voltage signal received by the control module from the primary fuel level sensor in the right side of the fuel tank.
Fuel Pressure Regulator Control Circuit Command	Engine Cranking or Running	On	This parameter displays the commanded state of the fuel pressure regulator 1 low side output (the output is considered to be commanded ON if the regulator is enabled while the engine is running or cranking).
Fuel Pressure Regulator Control Circuit High Voltage Test	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to voltage in the circuit.
Fuel Pressure Regulator Control Circuit Low Voltage Test	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to ground in the circuit.
Fuel Pressure Regulator			This parameter displays the status of the output driver for the fuel pressure regulator control circuit. The scan tool will display OK if the circuit is

Control Circuit Open Test Status	Ignition ON	OK	operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an open in the circuit.
Fuel Pressure Regulator High Control Circuit Command	Engine Idling	%	This parameter displays the commanded duty cycle for the fuel pressure regulator 1 solenoid output.
Fuel Pressure Regulator High Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator high control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to voltage in the circuit.
Fuel Pressure Regulator High Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator high control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to ground in the circuit.
Fuel Pressure Regulator High Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator high control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an open in the circuit.
Fuel Pressure Sensor	Engine Idling	kPa/PSI	For Port Fuel Injected (PFI) systems, this Parameter displays fuel rail pressure at the engine. For high pressure fuel systems, this Parameter indicates the low side fuel pressure before the high

			pressure pump.
Fuel Pressure Sensor	-	Volts	This parameter displays the fuel supply pressure sensor analog input as a percentage of its reference voltage.
Fuel Pump Enable Command	Ignition ON	On	This parameter displays the commanded state of the fuel pump output (the output is considered to be commanded ON if its duty cycle is not zero).
Fuel Pump Enabled Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pump control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to voltage in the circuit.
Fuel Pump Enabled Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pump control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to ground in the circuit.
Fuel Pump Enabled Circuit Open Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pump control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an open in the circuit.
Fuel Pump Relay Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the fuel pump relay control circuit. The parameter displays Malfunction if the fuel pump relay control circuit is shorted to voltage.
			This parameter displays the state of the fuel pump relay

Fuel Pump Relay Control Circuit Low Voltage Test Status	Ignition ON	OK	control circuit. The parameter displays Malfunction if the fuel pump relay control circuit is shorted to ground.
Fuel Pump Relay Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the fuel pump relay control circuit. The parameter displays Malfunction if the fuel pump relay control circuit is open.
Fuel Rail Pressure Regulator Command (If Equipped)	Engine idling	36 Degrees	The scan tool displays in degrees, the Fuel Rail Pressure Regulator ON time as commanded by the control module.
Fuel Rail Pressure Sensor	Engine Idling	1.9-5.0 MPa/279-725 PSI	This parameter displays the high side fuel pressure after the high pressure pump.
Fuel Rail Pressure Sensor	Engine Idling	0 to 5 Volts	This parameter displays the voltage signal received by the control module from the fuel rail pressure (FRP) sensor.
Fuel Rail Pressure Sensor Initial Learn	-	Complete	This parameter displays the if the Fuel Rail Pressure Sensor First Time Adaptation is Complete
Fuel Rail Pressure Sensor Learn	-	Active	This parameter displays the current state of the fuel rail pressure sensor learn condition.
			This parameter displays the reason for the fuel rail pressure sensor learn to be inhibited. These include: Assembly Plant Mode Counter Not Programmed, Assembly Plant Suspension, Barometric Pressure Sensor DTC, Barometric Pressure Too Low, Clutch Pedal Applied, Clutch Pedal Position Sensor DTC, Desired Fuel Rail Pressure Too Low, DTC Present, Engine in Catalyst Warm-Up Mode, Engine Not Synchronized, Engine Stopped, Fuel Pressure Spike, Fuel Level Too Low, Fuel Pressure Regulator Control

Fuel Rail Pressure Sensor Learn Inhibit	-	No	Circuit DTC, Fuel Pump Control Function Active, Fuel Pump is Off, Fuel Rail Pressure Control Function Active, Fuel Rail Pressure Sensor DTC, Fuel System in Open Loop Operation, Fuel Temperature Out of Range, Idle Test Failed, Injector Flow Test in Progress, Intake Air Temperature Too Low, Low Pressure Fuel System Malfunction, Low Pressure Fuel System Pressure Too Low, Minimum Engine Run Time Not Met, Minimum Normal Fuel Pressure Control Time Not Met, Minimum Run Time Time After New Engine Mode Not Met, Minimum Time After Drive Not Met, Minimum Time for Released Accelerator Pedal Not Met, New Engine Mode, Not in Control of Idle Speed, Other Diagnostics Active, Sensor Reading Too High Test Failed, Some Cylinders Are Turned Off, Stuck Sensor Test Failed, Vehicle Speed Too High
Fuel Rail Pressure Sensor Learn Status	-	Complete	This parameter displays several signals associated with the status of the power mode and starter systems.
Fuel Rail Pressure Sensor Learned Value	-	kPa	This parameter displays the fuel rail pressure learned value at the fuel rail pressure sensor.
Fuel System Monitor Complete	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and noncontinuous legislated emission related monitor.
Fuel System Monitor Complete This Ignition	Ignition ON	No	This parameter displays the completion status of the fuel system monitor during the

Cycle			current driving / monitoring cycle.
Fuel System Monitor Enabled	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and noncontinuous legislated emission related monitor.
Fuel System Monitor Enabled This Ignition Cycle	Ignition ON	No	This parameter displays the enable status of the fuel system monitor during the current driving / monitoring cycle.
Fuel Tank Pressure Sensor	Ignition ON, engine OFF	kPa/psi	This parameter displays the pressure/vacuum inside the fuel tank. A negative value indicates a vacuum, while a positive value indicates a pressure.
Fuel Tank Pressure Sensor	-	mmHg / in H2O	This parameter displays the fuel tank pressure in mmHg/in H2O at the fuel tank pressure sensor.
Fuel Tank Pressure Sensor	Ignition ON, engine OFF	0-5 Volts	This parameter displays the voltage signal received by the control module from the fuel tank pressure (FTP) sensor.
Fuel Tank Rated Capacity	Ignition ON	Varies	This parameter displays the capacity of the fuel tank in liters or gallons. The rated capacity displayed by the scan tool will varies with vehicle type.
Fuel Trim Cylinder Balance Test Bank 1-2	Ignition ON	Inactive	This parameter indicates the current state of the fuel trim cylinder balance test.
Fuel Trim Cylinder Balance Test Counter Bank 1-2	Ignition ON	Counts	This parameter displays the number of Air Fuel Imbalance Monitor tests that have been performed since a code clear or non volatile memory (NVM) reset for bank 1 or 2
Fuel Trim Cylinder Balance Test Status Bank 1-2	Ignition ON	No Result	This parameter indicates the current state of the fuel trim cylinder balance test.
			This parameter displays Enabled when conditions are

Fuel Trim Learn	Engine Idling	Enabled	appropriate for enabling long term fuel trim corrections. This indicates that the long term fuel trim is adapting continuing amounts of short term fuel trim. If the scan tool displays Disabled, then long term fuel trim will not respond to changes in short term fuel trim.
Fuel Trim Learn	-	Enabled	This parameter displays if the fuel trim learn is enabled.
Fuel Trim Memory Cell	Engine Idling	Counts 0 250	This parameter displays long term fuel corrections that is active based upon the current operating conditions (MAP, engine speed, purge duty cycle, A/C compressor state, and transmission range).
Fuel Trim Memory Cell	-	#	This parameter displays the intake air temperature (measured by a sensor located near the throttle body) recorded at power-up (Run/Crank transition from low to high).
Fuel Trim System Test State	Engine Idling	Complete	This parameter displays the current state of the fuel adjustment system diagnostic.
Fuel Trim System Test State	-	Complete	This parameter displays the state of the fuel trim system test.
Fuel Volatility	Engine Idling	Varies	This parameter indicates the rate the fuel can be vaporized in the cylinder as calculated by the control module. The scan tool will display HIGH when the fuel volatility is high. The scan tool will display LOW when the fuel volatility is low.
Generator F Terminal Signal	Engine Idling	0-100 %	This parameter displays the amount of generator ON-time as commanded by the control module. The higher the percentage the greater the generator output.
Generator Indicator Command	Engine Idling	On	This parameter displays On or Off associated with the status of the generator.

Generator L Terminal Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the generator L circuit terminal. The parameter displays Malfunction if the generator L circuit is shorted to voltage.
Generator L Terminal Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the generator L circuit terminal. The parameter displays Malfunction if the generator L circuit is shorted to ground.
Generator L Terminal Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the generator L circuit terminal. The parameter displays Malfunction if the generator L circuit is open.
Generator L-Terminal Command	Engine Idling	0-100 %	This parameter displays the control modules commanded state of the voltage regulator on the generator.
Heated Catalyst Monitor Complete	Engine Idling	Yes	This parameter indicates the status of the heated catalyst. The scan tool displays Yes when the diagnostic is complete. And No if the diagnostic has not ran or a malfunction is detected in the heated catalyst.
Heated Catalyst Monitor Enabled	Engine Idling	Yes	This parameter indicates the status of the heated catalyst monitor diagnostic. Catalyst Monitor Test Running indicates Yes or No when the heated catalyst monitor diagnostic is actively running a test.
Hood Position Switch	Ignition ON	Closed	This parameter displays the current position of the hood.
HO2S Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	0.00-1.00 Volts	This parameter displays the voltage output from the HO2S to the control module. A lower voltage indicates a lean exhaust, while a higher voltage indicates a rich exhaust.
HO2S Bank 1 Sensor 2 or			This parameter displays the voltage output from the HO2S to the control module. A lower

Bank 2 Sensor 2	Engine Idling	0.00-1.00 Volts	voltage indicates a lean exhaust, while a higher voltage indicates a rich exhaust.
HO2S Heater Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	mA	This parameter display the current feedback for the oxygen sensor heater output for bank 1 sensor 1 or bank 2 sensor 1.
HO2S Heater Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	mA	This parameter display the current feedback for the oxygen sensor heater output for bank 1 sensor 2 or bank 2 sensor 2.
HO2S Heater Command Bank 1 or 2 Sensor 1 or 2	Engine Idling	Off	This parameter display the state of the HO2S heater control circuit as commanded by the control module.
HO2S Heater Command Bank 1 or 2 Sensor 1 or 2 Heater Command	Engine Idling	0-100 %	This parameter displays the HO2S heater ON time in percentage, as commanded by the control module.
HO2S Heater Control Circuit High Voltage Test Status Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is shorted to voltage.
HO2S Heater Control Circuit High Voltage Test Status Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is shorted to voltage.
HO2S Heater Control Circuit Low Voltage Test Status Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is shorted to ground.
HO2S Heater Control Circuit Low Voltage Test Status Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is shorted to ground.

HO2S Heater Control Circuit Open Test Status Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is open.
HO2S Heater Control Circuit Open Test Status Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is open.
HO2S/Heater Monitor Complete This Ignition Cycle	Engine Idling	Yes/No	This parameter displays the diagnostic monitor completion status during the current driving/monitoring cycle.
HO2S Heater Monitor Enabled	Ignition ON	No	This parameter displays the current state of the HO2S heater monitor.
HO2S/Heater Monitor Enabled This Ignition Cycle	Engine Idling	Yes/No	This parameter displays the diagnostic monitor enable status during the current driving/monitoring cycle.
Humidity Sensor Intake Air Temperature Signal	Ignition ON	Hz	This parameter displays the frequency of the humidity sensor's intake air temperature (IAT) sensor input.
IAT Sensor 1	Ignition ON	-39° to +140°C (-38° to +284°F)	This parameter displays the temperature of the air entering the air induction system based on input to the control module from the intake air temperature (IAT) sensor.
IAT Sensor 2	Engine Idling	Hz	This parameter displays the frequency of the humidity sensor's intake air temperature (IAT) sensor input to the engine control module.
IAT Sensor 2	-	°C (°F)	This parameter displays the temperature of the air entering the engine as calculated by the control module based on the input from the intake air temperature (IAT) sensor 2. The scan tool will display a low value when the air temperature is low, and a high value when

			the air temperature is high.
IAT Sensor 3	-	°C (°F)	This parameter displays the temperature of the air entering the engine as calculated by the control module based on the input from the intake air temperature (IAT) sensor 3. The scan tool will display a low value when the air temperature is low, and a high value when the air temperature is high.
Idle Speed Correction	Ignition ON	RPM	This parameter displays the engine idle speed correction within a restricted range to address complaints of vehicle vibration.
Ignition 1 Signal	Ignition ON	B+	This parameter displays B+ when the control module detects a voltage at the ignition 1 input terminal.
Ignition Accessory Signal	Ignition ON	On	This parameter displays On when the control module detects a voltage at the ignition accessory input terminal.
Ignition Coil 1,2,3,4,5,6,7, or 8 Control Circuit High Voltage Test Status	Engine Running	OK	This parameter displays the state of the Ignition control circuit. The parameter displays Malfunction if the Ignition control circuit is shorted to voltage.
Ignition Coil 1,2,3,4,5,6,7, or 8 Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the Ignition control circuit. The parameter display Malfunctions if the Ignition control circuit is shorted to ground.
Ignition Coil 1,2,3,4,5,6,7, or 8 Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the Ignition control circuit. The parameter displays if Malfunction the Ignition control circuit is open.
Ignition Coil Supply Voltage Bank 1 or 2	Engine Idling	On	This parameter displays ON when voltage is supplied to the Ignition coil bank 1 or bank 2.
Ignition Cycles Since Recommended Maximum	Engine Idling	Counts	This parameter displays the number of Ignition Cycles since

Fuel Alcohol Content Exceeded			Recommended Maximum Fuel Alcohol Content Exceeded.
Ignition Cycles with Malfunction Since 1st Malfunction	Ignition ON	Counts	This parameter contains the number of ignition cycles with a failure reported since the first ignition cycle with a failure reported.
Ignition Cycles Without Completed Test Since 1st Malfunction	Engine Idling	Counts	This parameter displays the number of ignition cycles without a pass or a failure reported since the first ignition cycle with a failure reported.
Ignition Cycles Without Malfunction Since Last Malfunction	Engine Idling	Counts	This parameter displays the number of ignition cycles with a pass reported and no malfunctions reported since the first ignition cycle with a malfunction reported.
Ignition Cycles without Malfunction Since Last Malfunction	Ignition ON	Counts	This parameter contains the number of ignition cycles with a pass reported and no failures reported since the first ignition cycle with a failure reported.
Ignition Off Time	Ignition ON	hh:mm:ss	This parameter displays the time that the ignition has been OFF.
Ignition Timing	Engine Idling	Degrees	This parameter displays the final spark advance in terms of a crankshaft angle.
Immobilizer Auto Learn Counter	Ignition ON	Counts	This parameter displays the number of auto-learn cycles that have been successfully completed within the immobilizer system.
Immobilizer Automatic Learn Timer	Ignition ON	h/m/s	This parameter displays the time elapsed within the current auto-learn cycle within the immobilizer system.
Immobilizer ECM Identifier	Ignition ON	OK	This parameter displays that the immobilizer control module (ICM) has received the correct powertrain identifier.
Immobilizer Environment Device 1-4	Ignition ON	OK	This parameter displays that the associated device is OK or unknown or its identification is pending to the immobilizer

			control module (ICM).
Immobilizer Fuel Disable	Ignition ON	Inactive	This parameter displays if the vehicle is immobilized by the ECM.
Immobilizer Module Environment Identification	Ignition ON	Inactive	This parameter displays that the ICM has not received the powertrain identifier or has received the wrong powertrain identifier.
Immobilizer Module Fuel Disable	Ignition ON	Inactive	This parameter displays if the vehicle is immobilized by the ICM.
Immobilizer Module Identification	Ignition ON	Complete	This parameter indicates that the ICM has not received the powertrain identifier or has received the wrong powertrain identifier.
Immobilizer Module Security Code Programmed	Ignition ON	Yes	This parameter indicates that the ICM security code has been programmed (i.e., the immobilizer device is locked).
Immobilizer Password Learn	Ignition ON	Active/Inactive	Learning Enabled indicates that learning of immobilizer code information is enabled.
Immobilizer Password Learn Scan Tool Delay	Engine Idling	Active/Inactive	Scan tool Learn Delay Active indicates that the security code has been accepted but the scan tool learn delay is active and will not allow learning enabled, programming security code, or resetting security code.
Immobilizer Password Programmed	Ignition ON	Yes	This parameter indicates that the ICM password has been programmed.
Immobilizer Post-Release Passive State	Ignition ON	Active / Inactive	This parameter displays that the immobilizer algorithm is in the post release passive state.
Immobilizer Post-Release State	Ignition ON	Active / Inactive	This parameter displays that the immobilizer algorithm is in the post release passive state.
Immobilizer Pre-Release State	Ignition ON	Active / Inactive	This parameter displays that the immobilizer algorithm is in the pre release active state.
Immobilizer Release State	Ignition ON	Active / Inactive	This parameter displays that the immobilizer algorithm is in the release active state.

Immobilizer Security Code Accepted	Engine Idling	Yes/No	Security Code Accepted displaying Yes indicates' that the received security code is correct.
Immobilizer Security Code Function	Engine Idling	Present/Not Present	This parameter indicates if the ECU supports the immobilizer security code strategy.
Immobilizer Security Code Lockout	Engine Idling	Yes/No	Security Code Lockout Active indicates that the security code has not passed and lockout is active.
Immobilizer Security Code Lockout Active Timer	Engine Idling	ms	This parameter displays the time elapsed since the immobilizer security code lockout has been activated either due to a battery disconnect or an incorrect immobilizer security code being entered.
Immobilizer Security Code Programmed	Ignition ON	Yes/No	Security Code Programmed indicates that the security code has been programmed.
Immobilizer Security Code Programming Counter	Ignition ON	Counts	This parameter displays the number of times a new immobilizer security code has been programmed through secure access. This counter can only be incremented.
Immobilizer Security Code Reset Counter	Ignition ON	Counts	This parameter displays the number of times the immobilizer security code has been reset to the default value through secure access. This counter can only be incremented.
Immobilizer Security Information Programmed	Ignition ON	Yes/No	This parameter displays the status of the immobilizer system.
Immobilizer Security Level	Ignition ON	#	This parameter displays the current immobilizer security level. If the correct security code is entered, the security level will remain at or be reset to a level of 10. If an incorrect security code is entered, the security level will be set to a level of 9.

Immobilizer Transponder Identification	Ignition ON	Active / Inactive	This parameter displays that the transponder identification process is active within the ICM.
Immobilizer Transponder Key	Ignition ON	OK	This parameter displays that the transponder key is correct for the ICM.
Immobilizer Transponder Key Identification	Ignition ON	OK	This parameter displays that the transponder key identification process is active within the ICM.
Immobilizer System Status	Ignition ON	Varies	This parameter displays the status of the immobilizer system, the following maybe displayed. Standby, Immobilized at Startup, Immobilized, No Response, Immobilized Negative Response, Immobilized, Incorrect Response, Post-Release State, Pre-Release State, Release State.
Immobilizer Valid Response Received Time	Ignition ON	ms	This parameter displays the actual time observed for a valid immobilizer response.
Initialized Fuel Alcohol Content	Ignition ON	%	This parameter displays the initialized fuel composition to be used as a starting point for the fuel composition algorithm.
Injector Duty Cycle Bank 1 or 2	Engine idling	0.82-1.50 ms	This parameter displays the amount of fuel injector ON time or pulse width as commanded by the control module.
Inspection/Maintenance Drive Cycle Complete	Engine Idling	Yes/No	Inspection/Maintenance Drive Cycle Complete means that all required components of the standard drive cycle have completed.
Inspection/Maintenance Drive Cycle Idle Time Complete	Engine Idling	Yes/No	Inspection/Maintenance Drive Cycle Idle Time Complete indicates that the engine idle time requirement is complete.
Inspection/Maintenance Drive Cycle Idle Timer	Engine Idling	hh:mm:ss	This parameter displays the Inspection/Maintenance Drive Cycle Idle Timer.
			This parameter displays the

Inspection/Maintenance Drive Cycle Propulsion System Active Time Complete	Engine Idling	Yes/No	Inspection/Maintenance Drive Cycle Propulsion System Active Time Complete. The parameter displays Yes when the Inspection/Maintenance Drive Cycle Propulsion System Active Time is Complete.
Inspection/Maintenance Drive Cycle Propulsion System Active Timer	Engine Idling	hh:mm:ss	This parameter displays the total accumulated time in which the propulsion system has been active after the 1st time the engine is started.
Inspection/Maintenance Drive Cycle Vehicle Speed Time Complete	Engine Idling	Yes/No	This parameter displays Yes when the Vehicle Speed Time Complete indicates that the vehicle has been above 25 mph for five minutes.
Inspection/Maintenance Drive Cycle Vehicle Speed Timer	Engine Idling	hh:mm:ss	This parameter displays the total accumulated time in which the vehicle speed has been greater than 25 mph after the 1st time the engine is started.
Intake Air Humidity Sensor	Engine Idling	%	This parameter displays the raw duty cycle signal from the relative humidity sensor electronics, which represents the relative humidity of the intake air.
Intake Camshaft Position	Engine Idling	°	This parameter displays the position of the intake camshaft for bank 1 in terms of degrees of camshaft rotation (advance) from the park position (a value of zero represents the park position).
Intake Camshaft Position Active Counter Bank 1 or 2	Engine Idling	0-255	This parameter displays an incrementing counter when the control module receives a signal from the intake camshaft position (CMP) sensor.
Intake Camshaft Position Actuator Oil Pressure	Engine Idling	kPa	This parameter displays the oil pressure at the intake camshaft position actuator.
Intake Camshaft Position Actuator Oil Pressure Sensor	Engine Idling	Volts	This parameter displays the intake camshaft position actuator pressure sensor in voltage.

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is shorted to voltage.
Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is shorted to ground.
Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is open.
Intake Camshaft Position Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays the actual intake camshaft position in degrees.
	Engine speed at 2000 RPM	10 Degrees	
Intake Camshaft Position Commanded Bank 1 or 2	Engine Idling	20 %	This parameter displays the ON-time or duty cycle of the intake camshaft position (CMP) actuator solenoid valve as commanded by the control module.
	Engine speed at 2000 RPM	50 %	
Intake Camshaft Position Variance Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays in degrees, the difference between the desired intake camshaft position and the actual intake camshaft position.
	Engine speed at 2000 RPM	0 Degrees	
Intake Manifold Pressure	Engine Idling	kPa/psi	This parameter displays the engine intake manifold vacuum pressure calculated as the difference between ambient air pressure (barometric pressure) and intake manifold absolute pressure (MAP).
Intake Manifold Tuning Control Valve Control Circuit Command	Ignition ON	On	This parameter displays the commanded state of the intake manifold tuning valve output.
			This parameter displays the

Intake Manifold Tuning Control Valve Control Circuit High Voltage Test Status	Ignition ON	OK	state of the intake manifold tuning control valve control circuit. The parameter displays Malfunction if the intake manifold tuning control valve control circuit is shorted to voltage.
Intake Manifold Tuning Control Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is shorted to ground.
Intake Manifold Tuning Control Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is open.
Intake Manifold Tuning Control Valve Feedback Signal	Ignition ON	%	This parameter displays the duty cycle of the PWM feedback from the intake manifold tuning electronics, which represents the position of the intake manifold tuning valve.
Intake Manifold Tuning Control Valve Learn	Ignition ON	Inactive	This parameter displays that the intake manifold tuning electronics are currently learning the hard stop position for the intake manifold tuning valve.
Intake Manifold Tuning Control Valve Position	Ignition ON	Closed	This parameter displays whether the intake manifold tuning valve is in an open, closed, or intermediate position based upon the PWM feedback from the intake manifold tuning electronics.
Intake Rocker Arm Solenoid Valve 1-2 Command	Engine Idling	Off	This parameter displays the intake rocker arm solenoid valve command ON/OFF status.
Intake Rocker Arm Solenoid Valve 1-2 Command	Engine Idling	High Lift/Low Lift	This parameter displays the intake rocker arm solenoid valve command status.

Intake Rocker Arm Solenoid Valve 1-2 Control Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the intake rocker arm solenoid valve control circuit. The parameter displays Malfunction if the intake rocker arm solenoid valve circuit is shorted to voltage.
Intake Rocker Arm Solenoid Valve 1-2 Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the intake rocker arm solenoid valve control circuit. The parameter displays Malfunction if the intake rocker arm solenoid valve control circuit is shorted to ground.
Intake Rocker Arm Solenoid Valve 1-2 Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the intake rocker arm solenoid valve control circuit. The parameter displays Malfunction if the intake rocker arm solenoid valve control circuit is open.
ISS/OSS Supply Voltage	Engine Idling	OK	This parameter displays the state of the ISS/OSS Supply Voltage circuit.
Knock Retard	Engine Idling	0 Degrees	This parameter indicates the amount of spark advance the control module removes from the ignition control (IC) spark advance in response to the signal from the knock sensors.
Long Term Fuel Trim Bank 1 or 2	Engine Idling	0 %	This parameter displays the commanded Long Term Fuel Trim correction by the control module for bank 1 or bank 2 for cruise and acceleration conditions.
Long Term Fuel Trim Test Average Bank 1 or 2	Engine Idling	0 %	This parameter displays the filtered long term closed loop fuel correction for bank 1 or 2. This value is compared to thresholds to determine if the fuel adjustment system diagnostic is passing or failing or if an excess purge vapor test should be executed.
			This parameter displays the filtered non purge long term

Long Term Fuel Trim Test Average without Purge Bank 1 or 2	Engine Idling	0 %	closed loop fuel correction for bank 1 or 2. This value is compared to thresholds to determine if the fuel adjustment system diagnostic is passing, failing, or indeterminate during normal purge-OFF operation as well as during the intrusive excess purge vapor test.
Low Engine Oil Level Indicator Command	Engine Idling	Off	The scan tool displays On or Off. This is the state of the low engine oil level indicator as monitored by the ECM.
Low Engine Oil Pressure Indicator Command	Engine Idling	Off	This parameter displays the commanded state of the low EOP lamp control circuit by the control module.
MAF Performance Test	Engine Idling	OK	This parameter displays the status of the MAF performance test by the engine control module. The scan tool will display OK if no malfunction is found. The scan tool will display malfunction if the engine control module detects a malfunction during the test.
MAF Sensor	Engine Idling	3.0-8.3 g/s	This parameter displays in grams per second, the measured quantity of air flowing into the engine during all operating conditions.
	Engine speed at 2,500 RPM	11.88 g/s	
MAF Sensor	Engine Idling	2,000-2,500 Hz	The scan tool displays a range of 0-65,555 hertz. This parameter displays the frequency signal input to the control module, and represents measured quantity of air flowing into the engine during all operating conditions.
MAF When Engine Overspeed Detected	Engine Idling	g/s	This parameter indicates the quantity calculated by the control module based on a signal from the MAF sensor at the time an overspeed was detected.
			MAP Test 1 Residual Out of Tolerance indicates that the

MAP Performance Test 1	Engine Idling	OK	filtered MAP Test 1 residual (the difference between the measured intake manifold pressure and the intake manifold pressure predicted from the intake manifold model using the mass airflow predicted from the throttle model) exceeds a failure threshold.
MAP Performance Test 2	Engine Idling	OK	MAP Test 2 Residual Out of Tolerance indicates that the filtered MAP Test 2 residual (the difference between the measured intake manifold pressure and the intake manifold pressure predicted from the intake manifold model using the measured mass airflow) exceeds a failure threshold.
MAP Sensor	Engine Idling	kPa/psi	This parameter displays the actual engine intake manifold absolute pressure (MAP).
MAP Sensor	Engine Idling	0.4-2.0 Volts	The parameter displays The MAP sensor voltage as it measures the change in the intake manifold pressure which results from engine load and speed changes. As the intake manifold pressure increases, the air density in the intake also increases and additional fuel is required.
Maximum Engine Speed When Engine Overspeed Detected	Engine Idling	RPM	This parameter displays the Maximum Engine Speed When Engine Overspeed Detected.
MIL Command	Engine Idling	Off	This parameter displays the commanded state of the malfunction indicator lamp (MIL) control circuit by the control module.
MIL Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the MIL control circuit. The parameter displays Malfunction if the MIL control circuit is shorted to voltage.

MIL Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the MIL control circuit. The parameter displays Malfunction if the MIL control circuit is shorted to ground.
MIL Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the MIL control circuit. The parameter displays Malfunction if the MIL control circuit is open.
MIL Requested	Engine Idling	No	This parameter displays the reason the engine control module illuminated the MIL. The scan tool will display Yes when the MIL is requested as a result of an A or B type DTC. The scan tool will display No if the MIL is illuminated for another reason, such as transmission DTCs.
MIL Requested by DTC	Engine Idling	No	This parameter indicates the reason the control module illuminated the MIL. The scan tool will display YES when the MIL is requested as a result of an A or B type DTC. The scan tool will display NO if the MIL is illuminated for another reason, such as transmission DTCs.
Misfire Diagnostic Engine Load	Engine Idling	%	This parameter displays the engine load used within the misfire diagnostic (calculated as the ratio of the mass of air predicted to be in the cylinder two firing events into the future to the maximum possible mass of air in the cylinder based on the current ambient air pressure and charge temperature).
Misfire Diagnostic Engine Speed	Engine Idling	RPM	This parameter displays the engine speed used within the misfire diagnostic. This engine speed is the maximum engine speed observed over the previous engine cycle.
			This parameter displays the

Misfire Engine Load History 1-5	Engine Idling	%	specific engine load when the engine was operating for one of the last five misfire events .
Misfire Engine Speed History 1-5	Engine Idling	RPM	This parameter displays the specific engine speed when the engine was operating for one of the last five misfire events .
Misfire Monitor Complete	Engine Idling	Yes/No	This parameter displays the status of the Misfire Monitor. The parameter will display Yes when the Misfire Monitor is Complete.
Misfire Monitor Complete This Ignition Cycle	Ignition ON	No	This parameter displays the completion status of the misfire monitor during the current driving / monitoring cycle.
Misfire Monitor Enabled	Engine Idling	Yes/No	This parameter displays the status of the Misfire Monitor. The parameter will display Yes when the Misfire Monitor is Enabled.
Misfire Monitor Enabled This Ignition Cycle	Ignition ON	No	This parameter displays the enable status of the misfire monitor during the current driving / monitoring cycle.
Neutral Position Sensor	-	%	This parameter displays the current state of the neutral position sensor in degrees.
Number of Calibration History Events Stored	Ignition ON	Counts	This parameter displays the history entries for the primary calibration in the controller.
Number of DTC(s)	Engine Idling	0	This parameter indicates the number of diagnostic trouble codes (DTCs).
O2S/HO2S Monitor Complete	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and non continuous legislated emission related monitor.
O2S/HO2S Monitor Complete This Ignition	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of

Cycle			each continuous legislated emission related monitor and non continuous legislated emission related monitor.
O2S/HO2S Monitor Enabled	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and non continuous legislated emission related monitor.
O2S/HO2S Monitor Enabled This Ignition Cycle	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and non continuous legislated emission related monitor.
Odometer at Engine Shutdown - Excessive Idle Time	Ignition ON	km / miles	This parameter displays the odometer reading at an engine shutdown due to excessive idle time.
Odometer at Engine Shutdown - High Coolant Temperature	Ignition ON	km / miles	This parameter displays the odometer reading at an engine shutdown due to high coolant temperature.
Odometer at Engine Shutdown - Low Coolant Level	Ignition ON	km / miles	This parameter displays the odometer reading at an engine shutdown due to low coolant level.
Odometer at Engine Shutdown - Low Oil Level	Ignition ON	km / miles	This parameter displays the odometer reading at an engine shutdown due to low oil level.
Odometer When Engine Overspeed Detected	Engine Idling	km/miles	This parameter displays the kilometers or miles of the Odometer When Engine Overspeed Detected.
Oil Level Warning Counter City	Ignition ON	Counts	This parameter displays a rolling count of oil level debounce events for the city calibration.
Oil Level Warning Counter Country Road	Ignition ON	Counts	This parameter displays a rolling count of oil level debounce events for the country

			road calibration
Oil Level Warning Counter Highway	Ignition ON	Counts	This parameter displays a rolling count of oil level debounce events for the highway calibration.
Output Shaft Speed Sensor	Engine Idling	RPM	This parameter displays the transmission output speed.
Park/Neutral Position Switch (If Equipped)	Engine Idling	Park/Neutral	This parameter indicates the range selection of the automatic transmission as calculated by the control module based on input from the PNP switch. The scan tool will display, In Gear, Park, or Neutral depending on the PNP switch position.
Power Enrichment	Engine Idling	Inactive	This parameter indicates if the control module has detected conditions appropriate to operate in Power Enrichment mode. The scan tool will display Active if the mode is in operation, and Inactive if the mode is not in operation. The control module enters Open Loop operation and increases injector pulse width when in power enrichment mode.
Power Mode	Engine Idling	Run	This parameter displays the state of the System Power Mode. This signal is based upon the state of the system power mode received over serial communication from the vehicle electronics. If the serial data signal not received, the Parameter will display Off.
Radiator Coolant Temperature Sensor	-	Varies C° (F°)	This parameter displays the undefaulted radiator coolant temperature measured by a sensor located in the coolant outlet of the radiator.
RCT vs. IAT Sensor Temperature at Last ECT vs. RCT Malfunction Detection	Engine Idling	Agree	This parameter displays that the temperature values of the RCT and IAT sensors did not agree at the time of the most recent failure of the ECT/RCT rationality diagnostic.

Recommended Maximum Fuel Alcohol Content	Engine Idling	%	This parameter displays the percentage of the Recommended Maximum Fuel Alcohol Content.
Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	No	This parameter displays Yes or No if the Recommended Maximum Fuel Alcohol Content Exceeded.
Recommended Maximum Fuel Alcohol Content When Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	%	This parameter displays the percentage of the Recommended Maximum Fuel Alcohol Content When Recommended Maximum Fuel Alcohol Content Exceeded.
Reduced Engine Power	Engine Idling	Inactive	This parameter displays Active if the control module is commanding reduced engine power due to a throttle actuator control (TAC) system condition.
Reduced Engine Power History	Engine Idling	Throttle Malfunction, Cooling Fan Malfunction, Engine Over-temperature Protection Active, Engine Oil Temperature Too High, Remote Vehicle Speed Limiting, Engine Calibration Malfunction, Engine Oil Life, High Pressure Fuel System Malfunction	This parameter displays the last reason that Powertrain has illuminated the Reduced Engine Power (REP) indication.
Redundant Odometer Memory	Engine Idling	Present	ECU Odometer Programmed indicates if the ECU odometer value has been programmed.
Refueling Events Since Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	Counts	This parameter displays the number Refueling Events Since Recommended Maximum Fuel Alcohol Content Exceeded.
Remaining Fuel in Tank	Engine Idling	%	This parameter displays the total fuel level as a percentage of the rated capacity of the fuel tank.
Remaining Fuel in Tank	Engine Idling	Liters/Gallons	This parameter displays the actual total fuel volume contained in the fuel tank.
			These parameters displays the

Remote Vehicle Start Disable History 1-8	Engine Cranking	Reason for RVS Disable	last eight reasons the control module disabled remote vehicle start (RVS).
Remote Vehicle Start Request Signal	Ignition ON	Off	Remote Vehicle Start Request indicates the state of the request received over serial communication from the remote vehicle start (RVS) system to start the vehicle in remote mode.
Replicated Transmission OSS Signal	Ignition ON	RPM	This parameter displays the Replicated Transmission Output Speed (Replicated TOS) received from the Transmission Control Module.
Reverse Inhibit Solenoid Actuator Command	Ignition ON	Allowed	This parameter displays that the driver is inhibited from shifting into reverse.
Reverse Inhibit Solenoid Actuator Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the reverse inhibit solenoid actuator control circuit. The parameter displays Malfunction if the reverse inhibit solenoid actuator control circuit is shorted to voltage.
Reverse Inhibit Solenoid Actuator Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the reverse inhibit solenoid actuator control circuit. The parameter displays Malfunction if the reverse inhibit solenoid actuator control circuit is shorted to ground.
Reverse Inhibit Solenoid Actuator Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the reverse inhibit solenoid actuator control circuit. The parameter displays Malfunction if the reverse inhibit solenoid actuator control circuit is open.
Reverse Position Switch	Engine Idling	Off	This parameter displays if the manual transmission shifter is in reverse.
Secondary Air Injection Monitor Enabled	Engine Idling	Yes	This parameter displays the status of the secondary air injection monitor.
			This parameter displays the

Secondary Air Injection Pressure	Engine Idling	kPa	normalized secondary air injection system pressure for bank 1.
Secondary Air Injection Pressure Sensor	Engine Idling	kPa	This parameter displays the unfiltered secondary air injection system pressure for bank 1.
Secondary Air Injection Pressure Sensor	Engine Idling	Volts	This parameter displays the secondary air injection system pressure analog input for bank 1 as a percentage of its reference voltage.
Secondary Air Injection Pressure Sensor Variance	Engine Idling	kPa	This parameter displays the weighted average pressure error (difference between the predicted and actual secondary air injection system pressure) for bank 1 during the secondary air injection on test (phase 1).
Secondary Air Injection Pump Relay Command	Engine Idling	Off	This parameter displays the commanded state of the secondary air injection pump output.
Secondary Air Injection Pump Relay Control Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection pump relay control circuit. The parameter displays Malfunction if the secondary air injection pump relay control circuit is shorted to voltage.
Secondary Air Injection Pump Relay Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection pump relay control circuit. The parameter displays Malfunction if the secondary air injection pump relay control circuit is shorted to ground.
Secondary Air Injection Pump Relay Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection pump relay control circuit. The parameter displays Malfunction if the secondary air injection pump relay control circuit is open.
Secondary Air Injection Solenoid Valve Command	Engine Idling	Off	This parameter displays the commanded state of the secondary air injection valve

			output.
Secondary Air Injection Solenoid Valve Control Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection solenoid valve control circuit. The parameter displays Malfunction if the secondary air injection solenoid valve control circuit is shorted to voltage.
Secondary Air Injection Solenoid Valve Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection solenoid valve control circuit. The parameter displays Malfunction if the secondary air injection solenoid valve control circuit is shorted to ground.
Secondary Air Injection Solenoid Valve Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection solenoid valve control circuit. The parameter displays Malfunction if the secondary air injection solenoid valve control circuit is open.
Short Term Fuel Pump Trim	-	#	This parameter displays a numeric value. This is the short term (ST) fuel pump trim.
Short Term Fuel Trim Bank 1 or Bank 2	Engine Idling	-5 % to +5 %	This parameter displays the short-term correction to the fuel delivery by the control module in response to oxygen sensor 1 or 2. If the oxygen sensor indicates a lean air/fuel mixture, the control module will add fuel increasing the short term fuel trim above 0. If the oxygen sensor indicates a rich air/fuel mixture, the control module will reduce fuel decreasing the short term fuel trim below 0.
Short Term Fuel Trim Test Average Bank 1 or Bank 2	Engine Idling	%	This parameter display's the filtered short term closed loop fuel correction for bank 1 or 2. This value is compared to thresholds to determine if the fuel adjustment system diagnostic is passing or failing or if an excess purge vapor test should be executed.

Skip Shift Solenoid Actuator Command	Ignition ON	No Skip	This parameter indicates that the skip shift solenoid is commanded on, inhibiting the driver from shifting up to one of the next highest gears.
Skip Shift Solenoid Actuator Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is shorted to voltage.
Skip Shift Solenoid Actuator Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is shorted to ground.
Skip Shift Solenoid Actuator Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is open.
Specific Humidity	Ignition ON	%	This parameter shows the current specific humidity level.
Start Up ECT	Ignition ON	-39° to +140°C (-38° to +284°F)	This parameter displays the temperature of the engine coolant on start-up based on input to the control module from the ECT sensor.
Start Up IAT	Ignition ON	-39° to +140°C (-38° to +284°F)	This parameter displays the temperature of the intake air at start in the air induction system based on input to the control module from the IAT sensor.
Starter Relay Command	Ignition switch not in the crank position	Off	This parameter indicates whether the control module is commanding the starter relay to go On or Off.
	Ignition switch in the crank position	On	
Starter Relay Control			This parameter displays the state of the starter relay control circuit. The parameter displays Malfunction if the starter relay

Circuit High Voltage Test Status	Ignition ON	OK	control circuit is shorted to voltage. This parameter may not change if the scan tool is used to command the relay control circuit On.
Starter Relay Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the starter relay control circuit. The parameter displays Malfunction if the starter relay control circuit is shorted to ground. This parameter may not change if the scan tool is used to command the relay control circuit On.
Starter Relay Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the starter relay control circuit. The parameter displays Malfunction if the starter relay control circuit is open. This parameter may not change if the scan tool is used to command the relay control circuit On.
Supercharger Bypass Solenoid Valve Command	Ignition ON	%	This parameter displays the commanded duty cycle for the supercharger boost solenoid output.
Supercharger Bypass Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the supercharger bypass solenoid valve control circuit. The parameter displays Malfunction if the supercharger bypass solenoid valve control circuit is shorted to voltage.
Supercharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the supercharger bypass solenoid valve control circuit. The parameter displays Malfunction if the supercharger bypass solenoid valve control circuit is shorted to ground.
Supercharger Bypass Solenoid Valve Control	Ignition ON	OK	This parameter displays the state of the supercharger bypass solenoid valve control circuit. The parameter displays

Circuit Open Test Status			Malfunction if the supercharger bypass solenoid valve control circuit is open.
Supercharger Inlet Pressure	Engine Idling	kPa	This parameter displays the supercharger inlet vacuum pressure calculated as the difference between ambient air pressure (barometric pressure) and supercharger inlet absolute pressure (SCIAP).
Supercharger Inlet Pressure Sensor	Engine Idling	kPa	This parameter displays the unfiltered supercharger inlet absolute pressure (SCIAP).
Supercharger Inlet Pressure Sensor	Engine Idling	Volts	This parameter displays the supercharger inlet absolute pressure (SCIAP) analog input as a percentage of its reference voltage.
SVS Indicator Command	Ignition ON	Off	This parameter displays that the Service Vehicle Soon lamp is being commanded on due to the failure of a non emission related diagnostic test.
System Off	Ignition ON	No	This parameter displays that the vehicle is waiting for a key crank to happen (key crank not done yet).
TAC Forced Engine Shutdown	Ignition ON	No	This parameter indicates the status of the TAC motor by the control module. The scan tool will display Yes if the engine has been shut down due to a throttle control fault.
TAC Motor	Ignition ON	Enabled	This parameter indicates the status of the throttle actuator control (TAC) motor driver in the control module. The scan tool will display Enabled if TAC motor operation is allowed. The scan tool will display Disabled if the control module detects a condition that affects TAC motor operation.
TAC Motor Command	Ignition ON	%	This parameter displays the commanded duty cycle for the throttle actuator output.

TCC/Cruise Control Brake Pedal Switch	Ignition ON	Applied / Released	This parameter indicates the state of the TCC/Cruise Control Brake Pedal Switch.
Throttle Body Idle Air Flow Compensation	Engine Idling	%	This parameter displays the percent compensation of the Learned Airflow Variation Calibration. This value indicates the current amount of airflow compensation in response to engine intake airflow restrictions. It can also be used as feedback for the Learned Airflow Adapts Reset Trigger Device Control.
Throttle Position	Ignition ON	0-100 %	This parameter displays the desired throttle position angle commanded by the control module.
Throttle Position Performance Test	Engine Idling	OK	Throttle Position Residual Out of Tolerance indicates that the filtered throttle position residual (the product of the MAF residual and the MAP Test 1 residual) exceeds a failure threshold.
Throttle Position Sensor 1	Ignition ON	3.7-4.3 Volts	This parameter displays the actual voltage on the TP sensor 1 signal circuit as measured by the control module.
Throttle Position Sensor 1 Learned Minimum	Ignition ON	0.51 Volts	This parameter displays the learned minimum value of throttle position (TP) sensor 1 as recorded by the control module during the last learn procedure.
Throttle Position Sensor 1 or 2 Position	Ignition ON	%	This parameter displays the actual voltage on the TP sensor 2 signal circuit as measured by the control module.
Throttle Position Sensor 2	Ignition ON	0.5-0.8 Volts	This parameter displays the voltage signal sent to the control module from TP sensor 2 of the throttle assembly. The TP sensor 2 is a range of values indicating a low voltage when the throttle is closed to a high voltage when the throttle plate

			is fully open.
Throttle Position Sensor 2 Learned Minimum	Ignition ON	0.51 Volts	This parameter displays the learned minimum value of TP sensor 2 as recorded by the control module during the last learn procedure.
Throttle Position Sensors 1 and 2	Ignition ON	Agree	This parameter displays Disagree when the control module detects that TP sensor 1 voltage signal is not within the correct relationship to TP sensor 2. The scan tool displays Agree under the normal operating conditions.
Tire Size	Ignition ON	Rev/km	This parameter displays the vehicle tire circumference in centimeters.
Torque Delivered Signal	Vehicle Moving	/Lb/Ft	This parameter displays the engine torque based upon the airflow through the engine and the torque losses due to spark retard and fuel shutoff. Since this is a steady state engine torque, it does not include the inertial component of engine torque.
Torque Management Ignition Timing Retard	Engine Idling	Degrees	This parameter displays the total spark retard (in terms of a crankshaft angle).
Torque Request Inhibit - Fuel	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - Ignition Timing	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - Ignition Timing Advance	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - Minimum Idle	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
			This parameter displays the

Torque Request Inhibit - Minimum Torque	Engine Idling	No	existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - TAC	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - TAC Limit	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Total Engine Overspeed Time	Engine Idling	ms	This parameter displays the Total Engine Overspeed Time.
Total Knock Retard	Engine Idling	0°	This parameter displays how much ignition spark timing is being retarded due to all control systems monitored by the control module.
Total Misfire	Engine Idling	0	This parameter displays the total number of cylinder firing events that the control module detected as misfires for the last 200 crankshaft revolution sample period.
Traction Control Status	Ignition ON	Inactive	This parameter displays Active if the electronic brake and traction control module (EBTCM) is commanding traction control.
Transmission Fluid Temperature Sensor	Ignition ON	°C (°F)	This parameter displays the defaulted, unfiltered transmission oil / fluid temperature measured by a sensor.
Turbocharger 1 Turbine Inlet Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger 1 turbine inlet valve control circuit. The parameter displays Malfunction if the turbocharger 1 turbine inlet valve control circuit is shorted to voltage.
Turbocharger 1 Turbine Inlet Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger 1 turbine inlet valve control circuit. The parameter displays Malfunction if the turbocharger

			1 turbine inlet valve control circuit is open.
Turbocharger 1 Turbine Inlet Valve Duty Cycle	Ignition ON	%	This parameter displays the commanded duty cycle for the turbocharger 1 turbine inlet valve in a percentage.
Turbocharger Bypass Solenoid Valve Command	Ignition ON	%	This parameter displays the commanded duty cycle for the turbocharger bypass solenoid valve in a percentage.
Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger bypass solenoid valve control circuit. The parameter displays Malfunction if the turbocharger bypass solenoid valve control circuit is shorted to voltage.
Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger bypass solenoid valve control circuit. The parameter displays Malfunction if the turbocharger bypass solenoid valve control circuit is shorted to ground.
Turbocharger Bypass Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger bypass solenoid valve control circuit. The parameter displays Malfunction if the turbocharger bypass solenoid valve control circuit is open.
Turbocharger Wastegate Solenoid Valve Command	Ignition ON	%	This parameter displays the commanded duty cycle for the turbocharger wastegate solenoid valve in a percentage.
Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger wastegate solenoid valve control circuit. The parameter displays Malfunction if the turbocharger wastegate solenoid valve control circuit is shorted to voltage.
Turbocharger Wastegate Solenoid Valve Control			This parameter displays the state of the turbocharger wastegate solenoid valve control circuit. The parameter

Circuit Low Voltage Test Status	Ignition ON	OK	displays Malfunction if the turbocharger wastegate solenoid valve control circuit is shorted to ground.
Turbocharger Wastegate Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger wastegate solenoid valve control circuit. The parameter displays Malfunction if the turbocharger wastegate solenoid valve control circuit is open.
Upshift Indicator Command	Vehicle Moving	Off	This parameter displays On when commanded by the engine control module.
Variable Valve Lift Low Lift Disable History 1-8	Engine Idling	Varies	This parameter displays the reason for the last 8 variable valve lift disable history reasons.
Variable Valve Lift Low Lift Inhibit - Reason	Engine Idling	Varies	This parameter lists the reason the variable valve lift low lift may be inhibited. These include; 4WD Low State Invalid, A/C Compressor Clutch On, Acceleration Request, Brake Booster Pressure Sensor DTC, Brake Booster Weak Vacuum, Calculated Torque, Camshaft Position Sensor DTC, Control Function Active, Crankshaft Position Sensor DTC, ECT, ECT Sensor DTC, Engine Controls Ignition Relay DTC, Engine Not Synchronized, Engine Off, Engine Oil Pressure, Engine Oil Pressure Control Solenoid Valve Stuck Off, Engine Oil Pressure Control Test Active, Engine Oil Pressure Sensor DTC, Engine Oil Temperature, Engine Overtemperature Protection, Engine Power Not Requested, Engine Speed, Engine Torque Capacity, Fuel Alcohol Content Learn In Progress, Fuel Alcohol

			Content Too High, Fuel System Disabled, Green Engine Mode, HO2S 2 Test, Hot Coolant Mode, Hybrid/EV Powertrain Control Module Request, IAT Sensor DTC, Ignition Voltage, MAP Sensor DTC, Maximum Throttle Exceeded, Minimum Time After TAC DTC, Misfire DTC, Oil Aeration. On-Board Diagnostic System, Rocker Arm Solenoid Valve DTC, RPM Limit, TAC System DTC, Transmission Gear, Transmission Range, Transmission Shifting, Vehicle Speed Too Low, VSS DTC.
Variable Valve Lift System Command	-	Low Lift	This parameter displays the current state of the variable valve lift system command.
Vehicle Speed Sensor	Vehicle Moving	Km/h mph	This parameter displays the speed of the vehicle as calculated by the transmission control module (TCM) from information received from the vehicle speed sensor (VSS).
Vehicle Speed When Engine Overspeed Detected	Engine Idling	Km/h mph	This parameter displays the Vehicle Speed When Engine Overspeed Detected.
VIN Programming Counter	Ignition ON	Counts	This parameter displays the number of times the VIN has been programmed. This counter can only be incremented.
Warm Ups Since DTC Cleared	Engine Idling	Counts	This parameter indicates the number of warm up cycles that have occurred Since DTCs were cleared. The scan tool will display a higher counts as more warm up cycles have occurred since the DTCs were cleared.
Warm Ups without Emission Malfunctions	Engine Idling	Counts	This parameter displays the number of OBD defined warm up cycles since the last emissions related (fault type A or B) fail report or MIL request. Emissions related DTCs are cleared from memory when this

			counter reaches 40.
Warm Ups without Non Emission Malfunctions	Engine Idling	Counts	This parameter displays the number of OBD defined warm up cycles since the last non emissions related (fault type C) fail report. Non emissions related DTCs are cleared from memory when this counter reaches 40.
Weight Percent Water in Air	Engine Idling	%	This parameter displays the calculated value of weight per cent water (specific humidity) in the intake air.
Wide Open Throttle	Engine Idling	No	This parameter displays the throttle status commanded by the control module. The scan tool will display Yes if the vehicle throttle is commanded to 100 percent.
Wide Open Throttle	Ignition ON	No	This parameter displays the desired throttle position exceeds a WOT threshold (selected specifically for service).

Engine Control Module (ECM) Scan Tool Output Controls

Output Control	Description
This is a comprehensive list. Not all output controls listed are available for all applications.	
A/C Compressor Clutch Relay	This device control is used to override the state of the air conditioning compressor output.
Autostart/Autostop	This device control is used to override the internal combustion engine (ICE) running state.
Brake Pedal Position Learn	This device control is used to reset the brake pedal fully released learned position to its initialized value after a brake system repair.
Compression Test	This device control is used to set up the internal combustion engine for a compression test. The fuel pump, fuel injectors, and spark are all disabled. The throttle is opened to a Wide Open Throttle (WOT) position. For conventional engine vehicles, the extended crank feature is not active, and for strong hybrid vehicles, the Hybrid Powertrain Control Module is configured to crank at the speed specified in the device control command. Engine cranking is completely controlled by the technician either through the ignition key or through a remote starter switch as applicable. The device control limits and rejects will apply normally upon entry to the device control. Once the device control is active, the limits will be monitored (to prevent unwanted starter operation, for example), but in the case of a limit exceeded or a tester disconnect, device control of the fuel and spark will not be released until the Power

	Mode switches to Accessory or OFF. This will prevent unexpected fuel and spark operation in the case of a device control abort.
Cooling Fan Relay 1	<p>This function activates the cooling fan relay 1. The normal commanded state of the fan relay is NONE. The relay command status can also be monitored on the scan tool data parameter Cooling Fan Relay 1 Command. The control module allows cooling fan relay control when the following conditions are met:</p> <ul style="list-style-type: none"> • The Ignition is ON or the engine is running. • A/C compressor operation is not requested. • The engine coolant temperature is less than 106°C (224°F).
Cooling Fan Relay 1,2 and 3	<p>This function activates the cooling fan relay 1, 2 and 3. The normal commanded state of the fan relays is NONE. The relay command status can also be monitored on the scan tool data parameters Cooling Fan Relay 1 Command and Cooling Fan Relays 2 and 3 Command. The control module allows cooling fan relay control when the following conditions are met:</p> <ul style="list-style-type: none"> • The Ignition is ON or the engine is running. • A/C compressor operation is not requested. • The engine coolant temperature is less than 106°C (224°F).
Cooling Fan 2 and 3	<p>This function activates the cooling fan relay 2 and relay 3. The normal commanded state of the fan relays is NONE. The relay command status can also be monitored on the scan tool data parameter 2 and 3 Command. The control module allows cooling fan relay control when the following conditions are met:</p> <ul style="list-style-type: none"> • The Ignition is ON or the engine is running. • A/C compressor operation is not requested. • The engine coolant temperature is less than 106°C (224°F).
Crankshaft Position Variation Learn	<p>This device control is used to activate the crankshaft position variation learn algorithm which calculates the reference pulse correction factors for the misfire diagnostic.</p>
Cylinder Power Balance	<p>NOTE: The Misfire Current and Misfire History parameters may not increment when using this function.</p> <p>This function disables the selected fuel injector. The normal commanded state is None. The scan tool initiates the test when the following conditions are met:</p> <ul style="list-style-type: none"> • The engine is operating and the engine idle is stable. • The vehicle speed is 0 km/h (0 mph). • There are no DTCs set for the vehicle speed sensor.

	If the fuel injector was disabled for 30 seconds, fuel injector control is not allowed again on the same fuel injector for 60 seconds.
Depressurize Fuel System	When the low pressure fuel pump is used in conjunction with a separate high pressure fuel pump for Direct Injection (DI) engines, this device control can be used to reduce the high fuel pressure to a low working level. The high fuel pressure control shall monitor the low pressure "Fuel Pump Device Control with Engine Running" such that when the low pressure pump is commanded OFF the high pressure pump will be controlled to a low pressure value. This combination shall be held until either the FPMR device control is released, or the engine stalls.
Engine Controls Ignition Relay	This device control is used to override the state of the Powertrain Relay.
Engine Coolant Thermostat Heater	This device control is used to override the state of the Engine Coolant Thermostat Heater.
Engine Oil Life Reset	This DID contains the engine oil remaining life determined from an algorithm based upon the effective engine revolutions and the distance driven since the last oil change. This DID may be used to reset the engine oil remaining life to 100 % after an oil change or to any other value when replacing a control module.
Engine Oil Pressure Control Solenoid Valve	This device control is used to override the state of the variable displacement oil pump. When the variable displacement oil pump is turned on, the oil pump will be commanded to a low pressure state.
Engine Speed	<p>This function controls the idle speed override in 25 RPM, 100 RPM, and 500 RPM increments, from the base idle speed to 1,400 RPM. The scan tool initiates the test when the following conditions are met:</p> <ul style="list-style-type: none"> • The transmission is in park or neutral. • The engine speed is less than 1,000 RPM. <p>The engine speed will remain in the commanded state until cancelled by the scan tool.</p>
EVAP Purge/Seal	<p>NOTE: The EVAP Purge and Vent Solenoid Command parameters may not change states when using this output control.</p> <p>This function activates both the EVAP purge solenoid valve and EVAP vent solenoid to seal the EVAP system. When activated, the purge valve is commanded to 0 percent and the vent valve is commanded ON, Not-venting. The normal commanded state for both solenoids is None. Both of the solenoids remain in the commanded state until cancelled by the scan tool or the FTP sensor exceeds -24 mm Hg (-12 inch H2O).</p>
	<p>NOTE: The EVAP Purge Solenoid Command parameter may not change states when using this output control.</p> <p>This function controls the evaporative emission (EVAP) purge solenoid</p>

EVAP Purge Solenoid Valve	valve. The normal commanded state is NONE. The system will increase or decrease the amount of purge by changing the duty cycle of the purge valve in 10 percent increments within a range of 0-100 percent. The system remains in the commanded state until cancelled by the scan tool or the fuel tank pressure (FTP) sensor exceeds -24 mm Hg (-12 inch H2O).
EVAP Test	This device control is used to activate the evaporative emissions service bay test.
EVAP Vent Solenoid Valve	<p>NOTE: The EVAP Vent Solenoid Command parameter may not change states when using this output control.</p> <p>This function controls the EVAP vent solenoid. The normal commanded state is NONE. When commanded ON, the vent valve switches to Not-venting. The system remains in the commanded state unless one of the following conditions occur:</p> <ul style="list-style-type: none"> • Cancelled by the scan tool • The EVAP canister purge solenoid is more than 0 percent, and the FTP sensor exceeds -24 mm Hg (-12 inch H2O).
Exhaust Camshaft Position Actuator Bank 1	This device control is used to override the state of the exhaust cam phase output for bank 1. The commanded camshaft position is expressed in terms of degrees of camshaft rotation (retard for exhaust camshaft) from the park position (a camshaft position of zero represents the park position).
Exhaust Camshaft Position Actuator Bank 2	This device control is used to override the state of the exhaust cam phase output for bank 2. The commanded camshaft position is expressed in terms of degrees of camshaft rotation (retard for exhaust camshaft) from the park position (a camshaft position of zero represents the park position).
Exhaust Camshaft Position Actuator Solenoid Valve Bank 1	This device control is used to override the state of the exhaust cam phase solenoid output for bank 1.
Exhaust Camshaft Position Actuator Solenoid Valve Bank 2	This device control is used to override the state of the exhaust cam phase solenoid output for bank 2.
Fuel Composition Reset	<p>NOTE: Do not use this output control unless the actual alcohol content of the fuel in the tank is 10 percent or less. This will reset the learned alcohol composition to 0 percent in the engine control module (ECM).</p>
Fuel Control Loop Status	<p>This function controls the heated oxygen sensor (HO2S) loop status. The commanded states include NONE, OPEN, and CLOSED. The normal commanded state is NONE. The loop status changes as commanded, OPEN or CLOSED.</p> <p>The system remains in the commanded state until cancelled by the scan tool.</p>

Fuel Injector Balance Test (If Available)	<p>This function enables the fuel injector in order to verify the correct fuel injector flow. The ECM will pulse the selected fuel injector when the following conditions are met:</p> <ul style="list-style-type: none"> • All instruction on the scan tool is complete. • A fuel injector is selected. • The ignition is ON with the engine OFF. <p>The selected fuel injector can only be flowed/pulsed once per ignition cycle.</p>
Fuel Pressure	<p>This function allows control of the fuel rail pressure (FRP) regulator which is integral to the high pressure fuel pump. The system will Increase or Decrease the fuel rail pressure in increments, as commanded within an approximate range of 1862-17,237 kPa (270-2500 psi). The scan tool initiates the test when the following conditions are met:</p> <ul style="list-style-type: none"> • The engine is operating • The ignition voltage is 10-18 V • The vehicle speed is 0 mph • DTC P0700 is not set <p>The system remains in the commanded state for about 30 seconds or until cancelled by the scan tool or the ECM detects a vehicle speed.</p>
Fuel Pressure Regulator	<p>NOTE: As this is an electrical circuit test, a regulator solenoid commanded to ON does not necessarily equate to the regulator state at maximum fuel pressure.</p> <p>This device control is intended for use on a Direct Injection (DI) high pressure fuel supply system to activate the fuel pressure regulator at ignition ON, engine OFF. Both the low side and high side of the regulator are controlled together. Commanding the regulator to ON will modulate the high side driver to a calibratable Maximum Duty Cycle.</p>
Fuel Pump Enable	<p>This function controls the fuel pump. The normal commanded state is NONE. The scan tool initiates the test when the following conditions are met:</p> <ul style="list-style-type: none"> • There are no vehicle speed sensor DTCs set. • The vehicle speed is 0 km/h (0 mph). <p>When commanded ON/OFF, the engine control module (ECM) turns the fuel pump ON/OFF. If the engine is running and the fuel pump is</p>

	commanded OFF, the engine will stall. The system remains in the commanded state for about 2 seconds or until cancelled by the scan tool or the ECM detects a vehicle speed.
Fuel Pump Speed	This device control is used to override the normal control of the fuel pump output. The device control is a service diagnostic aid that is used to determine if the fuel pump system is functioning properly. Different limit checks are used when the engine is and is not running for the operation of the fuel pump.
Fuel Rail Pressure	This device control is intended for use on a Direct Injection (DI) high pressure fuel supply system to override the commanded fuel high pressure output from the powertrain controller.
Fuel Trim Enable	This function disables the control modules ability to learn new fuel trim parameters. The commanded states are NONE, ENABLED, DISABLED. The normal commanded state is NONE. The system remains in the commanded state until cancelled by the scan tool.
Fuel Trim Reset	This function is used to reset the learned fuel trim values to their initial values.
Generator L-Terminal	Commands the generator L terminal ON and OFF.
Heater Coolant Pump	This device control is used to override the state of the heater core pump relay output.
HO2S Heater Bank 1 Sensor 1	This device control is used to override the duty cycle of the oxygen sensor heaters. With the engine OFF, this device control is intended to be used as a discrete control for circuit diagnosis. With the engine OFF, none of the oxygen sensor heaters can be commanded ON for more than 3.0 seconds, after which the selected oxygen sensor heater must be disabled for a limited duration (typically 60 seconds) before it may be enabled again. With the engine running, this device control is used to operate the oxygen sensor heaters at the various duty cycles available to the engine controller.
HO2S Heater Bank 1 Sensor 2	This device control is used to override the duty cycle of the oxygen sensor heaters. With the engine OFF, this device control is intended to be used as a discrete control for circuit diagnosis. With the engine OFF, none of the oxygen sensor heaters can be commanded ON for more than 3.0 seconds, after which the selected oxygen sensor heater must be disabled for a limited duration (typically 60 seconds) before it may be enabled again. With the engine running, this device control is used to operate the oxygen sensor heaters at the various duty cycles available to the engine controller.
HO2S Heater Bank 2 Sensor 1	This device control is used to override the duty cycle of the oxygen sensor heaters. With the engine OFF, this device control is intended to be used as a discrete control for circuit diagnosis. With the engine OFF, none of the oxygen sensor heaters can be commanded ON for more than 3.0 seconds, after which the selected oxygen sensor heater must be disabled for a limited duration (typically 60 seconds) before it may be enabled again. With the engine running, this device control is used to operate the oxygen sensor heaters at the various duty cycles available to

	the engine controller.
HO2S Heater Bank 2 Sensor 2	This device control is used to override the duty cycle of the oxygen sensor heaters. With the engine OFF, this device control is intended to be used as a discrete control for circuit diagnosis. With the engine OFF, none of the oxygen sensor heaters can be commanded ON for more than 3.0 seconds, after which the selected oxygen sensor heater must be disabled for a limited duration (typically 60 seconds) before it may be enabled again. With the engine running, this device control is used to operate the oxygen sensor heaters at the various duty cycles available to the engine controller.
HO2S Heater Learn	This device control is used to trigger the reset of the learned resistances for the oxygen sensor heaters following a replacement in service. The learned resistances are reset to a calibration used to prevent overheating of the sensors until more accurate resistances may be learned following an extended engine OFF time (typically 12 or more hours).
Idle Ignition Timing	Disables and enables idle spark advance with the engine running.
Idle Learn	<p>This function allows the throttle position and the idle speed to be relearned by the ECM, once the following conditions have been met.</p> <ul style="list-style-type: none"> • The ignition is ON with the engine OFF. • The ECT is between 5-85°C (41-185°F). • No throttle actuator control (TAC) system DTCs are set.
Ignition Timing Retard	This device control is used to retard the spark angle from the software calculated spark angle. For example, if the software calculated spark angle was 15 degrees advanced and this device control requested a 3 degree retard, the commanded spark angle that would be delivered would be 12 degrees advanced.
Intake Air Heater	This device control is used to override the state of the intake air heater.
Intake Camshaft Position Actuator Bank 1	This device control is used to override the state of the intake cam phase output for bank 1. The commanded camshaft position is expressed in terms of degrees of camshaft rotation (advance for intake camshafts) from the park position (a camshaft position of zero represents the park position).
Intake Camshaft Position Actuator Bank 2	This device control is used to override the state of the intake cam phase output for bank 2. The commanded camshaft position is expressed in terms of degrees of camshaft rotation (advance for intake camshafts) from the park position (a camshaft position of zero represents the park position).
Intake Camshaft Position Actuator Solenoid Valve Bank 1	This device control is used to override the state of the intake cam phase solenoid output for bank 1.
Intake Camshaft Position Actuator Solenoid Valve Bank 2	This device control is used to override the state of the intake cam phase solenoid output for bank 2.
	When the engine is running, this device control may be used to command

Intake Rocker Arm Solenoid Valve 1-2 or 1 and 2	intake valve opening to low or high (high being default when the solenoid is not energized) valve lift mode either in cylinder pairs or as a system.
Malfunction Indicator Lamp (MIL)	This function controls the malfunction indicator lamp (MIL). The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the MIL ON/OFF. The system remains in the commanded state until cancelled by the scan tool.
Mass Air Flow Sensor Supply Voltage	This device control is used to override the state of the mass air flow sensor supply voltage output.
Misfire Graphic	This function clears the misfire graphics from the scan tool.
Oil Life Reset	This output control is used to reset the engine oil life monitor from 0 to 100 %.
Remote Vehicle Start Disable History Reset	This function clears the remote vehicle start (RVS) disable history. When RESET is selected the reason the control module did not allow RVS in the last 8 attempts is cleared.
Secondary Air Injection Pump Relay	This device control is used to turn the AIR Pump ON or OFF.
Secondary Air Injection Solenoid Valve	This device control is used to turn the AIR Valve ON or OFF.
Secondary Air Injection Test	This device control is used to trigger the secondary air injection (SAI) diagnostic service bay test, which causes the on board SAI diagnostic to execute until it is completed or aborted.
Starter Relay (If Available)	Commands the starter relay ON and OFF.
Throttle Position	This device control is used to override the commanded throttle position.
Throttle Sweep	This function moves the Throttle plate slowly from a closed position to wide open position, aiding diagnosis of TAC motor.
Turbocharger Bypass Solenoid Valve	This device control is used to control the duty cycle for the turbocharger A compressor bypass.
Turbocharger Wastegate Solenoid Valve	This device control is used to control the duty cycle for the turbocharger A wastegate.

FRONT AND REAR PARKING ASSIST CONTROL MODULE SCAN TOOL INFORMATION

Parking Assist Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine OFF/Parking Assist ON			
System Voltage	-	11-14 V	The scan tool displays V. This is the current battery voltage.
Vehicle Speed	-	km/h	The scan tool displays km/h. This is the current vehicle speed.
Reverse Gear Signal	Transmission in reverse	0 = Disabled 1 = Enabled	The scan tool displays Reverse Gear, Disabled or Enabled.
Trailer Connection		0 = No	The scan tool displays Yes or No. On is

Detected	-	1 = Yes	displayed if there is an object within the measuring range of the object sensors.
Trailer Hitch	-	0 = Not Installed 1 = Installed	The scan tool displays Installed or Not Installed Trailer Hitch.

FRONT VIEW CAMERA MODULE SCAN TOOL INFORMATION

Front View Camera Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine OFF/Lane Departure Warning ON			
System Voltage	-	Varies	The scan tool displays the system voltage depending of the current battery voltage.
System Power Mode	-	Varies	The scan tool displays Off, Accessory, Running, Cranking or Undefined. This is the state of the ignition switch.
Power Mode Controlled by Backup Device	-	Varies	The scan tool displays Off, Accessory, Running or Cranking depending of the current power mode.
Frontview Camera System Status	-	Varies	The scan tool displays Normal, Malfunction or Undefined depending on the state of the lane departure warning system.
Frontview Camera Calibration Status	-	Varies	The scan tool displays Not Calibrated, Calibrated, Dynamically Calibrated or Undefined. This is the current state of the calibration.
Frontview Camera Learn Mode Status	-	Varies %	The scan tool displays varies percentage between 0-100% depending on the state of the frontview camera learn mode.
Lane Departure Warning Status	-	Varies	The scan tool displays Off, Disabled, Not Ready to Assist, Ready to Assist, Malfunction, Unknown or Undefined depending on the state of the lane departure warning system.
Lane Departure Warning Switch Status	-	On	The scan tool displays On or Off depending on the state of the lane departure warning switch.
Lane Departure Warning Indicator Status	-	Varies	The scan tool displays Off, On, Malfunction, Unknown or Undefined depending on the state of the lane departure warning system.
Forward Collision Alert Function Status	-	Varies	The scan tool displays Off, On, Malfunction, Unknown or Undefined depending on the state of the lane departure

			warning system.
Intelligent Light Ranging Status	-	Varies	The scan tool displays Off, Disabled, Malfunction, Enabled, Unknown or Undefined depending on the state of the intelligent light ranging system.
Automatic High Beam Activation Status	-	Varies	The scan tool displays Disabled, Enabled or Undefined depending on the state of the automatic high beam assist system.
Following Distance Indicator Status	-	Varies	The scan tool displays Off, Disabled, Not Ready to Assist, Ready to Assist or Undefined depending on the state of the following distance indicator status.
Frontview Camera Disable History 1-4	-	Varies	The scan tool displays Empty, Lane Departure Warning Indicator Malfunction, Lane Departure Warning Switch Malfunction, Sensors Obstructed, Accelerator Pedal Position Out of Range, Driven Wheel Speed Signal Invalid, Non-Driven Wheel Speed Invalid, Brake Pedal Moderate Travel Signal Invalid, Brake Pedal Initial Travel Position Achieved, Lost Communication with Steering Wheel Angle Sensor Module, Invalid Data Received From Steering Wheel Angle Sensor Module, Forward Collision Alert Switch Malfunction, Clutch Pedal Position (CPP) Sensor Performance, Transmission Gear Engaged, Acceleration Sensor Longitudinal Signal, Invalid Data Received From Yaw Rate Sensor Module, Power Mode Controlled by Backup Device, System Power Mode, Overvoltage, Undervoltage or Undefined depending on the history data of the frontview camera disable history.

Front View Camera Module Scan Tool Output Controls

Output Control	Description
Clear Disable History Data	The frontview camera control module clears all disable history buffers when commanded from the scan tool.
Forward Collision Alert Switch	The frontview camera control module switches the forward collision alert system to Near, Medium or Far when commanded from the scan tool.
High Beams	The frontview camera control module switches the high beams On or Off when commanded from the scan tool.
Lane Departure Warning Indicator	The frontview camera control module switches the lane departure warning indicator On or Off when commanded from the scan tool.

Lane Departure Warning Switch	The frontview camera control module switches the lane departure warning system On or Off when commanded from the scan tool.
Vehicle Direction Camera Learn	The frontview camera control module initializes the service point calibration of the frontview camera and switches into the learn mode when commanded from the scan tool.

BATTERY ENERGY CONTROL MODULE SCAN TOOL INFORMATION

Hybrid/EV Battery Voltage Leveling Data

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Hybrid/EV Battery Pack Terminal 1 Voltage	Varies	The scan tool displays the hybrid/EV battery pack voltage as measured at the battery side of the contactor.
Hybrid/EV Battery Pack Low Resolution Current Sensor	0.00 A	The scan tool displays the current flow from the hybrid/EV battery pack.
5V Reference 1	5.00 V	The scan tool displays the voltage of the 5V reference circuit 1.
Power Mode	Run	The scan tool displays the current power mode.
Hybrid/EV Battery Voltage Leveling Status	Inactive	The scan tool displays the current status of the battery leveling function.
Hybrid/EV Battery 1 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 2 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 3 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 4 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 5 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 6 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 7 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 8 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 9 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 10 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.
Hybrid/EV Battery 11 Voltage Leveling	Off	The scan tool displays the current leveling status of the specific battery cell.

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Hybrid/EV Battery Pack Terminal 1 Voltage	Varies	The scan tool displays the hybrid/EV battery pack voltage as measured at the battery side of the contactor.
Hybrid/EV Battery Pack Low Resolution Current Sensor	0.00 A	The scan tool displays the current flow from the hybrid/EV battery pack.
5V Reference 1	5.00 V	The scan tool displays the voltage of the 5V reference circuit 1.
Power Mode	Run	The scan tool displays the current power mode.
Hybrid/EV Battery Pack Temperature	Varies	The scan tool displays the temperature at the air inlet temperature sensor.
Hybrid/EV Battery 1	Varies	The scan tool displays the temperature at the specific cell group.
Hybrid/EV Battery 2	Varies	The scan tool displays the temperature at the specific cell group.
Hybrid/EV Battery 3	Varies	The scan tool displays the temperature at the specific cell group.
Hybrid/EV Battery 4	Varies	The scan tool displays the temperature at the specific cell group.
Hybrid/EV Battery 5	Varies	The scan tool displays the temperature at the specific cell group.
Hybrid/EV Battery 6	Varies	The scan tool displays the temperature at the specific cell group.

Voltage Data

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Hybrid/EV Battery Pack Terminal 1 Voltage	Varies	The scan tool displays the hybrid/EV battery pack voltage as measured at the battery side of the contactor.
Hybrid/EV Battery Pack Low Resolution Current Sensor	0.00 A	The scan tool displays the current flow from the hybrid/EV battery pack.
5V Reference 1	5.00 V	The scan tool displays the voltage of the 5V reference circuit 1.
Power Mode	Run	The scan tool displays the current power mode.
Hybrid/EV Battery 1	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 2	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 3	Varies	The scan tool displays the voltage of the specific battery cell.

Hybrid/EV Battery 4	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 5	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 6	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 7	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 8	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 9	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 10	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 11	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 12	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 13	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 14	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 15	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 16	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 17	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 18	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 19	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 20	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 21	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 22	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 23	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 24	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 25	Varies	The scan tool displays the voltage of the specific battery cell.

Hybrid/EV Battery 26	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 27	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 28	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 29	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 30	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 31	Varies	The scan tool displays the voltage of the specific battery cell.
Hybrid/EV Battery 32	Varies	The scan tool displays the voltage of the specific battery cell.

HEATING, VENTILATION AND AIR CONDITIONING CONTROL MODULE SCAN TOOL INFORMATION

Heating Ventilation and Air Conditioning Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
A/C Compressor Clutch Inhibit Reason	-	Varies	The scan tool displays the reason why the activation of the A/C compressor is inhibit.
A/C Compressor Clutch Status	A/C Off	Disengaged	The scan tool displays Engaged or Disengaged depending on the state of the A/C compressor clutch.
	A/C On	Engaged	
A/C Evaporator Temperature Sensor	-	-40 to +80°C (-40 to +176°F)	The scan tool displays °C (°F). This is the current temperature at the A/C evaporator temperature sensor.
A/C High Side Pressure Sensor	-	Varies	The scan tool displays kPa. This is the current pressure of the A/C refrigerant.
A/C Indicator	A/C Off	Off	The scan tool displays On or Off depending on the state of the A/C mode.
	A/C On	On	
A/C Request Signal	A/C Off	Inactive	The scan tool displays Active or Inactive depending on the state of the A/C mode.
	A/C On	Active	
A/C Switch	A/C Switch released	Inactive	The scan tool displays Active or Inactive depending on the state of the A/C switch.
	A/C Switch pressed	Active	
Air Inlet Door Motor Calibration Status	-	Varies	The scan tool displays Not Running, In Progress, Complete or Failed depending the calibration status.

Air Recirculation LED	Air recirculation mode is deactivated	Off	The scan tool displays On or Off depending on the state of the Recirculation mode.
	Air recirculation mode is activated	On	
Air Recirculation Mode Switch	Air recirculation switch released	Inactive	The scan tool displays Active or Inactive depending on the state of the air recirculation mode switch.
	Air recirculation switch pressed	Active	
Battery Voltage	-	11-14 V	The scan tool displays V. This is the current battery voltage.
Bi-level Indicator	-	Varies	The scan tool displays On or Off depending on the state of the Bi-level switch.
Bi-level Switch	-	Varies	The scan tool displays Active or Inactive depending on the state of the Bi-level switch.
Blower Motor Switch	-	Varies	Only with C68 The scan tool displays OFF, 1-8 depending on the state of the selected blower motor speed.
			Only with CJ2 The scan tool displays Up, Down or Inactive depending on the state of the blower motor switches.
Desired Left Temperature	-	Varies	The scan tool displays °C (°F). This is the selected temperature at the temperature switch.
Desired Left Temperature Motor Door Position	-	Varies	The scan tool displays Counts. This is the desired position of the left temperature actuator.
Engine Coolant Temperature	-	-40 to +215°C (-40 to +419°F)	The scan tool displays °C (°F). This is the current engine coolant temperature.
Enhanced Defrost Indicator	Enhanced defrost mode is deactivated	Off	The scan tool displays On or Off depending on the state of the enhanced defrost mode.
	Enhanced defrost mode is activated	On	
Enhanced Defrost Switch	Enhanced defrost switch released	Off	The scan tool displays On or Off depending on the state of the enhanced defrost switch.
	Enhanced defrost switch pressed	On	
Floor Mode Indicator	Floor mode is deactivated	Off	The scan tool displays On or Off depending on the state of the floor mode.
	Floor mode is	On	

	activated		
Floor Mode Switch	Floor mode switch released	Off	The scan tool displays On or Off depending on the state of the floor mode switch.
	Floor mode switch pressed	On	
Front Defrost Indicator	Front defrost mode is deactivated	Off	The scan tool displays On or Off depending on the state of the front defrost mode.
	Front defrost mode is activated	On	
Front Defrost Switch	Front defrost switch released	Off	The scan tool displays On or Off depending on the state of the front defrost switch.
	Front defrost switch pressed	On	
HVAC Actuators Supply Voltage	-	Active	The scan tool displays Active or Inactive. Inactive is displayed if there is a malfunction at the actuators supply voltage circuit.
Instrument Panel Vents Indicator	Instrument panel vents mode is deactivated	Off	The scan tool displays On or Off depending on the state of the instrument panel vents mode.
	Instrument panel vents mode is activated	On	
Instrument Panel Vents switch	Instrument panel vents switch released	Inactive	The scan tool displays Active or Inactive depending on the state of the instrument panel vents switch.
	Instrument panel vents switch pressed	Active	
Left Mode Door Motor Direction	-	Varies	The scan tool displays Stop, Increase or Decrease. During the movement of the door, the scan tool shows Increase or Decrease depending the movement direction. When the position of the door is reached, the scan tool displays Stop.
Left Temperature Door Motor Calibration Status	-	Varies	The scan tool displays Not Running, In Progress, Complete or Failed depending the calibration status.
Left Temperature Door Motor Direction	-	-	The scan tool displays Stop, Increase or Decrease. During the movement of the door, the scan tool shows Increase or Decrease depending the movement direction. When the position of the door is reached, the scan tool displays

			Stop.
Left Temperature Door Position	-	Varies	The scan tool displays Counts. This is the current position of the temperature actuator.
Left Temperature Knob Position	-	Varies	The scan tool displays Counts. The value varies between -5 to +5 depending the selected temperature knob position. At the cold end position is the value 18 and at the hot end position -18.
Mode Door Motor Calibration Status	-	Varies	The scan tool displays Not Running, In Progress, Complete or Failed depending the calibration status.
Rear Defogger Indicator	Rear defogger is deactivated	Off	The scan tool displays On or Off depending on the state of the rear defogger.
	Rear defogger is activated	On	
Rear Defogger Switch	Rear defogger switch released	Inactive	The scan tool displays Active or Inactive depending on the state of the rear defogger switch.
	Rear defogger switch pressed	Active	
Recirculation Door Motor Direction	Air recirculation mode is deactivated	Outside Air	The scan toll displays Stop, Outside Air, Increase, Recirculation, Decrease or Not Used depending on the state of the recirculation door. During the movement of the door, the scan tool shows Increase or Decrease depending the movement direction.
	Air recirculation mode is activated	Recirculation	

Heating Ventilation and Air Conditioning Control Module Scan Tool Output Controls

Output Control	Description
A/C Indicator	The HVAC control module illuminates the A/C indicator when commanded from the scan tool.
A/C Switch	This control function simulates the state of the A/C switch.
Air Recirculation Door Motor Direction	The HVAC control module commands the air recirculation actuator from venting to recirculation and back again.
Air Recirculation LED	The HVAC control module illuminates the Air Recirculation indicator when commanded from the scan tool.
Air Recirculation Mode Switch	When On is selected, the HVAC control module commands the air recirculation door from outside air to recirculation. When Off is selected, the HVAC control module commands the air recirculation door from recirculation to outside air.
Blower Speed Indicator 1-6	The HVAC control module illuminates the appropriate blower speed indicator when commanded from the scan tool.
Blower Motor Switch	This control function simulates the state of the blower motor switch.

Front Defrost Indicator	The HVAC control module illuminates the front defrost indicator when commanded from the scan tool.
HVAC Actuators	The HVAC control module executes the Motor Learn Routine when commanded from the scan tool.
HVAC Afterblow Configuration	This control function disables and enables the afterblow configuration.
Left Temperature Door Motor Direction	When Increase is selected, the left temperature door position increases stepwise. When Decrease is selected, the left temperature door position decreases stepwise.
Left Temperature Door Position	This commands the left temperature door position from Cold to Hot.
Mode Door Motor Command	The HVAC control module commands the mode actuator stepwise from defrost to floor and back again.
Mode Door Position	When Floor is selected, the HVAC control module commands the mode actuator to the floor position. When Defrost is selected, the HVAC control module commands the actuator to the defrost position.
Rear Defog	The HVAC control module commands the rear defogger On and Off.
Rear Defog Indicator	The HVAC control module commands the rear defogger indicator On and Off.
Recirculation Door	The HVAC control module commands the recirculation actuator stepwise from outside air to recirculation and back again.

HUMAN MACHINE INTERFACE CONTROL MODULE SCAN TOOL INFORMATION

Human Machine Interface Control Module Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Battery Voltage	Varies	The scan tool displays volts. This is the voltage at the input to the human machine interface control module.
System Power Mode	Run	The scan tool displays Off, Accessory, Run or Crank Request. This is the vehicle power mode status as received by the human machine interface control module via high speed GMLAN.
Date From GPS	Varies	The scan tool displays the current date (Month, Day, and Year) acquired from the GPS satellites.
Time From GPS	Varies	The scan tool displays the current time acquired from the GPS satellites in 24 hour format HHMMSS
Human Machine Interface Control Module Microphone 1	Not Present	The scan tool displays Present or Not Present. Calibration indication that a primary microphone is present and connected to the human machine interface control module. The microphone input is ported to the MOST buss to the amplifier (for volume compensation, when required) instead of directly wired microphone to the amplifier.
		The scan tool displays Present or Not Present.

Human Machine Interface Control Module Microphone 2	Not Present	Calibration indication that a secondary microphone is present and connected to the human machine interface control module. The microphone input is ported to the MOST buss to the amplifier (for volume compensation, when required) instead of directly wired microphone to the amplifier.
Human Machine Interface Control Module Powers GPS	Not Present	The scan tool displays Present or Not Present. Calibration Indication that a GPS antenna input is primary to the human machine interface control module and powered by the human machine interface control module instead of shared with another vehicle location module.
Rearview Camera	Varies based on vehicle equipment	The scan tool displays Present or Not Present. Calibration indication that the system is calibrated for rear view camera operation.
Rearview Camera Display	Inactive	The scan tool displays Active or Inactive. Indication that rear camera views are actively being displayed.
Front Touch Screen	Varies based on vehicle equipment	The scan tool displays Present or Not Present. Calibration indication that the system is calibrated for front touch screen operation.
USB Receptacle 1	Varies based on vehicle equipment	The scan tool displays Present or Not Present. Calibration indication that a USB receptacle is connected to the human machine interface control module USB port 1. Does not indicate if a device is connected to the USB receptacle.
USB Receptacle 2	Varies based on vehicle equipment	The scan tool displays Present or Not Present. Calibration indication that a USB receptacle is connected to the human machine interface control module USB port 2. Does not indicate if a device is connected to the USB receptacle.
Memory Card Receptacle	Varies based on vehicle equipment	The scan tool displays Present or Not Present. Calibration indication that a SD Card receptacle input is present. Does not indicate the receptacle is occupied with digital media.
USB Hub 1	Varies based on vehicle equipment	The scan tool displays Present or Not Present. Calibration indication that a hub device is connected to the human machine interface control module USB port 1.
USB Hub 2	Varies based on vehicle equipment	The scan tool displays Present or Not Present. Calibration indication that a hub device is connected to the human machine interface control module USB port 2.
USB Hub 1 Number of Ports	Varies based on vehicle equipment	The scan tool displays the number of receptacles (USB and/or memory card receptacles) present in the hub device connected to the human machine interface control module USB port 1.

USB Hub 2 Number of Ports	Varies based on vehicle equipment	The scan tool displays the number of receptacles (USB and/or memory card receptacles) present in the hub device connected to the human machine interface control module USB port 1.
Valet Mode	Inactive	The scan tool displays Active or Inactive. Actual indication that Valet Parking Mode which limits vehicle features (speed limiting, no disc eject, trunk lock, etc.), is active or inactive.
Human Machine Interface Control Module Theft Protection Armed	VIN Learned	The scan tool displays VIN Learned or No VIN Learned. Actual indication if the human machine interface control module has learned a VIN.
Human Machine Interface Control Module Theft Protection Locked	Inactive	The scan tool displays Active or Inactive. Actual indication the human machine interface control module is in theft protection (limited functionality) mode.
Cooling Fan Speed	Varies	The scan tool displays OFF, or displays the current cooling fan speed expressed in stages from 1 to 6. Higher stages indicate increased speed of the cooling fan..
Control Module Temperature Sensor 1	Varies	The scan tool displays the actual value of the human machine interface control module circuit board temperature sensor 1.
Control Module Temperature Sensor 2	Varies	The scan tool displays the actual value of the human machine interface control module circuit board temperature sensor 2.
End Model Part Number	Varies	The scan tool displays the end software module part number.
Boot Software Part Number	Varies	The scan tool displays the boot software ID number.
Calibration Part Number 1	Varies	The scan tool displays the software calibration part number 1.
Calibration Part Number 2	Varies	The scan tool displays the software calibration part number 2.
Calibration Part Number 3	Varies	The scan tool displays the software calibration part number 3.
Calibration Part Number 4	Varies	The scan tool displays the software calibration part number 4.
Calibration Part Number 5	Varies	The scan tool displays the software calibration part number 5.
Calibration Part Number 6	Varies	The scan tool displays the software calibration part number 6.
Calibration Part Number 7	Varies	The scan tool displays the software calibration part number 7.
Calibration Part Number 8	Varies	The scan tool displays the software calibration part number 8.
Calibration Part Number 9	Varies	The scan tool displays the software calibration part

		number 9.
Calibration Part Number 10	Varies	The scan tool displays the software calibration part number 10.
Calibration Part Number 11	Varies	The scan tool displays the software calibration part number 11.
Software Module 11 Identifier Alpha Code	Varies	The scan tool displays a two character software identifier.
Calibration Part Number 12	Varies	The scan tool displays the software calibration part number 12.
Software Module 12 Identifier Alpha Code	Varies	The scan tool displays a two character software identifier.
Calibration Part Number 13	Varies	The scan tool displays the software calibration part number 13.
Calibration Part Number 14	Varies	The scan tool displays the software calibration part number 14.
Software Module 14 Identifier Alpha Code	Varies	The scan tool displays a two character software identifier.
Calibration Part Number 15	Varies	The scan tool displays the software calibration part number 15.
Calibration Part Number 16	Varies	The scan tool displays the software calibration part number 16.
Calibration Part Number 17	Varies	The scan tool displays the software calibration part number 17.
Calibration Part Number 18	Varies	The scan tool displays the software calibration part number 18.
Calibration Part Number 19	Varies	The scan tool displays the software calibration part number 19.
Software Freeze Date	Varies	The scan tool displays the software date in DD.MM.YYYY format.
Hardware Production Date	Varies	The scan tool displays the ECU hardware production date in DD.MM.YYYY format.
Manufacturer Enable Counter	0	The scan tool displays the counter value. This counter is used for manufacturing purposes only.
VIN Digits 2-17	Varies	The scan tool displays the learned VIN digits 2-17.
Diagnostic Data Identifier	Varies	The scan tool displays the 4 character alphanumeric device ID.

Wireless Access Data Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Number of Paired Bluetooth Devices Present	Varies	Number of paired (authenticated) devices detected and present but may or may not be connected.
Bluetooth Device	Varies	The scan tool displays Connected or Not Connected. The parameter indicates if a Bluetooth device is

Connection Status		currently connected to the system.
Bluetooth Device Hands Free Call Status	Varies	The scan tool displays Call Active or Inactive. Indicates if the currently connected Bluetooth device is actively in a hands free phone call.
Bluetooth Device Audio Streaming Status	Varies	The scan tool displays Active or Inactive. Indicates if the currently connected Bluetooth device is actively streaming audio.
Bluetooth Device Internet Connection Status	Varies	The scan tool displays Active or Inactive. Indicates if the currently connected Bluetooth device is actively connected to the Internet via the device's internet connection.
Bluetooth Device Supports Hands Free	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports the Bluetooth Hands Free profile.
Bluetooth Device Supports Phone Book Access	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports the Bluetooth Phone Book Access profile.
Bluetooth Device Supports Text Message Access	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports the Bluetooth Text Message Access profile.
Bluetooth Device Supports Serial Port	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports the Bluetooth Serial Port profile.
Bluetooth Device Supports Navigation	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports the Bluetooth Portable Navigation profile.
Bluetooth Device Supports Audio Streaming using Audio Video Remote Control Profile 1.0	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports the Bluetooth Audio Streaming AVRCP (Audio/Video Remote Control Profile) 1.0. The Audio/Video Remote Control Profile is a Bluetooth profile that allows Bluetooth devices to control media playback on remote devices. It is typically used with A2DP devices for next/previous track selection and pause/play functions.
Bluetooth Device Supports Audio Streaming using Audio Video Remote Control Profile 1.3	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports the Bluetooth Audio Streaming AVRCP (Audio/Video Remote Control Profile) 1.3. The Audio/Video Remote Control Profile is a Bluetooth profile that allows Bluetooth devices to control media playback on remote devices. It is typically used with A2DP devices for next/previous track selection and pause/play functions.
Bluetooth Device Supports Internet Access - Dial-Up Network	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports internet access only through the device's dial-up network.
Bluetooth Device Supports		The scan tool displays Yes or No. Indicates if the

Internet Access - Personal Area Network	Varies	currently connected Bluetooth device supports internet access only though the device's personal area network.
Bluetooth Device Supports Internet Access - Dial-Up/Personal Area Network	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device supports internet access though the device's dial-up or personal area network.
Bluetooth Device Class - Phone	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device class is identified as a phone.
Bluetooth Device Class - Audio/Video	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device class is identified as an audio and/or video device.
Bluetooth Device Class - Computer	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device class is identified as a computing device.
Bluetooth Device Class - LAN or Network Access Point	Varies	The scan tool displays Yes or No. Indicates if the currently connected Bluetooth device class is identified as a Local Area Network (LAN) or Network Access Point (NAP) device.
WLAN Link Quality	Counts	The scan tool displays the connection quality in counts, with higher numbers indicating a better connection.
App 1 Identifier	Varies	The scan tool displays the numeric identifier for the installed internet application number 1
App 1 Version	Varies	The scan tool displays the version number for the installed internet application number 1
App 2 Identifier	Varies	The scan tool displays the numeric identifier for the installed internet application number 2
App 2 Version	Varies	The scan tool displays the version number for the installed internet application number 2
App 3 Identifier	Varies	The scan tool displays the numeric identifier for the installed internet application number 3
App 3 Version	Varies	The scan tool displays the version number for the installed internet application number 3
App 4 Identifier	Varies	The scan tool displays the numeric identifier for the installed internet application number 4
App 4 Version	Varies	The scan tool displays the version number for the installed internet application number 4
App 5 Identifier	Varies	The scan tool displays the numeric identifier for the installed internet application number 5
App 5 Version	Varies	The scan tool displays the version number for the installed internet application number 5
App 6 Identifier	Varies	The scan tool displays the numeric identifier for the installed internet application number 6
App 6 Version	Varies	The scan tool displays the version number for the installed internet application number 6

App 7 Identifier	Varies	The scan tool displays the numeric identifier for the installed internet application number 7
App 7 Version	Varies	The scan tool displays the version number for the installed internet application number 7
App 8 Identifier	Varies	The scan tool displays the numeric identifier for the installed internet application number 8
App 8 Version	Varies	The scan tool displays the version number for the installed internet application number 8

HYBRID POWERTRAIN CONTROL MODULE SCAN TOOL INFORMATION

The hybrid powertrain control module is a non-serviceable module within the generator control module. The Hybrid Powertrain Control Module Scan Tool Data Parameters list contains hybrid controls-related parameters. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists, and in some cases may appear more than once, or in more than one data list in order to group certain related parameters together.

Use the Hybrid Powertrain Control Module Scan Tool Data Parameters list only after the following is determined:

- The **Diagnostic System Check - Vehicle** is completed.
- On-board diagnostics are functioning properly

The scan tool values from a properly running vehicle may be used for comparison with the vehicle you are diagnosing. The Hybrid Powertrain Control Module Scan Tool Data Parameters list represents values that would be seen on a normally running vehicle.

NOTE: **A scan tool that displays faulty data should not be used. The scan tool concern should be reported to the manufacturer. Use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.**

Only the parameters listed below are referenced in this service manual for use in diagnosis. If all values are within the typical range described below, refer to **Symptoms - Hybrid Controls** for diagnosis.

Hybrid Powertrain Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Closed Throttle/Park or Neutral/Accessories OFF, Engine On, normal operating temperature, unless otherwise noted			
5V Reference 1	Volts	5V	This parameter displays the voltage of the 5V reference circuit voltage in the Brake Pedal Switch sensor and the High Voltage Interlock Loop of the Starter Generator.
			This parameter displays the current status of the 5V reference

5 V Reference 1 Circuit Status	OK/Malfunction	OK	circuit voltage in the Brake Pedal Switch sensor and the High Voltage Interlock Loop of the Starter Generator
5 V Reference 2 Circuit Status	OK/Malfunction	OK	This parameter displays the current status of the 5V reference circuit voltage in the High Voltage Interlock Loop of the Generator Control and Battery Module
5V Reference 3	Volts	5V	This parameter displays the voltage of the 5V reference circuit voltage internal to the Generator Control Module.
5 V Reference 3 Circuit Status	OK/Malfunction	OK	This parameter displays the current status of the 5V reference circuit voltage internal to the Generator Control Module
14V Power Module Fan Speed	RPM	Varies	This parameter displays the speed of the hybrid battery cooling fan motor.
14V Power Module High Voltage Circuit Current	Amps	Varies	This parameter displays the high voltage circuit current as determined by the 14V power module. The parameter display range is -1638.4 to +1638.35 Amps.
14V Power Module Power Loss	Watts	Varies	This parameter displays the difference in power (power loss) between the input power and the output power of the 14V Power Module. The 14V power module converts high voltage to intermediate or low voltage in order to support the various electrical system loads. The power loss is determined based upon High Voltage current and voltage, Low Voltage current and voltage, and Intermediate Voltage current and voltage measurements from the 14V power module internal sensors.
			This parameter displays the target output, expressed in percent, the 14V power module will try to maintain while operating the

14V Power Module Setpoint	%	Varies	system. The 14V power module converts high voltage to intermediate or low voltage in order to support the various electrical system loads.
14V Power Module Setpoint	Volts	14.5	This parameter displays the target voltage the 14V power module will try to maintain while operating the system. The 14V power module converts high voltage to intermediate or low voltage in order to support the various electrical system loads.
14V Power Module Status	Normal; Out of Range; Low Power Mode; Shutdown Mode; Default; Unknown	Normal	This parameter displays the control status of the 14V power module as controlled in the hybrid powertrain control module. The 14V power module converts high voltage to intermediate or low voltage in order to support the various electrical system loads.
14V Power Module Temperature Sensor 1	°C (°F)	Varies	14V Power Module temperature measured by sensor 1
14V Power Module Temperature Sensor 2	°C (°F)	Varies	14V Power Module temperature measured by sensor 2
Autostart Inhibit Reason - Autostart/Autostop Malfunction	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Autostart/Autostop Malfunction.
Autostart Inhibit Reason - Control Function Active	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: control function AutoStop Override.
Autostart Inhibit Reason - Crank Abort	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Crank Aborted.
Autostart Inhibit Reason - Driver Exited Vehicle	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Driver Left Vehicle.
Autostart Inhibit Reason - ECM Malfunction	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: ECM System Failure.
Autostart Inhibit Reason - ECM Request	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the

			following reason: ECM Request.
Autostart Inhibit Reason - Engine Coolant Temperature Out of Range	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Engine Coolant Temperature.
Autostart Inhibit Reason - Hood Ajar	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Hood Open.
Autostart Inhibit Reason - Hybrid/EV Battery Pack Contactor Open	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: HV Battery Contactor Status.
Autostart Inhibit Reason - Hybrid/EV Battery Pack Power Low	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: HV Battery Power Limits.
Autostart Inhibit Reason - Hybrid/EV Battery Pack State Of Charge Low	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: HV Battery State of Charge.
Autostart Inhibit Reason - Hybrid/EV Battery Pack Voltage Low	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: HV Battery Module Voltage.
Autostart Inhibit Reason - Hybrid/EV Power Conditions	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Hybrid Power Conditions.
Autostart Inhibit Reason - Hybrid/EV Propulsion System Inactive	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: HV Propulsion System.
Autostart Inhibit Reason - Not Commanded	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Start Not Commanded.
Autostart Inhibit Reason - Run/Crank Not Active	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Run/Crank Not Active.
Autostart Inhibit Reason - System Malfunction	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Hybrid System Failure.
Autostart Inhibit Reason -			This parameter displays the status of an Autostart Inhibit due to the

Transmission Range	Yes / No	No	following reason: Transmission Range.
Autostart Reason - A/C Request	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: AC System active.
Autostart Reason - Acceleration Request	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Driveability.
Autostart Reason - Accelerator Pedal Pressed	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Accelerator Pedal Position.
Autostart Reason - Auxiliary Transmission Fluid Pump Not Available	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Auxiliary Transmission Pump.
Autostart Reason - Brake Booster Weak Vacuum	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Brake Vacuum Pressure.
Autostart Reason - Brake Pedal Released	Yes / No	Yes	This parameter displays the status of an Autostart due to the following reason: Brake Pedal Position.
Autostart Reason - Clutch Pedal Applied	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Clutch Pedal Pressed.
Autostart Reason - Control Function Active	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: control function AutoStart Override.
Autostart Reason - Drive Motor Inverter Temperature High	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Electric Motor Inverter Temperature.
Autostart Reason - Drive Motor Temperature High	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Electric Motor Temperature.
Autostart Reason - Driver Exited the Vehicle	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: The driver has exited the vehicle.
			This parameter displays the status

Autostart Reason - DTC Present	Yes / No	No	of an Autostart due to the following reason: DTC is present.
Autostart Reason - ECM Request	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: ECM Request.
Autostart Reason - Engine Coolant Temperature Out of Range	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Engine Coolant Temperature.
Autostart Reason - Hood Ajar	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Hood Open.
Autostart Reason - Hybrid/EV Battery Module Voltage Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: HV Battery Module Voltage
Autostart Reason - Hybrid/EV Battery Pack Power Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: HV Battery Power Limits.
Autostart Reason - Hybrid/EV Battery Pack State of Charge Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: HV Battery State of Charge.
Autostart Reason - Hybrid/EV Battery Pack Temperature	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: HV Battery Pack Temperature.
Autostart Reason - Hybrid/EV Battery Pack Voltage Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: HV Battery Pack Voltage Level.
Autostart Reason - Hybrid/EV Propulsion System Inactive	Yes / No	Yes	This parameter displays the status of an Autostart due to the following reason: HV Propulsion System.
Autostart Reason - Ignition Switch Start	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Key Forced AutoStart Request.
Autostart Reason - Inclination	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Vehicle Grade.
Autostart Reason - Invalid Data Received	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Data Validity.

Autostart Reason - Low-Voltage Battery Discharge Current High	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: 12V Battery Discharge Current.
Autostart Reason - Low-Voltage Battery State of Charge Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: 12V Battery SOC.
Autostart Reason - Low-Voltage Battery State of Function Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: 12V Battery SOF Voltage.
Autostart Reason - Low-Voltage Battery State of Health Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: 12V Battery SOH.
Autostart Reason - Low-Voltage Battery Voltage Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: 12V Battery Voltage.
Autostart Reason - Maximum Autostop Time Exceeded	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Max AutoStop Time.
Autostart Reason - Minimum Engine Run Time Not Met	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Minimum Run Time Not Met.
Autostart Reason - Reduced Engine Power Active	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Reduced Power.
Autostart Reason - Remote Vehicle Start Request	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Remote Start.
Autostart Reason - Stop/Start Select Switch	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Stop/Start Select Switch.
Autostart Reason - System Malfunction	Yes / No	No	This parameter displays the status of an Autostart Inhibit due to the following reason: Hybrid System Failure.
Autostart Reason - System Optimization	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: System Optimization.

Autostart Reason - System Voltage Low	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: System Voltage Low.
Autostart Reason - TCM Demand	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: TCM Override.
Autostart Reason - Transmission Fluid Temperature Out of Range	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Transmission Temperature.
Autostart Reason - Transmission In Reverse	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Reverse Grade.
Autostart Reason - Transmission Range	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Transmission Range.
Autostart Reason - Vehicle Speed Too High	Yes / No	No	This parameter displays the status of an Autostart due to the following reason: Vehicle Speed Too High.
Autostop Disable Reason - A/C Request	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: AC System.
Autostop Disable Reason - Acceleration Request	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Driveability.
Autostop Disable Reason - Accelerator Pedal Pressed	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Accelerator Pedal Position.
Autostop Disable Reason - Auxiliary Transmission Fluid Pump Not Available	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Auxiliary Transmission Pump.
Autostop Disable Reason - Brake Booster Weak Vacuum	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Brake Vacuum Pressure.
Autostop Disable Reason - Brake Pedal Released	Yes / No	Yes	This parameter displays the status of an Autostop Disable due to the following reason: Brake Pedal Position.
Autostop Disable Reason			This parameter displays the status of an Autostop Disable due to the

- Control Function Active	Yes / No	No	following reason: control function AutoStart Override.
Autostop Disable Reason - Drive Motor Inverter Temperature High	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Electric Motor Inverter Temperature.
Autostop Disable Reason - Drive Motor Temperature High	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Electric Motor Temperature.
Autostart Disable Reason - Driver Exited the Vehicle	Yes / No	No	This parameter displays the status of an Autostop due to the following reason: The driver has exited the vehicle.
Autostop Disable Reason - ECM Request	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: ECM Request.
Autostop Disable Reason - Engine Coolant Temperature Out Of Range	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Engine Coolant Temperature.
Autostop Disable Reason - Engine Speed High	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Engine Speed.
Autostop Disable Reason - Generator Load High	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Maximum Generator Load requested.
Autostop Disable Reason - Hood Ajar	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Hood Open.
Autostop Disable Reason - Hybrid/EV Battery Module Pack Low	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: HV Battery Pack Voltage.
Autostop Disable Reason - Hybrid/EV Battery Module Voltage Low	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: HV Battery Module Voltage.
Autostop Disable Reason - Hybrid/EV Battery Pack Power Low	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: HV Battery Power Limits.
Autostop Disable Reason - Hybrid/EV Battery Pack	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: HV Battery

State Of Charge Low			State of Charge
Autostop Disable Reason - Hybrid/ EV Battery Pack Temperature	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: HV Battery Pack Temperature.
Autostop Disable Reason - Hybrid/EV Propulsion System Inactive	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: HV Propulsion System.
Autostop Disable Reason - Idle Boost Mode Active	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Idle Boost Mode.
Autostop Disable Reason - Ignition Switch Start	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Key Forced AutoStart Request.
Autostop Disable Reason - Intake Manifold Weak Vacuum	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Intake Manifold Pressure.
Autostop Disable Reason - Invalid Data Received	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Data Validity.
Autostop Disable Reason - Low-Voltage Battery Discharge Current High	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: 12V Battery Discharge Current.
Autostop Disable Reason - Low-Voltage Battery State of Charge Low	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: 12V Battery SOC.
Autostop Disable Reason - Low-Voltage Battery State of Function Low	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: 12V Battery SOF Voltage.
Autostop Disable Reason - Low-Voltage Battery State of Health Low	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: 12V Battery SOH.
Autostop Disable Reason - Low-Voltage Battery Temperature Out of Range	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: 12V Battery Temperature.
Autostop Disable Reason			This parameter displays the status of an Autostop Disable due to the

- Low-Voltage Battery Voltage Low	Yes / No	No	following reason: 12V Battery Voltage.
Autostop Disable Reason - Maximum Vehicle Stop Time Exceeded	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Too Much Time Since Vehicle Stop.
Autostop Disable Reason - Minimum Engine Run Time Not Met	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Minimum Run Time Not Met.
Autostop Disable Reason - Reduced Engine Power Active	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Reduced Power.
Autostop Disable Reason - Remote Vehicle Start Request	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Remote Start.
Autostop Disable Reason - Run/Crank Not Active	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Run/Crank Not Active.
Autostop Disable Reason - Starter System Malfunction	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Starting System.
Autostop Disable Reason - Stop/Start Select Switch	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Autostop Disable Switch.
Autostop Disable Reason - System Malfunction	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: System Fault.
Autostop Disable Reason - System Optimization	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: System Optimization.
Autostop Disable Reason - System Voltage Low	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: System Voltage Low.
Autostop Disable Reason - TCM Request	Yes / No	Yes	This parameter displays the status of an Autostop Disable due to the following reason: TCM Override.
Autostop Disable Reason - Transmission Fluid Temperature Out Of Range	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Transmission Temperature.
Autostop Disable Reason			This parameter displays the status

- Transmission In Reverse	Yes / No	No	of an Autostop Disable due to the following reason: Reverse Grade.
Autostop Disable Reason - Transmission Range	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Transmission Range.
Autostop Disable Reason - Vehicle Inclination	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Vehicle Grade.
Autostop Disable Reason - Vehicle Speed Threshold Not Reached	Yes / No	Yes	This parameter displays the status of an Autostop Disable due to the following reason: Vehicle Speed Threshold Not Reached.
Autostop Disable Reason - Vehicle Speed Too High	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Vehicle Speed Too High.
Autostop Disable Reason - Wheel Slip Detected	Yes / No	No	This parameter displays the status of an Autostop Disable due to the following reason: Wheel Slip.
Auxiliary Transmission Fluid Pump Relay Control Circuit High Voltage Test Status	Failed, Indeterminate, Passed	-	This parameter displays the state of the control circuit for the auxiliary transmission fluid pump relay control circuit.
Auxiliary Transmission Fluid Pump Relay Control Circuit Low Voltage Test Status	Failed, Indeterminate, Passed	-	This parameter displays the state of the control circuit for the auxiliary transmission fluid pump relay control circuit.
Auxiliary Transmission Fluid Pump Relay Control Circuit Open Test Status	Failed, Indeterminate, Passed	-	This parameter displays the state of the control circuit for the auxiliary transmission fluid pump relay control circuit.
Auxiliary Transmission Pump Relay Command	Off / On	Off	This parameter displays the state of the control circuit for the auxiliary transmission fluid pump relay control circuit.
Brake Pedal Position Circuit Signal	Released / Applied	Released	This parameter displays that the brake pedal apply input to the controller indicates that the brake is applied.
Brake Pedal Position Sensor Learned Released Position Switch	Yes / No	Yes	This parameter displays that the brake pedal fully released position has been successfully learned.
Brake Pedal Position Sensor Signal	Released / Applied	Released	This parameter displays the status of the application of the brake pedal switch input to the

			controller.
Calculated Throttle Position	%	0	This parameter displays the accelerator effective position, which represents the driver's intended request for torque or acceleration. It is determined from the maximum of the driver requests to open the throttle (e.g., accelerator pedal, cruise control, PTO, etc.) and is normalized to 0 to 100%, where 0% represents an idle or coast request and 100% represents a request for wide open throttle (WOT). It is the primary indication of accelerator position / throttle position used by transmission control algorithms and, thus, is often referred to as transmission throttle position. In the event that the engine is operating in a forced idle mode due to an accelerator pedal position fault, the accelerator effective position will have a value of 0%, corresponding to an idle request.
Contactor Open Reason History 1	None; Normal Function; DTC Present; Control Function Active Invalid;	Normal Function	This parameter displays one of the last eight reasons that hybrid powertrain control module has either opened the high voltage contactor or prevented the high voltage contactor from closing.
Contactor Open Reason History 2	None; Normal Function; DTC Present; Control Function Active Invalid;	-	This parameter displays one of the last eight reasons that hybrid powertrain control module has either opened the high voltage contactor or prevented the high voltage contactor from closing.
Contactor Open Reason History 3	None; Normal Function; DTC Present; Control Function Active Invalid;	-	This parameter displays one of the last eight reasons that hybrid powertrain control module has either opened the high voltage contactor or prevented the high voltage contactor from closing.
Contactor Open Reason	None; Normal Function; DTC Present;	-	This parameter displays one of the last eight reasons that hybrid powertrain control module has

History 4	Control Function Active Invalid;		either opened the high voltage contactor or prevented the high voltage contactor from closing.
Contactor Open Reason History 5	None; Normal Function; DTC Present; Control Function Active Invalid;	-	This parameter displays one of the last eight reasons that hybrid powertrain control module has either opened the high voltage contactor or prevented the high voltage contactor from closing.
Contactor Open Reason History 6	None; Normal Function; DTC Present; Control Function Active Invalid;	-	This parameter displays one of the last eight reasons that hybrid powertrain control module has either opened the high voltage contactor or prevented the high voltage contactor from closing.
Contactor Open Reason History 7	None; Normal Function; DTC Present; Control Function Active Invalid;	-	This parameter displays one of the last eight reasons that hybrid powertrain control module has either opened the high voltage contactor or prevented the high voltage contactor from closing.
Contactor Open Reason History 8	None; Normal Function; DTC Present; Control Function Active Invalid;	-	This parameter displays one of the last eight reasons that hybrid powertrain control module has either opened the high voltage contactor or prevented the high voltage contactor from closing.
Crank Abort	Active / Inactive	Inactive	This parameter displays the status of the internal combustion engine crank request of the ECM. The hybrid control module monitors the ECM for this data in order to determine whether to enable or disable ICE cranking.
Crank Request	Yes / No	No	This parameter displays the status of the internal combustion engine (ICE) crank request of the ECM. The hybrid control module (HCM) monitors the ECM for this data in order to determine whether to enable or disable ICE cranking.
Distance with MIL On	km / miles	Varies	This parameter displays the distance With Malfunction Indicator Lamp On.
Drive Motor Belt Maximum Detected Slip	%	Varies	This parameter displays the maximum percent of belt slip detected for the drive motor

			accessory drive belt.
Drive Motor Belt Slip	%	-	This parameter displays the percent of belt slip detected for the drive motor accessory drive belt. A value of zero indicates that no slip is present. +100% indicates that the starter generator motor is turning and the internal combustion engine (ICE) is not.
Drive Motor Coolant Pump Relay Command	Off / On	On	This parameter displays the Commanded State and the Status of the Drive Motor Coolant Pump Relay.
Drive Motor Coolant Pump Relay Control Circuit High Voltage Test Status	OK, Not Run, Malfunction	OK	This parameter displays the Commanded State and the Status of the Drive Motor Coolant Pump Relay.
Drive Motor Coolant Pump Relay Control Circuit Low Voltage Test Status	OK, Not Run, Malfunction	-	This parameter displays the Commanded State and the Status of the Drive Motor Coolant Pump Relay.
Drive Motor Coolant Pump Relay Control Circuit Open Test Status	OK, Not Run, Malfunction	OK	This parameter displays the Commanded State and the Status of the Drive Motor Coolant Pump Relay.
Drive Motor Coolant Temperature	°C (°F)	Varies	This parameter displays the temperature of the drive motor coolant.
Drive Motor Current	Amps	Varies	This parameter displays the DC current consumed by the starter generator.
Drive Motor Inverter Status	Power Stage Inactive; Power Stage Active; Power Stage On: Shutdown Pending; Power Stage On: Active Discharge; Reserved; High Voltage Required	Active	This parameter displays the actual state of the Drive Motor Inverter.
Drive Motor Inverter Supply Voltage Circuit	Volts	114	This parameter displays the voltage on the DC bus at the drive motor inverter.
Drive Motor Speed	RPM	1800	This parameter displays the torque commanded by the hybrid powertrain control module to the starter generator.
Drive Motor Torque	Y (lb ft)	Varies	This parameter displays the torque

			value for the drive motor.
Drive Motor Torque Command	Y (lb ft)	Varies	This parameter displays the commanded torque value requested by the drive motor control module.
ECT Sensor	°C (°F)	Varies	This parameter displays the undefaulted engine coolant temperature measured by the sensor.
Engine Run Time	Seconds	Varies	This parameter displays the time that the engine has been running. The value of this parameter displays shall freeze if an engine stall occurs and shall be reset.
Engine Torque	Y (lb ft)	Varies	This parameter displays actual engine torque as determined by the ECM. This display is only active when the engine is running.
Engine Torque Command	Y (lb ft)	Varies	This parameter displays commanded engine torque as determined by the ECM. This display is only active when the engine is running.
Extended Travel Brake Pedal Position Signal	Active / Inactive	Inactive	This parameter displays the status of the brake pedal travel beyond a moderate / extended travel threshold.
Extended Travel Brake Pedal Switch	Active / Inactive	Inactive	This parameter displays the status of the brake pedal travel beyond a moderate / extended travel threshold.
High Voltage System Interlock Circuit Status	Unknown, Passed, Failed	Passed	This parameter displays the status of the HV interlock loop.
Hood Ajar Switch	Volts	-	This parameter displays the voltage of the hood ajar switch.
Hood Position	Open / Closed	Closed	This parameter displays the status of the hood latch switch. An autostart will be initiated if the hood switch indicates the hood is open.
Hybrid Powertrain Control Module High Voltage Circuit	Volts	114	This parameter displays the high voltage circuit voltage as detected by the hybrid powertrain control module which detects voltage in a range from 0-655.35 V.
Hybrid/EV Battery			This parameter displays the status

Multifunction Contactor Command	Open / Closed	Open	of the high voltage positive contactor relay.
Hybrid/EV Battery Pack Current	Amps	Varies	This parameter displays the actual current flow of the high voltage (115V) electrical system as determined by the Hybrid Powertrain Control Module. The parameter display range is -1638.4 to +1638.35 Amps. A negative current value indicates a battery charge while a positive current value indicates a battery discharge.
Hybrid/EV Battery Pack Precharge Transistor Command	Open / Closed	Open	This parameter displays the status of the high voltage precharge relay.
Hybrid/EV Battery Pack State Of Charge	%	50	This parameter displays the hybrid battery State Of Charge as calculated by the hybrid powertrain control module. The parameter display range is 0-100%.
Hybrid/EV Battery Pack Voltage	Volts	114	This parameter displays the total hybrid battery voltage value.
Hybrid/EV Battery Positive Contactor Command	Open / Closed	Closed	This parameter displays the status of the high voltage positive contactor relay (this is the same as multifunction).
IAT Sensor	°C (°F)	Varies	This parameter displays the temperature of the internal combustion engine (ICE) intake air as determined by the ECM. The parameter display range is -40°C to +215°C (-40°F to +419°F).
ICE Backup Start Counter	Counts	Varies	This parameter displays the number of backup starts commanded. (A backup start uses the low voltage starter due to a fault with the high voltage starting system.) This parameter displays value will not reset until a code clear is issued to the controller (either a natural code clear as defined by the diagnostic or a mode \$04). If a backup start event has not taken place (either initially

			or after a code clear), This parameter displays shall default to zero.
ICE Start Counter	Counts	Varies	This parameter displays the total number of times the internal combustion engine (ICE) has started over the life of the vehicle. This counter will include both key-crank starts and autostarts.
ICE Start Status	No Start Attempted; Hybrid/EV Motor; Starter Motor; Tandem Start; Start Not Complete	No Start Attempted	<p>This parameter displays the status of internal combustion engine (ICE) starting attempts. If an ICE start has completed, this parameter will indicate which starting machine was used for the start. This parameter will also indicate if no ICE start has been attempted or if an ICE start has failed. This parameter information is only valid for the current ignition key cycle.</p> <p>No Start Attempted indicates that no attempt has been made to start the ICE, either via a key crank or an autostart, during the current ignition key cycle.</p> <p>Hybrid/EV Motor indicates that the starter generator was used to start the ICE.</p> <p>Starter Motor indicates that the conventional ICE starter motor was used to start the ICE.</p> <p>Tandem Start indicates that a combination of the starter generator and conventional starter motor was used to start the ICE.</p> <p>Start Not Complete indicates that an ICE start was attempted, but failed.</p>
ICE Status	Engine Stalled, Stop, Running, Start, Off, Silent Start, Invalid	Running	This parameter displays the current status of the internal combustion engine (ICE) as determined by the ECM. The hybrid powertrain control module monitors the ECM for this data in order to determine ICE status.
Ignition 1 Signal	Volts	14.5	Run/Crank Voltage

Ignition Input Accessory	Active / Inactive	Active	This parameter displays that the accessory hardwire power input to the hybrid powertrain control module.
Ignition Input Off/On/Start	Active / Inactive	Active	This parameter displays that the ignition hardwire power input to the hybrid powertrain control module.
Low Voltage Circuit Current	Amps	Varies	This parameter displays the amount of current for the 12 volt battery as detected by the 14V power module.
Low Voltage Circuit Voltage	Volts	14.5	This parameter displays the actual voltage of the low voltage (12 V) circuit as detected by the 14V power module. The 14V power module internal sensor detects voltage in a range from 0-25.5 V.
Maximum Hybrid/EV Battery Module Temperature	°C (°F)	Varies	This parameter displays the temperature of the hybrid battery module with the highest temperature.
MIL Command	On / Off	Off	This parameter displays the command status to illuminate the malfunction indicator lamp (MIL) on the instrument cluster.
Minimum Hybrid/EV Battery Module Temperature	°C (°F)	Varies	This parameter displays the temperature of the hybrid battery module with the lowest temperature.
Minimum Hybrid/EV Battery Module Temperature	°C (°F)	Varies	This parameter displays the temperature of the hybrid battery module with the lowest temperature.
On-Board Jump Assist Counter	Counts	Varies	This parameter displays the on-board jump start counter which increments each time an on-board jump start is initiated.
On-Board Jump Assist Successful Crank Request Counter	Counts	Varies	This parameter displays the on-board jump start key crank counter which increments each time a successful key crank occurs.
	Not Requested; Key not in Run- Incorrect Power Mode; Faults Present;		

On-Board Jump Start Disable Reasons	Counters Exceeded; Jump Start Time Out; High Voltage Battery Status; HV Battery Contactor not Closed; HV Battery Low Discharge Power; Trans Shift Lever Position not in Park; Loss of Communication; Jump Start Max Time Out; Jump Start Inactive Time Out; Crank Assist Timeout	Not Requested	This parameter displays the general operating condition that is inhibiting the on-board jump start feature.
On-Board Jump Start Status	Inactive; In Progress; Complete; System Power Mode; Disabled	Inactive	<p>This parameter displays the following statuses of the On-board Jump Start feature:</p> <ul style="list-style-type: none"> • Inactive; Inactive indicates that the on-board jump start feature is not currently active. • In Progress; In Progress indicates that the low voltage battery is being charged from the high voltage battery. • Complete; Complete indicates that the low voltage battery is charged and the system is ready to crank. • System Power Mode; System Power Mode is not currently used. • Disabled; Disabled indicates that the on-board jump start system is currently disabled.
Power Mode	Off; Accessory; Run; Crank Request	Run	This parameter displays system power mode status as determined by ignition switch inputs to the power mode master. System power mode status should match the ignition switch position.
			This parameter displays that the

TCC/Cruise Control Brake Pedal Switch	Active / Inactive	-	undebounced / undefaulted state of the redundant discrete brake switch input to the hybrid powertrain control module indicates that the brake is applied.
Torque Delivered Signal	Y (lb ft)	Varies	This parameter displays the Engine Actual Steady State Torque.
Vehicle Speed	km/h (mph)	0	This parameter displays the vehicle speed calculated from the transmission output speed.

Hybrid Powertrain Control Module Scan Tool Output Controls

Output Control	Description
14V Power Module Set Point	This control function is used to override the state of the 14V power module low voltage output. The level of the low voltage output is controlled by the value supplied for "Regulation of Low Voltage".
Auto Start/Stop	<p>NOTE:</p> <ul style="list-style-type: none"> • The hood must remain closed while commanding either Autostart or Autostop with the scan tool. Opening the hood while commanding Autostop or Autostart will cause an engine stall, start/stall, vehicle disable condition. The disable condition will remain active until the hood is closed. • The Autostart command will not function when the gear selector is in Reverse, Drive, or Manual. Shift the gear selector to Park or Neutral in order to command an Autostart. <ul style="list-style-type: none"> • The hybrid powertrain control module controls the Autostop and Autostart hybrid operation modes. • When operating in the Autostop mode, the following control limits apply: <ul style="list-style-type: none"> ○ Ignition ON. ○ The internal combustion engine (ICE) must be running. ○ The drive motor battery state of charge must be greater than 25%. ○ The engine coolant temperature (ECT) must be between 68°C (154°F) and 109°C (228°F). • When operating in the Autostart mode, the following control limits apply: <p>Ignition ON</p>
Auxiliary Transmission Fluid Pump Relay	This control function is used to override the state of the auxiliary transmission fluid pump relay output by turning the relay ON and OFF.

Clear Secured High Voltage DTCs	<p>NOTE: Perform the high voltage disable procedure and repair or replace damaged high voltage components as specified in the applicable diagnostic prior using this control.</p> <ul style="list-style-type: none"> • The hybrid powertrain control module monitors for a high voltage present condition after the high voltage contactor relays have been opened. When high voltage is present this DTC will set. • The hybrid powertrain control module clears the DTC Information for the high voltage present DTC. • The following control limits apply: <ul style="list-style-type: none"> ○ Vehicle must be ON. ○ The hybrid powertrain control module must monitor that high voltage is not currently present. ○ Communication DTCs must not be present. ○ Turn the vehicle OFF and wait 5 minutes after performing this Output Control.
Drive Motor Coolant Pump Relay	This control function is used to override the state of the electric motor A coolant pump relay output by turning the relay ON and OFF.
Drive Motor Speed	This control function is used to override the state of electric motor in a hybrid/electric vehicle. The drive motor belt must be removed first in order for this to operate.
Hybrid/EV Battery Pack Cooling Fan	This control function is used to override the state of the power pack (hybrid battery) cooling fan.
ICE Only Mode	This control function allows the 14V power module to charge the 12 volt battery, but disables hybrid functions. "Normal Car" is defined in which the engine only provides the propulsion to drive the vehicle while the operation of hybrid subsystem is limited to charging the 12V. Disabled features include hybrid deceleration fuel cutoff, hybrid regeneration, and ICE autostop.
OnBoard Jump Assist Counter Reset	This control function is used to allow a service technician to reset the Jump Assist parameter counter.

INFLATABLE RESTRAINT PASSENGER PRESENCE SYSTEM SCAN TOOL INFORMATION

Passenger Presence Module Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Base Model Part Number	Varies, 8 Digit Number	The scan tool displays the part number of the PPS module which is stored in non volatile memory.
Battery Voltage	Volts	The scan tool will display battery voltage.
Calibration Part Number	Varies, 8 Digit Number	The scan tool displays the part number of the calibration file in the PPS module.

End Model Part Number	Varies, 8 Digit Number	The scan tool displays the part number of the PPS module in production.
Manufacturer's Traceability Number	Varies, 16 Digit Number	The scan tool displays the 16 digit traceability number in the PPS module.
Passenger Classification	Empty Seat	The scan tool displays Unknown, Calibration Mode, Empty Seat, Small Occupant Type 1, Small Occupant Type 2, Small Occupant Type 3, Small Occupant Type 4, Large Occupant Type 1, Large Occupant Type 2, Large Occupant Type 3, Large Occupant Type 4, Module Setup, Not Available, Child Seat Facing Rearward, Child Seat Facing Forward, Child Seat Facing Unknown Direction. This is the state of what occupies the passenger seat, as monitored by the passenger presence system.
Passenger Presence Module Primary Key	Hex Value	The scan tool indicates the primary key Hex value.
Passenger Presence System Reporting DTC(s)	Yes/No	The PPS module will report if there are DTCs set in the passenger presence module.
Passenger Seat Occupancy Status	Empty Seat	The scan tool displays Undefined, Empty Seat, Occupied, or Invalid. This is the state of the passenger seat if it is occupied or empty and monitored by the passenger presence system.
Power Mode	Off / Accessory / Run / Crank Request	The scan tool will display the power mode of the vehicle.
Primary Key Status	Valid/Invalid	The scan tool displays Valid if the primary key matches what is stored to memory in the PPS module.
Received Primary Key	Hex Value	The scan tool displays a Hex value indicating the PPS module received primary key data.
Software Part Number	Varies, 8 Digit Number	The scan tool displays the software part number in the PPS module.

INFLATABLE RESTRAINT SENSING AND DIAGNOSTIC MODULE SCAN TOOL INFORMATION

Sensing and Diagnostic Module Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
2nd Row Left Seat Belt Reminder Sensor Pad Enable Status	Disabled/Enabled	The scan tool displays if the left rear seat belt reminder sensor pad is enabled to the SDM.

2nd Row Left Seat Belt Reminder Sensor Pad Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the left rear seat belt reminder sensor pad has been learned by the SDM.
2nd Row Left Seat Belt Status	Buckled/Unbuckled	The scan tool displays Buckled or Unbuckled. This is the state of the left rear seat belt switch when the seat belt is buckled or unbuckled.
2nd Row Middle Seat Belt Reminder Sensor Pad Enable Status	Disabled/Enabled	The scan tool displays if the rear middle seat belt reminder sensor pad is enabled to the SDM.
2nd Row Middle Seat Belt Reminder Sensor Pad Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the rear middle seat belt reminder sensor pad has been learned by the SDM.
2nd Row Middle Seat Belt Status	Buckled/Unbuckled	The scan tool displays Buckled or Unbuckled. This is the state of the middle rear seat belt switch when the seat belt is buckled or unbuckled.
2nd Row Middle Seat Belt Reminder Sensor Pad Enable Status	Disabled/Enabled	The scan tool displays if the rear right seat belt reminder sensor pad is enabled to the SDM.
2nd Row Middle Seat Belt Reminder Sensor Pad Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the rear right seat belt reminder sensor pad has been learned by the SDM.
2nd Row Right Seat Belt Status	Buckled/Unbuckled	The scan tool displays Buckled or Unbuckled. This is the state of the right rear seat belt switch when the seat belt is buckled or unbuckled.
Air Bag Malfunction Indicator	On/Off/Flashes	The scan tool will display On or Flashes if there is a problem with the SIR system. Any problems within the SIR system will illuminate the air bag indicator. The indicator will either flash or stay on.
Base Model Part Number	Varies, 8 Digit Number	The scan tool displays the part number of the SDM which is stored in non volatile memory.
Calibration Part Number	Varies, 8 Digit Number	The scan tool displays the part number of the calibration file in the SDM.
Deployment Loop 1-18 Enable Status	Enabled/Disabled	The scan tool displays Enabled or Disabled. This is the status of the air bag or pretensioner.
Deployment Loop 1-18 Learn Status	Learned/Not Learned	The scan tool displays Learned or Not learned. Learned is displayed if the SDM has defined the number loop programmed

		from an air bag or pretensioner.
Deployment Loop 1-18 Resistance	1.44-4.25 Ohms	The scan tool displays the resistance of the learned loop of the air bag or pretensioner when connected to the SDM.
Deployment Loop 1-18 Type	Varies	The scan tool displays the name of the air bag or pretensioner associated with the loop type 1-18.
Driver Seat Belt Reminder Indicator	On/Off	The scan tool displays On if this indicator is on. If the indicator is on it means the seat belt has not been buckled.
Driver Seat Belt Sensor Enable Status	Enabled/Disabled	The scan tool displays if the seat belt sensor in the seat belt buckle is enabled to the SDM.
Driver Seat Belt Sensor Learn Status	Learned/Not learned	The scan tool displays Learned or Not Learned. Learned is displayed if the driver seat belt sensor has been learned by the SDM.
Driver Seat Belt Status	Buckled/Unbuckled	The scan tool displays Buckled or Unbuckled. This is the state of the driver seat belt switch when the seat belt is buckled or unbuckled.
Driver Seat Position Sensor	Rearward/Forward	The scan tool will display if the driver seat is forward or rearward of the sensor set position.
Driver Seat Position Sensor Enable Status	Enabled/Disabled	The scan tool displays if the seat position sensor is enabled to the SDM.
Driver Seat Position Sensor Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the driver seat position sensor has been learned by the SDM.
End Model Part Number	Varies, 8 Digit Number	The scan tool displays the part number of the SDM in production.
Impact Sensor 1-8 Enable Status	Enabled/Disabled	The scan tool displays Enabled or Disabled This is the status of the impact sensor.
Impact Sensor 1-8 Learn Status	Learned/Not Learned	The scan tool displays Learned or Not learned. Learned is displayed if the SDM has learned and has assigned a number to that impact sensor.
Impact Sensor 1-8 Type	Equipped/Not Equipped	The scan tool displays the name of the impact sensor associated with the type 1-8.
Inflatable Restraint Sensing and Diagnostic Module Primary Key	Hex Value	The scan tool indicates the primary key Hex value.
Manufacturer's Traceability Number	Varies, 16 Digit Number	The scan tool displays the 16 digit traceability number in the SDM.

Module Setup	Incomplete/Complete	The scan tool indicates if the SDM is set up.
Passenger Air Bag Disabled Switch	On/Off	The scan tool displays Off when the customer manually turns the passenger airbag off with this switch.
Passenger Air Bag Off Indicator	On/Off	The scan tool displays Off when the passenger indicator is not illuminated. This indicator is off when the disable switch is in the off position or no one is sitting in the passenger seat.
Passenger Air Bag On Indicator	On/Off	The scan tool displays On when the passenger indicator is illuminated. This indicator is on when the disable switch is in the on position and someone is sitting in the passenger seat.
Passenger Air Bag Status	Enabled/Disabled	The scan tool displays if the passenger air bag is enabled to the SDM.
Passenger Air Bag Disable Indicator Enable Status	Enabled/Disabled	The scan tool displays if the passenger air bag disable indicator is enabled to the SDM.
Passenger Air Bag Disable Indicator Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the SDM has learned the status of the passenger air bag disable indicator.
Passenger Air Bag Disable Switch Enable Status	Enabled/Disabled	The scan tool displays if the passenger air bag disable switch is enabled to the SDM.
Passenger Air Bag Disable Switch Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the SDM has learned the status of the passenger air bag disable switch.
Passenger Air Bag Enable Indicator Enable Status	Enabled/Disabled	The scan tool displays if the passenger air bag enable indicator is enabled to the SDM.
Passenger Air Bag Enable Indicator Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the SDM has learned the status of the passenger air bag enable indicator.
Passenger Classification	00-07	The scan tool will display what type of individual is sitting in the passenger seat.
Passenger Presence Detection System Enable Status	Enabled/Disabled	The scan tool displays if the passenger presence system is enabled to the SDM.
Passenger Presence Detection System Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the SDM has learned the passenger presence system.
Passenger Presence Detection System Reporting DTC(s)	Yes/No	The SDM will report if there are DTCs set in the passenger presence module.

Passenger Seat Belt Reminder Indicator	On/Off	The scan tool displays On if this indicator is on. If the indicator is on it means the seat belt has not been buckled.
Passenger Seat Belt Reminder Indicator Enable Status	Disabled/Enabled	The scan tool displays if the passenger seat belt reminder indicator is enabled to the SDM.
Passenger Seat Belt Reminder Indicator Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the passenger seat belt reminder indicator has been learned by the SDM.
Passenger Seat Belt Reminder Sensor Pad Enable Status	Disabled/Enabled	The scan tool displays if the passenger seat belt reminder sensor pad is enabled to the SDM.
Passenger Seat Belt Reminder Sensor Pad Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the passenger seat belt reminder sensor pad has been learned by the SDM.
Passenger Seat Belt Sensor Enable Status	Enabled/Disabled	The scan tool displays if the seat position sensor is enabled to the SDM.
Passenger Seat Belt Sensor Learn Status	Learned/Not learned	The scan tool displays Learned or Not Learned. Learned is displayed if the passenger seat belt sensor has been learned by the SDM.
Passenger Seat Belt Status	Buckled/Unbuckled	The scan tool displays Buckled or Unbuckled. This is the state of the passenger seat belt switch when the seat belt is buckled or unbuckled.
Passenger Seat Occupancy Status	Empty Seat/Occupied	The scan tool displays Occupied if someone is sitting in the passenger seat.
Passenger Seat Position Sensor	Rearward/Forward	The scan tool will display if the passenger seat is forward or rearward of the sensor set position.
Passenger Seat Position Sensor Enable Status	Disabled/Enabled	The scan tool displays if the passenger seat position sensor pad is enabled to the SDM.
Passenger Seat Position Sensor Learn Status	Learned/Not Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the passenger seat position sensor has been learned by the SDM.
Power Mode	Off/Accessory/Run/Crank Request	The scan tool will display the power mode of the vehicle.
Primary Key Status	Valid/Invalid	The scan tool displays Valid if the primary key matches what is stored to memory in the SDM.
Primary Key Status Last Ignition Cycle	Invalid/Valid	The SDM checks to see if the primary key data received is valid.

Received Primary Key	Hex Value	The scan tool displays a Hex value indicating the SDM received primary key data.
Rollover Sensor Enable Status	Disabled/Enabled	The scan tool displays if the rollover sensor is enabled to the SDM.
Rollover Sensor Learn Status	Learn/Unlearn	The scan tool displays Learned or Not Learned. Learned is displayed if the rollover sensor has been learned by the SDM.
Security Code Accepted	Yes/No	The SDM either accepts the security code or it does not. The scan tool displays Yes if the security code has been accepted by the SDM.
Security Code Lockout	Yes/No	The scan tool displays Yes if the SDM has been locked out because of the security code not being accepted.
Security Code Lockout Active Timer	Random Value	The SDM uses a timer before the security code is locked in the SDM.
Security Code Programmed	Yes/No	The scan tool displays Yes if the SDM has been programmed with the security code.
Security Code Programming Counter	Random Value	The SDM uses a counter for the value of the security code programming.
Security Code Reset Counter	Random Value	The SDM uses a counter to reset the value of the security code.
Software Part Number	Varies, 8 Digit Number	The scan tool displays the software part number in the SDM.
Vehicle Identification Number	Varies, 17 Digit Number	The VIN number of the vehicle programmed into the SDM.
VIN Programmed	Yes/No	The scan tool displays Yes if the VIN has been programmed into the SDM.
VIN Programming Counter	Random Value	The SDM uses this counter while programming the VIN.

INSTRUMENT CLUSTER SCAN TOOL INFORMATION

Instrument Cluster Scan Tool Data Parameters

Parameter	Expected Value	Description
Operating Conditions: Ignition ON		
Battery Voltage	12-14 V	The scan tool displays Volts. This is the current battery voltage signal.
Key in Ignition Status	Active/Inactive	The scan tool displays Active or Inactive. This is the state of the key in ignition switch.
Driver Information Center Switch	Varies	The scan tool displays Volts. This is the current driver information center switch input voltage.
Driver Information Center	Inactive	The scan tool displays either Inactive, Up, Down, or Menu. This is the state of the driver

Switch		information center switch.
Reset Switch	Active/Inactive	The scan tool displays Active or Inactive. This is the state of the reset switch.
Ambient Air Temperature	15°C	The scan tool displays outside temperature in °C.
Washer Fluid Level Switch	Open	The scan tool displays either Open, Closed, or Not Available.
Odometer Lock Status	Active/Inactive	The scan tool displays Active or Inactive depending on the state of the odometer.
Engine Speed	0 RPM	The scan tool displays the filtered value of engine speed.
Vehicle Speed	0 km/h	The scan tool displays the filtered vehicle speed value.
Fuel Level Sensor	-	The scan tool displays the filtered value of the fuel level.
Engine Coolant Temperature	-	The scan tool displays the filtered value of the engine coolant temperature.
Engine Oil Pressure	-	The scan tool displays the filtered value of the engine oil pressure.
Head-Up Display Dimming Level	percentage	The scan tool displays the current dimming intensity level.
Head-Up Display Switch	Head-Up Display Movement, Head Up Page Switch, Head-Up Display Dimming Level	The scan tool displays the current HUD button being pushed.
Steering Wheel Control Switches	Left, Select, Right , Volume UP, Volume Down	The scan tool displays the current steering wheel controls button being pushed.

Instrument Cluster Scan Tool Output Controls

Output Control	Description
Instrument Cluster Gauge Sweep	This function is used to command the gauges to sweep from minimum to maximum.
Driver Information Center Dimming	This function is used to command the dimming of the driver information display to Increase or Decrease by 10%.
Instrument Panel Dimmer Switch	This function is used to command the dimming of the instrument cluster to Increase or Decrease by 10%.
Driver Information Center Segments	This function is used to command the driver information center segments ON and OFF.
All Indicators	This function is used to command all the indicators ON or OFF.
Driver Information Center Options	This function is used to command the driver information center buttons using the scan tool.
CAN Bus Configuration Learn	This function is used to Reset the source ID for low speed CAN Bus communications.
Head Up Display Dimming	This function is used to command the dimming of the head up display to

Level	Increase or Decrease.
Head Up Display Pattern Check	This function is used to command the head up display to display a striped test pattern.

POWER STEERING CONTROL MODULE SCAN TOOL INFORMATION

The power steering control module scan tool data parameters list contains all power steering related parameters that are available on the scan tool. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists.

Power Steering Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
Battery Voltage	-	9-16 V	The scan tool displays the current battery voltage.

Power Steering Control Module Scan Tool Output Controls

Output Control	Description
Pressure Control Solenoid Valve	Commands the solenoid valve Increase or Decrease.

RADIO SCAN TOOL INFORMATION

Radio Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Battery Voltage	Varies	The scan tool displays volts. This is the voltage at the input to the radio via high speed GMLAN.
System Power Mode	Run	The scan tool displays Off, Accessory, Run or Crank Request. This is the vehicle power mode status as received by the radio.
Date	Varies	The scan tool displays the current date set in the radio.
Time	Varies	The scan tool displays the current time set in the radio in 24 hour format HHMMSS
Radio Band	Varies	The scan tool displays AM, AM High Definition, FM, FM High Definition, Digital Audio broadcast, or XM. This is the broadcast radio band currently selected.
Audio Source Status	Varies	This parameter displays the currently selected audio source
Current FM Frequency	Varies	When tuned to an FM station, the scan tool displays the currently selected frequency in MHz
Current AM Frequency	Varies	When tuned to an AM station, the scan tool displays the currently selected frequency in kHz
Volume Control	Varies	The scan tools displays the current volume setting in

		counts.
Mute Status	Off	The scan tool displays On or Off. This is the currently selected audio mute mode.
Surround Sound	Varies	The scan tool displays On or Off. This is the currently selected surround sound mode.
Equalizer Preset	Varies	The scan tool displays the currently selected preset equalizer mode
Radio Power Button	On	The scan tool displays On or Off. This is the currently selected radio power mode.
Remote CD	Varies based on vehicle equipment	The scan tool displays Present or Not Present. This parameter displays present when the infotainment system is equipped with the remote cd player.
Rear Seat Entertainment	Varies based on vehicle equipment	The scan tool displays Present or Not Present. This parameter displays present when the infotainment system is equipped with the rear seat entertainment system.
Remote Enable Circuit	On	The scan tool displays On or Off. This is the current state of the remote enable output as commanded by the radio.
Front 3.5 mm AUX Input	Varies	The scan tool displays Present or Not Present. This parameter displays Present when a device is connected to the front auxiliary input jack.
Rear 3.5 mm AUX Input	Varies	The scan tool displays Present or Not Present. This parameter displays Present when a device is connected to the rear auxiliary input jack.
Front USB Receptacle	Varies	The scan tool displays Present or Not Present. This parameter displays Present when a front USB receptacle is present.
Rear USB Receptacle	Varies	The scan tool displays Present or Not Present. This parameter displays Present when a rear USB receptacle is present.
Front SD Card Receptacle	Varies	The scan tool displays Present or Not Present. This parameter displays Present when a front SD card receptacle is present.
Rear SD Card Receptacle	Varies	The scan tool displays Present or Not Present. This parameter displays Present when a rear SD card receptacle is present.
Radio Theft Lock Status	Unlocked	The scan tool displays Locked or Unlocked. This is the state of the theft lock system.
Theft Lock Armed	VIN Learned	The scan tool displays VIN Learned or No VIN. This is the state of the VIN programming in the radio.
Test Bench Mode	Inactive	The scan tool displays Active or Inactive. This is the state of the test bench mode.
Valet Mode	Inactive	The scan tool displays Active or Inactive. This is the state of the valet mode.

XM Subscription Status	Varies	This parameter displays the country and type of XM service.
High Definition Signal	Varies	The scan tool displays Present or Not Present. This parameter displays Present when a high definition signal is being received.
Digital Audio Signal	Varies	The scan tool displays Present or Not Present. This parameter displays Present when a digital audio signal is being received.
Alternative Frequency Status	Varies	The scan tool displays Active or Inactive. This parameter displays Active if the radio is using an alternative frequency for a radio station broadcasting simultaneously from two different stations.
Last Working MOST ID of Node 1 (Master)	Radio	The scan tool displays the name of the ECU in the MOST BUS Node 1 position that was assigned when the MOST BUS was operational without any faults.
Last Working MOST ID of Node 2	Varies based on vehicle equipment	The scan tool displays the name of the ECU in the MOST BUS Node 2 position that was assigned when the MOST BUS was operational without any faults.
Last Working MOST ID of Node 3	Varies based on vehicle equipment	The scan tool displays the name of the ECU in the MOST BUS Node 3 position that was assigned when the MOST BUS was operational without any faults.
Last Working MOST ID of Node 4	Varies based on vehicle equipment	The scan tool displays the name of the ECU in the MOST BUS Node 4 position that was assigned when the MOST BUS was operational without any faults.
Last Working MOST ID of Node 5	Varies based on vehicle equipment	The scan tool displays the name of the ECU in the MOST BUS Node 5 position that was assigned when the MOST BUS was operational without any faults.
Last Working MOST ID of Node 6	Varies based on vehicle equipment	The scan tool displays the name of the ECU in the MOST BUS Node 6 position that was assigned when the MOST BUS was operational without any faults.
Last Working MOST ID of Node 7	Varies based on vehicle equipment	The scan tool displays the name of the ECU in the MOST BUS Node 7 position that was assigned when the MOST BUS was operational without any faults.
Last Working MOST ID of Node 8	Varies based on vehicle equipment	The scan tool displays the name of the ECU in the MOST BUS Node 8 position that was assigned when the MOST BUS was operational without any faults.
Last Working MOST ID of Node 9	Varies based on vehicle equipment	The scan tool displays the name of the ECU in the MOST BUS Node 9 position that was assigned when the MOST BUS was operational without any faults.
Surrogate MOST Master Node Upstream Position	Numeric	This parameter becomes available when DTC U0028 is current. The number identified is the device furthest upstream from the radio communicating on the MOST BUS when a communication fault is present.
Number of MOST Communication Breaks	Numeric	The number displayed increments each time the MOST BUS cannot communicate successfully.

Number of MOST Configuration Status Messages	Numeric	The number displayed increments each time a MOST BUS configuration status message is sent. A configuration status message is sent when the MOST BUS is initiated, including during or following a communication break.
Number of Short Term MOST Communication Breaks	Numeric	The number displayed increments each time the MOST BUS was temporarily unable to communicate successfully.
Diagnostic Data Identifier	Varies	The scan tool displays the 4 character alphanumeric device ID.
VIN Digits 2-17	Varies	The scan tool displays the learned VIN digits 2-17.
Manufacturer Enable Counter	0	The scan tool displays the counter value. This counter is used for manufacturing purposes only.
Boot Software Part Number	Varies	The scan tool displays the boot software ID number.
Diagnostic Data Identifier	Varies	Identifies a supplier and system specific data stream used by diagnostic testers to interpret a diagnostic data stream.
Calibration Part Number 1	Varies	The scan tool displays the software module ID 1.
Calibration Part Number 2	Varies	The scan tool displays the software module ID 2.
Calibration Part Number 3	Varies	The scan tool displays the software module ID 3.
Calibration Part Number 4	Varies	The scan tool displays the software module ID 4.
Calibration Part Number 5	Varies	The scan tool displays the software module ID 5.
Calibration Part Number 6	Varies	The scan tool displays the software module ID 6.
Calibration Part Number 7	Varies	The scan tool displays the software module ID 7.
Calibration Part Number 8	Varies	The scan tool displays the software module ID 8.
Calibration Part Number 9	Varies	The scan tool displays the software module ID 9.
Calibration Part Number 10	Varies	The scan tool displays the software module ID 10.
End Model Part Number	Varies	The scan tool displays the end model part number.
XM Electronic Serial Number	Varies	Identifies the integrated XM module serial number, if equipped.
HD Decoder Electronic Serial Number	Varies	Identifies the integrated HD decoder serial number, if equipped.
XM Firmware Version and Date	Varies	Identifies the XM module software version and release date, if equipped.
HD Decoder System Version	Varies	Identifies the HD decoder software version, if equipped.

REAR DIFFERENTIAL CLUTCH CONTROL MODULE SCAN TOOL INFORMATION

Rear Differential Clutch Control Module Scan Tool Data Parameters

Parameter	Expected Value	Description
Operating Conditions: Ignition is ON, engine OFF, and vehicle is stationary		
Left Front Wheel Speed		The scan tool displays 0-160 km/h (0-99.5 MPH). The scan tool displays 0 km/h (0 MPH) when the

Sensor	0	vehicle is not moving or is moving at speeds less than or equal to 0 km/h (0 MPH).
Left Rear Wheel Speed Sensor	0	The scan tool displays 0-160 km/h (0-99.5 MPH). The scan tool displays 0 km/h (0 MPH) when the vehicle is not moving or is moving at speeds less than or equal to 0 km/h (0 MPH).
Rear Differential Clutch Control Module Temperature	Varies	The scan tool displays °C. The scan tool indicates a range from -40 to 215 °C.
Rear Differential Clutch Pump Motor Current	0	The scan tool displays the current in mA through the pump motor.
Rear Differential Clutch Solenoid Valve Current	0	The scan tool displays the current in mA through the rear differential clutch solenoid valve.
Rear Differential Clutch Status	Temporarily Disabled	The scan tool displays either Normal, Temporarily Disabled, Temporarily Limited, Malfunctioned, or Externally Disabled.
Rear Drive Clutch Solenoid Valve Current	0	The scan tool displays the current in mA through the rear drive clutch solenoid valve.
Rear Drive Clutch Status	Temporarily Disabled	The scan tool displays either Normal, Temporarily Disabled, Temporarily Limited, Malfunctioned, or Externally Disabled.
Right Front Wheel Speed Sensor	0	The scan tool displays 0-160 km/h (0-99.5 MPH). The scan tool displays 0 km/h (0 MPH) when the vehicle is not moving or is moving at speeds less than or equal to 0 km/h (0 MPH).
Right Rear Wheel Speed Sensor	0	The scan tool displays 0-160 km/h (0-99.5 MPH). The scan tool displays 0 km/h (0 MPH) when the vehicle is not moving or is moving at speeds less than or equal to 0 km/h (0 MPH).

Rear Differential Clutch Control Module Scan Tool Output Controls

Output Control	Description
Pump Motor	This function allows the technician to command the pump motor ON and OFF.
Rear Differential Clutch Solenoid Valve	This function allows the technician to command the clutch solenoid valve. The system will increase or decrease the current in increments of 200 mA
Rear Drive Clutch Solenoid Valve	This function allows the technician to command the clutch solenoid valve. The system will increase or decrease the current in increments of 200 mA

SIDE OBJECT SENSING ALERT MODULE SCAN TOOL INFORMATION

Side Object Detection Scan Tool Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions: Ignition ON			
Manufacturer's Traceability			The scan tool displays the Manufacturer's

Number	-	Varies	Traceability Number
Manufacturer Enable Counter	-	Varies	The scan tool displays the Manufacturer Enable Counter
Module Diagnostic Address	-	Varies	The scan tool displays the Software Module 1 Identifier
Software Module 1 Identifier	-	Varies	The scan tool displays the Software Module 1 Identifier
Software Module 2 Identifier	-	Varies	The scan tool displays the Software Module 2 Identifier
End Model Part Number	-	Varies	The scan tool displays the End Model Part Number
Base Model Part Number	-	Varies	The scan tool displays the Base Model Part Number
Software Module 1 Identifier Alpha Code	-	Varies	The scan tool displays the Software Module 1 Identifier Alpha Code
Software Module 2 Identifier Alpha Code	-	Varies	The scan tool displays the Software Module 2 Identifier Alpha Code
End Model Part Number Alpha Code	-	Varies	The scan tool displays the End Model Part Number Alpha Code
Base Model Part Number Alpha Code	-	Varies	The scan tool displays the Base Model Part Number Alpha Code

Side Object Detection Module Output Controls

Scan Tool Output Control	Description
Object Detection Alert Indicators	When commanded by the scan tool, the module will provide power to illuminate the side blind zone indicators in appropriate outside rear view mirror. The outside rear view mirror indicator will illuminate.
Rear Cross Traffic Audible Alert	When commanded by the scan tool, the module will send a signal to the audio system to turn on the rear cross traffic audible alert signal. The audio system will beep.
Rear Cross Traffic Haptic Alert	When commanded by the scan tool, the module will send a signal to the memory seat module to turn on the rear cross traffic haptic alert. The driver's seat will vibrate.
Rear Cross Traffic Visual Alert	When commanded by the scan tool, the module will turn on the rear cross traffic alert indicators on infotainment display. The infotainment display will illuminate with the appropriate rear cross traffic alert.

TRANSMISSION CONTROL MODULE SCAN TOOL INFORMATION (6T70)

The Transmission Control Module Scan Tool Data List contains all transmission related parameters that are available on the scan tool. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists, and in some cases may appear more than once, or in more than one data list in order to group certain related parameters together.

The values below represent a typical display recorded from a properly functioning system.

Only the parameters listed below are used/referenced in this manual for diagnosis. If a scan tool displays other parameters, those values are not recommended by General Motors for use in diagnosis.

If all values are within the expected range described below, refer to **Symptoms - Automatic Transmission** for diagnosis.

The scan tool values from a properly functioning transmission may be used for comparison with the transmission you are diagnosing. The values below represent a typical display recorded from a properly functioning system.

Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Engine at idle, upper radiator hose hot, closed throttle, transmission in Park, closed loop operation, accessories OFF, brake pedal not applied.			
1-2 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last adaptable 1-2 shift. The shift time is based on the gear ratio change after the commanded 1-2 shift.
2-3 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last adaptable 2-3 shift. The shift time is based on the gear ratio change after the commanded 2-3 shift.
3-4 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last adaptable 3-4 shift. The shift time is based on the gear ratio change after the commanded 3-4 shift.
4-5 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last adaptable 4-5 shift. The actual shift time is obtained by measuring the time required for the input shaft to decelerate from the previous ratio to the current ratio.
5-6 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last 5-6 shift. The shift time is based on the gear ratio change after the commanded 5-6 shift.
Brake Switch	-	Released	This parameter displays the status of the brake switch circuit input. Applied indicates a zero voltage input, brake pedal applied. Released indicates a voltage input, brake pedal released. The scan tool displays Applied or Released.
			This parameter displays a calculated value, which is determined by the

Calc. Throttle Position	-	%, Varies	accelerator pedal position and the actual throttle position, used to optimize transmission controls. It represents the driver's intended request for torque or acceleration. The range is 0-100%, where 0% represents an idle or coast request and 100% represents a request for wide open throttle (WOT).
Commanded Gear	-	1	This parameter displays the current commanded state of the shift solenoid valves. The scan tool displays 1, 2, 3, 4 or 5
Driver Shift Control	-	Inactive	This parameter displays Active or Inactive. The scan tool displays Active when the gear selector is in the sport (S) position, which enables TAP shift. The scan tool displays Inactive when the gear selector is not in the S position, TAP shift disabled.
Driver Shift Request	-	None	This parameter displays the current request from the TAP Shift System. This parameter will display up shift, downshift or invalid depending on the amount of voltage measured at the remote shift selector input and also will display none when there is no request.
ECT	-	°C (°F), Varies	This parameter displays the input signal from the engine coolant temperature (ECT) sensor. ECT is high at 151°C (304°F) when the signal voltage is low (0 V). ECT is low at -40°C (-40°F) when the signal voltage is high (5 V).
Engine Speed	-	RPM, Varies	This parameter displays the rotational speed of the engine expressed as revolutions per minute.
Engine Torque	-	Y, Varies	This parameter displays a calculated value based on engine load, throttle position, mass air flow, and other engine inputs. This parameter is accurate to within 15 lb ft of actual measured engine torque.
Gear Ratio	-	Ratio, Varies	This parameter displays the actual transmission gear ratio. The scan tool displays the gear ratio calculated from the automatic transmission input shaft speed sensor (AT ISS) and the automatic transmission output shaft speed sensor

			(AT OSS) inputs.
High Side Driver 1	-	Enabled	This parameter displays the High Side Driver 1 status on the scan tool. When the High Side Driver 1 is commanded OFF this displays Disabled, when the High Side Driver 1 is commanded ON this displays Enabled.
High Side Driver 1 CKT Status	-	OK	This parameter displays the High Side Driver 1 circuit status on the scan tool. If the voltage is low when the solenoid is commanded OFF, the scan tool will display Open/Short to GND. If the voltage is high when the solenoid is commanded ON, the scan tool will display Short to Volts. If no circuit fault is present the scan tool will display OK.
Ignition Voltage	-	Volts, 12-14	This parameter displays the system voltage measured at the ignition feed.
IMS	-	Park	This parameter displays PARK, PARK/REVERSE, REVERSE, REVERSE/NEUTRAL, NEUTRAL, NEUTRAL/DRIVE 4, DRIVE 4, DRIVE 4/DRIVE 3, DRIVE 3, DRIVE 3/DRIVE 2, DRIVE 2, DRIVE 2/DRIVE 1, DRIVE 1 or INVALID. The IMS Range display represents a decoded status of the four inputs from the IMS. The combination of IMS inputs are used to determine what position the manual valve is in at any time.
IMS A/B/C/P	-	Varies	This parameter displays the status of the four A/B/C/P inputs from the automatic transmission internal mode switch. I indicates an ignition voltage signal and LOW indicates a 0 voltage signal. The scan tool will display HI/LOW, HI/LOW, HI/LOW, HI/LOW.
ISS/OSS Supply Voltage	-	OK	This parameter displays OK, Out of Range.
Last Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last up shift. This value is only accurate if the shift was adaptable.
Line PC Sol. Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
PC Sol. 2 Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).

PC Sol. 3 Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
PC Sol. 4 Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
PC Sol. 5 Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
Replicated OSS CKT Status	-	OK	This parameter displays OK, Open/Short to GND, Short to Volts, or Indeterminate.
Shift Sol. 1 CKT Status	-	OK	This parameter displays OK, Open/Short to GND, Short to Volts, or Indeterminate.
Shift Solenoid 1	-	On	This parameter displays the commanded state of the reverse, 1st shift solenoid valve (S1). The scan tool displays On/Off.
Shift Sol. 2 CKT Status	-	OK	This parameter displays OK, Open/Short to GND, Short to Volts, or Indeterminate.
Shift Solenoid 2	-	On	This parameter displays the commanded state of the 2-3, 3-4 shift solenoid valve (S2). The scan tool displays On/Off.
TCC Slip Speed	-	RPM, Varies	This parameter displays the difference between transmission input speed and engine speed. A negative value indicates that the engine speed is less than the input speed, deceleration. A positive value indicates that the engine speed is greater than the input speed, acceleration. A value of zero indicates that the engine speed is equal to the input speed, TCC applied.
TCM Temperature	-	°C (°F) Varies	This parameter displays results in °C (°F)
TFP Switch 1	-	HI/LOW	This parameter displays the state of the first clutch oil pressure switch. The scan tool displays HI/LOW.
TFP Switch 3	-	HI/LOW	This parameter displays state of the 3rd clutch oil pressure switch. The scan tool displays HI/LOW.
TFP Switch 4	-	HI/LOW	This parameter displays state of the 4th clutch oil pressure switch. The scan tool displays HI/LOW.
TFP Switch 5	-	HI/LOW	This parameter displays state of the fifth clutch oil pressure switch. The scan tool displays HI/LOW.
			This parameter displays the input signal

Trans. Fluid Temp.	-	°C (°F) Varies	of the transmission fluid temperature sensor. Transmission fluid temperature is high 151°C (304°F) when signal voltage is low, 0 V, and transmission fluid temperature is low -40°C (-40°F) when signal voltage is high, 5 V.
Transmission ISS	-	RPM, Varies	This parameter displays the rotational speed of the transmission input shaft. The scan tool displays input shaft speed is revolutions per minute (RPM).
Transmission OSS	-	RPM, Varies	This parameter displays the rotational speed of the transmission output shaft expressed as revolutions per minute.

Scan Tool Output Controls

Output Control	Description
TCC Control Solenoid	<ul style="list-style-type: none"> • The transmission control module (TCM) commands the torque converter clutch pressure control (TCC PC) solenoid pressure in order to apply and release the TCC. • When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF and vice versa. • When the engine is running, the following control limits apply: <ul style="list-style-type: none"> ○ If the transmission range is Park, and the transmission is in hot mode, the TCC PC solenoid may not be commanded OFF. If the solenoid is requested OFF, the message "TCC OFF command disabled in Hot Mode" appears on the scan tool display. ○ The TCC PC solenoid may not be commanded OFF for more than a calibrated amount of time. If the solenoid is commanded OFF, for a certain amount of time, the message "TCC OFF time has been exceeded" appears on the scan tool display.
Shift Solenoid	<ul style="list-style-type: none"> • The TCM commands Shift Solenoid 1 and Shift Solenoid 2 ON and OFF. • When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM. • When the engine is running, the following control limits apply: <ul style="list-style-type: none"> ○ The transmission range must be in Park or Neutral. If the transmission range is not Park or Neutral, the message "Engine running and transmission range is not Park/Neutral" appears on the scan tool display.

	<ul style="list-style-type: none"> ○ The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM. ○ Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.
Line PC Solenoid	<ul style="list-style-type: none"> ● The scan tool is used to request pressure in increments of 200 kPa (30 psi) from 200-2200 kPa (30-320 psi). The TCM will then command the solenoid to achieve a pressure within a range based on the requested pressure. Refer to <u>Solenoid Valve Pressure</u>. ● When the ignition is ON, and the engine is ON, the pressure request may be controlled within calibrated limits. There are no limits to the output control when the engine is OFF. ● When the engine is running, the following control limits apply: <ul style="list-style-type: none"> ○ When the transmission range is Park or Neutral, the pressure request may be controlled within calibrated limits. The engine speed must be less than 1,500 RPM. If the engine speed is greater than 1,500 RPM, the message "TR in park/neutral and engine speed over 1,500 RPM" appears on the scan tool display. ○ When the transmission range is not Park or Neutral, the requested pressure can only be controlled equal to or greater than the pressure determined by the TCM. The TCM does not allow a pressure to be selected that may cause damage to the transmission. If the requested pressure is less than allowed by the TCM, the message "Requested pressure for the Line PC Solenoid is too low" appears on the scan tool display. ○ Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.
Clutch PC Solenoids	<ul style="list-style-type: none"> ● The TCM commands the pressure control solenoids in order to apply and release the clutches. ● When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM. ● When the engine is running, the following control limits apply: <ul style="list-style-type: none"> ○ The transmission range must be in Park or Neutral. If the transmission range is not Park or Neutral, the message "Engine running and transmission range is not Park/Neutral" appears on the scan tool display. ○ The solenoid remains ON until commanded OFF, and vice

	<p>versa. When the output control is exited, the solenoid state is determined by the TCM.</p> <ul style="list-style-type: none"> Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.
Shift Transmission	<ul style="list-style-type: none"> The TCM commands upshifts and downshifts. The scan tool Commanded Gear parameter should correspond with the shift solenoid combination. Refer to the <u>Shift Solenoid Valve State and Gear Ratio</u> table. When the ignition is ON, and the engine is OFF, there are no limits to this control. The scan tool shift solenoid states change to match the Commanded Gear selected. When the engine is running, the following control limits apply: <ul style="list-style-type: none"> The TCM does not allow a shift if it causes the engine RPM to exceed a calibrated limit. If a gear is requested and the engine speed is too high, the message "Engine speed too high" appears on the scan tool display. The TCM does not allow a 3-2 or 2-1 downshift if the vehicle speed exceeds a calibrated limit. If either downshift is requested and the vehicle speed is too high, the message "Eng. is on and veh. speed too hi for 3-2 or 2-1 downshift" appears on the scan tool display. The TCM does not allow a 4-3 downshift if the vehicle speed exceeds a calibrated limit. If a 4-3 downshift is requested and the vehicle speed is too high, the message "Vehicle speed too high" appears on the scan tool display. The TCM does not allow an upshift if the vehicle speed exceeds a calibrated limit. If an upshift is requested and the vehicle speed is too high, the message "Vehicle speed too high" appears on the scan tool display. The TCM does not allow an upshift that is greater than the current selected transmission range (PRNDL). For example, 3rd gear is not allowed if the transmission range is D2. If an upshift is requested that is greater than the current selected transmission range, the message "Eng. running and gear request is greater than the current TR" appears on the scan tool display.
High Side Driver 1	<ul style="list-style-type: none"> The TCM commands the driver for the solenoid voltage supply ON and OFF. When the ignition is ON, and the engine is OFF, there are no limits to this control. High side drivers may not be commanded ON and OFF with the scan tool if the engine is running.

Service Cleaning Procedure	<ul style="list-style-type: none"> • The scan tool is used to start and stop the transmission cleaning procedure algorithm. • The following control limits apply: <ul style="list-style-type: none"> ○ The engine must be running. The message "Engine not Running" will appear on the scan tool if this control is attempted without the engine running. ○ There cannot be active transmission DTCs. The message "Transmission Fault present" will appear on the scan tool if this control is attempted with transmission DTCs active. ○ The transmission range must be Park or Neutral. The message "Transmission not in PARK or NEUTRAL" will appear on the scan tool if this control is attempted with the transmission in any range other than Park or Neutral. ○ The vehicle speed cannot exceed 5 mph. The message "Vehicle Speed too high" will appear on the scan tool if this control is attempted with a vehicle speed greater than 8 km/h (5 mph). ○ The engine speed cannot exceed 2500 RPM. The message "Engine Speed too high" will appear on the scan tool if this control is attempted with an engine speed greater than 2500 RPM. ○ The transmission oil temperature must be at a normal operating temperature. The message "Transmission oil temperature out of range" will appear on the scan tool if this control is attempted without a transmission oil temperature between 70-110°C (158-230°F).
Reset Transmission Adapts	<ul style="list-style-type: none"> • The scan tool is used to start and stop the transmission Fast Learn Adapt algorithm. • The following control limits apply: <ul style="list-style-type: none"> ○ The engine must be running. The message "Engine not Running" will appear on the scan tool if this control is attempted without the engine running. ○ There cannot be active transmission DTCs. The message "Transmission Fault present" will appear on the scan tool if this control is attempted with transmission DTCs active.

TRANSMISSION CONTROL MODULE SCAN TOOL INFORMATION (6T40)

The Transmission Control Module Scan Tool Data List contains all transmission related parameters that are available on the scan tool. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists, and in some cases may appear more than once, or in more than one data list in order to group certain related parameters together.

The values below represent a typical display recorded from a properly functioning system.

NOTE: Do not use a scan tool that displays faulty data. Report the condition to the scan tool manufacturer. The use of a faulty scan tool can result in misdiagnosis and the unnecessary replacement of components.

Only the parameters listed below are used/referenced in this manual for diagnosis. If a scan tool displays other parameters, those values are not recommended by General Motors for use in diagnosis.

If all values are within the expected range described below, refer to **Symptoms - Automatic Transmission** for diagnosis.

The scan tool values from a properly functioning transmission may be used for comparison with the transmission you are diagnosing. The values below represent a typical display recorded from a properly functioning system.

Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Engine at idle, upper radiator hose hot, closed throttle, transmission in Park, closed loop operation, accessories OFF, brake pedal not applied.			
1-2 Shift Time	Varies	Seconds	This parameter displays the actual time of the last adaptable 1-2 shift. The shift time is based on the gear ratio change after the commanded 1-2 shift.
2-3 Shift Time	Varies	Seconds	This parameter displays the actual time of the last adaptable 2-3 shift. The shift time is based on the gear ratio change after the commanded 2-3 shift.
3-4 Shift Time	Varies	Seconds	This parameter displays the actual time of the last adaptable 3-4 shift. The shift time is based on the gear ratio change after the commanded 3-4 shift.
4-5 Shift Time	Varies	Seconds	This parameter displays the actual time of the last adaptable 4-5 shift. The actual shift time is obtained by measuring the time required for the input shaft to decelerate from the previous ratio to the current ratio.
5-6 Shift Time	Varies	Seconds	This parameter displays the actual time of the last 5-6 shift. The shift time is base on the gear ratio change after the commanded 5-6 shift.
			This parameter displays the status of the brake switch circuit input. Applied indicates a zero voltage input, brake

Brake Pedal Switch	Released	Applied/Released	pedal applied. Released indicates a voltage input, brake pedal released. The scan tool displays Applied or Released.
Calculated Throttle Position	Varies	%	This parameter displays a calculated value, which is determined by the accelerator pedal position and the actual throttle position, used to optimize transmission controls. It represents the driver's intended request for torque or acceleration. The range is 0-100%, where 0% represents an idle or coast request and 100% represents a request for wide open throttle (WOT).
Control Module Voltage Signal	9-19	Volts	This parameter displays the system voltage measured at the module wake up signal feed.
Driver Shift Control Mode	Inactive	Active/Inactive	This parameter displays Active or Inactive. The scan tool displays Active when the gear selector is in the manual mode (M) position or left of the D position, which enables TAP shift. The scan tool displays Inactive when the gear selector is not in the M or left of D position, TAP shift disabled.
Driver Shift Request	None	Upshift / Downshift / None / Invalid	This parameter displays the current request from the TAP Shift System. This parameter will display up shift, downshift or invalid depending on the amount of voltage measured at the remote shift selector input and also will display none when there is no request.
Engine Coolant Temperature	Varies	°C (°F)	This parameter displays the input signal from the engine coolant temperature (ECT) sensor. ECT is high at 151°C (304°F) when the signal voltage is low (0 V). ECT is low at -40°C (-40°F) when the signal voltage is high (5 V). This parameter value is determined by the engine control module and communicated to the TCM through the High Speed GMLAN Serial Data link.
			This parameter displays the rotational

Engine Speed	Varies	RPM	speed of the engine expressed as revolutions per minute. This parameter value is determined by the engine control module and communicated to the TCM through the High Speed GMLAN Serial Data link.
Engine Torque	Varies	Y (lb ft)	This parameter displays a calculated value based on engine load, throttle position, mass air flow, and other engine inputs. This parameter is accurate to within 20 N.m (15 lb ft) of actual measured engine torque. This parameter value is determined by the engine control module and communicated to the TCM through the High Speed GMLAN Serial Data link.
Gear Command	1	1, 2, 3, 4, 5, or 6	This parameter displays the current commanded state of the shift solenoid valves. The scan tool displays 1, 2, 3, 4, 5, or 6.
Gear Ratio	Varies	Ratio	This parameter displays the actual transmission gear ratio. The scan tool displays the gear ratio calculated from the automatic transmission (AT) input speed sensor (ISS) and the automatic transmission (AT) output speed sensor (OSS) inputs.
High Side Driver 1	On	On/Off	This parameter displays the state of the High Side Driver 1. The scan tool displays On or Off.
High Side Driver 1 Circuit Low Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the high side driver 1 circuit. The scan tool displays OK, Malfunction, or Not Run.
High Side Driver 1 Circuit High Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to voltage exists in the high side driver 1 circuit. The scan tool displays OK, Malfunction, or Not Run.
High Side Driver 1 Circuit Open Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether an open exists in the high side driver 1 circuit. The scan tool displays OK, Malfunction, or Not Run.
Ignition Voltage	9-19	Volts	This parameter displays the system voltage measured at the ignition feed.

Internal Mode Switch	Park	Park-Drive 1, Open, Invalid	This parameter displays PARK, PARK/REVERSE, REVERSE, REVERSE/NEUTRAL, NEUTRAL, NEUTRAL/DRIVE 4, DRIVE 4, DRIVE 4/DRIVE 3, DRIVE 3, DRIVE 3/DRIVE 2, DRIVE 2, DRIVE 2/DRIVE 1, DRIVE 1 or INVALID. The IMS Range display represents a decoded status of the four inputs from the IMS. The combination of IMS inputs are used to determine what position the manual valve is in at any time.
Internal Mode Switch A/B/C/P	Varies	High/Low	This parameter displays the status of the four A/B/C/P inputs from the automatic transmission internal mode switch. HI indicates an ignition voltage signal and LOW indicates a 0 voltage signal. The scan tool will display High/Low, High/Low, High/Low, High/Low.
ISS/OSS Supply Voltage	OK	OK, Out of Range	This parameter displays OK, Out of Range.
Last Shift Time	Varies	Seconds	This parameter displays the actual time of the last up shift. This value is only accurate if the shift was adaptable.
Line Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the line pressure control valve 2 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Line Pressure Control Solenoid Valve Control Circuit High Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the line pressure control valve 2 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Line Pressure Control Solenoid Valve Performance Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a performance issue exists in the line pressure control solenoid valve control circuit by comparing the commanded current with the expected current. The scan tool displays OK, Malfunction, or Not Run.
Line Pressure Control Solenoid Valve Pressure	Varies	kPa (psi)	This parameter displays results in kPa (psi).

Command			
Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the pressure control solenoid valve 2 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to voltage exists in the pressure control solenoid valve 2 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 2 Performance Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a performance issue exists in the pressure control solenoid valve 2 control circuit by comparing the commanded current with the expected current. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 2 Pressure Command	Varies	kPa (psi)	This parameter displays kPa (psi).
Pressure Control Solenoid Valve 3 Control Circuit Low Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the pressure control solenoid valve 3 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 3 Control Circuit High Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to voltage exists in the pressure control solenoid valve 3 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 3 Performance Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a performance issue exists in the pressure control solenoid valve 3 control circuit by comparing the commanded current with the expected current. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 3 Pressure Command	Varies	kPa (psi)	This parameter displays kPa (psi).
Pressure Control Solenoid Valve 4 Control Circuit Low Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the pressure control solenoid valve 4 control circuit. The scan tool displays OK, Malfunction, or Not Run.

Pressure Control Solenoid Valve 4 Control Circuit High Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to voltage exists in the pressure control solenoid valve 4 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 4 Performance Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a performance issue exists in the pressure control solenoid valve 4 control circuit by comparing the commanded current with the expected current. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 4 Pressure Command	Varies	kPa (psi)	This parameter displays kPa (psi).
Pressure Control Solenoid Valve 5 Control Circuit Low Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the pressure control solenoid valve 5 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 5 Control Circuit High Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to voltage exists in the pressure control solenoid valve 5 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 5 Performance Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a performance issue exists in the pressure control solenoid valve 5 control circuit by comparing the commanded current with the expected current. The scan tool displays OK, Malfunction, or Not Run.
Pressure Control Solenoid Valve 5 Pressure Command	Varies	kPa (psi)	This parameter displays kPa (psi).
Replicated OSS CKT Status	OK	OK, Open/Short to GND, Short to Volts, Indeterminate	This parameter displays OK, Open/Short to GND, Short to Volts, Indeterminate.
Shift Solenoid Valve 1	On	On/Off	This parameter displays the commanded state of the reverse, 1st shift solenoid valve (S1). The scan tool displays On/Off.
Shift Solenoid Valve 1 Control Circuit Low Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the shift solenoid valve 1 control circuit. The scan tool displays OK, Malfunction,

			or Not Run.
1-2 Shift Solenoid Valve Control Circuit High Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to voltage exists in the shift solenoid valve 1 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Shift Solenoid Valve 1 Control Circuit Open Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether an open exists in the shift solenoid valve 1 control circuit. The scan tool displays OK, Malfunction, or Not Run.
Steady State TAP 1st Gear	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 1st Gear TCC Applied	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 2nd Gear	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 2nd Gear TCC Applied	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 3rd Gear	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 3rd Gear TCC Applied	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 4th Gear	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 4th Gear TCC Applied	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 5th Gear	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded

			clutch apply pressures.
Steady State TAP 5th Gear TCC Applied	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 6th Gear	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP 6th Gear TCC Applied	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
Steady State TAP Reverse	Varies	kPa (psi)	This parameter displays the amount of transmission adaptive pressure (TAP), which modifies the commanded clutch apply pressures.
TCC Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to ground exists in the TCC pressure control solenoid valve control circuit. The scan tool displays OK, Malfunction, or Not Run.
TCC Pressure Control Solenoid Valve Control Circuit High Voltage Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a short to voltage exists in the TCC pressure control solenoid valve control circuit. The scan tool displays OK, Malfunction, or Not Run.
TCC Pressure Control Solenoid Valve Performance Test Status	OK	OK, Malfunction, Not Run	This parameter displays whether a performance issue exist in the TCC pressure control solenoid valve control circuit by comparing the commanded current with the expected current. The scan tool displays OK, Malfunction, or Not Run.
TCC Pressure Control Solenoid Valve Pressure Command	Varies	kPa (psi)	This parameter displays results in kPa (psi).
TCC Slip Speed	Varies	RPM	This parameter displays the difference between transmission input speed and engine speed. A negative value indicates that the engine speed is less than the input speed, deceleration. A positive value indicates that the engine speed is greater than the input speed, acceleration. A value of zero

			indicates that the engine speed is equal to the input speed, TCC applied.
TCM Power-Up Temperature	Varies	°C (°F)	This displays the value of the temperature sensor inside the control solenoid and valve assembly.
TCM Temperature	Varies	°C (°F)	This displays the temperature of the TCM. This parameter displays results in °C (°F).
Transmission Fluid Pressure Switch 1	High/Low	High/Low	This parameter indicates the state of the normally closed transmission fluid pressure switch 1. Pressure to the switch is dependent on the position of the 3-5-Reverse clutch regulator valve. The scan tool displays High/Low.
Transmission Fluid Pressure Switch 3	High/Low	High/Low	This parameter indicates the state of the normally closed transmission fluid pressure switch 1. Pressure to the switch is dependent on the position of the 2-6 clutch regulator valve. The scan tool displays High/Low.
Transmission Fluid Pressure Switch 4	High/Low	High/Low	This parameter indicates the state of the normally closed transmission fluid pressure switch 1. Pressure to the switch is dependent on the position of the 1-2-3-4 clutch regulator valve. The scan tool displays High/Low.
Transmission Fluid Pressure Switch 5	High/Low	High/Low	This parameter indicates the state of the normally closed transmission fluid pressure switch 1. Pressure to the switch is dependent on the position of the R1/4-5-6 clutch regulator valve. The scan tool displays High/Low.
Transmission Fluid Life	Varies	%	This parameter displays the transmission oil life remaining. The scan tool displays the remaining oil life as a percentage. The transmission oil life is calculated based on fluid temperature and engine run time.
Transmission Fluid Temperature	Varies	°C (°F)	This parameter displays the input signal of the transmission fluid temperature sensor. Transmission fluid temperature is high 151°C (304° F) when signal voltage is low, 0 V, and transmission fluid temperature is low -40°C (-40°F) when signal voltage is high, 5 V.

Transmission Hot Mode	On/Off	On/Off	When The transmission fluid temperature is above a temperature which varies by calibration, the TCM will alter the shift pattern until the temperature drops below a value which varies by calibration.
Transmission ISS	Varies	RPM	This parameter displays the rotational speed of the transmission input shaft. The scan tool displays input shaft speed is revolutions per minute (RPM).
Transmission OSS	Varies	RPM	This parameter displays the rotational speed of the transmission output shaft expressed as revolutions per minute.

Scan Tool Output Controls

Output Control	Description
TCC Pressure Control Solenoid Valve	<ul style="list-style-type: none"> • The transmission control module (TCM) commands the torque converter clutch pressure control (TCC PC) solenoid pressure in order to apply and release the TCC. • When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF and vice versa. • When the engine is running, the following control limits apply: <ul style="list-style-type: none"> ○ If the transmission range is Park, and the transmission is in hot mode, the TCC PC solenoid may not be commanded OFF. If the solenoid is requested OFF, the message "TCC OFF command disabled in Hot Mode" appears on the scan tool display. ○ The TCC PC solenoid may not be commanded OFF for more than a calibrated amount of time. If the solenoid is commanded OFF, for a certain amount of time, the message "TCC OFF time has been exceeded" appears on the scan tool display.
Shift Solenoid: <ul style="list-style-type: none"> • Shift Solenoid Valve 1 	<ul style="list-style-type: none"> • The TCM commands Shift Solenoid 1 ON and OFF. • When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM. • When the engine is running, the following control limits apply: <ul style="list-style-type: none"> ○ The transmission range must be in Park or Neutral. If the transmission range is not Park or Neutral, the message "Engine running and transmission range is not Park/Neutral" appears on the scan tool display.

	<ul style="list-style-type: none"> ○ The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM. ○ Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.
Line Pressure Control Solenoid Valve	<ul style="list-style-type: none"> ● The scan tool is used to request pressure in increments of 207 kPa (30 psi) from 0-1862 kPa (0-270 psi). The TCM will then command the solenoid to achieve the requested pressure. ● When the ignition is ON, and the engine is OFF, the pressure request may be controlled within calibrated limits. There are no limits to the output control when the engine is OFF. ● When the engine is running, the following control limits apply: <ul style="list-style-type: none"> ○ When the transmission range is Park or Neutral, the pressure request may be controlled within calibrated limits. The engine speed must be less than 1,500 RPM. If the engine speed is greater than 1,500 RPM, the message "TR in park/neutral and engine speed over 1,500 RPM" appears on the scan tool display. ○ When the transmission range is not Park or Neutral, the requested pressure can only be controlled equal to or greater than the pressure determined by the TCM. The TCM does not allow a pressure to be selected that may cause damage to the transmission. If the requested pressure is less than allowed by the TCM, the message "Requested pressure for the Line PC Solenoid is too low" appears on the scan tool display. ○ Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.
Clutch PC Solenoids: <ul style="list-style-type: none"> ● Pressure Control Solenoid Valve 2 ● Pressure Control Solenoid Valve 3 ● Pressure Control Solenoid Valve 4 ● Pressure Control 	<ul style="list-style-type: none"> ● The TCM commands the pressure control solenoids in order to apply and release the clutches. ● When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM. ● When the engine is running, the following control limits apply: <ul style="list-style-type: none"> ○ The transmission range must be in Park or Neutral. If the transmission range is not Park or Neutral, the message "Engine running and transmission range is not Park/Neutral" appears on the scan tool display. ○ The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is

Solenoid Valve 5	<p>determined by the TCM.</p> <ul style="list-style-type: none"> Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.
Shift Transmission Gear	<ul style="list-style-type: none"> The TCM commands upshifts and downshifts. The scan tool Commanded Gear parameter should correspond with the shift solenoid combination. Refer to <u>Shift Solenoid Valve State and Gear Ratio</u>. When the ignition is ON, and the engine is OFF, there are no limits to this control. The scan tool shift solenoid states change to match the Commanded Gear selected. When the engine is running, the following control limits apply: <ul style="list-style-type: none"> The TCM does not allow a shift if it causes the engine RPM to exceed a calibrated limit. If a gear is requested and the engine speed is too high, the message "Engine speed too high" appears on the scan tool display. The TCM does not allow a 3-2 or 2-1 downshift if the vehicle speed exceeds a calibrated limit. If either downshift is requested and the vehicle speed is too high, the message "Eng. is on and veh. speed too hi for 3-2 or 2-1 downshift" appears on the scan tool display. The TCM does not allow a 4-3 downshift if the vehicle speed exceeds a calibrated limit. If a 4-3 downshift is requested and the vehicle speed is too high, the message "Vehicle speed too high" appears on the scan tool display. The TCM does not allow an upshift if the vehicle speed exceeds a calibrated limit. If an upshift is requested and the vehicle speed is too high, the message "Vehicle speed too high" appears on the scan tool display. The TCM does not allow an upshift that is greater than the current selected transmission range (PRNDL). For example, 3rd gear is not allowed if the transmission range is D2. If an upshift is requested that is greater than the current selected transmission range, the message "Eng. running and gear request is greater than the current TR" appears on the scan tool display.
Transmission Adaptive	<p>The TCM commands pressure to the clutches to learn the transmission adaptive values. As the procedure is being performed, the scan tool provides operator instructions.</p> <p>Test may not start or may abort for the following conditions:</p> <ul style="list-style-type: none"> Transmission fluid temperature must be between 70-100°C (158-212°F). Brakes and brake switch must function properly.

Values Learn	<ul style="list-style-type: none">• Closed throttle and engine speed increases above 1500 RPM.• Park/neutral position switch must be properly adjusted and functioning.• Line pressure control is able to command 1,000 kPa (145 psi).• Vehicle must be stopped.• Vehicle must not be vibrating excessive.
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ELECTRICAL

Wiring Systems and Power Management - Schematic and Routing Diagrams - Vehicle Zoning Strategy

SCHEMATIC AND ROUTING DIAGRAMS

VEHICLE ZONING STRATEGY

All grounds, in-line connectors, and splices have identifying numbers that correspond to where they are located in the vehicle. The following table explains the numbering system.

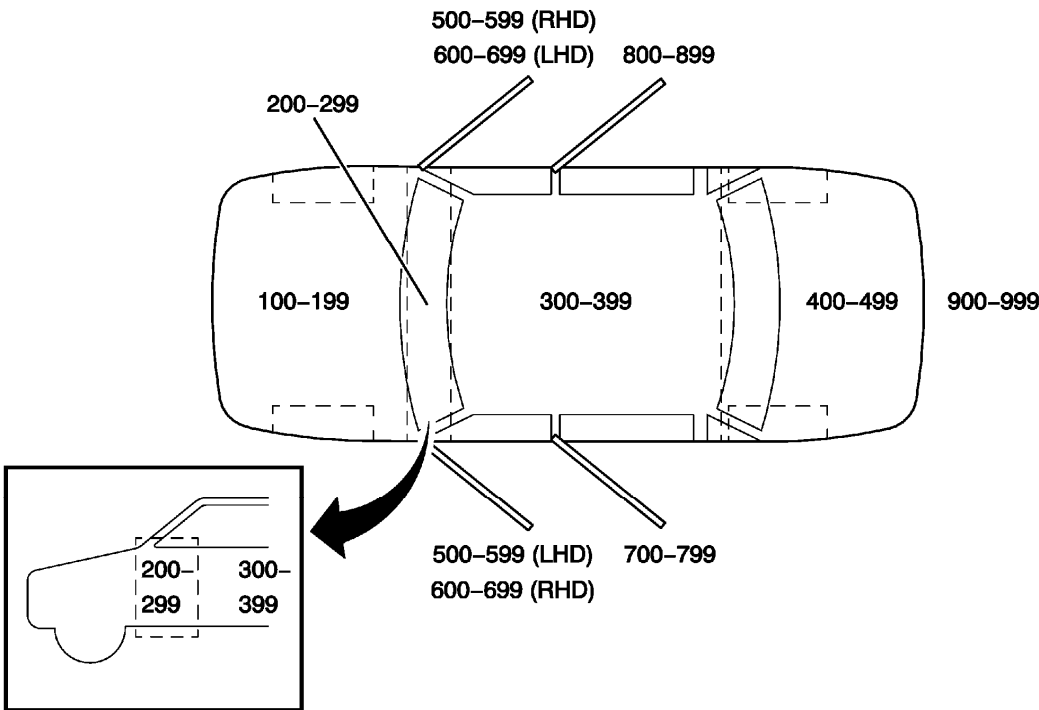


Fig. 1: Passenger Car Zoning View
Courtesy of GENERAL MOTORS COMPANY

Vehicle Zoning Strategy

Callout Numbers	Zone Description
100-199	Engine compartment (all forward of the instrument panel)
200-299	Within the instrument panel area (between the bulkhead and the front plane of the instrument panel)
300-399	Passenger compartment (from instrument panel to the back of the rear seats)
400-499	Luggage compartment (from the back of the rear seats to the rear of the vehicle)

500-599	Inline harness connectors to or within the driver door
600-699	Inline harness connectors to or within the front passenger door
700-799	Inline harness connectors to or within the left rear door
800-899	Inline harness connectors to or within the right rear door
900-999	Inline harness connectors to or within the luggage compartment lid or hatch

General Information

Vibration Diagnosis and Correction

SPECIFICATIONS

TIRE AND WHEEL RUNOUT SPECIFICATIONS

Tire and Wheel Runout Specifications

Application	Specification	
	Metric	English
Tire and Wheel Assembly- Lateral and Radial		
• Off-Vehicle	1.27 mm	0.050 in
• On-Vehicle	1.52 mm	0.060 in
Wheel, Aluminum		
• Lateral	0.762 mm	0.030 in
• Radial	0.762 mm	0.030 in
Wheel, Steel		
• Lateral	1.143 mm	0.045 in
• Radial	1.015 mm	0.040 in
Wheel Hub/Axle Flange- Guideline	0.132 mm	0.0052 in
Wheel Stud- Guideline	0.25 mm	0.010 in

DIAGNOSTIC INFORMATION AND PROCEDURES

VIBRATION DIAGNOSIS, STARTING POINT, AND CORRECTION

The information contained in this Vibration Diagnosis and Correction section is designed to cover various vehicle designs and configurations. Not all content will apply to all vehicles.

NOTE: **The following steps must be completed before using the analysis tables or the symptom tables.**

1. Perform the **Vibration Analysis - Road Testing** table before using the other Vibration Analysis tables or the Symptom tables in order to effectively diagnose the customer's concern.

The use of Vibration Analysis - Road Testing will first provide duplication of virtually any vibration concern and then identify the correct procedure for diagnosing the area of concern which has been duplicated.

2. Review the following Vibration Diagnostic Process.
3. Review the general descriptions to familiarize yourself with vibration theory and terminology, the **EL-**

38792-A Electronic Vibration Analyzer (EVA) 2 , and the **EL-38792-VS** Vibrate Software. Reviewing this information will help you determine whether the condition described by the customer is a potential operating characteristic or not.

Refer to the following:

- **Vibration Theory and Terminology**
- **Electronic Vibration Analyzer (EVA) Description and Operation**
- **Vibrate Software Description and Operation**
- **Reed Tachometer Description**

Vibration Diagnostic Process

NOTE: **Using the following steps of the vibration diagnostic process will help you to effectively narrow-down and pin-point the search for the specific source of a vibration concern and to arrive at an accurate repair.**

1. Gather specific information on the customer's vibration concern.
2. Perform the road testing steps in sequence as identified in Vibration Analysis - Road Testing in order to duplicate the customer's concern and evaluate the symptoms of the concern under changing conditions. Observe what the vibration feels like and what it sounds like. Observe when the symptoms first appear, when they change, and when they cease.
3. Determine if the customer's vibration concern is truly an abnormal condition or something that is potentially an operating characteristic of the vehicle.
4. Systematically eliminate or "rule-out" possible vehicle systems.
5. Focus diagnostic efforts on the remaining vehicle system and systematically eliminate or "rule-out" possible components of that system.
6. Make a repair on the remaining component, or components, which have not been eliminated systematically, and must therefore be the cause of the vibration.
7. Verify that the customer's concern has been eliminated or at least brought to an acceptable level.
8. Again perform the road testing steps in sequence as identified in Vibration Analysis - Road Testing in order to verify that the vehicle did not have more than one vibration occurring.

Preliminary Visual/Physical Inspection

- Inspect for aftermarket equipment and modifications which could affect the operation of the vehicle rotating component systems.
- Inspect the easily accessible or visible components of the vehicle rotating component systems for obvious damage or conditions which could cause the symptom.
- Inspect the tire inflation pressures for the proper pressure.

Diagnostic Aids

Improper component routing or isolation, or components which are worn or faulty may be the cause of

intermittent conditions that are difficult to duplicate. If the vibration concern could not be duplicated by following the steps of the Vibration Diagnostic Process, refer to **Vibration Diagnostic Aids**.

VIBRATION ANALYSIS - ROAD TESTING

Special Tools

EL-38792-A Electronic Vibration Analyzer (EVA) 2

For equivalent regional tools, refer to **Special Tools and Equipment**.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5

Obtaining rotational speed for the components rotating at tire/wheel speed is critical to systematically eliminating specific vehicle component groups. These component rotational speeds can be generated by using an electronic vibration analyzer, or through calculating them manually.

10

NOTE: **Be certain to OBSERVE for disturbances that match the customer's description FIRST, then look at the vibration analyzer frequency which corresponds with that disturbance.**

Proper location of the vibration analyzer sensor onto the component which is most excited by the vibration disturbance is critical to obtaining an accurate frequency reading.

This test will duplicate virtually any disturbance which occurs while the vehicle is in motion.

11

Accelerate to a speed high enough above the speed of the disturbance to allow for the time needed to shift into NEUTRAL and for the engine to decrease in RPM to idle speed, before coasting down through the disturbance range.

12

This test will either eliminate or confirm the engine as a contributing cause of the customer concern.

Vibration Analysis - Road Testing

Step	Action	Yes	No
WARNING: Refer to <u>Road Test Warning</u> .			

1	Did you review the Diagnostic Starting Point - Vibration Diagnosis?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	Did the customer concern indicate that the vibration occurs ONLY while the vehicle is standing still?	Go to Step 6	Go to Step 3
3	Visually inspect the tire and wheel assemblies, steering components and suspension components for any possible faults. Are the tire and wheel assemblies, steering components and suspension components in good working condition?	Go to Step 5	Go to Step 4
4	NOTE: Do NOT operate the vehicle until the faults are corrected. Correct the faults with the tire and wheel assemblies, steering components, and/or the suspension components before proceeding. Did you correct the faults with the tire and wheel assemblies, steering components, and/or the suspension components?	Go to Step 5	Go to Step 3
5	1. Obtain the drive axle final drive ratio. 2. If the vibration analyzer has suitable software, obtain the transmission gear ratios. 3. If the a vibration analyzer is not available, take note of the tire size on each axle, then calculate the tire rotational speed for each size tire used. Refer to <u>Component Rotational Speed Calculation</u> . Did you obtain the powertrain ratios for use with the vibration analyzer , or calculate the component rotational speeds, if a vibration analyzer is NOT available?	Go to Step 6	-
6	1. Install a scan tool. 2. With the scan tool, bring up the Powertrain Control Module data list and select Engine Speed. Is the scan tool operating properly?	Go to Step 7	Go to <u>Diagnostic Starting Point - Vehicle</u>
7	Using a vibration analyzer is the preferred method for gathering necessary vibration frequency data. If a vibration analyzer is not available, the necessary vibration frequency data will have to be obtained based on symptoms observed during testing. Review <u>Symptoms - Vibration Diagnosis and Correction</u> to		

	<p>become familiar with the possible frequency ranges. Review Symptoms - Vibration Diagnosis and Correction, as necessary throughout the remainder of diagnostics.</p> <p>Is a vibration analyzer available for use?</p>	Go to Step 8	Go to Step 9
8	<p>Install the EL-38792-A Electronic Vibration Analyzer 2 (EVA 2).</p> <p>Is the vibration analyzer operating properly?</p>	Go to Step 9	Go to <u>Electronic Vibration Analyzer (EVA) Description and Operation</u>
9	<p>Did the customer concern indicate that the vibration occurs ONLY while the vehicle is standing still?</p>	Go to <u>Vibration Analysis - Engine</u>	Go to Step 10
10	<ol style="list-style-type: none"> 1. Install the vibration analyzer sensor, if available, to the component identified by the customer as most respondent to the vibration. If no component was identified, install the vibration analyzer sensor, if available, to the steering column. You may have to move the sensor to other locations later. 2. Select a smooth, level road and slowly accelerate the vehicle up to highway speed. 3. Observe the vehicle for disturbances that match the customer's description and note the following conditions: <ul style="list-style-type: none"> • The vehicle speed • The engine RPM • The transmission gear range and the specific gear • The vibration frequency reading, if detected by the vibration analyzer • The feel and/or sound of the disturbance 4. If the vibration seems to excite a particular component of the vehicle more than the steering column, then move the vibration analyzer sensor, if available, onto that component and repeat steps 2 and 3. <p>Were you able to duplicate the customer's concern?</p>	Go to Step 11	Go to <u>Vibration Diagnostic Aids</u>
11	<ol style="list-style-type: none"> 1. Accelerate the vehicle to a speed higher than the speed at which the disturbance occurs. <p>NOTE: If the vehicle is equipped with an automatic transmission, let the vehicle coast to a stop before shifting back into gear.</p>		

	<p>2. Shift the vehicle into NEUTRAL and allow the vehicle to coast down through the disturbance range.</p> <p>Does the disturbance still occur while coasting-down in NEUTRAL?</p>	Go to Step 13	Go to Step 12
12	<p>1. Select a smooth, level road and slowly accelerate the vehicle up to the speed at which the disturbance occurs.</p> <p>2. Decelerate and safely downshift by one gear range.</p> <p>3. Operate the vehicle at the same VEHICLE SPEED at which the disturbance occurs.</p> <p>Does the same disturbance still occur while going the same vehicle speed in a lower gear range?</p>	Go to <u>Vibration Analysis - Hub and/or Axle Input</u>	Go to <u>Vibration Analysis - Engine</u>
13	<p>If the vibration analyzer is not available, refer to <u>Symptoms - Vibration Diagnosis and Correction.</u></p> <p>Did the vibration analyzer detect a dominant frequency?</p>	Go to Step 14	Go to <u>Symptoms - Vibration Diagnosis and Correction</u>
14	<p>1. If the vibration analyzer HAS the features, use the drive axle final drive ratio, the specific transmission gear ratio, and the engine RPM to make a comparison to the dominant frequency reading recorded.</p> <p>2. If the vibration analyzer does NOT have the features, compare the dominant frequency reading recorded to the component rotational data which you calculated previously.</p> <p>Does the frequency data clearly fall within the tire/wheel parameters ONLY?</p>	Go to <u>Vibration Analysis - Tire and Wheel</u>	Go to <u>Symptoms - Vibration Diagnosis and Correction</u>

COMPONENT ROTATIONAL SPEED CALCULATION

Special Tools

EL-38792-A Electronic Vibration Analyzer (EVA) 2

For equivalent regional tools, refer to **Special Tools and Equipment.**

Tire Rotational Speed

Determining Tire Revolutions Per Second at 8 km/h (5 mph) - Using EVA

Tire and wheel assembly rotational speed can be obtained through using the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2. Perform the following steps using the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 to obtain the rotational speed at 8 km/h (5 mph). Use the Enter key to advance and the Exit key to backup.

1. On the Main Menu screen, select Auto Mode.
2. On the Suspected Source screen, select Vehicle Speed.
3. On the Tire Info Source screen, select Manual Entry.
4. On the Tire Width screen, enter the specific width of the tires.

For example: For a P245/45/R18 tire, enter 245.

5. On the Aspect Ratio screen, enter the specific aspect ratio of the tires.

For example: For a P245/45/R18 tire, enter 0.45.

6. On the Rim Diameter screen, enter the specific rim diameter size.

For example: For a P245/45/R18 tire, enter 18.0.

7. On the Driveshaft Configuration screen, enter FWD, even if the vehicle is a rear wheel drive.
8. The next screen will display the tire size just entered for confirmation.

For example: 245 0.45 18.0 -Front Wheel Drive. If the tire size displayed is correct, press Enter.

9. On the Vehicle Speed Units screen, press Enter, disregard mph or km/h.
10. Press the Exit key several times slowly while watching the backwards progression of the screens. Stop at the Tire Info Source screen.
11. On the Tire Info Source screen, select RPS at 5 mph.
12. The next screen will display the revolutions per second (RPS) at 8 km/h (5 mph) for that specific tire size.

For example: The P245/45/R18 will display 1.08 RPS.

Calculating Tire Revolutions Per Second at 8 km/h (5 mph) - Without EVA

If the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 is not available, the tire and wheel assembly rotational speed can be calculated approximately by performing the following steps.

1. Convert the rim diameter size from inches to centimeters.

For example: For a P245/45/R18 tire, the rim diameter of 18 in X 2.54 converts to 45.72 cm.

2. Calculate the radius of the rim by dividing the rim diameter by 2.

For example: For a P245/45/R18 tire, the rim diameter of 18 is converted to 45.72 cm divided by 2 = rim radius 22.86 cm.

3. Calculate the approximate tire sidewall height by multiplying the specific tire tread width by the aspect ratio, then reduce 7 percent from the amount by multiplying by 93 percent to approximate load on the tire reducing the sidewall height.

For example: For a P245/45/R18 tire, tread width 245 mm X aspect ratio as a decimal 0.45 = 110 mm X 0.93 = approximate sidewall height 102.30 mm.

4. Convert the calculated approximate tire sidewall height from millimeters to centimeters.

For example: For a P245/45/R18 tire, approximate sidewall height 102.30 mm converts to 10.23 cm.

5. Calculate the approximate tire and wheel assembly radius by adding the rim radius and approximate sidewall height, both in cm.

For example: For a P245/45/R18 tire, rim radius 22.86 cm + 10.23 cm = approximate tire and wheel assembly radius 33.09 cm.

6. Calculate the approximate circumference of the tire and wheel assembly by multiplying 2 X pi, or 6.283185 X the approximate tire and wheel assembly radius.

For example: For a P245/45/R18 tire, 6.283185 X approximate tire and wheel assembly radius 33.09 cm = approximate tire and wheel assembly circumference 207.911 cm.

7. Calculate the approximate revolutions per kilometer by dividing the number of cm in 1 km, 100,000 cm by the approximate tire and wheel assembly circumference.

For example: For a P245/45/R18 tire, 100,000 cm divided by approximate tire and wheel assembly circumference 207.911 cm = approximate revolutions per kilometer 480.975.

8. Calculate the approximate revolutions per second (RPS), or Hz, by dividing the approximate revolutions per kilometer by the number of seconds to travel 1 km at a speed of 8 km per hour, 450 seconds.

For example: For a P245/45/R18 tire, approximate revolutions per kilometer 480.975 divided by the number of seconds to travel 1 km at a speed of 8 km per hour, 450 seconds = approximate RPS, or Hz 1.069 rounded to 1.07.

Calculating Tire Revolutions Per Second, or Hz at Concern Speed

A size P235/75R15 tire rotates ONE complete revolution per second (RPS), or 1 Hz, at a vehicle speed of 8 km/h (5 mph). This means that at 16 km/h (10 mph), the same tire will make TWO complete revolutions in one second, 2 Hz, and so on.

1. Determine the rotational speed of the tires in revolutions per second (RPS), or Hertz (Hz), at 8 km/h (5 mph), based on the size of the tires. Refer to the preceding Tire Rotational Speed information.

For example: According to the Tire Rotational Speed information, a P245/45R18 tire makes 1.08 revolutions per second (Hz) at a vehicle speed of 8 km/h (5 mph). This means that for every increment of

8 km/h (5 mph) in vehicle speed, the tire's rotation increases by 1.08 revolutions per second, or Hz.

2. Determine the number of increments of 8 km/h (5 mph) that are present, based on the vehicle speed in km/h (mph) at which the disturbance occurs.

For example: Assume that a disturbance occurs at a vehicle speed of 96 km/h (60 mph). A speed of 96 km/h (60 mph) has 12 INCREMENTS of 8 km/h (5 mph):

96 km/h (60 mph) divided by 8 km/h (5 mph) = 12 increments

3. Determine the rotational speed of the tires in revolutions per second, or Hz, at the specific vehicle speed in km/h (mph) at which the disturbance occurs.

For example: To determine the tire rotational speed at 96 km/h (60 mph), multiply the number of increments of 8 km/h (5 mph) by the revolutions per second, or Hz, for one increment:

12 increments X 1.08 Hz = 12.96 Hz, rounded to 13 Hz

NOTE: If the EL-38792-A Electronic Vibration Analyzer (EVA) 2 is not available, compare the calculated rotational speed to the frequency range associated with the symptoms of the vibration concern. Refer to Symptoms - Vibration Diagnosis and Correction.

4. Compare the rotational speed of the tires at the specific vehicle speed at which the disturbance occurs, to the dominant frequency recorded on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 during testing. If the frequencies match, then a first-order disturbance related to the rotation of the tire/wheel assemblies is present.

If the frequencies do not match, then the disturbance may be related to a higher order of tire/wheel assembly rotation.

5. To compute higher order tire/wheel assembly rotation related disturbances, multiply the rotational speed of the tires at the specific vehicle speed at which the disturbance occurs, by the order number:

13 Hz X 2, for second order = 26 Hz second-order tire/wheel assembly rotation related

13 Hz X 3, for third order = 39 Hz third-order tire/wheel assembly rotation related

If any of these computations match the frequency of the disturbance, a disturbance of that particular order, relating to the rotation of the tire/wheel assemblies and/or driveline components, also rotating at the same speed, is present.

Component Rotational Speed Worksheet

Utilize the following worksheet as an aid in calculating the first, second and third order of tire/wheel assembly rotational speed related disturbances that may be present in the vehicle.

If after completing the Tire/Wheel Rotation Worksheet, the frequencies calculated do NOT match the dominant frequency of the disturbance recorded during testing, either recheck the data, or attempt to rematch the figures allowing for 1 1/2 -8 km/h (1-5 mph) of speedometer error.

If the possible tire/wheel assembly rotational speed related frequencies still do not match the dominant frequency of the disturbance, the disturbance is most likely torque/load sensitive.

If after completing the Tire/Wheel Rotation Worksheet, one of the frequencies calculated DOES match the dominant frequency of the disturbance, the disturbance is related to the rotation of that component group - tire/wheel assembly related.

TIRE/WHEEL ROTATION WORKSHEET

Vehicle Information

Complaint Speed: _____ mph Year: _____ Model: _____
 Symptom: _____ VIN: _____
 Frequency: _____ Engine: _____ Trans: _____
 Engine Speed: _____ rpm Tire Size: _____ Axle Ratio: _____ : _____
 Gear: _____ TPC Spec: _____

Tire/Wheel Speed

Vibration Occurs at:	<input type="text"/>	mph ÷ 8 (km/h) 5 (mph)	=	<input type="text"/>	increments of 8 km/h / 5 mph
8 km/h / 5 mph increments	<input type="text"/>	x	<input type="text"/>	tire RPS * at 8 km/h / 5 mph (from table)	= <input type="text"/> Tire/Wheel Speed, RPS (Hz) 1st order
1st order	<input type="text"/>	x 2	=	<input type="text"/>	2nd order
1st order	<input type="text"/>	x 3	=	<input type="text"/>	3rd order

*RPS: revolutions per second; equates to cycles per second (cps).

Fig. 1: Tire/Wheel Rotation Worksheet
 Courtesy of GENERAL MOTORS COMPANY

VIBRATION ANALYSIS - TIRE AND WHEEL

Test Description

The numbers below refer to the step numbers in the diagnostic table:

4

A build-up of foreign material on a tire and wheel assembly and/or a damaged, abnormally or excessively worn tire and wheel assembly could cause a vibration disturbance.

6

Tire and wheel assemblies that exhibit excessive runout when measured while mounted on the vehicle, may or may not be contributing to, or causing a vibration disturbance. On-vehicle runout, if present, could contribute to, or cause a vibration disturbance, but the cause of the on-vehicle runout may not be the tire and wheel assemblies.

7

Tire and wheel assemblies that exhibit excessive runout when measured off of the vehicle could cause a vibration disturbance.

9

Tire and wheel assemblies that exhibit marginal runout-within acceptable limits, but close to the maximum-when measured off of the vehicle could still be contributing to a vibration disturbance, if its mating hub/axle flange also exhibits marginal runout. When the tire and wheel assembly and the hub axle flange are mounted to each other, the combined stack-up of their marginal amounts of runout could combine to produce an excessive amount of runout, which could cause a vibration disturbance.

14

Brake rotors and/or brake drums, if equipped, that exhibit excessive imbalance could contribute to, or possibly cause a vibration disturbance.

15

A hub/axle flange and/or wheel studs that exhibit excessive runout could cause a vibration disturbance.

16

When the tire and wheel assembly and the hub axle flange are mounted to each other, the combined stack-up of their marginal amounts of runout could combine to produce an excessive amount of runout, which could cause a vibration disturbance. Match-mounting or vectoring the tire and wheel assembly to the hub/axle flange will modify the amount of combined runout.

18

Force variation may be present in a tire and wheel assembly that exhibited acceptable balance and runout. Force variation, if present, could contribute to, or cause a vibration disturbance.

20

Vibration disturbances could be affected by, or possibly caused by, components that are susceptible to steering input and/or torque-load input.

22

On-vehicle balancing, or finish-balancing can be used to reduce small amounts of imbalance which may be present as a result of the combined stack-up of the tire and wheel assembly with other components which may exhibit marginal balance.

Vibration Analysis - Tire and Wheel

Step	Action	Yes	No
1	Has the Vibration Analysis - Road Testing table been completed?	Go to Step 2	Go to <u>Vibration Analysis - Road Testing</u>
2	Based on the Vibration Analysis - Road Testing table, is the concern first-order tire and wheel assembly related?	Go to Step 4	Go to Step 3
3	Based on the Vibration Analysis - Road Testing table, is the concern second-order, or higher-order tire and wheel assembly related?	Go to Step 18	Go to <u>Vibration Analysis - Road Testing</u>
4	Visually inspect the tire and wheel assemblies for the following: <ul style="list-style-type: none"> • Debris build-up, such as packed mud, undercoating, ice/snow buildup, road tar, etc. • Damage, abnormal or excessive wear Refer to <u>Tire and Wheel Inspection</u> . Do any of the tire and wheel assemblies exhibit any of the conditions listed?	Go to Step 5	Go to Step 6
5	<ol style="list-style-type: none"> 1. Remove the debris from the tire and wheel assemblies. 2. Replace the damaged, abnormally or excessively worn wheels or tires as necessary. Did you complete the repair or replacement?	Go to Step 23	-
6	Measure the on-vehicle runout of the tire and wheel assemblies. Refer to <u>Tire and Wheel Assembly Runout Measurement - On-Vehicle</u> . Does the runout measurement indicate a runout concern?	Go to Step 7	Go to Step 12
7	Measure the off-vehicle runout of the tire and wheel assemblies. Refer to <u>Tire and Wheel Assembly Runout Measurement - Off Vehicle</u> . Does the runout measurement indicate a runout		

	concern?	Go to Step 19	Go to Step 8
8	Is the vehicle equipped with run-flat tires?	Go to Step 12	Go to Step 9
9	Are any of the tire and wheel assembly runout measurements marginal; within acceptable limits, but close to the maximum?	Go to Step 10	Go to Step 15
10	<p>NOTE: Ensure that each tire and wheel assembly that is match-mounted is properly balanced before reinstalling to the vehicle.</p> <ol style="list-style-type: none"> 1. Match-mount the tire-to-wheel for each tire and wheel assembly with marginal runout. Refer to <u>Tire-to-Wheel Match-Mounting (Vectoring)</u>. 2. Measure the runout of each match-mounted tire and wheel assembly. Refer to <u>Tire and Wheel Assembly Runout Measurement - Off Vehicle</u>. <p>Were you able to significantly reduce the amount of tire and wheel assembly runout?</p>	Go to Step 11	Go to Step 19
11	<p>Re-measure the on-vehicle runout of the tire and wheel assemblies. Refer to <u>Tire and Wheel Assembly Runout Measurement - On-Vehicle</u>.</p> <p>Does the measurement indicate a runout concern?</p>	Go to Step 15	Go to Step 23
12	<p>Inspect the balance of the tire and wheel assemblies. Refer to <u>Tire and Wheel Assembly Balancing - Off Vehicle</u>.</p> <p>Are any of the tire and wheel assemblies out of balance?</p>	Go to Step 13	Go to Step 14
13	<p>Balance the tire and wheel assemblies as necessary. Refer to <u>Tire and Wheel Assembly Balancing - Off Vehicle</u>.</p> <p>Were you able to achieve balance?</p>	Go to Step 23	Go to <u>Vibration Diagnostic Aids</u>
14	<ol style="list-style-type: none"> 1. Inspect the brake rotors and brake drums, if equipped, for damage. 2. Inspect the balance of the brake rotors and brake drums, if equipped. Refer to <u>Brake Rotor/Drum Balance Inspection</u>. 3. Replace brake rotors and/or brake drums, if equipped, that are damaged and/or out of balance. <p>Did you find and correct a condition?</p>	Go to Step 23	Go to Step 17
	<ol style="list-style-type: none"> 1. Measure the runout of the hub/axle flanges and the wheel studs, if equipped. 2. Inspect the wheel bolts, if equipped, for straightness and damage. 		

15	<p>3. Refer to <u>Hub/Axle Flange and Wheel Stud Runout Inspection</u>.</p> <p>4. If the inspection procedure indicates a runout concern, replace the appropriate components:</p> <ul style="list-style-type: none"> • Wheel studs, if equipped • Wheel bolts, if equipped • Wheel bearing/hub assembly 		
	Did you find and correct a condition?	Go to Step 23	Go to Step 16
16	<p>1. Match-mount the tire and wheel assemblies-to-hub/axle flanges. Refer to <u>Tire and Wheel Assembly-to-Hub/Axle Flange Match-Mounting</u>.</p> <p>2. Re-measure the on-vehicle runout of tire and wheel assemblies. Refer to <u>Tire and Wheel Assembly Runout Measurement - On-Vehicle</u>.</p>		
	Were you able to significantly reduce the amount of on-vehicle tire and wheel assembly runout?	Go to Step 23	Go to Step 2
17	<p>Inspect for radial and lateral force variation. Refer to <u>Tire and Wheel Assembly Isolation Test</u>.</p> <p>Were you able to isolate one or more of the tire and wheel assemblies as the cause of the disturbance?</p>	Go to Step 19	Go to Step 20
18	<p>Inspect for radial and lateral force variation. Refer to <u>Tire and Wheel Assembly Isolation Test</u>.</p> <p>Were you able to isolate one or more of the tire and wheel assemblies as the cause of the disturbance?</p>	Go to Step 19	Go to Step 21
19	<p>Replace any tires and/or wheels that were isolated as the cause of the disturbance, as necessary.</p> <p>Did you complete the replacement?</p>	Go to Step 23	-
20	<p>Perform the Vibration Analysis - Hub/Axle Input table. Refer to <u>Vibration Analysis - Hub and/or Axle Input</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 23	Go to Step 22
21	<p>Perform the Vibration Analysis - Hub/Axle Input table. Refer to <u>Vibration Analysis - Hub and/or Axle Input</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 23	Go to <u>Vibration Diagnostic Aids</u>
22	<p>Finish-balance the tire and wheel assemblies on-vehicle. Refer to <u>Tire and Wheel Assembly Balancing - On-Vehicle</u>.</p> <p>Did you complete the on-vehicle finish balancing?</p>	Go to Step 23	-
23	<p>1. Install or connect any components that were removed or disconnected during diagnosis.</p> <p>2. Perform the Vibration Analysis - Road Testing table. Refer to <u>Vibration Analysis - Road</u></p>		

	<u>Testing.</u> Is the vibration still present?	Go to Step 2	System OK
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VIBRATION ANALYSIS - HUB AND/OR AXLE INPUT

Test Description

The numbers below refer to the step numbers on the diagnostic table:

2

This test will determine the effect of turning input on the vibration.

6

This test will determine the effect of an initial heavy torque load on the vibration.

7

Damaged or worn wheel drive shafts may cause a noise or vibration that may be transferred into the passenger compartment.

8

Damaged or worn wheel bearings may cause a noise or vibration that may be transferred into the passenger compartment.

9

Damaged or worn suspension components may cause a noise or vibration that may be transferred into the passenger compartment.

10

Damaged or worn powertrain mounts and/or exhaust mounts may cause a noise or vibration that may be transferred into the passenger compartment.

11

Incorrect trim height may cause binding and/or interference between components that may produce a vibration.

Vibration Analysis - Hub and/or Axle Input

Step	Action	Yes	No
WARNING:			

Refer to Road Test Warning .

1	Has the Vibration Analysis - Road Testing table been completed?	Go to Step 2	Go to <u>Vibration Analysis - Road Testing</u>
2	<ol style="list-style-type: none"> 1. Operate the vehicle at the speed of the vibration concern. 2. While maintaining the concern speed, drive the vehicle through slow, sweeping turns - first in one direction, then in the other direction. 3. Observe the vehicle for changes in the vibration disturbance. 4. Select a smooth, level surface, such as an empty parking lot or a remote road. 5. While maintaining the vehicle at the concern speed if possible, drive the vehicle through sharp turns; 360 degrees - first in one direction, then in the other direction. 6. Observe the vehicle for changes in the vibration disturbance. <p>Did the characteristics of the vibration change significantly-become worse or go away-during these steps?</p>	Go to Step 3	Go to Step 6
3	Did you hear a clicking noise and/or feel a shudder during these steps?	Go to Step 7	Go to Step 4
4	Did you hear a growling noise during these steps?	Go to Step 8	Go to Step 5
5	Did you hear a popping noise during these steps?	Go to Step 9	Go to Step 12
6	<ol style="list-style-type: none"> 1. With the vehicle at a stand-still, apply the regular brake and place the transmission in the lowest forward gear. <p>NOTE: Do not accelerate to the point of causing the drive wheels to squeal, slip or hop-this would obscure the results of the test.</p> <ol style="list-style-type: none"> 2. Release the regular brakes and accelerate aggressively to 32 km/h (20 mph). 3. Observe the vehicle for changes in the vibration disturbance. <p>Did you feel a shudder or shaking during these steps?</p>	Go to Step 7	Go to <u>Vibration Diagnostic Aids</u>
	<ol style="list-style-type: none"> 1. Inspect the wheel drive shafts, if equipped, for damage, abnormal and/or excessive wear. 		

7	<p>2. If the inspection indicated that a wheel drive shaft is damaged, abnormally and/or excessively worn, replace the shaft.</p> <p>Did you find and correct a condition?</p>	Go to Step 12	Go to Step 9
8	<p>1. Inspect the wheel bearings for wear and/or damage.</p> <p>2. Replace any of the wheel bearings found to be worn and/or damaged.</p> <p>Did you find and correct a condition?</p>	Go to Step 12	Go to <u>Vibration Diagnostic Aids</u>
9	<p>1. Inspect the following suspension components for wear, damage, looseness and/or possible contact with other vehicle components:</p> <ul style="list-style-type: none"> • Struts/shock absorbers • Springs • Bushings • Insulators <p>2. Replace any of the suspension components found to be worn, damaged, loose and/or contacting other vehicle components.</p> <p>Did you find and correct a condition?</p>	Go to Step 12	Go to Step 10
	<p>1. Inspect the powertrain mounts-engine, transmission, transfer case, and direct-mount differential, if equipped-and any powertrain braces for the following conditions:</p> <ul style="list-style-type: none"> • Loose and/or missing fasteners • Improper alignment • Cracked, dry-rotted, and/or oil-soaked insulators • Twisted, broken, torn, and/or collapsed insulators • Bent, twisted, and/or deformed brackets <p>2. Replace powertrain mounts as necessary.</p> <p>3. Inspect the exhaust system components for the following:</p> <ul style="list-style-type: none"> • Loose and/or missing fasteners <ul style="list-style-type: none"> ○ Heat Shields ○ Joints and/or couplings: <p style="padding-left: 40px;">Nuts, bolts, studs, clamps, straps</p>		

10	<ul style="list-style-type: none"> ○ Bracket and/or insulator mounting ● Inadequate clearance to body and/or chassis components <p>Inspect with the exhaust system both COLD and HOT; in NEUTRAL, FORWARD and REVERSE gears</p> <ul style="list-style-type: none"> ● Improper alignment ● Disconnected and/or missing insulators ● Cracked, dry-rotted, and/or oil-soaked insulators ● Stretched, twisted, broken, torn, and/or collapsed insulators ● Bent, twisted, cracked, and/or deformed brackets <p>4. Repair, replace, and/or realign exhaust system components as necessary.</p> <p>Did you find and correct a condition?</p>	Go to Step 12	Go to Step 11
11	<p>Inspect the vehicle trim height and adjust as necessary. Refer to <u>Trim Height Inspection (GNA)</u> , <u>Trim Height Inspection (GNB)</u> .</p> <p>Did you find and correct a condition?</p>	Go to Step 12	Go to <u>Vibration Diagnostic Aids</u>
12	<ol style="list-style-type: none"> 1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis - Road Testing table. Refer to <u>Vibration Analysis - Road Testing</u>. <p>Is the vibration still present?</p>	Go to Step 2	System OK

VIBRATION ANALYSIS - ENGINE

Special Tools

EL-38792-A Electronic Vibration Analyzer (EVA) 2

For equivalent regional tools, refer to **Special Tools and Equipment**.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

If powertrain related DTCs are present, there may be a powertrain performance condition present which could be a contributing cause to the customer's concern.

5

Making comparisons of the customer's vehicle with an equally equipped, same model year and type, KNOWN GOOD vehicle will help determine if certain disturbances may be characteristic of a vehicle design.

Vibration Analysis - Engine

Step	Action	Yes	No
WARNING: Refer to <u>Work Stall Test Warning</u> .			
1	Has the Vibration Analysis - Road Testing table been completed?	Go to Step 2	Go to <u>Vibration Analysis - Road Testing</u>
2	Using a scan tool, determine if any DTCs are set. Were any DTCs set?	Go to <u>Diagnostic Starting Point - Vehicle</u>	Go to Step 3
3	<ol style="list-style-type: none"> Block the front wheels. Apply BOTH the service brakes and the park brake. With the scan tool and the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available, still installed, start the engine. Place the transmission in NEUTRAL or PARK. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available. Place the transmission in DRIVE. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A 		

	<p>Electronic Vibration Analyzer (EVA) 2 , if available.</p> <p>10. If no frequency data was obtained, or if the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , is not available, place the transmission into REVERSE, then repeat steps 8 and 9. Reverse-loading of the powertrain may increase or change the characteristics of the vibration.</p> <p>Were you able to duplicate the customer's concern?</p>		
4	<p>Did the EL-38792-A Electronic Vibration Analyzer (EVA) 2 detect a dominant frequency, or was a significant vibration present?</p>	<p>Go to Step 4</p> <p>Go to <u>Vibration Analysis - Engine/Accessory Isolation</u></p>	<p>Go to <u>Vibration Diagnostic Aids</u></p> <p>Go to Step 5</p>
5	<p>Compare the test results of the customer's vehicle to the results of the same tests run, at the same engine RPM, on an equally-equipped, same model year and type, KNOWN GOOD vehicle. Refer to <u>Vehicle-to-Vehicle Diagnostic Comparison.</u></p> <ol style="list-style-type: none"> 1. Install a scan tool into the known good vehicle. 2. Install the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available, into the known good vehicle; place the sensor in exactly the same location as it was placed in the customer's vehicle. 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. Start the engine. 6. Place the transmission in NEUTRAL or PARK. 7. Slowly increase the engine RPM to the level at which the disturbance was most noticeable in the customer's vehicle. 8. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available. 9. Place the transmission in DRIVE. 		

<p>10. Slowly increase the engine RPM to the level at which the disturbance was most noticeable in the customer's vehicle.</p> <p>11. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available.</p> <p>12. If no frequency data was obtained, or if the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , is not available, place the transmission into REVERSE, then repeat steps 10 and 11. Reverse-loading of the powertrain may increase or change the characteristics of the vibration.</p>		
<p>Did both of the vehicles exhibit the same characteristics?</p>	<p>Go to <u>Vibration Diagnostic Aids</u></p>	<p>Go to <u>Vibration Analysis - Engine/Accessory Isolation</u></p>

ENGINE ORDER CLASSIFICATION

Engine First Order Classification

1. Convert the engine speed in revolutions per minute (RPM), recorded during duplication of the disturbance into Hertz , revolutions per second (RPS), by dividing the RPM by 60 seconds. Refer to the following example:

1,200 RPM divided by 60 = 20 Hz (or RPS)

2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the engine speed just converted into Hz, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine speed, converted into Hz, ARE related, then an engine FIRST ORDER related disturbance is present. Engine first order disturbances are usually related to an imbalanced component. Refer to the Engine Order Related Disturbances table.
4. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine speed, converted into Hz, are NOT related, then determine if the disturbance is related to the engine's firing frequency. Proceed to Engine Firing Frequency Classification.

Engine Firing Frequency Classification

Engine firing frequency is a term used to describe the number of firing pulses (one firing pulse = one cylinder firing) that occur during ONE complete revolution of the crankshaft, multiplied by the number of crankshaft revolutions per second, Hz.

1. Calculate the engine firing frequency.

- To determine the firing frequency of a 4-stroke engine during ONE complete revolution of the crankshaft, multiply the engine speed, converted into Hz, by HALF of the total number of cylinders in the engine.
- For example: The engine speed, converted into Hz, was 20 Hz; if the vehicle was equipped with a V8 engine, 4 of the 8 cylinders would actually fire during ONE complete revolution of the crankshaft.

- Multiply the converted engine speed (20 Hz) by 4 cylinders firing.

$$20 \text{ Hz} \times 4 = 80 \text{ Hz}$$

- The engine firing frequency for a V8 engine at the original engine speed of 1,200 RPM, recorded during duplication of the disturbance, would be 80 Hz.
- In like manner, a 6-cylinder engine would have a firing frequency of 60 Hz at the same engine speed of 1,200 RPM.

$$20 \text{ Hz} \times 3 = 60 \text{ Hz}$$

2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the engine firing frequency in Hz, just calculated, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine firing frequency in Hz, just calculated ARE related, then an engine FIRING FREQUENCY related disturbance is present. Engine firing frequency disturbances are usually related to improper isolation of a component. Refer to the Engine Order Related Disturbances table.
4. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine firing frequency in Hz, just calculated are NOT related, then determine if the disturbance is related to another engine order classification. Proceed to Other Engine Order Classification.

Other Engine Order Classification

1. Multiply the engine speed, converted into Hz, recorded during duplication of the disturbance by different possible order-numbers, other than 1 (first order) or the number used to determine the firing frequency of the engine.
2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the other possible engine orders just calculated, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and one of the other engine order frequencies in Hz, just calculated ARE related, then an engine related disturbance of that order is present. If an engine related disturbance is present that is NOT related to first order or firing frequency, then it could be related to an engine driven accessory system. Proceed to Engine Driven Accessories Related to Engine Order.

Engine Driven Accessories Related to Engine Order

Engine driven accessory systems can be related to specific engine orders depending upon the relationship of the accessory pulley diameter to the crankshaft pulley diameter. For example:

- If the crankshaft pulley measured 20 cm (8 in) in diameter and one of the engine driven accessory pulleys measured 10 cm (4 in) in diameter, then that accessory pulley would rotate 2 times for every one rotation of the crankshaft pulley. If that accessory system was not isolated properly, or was not operating properly, it would be identifiable as a 2nd order engine related disturbance.
- In like manner, if an engine driven accessory pulley measured 5 cm (2 in) in diameter, then that accessory pulley would rotate 4 times for every one rotation of the crankshaft pulley. If that accessory system was not isolated properly, or was not operating properly, it would be identifiable as a 4th order engine related disturbance.

Engine driven accessories that contribute to, are excited by, or are the sole cause of a disturbance are usually doing so because of improper isolation that causes a transfer path into the passenger compartment or to another major component of the vehicle body.

Using the **EL-38792-VS** Vibrate Software , accurately measuring the diameters of the accessory pulleys and the crankshaft pulley, and performing the appropriate diagnostic procedures completely will lead to the specific accessory system which is either contributing to, or causing the customer's concern.

Engine Order Related Disturbances

Engine Order	Engine Arrangement						
	L4 W/O Balance Shaft	L4 With Balance Shaft	L5	L6	60 Degree V6	90 Degree V6 With Balance Shaft	90 Degree
1/2 Order Torque Sensitive	Abnormal - Likely Single Cylinder Misfire	Abnormal - Likely Single Cylinder Misfire	Abnormal - Likely Single Cylinder Misfire	Abnormal - Likely Single Cylinder Misfire	Abnormal - Likely Single Cylinder Misfire and/or EGR/Fuel Variance	Abnormal - Likely Single Cylinder Misfire and/or EGR/Fuel Variance	Abnormal - Likely Single Cylinder Misfire
1st Order	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance
1 1/2 Order Torque Sensitive	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Abnormal - Likely Bank to Bank EGR/Fuel Variance	Abnormal - Likely Bank to Bank EGR/Fuel Variance	Possible Engine Driven Accessory Related
					Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	
2nd Order Non Torque	Characteristic of Engine Arrangement - Possible Powertrain	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Characteristic of Engine Arrangement - Possible Powertrain	Characteristic of Engine Arrangement - Possible Powertrain	Possible Engine Driven Accessory Related

Sensitive	Isolation Related				Isolation Related	Isolation Related	
2nd Order Torque Sensitive	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Abnorm Likely Ba Bank EGR/F Variation
	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related					Possib Engine D Accesso Related
2 1/2 Order Torque Sensitive	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possib Engine D Accesso Related
			Possible Engine Driven Accessory Related				
3rd Order Torque Sensitive	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related	Possib Engine D Accesso Related
				Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	
4th Order Torque Sensitive	Characteristic - Minimal Amount - of Engine Arrangement - Possible Powertrain Isolation Related	Characteristic - Minimal Amount - of Engine Arrangement - Possible Powertrain Isolation Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Characte - ENGI FIRING FREQUE - Possi Powertr Isolatio Related
				Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	

	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related					Possible Engine D Accessory Related
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VIBRATION ANALYSIS - ENGINE/ACCESSORY ISOLATION

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5

A loose, damaged, misaligned, or defective powertrain insulator and/or bracket may create a transfer path into the passenger compartment.

6

A loose, damaged, misaligned, or defective exhaust system insulator and/or bracket may create a transfer path into the passenger compartment.

7

Incorrectly seated and/or aligned powertrain components and/or exhaust system components may create a transfer path into the passenger compartment.

When loosening powertrain mounts in order to re-bed the powertrain observe the following:

Do not loosen the mount bracket-to-engine bolts/nuts, do not loosen the mount bracket-to-vehicle frame bolts/nuts if mount brackets are used.

Loosen the mount-to-mount bracket bolts/nuts if mount brackets are used, or loosen the mount-to-slotted holes in vehicle frame bolts/nuts if a direct-mount design is used.

8

Non-rotating engine driven accessory component systems can no longer produce a unique disturbance.

9

Non-rotating engine driven accessory components can no longer produce a unique disturbance. If a disturbance is still present, but the characteristics have been altered, it is possible that these component systems are acting as a transfer path for engine firing frequency or a first order engine disturbance.

If a disturbance is still present, but the characteristics have NOT been altered, it is NOT likely that these component systems are acting as a transfer path for engine firing frequency or a first order engine disturbance.

10

If the mark placed on the face of an engine driven accessory pulley seems to stand still while running this test, then that accessory system is either responding to an existing frequency, such as engine firing pulses, or creating a disturbance.

11

A loose, damaged, misaligned, or defective engine driven accessory system insulator and/or bracket may create a transfer path into the passenger compartment.

12

Removing the engine driven accessory and bracket, or brackets from the engine allows a thorough inspection to determine if any conditions are present that may create a transfer path into the passenger compartment.

Vibration Analysis - Engine/Accessory Isolation

Step	Action	Yes	No
WARNING: Refer to <u>Work Stall Test Warning</u> .			
1	Were you sent here from the Vibration Analysis - Engine table?	Go to Step 2	Go to <u>Vibration Analysis - Engine</u>
2	Is the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , available?	Go to Step 3	Go to Step 5
3	<ol style="list-style-type: none">Using the engine RPM and frequency data recorded for the customer's vehicle, determine the order of engine rotation to which the disturbance is related.Determine the possible causes of the disturbance as it relates to a specific order of engine rotation. Refer to <u>Engine Order Classification</u> . Does the Engine Order Classification table indicate that the disturbance is of the same order as the engine firing frequency?	Go to Step 5	Go to Step 4
4	Does the Engine Order Classification table indicate that the disturbance is likely related to engine driven accessories?	Go to Step 8	Go to Step 5
	Inspect the powertrain mounts-engine, transmission, transfer case, and direct-mount drive axle, if equipped-and any powertrain braces for the following conditions:		

5	<ul style="list-style-type: none"> • Loose and/or missing fasteners • Improper alignment • Cracked, dry-rotted, and/or oil-soaked insulators • Twisted, broken, torn, and/or collapsed insulators • Bent, twisted, and/or deformed brackets <p>Realign or replace powertrain mounts as indicated by the inspection. Did you find and correct a condition?</p>	Go to Step 13	Go to Step 6
6	<p>Inspect the exhaust system components for the following:</p> <ul style="list-style-type: none"> • Loose and/or missing fasteners <ul style="list-style-type: none"> ○ Heat Shields ○ Joints and/or couplings: <p>Nuts, bolts, studs, clamps, straps</p> ○ Bracket and/or insulator mounting • Inadequate clearance to body and/or chassis components <p>Inspect with the exhaust system both COLD and HOT; in NEUTRAL, FORWARD and REVERSE gears</p> <ul style="list-style-type: none"> • Improper alignment • Disconnected and/or missing insulators • Cracked, dry-rotted, and/or oil-soaked insulators • Stretched, twisted, broken, torn, and/or collapsed insulators • Bent, twisted, cracked, and/or deformed brackets <p>Repair, replace, and/or realign exhaust system components as indicated by the inspection. Did you find and correct a condition?</p>	Go to Step 13	Go to Step 7
	Perform the Powertrain Mount Balance Procedure if available or perform the following procedure to re-bed		

7	<p>the powertrain:</p> <ol style="list-style-type: none"> 1. Loosen, but do not remove, all powertrain mounts and exhaust system hangers. 2. Ensure that the exhaust flexible coupling, if equipped, moves freely. 3. Start the engine. 4. Settle the powertrain by shifting the transmission from DRIVE to REVERSE. 5. Place the transmission into NEUTRAL. 6. Turn OFF the ignition. 7. Tighten all of the loosened fasteners with the powertrain in a relaxed position. <p>Did you complete the operation?</p>	Go to Step 13	-
8	<p>CAUTION: Do not run the engine for longer than 60 seconds with the accessory drive belt, or belts removed, or overheating and/or damage may result.</p> <ol style="list-style-type: none"> 1. Remove the engine accessory drive belt, or belts. 2. Block the front wheels. 3. Apply BOTH the service brakes and the park brake. 4. With the scan tool still installed, start the engine. 5. Place the transmission in NEUTRAL or PARK. 6. Increase the engine RPM to the level recorded during duplication of the disturbance. 7. Allow the engine to idle, then place the transmission in DRIVE. 8. Increase the engine RPM to the level recorded during duplication of the disturbance. 9. Turn OFF the ignition. 10. Install the engine accessory drive belt, or belts. <p>Was the disturbance significantly reduced or eliminated?</p>	Go to Step 10	Go to Step 9
9	Were the characteristics of the disturbance altered but still present?	Go to Step 11	Go to Step 15
	1. Mark the face of the suspected accessory		

pulleys, including any related idler pulleys, near the outer edge with a paint mark.

2. Install the **EN-38792-25** Inductive Pickup Timing Light , to the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2.

For information on the use of the EVA features, refer to **Electronic Vibration Analyzer (EVA) Description and Operation**.

3. Block the front wheels.
4. Apply BOTH the service brakes and the park brake.
5. With the scan tool and the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , still installed, start the engine.
6. Select the Smart Strobe feature on the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2.
7. Enter the recorded frequency of the disturbance as the initial frequency for strobe operation.
8. Have an assistant place the transmission in NEUTRAL or PARK.
9. Slowly increase the engine RPM to the level recorded during duplication of the disturbance, then maintain that speed.
10. Using the **EL-38792-A** Inductive Pickup Timing Light , check each of the suspected accessory pulleys to determine if any of them is related to the frequency of the disturbance.

Check each of the accessory systems, both engaged and under maximum load and disengaged or under minimum load.

11. Allow the engine to idle, then place the transmission in DRIVE.
12. Slowly increase the engine RPM to the level recorded during duplication of the disturbance, then maintain that speed closely.
13. Using the **EN-38792-25** Inductive Pickup Timing Light , check each of the suspected accessory pulleys to determine if any of them is related to the frequency of the disturbance.

	<p>Check each of the accessory systems, both engaged and under maximum load and disengaged or under minimum load.</p> <p>14. Turn OFF the ignition.</p> <p>Did you identify an engine driven accessory system as being related to the frequency of the disturbance?</p>		
		Go to Step 11	Go to <u>Vibration Diagnostic Aids</u>
11	<p>Inspect the components of the engine driven accessory system for the following:</p> <ul style="list-style-type: none"> • Loose and/or missing fasteners <ul style="list-style-type: none"> ○ Heat Shields, if equipped ○ Joints and/or couplings: <li style="margin-left: 40px;">Nuts, bolts, studs, clamps, straps ○ Bracket and/or insulator mounting • Inadequate clearance to body and/or chassis components <p>Inspect with the accessory system both under a LOAD and NOT loaded</p> <ul style="list-style-type: none"> • Improper alignment • Bent or damaged pulleys • Disconnected and/or missing insulators • Cracked, dry-rotted, and/or oil-soaked component insulators • Stretched, twisted, broken, torn, and/or collapsed component insulators • Bent, twisted, cracked and/or deformed component brackets <p>Repair, replace, and/or realign the engine driven accessory system components as indicated by the inspection.</p> <p>Did you find and correct a condition?</p>		
		Go to Step 13	Go to Step 12
	<ol style="list-style-type: none"> 1. Remove the engine driven accessory and bracket, or brackets from the engine. 2. Thoroughly inspect the accessory bracket, or brackets, bolts/nuts/studs, and the accessory itself for signs of the following: 		

12	<p>Bent, twisted, cracked and/or deformed conditions</p> <ol style="list-style-type: none"> 3. Replace any of the components found to exhibit any of these conditions. 4. Reinstall the components to the engine. <p>Did you find and correct a condition?</p>	Go to Step 13	Go to Step 17
13	<p>Check the vehicle to determine if the disturbance is now significantly reduced or eliminated. Perform the following steps:</p> <ol style="list-style-type: none"> 1. Install a scan tool into the customer's vehicle. 2. Install the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available, into the customer's vehicle; place the sensor in exactly the same location as it was originally placed in the vehicle. 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. Start the engine. 6. Place the transmission in NEUTRAL or PARK. 7. Slowly increase the engine RPM to the level at which the disturbance was most noticeable. 8. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available. 9. Place the transmission in DRIVE. 10. Slowly increase the engine RPM to the level at which the disturbance was most noticeable. 11. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available. 12. If the disturbance has been significantly reduced or eliminated, confirm the results by placing the transmission into REVERSE, then repeat steps 10 and 11. Reverse-loading of the powertrain may increase or change the characteristics of the vibration. 		

	Has the disturbance been significantly reduced or eliminated?	Go to Step 18	Go to Step 14
14	Have you investigated powertrain isolation as a possible cause of the disturbance?	Go to Step 15	Go to Step 5
15	Have you investigated engine driven accessories as a possible cause of the disturbance?	Go to <u>Vibration Analysis - Engine Balance</u>	Go to Step 16
16	Is the EL-38792-A Electronic Vibration Analyzer (EVA) 2 available?	Go to Step 8	Go to <u>Vibration Diagnostic Aids</u>
17	Replace the engine driven accessory component causing the disturbance. Did you complete the replacement?	Go to Step 18	-
18	<ol style="list-style-type: none"> 1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis - Road Testing table. Refer to <u>Vibration Analysis - Road Testing</u>. <p>Is the disturbance still present?</p>	Go to Step 2	System OK

VIBRATION ANALYSIS - ENGINE BALANCE

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4

If sufficient clearance exists to separate the transmission torque converter from the engine flywheel/flexplate, then further tests can be used to isolate the transmission from the engine.

5

An engine flywheel/flexplate that has excessive lateral runout, when combined with the mass of the transmission torque converter, can produce a disturbance.

6

An engine flywheel/flexplate that is loose at the engine crankshaft or that is cracked or damaged, when combined with the mass of the transmission torque converter, can produce a disturbance.

7

This step is designed to isolate the transmission from the engine to determine if the disturbance is related to the engine ONLY.

9

Re-indexing the transmission torque converter to the engine flywheel/flexplate alters the balance relationship between the torque converter and the rear of the engine.

11

Placing the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 sensor onto the underside of the engine oil pan along the FRONT and the REAR edge allows for a determination to be made, which will help to narrow down the cause of the disturbance.

13

An engine flywheel that has excessive lateral runout, when combined with the extra mass of the clutch pressure plate and clutch driven plate, can produce a disturbance.

14

The clutch pressure plate and the engine flywheel are marked for proper indexing of the heavy-spot of one to the light-spot of the other. Improper indexing of the pressure plate to the flywheel can produce a disturbance.

15

An engine flywheel that is loose at the engine crankshaft or that is cracked, damaged and/or missing balance weights; and/or a clutch pressure plate and clutch driven plate that has loose springs, cracks, warpage, damage and/or missing balance weights - can produce a disturbance when their mass is combined.

16

An engine flywheel that is loose at the engine crankshaft or that is cracked, damaged and/or missing balance weights; and/or a clutch pressure plate and clutch driven plate that has loose springs, cracks, warpage, damage and/or missing balance weights - can produce a disturbance when their mass is combined.

17

Re-indexing the pressure plate to the engine flywheel alters the balance relationship between the pressure plate/flywheel assembly and the rear of the engine.

18

An engine flywheel/flexplate that is damaged, misaligned, and/or imbalanced, can produce a disturbance.

19

An engine crankshaft balancer that is damaged, misaligned, and/or imbalanced, can produce a disturbance.

Vibration Analysis - Engine Balance

Step	Action	Yes	No
1	Were you sent here from the Vibration Analysis - Engine/Accessory Isolation table?	Go to Step 2	Go to <u>Vibration Analysis - Engine/Accessory Isolation</u>
2	Is the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , available?	Go to Step 3	Go to <u>Vibration Diagnostic Aids</u>
3	Is the vehicle equipped with a manual transmission?	Go to Step 11	Go to Step 4
4	<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the flywheel/flexplate-to-torque converter bolts access cover, if equipped. 3. Determine if sufficient clearance exists to separate the transmission torque converter away from the engine flywheel/flexplate and safely secure the torque converter from accidentally engaging with the flywheel/flexplate. <p>Is there sufficient clearance to separate and safely secure the transmission torque converter away from the engine flywheel/flexplate?</p>	Go to Step 5	Go to Step 11
5	<ol style="list-style-type: none"> 1. With the flywheel/flexplate-to-torque converter access cover still removed, and with the vehicle still raised, mark the position of the transmission torque converter in relation to the engine flywheel/flexplate. 2. Disconnect the torque converter and move it away from the flywheel/flexplate. 3. Secure the transmission torque converter away from the engine flywheel/flexplate to avoid accidental engagement with the flywheel/flexplate. 4. Lower the vehicle, start the engine and allow the engine to idle. 5. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 6. Visually inspect the flywheel/flexplate for excessive lateral runout. 7. Lower the vehicle. 		

	<p>8. Turn OFF the ignition.</p> <p>Did the flywheel/flexplate exhibit excessive lateral runout?</p>	Go to Step 8	Go to Step 6
6	<p>1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .</p> <p>2. Inspect the flywheel/flexplate for the following:</p> <ul style="list-style-type: none"> • Looseness at the engine crankshaft • Cracks and/or damage • Missing balance weights <p>Did the flywheel/flexplate exhibit any of the conditions listed?</p>	Go to Step 8	Go to Step 7
7	<p>1. With the transmission torque converter still secured away from the engine flywheel/flexplate to avoid accidental engagement with the flywheel/flexplate, lower the vehicle.</p> <p>2. Block the front wheels.</p> <p>3. Apply BOTH the service brakes and the park brake.</p> <p>4. With the scan tool and the EL-38792-A Electronic Vibration Analyzer (EVA) 2 still installed, start the engine.</p> <p>5. Place the transmission in NEUTRAL or PARK.</p> <p>6. Slowly increase the engine RPM to the level at which the disturbance is most noticeable.</p> <p>7. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2.</p> <p>8. Turn OFF the ignition.</p> <p>Has the disturbance been significantly reduced or eliminated?</p>	Go to Step 9	Go to Step 11
8	<p>1. If the flywheel/flexplate is loose at the engine crankshaft, tighten the flywheel/flexplate mounting bolts in sequence and to specification.</p> <p>2. If the flywheel/flexplate is cracked, damaged, and/or has missing balance weights, replace</p>		-

	the damaged flywheel/flexplate.		
	Did you complete the tightening or replacement?	Go to Step 20	
9	<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Re-index the transmission torque converter to the engine flywheel/flexplate, 120 degrees from its original position. 3. Reconnect the transmission torque converter to the engine flywheel/flexplate. 4. Lower the vehicle. 5. Block the front wheels. 6. Apply BOTH the service brakes and the park brake. 7. With the scan tool and the EL-38792-A Electronic Vibration Analyzer (EVA) 2 still installed, start the engine. 8. Place the transmission in NEUTRAL or PARK. 9. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 10. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2. 11. If the disturbance is still noticeable, re-index the torque converter again to obtain the least amount of disturbance. <p>Has the disturbance been significantly reduced or eliminated?</p>	Go to Step 20	Go to Step 10
10	<p>Replace the out-of-balance transmission torque converter.</p> <p>Did you complete the replacement?</p>	Go to Step 20	-
	<ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Position the EL-38792-A Electronic Vibration Analyzer (EVA) 2 sensor onto the underside of the engine oil pan, along the FRONT edge. 3. Lower the vehicle. 4. Block the front wheels. 5. Apply BOTH the service brakes and the park brake. 		

11	<p>6. With the scan tool and the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , still installed, start the engine.</p> <p>7. Place the transmission in NEUTRAL or PARK.</p> <p>8. Slowly increase the engine RPM to the level at which the disturbance is most noticeable.</p> <p>9. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 from the underside of the engine oil pan.</p> <p>10. Repeat steps 1 through 9, placing the EL-38792-A Electronic Vibration Analyzer (EVA) 2 sensor onto the underside of the engine oil pan, along the REAR edge.</p> <p>Is the disturbance greater along the FRONT of the engine?</p>	Go to Step 19	Go to Step 12
12	<p>Is the vehicle equipped with an automatic transmission?</p>	Go to Step 18	Go to Step 13
13	<p>1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .</p> <p>2. Remove the flywheel inspection cover.</p> <p>3. Start the engine. Allow the engine to idle.</p> <p>4. Visually inspect the engine flywheel clutch surface for excessive lateral runout.</p> <p>Does the engine flywheel clutch surface exhibit excessive lateral runout?</p>	Go to Step 18	Go to Step 14
14	<p>Inspect the clutch pressure plate to engine flywheel mounting for proper factory indexing.</p> <p>Is the clutch pressure plate properly indexed to the engine flywheel?</p>	Go to Step 16	Go to Step 15
15	<p>1. Remove the clutch pressure plate and clutch driven plate from the engine flywheel.</p> <p>2. Inspect the engine flywheel for the following:</p> <ul style="list-style-type: none"> • Looseness at the engine crankshaft • Cracks, warpage and/or damage • Missing balance weights <p>3. Inspect the clutch pressure plate and clutch driven plate for the following:</p> <ul style="list-style-type: none"> • Loose and/or damaged clutch driven 		

	plate damper springs <ul style="list-style-type: none"> • Loose and/or damaged clutch pressure plate diaphragm springs • Cracks, warpage and/or damage • Missing balance weights 		
	Do any of the above conditions exist?	Go to Step 18	Go to Step 17
16	1. Remove the clutch pressure plate and clutch driven plate from the engine flywheel. 2. Inspect the engine flywheel for the following: <ul style="list-style-type: none"> • Looseness at the engine crankshaft • Cracks, warpage and/or damage • Missing balance weights 3. Inspect the clutch pressure plate and clutch driven plate for the following: <ul style="list-style-type: none"> • Loose and/or damaged clutch driven plate damper springs • Loose and/or damaged clutch pressure plate diaphragm springs • Cracks, warpage and/or damage • Missing balance weights 		
	Do any of the above conditions exist?	Go to Step 18	Go to <u>Vibration Diagnostic Aids</u>
17	Re-index the pressure plate to the engine flywheel. Did you complete the re-indexing?	Go to Step 20	-
18	Replace the engine flywheel/flexplate. Did you complete the replacement?	Go to Step 20	-
19	Replace the engine crankshaft balancer. Did you complete the replacement?	Go to Step 20	-
	Check the vehicle to determine if the disturbance is now significantly reduced or eliminated. Perform the following steps: <ol style="list-style-type: none"> 1. Install or connect any components that were removed or disconnected during diagnosis. 2. Install a scan tool into the customer's vehicle. 3. Install the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available, into the customer's vehicle; place the sensor in exactly the same location as it was originally placed in the vehicle. 4. Block the front wheels. 		

20	<ol style="list-style-type: none"> 5. Apply BOTH the service brakes and the park brake. 6. Start the engine. 7. Place the transmission in NEUTRAL or PARK. 8. Slowly increase the engine RPM to the level at which the disturbance was most noticeable. 9. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available. 10. Place the transmission in DRIVE. 11. Slowly increase the engine RPM to the level at which the disturbance was most noticeable. 12. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the EL-38792-A Electronic Vibration Analyzer (EVA) 2 , if available. 13. If the disturbance has been significantly reduced or eliminated, confirm the results by placing the transmission into REVERSE, then repeat steps 11 and 12. Reverse-loading of the powertrain may increase or change the characteristics of the vibration. 		
	Has the disturbance been significantly reduced or eliminated?	Go to Step 21	Go to <u>Vibration Diagnostic Aids</u>
21	Perform the Vibration Analysis - Road Testing table. Refer to <u>Vibration Analysis - Road Testing</u> . Is the disturbance still present?	Go to <u>Vibration Diagnostic Aids</u>	System OK

VIBRATION DIAGNOSTIC AIDS

NOTE: If you have not reviewed the Diagnostic Starting Point - Vehicle and completed the Vibration Analysis tables as indicated, refer to **Diagnostic Starting Point - Vehicle** BEFORE proceeding.

The diagnostic information contained in this Diagnostic Aids section will help you determine the correct course of action to take for the following 4 main conditions. Refer to the appropriate condition from this list:

- **Vibration Diagnostic Aids - Vibration Intermittent or Not Duplicated**
- **Vibration Diagnostic Aids - Vibration Duplicated, Component Not Identified**
- **Vibration Diagnostic Aids - Vibration Duplicated, Difficult to Isolate/Balance Component**

- **Vibration Diagnostic Aids - Vibration Duplicated, Appears to Be Potential Operating Characteristic**

VIBRATION DIAGNOSTIC AIDS - VIBRATION INTERMITTENT OR NOT DUPLICATED

NOTE: If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to Vibration Diagnostic Aids BEFORE proceeding.

If you have not been able to duplicate the vibration concern or have only been able to duplicate the concern intermittently, review the following information.

Most vibration concerns that cannot be duplicated are due to either specific conditions that are not present during the duplicating attempts, or due to not following the procedures designed to duplicate concerns properly and in the sequence indicated.

Specific Conditions Can Affect the Condition

Consider the following conditions which may not have been present while attempts were made to duplicate the vibration concern. Attempt to obtain more specific information from the customer as to the EXACT conditions that are present when they experience the vibration which they are concerned about. Attempt to duplicate the vibration concern again while recreating the EXACT conditions necessary, except those which pose a safety concern or are outside the boundaries of normal operating conditions, such as loading the vehicle beyond its designed weight ratings, etc.

Most attempts to duplicate a vibration concern are made after the vehicle has been driven to the repair facility and perhaps even sat inside the building for a time; the vehicle may be too warm to detect the concern during duplication efforts. The opposite could also occur; perhaps the vehicle has sat out in the cold for a time and fails to reach full operating temperatures during attempts to duplicate the concern.

Temperature, Ground-Out, Accessory Load

Flat Spots on Tires

Tires which have sat and been cool for a time can develop flat spots.

Irregular Wear on Tire Treads

Tires which have sat and been cool for a time will be stiffer and any irregular wear conditions will be more noticeable than they will be once the tires have warmed and softened.

Exhaust System Growth

Exhaust systems may exhibit a ground-out condition when cool which goes away once the system is hot. The opposite may be true that the exhaust system is fine when cool but a ground-out condition occurs once the system reaches operating temperatures. Exhaust systems can grow by 2 1/2 -5 cm (1-2 in) when hot.

Engine-Driven Accessory Noises

NOTE: When a stethoscope equipped with a probe is used to assist in identifying possible vibrating components, the results must be compared to the sound quality of the same accessory, in a equally-equipped, same model year and type, **KNOWN GOOD** vehicle, and under the same conditions. Refer to Vehicle-to-Vehicle Diagnostic Comparison.

A stethoscope equipped with a probe can be used as an additional means to assist in identifying accessories which may be causing or contributing to a vibration concern.

- Belt Whipping

An engine accessory drive belt, or belts could exhibit a whipping condition if a belt is deteriorating and deposits are building up on the underside of the belt.

- Loose Mounting Brackets or Component Ground-Out

Engine-driven accessories such as a generator, a power steering pump, or an air conditioning compressor could exhibit noise conditions due to either loose mounting brackets or due to related components of the system in a ground-out condition during certain operation of that accessory system.

- Cold or Hot

Accessories could exhibit noise conditions when cool which go away once they are fully warmed-up, or the opposite may be true.

- Load on an Accessory Component

Accessories could exhibit a noise condition while under a heavy load - perhaps when combined with a cool or fully warmed-up condition.

- Bent or Misaligned Pulleys

Bent or mis-aligned pulleys in one or more engine-driven accessory systems could contribute to a noise or vibration condition.

- Fluid Level in Accessory Systems

Accessories could exhibit a noise condition due to an abnormal amount of fluid contained in the system of which the accessory is a part. For example:

- An improper power steering fluid level could produce noises in the power steering system.
- An improper air conditioning refrigerant level or an excessive amount of refrigerant oil could produce noises or possibly vibrations in the air conditioning system.

- Incorrect Fluid Type in Accessory Systems

Accessories could exhibit a noise condition due to the incorrect type of fluid contained in the system of which the accessory is a part.

Vehicle Payload

The vibration concern may only occur when the vehicle is carrying heavy payloads or towing a trailer; the vehicle may have been empty during duplication efforts.

Heavy Payload

The vehicle may have been empty during attempts to duplicate the vibration concern, but the customer may actually experience the vibration concern while the vehicle is carrying a large payload.

Trailer Towing

The customer may experience the vibration concern only while towing a trailer.

Roadway Selection

The selection of roadways used to perform the vibration duplication procedures is likely to be in the near vicinity of the repair facility and may not provide a road surface that is similar enough to the surface on which the customer usually drives the vehicle.

The customer may only experience the vibration on a particular roadway. Perhaps the roadway is overly crowned or is very bumpy or rough.

VIBRATION DIAGNOSTIC AIDS - VIBRATION DUPLICATED, COMPONENT NOT IDENTIFIED

NOTE: If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to Vibration Diagnostic Aids BEFORE proceeding.

Aftermarket Add-On Accessories

Aftermarket accessories which have been added to the vehicle can actually transmit and magnify INHERENT component rotational frequencies, if the accessories were not installed correctly.

An accessory should be installed in such a way that it is isolated from becoming a possible transfer path into the rest of the vehicle. For example, if a set of running boards has been installed improperly and they are sensitive to a particular frequency of a rotating component, the running boards could begin to respond to the frequency and actually create a disturbance once the amplitude of the frequency reaches a high enough point, probably at a higher vehicle speed.

If the same set of running boards were installed properly-isolated properly-the transfer path would be removed and the disturbance would no longer be present.

VIBRATION DIAGNOSTIC AIDS - VIBRATION DUPLICATED, DIFFICULT TO

ISOLATE/BALANCE COMPONENT

NOTE: If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to Vibration Diagnostic Aids BEFORE proceeding.

If you have duplicated the vibration concern but have had difficulty in balancing a component or isolating a component, refer to the following information.

Most vibration concerns are corrected or eliminated through correcting excessive runout of a component, correcting balance of a component or isolating a component which has come into abnormal contact with another object/component.

Components which can generate a lot of energy and are experiencing excessive runout, imbalance or ground-out can produce a vibration with a strong enough amplitude that the vibration can transmit to components which are closely related. This type of a condition is usually related to and sensitive to torque-load. The most likely system that could exhibit this type of a condition is the driveline.

VIBRATION DIAGNOSTIC AIDS - VIBRATION DUPLICATED, APPEARS TO BE POTENTIAL OPERATING CHARACTERISTIC

NOTE: If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to Vibration Diagnostic Aids BEFORE proceeding.

Check Service Bulletins

If BOTH of the following statements are TRUE, then check service bulletins for the condition identified. If the condition has already been identified and investigated prior to this vehicle, and has been determined to be something that is not truly an operating characteristic or that perhaps is not design-intent, there will likely be adjustments or corrections identified which will address the condition.

- You CAREFULLY followed the steps indicated through reviewing the Diagnostic Starting Point - Vibration Diagnosis and completing the Vibration Analysis tables identified and you have duplicated the vibration concern.
- You have come to the conclusion through comparison with a very equally-equipped, same model year and type, KNOWN GOOD vehicle that the customer's concern is a condition that appears to be a potential operating characteristic of the vehicle.

SYMPTOMS - VIBRATION DIAGNOSIS AND CORRECTION

NOTE: Perform the following steps in sequence BEFORE using these symptom tables.

1. Begin the diagnosis of a vibration concern by reviewing Diagnostic Starting Point - Vehicle to become familiar with the diagnostic process used to properly diagnose vibration concerns.
2. Perform the Vibration Analysis - Road Testing table before using these symptom tables in order to

duplicate and effectively diagnose the customer's concern.

Symptom Tables

Refer to a Vibration Analysis table as indicated in the following symptom tables, based on the most dominant characteristic of the customer's vibration concern, felt or heard, that is evident during the appropriate condition of the occurrence.

Vibration Symptoms that are Felt

Category	Description	Typical Frequency Range	Condition of Occurrence	Area of Focus
Shake	Can sometimes be seen or felt in the steering wheel, seat or console. Related terminology: shimmy, wobble, waddle, shudder, hop	5-20 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to <u>Vibration Analysis - Tire and Wheel</u>
			Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to <u>Vibration Analysis - Hub and/or Axle Input</u>
			Engine Speed Sensitive	Go to <u>Vibration Analysis - Engine</u>
Roughness	Similar to the feeling of holding a jigsaw.	20-50 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to <u>Vibration Analysis - Tire and Wheel</u>
			Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to <u>Vibration Analysis - Hub and/or Axle Input</u>
			Engine Speed Sensitive	Go to <u>Vibration Analysis - Engine</u>
Buzz	Similar to the feeling of holding an electric razor. May be felt in the hands through the steering wheel, in the feet through the floor, or in the seat of the pants.	50-100 Hz	Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to <u>Vibration Analysis - Hub and/or Axle Input</u>
			Engine Speed Sensitive	Go to <u>Vibration Analysis - Engine</u>
Tingling	May produce a "pins and needles" sensation or may put hands or feet "to sleep". Highest vibration frequency range that can still be felt.	Greater than 100 Hz	Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to <u>Vibration Analysis - Hub and/or Axle Input</u>
			Engine Speed Sensitive	Go to <u>Vibration Analysis - Engine</u>

Vibration Symptoms that are Heard

		Typical Frequency	Condition of	
--	--	-------------------	--------------	--

Category	Description	Range	Occurrence	Area of Focus
Boom	Usually heard as an interior noise similar to the noise of a bowling ball rolling down an alley, deep thunder, or a bass drum. <ul style="list-style-type: none"> Related terminology- droning, growling, moaning, roaring, rumbling, humming May not be accompanied by a perceptible vibration or roughness 	20-60 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to <u>Vibration Analysis - Tire and Wheel</u>
			Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to <u>Vibration Analysis - Hub and/or Axle Input</u>
Moan or Drone	Similar to the sound of a bumblebee or blowing air across the top of a bottle. <ul style="list-style-type: none"> Related terminology- humming, buzzing, resonance May be accompanied by a perceptible vibration such as a buzz 	60-120 Hz	Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to <u>Vibration Analysis - Hub and/or Axle Input</u>
			Engine Speed Sensitive	Go to <u>Vibration Analysis - Engine</u>
Howl	Similar to the sound of the wind howling.	120-300 Hz	Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to <u>Vibration Analysis - Hub and/or Axle Input</u>
			Engine Speed Sensitive	Go to <u>Vibration Analysis - Engine</u>
Whine	Similar to the sound of mosquitoes, turbine engines, or vacuum cleaners.	300-500 Hz	Vehicle Speed Sensitive Affected by torque/load	Go to transmission diagnostic information

VEHICLE-TO-VEHICLE DIAGNOSTIC COMPARISON

Comparing the customer's vehicle to a KNOWN GOOD vehicle that is essentially identical will help determine if the customer's concern may be characteristic of a vehicle design. To arrive at a valid conclusion, the comparison must be performed under the same conditions, using the same criteria, on a vehicle that has the same option content as the customer's vehicle.

The comparison vehicle must match the customer's vehicle in the following areas:

- Model Year
- Make
- Model
- Body style
- Powertrain configuration
- Driveline configuration
- Final drive ratio
- Tire/wheel size and type
- Suspension package
- Trailering package
- GVW rating
- Performance options
- Luxury options

TIRE AND WHEEL INSPECTION

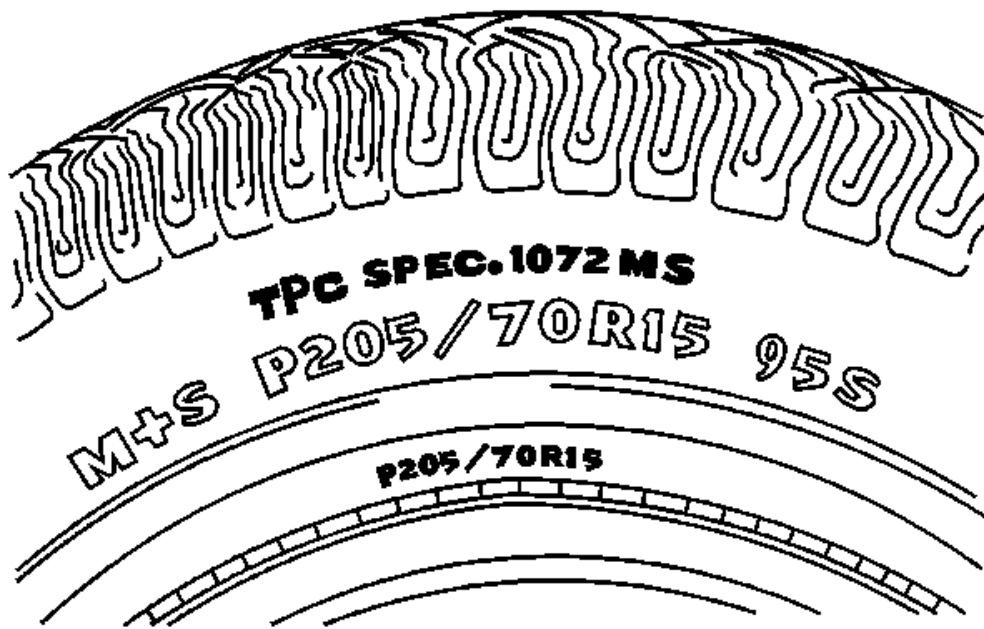


Fig. 2: Identifying Tire Performance Criteria (TPC) Rating Markings
Courtesy of GENERAL MOTORS COMPANY

The tires on all new production models have a tire performance criteria (TPC) rating number molded on the sidewall. The TPC rating will appear as a 4-digit number preceded by the letters TPC SPEC on the tire wall near the tire size. A replacement tire should have the same TPC rating.

Tire Wear

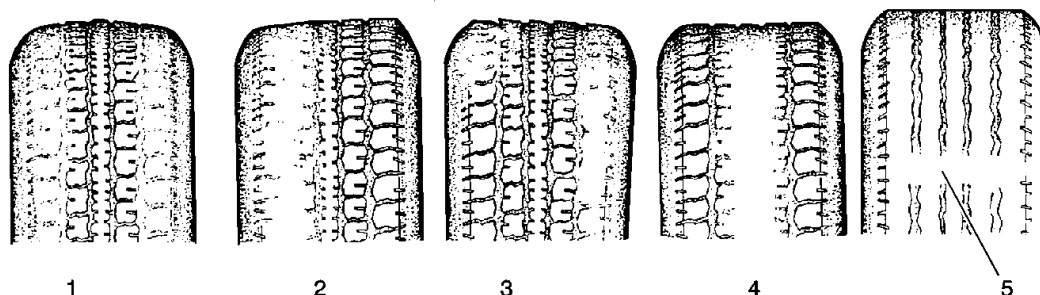


Fig. 3: Identifying Types Of Tire Wear
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Hard Cornering/Underinflation
2	Incorrect Alignment/Lack of Rotation
3	Incorrect Alignment/Non-uniform Tire
4	Heavy Acceleration/Over inflation
5	Wear Indicator

Inspect the tire and wheel assemblies for the following conditions:

- Unusual wear such as cupping, flat spots, and/or heel-and-toe wear

These conditions can cause tire growl, tire howl, slapping noises, and/or vibrations throughout the vehicle.

- Proper inflation to specifications for the vehicle
- Bulges in the sidewalls

Do not confuse bulges, which are an abnormal condition, with normal ply splices which are commonly seen as indentations in the sidewall.

- Bent rim flanges

TIRE AND WHEEL ASSEMBLY RUNOUT MEASUREMENT - ON-VEHICLE

1. Raise and support the vehicle.
2. Closely inspect each tire for proper and even bead seating.
3. If any of the tire beads were not properly or evenly seated, reseal the tire bead, then proceed to step 4. Refer to **Tire and Wheel Removal and Installation** .

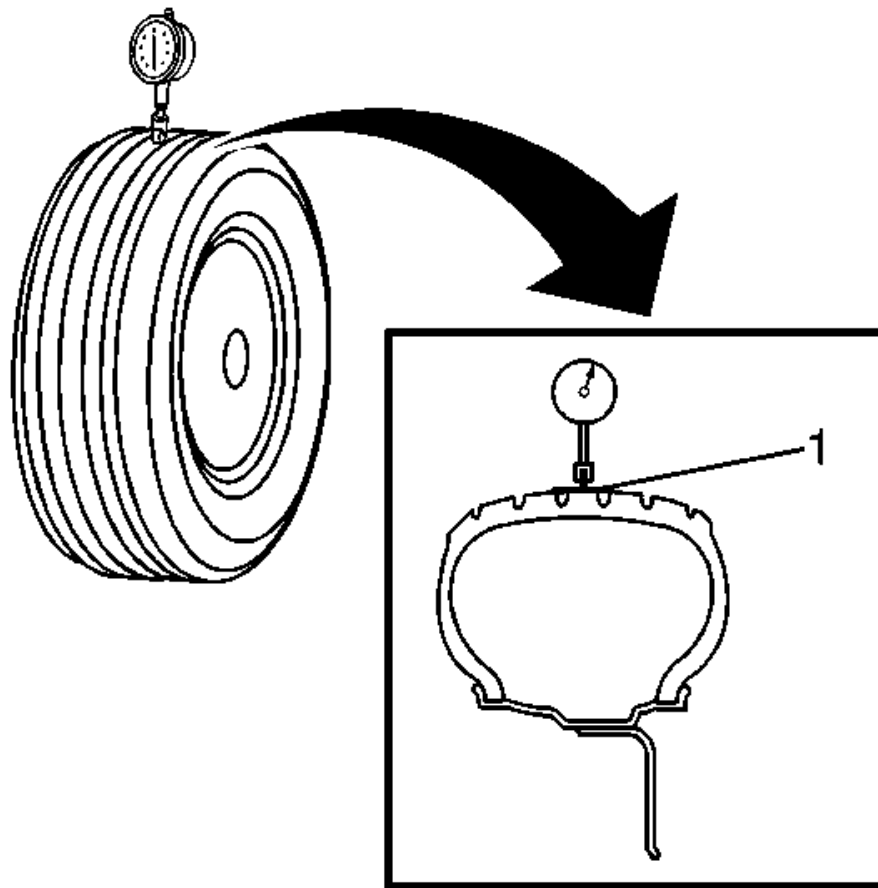


Fig. 4: Measuring Tire & Wheel Assembly Radial Runout
Courtesy of GENERAL MOTORS COMPANY

4. Wrap the circumference of each tire with tape (1) in the center tread area.

Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.

5. Position the dial indicator on the taped portion of the tire tread such that the dial indicator is perpendicular to the tire tread surface.
6. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
7. Set the dial indicator to zero at the low spot.
8. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of radial runout.

Specification

Maximum tire and wheel assembly radial runout - measured on-vehicle: 1.52 mm (0.060 in)

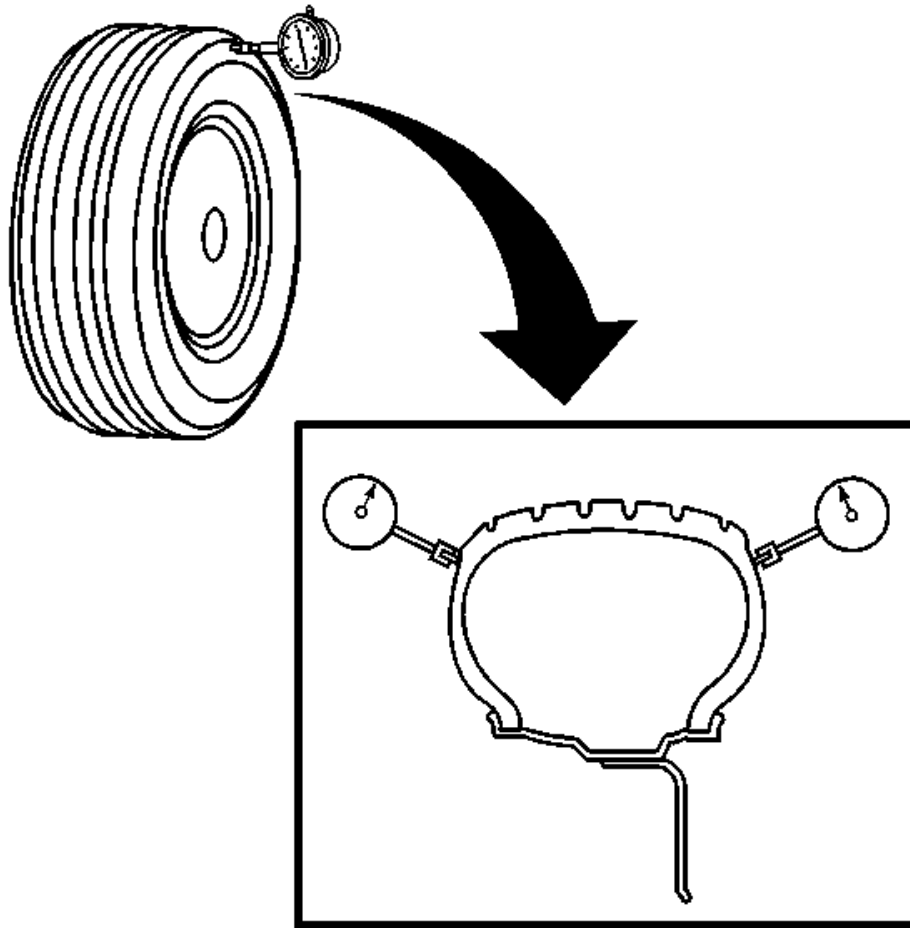


Fig. 5: Measuring Tire & Wheel Assembly Lateral Runout
Courtesy of GENERAL MOTORS COMPANY

9. Position the dial indicator on a smooth portion of the tire sidewall, as close to the tread as possible, such that the dial indicator is perpendicular to the tire sidewall surface.
10. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot. Ignore any jumps or dips due to sidewall splices.
11. Set the dial indicator to zero at the low spot.
12. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of lateral runout. Ignore any jumps or dips due to sidewall splices and attain an average runout measurement.

Specification

Maximum tire and wheel assembly lateral runout - measured on-vehicle: 1.52 mm (0.060 in)

13. Repeat steps 4 through 12 until all of the tire and wheel assembly radial and lateral runout measurements have been taken.

14. Lower the vehicle.

TIRE AND WHEEL ASSEMBLY RUNOUT MEASUREMENT - OFF VEHICLE

1. Raise and support the vehicle.
2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel - LF, LR, RF, RR.
3. Remove the tire and wheel assemblies from the vehicle.
4. Closely inspect each tire for proper and even bead seating.
5. If any of the tire beads were not properly or evenly seated, reseal the tire bead, then proceed to step 6.
6. Mount a tire and wheel assembly on a spin-type wheel balancer.

Locate the tire and wheel assembly on the balancer with a cone through the back side of the center pilot hole.

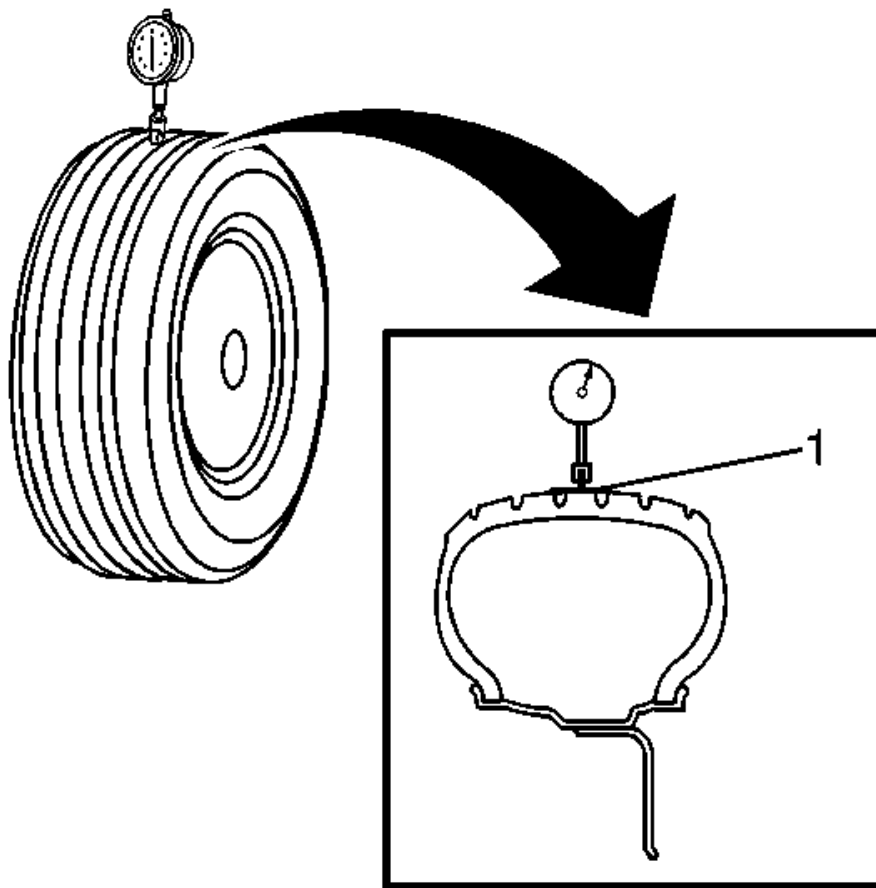


Fig. 6: Measuring Tire & Wheel Assembly Radial Runout

Courtesy of GENERAL MOTORS COMPANY

7. Wrap the outer circumference of each tire with tape (1) in the center tread area.

Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.

8. Position the dial indicator on the taped portion of the tire tread such that the dial indicator is perpendicular to the tire tread surface.
9. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
10. Set the dial indicator to zero at the low spot.
11. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of radial runout.

Specification

Maximum tire and wheel assembly radial runout - measured off-vehicle: 1.27 mm (0.050 in)

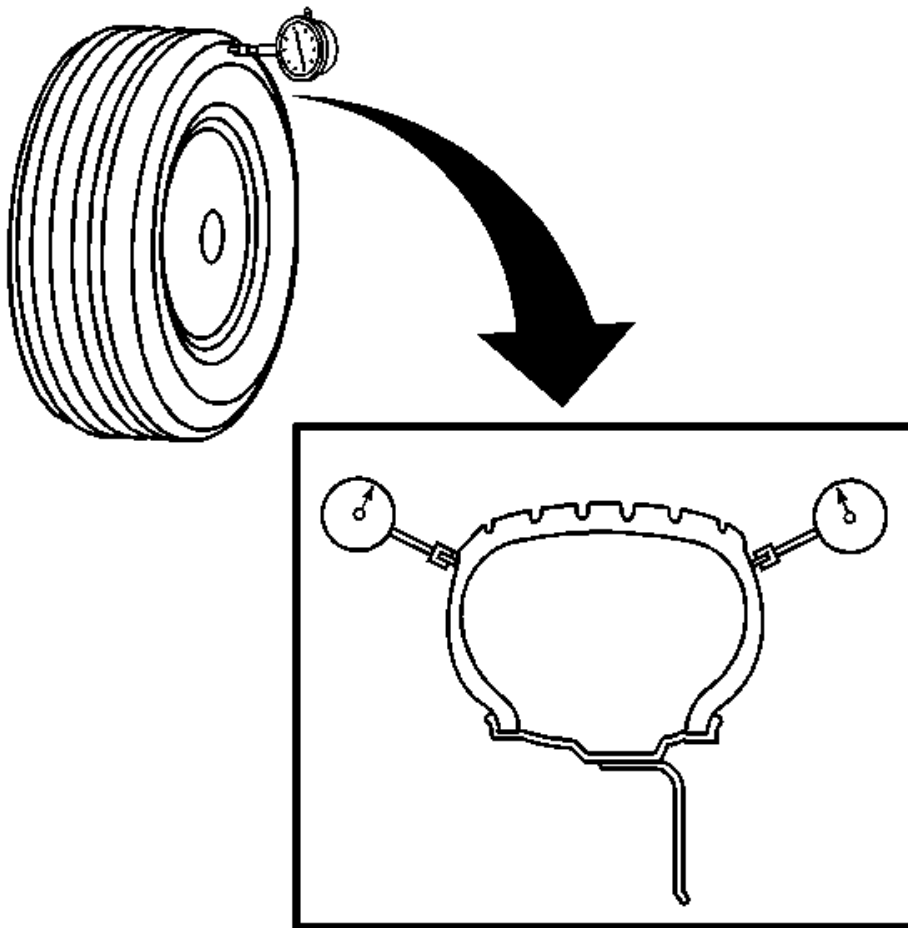


Fig. 7: Measuring Tire & Wheel Assembly Lateral Runout

Courtesy of GENERAL MOTORS COMPANY

12. Position the dial indicator on a smooth portion of the tire sidewall, as close to the tread as possible, such that the dial indicator is perpendicular to the tire sidewall surface.
13. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot. Ignore any jumps or dips due to sidewall splices.
14. Set the dial indicator to zero at the low spot.
15. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of lateral runout. Ignore any jumps or dips due to sidewall splices and attain an average runout measurement.

Specification

Maximum tire and wheel assembly lateral runout - measured off-vehicle: 1.27 mm (0.050 in)

16. Repeat steps 6 through 15 until all of the tire and wheel assembly radial and lateral runout measurements have been taken.
17. If ANY of the tire and wheel assembly runout measurements were NOT within specifications, proceed to step 19.
18. If ALL of the tire and wheel assembly runout measurements WERE within specifications, then the off-vehicle tire and wheel assembly runout is considered acceptable.

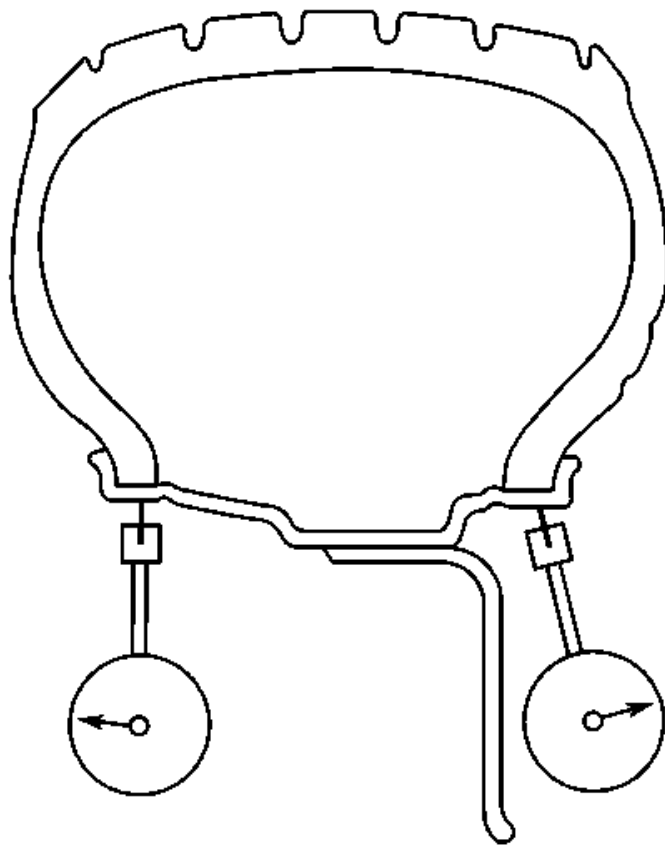


Fig. 8: Measuring Wheel Radial Runout (Off-Vehicle, Tire Mounted)
Courtesy of GENERAL MOTORS COMPANY

19. Position the dial indicator on the horizontal outer surface of the wheel rim flange - with the tire still mounted - such that the dial indicator is perpendicular to the rim flange surface.

Wheel runout should be measured on both the inboard and outboard rim flanges, unless wheel design will not permit. Ignore any jumps or dips due to paint drips, chips, or welds.

20. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
21. Set the dial indicator to zero at the low spot.
22. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of wheel radial runout.

Specification

- Maximum aluminum wheel radial runout - measured off-vehicle, tire mounted: 0.762 mm (0.030)

in)

- Maximum steel wheel radial runout - measured off-vehicle, tire mounted: 1.015 mm (0.040 in)

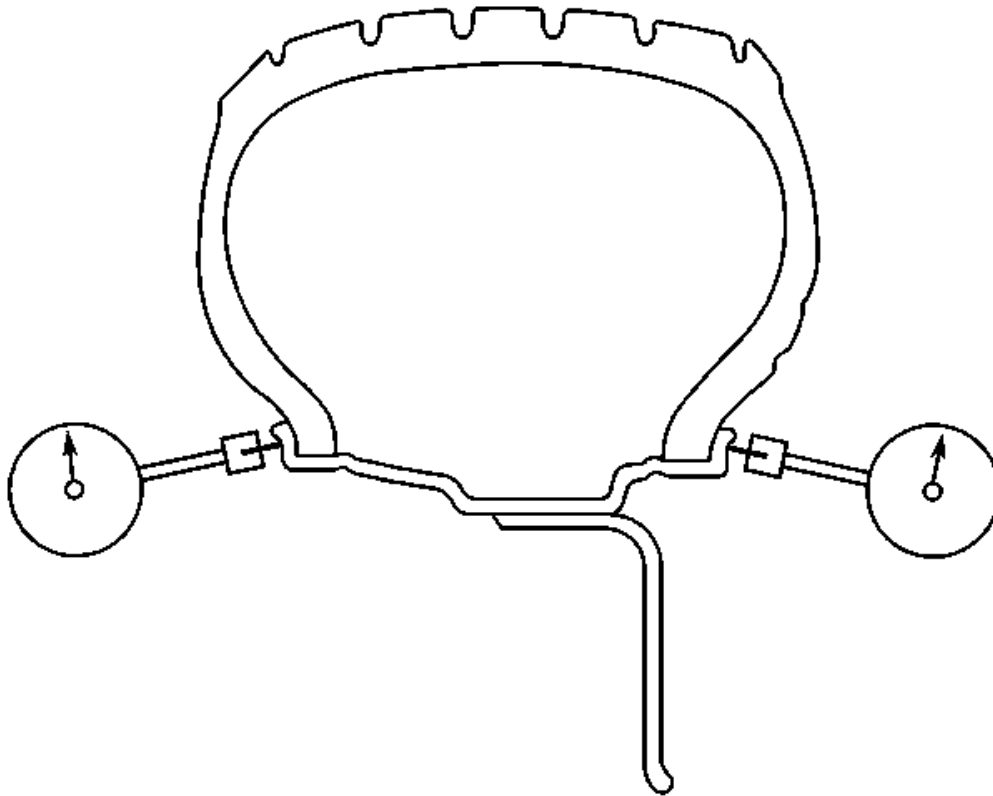


Fig. 9: Measuring Wheel Lateral Runout (Off-Vehicle, Tire Mounted)

Courtesy of GENERAL MOTORS COMPANY

23. Position the dial indicator on the vertical outer surface of the wheel rim flange - with the tire still mounted - such that the dial indicator is perpendicular to the rim flange surface.

Wheel runout should be measured on both the inboard and outboard rim flanges, unless wheel design will not permit. Ignore any jumps or dips due to paint drips, chips, or welds.

24. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
25. Set the dial indicator to zero at the low spot.
26. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of wheel lateral runout.

Specification

- Maximum aluminum wheel lateral runout - measured off-vehicle, tire mounted: 0.762 mm (0.030 in)
 - Maximum steel wheel lateral runout - measured off-vehicle, tire mounted: 1.143 mm (0.045 in)
27. Repeat steps 19 through 26 until all of the wheel radial and lateral runout measurements have been taken on each of the - tire and wheel - assemblies with assembly runout measurements which were NOT within specifications.
 28. If any of the wheel runout measurements were NOT within specifications, proceed to Measuring Wheel Runout - Tire Dismounted.
 29. For any of the wheel runout measurements which WERE within specifications, while the - tire and wheel - assembly runout measurements were NOT within specifications, replace the tire, then balance the assembly. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.
 30. After replacement of any tires, always re-measure the runout of the affected tire and wheel assembly, or assemblies.
 31. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle.
 32. Lower the vehicle.

Wheel Runout Measurement - Tire Dismounted

1. On the tire and wheel assembly, or assemblies with wheel runout measurements - tire mounted - which were NOT within specifications, mark each tire and wheel in relation to each other.
2. Dismount the tire from the wheel. Refer to **Tire Dismounting and Mounting** .
3. Mount the wheel on a spin-type wheel balancer.
4. Locate the wheel on the balancer with a cone through the back side of the center pilot hole.

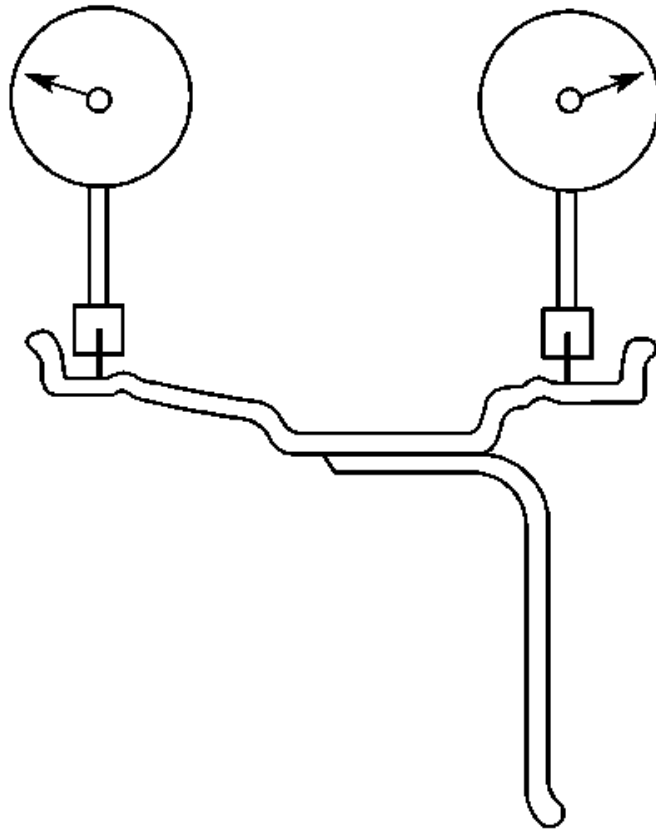


Fig. 10: Measuring Wheel Radial Runout (Off-Vehicle, Tire Dismounted)
Courtesy of GENERAL MOTORS COMPANY

5. Position the dial indicator on the horizontal inner surface of the wheel rim flange - with the tire dismounted - such that the dial indicator is perpendicular to the rim flange surface.

Wheel runout should be measured on both the inboard and outboard rim flanges. Ignore any jumps or dips due to paint drips, chips, or welds.

6. Slowly rotate the wheel one complete revolution in order to find the low spot.
7. Set the dial indicator to zero at the low spot.
8. Slowly rotate the wheel one more complete revolution and measure the total amount of wheel radial runout.

Specification

- Maximum aluminum wheel radial runout - measured off-vehicle, tire dismounted: 0.762 mm (0.030)

in)

- Maximum steel wheel radial runout - measured off-vehicle, tire dismounted: 1.015 mm (0.040 in)

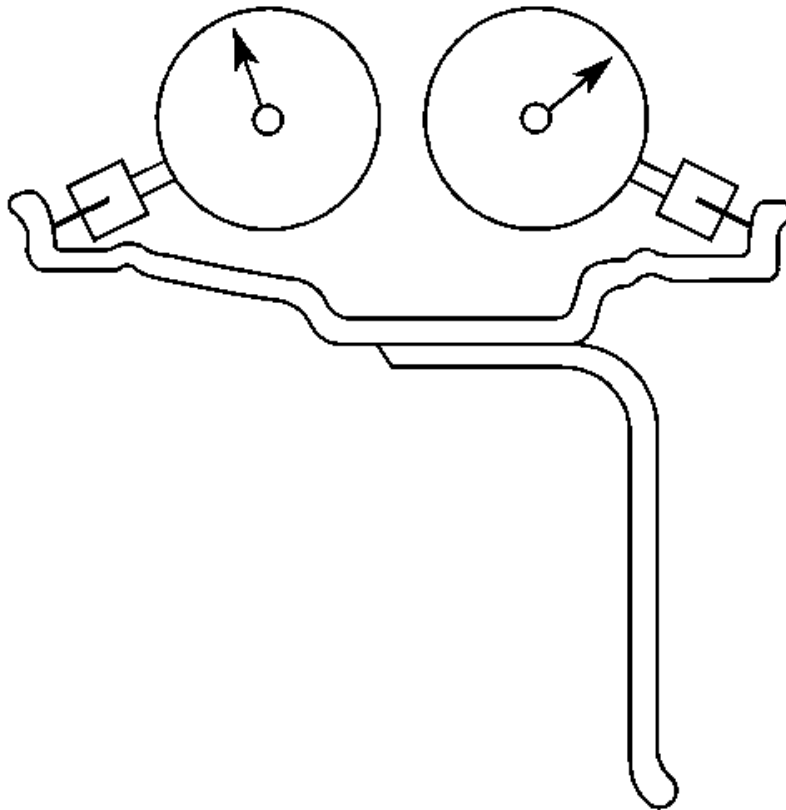


Fig. 11: Measuring Wheel Lateral Runout (Off-Vehicle, Tire Dismounted)

Courtesy of GENERAL MOTORS COMPANY

9. Position the dial indicator on the vertical inner surface of the wheel rim flange - with the tire dismounted - such that the dial indicator is perpendicular to the rim flange surface.

Wheel runout should be measured on both the inboard and outboard rim flanges. Ignore any jumps or dips due to paint drips, chips, or welds.

10. Slowly rotate the wheel one complete revolution in order to find the low spot.
11. Set the dial indicator to zero at the low spot.
12. Slowly rotate the wheel one more complete revolution and measure the total amount of wheel lateral runout.

Specification

- Maximum aluminum wheel lateral runout - measured off-vehicle, tire dismounted: 0.762 mm (0.030 in)
 - Maximum steel wheel lateral runout - measured off-vehicle, tire dismounted: 1.143 mm (0.045 in)
13. Repeat steps 2 through 12 until all of the wheel radial and lateral runout measurements - tire dismounted - have been taken on each wheel with runout measurements - tire mounted - which were NOT within specifications.
 14. If any of the wheel runout measurements - tire dismounted - were NOT within specifications, replace the wheel.

Always measure the runout of any replacement wheels.

15. For any of the wheel runout measurements which WERE within specifications, while the - tire and wheel - assembly runout measurements were NOT within specifications, replace the tire, then balance the assembly. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.
16. Using the matchmarks made prior to dismounting the tire, or tires, mount the tire, or tires to the wheel, or wheels, then balance the assembly, or assemblies. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.

Always measure the runout of any of the tire and wheel assemblies which have had the tires dismounted and mounted.

17. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle.
18. Lower the vehicle.

BRAKE ROTOR/DRUM BALANCE INSPECTION

1. Support the vehicle drive axle on a suitable hoist. Refer to **Lifting and Jacking the Vehicle**.
2. Remove the tire and wheel assemblies from the drive axle. Refer to **Tire and Wheel Removal and Installation**.

WARNING: Refer to **Work Stall Test Warning**.

3. Reinstall the wheel nuts in order to retain the brake rotors.
4. Run the vehicle at the concern speed while inspecting for the presence of the vibration.

CAUTION: Do not depress the brake pedal with the brake rotors and/or the brake drums removed, or with the brake calipers repositioned away from the brake rotors, or damage to the brake system may result.

5. If the vibration is still present, remove the rotors from the drive axle, then run the vehicle back to the concern speed.

6. If the vibration is eliminated when the brake rotors are removed from the drive axle, repeat the test with one rotor installed at a time. Replace the rotor that is causing or contributing to the vibration concern.

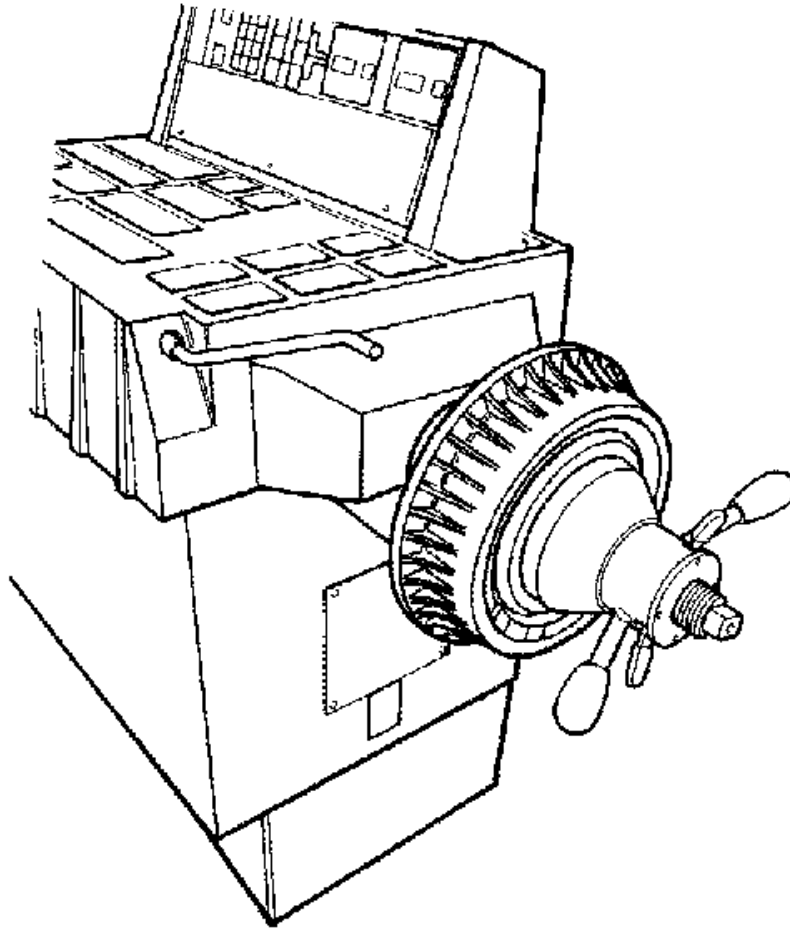


Fig. 12: Balancing Brake Drum
Courtesy of GENERAL MOTORS COMPANY

7. If a brake rotor was replaced as a result of following the previous steps, or if necessary to confirm the results obtained during the previous steps, and/or to check the non-drive axle components, perform the following:

1. Mount the brake rotor/drum on a balancer in the same manner as a tire and wheel assembly.

NOTE: **Check brake rotors/drums for static imbalance only; ignore the dynamic imbalance readings.**

2. Inspect the rotor/drum for static imbalance.

There is not a set tolerance for brake rotor/drum static imbalance. However, any brake rotor/drum measured in

this same manner which is over 21 g (3/4 oz) may have the potential to cause or contribute to a vibration. Rotors/drums suspected of causing or contributing to a vibration should be replaced. Any rotor/drum that is replaced should be checked for imbalance in the same manner.

HUB/AXLE FLANGE AND WHEEL STUD RUNOUT INSPECTION

Special Tools

GE-8001 Dial Indicator Set , or equivalent

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel - LF, LR, RF, RR.
3. Remove the tire and wheel assemblies from the vehicle. Refer to **Tire and Wheel Removal and Installation** .
4. Remove the brake rotors and/or brake drums from the vehicle. Clean the mounting surfaces of the brake rotors, the brake drums, if equipped, and the hub/axle flanges of any loose debris, rust, and corrosion.

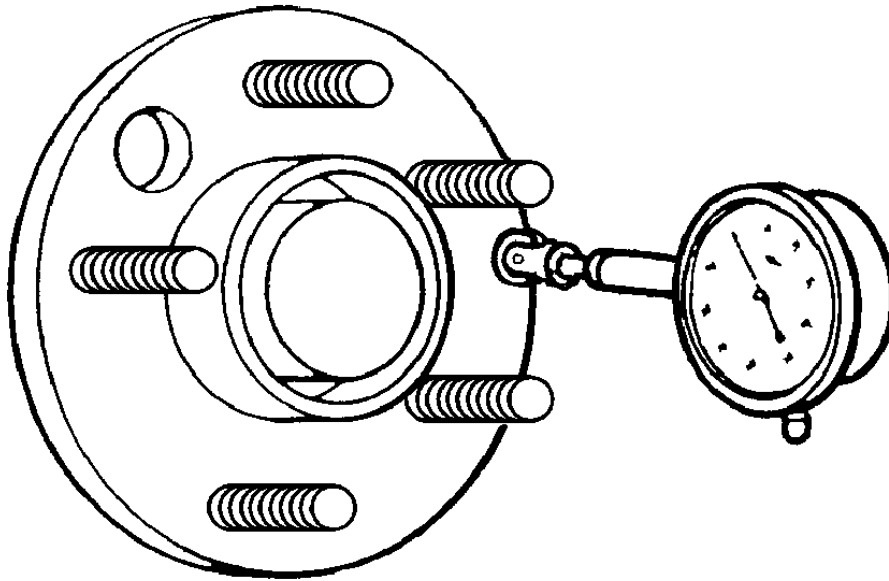


Fig. 13: Measuring Wheel Hub/Axle Flange Runout
Courtesy of GENERAL MOTORS COMPANY

5. Position the **GE-8001** Dial Indicator Set , or equivalent, on the machined surface of the wheel hub/axle flange outside of the wheel studs.
6. Rotate the hub one complete revolution in order to find the low spot.
7. Set the **GE-8001** Dial Indicator Set , or equivalent, to zero at the low spot.
8. Rotate the hub one more complete revolution and measure the total amount of wheel hub/axle flange runout.

Specification - Guideline

Wheel hub/axle flange runout tolerance guideline: 0.132 mm (0.005 in)

9. If the runout of the wheel hub/axle flange IS within specification and the vehicle is equipped with wheel studs, proceed to step 13.
10. If the runout of the wheel hub/axle flange IS within specification and the vehicle is equipped with wheel

bolts, proceed to step 19.

11. If the runout of the wheel hub/axle flange is marginal, the wheel hub may or may not be the source of the disturbance.
12. If the runout of the wheel hub/axle flange is excessive, replace the wheel hub/axle flange. Measure the runout of the new wheel hub/axle flange.

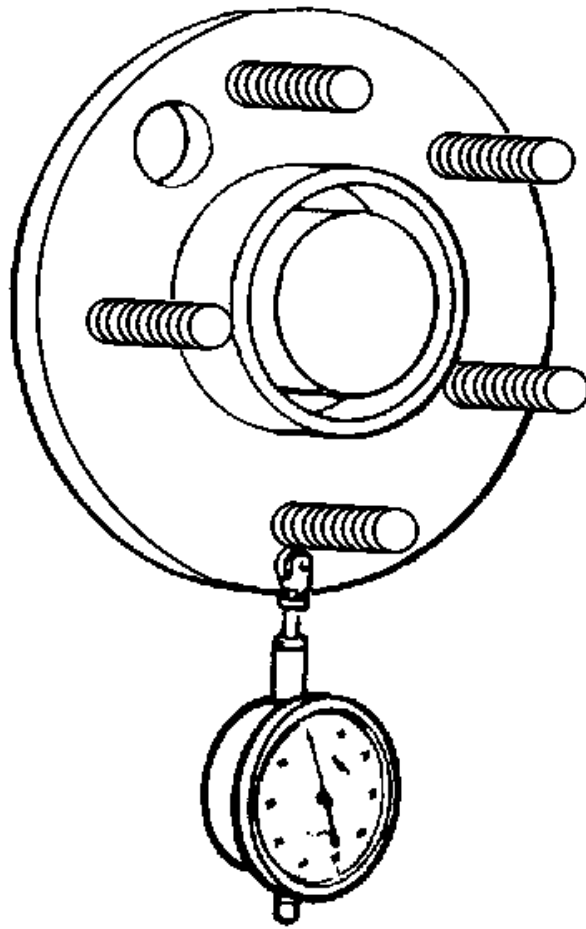


Fig. 14: Measuring Wheel Stud Runout
Courtesy of GENERAL MOTORS COMPANY

13. Position the **GE-8001** Dial Indicator Set , or equivalent, in order to contact the wheel mounting studs.

Measure the stud runout as close to the flange as possible.

14. Turn the hub one complete revolution to register on each of the wheel studs.
15. Zero the **GE-8001** Dial Indicator Set , or equivalent, on the lowest stud.
16. Rotate the hub one more complete revolution and measure the total amount of wheel stud - stud circle - runout.

Specification - Guideline

Wheel stud runout tolerance guideline: 0.254 mm (0.010 in)

17. If the runout of the wheel studs - stud circle - is marginal, the wheel studs may or may not be contributing to the disturbance.
18. If the runout of the wheel studs - stud circle - is excessive, replace the wheel studs as necessary. Measure the runout of the new wheel studs.
19. Inspect the threads and the tapered seat portion on each of the wheel bolts for damage.
20. Wheel bolts exhibiting damaged threads and/or damaged tapered seats require replacement.
21. Place the threaded portion of each wheel bolt along a straight edge to inspect for straightness.
22. Wheel bolts that are not straight require replacement.

TIRE AND WHEEL ASSEMBLY ISOLATION TEST

Force Variation

Force variation refers to a radial or lateral movement of the tire and wheel assembly which acts much like runout, however, force variation has to do with variations in the construction of the tire. These variations in tire construction may actually cause vibration in a vehicle, even though the tire and wheel assembly runout and balance may be within specifications.

Radial Force Variation

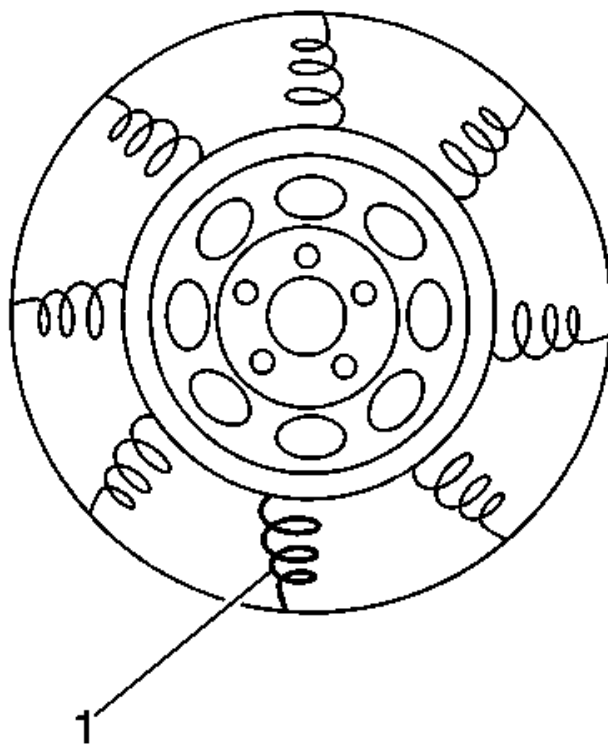


Fig. 15: Identifying Radial Force Variation
Courtesy of GENERAL MOTORS COMPANY

Radial force variation refers to the difference in the stiffness of a tire sidewall as the tire rotates and contacts the road. Tire sidewalls have some stiffness due to splices in the different plies of the tire, but these stiffness differences do not cause a problem unless the force variation is excessive. Stiff spots (1) in a tire sidewall can deflect a tire and wheel assembly upward as the assembly contacts the road.

Lateral Force Variation

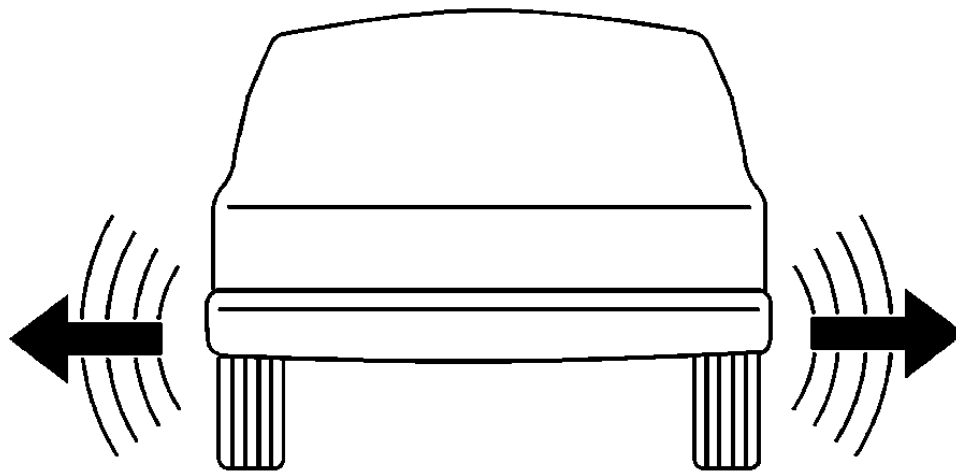


Fig. 16: Identifying Tire Wobble/Waddle
Courtesy of GENERAL MOTORS COMPANY

Lateral force variation refers to the difference in the stiffness or conformity of the belts within a tire as the tire rotates and contacts the road. Tire belts may have some stiffness or conformity differences, but these differences do not cause a problem unless the force variation is excessive. These variations in the belts of the tire can deflect the vehicle sideways or laterally. A shifted belt inside a tire may cause lateral force variation.

In most cases where excessive lateral force variation exists, the vehicle will display a wobble or waddle at low speeds, 8-40 km/h (5-25 mph), on a smooth road surface.

Isolation Test Procedure

Perform the following test in order to determine if force variation is present in the vehicle.

1. Substitute a set of KNOWN GOOD, pre-tested tire and wheel assemblies of the same size and type for the suspected original assemblies. Refer to **Tire and Wheel Removal and Installation** .
2. Road test the vehicle to determine if the vibration is still present. Refer to **Vibration Analysis - Road**

Testing.

3. If the vibration is still present while using the known good set of tire and wheel assemblies, then force variation is not the cause of the vibration.
4. If the vibration is eliminated when using the known good set of tire and wheel assemblies, install one of the original tire and wheel assemblies using the matchmarks made prior to removal. Refer to **Tire and Wheel Removal and Installation** , . Road test the vehicle to determine if the vibration has returned. Refer to **Vibration Analysis - Road Testing**.
5. Continue the process of installing the original tire and wheel assemblies one at a time, then road testing the vehicle, until the tire and wheel assembly, or assemblies which is causing the vibration has been identified.
6. Replace the tire, or tires on the vibration-causing tire and wheel assembly, or assemblies, then balance the assembly, or assemblies. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.

REPAIR INSTRUCTIONS

TIRE AND WHEEL ASSEMBLY BALANCING - OFF VEHICLE

WARNING: Failure to adhere to the following precautions before tire balancing can result in personal injury or damage to components:

- Clean away any dirt or deposits from the inside of the wheels.
- Remove any stones from the tread.
- Wear eye protection.
- Use coated weights on aluminum wheels.

Tire and Wheel Assembly Balancer Calibration

Tire and wheel balancers can drift out of calibration over time, or can become inaccurate as a result of heavy use. There will likely not be any visual evidence that a calibration problem exists. If a balancer is not calibrated within specifications, and a tire and wheel assembly is balanced on that machine, the assembly may actually be imbalanced.

Tire and wheel assembly balancer calibration should be checked approximately every 2 weeks, if the machine is used frequently, and/or whenever the balance readings are questionable.

Tire and Wheel Assembly Balancer Calibration Test

NOTE: If the balancer fails any of the steps in this calibration test, the balancer should be calibrated according to the manufacturer's instructions. If the balancer cannot be calibrated, contact the manufacturer for assistance.

Inspect the calibration of the tire and wheel assembly balancer according to the manufacturer's recommendations, or perform the following test.

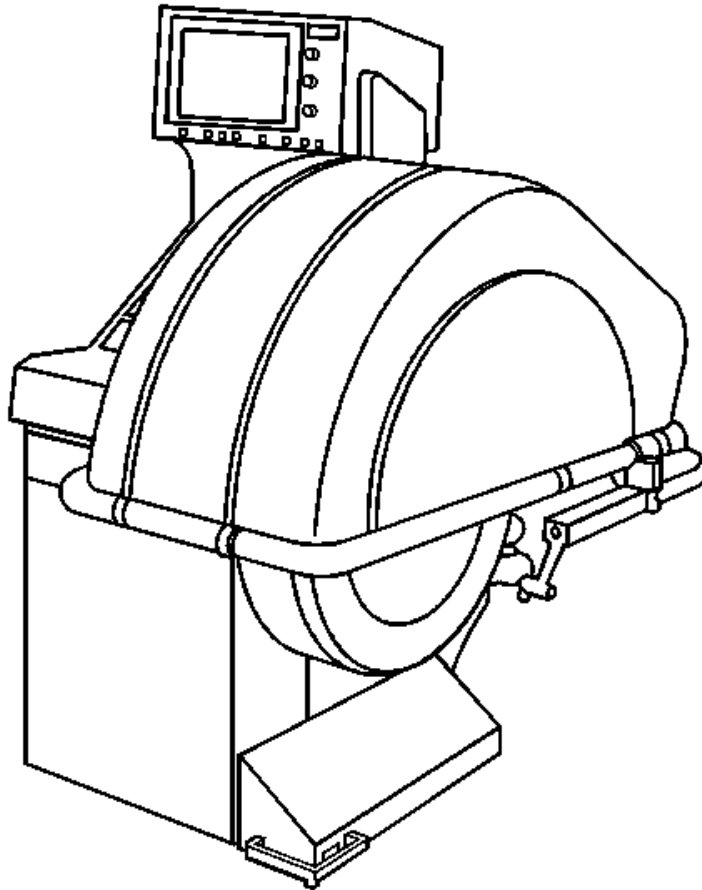


Fig. 17: View Of Tire & Wheel Assembly Balancer
Courtesy of GENERAL MOTORS COMPANY

1. Spin the balancer without a wheel or any of the adapters on the shaft.
2. Inspect the balancer readings.

Specification

Zero within 7 g (1/4 oz)

3. If the balancer is within the specification range, balance a tire and wheel assembly - that is within radial and lateral runout tolerances - to ZERO, using the same balancer.
4. After the tire and wheel assembly has been balanced, add an 85 g (3 oz) test weight to the wheel at any location.
5. Spin the tire and wheel assembly again. Note the readings.
 - In the static and dynamic modes, the balancer should call for 85 g (3 oz) of weight, 180 degrees opposite the test weight.
 - In the dynamic mode, the weight should be called for on the flange of the wheel opposite the test

weight.

6. With the assembly imbalanced to 85 g (3 oz), cycle the balancer 5 times.
7. Inspect the balancer readings:

Specification

Maximum variation: 7 g (1/4 oz)

8. Index the tire and wheel assembly on the balancer shaft, 90 degrees from the previous location.
9. Cycle the balancer with the assembly at the new location.
10. Inspect the balancer readings:

Specification

Maximum variation: 7 g (1/4 oz)

11. Repeat steps 8 through 10 until the tire and wheel assembly has been cycled and checked at each of the 4 locations on the balancer shaft.

Tire and Wheel Assembly Balancing Guidelines

NOTE: Tire and wheel assemblies which exhibit excessive runout can produce vibrations even if the assemblies are balanced.

It is strongly recommended that the tire and wheel assembly runout be measured and corrected if necessary BEFORE the assemblies are balanced.

If the runout of the tire and wheel assemblies has not yet been measured, refer to **Tire and Wheel Assembly Runout Measurement - Off Vehicle** before proceeding.

There are 2 types of tire and wheel balance:

Static Balance

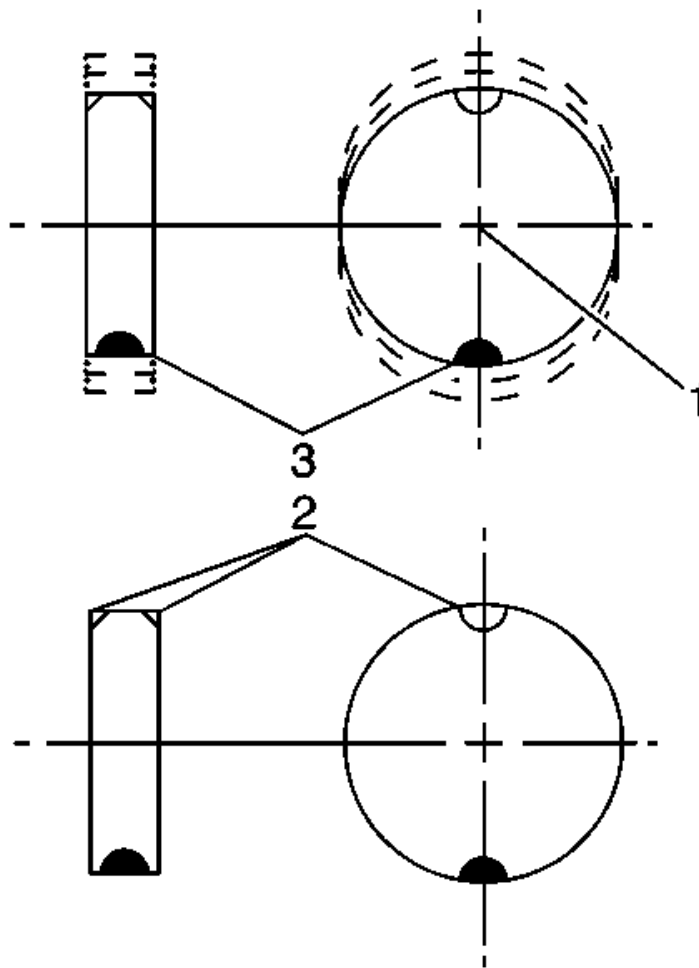


Fig. 18: View Of Static Balance

Courtesy of GENERAL MOTORS COMPANY

Static balance is the equal distribution of weight around the wheel circumference. The wheel balance weights (2) are positioned on the wheel in order to offset the effects of a heavy spot (3). Wheels that have static imbalance can produce a bouncing action called tramp.

Dynamic Balance

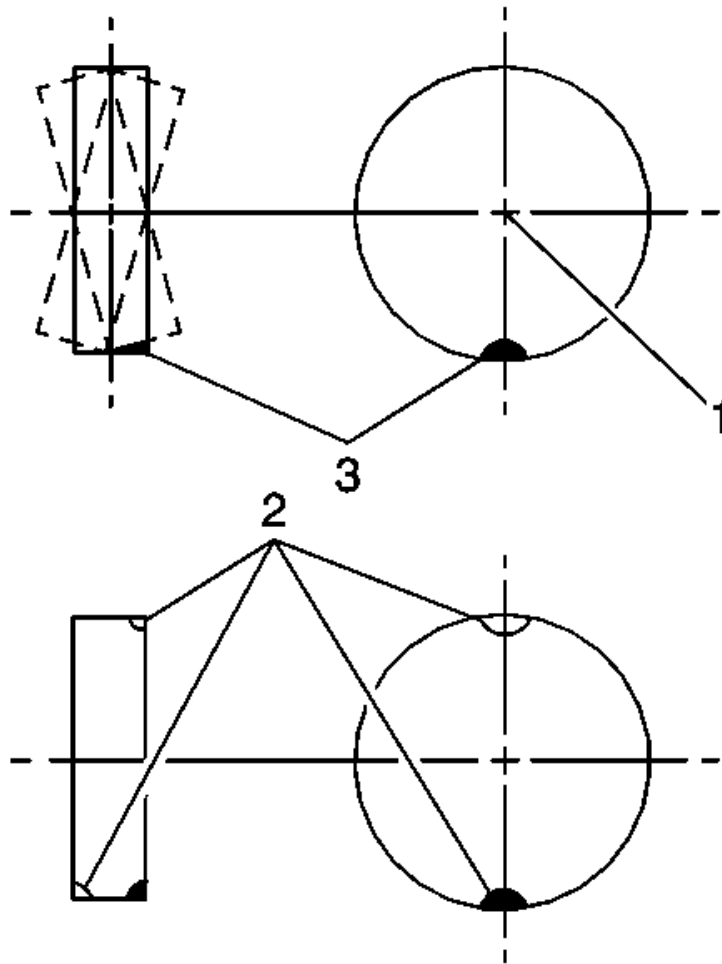


Fig. 19: View Of Dynamic Balance
Courtesy of GENERAL MOTORS COMPANY

Dynamic balance is the equal distribution of weight on each side of the tire and wheel assembly centerline. The wheel balance weights (2) are positioned on the wheel in order to offset the effects of a heavy spot (3). Wheels that have dynamic imbalance have a tendency to move from side to side and can cause an action called shimmy.

Most off-vehicle balancers are capable of checking both types of balance simultaneously.

As a general rule, most vehicles are more sensitive to static imbalance than to dynamic imbalance; however, vehicles equipped with low profile, wide tread path, high performance tires and wheels are susceptible to small amounts of dynamic imbalance. As little as 14-21 g (1/2 - 3/4 oz) imbalance is capable of inducing a vibration in some vehicle models.

Balancing Procedure

NOTE: When balancing tire and wheel assemblies, use a known good, recently calibrated, off-vehicle, two-plane dynamic balancer set to the finest balance

mode available.

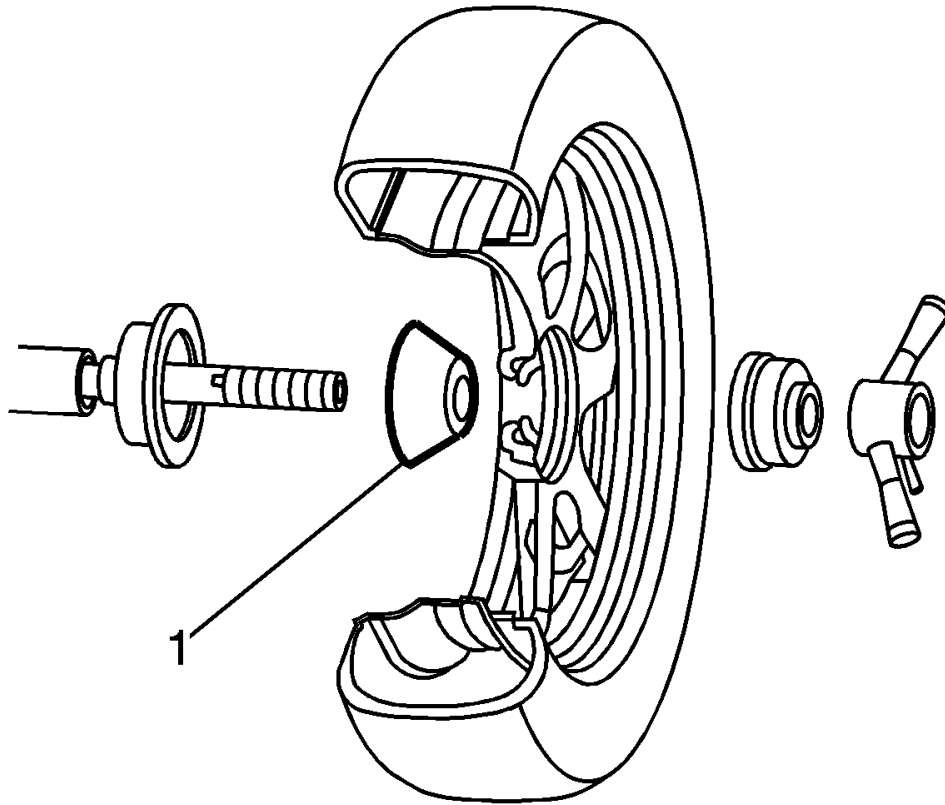


Fig. 20: Wheel Balancer Center Cone
Courtesy of GENERAL MOTORS COMPANY

NOTE: Carefully follow the wheel balancer manufacturers's instructions for proper mounting of the center cone (1).

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel - LF, LR, RF, RR.
3. Remove the tire and wheel assemblies one at a time and mount on a spin-type wheel balancer. Refer to **Tire and Wheel Removal and Installation** .
4. Carefully follow the wheel balancer manufacturer's instructions for proper mounting techniques to be used on different types of wheels.

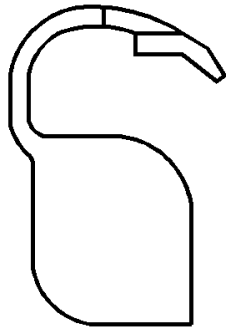
Regard aftermarket wheels, especially those incorporating universal lug patterns, as potential sources of runout and mounting concerns.

5. Be sure to use the correct type of wheel balance weights for the type of wheel rim being balanced. Be sure to use the correct type of coated wheel balance weights on aluminum wheels. Refer to Wheel Weight Usage.
6. Balance all four tire and wheel assemblies as close to zero as possible.
7. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.

Wheel Weight Usage

Tire and wheel assemblies can be balanced using either the static or dynamic method.

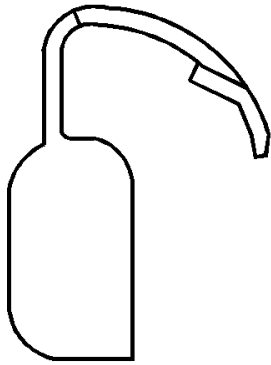
Clip-on Weights



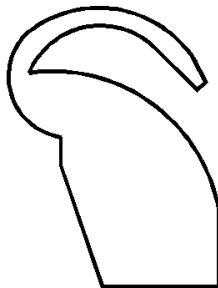
1



4



2



3

Fig. 21: Identifying Clip-On Wheel Weight Types
Courtesy of GENERAL MOTORS COMPANY

NOTE: When balancing factory aluminum wheels with clip-on wheel balance weights,

be sure to use special polyester-coated weights. These coated weights reduce the potential for corrosion and damage to aluminum wheels.

These coated weights reduce the potential for corrosion and damage to aluminum wheels.

- MC (1) and AW (2) series weights are approved for use on aluminum wheels.
- P (3) series weights are approved for use on steel wheels only.
- T (4) series coated weights are approved for use on both steel and aluminum wheels.

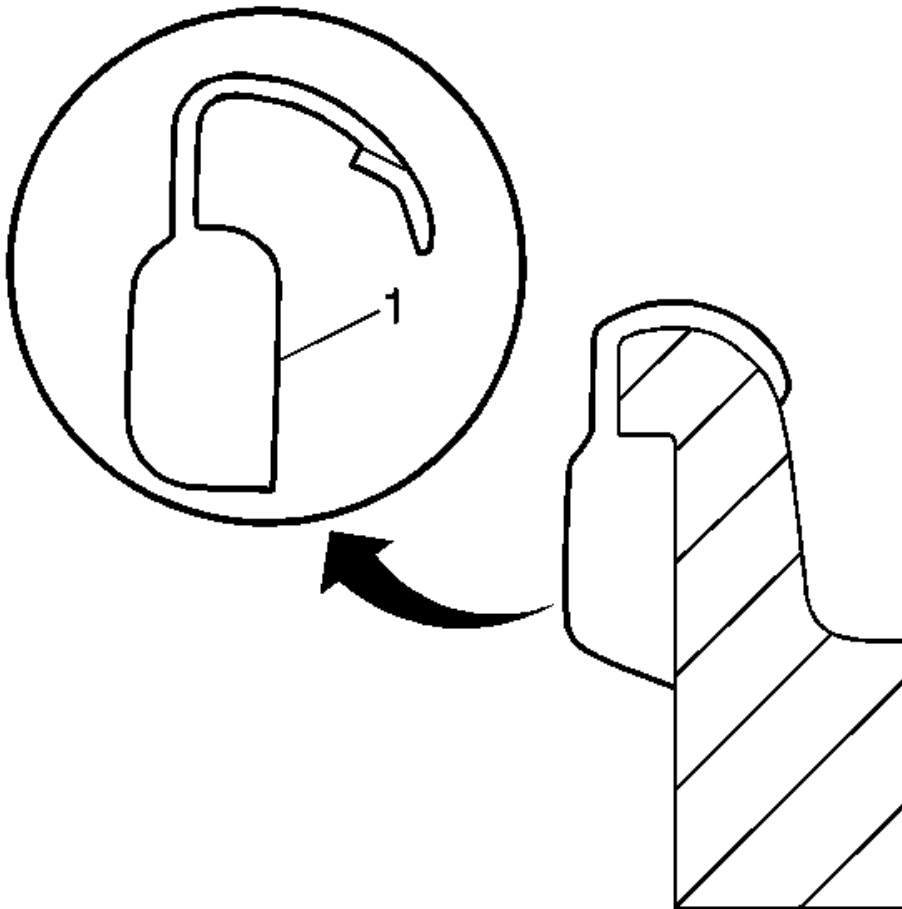


Fig. 22: Attaching Clip-On Wheel Weight
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a nylon or plastic-tipped hammer when installing coated clip-on wheel balance weights to minimize the possibility of damage to the polyester coating.

The contour and style of the wheel rim flange will determine which type of clip-on wheel weight (1) should be used. The weight should follow the contour of the rim flange. The weight clip should firmly grip the rim flange.

Wheel Weight Placement - Clip-on Weights

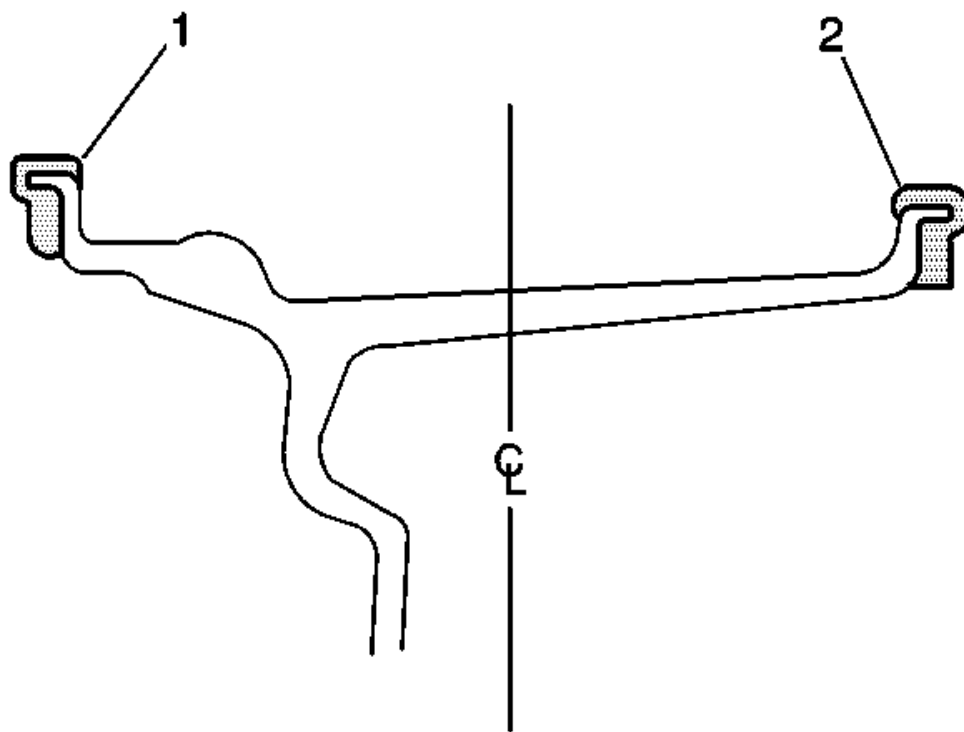


Fig. 23: View Of Wheel Weight Placement - Static Balancing
Courtesy of GENERAL MOTORS COMPANY

When static balancing, locate the wheel balance weights on the inboard flange (2) if only 28 g (1 oz) or less is called for. If more than 28 g (1 oz) is called for, split the weights as equally as possible between the inboard (2) and outboard (1) flanges.

When dynamic balancing, locate the wheel balance weights on the inboard (2) and outboard (1) rim flanges at the positions specified by the wheel balancer.

Adhesive Weights

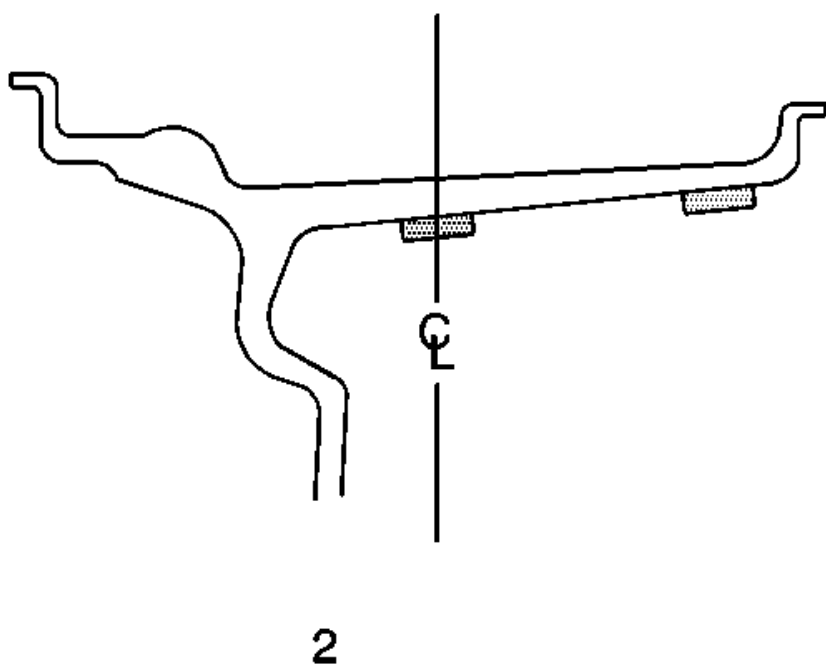
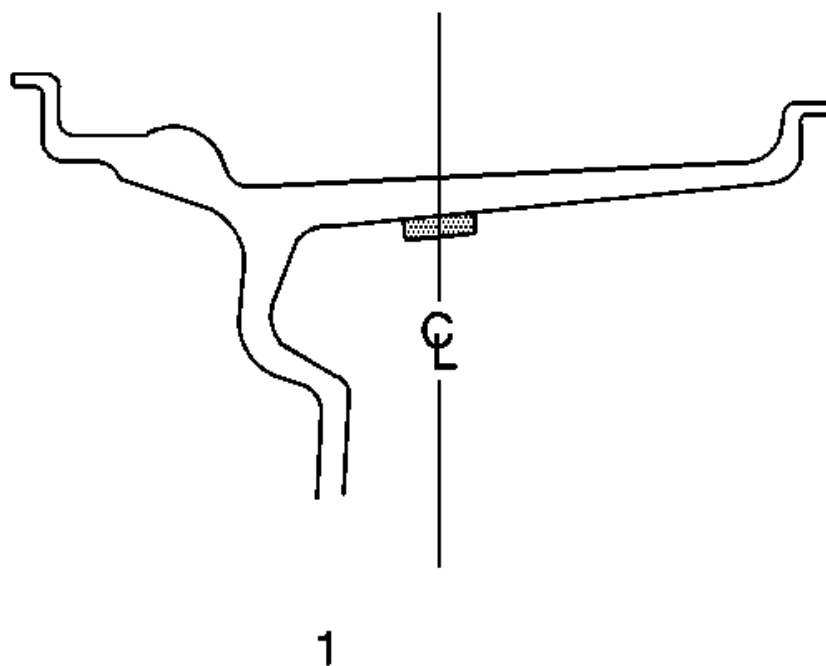


Fig. 24: Identifying Adhesive Weight Wheel Placement
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When installing adhesive balance weights on flangeless wheels, do NOT install the weight on the outboard surface of the rim.**

Adhesive wheel balance weights may be used on factory aluminum wheels. Perform the following procedure to install adhesive wheel balance weights.

1. Determine the correct areas for placement of the wheel weights on the wheel.
 - When static balancing, locate the wheel balance weights along the wheel centerline (1) on the inner wheel surface if only 28 g (1 oz) or less is called for. If more than 28 g (1 oz) is called for, split the weights as equally as possible between the wheel centerline and the inboard edge of the inner wheel surface (2).
 - When dynamic balancing, locate the wheel balance weights along the wheel centerline and the inboard edge of the inner wheel surface (2) at the positions specified by the wheel balancer.
2. Ensure that there is sufficient clearance between the wheel weights and brake system components.

NOTE: **Do not use abrasives to clean any surface of the wheel.**

3. Using a clean cloth or paper towel with a general purpose cleaner, thoroughly clean the designated balance weight attachment areas of any corrosion, overspray, dirt or any other foreign material.
4. To ensure there is no remaining residue, wipe the balance weight attachment areas again, using a clean cloth or paper towel with a mixture of half isopropyl alcohol and half water.
5. Dry the attachment areas with hot air until the wheel surface is warm to the touch.
6. Warm the adhesive backing on the wheel balance weights to room temperature.
7. Remove the protective covering from the adhesive backing on the back of the balance weights. **DO NOT** touch the adhesive surface.
8. Apply the wheel balance weights to the wheel, press into place with hand pressure.
9. Secure the wheel balance weights to the wheel with a 90 N (21 lb) force applied with a roller.

TIRE AND WHEEL ASSEMBLY BALANCING - ON-VEHICLE

Special Tools

EL-38792-A Electronic Vibration Analyzer (EVA) 2

If after following the tire and wheel vibration diagnostic process, some amount of tire and wheel vibration is still evident, an on-vehicle high-speed spin balancer may be used to perform an on-vehicle balance in an attempt to finish balance the tire and wheel assemblies, wheel hubs, brake rotors, brake drums, if equipped, and wheel trim, if equipped, simultaneously. On-vehicle balancing can also compensate for minor amounts of residual runout encountered as a result of mounting the tire and wheel assembly on the vehicle, as opposed to the balance which was achieved on the off-vehicle balancer.

In order to perform an on-vehicle balancing procedure, carefully follow the on-vehicle balancer manufacturer's specific operating instructions and carefully consider the following information before proceeding:

- Vehicles equipped with low profile, wide tread path, high performance tires and wheels are susceptible to small amounts of dynamic imbalance.
- When performing an on-vehicle balance, great care must be taken when placing the wheel balance weights on the wheels. If the wheel balance weights are not placed accurately, they can actually induce dynamic imbalance and thus increase the severity of the vibration.
- Inspect the vehicle wheel bearings to ensure that they are in good condition.
- Thoroughly inspect all on-vehicle balancing equipment and ensure that it is fully within the manufacturer's recommended specifications.
- Do not remove the off-vehicle balance weights. The purpose of on-vehicle balance is to fine tune the assembly balance already achieved off-vehicle, not to start over.
- Leave all wheel trim installed whenever possible.
- If the on-vehicle balancer calls for more than 56 g (2 oz) of additional weight, split the weight between the inboard and outboard flanges of the wheel, so as not to upset the dynamic balance of the assembly achieved in the off-vehicle balance. For wheel balance weight information, refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.
- If available, tape-off an area on top of the fenders and the quarter panels, then place the vibration sensor of the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 on the fender or quarter panel above the specific tire and wheel assembly while it is being on-vehicle balanced.

The **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 will provide a visual indication of the amplitude of the vibration, and the effect that the on-vehicle balance has on it.

TIRE-TO-WHEEL MATCH-MOUNTING (VECTURING)

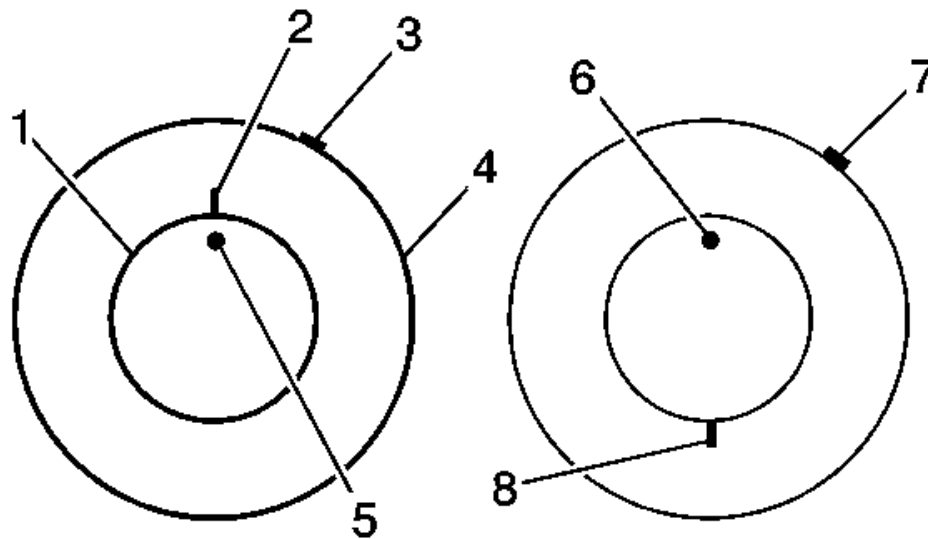


Fig. 25: View Of Tire-to-Wheel Match-Mounting
Courtesy of GENERAL MOTORS COMPANY

NOTE: After remounting a tire to a wheel or after replacing a tire and/or a wheel, remeasure the tire and wheel assembly runout in order to verify that the amount of runout has been reduced and brought to within tolerances. Ensure that the tire and wheel assembly is properly balanced before reinstalling to the vehicle.

1. Mark the location of the high spot (3) on the tire as determined during the off-vehicle tire and wheel assembly runout measurement.
2. Place a reference mark (2) on the tire sidewall at the location of the valve stem (5).
 - Always refer to the valve stem as the 12 o'clock position.
 - Refer to the location of the high spot (3) by its clock position on the wheel, relative to the valve stem.
3. Mount the tire and wheel assembly on a tire machine and break down the bead. Do not dismount the tire from the wheel at this time.

4. Rotate the tire 180 degrees on the rim so that the valve stem reference mark (8) is now at the 6 o'clock position in relation to the valve stem (6). You may need to lubricate the bead in order to easily rotate the tire on the wheel.
5. Reinflate the tire and seat the bead properly.
6. Mount the assembly on the tire balancer and remeasure the runout. Mark the new location of the assembly runout high spot on the tire.
7. If the assembly runout has been reduced and is within tolerance, no further steps are necessary. Balance the tire and wheel assembly, then install the assembly to the vehicle. Refer to the following:
 - **Tire and Wheel Assembly Balancing - Off Vehicle**
 - **Tire and Wheel Removal and Installation**
8. If the clock location of the high spot remained at or near the original clock location of the high spot (7) and the assembly runout has NOT been reduced, the wheel is the major contributor to the assembly runout concern.

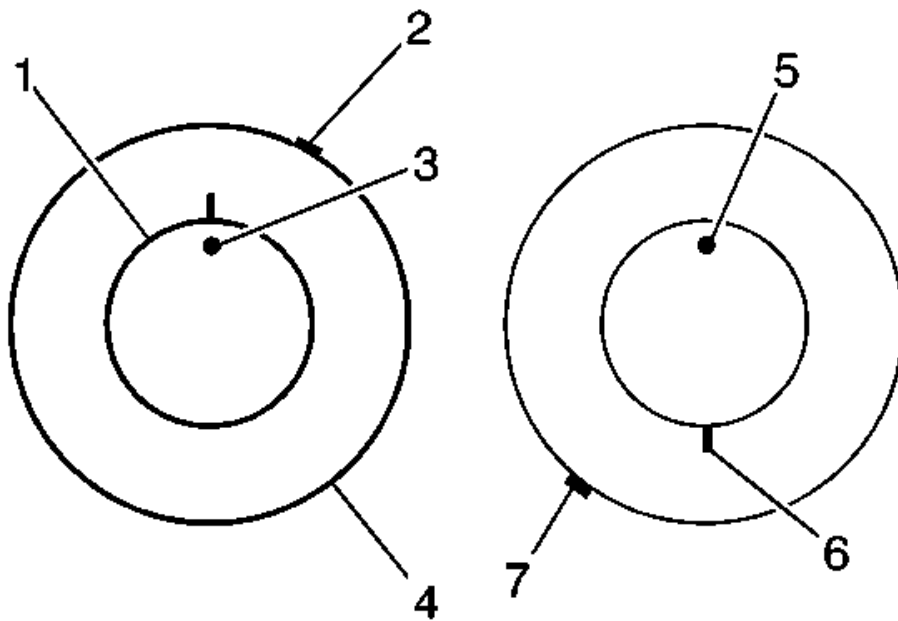


Fig. 26: View Of Match-Mounting Tire-To-Wheel
Courtesy of GENERAL MOTORS COMPANY

9. If the clock location of the high spot has moved, however the assembly runout has NOT been reduced, perform the following steps:
 1. If the clock location of the high spot (7) is now at or near a position 180 degrees from the original clock location of the high spot, the tire is the major contributor to the assembly runout concern.
 2. If the clock location of the high spot is now in-between the 2 extremes, then both the tire and the wheel are both contributing to the assembly runout concern. Rotate the tire an additional 90 degrees in both the clockwise and the counterclockwise directions to obtain the lowest amount of assembly runout.

TIRE AND WHEEL ASSEMBLY-TO-HUB/AXLE FLANGE MATCH-MOUNTING

NOTE: **After remounting a tire and wheel assembly to a hub/axle flange, remeasure the tire and wheel assembly on-vehicle runout in order to verify that the amount of runout has been reduced and brought to within tolerances.**

1. Mark the location of the high spot on the tire and wheel assembly as determined during the on-vehicle tire and wheel assembly runout measurement.
2. Place a reference mark on the wheel stud that is located closest to the wheel valve stem.
 - Always refer to the reference mark on the wheel stud as the 12 o'clock position.
 - Refer to the location of the high spot by its clock position on the tire and wheel assembly, relative to the marked wheel stud.
3. Remove the tire and wheel assembly from the hub/axle flange. Refer to **Tire and Wheel Removal and Installation** .
4. Rotate the tire and wheel assembly as close to 180 degrees as possible on the hub/axle flange, so that the wheel valve stem is now approximately at the 6 o'clock position in relation to the marked wheel stud.
5. Reinstall the wheel lug nuts to secure the tire and wheel assembly in the new position. Refer to **Tire and Wheel Removal and Installation** .
6. Remeasure the tire and wheel assembly on-vehicle runout. Mark the new location of the assembly on-vehicle runout high spot on the tire. Refer to **Tire and Wheel Assembly Runout Measurement - On-Vehicle**.
7. If the assembly on-vehicle runout has been reduced and is within tolerance, no further steps are necessary.
8. If the assembly runout has NOT been reduced, perform the following steps:
 1. If the clock location of the high spot remained at or near the original clock location of the high spot, the hub/axle flange and/or the brake rotor/drum mounting flange is the major contributor to the assembly on-vehicle runout concern.
 2. If the clock location of the high spot is now at or near a position 180 degrees from the original clock location of the high spot, the tire and wheel assembly is the major contributor to the assembly on-vehicle runout concern.
 3. If the clock location of the high spot is now in-between the 2 extremes, then both the tire and wheel assembly and the hub/axle flange are contributing to the assembly on-vehicle runout concern. Rotate the tire and wheel assembly as close to an additional 90 degrees as possible in both the clockwise and the counterclockwise directions to obtain the lowest amount of assembly on-vehicle runout.

DESCRIPTION AND OPERATION

VIBRATION THEORY AND TERMINOLOGY

Vibration Theory

The designs and engineering requirements of vehicles have undergone drastic changes over the last several years.

Vehicles are stiffer and provide more isolation from road input than they did previously. The structures of today's stiffer vehicles are less susceptible to many of the vibrations which could be present in vehicles of earlier designs, however, vibrations can still be detected in a more modern vehicle if a transfer path is created between a rotating component and the body of the vehicle.

There are not as many points of isolation from the road in many vehicles today. If a component produces a strong enough vibration, it may overcome the existing isolation and the component needs to be repaired or replaced.

The presence/absence of unwanted noise and vibration is linked to the customer's perception of the overall quality of the vehicle.

Vibration is the repetitive motion of an object, back and forth, or up and down. The following components cause most vehicle vibrations:

- A rotating component
- The engine combustion process firing impulses

Rotating components will cause vibrations when excessive imbalance or runout is present. During vibration diagnosis, the amount of allowable imbalance or runout should be considered a TOLERANCE and not a SPECIFICATION. In other words, the less imbalance or runout the better.

Rotating components will cause a vibration concern when they not properly isolated from the passenger compartment: Engine firing pulses can be detected as a vibration if a motor mount is collapsed.

A vibrating component operates at a consistent rate (km/h, mph, or RPM). Measure the rate of vibration in question. When the rate/speed is determined, relate the vibration to a component that operates at an equal rate/speed in order to pinpoint the source. Vibrations also tend to transmit through the body structure to other components. Therefore, just because the seat vibrates does not mean the source of vibration is in the seat.

Vibrations consist of the following three elements:

- The source - the cause of the vibration
- The transfer path - the path the vibration travels through the vehicle
- The responder - the component where the vibration is felt

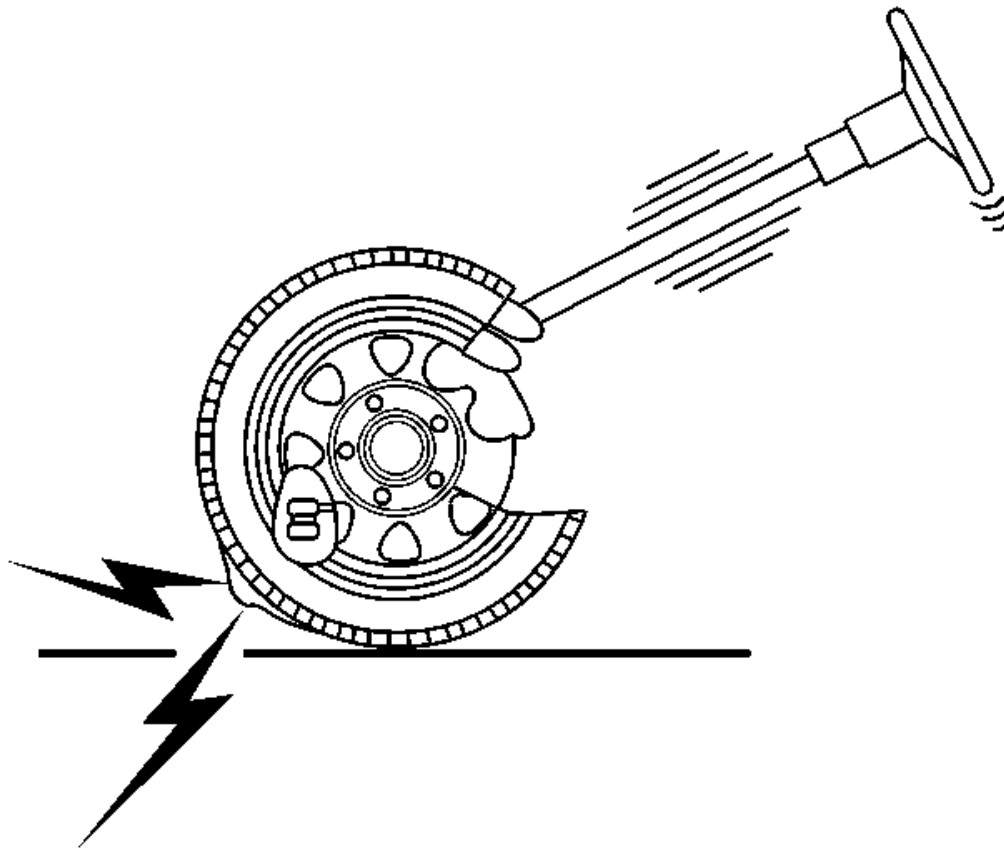


Fig. 27: Identifying Unbalanced Tire Vibration
Courtesy of GENERAL MOTORS COMPANY

In the preceding picture, the source is the unbalanced tire. The transfer path is the route the vibrations travels through the vehicle's suspension system into the steering column. The responder is the steering wheel, which the customer reports as vibrating. Eliminating any one of these three elements will usually correct the condition. Decide, from the gathered information, which element makes the most sense to repair. Adding a brace to the steering column may keep the steering wheel from vibrating, but adding a brace is not a practical solution. The most direct and effective repair would be to properly balance the tire.

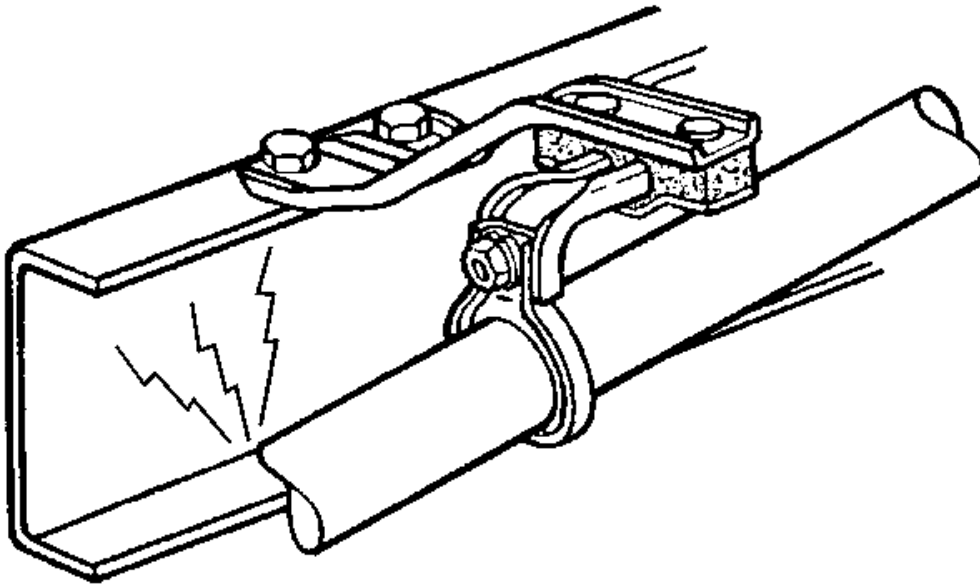


Fig. 28: Identifying Exhaust Pipe Noise
Courtesy of GENERAL MOTORS COMPANY

Vibration can also produce noise. As an example, consider a vehicle that has an exhaust pipe grounded to the frame. The source of the vibration is the engine firing impulses traveling through the exhaust. The transfer path is a grounded or bound-up exhaust hanger. The responder is the frame. The floor panel vibrates, acting as a large speaker, which produces noise. The best repair would be to eliminate the transfer path. Aligning the exhaust system and correcting the grounded condition at the frame would eliminate the transfer path.

Basic Vibration Terminology

The following are the 2 primary components of vibration diagnosis:

- The physical properties of objects
- The object's properties of conducting mechanical energy

The repetitive up and down or back and forth movement of a component cause most customer vibration complaints. The following are the common components that vibrate:

- The steering wheel
- The seat cushion
- The frame
- The IP

Vibration diagnosis involves the following simple outline:

1. Measure the repetitive motion and assign a value to the measurement in cycles per second or cycles per minute.
2. Relate the frequency back on terms of the rotational speed of a component that is operating at the same rate or speed.
3. Inspect and test the components for conditions that cause vibration.

For example, performing the following steps will help demonstrate the vibration theory:

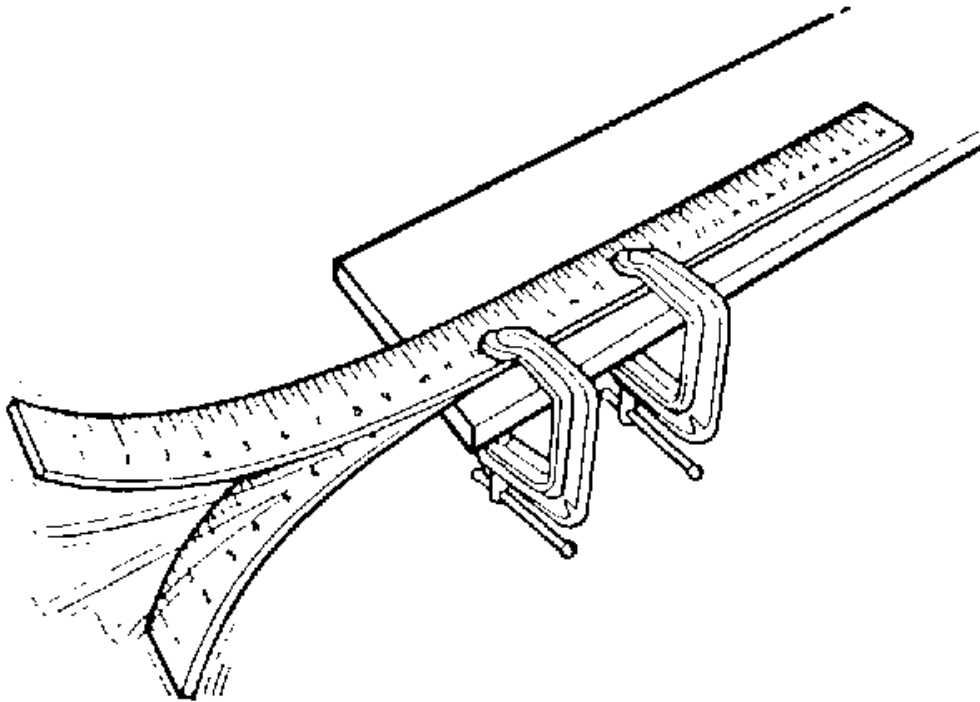


Fig. 29: Demonstrating Vibration Theory

Courtesy of GENERAL MOTORS COMPANY

1. Clamp a yardstick to the edge of a table, leaving about 50 cm (20 in) hanging over the edge of the table.
2. Pull down on the edge of the stick and release while observing the movement of the stick.

The motion of the stick occurs in repetitive cycles. The cycle begins at midpoint, continues through the lowest extreme of travel, then back past the midpoint, through the upper extreme of travel, and back to the midpoint where the cycle begins again.

The cycle occurs over and over again at the same rate, or frequency. In this case, about 10 cycles in one second. If we measure the frequency to reflect the number of complete cycles that the yardstick made in one minute, the measure would be $10 \text{ cycles} \times 60 \text{ seconds} = 600 \text{ cycles per minute (cpm)}$.

We have also found a specific amount of motion, or amplitude, in the total travel of the yardstick from the very top to the very bottom. Redo the experiment as follows:

1. Reclamp the yardstick to the edge of a table, leaving about 25 cm (10 in) hanging over the edge of the table.
2. Pull down on the edge of the stick and release while observing the movement of the stick.

The stick vibrates at a much faster frequency: 30 cycles per second (1,800 cycles per minute).

Cycle

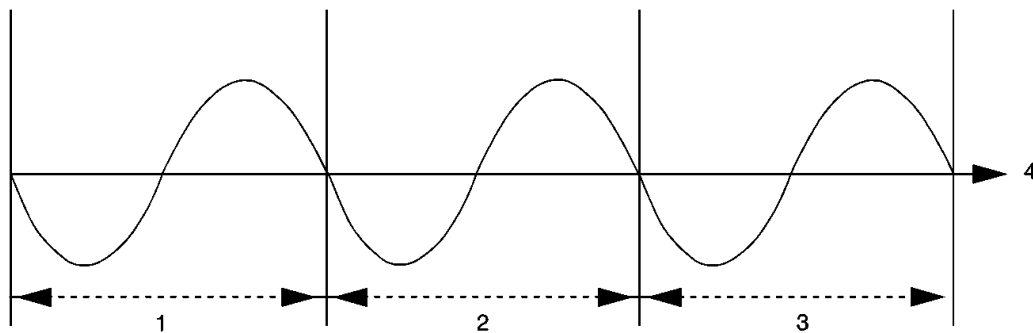


Fig. 30: Identifying Powertrain Vibration Cycles
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	1st Cycle
2	2nd Cycle
3	3rd Cycle
4	Time

Vibration Cycles in Powertrain Components

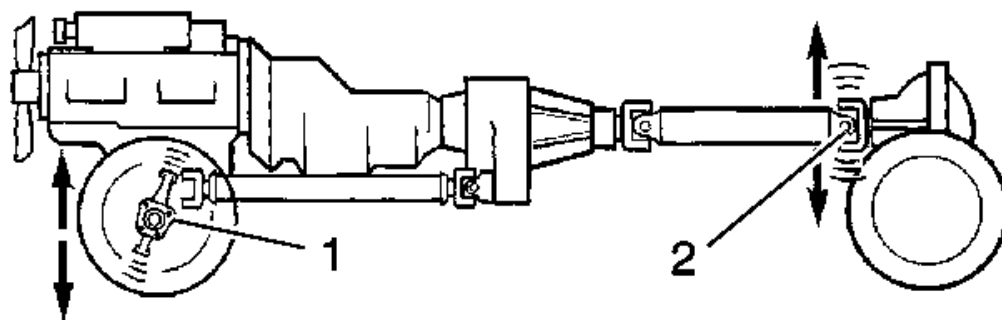


Fig. 31: Identifying Vibration Cycles In Powertrain Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Spindle
2	Pinion Nose

The word cycle comes from the same root as the word circle. A circle begins and ends at the same point, as thus, so does a cycle. All vibrations consist of repetitive cycles.

Frequency

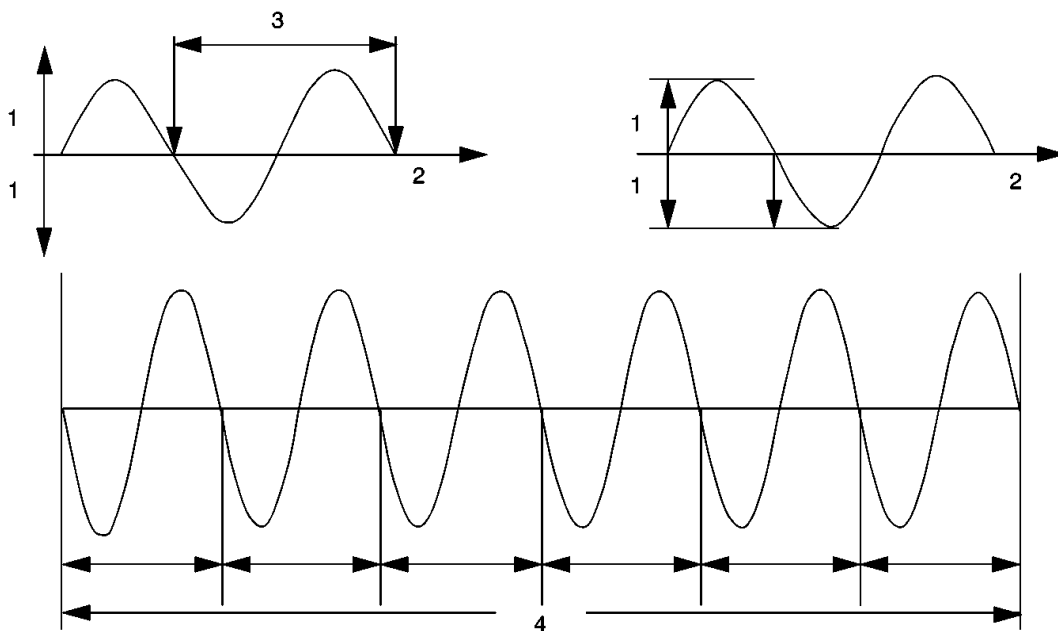


Fig. 32: Identifying Vibration Frequency
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Amplitude
2	Reference
3	Time in Seconds
4	1 Second

Frequency is defined as the rate at which an event occurs during a given period of time. With a vibration, the event is a cycle, and the period of time is 1 second. Thus, frequency is expressed in cycles per second.

The proper term for cycles per seconds is Hertz (Hz). This is the most common way to measure frequency. Multiply the Hertz by 60 to get the cycles or revolutions per minute (RPM).

Amplitude

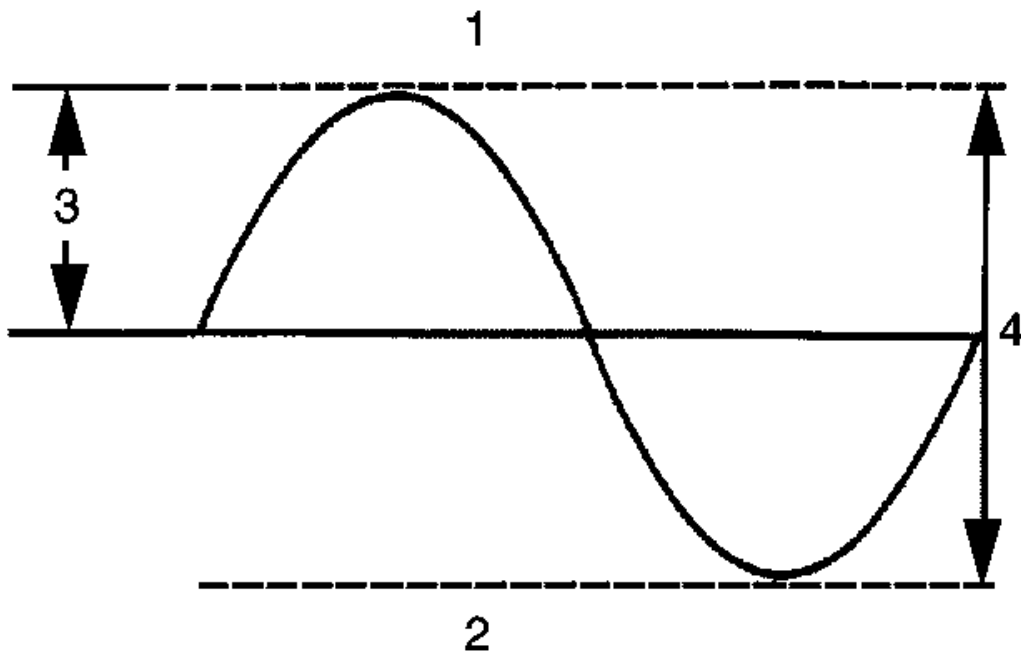


Fig. 33: Identifying Vibration Amplitude
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Maximum
2	Minimum
3	Zero-to-Peak Amplitude
4	Peak-to-Peak Amplitude

Amplitude is the maximum value of a periodically varying quantity. Used in vibration diagnostics, we are referring it to the magnitude of the disturbance. A severe disturbance would have a high amplitude; a minor disturbance would have a low amplitude.

Amplitude is measured by the amount of actual movement, or the displacement. For example, consider the vibration caused by an out-of-balance wheel at 80 km/h (50 mph) as opposed to 40 km/h (25 mph). As the speed increases, the amplitude increases.

Free Vibration

Free vibration is the continued vibration in the absence of any outside force. In the yardstick example, the yardstick continued to vibrate even after the end was released.

Forced Vibration

Forced vibration is when an object is vibrating continuously as a result of an outside force.

Centrifugal Force Due to an Imbalance

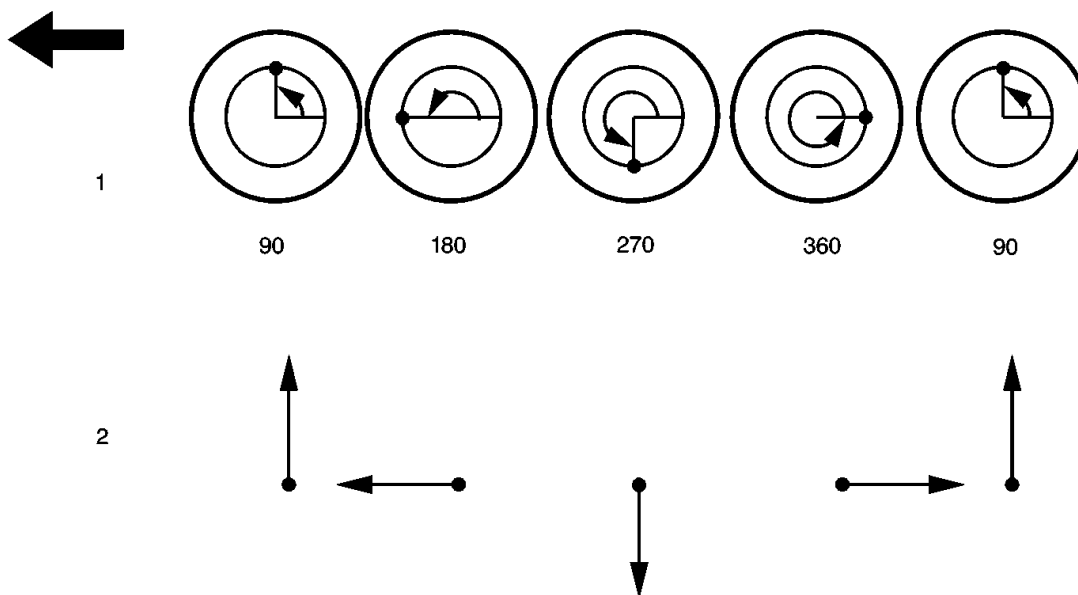


Fig. 34: Identifying Centrifugal Force Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Location of Imbalance (Degrees)
2	Centrifugal Force Acting on Spindle

A spinning object with an imbalance generates a centrifugal force. Performing the following steps will help to demonstrate centrifugal force:

1. Tie a nut to a string.
2. Hold the string. The nut hangs vertically due to gravity.
3. Spin the string. The nut will spin in a circle.

Centrifugal force is trying to make the nut fly outward, causing the pull you feel on your hand. An unbalanced tire follows the same example. The nut is the imbalance in the tire. The string is the tire, wheel, and suspension assembly. As the vehicle speed increases, the disturbing force of the unbalanced tire can be felt in the steering wheel, the seat, and the floor. This disturbance will be repetitive (Hz) and the amplitude will increase. At higher speeds, both the frequency and the amplitude will increase. As the tire revolves, the imbalance, or the centrifugal force, will alternately lift the tire up and force the tire downward, along with the spindle, once for each revolution of the tire.

Natural or Resonant Frequency

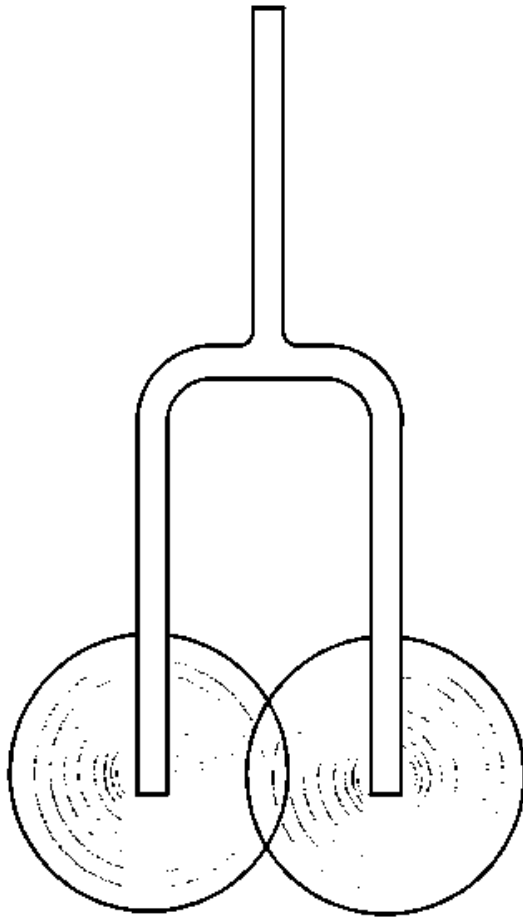


Fig. 35: View Of Natural Frequency
Courtesy of GENERAL MOTORS COMPANY

The natural frequency is the frequency at which an object tends to vibrate. Bells, guitar strings, and tuning forks are all examples of objects that tend to vibrate at specific frequencies when excited by an external force.

Suspension systems, and even engines within the mounts, have a tendency to vibrate at certain frequencies. This is why some vibration complaints occur only at specific vehicle speeds or engine RPM.

The stiffness and the natural frequency of a material have a relationship. Generally, the stiffer the material, the higher the natural frequency. The opposite is also true. The softer a material, the lower the natural frequency. Conversely, the greater the mass, the lower the natural frequency.

Resonance

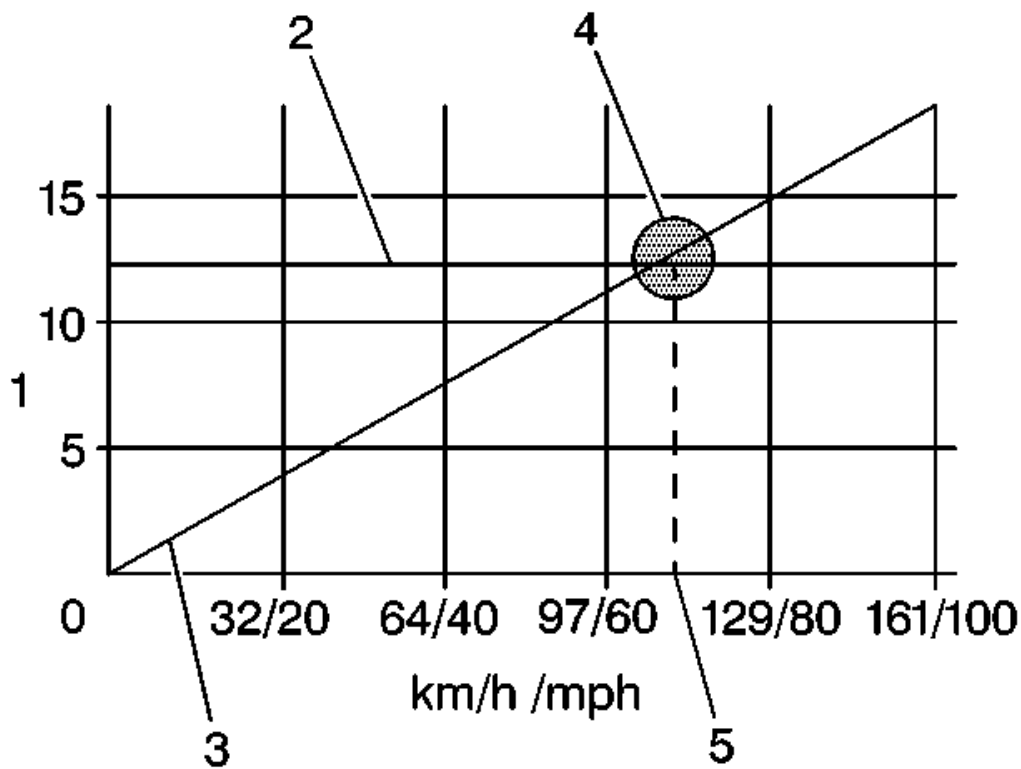


Fig. 36: Natural Frequency Of A Typical Automotive Front Suspension
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Frequency - cps
2	Suspension Frequency
3	Unbalanced Excitation
4	Point of Resonance
5	Problem Speed

All objects have natural frequencies. The natural frequency of a typical automotive front suspension is in the

10-15 Hz range. This natural frequency is the result of the suspension design. The suspension's natural frequency is the same at all vehicle speeds. As the tire speed increases along with the vehicle speed, the disturbance created by the tire increases in frequency. Eventually, the frequency of the unbalanced tire will intersect with the natural frequency of the suspension. This causes the suspension to vibrate. The intersecting point is called the resonance.

The amplitude of a vibration will be greatest at the point of resonance. While the vibration may be felt above and below the problem speed, the vibration may be felt the most at the point of resonance.

Damping

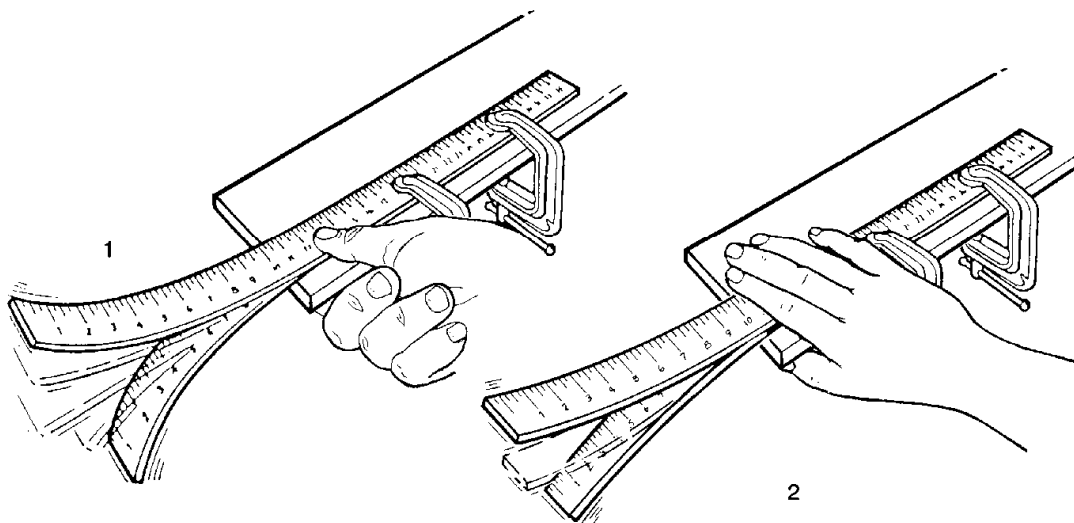


Fig. 37: Identifying Low & High Damping
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Low Damping
2	High Damping

Damping is the ability of an object or material to dissipate or absorb vibration. The automotive shock absorber is a good example. The function of the shock absorber is to absorb or dampen the oscillations of the suspension system.

Beating (Phasing)

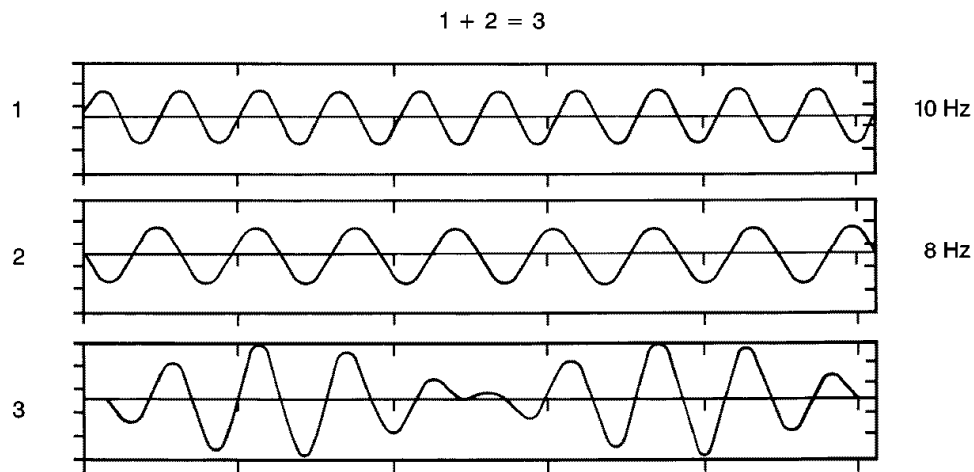


Fig. 38: Identifying Beating Or Phasing
Courtesy of GENERAL MOTORS COMPANY

Two separate disturbances that are relatively close together in frequency will lead to a condition called beating, or phasing. A beating vibration condition will increase in intensity or amplitude in a repetitive fashion as the vehicle travels at a steady speed. This beating vibration can produce the familiar droning noise heard in some vehicles.

Beating occurs when 2 vibrating forces are adding to each other's amplitude. However, 2 vibrating forces can also subtract from each other's amplitude. The adding and subtracting of amplitudes in similar frequencies is called beating. In many cases, eliminating either one of the disturbances can correct the condition.

Order

Order refers to how many times an event occurs during 1 revolution of a rotating component.

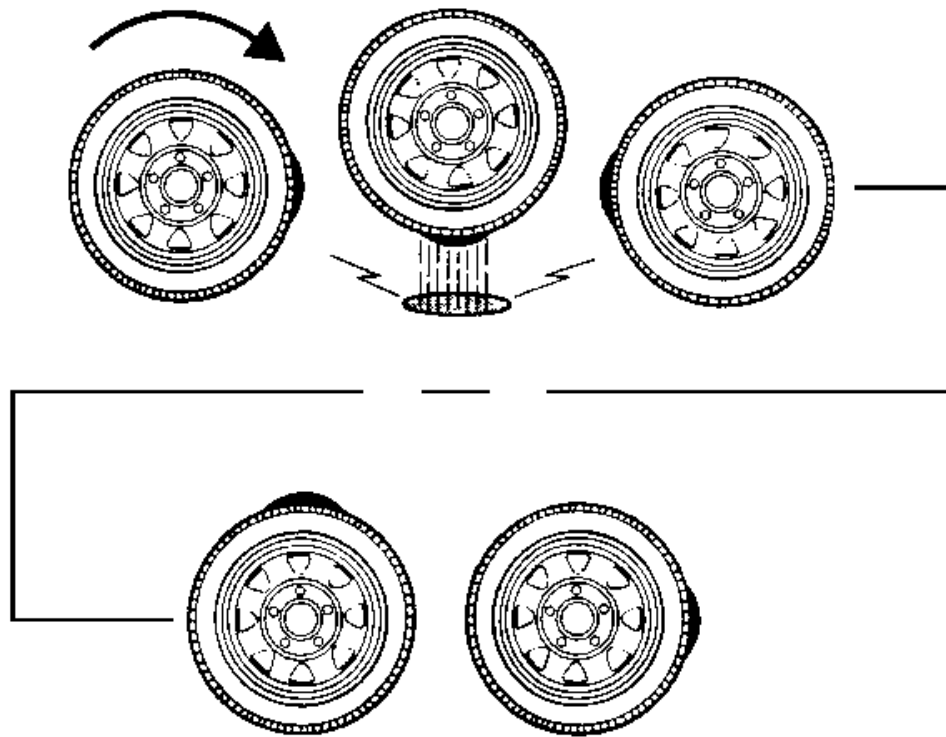


Fig. 39: Identifying First-Order Vibration
Courtesy of GENERAL MOTORS COMPANY

For example, a tire with 1 high spot would create a disturbance once for every revolution of the tire. This is called first-order vibration.

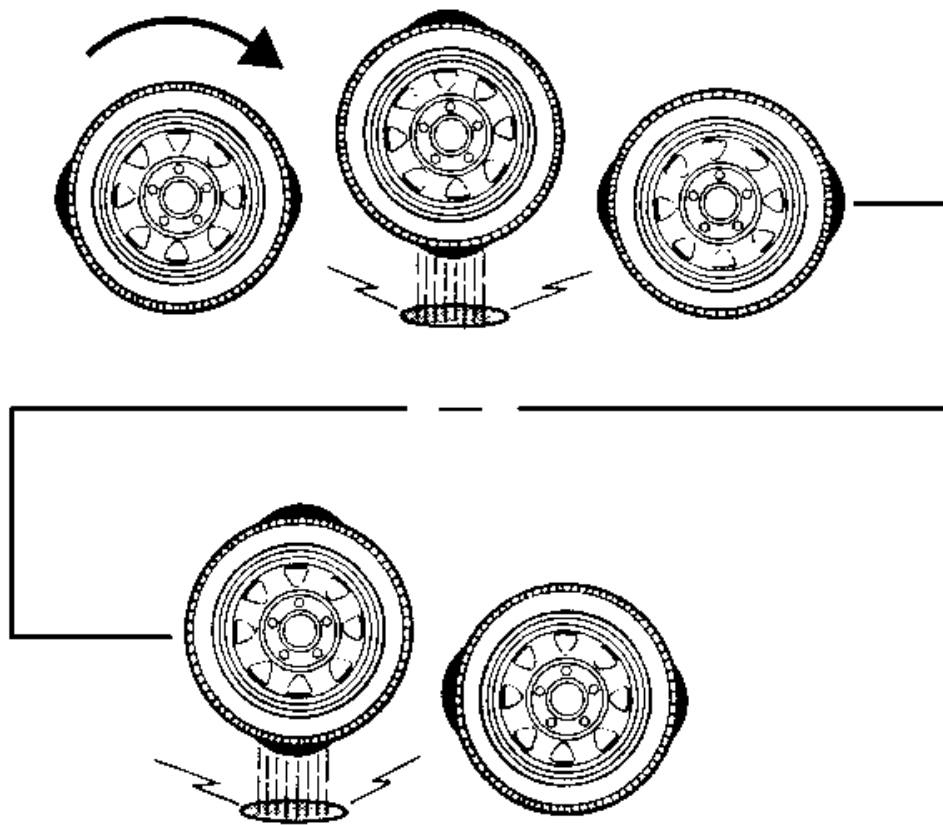


Fig. 40: Identifying Second-Order Vibration
Courtesy of GENERAL MOTORS COMPANY

An oval-shaped tire with 2 high spots would create a disturbance twice for every revolution. This is called second-order vibration. Three high spots would be third-order, and so forth. Two first-order vibrations may add or subtract from the overall amplitude of the disturbance, but that is all. Two first-order vibrations do not equal a second-order. Due to centrifugal force, an unbalanced component will always create at least a first-order vibration.

ELECTRONIC VIBRATION ANALYZER (EVA) DESCRIPTION AND OPERATION

Special Tools

- **EL-38792-25** Inductive Pickup Timing Light
- **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2)

For equivalent regional tools, refer to **Special Tools and Equipment**.

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) , is a 12-volt powered hand-held device, similar to a scan tool, which receives input from an attached vibration sensor or accelerometer and displays the most dominate input frequency(ies) (up to three) on its liquid crystal display. The vibration concern frequency(ies) are obtained through the use of the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) while following the Vibration Analysis Diagnostic Tables. The frequency(ies) obtained, when applied to the Vibration Analysis Diagnostic Tables, are used as a primary input to help determine the source of the vibration concern.

EVA Vibration Sensor

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor incorporates a 6.1 m (20 ft) cord, that allows the sensor to be placed on virtually any component of the vehicle where a vibration concern is felt.

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) contains 2 sensor input ports which can be activated individually to allow for 2 individual vibration sensor inputs. The vibration sensors can then be placed in 2 different locations in the vehicle and their individual inputs can be read without having to stop a test, move the sensor and resume the test. The use of 2 vibration sensors can help in more quickly finding and recording an accurate frequency of the vibration concern, and in more quickly making comparisons between 2 different areas of a single component, or a vehicle system, during the diagnostic process.

EVA Vibration Sensor Placement

Proper placement of the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor (accelerometer) is critical to ensure that proper vibration readings are obtained by the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2). The vibration sensor should be placed on the specific vehicle component identified as being the most respondent to the vibration. If no component has been identified, install the sensor to the steering column as a starting point.

EVA Vibration Sensor-to-Component Attachment

NOTE: **The EL-38792-A Electronic Vibration Analyzer 2 (EVA 2) vibration sensor must be attached to vehicle components in the manner indicated in order to achieve accurate frequency readings of the vibration disturbance.**

The vibration sensor of the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) is designed to pickup disturbances which primarily occur in the vertical plane, since most vibrations are felt in that same up-and-down direction. The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor is therefore directional sensitive and must be attached to vehicle components such that the side of the sensor marked UP is always facing upright and the sensor body is as close to horizontal as possible. The sensor must be installed in the exact same position each time tests are repeated or comparisons are made to other vehicles.

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor can be attached to vehicle components in various ways. For non-ferrous surfaces, such as the shroud of a steering column, the sensor can be attached using putty, or hook and loop fasteners. For ferrous surfaces, the sensor can be attached using a magnet supplied with the sensor.

EVA Software Cartridge

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) uses a software cartridge, the GE-38792-60, which

provides various information to the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2). The GE-38792-60 provides the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) with an additional feature which can be selected and utilized to assist in diagnosing vibration concerns.

NOTE: The Auto-Mode function of the EL-38792-A Electronic Vibration Analyzer 2 (EVA 2) cartridge, GE-38792-60, is designed to be used in SUPPORT of the Vibration Analysis Diagnostic Tables ONLY.

This support-feature is available through the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) Auto-Mode function. When selected, the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) will prompt the user to select which one of 2 vehicle systems (vehicle speed or engine speed), is the SUSPECTED source of the vibration concern. Using the inputted vehicle data parameters along with the most dominate vibration frequency obtained, it will identify a SUSPECTED source of the vibration concern, such as first-order tire and wheel. This can be a useful feature when used in conjunction with the Vibration Analysis Diagnostic Tables, to confirm results obtained through the diagnostic process.

EVA Smart Strobe Function

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) can be used to identify some rotating components/systems which exhibit imbalance IF the component rotational speed is the dominant frequency of the vibration concern. The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) is equipped with a strobe light trigger wire which can be used with an inductive pickup timing light, **EL-38792-25** Inductive Pickup Timing Light , or equivalent included with the GE-38792-25-KIT, or available separately. Using the Smart Strobe function enables the user to input the vibration frequency to which the strobe will flash. By marking the suspected rotating component, such as a pulley, adjusting the strobe frequency to match the dominant vibration frequency at the engine RPM noted during diagnosis, and then operating the engine at that specific RPM, the mark on the object will appear to be stationary if that object is imbalanced.

EVA Strobe Balancing Function

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) can be used to identify the light spot on a propeller shaft IF the propeller shaft rotational speed is the dominant frequency of the vibration concern. The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) is equipped with a strobe light trigger wire which can be used with an inductive pickup timing light, **GE-38792-25** Inductive Pickup Timing Light , or equivalent included with the J-38792-25-KIT, or available separately, and in conjunction with the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor to identify the light spot on a propeller shaft and to help in making a determination as to when propeller shaft balance is obtained.

Averaging/Non-Averaging Modes

The EVA provides 2 modes of displaying the most dominate frequencies which the EVA vibration sensor (accelerometer) detects; averaging and non-averaging (instantaneous).

The averaging mode uses multiple vibration samples taken over a period of time and then displays the most dominant frequencies which have been averaged-out. Using the averaging mode minimizes the distractions caused by a sudden vibration frequency being displayed that is not related to the concern vibration, such as from pot holes or from uneven road surfaces.

The non-averaging (instantaneous) mode is more sensitive to vibration disturbances than the averaging mode. Using the non-averaging mode will generate instantaneous frequency displays which are not averaged across multiple samples over a period of time; the specific vibration frequencies that occur at a specific moment during diagnostic testing will be displayed at that moment. The non-averaging (instantaneous) mode is useful when measuring a vibration disturbance that exists for only a short period of time or during acceleration/deceleration testing.

When operating the EVA in the averaging mode along with the Auto Mode, "A" will be displayed along the top of the screen to the left of the vibration sensor input port being used. When operating the EVA in the averaging mode and the Manual Mode, "AVG" will be displayed along the top center of the screen.

When operating the EVA in the non-averaging (instantaneous) mode along with the Auto Mode, "I" will be displayed along the top of the screen to the left of the vibration sensor input port being used. When operating the EVA in the non-averaging (instantaneous) mode and the Manual Mode, the top center of the screen will be blank.

EVA Display

R	P	M		A		A	V	G								G	'	S	
1	8	0	0													1	.	3	2
3	6	0														0	.	2	5
1	2	0	0													0	.	0	9

YES	NO	↑	↓	STROBE
0 RPM/HZ	1	2	3	RECORD
4 A/B	5	6	7	PLAY BACK
8 AVG	9	ENTER	EXIT	FREEZE

Fig. 41: View Of EVA Display
Courtesy of GENERAL MOTORS COMPANY

The most dominant input frequencies, up to three, received from the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor, are displayed in descending order of amplitude strength.

The frequency readings are displayed along the left side of the screen, followed to the right by either a bar graph or the suspected source of the vibration - depending upon the mode selected, then the amplitude reading for each frequency along the right side of the screen. The top row of the screen indicates the units of measure being displayed for the frequencies along the left side and for the amplitudes along the right side. The top row also indicates the vibration sensor input port which was selected on the keypad (A or B) and which mode was selected: averaging or non-averaging (instantaneous).

The frequency(ies) can be displayed in either revolutions per minute (RPM) or revolutions per second; Hertz (Hz). The selected display type (RPM or Hz) will be indicated at the left side of the screen, above the frequency readings.

When the AUTO MODE function is not in use, a bar graph is displayed next to each frequency to provide a quick visual indication of the relative amplitude strength.

When the AUTO MODE function is being used, the suspected source of the vibration is displayed next to each frequency to provide support to the diagnostic process.

The actual amplitude strength of each frequency is displayed at the right side of the screen and shown in G's-of-acceleration force.

VIBRATE SOFTWARE DESCRIPTION AND OPERATION

The **EL-38792-VS** Vibrate Software , is a computer software program which is designed to be used in support of the Vibration Analysis diagnostic tables, along with the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , and a scan tool, to help in determining the source of a vibration concern. The **EL-38792-VS** Vibrate Software is designed to provide quick calculations and produce a chart of the rotational speeds and frequency ranges for specific vehicle systems and components, based upon vehicle data parameters inputted by the user.

The **EL-38792-VS** Vibrate Software uses the vehicle data parameters, such as axle ratio, number of engine cylinders, etc. to create the base chart, depicting the relationships of the various vehicle systems and/or components. The chart view can be modified to show data related to vehicle speed only, engine speed only, or both vehicle speed and engine speed. The user can then plot the dominant frequency reading obtained on the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 which correlates with the vibration concern, and the engine RPM obtained on a scan tool which correlates with the concern. Once these pieces of data are correctly plotted, the chart will point to the source of the vibration concern, which should confirm the results obtained through the Vibration Analysis diagnostic tables.

REED TACHOMETER DESCRIPTION

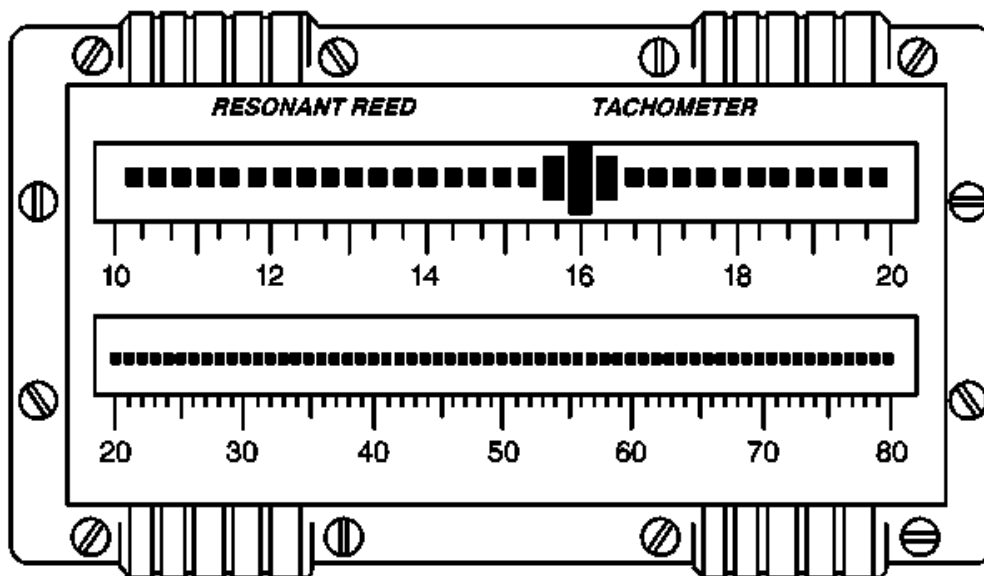


Fig. 42: Identifying Reed Tachometer
 Courtesy of GENERAL MOTORS COMPANY

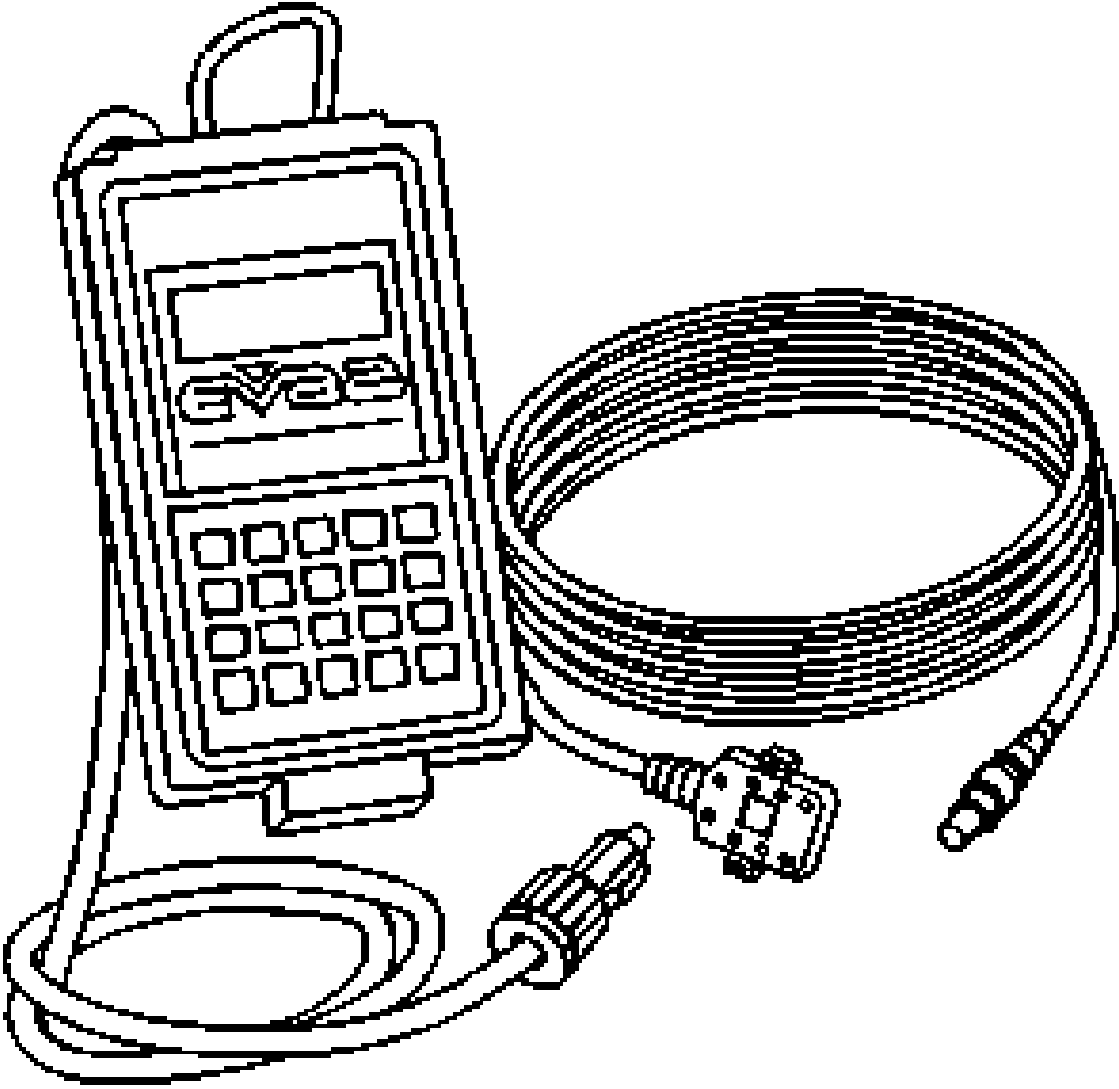
The reed tachometer consists of 2 rows of reeds arranged side-by-side. Each reed is tuned to vibrate or resonate when it is excited by a specific frequency. The reeds are arranged by their specific resonant frequency, increasing from left to right, ranging from 10-80 Hz. This arrangement allows for a visual display of the most dominate frequencies which fall within this range.

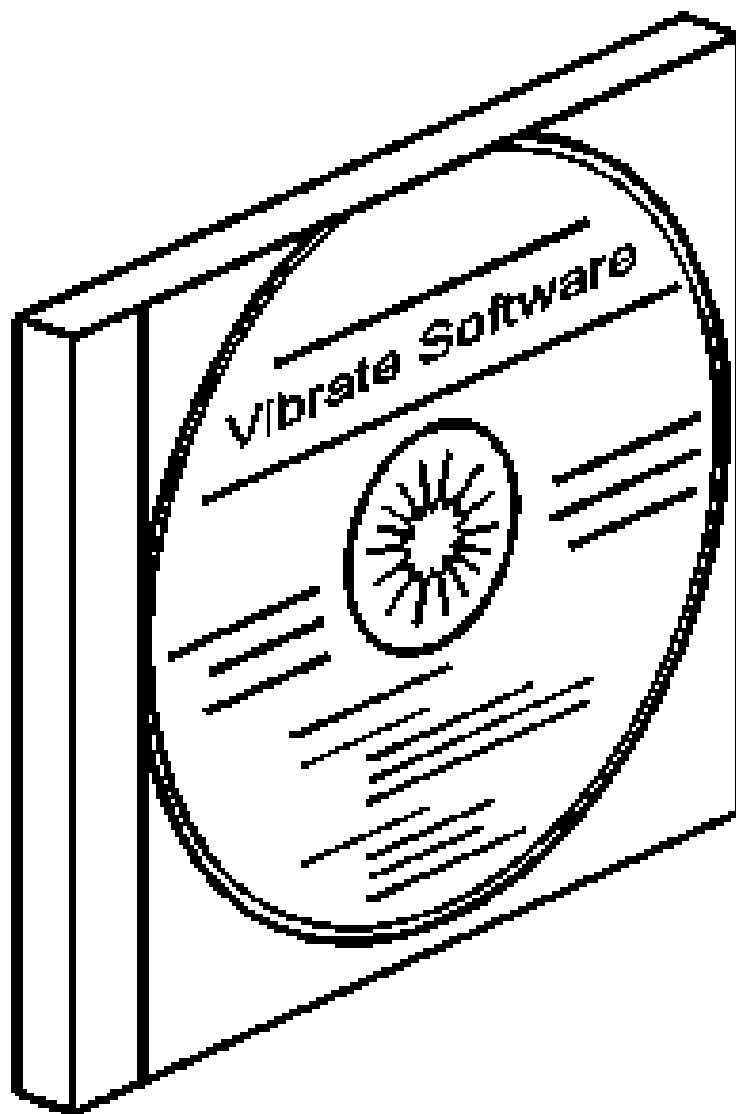
The reed tachometer can be a helpful diagnostic tool, however it is extremely sensitive to external inputs that are not related to the vibration concern, such as rough road surfaces, etc., and it is difficult to master its use. Due to these conditions, the reed tachometer has limited diagnostic capability.

Due to the limited diagnostic capability, limited availability and increasing costs of the reed tachometer, it is NOT recommended as the primary tool to use in diagnosing a vibration concern.

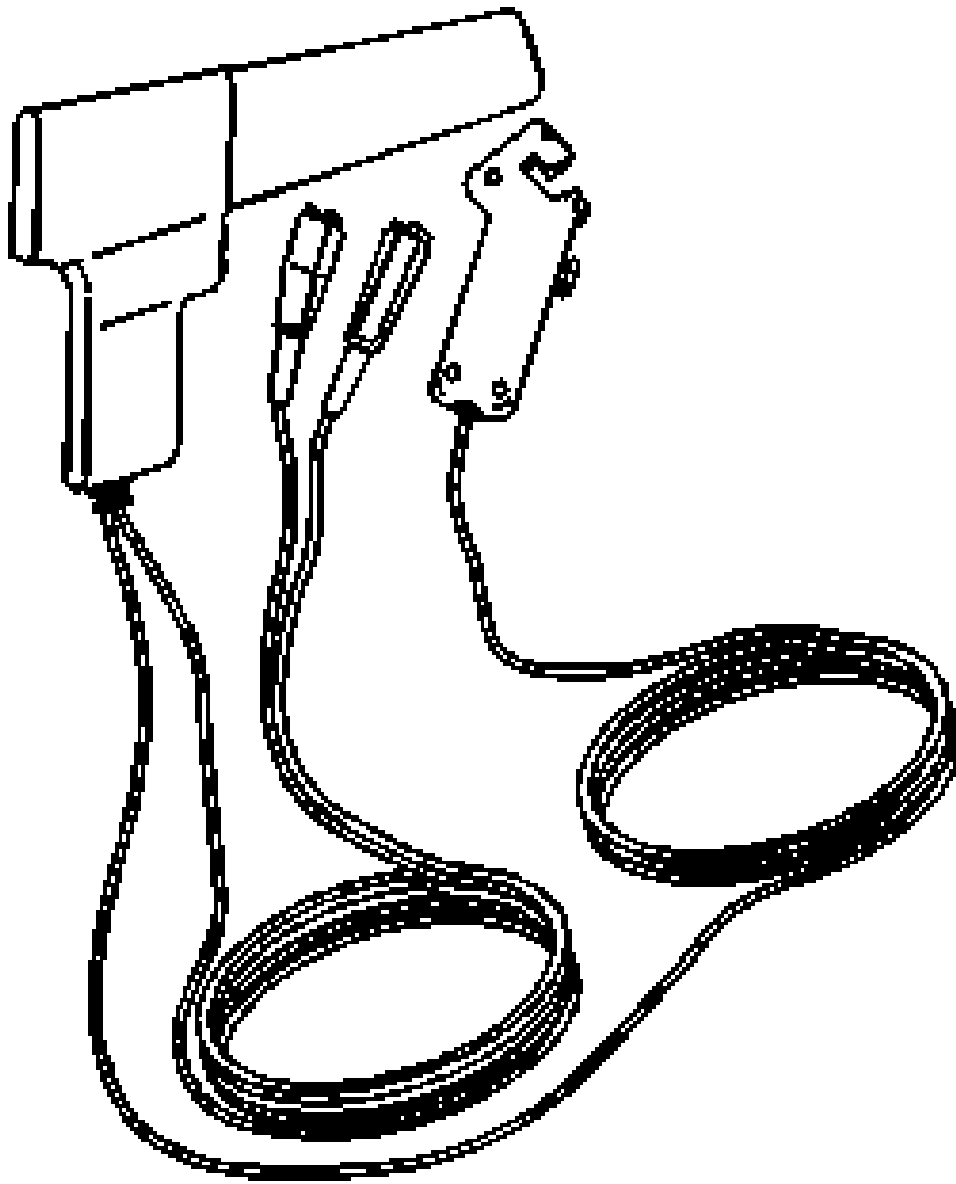
When diagnosing a vibration concern, use the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2. The **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 has been designed to overcome the shortcomings to the reed tachometer. Refer to **Electronic Vibration Analyzer (EVA) Description and Operation**.

SPECIAL TOOLS AND EQUIPMENT

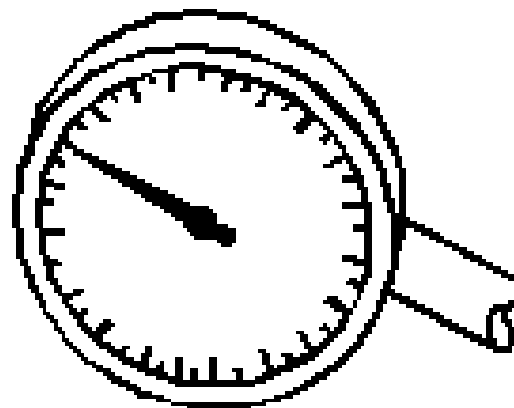
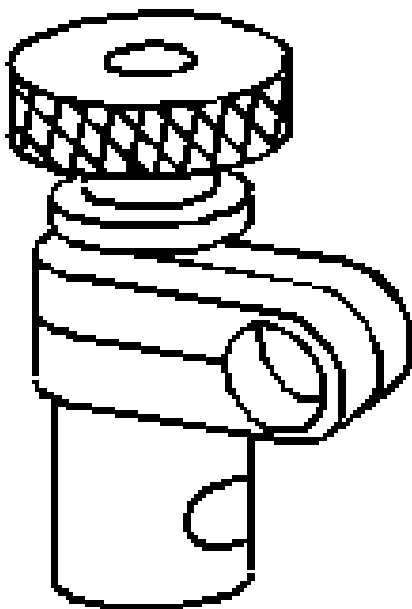
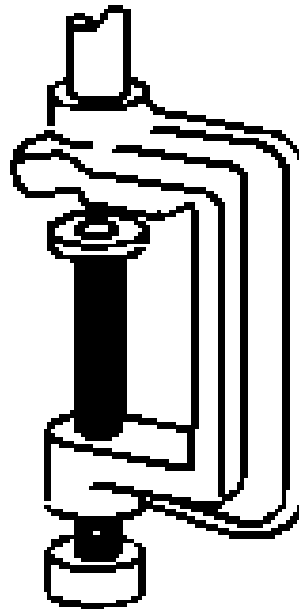
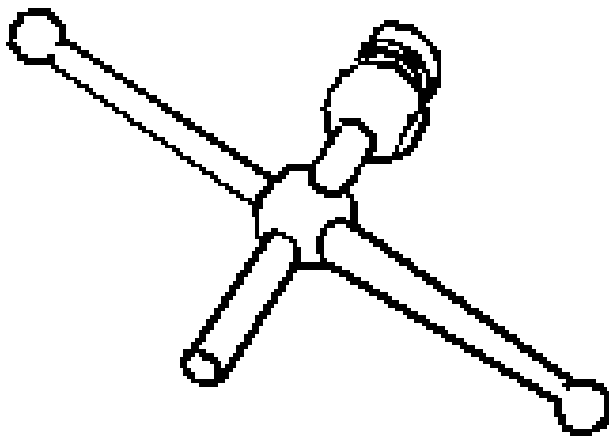
Illustration	Tool Number/Descrip
	<p>EL 38792-A J 38792-A Electronic Vibrat Analyzer (EVA)</p>



EL 38792-VS
J 38792-VS
Vibration Softw:



EN 38792-25
J 38792-25
Inductive Pickup
Timing Light



GE 8001
J 8001
Dial Indicator S

General Information

Waterleaks

DIAGNOSTIC INFORMATION AND PROCEDURES

WATERLEAK TEST PREPARATION

- GM vehicles are designed to operate under normal environmental conditions.
- The design criteria for sealing materials and components takes into consideration the sealing forces required to withstand the natural elements. These specifications cannot take into consideration any artificial conditions, i.e., high pressure car washes.
- The water leak test procedure has been correlated to the natural elements and will determine the ability of a vehicle to perform under normal operating conditions.
- The first step in diagnosing a leak is determining the conditions under which a leak occurs. If the general leak area can be found, the exact entry point can be isolated using a water hose or an air hose. Some trim panels or components may need to be removed in order to repair the leak.
- If leaks are found around a door, door window, rear compartment lid or liftgate area this does not necessarily indicate a bad weatherstrip. An adjustment to these areas may resolve the condition.

1. Watertest Stand Assembly

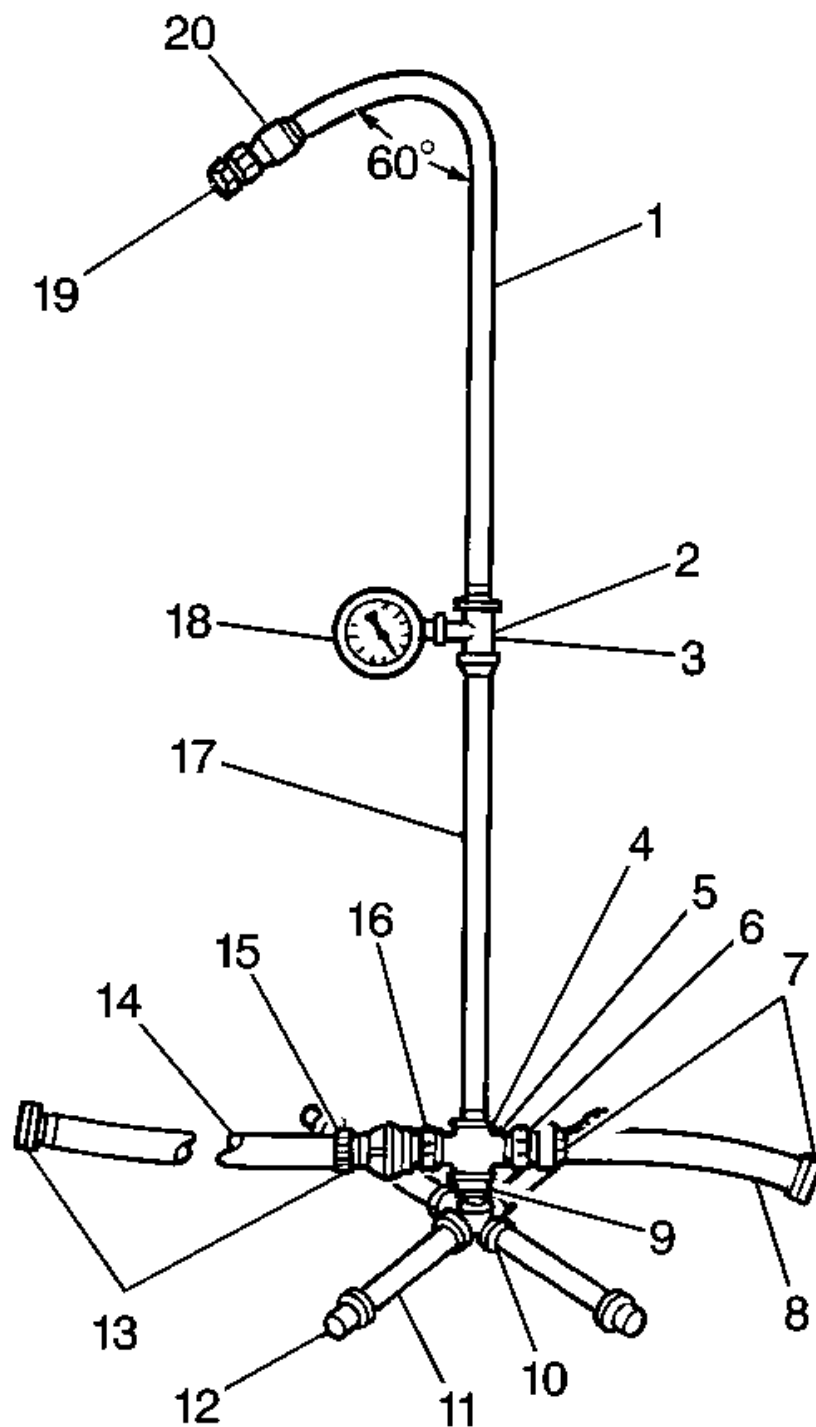


Fig. 1: View Of Watertest Stand Assembly
Courtesy of GENERAL MOTORS COMPANY

Assemble the water test stand as shown.

Callout	Component Name
1	Pipe (0.5 x 36 in)
2	Reducing Tee, Right Stand Only (0.5 x 0.5 x 0.25 in)
3	Coupling, Left Stand Only, (0.5 in)
4	Tee, Left Stand Only (0.5 in)
5	Cross, Right Stand Only (0.5 in)
6	Pipe to Hose Nipple, Right Stand Only (0.5 in)
7	Female Hose Coupling (5/8 in)
8	Input Hose, Right Stand Only (2.0 ft) (5/8 in diameter)
9	Close Nipple (0.5 in)
10	Cross (0.5 in) with Weld-On Cap (0.5 in)
11	Nipple (0.5 x 12 in)
12	Cap (0.5 in)
13	Female Hose Coupling (5/8 in)
14	Cross Hose (12 ft) (5/8 in diameter)
15	Hose Quick Connect
16	Pipe to Hose Nipple (0.5 in)
17	Pipe (0.5 x 60 in)
18	Water Pressure Gauge, Right Stand Only
19	Full Jet Spray Nozzle, No. 1/2GG-25 or Equivalent
20	Coupling (0.5 in)

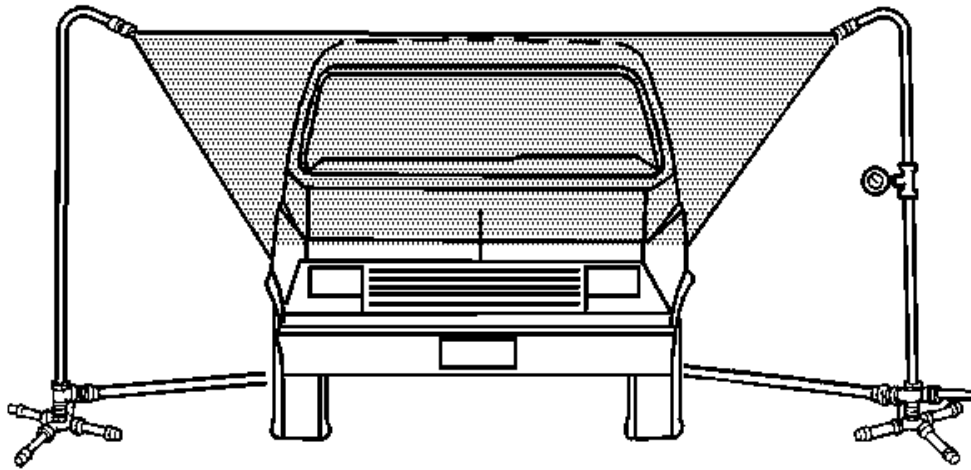


Fig. 2: Illustrating How Water Spray From Stands Should Overlap Vehicle
Courtesy of GENERAL MOTORS COMPANY

2. Position the stands as shown.

The water spray from the stands should overlap the vehicle as shown.

3. Have an assistant inside of the vehicle during the test in order to locate any leaks.
4. The water pressure at the nozzle should maintain a 155 kPa (22 psi), for at least 4 minutes.

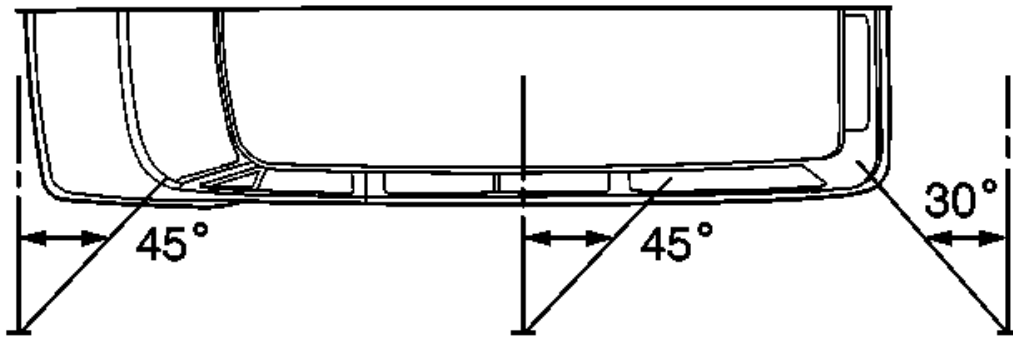


Fig. 3: Identifying Proper Water Spray Angles
Courtesy of GENERAL MOTORS COMPANY

5. In order to check the windshield, aim the water spray 30 degrees down and 45 degrees toward the rear.

Aim the water towards the corner of the windshield.
6. In order to check the side windows for leaks, position the water stand towards the center of the rear quarter, aiming the water spray 30 degrees down and 45 degrees toward the rear.
7. In order to check the back window, aim the water spray 30 degrees down and 30 degrees toward the front.

DUST LEAKS

Dust may leak into the vehicle where water will not. This happens particularly in the lower portion of the interior.

Forward motion of the vehicle can create a slight vacuum which pulls air and dust into the vehicle.

In order to determine the location of dust leaks, perform the following steps:

1. Remove the mats from the floor.
2. Remove the mats from the kick panel.
3. Remove the insulation from the floor.
4. Remove the insulation from the kick panel.
5. Drive the vehicle on a dusty road.
6. Examine the interior.

Dust in the shape of a small cone or slit will usually be found at the point of leakage.

7. Mark the points of leakage.

NOTE: **Ensure that the interior is darkened when performing this step.**

8. Shine bright lamps on the underside of the floor and the cowl.
9. Have an assistant mark any points inside of the vehicle for any points where the light shines through.
 - Inspect the weld joints.
 - Inspect the body mounts.
10. Seal any leaks with an air-drying, body-sealing compound.

WATER HOSE TEST

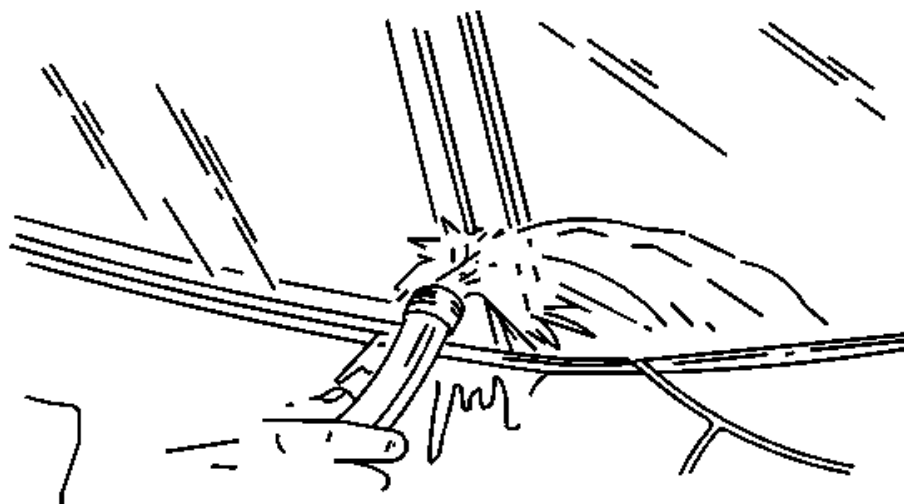


Fig. 4: Performing Water Hose Test
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a water hose without the nozzle attached.**

1. Have an assistant inside of the vehicle in order to locate the leak.
2. Begin testing at the base of the window or the windshield.
3. Slowly move the hose upward and across the top of the vehicle.

AIR HOSE TEST

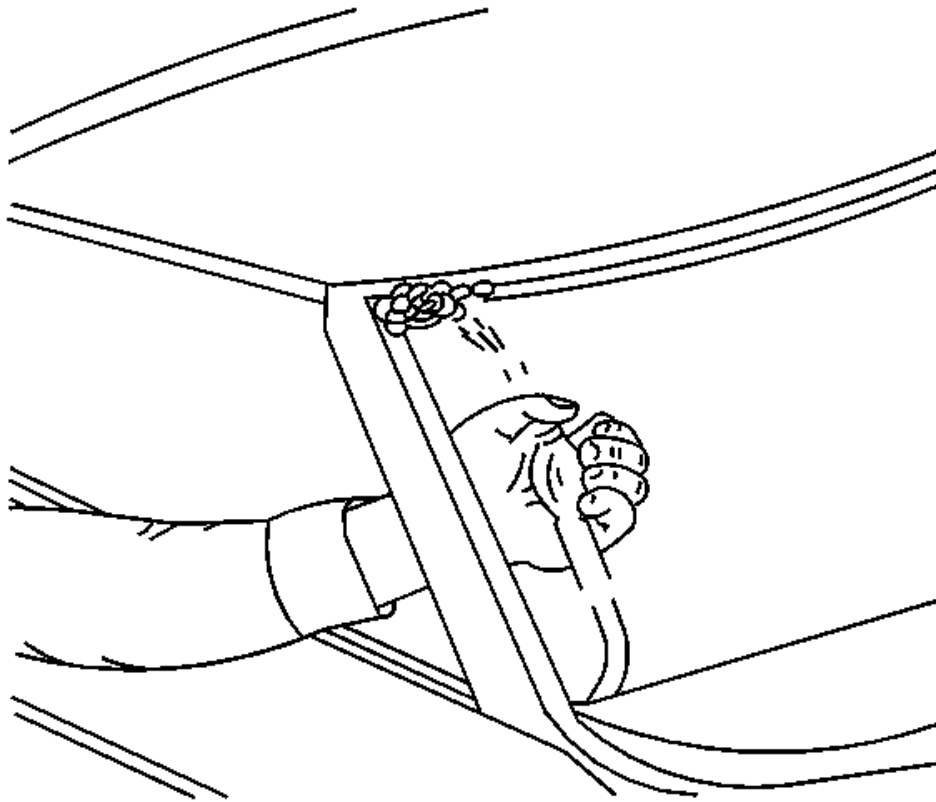


Fig. 5: Performing Air Hose Test

Courtesy of GENERAL MOTORS COMPANY

CAUTION: The air hose test should only be used on fully cured urethane adhesive. Otherwise, damage to the urethane adhesive bead could result in additional leaks.

1. Using a liquid detergent, diluted with water in a spray bottle, spray the window at the edges. Begin at the bottom and gradually move up and across the top.

NOTE: The compressed air should not exceed 205 kPa (30 psi).

2. Have an assistant inside of the vehicle with an air hose.
3. Have the assistant aim the compressed air at the suspected areas.

Bubbles will form in the soap solution at the location of the leak.

REPAIR INSTRUCTIONS

BODY WATERLEAK REPAIR

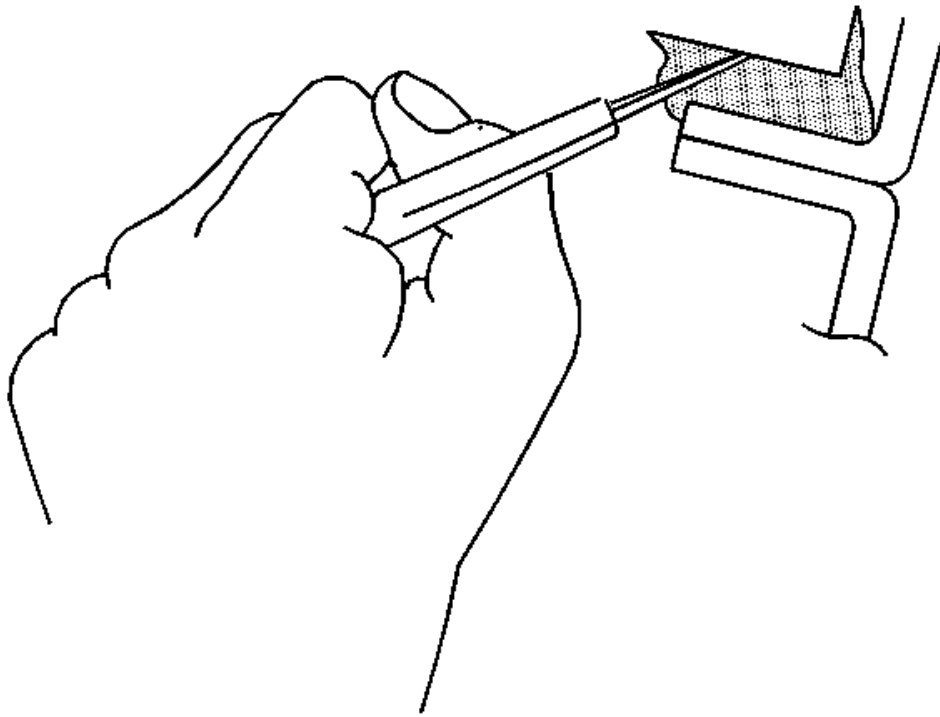


Fig. 6: Cutting Out A Portion Of The Adhesive Caulking (1 Of 2)
Courtesy of GENERAL MOTORS COMPANY

WARNING: If the vehicle interior is exposed to moisture and becomes soaked up to the level of the sensing and diagnostic module (SDM), the SDM and SDM harness connector must be replaced. The SDM could be activated when powered, which could cause airbag deployment and result in personal injury.

Depending on the location of the waterleak, you may have to remove certain interior components in order to repair the leak.

1. If the floor carpet is wet refer to **Floor Carpet Drying** .

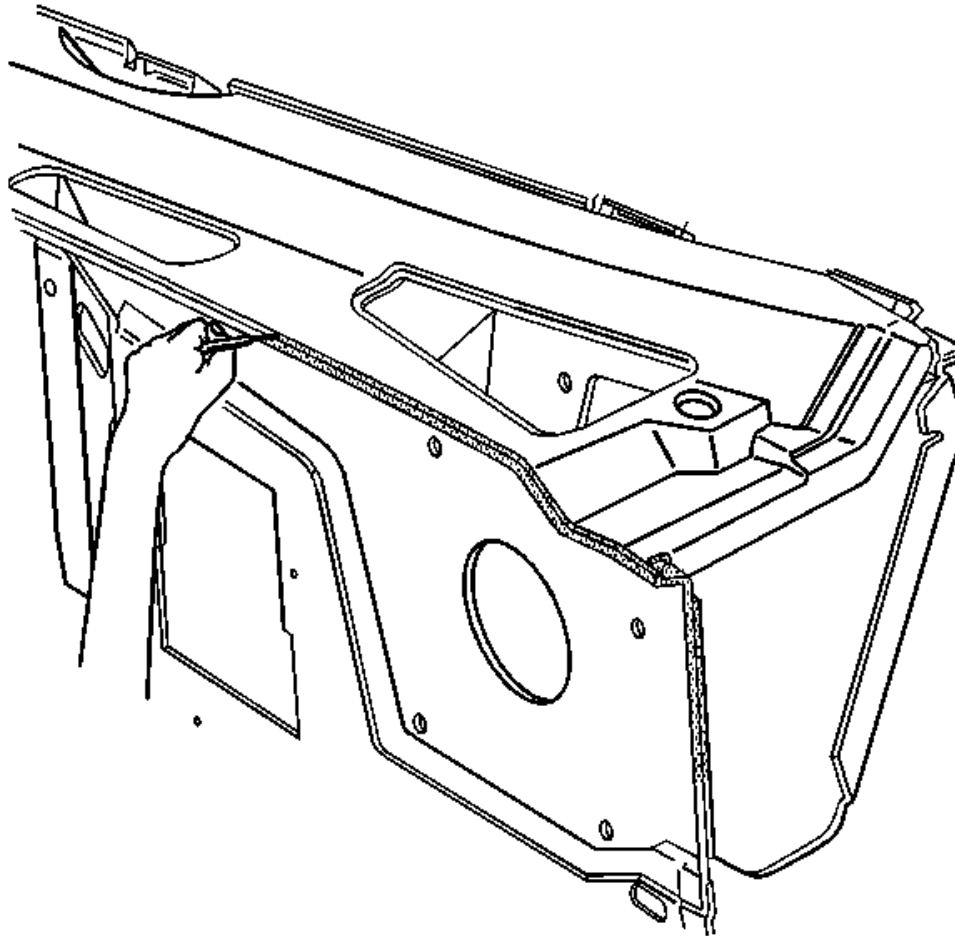


Fig. 7: Cutting Out A Portion Of The Adhesive Caulking (2 Of 2)
Courtesy of GENERAL MOTORS COMPANY

2. Cut out a portion of the adhesive caulk in the leak area from inside or outside of the vehicle.
3. Clean and remove all loose particles of the adhesive old caulk from the area.
4. Apply joint body and seam sealer where the old adhesive caulk was removed.
5. Allow the adhesive caulk to dry for several hours.
6. Test for leaks.
7. Install the trim, if removed.

STATIONARY WINDOW WATERLEAK REPAIR

WARNING: If any water enters the vehicle interior up to the level of the carpet or higher and soaks the carpet, the sensing and diagnostic module (SDM) and the SDM harness connector may need to be replaced. The SDM could be activated when powered, which could cause deployment of the air bag (s) and result in personal injury. Before attempting these procedures, the

SIR system must be disabled. Refer to Disabling the SIR System.

With the ignition OFF, inspect the SDM mounting area, including the carpet. If any significant soaking or evidence of significant soaking is detected, you must perform the following tasks:

- 1. Remove all water.**
- 2. Repair the water damage.**
- 3. Replace the SDM harness connector.**
- 4. Replace the SDM.**

Failure to follow these tasks could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

1. If the floor carpet is wet refer to **Floor Carpet Drying** .
2. Remove the trim moldings or the headliner in order to repair the leak, if needed.
3. Determine the source of water entry.
4. If water is leaking at the edge of the windshield, reseal the windshield using Urethane Adhesive Systems which meet GM Specification GM 3651G.
5. If water leaks into the vehicle at the sides of the stationary windows, reseal the window using Urethane Adhesive Systems which meet GM Specification GM 3651G.

GENERAL INFORMATION

Waveforms - Injector Pattern Tutorial

*** PLEASE READ THIS FIRST ***

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

PURPOSE OF THIS ARTICLE

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

Learning how to interpret injector drive patterns from a Lab Scope can be like learning ignition patterns all over again. This article exists to ease you into becoming a skilled injector pattern interpreter.

You will learn:

- How a DVOM and noid light fall short of a lab scope.
- The two types of injector driver circuits, voltage controlled & current controlled.
- The two ways injector circuits can be wired, constant ground/switched power & constant power/switched ground.
- The two different pattern types you can use to diagnose with, voltage & current.
- All the valuable details injector patterns can reveal.

SCOPE OF THIS ARTICLE

This is **NOT** a manufacturer specific article. All different types of systems are covered here, regardless of the specific year/make/model/engine.

The reason for such broad coverage is because there are only a few basic ways to operate a solenoid-type injector. By understanding the fundamental principles, you will understand all the major points of injector patterns you encounter. Of course there are minor differences in each specific system, but that is where a waveform library helps out.

If this is confusing, consider a secondary ignition pattern. Even though there are many different implementations, each still has a primary voltage turn-on, firing line, spark line, etc.

If specific waveforms are available in On Demand for the engine and vehicle you are working on, you will find them in the Engine Performance section under the Engine Performance category.

IS A LAB SCOPE NECESSARY?

INTRODUCTION

You probably have several tools at your disposal to diagnose injector circuits. But you might have questioned "Is a lab scope necessary to do a thorough job, or will a set of noid lights and a multifunction DVOM do just as well?"

In the following text, we are going to look at what noid lights and DVOMs do best, do not do very well, and when they can mislead you. As you might suspect, the lab scope, with its ability to look inside an active circuit, comes to the rescue by answering for the deficiencies of these other tools.

OVERVIEW OF NOID LIGHT

The noid light is an excellent "quick and dirty" tool. It can usually be hooked to a fuel injector harness fast and the flashing light is easy to understand. It is a dependable way to identify a no-pulse situation.

However, a noid light can be very deceptive in two cases:

- If the wrong one is used for the circuit being tested. Beware: Just because a connector on a noid light fits the harness does not mean it is the right one.
- If an injector driver is weak or a minor voltage drop is present.

Use the Right Noid Light

In the following text we will look at what can happen if the wrong noid light is used, why there are different types of noid lights (besides differences with connectors), how to identify the types of noid lights, and how to know the right type to use.

First, let's discuss what can happen if the incorrect type of noid light is used. You might see:

- A dimly flashing light when it should be normal.
- A normal flashing light when it should be dim.

A noid light will flash dim if used on a lower voltage circuit than it was designed for. A normally operating circuit would appear underpowered, which could be misinterpreted as the cause of a fuel starvation problem.

Here are the two circuit types that could cause this problem:

- Circuits with external injector resistors. Used predominately on some Asian & European systems, they are used to reduce the available voltage to an injector in order to limit the current flow. This lower voltage can cause a dim flash on a noid light designed for full voltage.
- Circuits with current controlled injector drivers (e.g. "Peak and Hold"). Basically, this type of driver allows a quick burst of voltage/current to flow and then throttles it back significantly for the remainder of the pulse width duration. If a noid light was designed for the other type of driver (voltage controlled, e.g. "Saturated"), it will appear dim because it is expecting full voltage/current to flow for the entire duration of the pulse width.

Let's move to the other situation where a noid light flashes normally when it should be dim. This could occur if

a more sensitive noid light is used on a higher voltage/amperage circuit that was weakened enough to cause problems (but not outright broken). A circuit with an actual problem would thus appear normal.

Let's look at why. A noid light does not come close to consuming as much amperage as an injector solenoid. If there is a partial driver failure or a minor voltage drop in the injector circuit, there can be adequate amperage to fully operate the noid light BUT NOT ENOUGH TO OPERATE THE INJECTOR.

If this is not clear, picture a battery with a lot of corrosion on the terminals. Say there is enough corrosion that the starter motor will not operate; it only clicks. Now imagine turning on the headlights (with the ignition in the RUN position). You find they light normally and are fully bright. This is the same idea as noid light: There is a problem, but enough amp flow exists to operate the headlights ("noid light"), but not the starter motor ("injector").

How do you identify and avoid all these situations? By using the correct type of noid light. This requires that you understanding the types of injector circuits that your noid lights are designed for. There are three. They are:

- Systems with a voltage controlled injector driver. Another way to say it: The noid light is designed for a circuit with a "high" resistance injector (generally 12 ohms or above).
- Systems with a current controlled injector driver. Another way to say it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) without an external injector resistor.
- Systems with a voltage controlled injector driver and an external injector resistor. Another way of saying it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) and an external injector resistor.

NOTE: Some noid lights can meet both the second and third categories simultaneously.

If you are not sure which type of circuit your noid light is designed for, plug it into a known good car and check out the results. If it flashes normally during cranking, determine the circuit type by finding out injector resistance and if an external injector resistor is used. You now know enough to identify the type of injector circuit. Label the noid light appropriately.

Next time you need to use a noid light for diagnosis, determine what type of injector circuit you are dealing with and select the appropriate noid light.

Of course, if you suspect a no-pulse condition you could plug in any one whose connector fit without fear of misdiagnosis. This is because it is unimportant if the flashing light is dim or bright. It is only important that it flashes.

In any cases of doubt regarding the use of a noid light, a lab scope will overcome all inherent weaknesses.

OVERVIEW OF DVOM

A DVOM is typically used to check injector resistance and available voltage at the injector. Some techs also use it check injector on-time either with a built-in feature or by using the dwell/duty function.

There are situations where the DVOM performs these checks dependably, and other situations where it can

deceive you. It is important to be aware of these strengths and weaknesses. We will cover the topics above in the following text.

Checking Injector Resistance

If a short in an injector coil winding is constant, an ohmmeter will accurately identify the lower resistance. The same is true with an open winding. Unfortunately, an intermittent short is an exception. A faulty injector with an intermittent short will show "good" if the ohmmeter cannot force the short to occur during testing.

Alcohol in fuel typically causes an intermittent short, happening only when the injector coil is hot and loaded by a current high enough to jump the air gap between two bare windings or to break down any oxides that may have formed between them.

When you measure resistance with an ohmmeter, you are only applying a small current of a few milliamps. This is nowhere near enough to load the coil sufficiently to detect most problems. As a result, most resistance checks identify intermittently shorted injectors as being normal.

There are two methods to get around this limitation. The first is to purchase a tool that checks injector coil windings under full load. The Kent-Moore J-39021 is such a tool, though there are others. The Kent-Moore costs around \$240 at the time of this writing and works on many different manufacturer's systems.

The second method is to use a lab scope. Remember, a lab scope allows you to see the regular operation of a circuit in real time. If an injector is having a short or intermittent short, the lab scope will show it.

Checking Available Voltage At the Injector

Verifying a fuel injector has the proper voltage to operate correctly is good diagnostic technique. Finding an open circuit on the feed circuit like a broken wire or connector is an accurate check with a DVOM. Unfortunately, finding an intermittent or excessive resistance problem with a DVOM is unreliable.

Let's explore this drawback. Remember that a voltage drop due to excessive resistance will only occur when a circuit is operating? Since the injector circuit is only operating for a few milliseconds at a time, a DVOM will only see a potential fault for a few milliseconds. The remaining 90+% of the time the unloaded injector circuit will show normal battery voltage.

Since DVOMs update their display roughly two to five times a second, all measurements in between are averaged. Because a potential voltage drop is visible for such a small amount of time, it gets "averaged out", causing you to miss it.

Only a DVOM that has a "min-max" function that checks EVERY MILLISECOND will catch this fault consistently (if used in that mode). The Fluke 87 among others has this capability.

A "min-max" DVOM with a lower frequency of checking (100 millisecond) can miss the fault because it will probably check when the injector is not on. This is especially true with current controlled driver circuits. The Fluke 88, among others fall into this category.

Outside of using a Fluke 87 (or equivalent) in the 1 mS "min-max" mode, the only way to catch a voltage drop fault is with a lab scope. You will be able to see a voltage drop as it happens.

One final note. It is important to be aware that an injector circuit with a solenoid resistor will always show a voltage drop when the circuit is energized. This is somewhat obvious and normal; it is a designed-in voltage drop. What can be unexpected is what we already covered--a voltage drop disappears when the circuit is unloaded. The unloaded injector circuit will show normal battery voltage at the injector. Remember this and do not get confused.

Checking Injector On-Time With Built-In Function

Several DVOMs have a feature that allows them to measure injector on-time (mS pulse width). While they are accurate and fast to hookup, they have three limitations you should be aware of:

- They only work on voltage controlled injector drivers (e.g. "Saturated Switch"), NOT on current controlled injector drivers (e.g. "Peak & Hold").
- A few unusual conditions can cause inaccurate readings.
- Varying engine speeds can result in inaccurate readings.

Regarding the first limitation, DVOMs need a well-defined injector pulse in order to determine when the injector turns ON and OFF. Voltage controlled drivers provide this because of their simple switch-like operation. They completely close the circuit for the entire duration of the pulse. This is easy for the DVOM to interpret.

The other type of driver, the current controlled type, start off well by completely closing the circuit (until the injector pintle opens), but then they throttle back the voltage/current for the duration of the pulse. The DVOM understands the beginning of the pulse but it cannot figure out the throttling action. In other words, it cannot distinguish the throttling from an open circuit (de-energized) condition.

Yet current controlled injectors will still yield a millisecond on-time reading on these DVOMs. You will find it is also always the same, regardless of the operating conditions. This is because it is only measuring the initial completely-closed circuit on-time, which always takes the same amount of time (to lift the injector pintle off its seat). So even though you get a reading, it is useless.

The second limitation is that a few erratic conditions can cause inaccurate readings. This is because of a DVOM's slow display rate; roughly two to five times a second. As we covered earlier, measurements in between display updates get averaged. So conditions like skipped injector pulses or intermittent long/short injector pulses tend to get "averaged out", which will cause you to miss important details.

The last limitation is that varying engine speeds can result in inaccurate readings. This is caused by the quickly shifting injector on-time as the engine load varies, or the RPM moves from a state of acceleration to stabilization, or similar situations. It too is caused by the averaging of all measurements in between DVOM display periods. You can avoid this by checking on-time when there are no RPM or load changes.

A lab scope allows you to overcome each one of these limitations.

Checking Injector On-Time With Dwell Or Duty

If no tool is available to directly measure injector millisecond on-time measurement, some techs use a simple DVOM dwell or duty cycle functions as a replacement.

While this is an approach of last resort, it does provide benefits. We will discuss the strengths and weaknesses in a moment, but first we will look at how a duty cycle meter and dwell meter work.

How A Duty Cycle Meter and Dwell Meter Work

All readings are obtained by comparing how long something has been OFF to how long it has been ON in a fixed time period. A dwell meter and duty cycle meter actually come up with the same answers using different scales. You can convert freely between them. See **RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE**.

The DVOM display updates roughly one time a second, although some DVOMs can be a little faster or slower. All measurements during this update period are tallied inside the DVOM as ON time or OFF time, and then the total ratio is displayed as either a percentage (duty cycle) or degrees (dwell meter).

For example, let's say a DVOM had an update rate of exactly 1 second (1000 milliseconds). Let's also say that it has been measuring/tallying an injector circuit that had been ON a total of 250 mS out of the 1000 mS. That is a ratio of one-quarter, which would be displayed as 25% duty cycle or 15° dwell (six-cylinder scale). Note that most duty cycle meters can reverse the readings by selecting the positive or negative slope to trigger on. If this reading were reversed, a duty cycle meter would display 75%.

Strengths of Dwell/Duty Meter

The obvious strength of a dwell/duty meter is that you can compare injector on-time against a known-good reading. This is the only practical way to use a dwell/duty meter, but requires you to have known-good values to compare against.

Another strength is that you can roughly convert injector mS on-time into dwell reading with some computations.

A final strength is that because the meter averages everything together it does not miss anything (though this is also a severe weakness that we will look at later). If an injector has a fault where it occasionally skips a pulse, the meter registers it and the reading changes accordingly.

Let's go back to figuring out dwell/duty readings by using injector on-time specification. This is not generally practical, but we will cover it for completeness. You NEED to know three things:

- Injector mS on-time specification.
- Engine RPM when specification is valid.
- How many times the injectors fire per crankshaft revolution.

The first two are self-explanatory. The last one may require some research into whether it is a bank-fire type that injects every 360° of crankshaft rotation, a bank-fire that injects every 720°, or an SFI that injects every 720°. Many manufacturers do not release this data so you may have to figure it out yourself with a frequency meter.

Here are the four complete steps to convert millisecond on-time:

1. Determine the injector pulse width and RPM it was obtained at. Let's say the specification is for one millisecond of on-time at a hot idle of 600 RPM.
2. Determine injector firing method for the complete 4 stroke cycle. Let's say this is a 360° bank-fired, meaning an injector fires each and every crankshaft revolution.
3. Determine how many times the injector will fire at the specified engine speed (600 RPM) in a fixed time period. We will use 100 milliseconds because it is easy to use. Six hundred crankshaft Revolutions Per Minute (RPM) divided by 60 seconds equals 10 revolutions per second. Multiplying 10 times .100 yields one; the crankshaft turns one time in 100 milliseconds. With exactly one crankshaft rotation in 100 milliseconds, we know that the injector fires exactly one time.
4. Determine the ratio of injector on-time vs. off-time in the fixed time period, then figure duty cycle and/or dwell. The injector fires one time for a total of one millisecond in any given 100 millisecond period. One hundred minus one equals 99. We have a 99% duty cycle. If we wanted to know the dwell (on 6 cylinder scale), multiple 99% times .6; this equals 59.4° dwell.

Weaknesses of Dwell/Duty Meter

The weaknesses are significant. First, there is no one-to-one correspondence to actual mS on-time. No manufacturer releases dwell/duty data, and it is time-consuming to convert the mS on-time readings. Besides, there can be a large degree of error because the conversion forces you to assume that the injector(s) are always firing at the same rate for the same period of time. This can be a dangerous assumption.

Second, all level of detail is lost in the averaging process. This is the primary weakness. You cannot see the details you need to make a confident diagnosis.

Here is one example. Imagine a vehicle that has a faulty injector driver that occasionally skips an injector pulse. Every skipped pulse means that that cylinder does not fire, thus unburned O₂ gets pushed into the exhaust and passes the O₂ sensor. The O₂ sensor indicates lean, so the computer fattens up the mixture to compensate for the supposed "lean" condition.

A connected dwell/duty meter would see the fattened pulse width but would also see the skipped pulses. It would tally both and likely come back with a reading that indicated the "pulse width" was within specification because the rich mixture and missing pulses offset each other.

This situation is not a far-fetched scenario. Some early GM 3800 engines were suffering from exactly this. The point is that a lack of detail could cause misdiagnosis.

As you might have guessed, a lab scope would not miss this.

RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS

Dwell Meter ⁽²⁾	Duty Cycle Meter
1°	1%
15°	25%
30°	50%
45°	75%
60°	100%

- (1) These are just some examples for your understanding. It is okay to fill in the gaps.

(2) Dwell meter on the six-cylinder scale.

THE TWO TYPES OF INJECTOR DRIVERS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

OVERVIEW

There are two types of transistor driver circuits used to operate electric fuel injectors: voltage controlled and current controlled. The voltage controlled type is sometimes called a "saturated switch" driver, while the current controlled type is sometimes known as a "peak and hold" driver.

The basic difference between the two is the total resistance of the injector circuit. Roughly speaking, if a particular leg in an injector circuit has total resistance of 12 or more ohms, a voltage control driver is used. If less than 12 ohms, a current control driver is used.

It is a question of what is going to do the job of limiting the current flow in the injector circuit; the inherent "high" resistance in the injector circuit, or the transistor driver. Without some form of control, the current flow through the injector would cause the solenoid coil to overheat and result in a damaged injector.

VOLTAGE CONTROLLED CIRCUIT ("SATURATED SWITCH")

The voltage controlled driver inside the computer operates much like a simple switch because it does not need to worry about limiting current flow. Recall, this driver typically requires injector circuits with a total leg resistance of 12 or more ohms.

The driver is either ON, closing/completing the circuit (eliminating the voltage-drop), or OFF, opening the circuit (causing a total voltage drop).

Some manufacturers call it a "saturated switch" driver. This is because when switched ON, the driver allows the magnetic field in the injector to build to saturation. This is the same "saturation" property that you are familiar with for an ignition coil.

There are two ways "high" resistance can be built into an injector circuit to limit current flow. One method uses an external solenoid resistor and a low resistance injector, while the other uses a high resistance injector without the solenoid resistor. See the left side of Fig. **Fig. 1**.

In terms of injection opening time, the external resistor voltage controlled circuit is somewhat faster than the voltage controlled high resistance injector circuit. The trend, however, seems to be moving toward use of this latter type of circuit due to its lower cost and reliability. The ECU can compensate for slower opening times by increasing injector pulse width accordingly.

NOTE: Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

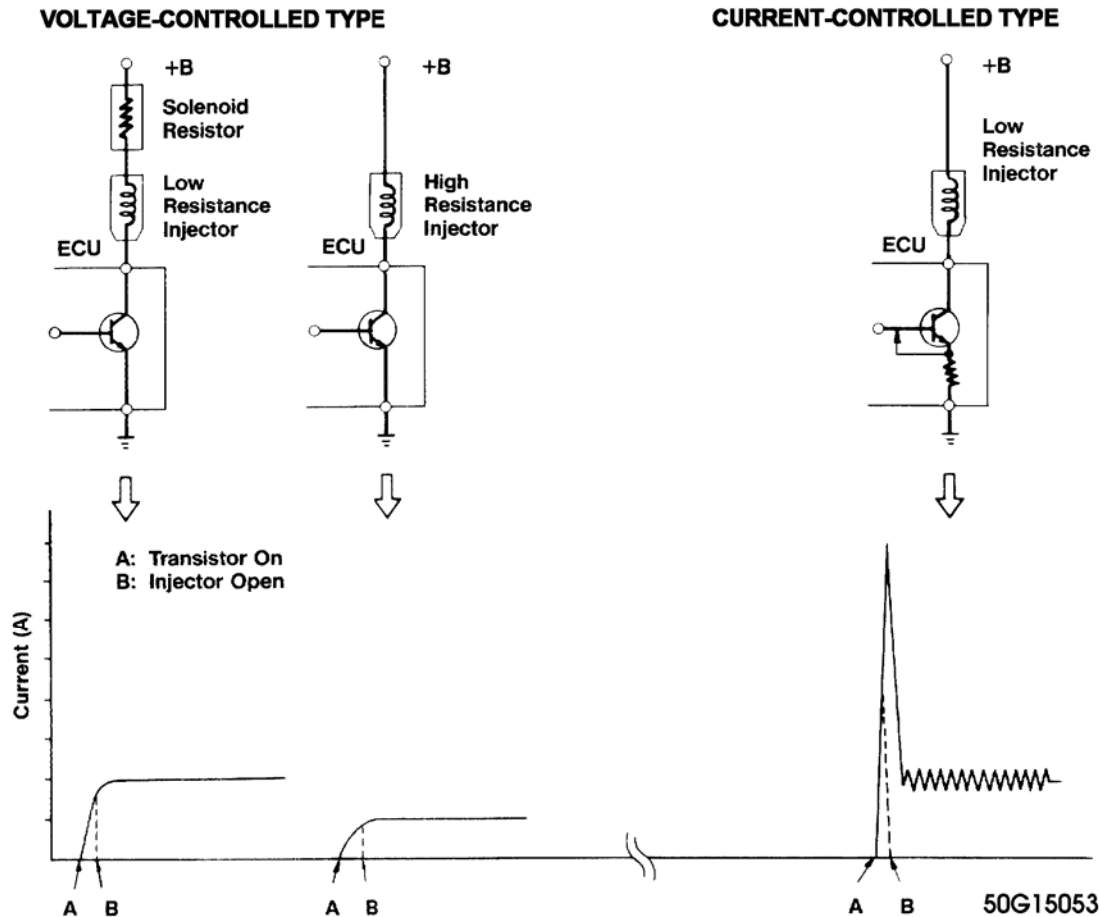


Fig. 1: Injector Driver Types - Current and Voltage

CURRENT CONTROLLED CIRCUIT ("PEAK & HOLD")

The current controlled driver inside the computer is more complex than a voltage controlled driver because as the name implies, it has to limit current flow in addition to its ON-OFF switching function. Recall, this driver typically requires injector circuits with a total leg resistance of less than 12 ohms.

Once the driver is turned ON, it will not limit current flow until enough time has passed for the injector pintle to open. This period is preset by the particular manufacturer/system based on the amount of current flow needed to open their injector. This is typically between two and six amps. Some manufacturers refer to this as the "peak" time, referring to the fact that current flow is allowed to "peak" (to open the injector).

Once the injector pintle is open, the amp flow is considerably reduced for the rest of the pulse duration to protect the injector from overheating. This is okay because very little amperage is needed to hold the injector open, typically in the area of one amp or less. Some manufacturers refer to this as the "hold" time, meaning that

just enough current is allowed through the circuit to "hold" the already-open injector open.

There are a couple methods of reducing the current. The most common trims back the available voltage for the circuit, similar to turning down a light at home with a dimmer.

The other method involves repeatedly cycling the circuit ON-OFF. It does this so fast that the magnetic field never collapses and the pintle stays open, but the current is still significantly reduced. See the right side of Fig. **Fig. 1** for an illustration.

The advantage to the current controlled driver circuit is the short time period from when the driver transistor goes ON to when the injector actually opens. This is a function of the speed with which current flow reaches its peak due to the low circuit resistance. Also, the injector closes faster when the driver turns OFF because of the lower holding current.

NOTE: Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

THE TWO WAYS INJECTOR CIRCUITS ARE WIRED

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Like other circuits, injector circuits can be wired in one of two fundamental directions. The first method is to steadily power the injectors and have the computer driver switch the ground side of the circuit. Conversely, the injectors can be steadily grounded while the driver switches the power side of the circuit.

There is no performance benefit to either method. Voltage controlled and current controlled drivers have been successfully implemented both ways.

However, 95% percent of the systems are wired so the driver controls the ground side of the circuit. Only a handful of systems use the drivers on the power side of the circuit. Some examples of the latter are the 1970's Cadillac EFI system, early Jeep 4.0 EFI (Renix system), and Chrysler 1984-87 TBI.

INTERPRETING INJECTOR WAVEFORMS

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

INTERPRETING A VOLTAGE CONTROLLED PATTERN

NOTE: Voltage controlled drivers are also known as "Saturated Switch" drivers. They typically require injector circuits with a total leg resistance of 12 ohms or more.

NOTE: **This example is based on a constant power/switched ground circuit.**

- See Fig. 2 for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This can occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Note that circuits with external injector resistors will not be any different because the resistor does not affect open circuit voltage.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is **HIGHLY** recommended that you use the battery as your hook-up.

The points between "B" and "D" represent the time in milliseconds that the injector is being energized or held open. This line at Point "C" should remain flat. Any distortion or upward bend indicates a ground problem, short problem, or a weak driver. Alert readers will catch that this is exactly opposite of the current controlled type drivers (explained in the next section), because they bend upwards at this point.

How come the difference? Because of the total circuit resistance. Voltage controlled driver circuits have a high resistance of 12+ ohms that slows the building of the magnetic field in the injector. Hence, no counter voltage is built up and the line remains flat.

On the other hand, the current controlled driver circuit has low resistance which allows for a rapid magnetic field build-up. This causes a slight inductive rise (created by the effects of counter voltage) and hence, the upward bend. You should not see that here with voltage controlled circuits.

Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts at the top of Point "D".

If you do see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning the injector has a weak winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

Point "E" brings us to a very interesting section. As you can see, the voltage dissipates back to supply value after the peak of the inductive kick. Notice the slight hump? This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking because of a faulty injector

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This could occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is **HIGHLY** recommended that you use the battery as your hook-up.

Right after Point "C", something interesting happens. Notice the trace starts a normal upward bend. This slight inductive rise is created by the effects of counter voltage and is normal. This is because the low circuit resistance allowed a fast build-up of the magnetic field, which in turn created the counter voltage.

Point "D" is the start of the current limiting, also known as the "Hold" time. Before this point, the driver had allowed the current to free-flow ("Peak") just to get the injector pintle open. By the time point "D" occurs, the injector pintle has already opened and the computer has just significantly throttled the current back. It does this by only allowing a few volts through to maintain the minimum current required to keep the pintle open.

The height of the voltage spike seen at the top of Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts.

If you see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning there is a problem with a weak injector winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

At Point "E", notice that the trace is now just a few volts below system voltage and the injector is in the current limiting, or the "Hold" part of the pattern. This line will either remain flat and stable as shown here, or will cycle up and down rapidly. Both are normal methods to limit current flow. Any distortion may indicate shorted windings.

Point "F" is the actual turn-off point of the driver (and injector). To measure the millisecond on-time of the injector, measure between points "C" and "F". Note that we used cursors to do it for us; they are measuring a 2.56 mS on-time.

The top of Point "F" (second inductive kick) is created by the collapsing magnetic field caused by the final turn-off of the driver. This spike should be like the spike on top of point "D".

Point "G" shows a slight hump. This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking. Some older Nissan TBI systems suffered from this.

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

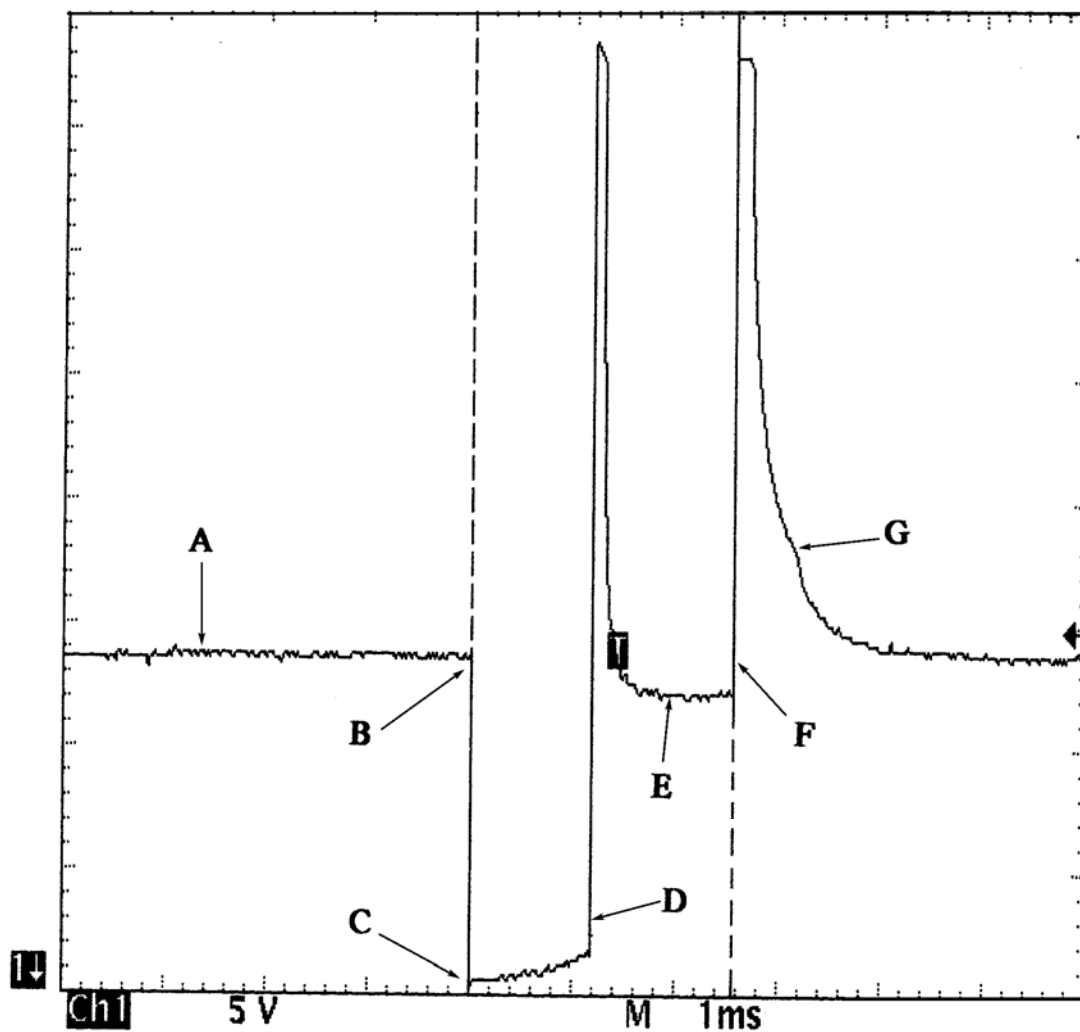


Fig. 3: Identifying Current Controlled Type Injector Pattern

CURRENT WAVEFORM SAMPLES

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

The waveform pattern shown in Fig. **Fig. 4** indicate a normal current waveform from a Ford 3.0L V6 VIN [U] engine. This voltage controlled type circuit pulses the injectors in groups of three injectors. Injectors No. 1, 3, and 5 are pulsed together and cylinders 2, 4, and 6 are pulsed together. The specification for an acceptable bank resistance is 4.4 ohms. Using Ohm's Law and assuming a hot run voltage of 14 volts, we determine that the bank would draw a current of 3.2 amps.

However this is not the case because as the injector windings become saturated, counter voltage is created which impedes the current flow. This, coupled with the inherent resistance of the driver's transistor, impedes the current flow even more. So, what is a known good value for a dynamic current draw on a voltage controlled bank of injectors? The waveform pattern shown below indicates a good parallel injector current flow of 2 amps. See **Fig. 4**.

Note that if just one injector has a resistance problem and partially shorts, the entire parallel bank that it belongs to will draw more current. This can damage the injector driver.

The waveform pattern in Fig. **Fig. 5** indicates this type of problem with too much current flow. This is on other bank of injectors of the same vehicle; the even side. Notice the Lab Scope is set on a one amp per division scale. As you can see, the current is at an unacceptable 2.5 amps.

It is easy to find out which individual injector is at fault. All you need to do is inductively clamp onto each individual injector and compare them. To obtain a known-good value to compare against, we used the good bank to capture the waveform in Fig. **Fig. 6**. Notice that it limits current flow to 750 milliamps.

The waveform shown in Fig. **Fig. 7** illustrates the problem injector we found. This waveform indicates an unacceptable current draw of just over one amp as compared to the 750 milliamp draw of the known-good injector. A subsequent check with a DVOM found 8.2 ohms, which is under the 12 ohm specification.

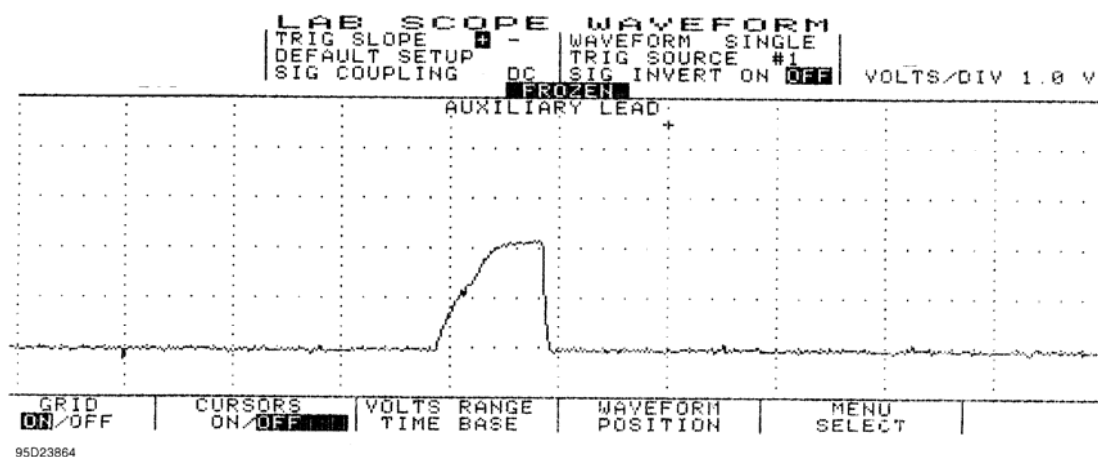


Fig. 4: Injector Bank w/Normal Current Flow - Current Pattern

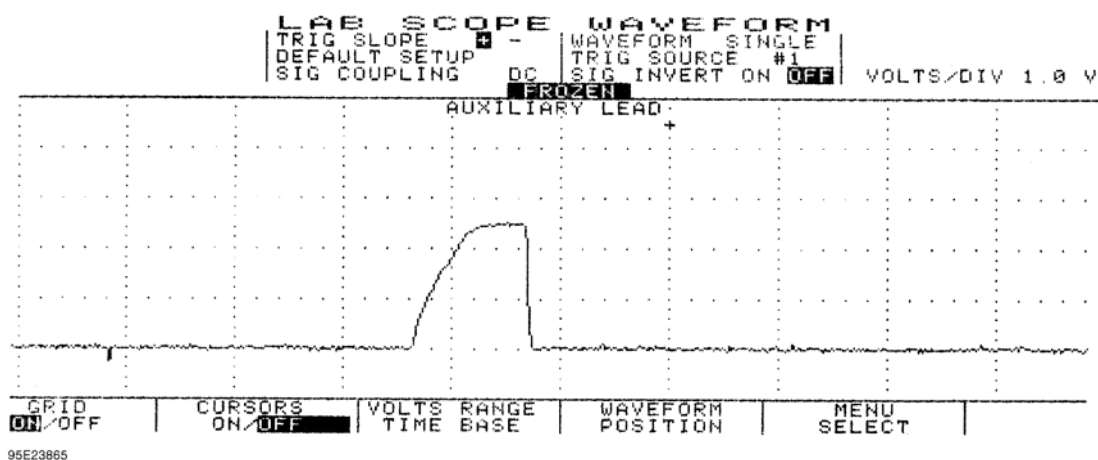


Fig. 5: Injector Bank w/Excessive Current Flow - Current Pattern

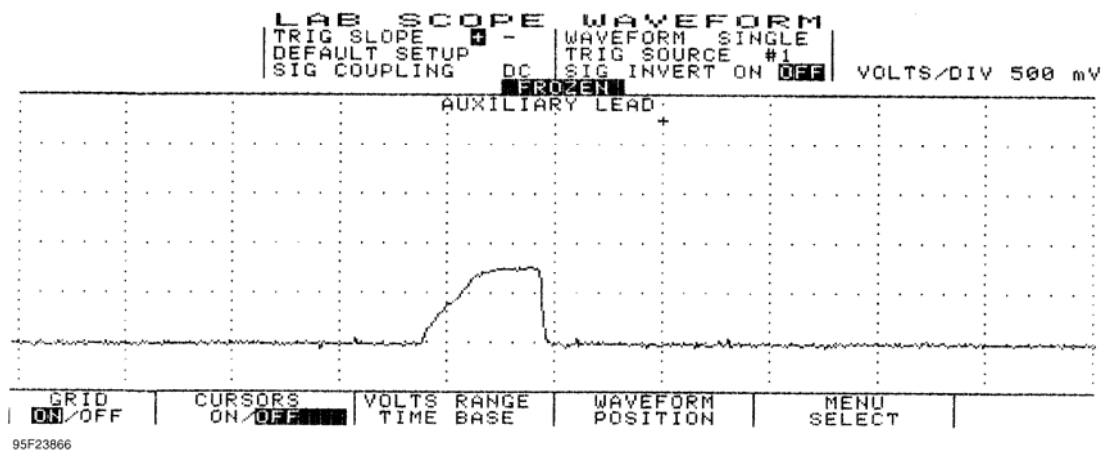


Fig. 6: Single Injector w/Normal Current Flow - Current Pattern

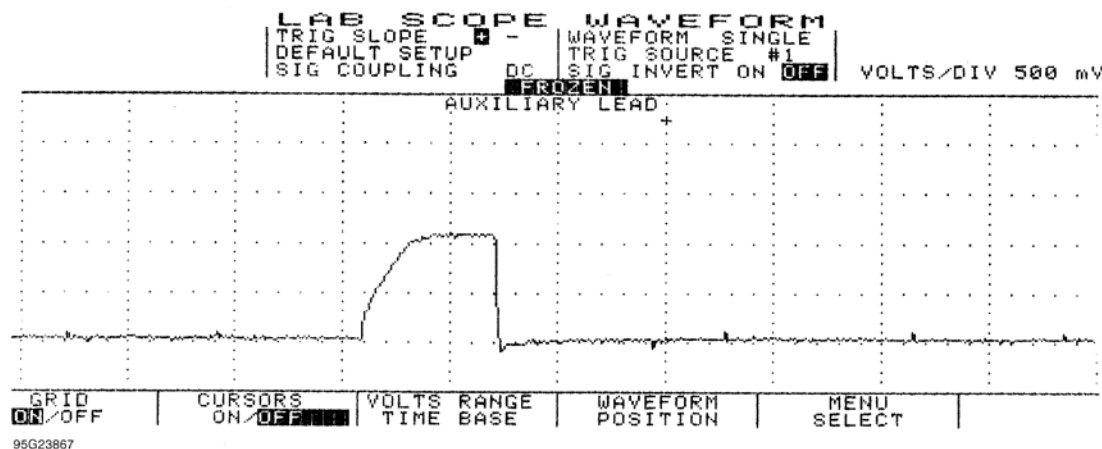


Fig. 7: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

This time we will look at a GM 3.1L V6 VIN [T]. Fig. **Fig. 8** shows the 1, 3, 5 (odd) injector bank with the current waveform indicating about a 2.6 amp draw at idle. This pattern, taken from a known good vehicle, correctly stays at or below the maximum 2.6 amps current range. Ideally, the current for each bank should be very close in comparison.

Notice the small dimple on the current flow's rising edge. This is the actual injector opening or what engineers refer to as the "set point." For good idle quality, the set point should be uniform between the banks.

When discussing Ohm's Law as it pertains to this parallel circuit, consider that each injector has specified resistance of 12.2 ohms. Since all three injectors are in parallel the total resistance of this parallel circuit drops to 4.1 ohms. Fourteen volts divided by four ohms would pull a maximum of 3.4 amps on this bank of injectors. However, as we discussed in **EXAMPLE #1** above, other factors knock this value down to roughly the 2.6 amp neighborhood.

Now we are going to take a look at the even bank of injectors; injectors 2, 4, and 6. See **Fig. 9**. Notice this bank peaked at 1.7 amps at idle as compared to the 2.6 amps peak of the odd bank (Fig. **Fig. 8**). Current flow between even and odd injectors banks is not uniform, yet it is not causing a driveability problem. That is because it is still under the maximum amperage we figured out earlier. But be aware this vehicle could develop a problem if the amperage flow increases any more.

Checking the resistance of this even injector group with a DVOM yielded 6.2 ohms, while the odd injector group in the previous example read 4.1 ohms.

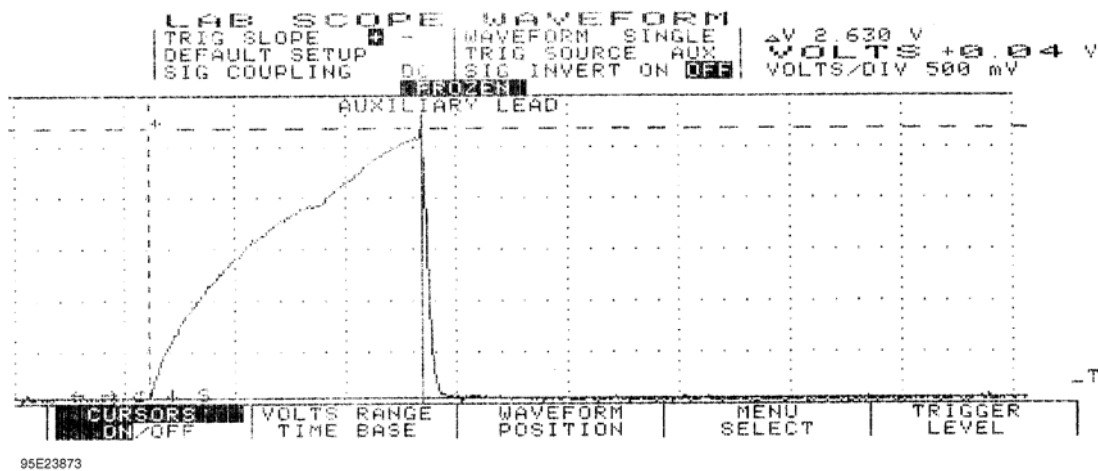


Fig. 8: Injector Odd Bank w/Normal Current Flow - Current Pattern

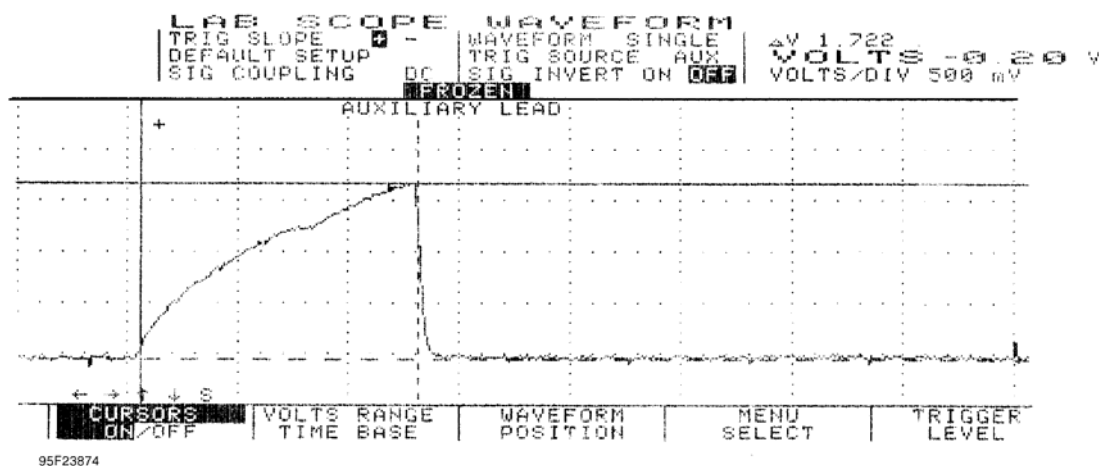


Fig. 9: Injector Even Bank w/Normal Current Flow - Current Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

Example #3 is of a Ford 5.0L V8 SEFI. Fig. **Fig. 10** shows a waveform of an individual injector at idle with the Lab Scope set on 200 milliams per division. Notice the dimple in the rising edge. This dimple indicates the actual opening of the injector (set point) occurred at 400 milliams and current peaked at 750 milliams. This is a good specification for this engine.

The next waveform pattern in Fig. **Fig. 11** shows an abnormality with another injector. With the Lab Scope set on 500 milliams per division, you can see that the current waveform indicates a 1200 milliamper draw. This is a faulty injector.

Abnormally low resistance injectors create excessive current draw, causing rough idle, and possible computer driver damage.

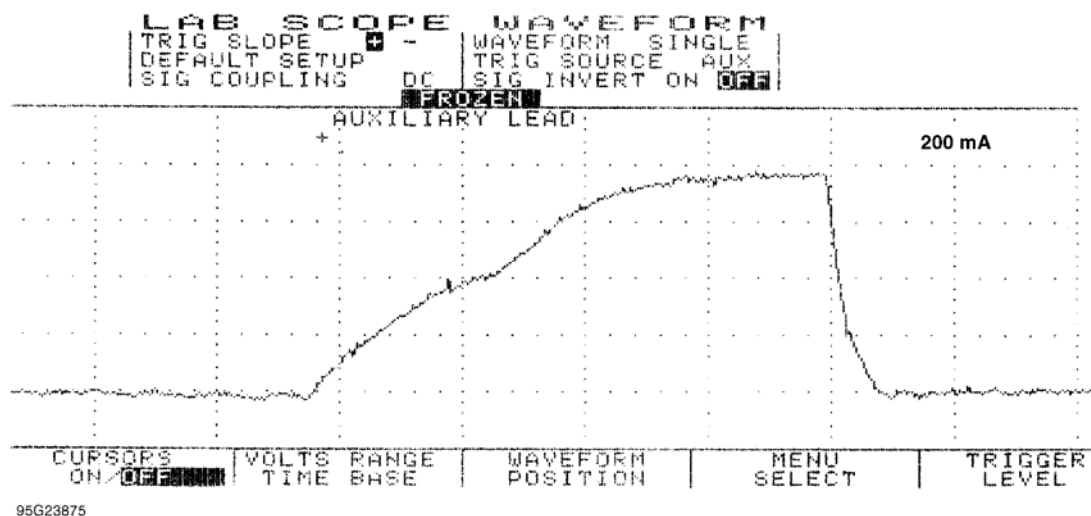


Fig. 10: Single Injector w/Normal Current Flow - Current Pattern

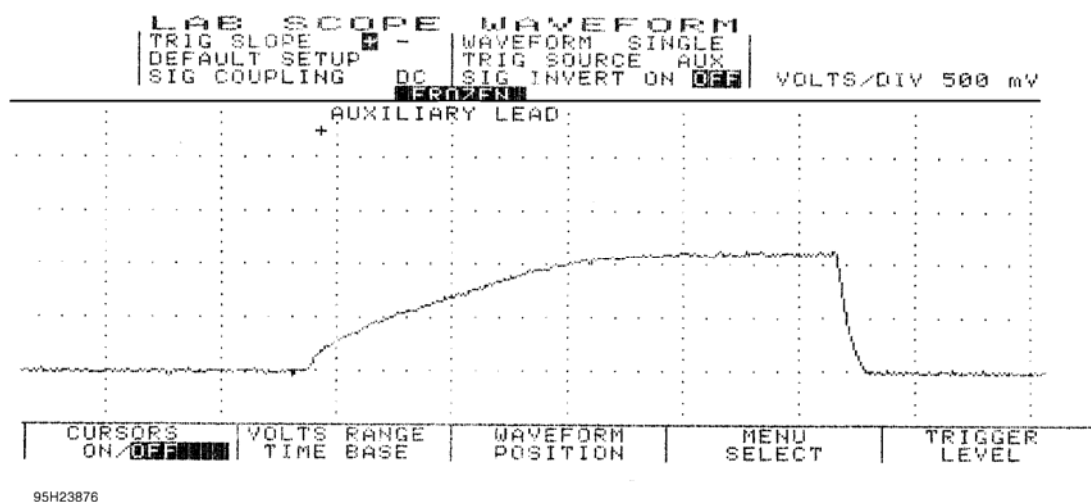


Fig. 11: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

Example #4 is of a Ford 4.6L SEFI VIN [W]. See **Fig. 12** for the known-good waveform pattern. This Ford system is different from the one above in **EXAMPLE #3** as it peaks at 900 milliamps and the actual opening of the injector (set point) is just below 600 milliamps.

This is offered as a comparison against the Ford pattern listed above, as they are both Ford SEFI injectors but with different operating ranges. The point is that you should not make any broad assumptions for any manufacturer.

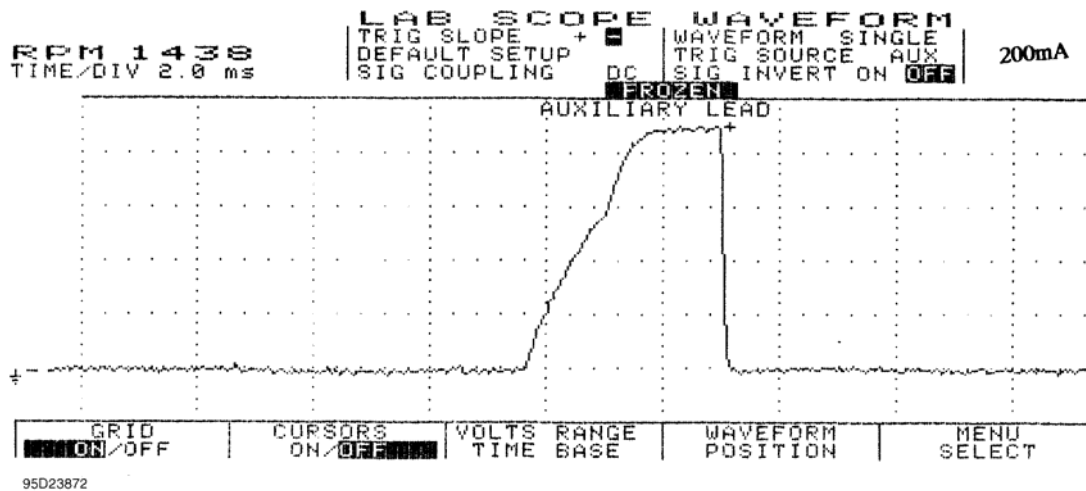


Fig. 12: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

The known-good waveform in Fig. [Fig. 13](#) is from a Chrysler 3.0L V6 PFI VIN [3]. It is a perfect example of the peak and hold theory. The waveform shows a 1-amp per division current flow, ramping to 4 amps and then decreasing to 1-amp to hold the injector open.

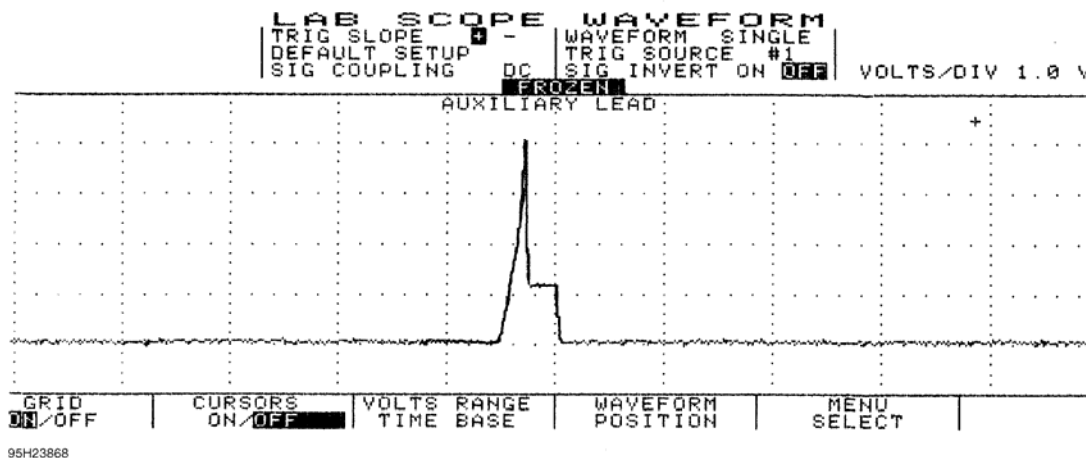


Fig. 13: Injector Bank w/Normal Current Flow - Current Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This next known-good waveform is from a Ford 5.0L V8 CFI VIN [F]. See [Fig. 14](#). The pattern, which is set on a 250 milliamps scale, indicates a 1.25 amp peak draw and a hold at 350 milliamps.

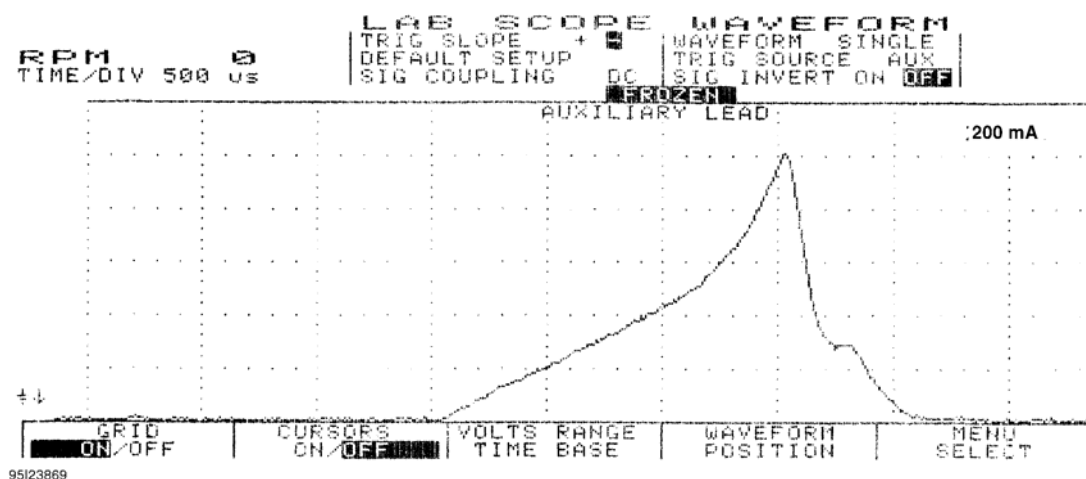


Fig. 14: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

The known-good current controlled type waveform in Fig. **Fig. 15** is from a GM 2.0L TBI VIN [1]. With the lab scope set at 2 amps per division, notice that this system peaks at 4 amps and holds at 1 amp.

The next waveform is from the same type of engine, except that it shows a faulty injector. See **Fig. 16**. Notice that the current went to almost 5 amps and stayed at 1 amp during the hold pattern. Excessive amounts of current flow from bad injectors are a common source of intermittent computer shutdown. Using a current waveform pattern is the most accurate method of pinpointing this problem.

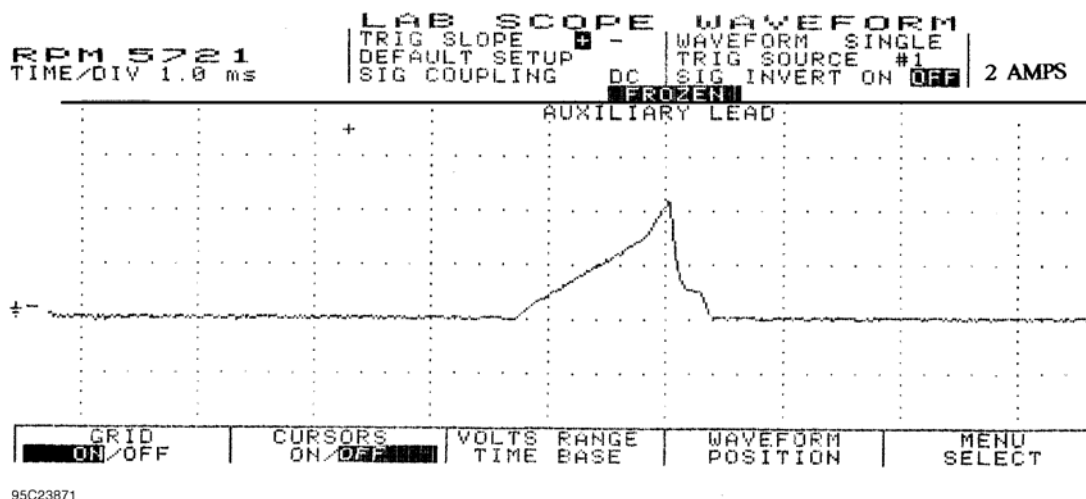
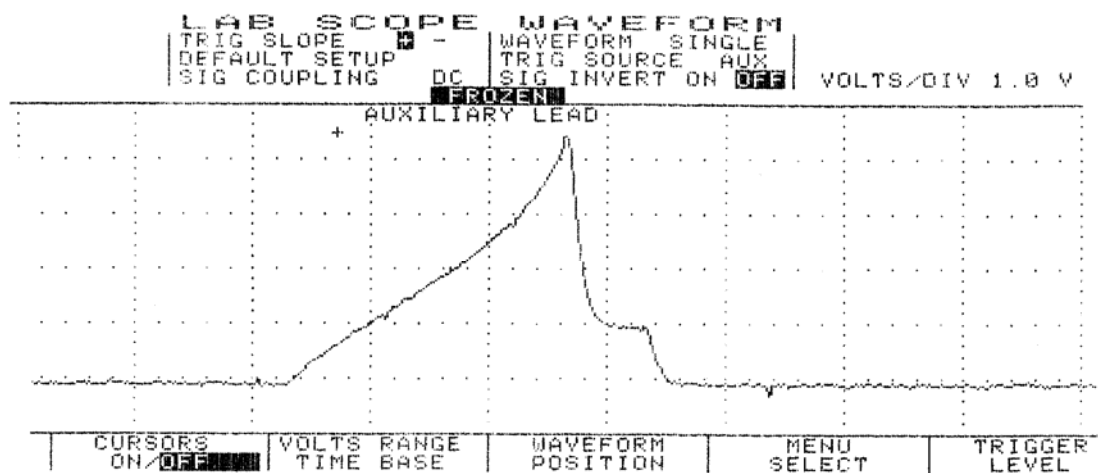


Fig. 15: Single Injector w/Normal Current Flow - Current Pattern

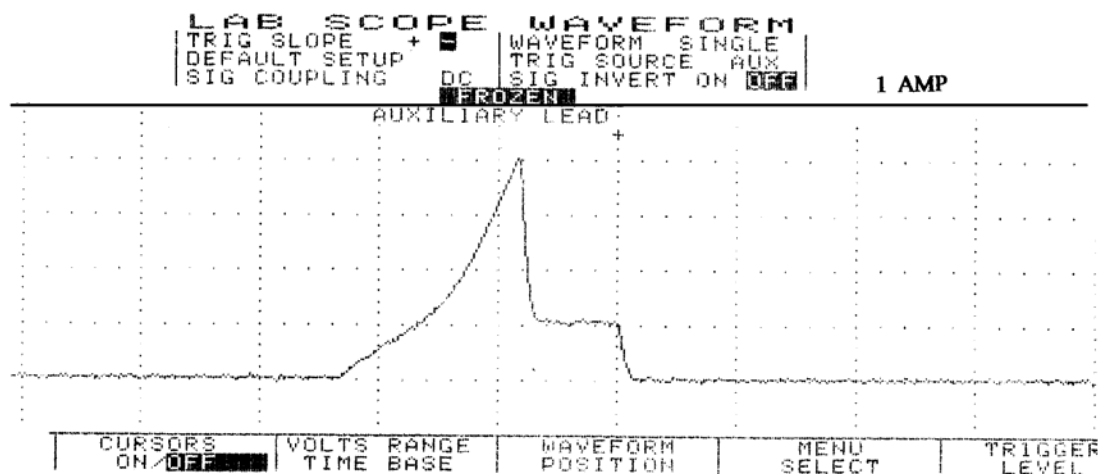


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Fig. 16: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

This known-good CPI system waveform from a GM 4.3L V6 CPI VIN [W] peaks at 4 amps and holds at 1-amp. See **Fig. 17** for waveform.



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Fig. 17: Single Injector w/Normal Current Flow - Current Pattern

VOLTAGE WAVEFORM SAMPLES

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

These two known-good waveform patterns are from a Ford 4.6L V8 VIN [W]. Fig. **Fig. 18** illustrates the 64 volt inductive kick on this engine, indicating no clamping is occurring. The second pattern, Fig. **Fig. 19**, was taken during hot idle, closed loop, and no load.

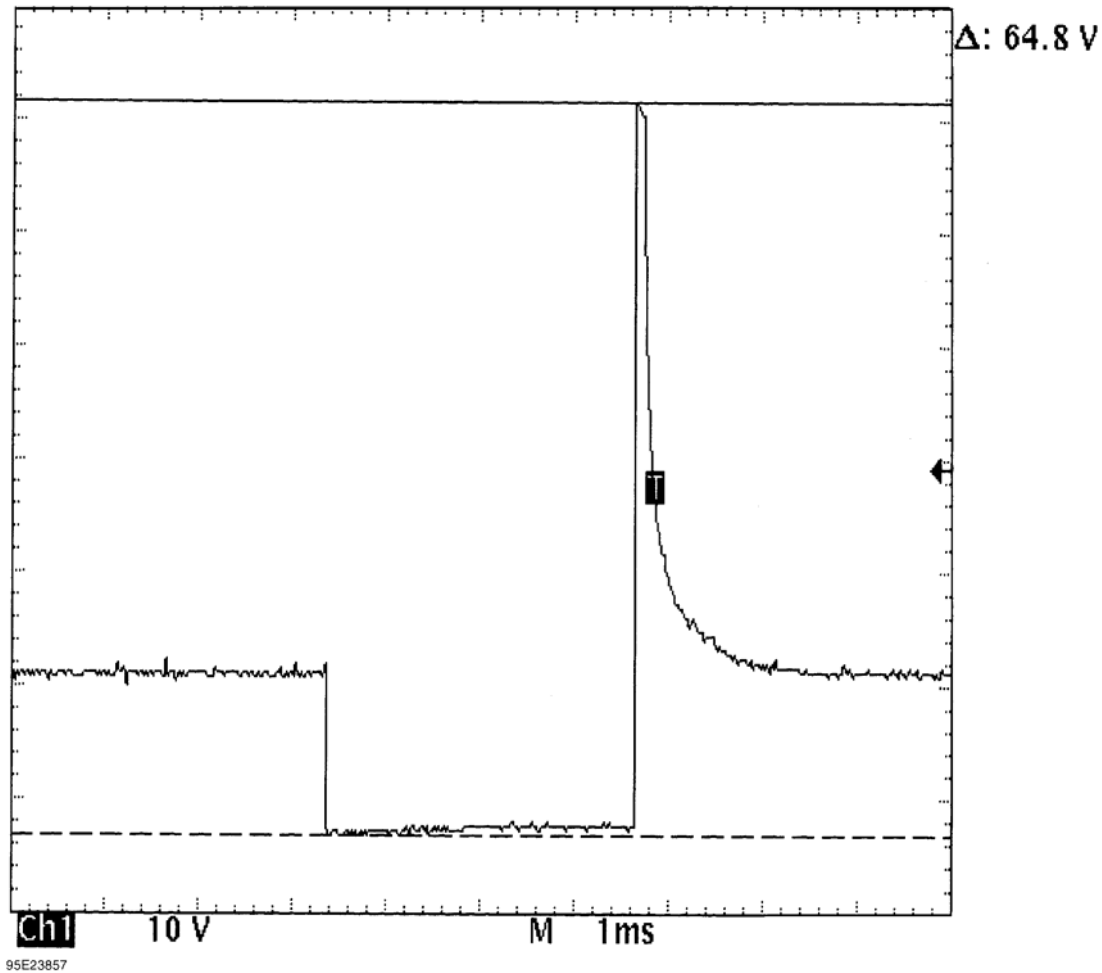


Fig. 18: Injector Bank - Known Good - Voltage Pattern

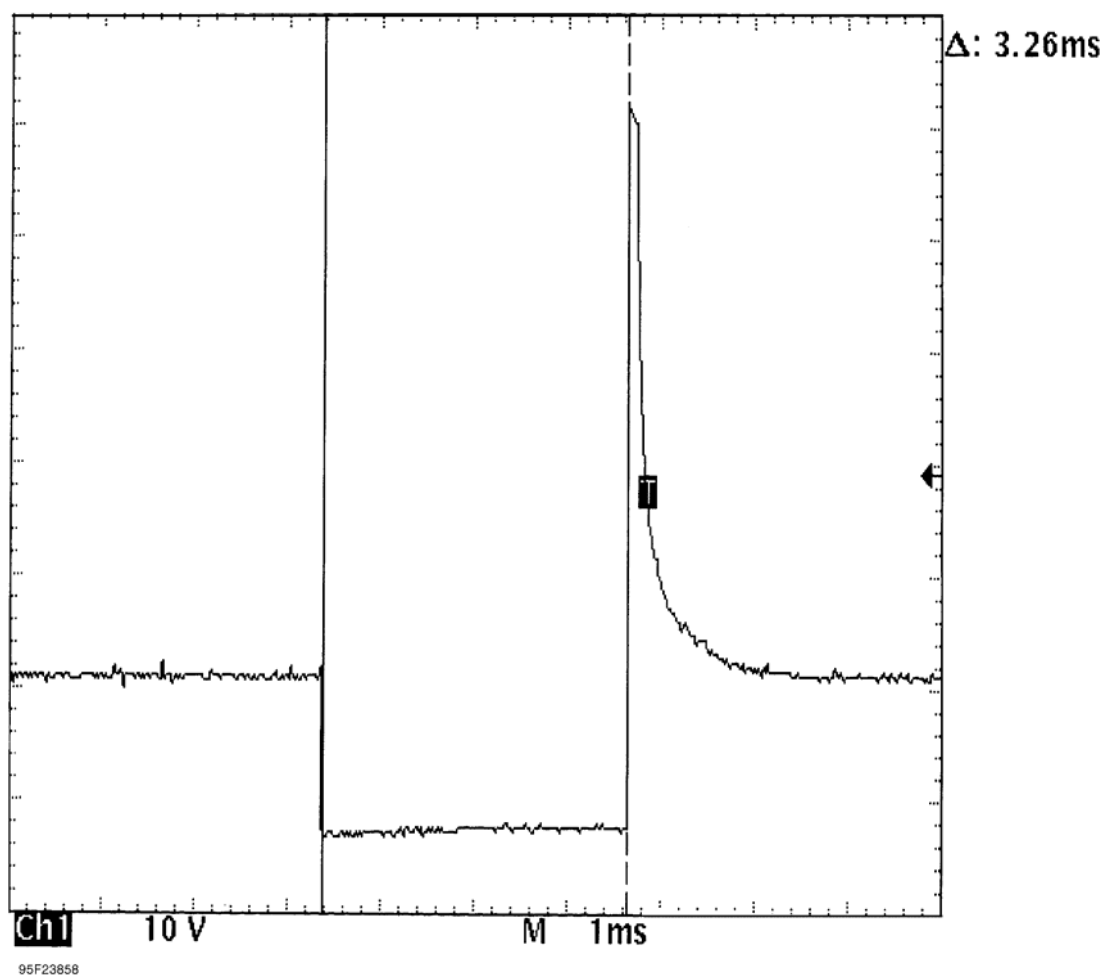


Fig. 19: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

The known-good waveform pattern in Fig. **Fig. 20** is from a GM 3.8L V6 PFI VIN [3]. It was taken during hot idle, closed loop and no load.

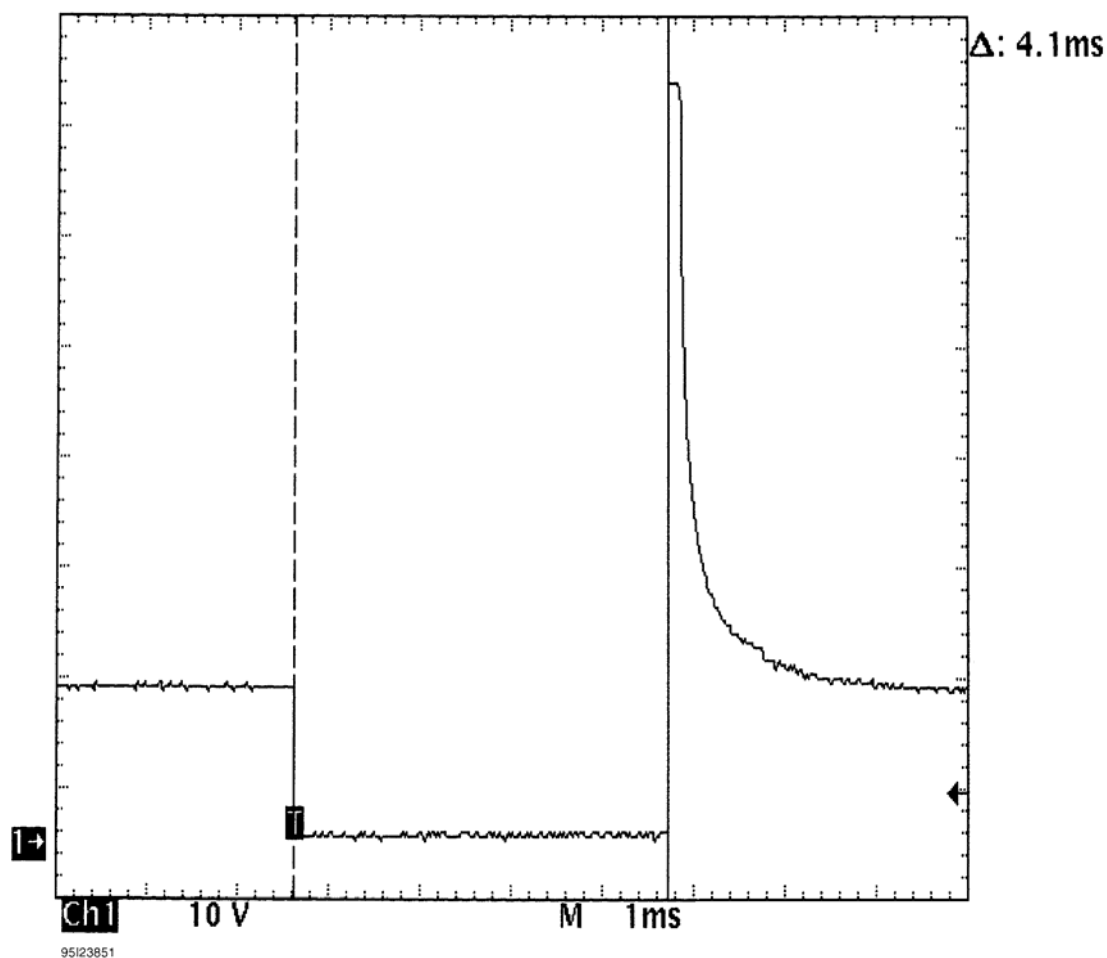


Fig. 20: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

This known-good waveform pattern, Fig. **Fig. 21**, is from a GM 5.0L V8 TPI VIN [F]. It was taken during hot idle, closed loop and no load.

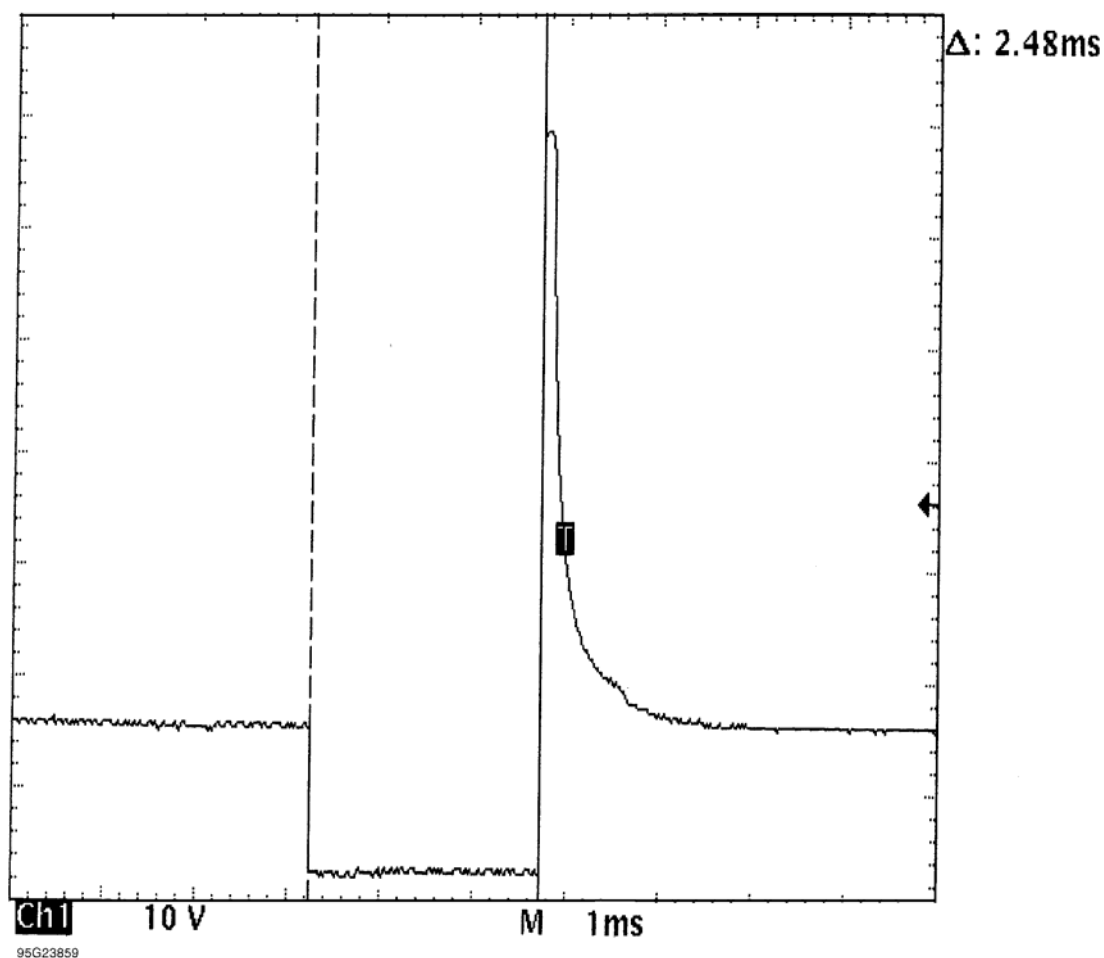


Fig. 21: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

From 1984 to 1987, Chrysler used this type injector drive on their TBI-equipped engines. See **Fig. 22** for a known-good pattern. Instead of the ground side controlling the injector, Chrysler permanently grounds out the injector and switches the power feed side. Most systems do not work this way.

These injectors peak at 6 amps of current flow and hold at 1 amp.

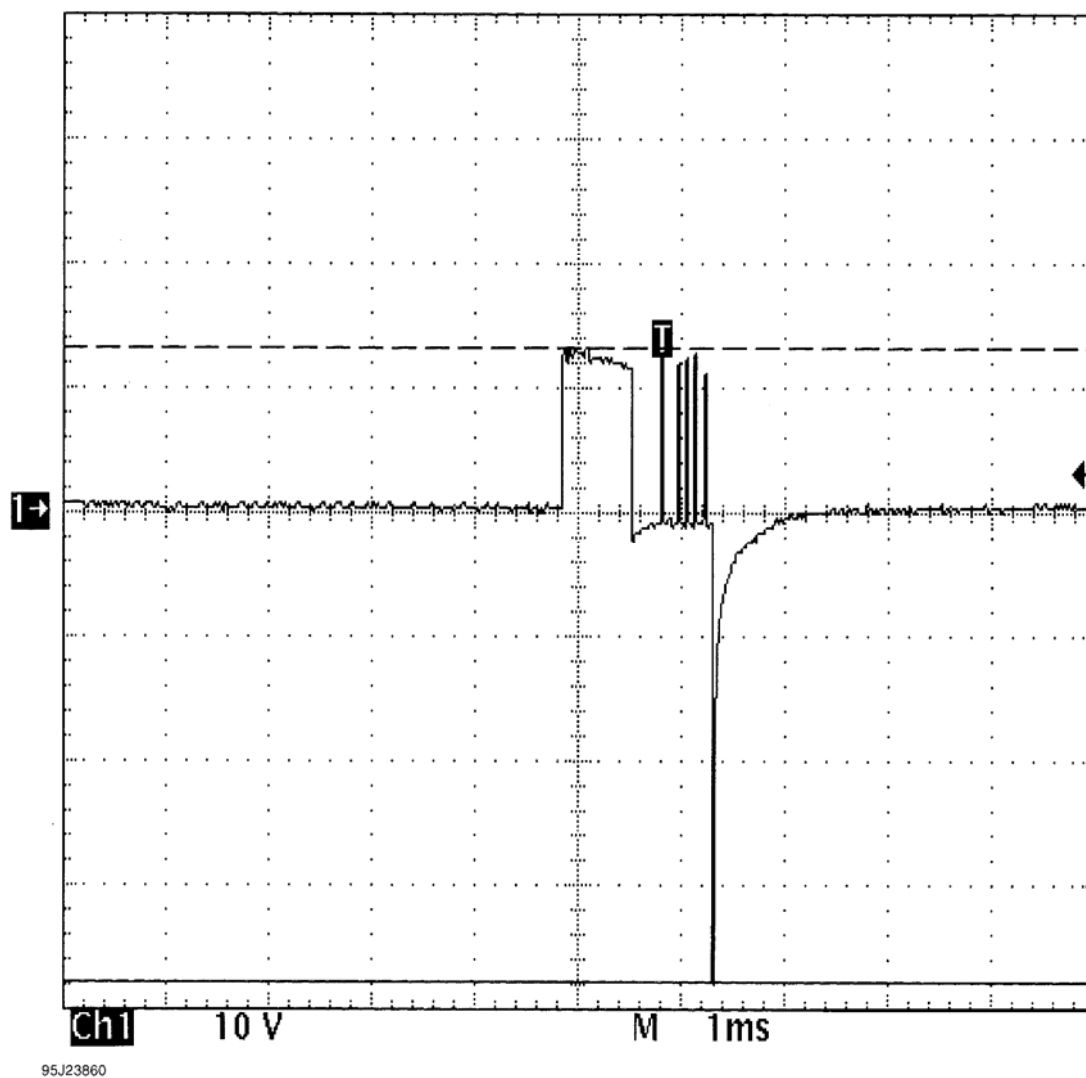
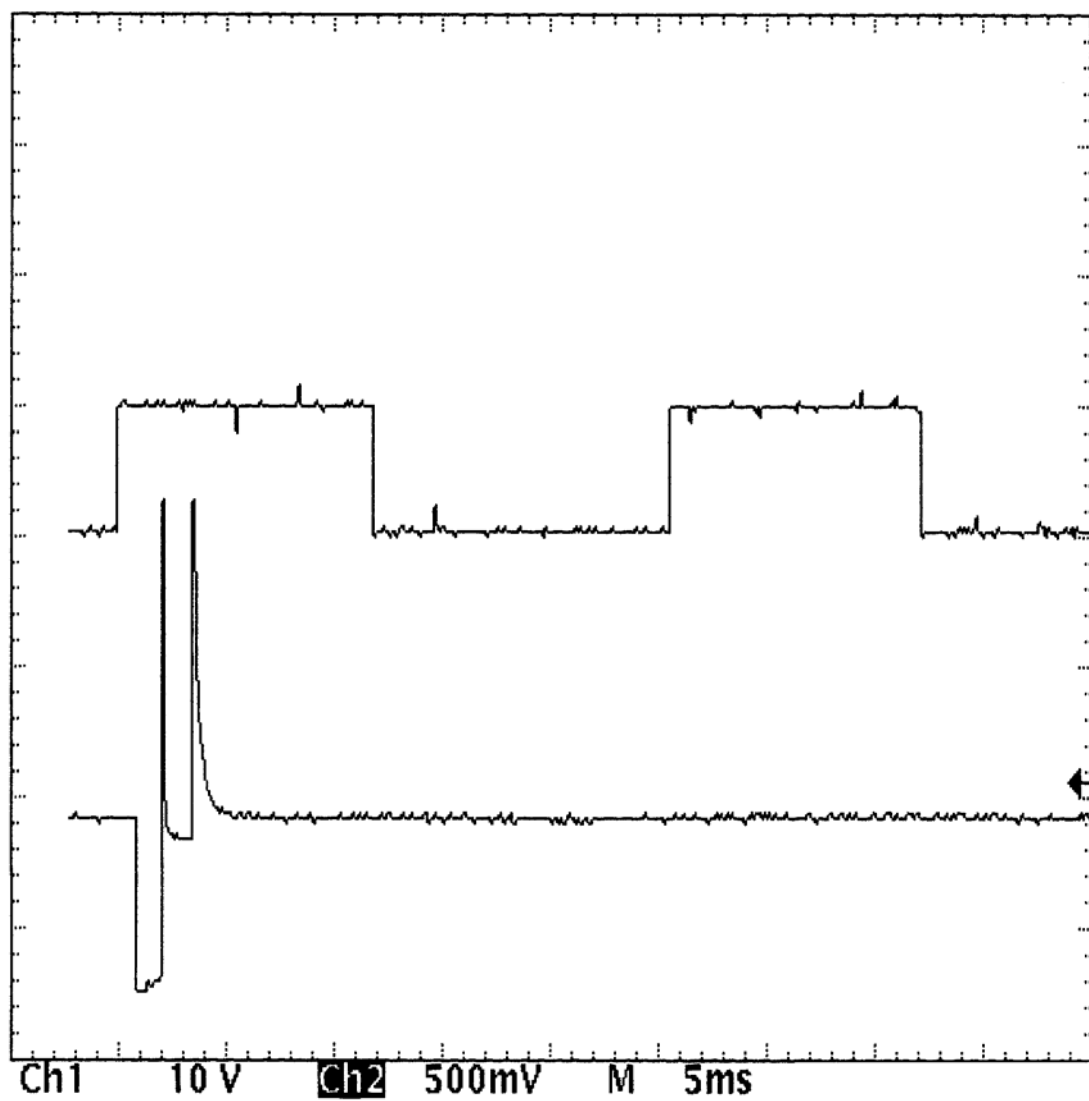


Fig. 22: Single Injector - Known Good - Voltage Pattern

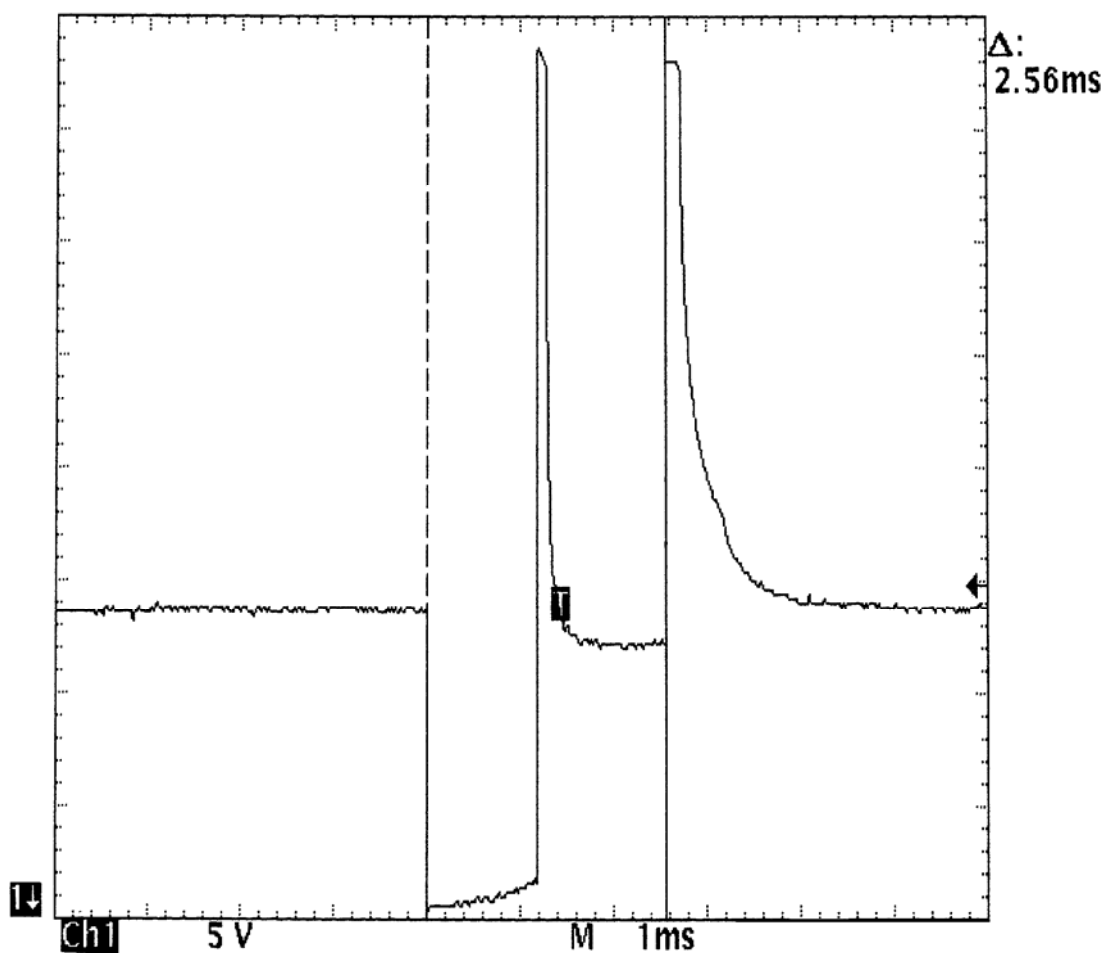
EXAMPLE #5 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a Chrysler 3.0L V6 VIN [3]. The first waveform, Fig. **Fig. 23**, is a dual trace pattern that illustrates how Chrysler uses the rising edge of the engine speed signal to trigger the injectors. The second waveform, Fig. **Fig. 24**, was taken during hot idle, closed loop, and no load.



95A23861

Fig. 23: Injector Bank - Known Good - Voltage Pattern



95B23854

Fig. 24: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This known-good pattern from a Ford 3.0L V6 PFI VIN [U] illustrates that a zener diode inside the computer is used to clamp the injector's inductive kick to 35-volts on this system. See **Fig. 25**.

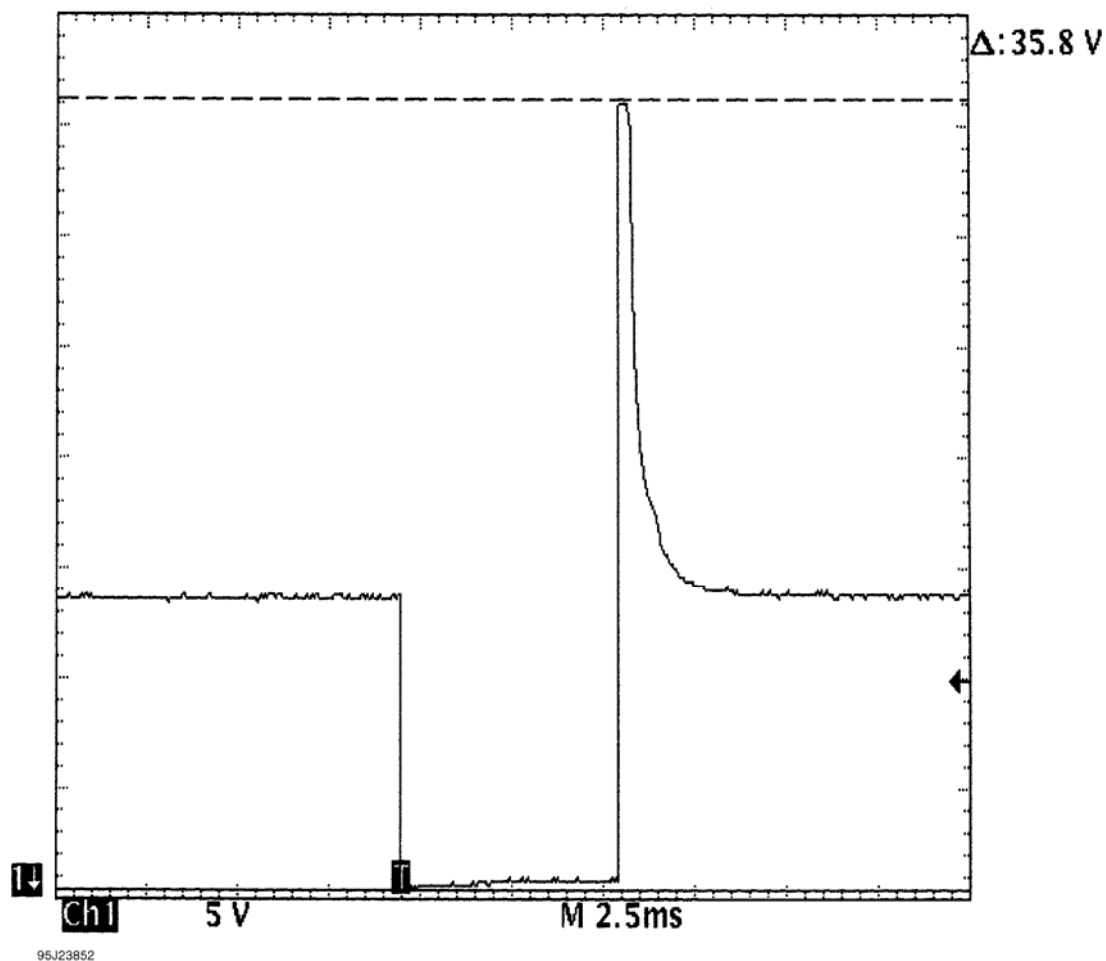


Fig. 25: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

This known-good waveform from a Ford 5.0L V8 CFI VIN [F] was taken during hot idle, closed loop, and no load. See **Fig. 26**.

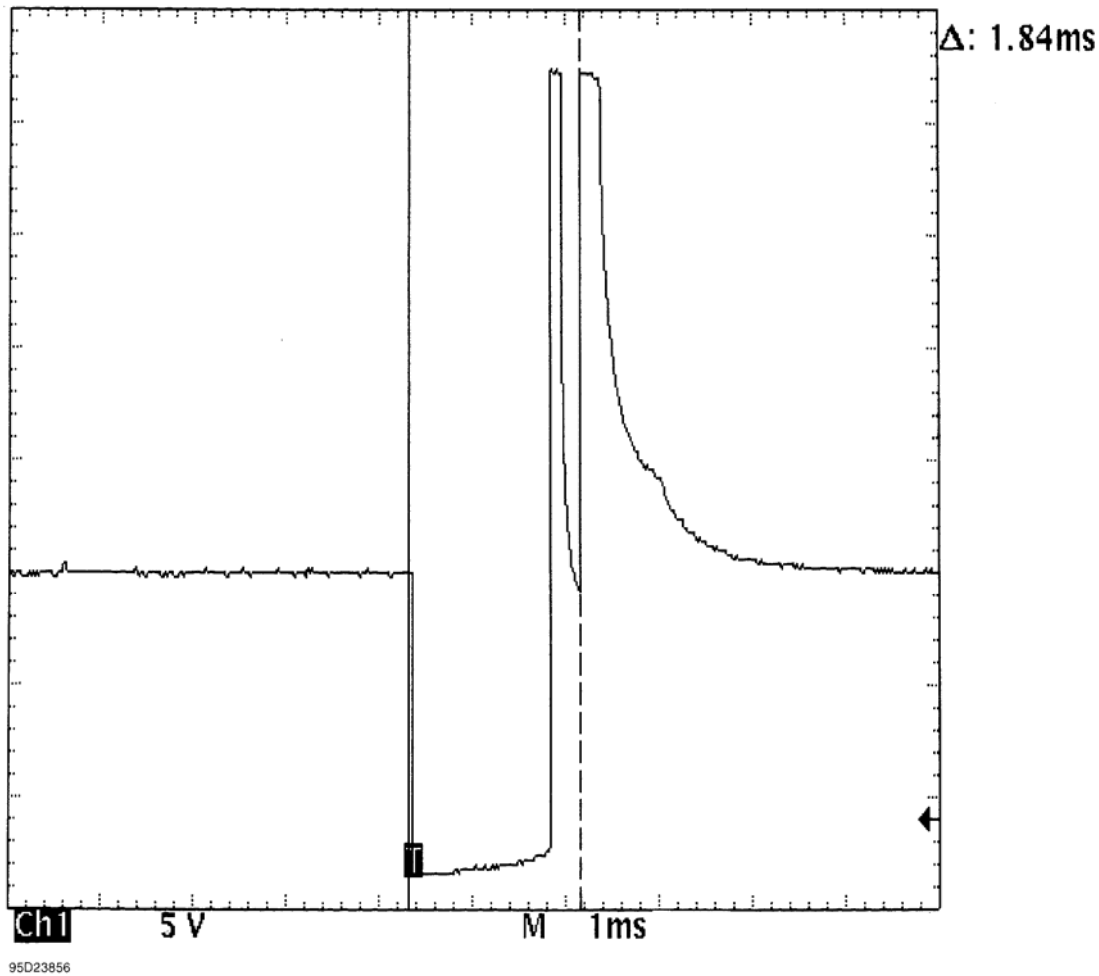


Fig. 26: Single Injector - Known Good - Voltage Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a GM 2.0L In-Line 4 VIN [1]. Fig. **Fig. 27** illustrates the 78 volt inductive spike that indicates a zener diode is not used. The second waveform, Fig. **Fig. 28**, was taken during hot idle, closed loop, and no load.

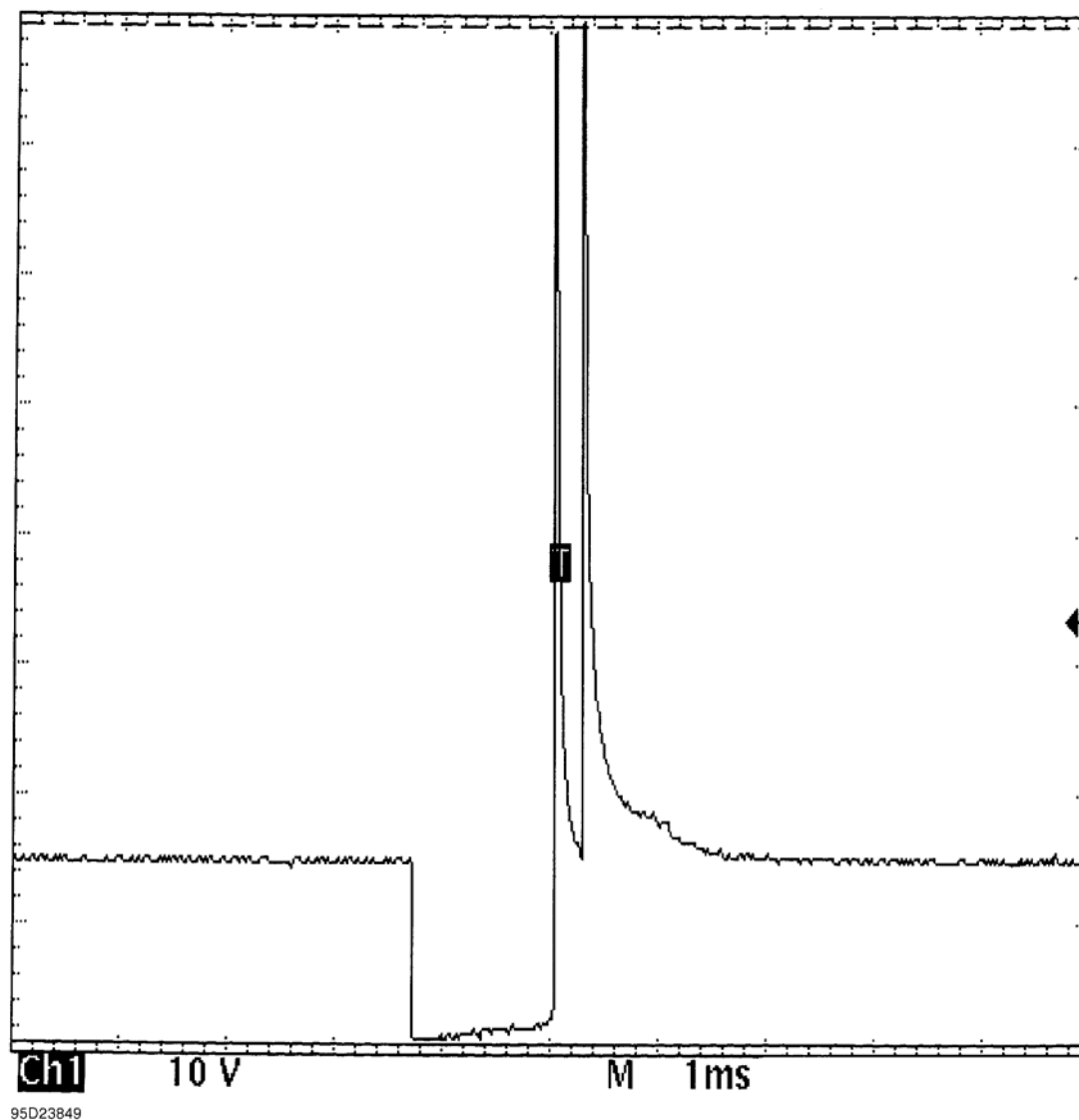


Fig. 27: Single Injector - Known Good - Voltage Pattern

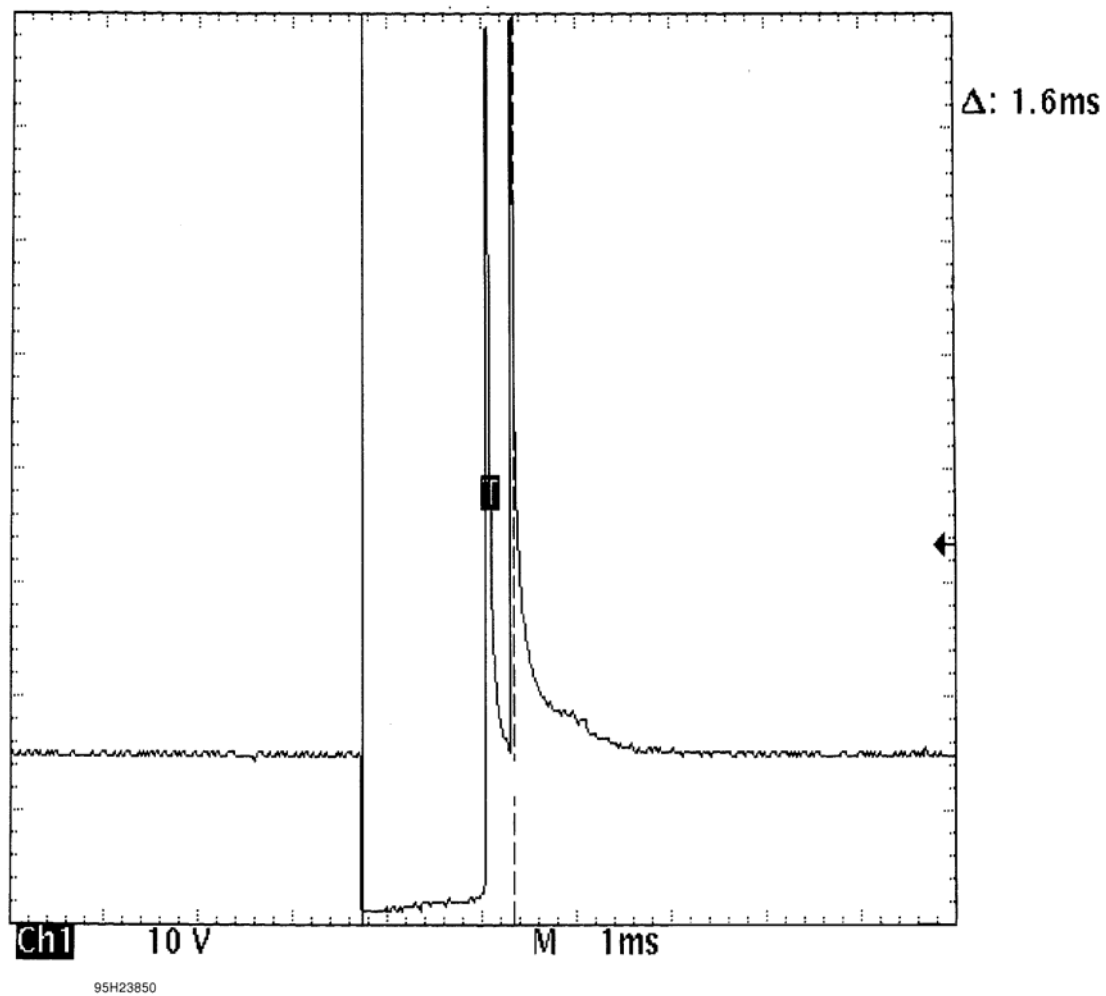


Fig. 28: Single Injector - Known Good - Voltage Pattern

GENERAL INFORMATION

Wheel Alignment Theory & Operation

*** PLEASE READ THIS FIRST ***

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

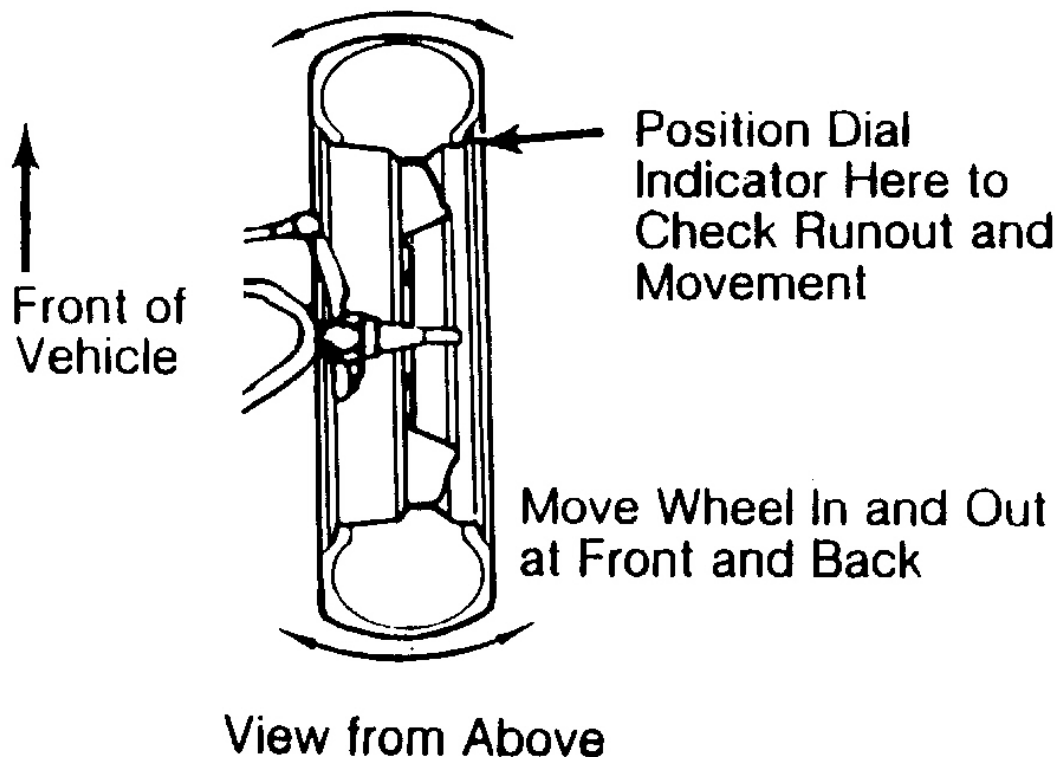
PRE-ALIGNMENT INSTRUCTIONS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

GENERAL ALIGNMENT CHECKS

Before adjusting wheel alignment, check the following:

- Each axle uses tires of same construction and tread style, equal in tread wear and overall diameter. Verify that radial and axial runout is not excessive. Inflation should be at manufacturer's specifications.
- Steering linkage and suspension must not have excessive play. Check for wear in tie rod ends and ball joints. Springs must not be sagging. Control arm and strut rod bushings must not have excessive play. See **Fig. 1**.

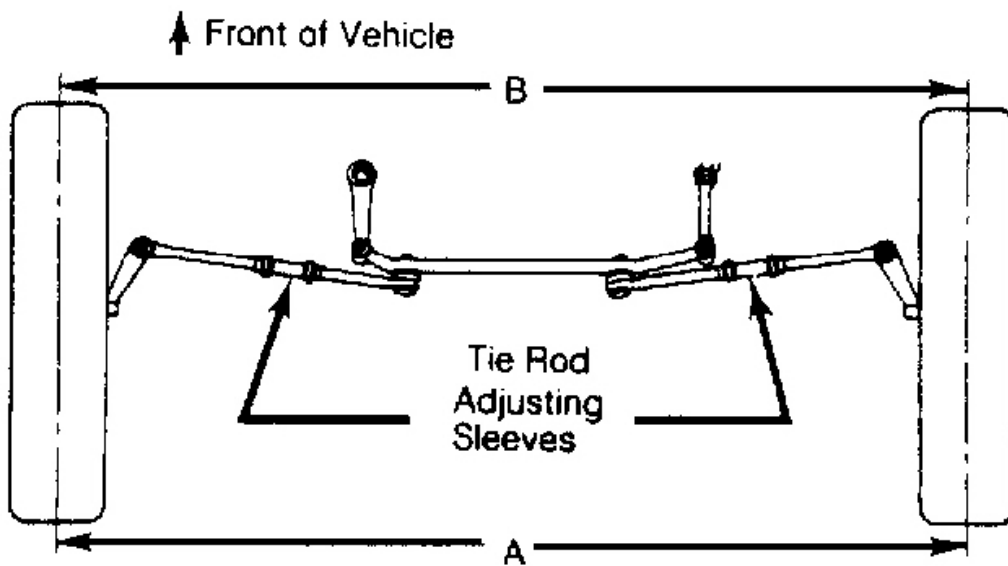


26694

Fig. 1: Checking Steering Linkage

- Vehicle must be on level floor with full fuel tank, no passenger load, spare tire in place and no load in trunk. Bounce front and rear end of vehicle several times. Confirm vehicle is at normal riding height.
- Steering wheel must be centered with wheels in straight ahead position. If required, shorten one tie rod adjusting sleeve and lengthen opposite sleeve (equal amount of turns). See **Fig. 2**.
- Wheel bearings should have the correct preload and lug nuts must be tightened to manufacturer's specifications. Adjust camber, caster and toe-in using this sequence. Follow instructions of the alignment equipment manufacturer.

CAUTION: DO NOT attempt to correct alignment by straightening parts. Damaged parts MUST be replaced.



26695

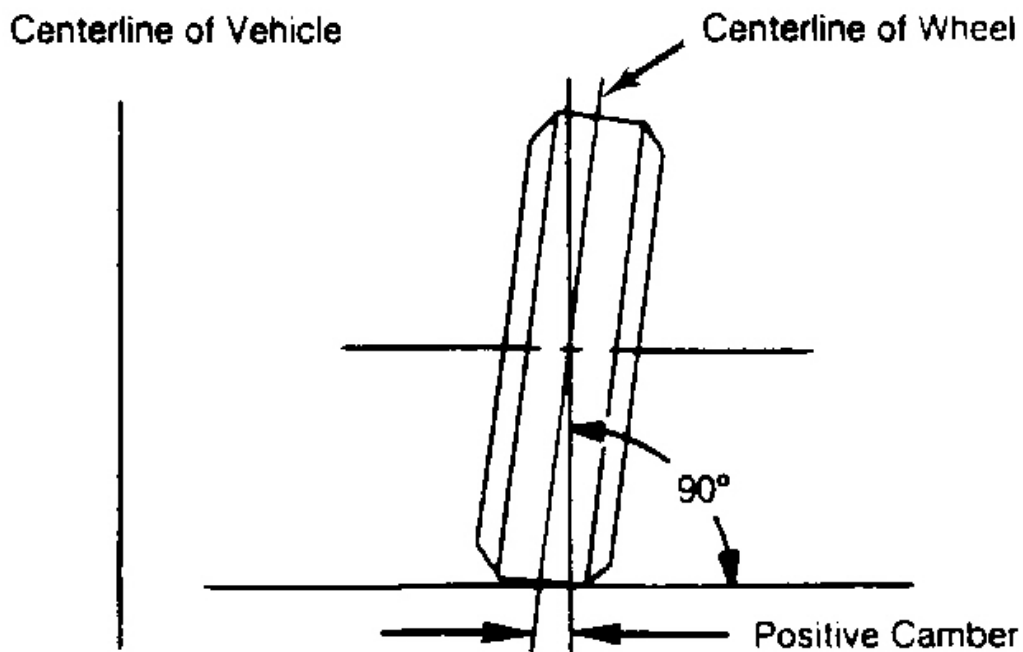
Fig. 2: Adjusting Tie Rod Sleeves (Top View)

ADJUSTMENTS

NOTE: This is **GENERAL** information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.

CAMBER

1. Camber is the tilting of the wheel, outward at either top or bottom, as viewed from front of vehicle. See **Fig. 3**.
2. When wheels tilt outward at the top (from centerline of vehicle), camber is positive. When wheels tilt inward at top, camber is negative. Amount of tilt is measured in degrees from vertical.

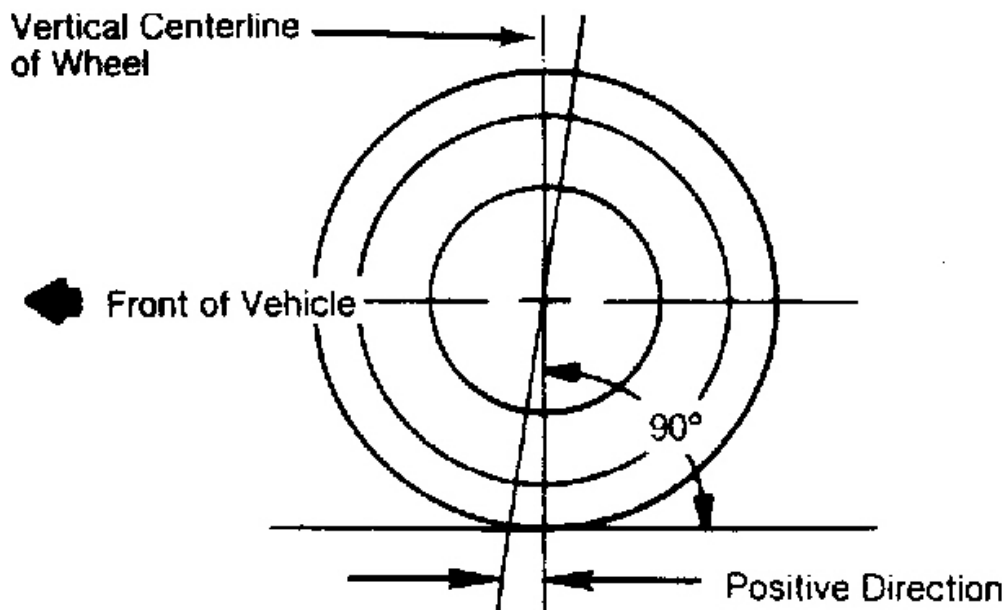


26696

Fig. 3: Determining Camber Angle

CASTER

1. Caster is tilting of front steering axis either forward or backward from vertical, as viewed from side of vehicle. See **Fig. 4**.
2. When axis is tilted backward from vertical, caster is positive. This creates a trailing action on front wheels. When axis is tilted forward, caster is negative, causing a leading action on front wheels.



26697

Fig. 4: Determining Caster Angle

TOE-IN ADJUSTMENT

Toe-in is the width measured at the rear of the tires subtracted by the width measured at the front of the tires at about spindle height. A positive figure would indicate toe-in and a negative figure would indicate toe-out. If the distance between the front and rear of the tires is the same, toe measurement would be zero. To adjust:

- 1) Measure toe-in with front wheels in straight ahead position and steering wheel centered. To adjust toe-in, loosen clamps and turn adjusting sleeve or adjustable end on right and left tie rods. See **Fig. 2** and **Fig. 5**.
- 2) Turn equally and in opposite directions to maintain steering wheel in centered position. Face of tie rod end must be parallel with machined surface of steering rod end to prevent binding.
- 3) When tightening clamps, make certain that clamp bolts are positioned so there will be no interference with other parts throughout the entire travel of linkage.

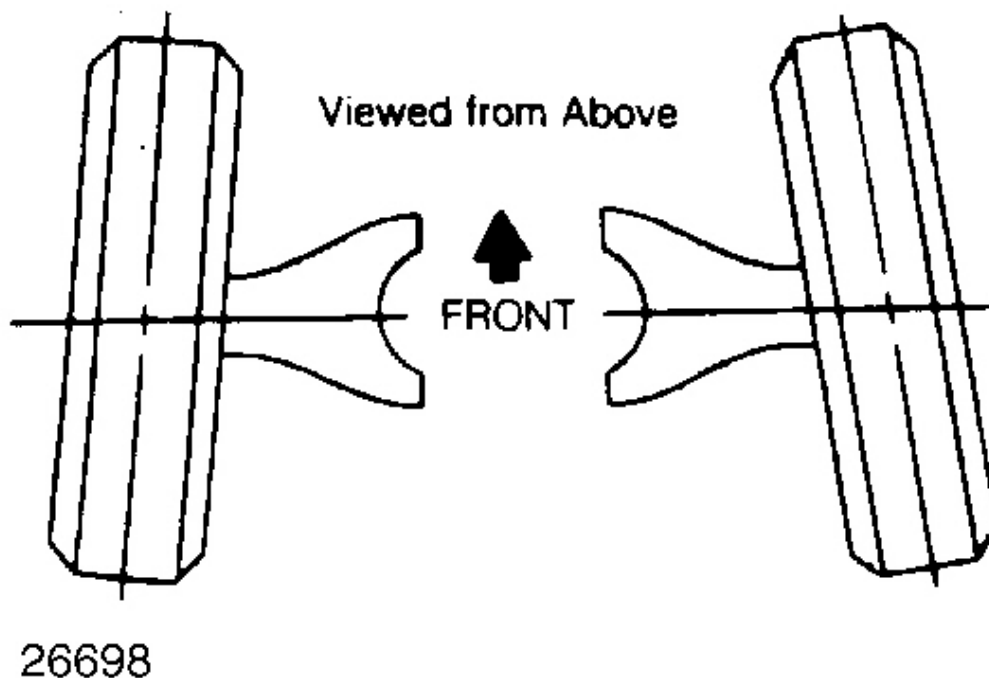


Fig. 5: Wheel Toe-In (Dimension A Less Dimension B)

TOE-OUT ON TURNS

1. Toe-out on turns (turning radius) is a check for bent or damaged parts, and not a service adjustment. With caster, camber, and toe-in properly adjusted, check toe-out with weight of vehicle on wheels.
2. Use a full floating turntable under each wheel, repeating test with each wheel positioned for right and left turns. Incorrect toe-out generally indicates a bent steering arm. Replace arm, if necessary, and recheck wheel alignment.

STEERING AXIS INCLINATION

1. Steering axis inclination is a check for bent or damaged parts, and not a service adjustment. Vehicle must be level and camber should be properly adjusted. See **Fig. 6**.
2. If camber cannot be brought within limits and steering axis inclination is correct, steering knuckle is bent. If camber and steering axis inclination are both incorrect by approximately the same amount, the upper and lower control arms are bent.

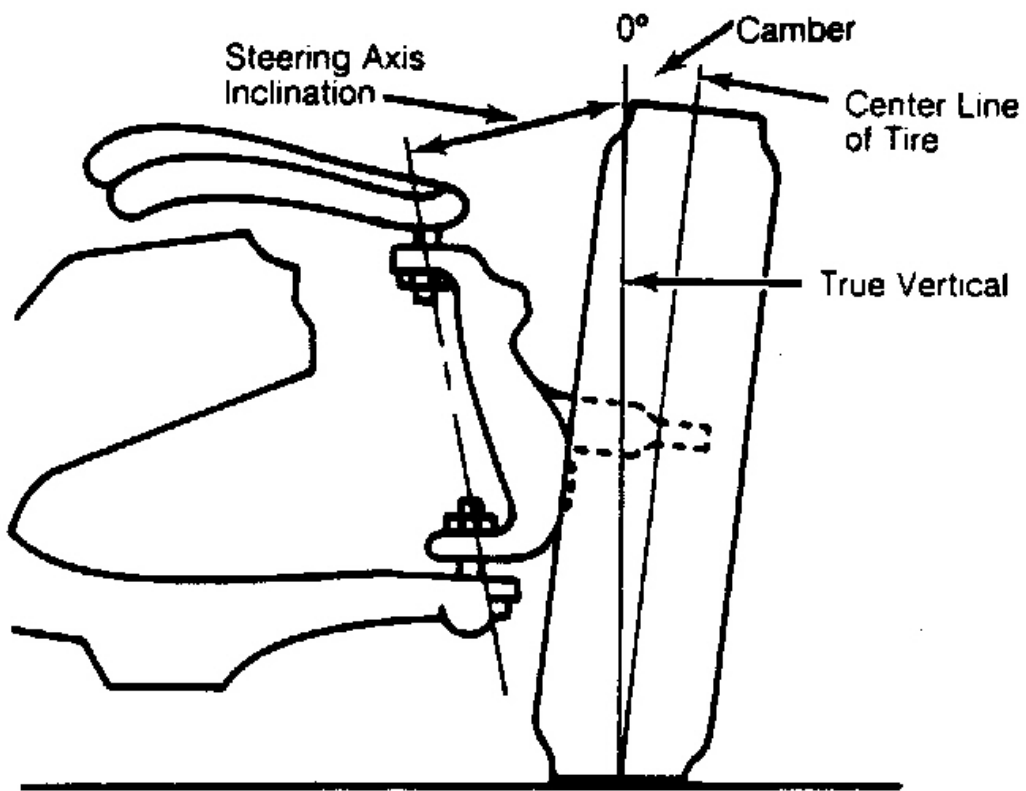


Fig. 6: Checking Steering Axis Inclination

Suspension

Wheel Alignment

SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS

Alignment Condition: Full tank of fuel, no passengers and placed on flat level surface.

Wheel Alignment Specifications

RPO Restriction	Wheels	Caster $\pm 0.8^\circ$		Cross Caster $\pm 0.8^\circ$	Camber $\pm 0.8^\circ$		Cross Camber $\pm 0.8^\circ$	Total Toe $\pm 0.2^\circ$	Steering Wheel Angle $\pm 3.5^\circ$	Thrust Angle $\pm 0.3^\circ$
		Left	Right	(Left - Right)	Left	Right	(Left - Right)	(Left + Right)		(Left - Right)/2
GNA	Front	3.8°	3.8°	0.0°	-0.4°	-0.4°	0.0°	0.2°	0.0°	-
	Rear	-	-	-	-0.8°	-0.8°	-	0.1°	-	0.0°
GNB	Front	6.0°	6.0°	0.0°	-0.4°	-0.4°	0.0°	0.2°	0.0°	-
	Rear	-	-	-	-0.8°	-0.8°	-	0.1°	-	0.0°

FASTENER TIGHTENING SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Rear Axle Lower Control Arm Inner Nut (GNC) (Requires NEW Bolt)		
First Pass	90 N.m	66 lb ft
Final Pass	plus 60 degrees	
Rear Suspension Toe Adjust Link Inner Nut (GNE)	150 N.m	111 lb ft
Rear Axle Upper Control Arm Inner Nut (GNE)	150 N.m	111 lb ft
Front Upper Camber Adjustment Nut (GNB)		
First Pass	70 N.m	52 lb ft
Final Pass	plus 60 degrees	
Front Lower Camber Adjustment Nut (GNB)		
First Pass	115 N.m	85 lb ft
Final Pass	plus 45 degrees	
Rear Suspension Toe Adjust Link Inner Nut (GNC)(Requires NEW Bolt)		
First Pass	90 N.m	66 lb ft
Final Pass	plus 60 degrees	

Front Steering Linkage Tie Rod Jam Nut	60 N.m	44 lb ft
Front Steering Knuckle Nut (at Strut Assembly)(GNA)(Requires NEW Bolt)		
First Pass	85 N.m	63 lb ft
Final Pass	plus 60 degrees	

REPAIR INSTRUCTIONS

WHEEL ALIGNMENT MEASUREMENT

Steering and vibration complaints are not always the result of improper alignment. One possible cause is wheel and tire imbalance. Another possibility is tire lead due to worn or improperly manufactured tires. Lead/pull is defined as follows: At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle straight path. Lead is the vehicle deviation from a straight path on a level road without pressure on the steering wheel.

Before performing any adjustment affecting wheel alignment, perform the following inspections and adjustments in order to ensure correct alignment readings:

- Inspect the tires for the proper inflation and irregular tire wear. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** , and **Tire Diagnosis - Irregular or Premature Wear** .
- Inspect the runout of the wheels and the tires.
- Inspect the wheel bearings for backlash and excessive play.
- Inspect the ball joints and tie rod ends for looseness or wear.
- Inspect the control arms and stabilizer shaft for looseness or wear.
- Inspect the steering gear for looseness at the frame. Refer to **Fastener Tightening Specifications** .
- Inspect the struts/shock absorbers for wear, leaks, and any noticeable noises. Refer to **Suspension Strut and Shock Absorber Testing - On Vehicle** .
- Inspect the vehicle trim height. Refer to **Trim Height Inspection (GNA)** , **Trim Height Inspection (GNB)** .
- Inspect the steering wheel for excessive drag or poor return due to stiff or rusted linkage or suspension components.

Give consideration to the condition of the equipment being used for the alignment. Follow the equipment manufacturer instructions.

Satisfactory vehicle operation may occur over a wide range of alignment settings. However, if the setting exceeds the service allowable specifications, correct the alignment to the service preferred specifications. Refer to **[Wheel Alignment Specifications](#)**.

Perform the following steps in order to measure the front and rear alignment angles:

1. Install the alignment equipment according to the manufacturer instructions.

2. Jounce the front and the rear bumpers 3 times prior to checking the wheel alignment.
3. Measure the alignment angles and record the readings.
4. Adjust alignment angles to vehicle specification, if necessary. Refer to **Wheel Alignment Specifications**.

FRONT CAMBER ADJUSTMENT (GNB)

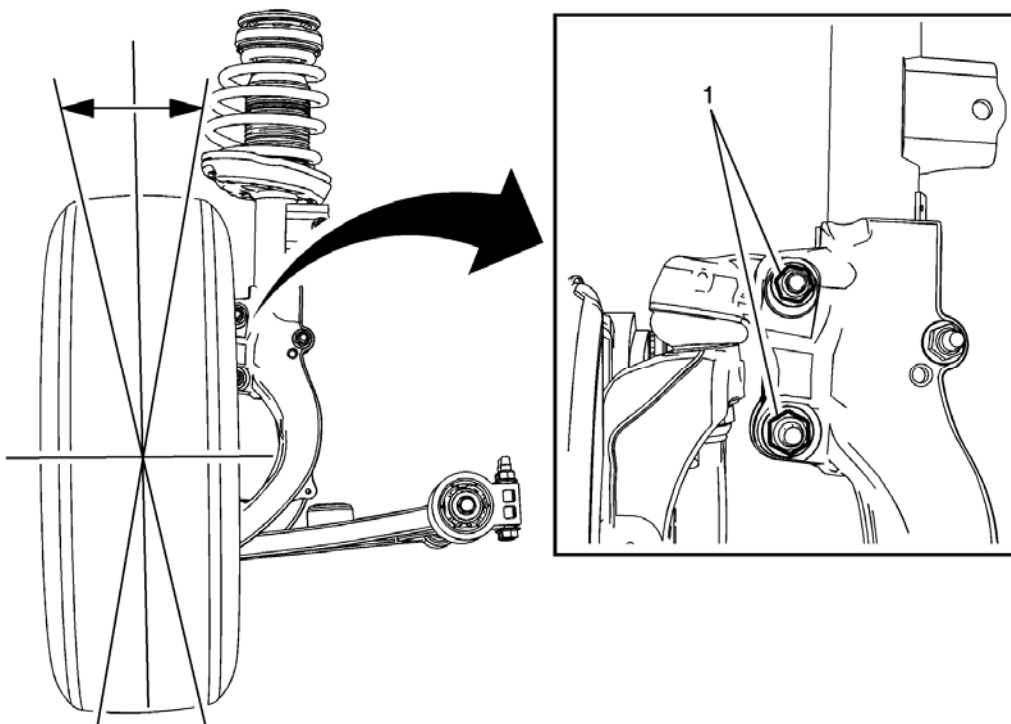


Fig. 1: Front Camber Angle Adjusting Nuts
Courtesy of GENERAL MOTORS COMPANY

Procedure:

1. Loosen the steering knuckle camber adjust bolt.
2. Rotate the upper steering knuckle camber adjust bolt inward or outward to adjust the front camber. Refer to **Wheel Alignment Specifications**.
3. DO NOT remove any material from the holes for the adjustment bolts as an alignment aide. If there is difficulty adjusting the camber, check for any excessively worn or damaged suspension components.
4. Once the camber adjustment is complete, tighten the camber adjust nuts to specification
5. Tighten the lower camber adjust nut.
6. Tighten the upper camber adjust nut
7. With the camber within the specifications, adjust the toe. Refer to Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment

Tighten:

Tighten lower camber adjust nut first pass, 115 N.m (85 lb ft).

Tighten lower camber adjust nut final pass, tighten an additional 45 degrees.

Tighten upper camber adjust nut, first pass 70 N.m (52 lb ft).

Tighten upper camber adjust nut, final pass tighten an additional 60 degrees

FRONT CAMBER ADJUSTMENT (GNA)

1. Position the vehicle properly on an alignment rack
2. Remove the tire and wheel assembly. Refer to **TIRE AND WHEEL REMOVAL AND INSTALLATION**

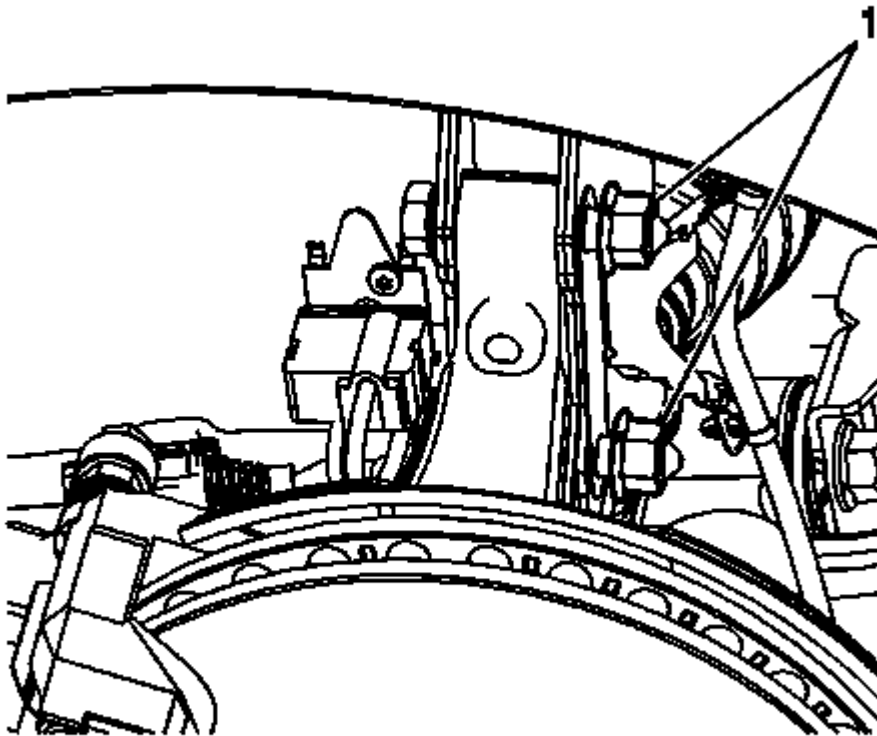


Fig. 2: Front Suspension Strut Nuts

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The front suspension does not have to be removed from the vehicle to perform the following steps
- DO NOT remove the front strut nuts and bolts at this time. Use the old nuts and bolts during the modification of the front strut

3. Loosen both of the front strut nuts (1) to for allow movement of the front strut.

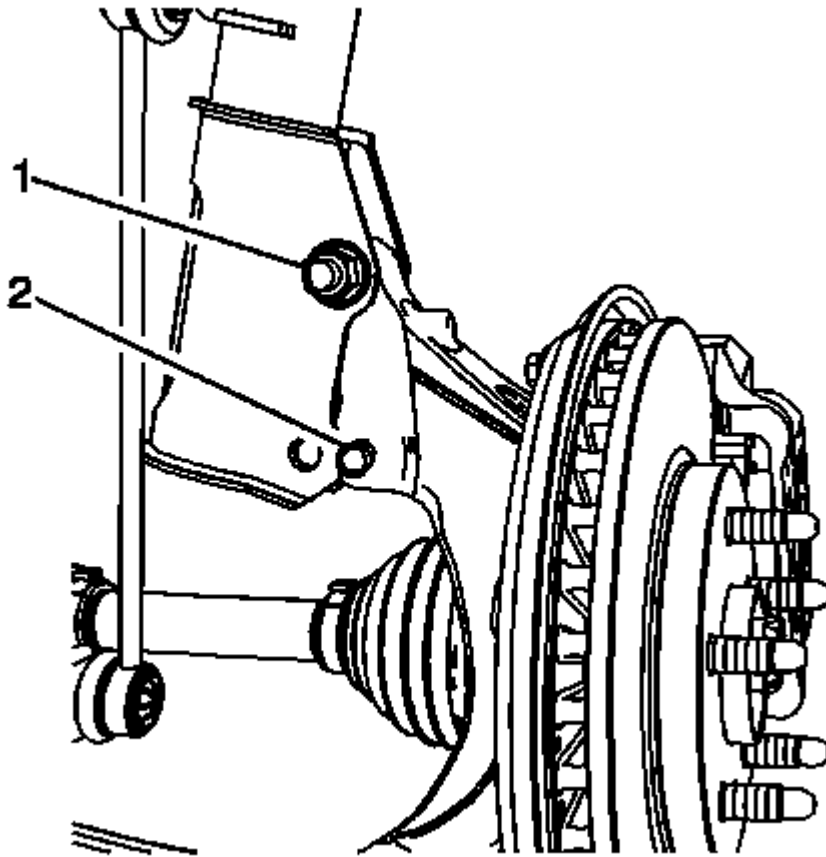


Fig. 3: Front Strut Lower Bolt And Nut
Courtesy of GENERAL MOTORS COMPANY

4. Remove the lower front strut nut and bolt (2).
5. Push the front strut inward and install the front strut lower bolt (2) in the lower bolt hole of the knuckle

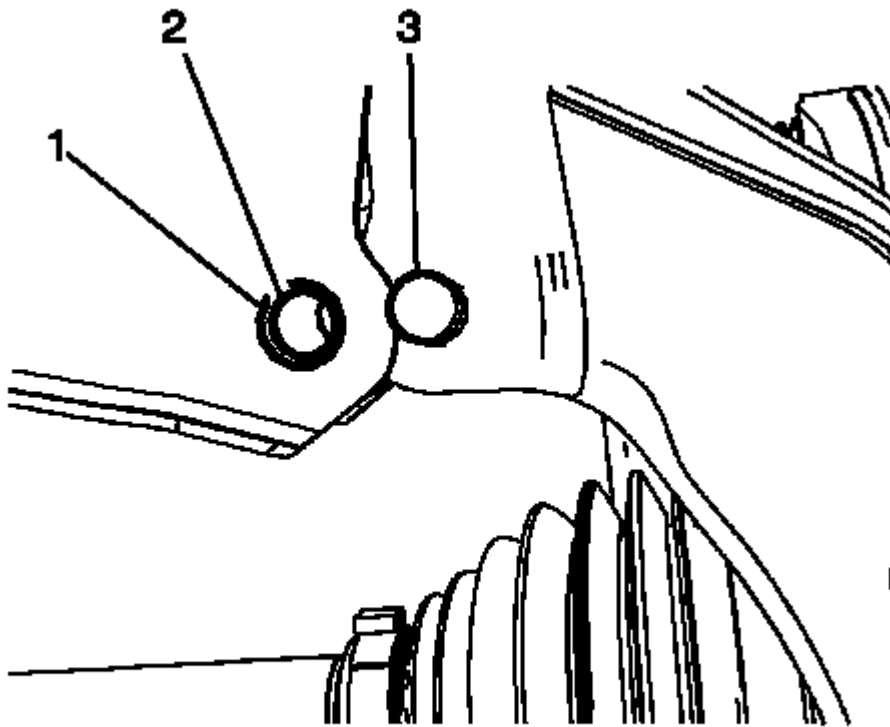


Fig. 4: Front Strut Lower Bolt Inner And Outer Holes
Courtesy of GENERAL MOTORS COMPANY

6. Using a file, enlarge the inner hole (2) to the same size as the outer hole (1).

NOTE: Replace the nut at the same time the bolt is replaced.

7. Remove and discard the lower bolt (3). Replace with NEW only
8. Remove and discard the upper nut and bolt. Replace with NEW only
9. Adjust the front camber to the proper specifications. Refer to **Wheel Alignment Specifications**
10. Tighten the front strut nuts. Refer to Strut Assembly Removal and Installation.
11. Verify the front camber adjustment. Repeat the camber adjustment if needed.

WHEEL ALIGNMENT - STEERING WHEEL ANGLE AND/OR FRONT TOE ADJUSTMENT

1. If equipped with NJ1 (Electronic Power Steering), and the steering angle sensor was recentered, the steering stops must be relearned. Refer to **Steering Angle Sensor Centering** .

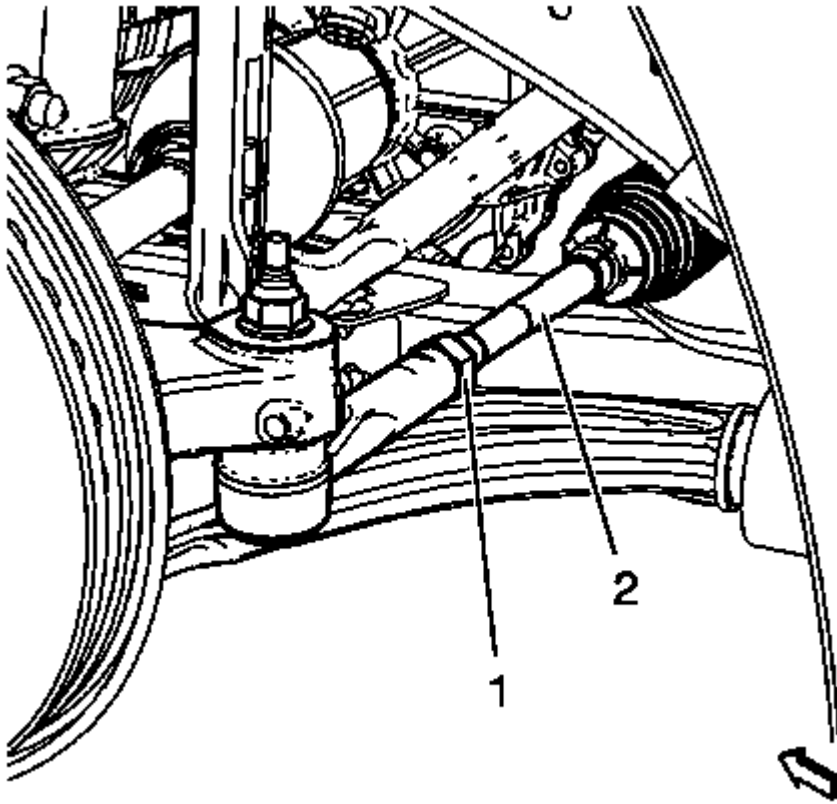


Fig. 5: Inner Tie Rod And Jam Nut
Courtesy of GENERAL MOTORS COMPANY

2. Ensure that the steering wheel is set in a straight ahead position.
3. Loosen the tie rod jam nut (1).
4. Adjust the toe to specification by turning the inner tie rod (2). Refer to **Wheel Alignment Specifications**.

CAUTION: Refer to Fastener Caution .

5. Tighten the tie rod jam nut (1) to 60 N.m (44 lb ft).

REAR CAMBER ADJUSTMENT (GNC)

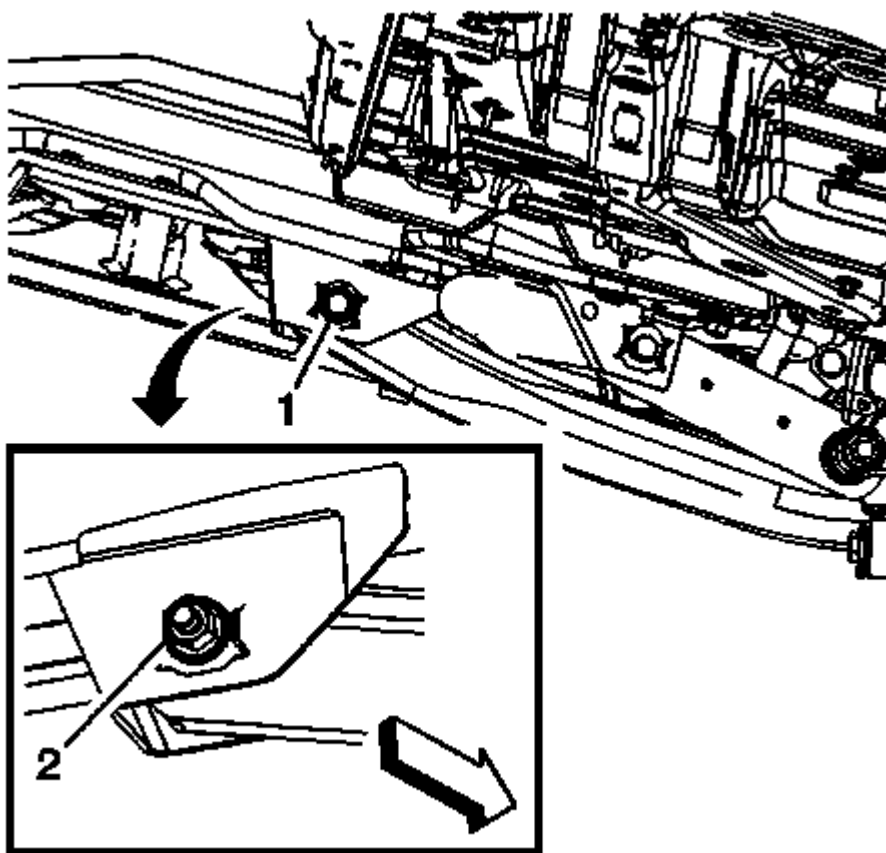


Fig. 6: Rear Lower Control Arm Bolt
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: This bolt is designed to permanently stretch when tightened, and therefore **MUST** be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the components may be damaged.

1. Remove the and discard the rear lower control arm bolt (1). DO NOT re-use. Replace with NEW only
2. With the NEW rear lower control arm bolt (1) in place, rotate the rear lower control arm bolt (1) until the proper camber setting is achieved. Refer to **Wheel Alignment Specifications**.
3. Verify the rear camber specifications and adjust as necessary

CAUTION: Refer to **Fastener Caution**

4. Tighten the rear suspension lower control arm nut (2) to 90 N.m (66 lb ft) plus an additional 60 degrees.

REAR CAMBER ADJUSTMENT (GNE)

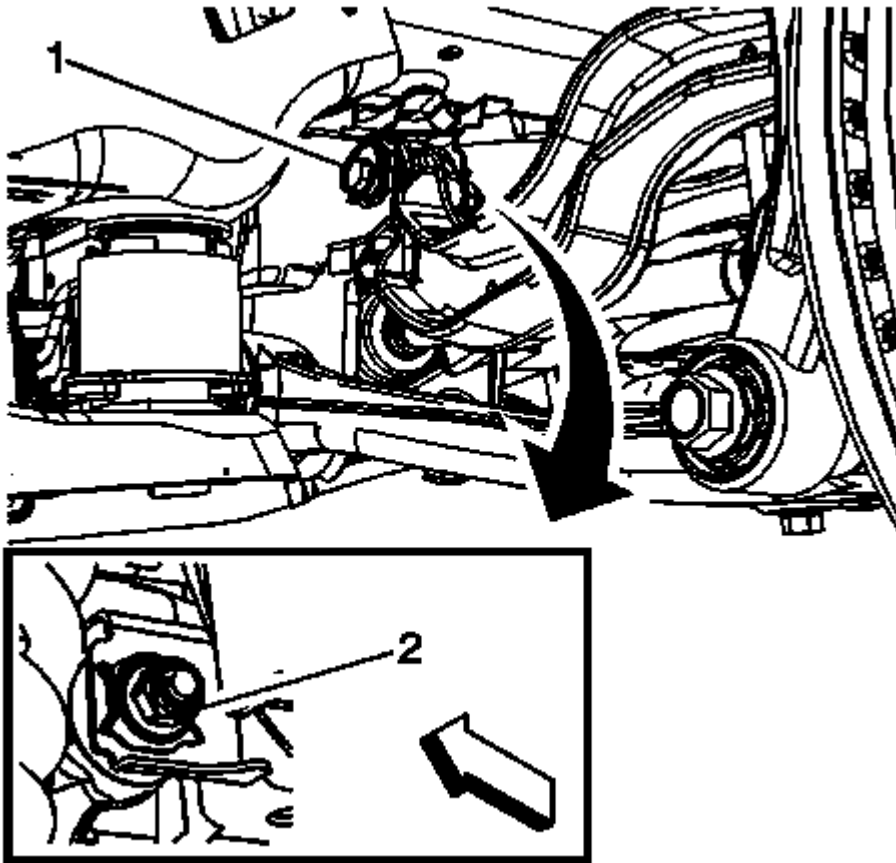


Fig. 7: Rear Suspension Upper Control Arm Nut
Courtesy of GENERAL MOTORS COMPANY

1. Loosen the rear upper control arm bolt (1).
2. Rotate the rear upper control arm bolt (1) until the proper camber setting is achieved. Refer to **Wheel Alignment Specifications**
3. Verify the rear camber specifications and adjust as necessary.

CAUTION: Refer to Fastener Caution

4. Tighten the rear suspension lower control arm nut (2) to 150 N.m (111 lb ft).

REAR TOE ADJUSTMENT (GNC)

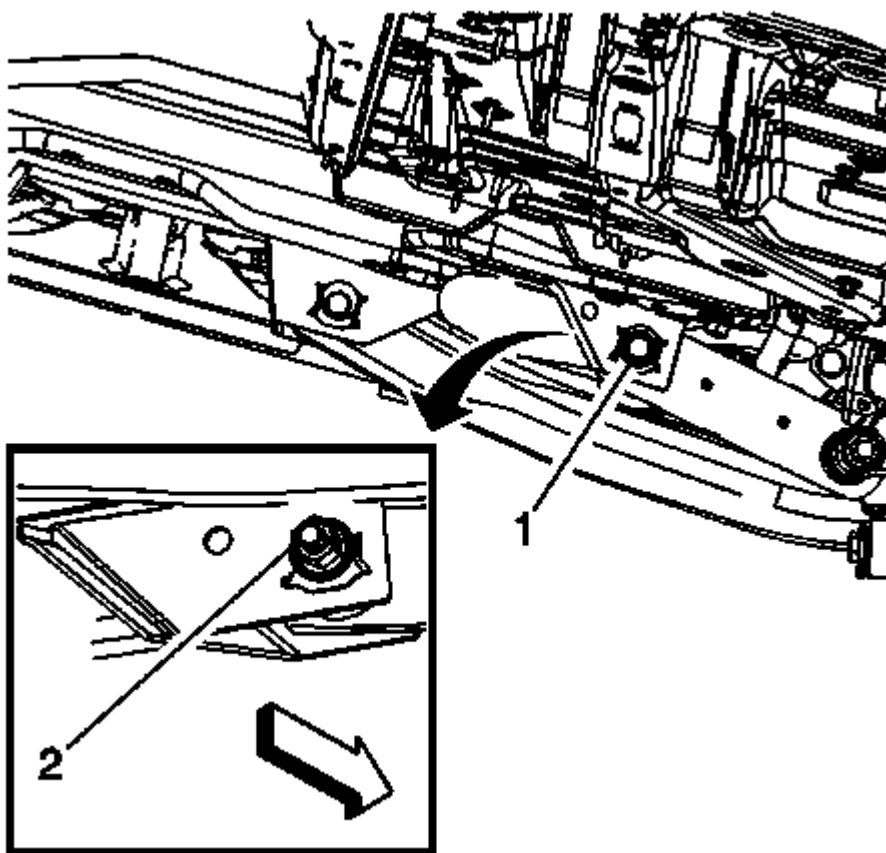


Fig. 8: Control Arm Bolt

Courtesy of GENERAL MOTORS COMPANY

1. Verify the alignment on an alignment rack. Refer to **Wheel Alignment Measurement**.

CAUTION: This bolt is designed to permanently stretch when tightened, and therefore **MUST** be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the components may be damaged.

2. Remove and discard the control arm bolt (1). DO NOT re-use, replace with NEW only.
3. Install the NEW control arm bolt (1).
4. Rotate the rear suspension link inner nut (2) in order to adjust the toe angle. Refer to **Wheel Alignment Specifications**

NOTE: Do not tighten the NEW bolts. Leave the NEW bolts loose to allow for adjustment

5. Hand tighten the rear suspension link inner nut (2), but do not tighten the nut (2) to the specification yet

6. Verify the rear toe angle and adjust as necessary

CAUTION: Refer to Fastener Caution .

7. Tighten the rear suspension link inner nut (2). **Tighten:** First Pass 90 N.m (66 lb ft). Final Pass plus an additional 60 degrees
8. Lower the vehicle.

REAR TOE ADJUSTMENT (GNE)

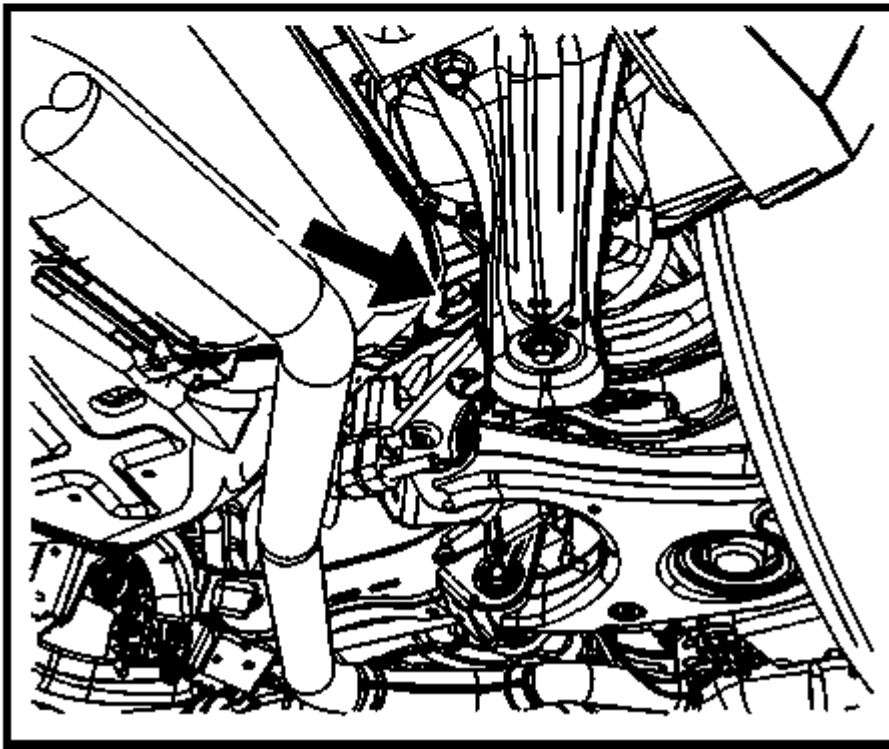
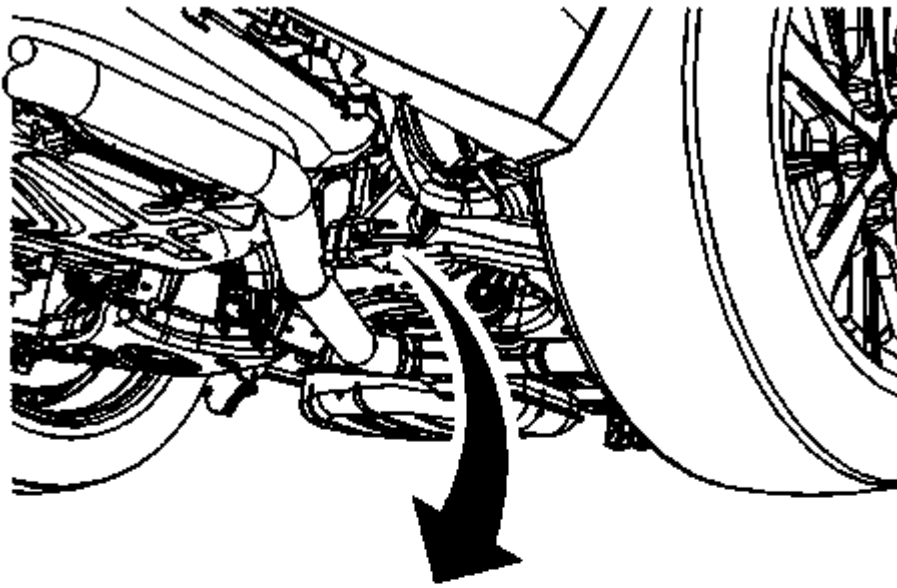


Fig. 9: Rear Toe Angle Adjustment

Courtesy of GENERAL MOTORS COMPANY

1. Measure the alignment on an alignment rack. Refer to **Wheel Alignment Measurement**.
2. If adjustment is necessary, loosen rear cam bolt and nut.
3. Rotate the cam bolt in order to adjust the toe angle. Refer to **Wheel Alignment Specifications**.
4. Hand tighten the cam nut, but do not tighten the nut to the specification yet.

5. Re-inspect the rear toe angle and adjust as necessary.
6. Hold the cam bolt in position and tighten the nut. Tighten to 150 N.m (111 lb ft)
7. Repeat the procedure for the other rear wheel
8. Lower the vehicle.

DESCRIPTION AND OPERATION

CAMBER DESCRIPTION

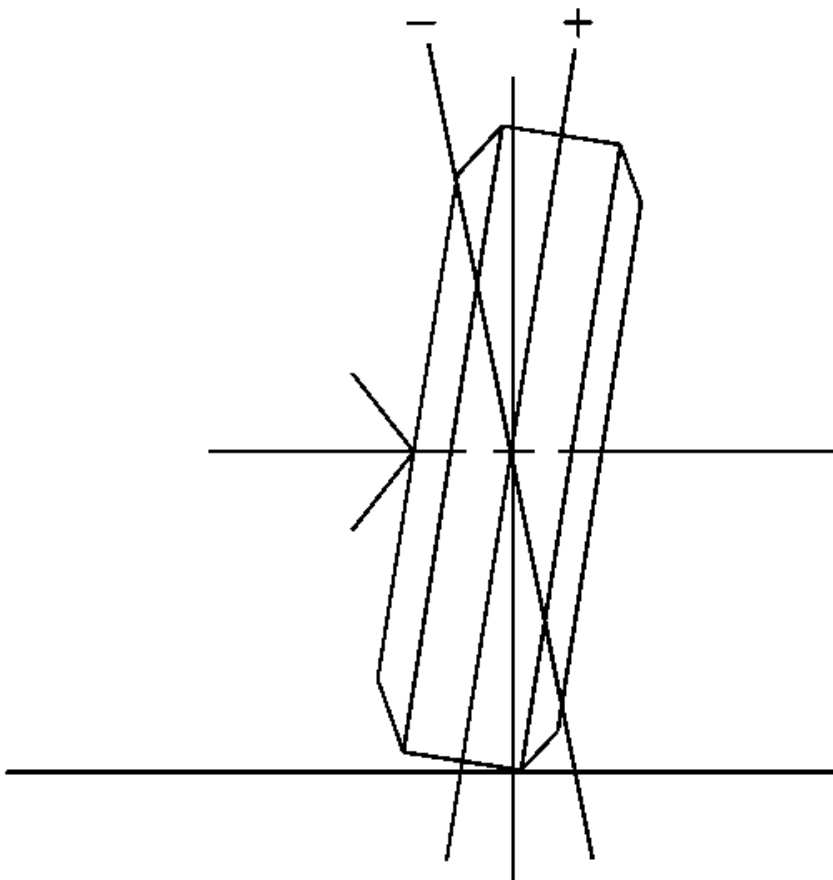


Fig. 10: Illustrating Camber Angle
Courtesy of GENERAL MOTORS COMPANY

Camber is the tilting of the wheels from the vertical when viewed from the front of the vehicle. When the wheels tilt outward at the top, the camber is positive (+). When the wheel tilts inward at the top, the camber is negative (-). The amount of tilt is measured in degrees from the vertical. Camber settings influence the directional control and the tire wear.

- Too much positive camber will result in premature wear on the outside of the tire and cause excessive wear on the suspension parts.
- Too much negative camber will result in premature wear on the inside of the tire and cause excessive wear on the suspension parts.
- Unequal side-to-side camber of 1 degree or more will cause the vehicle to pull or lead to the side with the most positive camber.

CASTER DESCRIPTION

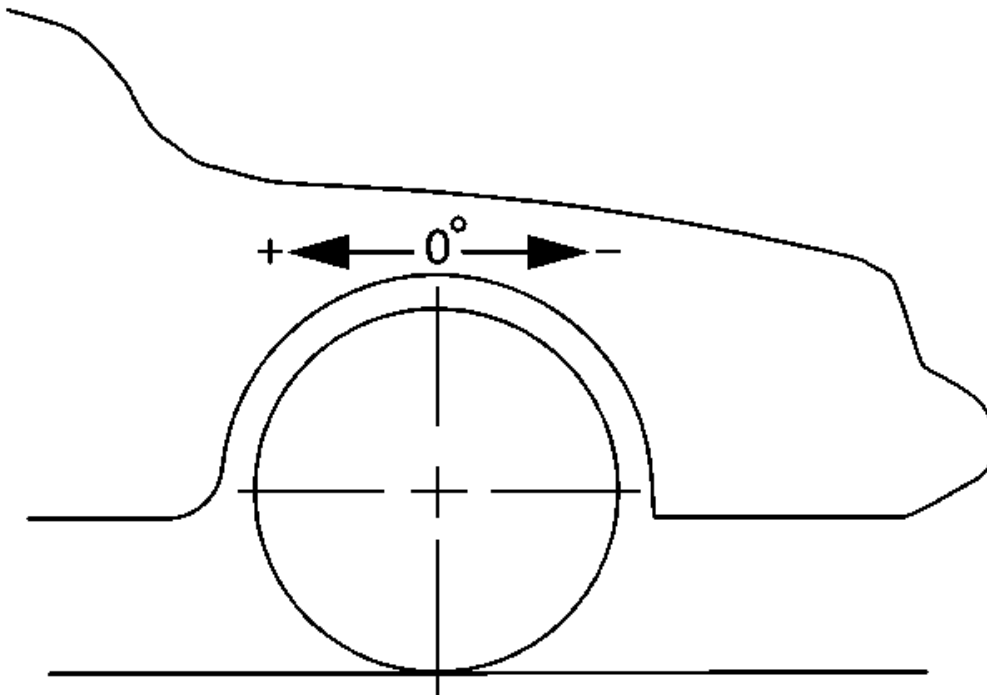


Fig. 11: Illustrating Caster Angle
Courtesy of GENERAL MOTORS COMPANY

Caster is the tilting of the uppermost point of the steering axis either forward or backward, when viewed from the side of the vehicle. A backward tilt is positive (+) and a forward tilt is negative (-). Caster influences directional control of the steering but does not affect the tire wear. Caster is affected by the vehicle height, therefore it is important to keep the body at its designed height. Overloading the vehicle or a weak or sagging rear spring will affect caster. When the rear of the vehicle is lower than its designated trim height, the front

suspension moves to a more positive caster. If the rear of the vehicle is higher than its designated trim height, the front suspension moves to a less positive caster.

With too little positive caster, steering may be touchy at high speed and wheel returnability may be diminished when coming out of a turn. If one wheel has more positive caster than the other, that wheel will pull toward the center of the vehicle. This condition will cause the vehicle to pull or lead to the side with the least amount of positive caster.

LEAD/PULL DESCRIPTION

At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle's straight path.

NOTE: Vehicles will tend to lead/pull in the direction of the road slope as part of normal operation.

Lead/pull is usually caused by the following factors:

- Road slope
- Variability in tire construction
- Wheel alignment (front cross caster and camber)
- Unbalanced steering gear
- Electronic power steering (EPS) steering position and torque sensors not calibrated correctly, if equipped

MEMORY STEER DESCRIPTION

Memory steer is when the vehicle wants to lead or pull in the direction the driver previously turned the vehicle. Additionally, after turning in the opposite direction, the vehicle will want to lead or pull in that direction.

SCRUB RADIUS DESCRIPTION

Ideally, the scrub radius is as small as possible. Normally, the SAI angle and the centerline of the tire and the wheel intersect below the road surface, causing a positive scrub radius. With struts, the SAI angle is much larger than the long arm/short arm type of suspension. This allows the SAI angle to intersect the camber angle above the road surface, forming a negative scrub radius. The smaller the scrub radius, the better the directional stability. Installing aftermarket wheels that have additional offset will dramatically increase the scrub radius. The newly installed wheels may cause the centerline of the tires to move further away from the spindle. This will increase the scrub radius.

A large amount of scrub radius can cause severe shimmy after hitting a bump. Four-wheel drive vehicles with large tires use a steering damper to compensate for an increased scrub radius. Scrub radius is not directly measurable by the conventional methods. Scrub radius is projected geometrically by engineers during the design phase of the suspension.

THRUST ANGLES DESCRIPTION

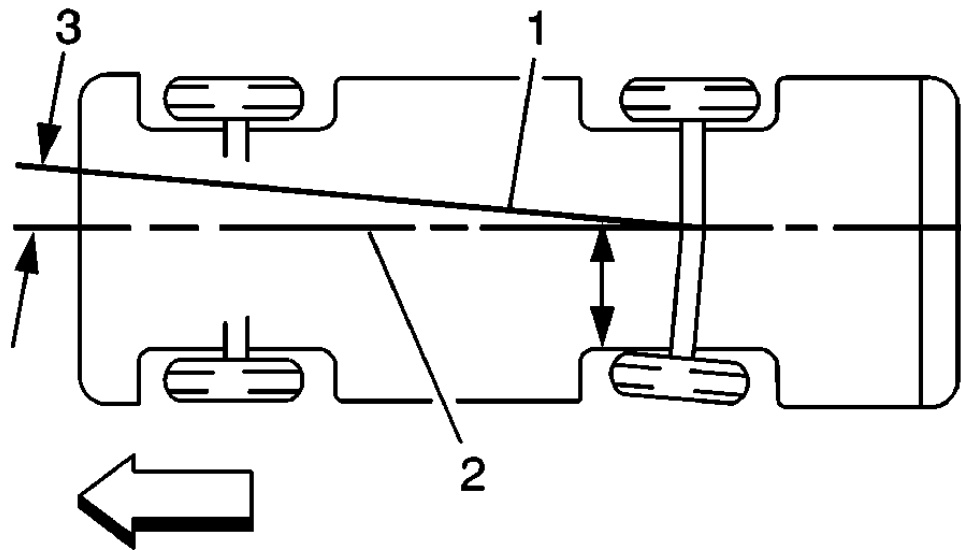


Fig. 12: Illustrating Thrust Angles
Courtesy of GENERAL MOTORS COMPANY

The front wheels aim or steer the vehicle. The rear wheels control tracking. This tracking action relates to the thrust angle (3). The thrust angle is the path that the rear wheels take. Ideally, the thrust angle is geometrically aligned with the body centerline (2).

In the illustration, toe-in is shown on the left rear wheel, moving the thrust line (1) off center. The resulting deviation from the centerline is the thrust angle.

If the thrust angle is not set properly the vehicle may "dog track", the steering wheel may not be centered or it could be perceived as a bent axle. Thrust angle can be checked during a wheel alignment.

Positive thrust angle means the thrust line is pointing to the right hand side (RHS) of the vehicle.

Negative thrust angle means the thrust line is pointing to the left hand side (LHS) of the vehicle.

If the thrust angle is out of specification, moving the axle to body relationship will change the thrust angle

reading.

If the vehicle is out in the Positive (+) direction-moving the RHS forward and/or LHS rearward will move the thrust angle towards zero degrees.

If the vehicle is out in the Negative (-) direction-moving the RHS rearward and/or LHS forward will move the thrust angle towards zero degrees.

TOE DESCRIPTION

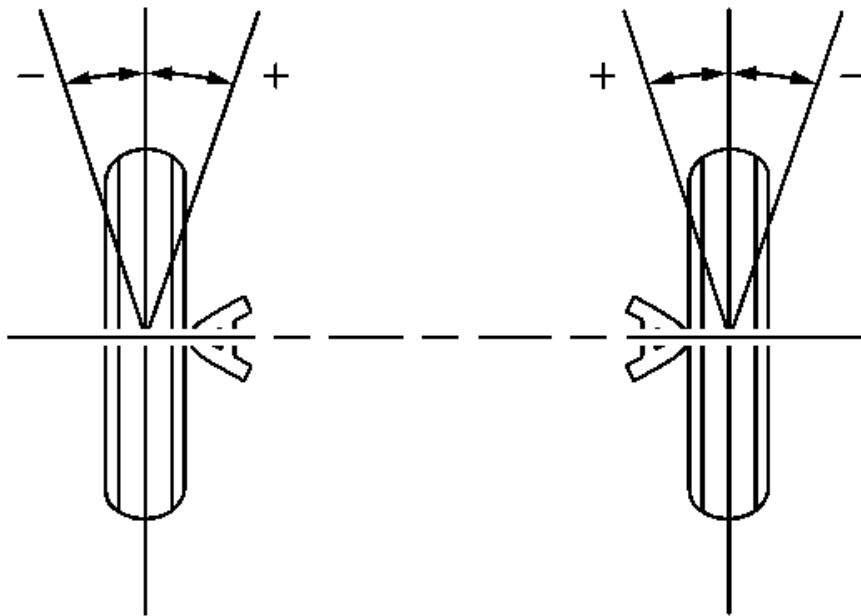


Fig. 13: Illustrating Toe Angle
Courtesy of GENERAL MOTORS COMPANY

Toe is a measurement of how much the front and/or rear wheels are turned in or out from a straight-ahead position. When the wheels are turned in, toe is positive (+). When the wheels are turned out, toe is negative (-). The actual amount of toe is normally only a fraction of a degree. The purpose of toe is to ensure that the wheels roll parallel.

Toe also offsets the small deflections of the wheel support system that occur when the vehicle is rolling forward. In other words, with the vehicle standing still and the wheels set with toe-in, the wheels tend to roll parallel on the road when the vehicle is moving.

Improper toe adjustment will cause premature tire wear and cause steering instability.

TORQUE STEER DESCRIPTION

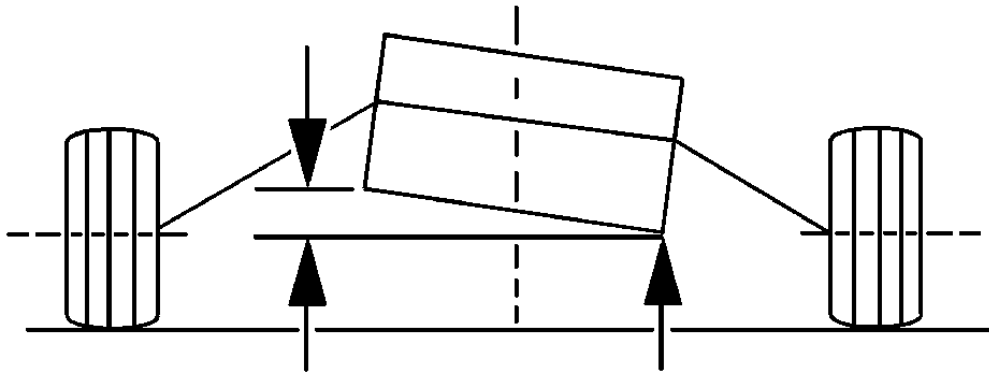


Fig. 14: Identifying Torque Steer
Courtesy of GENERAL MOTORS COMPANY

A vehicle pulls or leads in one direction during hard acceleration. A vehicle pulls or leads in the other direction during deceleration.

The following factors may cause torque steer to be more apparent on a particular vehicle:

- A slightly smaller diameter tire on the right front increases a right torque lead. Inspect the front tires for differences in the brand, the construction, or the size. If the tires appear to be similar, change the front

tires from side-to-side and retest the vehicle. Tire and wheel assemblies have the most significant effect on torque steer correction.

- A large difference in the right and left front tire pressure
- Left-to-right differences in the front view axle angle may cause significant steering pull in a vehicle. The pull will be to the side with the most downward sloping axle from the differential to the wheels. Axles typically slope downward from the differential. The slope of the transaxle pan to level ground may be used as an indication of bias axle angles. The side with the higher transaxle pan (shown on the left side of the illustration) has the most downward sloping axle angle.

WANDER DESCRIPTION

Wander is the undesired drifting or deviation of a vehicle to either side from a straight path with hand pressure on the steering wheel. Wander is a symptom of the vehicle's sensitivity to external disturbances, such as road crown and crosswind, and accentuated by poor on-center steering feel.

Driveline/Axle

Wheel Drive Shafts

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Wheel Drive Shaft Nut		
• First Pass:	150 N.m	111 lb ft
• Second Step:	loosen 45 degrees	
• Final Step:	250 N.m	184 lb ft
Intermediate Shaft Bolt	22 N.m	16 lb ft

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number
Wheel Drive Shaft	Grease	1051344 (Canadian P/N 993037)

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - WHEEL DRIVE SHAFTS

NOTE: Complete the following steps prior to beginning the wheel drive shaft diagnosis.

1. Review the Symptoms - Vibration Diagnosis and Correction .
2. Perform the Vibration Analysis - Road Testing in order to effectively diagnose the concern.
3. Review the system operation in order to become familiar with the system function. Refer to Wheel Drive Shafts Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket equipment and modifications which could affect the operation of the wheel drive shafts or other rotating components.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Thoroughly inspect the entire wheel drive shaft for visible damage, leaking joint seals, and missing seal clamps.

- Inspect the wheel drive shaft seals for cuts, tears, or other damage which may allow the loss of lubricant and the entry of contaminants.

Symptom List

After performing the Visual/Physical Inspection and no visual signs of damage or other interference impairing the wheel drive shaft function is apparent, it may be necessary to remove the wheel drive shaft from the vehicle and manipulate the joints manually. Any binding or otherwise impeded movement of the joints may indicate damage which could contribute to the concern. Refer to the following:

- **Click Noise In Turns**
- **Clunk When Accelerating from Coast**
- **Shudder or Vibration During Acceleration**

CLICK NOISE IN TURNS

A click noise occurring during turns may be caused by a worn or damaged wheel drive shaft outer joint. This may be more apparent while simultaneously turning and accelerating. This click is caused by wear and/or damage to the constant velocity joint bearings and/or races. Commonly, this damage or wear is caused by the loss of lubricating grease from the constant velocity joint and the entry of foreign material or contaminants.

Carefully inspect the wheel drive shaft seals for cuts, tears or other damage which may allow the lubricating grease to escape. The loss of this grease will cause damage to the wheel drive shaft constant velocity joint in a very short period of time.

If inspection reveals no visual evidence of wear or damage, it may be necessary to remove the wheel drive shaft from the vehicle and manipulate the outer joint manually. Any binding or impeded movement of the joint may indicate damage which could contribute to the concern.

CLUNK WHEN ACCELERATING FROM COAST

A clunk noise occurring when accelerating from coast or a standing start may be caused by a worn or damaged wheel drive shaft inner joint. The common cause of wheel drive shaft inner joint damage is the loss of lubricating grease and/or the presence of foreign material and contaminants in the joint. This usually occurs as a result of a torn or damaged inner joint seal.

Carefully inspect the wheel drive shaft seal for cuts, tears or other damage that may allow the loss of the lubricating grease and/or the entry of contaminants.

If inspection reveals no visual evidence of wear or damage, it may be necessary to remove the wheel drive shaft from the vehicle and manipulate the inner joint manually. Do not allow the joint to separate from the wheel drive shaft bar. Any binding or impeded movement of the joint may indicate damage which could contribute to the concern.

SHUDDER OR VIBRATION DURING ACCELERATION

In order to diagnose a shudder or vibration during acceleration, refer to **Symptoms - Vibration Diagnosis and**

Correction .

REPAIR INSTRUCTIONS

FRONT WHEEL DRIVE INTERMEDIATE SHAFT REPLACEMENT (WITH MR6)

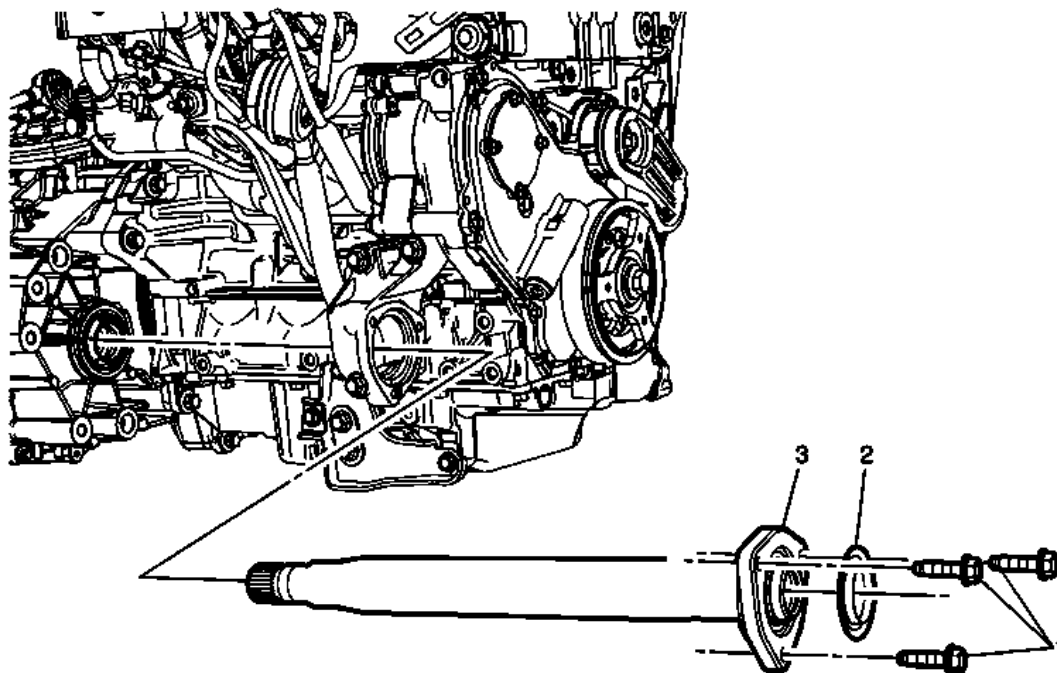


Fig. 1: Front Wheel Drive Intermediate Shaft & Components (with MR6)
Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Intermediate Shaft Replacement (with MR6)

Callout	Component Name
Preliminary Procedure	
Remove the right front wheel drive shaft. Refer to Front Wheel Drive Shaft Replacement - Right Side.	
1	Front Wheel Drive Intermediate Shaft Flange Bolt (Qty: 3) CAUTION: Refer to Fastener Caution Tighten 22 (16 lb ft)
2	Front Wheel Drive Intermediate Shaft Seal
	Front Wheel Drive Intermediate Shaft

CAUTION:

Wheel drive shaft seal protector must be installed into the differential output shaft seal prior to removing and installing the wheel drive shaft. Failure to install the wheel drive shaft seal protector as indicated may cause the splines of the wheel drive shaft to cut the differential output seal.

Procedure

3

1. Separate the intermediate shaft from the differential about 20 mm to allow clearance to install **DT-44394-A** protector , remove intermediate shaft.
2. Insert intermediate shaft through the opening of the seal protector until the splines make engagement to the differential. Remove seal protector.
3. Install Intermediate Shaft Flange bolts (1).
4. Refill transmission fluid, refer to **Transmission Fluid Drain and Fill** .

NOTE:

If servicing the wheel drive shaft, the DT-44394-A can remain in place until after the wheel drive shaft has been serviced.

Special Tools

DT-44394-A Seal Protector

For regional equivalent tools, refer to **Special Tools**.

FRONT WHEEL DRIVE INTERMEDIATE SHAFT REPLACEMENT (WITH MHH, MHK OR MDK)

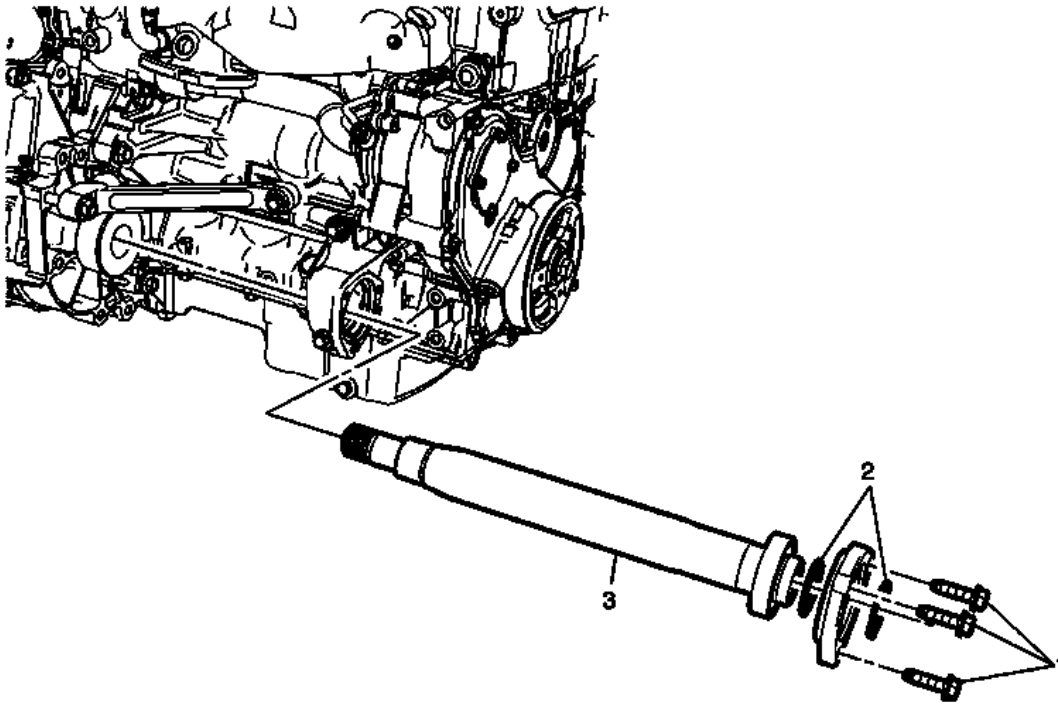


Fig. 2: Front Wheel Drive Intermediate Shaft & Components (with MHH, MHK or MDK)
 Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)

Callout	Component Name
Preliminary Procedure	
Remove the right front wheel drive shaft. Refer to Front Wheel Drive Shaft Replacement - Right Side .	
1	<p>Front Wheel Drive Intermediate Shaft Flange Bolt (Qty: 3)</p> <p>CAUTION: Refer to Fastener Caution</p> <p>Tighten 22 (16 lb ft)</p>
2	Retaining Ring (Qty: 2)
	<p>Front Wheel Drive Intermediate Shaft</p> <p>CAUTION: Wheel drive shaft seal protector must be installed into the differential output shaft seal prior to removing and installing the wheel drive shaft. Failure to install the wheel drive shaft seal protector as indicated may cause the splines of the wheel drive shaft to cut the differential output seal.</p> <p>Procedure</p>

3

1. Separate the intermediate shaft from the differential about 20 mm to allow clearance to install **DT-44394-A** protector , remove intermediate shaft.
2. Insert intermediate shaft through the opening of the seal protector until the splines make engagement to the differential. Remove seal protector.
3. Install Intermediate Shaft Flange bolts (1).
4. Refill transmission fluid.
 - For MHH and MHK transmission, refer to **Transmission Fluid Drain and Fill** , or **Transmission Fluid Level and Condition Check** .
 - For M7W transmission, refer to **TRANSMISSION FLUID DRAIN AND FILL** or **TRANSMISSION FLUID LEVEL AND CONDITION CHECK** .

NOTE:

If servicing the wheel drive shaft, the DT-44394-A can remain in place until after the wheel drive shaft has been serviced.

Special Tools

DT-44394-A Seal Protector

For regional equivalent tools, refer to **Special Tools**.

FRONT WHEEL DRIVE INTERMEDIATE SHAFT BRACKET REPLACEMENT (LUK)

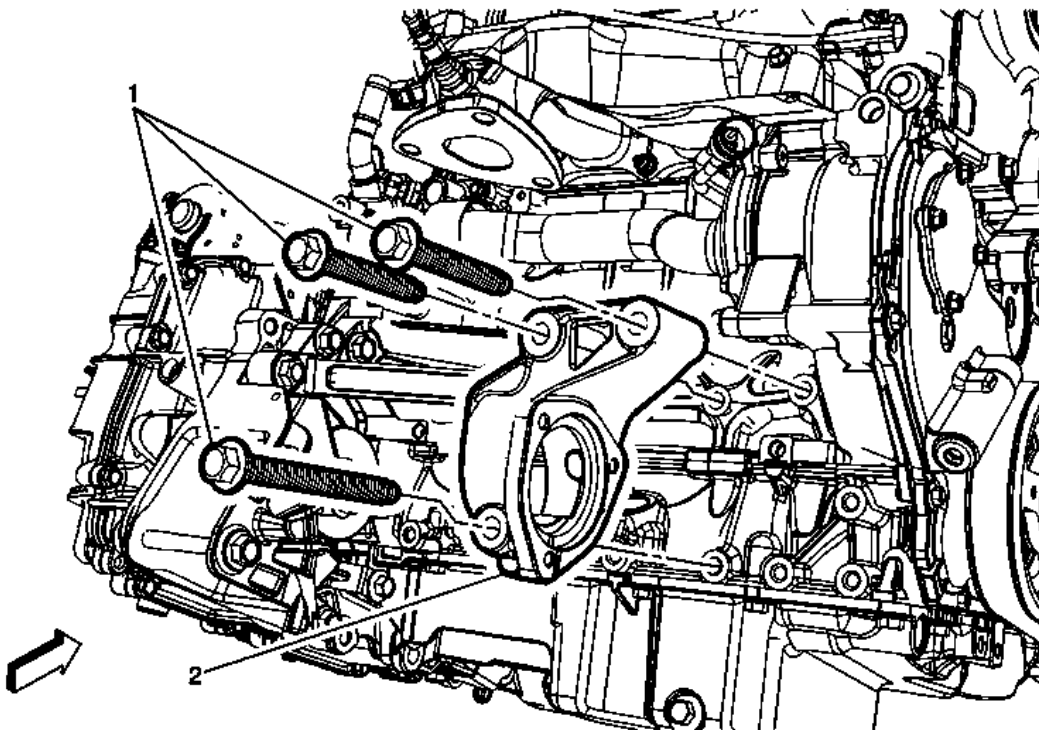


Fig. 3: Front Wheel Drive Intermediate Shaft Bracket & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Intermediate Shaft Bracket Replacement (LUK)

Callout	Component Name
Preliminary Procedure Remove the front wheel drive intermediate shaft. Refer to <u>Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)</u> .	
1	Front Wheel Drive Intermediate Shaft Bracket Bolts (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
2	Front Wheel Drive Intermediate Shaft Bracket

FRONT WHEEL DRIVE INTERMEDIATE SHAFT BRACKET REPLACEMENT (LTG)

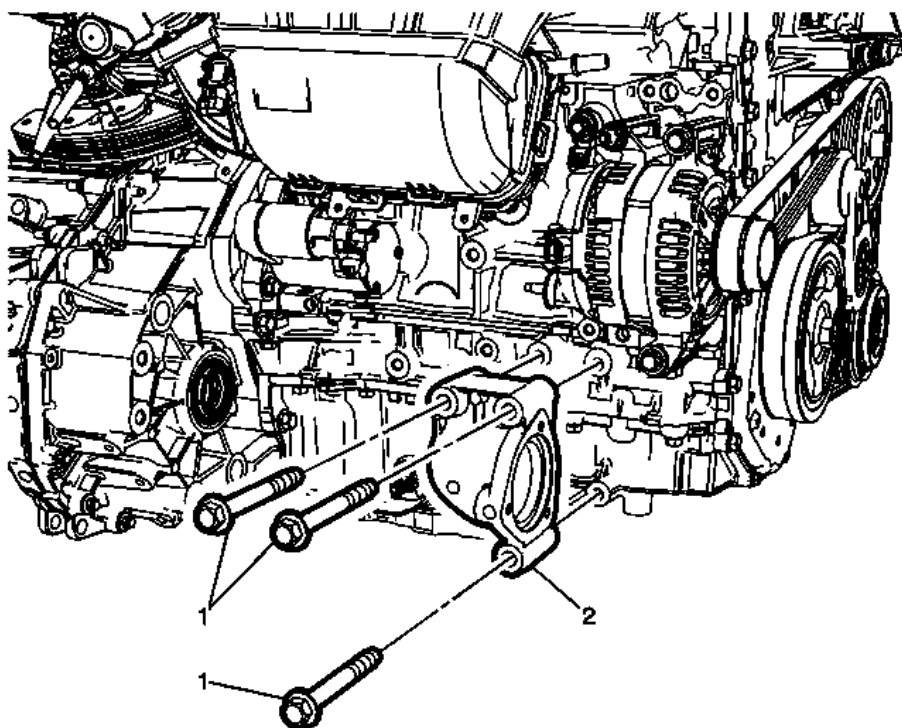


Fig. 4: Front Wheel Drive Intermediate Shaft Bracket (LTG)

Courtesy of GENERAL MOTORS COMPANY

Front Wheel Drive Intermediate Shaft Bracket Replacement (LTG)

Callout	Component Name
Preliminary Procedure Remove the intermediate shaft. Refer to <u>Front Wheel Drive Intermediate Shaft Replacement (with MR6)</u> , <u>Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)</u> .	

1	Intermediate Shaft Bracket Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
2	Intermediate Shaft Bracket

FRONT WHEEL DRIVE SHAFT REPLACEMENT - LEFT SIDE

Special Tools

- **DT-44394-A** Seal Protector
- **J-45859** Axle Remover

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

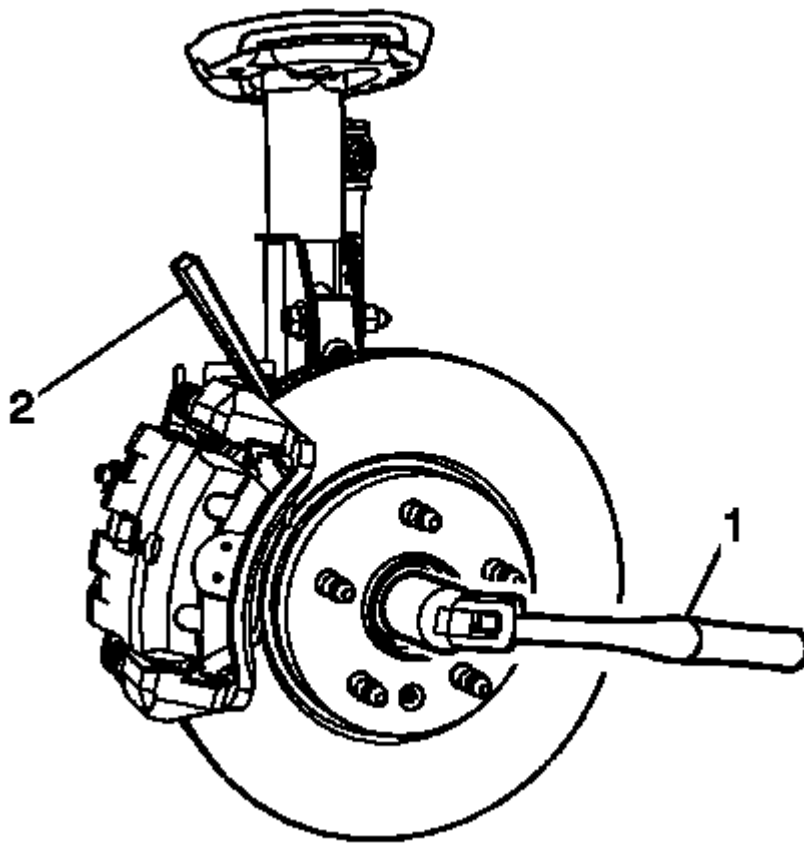


Fig. 5: Loosening/Tightening Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

3. Insert a drift or punch (2) in the cooling fins of the brake rotor.
4. Rotate the brake rotor until the drift or punch contacts the brake caliper mounting bracket.
5. Using a breaker bar (1), loosen the wheel drive shaft nut.

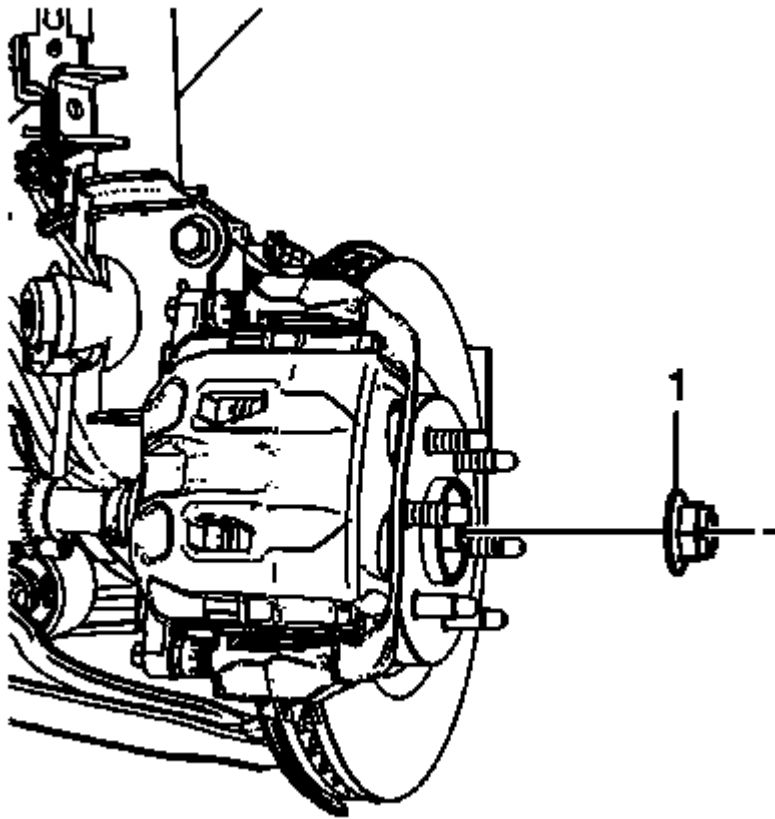


Fig. 6: Wheel Drive Shaft Nut

Courtesy of GENERAL MOTORS COMPANY

6. Remove the wheel drive shaft nut (1).

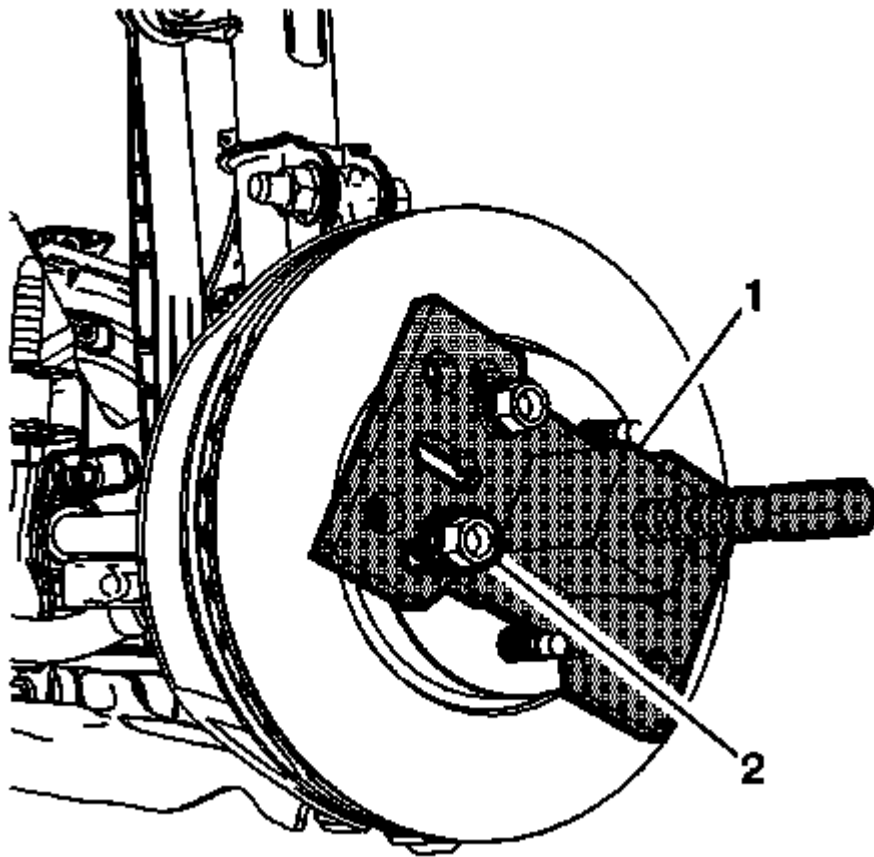


Fig. 7: Wheel Lug Nuts & Remover
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the lug nuts (2) in reverse with washers, so the flat part of the wheel nuts are facing the washers.

7. Using **J-45859** Axle Remover (1) , separate the wheel drive shaft from the knuckle.
8. Remove the lower control arm from the knuckle. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
9. Remove the outer tie rod end from the knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .

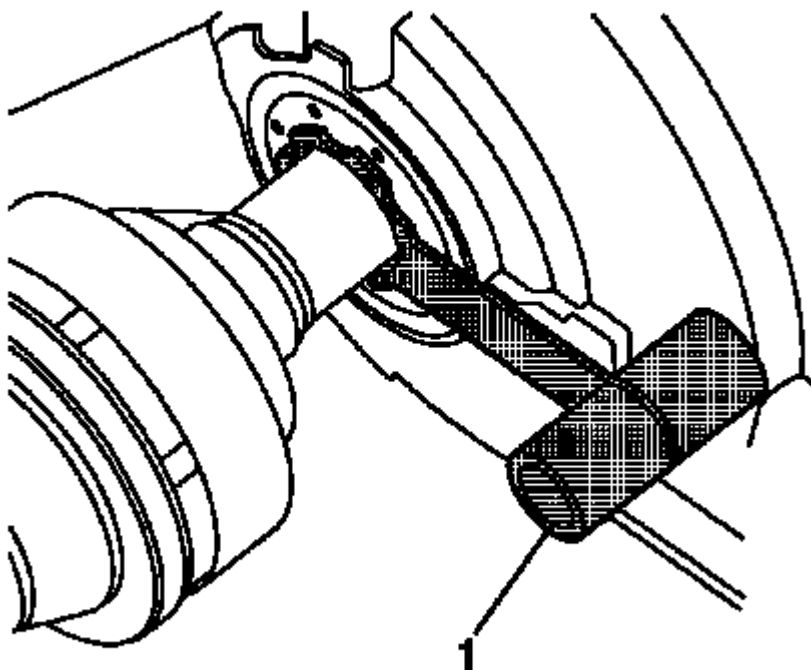


Fig. 8: Protector Tool

Courtesy of GENERAL MOTORS COMPANY

NOTE: May have to slide wheel drive shaft out board just enough to gain access to install seal protector.

10. Carefully install the **DT-44394-A** protector (1) over the front wheel drive shaft and slide into the transmission.

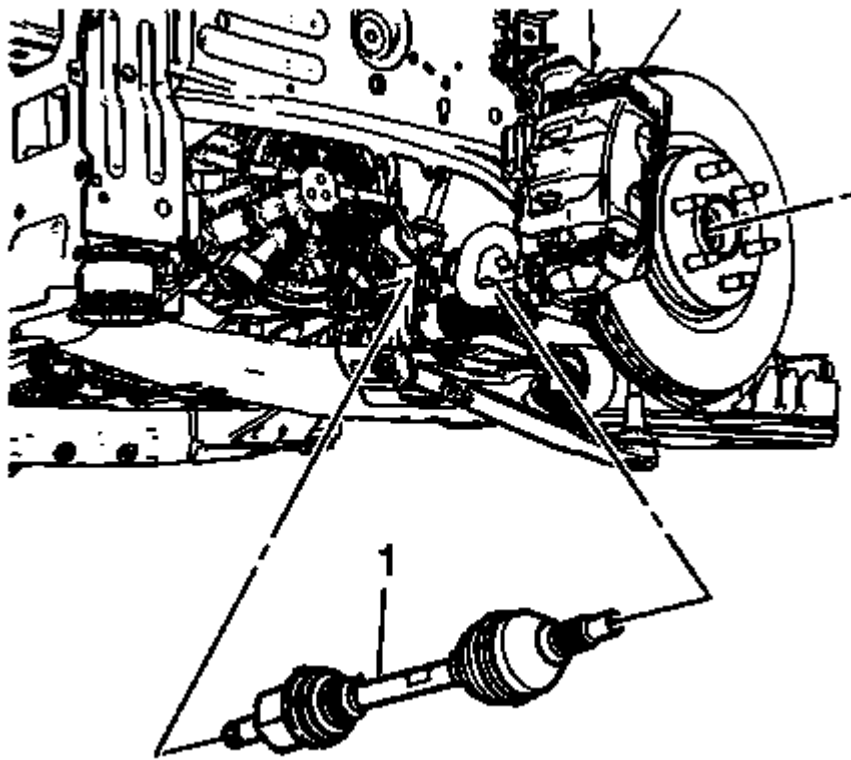


Fig. 9: Wheel Drive Shaft

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- It may be necessary to have an assistant hold the knuckle assembly while removing the wheel drive shaft.
- If removing the wheel drive shaft to service other suspension or driveline components, use care when removing or installing the wheel drive shaft so as not to damage the wheel drive shaft boots

11. Using an appropriate tool, remove the wheel drive shaft (1) from the vehicle.

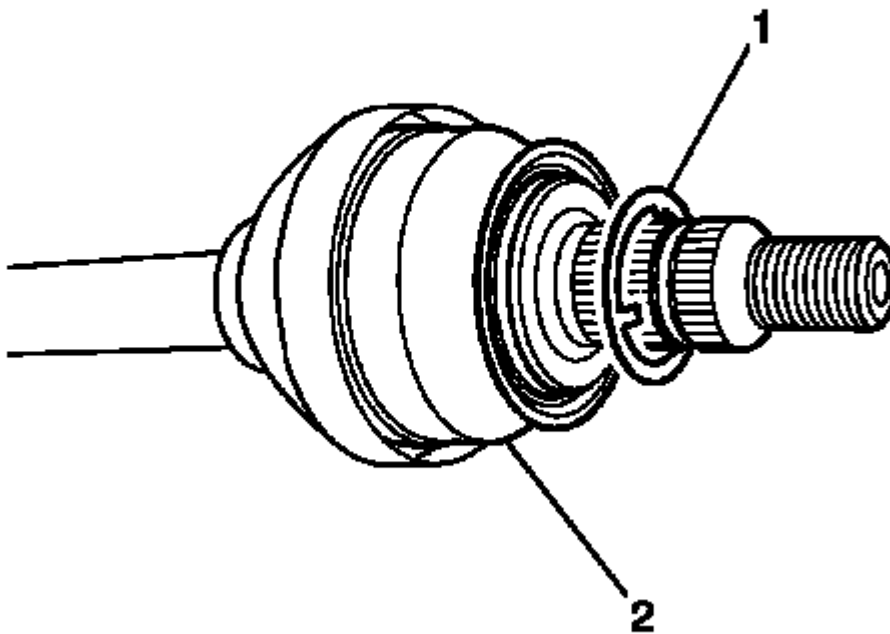


Fig. 10: Wheel Drive Shaft And Washer
Courtesy of GENERAL MOTORS COMPANY

NOTE: If there is no washer on the wheel drive shaft, install a NEW washer.

12. Remove and discard the washer (1) from the wheel drive shaft (2). DO NOT re-use the washer, replace with NEW only.

Installation Procedure

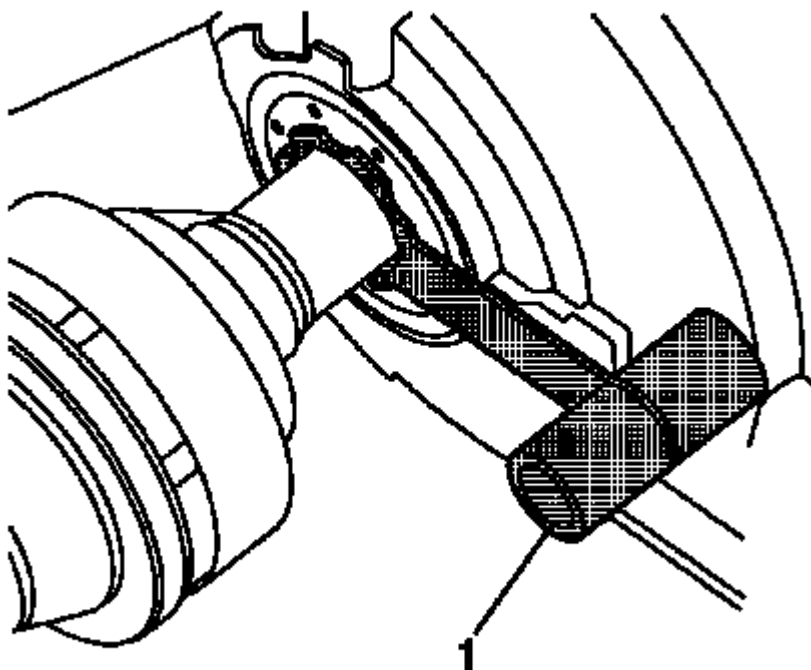


Fig. 11: Protector Tool

Courtesy of GENERAL MOTORS COMPANY

1. Insert the **DT-44394-A** protector (1) into the transmission.

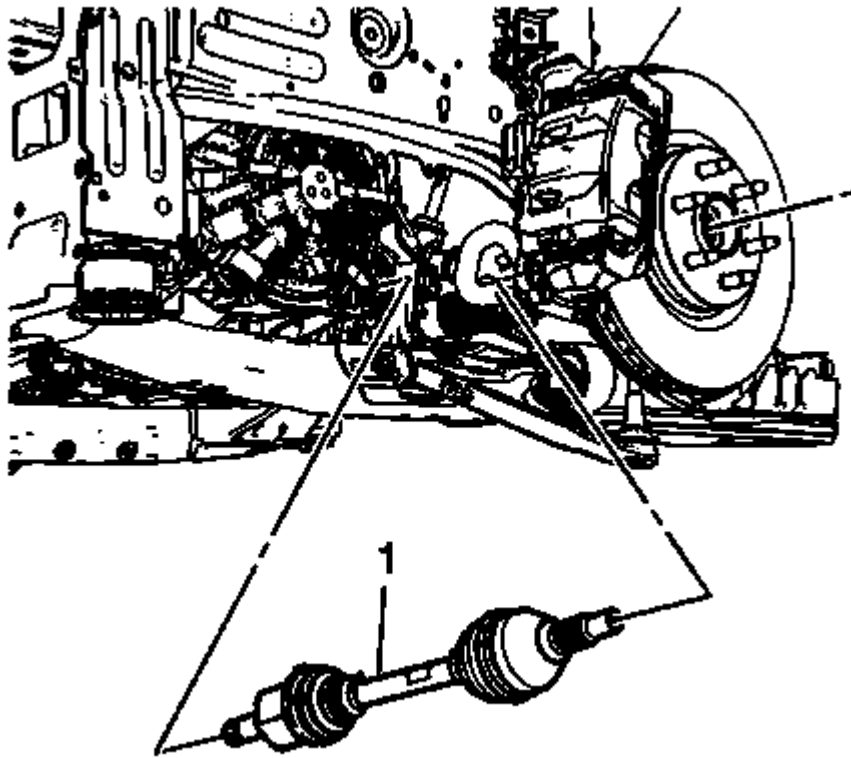


Fig. 12: Wheel Drive Shaft

Courtesy of GENERAL MOTORS COMPANY

2. Position the wheel drive shaft (1) in the vehicle.
3. Remove the **DT-44394-A** protector from the oil seal.
4. Insert the wheel drive shaft in the knuckle.
5. Install the lower control arm in the knuckle. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
6. Install the outer tie rod end in the knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .

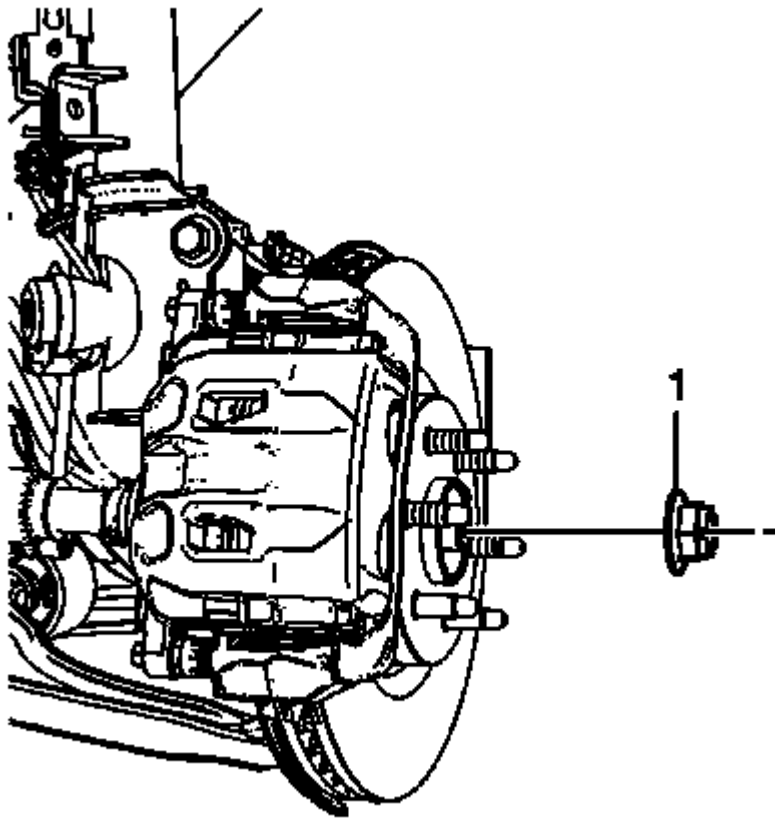


Fig. 13: Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install the wheel drive shaft nut (1).

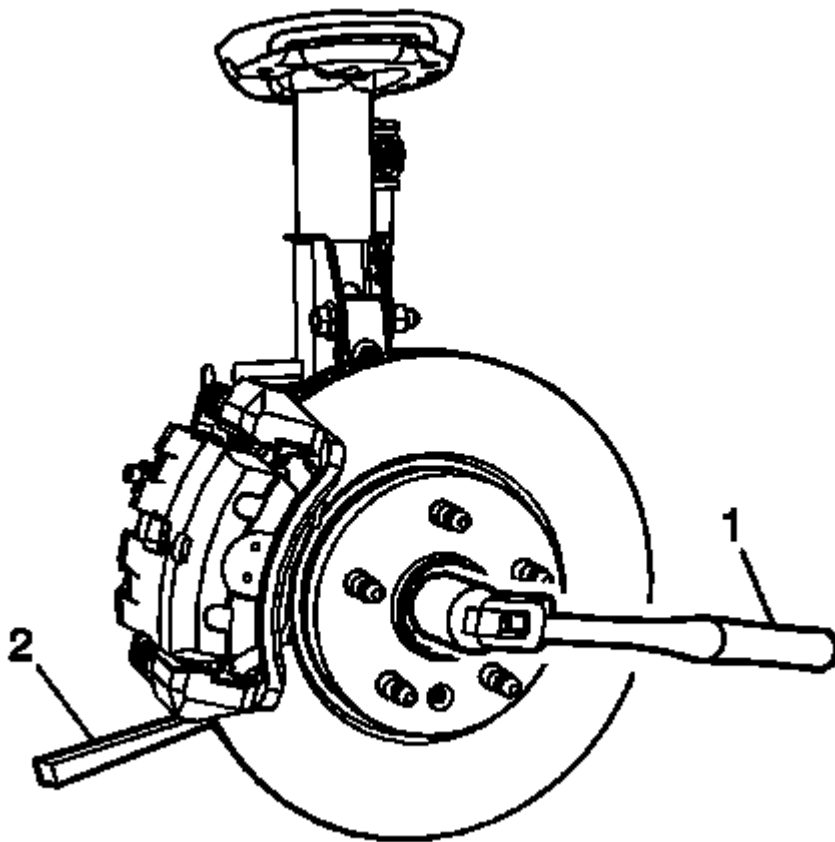


Fig. 14: Tightening Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

8. Insert a drift or punch (2) in the cooling fins of the brake rotor.
9. Rotate the brake rotor until the drift or punch contacts the brake caliper mounting bracket.

CAUTION: Refer to Fastener Caution .

10. Using a torque wrench (1), tighten the wheel drive shaft nut to:
 - First Pass: 150 (111 lb ft)
 - Second Pass: loosen 45 degrees
 - Final Pass: re-tighten to 250 (184 lb ft)
11. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
12. Remove the support and lower the vehicle.

FRONT WHEEL DRIVE SHAFT REPLACEMENT - RIGHT SIDE

Special Tools

- **J-45859** Axle Puller

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

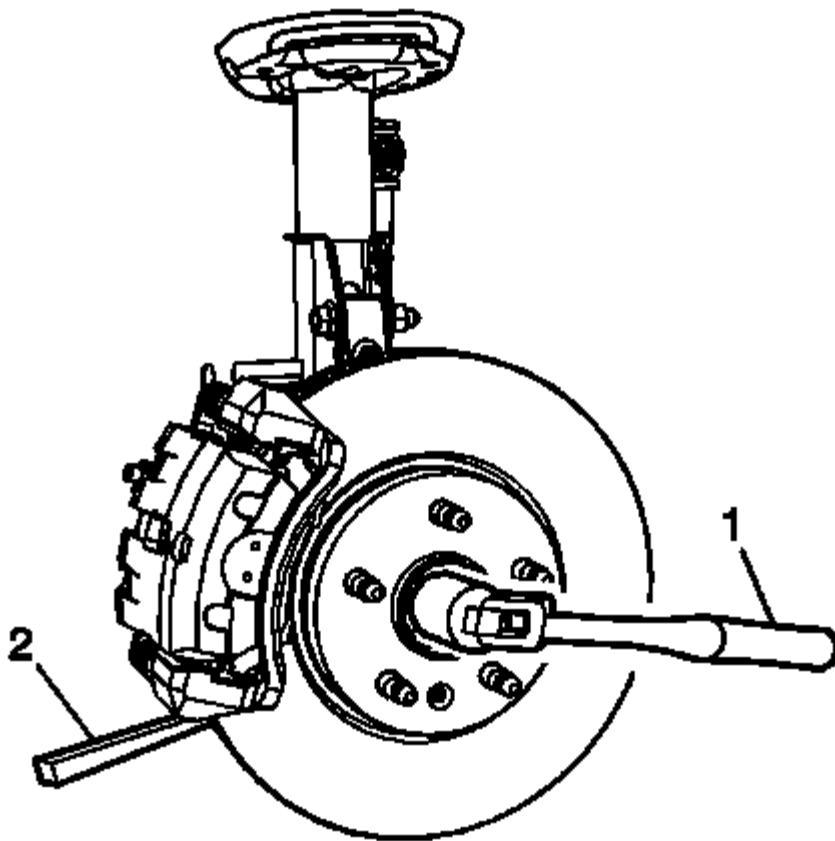


Fig. 15: Tightening Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

3. Insert a drift or punch (2) in the cooling fins of the brake rotor.
4. Rotate the brake rotor until the drift or punch contacts the brake caliper mounting bracket.
5. Using a breaker bar (1), loosen the wheel drive shaft nut.

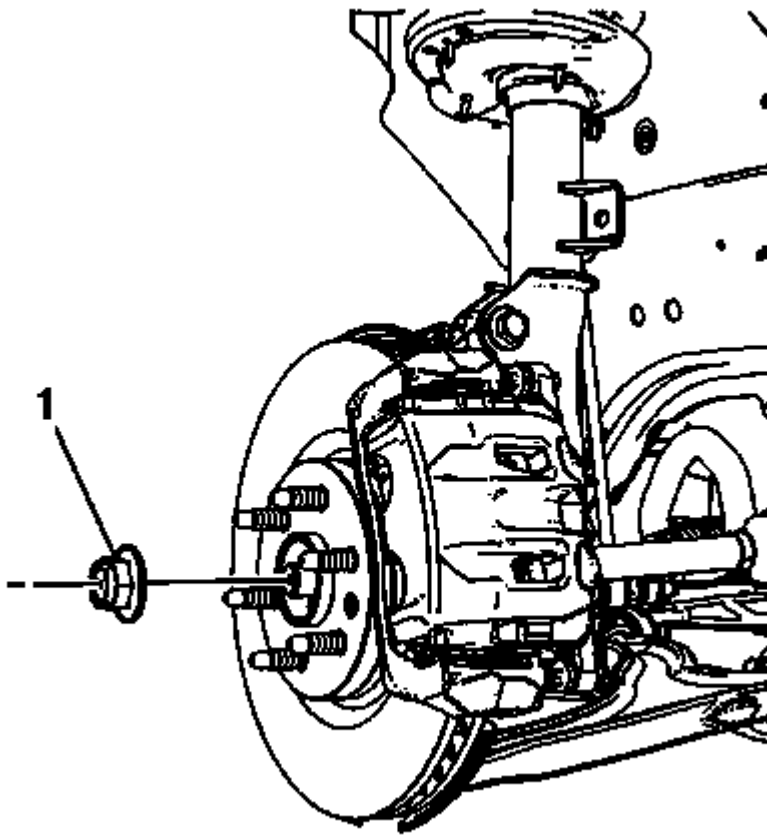


Fig. 16: Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

6. Remove the wheel drive shaft nut (1).
7. Using the **J-45859** puller , separate the wheel drive shaft from the knuckle assembly.
8. Remove the lower control arm from the knuckle. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
9. Remove the outer tie rod end from the knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .

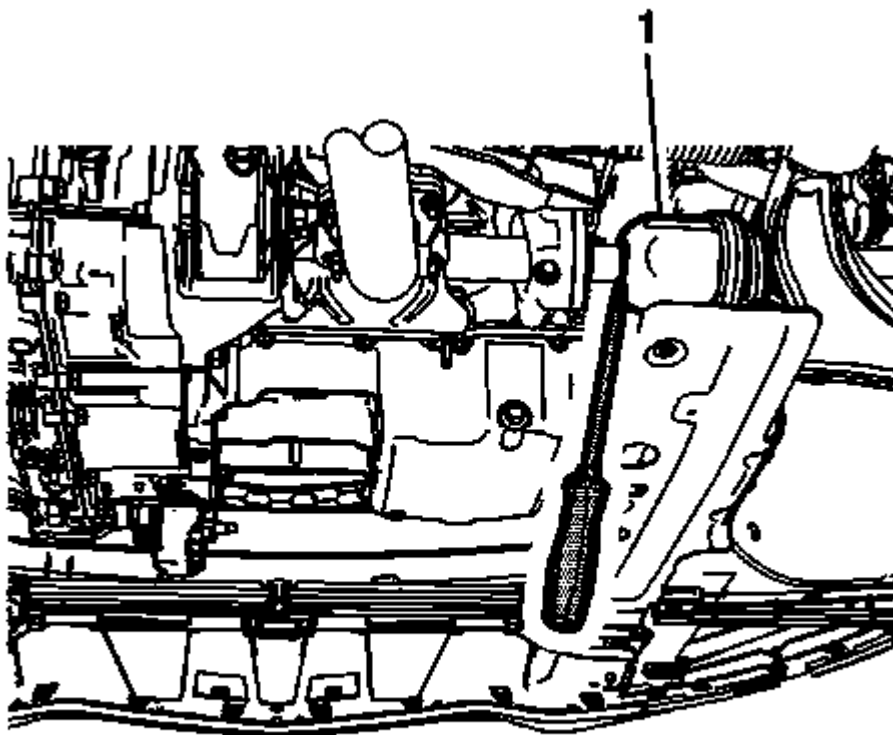


Fig. 17: Knuckle Assembly Puller
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- It may be necessary to have an assistant hold the knuckle assembly while removing the wheel drive shaft.
- If removing the wheel drive shaft to service other suspension or driveline components, use care when removing or installing the wheel drive shaft so as not to damage the wheel drive shaft boots.

10. Using an appropriate tool, remove the wheel drive shaft (1) from the intermediate shaft.

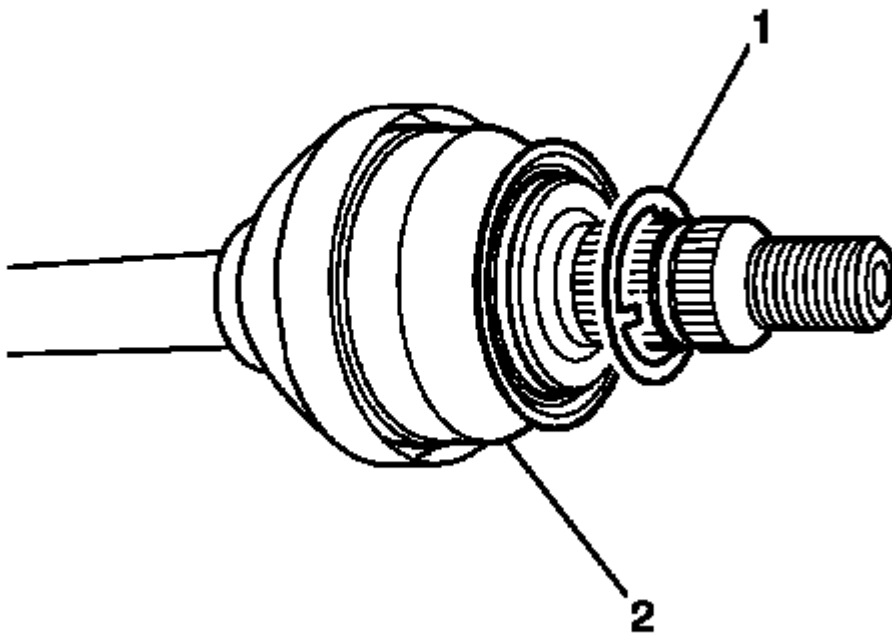


Fig. 18: Wheel Drive Shaft And Washer
Courtesy of GENERAL MOTORS COMPANY

NOTE: If there is no washer on the wheel drive shaft, install a NEW washer.

11. Remove and discard the washer (1) from the wheel drive shaft (2). DO NOT re-use the washer, replace with NEW only.

Installation Procedure

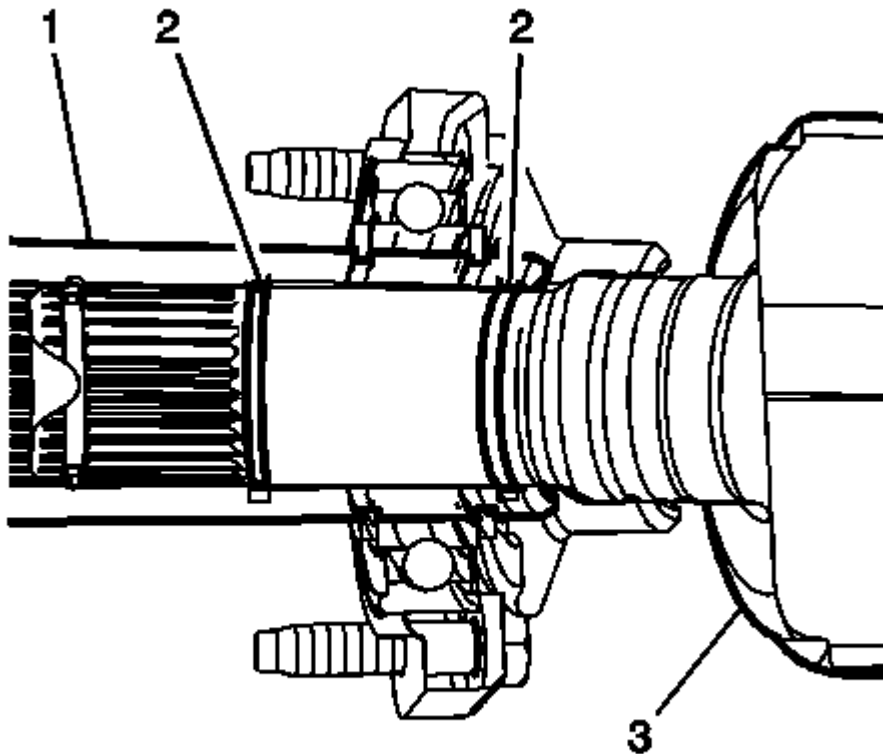


Fig. 19: Intermediate Shaft, Wheel Drive Shaft & O-Rings
Courtesy of GENERAL MOTORS COMPANY

1. If removing or replacing the drive shaft, replace the o-rings (2).
2. Apply a very small amount of grease to the splines of the wheel drive shaft inner joint. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
3. Install the wheel drive shaft (3) into the intermediate shaft (1) until fully seated.

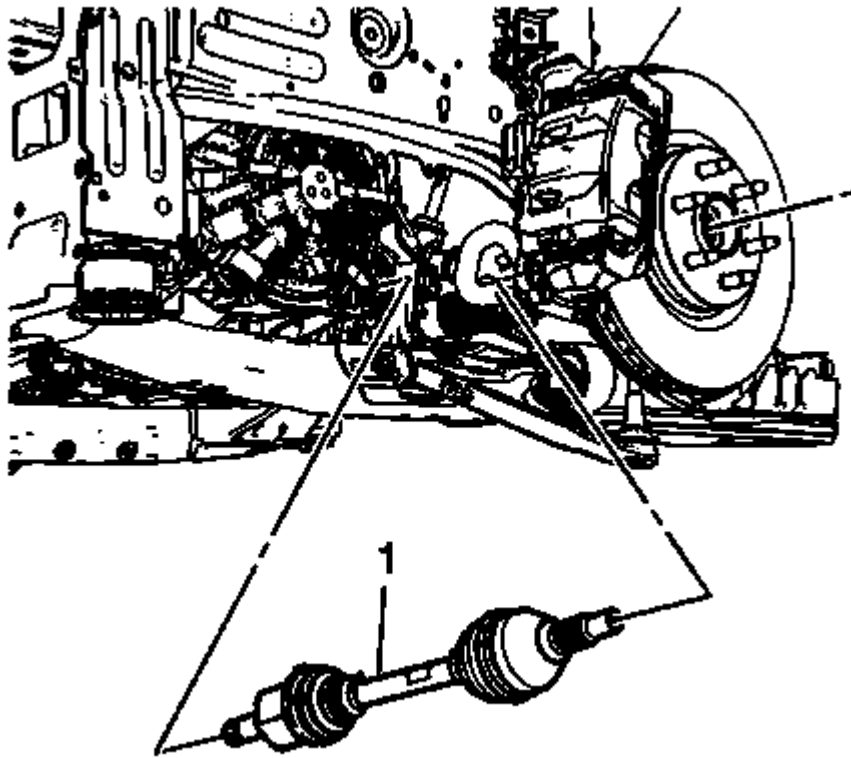


Fig. 20: Wheel Drive Shaft

Courtesy of GENERAL MOTORS COMPANY

4. Insert the wheel drive shaft (1) in the front wheel bearing/hub.
5. Install the lower control arm in the knuckle. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
6. Install the outer tie rod end in the knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .

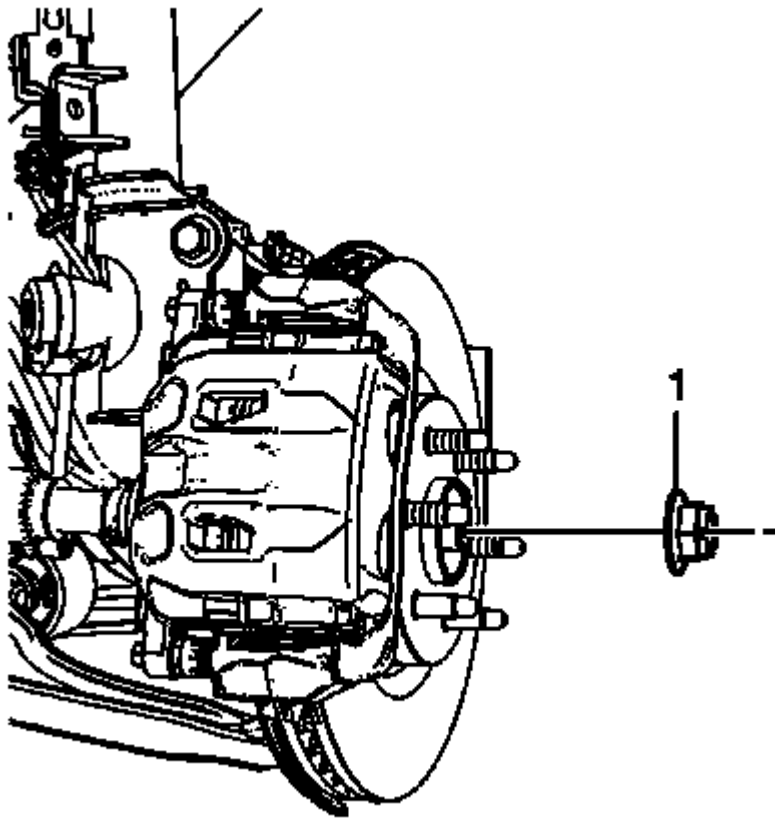


Fig. 21: Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install the wheel drive shaft nut (1).

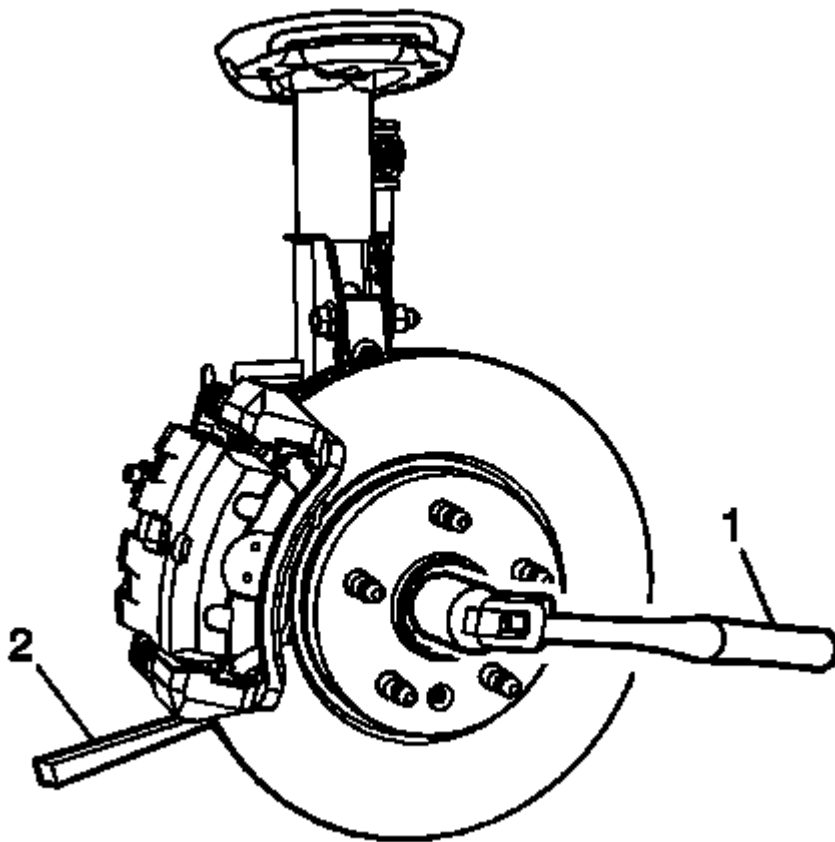


Fig. 22: Tightening Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

8. Insert a drift or punch (2) in the cooling fins of the brake rotor.
9. Rotate the brake rotor until the drift or punch contacts the brake caliper mounting bracket.

CAUTION: Refer to Fastener Caution .

10. Using a torque wrench (1), tighten the wheel drive shaft nut to :
 - First Pass: 150 N.m (111 lb ft)
 - Second Pass: loosen 45 degrees
 - Final Pass: re-tighten to 250 N.m (184 lb ft)
11. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
12. Remove the support and lower the vehicle.

REAR WHEEL DRIVE SHAFT REPLACEMENT

Removal Procedure

Special Tools

- **J-44394-A Seal Protector**

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Have an assistant apply the brakes.

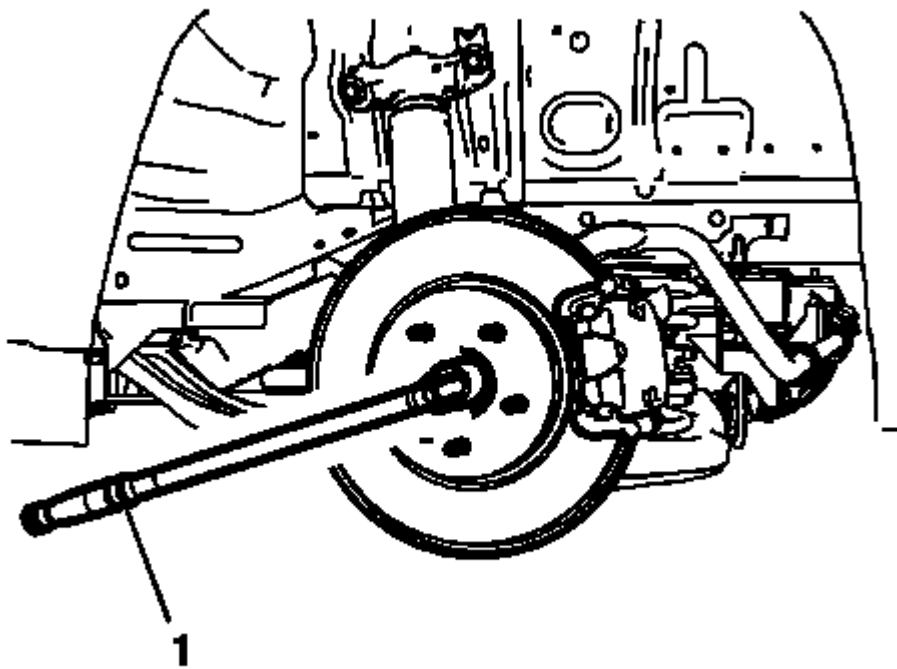


Fig. 23: Loosening Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

4. Using the proper size socket and a breaker bar (1), loosen the wheel drive shaft nut.

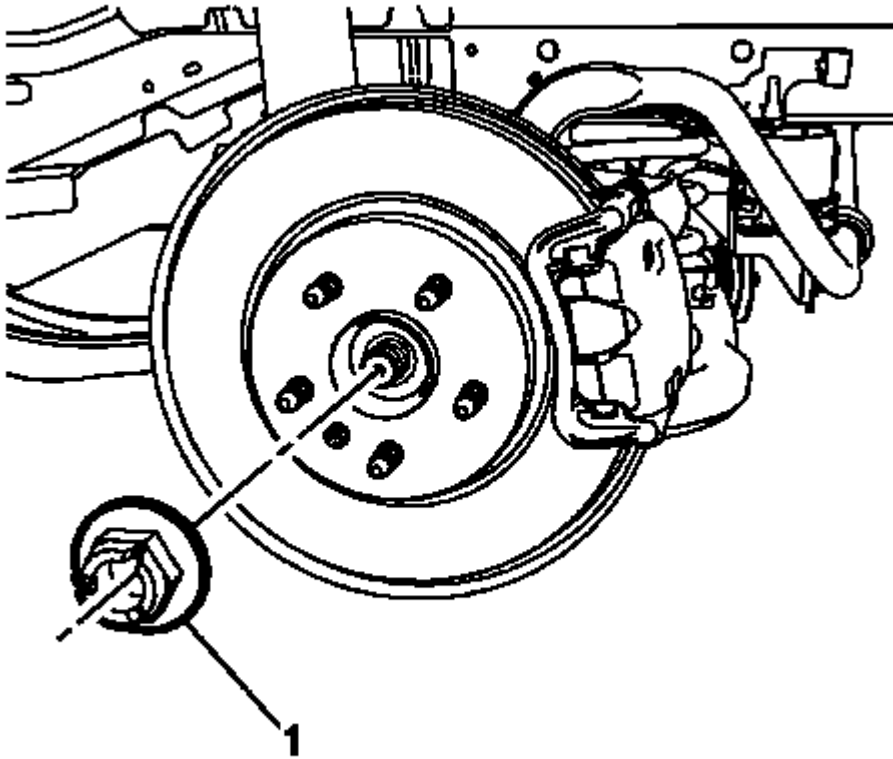


Fig. 24: Wheel Drive Shaft Nut

Courtesy of GENERAL MOTORS COMPANY

5. Remove and discard the wheel drive shaft nut (1). Replace with NEW only.
6. Using the appropriate tool, remove the wheel drive shaft from the rear wheel hub bracket.
7. Remove the rear wheel hub bracket. Refer to **Rear Wheel Hub Bracket Replacement** .

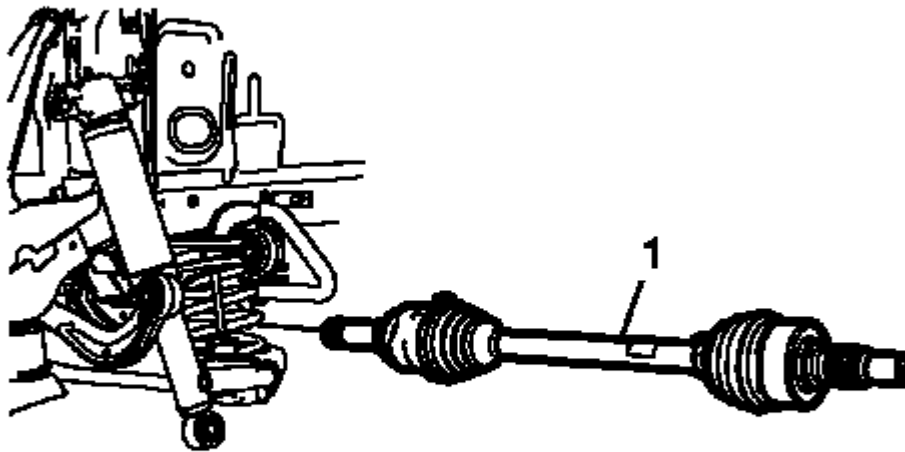


Fig. 25: Wheel Drive Shaft

Courtesy of GENERAL MOTORS COMPANY

CAUTION: J-44394 must be installed into the differential output shaft seal prior to removing and installing the wheel drive shaft. Failure to install J-44394 as indicated may cause the splines of the wheel drive shaft to cut the differential output seal.

8. Remove the wheel drive shaft (1) from the vehicle.

Installation Procedure

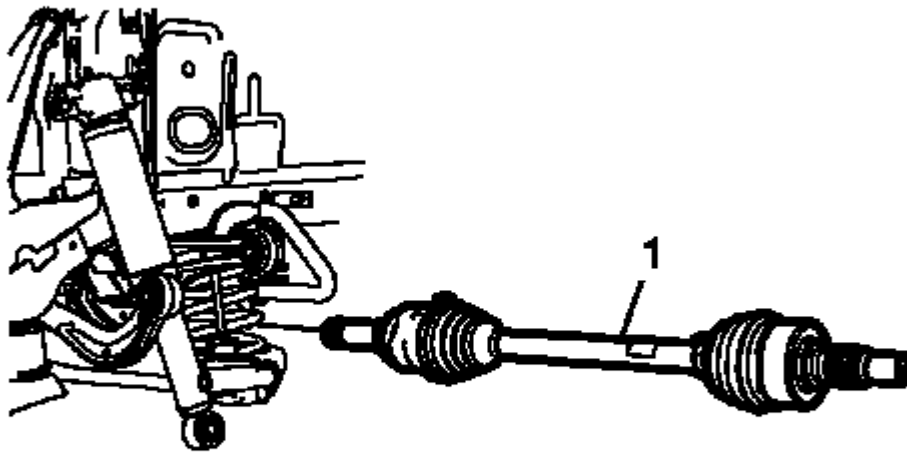


Fig. 26: Wheel Drive Shaft

Courtesy of GENERAL MOTORS COMPANY

CAUTION: J-44394 must be installed into the differential output shaft seal prior to removing and installing the wheel drive shaft. Failure to install J-44394 as indicated may cause the splines of the wheel drive shaft to cut the differential output seal.

NOTE: Apply a small amount of lubricant on the wheel drive shaft splines and the contact area of the axle seal to the wheel drive shaft.

1. Position the wheel drive shaft (1) in the vehicle.
2. Install the rear wheel hub bracket. Refer to **Rear Wheel Hub Bracket Replacement** .

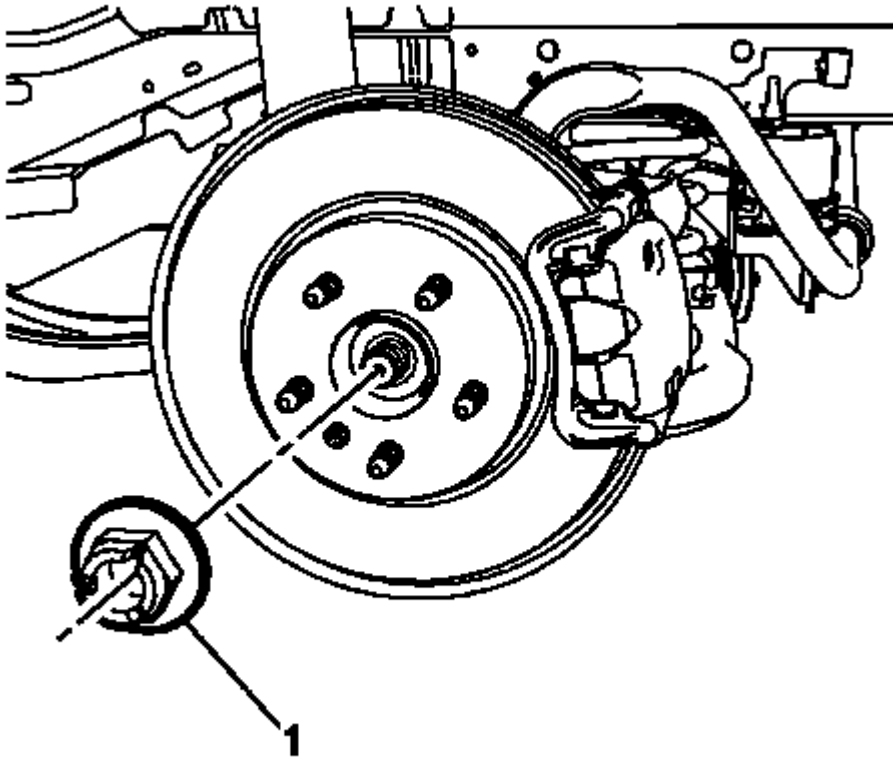


Fig. 27: Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW wheel drive shaft nut (1) .
4. Have an assistant apply the brakes.

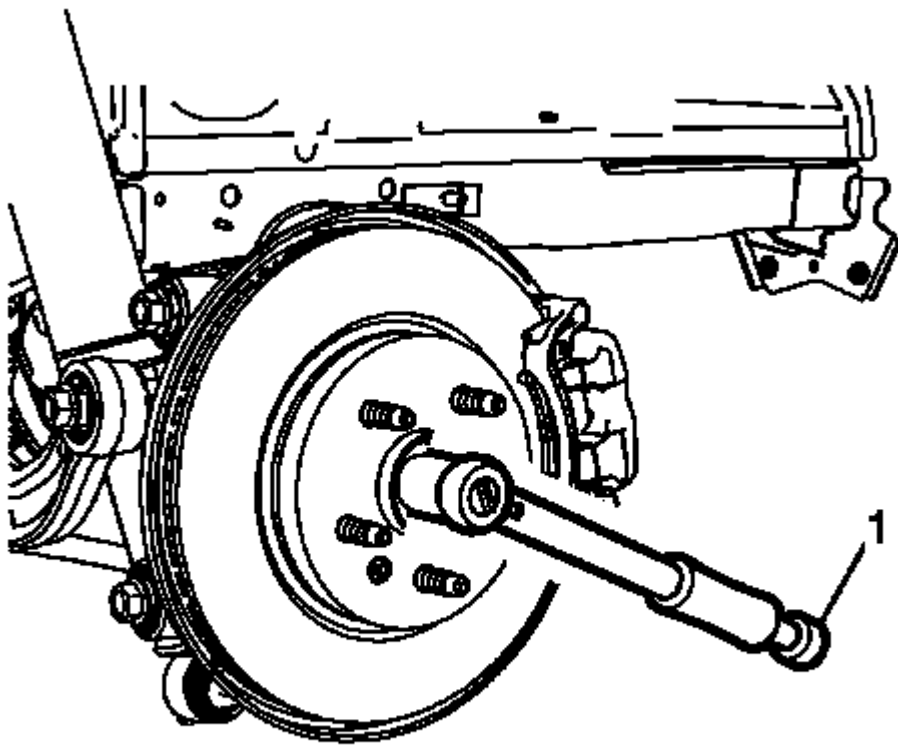


Fig. 28: Tightening Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

5. Using the torque wrench and the proper size socket (1), tighten the wheel drive shaft nut to:

Tighten

- First Pass: 150 (111 lb ft)
 - Second Pass: loosen 45 degrees
 - Final Pass: retighten to 250 (185 lb ft)
6. Check the fluid level of the rear axle. Add fluid if needed. Refer to **Rear Axle Lubricant Level Inspection** .
 7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
 8. Remove the support and lower the vehicle.

FRONT WHEEL DRIVE SHAFT INNER JOINT AND BOOT REPLACEMENT

Special Tools

J 35910 Drive Axle Seal Clamp Pliers

For equivalent regional tools, refer to Special Tools.

NOTE: The tripot assembly and the internal parts for the tripot assembly are not serviceable. If the tripot assembly is found to have excessive wear or damage, replace the wheel drive shaft as an assembly.

Disassemble Procedure

1. Remove the wheel drive shaft from the vehicle. Refer to Front Wheel Drive Shaft Replacement - Left Side, or Front Wheel Drive Shaft Replacement - Right Side.

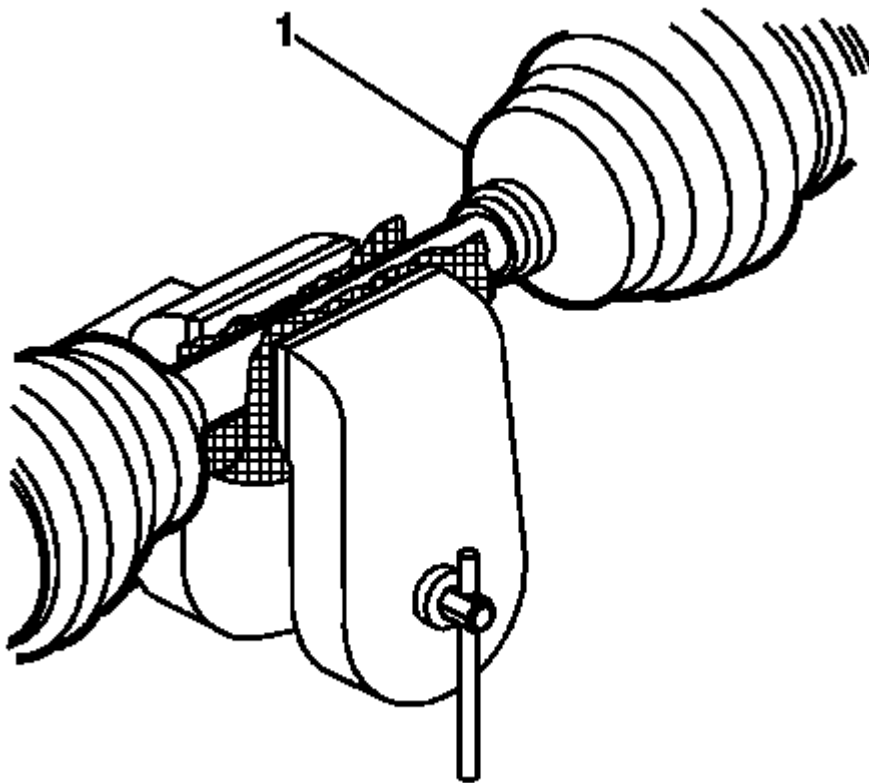


Fig. 29: View Of Front Wheel Drive Shaft Inner Joint
Courtesy of GENERAL MOTORS COMPANY

2. Position the wheel drive shaft in a soft jawed vise and clamp securely.

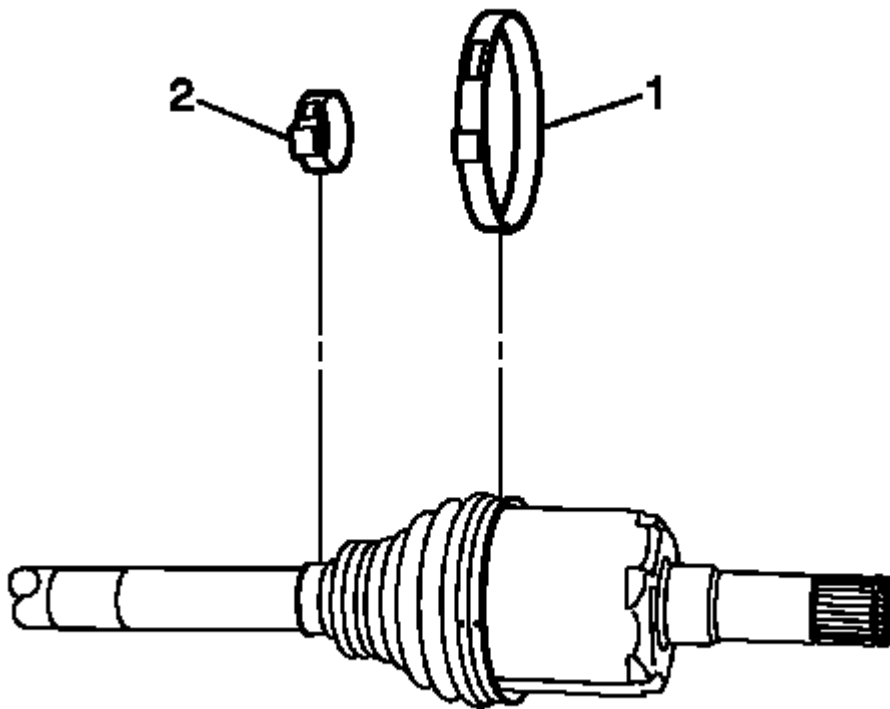


Fig. 30: View Of Boot Retaining Clamps
Courtesy of GENERAL MOTORS COMPANY

3. Using a flat-bladed tool, remove the boot retaining clamp (2).
4. Using side cutters, remove the boot clamp (1).

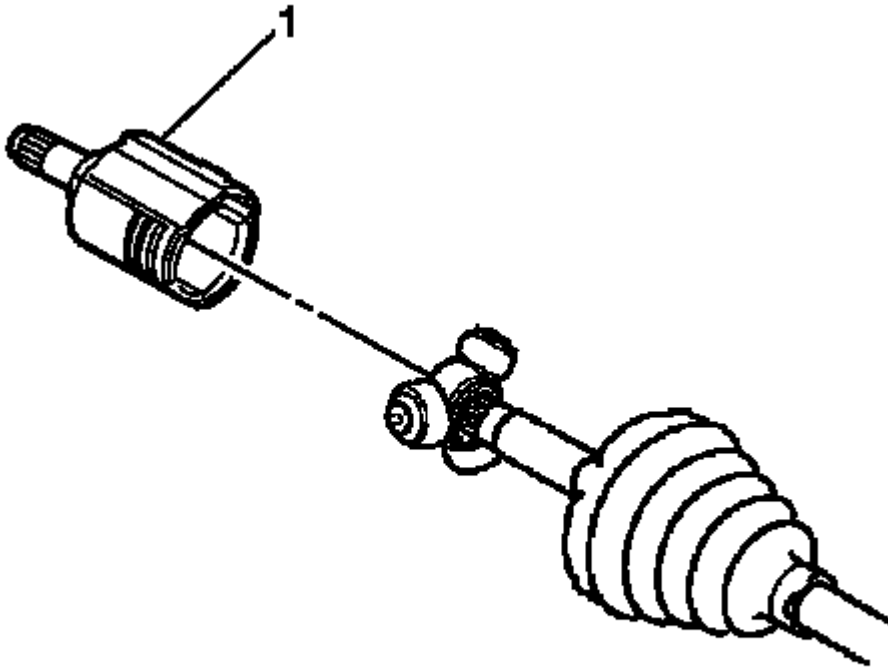


Fig. 31: Tripot Housing

Courtesy of GENERAL MOTORS COMPANY

NOTE: The tripot housing may be staked at the end to prevent removal. The staking will need to be ground down to allow removal.

5. Remove the tripot housing (1) from the wheel drive shaft.

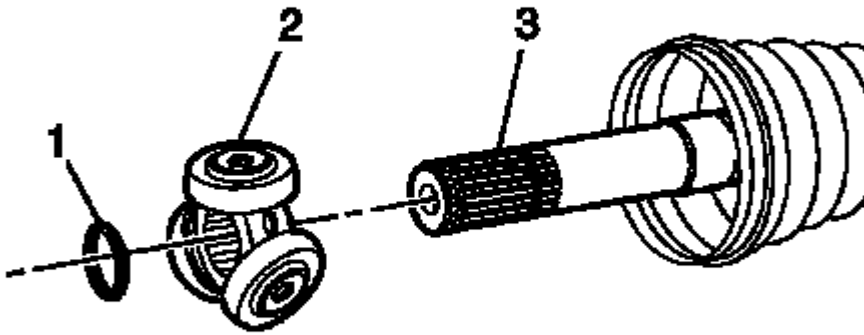


Fig. 32: View Of Wheel Drive Shaft, Tripod Spider And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

6. Remove the retaining clip (1) and the tripod spider (2) from the wheel drive shaft (3).

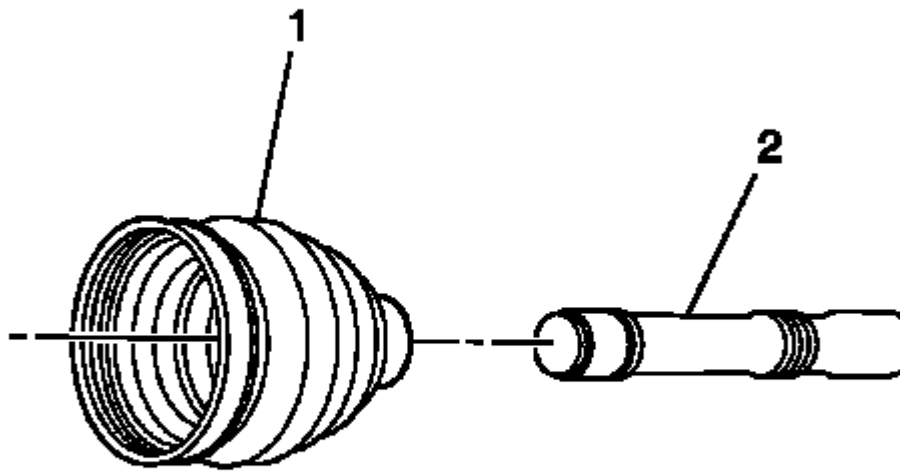


Fig. 33: Identifying Wheel Drive Shaft Boot
Courtesy of GENERAL MOTORS COMPANY

7. Remove the boot (1) from the wheel drive shaft (2).

Assemble Procedure

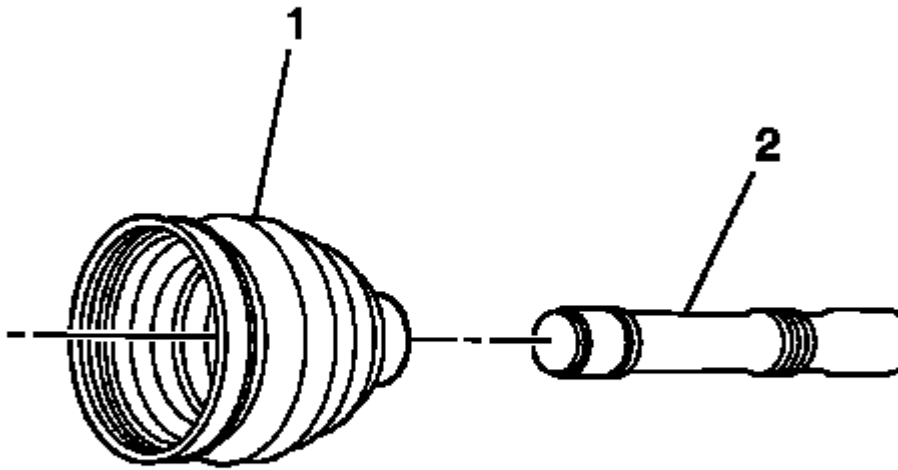


Fig. 34: Identifying Wheel Drive Shaft Boot
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the boot clamp is positioned correctly in the seal groove.

1. Position the boot (1) on the wheel drive shaft (2).

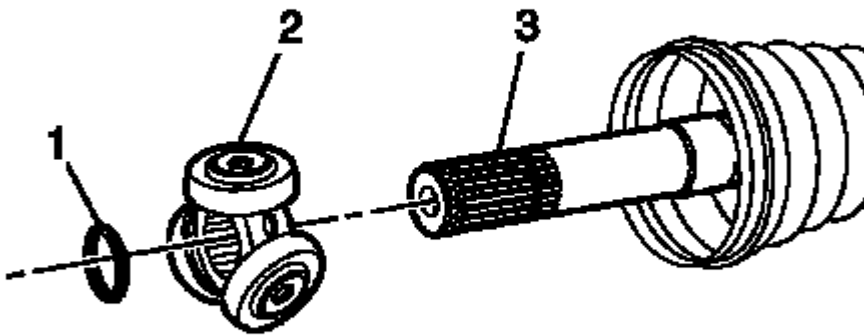


Fig. 35: View Of Wheel Drive Shaft, Tripod Spider And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

2. Install the tripod spider assembly (2) to the wheel drive shaft (3), until seated against the shoulder.
3. Install the retaining ring (1) in the wheel drive shaft (3).
4. Place approximately half of the grease in the kit into the boot and place the remainder in the tripod housing.

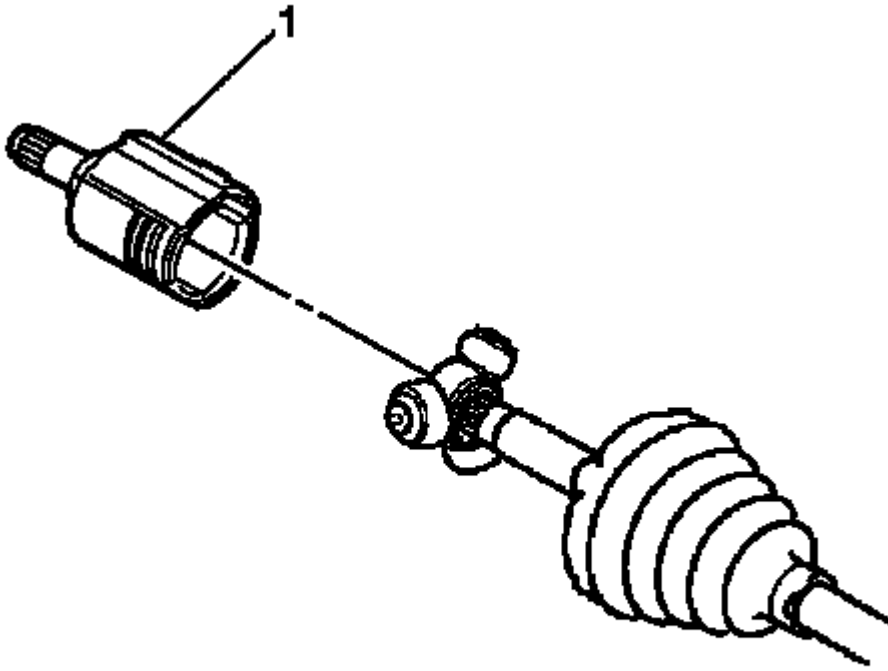


Fig. 36: Tripot Housing

Courtesy of GENERAL MOTORS COMPANY

5. Install the tripot housing (1) on the wheel drive shaft.

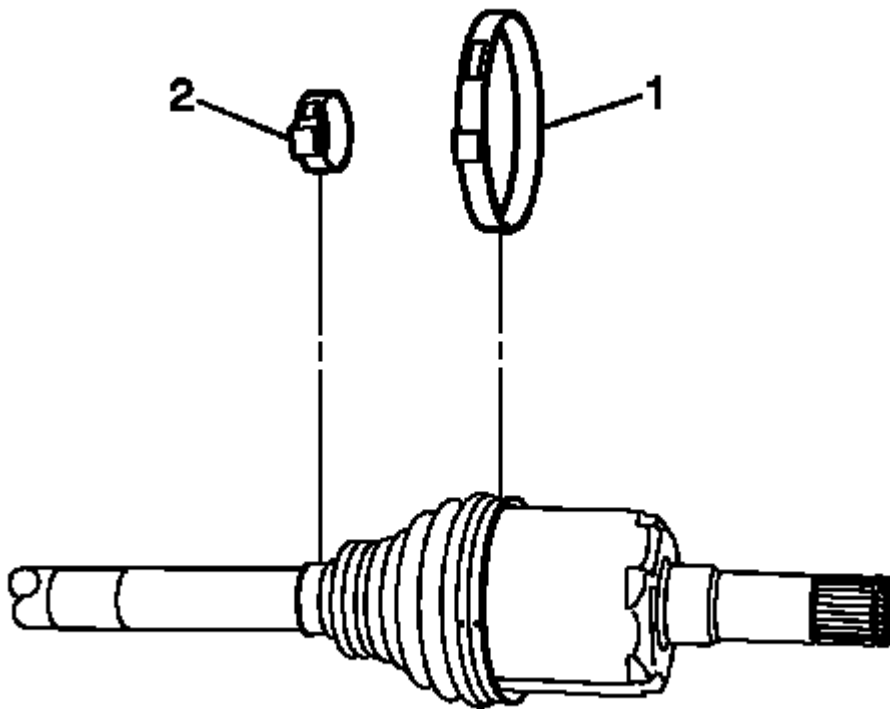


Fig. 37: View Of Boot Retaining Clamps
Courtesy of GENERAL MOTORS COMPANY

6. Install the inboard boot clamp (2).
7. Install the outboard boot clamp (1).

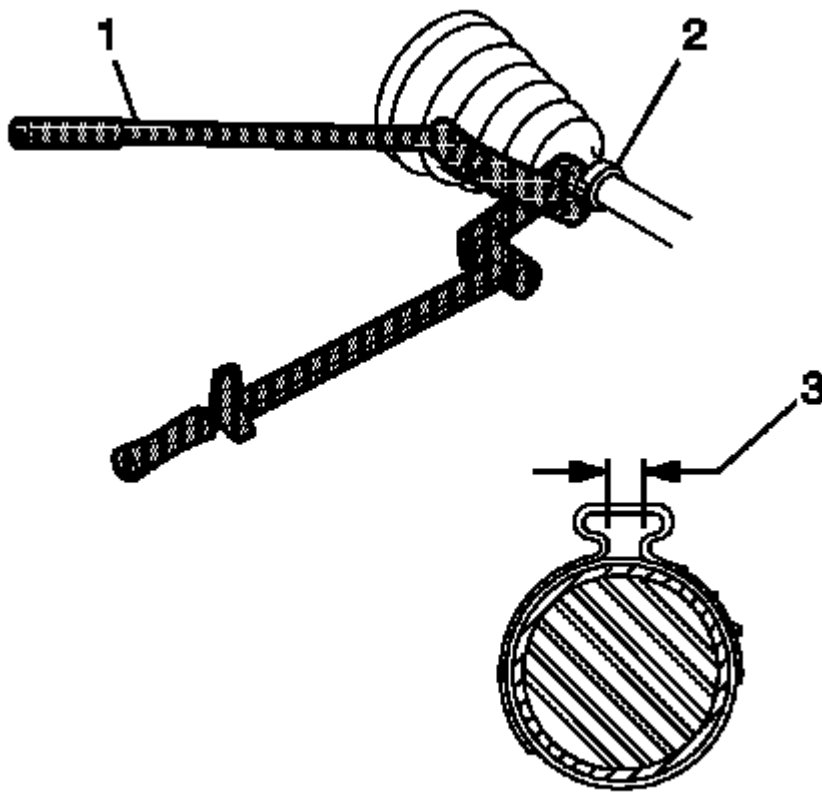


Fig. 38: Identifying Pliers Breaker Bar, Torque Wrench, Ratchet & Gap Measurement
Courtesy of GENERAL MOTORS COMPANY

8. Using the **J 35910** pliers , breaker bar, ratchet (1) , close the boot clamp (2) until the gap (3) measures 2.15 mm (0.085 in).

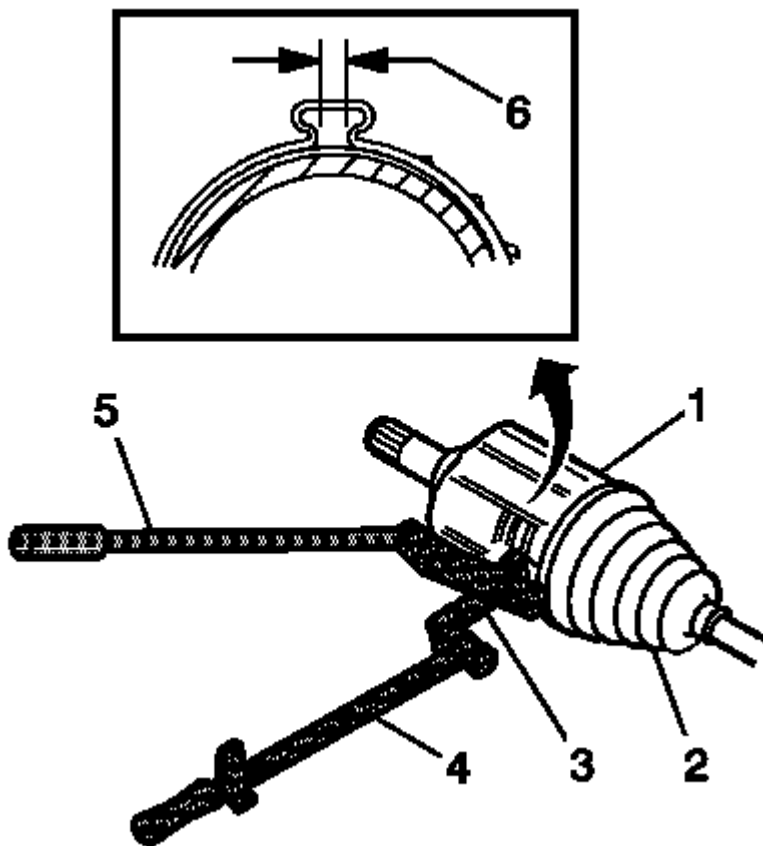


Fig. 39: Measuring Boot Clamp Gap
 Courtesy of GENERAL MOTORS COMPANY

9. Using the **J 35910** pliers (3), breaker bar (5), ratchet (4), close the clamp until the gap (6) measures 1.9 mm (0.070 in).
10. Rotate the housing in a circular motion to distribute the grease in the tripot joint.
11. Install the wheel drive shaft to the vehicle. Refer to **Front Wheel Drive Shaft Replacement - Left Side**, or **Front Wheel Drive Shaft Replacement - Right Side**.

REAR WHEEL DRIVE SHAFT INNER JOINT AND BOOT REPLACEMENT

Special Tools

DT 35910 Drive Axle Seal Clamp Pliers

For equivalent regional tools, refer to **Special Tools**.

NOTE: The tripot assembly and the internal parts for the tripot assembly are not serviceable. If the tripot assembly is found to have excessive wear or damage, replace the wheel drive shaft as an assembly.

Disassemble Procedure

1. Remove the wheel drive shaft from the vehicle. Refer to Rear Wheel Drive Shaft Replacement.

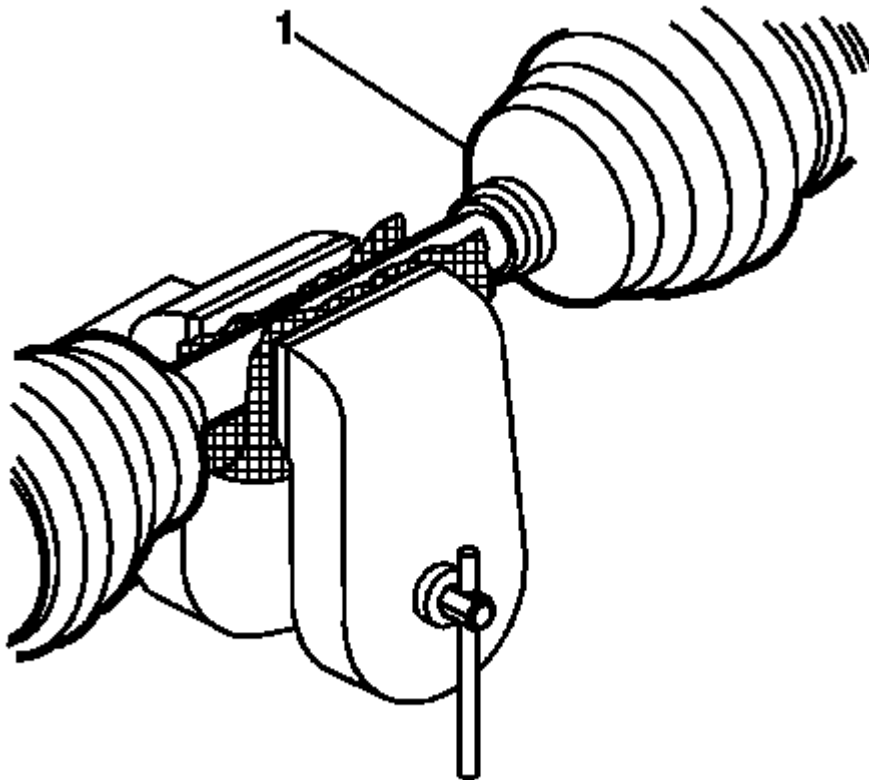


Fig. 40: View Of Front Wheel Drive Shaft Inner Joint
Courtesy of GENERAL MOTORS COMPANY

2. Position the wheel drive shaft in a soft jawed vise and clamp securely.

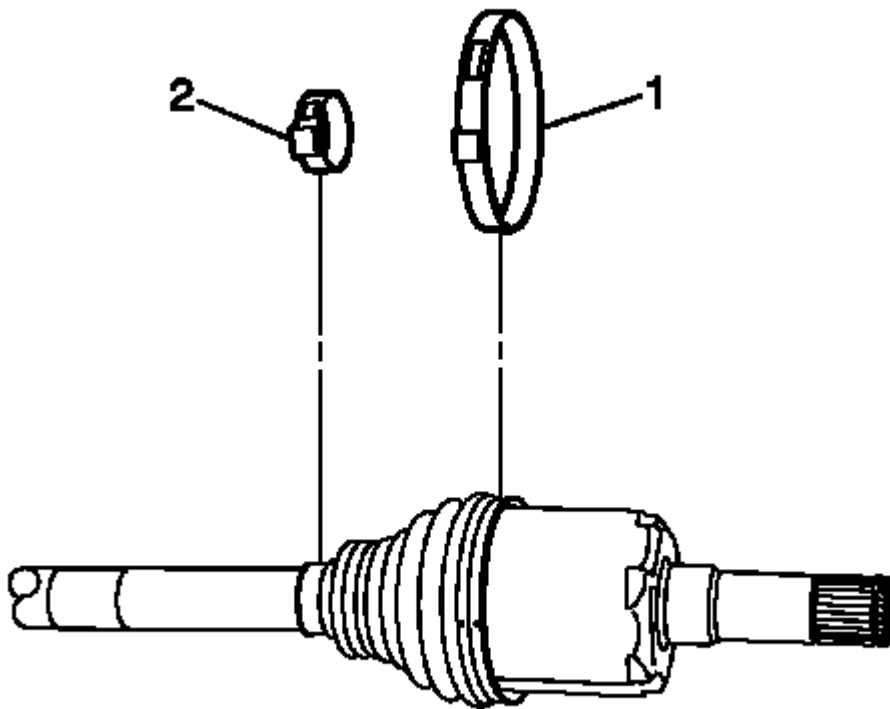


Fig. 41: View Of Boot Retaining Clamps
Courtesy of GENERAL MOTORS COMPANY

3. Using a flat-bladed tool, remove the boot retaining clamp (2).
4. Using side cutters, remove the boot clamp (1).

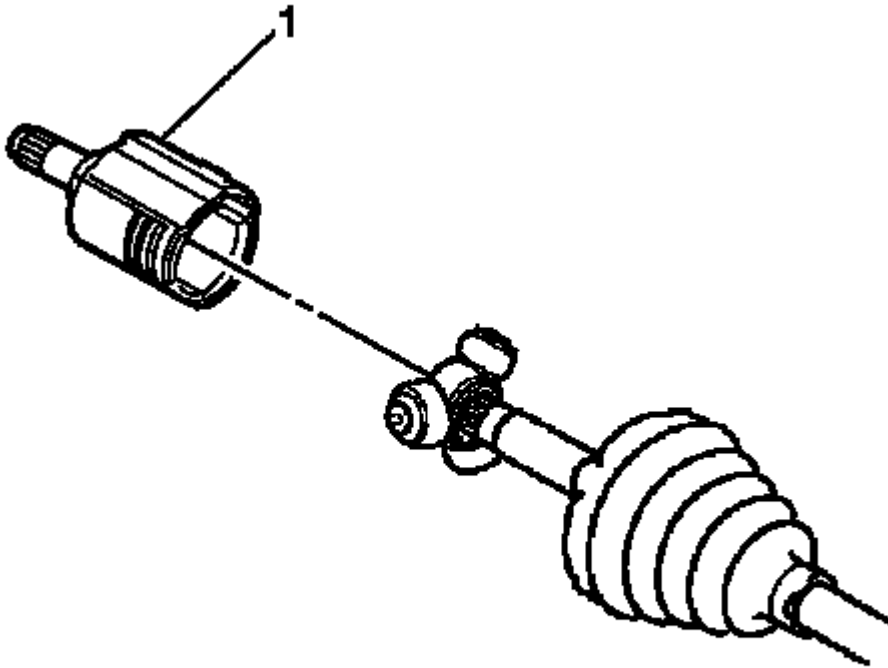


Fig. 42: Tripot Housing

Courtesy of GENERAL MOTORS COMPANY

NOTE: The tripot housing may be staked at the end to prevent removal. The staking will need to be ground down to allow removal.

5. Remove the tripot housing (1) from the wheel drive shaft.

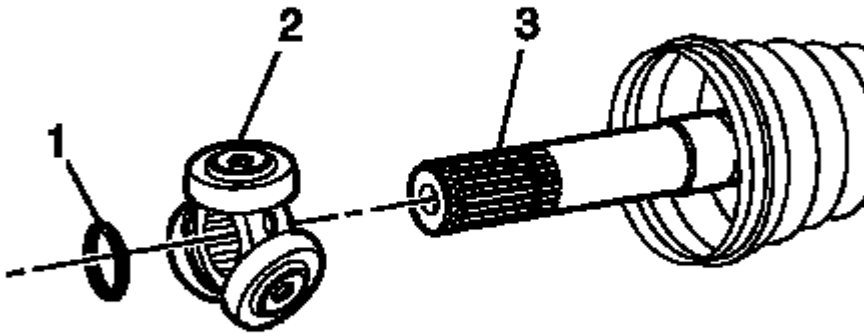


Fig. 43: View Of Wheel Drive Shaft, Tripod Spider And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

6. Remove the retaining clip (1) and the tripod spider (2) from the wheel drive shaft (3).

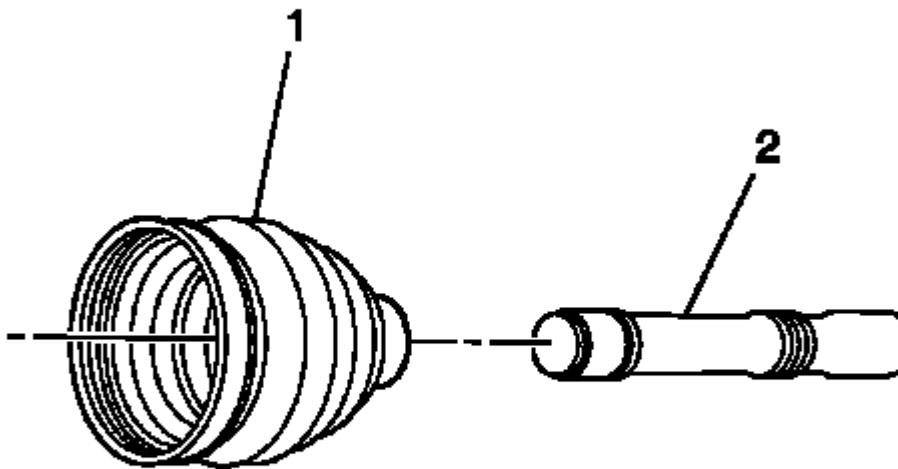


Fig. 44: Identifying Wheel Drive Shaft Boot
Courtesy of GENERAL MOTORS COMPANY

7. Remove the boot (1) from the wheel drive shaft (2).

Assemble Procedure

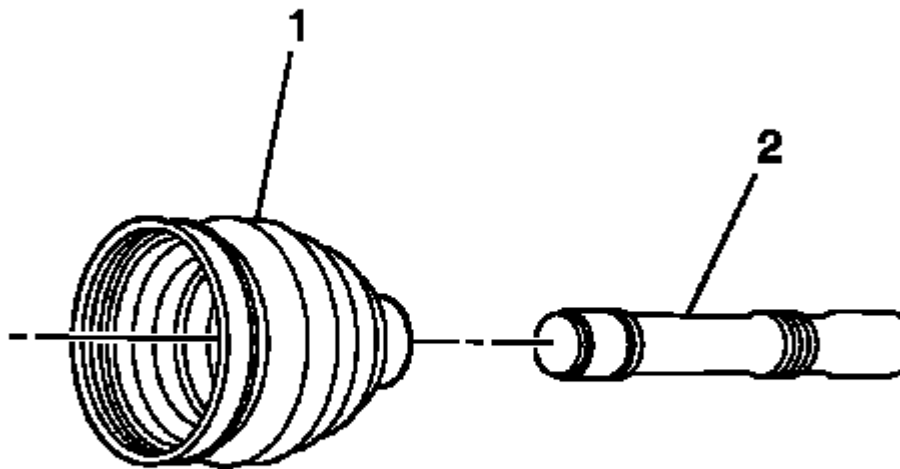


Fig. 45: Identifying Wheel Drive Shaft Boot
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the boot clamp is positioned correctly in the seal groove.

1. Position the boot (1) on the wheel drive shaft (2).

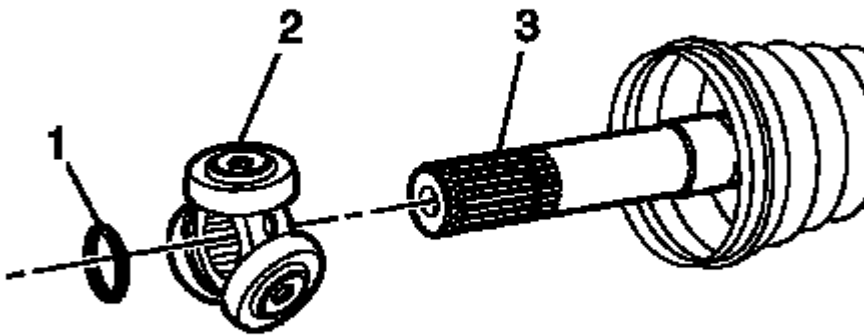


Fig. 46: View Of Wheel Drive Shaft, Tripod Spider And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

2. Install the tripod spider assembly (2) to the wheel drive shaft (3), until seated against the shoulder.
3. Install the retaining ring (1) in the wheel drive shaft (3).
4. Place approximately half of the grease in the kit into the boot and place the remainder in the tripod housing.

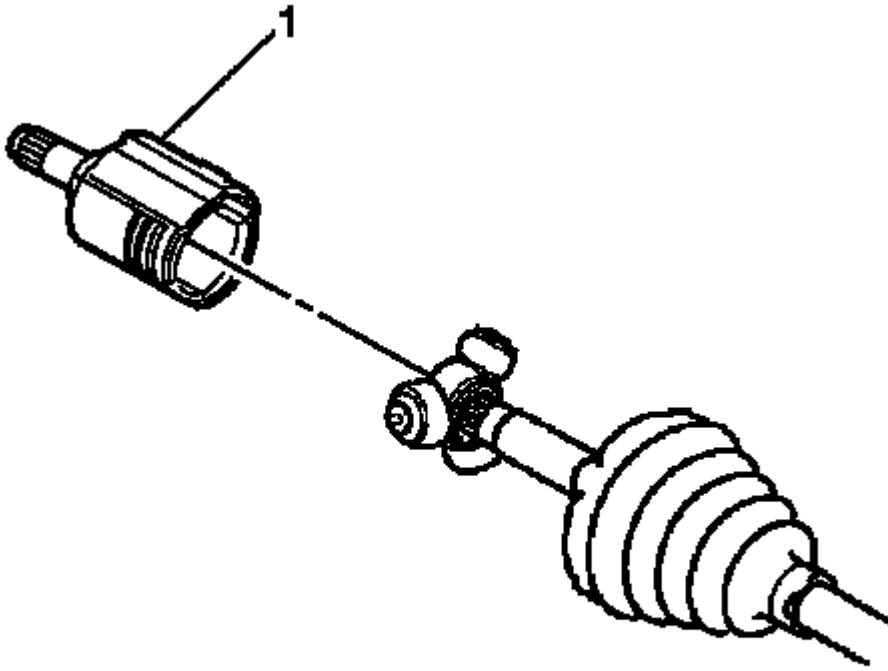


Fig. 47: Tripot Housing

Courtesy of GENERAL MOTORS COMPANY

5. Install the tripot housing (1) on the wheel drive shaft.

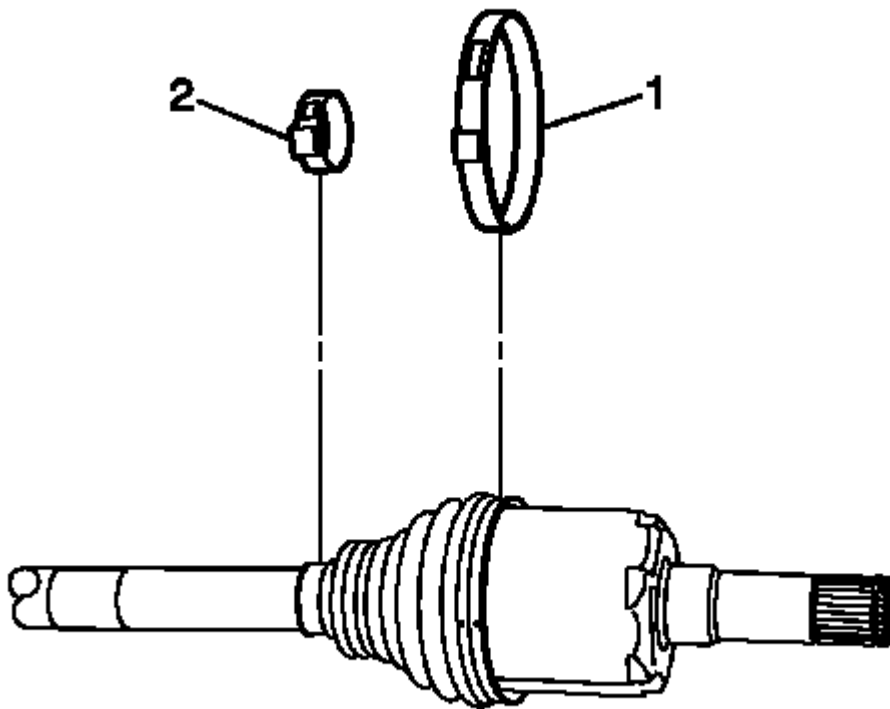


Fig. 48: View Of Boot Retaining Clamps
Courtesy of GENERAL MOTORS COMPANY

6. Install the inboard boot clamp (2).
7. Install the outboard boot clamp (1).

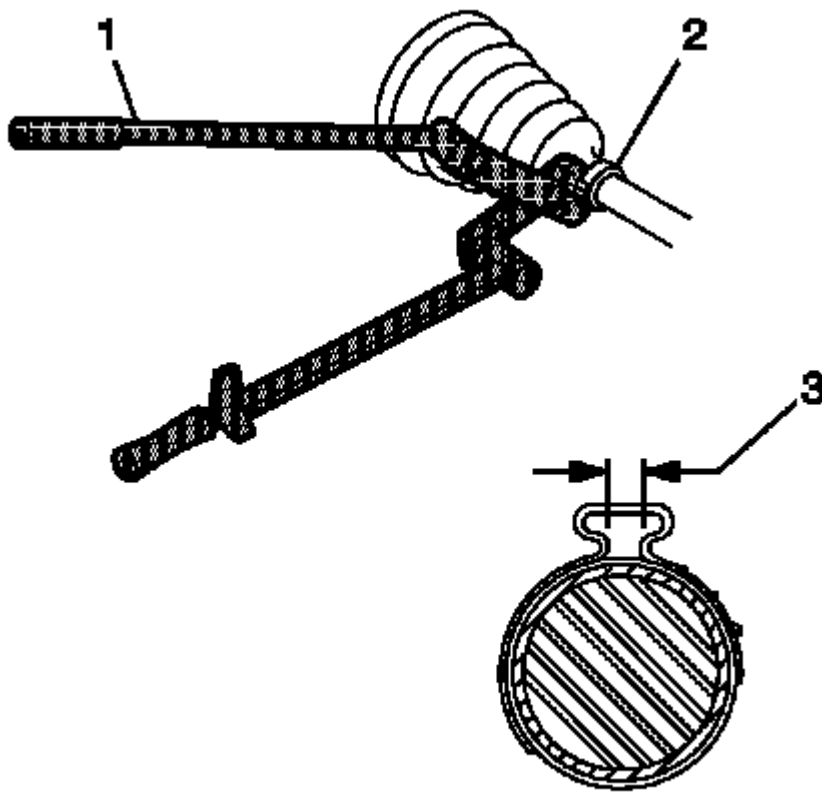


Fig. 49: Identifying Pliers Breaker Bar, Torque Wrench, Ratchet & Gap Measurement
Courtesy of GENERAL MOTORS COMPANY

8. Using the **DT 35910** pliers , breaker bar, torque wrench and or ratchet (1) , close the boot clamp (2) until the gap (3) measures 2.15 mm (0.085 in).

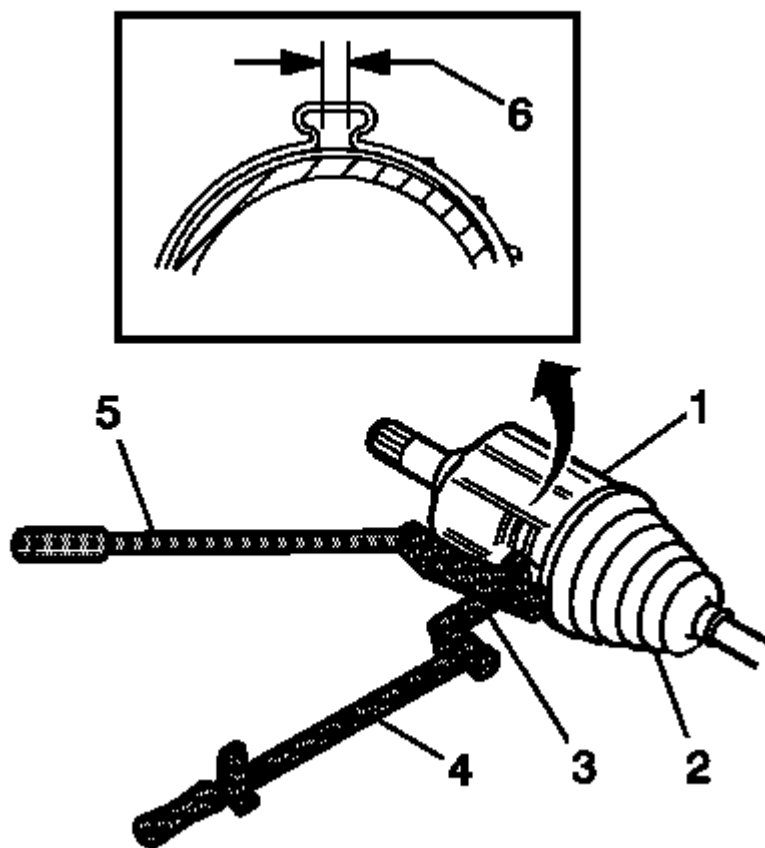


Fig. 50: Measuring Boot Clamp Gap
 Courtesy of GENERAL MOTORS COMPANY

9. Using the **DT 35910** pliers (3), breaker bar (5), torque wrench and or ratchet (4), close the clamp until the gap (6) measures 1.9 mm (0.070 in).
10. Rotate the housing in a circular motion to distribute the grease in the tripot joint.
11. Install the wheel drive shaft to the vehicle. Refer to **Rear Wheel Drive Shaft Replacement**.

FRONT WHEEL DRIVE SHAFT OUTER JOINT AND BOOT REPLACEMENT

Special Tools

- **CH 48894** Wheel Drive Shaft Boot Clamp Pliers
- **DT 35910** Drive Axle Seal Clamp Pliers

For equivalent regional tools, refer to **Special Tools**.

NOTE: The outer Constant Velocity Joint is not serviced separately. If the CV joint is found to have excessive wear or damage, replace the wheel drive shaft as an assembly.

Disassemble Procedure

1. Remove the wheel drive shaft from the vehicle. Refer to **Front Wheel Drive Shaft Replacement - Left Side**, or **Front Wheel Drive Shaft Replacement - Right Side**.

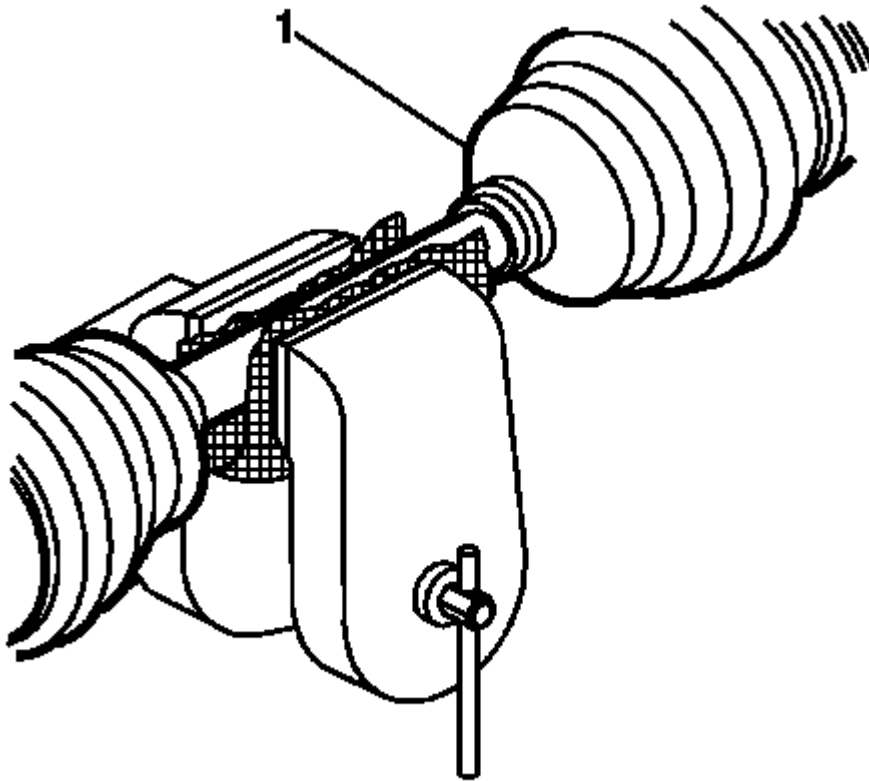


Fig. 51: View Of Front Wheel Drive Shaft Inner Joint
Courtesy of GENERAL MOTORS COMPANY

2. Clamp the drive axle shaft in a soft jawed vice.

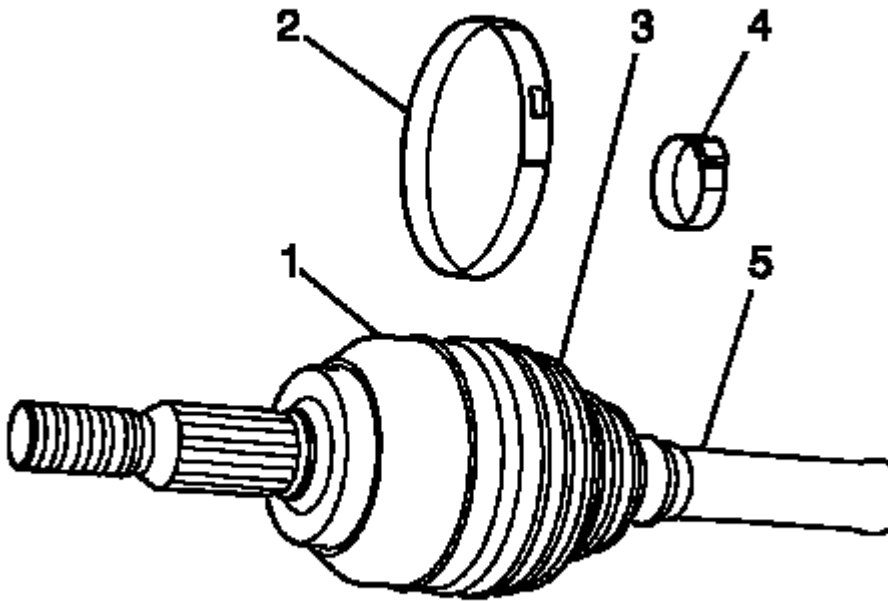


Fig. 52: Identifying Boot Clamps

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not cut through the wheel drive shaft inboard or outboard boot during service. Cutting through the boot may damage the sealing surface of the housing and the tripot or the constant velocity joint bushing. Damage to the sealing surface may lead to water and dirt intrusion and premature wear of the constant velocity joint.

3. Using a flat-bladed tool, remove the boot clamp (2) from the constant velocity (CV) joint (1) and the boot (3).
4. Using a pair of side cutters, remove and discard the boot clamp (4) from the boot (3) and the wheel drive shaft (5). Replace with NEW clamps.

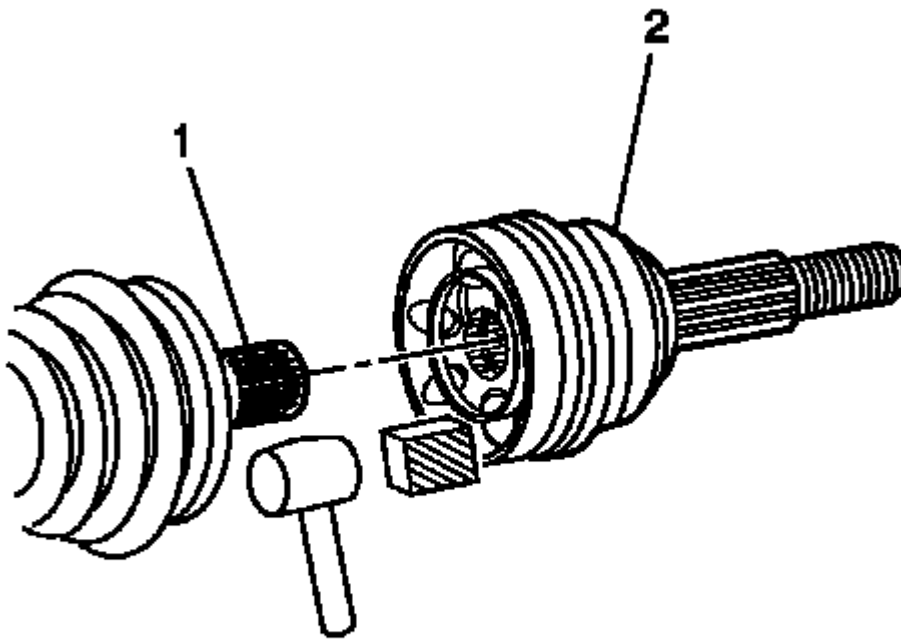


Fig. 53: Separating CV Joint From Axle Shaft
Courtesy of GENERAL MOTORS COMPANY

5. Using a block of wood and a hammer, remove the CV joint (2) from the wheel drive shaft (1).

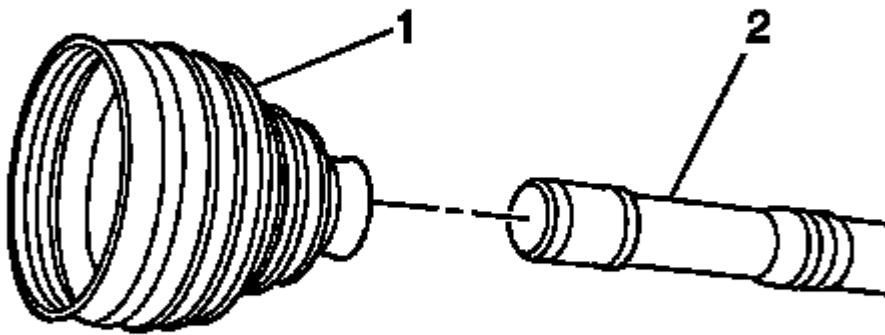


Fig. 54: Identifying Clamp & Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

6. Remove the boot (1) from the wheel drive shaft (2).

Assemble Procedure

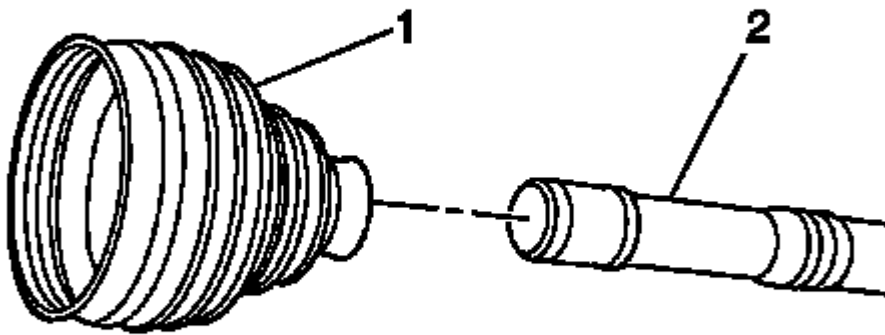


Fig. 55: Identifying Clamp & Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

1. Position the boot (1) on the wheel drive shaft (2).

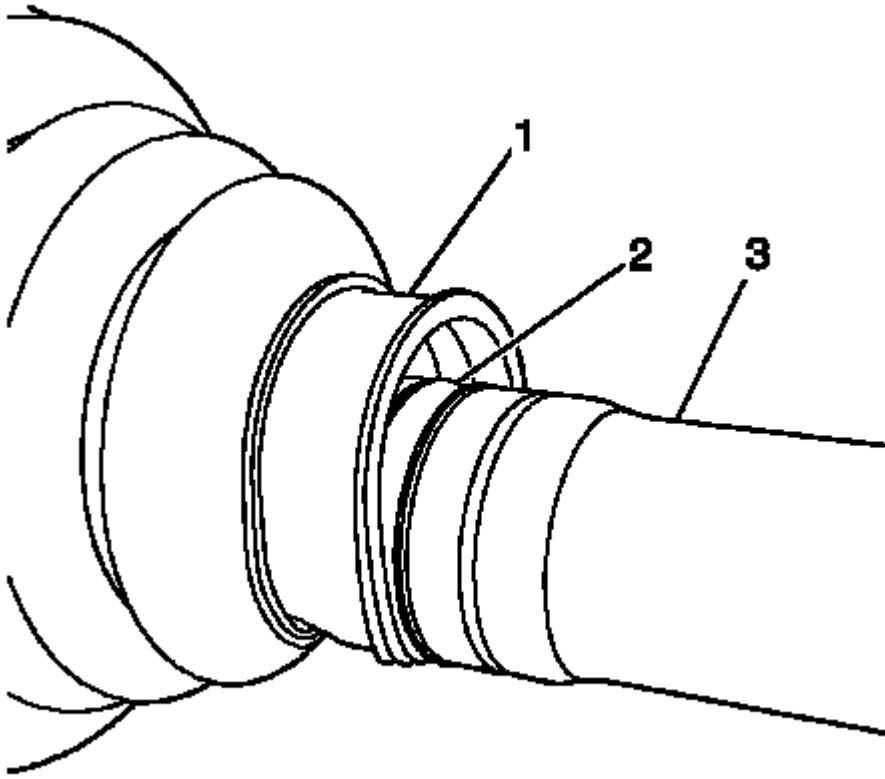


Fig. 56: Identifying Groove In Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

2. Ensure that the boot (1) is properly seated in the groove (2) in the wheel drive shaft (3).

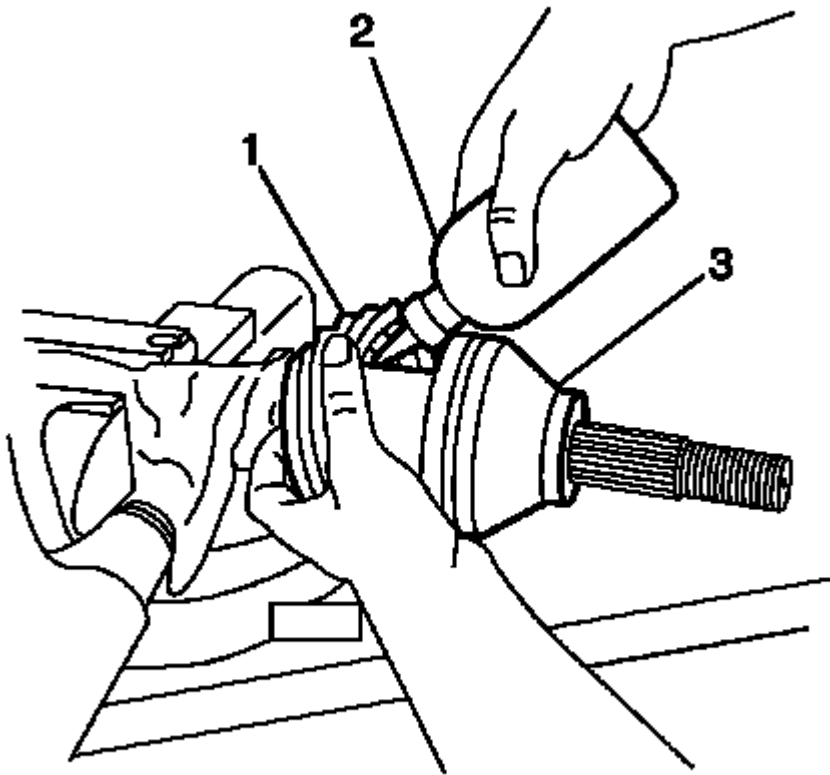


Fig. 57: Lubricating Boot Of Tripot Housing
Courtesy of GENERAL MOTORS COMPANY

3. Place approximately half the lubricant (2) inside the CV joint boot (1) and the other half in the CV joint (3).

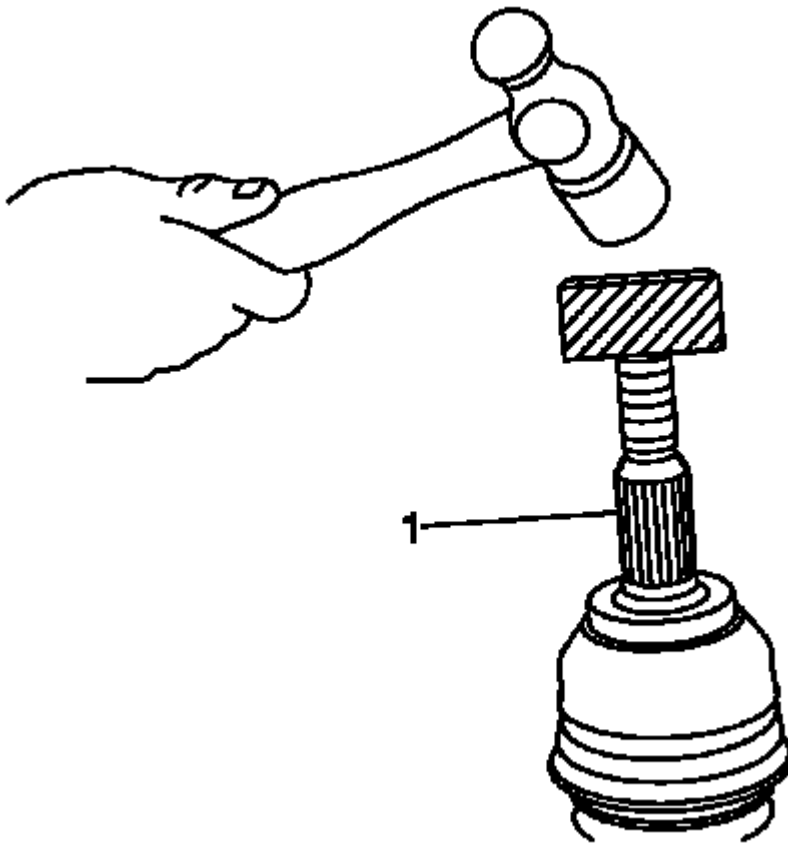


Fig. 58: Installing CV Joint

Courtesy of GENERAL MOTORS COMPANY

4. Using a block of wood and a hammer, install the CV joint on the wheel drive shaft (1).

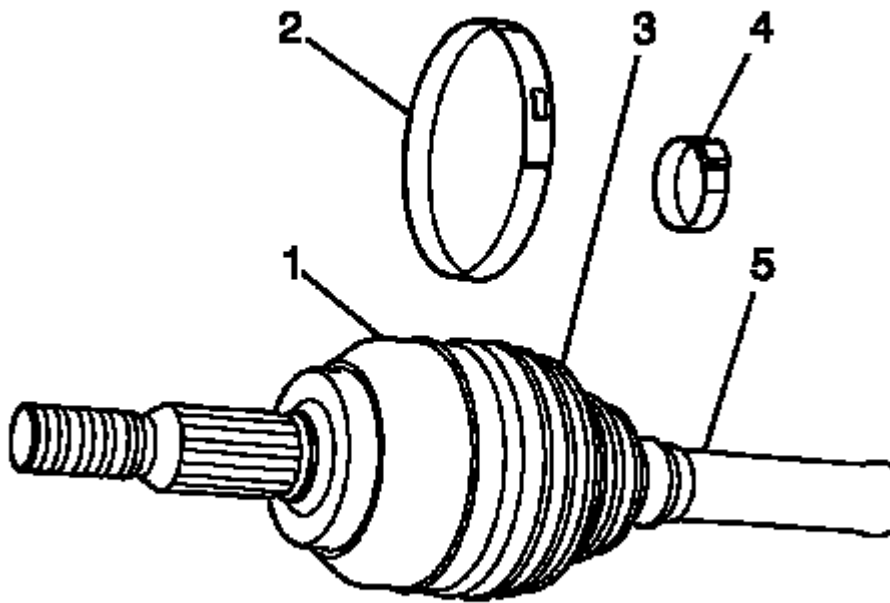


Fig. 59: Identifying Boot Clamps

Courtesy of GENERAL MOTORS COMPANY

5. Install the inboard boot clamp (4) on the boot (3) and the wheel drive shaft (5).
6. Install the outboard boot clamp (2) on the boot (3) and the CV joint housing (1).

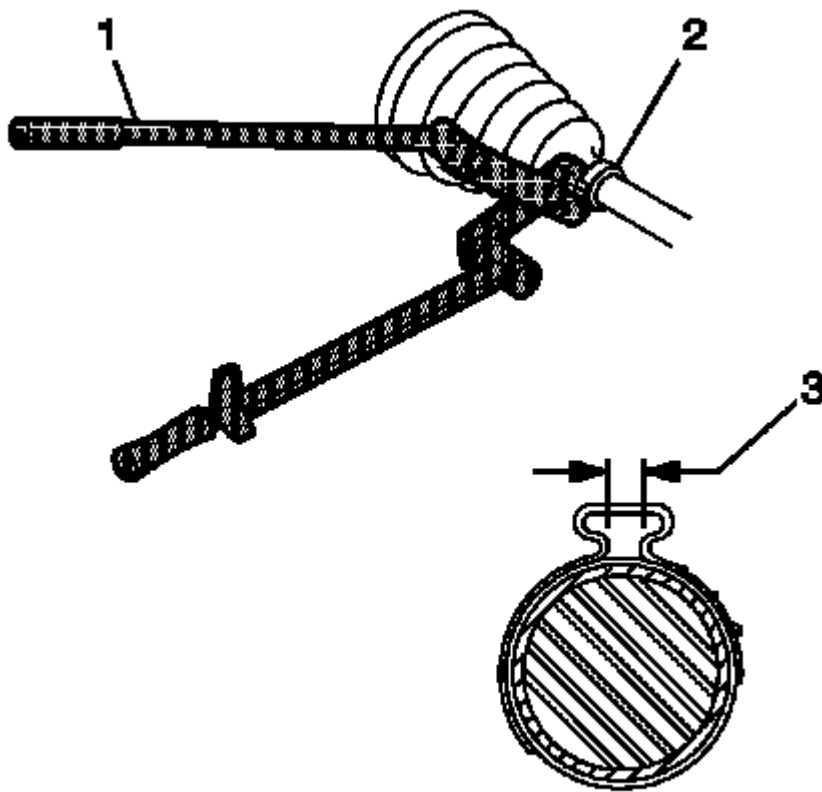


Fig. 60: Identifying Pliers Breaker Bar, Torque Wrench, Ratchet & Gap Measurement
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the boot clamp is properly positioned around the entire circumference of the boot.

7. Using the **DT 35910** pliers (1), close the clamp (2) until the gap (3) measures 2.15 mm (0.85 in).

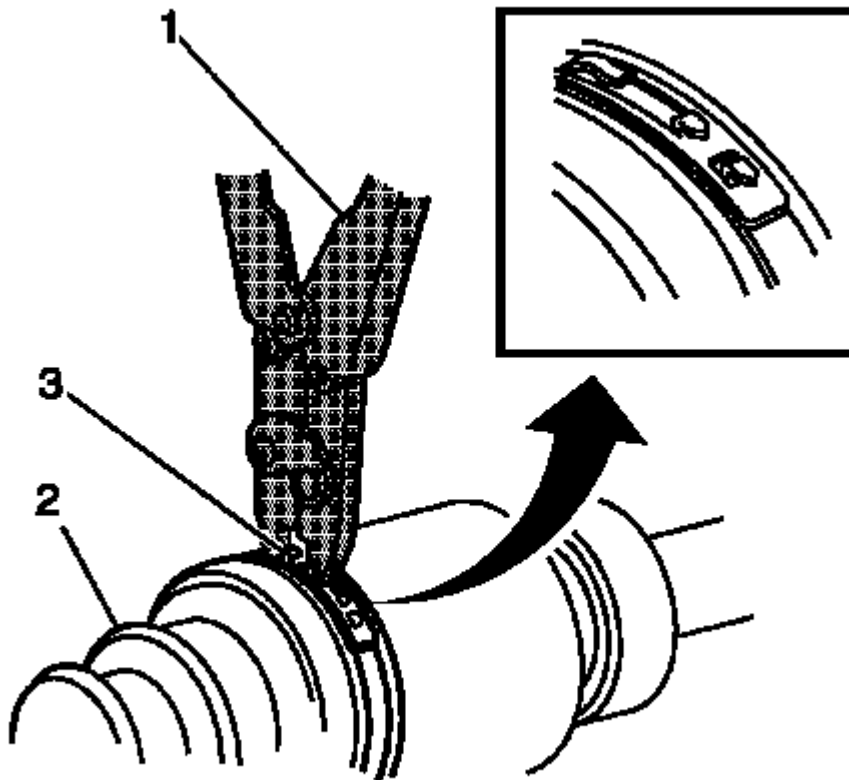


Fig. 61: Latching Large Seal Retaining Clamp
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the boot clamp is properly positioned around the entire circumference of the boot.

8. Using the **CH 48894** pliers (1), close the boot clamp (3).
9. Remove the wheel drive shaft from the bench vise.
10. Move the CV joint in a circular motion 4 to 5 times to distribute the lubricant.
11. Install the wheel drive shaft in the vehicle. Refer to Remove the wheel drive shaft from the vehicle. Refer to **Front Wheel Drive Shaft Replacement - Left Side**, or **Front Wheel Drive Shaft Replacement - Right Side**.

DESCRIPTION AND OPERATION

WHEEL DRIVE SHAFTS DESCRIPTION AND OPERATION

Wheel drive shafts are flexible assemblies consisting of an inner joint and an outer constant velocity joint connected by an axle shaft. The inner joint is completely flexible, and can plunge in and out. The outer joint is also flexible, but cannot plunge in and out. These drive axles are used to transmit rotational force from the

transaxle to the front tire and wheel assemblies.

Seal and Clamp

The wheel drive shafts use inboard and outboard joint seals made of thermoplastic material, and clamps made of stainless steel. The functions of the seals are as follows:

- The seals protect the internal parts of the inboard and outboard joints.
 - They protect the joint lubricating grease from surrounding detrimental atmospheric conditions; such as extreme temperatures, ozone gas, etc.
 - They protect the joint lubricating grease from foreign materials; such as stones, dirt, water, salt, etc.
- The seals facilitate angular movement of the outboard joint.
- The seals facilitate angular and axial movement of the inboard joint.

The function of the clamps is as follows:

Provide a leak proof connection at both the housing and the axle shaft for the inboard and outboard joints.

The thermoplastic material performs well against normal handling, operational wear and conditions. This material however, is not strong enough to withstand abusive handling or damage due to objects such as sharp tools or the sharp edge of any other surrounding component on the vehicle.

Inner Joint

The inner joints are of the tripot or CV-joint design without an over-extension limitation retainer. The inner joints incorporate a male spline which interlocks with the transaxle using snap rings.

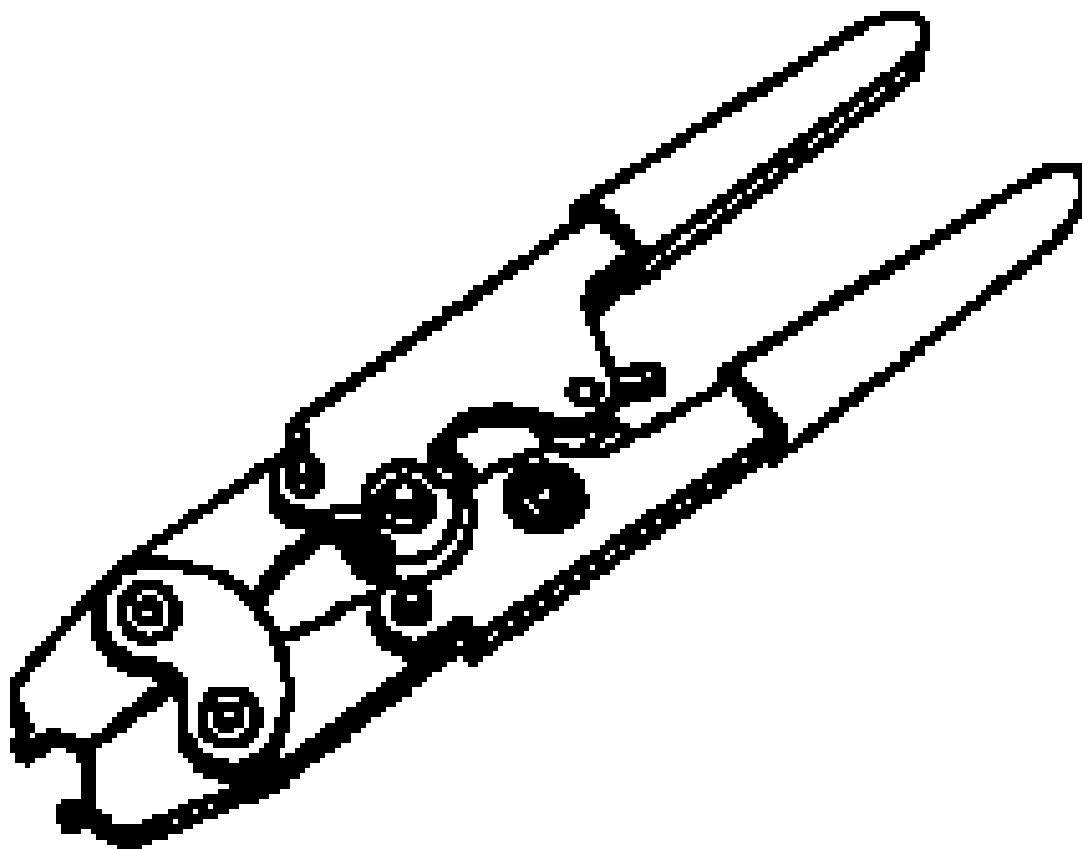
Outer Joint

The outer joints are of the Rzeppa, constant velocity joint design. The shaft end which mates with the wheel bearing and hub assembly, incorporates a helical spline to assure a tight, press-type fit. This design assures that no end play will exist between the hub bearing and the drive shaft assembly for added durability and reduced bearing noise.

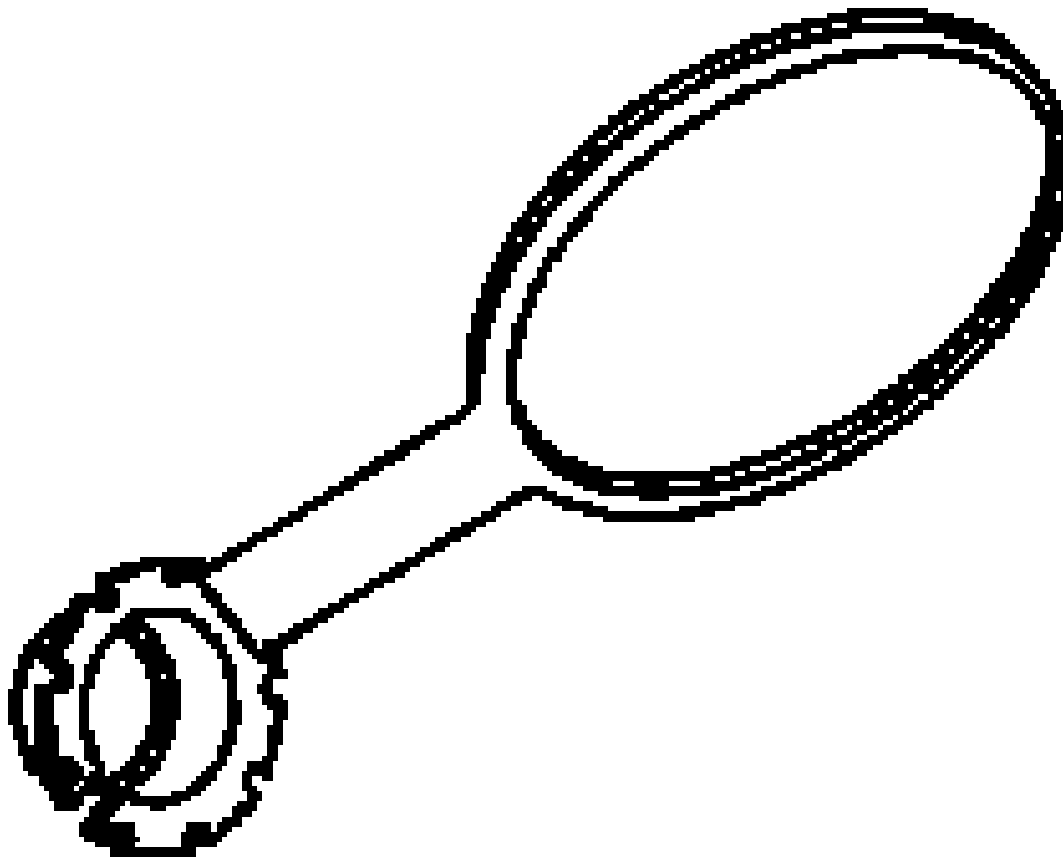
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

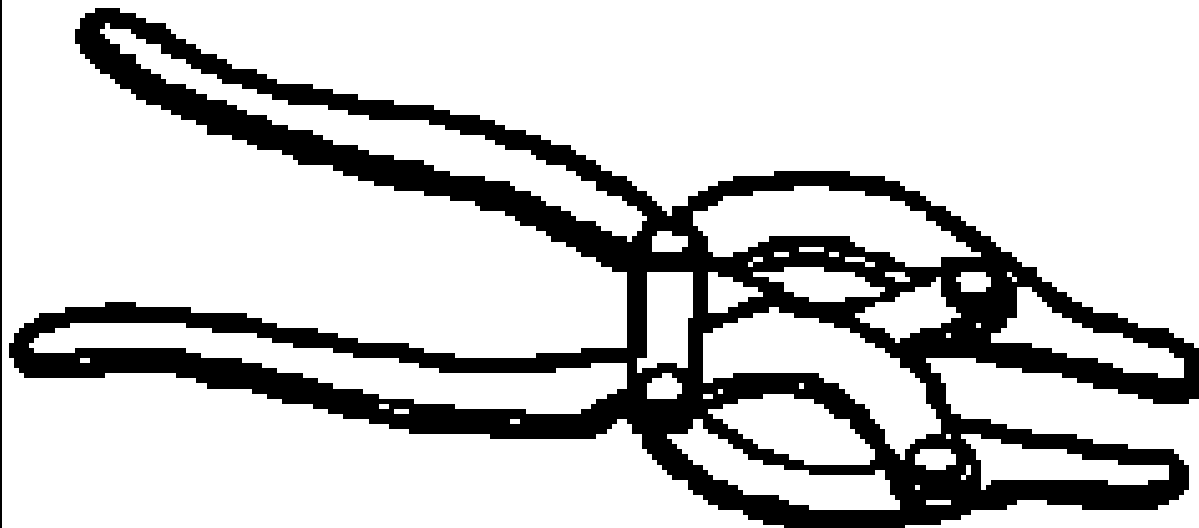
Illustration	Tool Number/Descrip



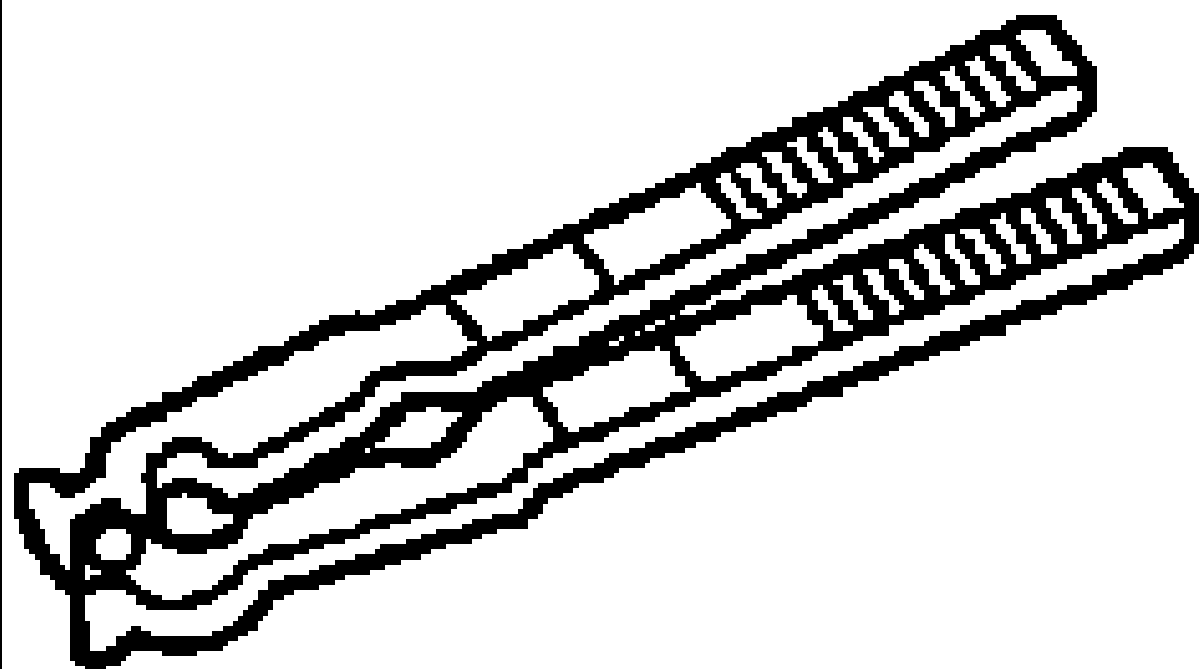
CH-804
CH-48894
DT-35910
DT-50185
J-35910
MKM-804
Wheel Drive Sh.
Boot Clamp Plic



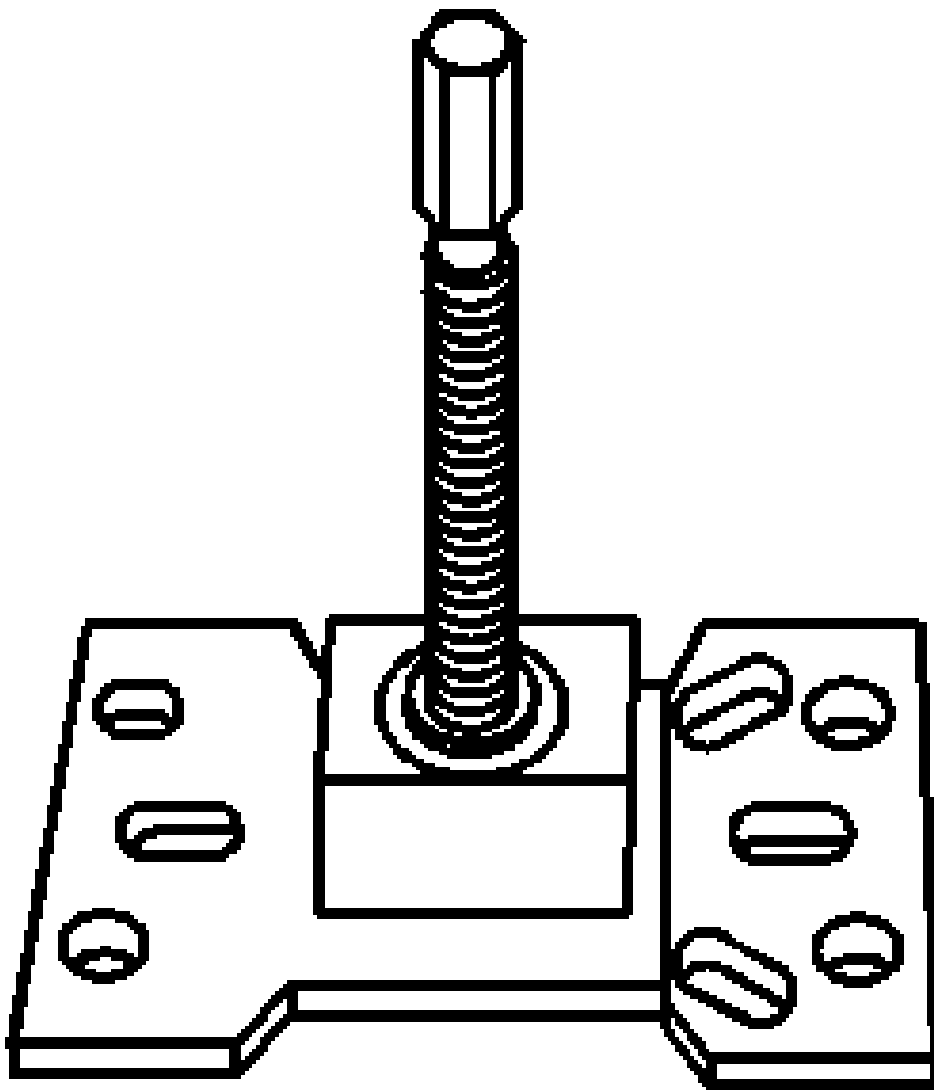
DT-6332
DT-44394-A
KM6332
J-44394-A
SA91112T
Seal Protector



DT-8059
J-8059
Snap Ring Plie



CH-22610
KM-J 22610
Keystone Clam
Pliers



CH 49400
J 45859
Hub Spindle
Remover

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Wheels/Vehicle Underbody Component Views

WHEELS/VEHICLE UNDERBODY COMPONENT VIEWS

FRONT WHEEL SPEED SENSOR COMPONENTS

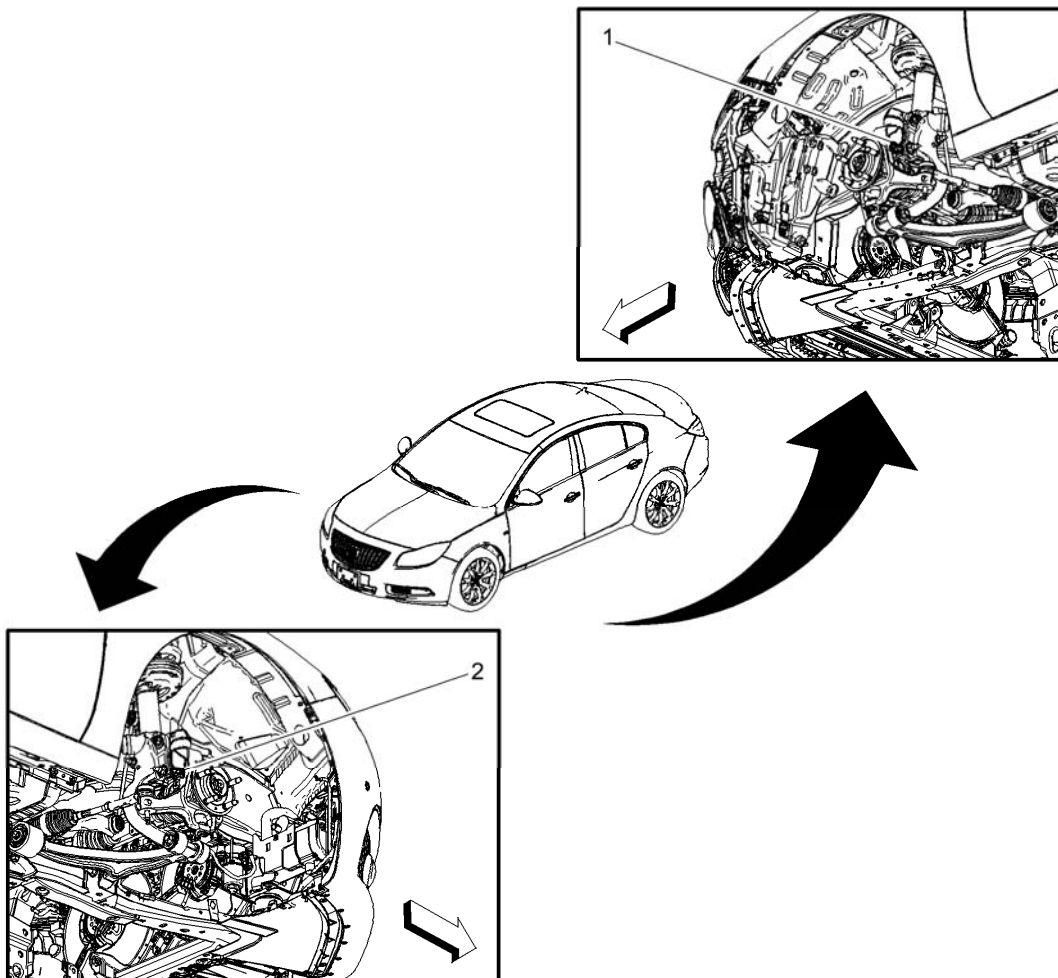


Fig. 1: Front Wheel Speed Sensor Components
Courtesy of GENERAL MOTORS COMPANY

Items

1: B5LF Wheel Speed Sensor - Left Front (without F45) B5LF Wheel Speed Sensor - Left Front (without F45/Without CZ2) B5LF Wheel Speed Sensor - Left Front (without F45/With CZ2)

2: B5RF Wheel Speed Sensor - Right Front (without F45) B5RF Wheel Speed Sensor - Right Front (without F45)

FUEL TANK COMPONENTS

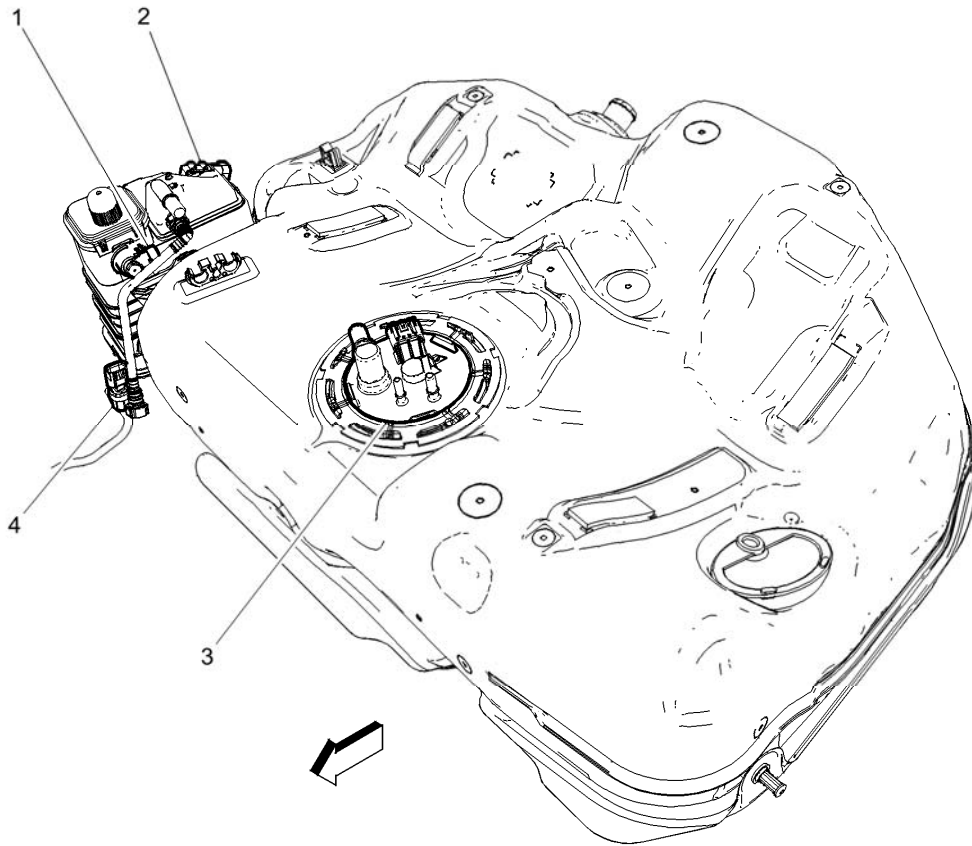


Fig. 2: Fuel Tank Sensor Components
Courtesy of GENERAL MOTORS COMPANY

Items
1: Q13 Evaporative Emission Vent Solenoid Valve <u>Q13 Evaporative Emission Vent Solenoid Valve</u>
2: B150 Fuel Tank Pressure Sensor <u>B150 Fuel Tank Pressure Sensor</u>
3: A7 Fuel Pump and Level Sensor Assembly <u>A7 Fuel Pump and Level Sensor Assembly</u>
4: B47 Fuel Pressure Sensor <u>B47 Fuel Pressure Sensor</u>

LEFT REAR WHEEL HOUSING COMPONENTS

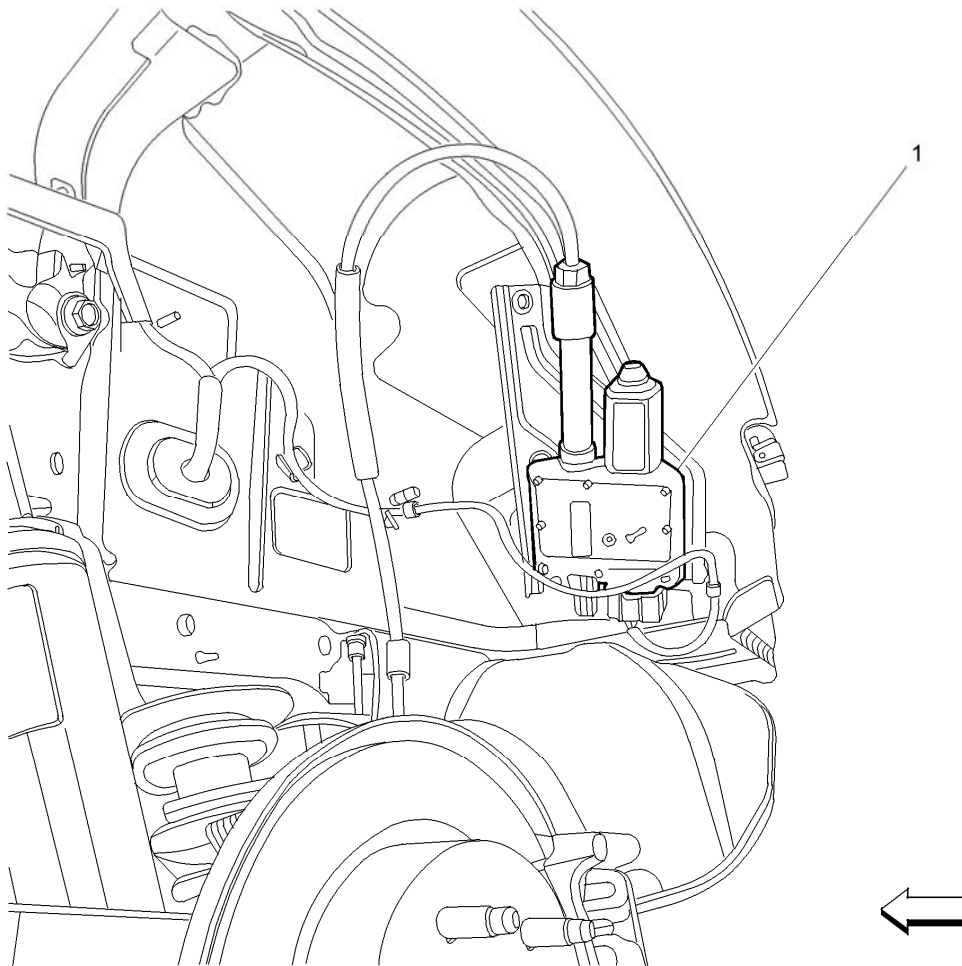


Fig. 3: Left Rear Wheel Housing Sensor Components
Courtesy of GENERAL MOTORS COMPANY

Items

1: K83 Park Brake Control Module K83 Parking Brake Control Module

ACCESSORIES & EQUIPMENT

Wipers and Washers

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Windshield Wiper Arm	38	28 lb ft
Windshield Wiper Motor Fastener	4.5	40 lb in

SCHEMATIC WIRING DIAGRAMS

WIPER/WASHER WIRING SCHEMATICS

Wiper System And Washer System

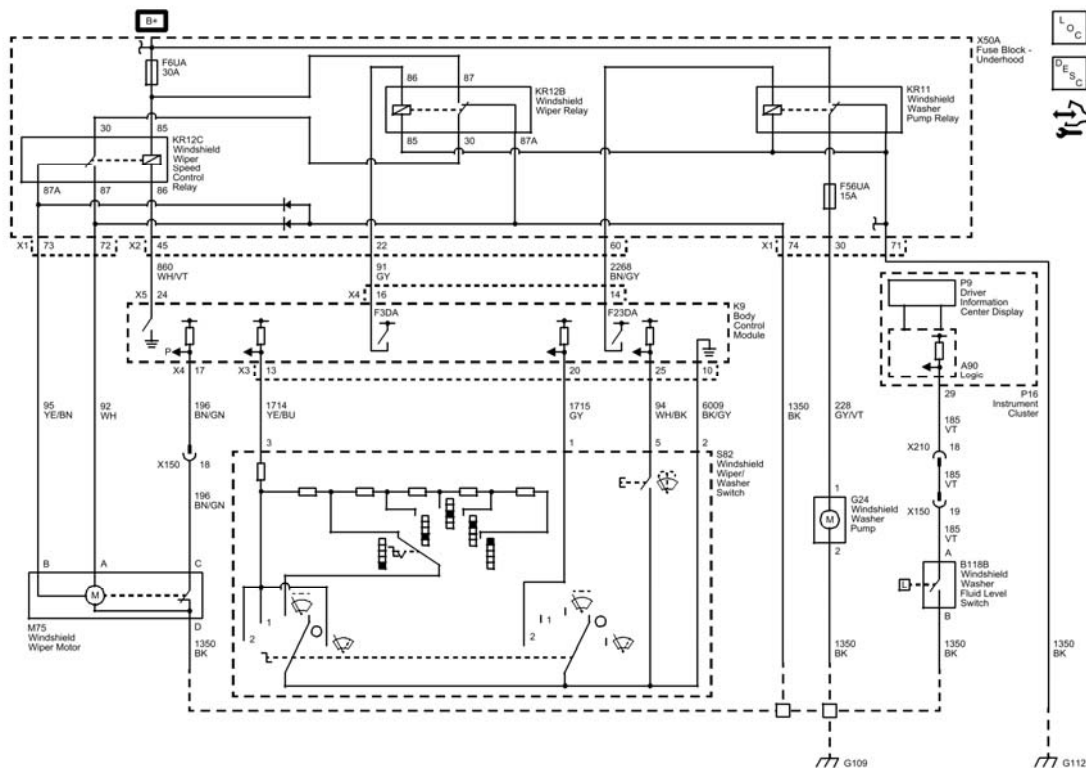


Fig. 1: Wiper System And Washer System
Courtesy of GENERAL MOTORS COMPANY

Headlamp Washer and Windshield Washer Pump, Outside Moisture Sensor (CZ2)

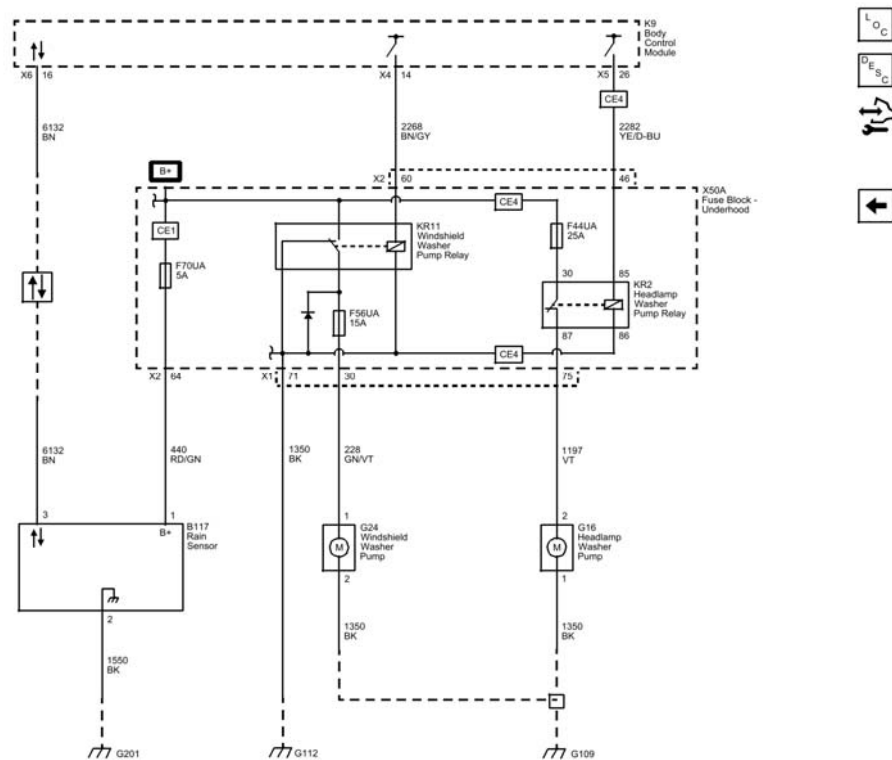


Fig. 2: Headlamp Washer and Windshield Washer Pump, Outside Moisture Sensor (CZ2)
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B370A	DTC B370A 39 Rain Sensor Internal Malfunction
DTC B3715 or B3875	DTC B3715 01 Windshield Wiper Relay Circuit Short to Battery DTC B3715 02 Windshield Wiper Relay Circuit Short to Ground DTC B3715 04 Windshield Wiper Relay Circuit Open DTC B3875 01 Windshield Wiper High Speed Relay Circuit Short to Battery DTC B3875 02 Windshield Wiper High Speed Relay Circuit Short to Ground DTC B3875 04 Windshield Wiper High Speed Relay Circuit Open
DTC B3810	DTC B3810 02 Headlamp Washer Relay Circuit Short to Ground
DTC B3873	DTC B3873 01 Front Washer Relay Circuit Short to Battery DTC B3873 02 Front Washer Relay Circuit Short to Ground DTC B3873 04 Front Washer Relay Circuit Open Circuit

DTC B370A: RAIN SENSOR INTERNAL MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptor

DTC B370A 39

Rain Sensor Internal Malfunction

Circuit/System Description

B+ voltage is supplied to the Rain Sensor. Whenever the ignition is ON, or accessory positions, the body control module (BCM), sends the turn signal/multifunction switch status by using a data communication circuit. When a wipe cycle is needed, the Rain Sensor sends a data communication message to the BCM, requesting the wiper operation. The BCM commands the Windshield Wiper Motor wipe cycles. If at anytime a fault occurs between the Rain Sensor and BCM, the BCM will use the inputs from the turn signal/multifunction switch in the delay positions to operate the Windshield Wiper Motor at continuous variable delay intervals.

Conditions for Running the DTC

- Ignition ON.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

The system voltage is between 9-16 V.

Action Taken When the DTC Sets

- If the BCM loses communication with the Rain Sensor while the Rain Sensor is requesting single wipes, it shall fail soft the wipers operation to front wiper manual - intermittent with a fixed dwell time of 4 seconds.
- If the BCM loses communication with the Rain Sensor while the Rain Sensor is continuously requesting low, it shall fail soft the wipers operation to front wiper manual - low.
- If the BCM loses communication with the Rain Sensor while the Rain Sensor is continuously requesting high, it shall fail soft the wipers operation to front wiper manual - high.

Conditions for Clearing the DTC

A current DTC clears when the diagnostic runs and passes.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U151A is not set.
 - **If DTC U151A is set**

Please Refer to **DTC U1500-U15FF**

- **If DTC U151A is not set**
3. Verify the wipers operate at low speed when the Windshield Wiper Switch is in the LOW position.
 - **If the wipers are not operating at low speed**

Refer to **Windshield Wiper System Malfunction.**

- **If the wipers are operating at low speed**
4. Place the Windshield Wiper Switch in the delay mode/moisture sensitivity settings Delay 1 through Delay 5 and spray the outside of the windshield in the rear view mirror/rain sensor region with a water bottle.
5. Verify the wipers operate at low speed.
 - **If the wipers are not operating at low speed**

Test or replace the B117 Rain Sensor.

- If the wipers are operating at low speed
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Windshield Outside Moisture and Headlamp Automatic Control Ambient Light Sensor Replacement**
- **Control Module References** for BCM replacement, programming and setup

DTC B3715 OR B3875: WINDSHIELD WIPER RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3715 01

Windshield Wiper Relay Circuit Short to Battery

DTC B3715 02

Windshield Wiper Relay Circuit Short to Ground

DTC B3715 04

Windshield Wiper Relay Circuit Open

DTC B3875 01

Windshield Wiper High Speed Relay Circuit Short to Battery

DTC B3875 02

Windshield Wiper High Speed Relay Circuit Short to Ground

DTC B3875 04

Windshield Wiper High Speed Relay Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Wiper Switch Low Signal terminal 3	1	1	1	-
Windshield Wiper Switch High Signal terminal 1	4	2	2	-
Windshield Wiper Motor Park Switch Signal terminal C	3	3	-	-
Front Wiper Relay Control terminal 85	B3715 02	B3715 04	B3715 01	-
Windshield Wiper High Speed Relay Control terminal 86	B3875 02	B3875 04	B3875 01	-
Windshield Wiper Motor Control terminal B	1	1	4	-
Windshield Wiper Motor High Speed Control terminal A	2	2	4	-
Windshield Wiper Switch Low Reference terminal 2	-	1, 2	1, 2	-
Windshield Wiper Motor Ground terminal D	-	1, 2, 3	-	-
Front Wiper Relay Ground terminal 85	-	1	-	-
1. Delay or Low Speed Wipers Inoperative 2. High Speed Wipers Inoperative 3. Wipers Do Not Park 4. Wipers Always ON				

Circuit/System Description

The body control module (BCM) controls the wiper motor based on input from the windshield wiper/washer switch. The BCM monitors the wiper/washer switch through two separate signal circuits and a low reference circuit. The windshield wiper switch high signal circuit is used to determine high speed wiper operation, the windshield wiper switch low signal is used to determine low speed, intermittent, and mist operation through the use of a resistor ladder, and the windshield washer switch signal circuit is used to determine washer operation.

The BCM controls the windshield wiper motor through two output controls, controlling two relays which determine the desired wiper speed, high or low.

Conditions for Running the DTC

- The DTC runs only when a wiper output is actively being requested by the BCM.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

- A short to ground is detected in the front wiper relay control circuit or in the high speed relay control

circuit.

- A short to voltage or an open/high resistance is detected in the front wiper relay control circuit or in the high speed relay control circuit.

Action Taken When the DTC Sets

The BCM will not activate the wiper output.

Conditions for Clearing the DTC

- A current DTC will clear when the condition for setting the fault is no longer present.
- A history DTC will clear after 50 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Windshield Wiper High Speed Switch parameter changes between Active and Inactive when activating the high speed windshield wipers.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Wiper/Washer Switch Malfunction.

- **If the parameter changes**

3. Verify the scan tool Windshield Wiper Switch parameter changes between Off and Low when activating the low speed windshield wipers.

- **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Wiper/Washer Switch Malfunction.

- **If the parameter changes**

4. Verify the scan tool Windshield Wiper Switch parameter changes between Delay 1 and Delay 5 when cycling the intermittent speed windshield wipers.

- **If the parameter does not change**

Test or replace the S82 Windshield Wiper/Washer Switch.

- **If the parameter changes**

5. Verify the M75 Windshield Wiper Motor changes between Off, Low, and High when cycling the S82 Windshield Wiper/Washer Switch between Off, Low, and High.

- **If the Windshield Wiper Motor does not cycle between Off, Low, and High**

Refer to Circuit/System Testing - Windshield Wiper Motor Malfunction

- **If the Windshield Wiper Motor cycles between Off, Low, and High**

6. Ignition OFF.
7. Verify the scan tool Windshield Wiper Park Switch parameter is Active.

- **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Wiper Motor Malfunction.

- **If the parameter changes**

8. All OK.

Circuit/System Testing

Windshield Wiper/Washer Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch. It may take up to 11 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the scan tool Windshield Wiper High Speed Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
- 6. Verify the scan tool Windshield Wiper High Speed Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
- 7. Test for greater than 8 V between the signal circuit terminal 3 and ground.
 - **If less than 8 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If 8 V or greater**
- 8. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module, ignition ON.
- 9. Test for less than 1 V between the S82 Windshield Wiper/Washer Switch signal circuit terminal 3 and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

10. Test or replace the S82 Windshield Wiper/Washer Switch.

Windshield Wiper Motor Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M75 Windshield Wiper Motor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal D and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Windshield Wiper Park Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal C and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal C and the ground circuit terminal D.
6. Verify the scan tool Windshield Wiper Park Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
7. Ignition OFF and all vehicle systems OFF, disconnect the KR12B Windshield Wiper Relay. It may take up to 2 min for all vehicle systems to power down.
8. Test for less than 10 ohms between the ground circuit terminals listed below and ground.
 - terminal 85
 - terminal 87A

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

9. Ignition ON.
10. Verify a test lamp illuminates between the B+ circuit terminal 87 and the ground circuit terminal 87A.
 - **If the test lamp does not illuminate and the circuit fuse is good**

Replace the X50A Fuse Block - Underhood.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp. Disconnect the KR12C Windshield Wiper Speed Control Relay.
2. Test for infinite resistance between the control circuits listed below and ground.
 - Terminal 87A
 - Terminal 87
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M75 Windshield Wiper Motor

- **If the test lamp illuminates**

11. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
12. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper Motor Relay Low and Off with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.

- **If the test lamp turns ON and OFF**

13. Ignition OFF, connect the KR12B Windshield Wiper Relay and disconnect the KR12C Windshield Wiper Speed Control Relay, ignition ON.

14. Test for less than 10 ohms between the control circuit terminal 30 and ground.

- **If 10 ohms or greater**

Test or replace the KR12B Windshield Wiper Relay.

- **If less than 10 ohms**

15. Connect a test lamp between the control circuit terminal 30 and ground.

16. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper Motor Relay Low and Off with a scan tool.

- **If the test lamp does not turn ON and OFF**

Test or replace the KR12B Windshield Wiper Relay.

- **If the test lamp turns ON and OFF**

17. Verify a test lamp illuminates between the B+ circuit terminal 85 and ground.

- **If the test lamp does not illuminate**

Replace the X50A Fuse Block - Underhood.

- **If the test lamp illuminates**

18. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.

19. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper High Speed Relay High and Off with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.

2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V

3. Ignition OFF.

4. Test for less than 2 ohms in the control circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.

2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K9 Body Control Module.
- **If the test lamp turns ON and OFF**
- 20. Ignition OFF, connect the KR12C Windshield Wiper Speed Control Relay.
- 21. Connect a test lamp between the M75 Windshield Wiper Motor control circuit terminal B and ground circuit terminal D, ignition ON.
- 22. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper Motor Relay Low and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the KR12C Windshield Wiper Speed Control Relay.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the KR12C Windshield Wiper Speed Control Relay.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the KR12C Windshield Wiper Speed Control Relay, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the KR12C Windshield Wiper Speed Control Relay.
 - **If the test lamp turns ON and OFF**
- 23. Connect a test lamp between the M75 Windshield Wiper Motor control circuit terminal A and ground circuit terminal D, ignition ON.
- 24. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper High Speed Relay High and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the KR12C Windshield Wiper Speed Control Relay.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the KR12C Windshield Wiper Speed Control Relay.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the KR12C Windshield Wiper Speed Control Relay, ignition ON.

2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the KR12C Windshield Wiper Speed Control Relay.
 - **If the test lamp turns ON and OFF**

25. Test or replace the M75 Windshield Wiper Motor.

Component Testing

Windshield Wiper/Washer Switch

1. Ignition OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch.
2. Test for infinite resistance between the signal terminal 1 and the low reference terminal 2 with the high speed switch in the open position.
 - **If less than infinite resistance**

Replace the S82 Windshield Wiper/Washer Switch.

- **If infinite resistance**

3. Test for less than 2 ohms between the signal circuit terminal 1 and the low reference circuit terminal 2 with the high speed switch in the closed position.
 - **If 2 ohms or greater**

Replace the S82 Windshield Wiper/Washer Switch.

- **If less than 2 ohms**

4. Test for infinite resistance between the signal terminal 3 and the low reference terminal 2 with the low speed switch in the open position.
 - **If less than infinite resistance**

Replace the S82 Windshield Wiper/Washer Switch.

- **If infinite resistance**

5. Test for the resistance values listed below between the signal circuit terminal 3 and the low reference circuit terminal 2 by cycling the switch between Delay 1 and Delay 5.
 - Delay 1 : 3.8kohms
 - Delay 2 : 2.8kohms
 - Delay 3 : 1.9kohms
 - Delay 4 : 2.8kohms
 - Delay 5 : 770ohms
 - **If not within the resistance values listed**

Replace the S82 Windshield Wiper/Washer Switch.

- **If within the resistance values listed**

6. All OK

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 60-200 ohms between terminals 85 and 86.
 - **If less than 60 or greater than 200**

Replace the relay.

- **If between 60-200 ohms**

3. Test for infinite resistance between the terminals listed below:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Test for less than 5 ohms between terminals 30 and 87A.
 - **If 5 ohms or greater**

Replace the relay.

- **If less than 5 ohms**

5. Install a 10 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
6. Test for less than 5 ohms between terminals 30 and 87.
 - **If 5 ohms or greater**

Replace the relay.

- **If less than 5 ohms**

7. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Windshield Wiper Motor Replacement**

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Windshield Wiper and Washer Switch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B3810: WINDSHIELD WIPER RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3810 02

Headlamp Washer Relay Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Washer Pump Control	1	1	2	-
Headlamp Washer Relay Control	B3810 02	1	2	-
Headlamp Washer Pump Ground	-	1	1	-
Headlamp Washer Pump Relay Ground	-	1	-	-
1. Headlamp Washer Inoperative 2. Headlamp Washers Always ON				

Circuit/System Description

The body control module (BCM) controls the washer motor based on an input from the windshield wiper/washer switch. The BCM monitors the washer switch through the windshield washer switch signal circuit. When the washer switch is closed, a low reference is supplied to the front washer switch signal circuit. When this is seen, the BCM will activate the front washer pump relay with a control circuit pulled high. While the washer pump relay is activated the windshield washers and low speed wipers will turn on.

When headlamp washers are equipped, they shall be sprayed with washer fluid as a result of an extended windshield wash switch activation. In order to preserve washer fluid, the feature shall only be allowed to activate if the low or high beam headlamps are active. In addition, after the initial headlamp wash operation has been performed, additional headlamp washes shall not be performed for the next 4 windshield wash activations or for 48 hours, whichever occurs first.

Conditions for Running the DTC

- Ignition ON.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

A short to ground is detected in the headlamp washer relay control circuit.

Action Taken When the DTC Sets

Washer operation is suspended.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- A history DTC will clear after 50 consecutive ignition cycles without a fault present.

Diagnostic Aids

The headlamp wash feature will only be activated if the low or high beam headlamps are active as well.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Windshield Washer Switch parameter changes between Active and Inactive when pressing the windshield washer switch.

- **If the parameter does not change**

Refer to **Washer Malfunction.**

- **If the parameter changes**

3. Verify the headlamp washers turn ON and OFF when commanding the Headlamp Washer Relay Active and Inactive with a scan tool.

- **If the headlamp washers do not turn ON and OFF**

Refer to Circuit/System Testing

- **If the headlamp washers turn ON and OFF**

4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR2 Headlamp Washer Pump Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 86 and ground.

- **If 10 ohms or greater**

1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

Replace the X50A Fuse Block - Underhood.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the G16 Headlamp Washer Pump.
2. Test for infinite resistance between the control circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the G16 Headlamp Washer Pump.

- **If the test lamp illuminates**

5. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
6. Verify the test lamp turns ON and OFF when commanding the Headlamp Washer Relay Active and

Inactive with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, remove the test lamp, disconnect the X5 harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit terminal 26 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.

- **If the test lamp turns ON and OFF**

7. Verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

- **If the test lamp illuminates**

Repair the short to voltage on the control circuit

- **If the test lamp does not illuminate**

8. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G19 Headlamp Washer Pump. It may take up to 2 min for all vehicle systems to power down.
9. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

10. Connect the harness connector at the G19 Headlamp Washer Pump.
11. Ignition ON, connect a 15 A fused jumper wire between the control circuit terminal 87 and B+.
12. Verify the G19 Headlamp Washer Pump is activated.

- **If the G19 Headlamp Washer Pump does not activate**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the G19 Headlamp Washer Pump.
2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the G19 Headlamp Washer Pump.
 - **If the G19 Headlamp Washer Pump activates**
13. Test or replace the KR2 Headlamp Washer Pump Relay.

Component Testing

Windshield Wiper/Washer Switch

1. Ignition OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch.
2. Test for infinite resistance between the signal terminal 5 and the low reference terminal 2 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S82 Windshield Wiper/Washer Switch.
 - **If infinite resistance**
3. Test for less than 2 ohms between the signal circuit terminal 5 and the low reference circuit terminal 2 with the switch in the closed position.
 - **If 2 ohms or greater**

Replace the S82 Windshield Wiper/Washer Switch.
 - **If less than 2 ohms**
4. All OK

Relay Test

1. Ignition OFF, disconnect the KR2 headlamp washer pump relay.
2. Test for 60-200 ohms between terminals 85 and 86.
 - **If less than 60 or greater than 200**

Replace the KR2 headlamp washer pump relay.
 - **If between 60-200 ohms**
3. Test for infinite resistance between the terminals listed below:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - **If less than infinite resistance**

Replace the KR2 headlamp washer pump relay.

- **If infinite resistance**

4. Install a 10 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.

5. Test for less than 10 ohms between terminals 30 and 87.

- **If 10 ohms or greater**

Replace the KR2 headlamp washer pump relay.

- **If less than 10 ohms**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Windshield Wiper and Washer Switch Replacement**
- **Control Module References** for BCM replacement, programming and setup

DTC B3873: FRONT WASHER RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3873 01

Front Washer Relay Circuit Short to Battery

DTC B3873 02

Front Washer Relay Circuit Short to Ground

DTC B3873 04

Front Washer Relay Circuit Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Windshield Washer Switch Signal	2	1	1	-
Windshield Washer Pump Control	1	1	2	-
Windshield Washer Relay Control	B3873 02	B3873 04	B3873 01	-
Windshield Washer Pump Ground	-	1	-	-
1. Washer Inoperative 2. Washer Always ON				

Circuit/System Description

The body control module (BCM) controls the windshield washer pump based on an input from the windshield wiper/washer switch. The BCM monitors the washer switch through the windshield washer switch signal circuit. When the washer switch is closed, ground is supplied to the windshield washer switch signal circuit. When this is the case, the BCM will command the windshield washer pump and the low speed wipers on.

Conditions for Running the DTC

- Ignition ON.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

- A short to ground or an open/high resistance is detected in the windshield washer relay control circuit.
- A short to voltage is detected in the windshield washer relay control circuit.

Action Taken When the DTC Sets

Washer operation is suspended.

Conditions for Clearing the DTC

A current DTC clears when the diagnostic runs and passes.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Windshield Washer Switch parameter changes between Active and Inactive when pressing the windshield washer switch.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Wiper/Washer Switch Malfunction.
 - **If the parameter changes**
3. Verify the scan tool Instrument Cluster Washer Fluid Level Switch parameter changes between Open when the fluid level is full and Closed when the fluid level is low.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Washer Fluid Level Switch Malfunction.
 - **If the parameter changes**
4. Verify the Windshield Washers turn On when commanding the Windshield Washer Relay Active with a scan tool.
 - **If the Windshield Washers do not turn ON**

Refer to Circuit/System Testing - Windshield Washer Pump Malfunction
 - **If the Windshield Washers turn ON**
5. All OK.

Circuit/System Testing

Windshield Wiper/Washer Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch. It may take up to 11 min for all vehicle systems to power down.

2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If less than 5 ohms**
3. Ignition ON.
4. Verify the scan tool Windshield Washer Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the low reference circuit terminal 2.
6. Verify the scan tool Windshield Washer Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
7. Test or replace the S82 Windshield Wiper/Washer Switch.

Windshield Washer Fluid Level Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B118B Windshield Washer Fluid Level Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal B and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the scan tool Washer Fluid Level Switch parameter is Open.
 - **If not Open**
 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 2. Test for infinite resistance between the signal circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the P16 Instrument Cluster.
 - **If Open**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B.
- 6. Verify the scan tool Washer Fluid Level Switch parameter is Closed.
 - **If not Closed**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.
 - **If Closed**
- 7. Test or replace the B118B Windshield Washer Fluid Level Switch.

Windshield Washer Pump Malfunction

1. Ignition OFF, and all vehicle systems OFF. Disconnect the harness connector at the G24 Windshield Washer Pump. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 1 and the ground circuit terminal 2, ignition ON.
4. Verify the test lamp does NOT turn ON and OFF when commanding the Windshield Washer Relay Active and Inactive with a scan tool.
 - **If the test lamp turns ON and OFF**

Test or replace the G24 Windshield Washer Pump.

- **If the test lamp does not turn ON and OFF**

5. Ignition OFF, connect the harness connector at the G24 Windshield Washer Pump. Disconnect the X1 harness connector at the X50A Fuse Block - Underhood, It may take up to 2 min for all vehicle systems to power down.
6. Test for less than 10 ohms between the ground circuit terminal 71 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
7. Ignition ON.
8. Verify the G24 Windshield Washer Pump is not activated.
 - **If the G24 Windshield Washer Pump is activated**
 1. Ignition OFF, disconnect the harness connector at the G24 Windshield Washer Pump, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the G24 Windshield Washer Pump.
 - **If the G24 Windshield Washer Pump is not activated**
9. Connect a 20 A fused jumper wire between the control circuit terminal 30 and B+.
10. Verify the G24 Windshield Washer Pump activates.
 - **If the G24 Windshield Washer Pump does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the G24 Windshield Washer Pump, ignition ON.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the G24 Windshield Washer Pump.
 - **If the G24 Windshield Washer Pump activates**
11. Ignition OFF, connect the X1 harness connector at the X50A Fuse Block - Underhood. Disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
12. Verify the G24 Windshield Washer Pump is not activated.
 - **If the G24 Windshield Washer Pump is activated**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for less than 1 V between the K9 Body Control Module control circuit terminal 14 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the X50A Fuse Block - Underhood.
- **If the G24 Windshield Washer Pump is not activated**
- 13. Connect a 3 A fused jumper wire between the control circuit terminal 14 and B+.
- 14. Verify the G24 Windshield Washer Pump activates.
 - **If the G24 Windshield Washer Pump does not activate**
 - 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the X50A Fuse Block - Underhood, ignition ON.
 - 2. Test for infinite resistance between the K9 Body Control Module control circuit terminal 14 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the X50A Fuse Block - Underhood.
 - **If the G24 Windshield Washer Pump activates**
- 15. Replace the K9 Body Control Module.

Component Testing

Windshield Wiper/Washer Switch

1. Ignition OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch.
2. Test for infinite resistance between the signal terminal 5 and the low reference terminal 2 with the switch in the open position.
 - **If less than infinite resistance**
 - Replace the S82 Windshield Wiper/Washer Switch.
 - **If infinite resistance**
3. Test for less than 2 ohms between the signal circuit terminal 5 and the low reference circuit terminal 2 with the switch in the closed position.
 - **If 2 ohms or greater**
 - Replace the S82 Windshield Wiper/Washer Switch.
 - **If less than 2 ohms**
4. All OK

Windshield Washer Fluid Level Switch

1. Ignition OFF, disconnect the harness connector at the B118B Windshield Washer Fluid Level Switch.
2. Test for infinite resistance between the signal circuit terminal A and the ground circuit terminal B with

the switch in the open position.

- **If less than infinite resistance**

Replace the B118B Windshield Washer Fluid Level Switch.

- **If infinite resistance**

3. Test for less than 2 ohms between the signal circuit terminal A and the ground circuit terminal B with the switch in the closed position.

- **If 2 ohms or greater**

Replace the B118B Windshield Washer Fluid Level Switch.

- **If less than 2 ohms**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuse Block Replacement**
- **Windshield Washer Pump Replacement**
- **Windshield Washer Solvent Level Sensor Replacement**
- **Windshield Wiper and Washer Switch Replacement**
- **Control Module References** for BCM and Instrument Cluster replacement, programming, and setup

SYMPTOMS - WIPER/WASHER SYSTEMS

NOTE: **The following steps must be completed before using the symptom tables:**

1. Perform **Diagnostic System Check - Vehicle** , in order to verify that all of the following conditions are true:
 - No DTCs are set.
 - The control modules can communicate via the serial data link.
2. Refer to **Wiper/Washer System Description and Operation** in order to familiarize yourself with the system functions.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the windshield wiper/washer system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Inspect the washer fluid reservoir for the proper fluid level.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Windshield Wiper System Malfunction**
- **Washer Malfunction**

WINDSHIELD WIPER SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3715 01

Windshield Wiper Relay Circuit Short to Battery

DTC B3715 02

Windshield Wiper Relay Circuit Short to Ground

DTC B3715 04

Windshield Wiper Relay Circuit Open

DTC B3875 01

Windshield Wiper High Speed Relay Circuit Short to Battery

DTC B3875 02

Windshield Wiper High Speed Relay Circuit Short to Ground

DTC B3875 04

Windshield Wiper High Speed Relay Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Wiper Switch Low Signal terminal 3	1	1	1	-
Windshield Wiper Switch High Signal terminal 1	4	2	2	-
Windshield Wiper Motor Park Switch Signal terminal C	3	3	-	-
Front Wiper Relay Control terminal 85	B3715 02	B3715 04	B3715 01	-
Windshield Wiper High Speed Relay Control terminal 86	B3875 02	B3875 04	B3875 01	-
Windshield Wiper Motor Control terminal B	1	1	4	-
Windshield Wiper Motor High Speed Control terminal A	2	2	4	-
Windshield Wiper Switch Low Reference terminal 2	-	1, 2	1, 2	-
Windshield Wiper Motor Ground terminal D	-	1, 2, 3	-	-
Front Wiper Relay Ground terminal 85	-	1	-	-
1. Delay or Low Speed Wipers Inoperative 2. High Speed Wipers Inoperative 3. Wipers Do Not Park 4. Wipers Always ON				

Circuit/System Description

The body control module (BCM) controls the wiper motor based on input from the windshield wiper/washer switch. The BCM monitors the wiper/washer switch through two separate signal circuits and a low reference circuit. The windshield wiper switch high signal circuit is used to determine high speed wiper operation, the windshield wiper switch low signal is used to determine low speed, intermittent, and mist operation through the use of a resistor ladder, and the windshield washer switch signal circuit is used to determine washer operation.

The BCM controls the windshield wiper motor through two output controls, controlling two relays which determine the desired wiper speed, high or low.

Conditions for Running the DTC

- The DTC runs only when a wiper output is actively being requested by the BCM.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

- A short to ground is detected in the front wiper relay control circuit or in the high speed relay control

circuit.

- A short to voltage or an open/high resistance is detected in the front wiper relay control circuit or in the high speed relay control circuit.

Action Taken When the DTC Sets

The BCM will not activate the wiper output.

Conditions for Clearing the DTC

- A current DTC will clear when the condition for setting the fault is no longer present.
- A history DTC will clear after 50 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Windshield Wiper High Speed Switch parameter changes between Active and Inactive when activating the high speed windshield wipers.
 - **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Wiper/Washer Switch Malfunction.

- **If the parameter changes**

3. Verify the scan tool Windshield Wiper Switch parameter changes between Off and Low when activating the low speed windshield wipers.

- **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Wiper/Washer Switch Malfunction.

- **If the parameter changes**

4. Verify the scan tool Windshield Wiper Switch parameter changes between Delay 1 and Delay 5 when cycling the intermittent speed windshield wipers.

- **If the parameter does not change**

Test or replace the S82 Windshield Wiper/Washer Switch.

- **If the parameter changes**

5. Verify the M75 Windshield Wiper Motor changes between Off, Low, and High when cycling the S82 Windshield Wiper/Washer Switch between Off, Low, and High.

- **If the Windshield Wiper Motor does not cycle between Off, Low, and High**

Refer to Circuit/System Testing - Windshield Wiper Motor Malfunction

- **If the Windshield Wiper Motor cycles between Off, Low, and High**

6. Ignition OFF.
7. Verify the scan tool Windshield Wiper Park Switch parameter is Active.

- **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Wiper Motor Malfunction.

- **If the parameter changes**

8. All OK.

Circuit/System Testing

Windshield Wiper/Washer Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch. It may take up to 11 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If less than 10 ohms**
- 3. Ignition ON.
- 4. Verify the scan tool Windshield Wiper High Speed Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
- 6. Verify the scan tool Windshield Wiper High Speed Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
- 7. Test for greater than 8 V between the signal circuit terminal 3 and ground.
 - **If less than 8 V**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit and ground
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If 8 V or greater**
- 8. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module, ignition ON.
- 9. Test for less than 1 V between the S82 Windshield Wiper/Washer Switch signal circuit terminal 3 and ground.
 - **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

10. Test or replace the S82 Windshield Wiper/Washer Switch.

Windshield Wiper Motor Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M75 Windshield Wiper Motor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal D and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Windshield Wiper Park Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal C and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal C and the ground circuit terminal D.
6. Verify the scan tool Windshield Wiper Park Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
7. Ignition OFF and all vehicle systems OFF, disconnect the KR12B Windshield Wiper Relay. It may take up to 2 min for all vehicle systems to power down.
8. Test for less than 10 ohms between the ground circuit terminals listed below and ground.
 - terminal 85
 - terminal 87A

- **If 10 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

9. Ignition ON.
10. Verify a test lamp illuminates between the B+ circuit terminal 87 and the ground circuit terminal 87A.
 - **If the test lamp does not illuminate and the circuit fuse is good**

Replace the X50A Fuse Block - Underhood.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp. Disconnect the KR12C Windshield Wiper Speed Control Relay.
2. Test for infinite resistance between the control circuits listed below and ground.
 - Terminal 87A
 - Terminal 87
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M75 Windshield Wiper Motor

- **If the test lamp illuminates**

11. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
12. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper Motor Relay Low and Off with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.

- **If the test lamp turns ON and OFF**

13. Ignition OFF, connect the KR12B Windshield Wiper Relay and disconnect the KR12C Windshield Wiper Speed Control Relay, ignition ON.

14. Test for less than 10 ohms between the control circuit terminal 30 and ground.

- **If 10 ohms or greater**

Test or replace the KR12B Windshield Wiper Relay.

- **If less than 10 ohms**

15. Connect a test lamp between the control circuit terminal 30 and ground.

16. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper Motor Relay Low and Off with a scan tool.

- **If the test lamp does not turn ON and OFF**

Test or replace the KR12B Windshield Wiper Relay.

- **If the test lamp turns ON and OFF**

17. Verify a test lamp illuminates between the B+ circuit terminal 85 and ground.

- **If the test lamp does not illuminate**

Replace the X50A Fuse Block - Underhood.

- **If the test lamp illuminates**

18. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.

19. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper High Speed Relay High and Off with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.

2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V

3. Ignition OFF.

4. Test for less than 2 ohms in the control circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.

2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
20. Ignition OFF, connect the KR12C Windshield Wiper Speed Control Relay.
 21. Connect a test lamp between the M75 Windshield Wiper Motor control circuit terminal B and ground circuit terminal D, ignition ON.
 22. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper Motor Relay Low and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the KR12C Windshield Wiper Speed Control Relay.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the KR12C Windshield Wiper Speed Control Relay.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the KR12C Windshield Wiper Speed Control Relay, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the KR12C Windshield Wiper Speed Control Relay.
 - **If the test lamp turns ON and OFF**
 23. Connect a test lamp between the M75 Windshield Wiper Motor control circuit terminal A and ground circuit terminal D, ignition ON.
 24. Verify the test lamp turns ON and OFF when commanding the Windshield Wiper High Speed Relay High and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the KR12C Windshield Wiper Speed Control Relay.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the KR12C Windshield Wiper Speed Control Relay.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the KR12C Windshield Wiper Speed Control Relay, ignition ON.

2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the KR12C Windshield Wiper Speed Control Relay.
 - **If the test lamp turns ON and OFF**

25. Test or replace the M75 Windshield Wiper Motor.

Component Testing

Windshield Wiper/Washer Switch

1. Ignition OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch.
2. Test for infinite resistance between the signal terminal 1 and the low reference terminal 2 with the high speed switch in the open position.
 - **If less than infinite resistance**

Replace the S82 Windshield Wiper/Washer Switch.

- **If infinite resistance**

3. Test for less than 2 ohms between the signal circuit terminal 1 and the low reference circuit terminal 2 with the high speed switch in the closed position.
 - **If 2 ohms or greater**

Replace the S82 Windshield Wiper/Washer Switch.

- **If less than 2 ohms**

4. Test for infinite resistance between the signal terminal 3 and the low reference terminal 2 with the low speed switch in the open position.
 - **If less than infinite resistance**

Replace the S82 Windshield Wiper/Washer Switch.

- **If infinite resistance**

5. Test for the resistance values listed below between the signal circuit terminal 3 and the low reference circuit terminal 2 by cycling the switch between Delay 1 and Delay 5.
 - Delay 1 : 3.8kohms
 - Delay 2 : 2.8kohms
 - Delay 3 : 1.9kohms
 - Delay 4 : 2.8kohms
 - Delay 5 : 770ohms
 - **If not within the resistance values listed**

Replace the S82 Windshield Wiper/Washer Switch.

- **If within the resistance values listed**

6. All OK

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 60-200 ohms between terminals 85 and 86.
 - **If less than 60 or greater than 200**

Replace the relay.

- **If between 60-200 ohms**

3. Test for infinite resistance between the terminals listed below:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Test for less than 5 ohms between terminals 30 and 87A.
 - **If 5 ohms or greater**

Replace the relay.

- **If less than 5 ohms**

5. Install a 10 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
6. Test for less than 5 ohms between terminals 30 and 87.
 - **If 5 ohms or greater**

Replace the relay.

- **If less than 5 ohms**

7. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Windshield Wiper Motor Replacement**

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Windshield Wiper and Washer Switch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

WASHER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3873 01

Front Washer Relay Circuit Short to Battery

DTC B3873 02

Front Washer Relay Circuit Short to Ground

DTC B3873 04

Front Washer Relay Circuit Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Washer Switch Signal	2	1	1	-
Windshield Washer Pump Control	1	1	2	-
Windshield Washer Relay Control	B3873 02	B3873 04	B3873 01	-
Windshield Washer Pump Ground	-	1	-	-
1. Washer Inoperative 2. Washer Always ON				

Circuit/System Description

The body control module (BCM) controls the windshield washer pump based on an input from the windshield wiper/washer switch. The BCM monitors the washer switch through the windshield washer switch signal

circuit. When the washer switch is closed, ground is supplied to the windshield washer switch signal circuit. When this is the case, the BCM will command the windshield washer pump and the low speed wipers on.

Conditions for Running the DTC

- Ignition ON.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

- A short to ground or an open/high resistance is detected in the windshield washer relay control circuit.
- A short to voltage is detected in the windshield washer relay control circuit.

Action Taken When the DTC Sets

Washer operation is suspended.

Conditions for Clearing the DTC

A current DTC clears when the diagnostic runs and passes.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Windshield Washer Switch parameter changes between Active and Inactive when pressing the windshield washer switch.

- **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Wiper/Washer Switch Malfunction.

- **If the parameter changes**

3. Verify the scan tool Instrument Cluster Washer Fluid Level Switch parameter changes between Open when the fluid level is full and Closed when the fluid level is low.

- **If the parameter does not change**

Refer to Circuit/System Testing - Windshield Washer Fluid Level Switch Malfunction.

- **If the parameter changes**

4. Verify the Windshield Washers turn On when commanding the Windshield Washer Relay Active with a scan tool.

- **If the Windshield Washers do not turn ON**

Refer to Circuit/System Testing - Windshield Washer Pump Malfunction

- **If the Windshield Washers turn ON**

5. All OK.

Circuit/System Testing

Windshield Wiper/Washer Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch. It may take up to 11 min for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.

- **If 5 ohms or greater**

1. Ignition OFF.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.

- **If less than 5 ohms**

3. Ignition ON.
4. Verify the scan tool Windshield Washer Switch parameter is Inactive.

- **If not Inactive**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the signal circuit terminal 5 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K9 Body Control Module.
- **If Inactive**
- 5. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the low reference circuit terminal 2.
- 6. Verify the scan tool Windshield Washer Switch parameter is Active.
 - **If not Active**
 - 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 - 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If Active**
- 7. Test or replace the S82 Windshield Wiper/Washer Switch.

Windshield Washer Fluid Level Switch Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B118B Windshield Washer Fluid Level Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal B and ground.
 - **If 10 ohms or greater**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Washer Fluid Level Switch parameter is Open.
 - **If not Open**
 - 1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
 - 2. Test for infinite resistance between the signal circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the P16 Instrument Cluster.
 - **If Open**
5. Install a 3 A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B.
6. Verify the scan tool Washer Fluid Level Switch parameter is Closed.

- **If not Closed**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the P16 Instrument Cluster.

- **If Closed**

7. Test or replace the B118B Windshield Washer Fluid Level Switch.

Windshield Washer Pump Malfunction

1. Ignition OFF, and all vehicle systems OFF. Disconnect the harness connector at the G24 Windshield Washer Pump. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 1 and the ground circuit terminal 2, ignition ON.
4. Verify the test lamp does NOT turn ON and OFF when commanding the Windshield Washer Relay Active and Inactive with a scan tool.
 - **If the test lamp turns ON and OFF**

Test or replace the G24 Windshield Washer Pump.

- **If the test lamp does not turn ON and OFF**

5. Ignition OFF, connect the harness connector at the G24 Windshield Washer Pump. Disconnect the X1 harness connector at the X50A Fuse Block - Underhood, It may take up to 2 min for all vehicle systems to power down.
6. Test for less than 10 ohms between the ground circuit terminal 71 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
7. Ignition ON.

8. Verify the G24 Windshield Washer Pump is not activated.
 - **If the G24 Windshield Washer Pump is activated**
 1. Ignition OFF, disconnect the harness connector at the G24 Windshield Washer Pump, ignition ON.
 2. Test for less than 1 V between the control circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the G24 Windshield Washer Pump.
 - **If the G24 Windshield Washer Pump is not activated**
9. Connect a 20 A fused jumper wire between the control circuit terminal 30 and B+.
10. Verify the G24 Windshield Washer Pump activates.
 - **If the G24 Windshield Washer Pump does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the G24 Windshield Washer Pump, ignition ON.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than Infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the G24 Windshield Washer Pump.
 - **If the G24 Windshield Washer Pump activates**
11. Ignition OFF, connect the X1 harness connector at the X50A Fuse Block - Underhood. Disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
12. Verify the G24 Windshield Washer Pump is not activated.
 - **If the G24 Windshield Washer Pump is activated**
 1. Ignition OFF, disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for less than 1 V between the K9 Body Control Module control circuit terminal 14 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the X50A Fuse Block - Underhood.
 - **If the G24 Windshield Washer Pump is not activated**
13. Connect a 3 A fused jumper wire between the control circuit terminal 14 and B+.
14. Verify the G24 Windshield Washer Pump activates.
 - **If the G24 Windshield Washer Pump does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the X50A Fuse Block - Underhood, ignition ON.
 2. Test for infinite resistance between the K9 Body Control Module control circuit terminal 14 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, test or replace the X50A Fuse Block - Underhood.

- **If the G24 Windshield Washer Pump activates**

15. Replace the K9 Body Control Module.

Component Testing

Windshield Wiper/Washer Switch

1. Ignition OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch.
2. Test for infinite resistance between the signal terminal 5 and the low reference terminal 2 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S82 Windshield Wiper/Washer Switch.

- **If infinite resistance**
3. Test for less than 2 ohms between the signal circuit terminal 5 and the low reference circuit terminal 2 with the switch in the closed position.
 - **If 2 ohms or greater**

Replace the S82 Windshield Wiper/Washer Switch.

- **If less than 2 ohms**
4. All OK

Windshield Washer Fluid Level Switch

1. Ignition OFF, disconnect the harness connector at the B118B Windshield Washer Fluid Level Switch.
2. Test for infinite resistance between the signal circuit terminal A and the ground circuit terminal B with the switch in the open position.
 - **If less than infinite resistance**

Replace the B118B Windshield Washer Fluid Level Switch.

- **If infinite resistance**
3. Test for less than 2 ohms between the signal circuit terminal A and the ground circuit terminal B with the switch in the closed position.
 - **If 2 ohms or greater**

Replace the B118B Windshield Washer Fluid Level Switch.

- **If less than 2 ohms**
4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuse Block Replacement**
- **Windshield Washer Pump Replacement**
- **Windshield Washer Solvent Level Sensor Replacement**
- **Windshield Wiper and Washer Switch Replacement**
- **Control Module References** for BCM and Instrument Cluster replacement, programming, and setup

RAIN SENSOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Rain Sensor B+	1	1	-	-
Rain Sensor LIN	U151A 00	U151A 00	U151A 00	B370A 39
Rain Sensor Ground	-	1	-	-
1. Rain Sensor Malfunction				

Circuit/System Description

B+ voltage is supplied to the Rain Sensor. Whenever the ignition is ON, or accessory positions, the body control module (BCM), sends the turn signal/multifunction switch status by using data communication. When a wipe cycle is needed, the Rain Sensor sends a data communication message to the BCM, requesting the wiper operation. The BCM commands the Windshield Wiper Motor wipe cycles. If at anytime a fault occurs between the Rain Sensor and BCM, the BCM will use the inputs from the turn signal/multifunction switch in the delay positions to operate the Windshield Wiper Motor at continuous variable delay intervals.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B370A is not set.
 - **If DTC B370A is set**

Please Refer to **DTC B370A**

- **If DTC B370A is not set**

3. Verify DTC U151A is not set.
 - **If DTC U151A is set**

Please Refer to **DTC U1500-U15FF**

- **If DTC U151A is not set**

4. Verify the wipers operate at low speed when the Windshield Wiper Switch is in the LOW position.
 - **If the wipers are not operating at low speed**

Refer to **Windshield Wiper System Malfunction.**

- **If the wipers are operating at low speed**

5. Place the Windshield Wiper Switch in the delay mode/moisture sensitivity settings Delay 1 through Delay 5 and spray the outside of the windshield in the rear view mirror/rain sensor region with a water bottle.
6. Verify the wipers operate at low speed.
 - **If the wipers are not operating at low speed**

Refer to Circuit System Testing.

- **If the wipers are operating at low speed**

7. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the B177 Rain Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the B177 Rain Sensor.
 - **If the test lamp illuminates**
4. Ignition OFF, remove the test lamp, ignition ON.
5. Test for 4.0-12.0 V between the serial data circuit terminal 2 and ground.
 - **If less than 4.0 V**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the serial data circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the serial data circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If greater than 12.0 V**
 1. Ignition OFF, disconnect the X6 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the serial data circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K9 Body Control Module.
 - **If between 4.0-12.0 V**
6. Test or replace the B177 Rain Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Windshield Outside Moisture and Headlamp Automatic Control Ambient Light Sensor Replacement**
- **Control Module References** for BCM replacement, programming and setup

HEADLAMP WASHER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3810 02

Headlamp Washer Relay Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Washer Pump Control	1	1	2	-
Headlamp Washer Relay Control	B3810 02	1	2	-
Headlamp Washer Pump Ground	-	1	1	-
Headlamp Washer Pump Relay Ground	-	1	-	-
1. Headlamp Washer Inoperative 2. Headlamp Washers Always ON				

Circuit/System Description

The body control module (BCM) controls the washer motor based on an input from the windshield wiper/washer switch. The BCM monitors the washer switch through the windshield washer switch signal circuit. When the washer switch is closed, a low reference is supplied to the front washer switch signal circuit. When this is seen, the BCM will activate the front washer pump relay with a control circuit pulled high. While the washer pump relay is activated the windshield washers and low speed wipers will turn on.

When headlamp washers are equipped, they shall be sprayed with washer fluid as a result of an extended windshield wash switch activation. In order to preserve washer fluid, the feature shall only be allowed to activate if the low or high beam headlamps are active. In addition, after the initial headlamp wash operation has been performed, additional headlamp washes shall not be performed for the next 4 windshield wash activations or for 48 hours, whichever occurs first.

Conditions for Running the DTC

- Ignition ON.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

A short to ground is detected in the headlamp washer relay control circuit.

Action Taken When the DTC Sets

Washer operation is suspended.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- A history DTC will clear after 50 consecutive ignition cycles without a fault present.

Diagnostic Aids

The headlamp wash feature will only be activated if the low or high beam headlamps are active as well.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Windshield Washer Switch parameter changes between Active and Inactive when pressing the windshield washer switch.
 - **If the parameter does not change**

Refer to **Washer Malfunction**.

- **If the parameter changes**
3. Verify the headlamp washers turn ON and OFF when commanding the Headlamp Washer Relay Active and Inactive with a scan tool.
 - **If the headlamp washers do not turn ON and OFF**

Refer to Circuit/System Testing

- **If the headlamp washers turn ON and OFF**
4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR2 Headlamp Washer Pump Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 86 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**

3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**

Replace the X50A Fuse Block - Underhood.

- **If the test lamp does not illuminate and the circuit fuse is open**
1. Ignition OFF, remove the test lamp, disconnect the harness connector at the G16 Headlamp Washer

Pump.

2. Test for infinite resistance between the control circuit terminal 2 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the G16 Headlamp Washer Pump.
 - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
6. Verify the test lamp turns ON and OFF when commanding the Headlamp Washer Relay Active and Inactive with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the X5 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the control circuit terminal 26 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, remove the test lamp, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
7. Verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.
 - **If the test lamp illuminates**

Repair the short to voltage on the control circuit

 - **If the test lamp does not illuminate**
8. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G19 Headlamp Washer Pump. It may take up to 2 min for all vehicle systems to power down.
9. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**
 1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
10. Connect the harness connector at the G19 Headlamp Washer Pump.

11. Ignition ON, connect a 15 A fused jumper wire between the control circuit terminal 87 and B+.
12. Verify the G19 Headlamp Washer Pump is activated.
 - **If the G19 Headlamp Washer Pump does not activate**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the G19 Headlamp Washer Pump.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the G19 Headlamp Washer Pump.
 - **If the G19 Headlamp Washer Pump activates**
13. Test or replace the KR2 Headlamp Washer Pump Relay.

Component Testing

Windshield Wiper/Washer Switch

1. Ignition OFF, disconnect the harness connector at the S82 Windshield Wiper/Washer Switch.
2. Test for infinite resistance between the signal terminal 5 and the low reference terminal 2 with the switch in the open position.
 - **If less than infinite resistance**

Replace the S82 Windshield Wiper/Washer Switch.
 - **If infinite resistance**
3. Test for less than 2 ohms between the signal circuit terminal 5 and the low reference circuit terminal 2 with the switch in the closed position.
 - **If 2 ohms or greater**

Replace the S82 Windshield Wiper/Washer Switch.
 - **If less than 2 ohms**
4. All OK

Relay Test

1. Ignition OFF, disconnect the KR2 headlamp washer pump relay.
2. Test for 60-200 ohms between terminals 85 and 86.
 - **If less than 60 or greater than 200**

Replace the KR2 headlamp washer pump relay.
 - **If between 60-200 ohms**
3. Test for infinite resistance between the terminals listed below:
 - 30 and 86

- 30 and 87
- 30 and 85
- 85 and 87
- **If less than infinite resistance**

Replace the KR2 headlamp washer pump relay.

- **If infinite resistance**

4. Install a 10 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 10 ohms between terminals 30 and 87.
 - **If 10 ohms or greater**

Replace the KR2 headlamp washer pump relay.

- **If less than 10 ohms**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Within an Electrical Center) , Relay Replacement (Attached to Wire Harness)**
- **Windshield Wiper and Washer Switch Replacement**
- **UNDERHOOD ELECTRICAL CENTER OR JUNCTION BLOCK REPLACEMENT**
- **Control Module References** for BCM replacement, programming and setup

REPAIR INSTRUCTIONS

WINDSHIELD WIPER AND WASHER SWITCH REPLACEMENT

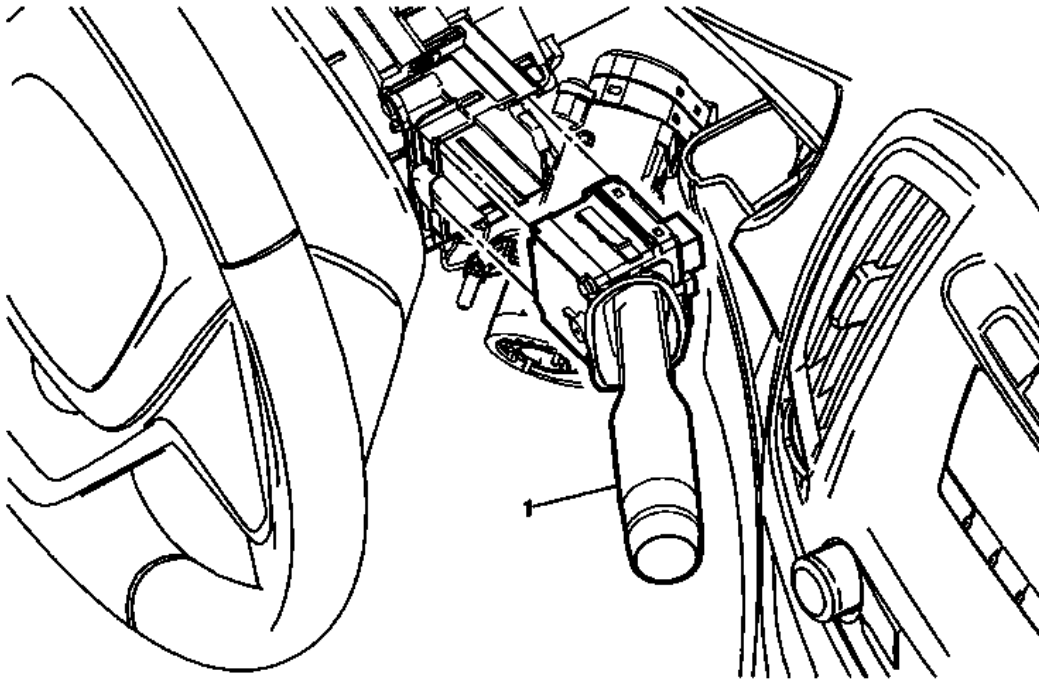


Fig. 3: Windshield Wiper and Washer Switch
 Courtesy of GENERAL MOTORS COMPANY

Windshield Wiper and Washer Switch Replacement

Callout	Component Name
Preliminary Procedure	
Remove the steering column trim covers. Refer to <u>Steering Column Trim Cover Replacement</u> .	
1	Windshield Wiper and Washer Switch Procedure <ol style="list-style-type: none"> 1. Disconnect the electrical connector. 2. Release the retaining tabs and remove the windshield wiper and washer switch from the turn signal switch bracket.

WINDSHIELD WASHER NOZZLE HOSE REPLACEMENT

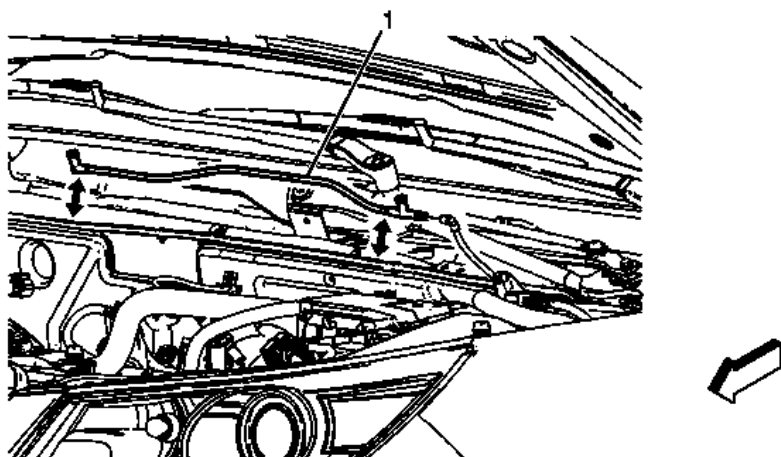


Fig. 4: Windshield Washer Nozzle Hose
 Courtesy of GENERAL MOTORS COMPANY

Windshield Washer Nozzle Hose Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the air inlet grille panel. Refer to <u>Air Inlet Grille Panel Replacement</u> . 2. Disconnect the washer container hose from the "T" connection at the windshield washer nozzle hose assembly in the plenum. 3. Remove the windshield washer nozzle hose from the plenum.	
1	Windshield Washer Nozzle Hose Assembly TIP: Prime the windshield washer pump after the new hose installation.

WINDSHIELD WASHER NOZZLE REPLACEMENT

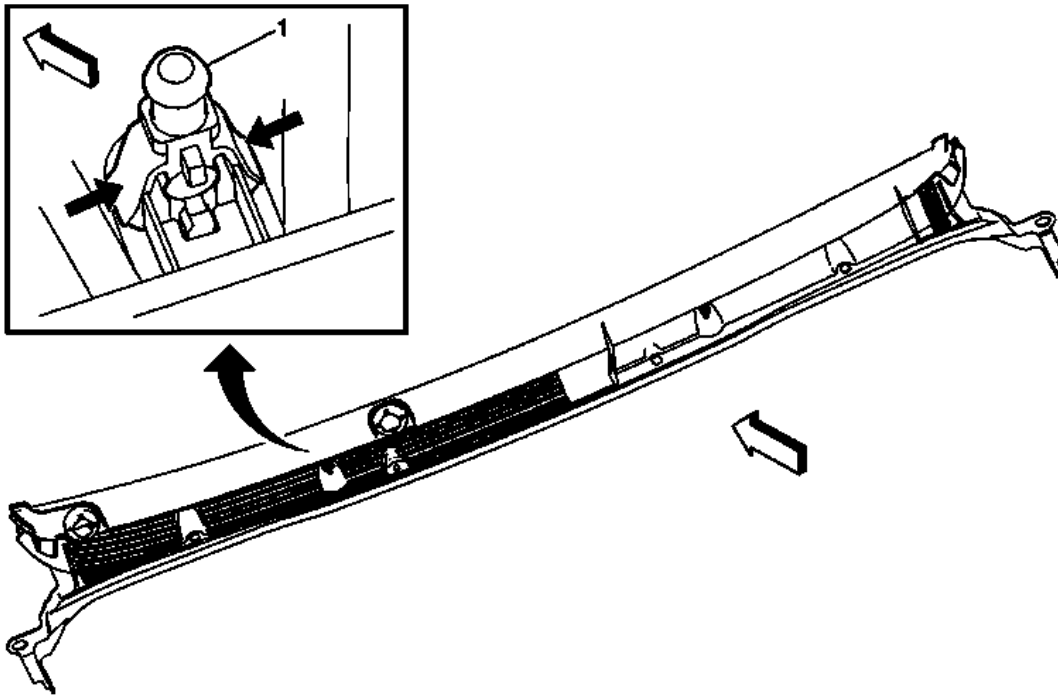


Fig. 5: Windshield Washer Nozzle
 Courtesy of GENERAL MOTORS COMPANY

Windshield Washer Nozzle Replacement

Callout	Component Name
Preliminary Procedure	
Remove the air inlet grille panel assembly. Refer to <u>Air Inlet Grille Panel Replacement</u> .	
1	Windshield Washer Nozzle (Qty: 2) TIP: Depress the two washer nozzle tabs and push outward in order to remove the nozzle from the air inlet grille panel assembly.

WINDSHIELD WASHER SOLVENT CONTAINER FILLER TUBE REPLACEMENT

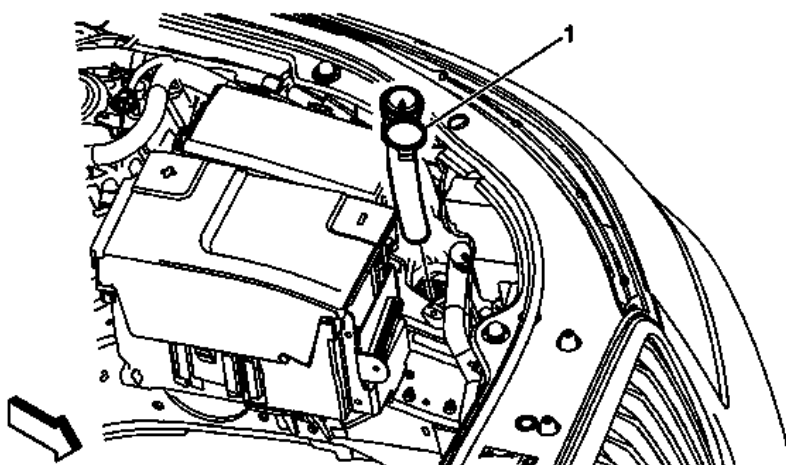


Fig. 6: Windshield Washer Solvent Container Filler Tube
 Courtesy of GENERAL MOTORS COMPANY

Windshield Washer Solvent Container Filler Tube Replacement

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Open and support the hood. 2. Reach into the engine compartment at the windshield washer solvent container fill tube side and grasp the fill tube neck. 3. With a slight turn and upward pull, remove the fill tube from the top of the windshield washer solvent container. 4. Inspect the fill tube grommet in the top of the washer container. 	
1	Windshield Washer Solvent Container Fill Tube Procedure <ol style="list-style-type: none"> 1. Lubricate the end of the fill tube with clean windshield washer solvent prior to installing the fill tube into the top of the windshield washer container. 2. Slowly press the fill tube neck into the windshield washer container seal. 3. Ensure the top of the fill tube tab locks into the tab on the front compartment fuse block housing. 4. Once connected, push downward in order to engage the fill tube.

WINDSHIELD WASHER SOLVENT CONTAINER REPLACEMENT

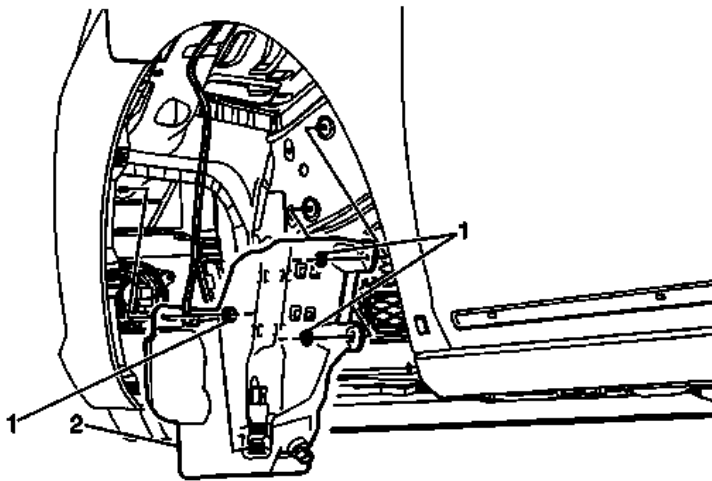


Fig. 7: Windshield Washer Solvent Container & Nuts
 Courtesy of GENERAL MOTORS COMPANY

Windshield Washer Solvent Container Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the windshield washer solvent container fill tube. Refer to <u>Windshield Washer Solvent Container Filler Tube Replacement</u>. 2. Remove the front LH wheelhouse liner. Refer to <u>Front Wheelhouse Front Liner Replacement</u>. 3. Disconnect the windshield washer pump and level sensor electrical connectors. 4. Disconnect the electrical harness from the washer container. 5. Disconnect the windshield washer pump hose from the pump and the washer container. 	
1	Windshield Washer Container Nut (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Windshield Washer Solvent Container Assembly Procedure <ol style="list-style-type: none"> 1. Lift the windshield washer container off the three studs securing the container to the vehicle. 2. Drain the windshield washer solvent from the container into a suitable clean drain pan. 3. Transfer parts as needed.

WINDSHIELD WASHER PUMP REPLACEMENT

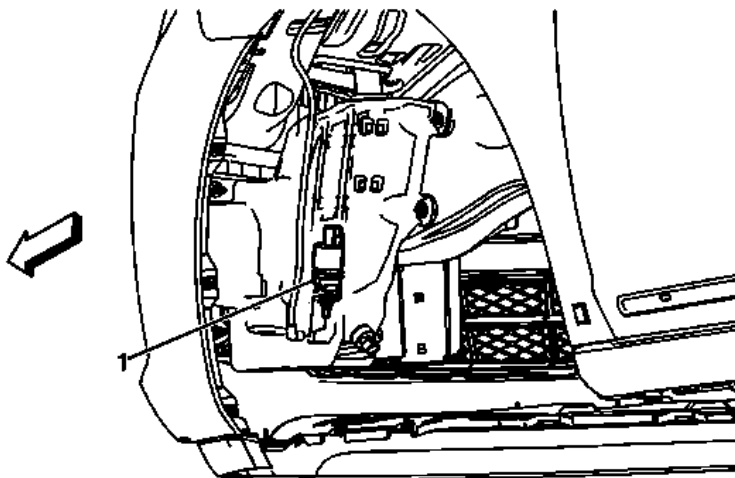


Fig. 8: Windshield Washer Pump
Courtesy of GENERAL MOTORS COMPANY

Windshield Washer Pump Replacement

Callout	Component Name
Preliminary Procedure	
<ol style="list-style-type: none">1. Remove the front wheelhouse liner. Refer to <u>Front Wheelhouse Front Liner Replacement</u> .2. Disconnect the windshield washer pump electrical connector.3. Disconnect the windshield washer pump hose from the washer pump spout.4. Place a clean suitable drain pan under the washer pump area in order to contain loss windshield washer solvent.5. Pull the top of the washer pump outward in order to disengage the top of the washer pump from the windshield washer container.6. Use two medium sized flat-bladed tools under the washer pump grommet and pry in opposite, disengage the washer pump from the windshield washer container.7. Remove and discard the windshield washer pump and grommet.	
1	Windshield Washer Pump Assembly TIP: Refill the windshield washer container after the washer pump replacement.

WINDSHIELD WASHER SOLVENT LEVEL SENSOR REPLACEMENT

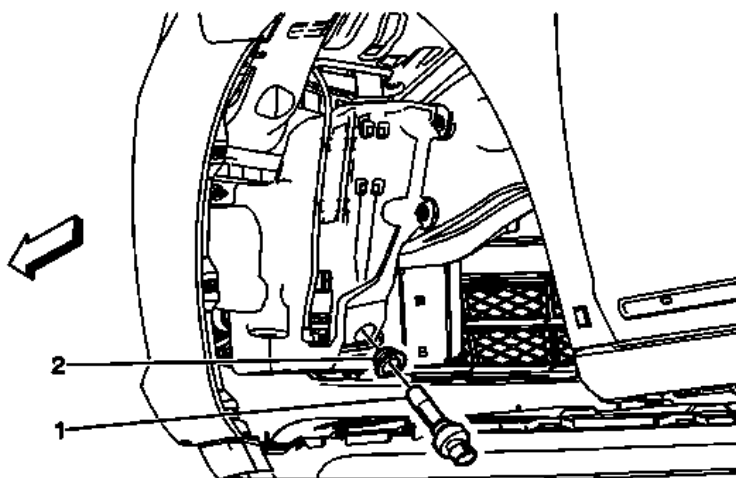


Fig. 9: Windshield Washer Solvent Level Sensor & Grommet
 Courtesy of GENERAL MOTORS COMPANY

Windshield Washer Solvent Level Sensor Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the front wheelhouse liner. Refer to <u>Front Wheelhouse Front Liner Replacement</u> . 2. Disconnect the windshield washer level sensor electrical connector. 3. Place a clean suitable drain pan under the level sensor area in order to contain the loss windshield washer solvent. 4. Use two medium sized flat-bladed tools under the level sensor grommet and pry in opposite directions, disengage the level sensor from the windshield washer container. 5. Remove and discard the level sensor grommet.	
1	Windshield Washer Solvent Container Level Sensor
2	Windshield Washer Solvent Container Level Sensor Grommet
Procedure Top off the windshield washer solvent container with new windshield washer solvent.	

PLENUM WATER DEFLECTOR SUPPORT REPLACEMENT

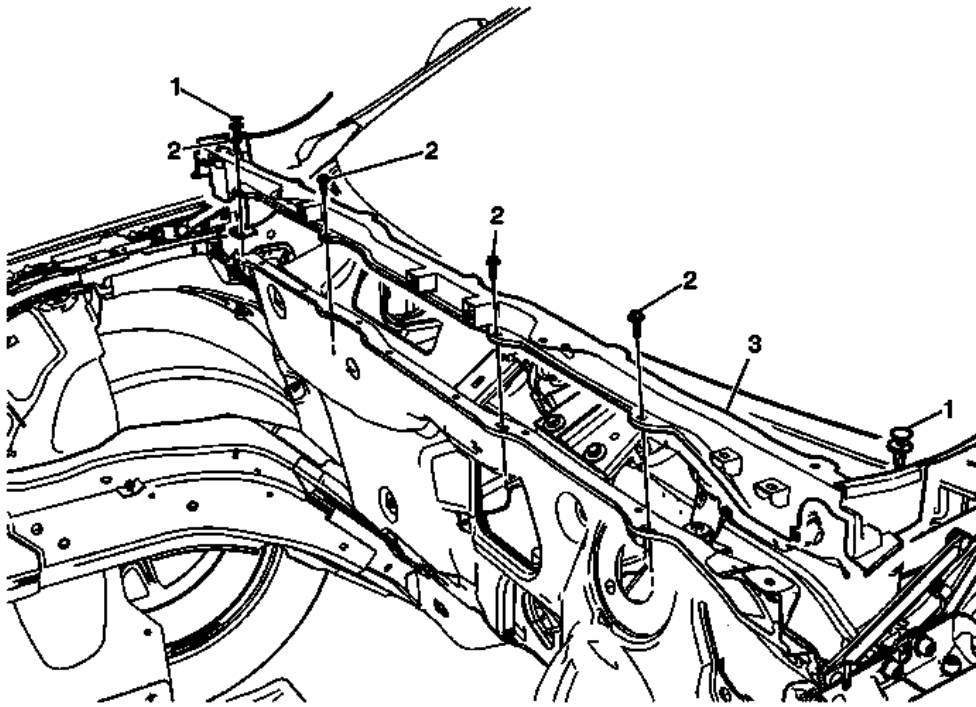


Fig. 10: Plenum Water Deflector Support & Screws
 Courtesy of GENERAL MOTORS COMPANY

Plenum Water Deflector Support Replacement

Callout	Component Name
Preliminary Procedures	
1. Open and support the hood assembly. 2. Remove the air inlet grille panel assembly. Refer to <u>Air Inlet Grille Panel Replacement</u> . 3. Remove the air inlet grille panel water deflector. Refer to <u>Air Inlet Grille Panel Water Deflector Replacement</u> .	
1	Push Pin Retainer (Qty: 2)
2	Plenum Water Deflector Support Screw (Qty: 4)
3	Plenum Water Deflector Support

AIR INLET GRILLE PANEL REPLACEMENT

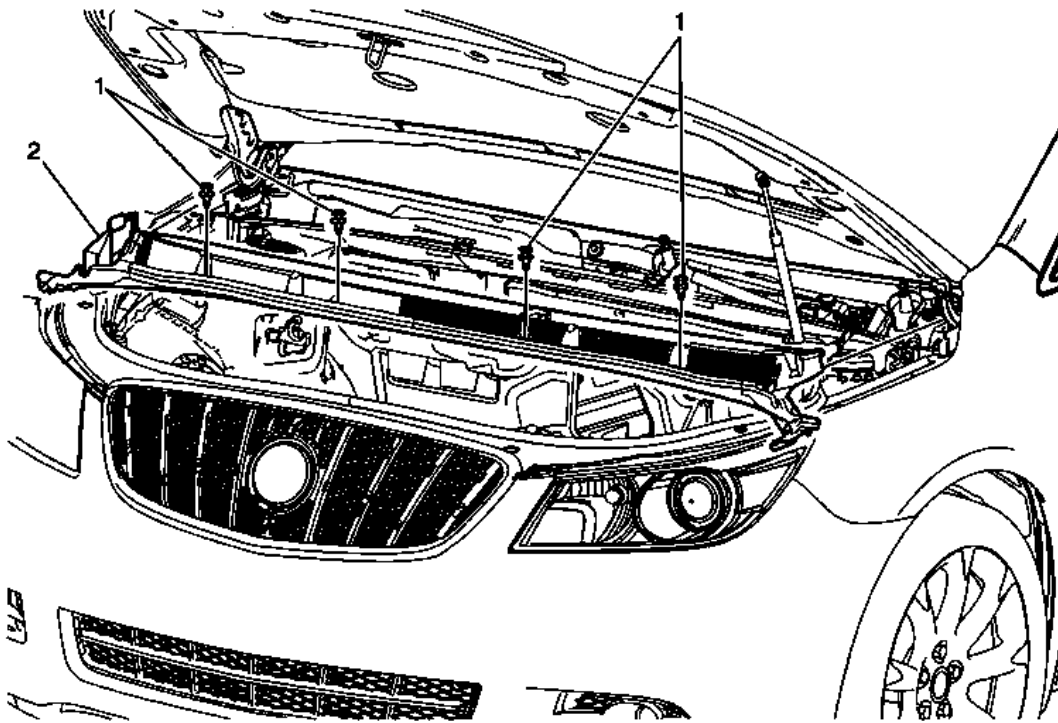


Fig. 11: Air Inlet Grille Panel & Retainers
 Courtesy of GENERAL MOTORS COMPANY

Air Inlet Grille Panel Replacement

Callout	Component Name
Preliminary Procedure	
Remove the windshield wiper arms. Refer to Windshield Wiper Arm Replacement .	
1	Push-Pin Retainer (Qty: 4) TIP: Lift the center of the push pin, then remove the lower portion from the grille panel.
2	Air Inlet Grille Panel Procedure <ol style="list-style-type: none"> 1. Disconnect the hood rear weather-strip from the air inlet panel flange. 2. Lift the front edge of the air inlet panel upward off the plenum edge far enough to clear the wiper motor pivot shafts. 3. Disengage the washer hose from the bottom edge of the panel. 4. Starting at the rear corner of the air inlet grille, lift the grille from the windshield trim and release across to the other side before pulling the air inlet grille forward. 5. Pull the grille forward to disengage the rear edge of the grille panel from the bottom of the windshield edge. 6. Pull the air inlet grille panel from around both hood hinges. 7. Angle the air inlet grille to clear the hood strut assembly. 8. Transfer the windshield washer nozzles. Refer to Windshield Washer Nozzle

Replacement.

AIR INLET GRILLE PANEL SIDE SEAL REPLACEMENT

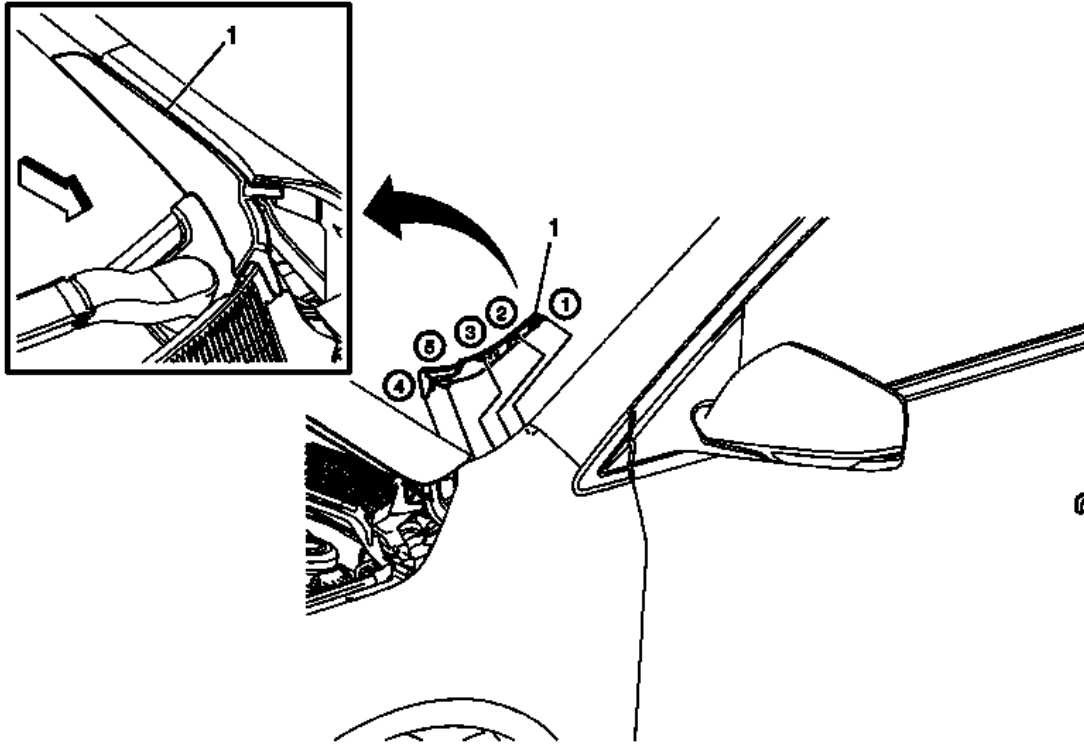


Fig. 12: Air Inlet Grille Panel Side Seal
Courtesy of GENERAL MOTORS COMPANY

Air Inlet Grille Panel Side Seal Replacement

Callout	Component Name
Preliminary Procedure	
Open and support the hood to gain better access to the side air inlet grille panel side seal.	
1	<p>Air inlet Grille Panel Side Seal</p> <p>Procedure</p> <ol style="list-style-type: none">1. The air inlet grille panel side seal has integral retention features that are not removable, but must be inserted with minimal force in the various locations.2. Install the air inlet grille panel side seal in the mandatory sequence, as shown.<ul style="list-style-type: none">• 1 to the A-pillar trim edge• 2 the integral tab inserted to the rear edge of the fender• 3 to the air inlet panel slot• 4 to the outer edge of the air inlet panel• 5 tucked under the rear edge of the front fender flange

- Ensure the air inlet grille panel side seal has no wrinkles and fits smooth to the windshield edge and A-pillar.

AIR INLET GRILLE PANEL WATER DEFLECTOR REPLACEMENT

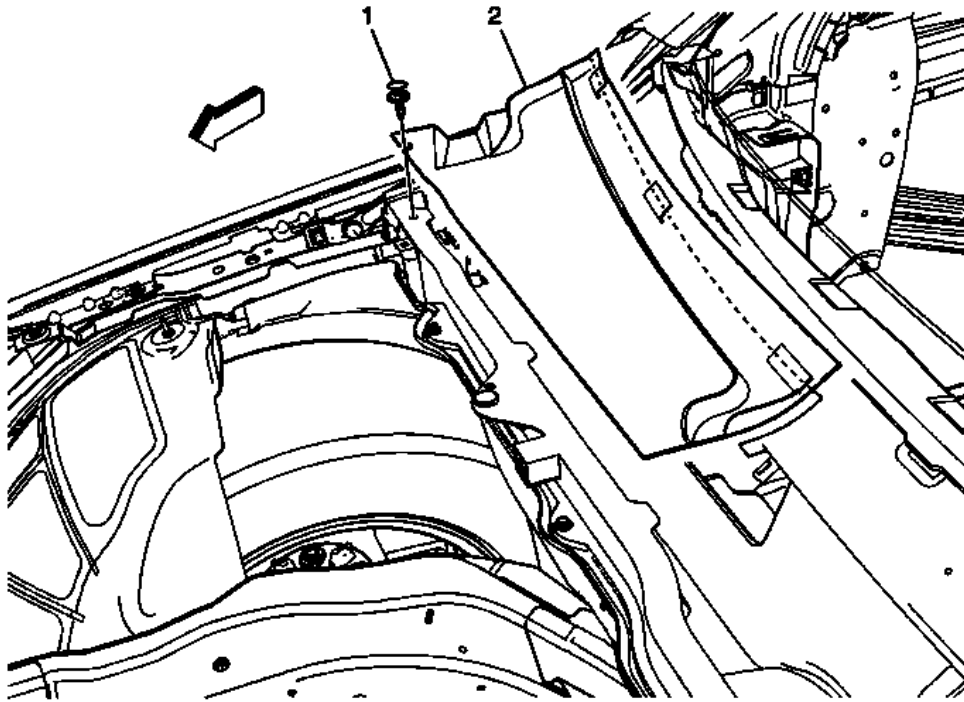


Fig. 13: Air Inlet Grille Panel Water Deflector
Courtesy of GENERAL MOTORS COMPANY

Air Inlet Grille Panel Water Deflector Replacement

Callout	Component Name
Preliminary Procedures	
1. Open and support the hood assembly. 2. Remove the air inlet grille panel assembly. Refer to <u>Air Inlet Grille Panel Replacement</u> .	
1	Push Pin Retainer
2	Procedure Once the push pin retainer has been removed, lift the front edge upward and pull the deflector from under the edge of the plenum upper panel.

WINDSHIELD WIPER ARM REPLACEMENT

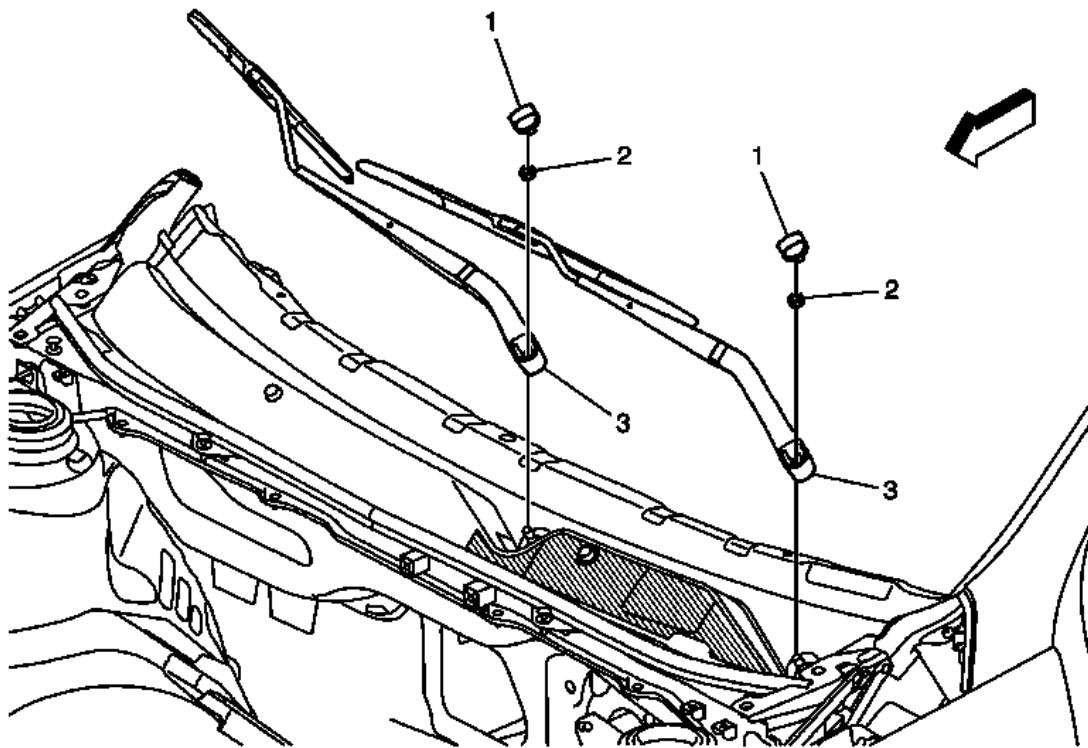


Fig. 14: Windshield Wiper Arm, Fastener & Finish Cap
 Courtesy of GENERAL MOTORS COMPANY

Windshield Wiper Arm Replacement

Callout	Component Name
1	Windshield Wiper Arm Finish Cap Procedure Use a small flat-bladed tool to remove finish cap.
2	Windshield Wiper Arm Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure <ol style="list-style-type: none"> 1. Locate the transparent circle with a black dot in the center at the lower windshield blackout area. 2. Position the windshield wiper arm to the pivot shaft so that the wiper blade is centered across the transparent circle. 3. Lift the arm blade portion while pushing down the arm onto the pivot shaft. 4. Install the windshield wiper arm fastener. 5. Hold the windshield wiper arm stationary in position as previously stated. 6. Torque the windshield wiper arm fastener.

	<p>7. Release the windshield wiper arm.</p> <p>8. Repeat the same procedure for the other windshield wiper arm.</p> <p>Tighten 38 (28 lb ft)</p>
3	Windshield Wiper Arm

WINDSHIELD WIPER BLADE REPLACEMENT

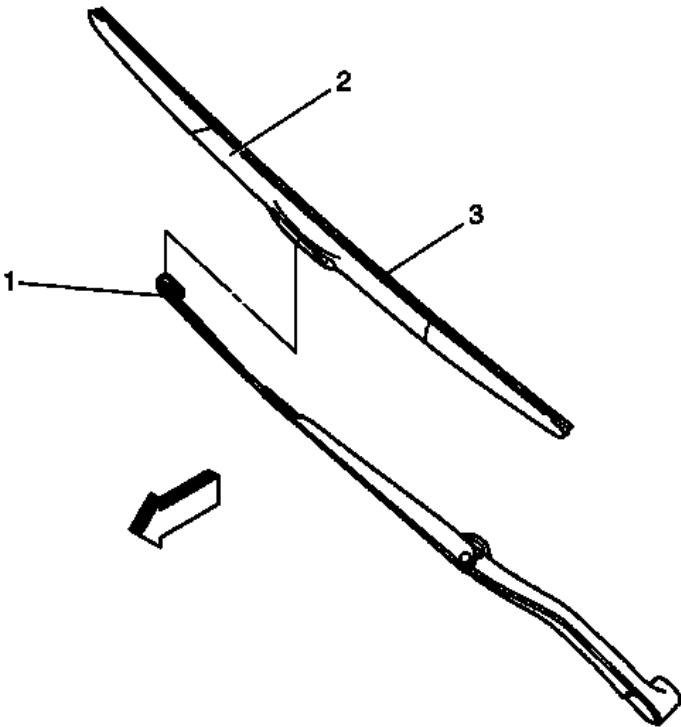


Fig. 15: Windshield Wiper Blades & Cap
 Courtesy of GENERAL MOTORS COMPANY

Windshield Wiper Blade Replacement

Callout	Component Name
Preliminary Procedure Raise the wiper arm up off the windshield.	
1	Windshield Wiper Blade Cap TIP: Use a small flat-bladed tool to open the cap.
2	Windshield Wiper Blade Procedure 1. Push upward the windshield wiper blade.

	2. Slide the windshield wiper blade from the wiper arm. 3. Carefully release the wiper arm back to the windshield.
3	Windshield Washer Blade TIP: Discard if rubber appears worn or does not wipe the windshield clean.

WINDSHIELD WIPER MOTOR REPLACEMENT

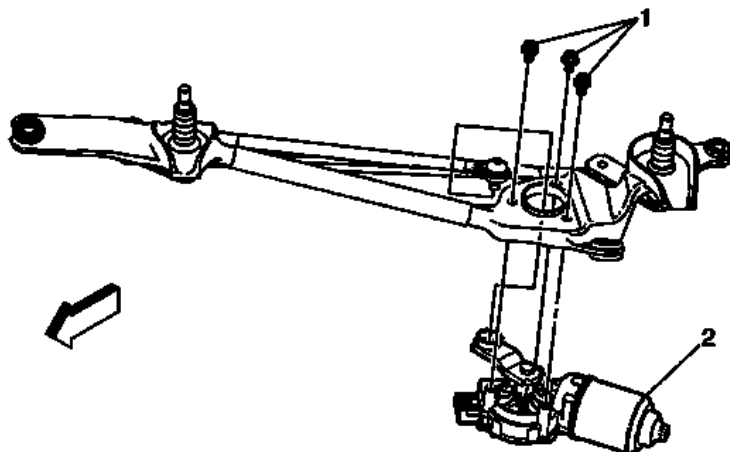


Fig. 16: Windshield Wiper Motor & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Windshield Wiper Motor Replacement

Callout	Component Name
Preliminary Procedure Remove the windshield wiper transmission. Refer to <u>Windshield Wiper Transmission Replacement</u> .	
1	Windshield Wiper Motor Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
	Windshield Wiper Motor Assembly Procedure <ol style="list-style-type: none"> 1. The NEW wiper motor is shipped with the crank arm in the PARK Position. 2. Using the J-39232 separator or equivalent, disconnect the crank arm ball socket from the wiper transmission link. 3. Using the J-39529 installer or equivalent, connect the crank arm ball socket to the wiper transmission link.

- | | |
|---|---|
| 2 | <ol style="list-style-type: none"> 4. Install the NEW wiper motor to the transmission as shipped. 5. Install the windshield wiper transmission. Refer to <u>Windshield Wiper Transmission Replacement</u>. |
|---|---|

Special Tools

- **J-39232** Wiper Linkage Separator
- **J-39529** Wiper Linkage Installer

For equivalent regional tools, refer to **Special Tools**.

WINDSHIELD WIPER TRANSMISSION REPLACEMENT

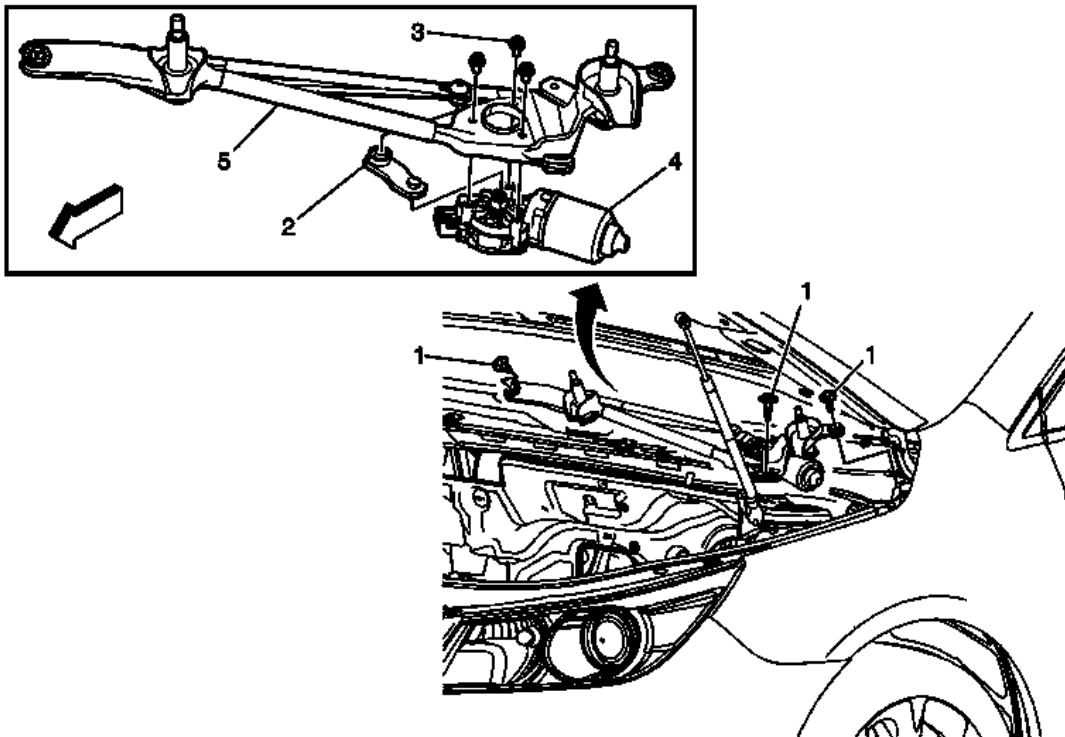


Fig. 17: Windshield Wiper Transmission Components
 Courtesy of GENERAL MOTORS COMPANY

Windshield Wiper Transmission Replacement

Callout	Component Name
Preliminary Procedure	
1.	Remove the air inlet grille panel. Refer to <u>Air Inlet Grille Panel Replacement</u> .
2.	Remove the dash panel brace.
	Windshield Wiper Transmission Bolt (Qty: 3)

1	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Lift the windshield wiper transmission from the plenum. 2. Disconnect the electrical connector from the windshield wiper motor. 3. Remove the windshield wiper transmission from the vehicle. <p>Tighten 9 N.m (80 lb in)</p>
2	Windshield Wiper Motor Crank Arm
3	Windshield Wiper Motor Bolt (Qty 3)
	<p>Procedure Remove the windshield wiper motor. Refer to <u>Windshield Wiper Motor Replacement</u>.</p>
4	Windshield Wiper Motor
5	Windshield Wiper Transmission Assembly

WINDSHIELD MULTIFUNCTION SENSOR MOUNT BRACKET COVER REPLACEMENT

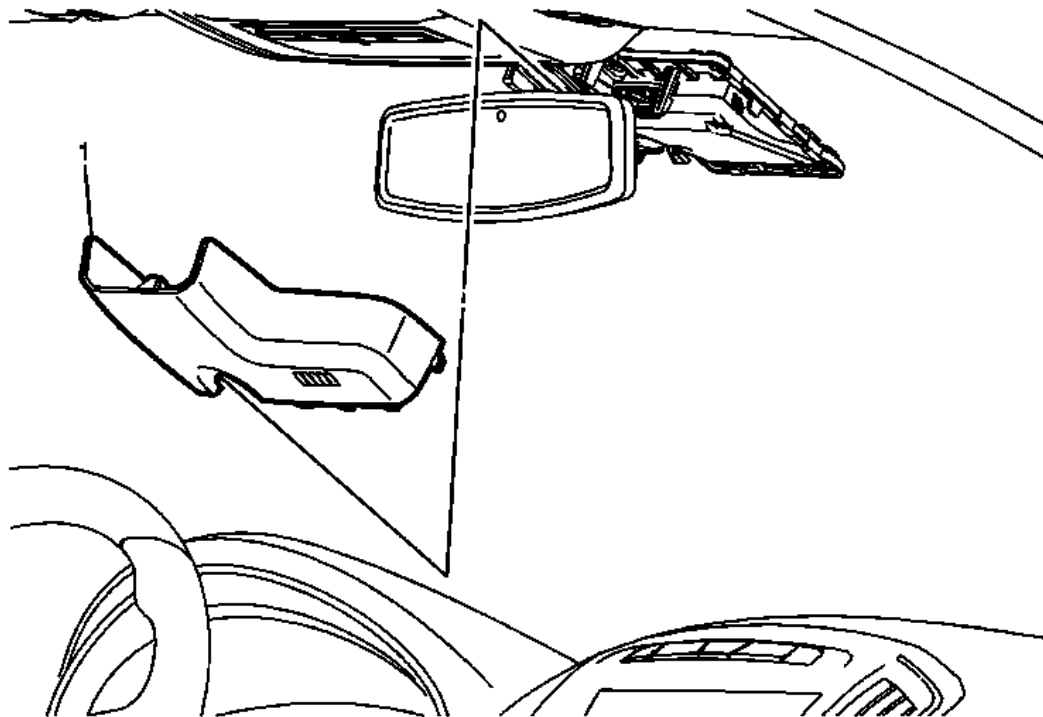


Fig. 18: Windshield Multifunction Sensor Mount Bracket Cover
Courtesy of GENERAL MOTORS COMPANY

Windshield Multifunction Sensor Mount Bracket Cover Replacement

Callout	Component Name
Preliminary Procedure Remove the windshield multifunction sensor mount lower cover. Refer to <u>Windshield Multifunction Sensor Mount Bracket Lower Cover Replacement</u> .	
1	Windshield Multifunction Sensor Mount Bracket Cover Procedure Grasp the cover on both sides and gently slide upward.

WINDSHIELD MULTIFUNCTION SENSOR MOUNT BRACKET LOWER COVER REPLACEMENT

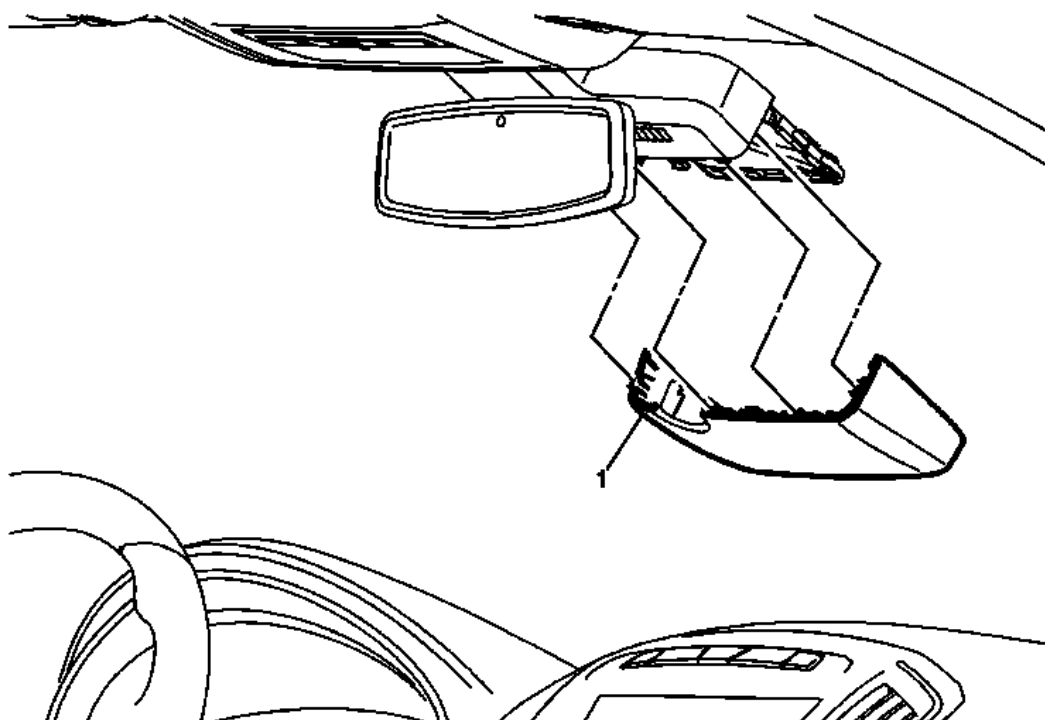


Fig. 19: Windshield Multifunction Sensor Mount Bracket Lower Cover
Courtesy of GENERAL MOTORS COMPANY

Windshield Multifunction Sensor Mount Bracket Lower Cover Replacement

Callout	Component Name
1	Windshield Multifunction Sensor Mount Bracket Lower Cover Procedure Grasp the cover on both sides and gently slide downward.

WINDSHIELD GLASS CLEANING

Special Tools

- **BO-46974** Glass Removal System
- **BO-641** Suction Holder

For equivalent regional tools, refer to **Special Tools** .

Non-Destructive Glass Removal

- Prescribed tools such as wire cutter are in working order
- Adhesive height / width of adhesive bead should be no less than 13 mm / 8 mm (0.5 in / 0.3 in)
- Additional cost or damage is not anticipated until you go outside this geometry (at vulcanized trim strips and paintwork, for example)
- Protect heating line connections

Check Paintwork

- Check paintwork after removal, particularly in the body frame area
- Clean, prime and apply top coat to bare areas
- Make good minor surface damage with a paint stick

NOTE: **Never use glass primer (formation of corrosion). Glass primer is for protection against UV light only, and is therefore only applied to the pane of glass.**

Pane of Glass

- Treat new panes of glass with glass primer in the adhesive areas
- To re-install panes of glass that have already been cut out, do not apply glass primer to the PU vulcanization or on residual adhesive that has been cut through (substandard adhesion)
- Apply new adhesive as per instructions, insert pane of glass into body frame and fix in position with fabric tape

Waiting Periods

Pay attention to waiting period for window depending on type of glass and vehicle equipment (airbag).

Tools, Auxiliary Equipment

- Assembly stand - normal commercial
- **BO-46974** Glass Removal System
- Video VT 54
- Gun for EU cartridge up to 310 ml - normal commercial
- **BO-641** Suction Holder
- Adhesive (not electrically conductive) see delivery program (our Parts Releases area)
- Paint stick (our Parts Releases area)

- Fabric tape

NOTE: Use provided protective glasses and gloves from BO-46974 glass removal system.

Regulation / safety: pay attention to waiting periods for vehicles with newly-installed windows, check chapter entitled "Expiry date" before using the adhesive.

WIPER BLADE ELEMENT CLEANING

Lift each blade assembly off of the windshield and clean the element with a cloth saturated with full strength washer solvent. Then rinse the blade assemblies with clear water.

WIPER CHATTER REPAIR

Some vehicles may exhibit a condition where the windshield wipers chatter and/or wipe unevenly. Several items may contribute to this condition. To completely repair this condition, ALL of the items listed should be tested and repaired as necessary.

- Clean the windshield glass. Refer to **Windshield Glass Cleaning**.
- Clean the wiper blade elements. Refer to **Wiper Blade Element Cleaning**.
- Inspect the wiper blade element set.

DESCRIPTION AND OPERATION

WIPER/WASHER SYSTEM DESCRIPTION AND OPERATION

Wiper/Washer System Components

The wiper/washer system consists of the following electrical components:

- Windshield Wiper Relay
- Windshield Wiper Speed Control Relay
- Windshield Washer Pump Relay
- Windshield Outside Moisture Sensor
- Windshield Washer Fluid Pump
- Windshield Wiper Motor
- Window Wiper/Washer Switch
- Windshield Wiper Motor Fuse
- Windshield Washer Fluid Pump Fuse
- Body Control Module (BCM)
- Rear Window Wiper Motor

- Rear Window Wiper Motor Fuse
- Rear Window Wiper Relay
- Rear Window Washer Pump Relay
- Headlamp Washer Fluid Pump Relay
- Headlamp Washer Fluid Pump Fuse
- Windshield Washer Fluid Level Switch
- Rain Sensor

Windshield Wiper System

The body control module (BCM) determines the front wipe/wash system mode of operation by monitoring several signals from the front wipe/wash switch as indicated in the wiper switch

The front wipe/wash switch receives a reference ground signal from the BCM. Each input of the BCM provides a switched battery pull-up for each front wiper/washer switch output signal it receives. All the BCM inputs are recognized as active when the wiper switch provides a path to the referenced ground signal. The first signal received by the BCM is the result of 6 resistors in the front wiper switch configured as a resistor ladder network. This signal is connected to a BCM analog to digital input. Depending on the function selected (High, Low, Intermittent 1 thru 5, Mist, Off), the front wiper control switch connects a different set of resistors into the circuit resulting in different voltages appearing on the BCM A/D input. By monitoring this voltage, the BCM determines how to control the wiper motor On/Off Relay. It should be noted that High, Low, and Mist all have the same value on this signal circuit. The second signal received from the front wiper switch is active only when the front wiper switch is in the high speed wiper position. When the wiper switch is not in the high speed position, the switch is open and the signal circuit is pulled to battery by the BCM. When the wiper switch is in the high speed position, the switch pulls the circuit low. The BCM determines how to control the Wiper high/low speed relay from this input. The third signal received from the front wiper switch is from the momentary windshield wash control switch. When the washer switch is not active the switch is open and the signal circuit is pulled to battery by the BCM. When the washer switch is active, the switch pulls the circuit low. The BCM controls the windshield wash and windshield wash activated wiper operation based on this input.

The BCM controls front wiper motor operation through two output signals and the monitoring of one input signal. The two outputs (one high side drive, one low side drive) are used to control two external wiper motor relays: front wiper motor on/off relay: which provides the wiper motor with battery power when it is activated by the high side drive signal (switched battery) from the BCM. When left deactivated, the normally closed contacts provide a ground to the wiper motor. Wiper high/low speed relay: when activated by a low side drive signal (ground) from the BCM, it switches the power supplied by the wiper motor's on/off relay to the motor's high speed input. When left deactivated, the normally closed contacts connect the power supplied by the wiper motor's on/off relay to the motor's low speed input. The input used by the BCM is from the park switch located in the wiper motor assembly. When the wiper blades are not in the park position, the wiper park switch is open and the circuit is pulled up to battery by the BCM. When the wiper blades are in the park position at the bottom of the glass, the wiper park switch closes to ground pulling the park signal circuit low.

To initiate low speed operation, the BCM only energizes the front wiper motor on/off relay. This allows battery voltage from the wiper fuse to be applied through the switched contacts of the wiper motor on/off relay, through the normally closed contacts of the wiper high/low speed relay, to the low speed control circuit of the windshield wiper motor.

Redundant high speed switch pass through. The BCM provides redundant circuitry which places battery power on its wiper motor on/off relay output with activation of its low assertion high speed wiper switch input. The BCM shall be capable of doing this, even if the module has lost all microprocessor control. This redundant circuit shall supply power while in the RUN and CRANK power modes. however; while in the CRANK power mode, the pass through shall only be active if the BCM is NOT in a computer operating properly state.

To initiate high speed operation, the BCM energizes both the front wiper motor on/off relay and the wiper high/low speed relay . This allows battery voltage from the wiper fuse to be applied through the switched contacts of the wiper motor on/off relay, through the switched contacts of the wiper high/low speed relay, to the high speed control circuit of the windshield wiper motor.

Parking the wiper motor. In order to perform an accurate read of the park switch and to ensure the wipers will come to rest while still in the park position, parking of the wipers only occurs while in a low speed wiper mode. This requires that if the wipers are performing a high speed wiper operation at the time they are required to park, the BCM shall transition the Wipers to low speed by deactivating the wiper high/low relay before attempting to park. In order to park the wipers, the BCM monitors the park circuit until the park switch pulls the park circuit to ground. At this time, the BCM will immediately deactivate the wiper motor on/off relay. The relay contacts will switch back to their normally closed position and will apply ground to the wiper motor power inputs through the normally closed contacts of the wiper high/low relay. This deactivates and dynamically brakes the wiper motor in the park position. When the wiper switch is turned to the OFF position while the wiper motor is somewhere in mid-cycle, the BCM will continue to operate the motor until the wipers reach the park position. If the BCM is running the wiper motor and does not see a state transition of the park switch after 8 s, the wipers will stop immediately when the wiper switch is turned to OFF. If the ignition is turned OFF while the wipers are in mid-cycle, the wipers will stop immediately, regardless of position. The BCM will park the wipers next time the ignition is turned ON.

The windshield wiper system MIST operation is identical to LOW speed operation, except that the MIST switch is a press and release type switch. When the wiper switch is moved to the MIST position and released, low speed wiper motor operation is started and will continue until 1 cycle is complete. If the wiper switch is moved to the MIST position and held, the wiper motor will operate in the LOW speed mode until the switch is released.

Windshield wiper intermittent operation is a low speed wiper motor function with a variable delay interval between the wiper motor cycles. The duration of the delay is controlled by the front wiper control switch's intermittent 1 thru intermittent 5 settings. The wiper operation is as follows

1. The BCM will initiate a single wipe by activating its front wiper ON/OFF relay output.
2. At the completion of a single wipe, the BCM will park the wipers as described above.
3. The BCM will then pause the wipers in their park position for the time duration associated with intermittent delay switch setting.
4. When the delay time expires repeat Steps 1 and 3 until the system is turned off or taken out of intermittent mode. If the wiper switch is moved from a longer delay interval to a shorter delay interval, the BCM will command an immediate wipe cycle and reset the delay timer to the shorter delay interval.

Intermittent wiper operation may be vehicle speed sensitive. When enabled, the speed compensated intermittent feature causes the intermittent wiper delay intervals to become shorter as a function of increased speed. As vehicle speed is reduced the intervals will become closer to the predetermined

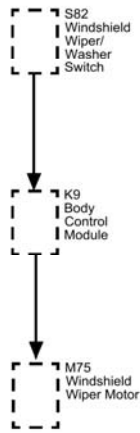


Fig. 20: Windshield Wiper System Diagram
 Courtesy of GENERAL MOTORS COMPANY

Windshield Washer System

The BCM controls the windshield wash operation and windshield wash activated wiper operation. When the BCM detects the activation of the momentary windshield wash control switch, it activates its washer pump relay drive output which supplies battery power to the coil of the washer pump relay. This energizes the relay, which switches battery power to the pump motor. The BCM will also activate continuous low speed windshield wipes as described above. Upon deactivation of the windshield wash control switch, the wiper control module (BCM) shall deactivate the wash motor and will also park the wiper motor as described above unless the drip wipe feature is enabled. On some vehicles the drip wipe feature will be enabled and cause the system to provide additional wiping of the windshield after the switch has been released and fluid is no longer being applied. The front wash feature may attempt to detect a stuck switch. When enabled, activation of the wash feature shall be limited to 10 seconds.

On vehicles with the Rear Wash feature a single reversing wash motor may be utilized for both the front and rear wash operation. In this system the wash motor is operated in one direction to spray fluid on the front windshield and then operated in the reverse direction to spray fluid on the rear window. The BCM Controls the reversing wash motor through two High Side Drive outputs. One controls the Front Wiper Motor Relay and one controls the Rear Wiper Relay.

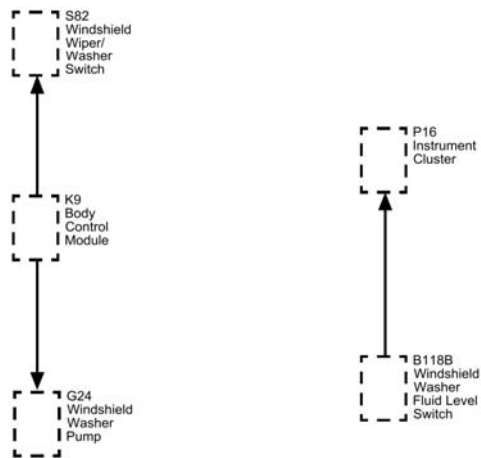


Fig. 21: Front Washer-Washer Fluid Level Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Headlamp Washer System

When Headlamp Wash Equipped, the headlamps shall be sprayed with wash fluid as a result of an extended Windshield Wash Switch Activation. In order to preserve wash fluid, the feature shall only be allowed to activate if the Low or High Beam Headlamps are active. In addition, after the initial Headlamp Wash operation has been performed, additional headlamp washes shall not be performed for the next 4 Windshield Wash activations or for 48 hours whichever comes first. In the event that the system has detected a Stuck Front Wash Switch condition, the Headlamp Wash Feature shall be disabled.

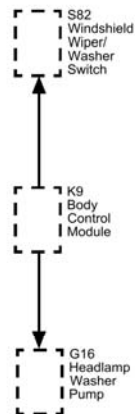


Fig. 22: Headlamp Washer Pump Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

Washer Fluid Level Indicator

The check washer fluid message is controlled by the instrument panel using an input from the washer fluid level switch. The washer fluid level signal circuit is supplied ignition voltage through a resistor then monitored within the instrument cluster. The washer fluid level switch is normally open so the instrument cluster detects ignition voltage on the washer fluid level signal circuit whenever the washer fluid level is not low. When the washer fluid reaches the point where the driver should be informed that the washer fluid is low, the washer fluid level switch closes. When the washer fluid level switch is closed the washer fluid level signal circuit voltage is pulled low, and the instrument panel displays the Check Washer Fluid message on the driver information center. In order to prevent the Check Washer Fluid message from being displayed while sloshing is occurring in the washer fluid container, the instrument cluster is programmed with a 1 min delay before changing states of the Check Washer Fluid message during an ignition cycle.

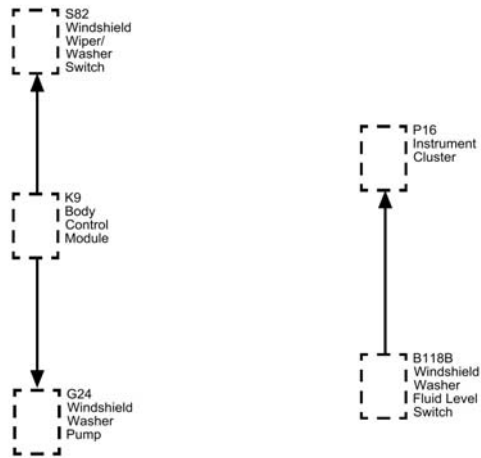


Fig. 23: Front Washer-Washer Fluid Level Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Rain Sensor Indicator

B+ voltage is supplied to the Rain Sensor. Whenever the ignition is ON, or accessory positions, the body control module (BCM), sends the turn signal/multifunction switch status by using data communication. When a wipe cycle is needed, the Rain Sensor sends a data communication message to the BCM, requesting the wiper operation. The BCM commands the Windshield Wiper Motor wipe cycles. If at anytime a fault occurs between the Rain Sensor and BCM, the BCM will use the inputs from the turn signal/multifunction switch in the delay positions to operate the Windshield Wiper Motor at continuous variable delay intervals.

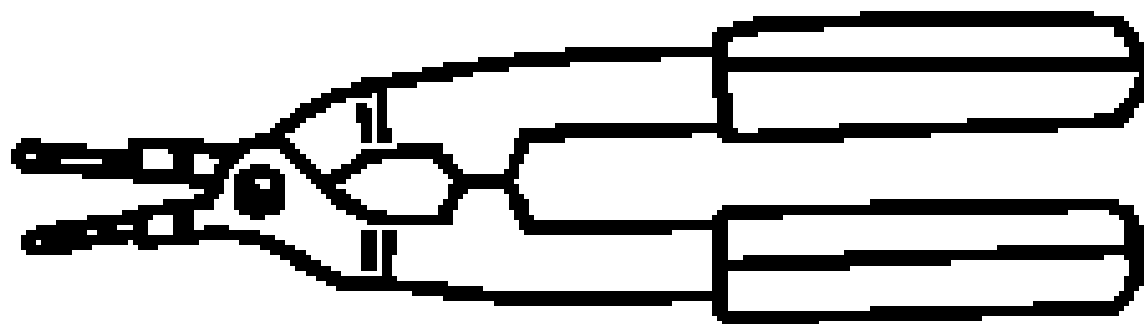


Fig. 24: Rain Sensor Indicator Block Diagram
Courtesy of GENERAL MOTORS COMPANY

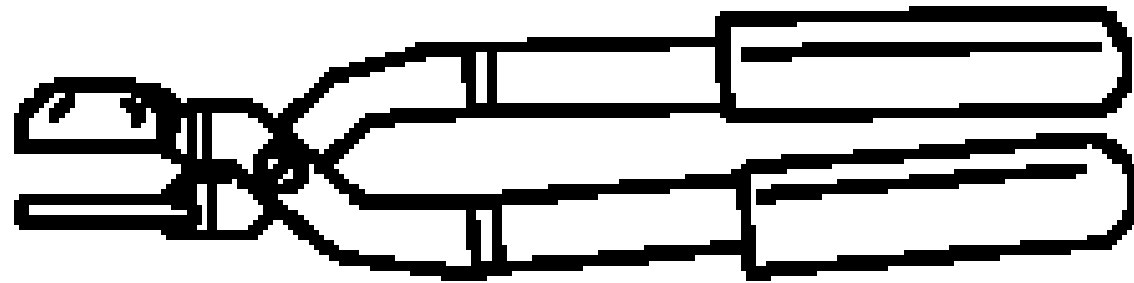
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

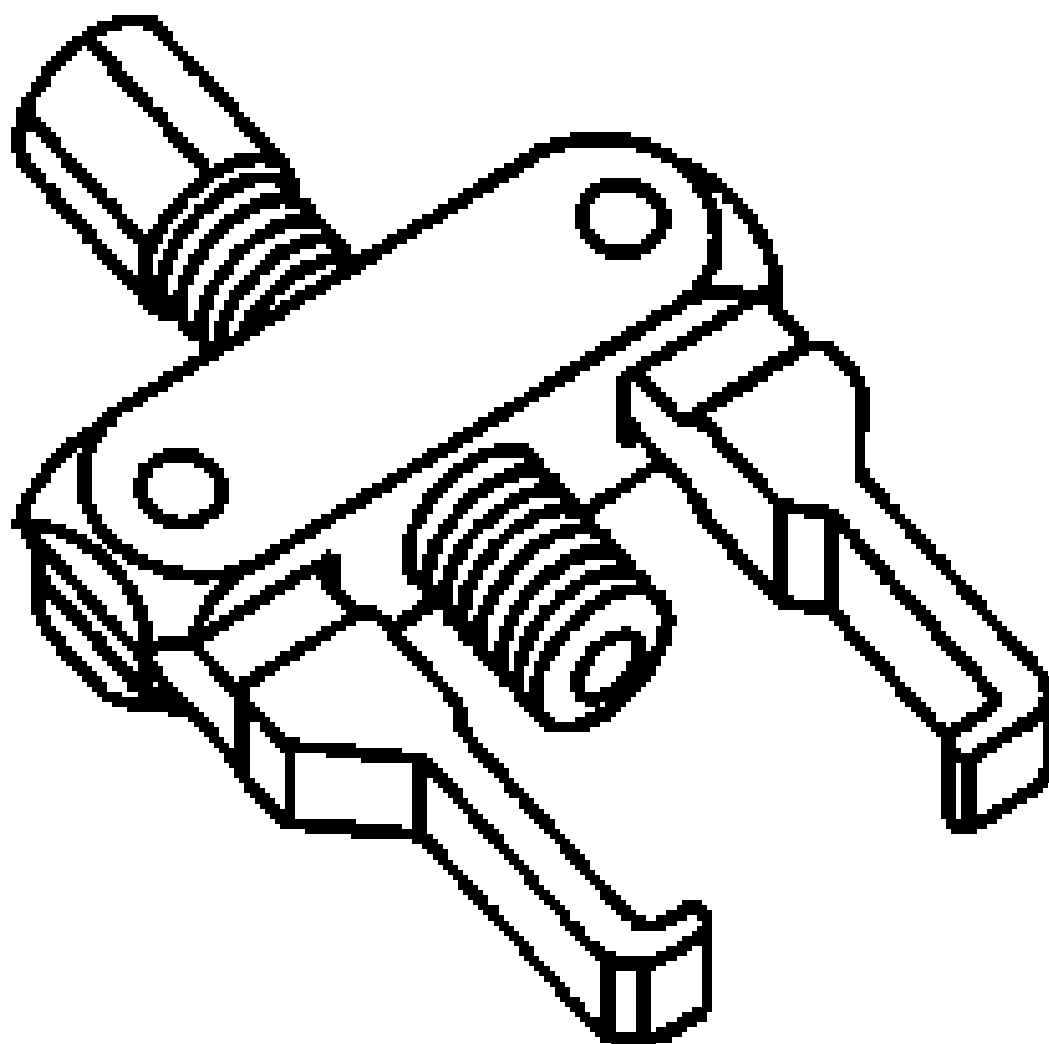
Illustration	Tool Number/ Description



J 39232
Wiper
Linkage
Separator



J 39529
Wiper
Linkage
Installer



J 39822
Wiper Arm
Puller

ELECTRICAL

Wiring Systems and Power Management - Wiring Harness Routing Views

WIRING HARNESS ROUTING DIAGRAMS

WIRING HARNESS ROUTING VIEWS

Front Bumper Harness Routing

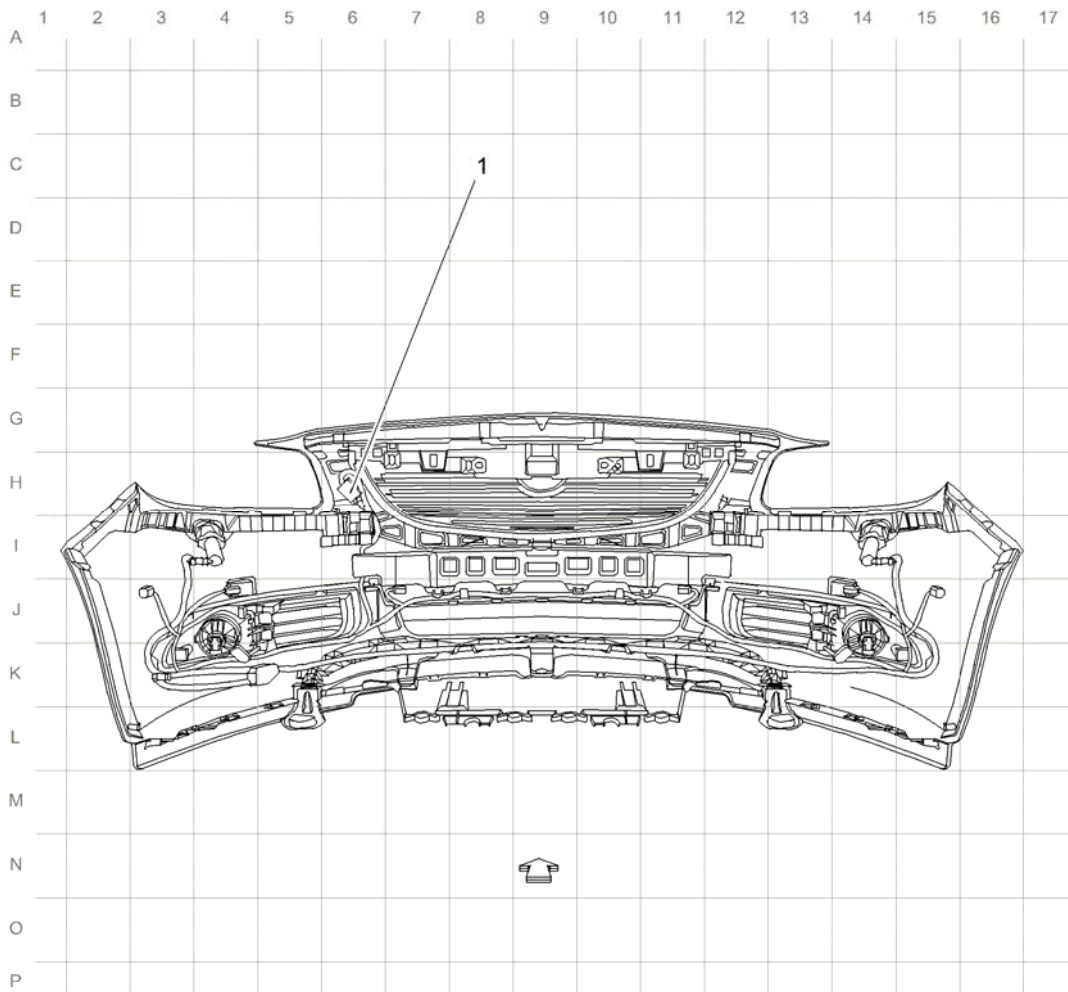


Fig. 1: Front Bumper Harness Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

Items

1: X110 X110 Forward Lamp Harness to Left Headlamp Harness

Left Front Suspension Harness Routing (F45)

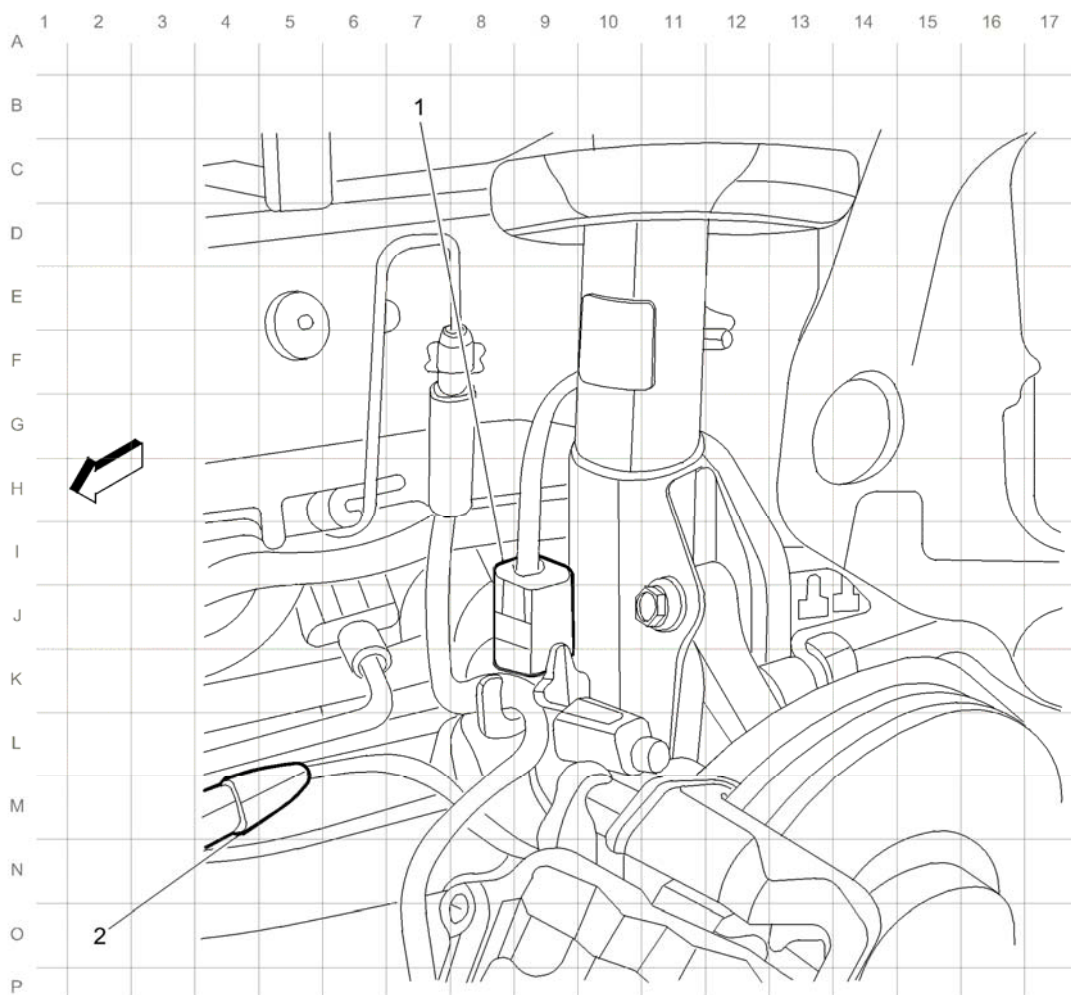


Fig. 2: Suspension - Left Front Wiring Harness Routing (F45)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: X131 (F45) X131 Left Front Suspension Components to Left Front Suspension Harness (F45)**
2: X130 (F45) X130 Forward Lamp Harness to Left Suspension Harness (F45)

Right Front Suspension Harness Routing (F45)

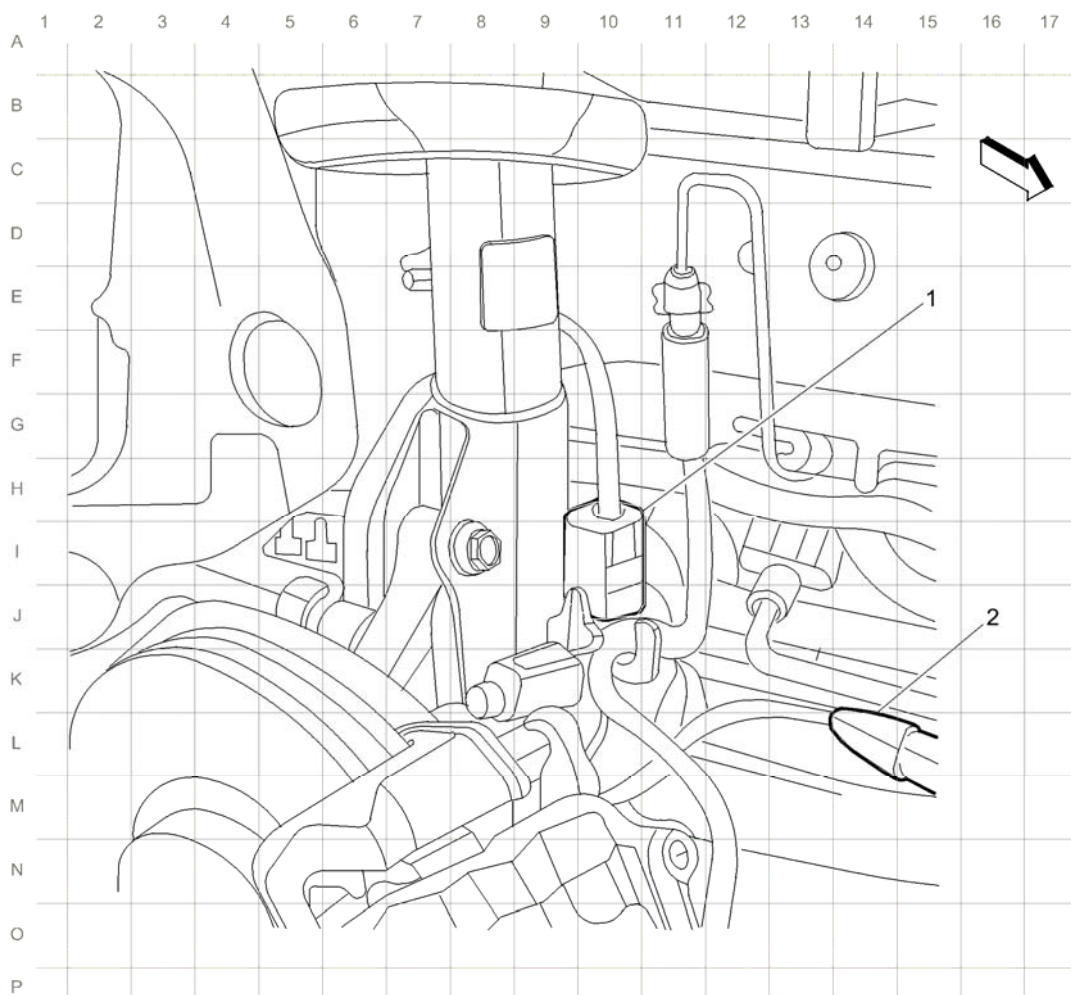


Fig. 3: Right Front Suspension Harness Routing Diagram (F45)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: X141 (F45) X141 Right Front Suspension Components to Right Front Suspension Harness (F45)**
2: X140 (F45) X140 Forward Lamp Harness to Right Front Suspension Harness (F45)

Cooling Fan Harness Routing

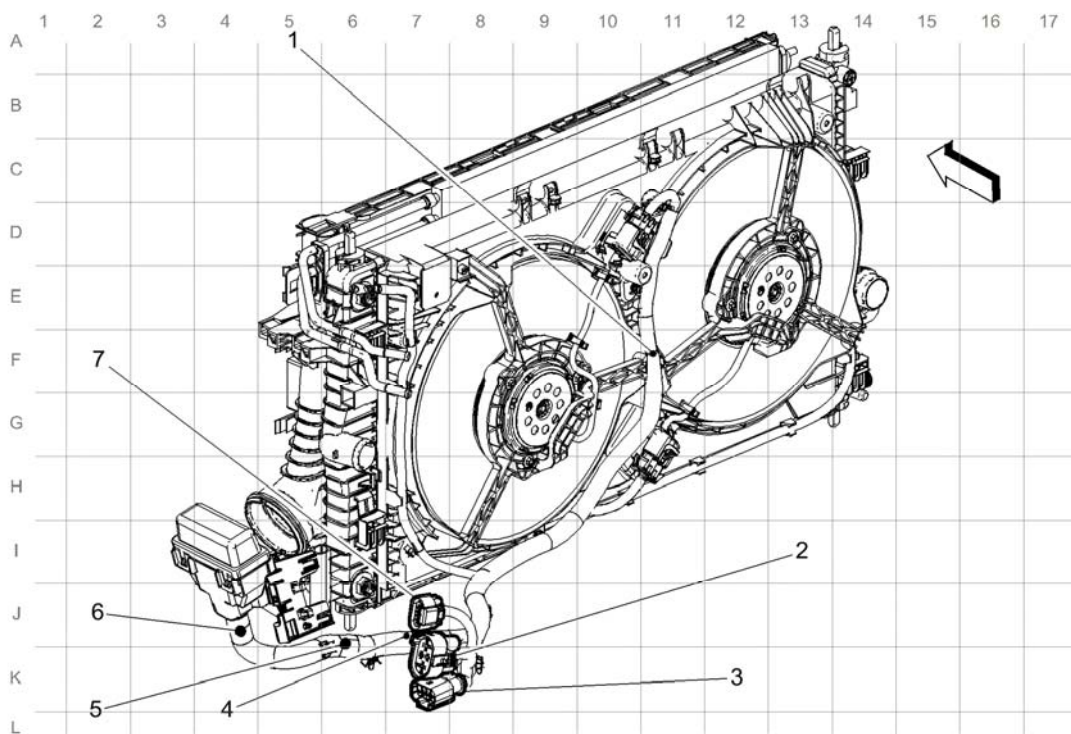


Fig. 4: Cooling Fan Harness Routing Diagram
 Courtesy of GENERAL MOTORS COMPANY

Items

1: J108

2: X118 (LHU) X118 Cooling Fan Harness to Forward Lamp Harness (LHU) X118 Engine Cooling Harness to Forward Lamp Harness (LDK)

3: X116 X116 Cooling Fan Harness to Forward Lamp Harness

4: J107 (LHU)

5: J106 (LHU)

6: J105 (LHU)

7: X117 X117 Cooling Fan Harness to Forward Lamp Harness

Engine Cooling Harness Routing 1 of 2 (CZ2)

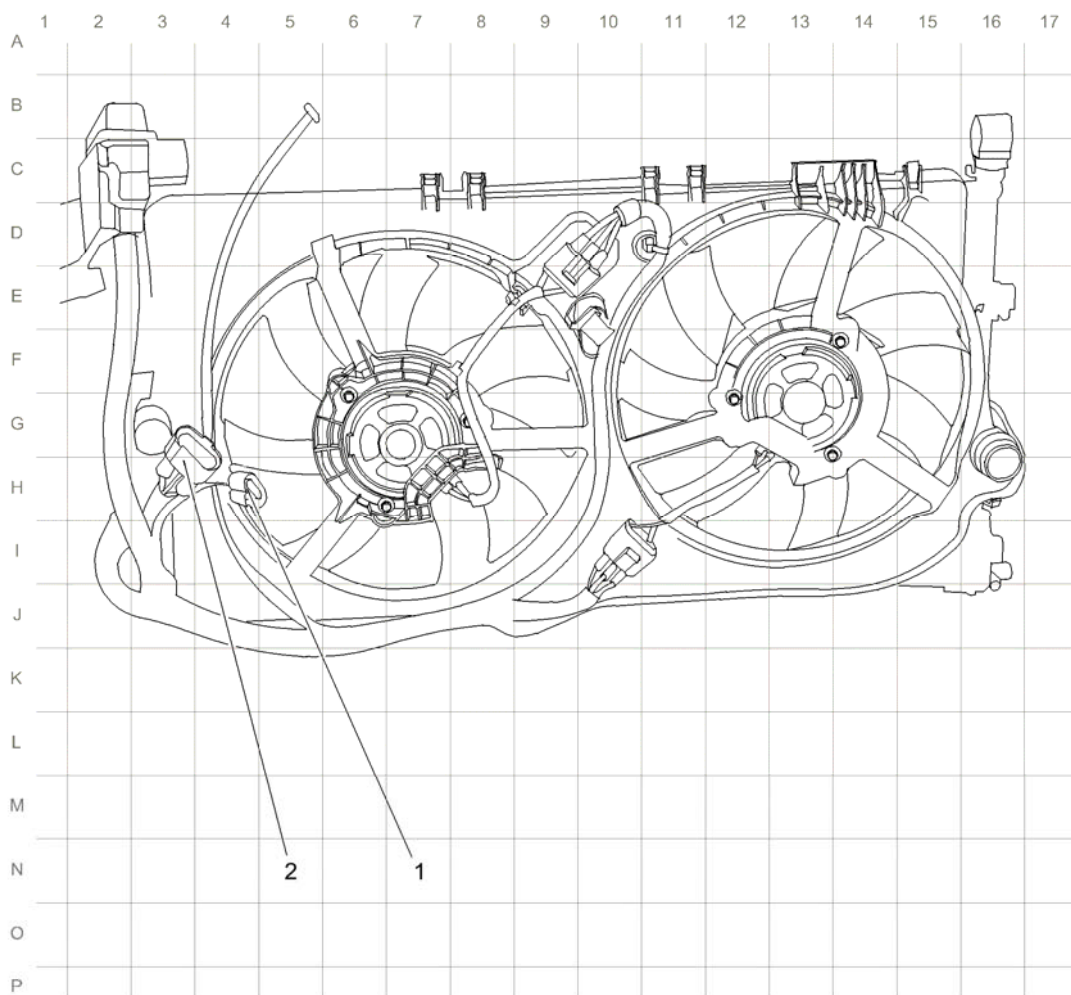


Fig. 5: Engine Cooling Harness Routing Diagram 1 of 2 (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Items

2: X130 (F45) X130 Forward Lamp Harness to Left Suspension Harness

Engine Cooling Harness Routing 2 of 2 (CZ2)

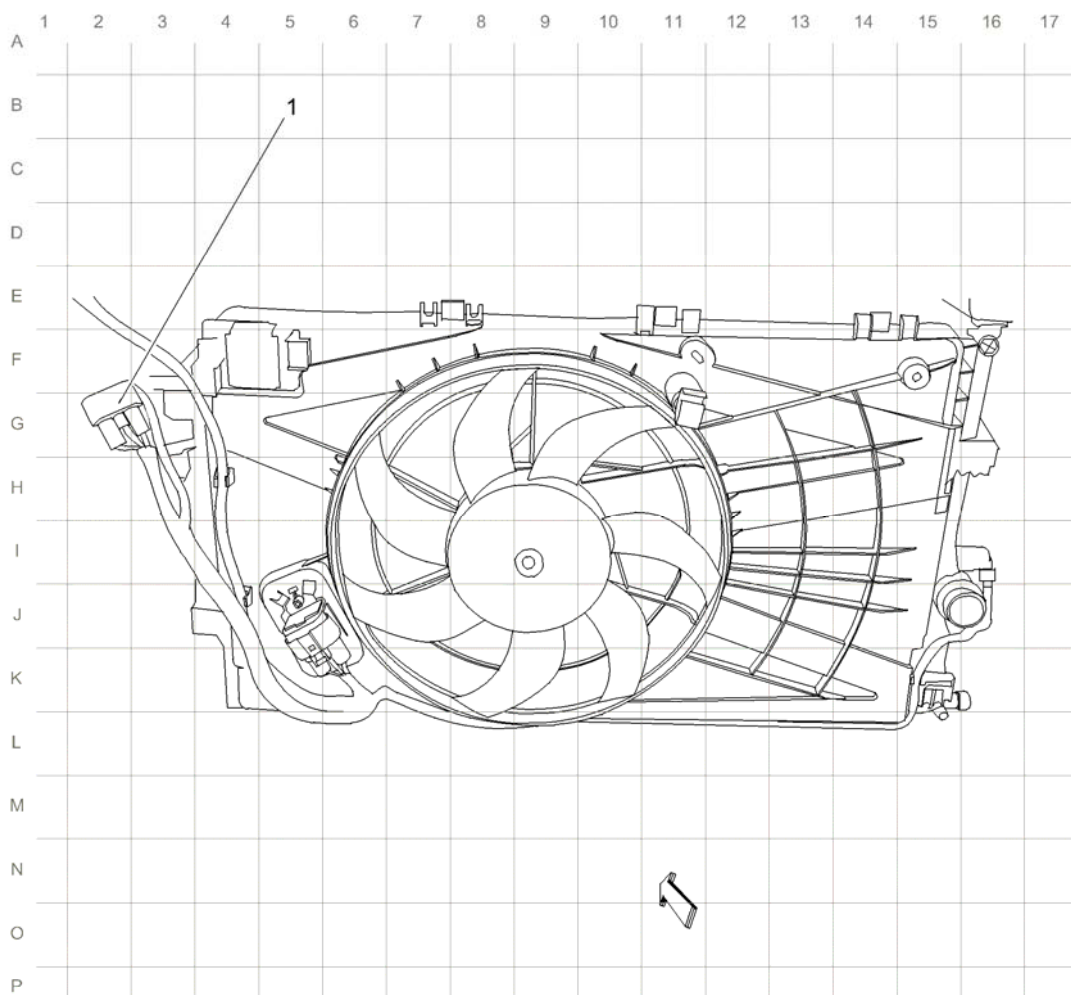


Fig. 6: Engine Cooling Harness Routing Diagram 2 of 2 (CZ2)
Courtesy of GENERAL MOTORS COMPANY

Items

1: X131 (F45) X131 Left Front Suspension Components to Left Front Suspension Harness

Engine Harness Routing (LHU)

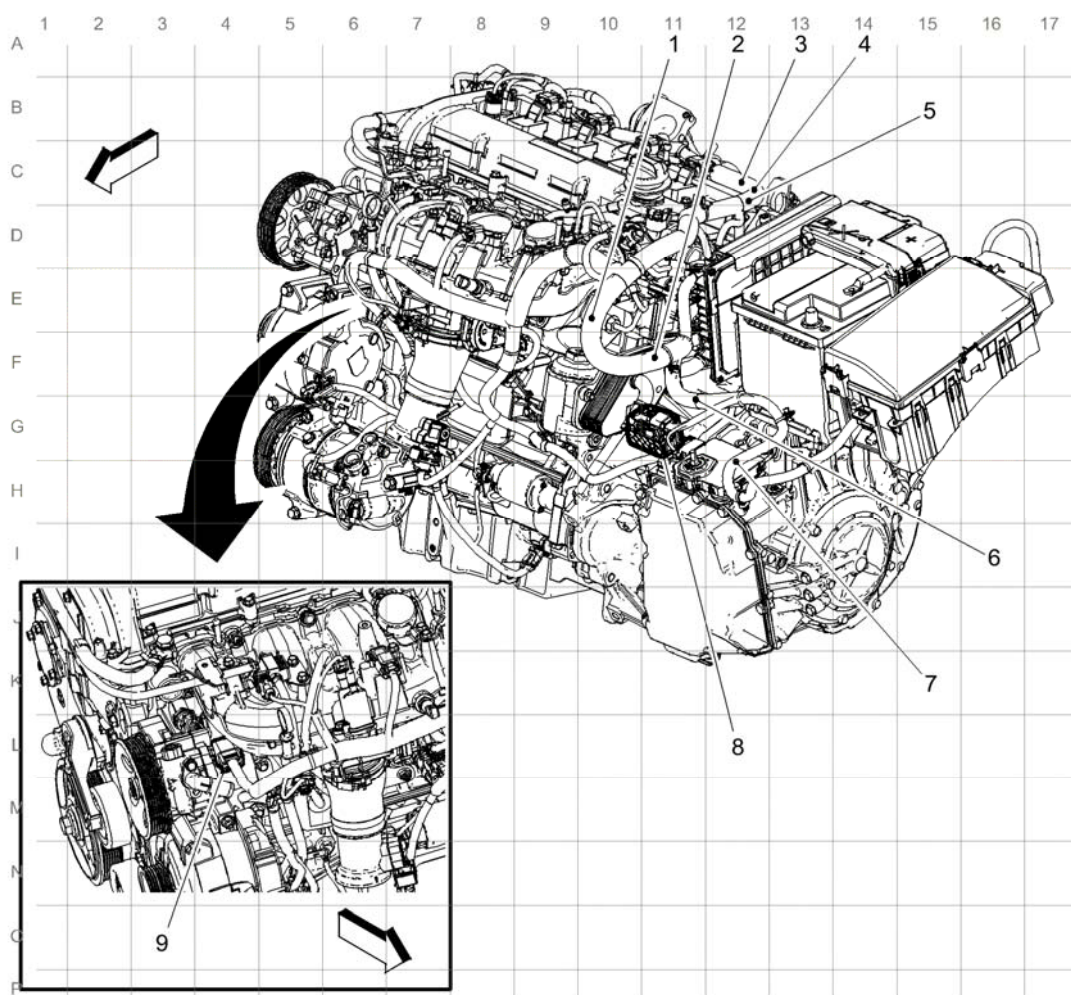


Fig. 7: Engine Wiring Harness Routing Diagram (LHU)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** J108
- 1:** J153 (LHU)
- 2:** J154 (LHU)
- 3:** J109
- 4:** J101 (LHU)
- 5:** J118
- 6:** J151 (LHU)
- 6:** J152 (LHU)
- 7:** J112 (LHU)
- 7:** J150 (LHU)
- 8:** X115 **X115 Engine Harness to Body Harness (LHU)**
- 9:** X160 **X160 Engine Harness to Fuel Rail Harness LUK/LHU**

Engine Harness Routing - Left Rear (LUK)

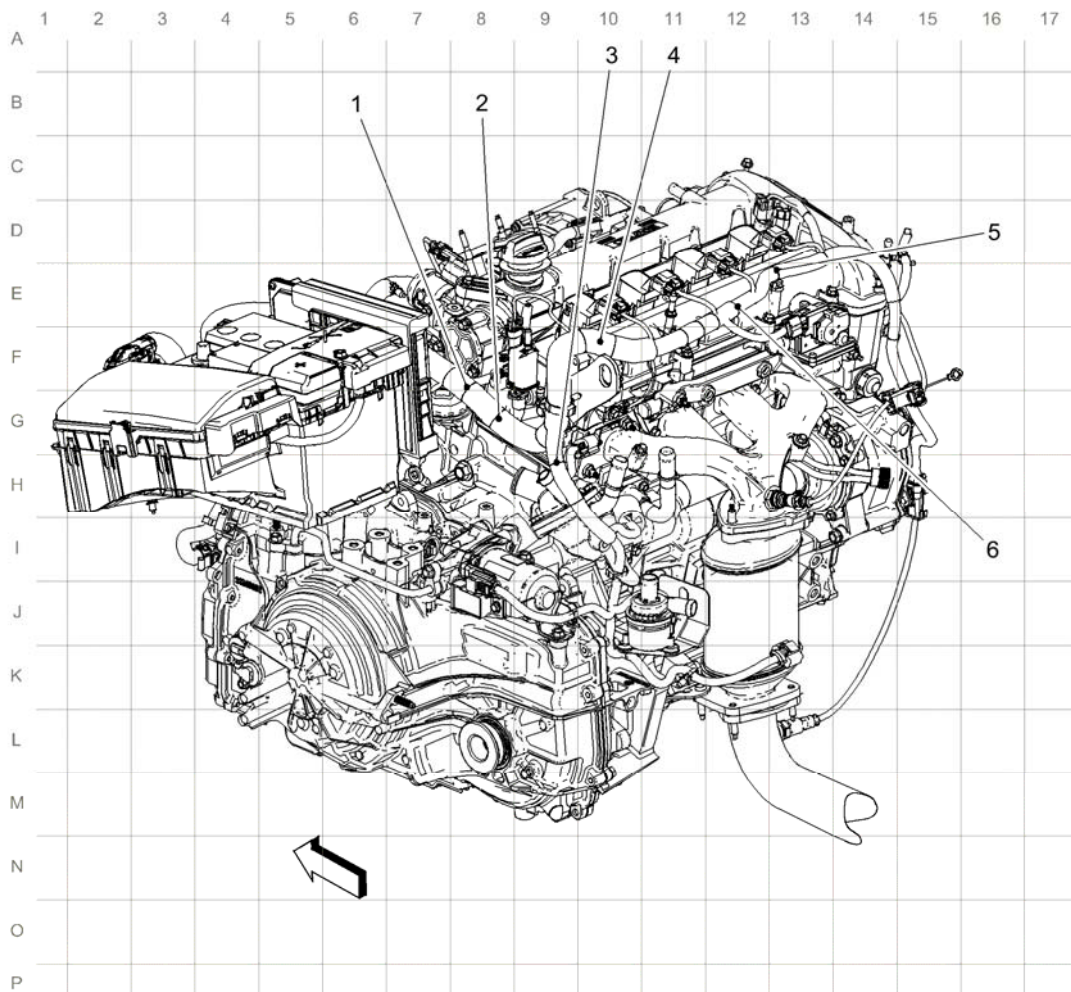


Fig. 8: Left Rear of Engine (LUK)

Courtesy of GENERAL MOTORS COMPANY

Items

- 1: J131
- 2: J132 (LUK)
- 3: J113
- 4: J118
- 5: J109
- 6: J140 (LUK)

Engine Harness Routing - Right Front (LUK)

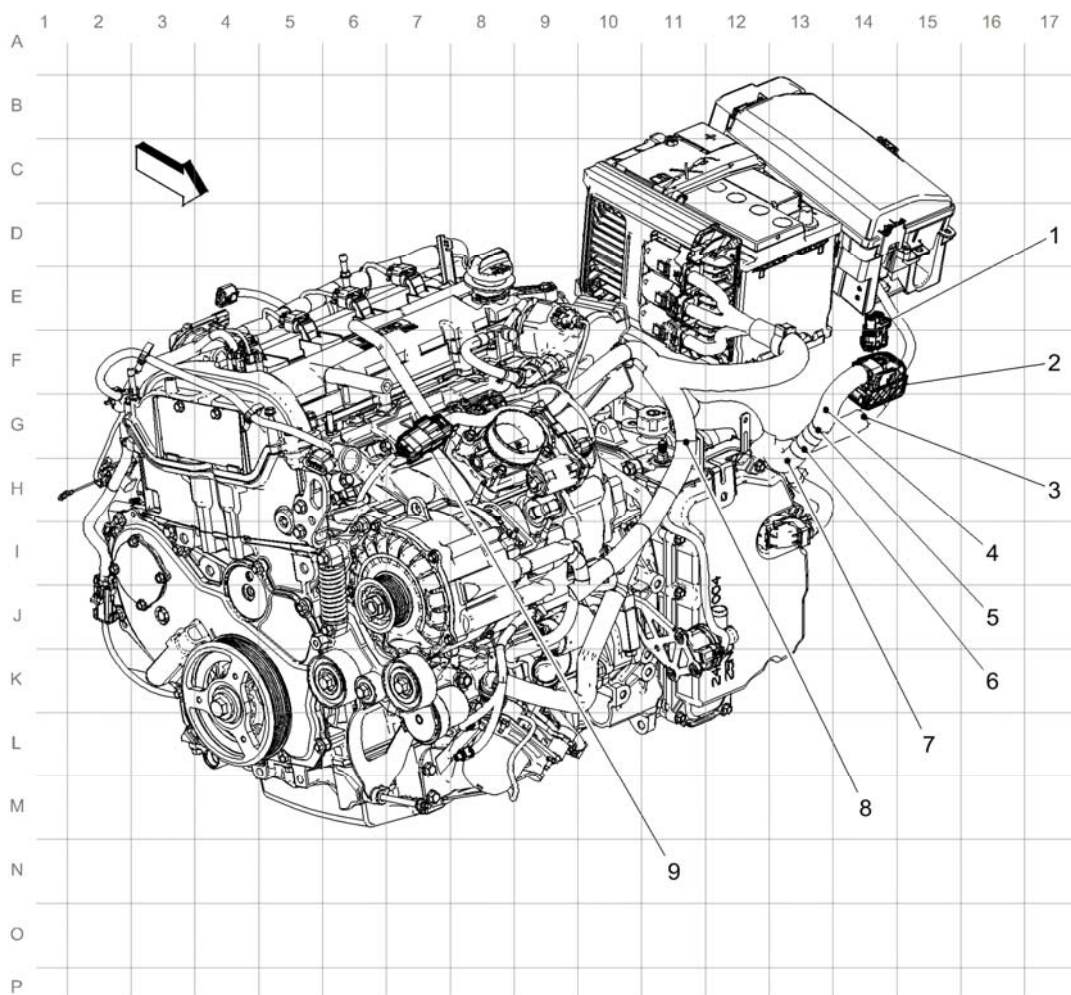


Fig. 9: Right Front of Engine (LUK)
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: X122 (NU6) X122 Engine Harness to Body Harness (NU6)**
- 2: X115 X115 Engine Harness to Body Harness (LUK)**
- 3: J117 (LUK)**
- 4: J124 (LUK)**
- 5: J123 (LUK)**
- 6: J122**
- 7: J121**
- 8: J108**
- 9: X160 X160 Engine Harness to Fuel Rail Harness LUK/LHU**

Engine Harness Routing (LDK)

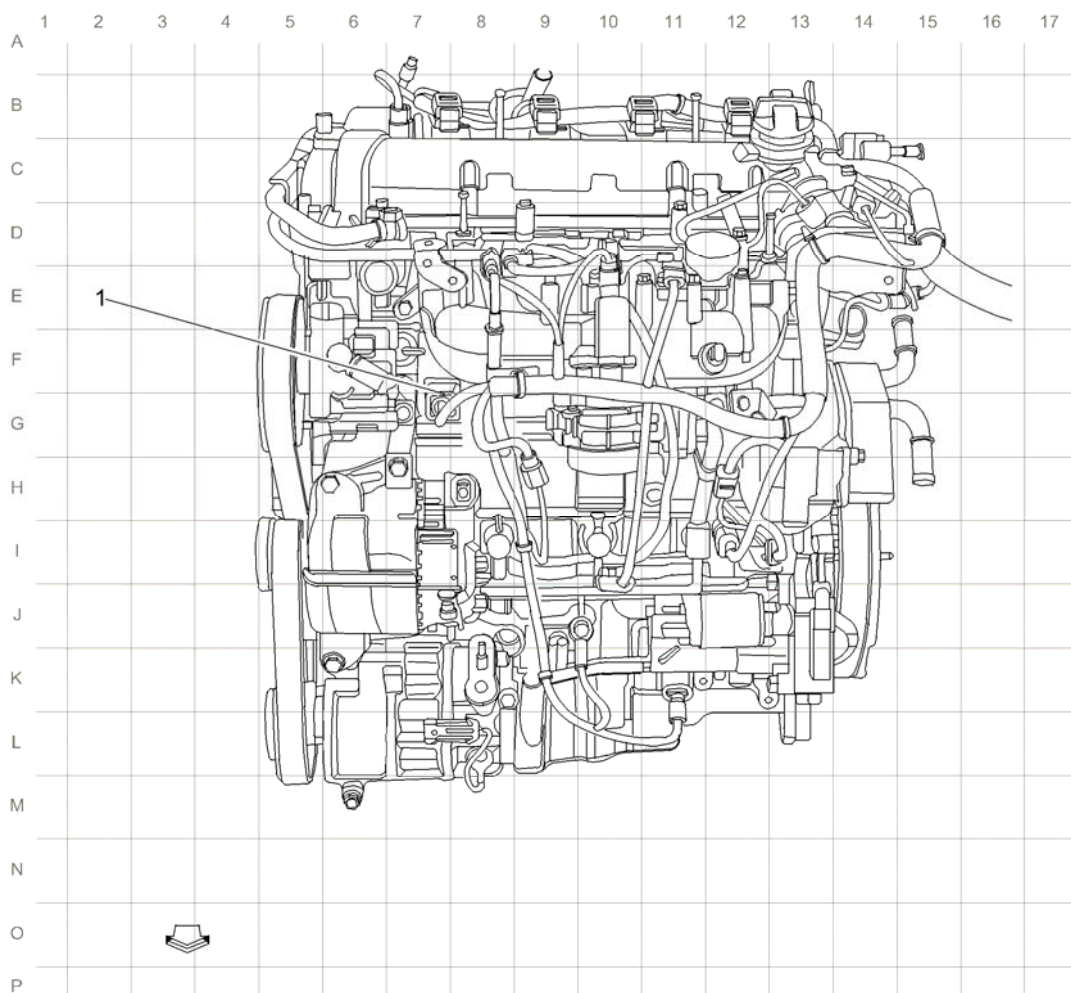


Fig. 10: Engine Harness Routing (LDK)
Courtesy of GENERAL MOTORS COMPANY

Items

1: X160 X160 Engine Harness to Fuel Injector Harness (LDK)

Body Harness Routing - Left Front of Vehicle

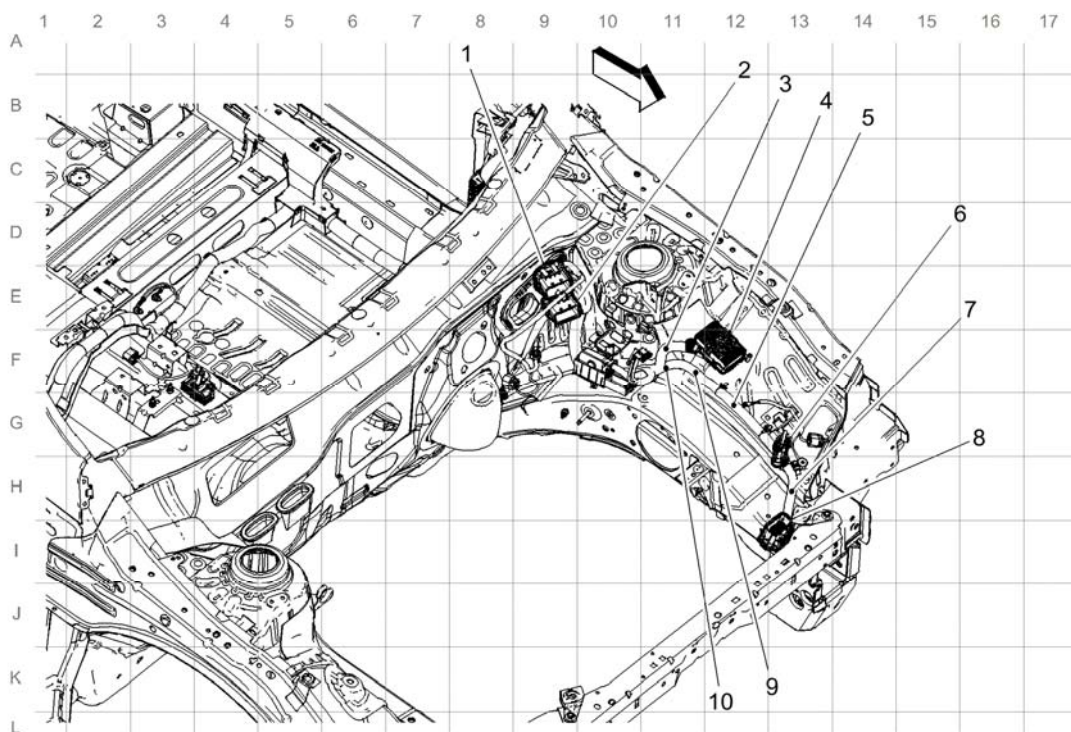


Fig. 11: Body Harness Routing - Left Front of Vehicle
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1: X150 X150 Forward Lamp Harness to Body Harness**
- 2: X151 (F45) X151 Forward Lamp Harness to Body Harness (F45)**
- 3: J121**
- 4: X50A Fuse Block - Underhood X50A Fuse Block - Underhood X1 (CZ2) X50A Fuse Block - Underhood X1 (except CZ2) X50A Fuse Block - Underhood X2 (CZ2) X50A Fuse Block - Underhood X2 (except CZ2) X50A Fuse Block - Underhood X3 (LDK) X50A Fuse Block - Underhood X3 (LHU) X50A Fuse Block - Underhood X3 (LLU) X50A Fuse Block - Underhood X3 (LTD) X50A Fuse Block - Underhood X3 (LUK) X50A Fuse Block - Underhood X4 X50A Fuse Block - Underhood X5 (HP6) X50A Fuse Block - Underhood X6 (NJ1)**
- 5: J127**
- 6: X122 (NU6) X122 Engine Harness to Body Harness (NU6)**
- 7: J126**
- 8: X115 X115 Engine Harness to Body Harness (LDK) X115 Engine Harness to Body Harness (LHU) X115 Engine Harness to Body Harness (LLU) X115 Engine Harness to Body Harness (LTD) X115 Engine Harness to Body Harness (LUK)**
- 9: J128**
- 10: J129**

Body Harness Routing - Left Front of Passenger Compartment

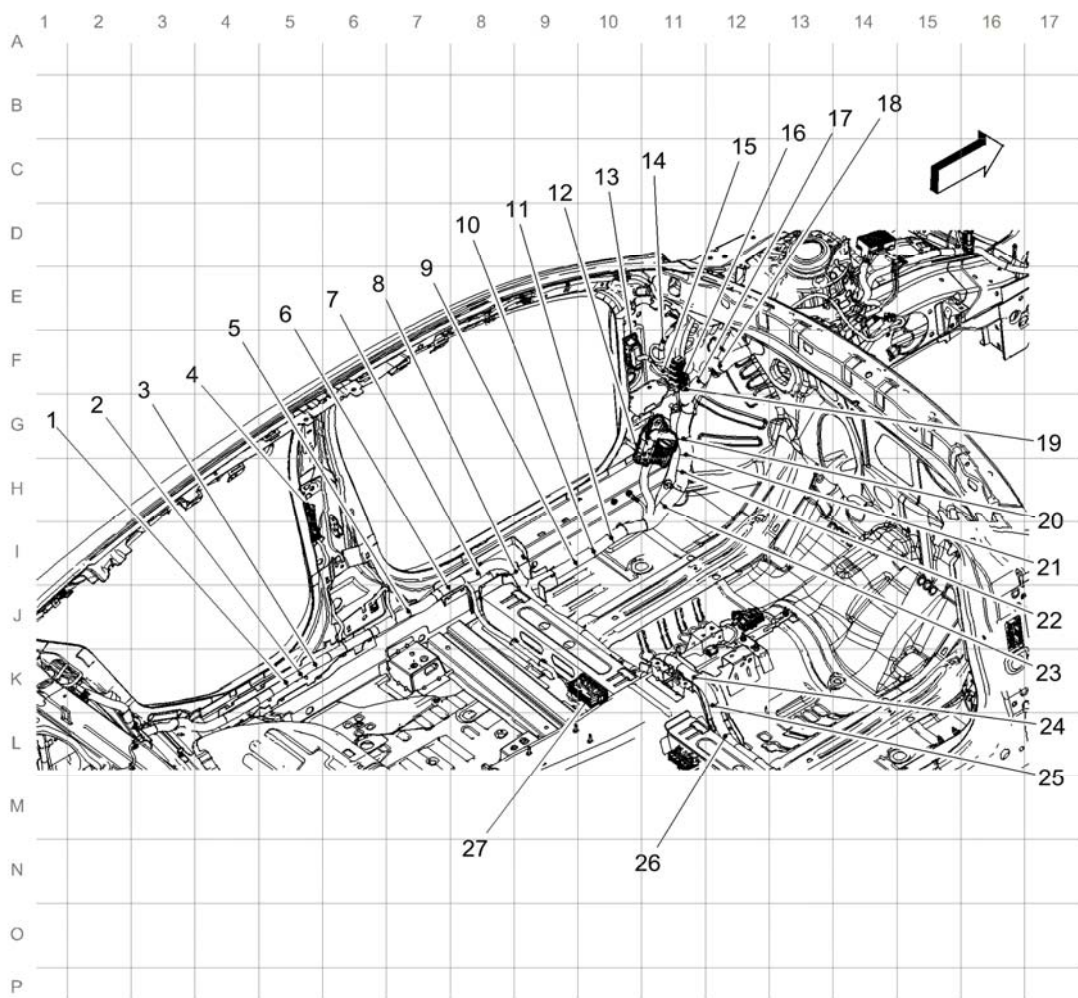


Fig. 12: Body Harness Routing - Left Front of Passenger Compartment
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** J231
- 2:** J236
- 3:** J224
- 4:** X700 **X700 Left Rear Door Harness to Body Harness**
- 5:** J328
- 6:** J330
- 7:** J310
- 8:** J318
- 9:** J313
- 10:** J200
- 11:** J201
- 12:** X210 **X210 Instrument Panel Harness to Body Harness**
- 13:** X500 **X500 Driver Door Harness to Body Harness**

- 14: J253
- 15: J355 (F45)
- 16: J203 (HP6)
- 17: J241
- 18: J240
- 19: J219 (F45)
- 20: J266
- 21: J233
- 22: J252
- 23: J242
- 24: J317
- 25: J316
- 26: J221
- 27: X310 X310 Body Harness to Driver Seat Harness

Body Harness Routing - Right Side of Passenger Compartment

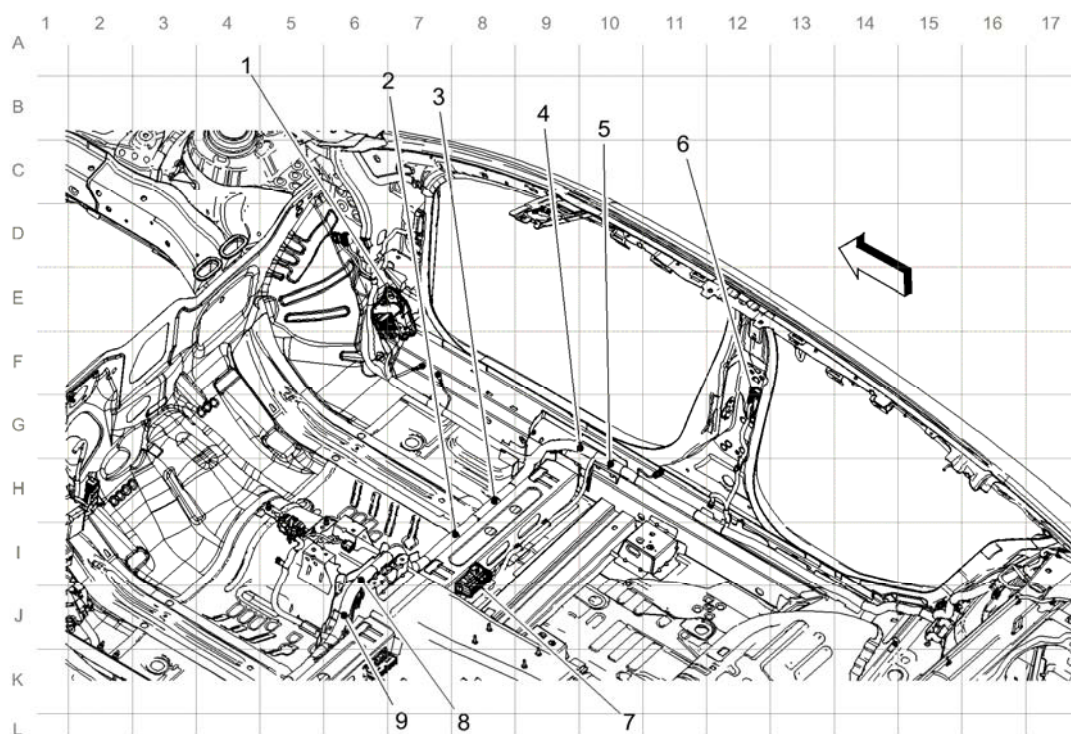


Fig. 13: Body Harness Routing - Right Side of Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Items

- 1: X220 (UQA) X220 Instrument Panel Harness to Body Harness except CZ2
- 2: J322

- 3: J314
- 4: J353
- 5: J311
- 6: X800 X800 Right Rear Door Harness to Body Harness
- 7: X320 X320 Body Harness to Passenger Seat Harness
- 8: J352
- 9: J327

Body Harness Routing - Left Rear of Passenger Compartment

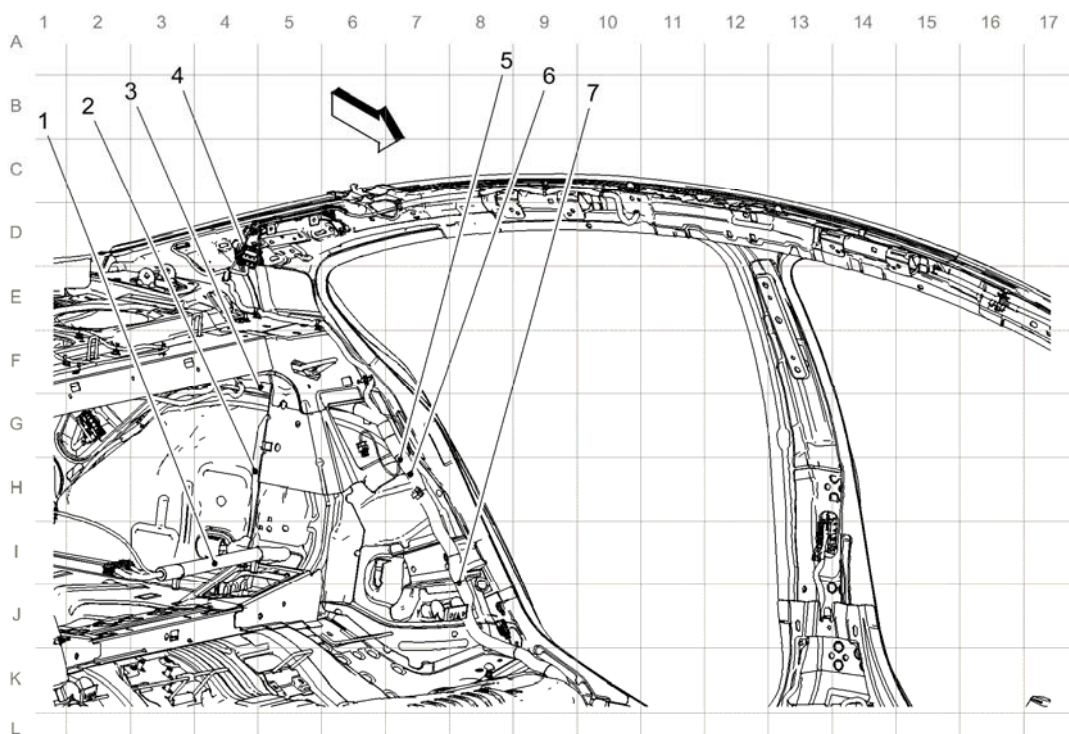


Fig. 14: Body Harness Routing - Left Rear of Passenger Compartment
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1: J301
- 2: J312
- 3: J361
- 4: X400 X400 Headliner Harness to Body Harness
- 5: J264
- 6: J301
- 7: J455

Instrument Panel Harness Routing - Behind Instrument Panel

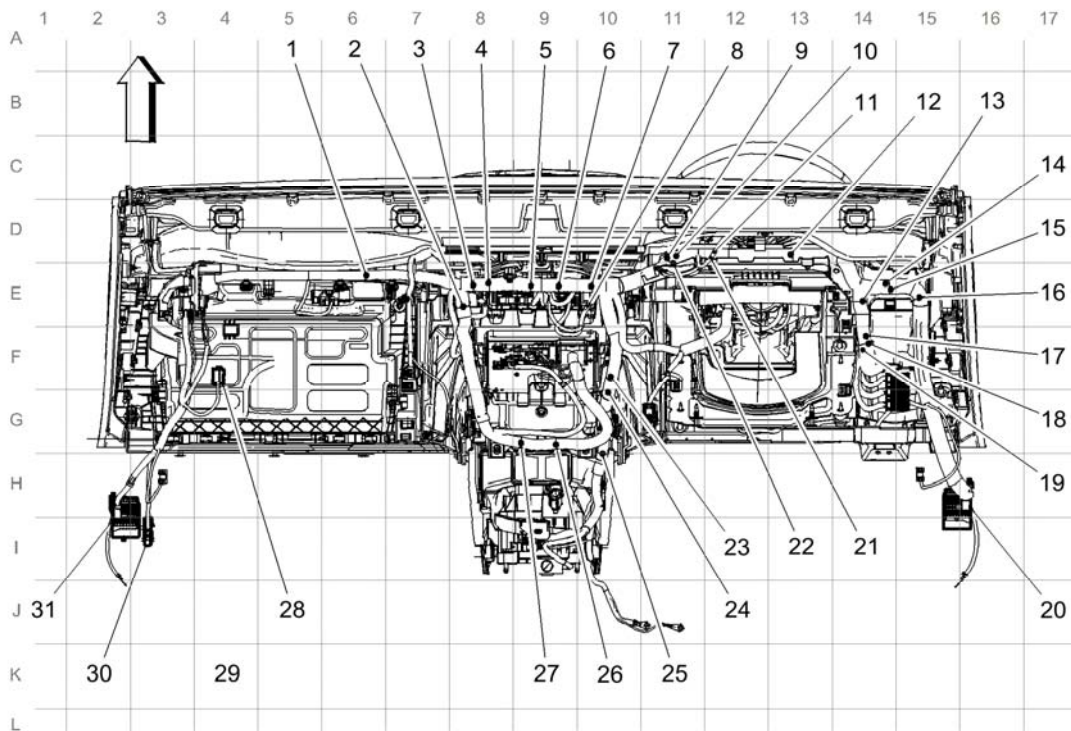


Fig. 15: Instrument Panel Harness Routing-- Behind Instrument Panel
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1: J258
- 2: J234 (F45)
- 3: J239
- 4: J245
- 5: J262
- 6: J269
- 7: J270
- 8: J204
- 9: J230
- 10: J243
- 13: J209
- 14: J213
- 15: J213
- 16: J256
- 17: J206
- 18: J215
- 19: J207
- 20: X210 X210 Instrument Panel Harness to Body Harness
- 22: J218

23: J235
24: J261
25: J263
26: J247
27: J246
28: X205 X205 Instrument Panel Harness to Passenger Instrument Panel Air Bag Harness except CZ2
29: X221
30: X222
31: X220 (UQA) X220 Instrument Panel Harness to Body Harness except CZ2

Driver Seat Harness Routing

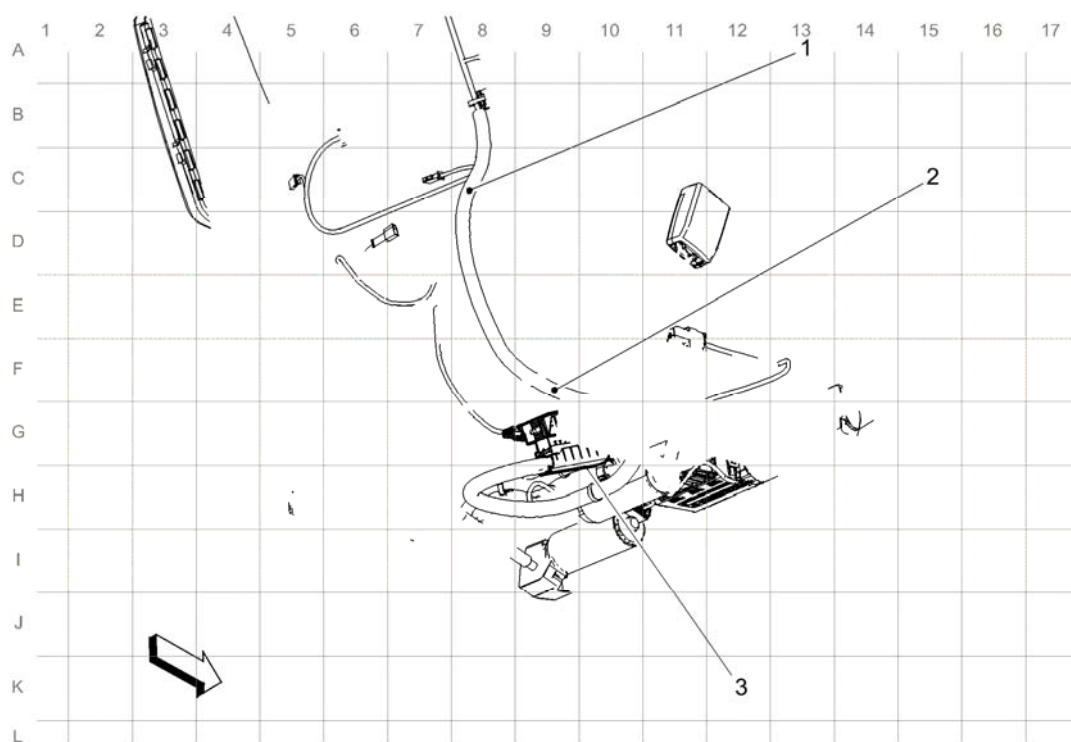


Fig. 16: Driver Seat Wiring Harness Routing
 Courtesy of GENERAL MOTORS COMPANY

Items

1: J310
2: J311
3: X310 X310 Body Harness to Driver Seat Harness

Passenger Seat Harness Routing

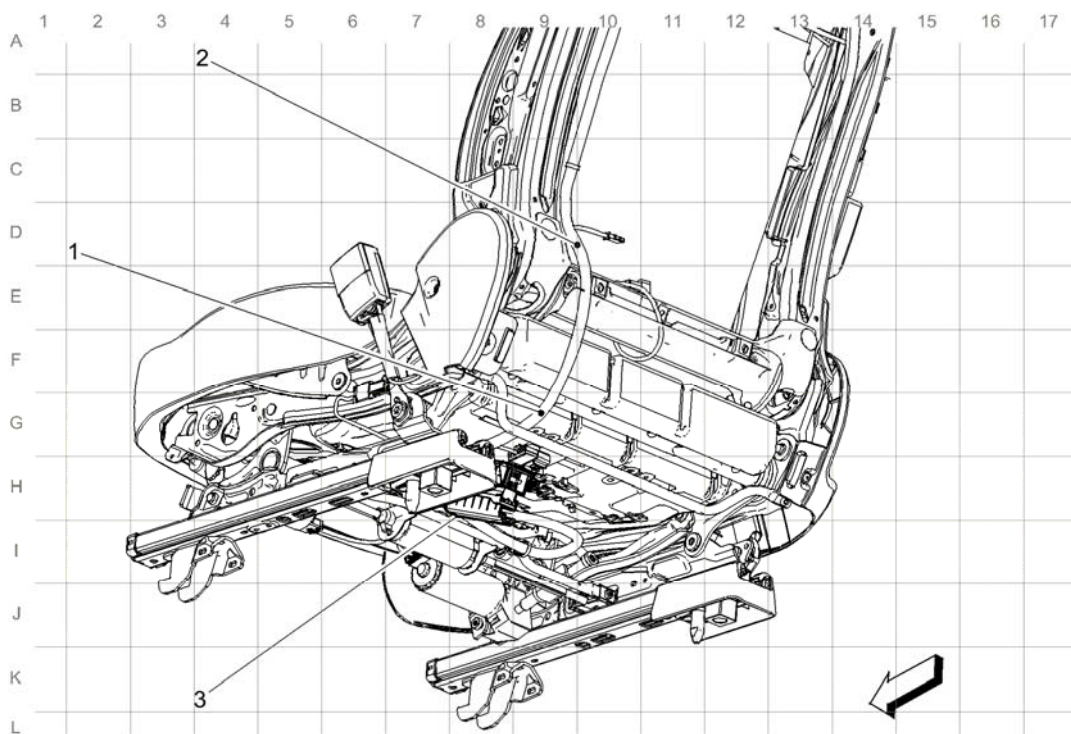


Fig. 17: Passenger Seat Wiring Harness Routing
 Courtesy of GENERAL MOTORS COMPANY

Items

1: J321 (APH)

2: J320 (APH)

3: X320 X320 Body Harness to Passenger Seat Harness

Floor Console Harness Routing

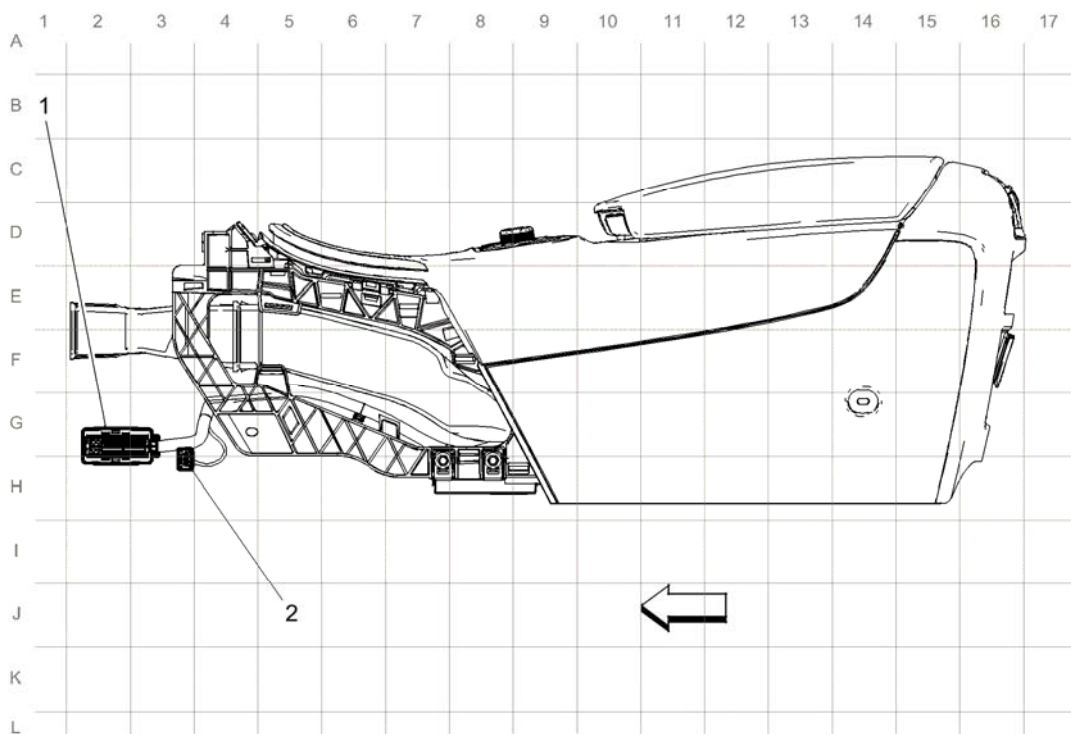


Fig. 18: Floor Console Harness Routing Diagram
 Courtesy of GENERAL MOTORS COMPANY

Items
1: X300 <u>X300 Floor Console Harness to Instrument Panel Harness</u>
2: X301

Driver Door Harness Routing

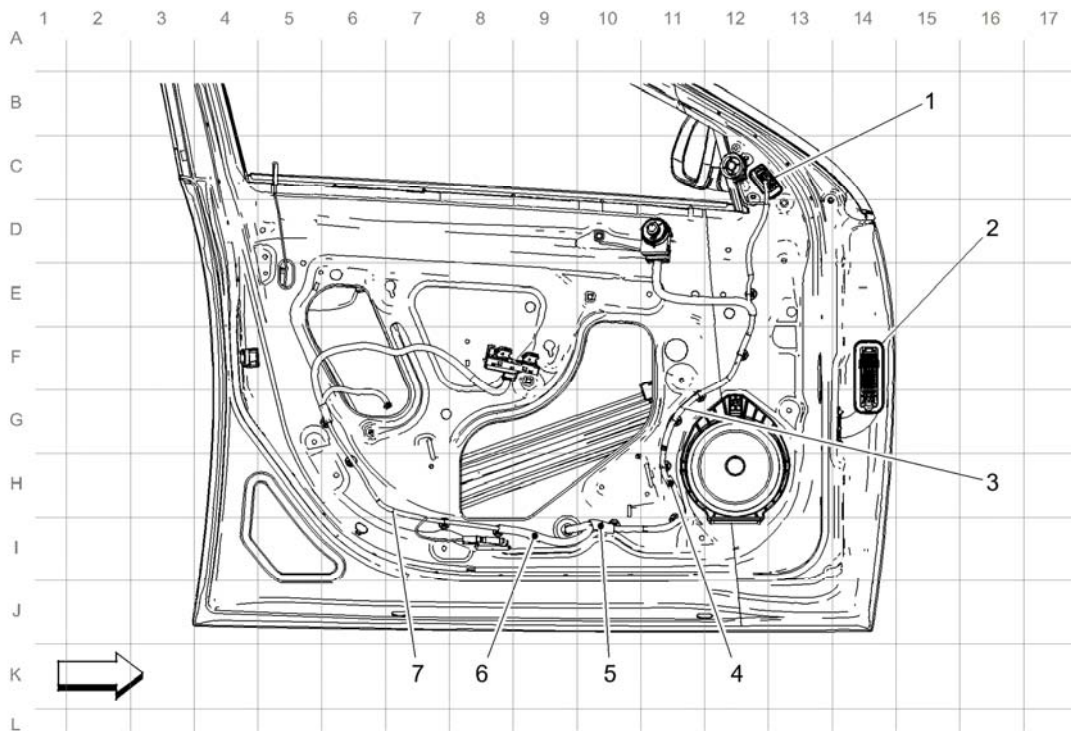


Fig. 19: Driver Door Harness Routing Diagram
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1: X510 X510 Driver Door Harness to Outside Rearview Mirror - Driver Harness**
- 2: X500 X500 Driver Door Harness to Body Harness**
- 3: J510**
- 4: J511**
- 5: J550**
- 6: J501**
- 7: J503**

Left Rear Door Harness Routing

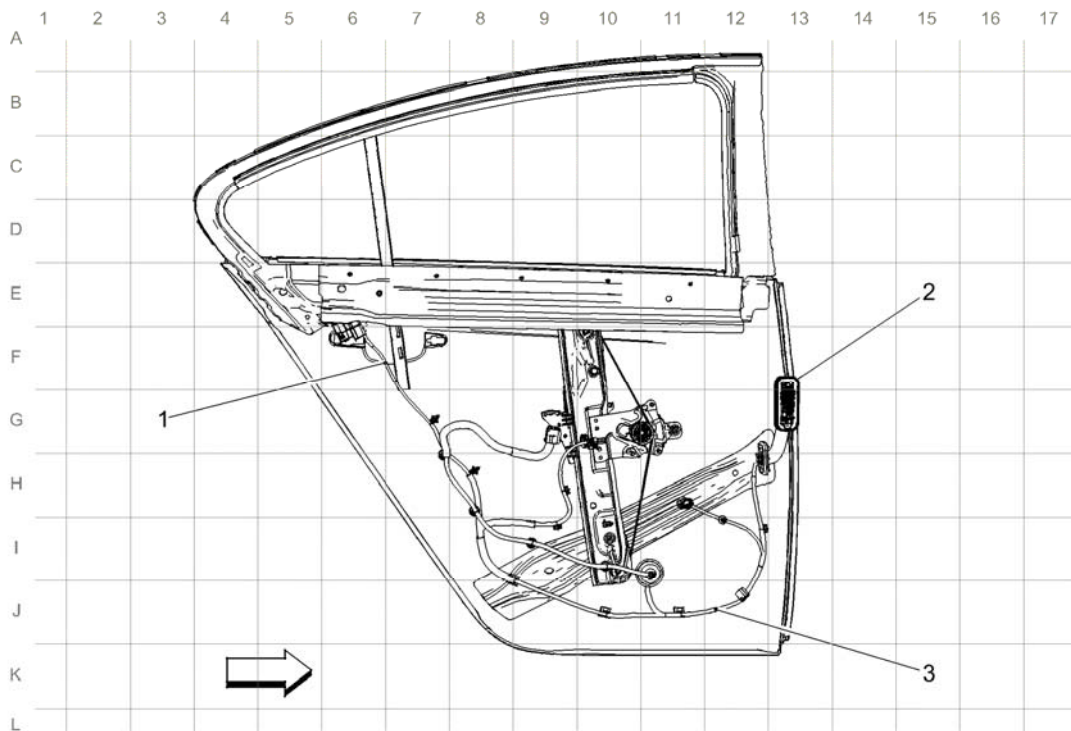


Fig. 20: Left Rear Door Harness Routing Diagram
 Courtesy of GENERAL MOTORS COMPANY

Items

- 1: J710**
- 2: X700 X700 Left Rear Door Harness to Body Harness**
- 3: J700**

Passenger Door Harness Routing

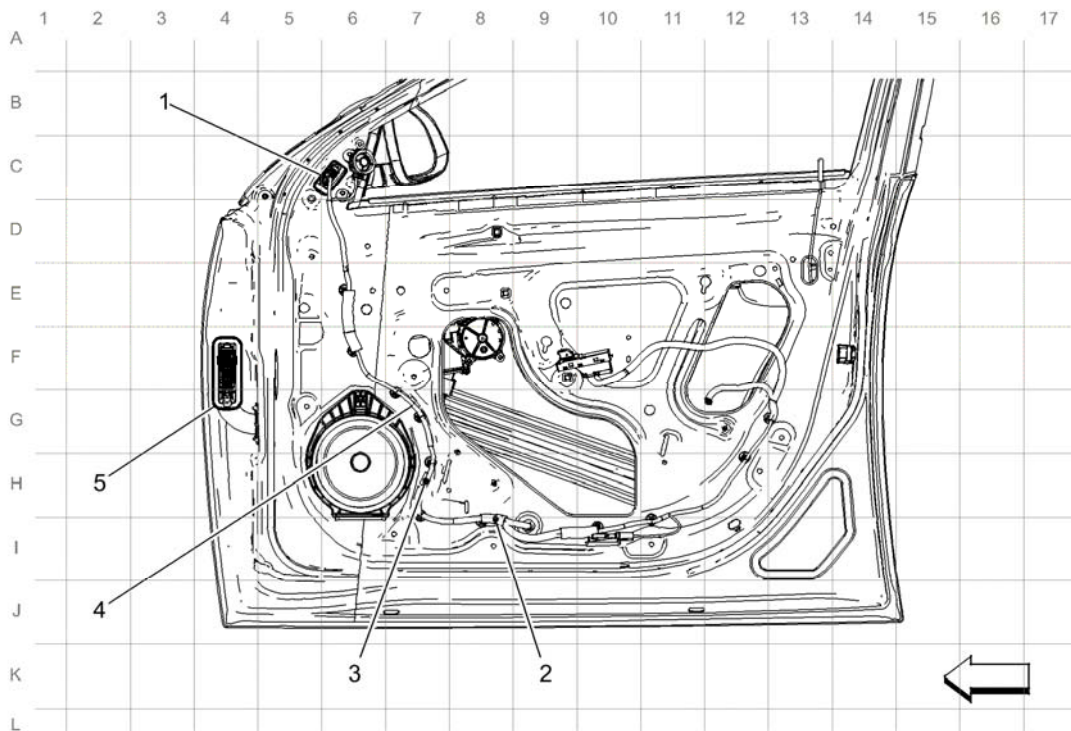


Fig. 21: Passenger Door Harness Routing Diagram
 Courtesy of GENERAL MOTORS COMPANY

Items	
1: X610	<u>X610 Passenger Door Harness to Outside Rearview Mirror - Passenger Harness</u>
2: J603	
3: J604	
4: J611	
5: J610	
6: X600	<u>X600 Passenger Door Harness to Body Harness</u>

Right Rear Door Harness Routing

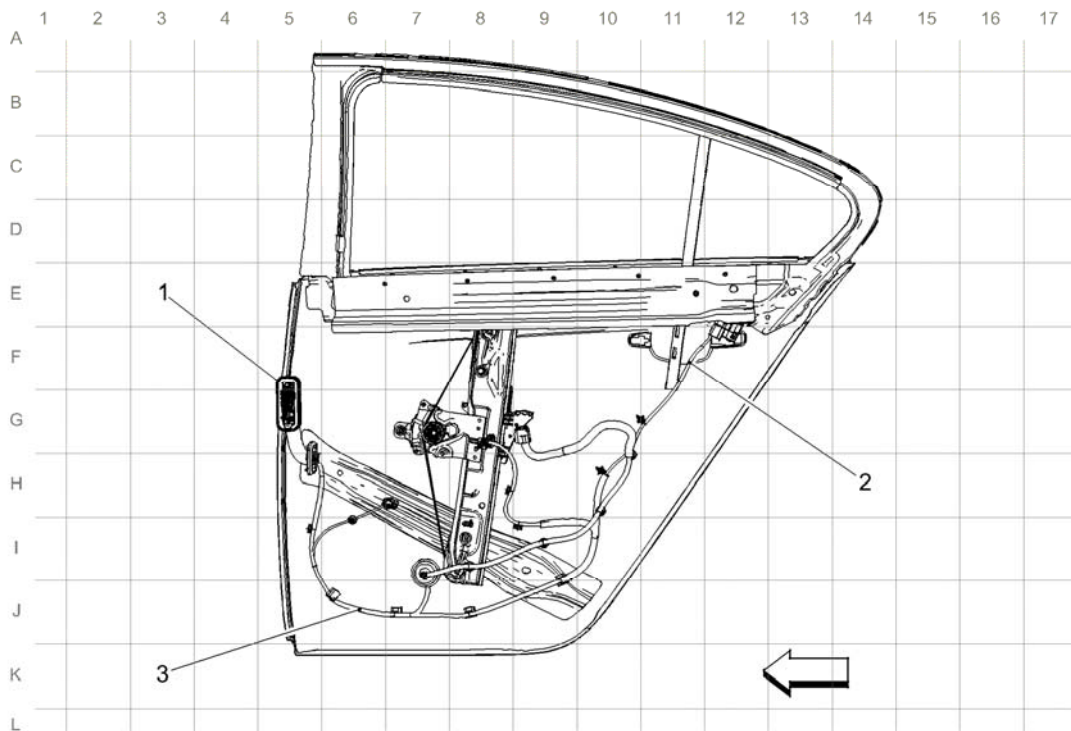


Fig. 22: Right Rear Door Harness Routing Diagram
 Courtesy of GENERAL MOTORS COMPANY

Items	
1:	X800 <u>X800 Right Rear Door Harness to Body Harness</u>
2:	J810
3:	J800

Fuel Tank Harness Routing

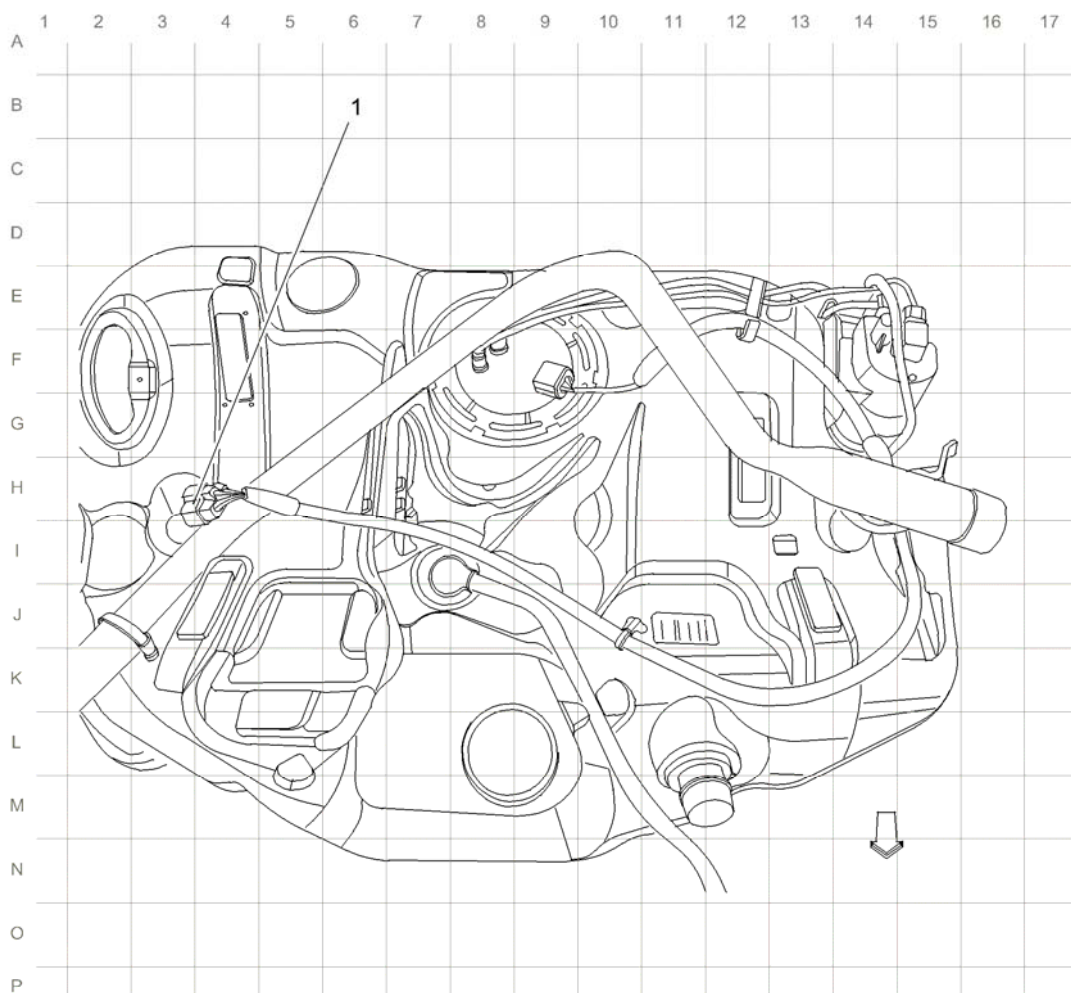


Fig. 23: Fuel Tank Harness Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

Items

1: X430 (F45) X430 Left Rear Suspension Harness to Body Harness (F45)

Rear Bumper Harness Routing (UD7)

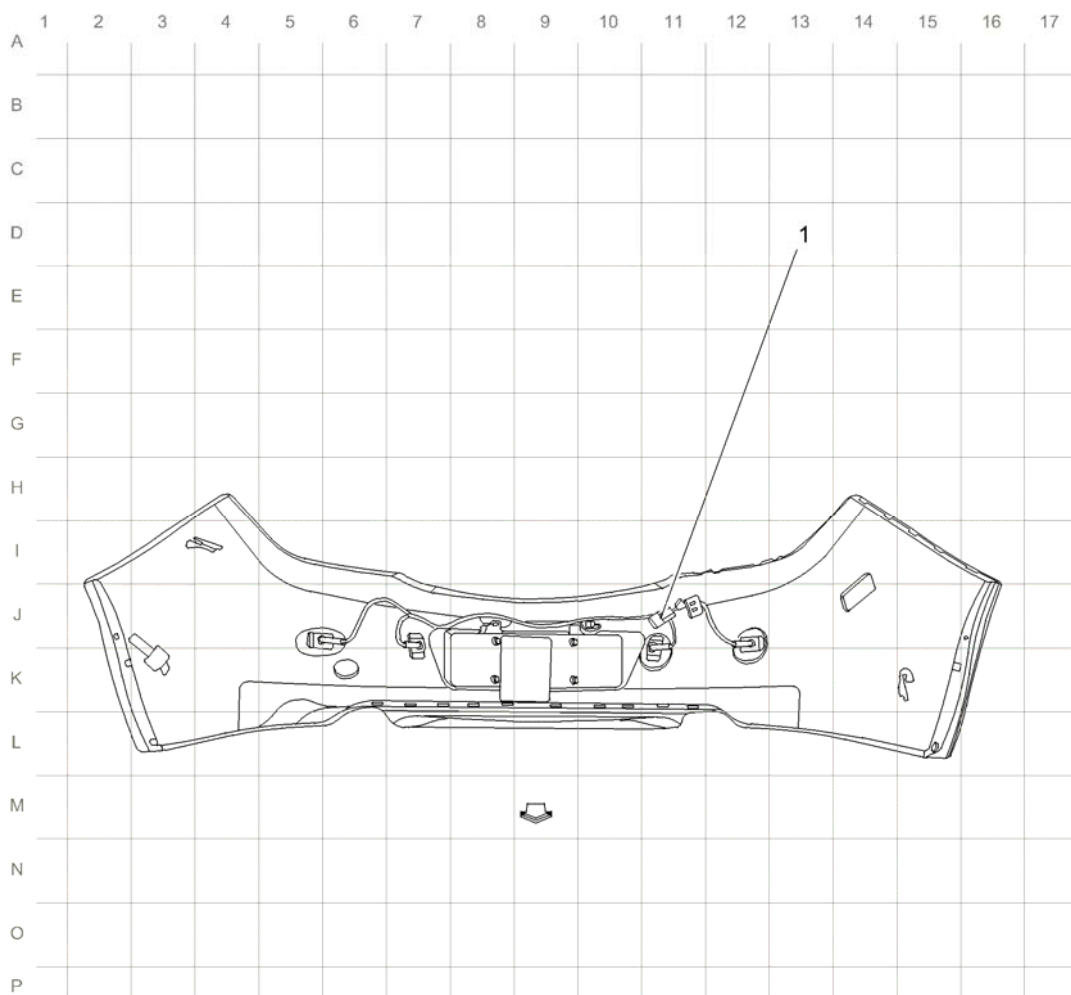


Fig. 24: Rear Bumper Wiring Harness Routing (UD7)
Courtesy of GENERAL MOTORS COMPANY

Items

1: X415 (UD5 or UD7) X415 Rear Bumper Harness to Body Harness (UD5 or UD7 without HP6)

Rear Bumper Harness to Rear Body Harness

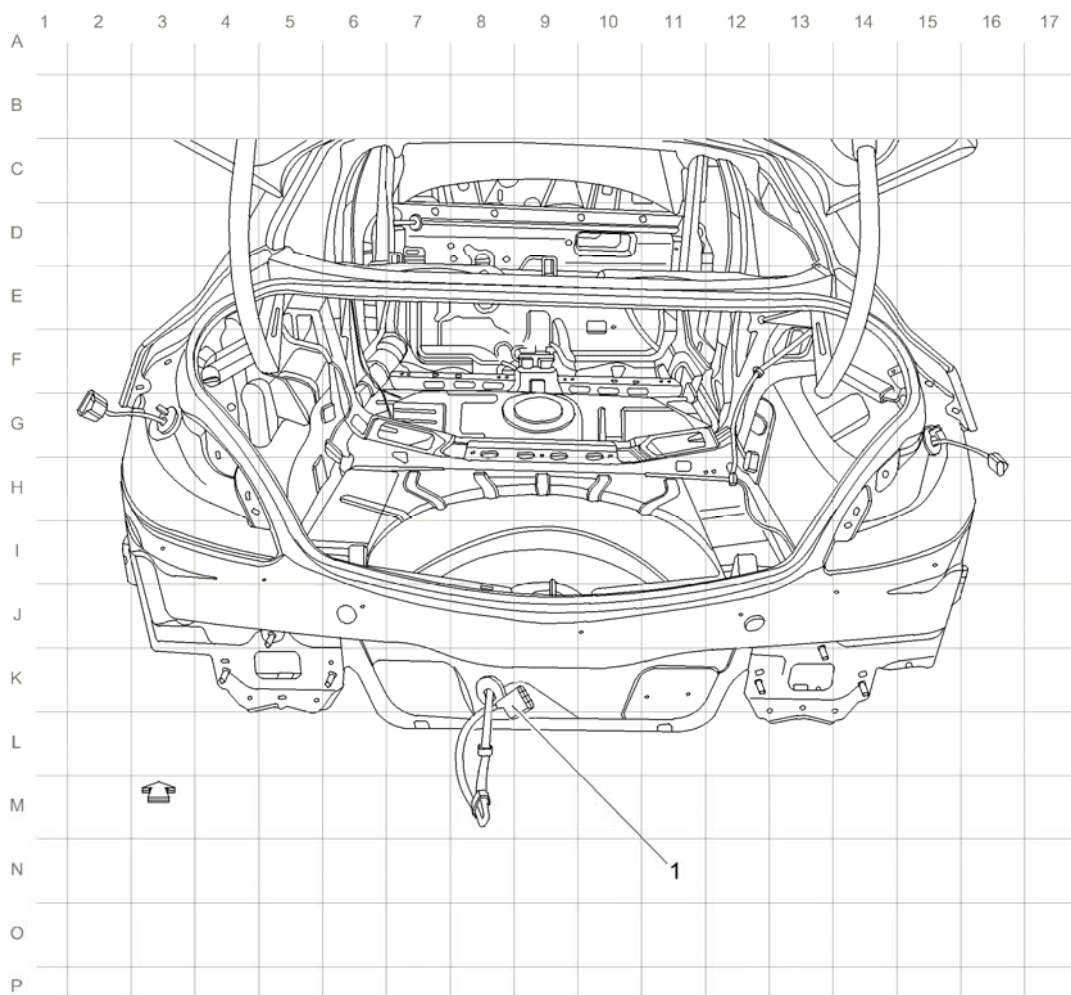


Fig. 25: Rear Bumper Harness to Rear Body Harness Routing Diagram
 Courtesy of GENERAL MOTORS COMPANY

Items

1: X410 X410 Body Harness to Left Tail Lamp Assembly Harness except CZ2

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Ground Views

GROUND VIEWS

G103, G106, AND G110

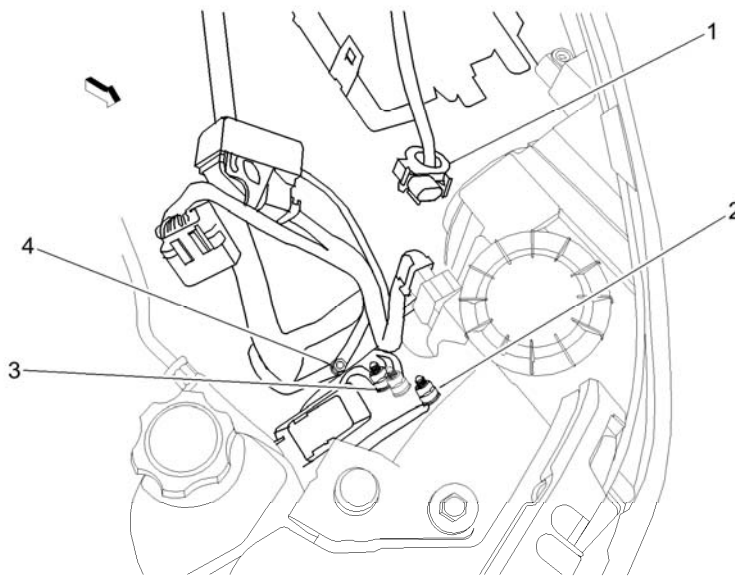


Fig. 1: G103, G106, and G110 Grounds
Courtesy of GENERAL MOTORS COMPANY

Items
1: B18 Battery Current Sensor <u>B18 Battery Current Sensor</u>
2: G106
3: G110
4: G103

G102 AND G108

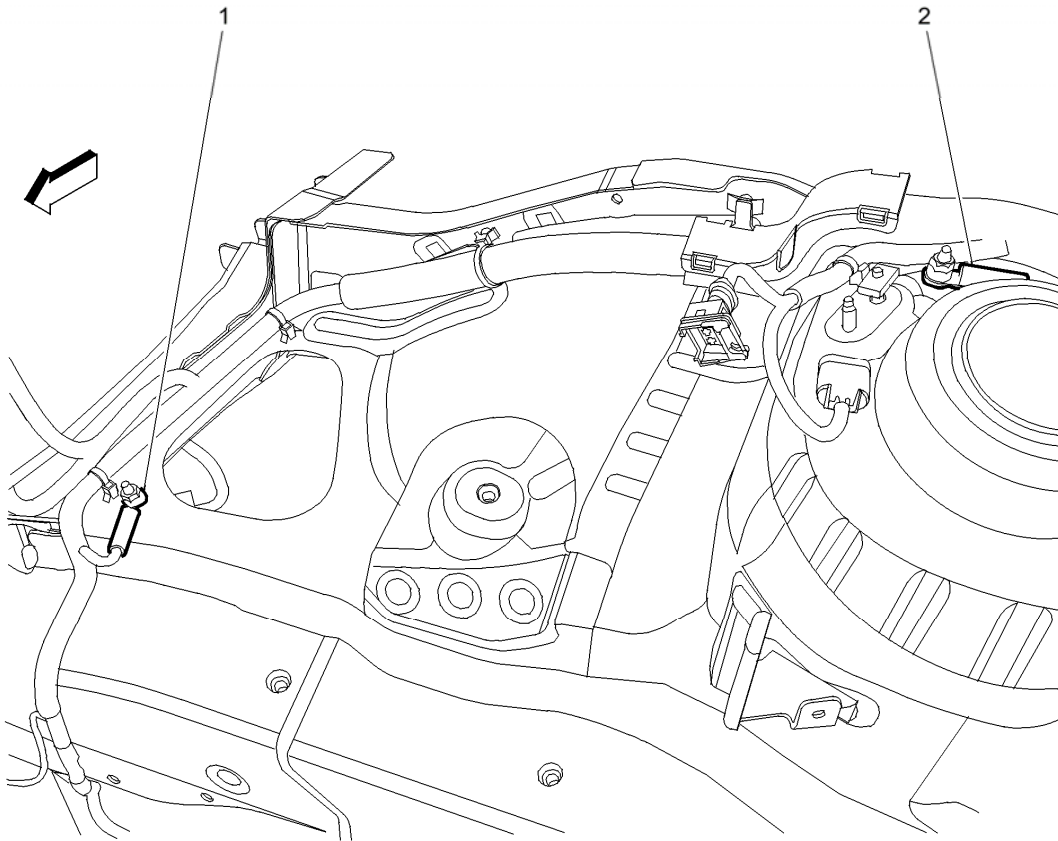


Fig. 2: G102 and G108 Grounds
Courtesy of GENERAL MOTORS COMPANY

Items	
1:	G108 (T4F)
2:	G102

G105 AND G109

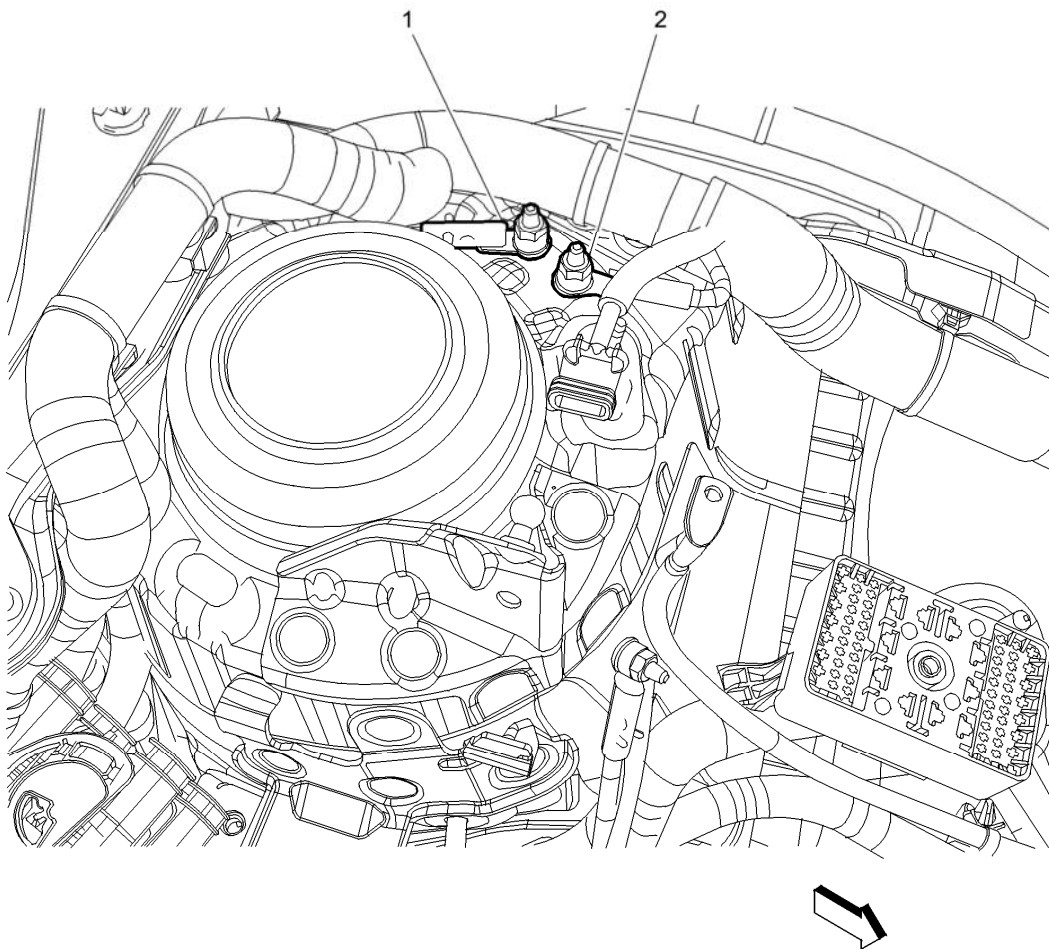


Fig. 3: G105 and G109 Grounds
Courtesy of GENERAL MOTORS COMPANY

Items	
1:	G105 (T4F)
2:	G109

G120, G121, G122, AND G140 (LUK)

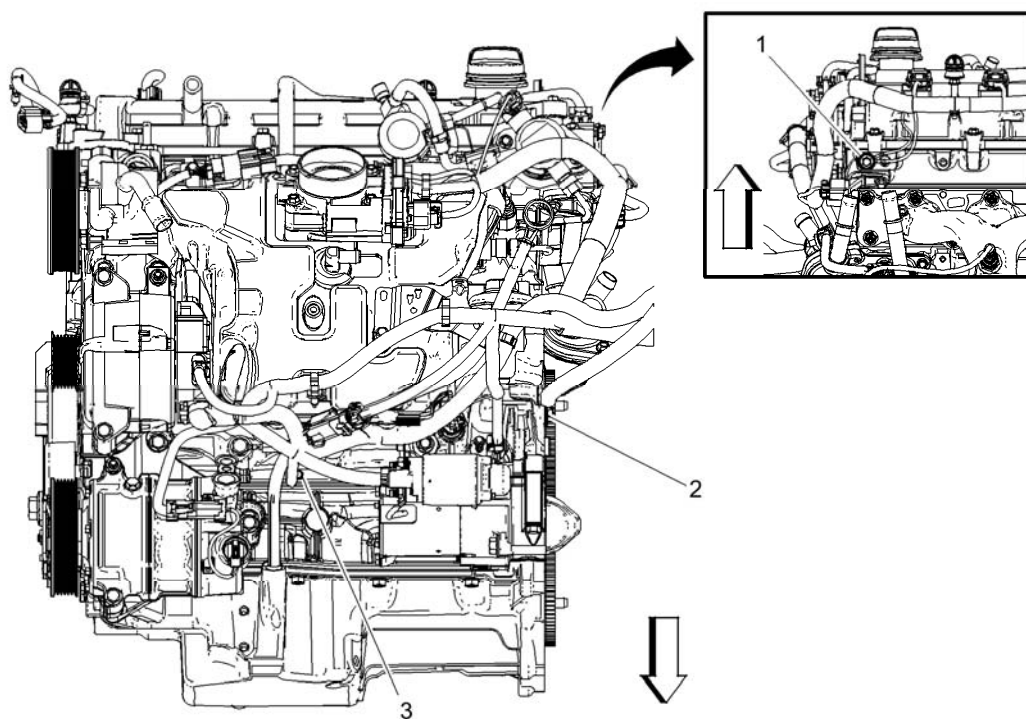


Fig. 4: G120, G121, G122, and G140 (LUK) Grounds
Courtesy of GENERAL MOTORS COMPANY

Items
1: G120 (LUK)
2: G140
3: G121 (LUK)

G120 (LUK)

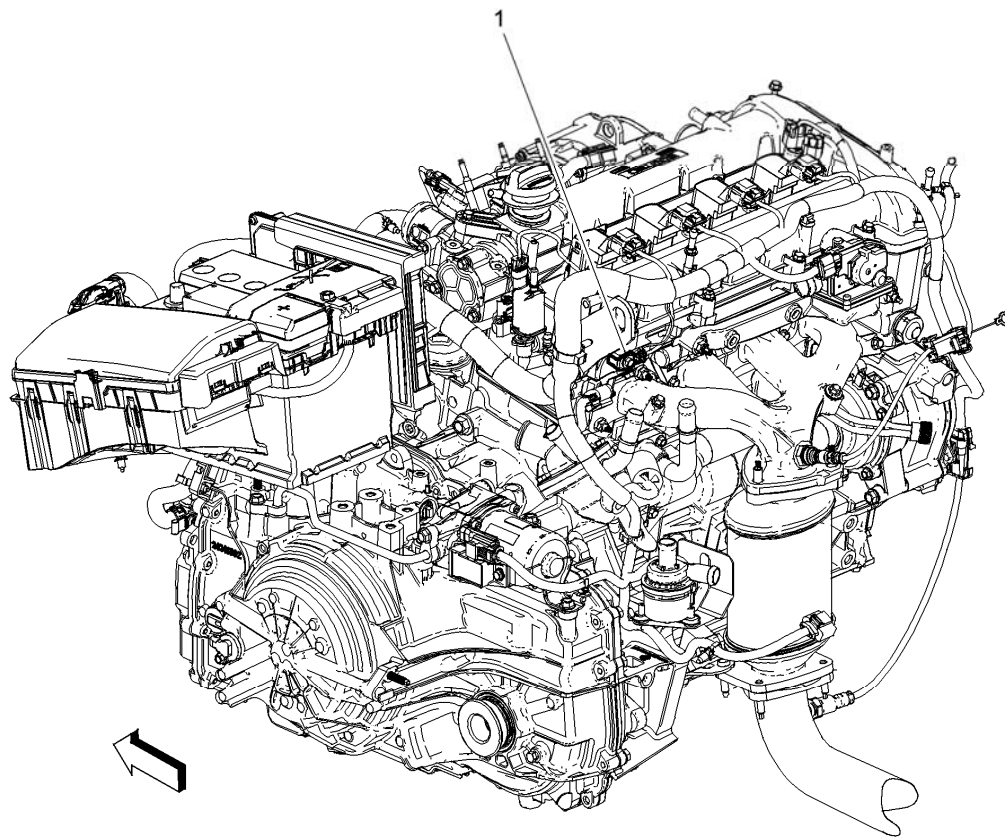


Fig. 5: G120 (LUK) Grounds
Courtesy of GENERAL MOTORS COMPANY

	Items
1: G120 (LUK)	

G121 (LUK)

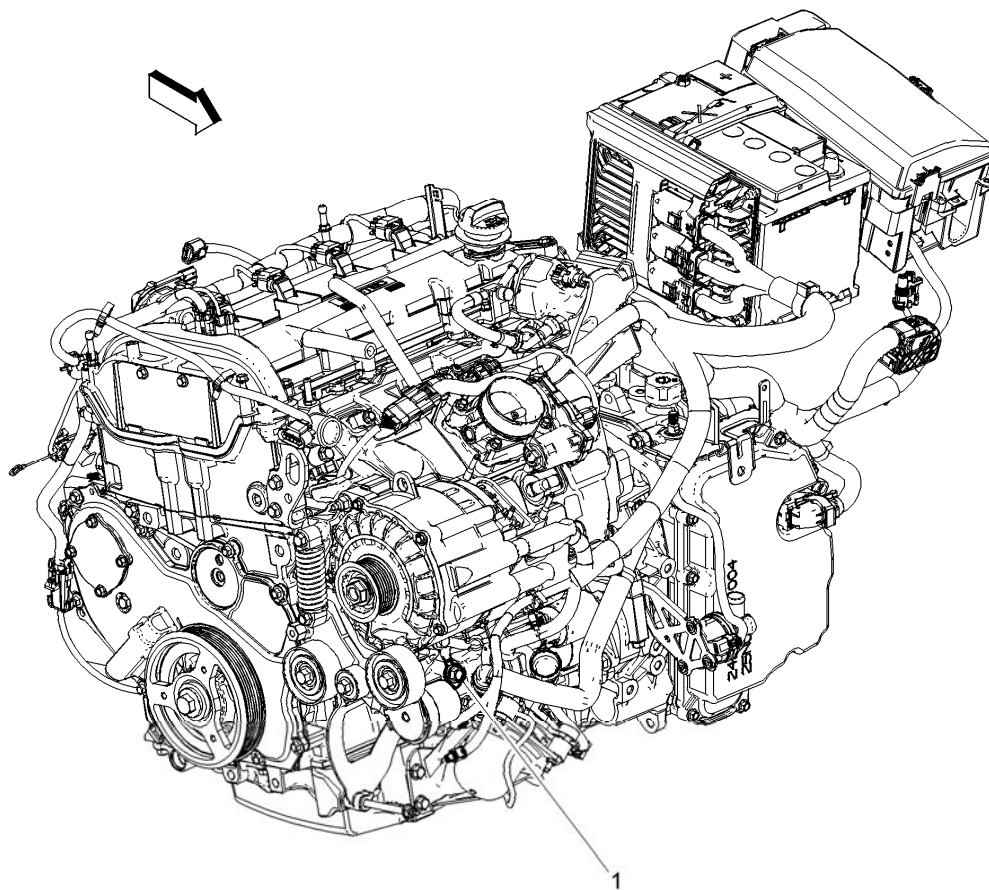


Fig. 6: G121 (LUK) Grounds
Courtesy of GENERAL MOTORS COMPANY

Items	
1:	G121 (LUK)

G122 (LHU)

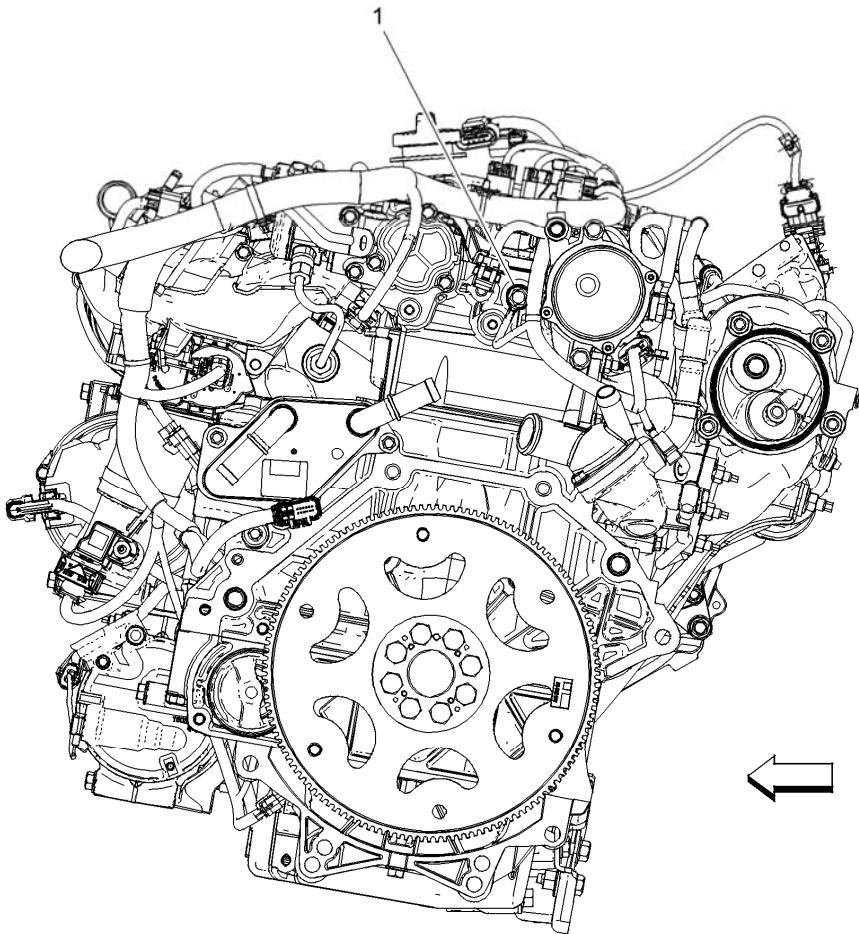


Fig. 7: G122 (LHU) Grounds

Courtesy of GENERAL MOTORS COMPANY

Items
1: G122

G201, G205, G302, G303, AND G305

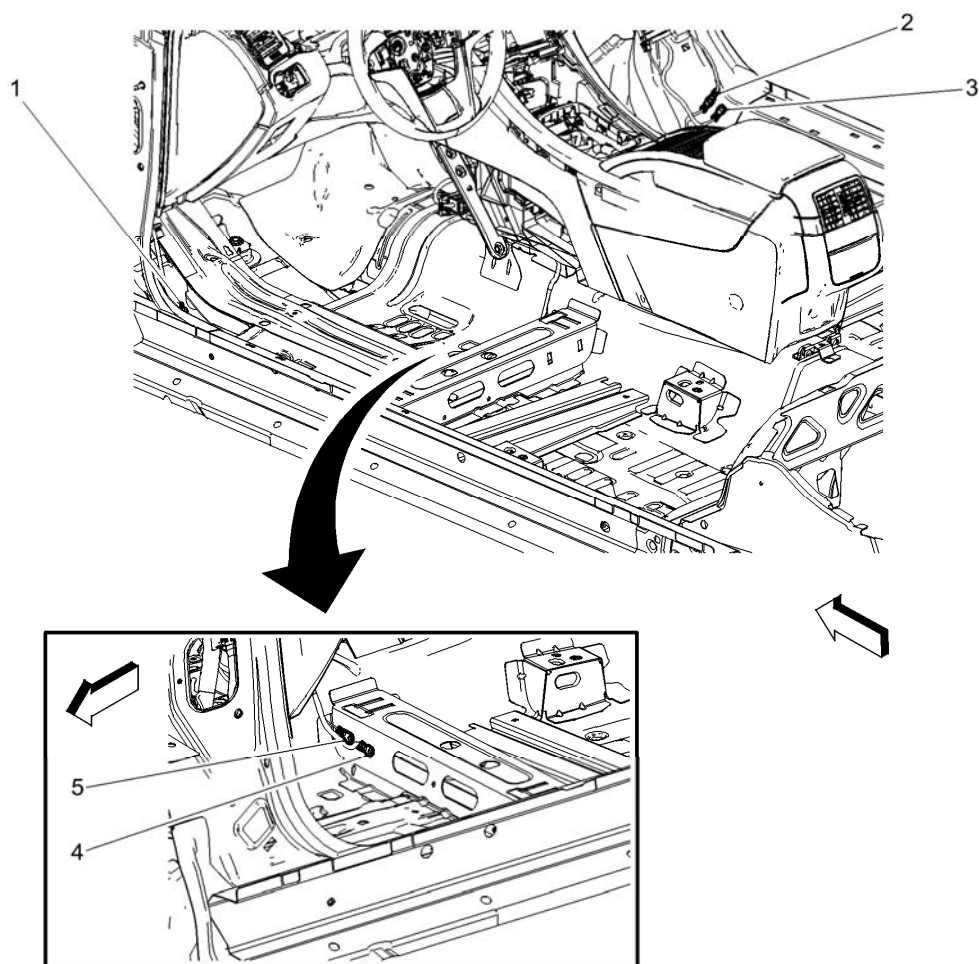


Fig. 8: G201, G205, G302, G303, and G305 Grounds
Courtesy of GENERAL MOTORS COMPANY

Items

- 1:** G201
- 2:** G205
- 3:** G302
- 4:** G305
- 5:** G303

G203 AND G206

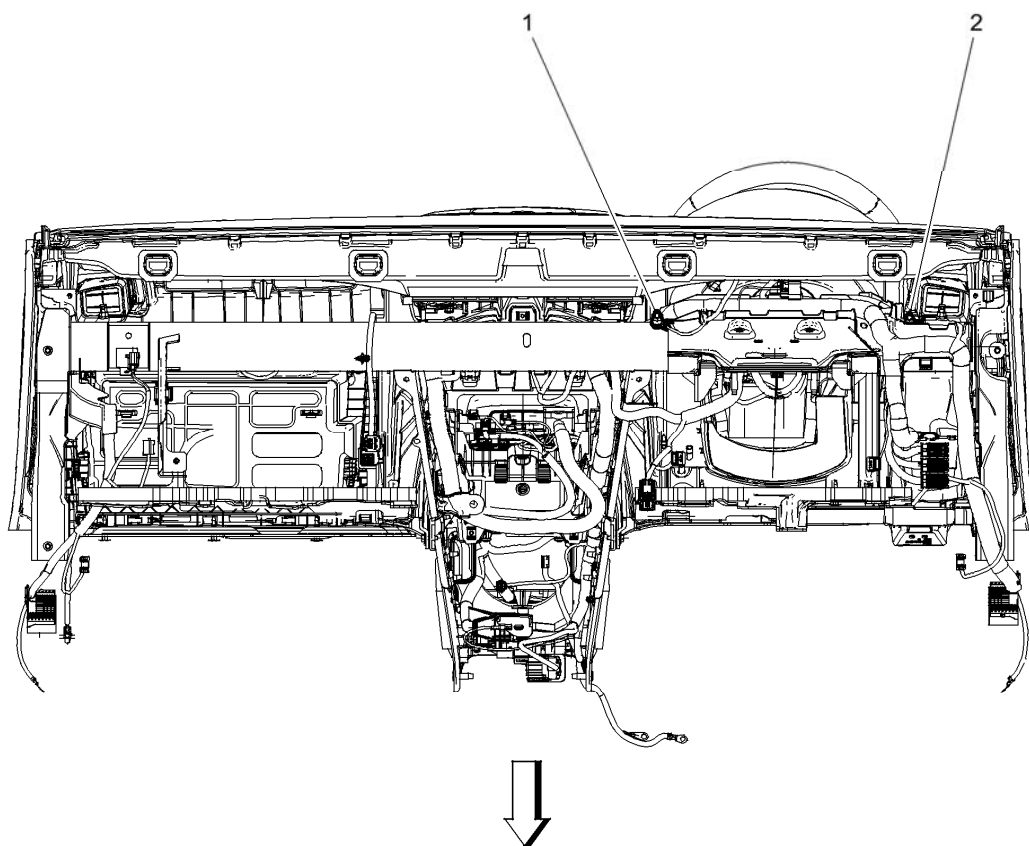


Fig. 9: G203 and G206 Grounds
Courtesy of GENERAL MOTORS COMPANY

Items	
1: G206	
2: G203	

G401

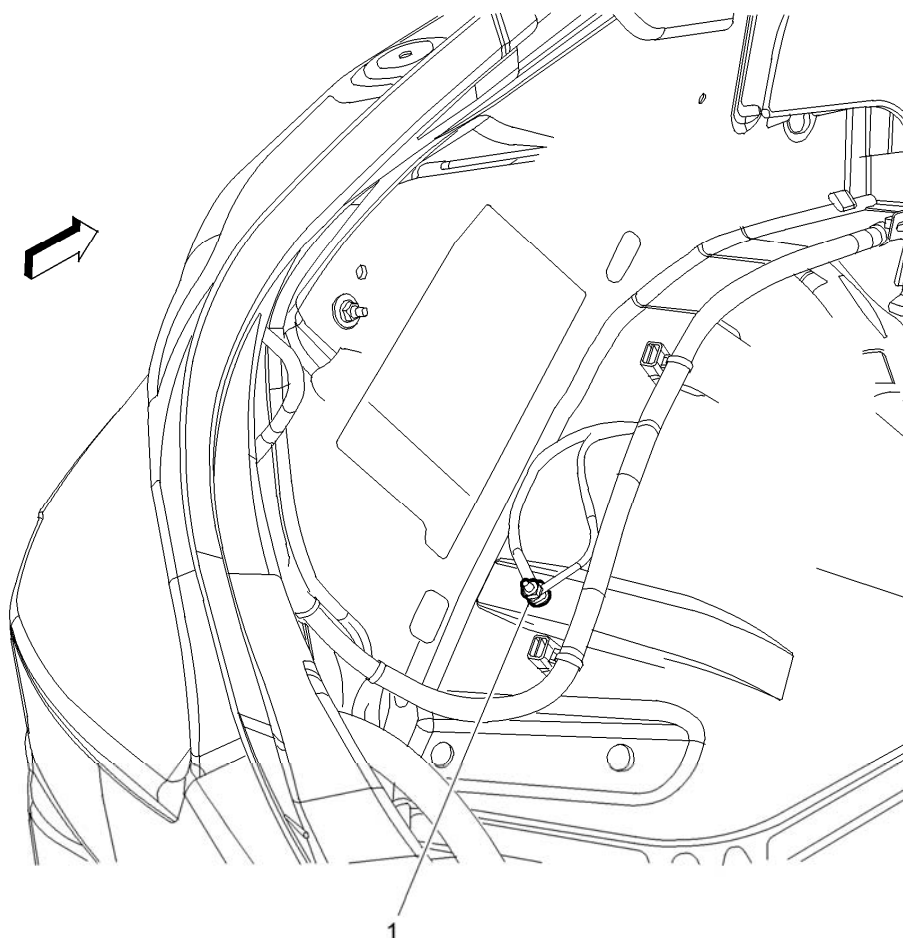


Fig. 10: G401 Grounds

Courtesy of GENERAL MOTORS COMPANY

Items	
1:	G401

G404

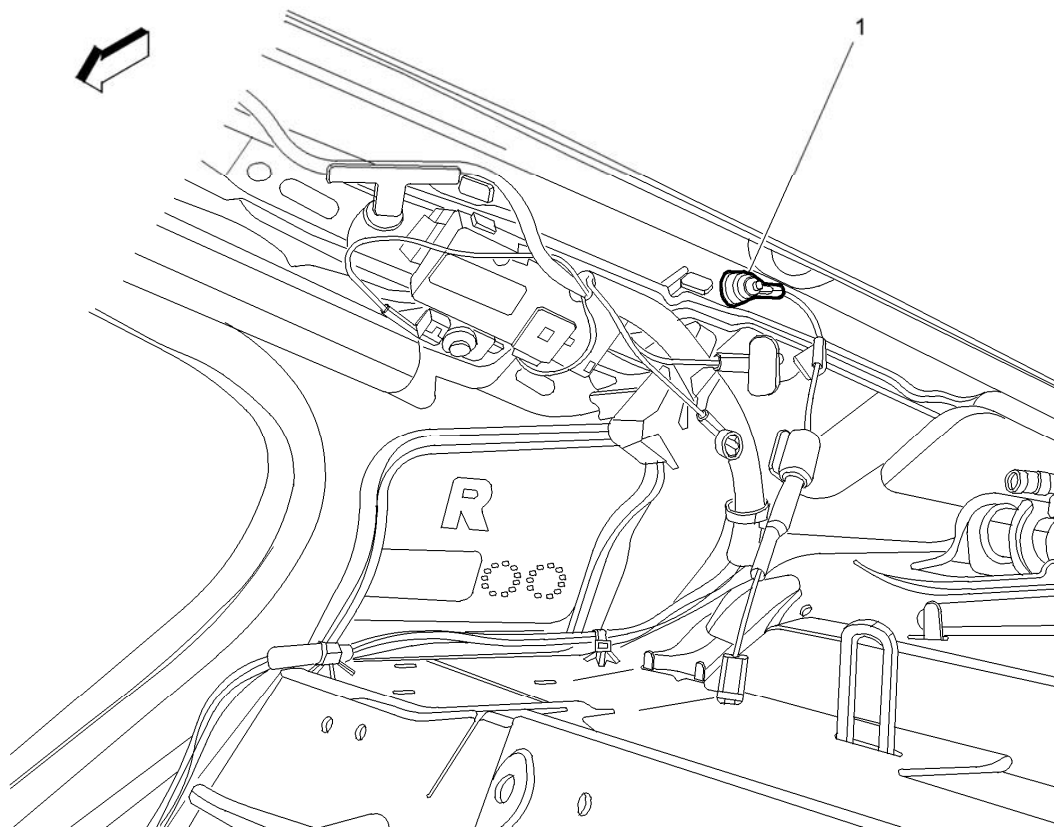


Fig. 11: G404 Grounds
Courtesy of GENERAL MOTORS COMPANY

Items	
1:	G404

G406

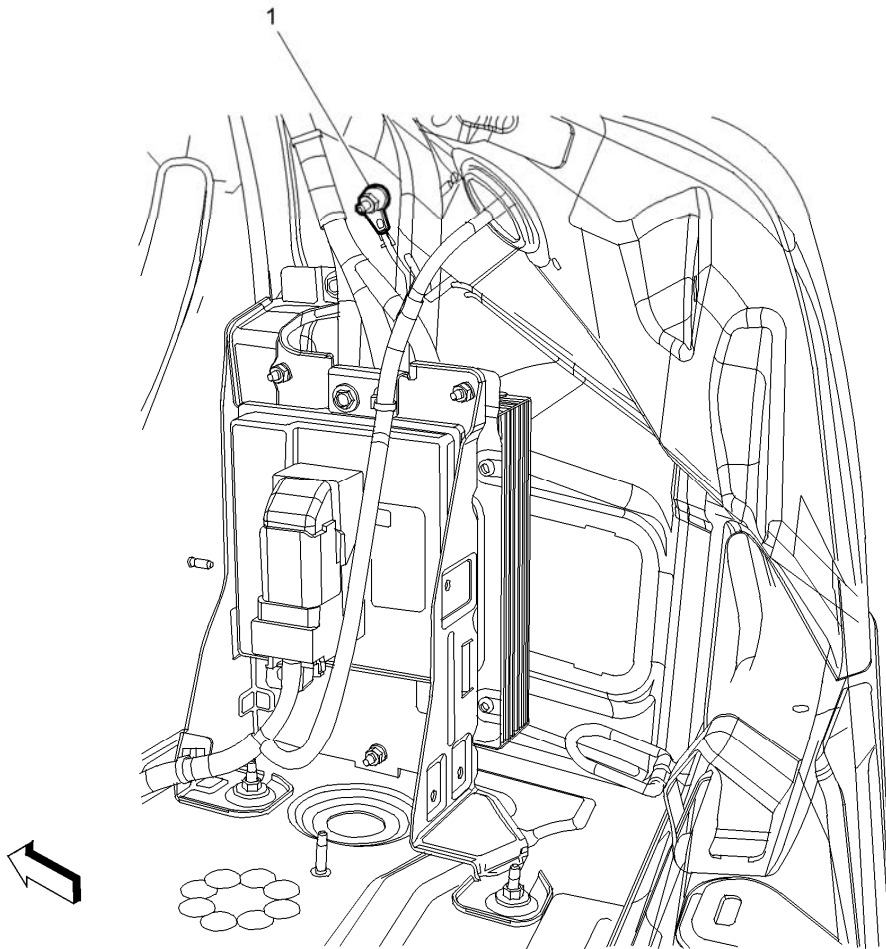


Fig. 12: G406 Grounds
Courtesy of GENERAL MOTORS COMPANY

Items	
1: G406	